East Raymond Basin Water Resources Plan Appendix E - Projected Extraction Demands

Prepared for: Cities of Arcadia and Sierra Madre And the Los Angeles County Department of Public Works







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EAST RAYMOND BASIN WATER RESOURCES PLAN APPENDIX E – PROJECTED EXTRACTION DEMANDS

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EAST RAYMOND BASIN WATER RESOURCES PLAN APPENDIX E – PROJECTED EXTRACTION DEMANDS

1.0 INTRODUCTION

Part of the East Raymond Basin Water Resources Plan requires the Project Team to develop projected water demands for the City of Arcadia and the City of Sierra Madre. Projected water demands will incorporate data from Urban Water Management Plans (UWMP), filed by both cities with the Department of Water Resources in 2000, and historical water extraction data from both cities.

In addition, the study of projected extraction demands includes an evaluation of the possibility of water exchanges and banking within the East Raymond Basin (ERB) to optimize "new" local/imported water that may be recharged in the ERB as a result of potential storage enhancements projects. The opportunity to utilize storage in the West Raymond Basin will also be evaluated.

2.0 HISTORIC WATER DEMANDS

2.1.1 City of Arcadia

Historical water extractions for the City of Arcadia have been obtained from ground water production from the Main San Gabriel Basin (Main Basin) and Raymond Basin, and imported surface water purchased from Upper San Gabriel Valley Water District, a member of Metropolitan Water District of Southern California. Table E-1 and Figure E-1 show historic extraction totals from each of the City of Arcadia's water sources. Imported surface water from Upper District is available through an interconnection but is used only in periods of emergency.

Table E-1
City of Arcadia – Water Extraction Totals (Acre-Feet)

Main Basin	Raymond Basin	Upper District	Total
11,184.22	6,005.45	0.00	17,189.67
9,801.69	5,411.91	631.70	15,845.30
7,323.35	6,414.71	0.00	13,738.06
9,493.29	5,200.48	0.00	14,693.77
7,486.55	7,707.16	0.00	15,193.71
7,863.02	7,436.50	0.00	15,299.52
11,214.80	5,512.10	0.00	16,726.90
10,175.83	7,103.10	0.00	17,278.93
9,328.21	5,750.90	0.00	15,079.11
8,737.43	7,315.40	0.00	16,052.83
11,696.19	6,182.60	0.00	17,878.79
11,161.46	6,021.60	0.00	17,183.06
11,417.87	5,595.90	0.00	17,013.77
12,153.32	4,547.50	0.00	16,700.82
12,438.79	5,077.60	540.50	18,056.89

Sources of Data: Annual Water Reports from Main San Gabriel Basin Watermaster and Raymond Basin Management Board (RBMB)

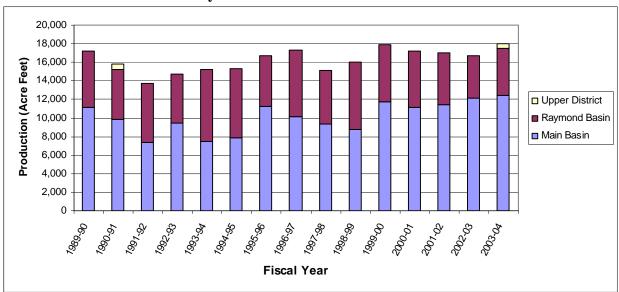


Figure E-1 City of Arcadia – Water Extractions

2.1.2 City of Sierra Madre

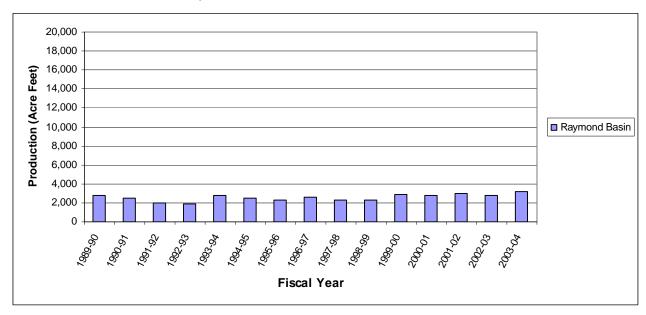
Historical water extractions for the City of Sierra Madre have been obtained solely from ground water production from the ERB. Table E-2 and Figure E-2 show historic extraction totals for the City of Sierra Madre.

Table E-2 City of Sierra Madre – Water Extraction Totals (Acre-Feet)

Sierra Madre Fiscal Year	Raymond Basin		
1989-90	2,769.95		
1990-91	2,504.50		
1991-92	2,011.56		
1992-93	1,893.34		
1993-94	2,783.08		
1994-95	2,464.10		
1995-96	2,269.00		
1996-97	2,553.20		
1997-98	2,244.30		
1998-99	2,302.10		
1999-00	2,897.10		
2000-01	2,755.50		
2001-02	2,969.30		
2002-03	2,762.80		
2003-04	3,229.60		

Sources of Data: Annual Water Reports from RBMB

Figure E-2 City of Sierra Madre – Water Extractions



3.0 PROJECTED WATER DEMANDS

3.1 Projected Water Demands Based on Urban Water Management Plans

An Urban Water Management Plan (UWMP), as required by the State of California's Urban Water Management Planning Act, describes and evaluates sources of water supply, reasonable and practical efficient uses, reclamation, and demand management strategies. The City of Arcadia's 2000 UWMP and the City of Sierra Madre's 2000 UWMP both provide projected water demands (see Table E-3).

Table E-3
UWMP - Projected Water Demands (Acre-Feet)

Year	City of Arcadia	City of Sierra Madre
2005	16,390	2,689
2010	16,800	2,745
2015	17,135	2,800
2020	17,477	2,860

The UWMP for the City of Arcadia projects water demands to increase from 16,390 acre-ft/year, in 2005, to 17,477 acre-ft/year, in 2020. The UWMP for the City of Sierra Madre projects water demands to increase from 2,689 acre-ft/year, in 2005, to 2,860 acre-ft/year, in 2020. However, the City of Arcadia's projected water demands for the year 2005 based on the UWMP (16,390 acre-ft/year) is less than existing current water demands (16,701 acre-ft/year) from 2002 to 2003. Additionally, the City of Sierra Madre's projected water demands for the year 2005 based on the UWMP (2,689 acre-ft/year) is less than existing current water demands (2,763 acre-ft/year) from 2002 to 2003. The 2005 water demand projections, from the 2000 UWMPs for both cities, were based on data available prior to 2000 and may not reflect current and projected water demands based on more recent water use trends. The Urban Water Management Planning Act requires water suppliers to update their UWMP every five years. It is

anticipated that the 2005 UWMPs (due by December 31, 2005) for the City of Arcadia and City of Sierra Madre will incorporate recent water use information to project future water demands.

3.2 Projected Water Demands Based on Historic Extractions

In addition to the 2000 UWMPs, future water demands for the City of Arcadia and the City of Sierra Madre can be projected based on historic water extractions. Incorporating linear regression on historic and current data produces a straight-line interpolation of projected water demands. In comparison to projected water demands from the 2000 UWMPs, linear regression includes current data reflective of more recent water use trends.

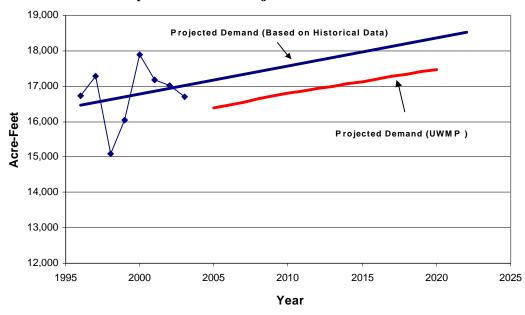
3.2.1 City of Arcadia

Based on historic extractions from 1996 to 2003, water demands for the City of Arcadia can be projected (see Table E-4). As shown in Figure E-3, the projected water demands based on linear regression appear greater than projections from the UWMP and are consistent with current water extraction quantities. Additionally, the City of Arcadia believes the projected water demands based on linear regression are more accurate than those from the 2000 UWMP.

Table E-4
Projected Water Demands (Acre-Feet) from Linear Regression for City of Arcadia

Year	City of Arcadia
2005	17,174
2006	17,253
2007	17,331
2008	17,410
2009	17,489
2010	17,568
2011	17,647
2012	17,726
2013	17,805
2014	17,884
2015	17,963
2016	18,042
2017	18,121
2018	18,200
2019	18,279
2020	18,357

Figure E-3 City of Arcadia – Projected Water Demands



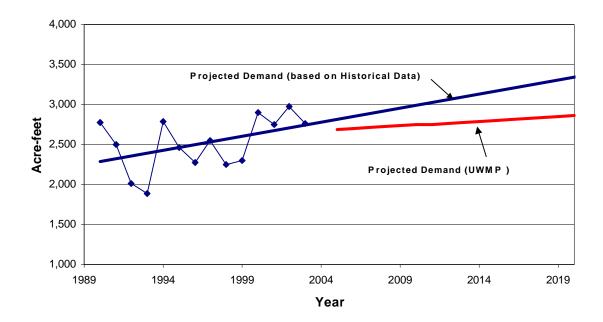
3.2.2 City of Sierra Madre

Based on historic extractions from 1990 to 2003, water demands for the City of Sierra Madre can be projected (see Table E-5). As shown in Figure E-4, the projected water demands based on linear regression appear greater than projections from the UWMP and are consistent with current water extraction quantities. Additionally, the City of Sierra Madre believes the projected water demands based on linear regression are more accurate than those from the 2000 UWMP.

Table E-5
Projected Water Demands (Acre-Feet) from Linear Regression for City of Sierra Madre

Year	City of Sierra Madre
2005	2,810
2006	2,845
2007	2,881
2008	2,916
2009	2,951
2010	2,986
2011	3,021
2012	3,056
2013	3,091
2014	3,126
2015	3,161
2016	3,196
2017	3,231
2018	3,266
2019	3,302
2020	3,337

Figure E-4 City of Sierra Madre – Projected Water Demands



4.0 OPPORTUNITIES FOR WATER EXCHANGES, BANKING, AND STORAGE CREDITS

4.1 Background

4.1.1 Salvage Credit Losses (Subsurface Outflow)

The City of Sierra Madre currently spreads water from the following sources to supplement ground water production:

- Diversion works from Little Santa Anita Creek (Sierra Madre Wash);
- Water collected from the streets; and
- Concrete lined channels of Little Santa Anita Creek

By placing water from these sources into spreading grounds in the Eastern Unit, the City of Sierra Madre can pump more ground water as a Salvage Credit, in addition to its Decreed Right.

The State Department of Water Resources published the report entitled "Determinations of Credit for Water Salvaged by the City of Sierra Madre," dated August 1959, which includes criteria concerning accounting of Sierra Madre's salvage credit. That criteria indicates Salvage Credit is accounted as follows:

- a. List any carryover of salvage credit from prior year.
- b. Add the total amount of water spread during the current year.
- c. Subtract the portion of the current years' recharge that otherwise would have naturally percolated had channels not been lined.
- d. Subtract the <u>total</u> amount of water in storage lost to subsurface outflow. (This accounting is made on a monthly basis.)

e. The balance, if any, may be pumped by Sierra Madre in addition to its Decreed Right of 1955. Following pumping, the remaining salvage credit will be carried over to the next year.

The Salvage Credit includes a deduction to the total amount of water in storage due to subsurface outflow. Losses from subsurface outflow are measured on a monthly basis and are subtracted from the City of Sierra Madre's Salvage Credit total. The amount of subsurface losses varies annually according to the amount of water spread and pumped (see Table E-6). Subsurface outflow can also vary based on ground water levels. Low ground water levels can result in little or no losses, and high ground water levels can result in significant losses.

Table E-6 shows that during the past 10 years, the City of Sierra Madre lost an average of approximately 570 acre-ft/year of Salvage Credit water due to subsurface outflow. Based on the average amount of water spread in the Eastern Unit (approximately 1,620 acre-ft/year after natural percolation has been deducted) prior to subsurface outflow, losses due to subsurface outflow have accounted for approximately 35 percent of the City of Sierra Madre's available Salvage Credit. Furthermore, if additional water supplies for spreading are made available for future conversion into Salvage Credit, the City of Sierra Madre may lose portions of that "new water" due to subsurface outflow. The City of Sierra Madre could reduce these losses by maximizing its Salvage Credit production, as discussed later.

4.1.2 City of Sierra Madre – Decreed Right Losses (Annual Carryover)

The Raymond Basin Judgment, which provides the City of Sierra Madre with a Decreed Right of 1,764.0 acre-ft/year from the Santa Anita Subarea, allows a maximum carryover of 10 percent of the Decreed Right from one year to the following year. Based on the Judgment, the maximum carryover amount for the City of Sierra Madre in any year is 176.4 acre-ft. The City of Sierra Madre has annually pumped and/or leased its full amount of Decreed Right over the past

10 years and has not experienced any losses due to carryover limitations imposed by the Judgment.

4.1.3 City of Sierra Madre – Extraction Amounts

The City of Sierra Madre obtains its water supply from ground water (Decreed Right and Salvage Credit) and from an emergency connection with the City of Arcadia. Table E-7 shows allowable and actual ground water extractions by the City of Sierra Madre for the past 10 years. Table E-7 also shows that the City of Sierra Madre has leased varying Decreed Right amounts to and from the City of Arcadia. Leased Decreed Right water rights are either credited or deducted from the City of Sierra Madre's allowable ground water extraction amount.

Over the past ten years, the average total amount of ground water extracted (approximately 2,660 acre-ft/year) by the City of Sierra Madre has been approximately 50 percent of the average allowable ground water extraction (5,304 acre-ft/year). Because the City of Sierra Madre currently extracts its full amount of Decreed Right (over the past 10 years), any allowable ground water extraction water remaining is unused Salvage Credit water. Although the City of Sierra Madre may carryover Salvage Credit water annually, the amount of Salvage Credit available is affected by subsurface losses.

4.2 Alternative 1 – Maximize Production of Salvage Credit (City of Sierra Madre)

Under existing conditions, the City of Sierra Madre uses its entire Decreed Right and a portion of its Salvage Credit. To avoid losses due to subsurface outflow, production of Salvage Credit can be maximized. Furthermore, if additional spreading water is available in the future, the City of Sierra Madre could increase its Salvage Credit (and production of Salvage Credit) by spreading this water. However, by maximizing and utilizing all available Salvage Credit, the City of Sierra Madre may not be able to fully use its Decreed Right. To avoid carryover losses of Decreed

Right, the City of Sierra Madre can lease any remaining portion of its Decreed Right, in the Santa Anita Subarea of the Raymond Basin, to the City of Arcadia.

The City of Arcadia, which also owns a Decreed Right to the Santa Anita Subarea (3,526 acre-ft/year), could lease available water rights (Decreed Right) from the City of Sierra Madre. Although the City of Arcadia also owns ground water rights to the Main Basin, all of these rights can be carried over for one year if not used¹. To maximize water availability, the City of Arcadia could utilize all existing and leased water rights in the Santa Anita Subarea. The City of Arcadia could then reduce ground water pumping from the Main Basin to the extent it would not also be needed to meet demands. This would result in additional carryover of any remaining Main Basin water rights the City of Arcadia owns. The City of Arcadia can retain these water rights for future needs or lease these water rights to other Main Basin water purveyors to obtain revenue.

Alternatively, during future years if additional water is needed by the City of Sierra Madre, the City of Arcadia could lease Decreed Right to the Santa Anita Subarea. In turn, the City of Arcadia could use the carryover water rights in the Main Basin to meet water demands.

4.3 Alternative 2 – Installation of Wells (Operated by the City of Arcadia)

4.3.1 Main San Gabriel Basin

Although the City of Sierra Madre is a party to the Main San Gabriel Basin Judgment, the City does not own any water rights to the Main Basin. To obtain additional water supplies, the City of Sierra Madre could pump water from the Main Basin. The City of Sierra Madre could pump ground water from the Main Basin as long as it purchases an equivalent amount of replenishment water for the basin.

Unused water rights in the Main San Gabriel Basin can carryover annually. However, carryover water rights must be used the following year, or it is lost.

Because the City of Sierra Madre does not own any ground water pumping facilities within the Main Basin, the City of Arcadia, which pumps from the Main Basin, could pump ground water on behalf of the City of Sierra Madre. The City of Arcadia could also transfer this pumped ground water through their system for delivery to the City of Sierra Madre.

The City of Arcadia has indicated that a new well site in the Main Basin could potentially be located in the vicinity of the Peck Road and Goldring Road intersection in the City of Arcadia. For the purposes of developing a well installation cost estimate, it is assumed that the City of Sierra Madre would install a 2,500 gallons per minute (gpm) production well, approximately 700 feet deep. The capital cost to install a 2,500 gpm production well and pump is approximately \$2,500,000. Although land may also need to be obtained within the City of Arcadia, a cost is not included. The annualized total capital cost (\$2,500,000 over 50 years at 6% interest) is approximately \$159,000 per year.

Assuming that the new well pumps 50 percent of the time, the annual production of ground water is approximately 2,000 acre-ft/year. The City of Arcadia has indicated that it currently charges approximately \$130 per acre-ft for pumping and transfer of water from its existing wells to the City of Sierra Madre. Based on this rate, the cost to pump and deliver about 2,000 acre-ft/year of water is approximately \$260,000 per year.

As a result of extracting ground water from the Main Basin, the City of Sierra Madre would need to replenish the basin by purchasing an equivalent amount of replenishment water from the San Gabriel Valley Municipal Water District (SGVMWD), currently priced at \$130 per acre-ft. The cost to purchase about 2,000 acre-ft/year of replenishment water is approximately \$260,000 per year.

The following is a summary of the annual costs to the City of Sierra Madre to pump ground water from the Main Basin:

Approximate Total Annual Cost:	\$ 679,000 per vear
Replenishment Water (from SGVMWD)	\$ 260,000 per year
Pump and Transfer Costs	\$ 260,000 per year
New Well and Pump Installation	\$ 159,000 per year

The equivalent cost for 2,000 acre-ft/year is approximately \$340 per acre-ft.

4.3.2 Raymond Basin – Pasadena Subarea

The City of Sierra Madre can obtain additional water supplies by pumping ground water from the Pasadena Subarea of the Raymond Basin. However, the City of Sierra Madre does not own any ground water rights or facilities in the Pasadena Subarea. The City of Arcadia, which pumps from the Pasadena Subarea, could pump ground water on behalf of the City of Sierra Madre. In addition, the City of Arcadia could transfer this pumped ground water through their system for delivery to the City of Sierra Madre. To obtain the right to pump ground water from the Pasadena Subarea, the City of Sierra Madre could lease Decreed Right to the Pasadena Subarea from other purveyors such as the City of Alhambra (1,031 acre-ft/year) and/or San Gabriel County Water District (1,091 acre-ft/year), both of which do not currently pump Raymond Basin ground water.

The City of Arcadia has indicated that a new well site in the Pasadena Subarea could potentially be located in the vicinity of the Baldwin Avenue and Colorado Boulevard intersection in the City of Arcadia. For the purposes of developing a well installation cost estimate, it is assumed that the City of Sierra Madre would install a 2,500 gpm production well, approximately 700 feet deep. The capital cost to install a 2,500 gpm production well and pump is approximately \$2,500,000. Although land may also need to be obtained within the City of Arcadia, a cost is not included. The annualized total capital cost (\$2,500,000 over 50 years at 6% interest) is approximately \$159,000 per year.

Assuming that the new well pumps 50 percent of the time, the annual production of ground water

is approximately 2,000 acre-ft/year. As mentioned previously, the City of Arcadia has indicated that it currently charges approximately \$130 per acre-ft for pumping and transfer of water from its existing wells to the City of Sierra Madre. Based on this rate, the cost to pump and deliver about 2,000 acre-ft/year of water is approximately \$260,000 per year.

Based on several water lease transactions in the Raymond Basin between 2002 and 2003, the current cost rate to lease water is approximately \$262 per acre-ft (includes a \$12 per acre-ft administrative fee). The cost to lease 2,000 acre-ft/year of available water from the Pasadena Subarea is approximately \$524,000 per year.

The following is a summary of the annual costs to the City of Sierra Madre to pump ground water from the Pasadena Subarea of the Raymond Basin:

New Well and Pump Installation \$ 159,000 per year

Pump and Transfer Costs \$ 260,000 per year

Decreed Right Lease Cost \$ 524,000 per year

Approximate Total Annual Cost: \$ 943,000 per year

The equivalent cost for 2,000 acre-ft/year is approximately \$472 per acre-ft.

4.4 Alternative 3 – Installation of Independent Well and Pipelines

4.4.1 Main San Gabriel Basin

As mentioned in Alternative 2, the City of Sierra Madre could pump water from the Main Basin in order to obtain additional water supplies. Although the City of Sierra Madre is a party to the Main San Gabriel Basin Judgment, the City does not own any water rights to the Main Basin. The City of Sierra Madre could pump ground water from the Main Basin as long as it purchases an equivalent amount of replenishment water for the basin. Although a new well could be installed in the City of Arcadia, the City of Sierra Madre could pump and transfer ground water

from the Main Basin independently of the City of Arcadia. However, the City of Sierra Madre would be required to construct a dedicated pipeline to transfer water from the new well to its system. An example of a potential area for a new well location and a pipeline route is shown in Figure E-5. The potential area for a new well site is a hypothetical location used in order to determine a cost estimate. A final well location will be influenced by factors such as the distance from the City of Sierra Madre, land availability, ground water yield, and water quality.

For the purposes of developing a well installation cost estimate, it is assumed that the City of Sierra Madre would install a 2,500 gpm production well, approximately 700 feet deep. In addition, the City of Sierra Madre would also need to install a booster pump and a pipeline (approximately 8,100 feet) from the new well site to the City's well field located at the corner of Sierra Madre Boulevard and Monterey Lane (where distribution facilities are available).

The capital cost to install a 2,500 gpm production well and pump is approximately \$2,500,000. The capital cost to install approximately 8,100 feet of 16-inch ductile iron pipe (at \$160 per lineal foot) is approximately \$1,296,000, which includes the cost to remove pavement and repave roadways. This pipeline cost does not include a potential pipeline crossing under the 10 Freeway (which may cost up to approximately \$75,000 to bore and jack an 8-inch line). The capital cost to install a 200 horsepower booster pump to transfer water from the new well to the City of Sierra Madre is approximately \$38,000. Although land may also need to be obtained within the City of Arcadia, a cost is not included. The annualized total capital cost (\$3,834,000 over 50 years at 6% interest) is approximately \$243,000 per year.

Assuming that the new well pumps 50 percent of the time, the annual production of ground water is approximately 2,000 acre-ft/year. The annual cost to pump about 2,000 acre-ft/year of ground water (at \$75 per acre-ft) is approximately \$150,000 per year. The annual cost to boost 2,000 acre-ft/year of water over 8,100 feet of pipeline is approximately \$115,000 per year.

As a result of extracting ground water from the Main Basin, the City of Sierra Madre would need to replenish the basin by purchasing an equivalent amount of replenishment water from the SGVMWD, currently priced at \$130 per acre-ft. The cost to purchase about 2000 acre-ft/year of replenishment water is approximately \$260,000 per year.

The following is a summary of the annual costs to the City of Sierra Madre to pump ground water from the Main Basin:

New Well, Pipe, and Pump Installation \$ 243,000 per year

Pump and Transfer Costs \$ 265,000 per year

Replenishment Water (from SGVMWD) \$260,000 per year

Approximate Total Annual Cost: \$ 768,000 per year

The equivalent cost for 2,000 acre-ft/year is approximately \$384.5 per acre-ft.

4.4.2 Raymond Basin – Pasadena Subarea

As mentioned in Alternative 2, the City of Sierra Madre could pump water from the Pasadena Subarea of the Raymond Basin in order to obtain additional water supplies. In order to obtain the right to pump ground water from the Pasadena Subarea, the City of Sierra Madre could lease Decreed Right from purveyors such as the City of Alhambra (1,031 acre-ft/year) and/or San Gabriel County Water District (1,091 acre-ft/year), both of which do not currently pump Raymond Basin ground water. Although a new well could be installed in the City of Arcadia, the City of Sierra Madre could pump and transfer ground water from the Pasadena Subarea independently of the City of Arcadia. However, the City of Sierra Madre would be required to construct a dedicated pipeline to transfer water from the new well to its system. An example of a potential area for a new well location and a pipeline route is shown in Figure E-6. The potential area for a new well site is a hypothetical location used in order to determine a cost estimate. A final well location will be influenced by factors such as the distance from the City of Sierra Madre, land availability, ground water yield, and water quality.

For the purposes of developing a well installation cost estimate, it is assumed that the City of Sierra Madre would install a 2,500 gpm production well, approximately 700 feet deep. In addition, the City of Sierra Madre would also need to install a booster pump and a pipeline (approximately 10,400 feet) from the new well site to the City's well field located at the corner of Sierra Madre Boulevard and Monterey Lane (where distribution facilities are available).

The capital cost to install a 2,500 gpm production well and pump is approximately \$2,500,000. The capital cost to install approximately 10,400 feet of 16-inch ductile iron pipe (at \$160 per lineal foot) is approximately \$1,664,000, which includes the cost to remove pavement and repave roadways. This pipeline cost does not include a potential pipeline crossing under the 10 Freeway (which may cost up to approximately \$75,000 to bore and jack an 8-inch line). The capital cost to install a 250 horsepower booster pump to transfer water from the new well to the City of Sierra Madre is approximately \$58,000. Although land may also need to be obtained within the City of Arcadia, a cost is not included. The annualized total capital cost (\$4,222,000 over 50 years at 6% interest) is approximately \$268,000 per year.

Assuming that the new well pumps 50 percent of the time, the annual production of ground water is approximately 2,000 acre-ft/year. The annual cost to pump about 2,000 acre-ft/year of ground water (at \$75 per acre-ft) is approximately \$150,000 per year. The annual cost to boost 800 acre-ft/year of water over 10,400 feet of pipeline is approximately \$145,000 per year.

Based on several water lease transactions in the Raymond Basin between 2002 and 2003, the current cost rate to lease water is approximately \$262 per acre-ft (includes a \$12 per acre-ft administrative fee). The cost to lease 2,000 acre-ft/year of available water from the Pasadena Subarea is approximately \$524,000 per year.

The following is a summary of the annual costs to the City of Sierra Madre to pump ground water from the Pasadena Subarea of the Raymond Basin:

New Well, Pipe, and Pump Installation \$ 268,000 per year

Pumping Costs \$ 295,000 per year

Decreed Right Lease Cost \$ 524,000 per year

Approximate Total Annual Cost: \$ 1,087,000 per year

The equivalent cost for 2,000 acre-ft/year is approximately \$544 per acre-ft.

5.0 FINDINGS

5.1 Projected Extraction Demands

Future water demands for the City of Arcadia and the City of Sierra Madre can be projected based on 2000 UWMPs and historic water extractions. The UWMP for the City of Arcadia projects water demands to increase from 16,390 acre-ft/year, in 2005, to 17,477 acre-ft/year, in 2020. The UWMP for the City of Sierra Madre projects water demands to increase from 2,689 acre-ft/year, in 2005, to 2,860 acre-ft/year, in 2020. Based on historical water extractions, and linear regression, the City of Arcadia's water demands are projected to increase from approximately 17,174 acre-ft/year, in 2005, to approximately 18,357 acre-ft/year, in 2020. Based on historical water extractions, and linear regression, the City of Sierra Madre's water demands are projected to increase from approximately 2,810 acre-ft/year, in 2005, to approximately 3,337 acre-ft/year, in 2020. Water projections based on linear regression appear more consistent with current water demand trends.

5.2 Opportunities for Water Exchanges, Banking, and Storage Credits

Because the City of Sierra Madre currently extracts its full amount of Decreed Right, any allowable ground water extraction water remaining is unused Salvage Credit water. Although the City of Sierra Madre may carryover Salvage Credit water annually, the amount of Salvage Credit available is affected by subsurface losses. Several alternatives may be available to optimize existing water supplies and/or obtain additional water supplies:

Alternative 1 – Maximize Production of Salvage Credit (City of Sierra Madre)

To avoid losses due to subsurface outflow, production of Salvage Credit can be maximized. To avoid carryover losses of Decreed Right, the City of Sierra Madre can lease any remaining

portion of its Decreed Right, in the Santa Anita Subarea of the Raymond Basin, to the City of Arcadia. To maximize water availability, the City of Arcadia could utilize all existing and leased water rights in the Santa Anita Subarea. The City of Arcadia could then reduce ground water pumping from the Main Basin to the extent it would not also be needed to meet demands.

<u>Alternative 2 – Installation of Wells (Operated by City of Arcadia)</u>

The City of Sierra Madre could pump ground water from the Main Basin as long as it purchases an equivalent amount of replenishment water for the basin. The City of Arcadia, which pumps from the Main Basin, could pump ground water on behalf of the City of Sierra Madre. The City of Arcadia could also transfer this pumped ground water through their system for delivery to the City of Sierra Madre. The equivalent cost for 2,000 acre-ft/year is approximately \$340 per acre-ft.

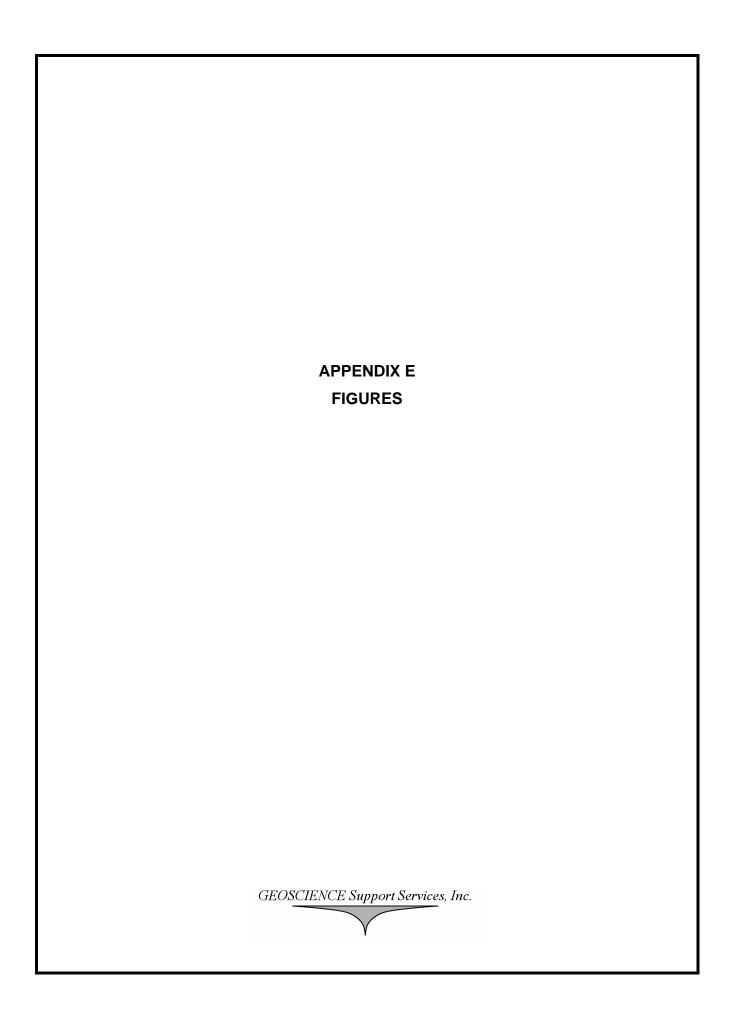
In addition, the City of Sierra Madre can obtain additional water supplies by pumping ground water from the Pasadena Subarea of the Raymond Basin. The City of Arcadia, which pumps from the Pasadena Subarea, could pump ground water on behalf of the City of Sierra Madre and could transfer this pumped ground water through their system for delivery to the City of Sierra Madre. To obtain the right to pump ground water from the Pasadena Subarea, the City of Sierra Madre could lease Decreed Right to the Pasadena Subarea from other purveyors. The equivalent cost for 2,000 acre-ft/year is approximately \$472 per acre-ft.

Alternative 3 – Installation of Independent Well and Pipelines

The City of Sierra Madre could pump and transfer ground water from the Main Basin independently of the City of Arcadia. However, the City of Sierra Madre would be required to

construct a dedicated pipeline to transfer water from the new well to its system. The equivalent cost for 2,000 acre-ft/year is approximately \$384.5 per acre-ft.

The City of Sierra Madre could pump and transfer ground water from the Pasadena Subarea independently of the City of Arcadia. The equivalent cost for 2,000 acre-ft/year is approximately \$544 per acre-ft.



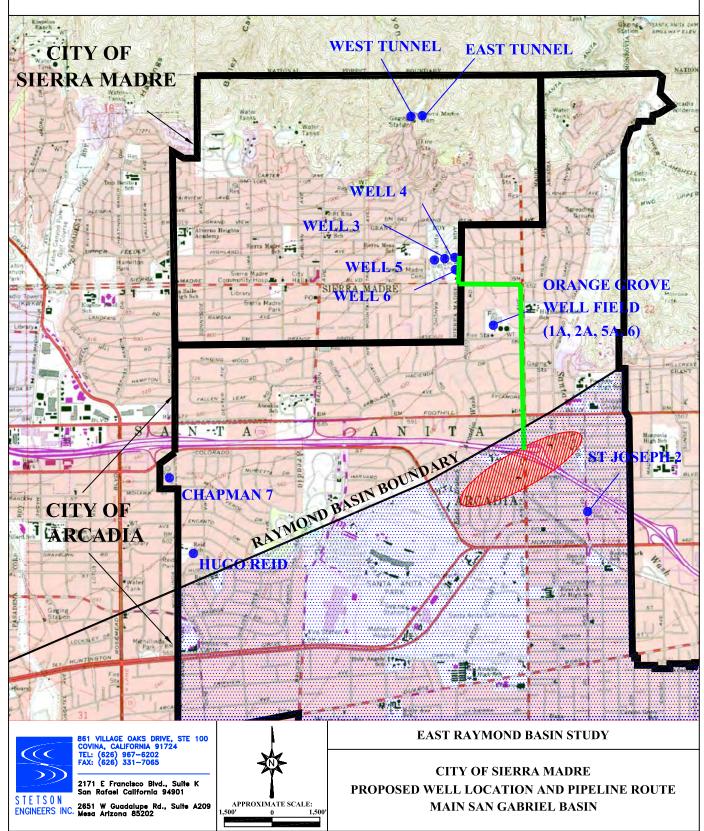
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CITY OF ARCADIA (MAIN SAN GABRIEL BASIN)



POTENTIAL WELL LOCATION

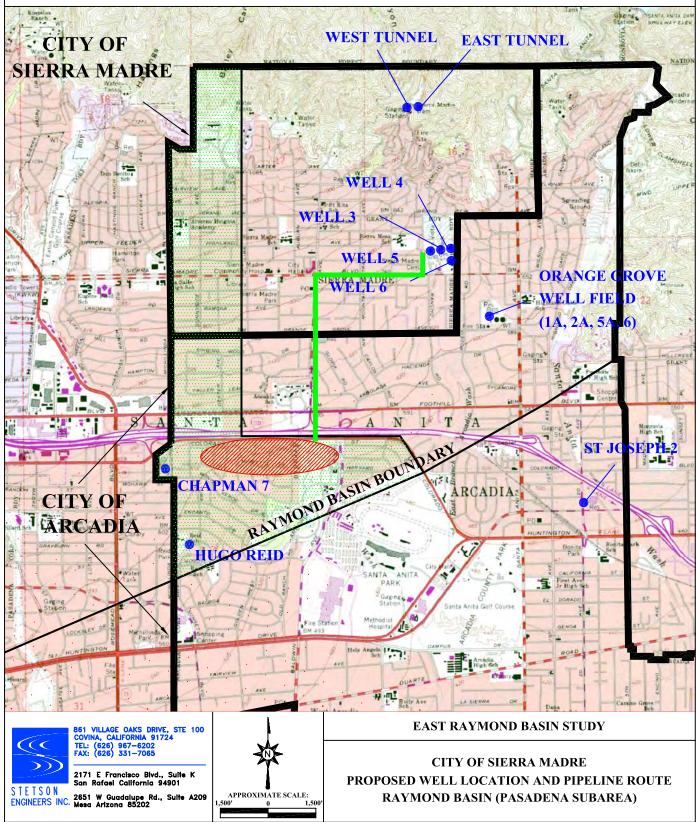
POTENTIAL PIPELINE ROUTE

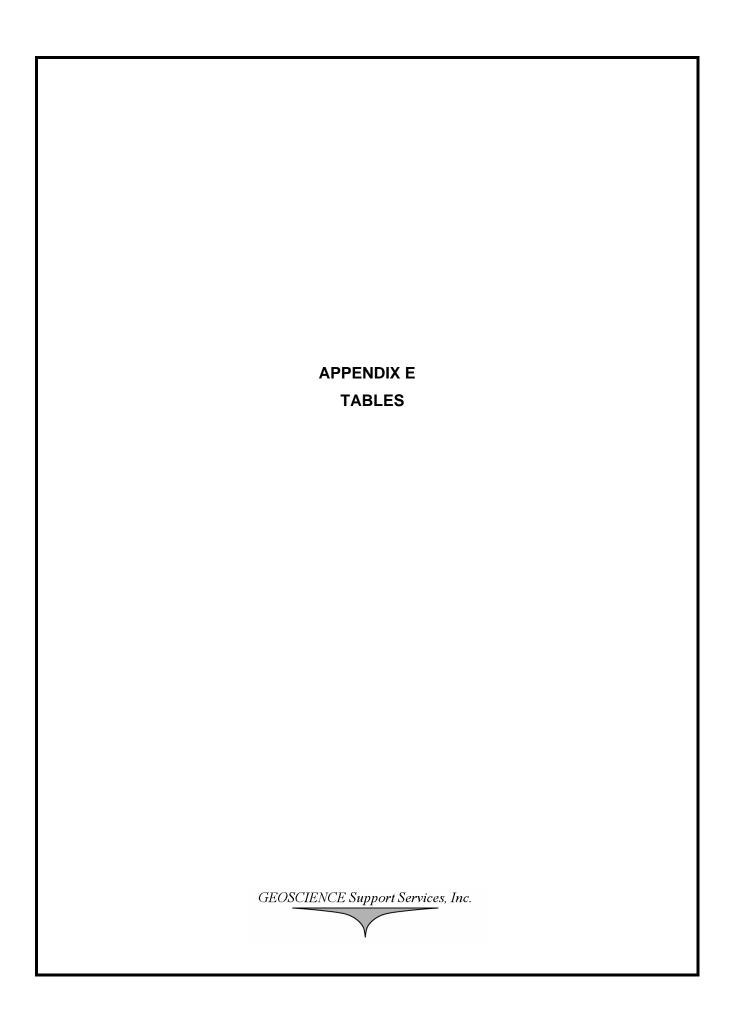


CITY OF SIERRA MADRE AND CITY OF ARCADIA (RAYMOND BASIN - PASADENA SUBAREA)

POTENTIAL WELL LOCATION

POTENTIAL PIPELINE ROUTE





Salvage Credit Lost to Subsurface Outflow

Season	Salvage Credit at Beginning of Year [acre-ft]	Water Spread [acre-ft]	Natural Percolation Losses [acre-ft]	Net Water Stored [acre-ft]	Subsurface Outflow (Salvage Credit Losses) [acre-ft]	Salvage Credit Extraction [acre-ft]	Salvage Credit at End of Year [acre-ft]
1993-94	4,445.1	2,113.2	747.2	1,366.0	1,262.7	1,919.1	2,629.3
1994-95	2,629.3	4,221.4	706.6	3,514.8	532.2	1,700.3	3,911.6
1995-96	3,911.6	3,697.8	1,252.2	2,445.6	1,482.8	505.0	4,369.4
1996-97	4,369.4	2,371.7	735.9	1,635.8	1,010.1	2,489.2	2,505.9
1997-98	2,505.9	3,424.0	435.1	2,988.9	214.3	984.3	4,296.2
1998-99	4,296.2	2,874.9	922.5	1,952.4	590.5	2,038.1	3,620.0
1999-00	3,620.0	1,195.0	304.7	890.3	740.6	1,483.1	2,286.6
2000-01	2,286.6	1,513.5	424.0	1,089.5	440.5	1,041.5	1,894.1
2001-02	1,894.1	294.8	14.7	280.1	0.0	1,205.3	968.9
2002-03	968.9	1,444.7	500.3	944.4	0.0	231.3	1,682.0
2003-04	1,682.0	922.9	192.2	730.7	0.0	1,465.6	947.1
Average				1,621.7	570.3		

Note: (Salvage Credit at End of Year) = (Salvage Credit from Beginning of Year) + (Net Water Stored) - (Subsurface Outflow) - (Salvage Credit Extraction)

Source: Watermaster Service in the Raymond Basin, September 2003

City of Sierra Madre's Extraction Amounts

[1] [2]

Season	Decreed Right [acre-ft]	Decreed Right Carryover [acre-ft]	Leases [acre-ft]	Available Salvage Credit [acre-ft]	Allowable Groundwater Extraction [acre-ft]	Amount Extracted [acre-ft]	Balance [acre-ft]
1993-94	1,764.0	0.0	-1,400.0	5,048.4	5,412.4	2,783.1	2,629.3
1994-95	1,764.0	0.0	-1,000.0	5,611.9	6,375.7	2,464.1	3,911.6
1995-96	1,764.0	0.0		4,874.4	6,638.4	2,269.0	4,369.4
1996-97	1,764.0	0.0	-1,700.0	4,995.1	5,059.1	2,553.2	2,505.9
1997-98	1,764.0	0.0	-500.0	5,276.5	6,540.5	2,244.3	4,296.2
1998-99	1,764.0	0.0	-1,500.0	5,658.1	5,922.1	2,302.1	3,620.0
1999-00	1,764.0	0.0	-350.0	3,769.7	5,183.7	2,897.1	2,286.6
2000-01	1,764.0	0.0	-50.0	2,935.6	4,649.6	2,755.5	1,894.1
2001-02	1,764.0	0.0		2,174.2	3,938.2	2,969.3	968.9
2002-03	1,764.0	0.0	767.5	1,913.3	4,444.8	2,762.8	1,682.0
2003-04	1,764.0	-86.9		2,499.6	4,176.7	3,229.6	947.1
Average				<u> </u>	5,303.7	2,657.3	2,646.5

Notes:

- [1] During 1993-95 and 96-01, the City of Sierra Madre leased water to the City of Arcadia During 2002-03, the City of Sierra Madre leased water from the City of Arcadia
- [2] Available Salvage Credit includes carryover from pervious year, deductions for natural percolation, and subsurface outflow losses
- [3] Carryover Salvage Credit for the following year

Source: Watermaster Service in the Raymond Basin, September 1994 to 2003