



City of Phoenix, Arizona

Final Revised Report
March 2008

Water Resources Acquisition Fee Update Phase 1: Technical and Cost Data



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Pathways to Lasting Solutions





City of Phoenix, Arizona

Water Resources Acquisition Fee Update – Phase 1 Report

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION..... 1

1.1 Purpose..... 1

1.2 Background..... 1

1.3 Assumptions..... 5

2.0 WATER RESOURCES ACQUISITION PROJECTS..... 7

2.1 Overview of Projects..... 7

2.2 McMullen Valley Water Transfer Project..... 8

2.3 Agua Fria Linear Recharge Project 12

2.4 Reclaimed Water from the 23rd Avenue WWTP..... 13

2.5 Reclaimed Water from the Northern WRPs 14

2.6 Central Arizona Project Reallocation..... 16

2.7 Lease of Central Arizona Project Water from the Gila River Indian Community 16

2.8 Western Canal Water..... 16

2.9 Water Efficiency for New Development..... 17

3.0 PROJECT COST ESTIMATES 18

3.1 Overview of Cost Estimates..... 18

3.2 McMullen Valley Water Transfer Project..... 19

3.3 Agua Fria Linear Recharge Project 24

3.4 Reclaimed Water from the 23rd Avenue WWTP..... 27

3.5 Reclaimed Water from the Northern Water Reclamation Plants 27

3.6 Central Arizona Project Reallocation..... 29

3.7 Lease of Central Arizona Project Water From Gila River Indian Community 30

3.8 Western Canal Water Treatment 31

3.9 Water Efficiency for New Development..... 31

4.0 SUMMARY OF ANALYSIS..... 33

5.0 REFERENCES 37



LIST OF FIGURES

- Figure 1: McMullen Valley Water Transfer Project - Schematic
- Figure 2: McMullen Valley Water Transfer Project - Conveyance Alternatives
- Figure 3: Agua Fria Linear Recharge Project - Schematic
- Figure 4: Agua Fria Linear Recharge Project - Alternative Layouts
- Figure 5: McMullen Valley Water Transfer Project - Western Alignment Schematic
- Figure 6: McMullen Valley Water Transfer Project - Southern Alignment Schematic
- Figure 7: Proposed Enhanced Treatment Schematic for 91st Avenue WWTP

LIST OF TABLES

- Table ES-1 - Water Resources Acquisition Projects and Capital Costs
- Table 1 - Water Resources Available for Current Customers
- Table 2a - Potential Water Resources Available for Future Customers
- Table 2b - Water Resources Selected for Future Customers
- Table 3 - Unit Cost Sources
- Table 4 - Potential Water Resources Acquisition Projects
- Table 5 - Cost Summary of McMullen Valley Water Transfer Project
- Table 6 - Summary of 91st Avenue WWTP's Treatment Cost - Attributable to Water Resources
- Table 7 - Summary of Agua Fria Linear Recharge Project Capital Costs
- Table 8 - Summary of Agua Fria Linear Recharge Project O&M Costs and Total Costs
- Table 9 - 23rd Ave WWTP Effluent Availability
- Table 10 - Recharge Cost for the Effluent from the Northern WRPs
- Table 11 - Cost Summary of Reclaimed Water from the Northern WRPs
- Table 12 - CAP Charges for Reallocation
- Table 13 - CAP Reallocation Cost Summary
- Table 14 - GRIC Charges for Water Lease
- Table 15 - GRIC Leased Water Cost Summary
- Table 16 - Summary of Water Resources Acquisition Costs
- Table 17 - Detailed Water Resources Acquisition Costs
- Table 18 - Summary of O&M Costs
- Table 19 - Summary of Annualized Project Costs



APPENDICES

Appendix A – McMullen Valley Water Transfer Project – Notes and Assumptions

Appendix B – Groundwater Wells – Notes and Assumptions

Appendix C – Agua Fria Linear Recharge Project – Notes and Assumptions

Appendix D – Reclaimed Water – Notes and Assumptions



EXECUTIVE SUMMARY

The City of Phoenix (City) retained Red Oak Consulting, a division of Malcolm Pirnie, Inc. (Red Oak) to update its Water Resources Acquisition Fee (WRAF). The study consisted of two phases of work: Phase 1 included a technical and cost assessment of proposed Water Resources Acquisition Projects (WRA Projects) and Phase 2 included the determination of a WRAF using the capital costs developed in Phase 1. This report contains Red Oak’s Phase 1 findings. **Table ES-1** provides a summary of the WRA Projects and Capital Costs.

Table ES-1: Water Resources Acquisition Projects and Capital Costs

No.	WRA Project Name	Annual Water Supply (Acre-Feet)	Capital Cost (2005 Dollars)	Capital Cost per Acre-Foot (2005 Dollars)
1	McMullen Valley Water Transfer Project	38,000	\$ 103,395,000	\$ 2,720
2	Agua Fria Linear Recharge Project – Reclaimed Water from the 91st Ave WWTP	16,000	\$ 76,693,000	\$ 4,790
3	Reclaimed Water from the 23rd Avenue WWTP	Not Evaluated	Not Evaluated	Not Evaluated
4	Reclaimed Water from the Northern WRPs	20,000	\$ 79,094,000	\$ 3,960
5	Central Arizona Project (CAP) Reallocation	8,206	\$ 5,055,000	\$ 620
6	Lease of Central Arizona Project (CAP) Water From Gila River Indian Community (GRIC)	15,000	\$ 25,455,000	\$ 1,700
7	Western Canal Water	44,800	\$ 25,200,000	\$ 560
8	Water Efficiency	26,966	\$ 19,582,000	\$ 730
Total		168,972	\$ 334,474,000	



1.0 INTRODUCTION

1.1 PURPOSE

In June 2005 the City of Phoenix (City) retained Red Oak Consulting, a division of Malcolm Pirnie, Inc. (Red Oak) to update its Water Resources Acquisition Fee (WRAF). The study consisted of two phases of work: Phase 1 included a technical and cost assessment of proposed Water Resources Acquisition Projects (WRA Projects) and Phase 2 included the determination of a WRAF using the capital costs developed in Phase 1.

Red Oak submitted its final Phase 1 and Phase 2 reports to the City on August 17, 2006. Due to a delay in updating the WRAF, the City amended Red Oak's professional services consulting agreement to allow for the inclusion of more recent information in the Phase 1 and Phase 2 reports. This report provides Red Oak's Phase 1 findings, revised to include additional information, and related editorial changes.

1.2 BACKGROUND

On March 8, 2006 the City Council adopted the *Water Resources Plan Update 2005* (WRP) which provided guidance for water acquisition, water management, and infrastructure necessary to ensure sustainable water availability for current customers and anticipated growth over the next 50 years. From the numerous scenarios evaluated in the WRP, the City and Red Oak determined that the General Plan, Moderate Shortage Conditions Scenario would be utilized as the basis for this Phase 1 report. The General Plan, Moderate Shortage Conditions Scenario assumes that the City will grow consistent with the current General Plan, and will experience moderate water shortage conditions between 2015 and 2030.

Red Oak derived the following tables based on the WRP General Plan, Moderate Shortage Conditions Scenario. **Table 1** lists water resources available to meet existing water demand (as of 2005). **Table 2a** identifies a range of potential water resources available to meet new demands (beyond 2005). **Table 2b** presents only the water resources selected to meet future customer demands, and serves as the basis for infrastructure cost estimates developed in this Phase 1 report.



Table 1 – Water Resources Available for Current Customers

	NORMAL CONDITIONS		MODERATE SHORTAGE CONDITIONS			
	2005	2010	2015	2020	2025	2030
ON PROJECT						
On-Project Demand – Existing	179,080	179,080	179,080	179,080	179,080	179,080
SRP Supplies (demand limited) ¹	<u>179,080</u>	<u>179,080</u>	<u>179,080</u>	<u>179,080</u>	<u>179,080</u>	<u>179,080</u>
SURPLUS/(DEFICIT)	0	0	0	0	0	0
OFF PROJECT						
Off-Project Demand – Existing	173,372	173,372	173,372	173,372	173,372	173,372
CAP - Subcontract/M&I Priority Supplies ²	113,914	113,914	113,914	113,914	113,914	113,914
CAP - Colorado River Exchange (Pre-1968) ³	4,751	4,751	4,751	4,751	4,751	4,751
CAP - Indian Leases ⁴	7,323	7,323	7,323	7,323	7,323	7,323
CAP - Agricultural-Priority ⁵	36,758	36,758	0	0	0	0
SRP - Phoenix Supplies Avail for Off Project Use ⁶	68,000	68,000	0	0	0	0
Reclaimed Water – Direct ⁷	2,000	3,000	5,000	5,000	5,000	5,000
Groundwater ⁸	<u>0</u>	<u>0</u>	<u>44,148</u>	<u>44,148</u>	<u>44,148</u>	<u>44,148</u>
Total Current Off Project Supplies	<u>232,746</u>	<u>233,746</u>	<u>175,136</u>	<u>175,136</u>	<u>175,136</u>	<u>175,136</u>
SURPLUS/(DEFICIT)	59,374	60,374	1,764	1,764	1,764	1,764

¹ SRP supply is On-Project demand constrained (excess allocation cannot be used off-project)

² Recovery of AWBA storage credits is assumed to replace cut-backs on CAP subcontract allocations during moderate Colorado River shortages

³ Mainstem (firm) Colorado River water available to Phoenix via the SRPMIC water right settlement

⁴ CAP water leases from Fort McDowell Indian Community (FMIC) and Salt River Pima-Maricopa Indian Community (SRPMIC)

⁵ Lower priority Colorado River water originally obtained from the Hohokam Irrigation & Drainage District (subject to 100% cut-back during shortages)

⁶ Includes Gatewater from Horseshoe Lake, New Conservation Space (NCS) water from Roosevelt Lake, and water from Phoenix/Roosevelt Irrigation District (RID)/SRP Three-Way Exchange

⁷ From existing Cave Creek WRF. Increase assumes offset of demands currently served with potable supplies.

⁸ Based on City's current active well capacity. This is a drought year supply only (not sustainable)



Table 2a – Potential Water Resources Available for Future Customers

	NORMAL CONDITIONS		MODERATE SHORTAGE CONDITIONS			
	2005	2010	2015	2020	2025	2030
ON PROJECT						
Demand Growth (from 2005)	0	19,270	27,149	35,033	38,850	42,607
Additional SRP Supplies (demand constrained) ⁹	0	19,270	27,149	35,033	38,850	42,607
Water efficiency ¹⁰	0	1,479	2,084	2,689	2,982	3,270
SURPLUS/(DEFICIT)	0	0	0	0	0	0
OFF PROJECT						
Demand Growth (from 2005)	0	27,736	53,006	81,176	100,131	120,398
Surplus / Deficit from Table 1 (Existing)	59,374	60,374	1,764	1,764	1,764	1,764
CAP Re-Allocation ¹¹	0	8,206	8,206	8,206	8,206	8,206
CAP – Gila River Indian Community Lease	0	15,000	15,000	13,402	12,930	12,813
Imported Groundwater - McMullen Valley	0	0	18,000	38,000	38,000	38,000
Underground Storage Credit Recovery ¹²	0	0	10,000	10,000	10,000	10,000
Additional Safe-Yield Groundwater ¹³	0	0	30,000	30,000	30,000	30,000
CAP - Arizona State Land - Phoenix Volume (M&I) ¹⁴	0	0	12,000	12,000	12,000	12,000
Reclaimed Water From 91st Ave WWTP (AFLRP) ¹⁵	0	0	0	8,881	15,851	19,260
Reclaimed Water From 23rd Ave WWTP ¹⁶	0	0	18,263	20,000	20,000	20,000
Reclaimed Water From Northern WRPs ¹⁷	0	0	0	2,000	3,000	8,000
Water efficiency ¹⁸	0	5,459	10,432	15,976	19,706	23,695
Total Supplies/Water efficiency	59,374	89,039	123,665	160,229	171,457	183,738
SURPLUS/(DEFICIT)	59,374	61,303	70,659	79,053	71,326	63,340

⁹ Assumed to be delivered through the proposed Western Canal WTP; A limited volume of additional SRP supplies may be available for higher density growth in the on-project areas. See the 2005 Water Resources Plan Update for further details.

¹⁰ On-project conservation preserves reservoir water (not available as a surplus supply within Phoenix)

¹¹ Recovery of AWBA storage credits is assumed to replace cut-backs on CAP subcontract allocations during moderate Colorado River shortages

¹² This represents currently stored credits and is not available on a continuous basis (i.e. this is not a base supply, but rather a shortage backup supply). 10,000 acre-feet per year can be made available for 10 years. This supply requires additional well capacity.

¹³ This represents the ADWR groundwater allocation which can be used as a drought backup supply (this is not a base supply). 30,000 acre-feet per year can be made available for 30 years. This supply requires additional well capacity.

¹⁴ This is CAP water reserved for State lands north of Jomax Rd. There is no agreement yet between the Arizona State Land Department and Phoenix as to how this supply will be made available to Phoenix. Supply includes AWBA credits during shortages.

¹⁵ Remaining effluent after subtracting commitments to the Palo Verde Nuclear Generating Station, Buckeye Irrigation Company and the Tres Rios Project.

¹⁶ Remaining effluent after subtracting commitments to Rio Salado and Rio Oeste, and includes volume currently committed to RID/SRP Three-Way Exchange which is assumed to be freed up due to either temporary (drought-related) or permanent (reduction of agricultural lands) factors.

¹⁷ Assumed capacity remaining after considering current reclaimed water system commitments (Table 1). Planned capacity increases could accommodate some flows associated with 91st Avenue and 23rd Avenue plants.

¹⁸ Volume associated with new development (compared to “stable rate” used in 2005 Water Resources Plan Update)



Table 2b – Water Resources Selected for Future Customers

	NORMAL CONDITIONS		MODERATE SHORTAGE CONDITIONS			
	2005	2010	2015	2020	2025	2030
ON PROJECT						
Demand Growth (from 2005)	0	19,270	27,149	35,033	38,850	42,607
<u>Additional SRP Supplies / Western Canal</u>	0	19,270	27,149	35,033	38,850	42,607
Water efficiency ¹⁹	0	1,479	2,084	2,689	2,982	3,270
SURPLUS/(DEFICIT)	0	0	0	0	0	0
OFF PROJECT						
Demand Growth (from 2005)	0	27,736	53,006	81,176	100,131	120,398
Surplus / Deficit from Table 1 (Existing)	59,374	60,374	1,764	1,764	1,764	1,764
<u>CAP Re-Allocation</u>	0	8,206	8,206	8,206	8,206	8,206
<u>CAP – Gila River Indian Community Lease</u>	0	15,000	15,000	13,402	12,930	12,813
<u>Imported Groundwater - McMullen Valley</u>	0	0	18,000	38,000	38,000	38,000
Underground Storage Credit Recovery ²⁰	0	0	0	0	0	0
Additional Safe-Yield Groundwater ²¹	0	0	0	0	0	0
CAP - Arizona State Land - Phoenix Volume (M&I) ²²	0	0	0	0	0	0
<u>Agua Fria Linear Recharge Project</u>	0	0	0	0	0	16,000
Reclaimed Water From 23rd Ave WWTP	0	0	0	0	0	0
<u>Reclaimed Water From Northern WRPs²³</u>	0	0	0	4,000	20,000	20,000
<u>Water efficiency</u>	0	5,459	10,432	15,976	19,706	23,695
Total Supplies/Water efficiency	59,374	89,039	73,402	81,348	100,606	120,478
SURPLUS/(DEFICIT)²⁴	59,374	61,303	396	172	475	80

The proposed WRA Projects include six projects in Table 2b above (identified with underlined text), plus additional water efficiency measures for new development. Red Oak evaluated seven WRA Projects in greater detail in the following sections of this report. It should be noted that reclaimed water from the 23rd Avenue WWTP was also identified as a potential future source, but was not further evaluated Phase 2 of the WRAF study.

¹⁹ On-project conservation preserves reservoir water (not available as a surplus supply within Phoenix)

²⁰ Not considered a firm long-term supply

²¹ Not considered a firm long-term supply

²² This supply will be made available as State lands develop. It is assumed that any water made available will serve as an offset to the acquisition fee, and thus this allocation is not considered as a base supply.

²³ Assumes all required reclaimed water will be treated at Northern water reclamation plants

²⁴ Supply selection designed to balance within 1,000 acre-feet.



1.3 ASSUMPTIONS

This report reflects the City's comments and guidance provided via regular project status conference calls and frequent meetings throughout the study. Findings are based on City-provided technical information, cost data, and related sources noted throughout this report. Red Oak has relied on this data in the formulation of our findings.

To allow readers of this report to assess the financial impact of the proposed WRA Projects, costs are presented in constant-cost terms (2005 dollars). Unless otherwise noted in this report, all cost data was adjusted into 2005 dollars using the 20-City Average Construction Cost Index (CCI) published by *Engineering News Record* (ENR), as follows:

<u>Year</u>	<u>Cost Index</u>	<u>Percent Change</u>
2000	6221	
2001	6334	1.8%
2002	6538	3.2%
2003	6695	2.4%
2004	7115	6.3%
2005	7446	4.6%
Average Annual (5-years)		3.7%

Future inflation adjustments were incorporated in Red Oak's Phase 2 report, as appropriate, to reflect future cost terms (2008 dollars) for WRAF calculation purposes. With the exception of editorial revisions and well cost adjustments, this March 2008 report maintains the original data and findings documented in our August 17, 2006 Phase 1 report.

When developing WRA Project cost estimates, Red Oak referenced a number of costs sources, including recent bids and vendor quotes submitted to the City of Phoenix and other local utilities. **Table 3** lists the unit cost items, the primary cost source, and the secondary cost source used for comparison and verification purposes.



Table 3 – Unit Cost Sources

Unit Cost Item	Primary Cost Source	Secondary Cost Source
Pipeline	Black & Veatch Corporation, Water and Wastewater Facility Unit Cost Study, November 2003	Actual bid tabs – Phoenix, El Mirage, and Peoria, Arizona
Groundwater Well*	HDR Engineering, Inc., Groundwater Utilization Master Plan, July 2006	Gary M. Gin, Hydrogeologist City of Phoenix
Pump & Motor	Vendor quotes	None
Reservoir	Construction cost survey in Chandler, Peoria, El Mirage	Vendor quotes
Power	APS Rate Schedule E-221 – 2005	None
Labor Rate	City of Phoenix, WSD rates	None
Well-head Treatment	HDR Engineering, Inc., Groundwater Utilization Master Plan, July 2006	Bid costs – Phoenix, Green Valley, Peoria

* Detailed well costs provided in Appendix B.

With the exception of the groundwater wells, Red Oak applied the unit costs from the primary cost source indicated above to calculate the WRA Project cost estimates. The primary cost sources were typically lower than those reported by the secondary cost source. The cost development rationale for groundwater well costs is provided in Appendix B.



2.0 WATER RESOURCES ACQUISITION PROJECTS

2.1 OVERVIEW OF PROJECTS

Red Oak evaluated eight WRA Projects to meet the City’s future water needs. **Table 4** includes water resources projects that are available and implementable to meet the City’s future water demands to 2030.

Table 4 – Potential Water Resources Acquisition Projects

Number	Project Name	Project Description
1	McMullen Valley Water Transfer Project	Transfer groundwater from McMullen Valley to Union Hills WTP.
2	Agua Fria Linear Recharge Project	A SROG project where the City of Phoenix will recharge effluent from the 91 st Ave. WWTP to the aquifer underlying the Agua Fria River bed.
3	Reclaimed Water from the 23rd Avenue WWTP	Use of reclaimed water to be available in the future by direct use or recharge and recovery.
4	Reclaimed Water from the Cave Creek and North Gateway Water Reclamation Plants (Northern WRPs)	Expansion of reclaimed water distribution system to increase direct use / recharge of reclaimed water in North Phoenix.
5	Central Arizona Project (CAP) Reallocation	Reallocation of 8,206 acre-feet of previously unallocated CAP M&I water to Phoenix.
6	Lease of Central Arizona Project (CAP) Water From Gila River Indian Community (GRIC)	Lease 15,000 acre-feet of CAP water from GRIC.
7	Western Canal WTP	Incremental treatment cost to improve the Western Canal water to the average quality equal to the water quality in the SRP canal system.
8	Water Efficiency	Savings through efficiency and demand management applicable to new development.

The WRA Projects listed above were selected based on their ability to access water sources (surface water or groundwater) either owned or leased by the City of Phoenix. They include new infrastructure to convey raw source water to the connection point to the existing distribution system and/or treatment plant. Red Oak only included treatment infrastructure costs if treatment was required to treat groundwater at the well head, to improve raw water quality to level equivalent with other City water sources (i.e., Western Canal), or to enhance secondary effluent



for direct use or recharge purposes. These projects are presented in numerical order in the following sections.

2.2 McMULLEN VALLEY WATER TRANSFER PROJECT

Background

McMullen Valley is in La Paz County, about 80 miles west of Phoenix. The City of Phoenix purchased 13,129 acres of farmland in the McMullen Valley in 1986. The City plans to use this land to extract groundwater and convey it to Phoenix. This transferred water will reduce reliance on groundwater within the Phoenix Active Management Area (AMA) consistent with the AMA safe yield goal of the 1980 Arizona Groundwater Management Act (GWMA). Detailed alternative strategies and costs for this project were developed by James M. Montgomery Consultants, Inc. in a December 1992 report: *McMullen Valley Water Transfer Project Study* (JMM Report). Legislation passed in 1991 authorizes the City to pump and transfer approximately an average of 38,000 acre-feet per year. In any one year, twice that amount may be pumped and transferred as long as the average is maintained over a 10 year period. Based on these limitations, the City selected an annual maximum of 50,000 acre-feet per year for pre-design of wells and pump stations to allow for increased transfer of water during drought years.

System Description

To extract groundwater, the City will develop a well field in the McMullen Valley. Groundwater will be collected from the well field by a manifold of collection pipes and a storage reservoir. Large diameter delivery pipes will be used to convey water from the reservoir to the CAP canal. Water will then be transported through the CAP canal to the City's water treatment plants (WTPs) on the CAP Canal (Union Hills WTP and Lake Pleasant WTP), and potentially to plants on the SRP system through the CAP/SRP Interconnect Facility. **Figure 1** shows the schematic of the proposed McMullen Valley Water Transfer Project.

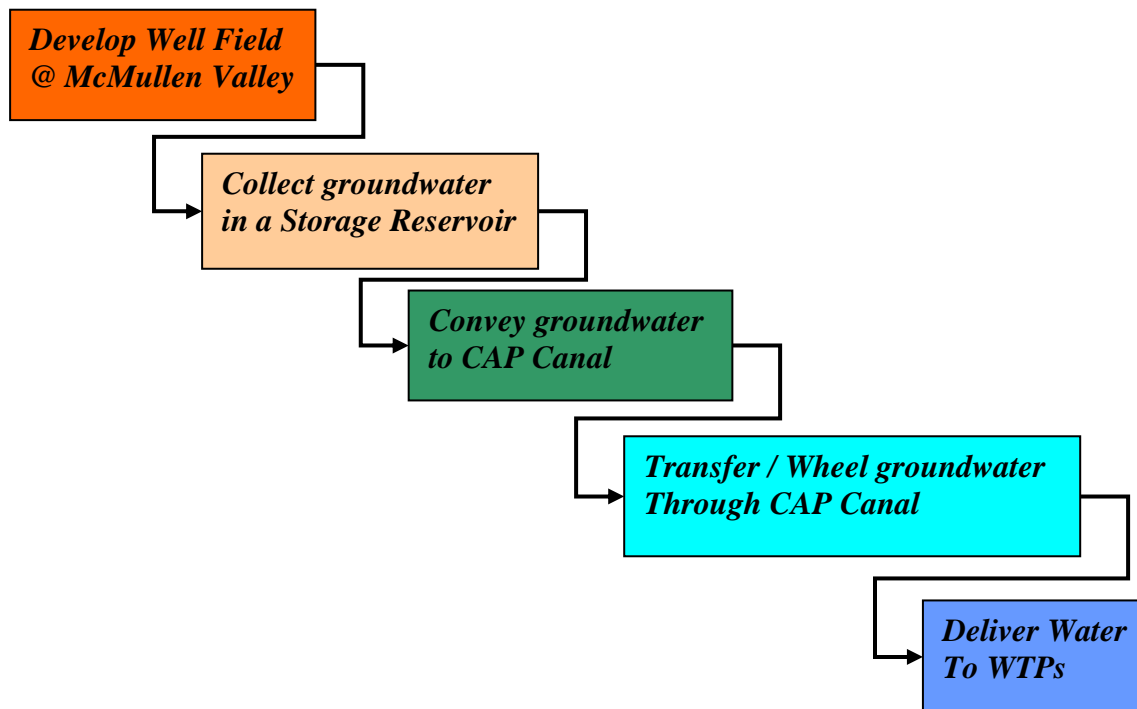


Figure 1: McMullen Valley Water Transfer Project – Schematic

Selection of CAP Scheduling Alternative

The number of wells required to develop the well field and the size of the infrastructure needed to carry groundwater from the well field to the CAP canal depend on the availability of the CAP canal at any given time. While the City of Phoenix has received from the Central Arizona Water Efficiency District (CAWCD) Board an “interim set aside” to transfer 38,000 acre-feet per year of this McMullen Valley water, scheduling logistics have not been finalized. Original coordination with CAWCD during the early 1990s assumed that the City would need the McMullen Valley water year round. This raised the concern of insufficient capacity in the CAP canal throughout the year to wheel the water. Several complex scenarios were analyzed to evaluate alternate seasonal wheeling quantities. The City developed three scheduling alternatives to complete the economic analysis. Alternatives labeled “Most Favorable” (lowest potential cost), “Most Probable” (most likely to happen), and “Least Favorable” (highest expected cost) were developed to respect range of potential system design options.

The “Most Favorable” Alternative assumed year-round wheeling at a constant flow. The “Most Probable” Alternative assumed that the CAP canal would be down for a period of 60 days in any given year. This modified version of the “Most Favorable” Alternative added a reasonable degree of conservatism to the year-round scheduling concept. Since the system would convey the same volume of water as in the “Most Favorable” Alternative in a fewer number of days (305 days), the flow capacity would be higher, resulting in a higher capital cost for the “Most Probable” Alternative than for the “Most Favorable” Alternative. The “Least Favorable Alternative” was based on CAWCD’s intended CAP operation plan developed in 1991. With



this alternative, eighty percent of the McMullen Valley water would be wheeled through the CAP canal between March 15 and May 31. The remaining twenty percent would be conveyed between October 1 and March 15. With a high volume of water to be conveyed over two and one-half months, the “Least Favorable” Alternative reflects the largest-sized system among the three alternatives, and, consequently, the greatest cost.

More than a decade has passed since the 1992 JMM study. Many of the factors at the time considered critical in developing the alternatives have changed. The City now is contemplating the use of McMullen Valley water predominantly during periods of surface water shortage, when water demands cannot be met by using other sources. It is anticipated that during Colorado River shortages, the CAP canal would not have substantial capacity limitations and thus more flexibility in transferring the McMullen Valley water would be afforded by CAWCD. In shortage years, the City would need to draw a substantial volume of water, while under normal supply conditions the transferred volume would be minimal. The City is confident that it can negotiate towards the “Most Favorable” wheeling alternative.

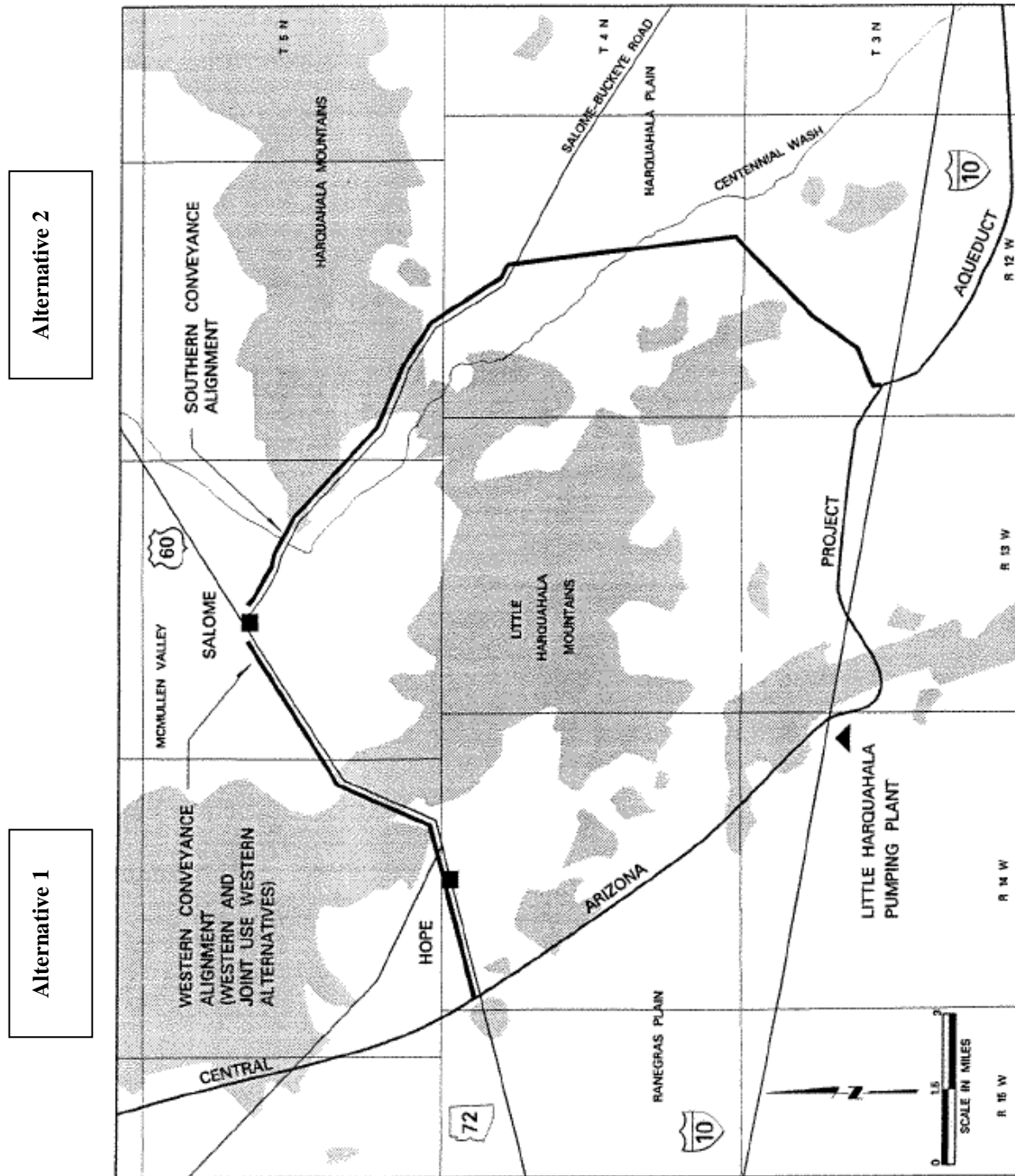
Selection of Conveyance Route

A total of 3 alternative routes to convey groundwater from the reservoir to the City WTPs were contemplated in the JMM report:

1. Western Alignment + CAP Canal
2. Southern Alignment + CAP Canal
3. Joint-Use Western Alignment + CAP Canal



These alternatives are shown in **Figure 2**.



**Figure 2: McMullen Valley Water Transfer Project – Conveyance Alternatives
(Courtesy: JMM Report)**



Alternative 1 has a relatively short route but requires a booster station to overcome elevation differences along its route. Approximately 46,000 feet of pipeline are required to convey water to the CAP canal, of which 36,000 feet would be by gravity pipe, and 10,000 feet would be by pressure pipe. Water would be wheeled through the CAP canal to City WTPs.

Alternative 2 has a longer route than Alternative 1, but is a gravity system. This alternative has a total gravity pipe length of 94,000 feet and CAP wheeling length of 100 miles.

Alternative 3 assumed that the McMullen Valley Irrigation District (MVID) would build a conveyance system for importing its CAP allocation to irrigate its agricultural land. Alternative 3 did not happen as anticipated. Therefore, Red Oak only evaluated Alternatives 1 and 2

Cost estimates for the McMullen Valley Water Transfer Project are summarized in Section 3.

2.3 AGUA FRIA LINEAR RECHARGE PROJECT

A lengthy planning exercise is underway among Sub-Regional Operating Group (SROG) cities (includes Phoenix, Mesa, Scottsdale, Glendale, and Tempe) and the Bureau of Reclamation to address the proposed Agua Fria Linear Recharge Project (AFLRP), which would provide a means for Phoenix to more fully utilize a portion of its share of the 91st Avenue WWTP effluent for growth or drought mitigation. **Figure 3** shows the plan in schematic.

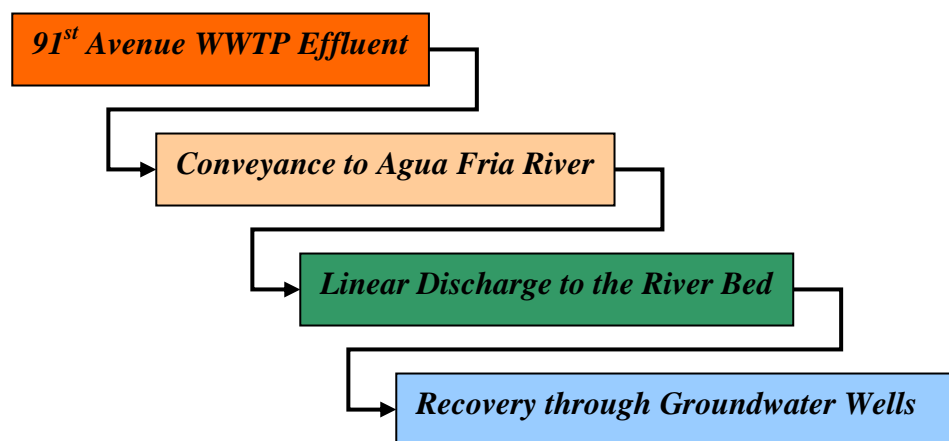


Figure 3: Agua Fria Linear Recharge Project – Schematic

The current conceptual plan includes three alternative pipe alignments for carrying the effluent from the 91st Avenue WWTP to a terminal location near Bell Road and the Agua Fria River. The effluent would be discharged to the river bed at various discharge points geographically aligned in a linear sequence. **Figure 4** shows the three alternative pipe routes.

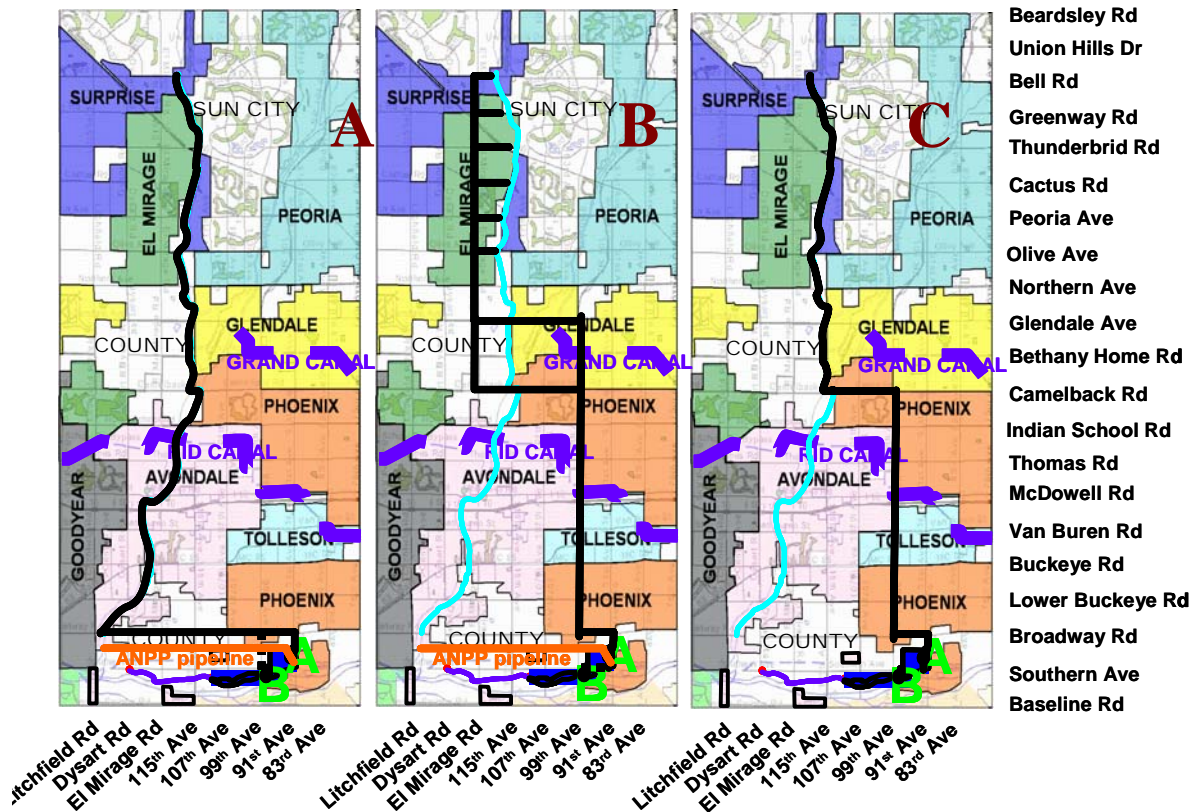


Figure 4: Agua Fria Linear Recharge Project – Alternative Layouts
(Courtesy: VEE and PS&J)

Alternative A, B, and C shown in **Figure 4** were evaluated by the City’s consultant team including PBS&J and Valentine Environmental Engineers (VEE). The City recently requested the consultant team to also evaluate alternatives that would involve bringing effluent from the 23rd Avenue WWTP to this linear recharge project. At the time of this report, only cost estimates for the Agua Fria Linear Recharge Project using 91st Avenue WWTP effluent were available.

2.4 RECLAIMED WATER FROM THE 23RD AVENUE WWTP

The City of Phoenix currently maintains a 3-way water exchange program with the Roosevelt Irrigation District (RID) and Salt River Project (SRP) that allows the City to exchange effluent from the 23rd Avenue WWTP for SRP water taken at Phoenix WTPs. Under this program, the City supplies 30,000 AF/year of 23rd Ave. WWTP effluent to RID. In return, RID supplies the same quantity of groundwater to SRP canals. In exchange, SRP provides 20,000 AF/year of its supplies to Phoenix WTPs. The remaining 10,000 AF/year of water goes to the Salt River Pima Maricopa Indian Community (SRPMIC) pursuant to a settlement agreement. Any unused portion of the water allocated to SRPMIC can be used by the City.

The 23rd Ave WWTP is currently producing an additional 20,000 AF/year of effluent. The City delivers some of this additional effluent to RID to offset groundwater pumping and receives “in-



lieu” recharge credits in return. Thus, all water delivered to RID yields groundwater credits, either under the exchange program or through "in-lieu" deliveries. Because RID demand drops below the agreed upon delivery quantity from the 23rd Ave. WWTP at certain times of the year, some effluent goes unused. Also, over time, agricultural land is expected to be converted to urban use, which will diminish RID's need for effluent. In the future, the City will need to directly store or directly deliver some of the effluent to keep it an active part of the water supply portfolio. In addition, the effluent production capacity of the 23rd Ave. WWTP is expected to be expanded, which creates additional opportunity for the City to put the effluent to beneficial use in order to increase the future available water supply.

The City is currently examining / re-evaluating the beneficial use of WWTP effluent to get maximum groundwater extraction credit available. This includes the possibility of adding the 23rd Ave WWTP's effluent to the Agua Fria Linear Recharge Project.

Since the City has not yet developed a specific plan for the full utilization of reclaimed water, a wide variety of opportunities are available to develop the conceptual level cost estimate for this WRAF project. One option is to identify direct reuse customers for the Class A+ water. The City should explore this option by conducting a study similar to the North Phoenix Recycled Water Distribution Master Plan project. Another alternative is to recharge the water similar to the AFLRP, where water would be discharged to land, and later, the credit would be recovered through groundwater wells. If an approach similar to the ‘Direct Delivery in North Phoenix’ project is used, the unit acquisition project costs would be in the range identified under that project. If an approach similar to AFLRP is used, the unit acquisition project costs would be similar to AFLRP.

The City’s current plan to expand its water supply portfolio to meet future demand includes the reclaimed water from the 23rd Avenue WWTP, but this supply is not needed prior to the year 2030, which is beyond the timeline of this WRAF project evaluation.

2.5 RECLAIMED WATER FROM THE NORTHERN WRPS

The City investigated the potential to expand the use of reclaimed water in North Phoenix from the Cave Creek Water Reclamation Facility (CCWRF) and proposed North Gateway Water Reclamation Facility (NGWRF). The strategies and related costs based on the study were summarized in the report: *The North Phoenix Recycled Water Master Plan, GIS Southwest and URS, January 2004.*

A long-standing strategy of the City has been to utilize water reclamation plants in the developing areas north of the CAP to augment the City’s water resources. This can be done either by using reclaimed water for irrigation, which reduces demand on potable water resources, or through groundwater recharge, which provides additional groundwater credits and capacity to pull water from existing or future wells.

The first phase of this strategy was the construction of the Cave Creek WRF, which treats wastewater collected from the surrounding area to standards appropriate for irrigation and other



non-potable reuse. Two large transmission mains serve as the backbone for the reclaimed water distribution system. One reclaimed water main runs up Cave Creek Road to Tatum Boulevard, and the other reclaimed water main follows along the Mayo Boulevard alignment to 64th Street. Reclaimed water is used to irrigate facilities that have large amounts of turf such as golf courses, parks, schools and cemeteries. Although this first phase proved to be an effective method of reducing the demand for potable water in the targeted area, the costs associated with constructing a dedicated distribution system for reclaimed water and difficulties associated with balancing the supply and customer demand have led the City to begin implementing groundwater recharge as an alternative to direct reuse.

The second phase of the program will maximize flexibility and efficacy of utilizing the new water resources created from future expansions of the Cave Creek Plant, as well as the future North Gateway plant or other water reclamation plants, through groundwater recharge and recovery rather than through direct reuse. More specifically, it is anticipated that the additional water produced by new reclaimed water facilities in northern Phoenix will be transported to recharge facilities, where it will be used to recharge aquifers and to provide additional groundwater credits under the rules established by the Arizona Groundwater Management Act.

For purposes of this study, it is assumed that the current capacity (8 MGD) of the Cave Creek Reclamation plant will be used to provide water to users in northeast Phoenix through the existing non-potable distribution system and additions to that system. Additional capacity provided by subsequent expansions of the Cave Creek Reclamation Plant and the new North Gateway reclamation plants will be used for recharge. Existing and potential recharge sites are located in relatively close proximity to both the Cave Creek plant and potential future plant sites in North Gateway, so the cost of constructing transmission lines for reclaimed water to recharge zones would be considerably less than that associated with constructing lines to transport 91st Ave reclaimed water to the Agua Fria or other recharge areas.

Costs associated with this option include:

- Any treatment costs associated with those beyond standard secondary wastewater treatment that might be required to facilitate water recharge.
- Costs associated with the design and construction of transmission and storage facilities needed to move reclaimed water from the treatment facilities to the recharge zones or injection sites.
- Capital costs associated with the development of recharge facilities, including purchase of land, drilling vadose zone wells or digging recharge basins, site construction (including access roads, power lines, and fencing), and electrical and mechanical equipment.
- Costs associated with the development of well sites, including drilling, well-site construction (including access roads, power lines or generators, and fencing), provision of electrical and mechanical equipment, and any additional treatment facilities for arsenic, nitrates or other contaminants.



- Costs associated with transporting well water to the existing potable water network or to a small, remote, non-potable water network.

Construction of these facilities would be timed to follow the various expansions of the Cave Creek WRF and construction of the North Gateway Reclamation Plant (or plants). Further studies by the Phoenix WSD will determine whether all future reclamation capacity will be located at the site that has already been acquired near I-17 and Dixeleta or will be divided between that location and an additional site west of I-17. Ultimate distribution/location of the reclamation treatment capacity will largely depend on anticipated opportunities for cost-effective reclaimed water recharge and well-field recovery.

The cost estimates for the North Phoenix reclamation projects are summarized in Section .3.

2.6 CENTRAL ARIZONA PROJECT REALLOCATION

The *Arizona Water Settlements Act* (Public Law 108-451-Dec. 10, 2004), Title 1, Sec. 104, provides for 8,206 acre-feet of previously un-contracted CAP municipal and industrial (M&I) priority water to be reallocated to the City of Phoenix. This water is expected to be available to Phoenix in 2008.

The Secretary of Interior declared the CAP canal substantially complete on October 1, 1993. This triggered the start of a CAP 50-year repayment period, within which CAWCD must repay the Federal Government for its share of money borrowed for the canal's construction. CAWCD assesses a capital charge to its subcontractors who purchase the CAP water to cover the repayment costs. If Phoenix wants to use the available reallocation water, it will be required by CAWCD to retroactively pay a proportionate share for the capital costs.

Costs for the CAP Reallocation water supply are summarized in Section .3.

2.7 LEASE OF CENTRAL ARIZONA PROJECT WATER FROM THE GILA RIVER INDIAN COMMUNITY

Section 205 of the *Arizona Water Settlements Act* (PL 108-451) authorizes the Gila River Indian Community (GRIC) to lease or exchange Central Arizona Project (CAP) water within various Arizona counties, including Maricopa County, subject to the approval of the Secretary of the Interior of the United States. The City of Phoenix expects to lease 15,000 AF/year of the CAP water available to GRIC. The City recently executed the lease agreement, and the actual costs for leasing CAP water from GRIC are summarized in Section 3.

2.8 WESTERN CANAL WATER

The City's current Water System Master Plan clearly shows the need for more water in its southern and south-western areas, and a site has been acquired for a proposed "Western Canal WTP" at 15th Avenue and SRP's Western Canal. Much of the territory to be served by this plant



has rights to SRP (Salt/Verde River) supplies, which become available to the City as agricultural land urbanizes. Water quality in the Western Canal is characterized by higher nitrate and TDS levels than those found in the SRP canals serving the City's Val Vista, Deer Valley and 24th Street WTPs.

As the City evaluated the costs for the Western Canal WTP, it found that the unit cost to treat the Western Canal water is significantly higher than those for the other plants on the SRP and CAP systems. The unit cost differential to treat the poorer water quality is considered a water resources acquisition cost. Estimated costs are summarized in Section 3. It should be noted that drilling additional wells to provide dilution to the Western Canal water or obtaining other SRP water sources are viable alternatives to improve the water quality to be used by the Western Canal WTP, but these alternatives appear to be more costly than providing additional pretreatment filtration.

2.9 WATER EFFICIENCY FOR NEW DEVELOPMENT

Water efficiency is an essential element in any utility's water supply portfolio. Successful efficiency programs reduce demand and accordingly, the need for future supply expenditures. Phoenix's water efficiency initiatives have resulted in a 20% reduction in per-capita usage over the last 20 years, and the City continually seeks to extend these results with additional programs. The reductions presented in the Tables 2a and 2b reflect the difference between the "stable rate" scenario presented in the WRP (which assumes all growth will develop at today's water use rate) and long term water efficiency use rates achieved through the efforts of ongoing City of Phoenix water efficiency initiatives. The anticipated long-term cost as calculated by the City is listed in Section .3.



3.0 PROJECT COST ESTIMATES

3.1 OVERVIEW OF COST ESTIMATES

Red Oak further evaluated the WRA Projects to identify the capital and operations and maintenance (O&M) costs of each project. This evaluation also considered the City's cost share costs on collaborative projects involving more than one party, such as the Agua Fria Linear Recharge Project. Capital costs were developed to support the WRAF Phase 2 study, while O&M costs were developed only to support this Phase 1 study and to assist the City with its long-range water resources planning.

In all cases, Red Oak excluded capital costs associated with routine surface water treatment and transmission infrastructure after treatment (e.g., distribution system piping, booster pumps, and storage facilities to convey treated water). If a single facility included water resource and treatment/distribution infrastructure, Red Oak included only the costs associated with the water resource related components. For example, Red Oak included the cost of wastewater treatment infrastructure prior to reclaimed water recharge and recovery for only those components required for groundwater recharge purposes (e.g., additional tertiary treatment, membranes, etc.).

Capital Cost Estimates

Red Oak estimated the total capital costs for each WRA Project, which included:

- Land acquisition costs, if applicable
- Costs or fees to purchase water rights, or to lease water from other government and nongovernmental agencies, if applicable
- Facility construction costs, including raw water storage and conveyance from the source to existing or planned treatment facilities (pipes, reservoir, boosters, etc.)
- Capital costs for groundwater well installation, including well development. Red Oak's estimates reflect the City's actual costs for well installation, and well development.
- Capital costs for groundwater well-head treatment, if required
- Reclaimed water tertiary filtration costs associated with improving water quality to levels required for recharge
- Capital costs for treating poor quality surface water from the Western Canal to bring it to a quality equal to average raw water quality for the water used by the City's existing WTPs
- Construction contingency (25 percent of the estimated construction costs)
- Engineering and administration contingencies (10 percent of the total estimated construction costs, including contingency)
- Construction management and legal contingencies (15 percent of the total estimated construction costs, including contingency)



Capital costs are expressed in July 2005 dollars, and exclude financing costs. For projects involving lease or reallocation of CAP water, capital investment costs represent the initial payment required to acquire the water supply and exclude future annual payments to the supplier. Capital costs for each WRA Project are tabulated in the following subsections and are summarized in Section 4.

Operations and Maintenance Expenses

To aid the City in its planning efforts and provide a means to compare alternative water supplies not only based on required capital investment costs but also based on recurring operations costs, Red Oak tabulated annual O&M expenses for each WRA project. O&M expenses include labor, materials, energy, and other recurring costs or fees for water conveyance or transport from the source to existing or planned treatment facilities.

For projects involving reallocation of CAP water, O&M expenses include the fixed Operation, Maintenance & Repair (OM&R) costs and pumping energy charges assessed by CAWCD. Detailed estimates of individual project costs are detailed in the following sections below. O&M costs for all projects are summarized in Section 4.

Annualized Cost Estimates

Annualized costs include two components: annualized capital costs plus annual O&M costs. Red Oak amortized the initial capital cost over a 20-year period, assuming an interest rate of 6 percent and level debt service payments each year. A twenty-year period is consistent with the City's typical bond repayment period.

For WRA projects involving reallocation of CAP water to the City of Phoenix, the annualized capital cost includes both the amortized initial capital investment and the current capital charge levied by CAWCD.

3.2 McMullen Valley Water Transfer Project

Conceptual designs for the two alternative conveyance systems were developed during the City's 1992 study. **Figures 5 and 6** are schematic diagrams of the cost components for the two alternatives.

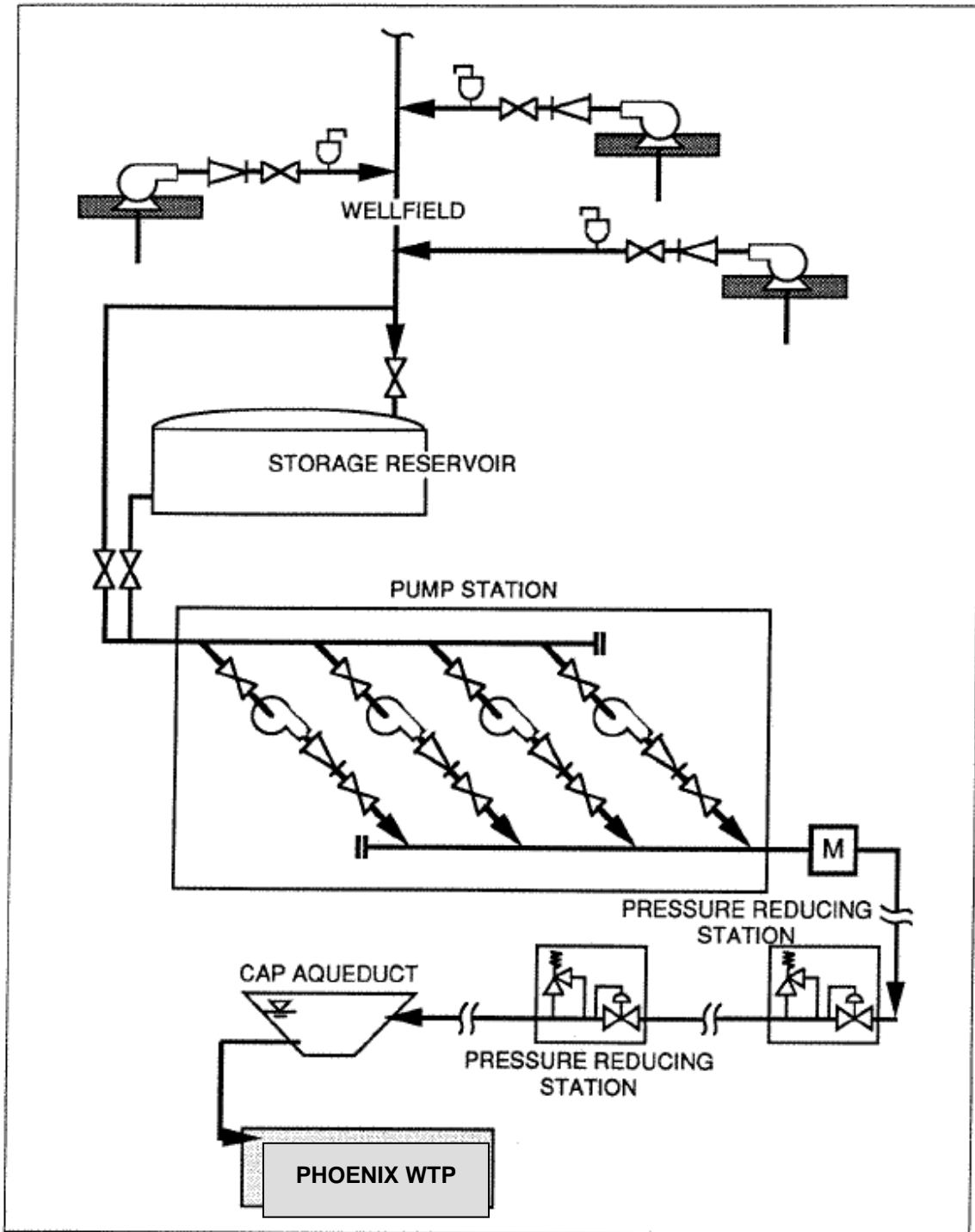


Figure 5: McMullen Valley Water Transfer Project –Western Alignment Schematic
(Courtesy: JMM Report)

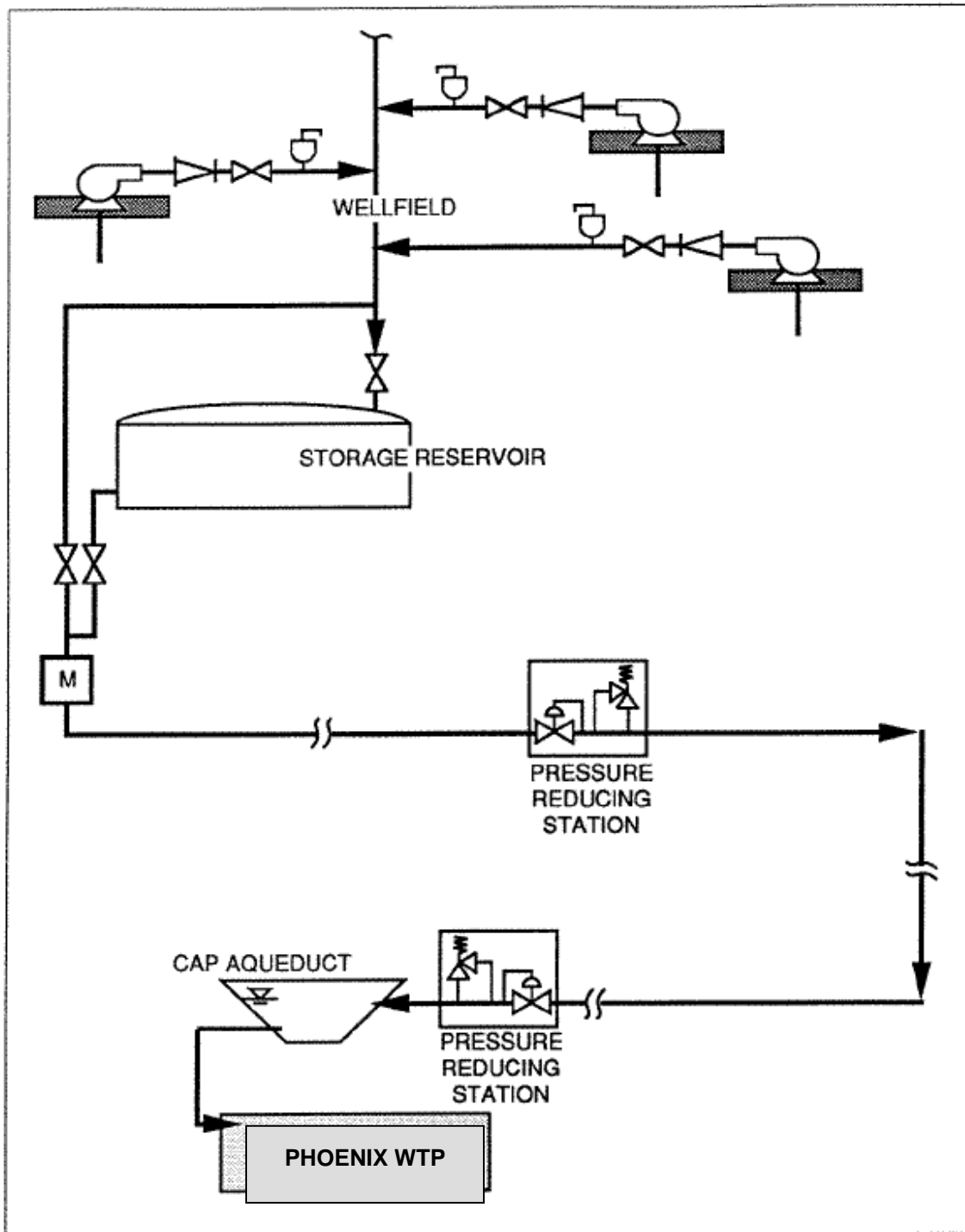


Figure 6: McMullen Valley Water Transfer Project – Southern Alignment Schematic
(Courtesy: JMM Report)



Based on the study and the discussion documented in Section 2, three major cost components were identified for the McMullen Valley Water Transfer Project: well field development, conveyance system from well field to the CAP canal, and CAP wheeling.

Two sets of cost estimates were developed. A conservative cost estimate is based upon the “Least Favorable” Alternative from the 1992 study (see Section 2 for an explanation of the selection of this alternative). Under this alternative, a total of seventy four wells with capacities varying from 1,100 gallon per minute (gpm) to 2,000 gpm were recommended for the well field. Well water would be collected by a manifold of pipes with sizes varying from 12-inch to 78-inch. A 7 million gallon reservoir was recommended to hold the water before sending it to the CAP canal. A cost estimate using the “Most Favorable” Alternative wheeling schedule was also developed. Under this alternative, a total of twenty one wells with capacities varying from 1,100 gallon per minute (gpm) to 2,000 gpm were recommended for the well field. Well water would be collected by a manifold of pipes with sizes varying from 12-inch to 48-inch. A 2 million gallon reservoir was recommended to hold the water before sending it to the CAP canal. Two cost tables were prepared for each of the two wheeling alternatives: one is for the Southern Alignment and the other is for the Western Alignment.

The Western Alignment would use a 2,800-HP pump station to pump the water from the reservoir to the CAP canal through a conveyance system comprised of 84-inch and 66-inch pipelines between the pump station and the canal. The Southern Alignment would use a 66-inch gravity pipe to convey water from the reservoir to the canal. Both alignments would require two 66-inch pressure reducing valve (PRV) stations. The system would have telemetry for remote access from UHWTP. Water conveyed through the CAP canal would be pumped to Phoenix treatment plants using existing intake systems.

In addition to the one time capital costs of the project, the City would incur O&M costs including costs for power, labor, material, sampling, CAP wheeling, and groundwater transportation. Energy costs and wheeling charges dominate the O&M costs for this WRA project. Wheeling costs are assumed charges by CAWCD for use of space in the CAP canal. Annual wheeling costs were calculated using the information provided by CAWCD in 1992 (see JMM Report for details). Wheeling costs include the proportionate CAP capital cost repayment share, annual operation, maintenance and replacement (OM&R) costs, and energy costs for moving the water. It should be noted that CAWCD has not yet developed fees associated with the wheeling of “non-project” water.

The groundwater transportation cost is governed by the Ground Water Transportation Act (GWTA) which limits the transfer of groundwater between basins. Two types of charges defined in the GWTA are applicable to the McMullen Valley Water Transfer Project: (1) a payment in-lieu of property taxes; and (2) a transportation fee. The in-lieu payment would be calculated by the La Paz County Assessor in accordance with the GWTA stipulations. The 1992 reported in-lieu property tax payment for the McMullen Valley project was estimated at \$175,000 which is less than what Phoenix paid in recent years. During the period of 1996-2005, Phoenix has paid \$1,959,000 in in-lieu taxes. Tax for 2005 alone was \$279,783. The transportation fee would also be calculated using GWTA stipulations, based on the amount of water transferred. In the 1992



JMM report, an inverted block rate schedule was used to calculate the groundwater transportation cost. Based on this schedule, the fee ranges from a minimum of \$3/AF for the first 1,000,000 AF of water transferred, to a maximum of \$30/AF for any water transferred in excess of 5,000,000 AF. A project-life cost of \$39,000 per year was calculated in 1992 for the transportation fee. Adding the cost components, the 1992 estimated groundwater transportation cost was \$214,000 (\$175,000 + \$39,000). For this Technical Memorandum, a yearly in-lieu tax of \$280,000 (2005 payment) was used to calculate groundwater transportation cost which is \$319,000. The fee schedule used in 1992 to compute the transportation fee can be adjusted upward by ADWR director in accordance with changes in an index defined by GWTA as the “GNP price deflator”.

The GWTA also allows for a credit for increased property tax valuation. The 1992 costs did not include this credit and have not been adjusted by the GNP price deflator. Current groundwater transportation costs could be determined through consultation with La Paz County Assessor’s office at an appropriate time. In the absence of detailed updated rates, the present analysis uses the groundwater transportation costs that were determined in 1992 and documented in the JMM report.

Tables A1 and A2 in Appendix A present the estimated costs for the McMullen Valley Water Transfer Project for both Western and Southern conveyance alignments based on the Least Favorable wheeling schedule. Table A3 and A4 in Appendix A present the project costs for both the conveyance alternatives based on the Most Favorable wheeling schedule. The summary of estimated project costs is shown in **Table 5**.

Table 5: Cost Summary of McMullen Valley Water Transfer Project

Alternative Alignment	Water Supply*	Total Capital Cost	Annualized Capital Cost	O&M Cost	Annualized Project Cost**	Unit Annualized Project Cost
<u>Least Favorable Route</u>						
Western Alignment	38,000 AF/Year	\$202,196,000	\$17,628,000	\$6,582,000	\$24,210,000	\$637 / AF
Southern Alignment	38,000 AF/Year	\$229,283,000	\$19,990,000	\$6,056,000	\$26,046,000	\$685 / AF
<u>Most Favorable Route</u>						
Western Alignment	38,000 AF/Year	\$103,395,000	\$9,014,000	\$7,502,000	\$16,516,000	\$435 / AF
Southern Alignment	38,000 AF/Year	\$109,199,000	\$9,520,000	\$7,224,000	\$16,744,000	\$441 / AF

* Average annual supply is used for acquisition fee calculation

** Annualized Capital Cost + O&M Cost

The most economically feasible alternative for the McMullen Valley Water Transfer Project is Western conveyance alignment, which uses the Most Favorable wheeling schedule. This alternative was selected for WRA Fee analysis.



3.3 AGUA FRIA LINEAR RECHARGE PROJECT

The AFLRP has three basic cost components relevant to determining WRA Fees: 1) Treatment costs attributable to water resources, 2) Capital costs associated with the recharge project; and 3) Capital costs associated with the recovery project. These three costs are described further in the following paragraphs.

- 1) Treatment costs attributable to water resources – Treatment costs were identified as the cost of the filters that will have to be installed to maintain certain level of water quality to discharge water into the environment for recharge. *The 91st Avenue Wastewater Treatment Plant 25-Year Facility Master Plan (2005-2030), Master Plan, December 2005* report (Master Plan) prepared by Greeley & Hansen and Malcolm Pirnie identified the advanced treatment needs at the WWTP. Such treatment is needed to capture fines or dissolved materials not removed by existing secondary treatment. Secondary effluent will be pumped through membrane filters to remove particles greater than the membrane pore size of 0.01 to 0.1 micron. Membrane filtration helps prevent aquifer clogging, and improves effluent quality by removing protozoa, bacteria, and viruses in its size range. Beneficial use of effluent including aquifer recharge and landscape irrigation may also require reduced TDS concentration. As the City predicts that the management of TDS will be a significant consideration for development of the planned markets for treated effluent, it developed plan to install a reverse osmosis (RO) system to remove dissolved solids. The Unified Plant at build-out is assumed to include a membrane filtration system and a reverse osmosis system. The conceptual process as described in the Master Plan is shown in **Figure 7**.

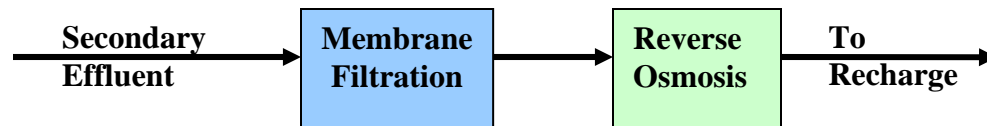


Figure 7: Proposed Enhanced Treatment Schematic for 91st Avenue WWTP

The cost for the membrane filtration system and reverse osmosis system are attributable to water resources. Costs developed using the 16,000 AF supply identified as needed from the AFLRP (per the 2030 portfolio listed in **Table 2b**) are listed in **Table 6**.



**Table 6: Summary of 91st Avenue WWTP's Treatment
Cost – Attributable to Water Resources**

Water Supply per the Portfolio¹	Cost for Membrane Filtration²	Cost for Reverse Osmosis³	Total Cost of Treatment	Phoenix's Share of Treatment Cost⁴	O&M Cost⁵
16,000 AF/Year	\$8,000,000	\$9,143,000	\$17,143,000	\$11,344,000	\$2,242,000

Note:

1. Facility treatment capacity projected for 2025 is 146 mgd including a wasting rate of 1.44. Cost attributable to water resources is developed based on the supply needed from the plant as per the 2030 supply portfolio developed for WRAF purposes.
 2. Membrane Filtration cost is based on the unit cost developed in the 2001 Master Plan Report (\$0.325/gallon), updated to 2005 value using the 2005 master Plan used escalation rate of 3.5% per year (\$0.37/gallon). A capital cost factor of 50% was added for engineering, administration, legal, and construction management. The unit cost used to develop the cost for membrane filtration was \$0.56/gallon.
 3. Reverse osmosis cost is based on the unit cost developed in the 2001 Master Plan Report (\$0.375/gallon), updated to 2005 value using the 2005 master Plan used escalation rate of 3.5% per year (\$0.43/gallon). A capital cost factor of 50% was added for engineering, administration, legal, and construction management. The unit cost used to develop the cost for membrane filtration was \$0.64/gallon.
 4. Phoenix's share used as 66.17% of the total cost based on the SROG billing schedule developed in August 2005 and listed in the 2005 Master Plan.
 5. O&M cost is developed based on the unit cost developed in the 2001 Master Plan Report (\$0.38/1000 gallon), updated to 2005 value using the 2005 master Plan used escalation rate of 3.5% per year (\$0.43/1000 gallon).
- 2) Capital costs associated with the recharge project – Recharge costs were developed using the conceptual designs presented by the consultant team PBS&J and VEE during the Sub-Regional Operating Group (SROG) Steering Committee Meeting held in August 24, 2005. Two flow delivery scenarios were being evaluated by the consultant team: 40,000 AF/year and 100,000 AF/year. The City decided to use only the 100,000-AF/year alternative to develop cost for acquisition.

Of the three alternative pipe routes being considered, pipe route C (shown in **Figure 5**) was used to develop the cost estimate for this WRA Fee report, since the estimated pipeline cost for this route is the most economical among the three routes and appears most likely to move forward in the planning process. Using pipe route C, several alternatives developed by the consultant team were examined, each alternative representing a different combination of possible sizes of the principal infrastructure components. Four alternatives were developed for a 100,000 AF/year system. These alternatives are listed in Table C-1, Appendix C. Cost for each alternatives include pipeline costs, and pump station costs. A detailed cost table based on the conceptual design provided by the City's consultant team is included in Table C-2, Appendix C. For the purposes of the present analysis, it was assumed that the least expensive alternative (Alternative A-3) would be implemented. This alternative form the basis for the AFLRP cost evaluation in this report.

The Master Plan indicated that the total effluent capacity of the 91st Avenue WWTP would be 204.5 mgd after UPO-1 project is completed by 2010. Phoenix would own 112.8 mgd or 55 percent of the Plant capacity. Since AFLRP is a SROG project, it is



assumed that the total recharge capacity would be owned by the member agencies in proportion to their percent ownership of the plant influent. Based upon this assumption Phoenix's proportionate share of recharge costs is 55% which is also listed in Table C-2, Appendix C. As, Phoenix will need to use only 16,000 AF water credit to meet its 2030 demand, only the cost to transport and recharge 16,000 AF of reclaimed water is considered for the WRAF calculation.

- 3) Capital costs associated with the recovery project - The City would receive groundwater extraction credits for nearly 100% of its share of water recharged through the AFLRP. Based upon its assumed 55% ownership share of the recharge water, Phoenix's credit for recharge would be approximately 55,000 AF/year. To recover the credit, Phoenix would have to install new production wells. Based on the 2030 water supply portfolio used for WRA purposes, Phoenix will need to recover only 16,000 AF of recharged water from this resource project. This 16,000 AF water would be a part of the 55,000 AF/ year credit generated from AFLRP. Water can be extracted from the aquifers underlying Phoenix using 11 new production wells with a capacity of 1,500 gpm per well and 65% duty cycle. The costs to recover groundwater credits are listed in Table C-3, Appendix C. They are based upon individual well costs presented in Table B-1 of Appendix B.

A summary of estimated capital costs for the AFLRP is presented in **Table 7**. **Table 8** summarizes O&M and total project costs for the AFLRP project.

Table 7: Summary of Agua Fria Linear Recharge Project Capital Costs

Water Supply Per the Portfolio	Capital Cost for Treatment	Capital Cost for Transfer and Recharge	Capital Cost for Recovery*	Total Capital Cost	Annualized Capital Cost	Unit Annualized Capital Cost
16,000 AF/Year	\$11,344,000	\$16,480,000	\$48,869,000	\$76,693,000	\$6,686,000	\$418 / AF

* Includes well development and nitrate treatment cost

Table 8: Summary of Agua Fria Linear Recharge Project O& M Costs and Total Costs

Water Supply per the Portfolio	Annualized Capital Cost	O&M Cost*	Annualized Project Cost**	Unit Annualized Project Cost
16,000 AF/Year	\$6,686,000	\$5,957,000	\$12,643,000	\$790 / AF

* O&M cost include O&M for running the Plant, and O&M for the recovery well system

** Annualized Capital Cost + O&M Cost



3.4 RECLAIMED WATER FROM THE 23RD AVENUE WWTP

The treatment capacity of the 23rd Avenue WWTP, currently at approximately 54 MGD, is designed to be expanded to 90 MGD. Upon expansion, and as wastewater flow to the plant increases, available effluent will increase. In addition, as RID lands are converted to urban use, RID's demands for the reclaimed water will decrease, further increasing its availability for other uses.

No reports are yet available to identify the future quantity of 23rd Ave WWTP effluent available for reuse or the strategies and costs that would be involved with using this resource to expand the City's water supply. **Table 9** shows the water availability from the 23rd Avenue WWTP based on the available information.

Table 9: 23rd Ave WWTP Effluent Availability

Description	Current (2005)		Future (Buildout)	
	MGD	AF/Year	MGD	AF/Year
Effluent production capacity	54	60,480	90	100,800
River discharge requirement*	15	16,800	15	16,800
Supplied to RID for 3-way exchange**	27	30,000	27	30,000
Supplied to RID for in-lieu recharge**	12	13,700	13	15,000
Subtotal, Supplied to RID	39	43,700	40	45,000
Available	0	0	35	39,000

* Assumed to remain constant

** Amount delivered to RID will be reduced over time as farmland diminishes. Figures assume water will be recharged at AFLRP and/or other substitute facilities.

It appears that up to 39,000 AF/year of effluent could be available from this plant in the future and that use of this resource could be expanded either with an approach similar to that of the AFLRP (recharge) or with an approach similar to the north Phoenix plants (direct reuse). The water supply portfolio developed for the WRAF project does not incorporate water available from the 23rd Avenue WWTP before 2030.

3.5 RECLAIMED WATER FROM THE NORTHERN WATER RECLAMATION PLANTS

Like the AFLRP, this resource can also have three basic cost components relevant to determining WRA Fees: 1) Treatment costs attributable to water resources, 2) Capital costs associated with the recharge project; and 3) Capital costs associated with the recovery project. These three costs are described further in the following paragraphs.

- 1) Treatment costs attributable to water resources - CCWRF is a satellite plant that treats wastewater, uses effluent for direct reuse, and recharges effluent to get water credits. Though the intention was to create high quality water to be used in the water supply



portfolio as a resource, it is basically a wastewater treatment plant. There is no cost breakdown available to calculate cost attributable to water resources (if any). Since the City has to treat the wastewater influent to this plant anyway, whether or not it can use the effluent for reclamation, it decided to assign the entire cost of treatment to the wastewater utility. Treatment cost is, therefore, not included in the WRAF calculation.

- 2) Capital costs associated with the recharge project - Recharge process cost includes two components for this project. First is the cost for transportation of reclaimed water to the recharge field, and second is the cost for recharge facilities. Cost of transporting the reclaimed water from the CCWRF to the adjacent recharge site (distance is less than 5 miles) was developed using the transportation cost model developed for the AFLRP. Effluent transportation cost developed for the AFLRP was \$16,480,000. Since the transportation distance between the CCWRF and the adjacent recharge site is less than one quarter of the effluent transportation distance for the AFLRP (approximate), estimated cost for the CCWRF effluent transportation was considered as one quarter of the estimated cost for the effluent transportation developed in AFLRP. The calculated transportation cost for the Northern WRP effluent was \$4,120,000. Acquisition cost for the recharge component was calculated using the cost model developed in the *North Phoenix Recycled Water Distribution Master Plan* report (URS Report). Per the URS Report, the recharge cost estimates for developing 2,800 AF recharge project was \$2,410,939 (see Table D-1, Appendix D), which provides a unit recharge cost of \$861/AF. Thus, the cost of recharging 20,000 AF (2030 Supply; see **Table 2b**) would be \$17,220,000. Cost calculation is shown in **Table 10**.

Table 10: Recharge Cost for the CCWRF Effluent

Annual Quantity	Effluent Transportation Cost	Recharge Facility Cost	Total Recharge Cost
20,000 AF	\$4,120,000	\$17,220,000	\$21,340,000

- 3) Capital costs associated with the recovery project - The City would receive groundwater recharge credits for 100% of its share of water recharged. Based on the 2030 supply scenario shown in **Table 2b**, Phoenix’s credit for recharge would be 20,000 AF/year. To recover the credit, Phoenix would have to install new production wells. Water can be extracted from the aquifers underlying Phoenix using 13 new production wells with a capacity of 1,500 gpm per well and 65% duty cycle. The cost to recover groundwater credits is calculated as \$48,882,000 and the calculation is shown in Table D-2, Appendix D. This is based upon individual well costs presented in Table B-1 of Appendix B.

A summary of project costs is shown in **Table 11**.



Table 11: Cost Summary of Reclaimed Water from the CCWRF

Water Supply Capacity	Total Capital Cost	Annualized Capital Cost	O&M Cost	Annualized Project Cost*	Unit Annualized Project Cost
20,000 AF/Year	\$79,094,000	\$6,896,000	\$889,000	\$7,785,000	\$389 / AF

* Annualized Capital Cost + O&M Cost

3.6 CENTRAL ARIZONA PROJECT REALLOCATION

Charges involved in CAP reallocation project include four components: retroactive capital cost (i.e. recovery of past capital charges), current capital charges, OM&R costs, and pumping energy costs. CAP is using its own standard calculation procedure for the retroactive capital cost. Mr. Gary Givens, Senior Financial Analyst of CAP, informed the team that CAP will charge \$648 for every acre-foot of water to be reallocated to Phoenix in 2006. This is an approximate number and may vary depending on when Phoenix starts taking the reallocated water. CAP is still working on the details of how this amount will be collected (one-time total versus over several years). To maintain consistency throughout the WRA Fee project, the 2005 equivalent charge of \$616 per acre-foot will be used as the retroactive capital cost for capital cost calculation. The current capital charge rate will vary year to year. The City will have to pay the current capital charges for the full allocation regardless of the amount delivered and for every year until CAP completes its Federal loan repayment obligation. For the present analysis, the 2005 rate is used for the current capital charge component. OM&R charges are fixed for every acre-foot, and the City will have to pay for all ordered water whether delivered or not. The last component, the pumping energy rate, also is fixed for every acre-foot, and the City will be paying only for the delivered quantity. The City will have to pay both the OM&R costs and pumping energy costs as long as it continues to use the CAP water. CAP charges are shown in **Table 12**. The one time retroactive capital charge will be approximately \$5 million. Amortized over 20 years, the annualized retroactive capital cost will be \$670,000. A summary of capital and OM & R costs is provided in **Table 13**.

Table 12 – CAP Charges for Reallocation

Cost Item	CAP Charges* (\$/AF)	Quantity**	(AF/year)	Total Cost
Retroactive Capital Charge	616	8,206		\$5,055,000
Current Capital Charge	28	8,206		\$230,000/yr
Fixed OM&R Charge	47	8,206		\$386,000/yr
Pumping Energy Charge	32	8,206		\$263,000/yr

* Retroactive capital rate is the 2005 equivalent of the rate obtained from Mr. Gary Givens of CAP (using 5% discount rate); other unit costs are published CAP rates for 2005

** Assumed that the City will use the entire quantity of reallocated water



Table 13 – CAP Reallocation Cost Summary

Water Supply Capacity	Initial Acquisition Cost*	Annualized Capital Cost**	OM&R Cost***	Annualized Project Cost****	Unit Annualized Project cost
8, 206 AF/Year	\$5,055,000	\$670,000	\$649,000	\$1,319,000	\$161 / AF

- * One time cost for retroactive capital charge
- ** Include annualized retroactive capital charge assuming a 20 year amortization period and 6% interest rate and current capital charges
- *** Sum of other yearly charges (fixed OM&R charge + pumping energy charge)
- **** Annualized Capital Cost + O&M Cost

3.7 LEASE OF CENTRAL ARIZONA PROJECT WATER FROM GILA RIVER INDIAN COMMUNITY

The City of Phoenix agreed to pay a one-time lease charge for 15,000 acre-feet of from GRIC. This one-time lease charge would be equal to the leased volume of water multiplied by the product of the “base payment” and an inflation adjustment factor tied to the Consumer Price Index (CPI). Phoenix the option of paying the lease charge: (1) entire amount at the beginning of the lease term; (2) one half at the beginning of the lease term with the remainder of the principal spaced evenly over the following four years; or (3) over 15 years, in equal payments of principal. The second and third payment options would involve interest charges, since they spread the payment over multiple years. Interest would apply to any principal remaining unpaid after the first year. Excluding such interest, the one time lease charge would have been approximately \$25.5 million in 2005 dollars. It should be noted that the actual cost of \$27.6 million is reflected in the March 2008 Phase 2 report.

Operations, maintenance and repair (OM&R) costs for delivered water would be determined according to the City’s M&I Water Service Subcontract. Leased water would not be subject to CAP capital charges or other M&I subcontract charges. Charges payable to GRIC and CAWCD are shown in **Table 14** (interest charges not included). A summary of capital and OM&R costs is provided in **Table 15**.

Table 14: GRIC Charges for Water Lease

No.	Cost Item	Unit Cost* (\$/AF)	Quantity** (AF/Year)	Total Cost
1	Lease Charge***	1,697	15,000	\$25,455,000
2	Fixed OM&R Charge	47	15,000	\$705,000/Year
3	Pumping Energy Charge	32	15,000	\$480,000/Year

- * Lease charge unit cost based upon draft Goodyear-GRIC lease document and CPI-U (All Items Consumer Price Index, All Urban Consumers, U.S. City Average, from U.S. Department of Labor, Bureau of Labor Statistics); other unit costs are published CAP M&I rates for 2005.
- ** Assumes that the City will use the entire quantity of leased water.
- *** Total lease charge excludes interest payments associated with multi-year payment options.



Table 15: GRIC Leased Water Cost Summary

Water Supply Capacity	Initial Acquisition Cost*	Annualized Capital Cost**	OM&R Cost***	Annualized Project Cost	Unit Annualized Project Cost
15,000 AF/Year	\$25,455,000	\$2,219,000	\$1,185,000	\$3,404,000	\$227 / AF

- * One time cost for obtaining the right to the leased quantity, payable to GRIC
- ** Annualized GRIC charge assuming a 20 year amortization period and 6% interest rate
- *** Sum of all yearly charges (fixed OM&R charge + pumping energy charge)

3.8 WESTERN CANAL WATER TREATMENT

Typical treatment cost in the SRP canal system as observed in the existing WTPs varies from \$1.32/ gallon to \$1.88/gallon with an average cost of \$1.50/gallon. The City is currently developing conceptual level planning for the Western Canal WTP (WCWTP). The costs developed for this plant include various alternate treatment schemes including conventional, membrane, and UV systems. The City decided to use the unit treatment costs without membrane and UV systems, as developed by Carollo Engineers, in calculating the differential treatment costs to bring the Western Canal water quality to a level equal to the water quality of the other Phoenix WTPs (TDS≤700 mg/L). The differential cost is the cost that is in excess of what is typically required for a Phoenix WTP. This excess cost was considered as an acquisition cost for the WCWTP. The 2030 supply portfolio indicates that future supply needs from the SRP system would be approximately 38 mgd (43,000 AF/year). The City planned to build a 40 mgd treatment plant. Acquisition cost for this project includes differential cost for the proposed 40 mgd plant.

A treatment cost of \$2.13/gallon was assumed to be the cost of the proposed 40 mgd WCWTP. The excess cost is: $\$2.13 - \$1.5 = \$0.63$ / gallon. The water resources acquisition cost is: $\$0.63/\text{gallon} \times 40,000,000 \text{ gallons} = \$25,200,000$.

3.9 WATER EFFICIENCY FOR NEW DEVELOPMENT

The estimated total expenditure to implement the water efficiency measures in Phoenix is \$37,500,000 (\$1,500,000/year). WRAF costs will include only the cost that is allocated to conserve water for the new customers. The City developed following method to calculate water efficiency cost for new customers.

- Projected increase in population from 2005 to 2030: 648,137 persons
- Projected increase in base demand from 2005 to 2030: 163,005 AF

Water efficiency by New Customers:

- Target use rate established by the Arizona Department of Water Resources (ADWR): 175 gpcd. Though ADWR used different gpcd values for single family units, multi-



- family units and non-residential uses in the Third Management Plan, the City decided to use one value to simplify calculation.
- Projected City-wide demand increase using ADWR's target gpcd: 127,051 AF (648,137 persons x 175 gpcd x 365 / 325851)
 - Assuming 25 percent of savings already built in (savings by the existing customers), **savings for new customers from 2005 to 2030: 26,966 AF** [(163,005 AF – 127,051 AF) x (1- 25% Savings)]

Water efficiency by Existing Customers:

- 2005 base demand (existing) : 352,452 AF
- Assuming 7% reduction in overall existing demand from 2005 to 2030, **savings for existing customers: 24,672 AF** (352,452 AF x 7%)

WRAF Calculation:

- Savings Allocation:

Savings for Existing Customers:	24,672 AF (48%)
Savings for New Customers:	26,966 AF (52%)
- Total expenditure to conserve water for the new customers: \$19,582,000 (\$37,500,000 x 52%). This is the WRAF cost for water efficiency.
- Unit WRAF cost: \$726 / AF (\$19,582,000 / 26,966 AF)



4.0 SUMMARY OF ANALYSIS

Capital costs and unit capital costs presented in this report are the costs to acquire the water resources and construct delivery infrastructure. **Table 16** summarizes the water resources acquisition costs for all the eight projects identified in **Table 3**, Section 2. **Table 17** includes additional cost details.

Table 16: Summary of Water Resources Acquisition Costs

No.	WRA Project Name	Annual Water Supply (AF)	Acquisition Cost (\$)
1	McMullen Valley Water Transfer Project	38,000	103,395,000
2	Agua Fria Linear Recharge Project – Reclaimed Water from the 91st Ave WWTP	16,000	76,693,000
3	Reclaimed Water from the 23rd Avenue WWTP		
4	Reclaimed Water from the Northern WRPs	20,000	79,094,000
5	Central Arizona Project (CAP) Reallocation	8,206	5,055,000
6	Lease of Central Arizona Project (CAP) Water From Gila River Indian Community (GRIC)	15,000	25,455,000
7	Western Canal WTP – Incremental Cost	44,800	25,200,000
8	Water Efficiency	26,966	19,582,000
Total		168,972	333,474,000

* Unit Acquisition Cost = (Acquisition Cost) / (Annual Water Supply)



Table 17 – Detailed Water Resources Acquisition Costs

Project	Land/Water Rights (Incl. CAP Rights)	Water Reclamation Processes	Recharge Processes	Partially Treated or Untreated Water Transmission	Reclaimed Distribution & Transmission	Well Extraction ⁶	On-Site Treatment for Well Extraction ⁷	Total Cost	Potential Annual Acre/Ft. Obtained (Annual)
CAP Reallocation	\$5,055,000							\$5,055,000	8,206
GRIC CAP Water Lease	\$25,455,000							\$25,455,000	15,000
McMullen Valley Water ¹				\$64,927,000		\$38,468,000		\$103,395,000	38,000
Reclaimed Water from the 91st Ave WWTP: Agua Fria Linear Recharge project ²		\$11,344,000			\$16,480,000	\$25,640,000	\$23,229,000	\$76,693,000	16,000
Reclaimed Water from the 23rd Ave WWTP ³									
Reclaimed Water from the Northern WRPs ⁴			\$17,220,000		\$4,120,000	\$30,302,000	\$27,452,000	\$79,094,000	20,000
Western Canal WTP Cost ⁵								\$25,200,000	44,800
Water efficiency ⁸								\$19,582,000	26,966
Total								\$334,474,000	168,972

Notes:

1. Costs for McMullen Valley Water Project are based on the system sizing per the 1992 JMM Report.
2. For water reclamation process costs, only the cost for future filters per the *91st Avenue WWTP 25 Year Facility Plan (2005-2030) Master Plan, December 2005* was used. For reclaimed water distribution and transmission costs, AFLRP costs were used. For well extractions and treatment costs, see note 6 and 7.
3. Not used for the current WRAF
4. Reclaimed water recharge cost was calculated based on the unit cost developed in the North *Phoenix Recycled Water Distribution Master Plan, January 2004 Report* prepared by GIS Southwest and URS. Reclaimed water transmission cost was developed using the unit costs used for the AFLRP. For well extraction and treatment costs, see note 6 and 7.
5. Typical treatment plant cost using SRP water=\$1.5/gallon. Proposed cost for the WCWTP due to the poorer quality water=\$2.13/gallon. So, incremental cost to acquire usable water is the difference which is (2.13-1.5)=\$0.63/gallon. Water needed in future within the SRP system is 42,607 AF = 38 mgd which is less than the proposed WCWTP size of 40 mgd. Acquisition cost was calculated for the 40 mgd supply capacity.
6. Well extraction cost includes cost to acquire land to install new wells. Wells are assumed to have a capacity of 1,500 gpm. A 65% duty cycle was assumed. Well costs are based on the *Groundwater Utilization Master Plan, Phase 1: Well Inventory and Groundwater Evaluation, Final report, July 2006 (HDR)*
7. Assuming that all wells will need treatment (arsenic, nitrate, and/or TDS).
8. Potential annual supply savings of 26,966 AF (in 2030) through water efficiency was calculated by the City.



A summary of O&M costs is listed in **Table 18** for information only. Capital costs (acquisition costs) were annualized using 6 percent interest rate and 20-year amortization period. Annualized capital costs were added to the annual O&M costs to calculate annualized project costs. Annualized project costs were divided by the supply capacity to generate unit annualized project cost. These costs are presented in **Table 19** for information purpose only to compare the total costs associated with funding alternative WRA projects, and were not included in any of the calculations associated with project capital costs or the determination of the WRAF

Table 18: Summary of O&M Costs
(For Information purpose only)

No.	WRA Project Name	Annual Water Supply (AF)	O&M Cost (\$)	Unit O&M Cost (\$/AF)
1	McMullen Valley Water Transfer Project	38,000	7,502,000	197
2	Agua Fria Linear Recharge Project – Reclaimed Water from the 91st Ave WWTP	16,000	5,957,000	372
3	Reclaimed Water from the 23rd Avenue WWTP			
4	Reclaimed Water from the Northern WRPs	20,000	889,000	44
5	Central Arizona Project (CAP) Reallocation Effluent Use Alternative	8,206	649,000	79
6	Lease of Central Arizona Project (CAP) Water From Gila River Indian Community (GRIC)	15,000	1,185,000	79
7	Western Canal WTP – Incremental Cost	44,800	-	-
8	Water Efficiency	26,966	-	-



**Table 19: Summary of Annualized Project Costs
(For Information purpose only)**

No.	WRA Project Name	Annual Water Supply (AF)	Annualized Project Cost (\$)	Unit Annualized Project Cost (\$/AF)
1	McMullen Valley Water Transfer Project	38,000	16,516,000	435
2	Agua Fria Linear Recharge Project – Reclaimed Water from the 91st Ave WWTP	16,000	12,643,000	790
3	Reclaimed Water from the 23rd Avenue WWTP	Not Evaluated	Not Evaluated	Not Evaluated
4	Reclaimed Water from the Cave Creek WRF	20,000	7,785,000	389
5	Central Arizona Project (CAP) Reallocation Effluent Use Alternative	8,206	1,319,000	161
6	Lease of Central Arizona Project (CAP) Water From Gila River Indian Community (GRIC)	15,000	3,404,000	227
7	Western Canal WTP – Incremental Cost	44,800	-	-
8	Water efficiency	26,966	-	-



5.0 REFERENCES

Arthur Young. *Development of a Water Resources Acquisition Fee, Draft Report*, City of Phoenix, Water Services Department, November 1988

James M. Montgomery. *McMullen Valley Water Transfer Project Study, Project Report*, City of Phoenix Project W-886457, December 1992

City of Phoenix, Water Services Department, Water Engineering Division. *Water Resources Plan Update 2005, Draft WRP*, February 2006

City of Phoenix, Water Services Department, Water Engineering Division. *Water Resources Plan Update 2000, Final report*, December 2000

Black & Veatch Corporation. *Water and Wastewater Facility Unit Cost Study, Final Report*, City of Phoenix, Water Services Department, Index No. WS85700053/WS90700035, November 2003

Arizona Water Settlements Act, Public Law 108-451-DEC. 10, 2004, 108th Congress

Draft Lease Agreement For CAP Water Among The City of Goodyear, The Gila River Indian Community and The United States, As Trustee for The Gila River Indian Community, Exhibit 17.1A, Work Session May 11, 2005 (this is a template for all other Cities leasing GRIC water)

HDR Engineering, Inc. *Groundwater Utilization Master Plan Phase 1: Well Inventory and Groundwater Capacity Evaluation, Draft Report*, July 15, 2005

GIS Southwest, URS. *North Phoenix Recycled Water Distribution Master Plan, Final report*, City of Phoenix, Water Services Department, Project No. WS85550010-S, January 2004

Valentine Environmental Engineers, *Agua Fria Linear Recharge Project Phase – 2 Delivery System Alternatives Analysis Update, Presentation*, SROG Steering Committee Meeting, August 24, 2005

Greeley and Hansen LLC, Malcolm Pirnie, Inc. *91st Avenue Wastewater Treatment Plant 25-Year Facilities Master Plan, Final Report*, Sub-Regional Operating Group, Project No. WS 90120014, December 2003

Greeley and Hansen LLC, Malcolm Pirnie, Inc. *91st Avenue Wastewater Treatment Plant 25-Year Facilities Master Plan (2005-2030), Sub-Regional Operating Group*, Project No. WS 90120028, December 2005

Greeley and Hansen LLC, Malcolm Pirnie, Inc. *UPO5 Flow and Loading Projections, Draft Report*, Sub-Regional Operating Group, Project No. WS 90120028, May 2005



City of Phoenix, Arizona
Water Resources Acquisition Fee Update
Phase 1: Technical and Cost Data

Appendix A: McMullen Valley Water Transfer Project – Notes and Assumptions





APPENDIX A: McMullen Valley Water Transfer Project – Notes and Assumptions

Project Name: McMullen Valley Water Transfer Project

Source Document: McMullen Valley Water Transfer Project Study, JMM

1. All quantities are based on the source document (JMM Report)
2. Well costs are based on bare well costs per the report: Groundwater Utilization Master Plan Phase I: Well Inventory and Groundwater Capacity Evaluation, Final Report, July 2006, HDR Engineering, Inc.
3. Pump and motor cost for the wells were obtained from vendor quotes.
4. Pipe costs are based on the report: Water and Wastewater Facility Unit Cost Study, Final Report, November 2003, Black & Veatch Corporation. Unit costs were updated to reflect 2005 dollars using the ENR CCI.
5. Well discharge pipe costs include cost of pipes, flow meters, air vacuum valve, check and gate valves, pressure gauges and other accessories to send water to the collection system.
6. Sampling costs are lump sum costs.
7. Reservoir costs are based on Malcolm Pirnie, Inc. developed cost data.
8. Power quantity is based on 1992 JMM report. Kilowatts used in that report was based on power use during the maximum 15-minute period in a month. Power costs are based on recent APS Rate Schedule E-221, Energy Charge:

\$0.09726	per kWh for the first 240 kWh, plus
\$0.06612	per kWh for the next 275 kWh, plus
\$0.05429	per kWh for all additional kWh
9. Direct labor rates are based on the City's current water labor 2005-2006 obtained from Jill Celaya, Budget Supervisor, Water Services Department, City of Phoenix.
10. Maintenance material costs are lump sum costs to maintain the well field and the reservoir
11. Groundwater (GW) transportation costs are based on water transportation fee developed in the 1992 JMM report, and 2005 in-lieu tax paid by Phoenix.
12. Wheeling costs are based on 1992 JMM report.
13. Equipment life are based on 1992 JMM report.
14. An interest rate of 6% is used for amortization.
15. An additional 25% of construction costs are added for contingency.
16. Engineering & administrating costs are assumed to be 10% of the construction cost after adding contingency.
17. Construction management and other legal costs are assumed to be 15% of the construction cost after adding contingency.
18. Based on most recent data, the City's costs for groundwater wells increased approximately 41% between Red Oak's August 2007 report and this March 2009 report. This increase was applied to well costs only.



Table A-1 – Western Alignment – Least Favorable Scheduling*

Capital Cost						
Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
<u>Well Field</u>						
1100 gpm well	ea	4	\$600,000	\$2,400,000	20	\$209,243
1400 gpm well	ea	19	\$600,000	\$11,400,000	20	\$993,904
1500 gpm Well	ea	10	\$600,000	\$6,000,000	20	\$523,107
2000 gpm Well	ea	41	\$600,000	\$24,600,000	20	\$2,144,740
1100 gpm Pump	ea	4	\$127,000	\$508,000	20	\$44,290
1400 gpm Pump	ea	19	\$154,000	\$2,926,000	20	\$255,102
1500 gpm Pump	ea	10	\$158,000	\$1,580,000	20	\$137,752
2000 gpm Pump	ea	41	\$176,000	\$7,216,000	20	\$629,124
12" Pipe	lf	4,000	\$101	\$404,000	20	\$35,223
16" Pipe	lf	9,6800	\$109	\$10,551,200	20	\$919,902
20" Pipe	lf	2,9100	\$149	\$4,335,900	20	\$378,024
24" Pipe	lf	1,6300	\$167	\$2,722,100	20	\$237,325
30" Pipe	lf	2,600	\$193	\$501,800	20	\$43,749
36" Pipe	lf	4,100	\$222	\$910,200	20	\$79,355
42" Pipe	lf	4,000	\$269	\$1,076,000	20	\$93,811
48" Pipe	lf	4,300	\$312	\$1,341,600	20	\$116,967
54" Pipe	lf	1,400	\$363	\$508,200	20	\$44,307
60" Pipe	lf	8,000	\$418	\$3,344,000	20	\$291,545
66" Pipe	lf	5,800	\$471	\$2,731,800	20	\$238,171
78" Pipe	lf	12,500	\$612	\$7,650,000	20	\$666,962
12" Well Discharge Pipe	ea	33	\$50,000	\$1,650,000	20	\$143,855
16" Well Discharge Pipe	ea	41	\$70,000	\$2,870,000	20	\$250,220
Sampling	LS		\$30,000	\$30,000	20	\$2,616



Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
<i>Well Field Subtotal</i>				\$97,256,800		\$8,479,291
<i>Conveyance System</i>						
2800 HP Pump Station	LS	1	\$3,100,000	\$3,100,000	20	\$270,272
7 MG Reservoir	LS	1	\$4,000,000	\$4,000,000	20	\$348,738
84" Pipe	lf	9,700	\$695	\$6,741,500	20	\$587,755
66" Pipe	lf	36,300	\$471	\$17,097,300	20	\$1,490,621
66" PRV Station	ea	2	\$600,000	\$1,200,000	20	\$104,621
Telemetry	LS	1	\$10,000	\$10,000	20	\$872
<i>Conveyance System Subtotal</i>				\$32,148,800		\$2,802,879
Subtotal				\$129,405,600	20	\$11,282,170
Contingency - 25%				\$32,351,400	20	\$2,820,542
Engineering, Administration, Construction Management - 25%				\$40,439,250		\$3,525,678
Total Capital Cost				\$202,196,250		\$17,628,390
O&M Cost						
Power	kwh	446,02,591	Varies	\$2,421,488		
Operations Labor	mh	2,080	\$45	\$93,600		
Maintenance Labor	mh	2,080	\$50	\$104,000		
Maintenance Material	LS		\$148,000	\$148,000		
GW Transportation Cost	LS		\$319,000	\$319,000		
Sampling	LS		\$37,000	\$37,000		
CAP Wheeling (Summer)	\$/AF	2,4083	\$92	\$2,224,547		
CAP Wheeling (Winter)	\$/AF	1,3917	\$89	\$1,234,020		
Total O&M Cost				\$6,581,655		\$6,581,655
Total Annual Cost						\$24,210,046

*See Notes for Unit Cost Sources.



Table A-2 – Southern Alignment – Least Favorable Scheduling*

Capital Cost						
Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
<i>Well Field</i>						
1100 gpm well	ea	4	\$600,000	\$2,400,000	20	\$209,243
1400 gpm well	ea	19	\$600,000	\$11,400,000	20	\$993,904
1500 gpm Well	ea	10	\$600,000	\$6,000,000	20	\$523,107
2000 gpm Well	ea	41	\$600,000	\$24,600,000	20	\$2,144,740
1100 gpm Pump	ea	4	\$127,000	\$508,000	20	\$44,290
1400 gpm Pump	ea	19	\$154,000	\$2,926,000	20	\$255,102
1500 gpm Pump	ea	10	\$158,000	\$1,580,000	20	\$137,752
2000 gpm Pump	ea	41	\$176,000	\$7,216,000	20	\$629,124
12" Pipe	lf	4,000	\$101	\$404,000	20	\$35,223
16" Pipe	lf	96,800	\$109	\$10,551,200	20	\$919,902
20" Pipe	lf	29,100	\$149	\$4,335,900	20	\$378,024
24" Pipe	lf	16,300	\$167	\$2,722,100	20	\$237,325
30" Pipe	lf	2,600	\$193	\$501,800	20	\$43,749
36" Pipe	lf	4,100	\$222	\$910,200	20	\$79,355
42" Pipe	lf	4,000	\$269	\$1,076,000	20	\$93,811
48" Pipe	lf	4,300	\$312	\$1,341,600	20	\$116,967
54" Pipe	lf	1,400	\$363	\$508,200	20	\$44,307
60" Pipe	lf	8,000	\$418	\$3,344,000	20	\$291,545
66" Pipe	lf	5,800	\$471	\$2,731,800	20	\$238,171
78" Pipe	lf	12,500	\$612	\$7,650,000	20	\$666,962
12" Well Discharge Pipe	ea	33	\$50,000	\$1,650,000	20	\$143,855
16" Well Discharge Pipe	ea	41	\$70,000	\$2,870,000	20	\$250,220
Sampling	LS		\$30,000	\$30,000	20	\$2,616
<i>Well Field Subtotal</i>				\$97,256,800		\$8,479,291
<i>Conveyance System</i>						
7 MG Reservoir	LS	1	\$4,000,000	\$4,000,000	20	\$348,738



Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
66" Pipe	lf	94,000	\$471	\$44,274,000	20	\$3,860,009
66" PRV Station	ea	2	\$600,000	\$1,200,000	20	\$104,621
Telemetry	LS	1	\$10,000	\$10,000	20	\$872
<i>Conveyance System Subtotal</i>				<i>\$49,484,000</i>		<i>\$4,314,241</i>
Subtotal				\$146,740,800		\$12,793,532
Contingency - 25%				\$36,685,200		\$3,198,383
Engineering, Administration, Construction Management - 25%				\$45,856,500		\$3,997,979
Total Capital Cost				\$229,282,500		\$19,989,893
O&M Cost						
Power	kwh	414,67,244	Varies	\$2,251,270		
Operations Labor	mh	1,040	\$45	\$46,800		
Maintenance Labor	mh	1,040	\$50	\$52,000		
Maintenance Material	LS		\$148,000	\$148,000		
GW Transportation Cost	LS		\$319,000	\$319,000		
Sampling	LS		\$37,000	\$37,000		
CAP Wheeling (Summer)	\$/AF	24,083	\$85	\$2,047,055		
CAP Wheeling (Winter)	\$/AF	13,917	\$83	\$1,155,111		
Total O&M Cost				\$6,056,236		\$6,056,236
Total Annual Cost						\$26,046,129

*See Notes for Unit Cost Sources.



Table A-3 – Western Alignment – Most Favorable Scheduling*

Capital Cost						
Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
<i>Well Field</i>						
1100 gpm well	ea	1	\$600,000	\$600,000	20	\$52,311
1400 gpm well	ea	5	\$600,000	\$3,000,000	20	\$261,554
1500 gpm Well	ea	2	\$600,000	\$1,200,000	20	\$104,621
2000 gpm Well	ea	13	\$600,000	\$7,800,000	20	\$680,040
1100 gpm Pump	ea	1	\$127,000	\$127,000	20	\$11,072
1400 gpm Pump	ea	5	\$154,000	\$770,000	20	\$67,132
1500 gpm Pump	ea	2	\$158,000	\$316,000	20	\$27,550
2000 gpm Pump	ea	13	\$176,000	\$2,288,000	20	\$199,478
16" Pipe	lf	44,600	\$109	\$4,861,400	20	\$423,839
20" Pipe	lf	7,800	\$149	\$1,162,200	20	\$101,326
24" Pipe	lf	8,900	\$167	\$1,486,300	20	\$129,582
30" Pipe	lf	6,500	\$193	\$1,254,500	20	\$109,373
36" Pipe	lf	4,100	\$222	\$910,200	20	\$79,355
42" Pipe	lf	16,000	\$269	\$4,304,000	20	\$375,242
48" Pipe	lf	31,300	\$312	\$9,765,600	20	\$851,410
12" Well Discharge Pipe	ea	8	\$50,000	\$400,000	20	\$34,874
16" Well Discharge Pipe	ea	13	\$70,000	\$910,000	20	\$79,338
<i>Well Field Subtotal</i>				<i>\$41,155,200</i>		<i>\$3,588,098</i>
<i>Conveyance System</i>						
800 HP Pump Station	LS	1	\$3,640,000	\$3,640,000	20	\$317,352
2 MG Reservoir	LS	1	\$900,000	\$900,000	20	\$78,466
48" Pipe	lf	9,700	\$312	\$3,026,400	20	\$263,855
36" Pipe	lf	36,300	\$222	\$8,058,600	20	\$702,585
36" PRV Station	ea	2	\$1,087,000	\$2,174,000	20	\$189,539



Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
Telemetry	LS	1	\$10,000	\$10,000	20	\$872
<i>Conveyance System Subtotal</i>				<i>\$17,809,000</i>		<i>\$1,552,670</i>
Subtotal				\$58,964,200		\$5,140,768
Contingency - 25%				\$14,741,050		\$1,285,192
Engineering, Administration, Construction Management – 25%				\$18,426,313		\$ 1,606,490
Total Capital Cost				\$92,131,563		\$8,032,449
O&M Cost						
Power	kwh	44,346,212	\$2,407,569.488	\$2,407,569		
Operations Labor	mh	2,080	\$45	\$93,600		
Maintenance Labor	mh	2,080	\$50	\$104,000		
Maintenance Material	LS		\$42,000	\$42,000		
GW Transportation Cost	LS		\$319,000	\$319,000		
Sampling	LS		\$10,500	\$10,500		
CAP Wheeling (Summer)	AF	25,000	\$92	\$2,300,000		
CAP Wheeling (Winter)	AF	25,000	\$89	\$2,225,000		
Total O&M Cost				\$7,501,669		\$7,501,669
Total Annual Cost						\$15,534,119

*See Notes for Unit Cost Sources.



Table A-4 – Southern Alignment – Most Favorable Scheduling*

Capital Cost						
Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
<i>Well Field</i>						
1100 gpm well	ea	1	\$600,000	\$600,000	20	\$52,311
1400 gpm well	ea	5	\$600,000	\$3,000,000	20	\$261,554
1500 gpm Well	ea	2	\$600,000	\$1,200,000	20	\$104,621
2000 gpm Well	ea	13	\$600,000	\$7,800,000	20	\$680,040
1100 gpm Pump	ea	1	\$127,000	\$127,000	20	\$11,072
1400 gpm Pump	ea	5	\$154,000	\$770,000	20	\$67,132
1500 gpm Pump	ea	2	\$158,000	\$316,000	20	\$27,550
2000 gpm Pump	ea	13	\$176,000	\$2,288,000	20	\$199,478
16" Pipe	lf	44,600	\$109	\$4,861,400	20	\$423,839
20" Pipe	lf	7,800	\$149	\$1,162,200	20	\$101,326
24" Pipe	lf	8,900	\$167	\$1,486,300	20	\$129,582
30" Pipe	lf	6,500	\$193	\$1,254,500	20	\$109,373
36" Pipe	lf	4,100	\$222	\$910,200	20	\$79,355
42" Pipe	lf	16,000	\$269	\$4,304,000	20	\$375,242
48" Pipe	lf	31,300	\$312	\$9,765,600	20	\$851,410
12" Well Discharge Pipe	ea	8	\$50,000	\$400,000	20	\$34,874
16" Well Discharge Pipe	ea	13	\$70,000	\$910,000	20	\$79,338
<i>Well Field Subtotal</i>				<i>\$41,155,200</i>		<i>\$3,588,098</i>
<i>Conveyance System</i>						
2 MG Reservoir	LS	1	\$900,000	\$900,000	20	\$78,466
42" Pipe	lf	94,000	\$269	\$25,286,000	20	\$2,204,549
42" PRV Station	ea	2	\$1,268,167	\$2,536,333	20	\$221,129
Telemetry	LS	1	\$10,000	\$10,000	20	\$872
<i>Conveyance System Subtotal</i>				<i>\$28,732,333</i>		<i>\$2,505,016</i>
Subtotal				\$69,887,533		\$6,093,114
Contingency - 25%				\$17,471,883		\$1,523,278



Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
Engineering, Administration, Construction Management – 25%				\$21,839,854		\$1,904,098
Total Capital Cost				\$109,199,271		\$9,520,490
O&M Cost						
Power	kwh	41,047,385	\$222,8476	\$2,228,476		
Operations Labor	mh	1,040	\$45	\$46,800		
Maintenance Labor	mh	1,040	\$50	\$52,000		
Maintenance Material	LS		\$42,000	\$42,000		
GW Transportation Cost	LS		\$319,000	\$319,000		
Sampling	LS		\$10,500	\$10,500		
CAP Wheeling (Summer)	AF	25,000	\$92	\$2,300,000		
CAP Wheeling (Winter)	AF	25,000	\$89	\$2,225,000		
Total O&M Cost				\$7,223,776		\$7,223,776
Total Annual Cost						\$16,744,266

*See Notes for Unit Cost Sources.



City of Phoenix, Arizona
Water Resources Acquisition Fee Update
Phase 1: Technical and Cost Data

**Appendix B:
Groundwater Wells
Notes and Assumptions**





APPENDIX B: Groundwater Wells – Notes and Assumptions

Ground Wells Capacity Development

Source Document: Groundwater Utilization Master Plan, Phase 1: Well Inventory and Groundwater Capacity Evaluation

1. New well cost includes costs for bare well development, sampling and disinfection, pump and appurtenances, 200' x 200' land, electrical instrumentation.
2. An additional 25% of construction costs are added for contingency.
3. Engineering and administration are assumed to be 10% of the construction cost after adding contingency.
4. Construction management and other legal costs are assumed to be 15% of the construction cost after adding contingency.
5. Cleaning well shaft every 5 to 10 years is recommended.
6. Direct labor rates are based on the City's current water labor 2005-2006 obtained from Jill Celaya, Budget Supervisor, Water Services Department, and the City of Phoenix. for full time labor of one operator and one maintenance person.
7. Power requirements were calculated using kWh numbers used in the McMullen Valley Water Transfer Project and adjusting the kWh proportionally based on proportional utilization factor, depth of water and system head; 100 percent utilization of the production wells (year-round operation) were assumed.

APS Rate schedule E-221 was used, Energy Charge:

\$0.09726	per kWh for the first 240 kWh, plus
\$0.06612	per kWh for the next 275 kWh, plus
\$0.05429	per kWh for all additional kWh

8. An interest rate of 6% is used for cost amortization.
9. Based on most recent data, the City's costs for well items have increased.



Table B-1 – Cost of New Well*

Item	Qty.	Unit	Unit Cost	Item Cost
Bare Well**	1	LS	\$600,000	\$600,000.00
Pump & Equipping***	1	LS	\$250,000	\$250,000.00
Land****	40,000	SF	\$3	\$120,000.00
Electrical & Instrumentation*****	1	LS	-	\$85,000.00
Well Construction Cost				\$1,055,000.00
Construction Contingency (25%)				\$263,750.00
Engineering, Inspection, and Construction Management (25%)				\$329,687.00
Total Well Development Cost*****				\$1,648,437.00
Well -head Treatment Cost*****				\$2,111,688.00
Total Well Acquisition Cost				\$3,760,125.00

- * Costs are modified from HDR reported costs. Adjustment reflects different percentage of construction costs as construction contingency, engineering, administration and management costs.
- ** Includes 18" diameter well casing at 1500 gpm and 1000 feet deep, surface conductor casing, borehole, gravel tube, well seal, well development, sampling, testing, and disinfection.
- *** Includes pump, equipping, testing, and other appurtenances.
- **** Assumes 200' x 200' area for new well and associated well head treatment.
- ***** Assumes 10% of construction cost with available power supply with emergency generator backup connection (no generator).
- ***** Based on actual bids received by the City, cost's have increased from \$1,648,437 to \$2,467,330.
- ***** Nitrate treatment cost, see Table B2.



Table B-2 – Well-head Treatment Costs

Item	Treatment Method	Unit	Unit Cost	Construction Contingency (25%)	Engineering, Administration, & Construction Management (25%)	Total Cost per Well
Capital Cost*						
Arsenic Treatment	GIM Treatment	LS / Well	\$956,200	\$239,050	\$298,813	\$1,494,063
Nitrate Treatment	Ion Exchange	LS / Well	\$1,351,480	\$337,870	\$422,338	\$2,111,688
TDS Removal	RO Treatment	LS / Well	\$1,099,601	\$274,900	\$343,625	\$1,718,126
O & M Cost**						
Arsenic Treatment	GIM Treatment	LS / Well	\$400,000			\$400,000
Nitrate Treatment	Ion Exchange	LS / Well	\$250,000			\$250,000
TDS Removal	RO Treatment	LS / Well	\$175,000			\$175,000

* Capital costs for Treatment in HDR report is updated to include the agreed upon construction contingency and engineering, administration and construction management costs used for the WRA projects in this report.

** O & M costs are based on Malcolm Pirnie's estimates from recent projects in Arizona.



City of Phoenix, Arizona
Water Resources Acquisition Fee Update
Phase 1: Technical and Cost Data

Appendix C: Agua Fria Linear Recharge Project Notes and Assumptions





APPENDIX C: Agua Fria Linear Recharge Project – Notes and Assumptions

Table C-1 – Agua Fria Linear Recharge Project Alternatives

Project Name:		Agua Fria Linear Recharge Project				
Source Document:		Agua Fria Linear Recharge Project, Phase-2, Delivery				
		System Alternatives Analysis Update, VEE Presentation				
Item	Capacity (AF/Year)	Pipeline Alternative	Pipeline Size (inch)	Equalization Basin Capacity (MG)	Pump Station Capacity (mgd)	Number of Pumps
Alternative A-1	100,000	Alternative C	1 - 108"	0	205	9
Alternative A-2	100,000	Alternative C	2 - 84"	0	205	9
Alternative A-3	100,000	Alternative C	1 - 90"	44	120	6
Alternative A-4	100,000	Alternative C	2 - 66"	44	120	6



Table C-2 – Capital Cost of Agua Fria Linear Recharge Project Alternatives

Project Name:	Agua Fria Linear Recharge Project							
Source Document:	Agua Fria Linear Recharge Project, Phase-2, Delivery							
	System Alternatives Analysis Update, VEE Presentation							
Item	Pipeline Cost	Pump Station Cost	Total Capital Cost	Pipeline Cost Amortization Period (Yr)	Pump Cost Amortization Period (Yr)	Annualized Pipe Cost	Annualized Pump Station Cost	Annualized Capital Cost
SROG Capital Cost								
Alternative A-1	\$131,700,000	\$16,300,000	\$148,000,000	20	20	\$11,482,206	\$1,421,108	\$12,903,314
Alternative A-2	\$164,200,000	\$16,300,000	\$180,500,000	20	20	\$14,315,704	\$1,421,108	\$15,736,813
Alternative A-3*	\$90,800,000	\$12,200,000	\$103,000,000	20	20	\$7,916,358	\$1,063,652	\$8,980,009
Alternative A-4	\$112,900,000	\$12,200,001	\$125,100,001	20	20	\$9,843,136	\$1,063,652	\$10,906,788
Phoenix's Share of Capital Cost**								
Alternative A-3*	\$49,940,000	\$6,710,000	\$56,650,000	20	20	\$4,353,997	\$585,008	\$4,939,005
Proportional Cost for 16,000 AF of water	\$14,528,000	\$1,952,000	\$16,480,000	20	20	\$1,266,617	\$170,184	\$1,436,801

* Selected alternative for WRA project cost calculation
 ** Phoenix's share of capital cost is assumed to be 55 percent of total SROG cost



Table C-3 – Costs to Recover Groundwater Credits for the AFLRP

Project Name:	Agua Fria Linear Recharge Project			
Source Document:	Groundwater Utilization Master Plan, Phase 1: Well Inventory and Groundwater Capacity Evaluation			
Alternative	Unit	Quantity	Unit Cost*	Item Cost
Capital Cost				
Well Installation Cost*	# of Wells	11	\$3,572,626	\$398,298,881
Land Cost	# of Wells	11	\$187,500	\$2,062,500
Total Capital Cost				\$41,361,381
O& M Cost				
Cleaning Well Shaft***	# of Wells	11	\$30,000	\$47,143
Operations Labor****	mh	540	\$45	\$24,300
Maintenance Labor*****	mh	540	\$50	\$27,000
Sampling	LS			\$12,000
Power*****	kWh	15,733,739	Varies	\$854,198
Treatment	# of Wells	11	\$250,000	\$2,750,000
Total O & M Cost				\$3,714,641
Total Annual Cost				

- * Based on most recent data, the City's costs have increased.
- ** Includes well development and Nitrate treatment cost.
- *** Cleaning is recommended in every 5 to 10 years (7years on average).
- **** 1 operator and 1 maintenance person, one quarter time each.
- ***** kWh is proportional to what used for groundwater well capacity development project.
- ***** 1 operator and 1 maintenance person, one tenth time each.



City of Phoenix, Arizona
Water Resources Acquisition Fee Update
Phase 1: Technical and Cost Data

**Appendix D:
Reclaimed Water
Notes and Assumptions**





APPENDIX D: Reclaimed Water – Notes and Assumptions

Table D-1 – Capital and O&M Costs for Reclaimed Water – Direct Delivery

Project Name:	Reclaimed Water Direct Delivery					
Source Document:	North Phoenix Recycled Water Distribution Master Plan, GISS & URS					
Item Description	Quantity	Units	Unit Cost	Total	Amortization Period (yr)	Annual Cost
Recharge Cost						
Vadoze Zone Wells	8	each	\$80,000	\$640,000	20	\$55,798
Dedicated Header	4,000	LF	\$120	\$480,000	20	\$41,849
Flow meter	8	each	\$6,000	\$48,000	20	\$4,185
Control Valves	8	each	\$5,000	\$40,000	20	\$3,487
Screening Facility	1	LS	\$150,000	\$150,000	20	\$13,078
Chlorination Pump & Accessories	1	LS	\$35,000	\$35,000	20	\$3,051
Miscellaneous Instrumentation	1	LS	\$25,000	\$25,000	20	\$2,180
Electrical	1	LS	\$100,000	\$100,000	20	\$8,718
Control System	1	LS	\$25,000	\$25,000	20	\$2,180
Total Construction Costs				\$1,543,000		\$134,526
Contingency (25%)				\$385,750		\$33,631
Engineering, Administration, Construction Management (25%)				\$482,188		\$42,039
Total Capital Cost				\$2,410,938		\$210,197



Table D-2 – Cost of Production Wells to Recover Groundwater Credit

Project Name:	Reclaimed Water Direct Delivery					
Source Document:	Groundwater Utilization Master Plan, Phase 1: Well Inventory					
	and Groundwater Capacity Evaluation					
Item	Unit	Quantity	Unit Cost	Item Cost	Amortization Period (yr)	Annual Cost
New Wells	# of Wells	13	\$3,760,125	\$48,881,625	20	\$4,261,723
O& M Cost						
					Life (Yr)	
Cleaning Well Shaft*	# of Wells	13	\$30,000	\$390,000	7	\$69,863
O&M Labor**	mh	540	\$45	\$23,400	-	\$24,300
Sampling	LS			\$6,000	-	\$6,000
Power***	kWh	14,538,283	\$789,297	\$789,297	-	\$789,297
Total O & M Cost						\$889,460
Total Annual Cost						\$5,151,183

* Cleaning every 5 to 10 years.
 ** One quarter time of one operator.
 *** kWh is proportional to that used for McMullen Valley Water Transfer Project.