City of Avondale

FINAL Report

# Water Infrastructure Master Plan

Registered Professional Engineer (Civil)
CERTIFICATE NO.
22684
TIMOTHY
FRANCIS
Date Signed 5/3/10
ARIZONA, U.S.A.
Expires 12/31/11

MAY 2010

0864-025

Solutions for Life

MALCOLM PIRNIE

MALCOLM PIRNIE

INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

**Malcolm Pirnie, Inc.**
4646 East Van Buren Street, Suite 400
Phoenix, Arizona 85008
T: 602.241.1770 F: 602.231.0131

**www.pirnie.com**

May 3, 2010

Michael N. Smith, P.E., Water Resources CIP Engineer
Water Resources Department
City of Avondale
399 East Lower Buckeye Road, Suite 100
Avondale, AZ 85323

Re: *Water Infrastructure Master Plan*
Final Report

Dear Mr. Smith:

Malcolm Pirnie, Inc. is pleased to submit the *Water Infrastructure Master Plan* Final Report. The master plan builds upon the recommended future water supply strategy, in the companion *Water Resource Master Plan,* by recommending water system improvements and new construction to improve service to current residents and businesses and to support future City growth. The City's water system hydraulic model was also updated and will allow the City to quickly and easily assess the water infrastructure for actual development that occurs or for alternative development plans.

We sincerely appreciate the assistance and guidance provided by the City's Water Resources Department during preparation of the *Water Infrastructure Master Plan*, and we look forward to continuing our working relationship in the future.

Very truly yours,

MALCOLM PIRNIE, INC.

Timothy Francis, P.E.
Senior Associate
Project Manager
Board Certified Environmental Engineer

Enclosures

0864-025

**City of Avondale, Arizona**
399 East Lower Buckeye Road • Suite 100 • Avondale, AZ 85323

# Water Infrastructure Master Plan

May 2010

Registered Professional Engineer (Civil)
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Report Prepared By:

**Malcolm Pirnie, Inc.**

4646 East Van Buren St.
Suite 400
Phoenix, AZ 85008

0864025

MALCOLM PIRNIE

Registered Professional Engineer (Civil)
CERTIFICATE NO. 22684
TIMOTHY FRANCIS
Date Signed 5/3/10
ARIZONA, U.S.A.
Expires 12/31/11

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# Abbreviations/Acronyms

| | |
|---|---|
| AAC | Arizona Administrative Code |
| AACE | Association for the Advancement of Cost Engineering |
| ADEQ | Arizona Department of Environmental Quality |
| ADWR | Arizona Department of Water Resources |
| AMA | active management area |
| BDL | below detection limit |
| CCI | Consumer Cost Index |
| D/DBPR | Disinfectants and Disinfection Byproducts Rule |
| DBP | disinfection byproduct |
| ENR | Engineering News and Record |
| EPS | extended period simulation |
| GER | General Engineering Requirements |
| GIS | geographic information system |
| gpd/acre | gallons per acre per day |
| gpd/du | gallons per dwelling unit per day |
| gpm | gallons per minute |
| IFC | International Fire Code |
| IOCs | inorganic chemicals |
| MCL | maximum contaminant level |
| MG | million gallons |
| mg/L | milligrams per liter |
| mgd | million gallons per day |
| NA | not applicable |
| NFCA | National Fire Protection Association |
| PRV | pressure reducing valve |
| psi | pounds per square inch |
| SCADA | supervisory control and data acquisition |
| SDWA | Safe Drinking Water Act |
| SOCs | synthetic organic chemicals |

| | |
|---|---|
| TBD | to be determined |
| TDS | total dissolved solids |
| TOC | total organic carbon |
| USEPA | United States Environmental Protection Agency |
| VOCs | volatile organic chemicals |
| WTP | water treatment plant |

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# Executive Summary

## Abstract

The work conducted in this Water Infrastructure Master Plan update, for the study area consisting of the City's Municipal Planning Area north of the Estrella Mountains, has identified water infrastructure improvements that the City should undertake to support existing residents and planned development through build-out. The recommended improvements include completing wells that are currently under construction (Wells #20, #22, #24, #25, and #26) between 2010 and 2015; rehabilitating, re-drilling, treating and/or blending other existing and inactive wells (Wells #1, #14, #17, #16B, #21 and #28) and building one new well between 2016 and 2020; and, building seven new wells between 2021 and build-out. The total capital costs for the wells and other new infrastructure (pipelines, booster station expansions, pressure reducing valves) are estimated to be $28.5 million for 2010 to 2015, $41.3 million for 2016 to 2020, and $56.5 million for 2021 to build-out.

The Water Infrastructure Master Plan update is based on continuing to build wells. However, because a surface water treatment plant may provide benefits in achieving future assured water supply designations and could alleviate the need to build additional recharge capacity, and given the inherent uncertainty for future groundwater treatment, it is recommended that the City lock up a site now for a potential surface WTP. The City currently owns a site south of Friendship Park. The site is near the location where the City currently receives its surface water entitlements and near its larger reservoirs, which would minimize pipeline upgrades needed should the City construct a WTP at the site. If the City selects another site, additional land acquisition costs would be incurred. Locking up a site now will preserve the City's future options should a treatment plant option become necessary due to regulatory, institutional, or water quality needs.

## Introduction

The City of Avondale (City) Water Resources Department is responsible for managing the City's water, wastewater, and reclaimed water systems. The department maintains comprehensive master plans for water resources and water, wastewater, and water reuse infrastructures. The water resource master plan ensures that the City's water supplies are adequate and of good quality to meet the current and projected water demands of residents and businesses. The water, wastewater and water reuse infrastructure master plans provide for orderly growth and expansion of the infrastructure to accommodate planned City growth. The City last updated its water resource master plan in 2002 and its water infrastructure master plan in 2005. Because there have been many changes in development and land use planning since, the City commissioned the Water Resource Master Plan project which includes updates to both the Water Resource Master Plan and the Water Infrastructure Master Plan.

This Executive Summary describes the Water Infrastructure Master Plan update. The purpose of the Water Infrastructure Master Plan update is to incorporate changes in water infrastructure that have resulted from capital improvement program achievements since the 2002 and 2005 master plans and to recommend water system improvements to support the updated water demand projections of the companion Water Resource Master Plan update.

The study area for the Water Resource Master Plan project is the City's Municipal Planning Area (MPA) north of the Estrella Mountains. The City's MPA south of the Estrella Mountains is not included in the study area because planning for this area is in the very early stages and is not yet at a level to sufficiently support detailed master planning. The City is projected to grow from a current (2009) population of approximately 70,000 to a little over 123,000 by 2030 within the project study area shown on Figure ES-1. The City anticipates serving both the Phoenix International Raceway (PIR) and Rigby Water Company service area in the future, thus the service areas of PIR and Rigby Water Company are included in the Water Infrastructure Master Plan update. The City does not intend to serve the Liberty Water Company service area in the future, thus this service area is not included in the update.

## New Planning Tools

Three useful planning tools were developed as part of the Water Resource Master Plan update. The first is a geographical information system (GIS) tool that will allow the City to evaluate any land use development scenario it wishes in developing water demand projections. The demand projection tool uses the City's most current land use planning documents, including the land use elements of the 2002 General Plan, the 2008 Avondale City Center Specific Plan, and the 2009 Draft Estrella Foothills Specific Plan. The updated land use map used for water demand projections is shown on Figure ES-2.

The second tool is an update to the City's water system hydraulic model that will allow the City to quickly and easily assess future water system infrastructure for the development scenarios. The third tool is a groundwater model that will allow the City to determine the long-term impacts of alternative well locations and pumping operations on local groundwater levels and movement.

## Future Water Supply Strategy

The Water Resource Master Plan update included a detailed evaluation of future water supply alternatives and determined that continuing to build wells was the preferred strategy. This strategy is less costly than building a new surface water treatment plant (WTP) and is easier to fund as construction of wells can be spread out over the study period and completed as demand increases dictate. The Water Infrastructure Master Plan update is, thus, based on continuing to build wells. However, because a surface WTP may provide benefits in achieving future assured water supply designations and could alleviate the need to build additional recharge capacity, and given the inherent uncertainty for future groundwater treatment, it is recommended that the City lock up a site now for a potential surface WTP. The City currently owns a site south of the Avondale Recharge Facility. The site is near the location where the City currently receives its surface water entitlements and near its larger reservoirs, which would minimize upgrades to pipelines needed should the City construct a WTP at the site. If the City selects another site, additional land acquisition costs would be incurred. Locking up a site now will preserve the City's future options should a treatment plant option become necessary due to regulatory, institutional, or water quality needs. The Water Infrastructure Master Plan update recommendations were developed to potentially accommodate a future surface WTP.

## Development Build-out Projections

City estimates for development phasing and growth within the study area are shown on Figure ES-3. The 5-year growth area will include infill within the existing water system, generally the area north of Lower Buckeye Road. The 10-year growth area will generally include the area between Lower Buckeye Road and Roeser Road. The growth area beyond 10 years through build-out will include the remaining areas north of the Estrella Mountains.

## Water Production Requirements

The City currently has 23 active and inactive wells. The active wells (currently 11 wells) are used to supply the potable water system. A twelfth active well (Well #16B) supplies water to Friendship Park and is not connected to the drinking water system. The total pumping capacity of the 11 active wells is 26.7 million gallons per day (mgd). The remaining inactive wells cannot be operated because they are currently under construction, treatment vendor leases have expired, have been capped, and/or because of water quality concerns.

Table ES-1 compares the study area projected water demands against existing production capacity and summarizes the additional supply or production capacity required through build-out.

**Table ES-1:**
**Water Production Requirements**

| Parameters | 2010 | 2015 | 2020 | Build-out |
|---|---|---|---|---|
| Average Day Demand (mgd) | 12.2 | 14.7 | 18.5 | 25.9 |
| Maximum Day Demand (mgd) | 20.1 | 24.2 | 30.5 | 42.7 |
| Existing Well Supply (mgd) | 26.7 | 26.7 | 26.7 | 26.7 |
| **Production Criteria** | | | | |
| Reliable Supply Needed (mgd)[1] | 26.8 | 32.3 | 40.7 | 57.0 |
| **Additional Supply Required (mgd)** | **0.1** | **5.6** | **14.0** | **30.3** |

Notes:
(1) System supply needed to fulfill the maximum day demand with all wells operating for 18 hours or less.

The additional production capacity can be provided by completing wells that are currently under construction; rehabilitating, re-drilling, treating and/or blending other inactive wells; and building new wells. Wells currently under construction (Wells #20, #22, #24, #25, and #26) will be operational between 2010 and 2015 and will increase the total well supply by 9.0 mgd, and will help meet production needs through 2015.

The remaining inactive wells were evaluated and prioritized for rehabilitation, re-drilling, blending, converting from non-potable to potable use, and treatment. Table ES-2 summarizes the evaluation of existing inactive wells, the assumed use of each well for the Water Infrastructure Master Plan update, pumping capacity, and timeline for implementation.

Accounting for the additional capacities from planned wells (9.0 mgd) and wells in Table ES-2 (4.2 mgd by 2020 and an additional 5.3 mgd by build-out), additional well capacity will be needed by 2020 (0.8 mgd) and by build-out (11.8 mgd). With an assumed capacity of 1,200 gpm for each new well, one new well will be needed prior to 2020, and seven additional new wells will be needed by build-out.

It is assumed that new wells will be drilled and screened in appropriate locations such that arsenic, nitrate, and TDS levels are below the City's water quality goals and treatment will not be needed. Figure ES-4 presents all existing and recommended new wells located in areas of favorable groundwater quality developed from the hydrogeologic evaluation contained in the Water Resource Master Plan update.

**Table ES-2:**
**Assumed Improvements to Existing Inactive Wells**

| Well No. | Current Status | Potential for Improvement | Assumption for Master Plan | Pumping Capacity (gpm) | Planning Period |
|---|---|---|---|---|---|
| #1 | Inactive - Capped | - Perform well assessment (water quality, condition of well/well screen, effect on contaminant plume)<br>- Rehabilitate if possible, as space is limited to re-drill<br>- Consider blending with other wells at Coldwater facility, if necessary | Rehabilitate with no treatment | 695 | 2016 - 2020 |
| #14 | Inactive - Water Quality | - Blending with Well #1 or other wells to Coldwater facility a possibility<br>- Depth of well screen may prohibit rehabilitation<br>- Consider re-drilling to shallower depth, increasing capacity from 400 gpm to 1,000 gpm | Re-drill with no treatment | 1,000 | 2016-2020 |
| #17 | Inactive - Lease Expiration | - Blending with system water may limit well capacity<br>- Rehabilitating/re-drilling may not improve water quality<br>- Nitrate treatment infrastructure in place | Treat for Nitrate | 1,200 | 2016-2020 |
| #16B | Active - Irrigation Well | - Connecting to potable system will increase well supply reliability | Connect to well transmission pipe for Coldwater Reservoir, with no treatment | 650 | 2021-Build-out |
| #21 | Inactive - Water Quality | - Distribution of high TDS prohibits rehabilitation<br>- Re-drilling to target lower TDS may increase arsenic<br>- Potential for blending with limited capacity | Treat for TDS | 1,820 | 2021-Build-out |
| #28 | Inactive - Under Construction | - Potential for blending with limited capacity | Treat for TDS | 1,200 | 2021-Build-out |

Note:
(1) Total dissolved solids (TDS)

## Storage Requirements

The City's existing system storage totaling 15.5 million gallons at six water supply facilities is sufficient to meet and surpass the City's storage needs through build-out.

## Recommended System Improvements for 2010 - 2015

The recommended system improvements for the 5-year planning period are shown on Figure ES-5 and summarized on Table ES-3 along with associated capital costs. The improvements are needed to increase the capacity and robustness of the existing system, provide connections for new development, and to create a new pressure zone in the south:

- Three pressure reducing valves (PRVs) added to establish the new pressure zone in the south. PRV-1 will provide an emergency interconnect between the two pressure zones, while PRV-2 and PRV-3 will separate the north and south pressure zones.
- 24-inch transmission lines from the Coldwater (P-26 and P-30) and Del Rio (P-27) facilities to the new pressure zone boundary.
- A fourth PRV (PRV-4) downstream of the Coldwater booster station to provide the flexibility to use the Coldwater booster station high head pumps to supply water to the new pressure zone.
- Improvement of pipes in the old town region to increase capacity by paralleling or replacing existing pipes with new pipes (P-21 to P-23).
- The capacity of an existing 8-inch pipe at the junction of El Mirage Rd and Lower Buckeye Rd was increased by providing an 8-inch parallel pipe (P-30).
- New pipes (P-3 to P-9) in the northeast region of the City to support planned commercial development assumed to occur by 2015.
- New pipes (P-15 to P-20) northwest of Avondale Boulevard and Van Buren Street to provide better fire flow for areas planned for increased commercial development.

## Recommended System Improvements for 2016 - 2020

The recommended system improvements for the 10-year planning period are shown on Figure ES-6 and summarized on Table ES-4 along with associated capital costs. The system improvements are required to serve increased demand in the existing system and to serve the development area generally between Lower Buckeye Road and Roeser Road:

- One new well (Well-A) and improvements at four existing and currently inactive wells (Wells #1, 8A, #14, and #17). The new well W-A delivers water to the Northside reservoir as it currently lacks adequate well supply.
- New transmissions mains (T-1 to T-4) to transport water from the new or improved wells to the reservoirs at the Coldwater and Northside facilities.
- A low head booster station (BPS-3) at the Coldwater facility to satisfy the demands in the new south pressure zone and to provide redundant supply.
- Increased pumping capacity at Rancho Santa Fe (BPS-1), Coldwater (BPS-2) and Garden Lakes (BPS-4) to meet increased demands and pressure requirements.
- New pipes (P-35 to P-55) to serve the developments in the south pressure zone.
- A new 24-inch transmission backbone (P-39, P-40, P-45, and P-47) to increase system reliability.
- New pipes (P-32 to P-34) to serve commercial areas west of the Aqua Fria River.

The City should conduct the following additional assessments to determine the feasibility of improving the existing and inactive wells described above. If the assessments indicate that a well is not suitable for improvement, additional capacity should be obtained in the form of an additional new well.

- **Well #1:** This well should be sampled for the primary constituents of concern (TDS, nitrate, arsenic and fluoride) and new source approval constituents. An evaluation of well production rates and pumping levels should also be conducted during water quality sampling if possible. If the water is of potable quality, then the well condition should be assessed by recovering the pumping equipment and performing a video survey of the well. The video survey of the well casing and screen will determine what level of cleaning and rehabilitation is needed to make the well suitable for a potable supply.
- **Well #14:** An exploratory borehole should be drilled and a thorough zonal sampling program should be conducted to verify that water quality conditions are favorable (i.e. TDS and nitrate are not exceeded at shallower depths).
- **Well #17:** Treatment is the recommended option at this location. The City should contact the treatment supplier (Envirogen) and extend its lease or purchase and operate the treatment system.
- **Wells #21 and #28:** The City should follow the recommendations in the Del Rio Wellhead Treatment Summary Report (2008) and blend or treat the wells for TDS and nitrate.
- **Well #8:** In addition to the improvements to the wells above, the City should also re-evaluate the blending plan for Well #18 based on recent water quality trends. By revoking the blending plan, the City may have greatly flexibility operating this well.

## Recommended System Improvements for 2021- Build-out

The recommended system improvements for the build-out period (2021 to build-out) are shown on Figure ES-7 and are summarized on Table ES-5 with associated capital costs. The improvements are required to serve all areas north of the Estrella Mountains:

- Seven new wells (Wells B, C, D, E, F, G, and H) and improvements to three existing wells (Wells #16B, #21, and #28) are needed to increase production capacity.
- New well transmissions mains (T-6 to T-12) from the new wells to the Coldwater, Garden Lakes, and Gateway reservoirs, and improvements to existing well transmission mains (T-5 and T-13).
- New pipes (P-57 to P-59) for the Phase II development of City Center.
- New pipes (P-61 to P-80) to serve the developments south of Roeser Road.
- New pipes (P-66, P-68, and P-70) to complete the new 24-inch transmission loop in the south area and to provide additional reliability to the water system.
- Increased capacity at all booster stations (BPS-5 to BPS-9) except Del Rio to meet increased demand and pressure requirements.

**Table ES-3:**
## Recommended Infrastructure (2010-2015)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-1 | 16-inch | 2,556 LF | Indian School Rd from Santa Fe Trail to Dysart Rd | $1,102,000 |
| P-2 | 16-inch | 1,310 LF | Dysart Rd from Fairmont Ave to Indian School Rd | $565,000 |
| P-3 | 12-inch | 2,733 LF | 103rd Ave from Osborn Rd to Thomas Rd | $823,000 |
| P-4 | 12-inch | 2,629 LF | Osborn Rd from 99th Ave to 103rd Ave | $442,000 |
| P-5 | 16-inch | 5,280 LF | 99th Ave from Thomas Rd to Indian School Rd | $1,183,000 |
| P-6 | 16-inch | 2,659 LF | Thomas Rd from 99th Ave to 103rd Ave | $596,000 |
| P-7 | 16-inch | 2,664 LF | 99th Ave from Encanto Blvd to Thomas Rd | $597,000 |
| P-8 | 12-inch | 1,390 LF | Encanto Blvd from 99th Ave to 101th Ave | $234,000 |
| P-9 | 16-inch | 1,748 LF | Indian School Rd from 99th Ave to 103rd Ave | $754,000 |
| P-10 | 12-inch | 960 LF | 111th Ave from Roosevelt St to I -10 | $162,000 |
| P-11 | 16-inch | 2,621 LF | Roosevelt St from 107th Ave to 111th Ave | $588,000 |
| P-12 | 16-inch | 788 LF | 111th Ave from Pierce Pkwy to Roosevelt St | $177,000 |
| P-13 | 12-inch | 1,463 LF | Coldwater Sp from 113th Ave to W Civic Dr | $246,000 |
| P-14 | 12-inch | 600 LF | 113th Ave from Coldwater Sp to Van Buren St | $101,000 |
| P-15 | 12-inch | 1,294 LF | 117th Ave from Van Buren St to Roosevelt St | $218,000 |
| P-16 | 12-inch | 1,343 LF | Roosevelt St from Avondale Blvd to 117th Ave | $226,000 |
| P-17 | 16-inch | 688 LF | 117th Ave from Roosevelt St due North | $155,000 |
| P-18 | 12-inch | 1,521 LF | 119th Ave from Roosevelt St to I-10 | $256,000 |
| P-19 | 12-inch | 1,735 LF | Roosevelt St from 120th Ave to El Mirage Rd | $292,000 |
| P-20 | 16-inch | 1,357 LF | Roosevelt St from 117th Ave to 119th Ave | $304,000 |
| P-21 | 12-inch | 1,190 LF | Riley Rd from 5th St to Dysart Rd | $359,000 |
| P-22 | 6-inch | 767 LF | 4th St from E La Canada Blvd to La Vista Dr | $82,100 |
| P-23 | 8-inch | 3,920 LF | Central Ave from Western Ave to E La Canada Blvd | $675,000 |
| P-24 | 16-inch | 2,000 LF | 127th Ave from Vermeesch Rd to Lower Buckeye Rd | $448,000 |
| P-25 | 8-inch | 1,867 LF | 125th Ave from Durango Rd due South | $210,000 |
| P-26 | 24-inch | 15,325 LF | El Mirage Rd from W Illini St to Coldwater BPS | $9,720,000 |
| P-27 | 24-inch | 4,422 LF | Lower Buckeye Rd from Avondale Blvd to Del Rio BPS | $2,810,000 |
| P-28 | 12-inch | 1,375 LF | Dysart Rd from Lower Buckeye Rd to Whyman Rd | $413,900 |
| P-29 | 12-inch | 35 LF | Van Buren St and 10th St | $10,600 |
| P-30 | 8-inch | 46 LF | El Mirage Rd and Lower Buckeye Rd | $8,000 |
| **Well Transmission Mains** | | | | |
| None | | | | |
| **Booster Pump Stations** | | | | |
| None | | | | |
| **Pressure Reducing Valves** | | | | |
| PRV-1 | 24-inch | - | El Mirage Rd and Railroad | $1,176,000 |
| PRV-2 | 24-inch | - | Avondale Blvd and Lower Buckeye Rd | $1,176,000 |
| PRV-3 | 24-inch | - | El Mirage Rd and Illini St | $1,176,000 |
| PRV-4 | 20-inch | - | Coldwater BPS | $1,176,000 |
| **Wells** | | | | |
| None | | | | |
| **Reservoirs** | | | | |
| None | | | | |

| Project No. | Description | Location | Cost ($)[1,2,3] |
|---|---|---|---|
| **Total** | | | **$28,500,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

**Table ES-4:**
## Recommended Infrastructure (2016-2020)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-31 | 12-inch | 2,784 LF | 103rd Ave from Thomas Rd to Mulberry Dr | $838,000 |
| P-32 | 16-inch | 6,954 LF | West of Aqua Fria River from Broadway Rd to Lower Buckeye Rd | $1,560,000 |
| P-33 | 8-inch | 1,630 LF | Elwood St from Aqua Fria River to Litchfield Rd | $183,000 |
| P-34 | 8-inch | 989 LF | Broadway Rd from Aqua Fria River to Litchfield Rd | $111,000 |
| P-35 | 12-inch | 5,213 LF | Roeser Rd from El Mirage Rd to Dysart Rd | $876,000 |
| P-36 | 12-inch | 2,077 LF | 127th Ave from Broadway Rd to Illini St | $349,000 |
| P-37 | 12-inch | 2,690 LF | 127th Ave from Roeser Rd to Broadway Rd | $452,000 |
| P-38 | 16-inch | 5,209 LF | Broadway Rd from El Mirage Rd to Dysart Rd | $1,170,000 |
| P-39 | 24-inch | 2,680 LF | El Mirage Rd from Roeser Rd to Broadway Rd | $901,000 |
| P-40 | 24-inch | 2,019 LF | El Mirage Rd from Broadway Rd to Illini St | $679,000 |
| P-41 | 12-inch | 5,285 LF | Elwood Rd from Avondale Blvd to El Mirage Rd | $888,000 |
| P-42 | 16-inch | 5,282 LF | Broadway Rd from Avondale Blvd to El Mirage Rd | $1,190,000 |
| P-43 | 12-inch | 5,232 LF | 119th Ave from Broadway Rd to Lower Buckeye Rd | $879,000 |
| P-44 | 12-inch | 2,691 LF | 119th Ave from Roeser Rd to Broadway Rd | $453,000 |
| P-45 | 24-inch | 2,676 LF | Avondale Blvd from Roeser Rd to Broadway Rd | $900,000 |
| P-46 | 12-inch | 5,227 LF | Roeser Rd from Avondale Blvd to El Mirage Rd | $879,000 |
| P-47 | 24-inch | 5,165 LF | Avondale Blvd from Broadway Rd to Lower Buckeye Rd | $1,740,000 |
| P-48 | 12-inch | 5,117 LF | Elwood Rd from 107th Ave to Avondale Blvd | $860,000 |
| P-49 | 12-inch | 1,435 LF | 111th Ave from Elwood St to Miami Rd | $242,000 |
| P-50 | 16-inch | 1,432 LF | 107th Ave from Broadway Rd Due North | $321,000 |
| P-51 | 16-inch | 5,098 LF | Broadway Rd from 107th Ave to Avondale Blvd | $2,200,000 |
| P-52 | 16-inch | 2,667 LF | 107th Ave from Roeser Rd to Broadway Rd | $1,150,000 |
| P-53 | 12-inch | 2,659 LF | 111th Ave from Roeser Rd to Broadway Rd | $447,000 |
| P-54 | 12-inch | 5,192 LF | Roeser Rd from 107th Ave to Avondale Blvd | $1,563,000 |
| P-55 | 16-inch | 3,321 LF | Dysart Rd from Southern Ave to Roeser Rd | $1,432,000 |
| **Well Transmission Mains** | | | | |
| T-1 | 12-inch | 6,965 LF | El Mirage Rd from Well W-A to Northside Reservoir | $2,100,000 |
| T-2 | 12-inch | 9,868 LF | Eliseo C Felix Jr Wy from Well #1 to Van Buren St | $2,980,000 |
| T-3 | 12-inch | 2,761 LF | Van Buren St from Coldwater Reservoir to Eliseo C Felix Jr Wy | $832,000 |
| T-4 | 12-inch | 1,300 LF | Eliseo C Felix Jr Wy from Van Buren St to Well #14 | $392,000 |
| **Booster Pump Stations** | | | | |
| BPS-1 | 2.9 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $1,057,000 |
| BPS-2 | 6.2 mgd | @ 170 ft | Coldwater Booster Pump Station | $2,260,000 |

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| BPS-3 | 2.5 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $920,000 |
| BPS-4 | 1.0 mgd | @ 165 ft | Garden Lakes Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W-1 | 1.0 mgd | Rehabilitate Existing | Well #1 - Riley Rd and 6th Street | $1,007,914 |
| W-8A | 2.0 mgd | Provide Treatment | Well #8A - 99th Ave and Encanto Blvd | $1,320,000 |
| W-14 | 1.4 mgd | Re-drill | Well #14 - Van Buren St and Eliseo C Felix Jr Way | $2,210,000 |
| W-17 | 1.7 mgd | Provide Treatment | Well #17 - 107th Ave and W Lakeshore Dr | $1,320,000 |
| W-A | 1.7 mgd | Construct New Well | Well W-A - Thomas Rd and Santa Fe Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$41,300,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

**Table ES-5:**
## Recommended Infrastructure (2021-Build-out)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-56 | 16-inch | 1,096 LF | From 99th Ave to Gateway BPS | $473,000 |
| P-57 | 8-inch | 4,607 LF | City Center | $793,000 |
| P-58 | 16-inch | 1,508 LF | City Center | $650,000 |
| P-59 | 12-inch | 1,295 LF | City Center | $390,000 |
| P-60 | 6-inch | 110 LF | El Mirage Rd and Elwood Rd | $11,800 |
| P-61 | 12-inch | 2,657 LF | Roeser Rd from Dysart Rd to Aqua Fria River | $447,000 |
| P-62 | 16-inch | 3,934 LF | Southern Ave from Dysart Rd to Aqua Fria River | $882,000 |
| P-63 | 16-inch | 1,302 LF | Southern Ave from 129th Ave to Dysart Rd | $292,000 |
| P-64 | 16-inch | 3,946 LF | Southern Ave from El Mirage Rd to 129th Ave | $884,000 |
| P-65 | 12-inch | 2,542 LF | 127th Ave from Southern Ave to Roeser Rd | $428,000 |
| P-66 | 24-inch | 2,547 LF | El Mirage Rd from Southern Ave to Roeser Rd | $856,000 |
| P-67 | 16-inch | 5,963 LF | El Mirage Rd from Indian Springs Rd to Southern Ave | $1,340,000 |
| P-68 | 24-inch | 5,212 LF | Southern Ave from Avondale Blvd to El Mirage Rd | $1,760,000 |
| P-69 | 12-inch | 2,579 LF | 119th Ave from Southern Ave to Roeser Rd | $434,000 |
| P-70 | 24-inch | 2,599 LF | Avondale Blvd from Southern Ave to Roeser Rd | $874,000 |
| P-71 | 24-inch | 2,049 LF | Avondale Blvd from Gila River to Southern Ave | $689,000 |
| P-72 | 16-inch | 5,254 LF | Southern Ave from 107th Ave to Avondale Blvd | $1,180,000 |
| P-73 | 16-inch | 2,580 LF | 107th Ave from Southern Ave to Roeser Rd | $578,000 |
| P-74 | 16-inch | 7,742 LF | Indian Springs Rd from Gila River to El Mirage Rd | $1,740,000 |
| P-75 | 16-inch | 6,717 LF | Indian Springs Rd from El Mirage Rd to 143rd Ave | $1,510,000 |
| P-76 | 16-inch | 2,007 LF | Coyote Ln from Mountain Rd to Indian Springs Rd | $450,000 |

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| P-77 | 16-inch | 889 LF | Coyote Ln from Mountain Rd Due South | $200,000 |
| P-78 | 12-inch | 5,163 LF | Mountain Rd from Coyote Ln to Dysart Rd | $868,000 |
| P-79 | 12-inch | 3,187 LF | City of Avondale Boundary from Mountain Rd to Indian Springs Rd | $536,000 |
| P-80 | 12-inch | 2,915 LF | Aqua Fria River from Southern Ave to Roeser Rd | $490,000 |
| **Well Transmission Mains** | | | | |
| T-5 | 16-inch | 2,090 LF | Aqua Fria River from Coldwater Reservoir to Well #26 | $901,000 |
| T-6 | 12-inch | 1,700 LF | Thomas Rd from Well G to Avondale Blvd | $512,000 |
| T-7 | 12-inch | 3,470 LF | Avondale Blvd from Well H to Thomas Rd | $1,045,000 |
| T-8 | 16-inch | 5,250 LF | Thomas Rd from Garden Lakes Reservoir to Avondale Blvd | $2,270,000 |
| T-9 | 16-inch | 1,070 LF | Aqua Fria River from Well E to Well #16 Connection | $462,000 |
| T-10 | 12-inch | 2,560 LF | McDowell Rd from Well B to Well E | $770,600 |
| T-11 | 12-inch | 2,310 LF | 107th Ave from Well C to McDowell Rd | $696,000 |
| T-12 | 16-inch | 2,875 LF | McDowell Rd from 103rd Ave to 107th Ave | $1,239,000 |
| T-13 | 12-inch | 2,600 LF | 103rd Ave from McDowell Rd to Gateway Reservoir | $783,000 |
| **Booster Pump Stations** | | | | |
| BPS-5 | 2.6 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $950,000 |
| BPS-6 | 5.1 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $1,859,000 |
| BPS-7 | 2.4 mgd | @ 165 ft | Garden Lakes Booster Pump Station | $875,000 |
| BPS-8 | 1.2 mgd | @ 165 ft | Gateway Booster Pump Station | $438,000 |
| BPS-9 | 1.0 mgd | @ 130 ft | Northside Booster Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W- 16B | 1.0 mgd | Convert to Potable | Well #16B - Friendship Park | $120,000 |
| W-21 | 2.6 mgd | Provide Treatment | Well #21- El Mirage Rd and Durango Rd | $4,450,000 |
| W-28 | 1.7 mgd | Provide Treatment | Well #28 - 117th Ave and Whyman Ave | $4,450,000 |
| W-B | 1.7 mgd | Construct New Well | Well B - 119th Ave and McDowell Rd | $2,210,000 |
| W-C | 1.7 mgd | Construct New Well | Well C - 107th Ave and Roosevelt Rd | $2,210,000 |
| W-D | 1.7 mgd | Construct New Well | Well D - 107th Ave and McDowell Rd | $2,210,000 |
| W -E | 1.6 mgd | Construct New Well | Well E - McDowell Rd and El Mirage Rd (Pecan Tree Trailer Park) | $2,210,000 |
| W-F | 1.7 mgd | Construct New Well | Well F - El Mirage Rd North of Van Buren St | $2,210,000 |
| W-G | 1.7 mgd | Construct New Well | Well G - 119th Ave and Thomas Rd | $2,210,000 |
| W-H | 1.7 mgd | Re-drill | Well H - 114th Ave and Encanto Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$56,500,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

**Table ES-3:**
## Recommended Infrastructure (2010-2015)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-1 | 16-inch | 2,556 LF | Indian School Rd from Santa Fe Trail to Dysart Rd | $1,102,000 |
| P-2 | 16-inch | 1,310 LF | Dysart Rd from Fairmont Ave to Indian School Rd | $565,000 |
| P-3 | 12-inch | 2,733 LF | 103rd Ave from Osborn Rd to Thomas Rd | $823,000 |
| P-4 | 12-inch | 2,629 LF | Osborn Rd from 99th Ave to 103rd Ave | $442,000 |
| P-5 | 16-inch | 5,280 LF | 99th Ave from Thomas Rd to Indian School Rd | $1,183,000 |
| P-6 | 16-inch | 2,659 LF | Thomas Rd from 99th Ave to 103rd Ave | $596,000 |
| P-7 | 16-inch | 2,664 LF | 99th Ave from Encanto Blvd to Thomas Rd | $597,000 |
| P-8 | 12-inch | 1,390 LF | Encanto Blvd from 99th Ave to 101th Ave | $234,000 |
| P-9 | 16-inch | 1,748 LF | Indian School Rd from 99th Ave to 103rd Ave | $754,000 |
| P-10 | 12-inch | 960 LF | 111th Ave from Roosevelt St to I -10 | $162,000 |
| P-11 | 16-inch | 2,621 LF | Roosevelt St from 107th Ave to 111th Ave | $588,000 |
| P-12 | 16-inch | 788 LF | 111th Ave from Pierce Pkwy to Roosevelt St | $177,000 |
| P-13 | 12-inch | 1,463 LF | Coldwater Sp from 113th Ave to W Civic Dr | $246,000 |
| P-14 | 12-inch | 600 LF | 113th Ave from Coldwater Sp to Van Buren St | $101,000 |
| P-15 | 12-inch | 1,294 LF | 117th Ave from Van Buren St to Roosevelt St | $218,000 |
| P-16 | 12-inch | 1,343 LF | Roosevelt St from Avondale Blvd to 117th Ave | $226,000 |
| P-17 | 16-inch | 688 LF | 117th Ave from Roosevelt St due North | $155,000 |
| P-18 | 12-inch | 1,521 LF | 119th Ave from Roosevelt St to I-10 | $256,000 |
| P-19 | 12-inch | 1,735 LF | Roosevelt St from 120th Ave to El Mirage Rd | $292,000 |
| P-20 | 16-inch | 1,357 LF | Roosevelt St from 117th Ave to 119th Ave | $304,000 |
| P-21 | 12-inch | 1,190 LF | Riley Rd from 5th St to Dysart Rd | $359,000 |
| P-22 | 6-inch | 767 LF | 4th St from E La Canada Blvd to La Vista Dr | $82,100 |
| P-23 | 8-inch | 3,920 LF | Central Ave from Western Ave to E La Canada Blvd | $675,000 |
| P-24 | 16-inch | 2,000 LF | 127th Ave from Vermeesch Rd to Lower Buckeye Rd | $448,000 |
| P-25 | 8-inch | 1,867 LF | 125th Ave from Durango Rd due South | $210,000 |
| P-26 | 24-inch | 15,325 LF | El Mirage Rd from W Illini St to Coldwater BPS | $9,720,000 |
| P-27 | 24-inch | 4,422 LF | Lower Buckeye Rd from Avondale Blvd to Del Rio BPS | $2,810,000 |
| P-28 | 12-inch | 1,375 LF | Dysart Rd from Lower Buckeye Rd to Whyman Rd | $413,900 |
| P-29 | 12-inch | 35 LF | Van Buren St and 10th St | $10,600 |
| P-30 | 8-inch | 46 LF | El Mirage Rd and Lower Buckeye Rd | $8,000 |
| **Well Transmission Mains** | | | | |
| None | | | | |
| **Booster Pump Stations** | | | | |
| None | | | | |
| **Pressure Reducing Valves** | | | | |
| PRV-1 | 24-inch | - | El Mirage Rd and Railroad | $1,176,000 |
| PRV-2 | 24-inch | - | Avondale Blvd and Lower Buckeye Rd | $1,176,000 |
| PRV-3 | 24-inch | - | El Mirage Rd and Illini St | $1,176,000 |
| PRV-4 | 20-inch | - | Coldwater BPS | $1,176,000 |
| **Wells** | | | | |
| None | | | | |
| **Reservoirs** | | | | |
| None | | | | |

| Project No. | Description | Location | Cost ($)[1,2,3] |
|---|---|---|---|
| **Total** | | | **$28,500,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

**Table ES-4:**
## Recommended Infrastructure (2016-2020)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-31 | 12-inch | 2,784 LF | 103rd Ave from Thomas Rd to Mulberry Dr | $838,000 |
| P-32 | 16-inch | 6,954 LF | West of Aqua Fria River from Broadway Rd to Lower Buckeye Rd | $1,560,000 |
| P-33 | 8-inch | 1,630 LF | Elwood St from Aqua Fria River to Litchfield Rd | $183,000 |
| P-34 | 8-inch | 989 LF | Broadway Rd from Aqua Fria River to Litchfield Rd | $111,000 |
| P-35 | 12-inch | 5,213 LF | Roeser Rd from El Mirage Rd to Dysart Rd | $876,000 |
| P-36 | 12-inch | 2,077 LF | 127th Ave from Broadway Rd to Illini St | $349,000 |
| P-37 | 12-inch | 2,690 LF | 127th Ave from Roeser Rd to Broadway Rd | $452,000 |
| P-38 | 16-inch | 5,209 LF | Broadway Rd from El Mirage Rd to Dysart Rd | $1,170,000 |
| P-39 | 24-inch | 2,680 LF | El Mirage Rd from Roeser Rd to Broadway Rd | $901,000 |
| P-40 | 24-inch | 2,019 LF | El Mirage Rd from Broadway Rd to Illini St | $679,000 |
| P-41 | 12-inch | 5,285 LF | Elwood Rd from Avondale Blvd to El Mirage Rd | $888,000 |
| P-42 | 16-inch | 5,282 LF | Broadway Rd from Avondale Blvd to El Mirage Rd | $1,190,000 |
| P-43 | 12-inch | 5,232 LF | 119th Ave from Broadway Rd to Lower Buckeye Rd | $879,000 |
| P-44 | 12-inch | 2,691 LF | 119th Ave from Roeser Rd to Broadway Rd | $453,000 |
| P-45 | 24-inch | 2,676 LF | Avondale Blvd from Roeser Rd to Broadway Rd | $900,000 |
| P-46 | 12-inch | 5,227 LF | Roeser Rd from Avondale Blvd to El Mirage Rd | $879,000 |
| P-47 | 24-inch | 5,165 LF | Avondale Blvd from Broadway Rd to Lower Buckeye Rd | $1,740,000 |
| P-48 | 12-inch | 5,117 LF | Elwood Rd from 107th Ave to Avondale Blvd | $860,000 |
| P-49 | 12-inch | 1,435 LF | 111th Ave from Elwood St to Miami Rd | $242,000 |
| P-50 | 16-inch | 1,432 LF | 107th Ave from Broadway Rd Due North | $321,000 |
| P-51 | 16-inch | 5,098 LF | Broadway Rd from 107th Ave to Avondale Blvd | $2,200,000 |
| P-52 | 16-inch | 2,667 LF | 107th Ave from Roeser Rd to Broadway Rd | $1,150,000 |
| P-53 | 12-inch | 2,659 LF | 111th Ave from Roeser Rd to Broadway Rd | $447,000 |
| P-54 | 12-inch | 5,192 LF | Roeser Rd from 107th Ave to Avondale Blvd | $1,563,000 |
| P-55 | 16-inch | 3,321 LF | Dysart Rd from Southern Ave to Roeser Rd | $1,432,000 |
| **Well Transmission Mains** | | | | |
| T-1 | 12-inch | 6,965 LF | El Mirage Rd from Well W-A to Northside Reservoir | $2,100,000 |
| T-2 | 12-inch | 9,868 LF | Eliseo C Felix Jr Wy from Well #1 to Van Buren St | $2,980,000 |
| T-3 | 12-inch | 2,761 LF | Van Buren St from Coldwater Reservoir to Eliseo C Felix Jr Wy | $832,000 |
| T-4 | 12-inch | 1,300 LF | Eliseo C Felix Jr Wy from Van Buren St to Well #14 | $392,000 |
| **Booster Pump Stations** | | | | |
| BPS-1 | 2.9 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $1,057,000 |
| BPS-2 | 6.2 mgd | @ 170 ft | Coldwater Booster Pump Station | $2,260,000 |

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| BPS-3 | 2.5 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $920,000 |
| BPS-4 | 1.0 mgd | @ 165 ft | Garden Lakes Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W-1 | 1.0 mgd | Rehabilitate Existing | Well #1 - Riley Rd and 6th Street | $1,007,914 |
| W-8A | 2.0 mgd | Provide Treatment | Well #8A - 99th Ave and Encanto Blvd | $1,320,000 |
| W-14 | 1.4 mgd | Re-drill | Well #14 - Van Buren St and Eliseo C Felix Jr Way | $2,210,000 |
| W-17 | 1.7 mgd | Provide Treatment | Well #17 - 107th Ave and W Lakeshore Dr | $1,320,000 |
| W-A | 1.7 mgd | Construct New Well | Well W-A - Thomas Rd and Santa Fe Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$41,300,000** |

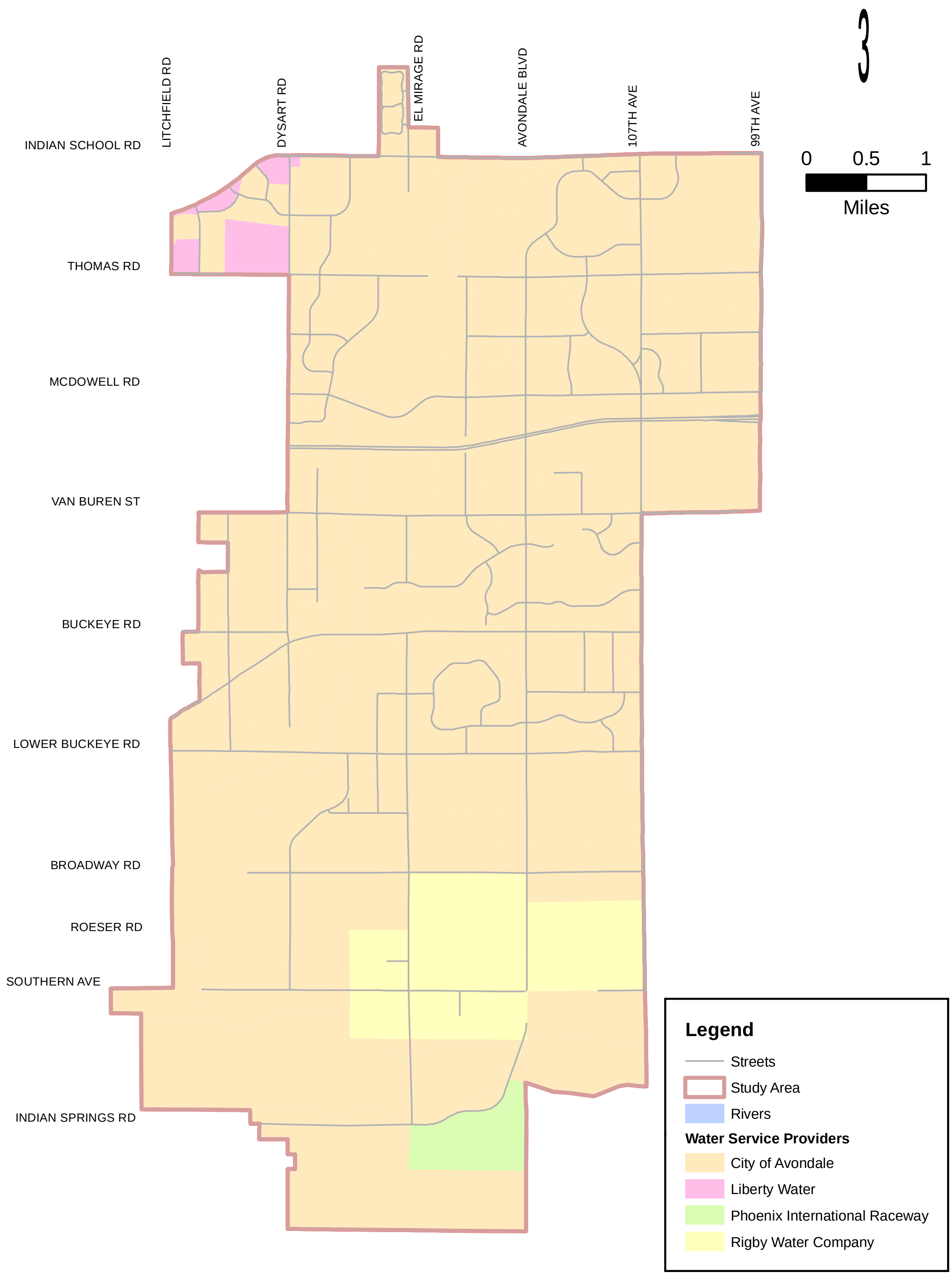
Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

## Table ES-5:
## Recommended Infrastructure (2021-Build-out)

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-56 | 16-inch | 1,096 LF | From 99th Ave to Gateway BPS | $473,000 |
| P-57 | 8-inch | 4,607 LF | City Center | $793,000 |
| P-58 | 16-inch | 1,508 LF | City Center | $650,000 |
| P-59 | 12-inch | 1,295 LF | City Center | $390,000 |
| P-60 | 6-inch | 110 LF | El Mirage Rd and Elwood Rd | $11,800 |
| P-61 | 12-inch | 2,657 LF | Roeser Rd from Dysart Rd to Aqua Fria River | $447,000 |
| P-62 | 16-inch | 3,934 LF | Southern Ave from Dysart Rd to Aqua Fria River | $882,000 |
| P-63 | 16-inch | 1,302 LF | Southern Ave from 129th Ave to Dysart Rd | $292,000 |
| P-64 | 16-inch | 3,946 LF | Southern Ave from El Mirage Rd to 129th Ave | $884,000 |
| P-65 | 12-inch | 2,542 LF | 127th Ave from Southern Ave to Roeser Rd | $428,000 |
| P-66 | 24-inch | 2,547 LF | El Mirage Rd from Southern Ave to Roeser Rd | $856,000 |
| P-67 | 16-inch | 5,963 LF | El Mirage Rd from Indian Springs Rd to Southern Ave | $1,340,000 |
| P-68 | 24-inch | 5,212 LF | Southern Ave from Avondale Blvd to El Mirage Rd | $1,760,000 |
| P-69 | 12-inch | 2,579 LF | 119th Ave from Southern Ave to Roeser Rd | $434,000 |
| P-70 | 24-inch | 2,599 LF | Avondale Blvd from Southern Ave to Roeser Rd | $874,000 |
| P-71 | 24-inch | 2,049 LF | Avondale Blvd from Gila River to Southern Ave | $689,000 |
| P-72 | 16-inch | 5,254 LF | Southern Ave from 107th Ave to Avondale Blvd | $1,180,000 |
| P-73 | 16-inch | 2,580 LF | 107th Ave from Southern Ave to Roeser Rd | $578,000 |
| P-74 | 16-inch | 7,742 LF | Indian Springs Rd from Gila River to El Mirage Rd | $1,740,000 |
| P-75 | 16-inch | 6,717 LF | Indian Springs Rd from El Mirage Rd to 143rd Ave | $1,510,000 |
| P-76 | 16-inch | 2,007 LF | Coyote Ln from Mountain Rd to Indian Springs Rd | $450,000 |

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| P-77 | 16-inch | 889 LF | Coyote Ln from Mountain Rd Due South | $200,000 |
| P-78 | 12-inch | 5,163 LF | Mountain Rd from Coyote Ln to Dysart Rd | $868,000 |
| P-79 | 12-inch | 3,187 LF | City of Avondale Boundary from Mountain Rd to Indian Springs Rd | $536,000 |
| P-80 | 12-inch | 2,915 LF | Aqua Fria River from Southern Ave to Roeser Rd | $490,000 |
| **Well Transmission Mains** | | | | |
| T-5 | 16-inch | 2,090 LF | Aqua Fria River from Coldwater Reservoir to Well #26 | $901,000 |
| T-6 | 12-inch | 1,700 LF | Thomas Rd from Well G to Avondale Blvd | $512,000 |
| T-7 | 12-inch | 3,470 LF | Avondale Blvd from Well H to Thomas Rd | $1,045,000 |
| T-8 | 16-inch | 5,250 LF | Thomas Rd from Garden Lakes Reservoir to Avondale Blvd | $2,270,000 |
| T-9 | 16-inch | 1,070 LF | Aqua Fria River from Well E to Well #16 Connection | $462,000 |
| T-10 | 12-inch | 2,560 LF | McDowell Rd from Well B to Well E | $770,600 |
| T-11 | 12-inch | 2,310 LF | 107th Ave from Well C to McDowell Rd | $696,000 |
| T-12 | 16-inch | 2,875 LF | McDowell Rd from 103rd Ave to 107th Ave | $1,239,000 |
| T-13 | 12-inch | 2,600 LF | 103rd Ave from McDowell Rd to Gateway Reservoir | $783,000 |
| **Booster Pump Stations** | | | | |
| BPS-5 | 2.6 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $950,000 |
| BPS-6 | 5.1 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $1,859,000 |
| BPS-7 | 2.4 mgd | @ 165 ft | Garden Lakes Booster Pump Station | $875,000 |
| BPS-8 | 1.2 mgd | @ 165 ft | Gateway Booster Pump Station | $438,000 |
| BPS-9 | 1.0 mgd | @ 130 ft | Northside Booster Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W- 16B | 1.0 mgd | Convert to Potable | Well #16B - Friendship Park | $120,000 |
| W-21 | 2.6 mgd | Provide Treatment | Well #21- El Mirage Rd and Durango Rd | $4,450,000 |
| W-28 | 1.7 mgd | Provide Treatment | Well #28 - 117th Ave and Whyman Ave | $4,450,000 |
| W-B | 1.7 mgd | Construct New Well | Well B - 119th Ave and McDowell Rd | $2,210,000 |
| W-C | 1.7 mgd | Construct New Well | Well C - 107th Ave and Roosevelt Rd | $2,210,000 |
| W-D | 1.7 mgd | Construct New Well | Well D - 107th Ave and McDowell Rd | $2,210,000 |
| W -E | 1.6 mgd | Construct New Well | Well E - McDowell Rd and El Mirage Rd (Pecan Tree Trailer Park) | $2,210,000 |
| W-F | 1.7 mgd | Construct New Well | Well F - El Mirage Rd North of Van Buren St | $2,210,000 |
| W-G | 1.7 mgd | Construct New Well | Well G - 119th Ave and Thomas Rd | $2,210,000 |
| W-H | 1.7 mgd | Re-drill | Well H - 114th Ave and Encanto Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$56,500,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas



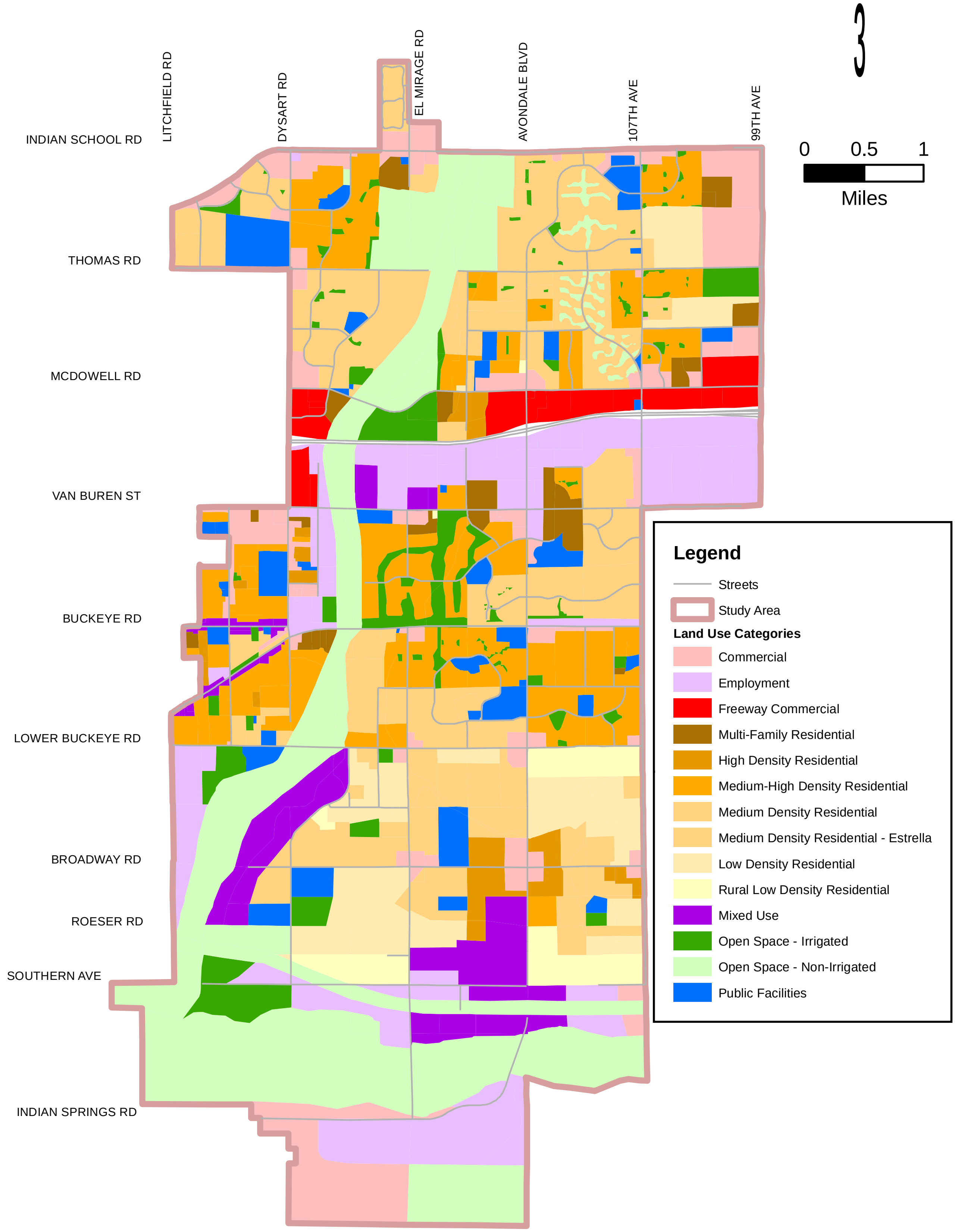

\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-1 Study Area.mxd

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Study Area**

May 2010

FIGURE ES-1




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-2 Land Use Map for Study Area.mxd

City of Avondale

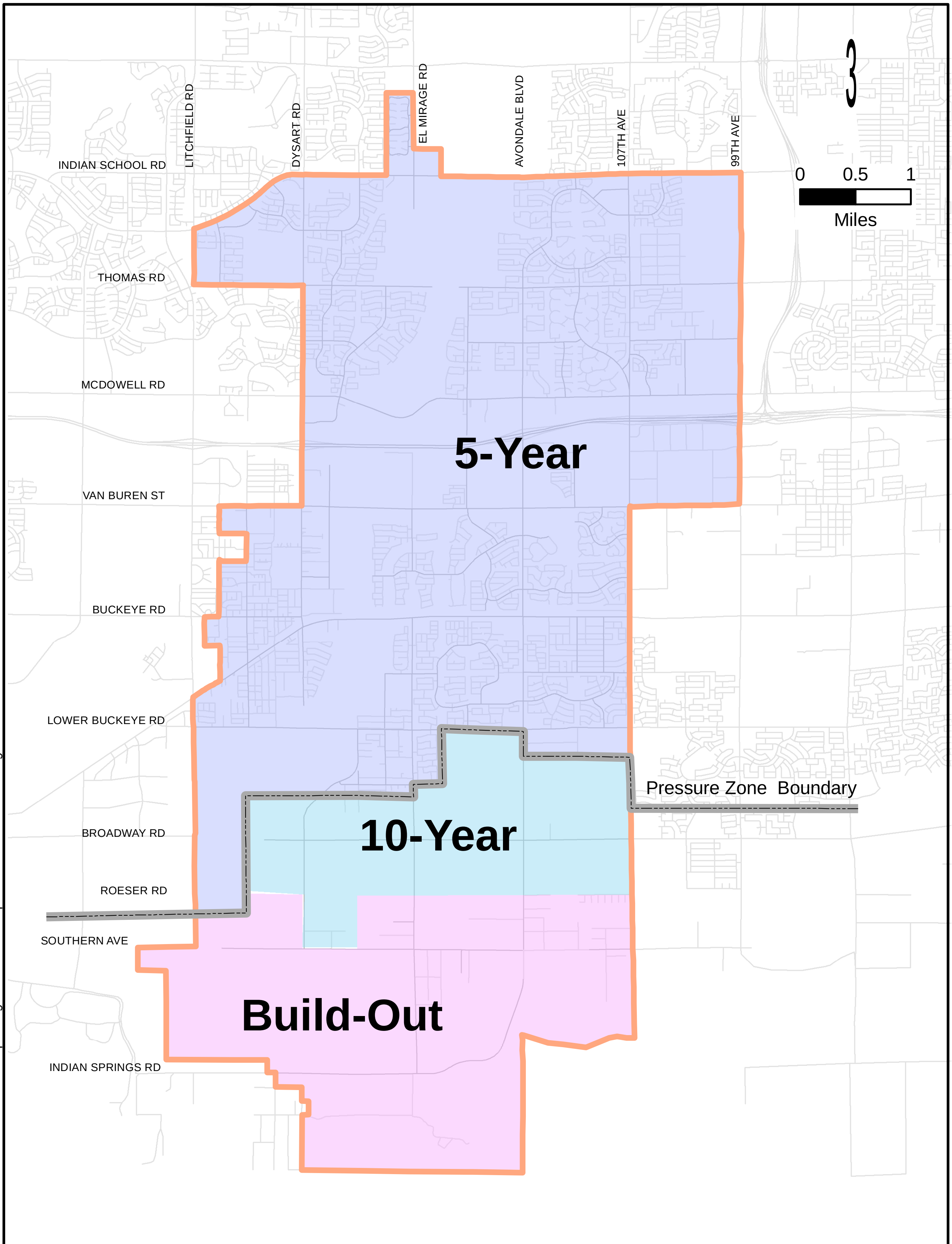
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Land Use Map for Study Area**

MALCOLM PIRNIE

May 2010

FIGURE ES-2




City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

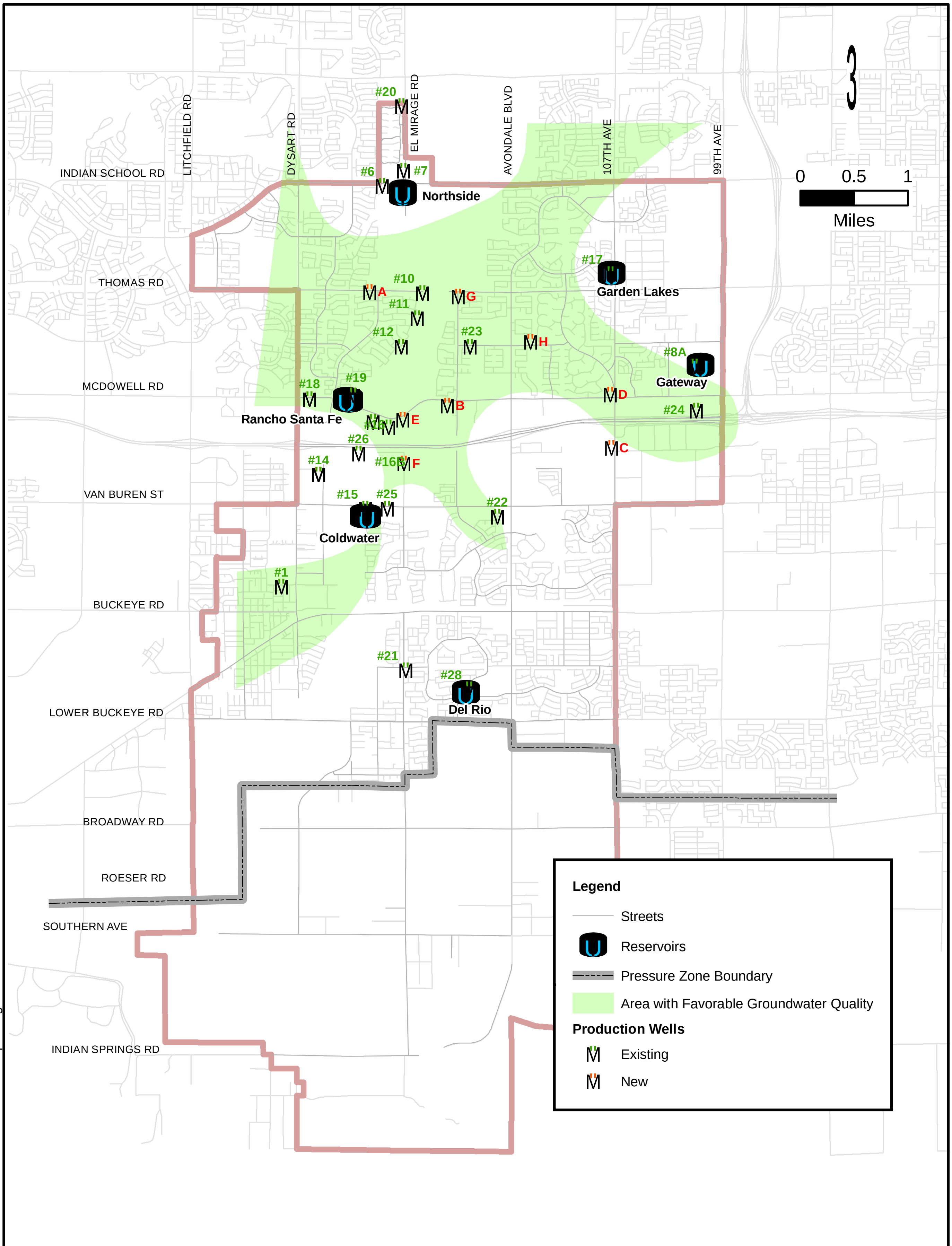
**Development and Growth Phasing**

MALCOLM PIRNIE

May 2010

FIGURE ES-3

\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-3 Development and Growth Phasing.mxd




City of Avondale

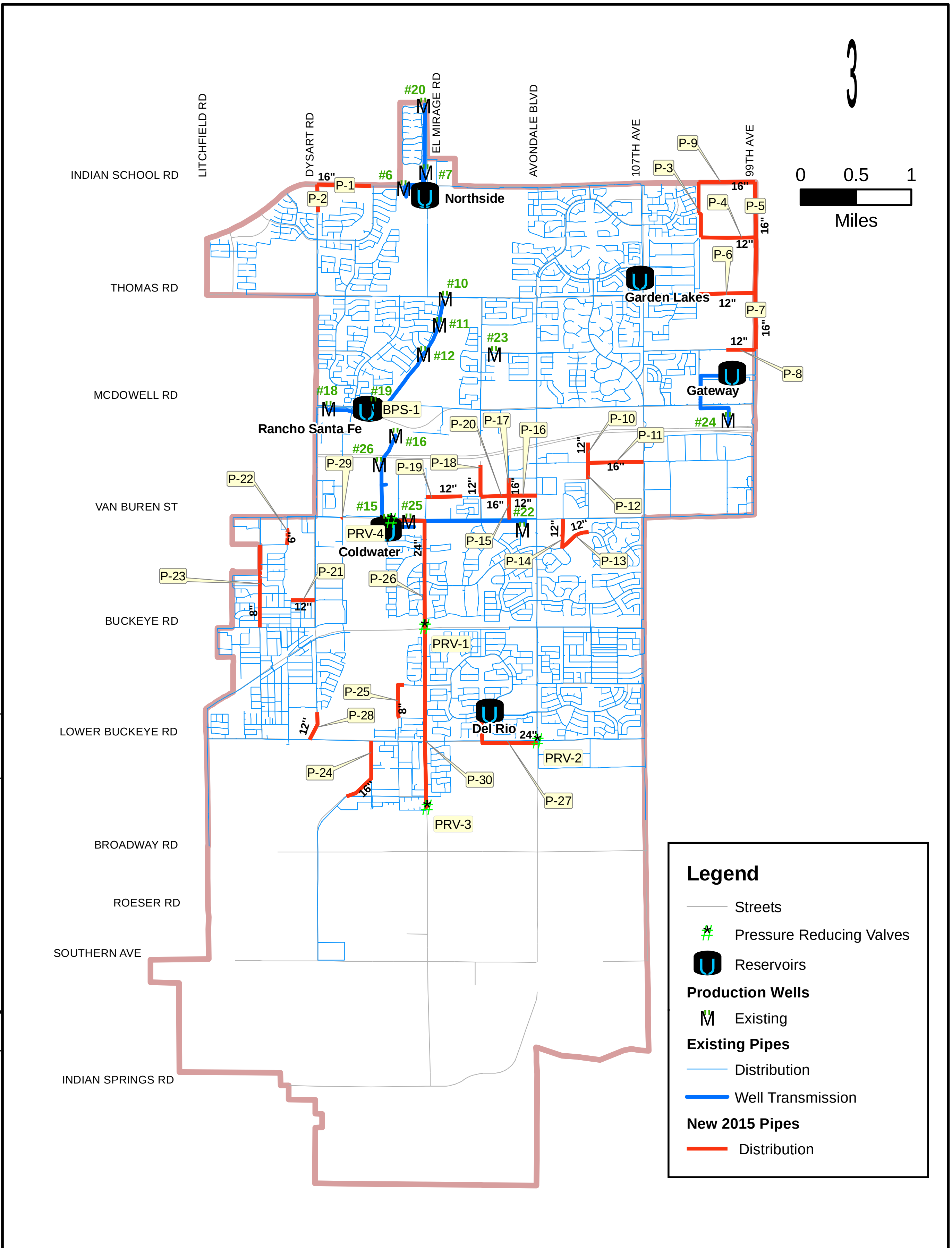
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Production Wells at Build-Out**

MALCOLM PIRNIE

May 2010

FIGURE ES-4




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-5 Recommended Infrastructure (2010-2015).mxd

City of Avondale

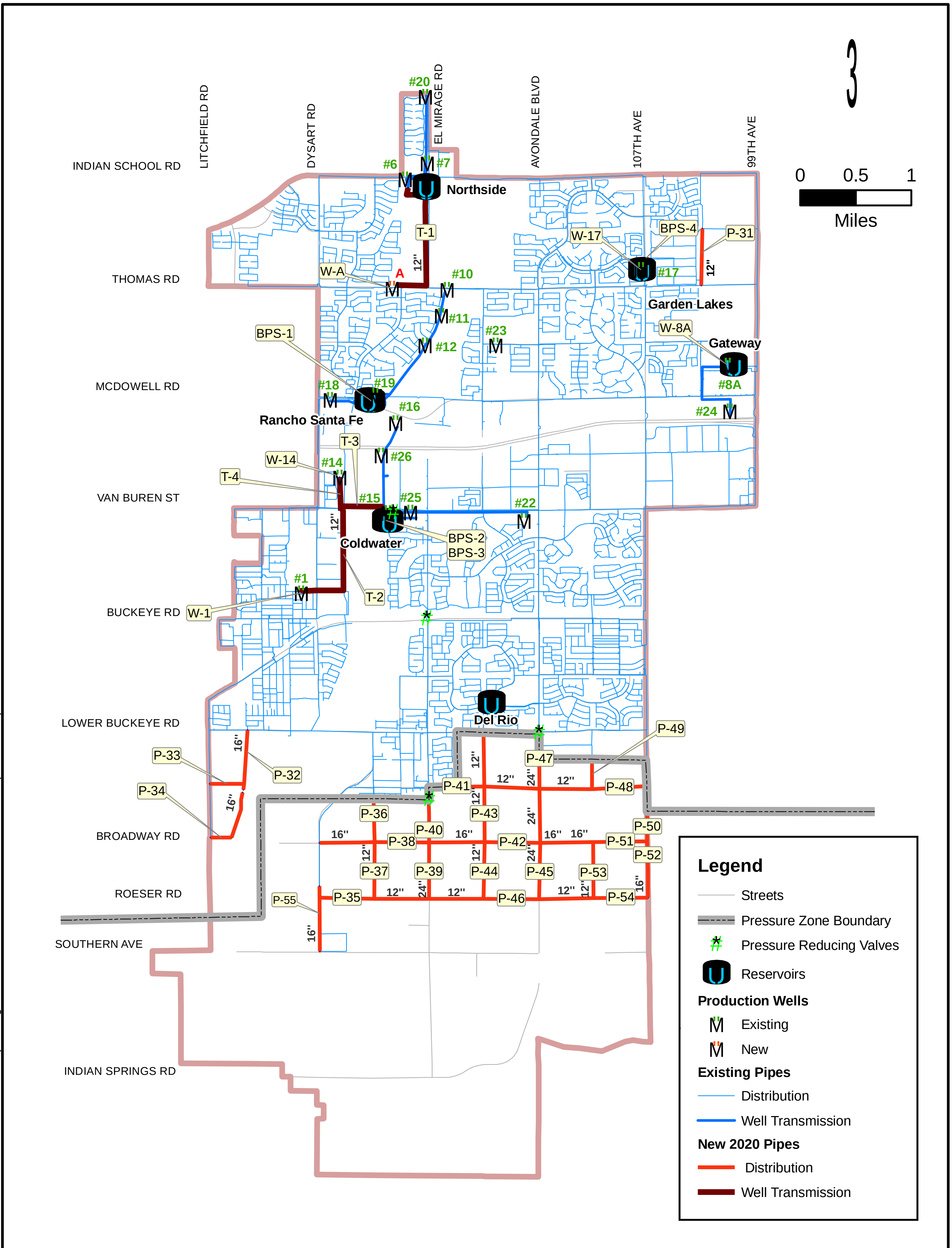
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Recommended Infrastructure (2010-2015)**

MALCOLM PIRNIE

May 2010

FIGURE ES-5




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

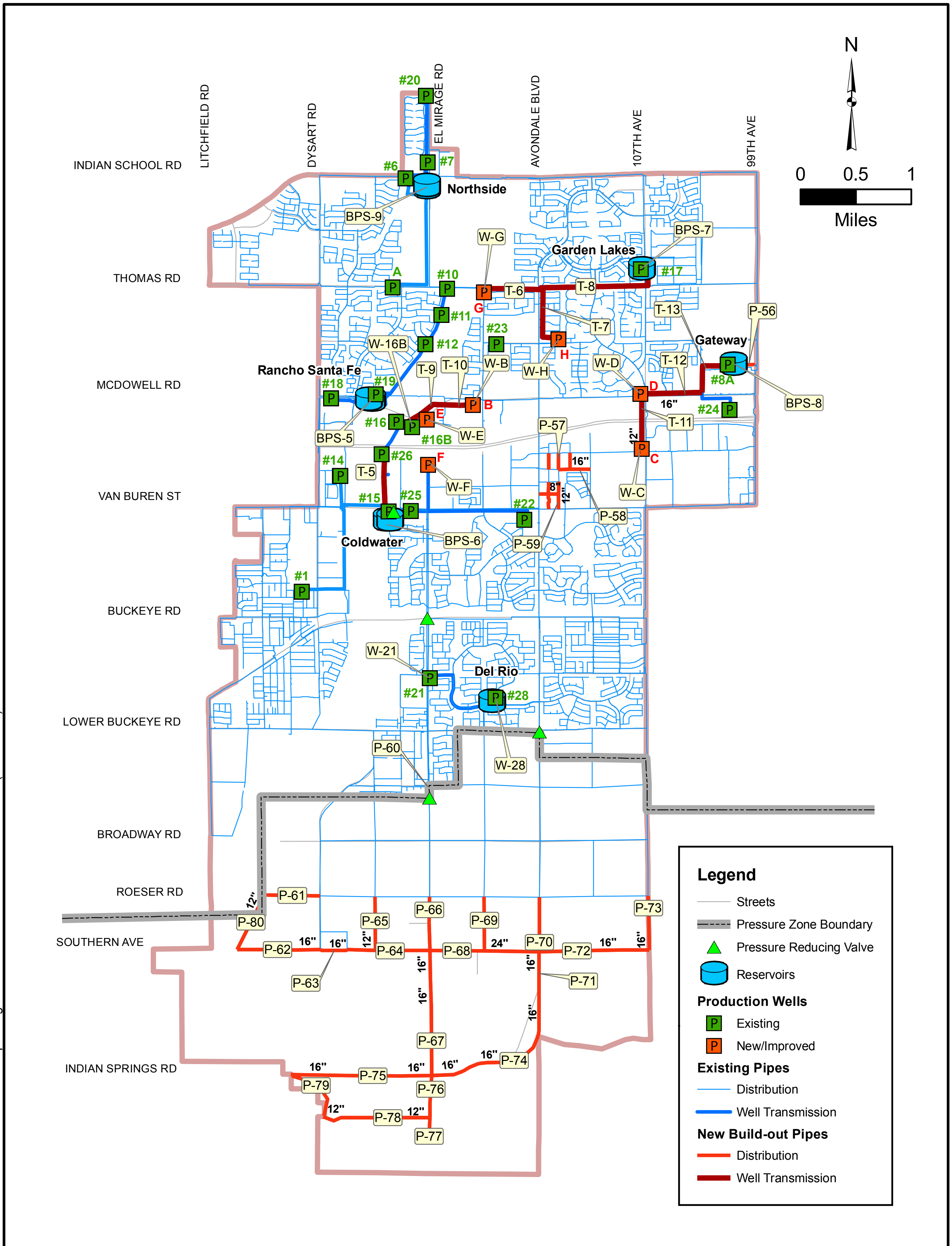
**Recommended Infrastructure (2016-2020)**

MALCOLM PIRNIE

May 2010

FIGURE ES-6

\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-6 Recommended Infrastructure (2016-2020).mxd




City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Recommended Infrastructure (2021 to Build-Out)**

MALCOLM PIRNIE

May 2010

FIGURE ES-7

\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure ES-7 Recommended Infrastructure (2016-2020).mxd

# 1. Introduction

## 1.1. Background

The City of Avondale (City) Water Resources Department is responsible for management of the City's water, wastewater, and reclaimed water systems. The department maintains comprehensive master plans for water resources and water, wastewater, and water reuse infrastructures. The water resource master plan ensures that the City's water supplies are adequate and of good quality to meet the current and projected water demands of residents and businesses. The water, wastewater and water reuse infrastructure master plans provide for orderly growth and expansion of the infrastructure to accommodate planned City growth. To prepare for this growth, the City prepared a water resource master plan in 2002 and updated its water infrastructure master plan in 2005. Because there have been many changes in development and land use planning within the City since 2002 and 2005, the master plans are in need of updating.

In July 2009, the City retained Malcolm Pirnie, Inc., in association with Replenishment Services, LLC, to complete the Water Resource Master Plan project which includes updates to both the Water Resource Master Plan and the Water Infrastructure Master Plan. This report contains the Water Infrastructure Master Plan.

## 1.2. Project Purpose and Scope

The purpose of the Water Infrastructure Master Plan update is to incorporate changes in water infrastructure that have resulted from capital improvement program achievements since the 2002 and 2005 master plans and to recommend water system improvements to support the updated water demand projections of the companion Water Resource Master Plan update. The scope of the Water Infrastructure Master Plan update generally includes:

- A review of the City's historical water production, peaking factors, and design criteria
- An update of the City's water system hydraulic model with recently added water infrastructure
- Evaluation of the existing system infrastructure to identify deficiencies
- Development of recommended infrastructure improvements to meet the City's projected water demands in 2015, 2020, and build-out.

Water demands were forecasted using a geographic information system (GIS)-based tool, developed in the companion Water Resource Master Plan update. The tool easily and quickly compares projected water demands against available water supplies for any development scenario that the City could envision (changes in land uses, residential densities, growth rates, etc.). The Water Resource Master Plan update also includes a hydrogeologic study and development of a groundwater model to assess the impacts to groundwater levels and movement due to long-term groundwater pumping.

## 1.3. Study Area

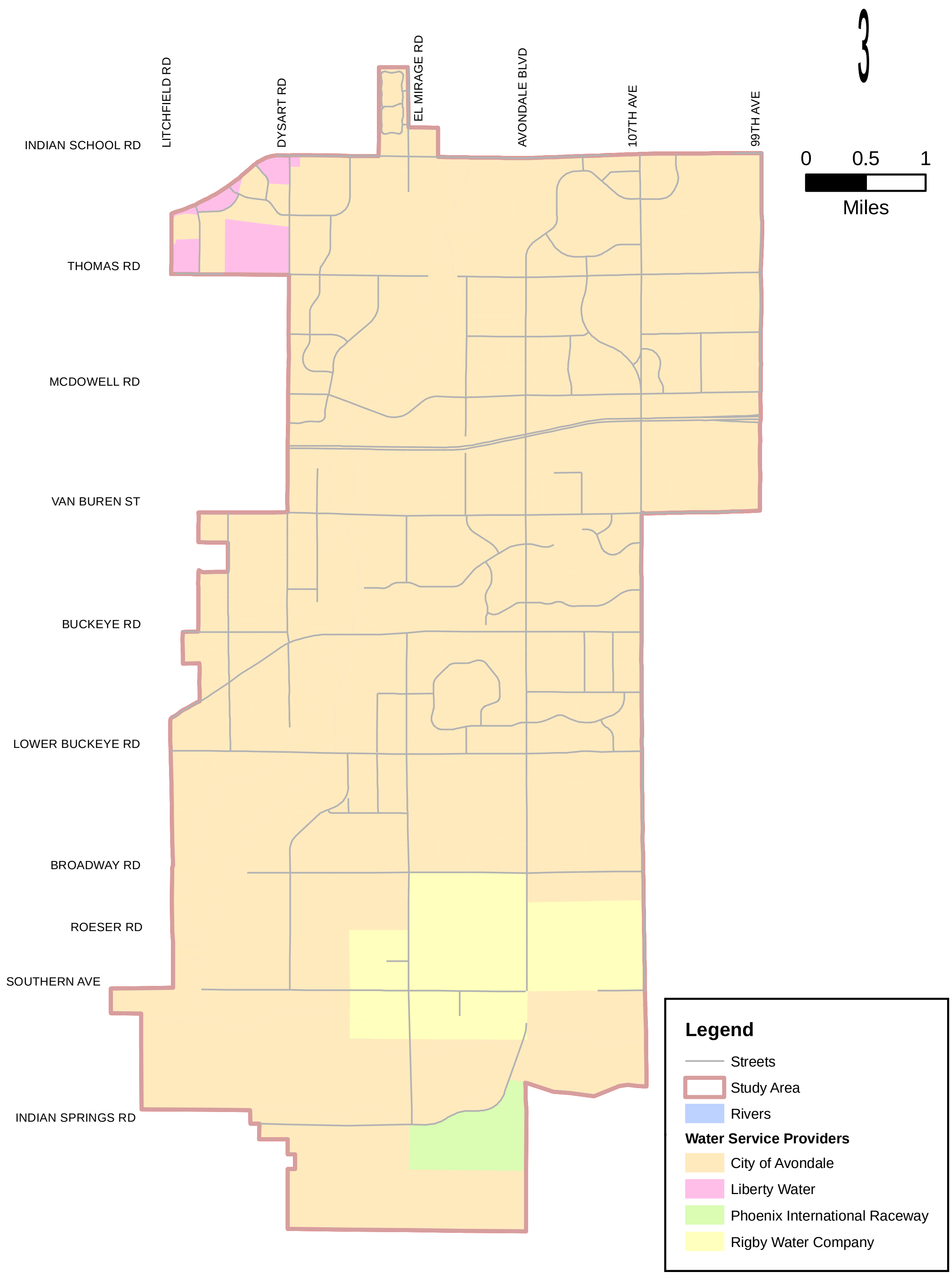
The study area for the Water Resource Master Plan project is the City's Municipal Planning Area (MPA) north of the Estrella Mountains, as illustrated on Figure 1-1. The City's MPA south of the Estrella Mountains is not included in the study area because planning for this area is in the very early stages and is not yet at a level to sufficiently support detailed master planning. According to information provided by the City Finance Department, the City is projected to grow from a current population of approximately 70,000 to a little over 123,200 by 2030 within the study area.

Figure 1-1 also illustrates the water service providers. The City of Avondale is the water service provider for the majority of the area within the City study area with the following exceptions:

- The Liberty Water Company (formerly Litchfield Park Service Company) serves four small areas within the area bounded by Thomas Road, Litchfield Road, Dysart Road, and Indian School Road. The customers in this area include a college, some schools, and a few commercial properties.
- Rigby Water Company serves an area of approximately 2.5 square miles in the south-eastern portion of the study area. The system is divided into two independent systems and has four wells. The City is currently in the process of purchasing the Rigby Water Company; the system will maintain current operational practices during the acquisition period.
- Phoenix International Raceway (PIR) is not a municipal water service provider; however, it is a self-supplier with its own water source and infrastructure to use water on the PIR site.

Prior to 2020, the City anticipates serving both PIR and Rigby Water Company. For this reason, the City's service area, PIR, and Rigby Water Company are included in the Water Infrastructure Master Plan update. The City currently has no intentions of acquiring Liberty Water Company; these areas are not covered in this planning document.

The City is also divided into Salt River Project (SRP) On-Project and Off-Project Areas (Figure 1-2). On-Project Areas are lands that are within the service area of SRP, while Off-Project Areas are outside the SRP service area.




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 1-1 Study Area.mxd

City of Avondale

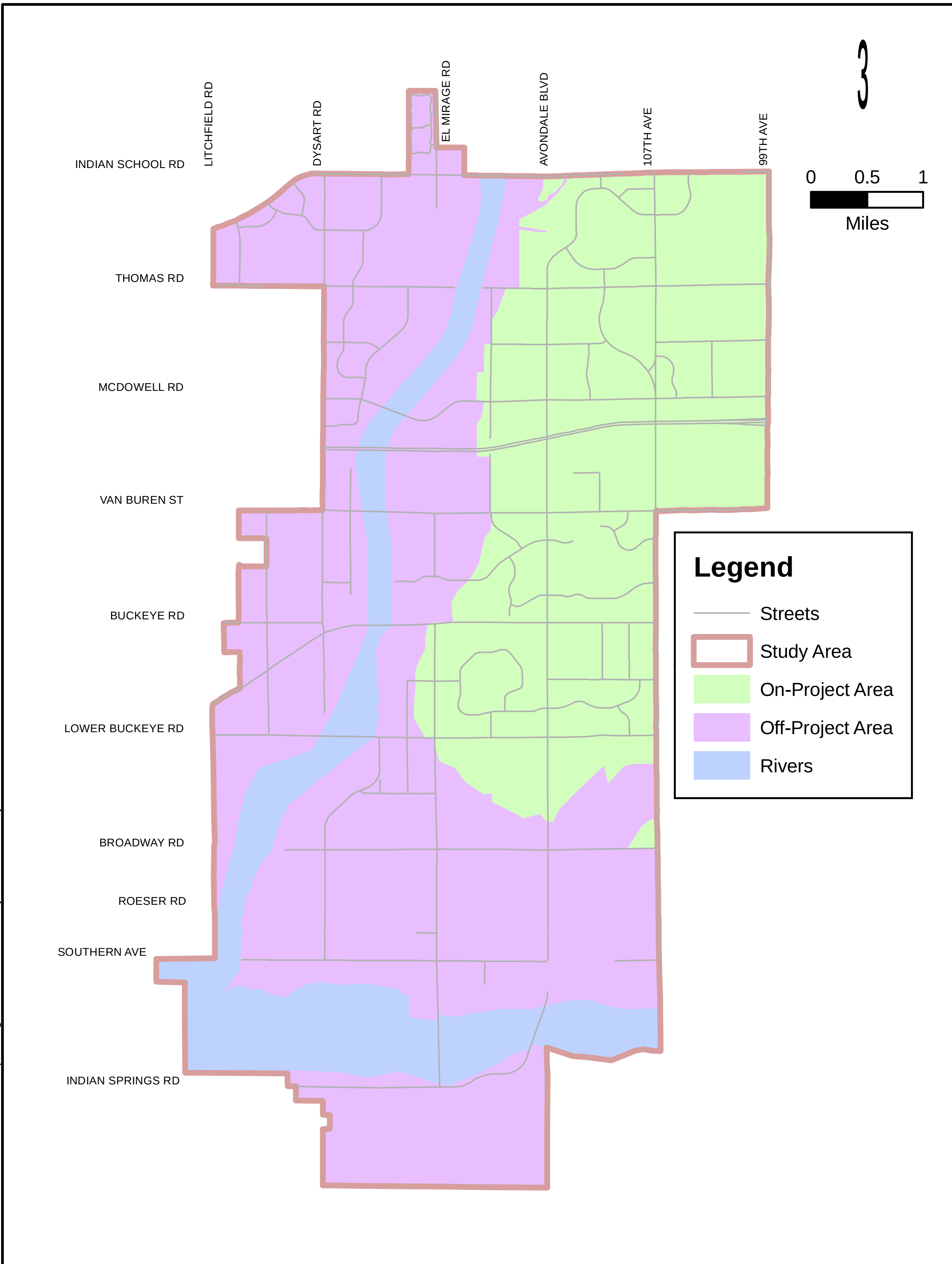
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Study Area**

MALCOLM PIRNIE

May 2010

FIGURE 1-1




\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 1-2 SRP On-Project and Off-Project Areas.mxd

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**SRP On-Project and Off-Project Areas**

MALCOLM PIRNIE

May 2010

FIGURE 1-2

# 2. Regulatory Framework

This section provides a brief overview of the applicable regulations, ordinances, and guidelines related to developing and maintaining drinking water infrastructure in Arizona. For the complete description of a particular regulation, ordinance, or guideline, contact local, state, or federal authorities to obtain a copy of the document in question.

Beyond the requirements of the federal, state, and county regulations summarized in this section, the City has its own set of water guidelines and standards that it uses to guide infrastructure requirements. The following documents provide the most current guidelines and policies:

- City of Avondale General Engineering Requirements Manual (2008)
- City of Avondale General Plan (2002)
- Wastewater Collection System Master Plan & Utility Systems Evaluation (2005)

## 2.1. Safe Drinking Water Act

Passed by Congress in 1974, the intent of the Safe Drinking Water Act (SDWA) is to protect public health by regulating the nation's public drinking water supply. The SDWA authorizes the United States Environmental Protection Agency (USEPA) to set health-based national standards for drinking water quality to protect against both naturally occurring and synthetic contaminants that may be found in drinking water. In addition to the health-related primary drinking water regulations, the SDWA also authorizes USEPA to develop secondary regulations for contaminants that may adversely affect the aesthetic quality of drinking water. Secondary standards are non-enforceable guidelines.

With the exception of the secondary standards, which have not been adopted, Arizona's Arizona Administrative Code (AAC) Title 18 regulations follow the SDWA requirements. The Arizona Department of Environmental Quality (ADEQ) is currently in the process of changing Title 18 to incorporate the SDWA regulations by reference, rather than providing a state-specific interpretation of the regulations.

Some of the key federal standards and regulations governing surface and groundwater systems are listed in Table 2-1. For current regulations, the published date is listed; for future regulations, proposed dates are shown. Table 2-1 also indicates whether a specific regulation currently applies to the City system and whether it will apply in the future. Unless the City incorporates surface water in the future, only the regulations for groundwater systems will apply.

**Table 2-1:**
**Drinking Water Regulation Applicability**

| Regulation | Final Rule Date | Applicability | | |
|---|---|---|---|---|
| | | Current Groundwater System | Future Groundwater System | Future Groundwater and Surface Water Systems |
| MCLs for IOCs, VOCs, SOCs, Radionuclides, and DBPs | 1976 - current | X | X | X |
| Stage 1 D/DBP Rule | 1998 | X | X | X |
| Stage 2 D/DBP Rule | 2006 | X | X | X |
| Surface Water Treatment Rule | 1989 | | | X |
| Interim Enhanced Surface Water Treatment Rule and Long-Term 1 Enhanced Surface Water Treatment Rule | 1998 and 2002 | | | X |
| Long Term 2 Enhanced Surface Water Treatment Rule | 2006 | | | X |
| Filter Backwash Recycling Rule | 2001 | | | X |
| Total Coliform Rule | 1989 | X | X | X |
| Lead and Copper Rule | 1991 | X | X | X |
| Arsenic Rule | 2001 | X | X | X |
| Groundwater Rule | 2007 | X | X | |
| Unregulated Contaminant Monitoring Regulation | 1999 - current | X | X | X |
| Total Coliform Rule Revisions and Distribution System Rule | 2011-2012 | X | X | X |
| Radon Rule | TBD[1] | X | X | X |

Note:
(1) To be determined.

A brief summary of the regulatory requirements of the existing rules summarized in Table 2-1 is provided below.

- **Maximum Contamination Levels (MCLs).** There are currently over 90 contaminants within inorganic chemicals (IOCs), volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs), radionuclides, and disinfection byproducts (DBPs) that require monitoring by a public water system (PWS).
- **Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR).** The Stage 1 D/DBPR is aimed at improving public health protection by reducing exposure to DBPs. This rule establishes limits for disinfection residuals and DBP formation and may require conventional treatment plants to employ enhanced coagulation to achieve total organic carbon (TOC) removal to help reduce DBP formation in the system.
- **Stage 2 Disinfectants/Disinfection By-Products Rule.** The Stage 2 D/DBPR aims to further reduce public exposure to DBPs by establishing new MCL goals for certain DBPs and basing DBP compliance on locational monitoring at individual distribution

system sites instead of system-wide monitoring. Monitoring locations, particularly for high-DBP areas of the system, are identified by an Initial Distribution System Evaluation program.

- **Surface Water Treatment Rule.** For surface water treatment systems, the Surface Water Treatment Rule establishes requirements for *Giardia* and virus removal, turbidity standards, and disinfectant residual in the distribution system. The rule also applies to groundwater systems that are deemed groundwater under the direct influence of surface water.
- **Interim Enhanced Surface Water Treatment Rule and the Long Term 1 Enhanced Surface Water Treatment Rule.** The Interim Enhanced Surface Water Treatment Rule focuses on further protections against microbial contaminants for systems serving greater than 10,000 people, and the Long Term 1 Enhanced Surface Water Treatment Rule applies these same requirements to systems serving fewer than 10,000 people. These rules establish requirements for *Cryptosporidium* removal, turbidity monitoring and standards, and DBP profiling and benchmarking for water treatment systems that exceed certain DBP concentrations. The rules also prohibit construction of new uncovered finished water storage facilities.
- **Long Term 2 Enhanced Surface Water Treatment Rule.** The purpose of the Long Term 2 Enhanced Surface Water Treatment Rule is to reduce illness linked with *Cryptosporidium* and other microorganisms in drinking water. The rule supplements existing regulations by targeting additional *Cryptosporidium* treatment requirements to higher risk systems. The rule establishes requirements for initial monitoring to determine treatment requirements, treatment based on monitoring, covering of uncovered finished water reservoirs or treatment for virus, and benchmarking current level of microbial treatment before making significant changes in disinfection practices.
- **Filter Backwash Recycling Rule.** The Filter Backwash Recycling Rule adds new requirements for conventional and direct filtration plants to ensure that recycle streams are properly treated.
- **Lead and Copper Rule.** The Lead and Copper Rule establishes action levels for lead and copper. Exceeding the action level is not a violation but may trigger additional sampling, corrosion control treatment, and public notification and/or education.
- **Arsenic Rule.** The Arsenic Rule applies to groundwater sources as well as to surface water sources and reduces the arsenic MCL from 0.050 to 0.010 milligrams per liter (mg/L).
- **Unregulated Contaminant Monitoring Regulation.** USEPA uses the Unregulated Contaminant Monitoring Regulation to collect data for contaminants suspected to be present in drinking water but that do not have health-based standards set under the SDWA. Every five years USEPA reviews the list of contaminants, largely based on the Contaminant Candidate List. The Unregulated Contaminant Monitoring

Regulation incorporates a tiered monitoring approach and establishes classified lists of contaminants to be monitored by specified groups of utilities.

- **Groundwater Rule.** The Groundwater Rule became effective in January 2007, with compliance beginning December 1, 2009. The Groundwater Rule provides increased protection against microbial pathogens in public water systems that use groundwater. The Groundwater Rule establishes requirements for periodic sanitary surveys of groundwater systems, triggered source water monitoring when a water system identifies a positive sample during Total Coliform Rule monitoring, corrective actions, and compliance monitoring to ensure treatment technologies reliably achieve virus removal.
- **Total Coliform Rule Revision and Distribution System Rule.** The original Total Coliform Rule set the total coliform standard based on the presence or absence of the total coliform bacteria rather than the bacterial density. USEPA is currently revising the Total Coliform Rule. The revision focuses on assessing the effectiveness of the current TCR in reducing public health risk and the possible use of more economic-effective alternatives or additional monitoring strategies that would maintain or improve public health protection. The USEPA is also considering a Distribution System Rule that would regulate a broader suite of distribution system issues such as pressure management and backflow prevention.
- **Revised Unregulated Contaminant Monitoring Regulation 3.** In February 2008, USEPA released the draft Contaminant Candidate List 3 that will be considered for possible monitoring and regulation.
- **Radon Rule.** When finalized, the Radon Rule will establish an MCL for radon and will require monitoring at each entry point to the system.

## 2.2. Fire Protection Standards

Fire protection requirements may affect the water infrastructure with respect to pipeline sizing, amount of storage, capacity of booster pumps, and amount of water production capacity needed. The City adopts the International Fire Code (IFC) with local amendments. The IFC (2006) contains fire flow requirements based on the size, type of construction, and proposed usage of the buildings. The fire flow requirements depend on maintaining a residual pressure of 20 pounds per square inch (psi) and are determined from the building's fire area. The IFC allows for a reduction in the required fire flow (as approved by the fire chief) if an approved automatic sprinkler system has been installed. The fire flow requirements in the IFC are as follows:

- Minimum fire flow of 1,000 gallons per minute (gpm) for one and two-family dwellings (fire area less than 3,600 square feet)
- 1,500 gpm to 8,000 gpm fire flow for commercial development (should not be less than 1,500 gpm, even with automatic sprinkler systems)

For water distribution system modeling, the City requires minimum fire flow demand of 1,000 gpm for two hours for single-family residential areas and minimum fire flow of 3,500 gpm for four hours for commercial and industrial areas while maintaining a minimum residual pressure of 20 psi (Avondale, 2008).

## 2.3. Arizona Department of Environmental Quality

State rules and regulations of ADEQ are outlined in the 1978 Arizona Department of Health Services Engineering Bulletin Number (No.) 8 "Disinfection of Water Systems" and Bulletin No. 10 "Guidelines for the Construction of Water Systems." These bulletins set forth rules and guidelines for public water system design, construction, and operation in the State of Arizona.

- Bulletin No. 8 requires proper and adequate disinfection of unsafe water supplies and facilities prior to public use. In addition, the bulletin provides disinfection methods and procedures that may apply to water mains, storage reservoirs/tanks, and wells after their construction or repair, in order to inactivate or remove any bacterial pollution introduced to these facilities during such work.
- Bulletin No. 10 provides guidance and minimum design criteria for modification and construction of water systems. It is intended to provide guidance to water system planning, design, plan development, specification writing, review, and construction. The bulletin provides guidance and planning criteria for general service, fire protection, hydro-pneumatic tanks, storage facilities, and distribution systems.

## 2.4. Arizona Department of Water Resources

The Arizona Department of Water Resources (ADWR) regulates drilling of wells that are used only for non-irrigation purposes. ADWR statute prohibits the drilling of an exempt well (a well that has a maximum pump capacity of not more than 35 gpm and that is used only for non-irrigation purposes) on land if any part of the land is within 100 feet of the operating water distribution system of a municipal water provider that has an assured water supply designation within the boundaries of an active management area (AMA) as shown on a digitized service area map provided to the director by the municipal provider. The statute also includes conditions to provide an exemption from this prohibition.

The ADWR new well spacing rules for non-exempt wells drilled in AMAs became effective on August 7, 2006 (Arizona Administrative Code, R12-15-1301 through R12-15-1308). According to ADWR, "The rules are designed to prevent unreasonably increasing damage to surrounding land or other water users from the concentration of wells. The well spacing criteria address three types of unreasonably increasing damage: (1) additional drawdown of water levels at neighboring wells of record; (2) additional regional land subsidence; and (3) migration of contaminated groundwater to a well of record." The following discussion provides a general summary of the well spacing requirements as they apply for most new and replacement service area production wells.

New production well(s), may not cause more than 10 feet of additional drawdown after the first five years of operation on one or more wells of record in existence as of the date of receipt of the application to construct new well(s). The owner of the new production well(s) will generally have the following options to address this issue,

- Attain a written consent form from the owners of affected well(s) of record consenting to the withdrawals from the proposed well
- Reduce the planned pumping rate for the proposed well to reduce the drawdown impact on the well(s) of record
- Move the proposed location of the new well further away from potentially affected well(s) of record

If the proposed well(s) is also planned to be permitted as a recovery well, the owner may submit a hydrological study to ADWR that demonstrates that the new well will be located within the area impact of an underground storage facility, and that the owner will account for all of the water recovered from the well as water stored at the facility.

The owner of new well(s) that will be located in an area of known land subsidence may be required to submit a hydrological study or geophysical study to demonstrate the impact of the withdrawals from the proposed well or wells. In other words, the owner will be required to demonstrate that the new production well(s), at its proposed pumping rate and location, will not significantly contribute to additional land subsidence in the area.

The owner of new production well(s) that will be located in close proximity to a area of known groundwater contamination may be required to submit a hydrologic study to demonstrate that the new production well at its proposed pumping rate and location will not result in degradation of the quality of the water withdrawn from a well of record so that the water will no longer be useable for the purpose for which it is currently being used without additional treatment.

In lieu of new wells, replacement wells may be drilled in approximately the same location of an existing well in accordance with A.A.C. R12-15-108. A proposed replacement well may not be located further than 660 feet from the original well. Reasons for drilling a replacement well may include replacing an existing well that needs to be moved, e.g., to accommodate a road widening project, replacing an aging or damaged well to achieve better production and water quality, etc.

In most situations, the proposed well may not annually withdraw an amount of water in excess of the maximum annual capacity of the original well. If an annual maximum pumping capacity of the existing well is not available, ADWR determines the annual maximum pumping capacity by multiplying the maximum pump capacity of the original well in gallons per minute by 525,600 and then converting the result in to acre-feet by dividing the result by 325,851.

A replacement well must be completed within one year of issuance of the drilling card for the well. At the time the drill card is issued, ADWR may approve a completion period that is greater than one year but not to exceed five years for situations where the state or political subdivision of the state has acquired or has begun a condemnation action to acquire the land on which the original well is located, or; the original well has been rendered inoperable due to flooding subsidence or other extraordinary physical circumstances that are beyond the control of the well owner. The proposed location of the replacement well must be provided with application for the drill card so ADWR can verify the new well is located within 660 feet of the original well. The drill card may be amended in the event that the proposed well location changes before the replacement well is drilled.

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# 3. Existing Water Infrastructure

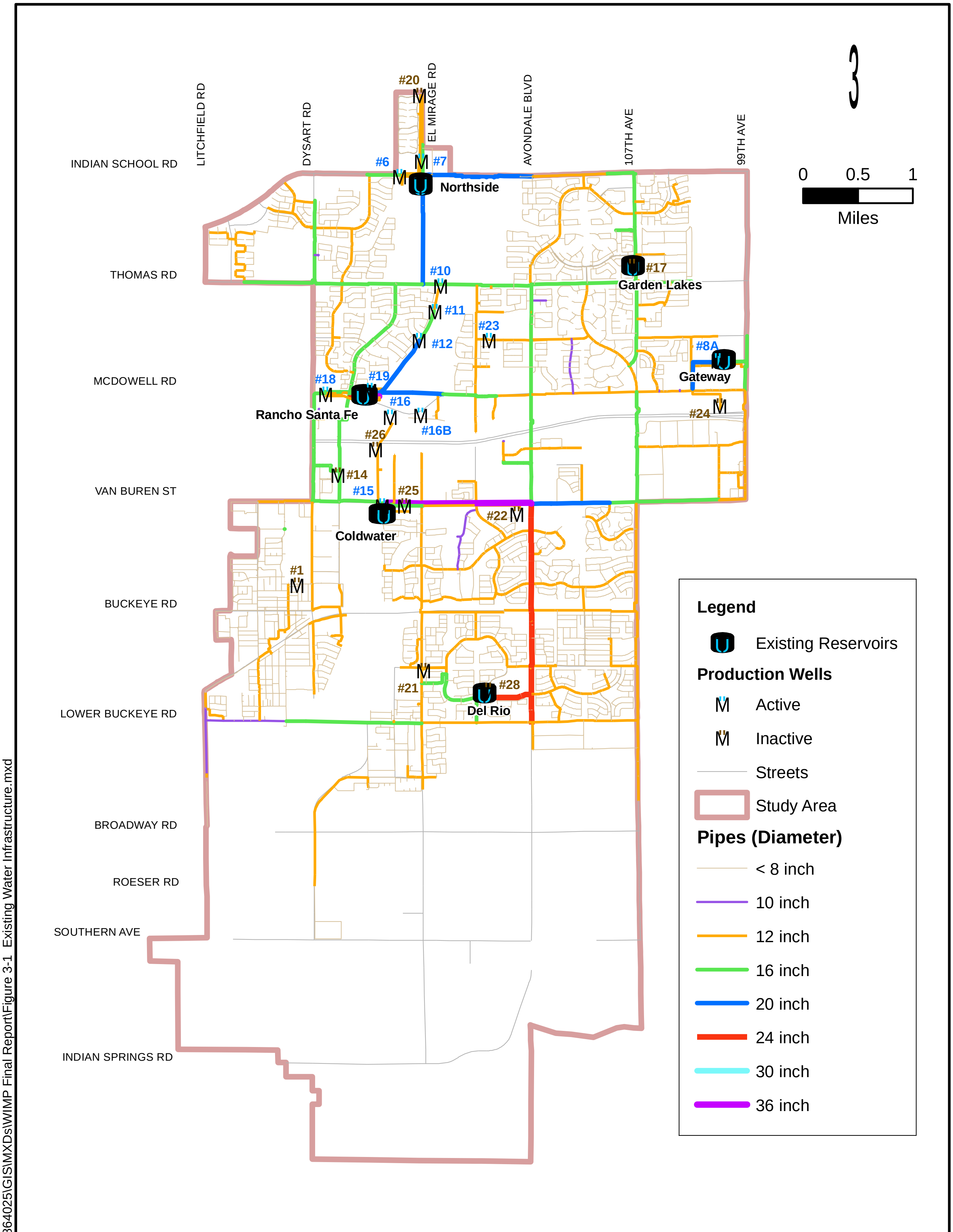
The City's drinking water infrastructure includes production wells, storage reservoirs, booster pumps, transmission pipelines, and distribution pipelines (Figure 3-1). This section summarizes the City's water infrastructure as of January 2010. Planned infrastructure included City-planned facilities and pipelines that can be considered "in-progress" (either under design or in construction) but have not yet been completed.

## 3.1. Production Wells

The City currently relies on 11 "active" production wells to meet the drinking water needs of residents and businesses (Table 3-1). A twelfth, active well (Well #16B) supplies water to Friendship Park and is not connected to the rest of the City's drinking water distribution system. The total pumping capacity of the City's active wells serving the main distribution system (excluding Well #16B) is 26.7 million gallons per day (mgd). The remaining wells owned by the City (termed "inactive) constitute a variety of wells that cannot be operated in their current state. As shown in Table 3-1, reasons for inactivity include under construction, lease expiration, capped, and water quality.

### 3.1.1. Water Quality

Table 3-2 summarizes the water quality data available for City production wells. With respect to water quality and treatment, the City strives to have all contaminants less than 80 percent of the federal MCL at the point of compliance. The City also strives to provide water that meets the secondary standards with the exception of total dissolved solids (TDS), which has a non-enforceable secondary standard of 500 mg/L. The City's treatment goal for TDS is 700 mg/L; however, TDS up to 1,000 mg/L is acceptable. The City has arsenic treatment at the Northside reservoir location (Wells #6, #7, and #20) and nitrate treatment facilities at Gateway and Garden Lakes reservoirs (Wells #8A and #17). The lease agreement for the Garden Lakes treatment facility expired in December 2009. The lease agreement for the Gateway treatment facility is still valid for another three years; however, this well is operated only during emergencies due to the cost of nitrate treatment. With the recent bankruptcy of the treatment unit vendor, the City is in the process of determining how best to utilize both wells to the extent possible.




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 3-1 Existing Water Infrastructure.mxd

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Existing Water Infrastructure**

MALCOLM PIRNIE

May 2010

FIGURE 3-1

**Table 3-1:**
## Existing Production Wells

| Well Registration Number | Well Number | Operation Status | Feed Point | Pumping Capacity (gpm)[1] |
|---|---|---|---|---|
| 55-608731 | 1 | Inactive - Capped | TBD[2] | 1,200[3] |
| 55-608733 | 5 | Inactive – Water Quality | Mountain View[4] | 275[5] |
| 55-501247 | 6 | Active | Northside | 1,550 |
| 55-501288 | 7 | Active | Northside | 1,550 |
| 55-599019 | 8A | Active | Gateway | 2,000[6] |
| 55-608792 | 10 | Active | Rancho Santa Fe | 2,200 |
| 55-608791 | 11 | Active | Rancho Santa Fe | 1,500 |
| 55-608793 | 12 | Active | Rancho Santa Fe | 2,000 |
| 55-583017 | 14 | Inactive – Water Quality | Distribution System | 400 |
| 55-578749 | 15 | Active | Coldwater | 700 |
| 55-200566 | 16 | Active | Coldwater | 2,200 |
| 55-807953 | 16B[7] | Active | Friendship Park Lake | 650 |
| 55-201730 | 17 | Inactive – Lease Expiration | Garden Lakes | 1,200 |
| 55-607157 | 18 | Active | Rancho Santa Fe | 2,100 |
| 55-588631 | 19 | Active | Rancho Santa Fe | 1,450 |
| 55-208099 | 20 | Inactive – Under Construction | Northside | 1,000[5] |
| 55-203924 | 21 | Inactive – Water Quality | Del Rio | 1,820[5] |
| 55-217002 | 22 | Inactive – Under Construction | Coldwater | 1,200[3] |
| 55-202404 | 23 | Active | Distribution System | 1,260 |
| 55-210430 | 24 | Inactive – Under Construction | Gateway | 650[5] |
| 55-217001 | 25 | Inactive – Under Construction | Coldwater | 1,200[3] |
| 55-618650 | 26 | Inactive – Under Construction | Coldwater | 2,200 |
| SRP well | 28 | Inactive – Under Construction | Del Rio | 1,200[3] |

Notes:
(1) Pumping capacity was determined by the City using 2009 well pumping records during maximum day.
(2) To be determined.
(3) Well capacity has not been determined. Assumed to be 1,200 gpm for the purposes of this report.
(4) Water from the Mountain View Reservoir is used for irrigation uses only.
(5) Estimated capacity provided by the City.
(6) Treatment capacity (2,000 gpm) limits well (3,000 gpm) production.
(7) Well #16B is used for irrigation uses only.

**Table 3-2:**
**Water Quality Data**

| | No. Samples | Arsenic (mg/L) | Fluoride (mg/L) | Nitrate as Nitrogen (mg/L) | TDS (mg/L) |
|---|---|---|---|---|---|
| **MCL** | **NA** | **0.010** | **4.0** | **10** | **NA** |
| **Secondary Standard** | **NA** | **NA** | **2.0** | **NA** | **500** |
| Well #1 | 1 | 0.005 | 0.19 | 6.43 | **648** |
| Well #5 | - | **-** | - | - | - |
| Well #6 | 2 | **0.0219** | 0.885 | 3.095 | 319 |
| Well #7 | 2 | **0.0328** | 1.29 | 2.02 | 248 |
| Well #8A | 2 | 0.0026 | 0.165 | **14.8** | **855** |
| Well #10 | 2 | 0.0051 | 0.28 | 6.325 | **543** |
| Well #11 | 2 | 0.00475 | 0.255 | 5.615 | **505** |
| Well #12 | 2 | 0.004 | 0.225 | 3.97 | **549** |
| Well #14 | - | **-** | - | - | - |
| Well #15 | 1 | **0.015** | 0.52 | 3.22 | 394 |
| Well #16 | - | - | - | - | **-** |
| Well #16B | 1 | 0.002 | 0.17 | 6.06 | **752** |
| Well #17 | 1 | 0.003 | 0.17 | **13.1** | **660** |
| Well #18 | 1 | 0.006 | 0.18 | 4.88 | **531** |
| Well #19 | 1 | 0.005 | 0.18 | 4.45 | 474 |
| Well #20 | 1 | **0.015** | 1.2 | 4.7 | 330 |
| Well #21 | 1 | <0.002 | 0.13 | 9.34 | **1450** |
| Well #22 | 1 | 0.0031 | BDL | **10** | **890** |
| Well #23 | 1 | 0.003 | 0.1 | 8.67 | **824** |
| Well #24 | 1 | 0.0025 | <0.4 | 6.9 | **780** |
| Well #25 | 1 | 0.0039 | BDL | **10** | **1100** |
| Well #26 | - | - | - | **-** | **-** |
| Well #28 | - | - | - | **-** | **-** |

Notes: NA – Not Applicable
BDL – Below Detection Limit
Red text signifies values are above the MCL or secondary standard.

### 3.1.2. Blending Plans

The City currently has two approved blending plans to use water from production wells with water quality issues:

- High arsenic water from Well #15 is blended with Well #16 and supplied to the Coldwater reservoir. Loss of Well #16 would result in the loss of Well #15, for a total capacity loss of 2,900 gpm.

- High nitrate water from Well #18 is blended by a combination of Wells #10, #11, #12, and #19 and supplied to the Rancho Santa Fe reservoir. According to the blending plan, the operation of Well #19 is needed in order to operate Well #18. Loss of Well #19 would result in the loss of Well #18, for a total capacity loss of 3,000 gpm.

The City is also reviewing options to blend some of its inactive wells (Wells #17, #21, #22, and #25) with system water or water from another production well. As the City identifies a blending plan and operation strategy for these and future wells, they will be included as additional sources of supply for future water supply alternatives.

## 3.2. Storage Reservoirs

With the exception of Well #23 that pumps directly into the distribution system, groundwater from production wells is treated and stored in storage reservoirs before it is pumped to the distribution system. The reservoirs are above-ground cylindrical steel tanks or below-grade concrete tanks ranging from 1 million gallons (MG) to 3.5 MG in individual capacity (Table 3-3). The water level in the storage reservoirs controls the operation of wells supplying water to it. The total existing storage capacity in the City's drinking water system is 15.5 MG. The City also maintains a small, 0.3 MG storage reservoir at Mountain View for storage of water used only to irrigate Festival Fields. The Mountain View reservoir does not supply water to the potable system; hence, the reservoir capacity is not included in the total drinking water storage capacity and is also not included in the hydraulic model evaluations.

**Table 3-3:**
**Existing Storage Reservoirs**

| Reservoir Name | Construction Type | Elevation (feet) | Tank Height (feet) | Number of Tanks | Total Capacity (MG) |
|---|---|---|---|---|---|
| Rancho Santa Fe | Above-ground steel | 982 | 20 | 2 | 2.8 |
| Northside | Above-ground steel | 1,012 | 16 | 2 | 1.2 |
| Garden Lakes | Below-grade concrete | 1,016 | 24 | 1 | 2.0 |
| Gateway | Below-grade concrete | 1,021 | 25 | 1 | 1.0 |
| Coldwater | Above-ground steel | 971 | 24 | 2 | 5.0 |
| Del Rio | Above-ground steel | 984 | 24 | 1 | 3.5 |
| **Total Drinking Water Storage Capacity** | | | | | **15.5** |

## 3.3. Booster Pump Stations

The booster pumps at each storage facility pump water from storage reservoirs to the distribution system. The booster pumps are set to pump water at a desired pressure into the distribution system. The design capacity and number of pumps at each booster pump station are summarized in Table 3-4. The pump design head and design flow information was obtained from the 2009 Water System Model Update and Analysis (Carollo, 2009).

**Table 3-4:**
**Existing Booster Pumps**

| Description | Design Head (feet) | Design Flow (gpm) |
|---|---|---|
| Rancho Santa Fe - VFD 1 | 162.37 | 2,000 |
| Rancho Santa Fe - VFD 2 | 162.37 | 2,000 |
| Rancho Santa Fe - Soft Start 1 | 162.37 | 2,200 |
| Rancho Santa Fe - Soft Start 2 | 162.37 | 2,200 |
| Coldwater Springs - VFD 1 | 173.3 | 2,000 |
| Coldwater Springs - VFD 2 | 173.3 | 4,000 |
| Coldwater Springs - VFD 3 | 173.3 | 4,000 |
| Coldwater Springs - VFD 4 | 173.3 | 4,000 |
| Northside - 1 | 131.7 | 1,200 |
| Northside - 2 | 131.7 | 1,200 |
| Northside - 3 | 131.7 | 1,800 |
| Northside - 4 | 131.7 | 1,200 |
| Northside - VFD 5 | 131.7 | 2,000 |
| Gateway - VFD 1 | 164 | 2,000 |
| Gateway - VFD 2 | 164 | 2,000 |
| Gateway - VFD 3 | 164 | 2,000 |
| Gateway - VFD 4 | 164 | 2,000 |
| Garden Lakes - 1 | 164 | 1,200 |
| Garden Lakes - 2 | 164 | 1,200 |
| Del Rio - VFD 1 | 166 | 4,000 |
| Del Rio - VFD 2 | 166 | 4,000 |
| Del Rio - VFD 3 | 166 | 2,000 |
| **Total Firm Capacity** | | |

Source: Carollo 2009 Water Model Update Memorandum

## 3.4. System Piping and Pressure Zones

The City's drinking water distribution system includes production well transmission mains, transmission mains, distribution mains, and service connections. As defined in the City's 2008 General Engineering Requirements (GER) Manual, well transmission mains are low pressure pipelines used to convey water from production wells to treatment facilities or storage reservoirs. Transmission mains are defined as pipelines in the distribution system with diameters 16 inches or larger. Distribution mains are pipelines in the distribution system with diameters 8 inches to 12 inches. Service connections are pipelines 6 inches in diameter and smaller that connect the distribution main to the water meter. There are exceptions, however, in many older parts of Avondale where 4- and 6-inch pipes are used as "distribution mains."

According to the City's water infrastructure geographic information system (GIS) database, the drinking water system consists of approximately 310 miles of pipeline (Table 3-5). These pipelines are primarily constructed from polyvinyl chloride; some pipes are also constructed from cast iron, ductile iron, steel, and asbestos cement.

The City's distribution system network is primarily on one pressure zone except for a small area south of Broadway Road that is served by a pressure reducing valve (PRV) at Dysart Road.

**Table 3-5:**
**Existing Distribution System Pipes**

| Type | Diameter (inches) | Total Length (feet) |
|---|---|---|
| Service Connections[1] | 0.75 | 149 |
| | 1 | 3,070 |
| | 1.5 | 0 |
| | 2 | 11,965 |
| | 3 | 4,427 |
| | 4 | 39,916 |
| | 6 | 268,388 |
| Distribution Mains[1] | 8 | 854,333 |
| | 10 | 16,398 |
| | 12 | 296,005 |
| Transmission Mains | 16 | 118,099 |
| | 20 | 19,550 |
| | 24 | 14,757 |
| | 30 | 171 |
| | 36 | 8,324 |

Source: 2009 City water infrastructure GIS database.
Note: (1) Older parts of Avondale contain 4- and 6-inch pipes classified as distribution mains.

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# 4. Historical Water Demands and Peaking Factors

This section summarizes the City's historical drinking water production data and presents the annual average demands and demand peaking factors. Water demand factors in gallons per acre per day (gpad) and gallons per dwelling unit per day (gpd/du) and water demand projections were developed in the companion Water Resource Master Plan update.

## 4.1. Historical Drinking Water Demand

Annual drinking water production data for the City's wells from 2005 to 2009 is summarized in Table 4-1. Total production steadily increased from 2005 to 2007; however, 2008 and 2009 saw a decline in production by approximately 1.0 mgd, going from 12.7 mgd in 2007 to 11.7 mgd in 2009 (excluding Friendship Park Well #16B). The reduction in demand is presumed to be due to the economic downturn that started in 2008 and that resulted in significant home foreclosures and business closures in the City's service area. Because it is anticipated that the City will resume growth as the general economy recovers, it is assumed that the conditions from 2007 will return. As such, the drinking water hydraulic model will be evaluated against the peak drinking water demand conditions of 2007. Thus, the "Existing (2010)" demands denoted herein are based on the 2007 demands.

## 4.2. Maximum Day Peaking Factor

Table 4-2 summarizes the City's maximum day demands, average day demands, and the resulting maximum day to peak day demand factor from 2006 to 2009. The observed peaking factor ranges from 1.51 to 1.61. The 2005 Wastewater Collection System Master Plan & Utility Systems Evaluation indicated that the maximum day to average day peaking factor for the City's water system in 2004 was 1.65. The City's General Engineering Requirements (GER) Manual adopted a maximum day to average day peaking factor of 1.65 based on the 2005 Wastewater Collection System Master Plan & Utility System Evaluation.

**Table 4-1:**
**Average Daily Drinking Water Production**

| Facility Name | Well | 2005 (mgd) | 2006 (mgd) | 2007 (mgd) | 2008 (mgd) | 2009 (mgd) |
|---|---|---|---|---|---|---|
| Rancho Santa Fe | #10 | 1.9 | 2.2 | 1.6 | 1.6 | 1.9 |
| | #11 | 0.7 | 1.1 | 1.5 | 1.1 | 1.2 |
| | #12 | 1.9 | 1.3 | 1.8 | 1.8 | 1.6 |
| | #18 | 0.8 | 1.9 | 2.0 | 1.8 | 0.8 |
| | #19 | 0.9 | 0.9 | 1.3 | 1.1 | 1.3 |
| Northside | #6 | 0.8 | 0.8 | 0.6 | 0.6 | 0.7 |
| | #7 | 0.7 | 0.8 | 0.5 | 0.3 | 0.6 |
| Garden Lakes | #17 | 0.0 | 0.0 | 0.3 | 0.4 | 0.4 |
| Coldwater | #15 | 0.3 | 0.3 | 0.5 | 0.4 | 0.5 |
| | #16 | 1.4 | 1.8 | 2.0 | 1.9 | 1.7 |
| Gateway | #8A | 0.7 | 0.7 | 0.7 | 0.7 | 0.4 |
| Distribution System | #23 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 |
| | #14 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Annual Production** | | 10.3 | 12.0 | 12.7 | 11.8 | 11.7 |

Source: 2005 – 2009 Well Production Reports.

**Table 4-2:**
**Historical Maximum Day Peaking Factors**

| Year | Maximum Day | | Annual Average Demand (mgd) | Maximum Day to Average Day Peaking Factor |
|---|---|---|---|---|
| | Date | Demand (mgd) | | |
| 2006 | July 25 | 19.4 | 12.0 | 1.62 |
| 2007 | July 21 | 20.5 | 12.7 | 1.61 |
| 2008 | July 1 | 17.8 | 11.8 | 1.51 |
| 2009 | August 31 | 18.5 | 11.7 | 1.58 |

Source: 2006 – 2009 Well Production Reports

## 4.3. Peak Hour Peaking Factor

The peak hour to average day peaking factor could not be calculated because the City's supervisory control and data acquisition (SCADA) system only stores 30 days of hourly operations data, and data were not available in other formats such as chart recorders. The City is currently updating its SCADA system to allow the capability to record hourly operations data for extended periods of time. A review of the 2005 Wastewater Collection System Master Plan & Utility Systems Evaluation indicates that the peak hour to average day peaking factor for the City's water system in 2004 was 3.17. The City's GER Manual has also adopted this peaking factor.

# 5. Model Update and Design Criteria

The City's water distribution system hydraulic model was updated and calibrated in February 2009 using MWHSoft H2OMAP Water, as part of the 2009 Water System Model Update and Analysis project. The City provided the calibrated hydraulic model for use in the Water Infrastructure Master Plan update project. The modeled infrastructure was updated with new infrastructure constructed since the previous model update. This section presents the steps taken to update the hydraulic model and to allocate existing water demands within the modeled system. The system performance and design criteria that will be used to evaluate the existing and future water infrastructure are also presented in this section.

## 5.1. Model Updates

The infrastructure and operations information in the calibrated model was verified against the City's water infrastructure GIS database, record drawings, and other information provided by the City. Based on the available information, the following updates were made to the hydraulic model:

- A half-mile of 16-inch transmission main was added along Van Buren Street between 101st Avenue and 105th Avenue
- A quarter-mile of 12-inch transmission main was added along Van Buren Street between 99th Avenue and 101st Avenue as a parallel pipe to the existing 12-inch pipe
- One mile of 36-inch transmission main was added along Van Buren Street between El Mirage Road and Avondale Boulevard
- As they are currently under construction, Well #20, supplying the Northside Reservoir, and Well #24, supplying the Gateway Reservoir, were added to the model
- Well #23 was added to the model and was set to operate 24 hours a day delivering water directly into the distribution system at 56 psi
- The modeled operating patterns for Wells #18 and #19 were modified so that the wells could operate for 24 hours a day as required by system demands
- The delivery pressure setting for the pressure reducing valves downstream of the booster pump stations were set at pressure values shown in Table 5-1

A comparison of the City's existing pipelines and the updated hydraulic model was performed (Table 5-2). More than 90 percent of the total pipe length greater than six inches in diameter is represented in the model. This level of modeled system representation is suitable for master planning and system operations analysis.

**Table 5-1:**
**Booster Station Pressure Model Settings**

| Booster Station | Pressure (psi) |
|---|---|
| Rancho Santa Fe | 65 |
| Northside | 56 |
| Gateway | 52 |
| Del Rio | 61 |
| Garden Lakes | 47 |
| Coldwater | 66 |
| Well #23 | 63 |

**Table 5-2:**
**Comparison of Modeled Versus Existing Pipelines**

| Type | Model Pipes | | Existing Pipes | | % of Length in Hydraulic Model |
|---|---|---|---|---|---|
| | Diameter (inches) | Total Length (feet) | Diameter (inches) | Total Length (feet) | |
| Service Connections | 0.75 | 0 | 0.75 | 149 | 0 |
| | 1 | 158 | 1 | 3,070 | 5 |
| | 1.5 | 45 | 1.5 | 0 | NA |
| | 2 | 6,946 | 2 | 11,965 | 58 |
| | 3 | 4,133 | 3 | 4,427 | 93 |
| | 4 | 34,176 | 4 | 39,916 | 86 |
| | 6 | 199,615 | 6 | 268,388 | 74 |
| Distribution Mains | 8 | 837,952 | 8 | 854,333 | 98 |
| | 10 | 15,982 | 10 | 16,398 | 97 |
| | 12 | 289,277 | 12 | 296,005 | 98 |
| Distribution Transmission Mains | 16 | 114,183 | 16 | 118,009 | 97 |
| | 20 | 18,320 | 20 | 19,550 | 94 |
| | 24 | 14,757 | 24 | 14,757 | 100 |
| | 30 | 55 | 30 | 171 | 32 |
| | 36 | 8,324 | 36 | 8,324 | 100 |

## 5.2. Demand Allocation

The City's existing and projected drinking water demands were obtained from the GIS-based demand projection tool developed as part of the Water Resource Master Plan update. The tool utilizes the City's land use map, land use demand factors, and development growth projections in order to spatially allocate drinking water demands. A summary of the land use-based water demand factors used in the demand projection tool is provided in Table 5-3. A summary of the study area drinking water demands that were used for the existing system evaluation and to develop 2015, 2020, and build-out recommended infrastructure are shown in Table 5-4 and on Figure 5-1.

**Table 5-3:**
**Calibrated Drinking Water Demand Factors**

| Land Use Category | Units | Drinking Demand Factor |
|---|---|---|
| Commercial | gpd/acre | 1,850 |
| Employment | gpd/acre | 1,000 |
| Freeway Commercial | gpd/acre | 1,300 |
| Mixed Use | gpd/acre | 2,230 |
| Open Space (Irrigated) | gpd/acre | 2,300 |
| Open Space (Non—Irrigated) | gpd/acre | 0 |
| Public Facilities | gpd/acre | 1,000 |
| Rural Low Density Residential | gpd/du | 361 |
| Low Density Residential | gpd/du | 361 |
| Medium Density Residential | gpd/du | 361 |
| Medium Density Residential - Estrella | gpd/du | 361 |
| Medium High Density Residential | gpd/du | 361 |
| High Density Residential | gpd/du | 361 |
| Multi-Family Residential | gpd/du | 361 |

Notes: Obtained from the 2010 Water Resource Master Plan update.
gpd/acre - gallons per day per acre
gpd/du - gallons per day per dwelling unit

**Table 5-4:**
**Drinking Water Demand Projections**[1]

| | 2010 | 2015 | 2020 | 2030 | Build-out (2050) |
|---|---|---|---|---|---|
| SRP On-Project Areas (mgd) | 6.3 | 7.5 | 9.7 | 11.3 | 11.3 |
| SRP Off-Project Areas (mgd) | 5.9 | 7.2 | 8.8 | 13.4 | 14.6 |
| Total Drinking Water Demand (mgd) | 12.2 | 14.7 | 18.5 | 24.7 | 25.9 |

Note:
(1) Projections for the City's MPA north of the Estrella Mountains obtained from 2010 Water Resource Master Plan update. Demands do not include Coldwater Gold Course. Friendship Park demands and well (#16B) will be connected to the main distribution system between 2031 and build-out.

For the purposes of the Water Infrastructure Master Plan update, demands for the Coldwater Golf Course, which receives SRP irrigation water and tail water, were not included in the model. Similarly, Friendship Park demands, currently served by a separate irrigation well, were incorporated into the model only at build-out. It is assumed that Friendship Park (and its well) will be connected to the City's main distribution system network between 2031 and build-out.

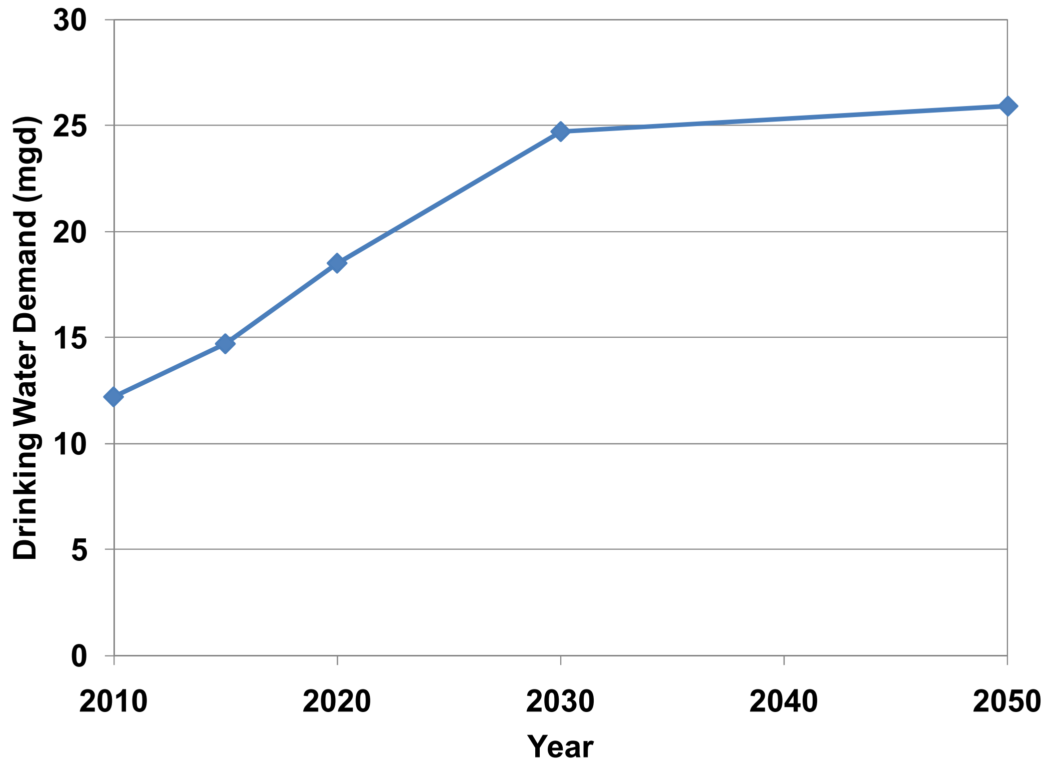



**Figure 5-1: Drinking Water Demand Projections**

The annual average drinking water demands for each planning year were allocated to the network nodes using the Demand Allocator tool, a built-in feature of the H2OMap software. The Demand Allocator tool assigns spatially-distributed water demands, obtained from the demand projection tool, to model nodes using a 'polygon intersection' allocation algorithm. After the base demand was allocated to network nodes, a single diurnal demand pattern (Figure 5-2), developed as a part of the February 2009 model calibration, was assigned to all land use categories in the model.

## 5.3. System Performance and Design Criteria

The system performance and design criteria provide the standards against which the water infrastructure in the hydraulic model will be evaluated to determine the adequacy of existing and future infrastructure. A review was conducted of the City's water system performance and design criteria used in previous master planning efforts and the City's GER Manual. Section 4.8 of GER Manual presents system performance and design requirements for any new water infrastructure.

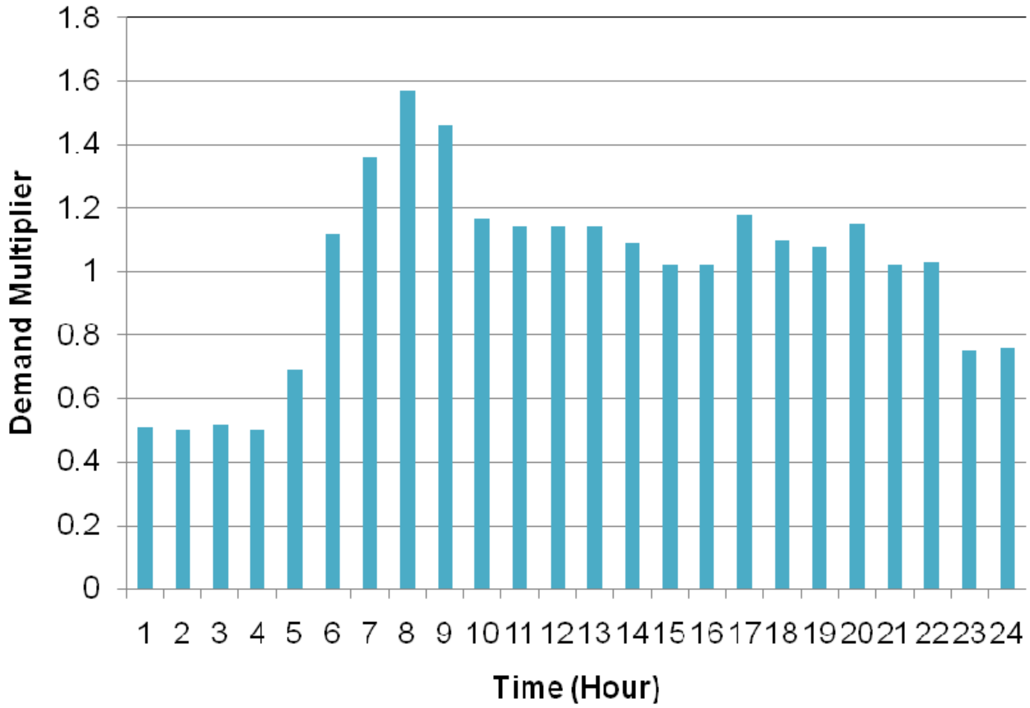



**Figure 5-2: Diurnal Demand Pattern**

The recommended maximum day to average day peaking factor in the GER Manual (1.65) was developed based on production data from 2004. Recent production data from 2006 to 2009 (shown previously in Table 4-2) indicate a maximum day to average day peaking factor between 1.51 to 1.62. Because the GER Manual recommended value was similar to the peaking factor in 2007 (1.61), it is recommended that the more conservative maximum day to average day peaking factor of 1.65, be used for master planning purposes.

The peak hour to average day peaking factor in the GER Manual (3.17) was based on production data from 2004. As described in Section 4, historical data were not available to calculate peak hour to average day demand factors from 2005 to 2009. The GER Manual peaking factor was determined by multiplying the maximum day to average day peaking factor (1.65) by a daily peaking factor (1.92). The City's hydraulic model (calibrated in February 2009) used a daily peaking factor of 1.57. The peak hour to average day peaking factor used was thus 2.59 (1.65 times 1.57). This peak hour to average day peaking factor is less than the value in the GER Manual, but is sufficient for master planning efforts. Thus the peak hour to average day peaking factor of 2.59 associated with the calibrated hydraulic model was used to evaluate existing and future infrastructure herein. As the City continues to collect historical water production data, the peaking factors in the GER Manual should be reviewed and updated in necessary.

A summary of the water system performance and design criteria that are used in the Water Infrastructure Master Plan update are presented in Table 5-5.

**Table 5-5:**
## Drinking Water System Performance and Design Criteria

| Parameters | | | Criteria[1] |
|---|---|---|---|
| Peaking Factor | | Maximum Day to Average Day | 1.65 |
| | | Peak Hour to Average Day | 2.59[2] |
| Wells/Production Facility | | Total Supply | Satisfy maximum day demand with largest well out of service |
| | | Reliable Supply | Satisfy maximum day demand with all wells operating 18 hours or less |
| Storage Facility | | Peak Hour Storage | Satisfy peak hour demand for 4 hours with 50 percent of storage capacity and 50 percent source capacity |
| | | Fire Flow | Satisfy maximum day plus fire flow utilizing all sources and 80 percent of total storage |
| | | Operating Storage | Total storage should be equal to or greater than 20 percent of maximum day demand |
| | | Emergency Supply | Satisfy average day demand with 80 percent of storage volume and 50 percent of well supply operated no more than 18 hours |
| Booster Station Capacity | | Demand Conditions | Satisfy maximum of maximum day and fire flow or peak hour demand without the single largest pump in service |
| Pipe | <36 inch | Velocity | ≤ 5 feet/second |
| | | Head Loss | < 2 to 7 feet / 1,000 feet |
| | | Demand | Maximum day |
| | ≥36 inch | Velocity | ≤ 6 feet/second |
| | | Head Loss | < 1 to 2.5feet / 1,000 feet |
| | | Demand | Maximum day |
| | All sizes | Velocity | ≤ 7 feet/second |
| | | Head Loss | < 10 feet / 1,000 feet |
| | | Demand | Peak hour |
| | All sizes | Fire Flow Velocity | ≤ 10 feet/second |
| Fire Flow | | Residential | 1,000 gpm for 2 hours |
| | | Commercial/Industrial | 3,500 gpm for 4 hours |
| | | Residual Pressure | 20 psi |
| System Pressure | | Maximum Pressure | 80 psi |
| | | Maximum Day Peak Hour Conditions | 40 to 80 psi |

Notes:

(1) Summarized from City of Avondale General Engineering Requirements (2008) Manual Section 4.8.
(2) Adjusted based on the calibrated hydraulic model (February 2009) provided by the City.

# 6. Existing System Evaluation

This section summarizes the findings of the evaluation of the existing system using the updated and calibrated hydraulic model. The hydraulic model developed in H2OMAP and the system performance and design criteria were used to evaluate the existing system for a 24-hour extended period simulation (EPS) during average day, maximum day, and maximum day plus fire flow demand conditions to assess existing system adequacy.

## 6.1. Existing Production Well and Storage Analysis

According to the City's GER Manual, production wells need to meet two criteria: *reliable supply* and *total supply*. *Total supply* is defined as meeting maximum day demands with the largest well out of service. *Reliable supply* is defined as meeting maximum day demands will all wells operating no more than 18 hours per day (Avondale, 2008). Table 6-1 summarizes the production requirements analysis and shows that the City currently does not meet the *reliable supply* criterion (deficit of 0.1 mgd or 100 gpm). The *total supply* criterion, however, is met even when Wells #18 and #19 (largest supply) are taken out of service because of blending restrictions. In order to meet both criteria, the City needs to bring one of its inactive wells online, increase the capacity of one of its active wells, or construct a new well.

**Table 6-1:**
**Existing System Production Well Capacity Analysis**

| | Existing |
|---|---|
| Average Day Demand (mgd) | 12.2 mgd |
| Maximum Day Demand (mgd) | 20.1 mgd |
| Reliable Supply Needed (mgd)[1] | 26.8 mgd |
| Existing Total Pumping Capacity (mgd) | 26.7 mgd |
| Deficit (mgd) | 0.1 mgd |
| Reliable Supply Criterion Met? | No |
| Total Supply Needed with Largest Well Out of Service (mgd)[2] | 22.4 mgd |
| Total Supply Criterion Met? | Yes |

Notes:
(1) Reliable supply needed = 12.2 mgd (average day) times 1.65 (maximum day peaking factor) divided by 0.75 (wells operating 18 hours per day) = 26.8 mgd.
(2) Largest production well out of service accounting for blending is Well #19 (1,500 gpm) because it also prevents blending with Well #18 (1,500 gpm), for a total pumping capacity loss of 4.3 mgd (3,000 gpm).

An analysis was also performed to determine the amount of additional storage needed according to the 2008 GER Manual requirements. The manual defines four criteria that must be met with the available storage and wells:

- Peak hour storage - satisfy demand for 4 hours with 50 percent of storage capacity and 50 percent of source capacity
- Fire flow – satisfy demand utilizing all sources and 80 percent of total storage
- Operating storage – total storage should be equal to or greater than 20 percent of demand
- Emergency supply – satisfy demand with 80 percent of storage volume and 50 percent of well supply operated no more than 18 hours

Based on the above criteria, it was determined that the City's existing system does not require any additional storage (Table 6-2).

**Table 6-2:**
**Existing System Storage Capacity Analysis**

| Storage Capacity Criteria | Storage Needed | Existing (2010) Storage Available | Criterion Met? |
|---|---|---|---|
| Peak Hour Storage[1] | 6.1 MG | 15.5 MG | Yes |
| Fire Flow[2] | 0.0 MG | 15.5 MG | Yes |
| Operating Storage[3] | 4.0 MG | 15.5 MG | Yes |
| Emergency Supply[4] | 2.7 MG | 15.5 MG | Yes |

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

## 6.2. Average Day Demand Analysis

As a part of its normal operations, the City does not regularly use water from the Gateway, Garden Lakes, and Del Rio reservoirs because of production well water quality issues. These reservoirs are occasionally filled with system water as needed to minimize water age in the storage reservoirs and to meet federal and state water quality regulations.

The hydraulic model was used to evaluate system performance for the following operations during average day demand conditions (12.2 mgd):

- Gateway, Garden Lakes, and Del Rio booster pumps not in operation
- Gateway, Garden Lakes, and Del Rio reservoirs filled with system water

### 6.2.1. Gateway, Garden Lakes, and Del Rio Boosters Not in Operation

Under this operational simulation, the system demand is supplied by Rancho Santa Fe, Northside, and Coldwater reservoirs and Well #23. The remaining booster pump stations (Gateway, Garden Lakes, and Del Rio) are not operated. The hydraulic model simulation for the average day demand conditions shows that the system pressure is between 40 psi and 80 psi. The velocities and head losses also met the system performance criteria. Figures 6-1 and 6-2 show the minimum pressure and maximum velocity distribution in the system under these operational conditions. The reservoir water levels are presented in Appendix A.

### 6.2.2. Gateway, Garden Lakes, and Del Rio Reservoirs Filled with System Water

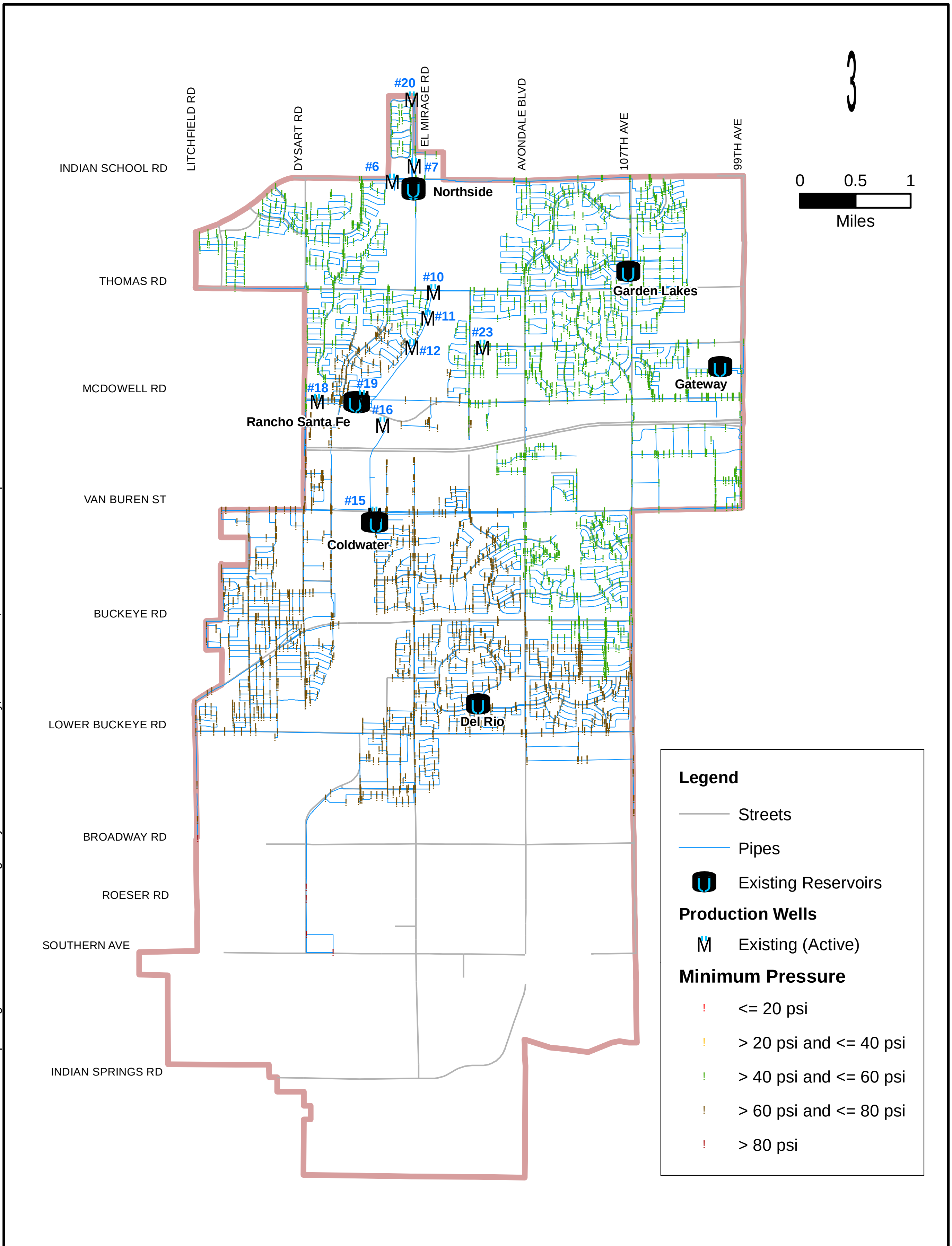
Gateway, Garden Lakes, and Del Rio reservoirs are occasionally filled with system water to meet water quality regulations and minimize the water age in the storage reservoirs. The hydraulic model was used to evaluate system performance while these reservoirs are filled with system water during average day demand conditions. These reservoirs were filled during the night hours when the system demand is lower. The model results show that pressures near these reservoirs are as low as 20 psi when the reservoirs are filling and the reservoir supply line velocities are higher than six feet per second. Figures 6-3 and 6-4 show the pressure and velocity distributions in the system when the Gateway reservoir is filled with system water. The results for the other reservoirs are similar.

For an average day operation, these reservoirs should be filled at night when the demands are low to minimize customer complaints due to low pressure. As additional well supplies feeding these reservoirs are brought online, the pressure and velocity issues observed near the reservoirs are expected to improve.

## 6.3. Maximum Day Demand Analysis

The distribution system was also analyzed for a maximum day demand of 20.1 mgd (average day demand of 12.2 mgd and maximum day to average day peaking factor of 1.65). Similar to the average day demand analysis, two operational conditions were simulated to evaluate the system during maximum day demand conditions. These operational conditions were simulated to show the system performance if the City continues to follow the current operational practice during the summer months, and to determine how the system performance can be improved during peak hour demand periods. The two operational conditions are:

- Gateway, Garden Lakes, and Del Rio booster pumps not in operation
- Gateway booster pumps operating during peak demand




\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-1 Minimum Average Day Pressures - Gateway, Garden Lakes, and Del Rio Not in Operation.mxd

City of Avondale

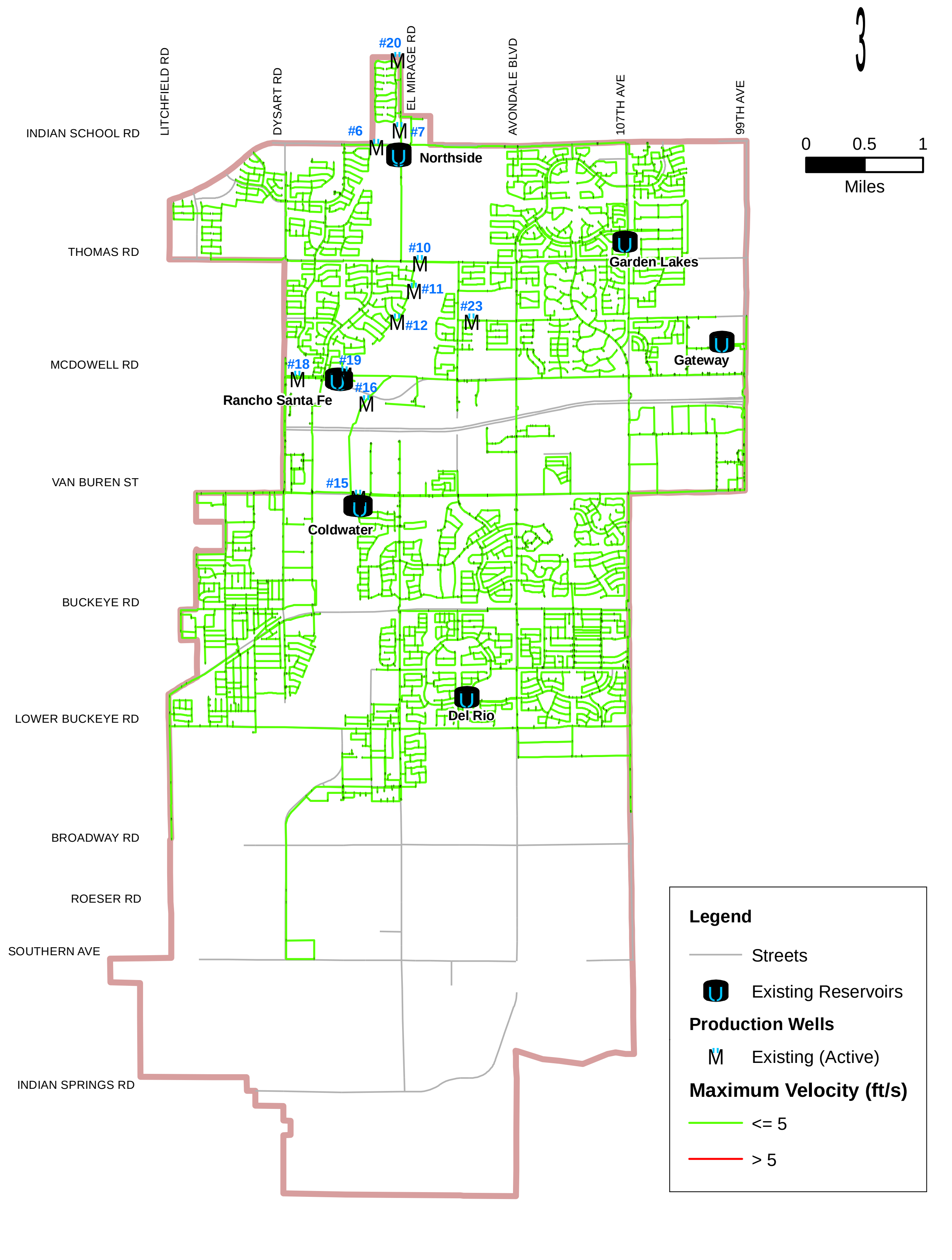
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Minimum Average Day Pressures -**
**Gateway, Garden Lakes, and Del Rio Boosters Not in Operation**

MALCOLM PIRNIE

May 2010

FIGURE 6-1




\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-2 Maximum Average Day Velocities - Gateway, Garden Lakes, and Del Rio Not in Operation.mxd

City of Avondale

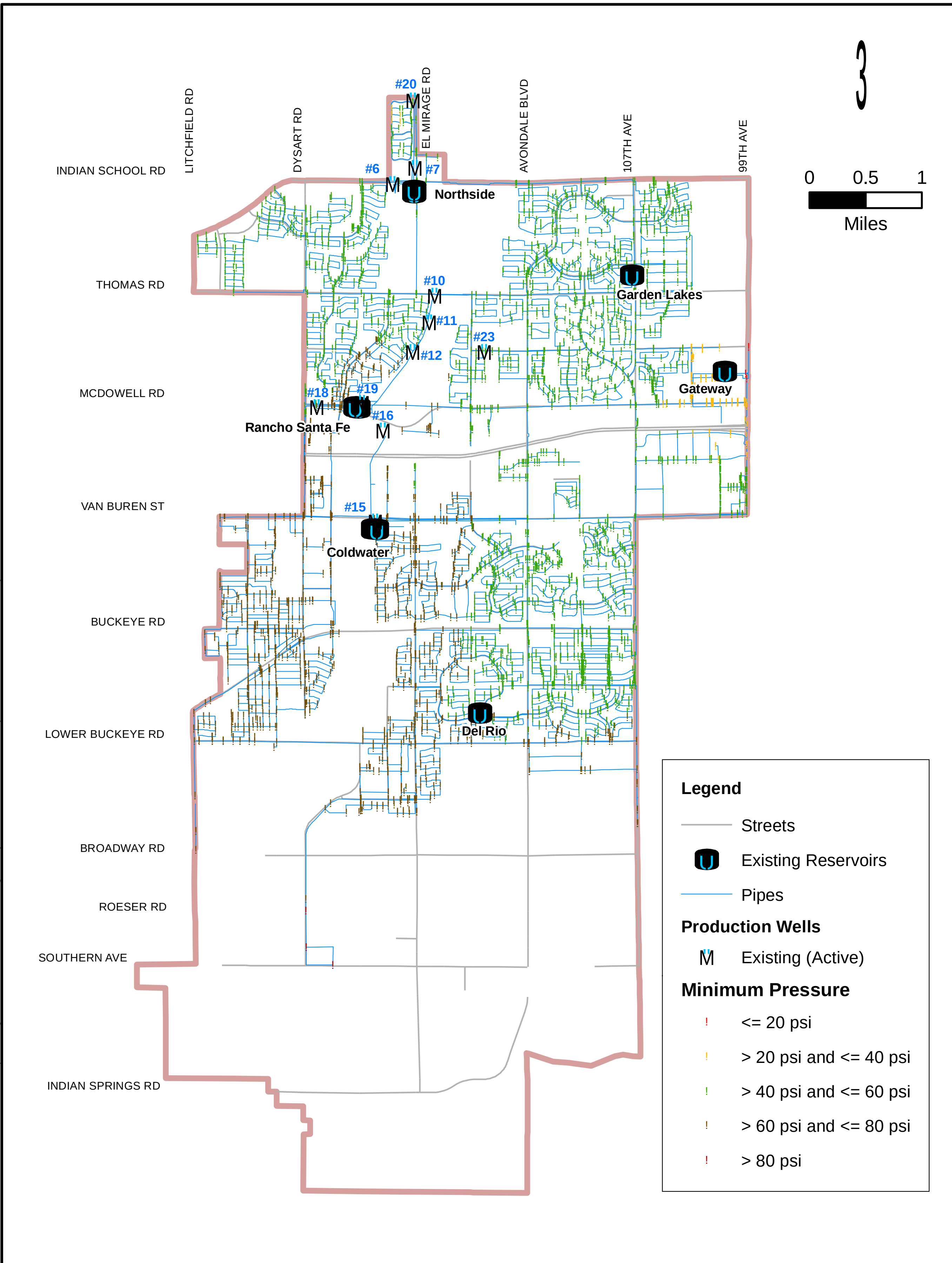
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Maximum Average Day Velocities -**
**Gateway, Garden Lakes, and Del Rio Boosters Not in Operation**

MALCOLM PIRNIE

May 2010

FIGURE 6-2




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-3 Minimum Average Day Pressures - Gateway Reservoir Filled with System Water.mxd

City of Avondale

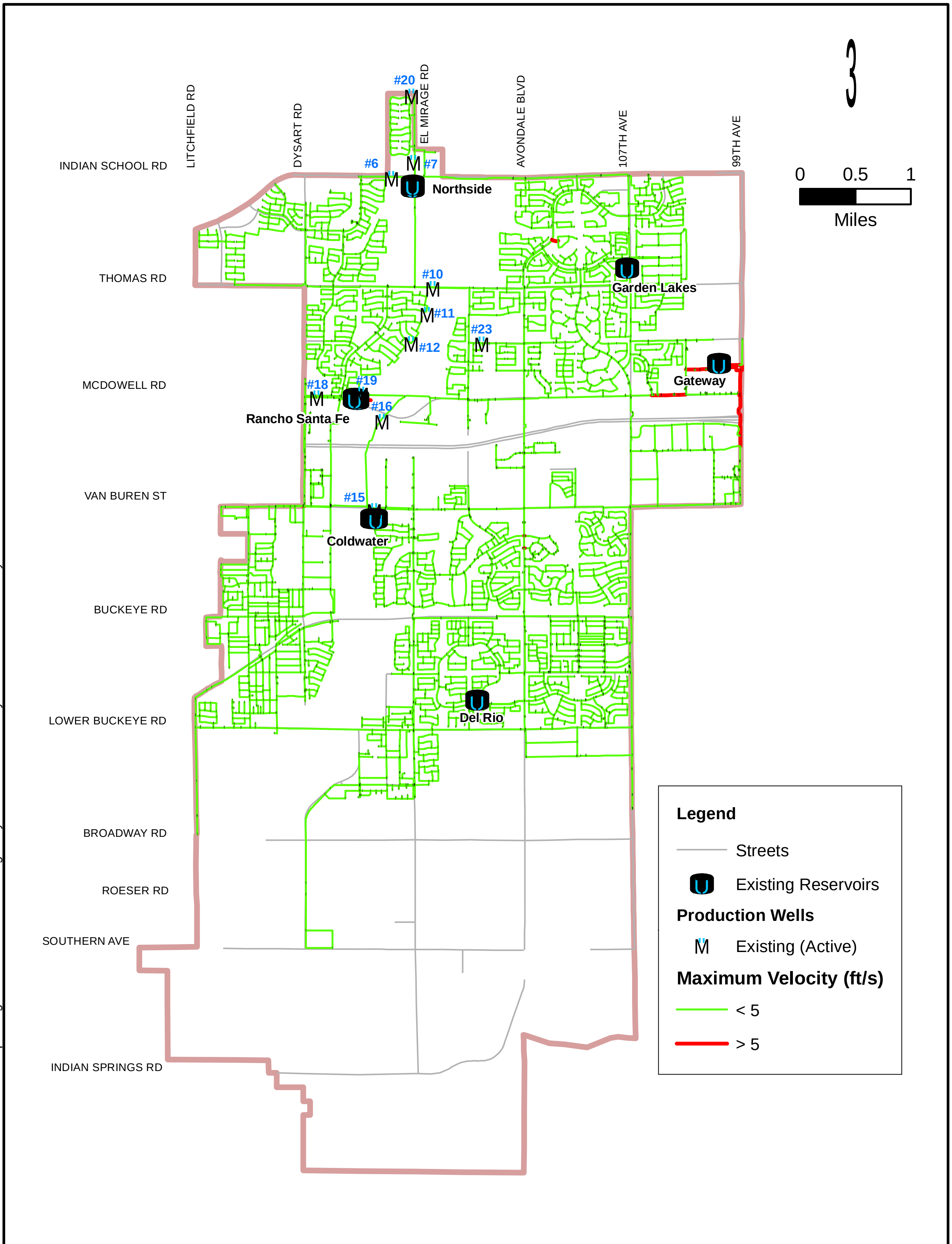
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Minimum Average Day Pressures -**
**Gateway Reservoir Filled with System Water**

MALCOLM PIRNIE

May 2010

FIGURE 6-3




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-4 Maximum Average Day Velocities - Gateway Reservoir Filled with System Water.mxd

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Maximum Average Day Velocities -**
**Gateway Reservoir Filled with System Water**

MALCOLM PIRNIE

May 2010

FIGURE 6-4

### 6.3.1. Gateway, Garden Lakes, and Del Rio Boosters Not in Operation

When the Gateway, Garden Lakes and Del Rio Boosters are not operated during maximum day demand conditions, low pressures (between 20 psi and 40 psi) were observed in the northeast part of the water system. The water level in the Coldwater and Northside reservoirs were below 40 and 70 percent, respectively during peak hour conditions. Figure 6-5 shows the distribution of minimum pressure during the peak hour demand conditions.

### 6.3.2. Gateway Boosters Operating During Peak Demand

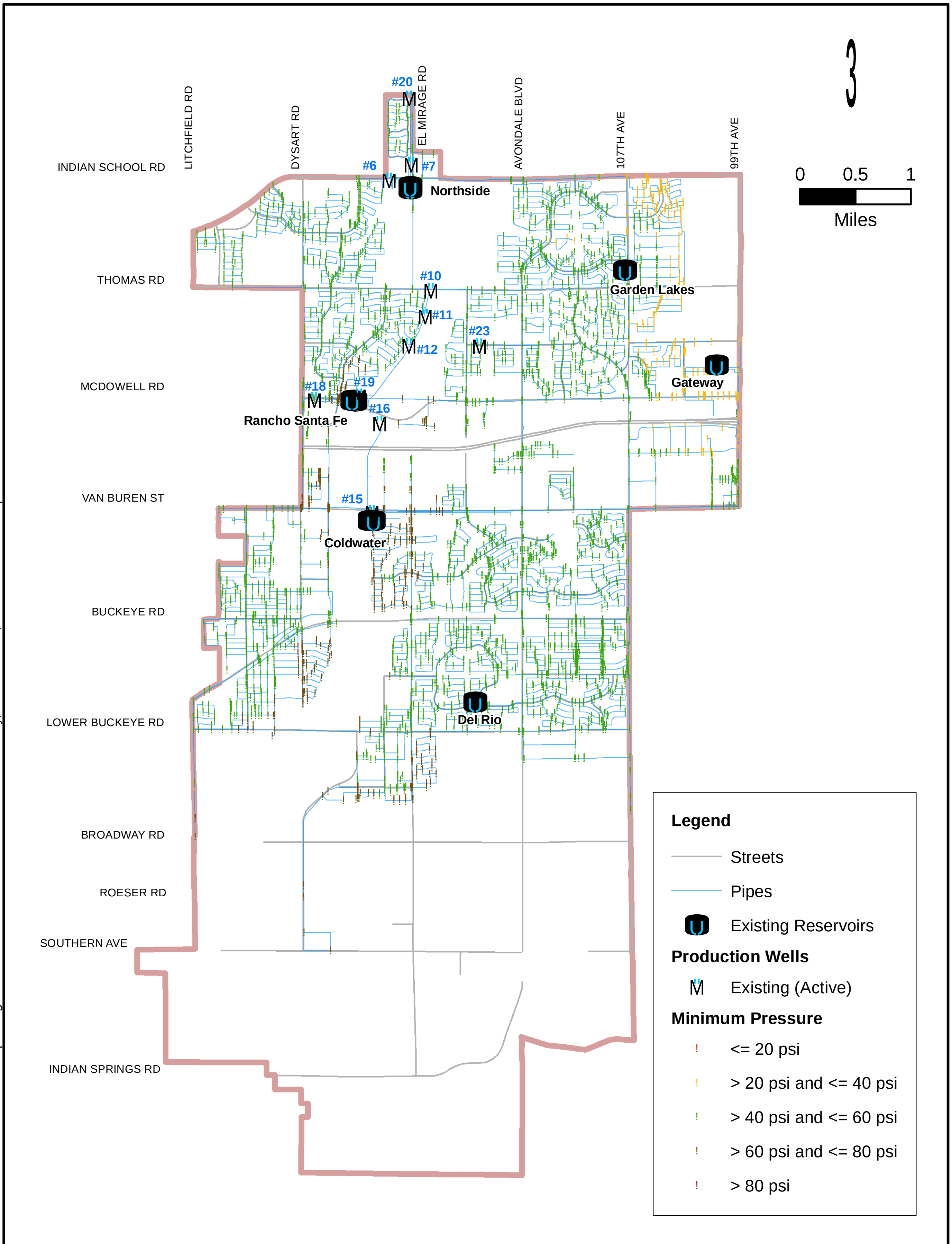
As the pressure in the system decreases below 40 psi, the booster stations at Gateway, Garden Lakes, and Del Rio can be operated individually or in combination to fulfill the system performance criteria. A scenario where the Gateway booster station was operated during the peak demand period was simulated (Figure 6-6). The Gateway booster station was selected because it lies in the eastern part of the network, is more effective in relieving the additional burden on the Rancho Santa Fe and Coldwater booster stations, and is the only station of the three with an active well.

Figure 6-6 shows that the pressure in the system improved when the Gateway booster pumps were operated during peak hour conditions. The velocities and headlosses in the pipes also met the system performance criteria during these conditions (Figures 6-7 and 6-8). When the Gateway booster pumps operate during peak hour demand, the water level in the Coldwater and Northside reservoirs does not fall below 40 and 70 percent, respectively, thus increasing the reliability of the system. Comparisons of reservoir water levels during the maximum day demand conditions are presented in Appendix A.

## 6.4. Fire Flow Analysis

The updated hydraulic model was used to evaluate the system's ability to meet the residential and commercial fire flow demands during existing maximum day demand conditions. The steady-state fire flow modeling option was used to identify network nodes where instantaneously available fire flow did not meet the system design and performance criteria.

The steady-state fire flow modeling analysis revealed that most of the nodes in the system were able to meet the residential fire flow of 1,000 gpm while maintaining residual pressures of 20 psi (Figure 6-9). However, there are a few nodes in the system that did not meet the minimum fire flow criteria. These nodes are located at the dead ends of residential neighborhood piping, on small diameter pipes (less than 4 inches). The fire flow simulation was carried out at all nodes in the system instead of at fire hydrant locations only. City staff indicates that the fire hydrants in these residential neighborhoods are typically located on larger diameter pipe, so, it is likely that all hydrants satisfy the fire flow requirements.




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-5 Minimum Peak Hour Pressures - Gateway, Garden Lakes, and Del Rio Not in Operation.mxd

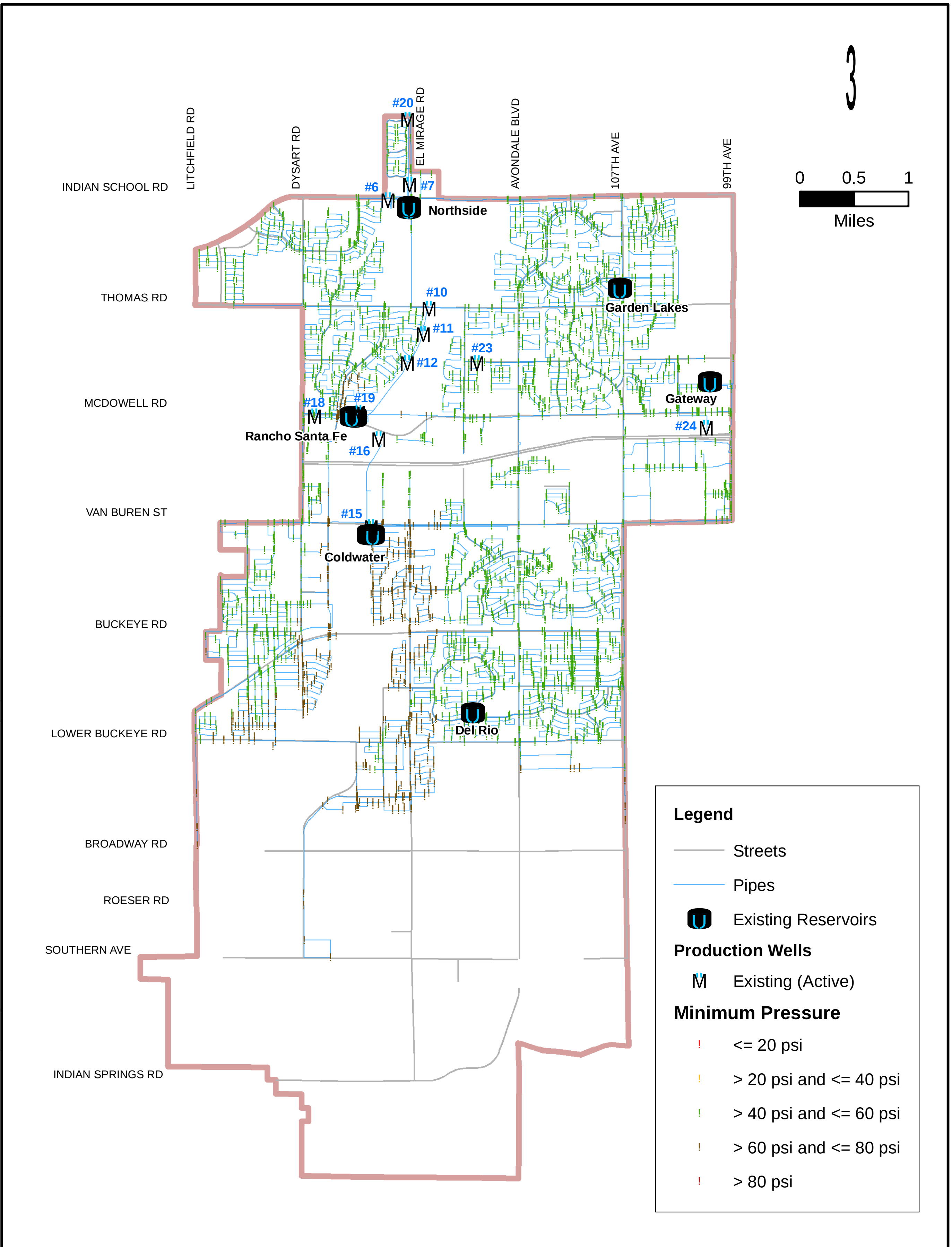
CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Minimum Peak Hour Pressures -**
**Gateway, Garden Lakes, and Del Rio Boosters Not in Operation**

MALCOLM PIRNIE

May 2010

FIGURE 6-5




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-6 Minimum Peak Hour Pressures - Gateway Operating During Peak Demand.mxd

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WATER INFRASTRUCTURE MASTER PLAN

**Minimum Peak Hour Pressures -**
**Gateway Operating During Peak Demand**

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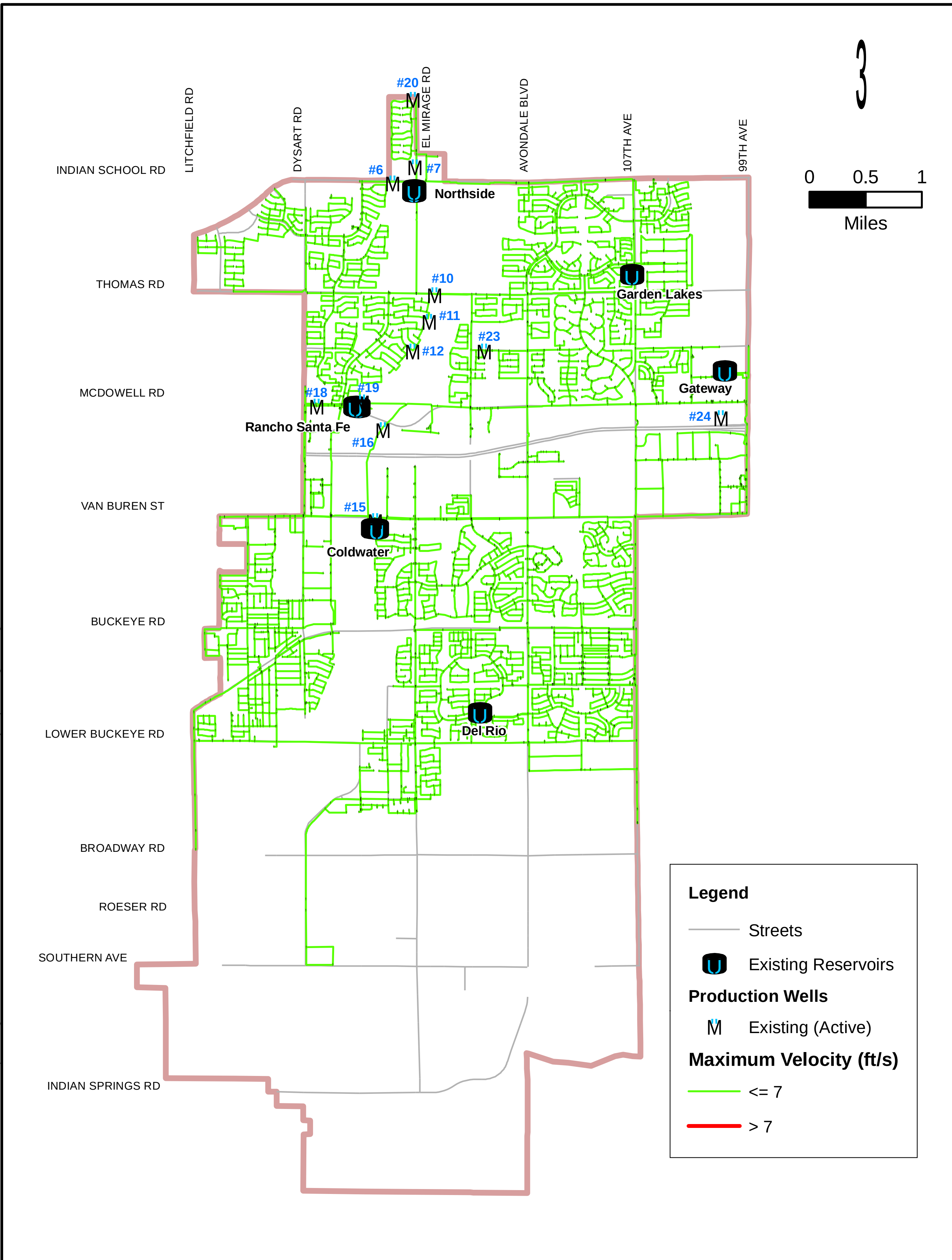
FIGURE 6-6




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-7 Maximum Peak Hour Velocities - Gateway Operating During Peak Demand.mxd

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WATER INFRASTRUCTURE MASTER PLAN

**Maximum Peak Hour Velocities -**
**Gateway Boosters Operating During Peak Demand**

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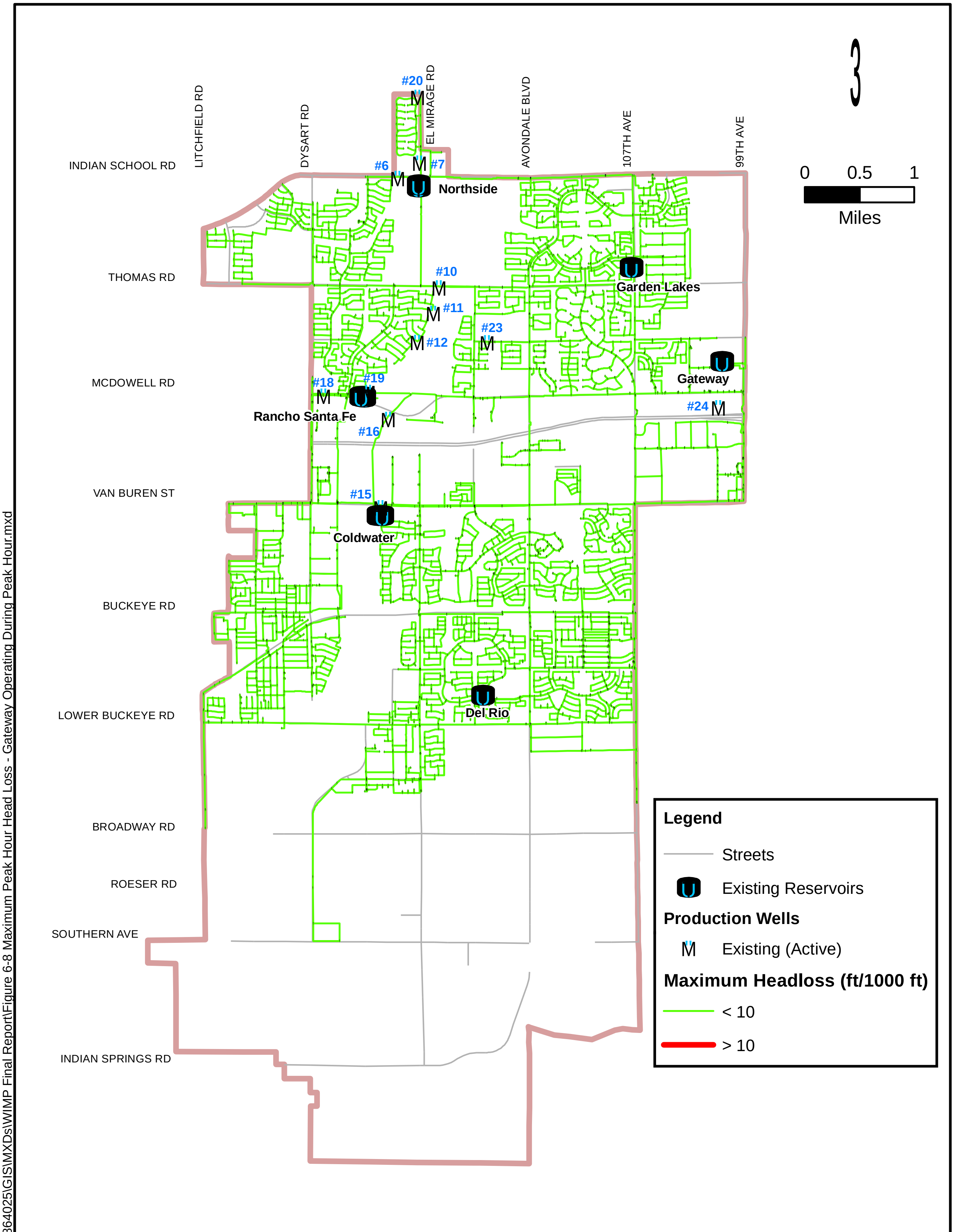
FIGURE 6-7




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-8 Maximum Peak Hour Head Loss - Gateway Operating During Peak Hour.mxd

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**Maximum Peak Hour Head Loss -**
**Gateway Boosters Operating During Peak Hour**

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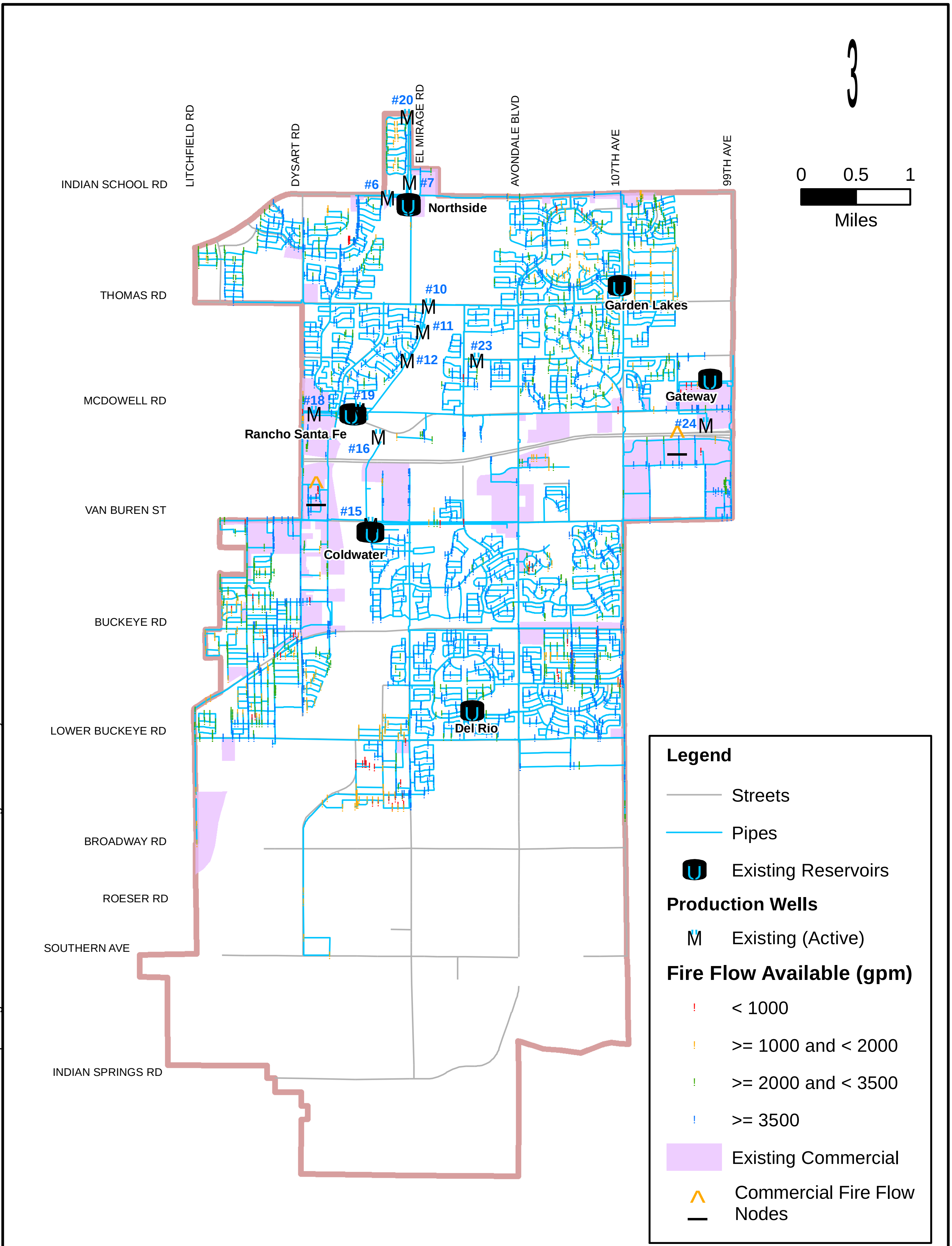
FIGURE 6-8




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 6-9 Available Fire Flow During Maximum Day Demand.mxd

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**Available Fire Flow During Maximum Day Demand**

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May 2010

FIGURE 6-9

As shown on Figure 6-9, all nodes within commercial zones are able to provide fire flows above 3,500 gpm. Individual commercial fire flow (3,500 gpm for 4 hours) was also evaluated for two select locations under an EPS for an existing maximum day demand condition. One high commercial demand node is located in the eastern part of the water system, near the I-10 Freeway between 99th Avenue and 107th Avenue. The other high commercial demand node is located in the western part of the water system east of Dysart Road between the I-10 Freeway and Van Buren Street. The EPS fire flow evaluation at these two high commercial demand locations did not show any fire flow deficiencies.

## 6.5. Summary

When the Gateway booster pump station is used during maximum day demand conditions, the existing water system adequately fulfills the performance and design criteria except for the source capacity. In its current operation, the system requires an additional 0.1 mgd well production capacity to satisfy the total and reliable supply criteria. Once one of the inactive wells comes online (construction, treatment system, or a blending plan), the system will meet both total source and reliable source requirements.

During average day demand conditions, the existing system fulfills the pressure, head loss, and velocity performance criteria without the use of Gateway, Garden Lakes, or Del Rio. If Well #8A is only used for emergency purposes, the City should fill all three reservoirs with system water during periods of low demand (between midnight and 4 am) to minimize low pressures near the reservoirs. During maximum day demand conditions, either the Gateway or Garden Lakes booster pump stations needs to be operated to maintain operating pressures above 40 psi during the peak hour demand conditions. The system was generally able to fulfill the required fire flow at all fire hydrants during maximum day demand conditions.

The existing system evaluation provided an understanding of how the system reacts to different demand scenarios under existing operational practices. Currently, the Rancho Santa Fe, Northside, and Coldwater booster stations provide a majority of the supply into the distribution system. Decreasing the pumping or lowering the pressure setting at these facilities will have direct impact on overall system pressures. The operating pressures at the Northside and Rancho Santa Fe booster stations also have a direct impact on the operating head and discharge of Well #23, as the well directly discharges into the service area of these booster stations.

When multiple booster stations are concentrated in a single pressure zone, such at the existing City system, the booster stations will interact with one another and optimizing system operations becomes more complex. The Northside, Gateway, and Garden Lake booster stations all lie within a narrow elevation difference (less than 9 feet), causing each station to pump against the head generated by the other two. A change in the pressure setting at any one of these booster stations will require a pressure setting change at the other two booster stations for more efficient operations. The Coldwater and Del Rio booster stations share a similar pressure setting dependency as they also lie within a narrow elevation difference (less than 8 feet).

Currently, the Garden Lakes, Del Rio, and Gateway facilities have limited well supply, which limits the use of these facilities (they are used mostly during peak demand or emergency operations). If supply to these facilities can be increased, it will help lower the discharge and pressure requirements at the Rancho Santa Fe and Coldwater booster stations. For efficient system operations, the pressure setting at each booster station has to be adjusted based on the supply conditions at each facility, seasonal fluctuations in demand, and pressure setting at the dependent booster stations.

The existing system performance results and understanding of system operations are considered in development of recommended system improvements in Section 7.

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# 7. Recommended System Improvements

This section presents the recommended water system improvements to enhance existing system operations and to support planned future growth. The recommendations are based on the preferred future water supply strategy identified in the companion Water Resource Master Plan update. Recommended system improvements and associated costs are identified for three planning periods: 5-year (2010 to 2015), 10-year (2016 to 2020), and build-out (2021 to 2050). In addition, supplemental evaluations were conducted to determine the minimum infrastructure requirements for connecting to the Rigby Water Company water system and to the Phoenix International Raceway (PIR) system if the City should choose to make these connections independently at any time.

## 7.1. Future Water Supply Strategy

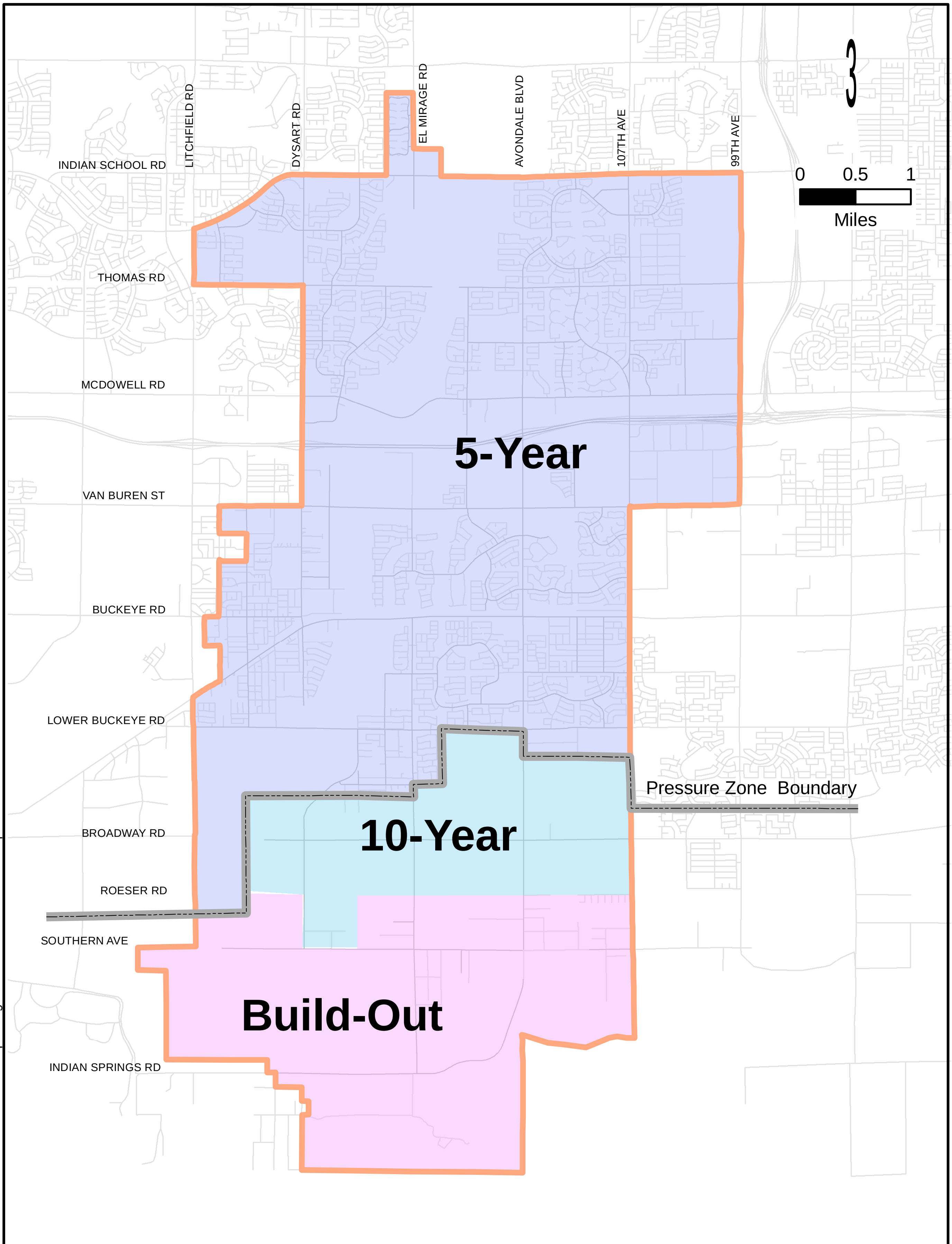
The Water Resource Master Plan update included a detailed evaluation of future water supply alternatives, including continuing to build wells and potentially building a surface water treatment plant (WTP). The water supply alternatives were compared based on 20-year life cycle costs and other criteria that were important to selecting a water supply strategy (annual operation and maintenance costs, financial [bonding] capacity, source water reliability, water quality management, system operational requirements, institutional/legal constraints, carbon footprint, and public perception). Based on the evaluations, the 'continue to build wells' strategy was identified as the preferred strategy, This strategy is less costly than building a new surface WTP and is easier to fund as construction of wells can be spread out over the study period and completed as demand increases dictate.

The recommendations in this Water Infrastructure Master Plan update are, thus, based on continuing to build wells. However, because a surface WTP may provide benefits in achieving future assured water supply designations and could alleviate the need to build additional recharge capacity, and given the inherent uncertainty for future groundwater treatment, it was recommended that the City lock up a site now for a potential surface WTP. The City currently owns the site which was evaluated in the Water Resources Master Plan update, on land south of the Avondale Recharge Facility. The site is near the location where the City currently receives its surface water entitlements and near its larger reservoirs, which would minimize upgrades to pipelines needed should the City construct a WTP at the site. If the City selects another site, additional land acquisition costs would be incurred. Setting aside land will preserve the City's future options should a treatment plant option become necessary due to regulatory, institutional, or water quality needs. Thus, the evaluations and recommendations made in this section were developed to also accommodate a future surface WTP.

## 7.2. Additional Master Plan Assumptions

The following additional assumptions were made in further defining and refining the water supply strategy and in hydraulic modeling evaluations to identify recommended system improvements and expansions:

- Water demands were distributed spatially across the service area using the water demand projection tool developed in the Water Resource Master Plan update.
- City staff assisted in refining the estimates for development phasing and growth within the study area. Figure 7-1 illustrates the resulting assumptions for development phasing and growth which includes the following:
  - The 5-year growth area will include infill within the existing water system, generally the area north of Lower Buckeye Road
  - The 10-year growth area will generally include the area between Lower Buckeye Road and Roeser Road
  - The growth area beyond 10 years through build-out will include the remaining areas north of the Estrella Mountains
- At the suggestion of City staff, a new pressure zone boundary (also shown on Figure 7-1) was established to isolate the area south of Lower Buckeye Road. The new pressure zone will help to maintain operating pressures in the northern areas of the City without creating excessive pressure in the southern areas of the City. This will also allow the City to operate the new pressure zone with minimal operational changes to the existing system.
- Similar to the existing system evaluation, hydraulic model simulations were performed for average day, maximum day, and fire flow conditions. All new pipelines were sized for build-out demand conditions, which would minimize the need to install parallel piping or to replace new pipes as future development continues.
- Existing pipes that did not meet the performance criteria were either replaced or a parallel pipe was provided to increase capacity.
- For all proposed new pipes, the City's standard minimum pipe sizing guidelines were used:
  - Minimum 16-inch diameter along major (mile) arterial roads
  - Minimum 12-inch diameter along minor (half-mile) arterial roads
- All inactive wells currently under construction were considered to be operational and available for use in the 5-year planning period (2010 to 2015). These include Wells #20, #22, #24, #25, and #26. The pumping capacity for Wells #22, #25, and #28 and all new wells is assumed to be 1,200 gpm (1.7 mgd).




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-1 Infrastructure Development Period.mxd

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**Development and Growth Phasing**

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May 2010

FIGURE 7-1

- Well #23 continuously supplies water directly into the City's distribution system.
- SRP water accounting was taken into consideration in locating new wells. Any water pumped from On-Project areas for Off-Project demands must be paid back and accounted for. Thus, to minimize accounting requirements, well capacity exceeding On-Project demands were located Off-Project as much as possible.
- All recommended pipes are sized to accommodate a surface WTP in the future.

## 7.3. Production, Storage, and Booster Pumping Requirements

The Water Resource Master Plan update developed production and storage requirements based on preliminary information on well capacities in order to compare and select a preferred water supply strategy. The preliminary facility information was updated and refined after selection of the water supply strategy. Thus, water production, storage, and booster pumping requirements for the selected water supply strategy was also updated as described in the following subsections.

### 7.3.1. Production Requirements

As described in Sections 5.3 and 6.1, the City's production wells need to meet maximum day demands under two criteria: *reliable supply* and *total supply*. As the system size increases, the *reliable supply* criteria governs the supply requirements. The projected water demands and production requirements are summarized in Table 7-1. The additional supply required at build-out is 30.3 mgd.

**Table 7-1:**
**System Demand and Production Requirements**

| Parameters | 2010 | 2015 | 2020 | Build-out |
|---|---|---|---|---|
| Average Day Demand (mgd) | 12.2 | 14.7 | 18.5 | 25.9 |
| Maximum Day Demand (mgd) | 20.1 | 24.2 | 30.5 | 42.7 |
| Existing Well Supply (mgd)[1] | 26.7 | 26.7 | 26.7 | 26.7 |
| **Production Criteria** | | | | |
| Reliable Supply Needed (mgd)[2] | 26.8 | 32.3 | 40.7 | 57.0 |
| Total Supply Needed (mgd)[3] | 24.4 | 28.5 | 34.8 | 47.1 |
| **Additional Supply Required (mgd)** | **0.1** | **5.6** | **14.0** | **30.3** |

Notes:
(1) Existing well supply was calculated based on the pumping information provided by the City (Section 3.1).
(2) System supply needed to fulfill the maximum day demand with all wells operating for 18 hours or less.
(3) System supply needed to fulfill the maximum day demand with largest well out of service. The capacity of largest well is determined by Wells #18 and #19. As both wells are operated to blend water, loss of Well #19 would result in the loss of Well #18, for a total capacity loss of 3,000 gpm.

### 7.3.2. Recommended Additional Production Capacity

In order to meet the reliable supply criterion, the City's existing, inactive wells were evaluated for additional capacity, placing priority on wells under construction, followed by wells with a potential for rehabilitation, re-drilling, and/or blending. According to

City staff, the production wells currently under construction (Wells #20, #22, #24, #25, and #26) will be operational between 2010 and 2015, increasing the total well supply by 9.0 mgd.

For additional production beyond 2015, four wells (Wells #1, #14, #16B, and #17) were identified as potential candidates for improvement, and TDS treatment was assumed for two additional wells (Wells #21 and #28). Wells #21 and #28 are required to fill the Del Rio reservoir as it currently does not have a well supply, but is needed to serve the increased demand in the south pressure zone. Table 7-2 presents a summary of the existing wells that were identified to be rehabilitated, re-drilled, converted, or treated for future use. Included in the summary is the assumed use of each well for the Water Infrastructure Master Plan update, pumping capacity, and timeline for implementation.

**Table 7-2:**
**Assumed Improvements to Existing Inactive Wells**

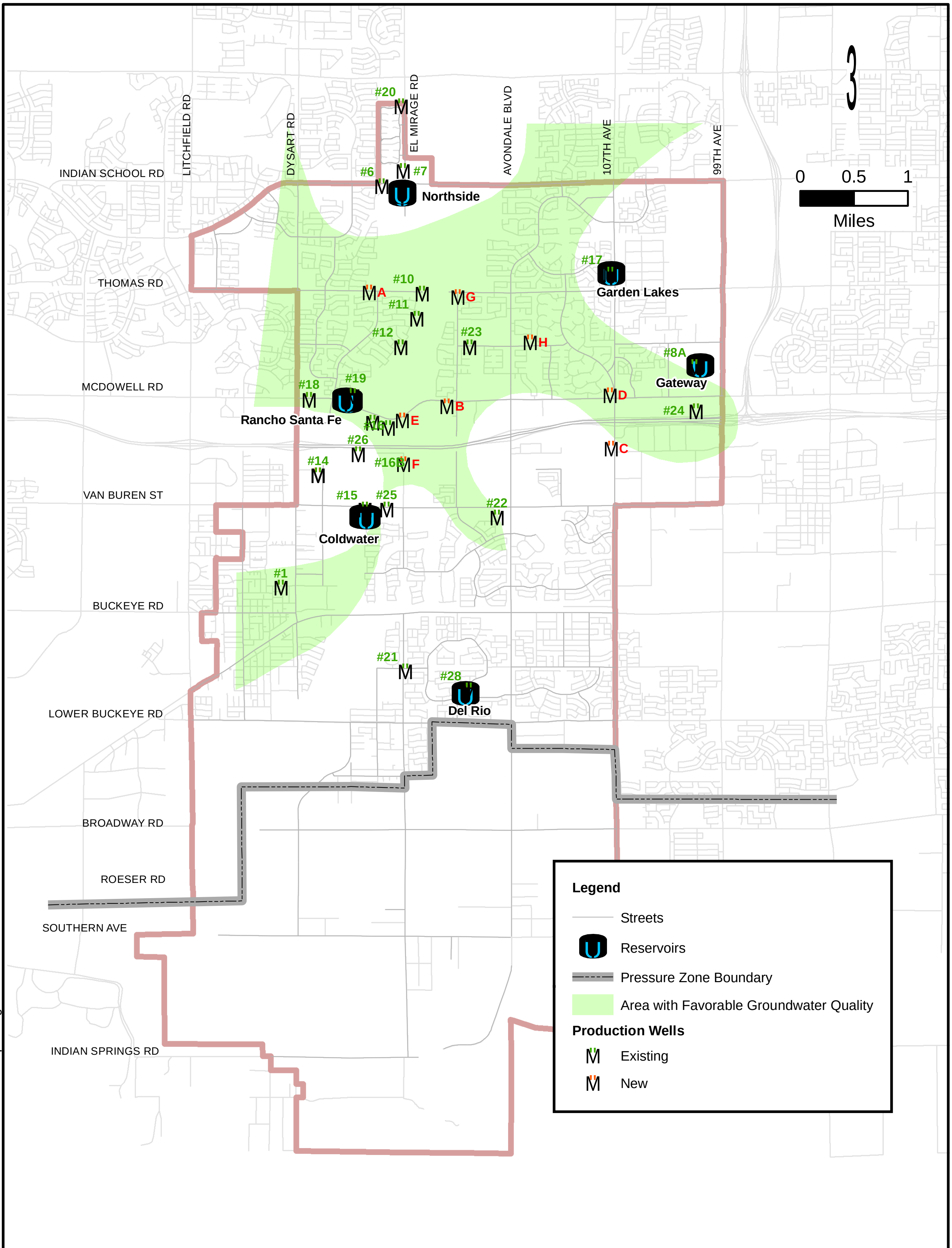
| Well No. | Current Status | Potential for Improvement | Assumption for Master Plan | Pumping Capacity (gpm) | Planning Period |
|---|---|---|---|---|---|
| #1 | Inactive - Capped | - Perform well assessment (water quality, condition of well/well screen, effect on contaminant plume)<br>- Rehabilitate if possible, as space is limited to re-drill<br>- Consider blending with other wells at Coldwater facility, if necessary | Rehabilitate with no treatment | 695 | 2016 - 2020 |
| #14 | Inactive - Water Quality | - Blending with Well #1 or other wells to Coldwater facility a possibility<br>- Depth of well screen may prohibit rehabilitation<br>- Consider re-drilling to shallower depth, increasing capacity from 400 gpm to 1,000 gpm | Re-drill with no treatment | 1,000 | 2016-2020 |
| #17 | Inactive - Lease Expiration | - Blending with system water may limit well capacity<br>- Rehabilitating/re-drilling may not improve water quality<br>- Nitrate treatment infrastructure in place | Treat for Nitrate | 1,200 | 2016-2020 |
| #16B | Active - Irrigation Well | - Connecting to potable system will increase well supply reliability | Connect to well transmission pipe for Coldwater Reservoir, with no treatment | 650 | 2021-Build-out |
| #21 | Inactive - Water Quality | - Distribution of high TDS prohibits rehabilitation<br>- Re-drilling to target lower TDS may increase arsenic<br>- Potential for blending with limited capacity | Treat for TDS | 1,820 | 2021-Build-out |
| #28 | Inactive - Under Construction | - Potential for blending with limited capacity | Treat for TDS | 1,200 | 2021-Build-out |

Accounting for the additional capacities from wells currently under construction (9.0 mgd) and wells in Table 7-2 (4.2 mgd by 2020 and an additional 5.3 mgd by build-out), the City still requires additional well capacity by 2020 (0.8 mgd) and by build-out (11.8 mgd). Assuming a capacity of 1,200 gpm for each new well, this is achieved with one new well in the 2016 to 2020 time period and seven additional wells between 2021 and build-out. It is assumed that new wells will be drilled and screened in appropriate locations such that arsenic, nitrate, and TDS levels are below the City's water quality goals. The hydrogeologic evaluation performed as part of the Water Resource Master Plan update developed a map of favorable groundwater quality based on updated water quality information for City wells and other monitoring wells in the study area. All new wells are assumed to be located in areas with favorable groundwater quality and will not need treatment. Figure 7-2 shows the wells that will be in the system at build-out.

### 7.3.3. Recommended Additional Well Assessments

Additional assessments are required to determine the feasibility of improving the existing wells included in Table 7-2. If the assessments indicate that a well is not suitable for improvement, additional capacity should be obtained in the form of an additional, new well. The following well assessments will help determine the feasibility of rehabilitating inactive wells:

- **Well #1:** Well #1 should be sampled to determine the current water quality for the primary constituents of concern (TDS, nitrate, arsenic and fluoride) and new source approval constituents. An evaluation of well production rates and pumping levels should also be conducted during water quality sampling if possible. If the water quality and production rates are favorable for potable use, then the current condition of the well should be assessed by removing the pumping equipment and performing a video survey of the well. The video survey of the well casing and screen will be used to determine what level of cleaning and rehabilitation is needed to make the well suitable for longer term use as a potable supply well.
- **Well #14:** An exploratory borehole should be drilled and a thorough zonal sampling program should be conducted to verify that water quality conditions are favorable for re-drilling (i.e. TDS and nitrate are not exceeded at shallower depths). While the current wellhead is designed to pump at 400 gpm, re-drilling Well #14 to shallower depths may increase capacity to as much as 1,000 gpm by targeting higher permeability sediments that have been observed at shallower depths. Despite an improvement in pumping capacity, the permitted annual withdrawal limitations will still remain at 970 acre-feet per year.
- **Well #17:** Treatment is the recommended option at this location. The City should contact the treatment supplier (Envirogen) and extend its lease or purchase and operate the treatment system.
- **Wells #21 and #28:** Follow the recommendations in the Del Rio Wellhead Treatment Summary Report (2008) and blend or treat the wells for TDS and nitrate.




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-2 Production Wells at Build-Out.mxd

City of Avondale

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**Production Wells at Build-Out**

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May 2010

FIGURE 7-2

In addition to the improvements to the wells above, the City should also re-evaluate the blending plan for Well #18 based on recent water quality trends in the well. By revoking the blending plan, the City may have greatly flexibility when operating this well.

### 7.3.4. Storage Requirements

As described in Sections 5.3 and 6.1, the City's available system storage must meet four storage criteria: *peak hour storage*, *fire flow storage*, *operating storage*, and *emergency supply storage*. Using these requirements, it was determined that the existing system storage is sufficient to meet and surpass the City's storage needs in all planning periods (Table 7-3). As such, no additional storage facilities and no capacity increases at existing storage facilities are included in the recommended infrastructure improvements.

**Table 7-3:**
**Storage Requirements**

| Parameters | 2010 | 2015 | 2020 | Build-out |
|---|---|---|---|---|
| Average Day Demand (mgd) | 12.2 | 14.7 | 18.7 | 25.9 |
| Maximum Day Demand (mgd) | 20.1 | 24.3 | 30.9 | 42.7 |
| Peak Hour Demand (mgd) | 31.6 | 38.1 | 48.4 | 67.1 |
| Fire Flow (MG) - 3,500 gpm for 4 hours | 0.8 | 0.8 | 0.8 | 0.8 |
| Total Production Capacity (mgd) | 26.8 | 32.3 | 41.1 | 57.0 |
| Existing Storage Capacity (MG) | 15.5 | 15.5 | 15.5 | 15.5 |
| **Storage Criteria** | | | | |
| Peak Hour Storage Needed (MG)[1] | 6.1 | 7.3 | 9.3 | 12.9 |
| Fire Flow Storage Needed (MG)[2] | 0.0 | 0.0 | 0.0 | 0.0 |
| Operating Storage Needed (MG)[3] | 4.0 | 4.9 | 6.2 | 8.5 |
| Emergency Supply Storage Needed (MG)[4] | 2.7 | 3.2 | 4.1 | 5.7 |
| **Additional Storage Required (MG)** | **0.0** | **0.0** | **0.0** | **0.0** |

Notes:
(1) Satisfy peak hour demand for four hours with 50% source capacity and 50% storage capacity
(2) Satisfy maximum day and fire flow demand with 80% total storage and all sources
(3) Operating storage should be equal to or greater than 20% of maximum day demand
(4) Satisfy average day demand with 80% storage volume and 50 % of well supply operated no more than 18 hours

### 7.3.5. Pumping Requirements

As the City grows, pumping capacities at the existing booster stations will have to be upgraded to satisfy the system performance criteria. The GER Manual requires the booster station capacity to fulfill the larger of 1) maximum day demand plus fire flow or 2) the peak hour demand with the single largest pump at each booster station out of service. Based on these criteria, it was determined that all booster stations, except Del Rio, need capacity increases at various times through build-out.

Based on discussions with the City, a new low head booster station near the existing Coldwater facility will be added to provide water from the Coldwater reservoir to the new south pressure zone through a dedicated 24-inch main. Additionally, the Coldwater booster station will have the capacity to serve the south pressure zone during emergencies through a new PRV located downstream of the Coldwater booster station, thus adding a redundant supply for the south pressure zone.

The Coldwater booster station will supply water to both the north and south pressure zones. As most of the existing and new wells are located in the north portion of the network in areas with favorable groundwater quality, the capacity at Coldwater booster station has to be increased to supply the newer developments in the south pressure zone. Other booster station capacities in the north pressure zone have to be increased to supply demands in the areas they serve. Table 7-4 provides a summary of the firm capacity of each booster station proposed for each planning period based on the hydraulic model evaluations. The firm capacity is the pumping capacity of the booster station with the largest pump out of service.

**Table 7-4:**
**Proposed Booster Pumping Capacity**

| Booster Station | Firm Capacity (mgd) | | | |
|---|---|---|---|---|
| | 2010 | 2015 | 2020 | Build-Out |
| Rancho Santa Fe | 8.9 | 8.9 | 11.8 | 14.4 |
| Northside | 7.8 | 7.8 | 7.8 | 8.8 |
| Gateway | 8.6 | 8.6 | 8.6 | 9.8 |
| Del Rio | 8.6 | 8.6 | 8.6 | 8.6 |
| Coldwater | 14.4 | 14.4 | 20.6 | 20.6 |
| Coldwater (Low Head) | 0.0 | 0.0 | 2.5 | 7.6 |
| Garden Lakes | 1.7 | 1.7 | 2.7 | 5.1 |
| **Total Firm Capacity** | **50.0** | **50.0** | **62.6** | **74.9** |

## 7.4. Basis for Cost Estimates

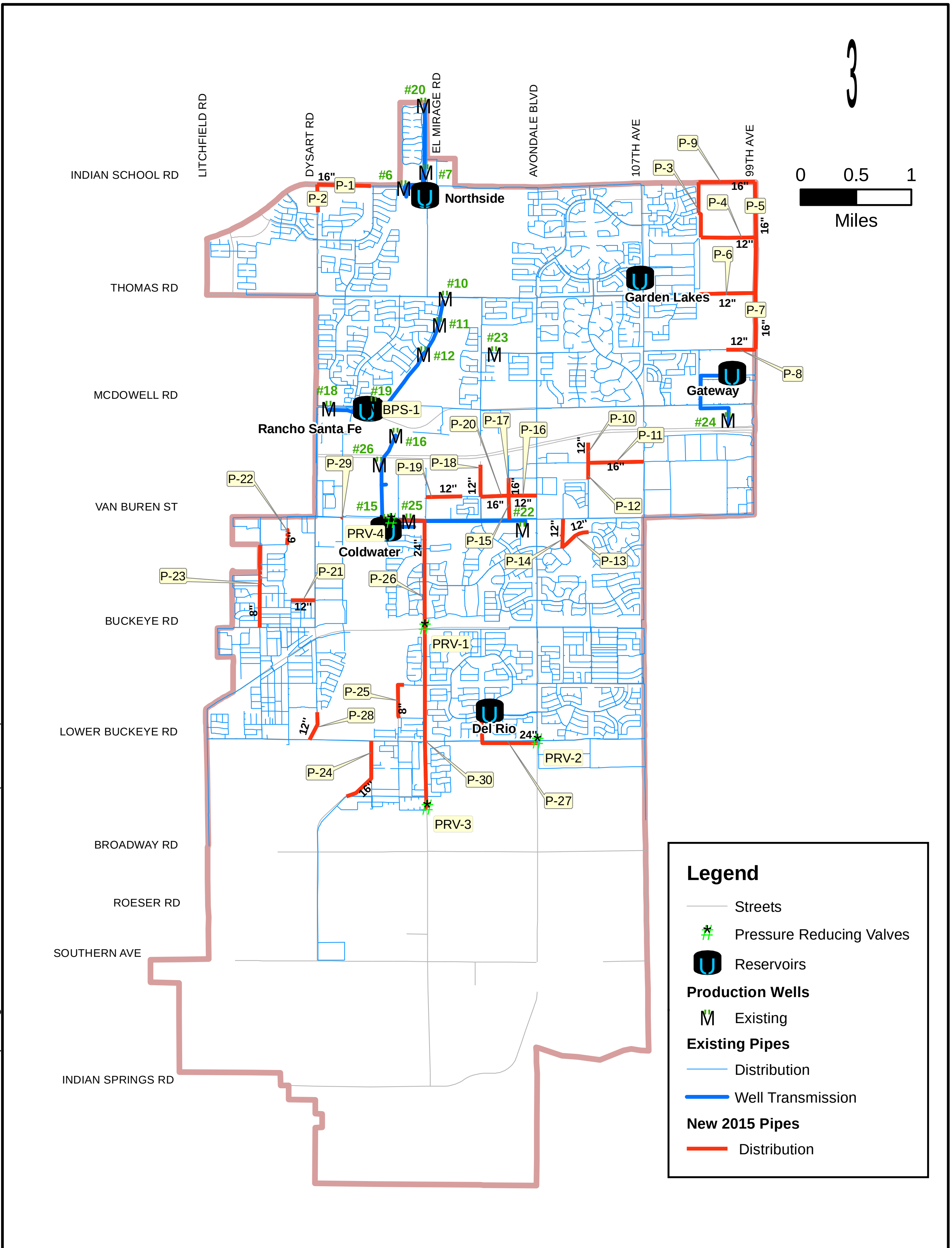
Capital cost estimates were developed for the recommended infrastructure described below. The cost estimates presented are based on available existing studies, recent projects with similar components, manufacturer's budget estimates, standard construction cost estimating manuals, and engineering judgment. The level of accuracy for the cost estimates corresponds to the Class 4 estimate as defined by the Association for the Advancement of Cost Engineering (AACE) International. This level of engineering cost estimating is approximate and generally made without detailed engineering data and site layouts, but is appropriate for preliminary budget-level estimating. The accuracy range of a Class 4 estimate is minus 15 percent to plus 20 percent in the best case and minus 30 percent to plus 50 percent in the worst case.

Appendix B contains unit cost information and other assumptions used in this project for estimating costs for new water supply infrastructure. Unit capital costs include materials of construction, installation, and contractor costs (overhead, profit, bonding, mobilization). Different unit cost values were used for pipes that were located in developed and undeveloped areas. Pipes located in developed areas have higher unit costs to account for additional costs associated with pavement resurfacing, traffic management in developed areas, etc. All costs also include a 20 percent factor for engineering and construction administration and 30 percent for project contingencies. All costs are in January 2010 dollars referenced to an Engineering News Record Construction Cost Index (ENR CCI) of 8,660.

## 7.5. Recommended Infrastructure for 2010-2015

The recommended system improvements for the 5-year planning period (2010 to 2015) are shown on Figure 7-3. The improvements include several piping improvements to increase the capacity and robustness of the existing system, to provide connections for new development, and to create a new pressure zone in the south. The major infrastructure improvements include the following:

- In order to establish the new southern pressure zone, some of the pipes in the pressure zone boundary were closed and three new pressure reducing valves (PRVs) were added to the model: one at El Mirage Road and the railroad (PRV-1), Avondale Boulevard and Lower Buckeye Road (PRV-2), and El Mirage Road and Illini Street (PRV-3). PRV-1 was added to provide an emergency interconnect between the two pressure zones, while PRV-2 and PRV-3 were added to separate the north and south pressure zones. A schematic of the new pressure zone boundary is included in Appendix B.
- 24-inch transmission lines from the Coldwater (P-26 and P-30) and Del Rio (P-27) facilities to the new pressure zone boundary.
- In addition to the three PRVs added to establish the new pressure zone in the south, a fourth PRV (PRV-4) was added downstream of the Coldwater booster station to allow the City the flexibility to use the Coldwater booster station high head pumps to supply the water to the new pressure zone.
- Improvement of some of the pipes in the old town region. The existing pipes are either increased in capacity by providing parallel pipes or are replaced with new pipes with larger diameter (P-21 to P-23).
- The capacity of an existing 8-inch pipe at the junction of El Mirage Rd and Lower Buckeye Rd was increased by providing an 8-inch parallel pipe (P-30).
- New pipes (P-3 to P-9) in the northeast region of the City to support planned commercial development assumed to occur by 2015.
- New pipes (P-15 to P-20) northwest of Avondale Boulevard and Van Buren Street to provide better fire flow for areas planned for increased commercial development.

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**Recommended Infrastructure (2010-2015)**

City of Avondale

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May 2010

FIGURE 7-3

\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-3 Recommended Infrastructure (2010-2015).mxd

The supply from the existing wells and wells that are planned to be finished between 2010 and 2015 (Wells #20, #22, #24, #25, and #26) will provide 9.0 mgd of additional capacity, sufficient to fulfill the projected 2015 production deficit of 5.6 mgd. Thus, no new wells are needed, and no improvements are required to well transmission mains or booster stations in this time period. As the Del Rio and Gateway reservoirs lack sufficient supply from existing wells, it was assumed that the pump stations at these facilities would be operated sparingly and would be filled with system water during non-peak hours.

Table 7-5 provides a summary of the recommended infrastructure and associated capital costs for the 5-year planning period. The estimated total capital cost for the recommended infrastructure for the 5-year planning period is $28.5 million.

**Table 7-5:**
**Recommended Infrastructure (2010-2015)**

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-1 | 16-inch | 2,556 LF | Indian School Rd from Santa Fe Trail to Dysart Rd | $1,102,000 |
| P-2 | 16-inch | 1,310 LF | Dysart Rd from Fairmont Ave to Indian School Rd | $565,000 |
| P-3 | 12-inch | 2,733 LF | 103rd Ave from Osborn Rd to Thomas Rd | $823,000 |
| P-4 | 12-inch | 2,629 LF | Osborn Rd from 99th Ave to 103rd Ave | $442,000 |
| P-5 | 16-inch | 5,280 LF | 99th Ave from Thomas Rd to Indian School Rd | $1,183,000 |
| P-6 | 16-inch | 2,659 LF | Thomas Rd from 99th Ave to 103rd Ave | $596,000 |
| P-7 | 16-inch | 2,664 LF | 99th Ave from Encanto Blvd to Thomas Rd | $597,000 |
| P-8 | 12-inch | 1,390 LF | Encanto Blvd from 99th Ave to 101th Ave | $234,000 |
| P-9 | 16-inch | 1,748 LF | Indian School Rd from 99th Ave to 103rd Ave | $754,000 |
| P-10 | 12-inch | 960 LF | 111th Ave from Roosevelt St to I -10 | $162,000 |
| P-11 | 16-inch | 2,621 LF | Roosevelt St from 107th Ave to 111th Ave | $588,000 |
| P-12 | 16-inch | 788 LF | 111th Ave from Pierce Pkwy to Roosevelt St | $177,000 |
| P-13 | 12-inch | 1,463 LF | Coldwater Sp from 113th Ave to W Civic Dr | $246,000 |
| P-14 | 12-inch | 600 LF | 113th Ave from Coldwater Sp to Van Buren St | $101,000 |
| P-15 | 12-inch | 1,294 LF | 117th Ave from Van Buren St to Roosevelt St | $218,000 |
| P-16 | 12-inch | 1,343 LF | Roosevelt St from Avondale Blvd to 117th Ave | $226,000 |
| P-17 | 16-inch | 688 LF | 117th Ave from Roosevelt St due North | $155,000 |
| P-18 | 12-inch | 1,521 LF | 119th Ave from Roosevelt St to I-10 | $256,000 |
| P-19 | 12-inch | 1,735 LF | Roosevelt St from 120th Ave to El Mirage Rd | $292,000 |
| P-20 | 16-inch | 1,357 LF | Roosevelt St from 117th Ave to 119th Ave | $304,000 |
| P-21 | 12-inch | 1,190 LF | Riley Rd from 5th St to Dysart Rd | $359,000 |
| P-22 | 6-inch | 767 LF | 4th St from E La Canada Blvd to La Vista Dr | $82,100 |
| P-23 | 8-inch | 3,920 LF | Central Ave from Western Ave to E La Canada Blvd | $675,000 |
| P-24 | 16-inch | 2,000 LF | 127th Ave from Vermeesch Rd to Lower Buckeye Rd | $448,000 |
| P-25 | 8-inch | 1,867 LF | 125th Ave from Durango Rd due South | $210,000 |
| P-26 | 24-inch | 15,325 LF | El Mirage Rd from W Illini St to Coldwater BPS | $9,720,000 |
| P-27 | 24-inch | 4,422 LF | Lower Buckeye Rd from Avondale Blvd to Del Rio BPS | $2,810,000 |
| P-28 | 12-inch | 1,375 LF | Dysart Rd from Lower Buckeye Rd to Whyman Rd | $413,900 |
| P-29 | 12-inch | 35 LF | Van Buren St and 10th St | $10,600 |

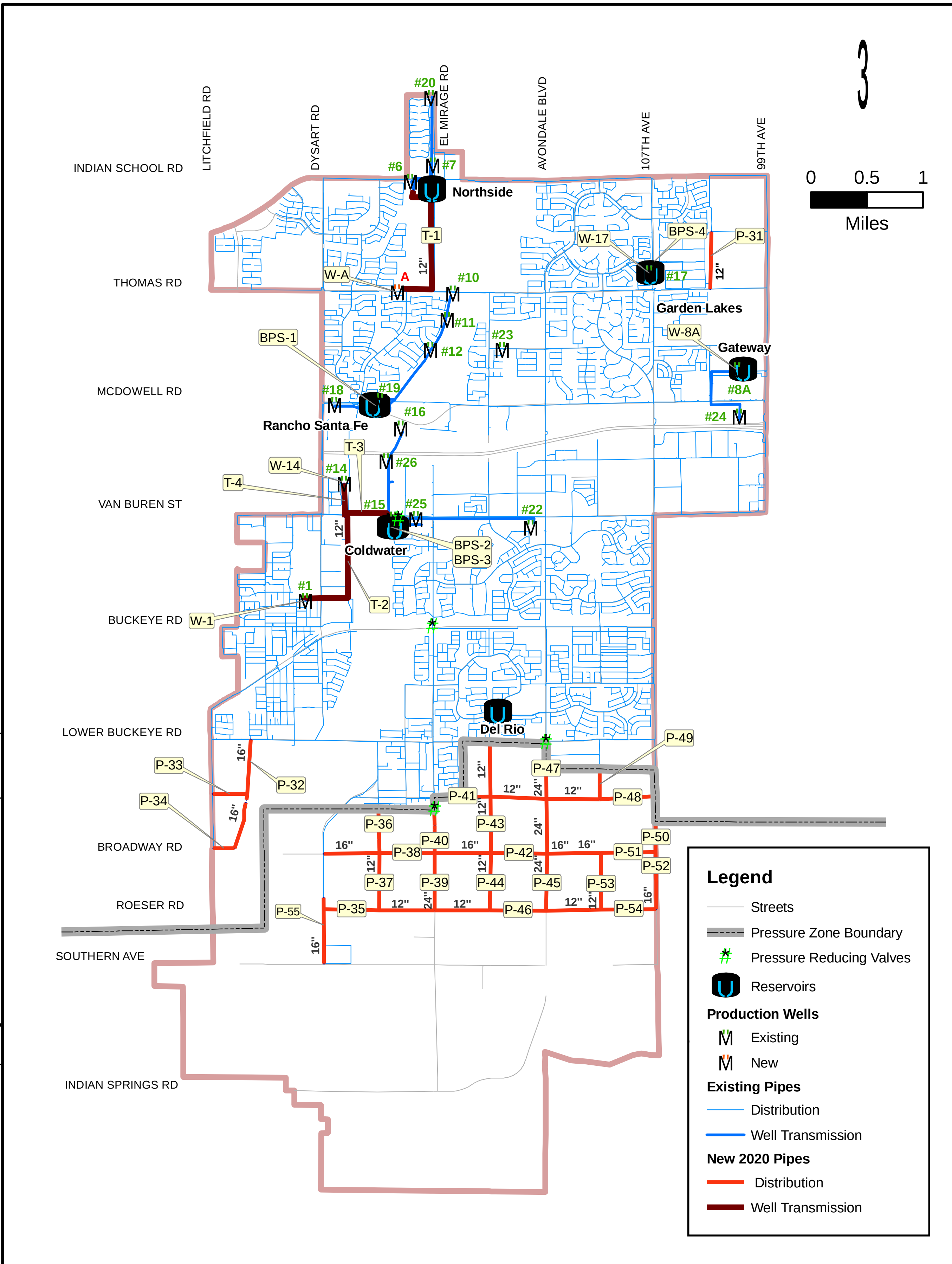
| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| P-30 | 8-inch | 46 LF | El Mirage Rd and Lower Buckeye Rd | $8,000 |
| **Well Transmission Mains** | | | | |
| None | | | | |
| **Booster Pump Stations** | | | | |
| None | | | | |
| **Pressure Reducing Valves** | | | | |
| PRV-1 | 24-inch | - | El Mirage Rd and Railroad | $1,176,000 |
| PRV-2 | 24-inch | - | Avondale Blvd and Lower Buckeye Rd | $1,176,000 |
| PRV-3 | 24-inch | - | El Mirage Rd and Illini St | $1,176,000 |
| PRV-4 | 20-inch | - | Coldwater BPS | $1,176,000 |
| **Wells** | | | | |
| None | | | | |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$28,500,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

## 7.6. Recommended Infrastructure for 2016-2020

The recommended system improvements for the 10-year planning period (2016-2020) are shown on Figure 7-4. The additional infrastructure is required to serve the increased demand in the existing system and to deliver water to new customers located in the new pressure zone generally between Lower Buckeye Road and Roeser Road. The average day demand increases from 14.7 mgd in 2015 to 18.7 mgd in 2020 requiring additional water supplies and pumping capacity. The major infrastructure improvements include the following:

- One new well (Well-A) and four existing wells (Wells #1, #8A, #14, and #17) with improvements to fulfill the reliable supply for the system. The new well W-A would deliver water to the Northside reservoir which currently lacks the well supply to fill the reservoir during average day conditions.
- New transmissions mains (T-1 to T-4) to transport water from the new or improved wells to the reservoirs at the Coldwater and Northside facilities.
- A low head booster station (BPS-3) at the Coldwater facility to satisfy the demands in the new pressure zone and to provide redundant supply.
- Increased pumping capacity at Rancho Santa Fe (BPS-1), Coldwater (BPS-2) and Garden Lakes (BPS-4) needed to meet increased demands and pressure requirements.
- New pipes (P-35 to P-55) to serve the developments in the south pressure zone.




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-4 Recommended Infrastructure (2016-2020).mxd

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Recommended Infrastructure (2016-2020)**

MALCOLM PIRNIE

May 2010

FIGURE 7-4

- A new 24-inch transmission backbone (P-39, P-40, P-45, and P-47) which will be looped in the next planning period to increase system reliability.
- New pipes (P-32 to P-34) to serve commercial areas west of the Aqua Fria River.

The new pressure zone will be supplied primarily by the Coldwater booster station while the Del Rio booster station will be available as a secondary supply for emergency or peak demands. As the Del Rio reservoir lacks a well supply, it was assumed that the Del Rio booster station would be operated sparingly and would be filled with system water during non-peak hours.

Table 7-6 provides a summary of the recommended system improvements and associated capital costs for the 10-year planning period. The total estimated capital cost for the recommended infrastructure for the 10-year planning period is $41.3 million.

**Table 7-6:**
**Recommended Infrastructure (2016-2020)**

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-31 | 12-inch | 2,784 LF | 103rd Ave from Thomas Rd to Mulberry Dr | $838,000 |
| P-32 | 16-inch | 6,954 LF | West of Aqua Fria River from Broadway Rd to Lower Buckeye Rd | $1,560,000 |
| P-33 | 8-inch | 1,630 LF | Elwood St from Aqua Fria River to Litchfield Rd | $183,000 |
| P-34 | 8-inch | 989 LF | Broadway Rd from Aqua Fria River to Litchfield Rd | $111,000 |
| P-35 | 12-inch | 5,213 LF | Roeser Rd from El Mirage Rd to Dysart Rd | $876,000 |
| P-36 | 12-inch | 2,077 LF | 127th Ave from Broadway Rd to Illini St | $349,000 |
| P-37 | 12-inch | 2,690 LF | 127th Ave from Roeser Rd to Broadway Rd | $452,000 |
| P-38 | 16-inch | 5,209 LF | Broadway Rd from El Mirage Rd to Dysart Rd | $1,170,000 |
| P-39 | 24-inch | 2,680 LF | El Mirage Rd from Roeser Rd to Broadway Rd | $901,000 |
| P-40 | 24-inch | 2,019 LF | El Mirage Rd from Broadway Rd to Illini St | $679,000 |
| P-41 | 12-inch | 5,285 LF | Elwood Rd from Avondale Blvd to El Mirage Rd | $888,000 |
| P-42 | 16-inch | 5,282 LF | Broadway Rd from Avondale Blvd to El Mirage Rd | $1,190,000 |
| P-43 | 12-inch | 5,232 LF | 119th Ave from Broadway Rd to Lower Buckeye Rd | $879,000 |
| P-44 | 12-inch | 2,691 LF | 119th Ave from Roeser Rd to Broadway Rd | $453,000 |
| P-45 | 24-inch | 2,676 LF | Avondale Blvd from Roeser Rd to Broadway Rd | $900,000 |
| P-46 | 12-inch | 5,227 LF | Roeser Rd from Avondale Blvd to El Mirage Rd | $879,000 |
| P-47 | 24-inch | 5,165 LF | Avondale Blvd from Broadway Rd to Lower Buckeye Rd | $1,740,000 |
| P-48 | 12-inch | 5,117 LF | Elwood Rd from 107th Ave to Avondale Blvd | $860,000 |
| P-49 | 12-inch | 1,435 LF | 111th Ave from Elwood St to Miami Rd | $242,000 |
| P-50 | 16-inch | 1,432 LF | 107th Ave from Broadway Rd Due North | $321,000 |
| P-51 | 16-inch | 5,098 LF | Broadway Rd from 107th Ave to Avondale Blvd | $2,200,000 |
| P-52 | 16-inch | 2,667 LF | 107th Ave from Roeser Rd to Broadway Rd | $1,150,000 |
| P-53 | 12-inch | 2,659 LF | 111th Ave from Roeser Rd to Broadway Rd | $447,000 |
| P-54 | 12-inch | 5,192 LF | Roeser Rd from 107th Ave to Avondale Blvd | $1,563,000 |
| P-55 | 16-inch | 3,321 LF | Dysart Rd from Southern Ave to Roeser Rd | $1,432,000 |
| **Well Transmission Mains** | | | | |
| T-1 | 12-inch | 6,965 LF | El Mirage Rd from Well W-A to Northside Reservoir | $2,100,000 |
| T-2 | 12-inch | 9,868 LF | Eliseo C Felix Jr Wy from Well #1 to Van Buren St | $2,980,000 |

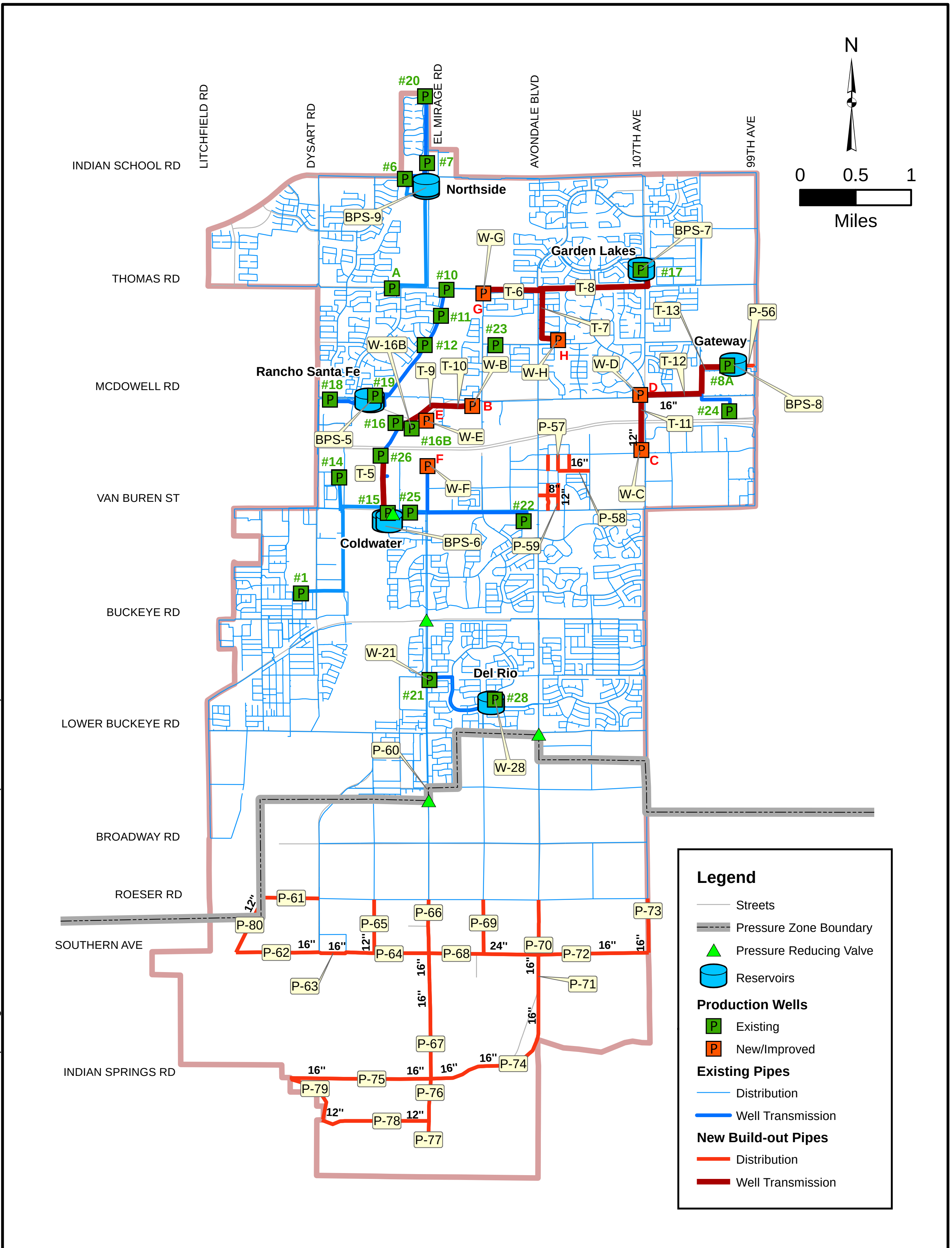
| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| T-3 | 12-inch | 2,761 LF | Van Buren St from Coldwater Reservoir to Eliseo C Felix Jr Wy | $832,000 |
| T-4 | 12-inch | 1,300 LF | Eliseo C Felix Jr Wy from Van Buren St to Well #14 | $392,000 |
| **Booster Pump Stations** | | | | |
| BPS-1 | 2.9 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $1,057,000 |
| BPS-2 | 6.2 mgd | @ 170 ft | Coldwater Booster Pump Station | $2,260,000 |
| BPS-3 | 2.5 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $920,000 |
| BPS-4 | 1.0 mgd | @ 165 ft | Garden Lakes Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W-1 | 1.0 mgd | Rehabilitate Existing | Well #1 - Riley Rd and 6th Street | $1,007,914 |
| W-8A | 2.0 mgd | Provide Treatment | Well #8A - 99th Ave and Encanto Blvd | $1,320,000 |
| W-14 | 1.4 mgd | Re-drill | Well #14 - Van Buren St and Eliseo C Felix Jr Way | $2,210,000 |
| W-17 | 1.7 mgd | Provide Treatment | Well #17 - 107th Ave and W Lakeshore Dr | $1,320,000 |
| W-A | 1.7 mgd | Construct New Well | Well W-A - Thomas Rd and Santa Fe Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$41,300,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

## 7.7. Recommended Infrastructure for 2021-Build-out

The recommended system improvements for the build-out period (2021 to build-out) are shown on Figure 7-5. The additional infrastructure is required to serve all areas of the City north of the Estrella Mountains. The average day demand increases from 18.7 mgd in 2020 to 25.9 mgd at build-out requiring additional supply and pumping capacity. The major infrastructure recommendations include the following:

- Seven new wells (Wells B, C, D, E, F, G, and H) and improvements to three existing wells (Wells #16B, #21, and #28) are needed to increase the available water supply and to fulfill the required reliable capacity.
- New well transmissions mains (T-6 to T-12) from the new wells to the Coldwater, Garden Lakes, and Gateway reservoirs, and improvements to the existing well transmission mains (T-5 and T-13).
- New pipes (P-57 to P-59) for the Phase II development of City Center.
- New pipes (P-61 to P-80) to serve the developments south of Roeser Road.




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Recommended Infrastructure (2021 to Build-Out)**

MALCOLM PIRNIE

May 2010

FIGURE 7-5

\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-5 Recommended Infrastructure (2021-Build-Out).mxd

- New pipes (P-66, P-68, and P-70) to complete the 24-inch transmission loop in the south area and to provide additional reliability to the water system.
- Increased capacity at all booster stations (BPS-5 to BPS-9) except Del Rio needed to meet increased demand and pressure requirements.

Table 7-7 provides the list of recommended system improvements and associated capital costs for the build-out period. The total estimated capital costs for the recommended infrastructure for the build-out period is $56.2 million.

**Table 7-7:**
**Recommended Infrastructure (2021-Build-out)**

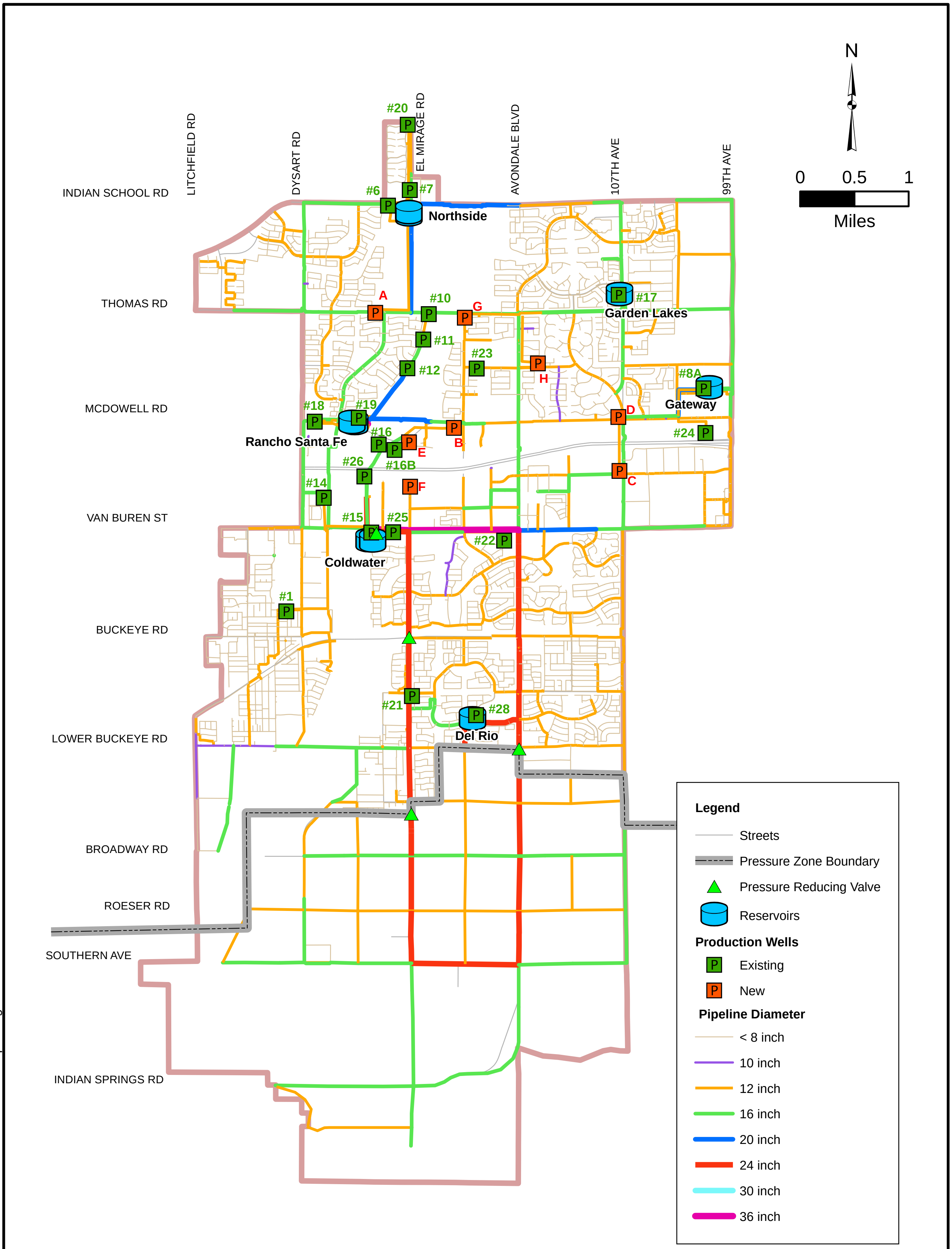
| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| P-56 | 16-inch | 1,096 LF | From 99th Ave to Gateway BPS | $473,000 |
| P-57 | 8-inch | 4,607 LF | City Center | $793,000 |
| P-58 | 16-inch | 1,508 LF | City Center | $650,000 |
| P-59 | 12-inch | 1,295 LF | City Center | $390,000 |
| P-60 | 6-inch | 110 LF | El Mirage Rd and Elwood Rd | $11,800 |
| P-61 | 12-inch | 2,657 LF | Roeser Rd from Dysart Rd to Aqua Fria River | $447,000 |
| P-62 | 16-inch | 3,934 LF | Southern Ave from Dysart Rd to Aqua Fria River | $882,000 |
| P-63 | 16-inch | 1,302 LF | Southern Ave from 129th Ave to Dysart Rd | $292,000 |
| P-64 | 16-inch | 3,946 LF | Southern Ave from El Mirage Rd to 129th Ave | $884,000 |
| P-65 | 12-inch | 2,542 LF | 127th Ave from Southern Ave to Roeser Rd | $428,000 |
| P-66 | 24-inch | 2,547 LF | El Mirage Rd from Southern Ave to Roeser Rd | $856,000 |
| P-67 | 16-inch | 5,963 LF | El Mirage Rd from Indian Springs Rd to Southern Ave | $1,340,000 |
| P-68 | 24-inch | 5,212 LF | Southern Ave from Avondale Blvd to El Mirage Rd | $1,760,000 |
| P-69 | 12-inch | 2,579 LF | 119th Ave from Southern Ave to Roeser Rd | $434,000 |
| P-70 | 24-inch | 2,599 LF | Avondale Blvd from Southern Ave to Roeser Rd | $874,000 |
| P-71 | 16-inch | 2,049 LF | Avondale Blvd from Gila River to Southern Ave | $460,000 |
| P-72 | 16-inch | 5,254 LF | Southern Ave from 107th Ave to Avondale Blvd | $1,180,000 |
| P-73 | 16-inch | 2,580 LF | 107th Ave from Southern Ave to Roeser Rd | $578,000 |
| P-74 | 16-inch | 7,742 LF | Indian Springs Rd from Gila River to El Mirage Rd | $1,740,000 |
| P-75 | 16-inch | 6,717 LF | Indian Springs Rd from El Mirage Rd to 143rd Ave | $1,510,000 |
| P-76 | 16-inch | 2,007 LF | Coyote Ln from Mountain Rd to Indian Springs Rd | $450,000 |
| P-77 | 16-inch | 889 LF | Coyote Ln from Mountain Rd Due South | $200,000 |
| P-78 | 12-inch | 5,163 LF | Mountain Rd from Coyote Ln to Dysart Rd | $868,000 |
| P-79 | 12-inch | 3,187 LF | City of Avondale Boundary from Mountain Rd to Indian Springs Rd | $536,000 |
| P-80 | 12-inch | 2,915 LF | Aqua Fria River from Southern Ave to Roeser Rd | $490,000 |
| **Well Transmission Mains** | | | | |
| T-5 | 16-inch | 2,090 LF | Aqua Fria River from Coldwater Reservoir to Well #26 | $901,000 |
| T-6 | 12-inch | 1,700 LF | Thomas Rd from Well G to Avondale Blvd | $512,000 |
| T-7 | 12-inch | 3,470 LF | Avondale Blvd from Well H to Thomas Rd | $1,045,000 |
| T-8 | 16-inch | 5,250 LF | Thomas Rd from Garden Lakes Reservoir to Avondale Blvd | $2,270,000 |
| T-9 | 16-inch | 1,070 LF | Aqua Fria River from Well E to Well #16 Connection | $462,000 |
| T-10 | 12-inch | 2,560 LF | McDowell Rd from Well B to Well E | $770,600 |
| T-11 | 12-inch | 2,310 LF | 107th Ave from Well C to McDowell Rd | $696,000 |
| T-12 | 16-inch | 2,875 LF | McDowell Rd from 103rd Ave to 107th Ave | $1,239,000 |

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| T-13 | 12-inch | 2,600 LF | 103rd Ave from McDowell Rd to Gateway Reservoir | $783,000 |
| **Booster Pump Stations** | | | | |
| BPS-5 | 2.6 mgd | @ 160 ft | Rancho Santa Fe Booster Pump Station | $950,000 |
| BPS-6 | 5.1 mgd | @ 150 ft | Coldwater Low Head Booster Pump Station | $1,859,000 |
| BPS-7 | 2.4 mgd | @ 165 ft | Garden Lakes Booster Pump Station | $875,000 |
| BPS-8 | 1.2 mgd | @ 165 ft | Gateway Booster Pump Station | $438,000 |
| BPS-9 | 1.0 mgd | @ 130 ft | Northside Booster Pump Station | $365,000 |
| **Pressure Reducing Valves** | | | | |
| None | | | | |
| **Wells** | | | | |
| W- 16B | 1.0 mgd | Convert to Potable | Well #16B - Friendship Park | $120,000 |
| W-21 | 2.6 mgd | Provide Treatment | Well #21- El Mirage Rd and Durango Rd | $4,450,000 |
| W-28 | 1.7 mgd | Provide Treatment | Well #28 - 117th Ave and Whyman Ave | $4,450,000 |
| W-B | 1.7 mgd | Construct New Well | Well B - 119th Ave and McDowell Rd | $2,210,000 |
| W-C | 1.7 mgd | Construct New Well | Well C - 107th Ave and Roosevelt Rd | $2,210,000 |
| W-D | 1.7 mgd | Construct New Well | Well D - 107th Ave and McDowell Rd | $2,210,000 |
| W -E | 1.6 mgd | Construct New Well | Well E - McDowell Rd and El Mirage Rd (Pecan Tree Trailer Park) | $2,210,000 |
| W-F | 1.7 mgd | Construct New Well | Well F - El Mirage Rd North of Van Buren St | $2,210,000 |
| W-G | 1.7 mgd | Construct New Well | Well G - 119th Ave and Thomas Rd | $2,210,000 |
| W-H | 1.7 mgd | Re-drill | Well H - 114th Ave and Encanto Blvd | $2,210,000 |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$56,200,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

## 7.8. Recommended Water System Map at Build-out

A complete system map of the recommended water system at build-out is shown on Figure 7-6. This map shows the existing system (Figure 3-1) and all the new infrastructure that has been recommended in this Water Infrastructure Master Plan update.




\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure 7-6 Water Infrastructure at Build-out.mxd

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Water Infrastructure at Build-out**

MALCOLM PIRNIE

May 2010

FIGURE 7-6

## 7.9. Additional Evaluations

If the City proceeds with current infrastructure plans, both the Rigby Water Company and PIR systems will be connected to the City system after 2020, during the build-out planning period. Additional model evaluations were performed to determine the infrastructure required to connect the City's existing water system with the Rigby or PIR systems, independently, to provide an estimate of infrastructure needed if the City decides to serve these systems at any time prior to 2020. The additional evaluations were conducted with the following assumptions:

- The infrastructure will be sized to serve the build-out demands of the Rigby and PIR systems only and will not consider additional demands within the existing City system and from other new developments in the south area.
- The existing infrastructure of the Rigby and PIR systems will not be replaced and any existing wells within these systems will not be used. The City connections will be assumed to serve all demands within these systems.

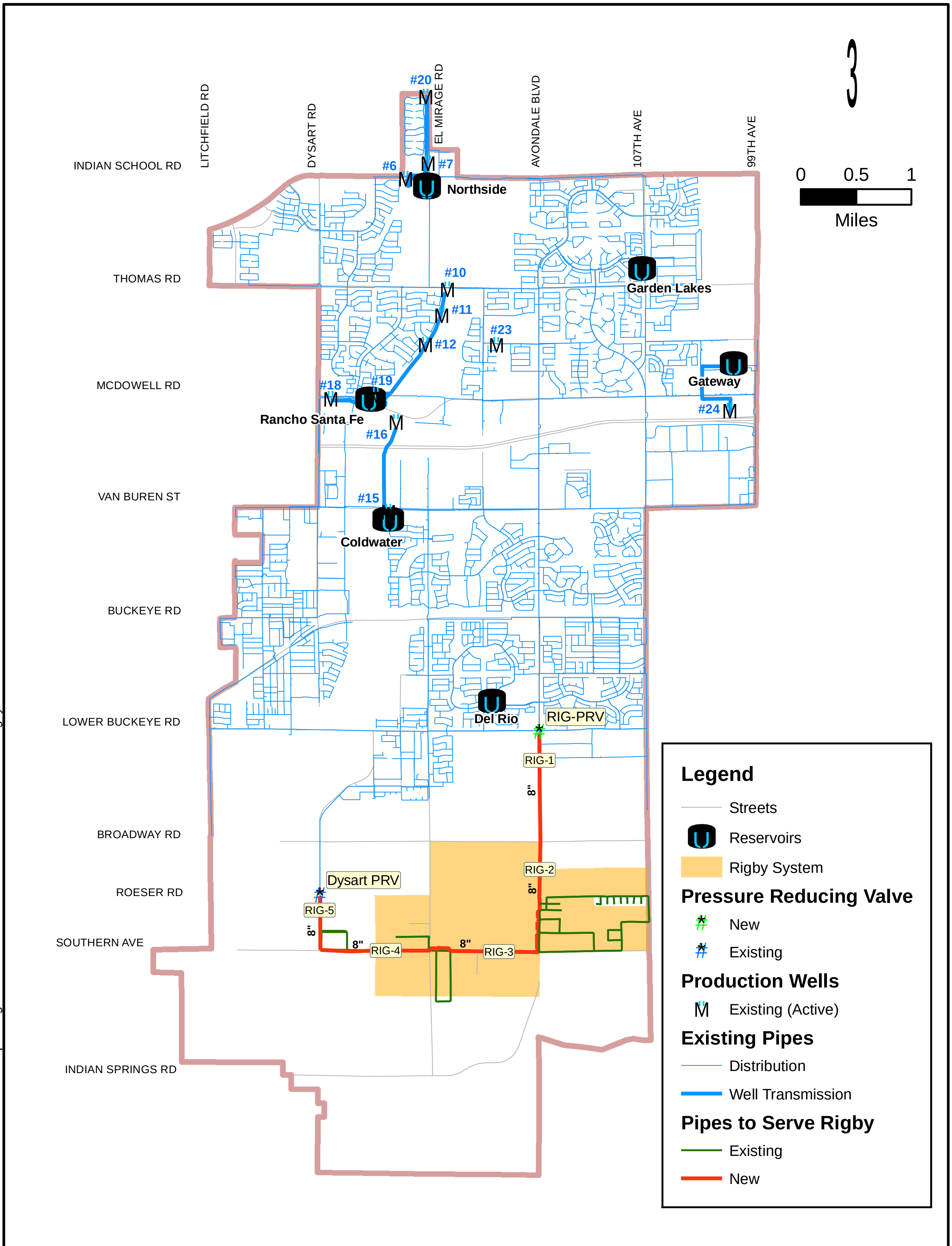
### 7.9.1. Connection to Rigby Water Company System

Figure 7-7 shows the recommended infrastructure for a near-term connection to the Rigby Water Company system. The Rigby Water Company system was evaluated for the maximum day demand of 410 gpm to determine the required infrastructure. The major infrastructure recommendations include the following:

- A temporary PRV (RIG-PRV) on the 24-inch transmission main along Avondale Boulevard to maintain the system pressure below 80 psi in the new connected system.
- An 8-inch pipe (RIG-5) from the existing PRV at Dysart Road (near the Charles M. Wolf Water Resources Center) to serve the Rigby system.
- 8-inch pipes (RIG-1 and RIG-2) along Avondale Boulevard to provide redundancy for the Rigby system.
- 8-inch pipes along Southern Avenue (RIG-3 and RIG-4) to connect the three separated systems within the Rigby system.

As there are no fire hydrants within the Rigby Water Company system, the system was not evaluated for fire flow conditions. No upgrades were required for the City wells and booster stations to serve water to the Rigby system in the near-term.

Table 7-8 provides a summary of the recommended infrastructure and associated capital costs for connection to the Rigby system. The total estimated capital costs for the near-term connection to the Rigby system is $3.4 million.






City of Avondale

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**Recommended Infrastructure to Serve Rigby Water System**

MALCOLM PIRNIE

May 2010

FIGURE 7-7

**Table 7-8:**
**Recommended Infrastructure to Serve Rigby Water System**

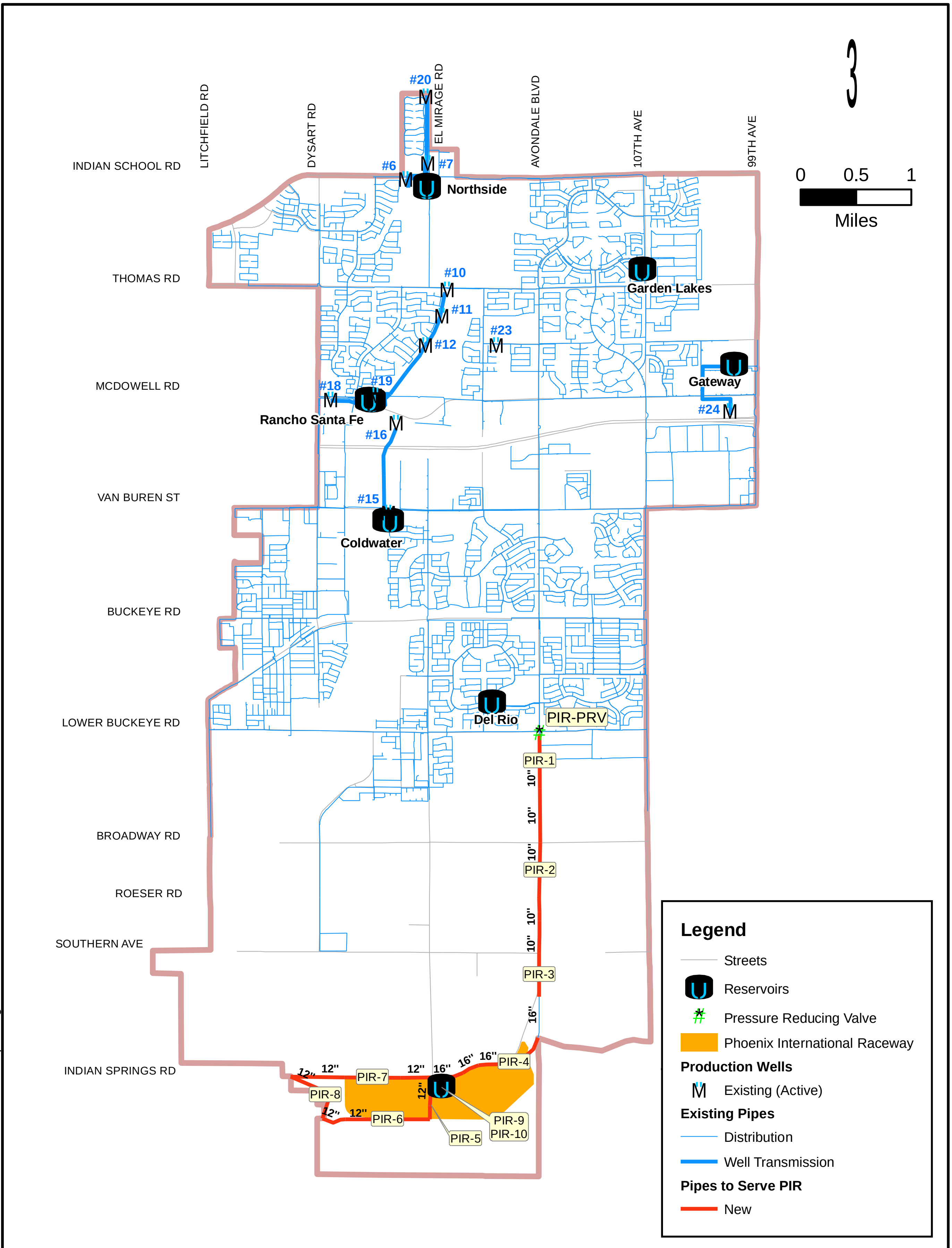
| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| RIG-1 | 8-inch | 5,163 LF | Avondale Blvd from Broadway Rd to Lower Buckeye Rd | $579,000 |
| RIG-2 | 8-inch | 5,467 LF | Avondale Blvd from Southern Ave to Broadway Rd | $941,000 |
| RIG-3 | 8-inch | 5,478 LF | Southern Ave from Avondale Blvd to El Mirage Rd | $614,000 |
| RIG-4 | 8-inch | 5,280 LF | Southern Ave from El Mirage Rd to Dysart Rd | $592,000 |
| RIG-5 | 8-inch | 2,600 LF | Dysart Rd from Southern Ave to Roeser Rd | $292,000 |
| **Well Transmission Mains** | | | | |
| None | | | | |
| **Booster Pump Stations** | | | | |
| None | | | | |
| **Pressure Reducing Valves** | | | | |
| RIG-PRV | 8-inch | | Lower Buckeye Rd and Avondale Blvd | $392,000 |
| **Wells** | | | | |
| None | | | | |
| **Reservoirs** | | | | |
| None | | | | |
| **Total** | | | | **$3,410,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

### 7.9.2. Connection to Phoenix International Raceway

Figure 7-8 shows the recommended infrastructure for a near-term connection to the PIR water system. The PIR system was evaluated for the maximum day demand of 498 gpm to determine the required infrastructure. The major infrastructure recommendations include the following:

- A temporary PRV (PIR-PRV) in the 24-inch transmission main along Avondale Boulevard to maintain system pressures below 80 psi in the new connected system.
- 10-inch pipes (PIR-1 to PIR-3) along Avondale Boulevard to the Gila River bridge.
- A 16-inch pipe (PIR-4) from the Gila River bridge to the PIR system.
- 12-inch pipes (PIR-5 to PIR-8) to serve the entire PIR area and to improve system connectivity.
- A 1.0 MG steel storage tank (PIR-10) and a booster station (PIR-9) to provide peak hour and fire flows, and to provide supply during emergencies.






City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Recommended Infrastructure to Serve PIR**

MALCOLM PIRNIE

May 2010

FIGURE 7-8

No upgrades were required for the existing City wells and booster stations to serve water to the PIR system in the near-term. This evaluation only considered a single feed to the PIR system with no provision for redundant supply, as providing a redundant pipeline crossing the river would be expensive.

Table 7-9 provides the list of recommended infrastructure and associated capital costs for the near-term connection to the PIR system. The total estimated capital costs for the recommended near-term connection to the PIR system is $10.0 million. If the City builds the recommended connection to the PIR system ahead of development, it would have to build parallel pipelines in the arterial roads to supply the ultimate build-out demands of new development.

**Table 7-9:**
**Recommended Infrastructure to Serve PIR**

| Project No. | Description | | Location | Cost ($)[1,2,3] |
|---|---|---|---|---|
| **Distribution System Pipes** | | | | |
| PIR-1 | 10-inch | 5,163 LF | Avondale Blvd from Broadway Rd to Lower Buckeye Rd | $730,000 |
| PIR-2 | 10-inch | 5,275 LF | Avondale Blvd from Southern Ave to Broadway Rd | $740,000 |
| PIR-3 | 10-inch | 2,050 LF | Avondale Blvd from Gila River Bridge to Southern Ave | $287,000 |
| PIR-4 | 16-inch | 5,784 LF | Indian Springs Rd from Gila River Bridge to El Mirage Rd | $1,300,000 |
| PIR-5 | 12-inch | 2,000 LF | El Mirage Rd from Mountain Rd to Indian Springs Rd | $336,000 |
| PIR-6 | 12-inch | 5,163 LF | Mountain Rd from El Mirage Rd to Dysart Rd | $868,000 |
| PIR-7 | 12-inch | 6,717 LF | Indian Springs Rd from El Mirage Rd to 143rd Ave | $1,130,000 |
| PIR-8 | 12-inch | 3,188 LF | City of Avondale Boundary from Mountain Rd to Indian Springs Rd | $536,000 |
| **Well Transmission Mains** | | | | |
| None | | | | |
| **Booster Pump Stations** | | | | |
| PIR-9 | 5.8 mgd | @ 125 ft | El Mirage Rd and Indian Springs Rd | $2,120,000 |
| **Pressure Reducing Valves** | | | | |
| PIR-PRV | 10-inch | | Lower Buckeye Rd and Avondale Blvd | $392,000 |
| **Wells** | | | | |
| None | | | | |
| **Reservoirs** | | | | |
| PIR-10 | 1.0 mgd | | El Mirage Rd and Indian Springs Rd | $1,530,000 |
| **Total** | | | | **$10,000,000** |

Notes:
(1) January 2010 Costs (ENR CCI = 8,660)
(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit
(3) Pipeline unit costs varied for developed and undeveloped areas

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# 8. References


Arizona Department of Environmental Quality. 1978. Engineering Bulletin No. 10: Guidelines for the Construction of Water Systems (May).

Arizona Department of Environmental Quality. 1978. Engineering Bulletin No. 8: Disinfection of Water Systems (August).

Avondale, City of. 2002. City of Avondale General Plan. City of Avondale, Arizona (June).

Avondale, City of. 2008. General Engineering Requirements Manual. City of Avondale Arizona.

Carollo Engineers. 2005. Wastewater Collection System Master Plan & Utility Systems Evaluation (August).

Carollo Engineers. 2009. City of Avondale Water System Model Update and Analysis. City of Avondale, Arizona (June).

RBF Consulting. 2002b. Water Infrastructure Master Plan. City of Avondale, Arizona (February).

Wilson Engineers. 2008. Del Rio Wellhead Treatment Summary Report. City of Avondale, Arizona (August).

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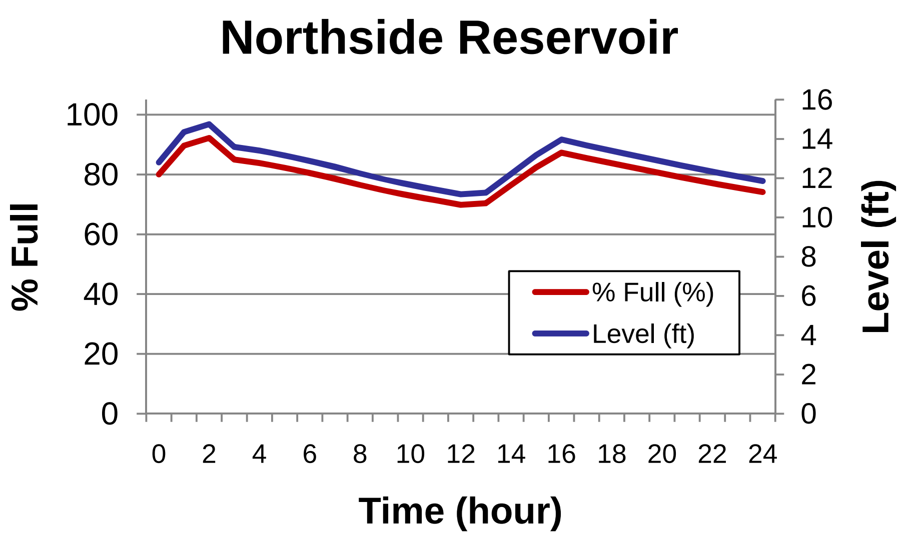
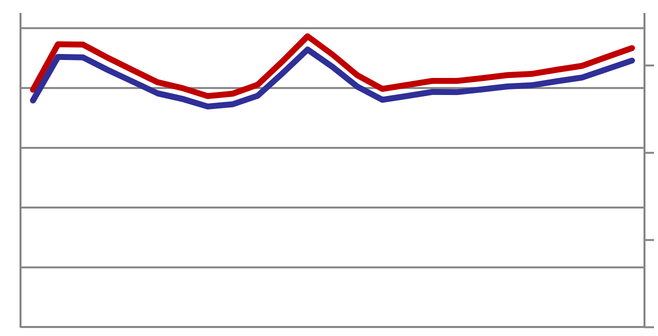
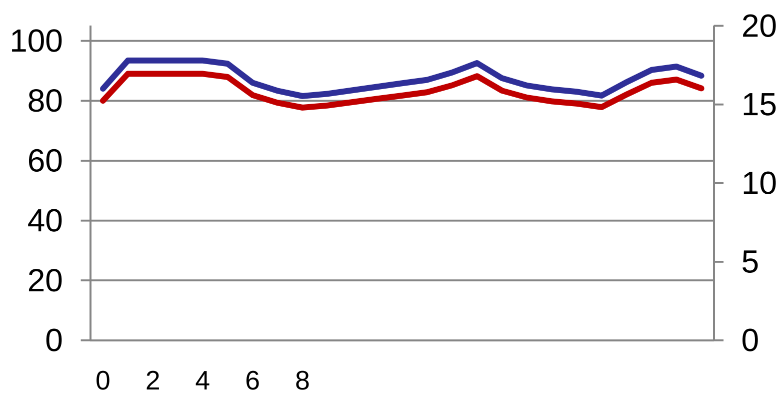
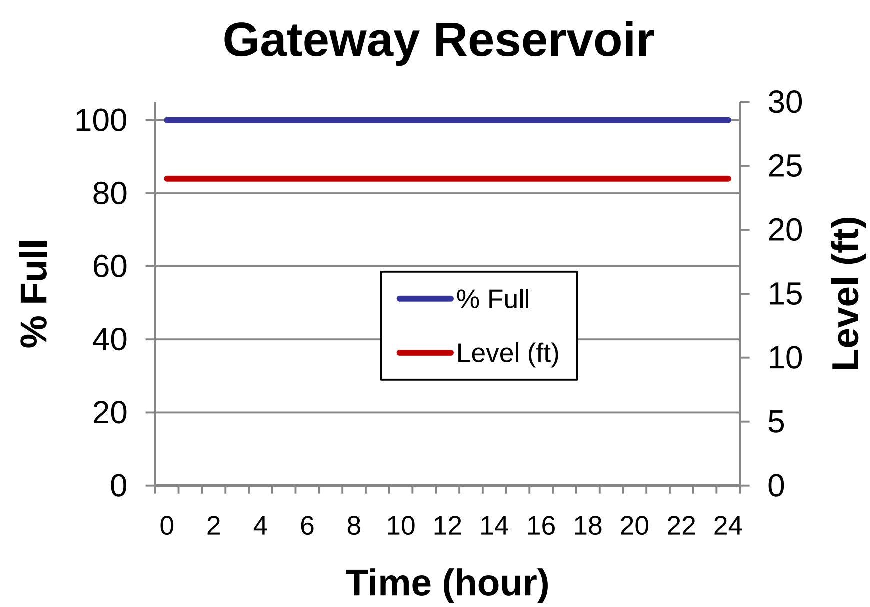
# A. Reservoir Operating Levels



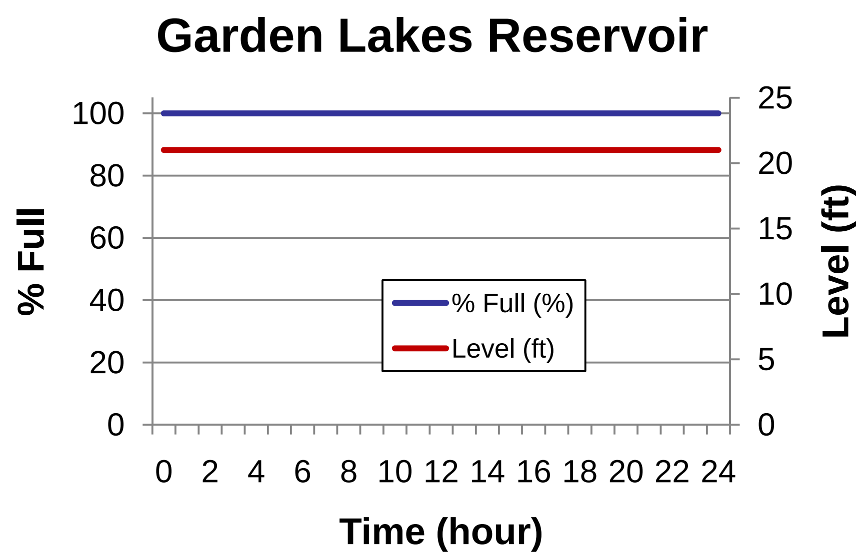



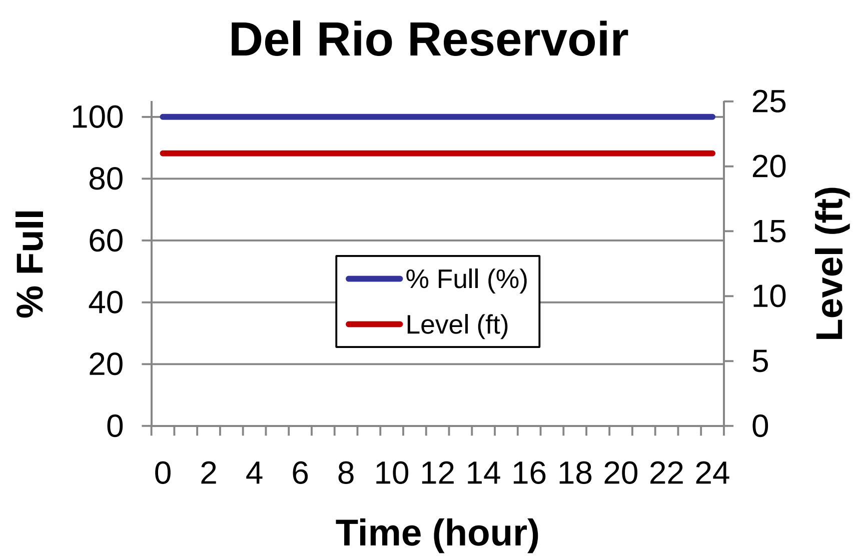





CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN
**Reservoir Levels: Average Day Demand**
**(Gateway, Garden Lakes, and Del Rio Boosters Not in Operation)**

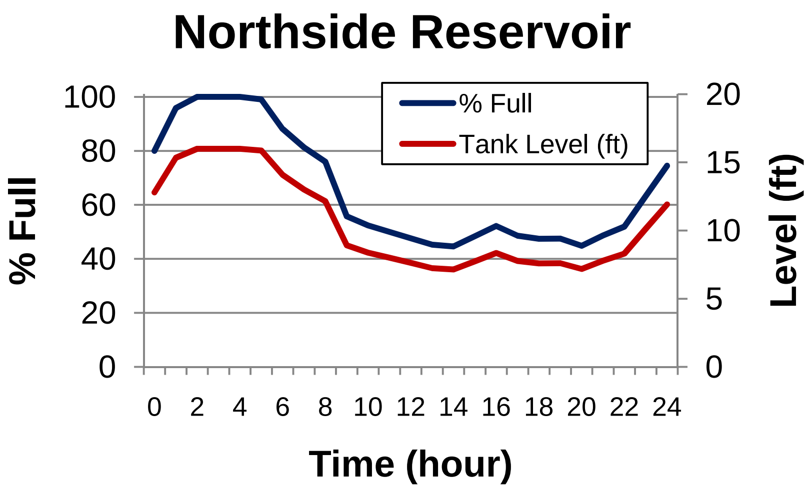
MAY 2010
**Figure A-1**



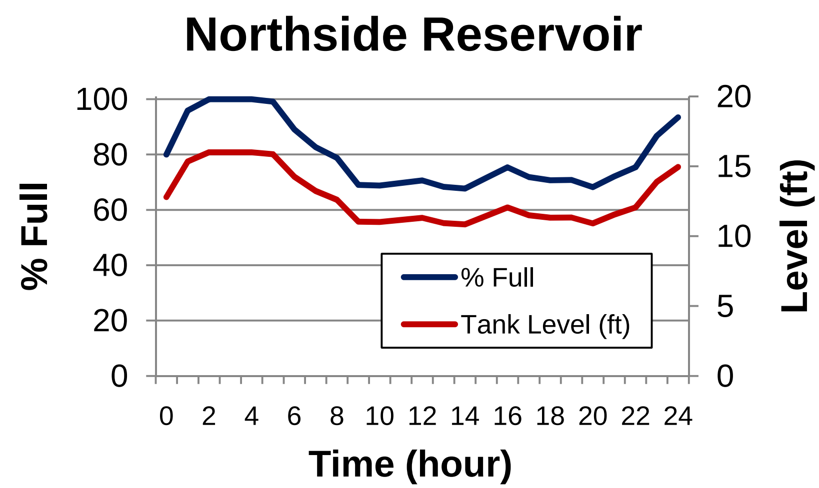




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN
**Reservoir Levels: Average Day Demand**
**(Gateway, Garden Lakes, and Del Rio Boosters Not in Operation)**

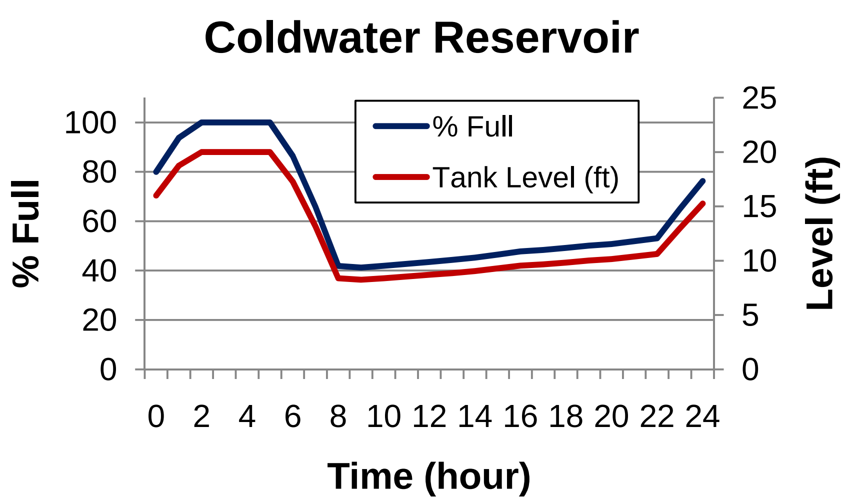
MALCOLM PIRNIE
MAY 2010
**Figure A-2**



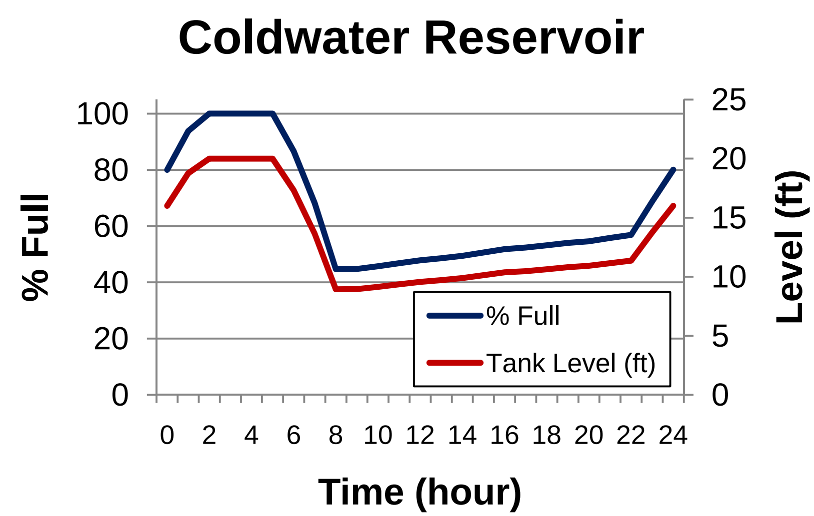

Gateway, Garden Lakes, and Del Rio Boosters Not Operational




Gateway Booster Operational During Peak Hours




Gateway, Garden Lakes, and Del Rio Boosters Not Operational




Gateway Booster Operational During Peak Hours

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Reservoir Levels: Maximum Day Demand**

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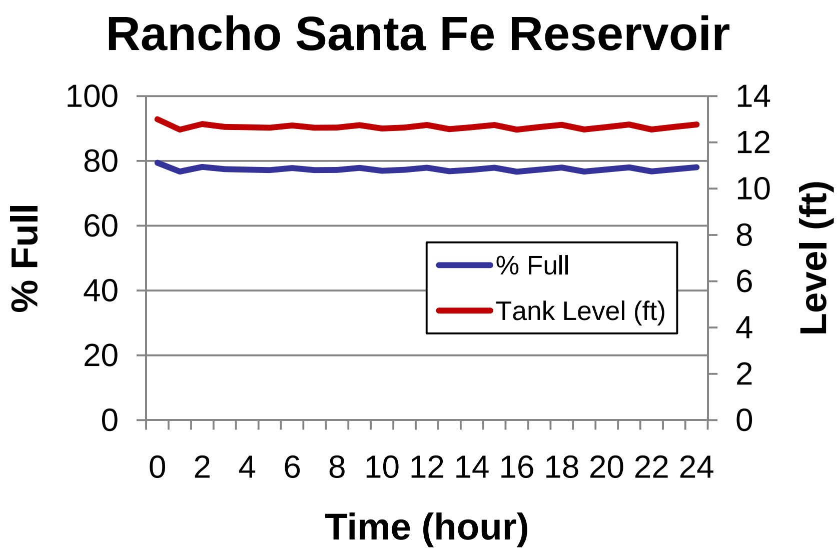
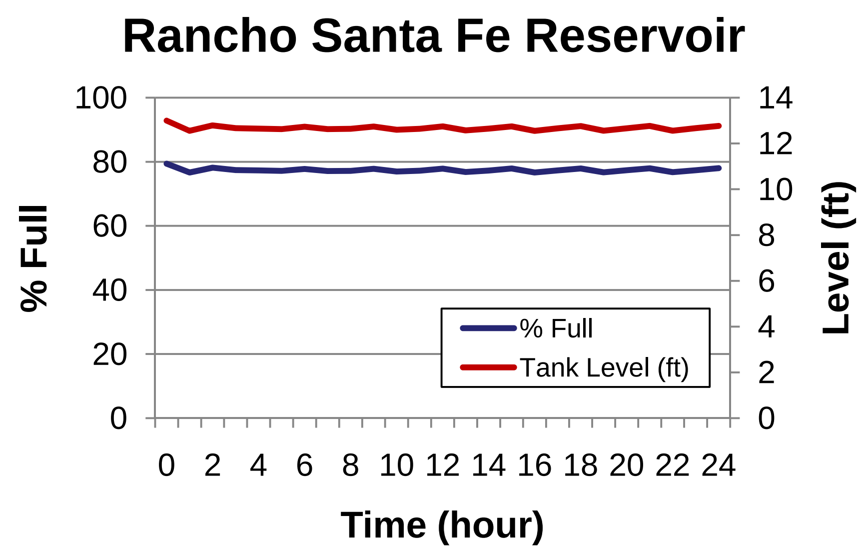
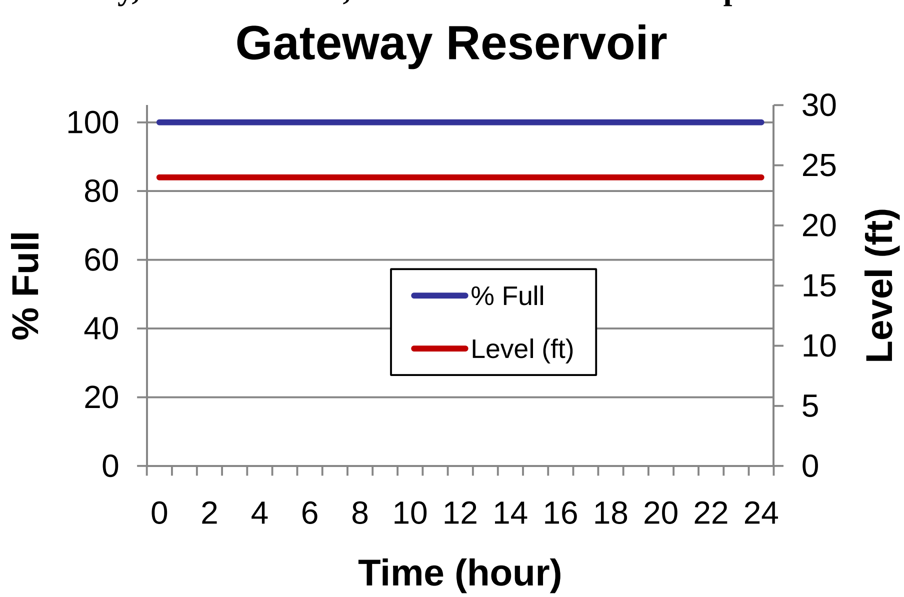
**Figure A-3**



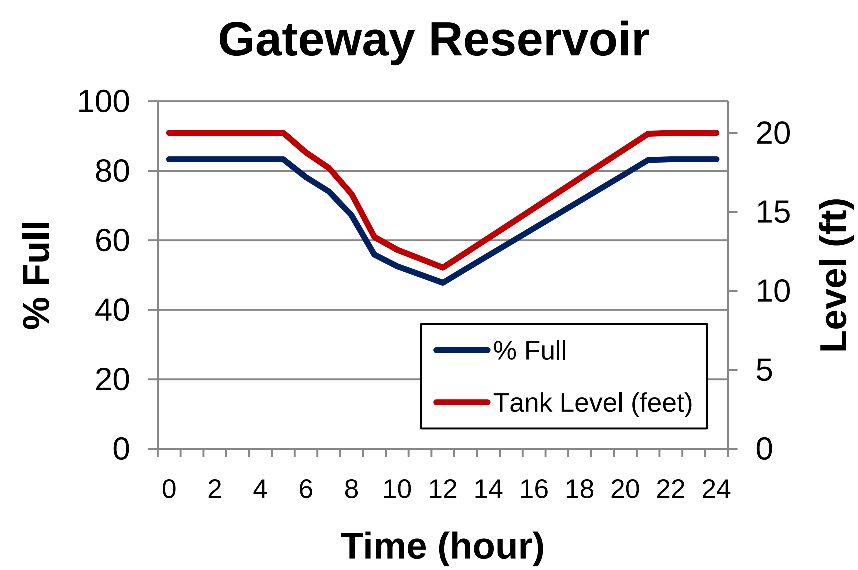

Gateway, Garden Lakes, and Del Rio Booster Not Operational




Gateway Booster Operational During Peak Hours




Gateway, Garden Lakes, and Del Rio Booster Not Operational




Gateway Booster Operational During Peak Hours

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Reservoir Levels: Maximum Day Demand**

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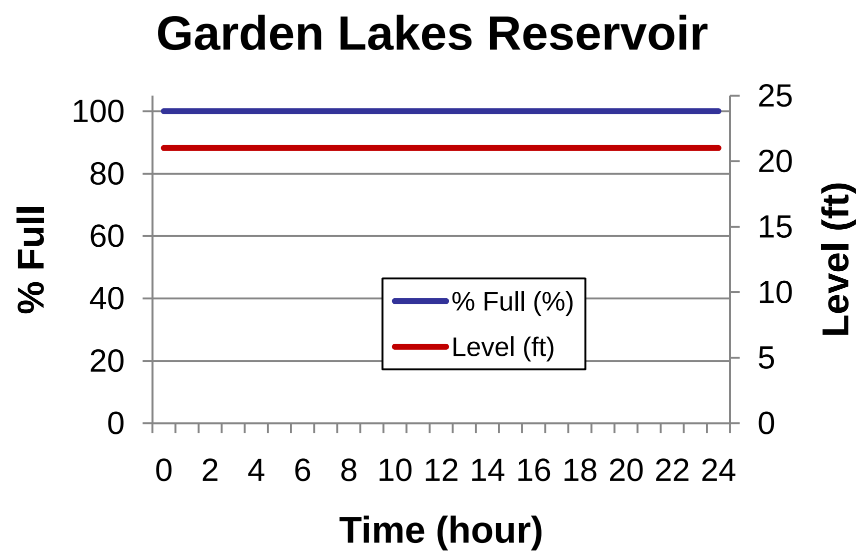
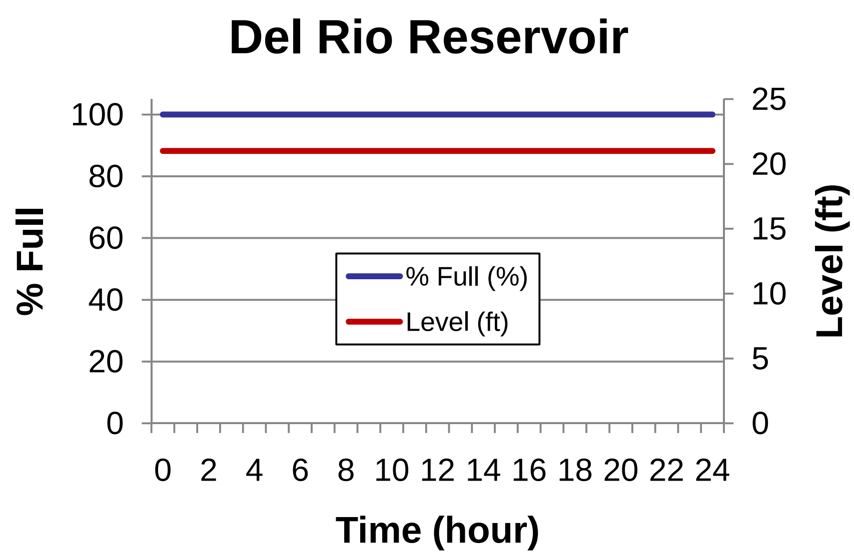
**Figure A-4**




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Reservoir Levels: Maximum Day Demand**

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**Figure A-5**

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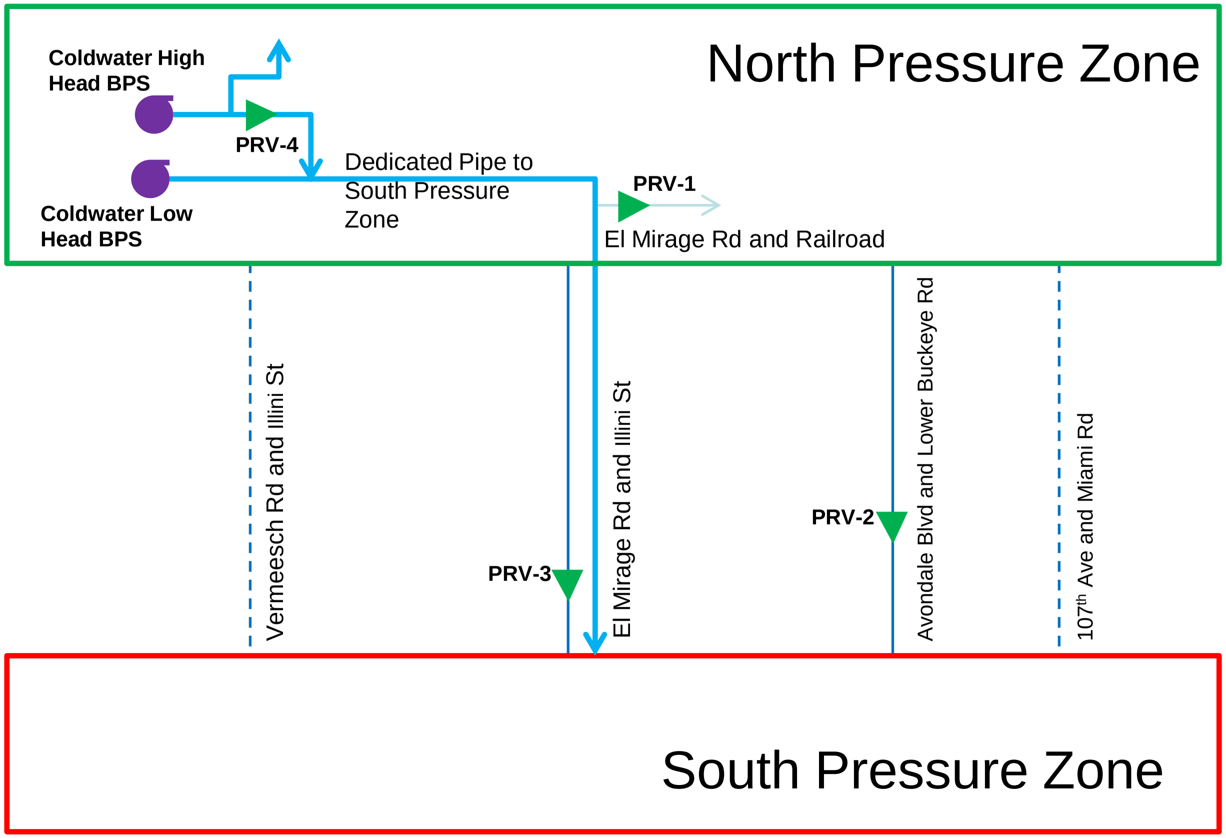
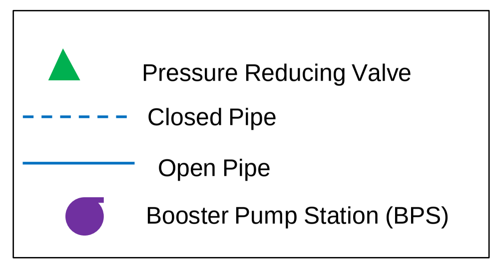
# B. New Pressure Zone Schematics




**PRV-1:** PRV-1 interconnect can supply water from the future low head pumps at Coldwater BPS to north pressure zone.

**PRV-2 and PRV-3:** These two PRVs can be used to regulate the high pressure from the north pressure zone, in the event of disruption to the dedicated line supplying south pressure zone.

**PRV-4:** Regulates the pressure from high head pumps at Coldwater facility before water enters the dedicated line to south pressure zone.




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Schematic of Pressure Zone Setup**

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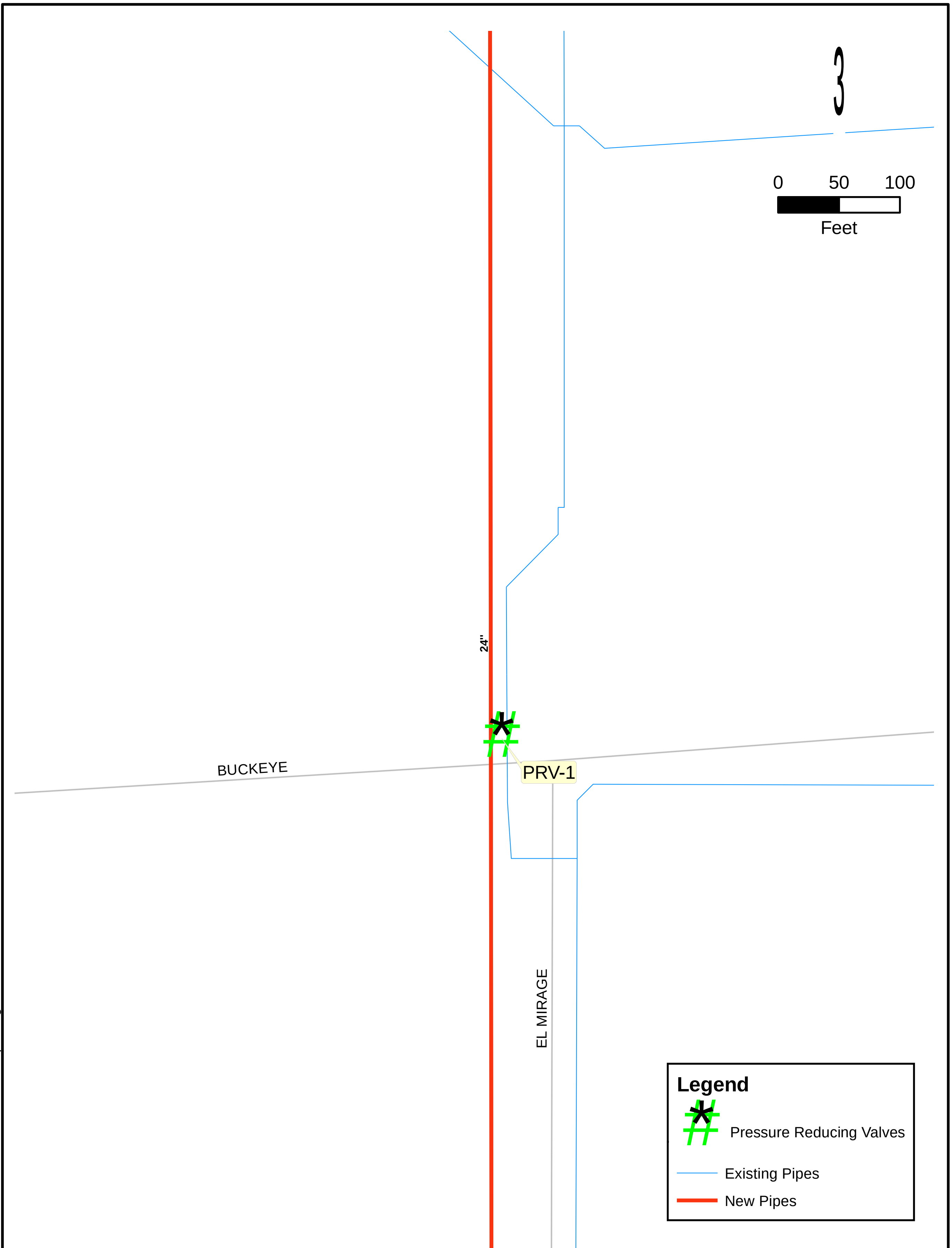
MAY 2010

**Figure B-1**




CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**PRV at El Mirage Road and Railroad**

City of Avondale

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FIGURE B-2

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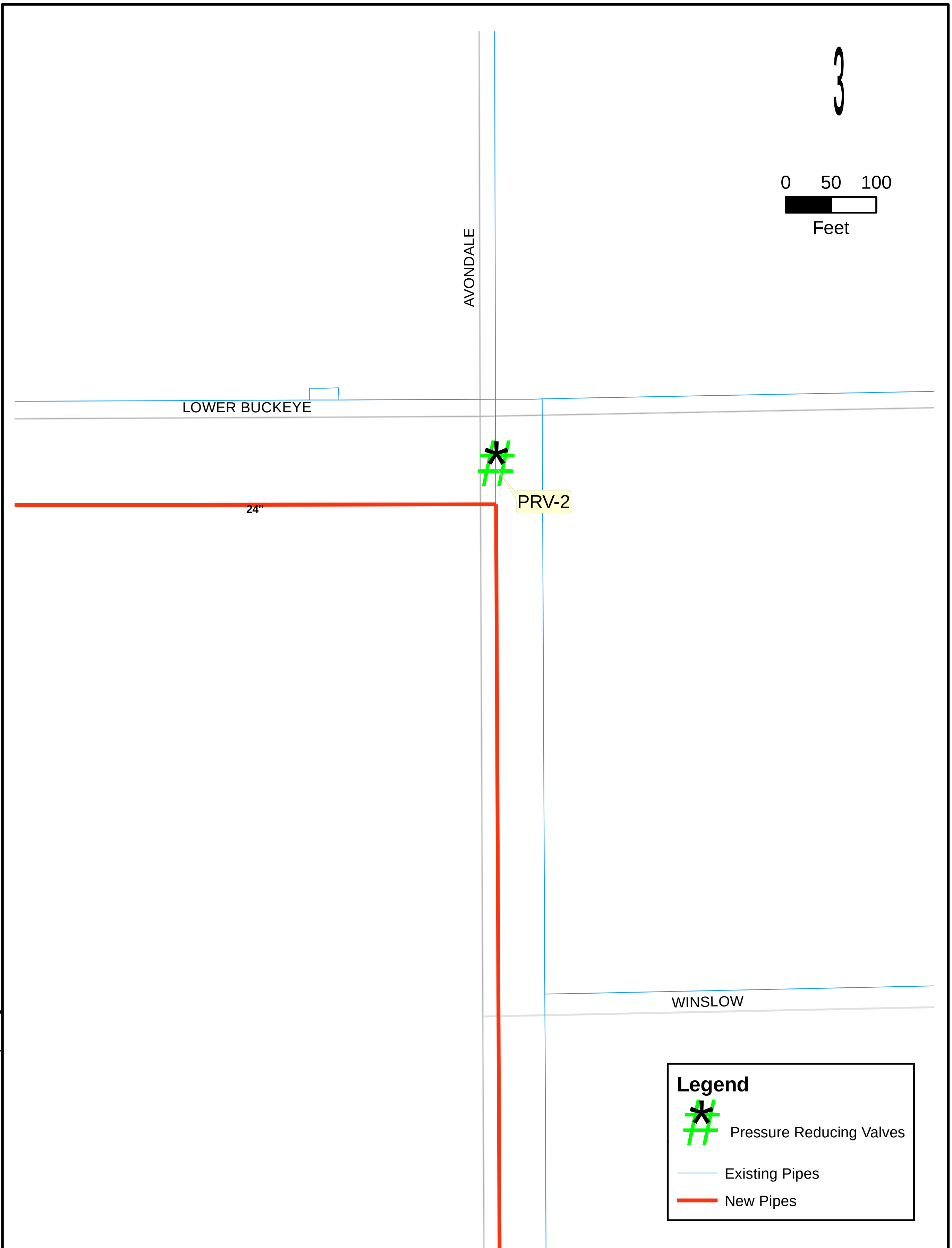


CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**PRV at Alvondale Boulevard and Lower Buckeye Road**

MALCOLM PIRNIE

May 2010

FIGURE B-3

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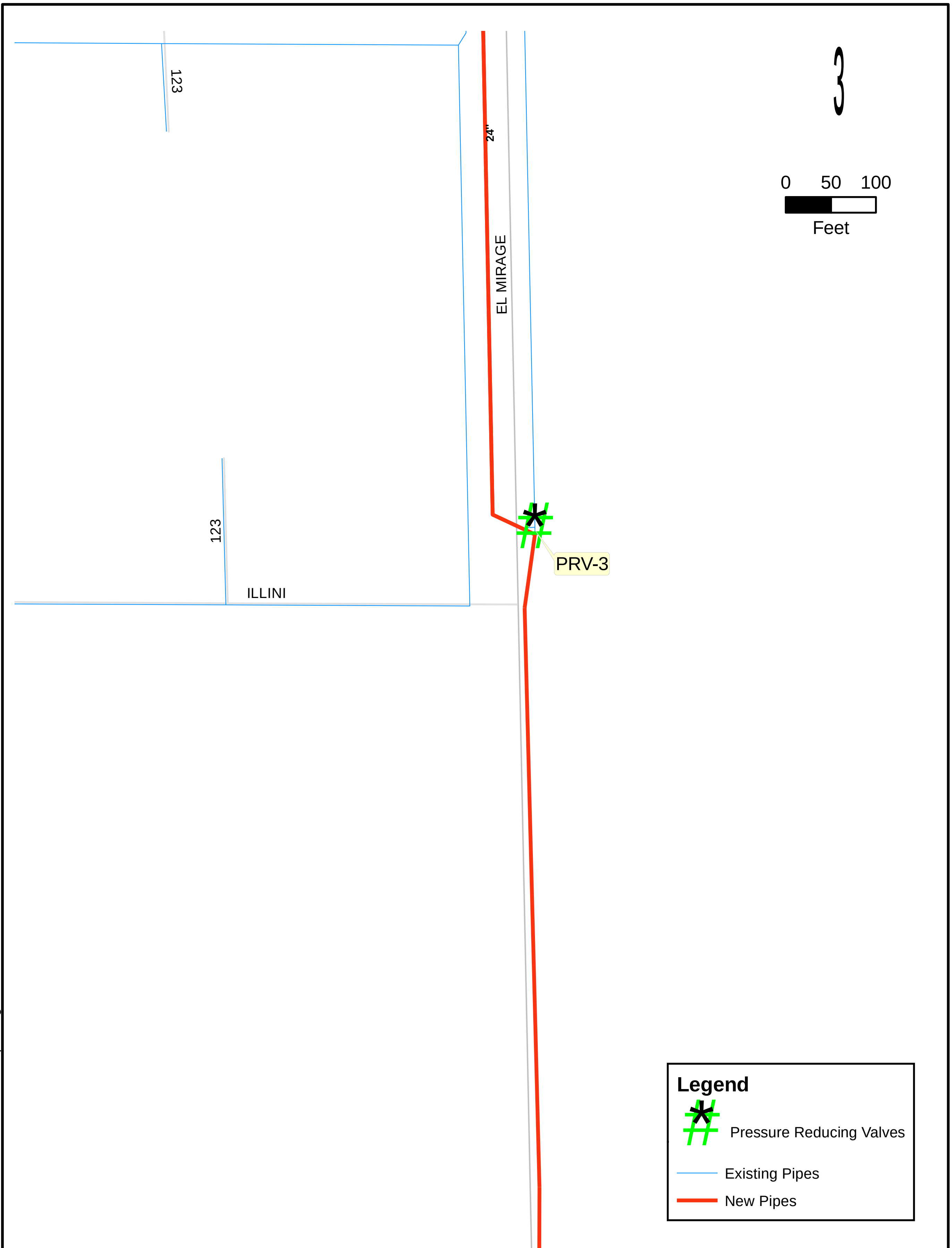


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City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**PRV at El Mirage Road and Illini Street**

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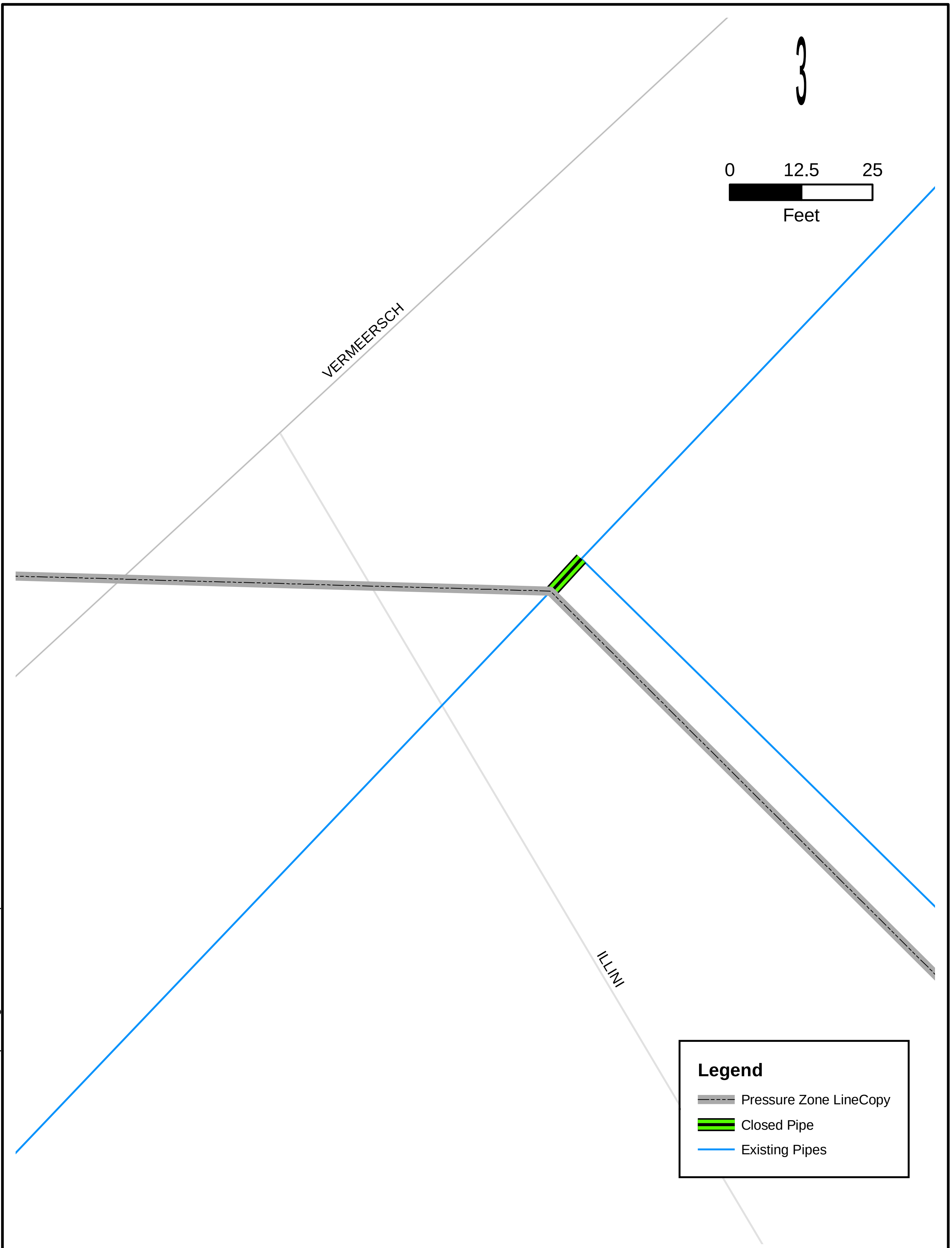
May 2010

FIGURE B-4




\\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure B-3 ClosedPipe1.mxd

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Closed Pipe at Vermeesch Road and Illini Street**

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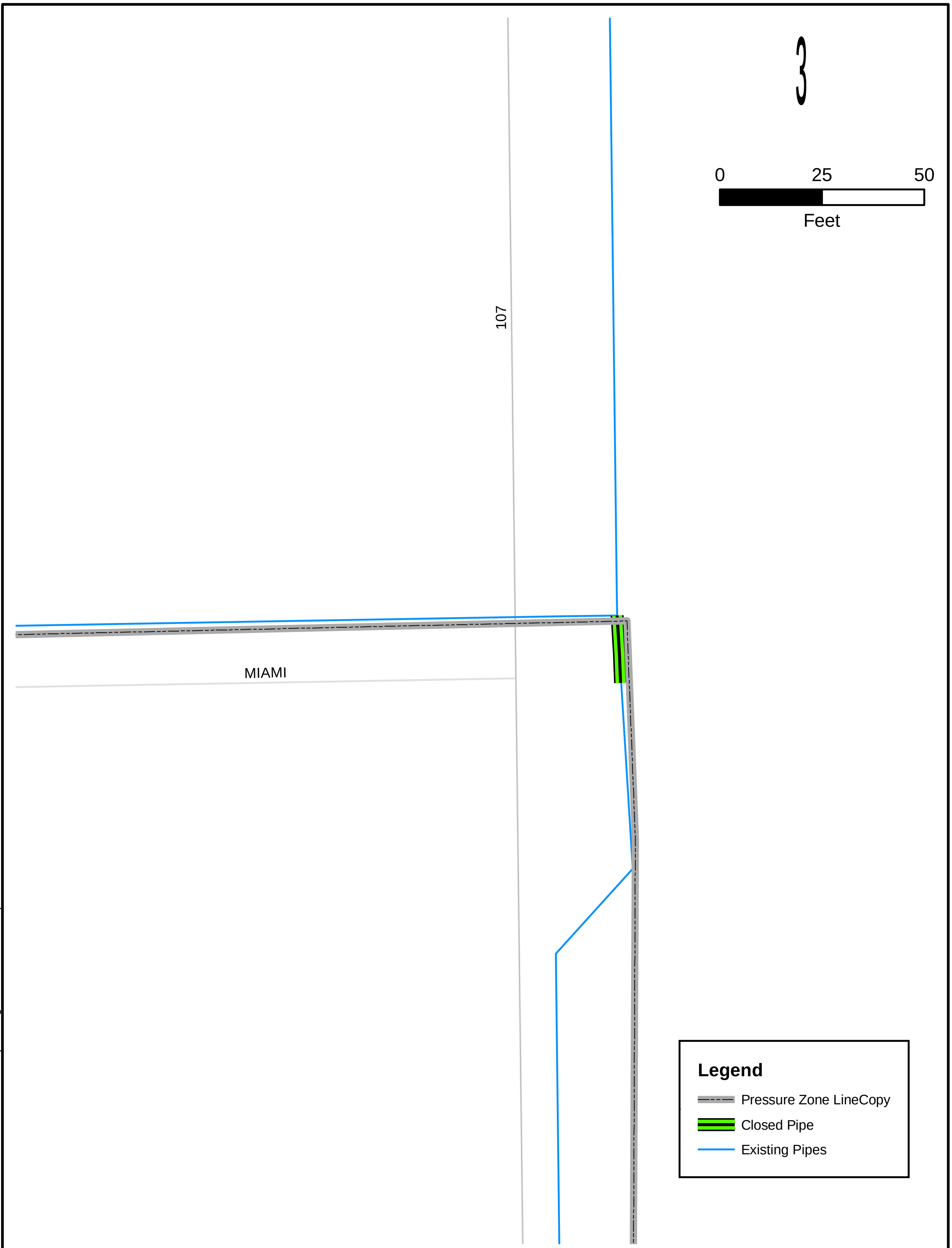
May 2010

FIGURE B-5




\phoenix\projects\0864025\GIS\MXDs\WIMP Final Report\Figure B-6 ClosedPipe2.mxd

City of Avondale

CITY OF AVONDALE, ARIZONA
WATER INFRASTRUCTURE MASTER PLAN

**Closed Pipe at 107th Avenue and Miami Street**

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May 2010

FIGURE B-6

# C. Unit Costs

# Summary of Capital Unit Costs[1,2]

| ITEM | UNITS | COST (Jan. 2010) | Included in Unit Cost |
|---|---|---|---|
| **CAPITAL COSTS** | | | |
| **Pipelines** | | | |
| **Ductile Iron Pipe (developed areas)** | | | |
| **6"** | $/LF | $107 | Ductile iron pipe with excavation, asphault removal and replacement, five feet of cover, backfill, bedding |
| **8"** | $/LF | $172 | |
| **10"** | $/LF | $237 | |
| **12"** | $/LF | $301 | |
| **16"** | $/LF | $431 | |
| **24"** | $/LF | $634 | |
| **36"** | $/LF | $938 | |
| **Ductile Iron Pipe (undeveloped areas)** | | | |
| **6"** | $/LF | $84 | Ductile iron pipe with excavation, five feet of cover, backfill, bedding |
| **8"** | $/LF | $112 | |
| **10"** | $/LF | $140 | |
| **12"** | $/LF | $168 | |
| **16"** | $/LF | $224 | |
| **24"** | $/LF | $336 | |
| **36"** | $/LF | $504 | |
| **Reservoirs (covered)** | | | |
| **0.0 to < 2.5 MG** | $/MG | $1,527,148 | |
| **Booster Pump Stations** | | | |
| **0 to < 7 mgd** | $/mgd | $364,433 | Includes fencing and access gates, site paving, landscaping, earth and concrete work, electrical, mechanical, instrumentation and SCADA |
| **Pressure Reducing Valves** | | | |
| **3 to < 6 mgd** | $/mgd | $391,717 | |
| **New Production Wells/Redrilling** | $/well | $2,209,440 | |
| **Wellhead Rehabilitation** | $/well | $1,007,914 | |
| **Arsenic Treatment** | $/mgd | $1,311,310 | |
| **TDS Treatment** | $/well | $4,446,374 | 1200 mg/L TDS; 700 mg/L target |

NOTES:

(1) January 2010 Costs (ENR CCI = 8,660).

(2) Unit capital costs include engineering/design, materials of construction, installation, and contractor overhead and profit.

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