SOUTHERN CALIFORNIA STEELHEAD PASSAGE ASSESSMENT, LOWER SANTA MARGARITA RIVER, CALIFORNIA AND CUP SURFACE WATER AVAILABILITY ANALYSIS (TM 1.1)

APPENDIX B

CUP SURFACE WATER AVAILABILITY ANALYSIS (TM 1.1)

TECHNICAL MEMORANDUM 1.1

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TO:	Office of Water Resources	DATE:	April 27, 2012
FROM:	Stetson Engineers	JOB NO:	2408-2009

RE: Update to Technical Memorandum 1.0: Statistical Analysis of Santa Margarita River Surface Water Availability at the Conjunctive Use Project's Point of Diversion

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1.0 INTRODUCTION

1.1 STUDY AUTHORITY

The Marine Corps Base Camp Pendleton (Base or CPEN), the United States Bureau of Reclamation (Reclamation), and the Fallbrook Public Utilities District (FPUD) have been working collaboratively to develop the Santa Margarita River Conjunctive Use Project (CUP). The Base and Reclamation have authorized this study in order to update a previous investigation of water supply and availability requirements for the proposed Santa Margarita River CUP. Stetson Engineers provided services to the Office of Water Resources, AC/S Facilities under contract M00681-06-F-0651 CLIN 5001.

1.2 UPDATE TO TM 1.0

In April 2007, Reclamation completed Final Technical Memorandum No. 1.0 (TM 1.0; Reclamation, 2007a) which investigated and reported on a statistical analysis of water availability at the Santa Margarita River CUP's point of diversion (POD). TM 1.0 addressed the natural variability of flows in the Santa Margarita River over the historical period of record and presented statistics that describe those flows in terms of both total water supply and water available for diversion. Based on the availability of surface water, the potential groundwater yield from the CUP was subsequently investigated in TM 2.2 (Reclamation, 2007b). The determination of the CUP yield involved an iterative process of optimizing surface and groundwater resources.

The purpose of updating TM 1.0 is two-fold: first, update the statistical analysis of surface water availability at the Santa Margarita River CUP's POD, and; second, support the in-stream flow analysis of critical habitat that may support anadromous fish migration. Originally based on the 81-year period of record from Water Year (WY) 1925 through WY 2005, TM 1.0 relied on available published hydrologic data to describe water availability for the Santa Margarita River CUP. This memorandum, known as TM 1.1, updates the statistical analysis to include published hydrologic data through WY 2009 and reports on refinements to the surface water model that have been made since 2007. The results of the extended period of record and improvements to the surface water analysis are included in the 2011 estimates of Santa Margarita River CUP groundwater yield described in Model Run 16.

The analysis of critical habitat for anadromous fish in the lower Santa Margarita River relies describing flow at the POD. National Oceanic and Atmospheric Administration, Marines Fisheries Service (NOAA Fisheries) requested hydrologic information important to identifying fish passage requirements in the Lower Santa Margarita River (NOAA Fisheries, 2011). Three time periods have been identified for study, including: unimpaired flow from WY 1931 through 1945; recent historical flow from WY 1997 through 2009, and streamflow under future project conditions. The surface water analysis presented in this study provides the hydrologic data that may be used by hydrologists and biologists to describe potential passage barriers through critical habitat areas downstream of the Santa Margarita River CUP's POD.

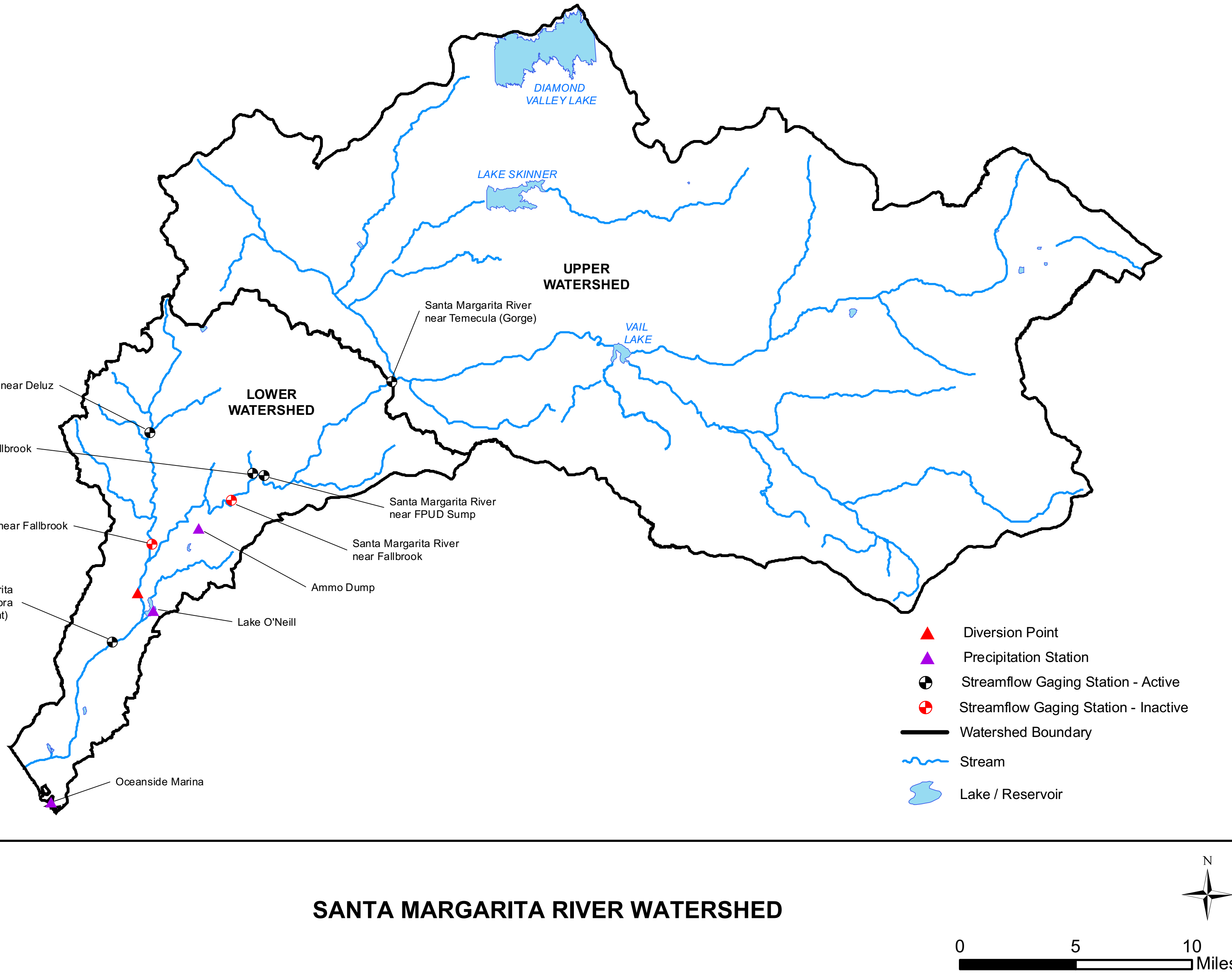
Reclamation began work on an Environmental Impact Report and Environmental Impact Statement (EIR/EIS) in 2007 to identify the environmental impact of various alternatives that may be used to achieve the purpose and need of the proposed Santa Margarita River CUP. The statistical analysis and supporting hydrologic study completed for TM 1.1 establishes the boundary conditions that will eventually support Reclamation's design of extraction, conveyance, and water treatment facilities.

Surface water availability was analyzed for historical hydrologic conditions based on long-term precipitation and streamflow records. The flows at the POD represent regulated or depleted conditions occurring over the historical period of record, not natural flow conditions that would have been seen without development or flow regulation. The use of historical conditions represents the operational water supply available at the POD and provides a more realistic estimation of the CUP's potential yield.

1.3 BACKGROUND

The 744-square-mile Santa Margarita River Basin lies within the counties of San Diego and Riverside in southern California. Hydrological conditions in the Santa Margarita River Basin are controlled by winter-time tropical and northern Pacific storm events and, to a minor degree, summer monsoon events. While most of the precipitation occurs as rainfall throughout the watershed, snowfall may occur in the higher mountain ranges located in the upper reaches of the watershed, influencing springtime baseflow above Vail Dam. Typical of many southwestern United States stream systems, extreme peak flows often occur during winter rain events, and minimum baseflows occur during the dry summer months. The flashy nature of the Santa Margarita River and the daily streamflow variability were considered to statistically describe the volume of water available at the POD.

The Santa Margarita River Watershed is divided into two distinct watersheds referred to as the Upper Watershed and Lower Watershed (Figure 1). The Upper Watershed is the drainage area located above the confluence of Murrieta and Temecula Creeks, a point referred to as the Gorge. The Lower Watershed is the drainage area downstream of the Gorge to the Pacific



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SANTA MARGARITA RIVER WATERSHED

FIGURE 1

Ocean. Major tributaries in the Lower Watershed include De Luz, Sandia, and Rainbow Creeks, all of which are monitored and measured by the United States Geologic Survey (USGS). The CUP POD is located on Marine Corps Base Camp Pendleton in the Lower Watershed (Figure 2). For the purpose of simulating water availability at the POD, all streamflow from the Upper Watershed was assumed to be measured at the USGS streamflow gage at the Gorge; hence, no other streamflow gages in the Upper Watershed were considered in this analysis.

The groundwater basins in the Santa Margarita River Watershed may also be divided into the Upper and Lower Basins. The Upper Basin commonly refers to the Murrieta-Temecula groundwater basin located up-gradient of the Gorge; additionally, the Anza Basin, separate from the Murrieta-Temecula basin, is also located up-gradient of the Gorge. The Lower Basin refers to the groundwater basin located entirely on Camp Pendleton and includes the Upper Ysidora, Chappo, and Lower Ysidora Subbasins. Neither the Upper Basin nor the Anza Basin was directly considered during the reconstruction of streamflow or the estimated future water availability at the POD.

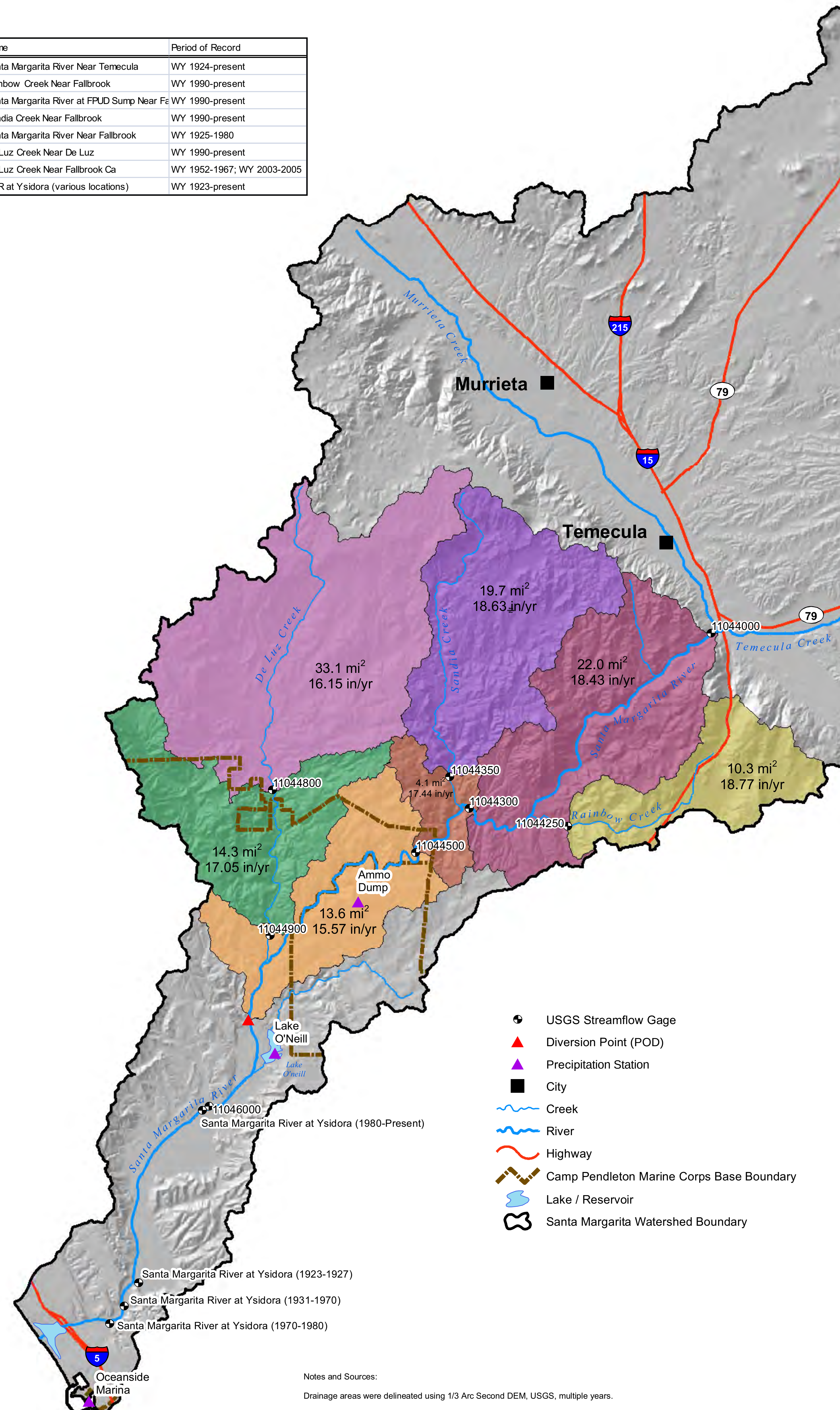
The Santa Margarita River CUP represents a physical solution to the long-standing water rights dispute between the Base and FPUD. The purpose of the CUP is to perfect the water rights permits held on behalf of the two parties by Reclamation (Permit 15000 for Camp Pendleton; Permits 8511 and 11357 for FPUD) while providing the parties with a reliable local water supply, reducing the dependence on imported water, and maintaining watershed resources.

Under the CUP, water diverted from the Santa Margarita River would be appropriated under the unperfected permits held by Reclamation and vested water rights held by Camp Pendleton. The proposed CUP is designed to increase the yield of the Santa Margarita River by storing water in Camp Pendleton's underground aquifers for subsequent extraction by groundwater wells. Up to 16 existing and new wells will be exercised to extract groundwater from the Upper Ysidora and Chappo Sub-basins for use by CPEN and FPUD.

1.4 METHODOLOGY TO DETERMINE WATER AVAILABILITY

The purpose of reconstructing historical streamflow at the POD is to estimate future surface water availability and determine the amount of water that may be diverted from the river and subsequently delivered to either Lake O'Neill or the recharge ponds. The reconstructed streamflow records are used as inputs to a Reservoir Operations Model (ROM) and the Lower Santa Margarita River Groundwater Model (LSMR Model), a numerical groundwater model that estimates basin yield from Camp Pendleton's aquifer.

USGS Gage ID	Name	Period of Record
11044000	Santa Margarita River Near Temecula	WY 1924-present
11044250	Rainbow Creek Near Fallbrook	WY 1990-present
11044300	Santa Margarita River at FPUD Sump Near Fa	WY 1990-present
11044350	Sandia Creek Near Fallbrook	WY 1990-present
11044500	Santa Margarita River Near Fallbrook	WY 1925-1980
11044800	De Luz Creek Near De Luz	WY 1990-present
11044900	De Luz Creek Near Fallbrook Ca	WY 1952-1967; WY 2003-2005
11046000	SMR at Ysidora (various locations)	WY 1923-present



Notes and Sources:

Drainage areas were delineated using 1/3 Arc Second DEM, USGS, multiple years.

Average annual precipitation is shown for each subwatershed. Precipitation values were determined from an isohyetal layer based on precipitation data from 1971 through 2000 (USDA/NRCS - National Cartography & Geospatial Center, "Processed Annual Precipitation", 2006). Due to the analysis period (1971-2000) used in the isohyetal layer, average annual precipitation shown for each subwatershed may not match average annual precipitation for nearby gages with different periods of record.

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SANTA MARGARITA RIVER GAGES AND SUBWATERSHEDS USED TO RECONSTRUCT FLOW AT CAMP PENDLETON POINT OF DIVERSION

N

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FIGURE 2

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Historical streamflow at the POD was reconstructed for the period WY 1925 through WY 2009. Due to gaps in the historical record, multiple hydrologic principles and methods were used to reconstruct the streamflow for the entire 85-year period. In addition to reflecting changes in streamflow at the POD due to varying hydrologic conditions, reconstructed historical streamflow also includes anthropogenic impacts from urbanization and water development projects that occurred during the historical period.

This memorandum describes the hydrologic datasets and methodologies that were used to reconstruct flow at the POD and estimate water availability. Streamflow at the POD refers to flow upstream of the diversion weir, prior to diversions...

1.5 HYDROLOGIC DATA SETS

Figure 2 depicts all USGS streamflow gages that were used to reconstruct flow at the POD. The accuracy of each gage varies depending on its location and flow and is described in annual USGS publications for each station. The Santa Margarita River at Ysidora gage (USGS 11046000), used as a reference, is located approximately one mile downstream of the POD.. Prior to 1980, the Ysidora gage was sited at multiple locations more than four miles downstream from Camp Pendleton's airfield. While the Ysidora gage may be the closest gage, due to its varied locations and influences from surface diversions, groundwater pumping, and Lake O'Neill releases, it was not used to determine historical streamflow at the POD. All other streamflow gages are located upstream of the POD and were used to reconstruct historical streamflow for the period of record WY 1925 to 2009 (Table 1A). Three precipitation stations shown in Table 1B were used to estimate rainfall in the Lower Watershed. The Lake O'Neill precipitation station has the longest period of record (1876 to present).

TABLE 1A STREAM GAGING STATIONS USED TO RECONSTRUCT STREAMFLOW IN THE SANTA MARGARITA RIVER AT THE POINT OF DIVERSION

Station Name	USGS Station ID No.	Operating Agency	Period of Record	Drainage Area[1] (square miles)
Santa Margarita River near Temecula (Gorge)	11044000	USGS	2/23-Present	588.0
Santa Margarita River at FPUD Sump	11044300	USGS	10/89-Present	620.3
Sandia Creek near Fallbrook	11044350	USGS	10/89-Present	19.7
Santa Margarita River near Fallbrook	11044500	USGS	10/24-9/80	644.1
De Luz Creek near De Luz	11044800	USGS	10/92-Present	33.1
De Luz Creek near Fallbrook	11044900	USGS	10/51-9/67	47.4
Santa Margarita River at Ysidora (various locations)	11046000	USGS	3/23-Present	723.0

[1]Drainage areas for gages 11044000 and 1104600 from USGS. Drainage areas for gages 11044300, 11044350, 11044500, 11044800 and 11044900 delineated using 1/3 Arc Second DEM, USGS, multiple years.

TABLE 1B PRECIPITATION STATIONS NEAR THE SANTA MARGARITA RIVER POINT OF DIVERSION

Station Name	Operating Agency	Elevation[1] (ft above MSL)	Latitude[2]	Longitude[2]	Data Format	Period of Record	
						From	To
Ammo Dump	OWR	1,068	33°22’53”	-117°17’08”	Daily	7/2002	Present
Lake O'Neill	OWR	120	33°19’46”	-117°19’10”	Daily[3]	7/1876	Present
Oceanside Marina	NWS	100	33°12’35”	-117°23’42”	Daily	12/1943	Present

[1]Elevation referenced to National Geodetic Vertical Datum of 1929 (NGVD29).
[2]Latitude and Longitude referenced to North American Datum of 1927 (NAD27), except Oceanside Marina which is referenced to North American Datum of 1983 (NAD83).
[3]Lake O’Neill records are monthly from 1876-1913 and daily thereafter.
NWS = National Weather Service Cooperative Network; OWR = Office of Water Resources, Camp Pendleton

1.6 HISTORICAL RECONSTRUCTED STREAMFLOW AT THE POINT OF DIVERSION

Surface water modeling was performed in order to estimate the water availability at the Santa Margarita River CUP's POD. Since historical gage measurements were not available at that location, surface water analysis was required to reconstruct historical flows. The reconstructed streamflow estimates represent surface flow that would have been measured at that location by a gage (*i.e*. flows represent actual flows, not unimpaired or natural flows).

The CUP's POD is proposed to be located at Camp Pendleton's existing diversion point to O'Neill Ditch. Because no long-term United States Geologic Survey (USGS) gage has ever been established at the existing diversion structure, recorded streamflow data from the USGS gages listed in Table 1a were used to develop a streamflow hydrograph at the diversion point. Figure 2 shows the locations of the historical USGS gages used to reconstruct flow at the CUP's proposed POD.

A spreadsheet model was developed to reconstruct the streamflow in the Santa Margarita River at the POD. The spreadsheet model used a daily time step, and annual and monthly streamflow records at the POD were summarized from the daily data. The hydrologic record is divided into three time periods defined by the activity of historical gages in the lower Santa Margarita River Watershed. Methods used during each of the three periods vary, and are described as follows:

- **Water Years 1925 to 1980**: The total streamflow at the POD was calculated by adding streamflow measured at the Santa Margarita River near Fallbrook gage (USGS #11044500) to streamflow from De Luz Creek, plus the estimated contribution between the downstream gages and the POD. During this period, the Santa Margarita River near Fallbrook gage was downstream of both Sandia and Rainbow Creeks, so their contributions were included in the main stem gaged flow. A net loss of flow between the gage at Fallbrook and the POD was allowed, based upon whether a net loss was observed between the Gorge and the Fallbrook gage. Losses on the main stem tend to occur during summer months when evapotranspiration is high, groundwater levels are low, and there are no contributing flows in tributaries. During water years 1925 to 1971, FPUD diverted water from the Santa Margarita River via a pump at the FPUD sump. While these diversions are not included in the estimated reconstructed streamflow at the POD, they were added to the streamflow at the Fallbrook gage for the purposes of estimating the flow contribution between the two gages. This was done to prevent overestimation of stream losses between the gages at the

Gorge and Fallbrook. Both the De Luz contribution and flow between the Fallbrook gage and POD are based upon the flow contribution between the Gorge and the Fallbrook gages.

During water years 1952 through 1967, streamflow from the De Luz Creek gage near Fallbrook (USGS #11044900) was used for the contribution of streamflow from De Luz Creek. For all other years, the contribution from De Luz Creek was calculated based on the flow contribution between the Gorge and the gage at the Santa Margarita River near Fallbrook, with proportional factors applied to adjust for differing drainage areas and average annual precipitation amounts (from NRCS, 2006). Contribution from the De Luz watershed was further adjusted based on calibration in the LSMR Model to historical water levels.

- **Water Years 1981 to 1989**: The streamflow records in the lower Santa Margarita River watershed during water years 1981 through 1989 were deficient due to missing gage data. During the 1980 flood, the Santa Margarita River near Fallbrook gage (USGS #11044500) was washed out and was not reconstructed until 1989. A new gage was installed in 1989 at the FPUD Sump on the Santa Margarita River (USGS #11044300), upstream of the confluence with Sandia Creek. The only reliable historical streamflow dataset available during the 1981 to 1989 period of record was from the Santa Margarita River near Temecula gage (USGS #11044000).

  To reconstruct streamflow at the POD, the contribution of streamflow below the Gorge was estimated using the Soil Conservation Service (SCS) Curve Number method and the United States Environmental Protection Agency's (USEPA) Hydrologic Simulation Program-Fortran (HSPF). The SCS method was used to calculate surface runoff during precipitation events while the HSPF model was used to simulate baseflows in each drainage area. Stetson Engineers applied these two methods in the development of the Permit 15000 water availability study (Stetson, 2001).

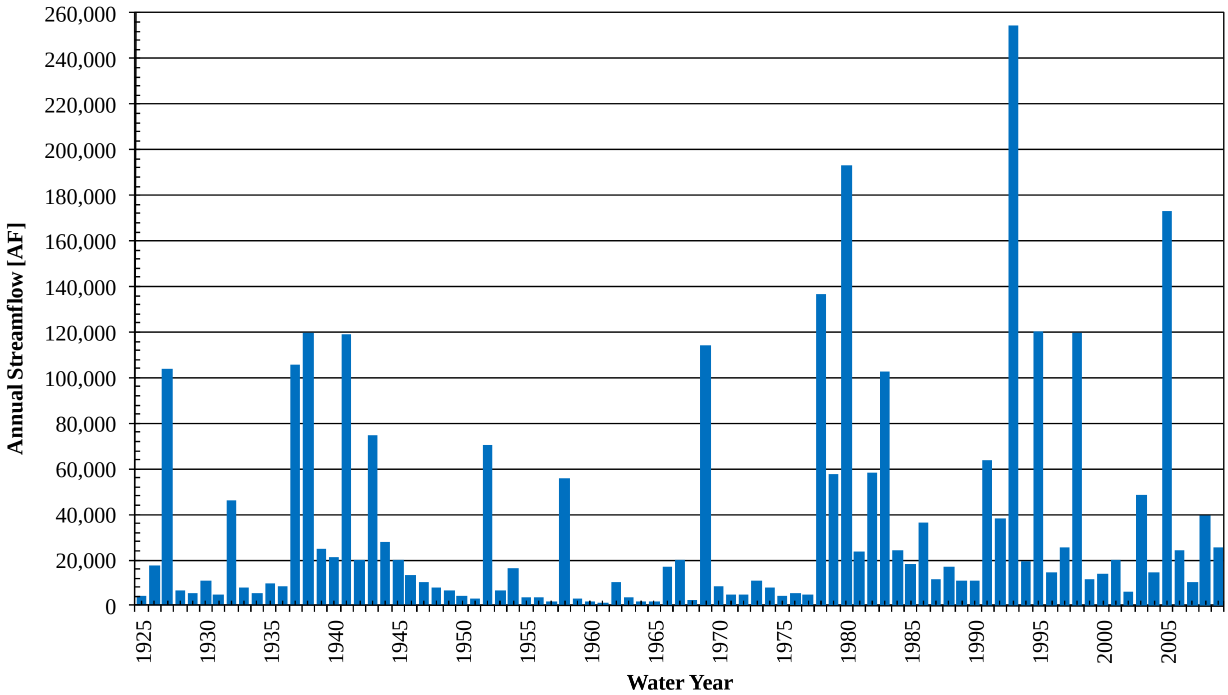
- **Water Years 1990 to 2009**: Streamflow at the POD for the most recent period was developed by summing historical streamflow at the Santa Margarita River at the FPUD Sump (USGS #11044300), Sandia Creek (USGS #11044350), and De Luz Creek near De Luz (USGS #11044800) gages, plus the estimated flow contribution between the downstream gages and the POD. The flow contribution between the gages and the POD was based upon the upstream gaged flows, with proportional factors applied to adjust for differing drainage areas and average annual precipitation amounts (from NRCS, 2006). A net loss of flow between the FPUD Sump gage and the POD was allowed, based upon whether a net loss was observed between the Gorge and the FPUD Sump gage. This occurred most often during summer months of dry years.

Geomorphologic conditions significantly influence the occurrence of surface flow and subsurface flow occurring below the Gorge. The geologic map indicates minimal stream channel alluvial sediments at the Gorge, thus the flow at this location is considered to be entirely surface flow. From the Gorge to the confluence with De Luz Creek, the amount of alluvial sediment ranges from 15 ft to 20 ft, allowing for a portion of the total water supply to occur as subflow. Below the De Luz Creek confluence, the alluvium increases considerably, supporting a larger volume of subflow. A general head boundary in the groundwater model evaluates the subflow contribution at the model boundary, identifying subflow contributions on a monthly basis. Thus, the recoverable portion of subflow is accounted for in the groundwater model, which was subsequently examined in TM 2.2. Due to the occurrence of alluvial sediments in the stream channel, a portion of the baseflow for the drainage areas below the USGS gages is accounted for in the groundwater model.

Observed flows from the Santa Margarita River near Ysidora (USGS #11046000)gage were not used in the surface water calibration process due to the poorly constrained physical conditions that influence the quality of the data, the impact of groundwater pumping from the lower Santa Margarita River basin, and the effect of five different historical gage locations over seven miles. Additional refinements to streamflow at the POD were made throughout the groundwater model calibration process.

The reconstructed annual streamflow at the POD in the Santa Margarita River for water years 1925 to 2009 is shown in the bar graph in Figure 3. The reconstructed monthly streamflow values for the same period are presented in Attachment A-1. The maximum annual streamflow of 254,800 acre-feet (AF) occurred during water year 1993 and the minimum annual streamflow (1,200 AF) occurred in 1961. This significant range in annual flows typifies the variability of streamflow in the Santa Margarita River, where flow in the wettest year is 200 times greater than flow in the driest year on record.

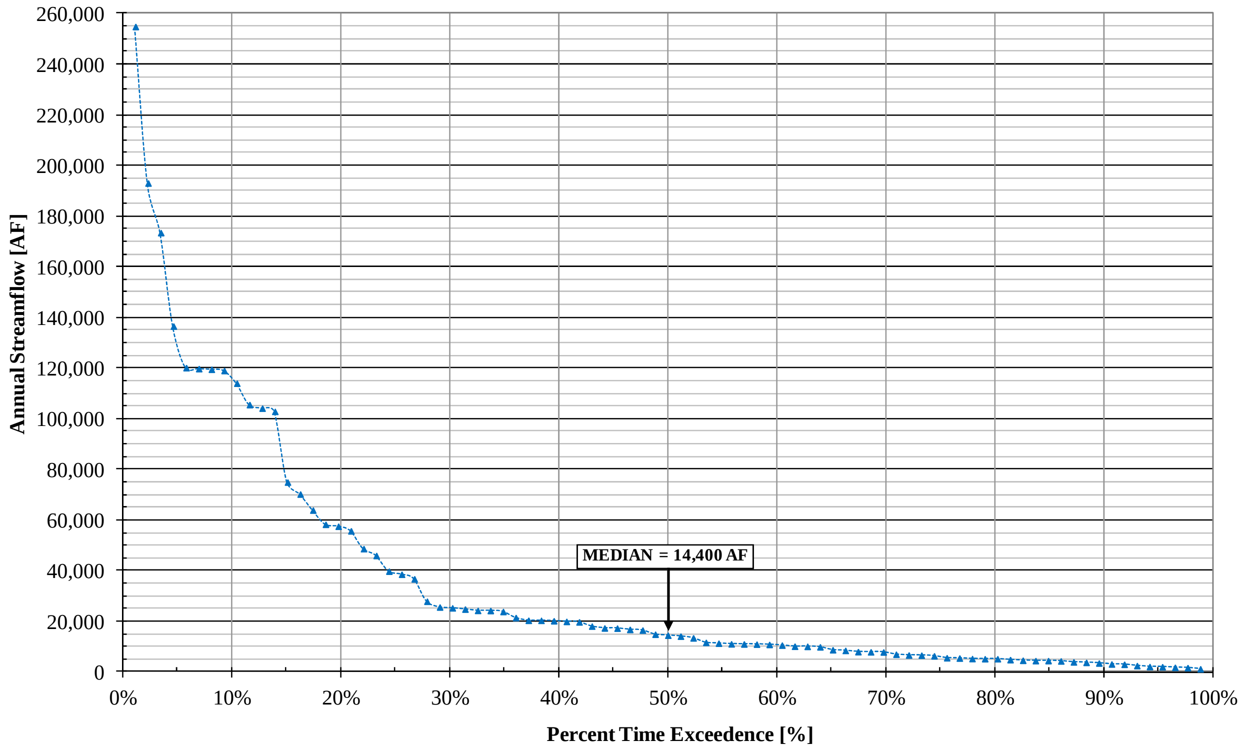
FIGURE 3 RECONSTRUCTED STREAMFLOW IN THE SANTA MARGARITA RIVER AT THE POINT OF DIVERSION, WATER YEARS 1925 - 2009



1.7 FREQUENCY ANALYSIS OF STREAMFLOW AT THE POINT OF DIVERSION

A frequency analysis was performed on historical annual streamflow in the Santa Margarita River at the POD for the 85-year period of record to establish the frequency with which annual streamflow volumes were historically exceeded. Similar to recurrence intervals assigned to flood events, exceedence intervals are used to establish a basis for predicting the frequency of future annual streamflow values. The historical streamflow for each year is ranked and assigned a percent time exceedence. The frequency curve depicts the frequency at which a given annual streamflow at the POD was exceeded during the 85-year historical period (Figure 4). Attachment A-2 lists the annual streamflow values at the point of diversion for this period, ranked in descending order.

FIGURE 4 FREQUENCY DISTRIBUTION OF RECONSTRUCTED ANNUAL STREAMFLOW AT THE POINT OF DIVERSION, WATER YEARS 1925 - 2009



The exceedence interval provides a statistical expression of the probability that annual streamflow will be equaled or exceeded in any given year. For this analysis, the exceedence interval represents the period of time, in years, that an annual flow will likely be exceeded and is calculated as the inverse of the percent time exceedence. For example, the median (50%) annual flow (14,400 AF) represents a minimum volume that is expected to be exceeded 1 year out of every 2 years (1 divided by 50%).

Storage facilities, including both surface reservoirs and groundwater aquifers, uniquely reduce the natural variability so that the median flow value becomes a more statistically meaningful number in the arid Southwestern United States. Diversion of water to either surface or underground storage reduces the impact of the natural variability to the water supply. Surface water during dry years may be captured and stored, increasing the water available during those years—effectively reducing the occurrence interval of dry years.

The anticipated annual streamflow for a variety of exceedence intervals, passing the POD on the Santa Margarita River, is shown in Table 2. A minimum flow of 24,200 AF has passed the

POD once out of every 3 years during the 85-year period of record. Another application of the exceedence interval to project design is to suggest that annual streamflow has historically exceeded 14,400 AF 50% of the time.

The frequency distribution and exceedence intervals represent the historical annual streamflow in the Santa Margarita River at the POD. However, these values do not necessarily represent the potential diversion to O'Neill Ditch or the potential yield of the Santa Margarita River CUP. The ability to divert surface water from the Santa Margarita River is dependent upon the frequency of wintertime rainfall events and antecedent conditions, but also relies upon a complicated function of water rights, environmental requirements, and operation of the diversion structure. The quantity of water diverted in a given year is limited by the diversion capacity (assumed 200 cubic feet per second (cfs)), a bypass flow (assumed 3 cfs), and the deflation of the diversion structure during the 10-year event or greater streamflow event to allow for sediment to pass from behind the diversion structure. The portion of water supply available for diversion is described in the section entitled "Maximum Potential Diversion."

TABLE 2 EXCEEDENCE INTERVALS AND ANNUAL STREAMFLOW IN THE SANTA MARGARITA RIVER AT THE POINT OF DIVERSION FOR WATER YEARS 1925-2009

Percent Time Exceedence (%)	Exceedence Interval	Annual Streamflow at the POD (AF)
4%	1 in 25 years	157,200
5%	1 in 20 years	131,600
7%	1 in 15 years	119,800
10%	1 in 10 years	116,000
11%	1 in 9 years	109,300
13%	1 in 8 years	104,500
14%	1 in 7 years	94,900
17%	1 in 6 years	68,100
20%	1 in 5 years	57,100
25%	1 in 4 years	39,100
33%	1 in 3 years	24,200
50%	1 in 2 years	14,400
75%	1 in 1.3 years	5,900
100%	1 in 1 years	1,200

1.7.1 Hydrologic Condition

The long-term reconstruction of annual streamflow at the POD provides a dataset that may be used to categorize hydrologic conditions. Hydrologic conditions were initially categorized in TM 1.0 and are updated here. Flows at the POD have been statistically grouped into one of four different categories. Due to the influence of wintertime precipitation events on annual streamflow, October through April wintertime total streamflow volume was used to define the limits of four hydrologic conditions: Very Wet, Above Normal, Below Normal, and Very Dry. The wintertime streamflow frequency curve is divided into four parts, established by graphical slope breaks (Attachment B-1). These slope breaks define the four categories based on the total volume of wintertime streamflow. The range of wintertime flows for each hydrologic condition is shown in Table 3. The median wintertime streamflow (12,800 AF) represents the break between Above Normal and Below Normal hydrologic conditions, while the average wintertime streamflow (34,600 AF) falls within the Above Normal hydrologic category. This is typical in the arid southwest, where high volumes of wintertime streamflow during Very Wet hydrologic years significantly increases the difference between the average and median streamflow values. The median wintertime streamflow (12,800 AF) is predictably less than the median annual streamflow (14,400 AF) due to the exclusion of non-winter streamflow.

TABLE 3 DELINEATION OF HYDROLOGIC CONDITION BASED ON WINTERTIME STREAMFLOW FOR WATER YEARS 1925-2009

Hydrologic Condition	Range of Wintertime Streamflow (AF)	Range of Wintertime Streamflow Percent Time Exceedence (%)
Very Wet	> 55,600	1 to 19
Above Normal	12,800 to 55,600	20 to 50
Below Normal	5,000 to 12,799	51 to 75
Very Dry	< 5,000	76 to 100

Note: Wintertime streamflow calculated as the total October through April Santa Margarita River streamflow at the POD. The median wintertime streamflow (12,800 AF) represents the break between Above Normal and Below Normal hydrologic conditions.

The break between Above Normal and Very Wet hydrologic conditions occurs when wintertime streamflow is greater than 55,600 AF. Statistically, this flow was exceeded 19% of the time. The median wintertime streamflow of 12,800 AF defines the break between Above Normal and Below Normal conditions. By definition, the median value was exceeded 50% of the time. The break between Below Normal and Very Dry conditions occurs at 5,000 AF. This value was exceeded 75% of the time.

Median wintertime streamflow during the four hydrologic conditions further describes the variability of flows at the POD (Table 4 and Attachment B-2). The median wintertime streamflow at the POD during Very Wet hydrologic conditions was 106,700 AF. While Very Wet hydrologic conditions occurred 19% of the time on the Santa Margarita River, the median wintertime flow associated with Very Wet conditions occurred only 10% of the time. Similarly, Above Normal hydrologic conditions cover the range of occurrence between 20% and 50%, but the median wintertime flow associated with Above Normal conditions (20,800 AF) occurred only 34% of the time.

TABLE 4 MEDIAN WINTERTIME STREAMFLOW DURING EACH HYDROLOGIC CONDITION FOR WATER YEARS 1925-2009

Hydrologic Condition	Median Wintertime Streamflow (AF)	Median Wintertime Streamflow Percent Time Exceedence (%)
Very Wet	106,700	10
Above Normal	20,800	34
Below Normal	8,400	63
Very Dry	3,700	87

1.7.2 Maximum Potential Diversion

The availability of surface water in the Santa Margarita River is highly variable. Large storms in the winter months typically provide a significant portion of the total annual flow in the river. The most efficient diversion of peak flow events would be the use of an in-stream dam and reservoir. Development of off-stream reservoirs are similarly infeasible since they demand large diversion and conveyance facilities that would require a design with flow rates exceeding at least 1,000 cfs. As previously stated, the quantity of water diverted under the proposed CUP is limited by the diversion capacity (200 cfs), the assumed year-round bypass (3 cfs), and the deflation of the diversion structure during the 10-year or greater event to allow for sediment to pass from behind the diversion structure, all of which were incorporated into the TM 1.0 and 1.1 analysis. The quantity of water diverted is further limited by storage in Lake O'Neill and the existing and rehabilitated recharge ponds, the groundwater aquifer's recharge capacity, the pumping schedule, and the groundwater aquifer's storage capacity. These items were addressed in the TM 2.2 groundwater analysis.

The maximum potential diversion is defined as the water diverted from the Santa Margarita River to O'Neill Ditch for use by the CUP and is based on the assumed diversion constraints. Water diverted for use by the CUP includes surface water diverted to both Lake O'Neill and the groundwater recharge ponds. The maximum monthly streamflow that can potentially be diverted in water years 1925 through 2009 based on the assumed diversion constraints is presented in Attachment C-1.

A frequency distribution was performed to rank and analyze the maximum potential diversion to Lake O'Neill and the recharge ponds for the 85-year period of record. The annual volume of maximum potential diversion for water years 1925 through 2009 is ranked in descending order in Attachment C-2. The frequency curve shown in Figure 5 depicts a comparison between the percent time exceedence of the maximum potential diversion and the annual streamflow at the POD. The gap between annual streamflow and maximum potential diversion is greatest during years characterized by a probability of exceedence of less than 30% (1 in every 3.3 years), typically Very Wet or Above Normal hydrologic conditions. The gap is due to the inability of the proposed facilities to capture large peak flow events. The gap between the two curves also includes the quantity of streamflow bypassed each year to satisfy the 3-cfs bypass. The deviation between available water supply and maximum potential diversion illustrates the importance of designing conveyance systems based on that portion of total annual flow that can feasibly be captured.

The annual streamflow at the POD and the maximum potential diversion for common exceedence intervals are shown in Table 5. The table is reflective of historical conditions and may not necessarily reflect the maximum potential diversion due to changes in future flow regimes from urban development and upstream mitigation of the water supply stipulated in the 2002 Cooperative Water Resources Management Agreement (CWRMA). The table also does not account for water that may recharge the groundwater aquifer by infiltrating the stream channel alluvium downstream from the POD. The accounting of water spilling from either Lake O'Neill

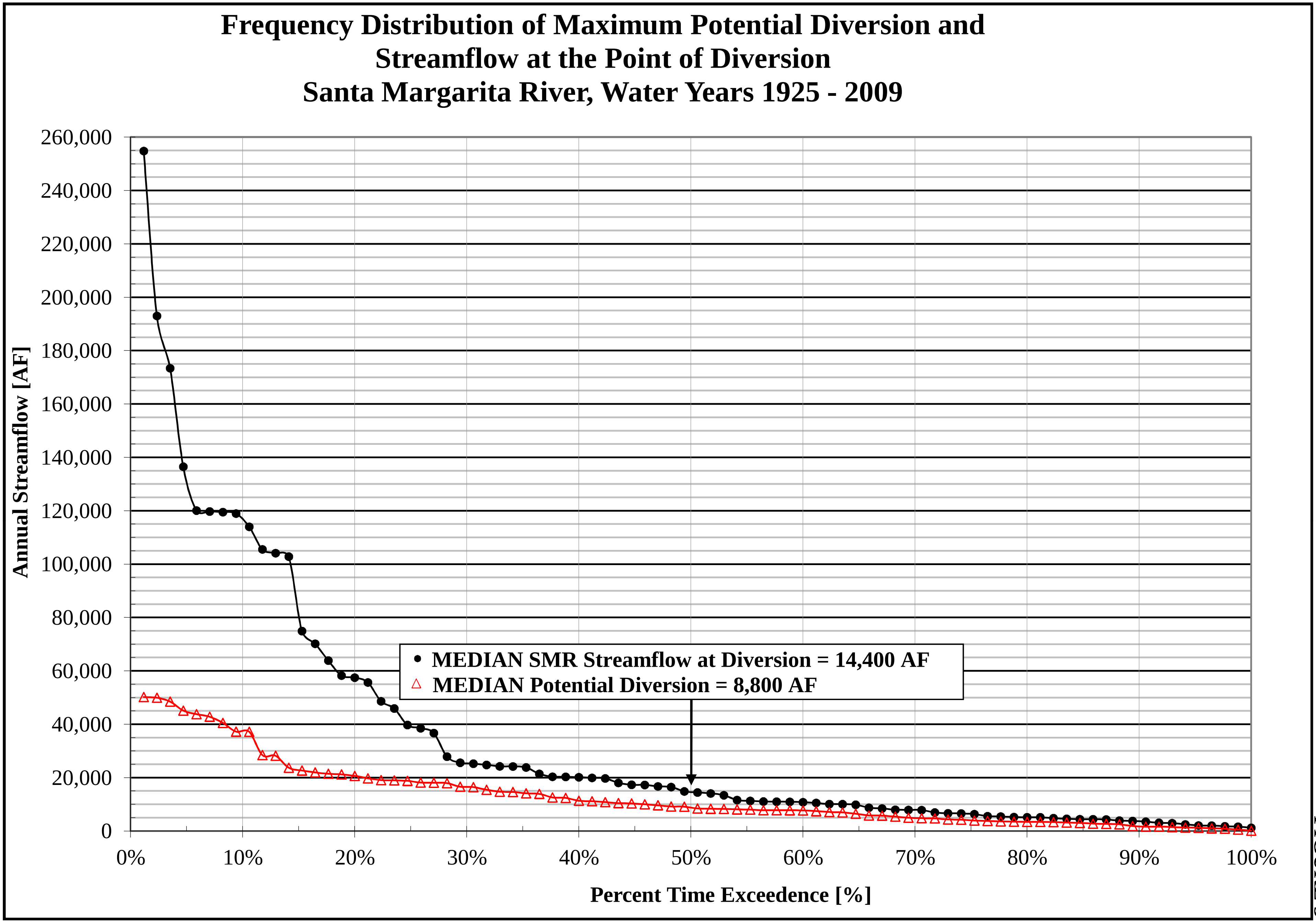

Frequency Distribution of Maximum Potential Diversion and
Streamflow at the Point of Diversion
Santa Margarita River, Water Years 1925 - 2009
Annual Streamflow [AF]
260,000
240,000
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent Time Exceedence [%]
MEDIAN SMR Streamflow at Diversion = 14,400 AF
MEDIAN Potential Diversion = 8,800 AF

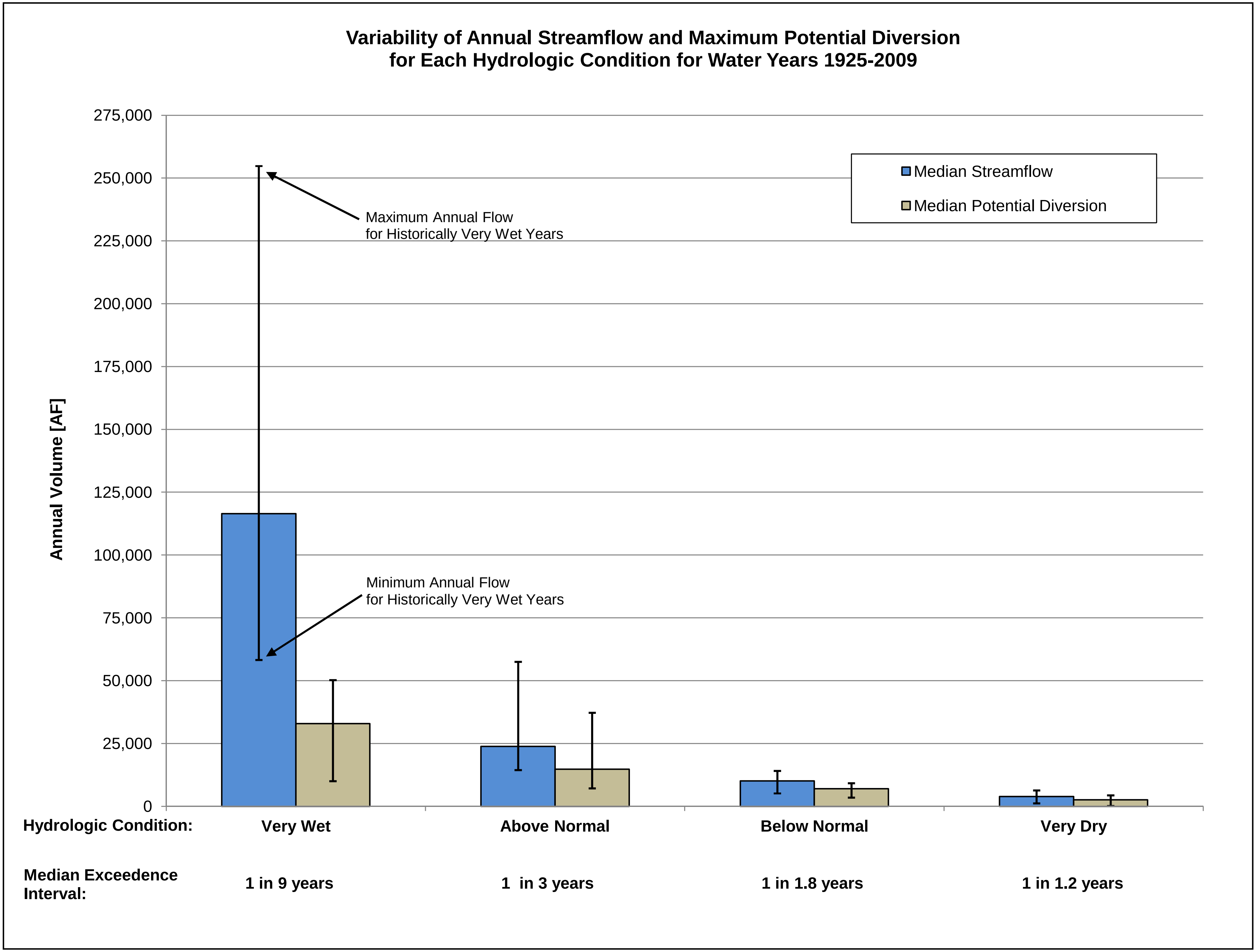
FIGURE 5

or the recharge ponds is incorporated in a Reservoir Operations Model (ROM), a component of the groundwater model discussed in TM 2.2.

TABLE 5 EXCEEDENCE INTERVAL FOR MAXIMUM POTENTIAL DIVERSION AND ANNUAL STREAMFLOW IN THE SANTA MARGARITA RIVER AT THE POINT OF DIVERSION FOR WATER YEARS 1925-2009

Percent Time Exceedence (%)	Exceedence Interval	Annual Streamflow at the POD (AF)	Potential Diversion (AF)
4%	1 in 25 years	157,200	47,200
5%	1 in 20 years	131,600	44,800
7%	1 in 15 years	119,800	43,200
10%	1 in 10 years	116,000	37,200
11%	1 in 9 years	109,300	33,300
13%	1 in 8 years	104,500	28,300
14%	1 in 7 years	94,900	23,600
17%	1 in 6 years	68,100	21,900
20%	1 in 5 years	57,100	20,700
25%	1 in 4 years	39,100	18,700
33%	1 in 3 years	24,200	14,700
50%	1 in 2 years	14,400	8,800
75%	1 in 1.3 years	5,900	4,000
100%	1 in 1 years	1,200	100

As previously discussed, each water year in the 85-year period of record can be categorized by hydrologic condition based on the total volume of wintertime streamflow. The variability of annual streamflow and maximum potential diversion for the water years, grouped by hydrologic condition, is graphically represented in Figure 6. The median annual streamflow (blue column) and median potential diversion (brown column) are shown for the water years grouped by hydrologic condition. The vertical lines represent the historical range of annual volume within each hydrologic condition for the 85-year period. For example, water passing the POD during Very Wet hydrologic conditions ranged between 55,600 and 249,500 AF with a median value of 106,700 AF, while the water available for diversion during these same years ranged between 12,800 and 50,200 AF with a median value of 35,000 AF. The reason for the disparity between the two ranges and median values is largely due to the volume of water



Variability of Annual Streamflow and Maximum Potential Diversion
for Each Hydrologic Condition for Water Years 1925-2009
Annual Volume [AF]
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
Median Streamflow
Median Potential Diversion
Maximum Annual Flow
for Historically Very Wet Years
Minimum Annual Flow
for Historically Very Wet Years
Hydrologic Condition:
Very Wet
Above Normal
Below Normal
Very Dry
Median Exceedence
Interval:
1 in 9 years
1 in 3 years
1 in 1.8 years
1 in 1.2 years

FIGURE 6

contained in flows greater than 200 cfs which pass the POD during short-duration peak flow events. These large flows cannot be captured by the diversion facilities due to capacity limitations and the deflation requirement. A daily accounting of streamflow rates is provided in the following section to describe the frequency and quantity of large flow events that are either difficult or impossible to capture without an in-stream storage facility.

1.7.3 Peak Surface Flows

In addition to investigating the annual flows at the POD and the maximum potential diversion, Stetson Engineers investigated both daily and monthly surface water flows. Similar to the trends in variability that exist when reviewing annual volumes, the variability in daily and monthly streamflow in any given year is greatest during Very Wet hydrologic conditions and least during Very Dry conditions. Water Year 1991 is a typical example of the variability that exists in the Santa Margarita River's monthly and daily streamflow record during Very Wet hydrologic conditions. Daily streamflow at the POD averaged 25 cfs from October 1990 through February 1991 but increased to average more than 400 cfs from March 1991 through April 1991. This demonstrates that low baseflows typically occur in the early winter period following the dry summer months. As spring arrives, the ground has become saturated, and increased precipitation events translate into surface runoff and higher baseflows. Thus, in Very Wet hydrologic conditions, a large portion of the annual flow volume tends to pass the POD over a few days during peak flow events. This type of flow regime results in a significant amount of the annual flow volume that cannot be captured by CUP facilities designed to divert only 200 cfs. The following section presents the variability in daily streamflow during each type of hydrologic condition.

This TM has described the difference between water passing the POD (annual streamflow) and maximum potential diversion for use by the CUP. The disparity between the values is based on the maximum 200-cfs diversion, the 3-cfs bypass, and the need to deflate the diversion structure to allow sediment to pass during the 10-year or greater storm event. Figure 6 graphically depicts the variance during Very Wet hydrologic conditions, demonstrating the median streamflow passing the POD (106,700 AF) is more than 3 times greater than the median potential water available for diversion (32,900 AF). The difference between water availability and maximum potential diversion can best be explained by investigating the percent time exceedence of flows greater than 200 cfs.

Table 6 shows that the average number of days per year in each hydrologic condition when flow at the diversion is less than 200 cfs, between 200 and 240 cfs, greater than 240 cfs without deflating the diversion structure, and the number of days when the diversion structure will deflate during each type of hydrologic condition. The 240-cfs interval is based on the potential ability to divert an additional 40 cfs to an off-stream reservoir, as investigated in Alternative 4 of Permit 15000 (Stetson, 2001) or to direct use at the Haybarn Canyon Water Treatment Plant. On days when the diversion structure deflates, it is assumed that no water can be diverted.

TABLE 6 AVERAGE NUMBER OF DAYS EACH YEAR DAILY STREAMFLOW EXCEEDS DIVERSION CAPACITY (DAYS PER YEAR)

Hydrologic Condition	Flow Less than 200 cfs	Flow Between 200 and 240 cfs	Flow Greater than 240 cfs Without Deflating Diversion Structure	Diversion Structure Deflates
Very Wet	327	4	31	3
Above Normal	355	2	9	0
Below Normal	362	1	3	0
Very Dry	363	1	2	0

Of the 30 days in which the flow was greater than 240 cfs during Very Wet hydrologic conditions, approximately 80% of the annual streamflow passed the POD. For example, in 1991, there were 11 days when the flow was greater than 240 cfs. On these 11 days, 45,600 AF passed the POD, which constituted nearly 75% of the annual flow for water year 1991. Similar to Very Wet hydrologic conditions, the peak flows during Above Normal years also dominated the annual flow volume passing the POD. Of the 9 days in which the flow was greater than 240 cfs, approximately 60% of the annual streamflow passed the POD. During years categorized as Below Normal and Very Dry, there are only a few days when the flow was greater than 240 cfs, but even one storm event may account for a significant percentage of that year's total flow.

1.8 HYDROLOGIC TRENDS AND FUTURE PERIOD OF RECORD

Due to the hydrologic variability of the Santa Margarita River Basin, the surface water and groundwater analysis for the CUP requires development of a future period of record representative of the historical variability of hydrologic conditions. Figure 7 shows a cumulative departure from the mean curve of annual streamflow at the POD and annual precipitation at Lake O'Neill for water years 1925 to 2009. Monthly precipitation records from Lake O'Neill (OWR, 2011) were used to evaluate annual precipitation trends at the POD. The annual departure from the mean graph depicts wet and dry cycles over an extended period of record. The solid line

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Cumulative Departure from Mean
WY 1925 - WY 2009

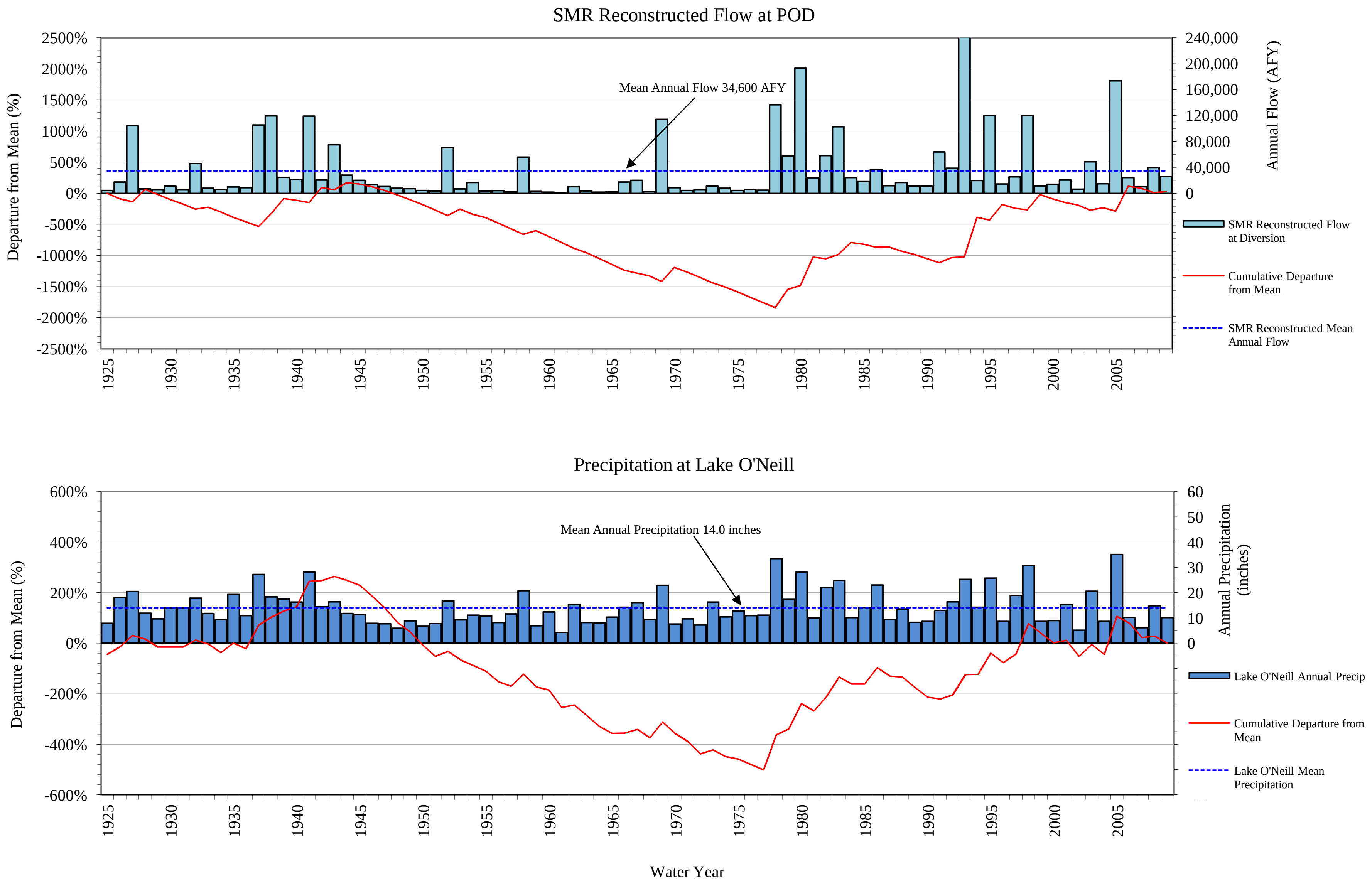

FIGURE 7

shows the hydrologic trend, where a downward slope indicates that the trend is to dry conditions and an upward slope indicates that the trend is to wetter conditions. The dashed line shows the long-term average annual precipitation at Lake O'Neill (14.0 inches) and the long-term average annual streamflow at the POD (34,600 AF) during the 85-year period of record.

The cumulative departure from the mean curve reveals that an extended dry period occurred from 1945 to 1978, followed by a prolonged wet period from 1979 to 1984. A moderately dry period occurred from 1985 to 1991, followed by a significantly wet period from 1993 to 1999. This pattern is similarly represented in both the precipitation and streamflow cumulative departure from the mean curves. The 50-year period from 1952 through 2001 is a balanced hydrologic period used in the Groundwater model to simulate groundwater yield for the CUP.

2.0 CONCLUSION AND RECOMMENDATIONS

Results of TM 1.1’s analyses confirm the wide variability of surface flows indicative of streams and rivers in the southwestern United States. Large quantities of water are contained in peak flow events that commonly occur in the winter during Very Wet hydrologic conditions. Surface water availability during drier Below Normal and Very Dry hydrologic conditions occur from less frequent rainfall events and sustained baseflow releases from springs and groundwater sources. Review of the 85-year period of record reconstructed for the lower Santa Margarita River watershed shows that total annual surface flow passing the POD ranged between 1,200 and 254,800 AF between 1925 and 2009. During the same period, the maximum potential surface diversion available to the proposed CUP would have ranged between 150 and 50,200 AF. The maximum potential surface diversion for this analysis assumes a 200-cfs diversion structure, a 3-cfs bypass, and the deflation of the diversion structure during the 10-year or greater event. This maximum potential surface diversion does not take into account overflow spill from the recharge ponds, variable recharge rates, or the capacity of the groundwater basin influenced by groundwater pumping.

Four hydrologic conditions were established to statistically describe both the annual surface water at the POD and the maximum potential diversion. The basis for the division of the four hydrologic conditions was a graphical interpretation method common to flood frequency analysis and other types of surface water flow characterizations. Reflective of the variability in streamflow volumes, the division of hydrologic conditions indicates that extreme wet cycles and extreme dry cycles occur less frequently than Above Normal and Below Normal Conditions. The hydrologic conditions and reconstructed historical streamflow are appropriate to analyze fish passage criteria in the Santa Margarita River at the POD and other downstream reaches.

Table 7 summarizes the quantity of annual streamflow at the POD and the maximum potential diversion to the CUP for the 85 years categorized by the four hydrologic conditions, based on historical streamflow only. The median potential diversions for Very Wet, Above Normal, Below Normal, and Very Dry conditions are expected to occur approximately 10%, 34%, 63%, and 87% of the time, respectively.

TABLE 7 SUMMARY OF MEDIAN ANNUAL AVAILABLE STREAMFLOW AND MAXIMUM POTENTIAL DIVERSION FOR WATER YEARS 1925-2009

Hydrologic Condition	Median Available Streamflow	Median Potential Diversion
Very Wet	106,700	32,900
Above Normal	20,800	14,800
Below Normal	8,400	7,000
Very Dry	3,700	2,500

Note: See Attachment C for annual potential diversion values

The values presented in Table 7, and the discussion of probability of exceedence presented in this TM, present two important concepts critical to the optimization of a long-term supply of water from the CUP. First, large quantities of water pass the POD in very short periods of time during all hydrologic conditions. Lastly, the wide range in median annual available streamflow and maximum potential diversion underscore the importance of the groundwater aquifer capacitance to store large surface flow events for use during Very Dry and Below Normal hydrologic conditions.

One constraint imposed on TM 1.1's analysis is its limitation to historical conditions. Increased groundwater pumping in the Upper Watershed has reduced baseflow levels in the Santa Margarita River, which have subsequently reduced the water available at the POD (United States/RCWD, 2002). The effect of upstream groundwater development is most pronounced during Below Normal and Very Dry hydrologic conditions. Additionally, changes in urban runoff may affect baseflows, but such changes have not been quantified for the purpose of this analysis. There are many factors that have contributed to the historical values of flow in the Santa Margarita River reaching the POD, which have not been enumerated in this TM.

The following recommendations should be followed to support the CUP:

1. Rely on TM 1.1 reconstructed flows at the POD to investigate flows available for anadromous fish passage.

2. Include the updated TM 1.1 reconstructed flows at the POD in the CUP surface and groundwater models.

3. Continue to support the 1952-2001 50-year future hydrologic period that reflects prolonged droughts, wet periods, and normal hydrologic conditions that have been identified in TM 1.1.

4. Address changes in the upper basin, such as urbanization and storm water practices, with respect to future changes in the flow regime at the POD.

Extensive hydrologic and hydrogeologic field investigations were initiated and completed between 2005 and 2009 in order to refine previous estimates of groundwater yield from the CUP. Additional environmental and operational restrictions, if any, may be used with these data and the groundwater model developed in TM 2.2 in order to quantify groundwater yield for the CUP.

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ATTACHMENT A-1
Reconstructed Streamflow in the Santa Margarita River at the Point of Diversion [AF]
Water Years 1925 to 2009

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1925	175	483	1,008	806	480	450	616	174	135	55	13	16	**4,411**
1926	309	470	656	555	1,287	556	12,508	593	294	76	12	16	**17,332**
1927	196	421	1,203	737	91,663	5,698	2,166	1,063	555	173	62	182	**104,119**
1928	548	802	1,048	1,132	1,048	1,129	445	245	121	21	5	22	**6,567**
1929	335	541	796	963	774	769	561	173	79	3	58	166	**5,219**
1930	155	165	301	3,518	972	2,050	542	2,253	311	214	162	159	**10,802**
1931	299	523	515	663	1,643	461	445	341	148	23	25	63	**5,149**
1932	296	535	2,065	1,289	35,076	3,893	1,084	620	392	245	191	237	**45,924**
1933	516	544	911	2,402	1,033	726	646	506	238	141	123	183	**7,970**
1934	269	408	720	1,582	848	636	357	209	204	105	44	44	**5,426**
1935	313	442	1,304	1,451	2,123	2,267	920	477	217	119	106	115	**9,856**
1936	245	407	468	532	4,427	962	896	278	113	32	26	48	**8,433**
1937	606	435	4,955	6,112	44,260	35,007	9,099	2,522	1,241	598	383	321	**105,539**
1938	499	717	1,199	1,288	4,325	98,877	6,078	2,792	1,209	1,034	790	694	**119,503**
1939	962	1,008	3,481	3,325	7,013	3,151	2,023	1,011	534	451	345	1,467	**24,773**
1940	763	877	986	5,637	7,012	1,725	2,189	847	474	239	260	418	**21,428**
1941	685	812	8,168	1,983	13,457	52,997	29,449	6,431	2,192	1,036	964	794	**118,967**
1942	1,675	1,717	2,492	3,172	2,620	3,378	2,356	1,065	684	447	343	394	**20,345**
1943	552	679	993	30,285	12,025	22,183	4,573	1,504	885	511	357	380	**74,926**
1944	717	754	2,799	1,926	11,390	5,425	1,794	1,106	784	474	356	357	**27,881**
1945	502	4,287	1,232	1,241	1,941	6,750	1,712	801	499	289	472	442	**20,168**
1946	475	671	4,183	906	1,016	2,494	1,683	637	356	650	168	170	**13,409**
1947	491	2,279	2,205	1,289	932	899	685	489	435	304	231	295	**10,534**
1948	447	557	1,204	912	1,336	1,124	887	536	371	225	170	131	**7,899**
1949	319	426	752	1,318	1,065	998	702	522	286	220	177	158	**6,943**
1950	231	372	612	720	693	607	505	373	130	45	4	21	**4,313**
1951	134	398	454	545	482	444	285	272	25	2	43	2	**3,086**
1952	82	163	3,172	29,219	1,425	29,603	5,225	970	226	31	0	63	**70,179**
1953	122	606	1,185	3,196	557	570	238	104	9	6	22	18	**6,633**
1954	76	213	182	3,749	5,518	4,317	2,104	289	31	7	0	0	**16,487**
1955	66	311	445	1,233	667	621	132	249	18	0	0	0	**3,742**
1956	0	85	202	2,651	432	197	277	55	0	0	0	0	**3,900**
1957	0	2	7	679	464	833	54	38	0	0	0	0	**2,076**
1958	0	71	209	121	3,540	17,166	33,334	1,150	82	0	4	0	**55,677**
1959	2	105	176	440	1,703	353	78	98	0	0	0	0	**2,956**
1960	0	16	66	703	440	321	164	64	0	0	0	0	**1,775**
1961	8	152	141	198	193	229	129	103	39	0	0	0	**1,193**
1962	76	163	369	645	5,422	2,429	663	252	68	0	0	0	**10,087**
1963	26	113	173	196	2,031	419	261	176	51	0	0	40	**3,487**
1964	17	102	133	381	234	328	285	121	26	0	0	0	**1,626**
1965	0	94	151	201	144	179	988	191	57	14	0	2	**2,022**
1966	48	6,016	5,407	3,110	1,415	809	274	161	7	10	13	0	**17,270**
1967	76	159	8,495	4,964	2,219	1,030	1,635	855	386	91	6	11	**19,925**
1968	33	119	603	372	453	541	242	99	9	0	1	1	**2,472**
1969	109	144	237	15,607	74,087	18,692	2,599	1,517	794	175	19	22	**114,001**
1970	79	377	423	680	878	5,537	431	263	58	0	0	0	**8,725**
1971	57	286	2,168	553	441	480	196	286	89	10	0	0	**4,567**
1972	34	162	2,746	774	649	506	175	85	20	0	0	0	**5,151**
1973	118	599	606	1,098	3,885	3,378	820	355	76	3	0	1	**10,939**
1974	48	214	211	4,936	464	1,325	418	176	48	0	0	0	**7,840**
1975	66	132	587	341	546	1,303	968	370	116	5	0	0	**4,435**

ATTACHMENT A-1
Reconstructed Streamflow in the Santa Margarita River at the Point of Diversion [AF]
Water Years 1925 to 2009

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1976	17	109	211	247	1,792	1,423	444	180	34	0	0	1,093	**5,548**
1977	208	143	224	2,200	503	622	299	542	30	0	47	0	**4,818**
1978	40	97	515	36,349	35,658	46,081	9,584	3,902	1,535	864	718	1,173	**136,516**
1979	834	1,068	3,734	12,909	12,504	14,592	5,847	2,430	1,057	1,004	737	765	**57,481**
1980	1,241	954	1,066	17,216	111,272	35,574	12,680	6,503	1,861	1,393	1,638	1,621	**193,019**
1981	541	418	2,381	3,419	4,586	9,731	615	502	436	428	371	396	**23,824**
1982	320	7,898	491	12,233	1,706	30,072	3,444	765	447	356	258	259	**58,248**
1983	313	2,347	7,201	9,865	10,569	47,244	18,874	1,502	670	516	482	3,244	**102,829**
1984	2,741	4,031	7,985	3,136	2,152	1,331	753	474	341	502	292	500	**24,239**
1985	384	338	4,897	2,692	3,776	2,294	1,344	805	403	448	294	368	**18,043**
1986	317	3,076	2,047	1,167	7,954	14,378	3,496	1,609	1,113	471	476	609	**36,713**
1987	639	1,283	1,276	2,242	1,834	1,679	620	643	376	287	370	370	**11,617**
1988	693	2,338	2,565	3,720	2,121	1,429	1,748	884	334	220	333	338	**16,723**
1989	298	523	2,255	1,595	1,634	1,500	902	732	465	364	379	343	**10,990**
1990	699	492	515	1,978	2,898	1,058	1,278	1,017	804	226	70	22	**11,056**
1991	495	549	649	907	3,810	48,044	4,133	1,941	1,441	623	708	569	**63,869**
1992	599	361	1,968	3,065	13,812	9,255	3,160	2,625	1,145	891	876	767	**38,525**
1993	494	482	2,806	143,176	74,203	15,407	7,197	5,208	3,140	1,395	648	652	**254,807**
1994	1,282	873	937	1,166	7,633	2,886	1,874	1,277	759	349	317	360	**19,714**
1995	393	474	543	39,273	17,317	46,546	7,978	3,206	1,988	1,077	725	571	**120,091**
1996	752	1,192	1,157	1,332	4,474	2,754	1,112	801	299	181	189	198	**14,440**
1997	445	2,024	2,865	12,208	3,274	1,393	1,343	607	135	352	241	356	**25,245**
1998	422	594	3,119	5,027	73,681	14,244	8,860	8,707	2,495	1,356	641	597	**119,742**
1999	768	1,413	1,176	1,359	1,232	1,160	1,756	721	560	496	305	354	**11,300**
2000	302	275	334	459	5,342	3,803	1,524	850	410	201	324	268	**14,092**
2001	715	725	813	2,595	6,870	3,890	2,004	1,221	637	285	324	233	**20,311**
2002	343	1,271	821	784	645	579	540	538	205	288	254	57	**6,325**
2003	381	789	2,490	1,341	17,251	13,830	5,074	3,098	1,883	1,084	650	745	**48,616**
2004	612	1,009	1,574	1,484	5,141	2,011	1,093	626	440	269	290	299	**14,849**
2005	13,949	3,110	14,771	60,161	53,774	12,622	6,126	3,290	1,786	1,423	1,238	1,161	**173,411**
2006	1,775	1,382	1,161	3,159	3,140	5,157	5,073	1,360	896	405	394	295	**24,197**
2007	654	1,241	831	1,208	1,569	1,304	1,094	729	532	496	250	164	**10,071**
2008	435	3,086	7,099	14,292	6,991	2,460	1,753	1,725	788	407	339	363	**39,738**
2009	523	1,359	8,129	1,765	7,865	1,819	1,155	815	1,077	681	305	106	**25,600**
Average	570	935	1,946	6,565	10,209	8,765	3,078	1,149	537	323	252	314	**34,643**
Median	319	523	1,008	1,451	2,123	1,819	1,094	637	356	220	177	170	**14,440**
Minimum	0	2	7	121	144	179	54	38	0	0	0	0	**1,193**
Maximum	13,949	7,898	14,771	143,176	111,272	98,877	33,334	8,707	3,140	1,423	1,638	3,244	**254,807**

ATTACHMENT A-2
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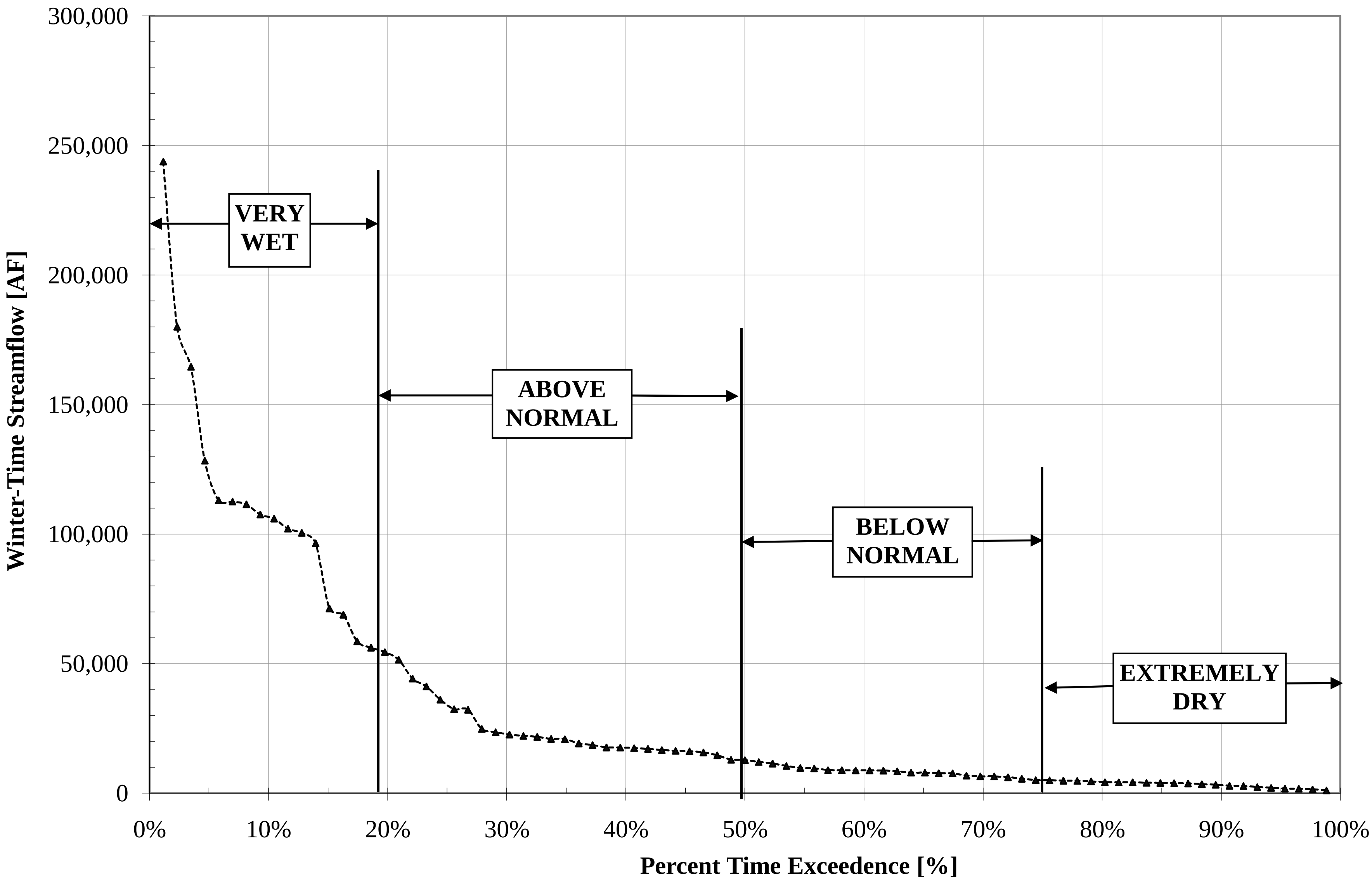
Exceedence Interval and Reconstructed Annual Streamflow In the Santa Margarita River at the Point of Diversion Water Years 1925 to 2009

Water Year	Reconstructed Streamflow at Point of Diversion [AF]	Percent Time Exceedence [%]	Exceedence Interval [years]
1993	254,807	1%	85.0
1980	193,019	2%	42.5
2005	173,411	4%	28.3
1978	136,516	5%	21.3
1995	120,091	6%	17.0
1998	119,742	7%	14.2
1938	119,503	8%	12.1
1941	118,967	9%	10.6
1969	114,001	11%	9.4
1937	105,539	12%	8.5
1927	104,119	13%	7.7
1983	102,829	14%	7.1
1943	74,926	15%	6.5
1952	70,179	16%	6.1
1991	63,869	18%	5.7
1982	58,248	19%	5.3
1979	57,481	20%	5.0
1958	55,677	21%	4.7
2003	48,616	22%	4.5
1932	45,924	24%	4.3
2008	39,738	25%	4.0
1992	38,525	26%	3.9
1986	36,713	27%	3.7
1944	27,881	28%	3.5
2009	25,600	29%	3.4
1997	25,245	31%	3.3
1939	24,773	32%	3.1
1984	24,239	33%	3.0
2006	24,197	34%	2.9
1981	23,824	35%	2.8
1940	21,428	36%	2.7
1942	20,345	38%	2.7
2001	20,311	39%	2.6
1945	20,168	40%	2.5
1967	19,925	41%	2.4
1994	19,714	42%	2.4
1985	18,043	44%	2.3
1926	17,332	45%	2.2
1966	17,270	46%	2.2
1988	16,723	47%	2.1
1954	16,487	48%	2.1
2004	14,849	49%	2.0

ATTACHMENT A-2
RANKED
Exceedence Interval and Reconstructed Annual Streamflow
In the Santa Margarita River at the Point of Diversion
Water Years 1925 to 2009

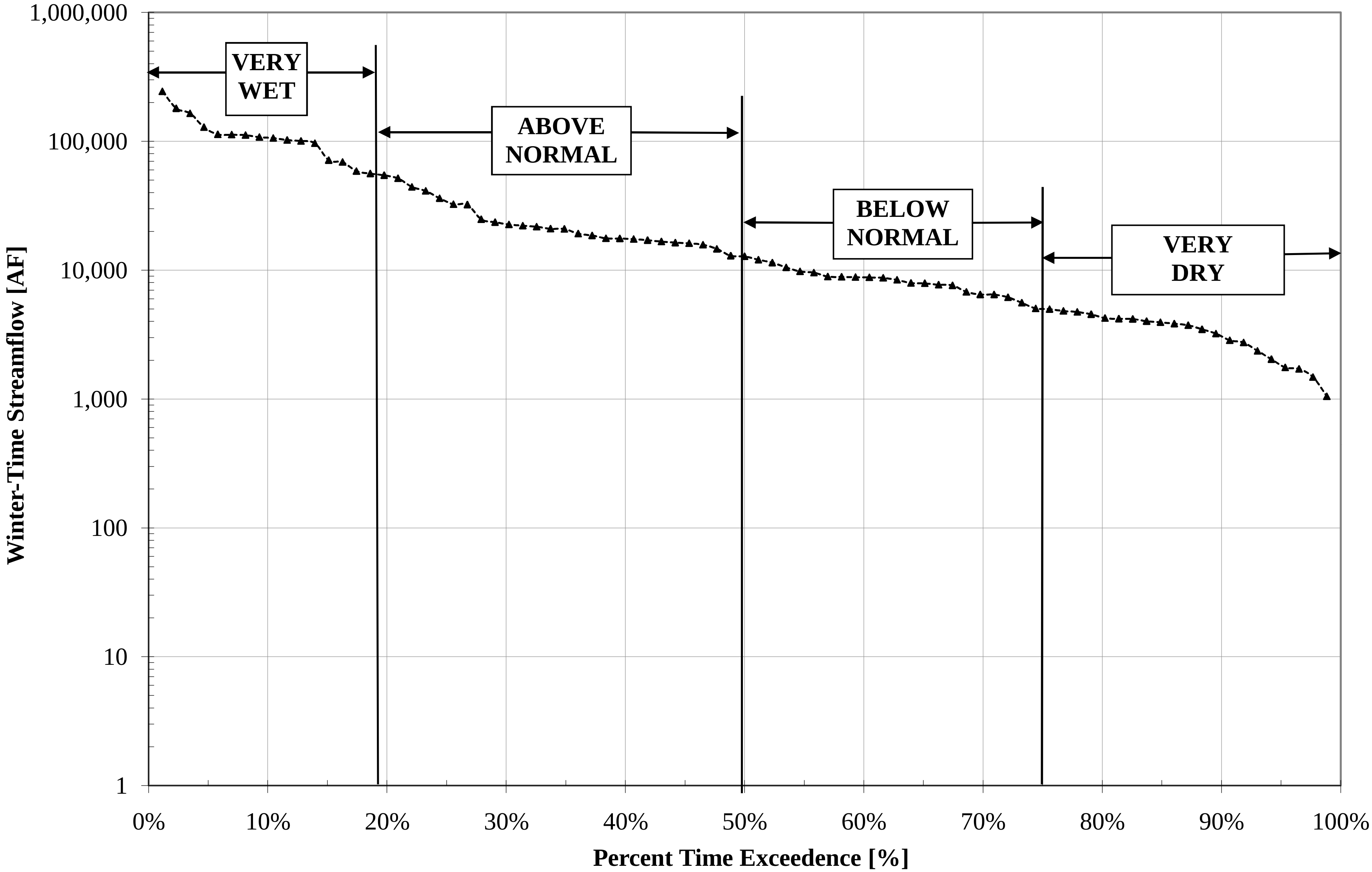
Water Year	Reconstructed Streamflow at Point of Diversion [AF]	Percent Time Exceedence [%]	Exceedence Interval [years]
1996	14,440	51%	2.0
2000	14,092	52%	1.9
1946	13,409	53%	1.9
1987	11,617	54%	1.8
1999	11,300	55%	1.8
1990	11,056	56%	1.8
1989	10,990	58%	1.7
1973	10,939	59%	1.7
1930	10,802	60%	1.7
1947	10,534	61%	1.6
1962	10,087	62%	1.6
2007	10,071	64%	1.6
1935	9,856	65%	1.5
1970	8,725	66%	1.5
1936	8,433	67%	1.5
1933	7,970	68%	1.5
1948	7,899	69%	1.4
1974	7,840	71%	1.4
1949	6,943	72%	1.4
1953	6,633	73%	1.4
1928	6,567	74%	1.3
2002	6,325	75%	1.3
1976	5,548	76%	1.3
1934	5,426	78%	1.3
1929	5,219	79%	1.3
1972	5,151	80%	1.3
1931	5,149	81%	1.2
1977	4,818	82%	1.2
1971	4,567	84%	1.2
1975	4,435	85%	1.2
1925	4,411	86%	1.2
1950	4,313	87%	1.1
1956	3,900	88%	1.1
1955	3,742	89%	1.1
1963	3,487	91%	1.1
1951	3,086	92%	1.1
1959	2,956	93%	1.1
1968	2,472	94%	1.1
1957	2,076	95%	1.0
1965	2,022	96%	1.0
1960	1,775	98%	1.0
1964	1,626	99%	1.0
1961	1,193	100%	1.0

Frequency Distribution of Discharge at the Point of Diversion Santa Margarita River based on Winter-Time Streamflow during Water Years 1925 to 2009



ATTACHMENT B-1

Frequency Distribution of Discharge at the Point of Diversion Santa Margarita River based on Winter-Time Streamflow during Water Years 1925 to 2009



ATTACHMENT B-2

ATTACHMENT C-1
Monthly Maximum Potential Diversion from the Santa Margarita River [AF]
Water Years 1925 to 2009

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1925	6	304	824	621	313	266	437	14	6	0	0	0	**2,792**
1926	138	292	472	371	1,120	371	3,840	409	120	2	0	0	**7,134**
1927	23	243	1,019	553	4,177	5,305	1,987	878	378	33	0	43	**14,639**
1928	368	624	864	947	876	944	271	75	21	0	0	0	**4,990**
1929	162	362	612	779	607	585	383	16	0	0	42	92	**3,640**
1930	13	15	117	2,308	806	1,866	364	2,068	133	33	11	4	**7,736**
1931	114	345	331	478	1,452	276	266	157	11	0	0	0	**3,431**
1932	112	357	1,845	1,105	9,148	3,708	906	435	214	61	15	62	**17,968**
1933	331	366	727	2,160	867	541	468	321	62	0	0	12	**5,855**
1934	85	230	536	1,284	681	452	178	27	33	0	0	0	**3,505**
1935	133	264	1,120	1,267	1,841	2,083	742	292	39	0	24	0	**7,804**
1936	61	228	284	347	2,895	777	718	94	2	0	0	0	**5,406**
1937	443	257	1,805	4,738	8,180	10,098	7,583	2,338	1,062	414	199	142	**37,258**
1938	315	539	1,014	1,104	3,029	10,983	5,891	2,607	1,030	850	606	516	**28,483**
1939	778	829	2,879	3,140	5,569	2,966	1,845	827	355	267	161	1,056	**20,672**
1940	579	698	801	2,637	4,344	1,541	2,011	662	296	57	76	240	**13,942**
1941	501	634	2,246	1,799	6,319	11,901	11,610	5,878	2,013	851	779	615	**45,147**
1942	1,491	1,539	2,308	2,987	2,454	3,194	2,178	881	506	262	159	215	**18,173**
1943	368	501	808	4,133	6,141	9,146	4,394	1,320	706	326	173	202	**28,217**
1944	533	575	2,614	1,741	4,610	5,135	1,615	921	606	289	171	179	**18,990**
1945	317	2,424	1,047	1,057	1,774	5,710	1,534	617	320	105	287	263	**15,455**
1946	291	492	1,890	721	849	1,584	1,505	453	177	466	12	14	**8,454**
1947	306	2,100	1,934	1,104	766	715	506	304	257	119	53	118	**8,284**
1948	263	378	1,019	728	1,163	940	709	351	192	41	0	2	**5,787**
1949	134	248	567	1,134	898	813	524	338	107	36	10	6	**4,815**
1950	50	194	427	535	526	423	327	188	12	0	0	0	**2,682**
1951	11	220	270	361	315	259	112	104	1	0	7	0	**1,660**
1952	9	45	1,005	4,608	1,252	8,240	3,753	785	67	0	0	0	**19,764**
1953	8	428	1,001	2,449	390	386	67	20	0	0	0	0	**4,749**
1954	14	70	47	2,052	2,483	3,769	1,926	124	0	0	0	0	**10,484**
1955	6	150	262	1,033	501	446	24	114	3	0	0	0	**2,539**
1956	0	11	22	1,183	259	49	133	0	0	0	0	0	**1,658**
1957	0	0	0	537	297	667	5	0	0	0	0	0	**1,507**
1958	0	1	76	56	2,083	7,178	8,736	965	4	0	0	0	**19,099**
1959	0	21	35	259	1,350	175	9	29	0	0	0	0	**1,877**
1960	0	0	2	532	268	152	65	6	0	0	0	0	**1,023**
1961	0	8	12	43	37	45	4	0	0	0	0	0	**149**
1962	0	14	185	461	4,305	2,244	484	77	0	0	0	0	**7,771**
1963	0	0	8	12	887	235	83	10	0	0	0	7	**1,242**
1964	0	23	4	198	62	145	108	16	0	0	0	0	**556**
1965	0	9	19	24	11	19	810	21	0	0	0	0	**914**
1966	0	1,649	3,106	2,925	1,248	625	95	15	0	0	0	0	**9,663**
1967	0	16	4,243	3,122	2,052	846	1,456	671	208	0	0	0	**12,614**
1968	0	4	421	188	281	358	72	0	0	0	0	0	**1,324**
1969	0	3	53	2,290	6,635	9,305	2,420	1,332	615	34	0	0	**22,687**
1970	0	212	239	495	711	2,244	252	85	2	0	0	0	**4,239**
1971	0	144	1,984	369	274	296	34	105	0	0	0	0	**3,205**
1972	0	4	2,039	589	477	321	12	0	0	0	0	0	**3,442**
1973	57	441	421	913	2,254	3,194	642	175	9	0	0	0	**8,106**
1974	0	65	27	2,169	298	1,140	239	19	0	0	0	0	**3,957**
1975	8	3	403	157	380	1,119	790	186	2	0	0	0	**3,047**
1976	0	14	36	64	1,405	1,239	265	30	0	0	0	745	**3,797**
1977	141	15	53	1,785	336	438	132	414	2	0	26	0	**3,341**

ATTACHMENT C-1
Monthly Maximum Potential Diversion from the Santa Margarita River [AF]
Water Years 1925 to 2009

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1978	0	3	360	8,387	9,180	9,099	8,543	3,717	1,357	679	533	994	**42,853**
1979	650	890	3,546	6,177	8,242	7,427	5,201	2,246	878	819	552	587	**37,215**
1980	1,056	776	882	5,057	6,681	12,298	11,377	6,319	1,682	1,208	1,453	1,442	**50,231**
1981	356	240	912	1,188	1,232	2,201	436	318	258	243	186	218	**7,789**
1982	136	1,141	306	2,577	908	2,524	1,280	581	268	171	74	80	**10,046**
1983	129	1,217	1,304	1,451	3,219	7,158	3,977	1,317	491	332	298	571	**21,464**
1984	413	1,608	634	2,951	1,980	1,147	426	290	163	318	107	321	**10,357**
1985	200	269	2,417	2,507	2,342	2,109	1,166	621	225	263	110	189	**12,419**
1986	132	1,477	495	406	1,381	3,081	701	1,425	934	286	292	550	**11,160**
1987	454	397	793	735	1,065	1,494	397	458	197	102	186	192	**6,470**
1988	421	654	1,065	1,214	413	1,245	1,234	699	156	36	149	159	**7,445**
1989	114	397	1,230	1,411	1,468	444	723	404	286	179	194	164	**7,015**
1990	514	313	331	1,793	1,841	874	1,099	832	626	100	32	0	**8,356**
1991	311	371	464	723	922	7,006	3,954	1,756	1,262	439	523	391	**18,122**
1992	446	182	1,177	1,757	4,086	5,195	2,981	2,441	967	707	691	588	**21,219**
1993	309	304	2,175	7,993	9,171	11,396	7,018	5,023	2,962	1,211	463	492	**48,518**
1994	1,098	694	753	982	4,715	2,633	1,696	1,092	580	169	158	183	**14,753**
1995	211	295	359	9,937	7,286	11,455	7,614	3,022	1,809	893	540	394	**43,816**
1996	568	1,013	973	1,148	3,350	2,525	933	616	139	28	36	41	**11,370**
1997	261	977	2,579	6,442	3,108	1,208	1,165	422	26	176	59	185	**16,606**
1998	237	416	1,576	1,889	8,277	9,836	7,094	6,835	2,317	1,171	462	418	**40,529**
1999	583	1,235	992	1,175	1,065	976	1,577	537	382	315	127	176	**9,138**
2000	123	99	149	274	2,909	3,092	1,344	666	233	62	149	97	**9,196**
2001	530	546	629	1,915	3,399	3,458	1,825	1,037	458	104	153	90	**14,144**
2002	169	1,064	636	599	479	395	361	354	82	112	99	8	**4,358**
2003	202	610	1,938	1,157	4,290	5,523	3,461	2,914	1,704	900	466	567	**23,730**
2004	427	831	1,330	1,300	3,157	1,827	915	442	262	97	117	129	**10,832**
2005	2,873	2,644	2,770	10,214	7,746	10,095	5,628	3,105	1,607	1,239	1,054	982	**49,958**
2006	1,590	1,204	976	2,667	1,940	4,493	3,492	1,175	717	231	209	119	**18,814**
2007	470	1,062	646	1,024	1,402	1,120	915	544	353	312	132	58	**8,038**
2008	250	868	2,492	5,681	6,099	2,276	1,575	1,541	609	222	155	203	**21,971**
2009	338	1,180	3,577	1,581	4,981	1,635	976	631	898	497	165	4	**16,464**
Average	279	513	1,018	1,917	2,595	3,114	1,960	955	405	210	150	178	**13,295**
Median	138	345	793	1,175	1,452	1,584	915	442	177	41	32	41	**8,454**
Minimum	0	0	0	12	11	19	4	0	0	0	0	0	**149**
Maximum	2,873	2,644	4,243	10,214	9,180	12,298	11,610	6,835	2,962	1,239	1,453	1,442	**50,231**

ATTACHMENT C-2
RANKED
Exceedence Interval and Maximum Potential Diversion from the Santa Margarita River at the Point of Diversion
Water Years 1925 to 2009

Water Year	Maximum Potential Diversion [AF]	Percent Time Exceedence [%]	Exceedence Interval [years]
1980	50,231	1%	85.0
2005	49,958	2%	42.5
1993	48,518	4%	28.3
1941	45,147	5%	21.3
1995	43,816	6%	17.0
1978	42,853	7%	14.2
1998	40,529	8%	12.1
1937	37,258	9%	10.6
1979	37,215	11%	9.4
1938	28,483	12%	8.5
1943	28,217	13%	7.7
2003	23,730	14%	7.1
1969	22,687	15%	6.5
2008	21,971	16%	6.1
1983	21,464	18%	5.7
1992	21,219	19%	5.3
1939	20,672	20%	5.0
1952	19,764	21%	4.7
1958	19,099	22%	4.5
1944	18,990	24%	4.3
2006	18,814	25%	4.0
1942	18,173	26%	3.9
1991	18,122	27%	3.7
1932	17,968	28%	3.5
1997	16,606	29%	3.4
2009	16,464	31%	3.3
1945	15,455	32%	3.1
1994	14,753	33%	3.0
1927	14,639	34%	2.9
2001	14,144	35%	2.8
1940	13,942	36%	2.7
1967	12,614	38%	2.7
1985	12,419	39%	2.6
1996	11,370	40%	2.5
1986	11,160	41%	2.4
2004	10,832	42%	2.4
1954	10,484	44%	2.3
1984	10,357	45%	2.2
1982	10,046	46%	2.2
1966	9,663	47%	2.1
2000	9,196	48%	2.1
1999	9,138	49%	2.0
1946	8,454	51%	2.0
1990	8,356	52%	1.9
1947	8,284	53%	1.9
1973	8,106	54%	1.8

ATTACHMENT C-2
RANKED
Exceedence Interval and Maximum Potential Diversion from the Santa Margarita River at the Point of Diversion
Water Years 1925 to 2009

Water Year	Maximum Potential Diversion [AF]	Percent Time Exceedence [%]	Exceedence Interval [years]
2007	8,038	55%	1.8
1935	7,804	56%	1.8
1981	7,789	58%	1.7
1962	7,771	59%	1.7
1930	7,736	60%	1.7
1988	7,445	61%	1.6
1926	7,134	62%	1.6
1989	7,015	64%	1.6
1987	6,470	65%	1.5
1933	5,855	66%	1.5
1948	5,787	67%	1.5
1936	5,406	68%	1.5
1928	4,990	69%	1.4
1949	4,815	71%	1.4
1953	4,749	72%	1.4
2002	4,358	73%	1.4
1970	4,239	74%	1.3
1974	3,957	75%	1.3
1976	3,797	76%	1.3
1929	3,640	78%	1.3
1934	3,505	79%	1.3
1972	3,442	80%	1.3
1931	3,431	81%	1.2
1977	3,341	82%	1.2
1971	3,205	84%	1.2
1975	3,047	85%	1.2
1925	2,792	86%	1.2
1950	2,682	87%	1.1
1955	2,539	88%	1.1
1959	1,877	89%	1.1
1951	1,660	91%	1.1
1956	1,658	92%	1.1
1957	1,507	93%	1.1
1968	1,324	94%	1.1
1963	1,242	95%	1.0
1960	1,023	96%	1.0
1965	914	98%	1.0
1964	556	99%	1.0
1961	149	100%	1.0