Technical Memorandum
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To:	Mr. Wen B. Huang, P.E. Principal Engineer San Bernardino Valley Municipal Water District 380 East Vanderbilt Way San Bernardino, CA 92408-3593
From:	Johnson Yeh, Ph.D., PG, CHG Principal/Groundwater Modeler GEOSCIENCE Support Services, Inc.
Date:	March 31, 2016
Subject:	**Addendum to Stormwater Flow and Capture Analysis - Active Recharge Project for the Tributaries of the Santa Ana River, San Bernardino Valley, California**

1.0 INTRODUCTION

1.1 Purpose and Scope

This Technical Memorandum (TM) provides supplemental information for the report entitled "Stormwater Flow and Capture Analysis – Active Recharge Project for the Tributaries of the Santa Ana River, San Bernardino Valley, California", prepared by GEOSCIENCE Support Services, Inc. (GEOSCIENCE) for the San Bernardino Valley Municipal Water District (Valley District), dated January 9, 2015. The purpose of this TM is to summarize the watershed model update and recalibration, and estimated yield associated with the Upper Santa Ana River (SAR) Watershed proposed recharge projects, including: San Bernardino Basin Area (SBBA) Active Recharge Project, SAR Enhanced Recharge Project, and Riverside North Aquifer Storage and Recovery Project (RNASRP). Figure 1 shows the project location and tributary sub-watersheds. Figure 2 depicts the location of each subarea and model node for the SBBA watershed model. The following tasks were performed by GEOSCIENCE during this study:

- Task 1 – Collect and Compile Hourly Precipitation and Streamflow Data,
- Task 2 – Update and Recalibrate the SBBA Watershed Model Using an Hourly Time Step,

- Task 3 – Run SCRBWM Model Scenarios and Provide Relevant Data to Scheeval Engineering and ICF International (ICFI),
- Task 4 – Prepare a Draft and Final Technical Memorandum to Summarize Modeling Results, and
- Task 5 – Prepare for and Attend Meetings

1.2 Sources of Data

Data was obtained from multiple sources in order to update the watershed model using an Hourly Time Step. The primary sources and the types of data used were:

1. San Bernardino County Flood Control District: San Bernardino County Hospital hourly precipitation data from October 1989 to September 2015.
2. U.S. Geological Survey (USGS): San Bernardino area streamflow data at the following gaging stations (see Figure 1):
    - Lytle Creek near Fontana Gaging Station;
    - Cajon Creek below Lone Pine Creek near Keenbrook Gaging Station;
    - Devil Canyon Creek near San Bernardino Gaging Station;
    - East Twin Creek near Arrowhead Springs Gaging Station;
    - City Creek near Highland Gaging Station;
    - Plunge Creek near East Highlands Gaging Station;
    - Mill Creek near Yucaipa Gaging Station;
    - San Timoteo near Redlands Gaging Station; and
    - Santa Ana River near Mentone.

2.0 SBBA WATERSHED MODEL UPDATE AND RECALIBRATION

In 2013, GEOSCOENCE developed a watershed model for the purpose of determining the amount of New Conservation in the SBBA resulting from the operation of Seven Oaks Dam and Reservoir. This model is known as the SBBA Colton Riverside Basin Watershed Model (SCRBWM) and covers the SBBA, Rialto-Colton, and Riverside Basins. The SCRBWM was calibrated to daily measured streamflow and scenario runs were made with a daily time step under projected future No Project and Project conditions (GEOSCIENCE, 2015). Valley District is in the process of reevaluating the operation of the Active Recharge Project as well as the diversion locations of the proposed spreading basins. For this reevaluation, hourly stormwater data was recommended by Valley District's consultant Scheeval Engineering. Therefore, the SBBA watershed model (part of the SCRBWM) was updated during this study to an hourly time step and was recalibrated against hourly measured streamflow.

2.1 SBBA Watershed Model Update

Hourly precipitation and streamflow data was used in order to update and calibrate the SBBA watershed model to an hourly time step. Missing data in the historical records was estimated using the regression equations shown in the report "Hydrology, Description of Computer Models, and Evaluations of Selected Water-Management Alternatives in the San Bernardino Area, California" (Danskin et al., 2006).

2.2 SBBA Watershed Model Recalibration

After the model is updated, it was recalibrated against hourly measured streamflow for the period from January 1, 1998 through December 31, 2012. The hourly measured streamflow from the following gaging stations were used for model recalibration:

- Santa Ana River at E Street Gaging Station;
- Lytle Creek at Colton Gaging Station;
- San Timoteo Creek near Loma Linda; and
- Warm Creek near San Bernardino Gaging Station.

The calibration process involved adjusting model parameters until the model provided a reasonable match between the simulated and measured water balance, and a good fit between the simulated and measured daily and monthly streamflow.

3.0 PREDICTIVE MODEL SCENARIOS

A total of four predictive model runs were made using the SBBA watershed model based on the assumed recharge projects, hydrologic period, and model time step. The following table summarizes the assumptions for these model scenarios.

Model Scenario	Recharge Project			Hydrologic Period		Model Time Step	
	Active Recharge	SAR Enhanced	RNASRP	1990-2000	1962-2000	Hourly	Daily
1				x		x	
1a					x		x
2	x	x			x		x
3	x	x	x		x		x

3.1 Modeling Assumptions

3.1.1 SBBA Active Recharge

During this study, 15 locations of stormwater capture grounds were proposed by Valley District's consultant Scheeval Engineering for SBBA Active Recharge Project. After initial review, only following 12 capture grounds were selected and simulated due to the availability of the surface flow. They are: 1) Mill Creek North 210 cfs, 2) Plunge Creek 2, 3) City Creek, 5) Waterman, 6) East Twin, 7) Lytle Creek, 8) Cable Creek, 10) Devil Creek, 11) Cajon Creek, 12) Vulcan/Cajon Creek, 13) Vulcan, and 14) Lytle Creek/Cajon Creek. Figure 3 shows the locations of these 12 selected stormwater capture grounds. Table 1 lists parameters for each capture grounds.

3.1.2 SAR Enhanced Recharge

The Santa Ana River spreading grounds (SAR SG) are the existing diversion and recharge facilities downstream of Seven Oaks Dam which are operated by the San Bernardino Valley Water Conservation District (Conservation District) (SAIC, 2010). Valley District plans to use the existing SAR SG to recharge SAR water coming from Seven Oaks Dam. In previous studies, GEOSCIENCE calculated surface outflow from the SAR SG under three difference forecast scenarios (e.g., existing spreading capacity of 195 cfs, enhanced spreading capacity of 300 cfs, and enhanced spreading capacity of 500 cfs) (GEOSCIENCE, 2013). In this study, Model Scenarios 1 and 1a were performed under existing SAR SG spreading condition of 195 cfs capacity, and Scenarios 2 and 3 were performed under enhanced SAR SG spreading condition of 500 cfs capacity.

3.1.3 Riverside North Aquifer Storage and Recharge Project

The RNASRP is an aquifer recharge and recovery project planned to capture surface flow from the SAR. Potential flows to the RNASRP consisted of three tributaries, Lytle Creek, Warm Creek and SAR (GEOSCIENCE, 2014). The RNASRP includes an in-channel spreading basin, an off-channel spreading basin, and additional diversion of up to 100 cfs of surface water conveyed by the Riverside Canal pipeline (see Figure 4).

3.2 Modeling Results

3.2.1 Scenario 1

After the hourly time step SBBA watershed model was recalibrated, it was used to run Scenario 1 for the hydrologic period of 1990 to 2000. Hourly available flows to each proposed recharge facility were calculated and submitted to Scheeval Engineering on December 2, 2015 to develop the recharge operation for the Active Recharge Project. On February 22, 2016, Scheeval Engineering finished calculation of recharge operation and provided GEOSCIENCE the remaining flow after each capture grounds. This approach was used to calculate the project diversions in Scenarios 2 and 3.

3.2.2 Scenario 1a

In order to evaluate the project yield and impacts under dry, wet and average hydrologic conditions, Scenario 1a was simulated on a daily basis for a long-term hydrologic period of 1962 to 2000. Table 2 shows the annual surface flows that leaves SBBA under no project conditions (e.g., Scenario 1a). Average annual surface flow that leaves SBBA will be 53,840 acre-ft/yr, which includes 7,370 acre-ft/yr from Lytle Creek, 5,150 acre-ft/yr from Warm Creek, and 41,320 acre-ft/yr from SAR.

3.2.3 Scenario 2

Scenario 2 was run under the operations of both SAR enhanced recharge and SBBA active recharge. Compared to SAR existing recharge condition (e.g., 195 cfs capacity), additional 4,100 acre-ft/yr of SAR flow will be diverted by the SAR enhanced recharge project (e.g., 500 cfs capacity) before entering SBBA (see Table 3). For the SBBA active recharge project, modeling results show that 35,940 acre-ft/yr of surface flow will be captured or percolated by proposed 12 capture grounds. Table 4 lists annual percolation amounts for each of proposed capture grounds. Results of Scenario 2 indicate that there will be 45,520 acre-ft/yr of surface flow leaving SBBA on average. Compared to results of Scenario 1a, net benefits from SAR enhanced recharge and SBBA active recharge will be 8,320 acre-ft/yr (see Table 2).

3.2.4 Scenario 3

Table 5 shows the results of Scenario 3. Under the operations of SAR enhanced recharge and SBBA active recharge, 45,520 acre-ft/yr of surface flow will leave SBBA and be available for RNASRP where 16,570 acre-ft/yr will be retained by RNASRP recharge facilities. Averagely, there will be 28,950 acre-ft/yr of surface flow left after RNASRP.

4.0 SUMMARY AND FINDINGS

During this study, SBBA watershed model was updated and recalibrated to an hourly time step from January 1, 1998 to December 31, 2012. Four predictive scenario runs were performed using the recalibrated SBBA watershed model for the hydrologic period of January 1, 1962 through December 31, 2000. Results of predictive scenarios indicate that:

- Under no project conditions, average annual surface flow that leaves SBBA will be 53,840 acre-ft/yr, which includes 7,370 acre-ft/yr from Lytle Creek, 5,150 acre-ft/yr from Warm Creek, and 41,320 acre-ft/yr from SAR.
- Compared to SAR existing recharge condition (e.g., 195 cfs capacity), additional 4,100 acre-ft/yr of SAR flow will be diverted by the SAR enhanced recharge project condition before entering SBBA (e.g., 500 cfs capacity).
- For the SBBA active recharge project, modeling results show that 35,940 acre-ft/yr of surface flow will be captured or percolated by proposed 12 capture grounds.
- Under Scenario 2 conditions, average annual surface flow that leaves SBBA will be 45,520 acre-ft/yr. Net benefits from SAR enhanced recharge and SBBA active recharge will be 8,320 acre-ft/yr.
- Under the operations of SAR enhanced recharge and SBBA active recharge, 45,520 acre-ft/yr of surface flow will leave SBBA and be available for RNASRP where 16,570 acre-ft/yr will be retained by RNASRP recharge facilities.

5.0 REFERENCES

Danskin, W.R., McPherson, K.R., and Woolfenden, L.R., 2006. Hydrology, Description of Computer Models, and Evaluation of Selected Water-Management Alternatives in the San Bernardino Area, California. U.S. Geological Survey Open-File Report 2005-1278, 178 p. and 2 pl.

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GEOSCIENCE Support Services, Inc., 2015. Stormwater Flow and Capture Analysis – Active Recharge Project for the Tributaries of the Santa Ana River, San Bernardino Valley, California, pared for San Bernardino Valley Municipal Water District. January 9, 2015.

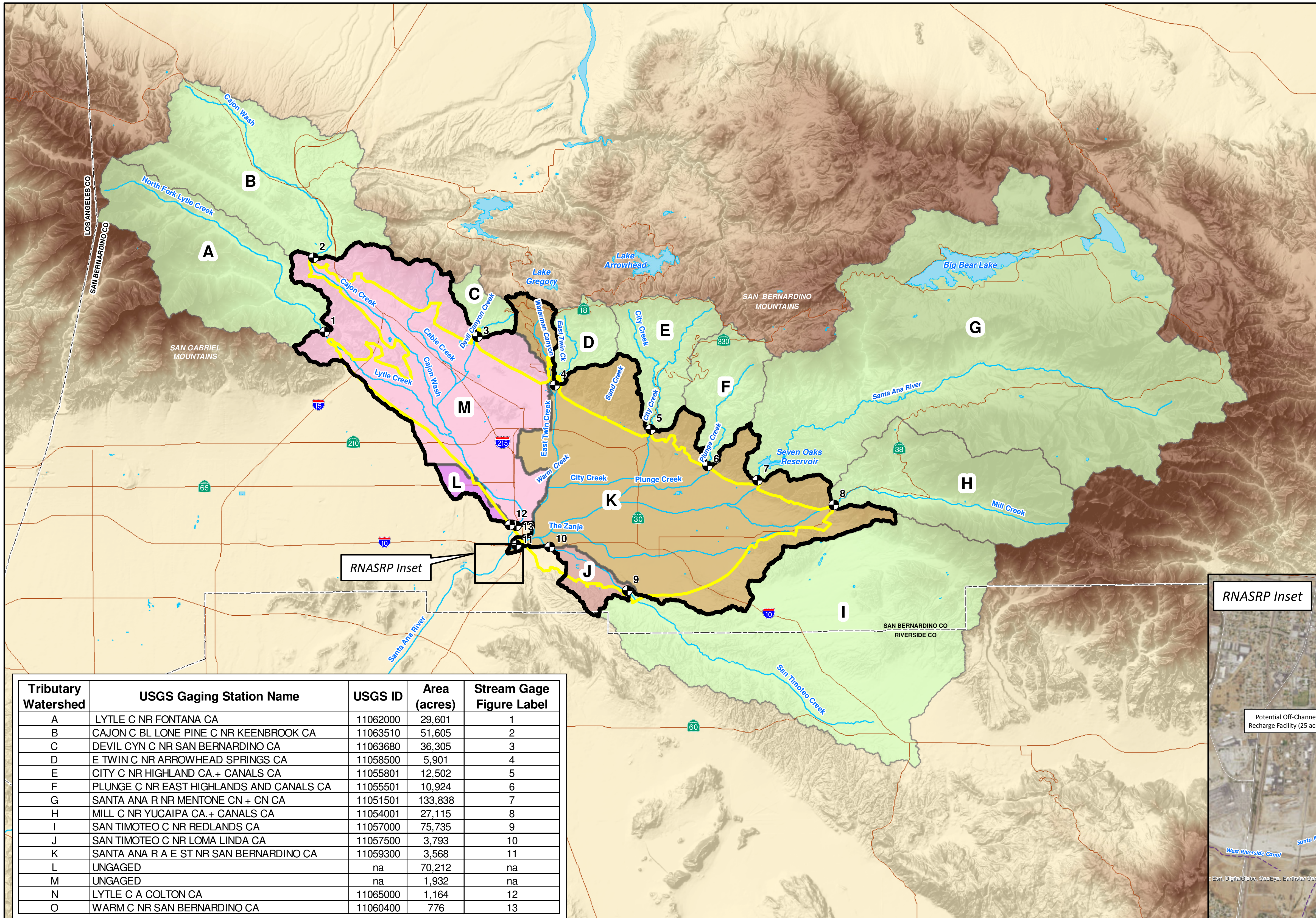
SAIC, Inc., 2010. Seven Oaks Dam Economic Analysis – Phasing of the Santa Ana River Diversion Facilities, pared for San Bernardino Valley Municipal Water District and Western Municipal Water District. March, 2010.

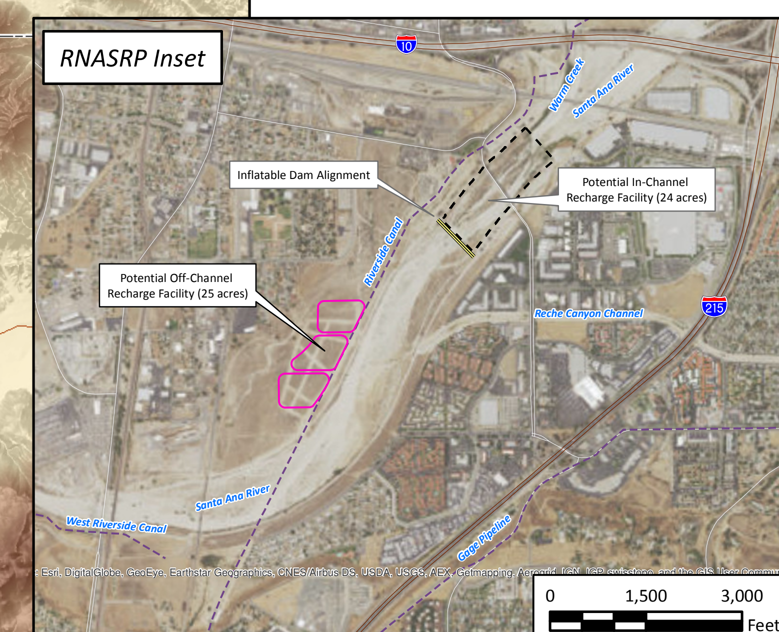
FIGURES

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

ADDENDUM TO STORMWATER FLOW AND CAPTURE ANALYSIS - ACTIVE RECHARGE PROJECT FOR THE TRIBUTARIES OF THE SANTA ANA RIVER, SAN BERNARDINO VALLEY, CALIFORNIA

PROJECT LOCATION AND TRIBUTARY SUB-WATERSHEDS





EXPLANATION

- Sub-Watershed with Gaged Tributary Inflow (Not part of SBBA Watershed Model)

Note: Other colors denote sub-watersheds that will be modeled in the SBBA Watershed Model.

- SBBA Watershed Model Boundary
- M SBBA Sub-Watershed Model Boundary
- USGS Gaging Station
- San Bernardino Basin Area (SBBA)

Tributary Watershed	USGS Gaging Station Name	USGS ID	Area (acres)	Stream Gage Figure Label
A	LYTLE C NR FONTANA CA	11062000	29,601	1
B	CAJON C BL LONE PINE C NR KEENBROOK CA	11063510	51,605	2
C	DEVIL CYN C NR SAN BERNARDINO CA	11063680	36,305	3
D	E TWIN C NR ARROWHEAD SPRINGS CA	11058500	5,901	4
E	CITY C NR HIGHLAND CA.+ CANALS CA	11055801	12,502	5
F	PLUNGE C NR EAST HIGHLANDS AND CANALS CA	11055501	10,924	6
G	SANTA ANA R NR MENTONE CN + CN CA	11051501	133,838	7
H	MILL C NR YUCAIPA CA.+ CANALS CA	11054001	27,115	8
I	SAN TIMOTEO C NR REDLANDS CA	11057000	75,735	9
J	SAN TIMOTEO C NR LOMA LINDA CA	11057500	3,793	10
K	SANTA ANA R A E ST NR SAN BERNARDINO CA	11059300	3,568	11
L	UNGAGED	na	70,212	na
M	UNGAGED	na	1,932	na
N	LYTLE C A COLTON CA	11065000	1,164	12
O	WARM C NR SAN BERNARDINO CA	11060400	776	13

31-Mar-16

Prepared by: DB. Map Projection: State Plane 1927, Zone V.

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NORTH

0 2.5 5 10 Miles

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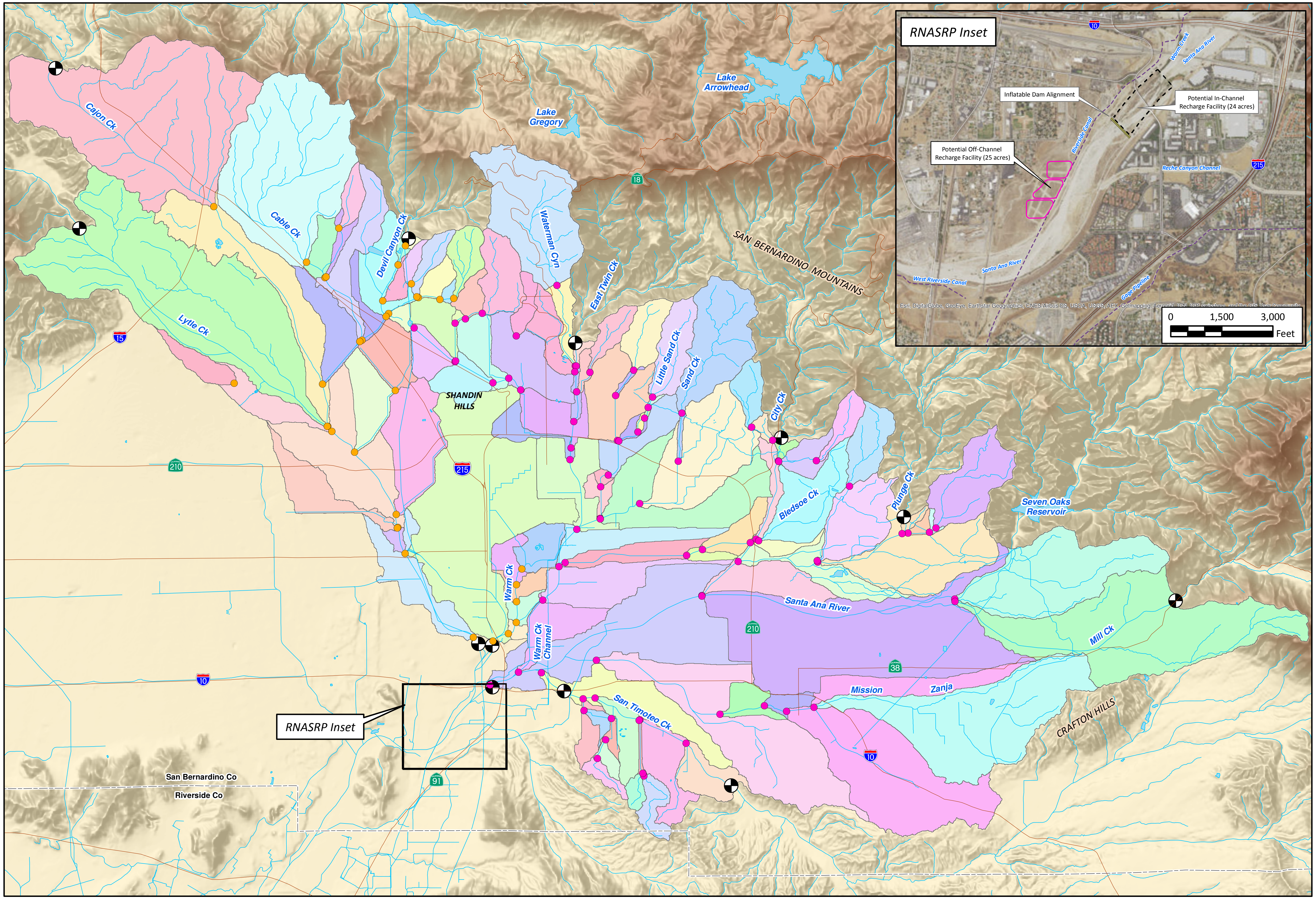
Figure 1

GIS_proj/sbvmwd_stormwater_capture_8-12/8_Fig_1_proj_loc_tributary_subwats_3-16.mxd

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

ADDENDUM TO STORMWATER FLOW AND CAPTURE ANALYSIS - ACTIVE RECHARGE PROJECT FOR THE TRIBUTARIES OF THE SANTA ANA RIVER, SAN BERNARDINO VALLEY, CALIFORNIA

HSPF MODEL WATERSHED AREAS



EXPLANATION

- Gaging Station to be Used to Estimate Outside Tributary Inflow of the SBBA
- Model Node for the Northwest Reaches
- Model Node for the Southeast Reaches
- Watershed Subarea

31-Mar-16

Prepared by: DB. Map Projection: State Plane 1927, Zone V.

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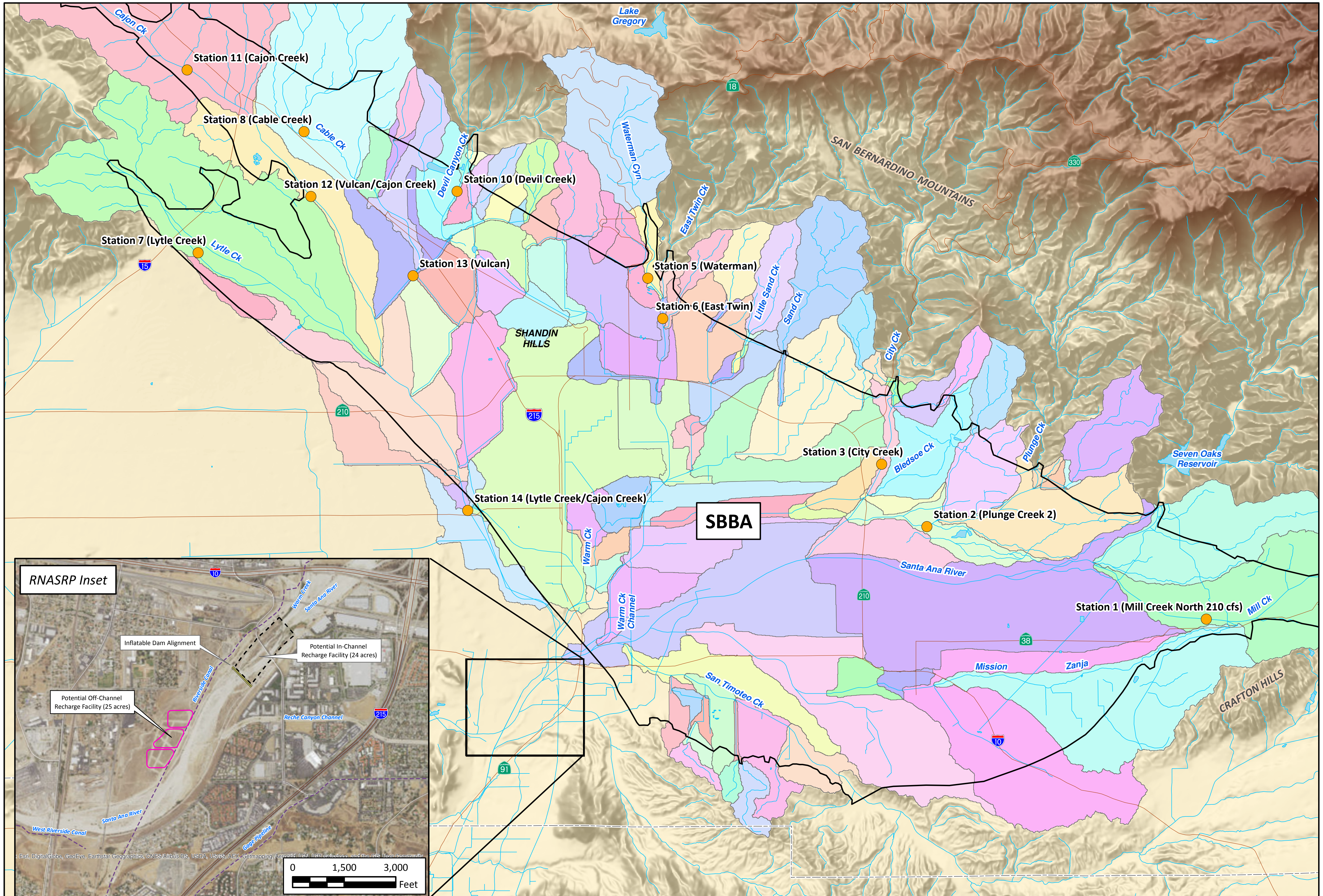
Figure 2

GIS_proj/sbvmwd_stormwater_capture_8-12/8_Fig_1_proj_loc_tributary_subwats_3-16.mxd

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

ADDENDUM TO STORMWATER FLOW AND CAPTURE ANALYSIS - ACTIVE RECHARGE PROJECT FOR THE TRIBUTARIES OF THE SANTA ANA RIVER, SAN BERNARDINO VALLEY, CALIFORNIA

LOCATION OF RNASRP RECHARGE FACILITIES



EXPLANATION

- Potential Recharge Location and Designation
- Watershed Subareas
- Groundwater Basin Boundary

NORTH

0 1 2 4 Miles

31-Mar-16

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Figure 3

GIS_proj/sbvmwd_stormwater_capture_8-12/8_Fig_3_proposed_sw_recharge_loc_3-16.mxd

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

ADDENDUM TO STORMWATER FLOW AND CAPTURE ANALYSIS - ACTIVE RECHARGE PROJECT FOR THE TRIBUTARIES OF THE SANTA ANA RIVER, SAN BERNARDINO VALLEY, CALIFORNIA

LOCATION OF PROPOSED IN-CHANNEL AND OFF-CHANNEL RECHARGE FACILITIES

EXPLANATION

- Potential Off-Channel Recharge Facility (25 acres)
- Inflatable Dam Alignment
- Potential In-Channel Recharge Facility (24 acres)
- City Boundary
- Canal

31-Mar-16

Prepared by: DB. Map Projection: State Plane 1927, Zone V.

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NORTH

0 500 1,000 2,000 Feet

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Figure 4

GIS_proj/sbvmwd_stormwater_capture_8-12/8_Fig_4_loc_of_RNASRP_rech_fac_3-16.mxd

TABLES

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Summary of Proposed Stormwater Capture Facilities for SBBA Active Recharge Project

Basin Name	Wetted Area	Effective Depth	Recharge Rate
	[acre]	[ft]	[ft/day]
Station 1 (Mill Creek North 210 cfs)	46.8	4.0	3.4
Station 2 (Plunge Creek 2)	10.7	8.0	3.4
Station 3 (City Creek)	37.7	8.0	3.4
Station 5 (Waterman)	31.5	7.0	0.9
Station 6 (East Twin)	70.2	6.0	0.9
Station 7 (Lytle Creek)	66.7	13.0	2.2
Station 8 (Cable Creek)	37.9	8.0	2.2
Station 10 (Devil Creek)	35.9	10.0	2.4
Station 11 (Cajon Creek)	18.3	8.0	3.5
Station 12 (Vulcan/Cajon Creek)	70.0	60.0	2.5
Station 13 (Vulcan)	35.2	14.0	3.5
Station 14 (Lytle Creek/Cajon Creek)	43.7	6.0	3.2

Source: Scheeval Engineering, 2016

Table 1

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Table 2

Annual Surface Flow That Leaves SBBA under Scenario 1a and Scenario 2 Conditions
1962 to 2000

Hydrologic Year	Scenario 1a				Scenario 2				Scenario 1a Minus Scenario 2			
	Lytle Creek	Warm Creek	SAR at "E" Street	Scenario 1a Total	Lytle Creek	Warm Creek	SAR at "E" Street	Scenario 2 Total	Lytle Creek	Warm Creek	SAR at "E" Street	Total Difference
	[acre-ft/yr]											
1962	1,244	2,710	6,245	**10,199**	381	2,710	5,086	**8,178**	863	0	1,159	**2,021**
1963	1,769	4,147	8,668	**14,583**	599	4,147	7,975	**12,720**	1,170	0	693	**1,863**
1964	668	1,881	3,081	**5,630**	275	1,881	2,845	**5,001**	393	0	236	**629**
1965	8,633	5,904	34,333	**48,870**	6,154	5,904	26,650	**38,708**	2,479	0	7,683	**10,162**
1966	7,351	5,209	59,989	**72,549**	5,370	5,209	47,927	**58,506**	1,982	0	12,062	**14,044**
1967	3,656	5,341	16,245	**25,242**	802	5,341	11,462	**17,604**	2,854	0	4,784	**7,638**
1968	724	2,153	3,468	**6,345**	273	2,153	3,172	**5,598**	451	0	297	**748**
1969	56,444	11,970	305,505	**373,919**	45,343	11,970	283,730	**341,043**	11,101	0	21,775	**32,876**
1970	1,857	4,135	10,586	**16,578**	587	4,135	8,441	**13,164**	1,270	0	2,144	**3,414**
1971	1,977	3,749	10,623	**16,350**	931	3,749	7,979	**12,660**	1,046	0	2,644	**3,690**
1972	686	2,286	3,318	**6,289**	280	2,286	3,035	**5,601**	406	0	283	**688**
1973	3,035	4,471	13,593	**21,099**	1,351	4,471	9,607	**15,430**	1,684	0	3,986	**5,670**
1974	2,259	4,518	10,828	**17,605**	741	4,518	9,346	**14,604**	1,518	0	1,482	**3,000**
1975	930	2,958	4,214	**8,102**	371	2,958	3,468	**6,797**	559	0	746	**1,305**
1976	2,152	4,181	13,388	**19,721**	944	4,181	11,831	**16,956**	1,209	0	1,556	**2,765**
1977	1,898	4,269	9,967	**16,133**	590	4,269	8,858	**13,717**	1,307	0	1,109	**2,416**
1978	33,416	9,972	157,832	**201,221**	21,240	9,972	143,925	**175,137**	12,176	0	13,907	**26,083**
1979	3,337	4,760	33,946	**42,043**	623	4,760	21,930	**27,313**	2,714	0	12,016	**14,730**
1980	32,821	9,506	220,731	**263,058**	23,930	9,506	211,117	**244,552**	8,891	0	9,614	**18,505**
1981	1,235	3,245	6,539	**11,019**	445	3,245	5,251	**8,941**	790	0	1,288	**2,078**
1982	4,744	6,729	23,548	**35,021**	1,555	6,729	18,412	**26,695**	3,190	0	5,136	**8,326**
1983	21,091	10,441	113,146	**144,678**	7,917	10,441	95,732	**114,090**	13,174	0	17,414	**30,588**
1984	1,102	2,798	5,629	**9,529**	361	2,798	4,602	**7,760**	741	0	1,028	**1,769**
1985	1,220	3,531	6,361	**11,112**	449	3,531	5,421	**9,400**	772	0	941	**1,712**
1986	2,279	4,616	13,210	**20,105**	693	4,616	10,476	**15,785**	1,586	0	2,734	**4,320**
1987	1,370	3,660	5,800	**10,830**	516	3,660	5,166	**9,342**	854	0	634	**1,488**
1988	1,533	3,750	7,244	**12,526**	515	3,750	6,475	**10,741**	1,017	0	768	**1,785**
1989	1,195	3,145	6,097	**10,437**	439	3,145	5,271	**8,855**	756	0	825	**1,581**
1990	1,032	2,649	4,666	**8,347**	392	2,649	4,323	**7,363**	640	0	343	**983**
1991	3,554	5,550	23,975	**33,079**	1,725	5,550	21,065	**28,340**	1,829	0	2,910	**4,740**
1992	6,150	7,031	22,755	**35,936**	2,449	7,031	19,687	**29,168**	3,701	0	3,068	**6,768**
1993	36,264	11,594	195,252	**243,109**	23,548	11,594	173,841	**208,982**	12,716	0	21,411	**34,127**
1994	1,578	3,909	7,344	**12,831**	540	3,909	6,165	**10,614**	1,037	0	1,179	**2,217**
1995	15,274	8,367	107,742	**131,384**	9,166	8,367	87,498	**105,032**	6,108	0	20,244	**26,352**
1996	3,363	5,656	19,905	**28,925**	1,294	5,656	15,732	**22,683**	2,070	0	4,173	**6,242**
1997	3,160	5,147	20,519	**28,826**	1,092	5,147	16,200	**22,439**	2,068	0	4,319	**6,387**
1998	14,561	9,594	86,268	**110,422**	8,001	9,594	64,944	**82,539**	6,560	0	21,324	**27,884**
1999	540	1,895	2,139	**4,574**	237	1,895	1,797	**3,929**	303	0	342	**645**
2000	1,325	3,307	6,839	**11,471**	444	3,307	5,692	**9,443**	880	0	1,148	**2,028**
Average	**7,370**	**5,147**	**41,322**	**53,838**	**4,425**	**5,147**	**35,952**	**45,524**	**2,945**	**0**	**5,369**	**8,315**

Annual SAR Surface Flow That Enters SBBA after Diversions of SAR Existing and Enhanced Recharge (1962 to 2000)

Hydrologic Year	SAR Existing Recharge (195 cfs Capacity)	SAR Enhanced Recharge (500 cfs Capacity)	Enhance Recharge Minus Existing Recharge
	[acre-ft/yr]		
1962	313	0	-313
1963	0	0	0
1964	0	0	0
1965	7,384	0	-7,384
1966	24,008	8,926	-15,082
1967	500	0	-500
1968	0	0	0
1969	115,614	106,614	-9,000
1970	1,236	0	-1,236
1971	2,420	0	-2,420
1972	0	0	0
1973	1,676	0	-1,676
1974	0	0	0
1975	0	0	0
1976	924	319	-605
1977	0	0	0
1978	42,432	28,432	-14,000
1979	32,019	16,871	-15,148
1980	149,113	136,260	-12,852
1981	0	0	0
1982	2,095	0	-2,095
1983	75,385	57,621	-17,765
1984	0	0	0
1985	0	0	0
1986	685	0	-685
1987	0	0	0
1988	0	0	0
1989	0	0	0
1990	0	0	0
1991	0	0	0
1992	30	0	-30
1993	81,401	62,401	-19,000
1994	0	0	0
1995	45,473	28,973	-16,500
1996	2,522	0	-2,522
1997	2,013	0	-2,013
1998	26,948	7,948	-19,000
1999	0	0	0
2000	0	0	0
Average	**15,748**	**11,650**	**-4,098**

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Table 4

Annual Percolation at Capture Grounds under Scenario 2 Conditions
1962 to 2000

Hydrologic Year	Station 1 (Mill Creek)	Station 2 (Plunge Creek)	Station 3 (City Creek)	Station 5 (Waterman)	Station 6 (East Twin)	Station 7 (Lytle Creek)	Station 8 (Cable Creek)	Station 10 (Devil Creek)	Station 11 (Cajon Creek)	Station 12 (Vulcan/Cajon Creek)	Station 13 (Vulcan)	Station 14 (Lytle Creek/Cajon Creek)	Total
	[acre-ft/yr]												
1962	1,858	2,244	3,360	1,035	1,736	609	1,627	523	160	0	848	860	14,860
1963	2,149	995	829	494	832	162	814	81	93	687	915	1,169	9,219
1964	1,261	629	695	282	659	87	490	53	22	779	330	392	5,677
1965	3,490	2,832	4,002	1,535	2,798	3,308	2,377	1,205	989	0	2,278	2,480	27,295
1966	4,150	2,681	4,508	2,023	2,757	3,530	3,228	1,363	964	0	1,764	1,960	28,927
1967	9,885	6,235	9,771	2,530	4,509	2,973	3,904	2,902	775	3,997	3,085	2,763	53,328
1968	1,203	931	1,642	467	1,339	253	800	866	63	0	475	451	8,488
1969	15,327	8,094	13,169	2,812	8,203	17,851	5,330	5,630	5,721	54	8,348	11,523	102,062
1970	3,996	2,091	2,983	602	2,074	535	994	2,184	144	0	1,337	1,270	18,210
1971	1,670	1,407	2,330	749	1,977	572	1,226	1,419	358	190	1,349	1,045	14,292
1972	1,217	727	758	491	946	144	816	480	103	0	432	405	6,519
1973	5,541	3,473	4,661	2,066	3,022	1,682	3,377	2,104	938	0	2,223	1,642	30,730
1974	7,331	1,780	2,136	1,198	1,680	695	1,896	1,983	590	81	1,668	1,520	22,558
1975	7,163	1,241	1,621	747	1,497	213	1,218	1,689	119	0	711	556	16,776
1976	6,448	1,320	1,348	709	1,347	307	1,161	1,588	522	3,288	1,406	1,208	20,652
1977	6,489	1,427	1,280	615	851	396	1,013	496	282	0	1,178	1,306	15,334
1978	17,582	8,493	13,033	3,218	7,247	19,261	6,076	5,609	5,023	3,606	8,834	12,144	110,126
1979	16,812	4,706	7,026	1,811	3,773	3,459	2,832	1,548	692	0	2,023	2,661	47,344
1980	18,464	8,634	13,479	2,665	8,387	13,780	5,004	4,990	3,929	0	7,926	8,857	96,115
1981	9,879	1,234	1,765	583	3,296	290	972	329	84	836	778	789	20,834
1982	12,418	3,734	5,316	2,095	4,731	3,221	3,343	1,206	897	0	2,552	3,152	42,665
1983	19,088	9,647	15,140	3,711	11,217	18,577	6,994	5,805	5,101	0	8,442	13,067	116,789
1984	8,798	1,458	2,492	638	2,869	576	1,050	468	262	0	722	736	20,070
1985	7,655	1,436	2,014	1,037	1,977	260	1,673	836	152	0	805	770	18,615
1986	7,030	2,626	3,783	1,520	3,587	971	2,368	1,623	571	0	1,856	1,562	27,496
1987	3,139	1,126	1,265	607	1,287	210	994	748	151	0	809	853	11,187
1988	2,442	1,277	1,350	947	1,340	349	1,531	639	218	0	930	1,016	12,040
1989	2,782	1,178	1,354	1,250	1,201	167	1,972	801	175	102	1,000	755	12,738
1990	2,521	652	733	375	1,664	108	652	516	111	111	641	639	8,721
1991	5,006	2,363	3,129	1,828	3,210	896	3,306	822	900	4,386	2,362	1,793	30,002
1992	8,022	3,132	4,407	2,316	2,810	4,284	3,812	1,457	1,671	0	3,204	3,632	38,748
1993	18,403	8,354	13,448	2,911	7,781	19,906	5,621	6,572	3,730	1,612	8,754	12,697	109,787
1994	6,796	1,475	1,963	776	2,092	340	1,274	1,810	242	0	1,112	1,036	18,913
1995	14,847	6,953	10,979	2,808	7,476	9,314	4,947	6,431	2,740	0	6,982	6,019	79,495
1996	11,247	2,585	3,845	1,289	3,595	1,206	2,019	2,584	639	1,726	2,710	2,052	35,497
1997	7,814	3,201	4,457	2,029	3,905	852	3,440	3,088	804	0	3,612	2,031	35,232
1998	18,791	8,705	13,236	3,187	9,167	6,963	6,197	5,492	2,312	0	7,170	6,525	87,746
1999	5,160	783	1,365	172	1,751	157	339	1,021	35	0	388	302	11,474
2000	5,595	1,279	1,273	772	1,468	233	1,259	1,010	375	0	992	879	15,135
Average	**7,935**	**3,157**	**4,665**	**1,459**	**3,386**	**3,556**	**2,511**	**2,051**	**1,094**	**550**	**2,640**	**2,936**	**35,941**

Annual Surface Flow Captured by RNASRP under Scenario 3 Conditions
1962 to 2000

Hydrologic Year	Flows Available to RNASRP	Flows Diverted by RNASRP	Flows after RNASRP
	[acre-ft/yr]		
1962	8,178	5,488	2,689
1963	12,720	7,481	5,239
1964	5,001	4,046	955
1965	38,708	11,114	27,594
1966	58,506	6,471	52,035
1967	17,604	11,163	6,441
1968	5,598	3,833	1,765
1969	341,043	69,161	271,882
1970	13,164	7,958	5,206
1971	12,660	6,841	5,818
1972	5,601	4,281	1,320
1973	15,430	9,278	6,152
1974	14,604	8,345	6,259
1975	6,797	5,985	812
1976	16,956	7,130	9,826
1977	13,717	7,992	5,725
1978	175,137	58,535	116,603
1979	27,313	20,859	6,454
1980	244,552	71,603	172,950
1981	8,941	5,814	3,127
1982	26,695	14,692	12,003
1983	114,090	55,191	58,899
1984	7,760	4,827	2,934
1985	9,400	7,041	2,360
1986	15,785	9,827	5,958
1987	9,342	7,758	1,584
1988	10,741	7,547	3,193
1989	8,855	5,876	2,980
1990	7,363	4,239	3,125
1991	28,340	10,308	18,031
1992	29,168	14,065	15,102
1993	208,982	56,826	152,155
1994	10,614	8,057	2,557
1995	105,032	35,999	69,033
1996	22,683	11,570	11,113
1997	22,439	10,928	11,511
1998	82,539	37,640	44,899
1999	3,929	3,722	207
2000	9,443	6,800	2,644
Average	**45,524**	**16,571**	**28,952**