Buena Vista Water Storage District
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March 19, 2013

Bob Worl, Project Manager
Siting, Transmission and Environmental Protection Division
California Energy Commission
1516 Ninth Street, MS-15
Sacramento, CA 95814

RE: CEC Preliminary Water Supply Analysis - Hydrogen Energy of California

Dear Mr. Worl,

On behalf of Buena Vista Water Storage District, I would like to thank the California Energy Commission (CEC) staff for providing us the opportunity to discuss their Preliminary Water Supply Analysis for the Hydrogen Energy of California (HECA) project dated January 2013 and docketed on February 4, 2013. The Buena Vista Water Storage District (BVWSD) has managed the irrigation and drainage systems along with is water rights and ground water banking programs since its formation in 1924. The mission of BVWSD is to provide the landowners and water users of the District with a reliable, affordable, and usable water supply, while facilitating programs that protect and benefit the groundwater basin and better utilize water supply resources. The agreement that BVWSD has made with HECA to supply the water used by this project is just such a program.

The purpose of this letter is to provide BVWSD's response to the Preliminary Water Supply Analysis prepared by CEC staff. This Preliminary Analysis was the subject of a CEC Staff Workshop on February 20, 2013 on the HECA Amended Application for Certification. This response is in the form of two memorandum's prepared by district consultants. Dan Bartel, PE, was employed by the District for over 19 years prior to becoming its consultant and Bob Crewdson, PhD., has consulted to the district for 10 consecutive years.

I believe these papers succinctly state the BVWSD's position and analysis of the proposed project. BVWSD's consultants demonstrate that the BVWSD Buttonwillow Service Area (BSA) has an adequate supply of water to provide for the project needs. It is also the BVWSD's position that this project will benefit the groundwater basin.

BVWSD would like to host appropriate CEC staff on a site visit. We believe that a "boots on the ground" review of the project, district operations, records and ensuing discussions between CEC and BVWSD staff will provide a level of assurance with information being provided and BVWSD's commitment to fulfilling its mission to all the landowners. We hope that the CEC will allow the staff to join us prior to the issuance of the Preliminary Staff Assessment. If you have any questions about our response or the coordination of the site visit please contact me 661.324.1101 or Maurice@bvh2o.com.

Sincerely,

Maurice J. Etchechury
Engineer-Manager

Attachments: Robert Crewdson, PhD., memo
GEI Dan Bartel, PE., memo

Cc: Karen Douglas, Commissioner & Presiding Member California Energy Commission Media and Public Communications Office
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Geotechnical
Environmental
Water Resources
Ecological

GEI Consultants

Memorandum

To: Maurice Etchechury (BVWSD)

From: Dan Bartel, P.E.

Date: March 18, 2013

Re: Review of CEC Preliminary Water Supply Analysis - HECA

Background: The Buena Vista Water Storage District's (BVWSD) Brackish Groundwater Remediation Project (BGRP) was designed to address two groundwater issues that the local groundwater management agency currently faces as shown on Attachment 1 from the CEC's Preliminary Water Supply Analysis, dated January 2013 and docketed on February 4, 2013.

> Target Area A – with its extremely shallow groundwater of 4 to 14 feet below ground surface (BGS) (Attachment 2) and total dissolved solids (TDS) of largely 1,500 milligrams per liter (mg/L) (Attachment 3) was designed to draw water levels down below the crop root zone to improve agricultural land productivity.
>
> Target Area B – with its deeper groundwater of 40-90 feet BGS (Attachment 4) and brackish groundwater intrusion from the west was designed to improve local groundwater quality for its pumpers by intercepting and removing the highest TDS water of 2,000-4,000 mg/L (Attachment 5) similar to that of picket fence seawater intrusion programs developed in coastal areas.

The HECA Project will have a beneficial impact on water resources of the BVWSD Buttonwillow Service Area (BSA) when coupled with the implementation of BGRP. The BGRP was envisioned long before the HECA Project came along and its implementation is only possible if someone can remove the water out of the local system. By implementing the BGRP Target Area B, there will be water resource benefits to the State, the basin, and the Landowners of BVWSD. In developing the BGRP Target Area B the BVWSD has:

1. Specifically sought to develop a sustainable, reliable, and proven method of improving local groundwater conditions for landowners.

2. The potential to create beneficial impacts to the local aquifer system that are real, significant, and desirable by the landowners.

3. Determined that the drawdown impacts are, by analogy, similar (or even less than) to the drawdown impacts of the other 200+ agricultural wells in the area, which quickly recover, are limited in areal extent, and are acceptable to BVWSD and the landowners.

CEC staff has developed an independent analysis of the BGRP. Unfortunately they did not have the benefit of much of the data and background information available at BVWSD which was readily available. Below are the CEC five findings of concern along with comments which are based on our local knowledge of the groundwater basin issues and management projects designed to address said issues. Note that this effort does not attempt to address groundwater model parameters as that topic is left to hydrogeologists.

1. ***The project pumping could result in well interference and lower water levels in neighboring wells.***

The centroid of the proposed BGRP/HECA Area B well field assumed in the CEC groundwater model is approximately 1/3 mile east of the actual proposed location. This is in part associated with the scale of 2009 figures that did not show the most precise location of the proposed well field and early uncertainties associated with land access to the proposed well locations. As the project has evolved the Target Area B wells are anticipated to be placed directly adjacent to the West Side Canal, not as shown on CEC Figure 7 (Attachment 6). For this reason URS did not call out drawdowns at specific wells, keeping drawdowns focused on distances from the center of the well field (1/4 mile, 1/2 mile, etc. from the well field). The CEC reported drawdowns at specific wells which is somewhat erroneous because the pumping center is ~1/3 mile east of where it is intended to be. In addition, and in review of CEC Figure 3 it is vital to mention that many of the wells reported on the map and likewise accounted for on CEC Table 3 either no longer exist or are actually shallow 20-foot deep piezometers used for shallow groundwater monitoring purposes only. As such we have completed a revised Figure 3 (see Attachment 7) and Table 3 (see Attachment 8), with the inappropriate wells removed and the drawdown projections spatially corrected. Upon doing so we found that the worst case reported by the CEC model (drawdowns of 5.1 feet up to 34.2 feet with 13 wells exceeding a 15-foot threshold) was reduced to drawdowns of 4.8 feet to 21.0 feet and 5 wells with drawdowns exceeding 15 feet. The other three model runs on Attachment 8 indicate only up to one well would have a drawdown greater than 15 feet. By adjusting the centroid to the west, the resultant drawdowns would be similar or less than those reported as not significant in the BVWSD FEIR. In addition, the portion of Target Area A that overlaps that of Target Area B would serve to be beneficial as the water table was lowered due to BGRP/HECA well field pumping. As such, drawdown in the overlapping portions of Target Areas A and B would be a benefit rather than an impact.

CEC Staff did not consider BVWSD significance findings and instead determined that a 15-foot threshold would be applicable because it comes from the Semitropic Water Storage District (SWSD) Banking Project Memorandum of Understanding (MOU) immediately to the east of the BVWSD BSA. As such, CEC staff has to some extent misinterpreted the threshold (language included as Attachment 9). GEI, particularly this office, helped develop and has administered the SWSD impact criteria for nearly 20 years. It is important that CEC staff understand that this referenced threshold has been applied between the public agencies at their respective political boundaries and when applied within the SWSD a pumping cone of depression does NOT qualify within the definition of "average groundwater levels within such area". SWSD instead employs the 15-foot standard over a very wide area and employs different point specific mitigation measures to address drawdown/well interference impacts. Applying the 15-foot rule to

BGRP Target Area B is like comparing apples with oranges in that the SWSD project is drastically different than the BGRP. Typical depth to groundwater in the BGRP Target B area is 60 feet BGS unlike in SWSD which is 200+ feet BGS. In the BGRP Target B area the aquifer system is considered to behave as unconfined and semiconfined. In the SWSD the aquifer system is considered to be confined and has been mapped accordingly by multiple entities and professionals. A groundwater level impact of 5-20 feet over 25 years, given the typical well construction and shallow nature would not measurably impact flow and would have a minimal impact on increased energy costs.

Throughout the development of the BGRP, it was envisioned that in-lieu of developing a well by well specific threshold the BVWSD would monitor and operate the project via its existing MOU Regarding Operation and Monitoring of the BVWSD Groundwater Banking Program which was an exhibit to the FEIR.

Upon development of the BGRP, BVWSD would modify their groundwater monitoring plan accordingly, just as it does from time to time given changes to the Groundwater Recharge and Recovery Project. BVWSD would collect and provide data, review potential concerns, modify operations, and/or mitigate impacts accordingly. Due to the large number of groundwater banking projects in the local area the local agencies have become proficient at managing these projects while cooperating via regional groundwater committees.

2. ***The proposed industrial supply wells may induce the inflow of relatively poor quality groundwater into a zone of relatively higher water quality within the water-supply aquifer beneath the Buttonwillow Service Area.***

The conclusions relative to potential water quality impacts are largely driven by the use of extremely old groundwater data collected from as early as 1961 as shown on CEC Figure 12 (Attachment 10). The data is valuable in that it depicts what the groundwater conditions were 50+ years ago but should not be confused with current conditions as shown in URS Figure 14-1 (Attachment 11). The local pumpers have documented, by the progressive replacement of their wells from west to the east, the degradation water quality over time on the west side of the BSA. CEC staff appears to incorrectly assume the 1961 data to be current and uses it within blending models to support their position. In regards to a proper environmental analysis we are required to use the most current data available as relying on such outdated data is not consistent with the legal requirements of CEQA. CEC staff has produced figures depicting groundwater contours created by BVWSD and has used this outdated data to discount the validity of said BVWSD information. Contour maps produced by BVWSD were created using the most comprehensive data available with a prioritization of using current data over older data when available. Historically the BVWSD has only published general water quality information so as to protect its ability to collect private data for such purposes. BVWSD could potentially provide said background site specific data to the CEC given confidentiality assurances.

The other issue considered to be of concern to CEC staff is the upward movement from deeper more brackish water near the base of fresh water. The FEIR, describes the pumping zone as generally between 200-700 foot BGS. CEC staff has assumed that the BGRP wells will be completed throughout that interval. The wells will however likely be completed in a much narrower interval, targeting the most brackish groundwater encountered upon construction. As we have and are learning more about the system we expect wells to be completed in a more narrow interval of about 150-350 feet BGS, but this will be based on exploratory boring and test well specific information. As part of the project development BVWSD will drill pilot test holes down to as deep as 1000 feet BGS and perform zone testing so as to identify the optimal screened interval placements that maximize removal of brackish water. It is anticipated that this portion of the BGRP will remove approximately 25,000 tons per year of salt from the aquifer system (if TDS concentrations average 2,500 mg/L at a BGRP/HECA well field pumping rate of 7,427 acre feet per year.

3. ***The project's pumping could exacerbate overdraft in the Kern County subbasin.***

According to BVWSD water diversion records, 1.7M acre-feet (44k acre-feet per year average) has been stored from 1970-2010 (see BVWSD Water Balance Table – Attachment 12) in various portions of the Kern Subbasin (see BVWSD Groundwater Projects Map – Attachment 13). Independent of brackish groundwater intrusion from the west BVWSD has stored and is forecasted to be able to supply HECA's demand from the BGRP. The Buttonwillow Subbasin is mostly distinct from the balance of the Kern Subbasin relative to subsurface structures and is shown on CEC Figure 1 (Attachment 14). The Kern Subbasin has been characterized as in overdraft but the Buttonwillow Subbasin clearly is not and contributes and consumes very little if any from the balance of the Kern Subbasin. While the specific yield and storativity numbers will be debated by hydrogeologists, the water has been recharged and is available from the various projects in various subbasins for use in the Buttonwillow Service Area which has experienced rising water levels for decades, in some cases approaching the surface, as depicted on CEC Figure 19 (Attachment 15). Attachment 16 (1994 Water Level Elevation) and Attachment 17 (2009 Water Level Elevation) further illustrate the hydraulic separation of the Buttonwillow Subbasin (including the BSA) from other Kern subbasins to the east. These figures indicate that the anticline that runs along Interstate 5, is acting as a barrier to groundwater flow as water level elevation contours are stacking up on the west or BSA side of the barrier, with adjacent water level elevation contours east of the anticline exhibiting a pronounced drawdown in response to local groundwater pumping in those eastern subbasins.

It is also noteworthy that the HECA project site will remove 453 acres from agricultural production. Aside from the economic impact discussion, this will result in a reduction in groundwater pumping to fulfill local irrigation demands. Per the water acquisition agreement with BVWSD, HECA waived its water service rights and groundwater rights for use on the project site. Those relinquished service rights, which average about 1.8 acre-feet per acre (453 acres x 1.8 acre-feet per acre per assessed acre = 815 acre-feet per year), will then be available to the other BVWSD landowners thus reducing their need to access other groundwater supplies in BVWSD. Because HECA has also relinquished its groundwater rights, an average of 335 acre-feet per year less groundwater pumping would occur from the project site which represents the deepest groundwater levels in the BSA, considering the 2011 BVWSD average consumptive use of 2.79 acre-feet per farmable acre. By removing irrigated agriculture from the site an annual irrigation demand of approximately 1,150 acre-feet per year will be replaced by the HECA plant demand of 7,500 acre-feet (net of 6,350 acre-feet). Historically BVWSD has added 44,000 acre-feet per year to the Kern Subbasin. The added demand of 6,350 acre-feet per year is well within BVWSD's ability to adequately provide.

4. ***The project pumping could reverse local water level increases and increase the threat to the California Aqueduct from subsidence.***

We expect that due to the BGRP/HECA pumping, that rising water levels will stabilize or reverse as shown in the modeling efforts in areas near the well field. Drawdowns are expected to be minimal (regardless of which model one chooses) in comparison to water level declines experienced in confined zones notorious for subsidence. Attachment 18 has been revised to include subsidence contours from CEC Figure 20 which depict areas of concern more than 20 miles from the well field and within separate subbasins. It is also noteworthy to point out that large recharge and recovery cycles (200,000+ acre-feet per year) that occur relative to the Kern Fan banking projects have only produced changes of +or- 0.02 feet (CEC Figure 21- see Attachment 19). It will take this portion of the BGRP more than 25 years to do what the Kern Fan projects can do in less than one.

Subsidence along the nearby portion of the Aqueduct has been well documented and is associated with shallow hydrocompaction which is completely different from subsidence in response to groundwater pumping. The BGRP/HECA well field area of the BSA does not exhibit geologic conditions (lacking in laterally thick and extensive aquitard like deposits) that would be subject to subsidence from groundwater pumping, nor has it experienced any subsidence associated with groundwater pumping in the BSA 200+ well field. DWR Bulletin 200 (portion included as Attachment 20) discusses the hydrocompaction issue and how it was accommodated for in the design elements of the Aqueduct. CEC staff reports that a one foot subsidence has already occurred since 1970. According to DWR Bulletin 200 80-90% of the hydrocompaction issues were resolved by pre-consolidation efforts and that they would expect 1-2 feet of additional subsidence over time. As such, the design engineers' predictions were accurate.

We have met with DWR staff and discussed the issue. Even though subsidence associated with BGRP/HECA groundwater pumping is remote at best, the BVWSD could consider including a subsidence monitoring component within its monitoring and reporting plan. The program could include extensometers or benchmarks and surveys at both the well field site and the Aqueduct to ensure the issue is monitored.

5. ***The project use of the proposed water supply may not be consistent with Energy Commission and other state water policies.***

CEC staff has concluded that well field production TDS is expected to be in the 945 to 3,730 mg/L range. The low range estimate is based on 50 year old data and does not properly reflect the conditions that exist today, as discussed above. Based on much more recent data we expect that well field production will likely produce water in the 2,000 to 4,000 mg/L range (see Attachment 11 - URS Figure 14-1). CEC staff and interveners are concerned that while this water is brackish, it is not brackish enough relative to certain state policies and could be used by the adjacent agricultural entities as an irrigation supply. The BGRP is designed to have a positive impact on groundwater quality within the basin which is extremely important to the local pumpers who do use, and will continue to use this as a backup supply. The BGRP will not inhibit this practice in that water levels will still be extremely shallow and accessible even with the project. According to the same authors cited by CEC staff, there is a vast and available water supply of 150,000 acre-feet per year that the BGRP seeks to tap into (see conclusions as Attachment 21). The BGRP Target Area B is focused on the worst local quality groundwater with the intent of intercepting and removing it as a means of improving groundwater quality conditions experienced by the adjacent pumpers.

Miles west of the proposed BGRP/HECA well field, farmers are carefully managing brackish groundwater supplies along with state water supplies for pistachio production. The site conditions on those test plots are however very different from that in the northern portion of the BSA. The test plots enjoy soils with a much higher ability to leach salts than the Buttonwillow and Lokern clays in the BSA. Likewise the test plots far west of the well field have much thicker unsaturated zone to store or adsorb the leached salts while the BGRP areas do not. Irrigating on a routine basis with 3,000 mg/L water in the BSA will quickly degrade soils, agricultural production, and groundwater quality that is already extremely fragile. Use of 3,000 mg/L water in the BSA is not a sustainable practice and is not consistent with BVWSD's goals of improving those fragile conditions. Before beginning any such practice, GEI highly suggests consultation with Blake Sanden (Co-Author and Kern County Irrigation and Agronomy Farm Advisor) who is involved with said test plots and is aware of the BGRP and the remediation objectives behind it.

CEC cited state policies that seek to protect water of 3,000 mg/L while the local agency is seeking to protect and improve water of 1,500 mg/L for its local pumpers. This improvement of groundwater quality is intended to help local farmers to improve crop diversity and production. CEC should consider both state policies and local management planning and when faced with unique situations should give deference to local efforts which are most equipped to solve local issues. BVWSD has submitted previous comments relative to state and local policy issues which are attached hereto as Attachment 22.

BVWSD has offered a portion of Target Area B to HECA. Target Area A offers much better water quality and is distributed over a larger area which could be more suited and accessible to an in-district blending water supply program than Target Area B. In addition BVWSD is considering the Northern Area Pipeline Project (Concept Drawing included as Attachment 23) which would eliminate the BGRP Target Area A project all together by drastically reducing canal seepage and when combined with irrigation system changes has been modeled to solve the shallow perching issue with a wider range of benefits, reduced energy costs, and is more consistent with state water use efficiency goals.

Attachments:

1. CEC Preliminary Water Supply Analysis Figure 2 - Brackish Groundwater Remediation Project
2. BVWSD Figure 1 – Map Showing Contours of Depth to Groundwater in Perched Zone (in feet)
3. CEC Preliminary Water Supply Analysis Figure 10 – Map Showing TDS Concentrations in samples from shallow and unknown depth wells and reported concentration contours for the shallow perched aquifer
4. BVWSD Figure 2 – Map Showing Contours of Depth to Water Level Pumping Zone (in feet)
5. CEC Preliminary Water Supply Analysis Figure 8 – Map Showing TDS Concentrations in samples from deep and unknown depth wells and reported 1970-2007 composite TDS concentration contours for the pumped groundwater zone
6. CEC Preliminary Water Supply Analysis Figure 7 – Simulated 25-year drawdown from staff modified model including reduced storativity (0.007) and anisotropy increased to 1,000
7. CEC Preliminary Water Supply Analysis Figure 3 (modified by GEI) – Selected existing wells and proposed well field. BSA of BVWSD
8. CEC Preliminary Water Supply Analysis Table 3 (modified by GEI) – drawdown at select well locations simulated by applicants model and three modified models
9. SWSD Figure 1 – MOU Regarding the Operation and Monitoring of the SWSD Groundwater Banking Project
10. CEC Preliminary Water Supply Analysis Figure 12 – Map showing reported depth to the base of freshwater and TDS concentrations in samples from deep and unknown depth wells
11. CEC Preliminary Water Supply Analysis Figure 14 (revised by GEI) – Conceptual Illustration of up-coning beneath partially penetrating water supply wells
12. BVWSD Water Balance Table
13. BVWSD Groundwater Projects Map
14. CEC Preliminary Water Supply Analysis Figure 1- Kern Water Districts and Subbasins

15. CEC Preliminary Water Supply Analysis Figure 19 – Water level locations and trends in the BSA 1974 – 2001
16. BVWSD Figure – 1994 Water Level Elevations
17. BVWSD Figure – 2009 Water Level Elevations
18. CEC Preliminary Water Supply Analysis Figure 1(modified by GEI - Kern Water Districts and Subbasins and Locations of Historic Subsidence Areas
19. CEC Preliminary Water Supply Analysis Figure 21- Water level changes in wells and observed aquifer compaction at the Kern Water Bank extensometer
20. California Department of Water Resources – California State Water Project – Volume II Conveyance Facilities – Bulletin November 1974 – Portions of text relative to subsidence and hydrocompaction
21. V.- Conclusions and Practical Application – Sandon
22. BVWSD letter dated November 10, 2010 to Mr. Rod Jones (CEC) – Statement in Support of Hydrogen Energy California Power Plant Project's Proposed Use of BVWSD Brackish Groundwater (CEC Docket No. 08-AFC-8)
23. BVWSD Conceptual Pipeline System 6-7-12 East/West Balanced Design

Robert A. Crewdson, Ph.D.
Groundwater Hydrogeologist

MEMORANDUM.

To: Maurice Etchechury ←
Manager - Buena Vista Water Storage District

David Hampton ←
Engineer - BVWSD

From: R. Crewdson
Date: 18 March, 2013

Subject: Comments on the CEC Preliminary Water Supply Analysis of January, 2012, authored by Mike Conway, John Fio, and Steve Deverel, in regard to the BVWSD proposed well field and water supply for the HECA power plant project.

Hello Maurice,

At your request, I am providing my comments on the Preliminary Water Supply Analysis Report (referred to herein as the PWSA or the CEC Report). My representation of the CEC's position, even where abbreviated for the simple purpose of being concise, is based on a careful reading of their report, coupled with my record of the CEC Staff comments and clarifications which were presented at the 2/20/13 Workshop. In the Discussion below, I have organized my comments in the same general order as the findings in the CEC Report.

Summary.

<u>CEC Report findings.</u> The CEC Report presents five preliminary findings which include concerns for potential ground subsidence, three types of groundwater impacts, and compliance with state policies. The CEC staff analysis also identifies several concerns requiring further review including: the reasonableness of water use, its suitability for other potential uses, the reclamation/ remediation value of the project, and the existence of preferable and/or insufficiently- evaluated alternative water sources. (PWSA, p. 6.9 29 - 30)

<u>Opinion.</u> I am in substantial agreement with the CEC methods and principles of analysis and I acknowledge the CEC's general thoroughness in preparing their evaluation, including their efforts to fill some data gaps. However, in my opinion, some of the CEC's numerical results, particularly the CEC's projected well field TDS, analysis of potential interzonal flow, and estimates of groundwater storage capacity, would have been different if they had used more- representative aquifer parameters and more- recent water level/water quality/water balance data that are available from the district.

BVWSD reported the availability of such data at the CEC workshop of 2/20/13 and, furthermore, BVWSD presented perspectives, mitigations, and additional lines of reasoning as part of its local- water- agency compliance policies that are not reflected in the January, 2013 CEC Report.

Based on my review, I conclude that:

1. The CEC preliminary evaluation is incomplete or inaccurate in a number of points, as detailed in the Discussion.
2. If the CEC were to incorporate the district's additional input data, then the revised project-impact analyses and findings would:
    a. have significantly lower uncertainty than the CEC's preliminary analyses, and
    b. be in much better compliance with the CEC's significance criteria and water policies.

Based on my understanding of the CEC's desire for a further review of issues like the reasonableness of water use, other beneficial uses, and the remediation value of the project, I conclude that:

3. The BVWSD's explanations of local agency policies and principles of analysis, as introduced at the 2/20/13 workshop, would clear up many of the CEC's preliminary reservations about the well field, and
4. The CEC analysis would be significantly more complete if they included a full evaluation of the local- water- agency perspectives and lines of reasoning that were not included in the January, 2013 Report.

I present the basis for my conclusions in the Discussion section below.

Recommendations.

I recommend that the district staff offer to meet with the CEC staff and discuss the data gaps, differences , and compliance policy issues as summarized above.

Discussion.

The CEC Report presents five preliminary findings with a clear line of reasoning and associated compliance criteria related to the proposed BVWSD well field and water supply for the HECA power plant. The findings included concerns for potential ground subsidence, three types of groundwater impacts, and compliance with state policies. (PWSA, pp. 6.9 1 - 3)

In addition, the CEC staff analysis also includes several additional preliminary compliance determinations, some proposed for further review, regarding the volume and reasonableness of water use, the suitability of the water supply for other beneficial uses, the reclamation/remediation value of the project, the existence of preferable and/or insufficiently- evaluated alternative water sources, and the requirement to limit groundwater withdrawal to be no greater than the verified [historical] increase in storage within the BSA. (PWSA, p. 6.9 29 - 30)

Potential impact 1. Water level changes and well interference.

CEC Findings. The CEC staff predicted the well field water- level- changes caused by the proposed well field by using a modified version of the URS-prepared ModFlow computer program. The CEC accepted the URS model grid, model layers, simulation period and stresses, well- depths, and value of K_H. The CEC model eliminated recharge, changed the URS boundary conditions, and changed the aquifer condition from unconfined to confined. The CEC made corresponding changes to the K_H/K_V ratio and the aquifer storage coefficient.

The CEC computed and illustrated (PWSA, S&W Figures 5 - 7)[1] the hypothetical water level drawdowns that would exist after 25 years of continuous well- field pumping at a rate of 7,500 af/y under the assumption of no compensating groundwater recharge over the entire period. This scenario is equivalent to removing 187,500 af of groundwater from the aquifer, and the drawdown contour map represents the conical void space that would be present within the zone of impact after 25 years of pumping, diminished by the natural lateral groundwater inflow from the sides but not by any deliberate recharge or canal seepage losses. The CEC applied a 15-ft drawdown threshold to help quantify the significance of the drawdown impacts on nearby wells.

RAC Comments.

1. Modifications. The CEC willingness to modify and improve the URS model is acceptable.

2. Conceptualization. The CEC does not present a cross- sectional diagram of their model conceptualization of the groundwater aquifer, so I cannot verify from their written description alone whether or not their model is an acceptable representation of the hydrogeological conditions under the district. However, I conclude from my understanding of the text of the CEC Report that the CEC model is an incorrect conceptualization in regard to the placement of layers and layer boundaries, the placement of screened intervals, the boundaries used to calculate upward fluxes, and the assignment of hydraulic conductivities in violation of the equivalence principle.

3. Recharge. In the original URS drawdown model, the hypothetical, calculated drawdown impacts are diminished somewhat by the compensating effects of a certain amount of annual groundwater recharge applied across a designated portion of the project area. In contrast, the CEC Report maintains that the hypothetical, calculated drawdown impacts should not be reduced by any compensating recharge because *"The source of the 'new' water was not identified as part of the project description, and therefore Staff concluded recharge is incorrectly specified in the model"* (PWSA, p. 6.9-13) A discussion arose at the 2/20/13 CEC Workshop between URS staff and the CEC staff on the issue, which remained unresolved.

   The elimination of recharge simplifies the analysis so that it shows only the isolated net impact of the well field, which I accept on that basis. But this CEC model scenario clearly does not

[1] The 3 maps represent 3 different combinations of model assumptions, as noted on the maps.

represent all of the physical water- flow processes that will be taking place within the zone of impact during the 25 years of pumping which the CEC recognizes[2] and, therefore, the CEC drawdown contour maps do not actually represent the water levels or well impacts that will exist at the end of the pumping period. I conclude that the CEC preliminary modeling has not yet gone far enough in the representation of actual, expected operations and water level impacts to make any policy determination about the actual, observable, potentially mitigatable water level impacts of the project well field on non- district wells in the area.

4. Boundary conditions. The CEC conceptualization which requires the placement of no- flow boundaries 6 miles west, 5 miles north, 17 miles south, and unspecified miles east of the well field[3] is acceptable. However, the final drawdown contour maps do not reflect these changes to the model construction. The CEC 25-year water level drawdown maps (PWSA, S&W Figures 5 - 7) show the expected no-flow water level behavior only on the west boundary, but not at the north and east boundary locations (the maps do not extend far enough south to show the south boundary. I conclude that the discrepancies between the preliminary text and figures need to be addressed in such a way that both the conceptualization and the final calculated/ illustrated results agree with the district conditions.

5. Storage coefficient. The CEC model conceptualization (PWSA, p. 6.9-11) does not correctly represent the aquifer in the project area. The drawdowns from local wells which are completed in varying intervals down to about 600 ft respond as if completed in an unconfined aquifer, so this is the representation that the model should provide. From theoretical considerations alone, the late-time behavior of the modeled wells should be a function of gravity drainage governed by specific yield (Sy) and not a function of elastic release governed by specific storage (Ss), especialy after 25 years of continuous pumping. Although the CEC staff has not explained how the ModFlow simulator incorporates storage constants into the calculation, I conclude that the staff's representation that *"storativity should therefore be utilized to represent storage properties of the pumped aquifer"* (PWSA, p. 6.9-11) is inapplicable to the project area and should be corrected.

6. Significance. The CEC staff apply and defend their choice of a 15-ft exceedance threshold to determine impact significance, which I accept. BVWSD staff pointed out at the 2/20/13 CEC Workshop that BVWSD, like other local water agencies, have established different exceedance thresholds/ mitigation policies according to their own local criteria, which have been voted on and approved by local landowners and/or their district board representatives. In other words, the CEC Report has applied a CEC- rationalized exceedance threshold that the local water agency disagrees with. I recommend that the CEC modify their Report to include a significance analysis for each potentially applicable exceedance threshold in the project area. The CEC Report has already established the precedence for using multiple analyses in their choice of four (4) different methods of determining the estimated TDS concentrations of the well field water

[2] *"Actual water level changes and volumetric fluxes will be the net result of multiple recharge and discharge processes occurring in the basin and can therefore be quite different from the model results."* (PWSA, p. 6.9-17)

[3] CEC Report, Staff Recommended Changes to Model Construction, p. 6.9-11.

supply. I recommend that the CEC then discuss the multiple drawdown findings within the context of the local issues which are unique to this project, recognizing that the state- chartered local water district is in favor of the project and operates according to landowner- derived directions.

Potential impact 2. Aquifer water quality degradation due to interzonal flow.

<u>CEC Findings.</u> The CEC Report speculates that if a number of unknown/unverified conditions were to exist in the project area, that the well field may possibly cause water quality degradation within the aquifer zone that the well field is designed to improve. This degradation is theorized to come from pumping- induced upconing of poorer quality water into the producing zone. The CEC Report speculates that the groundwater in the target aquifer above a depth of about 700 feet is separated by a permeable boundary from poorer- quality groundwater of both higher-TDS and different general mineral chemistry below a depth of about 700 ft. The CEC conceptualizes the boundary between the reported upper and lower waters to be just as transmissive as the upper aquifer itself.

The CEC finds that upconing could potentially add 13,200 tons of salt per year to the target aquifer under their base case assumptions and that the groundwater may shift from calcium- sulfate to sodium- chloride dominated water, which could reportedly result in significant impacts to other, unidentified, beneficial uses.

<u>RAC Comments.</u>

1. Misrepresentation. In an uncharacteristically poorly- worded description, the CEC acknowledges (PWSA, p. 6.9-21) but obfuscates the fact that all of the hypothetically- upconed tons of salt load will actually be extracted by the well field, leaving no additional salt in the producing zone except for the last, small, transient, portion of salt that remains in the producing zone when the wells are turned off after 25 years of operation. The vague CEC wording implies that hundreds of thousands of tons of salt may accumulate in the producing zone over the 25-year pumping period under this scenario. Therefore, I conclude that the complete mass transport and all of the calculated impacts of the hypothetical CEC upconing scenario need to be more fully- and more accurately- described.

2. Salt loading. The CEC resorts to talking about salt- loading rather than changes in salinity because it sounds bad. The CEC Report ignores the fact that even if the upconing took place as theorized, there would still be a net improvement in the aquifer salt balance due to the removal of many more tons of salt through the well field operation than brought in by upconing. I conclude that the description of the salt loading analysis under the hypothetical upconing scenario is inaccurate and incomplete.

3. Anisotropy. Based on fundamental theoretical principles, the CEC model placement of partially- penetrating wells within an extremely anisotropic medium is not equivalent to-, and

will not provide the same computed results as- a more representative layered- aquifer model with alternating layers of high and low conductivity and stratification of water chemistries, in the calculation of upconing and the percentage of yield coming from below the perforations, among other things. I conclude that the CEC model conceptualization is radically incorrect in this regard and has resulted in incorrect calculations of flow behavior and volumetrics under their scenario of hypothetical upconing.

4. Field experience. Based on the district's experience with approximately 200 water wells in the Buttonwillow Service Area, there is no recorded evidence of pumping wells which have experienced salt water breakthrough which could be interpreted as the result of upconing. Based on preliminary geological investigations which are still in progress, the district geologists conclude that a clayey layer exists in the depth range of 450 - 700 ft which acts as a barrier to vertical interzonal flow between the target aquifer and the underlying waters of the basin. I conclude that the CEC model conceptualization is inconsistent with the known hydrogeology of the project area and needs to be revised.

5. Questionable validity. Despite the highly speculative nature of the CEC's model assumptions and line of reasoning, the CEC Report asserts that *"This change in water quality could result in significant impacts to other reasonable beneficial uses[4]"*. In addition to the significant possibility that upconing will not even occur, the CEC report fails to substantiate whether or not other beneficial uses of the water even exist within the project area, upon which the impact significance is based.

I conclude that this speculative scenario has been incorrectly modeled, incorrectly described, and has been found significant with respect to possible alternate uses of the water that have not even been identified to exist. In my opinion, this CEC preliminary finding is purely hypothetical in its current form and lacks the necessary corroborations of the assumptions, conceptualizations, and impacts to be used as a project evaluation criterion at this time, and should be revised.

Potential impact 3. Worsening of basin overdraft.

<u>CEC Findings.</u> The CEC Report promulgates the principle that increases in storage in the basin may be used to "offset" the well field extraction volume on an acre-ft for acre-ft basis. The CEC Report theorizes that if the volume of proposed project pumping were to exceed the volumetric increase in storage, then such pumping in excess of the offset would worsen the apparent overdraft in the main basin. The CEC Report finds that the proposed 7,500 af/y groundwater extraction exceeds the observed, long- term, 4,600 - 6,100 af/y, average annual net increase in groundwater storage, which the CEC estimated from long- term, district- wide, water level rises. The CEC Report concludes that the appropriate mitigation would be to limit the extraction, stating that *"Reasonable groundwater withdrawal from within the BSA should be limited to the verified increase in storage within the BSA, between 4,600 to 6,100*

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[4] CEC Report, page 6.9-21.

af/y." (PWSA, p. 6.9-29)

At the 2/20/13 CEC Workshop the CEC staff appeared to contradict their own report by claiming that water stored in the basin under the Buttonwillow Service Area could not be used to offset the annual well field extraction volume. The CEC explained at the workshop that the existing pre-project baseline condition already includes the historical recharges of surplus water to the basin, so that the Project needs to come up with a new, additional source of 7,500 af/y water supply to compensate for the proposed groundwater extraction. (See Potential Impact 1., RAC Comment 3, 2nd paragraph.) In other words, the CEC Staff argued that the full 7,500 af/y of well field extraction would worsen the basin overdraft unless 7,500 af/y of new groundwater recharge over and above the existing historical trend was added to the basin in compensation.

<u>RAC Comments.</u>

The overdraft issue is a policy issue with little or nothing to do with groundwater impacts.

1. Offset principle. The CEC Report "offset" principle is consistent with the BVWSD position that it has a right to use its own historical and/or ongoing surplus water to "fund" a district water project like the proposed well field. BVWSD owns a pre-1914 water right to a substantial volume of Kern River water and BVWSD annually purchases a significant volume of SWP water. The district has stored and continues to store waters from both sources in the groundwater basin for in- district future use and claims a right to recover those waters for its appropriate use. The proposed well field extraction of 7,500 af/y constitutes the recovery of stored district waters which it has previously acquired either by right or by purchase, and does not constitute a taking of native groundwater. I conclude that the recovery of previously banked water cannot reasonably be argued to contribute in any way to overdraft, so with respect to this district project, the CEC has inappropriately used the overdraft issue as a compliance criterion and I conclude that it should be eliminated from this evaluation.

2. New offsets. Based on the foregoing, I disagree with the CEC position which the CEC Staff offered at the Workshop. That position was originally voiced as an objection to using recharge to lessen the drawdown impacts and appears to have been misapplied to the overdraft issue by CEC Staff during the discussions at the workshop in contradiction to the CEC Report. I conclude that there is no basis for reinterpreting or revising the offset principle as the appropriate mechanism for evaluating compensating impacts as presented in the CEC Report.

3. Long- term change in aquifer storage. The CEC Report finding that the net long-term change in storage is +4,600 to +6,100 af/y based on water level records is acceptable.

4. District water in storage. Based on the district's water delivery records, the historical average annual recharge of surplus district water in the Buttonwillow Service Area is about 30,000 af/y. There is no discrepancy between the 30,000 af/y and the +4,600 to +6,100 af/y because they are both correct measures of two different quantities. A discrepancy exists only if the CEC intended to represent the long- term change in aquifer storage as being the same as the long- term recharge rate of surplus district water. The difference between the two quantities is

accounted for by other gains and losses to the aquifer water balance that the CEC did not describe or include in their analysis. Because of significant lateral outflows from the district boundaries, the long- term net gain in aquifer storage within the district's boundaries and corresponding average water level rise is less than would be observed if all of the district water placed into aquifer storage remained within the district boundaries. Since groundwater is treated as a fungible commodity, the district can remove a like- amount of water from the basin without having to chase the exact molecules of water that it put in.

5. Overdraft. The CEC Report uses the net change in aquifer storage as its well field pumping cap, whereas the BVWSD uses the volume of district water in storage as its well field pumping cap. In the Kern County subbasin, every water district subscribes to the principle that the district's water in storage, not the behavior of the district's water table, is what governs the availability of project water and/or the calculation of overdraft impact. I conclude that the CEC use of the district's water table behavior as the exceedance threshold for the well field pumping rate is incorrect and should be modified or eliminated altogether. If the CEC continues to disagree with the district point of view, then the CEC Report needs to be revised to include an additional analysis using the district's policy for consideration of impact significance.

6. Reciprocity. Based on the last 40 years of district water level data, I find that there has been no observable water level impact in the proposed well field area from any known groundwater behaviors, small or large, in the main Kern County subbasin. Therefore, based on the principle of reciprocity, I conclude that the project well field operation will not have any observable water level impact at any location in the main Kern County subbasin. Given the empirical evidence for a lack of cause- and- effect connection between the project well field and the main- basin areas of water level decline, I conclude that no case can be made for the aggravation of the supposed overdraft by the well field.

Potential impact 4. Subsidence.

<u>CEC Findings.</u> The CEC Report speculates that declining water levels could contribute to an increased risk of land subsidence in the Buttonwillow Service Area, especially if water levels decline below historical lows. The concern about subsidence is due to the proximity of the well field to the California aqueduct, about two miles away. The CEC Report states that major subsidence has occurred elsewhere in the San Joaquin Valley groundwater basin due to declining water levels due to a proliferation of wells for irrigation but that there is no historical evidence for subsidence in the Buttonwillow Service Area. The CEC Report states that DWR extensometer data from a location in a large water banking project on the Kern Fan seventeen miles away shows a statistically significant subsidence of 0.001 ft per year over the period 1983 to 2009. The "statistically significant" implication of the data is that the subsidence cannot be significantly larger than this tiny amount, i.e., a maximum of about 1 inch of subsidence per century at the center of the well field, with an undetermined lesser amount of subsidence, if any, 2 - 3 miles away.

The CEC Report finds that *"If the proposed well field extraction indeed exacerbates overdraft in the*

Kern County subbasin, staff's analysis indicates it could also exacerbate subsidence in areas near the California Aqueduct." (PWSA, p. 6.9-2)

RAC Comments.

1. Concern. The CEC's general concern for subsidence is appropriate, however, the CEC Report provides essentially no quantitative justification for their concern except for the presence of two areas of subsidence, each about 35 miles away in different hydrogeological environments than in the project area. The background discussion of the mechanism of hydrocompaction is not correlated to any reported physical properties within the project area and the extensometer data showing a tiny amount of subsidence at a geologically- similar location 17 miles away is not offered or discussed as a constraint on the possible range of conditions that might occur in the project area. In my opinion, the CEC Report creates a vaguely alarmist concern for potential subsidence by reporting information that does nothing to suggest that there is any demonstrable risk in the project area.

2. Threshold. The CEC Report defines the threshold conditions for the potential onset of subsidence in the project area, i.e., water level declines below the historical lows. The CEC Report does not point out that based on their own data, the well field operation is unlikely to create any such scenario: Based on the data in S&W Figure 19, the historical water level lows are 40 -60 ft below current water levels in the project area. Based on the data in S&W Figures 5, 6, and 7, the predicted water level declines under the middle third of the Buttonwillow Service Area due to project pumping are expected to be a relatively negligible average of about 3.7 ft, 4.9 ft, and 7.5 ft for the three CEC reported drawdown scenarios after 25 years of continuous pumping. I conclude that there is nothing in the CEC analysis to warrant alarmist language like *"the threat to the California Aqueduct from subsidence"* (PWSA, p. 6.9-2). Quite the contrary. Based on the CEC's own water level drawdown analysis, I conclude that there is essentially no demonstrated threat to the aqueduct from subsidence, and nothing more than a simple monitoring program is a sufficient mitigation at this time for the small level of risk that has been justified by the CEC Report.

Potential impact 5. Compliance with state policies.

CEC Findings. The CEC Report cites four sources of compliance policy including the California Constitution, the Warren- Alquist Act, the CEC 2003 Integrated Energy Policy Report, and the SWRCB Resolutions. The CEC Report finds that the proposed well field water supply analysis is incomplete and that alternate water supplies have not been adequately evaluated.

The CEC Report states that the project approval must fundamentally depend on compliance with California laws and regulations. Some key regulatory provisions may include principles of conservation and reuse, prohibitions against waste or unreasonable use, the best of feasible alternatives and, for power plant use, using the least amount of the poorest quality water available, and the need to provide an equal volume of offsetting new water supplies.

The issues of concern, some of which are proposed for further review, include: the reasonableness of the proposed project water use, the role of the proposed BGRP well field as a reclamation or remediation, the suitability of the water supply for other reasonable beneficial uses, the existence of preferable and/or insufficiently- evaluated alternative water sources. (PWSA, p. 6.9 29 - 30)

The CEC recognizes that the proposed BGRP well field was located and designed like California coastal groundwater remediation well fields which operate to prevent or reduce salt water encroachment and thereby improve crop selection, crop yields, soil management, and land value within the zone of impact by improving the salinity of the underlying groundwater. The CEC Report states that the staff is supportive of projects that use degraded water supplies, that the project area is impacted by shallow saline groundwater, and that the removal of water that has limited use or may improve crop productivity *"would be supported by staff for use in power plant cooling." (PWSA, p. 6.9-1)* The CEC Report states that other well configurations could be more effective, that changes in pumping strategy would improve the capture of brackish water from the east, and the project would appear more reasonable if the water was supplied from a remediation project. (PWSA, p.6.9-30)

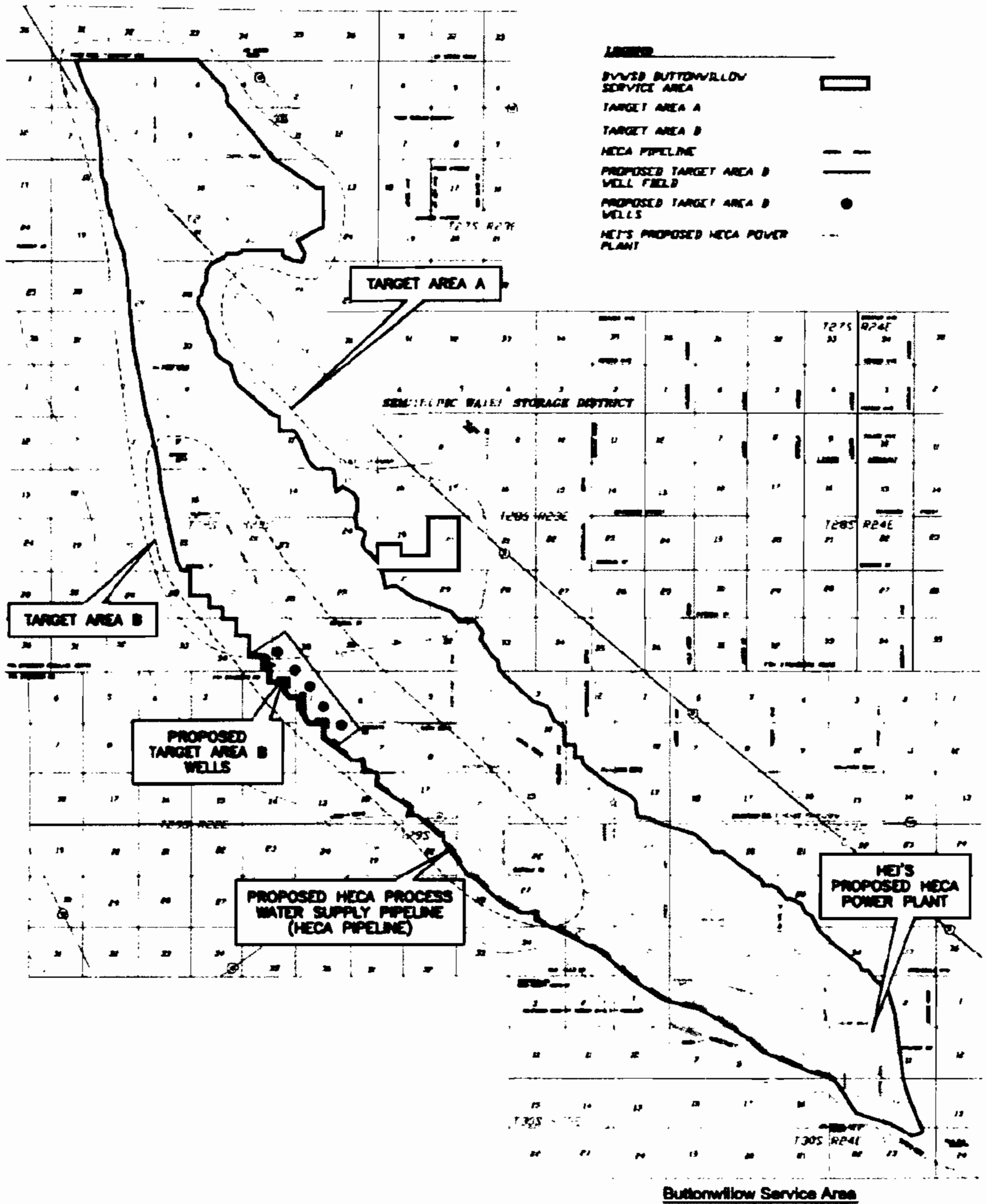
But in contrast to the foregoing, the CEC Report also states that the projected water supply of 7,500 af/y is inordinately high for the size of the power plant, the TDS of the water supply (in the range of 945 - 3730 mg/l) may not qualify as degraded water, that the proposed pumping would not constitute reclamation, there may be other reasonable beneficial uses for this water, the Target A BGRP alternative may provide benefits which are more acceptable to the CEC, the applicant has not sufficiently evaluated alternative water sources, and the CEC Staff is interested in learning more about the proposed well field.

<u>RAC Comments.</u>

1. Sources of policy. The CEC Report does not recognize the Buena Vista Water Storage District as a source of compliance policy or as a source of local perspectives and lines of reasoning. In my opinion, a local agency should have a significant voice in the project evaluation. The CEC Report does not appear to recognize or place any particular merit on the fact that this project was invented and promoted by the landowners and their representative managing organization. I conclude that most or all of the remaining, unresolved issues that are listed under this heading could easily be solved by incorporating relevant additional knowledge about the local conditions in the project area and the preferences of the landowners and local water agency.

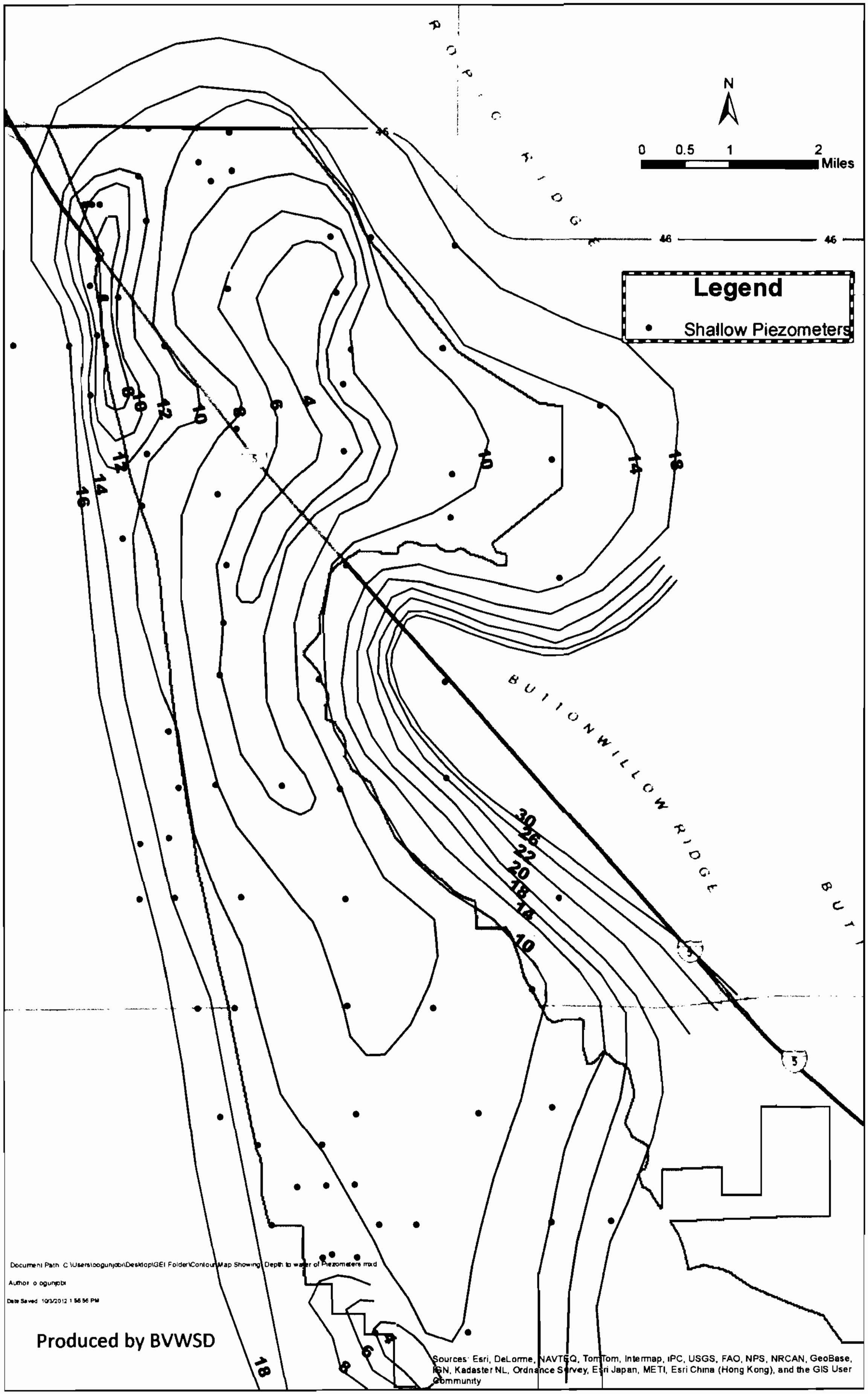
2. Specifics. I conclude that it will be difficult for the CEC to resolve these issues by themselves unless they make the obvious corrections and recalculations, become more familiar with the actual conditions in the project area, and include the BVWSD as a source of compliance policy. I recommend that the CEC Staff and the BVWSD Staff collaborate on these issues rather than each entity separately writing and airing its respective position papers on these issues.

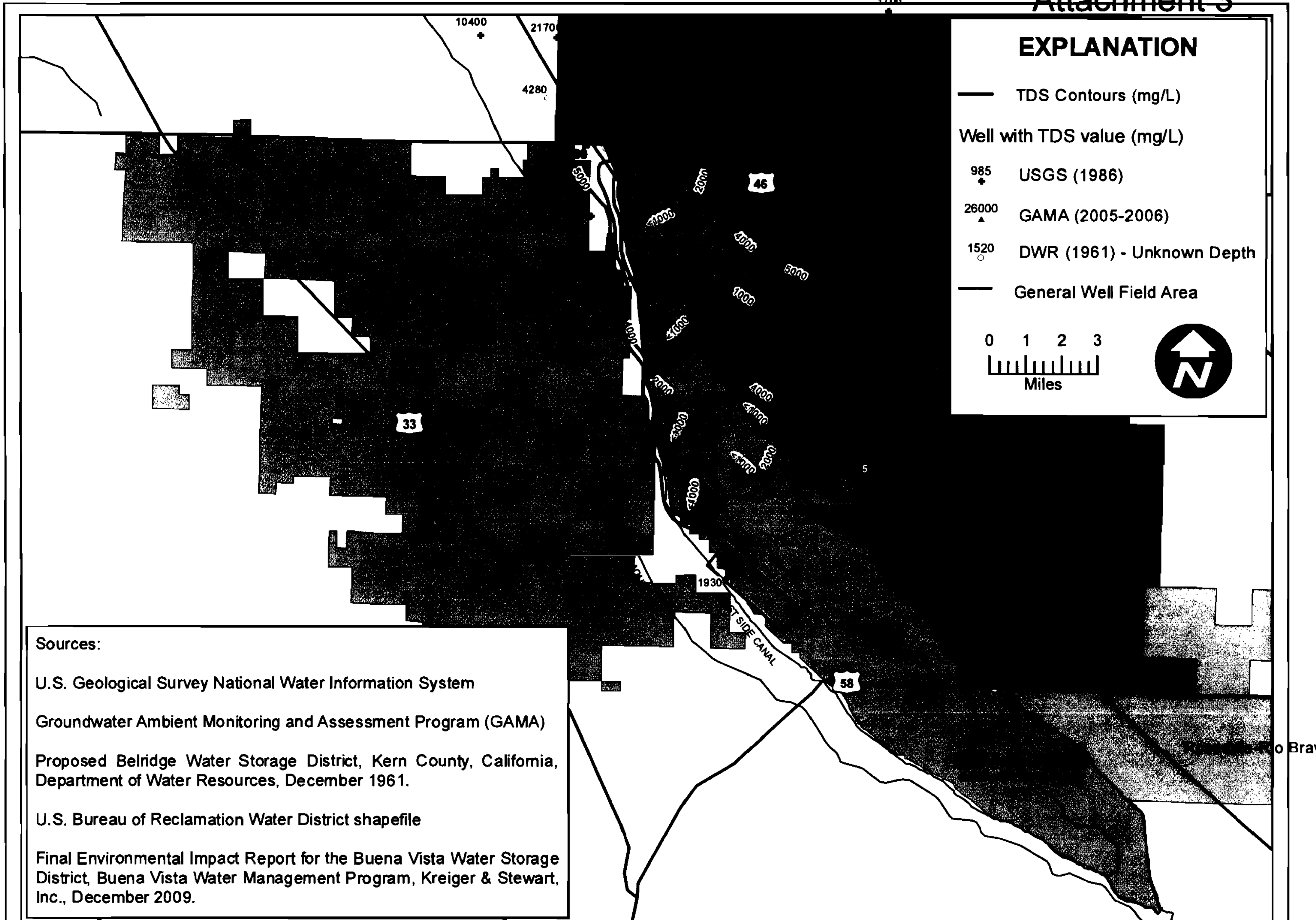
SOIL&WATER Figure 2: Brackish Groundwater Remediation Project



Attachment 2

Map Showing Contours of Depth to GW in Perched Zone (Ft.)

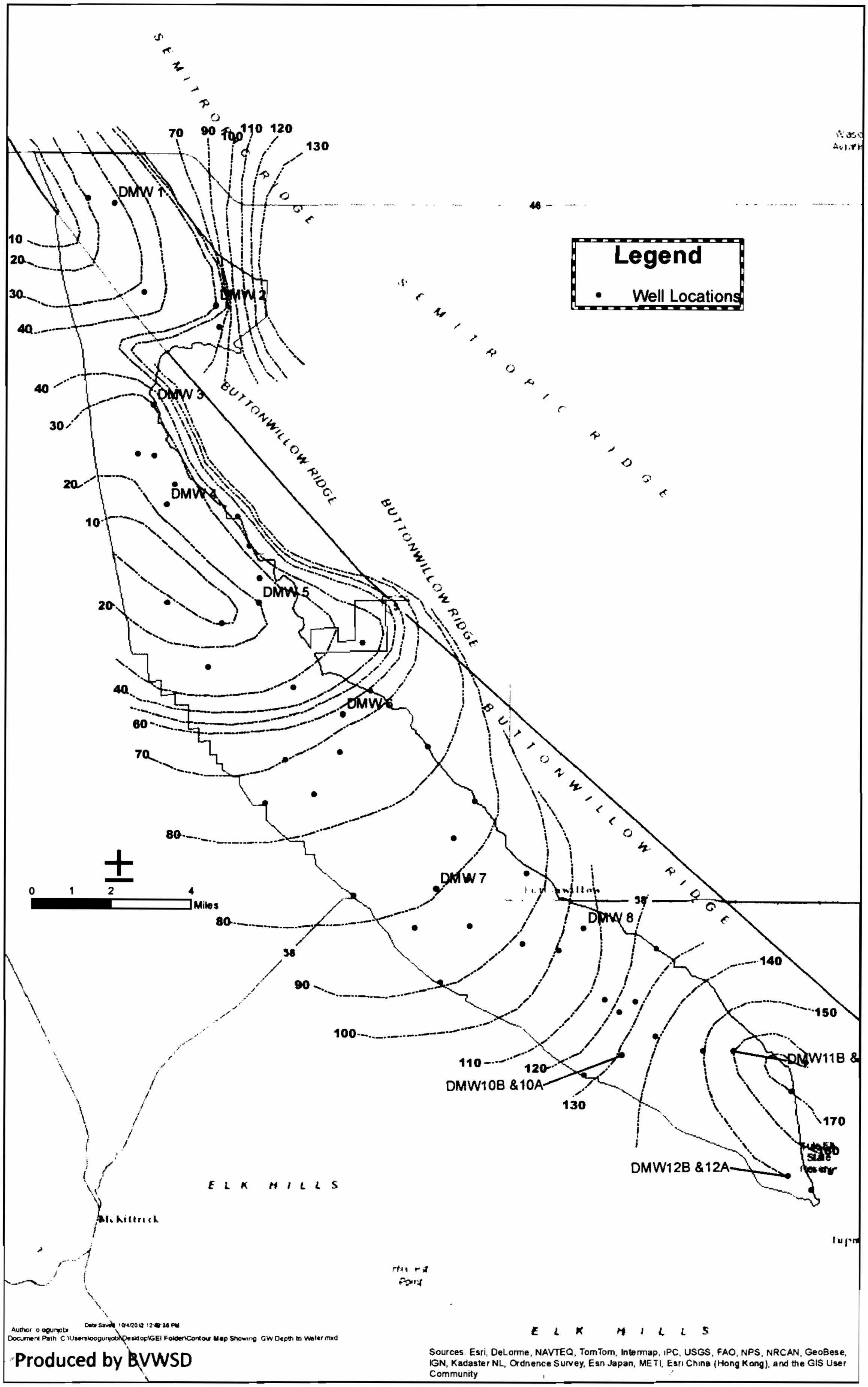




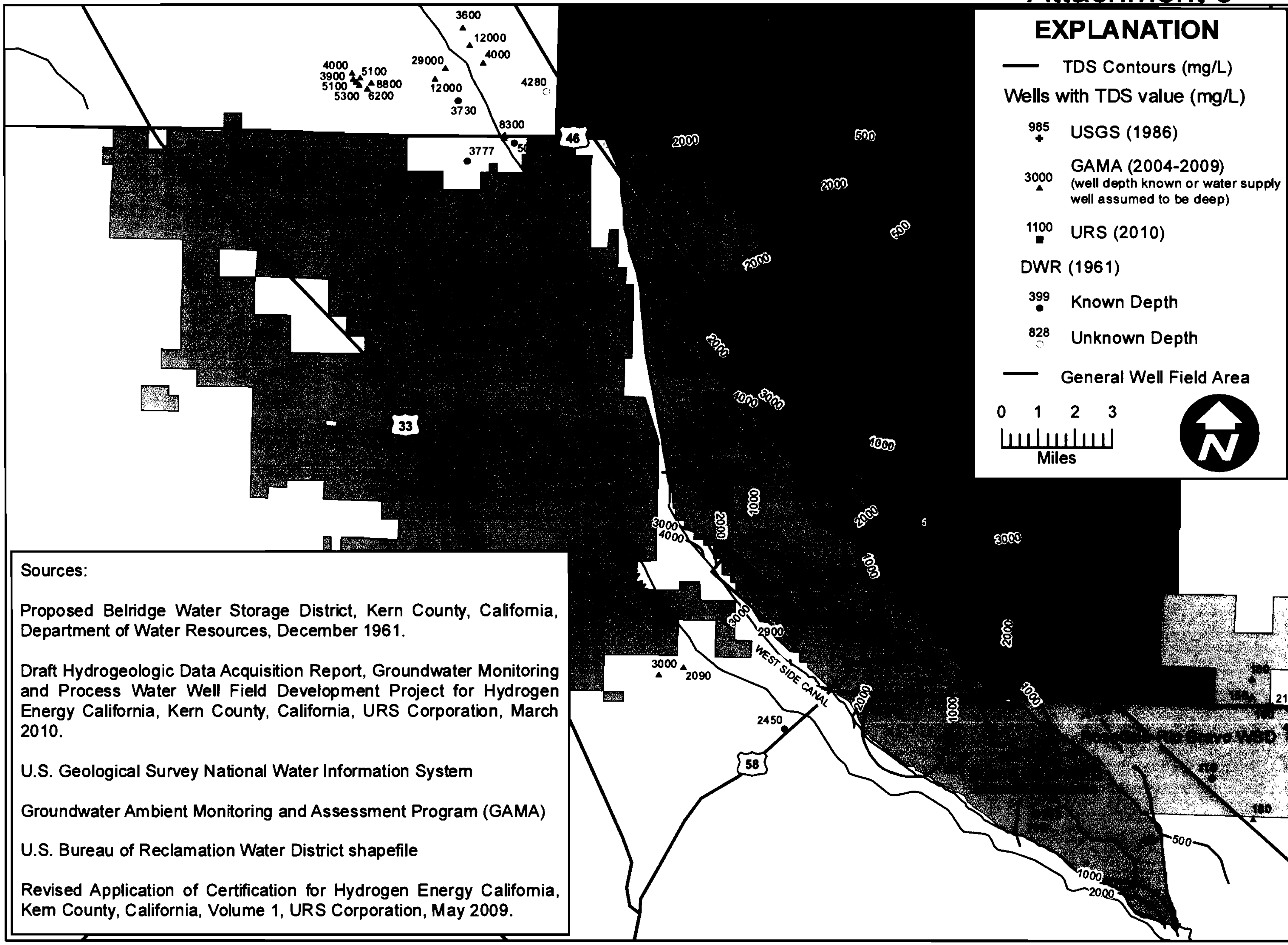
Soil and Water Figure 10. Map showing TDS concentrations in samples from shallow and unknown depth wells and reported concentration contours for the shallow perched aquifer.

BVWSD Figure 2 Attachment 4

Map Showing Contours of Depth to Water Level- Pumping Zone (Ft.)



Attachment 5



Sources:

Proposed Belridge Water Storage District, Kern County, California, Department of Water Resources, December 1961.

Draft Hydrogeologic Data Acquisition Report, Groundwater Monitoring and Process Water Well Field Development Project for Hydrogen Energy California, Kern County, California, URS Corporation, March 2010.

U.S. Geological Survey National Water Information System

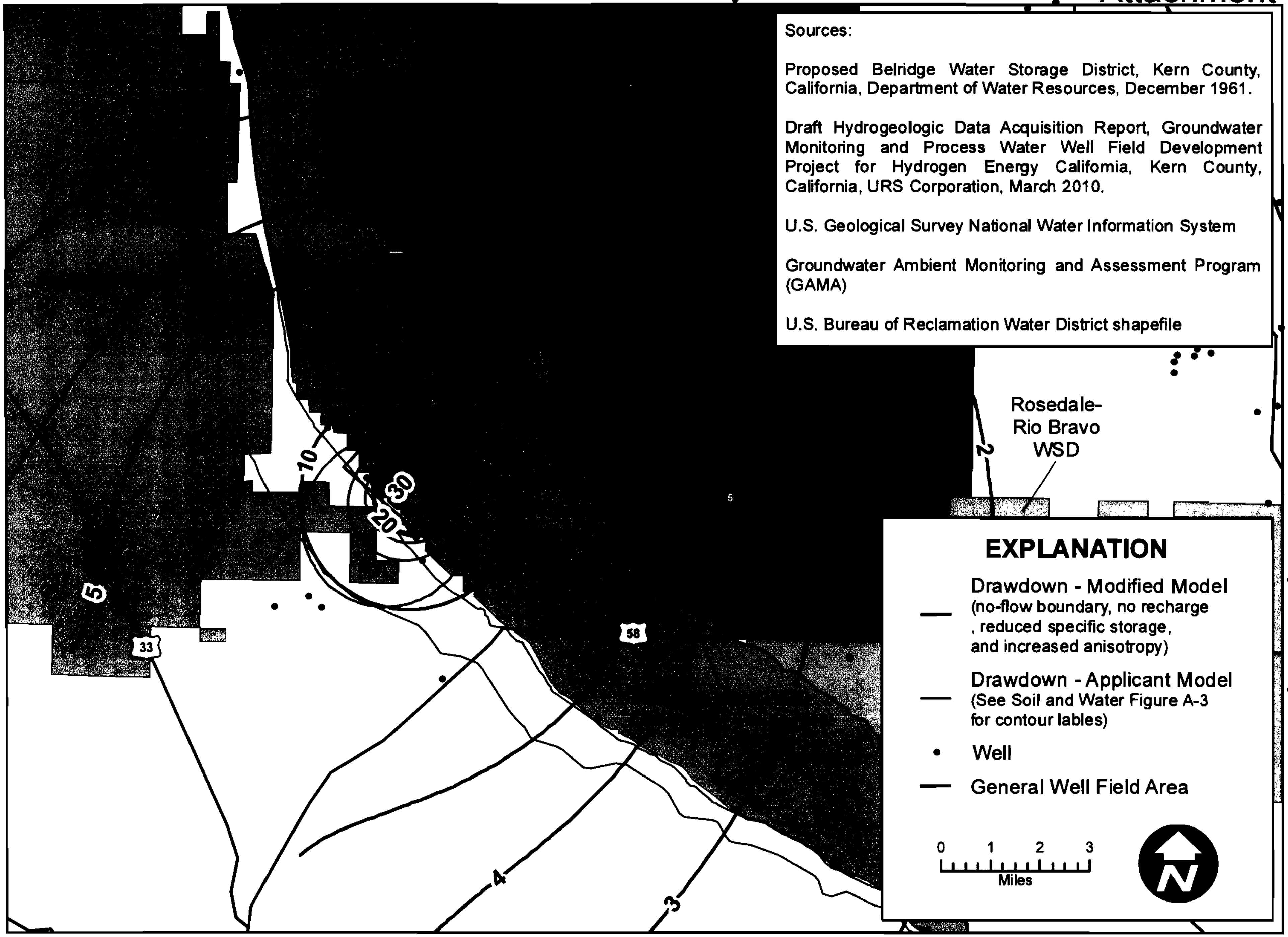
Groundwater Ambient Monitoring and Assessment Program (GAMA)

U.S. Bureau of Reclamation Water District shapefile

Revised Application of Certification for Hydrogen Energy California, Kern County, California, Volume 1, URS Corporation, May 2009.

Soil and Water Figure 8. Map showing deep TDS concentrations in samples from deep and unknown depth wells and reported 1970-2007 composite TDS concentration contours for the pumped groundwater zone.

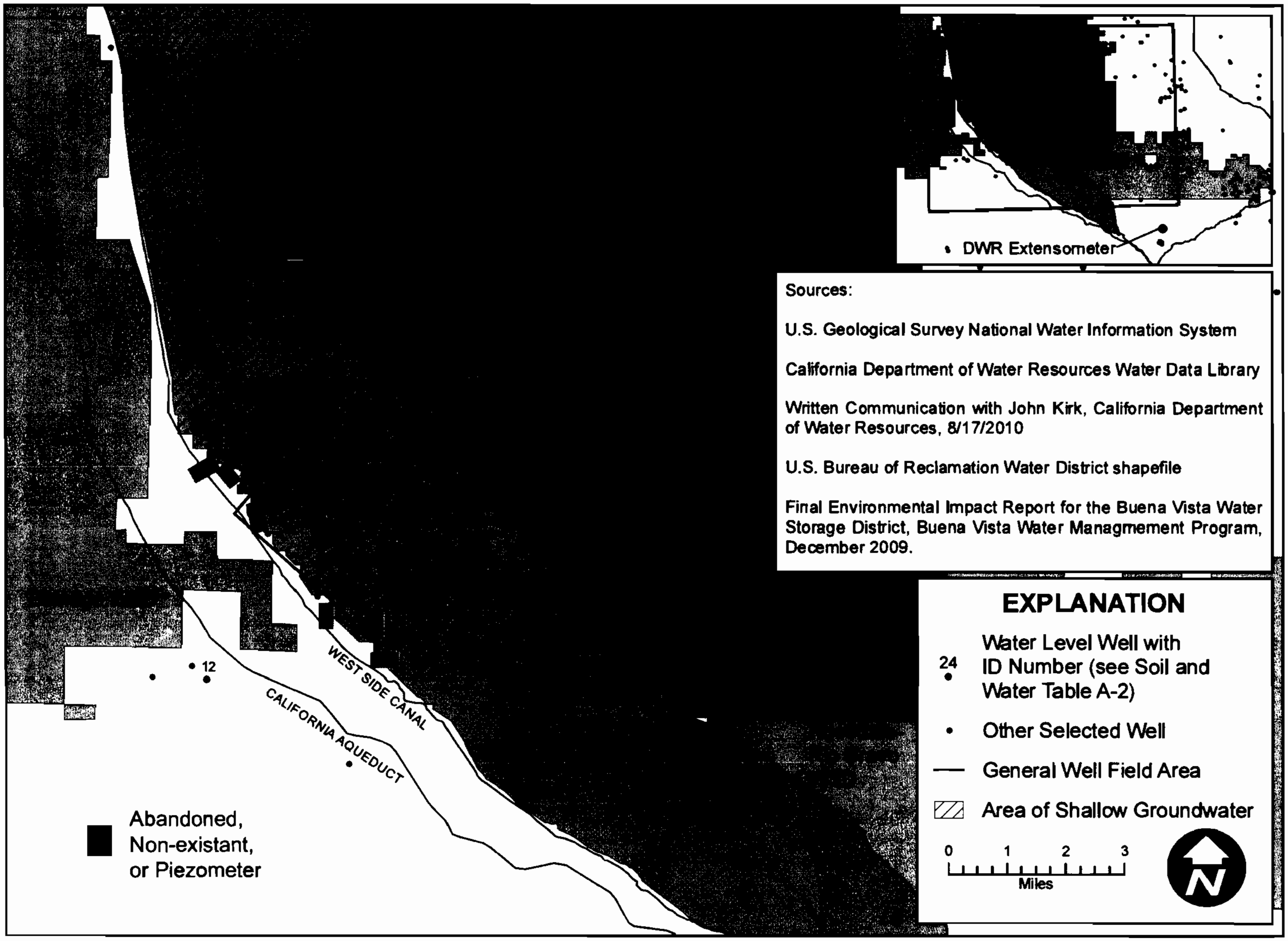
Attachment 6



Soil and Water Figure 7. Simulated 25-year drawdown from staff-modified model including reduced storativity (0.007) and anisotropy increased to 1,000.

Revised

Attachment 7



Soil and Water Figure 3. Selected existing wells and proposed well field, Buttonwillow Service Area, Buena Vista Water Storage District.

Attachment 8

(REVISED) SOIL&WATER Table 3 drawdown at select well locations simulated by applicant's model and three modified models

Map Number	Applicant's Model		Modified Model BC and Recharge		Modified Model with Reduced Storativity		Modified Model with Reduced Storativity and Vertical Conductivity	
	simulated drawdown, in feet							
	original	spatial correction	original	spatial correction	original	spatial correction	original	spatial correction
[redacted]								
2	0.9	0.0	4.1	3.9	5.5	5.8	11.3	10.5
3	-0.4	0.0	4.7	4.3	6.1	6.2	13.1	12.5
4	0.1	0.0	2.4	2.7	3.9	4.2	5.4	6.5
5	-0.4	0.0	3.9	3.6	5.3	4.9	10.7	9.5
6	6.8	3.5	15.8	5.7	17.3	9.8	34.2	21.0
7	-0.7	1.2	7.7	5.2	9.1	8.2	21.3	16.5
[redacted]								
9	1.0	1.4	7.6	5.2	9.1	8.6	21.0	17.5
10	-0.6	1.5	6.8	5.2	8.3	8.4	19.0	17.0
[redacted]								
12	-0.1	1.0	3.6	3.9	5.1	6.0	8.8	9.8
13	5.5	0.0	5.3	4.3	6.8	7.0	15.0	13.0
14	0.1	0.0	4.6	4.0	6.1	6.0	12.9	11.0
15	0.7	0.0	4.2	3.8	5.6	5.6	11.4	10.0
16	0.9	0.0	4.3	3.8	5.8	5.4	11.9	9.8
17	0.5	0.0	4.0	3.7	5.5	5.4	10.9	9.7
[redacted]								
19	12.0	0.0	3.1	3.2	4.5	4.6	7.6	8.5
[redacted]								
21	3.9	0.0	4.4	4.0	5.8	6.2	12.2	11.5
22	2.1	0.0	3.9	3.8	5.3	5.4	10.4	9.9
23	1.3	0.0	2.2	2.1	3.5	3.4	5.1	4.8
24	-0.6	0.0	2.6	2.6	3.9	3.9	6.1	6.5
[redacted]								
26	-0.5	0.0	3.2	2.7	4.6	4.0	8.1	7.2
27	-0.5	0.0	3.2	3.0	4.6	4.5	8.1	7.8
[redacted]								
30	-0.1	0.0	3.0	2.7	4.4	4.0	7.4	7.1
31	-0.1	0.0	3.4	3.1	4.9	4.5	8.9	8.4
32	2.9	0.0	3.3	3.0	4.7	4.5	8.4	8.1
33	0.3	0.0	2.5	2.7	3.9	4.0	5.9	7.0
34	0.3	0.0	2.6	2.8	4.0	4.1	6.1	7.0
35	0.7	0.0	2.7	2.8	4.1	4.2	6.2	7.5
36	0.2	0.0	2.8	2.8	4.2	4.2	6.7	7.7
[redacted]								
41	-0.2	0.0	2.3	2.2	3.6	3.5	5.1	4.8
42	2.8	0.0	2.4	2.4	3.8	3.7	5.6	6.5
43	0.2	0.0	4.0	3.7	5.4	5.0	10.9	9.7
[redacted]								
45	2.6	0.0	2.3	2.2	3.7	3.5	5.4	4.8
46	-0.2	0.0	2.3	2.2	3.7	3.6	5.3	4.9
47	-0.1	0.0	2.6	2.6	4.0	3.9	6.0	6.3
48	0.5	0.0	2.4	2.3	3.8	3.7	5.5	5.1
49	-0.4	1.6	6.7	5.2	8.2	8.4	19.0	17.5
50	3.8	0.0	4.0	3.8	5.5	5.5	11.0	9.9
51	-0.4	1.9	9.3	7.2	10.8	9.0	24.9	16.5
52	0.5	0.0	3.8	3.8	5.2	5.5	10.0	9.9
[redacted]								
59	0.6	0.0	3.4	3.6	4.8	4.9	8.6	9.5
[redacted]								
Maximum	12.0	3.5	15.8	7.2	17.3	9.8	34.2	21.0
Minimum	-0.7	0.0	2.2	2.1	3.5	3.4	5.1	4.8
Average	1.0	0.3	4.5	3.5	5.9	5.3	11.7	9.7
# > 15 FT	0	0	1	0	1	0	13	5

SWSD Figure 1

MOU Regarding the Operation and Monitoring of the SWSD Groundwater Banking Project

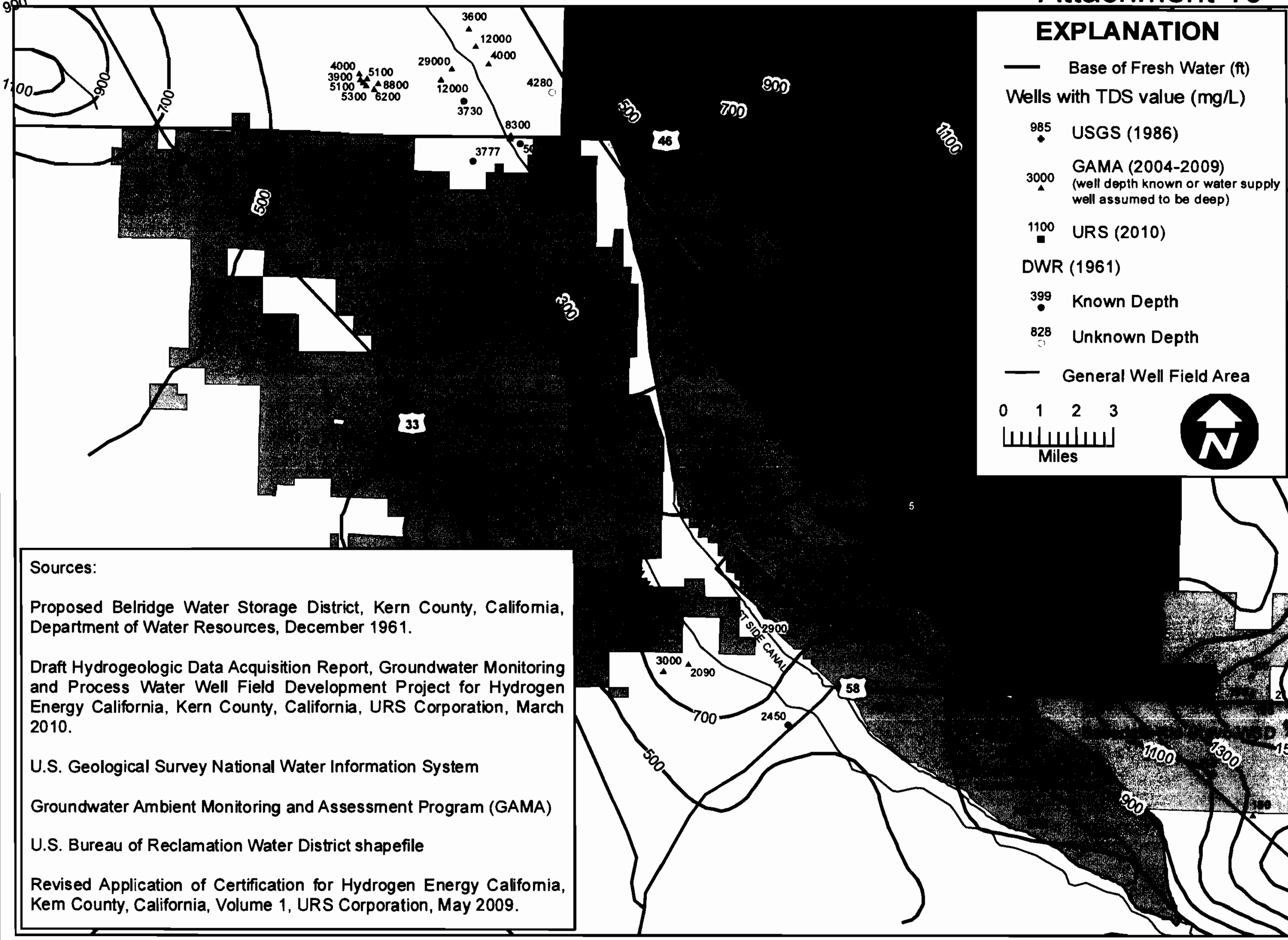
Applicable Excerpts

5. The Fifteen-Foot/Three-Year Rule. Notwithstanding any other provision of this Agreement SWSD agrees that it will not make withdrawals from any particular area of SWSD if such withdrawals have caused or would cause the average groundwater levels in such area or affected neighboring areas to be 15 feet or greater amount lower than what the average groundwater levels would have been without-Project over a 3-year period all as further defined at Exhibit E hereto.

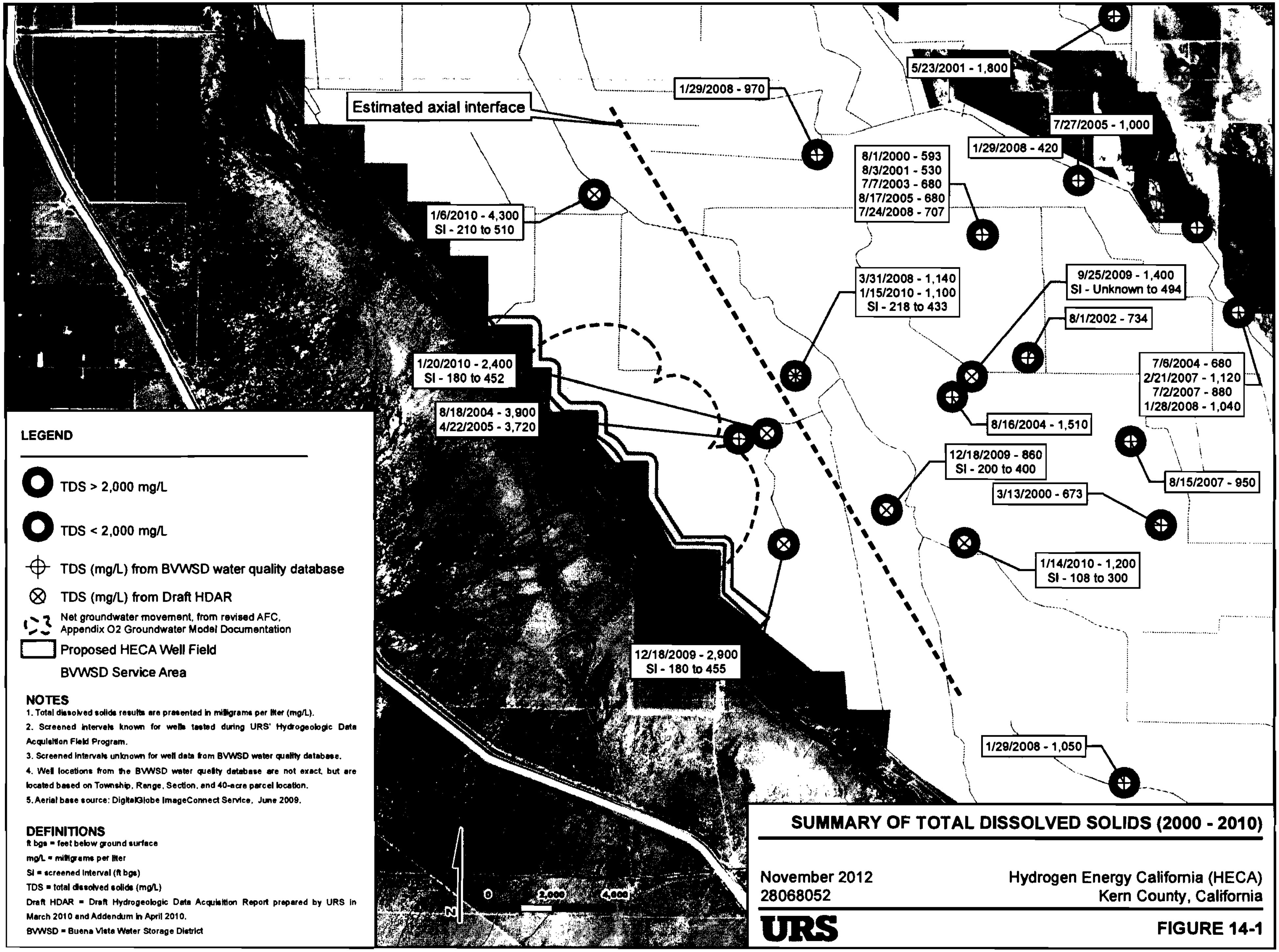
6. Well Interference. To the extent that interference, other than insignificant interference, with the pumping lift of any existing active well, is attributable to pumping of any Project well(s), Semitropic will either stop pumping or compensate the owner for such interference. The Monitoring Committee will establish the criteria necessary to determine if well interference, other than insignificant interference, is attributable to pumping of Project well(s) by conducting pumping tests of project wells following installation of monitor wells and considering hydrogeologic information.

7. Long-Term Monitoring Program. The Parties recognize that the monitoring program to be implemented hereunder will be larger in scope than any similar program heretofore conducted in the southern San Joaquin Valley of California and accordingly is fraught with the potential for a number of unknown conditions regarding geologic, engineering, legal and economic issues. The Parties agree to use their best efforts to develop a program which is practicably applicable in addressing such matters in the short-term and more refined and useful in the longer term.

Attachment 10



Soil and Water Figure 12. Map showing reported depth to the base of freshwater and TDS concentrations in samples from deep and unknown depth wells.



SUMMARY OF TOTAL DISSOLVED SOLIDS (2000 - 2010)

November 2012
28068052

Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE 14-1

BUENA VISTA WSD WATER BALANCE

	[1]	[2]	[3]	[4]	[5]	[6]	[8]	[9]	[10]	[11]	[12]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
YEAR	KR	WATER SUPPLY							TOTAL	WATER DEMANDS							ANNUAL	ACCUM
	A-J	KR	FK	SWP	SWP - A21	OTHER	SAFE YIELD		WATER	CROP	INDUSTRIAL	PROJECT	EVAP	GOOSE LAKE	MOU	WATER	BALANCE	BALANCE
	RUNOFF	SUPPLY	SUPPLY	SUPPLY	SUPPLY	SUPPLY	MINOR STREAMS	PRECIP	SUPPLY	USE	USE	USE	LOSS	OUTFLOW	LOSS	USE		
	% OF AVG	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
1970	69	120,361	7,310	10,284	-			17,647	155,602	105,076			2,332	9,086		116,494	39,108	39,108
1971	53	81,466	7,787	14,638	-			18,860	122,751	105,076			2,177	4,897		112,150	10,601	49,709
1972	28	32,853		35,206	2,700			9,879	80,638	99,391			2,288	740		102,419	(21,781)	27,927
1973	156	149,082	746	5,548	-			24,884	180,260	111,640			2,128	12,137		125,905	54,355	82,282
1974	115	160,269	14,771	20,875	-			25,217	221,132	115,768			2,122	6,121		124,011	97,121	179,403
1975	83	138,779		32,464	-			15,850	187,093	121,174			2,153	7,384		130,711	56,382	235,784
1976	23	40,747		25,137	-			18,086	83,970	115,063			2,138	4,463		121,664	(37,694)	198,090
1977	21	5,310		4,912	-			19,061	29,283	111,616			2,068	420		114,104	(84,821)	113,270
1978	236	238,040		969	-			36,914	275,923	120,059			2,017	13,877		135,953	139,970	253,240
1979	90	132,920	9,913	30,009	24,391			22,018	219,251	111,286			1,935	12,807		126,028	93,223	346,463
1980	213	271,540		856	-			20,889	293,285	112,780			1,880	18,295		132,955	160,330	506,793
1981	54	64,454		62,000	11,692			21,506	159,652	112,536			2,157	12,351		127,044	32,608	539,401
1982	172	182,654	34,882	14,200	15,976			25,581	273,293	112,883	703		1,852	15,904		131,342	141,951	681,351
1983	333	270,855	26,084	1,579	-			32,075	330,593	97,927	1,103	20,888	1,955	13,264		135,137	195,456	876,808
1984	91	154,914	2,289	55,937	-			11,821	224,961	109,366	1,148		2,252	16,478		129,244	95,717	972,524
1985	91	132,534		23,138	205			13,122	168,999	106,262	1,363		1,965	16,123		125,713	43,286	1,015,810
1986	191	230,925	10,276	1,438	-			18,601	261,240	103,154	960	2,041	2,043	24,589		132,787	128,453	1,144,264
1987	46	78,835		21,896	-			19,433	120,164	99,168	927	6,000	1,937	14,916		122,948	(2,784)	1,141,479
1988	35	50,470		25,328	-			14,655	90,453	103,320	690	5,000	2,103	16,309		127,422	(36,969)	1,104,511
1989	51	59,021		26,893	-			9,446	95,360	100,317	643	3,138	2,037	5,080		111,215	(15,855)	1,088,655
1990	25	21,124		4,885	-			11,723	37,732	105,159	555	2,242	2,039	4,165		114,160	(76,428)	1,012,227
1991	60	56,983		1,288	-			21,617	79,888	105,075	663	4,410	2,055	4,558		116,761	(36,873)	975,354
1992	39	42,594		1,824	-			27,647	72,065	110,298	549	4,004	2,082	3,927		120,860	(48,796)	926,558
1993	126	90,385	9,832	57,230	-			26,198	183,645	113,622	529		1,968	8,641		124,760	58,885	985,443
1994	41	73,712		11,267	5,403			22,341	112,723	103,758	536		2,167	8,404		114,865	(2,142)	983,302
1995	200	293,072	12,451	21,300	-			33,072	359,895	112,902	649	2,000	1,895	28,394	3,997	149,837	210,059	1,193,360
1996	129	222,028	15,938	29,900	-			27,299	295,165	113,409	1,241	7,467	2,114	23,555	1,474	149,260	145,905	1,339,265
1997	123	221,942	19,456	21,300	-			20,172	282,870	106,883	1,406	7,080	1,974	28,118	2,813	148,274	134,596	1,473,861
1998	245	307,672	22,339	21,300	-			46,520	397,831	113,188	1,384	1,309	1,901	31,760	5,503	155,045	242,786	1,716,647
1999	54	55,237	13,701	46,300	1,107			20,472	136,817	106,919	1,232		1,796	23,067	13	133,027	3,790	1,720,437
2000	66	61,535		27,837	2,703			18,251	110,326	102,937	1,500	8,613	1,803	23,083		137,936	(27,610)	1,692,827
2001	54	44,697		8,786	480	1,693		23,722	79,378	99,924	571	29,915	1,908	7,060	1,020	140,398	(61,020)	1,631,807
2002	46	58,203		13,451	1,511			12,715	85,880	93,321	1,264	33,073	1,302	5,035	771	134,766	(48,886)	1,582,921
2003	70	88,191		22,284	655			16,109	127,239	97,971	1,372	42,187	1,343	9,913	825	153,611	(26,373)	1,556,548
2004	48	78,550		10,987	3,341			17,497	110,375	102,224	1,328	28,005	1,415	9,098	310	142,380	(32,005)	1,524,544
2005	168	222,670	1,811	22,341	36,398			21,432	304,652	99,375	1,303	14,458	2,452	7,864	9,783	135,235	169,417	1,693,960
2006	169	177,597	20,714	18,848	32,792			20,262	270,213	102,145	1,569	1,966	2,343	12,591	6,314	126,928	143,285	1,837,245
2007	26	67,254	36,999	13,840	12,467			9,429	139,989	98,519	2,209	68,779	1,460	7,867	3,676	182,510	(42,521)	1,794,724
2008	71	92,878	239	10,291	-			9,786	113,194	91,705	1,864	42,537	1,586	4,093	413	142,198	(29,004)	1,765,721
2009	64	80,664	6,137	13,880	-			15,375	116,056	93,951	1,422	25,313	1,366	2,627	413	125,092	(9,035)	1,756,686
1970-09	99.4	123,825	6,842	19,811	3,796			20,430	174,746	106,179			1,963	11,977		130,829	43,917	

NOTES:

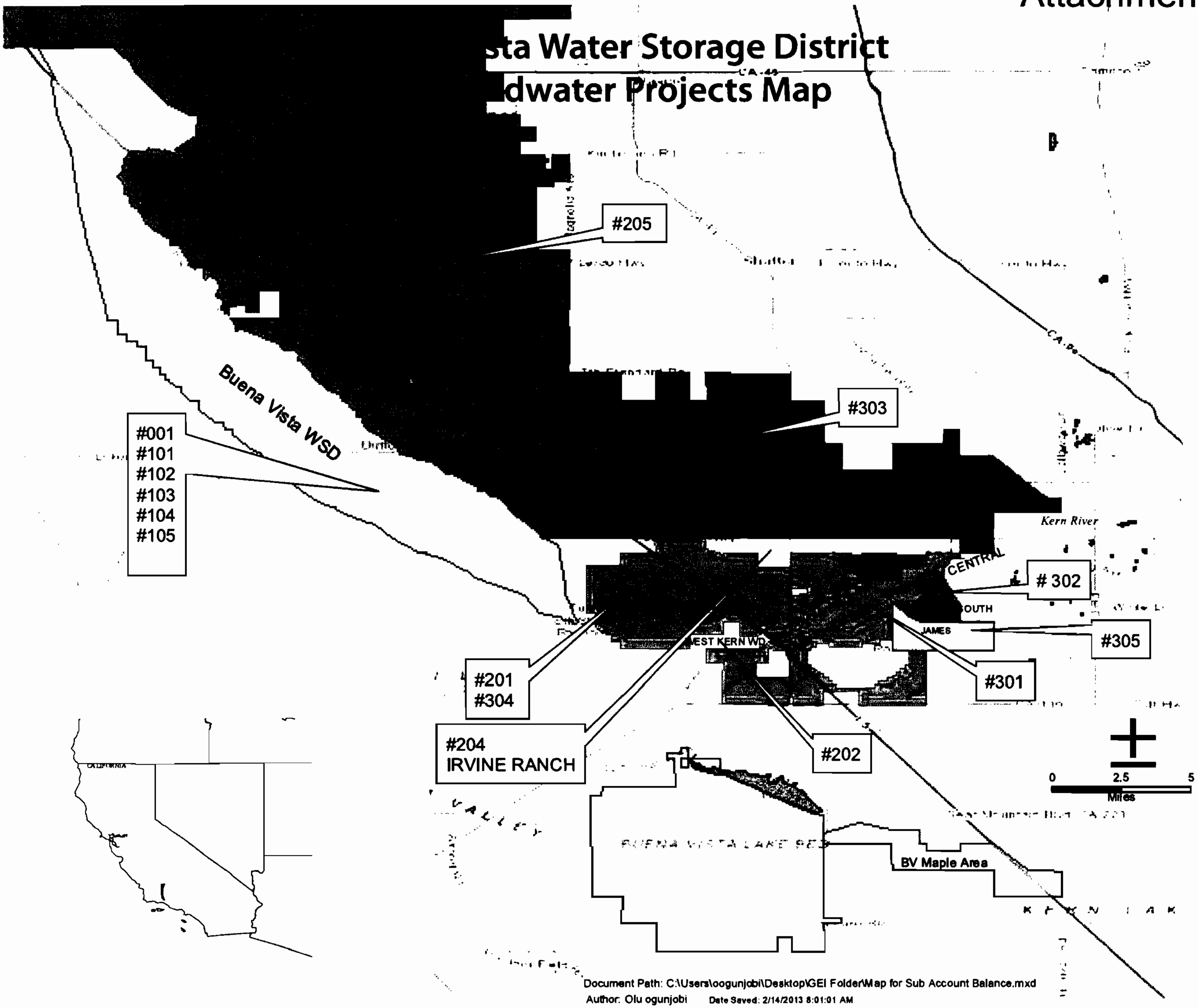
[1] April-July Runoff of the Kern River in % of average (1894-2005 = 464,430 AF)
[2] BV KR Supply (Surface deliveries to KR Intertie and surface sales to other in county jurisdictions downstream of 2nd Point taken out)
[3] FK supplies (NO BANKING FOR 3RD PARTY)
[4] SWP + pool purchases (NO BANKING FOR 3RD PARTY)
[5] Art 21 purchases
[6] Other purchased supplies

[8] Proportionate share of unappropriated minor local streams (#'s in discussion so left out for now)
[9] Gross Precip estimated at Meadows Field x cropped acreage + effective precip on other surfaces.
[10] = Sum of [2] through [9].

[11] Estimated crop water use (transpiration and soil evap) per CSPU.
[12] Industrial recovery contracts from BVWSD to westside oilfields

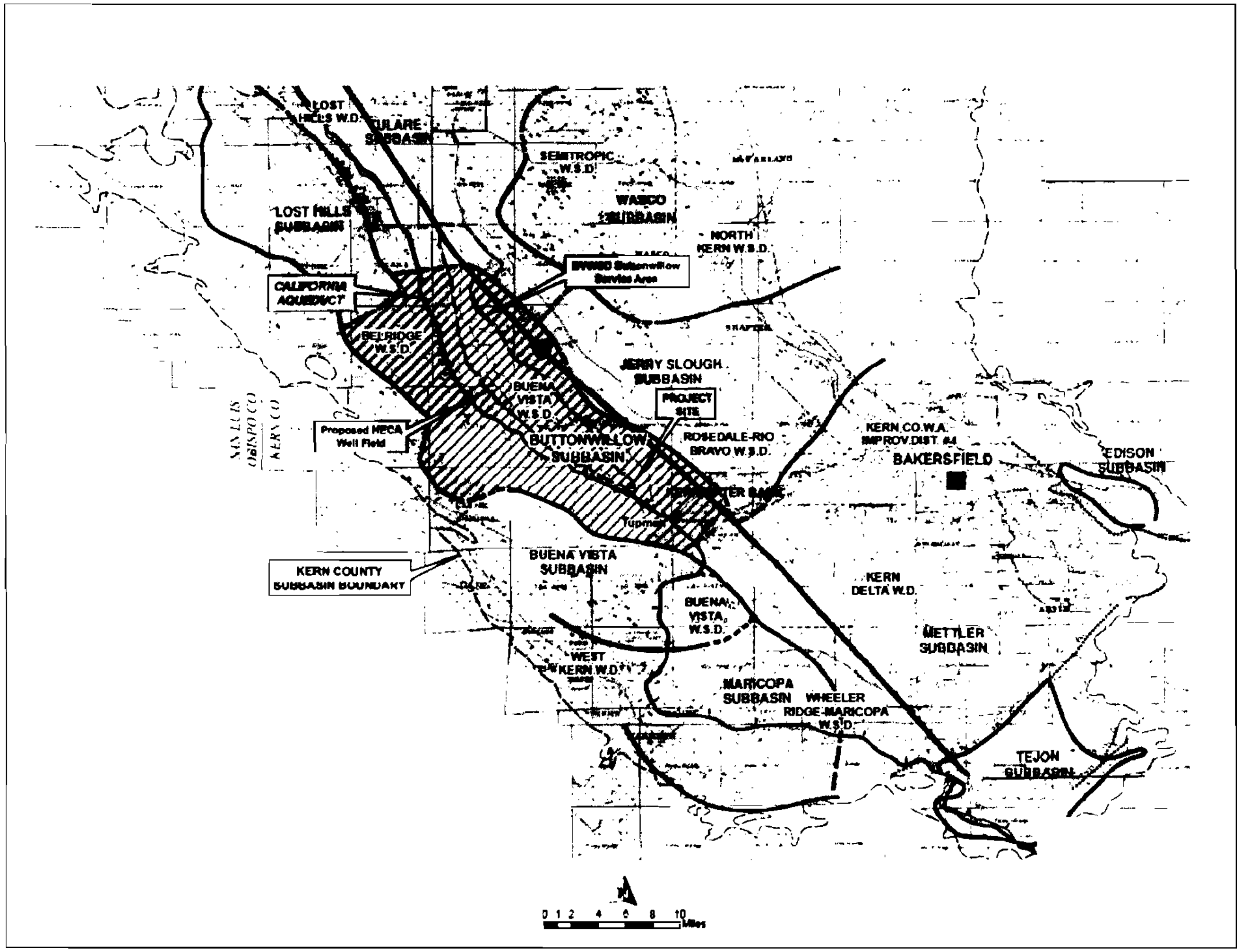
[14] Special project deliveries and Kern Fan pumping
[15] Water surface evaporation losses.
[16] Flows north of Hwy 46 (not including wheeling but including sales)
[17] MOU agreed to project losses start in 1995
[18] Sum of [11] through [17].

Attachment 13



Attachment 14

SOIL&WATER Figure 1: Kern Water Districts and Subbasins



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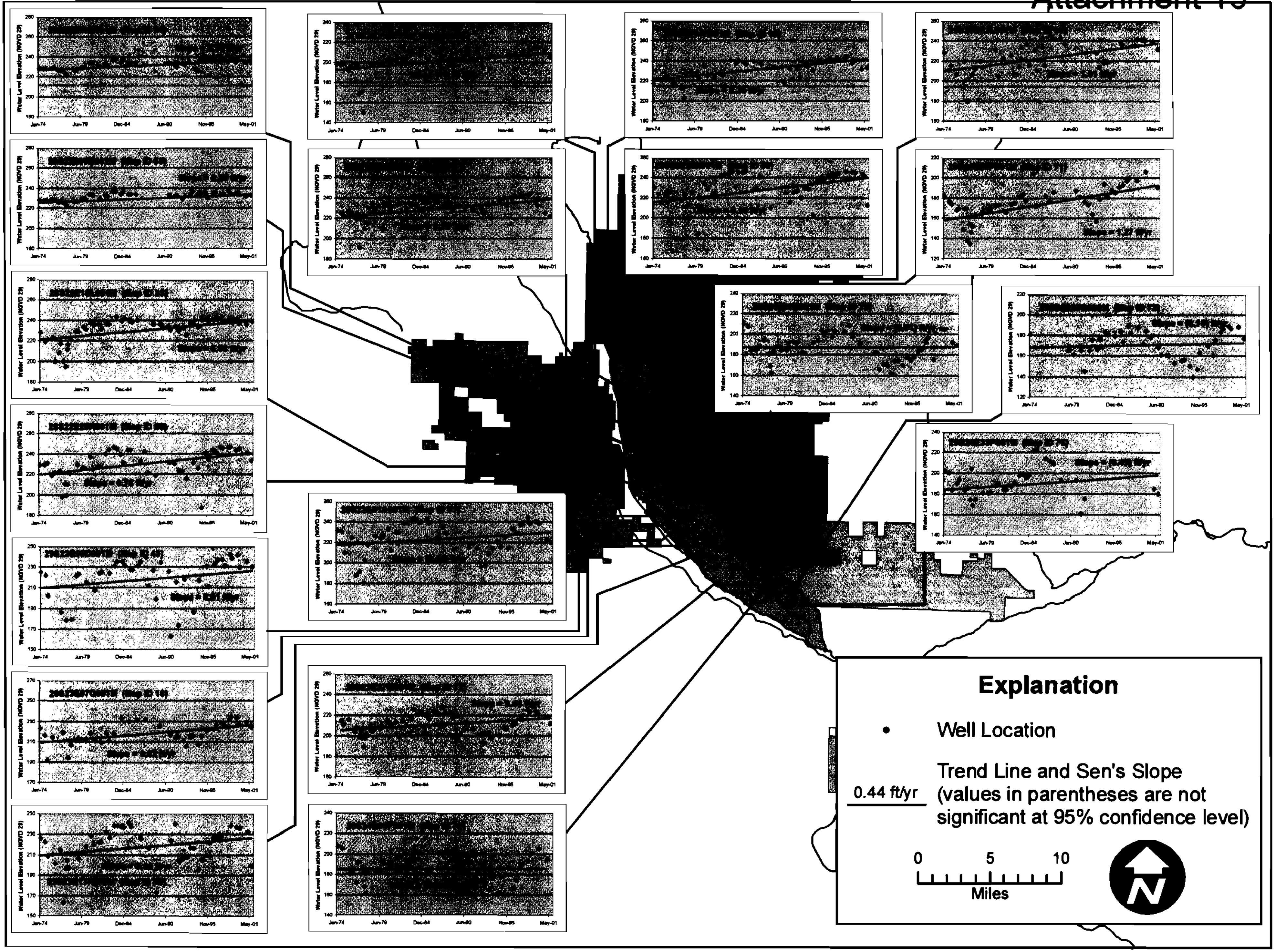
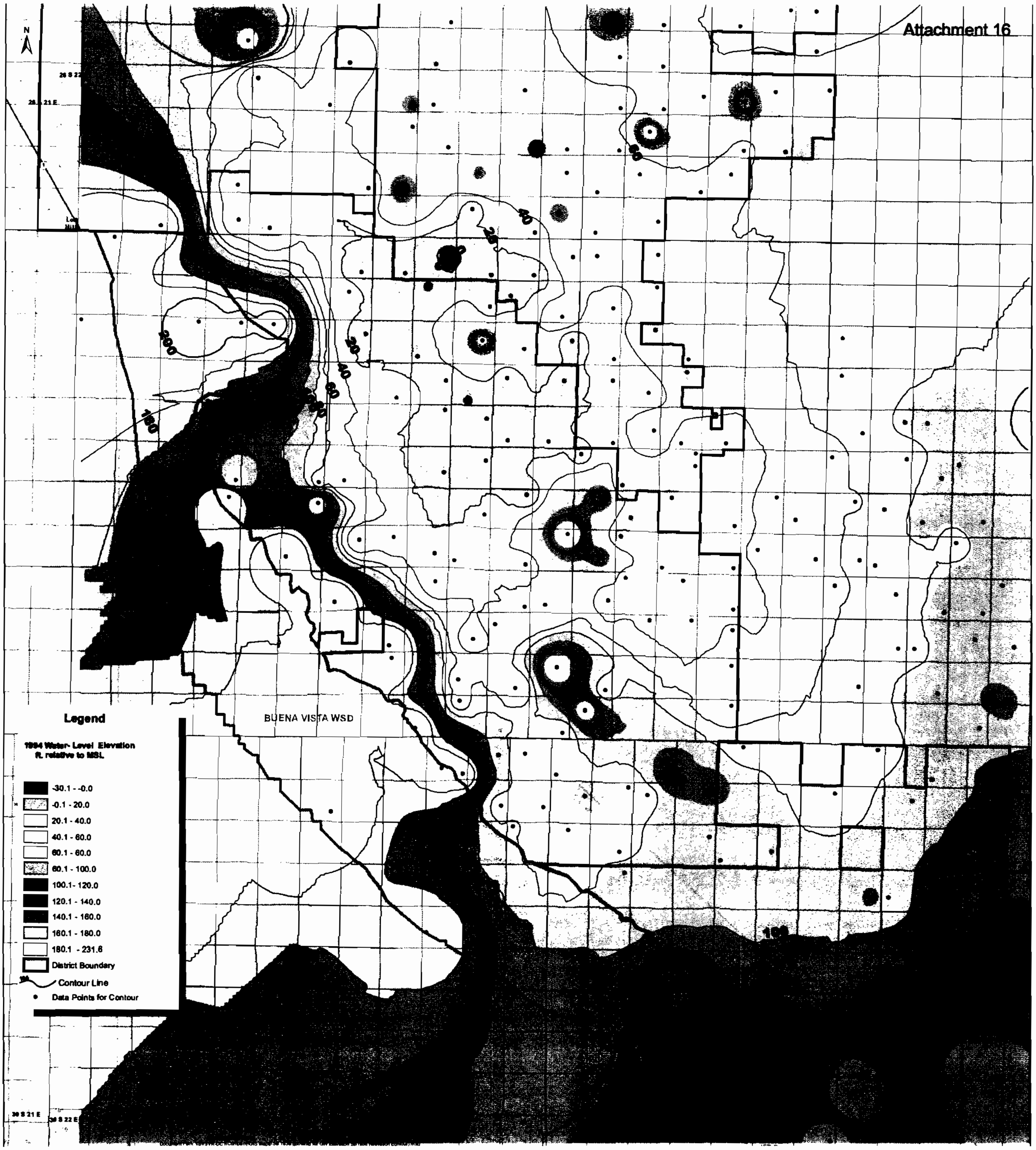
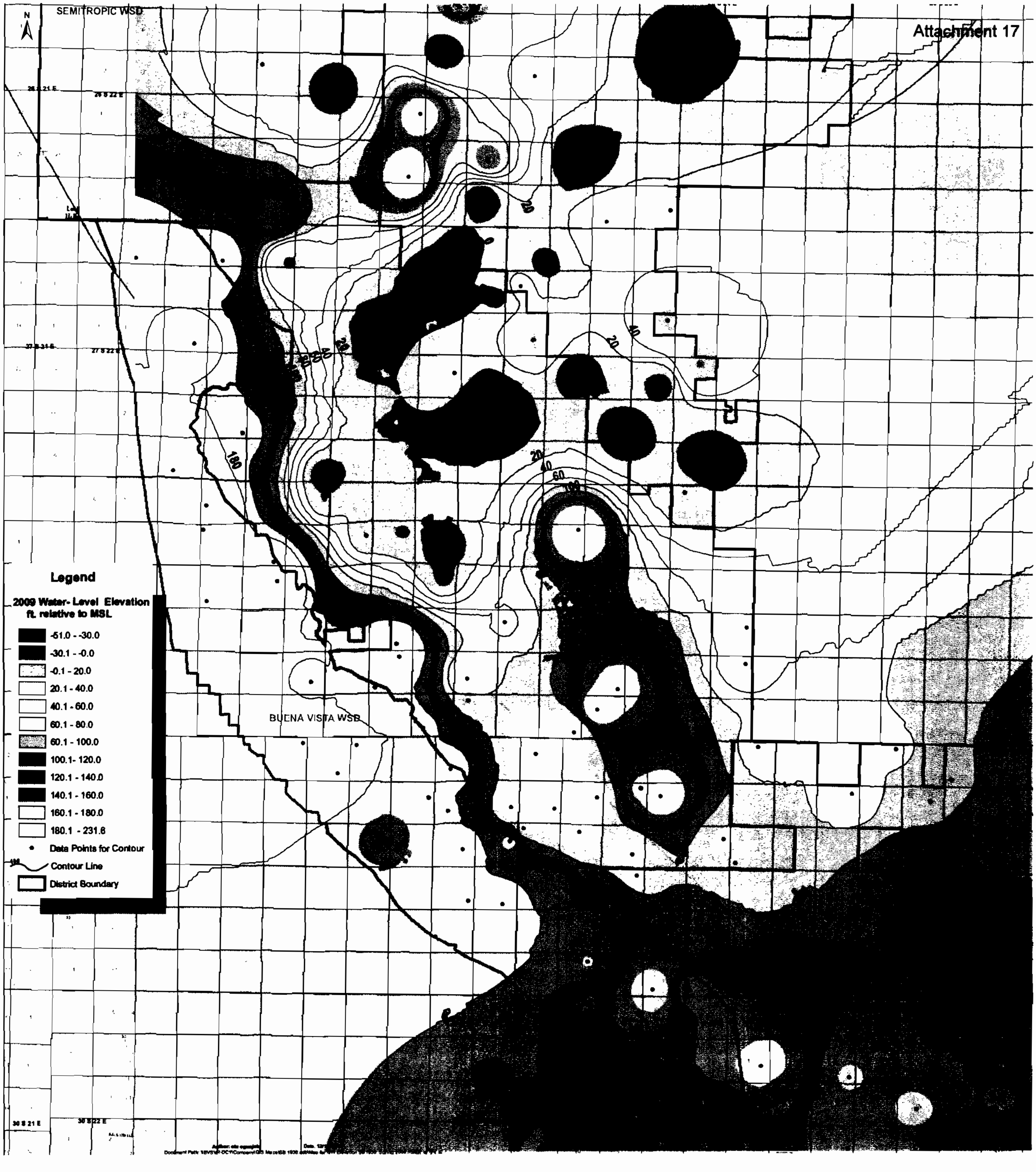


Soil and Water Figure 19. Water level locations and trends in Buttonwillow Service Area, 1974-2001.

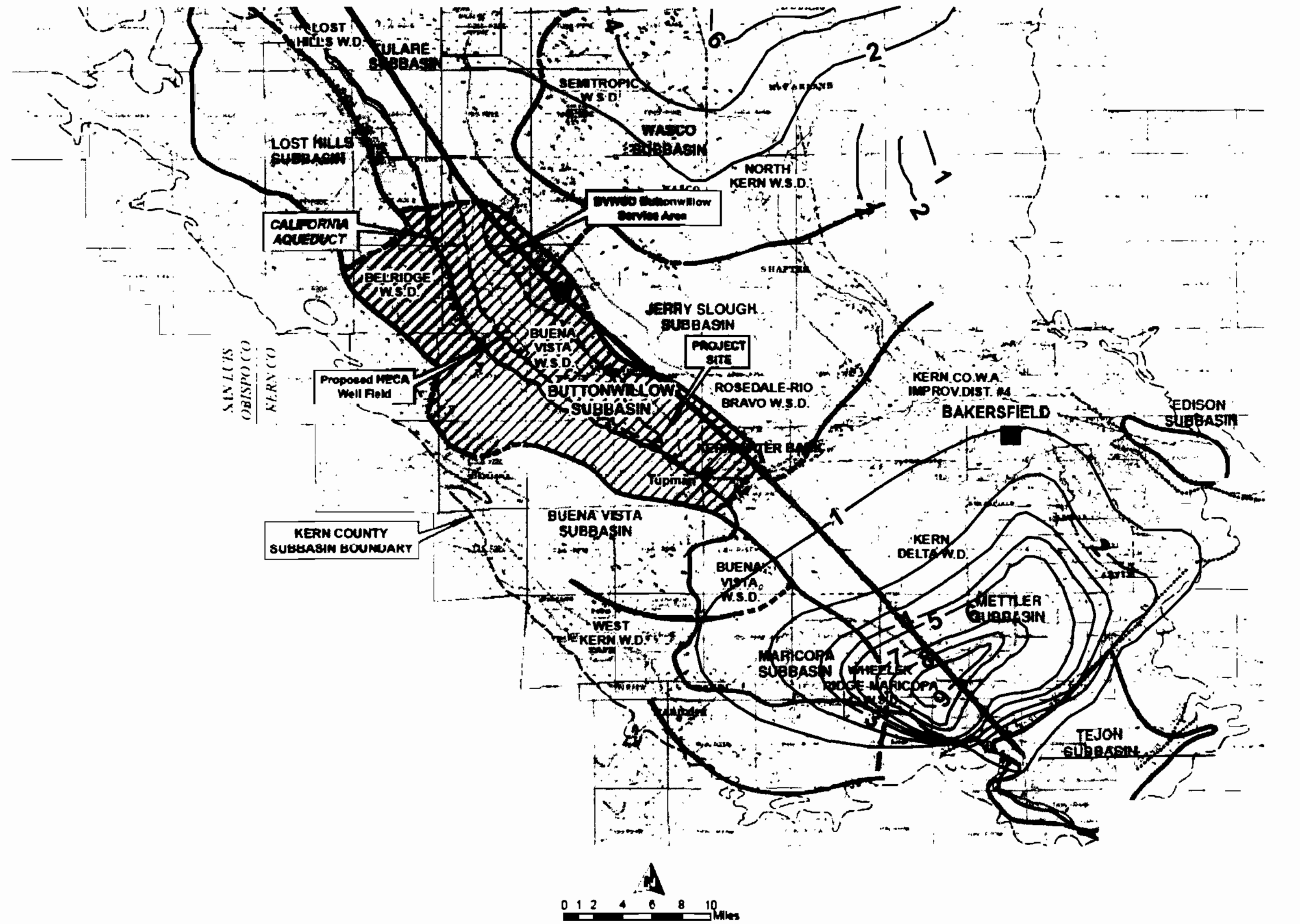

Attachment 16
N
BUENA VISTA WSD
200
180
20
40
60
25
40
60
100
Legend
1994 Water- Level Elevation
ft. relative to MSL
-30.1 - -0.0
-0.1 - 20.0
20.1 - 40.0
40.1 - 60.0
60.1 - 60.0
60.1 - 100.0
100.1- 120.0
120.1 - 140.0
140.1 - 160.0
160.1 - 180.0
180.1 - 231.6
District Boundary
Contour Line
Data Points for Contour

Attachment 17



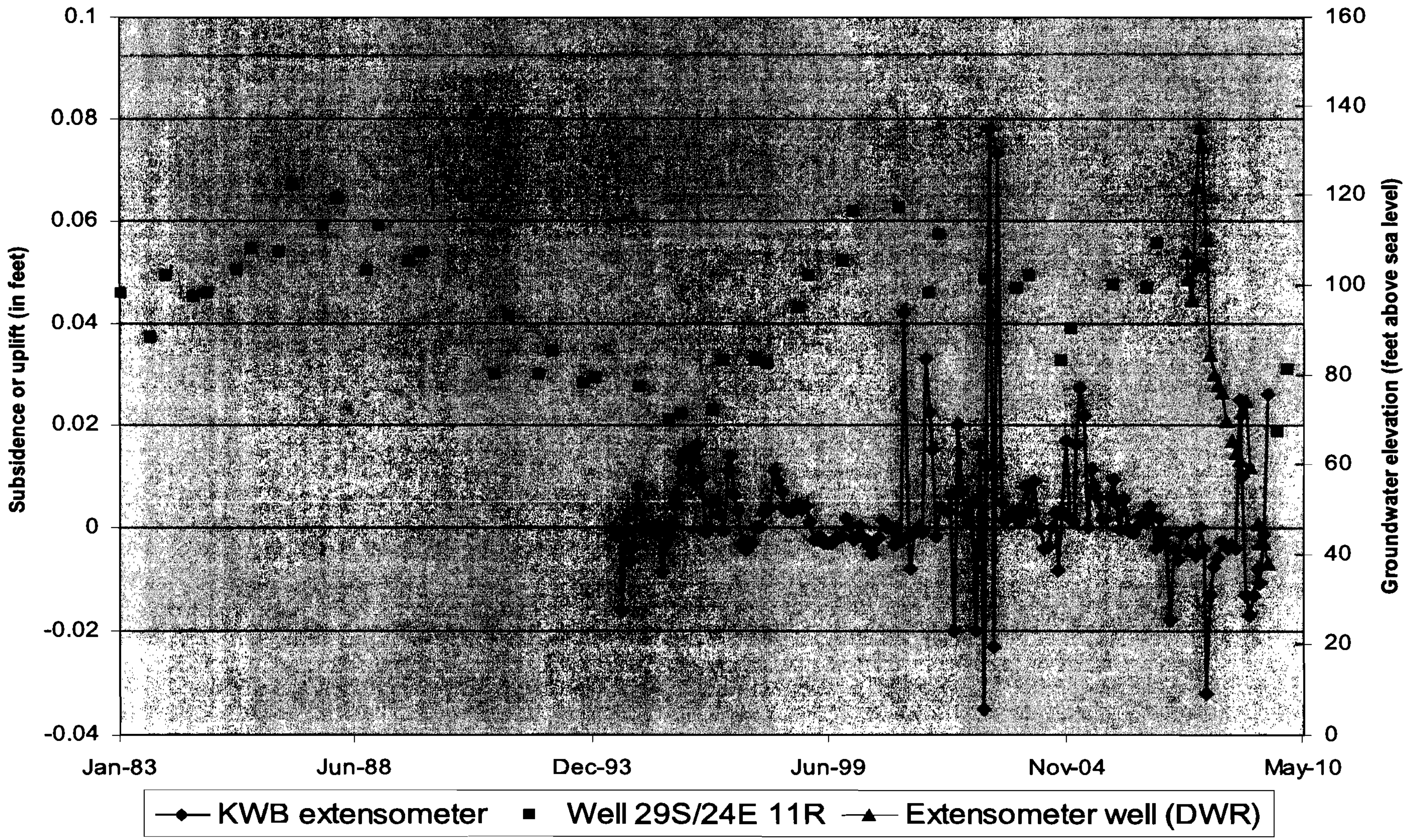
SOIL&WATER Figure 1: Kern Water Districts and Subbasins

Revised



Source: FEIR 2009

Attachment 18



Sources:

Written communication with John Kirk, California Department of Water Resources (DWR), 8/17/2010.

California DWR Water Data Library

Soil and Water Figure 21. Water level changes in wells and observed aquifer compaction at the Kern Water Bank extensometer.

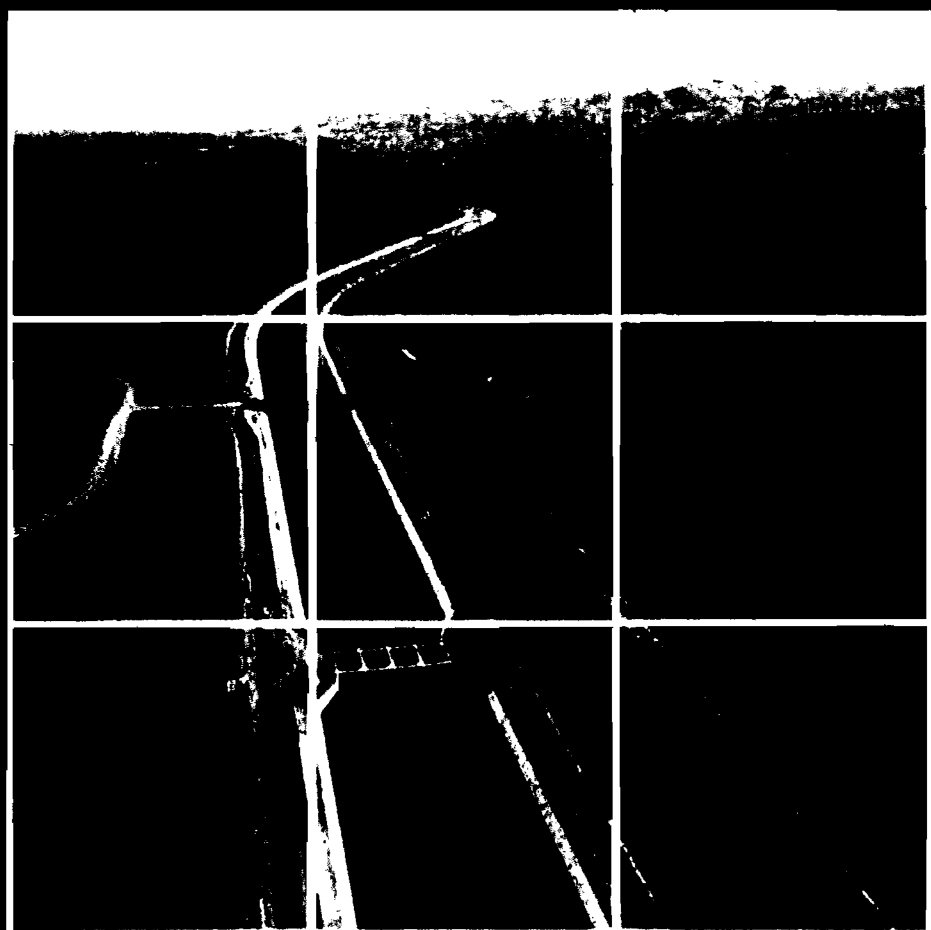


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TABLE OF CONTENTS—Continued

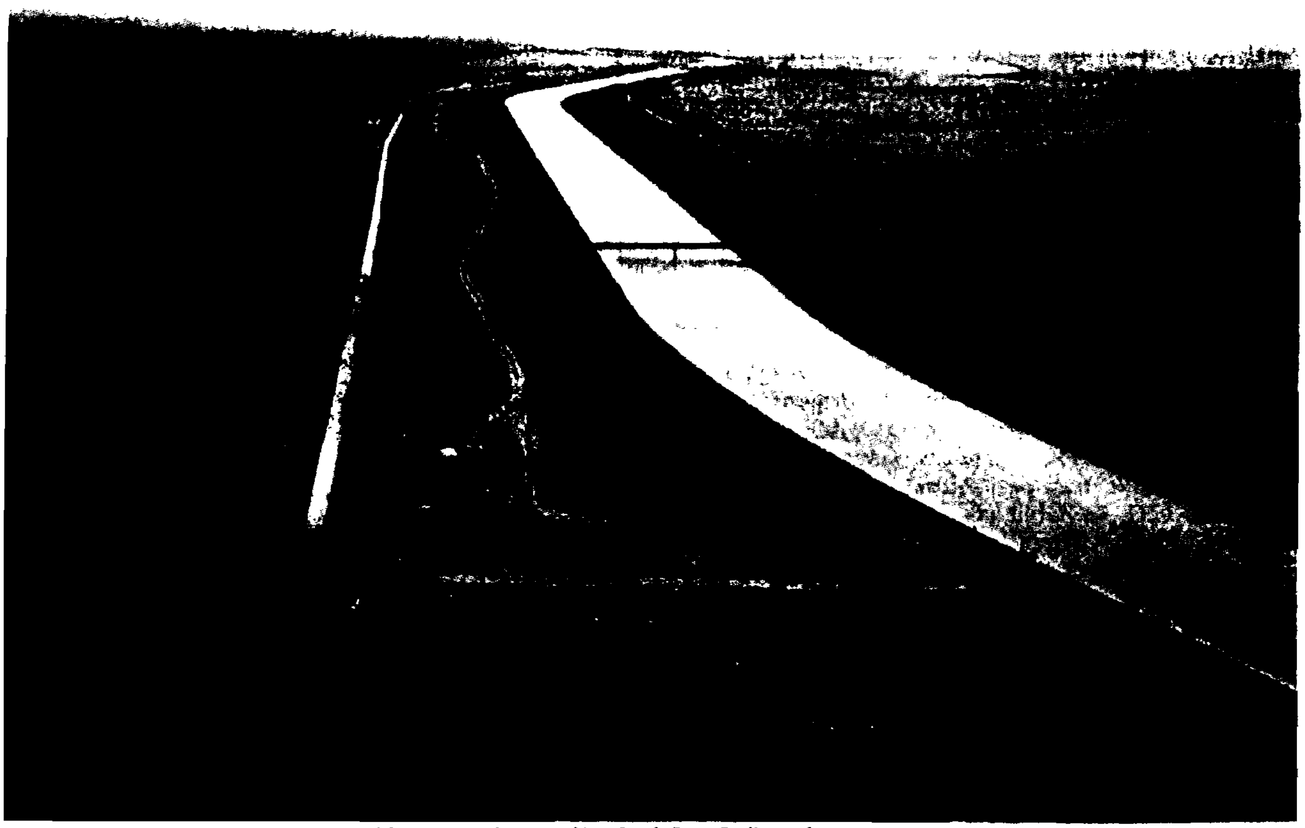

Figure 154. California Aqueduct—Looking South From Dudley Ridge Turnout Near Kettleman City

drive through the Division now dramatically illustrates the change taking place with the availability of project water. Miles of orchards and lush crops rapidly are replacing the previously bleak landscape. Annual precipitation is less than 12 inches in this area, nearly all of which accumulates from a few high-intensity short-duration storms during the winter months. The summers are long and hot with daily temperatures frequently in the upper 90- or lower 100-degree range. During the winters, freezing nighttime temperatures are not uncommon.

Features

The Division begins at Check No. 21 (Milepost 172.40) near Kettleman City. The design capacity at this check is 8,100 cfs. The bottom width decreases from 50 to 32 feet and the side slopes are 2:1.

At Milepost 236.60, the side slopes of the Aqueduct change to 2½:1 and remain so for a distance of 13 miles to the Buena Vista Pumping Plant forebay. Downstream of Buena Vista Pumping Plant, the side slopes are 2:1, the bottom width is 24 feet, the grade is 0.000045, and the design capacity is 5,050 cfs, at a depth of 22.9 feet. Eleven miles south of Buena Vista Pumping Plant, the canal capacity is reduced to 4,900 cfs and remains unchanged to Wind Gap Pumping Plant, 29 miles downstream from Buena Vista Pumping Plant.

At Wind Gap Pumping Plant, the design capacity is reduced to 4,400 cfs and remains unchanged to the terminus of the Division. There are no regulating or storage reservoirs in the South San Joaquin Division.

Twelve miles south of Kettleman City, the Coastal Branch forks from the main aqueduct. The Coastal Branch is discussed in the next chapter of this volume.

For design and construction purposes, the South San Joaquin Division conveyance facilities were divided into six sections: Kettleman City to Avenal Gap, Avenal Gap to 7th Standard Road, 7th Standard Road to Tupman Road, Tupman Road to Buena Vista Pumping Plant intake channel, Buena Vista Pumping Plant to Wheeler Ridge Pumping Plant, and Wheeler Ridge Pumping Plant to A. D. Edmonston Pumping Plant. A statistical summary of South San Joaquin Division conveyance facilities is presented in Table 11.

TABLE 11. Statistical Summary of South San Joaquin Division

CANAL

Type
Concrete-lined—trapezoidal—checked

Dimensions
Lined depth, varies from 26.31 to 21.00 feet; bottom width, varies from 32 and 24 feet; side slopes, 2:1 and 2¼:1; length, 121 miles

Capacity
Variable in steps from 8,100 cubic feet per second at head check to 7300, 6350, 5950, 5350, 5050, 4900, and 4400 at intake to A. D. Edmonston Pumping Plant

Freeboard
2.5 to 8.0 feet lined and a minimum of 2.5 feet of earth berm above lining—depth of lining dependent upon anticipated subsidence

Lining
4-inch unreinforced concrete—sealed longitudinal and transverse contraction joints on a maximum of 12¼-foot centers

Bridges
54 vehicular—1 railroad

Check Structures
15 four-radial-gate structures—11 three-radial-gate structures

Cross-Drainage Structures
26 culverts—80 overchutes

Canal Drains
2, one at Kern River and one at Pastoria Creek

Spill Basin
One located 7,000 feet upstream from Buena Vista Pumping Plant

SIPHONS

12, located at Avenal Gap channel; Temblor, Sandy, Santiago, Los Lobos, San Emigdio, Old River, Pleitito, Salt, Grapevine, and Pastoria Creeks; and Sunset Railroad

OPERATIONS

Manual on-site control or remote control from area control center (Kettleman City to Buena Vista Pumping Plant intake channel, San Luis Field Division; Buena Vista Pumping Plant to A. D. Edmonston Pumping Plant, San Joaquin Field Division)

Geology and Soils

Regional Geology

The California Aqueduct extends along the west side of the San Joaquin Valley and then turns east at the south end of the Valley to the foot of the Tehachapi Mountains. The Valley is a broad, northwest-trending, structural trough which is bordered on the east by the Sierra Nevada, on the west by the Diablo and Temblor Ranges, and on the south by the San Emigdio and Tehachapi Mountains. A great thickness of sedimentary rocks, mostly marine in origin, have been deposited from ancestral seas that once filled the San Joaquin Valley but includes some nonmarine sedimentary deposits, particularly the younger fluvial and alluvial deposits that cover the valley floor and margins. These soft, younger, nonmarine deposits which range from Plio-Pleistocene to Holocene in age are the erosional detritus from bordering highlands and form large coalescing alluvial fans and broad alluvial plains. Nearly all of the Aqueduct in the South San Joaquin Division is underlain by these younger alluvial and fluvial deposits.

About 500,000 years ago during the mid-Pleistocene epoch, there was a small orogeny or mountain-building period in the area. During this period, sedimentary deposits around the margin of the Valley were folded into low hills which protrude through the alluvial floor of the Valley. Kettleman Hills, Lost Hills, Elk Hills, and Buena Vista Hills resulted from this last orogeny.

Special Geologic Considerations

During the planning stage, it was recognized that a water conveyance system would encounter geologic-related engineering problems in the South San Joaquin Division that were unusual in most other aqueduct projects. The major geologic problems were seismicity, shallow subsidence, and deep subsidence.

The southern end of the San Joaquin Valley, because of its tectonic relationship to the active mountain-building forces in the Coast and Transverse Ranges, has been shaken by many earthquakes. Six major faults and numerous minor faults occur within 30 miles of the aqueduct alignment. Three of the major faults, the San Andreas, White Wolf, and Santa Ynez, were responsible for destructive earthquakes within historic time. The other three major faults, the Garlock, San Gabriel, and Big Pine, dominant features in the mountain ranges to the south, have not been sources of damaging earthquakes within historic times but are viewed as being capable of generating large earthquakes. In short, with the considerable seismic activity in the southern portion of the South San Joaquin Division, as well as in the Tehachapi crossing and beyond, allowances were made in design for potential disruption of the Aqueduct by seismic disturbances.

Subsidence of land surface in the western and southern portions of the San Joaquin Valley has been recognized for many years. This subsidence is attributed to two causes: (1) a deep subsidence which results from the withdrawal of ground water and the concurrent compaction of the aquifer; and (2) shallow subsidence which results from the collapse of low-density open-structure soils when saturated, a phenomenon also known as hydrocompaction.

An area of deep susidence (Figure 155), with the center of maximum subsidence near U.S. Highway 99, is approximately 15 miles south of Bakersfield. The subsidence extends from Arvin to Wheeler Ridge and westward to Maricopa. Data obtained by the U.S. Coast and Geodetic Survey and mapping by the U.S. Geological Survey indicate most of the Aqueduct across the southern end of the Valley is within an area that has subsided 1 foot. Northwest of Wheeler Ridge Pumping Plant, the canal is near the end of an area that has subsided 4 feet. To prevent this type of broad gentle settlement from impairing the delivery of water through canals, additional freeboard was added to canal embankments to compensate for anticipated settlement.

Extensive areas of shallow subsidence (Figure 156) occur along the west and south side of the San Joaquin Valley and in El Rincon Valley south of Wheeler Ridge. Soils subject to shallow subsidence originally were deposited on the alluvial fans by debris flows. Debris flows are slurries of unsorted clay, silt, sand, gravel, large boulders, and plant debris that flow from the mountains during brief but intense rainstorms. The fluid masses of debris race down canyons onto alluvial fans where they spread out within a short distance. The debris flow dries rapidly on the alluvial fans leaving a soil structure with a large amount of voids. When saturated, such soils weaken and the voids collapse, reducing soil volume and causing settlement. After much study, most of the effects of shallow subsidence were solved by applying water and inducing subsidence prior to construction of the canal.

Hydrocompactive Soils

The problem of shallow subsidence when water is applied to some of the soils in the San Joaquin Valley is discussed briefly in Chapter I of this volume. It had been recognized for decades that these hydrocompactive soils existed (Figure 156) and would create a challenging engineering problem to the southward conveyance of water. However, it was not until the Department of Water Resources and the U.S. Bureau of Reclamation became interested in the construction of the California Aqueduct and the Division of Highways (now the Department of Transportation) in building the Westside Freeway (Interstate 5) that sufficient interest, manpower, and funds became available for a full-scale investigation of the problem.

In May 1954, a joint conference held in Washington, D.C. established a cooperative program to study subsidence. This conference led directly, in December 1954, to the formation of the Interagency Committee on Land Subsidence in the San Joaquin Valley. The

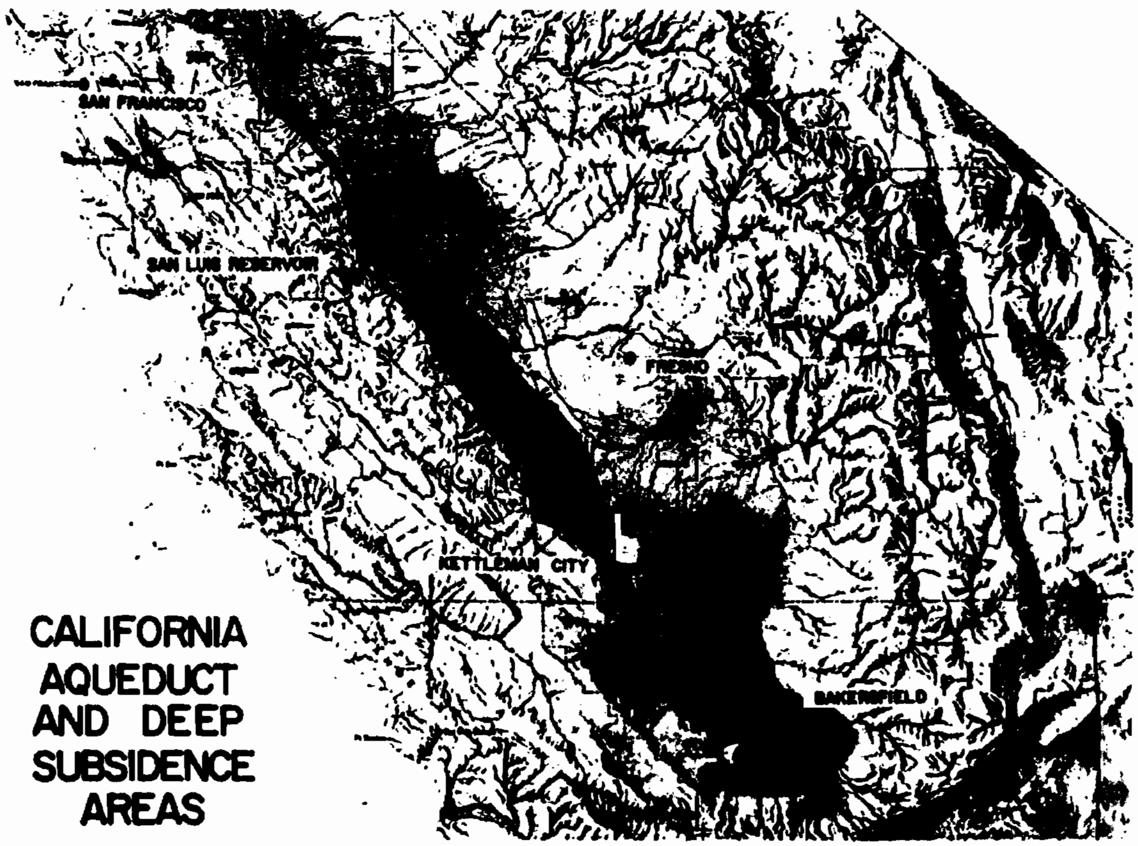

Figure 155. Areas of Deep Subsidence

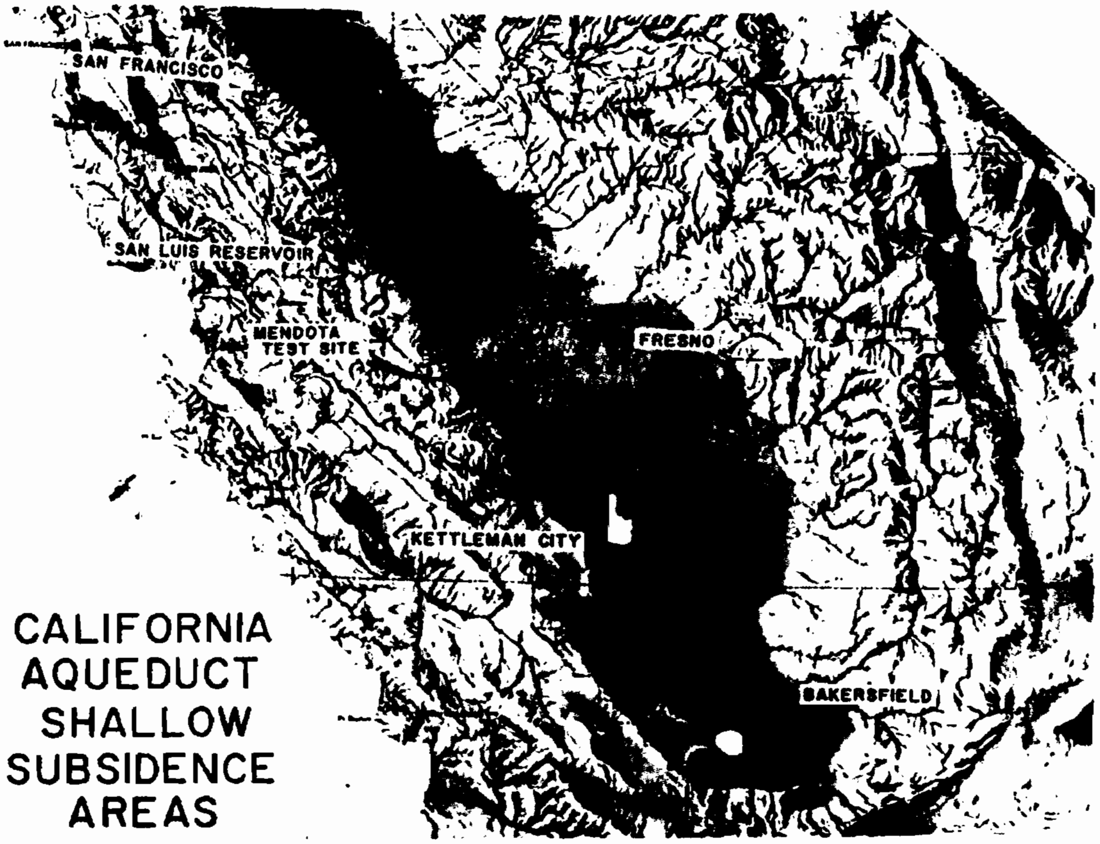

Figure 156. Areas of Shallow Subsidence

Committee was composed of federal representatives from the Bureau of Reclamation, Corps of Engineers, Geological Survey, Coast and Geodetic Survey, and the Soil Conservation Service and state representatives from the Department of Water Resources, the Division of Highways, and the University of California at Davis. The Committee was divided into three groups, each with a specific charge, to investigate (1) vertical control and topographic mapping, (2) shallow subsidence, and (3) deep subsidence.

A proposed program of investigation was prepared in 1955 by the Interagency Committee and, in 1958, a progress report on land subsidence investigations in the San Joaquin Valley was published.

One result of the interagency cooperation was an intensive study of land subsidence in the San Joaquin Valley by the U.S. Geological Survey, in financial cooperation with the Department of Water Resources. The Geological Survey reported some results of this investigation in 1972.

In 1957, the Department realized that forthcoming design and construction schedules for project facilities would require an additional and accelerated effort. Accordingly, an expanded program on shallow subsidence was initiated. This expanded program initially included the area of the San Luis Division; however, following the San Luis agreement in 1961, whereby the Bureau of Reclamation would design and construct the San Luis facilities (see Volume I of this bulletin), all information on subsidence which the Department had developed on that area was transferred to the Bureau of Reclamation.

The Department's expanded program was divided into two parts: a test site study and a route study. A 240-acre test site was selected about 15 miles south of Mendota to develop an economical technique for compaction of soils in subsidence areas and to collect data to provide a basis for route selection (Figure 157). The alignment phase was to delimit the areas of shallow subsidence, determine the rates and magnitudes of subsidence to be expected in those areas, and accomplish adequate treatment prior to construction. Data was obtained primarily from an extensive subsurface exploration program and test site investigations.

The alignment program consisted of exploratory drilling and sampling at selected locations approximately 5 miles apart along the anticipated alignment. Holes were drilled to various depths depending upon the characteristics of the samples obtained. Exploration was accomplished by utilizing compressed air as the drilling fluid and applying specialized sampling techniques. Soil samples thus

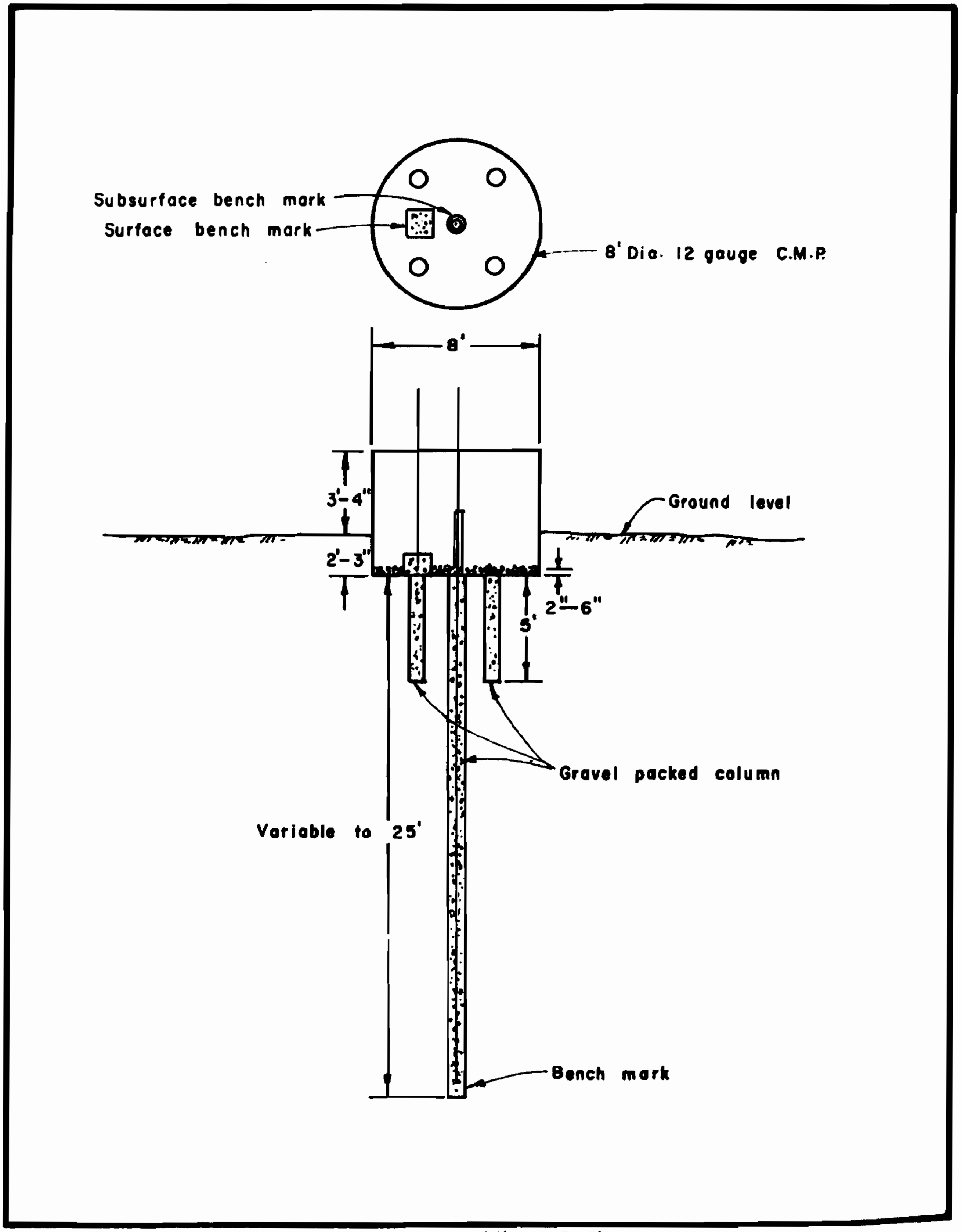

Figure 157. Typical Alignment Test Plot

provided were subjected to extensive laboratory testing.

Small test plots were installed at the sampled sites. A typical test plot consisted of embedding an 8-foot-diameter corrugated-metal pipe 2 to 3 feet into the soil. Four shallow (to 5 feet) and one deep (to 25 feet) gravel-packed wells were developed inside the perimeter of the pipe to increase the infiltration rate of the applied water (Figure 158). Usually, subsidence or swelling of the soil was observed a few hours after initial water application. After a few days, circumferential cracking occurred a few feet outside the pipe. As subsidence progressed, these cracks gradually widened to a few inches, and the soil block and tank settled. This continued action resulted in a typical, concentric, stair-stepped cavity.

The amount of subsidence along the alignment varied from 2 to 11 feet. The areas delineated which required special treatment prior to construction are shown on Figure 156.

At the Mendota test site, a study was made to determine the most effective method of water application, the optimum length of time required for water application, and the total required water. Four large and several small test plots were developed and operated. The first large plot was an unlined canal section. This section was a 200-foot by 400-foot rectangle with the depth of water kept at 1 foot. Water was applied for 484 days with an average settlement of 13.5 feet.

The second large plot was developed to evaluate the feasibility of utilizing shear cracks as a means of applying water at depth. A ditch 12 feet wide by 220 feet long was used and, as subsidence and cracking developed, the water was held at a constant elevation which resulted in the cracks becoming inundated. Water was applied for 346 days with an average subsidence of 11.5 feet.

The third large plot, also a 200-foot by 400-foot rectangle, was used to determine if the subsidence process could be accelerated by injecting water at depth through gravel-packed infiltration wells in conjunction with normal ponding. The plot was operated for 210 days with an average subsidence of 8.7 feet.

The last large plot was similar to the previous one except that the gravel-packed holes were spaced more closely. This plot was operated for 305 days with an average subsidence of 10 feet.

Several smaller test plots were used to compare various jetting techniques and to develop information on the rate at which water should be applied. Also, experiments were carried out using the vibroflotation process. This patented process increases soil density by the penetration of a vibrating tool into the soil. This process, which works better for sandy soils which are more granular than the fine-grained San Joaquin Valley alluvial soils, was not suitable.

The conclusions reached as a result of the experiments carried out at the Mendota test site in summary were:

1. Subsidence causes differential settlements of such severity that canal embankments and linings would be destroyed if the areas were not compacted.

2. Water application is an effective and most economical means of compacting those particular soils subject to subsidence.

3. Gravel-packed infiltration wells increase the rate of subsidence.

4. The extent of cracking measured from the pond's edge is dependent upon the subsidence magnitude and the soil type.

Figure 158. Example of Localized Shallow Subsidence

5. A drying period is required between completion of the ponding operation and construction of the Aqueduct, since the moisture content of soils encountered will be slightly over optimum after a 6- to 12-month drying period.

6. About 80 to 90% of expected shallow subsidence would be achieved prior to construction—allowance would be made for further subsidence by providing extra freeboard.

An additional study and experimental program were developed to explore the potential for soil liquefaction of the hydrocompacted soils during ground motions from earthquakes. A supplemental objective was to determine the dynamic soil characteristics of the canal embankments and foundation soils. This program also was carried out at the Mendota test site.

Phase I of the testing utilized a large vibration generator (40,000 pounds maximum force) to induce a dynamic loading. Resonant frequencies were determined by preliminary testing, and final tests were performed at the resonant frequencies using maximum input forces. Phase II testing utilized explosives to induce dynamic loading. A test pattern utilizing column charges and time-delay blasting caps was developed to simulate a seismic shock in the soil mass. Using this technique, it was possible to induce larger dynamic forces than were attainable with the vibration generator.

Instrumentation for the liquefaction studies was designed to obtain data on embankment vibrations, pore pressures, and vertical and horizontal movements of the test section. The instruments used were geophones, high-speed Brush Recorders, Carlson pore pressure cells, open piezometers, and survey reference points. Some use was made of a Sprengnether portable seismograph and a special strong-motion seismograph operated by the U.S. Coast and Geodetic Survey.

Geophones proved to be the most economical and reliable instrumentation for obtaining vibrational data. Embankment response was measured in three dimensions from several locations simultaneously. The results were compared on an energy-ratio basis with the 1940 El Centro and 1952 Taft earthquakes. These two seismic occurrences were used for comparison as data were recorded from them in deep alluvium and near the earthquakes. Caution was required in making comparisons as maximum amplitudes are more damaging to embankments, whereas duration and frequency of shaking are quite critical in the actual inducement of liquefaction in a soil mass.

The conclusions, based on the liquefaction tests at the Mendota test site, and the analysis of the resulting data follow:

1. Liquefaction of the foundation soils at the Mendota test site was not observed during any phase of the testing.

2. The accelerations caused by the large vibration generator were less than would be expected during a severe earthquake. Duration or cycles of the dynamic loading during this phase of the testing were much greater than would be expected for an earthquake.

3. Accelerations caused by the blasting tests were greater than would be expected for the design earthquake, but the duration of the dynamic loading was shorter than that of a severe earthquake.

4. Compaction, caused by the dynamic loading of a severe earthquake, will result in settlement of the canal embankments in most hydrocompacted subsidence areas. The magnitude of the settlements will be dependent upon the depth of subsidable soils and may be as large as 1 foot for the deeper deposits.

5. Seismic stress of the magnitude induced by the large vibration generator will have little or no effect on the canal embankments.

6. Extensive embankment cracking and settlement will result from seismic loadings of the magnitude induced by the blasting tests. A severe earthquake will cause settlement and cracking of the embankments founded on hydrocompacted alluvial soils.

7. Low-density saturated soils could be compacted in localized problem areas through the use of a blasting technique.

8. No general corrective design is indicated as a result of the liquefaction testing performed at the Mendota test site.

Geology on Canal Alignment

Excavation for the canal was almost entirely in alluvial deposits. Limited stretches of marine rocks (Tejon formation) and continental deposits (Tecuya and Tulare formations) were encountered in the flanks of the Kettleman Hills, in the intake channel to Buena Vista Pumping Plant, in Wind Gap Cut, and in the foothills of the Tehachapi Mountains near A. D. Edmonston Pumping Plant. The various formations encountered by the conveyance system in the South San Joaquin Division are described in more detail in the paragraphs that follow.

The Tejon formation is comprised mostly of massive, gray, silty-sandstone beds with thin interbeds of dark shale. Massive, hard, calcium-carbonate-cemented strata rich in fossils also are encountered. The formation is formed of Eocene marine sedimentary rock and rests unconformably on the crystalline rocks that constitute the core of the Tehachapi Mountains.

The Tecuya formation overlies the marine Tejon sandstones and is of Oligocene-Miocene Age. The formation is comprised of continental deposits, both alluvial fan and shallow water deposits which accumulated at the base of the Mountains near the edge of the retreating Eocene sea. Volcanic rocks, dacite, basalt, and agglomerate are interbedded with the sedimentary rocks. An exposure of the Tecuya formation which consists entirely of sedimentary rocks was encountered in bulldozer trenches excavated in the low foothills west of Pastoria Creek. The layers are comprised of poorly indurated siltstones and sandy-siltstones and poorly consolidated friable sandstones and conglomerates. The gravels in the conglomerates are comprised of well-rounded coarse-grained boulders and are distinguished by the decomposed coarse-grained rocks.

The Tulare formation is comprised of continental deposits which crop out at widely scattered locations along the west and south sides of the San Joaquin Valley. The formation contains beds of sand, gravel, and mudstone which have accumulated under environmental conditions similar to the present conditions and are, therefore, considered to be alluvial fan and lakebed deposits. The formation is Plio-Pleistocene in age and subsequently has been both folded and faulted. The gravels are limestone, metamorphic rocks, and distinctive white siliceous shale which comes from the Coast Ranges.

Recent Alluvium

A series of coalescing alluvial fans occur at the base of the mountain ranges that border the west and south sides of the San Joaquin Valley. In the central part, the Valley is occupied by lake bottom lands, sloughs, and flat alluvial plains. The alluvial fan deposits accumulated intermittently during brief but intense rainstorms, and the lakebed deposits were transported into the Valley during times of heavy runoff from the Sierra Nevada. At the shoreline of the lakes and on the alluvial fan surfaces, wind-blown deposits are interspersed with alluvial deposits. Character of the soils varies directly with the environment of deposition and the rock types on the alluvium source areas. There are many variations in both the vertical and horizontal distribution of the soil types encountered during the subsurface investigation for the California Aqueduct.

Because the rock types in the source areas are mainly shales and sandstones, the alluvial fan deposits along the west side of the Valley from Kettleman City to Maricopa predominantly are very fine-grained sand and silty sand with lesser amounts of sandy clay, silt, and gravel. Gravels characteristically have flat cobbles of siliceous shale. Interbedded with the alluvial fan deposits are lakebed deposits of silt and clay and fine- to coarse-grained sands and dune sands which were accumulated along the shoreline of ancestral Tulare and Buena Vista Lakes.

Both the San Emigdio Mountains to the south and the Tehachapi Mountains to the southeast of the San Joaquin Valley contain a core of older crystalline rocks that is overlain by northerly dipping, Tertiary, marine and nonmarine, sedimentary rocks and Tertiary volcanic rocks. Alluvial fans at the base of these mountains reflect the greater durability of the crystalline rock types and therefore contain more sand, gravel, and boulders. For this reason, alluvial deposits around the south margins of the San Joaquin Valley are, in general, comprised of coarser-grained soil types.

Adjacent to Buena Vista Slough and along the northern and western edges of Buena Vista Lake, alluvial fan deposits are interbedded with lakebed deposits composed primarily of lacustrine clays and micaceous sands. The bulk of the clay material was transported from the Sierra Nevada by the Kern River. Along the shoreline of the Lake, alluvial fan materials derived from the predominantly coarse-grained Tulare formation in the adjacent Elk Hills and Buena Vista Hills overlie, and are interbedded with, highly plastic clay lakebed deposits. Highly variable deposits have resulted from a fluctuating shoreline and recent uplift of the bordering hills.

Design

The majority of the design features and criteria are consistent with, and in many cases identical to, those used in the North San Joaquin Division, discussed in Chapters I and IV of this volume. The principal differences are the varying dimensions of the canal and the side-slope configuration used for the canal sections in this division.

The canal dimensional changes were determined by the reduction in required capacity between water delivery turnouts within the Division. Changes in physical dimensions were kept to a minimum to facilitate the use of standard operation and maintenance equipment and to reduce construction costs associated with specialized equipment, such as the paving train for the aqueduct lining. The dimensional changes were minimized by changing the depth of water to achieve the required flow.

Flatter side slopes were adopted because of the weaker soils encountered in this division and to allow for residual subsidence from hydrocompaction or foundation liquefaction. Between Tupman Road and Buena Vista Pumping Plant, side slopes of 2½:1 were used because of a combination of high ground water and weak soils.

Freeboard

The operational freeboard of 2.5 feet of lining above normal water surface and 2.5 feet of earth-berm freeboard above the lining is similar to the provisions used in the North San Joaquin Division. However, in this division, a variable contingency freeboard was established to allow for subsidence. Allowance was made for both shallow subsidence from hydrocompaction and deeper subsidence from ground water extraction.

The subsidence freeboard is lined above the operational freeboard, and the amount varied with the foundation conditions encountered. Deep subsidence freeboard varied from zero to 3.5 feet at Wheeler Ridge, where possible future regional tilting also was taken into consideration. Freeboard for shallow subsidence varies from zero to 2 feet and was established from the amount of subsidence experienced in preconstruction consolidation. The total lined freeboard in the Division, therefore, varies from a minimum of 2.5 feet to a maximum of 8.0 feet.

Underdrains

Although ground water during construction was not as extensive a problem as it was in the North San Joaquin Division, it will be a factor during the operation of the facilities in the southern portion of the South San Joaquin Division. Because of the low shear value of the soils over approximately one-half of the 120 miles of canal in this division, an extensive system of underdrains, sumps, and pumps with regulatory equipment was provided to control the ground water level and prevent the soils from becoming saturated.

Severe fluctuations in canal water levels are imposed downstream of project pumping plants by intermittent off-peak pumping. In those locations, design provided ground water level control features consistent with the anticipated canal water fluctuations to avoid overstressing the aqueduct lining.

The underdrains in this division differ from the filter blankets installed in the North San Joaquin Division. Extensive finger drains were constructed using larger size filter material, collector pipes, and automatic permanent pumping equipment.

The finger drains (Figure 159) adopted for the underdrain system are 18-inch-square trench sections placed on the side slopes perpendicular to the centerline of the canal and backfilled with 3-inch-maximum filter material. They are either directly under the concrete canal lining or beneath the compacted sublining on 12-foot-6-inch to 20-foot centers. The finger drains extend upward for varying distances from 9 feet vertical above the invert to full height. In critical areas, they extend downward from the top of the lining from 7 to 13 feet. The drains were placed on either one or both sides of the canal and

Figure 159. Finger Drain Excavation—Buena Vista Pumping Plant Intake Channel

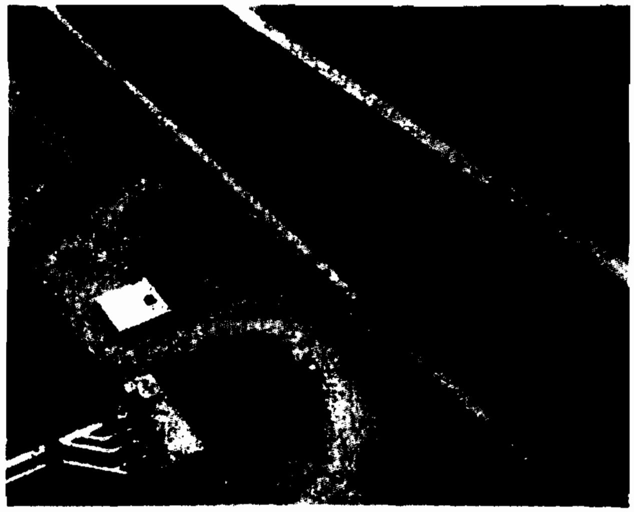

Figure 160. Turnout and Pumping Station for Belridge Irrigation District Near 7th Standard Road

terminate in collector pipes which drain directly or through a header pipe into a sump.

The sumps are 36-inch-diameter reinforced-concrete pipe extending from the top of the lining to approximately 10 feet below canal invert. The collected drainage is pumped from the sumps and discharged into the canal. Pipe cleanouts extend from the header pipes to slightly above ground surface. These cleanouts are located at the beginning and termination of each underdrain siphon and midway between the sumps. The portion of the cleanout extending aboveground is perforated for a vent.

Bridges

Bridge designs were similar to those in the North San Joaquin Division except for locations where further subsidence is expected. At these locations, design provided for raising the structure by jacking.

Turnouts

Turnouts (Figure 160) were classed as major or minor. Major turnouts are those with the capability of delivering 200 cfs or 5% of the aqueduct flow with the water surface at the minimum operating level. Minor turnouts are those with a lesser delivery capability. All turnouts in the South San Joaquin Division now are being equipped with automated flow controls operated either locally or from the area control center.

Turnouts were designed for either gravity or pump delivery with design standardized where possible. Special conditions, however, required individual design. In some cases, the design was prepared by the water users. In all cases, the design required mutual approval. If possible, the turnout construction was incorporated within the aqueduct contracts or by grouping the turnouts into a separate contract. In cases where the details of the turnout were not available but the location was known, only the headworks and a short section of delivery pipe were constructed. If the location was selected after lining construction, the lining was cut for the installation.

Turnout headworks normally consist of a trashrack with slide gates and a supporting structure. In some cases, the slide gates will not be installed until the water user constructs the connecting delivery system. Stoplogs are provided for dewatering the turnout. Deliveries are measured by a flow tube for a pipeline system or by a Parshall flume for an open-channel system. The slide gates are of the flat-back type and were designed to operate against a seating head of 20 feet and an unseating head of 5 feet.

The measuring system consists of primary and secondary equipment. Flow tubes and Parshall flumes are primary equipment; the secondary equipment provides a flow rate and records of flow. Flow through a Parshall flume is determined by the relationship between the width of the throat and the height of water in the stilling well. Secondary equipment converts the water-level reading from the stilling well to a flow-rate signal. Rate of flow through a flow tube is determined by the difference in pressure of the water at the inlet and throat sections of the tube. Secondary equipment converts the difference in the water pressure into a flow-rate signal. In both cases, the secondary equipment provides the on-site instantaneous flow rate, a readout of the totalized flow, and a recorder chart showing the continuous flow pattern.

Construction

Construction was supervised from a project office in Bakersfield. Field offices were established as needed at construction sites. A soils and concrete laboratory was established at Taft.

Because of the lead time required between preconsolidation and actual canal construction, work commenced on the preconsolidation contracts as early as the summer of 1963. The last section of the conveyance facilities was completed in the spring of 1971. The description of aqueduct construction is presented in a north-to-south order, irrespective of contract dates. The preconsolidation contracts are described first, since the preconsolidation work necessarily preceded aqueduct construction and was distinctive in itself.

Throughout the period of construction of the open-channel aqueduct in the South San Joaquin Division, new contraction joint designs, new methods of sealing the joints, and new sealants were proposed, investigated, and some were approved.

Preconsolidation Contracts

There were six major construction contracts covering five locations for preconsolidation ponds. There were two supplemental contracts for water wells and pumping equipment. Fifteen service and supply contracts were utilized to provide such back-up services as power facilities, pipe distribution systems, and contracts to furnish ponding water.

General information about the six major preconsolidation contracts is shown in Table 12.

Vicinity of Arroyo Pino Creek. This contract included three-tenths of a mile of the Aqueduct just south of Kettleman Hills, which was the only portion where significant shallow subsidence was identified in the first 39 miles of the South San Joaquin Division. The work consisted of constructing four consolidation ponds with turnouts and necessary water delivery pipelines and appurtenances. One of the ponds was in the channel of Arroyo Pino Creek.

The ponds were excavated and the surrounding dikes constructed from the excavated material with conventional earth-moving equipment. The ponds within the runoff channel were leveled with an uncompacted layer of earth to provide a uniform

TABLE 12. Major Preconsolidation Contracts—South San Joaquin Division

	Specification	Low bid amount	Final contract cost	Total cost—change orders	Starting date	Comple-tion date	Prime contractor
Arroyo Pino Features Mile 177.4 to Mile 177.7	65-16	$13,602	$16,972	..	5/17/65	7/ 1/65	W. M. Lyles Co.
Lerdo Highway to Tupman Road Mile 215.6 to Mile 238.9	64-41	2,213,629	2,354,106	$31,662	11/18/64	11/10/65	Peter Kiewit Sons' Co.
Buena Vista Pumping Plant to Wheeler Ridge No. 1 Mile 255.7 to Mile 279.2	64-46	3,910,386	4,184,121	135,756	1/ 2/65	3/11/66	Eugene Luhr & Co. and Hood Corporation and Hood Construction Co.
Sunset Railroad to Maricopa Highway Mile 261.6 to Mile 274.3	66-12	565,410	558,936	2,438	4/ 5/66	7/29/66	William H. Schallock
Wheeler Ridge Pumping Plant No. 1 to Standard Oil Company Road Mile 279.2 to Mile 283.9	64-21	874,672	796,403	54,041	6/22/64	4/ 2/65	William H. Schallock
Standard Oil Company Road to Grapevine Creek Mile 283.9 to Mile 288.7	63-32	610,539	635,092	37,949	11/ 8/63	3/31/65	Pascal and Ludwig

surface for the water application.

The water for preconsolidation was furnished and applied by the Tulare Lake Water Storage District. This district is a user of project water and, by agreement, was reimbursed in kind from the completed California Aqueduct for the water used. This arrangement was frequently followed for the preconsolidation contracts. Ponding operations began on July 7, 1965 and terminated on October 4, 1965. Only minor subsidence occurred, about 0.7 of a foot.

Lerdo Highway to Tupman Road. This contract extended over 23.3 miles and consisted of 273 subsidence ponds with infiltration wells. This section of the Aqueduct parallels the West Side Canal of the Buena Vista Water Storage District. Arrangements were made with this district to supply the ponding water. The contract included installation of the necessary pumps, motors, pipelines, and appurtenances to deliver the water from the West Side Canal to the filtration ponds.

The filtration ponds (Figure 161) usually were 200 by 500 feet but were widened as required to treat bridge and drainage structure sites. Excavation and dike compaction were conventional. The contractor used newly designed 32-cubic-yard scrapers. He also used a sprinkling system to wet the excavation areas prior to removal of the material.

A typical pond contained 14 gravel-packed infiltration wells without benchmarks and one well with a benchmark for measuring the subsidence at the bottom of the well. The depth of the wells varied from 40 to 80 feet, depending on information obtained during the foundation investigation program. In some cases, ground water was encountered prior to reaching the specified depth. If ground water was reached within 10 feet of the specified depth, the well was terminated at that depth.

Figure 161. Subsidence Ponds in Preconsolidation Area

Figure 162. Typical Cracking Caused by Preconsolidation of Subsidence Areas

The infiltration wells were drilled with auger equipment operated from motor cranes. Soil samples from each hole were tested for later use in design of the Aqueduct. The gravel was fed into the holes by means of an adjustable tremie operated by a drilling crane. The discharge end of the tremie was maintained 1 foot above the gravel level. Gravel was mounded above the hole and covered prior to water application.

Water for the ponds was obtained by installing pumps at suitable locations along the West Side Canal. The pumps were set on pile-supported platforms with the necessary delivery, header, and pond pipes running from each pump site.

Several road detours and service roads were included in the contract. Department personnel applied the water to the ponds. Work commenced in June 1965 and was completed in April 1967. A total of slightly more than 45,000 acre-feet was applied to the ponds. Maximum surface subsidence was 1.23 feet.

Buena Vista Pumping Plant to Wheeler Ridge Pumping Plant. This contract extended over 23.5 miles of the aqueduct alignment. Over the northerly quarter and southerly half of this alignment, medium to high subsidence was anticipated. However, over a length of about 7 miles from the Maricopa Road crossing westward, the anticipated subsidence was uncertain. The degree of treatment was determined by excavating a "V" ditch along this length and placing infiltration wells on 500-foot centers. The resulting subsidence demonstrated the need for further treatment which was provided by a later contract. Figures 162 and 163 show typical cracking in this reach.

V – Conclusions and practical application

The final verdict is not yet in on the long-term viability of this project. In addition, only sites with sufficient drainage allowing a 15 to 25% leaching fraction will be suitable for this strategy. But if proven successful, the eventual savings in water costs will be about $120/acre for mature tree ET. This equals $37,000/year for the 310 acre orchard. This doesn't even take into account the fact that planting this acreage would be impossible without using the "substandard" water. At this writing there are about 4,000 additional acres of pistachios planted or scheduled for 2007 in Buttonwillow and NW Kern County on saline ground with marginal well water that would not have been developed three years ago. Between marginal groundwater and blended drain water there is more than 150,000 ac-ft/year of additional "alternative" water supply on the Westside that appears suitable for pistachios. The aggregate value of this water and the potential development of 30 to 40,000 acres of pistachios replacing cotton and wheat rotations could easily exceed a benefit of $30 million/year over the value of the field crops.

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Attachment 22

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November 10, 2010

Mr. Rod Jones
Project Manager
CALIFORNIA ENERGY COMMISSION
Siting, Transmission, and Environmental Protection Division
1516 Ninth Street, MS-15
Sacramento, CA 95814-5512

Re: Statement in Support of Hydrogen Energy California Power Plant Project's Proposed Use of Buena Vista Water Storage District's Brackish Water
(California Energy Commission Docket No. 08-AFC-8)

Dear Mr. Jones:

Buena Vista Water Storage District ("Buena Vista" or "District") wishes to thank you for the opportunity of allowing the District to consider and favorably comment upon the important issue of using brackish groundwater supplies underlying the District for the proposed Hydrogen Energy California Power Plant Project (HECA Project). In addition to the State Water Resources Control Board correspondence dated June 20, 2010 which discusses certain State Water Resources Control Board policies (SWRCB Correspondence), the District also wishes to provide the California Energy Commission (CEC) with, and comment upon, other specific policies of the State of California which clearly and unequivocally support the use of the District's brackish groundwater for the HECA project.

As an introductory matter, Buena Vista Water Storage District (the supplier of the brackish water to be used in the HECA Project) is a California Water Storage District, formed and operating under Division 14 of the California Water Code (Section 39000, et seq.) The District principally supplies irrigation water to landowners. In accordance with its enabling legislation, the District is vested with all power and authority necessary to enable it to acquire, improve, and operate necessary works for the storage and distribution of water and any drainage or reclamation works connected therewith (see for example Water Code §§ 43000 and 43150). In fact, for water storage districts such as Buena Vista, the California Legislature has specifically provided that "All waters and water rights belonging to this State within the district are given, dedicated and set apart for the uses and purposes of the district." (Water Code § 43158.)

As part of the District's ongoing water management planning and operations, and in accordance with the powers and authorities vested in the District with respect to water-related issues, the District has developed and adopted a water management plan, known as the BUENA VISTA WATER MANAGEMENT PROGRAM ("Water Management Program"). The Water Management Program's Final Environmental Impact Report (FEIR) was certified on January 12, 2010 [State Clearinghouse No. 2009011008]. The Water Management Program was developed to further implement the District's mission, which is to provide the landowners and water users of the District with a reliable, affordable, and usable water supply, while facilitating programs that protect and benefit the groundwater basin and better utilize water supply resources (FEIR p. I-1). The Water Management Program consists of four components, each such component being a separate and individual project designed to more effectively and beneficially manage the District's water resources. The four Water Management Program components consist of:

Component 1: a Groundwater Recharge and Recovery Project;
Component 2: a Water Exchange Project;
Component 3: a Conservation Easement Water Acquisition and Management Project;
and Component 4: a Brackish Groundwater Remediation Project.

It is the last referenced water management project that is of interest in the HECA Project process. The Brackish Groundwater Remediation Project (BGRP) was developed to remediate brackish groundwater conditions within certain areas underlying the District. By way of background, there are a number of localized areas and zones within the District that contain elevated TDS concentrations in the range of 2,000 to 4,000 mg/l. Typically, these areas are located along the westerly District boundaries. These high TDS waters recharge the underground aquifer from the west (FEIR, p. III-7). Elevated TDS concentrations have already adversely impacted plant growth and crop yields in certain areas (FEIR, p. II-10). The purpose of the District's BGRP is to construct and operate strategically located brackish groundwater recovery wells and associated collection and conveyance pipelines that will extract and transport brackish water to participants who will operate receiving facilities that may be located either inside or outside District boundaries (FEIR, p. III-5). The HECA Project is one such participant. The use of extraction wells will enable the District to reduce the inflow of brackish groundwater underlying the District, thus tending to halt or slow the reduction of irrigable acres within the District, while also halting or slowing any trends of local farming interests to grow less economically viable crops or, in some cases, eliminate farming practices altogether.

With respect to the SWRCB Correspondence, the District fully concurs with the statement contained therein that provides ". . . state policy for water quality control does allow, under some circumstances, the use of supply water with TDS ranging from 1,000 to 3,000 mg/l to supply renewable energy projects." In fact, the circumstances surrounding the HECA Project and use of brackish water pursuant to the District's BGRP are fully consistent with such statement and the other principles that are discussed in the SWRCB Correspondence. As an example, the anticipated TDS of water provided under the BGRP to the HECA Project is expected to be within the range of 2,000 to 4,000 mg/l (FEIR, p. III-7), which is clearly within the TDS parameters referenced in the SWRCB Correspondence and therefore consistent with SWRCB Resolutions 75-58 and 88-63.

Additionally, the water to be provided is "brackish water from natural sources" as referenced in SWRCB Resolution 75-58 and as discussed in Principle No. 1 of such correspondence. The District's supply meets the priority scheme suggested by Principle No. 1 because no other higher priority brackish water is available for the project (higher priority water being defined and limited under Resolution 75-58 to only "wastewater being discharged to the ocean" or "ocean" water).

Use of brackish water pursuant to Buena Vista's BGRP is also consistent with Principle No. 2 as set forth in the SWRB Correspondence. The water being provided is not "fresh inland waters" as defined or described within such correspondence or as referenced in SWRCB Resolution 75-58. Again, the supply water will be brackish groundwater with an anticipated salinity range of between 2,000 to 4,000 mg/l, and which provides no habitat for fish or wildlife.

Use of brackish groundwater provided from Buena Vista's BGRP is also consistent with Principle No. 7, which suggests using wastewater for power plant purposes if available. The brackish water being provided by the District is consistent with this principle in that (a) no wastewater is available for use at the HECA Project location, and (b) using the naturally occurring brackish water is of a higher use "priority" than using wastewater, as is referenced in the priority scheme set forth in Principle No. 1 above and in SWRCB Resolution 75-58.

Buena Vista would also like to advise the CEC that Buena Vista Water Storage District's geographic boundaries are not located in a "water short area" where the commodity value of the water is so high that even highly brackish water should be preserved solely for domestic use. In fact, total District groundwater replenishment currently exceeds District groundwater extraction by an annual average of approximately 46,000 acre-feet per year (FEIR, p. III-2). Therefore, the use of Buena Vista's brackish groundwater for the HECA Project will not result in a water supply deficit within the area.

As explained above, Buena Vista believes the use of water pursuant to its BGRP is fully consistent with SWRCB policies, including Resolutions 75-58 and 88-63, as referenced and discussed in the SWRCB Correspondence of June 20, 2010.

In addition to the policies and SWRCB resolutions referenced in the SWRCB Correspondence, there are other California policy statements that support the use of Buena Vista's brackish groundwater for the HECA Project. In fact, the State of California has regularly and consistently recognized salinity and brackish water as an area of concern within the state. For example, the State Water Resources Control Board has included a statement on its website, as follows:

> Elevated salinity and nitrates in surface water and groundwater are increasing problems affecting much of California, other western states, and arid regions throughout the world. In California, as surface and groundwater supplies become scarcer, and as wastewater streams become more concentrated, salinity and nitrate impairments are occurring with greater frequency and magnitude. (See: www.swrcb.ca.gov\centralvalley\water-ssues\salinity\index.shtml.)

Furthermore, the State of California, by and through the State Water Resources Control Board, adopted Resolution 2009-0011 which, in turn, adopted California's Recycled Water Policy. The preamble to the Recycled Water Policy includes the following statements:

"To achieve that mission, we support and encourage every region in California to develop a **salt/nutrient management** plan by 2014 ...." (Emphasis added.)

"We strongly **encourage local and regional water agencies to move toward** clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply infrastructure ...." (Emphasis added.)

"We declare our independence from relying on the vagaries of annual precipitation and move towards sustainable **management of** surface waters and **groundwater**, together with enhanced water conservation, water reuse, and the use of stormwater." (Emphasis added.)

Section 6.b.(a) of the Recycled Water Policy proposes the adoption of salt/nutrient management plans and specifically provides:

"It is the intent of this Policy for every groundwater basin/sub-basin in California to have a consistent **salt/nutrient management** plan. The degree of specificity within these plans and the length of these plans will be dependent on a variety of **site-specific factors**, including but not limited to size and complexity of a basin, source water quality, stormwater recharge, hydrogeology, and aquifer water quality." (Emphasis added.)

In August of 2009, a memorandum was circulated by the Executive Officer of the State Water Resources Control Board informing the Regional Water Boards of their role in implementing the Recycled Water Policy with a goal of initiating and participating in stakeholder processes for the development of salt/nutrient management plans.

A further example of the State of California's acknowledgement of and concern over brackish water and salinity management is the fact that an entire chapter was devoted to salt and salinity management in the 2009 California Water Plan, Bulletin 160-09 of the Department of Water Resources ("California Water Plan"). The California Water Plan's steering committee includes representatives from a number of state agencies, including but not limited to the California Energy Commission, the California Environmental Protection Agency, the California Natural Resources Agency, the California Public Utilities Commission, the Department of Public Health, the Department of Water Resources, the Governor's Office of Planning and Research, the State Water Resources Control Board, and Regional Water Boards. (Water Plan, p. 1-12.) Chapter 18 of the California Water Plan, which is entitled *Salt and Salinity Management*, is dedicated entirely to salt and salinity management and in part provides:

"**Local and regional solutions to salt management can vary significantly, but are generally most appropriate to local and regional scales**, unless the planning process in developing those solutions determine that there is a benefit to developing infrastructure at a State level. Therefore **salt management should be fully integrated into water management** such as through integrated regional water

> management plans." (California Water Plan, p. 18-14.) (Emphasis added.)

Clearly, the State of California has recognized that not only is salinity a problem, but that it must be managed, beginning at the local level. To further support his proposition, the California Water Plan also states:

> "**Local solutions should be sought first**, as these can be implemented more rapidly than those imposed by State or federal authorities. All stakeholders affected by nitrate, seawater intrusion, soil or **groundwater salinization** or loss of fresh water flows should address salt management ...." (California Water Plan, p. 18-24.) (Emphasis added.)

The drafters of the California Water Plan also acknowledge ". . . water quality protection is more cost effective and has a greater chance of success than water quality remediation." (California Water Plan, p. 18-18.) This is precisely the type of water management program that the District is implementing under its BGRP, to wit: remove/extract the inflow of brackish water from the westerly edge of District boundaries to prevent salinization of higher quality water underlying the District. The extraction of such brackish water is the most cost-effective approach for managing the salinity problem underlying the District.

Under the *Collaboration* section within Chapter 18 of the California Water Plan, it is suggested that all state, federal, and local agencies should implement projects that assist the state's communities, watersheds, and regions in achieving a sustainable salt balance and that all such entities "should strive to coordinate their efforts where possible." (California Water Plan, p. 18-28.) Under the present circumstances, Buena Vista urges the coordination and cooperation of the CEC in allowing the HECA Project to use Buena Vista's brackish groundwater pursuant to the District's BGRP.

In addition to the Recycled Water Policy and the California Water Plan referenced above, salt-related problems have also been recognized by the U.S. Department of the Interior and the California Resources Agency. An example of such recognition is provided in the September 1990 report entitled A Management Plan for Agricultural Subsurface Drainage and Related Problems on The West Side San Joaquin Valley, commonly known as the "Rainbow Report". The Rainbow Report recognizes that salts have been a persistent problem in parts of the San Joaquin Valley for more than a century, making some cultivated land unusable as far back as the 1880s and 1890s (Rainbow Report, p. 15). The Rainbow Report also acknowledges that without proper mitigation measures, economic impacts to the San Joaquin Valley could be severe, and as a result of a decline in irrigated acreage, income, sales, and jobs will suffer tremendously. In fact, as of 1990, which is the year of the report's preparation, the economic effects of unchecked salinity problems were estimated to result in hundreds of millions of dollars in economic damages or losses on an annual basis (Rainbow Report, p. 83). The report also indicates that one of the methods available for coping with salinity and brackish water problems is through groundwater management, and the use of wells to extract brackish water (see for example, Rainbow Report, pp. 88 and 102). Interestingly, one of the brackish water management methodologies suggested in the Rainbow Report is exactly the type of project that will be used by the District to supply water for the HECA project, to wit: extract brackish water in an effort to protect and enhance other groundwater underlying the District.

As yet another example of the State of California's acknowledgement of and concern over brackish water, The Central Valley Regional Water Quality Control Board, in a report entitled Salinity in the Central Valley, an Overview (May 2006), also recognizes the impacts that brackish water and salinity are having within the State of California. The report references that cropping patterns may change, jobs may be lost, and other problems will occur as a result of salinity increases. The report also recognizes that, as is the case in the Buena Vista Water Storage District, salinity problems can be caused by naturally occurring salinity in soils and groundwater, due to the geology of the area. The report further provides that salinity management involving environmentally and economically sustainable solutions should take place to ensure that "responsibility for salinity mitigation actions is shared equitably." (Report, p. 53.) Buena Vista believes a viable economic solution is now available through the HECA Project to remediate at least a portion of Buena Vista's brackish groundwater problem.

The California Regional Water Quality Control Board, Central Valley Region, again recognized the problem of brackish water and salinity within a report entitled, Water Quality Control Plan for the Tulare Lake Basin, Second Edition (revised January 2004). The report recognizes that salinity is a problem, that some of the salt load to the groundwater is the result of natural processes, and that absent a drain to carry wastewater from the basin, "The only other solution is to manage the rate of degradation . . . ." (See Report, p. IV-5.)

Not only is the HECA Project's use of District brackish groundwater consistent with California brackish water remediation policies as set forth and defined by the various state regulatory and administrative agencies mentioned above, but Buena Vista believes that such brackish water use is consistent with, and perhaps compelled by, California Constitution Article X, Section 2, which provides:

> It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable ...."

This constitutional provision has also been codified by the California Legislature through both Water Code section 100 and Water Code section 520. In effect, by allowing HECA's use of brackish water pursuant to the District's BGRP, the remaining water underlying Buena Vista can be used for irrigation and/or domestic use, which are the two highest uses of water within the State of California. These high priority uses are codified within Water Code section 1254 which states, "In acting upon applications to appropriate water the board shall be guided by the policy that domestic use is the highest use and irrigation is the next highest use of water." Therefore, the HECA Projects' use of the District's brackish water provides, at a minimum, a trilogy of benefits consisting of:

(1) Putting to beneficial use certain brackish water that is otherwise unsuitable for existing present uses, and allowing it to be used for HECA purposes; and

(2) Protecting the existing groundwater resources underlying Buena Vista Water Storage District from persistent brackish water intrusion, thus enhancing such groundwater; and

(3) Allowing the newly protected groundwater resources within Buena Vista Water Storage District to be used for agricultural and/or other beneficial uses.

Without HECA's use of brackish water pursuant to the District's BGRP, water resources underlying Buena Vista Water Storage District will be of limited usefulness (and therefore of lesser beneficial use) as a result of brackish water intrusion that will continue to exacerbate groundwater salinity problems underlying the District.

As is evident from the above, the HECA Project's use of brackish water pursuant to Buena Vista's BGRP is not only consistent with California water policy as considered and developed by various state administrative and regulatory agencies, but such use is also consistent with the State Legislature which has repeatedly acknowledged that brackish groundwater is a problem within the State. The Legislature has specifically referenced brackish groundwater, desalination, or other salinity problems within Water Code sections 10013, 10608.50, 12947, 79545, and 79547.2, and the necessity to protect and manage the groundwater within the State (Water Code § 79501(e)) through a coordinated control of all factors that affect water quality in any given area (Water Code § 13241(c)).

In conclusion, the interception, extraction, delivery and use by the HECA Project of brackish water underlying Buena Vista Water Storage District pursuant to the District's Groundwater Management Plan and Brackish Groundwater Remediation Program is entirely consistent with state, regional, and local water management policies and associated mitigation implementation strategies. In fact, the use of such brackish water by the HECA Project will provide a clear benefit by protecting other Buena Vista groundwater supplies for higher and better uses, including irrigation and/or domestic use. As was stated by the California Legislature in 2002, "The Legislature finds and declares all of the following ... The long-term economic and environmental sustainability of agriculture is critical to the future of the state, and it is in the interest of the state to enact policies that enhance that sustainability." (Health and Safety Code § 25209.10). The HECA Project's use of Buena Vista's brackish water will further this stated goal, the other State policies discussed above, and be consistent with Water Code section 13146, which provides, "State offices, departments and boards, in carrying out activities which affect water quality, shall comply with state policy for water quality control unless otherwise directed or authorized by statute, in which case they shall indicate to the state board in writing their authority for not complying with such policy."

We appreciate the opportunity to comment on this very important issue and to indicate our support for the use of Buena Vista Water Storage District's brackish groundwater for the HECA Project. If you have any questions or concerns, please do not hesitate to contact me.

Sincerely,

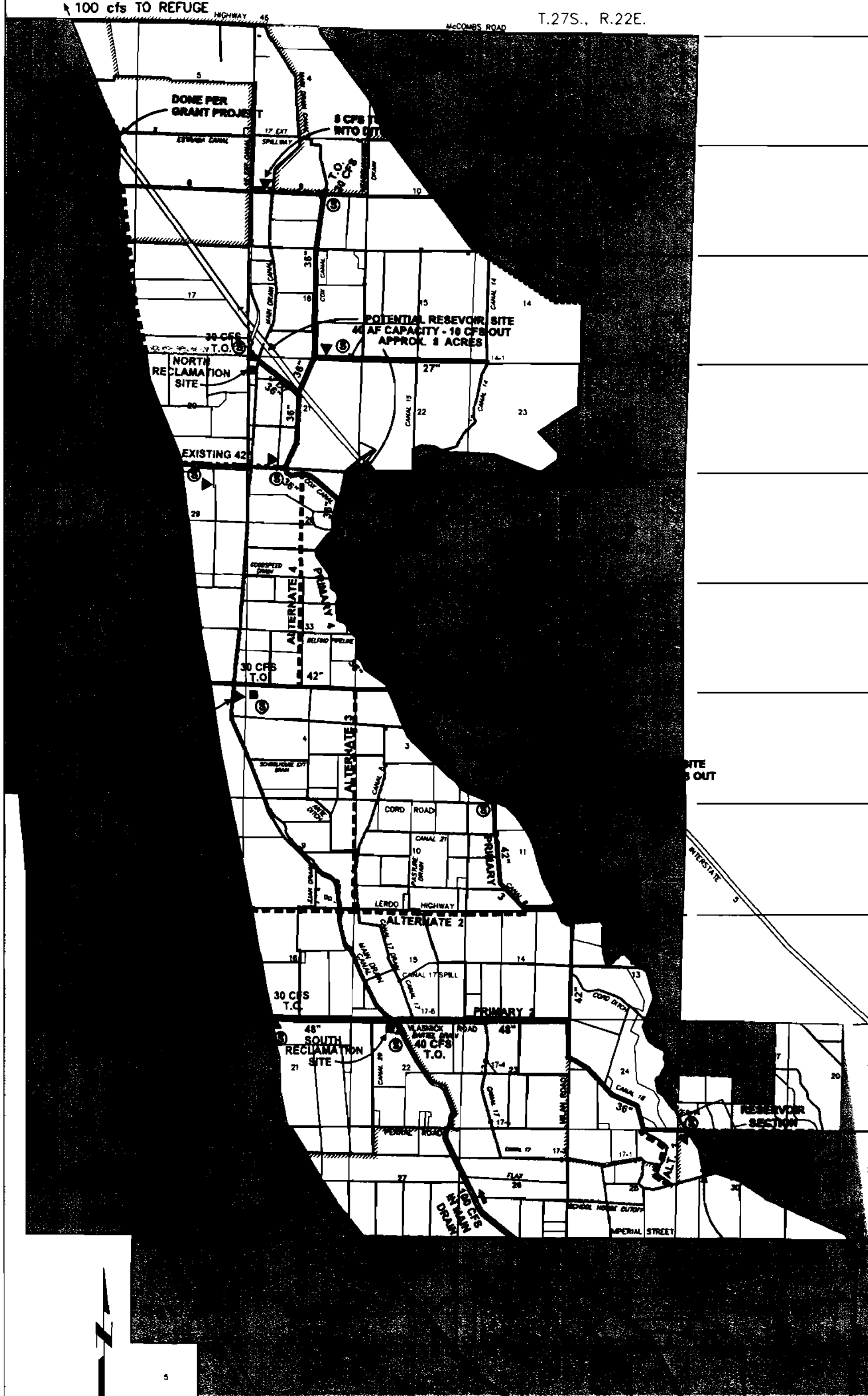
BUENA VISTA WATER STORAGE DISTRICT

Dan W. Bartel, Engineer-Manager

DWB:vty

cc: Robert W. Hartsock, Esq.
McMurtrey, Hartsock & Worth
(Your File No.: BV-5.2.16)

BUENA VISTA WATER STORAGE DISTRICT
CONCEPTUAL PIPELINE SYSTEM
6-7-12 EAST/WEST BALANCED DESIGN



	WEST OF MAIN DRAIN	EAST OF MAIN DRAIN	TOTAL EAST AND WEST
ACREAGE	0 AC 605 AC	0 AC 0 AC	CROPS= 0 AC HABITAT= 605 AC TOTAL= 605 AC
SUMMER DEMAND	4.05 cfs	0 cfs	
WINTER DEMAND	4.05 cfs	0 cfs	
ACREAGE	124 AC 0 AC	260 AC 362 AC	CROPS= 384 AC HABITAT= 362 AC TOTAL= 746 AC
SUMMER DEMAND	2.08 cfs	6.04 cfs	
WINTER DEMAND	1.24 cfs	4.79 cfs	
ACREAGE	700 AC 0 AC	804 AC 761 AC	CROPS= 1,504 AC HABITAT= 761 AC TOTAL= 2,265 AC
SUMMER DEMAND	11.72 cfs	18.58 cfs	
WINTER DEMAND	7.03 cfs	13.18 cfs	
ACREAGE	505 AC 0 AC	571 AC 1,211 AC	CROPS= 1,076 AC HABITAT= 1,211 AC TOTAL= 2,287 AC
SUMMER DEMAND	8.45 cfs	17.87 cfs	
WINTER DEMAND	5.07 cfs	13.85 cfs	
ACREAGE	330 AC	441 AC	CROPS= 771 AC HABITAT= 0 AC TOTAL= 771 AC
SUMMER DEMAND	5.52 cfs	7.38 cfs	
WINTER DEMAND	3.32 cfs	4.43 cfs	
ACREAGE	224 AC	640 AC	CROPS= 864 AC HABITAT= 0 AC TOTAL= 864 AC
SUMMER DEMAND	3.79 cfs	10.71 cfs	
WINTER DEMAND	2.25 cfs	6.43 cfs	
ACREAGE	151 AC	1,027 AC	CROPS= 1,178 AC HABITAT= 0 AC TOTAL= 1,178 AC
SUMMER DEMAND	2.53 cfs	17.18 cfs	
WINTER DEMAND	1.52 cfs	10.32 cfs	
ACREAGE	326 AC	1,209 AC	CROPS= 1,535 AC HABITAT= 0 AC TOTAL= 1,535 AC
SUMMER DEMAND	5.46 cfs	20.24 cfs	
WINTER DEMAND	3.27 cfs	12.14 cfs	
ACREAGE	528 AC	1,460 AC	CROPS= 1,988 AC HABITAT= 0 AC TOTAL= 1,988 AC
SUMMER DEMAND	8.04 cfs	24.44 cfs	
WINTER DEMAND	5.30 cfs	14.66 cfs	
ACREAGE	872 AC	540 AC	CROPS= 1,412 AC HABITAT= 0 AC TOTAL= 1,412AC
SUMMER DEMAND	14.80 cfs	9.04 cfs	
WINTER DEMAND	8.75 cfs	5.42 cfs	
ACREAGE	105 AC	207 AC	CROPS= 312 AC HABITAT= 0 AC TOTAL= 312 AC
SUMMER DEMAND	1.79 cfs	3.47cfs	
WINTER DEMAND	1.06 cfs	2.96 cfs	

	WEST	EAST	TOTAL
TOTAL IRRIGATED ACRES	4,476 AC.	9,443 AC.	13,918 AC.
TOTAL SUMMER DEMAND	68.76 cfs	134.73 cfs	203.49 cfs
TOTAL WINTER DEMAND	42.85 cfs	87.30 cfs	130.15 cfs

AREAS IN ACRES

ACREAGE = 10,979 AC
HABITAT = 2,939 AC
TOTAL = 13,918 AC

LEGEND:

- EXISTING PIPELINE
- EXISTING PIPELINE
- PROPOSED PIPELINE
- OPTIONAL PIPELINE ADDITION
- PROPOSED PIPELINE (WITH ALTERNATE)
- ALTERNATE PIPELINE ROUTE
- ■ PROPOSED RESERVOIR (APPROX. 2 AC)
- ▲ TURNOUT
- DISTRICT PROJECT BOUNDARY
- Ⓢ SCADA SITE
- POTENTIAL RESERVOIR
- POTENTIAL ADDITIONAL PROJECT SERVICE AREA
- NOT A PART AND / OR NOT IN DISTRICT

BUENA VISTA WATER STORAGE DISTRICT
525 NORTH MAIN STREET
BUTTONWILLOW, CALIFORNIA 93206

B.V.W.S.D.
NORTH SERVICE AREA
CONCEPTUAL PIPELINE SYSTEM

ZEIDERS CONSULTING
1655 GREELEY ROAD
BAKERSFIELD, CA. 93314
(661) 589-8366

DRAWING NO
1
of 2