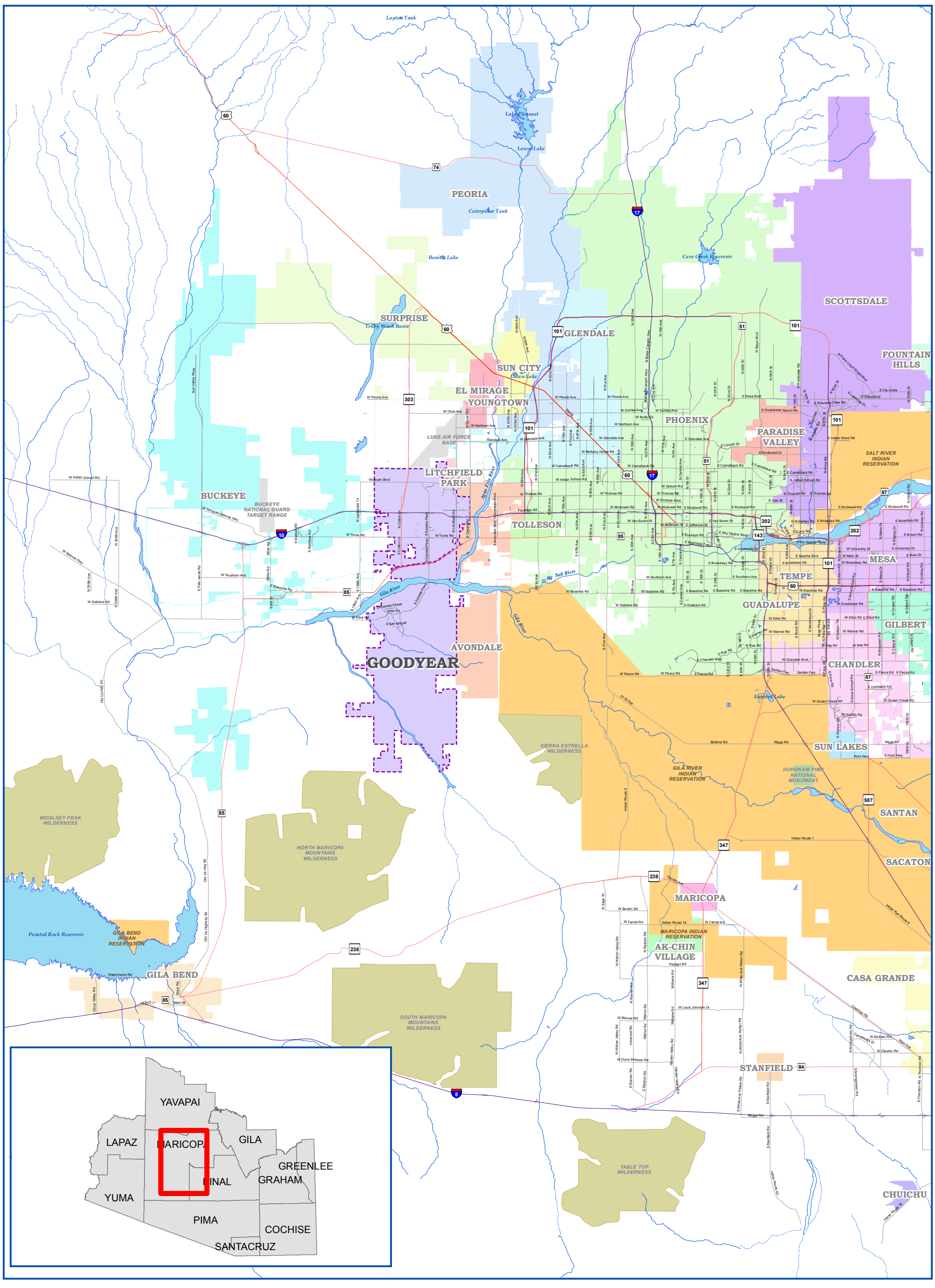
CITY OF GOODYEAR INTEGRATED WATER MASTER PLAN EXECUTIVE SUMMARY

ES-1 INTRODUCTION AND BACKGROUND

The City of Goodyear is one of the fastest growing communities in Western Maricopa County. Goodyear is bordered by the cities of Avondale, Litchfield Park and Buckeye as well as significant expanses of unincorporated county lands as shown in Figure ES-1. The City of Goodyear provides water, wastewater, and reclaimed water utility services for a population of approximately 49,000 yet projections show that the ultimate population reached at buildout will top 800,000.

The purpose of the 2007 IWMP is to develop an integrated recommendation of infrastructure improvements designed to support current and projected growth addressing the full range of issues including growth, resources, demands, optimal resource use, and infrastructure requirements within the City. The outcome of these recommendations is a phased Capital Improvement Plan (CIP) to guide efficient investment in the City's water, wastewater and reclaimed water infrastructure. Key goals / issues to be addressed within the IWMP include:

1) Accurately project water, wastewater and reclaimed demands and flow rates through buildout based upon the land use projections provided by the City of Goodyear.
2) Plan infrastructure which will efficiently and reliably meet projected water, wastewater and reclaimed water needs.
3) Optimize the interaction of water resources and water production infrastructure so as to accommodate projected water demands in a sustainable manner.
4) Provide a 10-year and buildout CIP for the remaining water, wastewater and reclaimed infrastructure.



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Data Sources:
City of Goodyear GIS
ALRIS
ESRI

Legend

Transportation
- US Route
- State Route
- Major Arterial
- Interstate Highway

- Lake

Streams
- Aqueduct
- Stream
- Wash

Figure ES-1
Vicinity Map

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Revised: Monday, March 24 2008

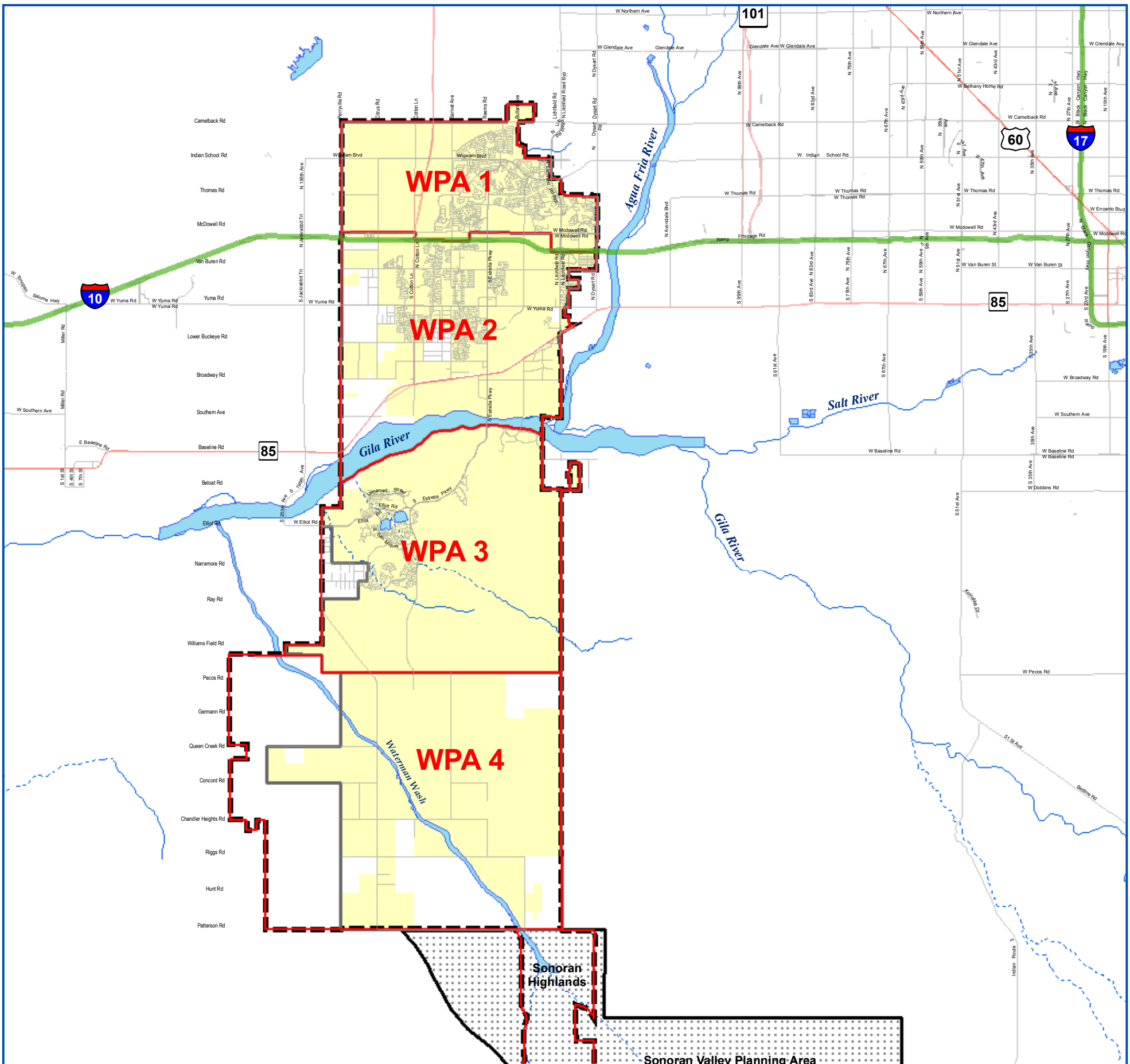
The results of the integrated master planning process are presented in a comprehensive set of documents including:

- Volume 1, 2007 Master Plan Report, contains a complete yet concise summary of the master planning process and a detailed phased Capital Improvement Plan (CIP) of the recommended water, wastewater and reclaimed water infrastructure.
- Volumes 2 through 4 contain a series of supporting technical memoranda with the detailed process by which the master plan was developed.
- Electronic copies of the entire IWMP (Volumes 1 through 4) in PDF format.

ES-2 LAND USE PLANNING

The Study Area for the Integrated Water Master Plan (IWMP) was based upon the City's municipal planning area (MPA), primarily as defined by the Maricopa County Association of Governments (MAG) but with several minor revisions to account for recent annexations and anticipated future revisions. Key among these is the Sonoran Valley Planning Area. The Sonoran Valley Planning Area consists of Arizona State Land (5,310 acres), private ownership (24,236 acres), and BLM Lands (31,358 acres). At the time of this IWMP only the Arizona State Land portion, commonly referred to as the "South 5,300", or Sonoran Highlands is to be included in the planning efforts associated with this IWMP. Figure ES-2 presents the IWMP Study Area.

In order to be able to put a sense of timing to the buildout projections and develop intermediate year phasing, a classic "S-curve" pattern and historical growth rates were utilized to transition from today's 18,219 dwelling units / 49,000 persons to buildout's 239,636 dwelling units / 635,000 persons (in the IWMP Planning Area) as can be seen in Figure ES-3.



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1 inch equals 3 miles

Data sources:
City of Goodyear GIS
RBF Consulting
ALRIS
ESRI

Legend

Major Highways
- US Route
- State Route
- Major Arterial
- Interstate

Streams
- Aqueduct
- Stream
- Wash

- City Limits
- Water Planning Area
- Master Plan Study Area
- Municipal Planning Area (MAG)
- Pending Sonoran Valley Annexation - Phase 1

Figure ES-2
Study Area

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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ENERGY WATER INFORMATION GOVERNMENT

Revised: Thursday, March 13, 2008

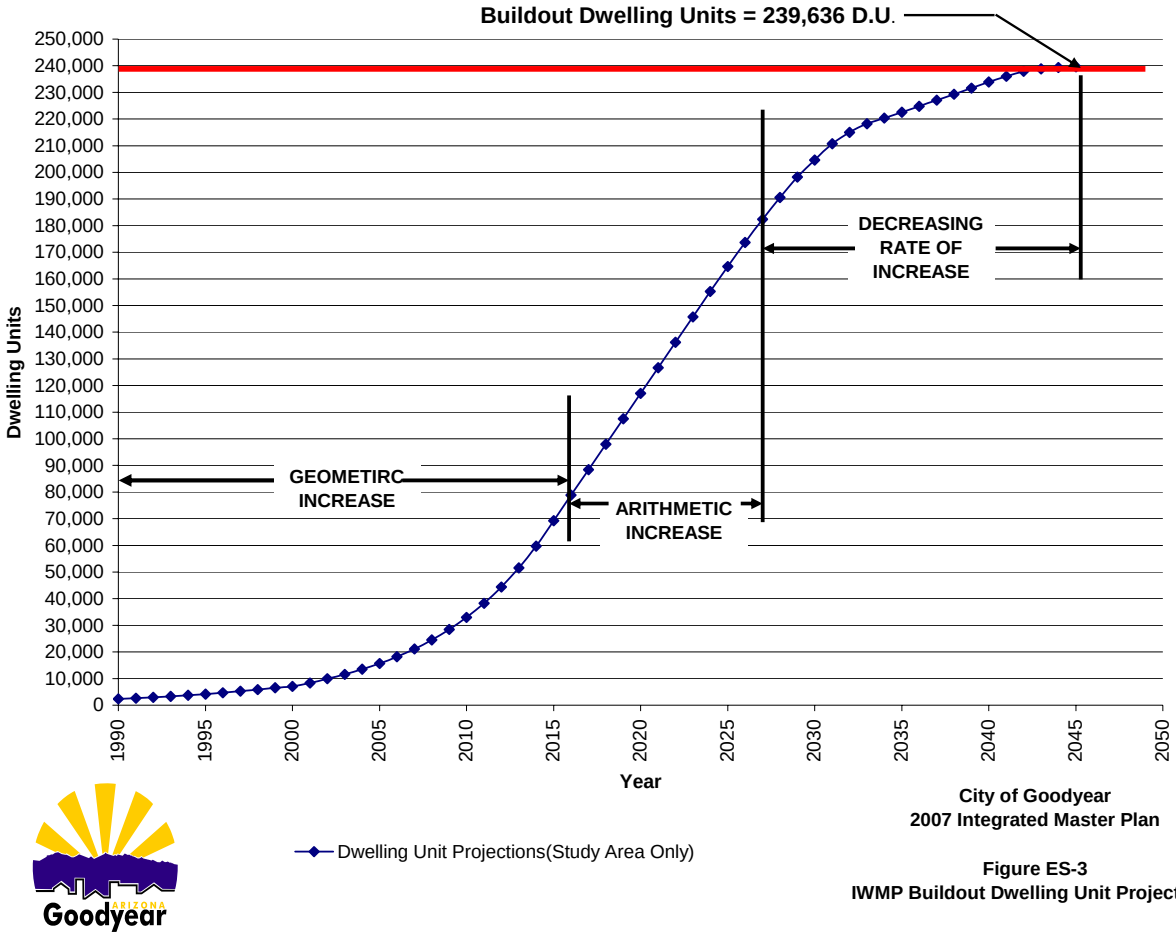


Figure ES-3
IWMP Buildout Dwelling Unit Projections

The resulting curve shows that buildout could be attained in roughly 40 more years or in the range of 2045 to 2050.

ES-3 WATER DEMANDS AND WASTEWATER FLOW RATES

Unit rate demands were developed for residential and non-residential potable and reclaimed water demands and wastewater flow rate projections. These unit rates were applied to the City's Land Use Plan shown in Figure ES-4 to develop the projected buildout demands. The population increase, as well as the projected commercial development, will increase the City's annual average potable water demand from 7.1 mgd to 92.2 mgd, wastewater generation from 2.9 mgd to 42.2 mgd and reclaimed demand from 0.9 mgd to 21.3 mgd by build-out. Table ES-1

summarizes the projected water demands and wastewater flows for each of the design years. As with population, these demands and flowrates will also increase more than ten-fold by buildout.

Table ES-1. Project Water Demands and Wastewater Flow

Demand Condition	Base Year (mgd)	2012 (mgd)	2017 (mgd)	Buildout (mgd)
Potable Water Demand	7.1	18.3	39.5	92.2
Wastewater Flow	2.9	9.0	18.5	42.2
Reclaimed Water Demand	0.9	9.2	15.0	21.3

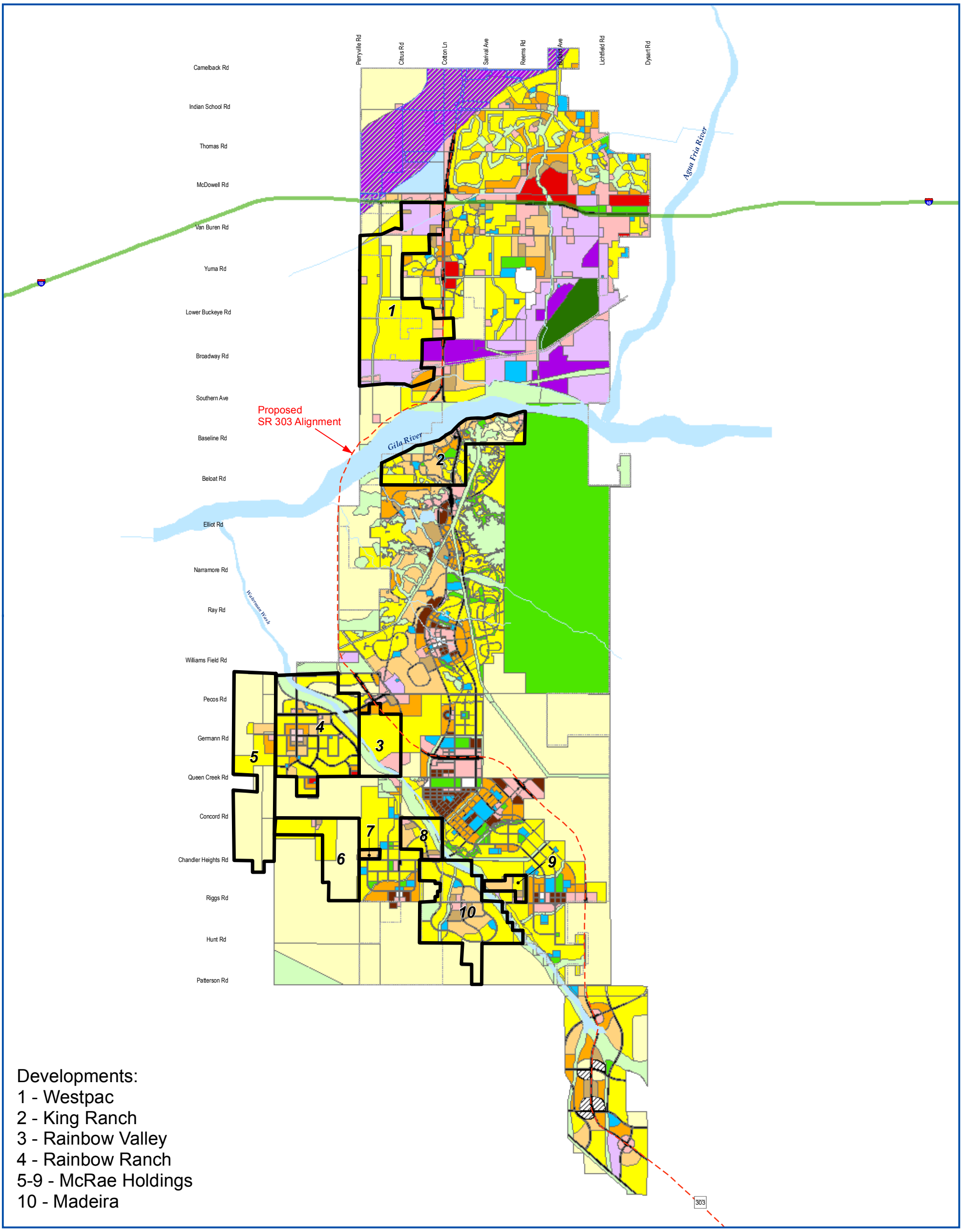
ES-4 WATER RESOURCE INTEGRATION

The City of Goodyear resides within the Sonoran Desert in the arid southwest, a location that receives on average less than 10-inches of total rainfall per year. Careful management and efficient planning will be required to develop the next increments of supply needed to support a projected ten-fold increase in population. The City relies entirely on groundwater pumping to meet current potable water demands and it is anticipated that future demands will be met by a combination of increased groundwater pumping and imported surface water. Table ES-2 shows the makeup of the City's available water resources.

Table ES-2: City of Goodyear Water Resources

Resource Type	2007 Resources	2012 Resources	2017 Resources	2045 Resources
Total Surface Water Resources	**3,681**	**19,706**	**19,706**	**19,706**
Total Groundwater Resources	**95,018**	**95,018**	**95,018**	**95,018**
Total Reclaimed Water Resources	**3,909**	**10,080**	**20,720**	**47,936**
TOTAL AVAILABLE SUPPLY	**102,608**	**124,804**	**135,444**	**162,660**

Notes:
1. Adjusted to reflect 32,662 af/yr set aside for Sonoran Valley Development.



Developments:
1 - Westpac
2 - King Ranch
3 - Rainbow Valley
4 - Rainbow Ranch
5-9 - McRae Holdings
10 - Madeira

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1 inch equals 2.25 miles

Data sources:
Carollo 2006 Hydraulic Model
City of Goodyear GIS
ALRIS
ESRI

LANDUSE

- Rural Residential (0-2.0 DU/AC)
- Low Density Residential (2.0-4.0 DU/AC)
- Medium Density Residential (6.0-10.0 DU/AC)
- Low - Medium Density Residentail (4.0 - 6.0 DU/AC)
- Medium - High Density Residential (10-20 DU/AC)
- High Density Residential
- Airport
- Agricultural Preserve
- Community Commercial
- City Center
- Mixed Use
- General Industrial
- Luke Compatible Land Use Area
- Light Industrial
- Open Space
- Park
- Public/Quasi Public
- Prison
- Regional Commercial
- Road
- VCO

Figure ES-4
Updated Landuse Map
Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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ENERGY WATER INFORMATION GOVERNMENT

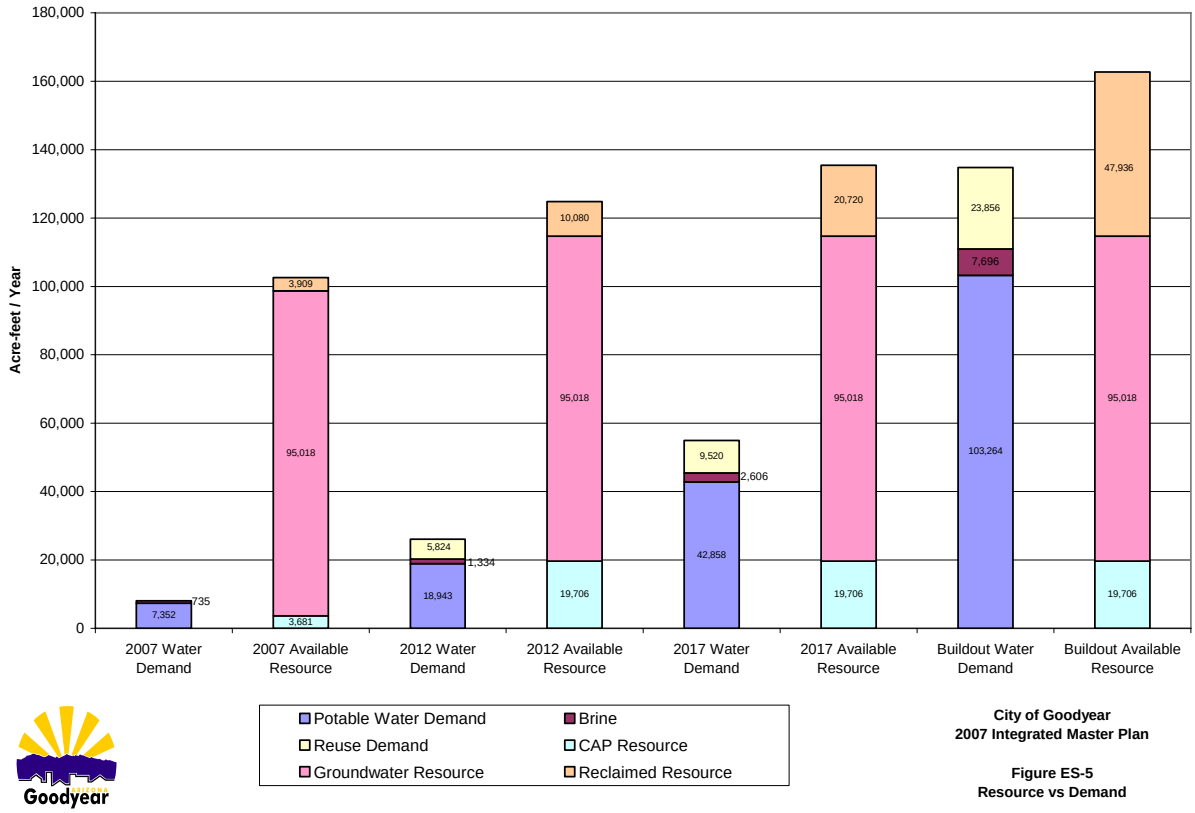
Revised: Thursday, March 13, 2008

\\Projects\GoodYear\11GIS\01MapDocuments\TM2-X_Landuse2007.mxd Christina Hassell 03 April 2007

It must be noted that the quantities shown in Table ES-2 do not reflect the total groundwater resource available to the City, but only that portion which is to be used for the development proposed within the IWMP planning area boundary. Out of the City's total proven groundwater resources, 32,662 af/yr of groundwater has been set-aside for the development of the Sonoran Valley, 14,362 af/yr from the WSRV aquifer and 18,300 af/yr from the Rainbow Valley aquifer.

Figure ES-5 graphically compares the available supply with projected demand within the City. The following conclusions can be drawn.

- The City has adequate resources identified in their portfolio to support projected growth plans through Buildout.
- There are significant resource surpluses, consisting primarily of un-tapped groundwater available currently and over the near-term.
- By Buildout, the entire supply of potable resources (surface water and groundwater) will be consumed and increased levels of development (beyond that addressed in the 2007 IWMP) could not be supported without acquiring additional resources.



City of Goodyear
2007 Integrated Master Plan

Figure ES-5
Resource vs Demand

Sustainability

In an effort to halt severe groundwater over pumping, the Arizona Legislature adopted a comprehensive groundwater code in 1980. The Groundwater Code dictates strict requirements for the use of groundwater resources within the Phoenix Active Management Area (AMA) with the ultimate goal of halting groundwater mining and achieving safe yield. Goodyear's service area falls within the Phoenix AMA and groundwater pumping must therefore comply with the safe-yield requirements.

In simple terms, the concept of safe yield requires that one ac-ft of groundwater be recharged for each ac-ft of groundwater pumped. Table ES-3 shows the projected levels of recharge and the quantity of long-term storage credits (LTSC) which the City is projected to earn and compares this with the recharge obligation associated with projected levels of groundwater pumping.

Table ES-3: Long-Term Storage Credits (LTSC) versus Pumping

Credits	2007 (af/yr)	2012 (af/yr)	2017 (af/yr)	2045 (af/yr)
Reclaimed Water Recharge	3,909	4,256	11,200	24,080
Incidental Recharge	294	818	2,152	5,393
CAP recharge	3,681	14,106	2,906	0
In-Lieu Credit	10,000	10,000	6,400	0
Total LTSC Earned Annually	**17,884**	**29,180**	**22,658**	**29,473**
Annual Groundwater Pumping	**8,087**	**16,326**	**30,237**	**91,274**
Safe-Yield Surplus or (Shortfall)	**9,797**	**12,854**	**(7,579)**	**(61,801)**

Projections show that the City currently meets the safe-yield requirement and will continue to do so over the near-term. The primary reason for this is that pumping levels are currently low and the City has unused CAP water resources which are being recharged. However, the City will fall significantly short of meeting safe yield requirements in the future, as groundwater pumping increases and CAP resources are put fully to use for potable water supply.

Figure ES-6 shows the manner in which the City's resources are linked in an integrated water-wastewater-reclaimed water utility and from this, a six-fold strategy was developed by which the long-term safe-yield shortfall can be mitigated and the City's groundwater pumping returned to a sustainable basis as follows.

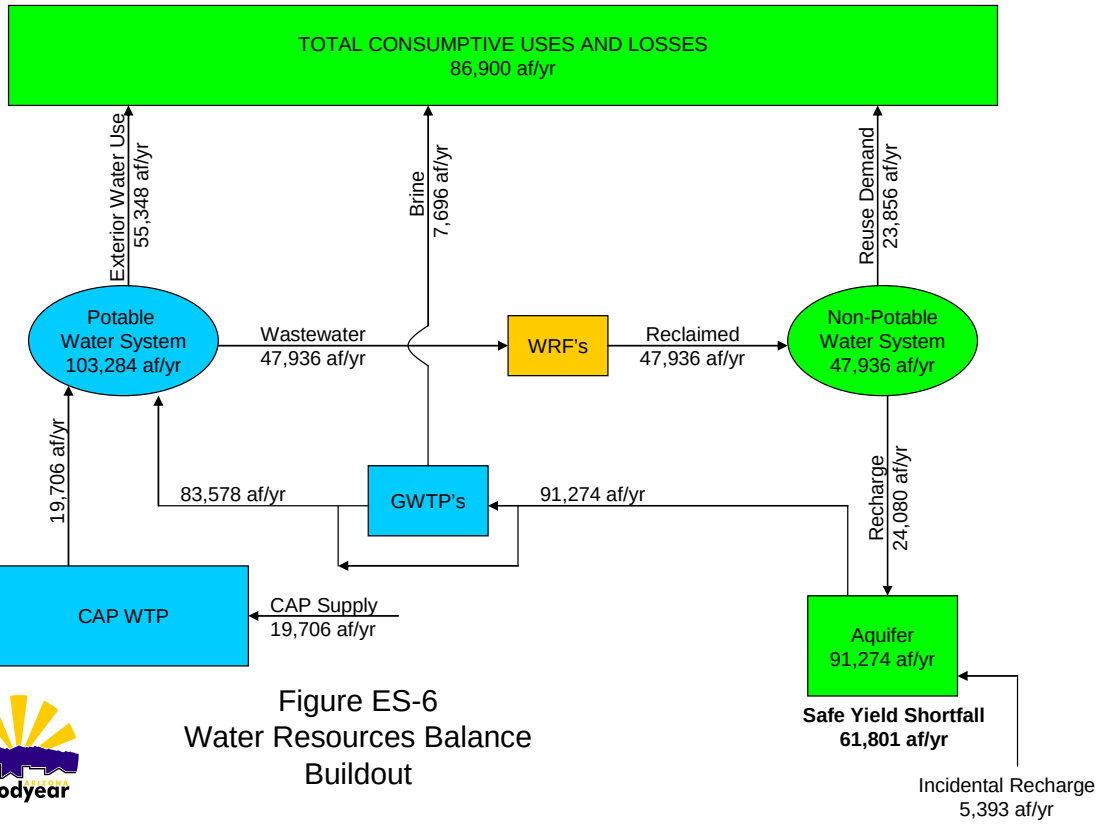


Figure ES-6
Water Resources Balance
Buildout

1. Purchase or Develop Recharge Credits – The City can move toward meeting their safe-yield requirement by simply purchasing or developing additional recharge credits from Central Arizona Groundwater Replenishment District (CAGRD) or other Intergovernmental Agreement.
2. Obtain Additional Imported Surface Water – Additional imported surface water could be obtained through future re-allocations of CAP resources, 99-year lease of CAP resources from an Indian Community or through purchase of main-stem Colorado River Water Rights.
3. Water Conservation – Conservation measures which reduce potable water demand will help to close the safe-yield gap, but primarily if it is the exterior fraction of potable water use which is reduced.
4. Reduce Waste Brine – At buildout, the majority of the City's potable supply will come from treated groundwater. A 1.0 ac-ft reduction in the quantity of waste brine produces an equal saving in pumped groundwater and in closing the safe-yield gap.
5. Reduce Reclaimed Water Reuse - Contrary to the general assumption, reducing rather than increasing reclaimed water reuse will help to close the safe-yield gap and help the

City achieve a sustainable resource position. A 1.0 af/yr reduction in reclaimed water reuse directly translates into a 1.0 af/yr increase in recharge which closes the safe yield gap by the same amount.

6. Pump from Buckeye Waterlogged Area - The western portion of the WSRV, along the Gila River has been declared to be a "waterlogged" area by ADWR and water pumped from a waterlogged area is free from safe-yield recharge obligations. Therefore, each ac-ft of WSRV water that is pumped from the waterlogged area closes the safe-yield gap by one ac-ft.

Using a single focus strategy, it would be difficult to erase the roughly 62,000 af / yr shortfall. However it would reasonable to obtain 5,000 to 15,000 af/yr of improvement in each of the areas presented above and in this manner maintain a sustainable resource position as the City completes its growth plan. It will be vitally important that the City begin implementing the elements of the sustainability strategy as growth progresses from today forward.

ES-5 WATER QUALITY

Historically, the City has been able to pump groundwater for use within the potable water system with only chlorination applied to the pumped water. However, due to tightening water quality regulations and declining groundwater quality, the City will be required to treat the majority of its water supply from here forward. Observations based on extensive sampling and analysis of the City's aquifers show:

TDS – The majority of the groundwater resources underlying the City are brackish with TDS levels in the range of 2,000 – 3,000 ppm, significantly over the recommended 500 ppm standard for potable water.

Nitrate, Arsenic and Fluoride – Show up at levels exceeding drinking water standards in large portions of the portions of the City's aquifers which are yet to be developed.

There is a significant quantity of groundwater available to the City of Goodyear, yet current data and observable trends indicate that the vast majority of the groundwater which will be tapped will have one or more constituents requiring treatment. This condition has been observed throughout much of the Salt River Basin, especially in areas where there has been significant agricultural activity.

At build-out, more than 100 mgd of groundwater will be extracted from the West Salt River Aquifer and the Waterman Basin Aquifers and the reverse osmosis process utilized to reduce the TDS to 500 ppm will result in 400 tons of salt extracted daily. It is imperative that this waste brine no longer be discharged to the sewer, as is currently done, for at theses levels it will impair wastewater treatment, render the reclaimed water unusable, and put the City in an unsustainable water resource position.

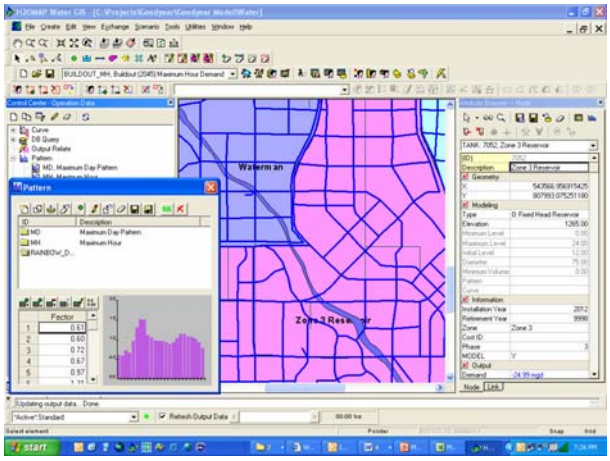
The IWMP recommends that solar evaporation beds be employed for brine disposal at this time due to the relative simplicity and low cost of this method. The required buildout acreage for brine disposal is roughly 2,400 acres and may not be readily available unless this quantity of land is set aside through planning. It is possible that a more suitable regional solution, such as a brine disposal line to the Gulf of California, will develop in the future because a number of the other municipalities in Maricopa County also have growing brine disposal needs. And, while a regional solution may have significantly less land impact, it will not likely be lower in cost. Therefore, from a planning point of view, it is recommended that the evaporation bed solution be used as a place holder guaranteeing that money is budgeted for brine disposal.

ES-6 WATER DISTRIBUTION SYSTEM

A comprehensive hydraulic model was constructed of the existing and future potable water distribution system and multiple steady state simulations were run covering a wide range of supply and demand conditions.

Model output was used to:

- Determine the diameter of new distribution and transmission mains.
- Optimize distribution system improvement to correct areas of low pressure
- Set the minimum capacity required for all reservoirs and booster pumps.



The recommended potable water system configuration was developed using hydraulic modeling and includes the following principal elements.

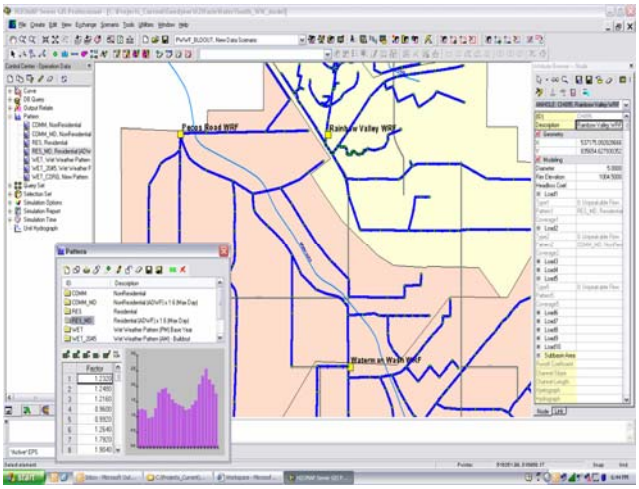
- **Distribution System –** 2,400,000 feet of new distribution mains will be required to extend water service throughout the City. Ten new storage / booster station facilities ranging in size from 3.0 to 7.0 MG and related booster station capacity will be installed. Six existing sites will be expanded with the remaining four existing facilities will be retired from service.
- **Groundwater Treatment Plants (GWTPs) –** Four centralized GWTPs will be provided: Gila River GWTP (60 mgd), Waterman GWTP (30 mgd), Estrella (20 mgd) and Adaman GWTP (10 mgd) to treat the majority of the City's groundwater. The GWTPs will treat raw water pumped from dedicated well fields and the brine rejected from the reverse osmosis process will be discharged to evaporation beds. Utilizing fewer and larger centralized GWTPs will result in significant economies of scale over employing many smaller individual well head GWTPs.
- **Central Arizona Project (CAP) WTP –** A surface water treatment plant, with 18 mgd of capacity will be required to receive and treat the City's current 19,706 af/yr CAP allotment. The City is currently in discussions about contracting for capacity in the White Tanks WTP which American Water is constructing to the north of the City.
- **Transmission System -** A separate transmission system was provided to convey water from production facilities (surface and groundwater treatment plants) to the points of distribution system supply (reservoirs). In general, significant quantities of treated water will move from sources in the north to development south of the Gila River. The transmission system will provide flexibility and greatly simplify production and distribution system operations.

ES-7 WASTEWATER COLLECTION SYSTEM

A comprehensive hydraulic model was constructed of the existing and future wastewater collection system and multiple extended period simulations were run covering a wide range of flow conditions.

Recommended improvements to the collection system were identified with the goal of:

- Identifying locations in the existing collection system where overloading or surcharging occurs under current or future loadings.
- Providing relief to overloaded segments in the most efficient manner either by paralleling or replacing sewer lines or re-routing future flow.
- Designing the collection system serving each zone so as to minimize the use of lift stations.



The recommended wastewater system configuration was developed using hydraulic modeling and includes the following principal elements.

- **Collection System –** 900,000 feet of lateral extensions will be required to extend service throughout the City. Eight new lift stations will be installed and four existing facilities will be expanded. The collection system has been configured such that all new growth, in the Rainbow Valley southward, can be accommodated by gravity flow without pumping.
- **WWTPs** - The City currently operates three wastewater treatment facilities serving the 157th Ave, Corgett, and Rainbow Valley Basins. At buildout, it is recommended the City build three new treatment plants as well as expand the capacity of the existing wastewater treatment plants. All WRFs will produce A+ effluent, suitable for reuse via unrestricted access irrigation and for recharge into the underlying potable water

aquifers. Residual Biosolids will be sent from the three smaller facilities, Corgett, Rainbow and Estrella to the larger downstream facilities for processing and final disposal. Consolidating processing at the larger WRFs, will simplify operations and save significant cost due to economies of scale. Table ES-4 summarizes the buildout WWTP capacities.

Table ES – 4 Buildout WWTPs

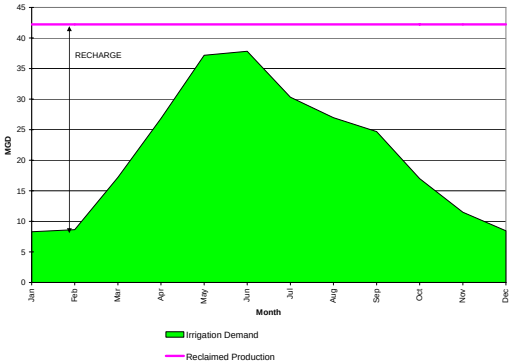
Facility	Plant Size	Reclaimed Water Quality	Bio-solids Processing
157th Ave WWTP	18.0	A+	Yes
Corgett WRF	2.0	A+	No
Rainbow WRF	6.0	A+	No
Pecos WRF	8.0	A+	Yes
Waterman WRF	10.0	A+	Yes
Estrella WRF	3.0	A+	No
Total Capacity	**47.0**		

ES-8 RECLAIMED WATER DISTRIBUTION SYSTEM

A comprehensive hydraulic model was constructed of the future reclaimed distribution system and multiple extended period simulations were run covering a wide range of supply and demand conditions.

Model output was used to:

- Determine the diameter of new reclaimed distribution and transmission mains.
- Determine the equalization volume necessary to equalize between reclaimed water production (reservoir fill rates) and peak hour pumping rates over a 24-hour period.
- Determine the booster pumping requirements.



Three levels of reuse were analyzed in the IWMP to determine the optimum balance between reclaimed water reuse and recharge; a *Zero Reuse* option, where all reclaimed water was recharged, a *Dual System* option where reclaimed water was provided for exterior landscaping at all residential and commercial customers, and a *Mid Level* option with a customer base consisting of large turf areas such as parks, schools and golf course as well as street ROW and decorative lakes. The Zero Reuse and Dual System options were found to be higher cost systems overall and because 100 percent of the reclaimed water will be either reused or recharged in any case, there was no difference to the City's overall recourse position among the three options. The reclaimed water system was therefore designed around the Mid Level reuse option.

The recommended system configuration was developed using hydraulic modeling and includes the following:

- **Distribution System –** 900,000 feet of distribution piping will be required to extend reclaimed water service throughout the City. Six new equalization reservoirs will be located at the WRF ranging in size from 2.0 to 7.0 MG and related booster station capacity will be installed. The reclaimed water distribution network will deliver water primarily to reuse in the summer month and primarily to and recharge locations in the winter months leading to an efficient utilization of the non-potable water distribution system throughout the year.
- **Recharge Well Fields –** Provide a critical link which integrates the City's resources and provides for sustainable groundwater pumping. The recharge configuration is planned to work interactively with the GWTP well fields so that overtime, the recharge of low TDS reclaimed water will result in improved groundwater quality and reduced treatment needs associated with the potable water system.
- **Transmission System -** The critical backbone element of the reclaimed water transmission system is the transmission system pipeline connecting the 157th Ave WWTP, with the Estrella, Corgett, Pecos Road, Rainbow Valley and Waterman Wash WRFs. This transmission line will provide for the transmission of excess reclaimed water to the Zone 2 and 3 recharge well-fields in the winter and will supply supplemental reclaimed water to meet peak irrigation demands during the summer.

The above recommendations were not presented in terms of a time scale since the rate of development will be highly variable. There are however two recommendations under which all the proceeding recommendations fall:

- Continue to construct the reclaimed water distribution system mains where shown when parallel water or sewer construction is being undertaken.
- Invest in recharge facilities to keep pace with reclaimed water production levels in order to ensure 100 percent recharge of the balance remaining after reuse.

ES-9 IDENTIFIED SYSTEM NEEDS AND RECOMMENDED CAPITAL IMPROVEMENTS

Black & Veatch used the data and system improvement recommendations obtained from the hydraulic analysis of the water, wastewater, and reclaimed water systems to develop Capital Improvement Plans (CIPs) for each system. A near-term CIP was developed on an annual basis for 2008-2012. An intermediate-term CIP developed for the period 2013-2017 and a long-term CIP for the period 2019-2045. Costs are tied to growth in demand, not years. If population growth slows, so will the rate of growth in demand and the accompanying rate of capital expenditure. It is assumed that the CIP will be reviewed on an annual or bi-annual basis and with each review, new projects will be prioritized and scheduled to maintain an up-to-date 5-year CIP.

The CIP costs presented represent 2007 construction dollars without inflation, to which a 30% contingency and 20% for design and construction administration have been added. Land costs are not included for any recommended improvement item.

The water distribution system analysis identified a 2045 build-out CIP for recommended system improvements totaling $2,442,096,668 in 2007 dollars. That figure was broken down as shown in Table ES-5.

Table ES-5. Summary of Water System Recommended Capital Improvement Costs (in Millions)							
Planning Period	Near-term					Intermediate-term	Build-out
Year	2008	2009	2010	2011	2012	2017	2045
Estimated cost of Recommended Capital Improvements	$70.5	$55.4	$69.4	$160.3	$181.1	$436.6	$1,461.7

The water system CIP can also be broken down by type of infrastructure as follows:

Table ES-6. Table Water Infrastructure Costs at Buildout	
GWTP	55%
Distribution System Pipelines	37%
Booster Stations	5%
Reservoirs	4%
WPA2 Wells	< 1%
PRV Stations	< 1%
Total Cost of Water Infrastructure	**100%**

It can be seen that the main cost of the water system is that associated with the GWTPs.

The wastewater collection system analysis identified a 2045 build-out CIP for recommended system improvements totaling $848,240,400 in 2007 dollars. That figure was broken down as shown in Table ES-7.

Table ES-7. Summary of Wastewater Collection System Recommended Capital Improvement Costs (in Millions)							
Planning Period	Near-term					Intermediate-term	Build-out
Year	2008	2009	2010	2011	2012	2017	2045
Estimated cost of Recommended Capital Improvements	$18.2	$18.2	$110.2	$18.2	$99.8	$261.5	$316.0

The wastewater system CIP can also be broken down by type of infrastructure as follows:

Table ES-8. Wastewater Infrastructure Costs at Buildout	
Wastewater Treatment Plants	62%
Collection System Pipeline	32%
Lift Stations	4%
Force Mains	2%
Total Cost of Wastewater Infrastructure	**100%**

It can be seen that the main cost of the wastewater system is that associated with the WWTPs.

The reclaimed water distribution system analysis identified a 2045 build-out CIP for recommended system improvements totaling $451,147,350 in 2007 dollars. That figure was broken down as shown in Table ES-9.

Table ES-9. Summary of Reclaimed Water System Recommended Capital Improvement Costs (in Millions)

Planning Period	Near-term					Intermediate-term	Build-out
Year	2008	2009	2010	2011	2012	2017	2045
Estimated cost of Recommended Capital Improvements	$22.9	$22.9	$40.4	$22.9	$48.4	$139.9	$153.7

The reclaimed water system CIP can also be broken down by type of infrastructure as follows:

Table ES-10. Reclaimed Water Infrastructure Costs at Buildout	
Reclaimed Water System Pipelines	73%
Reservoirs	13%
Wells	8%
Booster Stations	7%
Total Cost of Reclaimed Water Infrastructure	**100%**

It can be seen that the main costs of the reclaimed system are those associated with the reservoirs and booster stations.

Integrated Water Master Plan

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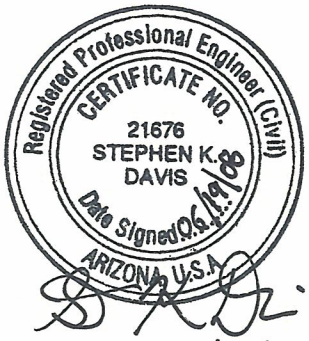

Expires 9/30/08

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Appendix

Appendix A Reuse Evaluation
Appendix B CIP Supporting Data

SECTION 1

INTRODUCTION

1.1 BACKGROUND

The City of Goodyear is one of the fastest growing communities in Western Maricopa County. Goodyear is bordered by the cities of Avondale, Litchfield Park and Buckeye as well as significant expanses of unincorporated county lands as shown in Figure 1-1. The City of Goodyear provides water, wastewater, and reclaimed water utility services for a population of approximately 49,000 the majority of which is currently located in the City's Central Planning Area (CPA) which lies north of the Gila River.

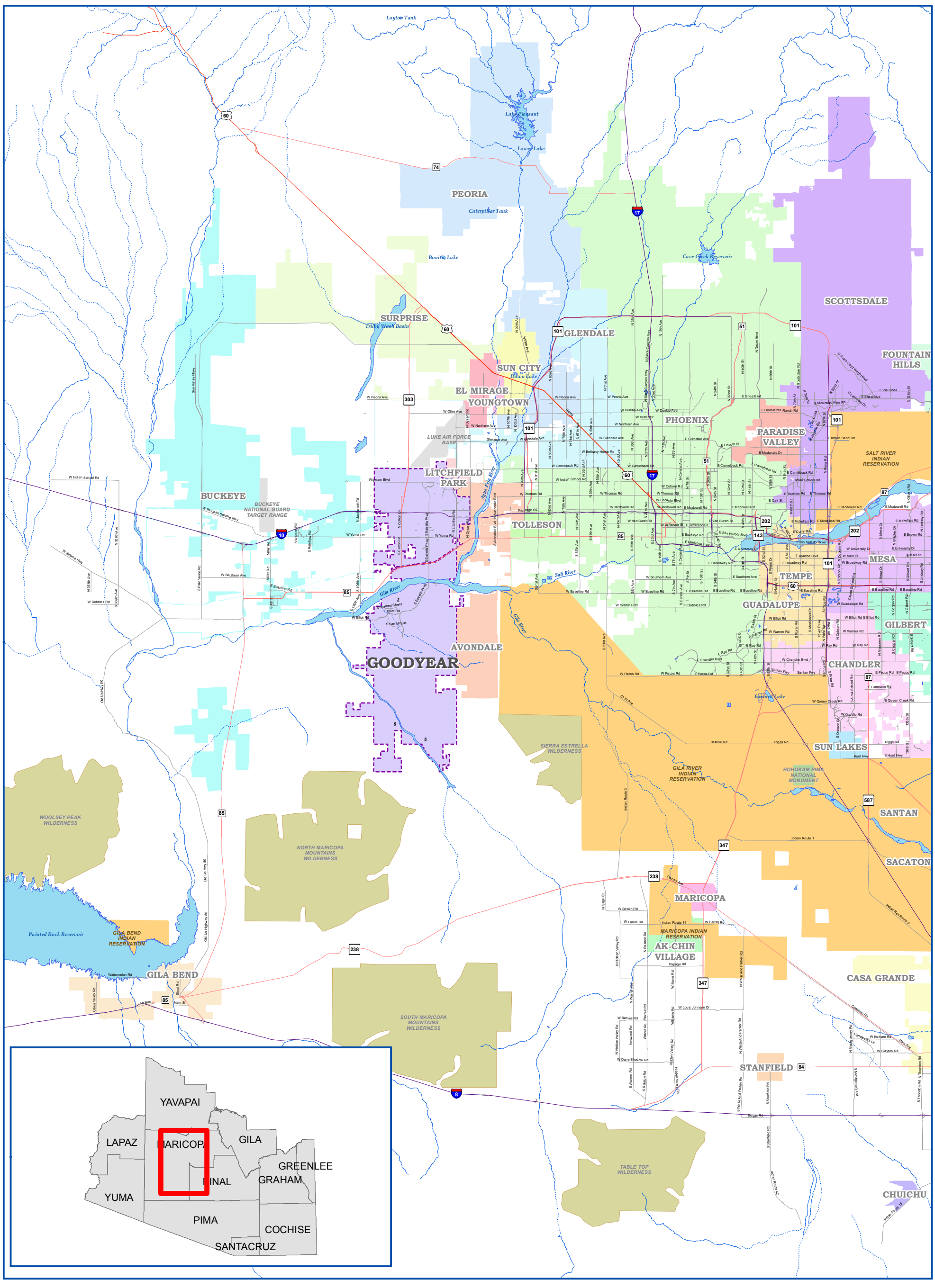
However, plans for the City include significant growth within the Southern Planning Area (SPA) and the recently annexed Sonoran Valley farther south. Upon buildout of these areas, the City's population can be expected to grow by more than ten-fold reaching over 800,000.

1.2 PURPOSE

The purpose of this Integrated Water Master Plan (IWMP) is to develop a comprehensive plan by which the City of Goodyear can accommodate current and projected growth while addressing the full range of water infrastructure issues including, resources, demands, water quality, optimal resource use, and infrastructure phasing requirements.

Key goals / issues to be addressed within the IWMP include:

1) Accurately project water, wastewater and reclaimed demands and flow rates through buildout based upon the land use projections provided by the City of Goodyear.
2) Plan infrastructure which will efficiently and reliably meet projected water, wastewater and reclaimed water needs.
3) Optimize the interaction of water resources and water production infrastructure so as to accommodate projected water demands in a sustainable manner.
4) Provide a detailed year by year Capital Improvements Plan (CIP) for water, wastewater and reclaimed infrastructure accommodating existing developer plans and regulatory requirements over the next five years.
5) Provide a 10-year and buildout CIP value for the remaining water, wastewater and reclaimed infrastructure.



Legend

Transportation

- US Route
- State Route
- Major Arterial
- Interstate Highway

- Lake

Streams

- Aqueduct
- Stream
- Wash

N W E S

2 0 2
Miles

Data Sources:
City of Goodyear GIS
ALRIS
ESRI

Figure 1-1
Vicinity Map

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Revised: Monday, March 24 2008

1.3 APPROACH

The IWMP provides a detailed and comprehensive guide by which the City can efficiently invest in the water, wastewater and reclaimed water infrastructure needed to provide high quality and reliable service. The following general approach was utilized:

- Demographics and land use patterns were developed primarily from the City's 2003 General Plan, supplemented with census data and other planning data obtained from the City and the Maricopa Association of Governments.
- Current water use patterns and unit rates were developed using records and data provided by the City. Future water demands, wastewater flowrates and reclaimed water demands were developed based upon buildout land uses.
- Quantify available water resources and develop an integrated plan which supports development in a sustainable manner.
- Build and calibrate water, wastewater, and reclaimed water system hydraulic models to provide the analytical tools for system analysis and infrastructure sizing.
- Analyze supply and treatment alternatives to identify the most efficient means of providing the projected levels of service to the City of Goodyear customers.
- Develop a detailed, phased CIP which will guide the City through the required infrastructure improvements.

1.4 ORGANIZATION OF THE IWMP

The result of the master planning effort is summarized in Volume 1 of the Integrated Water Master Plan, divided into eight chapters as shown below.

Volume 1 – Integrated Water Master Plan

- Executive Summary
- Chapter 1 – Introduction
- Chapter 2 – Demographics and Land Use
- Chapter 3 – Projected Water Demands and Flowrates
- Chapter 4 – Water Resources
- Chapter 5 – Water System Analysis and Recommendations
- Chapter 6 – Collection System Analysis and Recommendations
- Chapter 7 – Reuse System Analysis and Recommendations
- Chapter 8 – Capital Improvement Plan

A series of technical memoranda (TMs), were prepared and issued over the course of the project. They provide the supporting details for the discussions and conclusions contained in Volume I. The TMs are contained in their entirety in Volumes 2 through 4 of the IWMP and were titled as follows:

Volume 2 - Water Technical Memoranda

- TM1-1 – Infrastructure Inventory
- TM1-2 – Demand Analysis
- TM1-3 – Water Resources
- TM1-4 – Water Production Plan
- TM1-5 – Water Model Development and Hydraulic Analyses

Volume 3 - Wastewater Technical Memoranda

- TM 2-1 – Collection / Treatment Plan
- TM 2-2 – Collection System Hydraulic Analyses

Volume 4 - Reclaimed Water Technical Memoranda

- TM 3-1 – Effluent Management Plan
- TM 3-2 – Reclaimed Water System Parameters
- TM3-3 – Reuse Model Development and Hydraulic Analyses

1.5 REFERENCE DOCUMENTS

In the preparation of this IWMP Black & Veatch referred to following documents for system, demographic, and related planning information:

- City of Goodyear 2003 General Plan
- Arizona Department of Water Resources (ADWR) Third Management Plan
- The Arizona Department of Environmental Quality (ADEQ) Effluent Reuse Standards and Permitting
- Arizona Administrative Code, Title 18 Environmental Quality
- Sonoran Valley Planning Area Major General Plan Amendment Application
- City of Goodyear Groundwater Flow Model, Burgess & Niple Inc, December, 2007

1.6 ABBREVIATIONS

AAD	Annual Average Day	**MAD**	Monthly Average Day
AD	Average day	**maf**	million acre-feet
ADEQ	Arizona Department of Environmental Quality	**MAG**	Maricopa County Assn of Governments
ADWF	Average Dry Weather Flow	**MCESD**	Maricopa County Environmental Services Dept.
ADWR	Arizona Department of Water Resources	**MDD**	Maximum Day Demand
af	acre feet	**MG**	Million Gallons
AMA	active management area	**mgd**	million gallons/day
AMWC	Adaman Mutual Water Company	**mg/l**	milligrams per liter
APP	Aquifer Protection Permit	**MH**	Maximum Hour
ASR	aquifer storage and recovery	**MM**	Max Month
AZMET	Arizona Meteorological Network	**MPA**	Municipal Planning Area
AZPDES	Arizona Pollutant Discharge Elimination System	**MWD**	Maricopa Water District
CAP	Central Arizona Project	**NPDES**	National Pollution Discharge Elimination System
CAWCD	Central Arizona Water Conservation Dist.	**PDWF**	Peak Dry Weather Flow
CIP	Capital Improvement Plan	**PHD**	Peak Hour Demand
CPA	Central Planning Area	**ppm**	parts per million
DBP	disinfection by-product	**PRV**	Pressure Reducing Valves
d/D	depth of flow	**psi**	pounds per square inch
DU	Dwelling Units	**PWWF**	Peak Wet Weather Flow
EPA	Environmental Protection Agency	**RDII**	Rainfall Dependent Infiltration/Inflow
EPS	extended period simulation	**RO**	Reverse Osmosis
EQ	equalization volume	**ROW**	right-of-way
ET	Evapo-transpiration	**SAR**	sodium adsorption ratio
ETo	baseline evaporation	**SAT**	soil aquifer treatment
FAR	floor to area ratio	**SDWA**	Safe Drinking Water Act
GIS	Geographic Information System	**SPA**	Southern Planning Area
gpad	gallons per acre-day	**SSA**	Sewer Service Area
gpcd	gallons per capita per day	**TCE**	Trichloroethelyene
gpdu	gallons per dwelling unit	**TDS**	total dissolved solids
GWTP	Groundwater Treatment Plant	**TOC**	total organic carbon
HGL	hydraulic grade line	**USGS**	United States Geological Survey
IWMP	Integrated Water Master Plan	**WPA**	water planning area
IX	ion exchange	**WRF**	water reclamation facility
Kc	crop coefficient	**WTP**	water treatment plant
LPSCO	Litchfield Park Service Company	**WWTP**	wastewater treatment plant

SECTION 2

DEMOGRAPHICS AND LAND USE

2.1 STUDY AREA

The Study Area for the Integrated Water Master Plan (IWMP) was based upon the City's municipal planning area (MPA), primarily as defined by the Maricopa County Association of Governments (MAG) but with several minor revisions to account for recent annexations and anticipated future revisions. Figure 2-1 presents the IWMP Study Area as well as other City of Goodyear related boundaries including:

- **MAG Municipal Planning Area:** The City's Municipal Planning Area (MPA) as established by Maricopa Association of Governments (MAG) encompasses the existing corporate limits of the City and adjacent county lands that are considered to be within Goodyear's sphere in influence and anticipated to eventually be annexed within the corporate limits. The City has subdivided the MPA into four Water Planning Areas (WPA-1 thru WPA 4) It is anticipated that the recently annexed Sonoran Valley will be added by MAG to Goodyear's MPA

- **Goodyear Corporate Boundary:** The City's corporate boundary currently falls within the MPA, leaving pockets of unincorporated land. For the purpose of this study it is assumed that these lands will be annexed into the City by the time buildout is achieved.

- **Sonoran Valley Planning Area:** In 2006 the City proposed the annexation of the 60,000 acres south of the existing Goodyear MPA commonly referred to as the Sonoran Valley Planning Area. The Sonoran Valley Planning Area consists of Arizona State Land (5,310 acres), private ownership (24,236 acres), and BLM Lands (31,358 acres). At the time of this IWMP only the Arizona State Land portion, commonly referred to as the "South 5,300" is to be included in the planning efforts associated with this IWMP.

- **Master Plan Study Area:** The master plan study area consists of the City's Municipal Planning Area (MPA) to which, 1) 300 acres has been added to WPA-4 on the west to account for a pending annexation along the western boundary and 2) the 5,300 acre Sonoran Highlands has been added on the south.

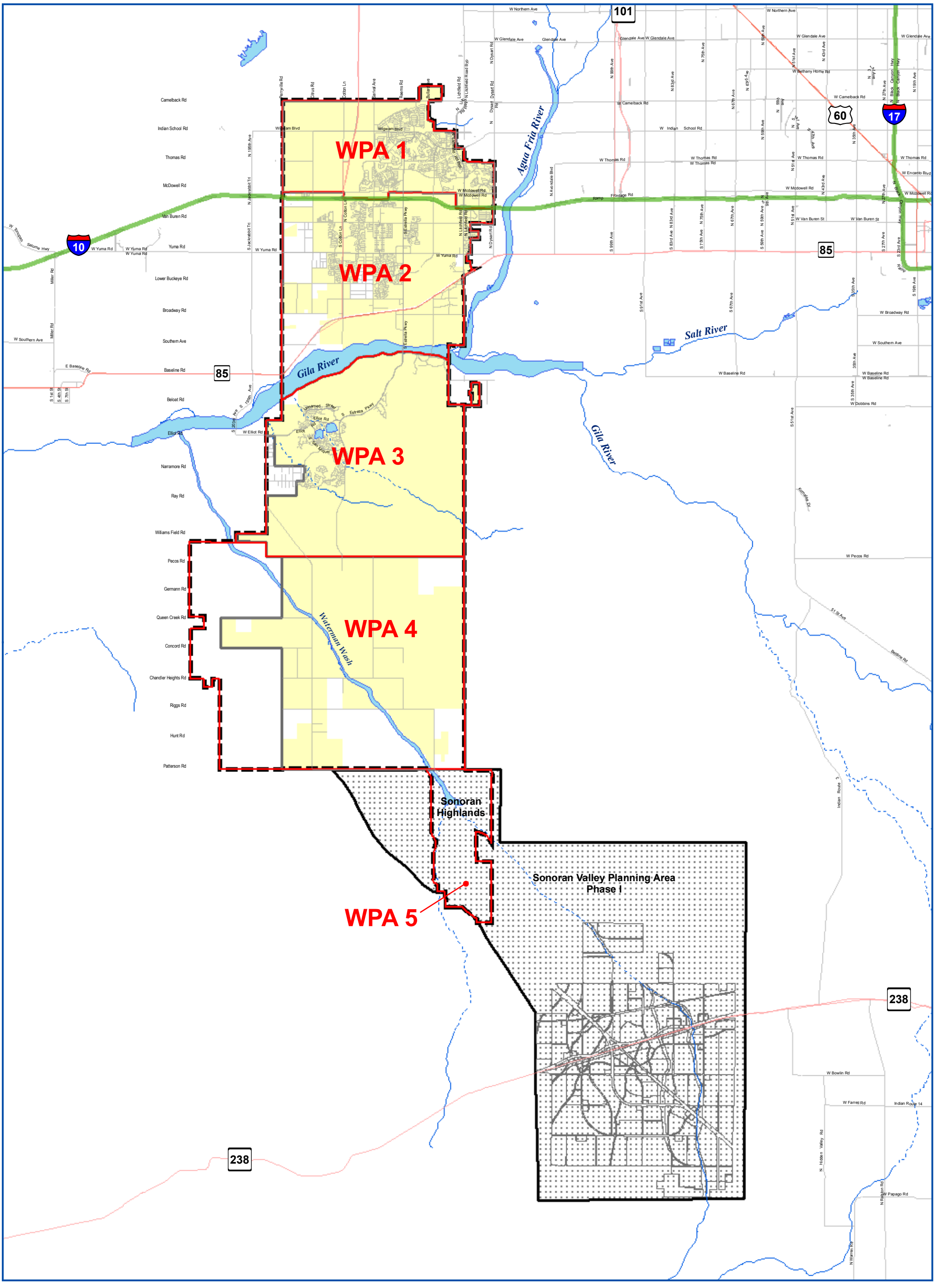
The current division of the MPA into four Water Planning Areas will be utilized within the IWMP, primarily to define the extent of the City's water, wastewater and reclaimed water service areas. The Sonoran Highlands has been added in the south as the fifth WPA. The five WPAs are shown on Figure 2-1 and can be identified as follows:

- WPA-1 is often referred to as the Northern Planning Area and is the area north of I-10 within the City's Municipal Planning Area. Within WPA1, the city will only provides wastewater collection service and that only for five sections of land within the western portion of WPA-1. Water and reclaimed water service in WPA-1 is currently provided by others and is not included in the IWMP.

- WPA-2, bounded by Interstate 10 in the North and the Gila River to the South, is generally referred to as the Central Planning Area. The City will provide water, wastewater and reclaimed water service within WPA-2.

- WPA-3 and WPA-4 form the City's Southern Planning Areas and extend from the Gila River southward to roughly the Patterson Road alignment. WPA-4 is also commonly referred to as Rainbow Valley or Hidden Valley. The City will provide water, wastewater and reclaimed water service within WPA-3 and 4.

- WPA-5 is a new water planning area created to accommodate the 5,300 acre Sonoran Highlands portion of the Sonoran Valley Planning Area. The City will provide water, wastewater and reclaimed water service within WPA-5.



N
W E
S

1 inch equals 3 miles

Data sources:
City of Goodyear GIS
RBF Consulting
ALRIS
ESRI

Legend

Major Highways
- US Route
- State Route
- Major Arterial
- Interstate

Streams
- Aqueduct
- Stream
- Wash

- City Limits
- Water Planning Area
- Master Plan Study Area
- Municipal Planning Area (MAG)
- Pending Sonoran Valley Annexation - Phase 1

Figure 2-1
Study Area

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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ENERGY WATER INFORMATION GOVERNMENT

Revised: Thursday, March 13, 2008

2.2 HISTORIC POPULATION AND GROWTH

Within this section, the City's historical population data were analyzed to establish a base year population and historic growth rates.

Base Year Projections (2007) – Base year projections and growth rates were developed from an analysis of historical population and dwelling unit data. Historical data was obtained from Maricopa Association of Governments (MAG) for years 1990 and 2000 through 2005 which are presented in Table 2-1.

Table 2-1: City of Goodyear Historical Populations

Year	Population	Dwelling Units (DU)	Incremental DU/year	Occupancy Per DU	Annual % Growth Rate
1990	6,300	2,371		2.66	
2000	19,605	7,056	469	2.78	12.02%
2001	22,820	8,372	1,316	2.73	16.40%
2002	26,715	10,002	1,630	2.67	17.07%
2003	30,290	11,555	1,553	2.62	13.38%
2004	35,810	13,564	2,009	2.64	18.22%
2005	41,240	15,706	2,142	2.63	15.16%
			2000-2005 Average	**2.68**	**16.05%**
			IWMP Planning Values	**2.65**	**16.00%**

The City experienced a 12% annual growth rate between 1990 and 2000 and 16% for the period of 2000-2005. The City's Economic Development Department and Water Resources Department indicated that the IWMP should utilize an occupancy factor of 2.65 and continue the growth rate of 16% for the next 10-year period, through 2015.

2.3 LAND USE AND BUILDOUT

Buildout is a fundamental and important concept in master planning work. Simply put, it refers to the point in time when completion or building out of all of the various residential and non-residential parcels within the city has been achieved. When there is not an acre left that has not been developed, the city is built-out. And while the date at which buildout will occur may be hard to predict, the actual condition can still be accurately interpreted in terms of the total number of dwelling units and acres of non-residential development as well as the resulting water demand and wastewater flow.

Planning water resources and water infrastructure for the buildout condition is important because it gives the master planner a picture of where he is headed and what the completed system will look like. Once this is done, planning for the interim years then becomes a matter of phasing the buildout system infrastructure, and if the growth rate changes, it does not affect what you build, only when you build it.

Buildout Projections – The City provided Black and Veatch with GIS shape files of the approved *2003 General Land Use Plan* showing buildout land uses and acreages for the City's Municipal Planning Area. The *2003 General Land Use Plan* was the primary basis for the demographics and buildout projections used in developing the IWMP. However, changes brought about by recent and pending General Plan amendments and/or anticipated annexations needed to be incorporated into the 2003 Land Use Plan first so that the IWMP could capture changes in the City's planned course of development. Modifications to the General Plan Land Use Plan which were utilized in the IWMP can be described as follows:

Approved General Plan Amendments. The *2003 General Land Use Plan* was modified to reflect approved General Plan Amendments associated with the following developments:

- Kings Ranch
- WESTPAC
- Rainbow Ranch

Pending Land Use Plan General Plan Amendments. The City provided Black and Veatch with information regarding several proposed developments in the Southern Planning Areas which differ significantly from the current zoning and for which General Plan Amendments are pending or anticipated. These developments include:

- Rainbow Valley
- McRae Holdings (Perryville & Ocotillo)
- Madeira

Planning Area Extensions. The City directed Black & Veatch to incorporate proposed development plans for the following areas which are currently outside of the City Current Municipal Planning Area:

- Sonoran Highlands (South 5,300)
- McRae Holdings (207th & Pecos)

Accounting for Turf Acreages. The Southern Planning Area was adjusted to account for the quantity of turf acreage planned for golf courses and parks. In order to avoid double counting, the turf quantities were subtracted from residential acreages already in the Land Use Plan. The following adjustments were made:

- In WPA-3, 388 acres for parks and 95 acres for golf course were added. 483 acres was then subtracted from rural residential.
- In WPA-4, 956 acres for parks and 1,126 acres for golf course were added. 2,082 acres was then subtracted from rural residential.
- In WPA-5, 137 acres for parks and 175 acres for golf course were added. 312 acres was then subtracted from rural residential.

Luke Compatible Land Use. The City has directed Black & Veatch to assume the Luke Compatible Land Use located within WPA-1 will be Low-Medium Density Residential Dwelling Units.

Revised Target Density. The 2003 Land Use Plan shows that large portions of WPA-4 are currently planned as Rural Residential; with a density of 0 to 2 dwelling units per acre for which the IWMP would have applied a target density of 1 du/ac. However based on observed development trends, it was believed that a target density of 2 du/ac was more appropriate for Rural Residential land uses in WPA-4.

The resulting Land Use Plan, used in this IWMP is shown on Figure 2-2 and the corresponding land use acreages and buildout dwelling units (DU) are summarized in Table 2-2. The revised land use acreages and target densities presented in Table 2-2 formed the basis for the development of the study area buildout dwelling unit projections. Buildout population projections were calculated by applying the design occupancy rate of 2.65 people per dwelling unit to the residential land use.

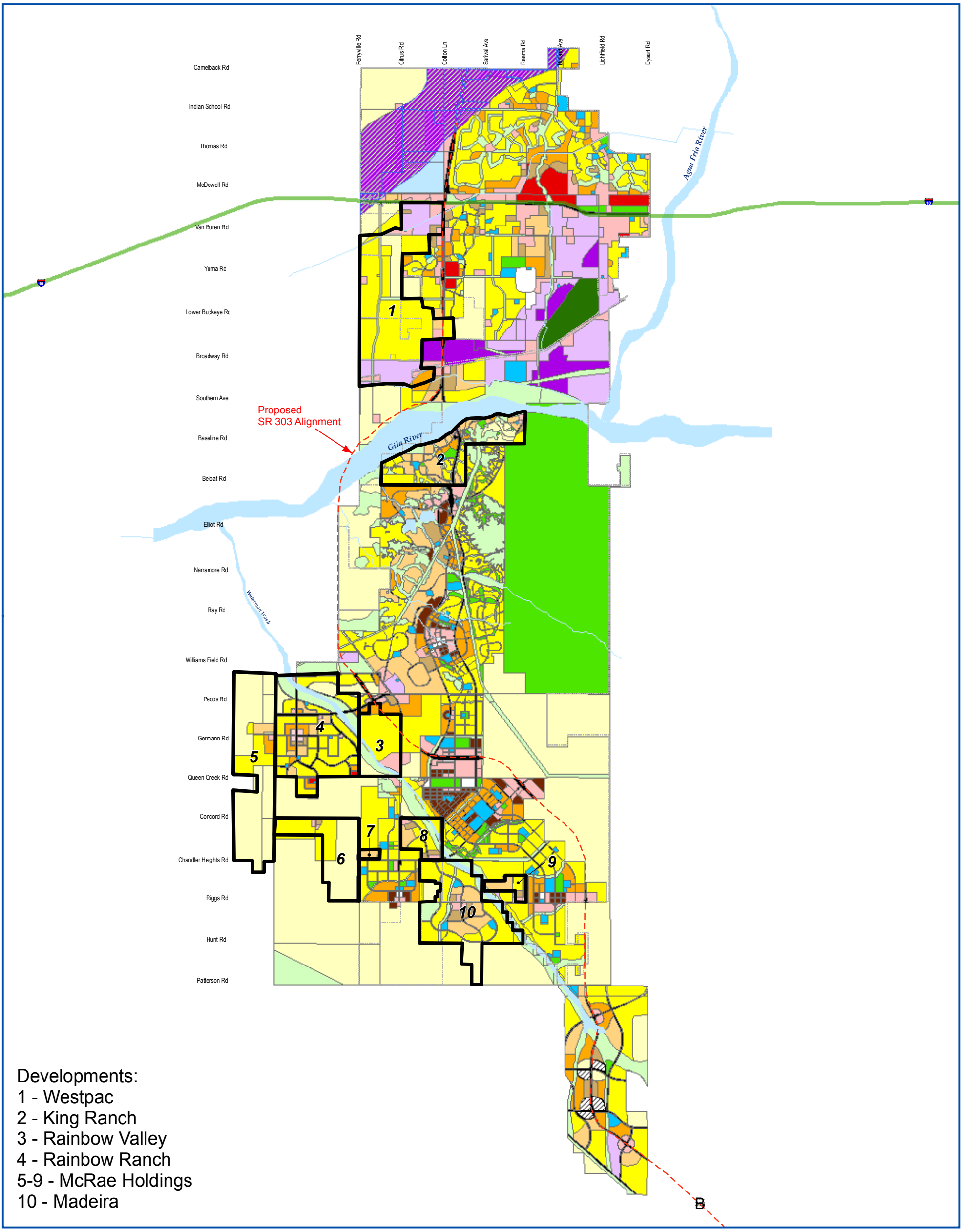

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
Pecos Rd
Germann Rd
Queen Creek Rd
Concord Rd
Chandler Heights Rd
Riggs Rd
Hunt Rd
Patterson Rd
Agua Fria River
Gila River
Waterman Wash
Proposed
SR 303 Alignment
1
2
3
4
5
6
7
8
9
10
B
Developments:
1 - Westpac
2 - King Ranch
3 - Rainbow Valley
4 - Rainbow Ranch
5-9 - McRae Holdings
10 - Madeira
N
W
E
S
1 inch equals 2.25 miles
LANDUSE
Rural Residential (0-2.0 DU/AC)
Low Density Residential (2.0-4.0 DU/AC)
Medium Density Residential (6.0-10.0 DU/AC)
Low - Medium Density Residentail (4.0 - 6.0 DU/AC)
Medium - High Density Residential (10-20 DU/AC)
High Density Residential
Airport
Agricultural Preserve
Community Commercial
City Center
Mixed Use
General Industrial
Luke Compatible Land Use Area
Light Industrial
Open Space
Park
Public/Quasi Public
Prison
Regional Commercial
Road
VCO
Data sources:
Carollo 2006 Hydraulic Model
City of Goodyear GIS
ALRIS
ESRI
Figure 2-2
Updated Landuse Map
Integrated Water Master Plan
City of Goodyear, AZ
2007
Goodyear
BLACK & VEATCH
building a world of difference
ENERGY WATER INFORMATION GOVERNMENT
\\Projects\GoodYear\11GIS\01MapDocuments\TM2-X_Landuse2007.mxd Christina Hassell 03 April 2007
Revised: Thursday, March 13, 2008

Table 2-2: Revised Study Area Land Use

LAND USE CATEGORY	Target Density (DU/ac)	Revised Study Area Land Use (acres)	Dwelling Units (DU)
RESIDENTIAL			
Single-Family Residential			
Agricultural Preservation (1 du/ac)	1	0	0
Rural (0-2 du/ac) (WPA1-WPA3 , WPA5)	1	5,337	5,337
Rural (0-2 du/ac) (WPA4)	2	16,979	33,958
Low Density (2-4 du/ac)	3	26,758	80,273
Low-Medium Density (4-6 du/ac)	5	8,012	40,062
Multi-Family Residential			
Medium Density (6-10 du/ac)	8	4,450	35,601
Medium-High Density (10-20 du/ac)	15	1,447	21,706
High Density Residential (20+ du/ac)	25	908	22,699
NON RESIDENTIAL			
Employment			
Community Commercial		4,393	
Regional Commercial		914	
Luke Compatible Land Use Area		0	
City Center / Village Center		305	
Light Industrial		4,429	
General Industrial		1,339	
Support			
Public / Quasi Public		1,565	
Prison		427	
Airport		796	
Parks		12,967	
Roads		3,484	
Open Space		13,506	
Total Acreage		**108,232**	**239,636**
Buildout IWMP Study Area Population			**635,035**

Notes:
1. Area summary by land use from projected land use as modified in land use GIS file land use.

It should be noted that the above buildout totals apply only to the IWMP study area and that aside from WPA-5 (Sonoran Highlands), they do not address development of the Sonoran Valley. The 2007 Sonoran Valley report estimated that at buildout, this area will bring an additional 189,793 in population and 70,818 dwelling units. Table 2-3 shows the resulting projected total, with the Sonoran Valley included and is provided only to put the final numbers in

perspective and show the study area totals in relation to the overall total. As previously indicated, the infrastructure developed within the IWMP is based on the study area totals.

Table 2-3 Goodyear Overall Buildout Total

Area	Dwelling Units	Population
IWMP Study Area	239,636	635,035
Sonoran Valley[2]	70,818	189,793
Goodyear Total[1]	**310,454**	**824,828**

Notes:
1. Including Sonoran Valley
2. Sonoran Valley – Sonoran Highlands

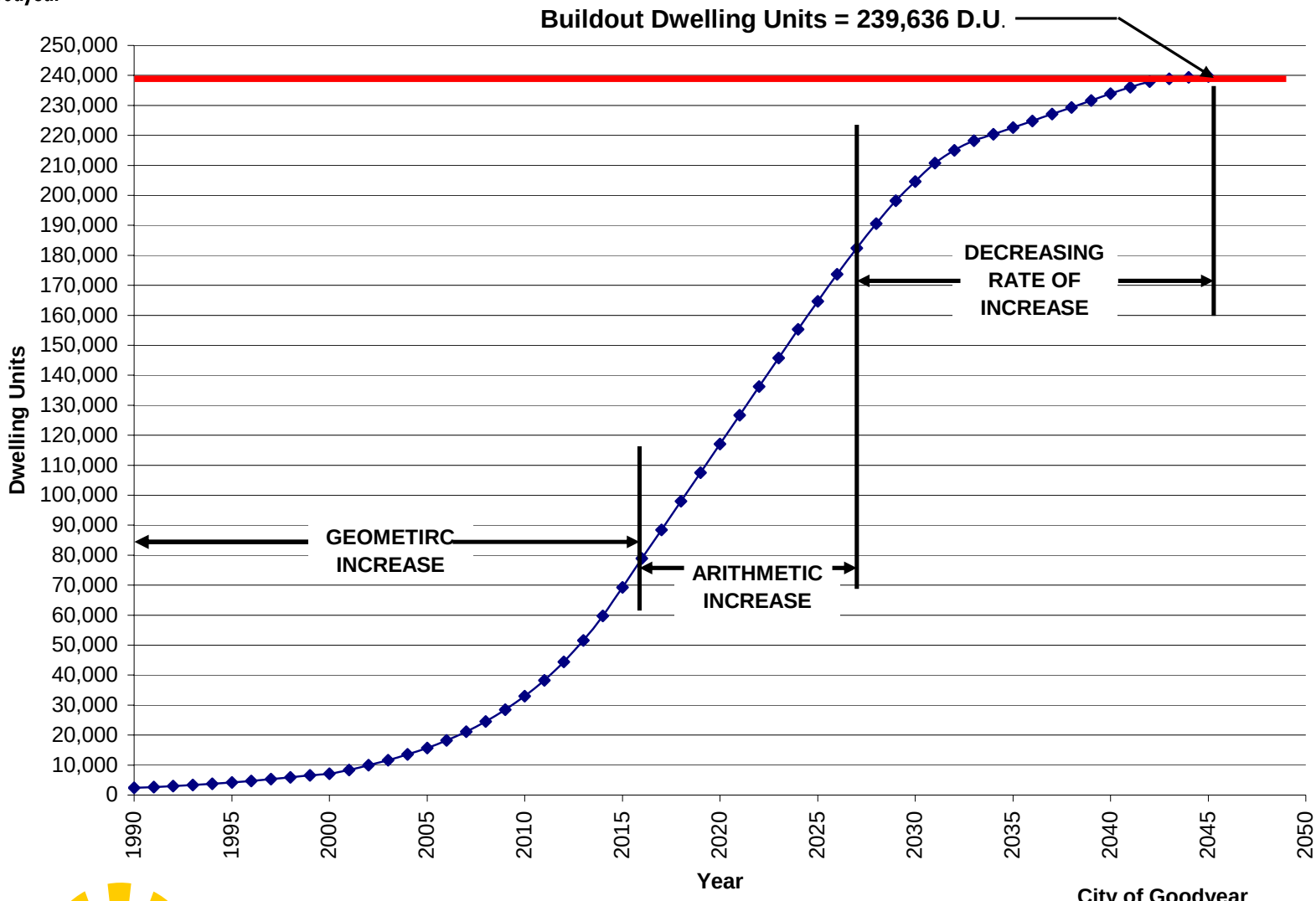
Projected Buildout Date – In order to be able to put a sense of timing to the buildout projections and develop intermediate year phasing, a classic "S-curve" pattern was utilized to transition from today's 18,219 dwelling units to buildout's 239,636 dwelling units. Figure 2-3 shows the path that growth might follow as Goodyear transitions from early stages of development through to buildout where the phases of a typical growth curve include:

Geometric Increase. Characterized by the upward trending curve, compounding growth, in the 12 to 16 percent range, brings geometrically increasing numbers of dwelling units constructed each year.

Arithmetic Increase. A period of declining growth rate, but with a constant increment of dwelling units each year creates the straight-line portion of the chart. During this phase, 9,557 dwelling units/year will be added to the City.

Decreasing Rate of Increase. Both growth rate and the growth increment decline each year, leading to a downward curving line as total dwelling units approach buildout numbers.

The resulting curve shows that buildout could be attained in roughly 40 more years or in the range of 2045 to 2050. Additional details related to the development of the projected growth curve and buildout projections are provided in Technical Memorandum 1-2.



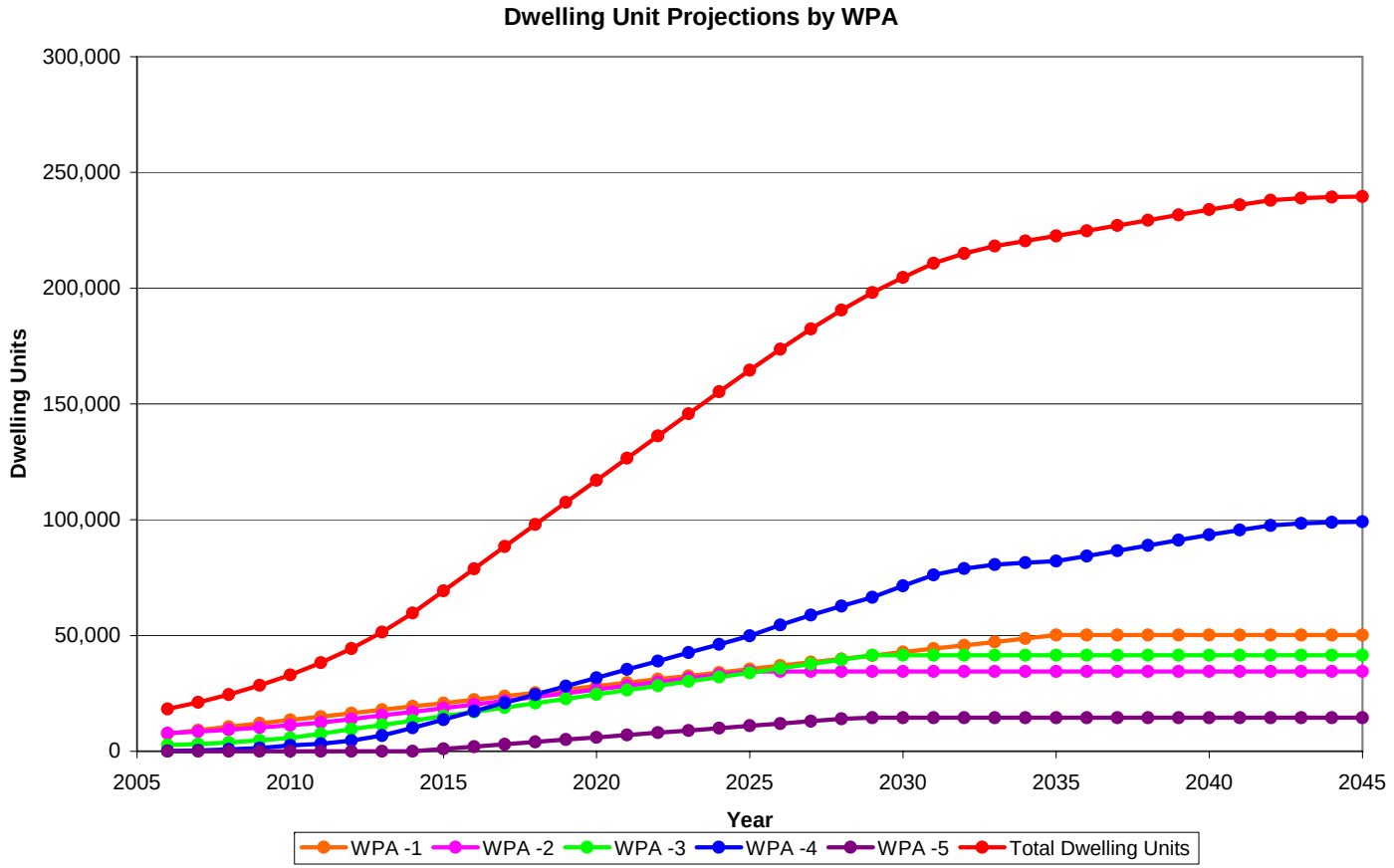
City of Goodyear
2007 Integrated Master Plan

Figure 2-3
IWMP Buildout Dwelling Unit Projections

Figure 2-4 shows the projected number of dwelling units completed per WPA in the Interim years and the percentage of buildout achieved. It was assumed that commercial development will progress at the same rate as residential development, even though commercial development typically lags residential by a small percentage.

Figure 2-4: City of Goodyear - IWMP
Dwelling Unit Projection Curves for Water Planning Areas (WPAs)

WPA	2006	2007	2010	2012	2015	2017	2020	2025	2030	2035	2040	2045
1	7,634	9,100	13,498	16,430	20,828	23,760	28,158	35,488	42,818	50,151	50,151	50,151
2	7,852	8,552	11,252	13,852	18,652	21,852	26,652	34,412	34,412	34,412	34,412	34,412
3	2,642	3,142	5,737	9,495	15,132	18,890	24,527	33,922	41,452	41,452	41,452	41,452
4	91	340	2,501	4,612	13,674	20,898	31,733	49,792	71,486	82,116	93,471	99,168
5	0	0	0	0	1,000	3,000	6,000	11,000	14,452	14,452	14,452	14,452
Total	**18,219**	**21,134**	**32,988**	**44,389**	**69,286**	**88,399**	**117,069**	**164,614**	**204,620**	**222,584**	**233,938**	**239,636**



SECTION 3

PROJECTED WATER DEMANDS AND WASTEWATER FLOWRATES

Historical water use and wastewater flow data was evaluated in the IWMP in order to understand past water use patterns within the City and to guide the development of representative peaking factors, seasonal patterns and unit rates. These factors, patterns and unit rates, together with the land use parameters developed in the previous section, would then be utilized to project future water demands and wastewater flowrates.

3.1 POTABLE WATER

3.1.1 Historic Water Demands

A water utility must be capable of supplying water in response to yearly, monthly, daily, and even hourly fluctuations in demand. The demand rates most important to the hydraulic design and operation of water production and distribution system infrastructure are annual average demand (AAD), monthly average demand (MAD), maximum day demand (MDD) and maximum hour demand (MHD).

Annual Average Demand - Annual average demand in simple terms is the total annual water use divided by the number of days in the year. The average day demand is used primarily as a basis for determining annual resource requirements.

Monthly Average Demand - Monthly average demand (MAD) varies over the course of the year and is tracked in order to understand general seasonal operating levels for supply and production facilities and the duration of summer peaks and winter periods of low demand.

Maximum Day Demand - Maximum day demand is the maximum quantity of water used on any one day of the year. Water production infrastructure (wells and water treatment facilities) are usually sized for MDD in order to be able to refill storage reservoirs in preparation for the next day.

Maximum Hour Demand - Maximum hour demand is the peak rate at which water is delivered through the distribution system during any one hour of the year. Distribution facilities (booster stations and pipelines) are generally sized and configured in order to maintain suitable pressure under MHD conditions. Maximum hour water demands are largely met by pumping from strategically located storage reservoirs which provide

equalization permitting a more uniform and economical operation of the water production facilities. Storage reservoirs are sized based on the difference between peak hour and maximum day demands.

MDD projections are usually made by multiplying AAD by the appropriate peaking factor. Black & Veatch analyzed the City's annual *Water Production Reports* for years 2001 through 2006 to determine historic MDD values. Table 3-1 summarizes the AAD and MDD values extrapolated from the annual *Water Production Reports*. Additional details of the data cleaning, review and analysis are contained in TM1-2 Demand Analysis.

Table 3-1. Historical Water Production

Year	AD (mgd)	MD (mgd)	MD/AD
2001	2.94	5.00	1.70
2002	3.24	4.95	1.53
2003	3.80	6.58	1.73
2004	4.60	7.68	1.67
2005	5.70	9.93	1.74
2006	6.56	10.77	1.64
Average	**1.67**		
Design	**1.70**		

Maximum Hour Demand (MHD) is the peak demand for any one hour of the year. Since minimum distribution system pressures are usually experienced during the maximum hour, the size and capacity of distribution system pipelines and booster stations are generally determined from an analysis performed under MHD conditions. The MHD is generally determined from a system mass balance calculation where:

Demand = Production +/- Change in Storage Volume

Because the City does not currently collect and record continuous SCADA data for well production and reservoir levels it was not possible to calculate hourly demands and determine the system's max hour. Therefore, a typical maximum hour peaking factor of 1.70 was assumed where MHD = 1.70 x MDD.

Table 3-2 compares the peaking factors applied by the City in the past with those recommended in this IWMP. It can be seen that the factors recommended in the IWMP are significantly lower. This will translate into significant savings in terms of required water production, storage, pumping and distribution infrastructure.

Table 3-2. Comparison of Peaking Factors

Peaking Factor Approach	Maximum Day	Maximum Hour
Current Goodyear Standard	2.00	4.00
2007IWMP Recommendation	1.70	2.89

Historical monthly average day (MAD) demands were evaluated in this master plan in order to understand the impact of seasonal variation in demand on water infrastructure. Figure 3-1 plots the seasonal variations recorded for years 2001 through 2006. It can be seen that July is traditionally the month with the highest average demand at 1.36 times the annual average.

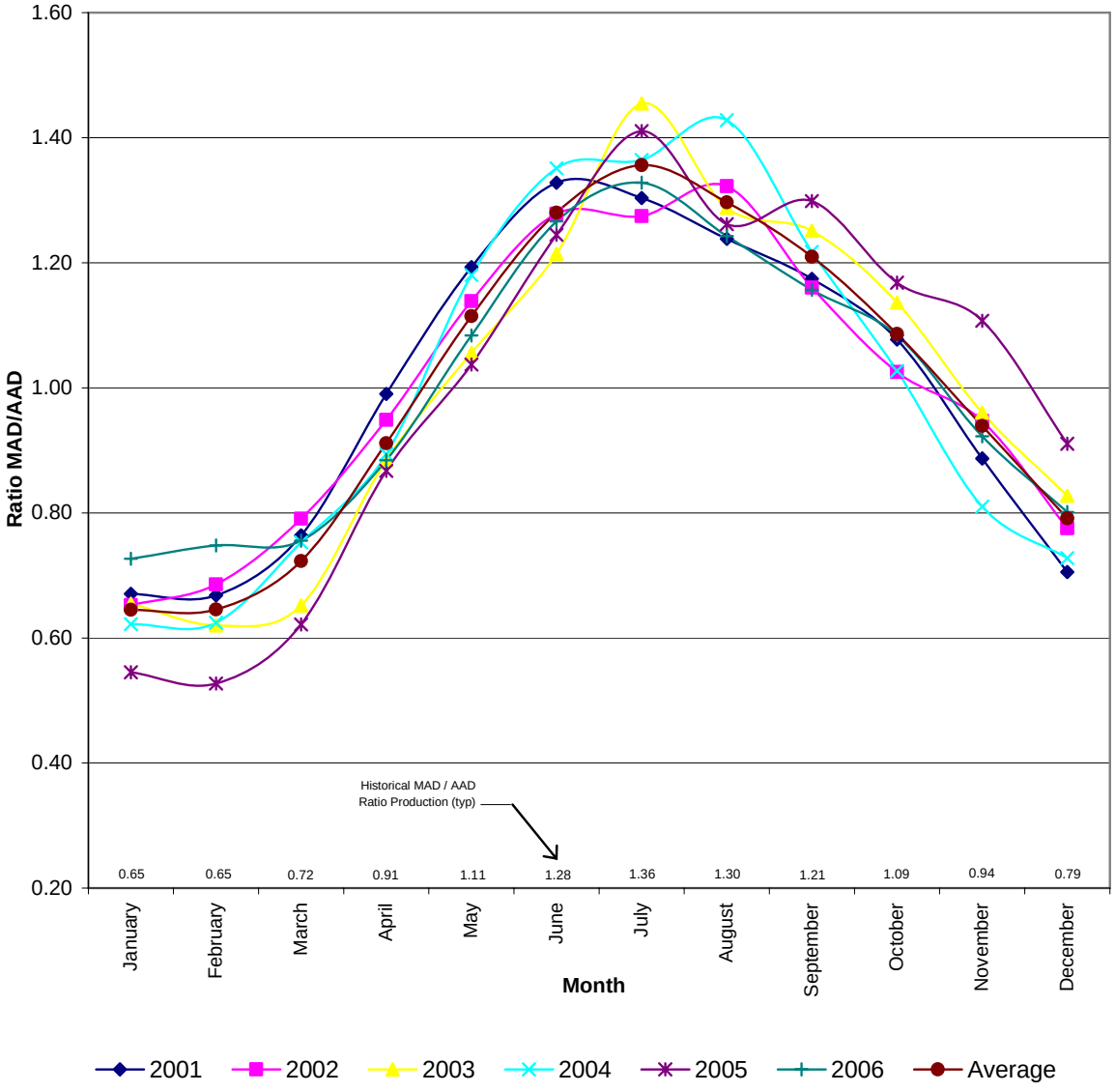


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Figure 3-1
Monthly Average Day Water Demand
(2001-2006)

3.1.2 Historical Metered Sales and Non-Revenue Water

Metered sales records by billing user class for years 2001 through 2005 were provided by the City in the end of the year Summary reports. Metered sales data by meter account for the period from January to December 2004 was also provided by the City and included the following information for each meter account:

- User class
- Rate structure for each account
- Water sales by month in units of 1,000 gallons.
- Account ID
- Meter number
- Parcel ID

GIS techniques were used to analyze the metered sales records and establish a variety of trends and parameters such as; geographic location for residential and non-residential sales, unit demand rates and geographical variations in water use. The detailed analysis of metered sales records is available in Technical Memorandum 1-2.

AAD water production records were compared to metered sales by billing user class for years 2001 through 2005. Comparing metered sales to historical production Black & Veatch determined an estimation of non-revenue water based on the equation below.

$$\textit{Non-revenue water} = \textit{Water production} - \textit{Metered water}$$

Metered water is water produced and delivered to customers for which the City receives revenue. This number is determined from metered use data. Non-revenue water is water that is produced but for which the utility does not receive revenue. Non-revenue is more complex as it is the sum of un-metered water use, leakage, unauthorized use, meter error, and accounting error and can be both, real losses, or perceived (apparent) losses. Ideally, non-revenue water would be zero and 100 percent of the water produced by the City's wells would flow through a customer meter and earn revenue. Realistically, a non-revenue water target of 10-15% of the produced quantity is an industry standard. Less than 10% is considered exceptional and the cost of achieving that level non-revenue water should be balanced against the cost of the water.

Analysis of the data showed that over the six year period of 2001-2006 the City average annual non-revenue water was 12.5%, within the industry recommended range of 10-15%. While the historical average of un-metered use was 12.5% the City of Goodyear is currently implementing several projects, including leak detection, meter re-sizing and construction water metering, which will likely decrease the overall system un-metered uses. Therefore for the purposes of this master plan, non-revenue water (construction uses, hydrant testing, system losses etc.) was assumed to be 10% of produced water.

3.1.3 Proposed Unit Rate Demands

Unit rate demands were developed for use in making residential and non-residential demand projections. In general, residential units rates were developed as gallons per day per dwelling unit (gpdu) and non-residential unit rates as gallons per acre per day (gpad). Residential gpdu unit rates were developed from an analysis of metered sales records which had been sorted into the following categories:

- Single Family – Low Density
- Single Family – Low-Med Density
- Multi Family – Medium Density

Table 3-3 shows the resulting gpdu unit rates determined from the metered sales records for these three categories of residential water use.

Table 3-3. Residential Unit Rate Calculations Based on Metered Sales

Residential Land Use Category	Number of Meters	Number of Dwelling Units	Average Metered Water Use (gallons/day)	Unit Rate (gpdu)
Single Family Residential				
Low Density Residential	1,525	1,525	535,410	351
Low-Med Density Residential	7,302	7,302	2,100,663	288
Multi-Family Residential				
Medium Density (individually metered)	370	370	94,786	
Med Density (master metered)	7	574	122,838	
Multi-Family Medium Density		**944**	**217,624**	**231**

Using these analytically derived rates as a guide, additional unit rates were extrapolated to cover the whole range of residential classes addressed in the City's Land Use Plan. Table 3-4 shows the resulting gpdu unit rates to be utilized in the IWMP for all residential use classes. The resulting gpdu unit rates in Table 3-4 also include 10% for non-revenue water.

Table 3-4. Residential Demand Unit Rate

RESIDENTIAL USE CLASS	Target Density (DU/Ac)	Unit Demand (gpdu)	% Unaccounted for Water	Production Demand (gpdu)
Single-Family Residential				
Agricultural Preservation (1 du/ac)	1	450	10	500
Rural (0-2 du/ac)	1	400	10	444
Low Density (2-4 du/ac)	3	351	10	390
Low-Medium Density (4-6 du/ac)	5	288	10	320
Multi-Family Residential				
Medium Density (6-10 du/ac)	8	256	10	285
Medium-High Density (10-20 du/ac)	15	231	10	256
High Density Residential (20+ du/ac)	25	200	10	222

Non-residential unit rates were developed utilizing the concept of *floor to area* ratio (FAR). FAR is a parameter commonly used by planning departments where the intensity of the land development is expressed as the total building square footage divided by the gross square footage of the project site. Unoccupied structures such as parking garages are not included in the FAR calculation. Table 3-5 shows the relationship of FAR to building footprint and the number of floors.

Table 3-5. FAR Value Comparison to Building Square-Footage

Number of Floors	Building Footprint (% of building / acre)	Ground Floor Footprint (square-feet)	FAR	Building Square-footage
1	25%	10,890	0.25	10,890
	30%	13,068	0.3	13,068
	35%	15,246	0.35	15,246
	40%	17,424	0.4	17,424
	45%	19,602	0.45	19,602
	50%	21,780	0.5	21,780
2	25%	10,890	0.5	21,780
	30%	13,068	0.6	26,136
	35%	15,246	0.7	30,492
	40%	17,424	0.8	34,848
	45%	19,602	0.9	39,204
	50%	21,780	1.0	43,560
6	25%	10,890	1.5	65,340
	30%	13,068	1.8	78,408
	35%	15,246	2.1	91,476
	40%	17,424	2.4	104,544
	45%	19,602	2.7	117,612
	50%	21,780	3	130,680

An FAR of 0.30 is typical of most single story commercial and business development found in Maricopa County. Table 3-6 shows the range of FARs used in the IWMP for the various non-residential use classes from 0.05 for the Airport, which of course is mostly open space, to 0.30 for most commercial and business developments, to 1.50 for the proposed high density City Center development. To calculate the resulting gpad unit rate, the following equation is used.

$$\textit{Unit Rate (gpad)} = \textit{FAR} * \textit{(43,560 sf/ac)} * \textit{Unit Demand (gpd/sf)}$$

A unit demand of 0.15 gallons per day per square foot (gpd/sf) of developed building is typical for most commercial and office developments. Table 3-6 shows the resulting water demand unit rates which will be applied to the various non-residential use classes in the IWMP. They cover a wide range from 373 gpad at the Airport to 12,321 gpad at the City Center primarily due to the wide range in FAR, or building intensity from one land use class to another.

Table 3-6 Non-Residential Demand Unit Rates

NON RESIDENTIAL USE CLASS	Floor to Area Ratio (FAR)	Unit Demand (gpd/sf)	Unit Demand (gpad)	% Unaccounted for Water	Production Demand (gpad)
Employment					
Community Commercial	0.30	0.14	1,830	10	2,033
Regional Commercial	0.30	0.16	2,091	10	2,323
Luke Compatible Land Use Area	0.30	0.16	2,091	10	2,323
City Center	1.50	0.17	11,108	10	12,342
Ball Park Village (Blocks 1 - 6)	1.00	0.17	7,405	10	8,228
Light Industrial	0.30	0.12	1,568	10	1,742
General Industrial	0.30	0.16	2,091	10	2,323
Support					
Public / Quasi Public	0.30	0.15	1,960	10	2,178
Prison	0.30	0.25	3,267	10	3,630
Airport	0.05	0.15	327	10	363
Parks	0	0	0	0	0
Roads	0	0	0	0	0
Open Space	0	0	0	0	0

3.1.4 Projected Water Demands

Base Year, Intermediate and Buildout Demands were projected for use within the IWMP from the unit rates and parameters developed above.

Base Year Annual Average Day Demand – Base year demand for 2007 was projected using partial year production records provided by the City. Production records through September 2007 were provided and demand was projected for the remainder of the year based on historic patterns of use. The total base year "design" demand was 7.1 mgd, which represents the average annual day demand for the base year, or existing conditions.

Buildout Annual Average Day Demand – Table 3-7 shows the calculation of Buildout AAD demands using buildout land use areas and the gpdu and gpad demand unit rates developed in Tables 3-4 and 3-6. The resulting buildout water demands are broken down in Table 3-8 by water planning area.

Table 3-7 Buildout Water Demands

		Land Use					Dwelling Units	Unit Rates			WPA-2		WPA-3		WPA-4		WSA-5		Water Service Area	
	Target Density						Dwelling Units	Demand Unit Rate[1]												
LAND USE CATEGORY	(du/ac)	WPA-2	WPA-3	WPA-4	WPA-5	Total Acreage in Water Service Area Area	Total Number of Dwelling Units in Water Service Area Area	(gpdu)	(gpad)	(af/ac-yr)	(mgd)	(af/yr)	(mgd)	(af/yr)	(mgd)	(af/yr)	(mgd)	(af/yr)	(mgd)	(af/yr)
RESIDENTIAL																				
Single-Family Residential																				
Agricultural Preservation (1 du/ac)	1	0	0	0	0	0	0	500	500	0.56	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Rural (0-2 du/ac)	1	1,988	1,915	0	437	4,340	4,340	444	444	0.50	0.9	990	0.9	953	0.0	0	0.2	217	1.9	2,160
Rural (0-2 du/ac)	2	0	0	16,979	0	16,979	33,958	444	889	1.00	0.0	0	0.0	0	15.1	16,903	0.0	0	15.1	16,903
Low Density (2-4 du/ac)	3	5,544	3,656	9,283	1,752	20,234	60,703	390	1,170	1.31	6.5	7,266	4.3	4,792	10.9	12,167	2.1	2,296	23.7	26,521
Low-Medium Density (4-6 du/ac)	5	799	2,055	931	529	4,313	21,567	320	1,598	1.79	1.3	1,430	3.3	3,678	1.5	1,666	0.8	946	6.9	7,721
						45,867	**120,568**	395	(Wtd Avg gpdu)		**8.6**	**9,686**	**8.4**	**9,423**	**27.4**	**30,737**	**3.1**	**3,460**	**47.6**	**53,306**
Multi-Family Residential																				
Medium Density (6-10 du/ac)	8	460	875	1,690	544	3,570	28,556	285	2,277	2.55	1.0	1,174	2.0	2,231	3.8	4,311	1.2	1,387	8.1	9,104
Medium-High Density (10-20 du/ac)	15	541	265	254	118	1,177	17,661	256	3,842	4.30	2.1	2,328	1.0	1,139	1.0	1,093	0.5	507	4.5	5,067
High Density Residential (20+ du/ac)	25	0	293	615	0	908	22,699	222	5,556	6.22	0.0	0	1.6	1,823	3.4	3,826	0.0	0	5.0	5,649
						5,655	**68,916**	257	(Wtd Avg gpdu)		**3.1**	**3,502**	**4.6**	**5,194**	**8.2**	**9,230**	**1.7**	**1,894**	**17.7**	**19,819**
Totals =		9,332	9,058	29,752	3,379		**189,484**												**65.3**	
NON RESIDENTIAL																				
Employment																				
Community Commercial		1,693	477	1,325	96	3,590			2,033	2.28	3.4	3,853	1.0	1,085	2.7	3,016	0.2	219	7.3	8,174
Regional Commercial		311	0	28	82	422			2,323	2.60	0.7	810	0.0	0	0.1	74	0.2	213	1.0	1,097
Luke Compatible Land Use Area		0	0	0	0	0			0	0.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
City Center / Village Center		173	28	103	0	305			12,342	13.83	2.1	2,392	0.3	391	1.3	1,431	0.0	0	3.8	4,214
Ballpark Village		48	0	0	0	48			8,228	9.22	0.4	443	0.0	0	0.0	0	0.0	0	0.4	443
Light Industrial		4,068	182	12	147	4,408			1,742	1.95	7.1	7,938	0.3	355	0.0	23	0.3	287	7.7	8,603
General Industrial		1,339	0	0	0	1,339			2,323	2.60	3.1	3,484	0.0	0	0.0	0	0.0	0	3.1	3,484
Mixed Use		0	0	0	216	216			2,000	2.24	0.0	0	0.0	0	0.0	0	0.4	484	0.4	484
											16.9	**18,921**	**1.6**	**1,831**	**4.1**	**4,544**	**1.1**	**1,203**	**23.7**	**26,499**
Support																				
Public / Quasi Public		345	239	715	68	1,367			2,178	2.44	0.8	841	0.5	582	1.6	1,744	0.1	167	3.0	3,334
Prison		0	0	0	0	0			3,630	4.07	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Airport		796	0	0	0	796			363	0.41	0.3	323	0.0	0	0.0	0	0.0	0	0.3	323
Parks		446	10,719	1,505	161	12,831			0	0.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Roads		348	776	1,745	452	3,322			0	0.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Open Space		3,020	3,975	4,106	1,096	12,196			0	0.00	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
											1.0	**1,165**	**0.5**	**582**	**1.6**	**1,744**	**0.1**	**167**	**3.3**	**3,658**
	TOTAL =	**21,919**	**25,454**	**39,292**	**5,697**	**92,361**	**189,484**	**TOTAL DEMAND =**			**29.7**	**33,274**	**15.2**	**17,029**	**41.3**	**46,255**	**6.0**	**6,724**	**92.2**	**103,284**

Table 3-8. Projected Water Requirements at Buildout					
	WPA-2	**WPA-3**	**WPA-4**	**WPA-5**	**Total**
MGD	29.7	15.2	41.3	6.0	92.2
Percent of Total Demand	32%	16%	45%	7%	100%
Acre ft/year	33,274	17,030	46,256	6,724	103,264

Intermediate Annual Average Day Demand – Intermediate Year demands were projected using the growth curve developed in Section 2. Intermediate Year demands are summarized in Figure 3-2.

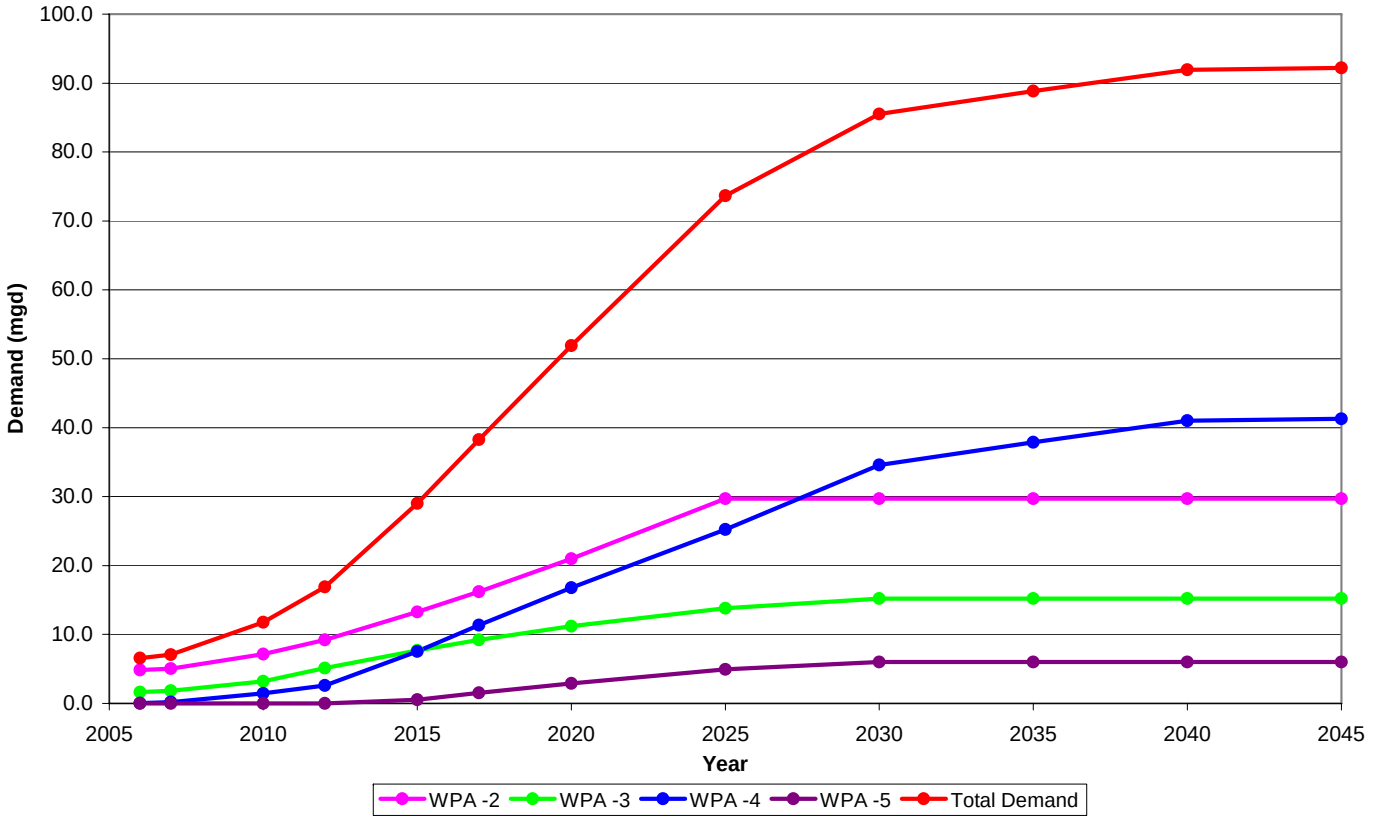
Table 3-9 provides a summary of projected demands under AAD and MDD and MHD conditions for each design year.

Table 3-9. AAD, MDD, and MHD Projected Water Demands				
Demand Condition	**Base Year (mgd)**	**2012 (mgd)**	**2017 (mgd)**	**Buildout (mgd)**
Annual Average Demand	7.1	18.3	39.5	92.2
Maximum Day Demand	12.0	31.1	67.2	156.8
Maximum Hour Demand	20.4	52.9	114.3	266.5

Figure 3-2: City of Goodyear - IWMP
Demand Projection Curves for Water Planning Areas (WPAs)

WPA	2006	2007	2010	2012	2015	2017	2020	2025	2030	2035	2040	2045
2	4.9	5.0	7.1	9.2	13.2	16.2	21.0	29.7	29.7	29.7	29.7	29.7
3	1.6	1.8	3.2	5.1	7.7	9.2	11.2	13.8	15.2	15.2	15.2	15.2
4	0.1	0.2	1.4	2.6	7.5	11.3	16.8	25.2	34.6	37.9	41.0	41.3
5	0.0	0.0	0.0	0.0	0.5	1.5	2.9	4.9	6.0	6.0	6.0	6.0
Total	6.6	7.1	11.8	16.9	29.0	38.3	51.9	73.7	85.5	88.8	92.0	92.2

1. 2006 Demands are based on production records
2. 2007 demands are projected from partial 2007 production records



3.2 WASTEWATER

3.2.1 Historic Wastewater Flow

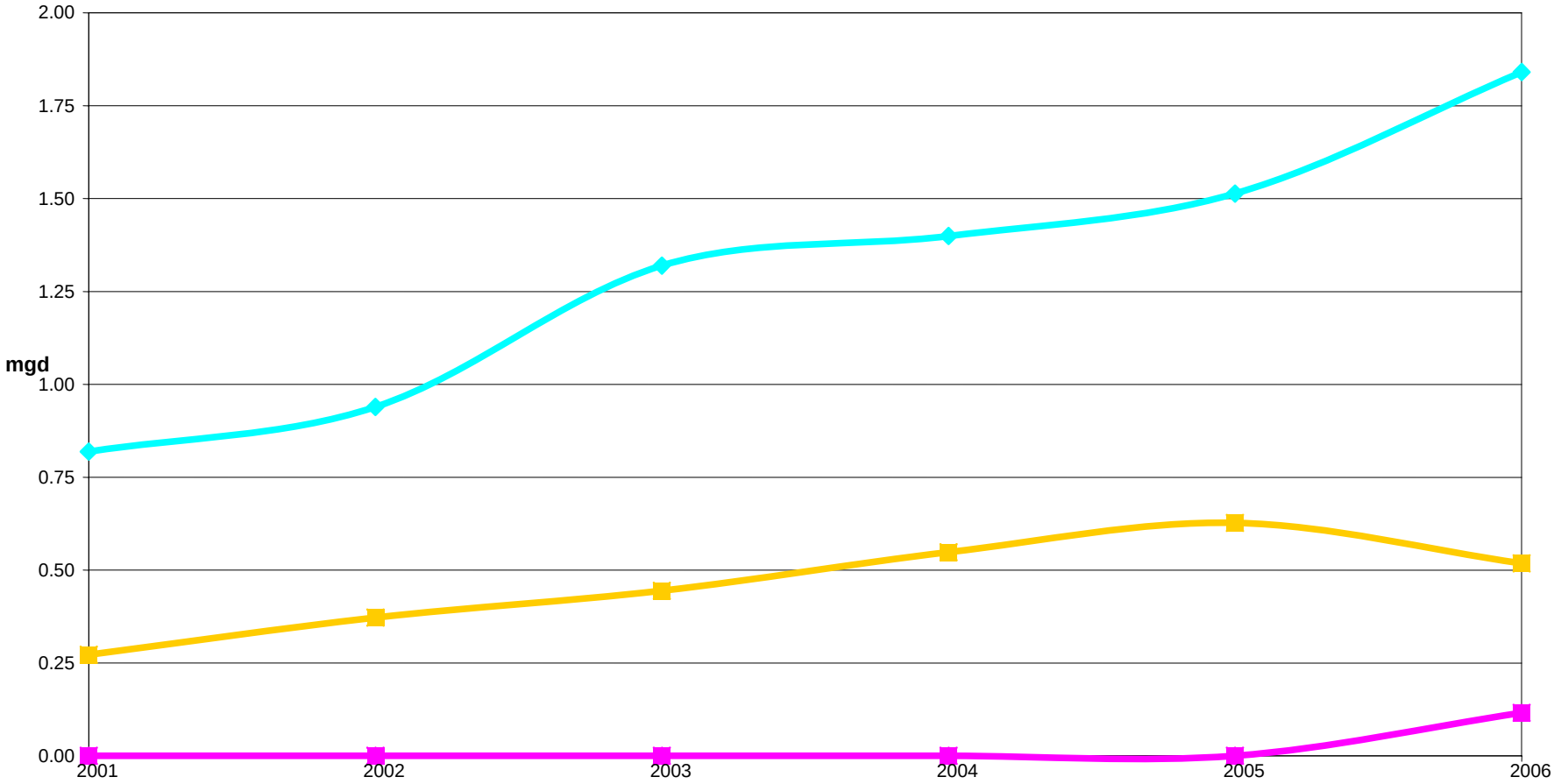
The City's historical wastewater flow records were analyzed to establish the following flow rates and factors:

- Average Dry Weather Flow (ADWF)
- Maximum month (MM)
- Percent returned
- Unit rates

Historic flow records, from January 2001 to February 2007, were available for both the 157th Ave. Wastewater Treatment Plant (WWTP) and Corgett Water Reclamation Facility (WRF). Flow data from the Rainbow Valley WRF was available from May 2006 (when the plant came on-line) through February 2007. Records were analyzed to calculate the historic ADWF at each plant and adjustments were made to account for:

- Wastewater Collected from LPSCO
- Plant Return Flows
- Reject Brine from RO Treatment Units

The goal was to determine the portion of recorded influent at each plant that was from wastewater generated within the City's Sewer Service Area so that unit flow rates could be developed and future wastewater flow projections could be made. Figure 3-3 plots the resulting historic wastewater flow data for each of the City's wastewater treatment plants. It can be seen there has been a steady increase in wastewater flow within the City's sewer service area over the past six years. Additional details with respect to the analysis of historic influent records can be found in TM 2-1.



City of Goodyear
2007 Integrated Master Plan

Figure 3-3
IWMP Wastewater Historical Annual Average Loading (mgd)

Aside from the steady increase in wastewater flow over the course of the year resulting from growth, the monthly average flow at each plant would be roughly the same through each month of the year. However, growth aside, there is normally some variability over the course of the year and the max month or max month factor is a parameter which can be developed. The max sustainable flow over the course of a month is an important factor used in the design of the biological processes at wastewater treatment plants. The maximum monthly flow was found to occur in the winter months and this factor has an average value of 1.19 times the annual average flow rate as shown in Table 3-10. It should be noted that the relationship of the max month to the annual average is likely influenced by the steady growth experienced at the City's plants, which would bias the max month towards the end of the year and inflate its value. Upon reaching buildout, that actual MM factor may be found to be less.

Table 3-10. Max Month Wastewater Generation

Year	Annual Average (mgd)	Month	Max Month Flow (mgd)	% of Annual Average
2001	0.82	December	0.95	1.16
2002	0.94	November	1.07	1.14
2003	1.32	November	1.58	1.20
2004	1.41	October	1.78	1.27
2005	1.51	January	1.72	1.14
2006	1.84	October	2.23	1.21
			Average =	**1.19**

3.2.2 Historic Percent Returned Calculation

Through a comparison of the quantity of water supplied to customers, to the quantity which is returned as wastewater, the *percent returned* factor was calculated. Understanding the percent returned helps in the calculation of wastewater unit rates and projections of future flow rates based on water demand. It provides an important linkage between potable water supply and reclaimed water production which is necessary in the development of integrated water, wastewater and reclaimed water infrastructure.

The percent or portion returned is generally the portion of potable water which is used for interior water uses, such as kitchen, bathroom and laundry uses, whereas the exterior water uses such as landscaping and pool filling do not generate wastewater returns. The percent returned

will vary between residential and non-residential users and will also vary depending on whether metered sales or water production values are used in the comparison. Table 3-11 shows the calculated factors, using 2004 data, a year for which complete records of both metered sales and wastewater flow records were available.

Table 3-11. Wastewater Percent Returned (2004)

Meter Sale Type	% Returned
Residential SF	42
Residential MF	54
Non-Residential	52
Weighted Average	**46**

3.2.3 Wastewater Unit Flow Rates

Wastewater unit flow rates, in terms of gallons per dwelling unit (GPDU) and gallons per acre-day (GPAD) were developed for each of the City's residential and non-residential land use classes by multiplying the potable water unit demand by the percent returned factor. Percent returned values were extrapolated for each of the residential use classes using the general single family and multi family rates initially developed from the 2004 records. Table 3-12 shows the percent returned and the resulting unit flow rate developed for each of the user classes.

Table 3-12. Wastewater Unit Rate Summary

RESIDENTIAL		Target Density (DU/Ac)	Unit Demand (gpdu)	% Returned	WW Generation Unit Rates
Single-Family Residential					
Agricultural Preservation (1 du/ac)		1	450	39	176
Rural (0-2 du/ac)		1	400	40	160
Low Density (2-4 du/ac)		3	351	41	144
Low-Medium Density (4-6 du/ac)		5	288	45	129
Multi-Family Residential					
Medium Density (6-10 du/ac)		8	256	50	128
Medium-High Density (10-20 du/ac)		15	231	54	124
High Density Residential (20+ du/ac)		25	200	55	110
NON RESIDENTIAL	**Floor to Area Ratio (FAR)**	**Unit Demand (gpd/sf)**	**Unit Demand (gpad)**	**% Returned**	**WW Generation Rates**
Employment					
Community Commercial	0.30	0.14	1,830	52	951
Regional Commercial	0.30	0.16	2,091	52	1,087
Luke Compatible Land Use Area	0.30	0.16	2,091	52	1,087
City Center	1.50	0.17	11,108	52	5,776
Ball Park Village (Blocks 1 thru 6)	1.00	0.17	7,405	52	3,851
Light Industrial	0.30	0.12	1,568	52	815
General Industrial	0.30	0.16	2,091	52	1,087
Support					
Public / Quasi Public	0.30	0.15	1,960	52	1,019
Prison	0.30	0.25	3,267	52	1,699
Airport	0.05	0.15	327	52	170
Parks	0	0	0	0	0
Roads	0	0	0	0	0
Open Space	0	0	0	0	0

3.2.4 Wastewater Basins and Flow Projections

Base year (2007) average wastewater flow represents the current level of wastewater flows and is based on recent historical records. The Base Year flow rate was projected as a 16 percent increase from the recorded 2006 wastewater flow as shown in Table 3-13. The projections for 2007 and the percent returned factors are discussed further in Technical Memorandum 2-1 – Collection/Treatment Plan.

Table 3-13. Projected Base Year Wastewater Flow[1]

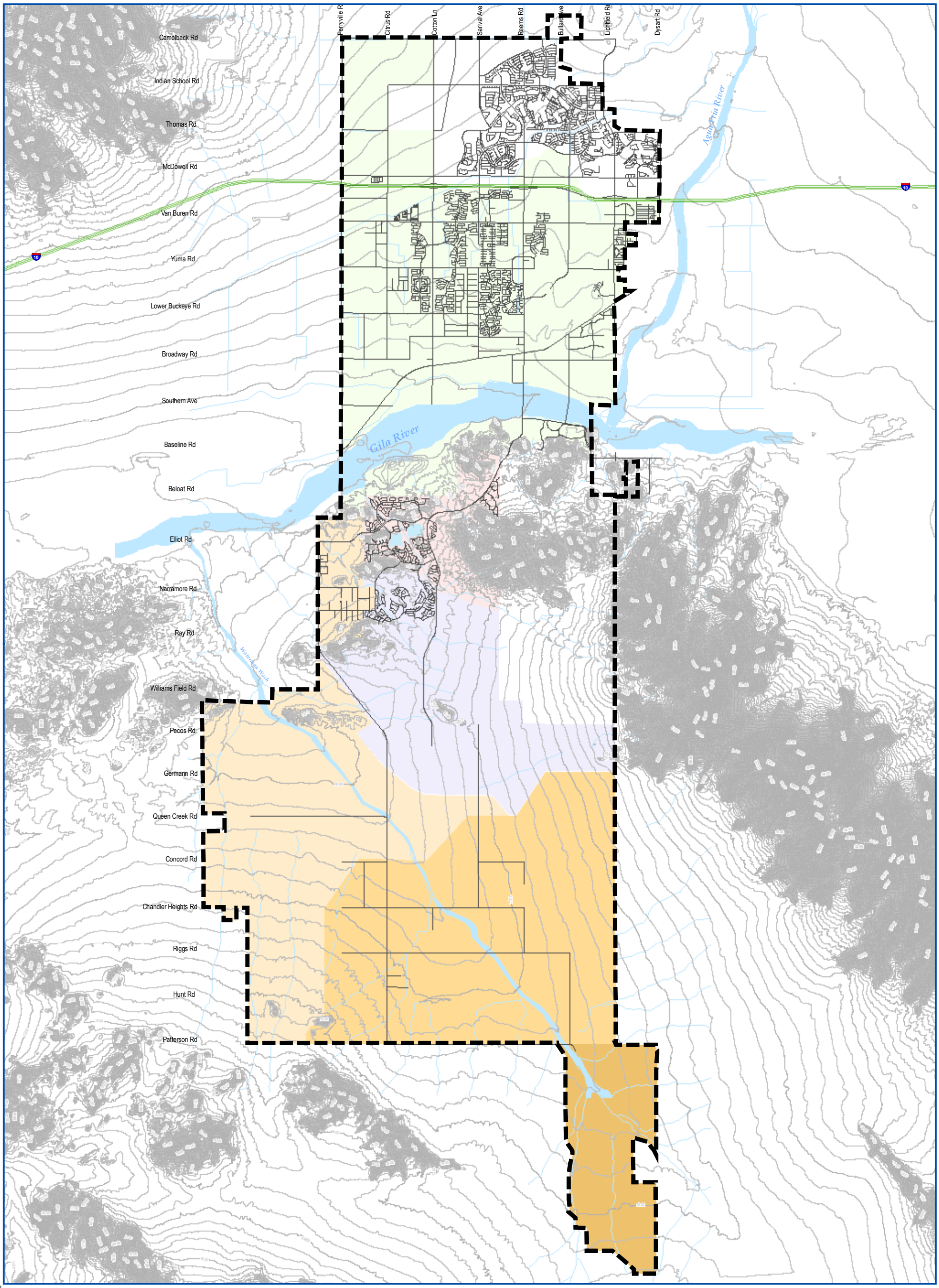
	Recorded 2006 Flow (mgd)	Projected 2007 Base Year Flow (mgd)
WPA 2	1.84	2.14
Corgett	0.52	0.60
Rainbow Valley	0.12	0.14
Total Flow	**2.48**	**2.88**

Notes:
1. Residential and Commercial Flow (not including Brine flow 0.43 mgd or Perryville Flow 0.20 mgd)

Buildout flowrate projections were made following the same basic process used for water demand projections; by multiplying wastewater unit flow rates with the residential and non-residential acreages from the land use plan. The land use acreages were sub-dived by flow basin instead of by water planning area so that the quantity of flow which would be tributary to each treatment plant could be determined. A full discussion of the topography of the Sewer Service Area and the development and configuration of the flow basins is provided in Section 6 and in TM2-2. Figure 3-4 shows the configuration of the collection basins and Table 3-14 shows the projected ADWF within each basin. Table 3-15 shows the projected ADWF flowrates by basin for the Base-Year, Intermediate Years and for Buildout.

Tabel 3-14. Average Day Wastewater Flow Per Basin

		Land Use								Acreage	Dwelling Units			Projected Generation (Annual Average)				
	Target Density													157th Ave	Corgett	Rainbow Valley	Waterman Wash	Waste Water Service Area
LAND USE CATEGORY	(du/ac)	157th Ave		Corgett		Rainbow Valley		Waterman Wash		Total Acreage in Waste Water Service Area Area	Total Number of Dwelling Units in Waste Water Service Area Area	WW Returned (gpdu)	WW Returned (gpad)	(mgd)	(mgd)	(mgd)	(mgd)	(mgd)
		(ac)	(du)	(ac)	(du)	(ac)	(du)	(ac)	(du)									
RESIDENTIAL																		
Single-Family Residential																		
Agricultural Preservation (1 du/ac)	1	0	0	0	0	0	0	0	0	0	0	176	176	0.00	0.00	0.00	0.00	0.00
Rural (0-2 du/ac)	1	3,257	3,257	2	2	0	0	830	830	4,088	4,088	160	160	0.52	0.00	0.00	0.13	0.65
Rural (0-2 du/ac)	2	0	1	0	0	2,880	5,761	18,227	36,454	21,108	42,215	160	320	0.00	0.00	0.92	5.83	6.75
Low Density (2-4 du/ac)	3	5,909	17,726	972	2,916	2,773	8,320	10,413	31,239	20,067	60,202	144	432	2.55	0.42	1.20	4.50	8.67
Low-Medium Density (4-6 du/ac)	5	3,125	15,625	260	1,301	1,321	6,604	1,459	7,293	6,165	30,824	129	647	2.02	0.17	0.85	0.94	3.99
Single Family Sub Totals =										**51,428**	**137,329**			**5.10**	**0.59**	**2.97**	**11.41**	**20.1**
Multi-Family Residential																		
Medium Density (6-10 du/ac)	8	549	4,395	396	3,167	686	5,488	1,939	15,516	3,571	28,565	128	1025	0.56	0.41	0.70	1.99	3.66
Medium-High Density (10-20 du/ac)	15	554	8,312	183	2,747	96	1,438	345	5,174	1,178	17,671	124	1867	1.03	0.34	0.18	0.64	2.20
High Density Residential (20+ du/ac)	25	0	0	97	2,429	258	6,450	553	13,837	909	22,717	110	2750	0.00	0.27	0.71	1.52	2.50
Multi-Family Sub Totals =										**5,657**	**68,953**			**1.60**	**1.01**	**1.59**	**4.15**	**8.36**
Residential Sub Totals =		13,394	49,316	1,911	12,562	8,014	34,061	33,766	110,343	**57,085**	**206,283**							
NON RESIDENTIAL																		
Employment																		
Community Commercial		1,701		175		477		1,219		3,573			951	1.62	0.17	0.45	1.16	3.40
Regional Commercial		627		0		0		67		694			1,087	0.68	0.00	0.00	0.07	0.75
City Center / Village Center		173		0		31		101		306			5,776	1.00	0.00	0.18	0.59	1.77
Ballpark Village		57		0		0		0		57			3,851	0.22	0.00	0.00	0.00	0.22
Light Industrial		3,982		0		117		224		4,323			815	3.25	0.00	0.10	0.18	3.53
General Industrial		1,336		0		0		0		1,336			1,087	1.45	0.00	0.00	0.00	1.45
Mixed Use		0		0		0		216		216			2,000	0.00	0.00	0.00	0.43	0.43
														8.22	**0.17**	**0.73**	**2.43**	**11.5**
Support																		
Public / Quasi Public		373		27		287		680		1,368			1,019	0.38	0.03	0.29	0.69	1.39
Prison		427		0		0		0		427			1,699	0.73	0.00	0.00	0.00	0.73
Airport		800		0		0		0		800			170	0.14	0.00	0.00	0.00	0.14
Parks		911		133		349		503		1,896			0	0.00	0.00	0.00	0.00	0.00
Roads		504		225		579		2,043		3,350			0	0.00	0.00	0.00	0.00	0.00
Open Space		1,355		1,152		1,164		4,193		7,864			0	0.00	0.00	0.00	0.00	0.00
Non- Residential Sub Totals =														**1.24**	**0.03**	**0.29**	**0.69**	**2.3**
	TOTAL =	**25,641**		**3,623**		**11,019**		**43,012**		**83,294**	**206,283**		**TOTAL GENERATION =**	**16.2**	**1.8**	**5.6**	**18.7**	**42.2**



N
W E
S

1 inch equals 2 miles

Data sources:
City of Goodyear GIS
ESRI

Legend

- Interstate
- Street
- Master Plan Study Area

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

Figure 3-4
Basin Map

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

\\Projects\GoodYear11GIS\01MapDocuments\ExistingReclaim.mxd Hassell/Ward 06 Mar 2008

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Table 3-15. Projected ADWF				
Basin	Base Year (mgd)	2012 (mgd)	2017 (mgd)	Buildout (mgd)
157th Basin	2.14	5.38	9.03	16.20
Corgett	0.60	0.66	1.03	1.80
Rainbow Valley	0.14	1.31	2.41	5.60
Waterman		1.63	5.99	18.70
Total	**2.86**	**8.98**	**18.46**	**42.20**

3.3 RECLAIMED WATER

Within the City of Goodyear, wastewater will be collected, treated and reclaimed for either direct reuse or recharge. Direct reuse would primarily include landscaping irrigation, lake filling and construction. The balance will be put to beneficial use by recharge into the underlying aquifers where it will earn valuable recharge credits. In this section, the projected demand for reclaimed water will be determined using much the same process as was used for potable water;

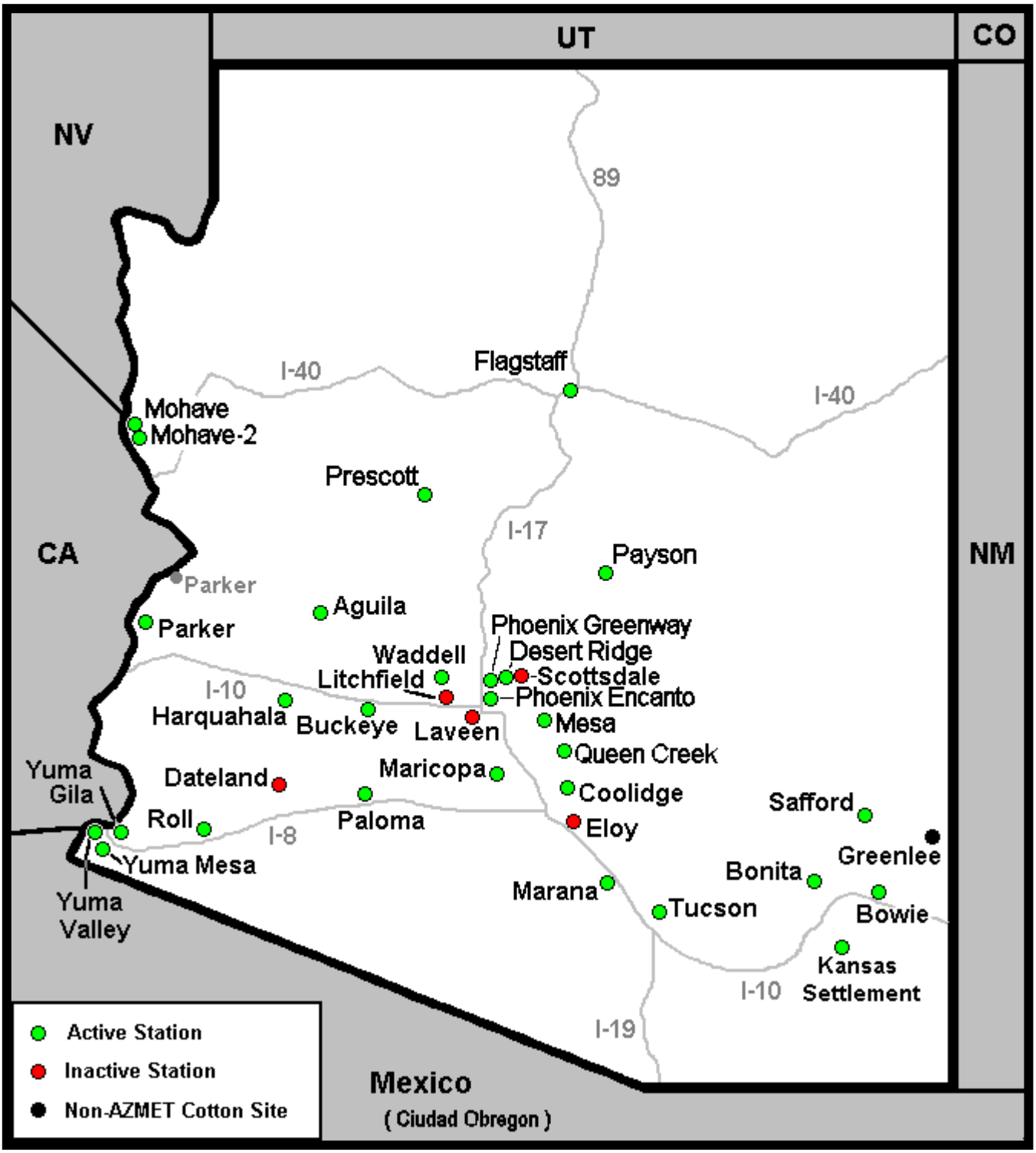
- Unit Rates and peaking factors will be developed.
- Acreage of landscaping and lakes will be established.
- Annual and seasonal demand will be determined.

3.3.1 Reuse Unit Rates and Seasonal Factors

Reuse rates were calculated for irrigation and lake filling using data from local stations in the Arizona Meteorological (AZMET) Network (ag.arizona.edu/azmet). AZMET provides meteorological data and weather-based information to agricultural and horticultural interests operating in southern and central Arizona. Meteorological data is collected from a network of automated weather stations located in both rural and urban production settings. Figure 3-5 shows the location of AZMET sites around the State; data from the Buckeye and Maricopa sites was utilized for the IWMP.

Meteorological data collected by AZMET include temperature (air and soil), humidity, solar radiation, wind (speed and direction), and precipitation. From these, a number of variables can be computed, the most important of which for the purposes of this study is evapotranspiration (ET), which will form the basis for estimating turf and landscaping irrigation requirements and lake evaporation.

Figure 3-5. AZ MET Station Locations



Evapotranspiration (ET) is the loss of water from a vegetative surface through the combined processes of plant transpiration and soil evaporation. Both environmental and biological factors affect ET. Important environmental factors include solar radiation, temperature, atmospheric dryness, and wind and soil moisture. Biological factors affecting ET include type of vegetation, foliage geometry and foliage density. Understanding ET is the first step to projecting irrigation requirements.

Utilizing AZMET records of ET in western Maricopa County, accurate projections were made of the irrigation requirements for turf and other landscaping that were tailored for Goodyear's specific climate. Several methods have been developed to estimate crop ET. The method used for this analysis utilized weather data to provide an estimate of reference evapotranspiration (ETo). From AZMET, daily estimates of ETo were gathered from two weather stations for a period of eight years. The City of Goodyear is located west of the city of Phoenix in Maricopa County. The climate within the locale is considerably dryer and warmer, thus evapotranspiration is higher and there is less precipitation. In Goodyear turf and landscaping will require more water and receive less precipitation so the irrigation demand will greater than it is farther to the east and north in Maricopa County.

Evapotranspiration data was obtained from the Buckeye and Maricopa AZMET sites in western and southern Maricopa County, which is considerably warmer and dryer than northern and eastern portions of the county. AZMET provides ETo (Baseline Evapotranspiration) which is defined as the ET from a 3-6" tall cool season grass that completely covers the ground, and is supplied adequate water. A crop coefficient (Kc) is used to convert ETo to the ET needs of a specific crop or landscaping cover desired. ETo, without adjustment, is also a good approximation of lake evaporation and will be used in the IWMP as a guide to lake filling requirements. Table 3-16 shows the resulting golf turf and parks turf ET as well as lake evaporation in Goodyear, AZ.

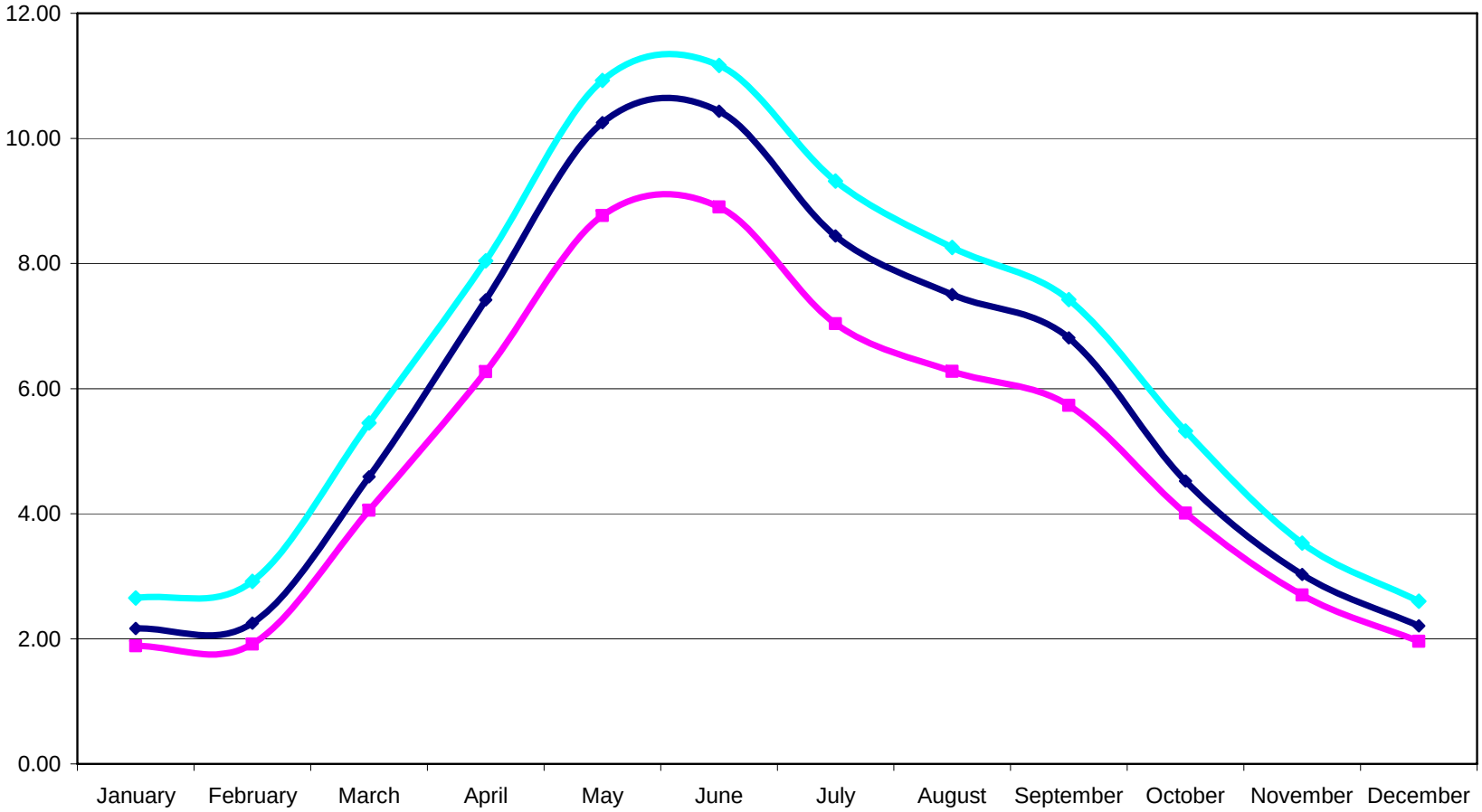
Table 3-16 Resulting Golf Turf, Parks and Lake ET						
		Golf Course Turf		Park Turf		Lakes
Month	ET_o (inches)	K_c	ET (inches)	K_c	ET (inches)	Evap (inches)
January	3.05	0.72	2.19	0.65	1.98	3.05
February	3.71	0.72	2.67	0.65	2.41	3.71
March	5.87	0.72	4.23	0.65	3.82	5.87
April	8.04	0.76	6.11	0.65	5.22	8.04
May	10.38	0.76	7.89	0.65	6.75	10.38
June	10.74	0.76	8.16	0.65	6.98	10.74
July	9.82	0.76	7.47	0.65	6.39	9.82
August	8.61	0.76	6.55	0.65	5.60	8.61
September	7.55	0.76	5.73	0.65	4.90	7.55
October	5.64	0.72	4.06	0.65	3.66	5.64
November	3.65	0.72	2.63	0.65	2.37	3.65
December	2.75	0.72	1.98	0.65	1.79	2.75
Total (inches per year)	**79.80**		**59.66**		**51.87**	**79.80**
Total (feet per year)	**6.65**		**4.97**		**4.32**	**6.65**

In order to finally determine the amount of reclaimed water required for irrigation, three other factors must be accounted for, rainfall, irrigation efficiency and non-revenue water. Rainfall will supply a portion of the ET needs and after accounting for annual precipitation, the balance will come from applied irrigation. Sprinkler efficiency also affects the actual irrigation requirements due to unavoidable inefficiencies in sprinkler patterns and evaporation losses. And, just as for the potable water system, a portion of the reclaimed water will be lost to non-metered uses and leakage. Figure 3-6 presents the calculated Adjusted ET for golf course turf, park turf and lakes. Table 3-17 shows the resulting reclaimed water requirements, for the various types of irrigation and lake maintenance, both on a monthly basis and annual total. Additional details regarding the calculation of ET and irrigation requirements can be found in TM3-2.

Table 3-17 Adjusted ET and Lake Filling

Month	Precipitation	Golf Course Application Rate[1,2,3] (inches)	Park Turf Application Rate[1,2,3] (inches)	Lakes Application Rate[3] (inches)
January	0.53	2.17	1.89	2.65
February	0.94	2.25	1.92	2.92
March	0.70	4.59	4.06	5.45
April	0.40	7.42	6.27	8.04
May	0.00	10.25	8.77	10.93
June	0.13	10.44	8.90	11.17
July	0.97	8.44	7.04	9.32
August	0.77	7.50	6.27	8.25
September	0.49	6.81	5.73	7.42
October	0.58	4.52	4.01	5.32
November	0.29	3.03	2.70	3.53
December	0.28	2.21	1.96	2.60
Total (inches per year)	**6.08**	**69.63**	**59.50**	**77.60**
Total (feet per year)		**5.80**	**4.96**	**6.47**

Notes:
1. Sprinkler Efficiency = 90%
2. Evaporative Losses = 10%
3. Non-Revenue Loss = 5%



City of Goodyear
2007 Integrated Water Master Plan

Figure 3-6
Monthly Application Rates

The Arizona Department of Water Resources (ADWR) has set irrigation limits for new large turf and lake facilities which use potable water or a mix of potable and reclaimed. While 100% reclaimed systems are exempt from these limits, they provide a good guideline for irrigation and conservation in the desert environment. Table 3-18 provides a comparison of ADWR's allowable potable water irrigation rates with proposed reclaimed water irrigation rates. It can be seen that the rates are comparable however the AZMET derived rates are slightly higher. It is believed this is a result of the hotter/dryer condition found in western Maricopa County and accounting for delivery losses.

Table 3-18: Irrigation Application Rate Comparison

Turf Related Facility	ADWR (acre-ft/acre)	IWMP (AZMET Based)
Golf Course Turf	4.9	5.8
Lake Filling	6.2	6.5
Low Use Landscaping[(2)]	1.5	1.9[1]
Parks/Schools Turf	3.4	5.0

Notes:
1. Assumed by ADWR Guide
2. 1/3 of Golf Course Turf Demand

3.3.2 Reuse Customers

An analysis was performed to determine the optimum balance between reclaimed water reuse versus reclaimed water recharge. The reuse alternatives considered include:

- Zero Reuse with 100 percent Recharge
- Mid Level Reuse & Recharge
- Maximum Reuse with Minimum Recharge

Knowing that 100 percent of the City's annual reclaimed production would be utilized either through reuse or recharge, there would be no net difference to the City's resource position between the three alternatives. The difference lay in the manner that the infrastructure would be configured and its cost to build and operate. The Zero and Mid-Level Reuse alternatives were found to have the lowest overall cost and of these two, the Mid-Level alternative was found to offer more flexibility and long-term sustainability. The details of the alternative analysis can be found in Appendix A.

Estimated reuse demands were therefore built around the Mid-Level reuse concept. The following is a list of the variety of potential applications for reclaimed water for which unit rates were included:

- Golf Courses
- Parks/Schools
- Street Right-of-way (ROW)
- Lakes
- Construction

The following is a discussion of the manner in which the acreage associated with each of the above areas of reuse was calculated. Additional details can be found in TM3-2.

Golf Courses. The City's land use plan does not locate or project the number of golf-courses which will be constructed within the city by buildout. It was therefore assumed that the trends observed in other cities in the region would be used as a guide to determine the likely number of golf-courses to be constructed in Goodyear. Table 3-19 shows the number of courses found in other cities.

Table 3-19. Observed Golf Course Development in Maricopa County

City	Golf Courses				Current Number of Courses	Number of Holes	2005 Population	People/ Hole	People/ 18 Hole Course
	9-Hole	18-Hole	27-Hole	36-Hole					
Chandler	1	8	1	1	11	216	234,939	1,088	21,358
Fountain Hills	0	4	0	0	4	72	23,217	322	5,804
Glendale	3	4	0	0	7	99	239,435	2,419	34,205
Mesa	6	15	2	1	24	414	442,780	1,070	18,449
Phoenix	6	23	1	4	34	639	1,461,575	2,287	42,988
Scottsdale	4	24	5	8	41	891	226,013	254	5,513
						Average =		**1,240**	**21,386**
						Max =		**2,419**	**42,988**
						Min =		**254**	**5,513**

The number of golf courses at build out was determined based on the average number of golf courses in the surrounding cities. Based on Goodyear's current land use plan the average population/18 hole golf course was applied to Goodyear's build out population to determine the number of golf courses per WPA. The maximum value for population/18 hole golf course was applied to WPA 2 because of the higher commercial density and less residential acreages, thus

decreasing the number of golf courses. The remaining WPAs all used the average population/18 hole golf course due to the larger residential acreages, thus increasing the number of golf courses. Table 3-20 shows the projected number of golf courses accounted for in Goodyear at buildout based on the average level.

Table 3-20. Goodyear Golf Courses

WPA	Population at Buildout	People/ 18 Hole Golf Course	Total Number of 18 Golf Courses at Buildout
2	90,349	42,988	2
3	111,128	21,386	5
4	273,830	21,386	13
5	39,125	21,386	2
Totals =	514,431		22

Parks/Schools. Under the mid level reuse alternative, the turf and landscaping at City schools and regional parks is to be irrigated with reclaimed water.

Park acreages were determined based on the average number of park acreage/1,000 people in the surrounding cities. Table 3-21 shows the number of parks found in other cities.

Table 3-21. Observed Parks in Maricopa County

City	2005 Population	Park Acreage	Park Acreage/ 1000 people
Fountain Hills	23,217	116	5.00
Gilbert	173,989	882	5.07
Glendale	239,435	521	2.18
Mesa	442,780	1080	2.44
Phoenix	1,461,575	4374	2.99
Scottsdale	226,013	734	3.25
		Average =	**3.49**
		Max =	**5.07**
		Min =	**2.18**
*Park acreage estimates obtained from City websites			

The average value of 3.49 was applied to Goodyear's build out population to determine the park acreage. A value of 35% turf and a value of 35% low water use landscaping were used to determine the turf and low water use acreages. Three acres of low water use equate to one acre

of turf and thus the adjustment to 12% low water use turf was determined. Table 3-22 shows the projected number of parks accounted for in Goodyear at buildout based on the average level.

Table 3-22. Goodyear Parks

WPA	Population at Buildout	Acreage/ 1000 people	Park Acreage
2	90,349	3.49	315
3	111,128	3.49	387
4	273,830	3.49	955
5	39,125	3.49	136
Totals at Buildout =	**514,431**		**1,794**

The number of schools at build out for Goodyear was determined based on the percentages of school age children in surrounding cities compared to the current percentages of children in Goodyear. Table 3-23 shows the number of schools found in other cities.

Table 3-23. Maricopa County School Age Children Population Estimates

US Census	Total Population	Elementary School Age	% Elementary	Middle School Age	% Middle	High School Age	% High
Goodyear 2000	18,911	1,222	6.5%	1,150	6.1%	952	5.0%
Phoenix 2000	1,321,045	111,367	8.4%	99,475	7.5%	97,425	7.4%
Phoenix 2005			8.0%		7.6%		6.9%
Glendale 2000	218,812	18,960	8.7%	17,994	8.2%	17,490	8.0%
Glendale 2005	229,913		7.6%		7.5%		8.3%
Mesa 2000	396,375	30,259	7.6%	28,842	7.3%	28,774	7.3%
Mesa 2005	442,445		7.2%		7.1%		7.4%
Scottsdale 2000	202,705	11,188	5.5%	11,256	5.6%	9,900	4.9%
Scottsdale 2005	215,933		6.1%		4.9%		4.5%
		Average =	**7.3%**		**6.9%**		**6.6%**
		Goodyear Value =	**6.5%**		**6.1%**		**5.0%**

The percentages were applied to the build out population to determine the number of school age children and number of schools required to serve the City of Goodyear at buildout which is summarized in Table 3-24. Based on Goodyear's School Facility Design Guidelines from the 2003 General Plan and a 90% enrollment capacity, the number of schools was determined.

Table 3-24 Goodyear Schools

		Elementary Schools				Middle Schools				High Schools			
WPA	Population	Percentage of Children	Child Population	Typical Enrollment	# of Elem Schools	Percentage of Children	Child Population	Typical Enrollment	# of Middle Schools	Percentage of Children	Child Population	Typical Enrollment	# of High Schools
2	90,349	6.5%	5,873	720	8	6.1%	5,511	900	6	5.0%	4,517	1,620	3
3	111,128	6.5%	7,223	720	10	6.1%	6,779	900	8	5.0%	5,556	1,620	3
4	273,830	6.5%	17,799	720	25	6.1%	16,704	900	19	5.0%	13,691	1,620	8
5	39,125	6.5%	2,543	720	4	6.1%	2,387	900	3	5.0%	1,956	1,620	1
Totals =	**514,431**		**33,438**		46		**31,380**		35		**32,202**		16

Street Right-of-Way. It was assumed that the rights-of-way (ROW) of those streets, which had reclaimed water mains would be irrigated with reclaimed water. To determine the street ROW that could have potential low water use irrigation it was assumed that all major artery streets would have a nonpotable water pipe within it as distribution to large scale turf users. The number of miles of road was determined based on square mile grids in each WPA. The low water use irrigation width was estimated to be 30 ft. From this information the ROW irrigation demand acreage was determined and is summarized in Table 3-25.

Table 3-25. Goodyear Right-of-way

WPA	Miles of Road	Width of Irrigation (ft)	Total ROW Area of Irrigation (acres)
2	41	30	149
3	36	30	131
4	85	30	309
5	9	30	33
Totals =	**171**		**622**

Lakes. It was assumed that the decorative lakes within developments would be filled with reclaimed water.

Construction. Construction water usage was not quantified on the basis of acreage, but as a percentage of the potable water demand. From the historical metered sales construction water usage was determined to be .25% of the potable water demand. Compared to cities in the vicinity of Goodyear the typical construction water usage percentage during considerable growth is approximately 1% of the potable water demand. It has been discussed that the City currently has water being used for construction that is not metered and that more stringent regulations are necessary to ensure all water is metered. As Goodyear approaches buildout, construction water usage will drop and draw near 0.5%. Construction water use had pipe losses applied as well to obtain the required production. Table 3-26 shows the projected level of construction reuse as the city develops.

Table 3-26 Reuse for Construction as a % of Potable Demand	
Design Year	**Percent of Potable Water Demand**
Base-Year	1.0%
2012	1.0%
2017	1.0%
Buildout	0.5%

3.3.3 Projected Reuse Demand

Base Year demand was calculated to be 0.9 mgd. Buildout projections of reclaimed water use were made following the same basic process used for water demand projections; by multiplying reclaimed water unit rate demands with the appropriate acreage projected for each reuse category. The exception being construction reuse which is based on a percent of potable water demand. Table 3-27 shows the projected reuse demand, available wastewater flow and water available for recharge for the Base, Intermediate and Buildout Years.

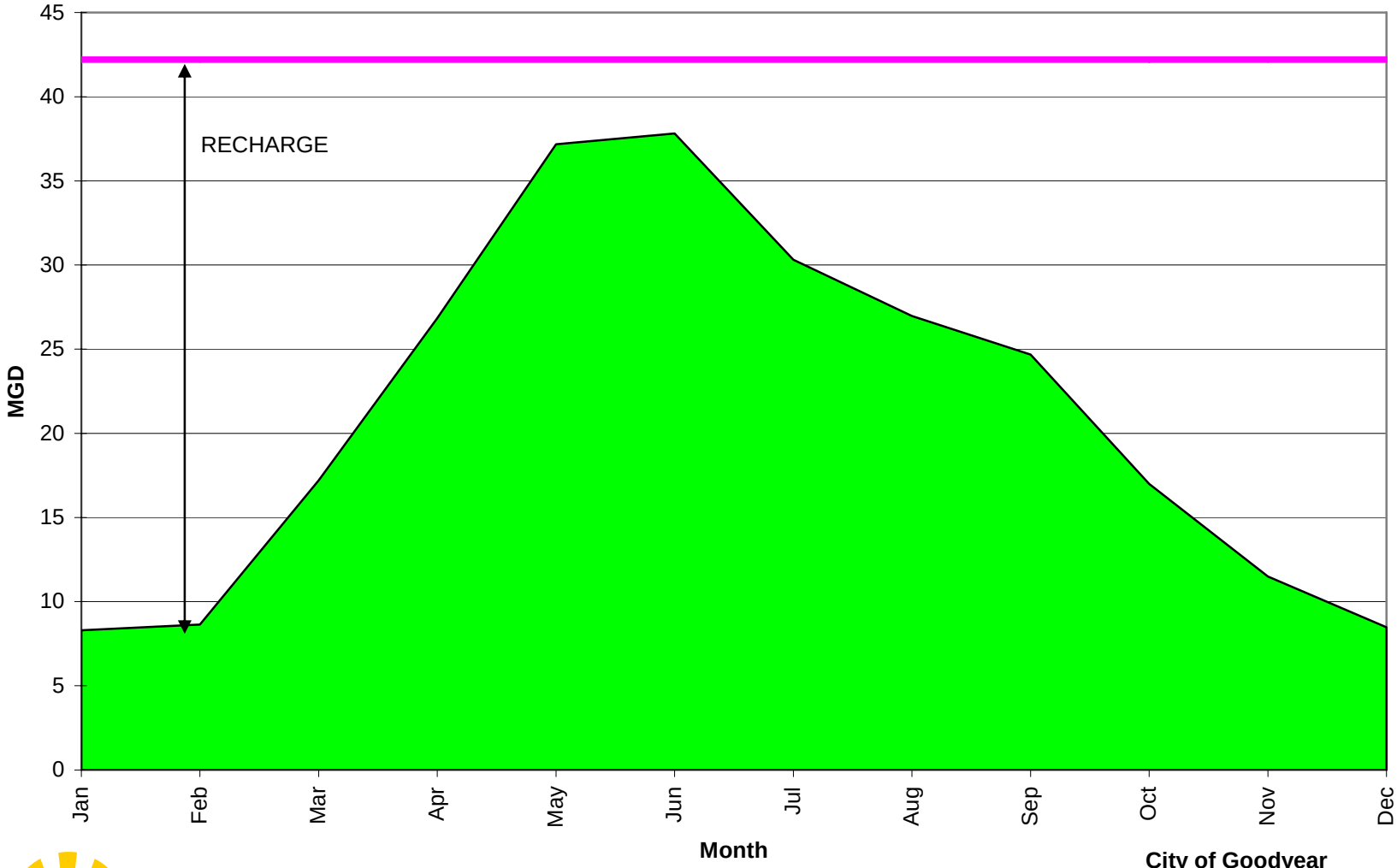
Table 3-27. Projected Reclaimed Demand

Seasonal Category	2007		2012		2017		2045	
	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)
Reuse Demand	1,023	0.9	10,304	9.2	16,800	15.0	23,801	21.3
Reclaimed Production	3,248	2.9	10,080	9.0	20,944	18.7	47,264	42.2
Recharge	**2,240**	**2.0**	**0**	**0.0**	**4,144**	**3.7**	**23,408**	**20.9**

Table 3-28 and Figure 3-7 show the seasonal irrigation demand and available reclaimed water production for the buildout condition. It can be seen from Figure 3-7 and Table 3-22 that reclaimed production is always equal to or greater than irrigation demand; therefore no recovery or potable water supplement is need to meet the projected City of Goodyear irrigation demand.

Table 28. Buildout Reuse Water Seasonal Balance

	Annual Average		January		February		March		April		May		**June (Max Month)**		July		August		September		October		November		December	
	af/yr	mgd	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	**Peaking Factor**	**Flowrate (mgd)**	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)
Parks/Schools/ROW																										
WPA 2	1,874	1.7		0.6		0.7		1.4		2.1		3.0		**3.0**		2.4		2.1		1.9		1.4		0.9		0.7
WPA 3	2,191	2.0		0.7		0.8		1.6		2.5		3.5		**3.5**		2.8		2.5		2.3		1.6		1.1		0.8
WPA 4	5,416	4.8		1.8		1.9		4.0		6.1		8.6		**8.7**		6.9		6.1		5.6		3.9		2.6		1.9
WPA 5	774	0.7		0.3		0.3		0.6		0.9		1.2		**1.2**		1.0		0.9		0.8		0.6		0.4		0.3
Total Demand =	10,255	9.2	0.38	3.5	0.39	3.6	0.82	7.5	1.26	11.5	1.77	16.2	**1.80**	**16.5**	1.42	13.0	1.27	11.6	1.16	10.6	0.81	7.4	0.54	4.9	0.39	3.6
Golf Courses																										
WPA 2	1,095	1.0		0.4		0.4		0.8		1.3		1.7		**1.8**		1.4		1.3		1.1		0.8		0.5		0.4
WPA 3	2,736	2.4		0.9		1.0		1.9		3.1		4.3		**4.4**		3.5		3.2		2.9		1.9		1.3		0.9
WPA 4	7,115	6.4		2.4		2.5		5.0		8.1		11.2		**11.4**		9.2		8.2		7.4		5.0		3.3		2.4
WPA 5	1,095	1.0		0.4		0.4		0.8		1.3		1.7		**1.8**		1.4		1.3		1.1		0.8		0.5		0.4
Total Demand =	12,040	10.7	0.37	4.0	0.39	4.2	0.79	8.5	1.28	13.8	1.77	19.0	**1.80**	**19.4**	1.45	15.6	1.29	13.9	1.17	12.6	0.78	8.4	0.52	5.6	0.38	4.1
Lakes																										
WPA 2	515	0.5		0.2		0.2		0.4		0.6		0.8		**0.8**		0.7		0.6		0.5		0.4		0.3		0.2
WPA 3	116	0.1		0.0		0.0		0.1		0.1		0.2		**0.2**		0.1		0.1		0.1		0.1		0.1		0.0
WPA 4	298	0.3		0.1		0.1		0.2		0.3		0.4		**0.5**		0.4		0.3		0.3		0.2		0.1		0.1
WPA 5	43	0.0		0.0		0.0		0.0		0.0		0.1		**0.1**		0.1		0.0		0.0		0.0		0.0		0.0
Total Demand =	972	0.9	0.41	0.4	0.45	0.4	0.84	0.7	1.24	1.1	1.69	1.5	**1.73**	**1.5**	1.44	1.2	1.28	1.1	1.15	1.0	0.82	0.7	0.55	0.5	0.40	0.3
Construction																										
Total Demand =	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5	534	0.5
TOTAL IRRIGATION DEMAND																										
WPA 2	3,617	3.2		1.3		1.4		2.6		4.0		5.6		5.7		4.6		4.1		3.7		2.6		1.8		1.3
WPA 3	5,178	4.6		1.8		1.9		3.7		5.8		8.1		8.2		6.6		5.9		5.4		3.7		2.5		1.9
WPA 4	12,962	11.6		4.4		4.6		9.3		14.7		20.4		20.7		16.6		14.7		13.5		9.2		6.2		4.5
WPA 5	2,045	1.8		0.8		0.8		1.5		2.3		3.1		3.2		2.6		2.3		2.1		1.5		1.0		0.8
Total Demand =	23,801	21.3		8.3		8.6		17.2		26.8		37.2	42,347	37.8		30.3		27.0		24.7		17.0		11.5		8.5
Wastewater Flow	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2	47,264	42.2
Recharge	23,476	21.0	37,980	33.9	37,598	33.6	27,993	25.0	17,192	15.4	5,625	5.0	4,917	4.4	13,310	11.9	17,064	15.2	19,630	17.5	28,235	25.2	34,397	30.7	37,767	33.7



City of Goodyear
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Figure 3-7
Buildout Seasonal Irrigation Demand

SECTION 4

WATER RESOURCES

The City of Goodyear resides within the Sonoran Desert in the arid southwest, a location that receives on average less than 10-inches of total rainfall per year. The City relies on groundwater pumping to meet current potable water demands and it is anticipated that future demands will be met by a combination of increased groundwater pumping and imported surface water. Careful management and efficient planning will be required to develop the next increments of supply needed to support a projected ten-fold increase in population.

The primary purpose of this section of the Master Plan is to provide a basic understanding of the raw water resources available to the City (present and future), so that water, wastewater and reclaimed water infrastructure can be planned and developed in a manner that will utilize the available resources efficiently. In order to accomplish this goal, the following tasks will be undertaken in this section of the Master Plan:

1) **Available Water Resources.** Current and future resources available to the City will be tabulated and the constraints associated with each will be discussed.

2) **Supply vs Demand.** Available resources will be compared with the projected demands developed in Section 3 in order to assess their sufficiency.

3) **Sustainability.** Projected resource utilization will be assessed in light ADWR's groundwater safe-yield requirements.

4) **Integrated Resource Management.** The linkage between water, wastewater and reclaimed water systems will be assessed in order to find the optimum strategy for long-term sustainability.

Each of the above items will be addressed on an integrated basis. That is to say the resources and infrastructure associated with all three systems (water, wastewater and reclaimed) will be analyzed together as a whole, in an effort to find the optimal balance or interaction between these integrated or linked systems which maximizes the reach of the available resources.

4.1 AVAILABLE RESOURCES

The City of Goodyear has a number of water resources available to it for meeting current and future water demands. These include surface water, groundwater and reclaimed water resources as quantified below in Table 4-1.

Table 4-1: City of Goodyear Water Resources

Resource Type	2007 Resources	2012 Resources	2017 Resources	2045 Resources
SURFACE WATER RESOURCES - CAP	**af/yr**	**af/yr**	**af/yr**	**af/yr**
Current CAP Allocation	3,531	3,531	3,531	3,531
Future CAP Re-Allocation (2010)		7,211	7,211	7,211
Future CAP Re-Allocation (2012)		1,814	1,814	1,814
ASLD CAP	150	150	150	150
Gila River Indian Community Lease		7,000	7,000	7,000
Total Surface Water Resources =	**3,681**	**19,706**	**19,706**	**19,706**
Percent of Total Supply =	4%	16%	15%	12%
GROUNDWATER RESOURCES	**af/yr**	**af/yr**	**af/yr**	**af/yr**
West Salt River Valley[1]	47,238	47,238	47,238	47,238
Rainbow Valley[1]	33,220	33,220	33,220	33,220
LPSCO	3,360	3,360	3,360	3,360
Adaman Mutual Water Co.	11,200	11,200	11,200	11,200
Total Groundwater Resources =	**95,018**	**95,018**	**95,018**	**95,018**
Percent of Total Supply =	93%	76%	70%	58%
RECLAIMED WATER RESOUCES	**af/yr**	**af/yr**	**af/yr**	**af/yr**
Total Reclaimed Water Resources =	**3,909**	**10,080**	**20,720**	**47,936**
Percent of Total Supply =	4%	8%	15%	29%
TOTAL AVAILABLE SUPPLY	**102,608**	**124,804**	**135,444**	**162,660**

Notes:
1. Adjusted to reflect 32,662 af/yr set aside for Sonoran Valley Development.

It must be noted that the quantities shown in Table 4-1 do not reflect the total groundwater available to the City but only that portion which is to be used for the development proposed within the IWMP planning area boundary. Out of the City's total proven groundwater resources, 32,662 af/yr of groundwater has been set-aside for the development of the Sonoran Valley, 14,362 af/yr from the WSRV aquifer and 18,300 af/yr from the Rainbow Valley aquifer.

It can be seen that the City's water resources, available for use within the IWMP planning area, are projected to grow from 102,608 af/yr in 2007 to 162,660 af/yr at build-out. This 59 percent increase is based on 1) the acquisition of an additional 16,025 af/yr of surface water resources

and 2) a projected 44,027 af/yr increase in reclaimed water resources. The following sections provide a detailed discussion of each water resources type, the individual components of which it is comprised and the constraints and limitations associated with its use.

4.1.1 Surface Water Resources

The City of Goodyear currently has 3,681 af/yr of surface water which equates to 4 percent of the City's currently available resources. Surface water resources are projected to reach 19,706 af/yr within the next 10 years and remain at that level till Build-out, representing 12 percent of the build-out resource portfolio. The City's surface water resources, both now and future are entirely composed of Central Arizona Project resources.

The Colorado River Basin Project Act (1968) authorized construction of the Central Arizona Project (CAP). The CAP is designed to deliver approximately 1.5 million acre-feet (maf) of Arizona's 2.8 maf of Colorado River Water to Pima, Pinal and Maricopa counties in Central Arizona. The balance, approximately 1.3 maf, generally represents Arizona water users located along the main stem of the Colorado River.

The CAP was built by the Federal Government and is operated by the Central Arizona Water Conservation District (CAWCD). Colorado River Water deliveries began to the Phoenix metropolitan area in 1985. CAP water users (subcontractors) are classified as; Municipal and Industrial (M&I), Indian and Agricultural. Different priorities in times of drought and different costs per acre-foot are assigned to each category of CAP water. As shown in Table 1, the water delivered to Goodyear, through the CAP system, can be broken down into the following subcategories:

Current CAP Allocation: The City of Goodyear's current CAP allocation is for 3,531 ac-ft/yr of M&I water. The City currently recharges this allocation and earns long-term storage credits.

Future CAP Re – Allocation (2010): The Federal Government is expected to allocate remaining available CAP M&I water. The reallocation is taking place in the context of settlement negotiations concerning 1) operation and repayment of the CAP and 2) a broad range of Indian water rights in Arizona. Under the alternative recommended by Arizona Department of Water Resources, the City of Goodyear is expected to receive another 7,211 af/yr of CAP M&I water.

Future CAP Re – Allocation (2012): Additional CAP M&I water is anticipated to be available in 2012 in the amount of 1,814 af/yr.

ASLD CAP: Arizona State Land Department (ASLD) CAP resources available to Goodyear is 150 af/yr. This is classified as M&I water.

Gila River Indian Community Lease: The City of Goodyear negotiated the lease of 7,000 af/yr of the Gila Indian Contract CAP water at a cost of $1,500 per af with a contract length of 100 years. The sum is payable over a period of 15 years, at approximately $800,000 per year. This water is tied to the Gila River Indian Community adjudication of the Gila River, and is currently anticipated for release by 2008. Leased Indian CAP water could be used in the same manner as the City's M&I CAP allocation, whether by recharge or direct use, and would require the same delivery mechanism. This agreement is contingent upon the current settlement proceedings.

Though the origin of the individual surface water components may vary, for practical purposes, all of the City's Colorado River resources can be considered as CAP water, which will likely be delivered through the CAP canal and would be subject to the following constraints.

Take or Pay Charges: Capital charges provide for the repayment of the capital cost of the CAP. The capital charge (currently $32/ac-ft) is charged to Goodyear whether its CAP allocation is utilized or not. The City therefore has an incentive to utilize its full CAP allocation each year. Capital charges apply only to subcontract water so long as Goodyear stays within its subcontract allocation. The City does not currently take direct delivery of their CAP resources for treatment and supply into the distribution system but instead has their allocation recharged and earns long term storage credits. The City anticipates initiating deliveries for treatment and supply within the 10-year Interim Period, reaching full utilization of their CAP allocation by build-out. A discussion of each component of the City's CAP water resources follows.

O&M Charges: Additional charges are assessed to cover O&M based on the quantity of water actually delivered in order to cover pumping energy and other variable operational costs. In 2008, the O&M charge is set at $230/ac-ft. This must be added to the capital charge making the total cost for CAP water delivered in 2008 to be $262/ac-ft.

System Dry-Up: The CAP system is an interruptible supply and outages are possible as a result of failures and as required for periodic maintenance. Since initiating service 1985, there have been very few outages, however, CAP has indicated that beginning in 2007, short

dry-ups (ranging from one week to one month in duration) are envisioned every two to three years on average for maintenance purposes.

A back-up to the CAP water supply is therefore required and the City's water production infrastructure will be planned to accommodate periodic CAP dry-ups. These dry-ups for maintenance purposes will be scheduled by the CAWCD to occur during the cooler months, typically at some time within the November to February time frame.

Seasonal Variations and Peaking Limits: CAP water can be ordered year-round but deliveries are contractually limited to a peak of no more than 11 percent of the annual supply in any given month. This equates to 1.32 times the annual average flow rate of CAP water. The City's current plans are to contract for CAP treatment capacity at outside facilities remote from the City, using base, un-peaked flowrates.

Drought Susceptibility: Colorado River water resources are susceptible to drought and City should take the steps necessary to be prepared in the event that their CAP deliveries are curtailed. A complex system of water rights priorities and shortage sharing agreements exist at both the Federal and State level and a careful discussion of Colorado River regulations and legal agreements are beyond the scope of the IWMP.

However, by making a simplifying assumption, as to the potential degree to which drought on the Colorado River watershed may cut normal deliveries, effective drought planning can then be undertaken. For the purposes of the IWMP, it was assumed that at times of significant and prolonged drought on the Colorado River, that Goodyear's CAP deliveries could be cut by 25 percent. The effect of this potential reduction on the City's normal operations is discussed in the second section of this Chapter, Supply and Demand.

4.1.2 Groundwater Resources

Table 4-2 shows that Goodyear has 127,680 af/yr of groundwater resources. This consists of quantities which the City is entitled to pump under their Municipal Water Right as well as quantities secured through agreements with other governmental agencies.

Table 4-2: Groundwater Resource		
GROUNDWATER RESOURCE PORTFOLIO	QUANTITY (af/yr)	SECURED VIA
West Salt River Valley (WPA2)	61,600	Municipal Water Right
Rainbow Valley	51,520	Municipal Water Right
Municipal Water Right Subtotal =	113,120	
LPSCO	3,360	Intergovernmental Agreement
Adaman Mutual Water Co.	11,200	Intergovernmental Agreement
IGA Subtotal =	14,560	
Total Groundwater Resources =	**127,680**	

The Arizona Department of Water Resources grants cities a Municipal Water Right to utilize the groundwater beneath their certificated service area, in quantities that have been demonstrated to be both continuously and legally available. Key, among the considerations which must be addressed in order to be considered continuously and legally available, the drawdown produced by municipality's pumping activity must:

- Limit drawdown over a 100-year period to no more than 1,000 feet below the ground surface
- Limit the impact to any registered well to no more than 10 feet in a five year period.

The City recently completed an analysis of the West Salt River Valley and Rainbow Valley aquifers using a hydraulic groundwater flow model. In the Groundwater Flow Model Report (GFM Report), their permissible pumping under their municipal water right was calculated to be 113,120 af/yr. This is a significant increase from previously established groundwater availability for the City due primarily to:

1. The 2007 GFM Report takes a significantly larger service area into consideration as a result of expansions of Goodyear's planning area boundaries to now include the Sonoran Valley.
2. A number of the hydraulic parameters within the ADWR approved hydraulic model for the Salt River Valley have been adjusted on the basis of additional information now available.

Figure 4-1 shows the location of Goodyear's groundwater water resources and a discussion of each component follows:

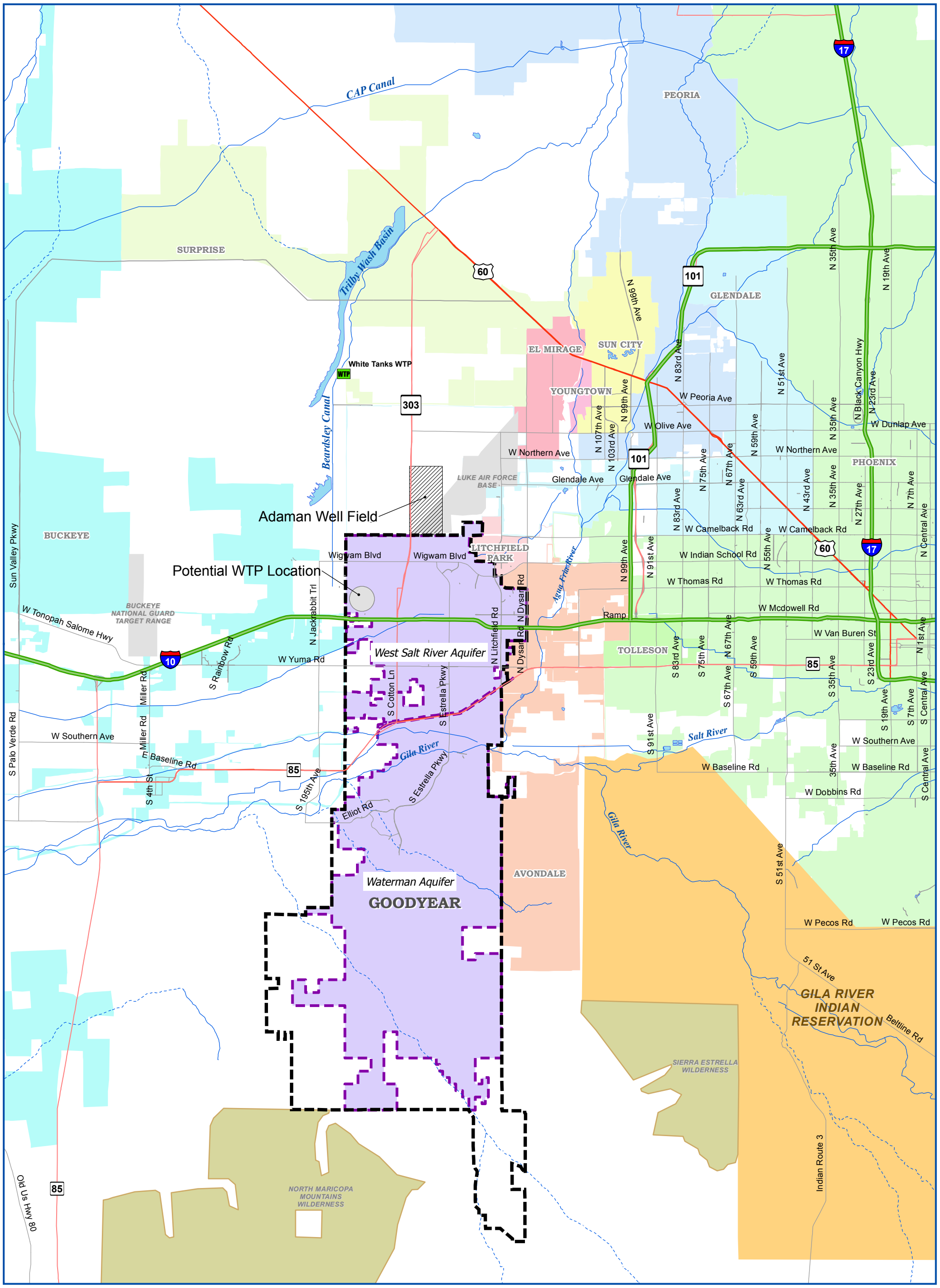
West Salt River Valley: The GFM Report indicates that up to 61,600 af/yr of groundwater pumping is available from the West Salt River Valley (WSRV) from within the footprint of WPA2. Ten wells are currently being utilized in WPA2 with a total annual pumping of approximately 12.7 mgd (14,224 af/yr), significantly less than the allowable total. The GFM Report also indicates that a number of contaminants are present in WSRV resources at levels exceeding drinking water MCLs including:

- Nitrate
- Arsenic
- Flouride
- TDS

WPA2 also contains a superfund site, where a trichloroethylene (TCE) plume is still being remediated. Nine of the 10 active potable water wells currently require treatment for arsenic, nitrate and/or TDS contaminants and efforts to drill new potable wells in WPA 2 have been consistently hampered by poor water quality or are too high in temperature for use as a potable water well. For this reason, it is assumed that while significant groundwater resources exist within the WSRV, all new wells drilled within WPA2 will likely need treatment.

The GFM Report noted that high water levels exist in the southern portion of WPA2, due to the agricultural drainage and recharge which occurs along the Gila River. The area is classified as "waterlogged" by ADWR and water pumped from inside a designated waterlogged area is not subject to safe-yield requirements. Given the high yield of this area, the City may be able to pump a significant portion of the WSRV's 61,600 af/yr free from the recharge obligation required for safe-yield. However, it must be noted that the water quality is generally poor, with TDS in the range of 2,500 ppm and it is assumed in the IWMP that RO treatment would be required for this brackish water.

Rainbow Valley: The Rainbow Valley aquifer runs southward from the confluence of Waterman Wash with the Gila River and with the exception of WPA2, it underlies all of the City's Southern Planning Area, including the recently annexed Sonoran Valley. The GFM Report establishes that 51,520 af/yr could be withdrawn by the City from within the footprint of their southern service area. Like the WSRV water resources underlying WPA2, Rainbow



Legend

- Adaman Well Field
- **Transportation**
  - US Route
  - State Route
  - Major Arterial
  - Interstate Highway
- Lake
- Aqueduct
- Ditch; Stream
- Wash

N W E S

2 0 2
Miles

Data Sources:
City of Goodyear GIS
ALRIS
ESRI

Figure 4-1
Water Resources

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Revised: Wednesday, March 26, 2008

Valley groundwater is generally poor quality brackish water with elevated levels of the following:

- Nitrate
- Arsenic
- Fluoride
- TDS

Although several wells have been found which are currently potable, they are located more towards the fringes of the aquifer where it reaches up to the surrounding mountains and thins considerably. Water quality in these peripheral fringe areas is not considered to be representative of the majority of the Rainbow Valley groundwater. For the purposes of this report, it is therefore assumed that the water pumped from the Rainbow Valley will require RO treatment.

However, because the Rainbow Valley aquifer is hydraulically isolated from the larger WSRV aquifer, it is believed that over time, a well planned program of recharge using low TDS reclaimed water will result in steadily falling TDS levels and less treatment.

LPSCO: Litchfield Park Service Company (LPSCO) currently provides the City of Goodyear with up to 3,360 ac-ft/yr of pumped groundwater through a negotiated contract. LPSCO is the certificated water service supplier within WPA-1 in the City of Goodyear and will deliver the 3,360 af/yr through metered connections between LPSCO's and Goodyear's potable water distribution systems, one at Bullard Ave and one at Sarival Ave. Water received from LPSCO is potable quality and treatment is not required, however the supply is interruptible and can not be peaked above the 3,360 ac-ft/yr (3 mgd) rate.

Adaman Mutual Water Co.: Under a long-term contract, the Adaman Mutual Water Company will provide up to11,200 ac-ft/yr of groundwater to the City of Goodyear. This quantity is anticipated to be fully available to the City by the Intermediate year of 2012 and is to be pumped and delivered on a steady 11,200 ac-ft/yr (10 mgd) basis without peaking. The information available from existing Adaman Mutual wells show that arsenic and/or nitrate is present at levels above the drinking water MCLs. For the purposes of this master plan, it is assumed that treatment will be required for water pumped from the Adaman Mutual wellfield.

In general, groundwater resources are not subject to peaking limits in the same manner as are surface water supplies. By virtue of the large volume of water present, the aquifer provides significant buffering and provided that annual limits on groundwater withdrawals are met, there is no need to impose daily or monthly peaking limits on the rate groundwater withdrawal. And, the underground aquifers provide a location for the storage of resources available to the City during times of surplus. This makes groundwater the ideal resource for both peaking and emergency supply. The exception in this case, being the peaking limitations included in the Adaman Mutual and LPSCO IGA's.

Because the resources tabulated in the City's portfolio are intended to be utilized for future development in the Sonoran Valley, as well as for the growth with the study area for the IWMP, it was necessary to estimate the demand that would occur in this area. A portion of the overall resources was set aside and reserved for future development of the Sonoran Valley. Table 4-3 shows the estimated demands in the Sonoran Valley, the portion of the overall resources reserved for their future development and the resulting balance available for use in this IWMP.

Table 4-3: Adjusted IWMP Groundwater Resources

Groundwater Resources	Annual Pumping	
	Mgd	Af/yr
Sonoran Valley AAD	26.25	29,400
Reject Brine	2.92	3,270
Sonoran Valley Resource Consumption	**29.17**	**32,670**
Available WSRV Resources	55.00	61,600
Portion Utilized for Sonoran Valley	12.82	14,362
Adjusted IWMP Availability	**42.18**	**47,238**
Rainbow Valley Resources	46.00	51,520
Portion Reserved for Sonoran Valley	16.34	18,300
Adjusted IWMP Availability	**29.66**	**33,220**
Groundwater Delivered by Adaman Mutual (no adjustment)	10.0	11,200
Groundwater Delivered by LPSCO (no adjustment)	3.0	3,360
Total IWMP Groundwater Resources	**84.84**	**95,018**

4.1.3 Reclaimed Water Resources

The City of Goodyear treats and reclaims the wastewater collected within the service area to create a renewable water supply. While the Arizona Department of Environmental Quality (ADEQ) standards and public perception do not permit reclaimed water to be directly reused as a potable water supply, there are several practical uses which improve the City's overall water resources balance including:

- Direct Reuse for non-potable applications such as turf and landscaping irrigation, filling artificial lakes and construction.
- Recharge into the underlying aquifers, earning long-term storage credits.

The volume of reclaimed water available to the City is projected to increase from 3,909 af/yr to 47,936 af/yr based on a calculated percentage of the potable water delivered within the City being returned through the wastewater collection system. The returned portion is generally that portion of which has been used for interior water uses where-as the exterior uses are generally consumptive uses such as landscape irrigation and pool filling and do not generate a return flow.

Because it is linked to the interior portion of potable water use, reclaimed water is generally thought of as a drought-proof supply. Under drought conditions, it is most often exterior water uses, landscape watering, car washing, etc which are restricted should a reduction in demand be necessary. And restrictions in interior water use would not be mandated except in the most severe conditions. Therefore the production of reclaimed water can be expected to remain relatively constant through a drought cycle.

Reclaimed water from the City's water reclamation facilities will meet A+ standards as defined by ADEQ, making it fully suitable for the full range of reuse and recharge activities proposed in the IWMP. However, it will be necessary to control TDS levels in the future in order to not compromise its suitability for these beneficial uses. Currently, the TDS of the City's reclaimed water from the 157th Ave WWTP approaches 2,000 ppm, due to brine which is discharged from the City's Site 11 reverse osmosis WTP, making it unsuitable for landscaping irrigation and further reducing the quality of the City's groundwater when recharged. The City must therefore develop and utilize brine disposal facilities for the waste brine stream from all groundwater treatment facilities and prohibit future brine disposal to the sewer in order to develop and utilize this valuable resource. Once waste brine disposal to the sewer is discontinued, the TDS of reclaimed water can be expected to be more in the range of 600 ppm, which reflects potable water standard of 500 ppm, plus the roughly 100 ppm of TDS which is picked up through one cycle of interior use.

4.2 SUPPLY VERSUS DEMAND

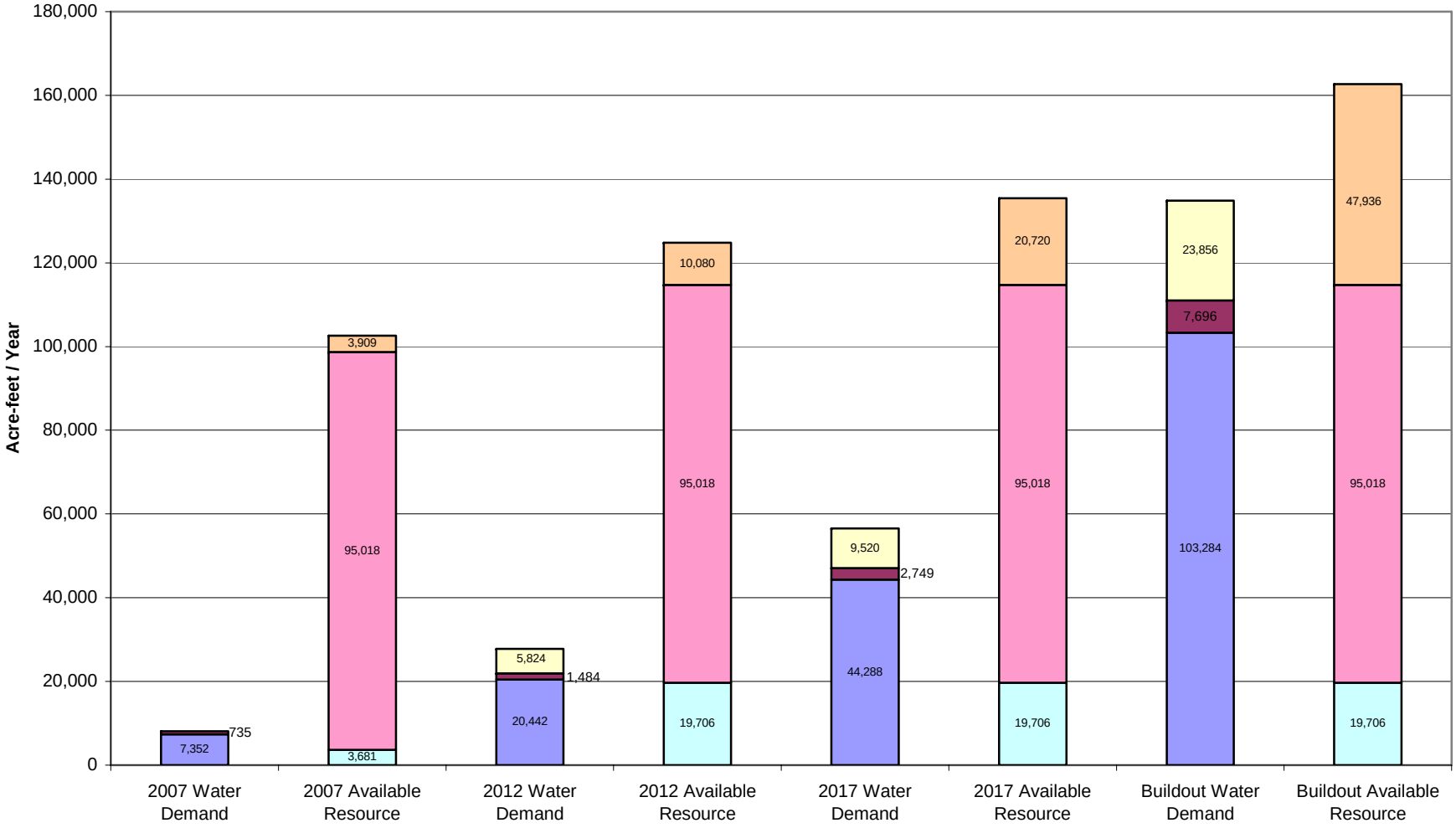
The availability of Goodyear's water resources is compared with projected demands, under both normal supply conditions and drought conditions.

4.2.1 Normal Year Supply

Goodyear's water resources were compared with projected demands and it can be seen in Table 4-4 and Figure 4-2 below that adequate resources are available to support the city's planned growth at all stages of the City's development through to build-out.

Table 4-4: City of Goodyear Supply vs Demand – Normal Supply Year

	2007	2012	2017	2045
POTABLE SYSTEM BALANCE				
Surface Water Resources	3,681	19,706	19,706	19,706
Groundwater Resources	95,018	95,018	95,018	95,018
Potable Demand	7,352	20,442	44,288	103,284
Reject Brine	735	1,484	2,749	7,696
Balance =	**90,612**	**92,798**	**67,687**	**3,744**
Percent of Potable Water Supply Utilized =	**8.2%**	**19.1%**	**41.0%**	**96.7%**
NON-POTABLE SYSTEM BALANCE				
Reclaimed Water Production	3,909	10,080	20,720	47,936
Reuse Demand	0	5,824	9,520	23,856
Balance Available for Recharge =	**3,909**	**4,256**	**11,200**	**24,080**
Percent of Reclaimed Water Supply Utilized for Reuse=	**0.0%**	**57.8%**	**45.9%**	**49.8%**
TOTAL SUPPLY VERSUS DEMAND				
Total Supply	102,608	124,804	135,444	162,660
Total Demand	8,087	27,750	56,557	134,836
Balance =	**94,521**	**97,054**	**78,887**	**27,824**
Percent of Supply Utilization =	**7.9%**	**22.2%**	**41.8%**	**83.9%**



City of Goodyear
2007 Integrated Master Plan

Figure 4-2
Resource vs Demand

From the above data and figures it can be seen that there are significant resource surpluses, consisting primarily of un-tapped groundwater available currently and over the near-term. However by Buildout, the entire supply of potable resources (surface water and groundwater) will be consumed satisfying potable water demand, which includes the fraction pumped but lost as reject brine. By Buildout, the overall surplus will have reduced to 16 percent, the vast majority of which is unused reclaimed water. It can be included from the above that:

- Sufficient resources are available to support the demands projected within the IWMP
- Additional growth, beyond IWMP projections could only be supported if reclaimed water was utilized.

For additional reclaimed water to be utilized, it would require either 1) that the increased growth was in the form of reuse projects or 2) that a portion of residential and commercial water use be converted to reclaimed water.

4.2.2 Drought Year Supply Impacts

The degree to which local or regional drought could impact Goodyear's balance of supply versus demand was also assessed and as Table 4-5 shows, the effect is minimal. The assumptions under which the evaluation was performed include:

- Twenty five percent reduction in CAP surface water supplies.
- No reduction in WSRV, Rainbow Valley or Adaman Mutual groundwater.
- LPSCO groundwater supply is interrupted.
- No reduction in reclaimed water resources.

Table 4-5: City of Goodyear Supply vs Demand – Drought				
	2007	**2012**	**2017**	**2045**
POTABLE SYSTEM BALANCE				
Surface Water Resources	2,941	14,780	14,780	14,780
Groundwater Resources	91,658	91,658	91,658	91,658
Potable Demand	7,352	20,442	44,288	103,284
Reject Brine	735	1,484	2,749	8,358
Balance =	**86,512**	**84,512**	**59,401**	**-5,204**
Percent of Potable Water Supply Utilized =	**8.5%**	**20.6%**	**44.2%**	**104.9%**
NON-POTABLE SYSTEM BALANCE				
Reclaimed Water Production	3,909	10,080	20,720	47,936
Reuse Demand	0	5,824	9,520	23,856
Balance Available for Recharge =	**3,909**	**4,256**	**11,200**	**24,080**
Percent of Reclaimed Water Supply Utilized for Reuse=	**0.0%**	**57.8%**	**45.9%**	**49.8%**
TOTAL SUPPLY VERSUS DEMAND				
Total Supply	98,508	116,518	127,158	154,374
Total Demand	8,087	27,750	56,557	135,498
Balance =	**90,421**	**88,768**	**70,601**	**18,876**
Percent of Supply Utilization =	**8.2%**	**23.8%**	**44.5%**	**87.8%**

From the above comparison of demand versus available supply in a drought year, it can be seen that:

- The Drought reduced supply will be sufficient to meet potable and non-potable system demands over the near term.
- At Build-out, the City's potable water supply will fall 4 percent short of the potable water demand in a drought year, as a result of potential reductions in surface water (CAP) deliveries.
- The 5,204 af/yr shortfall in surface water resources during a drought year could be offset by pumping additional groundwater.

It was concluded that Goodyear's water portfolio is not highly susceptible to drought year cutbacks and in fact being primarily groundwater based is relatively secure, even under drought conditions. A 6 percent increase in groundwater pumping or a 5 percent decrease in demand during a drought year would offset the anticipated reduction in surface water supplies.

4.3 SUSTAINABILITY

In an effort to halt severe groundwater over pumping, the Arizona Legislature adopted a comprehensive groundwater code in 1980. The Groundwater Code dictates strict requirements for the use of groundwater resources within the Phoenix Active Management Area (AMA) with the ultimate goal of halting groundwater mining and achieving safe yield. Goodyear's service area falls within the Phoenix AMA and groundwater pumping must therefore comply with the safe-yield requirements.

In simple terms, the concept of safe yield requires that one ac-ft of groundwater be recharged for each ac-ft of groundwater pumped. Table 4-6 shows the projected levels of recharge and the quantity of long-term storage credits (LTSC) which the City is projected to earn and compares this with projected levels of groundwater pumping.

Table 4-6: Long-Term Storage Credits (LTSC) versus Pumping				
Credits	**2007 (af/yr)**	**2012 (af/yr)**	**2017 (af/yr)**	**2045 (af/yr)**
Reclaimed Water Recharge	3,909	4,256	11,200	24,080
Incidental Recharge	294	818	2,152	5,393
CAP recharge	3,681	14,106	2,906	0
In-Lieu Credit	10,000	10,000	6,400	0
Total LTSC Earned Annually	**17,884**	**29,180**	**22,658**	**29,473**
Annual Groundwater Pumping	**8,087**	**16,326**	**30,237**	**91,274**
Safe-Yield Surplus or (Shortfall)	**9,797**	**12,854**	**(7,579)**	**(61,801)**

Projections show that the City currently meets the safe-yield requirement and will continue to do so over the near-term. The primary reason for this is that pumping levels are currently low and the City has unused CAP water resources which are being recharged. However, the City will fall significantly short of meeting safe yield requirements in the future, as groundwater pumping increases and CAP resources are put fully to use for potable water supply. A brief discussion of each of the sources of recharge from which the City earns long term storage credits is provided below.

Reclaimed Water Recharge: Reclaimed water which is not reused will be recharged to Long-Term Storage Credits. Goodyear recharges close to all of the reclaimed water produced in 2007 because reuse is currently minimal. However recharge volumes are projected to increase significantly in the future as the City develops because the growth in reclaimed water production is projected to outpace growth in reuse demand. Over the long run, reclaimed water will be the City's primary source of recharge, making it vitally important that the quality of this resource be protected and that 100 percent of what is not reused for irrigation, be recharged to earn LTSC.

Incidental Recharge: Some of the potable water delivered to customers ends up being "incidentally" recharged into the aquifer because a small percentage of what is applied as irrigation of outdoor landscaping, percolates through to the underlying aquifer. Other factors, such as pipe leakage also contribute to incidental recharge. The volume of incidental recharge is dependent upon municipal and industrial demand and use efficiency. As established by ADWR, the amount of incidental recharge in a municipal setting is 4% of potable and reuse demand. For Goodyear the incidental recharge is calculated by multiplying Goodyear's total annual water demand by 4 percent.

CAP Long Term Storage Credits: The City is currently recharging unused portions of their CAP allocation until the infrastructure is put in place which will allow them to fully utilize the resource as potable water supply. By the end of the near-term 2017, it is anticipated that the City will be utilizing 16,800 af/yr of their allocation, leaving only 2,906 to be recharged. By buildout, the City will no longer be recharging CAP resources but will instead be utilizing 100 percent to meet potable water demands.

In lieu credit: The City initiated an in-lieu recharge program where the City of Goodyear receives credits for CAP water that is diverted to farmers who would other wise use groundwater for crop irrigation. The City is able to purchase CAP water at the Incentive Recharge rate and receive a reimbursement form its irrigation district partner.

In years where recharge exceeds pumping, the surplus of LTSC earned is banked and to date the City has roughly 150,000 ac-ft of LTSC banked. These banked credits can be spent in years when there is a shortfall, however it can be seen that the 63,063 af/yr shortfall projected for buildout onward could not be sustained but for a few years using banked credits. Sustainable groundwater pumping basically requires that sufficient credits are earned each year to offset groundwater pumping. And on top of this, it is prudent to keep a positive balance in the groundwater account because it is banked credits which will be spent in years drought, when surface water supplies are cut and groundwater pumping is increased.

Methods by which the long-term safe-yield shortfall can be mitigated and the City's groundwater pumping returned to a sustainable basis are discussed in the following section on Integrated Resource Management.

4.4 INTEGRATED RESOURCE MANAGEMENT

It was shown above that Goodyear has adequate resources to meet projected demands within the IWMP Planning Area, however the level of groundwater pumping required is not in a sustainable position that meets ADWR safe-yield requirements. In order to properly mitigate this issue, it is first necessary understand the manner in which the City's resources and infrastructure are linked together in a larger integrated system. Figures 4-3, 4-4 and 4-5 show the linked pathway followed through the City's integrated infrastructure under Base-Year, Intermediate (2017) and Buildout conditions.

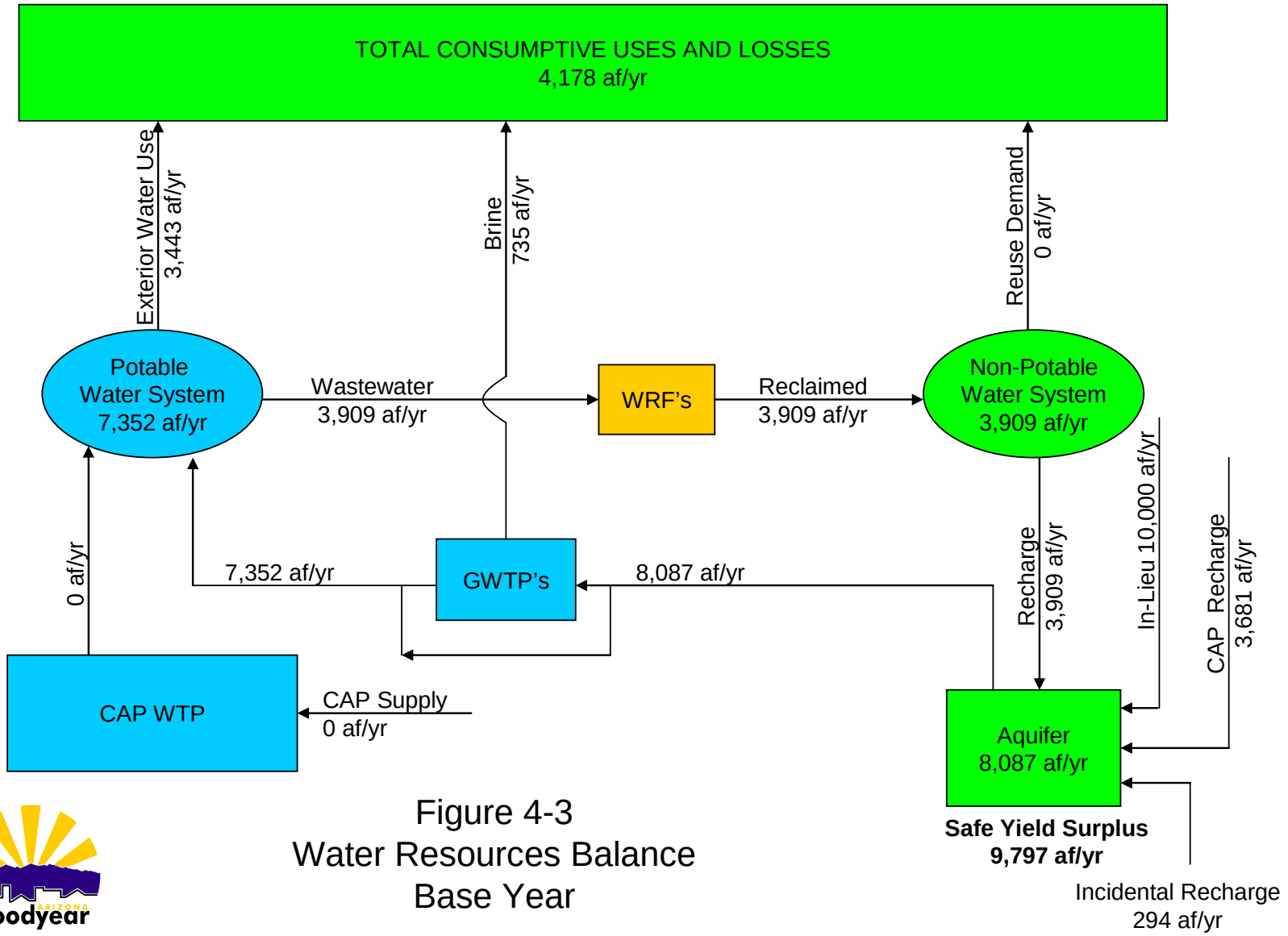


Figure 4-3
Water Resources Balance
Base Year

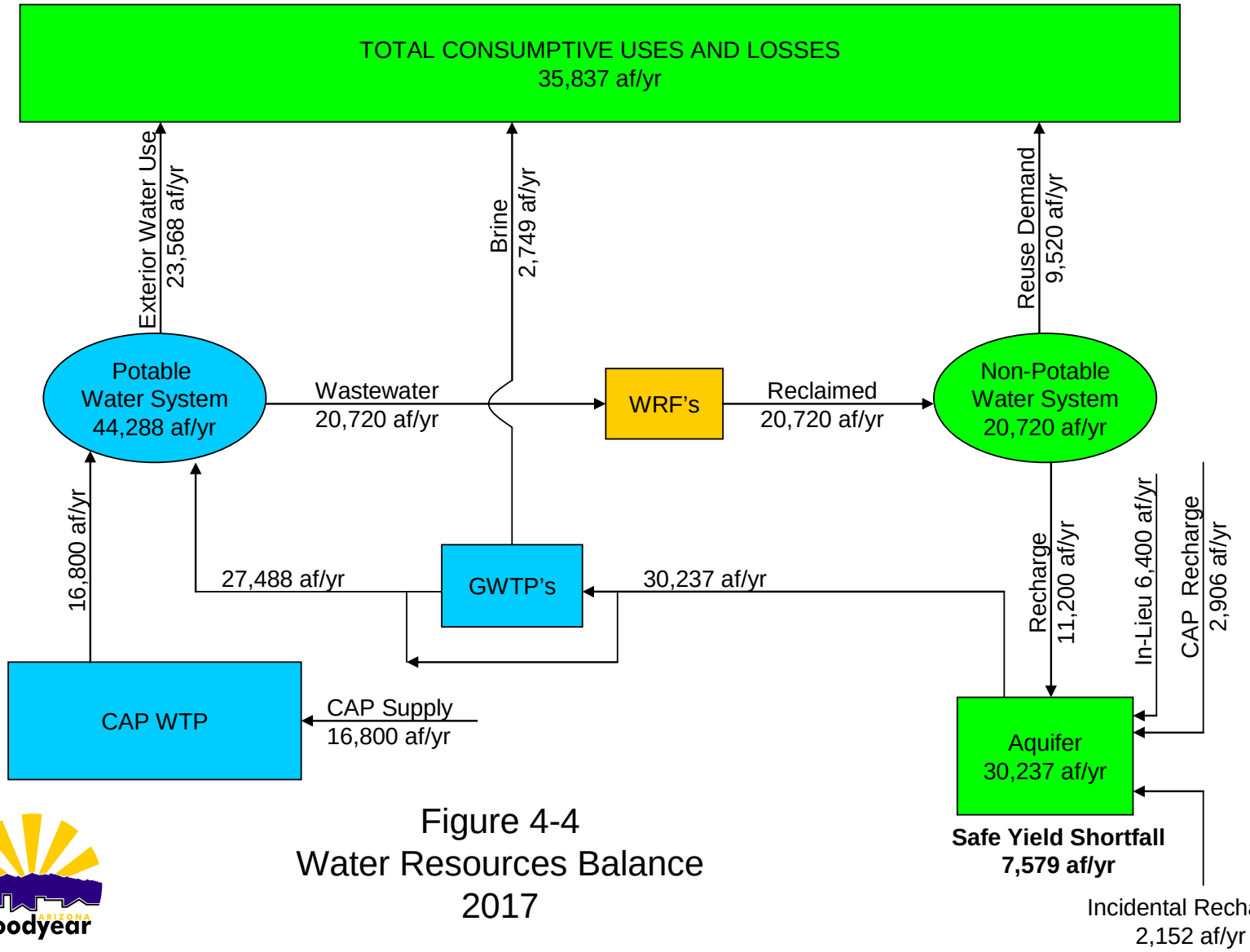


Figure 4-4
Water Resources Balance
2017

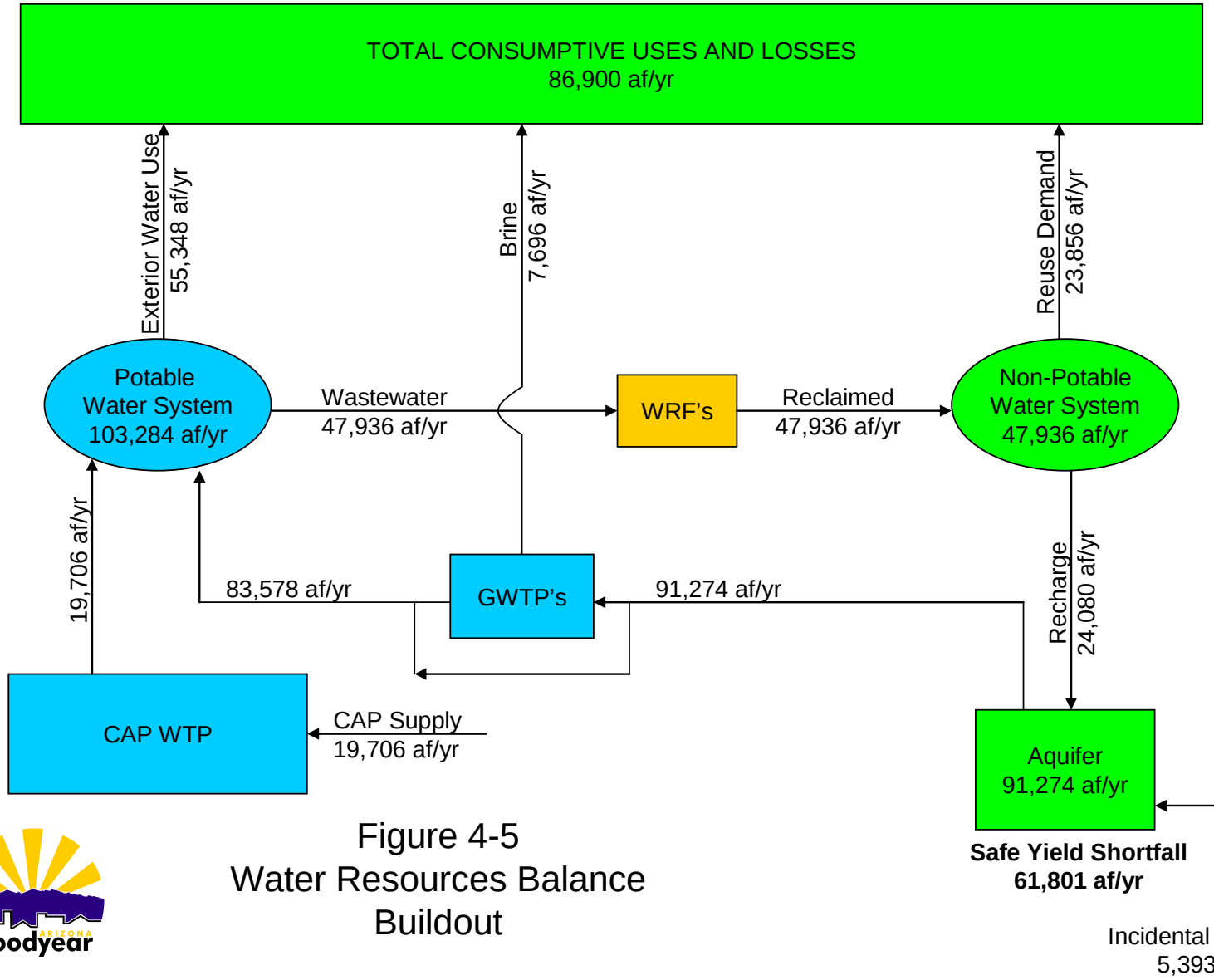


Figure 4-5
Water Resources Balance
Buildout

The key issue is that more water is being pumped from the aquifers, than is being recharged. Based on the flow charts presented, a number of strategies could be employed to close or narrow this gap and achieve safe-yield. The proposed strategies include:

1. Purchase or Develop Recharge Credits
2. Obtain Additional Imported Surface Water
3. Water Conservation
4. Reduce Waste Brine
5. Reduce Reclaimed Water Reuse
6. Pump from Buckeye Waterlogged Area

4.4.1 Purchase or Develop Recharge Credits

The City can move toward meeting their safe-yield requirement and putting their groundwater pumping plan on a sustainable basis simply by purchasing or developing additional recharge credits. The credits can accrue to Goodyear, even though the actual recharge may occur elsewhere within the Phoenix AMA. ADWR only requires that the recharge be accomplished within the overall Phoenix AMA. There are a number of ways that the City can obtain additional recharge credits:

CAGRD. The Central Arizona Groundwater Replenishment District (CAGRD) was established legislatively in 1993 to replenish excess groundwater pumped by its members within three years after the water is withdrawn. The City of Goodyear became a member in October of 2001. The contract between the City and CAGRD defines an upper limit of 10,000 ac-ft/yr as the amount of water that CAGRD will replenish on behalf of the City. CAGRD currently operates several recharge facilities within the Phoenix AMA including the Agua Fria, Hieroglyphic Hills, GRUSP and NAUSP. Members pay a tax based on the amount of groundwater pumped, which covers the cost to convey and recharge the CAP resource. The tax equals the capital charge + O&M charge plus an additional fee to cover the cost of operating the recharge facility.

Intergovernmental Agreement. The City could enter into a long-term Intergovernmental Agreement to purchase excess reclaimed water available at another other municipality or governmental entity within the Phoenix AMA and pay to have the water recharged. There are a number of ways that such an agreement could be structured, but it is anticipated that the resulting cost, on a per ac-ft basis would be roughly equal to the market cost for CAP water.

4.4.2 Obtain Additional Imported Surface Water

Obtaining additional surface water will allow groundwater pumping to be reduced and will have a one to one improvement in sustainability; that is for each ac-ft of imported surface water obtained, the safe yield shortfall will be reduced by an ac-ft. Additional surface water could be obtained from:

Future Re-Allocations of CAP Resources. The CAP's 1.5 maf of Colorado River water is divided among a variety of M&I, Indian and Agricultural subcontractors and since operations began in 1985 there have been several adjustments or re-allocations of the 1.5 maf total. Goodyear may receive additional allocations in the future as ongoing litigation is settled and subcontracts are adjusted. The cost to Goodyear would be the same as current CAP capital and O&M costs.

99-year Lease of CAP Resources from an Indian Community. Roughly one third of the Colorado River Water delivered by the CAP is allocated to Indian Nations located in Arizona. In some instances, Indian communities have chosen to lease portions of their allocation to M&I subcontractors. Leases can be written for up to 99 years. The cost to Goodyear would be the same as current CAP capital and O&M costs.

Purchase Main Stem Colorado River Water Rights. Goodyear could purchase water rights from a private party with rights to water on the main stem of the Colorado River. The cost of the purchase would be negotiated at market value. Once obtained, the water would need to be wheeled to Goodyear, presumably through the CAP canal system under agreement with the CAWCD. To date, no agreements exist for wheeling non-CAP water through the CAP. It could be assumed that the wheeling cost would equal current Capital + O&M charges plus a nominal administrative fee.

4.4.3 Water Conservation

Conservation measures which reduce potable water demand will help to close the safe-yield gap but only if it is the exterior fraction of potable water use which is reduced. As can be seen from Figure 4-5, a 1.0 ac-ft reduction in exterior water use reduces groundwater pumping by 1.1 ac-ft, without reducing reclaimed water production or recharge. In contrast, a 1.0 ac-ft reduction in interior water use reduces groundwater pumping by 1.1 ac-ft, but at the same time reduces reclaimed water production and recharge by 1.0 ac-ft. As a result, even though water consumption is reduced, little headway is made on reaching sustainability, because in a closed loop system, it is the losses from the system that must be curbed, not the recycled streams.

Reducing exterior water uses could be accomplished through instituting appropriate municipal ordinances which would prohibit and/or limit certain landscaping practices such as turf and guide the community towards low water use landscaping and efficient irrigation systems. Exterior water use is projected to reach 55,348 af/yr at buildout by extension of current per dwelling unit rates. A one third reduction in outdoor water uses would result in a 18,449 ac-ft reduction in potable demand and a 20,499 af/yr reduction in pumped groundwater.

Conservation will not only play an important role in helping the City to meet ADWR's Safe-Yield requirements but can also translate into significant savings in both Capital Investment and annual O&M costs. The ADWR in their third management plan established the following goals for residential interior and exterior water use:

- Single family and multifamily interior use of 57 gpcd
- Exterior water use for single family residential development of 189 GPHUD
- Exterior water use for multifamily housing unit of 77 GPHUD

Historical residential per-capita water use in Goodyear was calculated based on residential metered sales and population data and is shown in Table 4-7.

Table 4-7. Residential Per-Capita Water Use

Year	Population[1,2]	Avg. Day Residential Sales (mgd)	Residential Per-Capita Use (gpcd)	Avg. Day Non-Residential Sales (mgd)	Avg. Day Non-Residential Sales (gpcd)	Combined Sales (gpcd)	ADWR Third Management Plan Goal (Combined gpcd)
2001	15,746	1.46	93.00	1.48	93.76	186.76	274
2002	18,433	1.79	97.17	1.45	78.66	175.83	253
2003	20,900	2.17	103.80	1.63	78.01	181.81	253
2004	24,709	2.77	112.10	1.76	71.23	183.33	253
2005	28,456	3.11	109.20	2.59	91.18	200.38	235
Average			**103.05**			**185.62**	

Notes:
1. Only includes WPA2-WPA5 since WPA1 is served by others.
2. GIS Census block analysis indicates that 69% of the total population is located within WPA2-WPA5.

As shown in Table 4-7, Goodyear's *combined sales* gpcd unit rate has been consistently below the Arizona Department of Water Resources (ADWR) Third Management Plan goals for water conservation for the years listed. Currently at 200 gpcd (in 2005) it also complies with the long-

term goal of 217 gpcd set by ADWR for combined residential and non-residential demand. However, it is worth noting that the raw gpcd increased by 25 gpcd between 2002 and 2006 and the percentage of the ADWR goal has been steadily rising from 68% to 85% of the ADWR goal.

The single-family residential GPCD in the City at present is 113 GPCD, that puts the City ahead of many Western cities as shown in Table 4-8

Table 4-8. Comparison of Single-Family Residential Water Usage

Selected Western Cities	Single Family Residential (gpcd)
Albuquerque, New Mexico	95
City of Goodyear	113
El Paso, Texas	114
Tucson, Arizona	120
Mesa, Arizona	123
Glendale, Arizona	131
Tempe, Arizona	140
Phoenix, Arizona	165
Scottsdale, Arizona	169
Las Vegas, Nevada	230
Sacramento, California	242

4.4.4 Reduce Waste Brine

At buildout, the majority of the City's potable supply will come from treated groundwater and the waste brine rejected from this process projected to reach 11,300 af/yr. A 1.0 ac-ft reduction in the quantity of waste brine produces an equal saving in pumped groundwater and in closing the safe-yield gap. Methods by which the quantity of waste brine can be reduced include:

Improved Permeate Recovery. An 85 percent permeate recovery and 15 percent reject rate was assumed when treating the 2,000 to 3,000 ppm TDS brackish groundwater in the WSRV and Rainbow Valley aquifers. Through the application of improved technology and careful process operation, the City should be able to improve permeate recovery rates. The IWMP is structured around using fewer and larger centralized groundwater WTPs (instead of many individual well-head facilities) in order to improve the likelihood that state-of-the-art processes can be employed along with skilled operator attention.

Improved Groundwater Quality. The recharge and recovery well-fields in the Rainbow Valley have been configured and planned so as to produce an improvement in groundwater quality over time. Through steady recharge of reclaimed water with a TDS of roughly 600 ppm TDS, it is hoped that the 2,000 to 3,000 ppm TDS of the groundwater will be gradually

improved, allowing a higher percent age of the raw groundwater to bypass the RO process and producing significantly less brine overall.

A 50 percent reduction in waste brine would close the safe-yield gap by roughly 6,000 af/yr and while this is less than 10 percent of the credits needed, it would represent a very large savings in brine disposal costs, reaching into thousands of acres of land and many millions of dollars saved. Because of the multiple benefits, the City should continue to explore and implement all avenues to brine reduction which are found to be feasible.

4.4.5 Reduce Reclaimed Water Reuse

Contrary to the general assumption, reducing rather than increasing reclaimed water reuse will help to close the safe-yield gap and help the City achieve a sustainable resource position. A 1.0 af/yr reduction in reclaimed water reuse directly translates into a 1.0 af/yr increase in recharge which closes the safe yield gap by the same amount.

Furthermore, switching water use from potable water to reclaimed water does not "save" water or close the recharge gap either. As mentioned before, in an integrated system such as is planned for Goodyear, the consumptive losses must be reduced and the recycled fraction must be increased in order to improve sustainability.

Given that 30,600 af/yr are projected for reclaimed water reuse at buildout, a one-third reduction in the projected acreage turf, lakes and landscaping would produce a 10,200 increase in reclaimed water available for recharge and help to close the safe yield gap.

4.4.6 Pumping from Buckeye Waterlogged Area

The western portion of the WSRV, along the Gila River have been declared to be a "waterlogged" area by ADWR and water pumped from a waterlogged area is free from safe-yield recharge obligations. Therefore, each ac-ft of WSRV water that is pumped from the waterlogged area, closes the safe-yield gap by one ac-ft. It is not known at this point, how much of the 61,600 af/yr that Goodyear is to pump from the WSRV can be withdrawn from the Buckeye Waterlogged area. Nor is it known if it would be able to retain its water-logged status should pumping result in a significant decrease in water levels.

For the purposes of this IWMP, it is assumed that pumping from the waterlogged area would not produce reliable long term benefits but could prove beneficial over the interim years at lower initial pumping levels. It is recommended that further hydro-geologic investigations be made to see if longer-term benefits can be obtained by pumping from the Buckeye waterlogged area.

SECTION 5

WATER SYSTEM ANALYSIS AND CAPITAL IMPROVEMENT RECOMMENDATIONS

5.1 INTRODUCTION

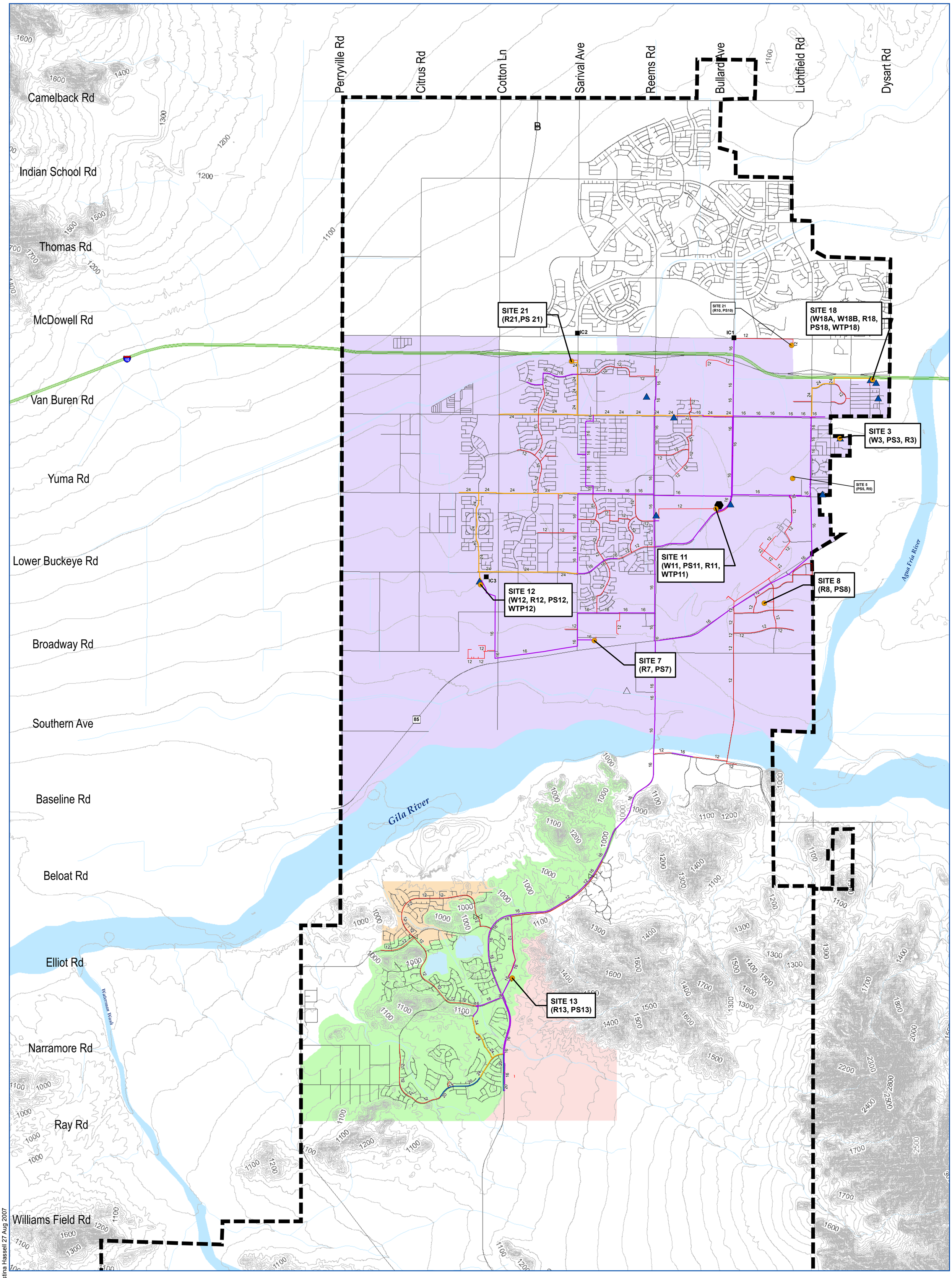
The City of Goodyear potable water system currently provides 7 mgd AAD to customers within WPA2 and WPA3. At build-out of the City's water service area, the service area will expand to cover WPA2 through WPA5 and the AAD will grow to 92 mgd. This section of the IWMP will develop the recommended potable water infrastructure; addressing the following items:

- Existing Water System Infrastructure.
- Water Quality
- Water Production Plan
- Hydraulic Model Construction.
- Distribution System Analysis and Recommended Infrastructure
- Water Production Analysis and Recommended Infrastructure

5.2 EXISTING WATER SYSTEM INFRASTRUCTURE

As part of the IWMP, Black & Veatch prepared a Facility Inventory (TM1-1) which provides a comprehensive inventory of the City's water distribution system. The components of the distribution system are summarized below and additional details of each facility; including schematics, operational diagrams, performance parameters, etc., are included in TM1-1. The Facility Inventory provides a valuable source of information for the hydraulic modeler as well as for the City's operations and engineering personnel. The existing water infrastructure, which is shown on Figure 5-1, represents the configuration of 2007 Base Year Model. The existing water infrastructure is described in the following sections;

- Distribution System
- Groundwater Wells
- Reservoirs
- Booster Stations
- IGA Connections



N
W E
S

1 inch equals 3,000 feet

Legend

- Pressure Reducing Valve (PRV)
- Reservoir/Booster Facility
- Inter-Agency Connection
- Well - Abandoned
- Well - Operational
- Water Treatment Plant

Water Mains

- 12"
- 16"
- 18"
- 20"
- 24"
- 36"

Existing Pressure Zones

- Central Planning Area
- Zone 1 Reduced
- Zone 1 South
- Zone 2 South

- Master Plan Study Area
- City Limits
- Stream
- Interstate
- Street

Data Sources:
City of Goodyear GIS
ESRI

Figure 5-1
Existing Facilities
Water Distribution System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

BLACK & VEATCH
building a world of difference™
ENERGY WATER INFORMATION GOVERNMENT

Revised: Tuesday, March 25, 2008

\\Projects\GoodYear\11GIS\01MapDocuments\ExistingWater.mxd Christina Hassell 27 Aug 2007

5.2.1 Distribution System

The existing distribution system can be seen in Figure 5-1 and is currently divided into three pressure zones. The City currently operates the distribution system in WPA2, which is the Central Planning Area, as one zone. It has a nominal hydraulic grade of 1140 feet although the settings for the various pumps and wells vary. Water is conveyed southward from WPA2, across the Gila River via a 16-inch distribution pipe where it fills the Site 13 Reservoir and supplies WPA3. It is then re-pumped to serve Zone 1 South and Zone 2 South (in WPA3) at hydraulic grades of 1175 and 1265 respectively. A reduced pressure zone is located within the existing Zone 1 South. The 16-inch supply line to WPA3 has a nominal 3 mgd capacity. Maximum day demand within WPA3 has reached 3.0 mgd, requiring that additional production capacity be brought on-line in WPA-3.

5.2.2 Groundwater Wells

The City of Goodyear is currently served entirely by groundwater with the exception of supplemental water supplied from LPSCO. Information for the existing wells that are currently operational is summarized in Table 5-1. All of the City's wells are located within WPA2 and it can be seen that treatment is required at all of the wells with the exception of W3 connected to Site 3.

Table 5-1. Existing Distribution System Wells

ID #	Point of Connection	Water Quality		Operating Capacity (mgd)
		Treatment Required	***Contaminant***	
W1	Site 11	Blended	Nitrate	0.7
W3	Site 3	None	--	0.8
W6	Site 18	Blended	Nitrate	0.7
W11	Site 11	Blended	--	1.2
W12B	Site 12	RO Treatment	High Temp/TDS/Flour/Ars	1.2
W18A	Site 18	Blended	Nitrate	1.4
W18B	Site 18	Arsenic Treatment	Arsenic	0.7
W19	Site 11	RO Treatment	Nitrate	1.7
W20	Site 11	Blended	Nitrate	1.7
W22	Site 11	RO Treatment	Nitrate	2.6
Total				**12.7**

Base-Year MDD is 12.0 mgd, and it can be seen that it is currently necessary operate all of the City's wells on a max day and water available from LPSCO through the system inter-connection provides standby capacity. Development of the first phase of the Adaman Well Field in the north and groundwater production/treatment facilities in the Southern Planning Area which are currently underway will provide the City with increased production capacity needed to accommodate growth and provide a continued margin of safety on future high demand days.

5.2.3 Reservoirs

The City of Goodyear operates ten finished water distribution system storage reservoirs providing a total storage capacity of 11 million gallons. Existing storage reservoirs are summarized in Table 5-2. All reservoirs operate as ground-level storage with booster pumps which pump to distribution hydraulic grade.

Table 5-2. Existing Finished Water Storage Reservoirs

ID #	Facility Location	Storage Volume (MG)
R3	Site 3	0.18
R5	Site 5	0.18
R7	Site 7	0.75
R8	Site 8	0.75
R10	Site 10	0.75
R11	Bullard Ave/Site 11	2.00
R12	Site 12	2.00
R13	Site 13	1.50
R18	Site 18	1.00
R21	Site 21	2.00
Total		**11.1**

Site 13, with 1.5 MG of volume, is currently the only storage reservoir south of the Gila River in WPA-3. However the 5 MG Rainbow Valley Reservoir is currently under construction and will augment WPA-3 storage.

5.2.4 Pump Stations

The City operates ten pump stations to provide system pressure. All pump stations are located at reservoir sites and pump directly from the reservoir into the distribution system. Existing pump stations are summarized in Table 5-3.

Table 5-3. Existing Pump Stations			
ID #	**Facility Location**	**Installed Capacity (mgd)**	**Firm Capacity (mgd)**
PS3	Site 3	1.4	0.7
PS5	Site 5	1.4	0.7
PS7	Site 7	2.2	1.4
PS8	Site 8	1.4	0.7
PS10	Site 10	1.4	0.7
PS11	Bullard Ave/Site 11	8.4	4.8
PS12	Site 12	3.6	1.4
PS13	Site 13	8.4	6.6
PS18	Site 18	2.9	1.4
PS21	Site 21	9.6	7.5
Totals		**40.7**	**25.9**

Site 13, with 6.6 mgd of firm pumping capacity, is currently the only booster station south of the Gila River in WPA-3. However the Rainbow Valley Reservoir/Booster Facility is currently under construction and will augment WPA-3 pumping capacity.

5.2.5 Interconnections

The City has an agreement with LPSCO to receive up to 3.0 mgd of interruptible service. However, due to current hydraulic limitations on the City's part, only 2.5 mgd can be obtained from the two interconnections. The locations and the capacity of the LPSCO interconnections are summarized in Table 5-4.

Table 5-4. Goodyear - LPSCO Interconnections		
ID #	**Point of Connection/Entry**	**Capacity (mgd)**
IC1	Bullard & McDowell / Site 10	1.3
IC2	Sarival & McDowell / Site 21	1.7

5.3 WATER QUALITY

5.3.1 Water Quality Parameters

Providing high quality water is an increasingly complex challenge which all utilities face. Key water quality issues analyzed within the IWMP are the result of:

- Ever more strict regulatory standards in the Federal Safe Drinking Water Act.
- Higher consumer expectations with regard to tap water quality.
- Decreasing quality within surface water and groundwater resources.

In order to meet future demands, the City's groundwater and surface water production capacity must be increased significantly. Key parameters of concern associated with the utilization of Goodyear's groundwater and surface water resources are provided in Table 5-5 and a description of the Safe Drinking Water Act (SDWA) regulatory limit follows.

Table 5-5: SDWA Regulatory Limits

Regulated Parameter	Maximum Contaminant Level (MCL)
TDS[1]	500 ppm
Nitrate	10 ppm
Arsenic	10 ppb
Fluoride	4.0 ppm
TCE	0.005 ppm
TTHM	80 ppb
HAA5	60 ppb

1. Secondary SDWS, no Primary SDWS is set for TDS.

Total Dissolved Solids (TDS). Total Dissolved Solids (TDS) are the total of salts dissolved in water, made up of anions such as bicarbonates and carbonates, chlorides, sulfates, and silica, and cations such as sodium, calcium, and magnesium. TDS originate in natural geologic formations and are concentrated in processes such as irrigation return and field run-off, water reclamation, and membrane technologies. USEPA does not regulate TDS as a primary contaminant in drinking water, but non-enforceable guidelines recommend a secondary standard of $\leq$ 500 mg/L for aesthetic effects.

Nitrate and Arsenic. Decades of agriculture and its use of chemical fertilizers has lead to high levels of nitrate in aquifers throughout much of Maricopa County. Arsenic, a naturally occurring mineral in the valley's groundwater will also become more of an issue beginning in

2006 when the maximum allowable contaminant level decreases from 50 parts per billion (ppb) to 10 ppb. Several City wells are currently at or over the future 10 ppb limit.

Tri-chloroethylene (TCE). Tri-chloroethylene is an organic solvent commonly used by the aero-space industries. A plume of TCE contamination, found in the eastern portion of WPA2, is classified as an EPA Superfund Site. Efforts to contain the plume and remediate the site consist of pumping the contaminated groundwater, removing the TCE by air-stripping and then discharging the treated water to the sewer.

TTHM and HAA5. Tri-halogenated methane (TTHM) and halo-acetic acids (HAA5) are disinfection by-products which form from the reaction of trace levels of organics found in surface waters with chlorine, which is used for disinfection. Compliance with SDWA limits for TTHM and HAA5 will need to be achieved when Goodyear begins utilizing their CAP surface water resources.

5.3.2 Groundwater Quality and Treatment Technology

Historically, the City of Goodyear had been able to pump and utilize groundwater directly for potable supply purposes without treatment other than chlorination. However, tightening water quality regulations and steadily declining groundwater quality has lead to the need to treat virtually all groundwater supplied in order to comply with SDWA standards. A brief overview of groundwater quality follows. A detailed discussion can be found in TM1-3 and in the Groundwater Flow Model Report, Burgess & Niple, November 2007.

WPA2 Groundwater. Of the 17 municipal wells located in WPA2, 7 have been de-activated due to the presence of contaminants. Of the 10 active wells, only one currently meets drinking water standards and treatment is required at the other nine wells in order to comply with drinking water standards. As shown in Table 5-1, the contaminants found in WPA2 groundwater includes: TDS, nitrate, arsenic and fluoride. A Federal EPA Superfund Site also exists within WPA2 as a result of TCE and perchlorate contamination; however no potable system wells are active in this area. Based on the historic record and trends observed, it was assumed in the IWMP that all water pumped within WPA2 will require treatment.

Southern Planning Area Groundwater. The City does not have any municipal supply wells currently active in the Southern Planning Area comprised of WPA3, WPA4 and WPA5. However the general quality of groundwater within the Rainbow Valley is well known from records associated with a long history of agricultural activity and a number of exploratory wells more recently drilled into the Rainbow Valley aquifer. The groundwater can be

generally characterized as brackish water with a TDS in the range of 1,000 to 4,000 ppm and with varying levels of nitrate, arsenic and fluoride which exceed the SDWA limit at many locations. Without exception, every well in the record analyzed shows that one or more of the following parameters exceeds SDWA standards; TDS, nitrate, arsenic and/or fluoride. Based on the historic record and trends observed, it was assumed in the IWMP that all water pumped from the Rainbow Valley aquifer in the Southern Planning Area will require treatment.

Adaman Mutual Groundwater. The City provided Black & Veatch with records of water quality from three wells within the Adaman Mutual service area. Two of these wells were found to exceed allowable nitrate levels and one exceeded allowable arsenic levels. Based on this historic record and trends observed in the Salt River Valley, it was assumed that all water pumped from Adaman Mutual wells will require treatment.

Based on the available water quality record and trends observed, it was assumed in the IWMP that all groundwater will require treatment in order to meet SDWA standards. In order to configure supply, treatment and distribution infrastructure and develop planning level cost estimates, it was assumed that the following treatment technologies would be utilized. A more detailed analysis at the preliminary design stage may result in the alternative recommendations, however the following are effective and commonly applied technologies and are valid assumptions at the master planning level.

Reverse Osmosis. Reverse osmosis (RO) utilizes selectively permeable membranes which permit purified water to pass under pressure but which retain virtually all dissolved minerals and organics in a concentrated brine. RO treatment is a proven technology which effectively reduces TDS levels to well below the 500 ppm secondary limit and also removes nitrate and arsenic in the process. For planning purposes, it can be assumed that roughly 85 percent of the raw water will be recovered as low TDS permeate whereas 15 percent will be rejected as waste brine. It is assumed that RO treatment will be utilized for the treatment of high TDS groundwater, especially where nitrate and/or arsenic may also require treatment.

Ion Exchange. Ion exchange treatment involves the use of resins which adsorb ions such as nitrate and arsenic from the water being treated. There are a variety of resins available and they are chosen based on their selectivity for the target ion(s). When the adsorptive capacity of the resin is reached, it is regenerated with a high strength sodium chloride brine solution and the waste brine, laden with nitrate and/or arsenic must then be disposed of. For low TDS wells, where the contaminant is nitrate or nitrate and arsenic, it is assumed that the ion-

exchange process would be utilized as it requires less energy and produces less brine waste than does the RO process. Ion exchange would not be utilized for the treatment of high TDS groundwater as it does not reduce TDS. Nor would it be recommended if the only contaminant were arsenic as there are more efficient processes for arsenic alone.

Coagulation-Filtration. Arsenic can be effectively removed from solution through the use of the coagulation-filtration (CF) process. In this case iron salts such as ferric or ferrous chloride are utilized to precipitate arsenic from solution and the coagulated iron salt with the precipitated arsenic is settled and filtered from the treated water. The settled coagulant and filter backwash can normally be discharged to the sewer, or concentrated and hauled to a landfill. For wells where the only contaminant is arsenic, it is assumed that the CF process would be utilized as it requires less energy than RO and it does not produce a brine waste. The CF process would not be utilized for the treatment of high TDS groundwater or where nitrate is present as it does not lower TDS levels or remove nitrate.

Blending. In certain cases, the cost of treatment can be avoided or reduced by blending contaminated groundwater with another source of higher quality water. In Goodyear's case, groundwater with high nitrate or arsenic levels could be blended with treated CAP surface water which has low levels of nitrate and arsenic. Blending with CAP water would not be utilized as a method to lower groundwater TDS because CAP water exceeds the 500 ppm secondary MCL.

5.3.3 Surface Water Quality and Treatment Technology

The City's surface water resources consist of Colorado River water delivered by the CAP. There are a number of treatment processes which can effectively meet SDWA turbidity and disinfection standards and it is assumed that the selection will be made based upon a detailed study at the preliminary design stage.

The TDS of Colorado River water received through the CAP is in the 700 to 800 ppm range. And, while this exceeds the secondary MCL of 500 ppm, it is standard practice among central Arizona municipalities not to treat CAP water for TDS, but to supply it to customers at the 700 to 800 ppm range. This is because:

- TDS is a secondary MCL where 500 ppm is recommended but not required.
- Exceeding the standard by 50 percent is not severe.
- Adding reverse-osmosis would greatly increase treatment costs.

Compliance with the Stage II DBP Rule is another factor which much be considered when utilizing surface water supplies. There are many factors which affect the formation of DBPs, but the primary methods through which compliance with the new DBP standards can be realistically achieved include reducing the level of total organic carbon (TOC) in the influent raw water or by limiting water aging within the distribution system.

Total Organic Carbon (TOC). By reducing the level of organic carbon prior to the application of chlorine, the potential level of DBPs that will ultimately form can be kept below the MCL. Treatment with activated carbon is the process normally used to lower organic carbon levels.

Water Age. The reaction of chlorine with dissolved organics is not instantaneous and can require 5 days or more to run to completion. DBP levels can also be controlled by limiting water aging which occurs following the application of chlorine through proper design and operation of the distribution system.

The practical experience gained by municipalities which are already using CAP water indicate that both TOC levels and water age will need be controlled and maintained within reasonable levels and that it is not practical or cost effective to achieve compliance using either TOC control or water age control alone.

5.4 WATER PRODUCTION PLAN

Water Production Plans were developed providing a balance between the seasonal demands tabulated in Section 3 and resource constraints established in Section 4. The key parameters and criteria which were addressed include:

- Determine water production rates required for each month of the year and max day.
- Provide for full utilization of the annual CAP resource at a flat, base-rate without seasonal peaking.
- Determine production capacity required from alternate resources during a CAP Dry-up (in the month of November).
- Provide for full utilization of the Adaman Mutual resources at a flat, base-rate without seasonal peaking.

- Maintain groundwater utilization within the annual pumping limits established in the Groundwater Flow Model; utilizing 42,280 af/yr from WPA2 and 31,775 af/yr from WPA4/5 after setting aside 30,000 ac-ft for Sonoran Valley.
- Account for the portion of groundwater pumping from WPA2 and WPA4/5 which is lost each year as rejected brine.

Table 5-6 (Base Year), Table 5-7 (2017), and Table 5-8 (Buildout), present the detailed water balance showing how each of the above conditions were met over the course of a year.

TABLE 5-6
WATER BALANCE SPREADSHEET (REV)
BASE YEAR (2007) NORMAL SUPPLY

	Annual Average af/yr	Annual Average mgd	**Jan (min month) Peaking Factor**	**Jan (min month) Flowrate (mgd)**	February Peaking Factor	February Flowrate (mgd)	March Peaking Factor	March Flowrate (mgd)	April Peaking Factor	April Flowrate (mgd)	May Peaking Factor	May Flowrate (mgd)	June Peaking Factor	June Flowrate (mgd)	**July (max month) Peaking Factor**	**July (max month) Flowrate (mgd)**	August Peaking Factor	August Flowrate (mgd)	September Peaking Factor	September Flowrate (mgd)	October Peaking Factor	October Flowrate (mgd)	November Peaking Factor	November Flowrate (mgd)	December Peaking Factor	December Flowrate (mgd)
DEMAND																										
WPA 2	5,630	5.0		**3.2**		3.2		3.6		4.6		5.6		6.4		**6.8**		6.5		6.1		5.5		4.7		4.0
WPA 3	2,068	1.8		**1.2**		1.2		1.3		1.7		2.1		2.4		**2.5**		2.4		2.2		2.0		1.7		1.5
WPA 4	224	0.2		**0.1**		0.1		0.1		0.2		0.2		0.3		**0.3**		0.3		0.2		0.2		0.2		0.2
WPA 5	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Total MP Demand =	**7,923**	**7**	**0.65**	**4.6**	0.65	4.6	0.72	5.1	0.91	6.4	1.11	7.9	1.28	9.1	**1.36**	**9.6**	1.30	9.2	1.21	8.6	1.09	7.7	0.94	6.6	0.79	5.6
MP Max Day Demand =				**5.7**		5.7		6.4		8.1		9.9		11.3		**12.0**		11.5		10.7		9.6		8.3		7.0
SUPPLY																										
Surface Water																										
CAP - White Tanks WTP	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Total Surface Water =	**0**	**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**
Groundwater (MP)																										
WPA 2 Pumped	7,933	7.1		**4.6**		4.6		5.1		6.4		7.9		9.1		**9.6**		9.2		8.6		7.7		6.6		5.6
WPA 2 Brine	793.3	0.7		**0.5**		0.5		0.5		0.6		0.8		0.9		**1.0**		0.9		0.9		0.8		0.7		0.6
Total WPA 2 Groundwater (MP)	**8,727**	**7.8**		**5.1**		**5.1**		**5.6**		**7.0**		**8.7**		**10.0**		**10.6**		**10.1**		**9.5**		**8.5**		**7.3**		**6.2**
WPA 4 / 5 Pumped	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
WPA 4 / 5 Brine	0.0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Total Rainbow Valley Pumping	**0**	**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**		**0.0**
LPSCO	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Adaman Mutual Water Co.	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Total Groundwater Water Pumped=	**8,727**	7.8		**5.1**		**5.1**		**5.6**		**7.0**		**8.7**		**10.0**		**10.6**		**10.1**		**9.5**		**8.5**		**7.3**		**6.2**
Total Groundwater Water Supplied=	**7,933**	**7.1**		**4.6**		**4.6**		**5.1**		**6.4**		**7.9**		**9.1**		**9.6**		**9.2**		**8.6**		**7.7**		**6.6**		**5.6**
Total Water Supplied (MP) =	**7,933**	**7.1**		**4.6**		**4.6**		**5.1**		**6.4**		**7.9**		**9.1**		**9.6**		**9.2**		**8.6**		**7.7**		**6.6**		**5.6**
HYDRAULIC TRANSFER (+ North & - South)	Annual Balance (ac-ft) -2,303		(ac-ft) -127	(mgd) -1.4	(ac-ft) -126	(mgd) -1.4	(ac-ft) -137	(mgd) -1.5	(ac-ft) -170	(mgd) -1.8	(ac-ft) -214	(mgd) -2.3	(ac-ft) -249	(mgd) -2.7	(ac-ft) -260	(mgd) -2.8	(ac-ft) -250	(mgd) -2.7	(ac-ft) -235	(mgd) -2.5	(ac-ft) -209	(mgd) -2.2	(ac-ft) -175	(mgd) -1.9	(ac-ft) -151	(mgd) -1.6

SUPPLY UTILIZATION

	Available	Production	Unused
CAP =	3,681	0	3,681
WPA 2 Wells =	47,238	8,727	38,511
WPA 4/5 Wells =	33,220	0	33,220
Adaman =	11,200	0	11,200
LPSCO =	3,360	0	3,360
Total =	**98,699**	**8,727**	**89,972**

PEAK DAY JULY

PRODUCTION (mgd)			DEMAND (mgd)	
CAP WTP =	0.0		8.5	WPA2
North Groundwater =	12.0		3.1	WPA3
South Groundwater =	0.0		0.3	WPA4
	12.0	**Total**	0.0	WPA5
			12.0	**Total**
Hydraulic Transfer =	**-3.5**			

PEAK DAY NOVEMBER (with CAP Dry-Up)

Not Needed for 2007

TABLE 5-7
WATER BALANCE SPREADSHEET (REV)
YEAR 2017 NORMAL SUPPLY

	Annual Average		**Jan (min month)**		February		March		April		May		June		**July (max month)**		August		September		October		November		December	
	af/yr	mgd	**Peaking Factor**	**Flowrate (mgd)**	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	**Peaking Factor**	**Flowrate (mgd)**	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)
DEMAND																										
WPA 2	18,133	16.2		**10.4**		10.5		11.7		14.8		18.0		20.7		**22.0**		21.0		19.6		17.6		15.2		12.8
WPA 3	10,311	9.2		**5.9**		5.9		6.7		8.4		10.3		11.8		**12.5**		11.9		11.1		10.0		8.6		7.3
WPA 4	12,702	11.3		**7.3**		7.3		8.2		10.3		12.6		14.5		**15.4**		14.7		13.7		12.3		10.7		9.0
WPA 5	1,712	1.5		**1.0**		1.0		1.1		1.4		1.7		2.0		**2.1**		2.0		1.8		1.7		1.4		1.2
Total MP Demand =	**42,857**	**38.3**	**0.65**	**24.7**	0.65	24.7	0.72	27.7	0.91	34.9	1.11	42.7	1.28	49.0	**1.36**	**51.9**	1.30	49.6	1.21	46.3	1.09	41.6	0.94	35.9	0.79	30.3
MP Max Day Demand =				**30.9**		30.9		34.6		43.6		53.3		61.2		**64.9**		62.0		57.9		52.0		44.9		37.9
SUPPLY																										
Surface Water																										
CAP - White Tanks WTP	16,803	15.0	**1.00**	**15.0**	1.00	15.0	1.00	15.0	1.00	15.0	1.00	15.0	1.00	15.0	**1.00**	**15.0**	1.00	15.0	1.00	15.0	1.00	15.0	1.00	15.0	1.00	15.0
Total Surface Water =	**16,803**	**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**		**15.0**
Groundwater (MP)																										
WPA 2 Pumped	9,455	8.4		**0.5**		0.5		2.0		6.0		14.1		15.0		**15.0**		15.0		12.8		10.0		7.1		3.3
WPA 2 Brine	945.5	0.8		**0.1**		0.1		0.2		0.6		1.4		1.5		**1.5**		1.5		1.3		1.0		0.7		0.3
Total WPA 2 Groundwater (MP)	**10,400**	**9.3**		**0.6**		**0.6**		**2.2**		**6.6**		**15.5**		**16.5**		**16.5**		**16.5**		**14.1**		**11.0**		**7.8**		**3.6**
WPA 4 / 5 Pumped	6,823	6.1		**0.0**		0.0		1.6		5.0		5.0		10.6		**13.6**		11.3		10.0		8.0		5.0		3.0
WPA 4 / 5 Brine	682.3	0.6		**0.0**		0.0		0.2		0.5		0.5		1.1		**1.4**		1.1		1.0		0.8		0.5		0.3
Total Rainbow Valley Pumping	**7,505**	**6.7**		**0.0**		**0.0**		**1.8**		**5.5**		**5.5**		**11.7**		**15.0**		**12.4**		**11.0**		**8.8**		**5.5**		**3.3**
LPSCO	0	0.0		**0.0**		0.0		0.0		0.0		0.0		0.0		**0.0**		0.0		0.0		0.0		0.0		0.0
Adaman Mutual Water Co.	11,200	10.0		**10.0**		10.0		10.0		10.0		10.0		10.0		**10.0**		10.0		10.0		10.0		10.0		10.0
Total Groundwater Water Pumped=	**29,105**	26.0		**10.6**		**10.6**		**14.0**		**22.1**		**31.0**		**38.2**		**41.5**		**38.9**		**35.1**		**29.8**		**23.3**		**16.9**
Total Groundwater Water Supplied=	**27,477**	**24.5**		**10.5**		**10.5**		**13.6**		**21.0**		**29.1**		**35.6**		**38.6**		**36.3**		**32.8**		**28.0**		**22.1**		**16.3**
Total Water Supplied (MP) =	**44,281**	**39.5**		**25.5**		**25.5**		**28.6**		**36.0**		**44.1**		**50.6**		**53.6**		**51.3**		**47.8**		**43.0**		**37.1**		**31.3**
HYDRAULIC TRANSFER (+ North & - South)	Annual Balance (ac-ft) -19,326		(ac-ft) -1,405	(mgd) -15.1	(ac-ft) -1,405	(mgd) -15.0	(ac-ft) -1,428	(mgd) -15.3	(ac-ft) -1,516	(mgd) -16.2	(ac-ft) -1,965	(mgd) -21.1	(ac-ft) -1,799	(mgd) -19.3	(ac-ft) -1,685	(mgd) -18.0	(ac-ft) -1,774	(mgd) -19.0	(ac-ft) -1,700	(mgd) -18.2	(ac-ft) -1,625	(mgd) -17.4	(ac-ft) -1,577	(mgd) -16.9	(ac-ft) -1,446	(mgd) -15.5

SUPPLY UTILIZATION

	Available	Production	Unused
CAP =	19,706	16,803	2,903
WPA 2 Wells =	47,238	10,400	36,838
WPA 4/5 Wells =	33,220	7,505	25,715
Adaman =	11,200	11,200	0
LPSCO =	3,360	0	3,360
Total =	**114,724**	**45,908**	**68,815**

PEAK DAY JULY

PRODUCTION (mgd)			DEMAND (mgd)	
CAP WTP =	15.0		27.4	WPA2
North Groundwater =	37.0		15.6	WPA3
South Groundwater =	15.0		19.2	WPA4
	67.0	**Total**	2.6	WPA5
			64.9	**Total**
Hydraulic Transfer =	**-24.6**			

PEAK DAY NOVEMBER (with CAP Dry-Up)

PRODUCTION (mgd)		DEMAND (mgd)	
CAP WTP =	0.00	19.0	WPA2
North Groundwater =	29.92	10.8	WPA3
South Groundwater =	15.00	13.3	WPA4
Total	**44.9**	1.8	WPA5
		44.9	**Total**
Hydraulic Transfer =	**-10.9**		

TABLE 5-8
WATER BALANCE SPREADSHEET (REV)
BUILDOUT YEAR (2045) NORMAL SUPPLY

	Annual Average		**Jan (min month)**		February		March		April		May		June		**July (max month)**		August		September		October		November		December	
	af/yr	mgd	**Peaking Factor**	**Flowrate (mgd)**	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	**Peaking Factor**	**Flowrate (mgd)**	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)
DEMAND																										
WPA 2	33,274	29.7		**19.2**		19.2		21.5		27.1		33.1		38.0		**40.3**		38.5		35.9		32.3		27.9		23.5
WPA 3	17,030	15.2		**9.8**		9.8		11.0		13.9		16.9		19.5		**20.6**		19.7		18.4		16.5		14.3		12.0
WPA 4	46,256	41.3		**26.7**		26.7		29.9		37.7		46.0		52.9		**56.0**		53.6		50.0		44.9		38.8		32.7
WPA 5	6,724	6.0		**3.9**		3.9		4.3		5.5		6.7		7.7		**8.1**		7.8		7.3		6.5		5.6		4.8
Total MP Demand =	**103,284**	**92.2**	**0.65**	**59.5**	0.65	59.5	0.72	66.7	0.91	84.1	1.11	102.8	1.28	118.1	**1.36**	**125.1**	1.30	119.6	1.21	111.6	1.09	100.2	0.94	86.6	0.79	73.0
MP Max Day Demand =				**74.4**		74.4		83.3		105.1		128.5		147.6		**156.3**		149.5		139.4		125.2		108.2		91.2
SUPPLY																										
Surface Water																										
CAP - White Tanks WTP	19,604	17.5	**1.00**	**17.5**	1.00	17.5	1.00	17.5	1.00	17.5	1.00	17.5	1.00	17.5	**1.00**	**17.5**	1.00	17.5	1.00	17.5	1.00	17.5	1.00	17.5	1.00	17.5
Total Surface Water =	**19,604**	**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**		**17.5**
Groundwater (MP)																										
WPA 2 Pumped	40,255	35.9		**19.0**		19.0		25.0		30.0		40.0		45.0		**50.0**		50.0		46.1		44.7		35.0		27.5
WPA 2 Brine	4,025.5	3.6		**1.9**		1.9		2.5		3.0		4.0		4.5		**5.0**		5.0		4.6		4.5		3.5		2.8
Total WPA 2 Groundwater (MP)	**44,280**	**39.5**		**20.9**		**20.9**		**27.5**		**33.0**		**44.0**		**49.5**		**55.0**		**55.0**		**50.7**		**49.2**		**38.5**		**30.3**
WPA 4 / 5 Pumped	28,887	25.8		**10.0**		10.0		11.2		23.6		32.3		42.6		**44.6**		39.1		35.0		25.0		21.1		15.0
WPA 4 / 5 Brine	2,888.7	2.6		**1.0**		1.0		1.1		2.4		3.2		4.3		**4.5**		3.9		3.5		2.5		2.1		1.5
Total Rainbow Valley Pumping	**31,775**	**28.4**		**11.0**		**11.0**		**12.3**		**26.0**		**35.5**		**46.9**		**49.1**		**43.0**		**38.5**		**27.5**		**23.2**		**16.5**
LPSCO	3,360	3.0		**3.0**		3.0		3.0		3.0		3.0		3.0		**3.0**		3.0		3.0		3.0		3.0		3.0
Adaman Mutual Water Co.	11,200	10.0		**10.0**		10.0		10.0		10.0		10.0		10.0		**10.0**		10.0		10.0		10.0		10.0		10.0
Total Groundwater Water Pumped=	**90,615**	80.9		**44.9**		**44.9**		**52.8**		**72.0**		**92.5**		**109.4**		**117.1**		**111.0**		**102.2**		**89.7**		**74.7**		**59.8**
Total Groundwater Water Supplied=	**83,701**	**74.7**		**42.0**		**42.0**		**49.2**		**66.6**		**85.3**		**100.6**		**107.6**		**102.1**		**94.1**		**82.7**		**69.1**		**55.5**
Total Water Supplied (MP) =	**103,305**	**92.2**		**59.5**		**59.5**		**66.7**		**84.1**		**102.8**		**118.1**		**125.1**		**119.6**		**111.6**		**100.2**		**86.6**		**73.0**
HYDRAULIC TRANSFER	Annual Balance (ac-ft)		(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)	(ac-ft)	(mgd)
(+ North & - South)	-41,149		-2,831	-30.3	-2,830	-30.3	-3,176	-34.0	-3,119	-33.4	-3,490	-37.4	-3,497	-37.5	-3,754	-40.2	-3,918	-42.0	-3,796	-40.7	-4,007	-42.9	-3,510	-37.6	-3,219	-34.5

SUPPLY UTILIZATION

	Available	Production	Unused
CAP =	19,706	19,604	102
WPA 2 Wells =	47,238	44,280	2,958
WPA 4/5 Wells =	33,220	31,775	1,445
Adaman =	11,200	11,200	0
LPSCO =	3,360	3,360	0
Total =	**114,724**	**110,219**	**4,504**

PEAK DAY JULY

PRODUCTION (mgd)			DEMAND (mgd)	
CAP WTP =	17.5		50.4	WPA2
North Groundwater =	89.0		25.8	WPA3
South Groundwater =	50.0		70.0	WPA4
	156.5	**Total**	10.2	WPA5
			156.3	**Total**
Hydraulic Transfer =	**-56.1**			

PEAK DAY NOVEMBER (with CAP Dry-Up)

PRODUCTION (mgd)		DEMAND (mgd)	
CAP WTP =	0.00	34.9	WPA2
North Groundwater =	63.3	17.8	WPA3
South Groundwater =	45.00	48.5	WPA4
Total	**108.3**	7.0	WPA5
		108.3	**Total**
Hydraulic Transfer =	**-28.4**		

Table 5-9. Buildout Water Production Summary				
Source	Annual Average Production (mgd)	Maximum Day Production (mgd)	CAP Outage Production (mgd)	Resource Peaking (factor)
CAP	17.5	17.5	0	1.00
Adaman Mutual	10.0	10	10	1.00
LPSCO	3.0	3.0	0	1.00
WPA2 Groundwater	35.9	76	53.3	2.12
WPA 4/5 Groundwater	25.8	50	45	1.94
Total Demand / Production	**92.2**	**157.5**	**108.3**	**1.70**
Hydraulic Transfer	**36.7**	**56.1**	**28.4**	

From the Water Production Plans above a summary can be made of annual average and maximum day production requirements and the following operational characteristics can be seen:

- Imported Resources; CAP, Adaman Mutual and LPSCO, are utilized at a steady annual average rate without peaking.
- Groundwater Resources; located in WPA2 and WPA4/5 carry all of the seasonal peaking, reaching summer production levels that are roughly 200 percent of the annual average.
- Groundwater peaking at roughly 2 times the annual average exceeds the overall MDD peaking factor of 1.70 AAD.
- On average 36.7 mgd of treated water will be sent from WPA2, into the Southern Planning Area. On a max day 56.1 mgd will be pumped across the Gila River for the Southern Planning Area.

5.5 HYDRAULIC MODEL CONSTRUCTION AND DEMAND ALLOCATION

The goal of the modeling process was to create hydraulic models which accurately represent the City's distribution and transmission systems and which will be used as the analytical engine for the master planning process. Key features of the modeling process included:

- Update the City's existing H2OMAP model to reflect current conditions.
- Current demand allocation based on metered sales records.
- Construct a build-out model supporting buildout service projections.
- Future demand allocation based upon the City's Land Use Plan.

A separate Water Transmission Model was also constructed to analyze the transmission of water from production sources (WTPs and GWTPs) to the distribution system reservoirs. The design and function of this model is discussed in more detail in the Water Transmission System section of the IWMP. The following section provides a brief overview of the distribution system model construction and demand allocation process. Detailed information on the model construction process is provided in Technical Memorandum 1-5.

5.5.1 Distribution Model Construction

Black & Veatch made use of the City's existing hydraulic model constructed and calibrated in an MWHSOFT H2OMAP Water format, using H2OMAP GIS Suite 7.0. The model was reviewed and updated for this IWMP to reflect the current conditions in the City. The buildout model was created from the base year model by incorporating the additional facilities and expanding the pipe network as needed to serve buildout conditions. The distribution system model addressed the following distribution system elements:

- Reservoirs and Booster Pump Stations
- Pressure Zones
- Pressure Reducing Valves (PRV)
- Distribution Pipe Network

Three models were constructed, a Base Year (2007), Intermediate Year (2017) and Buildout (2045).

5.5.2 Pressure Zones

In order to provide for acceptable system pressures across the existing and expanded buildout service area for the city of Goodyear, five pressure zones were established. The City's goals are to provide customer service within the following limits.

Minimum Pressure is not to drop below 40 psi at peak hour. In order to achieve this, the pressure zones were set-up so as to provide a minimum static pressure of 50 psi. Then, through hydraulic modeling, the distribution system was designed and pipelines sized so that peak-hour friction losses would not exceed 10 psi, thereby meeting the City's minimum service pressure goal of 40 psi.

Maximum Pressure within the service area is not to exceed 80 psi. The span from 50 psi to 80 psi is equal to 69 feet of water, allowing 69 feet of elevation to be covered from the lower boundary of a pressure zone to the top boundary. However in order to avoid the complexity of too many pressure zones or small pockets served by another pressure zone, this elevation range was stretched to 100 feet resulting in pressures along the lower boundary reaching 93 psi. Residential customers in those areas will install individual pressure reducing valves at the service connections to trim the pressure at the residence to 80 psi or less.

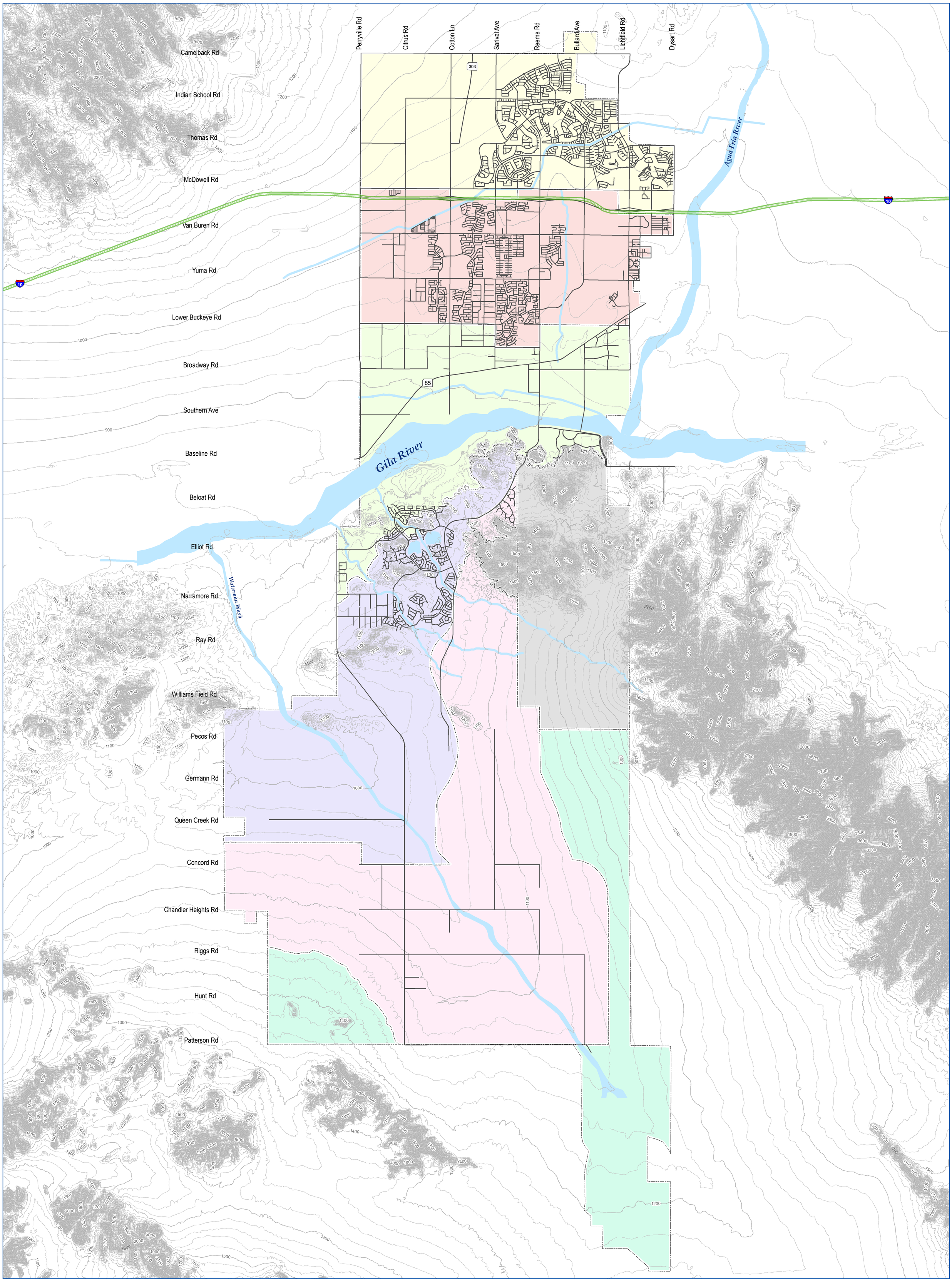
The above service pressure goals were accommodated with pressure zones designed as shown on Figure 5-2 and summarized in Table 5-10.

Table 5-10. Recommended Pressure Zones

ZONE	STATIC HYDRAULIC GRADIENT (ft)	SERVICE ELEVATION RANGE (ft)	STATIC PRESSURE RANGE (psi)
Gila Zone	1,100	890 – 950	65 – 91
Zone 1	1,165	950 – 1050	50 – 93
Zone 2 (Previously Zone 1 South)	1,175	950 – 1050	54 – 98
Zone 3 (Previously Zone 2 South)	1,265	1050 – 1150	50 – 93
Zone 4	1,365	1150 – 1250	50 – 93

Where possible, and without stretching the elevation limits more than +/- 10 feet (+/- 4 psi), the zone boundaries were constrained to follow major roadways or other features which would facilitate the transition from the piping of one zone to the piping of the next. Where roadways or other suitable features have not yet been planned and identified, the zone boundaries simply follow the appropriate contour line. It is anticipated that the zone boundaries will be refined in these areas in the future as roadway and development patterns become established.

To assist with the sizing and design of distribution system infrastructure, the projected demands developed in Section 3 were distributed over the 5 pressure zones. Table 5-11 summarizes the projected AAD and MDD by zone for each the respective design years.



N
W E
S

1 inch equals 1 mile

Legend

Recommended Pressure Zones

- Estrella Mountain Park
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Data Sources:
City of Goodyear GIS
ESRI

Figure 5-2
Recommended Pressure Zone Boundaries

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
building a world of difference™
ENERGY WATER INFORMATION GOVERNMENT

Revised: Monday, March 17, 2007

Cygnet 145521\11GIS\zGISMaps\RecommendedPressureZones.mxd 03/18/2007

Table 5-11. Potable Water Requirements by Pressure Zone

Zone	2007		2012		2017		Buildout	
	AAD (mgd)	MD (mgd)	AAD (mgd)	MD (mgd)	AAD (mgd)	MD (mgd)	AAD (mgd)	MD (mgd)
1	2.59	4.41	4.68	7.96	8.31	14.12	16.37	27.82
2	1.20	2.05	4.27	7.26	8.60	14.62	18.44	31.34
3	0.64	1.09	3.30	5.61	9.22	15.68	25.27	42.95
4	0.04	0.07	0.73	1.24	4.40	7.49	15.45	26.26
Gila River	2.60	4.42	5.27	8.96	9.01	15.32	16.70	28.40
Total	**7.07**	**12.03**	**18.25**	**31.03**	**39.54**	**67.22**	**92.22**	**156.77**

5.5.3 Demand Allocation

Annual Average Day (AAD) demands were allocated to the model for each design year. The "Demand Allocation Manager" in H2OMAP was used to create Thiessen polygons from a selection set of nodes to which demands were allocated. The pressure zone boundaries were used in the creation process to ensure polygons followed pressure zone boundaries.

Base Year Demand Allocation – The Base Year demand was spatially allocated using the geo-coded metered sales data provided by the City. The data spanned a one-year frame from January 2004 to December 2004 and was adjusted (factored) to represent 2007 Base Year AAD.

Buildout Demand Allocation – The Buildout demand was spatially allocated using the Land Use Plan and the water duties, in gallons per acre day that were developed for each land use type. Demand nodes for this allocation included the base demand nodes as well as buildout nodes in areas that are not as yet developed.

5.6 HYDRAULIC MODEL ANALYSES

The results of the steady state hydraulic analysis and the recommended distribution and transmission system improvements are described in the following sections.

5.6.1 Summary of Analyses

A series of hydraulic model analyses were performed to assess current performance and to determine the potable water infrastructure required to meet future potable water demands under varying conditions. Technical Memorandum 1-5 describes analysis procedures and results in detail. The following list summarizes the steady state hydraulic model analyses performed.

- Base Year Maximum Hour
- Base Year Maximum Day + Fire Flow
- Build-out Maximum Hour
- Build-out Maximum Day + Fire Flow
- Build-out Transmission System
- Build-out Transmission System CAP Outage

Model output from each of the hydraulic analyses performed was analyzed to determine:

- Reservoir storage volumes and refill requirements
- The required pumping station capacity in terms of pressure and flowrate.
- Distribution main sizing to meet pressure goals under build-out demands and to provide the required residential and commercial fire flow.

5.6.2 Storage Improvements

The maximum day and peak hour hydraulic analyses for the base year and buildout scenarios were analyzed to determine the required potable water storage requirements to meet future potable water demands. To determine the optimum amount of water storage for a distribution system, the two major considerations that must be evaluated are:

- Equalization storage, calculated as the difference between maximum hourly and maximum daily demands for a three hour period.

- Fire reserve, based on providing a commercial fire flow of 3,500 gpm for a 3 hour period. (residential fire flow requires 1,500 gpm for 3 hours)

The minimum required storage volumes were then calculated as the greater of twice the equalization storage (2EQ) requirement or equalization storage plus fire reserve (EQ + Fire). Detailed calculations of the required storage volumes can be found in TM 1-5. A summary of the required storage volumes for the base year and buildout are summarized in Tables 5-12 and 5-13.

Table 5-12. Base Year Storage Requirements

Facility	MD Demand (mgd)	Required Equalization Volume (MG)	Required Fire Volume (MG)	Required Total Volume (MG)	Existing Storage Volume (MG)
Site 21	5.28	0.92	0.63	1.85	2.00
Site 3	0.19	0.03	0.27	0.30	0.18
Site 11	4.09	0.72	0.63	1.43	2.00
Site 12	0.64	0.11	0.63	0.74	2.00
Site 18	0.91	0.16	0.63	0.79	1.00
Site 8	0.41	0.07	0.63	0.70	0.75
Site 5	0.42	0.07	0.27	0.34	0.18
Site 7	0.85	0.15	0.63	0.78	0.75
Site 10	0.33	0.06	0.63	0.69	0.75
Site 13	3.11	0.54	0.63	1.17	1.50

By applying the storage criteria presented above it can be seen that:

- The existing storage volumes exceed the minimum required volumes at all storage locations with the exception of Site 3 and Site 5. Both of these tanks have adequate equalization storage however they do not have adequate fire storage. However, during a fire flow event storage from near by tanks could be utilized and these tanks are to be phased out in the future.
- At the currently lower levels of demand, providing sufficient fire storage (1EQ + Fire) typically governs the required storage volumes. However at higher levels of demand, meeting the 2EQ criteria usually governs.

Table 5-13. Buildout Storage Requirements

Reservoir Size	MD Demand (mgd)	Required Equalization Volume (MG)	Required Fire Volume (MG)	Required Total Volume (MG)	Future Storage Volume (MG)
Site 21	8.52	1.49	0.63	2.98	3.00
Site 11	5.36	0.94	0.63	1.88	2.00
Site 18	4.78	0.84	0.63	1.67	2.00
WestPac	6.55	1.15	0.63	2.29	3.00
Site 12					5.00
Zone 1	*6.94*	*1.21*	*0.63*	*2.43*	
Gila River	*6.24*	*1.09*	*0.63*	*2.18*	
Gila River	9.74	1.70	0.63	3.41	4.00
Site 8	1.66	0.29	0.27	0.58	0.75
Kings Ranch	6.27	1.10	0.63	2.19	3.00
Site 13					5.00
Zone 2	*7.56*	*1.32*	*0.63*	*2.65*	
Zone 3	*4.91*	*0.86*	*0.63*	*1.72*	
Rainbow Valley					7.00
Zone 2	*13.29*	*2.33*	*0.63*	*4.65*	
Zone 3	*4.05*	*0.71*	*0.63*	*1.42*	
Zone 4	*1.62*	*0.28*	*0.63*	*0.91*	
Waterman	9.09	1.59	0.63	3.18	4.00
Zone 3/4 West					4.00
Zone 3	*8.41*	*1.47*	*0.63*	*2.94*	
Zone 4	*3.30*	*0.58*	*0.63*	*1.21*	
Zone 3/4 East					7.00
Zone 3	*12.86*	*2.25*	*0.63*	*4.50*	
Zone 4	*5.66*	*0.99*	*0.63*	*1.98*	
Zone 3	13.68	2.39	0.63	4.79	5.00
Estrella					4.00
Zone 3	*5.36*	*0.94*	*0.63*	*1.88*	
Zone 4	*3.12*	*0.55*	*0.63*	*1.18*	
Sonoran Highland	7.78	1.36	0.63	2.72	3.00
Total	**156.76**			**55.35**	**61.75**

At buildout storage has been consolidated into larger reservoirs for overall efficiency and simplicity of system operations. Site 3, Site 5, Site 7, and Site 10 all 0.75 MG or smaller reservoirs will have been retired and replaced with larger reservoirs of 2.0 to 7.0 MG each. At the time of retirement, the existing smaller reservoirs would be drawing toward the end of their useful lives and these sites would not have leant themselves to an efficient expansion of five fold or more.

By applying the storage criteria to the Buildout reservoirs it can be seen that:

- Total storage of 61.75 MG exceeds the minimum required operational volume of 55.35 by 11 percent. This additional volume above the minimum required will provide an additional margin to buffer transmission operations between Surface and Groundwater WTPs and the storage locations.
- Due to the use of larger reservoirs at Buildout, which serve correspondingly greater demands, meeting the operational storage requirement of 2 EQ governs the capacity required at all storage sites, with the exception of Site 8, where fire storage (1EQ +Fire) still controls.

Storage requirements for the intermediate years were interpolated between the base year and buildout storage volume requirements. Table 5-14 summarizes the storage requirements and phasing of storage capacity from base year through the near term (next ten years) and Buildout.

Table 5-14. Storage Requirements through Buildout

Total Storage	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2045
Site 21	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00
Site 11	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Site 18	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00
WestPac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00
Site 12	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	5.00
Gila River	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00	4.00	4.00	4.00
Site 8	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Kings Ranch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	1.50	1.50	1.50	3.00
Site 13	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	5.00
Rainbow Valley	0.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.00
Waterman	0.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	4.00
Zone 3/4 (West)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
Zone 3/4 (East)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00
Zone 3	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00	5.00	5.00	5.00	5.00
Estrella	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	4.00	4.00	4.00	4.00
Sonoran Highland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00
Total Storage	**9.25**	**14.25**	**14.25**	**16.25**	**21.25**	**21.25**	**21.25**	**26.75**	**31.75**	**33.75**	**33.75**	**61.75**

5.6.3 Booster Pumping Improvements

The results of the peak hour hydraulic analyses for the base year and buildout scenarios were analyzed to determine the required booster pumping station and distribution main improvements needed to meet future demands. The following requirements were utilized in the booster capacity evaluation.

- The stations firm pumping capacity must meet 120% of the Maximum Hour Demands (MH) with largest single unit out of service.
- Booster stations are to be designed with a TDH which meets the static design gradient of the zone served at the point of connection to the zone.
- At buildout, all existing and future booster stations will be equipped with variable speed pumps which will modulate flowrate as needed to hold a steady HGL as the point of connection to the distribution system.

Tables 5-15 and 5-16 summarize the pump capacity required at each booster pump station for base year and Buildout conditions.

Table 5-15. Base Year Booster Station Capacity versus Existing Capacity

Facility	Maximum Hour Demand	Firm Booster Required	Existing	
			Firm	Installed
	(mgd)	(mgd)	(mgd)	(mgd)
Site 21	9.0	10.8	7.5	9.6
Site 3	0.3	0.4	0.7	1.4
Site 11	7.0	8.3	6.2	8.4
Site 12	1.1	1.3	1.4	3.6
Site 18	1.5	1.8	1.4	2.9
Site 8	0.7	0.8	0.7	1.4
Site 5	0.7	0.9	0.7	1.4
Site 7	1.5	1.7	1.4	2.2
Site 10	0.6	0.7	0.7	1.4
Site 13 Zone 1 South	5.2	6.3	3.8	5.5
Site 13 Zone 2 South	0.1	0.1	1.4	2.8

From Table 5-15 it can be seen that:

- For most of the stations, little or no reserve is left to accommodate growth with holding one pump in reserve. This operating condition will require that either (1) the firm pumps operate beyond their rated design point at a lower head / higher flow point on their curve resulting in lower discharge pressures or (2) the station operate with installed pumps running. It should be noted that during the base year peak hour analysis the existing booster stations north of the Gila River were able to maintain adequate pressures throughout the distribution system.
- Since the Site 13 booster station is the only Zone 1 South booster station currently operating south of the Gila River, under the base year peak hour analysis the pump

station operates out on the pump curves which resulted in lower than acceptable pressure during peak hour demand conditions.

Table 5-16. Buildout Year Booster Station Capacity versus Existing Capacity

Storage Site	Maximum Hour Demand (mgd)	Firm Booster Require (mgd)	Existing Booster Firm (mgd)	Incremental Capacity (mgd)	Buildout Firm Capacity (mgd)
Zone 1					
Site 21	14.49	17.39	7.50	10.00	18.00
Site 11	9.11	10.93	6.20	5.00	11.00
Site 18	8.12	9.74	1.40	9.00	10.00
Site 12 Zone 1	11.79	14.15	6.60	8.00	15.00
WestPac	11.13	13.36	0.00	14.00	14.00
Gila River Zone					
Site 12	10.60	12.72	0.00	13.00	13.00
Gila River	16.56	19.87	0.00	20.00	20.00
Kings Ranch	10.66	12.79	0.00	13.00	13.00
Site 8	2.82	3.38	0.70	3.00	4.00
Zone 2					
Site 13	12.85	15.42	3.80	12.00	16.00
Waterman	15.46	18.55	0.00	19.00	19.00
Rainbow Valley	22.60	27.12	0.00	28.00	28.00
Zone 3					
Site 13	8.35	10.02	1.40	9.00	11.00
Rainbow Valley	6.89	8.27	0.00	9.00	9.00
Zone 3/4 (West)	14.29	17.15	0.00	18.00	18.00
Zone 3/4 (East)	21.87	26.24	0.00	27.00	27.00
Zone 3	23.26	27.91	0.00	28.00	28.00
Estrella Zone 3	9.12	10.94	0.00	11.00	11.00
Zone 4					
Rainbow Valley	2.76	3.31	0.00	4.00	4.00
Zone 3/4 (West)	5.61	6.73	0.00	7.00	7.00
Zone 3/4 (East)	9.63	11.56	0.00	12.00	12.00
Estrella Zone 4	5.31	6.37	0.00	7.00	7.00
Sonoran Highland	13.22	15.86	0.00	16.00	16.00
Total	**266.50**	**319.80**	**27.60**		**331.00**

Booster station requirements for the intermediate years were interpolated between the base year and buildout pumping requirements. Table 5-17 summarizes the booster station requirements and phasing of booster capacity from Base year through the near term (next ten years) and buildout.

Table 5-17. Near Term Pump Station Requirements

Zone 1	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Site 10	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Site 21	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Site 11	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Site 18	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
WestPac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Site 12 Zone 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	18.00	18.00
Zone 1 Total Booster Station Capacity	34.00	34.00	34.00	34.00	34.00	34.00	34.00	34.00	51.00	51.00	51.00
Gila River Zone											
Site 12 (Gila River)	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Gila River	0.00	0.00	0.00	12.00	12.00	12.00	12.00	12.00	12.00	24.00	24.00
Site 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.00	9.00	9.00	9.00
Site 8	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Kings Ranch	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Gila River Total Booster Station Capacity	21.00	21.00	21.00	33.00	33.00	33.00	33.00	41.00	41.00	53.00	53.00
Zone 2											
Site 13 (Zone 2)	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Rainbow Valley (Zone 2)	0.00	0.00	0.00	0.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Waterman (Zone 2)	0.00	12.00	12.00	12.00	12.00	18.00	18.00	18.00	18.00	18.00	18.00
Zone 2 Total Booster Station Capacity	6.00	18.00	18.00	18.00	30.00	35.00	35.00	35.00	35.00	35.00	35.00
Zone 3											
Site 13 (Zone 3)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Rainbow Valley (Zone 3)	0.00	12.00	12.00	12.00	12.00	6.00	6.00	6.00	6.00	6.00	6.00
Zone 3/4 (West) Zone 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 3/4 (East) Zone 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 3	0.00	0.00	0.00	0.00	18.00	18.00	18.00	18.00	30.00	30.00	30.00
Estrella Zone 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	12.00	12.00	12.00
Zone 3 Total Booster Station Capacity	3.00	15.00	15.00	15.00	33.00	27.00	27.00	38.00	50.00	50.00	50.00
Zone 4											
Rainbow Valley (Zone 4)	0.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Estrella Zone 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 3/4 (West) Zone 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 3/4 (East) Zone 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	12.00	12.00	12.00
Sonoran Highland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zone 4 Total Booster Station Capacity	0.00	6.00	6.00	6.00	6.00	6.00	6.00	18.00	18.00	18.00	18.00

5.6.4 Distribution System Improvements

The distribution system was analyzed under MHD and Fire Flow conditions using the Base Year and Buildout models. Piping was extended to accommodate growth within the service area and sized to provide the required pressures and flowrates. Key criteria used in the design of distribution system piping include:

- Pressure: System pressure was not to drop below 40 psi under MHD.
- Fire flow: Residential (1,500 gpm) and commercial (3,500 gpm) fire flows were to be delivered with a minimum of 20 psi residual pressure.
- Velocity: Maximum velocity is not to exceed 10-feet per second under MHD conditions and friction loss gradient upper limit in the 2-3 ft / 1000 ft range under MHD.

The following key observations and recommendations result from the modeling and analysis of the distribution system. Additional information on the distribution system hydraulic analyses is provided in Technical Memorandum 1-5.

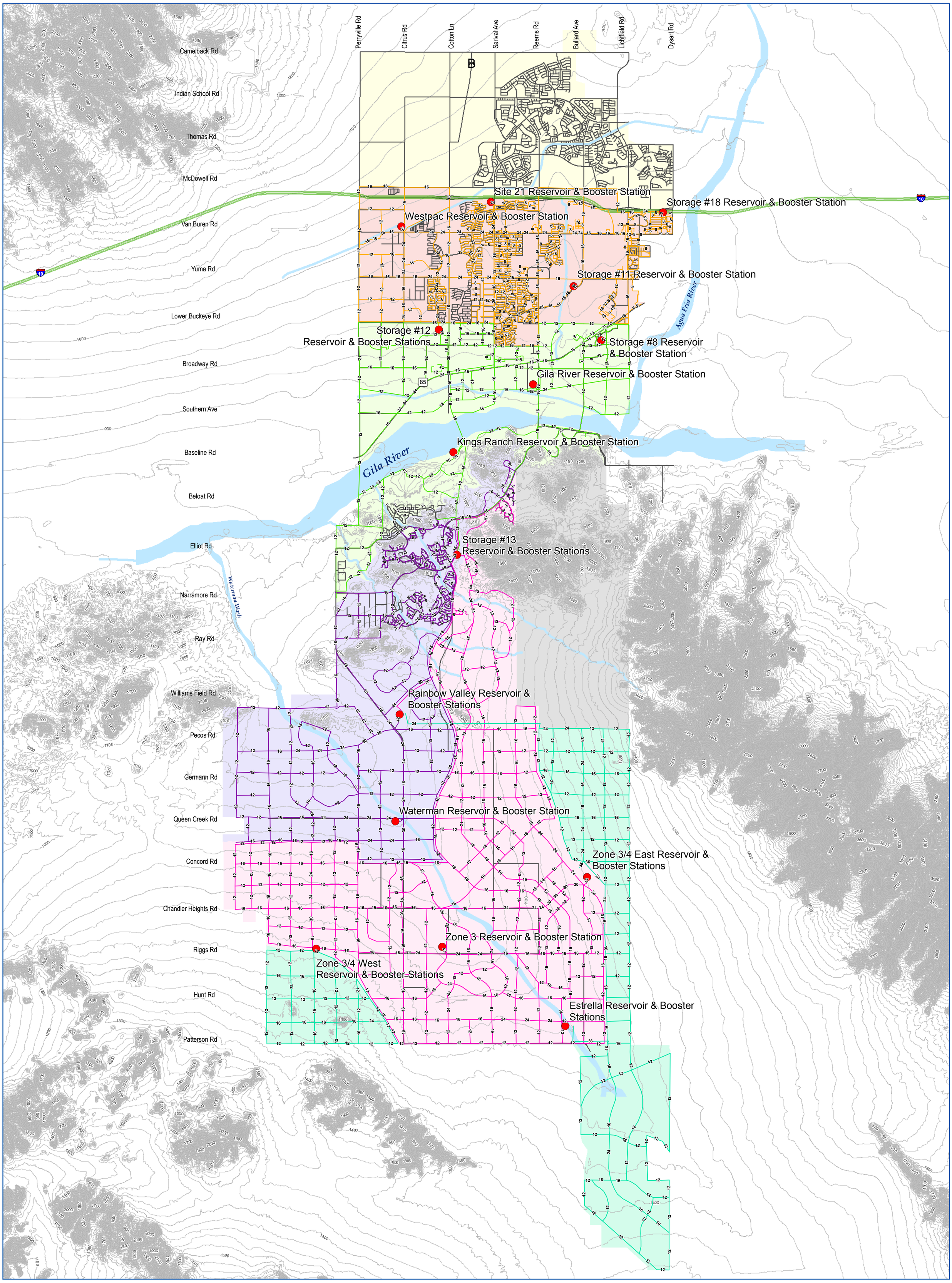
Existing – The existing distribution mains have adequate capacity to meet base year demands.

Growth – Figure 5-3 shows the recommended buildout distribution system piping improvements required to accommodate growth within the service area. Based on information provided by the City of Goodyear and developers an assumed intermediate year (2017) limit of growth was established. This area will be served by the intermediate distribution system which is shown on Figure 5-4.

As it can be seen on Figure 5-3 a new Gila River pressure zone is recommended and will be located between Zone 1 and Zone 2. The creation of the new Gila River Zone will be required in the near future (2010). An analysis of the existing piping configuration, ground topography and facility layouts was conducted to identify the most effective way to implement the new zone while minimizing the capital cost associated with the project. The following list summarizes the necessary modification that is required for the full implementation of the Gila River Zone:

- New Gila River piping will need to be installed parallel to the existing piping along the Zone 1 / Gila River Pressure Zone boundary.

- The transmission line crossing the Gila River to the Kings Ranch and Site 13 Reservoir will need to in place. Once the distribution piping for Zone 1 and Gila River have been disconnected the existing 16 inch line which conveys water to the Site 13 Reservoir will not have adequate head to convey water south of the Gila River. Additionally in the near term planning horizon significant quantities of water will be conveyed from production sources located in the northern portion of the City (CAP WTP/Adaman/Northern Groundwater) to supply re-fill capacity to reservoirs located south of the Gila River.



N
W E
S

1 inch equals 1 mile

Legend

Street

Tanks and Reservoirs

Pressure Zones

Estrella Mountain Park

Gila Zone

LPSCO

Zone 1

Zone 2

Zone 3

Zone 4

Data Sources:
City of Goodyear GIS
ESRI

Figure 5-3
Build Out Water Distribution System

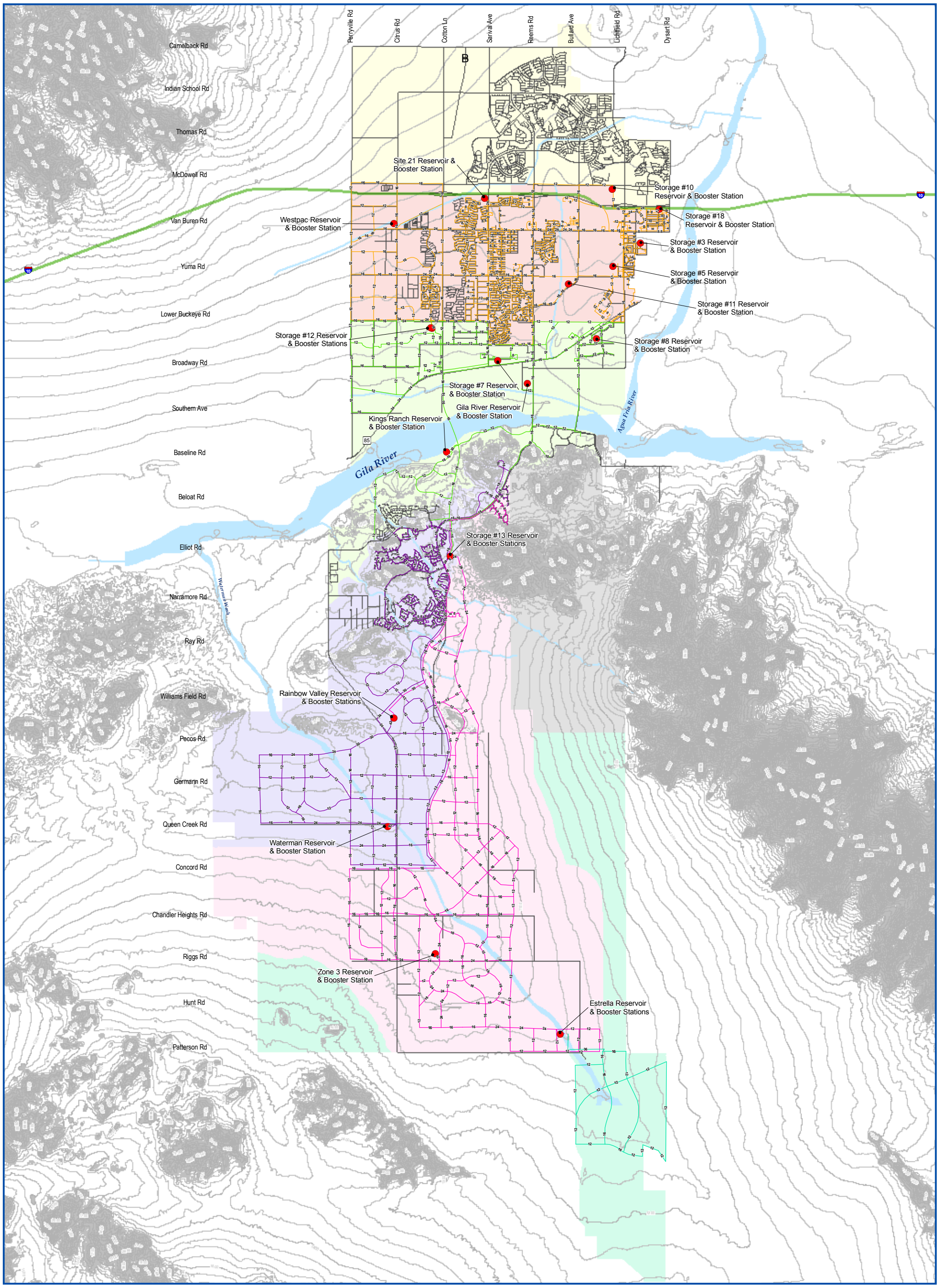
Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
building a world of difference™
ENERGY WATER INFORMATION GOVERNMENT

Cygnet\145521\11GIS\zGISMaps\Buildout Peak Hour.mxd

Revised: Tuesday, March 25, 2008



N
W E
S

1 inch equals 2 miles

Data Sources:
City of Goodyear GIS
ESRI

Legend

- Street
- Tanks and Reservoirs

Pressure Zones

- Estrella Mountain Park
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Figure 5-4
2017 Water Distribution System
Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

Revised: Tuesday, March 18, 2007

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5.7 WATER PRODUCTION INFRASTRUCTURE

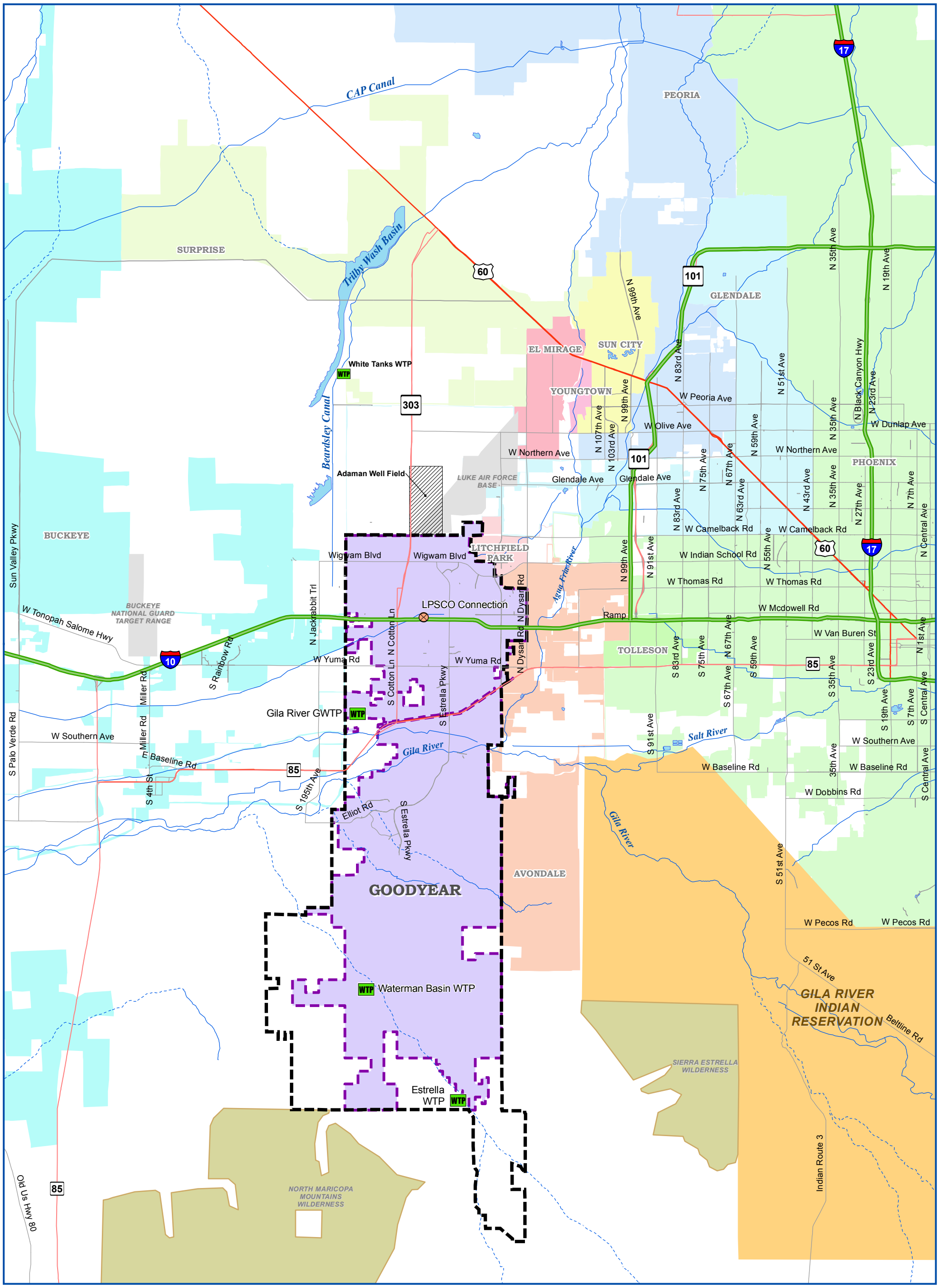
5.7.1 Production Capacity

The Water Production Plans prepared in Section 5.4 outline the seasonal production levels associated with each element of the City's water resources. Table 5-18 shows the actual infrastructure which will produce the water associated with each resource.

Table 5-18. Buildout Year Infrastructure and Resource

PRODUCTION FACILITY	Existing Capacity (mgd)	Buildout Firm Capacity (mgd)
CAP Water Treatment Plant	0	18
Adaman Mutual Well Field and GWTP	0	10
LPSCO Connection	3	3
Imported Water Subtotal =	**3**	**31**
WPA2 Wells	13	16
Gila River GWTP	0	60
WPA2 Groundwater Subtotal =	**13**	**76**
Waterman Wash GWTP	0	30
Estrella GWTP	0	20
WPA4 / 5 Groundwater Subtotal =	**0**	**50**
Total Production Infrastructure =	**16**	**157**

CAP Water Treatment Plant. A surface water treatment plant, with 18 mgd of capacity will be required to receive and treat the City's 19,706 af/yr of CAP water resources. The City is currently in discussions about contracting for capacity in the White Tanks WTP which American Water is constructing to the north of the City. Figure 5-5 shows the location of the White Tanks Plant and the transmission infrastructure which will be required to deliver Goodyear's share of the treated water to the City's service area. This configuration, based on contracting 18 mgd of capacity at the White Tanks WTP and constructing an 36-inch by 10 mile transmission main, is used as the default arrangement in the IWMP.



Legend

- WTP Water Treatment Plant/GWTP
- LPSCO Connection

Transportation

- US Route
- State Route
- Major Arterial
- Interstate Highway

- Lake
- Aqueduct
- Ditch; Stream
- Wash

2 0 2
Miles

Data Sources:
City of Goodyear GIS
ALRIS
ESRI

Figure 5-5
Regional Water Supply Sources
Integrated Water Master Plan
City of Goodyear, AZ
2007

Revised: Wednesday, March 26, 2008

Alternately, the City could construct their own CAP WTP, located within the City limits in WPA1 or WPA2. Raw CAP water could be delivered to the plant via the Beardsley Canal as shown on Figure 5-5. Benefits associated with this arrangement would include:

- Potentially lower long-term treatment costs from a City owned plant versus contracting capacity with others.
- Lower transmission costs associated with wheeling water through the Beardsley Canal versus construction of 5 miles of 36-inch pipeline.
- Lower water age and improved water quality with respect to disinfection-by-products (DBPs)
- Ability to peak plant operations at 1.32 times annual average, reaching 24 mgd. This extra 6 mgd of surface water capacity would allow the Gila River GWTP to be reduced by 6 mgd.

Adaman Mutual Well Field and GWTP. The City will pump up to 11,200 af/yr of groundwater from the Adaman Mutual service area located to the north of the City as shown on Figure 5-5. Pumping is to be done without peaking, at a steady 10 mgd rate. Based on available water quality information and local groundwater trends, it is assumed that all Adaman Mutual groundwater will need treatment for arsenic and/or nitrate. Treatment is to be accomplished in the following manner:

1. Initial Operations (0.0 to 4.0 mgd) will be supported with well-head treatment units. Wells requiring arsenic treatment will be selected prior to wells requiring nitrate treatment in order to avoid brine disposal.

2. Long Term Operation (4.0 to 10.0 mgd) is to be provided by a centralized GWTP located within Goodyear in WPA1 or WPA2. A water campus site, combining the Adaman Mutual GWTP and the CAP WTP would provide significant savings due to economies of scale, combining of operations and blending opportunities.

Additional benefits that could be achieved if the Adaman Mutual and CAP plant are co-sited at a single water campus location include:

- Water from the Adaman well-filed would be blended most of the year for its treatment needs. The Adaman GWTP would only provide standby treatment

capacity for times when the CAP was down. However, if the Adaman Water requires arsenic treatment the following strategy could be implemented when CAP is down. The Adaman water could be treated with the idle CAP plan and use the coagulation filtration to remove arsenic from extracted from the Adaman Wellfield. If nitrate treatment is required, then an IX facility would be required but the facility could be in standby mode for most of the year while blending with CAP water is utilized. Under this scenario the IX facility would only incur operational costs only for short periods when the CAP was down.

LPSCO Connection. A maximum of up to 3 mgd will be available from LPSCO at the current connection points on Bullard and Sarival Avenues.

WPA2 Wells. The City currently has 10 wells operational in WPA2 which provide 13 mgd of installed capacity and 11 mgd of firm capacity. It is assumed that these wells will continue in operation as they are currently configured and will be expanded to support and firm up refill needs at Site 11, 18 and 8. An additional 7 mgd of wells is to be installed, bringing the total installed capacity to 20 and firm to 18 mgd. These wells will be provided with well-head treatment as necessary.

Gila River GWTP. The remaining 60 mgd of firm groundwater production capacity required in WPA2 will be provided by the Gila River GWTP and its well field. Operation of the Gila River GWTP will vary from low winter rates of 15 mgd, to an annual average production of roughly 30 mgd to peak summer production at 60 mgd. A centralized groundwater treatment plant is to be utilized instead of many well-head treatment units located at individual wells in order to obtain:

- **Simplified Operations.** The operation of several larger facilities will be greatly simplified in comparison to keeping many small facilities properly operating. The larger facilities can be provided with a fuller staff which can better focus on the details of efficient operation of the RO treatment process and disposal of waste brine.

- **Economies of Scale.** Significant savings can be realized, both in capital cost and O&M cost, through construction and operation of several larger groundwater treatment plants instead of many smaller units located at the well-head.

- **Reduced Land Requirements.** Land requirements of several larger GWTPs will be considerably less than that required for multiple well head facilities of the same total capacity.

Waterman Wash and Estrella GWTPs. Two centralized GWTPs will be provided to produce the 50 mgd of treated groundwater required from the Rainbow Valley Aquifer in WPA4 / 5. The Waterman Wash GWTP will produce 30 mgd firm and the Estrella GWTP will produce 20 mgd firm.

Table 5-19 summarizes the phasing of production sources and their nominal capacity ratings from Base year through the near term (next ten years) and at buildout.

Table 5-19. Production Recommended Phasing

Production Sources	Base Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Buildout
WPA2 Wells	12.70	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	16.00
Gila River GWTP						5.0	5.0	5.0	10.0	10.0	10.0	60.0
LPSCO	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Adaman Mutual	0.00	2.00	2.00	4.00	4.00	6.00	8.00	10.00	10.00	10.00	10.00	10.00
CAP WTP	0.00	0.00	0.00	0.00	5.00	5.00	10.00	10.00	15.00	15.00	15.00	18.00
Waterman Wash GWTP	0.00	1.25	2.50	3.75	5.00	5.00	5.00	10.00	10.00	10.00	15.00	30.00
Estrella GWTP	0.00										5.0	20.00
Total Production	**14.70**	**21.25**	**22.50**	**25.75**	**32.00**	**39.00**	**46.00**	**53.00**	**63.00**	**63.00**	**68.00**	**157.0**

5.7.2 GWTP Well-Fields

In order to support the GWTPs at their nominal production capacities, the connected pumping capacity in the well-fields must account for:

Brine Losses. Net losses as rejected brine are assumed to be 10 percent of the pumped groundwater after accounting for the bypassed fraction. Brine losses may be further reduced if significant aquifer clean-up is accomplished over the long-term.

Reserve Capacity. Ten percent of the installed wells will provide back-up capacity to firm the GWTPs nominal capacity ratings.

Table 5-20 Build-out Nominal Production Capacities and Installed Wells

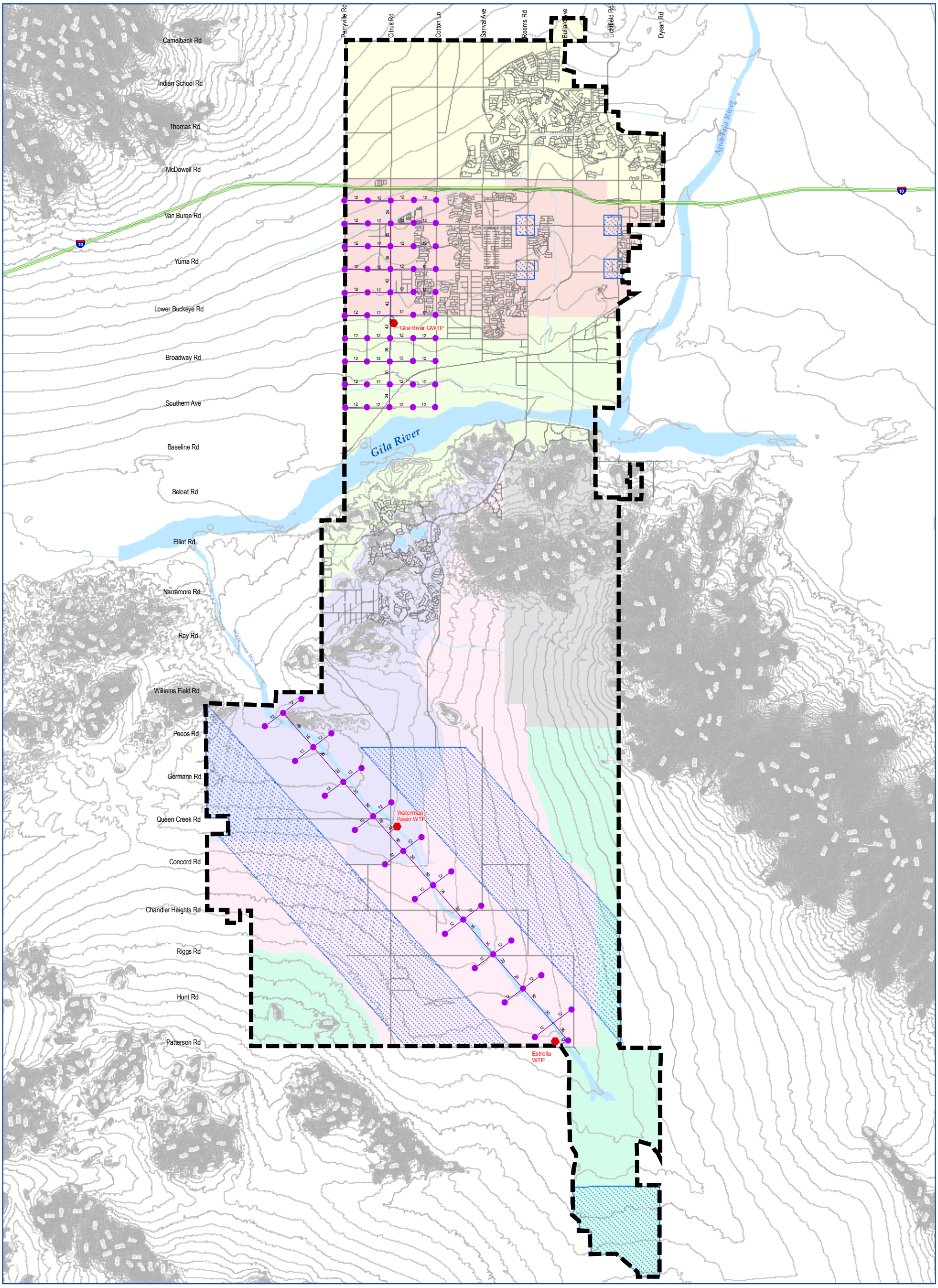
Production Sources	Firm Capacity (mgd)	Installed Well Capacity (mgd)[1,2]	Number of Wells
Adaman Mutual Wells	10	12	6
WPA2 Wells	18	22	11
Gila River GWTP	60	74	37
Waterman Wash GWTP	30	37	19
Estrella GWTP	20	25	13
Total Production	**137**	**170**	**86**

Notes:
1. Assumes 10% brine Loss and 10% reserve.
2. Assumes 2 mgd per well

It can be seen from Table 5-20 that a significant number of wells, roughly 86, will be required to meet the buildout demands plus reserve. It is recommended that centralized GWTPs be served by well-fields where multiple wells are manifolded together and their capacity conveyed to the GWTPs. A schematic of the proposed well fields and their recommended locations is shown on Figure 5-6. The proposed well field configuration is designed to provide:

- Coordinated development such that proper separation can be maintained between reclaimed water injection wells and potable water extraction wells.
- Sustainable pumping and long-term clean-up of the Rainbow aquifer through hydraulic interaction with the recharge well-fields.
- Efficient compact well-field piping, close to the GWTPs and with favorable hydraulics.

It is recommended that the City undertake detailed hydro-geologic modeling of the proposed recharge and recovery well-fields in order to optimize long term aquifer hydraulic performance and enhance groundwater clean-up. The proposed layout is designed to lower the TDS of the extracted water by recharging reclaimed water with a TDS of 600 to 700 to either side of the GWTP extraction zone. It is hoped that modeling will confirm that over-time, the raw water TDS pumped from the Rainbow Aquifer will drop significantly from its current levels in the 3,000 ppm range.



\\Cygnet 145521\11\GIS\zGISMaps\Wellfield.mxd 21 Dec 2007

Figure 5-6
Well Field Schematic
Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Revised: Friday, March 14, 2007

5.7.3 Brine Disposal

The majority of the City's water will be supplied by treating brackish groundwater and the proposed 60 mgd Gila River, 30 mgd Waterman Wash and 20 mgd Estrella GWTPs, will produce large quantities of waste brine from the reverse-osmosis process which must be disposed of properly.

The City currently allows the brine generated at the 5 mgd Site 11 RO GWTP to be disposed of in the sewer, however this practice is already making it difficult to use the reclaimed water from the 157th Ave WWTP due to the added salinity. Brine disposal to the sewer can sometimes be acceptable, if the quantity is limited and/or if there is no intent to reuse or recharge the reclaimed water. However, the magnitude of Goodyear's future RO treatment and quantity of salt to be removed per day, absolutely preclude the use of the sewer for disposal. Continued disposal in this manner would have multiple damaging impacts including:

- Severe adverse impacts to the biological treatment processes used at the WRFs.
- Severe adverse impacts to the reclaimed water quality, rendering it unsuitable for reuse or recharge.
- Placement of the City in a non-sustainable resource position.

A number of methods exist for brine disposal with varying levels of cost and practicality including future regional options. Alternatives for proper disposal of the brine concentrate include the following:

Sewer Discharge. Simple and low cost method suitable disposal for small amounts of brine. Large amounts of brine severely impact wastewater treatment processes and render reclaimed water unusable. Sewer discharge is not an option for Goodyear due to the quantity of brine being considered.

Evaporation Basins. Lined shallow earthen basins provide for the evaporation of water from the discharged brine. Basins are sized based on annual brine production levels and account for precipitation. Evaporation basins are simple technology and are most effective in hot arid regions, however large amounts of land are required.

Vapor Compression / Crystallizer. Vapor compression and crystallizer units are highly capital and energy intensive as well as being extremely complex from an operational standpoint. This technology may become cost effective for Goodyear as the technology improves and as the scale of the RO plants increases.

Regional Brine Disposal Pipeline. A brine disposal pipeline discharging in Mexico at the Sea of Cortez is a regional option that has been discussed, but has not advanced to a practical level.

Regional Deep Well Injection. Injection into underground aquifers has been discussed, but a suitable aquifer, where ADWR regulations would permit brine injection, has not been identified.

For the purposes of the IWMP, brine disposal was planned using evaporation basins because it is currently the only feasible method for which implementation can be guaranteed. Table 5-21 shows the amount of brine generated by the RO treatment process and the acreage of recharge beds which would be required for its disposal. The calculations were based on the following assumptions:

- 100% of the WPA2 and WPA4 / 5 groundwater will require treatment.
- The treatment process that will be used for the southern groundwater treatment is assumed to be reverse osmosis (RO) membrane technology.
- It is assumed that the treatment will generate a net 10% brine waste at buildout.
- Evaporation basin and salt removal requirements are based on AAD production levels.

Table 5-21. Build-out Brine Requirements for City of Goodyear GWTP				
Brine Requirements	**Waterman**	**Estrella**	**WPA 2**	**Total Groundwater WTP**
Average Day Groundwater Requirement (mgd)	17	11	40	69
Plant Production (mgd)	15	10	36	62
Brine flow Rate (mgd)	2	1	4	7
Brine flow Rate (cubic feet / year)	75,518,774	50,345,849	175,397,130	334,735,281
Annual Evaporation inches per year	74.96	74.96	74.96	74.96
Precipitation	6.76	6.76	6.76	6.76
Adjustment for Precipitation	68.19	68.19	68.19	68.20
Adjustment for Low Vapor Pressure of Brine Solution (0.7)	47.74	47.74	47.74	47.74
Annual Evaporation feet per year	3.98	3.98	3.98	3.98
Wet Surface acreage (square footage)	18,984,313	12,656,209	44,092,269	84,145,488
Wet Surface acreage (acreage)	436	291	1,012	1,932
Net Land Required (acres)	545	363	1,265	2,415
Annual Deposition Depth (inches / year)	0.24	0.24	0.24	0.24
Salt Removal from Groundwater lbs / day	**193,593**	**129,062**	**449,631**	**772,284**
Salt Removal from Groundwater tons / day	**97**	**65**	**225**	**386**
Salt Removal from Groundwater tons / year	**35,331**	**23,554**	**82,058**	**140,942**

The buildout acreage shown for brine disposal is quite large and may not be readily available unless this quantity of land is set aside through planning. It can be seen that roughly 60 acres should be set aside for brine disposal per 1 mgd of AAD plant capacity. It is quite possible that a more suitable regional solution will develop in the future because a number of the other municipalities in Maricopa County also have growing brine disposal needs. And, while a regional solution may have significantly less land impact, it will not likely be low cost. Therefore, from a planning point of view, it is recommended that the evaporation bed solution be used as a place holder guaranteeing that money is budgeted for brine disposal.

Adaman Mutual Brine Management - Initial water quality reports indicated that groundwater developed within Adaman Mutual will need treatment for either Arsenic and / or Nitrate. Buildout evaporation basin and salt removal requirements for the Adaman Mutual are summarized in Table 5-22 and were calculated based on the following assumptions:

- It was assumed that 50% of the groundwater developed by Adaman Mutual will be blended with CAP surface water and will not require treatment.

- Of the remaining 50% of the Adaman Mutual groundwater developed requiring treatment, it was assumed that 50% of the groundwater will require nitrate removal and 50% will require arsenic removal.
- The treatment assumed for Nitrate removal was Ion Exchange (IX).
- IX will generate 5,000 gpd of brine per mgd of treatment.
- Waste sludge / spent iron media from the arsenic treatment will be disposed of to the sewer or hauled to a landfill.
- Evaporation basin and salt removal requirements are based on average groundwater production.

Table 5-22. Build-out Brine Requirements for Adaman Mutual

Brine Requirements	**Adaman Mutual**
Average Day Northern Groundwater Requirement	10
Nitrate Treatment Flow Rate Requirement	3
Brine Flow Rate (gpd)	12,500
Brine flow Rate (cubic feet / year)	610,006
Annual Evaporation inches per year	74.98
Precipitation	7
Adjustment for Precipitation	68.19
Adjustment for Low Vapor Pressure of Brine Solution (0.7)	47.74
Annual Evaporation feet per year	3.98
Surface acreage (square footage)	153,347
Surface acreage (acreage)	4
Land Required (acres /year)	4
Salt Removal lbs / day	**31,275**
Salt Removal tons / day	**16**
Salt Removal tons / year	**5,708**

5.8 WATER TRANSMISSION SYSTEM

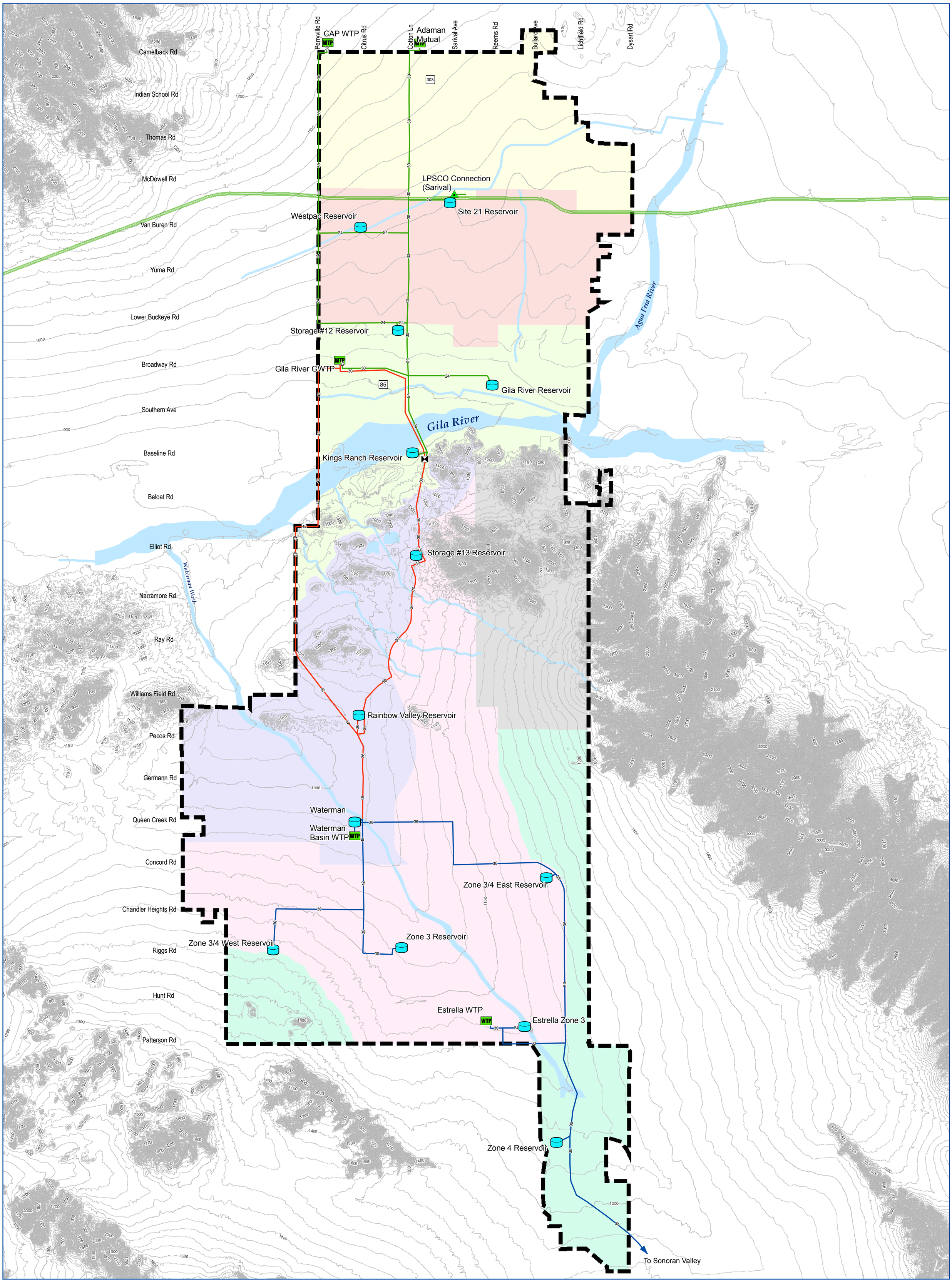
A separate transmission system was provided to convey water from production facilities (surface and groundwater treatment plants) to the points of distribution system supply (reservoirs). The benefits of a dedicated transmission system are:

- Limits distribution pipe sizing to only that needed for demand and fire. Over-sizing of pipes to also provide for refill is not required
- Avoids dump and re-pump operations which waste energy by pumping water up to the hydraulic grade of the zone, dumping the water to atmosphere at reservoir locations then re-pumping back up to the zone grade.
- Stabilizes distribution system gradients within each pressure zone since water is not being transferred across zones but only distributed within zones.
- Increases water transfer flexibility to convey water to alternative points of storage prior to the completion of build-out infrastructure or in the event of a plant outage.
- Increases the ability to use treated surface water to blend with poor quality groundwater before delivery to storage reservoirs.
- Simplifies system operation by allowing water production and reservoir refill to be managed independent of maintaining distribution system pressure.

The proposed build-out transmission system will deliver water from production sites to reservoir sites using pumps to provide the HGL needed to move the water and control valves to set the refill rate at each reservoir. The transmission system will operate independent of distribution system pressure and will be sized to provide adequate reservoir re-fill capacity based on the quantity of water required from each of the reservoirs during a maximum day demand condition.

Hydraulic analyses were conducted to test the transmission system to verify that the system is capable of conveying adequate capacity to refill reservoirs under varying conditions. In addition to maximum day refill capacity an important issue for the City is the ability to adequately provide water during a scheduled shutdown of the CAP canal. It was assumed that a scheduled CAP shutdown would occur during the cooler months, between November and February. Of these months, November has the highest demand and so the hydraulic analysis was conducted under November demand conditions. The system was then evaluated to determine the ability to meet maximum winter time demands with CAP supplied treatment facilities off-line.

Figure 5-7 presents the proposed buildout transmission system. The final alignment of the transmission system does not need to follow the exact alignment shown in the IWMP as long as the system meets the same functional intent of the transmission system and can convey the indicated quantities of water from the production sources to the reservoirs. A profile of the transmission system under buildout maximum day conditions is shown on Figure 5-8.



N
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1 inch equals 1 miles

Legend

Facility
- Water Treatment Plant/GWTP
- Tank
- LPSCO Connection
- Valve

Transmission Main
- WPA 2
- WPA 4/5 Low
- WPA 4/5 High

Pressure Zones
- Estrella Mountain Park
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

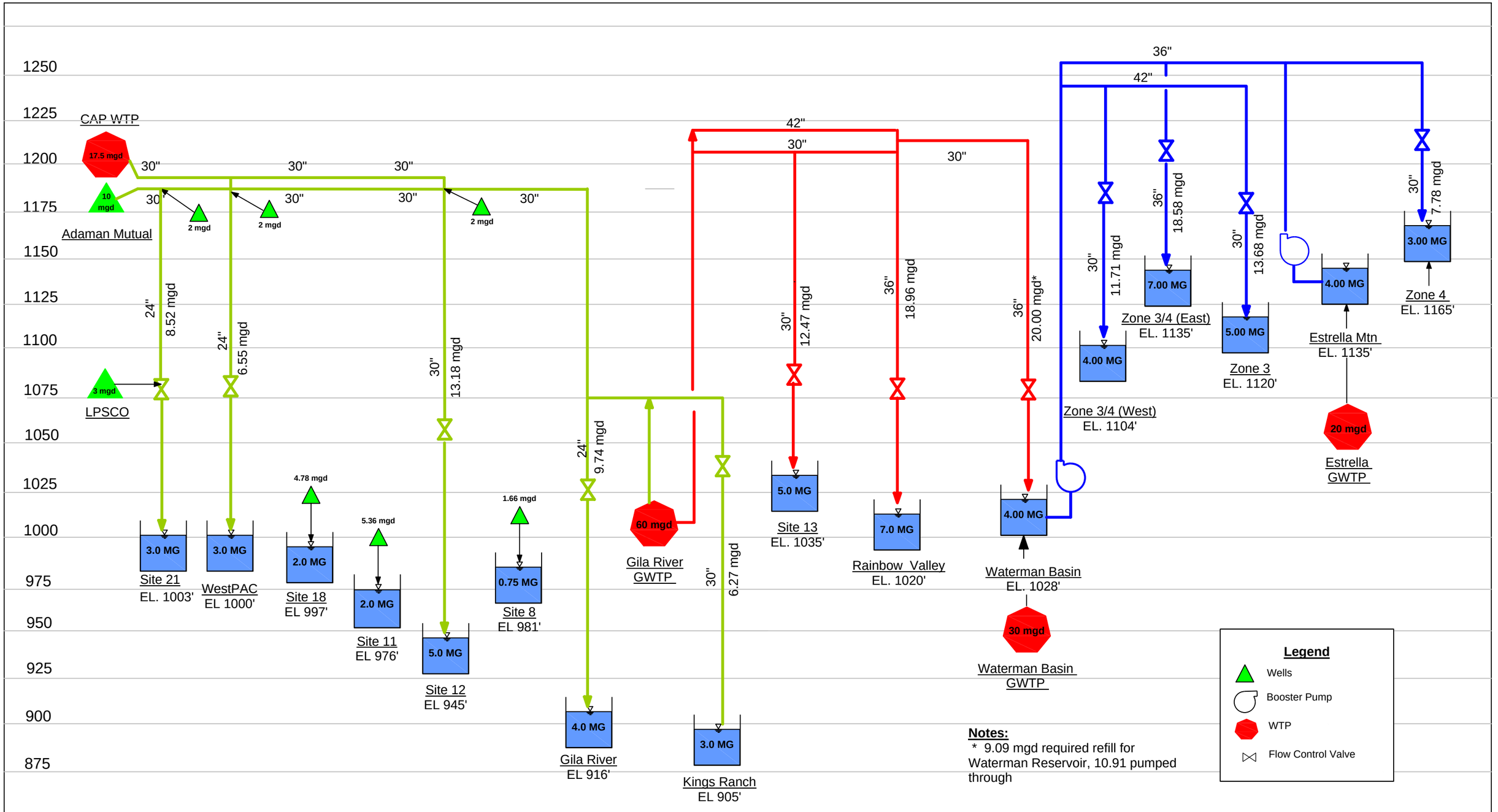
Figure 5-7
Transmission System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Data source:
City of Goodyear GIS
ESRI

Cygnet 145521\11GIS\zGISMaps\Buildout Trans.mxd 10 Sept 2007

Revised: Wednesday, March 26, 2007



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PROJECT 145521

CITY OF GOODYEAR
2007 INTEGRATED MASTER PLAN
TRANSMISSION SYSTEM HYDRAULIC PROFILE
Figure 5-8 - Buildout Maximum Day

Goodyear ARIZONA

SECTION 6

COLLECTION SYSTEM ANALYSIS AND RECOMMENDATIONS

The City of Goodyear currently provides wastewater collection and treatment to customers located in WPA2 and WPA3. An average dry weather flow of 3.5 mgd is currently treated at three wastewater reclamation facilities; the 157th Ave WWTP, Corgett WRF and Rainbow Valley WRF. The purpose of this section is to:

- Provide an outline of the City's existing collection system and treatment facilities.
- Provide an overview of collection basin configuration, hydraulic model construction, and flow allocation.
- Perform hydraulic analyses and develop a phased plan of the recommended collection and treatment infrastructure.

6.1 EXISTING COLLECTION SYSTEM INFRASTRUCTURE

Black & Veatch completed a comprehensive inventory of the City's wastewater collection system as part of the master planning process. The components of the collection system are summarized below. Additional details for each facility including; locations, schematics, operational diagrams and performance parameters, are included in Technical Memorandum 1-1. In addition to serving as reference for construction and operation of the hydraulic models, the Facility Inventory provides a valuable source of information for the City's operations and engineering personnel.

The existing collection system and facilities are shown on Figure 6-1, which represent the 2007 Base Year Model. The following components are addressed:

- Collection System Mains
- Lift Stations and Force mains
- Water Reclamation Facilities

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
Pecos Rd
Gila River
Agua Fria River
Waterman Wash
303
85
10
Del Camino LS
Palm Valley LS
Wells Fargo LS
Bio Flora LS
Rubbermaid LS
157th Ave WWTP
Corgett WRF
Rainbow Valley WRF
Lost LS
Ricardo LS
Irene LS
Lum Wash LS
Rainbow Valley LS

Christina Hassell 27 Aug 2007

\\Projects\GoodYear\11GIS\01MapDocuments\Base Year Wastewater.mxd

N
W E
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1 inch equals 3,000 feet

Legend

- Master Plan Study Area
- Water Reclamation Facility
- Wastewater Treatment Plant
- Lift Station

Pipes

- Force Main
- 157th Avenue
- Corgett
- Rainbow Valley

Data Sources:
City of Goodyear GIS
ESRI

Figure 6-1
Existing Collection System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

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Revised: Wednesday, March 26, 2008

6.1.1 Collection Mains

The City's collection system, shown on Figure 6-1, consists of approximately 175 miles of gravity flow pipelines ranging from the 8-inch diameter neighborhood sewer-lines to 60-inch interceptor mains. The collection system is currently configured around three basins which deliver flow to the 157th Ave WWTP, the Corgett WRF and the Rainbow Valley WRF.

6.1.2 Lift Stations and Forcemains

The City operates eleven duplex-submersible wastewater lift stations. The stations range in capacity from 0.2 to 4.6 mgd. These lift stations enable the system to serve areas with insufficient or adverse grade when moving wastewater to treatment facilities. Existing lift stations are summarized in Table 6-1.

Table 6-1. Collection System Lift Stations

Station Name	Installed Capacity (mgd)	Forcemain Diameter (inches)	Type	Standby Power
Wells Fargo	0.7	6	duplex-submersible	yes
Del Camino	0.9	8		
Rainbow Valley	4.6	2 - 12		
Lum Wash	0.2	8		no
Ricardo	0.3	4		
Irene	0.4	4		
Rubbermaid	0.6	4		
Bio Flora	0.7	6		
Palm Valley	1.0	8		
Cotton	1.4	8		
Lost	2.0	8		

6.1.3 Wastewater Reclamation Facilities

The City of Goodyear currently operates three wastewater reclamation facilities (WRF) with a total treatment capacity of 5.6 mgd. The City's existing treatment facilities, listed in Table 6-2, are designed to produce reclaimed water for reuse and/or recharge applications.

Table 6-2. Wastewater Treatment Facilities		
Facility Name	**Capacity (MGD)**	**Effluent Class**
157th Ave WWTP	4.0	A+
Corgett WRF	0.8	A+
Rainbow Valley WRF	0.8	A+

6.2 COLLECTION BASINS

Wastewater collection systems are designed and configured to first utilize gravity sewers wherever possible and then lift stations and pressurized force mains only where necessary to overcome adverse grade and convey flows to treatment facilities which are typically located at the lower end of the collection basin they serve. Therefore, the topography of the project area is the primary influence on the locations chosen for the City's wastewater treatment facilities and the configuration in which the collection system develops. Additionally, collection system development must take existing sewer collection and treatment facilities and jurisdictional boundaries into consideration. The existing system is shown in Figure 6-1 with the boundaries of the sewer service area at buildout, developed in Section 2 of the IWMP

Utilizing this approach, an overall basin plan and collection system configuration was developed for the largely undeveloped remainder of the sewer service area. As addressed in Section 2 of the IWMP, the City's Sewer Service area at buildout will cover the entire study area, with the exception of WPA1 where LPSCO also provides service. By carefully evaluating the topography it was possible to establish natural gravity flow drainage basins and plant locations for the remaining portions of the City's sewer service area which is yet to be developed. The resulting proposed plant locations and drainage basins are shown in Figure 6-2. The Waterman Wash drainage basin was further divided into sub-basins to accommodate multiple plant locations. Table 6-3 provides a breakdown of the flow which will be collected within the basins and sub-basins and delivered to each of the treatment facilities at buildout.

Table 6-3. Basin and Sub-basin ADWF at Buildout

Basin Name	Facility Name	ADWF (mgd)
157th Ave	157th Ave WWTP	16.2
Corgett	Corgett WRF	1.8
Rainbow Valley	Rainbow Valley WRF	5.6
Waterman Wash Sub-basin 1	Pecos Rd. WRF	6.8
Waterman Wash Sub-basin 2	Waterman Wash WRF	9.2
Waterman Wash Sub-basin 3	Estrella WRF	2.7
	Total Service Area ADWF	42.2

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Litchfield Rd
Dysart Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
Pecos Rd
Germann Rd
Queen Creek Rd
Concord Rd
Chandler Heights Rd
Riggs Rd
Hunt Rd
Patterson Rd
303
85
10
Gila River
Agua Fria River
Waterman Wash
157th Ave WWTP
Corgett WRF
Pecos Road WRF
Rainbow Valley WRF
Waterman Wash WRF
Estrella WRF
Sub-basin 1
Sub-basin 2
Sub-basin 3

N
W E
S

1 inch equals 5,280 feet

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Legend

- Master Plan Study Area
- Street

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

Figure 6-2
Collection Basin Configuration

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

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Revised: Wednesday, June 18, 2008

6.3 MODEL CONSTRUCTION AND DEMAND ALLOCATION

A hydraulic model of the City's existing and buildout collection systems was developed to analyze the conveyance of wastewater through the collection system to the points of treatment. In the modeled system, wastewater enters at nodes using a dynamic (non-steady state) pattern that represents daily variations of incoming flow. The resulting flow is routed through the model accounting for filling and draining of the pipe volume in response to the dynamic loadings. The model predicts hydraulic performance in terms of velocity, depth of flow and other hydraulic parameters. The model also predicts lift station and force main performance when incorporated into the gravity flow collection system model. Key features of the model construction and calibration process included:

- Updating the City's existing H2OMAP sewer model to reflect current conditions and extending the model to service the buildout area.
- Allocation of base year flow using water meter records as a guide to spatial distribution.
- Allocation of buildout flow based upon the City's land use plan.
- Calibration of the model to match recorded dry weather and wet weather flow.

6.3.1 Collection System Model Construction

The City provided the existing collection H2OMAP Sewer/Pro model as the basis for further development and hydraulic analysis. Black & Veatch updated the model to reflect the City's current collection system using as-builts and other data provided by the City. The City's buildout model was created by extending the existing sewer mains and laying out new sewer mains in accordance with gravity flow basin plan developed above. Pipeline routing and sewer invert depths were initially set so as to provide continuous and smooth downhill gradients while maintaining depths of cover in the 12 to 20 foot range. Invert elevations and pipeline diameters would be refined during the hydraulic analysis process. The resulting collection system models include the following features:

- Junctions (manholes)
- Outlets (treatment plants)
- Wet wells, Pumps and Forcemains
- Links (collection system pipe network)

Further details of model construction can be found in Technical Memorandum 2-2.

6.3.2 Base Year Flow Allocation

Before allocating the base year (2007) wastewater flow of 2.88 mgd (see Section 3) it was divided into residential and non-residential components because each of these would utilize different input peaking patterns. Spatial distribution was achieved by first allocating 2004 metered water sales records to the model and then factoring the allocated loads until they matched the 2.88 mgd base year flow shown in Table 6-4.

Point sources of wastewater (Perryville Prison and Brine) were manually added into the model because these flows did not come from the spatial allocation of metered water sales. Table 6-4 summarizes the average dry weather flow (ADWF) allocated load for the base year collection system.

Table 6-4. Base Year Loads by Source

Load Category	Average Dry Weather Flow 2007 (mgd)			
	157th Ave Basin	Corgett and Rainbow Valley Basin	Rainbow Valley Basin	Total
Residential	1.10	0.49	0.11	1.70
Non-Residential	1.04	0.11	0.03	1.18
Res/Non-Res Sub-total	2.14	0.60	0.14	2.88
Brine Waste (1)	0.43			0.43
Perryville Prison	0.20			0.20
Total ADWF	2.77	0.74		3.51

(1) Includes brine waste from Well 12 and Well 19.

Once the ADWF was spatially allocated, it was necessary to apply the appropriate residential and non-residential patterns and the additional multipliers and loads which would produce the peak dry weather flow (PDWF) and peak wet weather flow (PWWF) for the existing collection system. These patterns, multipliers, and additional loads are discussed in further detail in the model calibration section

6.3.3 Buildout Flow Allocation

The projected buildout flow of 42.2 mgd was calculated based on the City's Land Use Plan and the wastewater unit rates, in gallons per acre per day, established for each land use type (see

Section 3). The same Land Use Plan and unit rates were used as the guide for allocation and spatial distribution of the buildout flow to the model. The "Allocation Manager" tool in H2OMAP Sewer was used to create Thiessen polygons around the manhole selection set or junctions to which the ADWF was allocated. The sub-basin boundaries were used in the creation process to ensure the polygons followed sub-basin boundaries. Table 6-5 shows the total buildout load allocated within each basin in the City's study area.

Table 6-5. Buildout Loads by Basin

Basin Name	Load Category	ADWF (mgd)
157th Ave	Residential	6.7
	Commercial	9.5
Total flow allocated to 157th Ave Basin		16.2
Corgett	Residential	1.6
	Commercial	0.2
Total flow allocated to Corgett Basin		1.8
Rainbow Valley	Residential	4.6
	Commercial	1.0
Total flow allocated to Rainbow Valley Basin		5.6
Waterman Wash	Residential	15.6
	Commercial	3.1
Total flow allocated to Waterman Wash Basin		18.7
Total flow allocated to Goodyear's service area		**42.2**

Unlike the base year model, there were no brine discharges allocated to the buildout model as it is assumed that brine will not be discharged to the sewer in the future in order to protect both the wastewater treatment process and reclaimed water quality. It was not necessary to manually allocate the Perryville Prison as it was automatically allocated from the Land Use Plan. As with the base year, the model applied the appropriate pattern to each load. Detailed flow calculations can be found in Technical Memorandum 2-2.

6.3.4 Model Calibration

Flow within a collection system varies continuously in response to the diurnal pattern of flow input. The collected flows undergo further change as peak flows and minimum flows travel through the collection system and combine into new patterns; and as the collection system fills and drains over the course of a typical day. The resulting flow pattern recorded at the wastewater treatment plant may differ significantly from the input pattern, with peaking attenuated and timing shifted, as affected by the collection system geometry.

The purpose of calibrating the flow model is to develop input patterns and factors such that total daily flow received at the treatment plants will not only match on a daily total basis, but also on an hourly basis over the course of the day. A model calibrated in this manner will reflect the dynamic hydraulics which occur in the collection system and can realistically reflect peak dry weather flow (PDWF) and peak wet weather flow (PWWF) throughout the system. Once these input patterns are developed, they can be applied to future models, even though the geometry of these models has changed. Detailed discussion of the calibration procedure is included in Technical Memorandum 2-2.

The model was calibrated using dry and wet weather flow records, in the form of circular charts (instantaneous flow) and daily totalized flow records available from the 157th Ave. WWTP and daily totalized flow records from the Corgett WRF. The historical flow records addressed the period from January 2001 to February 2007 for both facilities, although there were missing records for parts of this time. The collection system model was calibrated using 157th Ave WWTP influent records as Corgett flow records provided only daily totalized flow. The following dates were used for calibration purposes:

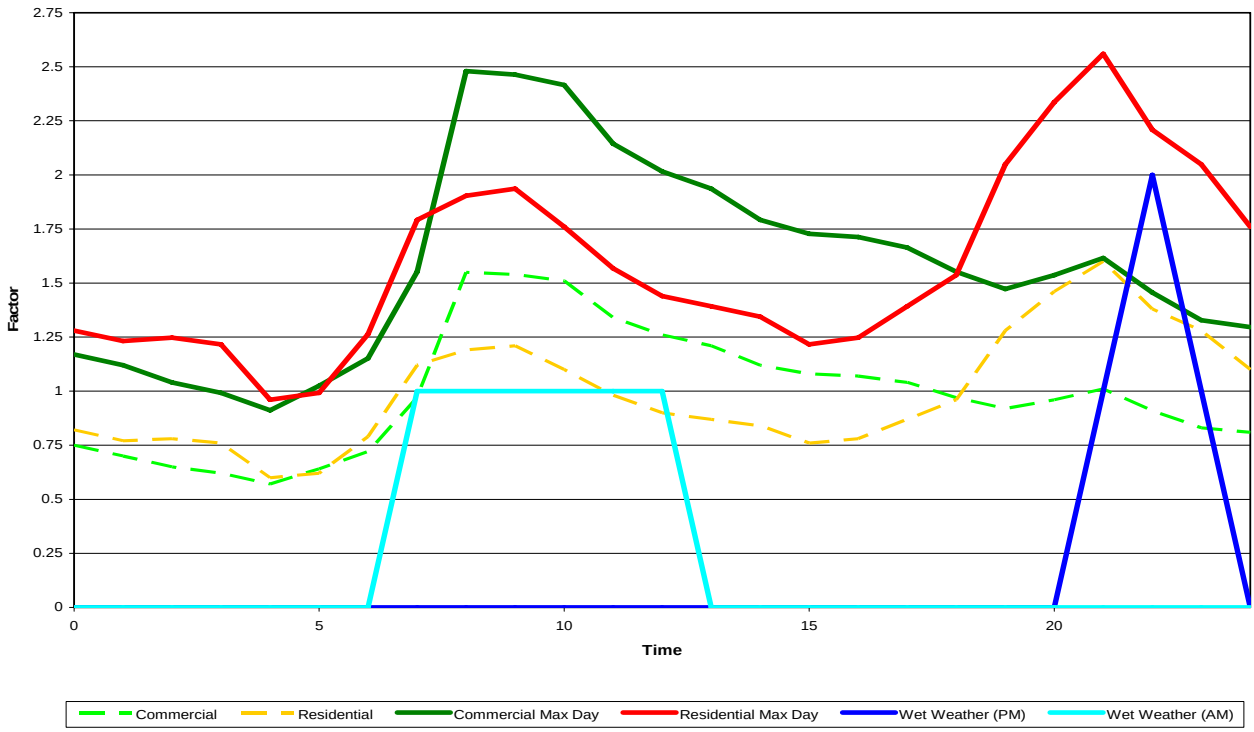
- Dry Weather - March 7, 2007
- Wet Weather - July 14, 2002

Input patterns were applied to the flows allocated to the manholes over the 48 – hour extended period simulation run. Three input patterns were created for the model simulations:

- Residential Pattern – applied at manholes receiving a residential load as dictated by the land use.
- Commercial Pattern – applied at manholes receiving a non-residential load as dictated by the land use.
- Wet Weather Pattern – a short duration pattern applied to every manhole in the system.

Figure 6-3 shows the resulting input patterns developed for use in the collection system model.

Figure 6-3. Model Input Patterns

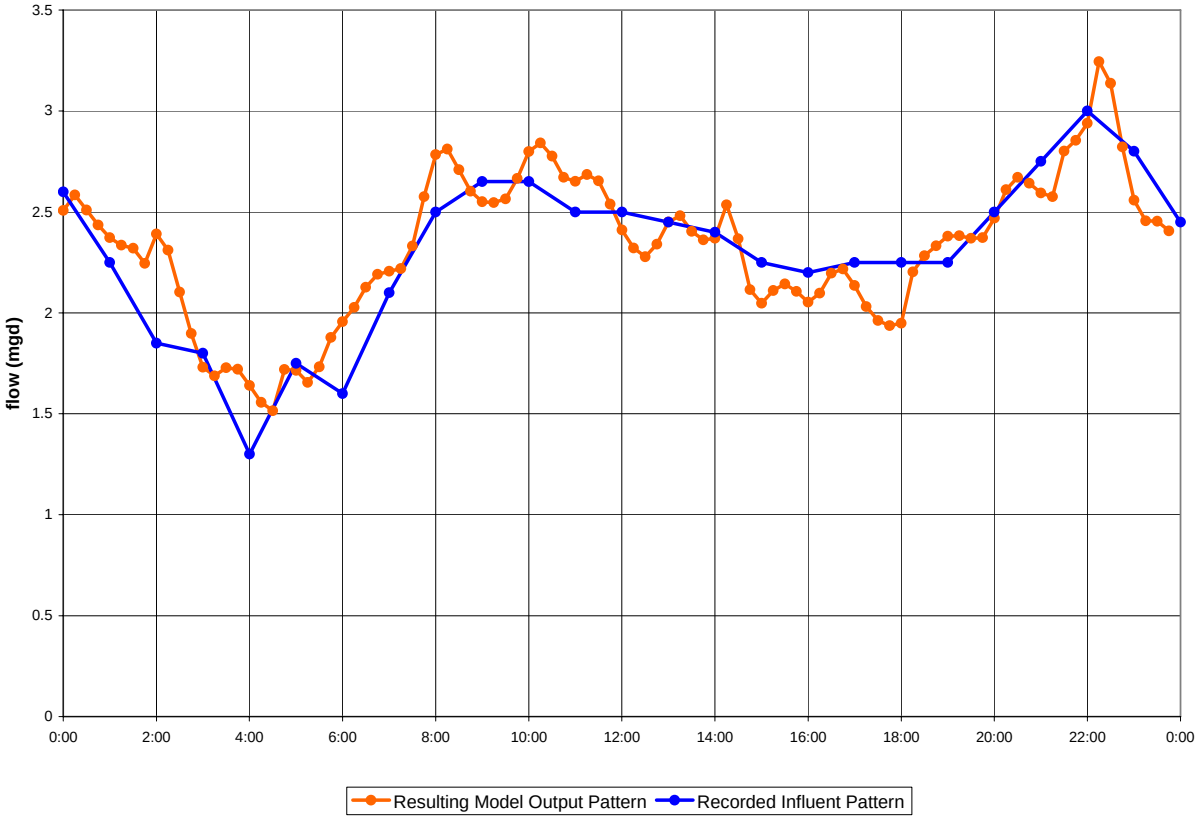


The following paragraphs summarize how each input pattern was created and applied to the model nodes.

Dry Weather Calibration

The March 7, 2007 date was chosen for dry-weather calibration because it provided recent flow data and the recorded pattern appeared to be typical for weekday dry weather flow. The allocated load was adjusted to match the calibration day inflow of 2.2 mgd and hourly input patterns, for both the residential and commercial loadings were developed and adjusted until the resulting collection system output pattern matched the pattern recorded at the 157th Ave WWTP for that day. Figure 6-4 shows the resulting model output at the 157th Ave. WWTP compared with the recorded flow seen at the plant on March 7th. Further details of the calibration process can be found in Technical Memorandum 2-2.

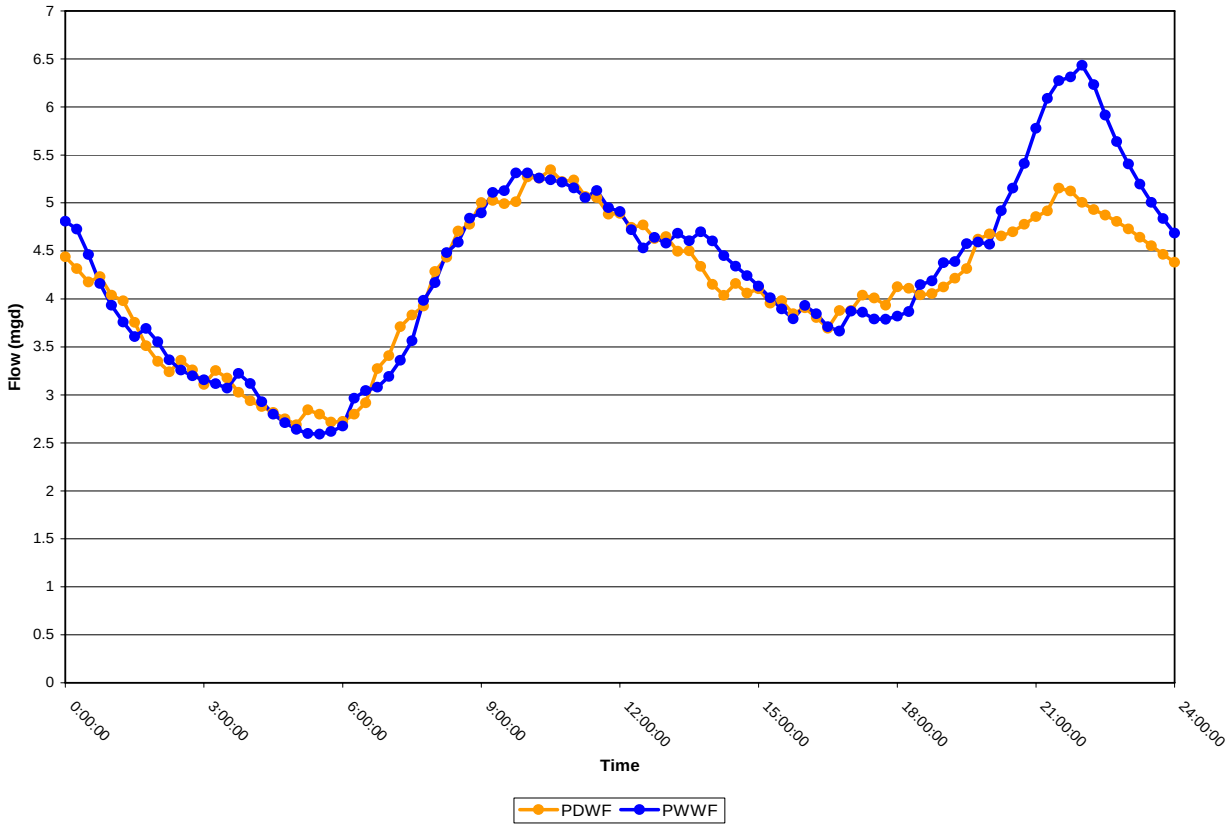
Figure 6-4. 157th Ave. WWTP Dry Weather Calibration



Wet Weather Calibration

Rainfall records from Maricopa County Flood Control District weather stations were reviewed and a rain event on July 14, 2002 was selected for calibrating the model's rainfall dependent inflow and infiltration (RDII) response. The rain event was identified on the circular flow charts in the evening of July 14th 2002 where it produced a typical short-duration, high-intensity summer rainfall reaction. A rain load and pattern were then developed and adjusted until the model produced a similar RDII response at the 157th Ave WWTP. Figure 6-5 shows the resulting PWWF output in comparison to PDWF output in the base year model.

Figure 6-5. 157th Ave WWTP Calibrated PDWF and PWWF Flow Curves



Design Rain Event

In order to see the potential impact of RDII on the collection system hydraulics, the rain event must be programmed to occur on top of the dry weather peak so as to contribute to an even higher peak flow. If the rain contribution entered the system at non-peak hours, it would not be possible to model and design for the potentially higher flows which can occur during significant rain events. The time at which dry-weather peaking occurs within each basin depends on the proportional mix of residential and non-residential customers therefore it was necessary to fit each basin with the correct rain pattern.

As is shown in Figure 6-4, dry weather peaking in the 157th Ave Basin is roughly equal from morning to evening reflecting the current balance of residential and non-residential customers. However, by buildout, the majority of the flow will be from non-residential customers and the dry weather peak flow will occur in the morning due to the dominant effect of the non-residential

pattern. In the largely residential southern basins, the opposite occurs, with peak dry weather flow occurring in the early evening due to the dominant effect of the residential pattern.

Therefore, two types of rain events were created, an evening rain event which would be utilized in the southern basins and a morning rain event which will be utilized in the 157th WWTP basin. Table 6-6 summarizes the characteristics of each rain event.

Table 6-6. Design Rain Event Characteristics

Summer Rain Event	Winter Rain Event
High-Intensity	Moderate Intensity
Short Duration	Moderate Duration
Load = 400 gpad	Load = 200 gpad
Duration = 1 hour	Duration = 4 hours
Applied to evening peaks	Applied to morning peaks
Corgett, Rainbow & Waterman	157th Ave WWTP Basin

SCADA Data

It is known that the City is implementing a significant expansion and upgrade to their SCADA system. In preparation for future modeling efforts, it is recommended that the City monitor flow at additional points and ensure that all flow data is recorded in the interim period until the next IWMP update is produced. The following data should be recorded by the City's SCADA system:

- Influent flow records, with both totalized and instantaneous flow readings at all wastewater plants.
- Lift Station flow records and/or pump run times at all wastewater lift stations.

Prior to the next master plan update, the City should also prepare and execute a collection system flow monitoring / rainfall monitoring plan designed to gather flow data and rainfall data from key points within the collection system basins. The monitoring plan data will supplement the City's SCADA records and provide an even better basis for future calibration efforts.

6.4 HYDRAULIC ANALYSIS AND RESULTS

6.4.1 Summary of Analyses

A number of model scenarios were formulated in order to analyze collection system performance and determine the improvements required to provide service under future wastewater flow conditions. The hydraulic model studies were all performed using extended period simulations (EPS) or dynamic modeling. This approach considers diurnal variations in flow input and differences in travel time for system flow peaks (time of concentration) as well as system filling and draining. The following list summarizes the EPS hydraulic analyses performed.

- Base Year Average Dry Weather Flow
- Base Year Peak Dry Weather Flow
- Base Year Peak Wet Weather Flow
- Base Year Peak Wet Weather Flow + 1,000gpm LPSCO Flow
- Buildout Average Dry Weather Flow
- Buildout Peak Dry Weather Flow
- Buildout Peak Wet Weather Flow

Model output from the above runs was analyzed and recommended improvements to the collection system were identified with the goal of:

- Identifying locations in the existing collection system where overloading or surcharging will occur under current or future loadings.
- Providing relief to overloaded segments in the most efficient manner either by paralleling or replacing sewer lines or re-routing future flow.
- Designing the collection system serving each basin so as to minimize lift stations.
- Determining the optimum slope and diameter for all new pipelines so that adequate velocity is maintained at an efficient depth of flow (d/D).

6.4.2 Collection System Pipe Network

Wastewater collection systems are designed to utilize gravity sewers to the extent possible and lift stations / pressurized force mains where necessary to collect and convey flow to the treatment facility. The topography of the service area greatly influences the nature and configuration of the collection system which is developed. The criteria used for design of the wastewater collection system are shown in Table 6-7 below. Additional guidelines from ADEQ Bulletin 11 were used where applicable.

Table 6-7. Gravity Main Hydraulic Design Criteria	
Criteria	**Value**
Velocity – Gravity Sewer	
Minimum Average Velocity	2.5 fps
Maximum Velocity	10 fps
Depth of Flow (d/D)	
Peak Dry Weather Flow	0.60
Peak Wet Weather Flow	0.65
Capacity Calculation	
Mannings (n)	0.013
Depth to Invert – Gravity Sewer	12 – 20 ft

In the hydraulic model results, an overloaded pipe is defined as a pipe carrying flow equal to, or greater than, the pipe's "design capacity". Design capacity of a gravity sewer pipe is defined as the flow which generates a liquid depth of 65 percent of the pipe diameter under PWWF conditions.

6.4.3 Base Year Analysis and Recommendations

The base year collection system analysis consisted of three basins and conveyance of LPSCO flows to the 157th WWTP and Figure 6-6 shows the results, highlighting those areas where the systems design capacity has been exceeded. The two areas within the existing system exceeding the d/D design standard are briefly described below:

Bullard. Under current PWWF base year loadings the 12-inch segment located west of Bullard Wash along Lower Buckeye Rd. is surcharging. The decision was made that specific replacement of the pipe would not be recommended since flow will be re-routed through a new Bullard 36-inch pipeline currently under construction. Re-routing the flow eliminates the surcharging in the Bullard pipeline.

Lift Stations. It is recommended that the City confirm the optimum pump settings are being used for both the Del Camino and Wells Fargo lift stations. The pipes downstream from both of these lift stations experience surcharging or d/D ratios greater than the design standard of 0.65 under base year PWWF loadings. The pump settings should be revised to operate such that under normal fill and drain only one pump comes on. Future recommended improvements will re-route portions of the flow into the Bullard system.

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
303
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
10
85
Gila River
Agua Fria River
Waterman Wash
LIFT STATIONS
Del Camino LS
Palm Valley LS
Wells Fargo LS
BULLARD
Bio-Flora LS
Rubbermaid LS
157th Ave
WWTP
Corgett
WRF
Lost LS
Ricardo LS
Irene LS
Lum Wash LS
Rainbow Valley LS
Rainbow Valley
WRF

Christina Hassell 27 Aug 2007
\\Projects\GoodYear\11GIS\01MapDocuments\Base Year Wastewater.mxd

N
W E
S

1 inch equals 3,000 feet

Legend

- Master Plan Study Area
- Water Reclamation Facility
- Wastewater Treatment Plant
- 0.66 d/D => 0.65
- Lift Station

Pipes

- Force Main
- 157th Avenue
- Corgett
- Rainbow Valley

Data Sources:
City of Goodyear GIS
ESRI

Figure 6-6
Base Year, Model Output: Areas of Hydraulic Stress

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City of Goodyear, AZ
2007

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A detailed discussion of the collection system analysis is included in Technical Memorandum 2-2. A summary of the findings is presented in the following:

- 157th Ave WWTP Basin PWWF loadings identified two main locations where the design d/D of 0.65 was exceeded. However, no improvements were recommended in these specific areas as the overloading is not currently severe and it was possible to re-route flow through later collection system improvements associated with buildout. The future improvements, provided in other areas, were shown to relieve the stress points seen in the base year model. These areas should be monitored until the future improvements are made

- Temporary conveyance of 1,000 gpm from LPSCO to the 157th WWTP can be accommodated without causing the existing collection system to overload or surcharge. The flow was assumed to be input at McDowell and Sarival Ave. as a steady 1,000 gpm load.

- Corgett and Rainbow WRF Basins showed no areas where the design d/D of 0.65 was exceeded under current PWWF. Hydraulic performance within the Corgett and Rainbow basins is currently acceptable.

6.4.4 Buildout Analysis and Recommendations

Following the base year analysis, the gravity mains were analyzed under the projected buildout conditions. Figure 6-7 shows the resulting recommended buildout wastewater infrastructure layout for the 157th Ave Basin along with the recommended sewer main diameters. Figure 6-8 shows the resulting recommended buildout wastewater infrastructure layout for the Corgett, Rainbow Valley, and Waterman Wash Basins. Detailed hydraulic reports showing pipe performance can be found in Technical Memorandum 2-2.

The buildout model incorporates both existing lines in the 157th, Corgett, and Rainbow Valley Basins as well as new lines which were extended out into areas of future development. New lines were input at depths which conformed to the topography and which yielded proper slope. The results and key findings can be summarized as follows:

Bethany Home Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
El Mirage Rd
303
85
Indian School LS
Del Camino LS
Palm Valley LS
Wells Fargo LS
Las Brisas LS
Rubbermaid LS
Bio Flora LS
Lakin LS
157th Ave WWTP
Buckeye Canal LS
Estrella Mountain Park LS
Extension Canal LS
Kings Ranch LS
Gila River
Agua Fria River

Legend

- Master Plan Study Area
- Street
- Lift Station
- Wastewater Treatment Plant

Pipes

- Force Main
- 157th Avenue

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

N W E S

1 inch equals 0.5 miles

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Figure 6-7
Build Out Collection System
157th Avenue Basin

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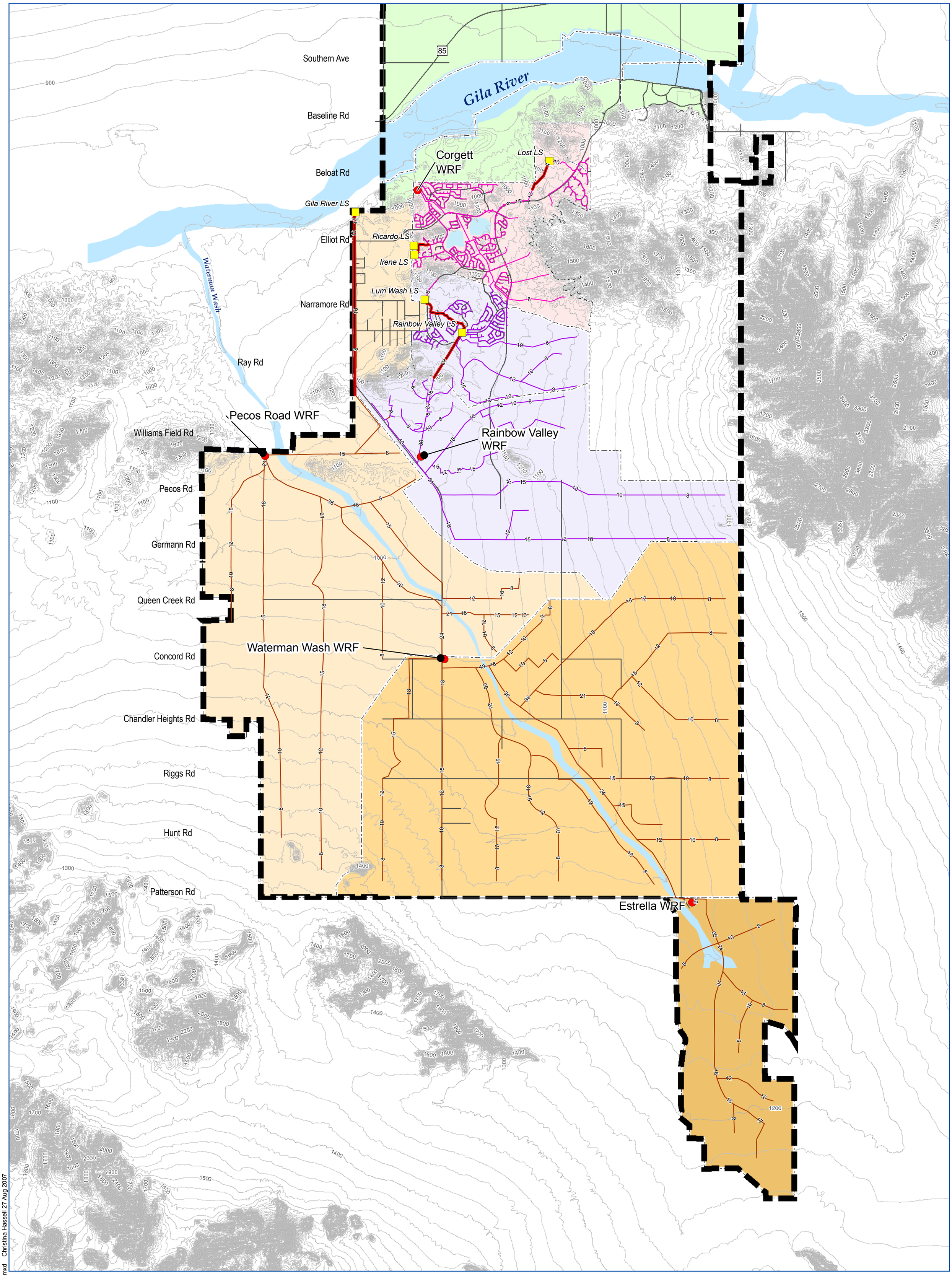

N
W E
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1 inch equals 0.8 miles

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Legend

- Master Plan Study Area
- Street
- Lift Station
- Water Reclamation Facility

Pipes

- Force Main
- Corgett
- Rainbow Valley
- Waterman Wash

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

Figure 6-8
Build Out Collection System Corgett, Rainbow Valley, & Waterman Wash Basins

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\\Projects\GoodYear\11GIS\01MapDocuments\BuildoutCollection System.mxd Christina Hassell 27 Aug 2007

157th Basin General Results

Overloading of existing collection lines was generally solved through implementation of the buildout system. There are few segments of existing pipelines which exceed d/D of 0.65 under PWWF, however the overloading is minimal (no surcharging) and it was not judged severe enough to merit line replacement or paralleling. The following descriptions and Figure 6-9 show the location of the stressed pipe segments.

McDowell Rd. The 18-inch pipeline in Mc Dowell Rd experiences minimal hydraulic stress at buildout. A 24-inch parallel line in Mc Dowell Rd relieves some of the surcharging the 18-inch line would have experienced at buildout by carrying much of the flow from the 18-inch line in Citrus Rd. The d/D values experienced in the 18-inch Mc Dowell Rd. pipeline range from 0.66 – 0.68.

Sarival Ave and Elwood Rd. With the additional service area north of the I-10 being routed south through the Sarival Ave and Elwood Rd. pipelines many pipe segments experience hydraulic stress as shown in Figure 6-9. d/D values along theses pipe lines range from 0.66 – 0.81. Due to higher d/D values, this pipeline should be monitored once it begins accepting flow from newly developed areas.

Pebble Creek. The pipe connecting the Pebble Creek development to the 157th Ave Basin south of I-10 experiences marginal stress with d/D values ranging from 0.66 to 0.69. If this line is to serve more development in the future, flows should be closely monitored in this pipe segment.

Lift Stations. To reduce the surcharging experienced downstream from both the Del Camino and Wells Fargo Lift Stations, the pump controls were adjusted in the model for both lift stations. A new force main was recommended to convey flow from the Wells Fargo lift station south into the Bullard collection system. The pump adjustment and flow re-routing lessened the stress on this system; however, some pipes still exceed the design d/D of 0.65 and should be monitored closely as loads approach buildout.

Broadway Rd. It can be seen in Figure 6-9 that several pipe segments east of Estrella Parkway experience d/D values ranging from 0.66 – 0.68 at PWWF loadings. This area should be monitored as its service area approaches buildout.

The above segments should be monitored in future modeling efforts. All new collection mains added within the basin comply with the design criteria in terms of depth of flow and velocity

under buildout loadings. Further details of the recommended 157th Ave Basin collection system are summarized below.

157th Ave WWTP North Plant Interceptor

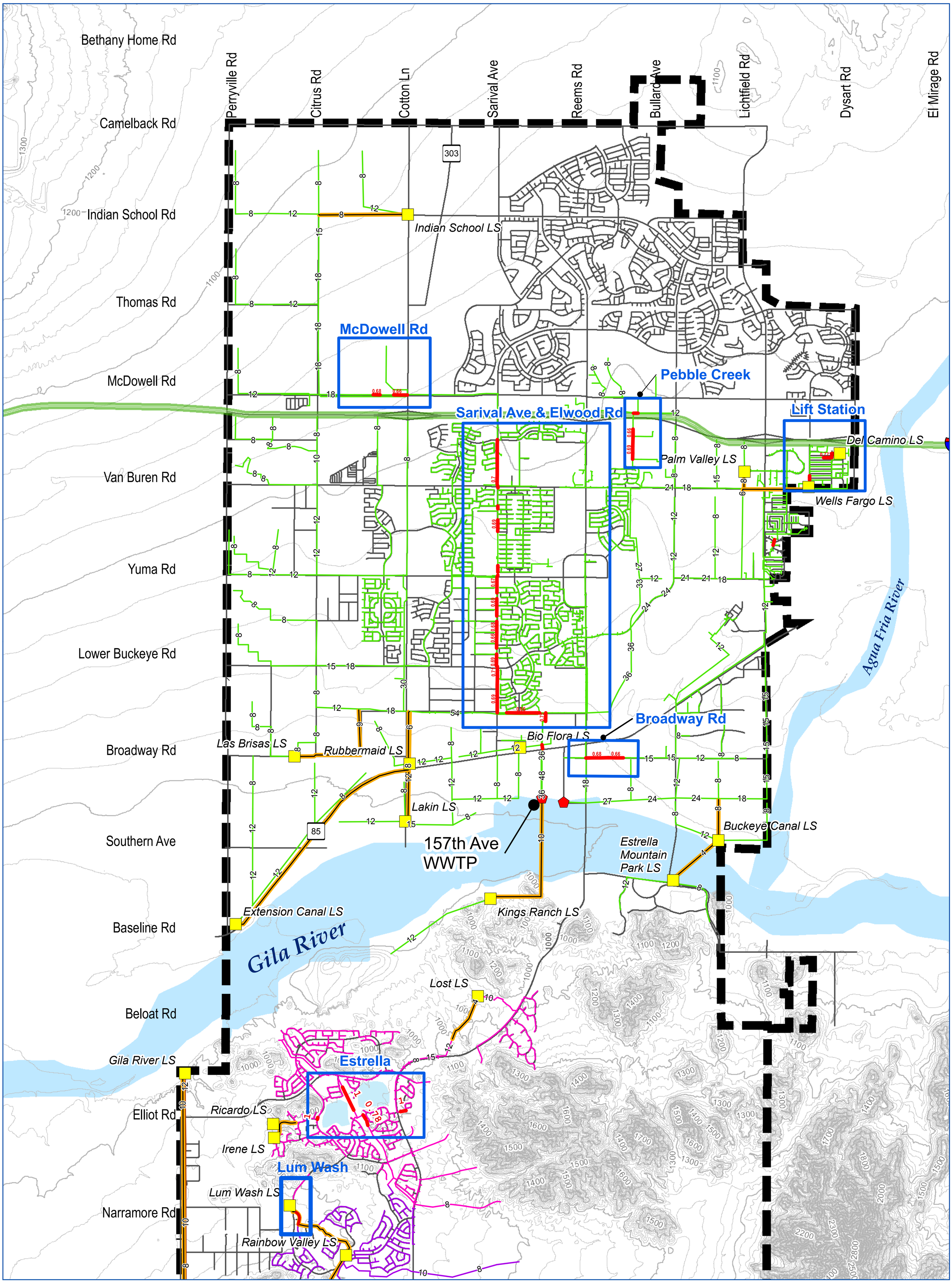
A new North Plant Interceptor was modeled to handle incoming flow delivered primarily through the Dunlap Ave and the Bullard Wash Interceptors. The hydraulic capacity of the existing interceptor is adequate to carry buildout flow rates to junction 4656 (end of pipe 9B6C5), just south of the railroad line, at which point a new 48-inch line (paralleling the existing 36-inch line) will connect to the 157th Ave WWTP. The parallel 24-inch line will be abandoned.

157th Ave WWTP East Plant Interceptor

The new 30-inch East Plant Interceptor was designed to extend service into currently un-sewered areas to the east of the plant and to operate by gravity flow. In addition to serving areas of new development in the east, the new interceptor will pick-up flow which is currently conveyed southward along Litchfield Park Ave and then along the 15-inch line in MC 85 and re-route this flow through the new interceptor. Doing so frees-up capacity in the MC 85 sewer line to handle increased future flow collected south of the airport.

Bullard Wash Collector

The new 36-inch Bullard Wash Interceptor was designed to extend service, by gravity flow, into currently un-sewered areas along Bullard Wash and north of the airport; approximately Bullard to Litchfiled and Yuma to Van Buren. In addition to serving areas of new development north of the airport, flow from the Wells Fargo Lift Station will be re-directed and will be input into a new 12-inch line in the upper reaches the Bullard Wash system.



1 inch equals 0.5 miles

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Legend

- d/D => 0.65
- Master Plan Study Area
- Street
- Wastewater Treatment Plant
- Lift Station

Pipes

- Force Main
- 157th Avenue
- Force Main
- Corgett
- Rainbow Valley
- Waterman Wash

Figure 6-9
Build Out,
Model Output:
Areas of Hydraulic Stress

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Corgett Basin General Results

Overloading of existing collection lines was generally solved through implementation of the buildout system. There are few segments of existing pipelines which exceed d/D of 0.65 under PWWF, however the overloading is minimal (no surcharging) and it was not judged severe enough to merit line replacement or paralleling. These segments should be monitored in future modeling efforts. All new collection mains added within the basin comply with the design criteria in terms of depth of flow and velocity under buildout loadings.

Estrella Mountain Ranch. The 15-inch pipe flowing north to Elliot Rd. experiences surcharging and hydraulic stress under PWWF buildout loadings. It was determined that the inverts of these pipe segments could be lowered and still tie into the existing system creating a steeper slope to the pipe segment and relieving the surcharging in the pipe segments. It is recommended that as this area approaches buildout that this pipe be replaced by a new 15-inch pipe utilizing a steeper slope.

Lum Wash. Many 10-inch pipe segments from the intersection of Ocotillo and 184th flowing north to the Lum Wash lift station experience surcharging and hydraulic stress under PWWF buildout loadings. It was determined that the inverts of the pipe segments upstream of the 10-inch line flowing into the lift station could be lowered and still tie into the existing system creating a steeper slope to the pipe segments and relieving the surcharging. It is recommended that as this area approaches buildout, this pipe be replaced by a new 10-inch pipe utilizing a steeper slope.

The above segments should be monitored in future modeling efforts. All new collection mains added within the basin comply with the design criteria in terms of depth of flow and velocity under buildout loadings.

Rainbow Basin General Results

The southern influent main to the Rainbow Valley WRF became surcharged under buildout loadings and will require replacement from manhole CH1273 to manhole CH893. It is anticipated that the plant will be operated in the future with two influent pumping stations due to the significantly different depths of the existing northern and southern influent sewers. All new collection mains added within the basin comply with the design criteria in terms of depth of flow and velocity under buildout loadings.

Waterman Basin General Results

The Waterman Basin was designed to operate without any lift stations, using gravity flow to collect and convey wastewater to the three Waterman Basin Plants. All new collection mains added within the basin comply with the design criteria in terms of depth of flow and velocity under buildout loadings.

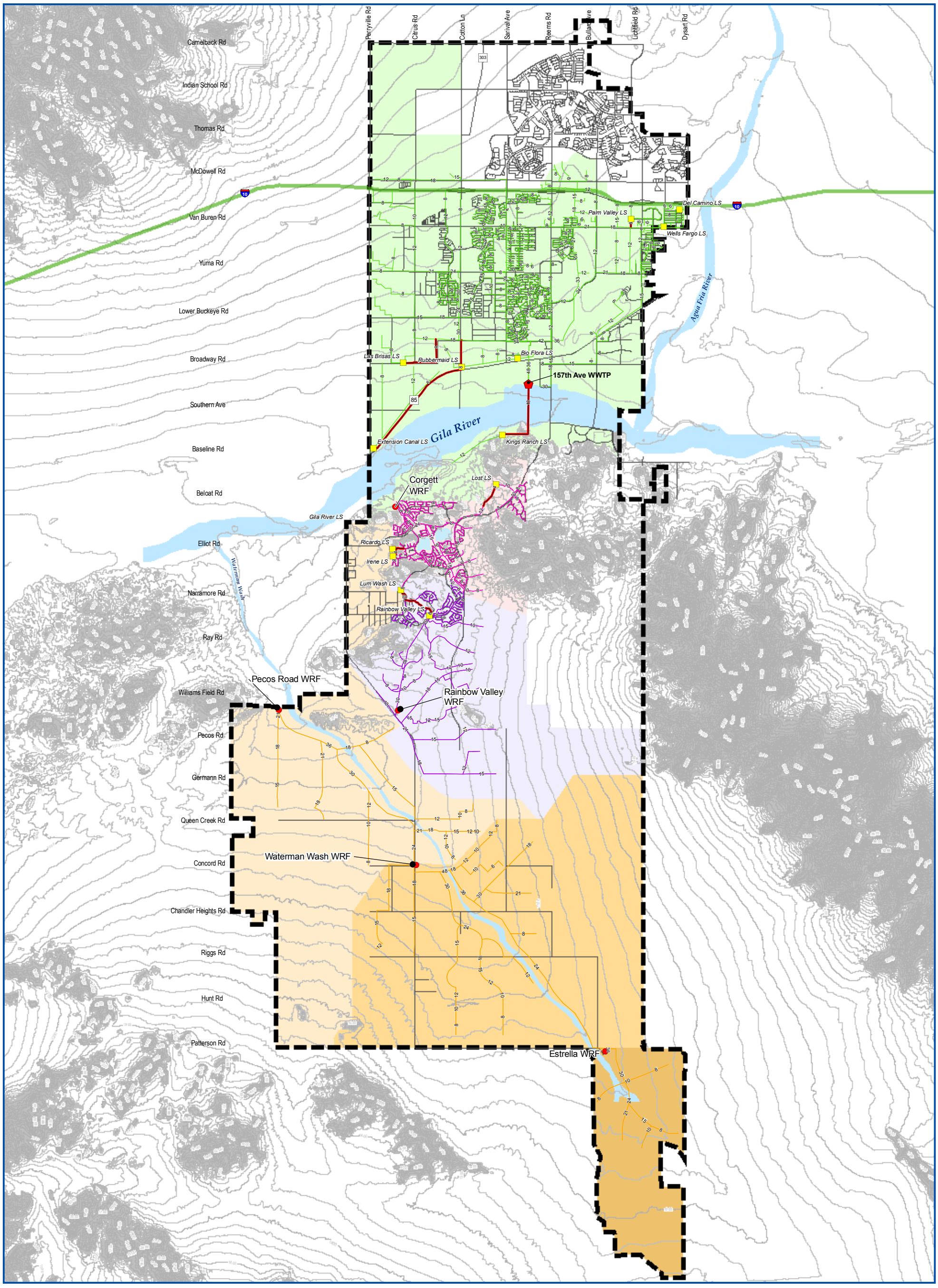
Waterman Wash Interceptor

The trunk interceptor was located along the Waterman Wash and connects between the three reclamation facilities so that the following features could be provided:

- Gravity Flow Operation. The interceptor and collectors are routed along natural flow paths and located at a depth which will support wastewater collection in the Waterman Basin without lift stations.

- Bypass Conveyance Capacity. The Waterman Wash Interceptor was designed with additional capacity, which will allow 25 percent of the Estrella WRF influent to be diverted downstream to the Waterman Wash WRF and 25 percent of the Waterman Wash influent to be diverted to the Pecos Rd. WRF. This would allow; 1) flow to be diverted to a downstream plant in an emergency/maintenance situation and 2) flow to be directed to plants which have been recently expanded and have available capacity thereby improving plant utilization.
- Solids Conveyance. Solids produced at the Estrella WRF are to be conveyed to the Waterman Wash WRF via the Waterman Wash Interceptor. This eliminates the need for solids treatment facilities at the smaller Estrella WRF.

An intermediate year (2017) collection system can be seen in Figure 6-10. The boundaries of the intermediate growth were projected from information provided by developers and input from the City. As growth occurs in each basin, the collection system should be extended outward by constructing lines of the indicated size required for buildout flow.



N
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1 inch equals 2 miles

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Legend

- Master Plan Study Area
- Street
- Water Reclamation Facility
- Wastewater Treatment Plant
- Lift Station

Pipes

- Force Main
- 157th Avenue
- Corgett
- Rainbow Valley
- Waterman Wash

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

Figure 6-10
Intermediate Year Collection System

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6.4.5 Lift Stations and Force Mains

New lift stations were sized to accommodate the peak wet weather flow at buildout. The criteria used to size and hydraulically model the lift stations and force mains are shown in Table 6-8.

Table 6-8. Lift Station and Force Main Hydraulic Analysis Criteria

Criteria	Value
Velocity – Force Mains	
Minimum Average Velocity	2.0 fps
Maximum Velocity	6.0 fps
Lift Station Firm Capacity	Peak Wet Weather
Lift Station Configuration	0.60
Flow < 1.0 mgd	Duplex
Flow 1.0 to 2.0 mgd	Duplex or Triplex
Flow > 2.0 mgd	Triplex or Greater

The existing system's lift stations were analyzed under peak wet weather flows and it was determined the current size of all the lift stations was adequate. However, it was noted that slight adjustments to some of the lift station pump controls would optimize the lift station and force main performance.

The City's buildout collection system will include seventeen lift stations at buildout as shown on Figure 6-7 and 6-8, however, nine of the buildout lift stations currently exist. Table 6-9 lists all seventeen recommended lift stations at buildout, the required firm pumping capacities, and force main diameters.

Table 6-9. Buildout Collection System Lift Station Capacity Summary

Lift Station/Capacity	PWWF (mgd)	Installed Capacity (mgd)	Firm Capacity (mgd)	Force Main Diameter (in)
Bio Flora				
Current	0.21	0.80	0.40	6
Buildout	0.47	0.92	0.46	6
Buckeye Canal				
Current	N/A	N/A	N/A	N/A
Buildout	0.88	1.70	0.85	8
Del Camino				
Current	0.08	0.80	0.40	8
Buildout	0.05	0.86	0.43	8
Estrella Mtn. Park				
Current	N/A	N/A	N/A	N/A
Buildout	0.15	0.30	0.15	4
Extension Canal				
Current	N/A	N/A	N/A	N/A
Buildout	1.56	3.00	1.50	8
Gila River				
Current	N/A	N/A	N/A	N/A
Buildout	1.70	3.40	1.70	10
Indian School				
Current	N/A	N/A	N/A	N/A
Buildout	0.75	1.50	0.75	8
Irene				
Current	0.04	0.40	0.20	4
Buildout	0.09	0.40	0.20	4
Kings Ranch				
Current	N/A	N/A	N/A	N/A
Buildout	2.15	4.40	2.20	10
Lakin				
Current	N/A	N/A	N/A	N/A
Buildout	2.47	5.0	2.5	12
Las Brisas				
Current	N/A	N/A	N/A	N/A
Buildout	0.57	1.20	0.60	6
Lost				
Current	0.19	2.0	1.0	8
Buildout	0.68	2.0	1.0	8
Lum Wash				
Current	0.35	0.20	0.10	8
Buildout	0.69	1.80	0.90	8
Palm Valley				
Current	0.56	1.0	0.50	8
Buildout	0.62	1.20	0.60	8
Rainbow Valley				
Current	0.90	6.70	4.50	12
Buildout	4.20	8.40	4.20	2 - 12
Rubbermaid				
Current	0.12	0.60	0.30	4
Buildout	0.56	1.10	0.55	6
Wells Fargo				
Current	0.46	0.80	0.40	6
Buildout	0.39	0.80	0.40	6

It was assumed in the model that all pumps were constant speed. In each duplex (two pumps) lift station, the second pump provides redundancy to the first pump. Firm pumping capacity of these lift stations equates to single pump operation and the associated force main was sized to carry the PWWF for the duplex station. For a triplex (three pumps) lift station, the third pump provides the redundant capacity and firm capacity equates to two pumps in operation. The force main for the triplex station was sized to carry the PWWF as well as maintain an acceptable velocity at half the PWWF. In general, it is recommended that lift stations have firm pumping capacity equal to or slightly greater than the estimated peak inflow received by the station.

To accommodate current and intermediate loadings, smaller capacity submersible pumps can be installed initially in duplex stations. Triplex stations will operate initially utilizing the capacity of one duty pump. Lift station designers should verify that initial force main velocity will be in the 2 to 4 ft/sec range with final velocity in the 5 to 6 ft/sec range.

6.4.6 Wastewater Treatment

The City currently operates three wastewater treatment facilities serving the 157th Ave, Corgett, and Rainbow Valley Basins. At buildout, it is recommended the City build three new treatment plants as well as expand the capacity of the existing wastewater treatment plants. The main hydraulic design criteria for sizing the treatment plant nominal capacity was the annual average day flow seen at the incoming interceptors.

Table 6-10 shows the projected intermediate and buildout capacity required at the reclamation facilities treating wastewater collected in the service area. The capacity shown has been rounded upward from the actual projected flow to a nominal value to be used for plant design. Intermediate year capacity is based upon projected growth in each basin and builds incrementally to the nominal buildout rating. The schedule shown for the construction of intermediate year reclamation facilities may need to be adjusted to accommodate the actual pace of growth within each basin. The capacity shown for the Waterman Wash and Pecos Road WRFs does not include any additional capacity which would allow the upstream WRFs to bypass flow.

Table 6-10. Wastewater Treatment Facility Phasing

Planning Phase	Near Term						Intermediate Term						Long Term		Buildout	
Year	2007		2008	2009	2010	2011	2012		2013	2014	2015	2016	2017		2045	
Facility	Flow (mgd)	Plant Size					Flow (mgd)	Plant Size					Flow (mgd)	Plant Size	Flow (mgd)	Plant Size
157th Ave WWTP	3.1	4.0	4.0	8.0	8.0	8.0	5.4	8.0	8.0	8.0	12.0	12.0	9.0	12.0	16.2	18.0
Corgett WRF	0.2	0.8	0.8	0.8	0.8	0.8	0.7	1.0	1.0	1.0	1.0	1.0	1.1	1.4	1.8	2.0
Rainbow WRF	0.4	0.8	0.8	1.5	1.5	1.5	1.3	3.0	3.0	3.0	3.0	3.0	2.4	3.0	5.6	6.0
Pecos WRF	--	--	--	1.25	1.25	2.5	2.5	2.5	3.0	6.0	6.0	6.0	5.0	6.0	6.8	8.0
Waterman WRF	--	--	--	1.25	1.25	2.5	1.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0	9.2	10.0
Estrella WRF	--	--	--	--	--	--	--	--	--	2.0	2.0	2.0	1.5	2.0	2.7	3.0
Total Capacity	**3.7**	**5.6**	**5.6**	**12.8**	**12.8**	**15.3**	**11.4**	**17.0**	**18.0**	**23.0**	**27.0**	**27.0**	**22.0**	**27.4**	**42.2**	**47.0**

Table 6-11 shows the resulting peaking factor for PWWF at each of the WRFs under buildout flow as determined from the model. At interim levels of system development, the PWWF can be assumed to be higher than the factors shown here. The actual design of the plant's headworks and other hydraulic features should provide an appropriate margin of safety at all phases of the plants design.

Table 6-11. Wastewater Treatment Influent Peaking

Facility Name	ADWF (mgd)	PWWF (mgd)	PWWF Factor
157th Ave. WWTP	16.2	40.1	2.5
Corgett WRF	1.8	4.8	2.7
Rainbow Valley WRF	5.6	13.7	2.4
Pecos Rd. WRF	6.8	21.1	3.1
Waterman Wash WRF(1)	9.2	16.9	1.8
Estrella WRF(1)	2.7	4.9	1.8

(1) 25% of inflow by-passed to downstream trunk

SECTION 7

RECLAIMED WATER SYSTEM ANALYSIS AND CAPITAL IMPROVEMENT RECOMMENDATIONS

7.1 INTRODUCTION

The reclaimed water system will play a critical role in the City's future; ensuring that the 42.7 million gallons of reclaimed water produced each day at Buildout (47,800 ac-ft / year) are beneficially reused or recharged. Reuse; primarily for the irrigation of parks, golf courses and other large turf / landscaping areas, will peak in the summer months, and the reclaimed water delivered for this purpose will reduce the stress on the City's potable water infrastructure and resources. In a complementary pattern, recharge of the unused balance of the reclaimed water supply will peak in the winter months, and will provide recharge credits which are vital to putting the City's future groundwater utilization on a sustainable safe-yield basis.

The purpose of this section of the IWMP is to develop the future system of reclaimed water infrastructure which will permit beneficial reuse or recharge of 100 percent of the City's reclaimed water each year. This section of the IWMP will develop the recommended reuse system infrastructure; addressing the following items:

- Existing Reuse System Infrastructure
- Water Quality Requirements
- Hydraulic Model Construction
- Reclaimed System Analysis and Recommended Infrastructure

7.2 EXISTING RECLAIMED WATER SYSTEM INFRASTRUCTURE

As part of the IWMP, Black & Veatch prepared a Facility Inventory (TM1-1) which provides a comprehensive inventory of the City's existing water, wastewater and reclaimed water infrastructure. The components of the existing reclaimed water system are shown on Figure 7-1 and summarized below. Additional details of these facilities; including schematics, operational diagrams, performance parameters, etc., can be found in TM1-1. The Facility Inventory provides a valuable source of information for the hydraulic modeler as well as for the City's operations

and engineering personnel. Existing reclaimed water infrastructure is fairly limited and consists of the following systems:

157th Ave WWTP System. Reclaimed water produced at the 157th Ave WWTP is currently recharged at the SAT Site or used for construction. The existing reclaimed water system consists of:

- Reclaimed water pumping station at the 157th Ave WWTP
- 24-inch Reclaimed Water Transmission Main
- 4,480 af/yr Soil Aquifer Treatment (SAT) Site

Corgett WRF System. Reclaimed water produced at the Corgett WRF is not at this time reused or recharged but instead is discharged to the Corgett Wash. It is anticipated that once improvements are made to the Corgett WRF to increase its filtration capacity, it will be connected into the Estrella Mountain Ranch non-potable distribution system, where it will be used for irrigation.

Rainbow Valley WRF System. Reclaimed water produced at the Rainbow Valley WRF is currently delivered through a 16-inch transmission main to the Estrella Mountain Ranch non-potable distribution system, where it is used for irrigation.

Estrella Mountain Ranch Non-Potable Water System. A privately owned, non-potable water system, in the community of Estrella Mountain Ranch (EMR), which consists of the following components:

- Wells H3, G1, H10 and H7 located in WPA4
- 24-Inch Groundwater Transmission Main
- Lakeside Non-Potable Water Pumping Station
- Non-potable Water Distribution System

Groundwater pumped from the wells in WPA4, is delivered to large lakes in the EMR Community via the 24-inch main. The groundwater is then pumped from the lakes and used to irrigate golf-course turf, community parks, and other landscaping via a non-potable water distribution system consisting of 6 thru 16-inch pipelines. The system is currently owned and operated by the developer, Newland Communities and the EMR Home Owner's Association. It is anticipated that the non-potable distribution system will be incorporated into the larger

City of Goodyear Reclaimed Water System in the near-term and will be supplied with and deliver only reclaimed water. However the wells, 24-inch groundwater transmission main and non-potable water pumping station will not be transferred to the City or utilized in the City's reclaimed water system.

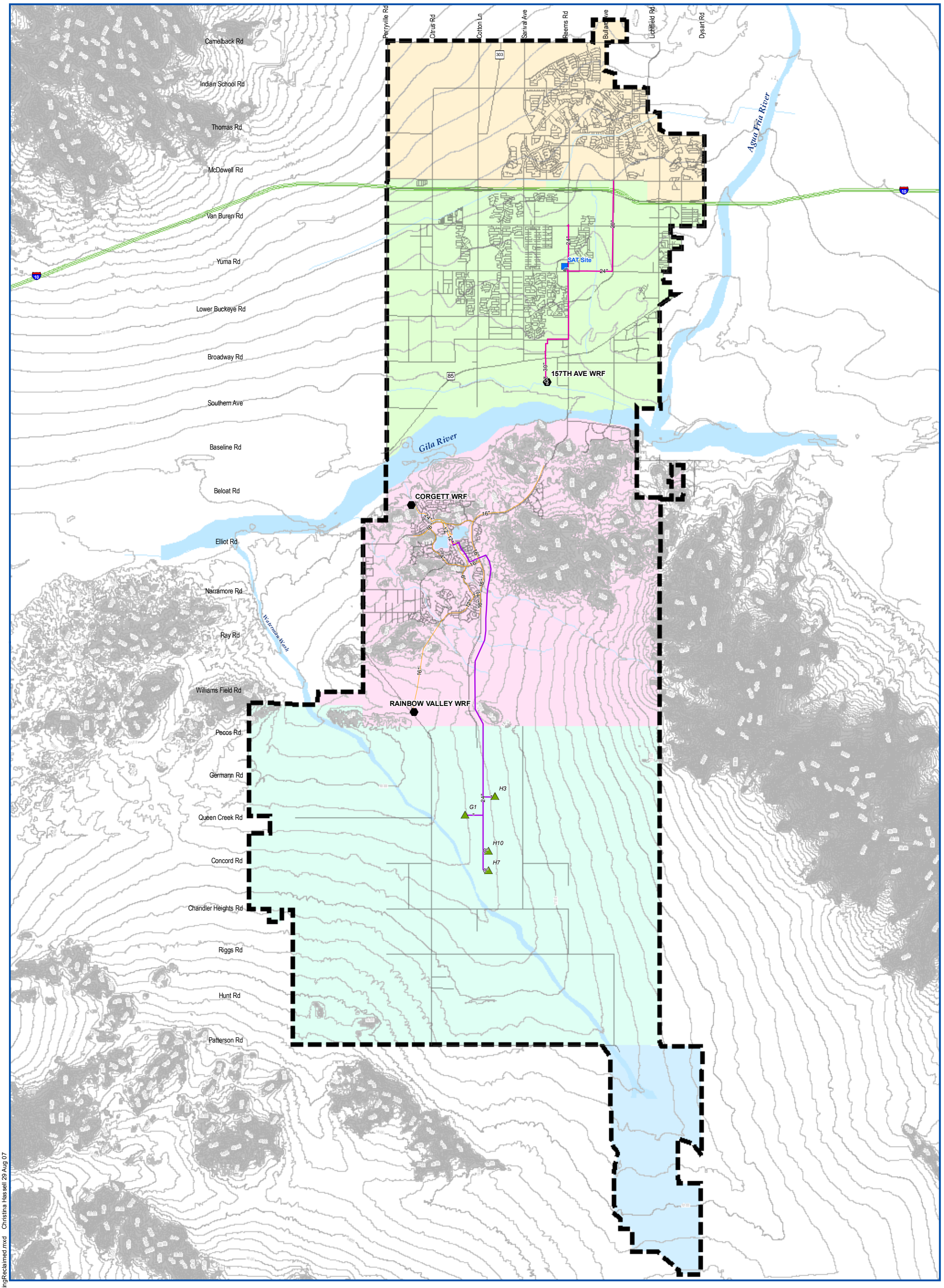


Figure 7-1
Existing Reclaimed Water System
Integrated Water Master Plan
City of Goodyear, AZ
2007

Revised: Wednesday, March 26, 2008

7.3 RECLAIMED WATER QUALITY

Reclaimed water must meet strict guidelines set by Arizona Department of Environmental Quality (ADEQ) in order to protect public health and environmental quality. Additional parameters must also be addressed and controlled if the reclaimed water is to be suitable for proposed irrigation uses. The following sections address:

- Regulatory Requirements and Permitting.
- Irrigation Water Quality.

7.3.1 Regulatory Requirements

Reclaimed water production, reuse and recharge is closely regulated by ADEQ primarily through the following permits:

- Arizona Pollutant Discharge Elimination System (AZPDES)
- Aquifer Protection Permit (APP)
- Reclaimed Water Individual or General Permit

The requirements in these permits are generally linked to and dependent on the intended use for the reclaimed water. Table 7-1 shows the range of uses addressed under the APP program.

Table 7-1. Minimum Reclaimed Water Quality Requirements for Direct Reuse	
Type of Direct Reuse	**Minimum Class of Reclaimed Water Required**
Class A Uses and Recharge	A+
Irrigation of food crops	A
Recreational impoundments	A
Residential landscape irrigation	A
Schoolground landscape irrigation	A
Open access landscape irrigation	A
Toilet and urinal flushing	A
Fire protection systems	A
Spray irrigation of an orchard or vineyard	A
Commercial closed loop air conditioning systems	A
Vehicle and equipment washing	A
Snowmaking	A
Class B Uses and Recharge	B+
Surface irrigation of an orchard or vineyard	B
Golf course irrigation	B
Restricted access landscape irrigation	B
Landscape impoundment	B
Dust control	B
Soil compaction and similar construction activities	B
Pasture for milking animals	B
Livestock watering (dairy animals)	B
Concrete and cement mixing	B
Materials washing and sieving	B
Street Cleaning	B
Pasture for non-dairy animals	C
Livestock watering (non-dairy animals)	C
Irrigation of sod farms	C
Irrigation of fiber, seed, forage, and similar crops	C
Silviculture	C

Because the primary uses anticipated for the City's reclaimed water is unrestricted access irrigation with recharge of the surplus, Class A+ reclaimed water quality will be required. While some of the future uses could be supported with lower class standards, it is not practical to design and operate reclaimed water facilities which produce and distribute water treated to multiple

classes of water. Therefore the highest use governs the requirement for Class A+ reclaimed water and allows the reclaimed water distribution system to be designed to service the full range of reuse and recharge activities anticipated.

The Class A+ designation also sets the degree of wastewater treatment which is to be provided at the City's water reclamation facilities; requiring secondary treatment, filtration, nitrogen removal, and disinfection. These treatment requirements are further discussed in Section 6 of the IWMP which addresses wastewater infrastructure.

7.3.2 Irrigation Water Quality

Water quality must be maintained within certain limits if it is to be suitable for irrigation of turf and landscaping. There are a number of additional water quality parameters, which are not regulated under the AZPDES, APP or Reclaimed Water Permits but which must be addressed if irrigation needs are to successfully met. Key parameters of concern for Goodyear's system include:

- Total Dissolved Solids (TDS)
- Sodium Adsorption Ratio (SAR)

Total Dissolved Solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides and sulfates) and some small amounts of organic matter that are dissolved in water. In general, the total dissolved solids concentration is the sum of the cations (positively charged) and anions (negatively charged) ions in the water and if the water is to be used for irrigation, TDS must be maintained within limits as shown in Table 7-2.

Table 7-2. TDS Limits

Quality	TDS (ppm)
Excellent	175
Good	175 to 525
Permissible	525 to 1400
Doubtful	1400 to 2100
Unsuitable	>2100

For comparison purposes, the maximum contaminant level (MCL) for TDS in drinking water is 500 ppm. This is a "secondary" MCL which means that TDS level is not a hard limit for which compliance is mandatory, but instead is a recommended water quality goal.

Salinity in raw water originates from many sources including contact with natural mineral and salt deposits, and from man-made sources such as sewage discharge, urban run-off, industrial wastewater, and agricultural fertilizers. In Goodyear's case, the TDS of their surface water and groundwater sources is as follows:

- CAP Surface Water 700 to 800 ppm
- Groundwater 600 to 3,000 ppm

While the TDS of the surface water is still in the permissible range for drinking water and irrigation, it can be seen that much of the City's groundwater is well over suitable levels for drinking water or irrigation purposes. As discussed in Section 4 – Water Infrastructure, the majority of the City's future drinking water will come from treated groundwater for which the reverse-osmosis process will be used to lower the TDS. The RO treatment process will produce millions of gallons / day of waste brine and many tons of waste salt.

Of particular concern for the reclaimed water supply is that the brine discharged from the drinking water treatment process is currently being discharged to the sewer and ending up in the reclaimed water. This practice has already led to increased TDS levels at the 157th Ave WWTP and rendered the reclaimed water from this plant unsuitable for irrigation use. It should be noted that because the reclaimed water volume into which the brine is diluted, is less than half the volume of the potable water from which it was taken, (See Section 3 discussion of percent wastewater returned) the effect of discharging the brine to the sewer is more than twice as damaging. In other words, reducing the groundwater TDS by 2,000 ppm to meet drinking water standards, would raise the reclaimed water TDS by more than 4,000 ppm if the brine is discharged to the sewer. It is imperative therefore that the waste brine, containing the salts removed during reverse osmosis and ion exchange treatment processes, not be discharged to the sewer for disposal. Once removed, the salt must be kept out of the water cycle or the TDS of the reclaimed water will be driven to levels rendering it totally unsuitable for reuse or recharge and the reclaimed water itself will become a waste-stream even more difficult to dispose of than the brine. A more detailed discussion of the recommended methods for brine disposal is provided in the Water Production Section of the Water Master Plan.

If the brine is kept from the sewer system, the TDS of the City's reclaimed water can be anticipated to be in the range of 600 to 800 ppm. This is based on the assumption that the TDS of the potable water supply after treatment will be in the 500 to 700 ppm range and that after returning as wastewater, it will have picked up approximately 100 ppm of additional TDS from one cycle of municipal use.

Sodium Adsorption Ratio (SAR) is a measurement of sodium content compared to calcium and magnesium within the soil as expressed in the following formula.

$$SAR = \frac{NA}{\sqrt{\frac{Ca + Mg}{2}}}$$

where: Na = sodium in me/l
Ca = calcium in me/l
Mg = magnesium in me/l

The SAR of an irrigation water must also be maintained within limits because excess sodium (relative to calcium) tends to adsorb onto clay particles and break-down or disperse the soil structure. The dispersed finer soil particles fill many of the smaller pore spaces, sealing the surface and greatly reducing the rate at which water infiltrates the soil surface. Soil crusting and crop emergence problems often result, in addition to a reduction in the amount of water that will enter the soil in a given amount of time and which may ultimately cause water stress between irrigations. Water that has a SAR of less than 5 is considered to be good for agricultural use and a SAR of up to a maximum of 10 is permissible as shown below in Table 7-3.

Table 7-3. Sodium Hazard Classification

Quality	SAR
Excellent	3
Good	3 to 5
Permissible	5 to 10
Doubtful	10 to 15
Unsuitable	> 15

Analysis of Rainbow Valley groundwater shows the SAR to be in the 10 to 15 range while the SAR of CAP surface water is anticipated to be generally in the 3 to 5 range. Therefore the quality of Rainbow Valley groundwater should be improved if it is to be suitable for irrigation.

It is important to note that the design of the treatment process utilized by the City to lower the TDS in their drinking water will have an impact on the SAR of their reclaimed water. Reverse-osmosis and nano-filtration are both membrane separation processes which could be used to lower the TDS of the drinking water. Both allow relatively pure water to pass through membrane pores while retaining and concentrating most of the dissolved solids in the waste brine stream. However they differ in the manner and degree to which they remove dissolved solids.

Reverse-Osmosis membranes have smaller pore sizes and remove virtually all dissolved salts, including both mono-valent ions such as sodium and chloride and divalent ions such as calcium and magnesium. As a result not only is the TDS lowered in the process of treatment, but the SAR is lowered as well.

Nano-filtration membranes in comparison have larger pore sizes and while they remove virtually all of the larger divalent and trivalent ions, they allow a significantly higher portion of the mono-valent ions principally sodium and chloride to pass through. So while the overall TDS can be lowered to below the 500 ppm MCL, the remaining salinity will be composed of predominantly sodium and chloride ions which will result in a very high SAR level.

Because nano-filtration membranes operate at lower pressures and require less energy, they are often chosen when it is only necessary lower the TDS. However, it can be seen in this case, where the low TDS drinking water then becomes the reclaimed water source for irrigation, nano-filtration must not be used as it will lead to unacceptably high SAR levels. This is also addressed in Section 5, the Water Infrastructure portion of the IWMP.

7.4 HYDRAULIC MODEL CONSTRUCTION AND DEMAND ALLOCATION

At the time of this IWMP a model of the existing, limited reclaimed water system did not exist. Therefore, a reclaimed water hydraulic model was built from scratch using the H2OMAP Water software. As a starting point the potable water system pipe network was used as a guide to build a reclaimed water model with pipelines which would generally follow the same major arterials. The model was developed with the goal of putting 100% of reclaimed water to beneficial use, either through reuse or recharge. The objective was to devise a system that would enable the City to earn recharge throughout the entire year with additional credits earned during winter months when irrigation demands decreased.

It is the City's objective to incorporate existing facilities into a single non-potable reclaimed water system. Because the extent of the existing system is limited and future development will result in significantly different modes of operation, a base-year model was not created, only a buildout model was made.

It was assumed that the non-potable system will be extended as areas are developed. Therefore, the extent of the intermediate year model covers the same limits of projected development defined for the potable water system. Non-potable pipelines would be installed at the size and configuration indicated in the build-out model at the time of installation.

7.4.1 Distribution Network

A distribution network model was built to deliver reclaimed water to markets throughout the service area. However, the location of specific points of use (parks, golf courses, etc) are for the most part not yet known as very little development planning has reached such a level of definition. While specific reuse applications are not known, the approximate demand by zone has been estimated (see IWMP Section 3 and TM 3-1 Effluent Management Plan) and it was assumed that the future markets for reclaimed water will be generally distributed throughout the service area. Therefore, a skeletonized system of distribution piping was created on a nominal two-mile grid which covered the service area. It was assumed that the reclaimed water customers would provide final connecting service lines, from the skeletonized grid, to the location of their parcel/property/project.

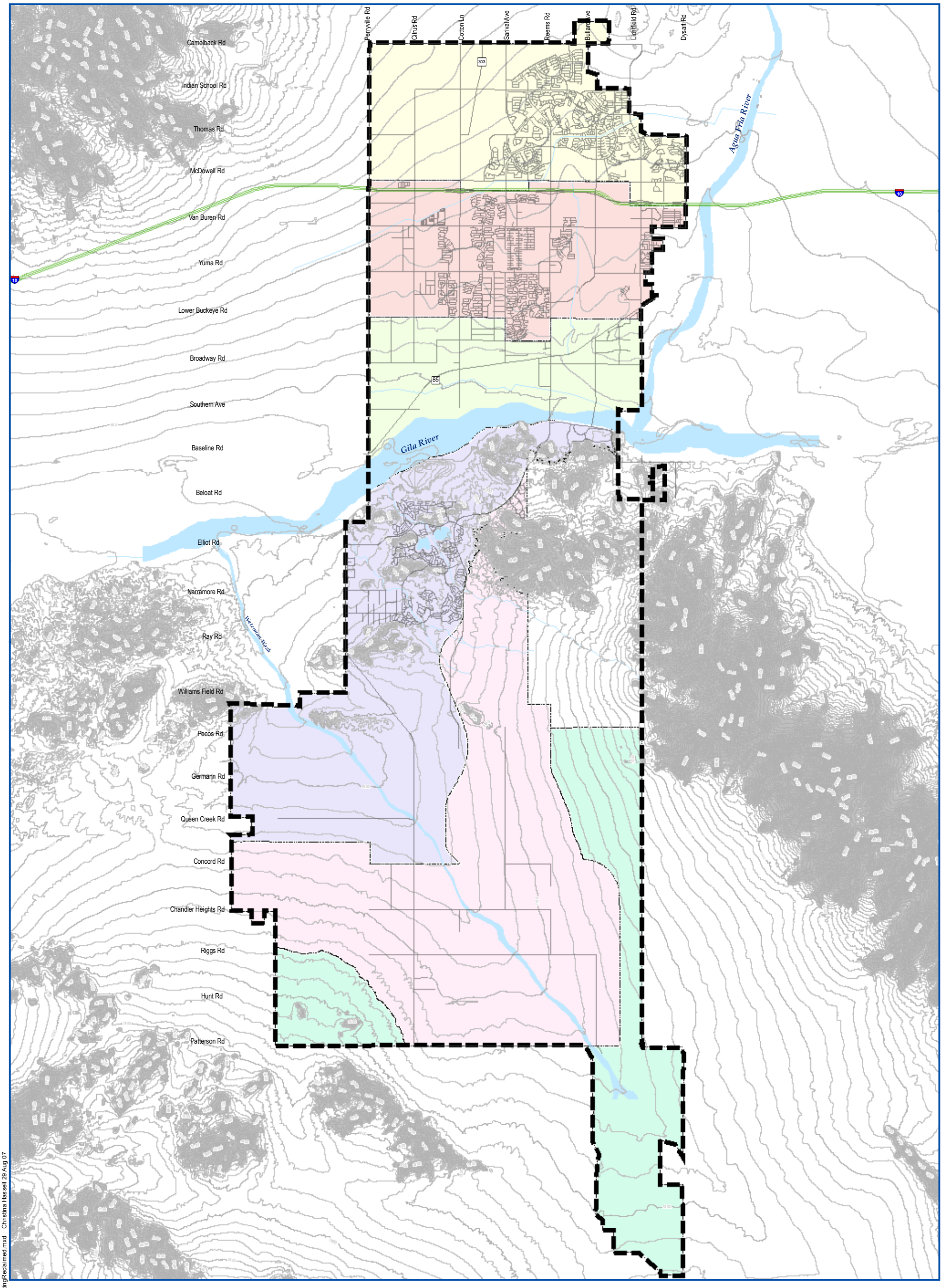
7.4.2 Reuse Pressure Zones

Pressure zones were established for the reclaimed water distribution system throughout the MPA, covering the same area in which potable water service is provided. The layout of the reclaimed water pressure zones followed that of the potable water system. Service pressure is not as critical for a non-potable system, therefore, the design HGL or pressure within each reclaimed zone was designed to be 10 psi less than in the overlaying potable water system. Table 7-4 shows the pressure zones for the potable and non-potable systems.

Table 7-4. Comparison of Potable and Reclaimed Water System Pressure Zones

Zone	Service Elevation Range (ft)	System			
		Potable		*Non-potable*	
		Static Hydraulic Gradient (ft)	Static Pressure Range (psi)	Static Hydraulic Gradient (ft)	Static Pressure Range (psi)
Gila River	890 - 950	1,100	65 - 91	1,075	55 - 80
Zone 1	950 - 1050	1,165	50 - 93	1,140	40 - 83
Zone 2	950 - 1050	1,175	54 - 98	1,150	44 - 88
Zone 3	1050 - 1150	1,265	50 - 93	1,240	40 - 83
Zone 4	1150 - 1250	1,365	50 - 93	1,340	40 - 83

Demands were calculated for each pressure zone utilizing the demand projections developed in Section 3 of the IWMP. To determine the required reclaimed water infrastructure needed for each pressure zone, demands were calculated for each pressure zone. Demands by pressure zones are shown in Table 7-5. The reclaimed system pressure zones are shown in Figure 7-2.



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1 inch equals 2 miles

Data Sources:
City of Goodyear GIS
ESRI

Legend

Street

Master Plan Study Area

Reclaim Pressure Zones

Gila Zone

LPSCO

Zone 1

Zone 2

Zone 3

Zone 4

Figure 7-2
Reclaimed Water System Pressure Zones
Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Revised: Friday, March 21, 2007

\\Projects\GoodYear\11GIS\01MapDocuments\ExistingReclaimed.mxd Christina Hassell 29 Aug 07

Table 7-5. Demand Projection per Pressure Zone			
Zone	Year		
	2012 (MGD)	2017 (MGD)	2045 (Build-out) (MGD)
1	0.77	1.26	1.78
2	2.63	4.28	6.07
3	3.42	5.57	7.9
4	1.76	2.86	4.06
Gila River	0.63	1.02	1.45
Total	**9.2**	**15.0**	**21.3**

7.4.3 Buildout Demand Allocation

Reclaimed water demands, for irrigation, lake filling and construction were developed in Section 3 of the IWMP. A summary of projected build-out demands by WPA and pressure zone can be seen in Table 7-6.

Table 7-6. Build-out Average Day Demand (MGD)						
WPA	Zone 1	Zone 2	Zone 3	Zone 4	Gila River	Total
2	1.78	0	0	0	1.45	3.23
3	0	3.38	1.24	0	0	4.62
4	0	2.69	6.65	2.23	0	11.57
5	0	0	0	1.83	0	1.83
Total	**1.78**	**6.07**	**7.90**	**4.06**	**1.45**	**21.3**

In order to model summer and winter conditions, the following peaking factors were applied to the average day demands which had been allocated to the model:

- Max Month = ADD x 1.70
- Min Month = ADD x 0.39

GIS techniques were used to allocate the projected demands to the model using the Polygon Intersection method. The demand per zone was then translated to a water-duty (gpad) by dividing zone demand by zone acreage.

Reclaimed water production in excess of demand is to be recharged to earn recharge credits. Demand analysis showed that reclaimed water production exceeds demand throughout the year. The extent of the reclaimed surplus depends on the time of year. The exception is a brief period in the initial years when peak summer demands are projected to exceed supply by a small margin and supplemental groundwater would be required.

7.4.4 Recharge

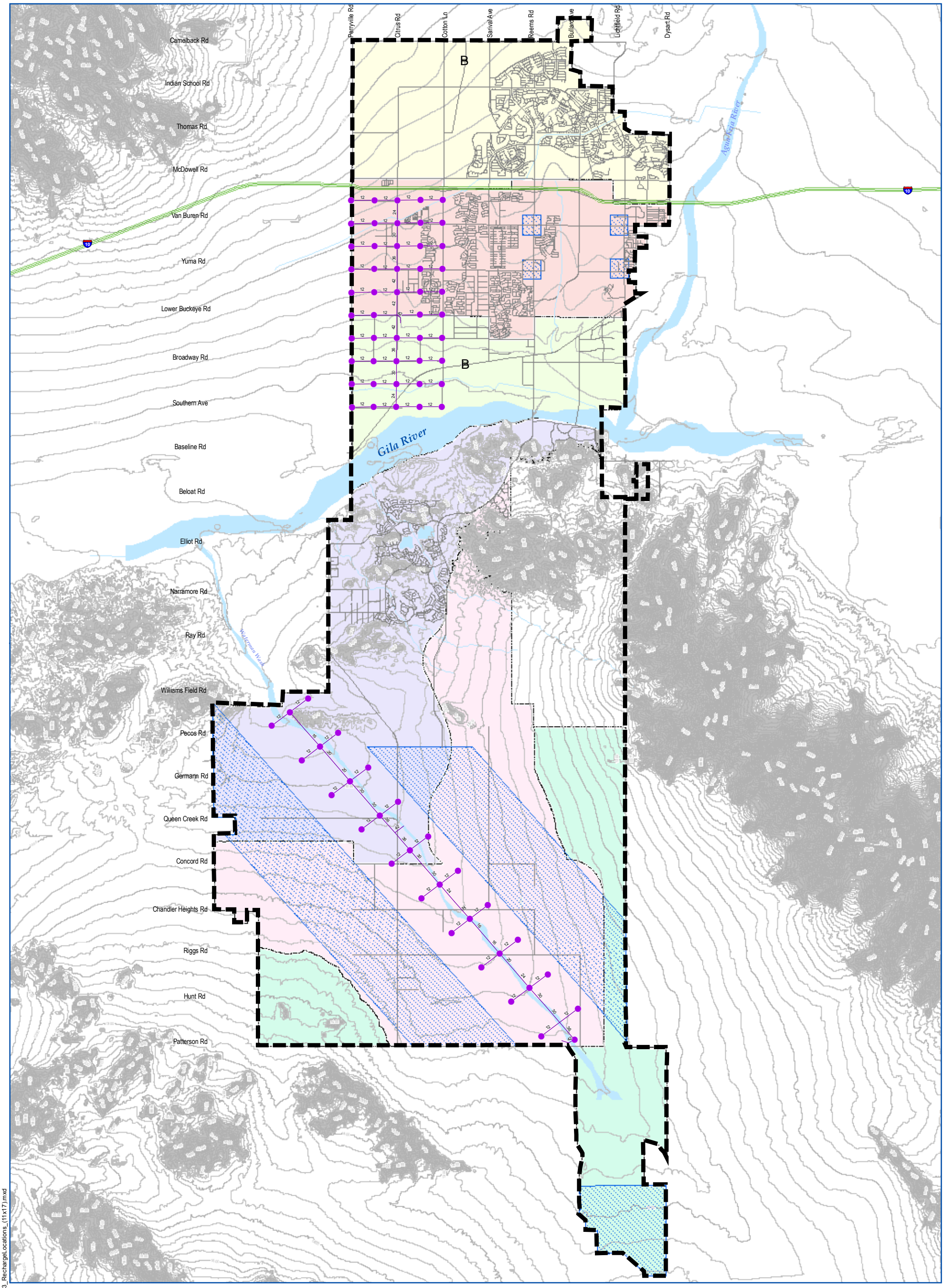
Based on knowledge of the hydrogeology of the area it was assumed that recharge can only be accomplished as follows:

- Recharge will only be conducted where a suitable aquifer permits such as the Salt River Basin to the north and Waterman Basin to the south.
- Recharge in the north will only be conducted in Zone 1, and not in the water-logged areas along the Gila River.
- Recharge in the south would be conducted in well fields, oriented along the Waterman Wash, leaving a central band for the extraction well fields providing raw water supply for the potable system.
- California Title-22 parameters were assumed that require a minimum of 2,000 feet or 12-months travel from a recharge well to a potable water extraction well.
- The majority of the recharge will occur in the Waterman Basin, in support of future pumping projections and due to the more confined nature of this aquifer.

Figure 7-3 shows the layout of the recharge areas which have been configured in accordance with the above criteria. It is recommended that detailed hydro-geologic modeling and studies be conducted in order to refine and optimize the locations for reclaimed water recharge and potable water extraction. The goals of hydro-geologic modeling should be to:

- Support reclaimed water recharge operations at the rates and quantities forecast.
- Support raw water extraction (for potable supply) at the rates and quantities forecast.
- Optimize recharge and extraction well-fields to provide long-term water quality improvements.
- Optimize recharge and extraction well-fields for long-term support of water levels.

It is assumed that the Waterman Basin will be the primary focus of recharge and extraction operations due to the more confined nature of this aquifer, which will allow the City to reap the benefits of long-term recharge programs designed to support aquifer water levels and improve aquifer water quality. Clay lenses prohibit the use of low cost surface spreading basins for recharge operations in the Waterman Basin. However, lower cost vadose zone wells can be used for recharge operations instead of higher cost aquifer storage and recovery (ASR) wells because reclaimed water recovery for supplemental supply to the non-potable system is not required. It should be noted however that the use of vadose zone wells will require a lower turbidity of 0.1 NTU or less and to meet this requirement, membrane filtration or membrane bio-reactor technology will need to be utilized at the water reclamation facilities.



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1 inch equals 2 miles

Data Sources:
City of Goodyear GIS
Black & Veatch
ESRI

Legend

- Street
- CIP Wells
- Well Field Mains
- Master Plan Study Area
- Recharge Zone

Reclaim Pressure Zones

- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Figure 7-3
Recharge Locations

Integrated Water Master Plan
City of Goodyear, AZ
2008

Goodyear

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Revised: Friday, March 14, 2007

\\Cygnet 145521\11GIS\TM Report Figures\Figure7-3_RechargeLocations_(11x17).mxd

The City's Soil Aquifer Treatment (SAT) site in Zone 1 currently provides 4 mgd of recharge capacity using surface spreading basins. However, this facility will be phased out as the new City Center is developed at that location. It was assumed that the SAT Site's capacity will be replaced with 4 mgd of injection wells and augmented with an additional 4 mgd of injection wells located in Zone 1.

A key concept upon which the non-potable water system was developed is that the non-potable distribution network will deliver water to both reuse and recharge locations. This leads to an efficient utilization of the non-potable water distribution system to equalize delivery throughout the year. As reclaimed water demand drops off in the cooler months, it is replaced by increased rates of recharge. Recharge acts like an artificially imposed demand, which rises as reclaimed water demand falls and falls as reclaimed water demand rises again in the summer. The total water delivered through the non-potable water system remains constant and equal to reclaimed water production.

Recharge "demands" can be determined by subtracting the seasonal reclaimed demand from the annual wastewater supply. Table 7-7 shows the summer minimum and winter maximum recharge rates projected for buildout.

Table 7-7. Buildout Recharge Rates

Seasonal Condition	Recharge Rate
Summer – Minimum Recharge	4.4 mgd
Winter – Maximum Recharge	33.9 mgd

Even though 8 mgd of recharge capacity will be available in Zone 1, the system will also be designed such that 100 percent of the recharge could be accomplished within the Waterman Basin. This will provide the City's operators and resource managers with flexibility and redundancy in the management of recharge operations.

Similar to the process followed for the allocation of build-out demand, recharge loads were allocated to the model by the using the polygon intersection method. A spatial intersection of the two layers determined the recharge demand that would be allocated to each node within the recharge bands. The recharge demands can then be factored-up to represent winter recharge rates or factored-down to represent summer recharge rates.

Using GIS techniques, the Waterman Basin recharge bands were intersected with the zone boundaries and Table 7-8 shows the amount of recharge that will occur in each zone, which is proportional to the area of each zone that lies within the recharge bands.

Table 7-8. Recharge Demand per Pressure Zone

Scenario	Zone			
	2	3	4	Total
Max Month (Summer)	0.9	2.7	0.8	4.4
Min Month (Winter)	6.0	21.3	6.6	33.9

7.5 HYDRAULIC MODEL ANALYSIS

As the City grows putting reclaimed water to beneficial use will be necessary for the City to meet its water resource needs and the reclaimed water system will largely needs to be built from scratch. The system developed and modeled for this IWMP addresses a skeletonized transmission and distribution system, theoretical storage and pumping needs based on a build out scenario, and the production and recharge capacities of treatment facilities yet to be built. The analysis provides a starting point from which the realities of the eventual system will diverge.

The production of, and demand for, reclaimed water will parallel the City's growth. Water and wastewater planning is challenging for a city such as Goodyear with most of its growth in front of it. Planning for reclaimed water combines the complexities of water and wastewater planning and adds the unknowns of developing a need for the water and then redistributing it to meet the need.

For these reasons specific, detailed infrastructure planning is difficult. However, the City has the unique opportunity to plan reclaimed water into its future from the start rather than being faced with retrofitting it into an existing utility network. For these reasons, and associated unknowns, the recommendations provided are general in nature to reflect the City's commitment and the flexibility that will be necessary to meet future needs in the most efficient way possible. The recommendations are not presented in terms of a time scale since the rate of development will be highly variable. There are two recommendations under which all the proceeding recommendations fall:

- Continue to construct the reclaimed water distribution system mains where shown when parallel water or sewer construction is being undertaken.
- Invest in recharge facilities to keep pace with reclaimed water production levels in order to ensure 100 percent recharge of the balance remaining after reuse.

7.5.1 Summary of Analyses

A series of hydraulic model analyses were performed to assess current performance and to determine the reclaimed water infrastructure required to meet future reclaimed water reuse and recharge needs under varying conditions. Technical Memorandum 3-3 describes analysis procedures and results in detail. The following analyses were performed.

- Max Month (summer) with peak reuse demand and minimum recharge.
- Min Month (winter) with minimum reuse demand and peak recharge.

Table 7-9 shows the reuse demands and recharge loads that are associated with each scenario and each zone.

Table 7-9. Reclaimed Water Scenario Demands per Zone (mgd)

Scenario	Demand	Zone					Total
		1	2	3	4	Gila River	
Max Month (Summer)	Reuse	3.08	11.2	13.6	7.4	2.6	37.8
	Recharge	0	0.9	2.7	0.8	0	4.4
	Total	**3.08**	**12.1**	**16.3**	**8.2**	**2.6**	**42.2**
Min Month (Winter)	Reuse	0.66	2.4	3.0	1.6	0.6	8.3
	Recharge	0	6.0	21.3	6.6	0	33.9
	Total	**0.66**	**8.4**	**24.3**	**8.2**	**0.6**	**42.2**

The total flow rate for each scenario remained constant at 42.7 mgd, which is the projected average dry weather flow (ADWF) treated and reclaimed by the City's water reclamation facilities. Yet while the overall flow rate is the same, the destination and use varies. The total load on Zone 3 increases significantly in the winter months because it carries the majority of the recharge load.

Under the maximum and minimum scenarios shown in Table 7-8, 100% of recharge was to be conducted in the Waterman Basin. However, because 8 mgd of recharge wells will be available

in Zone 1, an alternate winter recharge scenario is possible where 8 mgd will be recharged in Zone 1, leaving 25.9 mgd to be recharged in the Waterman Basin. Table 7-10 shows the resulting distribution system loading by zone when Zone 1 recharge is included.

Table 7-10. Alternate Winter Recharge Scenario Demands per Zone (mgd)

Scenario	Demand	Zone					
		1	2	3	4	Gila River	Total
Min Month (Winter)	Reuse	0.7	2.4	3.0	1.6	0.6	8.3
	Recharge	8.0	4.6	16.1	5.2	0.0	33.9
	Total	**8.7**	**7.0**	**19.1**	**6.8**	**0.6**	**42.2**

Diurnal variations are the pattern throughout the day at which the demand fluctuations occur. Each type of irrigation has a different diurnal pattern due to varying application times. Irrigation typically occurs during the nighttime hours, limiting wind and precipitation, whereas construction occurs during the day. These patterns are used to help determine:

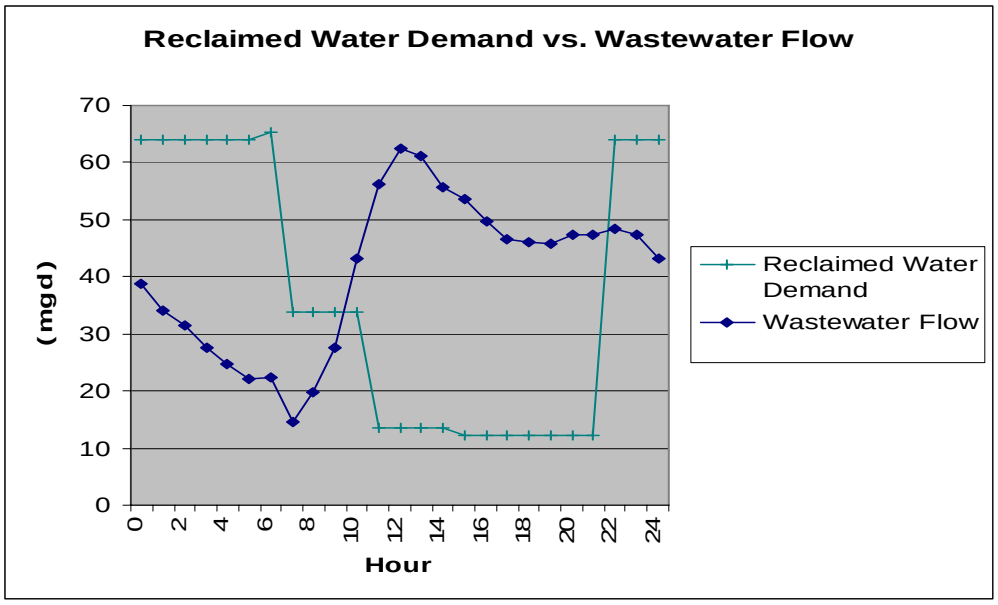
- Operational storage
- Booster pumping rates (peak hour)

The demand curve was built on the following assumptions:

- For parks, schools, and ROW, 80% of irrigation water is applied between 10 pm to 6 am
- For parks, schools, and ROW, the remaining 20% of irrigation water is applied at a constant rate throughout the day
- For golf courses 80% of irrigation water is applied between 10 pm and 10 am
- For golf courses the remaining 20% of irrigation water is applied at a constant rate throughout the day
- All city lakes will be filled continuously throughout the day
- Construction water is used between 6 am and 2 pm.

The diurnal patterns were developed individually per type of irrigation and its typical application pattern. A weighted composite pattern was then determined and compared to the diurnal pattern of wastewater, shown on Figure 7-4.

Figure 7-4: Reclaimed Water Diurnal Curve



7.5.2 Reclaimed Water Storage Improvements

EPS model runs provided the peak hour flow rates which were used to determine the operational storage volume required at each of the WRFs. Storage reservoirs were sized based on the following criteria:

- **Equalization Volume.** EQ volume provides the storage necessary to equalize between reclaimed water production (reservoir fill rates) and peak hour pumping rates over a 24-hour period.

- **Margin of Safety.** The calculated EQ volume is to be multiplied by 1.5 in order to provide a margin of safety and flexibility in system operations. A larger operational volume of 2.0 EQ is to be provided at the Waterman Wash WRF due to the central role it will play in balancing overall system reuse and recharge operations.

The objective of the storage reservoirs will be to provide daily operational storage needs. Seasonal storage will be accomplished through aquifer recharge. The dump/repump reservoirs will be filled during off peak hours from 11 am to 10 pm, when irrigation demands are low.

Flow balance calculations were performed for the reservoirs at each WRF and for the Zone 4 East and Zone 4 West dump/repump reservoirs and Table 7-11 presents a summary of the required operational storage volumes by plant.

Table 7-11. Reclaimed Water System Operational Storage Requirements

Reservoir Location	Plant Capacity (mgd)	Operational Storage Required (MG)	Safety Factor	Calculated Storage Required (MG)	Nominal Storage Provided (MG)
157th Ave WWTP	17.0	4.4	1.5	6.7	7.0
Corgett WRF	1.8	1.02	1.5	1.5	2.0
Rainbow Valley WRF	6.0	2.61	1.5	3.9	4.0
Pecos Road WRF	7.0	1.98	1.5	3.0	3.0
Waterman Wash WRF	10.0	3.2	2.0	6.4	6.0
Estrella WRF	3.0	2.61	1.5	3.9	4.0
Zone 4 East	-	1.61	1.5	2.4	3.0
Zone 4 West	-	1.32	1.5	2.0	2.0
Total				**29.8**	**31.0**

Table 7-12 presents the recommended reservoir capacities. Phased storage was determined based on the proportion of phased plant capacity compared to build-out plant capacity.

Table 7-12. Reclaimed Water System Build-out Reservoir Capacities

Storage Location	2007	2012	2017	2045
157th WWTP	0.0	3.0	5.0	7.0
Corgett WRF	0.0	2.0	2.0	2.0
Pecos Road WRF	0.0	1.0	2.0	3.0
Rainbow Valley WRF	0.0	2.0	2.0	4.0
Waterman Wash WRF	0.0	1.0	2.0	6.0
Estrella WRF	0.0	0.0	2.0	4.0
Zone 4 East	0.0	0.0	0.0	3.0
Zone 4 West	0.0	0.0	0.0	2.0
Total	**0.0**	**9.0**	**15.0**	**31.0**

7.5.3 Reclaimed Water Booster Pumping Improvements

EPS hydraulic analyses were conducted to determine the appropriate capacity of all reclaimed water booster pumping stations. Pumping stations were sized based on the following design criteria:

- **Peak Hour Flow.** The booster pumps must be capable of providing the peak hour flow supplied into each zone from each booster site.

- **Reserve Margin.** A 25% margin of safety should be provided, above the peak hour flow rate recorded in the model, to provide operational flexibility.

- **Firm Capacity.** Firm capacity of 125% of peak hour should be provided with the largest single pumping unit out of service.

The model assumed that all booster pumping stations will be equipped with variable-speed, constant head pumps to maintain the design static HGL at the point of discharge or connection to the distribution system network under variable flow conditions. It was further anticipated that all booster pumping stations will be designed to run normally in automatic mode, where the pump control parameter is constant discharge head. Table 7-13 shows the pumping capacity required (including the 25% reserve margin) to meet 2045 peak hour demands, as determined from the three EPS scenarios analyzed.

Table 7-13. Booster Pumping Capacities per Zone at Buildout (mgd)

Plant	Zone					
	1	2	3	4	Gila River	Total
157th	11.6	2.3			5.9	19.8
Corgett		5.8				5.8
Pecos Road		5.6				5.6
Rainbow Valley		8.9	14.9			23.9
Waterman Wash		3.3	19.9			23.2
Estrella			8.4	9.9		18.2
Zone 4 East				4.4		4.4
Zone 4 West				3.6		3.6
Total	**11.6**	**25.9**	**43.2**	**17.9**	**5.9**	**104.4**

At each WRF the pumping capacity must meet max month peak hour irrigation demand and be able to pump out the remaining water for recharge purposes. Table 7-14 provides the booster pumping capacities with the reserve margin of 25 percent taken into account for each location.

Table 7-14. Reclaimed Water Booster Pumping by Phase (mgd)

Booster Pumping Location	2007	2012	2017	2045
157th WWTP	5.0	9.3	14.0	19.8
Corgett WRF	2.4	5.8	5.8	5.8
Pecos Road WRF	0.0	2.0	4.0	5.6
Rainbow Valley WRF	3.0	11.9	11.9	23.9
Waterman Wash WRF	0.0	3.5	7.0	23.2
Estrella WRF	0.0	0.0	9.1	18.2
Zone 4 East	0.0	0.0	0.0	4.4
Zone 4 West	0.0	0.0	0.0	3.6
Total	**10.4**	**32.5**	**51.7**	**104.4**

7.5.4 Distribution System Improvements

Through hydraulic modeling, the appropriate diameter of all reclaimed distribution network pipes was determined. The pipes were sized under the following criteria:

- **Node Pressure.** Under static conditions (zero flow) the pressure range across each zone will range from 25 psi at the upper boundary to 68 psi at the lower boundary. Pressure loss at peak hour flow was to be limited to 5 psi in order to maintain a minimum pressure of 20 psi along the upper boundary.

- **Pipeline Velocity.** In order to limit pressure losses due to pipeline friction, pipeline velocities were not to exceed 5 ft/sec when ever possible.

- **Minimum Diameter.** The minimum diameter to be used in the skeletonized distribution system was 8-inch. This would reasonably provide sufficient flow capacity would be available at all points in the system to accommodate the point demands of future reuse projects, whose locations are not yet known.

The allowable pressure loss and velocity limits shown above are more conservative or restrictive than typically used for the design of water distribution systems. The reason was that the lower

operating pressure range set for the non-potable system leaves little margin for pressure losses before unacceptably low pressures would occur along the upper zone boundary.

The reclaimed water distribution system was developed as a skeletonized system of distribution piping on a nominal two-mile grid covering the service area. The recommended build-out distribution piping was shown on Figure 7-5. As arterial roads are constructed it is recommended that the reclaimed water system be built along with water mains and wastewater collection. As growth occurs and varies from the model, the reclaimed water system will need to be adjusted as reuse markets emerge.

The following observations were made with respect to the reclaimed water distribution system's hydraulic performance:

- Acceptable pressure was maintained along the upper zone boundaries. Near the Rainbow Valley WRF the pressure fell below 20 psi due to the Zone 2 boundary following Estrella Parkway to an elevation above the Zone 2 Service Elevation Range. Reuse in this location can be connected to Zone 3 piping to maintain adequate pressure.

- Booster pumping from the Zone 4 East and Zone 4 West Reservoirs provides critical pressure support at remote corners of the system where significant pressure degradation would have otherwise occurred.

- The Zone 4 East and Zone 4 West Reservoirs operate as dump/repump reservoirs that refill during off-peak hours.

- PRVs No. Z1/GR and Z4/Z3 were not called upon to provide flow under peak hour conditions as modeled. However they should be installed in order to maintain pressure at zone boundaries, should higher demands occur in their vicinity.

- Winter recharge with 100% occurring in the Waterman Basin, was the controlling hydraulic condition for the sizing of Zone 3 pipelines in the vicinity of the recharge zones.

- Winter recharge with 8 mgd occurring in Zone 1, was the controlling hydraulic condition for the sizing of Zone 1 pipelines.

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
Pecos Rd
Germann Rd
Queen Creek Rd
Concord Rd
Chandler Heights Rd
Riggs Rd
Hunt Rd
Patterson Rd
Gila River
Agua Fria River
Waterman Wash
157th WWTP
Corgett WRF
Pecos Rd WRF
Rainbow Valley WRF
NE Dump & Repump
Waterman Wash WRF
SW Dump & Repump
Estrella WRF
303
85
10

Cygnet \\14552\1\11GIS\TM Report Figures\Figure7-4_BuildOut_ReclaimedWaterSystem_(22x34).mxd Steve Kincade, 21 Mar 2008

Legend

- Street
- Master Plan Study Area
- Recharge Zone
- Tank

Distribution Mains

- Transmission Pipeline
- Gila River
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Reclaim Pressure Zones

- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

N W E S

1 inch equals 1 mile

Data Sources:
City of Goodyear GIS
ESRI

Figure 7-5
Build Out Reclaimed Water System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

BLACK & VEATCH
Building a world of difference.

Revised: Friday, March 21, 2007

Since a single set of reclaimed distribution pipelines will serve two functions; reuse demand conveyance and conveyance to the recharge wells, the City of Goodyear operational staff will need to watch reservoir levels as they transition through the seasons. As the reservoir trend towards the full side when the City transitions from peak to off peak irrigation demands, staff will need to turn on recharge wells to artificially impose demand on the system. As the reservoirs are not able to consistently return to their starting point at the end of the day, operators will need to turn off the recharge wells. The reservoirs, most specifically the Waterman Basin Reservoir because all of the other plants pump to the Waterman Basin site, will be a good graphic indicator from which operational staff will impose or trim demands on the reclaimed system.

7.5.5 Transmission System Improvements

A steady state hydraulic analysis was performed to determine the required pipeline diameters and resulting hydraulic grade for the reclaimed water transmission system. The transmission system was analyzed and sized under the following criteria:

- **System Balance.** The transmission pipeline and pumps should be capable of balancing supply and demand throughout the service area; moving reclaimed water from locations of surplus supply to locations of higher demand or recharge.

- **Maximum Month.** The system balance shall be calculated under conditions of Max Month reclaimed water production which is 110% of the ADWF rating for each WRF.

- **Maximum Velocity.** Maximum pipeline velocity shall be 5 ft/sec in order to minimize friction losses and surge potential in the long transmission lines.

Reclaimed water produced at the WRFs will be stored in reservoirs on-site before pumping into the non-potable distribution system. The required pumping will be dependent on the demand served. The amount of storage is dependent on the incoming flow from the collection system. However, projected levels of reclaimed water production do not always match reclaimed water demand at each location. Therefore, a reclaimed water transmission system is proposed to enable the movement of reclaimed water from points of excess to points of shortage. Figure 7-5 shows the proposed transmission system at buildout. Similar to the potable water transmission and distribution systems, the non-potable water transmission system will operate independent of the non-potable water distribution system thereby allowing:

- Reclaimed water to be moved from production facilities to storage reservoirs without energy wasting dump/re-pump operations.

- Reclaimed water distribution system design to be optimized for automatic booster pumping operations and to support stable HGL/Pressure throughout the zone.

- Bulk reclaimed water transmission, 24-hours of the day, without interfering with distribution system operation or affecting distribution system pressure.

The critical backbone element of the reclaimed water transmission system is the transmission system pipeline connecting the 157th Ave WWTP, with the Estrella, Corgett, Pecos Road, Rainbow Valley and Waterman Wash WRFs. This transmission line will provide for the transmission of reclaimed water to share the total Zone 2 and 3 recharge capacities across the service area and supply supplemental reclaimed water to meet peak irrigation demands during the summer.

Tables 7-15 and 7-16 show the cumulative flows into and leaving the transmission system at each plant for maximum and minimum month scenarios.

Table 7-15. Maximum Month Transmission System Flow (mgd)

Plant	Reclaimed Water Production (ADWF)	Reclaimed Water Production (Max Mon.)	Max Month Summer Flow		
			Additional Supply Needed	Excess Supply	Cumulative Transmission Flow
157th	16.7	18.4	0	9.9	9.9
Corgett	1.8	2.0	0.8	0	9.1
Pecos Road	6.3	6.9	0	3.6	12.7
Rainbow Valley	5.9	6.5	4.9	0	7.8
Waterman Wash	9.2	10.1	1.9	0	5.9
Estrella	2.7	3.0	6.2	0	-0.3

Table 7-16. Minimum Month Transmission System Flow (mgd)					
Plant	Reclaimed Water Production (ADWF)	Reclaimed Water Production (Max Mon.)	Min Month Winter Flow		
			Additional Supply Needed	Excess Supply	Cumulative Transmission Flow
157th	16.7	18.4	0	15.1	15.1
Corgett	1.8	2.0	0	1.1	16.2
Pecos Road	6.3	6.9	0	3.1	19.3
Rainbow Valley	5.9	6.5	3.5	0	15.8
Waterman Wash	9.2	10.1	6.8	0	9.0
Estrella	2.7	3.0	9.4	0	-0.3

7.5.6 Recharge Capacity Improvements

Storage of seasonal surpluses of reclaimed water will be accomplished through aquifer recharge via injection wells. The recharge well fields are to be sized based on the following criteria:

- **Max Month Recharge Capacity.** Sufficient recharge capacity shall be available to provide for recharge of the balance of max month production volumes (1.1 x ADWF) after winter minimum reuse demand conditions have been met.

- **PDWF & PWWF.** All WRFs shall have surface discharge permits allowing the higher quantities of reclaimed water production under peak dry weather flow (PDWF) and peak wet weather flow (PWWF) conditions to be discharged. Recharge capacity will be sized for these production levels.

- **Zone 1 Capacity.** At the 157th Ave WWTP recharge currently occurs at the SAT Site location with a recharge capacity of 4 mgd. The SAT Site will be taken out of service for construction of the city center by 2011 and at that time recharge wells in Zone 1 with a capacity of 8 mgd will be constructed to provide a recharge outlet for this plant until the Reclaimed Water Transmission Main is constructed providing access to the recharge well-fields in the Waterman Basin.

- **ASR Wells.** It is recommended that the Zone 1 recharge wells serving the 157th Ave WWTP be ASR wells which can be backwashed and operated with the higher 2.0 NTU

turbidity limit for this plant. Tertiary membrane filtration is to be provided at this plant once water transmission starts to the Waterman Basin recharge well-fields which will employ vadose-zone injection.

- **Zone 2 and 3 Capacity.** Zones 2 and 3 will have vadose zone recharge wells with a capacity of 40 mgd to meet max month peak recharge rates. Reclaimed water will be moved between plants to share the total Zone 2 and 3 recharge capacities.

- **Estrella WRF.** Zone 4 will have recharge capacity will keep pace with the Estrella WRF plant capacity during its initial years of operation as a satellite plant. Once the reclaimed water transmission and distribution pipeline connections are made, this plant will have access to the larger field of recharge wells through-out the Waterman Basin.
- **Waterman Basin Capacity.** The Waterman Basin recharge fields will be provided with 100 percent of the calculated max month recharge capacity.

Table 7-17 shows the calculated recharge capacity to be provided in the Waterman Basin and also breaks down the total by zone.

Table 7-17. Reclaimed Water System Recharge Capacities (mgd)

Plant	Recharge Capacity	Max Month (Summer)		Min Month (Winter)		No Irrigation Demand	
		Recharge Wells Utilized	*Excess WW to Discharge*	*Recharge Wells Utilized*	*Excess WW to Discharge*	*Recharge Wells Utilized*	*Excess WW to Discharge*
157th Avenue WWTP	8	8	0	8	0	8	0
Corgett Rainbow Valley Pecos Road Waterman Wash	40	17.1	0	40	2.6	40	12
Estrella	4	0	0	4	0	4	0

SECTION 8

CAPITAL IMPROVEMENTS PLAN

8.1 INTRODUCTION

Black & Veatch used the recommended improvements from the hydraulic analysis of the water, wastewater, and reclaimed water systems to develop Capital Improvement Plans (CIP) for each system. The format for the phased CIP is as follows.

- Near-Term: Five-Year CIP with individual year projections from 2008 thru 2012
- Intermediate: 2017 CIP with a summary of the five-year period of 2013 thru 2017
- Buildout: 2045 CIP with a summary of remaining years to buildout of 2018 thru 2045

The CIP was developed from two basic components being quantity and unit cost. In Sections 5, 6 and 7, the required infrastructure quantities and their phasing was developed. Additional quantity-take-off details can be found in Appendix B. The applicable unit cost for each item of infrastructure are presented below in Section 8.2. From these two items, the phased CIP was then assembled and is presented in Section 8.3. The extension of unit cost quantity is presented in the CIP as 2007 dollars without inflation. The CIPs have been prepared in an MS Excel format to provide the City with a planning tool that can be revised as needed as planning moves forward.

8.2 UNIT COSTS

Unit costs were developed for each item of infrastructure and are shown in Table 8-1. The unit costs are presented as 2007 dollars. Included in the unit capital costs are a 30% contingency and 20% for design and construction administration. Land, rights-of-way and easement costs are not included for any recommended improvement item. In general, the unit cost for each item of infrastructure is for completed operational infrastructure, with the exception of land, rights-of-way and easements.

Table 8-1: CIP Unit Costs [1]			
Item	**Unit**	**Construction Cost**	**Capital Cost (2)**
DISTRIBUTION SYSTEM			
GWTP (Ion Exchange)	$/gpd	$1.18	$1.84
WTP (R/O Plant)			
Initial Construction	$/gpd	$11.30	$17.63
Expansion	$/gpd	$6.20	$9.67
Wells (2 mgd)	$/each	$1,000,000	$1,560,000
Well Head Treatment			
Ion Exchange (Nitrate)	$/gpd	$3.50	$5.46
Iron Adsorption (Arsenic)	$/gpd	$1.58	$2.46
Storage Reservoirs [1]	$/gallon	$0.72 to $1.37	$1.13 to $2.14
Booster Stations [1]	$/gpd	$0.09 to $0.33	$0.14 to $0.52
PRV's	$/each	$150,000	$234,000
Distribution Pipeline	$/in-ft	$12	$18.72
COLLECTION SYSTEM			
WRF			
Initial Construction [1]	$/gpd	$8.20 to $15.7	$12.79 to $24.49
Expansion [1]	$/gpd	$6.15 to $11.75	$9.60 to $18.34
Lift Station			
Initial Construction [1]	$/gpd	$0.41 to $1.73	$0.64 to $2.70
Expansion [1]	$/gpd	$0.27 to $1.15	$0.42 to $1.80
Gravity Pipeline	$/in-ft	$12	$15.60
Force Main Pipeline	$/in-ft	$12	$18.72
RECLAIMED SYSTEM			
ASR Wells (2 mgd each)	$/each	$1,000,000	$1,560,000
Vadose Zone Wells (2 mgd each)	$/each	$300,000	$468,000
Reservoirs [1]	$/gallon	$0.72 to $1.37	$1.13 to $2.14
Booster Stations [1]	$/gpd	$0.07 to $0.26	$0.11 to $0.41
Distribution Pipeline	$/in-ft	$12	$18.72

Notes:
(1) 2007 dollars with inflation. Land costs not included.

(2) Capital Cost = Construction cost x 1.30(contingency) x 1.20(design & construction administration)

Appendix B contains the cost sheets and curves showing the unit cost development. General observations with respect to the unit costs include:

Unit Cost Curves were prepared for use with the following items of infrastructure. The actual unit cost was taken from the curve depending on the capacity of the individual item. The unit costs are for completed, operational facilities including typical site work and ancillary components.

- Reservoirs
- Potable Water Booster Stations
- Non-Potable Water Booster Stations
- Wastewater Lift Stations
- Water Reclamation Facilities

Groundwater Treatment Plants. Unit cost estimates were prepared for new construction and expansion of centralized reverse-osmosis and ion-exchange water treatment facilities. The GWTP unit costs include; wells, well-field piping, RO or ion exchange (IX) water treatment plant (including typical site work and ancillary components) and brine disposal (evaporation beds)

Well Head Treatment Facilities. Unit cost estimates were prepared for ion-exchange (nitrate treatment) and iron adsorption (arsenic treatment) units installed at the well-head. The WHTP cost covers the treatment facility, including typical site work and ancillary components and in the case of IX, the cost of a proportional share of evaporation beds in a centralized brine disposal facility. The cost of the well is accounted for separately.

Water Reclamation Facilities. Unit cost curves were prepared for new construction and expansion of water reclamation facilities. The WRF unit costs are for completed wastewater treatment facilities, including typical site work and ancillary components. Residual bio-solids processing is included at the 157th Ave, Pecos, and Waterman WRFs. The WRF facilities produce class A+ reclaimed water and include membrane filtration, either as an MBR or as a tertiary treatment step to reach 0.1 NTU effluent turbidity. The cost effluent disposal infrastructure, via reuse or recharge, beginning at the onsite reclaimed water reservoir and booster pumps, is addressed separately in the Reclaimed Water CIP.

Wells. Unit costs are for completed and operational wells, including drilling, casing/screening testing and equipping, including typical site work and ancillary components.

Pipelines. Unit cost estimates for pipelines are for completed pipelines including; construction, materials, traffic control, and typical ancillary components such as valves, vaults, manholes, etc.

8.3 PHASED CAPITAL IMPROVEMENTS PLAN

A separate phased CIP was developed addressing each of the three water utilities; Water Infrastructure, Wastewater Infrastructure and Reclaimed Water Infrastructure and are presented in the following.

8.3.1 Water Infrastructure CIP

A phased CIP was developed based on the recommended water infrastructure improvements from Section 5. The water distribution system analysis identified a 2045 buildout CIP for recommended system improvements totaling $2,442,096,668 in 2007 dollars. The CIP is presented in Table 8-3 in 2007 dollars, without inflation. Table 8-2 summarizes total cost at buildout of the recommended water infrastructure improvements by type. Figure 8-1 shows the location of the phased water distribution infrastructure and Figure 8-2 shows the location of the phased water transmission system infrastructure.

Table 8-2: Water Infrastructure Costs at Buildout

Infrastructure	Capital Cost	% of Total CIP Cost
Gila River GWTP	$687,519,900	28%
Waterman Wash GWTP	$360,185,700	15%
Estrella GWTP	$234,660,500	10%
Adaman Mutual GWTP	$43,614,168	2%
Distribution System Pipelines	$661,941,100	27%
Transmission System Pipelines	$233,828,300	10%
Booster Stations	$115,624,800	5%
Reservoirs	$99,295,200	4%
WPA2 Wells	$4,680,000	< 1%
PRV Stations	$675,000	< 1%
Total Cost of Water Infrastructure	**$2,442,096,668**	**100%**

Appendix B provides more detailed CIP items categorized by project type and unit cost information pertaining to potable water system improvements. It can be seen from the above summary that water treatment costs, at 52 percent of the total are the single largest category of

future cost in developing the water system infrastructure. This is due in-part to the high cost of constructing reverse-osmosis plants with brine disposal facilities. The high cost of this infrastructure underscores the importance of:

- Proper brine disposal and development of the recharge and recovery well-fields in a manner that promotes long-term aquifer clean-up and lower treatment costs in the future.
- Obtaining additional imported surface water supplies in order to reduce dependence on poor quality groundwater.

Perryville Rd
Citrus Rd
Cotton Ln
Sarival Ave
Reems Rd
Bullard Ave
Lichtfield Rd
Dysart Rd
Camelback Rd
Indian School Rd
Thomas Rd
McDowell Rd
Van Buren Rd
Yuma Rd
Lower Buckeye Rd
Broadway Rd
Southern Ave
Baseline Rd
Beloat Rd
Elliot Rd
Narramore Rd
Ray Rd
Williams Field Rd
Pecos Rd
Germann Rd
Queen Creek Rd
Concord Rd
Chandler Heights Rd
Riggs Rd
Hunt Rd
Patterson Rd
303
10
85
Gila River
Agua Fria River
Waterman Wash
Site 21 Reservoir & Booster Station
Storage #18 Reservoir & Booster Station
Westpac Reservoir & Booster Station
Storage #11 Reservoir & Booster Station
Storage #12 Reservoir & Booster Stations
Storage #8 Reservoir & Booster Station
Gila River GWTP
Gila River Reservoir & Booster Station
Kings Ranch Reservoir & Booster Station
Storage #13 Reservoir & Booster Stations
Rainbow Valley Reservoir & Booster Stations
Waterman Basin WTP
Waterman Reservoir & Booster Station
Zone 3/4 East Reservoir & Booster Stations
Zone 3 Reservoir & Booster Station
Zone 3/4 West Reservoir & Booster Stations
Estrella WTP
Estrella Reservoir & Booster Stations

N
W
E
S

1 inch equals 1 mile

Data Sources:
City of Goodyear GIS
ESRI

Legend

Reservoir / Booster Sites

Year Installed

- Existing (2000-2007)
- 2008-2017
- Build Out (2018-2045)
- PRV

2008-2017

Pipelines

Year Installed

- Existing (2000-2007)
- 2008-2017
- Build Out (2018-2045)
- Estrella Mountain Park
- Gila Zone

- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Figure 8-1
Water Distribution System CIP

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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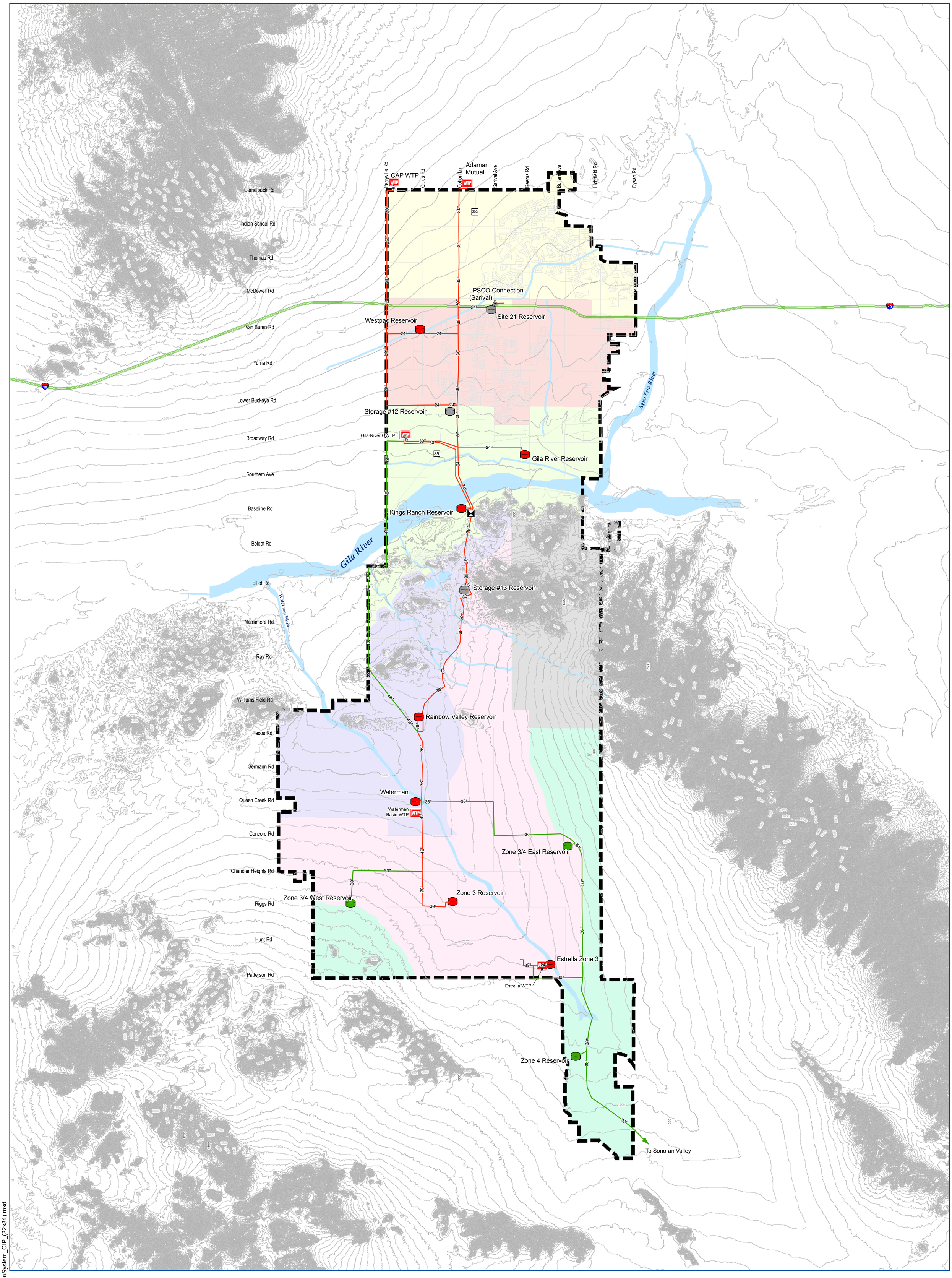
Revised: Thursday, March 27, 2008

\\Cygnet\14552\1\11GIS\TM Report Figures\Figure8-1_WaterDistributionSystemCIP_(22x34).mxd



\\Cygnet\145521\11\GIS\TM Report Figures\Figure8-2_WaterTransmissionSystem_CIP_(22x34).mxd

N
W E
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1 inch equals 1.25 miles

Legend

Facility

- Existing LPSCO Connection
- Exisitng Tank
- Water / Groundwater Treatment Plant (2008-2017)
- Tank (2008-2017)
- Build Out Tank (2018-2045)
- Valve

Transmission Mains

Year Installed

- 2008-2017
- Build Out (2018-2045)

Pressure Zones

- Estrella Mountain Park
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Data source:
City of Goodyear GIS
ESRI

Figure 8-2
Water Transmission System CIP

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

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Table 8-2: CIP - Water System Infrastrucutre [1]

	Length/Capacity	Capital Cost [2]	CIP Phasing 2008	2009	2010	2011	2012	2017	Buildout
WATER PRODUCTION INFRASTRUCTURE									
Contract Capacity									
LPSCO 3 mgd (1 mgd expansion)	1 mgd	N/A	N/A						
CAP WTP									
Phase I 5 mgd	5 mgd	N/A				N/A			
Phase II 10 mgd (5 mgd expansion)	5 mgd	N/A						N/A	
Phase III 17.5 mgd (7.5 mgd expansion)	7.5 mgd	N/A						N/A	
WPA 2 Wells (3 wells at 2 mgd each)									
without treatment	3 each	$4,680,000					$3,120,000		$1,560,000
Adaman Mutual GWTP									
Phase I 2 mgd well with nitrate well head treatment	2 mgd	$12,480,000	$12,480,000						
Phase II 4 mgd (2 mgd well with arsenic wellhead treatmer	2 mgd	$6,489,600			$6,489,600				
Phase III 10 mgd GWTP	10 mgd	$18,404,568					$18,404,568		
4 wells	4 at 2 mgd	$6,240,000					$6,240,000		
Total	**12 mgd**	**$43,614,168**							
RO Water Treatment Plants									
Waterman Wash GWTP									
Phase I 5 mgd	5 mgd	$70,957,400				$70,957,400			
Phase II 10 mgd (5 mgd expansion)	5 mgd	$70,957,400						$70,957,400	
Phase IV 30 mgd (20 mgd expansion)	35 mgd	$218,270,900							$218,270,900
Total	**45 mgd**	**$360,185,700**							
Estrella GWTP									
Phase I 5 mgd	5 mgd	$70,957,400						$70,957,400	
Phase III 20 mgd (15 mgd expansion)	35 mgd	$163,703,100							$163,703,100
Total	**40 mgd**	**$234,660,500**							
Gila River GWTP									
Phase I 5 mgd	5 mgd	$70,957,400					$70,957,400		
Phase II 10 mgd (5 mgd expansion)	5 mgd	$70,957,400						$70,957,400	
Phase III 60 mgd (50 mgd expansion)	50 mgd	$545,677,200							$545,677,200
Total	**60.00 mgd**	**$687,591,900**							
Total Water Production	**187.50 mgd**	**$1,330,732,268**	**$12,480,000**	**$0**	**$6,489,600**	**$70,957,400**	**$98,721,968**	**$212,872,200**	**$929,211,200**
RESERVOIRS / BOOSTER STATIONS									
Site 21									
Reservoir	1.0 mg	$1,950,500	$0	$0	$0	$0	$0	$0	$1,950,500
Zone 1 Booster Station	10.5 mgd	$4,897,300	$0	$0	$0	$0	$0	$2,239,800	$2,657,500
Site 11									
Reservoir	0.0 mg	$0	$0	$0	$0	$0	$0	$0	$0
Zone 1 Booster Station	5.8 mgd	$2,515,800	$0	$0	$2,515,800	$0	$0	$0	$0
Site 8									
Reservoir	0.0 mg	$6,724,500	$0	$0	$0	$0	$0	$0	$0
Zone 1 Booster Station	4.3 mgd	$2,193,800	$0	$0	$0	$0	$0	$0	$2,193,800
Site 18									
Reservoir	1.0 mg	$1,950,500	$0	$0	$0	$0	$0	$0	$1,950,500
Zone 1 Booster Station	10.6 mgd	$4,920,000	$0	$0	$0	$0	$0	$2,262,500	$2,657,500
Site 12									
Reservoir	3.0 mg	$5,364,400	$0	$0	$0	$0	$0	$0	$5,364,400
Zone 1 Booster Station	15.0 mgd	$4,042,600	$0	$0	$0	$0	$0	$0	$4,042,600
Gila River Booster Station	13.6 mgd	$4,782,500	$3,315,800	$0	$0	$0	$0	$0	$1,466,700
WestPac									
Reservoir	3.0 mg	$5,364,400	$0	$0	$0	$0	$0	$5,364,400	$0
Zone 1 Booster Station	18.0 mgd	$4,394,500	$0	$0	$0	$0	$0	$4,394,500	$0
Gila River									
Reservoir	4.0 mg	$7,802,200	$0	$0	$3,901,100	$0	$0	$3,901,100	$0
Gila River Booster Station	24.0 mgd	$7,299,800	$0	$0	$3,649,900	$0	$0	$3,649,900	$0
Kings Ranch									
Reservoir	3.0 mg	$5,851,600	$0	$0	$0	$0	$0	$2,925,800	$2,925,800
Gila River Booster Station	18.0 mg	$6,399,200	$0	$0	$0	$0	$0	$3,199,600	$3,199,600
Site 13									
Reservoir	3.5 mg	$6,054,800	$0	$0	$0	$0	$0	$0	$6,054,800
Zone 2 Booster Station	14.2 mg	$5,263,900	$1,614,000	$0	$0	$0	$0	$0	$3,649,900
Zone 3 Booster Station	10.6 mg	$4,594,600	$1,395,000	$0	$0	$0	$0	$0	$3,199,600
Rainbow Valley									
Reservoir	7.0 mg	$11,914,000	$8,012,900	$0	$0	$0	$0	$0	$3,901,100
Zone 2 Booster Station	24.0 mgd	$8,964,900	$3,649,900	$0	$0	$0	$2,657,500	$0	$2,657,500
Zone 3 Booster Station	12.0 mgd	$3,649,900	$3,649,900	$0	$0	$0	$0	$0	$0
Zone 4 Booster Station	12.0 mgd	$5,212,800	$2,657,500	$0	$0	$0	$0	$0	$2,555,300
Waterman Wash									
Reservoir	4.0 mg	$7,802,200	$0	$0	$0	$3,901,100	$0	$0	$3,901,100
Zone 2 Booster Station	24.0 mgd	$7,299,800	$0	$0	$0	$3,649,900	$0	$0	$3,649,900
Zone 3/4 (West)									
Reservoir	4.0 mg	$6,724,500	$0	$0	$0	$0	$0	$0	$6,724,500
Zone 3 Booster Station	18.0 mgd	$4,394,500	$0	$0	$0	$0	$0	$0	$4,394,500
Zone 4 Booster Station	6.0 mgd	$2,657,500	$0	$0	$0	$0	$0	$0	$2,657,500
Zone 3/4 (East)									
Reservoir	7.0 mg	$10,437,200	$0	$0	$0	$0	$0	$0	$10,437,200
Zone 3 Booster Station	30.0 mgd	$5,552,500	$0	$0	$0	$0	$0	$0	$5,552,500
Zone 4 Booster Station	12.0 mgd	$3,649,900	$0	$0	$0	$0	$0	$0	$3,649,900
Zone 3									
Reservoir	5.0 mg	$9,265,500	$0	$0	$0	$5,364,400	$0	$3,901,100	$0
Zone 3 Booster Station	30.0 mgd	$7,735,100	$0	$0	$0	$4,225,500	$0	$3,509,600	$0
Estrella									
Reservoir	4.0 mg	$6,724,500	$0	$0	$0	$0	$0	$6,724,500	$0
Zone 3 Booster Station	12.0 mgd	$3,649,900	$0	$0	$0	$0	$0	$3,649,900	$0
Zone 4 Booster Station	24.0 mgd	$7,159,500	$0	$0	$0	$0	$0	$3,649,900	$3,509,600
Sonoran Highland									
Reservoir	3.0 mg	$5,364,400	$0	$0	$0	$0	$0	$0	$5,364,400
Zone 4 Booster Station	18.0 mgd	$4,394,500	$0	$0	$0	$0	$0	$0	$4,394,500
Total Storage Capacity	**52.5 mg**	**$99,295,200**	**$8,012,900**	**$0**	**$3,901,100**	**$9,265,500**	**$0**	**$22,816,900**	**$48,574,300**
Total Booster Capacity	**366.6 mg**	**$115,624,800**	**$16,282,100**	**$0**	**$6,165,700**	**$7,875,400**	**$2,657,500**	**$26,555,700**	**$56,088,400**
PRESSURE REDUCING VALVES (PRV)									
Zone 4 / Zone 3 PRV	1.0 each	$225,000							$225,000
Zone 2 / Gila River Zone PRV	1.0 each	$225,000							$225,000
Zone 4 / Zone 3 PRV	1.0 each	$225,000							$225,000
Total	**3.0 each**	**$675,000**							**$675,000**
DISTRIBUTION SYSTEM PIPELINES									
8-inch	42 ft	$6,400	$640	$640	$640	$640	$640	$3,200	
12-inch	1,410,967 ft	$316,959,600	$13,298,160	$13,298,160	$13,298,160	$13,298,160	$13,298,160	$66,490,800	$183,978,000
16-inch	697,842 ft	$209,017,700	$12,841,450	$12,841,450	$12,841,450	$12,841,450	$12,841,450	$64,207,250	$80,603,200
18-inch	10,980 ft	$3,699,700							$3,699,700
24-inch	196,329 ft	$88,206,800	$4,729,000	$4,729,000	$4,729,000	$4,729,000	$4,729,000	$23,645,000	$40,916,800
30-inch	33,759 ft	$18,959,100	$1,399,100	$1,399,100	$1,399,100	$1,399,100	$1,399,100	$6,995,500	$4,968,100
36-inch	23,251 ft	$15,669,600	$882,600	$882,600	$882,600	$882,600	$882,600	$4,413,000	$6,843,600
42-inch	11,984 ft	$9,422,200	$616,120	$616,120	$616,120	$616,120	$616,120	$3,080,600	$3,261,000
Total	**2,385,156 ft**	**$661,941,100**	**$33,767,070**	**$33,767,070**	**$33,767,070**	**$33,767,070**	**$33,767,070**	**$168,835,350**	**$324,270,400**
TRANSMISSION SYSTEM PIPELINES									
12-inch	2,045 ft	$459,300		$459,300					
18-inch	290 ft	$97,700						$97,700	
24-inch	59,155 ft	$26,577,100		$3,018,900	$8,632,300	$9,644,200		$5,281,700	
30-inch	178,910 ft	$100,475,800		$18,193,500	$10,684,300	$12,981,500	$37,164,700	$176,400	$21,275,400
36-inch	73,877 ft	$58,628,800				$7,937,300	$8,841,500		$41,850,000
42-inch	71,773 ft	$47,589,600				$7,877,800			$39,711,800
Total	**386,050 ft**	**$233,828,300**		**$21,671,700**	**$19,316,600**	**$38,440,800**	**$46,006,200**	**$5,555,800**	**$102,837,200**
TOTAL WATER SYSTEM INFRASTRUCTURE		**$2,442,096,668**	**$70,542,070**	**$55,438,770**	**$69,640,070**	**$160,306,170**	**$181,152,738**	**$436,635,950**	**$1,461,656,500**

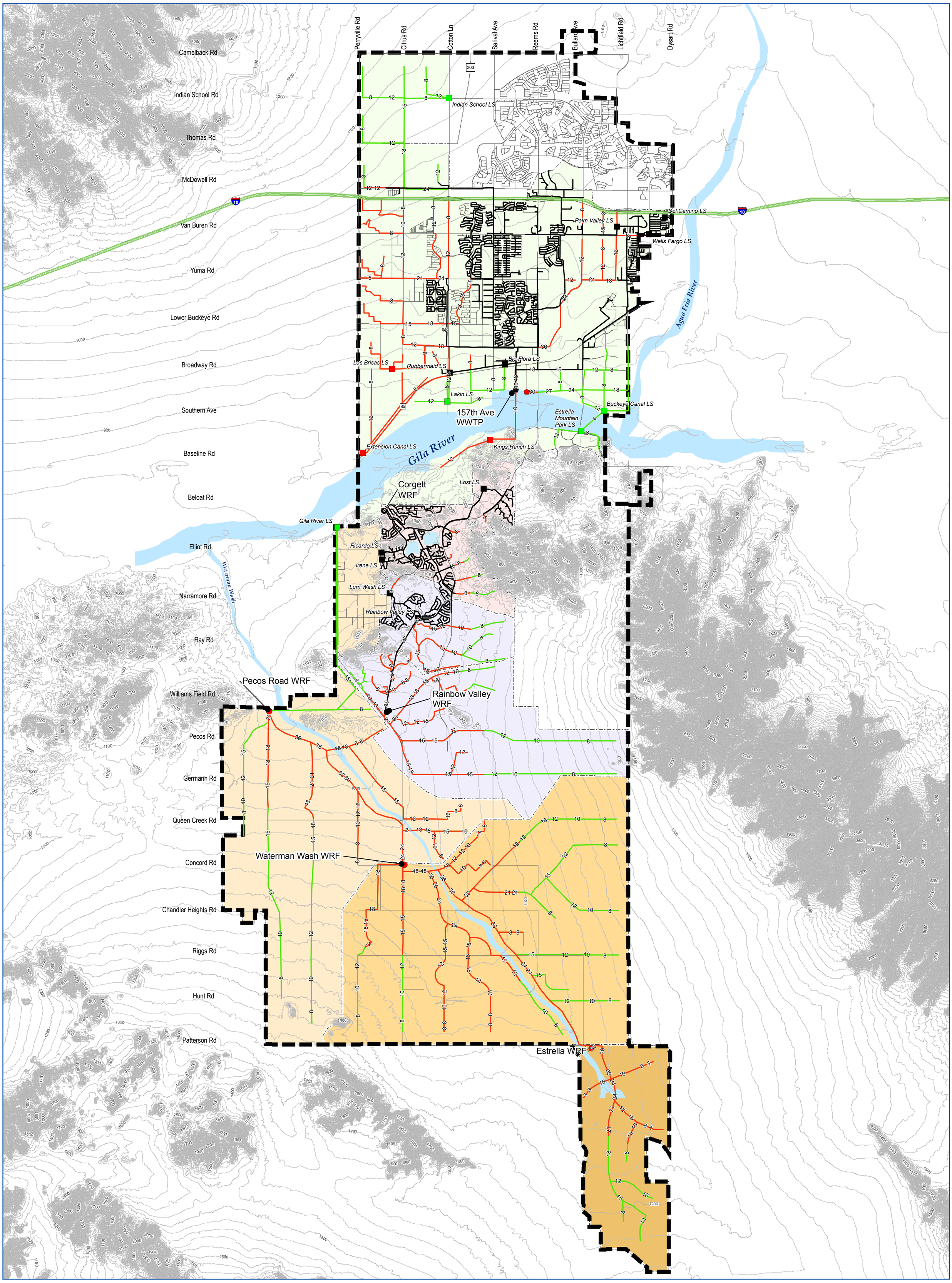
(1) Costs are in 2007 dollars without inflation. Land costs not included.
(2) Capital cost = Construction cost x 1.30 (contingency) x 1.20 (design & construction administration)

8.3.2 Wastewater Infrastructure CIP

A phased CIP was developed based on the recommended wastewater infrastructure improvements from Section 6. The wastewater collection system analysis identified a 2045 buildout CIP for recommended system improvements totaling $848,240,400 in 2007 dollars as shown in Table 8-5. Table 8-4 summarizes total costs at buildout for the recommended wastewater infrastructure improvements by type. Figure 8-3 shows the location of the phased wastewater infrastructure. Appendix B provides additional details categorized by phase and item.

Table 8-4: Wastewater Infrastructure Costs at Buildout

Infrastructure	Capital Cost	% of Total CIP Cost
Wastewater Treatment Plants	$528,782,400	62%
Collection System Pipeline	$273,221,700	32%
Lift Stations	$33,541,300	4%
Force Mains	$12,695,000	2%
Total Cost of Wastewater Infrastructure	**$848,240,400**	**100%**



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W E
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1 inch equals 1 mile

Data Sources:
City of Goodyear GIS
Wastewater Model
ESRI

Legend

- Lift Station (Existing)
- Wastewater Treatment Plant (Existing)
- Water Reclamation Facility (Existing)
- Pipe (Existing)
- Lift Station (2008-2017)
- Wastewater Treatment Plant (2008-2017)
- Water Reclamation Facility (2008-2017)
- Pipe (2008-2017)
- Lift Station (2018-2045)
- Wastewater Treatment Plant (2018-2045)
- Water Reclamation Facility (2018-2045)
- Build Out Pipe (2018-2045)
- Street
- Master Plan Study Area

Basins

- 157th Ave WWTP Basin
- Corgett Basin
- Rainbow Valley Basin
- Waterman Wash Sub-basin 1
- Waterman Wash Sub-basin 2
- Waterman Wash Sub-basin 3

Figure 8-3
Collection System CIP

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

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Revised: Wednesday, June 18, 2008

Table 8-4: CIP - Wastewater System Infrastrucutre [1]

	Length/Capacity	Capital Cost [2]	2008	2009	2010	2011	2012	2017	Buildout
WATER RECLAMATION FACILITIES									
157th Ave WWTP (6 mgd)									
Phase I 9 mgd (3 mgd expansion)	3 mgd	$39,163,500			$39,163,500				
Phase II 15 mgd (6 mgd expansion)	6 mgd	$69,469,300						$69,469,300	
Phase III 18 mgd (3 mgd expansion)	3 mgd	$39,163,500							$39,163,500
Total	**12 mgd**	**$147,796,300**							
Corgett WRF (0.8 mgd)									
Phase I 1 mgd (0.2 mgd expansion)	0.2 mgd	$2,886,500					$2,886,500		
Phase II 1.4 mgd (0.4 mgd expansion)	0.4 mgd	$5,694,200						$5,694,200	
Phase III 2 mgd (0.6 mgd expansion)	0.6 mgd	$8,541,300							$8,541,300
Total	**1.2 mgd**	**$17,122,000**							
Rainbow Valley WRF (0.8 mgd)									
Phase I 2 mgd (1.2 mgd expansion)	1.2 mgd	$16,728,300			$16,728,300				
Phase II 4 mgd (2 mgd expansion)	2 mgd	$27,093,100						$27,093,100	
Phase III 6 mgd (2 mgd expansion)	2 mgd	$27,093,100							$27,093,100
Total	**5.2 mgd**	**$70,914,500**							
Pecso WRF									
Phase I 2 mgd	2 mgd	$36,124,300			$36,124,300				
Phase II 4 mgd (2 mgd expansion)	2 mgd	$27,093,100						$27,093,100	
Phase III 8 mgd (4 mgd expansion)	4 mgd	$50,249,600							$50,249,600
Total	**8 mgd**	**$113,467,000**							
Waterman WRF									
Phase I 2 mgd	2 mgd	$36,124,300					$36,124,300		
Phase II 4 mgd (2 mgd expansion)	2 mgd	$27,093,100						$27,093,100	
Phase III 10 mgd (6 mgd expansion)	6 mgd	$69,469,300							$69,469,300
Total	**10 mgd**	**$132,686,700**							
Estrella WRF									
Phase I 1 mgd	1 mgd	$18,718,300					$18,718,300		
Phase II 2 mgd (1 mgd expansion)	1 mgd	$14,038,800						$14,038,800	
Phase III 3 mgd (1 mgd expansion)	1 mgd	$14,038,800							$14,038,800
Total	**3 mgd**	**$46,795,900**							
Total WRF	**39.4 mgd**	**$528,782,400**			**$92,016,100**		**$57,729,100**	**$170,481,600**	**$208,555,600**
LIFT STATIONS									
Bio Flora (Refit)									
Lift Station	0.20 mgd	$344,400					$344,400		
Buckeye Canal									
Lift Station	1.70 mgd	$3,231,200							$3,231,200
Force Main (8 in)	2,438 ft	$365,000							$365,000
Estrella Mountain Park									
Lift Station	0.30 mgd	$795,600							$795,600
Force Main (4 in)	3,389 ft	$253,800							$253,800
Extension Canal									
Lift Station	3.00 mgd	$4,105,900					$4,105,900		
Force Main (8 in)	17,243 ft	$2,582,300					$2,582,300		
Gila River									
Lift Station	3.40 mgd	$4,328,500							$4,328,500
Force Main (10 in)	16135 ft	$3,020,500							$3,020,500
Indian School									
Lift Station	1.50 mgd	$3,065,100							$3,065,100
Force Main (8 in)	5086 ft	$761,700							$761,700
Kings Ranch									
Lift Station	4.40 mgd	$4,825,900					$4,825,900		
Force Main (10 in)	8700 ft	$1,628,600					$1,628,600		
Lakin									
Lift Station	5.00 mgd	$5,093,200							$5,093,200
Force Main (12 in)	6,460 ft	$1,451,300							$1,451,300
Las Brisas									
Lift Station	1.20 mgd	$2,789,700					$2,789,700		
Force Main (6 in)	6524 ft	$732,700					$732,700		
Lum Wash (Expansion)									
Lift Station	1.62 mgd	$2,111,000					$2,111,000		
Palm Valley (Expansion)									
Lift Station	0.24 mgd	$413,400					$413,400		
Rainbow Valley (Expansion)									
Lift Station	0.90 mgd	$1,550,000					$1,550,000		
Force Main (12 in)	4732 ft	$1,063,000					$1,063,000		
Rubbermaid (Refit)									
Lift Station	0.46 mgd	$749,700					$749,700		
Force Main (6 in)	3076 ft	$345,500					$345,500		
Wells Fargo (Refit)									
Lift Station	0.08 mgd	$137,700					$137,700		
Force Main (6 in)	4368 ft	$490,600					$490,600		
Total Lift Station	**24 mgd**	**$33,541,300**					**$17,027,700**		**$16,513,600**
Total Force Main	**78152 ft**	**$12,695,000**					**$6,842,700**		**$5,852,300**
GRAVITY PIPELINES									
8-inch	287,705 ft	**$43,086,700**	$2,162,910	$2,162,910	$2,162,910	$2,162,910	$2,162,910	$10,814,550	$21,457,600
10-inch	97,221 ft	**$18,199,700**	$607,460	$607,460	$607,460	$607,460	$607,460	$3,037,300	$12,125,300
12-inch	213,909 ft	**$48,052,500**	$2,500,510	$2,500,510	$2,500,510	$2,500,510	$2,500,510	$12,502,550	$23,047,400
15-inch	163,307 ft	**$45,856,700**	$2,492,930	$2,492,930	$2,492,930	$2,492,930	$2,492,930	$12,464,650	$20,927,200
18-inch	77,162 ft	**$26,000,500**	$1,910,910	$1,910,910	$1,910,910	$1,910,910	$1,910,910	$9,554,550	$6,891,500
21-inch	37,769 ft	**$14,847,600**	$1,419,130	$1,419,130	$1,419,130	$1,419,130	$1,419,130	$7,095,650	$656,400
24-inch	48,314 ft	**$21,706,600**	$1,700,100	$1,700,100	$1,700,100	$1,700,100	$1,700,100	$8,500,500	
27-inch	33,802 ft	**$17,084,800**	$1,574,350	$1,574,350	$1,574,350	$1,574,350	$1,574,350	$7,871,750	
30-inch	31,148 ft	**$17,492,700**	$1,749,270	$1,749,270	$1,749,270	$1,749,270	$1,749,270	$8,746,350	
36-inch	20,444 ft	**$13,777,300**	$1,377,730	$1,377,730	$1,377,730	$1,377,730	$1,377,730	$6,888,650	
48-inch	7,691 ft	**$6,910,500**	$691,050	$691,050	$691,050	$691,050	$691,050	$3,455,250	
54-inch	204 ft	**$206,100**	$20,610	$20,610	$20,610	$20,610	$20,610	$103,050	
Total	**1,018,676 ft**	**$273,221,700**	**$18,206,960**	**$18,206,960**	**$18,206,960**	**$18,206,960**	**$18,206,960**	**$91,034,800**	**$85,105,400**
TOTAL WASTEWATER INFRASTRUCTURE		**$848,240,400**	**$18,206,960**	**$18,206,960**	**$110,223,060**	**$18,206,960**	**$99,806,460**	**$261,516,400**	**$316,026,900**

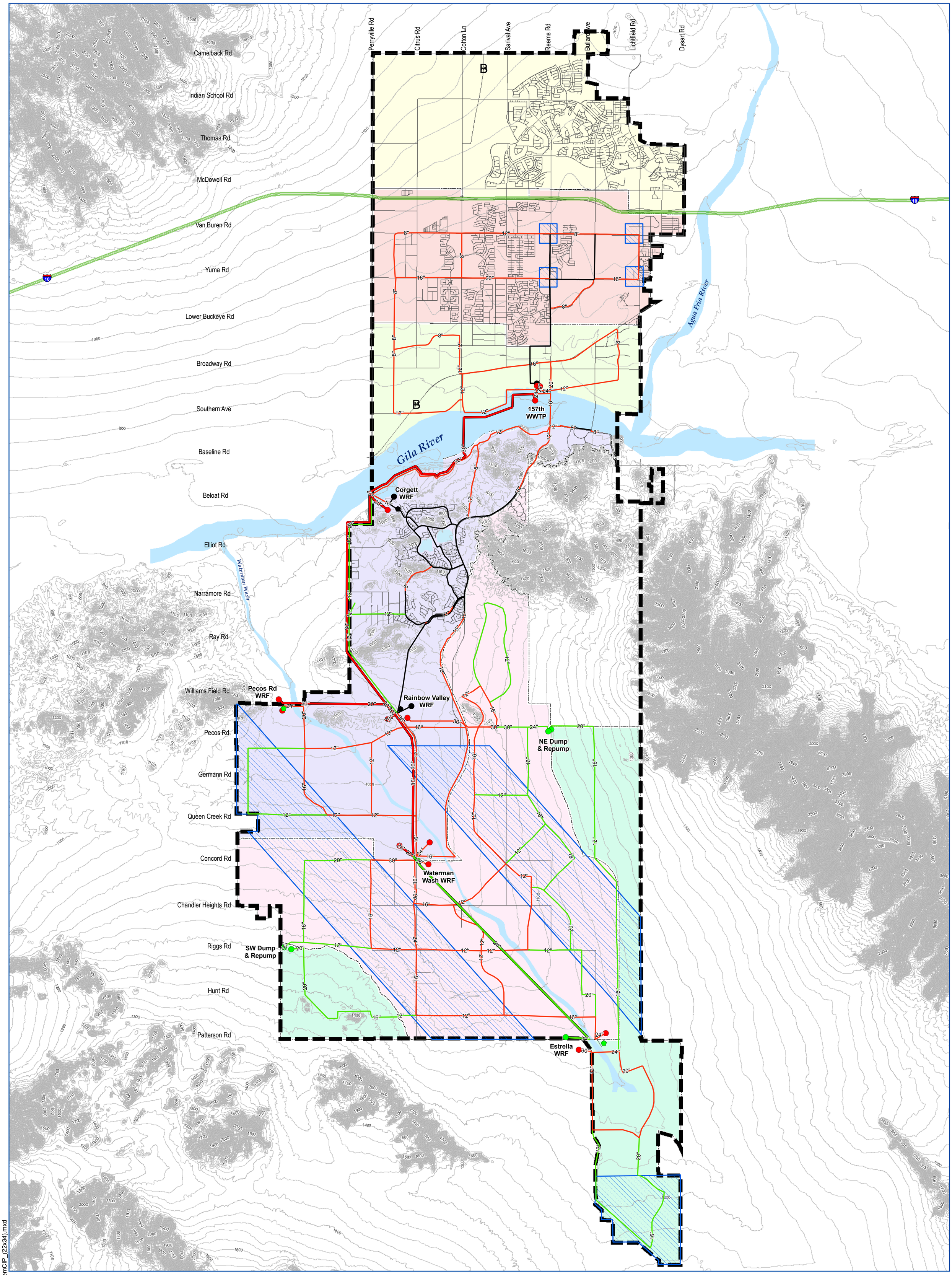
(1) Costs are in 2007 dollars without inflation. Land costs not included.
(2) Capital cost = Construction cost x 1.30 (contingency) x 1.20 (design & construction administration)

8.3.3 Reclaimed Water System Infrastructure CIP

A phased CIP was developed for the reclaimed water system based upon the recommended infrastructure improvements presented in Section 7. The reclaimed water system analysis identified a 2045 buildout CIP for recommended system improvements totaling $451,147,350 in 2007 dollars as shown in Table 8-7. Table 8-6 summarizes total costs at buildout for the recommended reclaimed water infrastructure improvements by type. Figure 8-4 shows the location of the phased reclaimed water system infrastructure. Appendix B provides more detailed CIP items categorized by project type and unit cost information pertaining to wastewater collection system improvements.

Table 8-6: Reclaimed Water Infrastructure Costs at Buildout

Infrastructure	Capital Cost	% of Total CIP Cost
Reclaimed Water System Pipelines	$326,500,400	72%
Reservoirs	$58,414,500	13%
Wells	$35,256,000	8%
Booster Stations	$30,976,700	7%
Total Cost of Reclaimed Water Infrastructure	**$451,147,350**	**100%**



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N
W E
S

1 inch equals 1 mile

Data Sources:
City of Goodyear GIS
ESRI

Legend

- Street
- Master Plan Study Area
- Recharge Zone

Distribution Mains

Year Installed

- Existing (2000-2007)
- 2008-2017
- Build Out (2018-2045)

Reservoir / Booster Sites

Year Installed

- Existing (2000-2007)
- 2008-2017
- Build Out (2018-2045)

Water Reclamation Facility

Year Installed

- Existing (2000-2007)
- Build Out (2018-2045)

Reclaim Pressure Zones

- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Figure 8-4
Reclaim Water System CIP

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear ARIZONA

BLACK & VEATCH
Building a world of difference.

Revised: Thursday, March 27, 2008

Table 8-6: CIP - Reclaimed Water System Infrastrucutre [1]

Reclaimed System Infrastructure			CIP Phasing						
	Length/Capacity	Capital Cost [2]	2008	2009	2010	2011	2012	2017	Buildout
WELLS									
ASR Wells	8 wells	$12,480,000					$12,480,000		
Zone 2/3 Wells	40 wells	$18,720,000					$3,744,000	$4,212,000	$10,764,000
Zone 4 Recharge Wells	4 wells	$4,056,000						$3,120,000	$936,000
Total	**52 wells**	**$35,256,000**					**$16,224,000**	**$7,332,000**	**$11,700,000**
RESERVOIRS / BOOSTER STATIONS									
157th Site									
Reservoir	7 mg	$13,166,560			$5,364,370			$3,901,090	$3,901,090
157th Booster	19.8 mgd	$6,512,380			$2,598,340			$1,818,800	$2,095,240
Corgett Site									
Reservoir	2 mg	$3,901,090					$3,901,090		
Corgett Booster	5.8 mgd	$2,084,940					$2,084,940		
Rainbow Valley Site									
Reservoir	4 mg	$7,802,180			$3,901,090				$3,901,090
Rainbow Valley Booster	23.9 mgd	$5,823,170			$2,911,580				$2,911,580
Pecos Site									
Reservoir	3 mg	$5,851,400			$1,950,470			$1,950,470	$1,950,470
Pecos Booster	5.6 mgd	$2,195,390			$784,060			$784,060	$627,280
Waterman Site									
Reservoir	6 mg	$10,625,470					$1,950,470	$1,950,470	$6,724,540
Waterman Booster	23.2 mgd	$6,078,380					$1,361,880	$1,361,880	$3,354,620
Estrella Site									
Reservoir	4 mg	$7,802,180						$3,901,090	$3,901,090
Estrella Booster	18.2 mgd	$5,148,310						$2,574,160	$2,574,160
Zone 4 East									
Reservoir	3 mg	$5,364,370							$5,364,370
Zone 4 East Booster	4.4 mgd	$1,716,160							$1,716,160
Zone 4 West Site									
Reservoir	2 mg	$3,901,090							$3,901,090
Zone 4 West Booster	3.6 mgd	$1,417,880							$1,417,880
Total Storage	**31.00 mg**	**$58,414,340**			**$11,215,930**		**$5,851,560**	**$11,703,120**	**$29,643,740**
Total Boosters	**104.4 mgd**	**$30,976,610**			**$6,293,980**		**$3,446,820**	**$6,538,900**	**$14,696,920**
RECLAIMED SYSTEM PIPELINES									
8-inch	111,618 ft	**$16,716,000**	$1,671,600	$1,671,600	$1,671,600	$1,671,600	$1,671,600	$8,358,000	
12-inch	407,049 ft	**$91,439,600**	$5,445,590	$5,445,590	$5,445,590	$5,445,590	$5,445,590	$27,227,950	$36,983,700
16-inch	260,971 ft	**$78,166,000**	$5,171,180	$5,171,180	$5,171,180	$5,171,180	$5,171,180	$25,855,900	$26,454,200
20-inch	101,018 ft	**$37,821,300**	$2,145,450	$2,145,450	$2,145,450	$2,145,450	$2,145,450	$10,727,250	$16,366,700
24-inch	80,194 ft	**$36,029,400**	$2,019,780	$2,019,780	$2,019,780	$2,019,780	$2,019,780	$10,098,900	$15,831,700
30-inch	111,448 ft	**$62,589,200**	$6,050,290	$6,050,290	$6,050,290	$6,050,290	$6,050,290	$30,251,450	$2,086,500
36-inch	5,548 ft	**$3,738,900**	$373,890	$373,890	$373,890	$373,890	$373,890	$1,869,450	
Total	**1,077,847 ft**	**$326,500,400**	**$22,877,780**	**$22,877,780**	**$22,877,780**	**$22,877,780**	**$22,877,780**	**$114,388,900**	**$97,722,800**
TOTAL RECLAIMED WATER SYSTEM INFRASTRUCTURE		**$451,147,350**	**$22,877,780**	**$22,877,780**	**$40,387,690**	**$22,877,780**	**$48,400,160**	**$139,962,920**	**$153,763,460**

(1) Costs are in 2007 dollars without inflation. Land costs not included.
(2) Capital cost = Construction cost x 1.30 (contingency) x 1.20 (design & construction administration)

A.1 Potential Reuse Markets

An estimate of the potential markets for reclaimed water reuse was made based Direct reuse and aquifer recharge of reclaimed water mandate slightly different water quality requirements by the Arizona Department of Environmental Quality (ADEQ). Direct reuse of effluent for open-access areas requires Class A effluent (tertiary treatment with disinfection). However, aquifer recharge of effluent requires Class A+ effluent which is defined as tertiary treatment with the addition of denitrification.

The following is a list of the variety of potential applications for reclaimed water for which unit rates were included:

- Golf Courses
- Parks/Schools
- Street Right-of-way (ROW)
- Lakes
- Construction

In the Phoenix Active Management Area (AMA), golf courses include 9-hole to 72-hole facilities. Golf courses are the largest turf-related facilities, usually having more than 80 acres of water-intensive landscaping. Golf courses typically use Bermuda grass or bent grass on greens. All golf courses overseed their tees and greens with rye grass in winter unless they have bent grass greens. Due to the overseeding and strong emphasis on turf appearance golf course turf has a larger irrigation demand than that of schools and parks.

The application rate is able to be maintained lower than that of golf course turf due to the relaxed turf appearance standards of parks and the practice of generally not overseeding. Bermuda grass is usually the only species planted, with rye grass overseeding limited to a few baseball fields. Schools also use Bermuda grass, are seldom overseeded and have relaxed appearance standards. Schools must only maintain a surface adequate for active play thus enabling low water application rates without adversely impacting the turf use.

A.2 Reuse Alternatives

An analysis was performed to determine reclaimed water requirements and the effect on overall resource utilization at three potential levels of reuse. The three potential levels of reuse addressed are:

Zero Reuse: The analysis with zero reclaimed water reuse will recharge all reclaimed water while increasing the demand for potable water. The increase in potable demand is due to the large scale turf users requiring additional potable water to irrigate that would normally be irrigated by nonpotable water.

Midlevel Reuse: The midlevel analysis includes reclaimed water to be used for large scale turf irrigation, lakes and construction. The potable water demand would drop and the amount of recharge from reclaimed water would drop due to the irrigation demand. The large scale turf users include golf courses, school, parks, and street ROW in locations where nonpotable water pipe is laid for transmission to turf facilities. Lakes and construction will be served the nonpotable water system, with construction serviced by nonpotable hydrants located in the city.

Dual System: The dual system analysis includes residential exterior landscaping irrigation as well as the large scale turf users, lakes, and construction. The potable water demand would drop due to transfer of residential exterior landscaping irrigation being fed by nonpotable water. Recharge of reclaimed water would also drop thus increasing the need for recharge credits elsewhere.

Table A-1 show the reclaimed water demand and resource utilization for each alternative level of reuse analyzed. It can be seen that:

- As direct reuse increases, potable water demand decreases
- Reclaimed water production remains the same throughout the three levels due to interior water usage remaining the same
- Available resources for recharge decrease as direct reuse increases
- Recovery is required when the direct reuse demand exceeds the reclaimed water production
- In every case 100% of the reclaimed water resource is beneficially used, either directly for irrigation lake filling and construction, which lowers potable demand or for recharge which provides the groundwater replenishment necessary to support potable water extraction.

Table A-1: Reclaimed Water Demand and Resource Utilization

Level of Reuse	Potable Demand	Reclaimed Water Production	Direct Reuse	Recharge	Recovery
Zero	119,801	45,592	0	45,592	0
Midlevel	101,315	45,592	24,035	21,557	0
Dual System	76,783	45,592	49,858	0	4,266

In the following sections we explain the alternative markets for reclaimed water and the seasonal demands that occur.

ZERO REUSE

A reuse analysis with zero reuse was completed to determine the impact on the potable water system if the irrigation demand associated with all golf courses, lakes, schools, and parks was met with potable water. The same number of recharge credits will be necessary to meet the increased potable demand and decreased nonpotable demand, even though the amount of recharged reclaimed water is at its highest.

Additional groundwater pumping will be required to meet the irrigation requirements of large scale turf users that would normally require nonpotable water irrigation. An increase in brine disposal would occur and additional brine beds and treatment processes would be required. Figure 4 displays the water resources balance at build out with zero reuse.

MIDLEVEL

The Midlevel reuse analysis was based on the determination of irrigation demand for large scale turf users, including schools, golf courses, parks, and street ROW where nonpotable water pipe is laid for transmission to turf facilities. Construction water will be metered from nonpotable hydrants located in the city.

The following Table A-2 is a partial list of assumptions associated with planning for the reuse sites.

Table A-2 Land Use Assumptions	
Park Reuse Areas	
Density of parks	3.49 acres/1,000 persons
Irrigated turf in parks	35% of total area
Irrigated LWU in parks	35% of total area
School Reuse Areas	
Irrigated turf at schools	45% of developed area
Golf Course Reuse Areas	
Irrigated turf at golf courses	74% of total area
Irrigated LWU at golf courses	23% of total area
Total area per 18 hole course	117 acres
Lake area per 18 hole course	3.6 acres
Roadway Reuse Areas	
Width of Irrigated Road ROW	30 feet
Irrigated LWU at roadways	100% of available area

These assumptions have been used to estimate the future potential reuse acreages for Goodyear. A complete breakdown of acres of turf, LWU areas, and lakes is provided in Appendix B.

The number of schools at build out for Goodyear was determined based on the percentages of school age children in surrounding cities compared to the current percentages of children in Goodyear. The percentages were applied to the build out population to determine the number of school age children. Based on Goodyear's School Facility Design Guidelines from the 2003 General Plan and a 90% enrollment capacity, the number of schools was determined. The turf acreage was determined based on 45% turf site requirements to maintain an average of 10.9 acres of turf throughout the city schools.

The number of golf courses at build out was determined based on the average number of golf courses in the surrounding cities. Based on Goodyear's current land use plan the average population/18 hole golf course was applied to Goodyear's build out population to determine the number of golf courses per WPA. The maximum value for population/18 hole golf course was applied to WPA 2 because of the higher commercial density and less residential acreages, thus decreasing the number of golf courses. The remaining WPAs all used the average population/18 hole golf course due to the larger residential acreages, thus increasing the number of golf courses. Using the ADWR Third Management Plan average landscaping acres per hole for new

golf courses, the number of turf acres was determined. Table A-3 displays the acreages for turf, lake, and low water use landscaping.

Table A-3 Average Landscaping Acres per Hole

Type of Acres	New Regulation Golf Courses (Post-1984 Courses)
Turf	4.8
Lake	0.2
Low Water Use Landscaping	1.5

Park acreages were determined based on the average number of park acreage/1,000 people in the surrounding cities. The average value of 3.49 was applied to Goodyear's build out population to determine the park acreage. A value of 35% turf and a value of 35% low water use landscaping were used to determine the turf and low water use acreages. Three acres of low water use equate to one acre of turf and thus the adjustment to 12% low water use turf was determined.

To determine the street ROW that could have potential low water use irrigation it was assumed that all major artery streets would have a nonpotable water pipe within it as distribution to large scale turf users. The number of miles of road was determined based on square mile grids in each WPA. The low water use irrigation width was estimated to be 30 ft. From this information the ROW irrigation demand acreage was determined.

Construction water was determined as a percentage of the potable water demand. As Goodyear approaches buildout, construction water usage will drop and draw near 0.5%.

Seasonal reuse demand curves were developed to determine the monthly demand based on the evapotranspiration peaking factor, enabling sizing of reuse and recovery infrastructure. The peaking factors were applied to the annual average reuse demand for the midlevel reuse analysis and compared to the wastewater annual average. The wastewater effluent will always be greater than the midlevel reuse demand, thus recharge will occur throughout the entire year. The recharge facilities will be designed to accommodate a maximum capacity reached during winter of approximately 36,624 af. During the summer reuse will be at its maximum and the infrastructure will be designed for a maximum capacity of 40,798 af. Additional resources to supplement the reuse irrigation demand will not be necessary as the reuse demand never exceeds the wastewater effluent.

DUAL SYSTEM

The Dual system reuse analysis was based on the determination of irrigation demand for large scale turf users and exterior residential landscaping. The acreages for large scale turf users and construction were calculated with the midlevel reuse analysis and were simply reapplied for the dual system. The ADWR Third Management Plan was the guide for determining the exterior landscaping irrigation demand for Goodyear.

From the Third Management Plan the interior water usage was determined on a household basis, based on an occupancy rate of 2.65. The approximate interior water usage per dwelling unit in Goodyear was determined to be 151 gpdu. The exterior water usage for new single family homes from the Third Management Plan is 189 gallons per dwelling unit, with 143 gpdu used for landscape watering. The Third Management Plan provides a value of 77 gpdu for exterior multi family landscaping usage. A comparison was made between single and multi family homes to determine the landscaping usage for multi family of 58 gpdu.

Table A-4 Exterior vs. Interior Family Water Use

Third Management Plan Water Use New Residential Development using Occupancy Rate of 2.65 people/du				Goodyear Estimate for Irrigation Demand
Type	**Interior (gpdu)**	**Exterior (gpdu)**	**Total (gpdu)**	**Unit Rate (gpdu)**
Single Family	151	189	340	**143***
Multi Family	151	77	228	**58****
*Based on Landscape Watering from ADWR Third Management Plan				
**Based on ratio of Single Family Exterior Use Landscaping to Multi Family Exterior Use				

The irrigation demand unit rate was then applied to the number of dwelling units per land use category to determine the required Irrigation Demand.

Seasonal reuse demand curves were developed to determine the monthly demand based on the evapotranspiration and pan evaporation peaking factors, enabling sizing of reuse and recovery infrastructure. The peaking factors were applied to the annual average reuse demand for the dual system reuse analysis and compared to the wastewater annual average, as displayed on Table 14. The wastewater effluent will remain constant throughout the year due to interior water use typically remaining the same. The recharge facilities will be designed to accommodate a maximum capacity reached during winter of approximately 26,811 af. During the summer reuse will be at its maximum and the infrastructure will be designed for a maximum capacity of 87,279

af. Additional resources of 41,687 af to supplement the reuse irrigation demand in the max month will be necessary as the reuse demand exceeds the wastewater effluent in the summer months. Recovery wells will be used to extract additional groundwater when irrigation demand exceeds the wastewater effluent.

A.3 Cost Analysis

A cost analysis was completed to determine whether any of the reuse levels offered significant savings over the others. The analysis included water and reclaimed water infrastructure. Wastewater infrastructure was not analyzed due to interior flows remaining the same for residential and commercial and will never change based on irrigation demand being potable or nonpotable water.

Cost estimates were determined on the potable water side for surface water and for ground water infrastructure. .

The zero reuse system has the following costs associated with it:

- Highest potable water system cost
- Lowest nonpotable water system cost
- Comparable recharge cost
- Zero recovery cost

The midlevel reuse system has the following costs associated with it:

- Middle potable water system cost
- Lower nonpotable water system cost
- Comparable recharge cost
- Zero recovery cost

The dual system has the following costs associated with it:

- Lowest potable water system cost
- Highest nonpotable water system cost
- Comparable recharge cost
- Highest recover cost

The potable water system includes treatment facilities, wells, storage, boosters, and piping. The larger the demand with the zero reuse system based on increased potable water demand to irrigate with increases the potable system size. Less potable water demand with the dual system,

reduces extraction of water from the aquifer, size of the distribution system and as well, treatment facilities. Even with decreased potable water demand the pipe sizes would remain the same due to sizing for fire flow.

The nonpotable water system includes storage, boosters, and piping. The zero reuse system would have zero reuse infrastructure whereas the dual system would have extensive reuse infrastructure. The midlevel reuse system would require piping to all large scale turf users within street ROW. Boosters and storage would be required to supply the water to the user. For the dual system a complete network of pipes mimicking the potable water system would be required. Piping to every household would be required for exterior landscaping.

The nonpotable water system piping was determined on a midlevel reuse basis and on a dual system basis. For the midlevel reuse system it was assumed that a nonpotable pipe would be located within every major street artery located on the square mile grid of the city. The length of pipe was calculated per square mile, maintaining only one pipe within every square mile. The pipe will be 12-inch pipe. The dual system piping was determined based on an estimate of the typical length of pipe within a residential square mile. The length of pipe per residential square mile was then applied to the land use residential square miles to determine the total pipe length within the city required for the dual system.

For recharge and recovery facilities the maximum demand based on the peaking factor per month must be met by the infrastructure. The zero reuse system would only have recharge wells sized to meet the wastewater effluent. The effluent does not change and therefore the infrastructure can be sized based on the effluent. The midlevel reuse system has a maximum irrigation demand that never exceeds the wastewater effluent, thus never requiring recovery wells. The number of recharge wells is based on the lowest irrigation demand month during the year. The dual system will require recharge and recovery facilities. During the summer additional water will be required to meet the high irrigation demand. Recovery wells will meet all demands that exceed the wastewater effluent. During the winter months when the irrigation demand is low, recharge will be required for the excess effluent.

The total cost of infrastructure (potable and nonpotable) for each level of reuse is comparable and does not provide an adequate justification to choose one level of reuse over another. The impact that does exist is the amount of water extracted from the aquifer and treated to meet the potable water demand. The lower the potable water demand the less brine disposal required. If the brine is to be disposed into the aquifer, over time the brine concentration will become too great and eventually could raise the salt concentration too high for potable water.

A.4 Conclusions and Recommendations

The three alternatives are summarized in Table A-5 and based on the analysis, it is recommended that Goodyear implement the midlevel reuse system for the following reasons:

1) It provides a high degree of reuse, approaching 100% in summer months. As the level of reuse increases the potable water demand decreases lowering the amount of water extracted from the aquifer. The brine losses will decrease in the southern planning areas, creating less of a problem for disposal and treatment of brine. As well, as water quality standards become more stringent in the future, the potable water will strictly be used for drinking water purposes and not as irrigation demand.
2) Has a low total infrastructure cost (roughly same as zero reuse).
3) It provides a balance between potable water and reclaimed water infrastructure. Midlevel reuse lowers the size of the potable water system storage and treatment.
4) Administratively simpler to execute. If a dual system was implemented a number of regulations would be required to be met and education to the population on health and safety issues. Serious consideration should be given for nonpotable water use on yards of residences to ensure that cross connecting with the public supply system and inappropriate human contact is avoided.
5) It leaves open the opportunity for implementation of a dual system in communities where developers propose. Developers will coordinate design with the Maricopa County Health Services (MCHS), and the Arizona Department of Environmental Quality (ADEQ).

Table A-5 Reuse Comparison Summary

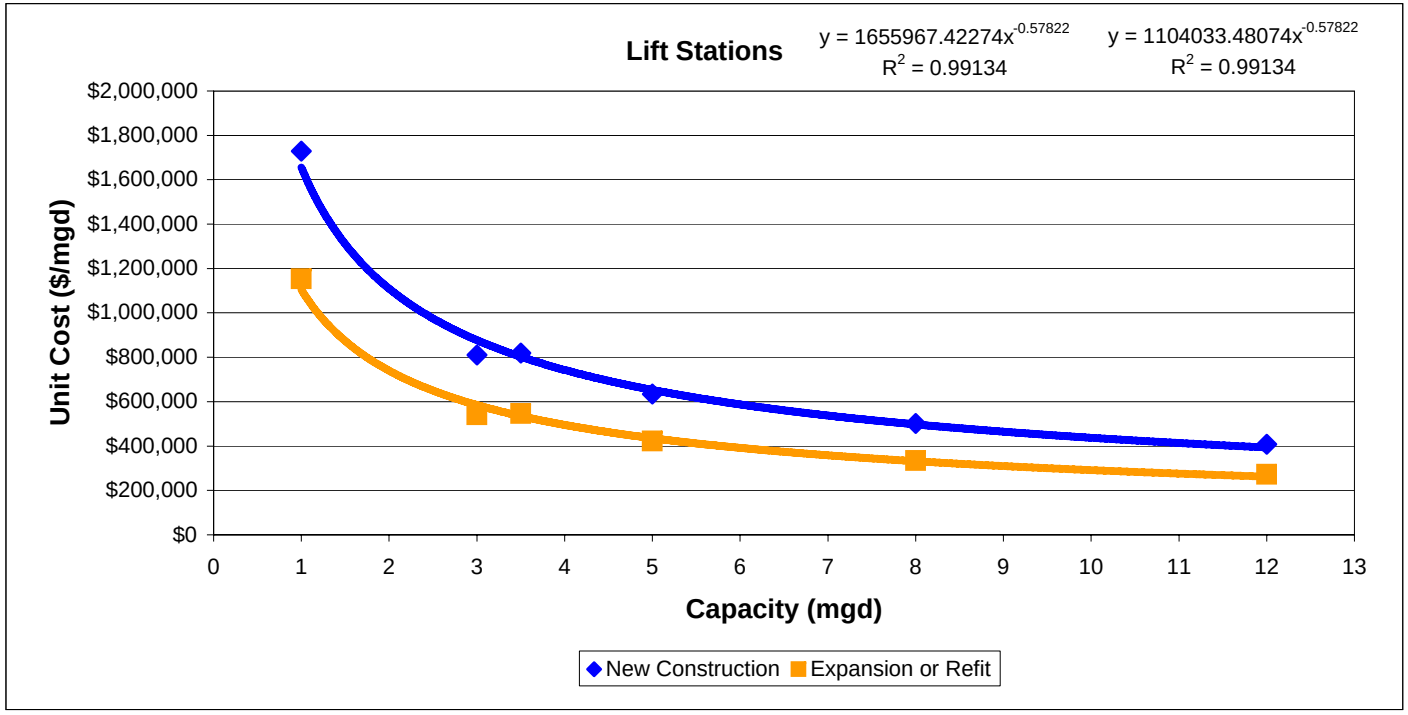
Reuse Alternative	Infrastructure Cost (Millions)	Resource Utilization		
		Potable (ac-ft/yr)	Reclaimed (ac-ft/yr)	Total (ac-ft/yr)
Zero	1,424	119,801	0	119,801
Mid level	1,480	101,315	24,035	125,350
Dual System	1,645	76,783	43,018	126,641

COST CURVES

Lift Station Cost Summary				
Station Capacity (mgd)	New Construction		Refit or Expansion (1)	
	Total Cost	Unit Cost ($/mgd)	Total Cost	Unit Cost ($/mgd)
1	$1,729,500	$1,729,500	$1,153,058	$1,153,058
3	$2,430,500	$810,167	$1,620,414	$540,138
3.5	$2,866,000	$818,857	$1,910,762	$545,932
5	$3,169,000	$633,800	$2,112,772	$422,554
8	$4,017,800	$502,225	$2,678,667	$334,833
12	$4,899,300	$408,275	$3,266,363	$272,197

(1) Refits or expansions do not include structure costs, only electrical/mechanical costs and are assumed to be 67% of new construction costs.

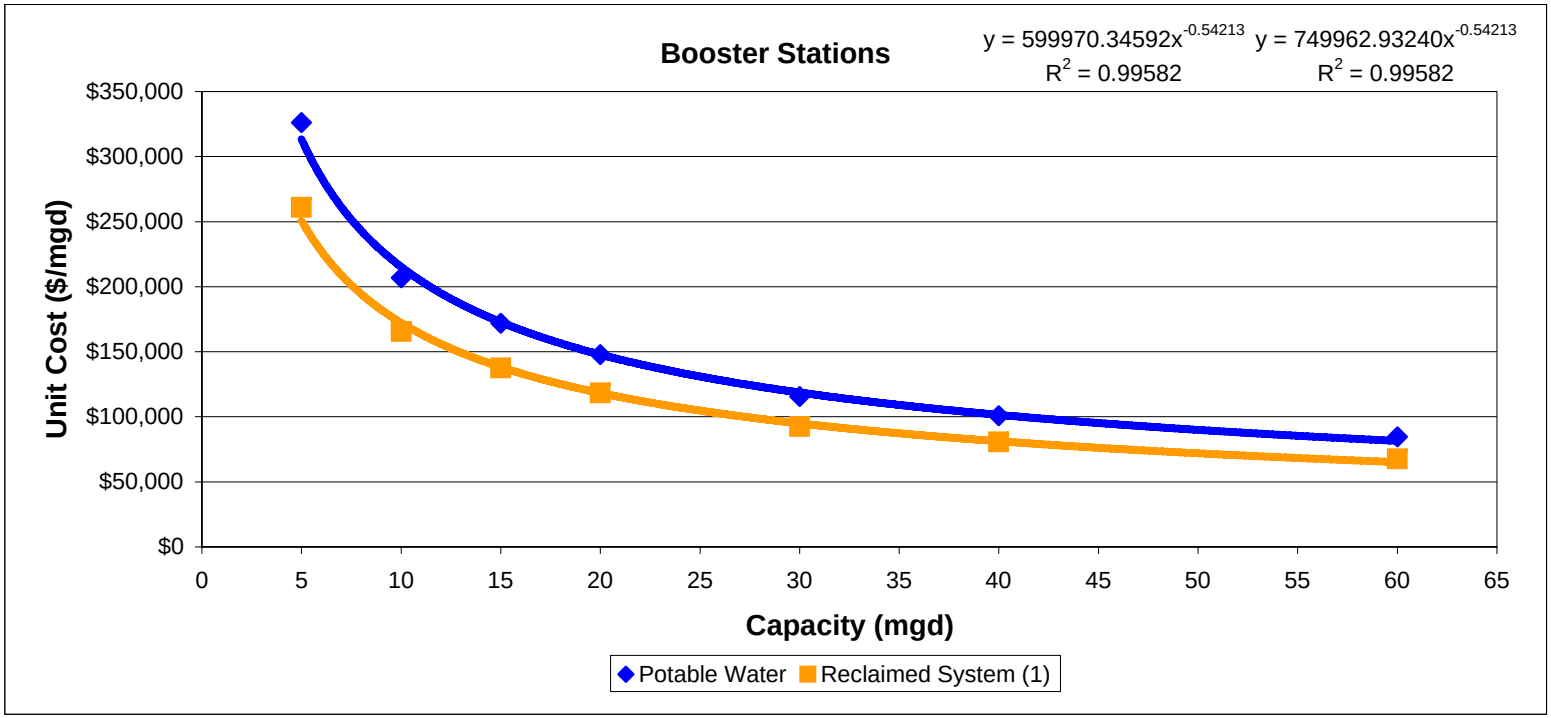
Source: City of Phoenix Water and Wastewater Facility Unit Cost Study Update (2006)
Cost adjusted to 2007 using ENR Index



Booster Station Cost Summary				
Station Capacity (mgd)	Potable Water		Reclaimed Water (1)	
	Total Cost	Unit Cost ($/mgd)	Total Cost	Unit Cost ($/mgd)
5	$1,630,900	$326,180	$1,304,720	$260,944
10	$2,068,700	$206,870	$1,654,960	$165,496
15	$2,578,500	$171,900	$2,062,800	$137,520
20	$2,954,800	$147,740	$2,363,840	$118,192
30	$3,465,600	$115,520	$2,772,480	$92,416
40	$4,037,400	$100,935	$3,229,920	$80,748
60	$5,075,800	$84,597	$4,060,640	$67,677

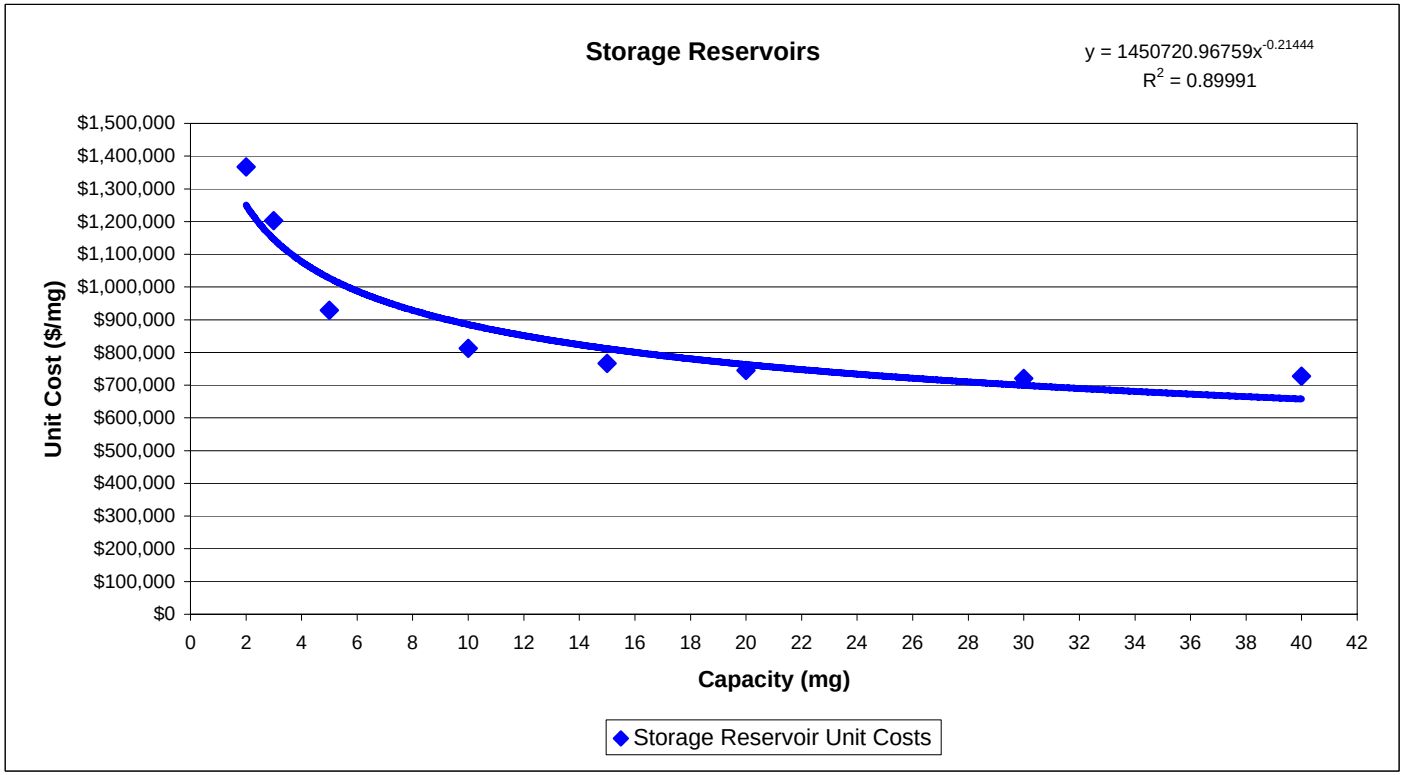
(1) Booster stations for reclaimed water systems do not include standby pumps or generators and are assumed to be 80% of potable system station costs.

Source: City of Phoenix Water and Wastewater Facility Unit Cost Study Update (2006)
Cost adjusted to 2007 using ENR Index

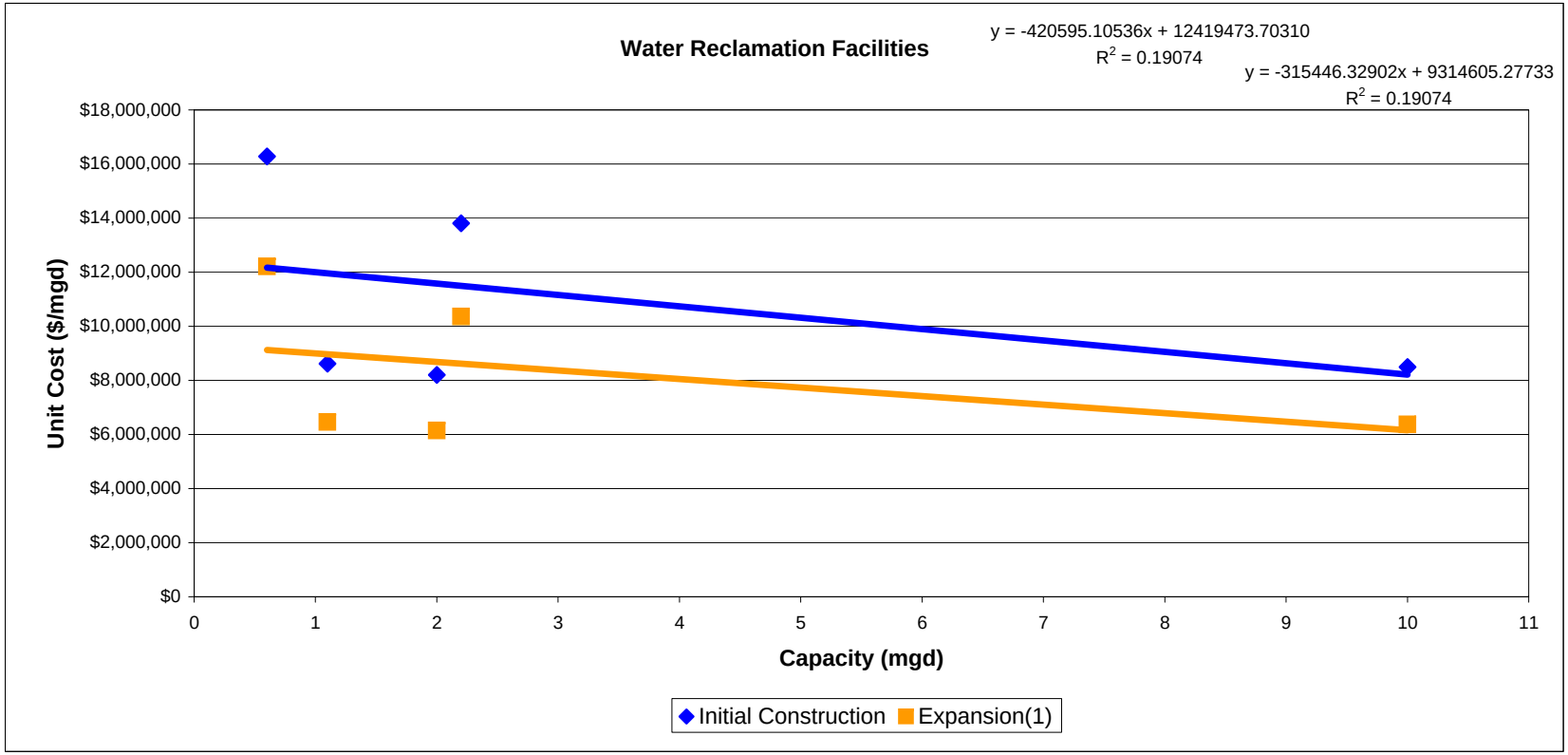


Storage Reservoir Costs		
Storage Capacity (mgd)	Total Cost	Unit Cost ($/mgd)
2	$2,733,700	$1,366,850
3	$3,608,000	$1,202,667
5	$4,645,700	$929,140
10	$8,130,400	$813,040
15	$11,496,200	$766,413
20	$14,902,900	$745,145
30	$21,608,300	$720,277
40	$29,090,500	$727,263

Source: City of Phoenix Water and Wastewater Facility Unit Cost Study Update (2006)
Cost adjusted to 2007 using ENR Index



WRF Unit Costs								
Facility	**Reclaimed Water Quality**	**Solids Processing**	**Capacity (mgd)**	**Construction Cost ($)**	**Year**	**ENR Index [(1)]**	**2007 ($)**	**Unit Cost ($/mgd)**
Shadow Mountain	A+	Dewater/Landfill	0.6	$9,400,000	2006	1.04	$9,768,422	$16,280,704
Peoria South West	A+	Dewater/Landfill	10	$85,000,000	2007	0	$85,000,000	$8,500,000
Baltera								
Phase I	A+	Dewater/Landfill	1.1	$8,800,000	2005	1.08	$9,480,898	$8,618,998
Phase II	A+	Dewater/Landfill	2.2	$14,100,000	2005	1.08	$15,190,984	$13,809,986
Safford	A+	Stabilize/Landfill	2	$13,200,000	2001	1.24	$16,400,437	$8,200,219
						1) ENR Index for 2007 = 8979.14		



(1) Expansion Capacity = 75% of Initial Construction Costs

COST ESTIMATES

ESTIMATED CAPITAL COST
WELLHEAD 2.0 MGD ARSENIC GWTP

WELLHEAD ARSENIC GWTP - 2.0 MGD CAPITAL COST SUMMARY

				2 MGD ***Total Cost***
Item 1. Wellhead Arsenic Treatment Plant (Ion Adsorption - 2 MGD)				$1,523,003
Subtotal 2 MGD GTP				**$1,523,003**
Mobilization, General Requirements, Taxes			8%	$121,800
TOTAL PROBABLE CONSTRUCTION COST				**$1,644,803**
CONSTRUCTION COST				**$3,167,805**
CONSTRUCTION COST ($ / gal, Peak Day)				**$1.58**

I. WELLHEAD ARSENIC GW TREATMENT PLANT	Quantity	Unit	Unit Cost	Total Cost
Ion Exchange Treatment Systems (Inflow Well Water: Nitrate = 15 mg/L, Treated Water: Nitrate = 8 mg/L	LS			$593,303
1. Arsenic Adsorption Vessels with Media				
2. One (1) Softener				
3. Two (2) Sets of Transfer Pumps				
4. One (1) PLC Control System				
5. Backwash Storage Tank				
6. Piping, Fittings and Valves			20%	$118,700
Subtotal (on Exchange Treatment System)				**$712,003**
1. Strainers	LS		$49,000	$49,000
2. Backwash/Rinse Water to Sanitary Sewer System (6")	200	L.F.	$90	$18,000
3. Chemical Feed Systems	LS		$345,000	$345,000
4. Sitework (15%)			15%	$168,600
5. Electrical (15%)			15%	$168,600
6. Control (5%)			5%	$61,800
Subtotal				**$811,000**
Subtotal Wellhead GWTP				**$1,523,003**

Estimated Capital Cost
10 MGD Adaman Mutual Ion Exchange GWTP

Adaman Mutual G W T P - 10 M G D C A P I T A L C O S T S U M M A R Y

		Ultimate 10 MGD *Total Cost*
Item 1.	GW Treatment Plant (Ion Exchange - 10 MGD)	$9,923,900
Item 2.	Brine Beds	$1,000,000
Subtotal 10 MGD GWTP		**$10,923,900**
Mobilization, General Requirements, Taxes	8%	$873,900
CONSTRUCTION COST		**$11,797,800**
CONSTRUCTION COST ($ / gal, Peak Day)		**$1.18**

I. CENTRALIZED GW TREATMENT PLANT	Quantity	Unit	Unit Cost	Total Cost
Ion Exchange Treatment Systems				
(Inflow Well Water: Nitrate = 15 mg/L, Treated Water: Nitrate = 8 mg/L)	LS			$5,419,400
1. Twelve (12) Ion Exchange Vessels With Media Beds				
2. Two (2) Softeners				
3. Two (2) Brine Makers Including Storage and Mixing				
4. Two (2) Brine Regeneration Systems				
5. Two (2) Backwash Rinse Storage Tanks				
6. One (1) Sets of Transfer Pumps				
7. One (1) PLC Control System				
8. Piping, Fittings and Valves			20%	$1,083,900
Subtotal (Ion Exchange Treatment System)				**$6,503,300**
1. Strainers	LS		$245,000	$245,000
4. Chemical Feed			5%	$337,400
5. Sitework (15%)			15%	$1,062,900
6. Electrical (15%)			15%	$1,062,900
7. Control (5%)			5%	$87,400
Subtotal				**$2,795,600**
GTP Operation Building				
1. Building Including Electrical Room and Control Room	2,000	S.F.	$250	$500,000
2. I/C and Electrical (20%)			20%	$100,000
3. HVAC (5%)			5%	$25,000
4.Plumbing (5%)			5%	$25,000
Subtotal (Building Cost)				**$625,000**
Subtotal Centralized GW Treatment Plant				**$9,923,900**

II. BRINE BEDS	Quantity	Unit	Unit Cost	Total Cost
1. Brine Beds	5	acres	$200,000	$1,000,000
Subtotal (Brine Beds)				**$1,000,000**

Notes:
1. Assumes 25% Annual GWTP Operation.
2. Brine beds are Co-sited at GWTP site.
3. Cost Estimates do not include land.

Estimated Capital Cost
5.0 MGD RO WTP Initial Construction

RO WTP - 5.0 MGD CAPITAL COST SUMMARY

			Ultimate 5 MGD *Total Cost*
Item 1.	RO WTP (5 mgd)		$15,933,175
Item 2.	Brine Beds		$21,867,613
Item 3.	Wells & Well Field Piping		$6,000,000
Subtotal 5 MGD WTP			**$43,800,788**
Mobilization, General Requirements, Taxes		8%	$3,504,100
CONSTRUCTION COST			**$47,304,888**
CONSTRUCTION COST ($ / gal, Peak Day)			**$9.46**

I. RO Membrane Water Treatment Plant	Quantity	Unit	Unit Cost	Total Cost
5.0 MGD RO Membrane WTP	5	mgd	$3,186,635	$15,933,175

II. BRINE BEDS	Quantity	Unit	Unit Cost	Total Cost
1. Brine Beds[1]	124	acres	$160,000	$19,879,648
2. Berms and Fencing (10% of Brine Bed Cost)				$1,987,965
Subtotal (Brine Beds)				**$21,867,613**

1. Based on 85% net recovery
2. Brine bed designed on % utilization

III. Wells & Well Field Piping	Quantity	Unit	Unit Cost	Total Cost
1. Wells	4	each	$1,000,000	$4,000,000
2. Well Field Piping	5	mgd	$400,000	$2,000,000
Subtotal (Wells & Well Field Piping)				**$6,000,000**

Based on 20% Reserve Capacity abd 15% Brine Reject

Estimated Capital Cost
10 MGD RO WTP Future Expansion

RO WTP - 10 MGD CAPITAL COST SUMMARY

			Ultimate 10 MGD *Total Cost*
Item 1.	RO WTP (10 mgd)		$28,210,742
Item 2.	Brine Beds		$29,156,817
Item 3.	Wells & Well Field Piping		$10,000,000
Subtotal 5 MGD WTP			**$67,367,559**
Mobilization, General Requirements, Taxes		8%	$5,389,400
CONSTRUCTION COST			**$72,756,959**
CONSTRUCTION COST ($ / gal, Peak Day)			**$7.28**

I. RO Membrane Water Treatment Plant	Quantity	Unit	Unit Cost	Total Cost
10 MGD RO Membrane WTP	10	mgd	$2,821,074	$28,210,742

II. BRINE BEDS	Quantity	Unit	Unit Cost	Total Cost
1. Brine Beds	166	acres	$160,000	$26,506,197
2. Berms and Fencing (10% of Brine Bed Cost)				$2,650,620
Subtotal (Brine Beds)				**$29,156,817**

1. Based on 90% net recovery
2. Brine bed designed on % utilization

III. Wells & Well Field Piping	Quantity	Unit	Unit Cost	Total Cost
1. Wells	6	each	$1,000,000	$6,000,000
2. Well Field Piping	10	mgd	$400,000	$4,000,000
Subtotal (Wells & Well Field Piping)				**$10,000,000**

Based on 10% Reserve Capacity and 10% Brine Reject

ESTIMATED CAPITAL COST
WELLHEAD 2.0 MGD NITRATE GWTP

WELLHEAD NITRATE GTP - 2.0 MGD CAPITAL COST SUMMARY

				2.5 MGD ***Total Cost***
Item 1. Wellhead Nitrate Treatment Plant (Ion Exchange - 2.0 MGD)				$3,167,240
Item 2. Proportional Brine Beds				$200,000
Subtotal 2 MGD GTP				**$3,367,240**
Mobilization, General Requirements, Taxes			8%	$269,400
TOTAL PROBABLE CONSTRUCTION COST				**$3,636,640**
CONSTRUCTION COST				**$7,003,880**
CONSTRUCTION COST ($ / gal, Peak Day)				**$3.50**

I. WELLHEAD GW TREATMENT PLANT	Quantity	Unit	Unit Cost	Total Cost
Ion Exchange Treatment Systems (Inflow Well Water: Nitrate = 15 mg/L, Treated Water: Nitrate = 8 mg/L) 1. Ion Exchange Vessels With Media Beds 2. One (1) Set of Transfer Pumps 3. One (1) PLC Control System 4. One (1) Softener 5. One (1) Brine Maker Including Storage and Mixing 6. One (1) Brine Regeneration System 7. One Backwash Rinse Storage Tank	LS			$1,407,840
8. Piping, Fittings and Valves			20%	$281,600
Subtotal (on Exchange Treatment System)				**$1,689,440**
1. Strainers	LS		$39,200	$39,200
2. Backwash Rinse Water to Sanitary Sewer System (6")	200	L.F.	$72	$14,400
3. Perimeter Wall and Gates	LS		$220,000	$220,000
3. Chemical Feed Systems	LS		$196,000	$196,000
4. Site Security	LS		$200,000	$200,000
5. Sitework (15%)			15%	$353,900
6. Electrical (15%)			15%	$353,900
7. Control (5%)			5%	$100,400
Subtotal				**$1,477,800**
Subtotal Centralized GW Treatment Plant				**$3,167,240**

II. PROPORTIONAL BRINE BEDS	Quantity	Unit	Unit Cost	Total Cost
1. Brine Beds	1	acre	$200,000	$200,000
Subtotal				**$200,000**

Notes:
1. Assumes 25% Annual Operation.
2. Brine is hauled to offsite beds a centralized GWTP.
3. Costs estimated do not include land costs.

QUANTITY TAKEOFFS

Water System Wells

Year	Name	Quanity (# wells)	Unit Cost ($/each)			Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2007	North Groundwater	5	$1,000,000.00			$5,000,000	$1,500,000	$1,000,000	$7,500,000
	South Groundwater	0	$1,000,000.00			$0	$0	$0	$0
2008	North Groundwater	2	$1,000,000.00			$2,000,000	$600,000	$400,000	$3,000,000
	South Groundwater	1	$1,000,000.00			$1,000,000	$300,000	$200,000	$1,500,000
2009	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	1	$1,000,000.00			$1,000,000	$300,000	$200,000	$1,500,000
2010	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	1	$1,000,000.00			$1,000,000	$300,000	$200,000	$1,500,000
2011	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	1	$1,000,000.00			$1,000,000	$300,000	$200,000	$1,500,000
2012	North Groundwater	3	$1,000,000.00			$3,000,000	$900,000	$600,000	$4,500,000
	South Groundwater	0	$1,000,000.00			$0	$0	$0	$0
2013	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	0	$1,000,000.00			$0	$0	$0	$0
2014	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	4	$1,000,000.00			$4,000,000	$1,200,000	$800,000	$6,000,000
2015	North Groundwater	4	$1,000,000.00			$4,000,000	$1,200,000	$800,000	$6,000,000
	South Groundwater	0	$1,000,000.00			$0	$0	$0	$0
2016	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	0	$1,000,000.00			$0	$0	$0	$0
2017	North Groundwater	0	$1,000,000.00			$0	$0	$0	$0
	South Groundwater	4	$1,000,000.00			$4,000,000	$1,200,000	$800,000	$6,000,000
2045	North Groundwater	29	$1,000,000.00			$29,000,000	$8,700,000	$5,800,000	$43,500,000
	South Groundwater	19	$1,000,000.00			$19,000,000	$5,700,000	$3,800,000	$28,500,000
Total (N. GW Wells)		**43**				**$43,000,000**	**$12,900,000**	**$8,600,000**	**$64,500,000**
Total (S. GW Wells)		**31**				**$31,000,000**	**$9,300,000**	**$6,200,000**	**$46,500,000**
Total		**69**				**$74,000,000**	**$22,200,000**	**$14,800,000**	**$111,000,000**

Water System Groundwater Treatment - Groundwater Treatment Plants

Year	Name		Quanity (mgd)	Unit Cost ($/gallon)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2007	Waterman		0.00						
	Estrella		0.00						
	Gila River		0.00	Existing					
2008	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2009	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2010	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2011	Waterman		5.00	$9.46		$47,304,900	$14,191,470	$9,460,980	**$70,957,400**
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2012	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		5.00	$9.46		$47,304,900	$14,191,470	$9,460,980	$70,957,400
2013	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2014	Waterman		5.00	$9.46		$47,304,900	$14,191,470	$9,460,980	**$70,957,400**
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2015	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		5.00	$9.46		$47,304,900	$14,191,470	$9,460,980	$70,957,400
2016	Waterman		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
2017	Waterman		0.00			$0	$0	$0	$0
	Estrella		5.00	$9.46		$47,304,900	$14,191,470	$9,460,980	**$70,957,400**
	Gila River		0.00			$0	$0	$0	$0
2045	Waterman		20.00	$7.28		$145,513,900	$43,654,170	$29,102,780	**$218,270,900**
	Estrella		15.00	$7.28		$109,135,400	$32,740,620	$21,827,080	**$163,703,100**
	Gila River		50.00	$7.28		$363,784,800	$109,135,440	$72,756,960	$545,677,200
Total (Waterman)			**30.00**			**$240,123,700**	**$72,037,110**	**$48,024,740**	**$360,185,600**
Total (Estrella)			**20.00**			**$156,440,300**	**$46,932,090**	**$31,288,060**	**$234,660,500**
Total (Gila River)			**60.00**			**$458,394,600**	**$137,518,380**	**$91,678,920**	**$687,591,900**
Total			**110.00**			**$854,958,600**	**$256,487,580**	**$170,991,720**	**$1,282,437,900**

Water System Reservoirs

Year	Name		Quanity (mg)	Unit Cost ($/gallon)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2008	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		5.00	$1.03		$5,136,500	$1,540,950	$1,335,490	$8,012,900
	Waterman Wash		0.00			$0	$0	$0	$0
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
2010	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Gila River		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Waterman Wash		0.00			$0	$0	$0	$0
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
2011	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Waterman Wash		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
2014	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		1.50	$1.25		$1,875,500	$562,650	$487,630	$2,925,800
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Waterman Wash		0.00			$0	$0	$0	$0
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella		4.00	$1.08		$4,310,600	$1,293,180	$1,120,756	$6,724,500
	Sonoran Highland		0.00			$0	$0	$0	$0
2015	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Waterman Wash		0.00			$0	$0	$0	$0
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
2016	Site 21		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Gila River		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 13		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Waterman Wash		0.00			$0	$0	$0	$0
	Zone 3/4 (West)		0.00			$0	$0	$0	$0
	Zone 3/4 (East)		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
2045	Site 21		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Site 18		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Site 12		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
	WestPac		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		1.50	$1.25		$1,875,500	$562,650	$487,630	$2,925,800
	Site 13		3.50	$1.11		$3,881,300	$1,164,390	$1,009,138	$6,054,800
	Rainbow Valley		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Waterman Wash		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Zone 3/4 (West)		4.00	$1.08		$4,310,600	$1,293,180	$1,120,756	$6,724,500
	Zone 3/4 (East)		7.00	$0.96		$6,690,500	$2,007,150	$1,739,530	$10,437,200
	Zone 3		0.00			$0	$0	$0	$0
	Estrella		0.00			$0	$0	$0	$0
	Sonoran Highland		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
Final Buildout Totals	**Site 21**		**1.00**			**$1,250,300**	**$375,090**	**$325,078**	**$1,950,500**
	Site 18		**1.00**			**$1,250,300**	**$375,090**	**$325,078**	**$1,950,500**
	Site 12		**3.00**			**$3,438,700**	**$1,031,610**	**$894,062**	**$5,364,400**
	WestPac		**3.00**			**$3,438,700**	**$1,031,610**	**$894,062**	**$5,364,400**
	Gila River		**4.00**			**$5,001,400**	**$1,500,420**	**$1,300,364**	**$7,802,200**
	Kings Ranch		**3.00**			**$3,751,000**	**$1,125,300**	**$975,260**	**$5,851,600**
	Site 13		**3.50**			**$3,881,300**	**$1,164,390**	**$1,009,138**	**$6,054,800**
	Rainbow Valley		**7.00**			**$7,637,200**	**$2,291,160**	**$1,985,672**	**$11,914,000**
	Waterman Wash		**4.00**			**$5,001,400**	**$1,500,420**	**$1,300,364**	**$7,802,200**
	Zone 3/4 (West)		**4.00**			**$4,310,600**	**$1,293,180**	**$1,120,756**	**$6,724,500**
	Zone 3/4 (East)		**7.00**			**$6,690,500**	**$2,007,150**	**$1,739,530**	**$10,437,200**
	Zone 3		**5.00**			**$5,939,400**	**$1,781,820**	**$1,544,244**	**$9,265,500**
	Estrella		**4.00**			**$4,310,600**	**$1,293,180**	**$1,120,756**	**$6,724,500**
	Sonoran Highland		**3.00**			**$3,438,700**	**$1,031,610**	**$894,062**	**$5,364,400**
	Total		**52.50**			**$59,340,100**	**$17,802,030**	**$15,428,426**	**$92,570,600**

Water System Booster Stations

Year	Name		Quanity (mgd)	Unit Cost ($/mgd)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		10.60	$208,541		$2,210,500	$663,150	$442,100	$3,315,800
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		2.20	$489,105		$1,076,000	$322,800	$215,200	$1,614,000
2008	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Site 13 (Zone 3)		1.60	$581,273		$930,000	$279,000	$186,000	$1,395,000
	Rainbow Valley (Zone 3)		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		5.80	$289,176		$1,677,200	$503,160	$335,440	$2,515,800
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2010	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2011	Waterman (Zone 2)		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		18.00	$156,502		$2,817,000	$845,100	$563,400	$4,225,500
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2012	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		4.50	$331,829		$1,493,200	$447,960	$298,640	$2,239,800
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2013	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (South) Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0

Water System Booster Stations

Year	Name		Quanity (mgd)	Unit Cost ($/mgd)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		9.00	$227,885		$2,051,000	$615,300	$533,260	$3,199,600
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2014	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		0.00			$0	$0	$0	$0
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		18.00	$156,502		$2,817,000	$845,100	$732,420	$4,394,500
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2015	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		12.00	$194,977		$2,339,700	$701,910	$467,940	$3,509,600
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		0.00			$0	$0	$0	$0
	Site 11		0.00			$0	$0	$0	$0
	Site 18		4.60	$327,898		$1,508,300	$452,490	$301,660	$2,262,500
	Site 12 Zone 1		0.00			$0	$0	$0	$0
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		0.00			$0	$0	$0	$0
	Gila River		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Kings Ranch		0.00			$0	$0	$0	$0
	Site 7		0.00			$0	$0	$0	$0
	Site 8		0.00			$0	$0	$0	$0
	Site 13 (Zone 2)		0.00			$0	$0	$0	$0
2016	Waterman (Zone 2)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 2)		0.00			$0	$0	$0	$0
	Site 13 (Zone 3)		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 3		0.00			$0	$0	$0	$0
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 4		0.00			$0	$0	$0	$0
	Zone 3/4 (East) Zone 4		0.00			$0	$0	$0	$0
	Estrella Zone 4		0.00			$0	$0	$0	$0
	Sonoran Highland		0.00			$0	$0	$0	$0
	Site 10		0.00			$0	$0	$0	$0
	Site 21		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Site 11		0.00			$0	$0	$0	$0
	Site 18		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Site 12 Zone 1		15.00	$172,761		$2,591,400	$777,420	$673,764	$4,042,600
	WestPac		0.00			$0	$0	$0	$0
	Site 12 (Gila River)		3.00	$313,406		$940,200	$282,060	$244,452	$1,466,700
	Gila River		0.00			$0	$0	$0	$0
	Kings Ranch		9.00	$227,885		$2,051,000	$615,300	$533,260	$3,199,600
	Site 7		0.00			$0	$0	$0	$0
	Site 8		4.30	$340,109		$1,462,500	$438,750	$292,500	$2,193,800
	Site 13 (Zone 2)		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
2045	Waterman (Zone 2)		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Rainbow Valley (Zone 2)		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Site 13 (Zone 3)		9.00	$227,885		$2,051,000	$615,300	$533,260	$3,199,600
	Rainbow Valley (Zone 3)		0.00			$0	$0	$0	$0
	Zone 3/4 (West) Zone 3		18.00	$156,502		$2,817,000	$845,100	$732,420	$4,394,500
	Zone 3/4 (East) Zone 3		30.00	$118,645		$3,559,300	$1,067,790	$925,418	$5,552,500
	Zone 3		0.00			$0	$0	$0	$0
	Estrella Zone 3		0.00			$0	$0	$0	$0
	Rainbow Valley (Zone 4)		6.00	$283,910		$1,703,500	$511,050	$340,700	$2,555,300
	Zone 3/4 (West) Zone 4		6.00	$283,910		$1,703,500	$511,050	$442,910	$2,657,500
	Zone 3/4 (East) Zone 4		12.00	$194,977		$2,339,700	$701,910	$608,322	$3,649,900
	Estrella Zone 4		12.00	$194,977		$2,339,700	$701,910	$467,940	$3,509,600
	Sonoran Highland		18.00	$156,502		$2,817,000	$845,100	$732,420	$4,394,500
	Site 10		**0.00**			**$0**	**$0**	**$0**	**$0**
	Site 21		**10.50**			**$3,196,700**	**$959,010**	**$741,550**	**$4,897,300**
	Site 11		**5.80**			**$1,677,200**	**$503,160**	**$335,440**	**$2,515,800**
	Site 18		**10.60**			**$3,211,800**	**$963,540**	**$744,570**	**$4,920,000**
	Site 12 Zone 1		**15.00**			**$2,591,400**	**$777,420**	**$673,764**	**$4,042,600**
	WestPac		**18.00**			**$2,817,000**	**$845,100**	**$732,420**	**$4,394,500**
	Site 12 (Gila River)		**13.60**			**$3,150,700**	**$945,210**	**$686,552**	**$4,782,500**
	Gila River		**24.00**			**$4,679,400**	**$1,403,820**	**$1,216,644**	**$7,299,800**
	Kings Ranch		**18.00**			**$4,102,000**	**$1,230,600**	**$1,066,520**	**$6,399,200**
	Site 7		**0.00**			**$0**	**$0**	**$0**	**$0**
	Site 8		**4.30**			**$1,462,500**	**$438,750**	**$292,500**	**$2,193,800**
	Site 13 (Zone 2)		**14.20**			**$3,415,700**	**$1,024,710**	**$823,522**	**$5,263,900**
Final Build Out Totals	**Waterman (Zone 2)**		**24.00**			**$4,679,400**	**$1,403,820**	**$1,216,644**	**$7,299,800**
	Rainbow Valley (Zone 2)		**24.00**			**$5,746,700**	**$1,724,010**	**$1,494,142**	**$8,964,900**
	Site 13 (Zone 3)		**10.60**			**$2,981,000**	**$894,300**	**$719,260**	**$4,594,600**
	Rainbow Valley (Zone 3)		**12.00**			**$2,339,700**	**$701,910**	**$608,322**	**$3,649,900**
	Zone 3/4 (West) Zone 3		**18.00**			**$2,817,000**	**$845,100**	**$732,420**	**$4,394,500**
	Zone 3/4 (East) Zone 3		**30.00**			**$3,559,300**	**$1,067,790**	**$925,418**	**$5,552,500**
	Zone 3		**30.00**			**$5,156,700**	**$1,547,010**	**$1,031,340**	**$7,735,100**
	Estrella Zone 3		**12.00**			**$2,339,700**	**$701,910**	**$608,322**	**$3,649,900**
	Rainbow Valley (Zone 4)		**12.00**			**$3,407,000**	**$1,022,100**	**$783,610**	**$5,212,800**
	Zone 3/4 (West) Zone 4		**6.00**			**$1,703,500**	**$511,050**	**$442,910**	**$2,657,500**
	Zone 3/4 (East) Zone 4		**12.00**			**$2,339,700**	**$701,910**	**$608,322**	**$3,649,900**
	Estrella Zone 4		**24.00**			**$4,679,400**	**$1,403,820**	**$1,076,262**	**$7,159,500**
	Sonoran Highland		**18.00**			**$2,817,000**	**$845,100**	**$732,420**	**$4,394,500**
Total Booster			**366.60**			**$74,870,500**	**$22,461,150**	**$18,292,874**	**$115,624,800**

PRV's							
Year	Name	Quanity (each)	Price/PRV	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	Zone 4 / Zone 3 PRV	1	$150,000	$150,000	$45,000	$30,000	$225,000
2045	Zone 2 / Gila River Zone PRV	1	$150,000	$150,000	$45,000	$30,000	$225,000
2045	Zone 4 / Zone 3 PRV	1	$150,000	$150,000	$45,000	$30,000	$225,000
	Total PRV	**3**		**$450,000**	**$135,000**	**$90,000**	**$675,000**

Water System Distribution Piping

Gila River Zone Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	8	12	96		32	258	$3,100	$930	$806	$4,800
2017	12	12	144		114,234	1,370,810	$16,449,700	$4,934,910	$4,276,922	$25,661,500
2017	16	12	192		75,748	1,211,976	$14,543,700	$4,363,110	$3,781,362	$22,688,200
2017	24	12	288		10,172	244,130	$2,929,600	$878,880	$761,696	$4,570,200
2017	30	12	360		5,380	161,406	$1,936,900	$581,070	$503,594	$3,021,600
Total 2017 Gila River Distribution Piping					**205,567**	**2,988,579**	**$35,863,000**	**$10,758,900**	**$9,324,380**	**$55,946,300**
Year	**Size**	**Unit Cost ($/in/LF)**	**Price/LF**	**Description**	**LF**	**in-ft**	**Estimated Construction Cost**	**Contingency (30%)**	**Design and Construction Administration Expenses (20%)**	**Projected Capital Cost $**
2045	12	12	144		126,001	1,512,013	$18,144,200	$5,443,260	$4,717,492	$28,305,000
2045	16	12	192		29,550	472,792	$5,673,500	$1,702,050	$1,475,110	$8,850,700
2045	24	12	288		5,373	128,944	$1,547,300	$464,190	$402,298	$2,413,800
2045	30	12	360		1,006	30,190	$362,300	$108,690	$94,198	$565,200
Total 2045 Gila River Distribution Piping					**161,930**	**2,143,940**	**$25,727,300**	**$7,718,190**	**$6,689,098**	**$40,134,600**

Zone 1 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	12	12	144		75,704	908,446	$10,901,400	$3,270,420	$2,834,364	$17,006,200
2017	16	12	192		83,143	1,330,291	$15,963,500	$4,789,050	$4,150,510	$24,903,100
2017	24	12	288		15,802	379,242	$4,550,900	$1,365,270	$1,183,234	$7,099,400
2017	30	12	360		2,374	71,214	$854,600	$256,380	$222,196	$1,333,200
2017	36	12	432		5,358	192,905	$2,314,900	$694,470	$601,874	$3,611,200
Total 2017 Gila River Distribution Piping					**182,381**	**2,882,098**	**$34,585,300**	**$10,375,590**	**$8,992,178**	**$53,953,100**

Zone 2 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	12	12	144		145,142	1,741,705	$20,900,500	$6,270,150	$5,434,130	$32,604,800
2017	16	12	192		80,257	1,284,116	$15,409,400	$4,622,820	$4,006,444	$24,038,700
2017	24	12	288		39,393	945,442	$11,345,300	$3,403,590	$2,949,778	$17,698,700
2017	30	12	360		10,302	309,069	$3,708,800	$1,112,640	$964,288	$5,785,700
2017	42	12	504		5,621	236,100	$2,833,200	$849,960	$736,632	$4,419,800
Total 2017 Zone 2 Distribution Piping					**280,716**	**4,516,432**	**$54,197,200**	**$16,259,160**	**$14,091,272**	**$84,547,600**

Zone 2 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	12	12	144		94,887	1,138,642	$13,663,700	$4,099,110	$3,552,562	$21,315,400
2045	16	12	192		38,121	609,934	$7,319,200	$2,195,760	$1,902,992	$11,418,000
2045	18	12	216		10,980	197,637	$2,371,600	$711,480	$616,616	$3,699,700
Total 2045 Zone 2 Distribution Piping					**143,988**	**1,946,213**	**$23,354,500**	**$7,006,350**	**$6,072,170**	**$36,433,000**

Zone 3 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	8	12	96		10	81	$1,000	$300	$260	$1,600
2017	12	12	144		197,706	2,372,475	$28,469,700	$8,540,910	$7,402,122	$44,412,700
2017	16	12	192		173,479	2,775,666	$33,308,000	$9,992,400	$8,660,080	$51,960,500
2017	24	12	288		39,890	957,361	$11,488,300	$3,446,490	$2,986,958	$17,921,700
2017	30	12	360		6,856	205,692	$2,468,300	$740,490	$641,758	$3,850,500
2017	36	12	432		1,343	48,333	$580,000	$174,000	$150,800	$904,800
2017	42	12	504		2,215	93,027	$1,116,300	$334,890	$290,238	$1,741,400
Total 2017 Zone 3 Distribution Piping					**371,196**	**5,148,223**	**$77,431,600**	**$23,229,480**	**$20,132,216**	**$120,793,300**

Zone 3 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	12	12	144		307,338	3,688,052	$44,256,600	$13,276,980	$11,506,716	$69,040,300
2045	16	12	192		121,878	1,950,047	$23,400,600	$7,020,180	$6,084,156	$36,504,900
2045	24	12	288		34,503	828,080	$9,937,000	$2,981,100	$2,583,620	$15,501,700
2045	30	12	360		7,840	235,204	$2,822,400	$846,720	$733,824	$4,402,900
2045	36	12	432		785	28,243	$338,900	$101,670	$88,114	$528,700
2045	42	12	504		2,341	98,303	$1,179,600	$353,880	$306,696	$1,840,200
Total 2045 Zone 3 Distribution Piping					**429,216**	**5,638,099**	**$81,935,100**	**$24,580,530**	**$21,303,126**	**$127,818,800**

Zone 4 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	12	12	144		59,190	710,282	$8,523,400	$2,557,020	$2,216,084	$13,296,500
2017	16	12	192		16,107	257,705	$3,092,500	$927,750	$804,050	$4,824,300
2017	36	12	432		6,395	230,237	$2,762,800	$828,840	$718,328	$4,310,000
Total 2017 Zone 4 Distribution Piping					**75,297**	**967,987**	**$14,378,700**	**$4,313,610**	**$3,738,462**	**$22,430,800**

Zone 4 Distribution Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	12	12	144		290,765	3,489,180	$41,870,200	$12,561,060	$10,886,252	$65,317,500
2045	16	12	192		79,560	1,272,953	$15,275,400	$4,582,620	$3,971,604	$23,829,600
2045	24	12	288		51,196	1,228,702	$14,744,400	$4,423,320	$3,833,544	$23,001,300
2045	36	12	432		9,370	337,329	$4,047,900	$1,214,370	$1,052,454	$6,314,700
2045	42	12	504		1,807	75,899	$910,800	$273,240	$236,808	$1,420,800
Total 2045 Zone 4 Distribution Piping					**370,325**	**4,762,134**	**$76,848,700**	**$23,054,610**	**$19,980,662**	**$119,884,000**

Water System Distribution Piping

Total 2017 Distribution Pipeline										
Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	8	12	96		42	339	$4,100	$1,230	$1,066	$6,400
	12	12	144		591,977	7,103,719	$85,244,600	$25,573,380	$22,163,596	$132,981,600
	16	12	192		428,735	6,859,753	$82,317,000	$24,695,100	$21,402,420	$128,414,500
	24	12	288		105,257	2,526,175	$30,314,100	$9,094,230	$7,881,666	$47,290,000
	30	12	360		24,913	747,380	$8,968,600	$2,690,580	$2,331,836	$13,991,000
	36	12	432		13,097	471,475	$5,657,700	$1,697,310	$1,471,002	$8,826,000
	42	12	504		7,836	329,127	$3,949,500	$1,184,850	$1,026,870	$6,161,200
	Total 2017 Distribution Piping				**1,171,856**	**17,237,366**	**$206,848,400**	**$62,054,520**	**$53,780,584**	**$322,683,500**

Total 2045 Distribution Pipeline										
Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	12	12	144		818,991	9,827,887	$117,934,600	$35,380,380	$30,662,996	$183,978,000
	16	12	192		269,108	4,305,727	$51,668,700	$15,500,610	$13,433,862	$80,603,200
	18	12	216		10,980	197,637	$2,371,600	$711,480	$616,616	$3,699,700
	24	12	288		91,072	2,185,726	$26,228,700	$7,868,610	$6,819,462	$40,916,800
	30	12	360		8,846	265,394	$3,184,700	$955,410	$828,022	$4,968,100
	36	12	432		10,155	365,572	$4,386,900	$1,316,070	$1,140,594	$6,843,600
	42	12	504		4,148	174,203	$2,090,400	$627,120	$543,504	$3,261,000
	Total 2045 Distribution Piping				**1,213,299**	**17,322,145**	**$207,865,600**	**$62,359,680**	**$54,045,056**	**$324,270,300**

Total Distribution Pipeline										
Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
Final Build Out Totals	8	12	96		42	339	$4,100	$1,230	$1,066	$6,400
	12	12	144		1,410,967	16,931,606	$203,179,300	$60,953,790	$52,826,618	$316,959,700
	16	12	192		697,842	11,165,480	$133,985,800	$40,195,740	$34,836,308	$209,017,800
	18	12	216		10,980	197,637	$2,371,600	$711,480	$616,616	$3,699,700
	24	12	288		196,329	4,711,901	$56,542,800	$16,962,840	$14,701,128	$88,206,800
	30	12	360		33,759	1,012,774	$12,153,300	$3,645,990	$3,159,858	$18,959,100
	36	12	432		23,251	837,047	$10,044,600	$3,013,380	$2,611,596	$15,669,600
	42	12	504		11,984	503,330	$6,040,000	$1,812,000	$1,570,400	$9,422,400
	Total Distribution Piping				**2,385,156**	**35,360,113**	**$424,321,500**	**$127,296,450**	**$110,323,590**	**$661,941,500**

Water System Transmission Pipeline

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2009	12	12	144		2,045	24,537	$294,400	$88,320	$76,544	$459,300
2009	24	12	288		6,719	161,267	$1,935,200	$580,560	$503,152	$3,018,900
2009	30	12	360		32,396	971,874	$11,662,500	$3,498,750	$3,032,250	$18,193,500
		Total 2009 Transmission Piping			**41,160**	**1,157,678**	**$13,892,100**	**$4,167,630**	**$3,611,946**	**$21,671,700**

Year	Size	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2010	24	12	288		19,214	461,128	$5,533,500	$1,660,050	$1,438,710	$8,632,300
2010	30	12	360		19,025	570,745	$6,848,900	$2,054,670	$1,780,714	$10,684,300
		Total 2010 Transmission Piping			**38,238**	**1,031,872**	**$12,382,400**	**$3,714,720**	**$3,219,424**	**$19,316,500**

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2011	24	12	288		21,466	515,184	$6,182,200	$1,854,660	$1,607,372	$9,644,200
2011	30	12	360		23,115	693,455	$8,321,500	$2,496,450	$2,163,590	$12,981,500
2011	36	12	432		11,778	423,998	$5,088,000	$1,526,400	$1,322,880	$7,937,300
2011	42	12	504		10,020	420,825	$5,049,900	$1,514,970	$1,312,974	$7,877,800
		Total 2011 Transmission Piping			**44,913**	**2,053,462**	**$24,641,600**	**$7,392,480**	**$6,406,816**	**$38,440,900**

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2012	30	12	360		66,176	1,985,293	$23,823,500	$7,147,050	$6,194,110	$37,164,700
2012	42	12	504		11,245	472,296	$5,667,600	$1,700,280	$1,473,576	$8,841,500
		Total 2012 Transmission Piping			**77,422**	**2,457,589**	**$29,491,100**	**$8,847,330**	**$7,667,686**	**$46,006,100**

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	18	12	216		290	5,218	$62,600	$18,780	$16,276	$97,700
2017	24	12	288		11,756	282,144	$3,385,700	$1,015,710	$880,282	$5,281,700
2017	30	12	360		314	9,428	$113,100	$33,930	$29,406	$176,400
		Total 2017 Transmission Piping			**12,360**	**296,791**	**$3,561,400**	**$1,068,420**	**$925,964**	**$5,555,800**

Year	Size (in)	Unit Cost ($/in/LF)	Price/LF	Description	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	30	12	360		37,884	1,136,509	$13,638,100	$4,091,430	$3,545,906	$21,275,400
2045	36	12	432		62,099	2,235,573	$26,826,900	$8,048,070	$6,974,994	$41,850,000
2045	42	12	504		50,509	2,121,357	$25,456,300	$7,636,890	$6,618,638	$39,711,800
		Total 2045 Transmission Piping			**150,491**	**5,493,439**	**$65,921,300**	**$19,776,390**	**$17,139,538**	**$102,837,200**

Total Pipelines					**364,584**	**12,490,830**	**$149,889,900**	**$44,966,970**	**$38,971,374**	**$233,828,200**

Wastewater Treatment Facilities									
Year	Name	Quanity (mgd)	Unit Cost ($/mgd)			Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2008	157th Ave	0.0				$0	$0	$0	$0
	Corgett	0.0				$0	$0	$0	$0
	Rainbow Valley	0.0				$0	$0	$0	$0
	Pecos	0.0				$0	$0	$0	$0
	Waterman	0.0				$0	$0	$0	$0
	Estrella	0.0				$0	$0	$0	$0
2009	157th Ave	0.0				$0	$0	$0	$0
	Corgett	0.0				$0	$0	$0	$0
	Rainbow Valley	0.0				$0	$0	$0	$0
	Pecos	0.0				$0	$0	$0	$0
	Waterman	0.0				$0	$0	$0	$0
	Estrella	0.0				$0	$0	$0	$0
2010	157th Ave	3.0	$8,368,266			$25,104,800	$7,531,440	$6,527,248	$39,163,500
	Corgett	0.0				$0	$0	$0	$0
	Rainbow Valley	1.2	$8,936,070			$10,723,300	$3,216,990	$2,788,058	$16,728,300
	Pecos	2.00	$11,578,283			$23,156,600	$6,946,980	$6,020,716	$36,124,300
	Waterman	0.0				$0	$0	$0	$0
	Estrella	0.0				$0	$0	$0	$0
2011	157th Ave	0.0				$0	$0	$0	$0
	Corgett	0.0				$0	$0	$0	$0
	Rainbow Valley	0.0				$0	$0	$0	$0
	Pecos	0.0				$0	$0	$0	$0
	Waterman	0.0				$0	$0	$0	$0
	Estrella	0.0				$0	$0	$0	$0
2012	157th Ave	0.0				$0	$0	$0	$0
	Corgett	0.2	$9,251,516			$1,850,300	$555,090	$481,078	$2,886,500
	Rainbow Valley	0.0				$0	$0	$0	$0
	Pecos	0.0				$0	$0	$0	$0
	Waterman	2.0	$11,578,283			$23,156,600	$6,946,980	$6,020,716	$36,124,300
	Estrella	1.0	$11,998,879			$11,998,900	$3,599,670	$3,119,714	$18,718,300
2017	157th Ave	6.0	$7,421,927			$44,531,600	$13,359,480	$11,578,216	$69,469,300
	Corgett	0.4	$9,125,337			$3,650,100	$1,095,030	$949,026	$5,694,200
	Rainbow Valley	2.0	$8,683,713			$17,367,400	$5,210,220	$4,515,524	$27,093,100
	Pecos	2.0	$8,683,713			$17,367,400	$5,210,220	$4,515,524	$27,093,100
	Waterman	2.0	$8,683,713			$17,367,400	$5,210,220	$4,515,524	$27,093,100
	Estrella	1.0	$8,999,159			$8,999,200	$2,699,760	$2,339,792	$14,038,800
2045	157th Ave	3.0	$8,368,266			$25,104,800	$7,531,440	$6,527,248	$39,163,500
	Corgett	0.6	$9,125,337			$5,475,200	$1,642,560	$1,423,552	$8,541,300
	Rainbow Valley	2.0	$8,683,713			$17,367,400	$5,210,220	$4,515,524	$27,093,100
	Pecos	4.0	$8,052,820			$32,211,300	$9,663,390	$8,374,938	$50,249,600
	Waterman	6.0	$7,421,927			$44,531,600	$13,359,480	$11,578,216	$69,469,300
	Estrella	1.0	$8,999,159			$8,999,200	$2,699,760	$2,339,792	$14,038,800
Total 157th Ave		**18**				**$94,741,200**	**$28,422,360**	**$24,632,712**	**$147,796,300**
Total Corgett		**2**				**$10,975,600**	**$3,292,680**	**$2,853,656**	**$17,121,900**
Total Rainbow Valley		**6**				**$45,458,100**	**$13,637,430**	**$11,819,106**	**$70,914,600**
Total Pecos		**8**				**$72,735,300**	**$21,820,590**	**$18,911,178**	**$113,467,100**
Total Waterman		**10**				**$85,055,600**	**$25,516,680**	**$22,114,456**	**$132,686,700**
Total Estrella		**3**				**$29,997,300**	**$8,999,190**	**$7,799,298**	**$46,795,800**
Total		**47**				**$338,963,100**	**$101,688,930**	**$88,130,406**	**$528,782,400**

Collection System Lift Stations									
Year	Name	Construction Type	Quanity (mgd)	Unit Cost ($/mgd)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2012	Bio Flora	Refit	0.20	$1,104,033		$220,800	$66,240	$57,408	$344,400
	Extension Canal	New	3.00	$877,346		$2,632,000	$789,600	$684,320	$4,105,900
	Kings Ranch	New	4.40	$703,064		$3,093,500	$928,050	$804,310	$4,825,900
	Las Brisas	New	1.20	$1,490,279		$1,788,300	$536,490	$464,958	$2,789,700
	Lum Wash	Expansion	1.62	$835,288		$1,353,200	$405,960	$351,832	$2,111,000
	Palm Valley	Expansion	0.24	$1,104,033		$265,000	$79,500	$68,900	$413,400
	Rainbow Valley	Expansion	0.90	$1,104,033		$993,600	$298,080	$258,336	$1,550,000
	Rubbermaid	Refit	0.46	$1,044,836		$480,600	$144,180	$124,956	$749,700
	Wells Fargo	Refit	0.08	$1,104,033		$88,300	$26,490	$22,958	$137,700
	Total 2012 Lift Stations		**12.10**	**$9,366,947**		**$10,915,300**	**$3,274,590**	**$2,837,978**	**$17,027,900**
2045	Buckeye Canal	New	1.70	$1,218,433		$2,071,300	$621,390	$538,538	$3,231,200
	Estrella Mountain Park	New	0.30	$1,700,000		$510,000	$153,000	$132,600	$795,600
	Gila River	New	3.40	$816,094		$2,774,700	$832,410	$721,422	$4,328,500
	Indian School	New	1.50	$1,309,882		$1,964,800	$589,440	$510,848	$3,065,100
	Lakin	New	5.00	$652,970		$3,264,900	$979,470	$848,874	$5,093,200
	Total 2045 Lift Stations		**11.90**	**$5,697,379**		**$10,585,700**	**$3,175,710**	**$2,752,282**	**$16,513,700**
Final Build Out Totals	**Bio Flora**		**0.20**	**$1,104,033**		**$220,800**	**$66,240**	**$57,408**	**$344,400**
	Buckeye Canal		**1.70**	**$1,218,433**		**$2,071,300**	**$621,390**	**$538,538**	**$3,231,200**
	Estrella Mountain Park		**0.30**	**$1,700,000**		**$510,000**	**$153,000**	**$132,600**	**$795,600**
	Extension Canal		**3.00**	**$877,346**		**$2,632,000**	**$789,600**	**$684,320**	**$4,105,900**
	Gila River		**3.40**	**$816,094**		**$2,774,700**	**$832,410**	**$721,422**	**$4,328,500**
	Indian School		**1.50**	**$1,309,882**		**$1,964,800**	**$589,440**	**$510,848**	**$3,065,100**
	Kings Ranch		**4.40**	**$703,064**		**$3,093,500**	**$928,050**	**$804,310**	**$4,825,900**
	Lakin		**5.00**	**$652,970**		**$3,264,900**	**$979,470**	**$848,874**	**$5,093,200**
	Las Brisas		**1.20**	**$1,490,279**		**$1,788,300**	**$536,490**	**$464,958**	**$2,789,700**
	Lum Wash		**1.62**	**$835,288**		**$1,353,200**	**$405,960**	**$351,832**	**$2,111,000**
	Palm Valley		**0.24**	**$1,104,033**		**$265,000**	**$79,500**	**$68,900**	**$413,400**
	Rainbow Valley		**0.90**	**$1,104,033**		**$993,600**	**$298,080**	**$258,336**	**$1,550,000**
	Rubbermaid		**0.46**	**$1,044,836**		**$480,600**	**$144,180**	**$124,956**	**$749,700**
	Wells Fargo		**0.08**	**$1,104,033**		**$88,300**	**$26,490**	**$22,958**	**$137,700**
Total			**24.00**	**$15,064,326**		**$21,501,000**	**$6,450,300**	**$5,590,260**	**$33,541,600**

Collection System Gravity Pipeline

Year	Size	Unit Cost ($/in/LF)	Price/LF	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	8	12	96	144,425	1,155,402	$13,864,800	$4,159,440	$3,604,848	$21,629,100
2017	10	12	120	32,450	324,497	$3,894,000	$1,168,200	$1,012,440	$6,074,600
2017	12	12	144	111,312	1,335,740	$16,028,900	$4,808,670	$4,167,514	$25,005,100
2017	15	12	180	88,780	1,331,694	$15,980,300	$4,794,090	$4,154,878	$24,929,300
2017	18	12	216	56,710	1,020,787	$12,249,400	$3,674,820	$3,184,844	$19,109,100
2017	21	12	252	36,099	758,081	$9,097,000	$2,729,100	$2,365,220	$14,191,300
2017	24	12	288	37,840	908,172	$10,898,100	$3,269,430	$2,833,506	$17,001,000
2017	27	12	324	31,148	841,001	$10,092,000	$3,027,600	$2,623,920	$15,743,500
2017	30	12	360	31,148	934,445	$11,213,300	$3,363,990	$2,915,458	$17,492,700
2017	36	12	432	20,444	735,970	$8,831,600	$2,649,480	$2,296,216	$13,777,300
2017	48	12	576	7,691	369,154	$4,429,800	$1,328,940	$1,151,748	$6,910,500
2017	54	12	648	204	11,009	$132,100	$39,630	$34,346	$206,100
Total for 2017				**598,251**	**9,725,952**	**$116,711,300**	**$35,013,390**	**$30,344,938**	**$182,069,600**
2045	8	12	96	143,280	1,146,240	$13,754,900	$4,126,470	$3,576,274	$21,457,600
2045	10	12	120	64,771	647,713	$7,772,600	$2,331,780	$2,020,876	$12,125,300
2045	12	12	144	102,597	1,231,168	$14,774,000	$4,432,200	$3,841,240	$23,047,400
2045	15	12	180	74,527	1,117,911	$13,414,900	$4,024,470	$3,487,874	$20,927,200
2045	18	12	216	20,452	368,131	$4,417,600	$1,325,280	$1,148,576	$6,891,500
2045	21	12	252	1,670	35,064	$420,800	$126,240	$109,408	$656,400
2045	24	10	240	10,474	251,370	$2,513,700	$754,110	$653,562	$3,921,400
2045	27	10	270	2,654	71,651	$716,500	$214,950	$186,290	$1,117,700
Total for 2045				**407,297**	**4,546,227**	**$54,554,800**	**$16,366,440**	**$14,184,248**	**$85,105,400**
Final Build Out Totals	8	12	96	287,705	2,301,642	$27,619,700	$8,285,910	$7,181,122	$43,086,700
	10	12	120	97,221	972,210	$11,666,500	$3,499,950	$3,033,290	$18,199,700
	12	12	144	213,909	2,566,908	$30,802,900	$9,240,870	$8,008,754	$48,052,500
	15	12	180	163,307	2,449,605	$29,395,300	$8,818,590	$7,642,778	$45,856,700
	18	12	216	77,162	1,388,919	$16,667,000	$5,000,100	$4,333,420	$26,000,500
	21	12	252	37,769	793,145	$9,517,700	$2,855,310	$2,474,602	$14,847,600
	24	12	288	48,314	1,159,542	$13,914,500	$4,174,350	$3,617,770	$21,706,600
	27	12	324	33,802	912,652	$10,951,800	$3,285,540	$2,847,468	$17,084,800
	30	12	360	31,148	934,445	$11,213,300	$3,363,990	$2,915,458	$17,492,700
	36	12	432	20,444	735,970	$8,831,600	$2,649,480	$2,296,216	$13,777,300
	48	12	576	7,691	369,154	$4,429,800	$1,328,940	$1,151,748	$6,910,500
	54	12	648	204	11,009	$132,100	$39,630	$34,346	$206,100
	Total Gravity Pipeline			**1,018,676**	**14,595,200**	**$175,142,200**	**$52,542,660**	**$45,536,972**	**$273,221,700**

Collection System Force Mains

Year		Size	Unit Cost ($/in/LF)	Price/LF	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2012	Extension Canal	8	12	96	17,243	137,946	$1,655,300	$496,590	$430,378	$2,582,300
2012	Kings Ranch	10	12	120	8,700	87,000	$1,044,000	$313,200	$271,440	$1,628,600
2012	Las Brisas	6	12	72	6,524	6,460	$469,700	$140,910	$122,122	$732,700
2012	Rainbow Valley	12	12	144	4,732	4,881	$681,400	$204,420	$177,164	$1,063,000
2012	Rubbermaid	6	12	72	3,076	3,076	$221,500	$66,450	$57,590	$345,500
2012	Wells Fargo	6	12	72	4,368	26,208	$314,500	$94,350	$81,770	$490,600
Total 2012 Force Mains					**44,644**	**265,571**	**$4,386,400**	**$1,315,920**	**$1,140,464**	**$6,842,700**
2045	Buckeye Canal	8	12	96	2,438	19,504	$234,000	$70,200	$60,840	$365,000
2045	Estrella Mountain Park	4	12	48	3,389	13,556	$162,700	$48,810	$42,302	$253,800
2045	Gila River	10	12	120	16,135	6,460	$1,936,200	$580,860	$503,412	$3,020,500
2045	Indian School	8	12	96	5,086	4,881	$488,300	$146,490	$126,958	$761,700
2045	Lakin	12	12	144	6,460	3,076	$930,300	$279,090	$241,878	$1,451,300
Total 2045 Force Mains					**33,508**	**47,477**	**$3,751,500**	**$1,125,450**	**$975,390**	**$5,852,300**
Total Force Mains					**78,152**	**313,048**	**$8,137,900**	**$2,441,370**	**$2,115,854**	**$12,695,000**

Reclaimed Water System Reservoirs

Year	Name		Quanity (mgd)	Unit Cost ($/gal)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2012	157th		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
	Corgett		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Rainbow Valley		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Pecos		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Waterman		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Estrella		0.00			$0	$0	$0	$0
	Zone 4 East		0.00			$0	$0	$0	$0
	Zone 4 West		0.00			$0	$0	$0	$0
2017	157th		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Corgett		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Pecos		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Waterman		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Estrella		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Zone 4 East		0.00			$0	$0	$0	$0
	Zone 4 West		0.00			$0	$0	$0	$0
2045	157th		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Corgett		0.00			$0	$0	$0	$0
	Rainbow Valley		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Pecos		1.00	$1.25		$1,250,300	$375,090	$325,078	$1,950,500
	Waterman		4.00	$1.08		$4,310,600	$1,293,180	$1,120,756	$6,724,500
	Estrella		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
	Zone 4 East		3.00	$1.15		$3,438,700	$1,031,610	$894,062	$5,364,400
	Zone 4 West		2.00	$1.25		$2,500,700	$750,210	$650,182	$3,901,100
Total	**157th**		**7.00**			**$8,440,100**	**$2,532,030**	**$2,194,426**	**$13,166,600**
Total	**Corgett**		**2.00**			**$2,500,700**	**$750,210**	**$650,182**	**$3,901,100**
Total	**Rainbow Valley**		**4.00**			**$5,001,400**	**$1,500,420**	**$1,300,364**	**$7,802,200**
Total	**Pecos**		**3.00**			**$3,750,900**	**$1,125,270**	**$975,234**	**$5,851,400**
Total	**Waterman**		**6.00**			**$6,811,200**	**$2,043,360**	**$1,770,912**	**$10,625,500**
Total	**Estrella**		**4.00**			**$5,001,400**	**$1,500,420**	**$1,300,364**	**$7,802,200**
Total	**Zone 4 East**		**3.00**			**$3,438,700**	**$1,031,610**	**$894,062**	**$5,364,400**
Total	**Zone 4 West**		**2.00**			**$2,500,700**	**$750,210**	**$650,182**	**$3,901,100**
	Total Reservoirs		**31.00**			**$37,445,100**	**$11,233,530**	**$9,735,726**	**$58,414,400**

Reclaimed Water System Wells

Year	Name	Quanity (# wells)	Unit Cost ($/each)			Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2007	ASR Wells	0							
	Wells Zone 2/3	0							
	Zone 4 Recharge	0	Existing						
2012	ASR Wells	8	$1,000,000.00			$8,000,000	$2,400,000	$2,080,000	$12,480,000
	Wells Zone 2/3	8	$300,000.00			$2,400,000	$720,000	$624,000	$3,744,000
	Zone 4 Recharge	0	$300,000.00			$0	$0	$0	$0
2017	ASR Wells	0	$1,000,000.00			$0	$0	$0	$0
	Wells Zone 2/3	9	$300,000.00			$2,700,000	$810,000	$702,000	$4,212,000
	Zone 4 Recharge	2	$1,000,000.00			$2,000,000	$600,000	$520,000	$3,120,000
2045	ASR Wells	0	$1,000,000.00			$0	$0	$0	$0
	Wells Zone 2/3	23	$300,000.00			$6,900,000	$2,070,000	$1,794,000	$10,764,000
	Zone 4 Recharge	2	$300,000.00			$600,000	$180,000	$156,000	$936,000
Total	**ASR Wells**	**8**	**$1,000,000.00**			**$8,000,000**	**$2,400,000**	**$2,080,000**	**$12,480,000**
Total	**Wells Zone 2/3**	**40**	**$300,000.00**			**$12,000,000**	**$3,600,000**	**$3,120,000**	**$18,720,000**
Total	**Zone 4 Recharge**	**4**	**$300,000.00**			**$2,600,000**	**$780,000**	**$676,000**	**$4,056,000**
Total Wells		**52**				**$22,600,000**	**$6,780,000**	**$5,876,000**	**$35,256,000**

Reclaimed Water System Boosters

Year	Name		Quanity (mgd)	Unit Cost ($/mgd)		Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2012	157th		9.30	$179,096		$1,665,600	$499,680	$433,056	$2,598,300
	Corgett		5.75	$232,429		$1,336,500	$400,950	$347,490	$2,084,900
	Rainbow Valley		11.93	$156,513		$1,866,400	$559,920	$485,264	$2,911,600
	Pecos		2.00	$250,725		$502,600	$150,780	$130,676	$784,100
	Waterman		3.48	$250,725		$873,000	$261,900	$226,980	$1,361,900
	Estrella		0.00			$0	$0	$0	$0
	Zone 4 East		0.00			$0	$0	$0	$0
	Zone 4 West		0.00			$0	$0	$0	$0
2017	157th		4.65	$250,725		$1,165,900	$349,770	$303,134	$1,818,800
	Corgett		0.00			$0	$0	$0	$0
	Rainbow Valley		0.00			$0	$0	$0	$0
	Pecos		2.00	$250,725		$502,600	$150,780	$130,676	$784,100
	Waterman		3.48	$250,725		$873,000	$261,900	$226,980	$1,361,900
	Estrella		9.11	$181,085		$1,650,100	$495,030	$429,026	$2,574,200
	Zone 4 East		0.00			$0	$0	$0	$0
	Zone 4 West		0.00			$0	$0	$0	$0
2045	157th		5.81	$231,071		$1,343,100	$402,930	$349,206	$2,095,200
	Corgett		0.00			$0	$0	$0	$0
	Rainbow Valley		11.93	$156,513		$1,866,400	$559,920	$485,264	$2,911,600
	Pecos		1.60	$250,725		$402,100	$120,630	$104,546	$627,300
	Waterman		16.25	$132,345		$2,150,400	$645,120	$559,104	$3,354,600
	Estrella		9.11	$181,085		$1,650,100	$495,030	$429,026	$2,574,200
	Zone 4 East		4.39	$250,725		$1,100,100	$330,030	$286,026	$1,716,200
	Zone 4 West		3.63	$250,725		$908,900	$272,670	$236,314	$1,417,900
Total	**157th**		**19.76**			**$4,174,600**	**$1,252,380**	**$1,085,396**	**$6,512,400**
Total	**Corgett**		**5.75**			**$1,336,500**	**$400,950**	**$347,490**	**$2,084,900**
Total	**Rainbow Valley**		**23.85**			**$3,732,800**	**$1,119,840**	**$970,528**	**$5,823,200**
Total	**Pecos**		**5.61**			**$1,407,300**	**$422,190**	**$365,898**	**$2,195,400**
Total	**Waterman**		**23.21**			**$3,896,400**	**$1,168,920**	**$1,013,064**	**$6,078,400**
Total	**Estrella**		**18.23**			**$3,300,200**	**$990,060**	**$858,052**	**$5,148,300**
Total	**Zone 4 East**		**4.39**			**$1,100,100**	**$330,030**	**$286,026**	**$1,716,200**
Total	**Zone 4 West**		**3.63**			**$908,900**	**$272,670**	**$236,314**	**$1,417,900**
	Total Boosters		**104.43**			**$19,856,800**	**$5,957,040**	**$5,162,768**	**$30,976,600**

Reclaimed Water System Piping

2017 Piping

Year	Size	Unit Cost ($/in/LF)	Price/LF	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2017	8	12	96	111,618	892,946	$10,715,400	$3,214,620	$2,786,004	$16,716,000
2017	12	12	144	242,414	2,908,967	$34,907,600	$10,472,280	$9,075,976	$54,455,900
2017	16	12	192	172,649	2,762,384	$33,148,600	$9,944,580	$8,618,636	$51,711,800
2017	20	12	240	57,304	1,146,074	$13,752,900	$4,125,870	$3,575,754	$21,454,500
2017	24	12	288	44,956	1,078,943	$12,947,300	$3,884,190	$3,366,298	$20,197,800
2017	30	12	360	107,733	3,231,988	$38,783,900	$11,635,170	$10,083,814	$60,502,900
2017	36	12	432	5,548	199,721	$2,396,700	$719,010	$623,142	$3,738,900
Total 2017 Reclaimed System Piping					**12,221,022**	**$146,652,400**	**$43,995,720**	**$38,129,624**	**$228,777,700**

2045 Piping

Year	Size	Unit Cost ($/in/LF)	Price/LF	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
2045	12	12	144	164,636	1,975,627	$23,707,500	$7,112,250	$6,163,950	$36,983,700
2045	16	12	192	88,322	1,413,152	$16,957,800	$5,087,340	$4,409,028	$26,454,200
2045	20	12	240	43,715	874,293	$10,491,500	$3,147,450	$2,727,790	$16,366,700
2045	24	12	288	35,238	845,709	$10,148,500	$3,044,550	$2,638,610	$15,831,700
2045	30	12	360	3,715	111,456	$1,337,500	$401,250	$347,750	$2,086,500
Total 2045 Reclaimed System Piping					**5,220,238**	**$62,642,800**	**$18,792,840**	**$16,287,128**	**$97,722,800**

Total Piping

Year	Size	Unit Cost ($/in/LF)	Price/LF	LF	in-ft	Estimated Construction Cost	Contingency (30%)	Design and Construction Administration Expenses (20%)	Projected Capital Cost $
Final Build Out Totals	8	12	96	111,618	892,946	$10,715,400	$3,214,620	$2,786,004	$16,716,000
	12	12	144	407,049	4,884,594	$58,615,100	$17,584,530	$15,239,926	$91,439,600
	16	12	192	260,971	4,175,536	$50,106,400	$15,031,920	$13,027,664	$78,166,000
	20	12	240	101,018	2,020,367	$24,244,400	$7,273,320	$6,303,544	$37,821,300
	24	12	288	80,194	1,924,652	$23,095,800	$6,928,740	$6,004,908	$36,029,400
	30	12	360	111,448	3,343,444	$40,121,300	$12,036,390	$10,431,538	$62,589,200
	36	12	432	5,548	199,721	$2,396,700	$719,010	$623,142	$3,738,900
Total Reclaimed System Piping					**17,441,259**	**$209,295,100**	**$62,788,530**	**$54,416,726**	**$326,500,400**