DOCKETED

Docket Number:	97-AFC-01C
Project Title:	High Desert Power Plant (COMPLIANCE)
TN #:	210565
Document Title:	Opening Testimony
Description:	Opening Testimony
Filer:	Nancee Murray
Organization:	California Department of Fish and Wildlife
Submitter Role:	Intervenor
Submission Date:	3/1/2016 12:36:39 PM
Docketed Date:	3/1/2016

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

March 1, 2016

California Energy Commission
Docket Unity
Docket Number: 97-AFC-01C
1516 Ninth Street, MS-4
Sacramento, CA 95814

RE: High Desert Power Project (97-AFC-01C)

Dear Docket Clerk,

In accordance with the California Energy Commission's (CEC) February 19, 2016 *Notice of Postponed Prehearing Conference and Evidentiary Hearing, Revised Committee Schedule, and Further Orders,* attached is the Opening Testimony of the California Department of Fish and Wildlife (CDFW) for filing in docket number 97-AFC-01C.

CDFW appreciates the CEC giving CDFW additional time in this proceeding to submit this testimony. CDFW fully participated in the proceedings before the CEC that resulted in the license being issued to the High Desert Power Project (HDPP). CDFW requests the CEC grant CDFW status as an Intervenor in this proceeding. In addition, CDFW requests that it receive notice of any ongoing compliance or possible future amendments to the license. For this Docket, please add the following addresses to the service list:

Ongoing Compliance Matters, High Desert Power Project
AskRegion6@wildlife.ca.gov

For the Evidentiary Hearing and Matters Related to that Hearing:

Nancee Murray
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Thank you for your assistance.

Sincerely,

Nancee M. Murray
Senior Staff Counsel
California Department of Fish and Wildlife

High Desert Power Project

97-AFC-1C

OPENING TESTIMONY OF THE CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

Petition for Modification to Drought-Proof the High Desert Power Project, Filed October 30, 2015

March 1, 2016

DESCRIPTION OF CDFW TESTIMONY – WATER RESOURCES

I. INTRODUCTION

A. CDFW Witness

Kit Custis

B. Qualifications

The qualifications and declaration for Kit Custis are attached in Appendix A.

II. BACKGROUND OF CDFW PARTICIPATION IN THE MOJAVE RIVER

A. CDFW is a Party to the Mojave River Judgment.

Beginning in 1991, CDFW was a party litigating and then ultimately signed on and became a Party to the Stipulated Judgment that was litigated in Riverside County Superior Court, and ultimately upheld by the California Supreme Court. (Mojave River Judgment or Judgment).[1] CDFW owns land in the Alto Subarea, where the High Desert Power Project (HDPP) is located, owns land in the Baja Subarea, downstream of the Alto Subarea, and represented the public trust resources in the Mojave River litigation that resulted in the Judgment being adopted and upheld by the courts. CDFW actively participates in the Baja Subarea Advisory Committee established by the Judgment, attends Mojave River Watermaster meetings, and is generally active in the ongoing implementation of the Judgment.

B. In 1999, CDFW Filed Testimony and Fully Participated in the Proceedings before the California Energy Commission (CEC) regarding the original license application for the High Desert Power Project (HDPP).

CDFW participated in the CEC proceedings in the original license application because CDFW staff was concerned that the HDPP represented a new, consumptive use in a groundwater basin that had been in overdraft since the 1950s[2]. The Judgment was in its early implementation stages in 1999, and was just beginning to try to gain some control on the decades of overpumping that had resulted in that overdraft. As stated in the Opening Testimony of HDPP, CDFW (then California Department of Fish and Game) opposed the use of recycled water by HDPP out of concern that the reduced discharge of recycled water to the Mojave River would negatively impact the water balance in the

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[1] *City of Barstow v. Mojave Water Agency* (2000) 23 Cal 4th 1224.

[2] Amended Statement of Decision, *City of Barstow v. Adelanto Case No. CIV 208568, Riverside Superior Court, p. 7.*

entire basin, and the riparian vegetation in the Transition Zone of the Mojave River, in particular.

C. ***In 2000, CDFW Filed Testimony and Fully Participated in State Water Resources Control Board Hearings Regarding a Petition Filed by the Victor Valley Water Reuse Authority(VVWRA) to Reduce Discharges to the Mojave River.***

In 2000, VVWRA filed a petition to the State Water Resources Control Board (SWRCB) to divert up to 8 MGD (8,961 AFY) from the Mojave River to the City of Victorville for irrigation uses at a nearby golf course and the Southern California Logistics Airport. CDFW submitted testimony by Kit Custis, demonstrating the hydrologic connection between the groundwater pumping in the Alto Subarea, where VVWRA is located, and the Mojave River. CDFW staff also presented testimony to the SWRCB regarding the importance of the Transition Zone area to many public trust resources in that area just downstream of the VVWRA discharge, and the potential impact the approval of the VVWRA petition might have on those resources. The SWRCB issued a draft decision generally agreeing with the CDFW testimony and largely adverse to VVWRA's petition to redirect this amount of discharge away from the Mojave River. VVWRA withdrew its petition to the SWRCB that was the basis of the hearing before the SWRCB could issue a final decision.

D. ***In 2003, CDFW and VVWRA entered into a Memorandum of Understanding regarding the Discharge to the Mojave River Transition Zone by VVWRA (2003 MOU).***

The 2003 MOU was entered into the docket for this proceeding on February 23, 2016, TN# 210503.

E. ***CDFW Regularly Participates in the Mojave River Judgment implementation, including filing a Motion on May 14, 2015 with the Riverside County Superior Court in Response to Watermaster's Motion to Adjust Free Production Allowance for Water Year 2015-2016.***

That Motion included Declarations of Alisa Ellsworth and Kit Custis in support of the CDFW Recommendation to comply with the Judgment and that the Watermaster should order a continued rampdown of Free Production Allowance in the Baja Subarea.

F. ***CDFW Lost Contact with the HDPP Amendments and Ongoing Compliance.***

CDFW Contact Information on the HDPP Compliance Docket got shuffled to a CDFW office in Blythe that had no connection or information regarding HDPP or the Mojave River. CDFW has respectfully requested that a more general email address for the CDFW Region in which the HDPP is located instead be added to the service list for compliance matters involving HDPP in the future. On February 12, 2016, CDFW staff in Sacramento was notified of this proceeding, and appreciates the opportunity to submit testimony in this proceeding.

G. ***On February 29, 2016 CDFW Filed an Answer to Committee Questions 1a and 1b (in a Feb. 16, 2016 Memo) regarding the status of habitat and threatened/endangered or special status species in the Transition Zone of the Mojave River.***

Rather than file separate and duplicative CDFW Testimony that would have mirrored the Answers to the Committee Questions set forth in the Feb. 16, 2016 Memo, CDFW instead has submitted that information it wishes to be added to this Docket Record regarding the current status of habitat and species in the separate Answer to Committee Questions.

III. TESTIMONY OF KIT CUSTIS – WATER RESOURCES

A. The October 30, 2015 Petition for Modification to Drought-Proof the High Desert Power Project (Applicant's Petition) Incorrectly Asserts that "There is No Groundwater Overdraft in the Alto Subarea Where the Facility is Located".

The Applicant's Petition, in that same Section 3.6, more specifically states that:

1). *The physical solution employed by WMA and the Watermaster has resulted in increased storage in the Alto Subarea over time;* 2) *groundwater storage has increased approximately 140,000 acre-feet since 1996;* 3) *groundwater levels have remained in the Operating Range (above levels considered to be of concern) since at least 1996*; and 4) the *Free Production Allowance reduction has resulted in the purchase of Replacement Water as part of the physical solution which, in part, maintains the long-term sustainability of the Alto Subarea.*

Although the volume of groundwater stored in the upper Alto Subarea has increased approximately 140,000 acre-feet (AF) since the Judgment began being implemented in 1996, this increase in stored groundwater hasn't resulted in an increase, or even cessation, of the historic decline in Base Flow at the Lower Narrows. This Base Flow is an important component of river flow because it sustains the river during periods of lowest flow. The Judgment defines Base Flow in Section 4(h) as *that portion of the total surface flow measured Annually at the Lower Narrow which remains after subtracting Storm Flow.* The procedures for calculating Storm Flow and Base Flow are given in Exhibit C of the Judgment. Accounting for Base Flow is important to the Alto Subarea's water management because Base Flow along with the VVWRA discharge at the Shay Road Plant provide most of the recharge to the groundwater aquifers in the Transition Zone, and the sum of Base Flow and VVWRA discharge are use in the calculation of the Alto Subarea's obligation to provide water to the downstream Centro Subarea.

The lowest volume of Base Flow shown in Table 1 prior to 1996 was in Water Year 1994-95 at 7,472 AFY. Since 1996, Base Flow has systematically declined (Table 1, Figures 1 and 2) to where flows below 7,500 AFY have occurred 75% of the time, or 15 of the last 20 years. Base Flows near or below 4,500 AFY occurred 25% of the time, or 5 of the last 20 years. The decline is temporarily reversed by Storm Flows, but the rise in Base Flow only lasts for approximately 3 years (Table 1, Figures 1 and 2) the continual decrease in Base Flow is a potentially significant impact to groundwater storage in the Transition Zone, which is located in the Alto Subarea as depicted in the Judgment, the same subarea in which the HDPP is located, and which affects the water levels and the sustainability of the riparian habitat in the Transition Zone.

The statements in Section 3.6 of the Applicant's Petition appear to say that the stability of groundwater levels in the Alto Subarea is the only requirement to prevent groundwater "overdraft" and to achieve groundwater "sustainability." I disagree that the condition of "overdraft" and "sustainability" are only measured by the stability of groundwater levels. Other important hydrologic conditions that need to be considered when assessing groundwater overdraft and sustainability include:

a. The definition of "overdraft" in Section 4(u) of the Judgment is "*[t]he condition wherein the current total Annual Consumptive Use of water in the Mojave Basin Area or any of its Subareas exceeds the long term average Annual natural water supply to the Basin Area or Subarea.*" The Judgment's definition specifically states that overdraft is the ratio of consumptive use to the long-term average annual "natural" water supply. Although the Judgment's overdraft definition would include a condition where groundwater levels are fluctuating within an Operational Range, this condition in the Alto Subarea is obtained by infiltrating imported water or by the accounting exercise of trading Free Production Allowance (FPA). The imported State Water Project water, while important to the basin's water balance, isn't natural to the basin. The availability to use FPA to balance the water budget shouldn't be considered a permanent source of water because it won't be available should the FPA owners choose to increase their pumping.

b. Although maintaining groundwater levels within a specified range for a long period of time is one indication that consumptive uses are nearly matched with the water being supplied to a groundwater basin, it's not the only criterion for determining that groundwater pumping in the Alto Subarea is "sustainable." Specifically, there is a continuing decline in the long-term volume of the Base Flow to the Transition Zone. This decline is in part due to the VVWRA regional sewer system that directs wastewater to the Shay Road Plant, which prevents its local infiltration in the upper Alto Subarea.

Exhibit F of the Judgment specifies the consumptive use rates for various water uses in the Mojave River Basin. Municipal and irrigation uses are given at 50% consumptive use, lakes and aquaculture are given a use rate of 7 feet per acre, and industrial use is on a case-by-case basis. With the creation of the regional sewer system the recharge of 50% of groundwater pumped in the upper Alto Subarea for municipal use became VVWRA wastewater that now discharges to the Mojave River approximately 4 miles below the USGS Lower Narrows gauge. Table 1 shows that the total volume of VVWRA discharge since Water Year 1982-83 is 312,770 AF with 227,463 AF discharged since Water Year 1996-97. The re-direction of Alto Subarea recharge by the regional sewer system is approximately 160% of the increase in groundwater storage cited by the Applicant as evidence of no overdraft. Table 1 also shows that the annual volume of VVWRA discharge has significantly increased since the 1980s while the volume of Base Flow has decreased. Today, VVWRA discharge is approximately 65% the total sum of these two flows. If the volume of wastewater delivered to VVWRA continues to increase, then continued decline in Base Flow is likely. Any large change in the volume of VVWRA discharge should be considered potentially significant because it provides the greatest portion of recharge to groundwater in the Transition Zone. The proposed use of 100% recycled water at the HDPP has the potential to reduce the storage of groundwater in the Transition Zone and impact the riparian habitat, which would be an undesirable result.

B. Staff Rebuttal Testimony Incorrectly Concludes that if HDPP Transitions to 100 Percent Recycled Water Use, the Potentially Significant Impact of Pumping 3,090 AFY of Groundwater from the Mojave River Basin Would be Mitigated.

I have read the Energy Commission Staff's Rebuttal Testimony submitted on Feb. 12, 2016 (Staff Rebuttal). I disagree with the opinion stated on page 32 of the Staff Rebuttal that the diversion of VVWRA Shay Road Plant wastewater to supply 100% of the water needs of the HDPP would mitigate the potentially significant impacts from HDPP's use of up to 3,090 AFY from groundwater in the Mojave River Basin. . The Staff Rebuttal opinion seems to be based on the assumption that the diversion of VVWRA wastewater will have no significant impacts as long as the discharges to the Transition Zone are consistent with the 2003 MOU, and presumably at least 9,000 AFY. This assumption isn't correct. Tables 4 and 5B show using theoretical Transition Zone water budgets, that a 4,000 AFY reduction is the VVWRA discharge can have a detrimental impact on the groundwater stored in the Transition Zone even when the VVWRA discharges are 9,000 AFY or more.

The Alto Subarea is made up of two groundwater sub-basins, the upper Alto Subarea and a lower sub-basin, the Transition Zone. These two sub-basins are separated by the bedrock high that underlies the Narrows, and the Shadow Mountains and Adelanto faults. The Watermaster's Engineer (Wagner, 2006) and URS (2003a, 2003b) quantified the subsurface flow between the upper Alto sub-basin and the Transition Zone. Groundwater flows northward in the Regional aquifer from the upper Alto sub-basin across the partial hydraulic barriers of the Shadow Mountains and Adelanto faults that define the southern Transition Zone basin boundary. URS concluded that these faults help isolate the two ground water sub-basins and that groundwater management practices that affect the Regional aquifer in the upper Alto sub-basin may have limited impacts on Regional aquifer groundwater conditions in the Transition Zone. Therefore, when analyzing the impacts of using recycled water at the HDPP, the water budget of the Transition Zone should be evaluated separately from the upper Alto Subarea.

Any assessment of the Transition Zone water balance requires accounting of inflows and outflows of both surface and groundwater. The hydrogeologic studies of the Transition Zone (URS, 2003a, 2003b) as well as the Judgment assume that surface water into the Transition Zone flows primarily through the Narrows. This surface water flow is measured at the USGS Lower Narrows river gauge (10261500). The Watermaster, using a method required by Exhibit C in the Judgment, separates the total surface water flow into the Storm Flow and Base Flow components. The water budget for the Transition Zone, URS (2003b) assumed that long-term average outflow of surface waters is within 105% of inflow (Figures 3A and 3B). Therefore this component of surface flow doesn't significantly influence the water balance. Both URS and the Judgment assume that the subsurface groundwater flows into and out of the Transition Zone are nearly balanced; URS assumed a gain in storage of 300 AFY. Therefore this component of subsurface flow doesn't significantly influence the water balance. The only components that aren't relatively constant are Base Flow and the VVWRA discharge. These are the components that have the most influence of the Transition Zone water budget.

Figures 1 and 2 show the historic levels of Base Flow at the Lower Narrows gauge from 1930s to 2015. Figure 2 also shows the Base Flow and VVWRA discharges since Water Year 1982-83. Table 1 lists the annual Base Flow and VVWRA discharge along with the sum of the two inflows. Table 1 shows that the annual percentage of VVWRA discharge to the total inflow has increased from approximately 15% in the early 1980s to peak at approximately 77% in 2008-09. The increase in VVWRA discharge while Base Flow was declining suggests they are connected. That connection is the expansion of the regional sewer system. Without the regional sewer system, the VVWRA wastewater would have recharged the upper Alto Subarea and added to its groundwater storage. This stored groundwater would have helped to maintain the Base Flow.

Tables 3A and 3B are taken from a 2003 report prepared by URS (2003a) for the Mojave Water Agency that evaluated the hydrogeology and the water budget of the Transition Zone. Table 3A gives an average annual water budget for the Transition Zone for Water Years 1994 to 2001 and Table 3B gives the footnotes. Table 4 compares the average water budget in Table 3 to several theoretical average budgets that could have occurred since the 2003 MOU. The bolded and red colored numbers in the inflow section of Table 4 come from the statistics for Water Years 2003 to 2015 given in Table 2. Note that the values of Subsurface Flow are changed in Table 4 to match the requirements of the Judgment.

The results of theoretical average water balance calculations in Table 4 show that the actual average Base Flow and VVWRA discharges to the Transition Zone from 2003 to 2015 resulted in a surplus of 2,147 AFY. However, if 4,000 AFY of VVWRA's wastewater had been diverted to the HDPP for complete consumptive use, there would have been a deficit of 1,523 AFY. Full implementation of 2003 MOU Conditions #3 and #3C would also have produced deficits from 1,576 AFY to 5,833 AFY, respectively.

A second water budget method for evaluating the potential impact to groundwater from diverting VVWRA wastewater to the HDPP is the Alto Subarea Makeup Obligation calculation required by the Judgment and provided each year in Table 4-3 of the Watermaster's Annual Report. The requirements of the obligation accounting method are given Exhibit G of the Judgment. The purpose of this obligation accounting is to demonstrate that the Alto Subarea is providing sufficient water to the downstream Centro Subarea and to quantify any surplus or deficit. Because the obligation accounting requires balancing the inflows and outflows that affect groundwater storage in the Transition Zone, it can be used to evaluate the change in groundwater storage that might result from diversion of VVWRA wastewater to the HDPP. VVWRA discharges are accounted for as an inflow under the "Other Waters" category. When the inflows to the Transition Zone are insufficient, a makeup obligation is created. The makeup obligation can be used as a measure of the reduction in groundwater stored in the Transition Zone.

Attached Tables 5A and 5B are modified after Table 4-3 in the Watermaster's 2013-2014 Annual Report. Table 5A is Table 4-3 from the 2013-2014 Annual Report with the addition of Water Year 2014-15 Base Flow, VVWRA discharge and Makeup Water purchases taken from the February 24, 2016 Draft 2014-15 Watermaster's Annual Report (Watermaster, 2016). Table 5B is a theoretical calculation assuming that 4,000 AFY of VVWRA wastewater is taken out. Table 5A and 5B have two additional rows to allow a comparison between the long-term obligation assuming an HDPP diversion and no diversion. One row allows for inclusion of the VVWRA's diversions away from the river, and the other row gives a cumulative sum of the annual Makeup Obligation.

Calculation of the annual Alto Subarea's Makeup Obligation requires that the accounting start from an average annual obligation of 23,000 AFY as given in Exhibit G of the Judgment. This obligation then needs to be met by summing Base Flow, Subsurface Flow, any Other Waters that inflow into the Transition Zone, plus any Makeup Water purchased for the previous year's deficit. At the present time, the only "Other Water" is the discharge from VVWRA's Shay Road Plant. Note that the volume of "Other Waters" is the full VVWRA discharge to the Transition Zone and not the 9,000 AFY generally specified in the 2003 MOU.

The accounting is complicated by the requirement to carry over into the next year some of the Net Cumulative Obligation credit or debt. In Tables 5A and 5B, the Net Cumulative Obligation over the most recent 11 years is always in debt, which then requires that 1/3 of that deficit be carried over into the next year. The last rows in Tables 5A and 5B give the Minimum Makeup Obligation for subsequent years. Even without the proposed HDPP diversion, Table 5A shows that the Minimum Obligation for Next Year in the last 11 years has exceeded the starting obligation 23,000 AFY, except in two years. Table 5B shows that with the proposed 4,000 AFY HDPP diversions, the annual Minimum Obligation for Next Year always exceeds the starting 23,000 AFY. This shows that the use of 100% recycled water by HDPP will likely result in an ongoing deficit in the Alto Subarea's obligation, which indicates an ongoing deficit in groundwater stored in the Transition Zone.

An important result from Table 5A and 5B is the comparison of the cumulative theoretical obligation from the HDPP diversions to the actual historic obligation. The shaded box at the right side of the Cumulative Makeup Obligation row shows that with the VVWRA wastewater from the Shay Road Plant supplying 100% of the HDPP recycled water in each of the last 11 years, the cumulative makeup obligation would have increased to 49,484 AFY from the actual 15,631 AFY, or an increase of 33,853 AFY. This is an annual average increase of 3,078 AFY, which is approximately twice water budget deficit calculated for HDPP in Table 4. It is important to note that this 300% increase in makeup obligation is occurring even though the Watermaster is purchasing Makeup Water each year.

The conclusion from these theoretical water budgets is that the proposed 100% recycled water use at the HDPP will likely cause an ongoing impact to the Alto Subarea through a reduction in groundwater recharge in the Transition Zone. This deficit will likely lower groundwater levels, which may create a significant impact to the health of the riparian habitat and wildlife.

C. The CEC Staff have not adequately analyzed the potential environmental impacts to the Alto Subarea and the Transition Zone from the HDPP use of 100% recycle water.

The water budget discussions above show that the consumptive use by HDPP of recycled water from the VVWRA Shay Road Plant would result in a reduction in recharge to the groundwater system in the Transition Zone. The reduced recharge resulting from the 100% recycled water use at the HDPP will likely result in a long-term deficit in the groundwater stored in the Transition Zone. This deficit has the potential to lower groundwater levels and thereby impact the riparian habitat and wildlife in the Transition Zone. This deficit may occur even though the VVWRA discharge to the river meets the minimum required by the 2003 MOU. I have not seen an analysis done in the documents that I have reviewed in the docket that addresses the potential impacts from a reduction in recharge to the Transition Zone that would result from the HDPP using 100% recycled water. I recommend that the CEC analyze the potential environmental impacts from the use of 100% VVWRA Shay Road Plant recycled wastewater by the HDPP prior to creating a license requirement for HDPP to use 100% recycled water.

D. Conclusion

I believe that if the HDPP uses one hundred percent recycled water, the water balance in the Alto Subarea would be significantly negatively impacted. HDPP should be required to buy imported State Water Project water for a major portion of their water use demand. The amount of recycled water HDPP uses should be limited in the CEC license. The CEC staff, or the Applicant, should do an environmental analysis to better determine the maximum amount of recycled water that could be consumptively used by HDPP without a significant negative impact to the water balance in the subarea and the public trust resources in the Transition Zone.

References Cited

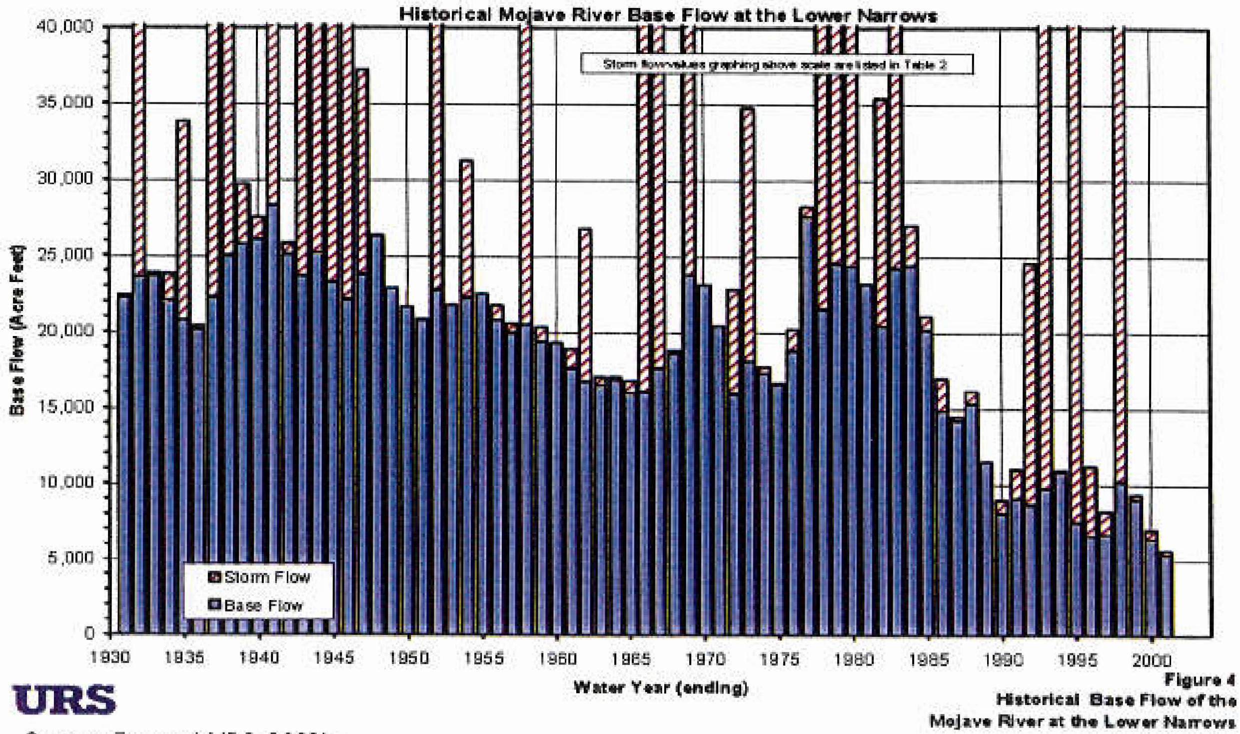
Wagner, R.C., 2006, Mojave Basin Area Watermaster Summary Report Subsurface Flow Between Subareas, February 22, 2006, 7 pgs, 9 Figures. (http://earthsci.fullerton.edu/laton/Mojave_Water_Agency/Special_Reports_files/Mojave%20Basin%20Area%20Watermaster%20Flow%20Between%20Basins.pdf)

Watermaster, 2016, Draft Twenty-Second Annual Report of the Mojave Basin Area Watermaster, Water Year 2014-15, February 24, 2016, 197 pgs. https://www.mojavewater.org/files/22DraftAR1415.pdf

URS, 2003a, Mojave River Transition Zone Recharge Project, Phase I Report, Transition Zone Hydrogeology, Mojave Water Agency, March 13, 2003, 101 pgs. (https://www.mojavewater.org/files/TransitionZonePhaseI-Report_2.pdf)

URS, 2003b, Mojave River Transition Zone Recharge Project, Phase II Report, Groundwater Supply and Demand in the Transition Zone (https://www.mojavewater.org/files/TransitionZonePhaseII-Report_2.pdf)

Figure 1



Source: Figure 4 URS, 2003b

Figure 2

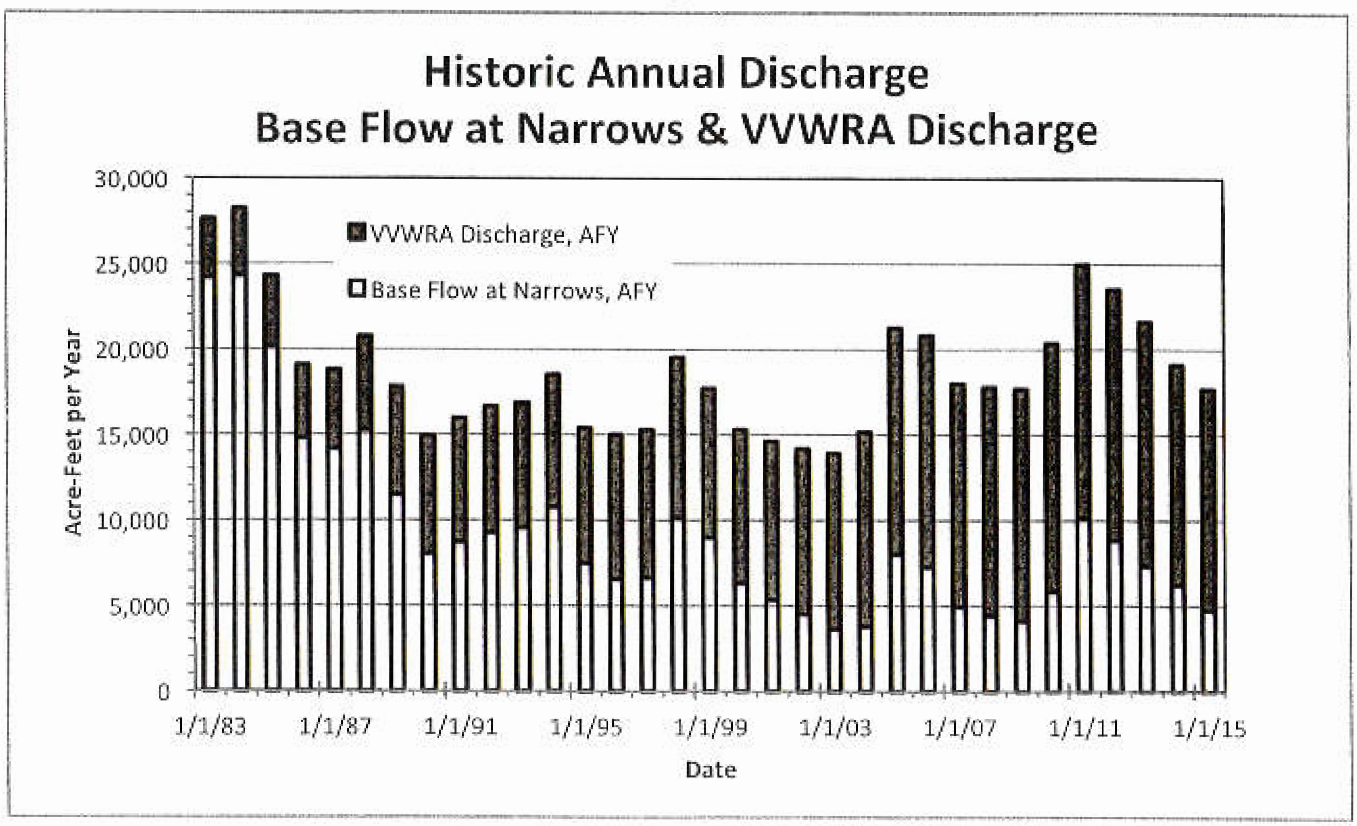


Table 1
Alto Subarea Historic Flows to Alto Transition Zone
Annual Base Flow and Storm Flow at Lower Narrows Gauge, and VVWRA Discharge
(Acre-feet per Year)

Year	Base Flow	VVWRA Discharge	Total Base Flow + VVWRA	VVWRA to Total, %	5-Year Average, %	Storm Flow
1982-83	24,195	3,428	27,623	12.4%		
1983-84	24,312	3,932	28,244	13.9%		
1984-85	20,161	4,134	24,295	17.0%		
1985-86	14,790	4,286	19,076	22.5%		
1986-87	14,191	4,601	18,792	24.5%	18.1%	
1987-88	15,268	5,484	20,752	26.4%	20.9%	
1988-89	11,487	6,330	17,817	35.5%	25.2%	
1989-90	8,027	6,941	14,968	46.4%	31.1%	
1990-91	8,714	7,276	15,990	45.5%	35.7%	
1991-92	9,257	7,387	16,644	44.4%	39.6%	
1992-93	9,552	7,331	16,883	43.4%	43.0%	
1993-94	10,766	7,753	18,519	41.9%	44.3%	147
1994-95	7,472	7,949	15,421	51.5%	45.3%	105,807
1995-96	6,552	8,475	15,027	56.4%	47.5%	4,630
1996-97	6,619	8,705	15,324	56.8%	50.0%	1,592
1997-98	10,162	9,353	19,515	47.9%	50.9%	73,355
1998-99	8,970	8,744	17,714	49.4%	52.4%	328
1999-00	6,322	9,006	15,328	58.8%	53.8%	668
2000-01	5,345	9,286	14,631	63.5%	55.3%	273
2001-02	4,515	9,689	14,204	68.2%	57.5%	35
2002-03	3,648	10,281	13,929	73.8%	62.7%	2,594
2003-04	3,783	11,392	15,175	75.1%	67.9%	1,601
2004-05	8,016	13,246	21,262	62.3%	68.6%	184,574
2005-06	7,261	13,542	20,803	65.1%	68.9%	19,991
2006-07	4,942	13,067	18,009	72.6%	69.8%	0
2007-08	4,421	13,385	17,806	75.2%	70.0%	4,734
2008-09	4,093	13,609	17,702	76.9%	70.4%	267
2009-10	5,849	14,525	20,374	71.3%	72.2%	13,317
2010-11	10,149	14,825	24,974	59.4%	71.1%	116,202
2011-12	8,829	14,674	23,503	62.4%	69.0%	675
2012-13	7,325	14,310	21,635	66.1%	67.2%	0
2013-14	6,227	12,898	19,125	67.4%	65.3%	563
2014-15*	5,418	12,926	18,344	70.5%	65.2%	0
Total Flow 1983-2015	306,638	312,770	619,408		Total Flow 2002-03 to 2014-15	344,518
Total Flow 1983-1995	184,744	85,307	270,051		Average Storm Flow 2002-03 to 2014-15	26,501
Total Flow 1996-2015	121,894	227,463	349,357			

* Draft values from 2/24/2016 WY 2014-15 Watermaster's Annual Report Table 4-3

Table 2
Theoretical Alto Transition Zone Flows Under DFW MOU
Base Flow and VVWRA Available Water
(Acre-Feet per Year)

	1	2	3	4	5	6	7	8	9	10
Year	Narrows Base Flow Discharge	VVWRA Total Discharge	Transition Zone Unadjusted Total Discharge	VVWRA[1] Theoretical MOU #3 Required Discharge	VVWRA[2] Theoretical MOU #3C Required Discharge	VVWRA[3] Theoretical Maximum DFW-MOU Diversion	VVWRA[4] Theoretical HDPP DFW-MOU Diversion	VVWRA[5] Theoretical HDPP DFW-MOU Discharge	Transition[6] Zone Theoretical Discharge w/HDPP	Transition[7] Zone Theoretical Discharge w/MOU 3#C
2002-03	3,648	10,281	13,929	9,000	8,966	1,315	1,315	8,966	12,614	12,614
2003-04	3,783	11,392	15,175	9,000	9,000	2,392	2,392	9,000	12,783	12,783
2004-05	8,016	13,246	21,262	9,222	9,047	4,199	4,000	9,246	17,262	17,063
2005-06	7,261	13,542	20,803	9,593	3,331	10,211	4,000	9,542	16,803	10,592
2006-07	4,942	13,067	18,009	9,652	3,849	9,218	4,000	9,067	14,009	**8,791**
2007-08	4,421	13,385	17,806	9,557	6,548	6,837	4,000	9,385	13,806	10,969
2008-09	4,093	13,609	17,702	9,621	6,815	6,794	4,000	9,609	13,702	10,908
2009-10	5,849	14,525	20,374	9,666	6,964	7,561	4,000	10,525	16,374	12,813
2010-11	10,149	14,825	24,974	9,849	4,475	10,350	4,000	10,825	20,974	14,624
2011-12	8,829	14,674	23,503	9,909	0	14,674	4,000	10,674	19,503	**8,829**
2012-13	7,325	14,310	21,635	9,879	1,376	12,934	4,000	10,310	17,635	**8,701**
2013-14	6,227	12,898	19,125	9,806	3,171	9,727	4,000	8,898	15,125	**9,398**
2014-15[8]	5,418	12,926	18,344	9,523	5,398	7,528	4,000	8,926	14,344	10,816
Minimum	3,648	10,281	13,929	9,000	0	1,315	1,315	8,898	12,614	8,701
Average	6,151	13,283	19,434	9,560	5,303	7,980	3,670	9,613	15,764	11,454
Maximum	10,149	14,825	24,974	9,909	9,047	14,674	4,000	10,825	20,974	17,063

1. Theoretical 2003 DFW-VVWRA MOU required **discharge** based on Condition #3 (MOU #3):
   Transition Zone minimum discharge = 9,000 AFY + 20% of VVWRA 2002-03 discharge above 10,281 AFY
2. Theoretical 2003 DFW-VVWRA MOU required **discharge** based on Condition #3C (MOU #3C):
   When Base Flow + VVWRA Total Discharge <= 15,000 AFY = DFW MOU #3;
   When Base Flow + VVWRA Total Discharge > 15,000 AFY = DFW-MOU #3 - prior year's flows exceeding 15,000 AFY;
   Transition Zone Unadjusted Total Discharge in 2001-02 = 15,034
3. Theoretical maximum VVWRA **diversion** under 2003 DFW-VVWRA MOU =
   Unadjusted Total Transition Zone Discharge (Column 3) - either MOU #3 (Column 5), or MOU #3C (Column 6), whichever is less.
4. Theoretical VVWRA **diversion** to HDPP under DFW MOU = VVWRA Theoretical Maximum Diversion (Column 6) if < 4,000 AFY, otherwise = 4,000 AFY.
5. Theoretical VVWRA **discharge** with HDPP diversion under DFW MOU = VVWRA Total Discharge (Column 2) - VVWRA Theoretical HDPP Diversion (column 7)
6. Theoretical Transition Zone **discharge** with HDPP diversion = Transition Zone Unadjusted Total Discharge (Column 3)
   - VVWRA Theoretical HDPP Diversion (column 7)
7. Theoretical Transition Zone **discharge** under MOU #3C = Base Flow (Column 1) + MOU #3C (Column 5)
   Values are **bolded** when the discharge is less than required by MOU #3.
8. Draft values from 2/24/2016 WY 2014-15 Watermaster's Annual Report Table 4-3

~~Table 4~~ Table 3*

Transition Zone Water Budget

Components	Average Year	Subtotal
Sources (Inflow)		61,150 AF
Surface Water		
Mojave River Base Flow at the Lower Narrows	8,142 AF [1]	
Mojave River Stormflow at the Lower Narrows	33,107 AF [2]	
Precipitation	96 AF [3]	
VVWRA Discharge	8,659 AF [4]	
Ungaged Tributaries	320 AF [7]	
Pumping Return Flows	5,926 AF [6]	
Groundwater		
Subsurface Inflows	4,900 AF [5]	
Sinks (Outflow)		61,336 AF
Surface Water		
Evaporation	1,159 AF [9]	
Riparian Transpiration	6,000 AF [10]	
Surface Outflow Across Helendale Fault	34,762 AF [12]	
Groundwater		
Subsurface Outflow Across Helendale Fault	4,600 AF [11]	
Total Pumping	14,815 AF [8]	
Municipal Well Pumping	5,208 AF [8]	
Domestic Well Pumping	99 AF [8]	
Agricultural Pumping	3,819 AF [8]	
Industrial Pumping	2,224 AF [8]	
Silver Lakes Association	3,288 AF [8]	
Minimal Producers (<10 AFY)	177 AF [13]	
Difference		-186 AF

Footnotes are on the following page.

* Taken from Table 4 in URS, 2003a

Table 3B Footnotes for Table 3

~~Footnotes to Table 4~~

1 The base flow value is an average value determined from data provided by the Mojave River Basin Watermaster for Water Years 1991 through 2001. Storm flow and base flow are derived from total flow by the Mojave River Basin Watermaster using the method outlined in Exhibit C of the Judgment After Trial (California Superior Court, 1996). Base flow and Storm flow values at the Lower Narrows are based on total flow measurements taken at the USGS stream gage at the Lower Narrows. For the water budget, a longer period average was not used because the decline in base flow values observed since 1950 would not representing average conditions over the past 10 years. The long term average base flow (1931-2001) is 18,829 AFY.

2 This value is an average of storm flow values reported by the Watermaster for Water Years 1931 through 2001. Base flow and Storm flow values at the Lower Narrows are based on stream flow measurements taken at the USGS stream gage at the Lower Narrows. The determination of storm flow and base flow was made by the Mojave River Basin Watermaster using the method outlined in Exhibit C of the Judgment After Trial (California Superior Court, 1996).

3 Precipitation falling on desert areas, in the dry river channel, and/or in riparian areas is considered lost to evapotranspiration in accordance with assumptions made by the USGS (1996c and 2001a). The value presented reflects direct precipitation on bodies of open water from which recharge can occur. The value presented was estimated by multiplying the average annual precipitation by the area of the open water body. Open bodies of water were determined from USGS (1996c) and personal communication with VVWRA to be approximately 206 acres. NOAA data collected from 1939 through 2001 at the Victorville Pumping Plant, indicate an average precipitation of 5.61 inches per year.

4 The value presented is an average of annual VVWRA discharge for the period tabulated by the Watermaster (1994-2001). This period corresponds to the verified groundwater production data tabulated by the Watermaster. VVWRA annual discharges observed during this period are the highest recorded. Future VVWRA discharges are expected to increase annually.

5 As calculated by URS for this study. Calculations are presented in Appendix H of this report.

6 Return flow value is estimated to be 40 percent of total pumping. USGS (1971) assumes 40 - 45 percent return on total pumping and 55 - 60 percent return on water pumped for irrigation. USGS (2001a) states that improvements to irrigation techniques since 1971 have reduced irrigation return flows to approximately 46 percent. Webb (2000) performed a detailed consumptive use study based on the 1996-97 water year. Webb assumed a maximum irrigation consumptive use of 65 percent when production exceeded crop requirements. Otherwise, Webb applied crop specific consumptive use values to the number of acres under cultivation with each crop. Webb assumed a 50 percent return value for water produced for domestic and municipal use. Webb assumed that 100 percent of water produced for industrial processes in the Transition Zone is consumed.

Based on these calculations and assumptions Webb determined a consumptive use value for the Transition Zone of 10,390 AFY for the 1996-97 Water Year. Total verified production in the Transition Zone for the 1996-97 Water Year was 17,199 AFY. The detailed consumptive use value determined by Webb for the 1996-97 water year is 60.4 percent which leaves a return flow of approximately 40 percent. For the purposes of this study, Pumping Return Flows are assumed to be returns of groundwater pumped from within the Transition Zone and include averaged returns from irrigation and domestic septic systems.

7 The value presented is from Webb (2000). This value for ungaged tributary stream flow in the Transition Zone was determined from data presented in *Groundwater and Surface Water Relations Along the Mojave River, Southern California, USGS (1996a)*. Described in text as occurring at the Transition Zone boundaries. Assumes 100 percent is recharged.

8 The Mojave River Basin Watermaster has tabulated Transition Zone groundwater pumping since 1994. The groundwater production values used in this water balance are average values representing the years 1994-2001.

9 This value reflects an evaporation rate of 67.5 inches per year (USGS 1996c) from 206 acres of free surface water associated with the VVWRA percolation ponds and surface water in the Mojave River Channel. Silver Lakes are not included in this value because the lakes are lined, and water pumped to fill the lakes is considered outflow from the system accounted for by Total Pumping (Footnote 8). Losses associated with agriculture, including evaporation, are accounted for in the estimate of pumping return flow, which is derived in part from agricultural consumptive use (Webb, 2000).

10 The value represents only riparian transpiration as determined by the USGS (1996c). Transpiration from vegetation irrigated in urban areas is accounted for in domestic consumptive use as calculated by Webb (2000). Transpiration from non-irrigated vegetation in urban areas is accounted for by the loss of deep infiltration from direct rainfall, similar transpiration from xerophytes in undeveloped areas as assumed by USGS (1996c). Transpiration losses associated with agriculture are accounted for as agricultural consumptive use as calculated by Webb (2000).

11 As calculated by URS for this study. Calculations are presented in Appendix H of this report. The Mojave Basin Area Adjudication, Table C-1 gives a value of 2,000 AFY.

12 This value represents 105% of storm flow measured at the Lower Narrows gage. Based on calculations performed by Webb (2000) approximately 105% of long term average storm flow leaves the Transition Zone as surface flow in an average year. There is likely a lower limit of storm flow beneath which this relationship cannot be applied. That limit has not been defined.

13 The Mojave Water Agency estimates that there are approximately 177 small producers in the Transition Zone. The small producers typically use the water for domestic purposes and use an average of 1 AFY (Webb, 2000). For this study it is assumed that the 177 small producers each use 1 AFY.

Table 4
Transition Zone Annual Theoretical Water Budget 2003-2015

	URS 2003 Table 4 *Average* 1994-2001	Actual[3] VVWRA *Average* 2003-2015	DFW[4] MOU #3 *Average* 2003-2015	DFW[5] MOU #3C *Average* 2003-2015	DFW[6] w/HDPP *Average* 2003-2015
Inflows Sources (acre-feet per year)					
Surface Water	1	2	3	4	5
Mojave River Base Flow at the Lower Narrows	**8,142**	**6,151**	**6,151**	**6,151**	**6,151**
Mojave River Storm flow at the Lower Narrows[1]	33,107	33,107	33,107	33,107	33,107
Precipitation	96	96	96	96	96
VVWRA Discharge	**8,659**	**13,283**	**9,560**	**5,303**	**9,613**
Ungaged Tributaries	320	320	320	320	320
Pumping Return Flows	5,926	5,926	5,926	5,926	5,926
Groundwater					
Subsurface Flows[2]	2,000	2,000	2,000	2,000	2,000
Subtotal	58,250	60,883	57,160	52,903	57,213
Outflow Sinks (acre-feet per year)					
Surface Water					
Evaporation	1,159	1,159	1,159	1,159	1,159
Riparian Transpiration	6,000	6,000	6,000	6,000	6,000
Surface Outflow Across Helendale Fault	34,762	34,762	34,762	34,762	34,762
Groundwater					
Subsurface Outflow Across Helendale Fault	2,000	2,000	2,000	2,000	2,000
Total Pumping = 14,815 AFY					
Municipal Well Pumping	5,208	5,208	5,208	5,208	5,208
Domestic Well Pumping	99	99	99	99	99
Agricultural Pumping	3,819	3,819	3,819	3,819	3,819
Industrial Pumping	2,224	2,224	2,224	2,224	2,224
Silver Lakes Association	3,288	3,288	3,288	3,288	3,288
Minimal Producers (<10 AFY)	177	177	177	177	177
Subtotal	58,736	58,736	58,736	58,736	58,736
Water Balance	**(486)**	**2,147**	**(1,576)**	**(5,833)**	**(1,523)**

1. Storm Flow values are long-term average from 1931 to 2001, URS 2003a
2. Subsurface Flows modified from URS 2003 report to 2,000 AFY to match Judgment and Wagner, 2006
3. Values from Column 1 and Column 2 of Table 2
4. Values from Column 1 and Column 4 of Table 2
5. Values from Column 1 and Column 5 of Table 2
6. Values from Column 1 and Column 8 of Table 2

Table 5A
Status of Alto Subarea Obligations
Water Years 2004-05 Through 2014-15

Water Year	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15[2]
Average Annual Obligation in acre-feet	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000
Status at Beginning of Water Year											
Cumulative Obligation	253,000	276,000	299,000	322,000	345,000	368,000	391,000	414,000	437,000	460,000	483,000
Cumulative Flow	226,284	253,768	276,571	299,588	322,253	345,160	370,610	398,148	423,651	447,286	468,411
Net Cumulative Credit (Debit)	(26,716)	(22,232)	(22,429)	(22,412)	(22,747)	(22,840)	(20,390)	(15,852)	(13,349)	(12,714)	(14,589)
Flow During Water Year											
Base Flow	8,016	7,261	4,942	4,421	4,093	5,849	10,149	8,829	7,325	6,227	5,418
Subsurface Flow	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other Water - **VVWRA Total**	13,246	13,542	13,067	13,385	13,609	14,525	14,825	14,674	14,310	12,898	12,926
Maximum HDPP Diversion	0	0	0	0	0	0	0	0	0	0	0
Makeup Water Purchased	4,222	0	3,008	2,860	3,205	3,075	564	0	0	0	1,513
Total Flow	27,484	22,803	23,017	22,666	22,907	25,449	27,538	25,503	23,635	21,125	21,857
Minimum Obligations	27,305	25,811	25,876	25,871	25,982	26,013	25,197	23,684	22,850	22,638	23,263
Makeup Obligations Incurred	0	3,008	2,860	3,205	3,075	564	0	0	0	1,513	1,406
Cumulative Makeup Obligations	0	3,008	5,867	9,072	12,148	12,712	12,712	12,712	12,712	14,225	15,631
Status at End of Water Year											
Cumulative Obligation	276,000	299,000	322,000	345,000	368,000	391,000	414,000	437,000	460,000	483,000	506,000
Cumulative Flow	253,768	276,571	299,588	322,253	345,160	370,610	398,148	423,651	447,286	468,411	490,268
Net Cumulative Credit (Debit)	(22,232)	(22,429)	(22,412)	(22,747)	(22,840)	(20,390)	(15,852)	(13,349)	(12,714)	(14,589)	(15,732)
Minimum Obligation for Next Year	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400
Annual Minimum											
'+ 1/3 of Cumulative Debit	7,411	7,476	7,471	7,582	7,613	6,797	5,284	4,450	4,238	4,863	5,244
'+ Additional to reduce Cumulative Debit to Annual Obligation	0	0	0	0	0	0	0	0	0	0	0
Alternative Minimum[1]	—	---	---	---	—	---	—	---	—	—	—
Minimum Obligation for Next Year	25,811	25,876	25,871	25,982	26,013	25,197	23,684	22,850	22,638	23,263	23,644

1. Annual minimums minus cumulative credit, but not less than 15,000 acre-feet
2. Values from Draft 2014-15 Watermaster's Annual Report, Table 4-3

Table 5B
Status of Alto Subarea Obligations with Theoretical HDPP Diversions
Water Years 2004-05 Through 2014-15

Water Year	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15[2]
Average Annual Obligation in acre-feet	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000
Status at Beginning of Water Year											
Cumulative Obligation	253,000	276,000	299,000	322,000	345,000	368,000	391,000	414,000	437,000	460,000	483,000
Cumulative Flow	226,284	251,376	272,392	293,993	315,467	337,431	362,086	388,994	411,627	435,365	455,609
Net Cumulative Credit (Debit)	(26,716)	(24,624)	(26,608)	(28,007)	(29,533)	(30,569)	(28,914)	(25,006)	(25,373)	(24,635)	(27,391)
Flow During Water Year											
Base Flow	8,016	7,261	4,942	4,421	4,093	5,849	10,149	8,829	7,325	6,227	5,418
Subsurface Flow	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other Water - **VVWRA Total**	13,246	13,542	13,067	13,385	13,609	14,525	14,825	14,674	14,310	12,898	12,926
Maximum HDPP Diversion	**(2,392)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**	**(4,000)**
Makeup Water Purchased	4,222	2213	5,592	5,668	6,261	6,281	3,935	1,129	4,103	3,120	6,367
Total Flow	25,092	21,016	21,601	21,474	21,963	24,655	26,909	22,632	23,738	20,245	22,711
Minimum Obligations	27,305	26,608	27,269	27,736	28,244	28,590	28,038	26,735	26,858	26,612	27,530
Makeup Obligations Incurred	**2,213**	**5,592**	**5,668**	**6,261**	**6,281**	**3,935**	**1,129**	**4,103**	**3,120**	**6,367**	**4,819**
Cumulative Makeup Obligations	2,213	7,805	13,473	19,735	26,016	29,950	31,080	35,183	38,302	44,669	**49,489**
Status at End of Water Year											
Cumulative Obligation	276,000	299,000	322,000	345,000	368,000	391,000	414,000	437,000	460,000	483,000	506,000
Cumulative Flow	251,376	272,392	293,993	315,467	337,431	362,086	388,994	411,627	435,365	455,609	478,320
Net Cumulative Credit (Debit)	(24,624)	(26,608)	(28,007)	(29,533)	(30,569)	(28,914)	(25,006)	(25,373)	(24,635)	(27,391)	(27,680)
Minimum Obligation for Next Year	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400	18,400
Annual Minimum											
'+ 1/3 of Cumulative Debit	8,208	8,869	9,336	9,844	10,190	9,638	8,335	8,458	8,212	9,130	9,227
'+ Additional to reduce Cumulative	0	0	0	0	0	0	0	0	0	0	0
' Debit to Annual Obligation											
Alternative Minimum[1]	---	—	---	---	—	---	—	—	---	—	—
Minimum Obligation for Next Year	**26,608**	**27,269**	**27,736**	**28,244**	**28,590**	**28,038**	**26,735**	**26,858**	**26,612**	**27,530**	**27,627**

1. Annual minimums minus cumulative credit, but not less than 15,000 acre-feet
2. Values from Draft 2014-15 Watermaster's Annual Report, Table 4-3

APPENDIX A

DECLARATION OF KIT CUSTIS

I, Kit Custis, declare as follows:

1. I am presently employed by the California Department of Fish and Wildlife (CDFW) as a Senior Engineering Geologist and am a Retired Annuitant for CDFW.
2. A copy of my professional qualifications and experience is attached to my testimony.
3. The testimony on Water Resources for the High Desert Power Project (97-AFC-01C) was prepared by me and is based on my independent analysis, data from reliable sources, and my professional experience and knowledge.
4. It is my professional opinion that the prepared testimony is valid and accurate with respect to the issue addressed in my testimony.
5. I am personally familiar with the fact and conclusions presented in the testimony and if called as a witness could testify competently thereto.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct to the best of my knowledge and belief.

Dated: March 1, 2016 Signed: Kit H Custis

Kit H. Custis
Engineering Geologist, Hydrogeologist

Professional Experience

2007- present Senior Engineering Geologist, CA Dept. of Fish and Game, retired annuitant (DFG)
2008- present Engineering Geologist and Hydrogeologist, part-time, MBI-PMC, Davis, CA
2004-2006, Senior Engineering Geologist (Specialist), DOC-Office of Mine Reclamation (OMR)
1999-2004, Senior Engineering Geologist (Specialist), DOC-California Geological Survey (CGS)
1998, Engineering Geologist, Central Valley Regional Water Quality Control Board, Sacramento
1989-1998, Engineering Geologist, California Department of Conservation (DOC)
1988-1989, Engineering Geologist, Luhdorff and Scalmanini, Woodland, CA
1988, Hydrogeologist, Herzog Associates, Sacramento, CA
1984-1988, Sr. Engineering Geologist (Supervisory), California State Water Resources Control Board
1981-1983, Consulting Geologist, Los Angeles, CA
1980-1981, Engineering Geologist, Ertec Western, Inc., Long Beach, CA
1977-1979, Engineering Geologist, Foundation Engineering Co., Tarzana, CA

Education

B.S., Geology, 1977, California State University, Northridge, California
M.S., Geology, 1984, California State University, Northridge, California
Ph.D. program in Hydrologic Sciences, 1990-1997, University of California, Davis

Professional Licenses

California Professional Geologist, PG #3942
California Certified Engineering Geologist, CEG #1219
California Certified Hydrogeologist, CHG #254
Oregon Registered Geologist, G1099
Oregon Certified Engineering Geologist, E1099

Professional Experience

Thirty-eight years experience in engineering geology and hydrology, including ground water and surface water impacts, subterranean stream flow, ground water contamination, water resources, water rights, storm water pollution, fluvial studies of watersheds, mine reclamation, acid mine drainage, evaluation of slope stability, landslide hazards, seismic hazards, soil erosion, geophysical surveys. Work experience in both private consulting and government.

Projects included:

- California Department of Fish and Game, working as a retired annuitant on ground water issues related to water rights and 1600 permitting in California. Current and past projects include: Mammoth Creek, Big Sur River, Mojave River, North Gualala River, Shasta River, Salinas River, and various desert solar projects. Advise DFG staff at Fish Springs Hatchery in Owens Valley on ground water development and pumping impacts. Advise DFG regions on ground water contaminant issues related to property acquisitions for wildlife preserves. Testified for DFG at State Water Resource Control Board Water Rights hearings on Victor Valley Water Reclamation Authority's Mojave River diversion permit and North Gualala Water Company and El Sur Ranch on the Big Sur River regarding subterranean stream channel determination and impacts.

- Work part-time for Michael Baker International (formerly PMC) on mine reclamation and geologic elements of CEQA documents. Projects included conducting annual SMARA inspections and FACE reviews for Santa Clara and Siskiyou Counties. CEQA preparation of Coldstream Specific Plan, Town of Truckee, California, for development of 178+ acre previous aggregate mining site; Omya Limestone mine, Lucerne Valley, CEQA preparation for a revised reclamation plan.

- Stephen G. Muir, Consulting Geologist and Geophysicist, provide consultant services on ground water contamination investigations and cleanups, storm water permits, risk assessments, and regulatory compliance. Various projects throughout the San Joaquin Valley.

- California Department of Conservation, Office of Mine Reclamation, served 10 years in OMR providing technical expertise to Local Agencies and the SMGB on stability of mine slopes and hydrology on mines throughout California. Provided technical training to lead agencies on mine slope stability assessment methods and regulatory requirements. Provided expert testimony at County Planning Commissions, County Board of Supervisors, and State Mining and Geology Board.

- California Geological Survey formerly Division of Mines and Geology, conducted engineering geology studies and regulatory reviews for projects throughout California. Work included evaluation of geologic and seismic hazards studies for hospitals and school sites, general plans and seismic safety elements. Senior technical lead on fluvial geomorphic studies in the north coast of California as part of the multi-agency North Coast Watershed Assessment Program. Prepared a report for the U.S. Environmental Protection Agency on the application of geophysical methods to acid mine drainage investigations. Prepared a remediation plan to abate acid mine drainage from the abandoned Spenceville copper mine for the DFG. Lectured at the DFG's Watershed Academy on landslide and fluvial issues related to protection of waterways including bank stability and channel restoration methods.

- California Department of Parks and Recreation, Off-Highway Vehicle Division, while at CGS provided geotechnical expertise on erosion and sedimentation controls for trails and staging areas including assessment of storm water control measures.

- Herzog Associates, Sacramento, as staff geologist conducted geotechnical studies for slope stability and landslide potential at hillside home sites in Napa Valley, Phase I site assessments for property transfers and ground water resource assessments.

- Luhdorff and Scalmanini, Woodland, as staff hydrogeologist conducted hydrogeologic evaluations of ground water resources and potential for ground water contamination, water well design, oversight of Sacramento Area Water Works Association groundwater monitoring program, and development and design of data base and computer mapping applications.

- California State Water Resources Control Board and Central Valley Regional Water Quality Control Board, as a Senior Engineering Geologist developed a statewide ground water pollution management program, the AB1803 Follow-Up Program, which conducted investigations to find sources of known pollution of public drinking-water wells. As program director provided technical guidance for over fifty professional staff at the State and Regional Water Boards. At the Central Valley Regional Board case officer on 30 contaminated soil and groundwater site cleanups, prepared Waste Discharge Requirements and National Pollutant Discharge Elimination System permits, Monitoring and Reporting Programs and Cleanup and Abatement Orders.

- Earth Western, Long Beach, as staff engineering geologist conducted field mapping and site investigations for geologic and soils engineering studies in California, Arizona and Nevada. Projects include seismic and geologic hazard studies of major dams in Arizona, project geologist at Palos Verde Nuclear Project, MX missile project verification and aggregate resource studies in Nevada and Utah, and site geologist for hillside grading for Mission Viejo developments.

- Foundation Engineering, Inc., Tarzana, as staff engineering geologist conducted field mapping, subsurface investigations for geologic and soils engineering studies in the greater Los Angeles area. Projects included geotechnical studies for hillside home and tract development, assessment of slope stability and rock fall hazards, and Alquist-Priolo seismic safety studies.

Professional Affiliations

National Ground Water Association, Member
Association of Engineering Geologist, Member
California Groundwater Association, Member
American Geophysical Union, Member
Geological Society of America, Member

Papers and Publications

Custis, K., 2005-06, Slope Stability for Mined Lands, presentation as part of the Department of Conservation, Office of Mine Reclamation's Workshops for lead agency and mine operator staff on Preparation and Review of Reclamation Plans.

Fuller, M.S., Curless, J.M., Custis, K., and Purcell, M.G., 2004, Maps and GIS data for the Albion River Watershed, Mendocino County, California, Watershed Mapping Series, Map Set 8 CGS CD 2004-03 MAPS.

M.S. Fuller, W.D. Haydon, M.G. Purcell and K. Custis, 2002, GIS Data and Geologic Report for the Watershed Mapping Series, Map Set 5, Gualala River Watershed, Sonoma and Mendocino Counties, California, CGS CD 2002-08 MAPS.

Custis, Kit H., 2001, Digital Elevation Models: Uses and Challenges, in Managing California's Groundwater: *in* The Challenges of Quality and Quantity, 23rd Biennial Groundwater Conference and 10th Annual Meeting of the Groundwater Resources Association of California October 30-31, 2001, Radisson Hotel, Sacramento, California.

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staff, Department of Conservation, Office of Mine Reclamation.

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<u>Awards</u>

State Mining and Geology Board, 2006, Recognition of Distinguished Service to the Office of Mine Reclamation.

Governor's Environmental and Leadership Award, 2002, Watershed Management, Spenceville Wildlife Area and Mine Reclamation, Nevada County, received along with DFG and DOC team members and Walker and Associates consultants, project consultant.

Department of Fish and Game, Director's Achievement Award, 2002, for Cleanup and Closure of Spenceville Mine Site.