TABLE OF CONTENTS

VOLUME 4

The individual Technical Memorandum contained in Volume 4 were developed and issued over the course of the project. Some of the figures and values contained in Volume 4 may differ slightly from the values presented in Volume 1 as a result of refinements made while finalizing the recommended 2007 Integrated Water Master Plan

EFFLUENT MANAGEMENT PLAN
TECHNICAL MEMORANDUM NO. 3-1

Table of Contents

RECLAIMED WATER SYSTEM PARAMETERS TECHNICAL MEMORANDUM NO. 3-2

Table of Contents

RECLAIMED WATER SYSTEM HYDRAULIC MODEL AND ANALYSIS TECHNICAL MEMORANDUM NO. 3-3

Table of Contents

EFFLUENT MANAGEMENT PLAN
TECHNICAL MEMORANDUM NO. 3-1

Table of Contents

1.0 INTRODUCTION

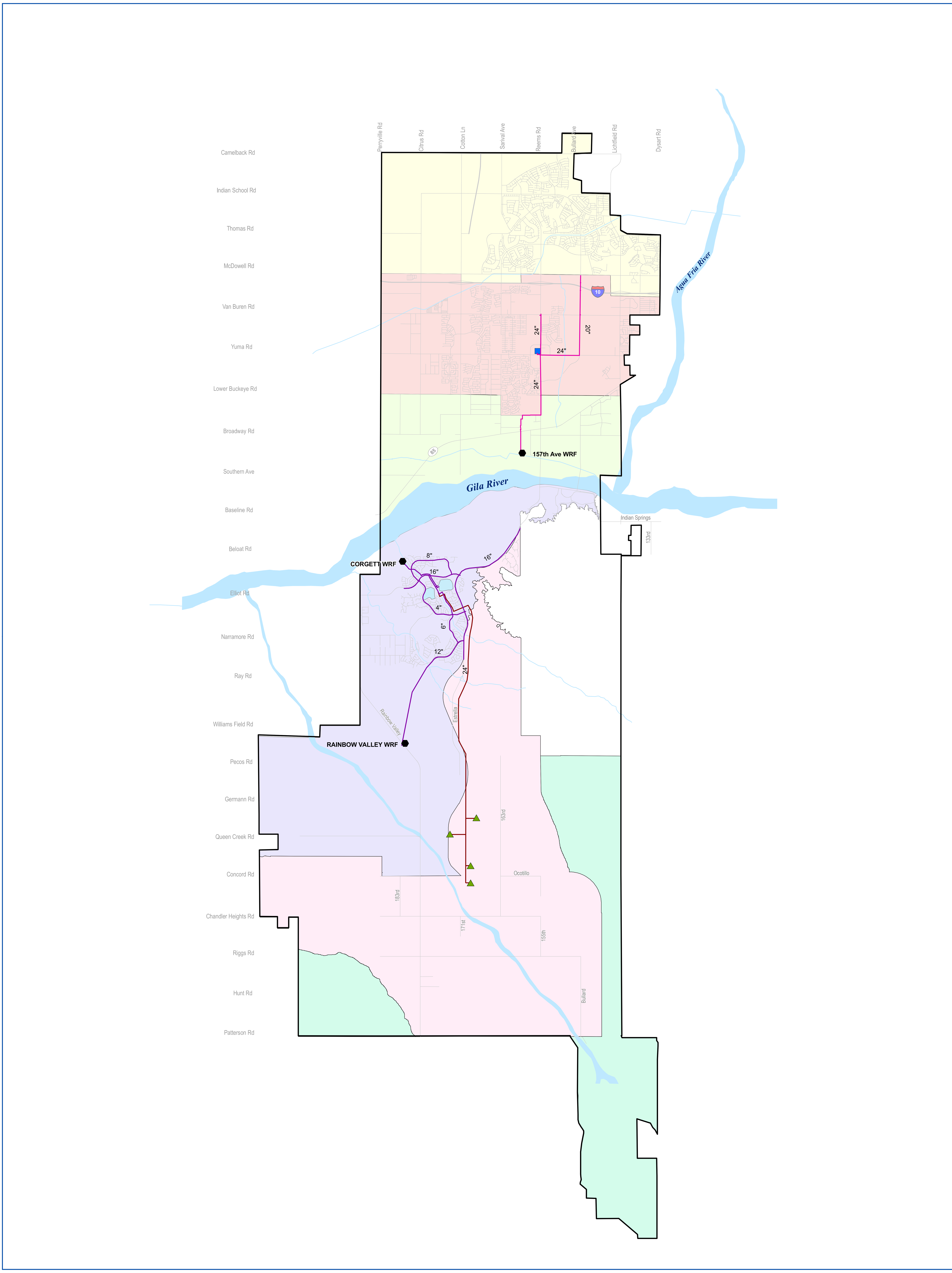
Within the City of Goodyear wastewater will be collected to be treated and used as reuse for irrigation, recharge into an aquifer, and/or discharge into the waterman wash. As technology and water quality standards evolve for water it becomes more apparent the necessity to use reclaimed water to lower the potable water demand. Reclaimed water will be utilized to the extent advantageous as the expense and rigorous standards heighten for potable water demand.

Direct reuse of effluent involves the distribution and application of effluent to an assortment of turf sites (such as golf courses), lakes, and low water use areas (such as roadway ROW landscaping). The volume of effluent produced by the WRFs is fairly constant on a month-to-month basis. However, the demand for effluent as an irrigation water source varies significantly throughout the year.

In the wintertime, irrigation demand for effluent decreases significantly. The surplus effluent in this period must be disposed. One disposal option is to recharge the effluent to replenish the aquifer. For every acre-foot of water pumped from the aquifer, an acre-foot must be replaced. Recharge from effluent will provide some but not all of the necessary recharge credits. Seasonal storage is also created during months when irrigation demand is low that in turn can be used during months when irrigation demand is high.

During the year when reclaimed irrigation demands are at their lowest and a significant rainfall event occurs it will be necessary to discharge effluent to the waterman wash. The recharge infrastructure will be designed to meet normal recharge requirements not peak flow occurrences. With discharge as a final option, the City of Goodyear has created a fail safe discharge point.

In order to size and plan the necessary non-potable water system facilities, a careful seasonal tabulation of the non-potable water demands is required to determine the maximum non-potable demand. The non-potable water system will be designed to meet this demand. Of even greater importance is the ability of the system to carry the surplus effluent quantities from the WRFs to the recharge areas. Figure 1 shows the current Facility Inventory and Water Planning Areas for the Reclaimed Water System. Figure 2 shows the Landuse Map for Goodyear.



N
W E
S

Note: Map not printed to scale

1 inch equals 6,000 feet

Data source:
City of Goodyear GIS

LEGEND

- WRF
- Wells
- SAT Site
- Ground Water Pipeline
- Non-Potable System Main

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

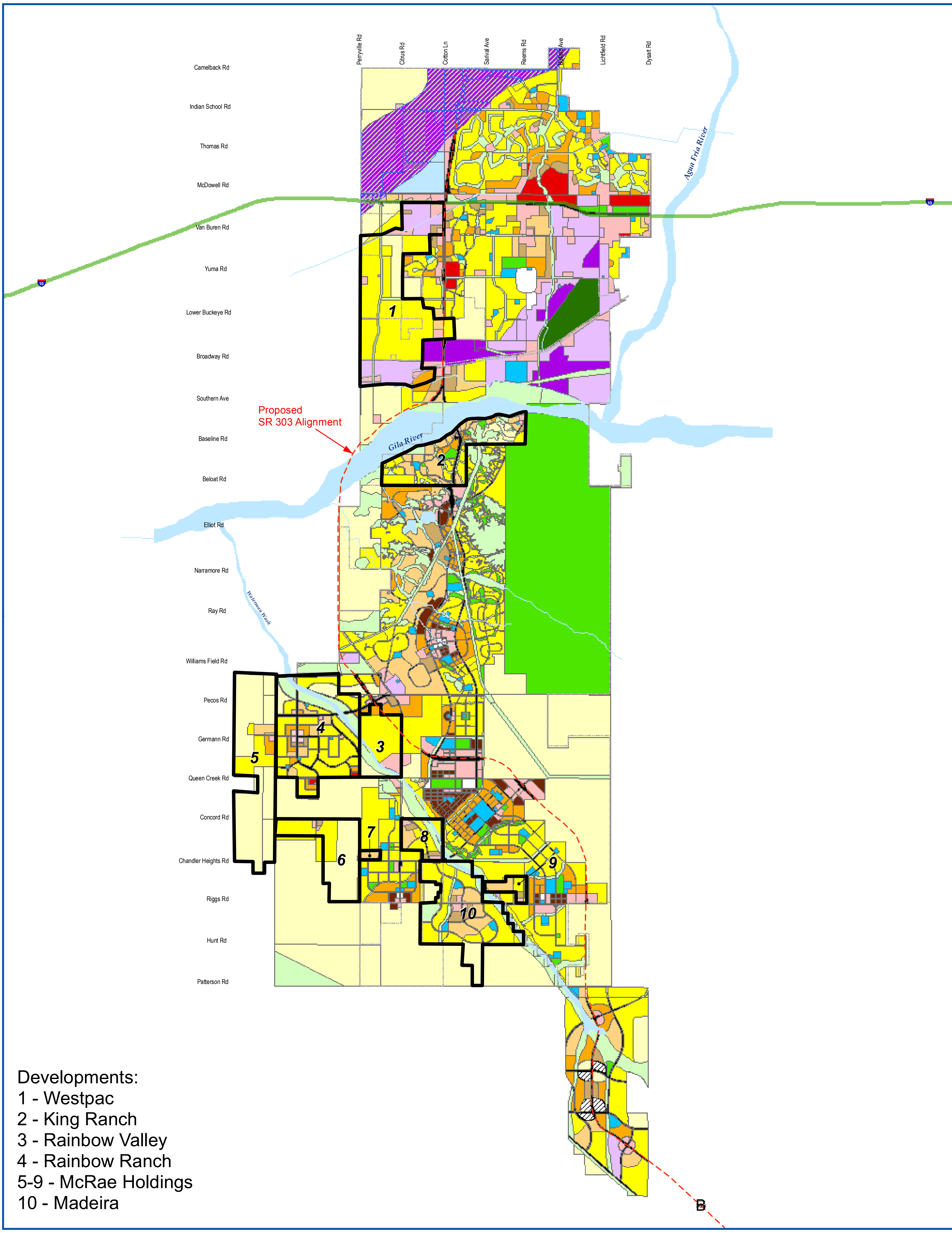
Figure 1
Facility Inventory
Reclaimed Water System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

\\Projects\GoodYear11\GIS\01MapDocuments\ExistingReclaim.mxd Christina Hassell 11/06/2007



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

N W E S

1 inch equals 2.25 miles

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

Figure 2
Land Use Map
Revised General Plan

Integrated Water Master Plan
City of Goodyear, AZ
2007

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

Revised: Thursday, March 13, 2008

Direct reuse and aquifer recharge of effluent mandate slightly different water quality requirements by 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 has the added treatment step of denitrification.

2.0 REUSE DEMANDS

In this section the basic unit rates which apply to irrigation and lake evaporation will be developed. Arizona Meteorological Network (AZMET) data will be used and the results will be compared with Arizona Department of Water Resources (ADWR) irrigation guidelines.

The following is a list of the variety of applications of unit rates that will be included:

- Golf Courses
- Parks/Schools/Street Right-of-way (ROW)
- Residential Exterior Landscaping
- 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.

2.1 AZMET DEMAND UNIT RATES

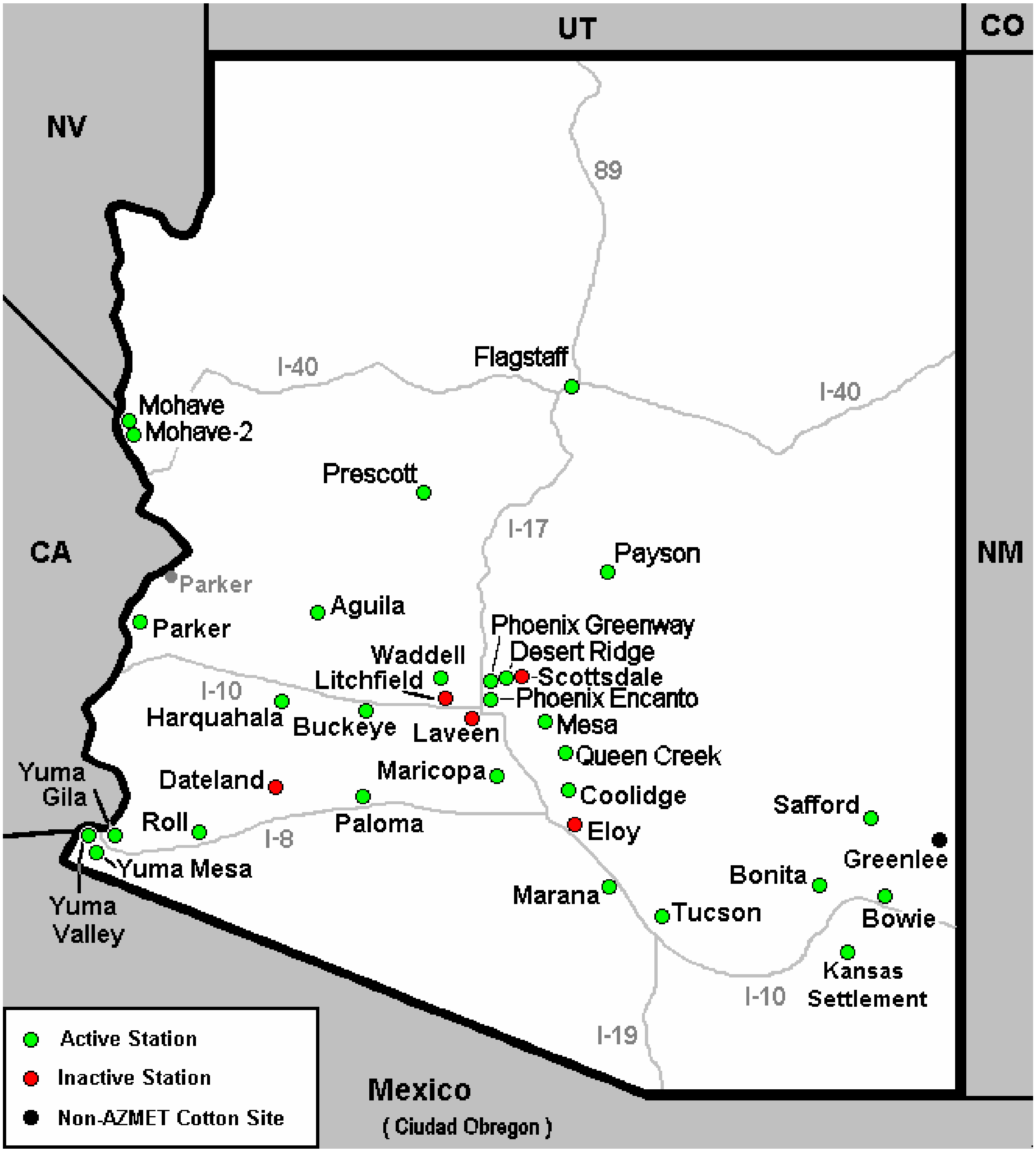
AZMET presently provides weather information to assist irrigation management throughout southern and central Arizona including the Phoenix and Tucson metropolitan areas. Station locations gathering information are located throughout the area and data collected is accessible through the AZMET website. The Maricopa and Buckeye stations are within the vicinity of Goodyear. The two stations were averaged to provide monthly values that were representative for the area. The station locations are shown on Figure 3. The data collected for the two sites is tabulated in Table 2.

Table 1 displays the unit rates obtained from AZMET data. The development of these unit rates will be discussed in the following sections.

Table 1: Unit Rates

Application	Unit Rate
Golf Courses	5.7
Parks/Schools/ROW	5.0
Lakes	6.5
Residential	-
Construction	-

Figure 3: AZ MET Station Locations



T A B L E 2
A Z M E T C L I M A T E D A T A
Arizona Meteorological Network Monthly Summary

12-May-08

ETo(inches)	Buckeye AZMET Station 1999	2000	2001	2002	2003	2004	2005	2006	Station Average	Two Station Average ETo (inches)
January	3.97	3.76	2.63	3.47	3.26	2.89	1.91	4.17	3.26	3.05
February	4.76	4.44	3.27	4.73	2.89	3.64	2.38	4.48	3.82	3.71
March	6.85	5.78	5.60	6.81	5.37	6.60	5.18	5.42	5.95	5.87
April	7.86	9.33	7.54	8.27	8.05	7.81	7.99	7.80	8.08	8.04
May	10.80	11.28	10.86	10.21	9.61	9.81	9.59	9.92	10.26	10.38
June	11.15	10.16	10.73	11.39	10.47	9.88	9.88	9.98	10.46	10.74
July	8.89	10.37	9.08	10.30	9.12	9.73	10.19	9.40	9.64	9.82
August	9.12	8.34	8.57	9.93	7.75	8.47	7.96	8.85	8.62	8.61
September	7.77	7.92	8.17	7.76	6.94	7.72	7.51	7.64	7.68	7.55
October	7.12	5.08	5.78	5.46	5.63	5.45	5.62	5.96	5.76	5.64
November	4.42	3.02	4.00	4.54	3.08	2.92	4.30	4.62	3.86	3.65
December	3.79	3.06	2.72	2.49	3.02	2.20	2.99	3.15	2.93	2.75
Annual Totals	86.50	82.54	78.95	85.36	75.19	77.12	75.50	81.39	80.32	79.80
										AVG ETo/Month
										6.65

ETo(inches)	Maricopa AZMET Station 1999	2000	2001	2002	2003	2004	2005	2006	Station Average
January	3.31	3.26	2.29	2.89	2.81	2.45	1.93	3.76	2.84
February	4.26	4.42	3.19	4.30	2.77	3.33	2.24	4.19	3.59
March	6.26	5.85	5.53	6.53	5.48	6.15	5.31	5.24	5.79
April	7.66	8.99	7.15	8.02	8.18	8.06	8.19	7.71	8.00
May	10.69	11.41	10.47	10.21	9.73	10.84	10.11	10.56	10.50
June	11.16	10.59	11.16	11.12	11.24	11.41	10.50	11.02	11.03
July	8.91	11.30	9.41	9.49	10.32	9.95	10.91	9.81	10.01
August	8.84	9.07	8.68	8.88	8.34	8.48	8.15	8.36	8.60
September	6.95	8.26	8.16	6.71	6.89	7.46	7.90	6.96	7.41
October	6.37	4.93	5.50	5.04	5.57	5.15	5.89	5.62	5.51
November	3.85	2.63	3.68	3.73	2.86	2.74	3.89	4.07	3.43
December	3.13	2.54	2.35	2.03	2.78	2.09	2.78	2.93	2.58
Annual Totals	81.39	83.25	77.57	78.95	76.97	78.11	77.80	80.23	79.28

Precipitation (inches)	Buckeye AZMET Station 1999	2000	2001	2002	2003	2004	2005	2006	Station Average	Two Station Average Precip (inches)
January	0.05	0.01	0.92	0.00	0.64	0.08	1.45	0.00	0.39	0.53
February	0.18	0.30	0.93	0.00	3.69	0.66	2.93	0.00	1.09	0.94
March	0.07	1.77	0.73	0.00	0.38	0.58	0.27	0.93	0.59	0.70
April	1.28	0.00	0.08	0.00	0.12	1.36	0.12	0.16	0.39	0.40
May	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00
June	0.17	0.44	0.00	0.00	0.00	0.00	0.05	0.00	0.08	0.13
July	3.11	0.04	1.28	2.05	1.03	0.21	0.34	0.41	1.06	0.97
August	1.36	0.93	0.82	0.02	1.21	0.48	0.88	0.27	0.75	0.77
September	0.76	0.00	0.00	1.52	0.12	0.25	0.00	0.65	0.41	0.49
October	0.00	2.51	0.22	0.25	0.46	1.50	0.48	0.10	0.69	0.58
November	0.00	0.04	0.19	0.34	0.55	1.39	0.00	0.00	0.31	0.29
December	0.00	0.00	0.43	0.07	0.34	1.32	0.00	0.17	0.29	0.28
Annual Totals	7.00	6.04	5.60	4.25	8.54	7.83	6.52	2.71	6.06	6.08
										AVG Precip/Month
										0.51

Precipitation (inches)	Maricopa AZMET Station 1999	2000	2001	2002	2003	2004	2005	2006	Station Average
January	0.00	0.00	1.30	0.04	0.51	0.71	2.74	0.00	0.66
February	0.16	0.00	0.63	0.00	1.18	0.90	3.40	0.00	0.78
March	0.04	1.97	1.06	0.00	0.24	0.28	0.38	2.44	0.80
April	0.98	0.00	1.03	0.00	0.16	0.98	0.12	0.00	0.41
May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
June	0.00	0.75	0.04	0.00	0.00	0.00	0.26	0.40	0.18
July	2.21	0.00	0.82	0.83	0.82	0.99	0.65	0.74	0.88
August	0.59	2.08	0.59	0.00	1.15	0.16	1.38	0.40	0.79
September	2.16	0.04	0.00	1.26	0.23	0.90	0.00	0.02	0.58
October	0.00	2.05	0.40	0.04	0.08	0.79	0.36	0.03	0.47
November	0.00	0.59	0.27	0.39	0.35	0.59	0.00	0.00	0.27
December	0.00	0.00	0.67	0.43	0.16	0.71	0.00	0.23	0.28
Annual Totals	6.14	7.48	6.81	2.99	4.88	7.01	9.29	4.26	6.11

2.2 IRRIGATION

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, wind and soil moisture. Biological factors affecting ET include type of vegetation, foliage geometry and foliage density.

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 lower and there is more precipitation. Less water is required in the Phoenix area to irrigate because the plants require less and have more rain. In Goodyear the plants require more water and receive less precipitation so the irrigation demand is greater.

The evapotranspiration data obtained from the two AZMET locations surrounding ETo is defined as the ET from a 3-6" tall cool season grass that completely covers the ground, and is supplied adequate water. ETo is determined using a weather-based model known as the Penman Equation. ETo is converted to "actual" ET using a multiplicative factor known as a crop coefficient (Kc). The crop coefficient for turfgrass depends on the type of grass (warm or cool season), cutting height and desired turf quality.

Table 3: Crop Coefficients

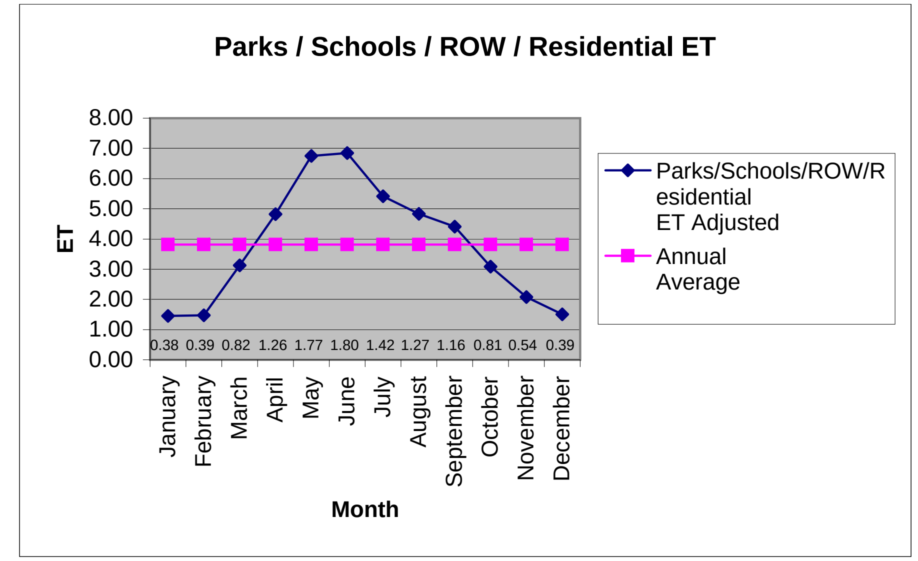
Type of Grass	Cutting Height	Quality	Kc
Warm Season	4 - 5 cm	Acceptable (Park)	0.65
Warm Season	2 - 2.5 cm	High (Golf Course)	0.76
Cool Season	4 - 5 cm	Acceptable (Park)	0.65
Cool Season	2 - 2.5 cm	High (Golf Course)	0.72

The coefficients listed in Table 3 were applied to the ETo to obtain ET for both high quality turf and for acceptable quality turf as shown in Table 4. During the year, precipitation accounts for some of the irrigation requirement for plants. Precipitation is subtracted from the ET to determine the irrigation demand for the plants during the year. These values for acceptable quality turf for parks, schools, ROW, and residential and for high quality turf for golf courses are show in Table 4.

Table 4

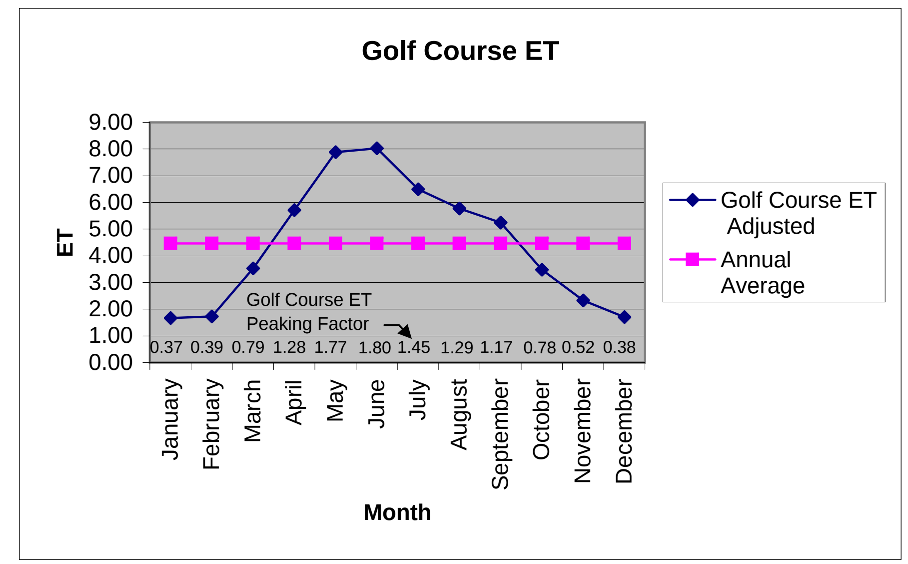
Parks/Schools/ROW/Residential

Month	Two Station Average ETo (inches)	Kc	ET	Precipitation	ET Adjusted (subtracted Precipitation)	Peaking Factor
January	3.05	0.65	1.98	0.53	1.45	0.38
February	3.71	0.65	2.41	0.94	1.47	0.39
March	5.87	0.65	3.82	0.70	3.12	0.82
April	8.04	0.65	5.22	0.40	4.83	1.26
May	10.38	0.65	6.75	0.00	6.75	1.77
June	10.74	0.65	6.98	0.13	6.85	1.80
July	9.82	0.65	6.39	0.97	5.41	1.42
August	8.61	0.65	5.60	0.77	4.83	1.27
September	7.55	0.65	4.90	0.49	4.41	1.16
October	5.64	0.65	3.66	0.58	3.08	0.81
November	3.65	0.65	2.37	0.29	2.08	0.54
December	2.75	0.65	1.79	0.28	1.51	0.39
Total =	79.80			6.08	45.79	
Average =	6.65			0.51	3.82	



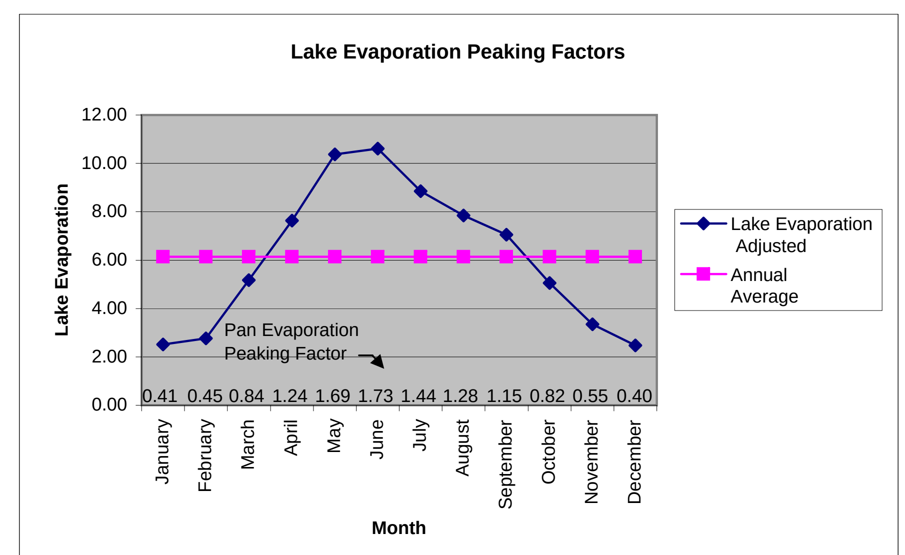
Golf Courses

Month	Two Station Average ETo (inches)	Kc	ET	Precipitation	ET Adjusted (subtracted Precipitation)	Peaking Factor
January	3.05	0.72	2.19	0.53	1.67	0.37
February	3.71	0.72	2.67	0.94	1.73	0.39
March	5.87	0.72	4.23	0.70	3.53	0.79
April	8.04	0.76	6.11	0.40	5.71	1.28
May	10.38	0.76	7.89	0.00	7.89	1.77
June	10.74	0.76	8.16	0.13	8.03	1.80
July	9.82	0.76	7.47	0.97	6.50	1.45
August	8.61	0.76	6.55	0.77	5.78	1.29
September	7.55	0.76	5.73	0.49	5.24	1.17
October	5.64	0.72	4.06	0.58	3.48	0.78
November	3.65	0.72	2.63	0.29	2.33	0.52
December	2.75	0.72	1.98	0.28	1.70	0.38
Total =	79.80			6.08	53.58	
Average =	6.65			0.51	4.46	



Lake Evaporation

Month	Two Station Average ETo (inches)	Precipitation	Lake Evaporation Adjusted	Peaking Factor
January	3.05	0.53	2.52	0.41
February	3.71	0.94	2.77	0.45
March	5.87	0.70	5.18	0.84
April	8.04	0.40	7.64	1.24
May	10.38	0.00	10.38	1.69
June	10.74	0.13	10.61	1.73
July	9.82	0.97	8.85	1.44
August	8.61	0.77	7.84	1.28
September	7.55	0.49	7.05	1.15
October	5.64	0.58	5.06	0.82
November	3.65	0.29	3.35	0.55
December	2.75	0.28	2.47	0.40
Total =	79.80	6.08	73.72	
Average =	6.65	0.51	6.14	



The peaking factors for turf ET were then applied to the yearly irrigation demand to determine the monthly irrigation demand. Monthly irrigation demand was plotted for comparison against the yearly wastewater flow. The wastewater flow typically remains constant throughout the year.

To obtain the unit rates for acceptable quality turf (schools/parks/ROW) and for high quality turf (golf courses) the yearly total adjusted ET subtracted out the precipitation. The losses associated with sprinklers efficiency, evaporation and pipe were applied to the adjusted ET and the adjusted application requirement was determined as shown in Appendix A. The adjusted application requirement is the amount of water that must be delivered to the system to provide the necessary water to the plant after pipe losses, evaporation, and sprinkler efficiency.

Table 5: Loss Adjustments

Sprinkler Efficiency	Evaporative Losses	Pipe Losses
90%	10%	5%

Residential irrigation uses the same peaking factors as parks/schools/ROW but a different application rate is required. Residential irrigation is acceptable quality turf and does not require the amount of irrigation similar to golf courses. Overseeding is not required during the winter as lower standards of acceptable turf appearance apply to residential turf. Residential demand for irrigation was determined based on interior vs. exterior water usage and is further discussed in the TM in the Dual System alternative. The adjustment required for residential irrigation is for pipe losses of 5%.

2.3 LAKES

ETo values can be considered equal to evaporation from a large body of water, such as a pond or lake. Many factors affect lake/pond evaporation including surface area depth, water temperature, and turbidity. The size of the minimum body of water at which ETo is equal has not yet been determined to date. Lakes and ponds were only evaluated and included within this analysis therefore ETo will not be adjusted but considered equal to the evaporation exhibited by a lake or pond.

The adjustment for precipitation is due to precipitation replacing some of the water that was lost to evaporation. ETo or lake evaporation was adjusted to account for precipitation by subtracting out the averages of the two AZMET stations. The peaking factors for lake evaporation were determined by comparing the monthly adjusted averages to the adjusted annual average lake evaporation, as shown in Table 4.

The peaking factors for lake evaporation were then applied to the yearly irrigation demand to determine the monthly irrigation demand. Monthly irrigation demand was plotted for comparison against the yearly wastewater flow. The wastewater flow typically remains constant throughout the year.

For lakes once the adjusted irrigation demand was determined by subtracting the annual precipitation from the annual ETo, the 5% losses for pipes was applied to determine the adjusted application rate for lakes.

2.4 CONSTRUCTION

Construction water was determined 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.

2.5 ADWR

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, Goodyear will design to these standards as a prudent practice for irrigation in the desert environment.

Table 6 provides a comparison of allowable potable water irrigation rates with proposed reclaimed water irrigation rates. It can be seen that the rates are comparable. The AZMET derived rates are however slightly higher and this is believed as result of the hotter/dryer condition found in western Maricopa County.

Table 6: Irrigation Application Rate Comparison

Turf Related Facility	ADWR (acre-ft/acre)	Adjusted ET & Evap	AZMET
Golf Courses	4.9	4.9	5.7
Lakes	6.2	6.1	6.5
Low Water Use	1.5	1.6*	1.9*
Parks/Schools/ROW	3.4	4.3	5.0

*Assumed by ADWR Guide

3.0 WATER QUALITY

Water quality has a significant affect on the ability to reuse reclaimed water for irrigation purposes. Parameters of key concern include total dissolved solids (TDS) and the sodium adsorption ratio (SAR). The acceptable range for these two parameters will be addressed below and recommendations made with respect to maintaining reclaimed water quality within the desired range.

Additional parameters, such as turbidity, total nitrate and disinfection must be met where potential human contact and/or groundwater recharge is involved, however these will be addressed in another section of the Reclaimed Water Master Plan.

3.1 TOTAL DISSOLVED SOLIDS

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. However, if the water is to be used for irrigation, TDS must be maintained within limits as shown in Table 7.

Table 7: TDS

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

For comparison purposes, the MCL for TDS in drinking water is 500 ppm. This is a "secondary" MCL which means that TDS level is not a hard limit which can't be exceeded, but a 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 sources is as follows:

CAP Surface Water	700 to 800 ppm
Groundwater WPA2	600 to 1,200 ppm
Groundwater WPA4	1,500 to 3,000 ppm

It can be seen that the TDS of the surface water source, while above the drinking water secondary MCL, is still in the permissible range for irrigation. However the groundwater sources are significantly above both the Secondary MCL for drinking water and the acceptable standards for irrigation. Therefore this water will be treated (by reverse osmosis), lowering the TDS to 500 ppm before being supplied as drinking water. After returning as wastewater, it will have picked up approximately 100 ppm of additional TDS, producing reclaimed water with a TDS of approximately 600 ppm. This water, even after mixing with reclaimed water of CAP origin, will likely have a TDS in the 600 to 900 ppm range which will be suitable for irrigation.

It is imperative 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 they must be kept out of the water cycle or the TDS of the reclaimed water will return to pre-treatment levels rendering it unsuitable for reuse or recharge. A more detailed discussion of the recommended methods for brine disposal is provided in the Water Production Section of the Water Master Plan.

3.2 SODIUM ADSORPTION RATIO

Adjusted 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 be maintained within limits because excess sodium (relative to calcium) tends to adsorb onto clay particles and tends to 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 6 is considered to be permissible for agricultural use, with a maximum SAR of 6 as shown below.

Table 8: Sodium Hazard Classification

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

Analysis of WPA4 groundwater shows the SAR to be in the 10 to 15 range and the SAR of CAP surface water is anticipated to be generally in the 3 to 5 range. Therefore the quality of the WPA4 groundwater should be improved and the quality of the CAP source water should be protected. It is important to note that in order to lower the TDS of the groundwater in order to meet the secondary drinking water MCL, reverse-osmosis or nano-filtration could be used. Both are membrane separation processes which allow 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 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 will be further discussed in the Water Treatment portion of the Water Master Plan.

4.0 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.

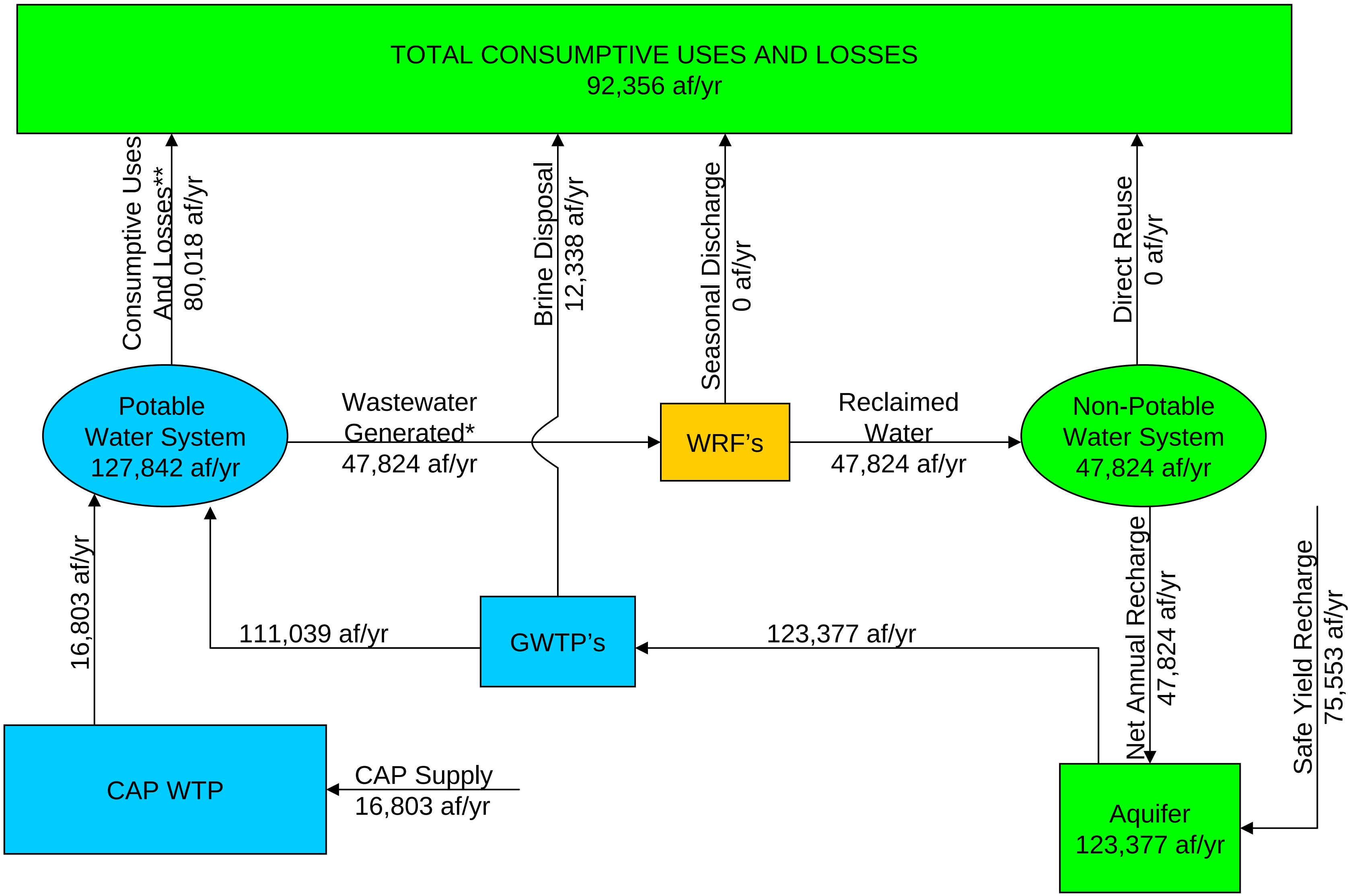
The following figures and Table 9 show the reclaimed water demand and resource utilization for each alternative level of reuse analyzed. It can be seen that:

- 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

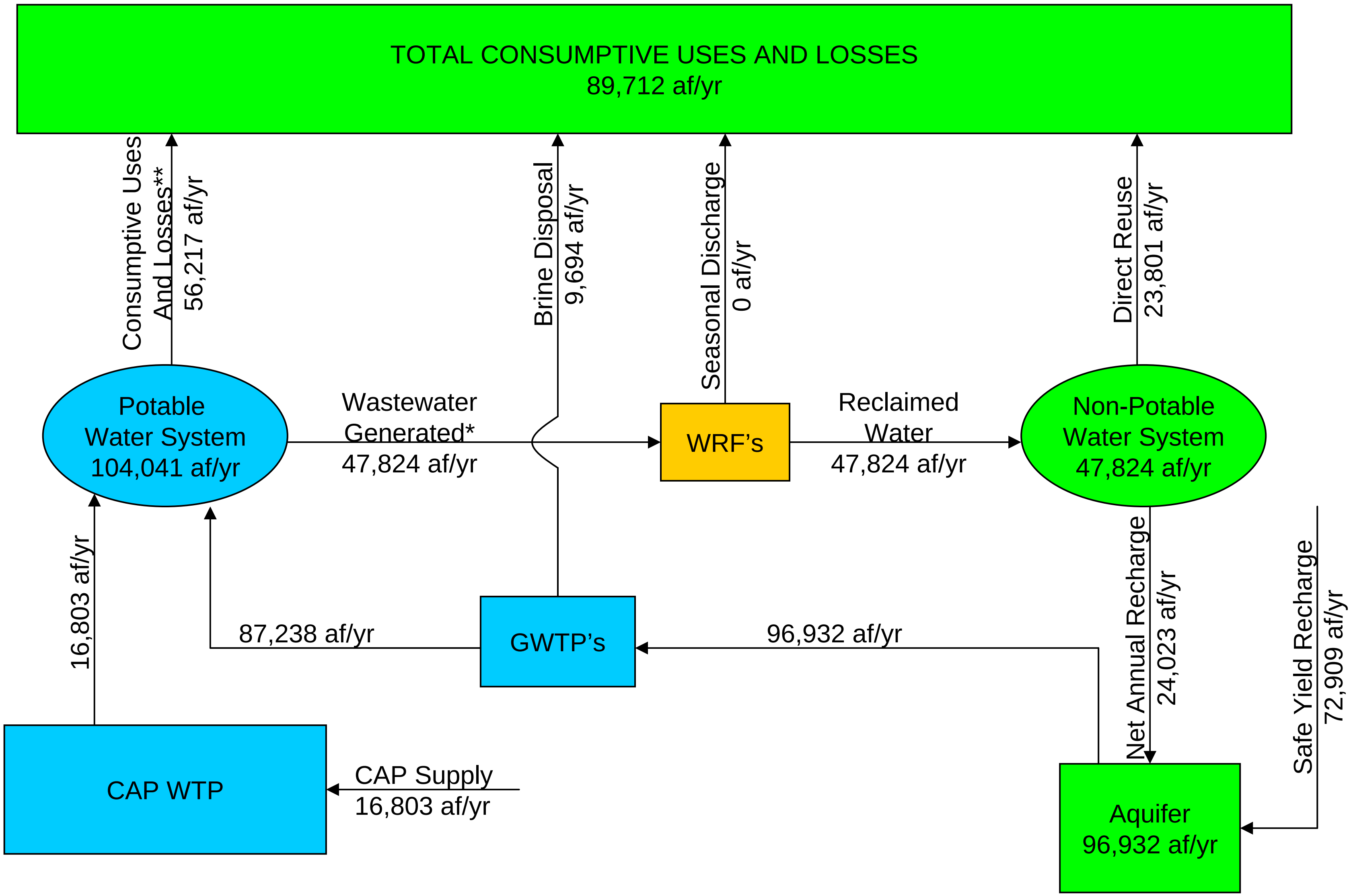
Table 9: Reclaimed Water Demand and Resource Utilization

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



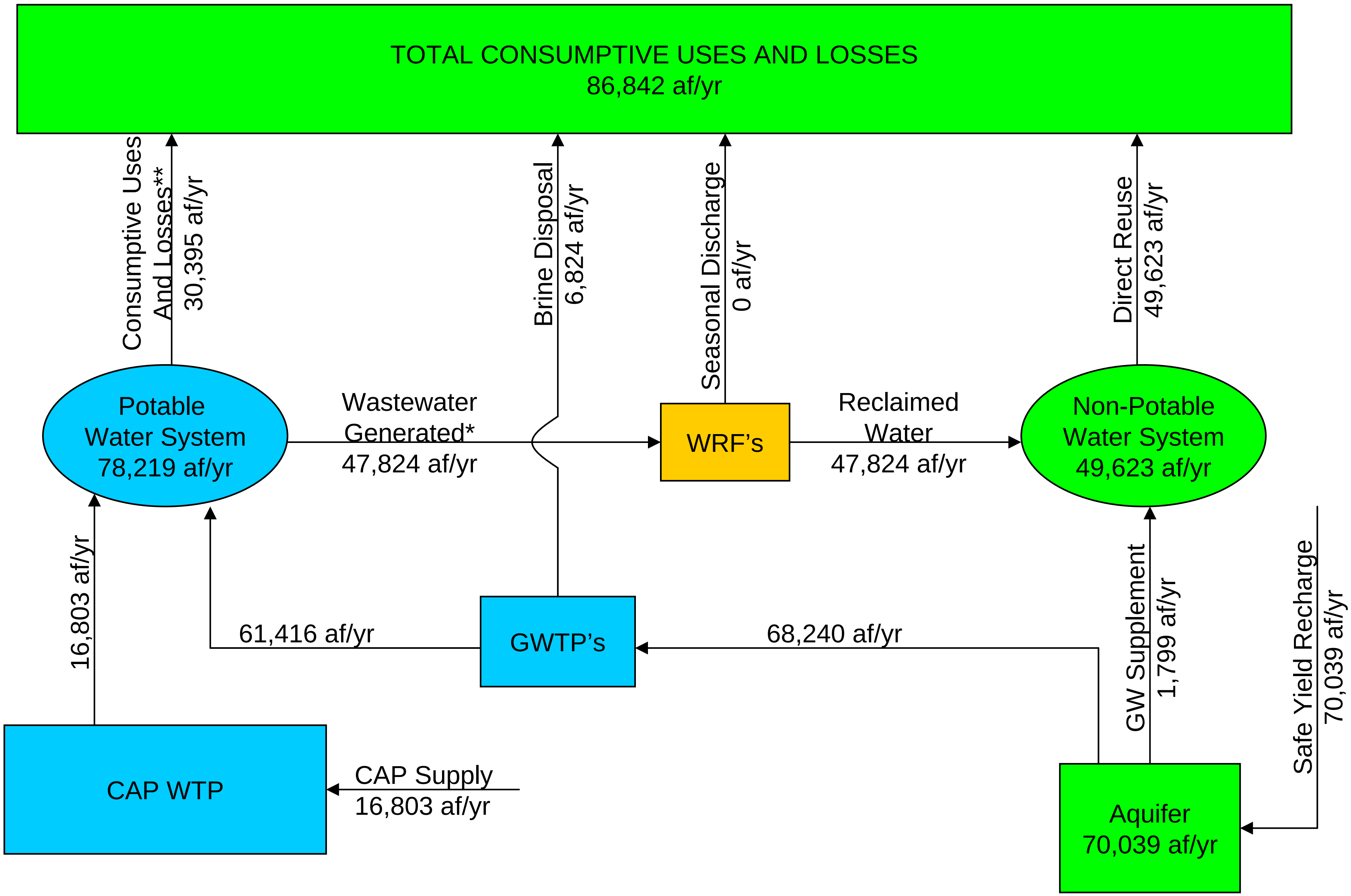
Water Resources Balance
Build out / No Reuse
Figure 4

*Interior Wastewater Generated
**Based on 10% Lost and 50% Returned



Water Resources Balance
Build out / Midlevel Reuse
Figure 5

*Interior Wastewater Generated
**Based on 10% Lost and 50% Returned



Water Resources Balance
Build out / Dual System
Figure 6

*Interior Wastewater Generated
**Based on 10% Lost and 50% Returned

In the following sections we explain the alternative markets for reclaimed water and the seasonal demands that occur.

4.1 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.

4.2 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 10 is a partial list of assumptions associated with planning for the reuse sites.

Table 10: 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 11 displays the acreages for turf, lake, and low water use landscaping.

Table 11: 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.

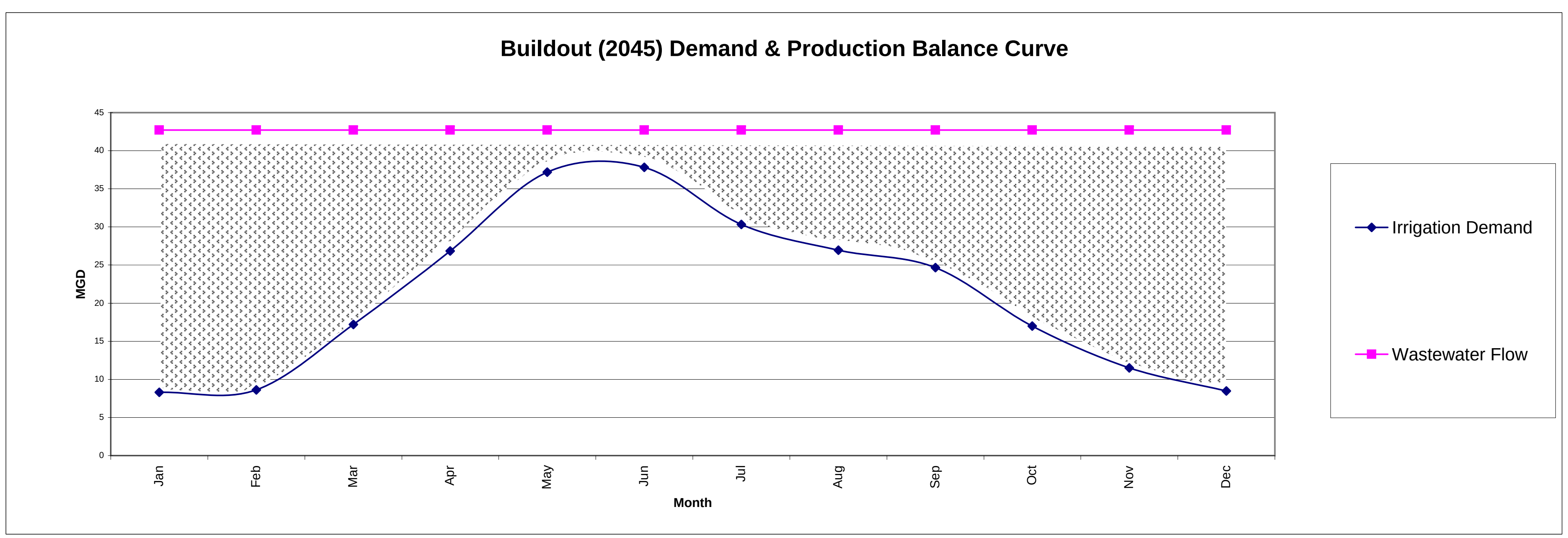
To determine the street ROW that could have potential low water use irrigation it was assumed that all major artery streets would have a nonpotable water pipe within it as distribution to large scale turf users. The number of miles of road was determined based on square mile grids in each WPA. The low 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, as displayed on Table 12. 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.

REUSE WATER BALANCE SPREADSHEET
BUILDOUT (2045) MIDLEVEL REUSE
Table 12

	Annual Average af/yr	Annual Average mgd	January Peaking Factor	January 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 (Max Month) Peaking Factor**	**June (Max Month) Flowrate (mgd)**	July Peaking Factor	July 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)
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	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7
Recharge	24,036	21.5	38,540	34.4	38,158	34.1	28,553	25.5	17,752	15.9	6,185	5.5	5,477	4.9	13,870	12.4	17,624	15.7	20,190	18.0	28,795	25.7	34,957	31.2	38,327	34.2
Additional Resources Required	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



4.3 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 13: Exterior vs. Interior Family Water Use

Third Mangement Plan Water Use New Residential Development using Occupany 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****

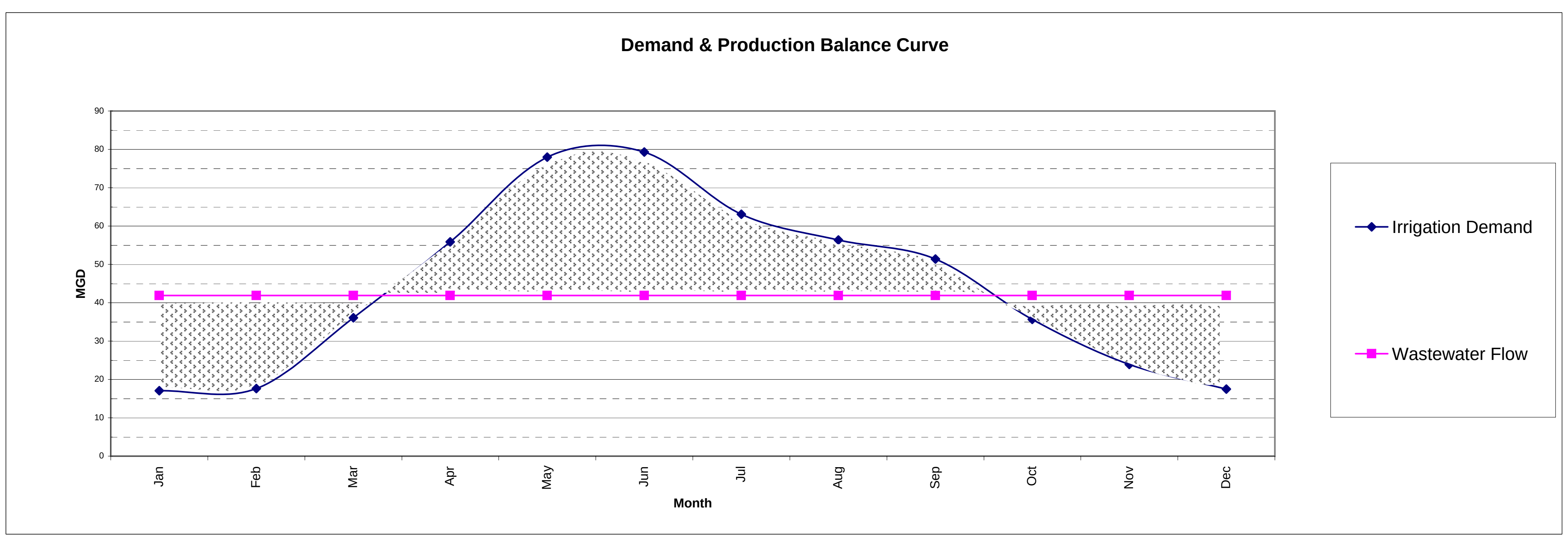
*Based on Landscape Watering from ADWR Third Management Plan
**Based on ratio of Single Family Exterior Use Landscaping to Multi Family Exterior Use

The irrigation demand unit rate was then applied to the number of dwelling units per land use category to determine the required Irrigation Demand. These values can be found in Appendix B.

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.

REUSE WATER BALANCE SPREADSHEET
BUILDOUT (2045) DUAL SYSTEM
Table 14

	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/Residential																										
WPA 2	6,440	5.7		2.2		2.2		4.7		7.2		10.2		**10.3**		8.2		7.3		6.7		4.7		3.1		2.2
WPA 3	7,428	6.6		2.5		2.6		5.4		8.4		11.7		**11.9**		9.4		8.4		7.7		5.4		3.6		2.6
WPA 4	19,559	17.5		6.6		6.8		14.3		22.0		30.9		**31.4**		24.8		22.2		20.3		14.1		9.4		6.8
WPA 5	2,651	2.4		0.9		0.9		1.9		3.0		4.2		**4.3**		3.4		3.0		2.7		1.9		1.3		0.9
Total Demand =	36,078	32.2	0.38	12.2	0.39	12.6	0.82	26.4	1.26	40.6	1.77	57.0	**1.80**	**58.0**	1.42	45.7	1.27	40.9	1.16	37.4	0.81	26.1	0.54	17.4	0.39	12.6
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	8,182	7.3		2.9		2.9		6.0		9.2		12.8		13.0		10.4		9.3		8.5		5.9		4.0		2.9
WPA 3	10,415	9.3		3.6		3.7		7.6		11.7		16.4		16.6		13.2		11.8		10.8		7.5		5.0		3.7
WPA 4	27,105	24.2		9.2		9.5		19.7		30.6		42.7		43.4		34.5		30.8		28.1		19.4		13.0		9.5
WPA 5	3,921	3.5		1.4		1.4		2.9		4.4		6.1		6.2		5.0		4.4		4.1		2.8		1.9		1.4
Total Demand =	49,623	44.3		17.1		17.6		36.1		55.9		78.0	88,827	79.3		63.1		56.4		51.4		35.7		23.9		17.5
Wastewater Flow	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9	46,928	41.9
Recharge	9,664	8.6	27,831	24.8	27,191	24.3	6,482	5.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6,983	6.2	20,117	18.0	27,360	24.4
Additional Resources Required	12,379.1	11.1	0.0	0.0	0.0	0.0	0.0	0.0	15,680	14.0	40,417	36.1	41,899	37.4	23,694	21.2	16,200	14.5	10,660	9.5	0.0	0.0	0.0	0.0	0.0	0.0



5.0 COST ANALYSIS

A cost analysis was completed to determine whether any of the reuse levels offered significant savings over the others, as shown on Table 16. 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 break down of the unit rates are listed in Table 15.

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.

Table 15: Unit Rates

SYSTEM INFRASTRUCTURE	Unit	Unit Rate
Surface Water Production		
CAP WTP	$/gallon	$4.00
CAP WTP Expansion	$/gallon	$2.00
Groundwater Production		
Wells	$/gallon	$0.50
Well Piping	$/gallon	$0.65
Plant/Brine	$/gallon	$8.00
Plant/Brine Expansion	$/gallon	$6.00
Storage	$/gallon	$1.00
Boosters	$/gallon	$0.20
Piping	$/in-ft	$10.00
Piping - Nonpotable	$/in-ft	$8.00
Recharge Wells (Vadose Zone)	$/gallon	$0.20
Recovery Wells (ASR)	$/gallon	$0.50

CAPITAL COST
TABLE 16

	No Reuse				Moderate Reuse				Dual System			
POTABLE SYSTEM DEMANDS	Demand		(mgd)	(af/yr)	Demand		(mgd)	(af/yr)	Demand		(mgd)	(af/yr)
	AAD		107.0	119,801	AAD		90.5	101,315	AAD		68.6	76,783
	MDD		182		MDD		154		MDD		117	
	PH		309		PH		261		PH		198	
SYSTEM INFRASTRUCTURE	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)
POTABLE SYSTEM												
Surface Water Production												
CAP WTP	20	$/gallon	$4.00	80	12	$/gallon	$4.00	48	12	$/gallon	$4.00	48
CAP WTP Expansion	40	$/gallon	$2.00	80	12	$/gallon	$2.00	24	12	$/gallon	$2.00	24
Groundwater Production												
Adaman Mutual	15	$/gallon	$6.00	90	15	$/gallon	$6.00	90	10	$/gallon	$6.00	60
WPA-2	35	$/gallon	$6.00	210	35	$/gallon	$6.00	210	25	$/gallon	$6.00	150
WPA-4 (Wells)	116	$/gallon	$0.50	58	116	$/gallon	$0.50	58	92	$/gallon	$0.50	46
WPA-4 (Well Piping)	116	$/gallon	$0.65	75	116	$/gallon	$0.65	75	92	$/gallon	$0.65	60
WPA-4 (Plant/Brine)	46	$/gallon	$8.00	368	46	$/gallon	$8.00	368	35	$/gallon	$8.00	280
WPA-4 (Plant/Brine Expansion)	46	$/gallon	$6.00	276	46	$/gallon	$6.00	276	35	$/gallon	$6.00	210
Potable Supply Total =				1,237				1,149				878
Distribution System												
Storage	107	$/gallon	$1.00	107	90	$/gallon	$1.00	90	69	$/gallon	$1.00	69
Boosters	309	$/gallon	$0.20	62	261	$/gallon	$0.20	52	198	$/gallon	$0.20	40
Piping				10				0				-10
Potable Distribution System Total =				178				143				98
WASTEWATER TREATMENT	41				41				41			
	No Reuse				Moderate Reuse				Dual System			
NONPOTABLE SYSTEM DEMANDS	Demand		(mgd)	(af/yr)	Demand		(mgd)	(af/yr)	Demand		(mgd)	(af/yr)
	AAD		0	0	AAD		21	24,035	AAD		45	49,858
	MDD		0		MDD		36		MDD		76	
	PH		0		PH		62		PH		129	
SYSTEM INFRASTRUCTURE	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)	Capacity (mgd)	Unit	Unit Rate	Capital Cost (Million Dollars)
Non-Potable Distribution System												
Storage	0	$/gallon	$1.00	0	21	$/gallon	$1.00	21	45	$/gallon	$1.00	45
Boosters	0	$/gallon	$0.20	0	62	$/gallon	$0.20	12	129	$/gallon	$0.20	26
Piping				0				148				576
Nonpotable Distribution System =				0				181				646
RECHARGE/RECOVERY												
Recharge Wells (Vadose Zone)	41	$/gallon	$0.20	8	33	$/gallon	$0.20	7	24	$/gallon	$0.20	5
Recovery Wells (ASR)	0	$/gallon	$0.50	0	0	$/gallon	$0.50	0	37	$/gallon	$0.50	19
WPA-4 (Plant/Brine)	0	$/gallon	$8.00	0	0	$/gallon	$8.00	0	20	$/gallon	$8.00	160
WPA-4 (Plant/Brine Expansion)	0	$/gallon	$6.00	0	0	$/gallon	$6.00	0	17	$/gallon	$6.00	102
TOTAL SYSTEM COST =				**1,424**				**1,480**				**1,907**

6.0 CONCLUSIONS AND RECOMMENDATIONS

The three alternatives are summarized in Table 17 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 17: 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

APPENDIX A
ETo AND ET CALCULATIONS

AZMET CROP COEFFICIENTS			
TYPE OF GRASS	**CUTTING HEIGHT**	**QUALITY**	**Kc**
Warm Season	4 - 5 cm	Acceptable (Park)	0.65
Warm Season	2 - 2.5 cm	High (Golf Course)	0.76
Cool Season	4 - 5 cm	Acceptable (Park)	0.65
Cool Season	2 - 2.5 cm	High (Golf Course)	0.72

Turf Unit Rates for Parks/Schools/ROW and Golf Courses									
TURF QUALITY	**Average Yearly Kc**	**Goodyear Average Eto (inches/yr)**	**ET**	**Average Precipitation (inches/yr)**	**Adjusted Plant Irrigation Demand (inches/yr)**	**Sprinkler Losses**	**Evaporative Losses**	**Adjusted Application (inches/yr)**	**Adjusted Application (feet/yr)**
Acceptable (Park)	0.65	79.8	51.9	6.08	45.8	90%	10%	56.5	4.7
High (Golf Course)	0.74	79.8	59.1	6.08	53.0	90%	10%	65.4	5.4

Lake Unit Rate				
QUALITY	**Goodyear Average Eto (inches/yr)**	**Average Precipitation (inches/yr)**	**Adjusted Lake Irrigation Demand (inches/yr)**	**Adjusted Application (feet/yr)**
Lakes	79.80	6.08	73.72	6.14

Unit Rate Summary	
Application	**Unit Rate**
Parks/Schools/ROW	4.7
Golf Courses	5.4
Lakes	6.1
Residential	-
Construction	-

Buildout Acreages - Midlevel Reclaimed Water Utilization

Reclaimed Water Utilization - Schools/Parks/ROW						
WPA	**School Turf (acres)**	**Park Turf (acres)**	**ROW Equiv. Turf (acres)**	**Total Turf per WPA (acres)**	**Application Rate (ft/yr)**	**Reclaimed Production (acre-ft/yr)**
2	180	148	50	378	4.7	1,780
3	216	182	44	442	4.7	2,082
4	540	449	103	1092	4.7	5,145
5	81	64	11	156	4.7	735
Totals =	1017	844	207	2068		9,743

Reclaimed Water Utilization - Golf Courses			
WPA	**Golf Course Turf (acres)**	**Application Rate (ft/yr)**	**Reclaimed Production (acre-ft/yr)**
2	191	5.4	1,040
3	477	5.4	2,600
4	1240	5.4	6,759
5	191	5.4	1,040
Totals =	2099		11,438

Reclaimed Water Utilization - Lakes			
WPA	**Lakes (acres)**	**Adjusted Production (feet)**	**Reclaimed Production (acre-ft/yr)**
2	80	6.1	489
3	18	6.1	111
4	46	6.1	283
5	7	6.1	40
Totals =	150		923

Reclaimed Water Utilization - Construction			
WPA	**Construction (acre-ft/yr)**	**Pipe Losses**	**Reclaimed Production (acre-ft/yr)**
2	127	5%	133
3	127	5%	133
4	127	5%	133
5	127	5%	133
Totals =	507		534

Irrigation Production Demand with Pipe Losses									
WPA	**Lake Reclaimed Production (acre-ft/yr)**	**Pipe Losses**	**Lake Production (acre-ft/yr)**	**Golf Course Production (acre-ft/yr)**	**Pipe Losses**	**Golf Course Production (acre-ft/yr)**	**Park/School/ROW Production (acre-ft/yr)**	**Pipe Losses**	**Park/School/ROW Production (acre-ft/yr)**
2	489	5.0%	515	1,040	5.0%	1,095	1,780	5.0%	1,874
3	111	5.0%	116	2,600	5.0%	2,736	2,082	5.0%	2,191
4	283	5.0%	298	6,759	5.0%	7,115	5,145	5.0%	5,416
5	40	5.0%	43	1,040	5.0%	1,095	735	5.0%	774
Totals =	923		972	11,438		12,040	9,743		10,255

Reclaimed Water Utilization - Summary Midlevel Reuse					
WPA	**Construction (acre-ft/yr)**	**Lake Reclaimed Production (acre-ft/yr)**	**Golf Course Production (acre-ft/yr)**	**Park/School/ROW Production (acre-ft/yr)**	**Total Reclaimed Production (acre-ft/yr)**
2	133	515	1,095	1,874	3,616
3	133	116	2,736	2,191	5,178
4	133	298	7,115	5,416	12,962
5	133	43	1,095	774	2,045
Totals =	534	972	12,040	10,255	23,801

Buildout Acreages - Dual System Reclaimed Water Utilization

Reclaimed Water Utilization - Residential			
WPA	**Residential Irrigation (acre-ft/yr)**	**Lost and Unaccounted Water**	**Reclaimed Production (ac-ft/yr)**
2	4,337	5%	4,566
3	4,975	5%	5,237
4	13,436	5%	14,143
5	1,783	5%	1,877
Totals =	24,531	5%	25,822

Reclaimed Water Utilization - Summary Dual System						
WPA	**Construction (acre-ft/yr)**	**Lake Reclaimed Production (acre-ft/yr)**	**Golf Course Production (acre-ft/yr)**	**Park/School/ROW Production (acre-ft/yr)**	**Residential Reclaimed Production (ac-ft/yr)**	**Total Reclaimed Production (acre-ft/yr)**
2	133	515	1,095	1,874	4,566	8,182
3	133	116	2,736	2,191	5,237	10,415
4	133	298	7,115	5,416	14,143	27,105
5	133	43	1,095	774	1,877	3,921
Totals =	534	972	12,040	10,255	25,822	49,623

APPENDIX B
REUSE CALCULATIONS
-MIDLEVEL
-DUAL SYSTEM

CITY OF GOODYEAR
RECLAIMED WATER MASTER PLAN
BUILDOUT REUSE CALCULATION - MID LEVEL REUSE

School Facility Design Guidelines			
Guideline	**Elementary School**	**Middle School**	**High School**
Square Feet Per Student	100	110	150
Site Requirements (acres)	20	20	40
Enrollment Capacities	700-800	800-1000	1200-1800
Enrollment percentage	90%	90%	90%
Typical Enrollment	720	900	1620

School Turf Application															
WPA	**Elementary**	**Middle**	**High**	**Total Schools**	**Elementary Acreage**	**Middle Acreage**	**High Acreage**	**Total Acreage**	**Turf Percentage**	**Elementary Turf (1)**	**Middle Turf (1)**	**High Turf (1)**	**Total Turf**	**Turf Application Rate (acre-ft/yr)**	**Turf Irrigation (acre-ft/yr)**
2	8	6	3	17	160	120	120	400	45%	72	54	54	**180**	**3.4**	**612**
3	10	8	3	21	200	160	120	480	45%	90	72	54	**216**	**3.4**	**734**
4	25	19	8	52	500	380	320	1,200	45%	225	171	144	**540**	**3.4**	**1,836**
5	4	3	1	7	80	60	40	180	45%	36	27	18	**81**	**3.4**	**275**
Totals =	**46**	**35**	**16**	**97**	**940**	**720**	**600**	**2,260**		**423**	**324**	**270**	**1,017**		**3,458**

(1) ADWR Third Management Plan determined average turf acreage to be 10.9.

Average Landscaping Acres per Hole, Existing, & New Golf Courses -	
Type of Acres	**New Regulation Golf Courses**
Turf	4.8
Lake	0.2
Low Water Use Landscaping	1.5
Equivalent Turf equates to 3 Low Water Use acres to 1 Turf Acre	
Equivalent Turf	**5.3**

*Obtained from ADWR Third Management Plan

Golf Courses								
WPA	**Total Number of Golf Courses at Buildout**	**Equivalent Turf (acre per hole)**	**Equivalent Turf (acres per 18 hole course)**	**Lake Acreage (1)**	**Turf Application Rate (acre-ft/acre)**	**Turf Irrigation (acre-ft)**	**Lake Application Rate (acre-ft/acre)**	**Lake Irrigation (acre-ft)**
2	2	5.3	191	8	4.9	935	6.2	47
3	5	5.3	477	18	4.9	2,337	6.2	112
4	13	5.3	1,240	46	4.9	6,077	6.2	286
5	2	5.3	191	7	4.9	935	6.2	41
Totals =	**22**		**2,099**	**78**		**10,284**		**485**

(1) Acreages based on ADWR Third Management Plan

Goodyear Parks at Buildout							
WPA	**Population at Buildout**	**Acreage/ 1000 people**	**Park Acreage**	**Equivalent Park Turf (1)**	**Park Turf (1) (acres)**	**Turf Application Rate (acre-ft/yr)**	**Turf Irrigation (acre-ft/yr)**
2	90,349	3.49	315	47%	148	**3.4**	**504**
3	111,128	3.49	388	47%	182	**3.4**	**620**
4	273,830	3.49	956	47%	449	**3.4**	**1,527**
5	39,125	3.49	137	47%	64	**3.4**	**218**
Totals =	**514,431**		**1,795**		**844**		**2,869**

(1) Based on 35% turf plus equivalent Low Water Use (35% Low Water Use Acreage equals 12% Turf Acreage)

Lakes other than Golf Courses			
WPA	**Existing Lakes (acres)**	**Lake Application Rate (acre-ft/yr)**	**Lake Irrigation (acre-ft/yr)**
2	72	**6.2**	**446**
3	0	**6.2**	**0**
4	0	**6.2**	**0**
5	0	**6.2**	**0**
Totals =	**72**		**446**

Golf Courses - Totals				
WPA	**Total Courses at Buildout**	**Current Courses Built**	**Remaining Courses**	**Remaining Course Acreage**
2	2		2	201
3	5	4	1	95
4	13	1	12	1,126
5	2	0	2	175
	22			

Right-of-Way						
WPA	**Miles of Road**	**Width of Irrigation (ft)**	**Total ROW Area of Irrigation (acres)**	**Equivalent Turf (acres)**	**Low Water Use Irrigation Application Rate**	**ROW Irrigation (acre-ft/yr)**
2	41	30	149	50	1.5	224
3	36	30	131	44	1.5	196
4	85	30	309	103	1.5	464
5	9	30	33	11	1.5	49
Totals =	**171**		**622**	**207**		**933**

Construction Water Usage		
Potable Water Demand	**Construction Reclaimed**	**Construction Reuse**
101,315	0.5%	507

*Construction use from metered records is approximately 0.25% which is lower than typical. Compared to similar cities in the area a value was used as 0.5% of potable water demand at build out to account for unmetered usage.

Buildout Acreages						
WPA	**School Turf (acres)**	**Golf Course Turf (acres)**	**Park Turf (acres)**	**ROW Equiv. Turf (acres)**	**Total Turf per WPA (acres)**	**Lakes (acres)**
2	180	191	148	50	569	80
3	216	477	182	44	919	18
4	540	1240	449	103	2,332	46
5	81	191	64	11	347	7
Totals =	**1,017**	**2,099**	**844**	**207**	**4,167**	**150**

Buildout Irrigation Demand						
WPA	**School Irrigation (acre-ft/yr)**	**Golf Course Irrigation (acre-ft/yr)**	**Park Irrigation (acre-ft/yr)**	**ROW Irrigation (acre-ft/yr)**	**Lake Irrigation (acre-ft/yr)**	**Total Irrigation per WPA**
2	612	935	504	224	493	2,768
3	734	2337	620	196	112	3,999
4	1,836	6077	1527	464	286	10,190
5	275	935	218	49	41	1,518
Totals =	**3,458**	**10,284**	**2,869**	**933**	**932**	**18,475**

Buildout Reuse Demand	
Irrigation	18,475
Construction	507
Total	18,982

CITY OF GOODYEAR
RECLAIMED WATER MASTER PLAN
BUILDOUT REUSE CALCULATION - DUAL SYSTEM REUSE

School Facility Design Guidelines			
Guideline	Elementary School	Middle School	High School
Square Feet Per Student	100	110	150
Site Requirements (acres)	20	20	40
Enrollment Capacities	700-800	800-1000	1200-1800
Enrollment percentage	90%	90%	90%
Typical Enrollment	720	900	1620

School Turf Application															
WPA	Elementary	Middle	High	Total Schools	Elementary Acreage	Middle Acreage	High Acreage	Total Acreage	Turf Percentage	Elementary Turf (1)	Middle Turf (1)	High Turf (1)	Total Turf	Turf Application Rate (acre-ft/yr)	Turf Irrigation (acre-ft/yr)
2	8	6	3	17	160	120	120	400	45%	72	54	54	180	3.4	612
3	10	8	3	21	200	160	120	480	45%	90	72	54	216	3.4	734
4	25	19	8	52	500	380	320	1,200	45%	225	171	144	540	3.4	1,836
5	4	3	1	7	80	60	40	180	45%	36	27	18	81	3.4	275
Totals =	46	35	16	97	940	720	600	2,260		423	324	270	1,017		3,458

(1) ADWR Third Management Plan determined average turf acreage to be 10.9.

Average Landscaping Acres per Hole, Existing, & New Golf	
Type of Acres	New Regulation Golf
Turf	4.8
Lake	0.2
Low Water Use Landscaping	1.5
Equivalent Turf equates to 3 Low Water Use acres to 1 Turf	
Equivalent Turf	5.3

*Obtained from ADWR Third Management Plan

Golf Courses								
WPA	Total Number of Golf Courses at Buildout	Equivalent Turf (acre per hole)	Equivalent Turf (acres per 18 hole course)	Lake Acreage (1)	Turf Application Rate (acre-ft/acre)	Turf Irrigation (acre-ft)	Lake Application Rate (acre-ft/acre)	Lake Irrigation (acre-ft)
2	2	5.3	191	8	4.9	935	6.2	47
3	5	5.3	477	18	4.9	2,337	6.2	112
4	13	5.3	1,240	46	4.9	6,077	6.2	286
5	2	5.3	191	7	4.9	935	6.2	41
Totals =	22		2,099	78		10,284		485

(1) Acreages based on ADWR Third Management Plan

Goodyear Parks at Buildout							
WPA	Population at Buildout	Acreage/ 1000 people	Park Acreage	Equivalent Park Turf (1)	Park Turf (1) (acres)	Turf Application Rate (acre-ft/yr)	Turf Irrigation (acre-ft/yr)
2	90,349	3.49	315	47%	148	3.4	504
3	111,128	3.49	388	47%	182	3.4	620
4	273,830	3.49	956	47%	449	3.4	1,527
5	39,125	3.49	137	47%	64	3.4	218
Totals =	514,431		1,795		844		2,869

(1) Based on 35% turf plus equivalent Low Water Use (35% Low Water Use Acreage equals 12% Turf Acreage)

Lakes other than Golf Courses			
WPA	**Existing Lakes (acres)**	**Lake Application Rate (acre-ft/yr)**	**Lake Irrigation (acre-ft/yr)**
2	72	**6.2**	**446**
3	0	**6.2**	**0**
4	0	**6.2**	**0**
5	0	**6.2**	**0**
Totals =	**72**		**446**

Right-of-Way						
WPA	**Miles of Road**	**Width of Irrigation (ft)**	**Total ROW Area of Irrigation (acres)**	**Equivalent Turf (acres)**	**Low Water Use Irrigation Application Rate**	**ROW Irrigation (acre-ft/yr)**
2	41	30	149	50	1.5	224
3	36	30	131	44	1.5	196
4	85	30	309	103	1.5	464
5	9	30	33	11	1.5	49
Totals =	**171**		**622**	**207**		**933**

Buildout Acreages						
WPA	**School Turf (acres)**	**Golf Course Turf (acres)**	**Park Turf (acres)**	**ROW Equiv. Turf (acres)**	**Total Turf per WPA (acres)**	**Lakes (acres)**
2	180	191	148	50	569	80
3	216	477	182	44	919	18
4	540	1240	449	103	2,332	46
5	81	191	64	11	347	7
Totals =	**1,017**	**2,099**	**844**	**207**	**4,167**	**150**

ADWR Third Management Plan		
Device	**Model Assumptions**	**Model Use Rate**
Toilet	5 flushes/person/day x 1.7 gallon/flush	9 gpcd
Shower	7.9 minutes/shower x 2.50 gpm x 0.9 shower/person/day	18 gpcd
Bath	32.5 gallons/bath x 0.10 bath/person/day	3 gpcd
Faucets	Kitchen & Bathroom 2.5 gpm x 4.0 minutes/person/day	10 gpcd
Dishwasher	9.81 gallons/load x 0.20 loads/person/day	2 gpcd
Clothes Washer	30.3 gallons/load x 0.30 loads/person/day	9 gpcd
Miscellaneous		6 gpcd
Total =		**57 gpcd**

ADWR Third Mangement Plan	
Exterior Use	**Model Use Rate**
Evaporative Cooling	3 gpdud
Swimming Pool	43 gpdud
Landscape Watering	143 gpdud
Total =	**189 gpdud**
Exterior Use Rate for Multifamily	**77 gpdud**

Goodyear Occupany Rate Comparison		
Interior Water Use (gpcd)	**Occupancy Rate**	**Interior Water Use (gpdu)**
57	2.65	151

Third Mangement Plan Water Use				Goodyear Estimate for
Type	Interior (gpdu)	Exterior (gpdu)	Total (gpdu)	Unit Rate (gpdu)
Single Family	151	189	340	**143***
Multi Family	151	77	228	**58****

*Based on Landscaping Watering from ADWR Third Management Plan
**Based on ratio of Single Family Exterior Use Landscaping to Multi Family Exterior Use

Residential Irrigation Demand																	
		WPA 2				WPA 3				WPA 4				WPA 5			
Land Use Category	Target Density (du/ac)	Land Use acreage	Dwelling Units	Irrigation Demand Unit	Irrigation Demand	Land Use acreage	Dwelling Units	Irrigation Demand Unit	Irrigation Demand	Land Use acreage	Dwelling Units	Irrigation Demand	Irrigation Demand	Land Use acreage	Dwelling Units	Irrigation Demand	Irrigation Demand
RESIDENTIAL																	
Single-Family Residential																	
Agricultural Preservation (1 du/ac)	1	0	0	143	0	0	0	143	0	0	0	143	0	0	0	143	0
Rural (0-2 du/ac)	1	1,988	1988	143	318	2,398	2398	143	384	0	0	143	0	748	748	143	120
Rural (0-2 du/ac)	2	0	0	143	0	0	0	143	0	19,061	38,122	143	6,106	0	0	143	0
Low Density (2-4 du/ac)	3	5,438	16314	143	2,613	3,656	10968	143	1,757	9,283	27,849	143	4,460	1,752	5,256	143	842
Low-Medium Density (4-6 du/ac)	5	799	3995	143	640	2,055	10275	143	1,646	931	4,655	143	746	529	2,645	143	424
Multi-Family Residential																	
Medium Density (6-10 du/ac)	8	460	3680	58	239	875	7000	58	455	1,690	13,520	58	878	544	4,352	58	283
Medium-High Density (10-20 du/ac)	15	541	8115	58	527	265	3975	58	258	254	3,810	58	247	118	1,770	58	115
High Density Residential (20+ du/ac)	25	0	0	58	0	293	7325	58	476	615	15,375	58	999	0	0	58	0
Totals =		**9,226**			**4,337**	**9,542**			**4,975**	**31,834**			**13,436**	**3,691**			**1,783**

Residential Irrigation Demand	
WPA	Irrigation Demand (acre-ft/yr)
2	4,337
3	4,975
4	13,436
5	1,783
Total =	**24,531**

Buildout Irrigation Demand							
WPA	School Irrigation (acre-ft/yr)	Golf Course Irrigation (acre-ft/yr)	Park Irrigation (acre-ft/yr)	ROW Irrigation (acre-ft/yr)	Lake Irrigation (acre-ft/yr)	Residential Irrigation (acre-ft/yr)	Total Irrigation per WPA
2	612	935	504	224	493	4,337	7,105
3	734	2337	620	196	112	4,975	8,975
4	1,836	6077	1527	464	286	13,436	23,626
5	275	935	218	49	41	1,783	3,301
Totals =	**3,458**	**10,284**	**2,869**	**933**	**932**	**24,531**	**43,006**

Buildout Reuse Demand	
Irrigation	43,006
Construction	507
Total	43,513

RECLAIMED WATER SYSTEM PARAMETERS TECHNICAL MEMORANDUM NO. 3-2

Table of Contents

1.0 INTRODUCTION

Within the City of Goodyear wastewater will be collected and treated to be either reused for landscape irrigation, lake filling and construction, or recharged into underground aquifers in order to augment the City's groundwater resources. Small amounts of excess reclaimed water may also be periodically discharged into adjacent washes and rivers. Therefore, in addition to the treatment facilities which reclaim the wastewater, a nonpotable water distribution system will be developed which can convey the reclaimed water from the Water Reclamation Facilities (WRF), to the point of reuse or recharge. The purpose of this TM is to provide direction for the design of the reclaimed water system with respect to:

- Reclaimed Water Reuse Regulations
- Reclaimed Water Recharge Regulations
- Landscape Irrigation Water Quality
- Distribution System Design

There are a number of regulations currently put into place for the purpose of effluent reuse. The Arizona Department of Environmental Quality (ADEQ) maintains and coordinates these regulations. Wastewater effluent used as reclaimed water has regulations that mostly address treated effluent quality, especially the removal of chemical pollutants and biological pathogens that could have a harmful effect on the receiving waters or reuse facilities.

The Arizona Administrative Code maintains water quality standards for effluent reuse. Water quality standards vary for the type of reuse as certain types of irrigation don't require such high quality water, but to eliminate confusion all effluent will be treated to A+ standards for all reuse applications.

The design parameters to be implemented for the reclaimed water system include seasonal factors, diurnal variations, system pressure, distribution system, and recharge systems. All of these help maintain the reliability of and accessibility to the reclaimed water. Certain safeguards will also be implemented to protect public health and encourage education. All further development of the reclaimed water nonpotable systems is based on the recommended midlevel reuse. In TM 3-1 the reclaimed water markets were developed as a projection of build out demands from Goodyear's Land use plan. As reclaimed water markets change and demands vary additional research will be required to determine all necessary parameters.

2.0 RECLAIMED WATER REUSE AND RECHARGE REGULATIONS

Regulations are provided within the state to help guide the design and planning of reuse systems. A thorough understanding of all applicable regulations is required to plan the most effective design and operation of a water-reuse program and to streamline implementation. Currently no federal regulations exist but the American Water Works Association (AWWA) is working to create national regulations and guidelines to be adopted at a national level. This section discusses permits required, reuse effluent requirements, health protection measures, and monitoring requirements.

2.1 PERMITS

The following permits will be required for the construction related to reuse:

- National Pollution Discharge Elimination System (NPDES) Permit for discharge into washes, rivers and other watercourses. Issued by ADEQ.
- Aquifer Protection Permit (APP) allowing the recharge of reclaimed water to the underlying aquifers. Issued by ADEQ.
- Reclaimed Water Individual or General Permit, allowing reuse of reclaimed water for large scale turf irrigation (golf courses and parks) and other permitted uses. Issued by ADEQ.

2.1.1 National Pollution Discharge Elimination System (NPDES) Permit

Under the Arizona Pollutant Discharge Elimination System (AZPDES) Permit Program, all facilities that discharge pollutants from any point source into waters of the United States (navigable waters) are required to obtain or seek coverage under an AZPDES permit. Pollutants can enter waters of the United States from a variety of pathways, including agricultural, domestic and industrial sources. For regulatory purposes these sources are generally categorized as either point source or nonpoint sources. Discharge to surface waters will require treatment in support of the following designated uses as determined by the Arizona Administrative Code:

- Aquatic
- Wildlife
- Partial Body Contact

2.1.2 Aquifer Protection Permit

Reclaimed water that is recharged into an aquifer can not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health. The recharge can not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer. An Aquifer Protection Permit (APP) is required for a facility that discharges a pollutant either directly to an aquifer or to the land surface vadose zone in such manner that there is reasonable probability that the pollutant will reach an aquifer.

There are a number of different types of facilities that are considered to be "discharging" and require permits, unless exempted. It is also possible for the director of ADEQ to determine that the facility will be designed, constructed and operated so there will be no migration of pollutants directly to the aquifer or to the vadose zone. The only type of facility requiring an APP in the master plan is wastewater treatment plants. ADEQ issues both general and individual APPs. ADEQ will help determine if a facility qualifies for a general permit or an exemption upon request. There are currently 24 types of facilities specified under A.R.S. § 49-250 as exempt from requiring an APP. In addition, there are four class exemptions and two activities to which the program does not apply. Additional information on the facilities requiring the permit and facilities that are exempted can be found on ADEQ Permit Information page.

The APPs for the Goodyear WWTPs will reference that the underlying aquifers will need to be protected for use as drinking water sources.

The Goodyear WWTPs are to be designed to provide for the following discharge options:

- Groundwater Recharge (primary discharge method)
- Surface Discharge to Waterman Wash (failsafe back-up)
- Unrestricted Access Irrigation

To provide for the first two discharge options and meet the regulatory requirements, it will be necessary to provide a secondary treated effluent which has been nitrified/denitrified, disinfected and de-chlorinated prior to recharge or discharge. Strictly speaking, this involves biological nutrient removal secondary treatment followed by disinfection and de-chlorination. While not specifically required, filtration would also be included in the treatment process to guard against solids carryover, which will improve the efficiency of the disinfection process and more reliably maintain total effluent nitrate within regulatory limits.

Practically speaking, the above treatment process would produce a Class A+ effluent which could be used in the future for unrestricted access irrigation (discharge option 3). Table 1 below indicates the proposed wastewater treatment requirements to be achieved in order to permit the intended discharge options and comply with regulations.

All wastewater treatment facilities providing reclaimed water for reuse must have an individual Aquifer Protection Permit (APP), or amend their existing APP to contain certification for a particular Class (A+, A, B+, B or C) of reclaimed water. The APP requires monitoring and reporting of reclaimed water quality to ensure that effluent limitations for reclaimed water quality classes are met.

Reclaimed Water Quality Standards establish five classes of reclaimed water expressed as a combination of minimum treatment requirements and a limited set of numeric reclaimed water quality criteria. Class A reclaimed water is required for reuse applications where there is a relatively high risk of human exposure to potential pathogens in the reclaimed water. For uses where the potential for human exposure is lower, Class B and Class C are acceptable. Class B reclaimed water can be used for restricted access irrigation; irrigation must be over for a number of hours before contact occurs, and not within so many days of harvest of certain crops.

The Reclaimed Water Quality Standards include two "+" categories of reclaimed water, Class A+ and Class B+. Both categories require treatment to produce reclaimed water with a total nitrogen concentration of less than 10 mg/l. These categories of reclaimed water will minimize concerns over nitrate contamination of groundwater beneath sites where reclaimed water is applied. As a result, the general permits for the direct reuse of Class A+ and Class B+ reclaimed water do not include nitrogen management as a condition of the reuse.

Class A+ reclaimed water is wastewater that has undergone secondary treatment, filtration, nitrogen removal treatment, and disinfection.

Table 1: Class and Treatment Required

Class	Secondary	Filtration	Disinfection	Nitrogen Removal
A+	X	X	X	X
A	X	X	X	
B+	X		X	X
B	X		X	
C	X			

Table 2: Minimum Reclaimed Water Quality Requirements for Direct Reuse

Type of Direct Reuse	Minimum Class of Reclaimed Water Required
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 (does not include self-service vehicle washes)	A
Snowmaking	A
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

The minimum requirements suggested does not prevent a wastewater treatment plant from using higher quality reclaimed water for a type of direct reuse than the minimum class of reclaimed water listed in Table 2.

2.1.3 Reclaimed Water Individual or General Permit

Direct reuse of reclaimed water recycles treated effluent for beneficial uses, thereby conserving potable water sources for human consumption and domestic uses. Regulations apply to wastewater treatment facilities supplying reclaimed water and to the sites where water is applied or used.

A Reclaimed Water Individual Permit or Reclaimed Water General Permit is required if you are:

- An owner or operator of a sewage treatment facility that generates reclaimed water for direct reuse
- An owner or operator of a reclaimed water blending facility
- A reclaimed water agent
- An end user
- A person who uses gray water
- A person who directly reuses reclaimed water from a sewage treatment facility combined with industrial wastewater or combined with reclaimed water from an industrial wastewater treatment facility
- A person who directly reuses reclaimed water from an industrial wastewater treatment facility in the production or processing of a crop or substance that may be used as human or animal food

2.1.4 Treatment Standards

The resulting treatment standards which will meet anticipated NPDES, APP and Reuse Regulations are shown in Table 3 and will permit the following effluent reuse / disposal options:

1. Unrestricted Access Irrigation.
2. Groundwater recharge.
3. Surface discharge to Waterman Wash and/or Corgett Wash.

Table 3: Wastewater Treatment Standards

Parameter	Treatment Standard
BOD, mg/l	30 mg/l (monthly average) 45 mg/l (weekly average)
TSS, mg/l	30 mg/l (monthly average) 45 mg/l (weekly average)
Total Nitrogen, mg/l	8 mg/l design, 10 mg/l max permitted
Fecal Coliforms, colonies/100 ml	Non-detect
Chlorine Residual Distribution System (1) Groundwater recharge Surface discharge	 0.5 mg/l (monthly average) not specified non-detect
Turbidity, NTU Class A+ Injection Wells (1)	 2 NTU (24hr avg) & 5 NTU (not to exceed) 0.1 NTU (average)

1) Not required by ADEQ but recommended for long term operation of the reuse/recharge system.

As noted in the table above, maintenance of a chlorine residual is recommended in the distribution system even though not required by regulations. A small chlorine residual in the effluent leaving the plant will protect against bacterial growth either through re-activation or introduction of contaminants down stream from the WRF.

Treatment standards to be met by wastewater treatment plants are dictated by Arizona Administrative Code, Title 18 – Environmental Quality, Chapter 11 – Water Quality Standards. The full details of Title 18 – Chapter 11 regulations can be found on the internet at:

http://www.azsos.gov/public_services/Title_18/18-11.htm

2.2 HEALTH PROTECTION MEASURES

To protect public health from the outset, a reclaimed water distribution system should be accompanied by health codes, procedures for approval (and disconnection) of service, regulations governing design and construction specifications, inspections, and operation and maintenance staffing. Public health protection measures that should be addressed in the planning phase are identified below.

- Establish that public health is the overriding concern
- Devise procedures and regulations to prevent cross-connections

- Develop a uniform system to mark all nonpotable components of the system
- Prevent improper or unintended use of nonpotable water through a proactive public information program
- Provide for routine monitoring and surveillance of the nonpotable system
- Establish and train special staff members to be responsible for operations, maintenance, inspection, and approval of reuse connection
- Develop construction and design standards.
- Provide for the physical separation of the potable water, reclaimed water, sewer lines and appurtenances.

Listed in Table 4 are typical signage requirements for different irrigation types. These are provided from the Arizona Administrative Codes.

Table 4: Signage Requirements

Reclaimed Water Class	Hose Bibbs	Residential Irrigation	Schoolground Irrigation	Other Open Access Irrigation	Restricted Irrigation	Mobile Reclaimed Water Dispersal
A+	Each Bibb	Front yard, or all entrances to a subdivision if the signage is supplemented by written yearly notification to individual homeowners by the homeowner's association.	On premises visible to staff and students	None	None	Back of truck or on tank
A	Each Bibb	Front yard, or all entrances to a subdivision if the signage is supplemented by written yearly notification to individual homeowners by the homeowner's association.	On premises visible to staff and students	None	None	Back of truck or on tank
B+	Each Bibb	Direct Reuse Not Allowed	Direct Reuse Not Allowed	Direct Reuse Not Allowed	1. Ingress points. 2. On premises or at reasonably spaced intervals not more than ¼ mile, as applicable to the use. 3. Notice on golf score cards, if applicable.	Back of truck or on tank
B	Each Bibb	Direct Reuse Not Allowed	Direct Reuse Not Allowed	Direct Reuse Not Allowed	1. Ingress points. 2. On premises or at reasonably spaced intervals not more than 1/4 mile, as applicable to the use. 3. Notice on golf score cards, if applicable.	Back of truck or on tank
C	Each Bibb	Direct Reuse Not Allowed	Direct Reuse Not Allowed	Direct Reuse Not Allowed	1. Ingress points. 2. On premises or at reasonably spaced intervals not more than 1/4 mile, as applicable to the use. 3. Notice on golf score cards, if applicable	Back of truck or on tank

2.3 MONITORING REQUIREMENTS

Arizona requires sampling for fecal coliform on a daily basis for reclaimed water to be used for irrigation on parks, schools, ROW, and residential landscaping. For agricultural reuse of nonfood crops, such sampling is required once a month. Turbidity is also required to be monitored on a continuous basis when a limit on turbidity is specified.

3.0 WATER QUALITY REQUIREMENTS FOR REUSE

The primary reuse method will be for landscape irrigation and the following water quality constraints apply:

3.1 TDS

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. However, if the water is to be used for irrigation, TDS must be maintained within limits as shown in Table 5.

Table 5: TDS

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

For comparison purposes, the MCL for TDS in drinking water is 500 ppm. This is a "secondary" MCL which means that TDS level is not a hard limit which can't be exceeded, but a 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 sources is as follows:

CAP Surface Water	700 to 800 ppm
Groundwater WPA2	600 to 1,200 ppm
Groundwater WPA4	1,500 to 3,000 ppm

It can be seen that the TDS of the surface water source, while above the drinking water secondary MCL, is still in the permissible range for irrigation. However the groundwater sources are significantly above both the Secondary MCL for drinking water and the acceptable standards for irrigation. Therefore this water will be treated (by reverse osmosis), lowering the TDS to 500 ppm before being supplied as drinking water. After returning as wastewater, it will have picked up approximately 100 ppm of additional TDS, producing reclaimed water with a TDS of approximately 600 ppm. This water, even after mixing with reclaimed water of CAP origin, will likely have a TDS in the 600 to 900 ppm range which will be suitable for irrigation.

It is imperative 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 they must be kept out of the water cycle or the TDS of the reclaimed water will return to pre-treatment levels rendering it unsuitable for reuse or recharge. A more detailed discussion of the recommended methods for brine disposal is provided in the Water Production Section of the Water Master Plan.

3.2 SAR

Adjusted 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 irrigation water must be maintained within limits because excess sodium (relative to calcium) tends to adsorb onto clay particles and tends to 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 6 is considered to be permissible for agricultural use, with a maximum SAR of 6 as shown in Table 6.

Table 6: Sodium Hazard Classification

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

Analysis of WPA4 groundwater shows the SAR to be in the 10 to 15 range and the SAR of CAP surface water is anticipated to be generally in the 3 to 5 range. Therefore the quality of the WPA4 groundwater should be improved and the quality of the CAP source water should be protected. It is important to note that in order to lower the TDS of the groundwater in order to meet the secondary drinking water MCL, reverse-osmosis or nano-filtration could be used. Both are membrane separation processes which allow 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 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 to 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 will be further discussed in the Water Treatment portion of the Water Master Plan.

3.3 BORON

Boron is essential to plant growth, with optimum yields for many obtained at few-tenths mg/L in nutrient solutions. Boron is toxic to many sensitive plants (i.e. citrus) at 1 mg/L. Surface water rarely contains enough boron to be toxic but well water or springs occasionally contain toxic amounts, especially near geothermal areas and earthquake faults. Boron problems originating from the water are probably more frequent than those originating in the soil. Boron toxicity can affect nearly all crops but, like salinity, there is a wide range of tolerance among crops. Using sufficient quantities in reclaimed water can correct soil deficiencies. As well, most grasses can tolerate 2.0 to 10 mg/L.

4.0 WATER QUALITY REQUIREMENTS FOR RECHARGE

Reclaimed water can replenish groundwater as planned groundwater recharge. The purposes of groundwater recharge using reclaimed water for this master plan will be:

- to augment potable or nonpotable aquifers
- to provide storage of reclaimed water for subsequent retrieval and reuse
- to meet safe yield recharge requirements of the groundwater code

Infiltration and percolation of reclaimed water takes advantage of the natural removal mechanisms within soils, including biodegradation and filtration, thus providing additional in situ treatment of reclaimed water and additional treatment reliability to the overall wastewater management system. The treatment achieved in the subsurface environment may eliminate the need for costly advanced wastewater treatment processes. The ability to implement such treatment systems will depend on the method of recharge, hydrogeological conditions, requirements of the down gradient users, as well as other factors.

Aquifers provide a natural mechanism for storage and subsurface transmission of reclaimed water. Irrigation demands for reclaimed water are often seasonal, requiring large storage facilities or alternative means of disposal when demands are low. In addition, suitable sites for surface storage facilities may not be available, economically feasible, or environmentally acceptable. Groundwater recharge eliminates the need for surface storage facilities and the attendant problems associated with uncovered surface reservoirs, such as evaporative losses, algae blooms resulting in deterioration of water quality, and creation of odors. Aquifer storage and recovery (ASR) systems are being used in a number of states to overcome seasonal imbalances in both potable and reclaimed water projects. The tremendous volumes of storage potentially available in ASR systems means that a greater percentage of the resource, be it raw water or reclaimed water, can be captured for beneficial use.

Should injection wells be utilized, it will be important to maintain a lower average effluent turbidity than the regulations require; specifically 0.1 NTU instead of 2.0 NTU for the following reasons:

- At higher turbidities, the injection wells will lose capacity over time.
- Possibility to operate injection wells at the higher Class A+ turbidities with frequent backwashing. However, up to 10 percent of the effluent will be lost to backwashing and backwashing will only work with deeper direct injection wells. Backwashing is not an option with shallower vadose-zone injection wells.
- Lower turbidity (0.1 NTU) will simplify injection well design / operation and maximize both the life of the injection wells as well as the quantity of effluent recharged.

5.0 DESIGN PARAMETERS

Design of a reclaimed water system is similar in many ways to potable water system design. However there are significant differences in the seasonal and daily demand patterns which lead to different peaking factors and storage requirements for a non-potable system.

5.1 SEASONAL FACTORS

Seasonal reuse demand curves were developed in TM 3-1 to determine the monthly demand based on evapotranspiration peaking factors for base year, intermediate years, and buildout. The curves illustrate the seasonal variation in wastewater flows and the potential supply of irrigation water. The following will be determined based on the seasonal curves:

- Sizing of recharge wells – the surplus reclaimed production during winter months
- Sizing of reuse infrastructure – the maximum month demand
- Discharge – wet weather discharge to washes
- Peak Month Supplement – additional supply required to meet peak monthly demand

Wastewater-generation rates in resort areas and communities with large seasonal industries can vary greatly from month to month. In Goodyear, however, seasonal variations in wastewater flows are relatively small due to relatively typical cross-sections of residential, institutional, commercial and industrial sources. Table 7 provides the results obtained from the seasonal curves.

Table 7: Seasonal Tabulations

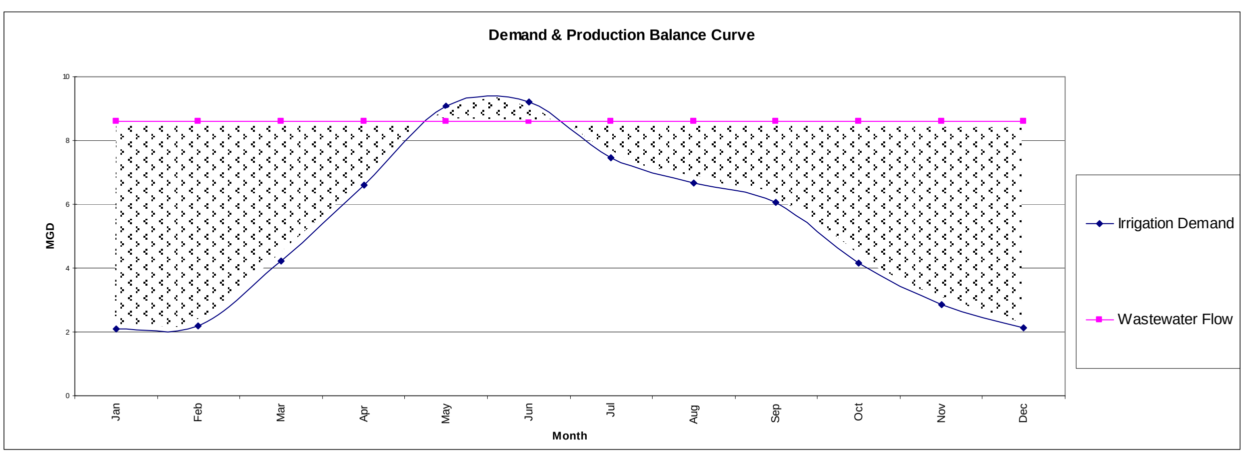
Seasonal Category	2007		2012		2017		2045	
	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)	Volume (af/yr)	Peak Rate (mgd)
Reclaimed Production	3,460	3.1	9,646	8.6	19,208	17.2	45,592	40.7
Max Month Demand	1,731	1.5	10,328	9.2	16,743	14.9	42,769	38.2
Min Month Demand	460	0.4	2,331	2.1	3,837	3.4	9,373	8.4
Recharge Capacity	3,000	2.7	7,315	6.5	15,371	13.7	36,219	32.3
Peak Month Supplement	0	0.0	681	0.6	0	0.0	0	0.0
Wet Weather Discharge	460	0.4	2,331	2.1	3,837	3.4	9,373	8.4

From the tabulation above the following conclusions can be drawn:

- The max month demand exceeds the reclaimed water production in the year 2012. Supplemental water will be required. For base year, 2017, and 2045 no supplemental supply will be required.
- The minimum month demand enables a large amount of recharge during the winter months.
- The wet weather discharge occurs when a large rainfall event occurs over the course of a couple days. The recharge system (wells) will not be sized for this flow which only occurs a couple times a year. This excess flow will be discharged to the washes.

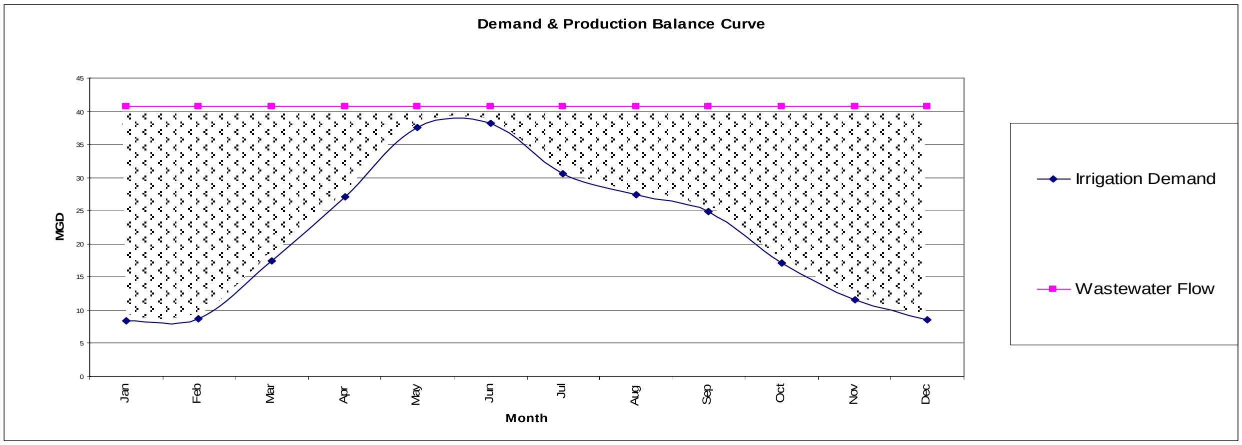
Figure 1 displays the reuse demand and production curve for 2012. During the hottest months of May and June supplemental production will be required of groundwater. Recovery wells will be utilized for this purpose.

Figure 1: Reuse Demand and Production Curve 2012



At buildout the largest irrigation demand occurs and the largest reclaimed water production occurs. Figure 2 displays the reuse demand and production curve at buildout. Supplemental supply is not required as the monthly demands, over the course of the year, never exceed the production. Recharge will occur throughout the entire year and significantly increase during winter months.

Figure 2: Reuse Demand and Production Curve Buildout



From the Reuse Demand and Production curve it can be seen that recharge wells will be required to have a maximum capacity of 32.3 mgd.

5.2 DIURNAL VARIATIONS

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:

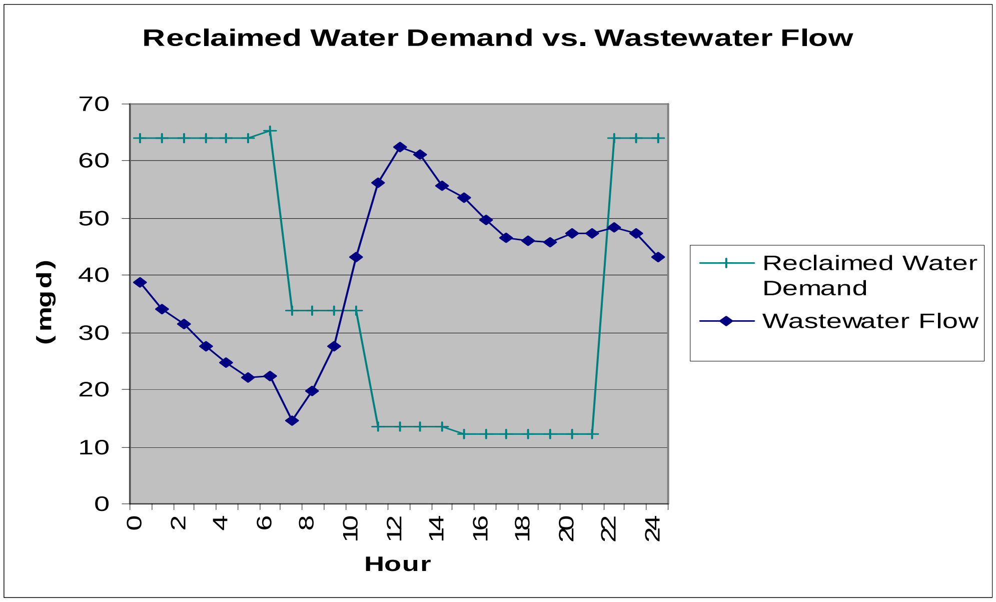
- Operational storage
- Booster pumping rates (peak hour)

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 3.

Figure 3: Buildout Reclaimed Water Diurnal Curve



The following conclusions tabulated in Table 8 provide the operational storage and peak hour pumping rate. From the reclaimed demand curve the maximum pumping rate occurs at 6 am thus determining that booster requirement for the system. As the demand increases the rate at which the water is pumped for distribution will increase from the water reclamation facilities. The operational storage was determined based on rate at which the storage requirement changes. Throughout the morning as reclaimed water demand continues to exceed the wastewater production the amount of water in the system will be drawn down considerably. Around 10 am as the reclaimed water demand decreases and wastewater production increases the system will be able to recover and fill back up the tanks. This rate of change as a comparison of production versus demand produces the operational storage as shown in Table 8. The spreadsheets and additional diurnal curves are included in Appendix B.

Table 8: Diurnal Parameters

Diurnal Parameters	2007	2012	2017	2045
Operational Storage (MG)	1.1	5.0	10.6	24.2
Peak Hour Pumping Rate	2.43	14.8	29.38	65.3

Once the operational storage and peak hour pumping rate are determined, the corresponding parameters can be applied to each basin/plant in the reclaimed system. The breakdown of wastewater production, storage requirement, and peak hour pumping capacity are shown in Table 9.

Table 9: Parameters by Basin

Basin	WW Flow (mgd)	Storage Requirement (MG)	Pumping Capacity (mgd)
157th	13.7	8.3	22.4
Corgett	2.6	1.6	4.2
Rainbow Valley	5.7	3.5	9.3
Waterman Wash	18.0	10.9	29.4
Totals =	40.0	24.2	65.3

The following assumptions were derived from the diurnal parameters:

- For every million gallon capacity of a plant, approximately 0.5 MG is required for storage.
- For every million gallon capacity of a plant, approximately 1.5 MG pumping capacity is required.

5.3 SYSTEM PRESSURE

An effective means of eliminating cross contamination between potable and nonpotable systems is to operate the nonpotable system at a lower pressure than the potable system. In this manner, the lower pressure is a signal to City Utility employees that they are tapping into the non-potable system and if a cross-connection were to occur, potable water would flow to the non-potable system instead of the other direction. The pressure zones for the nonpotable system will mimic the potable water pressure zones, covering 100 feet of elevation within each zone, however the nonpotable system pressures will be 30 psi less than the potable. Figure 4 shows the layout of each zone in the non-potable system and a comparison will show that the layout is spatially the same as for the potable water system. Table 10 shows the HGL and service range for each non-potable zone to be set-up as well as the potable system zone parameters for comparison.

Table 10: Pressure Zone Parameters

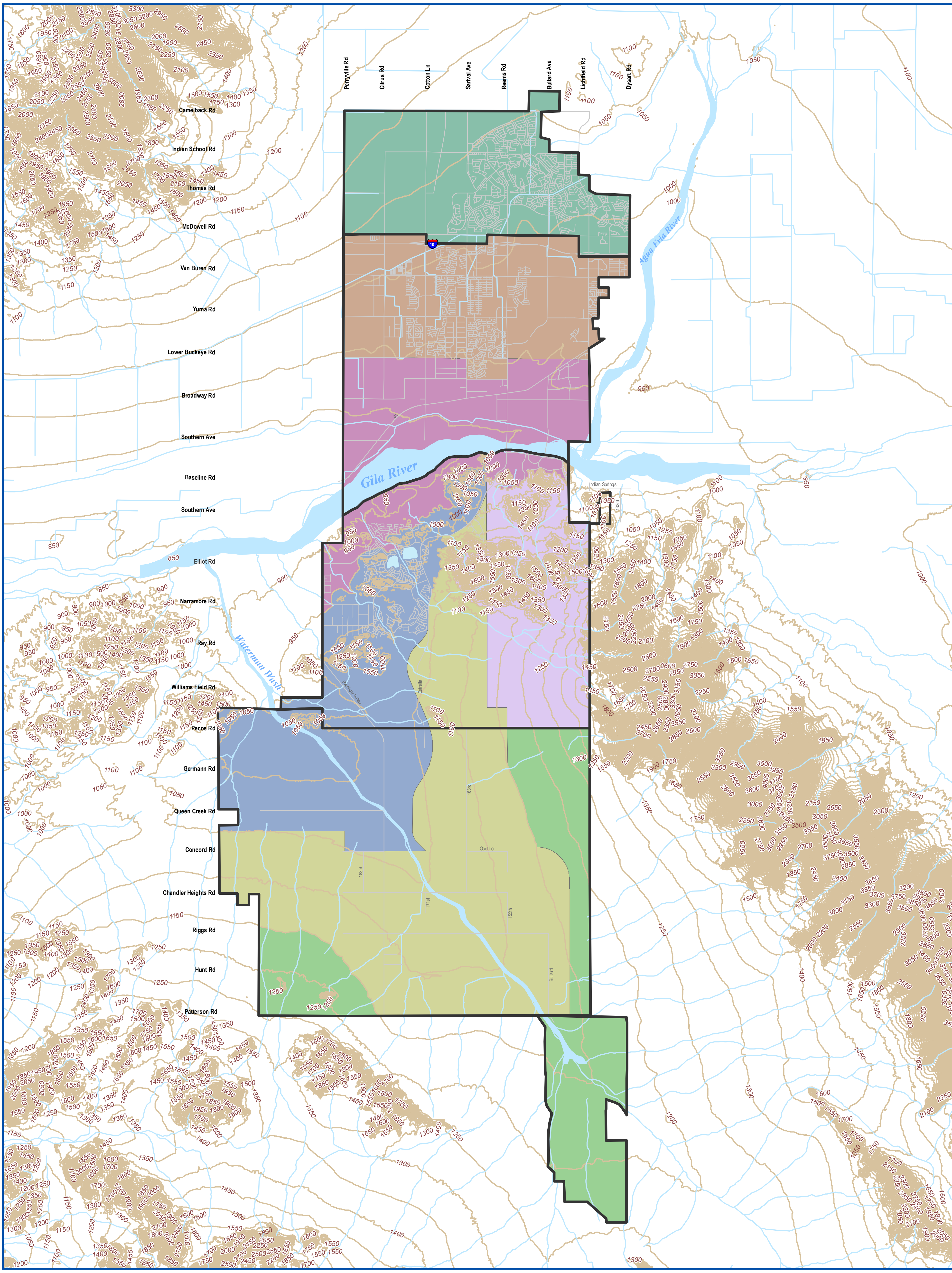
System		Potable		Nonpotable	
Zone	**Service Elevation Range (ft)**	**Static Hydraulic Gradient (ft)**	**Static Pressure Range (psi)**	**Static Hydraulic Gradient (ft)**	**Static Pressure Range (psi)**
Gila Zone (reduced)	890 - 950	1,100	65 - 91	1,040	22 - 65
Zone 1	950 - 1050	1,165	40 - 93	1,100	22 - 65
Zone 2	950 - 1050	1,175	54 - 98	1,100	22 - 65
Zone 3	1050 - 1150	1,265	50 - 93	1,200	22 - 65
Zone 4	1150 - 1250	1,365	50 - 93	1,300	22 - 65

The Water Reclamation Facilities will be the sources of supply. Operational storage reservoirs will be provided at each supply site and the boosters will feed the non-potable water distribution system

5.4 DISTRIBUTION SYSTEM

The design of a reuse distribution system is similar in many regards to a potable water system in that they are both comprised of supply, storage, boosters, distribution pipelines and control valves. The design of this system will be accomplished using computer modeling to connect points of supply to the geographically distributed demands. Development of the non potable system water model and the water production plan will be addressed in detail in the next TM.

Materials of equal quality for construction are recommended for the non-potable system and system integrity should be assured; however the same degree of redundancy is not required because fire flow needs are met by the potable water system. No special measures are needed to pump and deliver the reclaimed water other than equipment and pipelines being clearly marked as non-potable. All pipelines within the distribution system should be AWWA C900 PVC purple pipe which is clearly marked “Non-Potable”. All pumping and PRV stations should also utilize C900 PVC purple pipe or steel / ductile piping which has been painted purple.



N
W E
S

1 inch equals 12,000 feet

Data source:
City of Goodyear GIS

LEGEND

Pressure Zones
- Other
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

Contours (50 foot)

Study Area

FIGURE 4

Nonpotable Pressure Zone Map
Reclaimed Water System
City of Goodyear, AZ
2007

Goodyear

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

\Projects\GoodYear\11GIS\01MapDocuments\NonpotablePZ_Map.mxd

5.5 RECHARGE SYSTEMS

With the exception of the volume needed for daily operations, excess reclaimed water which is generated at the WRFs is best stored through recharge into underground aquifers. The quantities of excess reclaimed water, generated over a winter season or during the entire year, reach into thousands of acre-feet and are too great to be stored in above ground tanks. And, while surface water reservoirs could be viable, their sitting is often problematic and the water stored is subject to evaporation and degradation through algae growth due to the level of nitrogen and phosphorous nutrients found in reclaimed waste water.

Underground storage, through recharge to the aquifers is the common practice throughout Maricopa County and will be the assumed method for storage of excess reclaimed water used in this Master Plan. Within this section of TM3-2 the various methods available for aquifer recharge will be discussed including:

- Infiltration Basins
- Injection Wells

The City currently operates one recharge facility, the Soil Aquifer Treatment Site or SAT Site, which is a 40 acre Infiltration Basins Facility located on the NE corner of Yuma and Reems Rd. The facility is a registered Recharge Facility with ADWR and is rated for recharge of up to 3.0 mgd per day. It currently receives and recharges excess reclaimed water from the 157th Ave WWTP. However, the SAT Site will be closed in the near future and the site will be redeveloped as part of the proposed City Center. The recharge function will have to be relocated to another site or resumed using less land intensive injection wells. Reclaimed water from the Corgett WRF and the Rainbow Valley WRF is discharged into adjacent washes and no recharge credits are currently earned. In order to beneficially use this valuable resource, the non-potable water system will be designed to receive reclaimed water from all of the City's WRFs and convey it either to direct reuse customers or to recharge facilities.

5.5.1 Infiltration Basins

Percolation, through simple spreading basins is the most conservative method of recharge from a water quality perspective because it allows the soil vadose zone, the non-saturated soils above the water table, to provide polishing treatment to the effluent as it migrates downward. It is also requires the largest land area per volume recharged. The land area is a direct function of the percolation rate, measured in feet of water/day that the site soil will yield. Overall, an infiltration basin site is comprised of the following:

Active Infiltration Basins. Consists of basins flooded with reclaimed water, where the total "wet" surface area is determined by the reclaimed water application rate divided by the percolation rate.

Standby Infiltration Basins. In order to maintain their percolation rate, the basins need to be periodically removed from service and dried. The basin surface may then be scarified or cleaned in order to improve infiltration rates. Approximately 1/3 of the total infiltration basins will be in standby.

Buffer Zone and Access. Approximately 50 percent of the calculated infiltration basin area (active and standby) will be utilized for access roadways, berms, fencing and buffer.

Table 11 shows the acreage which would be required to recharge excess reclaimed water at Base Year, Intermediate Years and Buildout with a percolation rate of 0.28 ft/day based on the HSI field testing.

Table 11: Infiltration Bed Calculations

Year	Recharge Flow Rate (mgd)	Recharge Flow Rate (ft^3/day)	Area for Recharge (ft^2)	Active Filtration Basins (acres)	Standby Filtration Basin (acres)	Buffer Zone and Access (acres)	Total Facility (acres)
2007	2.7	360,963	1,289,152	30	15	22	67
2012	6.5	873,164	3,118,443	72	36	54	161
2017	13.7	1,834,721	6,552,576	150	75	113	338
2045	32.3	4,318,182	15,422,078	354	177	266	797

Because the majority of the excess reclaimed water will be recharged into the Waterman Basin, as recommended in Water Resources TM1-3, it would require 797 acres dedicated to recharge sites.

5.5.2 Injection Wells

5.5.2.1 Vadose Zone Wells

Vadose Zone injection wells for groundwater recharge with reclaimed water are designed to promote recharge by introducing water into permeable, unsaturated strata above the water table. Typical vadose zone wells are 6 feet in diameter and 100 to 150 feet deep. They are backfilled with porous material and a riser pipe is used to allow for water to enter at the bottom of the injection well to prevent air entrainment. An advantage of vadose zone injection wells is the significant cost savings as compared to direct injection wells. A significant disadvantage is that they cannot be backwashed and a severely clogged well can be permanently destroyed.

Therefore, reliable pretreatment is considered essential to maintaining the performance of a vadose zone injection well. Because of considerable cost savings associated with vadose zone injection wells as compared to direct injection wells, a life cycle of 5 years for a vadose zone well can still make the vadose zone well the economical choice. Since vadose zone wells allow for percolation of water through vadose zone and flow in the saturated zone, one would expect water quality improvements commonly associated with soil aquifer treatment to be possible.

Table 12 shows the number of wells required to recharge excess reclaimed water at Base Year, Intermediate Years and Buildout based on a well capacity of 1 MG.

Table 12: Vadose Zone Well Calculations

Year	Recharge Flow Rate (mgd)	# of 1 MG Capacity Wells
2007	2.7	3
2012	6.5	7
2017	13.7	14
2045	32.3	33

5.5.2.2 Direct Inject Wells

Injection wells are used to inject water directly into the water-bearing unit of the aquifer. Direct injection is used where groundwater is deep or where hydrogeological conditions are not conducive to surface spreading. Such conditions might include unsuitable soils of low permeability, unfavorable topography for construction of basins, and the desire to recharge confined aquifers, or scarcity of land.

Direct Injection generally requires source water that meets drinking water Maximum Contaminant Levels (MCLs). The absence of vadose zone and/or shallow soil matrix treatment afforded by surface spreading requires the higher quality source water. Treatment processes beyond secondary treatment that are used prior to injection include disinfection, filtration, air stripping, ion exchange, granular activated carbon, and reverse osmosis or other membrane separation processes.

It is important to maintain the recovery wells a great distance from the injections wells to provide long enough travel and residence time in the underground, as well as the missing of the recharged water with the natural ground water.

5.6 RECOMMENDATIONS AND SUMMARY

The following parameters will be applied to the reclaimed water system:

1) All effluent will be treated to A+ effluent standards for all reuse applications.
2) The following permits must be filed for reclaimed water facilities:

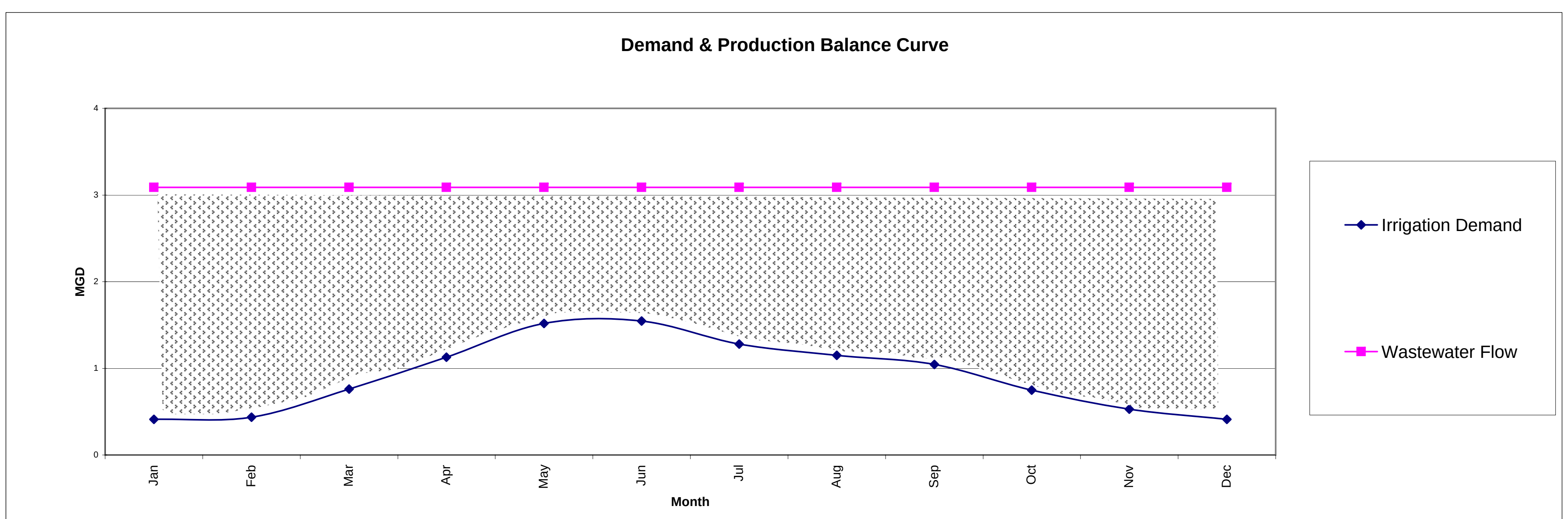
    - National Pollution Discharge Elimination System (NPDES)
    - Aquifer Protection Permit
    - Reclaimed Water Individual or General Permit

3) The static pressure range will be 22-65 psi for the nonpotable system, set approximately 25 psi lower than the potable system.
4) Operational storage of 24.2 million gallons is required at buildout with 65.3 mgd pumping capacity.
5) To recharge the 32.3 mgd of excess reclaimed water via infiltration beds, 797 acres would be required. Due to the large amount of acreage required to recharge, it is recommended that vadose zone wells be used. With a capacity of 1 MG per well, it was determined that 33 wells would be required.

APPENDIX A
REUSE WATER BALANCE SPREADSHEETS

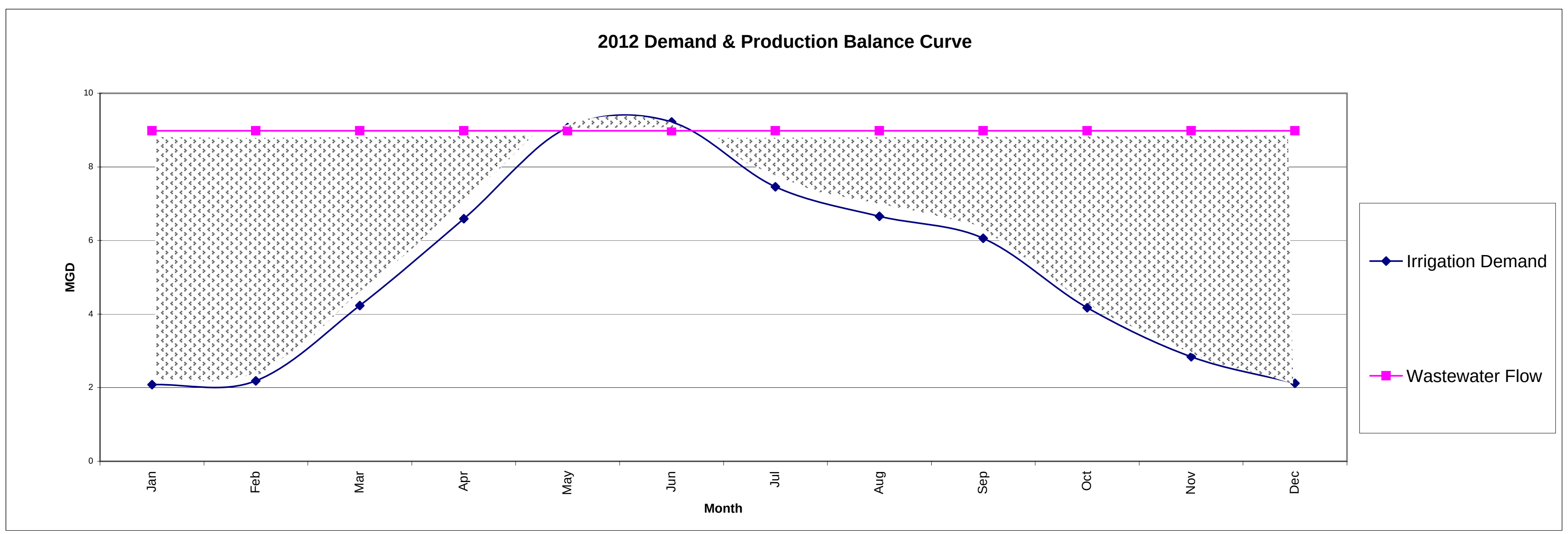
REUSE WATER BALANCE SPREADSHEET
BASE YEAR (2007) MIDLEVEL REUSE

	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	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 3	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	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 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 Demand =	0	0.0	0.38	0.0	0.39	0.0	0.82	0.0	1.26	0.0	1.77	0.0	**1.80**	**0.0**	1.42	0.0	1.27	0.0	1.16	0.0	0.81	0.0	0.54	0.0	0.39	0.0
Golf Courses																										
WPA 2	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 3	382	0.3		0.1		0.1		0.3		0.4		0.6		**0.6**		0.5		0.4		0.4		0.3		0.2		0.1
WPA 4	95	0.1		0.0		0.0		0.1		0.1		0.2		**0.2**		0.1		0.1		0.1		0.1		0.0		0.0
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 Demand =	477	0.4	0.37	0.2	0.39	0.2	0.79	0.3	1.28	0.5	1.77	0.8	**1.80**	**0.8**	1.45	0.6	1.29	0.5	1.17	0.5	0.78	0.3	0.52	0.2	0.38	0.2
Lakes																										
WPA 2	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 3	446	0.4		0.2		0.2		0.3		0.5		0.7		**0.7**		0.6		0.5		0.5		0.3		0.2		0.2
WPA 4	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 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 Demand =	446	0.4	0.41	0.2	0.45	0.2	0.84	0.3	1.24	0.5	1.69	0.7	**1.73**	**0.7**	1.44	0.6	1.28	0.5	1.15	0.5	0.82	0.3	0.55	0.2	0.40	0.2
Construction																										
Total Demand =	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1	100	0.1
TOTAL IRRIGATION DEMAND																										
WPA 2	25	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 3	853	0.8		0.3		0.3		0.6		1.0		1.3		1.3		1.1		1.0		0.9		0.6		0.4		0.3
WPA 4	120	0.1		0.1		0.1		0.1		0.1		0.2		0.2		0.1		0.1		0.1		0.1		0.1		0.1
WPA 5	25	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 Demand =	1,023	0.9		0.4		0.4		0.8		1.1		1.5	1,731	1.5		1.3		1.1		1.0		0.7		0.5		0.4
Wastewater Flow	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1	3,460	3.1
Recharge	2,437	2.2	3,000	2.7	2,973	2.7	2,608	2.3	2,196	2.0	1,761	1.6	1,729	1.5	2,026	1.8	2,173	1.9	2,289	2.0	2,622	2.3	2,866	2.6	3,000	2.7
Additional Resources Required	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



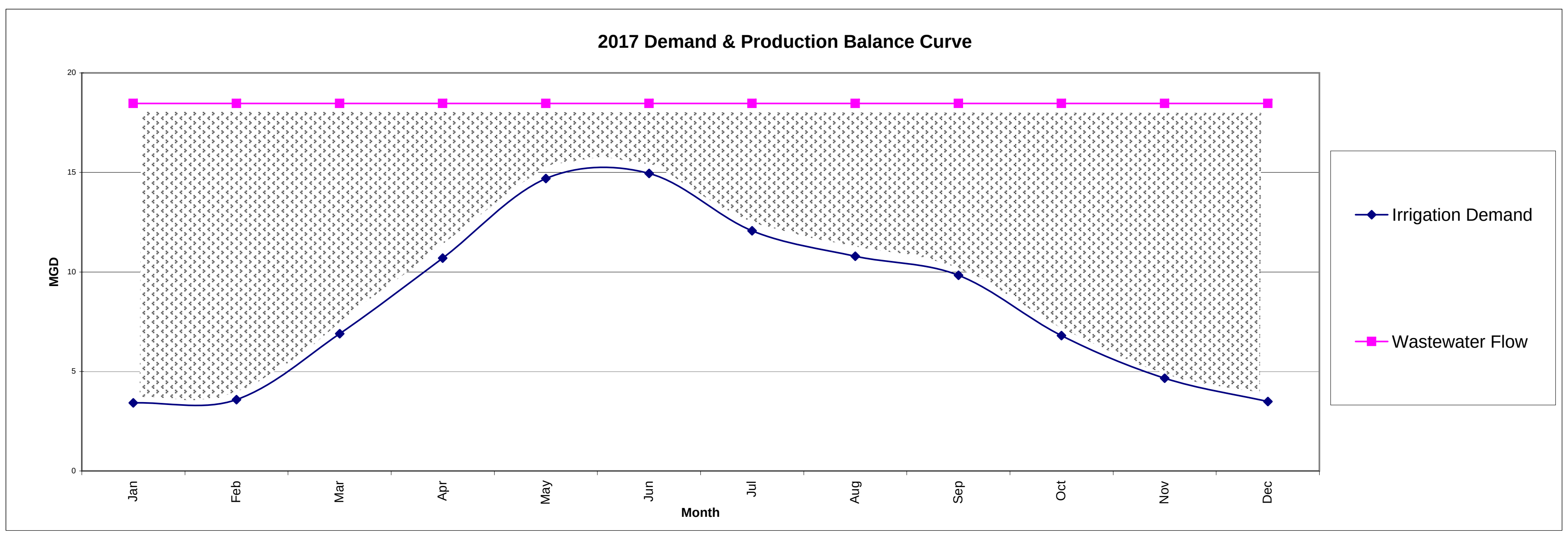
R E U S E   W A T E R   B A L A N C E   S P R E A D S H E E T
I N T E R M E D I A T E   (2 0 1 2)   M I D L E V E L   R E U S E

	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 Total Demand =	1,284	1.1	0.38	0.4	0.39	0.4	0.82	0.9	1.26	1.4	1.77	2.0	**1.80**	**2.1**	1.42	1.6	1.27	1.5	1.16	1.3	0.81	0.9	0.54	0.6	0.39	0.4
Golf Courses Total Demand =	3,740	3.3	0.37	1.2	0.39	1.3	0.79	2.6	1.28	4.3	1.77	5.9	**1.80**	**6.0**	1.45	4.8	1.29	4.3	1.17	3.9	0.78	2.6	0.52	1.7	0.38	1.3
Lakes Total Demand =	625	0.6	0.41	0.2	0.45	0.3	0.84	0.5	1.24	0.7	1.69	0.9	**1.73**	**1.0**	1.44	0.8	1.28	0.7	1.15	0.6	0.82	0.5	0.55	0.3	0.40	0.2
Construction Total Demand =	203	0.2	203	0.2	203	0.2	203	0.2	203	0.2	203	0.2	**203**	**0.2**	203	0.2	203	0.2	203	0.2	203	0.2	203	0.2	203	0.2
TOTAL IRRIGATION DEMAND Total Demand =	5,852	5.2		2.1		2.2		4.2		6.6		9.1	10,328	9.2		7.5		6.7		6.1		4.2		2.8		2.1
Wastewater Flow	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0	10,058	9.0
Recharge	4,238	3.8	7,726	6.9	7,614	6.8	5,322	4.8	2,674	2.4	0	0.0	0	0.0	1,708	1.5	2,599	2.3	3,270	2.9	5,384	4.8	6,872	6.1	7,682	6.9
Additional Resources Required	30.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.5	0.1	270.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



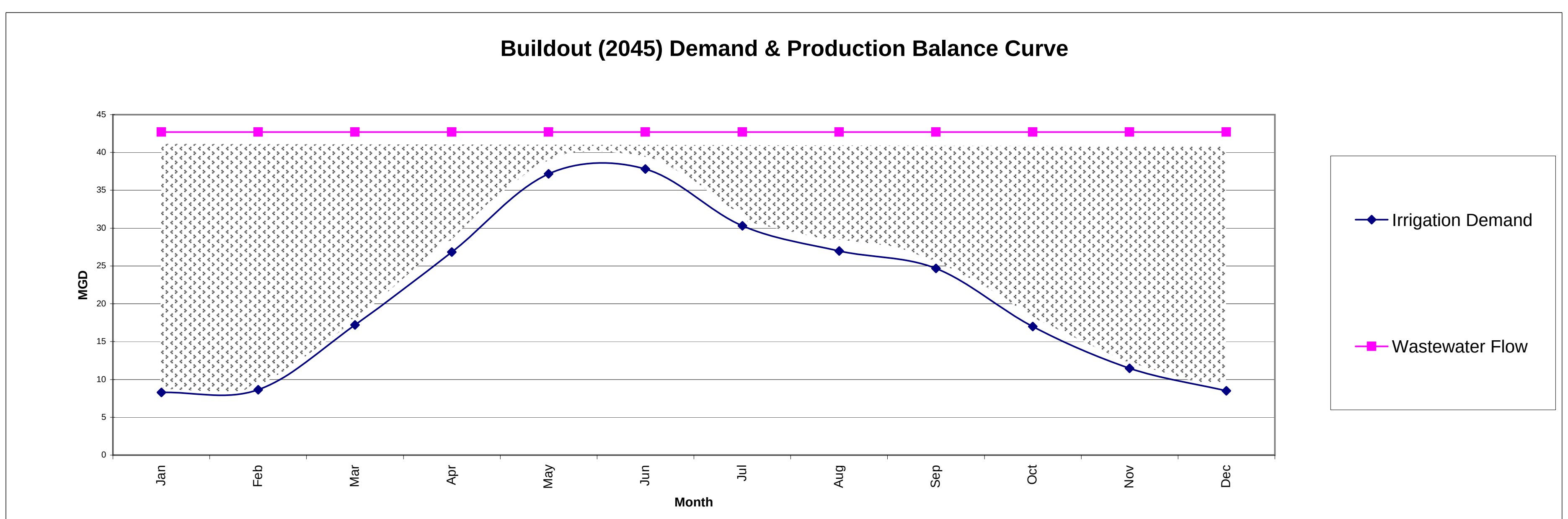
R E U S E   W A T E R   B A L A N C E   S P R E A D S H E E T
I N T E R M E D I A T E   (2 0 1 7)   M I D L E V E L   R E U S E

	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 Total Demand =	2,775	2.5	0.38	0.9	0.39	1.0	0.82	2.0	1.26	3.1	1.77	4.4	**1.80**	**4.5**	1.42	3.5	1.27	3.1	1.16	2.9	0.81	2.0	0.54	1.3	0.39	1.0
Golf Courses Total Demand =	5,610	5.0	0.37	1.9	0.39	2.0	0.79	4.0	1.28	6.4	1.77	8.9	**1.80**	**9.0**	1.45	7.3	1.29	6.5	1.17	5.9	0.78	3.9	0.52	2.6	0.38	1.9
Lakes Total Demand =	714	0.6	0.41	0.3	0.45	0.3	0.84	0.5	1.24	0.8	1.69	1.1	**1.73**	**1.1**	1.44	0.9	1.28	0.8	1.15	0.7	0.82	0.5	0.55	0.4	0.40	0.3
Construction Total Demand =	414	0.4	414	0.4	414	0.4	414	0.4	414	0.4	414	0.4	**414**	**0.4**	414	0.4	414	0.4	414	0.4	414	0.4	414	0.4	414	0.4
TOTAL IRRIGATION DEMAND Total Demand =	9,514	8.5		3.4		3.6		6.9		10.7		14.7	**16,743**	**14.9**		12.1		10.8		9.8		6.8		4.7		3.5
Wastewater Flow	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5	20,675	18.5
Recharge	11,164	10.0	16,838	15.0	16,669	14.9	12,954	11.6	8,698	7.8	4,213	3.8	3,932	3.5	7,158	6.4	8,586	7.7	9,657	8.6	13,052	11.7	15,452	13.8	16,761	15.0
Additional Resources Required	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



R E U S E W A T E R B A L A N C E S P R E A D S H E E T
B U I L D O U T (2 0 4 5) M I D L E V E L R E U S E

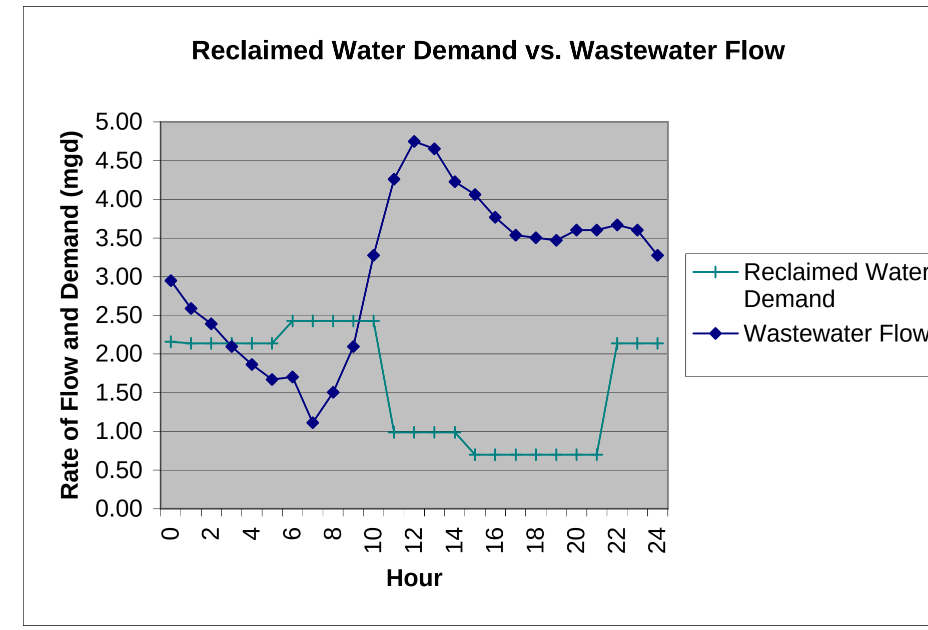
	Annual Average		January		February		March		April		May		**June (Max Month)**		July		August		September		October		November		December	
	af/yr	mgd	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	Peaking Factor	Flowrate (mgd)	**Peaking 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	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7	47,824	42.7
Recharge	24,036	21.5	38,540	34.4	38,158	34.1	28,553	25.5	17,752	15.9	6,185	5.5	5,477	4.9	13,870	12.4	17,624	15.7	20,190	18.0	28,795	25.7	34,957	31.2	38,327	34.2
Additional Resources Required	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



APPENDIX B
DIURNAL CURVES

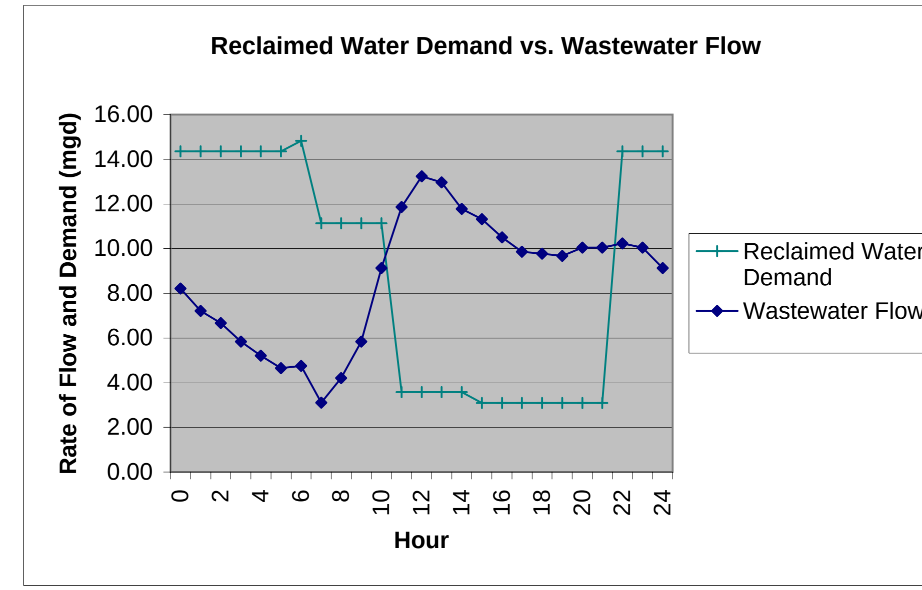
BASE YEAR 2007 DIURNAL CURVE						
Reclaimed Water Demand						Wastewater Flow (mgd)
Parks/Schools/ ROW (mgd)	Golf Courses (mgd)	Lakes (mgd)	Construction (mgd)	Recharge (mgd)	Total (mgd)	
0	0.8	0.7	0.1	1.5	3.1	3.1

Time	Reclaimed Water Demand						Wastewater Production			Incoming Reclaimed Water (MG)	Outgoing Reclaimed Water (MG)	Change in Storage	Running Balance
	Parks/Schools/ ROW (MG)	Golf Courses (MG)	Lakes (MG)	Construction (MG)	Total (MG)	Flow Rate (mgd)	WW Flow (MG)	Coefficient	Flow (mgd)				
0	0.00	0.06	0.03	0.00	0.09	2.16	2.25	0.95	2.95	0.12	0.15	-0.03	-0.03
1	0.00	0.06	0.03	0.00	0.09	2.14	1.98	0.84	2.59	0.10	0.15	-0.05	-0.08
2	0.00	0.06	0.03	0.00	0.09	2.14	1.83	0.77	2.39	0.10	0.15	-0.05	-0.13
3	0.00	0.06	0.03	0.00	0.09	2.14	1.60	0.68	2.10	0.08	0.15	-0.07	-0.20
4	0.00	0.06	0.03	0.00	0.09	2.14	1.43	0.60	1.87	0.07	0.15	-0.07	-0.27
5	0.00	0.06	0.03	0.00	0.09	2.14	1.28	0.54	1.67	0.07	0.15	-0.08	-0.35
6	0.00	0.06	0.03	0.01	0.10	2.43	1.30	0.55	1.70	0.07	0.16	-0.09	-0.45
7	0.00	0.06	0.03	0.01	0.10	2.43	0.85	0.36	1.11	0.04	0.16	-0.12	-0.56
8	0.00	0.06	0.03	0.01	0.10	2.43	1.15	0.49	1.51	0.06	0.16	-0.10	-0.66
9	0.00	0.06	0.03	0.01	0.10	2.43	1.60	0.68	2.10	0.08	0.16	-0.08	-0.74
10	0.00	0.06	0.03	0.01	0.10	2.43	2.50	1.06	3.28	0.13	0.16	-0.03	-0.77
11	0.00	0.00	0.03	0.01	0.04	0.99	3.25	1.38	4.26	0.17	0.10	0.07	-0.70
12	0.00	0.00	0.03	0.01	0.04	0.99	3.63	1.54	4.75	0.19	0.10	0.09	-0.61
13	0.00	0.00	0.03	0.01	0.04	0.99	3.55	1.51	4.65	0.19	0.10	0.08	-0.53
14	0.00	0.00	0.03	0.01	0.04	0.99	3.23	1.37	4.23	0.17	0.10	0.07	-0.46
15	0.00	0.00	0.03	0.00	0.03	0.70	3.10	1.31	4.06	0.16	0.09	0.07	-0.39
16	0.00	0.00	0.03	0.00	0.03	0.70	2.88	1.22	3.77	0.15	0.09	0.06	-0.33
17	0.00	0.00	0.03	0.00	0.03	0.70	2.70	1.15	3.54	0.14	0.09	0.05	-0.27
18	0.00	0.00	0.03	0.00	0.03	0.70	2.68	1.13	3.50	0.14	0.09	0.05	-0.22
19	0.00	0.00	0.03	0.00	0.03	0.70	2.65	1.12	3.47	0.14	0.09	0.05	-0.17
20	0.00	0.00	0.03	0.00	0.03	0.70	2.75	1.17	3.60	0.14	0.09	0.05	-0.12
21	0.00	0.00	0.03	0.00	0.03	0.70	2.75	1.17	3.60	0.14	0.09	0.05	-0.06
22	0.00	0.06	0.03	0.00	0.09	2.14	2.80	1.19	3.67	0.15	0.15	0.00	-0.07
23	0.00	0.06	0.03	0.00	0.09	2.14	2.75	1.17	3.60	0.14	0.15	-0.01	-0.07
24	0.00	0.06	0.03	0.00	0.09	2.14	2.50	1.06	3.28	0.13	0.15	-0.02	-0.09
Total	0.0	0.8	0.7	0.1	1.68	40.27	2.36		3.1	3.1	3.2		



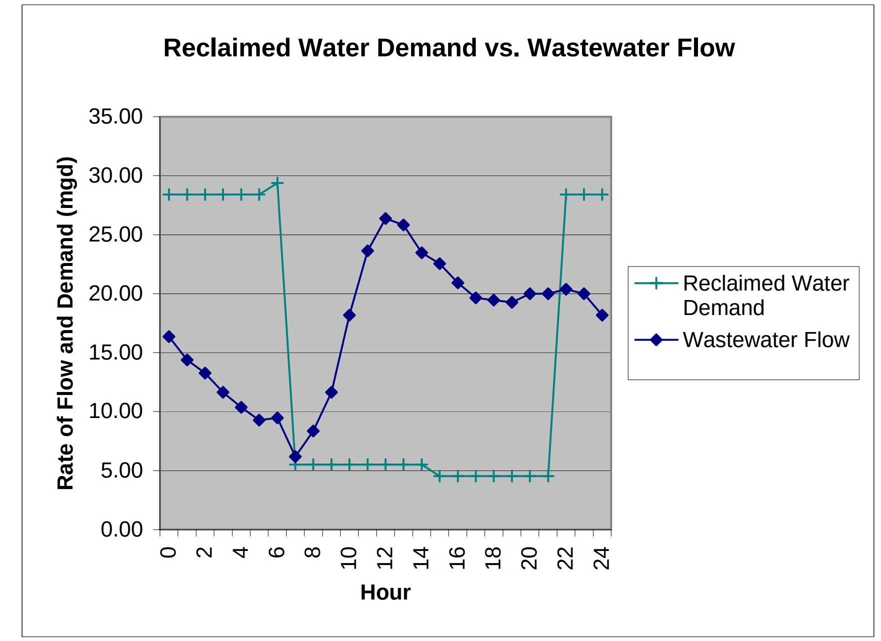
2012 DIURNAL CURVE						
Reclaimed Water Demand						Wastewater Flow (mgd)
Parks/Schools/ROW (mgd)	Golf Courses (mgd)	Lakes (mgd)	Construction (mgd)	Recharge (mgd)	Total (mgd)	
2.1	6	1	0.2	-0.6	8.7	8.61

Time	Reclaimed Water Demand						Wastewater Production						
	Parks/Schools/ ROW (MG)	Golf Courses (MG)	Lakes (MG)	Construction (MG)	Total (MG)	Flow Rate (mgd)	WW Flow (MG)	Coefficient	Flow (mgd)	Incoming Reclaimed Water (MG)	Outgoing Reclaimed Water (MG)	Change in Storage	Running Balance
0	0.18	0.38	0.04	0.00	0.60	14.35	2.25	0.95	8.22	0.33	0.60	-0.27	-0.27
1	0.18	0.38	0.04	0.00	0.60	14.35	1.98	0.84	7.21	0.29	0.60	-0.31	-0.58
2	0.18	0.38	0.04	0.00	0.60	14.35	1.83	0.77	6.67	0.27	0.60	-0.33	-0.91
3	0.18	0.38	0.04	0.00	0.60	14.35	1.60	0.68	5.84	0.23	0.60	-0.36	-1.27
4	0.18	0.38	0.04	0.00	0.60	14.35	1.43	0.60	5.20	0.21	0.60	-0.39	-1.66
5	0.18	0.38	0.04	0.00	0.60	14.35	1.28	0.54	4.66	0.19	0.60	-0.41	-2.08
6	0.18	0.38	0.04	0.02	0.62	14.83	1.30	0.55	4.75	0.19	0.62	-0.43	-2.50
7	0.02	0.38	0.04	0.02	0.46	11.14	0.85	0.36	3.10	0.12	0.46	-0.34	-2.84
8	0.02	0.38	0.04	0.02	0.46	11.14	1.15	0.49	4.20	0.17	0.46	-0.30	-3.14
9	0.02	0.38	0.04	0.02	0.46	11.14	1.60	0.68	5.84	0.23	0.46	-0.23	-3.37
10	0.02	0.38	0.04	0.02	0.46	11.14	2.50	1.06	9.13	0.37	0.46	-0.10	-3.47
11	0.02	0.07	0.04	0.02	0.15	3.58	3.25	1.38	11.87	0.47	0.15	0.33	-3.14
12	0.02	0.07	0.04	0.02	0.15	3.58	3.63	1.54	13.24	0.53	0.15	0.38	-2.76
13	0.02	0.07	0.04	0.02	0.15	3.58	3.55	1.51	12.97	0.52	0.15	0.37	-2.39
14	0.02	0.07	0.04	0.02	0.15	3.58	3.23	1.37	11.78	0.47	0.15	0.32	-2.07
15	0.02	0.07	0.04	0.00	0.13	3.10	3.10	1.31	11.32	0.45	0.13	0.32	-1.75
16	0.02	0.07	0.04	0.00	0.13	3.10	2.88	1.22	10.50	0.42	0.13	0.29	-1.46
17	0.02	0.07	0.04	0.00	0.13	3.10	2.70	1.15	9.86	0.39	0.13	0.27	-1.19
18	0.02	0.07	0.04	0.00	0.13	3.10	2.68	1.13	9.77	0.39	0.13	0.26	-0.93
19	0.02	0.07	0.04	0.00	0.13	3.10	2.65	1.12	9.68	0.39	0.13	0.26	-0.67
20	0.02	0.07	0.04	0.00	0.13	3.10	2.75	1.17	10.04	0.40	0.13	0.27	-0.40
21	0.02	0.07	0.04	0.00	0.13	3.10	2.75	1.17	10.04	0.40	0.13	0.27	-0.12
22	0.18	0.38	0.04	0.00	0.60	14.35	2.80	1.19	10.23	0.41	0.60	-0.19	-0.31
23	0.18	0.38	0.04	0.00	0.60	14.35	2.75	1.17	10.04	0.40	0.60	-0.20	-0.51
24	0.18	0.38	0.04	0.00	0.60	14.35	2.50	1.06	9.13	0.37	0.60	-0.23	-0.74
Total	2.1	6.0	1.0	0.2	9.4	224.52	2.36		8.6	8.6	9.36		



2017 DIURNAL CURVE						
Reclaimed Water Demand						Wastewater Flow (mgd)
Parks/Schools/ ROW (mgd)	Golf Courses (mgd)	Lakes (mgd)	Construction (mgd)	Recharge (mgd)	Total (mgd)	
4.5	9	1.1	0.4	2.2	17.15	17.15

Time	Reclaimed Water Demand						Wastewater Production			Incoming Reclaimed Water (MG)	Outgoing Reclaimed Water (MG)	Change in Storage	Running Balance
	Parks/Schools/ ROW (MG)	Golf Courses (MG)	Lakes (MG)	Construction (MG)	Total (MG)	Flow Rate (mgd)	WW Flow (MG)	Coefficient	Flow (mgd)				
0	0.38	0.76	0.04	0.00	1.18	28.42	2.25	0.95	16.37	0.65	1.27	-0.62	-0.62
1	0.38	0.76	0.04	0.00	1.18	28.42	1.98	0.84	14.37	0.57	1.27	-0.70	-1.31
2	0.38	0.76	0.04	0.00	1.18	28.42	1.83	0.77	13.28	0.53	1.27	-0.74	-2.05
3	0.38	0.76	0.04	0.00	1.18	28.42	1.60	0.68	11.64	0.47	1.27	-0.80	-2.85
4	0.38	0.76	0.04	0.00	1.18	28.42	1.43	0.60	10.37	0.41	1.27	-0.86	-3.71
5	0.38	0.76	0.04	0.00	1.18	28.42	1.28	0.54	9.27	0.37	1.27	-0.90	-4.61
6	0.38	0.76	0.04	0.04	1.22	29.38	1.30	0.55	9.46	0.38	1.31	-0.93	-5.54
7	0.05	0.10	0.04	0.04	0.23	5.50	0.85	0.36	6.18	0.25	0.32	-0.07	-5.61
8	0.05	0.10	0.04	0.04	0.23	5.50	1.15	0.49	8.37	0.33	0.32	0.02	-5.59
9	0.05	0.10	0.04	0.04	0.23	5.50	1.60	0.68	11.64	0.47	0.32	0.15	-5.44
10	0.05	0.10	0.04	0.04	0.23	5.50	2.50	1.06	18.19	0.73	0.32	0.41	-5.03
11	0.05	0.10	0.04	0.04	0.23	5.50	3.25	1.38	23.64	0.95	0.32	0.63	-4.39
12	0.05	0.10	0.04	0.04	0.23	5.50	3.63	1.54	26.37	1.05	0.32	0.74	-3.65
13	0.05	0.10	0.04	0.04	0.23	5.50	3.55	1.51	25.82	1.03	0.32	0.72	-2.94
14	0.05	0.10	0.04	0.04	0.23	5.50	3.23	1.37	23.46	0.94	0.32	0.62	-2.31
15	0.05	0.10	0.04	0.00	0.19	4.54	3.10	1.31	22.55	0.90	0.28	0.63	-1.69
16	0.05	0.10	0.04	0.00	0.19	4.54	2.88	1.22	20.91	0.84	0.28	0.56	-1.13
17	0.05	0.10	0.04	0.00	0.19	4.54	2.70	1.15	19.64	0.79	0.28	0.51	-0.61
18	0.05	0.10	0.04	0.00	0.19	4.54	2.68	1.13	19.46	0.78	0.28	0.50	-0.11
19	0.05	0.10	0.04	0.00	0.19	4.54	2.65	1.12	19.28	0.77	0.28	0.50	0.38
20	0.05	0.10	0.04	0.00	0.19	4.54	2.75	1.17	20.00	0.80	0.28	0.53	0.91
21	0.05	0.10	0.04	0.00	0.19	4.54	2.75	1.17	20.00	0.80	0.28	0.53	1.44
22	0.38	0.76	0.04	0.00	1.18	28.42	2.80	1.19	20.37	0.81	1.27	-0.46	0.98
23	0.38	0.76	0.04	0.00	1.18	28.42	2.75	1.17	20.00	0.80	1.27	-0.47	0.51
24	0.38	0.76	0.04	0.00	1.18	28.42	2.50	1.06	18.19	0.73	1.27	-0.54	-0.03
Total	4.5	9.1	1.1	0.4	15.04	360.84	2.36		17.15	17.2	17.2		

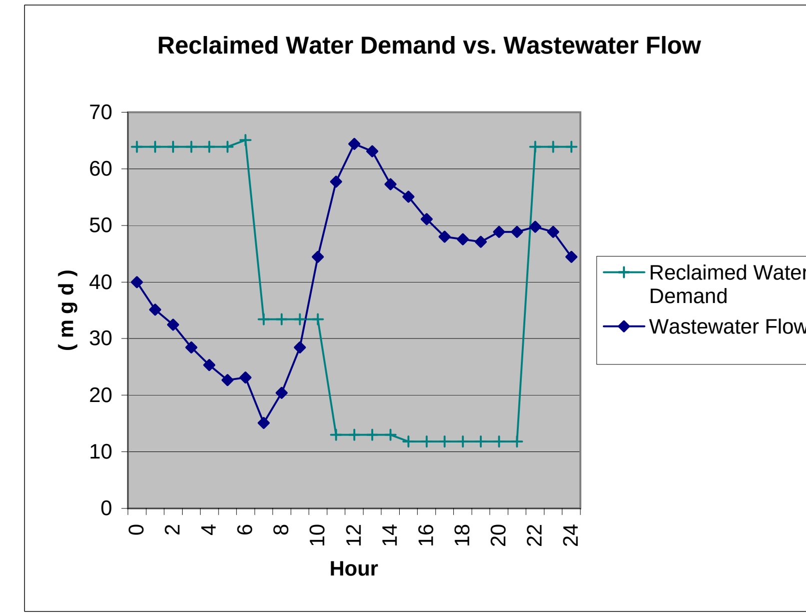


BUILD OUT 2045 DIURNAL CURVE-MAX MONTH						
Reclaimed Water Demand						Wastewater Flow (mgd)
Parks/Schools/ ROW (mgd)	Golf Courses (mgd)	Lakes (mgd)	Construction (mgd)	Recharge (mgd)	Total (mgd)	
16.5	19.4	1.5	0.5	4	41.9	42.7

Time	Reclaimed Water Demand						Wastewater Production			Incoming Reclaimed Water (MG)	Outgoing Reclaimed Water (MG)	Change in Storage	Running Balance
	Parks/Schools/ ROW* (MG)	Golf Courses** (MG)	Lakes (MG)	Construction (MG)	Total (MG)	Flow Rate (mgd)	WW Flow (MG)	Coefficient	Flow (mgd)				
0	1.45	1.15	0.06	0.00	2.66	63.888	2.25	0.95	39.98	1.60	2.66	-1.06	-1.06
1	1.45	1.15	0.06	0.00	2.66	63.888	1.98	0.84	35.09	1.40	2.66	-1.26	-2.32
2	1.45	1.15	0.06	0.00	2.66	63.888	1.83	0.77	32.43	1.30	2.66	-1.36	-3.69
3	1.45	1.15	0.06	0.00	2.66	63.888	1.60	0.68	28.43	1.14	2.66	-1.52	-5.21
4	1.45	1.15	0.06	0.00	2.66	63.888	1.43	0.60	25.32	1.01	2.66	-1.65	-6.86
5	1.45	1.15	0.06	0.00	2.66	63.888	1.28	0.54	22.66	0.91	2.66	-1.76	-8.62
6	1.45	1.15	0.06	0.05	2.71	65.088	1.30	0.55	23.10	0.92	2.71	-1.79	-10.40
7	0.13	1.15	0.06	0.05	1.39	33.408	0.85	0.36	15.10	0.60	1.39	-0.79	-11.19
8	0.13	1.15	0.06	0.05	1.39	33.408	1.15	0.49	20.43	0.82	1.39	-0.57	-11.77
9	0.13	1.15	0.06	0.05	1.39	33.408	1.60	0.68	28.43	1.14	1.39	-0.25	-12.02
10	0.13	1.15	0.06	0.05	1.39	33.408	2.50	1.06	44.42	1.78	1.39	0.38	-11.64
11	0.13	0.30	0.06	0.05	0.54	13.008	3.25	1.38	57.75	2.31	0.54	1.77	-9.87
12	0.13	0.30	0.06	0.05	0.54	13.008	3.63	1.54	64.41	2.58	0.54	2.03	-7.83
13	0.13	0.30	0.06	0.05	0.54	13.008	3.55	1.51	63.08	2.52	0.54	1.98	-5.85
14	0.13	0.30	0.06	0.05	0.54	13.008	3.23	1.37	57.31	2.29	0.54	1.75	-4.10
15	0.13	0.30	0.06	0.00	0.49	11.808	3.10	1.31	55.08	2.20	0.49	1.71	-2.39
16	0.13	0.30	0.06	0.00	0.49	11.808	2.88	1.22	51.09	2.04	0.49	1.55	-0.84
17	0.13	0.30	0.06	0.00	0.49	11.808	2.70	1.15	47.98	1.92	0.49	1.43	0.59
18	0.13	0.30	0.06	0.00	0.49	11.808	2.68	1.13	47.53	1.90	0.49	1.41	2.00
19	0.13	0.30	0.06	0.00	0.49	11.808	2.65	1.12	47.09	1.88	0.49	1.39	3.39
20	0.13	0.30	0.06	0.00	0.49	11.808	2.75	1.17	48.87	1.95	0.49	1.46	4.85
21	0.13	0.30	0.06	0.00	0.49	11.808	2.75	1.17	48.87	1.95	0.49	1.46	6.31
22	1.45	1.15	0.06	0.00	2.66	63.888	2.80	1.19	49.75	1.99	2.66	-0.67	5.64
23	1.45	1.15	0.06	0.00	2.66	63.888	2.75	1.17	48.87	1.95	2.66	-0.71	4.94
24	1.45	1.15	0.06	0.00	2.66	63.888	2.50	1.06	44.42	1.78	2.66	-0.89	4.05
Total	16.5	19.4	1.50	0.5	37.85	908.4	2.36	Average =	41.9	41.9	37.85		

*80% of school/park/ROW irrigation occurs between the hours of 10 pm to 6 am

**80% of the golf course irrigation occurs between the hours of 10 pm to 10 am



RECLAIMED WATER SYSTEM HYDRAULIC MODEL AND ANALYSIS TECHNICAL MEMORANDUM NO. 3-3

Table of Contents

1.0 INTRODUCTION

1.0 INTRODUCTION

The purpose of this memorandum is to describe the creation of the reclaimed water distribution system model, the hydraulic analyses performed, and present the recommended distribution system improvements as part of the 2007 City of Goodyear Integrated Master Plan.

1.1 MODEL CONSTRUCTION

The reclaimed water hydraulic model was built using the H20MAP Water software. An existing model of the existing limited reclaimed water system had not yet been built. As a guide the potable water system pipe network was utilized to outline the reclaimed water model along major arterials. The model was developed to provide a process in which all reclaimed water could be used for a purpose that would best serve Goodyear. Recharge credits will be earned throughout the entire year with additional credits earned during winter months when irrigation demand decreases. It is anticipated that all irrigation demand can be supplied by the reclaimed water supply and potable water will not be required for irrigation demand.

1.2 HYDRAULIC ANALYSES

Hydraulic analyses were conducted to evaluate the Goodyear reclaimed water distribution system, and to establish an improvement program to reinforce the existing system and allow for expansion in order to meet projected reclaimed water growth in demands through the buildout year (2045).

An extended period simulation (EPS), evaluating the hydraulics of supply and demand over a 24 hour period instead of a single hydraulic timestep (steady state), was completed to size the following system components:

- Distribution network
- Booster pumping
- Reservoirs

2.0 MODEL CONSTRUCTION

The existing reclaimed water or non-potable water facilities within the City of Goodyear are shown on Figure 1 and consist of:

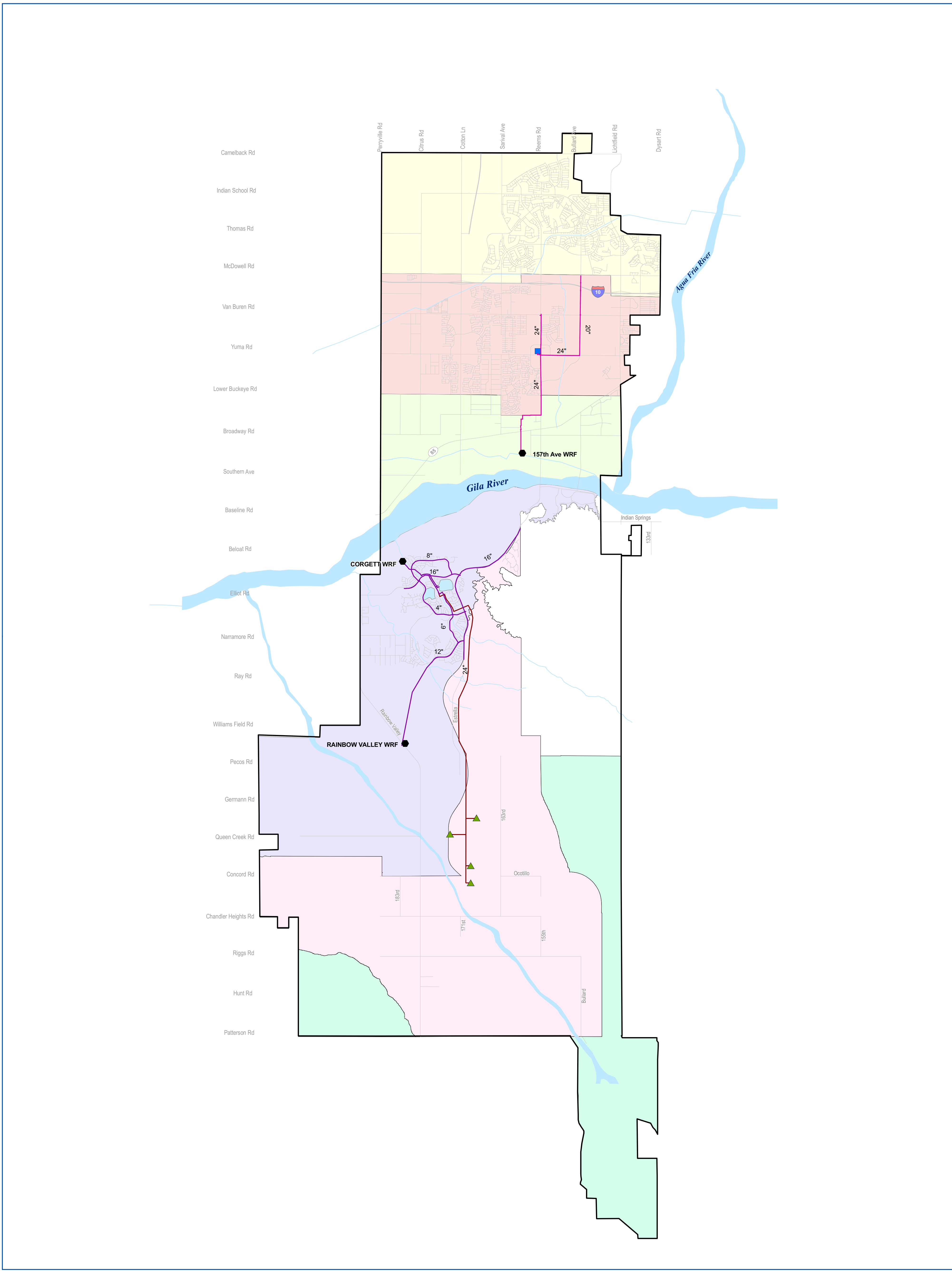
- WPA-2. A single 24-inch line delivers reclaimed water from the 157^{th} Ave WWTP to the Soil Aquifer Treatment (SAT) Site.
- WPA-3. The Estrella Mountain Ranch HOA operates a system which currently delivers groundwater to the lakes, common areas and golf course in the community.

It is envisioned that these two systems will be incorporated into the City's single overall non-potable system. However, due to the limited extent of the current non-potable water system, and the fact that its methods of operation will change significantly, a Base-Year model was not created around the current configuration.

A new reclaimed water distribution system model of the Buildout Non-Potable system was created for Goodyear for this project. The following sections provide an overview of the model construction and demand allocation.

2.1 PRESSURE ZONES

Pressure zones were established for the reclaimed water distribution system throughout the reclaimed water service area, covering the same area in which potable water service is provided. The layout of the reclaimed water pressure zones follows that of the potable water system; however the design HGL or pressure within each reclaimed zone is 25 psi less than in the overlaying potable water zone for safety purposes. With lower pressures in the non-potable system, if a cross-connection were to occur, potable water would flow into the non-potable system, instead of the other way around. Table 1 shows the pressure zones for the potable and non-potable systems. Figure 2 shows the pressure zones for the reclaimed water distribution system.



N
W E
S

Note: Map not printed to scale

1 inch equals 6,000 feet

Data source:
City of Goodyear GIS

LEGEND

- WRF
- Wells
- SAT Site
- Ground Water Pipeline
- Non-Potable System Main
- Study Area
- Gila Zone
- LPSCO
- Zone 1
- Zone 2
- Zone 3
- Zone 4

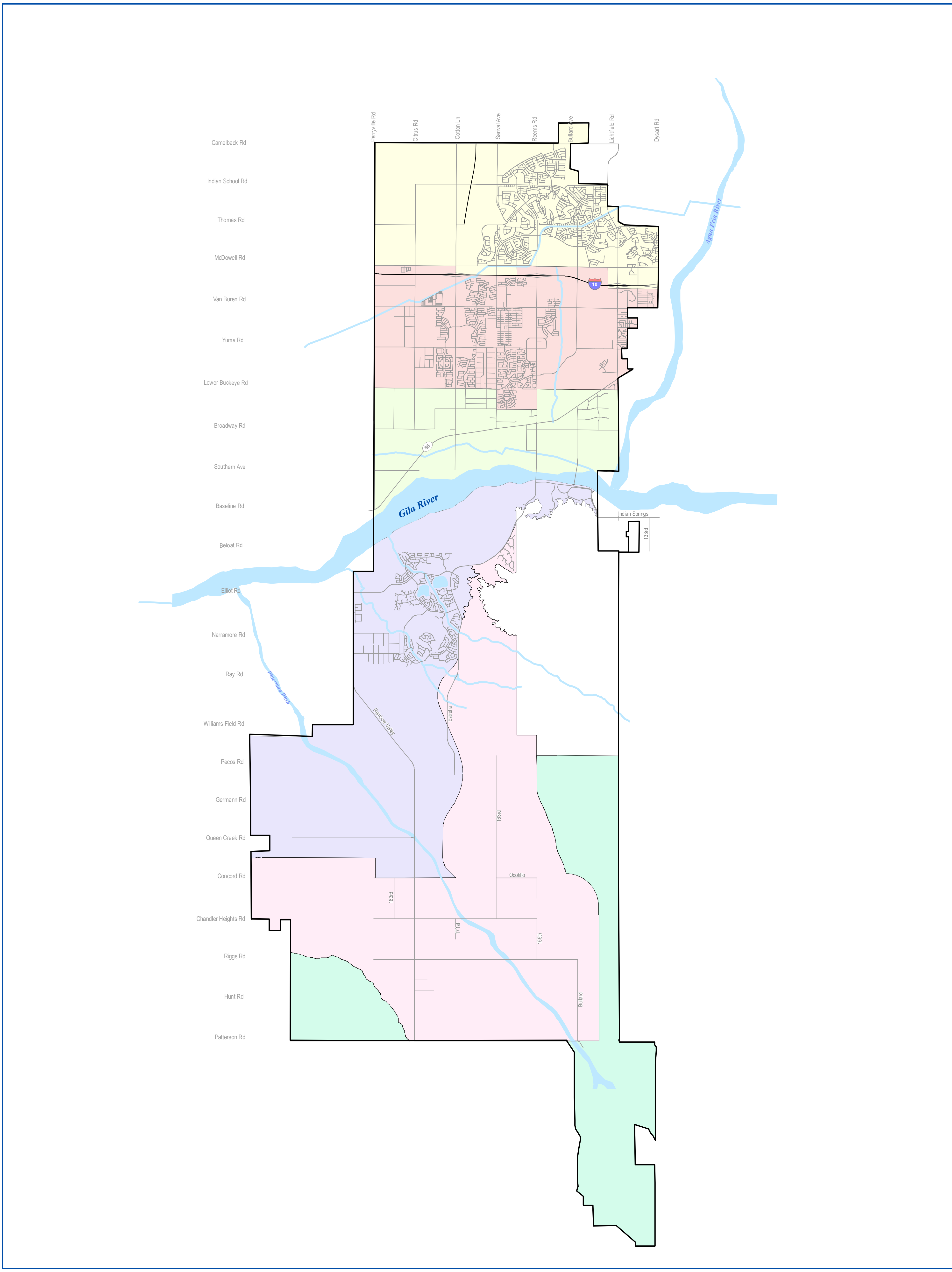
Figure 1
Facility Inventory
Reclaimed Water System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

\\Projects\GoodYear\11GIS\01MapDocuments\ExistingReclaim.mxd Christina Hassell 11/06/2007



N
W E
S

0 1 2
Miles

1 inch equals 12,000 feet

Data source:
City of Goodyear GIS

Legend

Study Area

Reclaim Pressure Zones

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

Figure 2
Reclaim System Pressure Zones

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

Table 1: Pressure Zones

System		Potable		Nonpotable	
Zone	**Service Elevation Range (ft)**	**Static Hydraulic Gradient (ft)**	**Static Pressure Range (psi)**	**Static Hydraulic Gradient (ft)**	**Static Pressure Range (psi)**
Gila Zone (reduced)	890 - 950	1,100	65 - 91	1,050	25 - 68
Zone 1	950 - 1050	1,165	40 - 93	1,110	25 - 68
Zone 2	950 - 1050	1,175	54 - 98	1,110	25 - 68
Zone 3	1050 - 1150	1,265	50 - 93	1,210	25 - 68
Zone 4	1150 - 1250	1,365	50 - 93	1,310	25 - 68

Demands were calculated for each pressure zone utilizing the demand projections developed in TM 3-1 Effluent Management Plan. Pressure zone demands were used to determine the required reclaimed water infrastructure needed for each pressure zone. Demands by pressure zones are shown in Table 2.

Table 2: Demand Projection per Pressure Zone

Zone	Year		
	2012 (MGD)	**2017 (MGD)**	**2045 (Buildout) (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
GR	0.63	1.02	1.45
Total	9.2	15.0	21.3

2.2 BUILD OUT MODEL

2.2.1 Distribution Network

A distribution network 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 this level of definition. While specific reuse applications are not known, the approximate demand by zone has been estimated, see TM 3-1 Effluent Management Plan and it is 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. And, 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.

The model is constructed of pipes 8-inch and larger, with the exception of some existing 4 and 6-inch pipes located in the Estrella Mountain Ranch area. The model includes storage reservoirs, booster pumps, and control valves as required for system operation. Ten-foot contours in GIS format were used to assign elevations to the nodes in the system. Upon completion, the model contained approximately 525 pipes and 475 pressure junctions. A Hazen-Williams C-value of 130 was assigned for each pipe in the model assuming that the pipe material would be PVC.

2.2.2 Buildout Demand Allocation

Reclaimed water demands, for irrigation, lake filling and construction were estimated and the details can be found in TM 3-1 Effluent Management Plan. A summary of projected buildout demands by water planning area (WPA) and pressure zone can be seen in Table 3.

Table 3: 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 max month (summer) or min month (winter) conditions, the following peaking factors were applied to the average day demands which had been allocated to the model.

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

2.2.3 Demand Nodes

Each node in the model was given a value in the DMD_NODE field in H20MAP to designate whether it would have demand allocated to it or not. These values were assigned as shown in Table 4.

Table 4: Demand Nodes

Allocatable	Non-Allocatable
0	1

Nodes that represented connections to the dump and repump facilities, PRV locations, and within the transmission pipeline were assigned a value 1 to indicate that they will not receive demand. The transmission pipeline shown in the model will move water from north to south but will not contain any demands within the pipeline. All other existing nodes were assigned a value of 0 to indicate that they are demand nodes.

2.2.4 Demand Allocation in H20MAP

GIS techniques were used to allocate the projected demands to the model using the Polygon Intersection method. Thiessen polygons were created around the demand nodes and were specified as the primary layer in the Demand Allocation Manager. The demand per zone was then translated to a water-duty (gpad) by dividing zone demand by zone acreage and this water duty shapefile became the secondary layer. A spatial intersection of the two layers determined the portion of each zone's demand that would be allocated to each node. H20MAP has ten fields available for demand classes.

The irrigation demand for Buildout was assigned to the field shown in Table 5. The artificial demands associated with recharge were assigned to the field as shown in Table 5 and will be discussed in further detail in the following sections.

Table 5: Buildout Demand Assignment Fields

Demand	Field
Irrigation	Demand1
Recharge	Demand3

2.2.5 Recharge Allocation

Reclaimed water production, which is in excess of demand is to be recharged, earning recharge credits for the City. The following figures show the seasonal relationship of reclaimed water production to projected demands for the Base-Year, Intermediate and Buildout conditions (See TM 3-2 Reclaimed Water System Parameters for the details). It can be seen that reclaimed water production always exceeds demand and therefore recharge will occur throughout the 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.

Based on knowledge of the hydrogeology of the area and the following constraints and goals, it was assumed that recharge would be accomplished as follows:

1. Recharge can only be accomplished where a suitable aquifer permits. These areas would include the Salt River Basin to the north and Waterman Basin to the south.
2. Recharge in the north would not be conducted in the water-logged areas along the Gila River, but only in Zone 1.
3. 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.
4. California Title-22 parameters are assumed to apply which call for a minimum of 2,000 feet or 12-months travel from a recharge well to a potable water extraction well.
5. 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 6 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:

Figure 3

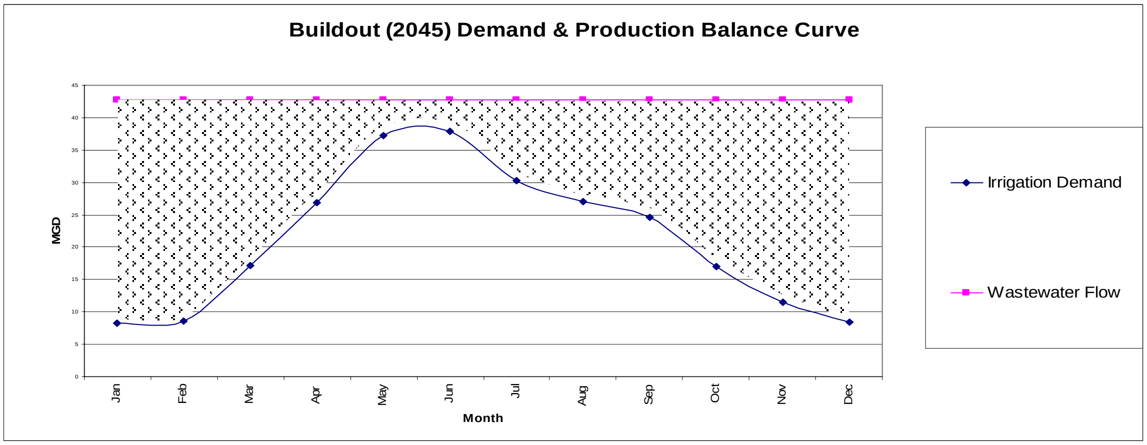


Figure 4

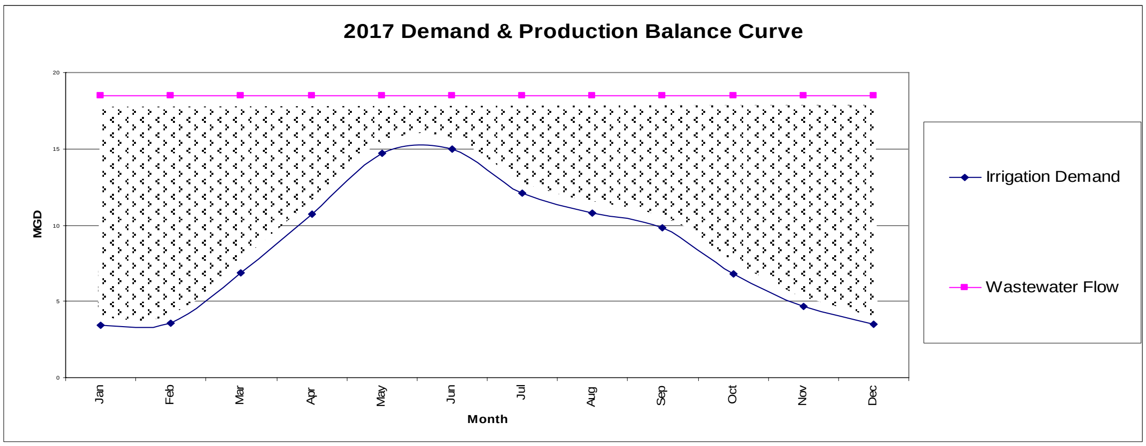
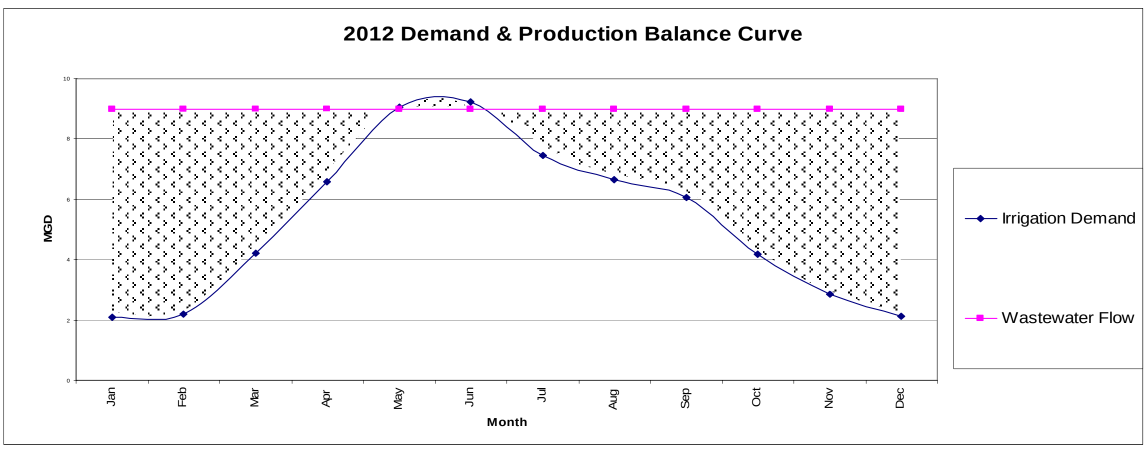
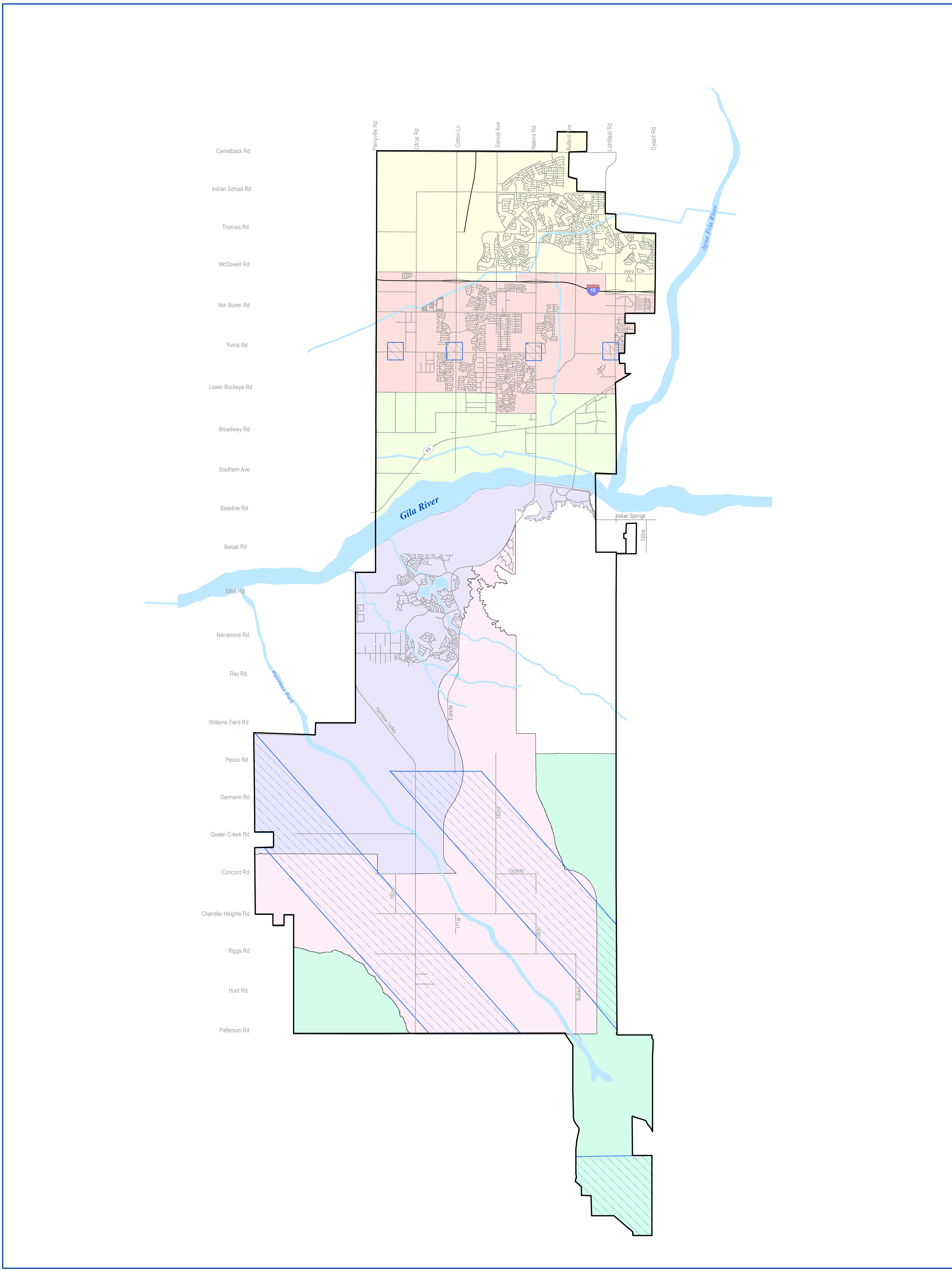


Figure 5





N W E S

0 1 2 Miles

1 inch equals 12,221 feet

Data source:
City of Goodyear GIS

Legend

- Study Area
- Recharge zone

Reclaim Pressure Zones

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

Figure 6
Recharge Locations

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear
BLACK & VEATCH
Building a world of difference.

- Support Reclaimed water recharge operations at the rates and quantities forecast in the Non-Potable Water Master Plan.
- Support raw water extraction (for potable supply) at the rates and quantities forecast in the Potable Water Master Plan.
- 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. These concepts are discussed in more detail in TM 3-2 Reclaimed Water System Parameters.

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 and 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 wherein a single system delivers water for both functions and the total water delivered is relatively constant throughout the 12-months of 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. Figures 3, 4, and 5 show the seasonal variations in recharge and reuse for Base-Year, Intermediate and Build-out conditions. Table 6 shows the summer minimum and winter maximum recharge rates projected for buildout.

Table 6: Buildout Recharge Rates

Seasonal Condition	Recharge Rate
Summer – Minimum Recharge	4.9 mgd
Winter – Maximum Recharge	34.4 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.

Using GIS techniques, the Waterman Basin recharge bands were intersected with the zone boundaries and Table 7 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: Recharge Demand per Pressure Zone

Scenario	Zone			
	2	3	4	Total
Max Month (Summer)	0.89	3.06	0.94	4.90
Min Month (Winter)	6.12	21.6	6.70	34.4

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. Thiessen polygons were created around the recharge nodes (those which fell within the recharge bands) and were specified as the primary layer in the Demand Allocation Manager. Recharge quantities were converted to a water-duty (gpad) by dividing the total recharge by the recharge band acreage and this water duty shapefile became the secondary layer. 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.

2.3 TRANSMISSION SYSTEM

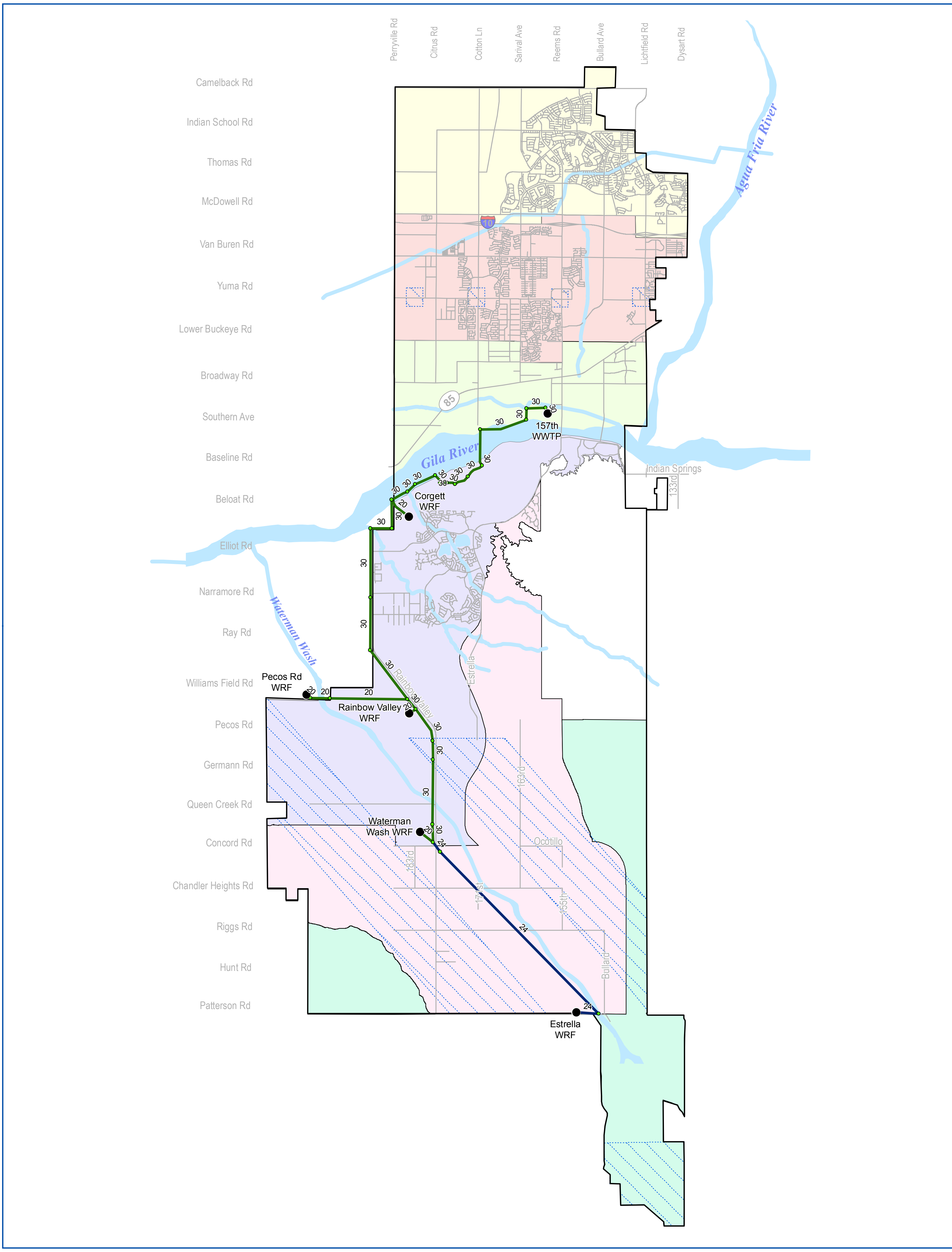
Reclaimed water produced at the City's Water Reclamation Facilities (WRFs) will be stored in reservoirs on-site before pumping into the non-potable distribution system. The amount of pumping will be dependent on the demand served in the distribution system and the amount of storage is dependent on the incoming flow from the collection system. However, projected levels of reclaimed water production do not always match reclaimed water demand at each location and therefore a reclaimed water transmission system is proposed to enable the movement of reclaimed water from points of excess to points of shortage. 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:

- Water to be moved from production facilities to storage reservoirs without energy wasting dump / re-pump operations.
- Distribution system design to be optimized for automatic booster pumping operations and to support stable HGL / Pressure throughout the zone.
- Bulk water transmission, 24-hours of the day, without interfering with distribution system operation or affecting distribution system pressure.

Figure 7 displays the transmission system and provides phasing for the building of the transmission pipeline.

2.4 INTERMEDIATE YEAR MODEL

It is assumed that the non-potable system will be extended as areas are developed. The extent of the Intermediate Year Model covers the same limits of projected development that were defined in the Water Master Plan for the potable water system. Non-potable pipelines should be installed at the size and configuration indicated in the Buildout model at the time of installation, or in the nearest equivalent configuration that fits the actual roadway geometry.



N W E S

0 1 2
Miles

1 inch equals 12,000 feet

Data source:
City of Goodyear GIS

LEGEND

- Junction
- Tank

Transmission Main by Year

- 2017
- 2045
- Road

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

Figure 7
Reclaimed Water Transmission System Pipeline Phasing

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

3.0 HYDRAULIC ANALYSES

3.1 OPERATIONAL SCENARIOS

In order to analyze the full range distribution system stress, two key scenarios were analyzed with the non-potable water system model:

- Summer max month when reuse is at its highest and recharge is at its lowest.
- Winter min month run when reuse is at its lowest and recharge is at its highest.

Table 8 below shows the reuse demands and recharge loads that are associated with each scenario and which were applied in each zone.

Table 8: Scenario Demands per Zone (mgd)

Scenario	Demand	Zone					
		1	2	3	4	Gila River	Total
1) Max Month (Summer)	Reuse	3.08	11.2	13.6	7.4	2.59	37.8
	Recharge	0	0.89	3.06	0.94	0	4.4
	Total =	3.08	12.1	16.7	8.34	2.59	42.7
2) Min Month (Winter)	Reuse	0.66	2.41	3.03	1.62	0.6	8.32
	Recharge	0	6.12	21.6	6.70	0	34.4
	Total =	0.66	8.53	24.6	8.32	0.6	42.7

It can be seen that the total flowrate 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 flowrate is the same, the location to which the 42.7 mgd of reclaimed water is sent and the use to which it is put varies. The total load on Zone 3 increases significantly in the winter months because it carries the majority of the recharge load.

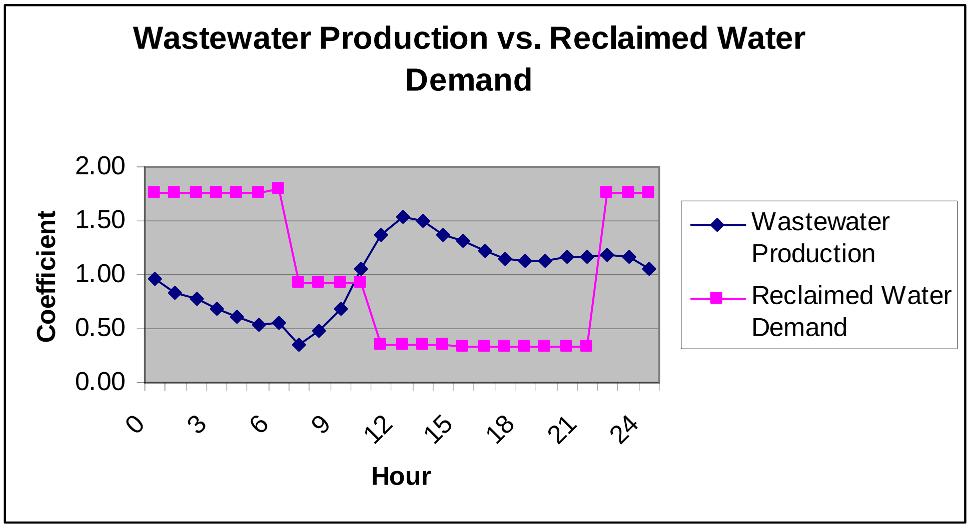
Under the first two scenarios, 100 percent of the recharge was to be accomplished in the Waterman Basin, both in the summer and winter. Under a second winter scenario, 8 mgd will be recharged in Zone 1 during winter leaving 26.4 mgd to be recharged in the Waterman Basin. Table 9 shows the resulting distribution system loading by zone.

Table 9: Scenario Demands per Zone (mgd)

Scenario	Demand	Zone					
		1	2	3	4	Gila River	Total
3) Min Month (Winter)	Reuse	0.66	2.41	3.03	1.62	0.6	8.29
	Recharge	8.0	4.68	16.5	5.18	0.0	34.4
	Total =	8.66	7.09	19.5	6.80	0.6	42.7

The model runs were extended period simulations (EPS) where reuse demand, recharge and reclaimed water production varied throughout the day. The 24-hour patterns (diurnal curves) used in the model are shown in Figure 8. A detailed discussion of the development of these diurnal patterns can be found in TM 3-2 Reclaimed Water System Parameters.

Figure 8



3.2 DISTRIBUTION NETWORK ANALYSIS

EPS hydraulic analyses were used to determine the appropriate diameter of all distribution network pipes. The pipelines were sized based on the following design 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 above 5 ft/sec were to be avoided.
>
> **Minimum Diameter**. The minimum diameter to be used in the skeletonized distribution system was 8-inch. This would ensure that sufficient flow capacity would likely be available at all points in the system to accommodate the point demands of future reuse projects, whose locations are not yet known.

It should be noted that 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 for this is that with the lower operating pressure range set for the non-potable system, there is little margin left for pressure losses before unacceptably low pressure would occur along the upper zone boundary.

Figures 9, 10 and 11 provide the model output for Max Month Summer Scenario, Min Month Winter Scenario, and Zone 1 Recharge Min Month Scenario. The pipes are color coded to indicate velocity and the nodes are color coded for the pressures at peak hour. The following observations can be made with respect to the distribution system's hydraulic performance:

- Acceptable pressure was maintained along the upper zone boundaries, dropping to 20 psi in some locations. 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 will connect 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.
- PRVs No. Z1/GR and Z4/Z3 provided 0 mgd of flow under peak hour conditions. The PRVs are provided to maintain pressure at zone boundaries, if needed during daily operation.
- The Zone 4 East and Zone 4 West Reservoirs operate as dump/repump reservoirs that refill during off-peak hours.
- Scenario 2, winter, with 100 percent recharge in the Waterman Basin, was the controlling hydraulic condition for the sizing of Zone 3 pipelines in the vicinity of the recharge zones.
- Scenario 3, winter, with 8 mgd of recharge in Zone 1, was the controlling hydraulic condition for the sizing of Zone 1 pipelines.

BUILDOUT RECLAIMED WATER MODEL MAX MONTH SCENARIO

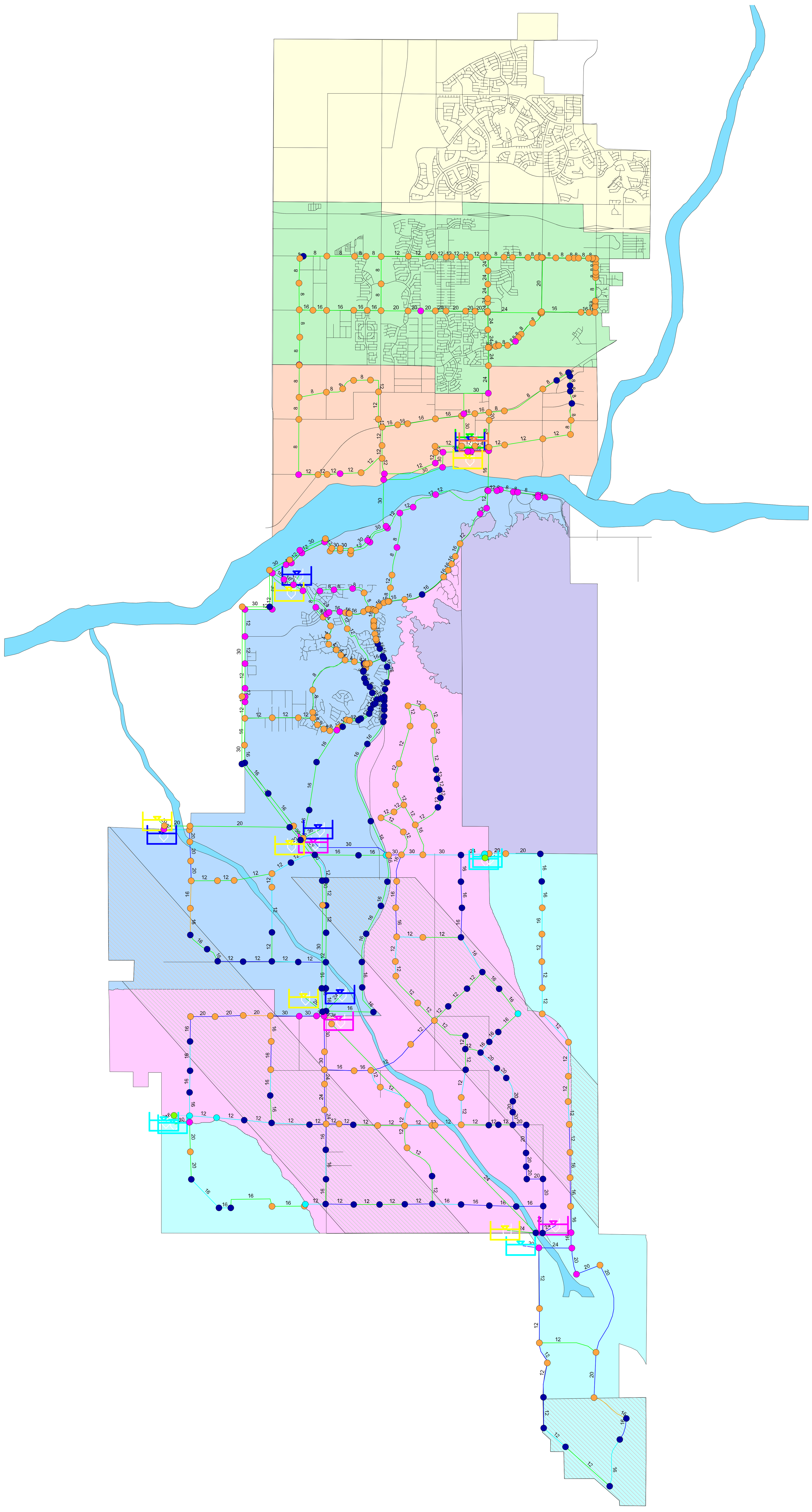
FIGURE 9

Prepared By: Black & Veatch

Date: Tuesday, November 06, 2007

BUILDOUT RECLAIMED WATER MODEL MIN MONTH SCENARIO

FIGURE 10



JUNCTION (VALUE)
- Less than 0
- 0~15
- 15~20
- 20~44
- 44~68
- Greater than 68

TANK (VALUE)
- GILARIVER_RES
- TRANS_RES
- ZONE1_RES
- ZONE2_RES
- ZONE3_RES
- ZONE4_RES
- GILARIVER_RES
- TRANS_RES
- ZONE1_RES
- ZONE2_RES
- ZONE3_RES
- ZONE4_RES

PIPE (VALUE)
- Less than 0
- 0~1
- 1~2
- 2~3
- 3~4
- Greater than 4

VALVE (VALUE)
- GILARIVER_VALVE
- ZONE1_VALVE
- ZONE2_VALVE
- ZONE3_VALVE
- ZONE4_VALVE

PIPE

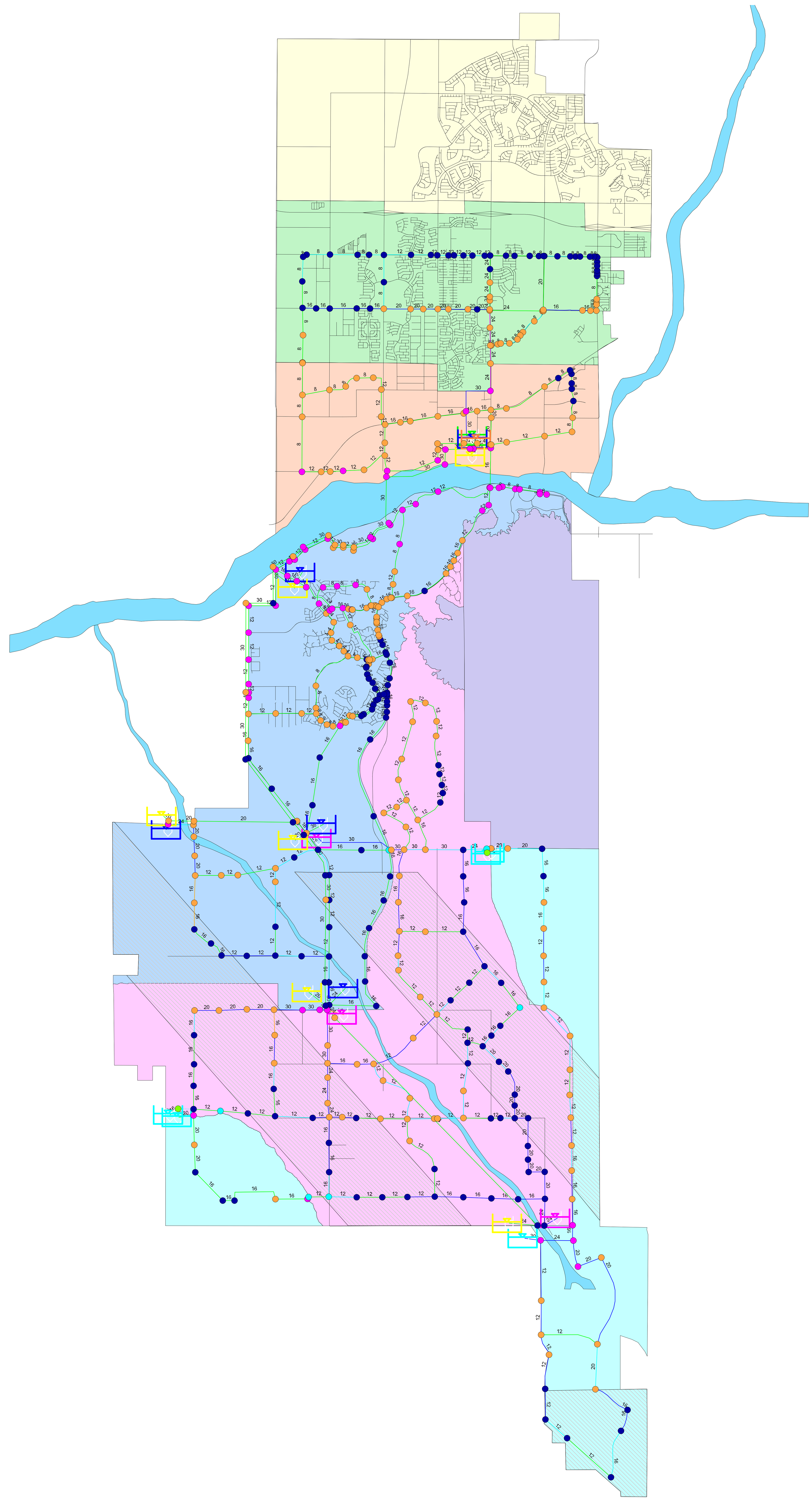
GY_RIVERS

GY_Streets

RechargeZoneONLY_

PressZone_Reclaim_s
- Gila Zone
- LPSCO

BUILDOUT RECLAIMED WATER MODEL ZONE 1 RECHARGE MIN MONTH SCENARIO FIGURE 11



JUNCTION (VALUE)
- Less than 0
- 0~15
- 15~20
- 20~44
- 44~68
- Greater than 68

TANK (VALUE)
- GILARIVER_RES
- TRANS_RES
- ZONE1_RES
- ZONE2_RES
- ZONE3_RES
- ZONE4_RES
- GILARIVER_RES
- TRANS_RES
- ZONE1_RES
- ZONE2_RES
- ZONE3_RES
- ZONE4_RES

PIPE (VALUE)
- Less than 0
- 0~1
- 1~2
- 2~3
- 3~4
- Greater than 4

VALVE (VALUE)
- GILARIVER_VALVE
- ZONE1_VALVE
- ZONE2_VALVE
- ZONE3_VALVE
- ZONE4_VALVE

PIPE

GY_RIVERS

GY_Streets

RechargeZoneONLY_

PressZone_Reclaim_s
- Gila Zone
- LPSCO

Prepared By: Black & Veatch

Date: Tuesday, November 06, 2007

3.3 BOOSTER PUMPING ANALYSIS

EPS hydraulic analyses were used to determine the appropriate capacity of all 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 percent margin of safety should be provided, above the peak hour flowrate recorded in the model, to provide operational flexibility.

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

Variable Speed-Constant Head. Booster pumping stations must be equipped with variable-speed, constant head pumping units which hold the Zone HGL steady at the point of discharge or connection to the distribution system network, while flow varies.

It is anticipated that all booster pumping stations will be designed to run normally in automatic mode, where the pump control parameter is constant discharge head. In this manner, the booster pumping stations located at the WRFs and at the Zone 4 East and West Reservoirs will provide locations of constant or stable head within each zone of the distribution system. Table 10 shows the flowrate supplied to meet 2045 peak hour demands, as determined from the three EPS scenarios analyzed.

Table 10: Peak Hour Flowrate at Buildout (mgd)

Booster Pumping Station Location	Zone (MGD)					
	1	2	3	4	GR	Total
157th Ave WWTP	5.6	1.9			4.7	12.2
Corgett WRF		4.6				4.6
Rainbow Valley WRF		7.2	11.9			19.1
Pecos Road WRF		4.5				4.5
Waterman Wash WRF		2.6	15.9			18.6
Estrella WRF			6.7	7.9		14.6
Zone 4 East Reservoir				3.5		3.5
Zone 4 West Reservoir				2.9		2.9
Total =	5.6	20.7	34.6	14.3	4.7	79.9

The design firm capacity for each booster pumping station should provide 125 percent of the values shown in Table 7.

3.4 TRANSMISSION SYSTEM ANALYSIS

A steady state hydraulic analysis was performed to determine the required pipeline diameters and resulting hydraulic grade for the reclaimed water transmission system which will connect between the City's WRFs and allow reclaimed water to be moved from locations of surplus to locations of higher reuse demand or recharge. Figure 12 provides a profile plot to display the connection between each plant. 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.

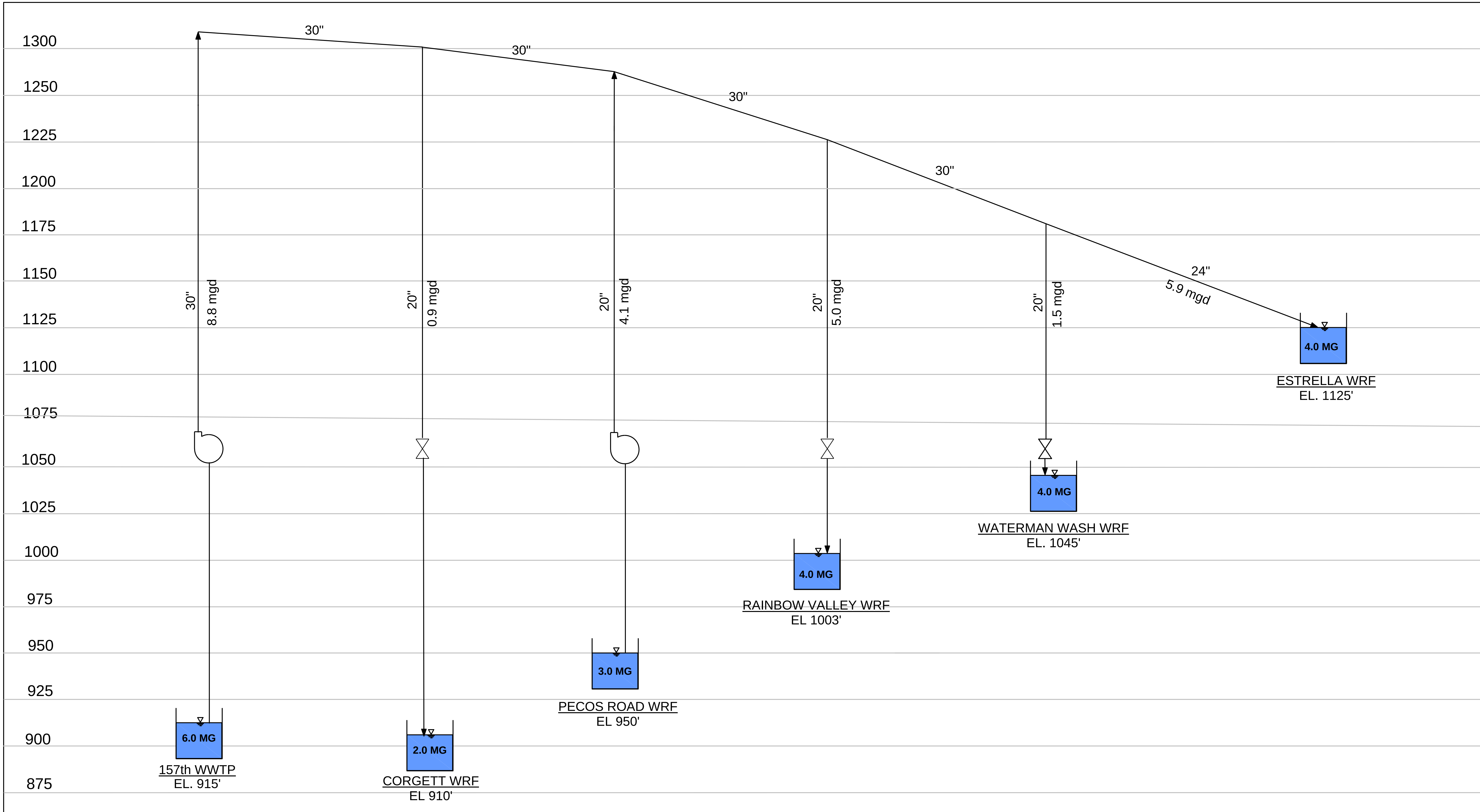
Max Month. The system balance shall be calculated under conditions of Max Month reclaimed water production which is 110 percent of the average dry weather flow (ADWF) rating for each WRF.

Maximum Velocity. Maximum pipeline velocity shall be 5 ft/sec in order to minimize friction losses and surge potential in the long transmission lines.

Table 11 shows the cumulative flow coming into and leaving the transmission system at each plant for both the max month summer and min month winter scenarios.

Table 11: Transmission System Flow (mgd)

Plant	Reclaimed Water Production (ADWF)	Reclaimed Water Production (Max Month)	Max Month Summer Flow			Min Month Winter Flow		
			Additional Supply Needed	Excess Supply	Cumulative Transmission Flow	Additional Supply Needed	Excess Supply	Cumulative Transmission Flow
157th	16.7	18.4	0	9.9	9.9	0	15.1	15.1
Corgett	1.8	2.0	0.8	0	9.1	0	1.1	16.2
Pecos Road	6.3	6.9	0	3.6	12.7	0	3.1	19.3
Rainbow Valley	5.9	6.5	4.9	0	7.8	3.5	0	15.8
Waterman Wash	9.2	10.1	1.9	0	5.9	6.8	0	9.0
Estrella	2.7	3.0	6.2	0	-0.3	9.4	0	-0.3



BLACK & VEATCH
Corporation
PROJECT 145521

FIGURE 12
CITY OF GOODYEAR
2007 INTEGRATED MASTER PLAN
RECLAIMED TRANSMISSION SYSTEM HYDRAULIC PROFILE
Buildout Maximum Month

Goodyear
ARIZONA

3.5 STORAGE ANALYSIS

EPS model runs provided the peak hour flowrates which were utilized in determining the operational storage volume which is to be provided 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.

It should be noted that the storage reservoirs provide for daily operational storage needs. Seasonal storage needs are accomplished through aquifer recharge. Flow balance calculations were performed for the reservoirs at each WRF and for the Zone 4 East and Zone 4 West dump/repump reservoirs. Detailed flow-balance spreadsheets are provided in Appendix A. Table 12 presents a summary of the required operational storage volumes by plant.

Table 12: 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

3.5.1 Dump and Repump Facilities

Dump and Repump Reservoirs were modeled as a control valve attached to a reservoir. The Dump and Repump Reservoirs will be filled during off peak hours from 11 am to 10 pm, when irrigation demands are low. The control valve was set to receive water based on the demand exhibited on the reservoir. To meet the demand that occurs over 24 hours, the control valve was set to receive that much flow during the off peak 11 hours.

3.6 RECHARGE CAPACITY ANALYSIS

Storage of seasonal surpluses of reclaimed water is to be accomplished through aquifer recharge via injection wells. The recharge well fields are to be sized based on the following criteria:

Max Month Production. Sufficient recharge capacity shall be available to provide for recharge of the balance of max month production volumes (1.1 x ADWF) and winter minimum reuse demand conditions.

Waterman Basin Capacity. The Waterman Basin recharge fields shall be provided with 100 percent of the calculated max month recharge capacity.

Zone 1 Capacity. The existing SAT site shall be replaced with 4 mgd of injection well capacity and augmented with an additional 4 mgd of injection well capacity.

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. At the 157th Ave WWTP the connection to the Palo Verde Nuclear Supply Line and Gila River serve as the fail safe discharge options.

Table 13 shows the calculated recharge capacity to be provided in the Waterman Basin and also breaks down the total by zone.

Table 13: Recharge Capacity (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	8	8	0	8	0	8	0
Corgett Rainbow Valley Pecos Road Waterman Wash	32	17.1	0	40	2.6	40	12
Estrella	4	0	0	4	0	4	0

4.0 RECOMMENDED IMPROVEMENTS

This section of the technical memorandum will provide recommendations for the growth and expansion of the reclaimed water system for the City of Goodyear. Recommendations are provided on these key elements:

- Distribution network
- Storage
- Booster Pumping
- Transmission Phasing
- Recharge

The sizing and phasing of the facilities is based on the analysis discussed earlier and logical phasing to best suit the growth of Goodyear. It is anticipated the growth may vary from the current landuse but the Buildout Model will stand as a guide to best meet the needs of the reuse markets as they are developed. Recommended improvements are presented in three phases:

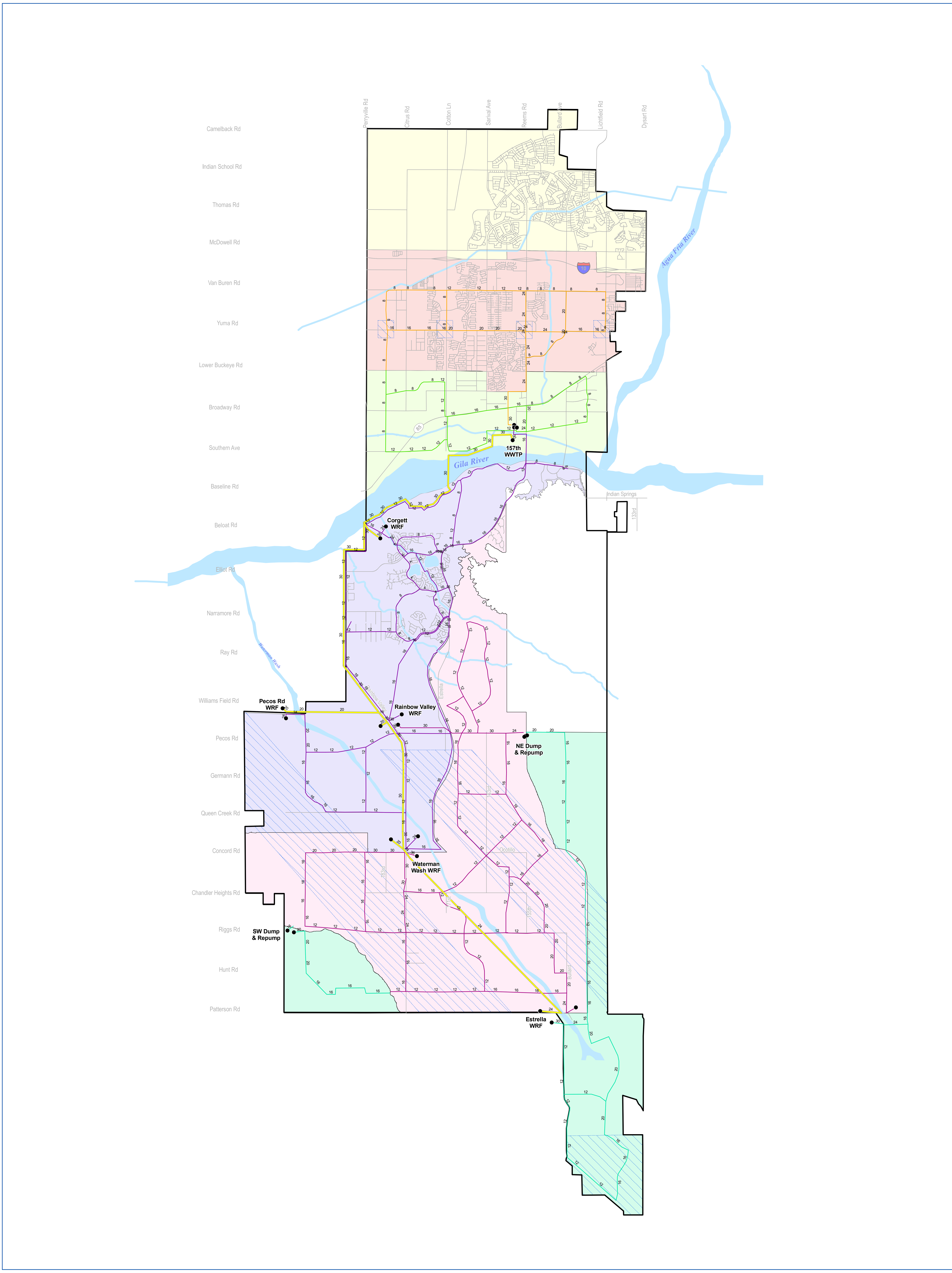
- Buildout – A summary of the recommended projects required for the City to meet buildout reclaimed water demand projections.
- 2017 – Near Term, based on development expected in 2017
- 2012 – Near Term, based on development expected in 2012

4.1 DISTRIBUTION NETWORK

4.1.1 Buildout Distribution System

The distribution system network was developed to maintain a skeletonized system of distribution piping on a nominal two-mile grid covering the service area. The recommended buildout distribution piping is shown on Figure 13.

Pressure reducing valves (PRVs) are provided in two locations in the distribution network to provide greater flexibility in areas of the distribution system where pressures may diminish. The peak hour flows are provided in Table 14.



N W E S

0 1 2
Miles

1 inch equals 6,000 feet

Data source:
City of Goodyear GIS

Cygnet145521\11\GIS\GISMaps\Reclaim_BuildOut_System.mxd 11/06/2007

LEGEND

- Tank
- Transmission
- Gila River Zone
- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Road
- Recharge zone

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

Figure 13
Build Out
Reclaimed Water System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

Table 14: PRV Peak Hour Flow

PRV	Peak Hour Flow (mgd)
Z1/GR	0.0
Z4/Z3	0.0

4.1.2 2017 Distribution System

The arterial roads that are built shall have the reclaimed water pipe placed. But as growth occurs and varies from the model, it will be necessary for Goodyear to adjust the system to meet the needs of the reuse markets. The recommended 2017 distribution network is shown on Figure 14.

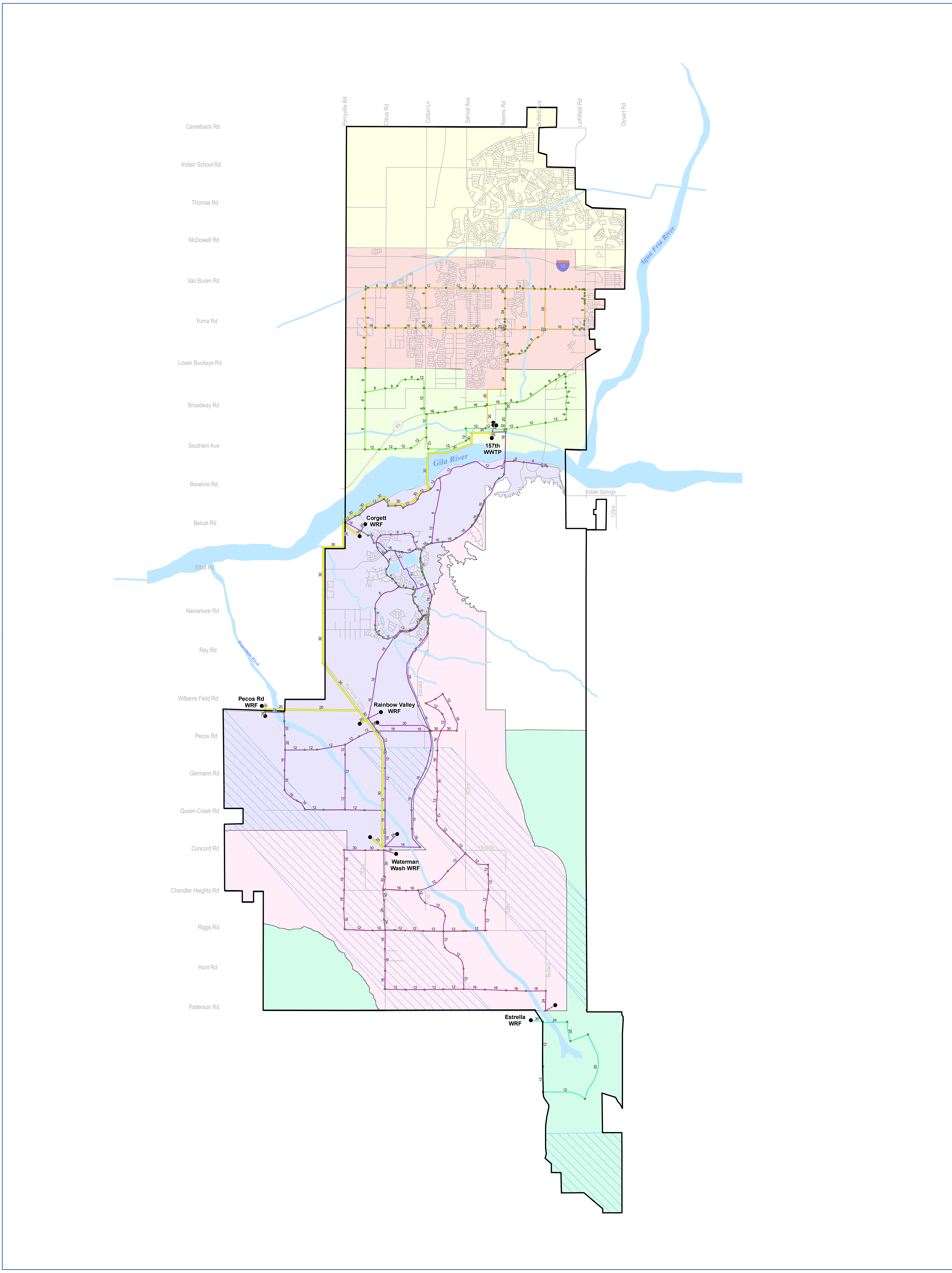
4.2 STORAGE

4.2.1 Reservoir Capacities

Table 15 presents the recommended reservoir capacities. Phased Storage was determined based on the proportion of phased plant capacity compared to buildout plant capacity. In addition the plant capacities were adjusted to enable a phasing plan that could be easily implemented and be cost effective to build for Goodyear.

Table 15: Buildout Reservoir Capacity

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



N
W E
S

0 1 2
Miles

1 inch equals 6,000 feet

Data source:
City of Goodyear GIS
Reclaim System Model

Cygnet 145521\1\GIS\zGISMaps\Reclaim_2017_System.mxd 11/04/2007

LEGEND

Intermediate Year (2017) Mains

- Transmission
- Gila River Zone
- Zone 1
- Zone 2
- Zone 3
- Zone 4
- Tank
- Junction
- Road
- Recharge zone

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

Figure 14
2017 Reclaimed Water System

Integrated Water Master Plan
City of Goodyear, AZ
2007

Goodyear

BLACK & VEATCH
Building a world of difference.

4.2.2 Plant Capacity

The water reclamation facilities will be phased in 1 mgd and 2 mgd increments and will utilize membrane bio-reactor (MBR) technology which:

- Supports the scalping role that some of the plants will play
- Provides low turbidity (0.1 NTU or less) needed for vadose zone recharge wells
- Provides easy to operate, small footprint plants
- Lends itself to modular expansions

Table 16 provides the phased plant capacities.

Table 16: Plant Capacity

Plant Capacity	2007	2012	2017	2045
157th WWTP	4.0	8.0	12.0	17.0
Corgett WRF	0.8	1.8	1.8	1.8
Pecos Road WRF	0.0	2.5	5.0	7.0
Rainbow Valley WRF	0.8	3.0	3.0	6.0
Waterman Wash WRF	0.0	1.5	3.0	10.0
Estrella WRF	0.0	0.0	1.5	3.0
Total =	5.6	16.8	26.5	45.0

4.3 BOOSTER PUMPING

4.3.1 Booster Pumping

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 17 provides the booster pumping capacities with the reserve margin of 25 percent taken into account for each location. Phased Storage was determined based on the proportion of phased plant capacity compared to buildout plant capacity.

Table 17: Buildout Booster Pumping

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

Table 18 provides the buildout booster pumping capacities broken down by zone with the reserve margin of 25 percent taken into account. The reserve margin provides operational flexibility.

Table 18: Booster Pumping Capacities per Zone

Reserve Margin Pumping Capacity (mgd) Max Month						
	Zone					
Plant	1	2	3	4	GR	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

Table 19 provides the HGL per zone that the booster locations will pump to.

Table 19: HGL per Zone

System		Nonpotable	
Zone	Service Elevation Range (ft)	Static Hydraulic Gradient (ft)	Static Pressure Range (psi)
Gila Zone (reduced)	890 - 950	1,050	25 - 68
Zone 1	950 - 1050	1,110	25 - 68
Zone 2	950 - 1050	1,110	25 - 68
Zone 3	1050 - 1150	1,210	25 - 68
Zone 4	1150 - 1250	1,310	25 - 68

4.4 TRANSMISSION SYSTEM

As previously discussed based on the projected resources and demands, a transmission system is necessary for movement of reclaimed water in the system.

4.4.1 2017 Transmission System

The transmission system will be phased into use in year 2015. The transmission pipeline will connect the 157th Ave WWTP to Corgett WRF, Pecos Road WRF, Rainbow Valley WRF, and the Waterman Wash WRF in 2015. Reclaimed water will be moved between plants to share the total Zone 2 and 3 recharge capacities.

4.4.2 Buildout Transmission System

The buildout transmission system will interconnect the 157th Ave WWTP, Zones 2 and 3 WRFs, and Estrella WRF. Estrella will serve Zones 3 and 4 at Buildout and share in the Zone 2/3 recharge capacity. The transmission pipeline will supply supplemental reclaimed water to meet peak irrigation demands during the summer. Table 20 provides the cumulative transfer of water between the WRFs.

Table 20: Transmission Flow

Location	Additional WW Needed (mgd)	Excess WW (mgd)	Cumulative Flow
157th Ave WWTP		9.9	9.9
Corgett WRF	0.8		9.1
Pecos Road WRF		3.6	12.7
Rainbow Valley WRF	4.9		7.8
Waterman Wash WRF	1.9		5.9
Estrella WRF	6.2		-0.3

4.5 RECHARGE

4.5.1 Recharge Phasing

Recharge well capacity in the Waterman Basin was determined based on the comparison of maximum month wastewater production and minimum month reclaimed water demand. Table 21 provides the recharge phasing for the Waterman Basin.

Table 21: Recharge Phasing

Year	ADWF (mgd)	MM (mgd)	Average Reuse (mgd)	Min Month (mgd)	Recharge (mgd)
2012	9.0	9.9	5.2	2.1	8
2017	18.5	20.4	8.5	3.4	17
Buildout	42.7	47.0	21.3	8.3	40

At the 157th Ave WWTP recharge 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. It is recommended that the recharge wells be ASR wells located through the distribution piping.

Zones 2 and 3 will have vadose zone recharge wells with a capacity of 40 mgd to meet max month peak flow rates. Corgett WRF, Pecos Road WRF, Rainbow Valley WRF, and Waterman Wash WRF will be converted and/or constructed as MBRs or have membrane filtration as a tertiary treatment step to maintain the lower turbidity of 0.1 NTU or less. Reclaimed water will be moved between plants to share the total Zone 2 and 3 recharge capacities.

Zone 4 will have recharge capacity equivalent to the Estrella WRF plant capacity due to the WRF remaining a satellite plant serving zone 4 until the transmission pipeline connection in 2017. Further break down of phasing is included in Appendix B.

APPENDIX A
STORAGE CALCULATIONS

Buildout Storage Calculations

Hour	Wastewater Coefficient	WWTP Hourly WW Supply					
		157 th	Corgett	Pecos Road	Rainbow Valley	Waterman Wash	Estrella
		17	1.8	7	6	10	3
0	0.95	16.22	1.72	6.68	5.73	9.54	2.86
1	0.84	14.24	1.51	5.86	5.03	8.38	2.51
2	0.77	13.16	1.39	5.42	4.64	7.74	2.32
3	0.68	11.54	1.22	4.75	4.07	6.79	2.04
4	0.60	10.27	1.09	4.23	3.63	6.04	1.81
5	0.54	9.19	0.97	3.78	3.24	5.41	1.62
6	0.55	9.37	0.99	3.86	3.31	5.51	1.65
7	0.36	6.13	0.65	2.52	2.16	3.60	1.08
8	0.49	8.29	0.88	3.41	2.93	4.88	1.46
9	0.68	11.54	1.22	4.75	4.07	6.79	2.04
10	1.06	18.02	1.91	7.42	6.36	10.60	3.18
11	1.38	23.43	2.48	9.65	8.27	13.78	4.13
12	1.54	26.13	2.77	10.76	9.22	15.37	4.61
13	1.51	25.59	2.71	10.54	9.03	15.06	4.52
14	1.37	23.25	2.46	9.57	8.21	13.68	4.10
15	1.31	22.35	2.37	9.20	7.89	13.15	3.94
16	1.22	20.73	2.19	8.53	7.32	12.19	3.66
17	1.15	19.47	2.06	8.02	6.87	11.45	3.44
18	1.13	19.29	2.04	7.94	6.81	11.34	3.40
19	1.12	19.11	2.02	7.87	6.74	11.24	3.37
20	1.17	19.83	2.10	8.16	7.00	11.66	3.50
21	1.17	19.83	2.10	8.16	7.00	11.66	3.50
22	1.19	20.19	2.14	8.31	7.12	11.87	3.56
23	1.17	19.83	2.10	8.16	7.00	11.66	3.50
24	1.06	18.02	1.91	7.42	6.36	10.60	3.18

Storage Requirements				
Plant	Plant Capacity	Max Storage Required	Safety Factor	Calculated Storage Required
157th	17.00	4.4	1.5	6.7
Corgett	1.80	1.02	1.5	1.5
Pecos Road	6.00	1.98	1.5	3.0
Rainbow Valley	7.00	2.61	1.5	3.9
Waterman Wash	10.00	3.20	2	6.4
Estrella	3.00	2.61	1.5	3.9
			Total =	25.4

Max Month (Summer) Hourly Demand and Supply - 157th							
	WW Supply	**Reclaimed Demand**			**Transmission**	**Change in**	**Running**
Time	**157 th**	**Zone 1**	**Zone 2**	**Gila River**	**Flow to Zone 2**	**Storage**	**Balance**
0	16.22	5.54	1.83	4.62	9.87	-0.23	-0.23
1	14.24	5.54	1.83	4.62	9.87	-0.32	-0.55
2	13.16	5.54	1.83	4.62	9.87	-0.36	-0.92
3	11.54	5.54	1.83	4.62	9.87	-0.43	-1.35
4	10.27	5.54	1.83	4.62	9.87	-0.48	-1.83
5	9.19	5.54	1.83	4.62	9.87	-0.53	-2.36
6	9.37	**5.64**	**1.86**	**4.7**	9.87	-0.53	-2.88
7	6.13	2.9	0.96	2.42	9.87	-0.42	-3.30
8	8.29	2.9	0.96	2.42	9.87	-0.33	-3.63
9	11.54	2.9	0.96	2.42	9.87	-0.19	**-3.82**
10	18.02	2.9	0.96	2.42	9.87	0.08	-3.74
11	23.43	1.13	0.38	0.95	9.87	0.46	-3.28
12	26.13	1.13	0.38	0.95	9.87	0.58	-2.71
13	25.59	1.13	0.38	0.95	9.87	0.55	-2.15
14	23.25	1.13	0.38	0.95	9.87	0.46	-1.70
15	22.35	1.04	0.35	0.87	9.87	0.43	-1.27
16	20.73	1.04	0.35	0.87	9.87	0.36	-0.91
17	19.47	1.04	0.35	0.87	9.87	0.31	-0.61
18	19.29	1.04	0.35	0.87	9.87	0.30	-0.31
19	19.11	1.04	0.35	0.87	9.87	0.29	-0.02
20	19.83	1.04	0.35	0.87	9.87	0.32	0.30
21	19.83	1.04	0.35	0.87	9.87	0.32	**0.62**
22	20.19	5.54	1.83	4.62	9.87	-0.07	0.55
23	19.83	5.54	1.83	4.62	9.87	-0.08	0.47
24	18.02	5.54	1.83	4.62	9.87	-0.16	0.31
						Storage Requirement =	**4.4**

Max Month (Summer) Hourly Demand and Supply - Corgett					
Time	WW Supply Corgett	Transmission Flow from 157th	Reclaimed Demand Zone 2	Change in Storage	Running Balance
0	1.72	0.79	4.52	-0.08	-0.08
1	1.51	0.79	4.52	-0.09	-0.18
2	1.39	0.79	4.52	-0.10	-0.27
3	1.22	0.79	4.52	-0.10	-0.38
4	1.09	0.79	4.52	-0.11	-0.49
5	0.97	0.79	4.52	-0.11	-0.60
6	0.99	0.79	4.6	-0.12	-0.72
7	0.65	0.79	2.38	-0.04	-0.76
8	0.88	0.79	2.38	-0.03	-0.79
9	1.22	0.79	2.38	-0.02	**-0.80**
10	1.91	0.79	2.38	0.01	-0.79
11	2.48	0.79	0.95	0.10	-0.69
12	2.77	0.79	0.95	0.11	-0.59
13	2.71	0.79	0.95	0.11	-0.48
14	2.46	0.79	0.95	0.10	-0.38
15	2.37	0.79	0.87	0.10	-0.29
16	2.19	0.79	0.87	0.09	-0.20
17	2.06	0.79	0.87	0.08	-0.12
18	2.04	0.79	0.87	0.08	-0.04
19	2.02	0.79	0.87	0.08	0.04
20	2.10	0.79	0.87	0.08	0.13
21	2.10	0.79	0.87	0.08	**0.21**
22	2.14	0.79	4.52	-0.07	0.15
23	2.10	0.79	4.52	-0.07	0.08
24	1.91	0.79	4.52	-0.08	0.00
				Storage Requirement =	**1.02**

Max Month (Summer) Hourly Demand and Supply - Pecos Road					
Time	**WW Supply Pecos Road**	**Reclaimed Demand Zone 2**	**Transmission to Watermann**	**Change in Storage**	**Running Balance**
0	6.68	4.42	3.62	-0.06	-0.06
1	5.86	4.42	3.62	-0.09	-0.15
2	5.42	4.42	3.62	-0.11	-0.26
3	4.75	4.42	3.62	-0.14	-0.39
4	4.23	4.42	3.62	-0.16	-0.55
5	3.78	4.42	3.62	-0.18	-0.73
6	3.86	4.49	3.62	-0.18	-0.91
7	2.52	2.49	3.62	-0.15	-1.06
8	3.41	2.49	3.62	-0.11	-1.17
9	4.75	2.49	3.62	-0.06	**-1.23**
10	7.42	2.49	3.62	0.05	-1.17
11	9.65	1.21	3.62	0.20	-0.97
12	10.76	1.21	3.62	0.25	-0.72
13	10.54	1.21	3.62	0.24	-0.48
14	9.57	1.21	3.62	0.20	-0.29
15	9.20	1.14	3.62	0.19	-0.10
16	8.53	1.14	3.62	0.16	0.06
17	8.02	1.14	3.62	0.14	0.19
18	7.94	1.14	3.62	0.13	0.32
19	7.87	1.14	3.62	0.13	0.45
20	8.16	1.14	3.62	0.14	0.59
21	8.16	1.14	3.62	0.14	**0.74**
22	8.31	4.42	3.62	0.01	0.75
23	8.16	4.42	3.62	0.01	0.75
24	7.42	4.42	3.62	-0.03	0.73
				Storage Requirement =	**1.98**

Max Month (Summer) Hourly Demand and Supply - Rainbow Valley						
	WW Supply	**Transmission**	**Reclaimed Demand**		**Change in**	**Running**
Time	**Rainbow Valley**	**Flow from 157th**	**Zone 2**	**Zone 3**	**Storage**	**Balance**
0	5.73	4.91	7.03	8.29	-0.20	-0.20
1	5.03	4.91	7.03	8.29	-0.22	-0.42
2	4.64	4.91	7.03	8.29	-0.24	-0.66
3	4.07	4.91	7.03	8.29	-0.26	-0.92
4	3.63	4.91	7.03	8.29	-0.28	-1.21
5	3.24	4.91	7.03	8.29	-0.30	-1.51
6	3.31	4.91	7.15	8.42	-0.31	-1.81
7	2.16	4.91	3.8	4.64	-0.06	-1.87
8	2.93	4.91	3.8	4.64	-0.03	**-1.89**
9	4.07	4.91	3.8	4.64	0.02	-1.87
10	6.36	4.91	3.8	4.64	0.12	-1.75
11	8.27	4.91	1.65	5.71	0.24	-1.51
12	9.22	4.91	1.65	5.71	0.28	-1.23
13	9.03	4.91	1.65	5.71	0.27	-0.95
14	8.21	4.91	1.65	5.71	0.24	-0.71
15	7.89	4.91	1.53	5.58	0.24	-0.48
16	7.32	4.91	1.53	5.58	0.21	-0.26
17	6.87	4.91	1.53	5.58	0.19	-0.07
18	6.81	4.91	1.53	5.58	0.19	0.12
19	6.74	4.91	1.53	5.58	0.19	0.31
20	7.00	4.91	1.53	5.58	0.20	0.51
21	7.00	4.91	1.53	5.58	0.20	**0.71**
22	7.12	4.91	7.03	11.93	-0.29	0.42
23	7.00	4.91	7.03	8.29	-0.14	0.28
24	6.36	4.91	7.03	8.29	-0.17	0.11
					Storage Requirement =	**2.61**

Max Month (Summer) Hourly Demand and Supply - Waterman Wash						
	WW Supply	Transmission	Reclaimed Demand		Change in	Running
Time	Waterman Wash	Flow from 157th	Zone 2	Zone 3	Storage	Balance
0	9.54	1.91	2.59	12.44	-0.15	-0.15
1	8.38	1.91	2.59	12.44	-0.20	-0.35
2	7.74	1.91	2.59	12.44	-0.22	-0.57
3	6.79	1.91	2.59	12.44	-0.26	-0.83
4	6.04	1.91	2.59	12.44	-0.29	-1.13
5	5.41	1.91	2.59	12.44	-0.32	-1.45
6	5.51	1.91	2.63	12.63	-0.33	-1.78
7	3.60	1.91	1.44	7.35	-0.14	-1.91
8	4.88	1.91	1.44	7.35	-0.08	-2.00
9	6.79	1.91	1.44	7.35	0.00	**-2.00**
10	10.60	1.91	1.44	7.35	0.16	-1.85
11	13.78	1.91	0.68	7.51	0.31	-1.53
12	15.37	1.91	0.68	7.51	0.38	-1.15
13	15.06	1.91	0.68	7.51	0.37	-0.79
14	13.68	1.91	0.68	7.51	0.31	-0.48
15	13.15	1.91	0.64	7.33	0.30	-0.19
16	12.19	1.91	0.64	7.33	0.26	0.07
17	11.45	1.91	0.64	7.33	0.22	0.29
18	11.34	1.91	0.64	7.33	0.22	0.51
19	11.24	1.91	0.64	7.33	0.22	0.73
20	11.66	1.91	0.64	7.33	0.23	0.96
21	11.66	1.91	0.64	7.33	0.23	**1.20**
22	11.87	1.91	2.59	15.94	-0.20	1.00
23	11.66	1.91	2.59	12.44	-0.06	0.94
24	10.60	1.91	2.59	12.44	-0.10	0.83
					Storage Requirement =	**3.20**

Max Month (Summer) Hourly Demand and Supply - Estrella						
	WW Supply	**Transmission Flow**	**Reclaimed Demand**		**Change in**	**Running**
Time	**Estrella**	**from Waterman**	**Zone 3**	**Zone 4**	**Storage**	**Balance**
0	2.86	6.17	6.23	7.76	-0.21	-0.21
1	2.51	6.17	6.23	7.76	-0.22	-0.43
2	2.32	6.17	6.23	7.76	-0.23	-0.66
3	2.04	6.17	6.23	7.76	-0.24	-0.90
4	1.81	6.17	6.23	7.76	-0.25	-1.15
5	1.62	6.17	6.23	7.76	-0.26	-1.41
6	1.65	6.17	6.33	7.88	-0.27	-1.67
7	1.08	6.17	3.58	4.45	-0.03	-1.70
8	1.46	6.17	3.58	4.45	-0.02	-1.72
9	2.04	6.17	3.58	4.45	0.01	**-1.71**
10	3.18	6.17	3.58	4.45	0.06	-1.66
11	4.13	6.17	2.36	2.23	0.24	-1.42
12	4.61	6.17	2.36	2.23	0.26	-1.16
13	4.52	6.17	2.36	2.23	0.25	-0.91
14	4.10	6.17	2.36	2.23	0.24	-0.67
15	3.94	6.17	2.26	2.11	0.24	-0.43
16	3.66	6.17	2.26	2.11	0.23	-0.21
17	3.44	6.17	2.26	2.11	0.22	0.01
18	3.40	6.17	2.26	2.11	0.22	0.23
19	3.37	6.17	2.26	2.11	0.22	0.45
20	3.50	6.17	2.26	2.11	0.22	0.67
21	3.50	6.17	2.26	2.11	0.22	**0.89**
22	3.56	6.17	6.7	7.76	-0.20	0.69
23	3.50	6.17	6.23	7.76	-0.18	0.51
24	3.18	6.17	6.23	7.76	-0.19	0.32
					Storage Requirement =	**2.61**

Storage Requirements - Dump and Repump Facilities				
Dump / Repump Location	**Operational Storage Required**	**Safety Factor**	**Calculated Storage Required**	**Nominal Storage Required**
East	1.61	1.5	2.41	3.0
West	1.32	1.5	1.97	2.0

Max Month (Summer) Hourly Demand and Supply				
East Reservoir				
Hour	**Inflow**	**Outflow**	**Change in Storage**	**Running Balance**
0	0.00	3.45	-0.14	-0.14
1	0.00	3.45	-0.14	-0.29
2	0.00	3.45	-0.14	-0.43
3	0.00	3.45	-0.14	-0.58
4	0.00	3.45	-0.14	-0.72
5	0.00	3.45	-0.14	-0.86
6	0.00	3.51	-0.15	-1.01
7	0.00	1.88	-0.08	-1.09
8	0.00	1.88	-0.08	-1.17
9	0.00	1.88	-0.08	-1.24
10	0.00	1.88	-0.08	-1.32
11	4.24	0.84	0.14	-1.18
12	4.24	0.84	0.14	-1.04
13	4.24	0.84	0.14	-0.90
14	4.24	0.84	0.14	-0.76
15	4.24	0.79	0.14	-0.61
16	4.24	0.79	0.14	-0.47
17	4.24	0.79	0.14	-0.32
18	4.24	0.79	0.14	-0.18
19	4.24	0.79	0.14	-0.04
20	4.24	0.79	0.14	0.11
21	4.24	0.79	0.14	0.25
22	4.24	3.45	0.03	0.28
23	0.00	3.45	-0.14	0.14
24	0.00	3.45	-0.14	0.00
			Storage Required =	1.61

Max Month (Summer) Hourly Demand and Supply				
West Reservoir				
Hour	Inflow	Outflow	Change in Storage	Running Balance
0	0.00	2.85	-0.12	-0.12
1	0.00	2.85	-0.12	-0.24
2	0.00	2.85	-0.12	-0.36
3	0.00	2.85	-0.12	-0.48
4	0.00	2.85	-0.12	-0.59
5	0.00	2.85	-0.12	-0.71
6	0.00	2.9	-0.12	-0.83
7	0.00	1.49	-0.06	-0.90
8	0.00	1.49	-0.06	-0.96
9	0.00	1.49	-0.06	-1.02
10	0.00	1.49	-0.06	-1.08
11	3.37	0.58	0.12	-0.97
12	3.37	0.58	0.12	-0.85
13	3.37	0.58	0.12	-0.73
14	3.37	0.58	0.12	-0.62
15	3.37	0.53	0.12	-0.50
16	3.37	0.53	0.12	-0.38
17	3.37	0.53	0.12	-0.26
18	3.37	0.53	0.12	-0.14
19	3.37	0.53	0.12	-0.03
20	3.37	0.53	0.12	0.09
21	3.37	0.53	0.12	0.21
22	3.37	2.85	0.02	0.23
23	0.00	2.85	-0.12	0.11
24	0.00	2.85	-0.12	0.00
			Storage Required =	1.32

APPENDIX B
PHASING SPREADSHEET

APPENDIX B
PHASING SPREADSHEET

	Flow 2007	Plant 2007	Flow 2012	Plant 2012	Flow 2017	Plant 2017	Flow 2045	Plant 2045
157th Ave WWTP	3.1	4.0	5.4	8.0	9.0	12.0	16.7	17.0
Transmission Capacity						10.0		10.0
SAT Site (Perc Beds)		4.0						
ASR Wells				8.0		8.0		8.0
157th Storage				3.0		5.0		7.0
157th Pumping Capacity				9.3		14.0		19.8
Corgett WRF	0.2	0.8	0.7	1.8	1.1	1.8	1.8	1.8
Corgett Storage				2.0		2.0		2.0
Corgett Pumping Capacity				5.8		5.8		5.8
Rainbow Valley WRF	0.4	0.8	1.3	3.0	2.5	3.0	5.9	6.0
Rainbow Valley Storage				2.0		2.0		4.0
RV Pumping Capacity				11.9		11.9		23.9
Pecos WRF	0.0	0.0	1.1	2.5	3.3	5.0	6.3	7.0
Pecos Storage				1.0		2.0		3.0
Pecos Pumping Capacity				2.0		4.0		5.6
Waterman WRF	0.0	0.0	0.6	1.5	2.0	3.0	9.2	10.0
Waterman Storage				1.0		2.0		6.0
Waterman Pumping Capacity				3.5		7.0		23.2
Total Zone 2/3 Treatment Capacity =	0.6	1.6	3.7	8.8	8.8	12.8	23.2	24.8
Zone 2/3 Recharge (Vadose Wells) =				8.0		17		40.0
Total Zone 2/3 Pumping Capacity =		0.0		23.2		28.6		58.4
Estrella WRF	0.0	0.0	0.0	0.0	1.0	1.5	2.7	3.0
Zone 4 Recharge (Vadose Wells)						2.0		4.0
Transmission Capacity						4.0		4.0
Estrella Storage						2.0		4.0
Estrella Pumping Capacity						9.1		18.2
Dump and Repump Facilities								
Zone 4 East Storage								3.0
Zone 4 East Pumping								4.4
Zone 4 West Storage								2.0
Zone 4 West Pumping								3.6
Total Treatment Capacity =	3.7	5.6	9.1	16.8	18.8	26.3	42.6	44.8
Total Recharge Capacity =		4.0		16.0		27.0		52.0
Total Storage Capacity =		0.0		9.0		15.0		31.0
Total Pumping Capacity =		0.0		32.5		51.7		104.4