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August 20, 2013

California Energy Commission
Mr. John Heiser, AICP
Siting – Project Manager
1516 Ninth Street, MS-15
Sacramento, CA 95814

RE: Response to CEC Data Request dated March 21, 2013
Response to Preliminary Staff Assessment dated June 28, 2013

Dear Mr. Heiser

On behalf of Buena Vista Water Storage District, I would like offer our apologies for a less than timely response to the CEC Data request. Hopefully this will assist the Commission in processing the HECA application.

The district staff and consultants have prepared the attached response to CEC Data Request dated March 21, 2013 and respectfully submit for your consideration. This submittal should also act as the District's comments to the Preliminary Staff Assessment for the HECA project dated June 28, 2013.

I understand that Public Workshops have been preliminarily planned for September 17 – 19. Unfortunately, I will be out of the country on a trip that has been planned since November 2012. Based on my inability to attend the workshops, I would like to emphasize the District's offer to host appropriate CEC staff on a site visit sometime before September 6, 2013. I believe that the face to face Agency contact will give the CEC staff confidence that the District has the capability and commitment to fulfill its mission of providing the landowners and water users a reliable, affordable and usable water supply. 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

Response to CEC Data Request of 21 March, 2013.

The following responses to CEC Data Request are intended to complement the explanations and clarifications on the same or similar issues contained in BVWSD previous response dated 19 March, 2013.

The CEC Data Request asks the district to provide several datasets, to quantify several relationships, and to explain several issues. The requests are presented as inquiries into fourteen specific topics of interest.

Below, we present each CEC data request highlighted in **bold** followed by the BVWSD's response.

CEC DR 1. **Please provide all water quality data from within the potential zone of influence (or within two miles) of the proposed HECA project pumping wells.**

BVWSD Response 1.

- Table 1. CEC- EC & TDS data1.xls
- Attachment 1: Potential Zone of Influence

Attachment 1 shows CEC- EC & TDS data1.xls data coverage which includes sections from four township areas centered on the proposed well field (28s/22-23e, 29s/22-23e). Table 1 includes 285 records, including 284 records of EC and 24 records of TDS, from 77 wells.

District concludes from these dataset that the EC and TDS data which have been collected over the years in and around the project area demonstrate that the area between the West Side Canal and the Main Drain Canal near- and to the north of-the latitude of 7th Standard Rd is underlain by saline groundwater which interfaces with fresher groundwater to the east.

CEC DR 2. **Please provide numeric data that support the conclusion that highly saline water originates in the west (in the Coast Ranges) and enters the BVWSD?**

BVWSD Response 2.

- Table 1. CEC- EC & TDS data1.xls
- Referenced reports: Dale, et al, 1966.

The dataset for this data request is the same as that described for Response 1.

Please refer to Dale, et al, 1966 report. BVWSD provided a copy of the report to the CEC staff on 21 February, 2013.

(Dale R.H., J.J. French, G.V. Gordon, 1966, Ground-water geology and hydrology of the Kern River alluvial fan area, California, U.S. Geol. Surv. Water Res. Div. Open-File Report.)

Based on a preliminary review of BVWSD EC data, EC values in and around the project area is equivalent to a range in TDS of about 3,000 - 5,000 mg/l, with lower values to the east and south and, where present, equal or higher values to the west and north. This data from the BVWSD database are consistent with the findings of the above cited USGS work.

CEC DR 3. **Please provide time-series water quality data from wells located on either side of the "axial interface" showing the water quality at specific locations is changing over time. Include quantitative data (i.e., extraction volumes) showing the relationship between annual extraction rates and annual water quality changes over times at specific locations.**

BV Response 3.
Data: Table 1. CEC-EC & TDS data1.xls
Figure 1. EC in 4 Project- Area Townships, 1960 - 2010.

All of the available EC data from which time-series can be constructed have been provided in the dataset described above in BVWSD Response 1, i.e., Filename: CEC- EC & TDS data1.xls.

Out of a total of 77 wells from CEC- EC & TDS data1.xls dataset (Table 1.), there are only 25 wells that were sampled frequently enough to provide a time-series of EC data from the late 1980s/early 1990s to the present. Of those, EC data from seven wells (7) can be composited with earlier EC data from nearby wells to provide a time-series of EC data from the 1960s to the present.

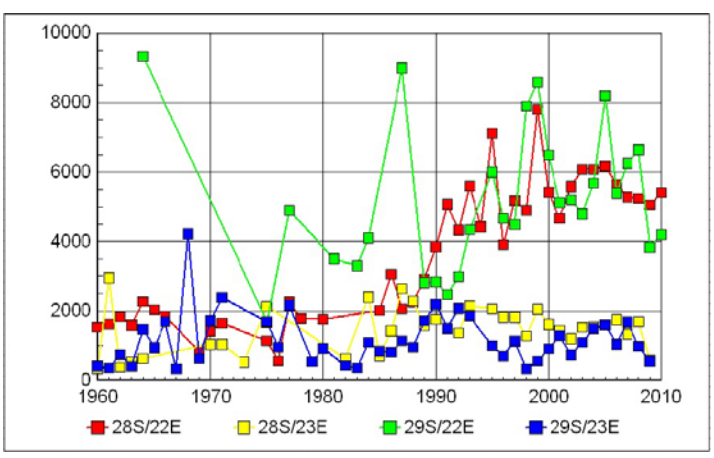


Figure1. EC in 4 Project- Area Townships, 1960 - 2010.

Time-series data constructed from the CEC- EC & TDS data1.xls dataset shows that the EC for the last 25 years has been in the range of 4,000 -10,000 uS/cm, which is approximately equivalent to a range in TDS of 2,560 -6,400 mg/l, assuming a conversion constant of 0.64 mg/l/uS/cm.

Prior to the late-1980s, there is insufficient data to illustrate the temporal EC trends in individual wells. Therefore the District has calculated the average annual EC value for each year from 1960 to 2010 for the sections covered by the dataset in Table 1.

The average groundwater ECs in the two easterly townships (T28s/R23e and T29s/R23e) in the potential zone of influence (Attachment 1) are approximately constant for the 50-year period from 1960 to 2010 at 1,450 uS/cm and 1,170 uS/cm, respectively, equivalent to an average TDS of 928 mg/l and 748 mg/l, respectively.

The average groundwater ECs in the two westerly townships (T28s/R22e and T29s/R22e) are significantly higher and show increases in EC over time. In township T28s/R22e, the average EC from 1960 to 1989 is 1,820 uS/cm (1,164 mg/l TDS) and the average EC from 1990 to 2010 is an average 5,373 uS/cm (3,439 mg/l TDS). In this township, most of the increase in EC occurs during the last half of the 1980s. In township T29s/R22e, the average EC from 1960 to 1989 is 4,829 uS/cm (3,091 mg/l TDS) and the average EC from 1990 to 2010 is 5,308 uS/cm (3,397 mg/l TDS). In this township, most of the increase in EC appears to occur from the early 1980s to the early 1990s.

The low spatial data density makes it difficult to map the lateral boundary (i.e., the interface) between the fresh and brackish waters under the district. Regardless of whether we define the boundary between fresh and brackish water as 1,000 or 1,500 mg/l, we have insufficient data to identify the exact location of the lateral boundary between the fresh and brackish waters under the district more precisely than somewhere east of the main drain, i.e., more than 1.9 miles east of the axis of the proposed well field. Similarly, we have insufficient data to determine whether or not the lateral boundary between fresh and brackish water is migrating over time.

The water district does not have extraction-volume or extraction- rate data for the irrigation wells in the project area, so we cannot provide the requested correlation analysis between groundwater EC and annual extraction rates.

CEC DR 4. ***BVWSD's Target Area A is located in the northern portions of the Buttonwillow Service Area, where reportedly a shallow "perching layer isolates a persistent zone of shallow, perched, salty groundwater from the underlying aquifer" (Draft Environmental Impact Report for the Buena Vista Water Storage District Buena Vista Water Management Program). In the February, 2013, water workshop in Sacramento, BVWSD stated that project pumping from Target Area B may lower water levels in the areas with problematic shallow water (Target Area A). Please explain and quantify how groundwater extractions from the underlying aquifer beneath Target Area B provides a benefit to shallow groundwater levels in Target Area A where the shallow aquifer is "isolated" from the underlying aquifer.***

BV Response 4.

BVWSD does not have any specific recollection of what might have been said at the February 20, 2013, CEC workshop to give the impression that we expect to see benefits in the perched zone of the Target A area from well field operations in the Target B area.
BVWSD staff have not designed the proposed well field to have any particular impact on the Target A area, nor do we require any particular benefit to accrue in the Target A area from pumping at the proposed well field.

<u>CEC DR 5.</u> The BVWSD FEIR states "The Kern County Subbasin has been classified by DWR as a critically overdrafted groundwater basin (BVWSD, FEIR, 2009)." Please explain how the district is isolated from this condition.

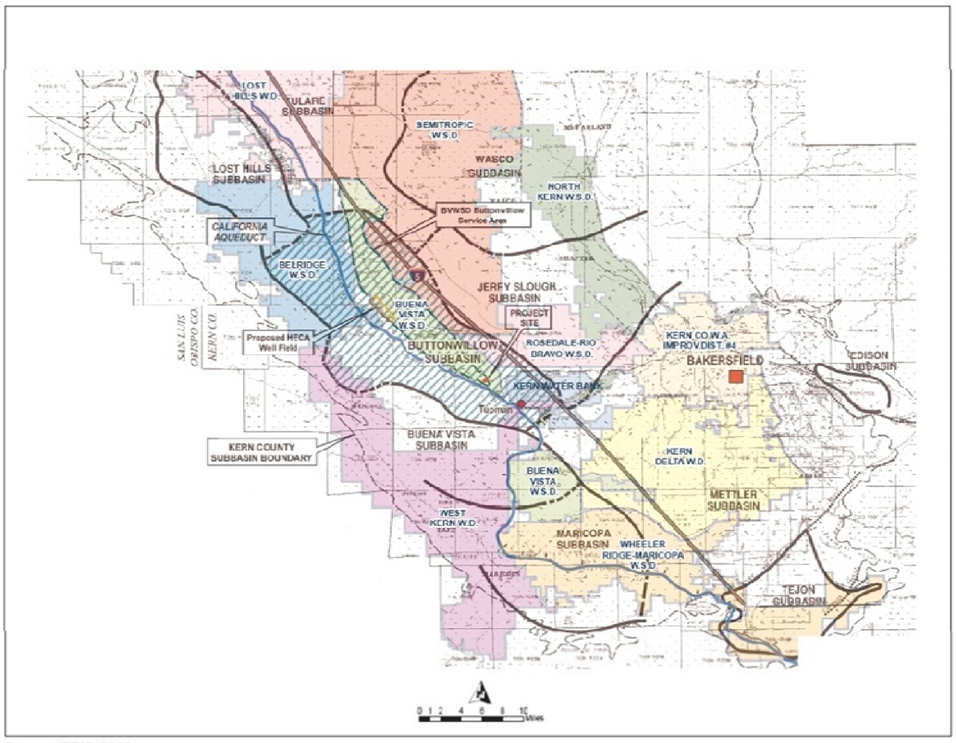
BV Response 5.

We address the overdraft issue in BV Response 6 below and address the issue of physical sub basin isolation in BV Response 5, beginning with some background information.

- Figure 2. Kern County Water Districts and Subbasins.
- Figure 3. Structure Map on Base E-Clay.
- Attachment 2. Water Level Elevation Map, Jan-Feb 1994.
- Attachment 3. Water Level Elevation Map, Jan-Feb 2009.

The Southern San Joaquin Valley (SSJV) groundwater basin lies entirely within the geographic boundaries of Kern County, CA. The basin is bounded on the east, south, and west by the natural flow barriers associated with the geology which causes the topographic slope break between the flat-lying valley fill and the surrounding dissected foothills on three sides. The basin boundary on the north is the Kern County Line between Kern, Kings, and Tulare Counties, which is a political boundary but not a flow boundary.

The SSJV groundwater basin is often considered to be a single, large bathtub- like basin in which the lateral flow of groundwater down the opposite flanks of a persistent elongated recharge mound underlying the southwest- trending Kern River channel separates the basin into two halves with different flow dynamics, one subbasin to the northwest and one subbasin to the southeast. These two subbasins remain fully hydrologically connected and are considered to constitute the main basin.



Source: FEIR 2009

In detail, there are several small subbasins caused by local geological complexities along the east, south, and west basin boundaries. Each of these small subbasins has some degree of isolation from the main basin as manifested by some form of isolated water level behavior,

Figure 2: Kern water District and Subbasin 1

distinct water chemistry, and delayed and/or attenuated pressure response to main- basin events, or vice versa. The Buttonwillow Service Area of the BVWSD occupies one such subbasin. See Figure 2.

The BSA is a 24-mile long, 3- mile wide, thin strip of land along the western basin margin and occupies the overflow lands within the Buttonwillow Syncline, lying between Elk Hills and Buttonwillow Ridge (Dale, et al, 1966) west of the Kern River alluvial fan. The BSA overlies a part of the SSJV groundwater basin which is contained within the flanks of the doubly-plunging Buttonwillow Syncline (Figure 3.) and is geologically separated from the main basin to the east by the doubly-plunging Buttonwillow Anticline (PGA, 1991). There is no surface expression to the Buttonwillow Syncline, but the en echelon, axial ridge of the Buttonwillow Anticline forms the Buttonwillow Ridge which is about 30 ft topographically higher than the flat lands overlying the syncline. The Buttonwillow Anticline is approximately three (3) miles wide. Immediately to the east of the Buttonwillow Anticline is the Jerry Slough Syncline which is another en echelon structural trough which is considered to be part of the main basin north of the Kern River channel.

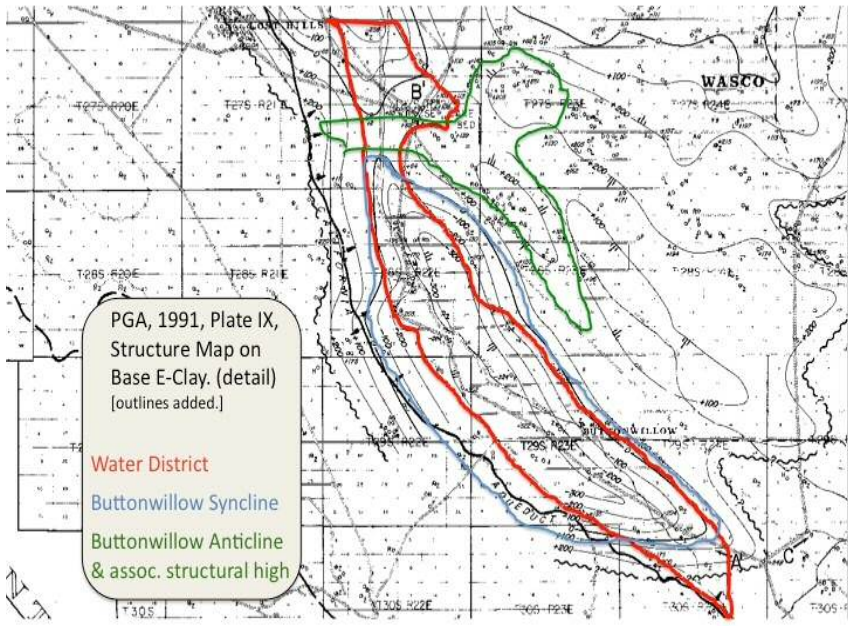


Figure 3. Structural Map on Base E-Clay

Seventh Standard Rd separates the BSA subbasin into two parts of approximately equal length and area, but with different hydrological behavior. The northern half of the BSA shows significant degrees of hydrologic isolation from the basin to the west and north but, most importantly, complete isolation from the main basin to the east. Based on the available basin water level data, BVWSD concludes that there has been no correlatable water level impact in the northern half of the BSA, including the proposed well field area, from any observed groundwater behavior in the main Kern County subbasin to the east. See Attachments 2 & 3.

The empirical evidence is simply that the groundwater elevations within the northern BSA have remained essentially static over time, while a very large pumping depression in the main basin just a few miles to the east- northeast has lowered the groundwater levels across many townships from their 1940 levels. This documented depression does not extend into the Buttonwillow Service Area which is only 2 -3 miles to the west and southwest, even though it would be expected, based on proximity. The capture zone ends abruptly at a narrow band of steep gradients between the BSA and the pumping depression. The groundwater gradients across this 2 -3 mile wide band are -70 ft/mile which accounts for the significant difference in groundwater elevation between the BSA and the area to the east. The groundwater gradient in this narrow band is 7 to 10 times steeper than the inward gradients on the north, east and southeast sides of the pumping depression (approx. -10 ft/mile).

This narrow band of steep gradient in Attachments 2 and 3 represents the manifestation of a northwest - southeast trending flow barrier which runs across four townships (T27s/R22-23e and T28s/R22-23e) between the BSA and the main basin to the east. The water level in the northern Buttonwillow Service Area has remained unimpacted from the pumping depression which is located immediately adjacent to the BSA on the opposite side of this barrier.

The water district concludes, based on the principle of reciprocity that if a groundwater impact cannot propagate from the main basin into the northern BSA, then a groundwater impact cannot propagate in the opposite direction from the BSA into the main basin. The water district also concludes that if a pumping depression, like that in T27s/R23e, caused by scores of wells operating over a period of decades cannot propagate a water level impact across a basin interconnection pathway of only 2 -3 miles, then a smaller well field operating for similar or lesser time periods could not propagate a water level impact.

The water district concludes therefore that the operation of the proposed project well field located on the west side of the BSA must be in complete isolation from the main basin to the east, and that the operation of the proposed well field averaging 10 cfs for years will have no observable impact at any location in the main basin, which begins on the opposite side of the barrier about 4 miles to the northeast.

CEC DR 6. It was stated in Crewdson (2009) that "The District's Buttonwillow Service Area is located in the so-called Buttonwillow (hydrologic) Subbasin, which exhibits some isolation from the larger main basin to the east and exhibits groundwater behavior which is consistent with the interpreted shape and structural controls of the Buttonwillow Subbasin." Please quantify the hydrologic isolation from this structural feature. Please provide data showing whether the Buttonwillow Subbasin is in overdraft.

BV Response 6.

As in BV Response 5, above, the district considers the main basin to be completely physically isolated from the potential groundwater impacts of the proposed well field. The groundwater flow barrier will prevent the proposed well field from creating an observable impact on the main basin and will therefore not change the water levels or the water balance of the main basin over the project life.

State of the Buttonwillow Subbasin.

As the CEC has pointed out, the water levels in wells in the BSA spanning the period 1974-2001 show a statistically significant upward trend of +6.8 ft/decade. This represents an estimated gain in the volume of groundwater in aquifer storage of 4,600 -6,100 af/y, assuming a specific yield of 0.15 0.20. The rising water table is the empirical evidence that the volume of water in aquifer storage within the Buttonwillow subbasin is increasing over time. If the definition of overdraft is based on water table behavior, then the Buttonwillow subbasin is not in overdraft.

As mentioned, the district has stored in the SSJV groundwater basin an average 46,409 af/y more of its water supply than the district has consumed over the period 1970 - 2007. For the period, this represents an estimated 36,964 af/y and 1,652 af/y of surface waters which were percolated within the Buttonwillow Service Area and the Maples Service Area, respectively. The remaining 7,793 af/y was banked in out- of-subbasin banking projects. This means that the district is in long term positive balance relative to the basin, and the BSA is in long term positive balance with respect to the Buttonwillow Subbasin. If the definition of overdraft is based on the net balance of district recharge and recovery, then the Buttonwillow Subbasin is not in overdraft.

The 36,964 af/y of BSA recharge and the calculated +4,600 to +6,100 af/y of net BSA basin water level rise are both correct measures of two different quantities. The difference between the two quantities is accounted for by other gains and losses to the physical water balance of the subbasin. Because of southward lateral outflow from the northern BSA into the southern BSA, and lateral outflow from the BSA along the eastern district margin south of 7th Standard Rd (see discussion in BV Response 9), 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. The water district concludes that the Buttonwillow subbasin is in positive balance and not in a state of overdraft.

<u>CEC DR 7.</u> Groundwater banking is described in "the District's Groundwater Status and Management Plan (GSMP, 2002). A copy of the GSMP is available for review at the District office." Please provide a recent copy of the plan.

BVWSD Response 7.

Data: Attachment 6. BVWSD Groundwater Status and Management Plan, revision of May, 2002.

<u>CEC DR 8.</u> Please provide an updated district water budget and an updated forecast of future water levels. Compare the actual annual water balance with the forecasted balance (2008-2012). Please explain what portion of the historical and forecasted water budget and water levels applies solely to the Buttonwillow Service Area.

BVWSD Response 8.

Data: Table 2: BVWSD Water Balance, 1970 - 2011.

Attached is an update water budget table, Table 2. Forecasting in an individual year is impossible. What is important is forecasting if there will be changes going forward which affect the averages.

Of the average water surplus to groundwater of 46,409 (through 2007) it can be divided as:

1. 1,652 in the Maples Services Area and outside the Buttonwillow Sub-basin but within the larger Kern Basin.
2. 7,793 outside the BVWSD and Buttonwillow Sub-Basin but within the larger Kern Basin.

3. 36,964 within the BVWSD and Buttonwillow sub-basin.

Since the District's water supply should remain stable, BVWSD expects a similar average surplus to groundwater going forward, however any one year will likely vary significantly. However, BVWSD is working to develop new sources for groundwater banking in the BVWSD and Buttonwillow Sub-basin and also within the Buttonwillow Sub-basin but outside the BVWSD.

So the amount in the Maples should remain constant, as with the total surplus, while some of the 7,792 surplus moves into the BVWSD, the Buttonwillow Sub-basin, or both.

The water district does not forecast any foreseeable change which might impact the operation or impacts of the proposed well field.

CEC DR 9. ***Staff reviewed water level records in the district and stated in the recent workshop notice that "observed water levels in wells spanning the period 1974-2001 show a statistically significant upward trend at the 95 percent confidence level. The significant upward trends range from 0.28 foot per year (ft/yr) to 1.27 ft/yr. Please quantify the relationship between these observed trends and BVWSD's historical water budget results. Specifically, quantify the relationship between water considered banked in the Buttonwillow Service Area and the observed water level trends. Also, if the district banks water outside of the Buttonwillow Service Area, as suggested in the February, 2013, workshop, please show where this water was banked and how much. Finally, show the spatial distribution and estimated quantities of the forecasted water that will be banked.***

BVWSD Response 9.

Data: Previously reported water balance data.
Attachment 4. Out-of-District Water Banking Facilities Map.

The water district provides responses to the correlation analysis and the out- of-district banking issue separately, below.

Correlation between groundwater recharge and water level behavior in the BSA.
The water balance for the Buttonwillow Service Area can be represented mathematically as follows:
Change in groundwater storage = Water in - Water out.

A positive water balance means that the groundwater aquifer under the BSA is physically gaining water while a negative balance means that the groundwater aquifer under the BSA is physically losing water.

The CEC has represented the BSA water level change over time as a linear increase with a slope of +6.8 ft/decade which they convert to a constant change in groundwater storage of 4,600 af/y at a specific yield of 0.15. The district has linearized the net average annual groundwater recharge in the BSA as +36,964 af/y. Therefore, the net average annual outflow of groundwater from the BSA is -32,364 af/y. This is a relatively small outflow, equal to only 89 af/d, which is equivalent to 9 water wells, each pumping at a constant rate of 5 cfs. This outflow is also equivalent to about 18 irrigation wells, each pumping at a constant rate of 5 cfs for about half a year, which is a reasonable scenario in the subbasin areas outside the BSA for which no surface water delivery system exists which would require crops to be on irrigation- well water. In other words, it is possible that ±32,000 af/y of BV's surplus water is being extracted by non- district water wells which are located outside the district boundary but inside the Buttonwillow subbasin. The district currently has no means to determine to what extent this may be true.

The loss of ±32,000 af/y from the basin may also be due to a limited amount of groundwater lateral outflow from the southern BSA along a 4-mile stretch of the eastern district boundary from about T29s/R23e-Sec14 to T29s/R24e-Sec28. Assuming that there is a significant, but not quite complete, isolation of the southern BSA from the main basin to the east due to the same structural causes as to the north, then an outward flux of 89 af/d, across a 4-mile stretch of district boundary, through a net 40 ft of aquifer thickness under a gradient of 20 ft/mi and a reduced hydraulic conductivity of 10 ft/d will completely explain the loss of ±32,000 af/y from storage under the BSA. The water district currently has insufficient data to determine whether the parameters or the existence of such lateral flow are correct, but all of the combined physical properties which are required to account for such an outflow are completely consistent with the volumetrics and the expected groundwater flow behaviors in the area.

<u>Water banked out- of-district.</u>

BVWSD banks all of the 7,793 af/y average annual volume of out- of-district banked surface water in one or more of the Kern Fan banking projects. See Attachment 4. Going forward, although the banked volume should average the same, BVWSD is developing sources to allow for more recharge within the immediate Buttonwillow area.

CEC DR 10. ***At the February 2013 workshop BVWSD's Hydrogeologic consultant Robert Crewdson stated that the proposed project pump field is underlain by clean sand and has a specific yield between 0.15 and 0.20 and that this information was used in-lieu of pump test data provided through URS' Hydrogeologic Acquisition Report. Please provide boring logs, geophysical logs, and pump test data that would support the use of the values over the values provided in URS' Report.***

BVWSD Response 10.

Attachment 7: Petrographic and Geologic Results of Laboratory testing performed on samples retrieved from eight 100-ft holes drilled in the BSA for 2011 HECA Well Field Phase-2

In April, 2011, BVWSD collected core samples of unconsolidated sediments down to depths of 100 ft from eight (8) hollow stem auger holes located throughout the Buttonwillow Service Area. We consider the lithology from surface to 100ft to be similar to lithology at depths of 500-700ft. This is supported by lithologic data from drillers' and electric logs of over one hundred wells within the boundary of BVWSD.

The laboratory analysis of the retrieved cores were carried out on behalf of BVWSD by Soils Engineering, Inc. in a data package dated 02 September, 2011, referred to as the 2011 Phase-2 HSA data. The data has not yet been vetted, interpreted, or reported in final form because BVWSD has agreed to collect core samples from two additional core holes which have not yet been drilled. A copy of the report is Attachment 1. Our preliminary interpretation is as follows:

For two core samples of clean, medium - coarse-grained quartz sands (07-90C and 08-20B), the specific yield of each is approximately 32%. For three core samples of very fine- grained sandy silt (03-60B, 05-30B, and 05-70B), the specific yields are approximately 17%, 12%, and 13%. For an average aquifer interval under the project area consisting of 60% silt and 40% sand, the bulk average specific yield is 20.6% [(0.6)(0.13) + (0.4)(0.32) = 0.206]. Based on this data, collected from within the project area and from other locations within the Buttonwillow Service Area, the average measured specific yield is approximately 21%, and the value of 18% used by URS prior to the acquisition of this data still appears reasonable. In fact, URS slightly underestimated the specific yield, so the drawdowns computed from their computer model would be approximately 14% smaller than those originally reported by URS if they were to recalculate their model with the value of SY = 20.6%.

***<u>CEC DR 11.</u>* At the February, 2013 workshop BVWSD and their consultant's [sic] discussed the absence of the Corcoran Clay as the reason for "low" anisotropy. Staff believes this has nothing to do with potential effects of shallow fine-grained zones on anisotropy in a single model layer that is 100's of feet thick and representing the pumped interval of the extraction wells. Please provide geologic data, boring logs, or geophysical logs that support the conclusion that aquifer conditions are unconfined within the depth interval between the water table and well extraction depths.**

BVWSD Response 11.

BVWSD does not have any specific recollection of what might have been said at the February 20 , 2013, CEC workshop to give the impression that the absence of the Corcoran Clay is the reason for "low" anisotropy.

As part of our preliminary interpretation of data in Attachment 7., BV went ahead and produced lithologic cross sections of the eight (8) hollow stem auger holes. Although the data has not yet been vetted, or reported in final form, our preliminary interpretation confirms that the fine grained horizons of various thicknesses encountered in the holes are laterally non-continuous. These are considered not extensive enough to produce a confined aquifer. We expect the aquifer system to behave in most part as unconfined and to a lesser extent as semi-confined due to the presence of the localized fine grained horizons.

***<u>CEC DR 12.</u>* In Table 2 of the BVWSD FEIR (2009) a crop inventory is provided. Please provide an update to the crop inventory and a recent map showing where specific crops are located within the district.**

BVWSD Response 12.

Data: Attachment 5. Crop Map March/April 2013

***<u>CEC DR 13.</u>* As discussed at the February 2013 workshop, the leaking Reagan Ponds have produced a contaminant plume that may have already reached the Buena Vista Water Storage District. The HECA wells may have some influence on the plume's zone of impact. Please provide data on water quality and aquifer characteristics that can be used to evaluate potential impacts from migration of the plume due to the proposed project pumping. Also, please discuss the following:**

a) Is the District involved in monitoring of this plume?
b) If the HECA project was licensed as proposed, how would the district mitigate for

potential impacts to local well owners?
c) What kind of monitoring program would the district suggest?

BVWSD Response 13.

Reference Cited: *RWQCB Memorandum of 15 November, 2011 to Aera Energy LLC, "Review- Phase II Groundwater Investigation Report, Row4/Lost Hills Wastewater Disposal Facility, south Belridge Opil Field, Kern County.*
Figure 4. Lost Hills Brine Plume.

a. BVWSD is not involved in monitoring the plume. Based on the RWQCB memo, Aera Energy LLC operates a monitoring and reporting program under RWQCB WDRO R5-2006-0073 which includes semi- annual monitoring of 55 accessible monitoring wells. The RWQCB reports that the *"discharge of wastewater ceased in 2006"* and that the groundwater levels in the underlying groundwater mound *"continue to drop."* The monitoring program includes a linear array of sentinel wells located between the Aqueduct and the West Side Canal west- northwest of the project location which have not detected the presence of the plume to date. See Fig 4.

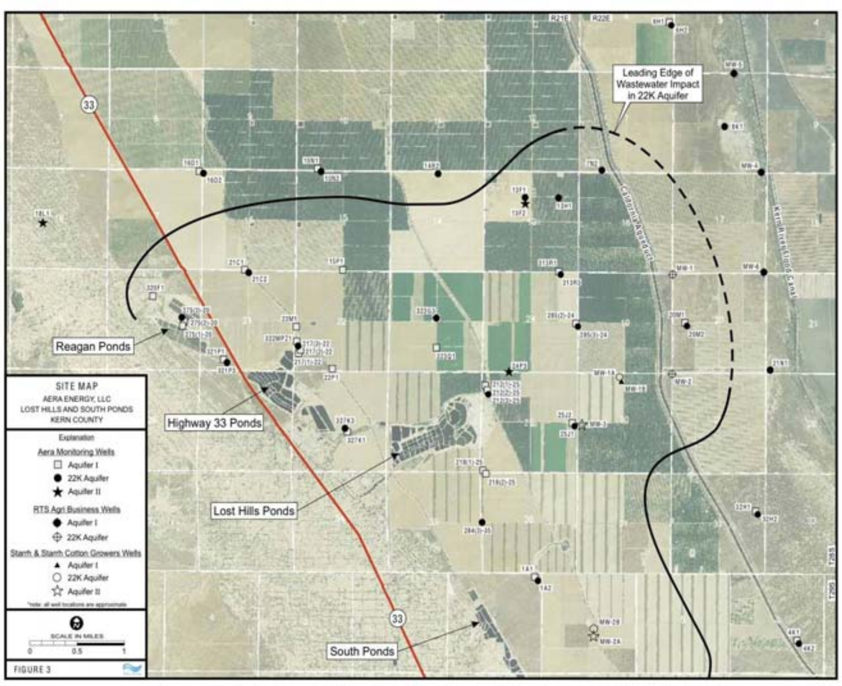


Figure 4. Lost Hills Brine Plume 1

b. The operation of the proposed well field will not induce a significant change in the plume location and, therefore, not significantly change in the groundwater chemistry at any well location within the zone of impact of the proposed well field.

As long as the RWQCB continues to be satisfied with the ongoing natural degradation or dilution of the plume and insufficient threat to existing or potential receptors, then BVWSD concludes that the situation requires no additional monitoring facilities, no further impact analyses, and no proposed remediation or mitigation.

c. BVWSD does not recommend any additions or changes to its own in- district monitoring program or to the existing plume monitoring program which Aera is operating under the WDRO. However, the water district may propose to install groundwater monitoring wells around the proposed well field in order to monitor and optimize the operation of the well field, including detection monitoring for potential fresh water breakthrough. If such monitoring wells are located to the west of the proposed well field, they will serve as sentinel wells for the detection of water quality changes, regardless of source.

<u>CEC DR 14.</u> BVWSD has stated that the Target Area A could only provide up to 4,500 acre-feet per year to the Brackish Groundwater Remediation Program. Please provide economic data demonstrating whether it would be feasible to use this source for the project supply.

BVWSD Response 14.

The water district does not have an economic analysis of the BGRP Target- A alternative at this time, except for a rough preliminary cost estimate.

The preliminary Target A BGRP cost estimate is based on the following estimates of the key operating parameters. The purpose of the proposed Target- A BGRP is to uniformly lower the shallow water table by about twenty feet across a specified project area. The proposed method is to use a grid of closely- spaced, low- flow water wells which are completed entirely within the shallow portion of the perched zone. The aquifer parameters are estimated to be: K = 20 ft/d, Ss = 5x10 ft , H = 40 ft, so that T = 800 sqft/d and S = 0.002. A steady, continuous well flow of Q = 80gpm will create a field- wide drawdown of about 20 ft during early pumping. As dewatering progresses, the flow dynamics will change and the well flow rates will have to be adjusted accordingly. Given the natural variability and many unknowns, the operation of such a well field could require a high level of effort at considerable expense. One of the design concerns is that, once this well field dewaters the project area down to ±20 ft, or another similar selected depth, we do not know whether or not the shallow aquifer will continue to yield sufficient water to the well field through inward lateral flow at the perimeter and/or through upward flow from below the completion interval to meet the water supply requirements for the power facility.

If this design scenario is correct and if the aquifer can provide the long-term, continuous flow to the wells, the project will require 581 wells, covering an area of 133 acres to deliver 5,700 af/y. Assuming each well can be installed for $10,000, a variable rate downhole pump can be installed for $8500, and each wellhead can be connected to a water gathering system for $6500, the cost of the wellfield is about $25,000 per well, or $14,525M . The gathering system which is required to connect all of the wells, assuming a rectangular project area of 1,700 ft by 3,400 ft will need to be about 57,800 ft long plus about 2,000 ft of pipeline to manifold all of the gathering pipelines together. Assuming the cost of piping and installation can be done for $18 per linear foot, the gathering system will cost $1,076M. Assuming that the power plant operator will require a 2 out of 3 redundancy, the same as is required for the Target B water supply well field, the estimated cost for the Target A BGRP well field installation is $15,601,000 x 1.67 = $26,001M. If the pipeline which connects the Target A BGRP well field to is 5 miles longer than the pipeline for the Target B well field, then the Target A pipeline cost about 133% more than the Target B pipeline.

Let us compare the estimated well field and pipeline installation costs for the Target- A and Target- B BGRP well fields. Five Target- B wells and pumps (3 plus 2 redundant) are estimated to cost $500k each for a total $2,500M plus an estimated $0.8M for the gathering system. The Target-A wells and gathering system are estimated to cost 7.9 times more than the Target-B wells and gathering system. The Target-A pipeline is estimated to cost 1.7 times more than the Target-B pipeline. We know that the engineering requirements, operating costs, and deliverability risks of a Target-A BGRP would be much greater than those of the proposed Target- B BGRP.

The water district chose not to develop the Target A BGRP for reasons other than the cost, including the fact that the TDS of the shallow groundwater in the perched zone is much more variable than the groundwater TDS in the Target- B site, the operation of the target-A BGRP would require a lot of engineering and supervision beyond the current capability or willingness of the district staff to provide, the Target-A zone of benefit would be smaller than the Target-B zone of benefit, and the installation of the well field and gathering system would make it more difficult to farm the land for which the zone of benefit was intended.

Tables, Attachments & Appendixes

Table 1. CEC- EC & TDS data1.xls

Buena Vista Water Storage District WQ Data.

CONFIDENTIALITY: These data are subject to the privacy/nondisclosure requirements of the Kern County Water Agency and the Buena Vista Water Storaqge District.

Note: For most of these sample records, EC was the ONLY reported constituent (Record # is internal to this sheet and not part of database).

Record	Well	Date	EC	TDS	
1	28S/22E-21K61	Aug-09	1800		
2	28S/22E-21K61	Nov-09	1700		
3	28S/22E-21K61	Jun-10	2300		
4	28S/22E-21P61	Nov-01	4030		
5	28S/22E-21P61	Dec-02	3830		
6	28S/22E-21P61	Aug-03	4280		
7	28S/22E-21P61	Aug-04	7100		
8	28S/22E-21P61	Dec-04	4000		
9	28S/22E-21P61	Aug-05	7900		
10	28S/22E-21P61	Dec-05	5400		
11	28S/22E-21P61	Jul-06	9000		
12	28S/22E-21P61	Nov-06	7600		
13	28S/22E-21P61	Jul-07	7700		
14	28S/22E-21P61	Nov-07	12000		
15	28S/22E-21P61	Aug-08	6800		
16	28S/22E-21P61	Aug-09	6300		
17	28S/22E-21P61	Jun-10	6200		
18	28S/22E-22C02	Aug-07	4380		
19	28S/22E-22D01	Mar-61	2610		
20	28S/22E-22M01	Aug-62	4140		
21	28S/22E-22M01	Aug-66	4120		
22	28S/22E-22Q01	Aug-65	539		
23	28S/22E-23E01	Jun-01	1405		
24	28S/22E-23F	Aug-01	1150		
25	28S/22E-24N61	Apr-00	962		
26	28S/22E-24N61	Nov-07	1350		
27	28S/22E-24Q61	Apr-00	4830		
28	28S/22E-25K	Oct-88	1000		
29	28S/22E-25K01	Aug-66	1060		
30	28S/22E-25K01	Jun-75	840		
31	28S/22E-25K01	Jul-95	875		
32	28S/22E-25K01	Jan-08	1460		
33	28S/22E-26A	Aug-92	1550		
34	28S/22E-26J01	Jul-60	1510		
35	28S/22E-26J01	Jun-61	606		
36	28S/22E-26J01	Aug-62	937		
37	28S/22E-26J01	Feb-63	1170		
38	28S/22E-26J01	Sep-64	712		
39	28S/22E-26J01	Aug-66	1110		
40	28S/22E-26J02	Aug-65	642		
41	28S/22E-26N61	Apr-00	4520		
42	28S/22E-26P61	Jul-99	3680		
43	28S/22E-26P61	Nov-99	3600		
44	28S/22E-26P61	Jul-00	3160		
45	28S/22E-26P61	Nov-00	4300		
46	28S/22E-26P61	Aug-01	3400		
47	28S/22E-26P61	Nov-01	3320		
48	28S/22E-26P61	Jul-06	3430		
49	28S/22E-26P61	Nov-06	3800		
50	28S/22E-26P61	Jul-07	1830		
51	28S/22E-26P61	Nov-07	3230		
52	28S/22E-26R61	Jul-86	2250		
53	28S/22E-26R61	Jul-87	2500		
54	28S/22E-26R61	Jan-88	2100		
55	28S/22E-26R61	Nov-89	1630		

56	28S/22E-26R61	Jul-95	1650		
57	28S/22E-26R61	Jul-96	1800		
58	28S/22E-26R61	Nov-96	1850		
59	28S/22E-26R61	Jun-97	2000		
60	28S/22E-26R61	Dec-97	2250		
61	28S/22E-26R61	Jul-98	1800		
62	28S/22E-26R61	Nov-98	1880		
63	28S/22E-26R61	Jul-99	2100		
64	28S/22E-26R61	Nov-99	2220		
65	28S/22E-26R61	Jul-00	2400		
66	28S/22E-26R61	Nov-00	2360		
67	28S/22E-26R61	Jul-06	2000		
68	28S/22E-26R61	Nov-06	1850		
69	28S/22E-27A61	Apr-00	6680		
70	28S/22E-27B61	Nov-01	7000		
71	28S/22E-27B61	Dec-02	7800		
72	28S/22E-27B61	Aug-03	9700		
73	28S/22E-27B61	Aug-04	7200		
74	28S/22E-27B61	Dec-04	9000		
75	28S/22E-27B61	Aug-05	7000		
76	28S/22E-27B61	Dec-05	6400		
77	28S/22E-27B61	Jul-06	7600		
78	28S/22E-27B61	Nov-06	8300		
79	28S/22E-27B61	Jul-07	6500		
80	28S/22E-27B61	Nov-07	7300		
81	28S/22E-27B61	Aug-08	9800		
82	28S/22E-27B61	Nov-08	10000		
83	28S/22E-27B61	Aug-09	6200		
84	28S/22E-27B61	Nov-09	5700		
85	28S/22E-27B61	Jun-10	6000		
86	28S/22E-27C61	Apr-00	3810		
87	28S/22E-27C61	Nov-01	2820		
88	28S/22E-27C61	Dec-02	3130		
89	28S/22E-27C61	Aug-03	2420		
90	28S/22E-27C61	Aug-04	2160		
91	28S/22E-27C61	Dec-04	1500		
92	28S/22E-27C61	Aug-05	2900		
93	28S/22E-27C61	Dec-05	3470		
94	28S/22E-27C61	Jul-06	1300		
95	28S/22E-27C61	Nov-06	1800		
96	28S/22E-27C61	Jul-07	2250		
97	28S/22E-27C61	Nov-07	1530		
98	28S/22E-27C61	Aug-08	2700		
99	28S/22E-27C61	Nov-08	2050		
100	28S/22E-27C61	Aug-09	2200		
101	28S/22E-27C61	Jun-10	1570		
102	28S/22E-27E61	Apr-00	612		
103	28S/22E-27H61	Apr-00	4270		
104	28S/22E-27J61	Apr-00	14710		
105	28S/22E-27P61	Jul-99	18500		
106	28S/22E-27P61	Nov-99	17800		
107	28S/22E-27P61	Jul-00	20500		
108	28S/22E-27P61	Nov-00	17600		
109	28S/22E-27P61	Nov-01	12900		
110	28S/22E-27P61	Dec-02	18300		
111	28S/22E-27P61	Aug-03	18500		
112	28S/22E-27P61	Aug-04	18300		
113	28S/22E-27P61	Dec-04	13500		
114	28S/22E-27P61	Aug-05	18700		
115	28S/22E-27P61	Dec-05	11100		
116	28S/22E-27P61	Jul-06	12300		
117	28S/22E-27P61	Nov-06	12500		

118	28S/22E-27P61	Jul-07	11000		
119	28S/22E-27P61	Nov-07	13300		
120	28S/22E-27P61	Aug-08	10500		
121	28S/22E-27P61	Nov-08	11600		
122	28S/22E-27P61	Aug-09	14000		
123	28S/22E-27P61	Nov-09	13300		
124	28S/22E-27P61	Jun-10	15000		
125	28S/22E-27P62	Apr-00	17170		
126	28S/22E-28H61	Apr-00	777		
127	28S/22E-28J01	Apr-65	4600		
128	28S/22E-29R61	Nov-98	36000		
129	28S/22E-29R61	Jul-99	38800		
130	28S/22E-29R61	Nov-99	43200		
131	28S/22E-29R61	Jul-00	30500		
132	28S/22E-30P01	Apr-00	2590		
133	28S/22E-33N01	Apr-71	3360		
134	28S/22E-34C61	Jul-86	10000		
135	28S/22E-34C61	Jul-89	6800		
136	28S/22E-34C61	Nov-89	4910		
137	28S/22E-34C61	Jun-90	5100		
138	28S/22E-34C61	Jun-91	6200		
139	28S/22E-34C61	Jul-92	8000		
140	28S/22E-34C61	Jun-93	10000		
141	28S/22E-34C61	Dec-93	9000		
142	28S/22E-34C61	Jul-95	27000		
143	28S/22E-34C61	Jul-96	14000		
144	28S/22E-34C61	Nov-96	13500		
145	28S/22E-34C61	Jun-97	16000		
146	28S/22E-34C61	Dec-97	14500		
147	28S/22E-34C61	Jul-98	9250		
148	28S/22E-34C61	Nov-98	9200		
149	28S/22E-34C61	Jul-99	10400		
150	28S/22E-34C61	Nov-99	11000		
151	28S/22E-34C61	Jul-00	9500		
152	28S/22E-34C61	Nov-00	8500		
153	28S/22E-34C61	Aug-01	9100		
154	28S/22E-34C61	Nov-01	7000		
155	28S/22E-34C61	Dec-02	4500		
156	28S/22E-34C61	Aug-03	4300		
157	28S/22E-34C61	Aug-04	4900		
158	28S/22E-34C61	Dec-04	3880		
159	28S/22E-34C61	Aug-05	7200		
160	28S/22E-34C61	Dec-05	6300		
161	28S/22E-34C61	Jul-06	7800		
162	28S/22E-34C61	Nov-06	7000		
163	28S/22E-34C61	Jul-07	4260		
164	28S/22E-34C61	Nov-07	3280		
165	28S/22E-34C61	Aug-08	3700		
166	28S/22E-34C61	Nov-08	3930		
167	28S/22E-34C61	Aug-09	3400		
168	28S/22E-34C61	Nov-09	3280		
169	28S/22E-34C61	Jun-10	6000		
170	28S/22E-34R01	May-85	2840		
171	28S/22E-35P01	Oct-64	636		
172	28S/22E-35P01	Aug-66	639		
173	28S/22E-36N01	Jul-60	1080		
174	28S/22E-36N01	Jun-61	1140		
175	28S/22E-36N01	Aug-62	1230		
176	28S/22E-36N01	Feb-63	1520		
177	28S/22E-36T80	Mar-78	1780		
179	28S/23E-30J01	May-70	590		
180	28S/23E-31B	Jul-98	859.7		

181	28S/23E-31B	Jul-99	914.7		
182	28S/23E-31B	Aug-00	945.8	601.5	
183	28S/23E-31B	Aug-01	785	553	
184	28S/23E-31B	Jul-03	992	754	
185	28S/23E-31B	Sep-04	987	711	
186	28S/23E-31B	Aug-05	972		
187	28S/23E-31B	Aug-06	1150	840	
188	28S/23E-31B	Jul-08	992	707	
189	28S/23E-31B	Aug-09	673		
190	28S/23E-31B	Aug-09	645		
191	28S/23E-31R	Oct-88	660		
192	28S/23E-31R	Dec-89	660		
193	28S/23E-31R	Aug-02	1010		
194	28S/23E-31R01	Aug-01	668	436	
195	28S/23E-31R03	Jul-98		408	
196	28S/23E-32A	Jun-90	1390		
197	28S/23E-32A	Jul-92	1450		
198	28S/23E-32A01	Jul-05	1440	950	
199	28S/23E-32P02	Mar-07	1900		
201	29S/22E-01A01	Mar-08	1800	1130	
202	29S/22E-01C01	Aug-64	9300		
203	29S/22E-01C01	Aug-64	9360		
204	29S/22E-01C02	Aug-64	9360		
205	29S/22E-01G01	Aug-04	6160	3960	
206	29S/22E-01G01	Apr-05	5870	3800	
207	29S/22E-01H01	Jul-01	6130	3730	
208	29S/22E-01T80	Nov-81	3500		
209	29S/22E-02C61	Jul-89	3090		
210	29S/22E-02C61	Nov-89	2530		
211	29S/22E-02C61	Jun-90	2830		
212	29S/22E-02C61	Jun-91	1500		
213	29S/22E-02C61	Jul-92	2980		
214	29S/22E-02C61	Jun-93	4350		
215	29S/22E-02C61	Jul-95	6000		
216	29S/22E-02C61	Jul-96	4350		
217	29S/22E-02C61	Nov-96	5000		
218	29S/22E-02C61	Jun-97	8000		
219	29S/22E-02C61	Dec-97	1000		
220	29S/22E-02C61	Jul-98	7000		
221	29S/22E-02C61	Jul-99	7200		
222	29S/22E-02C61	Nov-99	10000		
223	29S/22E-02C61	Jul-00	5000		
224	29S/22E-02C61	Nov-00	8000		
225	29S/22E-02C61	Jul-01	6000		
226	29S/22E-02C61	Nov-01	7000		
227	29S/22E-02C61	Dec-02	5200		
228	29S/22E-02C61	Aug-03	4800		
229	29S/22E-02C61	Aug-04	5200		
230	29S/22E-02C61	Aug-05	5050		
231	29S/22E-02C61	Jul-06	5500		
232	29S/22E-02C61	Nov-06	5300		
233	29S/22E-02C61	Jul-07	6500		
234	29S/22E-02C61	Nov-07	6000		
235	29S/22E-02C61	Aug-08	11500		
236	29S/22E-02C61	Aug-09	3830		
237	29S/22E-02C61	Jun-10	4200		
238	29S/22E-04N61	Jun-91	3900		
239	29S/22E-05A61	Jun-91	2040		
240	29S/22E-05B01	Aug-05	17000	11000	
241	29S/22E-07R01	Sep-75	2900		
242	29S/22E-08L01	Jul-05	4300	3100	
243	29S/22E-11R61	Jun-87	9000		

244	29S/22E-11R61	Nov-98	8800		
245	29S/22E-12L01	Sep-77	4900		
246	29S/22E-12L01	Sep-77	4900		
247	29S/22E-16Q01	Aug-83	3300		
248	29S/22E-16Q01	Apr-84	4100		
249	29S/22E-16Q02	Apr-84	4100		
250	29S/22E-18G01	Aug-05	8800	5800	
251	29S/22E-21H01	Jul-75	1070		
252	29S/22E-21H01	Sep-75	1070		
253	29S/22E-25K01	Jul-01	1360	967	
255	29S/23E-05D	May-85	650		
256	29S/23E-05D01	Aug-65	424		
257	29S/23E-05D01	Apr-84	650		
258	29S/23E-05D01	May-85	800		
259	29S/23E-05H02	Aug-07	1370	1100	
260	29S/23E-05Q61	Nov-06	2050		
261	29S/23E-05R01	Aug-01	1300	1020	
262	29S/23E-06A02	Aug-04	2030	1650	
263	29S/23E-07L02	Aug-77	3000		
264	29S/23E-07Q01	Oct-64	3740		
265	29S/23E-07Q01	Aug-66	3110		
266	29S/23E-08N	Aug-90	1980		
267	29S/23E-08N01	Mar-84	1950		
268	29S/23E-08P01	Aug-01	2390	1580	
269	29S/23E-08Q	Aug-92	1780		
270	29S/23E-08R01	Oct-64	1080		
271	29S/23E-08R03	Aug-66	772		
273	29S/23E-17G01	Aug-62	1200		
274	29S/23E-17G01	Aug-66	1490		
275	29S/23E-17G01	Aug-87	1540		
276	29S/23E-17G01	Oct-88	1330		
277	29S/23E-17H	Sep-90	5000		
278	29S/23E-17H01	Jan-08	1480	1130	
279	29S/23E-17P01	Mar-66	3770		
280	29S/23E-17P01	Feb-68	4220		
281	29S/23E-17R	Apr-85	320		
282	29S/23E-17R01	Apr-85	1060		
283	29S/23E-17R02	Mar-05	2400	1700	
284	29S/23E-17R02	Dec-05	2360	1700	
285	29S/23E-18N01	Apr-71	5290		

TABLE 2.

BUENA VISTA WSD WATER BALANCE 1970-2011

YEAR	[1]	[2]	[3]	[4]	[5]	[6]	[8]	[9]	[10]	[11]	[12]	[14]	[15]	[16]	[17]	[18]	[19]	[20]
		WATER SUPPLY					SAFE YIELD			WATER DEMANDS								
	KR A-J RUNOFF % OF AVG	KR SUPPLY (AF)	FK SUPPLY (AF)	SWP SUPPLY (AF)	SWP - A21 SUPPLY (AF)	OTHER SUPPLY (AF)	MINOR STREAMS (AF)	PRECIP (AF)	TOTAL WATER SUPPLY (AF)	CROP USE (AF)	INDUSTRIAL USE (AF)	PROJECT USE (AF)	EVAP LOSS (AF)	GOOSE LAKE OUTFLOW (AF)	MOU LOSS (AF)	WATER USE (AF)	ANNUAL BALANCE (AF)	ACCUM BALANCE (AF)
1970	69	120,361	7,310	10,284	-		0	17,647	155,602	105,076			2,332	9,086		116,494	39,108	39,108
1971	53	81,466	7,787	14,638	-		0	18,860	122,751	105,076			2,177	4,897		112,150	10,601	49,709
1972	28	32,853	0	35,206	2,700		0	9,879	80,638	99,391			2,288	740		102,419	(21,781)	27,927
1973	156	149,082	746	5,548	-		0	24,884	180,260	111,640			2,128	12,137		125,905	54,355	82,282
1974	115	160,269	14,771	20,875	-		0	25,217	221,132	115,768			2,122	6,121		124,011	97,121	179,403
1975	83	138,779	0	32,464	-		0	15,850	187,093	121,174			2,153	7,384		130,711	56,382	235,784
1976	23	40,747	0	25,137	-		0	18,086	83,970	115,063			2,138	4,463		121,664	(37,694)	198,090
1977	21	5,310	0	4,912	-		0	19,061	29,283	111,616			2,068	420		114,104	(84,821)	113,270
1978	236	238,040	0	969	-		0	36,914	275,923	120,059		0	2,017	13,877		135,953	139,970	253,240
1979	90	132,920	9,913	30,009	24,391		0	22,018	219,251	111,286			1,935	12,807	0	126,028	93,223	346,463
1980	213	271,540	0	856	-		0	20,889	293,285	112,780		0	1,880	18,295	0	132,955	160,330	506,793
1981	54	64,454	0	62,000	11,692		0	21,506	159,652	112,536	0	0	2,157	12,351	0	127,044	32,608	539,401
1982	172	182,654	34,882	14,200	15,976		0	25,581	273,293	112,883	703	0	1,852	15,904		131,342	141,951	681,351
1983	333	270,855	26,084	1,579	-		0	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	-		0	11,821	224,961	109,366	1,148	0	2,252	16,478		129,244	95,717	972,524
1985	91	132,534	0	23,138	205		0	13,122	168,999	106,262	1,363	0	1,965	16,123		125,713	43,286	1,015,810
1986	191	230,925	10,276	1,438	-		0	18,601	261,240	103,154	960	2,041	2,043	24,589		132,787	128,453	1,144,264
1987	46	78,835	0	21,896	-		0	19,433	120,164	99,168	927	6,000	1,937	14,916		122,948	(2,784)	1,141,479
1988	35	50,470	0	25,328	-		0	14,655	90,453	103,320	690	5,000	2,103	16,309		127,422	(36,969)	1,104,511
1989	51	59,021	0	26,893	-		0	9,446	95,360	100,317	643	3,138	2,037	5,080		111,215	(15,855)	1,088,655
1990	25	21,124	0	4,885	-		0	11,723	37,732	105,159	555	2,242	2,039	4,165		114,160	(76,428)	1,012,227
1991	60	56,983	0	1,288	-	0	0	21,617	79,888	105,075	663	4,410	2,055	4,558		116,761	(36,873)	975,354
1992	39	42,594	0	1,824	-	0	0	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	-		0	26,198	183,645	113,622	529	0	1,968	8,641		124,760	58,885	985,443
1994	41	73,712	0	11,267	5,403	0	0	22,341	112,723	103,758	536	0	2,167	8,404		114,865	(2,142)	983,302
1995	200	293,072	12,451	21,300	-	0	0	33,072	359,895	112,902	649	2,000	1,895	28,394	3,997	149,837	210,059	1,193,360
1996	129	222,243	15,938	29,900	-	0	0	27,299	295,380	113,409	1,241	7,467	2,114	23,555	1,487	149,273	146,107	1,339,467
1997	123	221,727	19,456	21,300	-	0	0	20,172	282,655	106,883	1,406	7,080	1,974	28,118	2,800	148,261	134,394	1,473,861
1998	245	307,672	22,339	21,300	-	0	0	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	0	0	20,472	136,817	106,919	1,232	0	1,796	23,067	13	133,027	3,790	1,720,437
2000	66	61,535	0	27,837	2,703	0	0	18,251	110,326	102,937	1,500	8,613	1,803	23,083	0	137,936	(27,610)	1,692,827
2001	54	44,697	0	8,786	480	1,693	0	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	0	13,451	1,511		0	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	0	22,284	655		0	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	0	10,987	3,341		0	17,497	110,375	102,224	1,328	28,005	1,415	9,098	322	142,392	(32,017)	1,524,532
2005	168	223,620	1,811	22,341	36,398		0	21,432	305,602	99,375	1,303	14,458	2,452	7,864	9,840	135,292	170,310	1,694,841
2006	169	177,463	21,035	18,848	32,792		0	20,262	270,400	104,196	1,569	1,966	2,343	12,591	6,329	128,994	141,406	1,836,247
2007	26	67,254	1,583	13,840	12,467		0	9,429	104,573	98,519	2,209	68,779	1,460	7,867	1,488	180,322	(75,748)	1,760,499
2008	71	72,483	0	10,291	-		0	9,786	92,560	91,705	1,864	42,537	1,586	4,093	413	142,198	(49,638)	1,710,861
2009	64	85,904	0	13,880	-		0	15,375	115,159	97,361	1,422	25,313	1,366	2,627	413	128,502	(13,342)	1,697,519
2010	124	165,659	0	10,720	-		0	32,421	208,800	101,193	1,574	59,584	1,248	2,907	413	166,919	46,961	1,744,480
2011	202	344,729	474	17,138	-		0	12,833	375,174	99,694	559	52,250	1,172	1,788	9,921	165,384	200,462	1,944,943
1970-2011	102.4	129,740	5,540	19,531	3,615	169	0	20,534	179,000	106,036			1,927	11,518		132,591	46,308	

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].

**Data in Blue are subject to revision

[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.

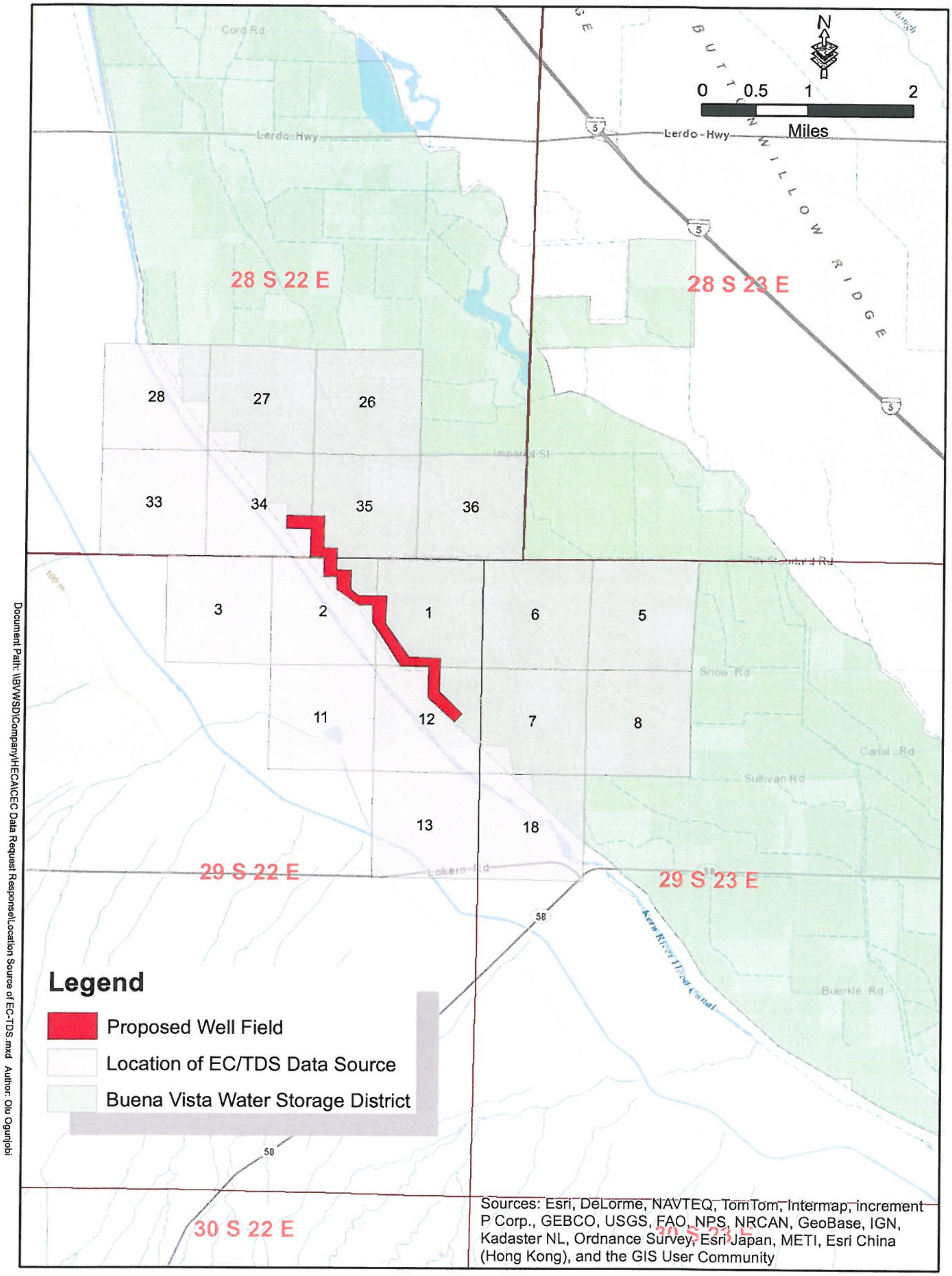
[16] Flows north of Hwy 46 (not including wheeling but including sales)

[17] MOU agreed to project losses start in 1995

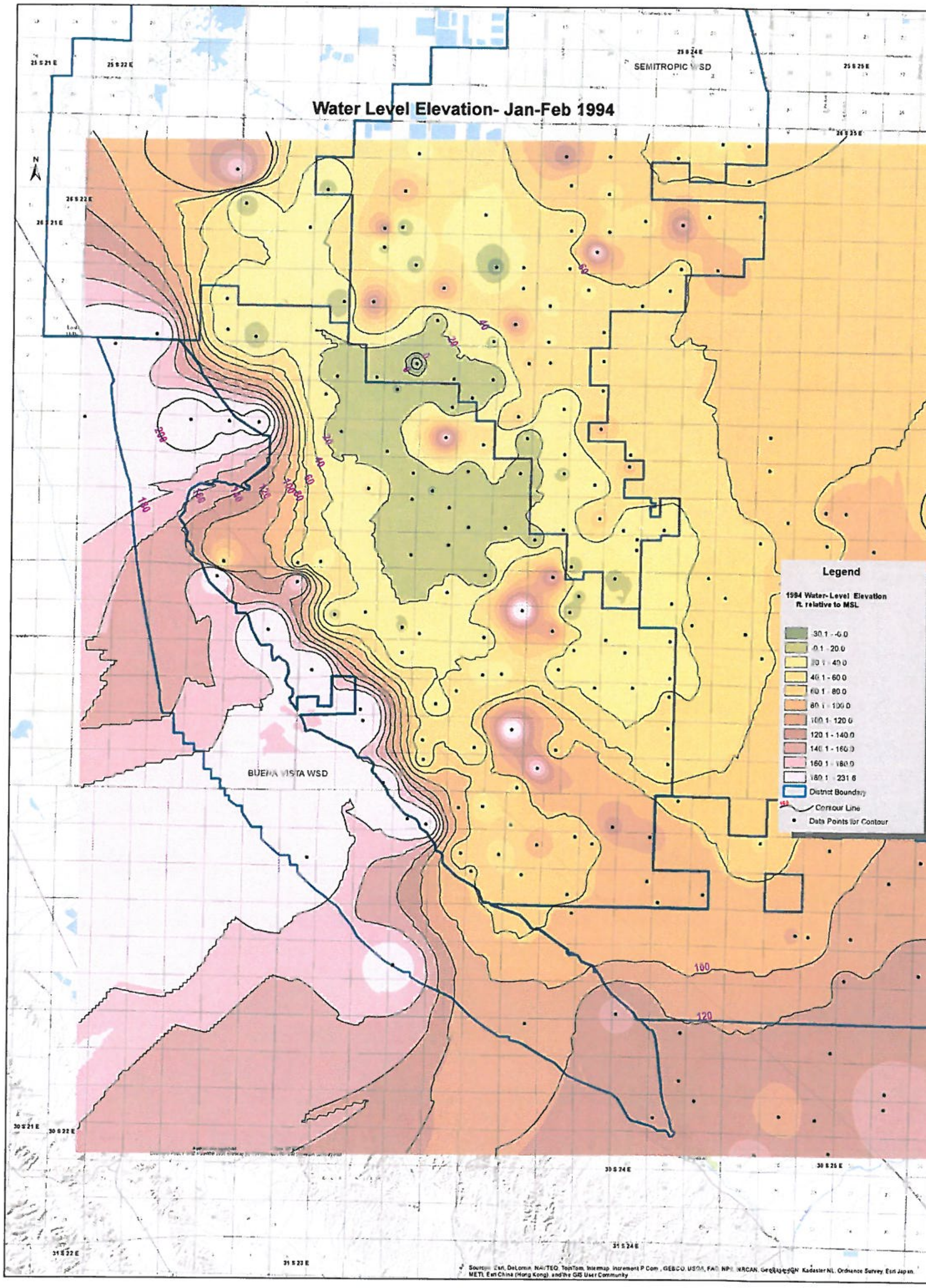
[18] Sum of [11] through [17].

Attachment 1.

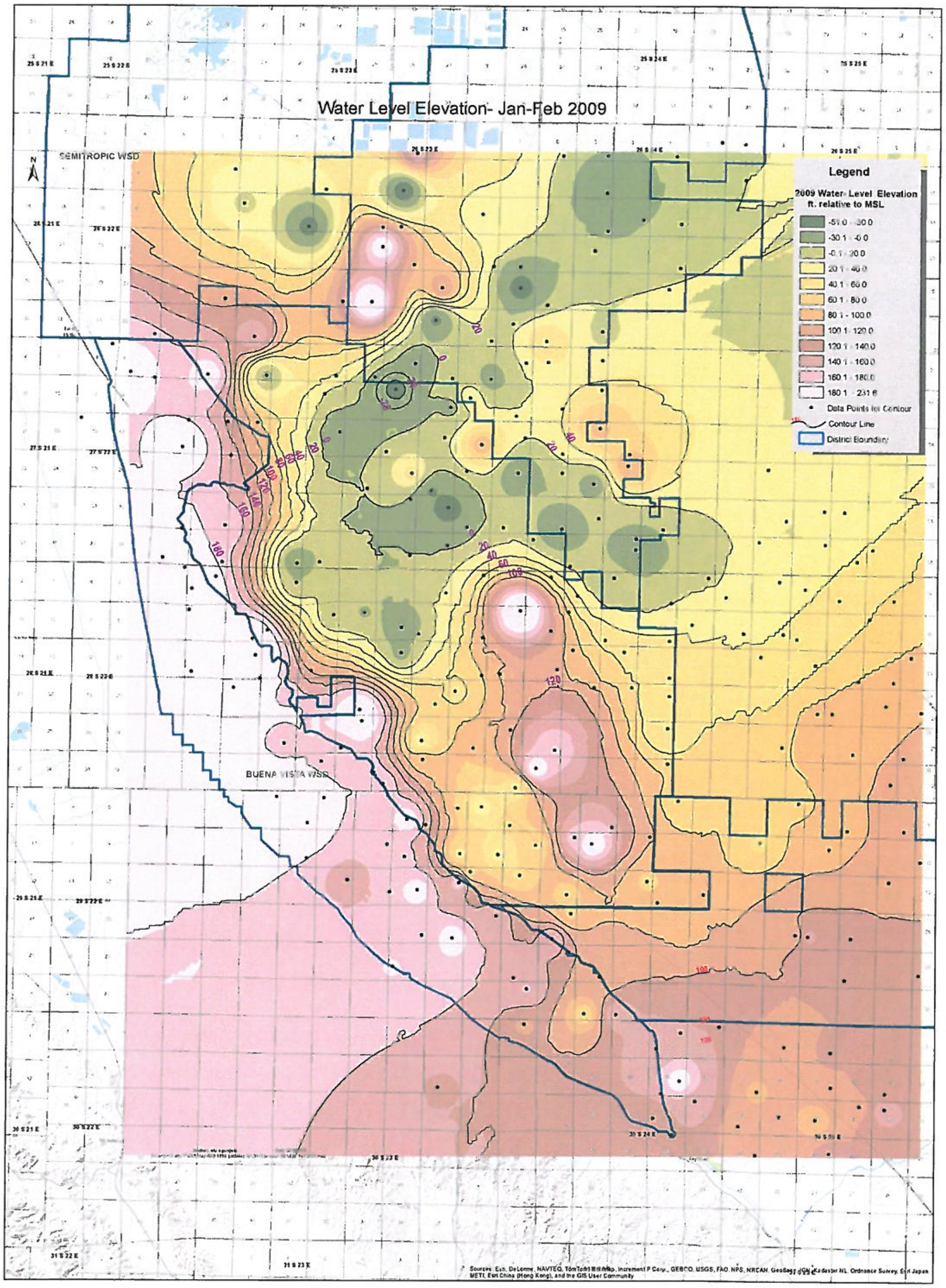
Potential Zone of Influence



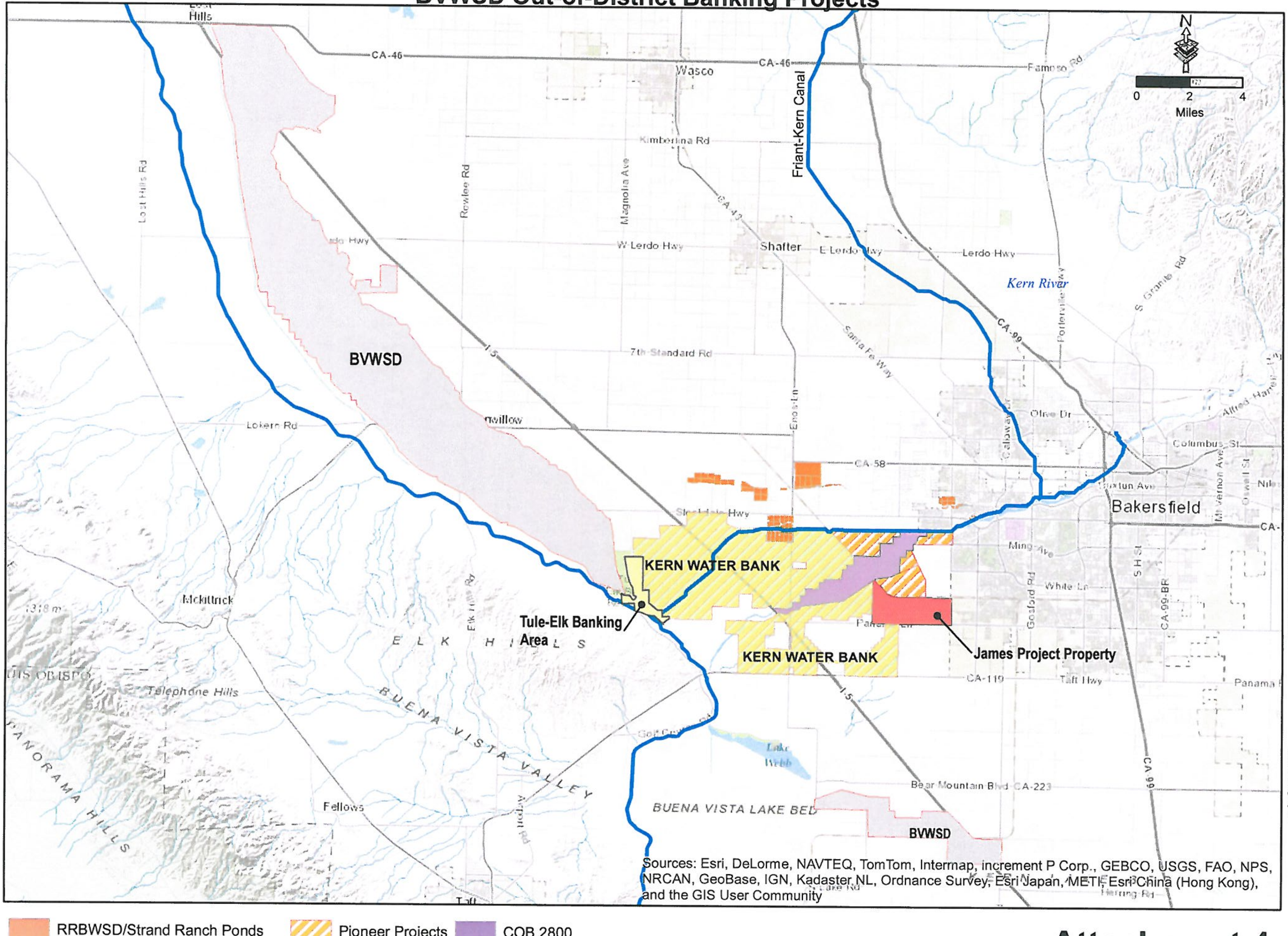
ATTACHMENT 2.



ATTACHMENT 3.



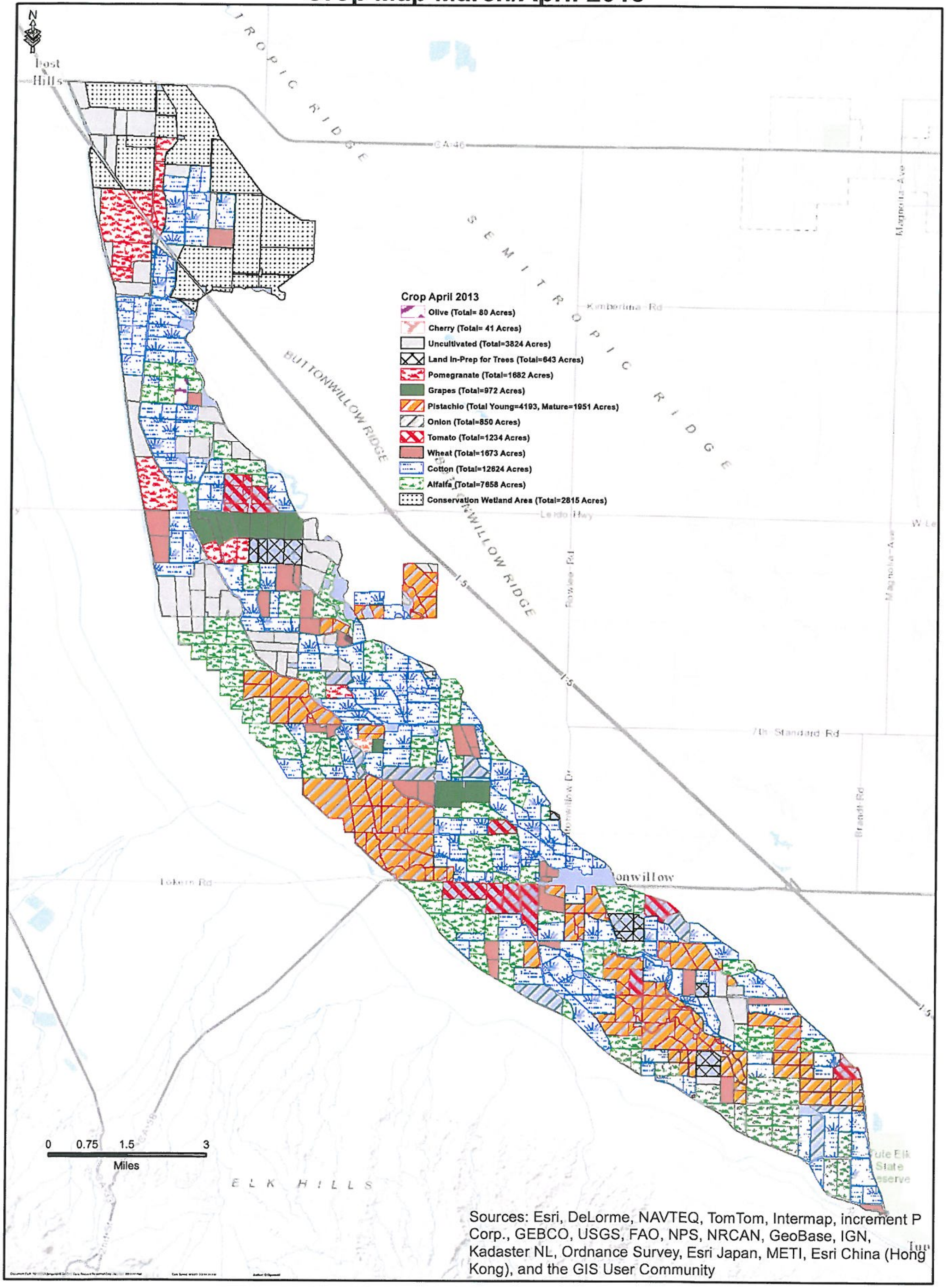
BVWSD Out-of-District Banking Projects



Attachment 4.

Attachment 5.

Crop Map March/April 2013



Attachment 7.

SOILS ENGINEERING, INC.

September 2, 2011

SEI File No.: 11-13636

Buena Vista Water Storage District
P.O. Box 756
Buttonwillow, CA 93206-0756

Attention: Mr. David Hampton

Subject: Submittal of Laboratory Testing Results
For 2011 HECA Well field Phase-2

Dear Mr. Hampton:

Attached herewith are the results of laboratory testing performed on samples retrieved during the drilling for the subject 2011 HECA Well Field Phase-2. This program was performed to collect petrophysical data on geological strata to help determine aquifer properties for the well field analysis per the guidelines outlined by Dr. Crewdson dated March 7, 2011.

All laboratory testing was performed in accordance with the most current ASTM Standards and are shown on the attached laboratory testing reports. A summary of the testing data has also been provided for your reference as Page 2, Page 3 and Page 4.

We hope this provides the information you require. If you have questions or need further assistance please contact our office.

Respectfully submitted,
SOILS ENGINEERING, INC.

REGISTERED PROFESSIONAL ENGINEER TONY M. FRANGIE No. 39549 Exp. 12-31-11 CIVIL STATE OF CALIFORNIA

REGISTERED ENVIRONMENTAL ASSESSOR II TONY M. FRANGIE No. 20131 Exp. Date 7/12 STATE OF CALIFORNIA

Tony M. Frangie, P.E., REA II
C39549, REA 20131

Attachments:

Laboratory Testing Data Table – Pages 2 through 4
Particle Size Distribution Reports – Figures A-1 through A-35
Consolidation Test Reports – Figures B-1 through B-7

BUENA VISTA WATER STORAGE DISTRICT

Geotechnical Soils Investigation
HECA Well Field Phase 2
Buttonwillow, CA

September 2, 201

TEST LOCATION	USCS	% < # 200	d90	d60	d50	d10	CONSOLIDATION						S.G.	PERM.	TUBE DENSITY	
							C_C	C_S	S.P. (pcf)	p_{MAX}	ε_{MAX}	ε_{FINAL}		K	Dry Wt., p.c.f.	% Moisture
01-040B	CL	95	0.0342**	N/A	N/A	N/A								0.00292		
01-060B	ML						0.14	0.02	0	5410	5.8	4.4	2.58		85.8	35.1%
01-060C	ML	89	0.0876	N/A	N/A	N/A								0.00065		
01-070B	SW-SM	7	0.8055	0.4626	0.4044	0.0887										
01-080C	ML	94	0.0460**	N/A	N/A	N/A										
02-020B	SP												2.63			
02-020C	SP	5	0.4831	0.2978	0.2616	0.1174								2.95		
02-030B	SM						0.06	0.01	0	5410	2.9	2.4	2.65		96.5	30.2%
02-030C	SM	15	0.3076	0.1904	0.1656	0.0595**								0.05		
02-040B	SP	5	0.5148	0.3258	0.2829	0.1342								18.03		
02-050B	SW-SM	7	1.1229	0.4822	0.3769	0.1096								4.25		
02-050C	SW-SM												2.59			
02-070B	ML	60	0.9757	0.0778	0.0344**	N/A								0.00408		
03-020B	SP	5	1.4074	0.4023	0.2986	0.0912	0.02	0	0	5410	1.6	1.3		6.46	117.5	11.3%
03-050B	ML	53	0.4389	0.1209	0.0605	N/A										

**** Represents extrapolated value**

CONSOLIDATION
Cc - Compression Index, Cs - Swell Index
S.P. (pcf) - Swell Pressure, Pmax - Max Stress in KSF,
Emax - % change at max Stress,
Final % change at stress 335 psf

CONSTANT HEAD PERMEABILITY
K - Coefficient of Permeability (cm./sec)
S.G. - Specfic Gravity

BUENA VISTA WATER STORAGE DISTRICT

Geotechnical Soils Investigation
HECA Well Field Phase 2
Buttonwillow, CA

TEST LOCATION	USCS	% < # 200	d90	d60	d50	d10	CONSOLIDATION						S.G.	PERM.	TUBE DENSITY	
							C_C	C_S	S.P. (pcf)	p_{MAX}	ε_{MAX}	ε_{FINAL}		K	Dry Wt., p.c.f.	% Moisture
03-060B	SM						0.04	0	0	5410	2.7	2.4			102.4	19.8%
03-060C	SM	27	0.3151	0.2001	0.1757	N/A								0.00532		
03-080A	SM	12	1.4902	0.7758	0.6435	0.0487**										
03-080B	SW-SM	11	3.3790	0.9532	0.7128	0.0614**										
04-010B	SM	30	0.9683	0.1884	0.1394	0.0410**										
04-010C	ML	96	0.0206**	N/A	N/A	N/A										
04-020B	ML												2.65			
04-050A	ML	52	0.2976	0.1201	0.0605**	N/A							2.58			
04-060B	SM												2.64			
04-090A	SM	21	1.0784	0.5056	0.3645	0.0210**								0.40819		
04-090B	SW-SM	8	1.0691	0.5195	0.3897	0.0951										
04-090C	SW-SM	11	1.0916	0.5724	0.4456	0.0677**										
05-030B	SW						0.04	0.02	0	5410	3.0	1.8			97.5	28.1%
05-030C	SM	46	0.1431	0.0895	0.0789	N/A								0.11820		
05-060C	ML	64	0.4130	0.0524**	0.0204**	N/A										

**** Represents extrapolated value**

CONSOLIDATION
Cc - Compression Index, Cs - Swell Index
S.P. (pcf) - Swell Pressure, Pmax - Max Stress in KSF,
Emax - % change at max Stress,
Final % change at stress 335 psf

CONSTANT HEAD PERMEABILITY
K - Coefficient of Permeability (cm./sec)
S.G. - Specfic Gravity

BUENA VISTA WATER STORAGE DISTRICT

Geotechnical Soils Investigation
HECA Well Field Phase 2
Buttonwillow, CA

September 2, 2011

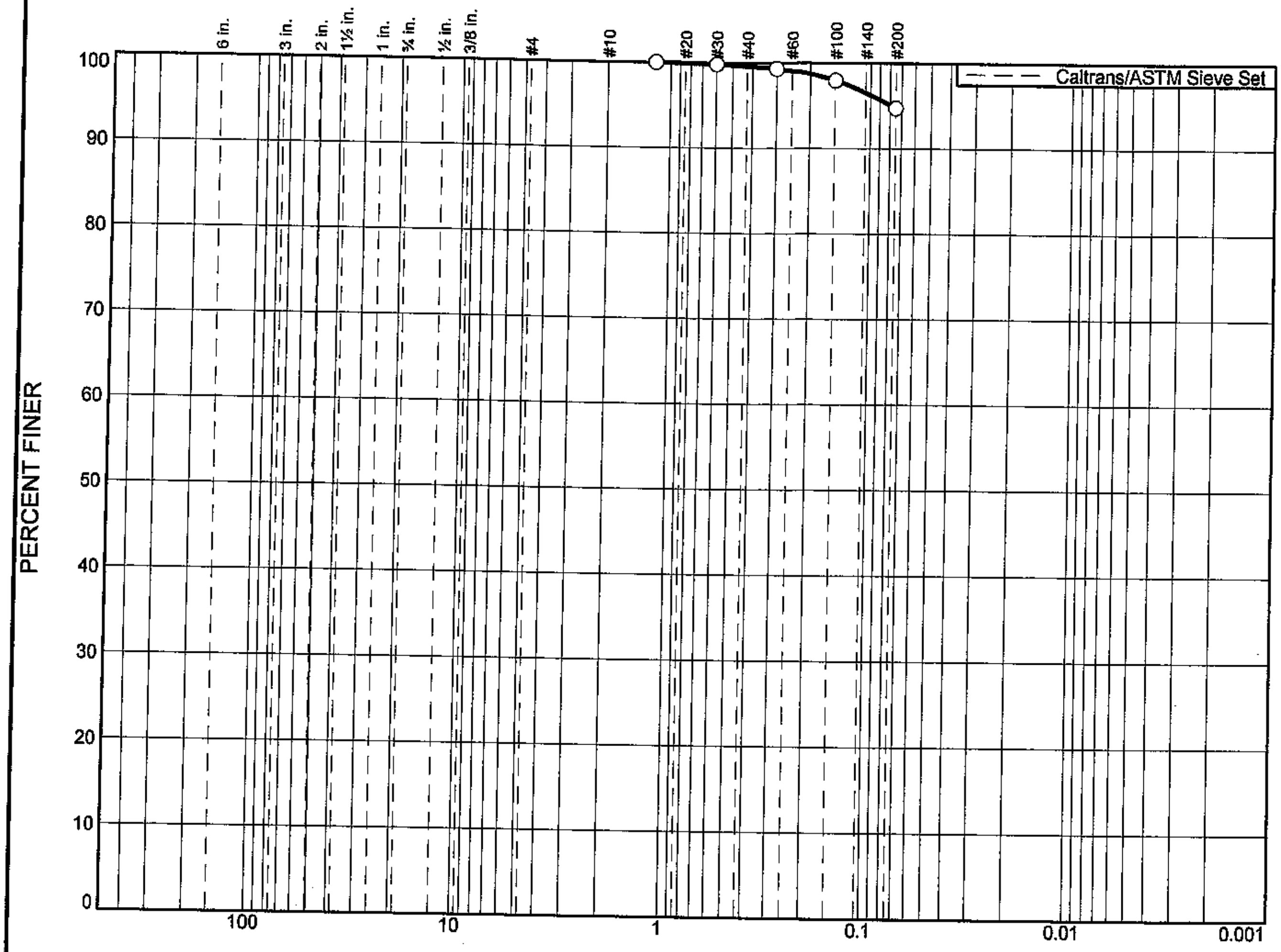
TEST LOCATION	USCS	% < # 200	d90	d60	d50	d10	CONSOLIDATION						S.G.	PERM.	TUBE DENSITY	
							C_C	C_S	S.P. (pcf)	p_{MAX}	ε_{MAX}	ε_{FINAL}		K	Dry Wt., p.c.f.	% Moisture
05-070B	SM						0.05	0.01	184	5410	2.5	1.7			104.5	23.0%
05-070C	ML	70	0.1435	0.0630**	0.0534**	N/A								0.00114		
05-090C	ML	67	0.1792	0.0557**	0.0342**	N/A							2.61			
06-010B	ML	79	0.1184	0.0382**	0.0275**	N/A										
06-020B	ML	57	0.2633	0.0815	0.0647**	N/A								0.24151		
07-010B	SM	40	0.2169	0.1018	0.0869	N/A								0.02565		
07-040B	SP	5	0.6832	0.4004	0.347	0.1468							2.63			
07-060B	SM	43	0.4029	0.1275	0.0925	N/A										
07-070B	ML	95	0.0088**	N/A	N/A	N/A								0.36850		
07-080B	SP-SM	8	0.7693	0.3547	0.2895	0.0969								14.60		
07-090C	SP	4	1.1482	0.7260	0.6309	0.2009							2.70		107.3	3.8%
08-020B	SP	3	0.5699	0.4124	0.3745	0.1986								18.17	102.8	5.8%
08-040B	SP						0.02	0	0	5410	2.1	1.8	2.62			
08-040C	SW-SM	8	0.9000	0.4936	0.4239	0.0939								0.58110		
08-090C	SP	6	0.4440	0.2642	0.2294	0.0966							2.75			

**** Represents extrapolated value**

CONSOLIDATION
Cc - Compression Index, Cs - Swell Index
S.P. (pcf) - Swell Pressure, Pmax - Max Stress in KSF,
Emax - % change at max Stress,
Final % change at stress 335 psf

CONSTANT HEAD PERMEABILITY
K - Coefficient of Permeability (cm./sec)
S.G. - Specfic Gravity

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	4.9	94.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○ SAND CLAY	CL	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

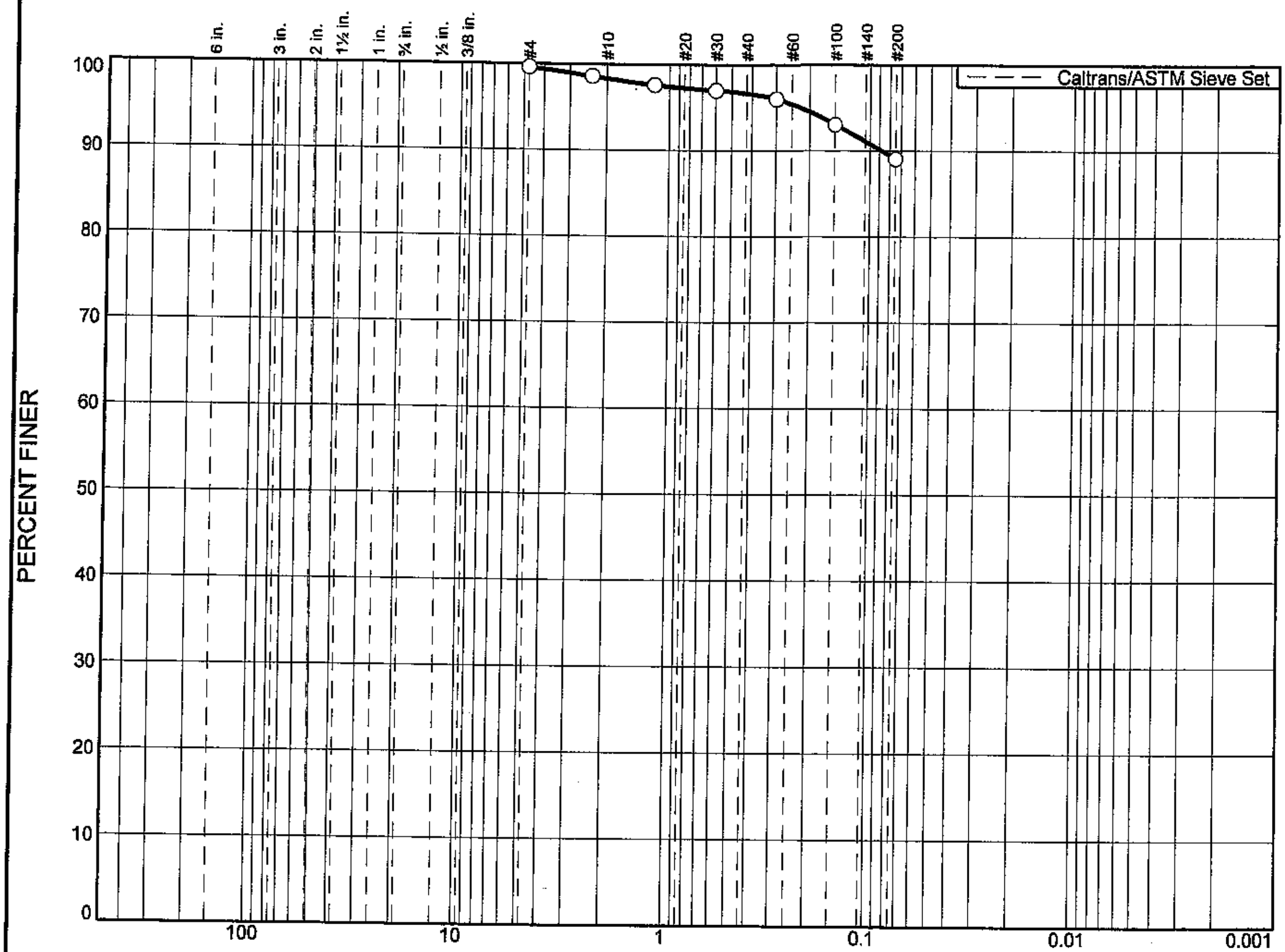
○ **Location:** B-01-040B **Sample Number:** 35886

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				1.3	1.6	7.6	89.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○ SANDY SILT	ML	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

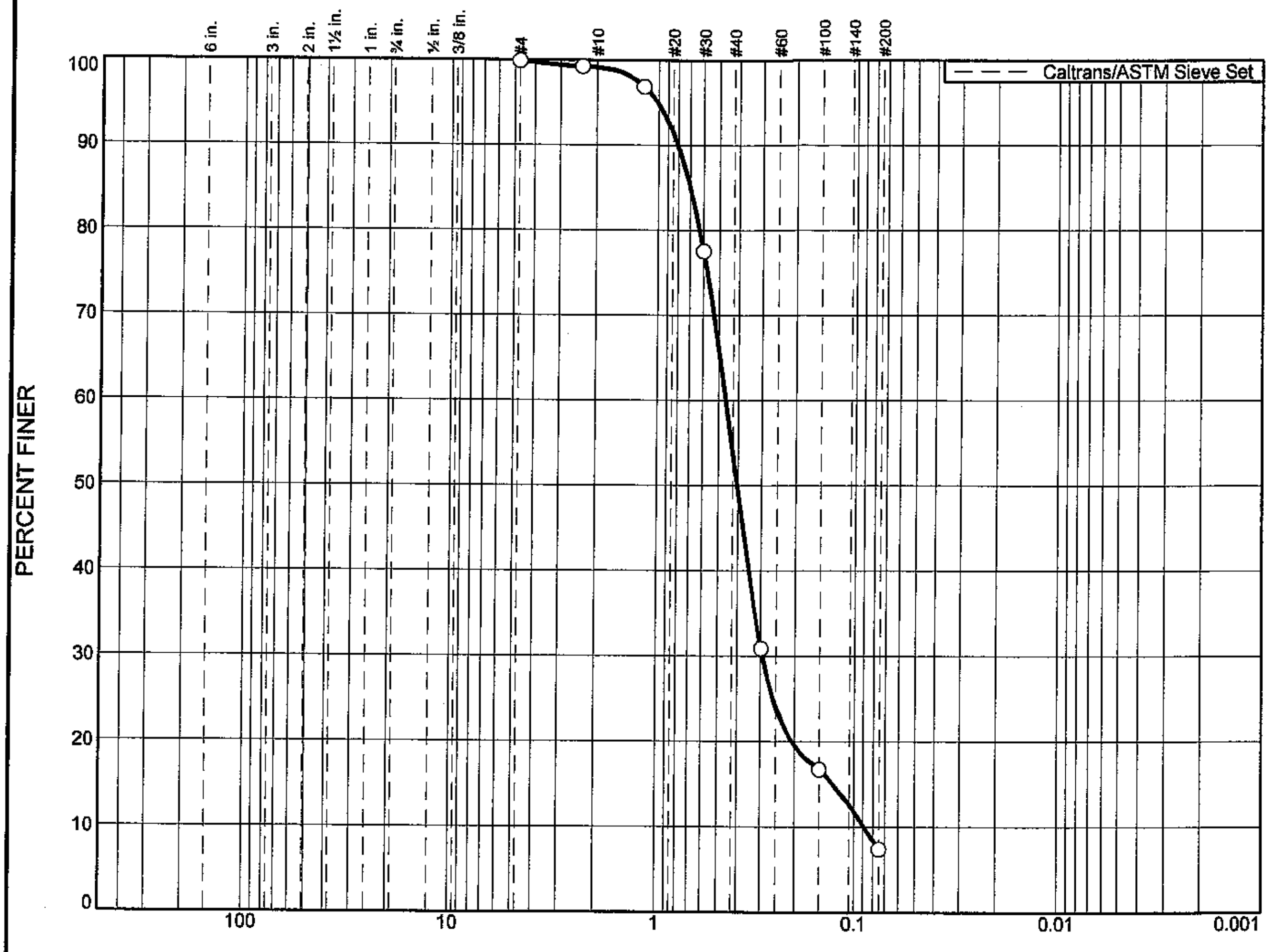
○ **Location:** B-01-060C **Sample Number:** 35889

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-2

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				0.8	45.4	46.3	7.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6987	0.4626	0.4044	0.2945	0.1274	0.0887	2.11	5.21

Material Description	USCS	AASHTO
○ WELL-GRADED SAND with low fine content	SW-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

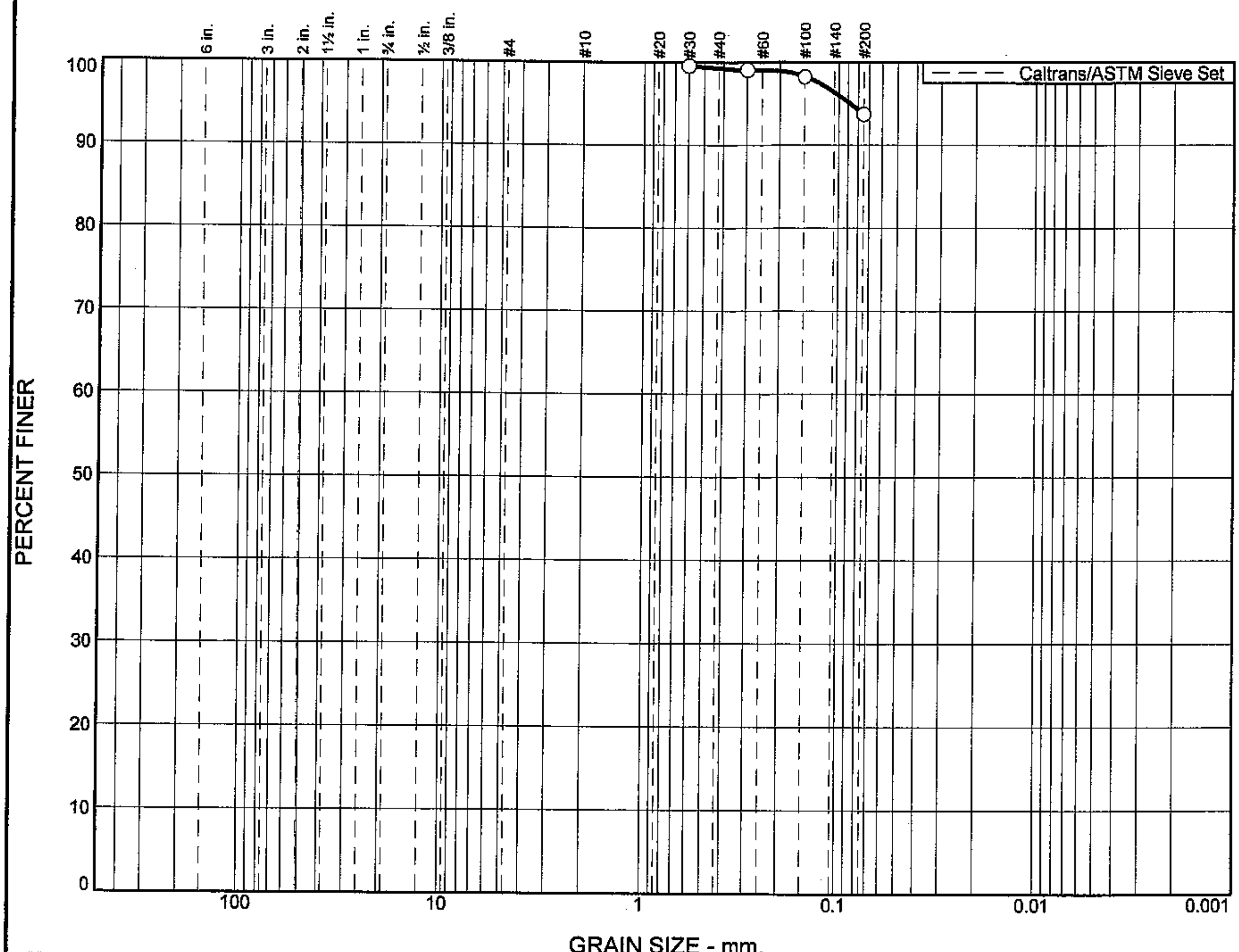
○ **Location:** B-01-070B **Sample Number:** 35891

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-3

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						5.6	93.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○ CLAYEY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

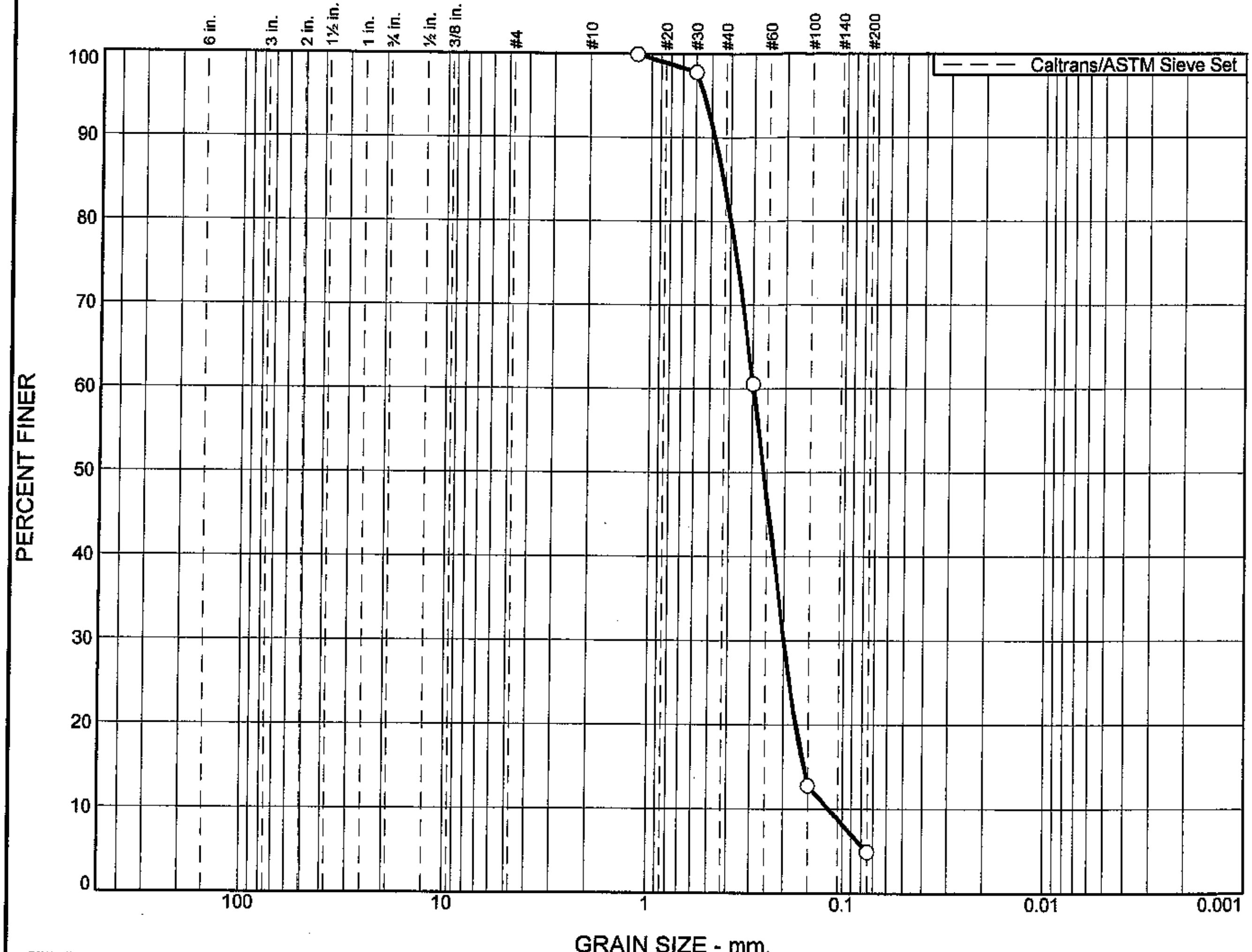
○ **Location:** B-01-080C **Sample Number:** 35893

Remarks:

SOILS ENGINEERING, INC.

Figure A-4

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						78.6	4.9	

╳	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4367	0.2978	0.2616	0.2012	0.1574	0.1174	1.16	2.54

Material Description	USCS	AASHTO
○ POORLY-GRADED SAND	SP	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

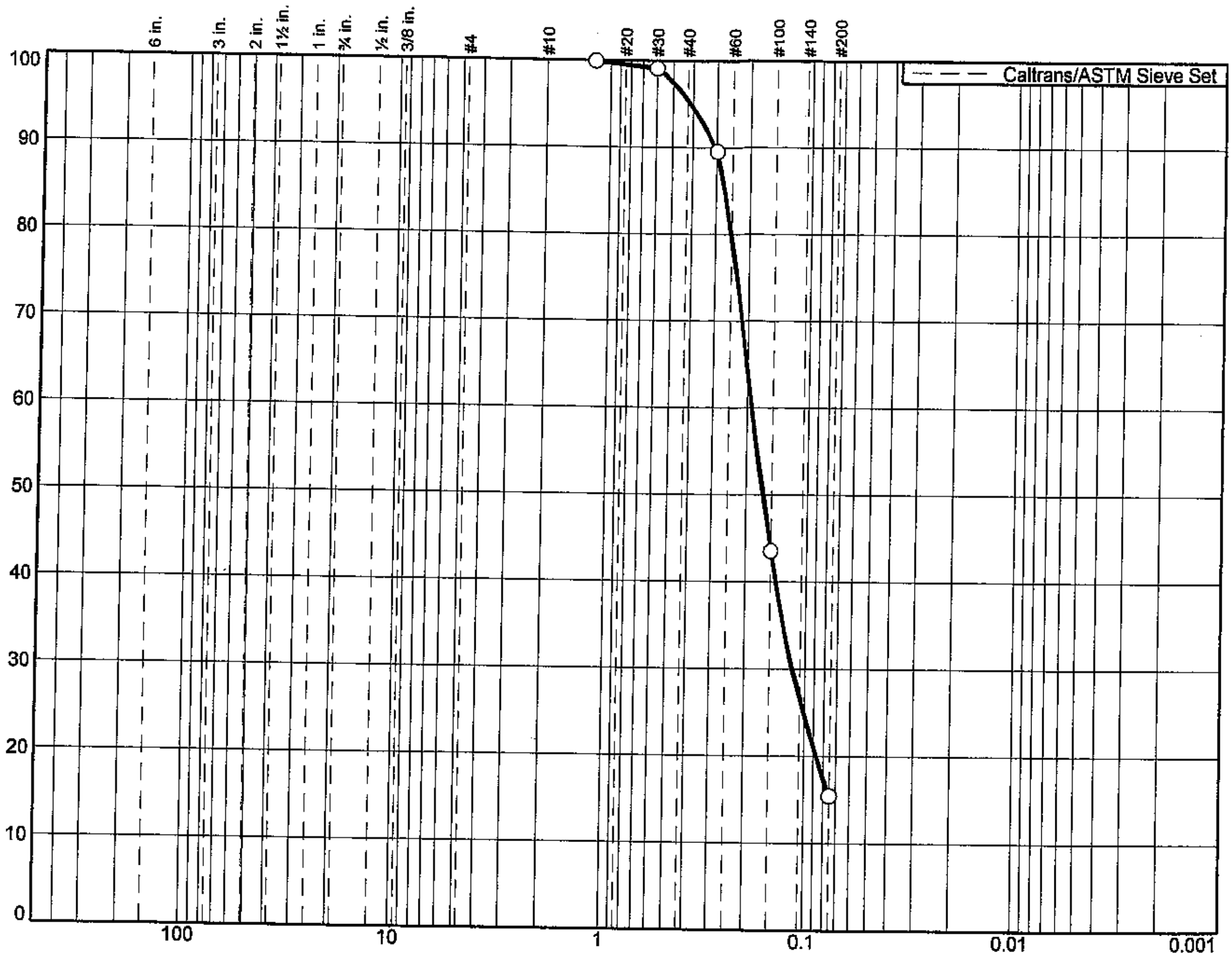
○ **Location:** B-02-020C **Sample Number:** 35897

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-5

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						80.0	15.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2744	0.1904	0.1656	0.1150				

Material Description	USCS	AASHTO
○ SILTY SAND	SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

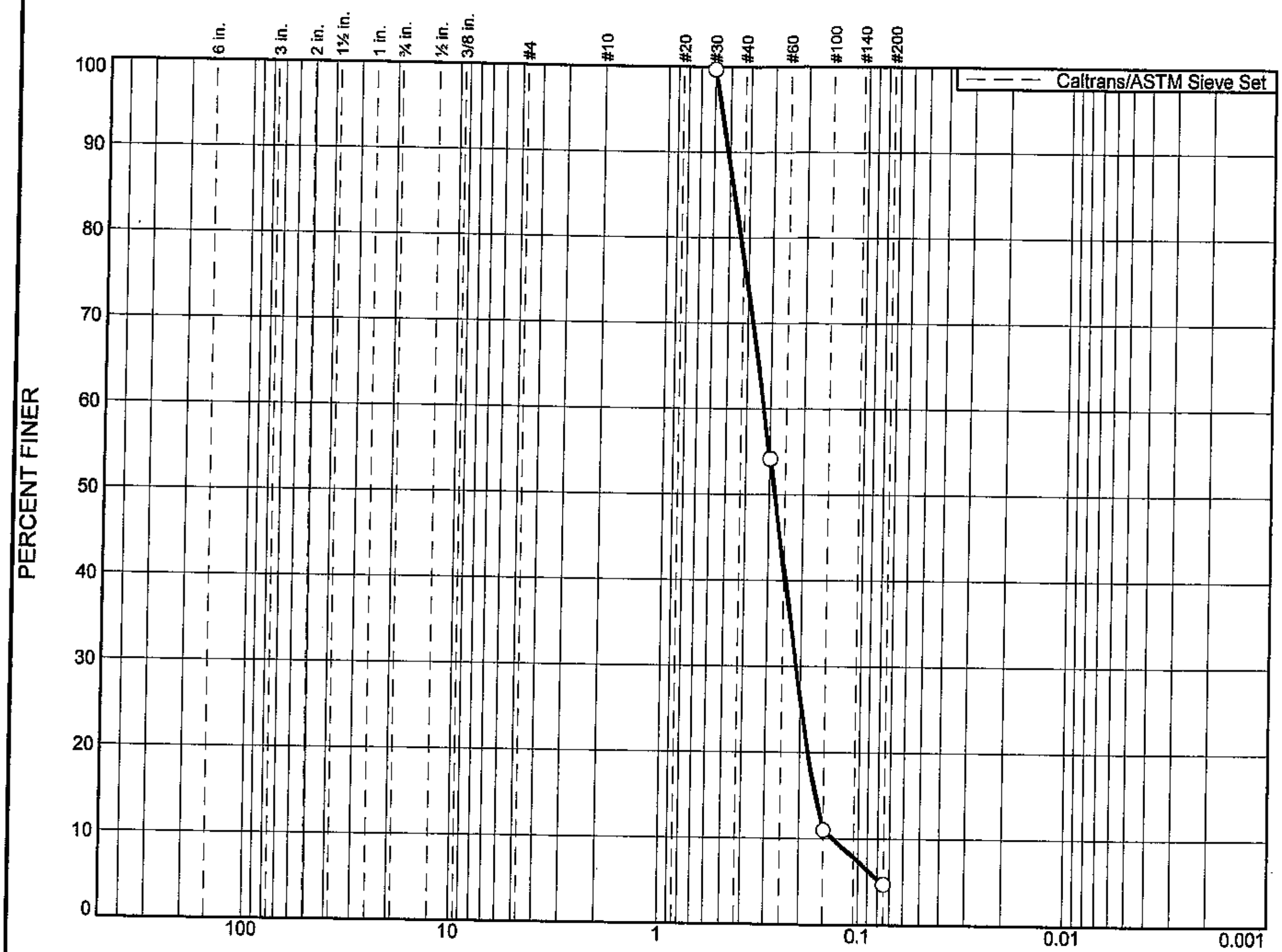
○ **Location:** B-02-030C **Sample Number:** 35900

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-6

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						73.0	4.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4758	0.3259	0.2829	0.2132	0.1648	0.1342	1.04	2.43

Material Description	USCS	AASHTO
○ POORLY-GRADED SAND	SP	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

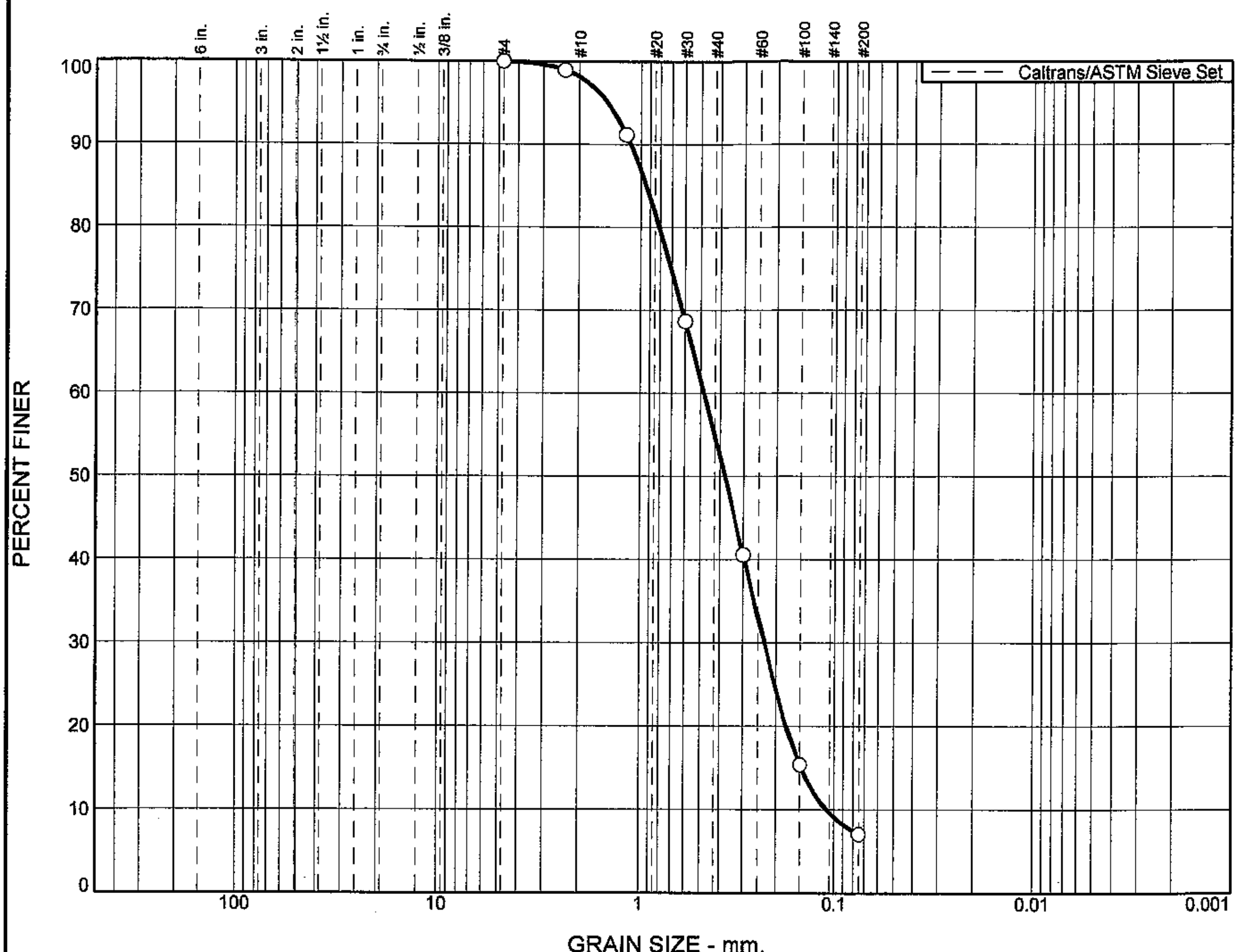
○ **Location:** B-02-040B **Sample Number:** 35901

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-7

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				1.8	43.3	47.8	7.1	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.9407	0.4822	0.3769	0.2323	0.1475	0.1096	1.02	4.40

Material Description	USCS	AASHTO
○ WELL-GRADED SAND with low fine content	SW-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

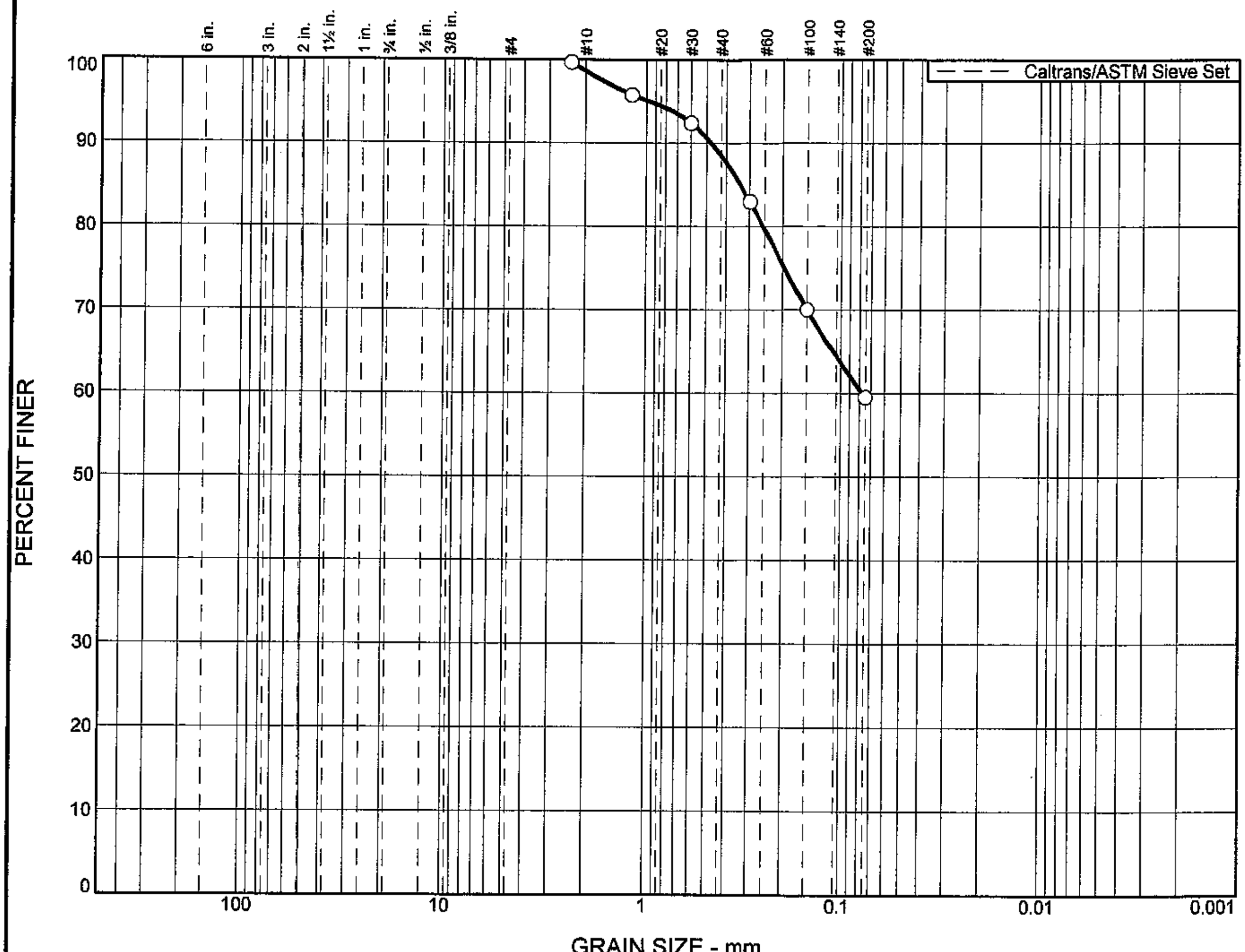
○ **Location:** B-02-050B **Sample Number:** 35903

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-8

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o					10.1	29.0	59.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.3377	0.0776						

Material Description	USCS	AASHTO
o SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

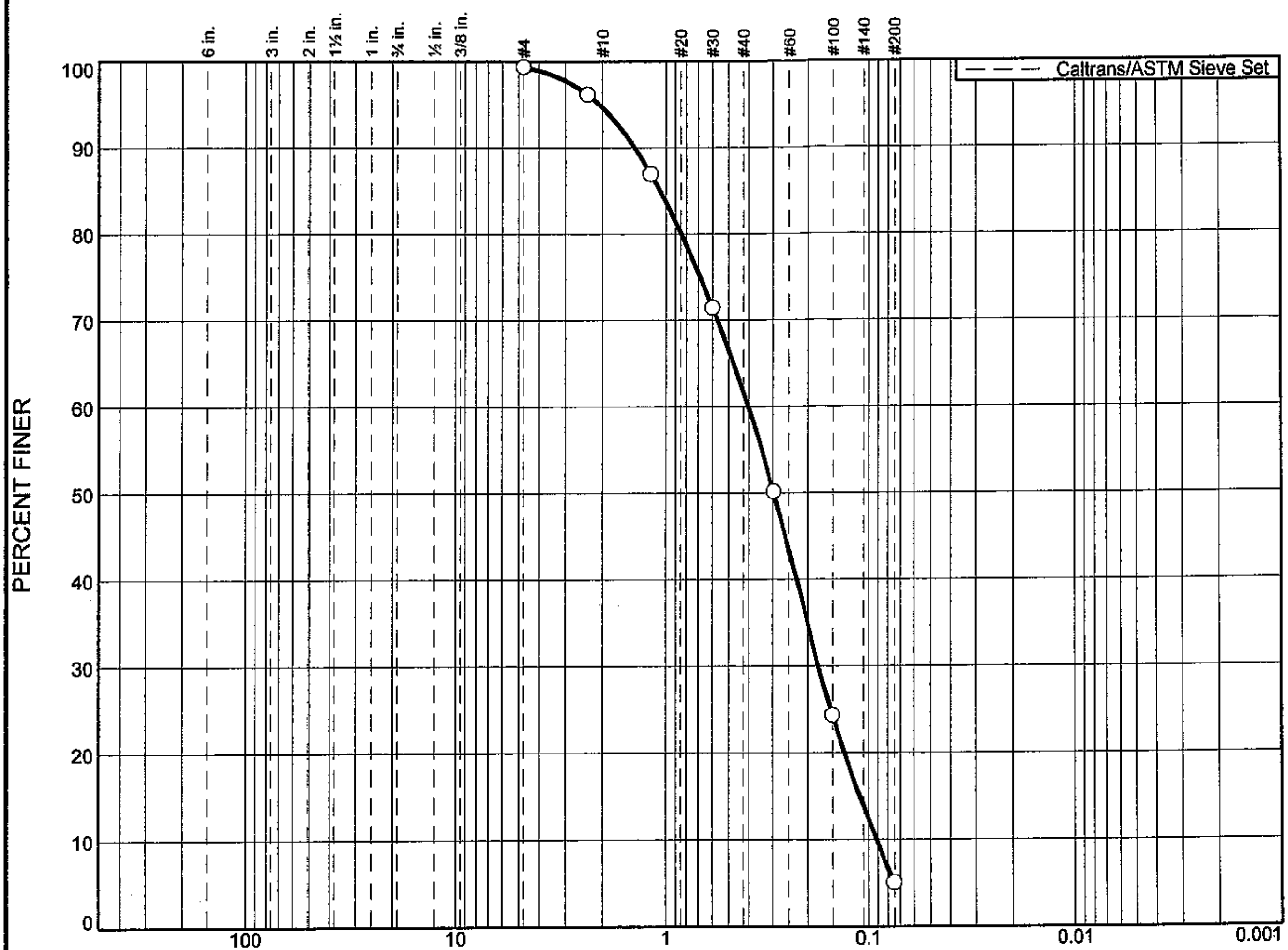
o **Location:** B-02-070B **Sample Number:** 35907

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-9

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○				4.8	32.9	56.6	5.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	N/A		1.0648	0.4023	0.2986	0.1760	0.1101	0.0912	0.84	4.41

Material Description	USCS	AASHTO
○ POORLY-GRADED SAND	SP	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

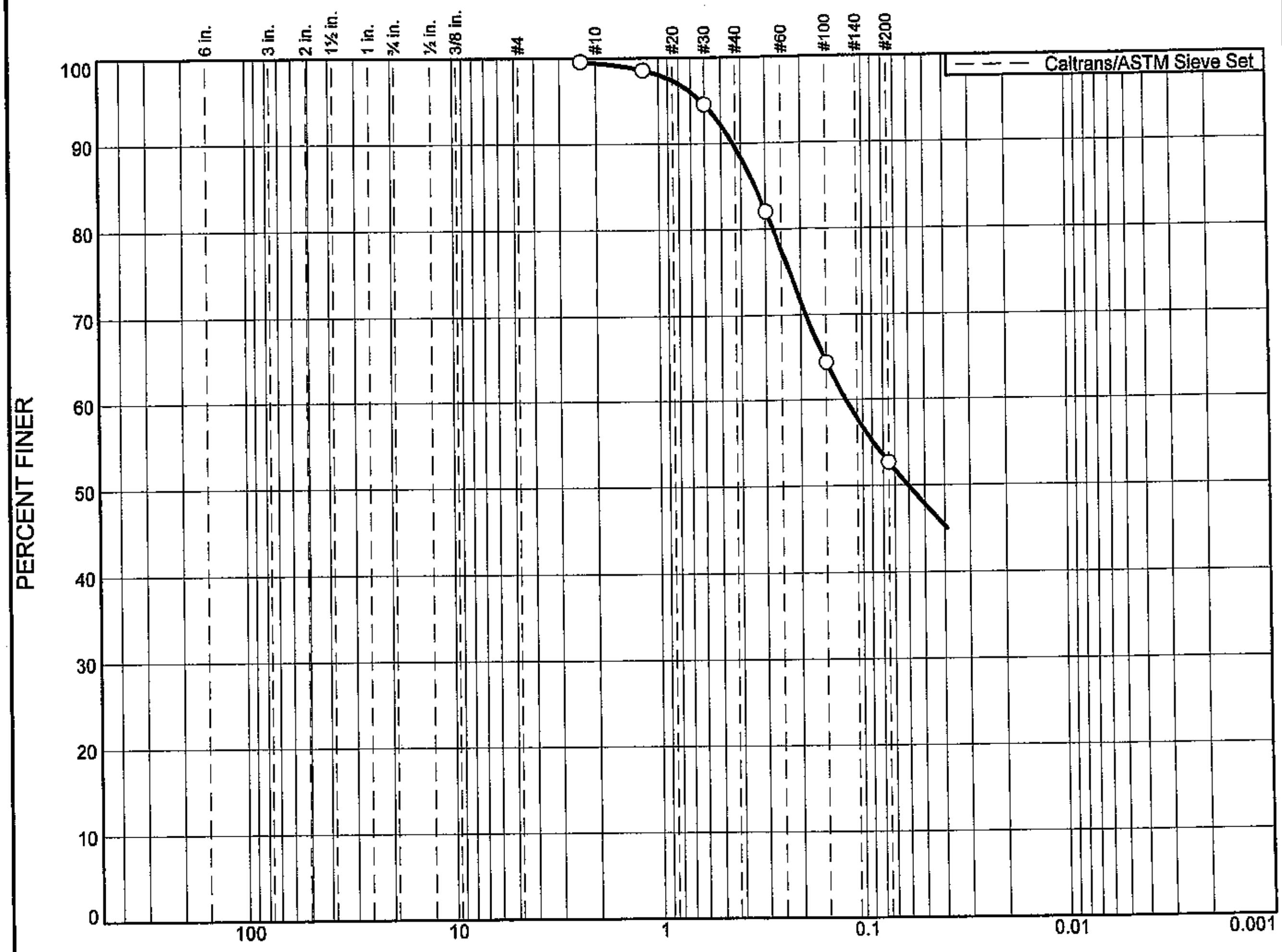
○ **Location:** B-03-020B **Sample Number:** 35917

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-10

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					10.1	36.7	52.7	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3415	0.1209	0.0605					

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

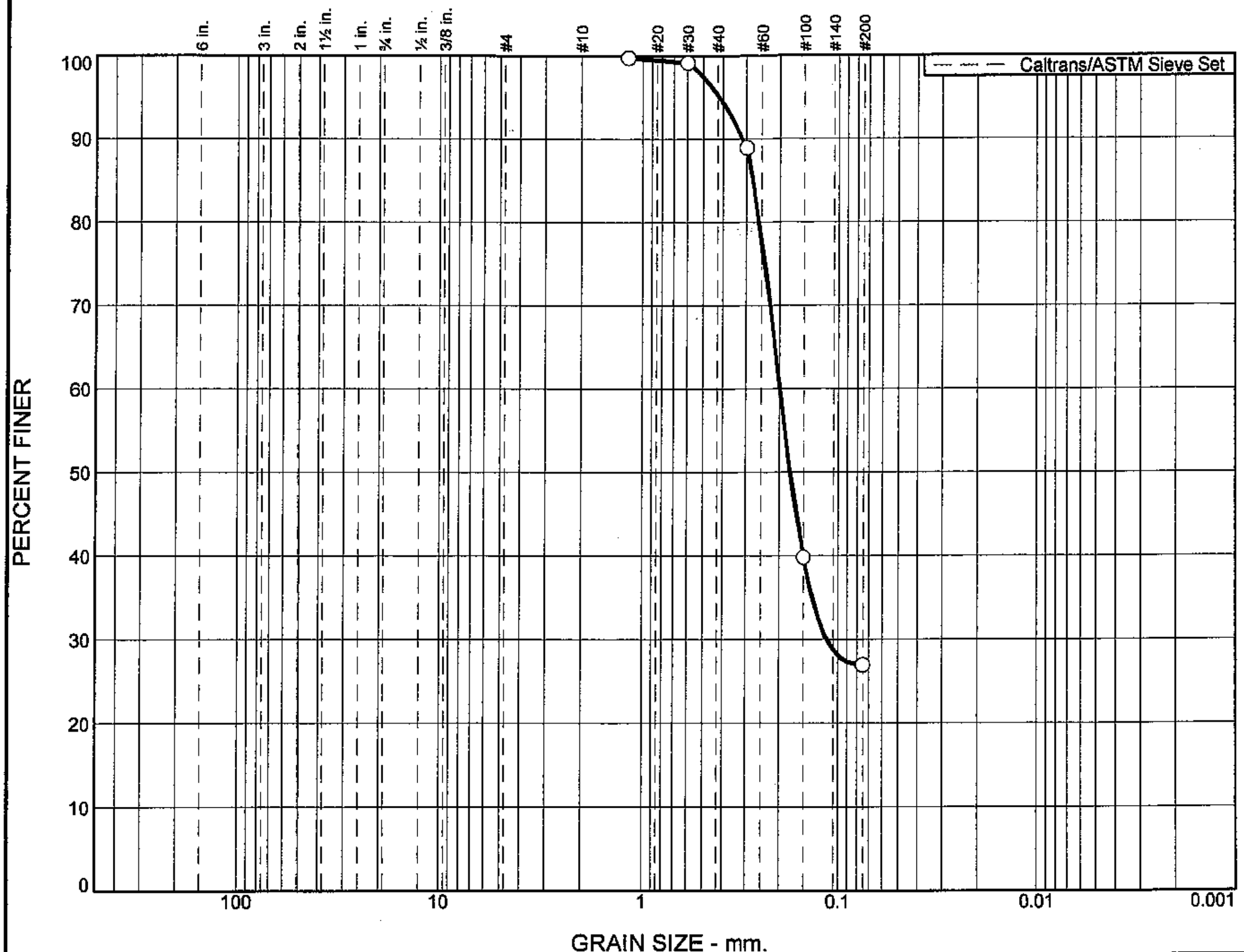
○ **Location:** B-03-050B **Sample Number:** 35923

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-11

Particle Size Distribution Report



	% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
○						68.4	26.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2797	0.2001	0.1757	0.1141				

Material Description	USCS	AASHTO
○ SILTY SAND	SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

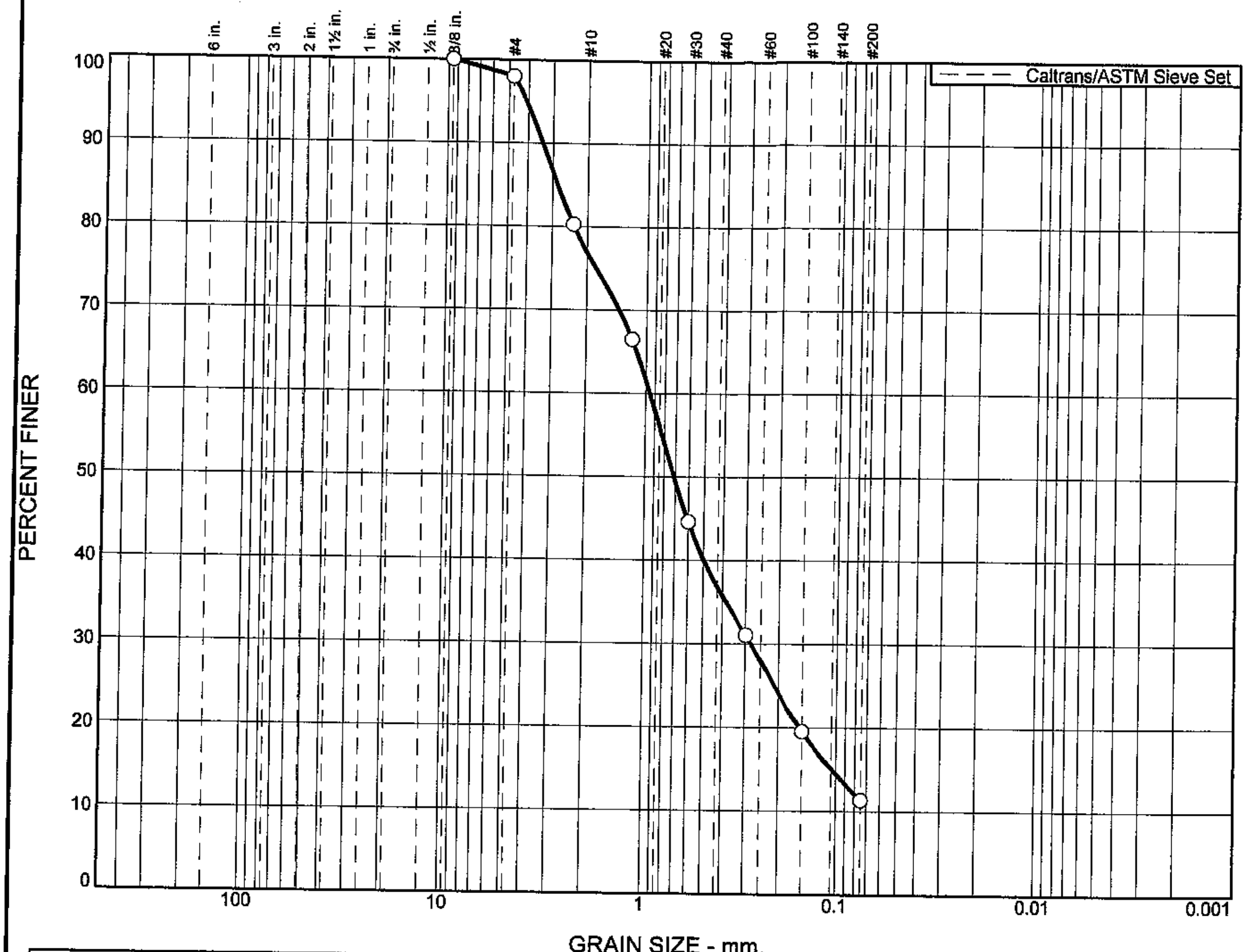
○ **Location:** B-03-060C **Sample Number:** 35926

Remarks:

SOILS ENGINEERING, INC.

Figure A-12

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	2.0	21.1	40.1	25.4	11.4	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.8321	0.9532	0.7128	0.2815	0.1052			

Material Description	USCS	AASHTO
○ WELL-GRADED SAND with low fine content	SW-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

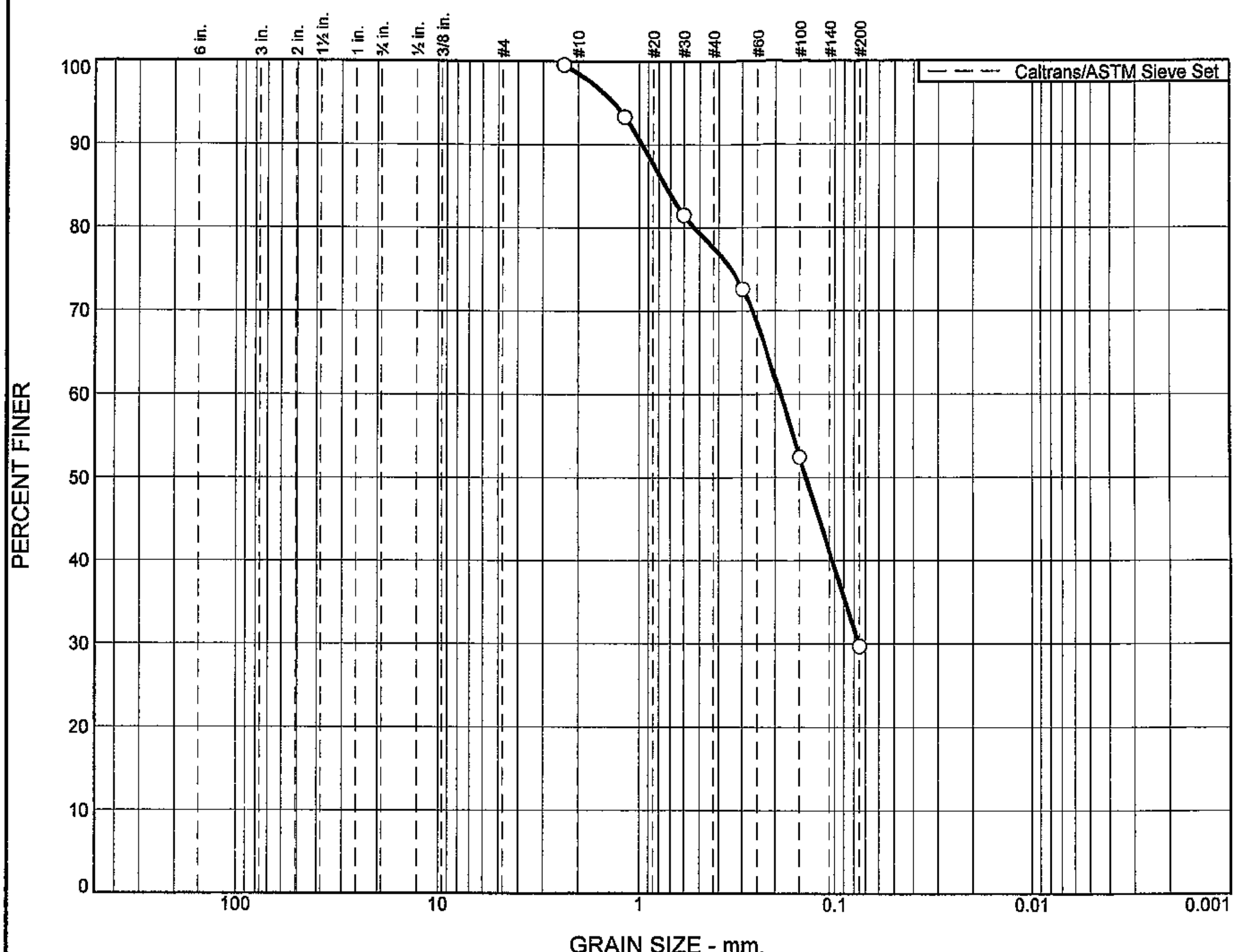
○ **Location:** B-03-080B **Sample Number:** 35930

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-14

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o					21.0	47.8	29.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.7417	0.1884	0.1394	0.0758				

Material Description	USCS	AASHTO
o SILTY SAND	SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

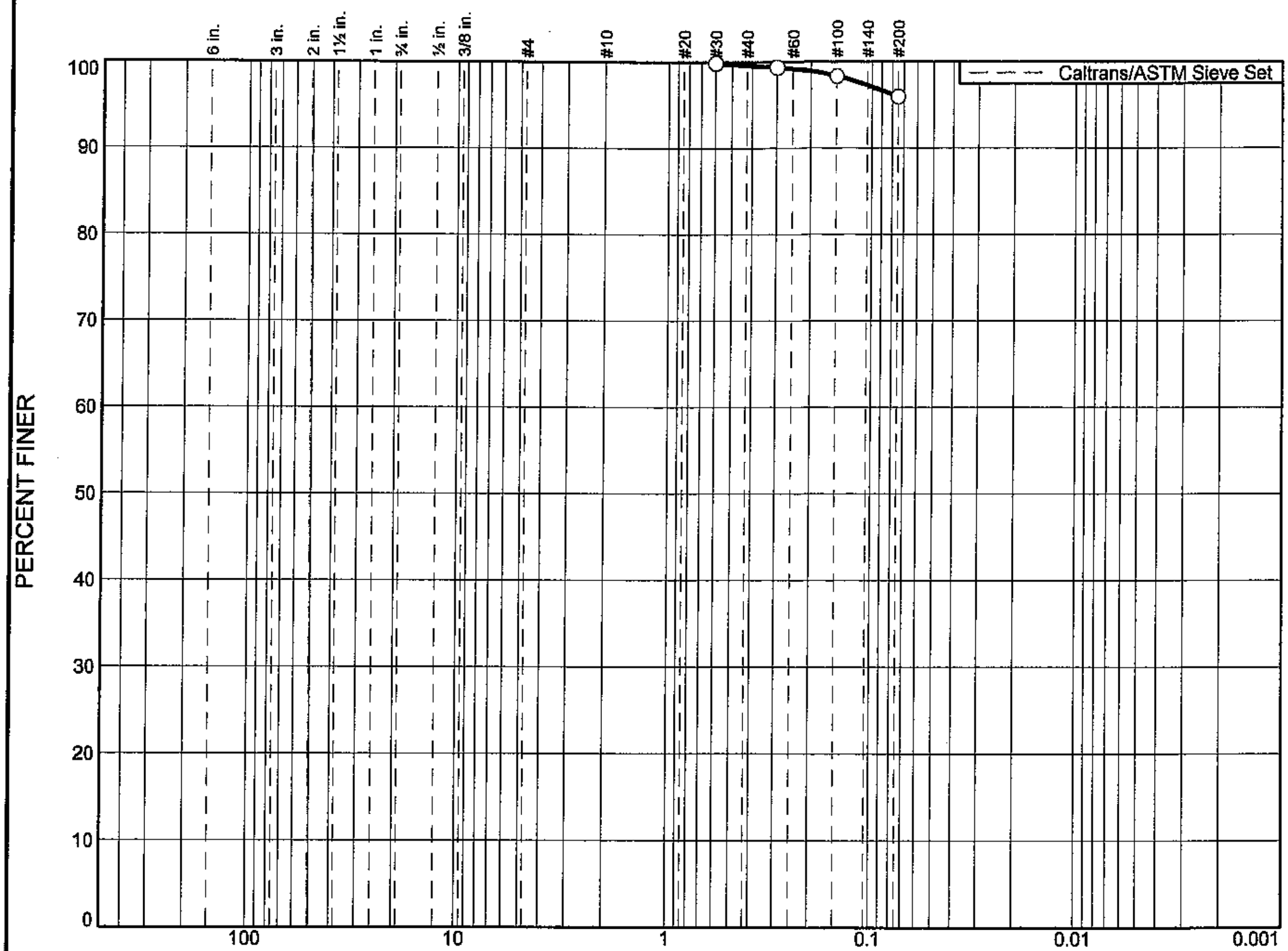
o **Location:** B-04-010B **Sample Number:** 35934

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-15

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						3.7	95.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

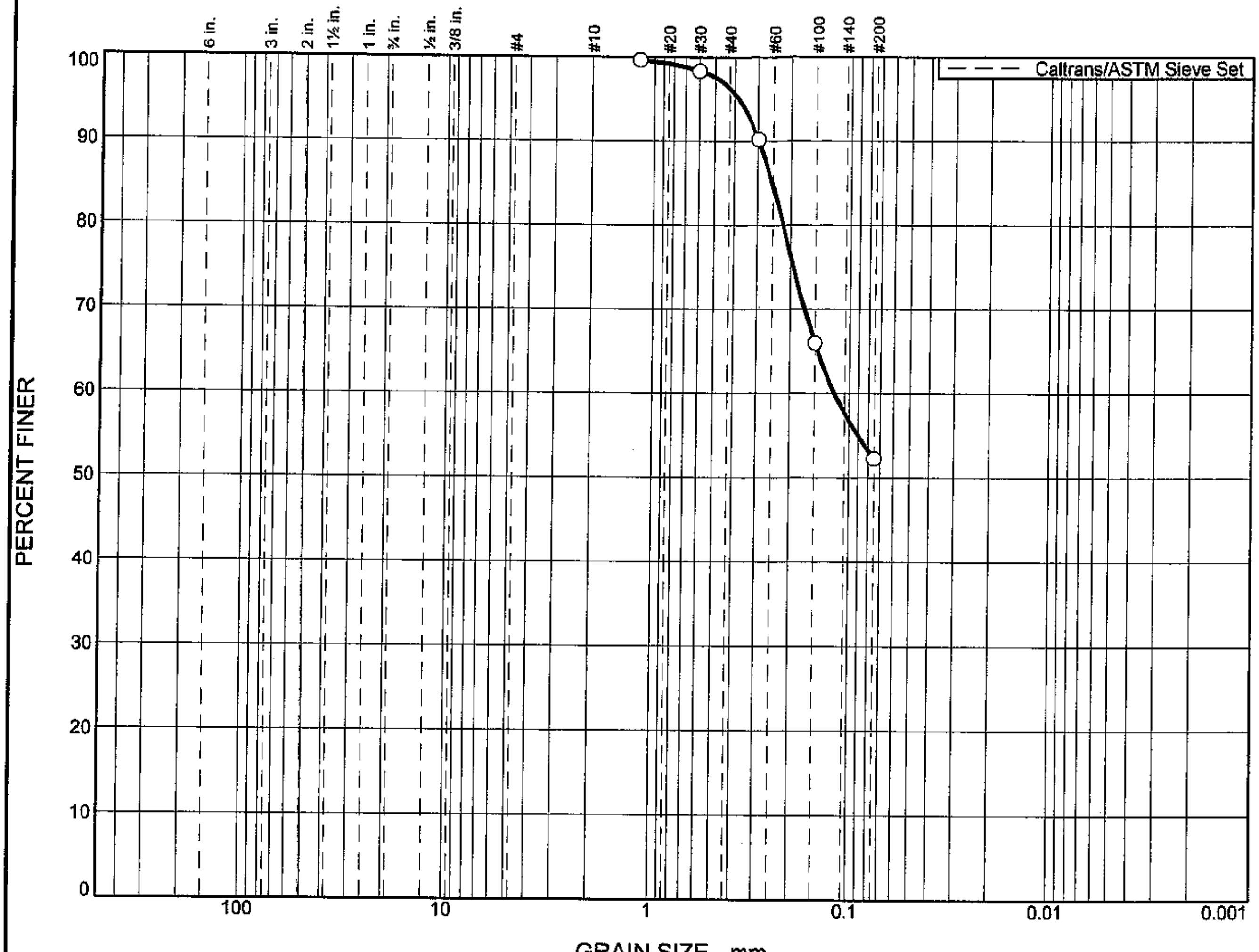
○ **Location:** B-04-010C **Sample Number:** 35935

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-16

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						44.0	52.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2533	0.1190						

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

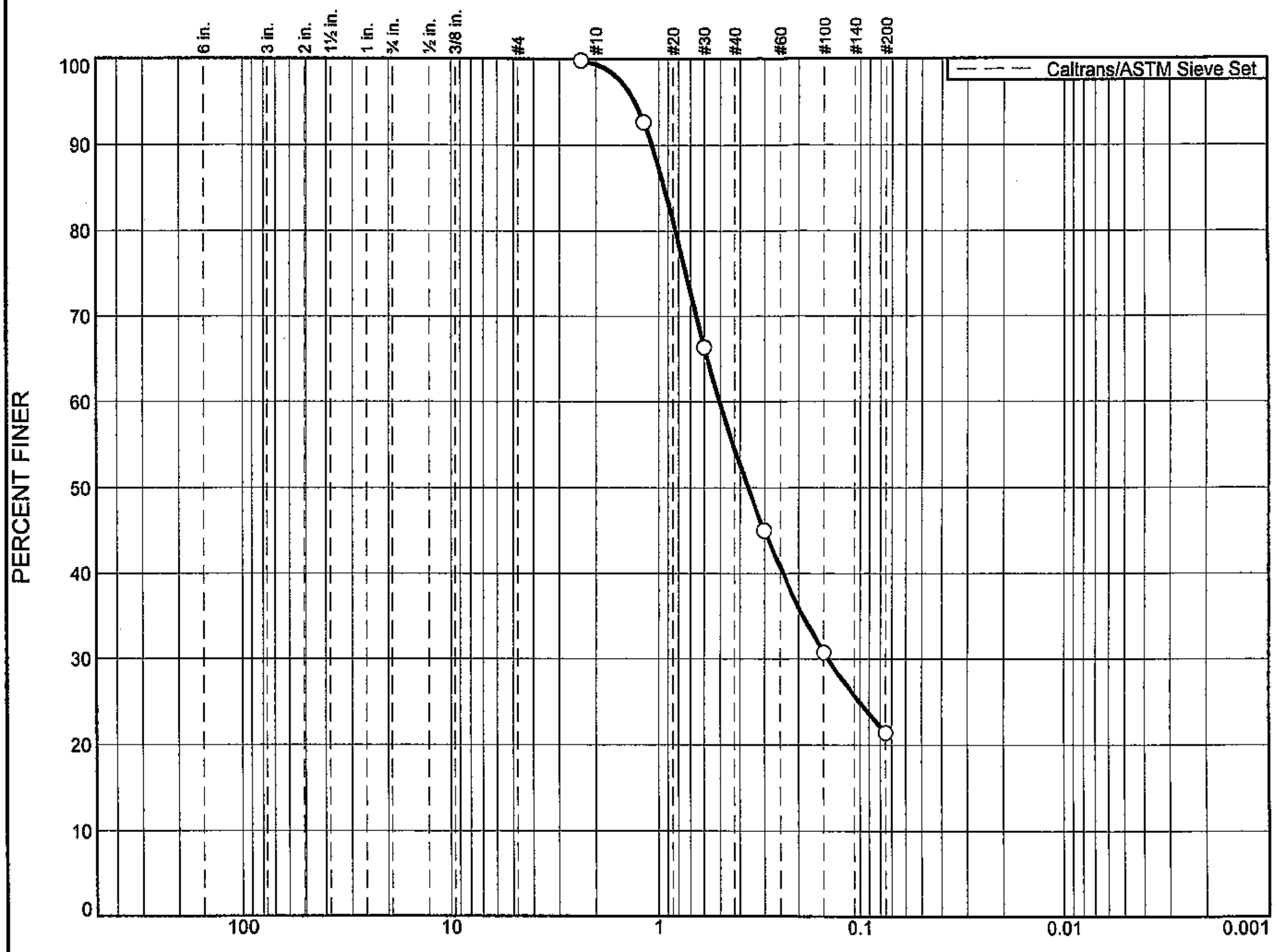
○ **Location:** B-04-050A **Sample Number:** 35942

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-17

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o					45.0	33.0	21.4	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.9382	0.5056	0.3644	0.1437				

Material Description	USCS	AASHTO
o SILTY SAND	SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

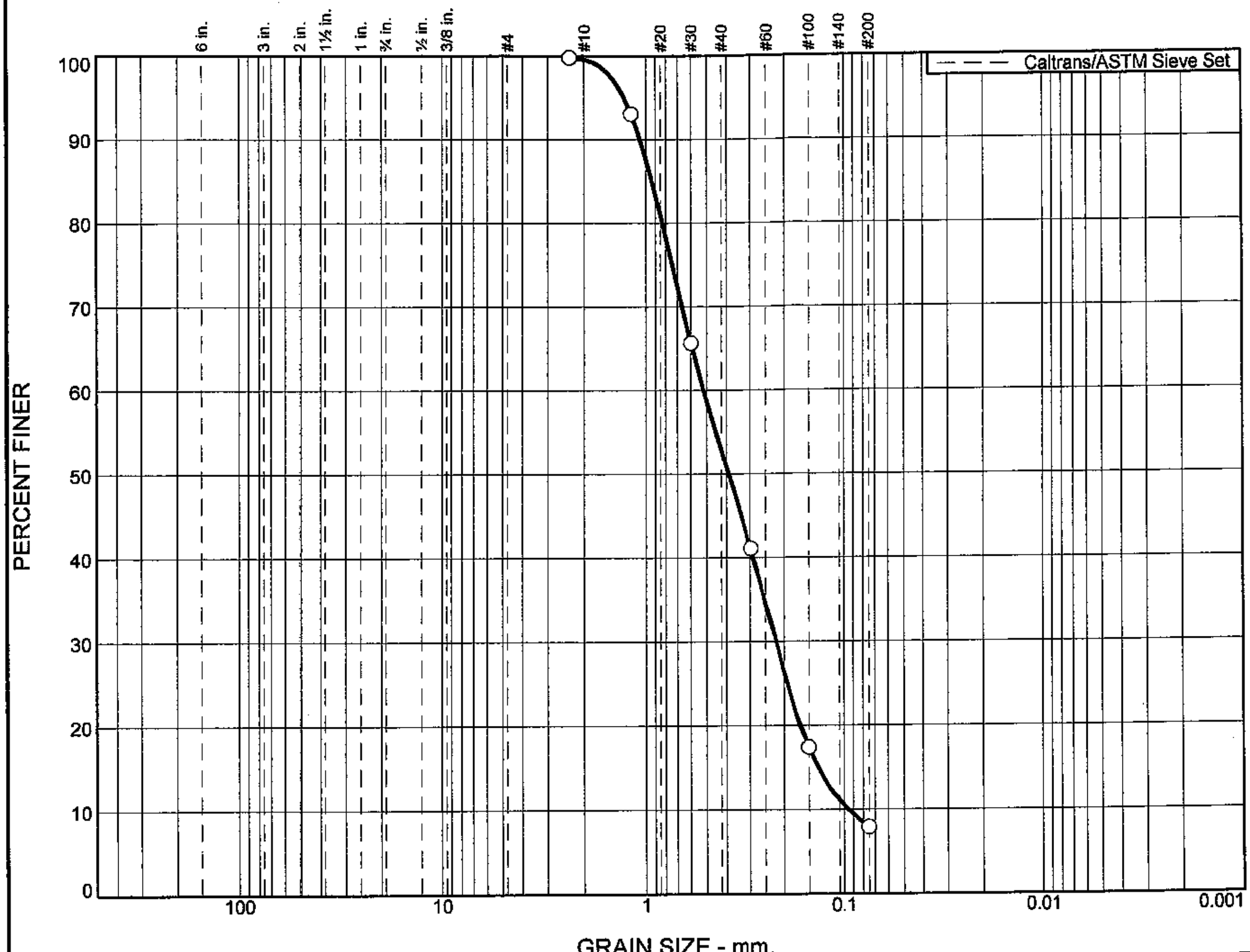
o **Location:** B-04-090A **Sample Number:** 35950

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-18

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					46.6	45.0	7.9	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.9356	0.5195	0.3897	0.2221	0.1347	0.0951	1.00	5.46

Material Description	USCS	AASHTO
○ WELL-GRADED SAND with low fine content	SW-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

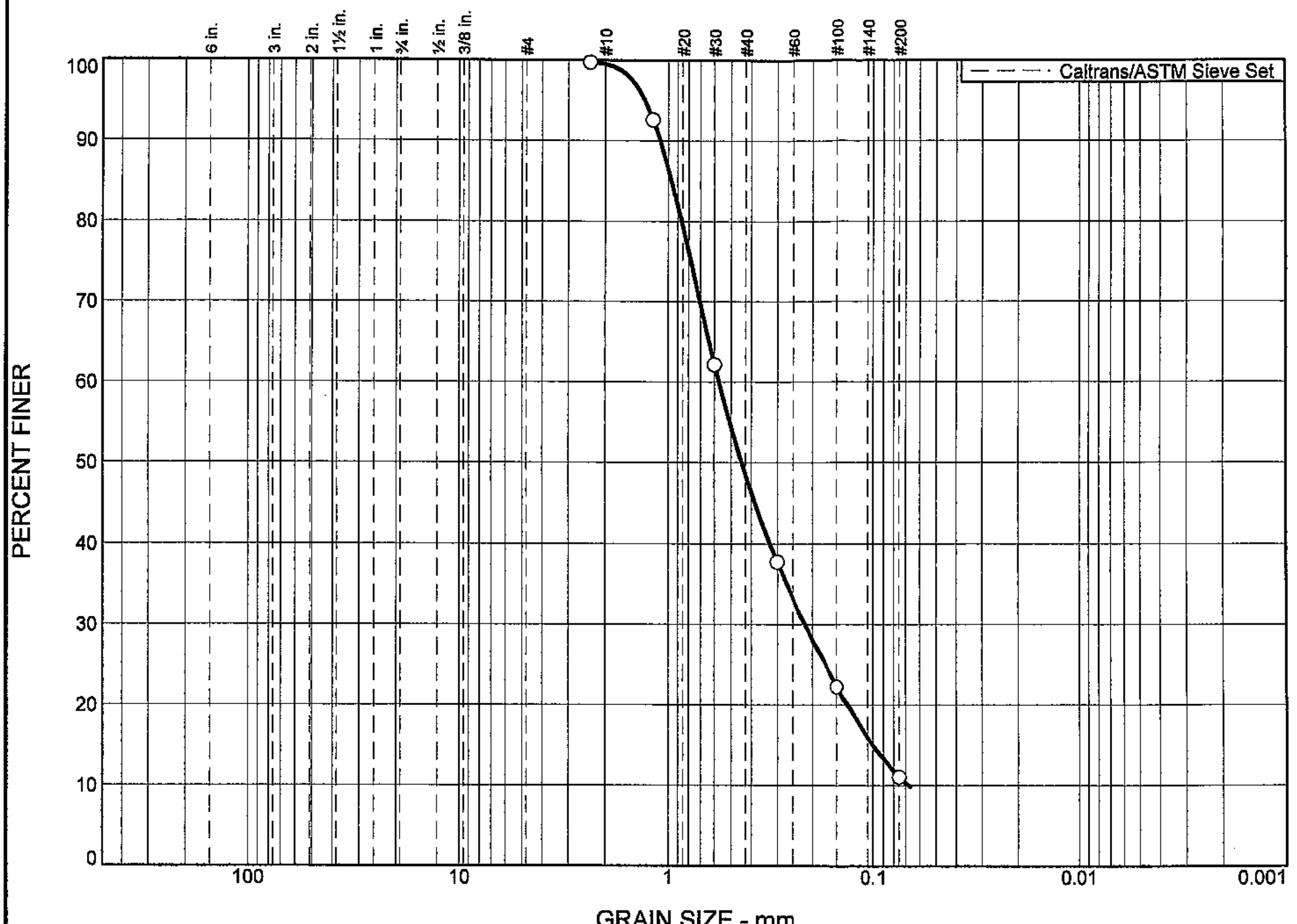
○ **Location:** B-04-090B **Sample Number:** 35951

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-19

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					51.3	37.3	11.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.9638	0.5724	0.4456	0.2186	0.1005	0.0677	1.23	8.45

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ WELL-GRADED SAND with low fine content		SW-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

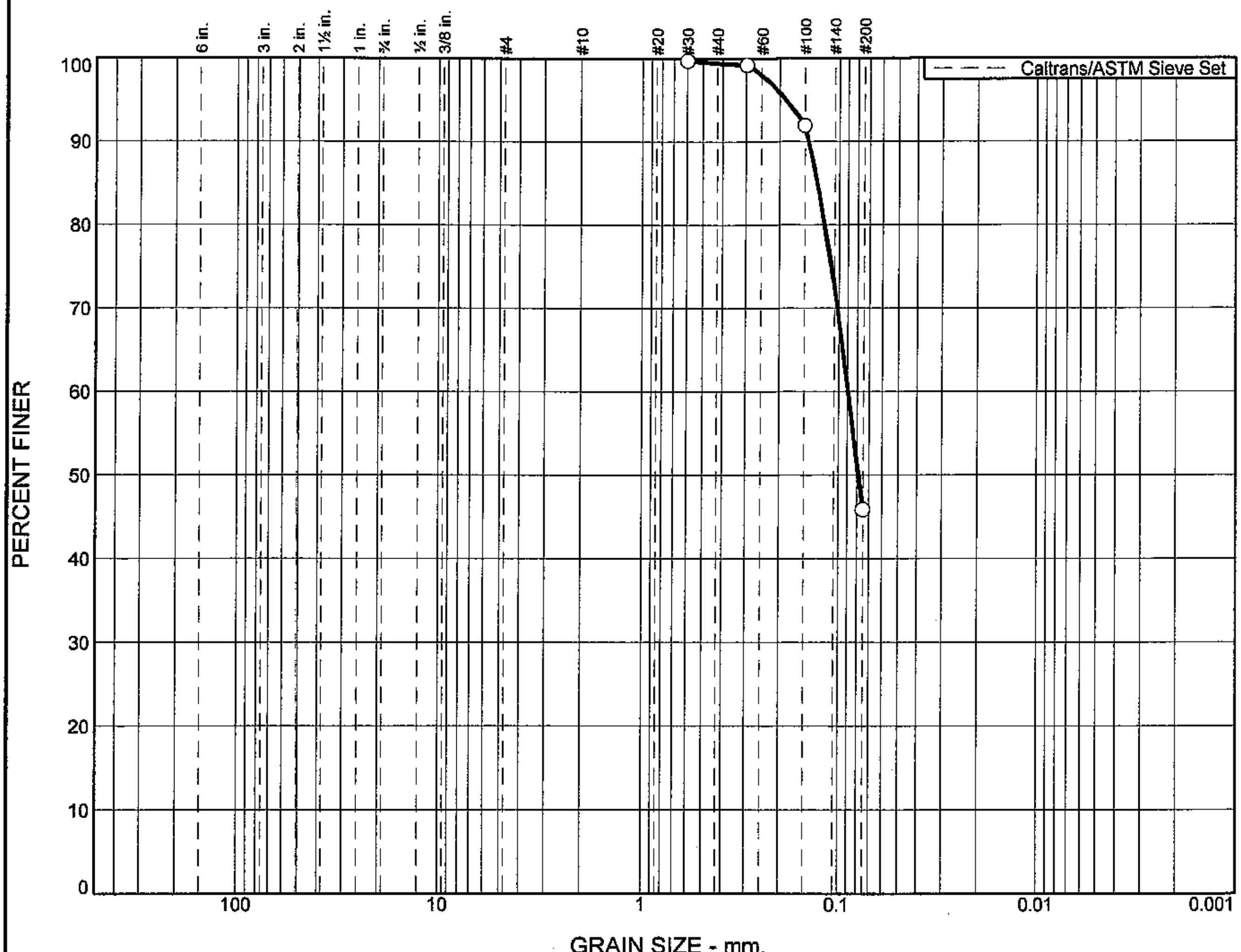
○ **Location:** B-04-090C **Sample Number:** 35952

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-20

Particle Size Distribution Report



	% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
○						53.6	45.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1292	0.0895	0.0789					

Material Description	USCS	AASHTO
○ SILTY SAND	SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

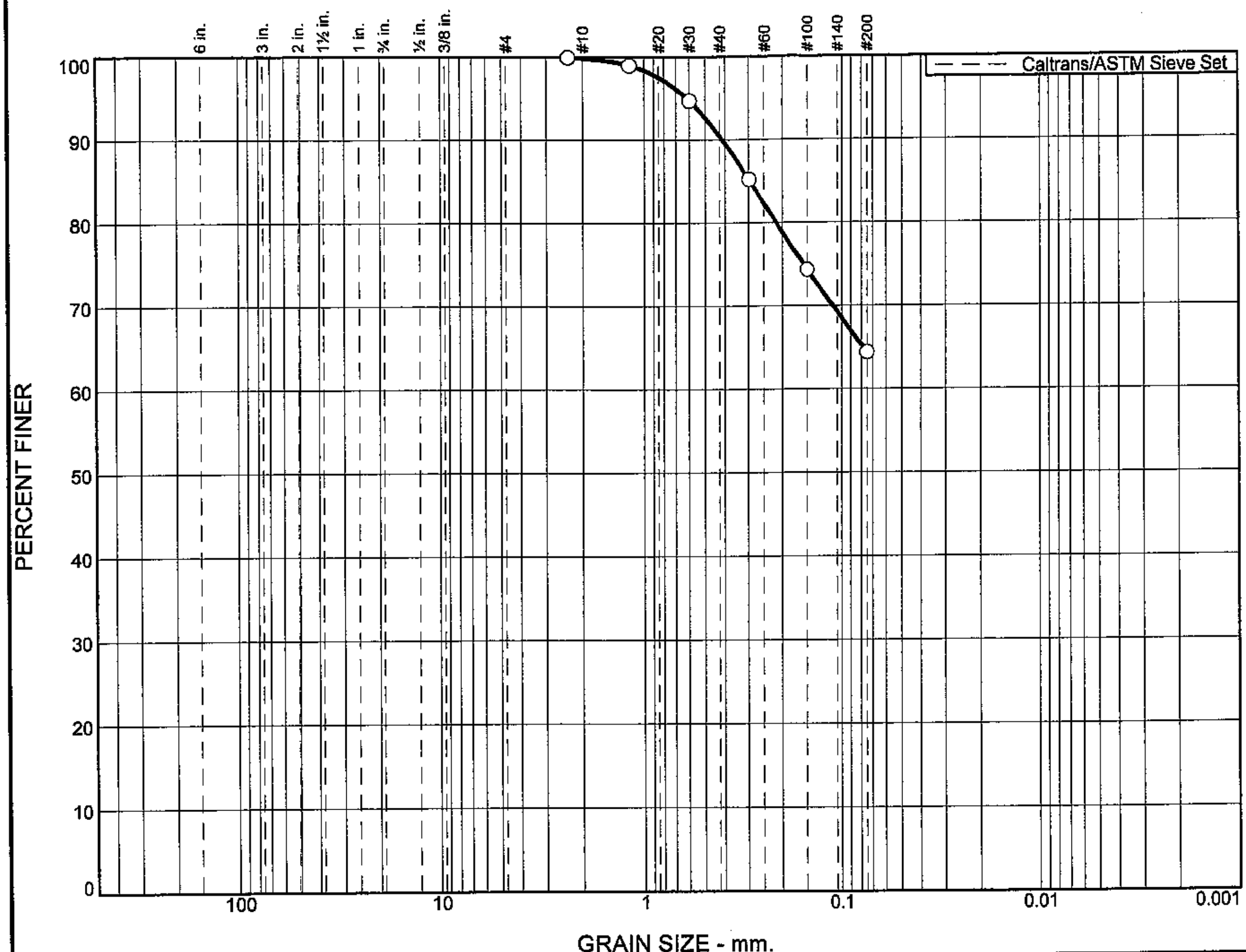
○ **Location:** B-05-030C **Sample Number:** 35961

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-21

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					9.4	26.0	64.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2968							

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

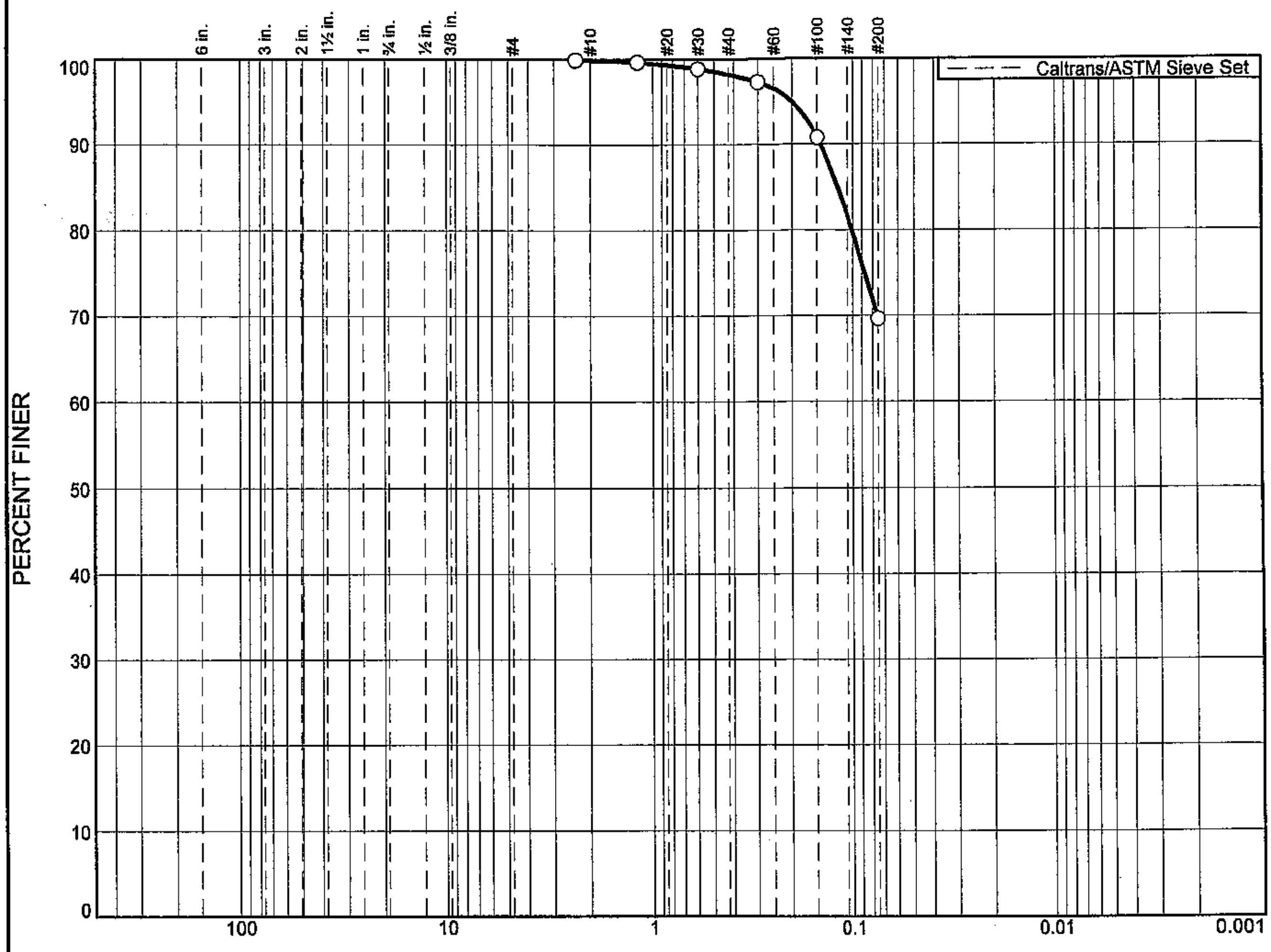
○ **Location:** B-05-060C **Sample Number:** 35967

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-22

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					1.7	28.6	69.6	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1189							

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

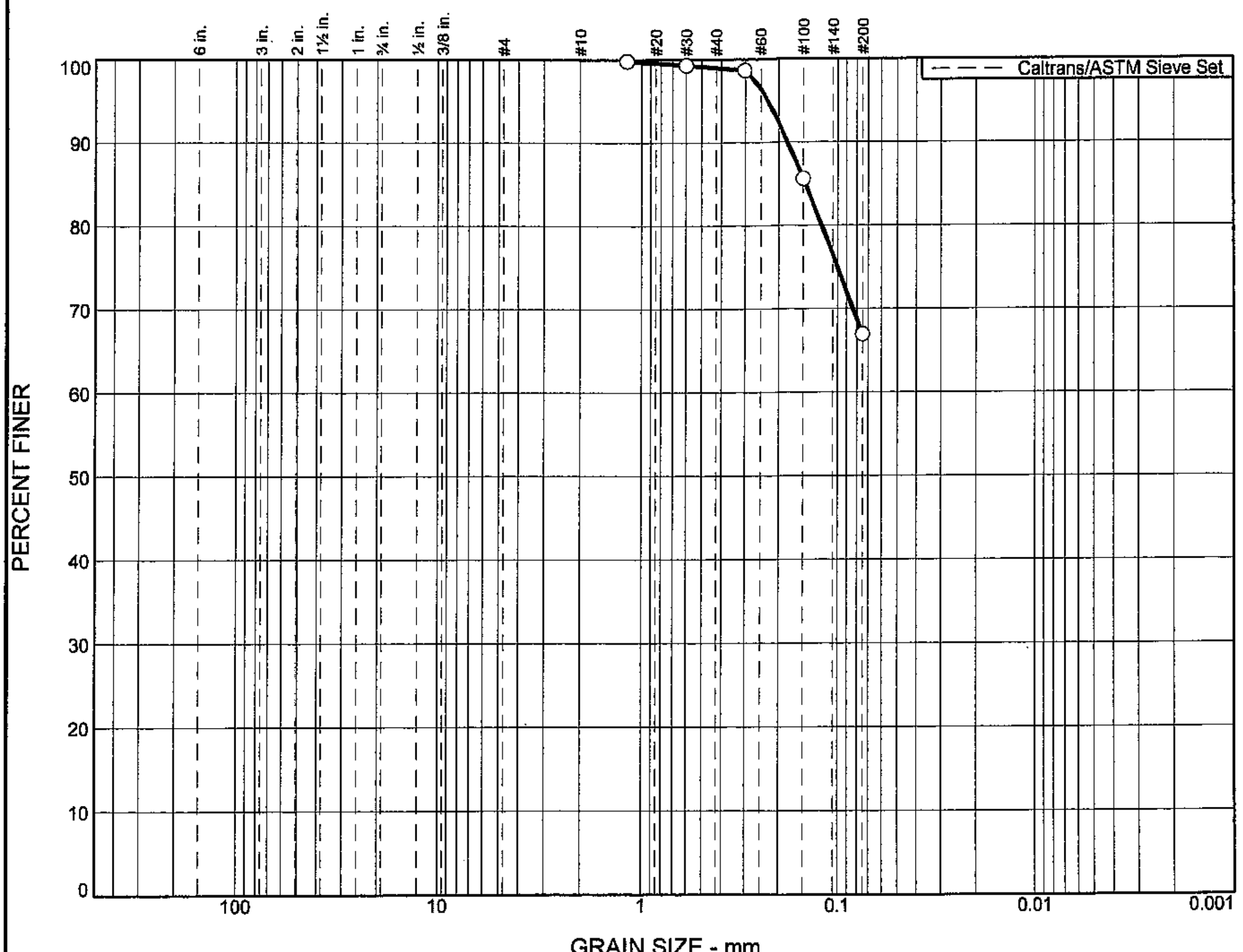
○ **Location:** B-05-070C **Sample Number:** 35969

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-23

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o						32.0	67.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.1464							

Material Description	USCS	AASHTO
o SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

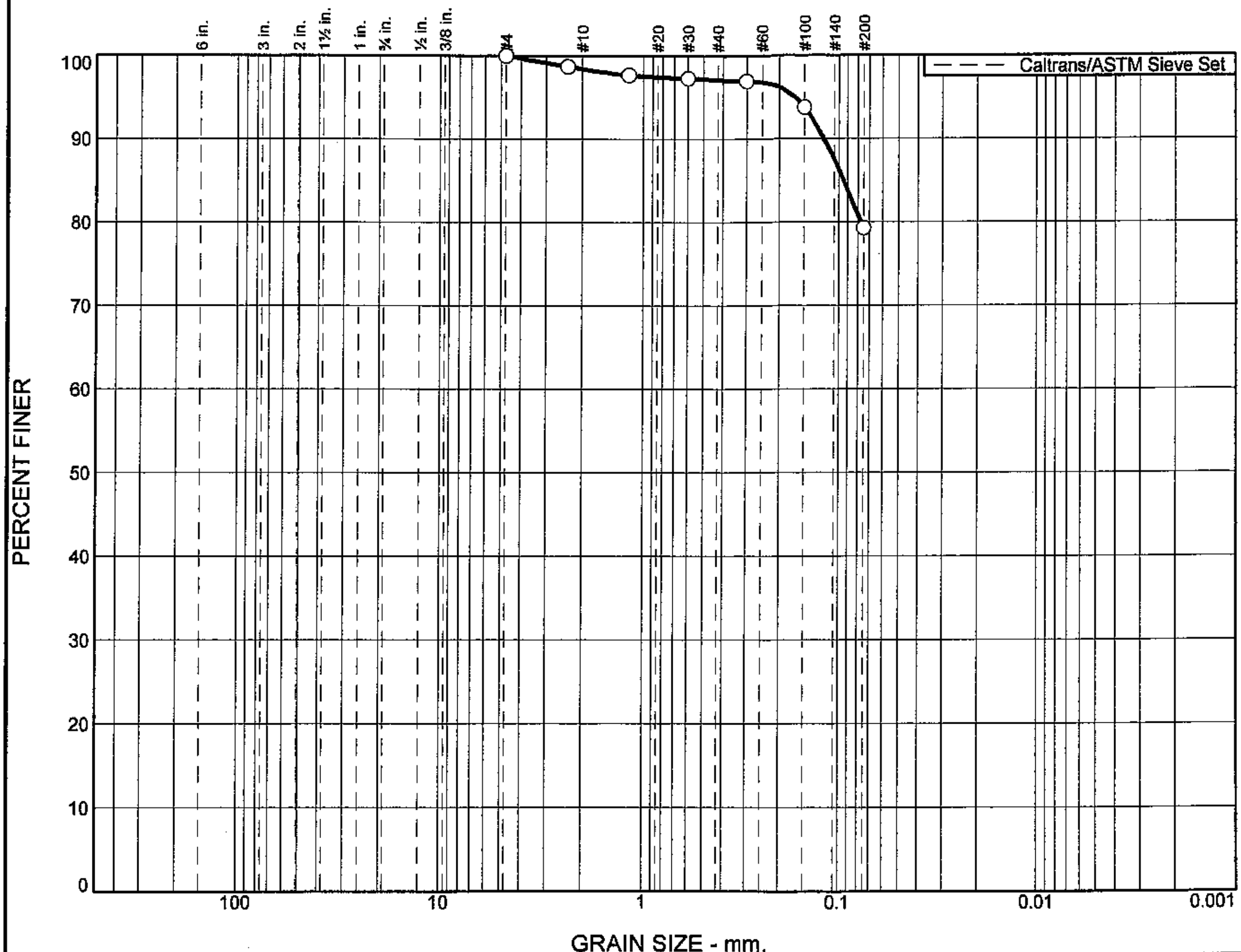
o **Location:** B-05-090C **Sample Number:** 35971

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-24

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	1.6	1.3	17.8	79.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0947							

Material Description	USCS	AASHTO
○ SANDY SILT	ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

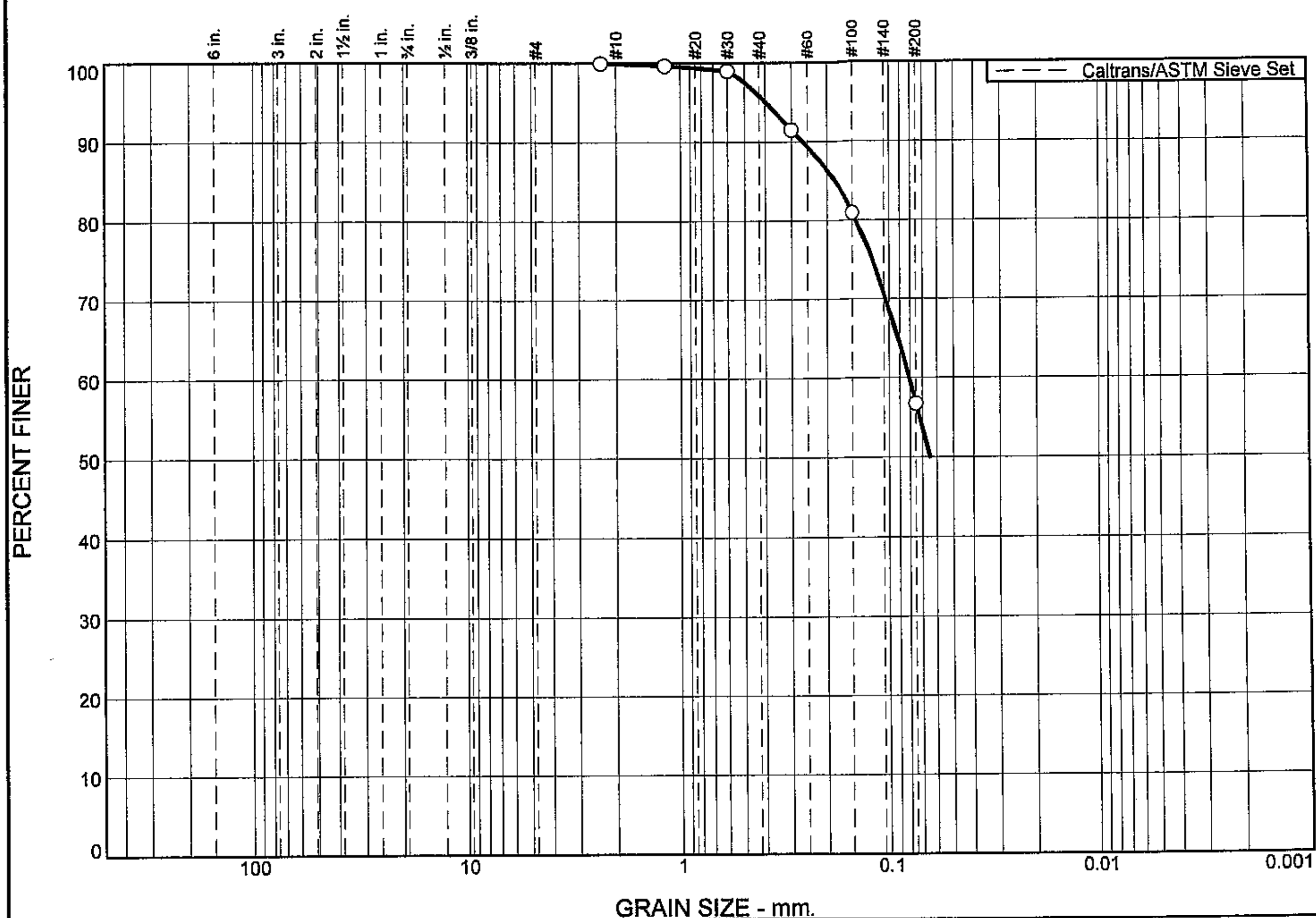
○ **Location:** B-06-010B **Sample Number:** 35972

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-25

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					4.1	39.1	56.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1841	0.0809	0.0647					

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ SANDY SILT		ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

○ **Location:** B-06-20B **Sample Number:** 35975

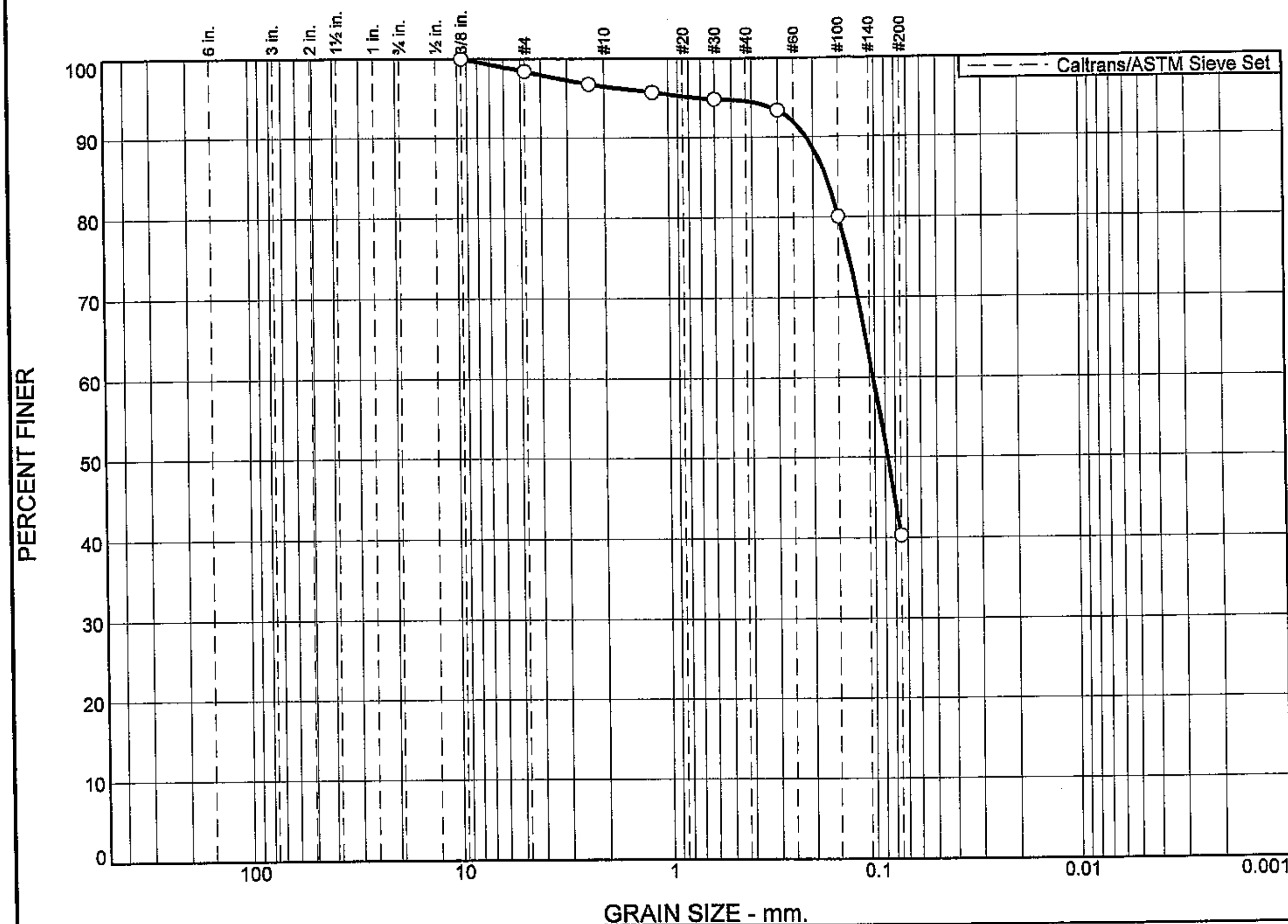
Remarks:

SOILS ENGINEERING, INC.

Figure A-26

Tested By: AL **Checked By:** JNW

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.6	1.9	1.9	54.3	40.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1735	0.1018	0.0869					

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ SILTY SAND		SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

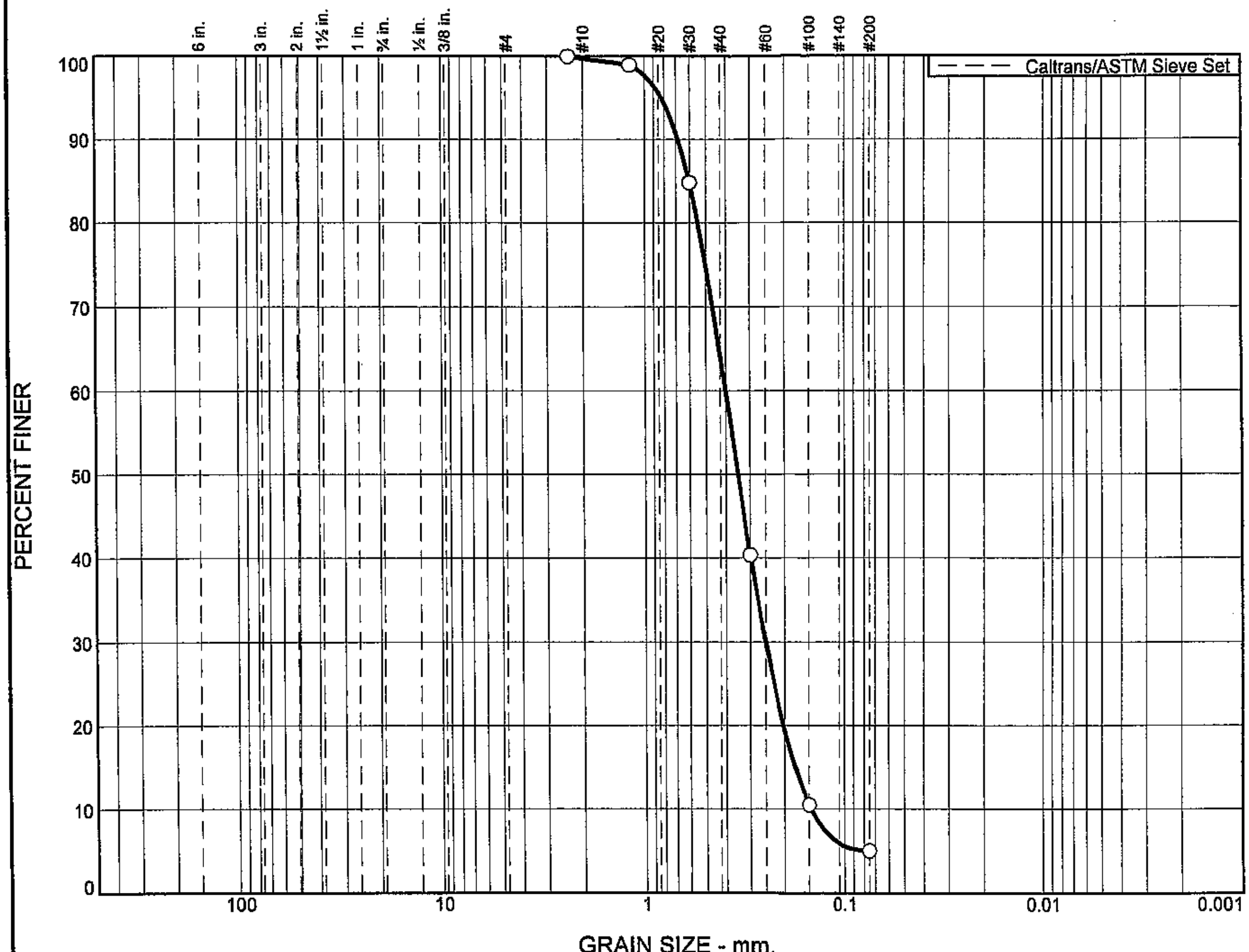
○ **Location:** B-07-010B **Sample Number:** 35979

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-27

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.2	35.7	59.1	5.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6026	0.4004	0.3470	0.2513	0.1771	0.1468	1.07	2.73

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ POORLY-GRADED SAND		SP	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

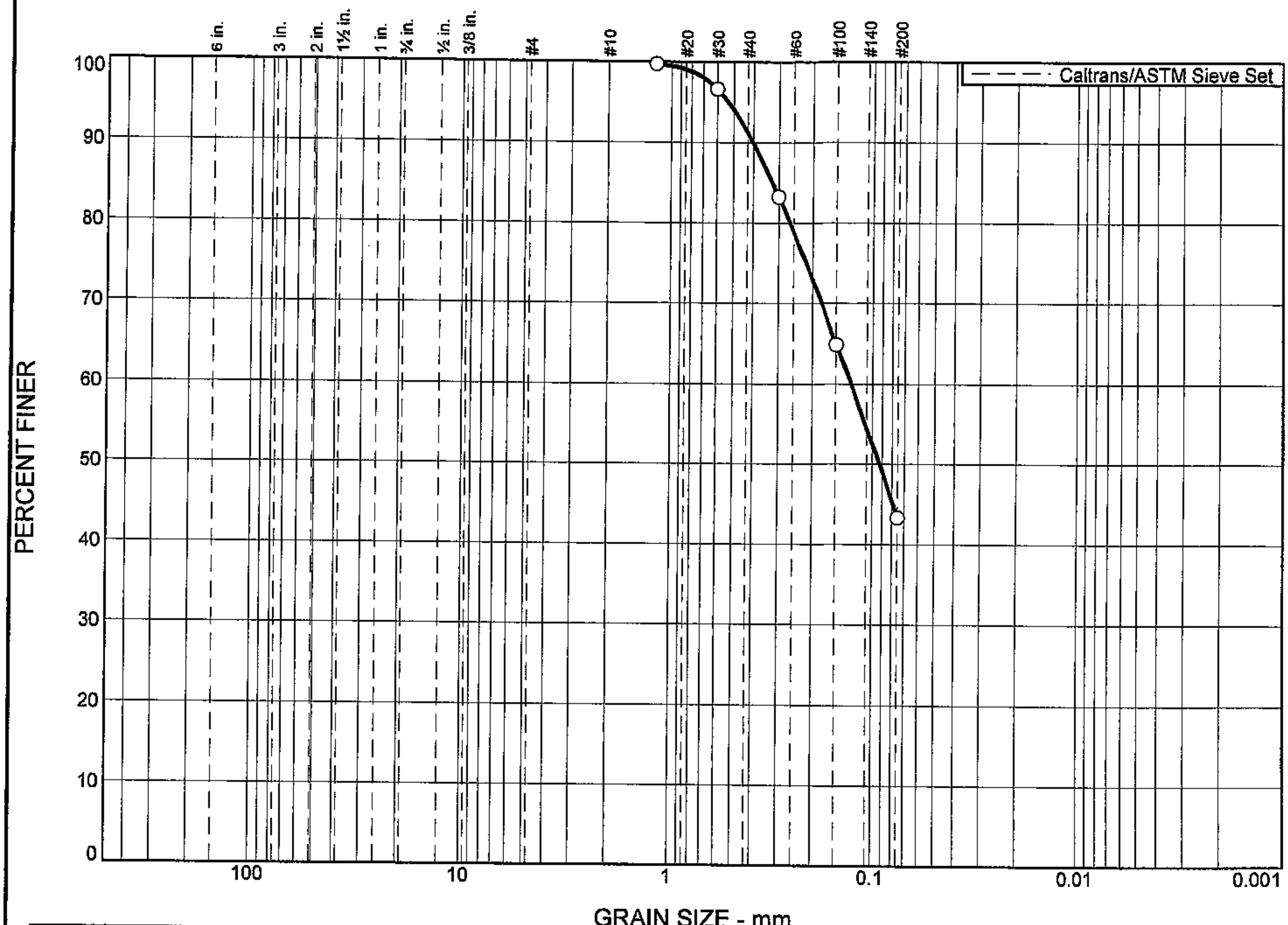
○ **Location:** B-07-040B **Sample Number:** 35984

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-28

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o						47.8	43.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.3224	0.1275	0.0925					

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
o SILTY SAND		SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

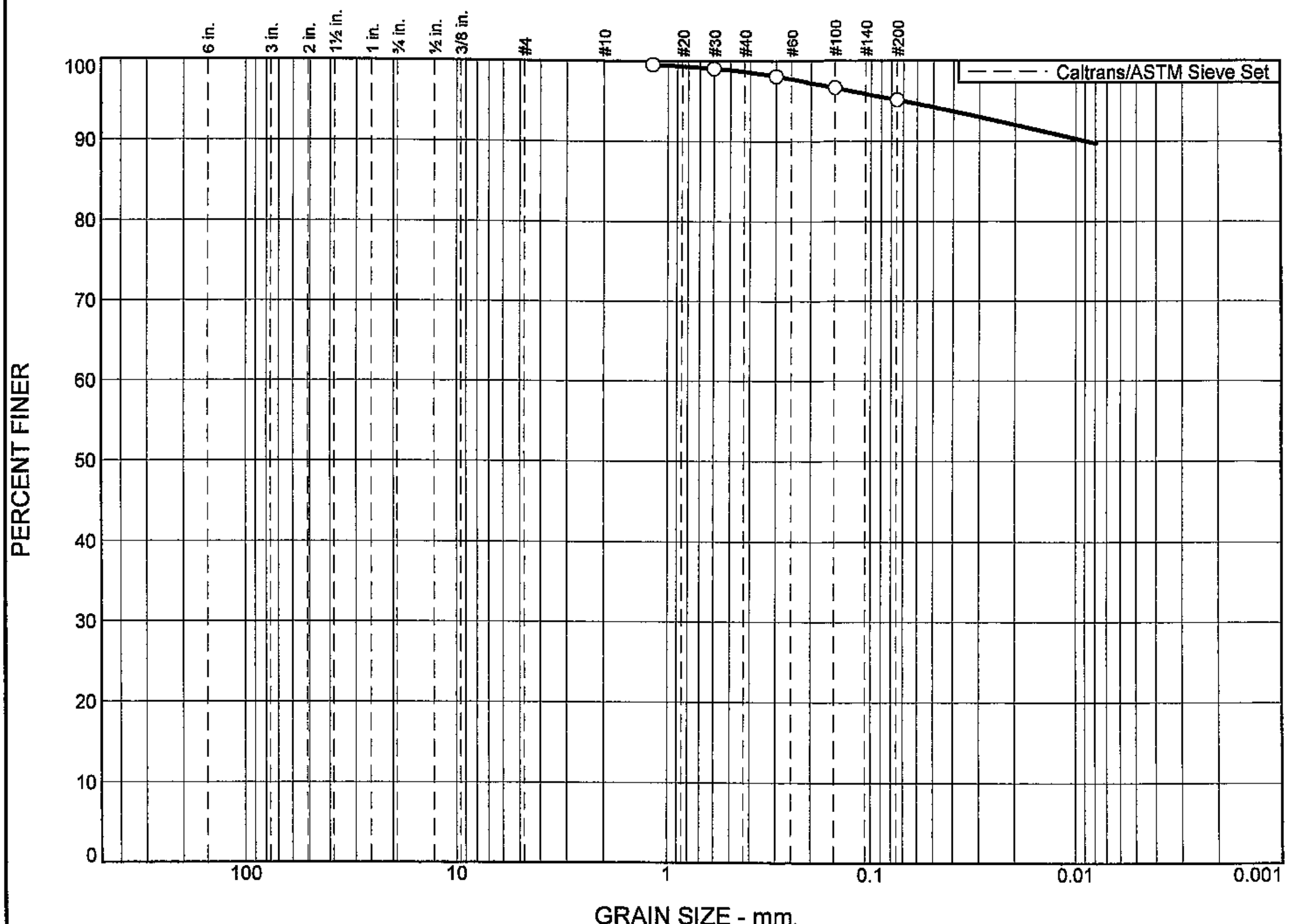
o **Location:** B-07-060B **Sample Number:** 35987

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-29

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						3.6	95.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ CLAYEY SILT		ML	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

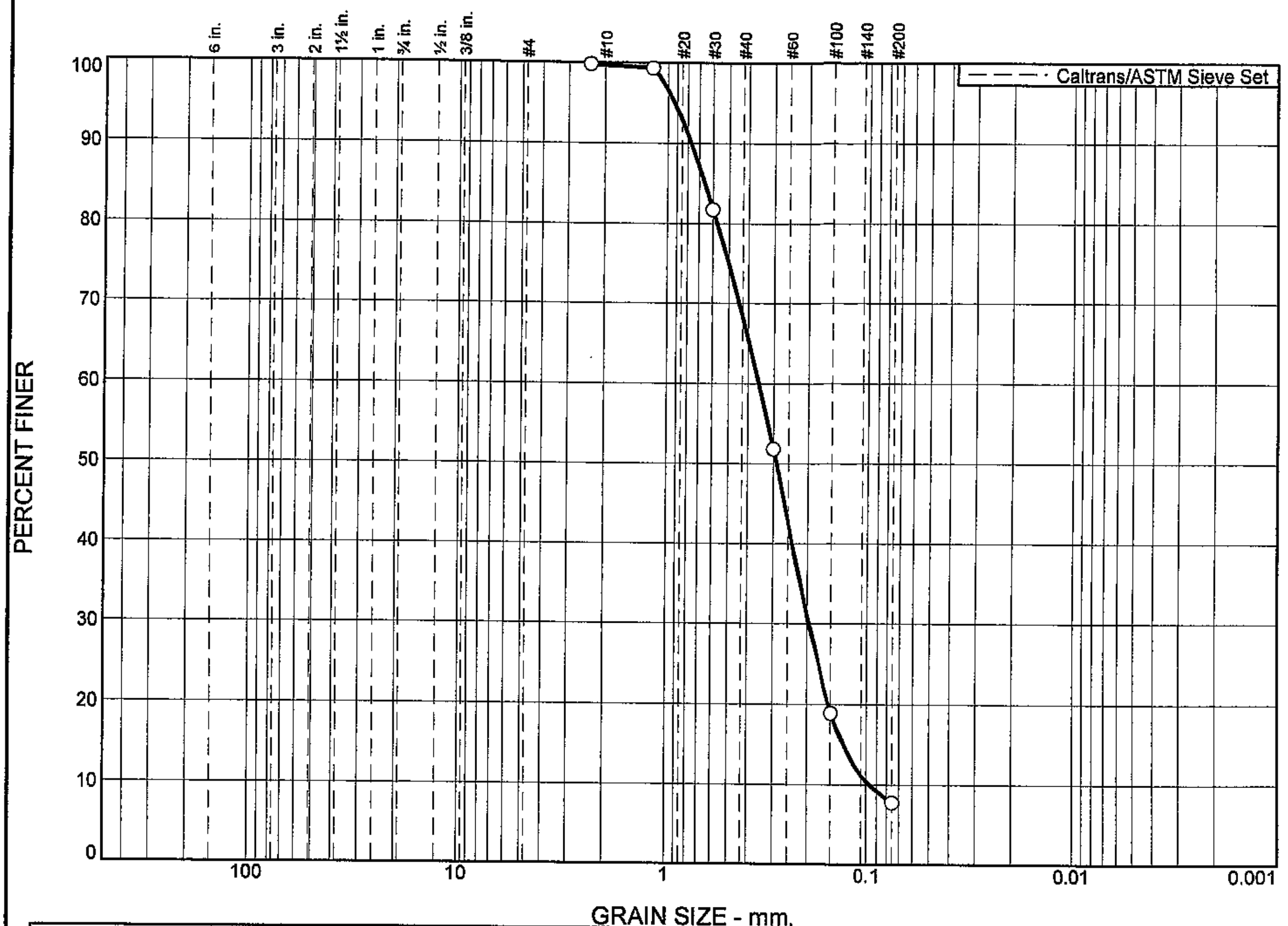
○ **Location:** B-07-070B **Sample Number:** 35990

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-30

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					31.6	60.3	7.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.6583	0.3547	0.2895	0.1962	0.1307	0.0969	1.12	3.66

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ POORLY-GRADED SAND with low fine content		SP-SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

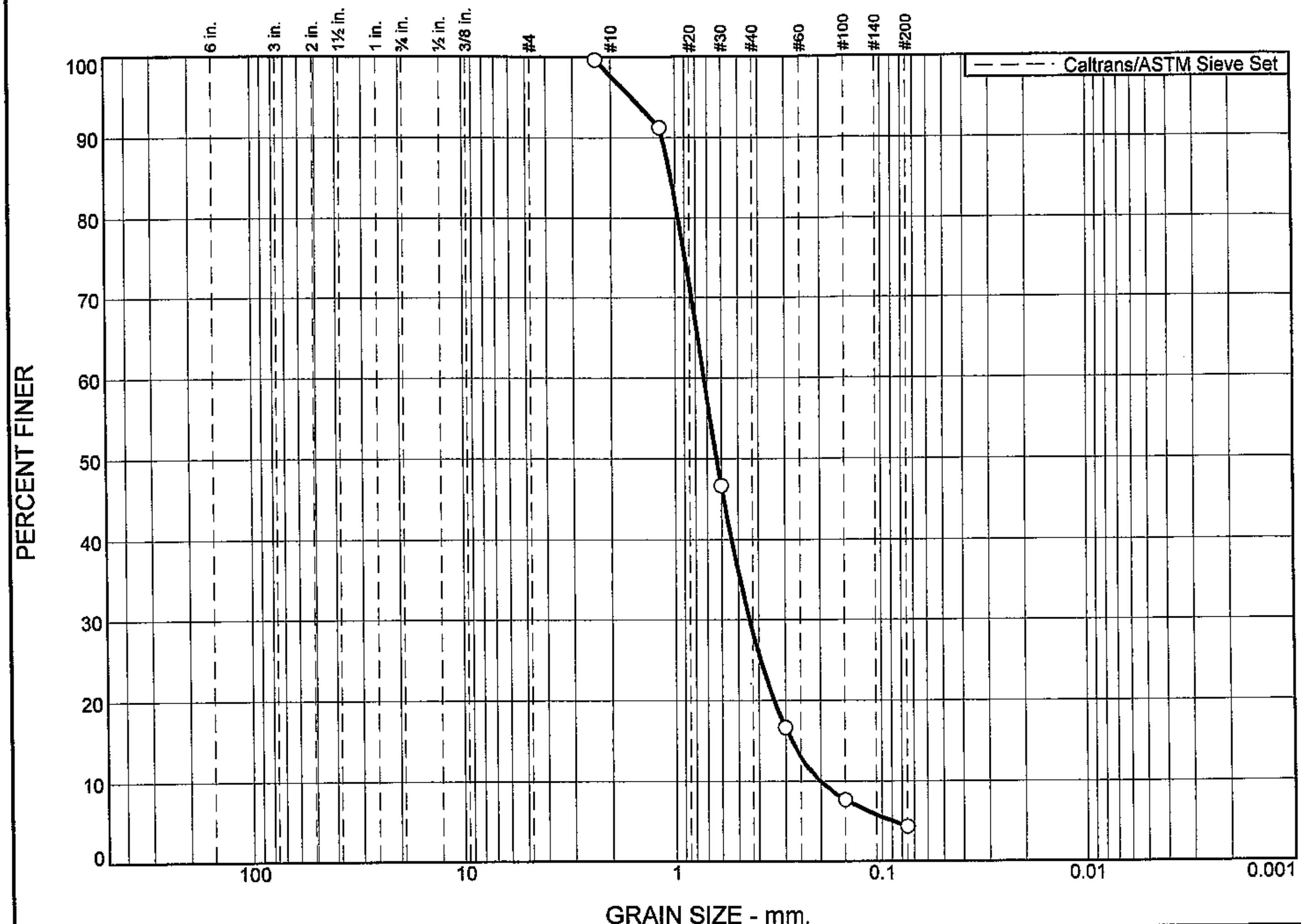
○ **Location:** B-07-080B **Sample Number:** 35992

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-31

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					69.4	23.9	4.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.0441	0.7260	0.6309	0.4429	0.2789	0.2009	1.34	3.61

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ POORLY-GRADED SAND		SP	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

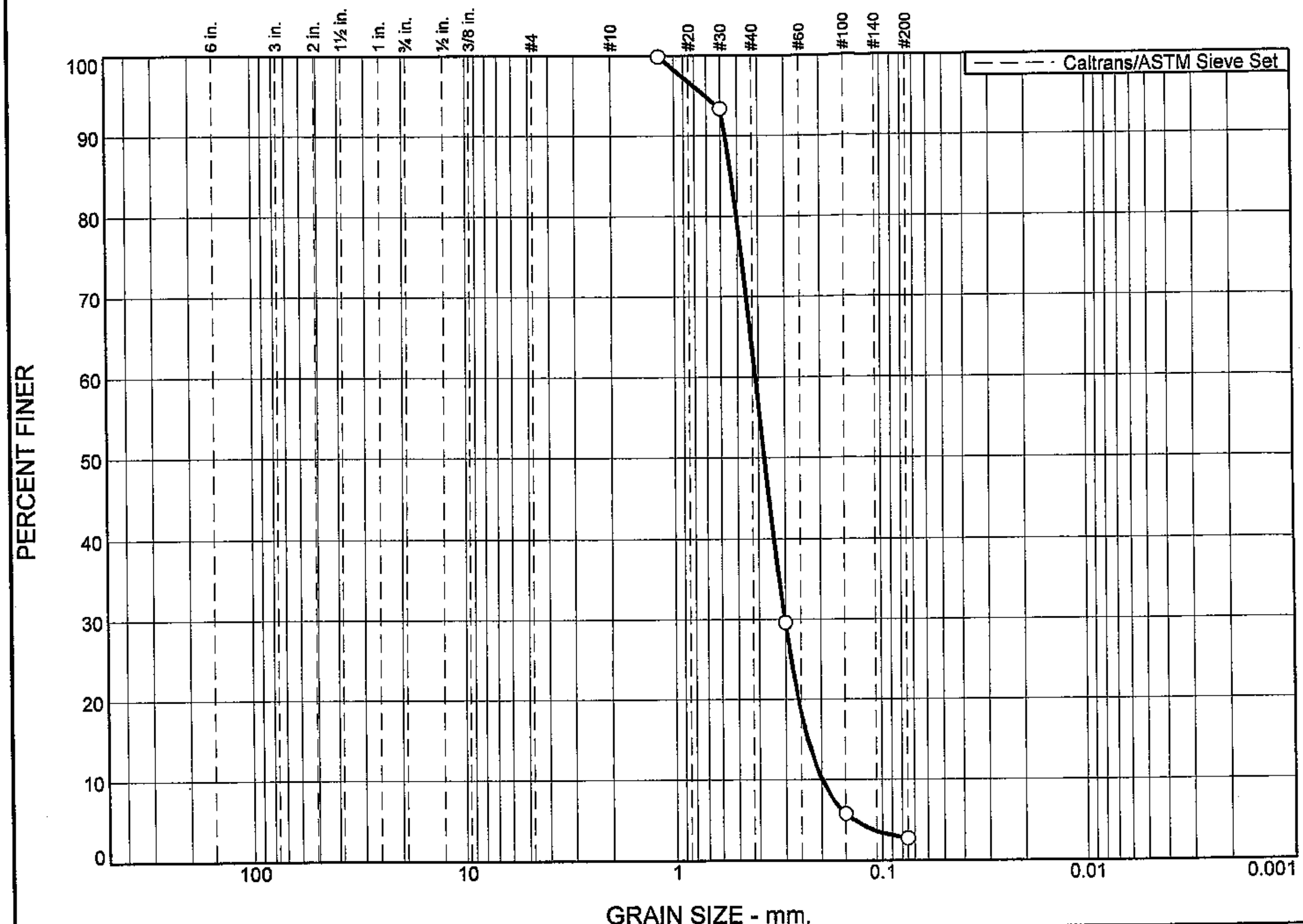
○ **Location:** B-07-090C **Sample Number:** 35994

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-32

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○						60.4	2.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.5342	0.4124	0.3745	0.3017	0.2329	0.1986	1.11	2.08

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ POORLY-GRADED SAND		SP	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

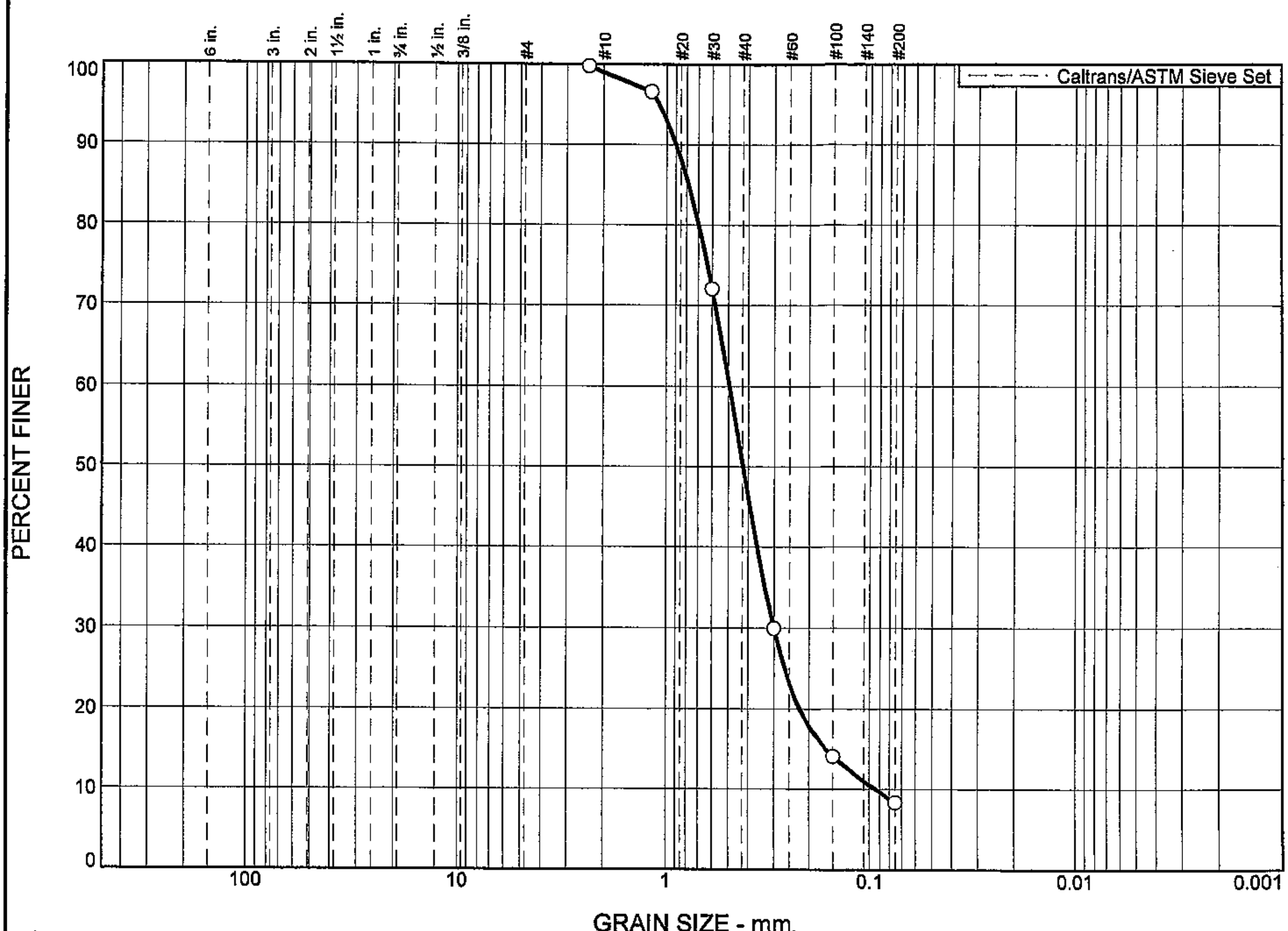
○ **Location:** B-08-020B **Sample Number:** 35997

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-33

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o					48.8	41.9	8.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o			0.7837	0.4936	0.4239	0.3002	0.1639	0.0939	1.94	5.26

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
o WELL-GRADED SAND with low fine content		SW/SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

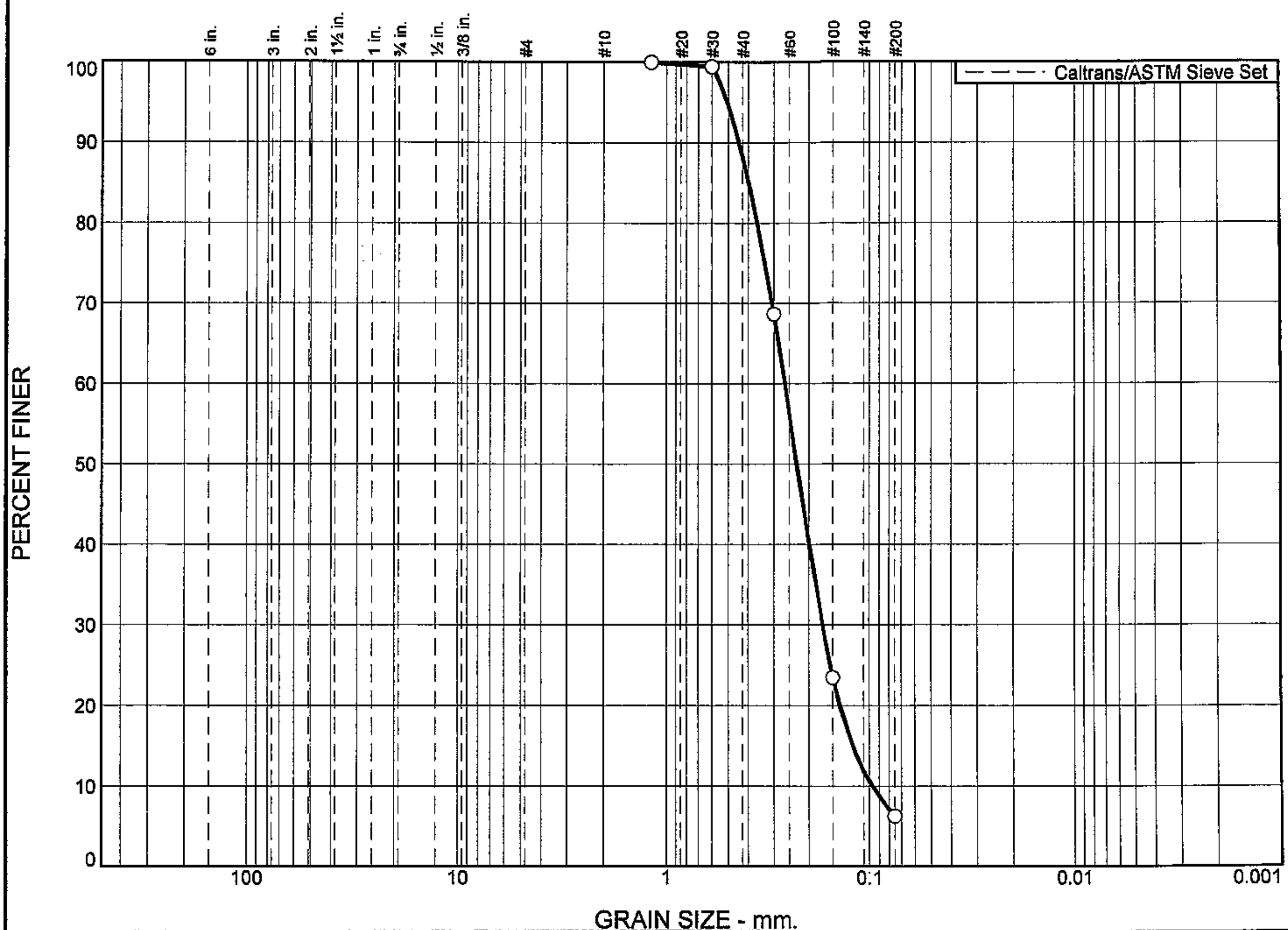
o **Location:** B-08-040C **Sample Number:** 36001

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-34

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	11.9	81.8	6.3	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3982	0.2642	0.2294	0.1697	0.1201	0.0966	1.13	2.73

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ POORLY-GRADED SAND with low fine content		SP/SM	

Project No. 11-13636 **Client:** Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA

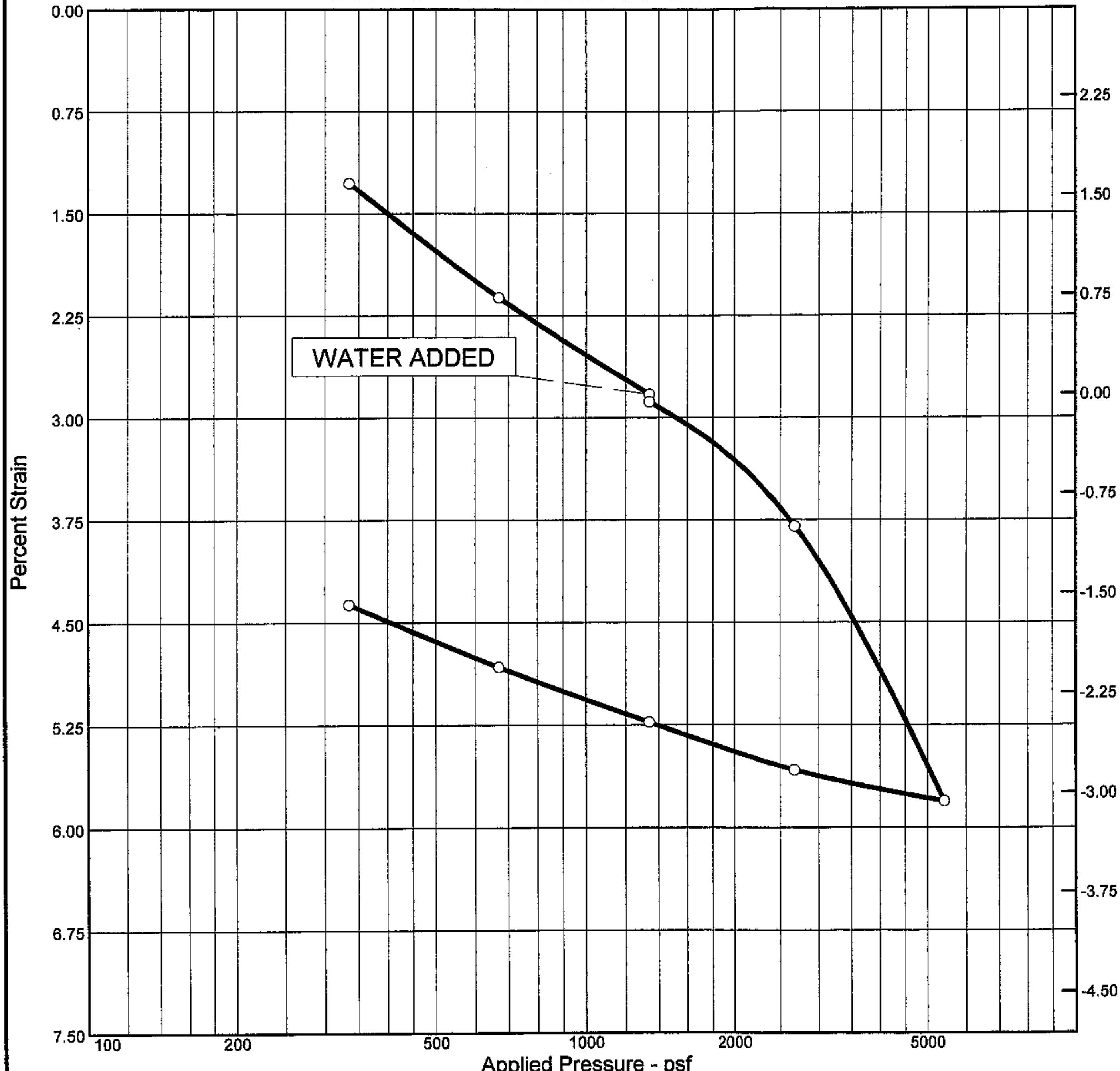
○ **Location:** B-08-090C **Sample Number:** 36008

Remarks:

SOILS ENGINEERING, INC.

Figure ,A-35

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
90.1 %	35.1 %	81.4	N/A	N/A	2.65	336	2743	0.14	0.02		-0.1	1.032

MATERIAL DESCRIPTION	USCS	AASHTO
SANDY SILT Location: B-01-060B	ML	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-01-060B

CONSOLIDATION TEST REPORT

SOILS ENGINEERING, INC.

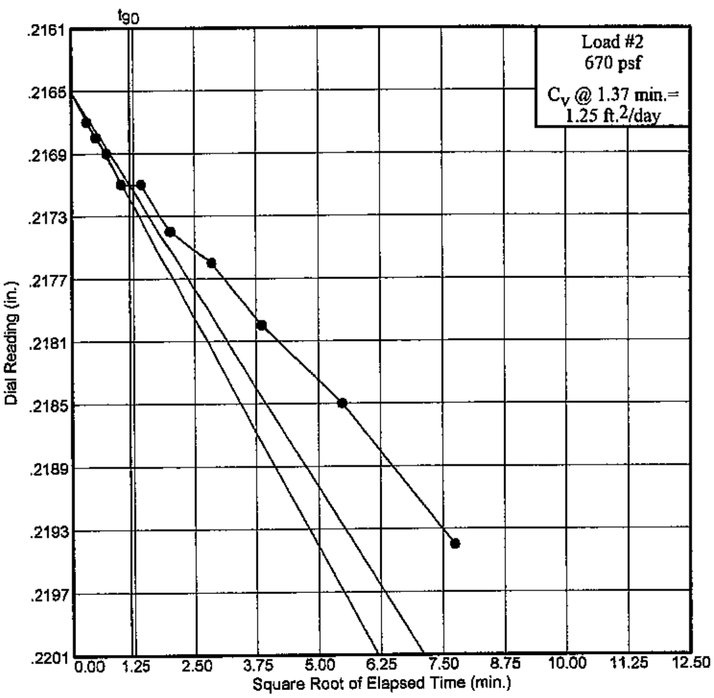
Remarks:
Test Date: 07/21/11
Tested By: AL
Sample No: 35888

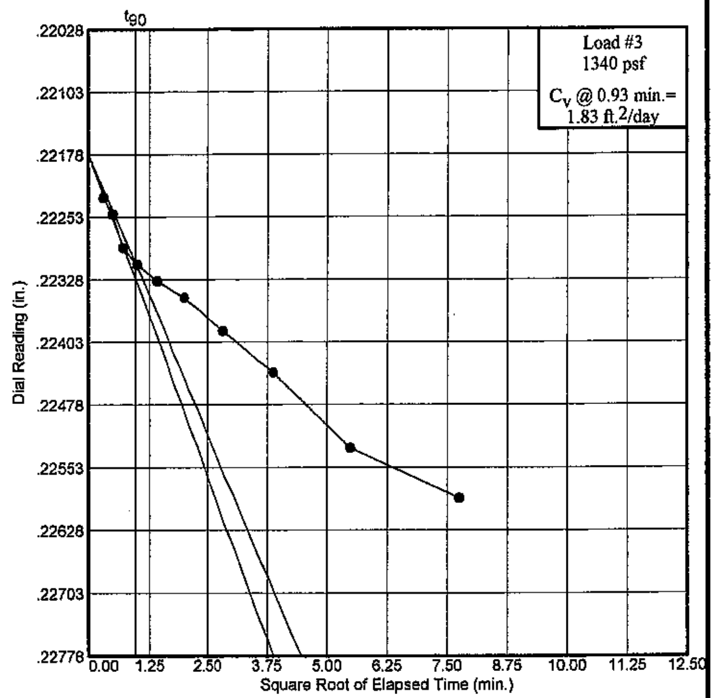
Figure B-1

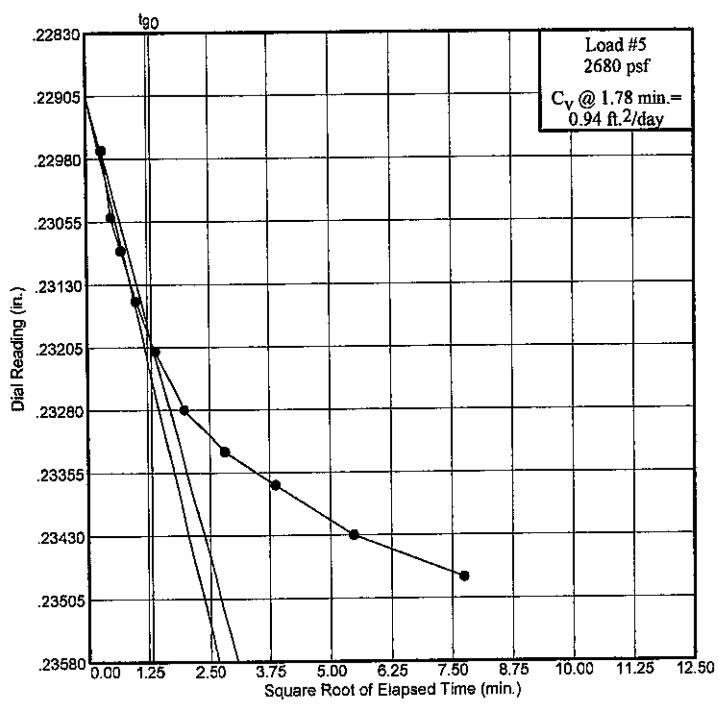
Dial Reading vs. Time

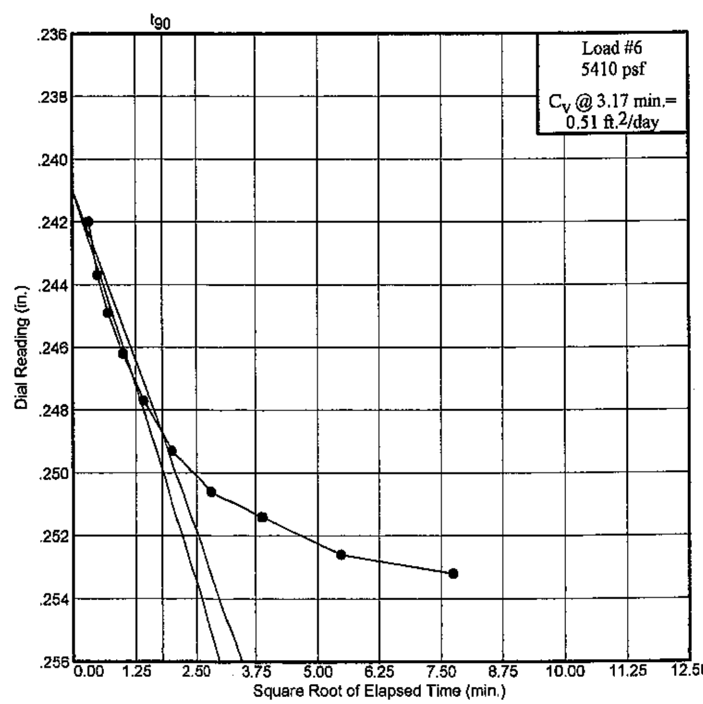
Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-01-060B









Dial Reading vs. Time

SOILS ENGINEERING, INC.

Figure B-1

CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35888
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-01-060B
Description: SANDY SILT
Location: B-01-060B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: ML **AASHTO:** N/A **Figure No.:** B-1
Testing Remarks: Test Date: 07/21/11
Tested By: AL
Sample No: 35888

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 167.00 g.	Consolidometer # = 1	Wet w+t = 166.40 g.
Dry w+t = 134.40 g.		Dry w+t = 134.40 g.
Tare Wt. = 41.50 g.	Spec. Gravity = 2.65	Tare Wt. = 41.50 g.
Height = .92 in.	Height = .92 in.	
Diameter = 2.46 in.	Diameter = 2.46 in.	
Weight = 125.50 g.	Defl. Table = Con # 1	
Moisture = 35.1 %	Ht. Solids = 0.4508 in.	Moisture = 34.4 %
Wet Den. = 110.0 pcf	Dry Wt. = 92.90 g.	Dry Wt. = 92.90 g.*
Dry Den. = 81.4 pcf	Void Ratio = 1.032	Void Ratio = 0.943
Ovrbrdn. = 336 psf	Saturation = 90.1 %	

* Final dry weight used in calculations

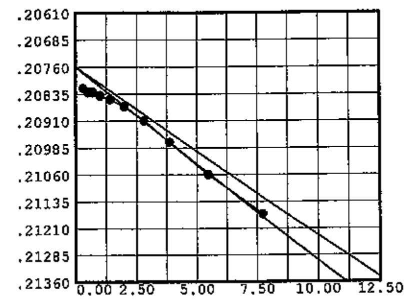
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				1.032	
335	0.21340	0.00170			1.006	1.3 Comprs.
670	0.22170	0.00230	1.25		0.989	2.1 Comprs.
1340	0.22870	0.00280	1.83		0.974	2.8 Comprs.
water	0.22920	0.00280			0.973	2.9 Comprs.
2680	0.23840	0.00360	0.94		0.954	3.8 Comprs.
5410	0.25800	0.00480	0.51		0.914	5.8 Comprs.
2680	0.25530	0.00420			0.918	5.6 Comprs.
1340	0.25160	0.00370			0.925	5.2 Comprs.
670	0.24750	0.00330			0.934	4.8 Comprs.
335	0.24300	0.00300			0.943	4.4 Comprs.

C_c = 0.14 P_c = 2743 psf C_s = 0.02
Heave percentage = -0.1

Pressure: 335 psf **TEST READINGS** **Load No. 1**

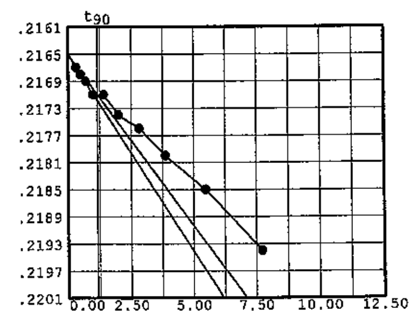
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20000	11	60.00	0.21340
2	0.10	0.20990			
3	0.25	0.21000			
4	0.50	0.21000			
5	1.00	0.21010			
6	2.00	0.21020			
7	4.00	0.21040			
8	8.00	0.21080			
9	15.00	0.21140			
10	30.00	0.21230			



Void Ratio = 1.006 **Compression** = 1.3 %

Pressure: 670 psf **TEST READINGS** **Load No. 2**

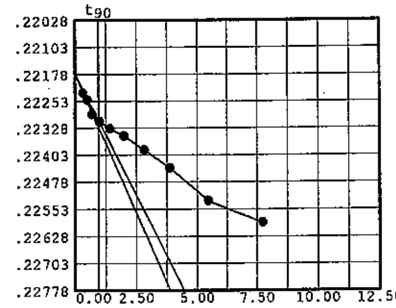
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.21340	11	60.00	0.22170
2	0.10	0.21900			
3	0.25	0.21910			
4	0.50	0.21920			
5	1.00	0.21940			
6	2.00	0.21940			
7	4.00	0.21970			
8	8.00	0.21990			
9	15.00	0.22030			
10	30.00	0.22080			



Void Ratio = 0.989 **Compression** = 2.1 %
D_0 = 0.21651 D_{90} = 0.21710 D_{100} = 0.21717
C_v **at 1.4 min.** = 1.25 ft.^{2}/day

Pressure: 1340 psf	TEST READINGS	Load No. 3

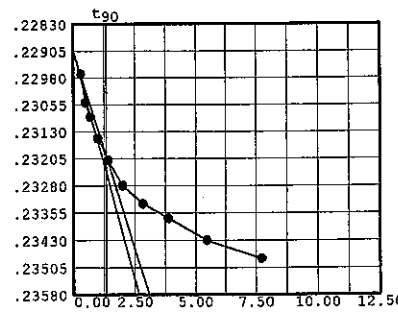
No.	Elapsed Time	Dial Reading
1	0.00	0.22170
2	0.10	0.22510
3	0.25	0.22530
4	0.50	0.22570
5	1.00	0.22590
6	2.00	0.22610
7	4.00	0.22630
8	8.00	0.22670
9	15.00	0.22720
10	30.00	0.22810
11	60.00	0.22870



Void Ratio = 0.974 **Compression** = 2.8 %
D_0 = 0.22178 D_{90} = 0.22307 D_{100} = 0.22322
C_v **at 0.9 min.** = 1.83 ft.^{2}/day

Pressure: 2680 psf	TEST READINGS	Load No. 5

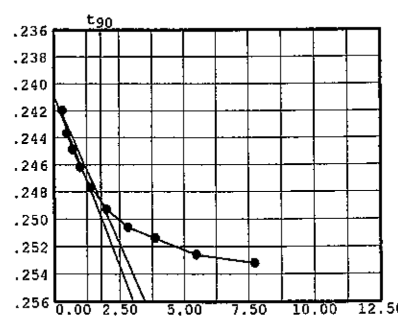
No.	Elapsed Time	Dial Reading
1	0.00	0.22920
2	0.10	0.23330
3	0.25	0.23410
4	0.50	0.23450
5	1.00	0.23510
6	2.00	0.23570
7	4.00	0.23640
8	8.00	0.23690
9	15.00	0.23730
10	30.00	0.23790
11	60.00	0.23840



Void Ratio = 0.954 **Compression** = 3.8 %
D_0 = 0.22906 D_{90} = 0.23198 D_{100} = 0.23231
C_v **at 1.8 min.** = 0.94 ft.^{2}/day

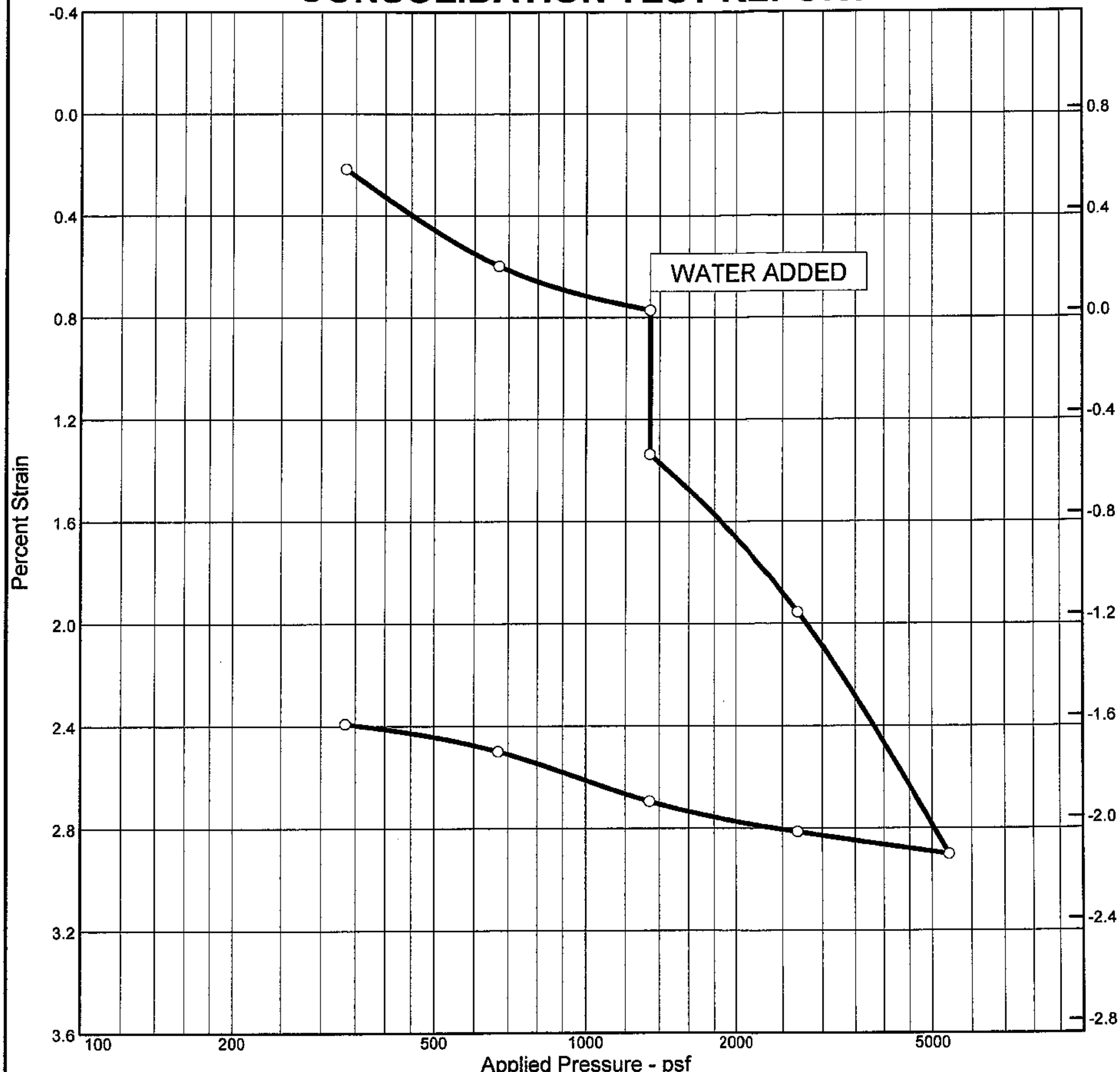
Pressure: 5410 psf	TEST READINGS	Load No. 6

No.	Elapsed Time	Dial Reading
1	0.00	0.23840
2	0.10	0.24680
3	0.25	0.24850
4	0.50	0.24970
5	1.00	0.25100
6	2.00	0.25250
7	4.00	0.25410
8	8.00	0.25540
9	15.00	0.25620
10	30.00	0.25740
11	60.00	0.25800



Void Ratio = 0.914 **Compression** = 5.8 %
D_0 = 0.24097 D_{90} = 0.24870 D_{100} = 0.24956
C_v **at 3.2 min.** = 0.51 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
97.8 %	30.2 %	91.0	N/A	N/A	2.65	336	1104	0.06	0.01		-0.6	0.818

MATERIAL DESCRIPTION	USCS	AASHTO
SILTY SAND Location: B-01-040B	SM	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-02-030B

Remarks:

Test Date: 07/21/11
Tested By: AL
Sample No: 35899

CONSOLIDATION TEST REPORT

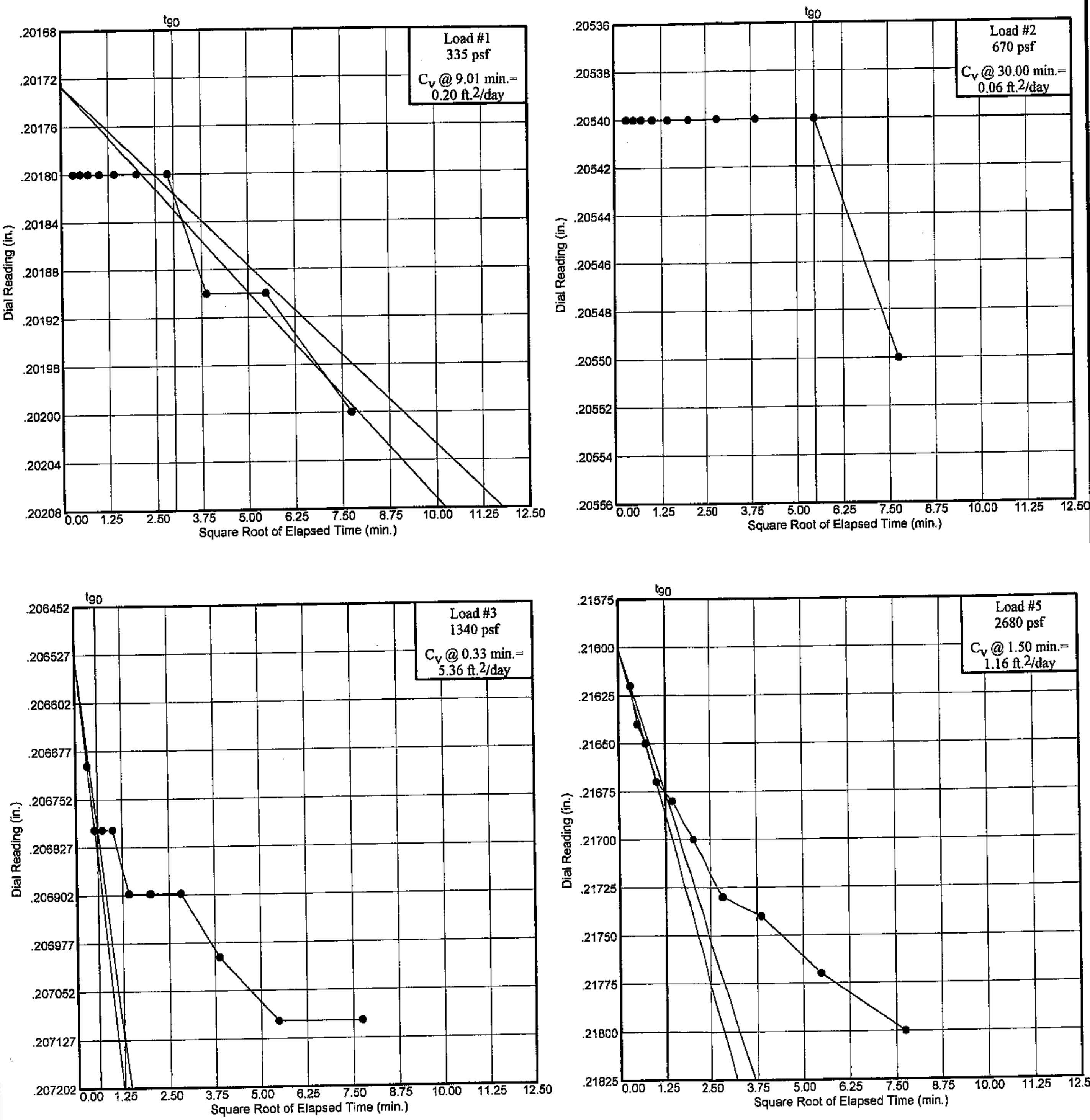
SOILS ENGINEERING, INC.

Figure B-2

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-02-030B



Dial Reading vs. Time

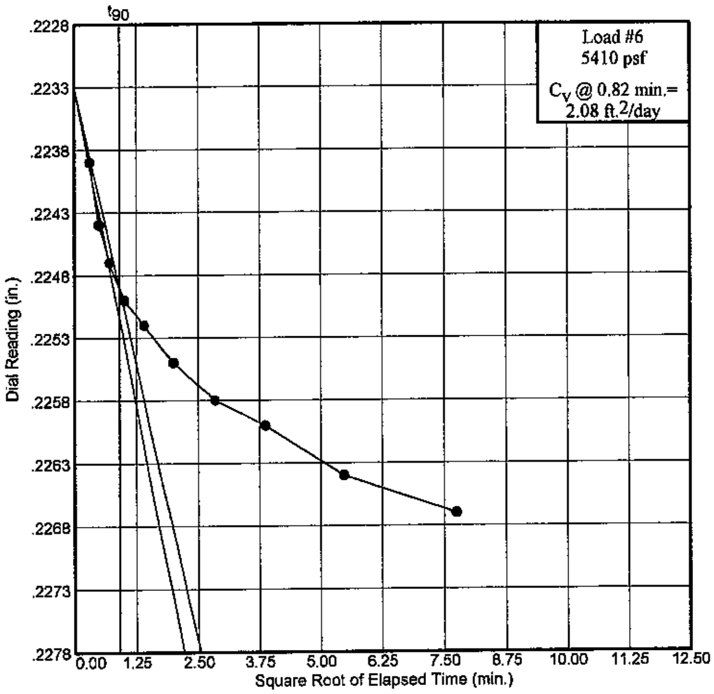
SOILS ENGINEERING, INC.

Figure B-2

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-02-030B



CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35899
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-02-030B
Description: SILTY SAND
Location: B-02-030B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SM **AASHTO:** N/A **Figure No.:** B-2
Testing Remarks: Test Date: 07/21/11
Tested By: AL
Sample No: 35899

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 177.70 g.	**Consolidometer #** = 2	**Wet w+t** = 173.90 g.
Dry w+t = 146.20 g.		**Dry w+t** = 146.20 g.
Tare Wt. = 41.90 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 41.90 g.
Height = .92 in.	**Height** = .92 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 135.80 g.	**Defl. Table** = Con # 2	
Moisture = 30.2 %	**Ht. Solids** = 0.5062 in.	**Moisture** = 26.6 %
Wet Den. = 118.5 pcf	**Dry Wt.** = 104.30 g.	**Dry Wt.** = 104.30 g.*
Dry Den. = 91.0 pcf	**Void Ratio** = 0.818	**Void Ratio** = 0.775
Ovrbrdn. = 336 psf	**Saturation** = 97.8 %	

*** Final dry weight used in calculations**

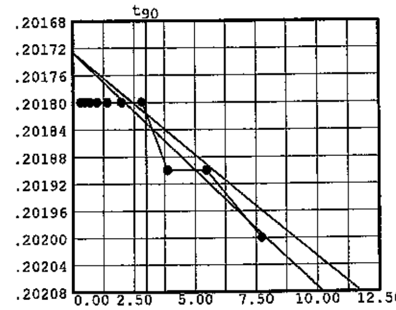
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.818	
335	0.20270	0.00070	0.20		0.814	0.2 Comprs.
670	0.20640	0.00090	0.06		0.807	0.6 Comprs.
1340	0.20850	0.00140	5.36		0.804	0.8 Comprs.
water	0.21370	0.00140			0.794	1.3 Comprs.
2680	0.22030	0.00230	1.16		0.783	2.0 Comprs.
5410	0.23030	0.00360	2.08		0.765	2.9 Comprs.
2680	0.22890	0.00300			0.767	2.8 Comprs.
1340	0.22720	0.00240			0.769	2.7 Comprs.
670	0.22510	0.00210			0.773	2.5 Comprs.
335	0.22310	0.00110			0.775	2.4 Comprs.

C_c = 0.06 P_c = 1104 psf C_s = 0.01
Heave percentage = -0.6

Pressure: 335 psf **TEST READINGS** **Load No. 1**

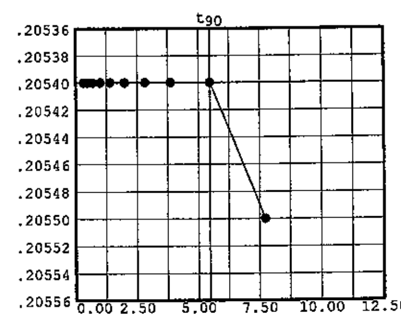
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20000	11	60.00	0.20270
2	0.10	0.20250			
3	0.25	0.20250			
4	0.50	0.20250			
5	1.00	0.20250			
6	2.00	0.20250			
7	4.00	0.20250			
8	8.00	0.20250			
9	15.00	0.20260			
10	30.00	0.20260			



Void Ratio = 0.814 **Compression** = 0.2 %
D_0 = 0.20173 D_{90} = 0.20182 D_{100} = 0.20183
C_v **at 9.0 min.** = 0.20 ft.^{2}/day

Pressure: 670 psf **TEST READINGS** **Load No. 2**

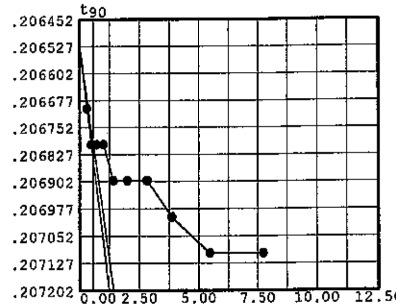
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20270	11	60.00	0.20640
2	0.10	0.20630			
3	0.25	0.20630			
4	0.50	0.20630			
5	1.00	0.20630			
6	2.00	0.20630			
7	4.00	0.20630			
8	8.00	0.20630			
9	15.00	0.20630			
10	30.00	0.20630			



Void Ratio = 0.807 **Compression** = 0.6 %
D_0 = 0.20540 D_{90} = 0.20540 D_{100} = 0.20540
C_v **at 30.0 min.** = 0.06 ft.^{2}/day

Pressure: 1340 psf — **TEST READINGS** — **Load No. 3**

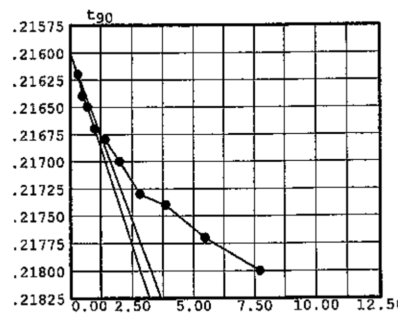
No.	Elapsed Time	Dial Reading
1	0.00	0.20640
2	0.10	0.20810
3	0.25	0.20820
4	0.50	0.20820
5	1.00	0.20820
6	2.00	0.20830
7	4.00	0.20830
8	8.00	0.20830
9	15.00	0.20840
10	30.00	0.20850
11	60.00	0.20850



Void Ratio = 0.804 **Compression** = 0.8 %
D_0 = 0.20653 D_{90} = 0.20680 D_{100} = 0.20683
C_v **at 0.3 min.** = 5.36 ft.^{2}/day

Pressure: 2680 psf — **TEST READINGS** — **Load No. 5**

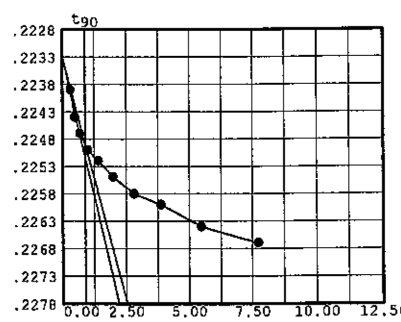
No.	Elapsed Time	Dial Reading
1	0.00	0.21370
2	0.10	0.21850
3	0.25	0.21870
4	0.50	0.21880
5	1.00	0.21900
6	2.00	0.21910
7	4.00	0.21930
8	8.00	0.21960
9	15.00	0.21970
10	30.00	0.22000
11	60.00	0.22030



Void Ratio = 0.783 **Compression** = 2.0 %
D_0 = 0.21601 D_{90} = 0.21675 D_{100} = 0.21684
C_v **at 1.5 min.** = 1.16 ft.^{2}/day

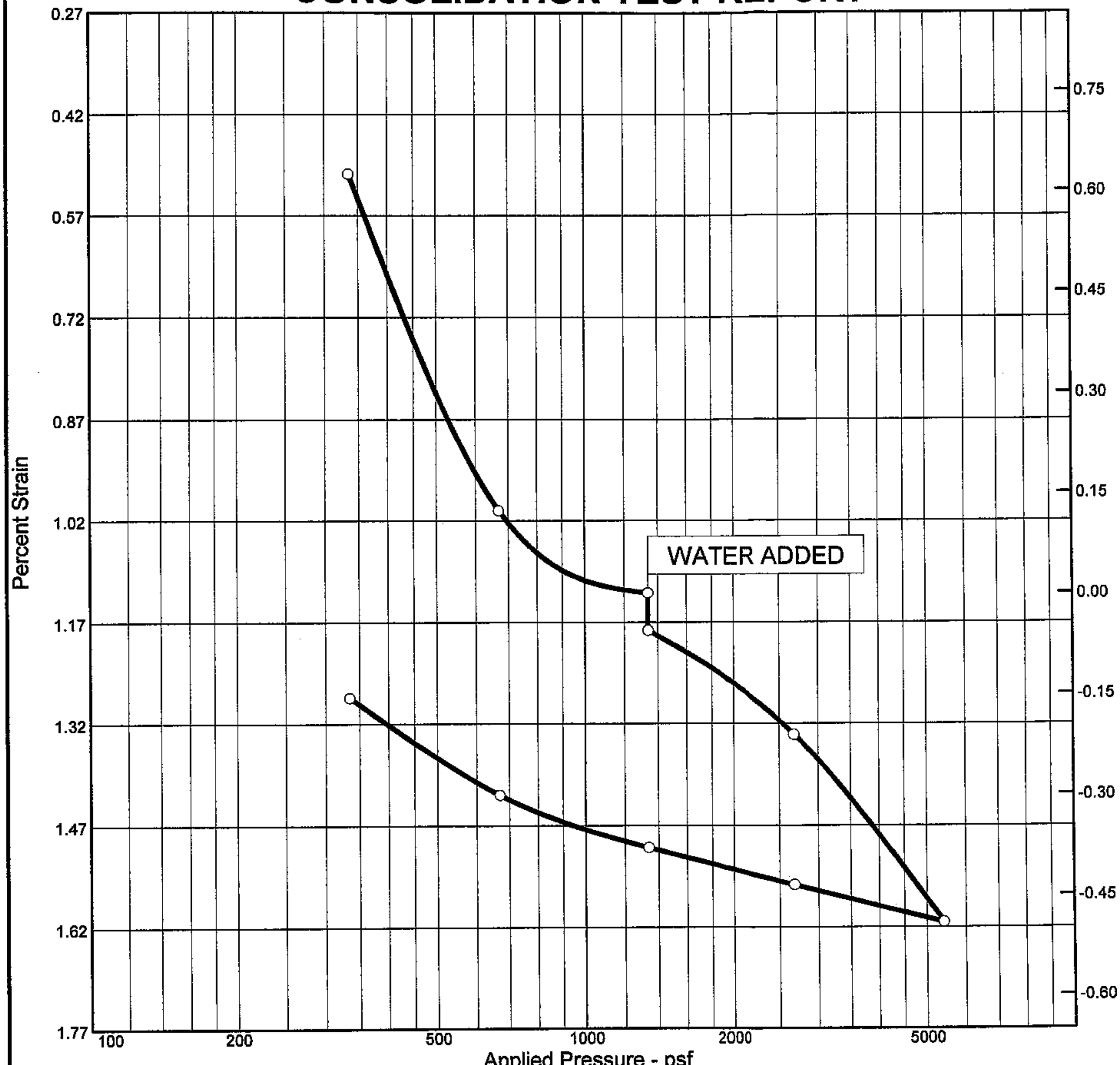
Pressure: 5410 psf — **TEST READINGS** — **Load No. 6**

No.	Elapsed Time	Dial Reading
1	0.00	0.22030
2	0.10	0.22750
3	0.25	0.22800
4	0.50	0.22830
5	1.00	0.22860
6	2.00	0.22880
7	4.00	0.22910
8	8.00	0.22940
9	15.00	0.22960
10	30.00	0.23000
11	60.00	0.23030



Void Ratio = 0.765 **Compression** = 2.9 %
D_0 = 0.22330 D_{90} = 0.22490 D_{100} = 0.22508
C_v **at 0.8 min.** = 2.08 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
73.0 %	18.0 %	100.1	N/A	N/A	2.65	336	2079	0.02	0.00		-0.1	0.652

MATERIAL DESCRIPTION	USCS	AASHTO
POORLY-GRADED SAND Location: B-03-020B	SP	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-020B

Remarks:
Test Date: 07/27/11
Tested By: AL
Sample No: 35917

CONSOLIDATION TEST REPORT

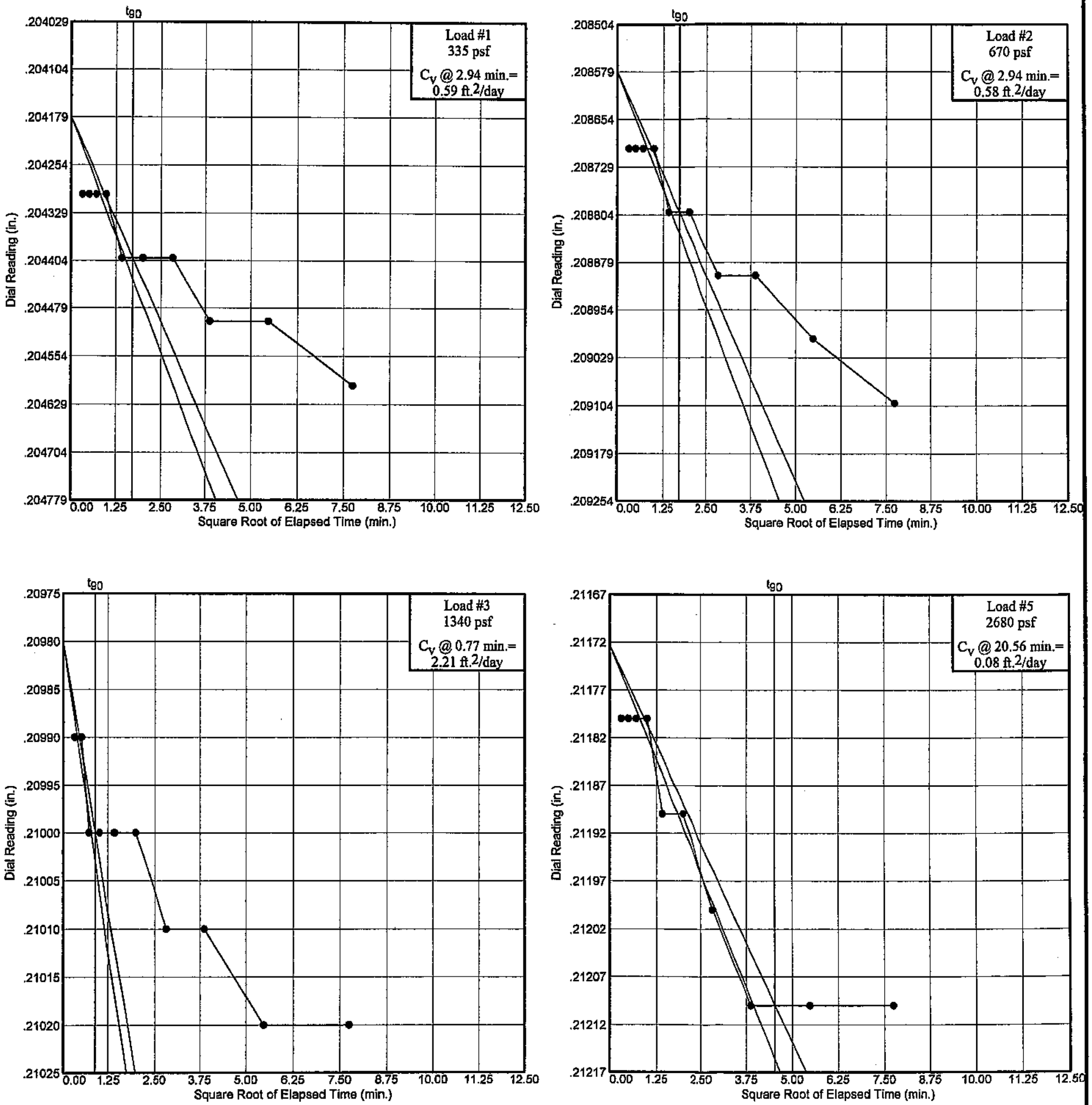
SOILS ENGINEERING, INC.

Figure B-3

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-020B



Dial Reading vs. Time

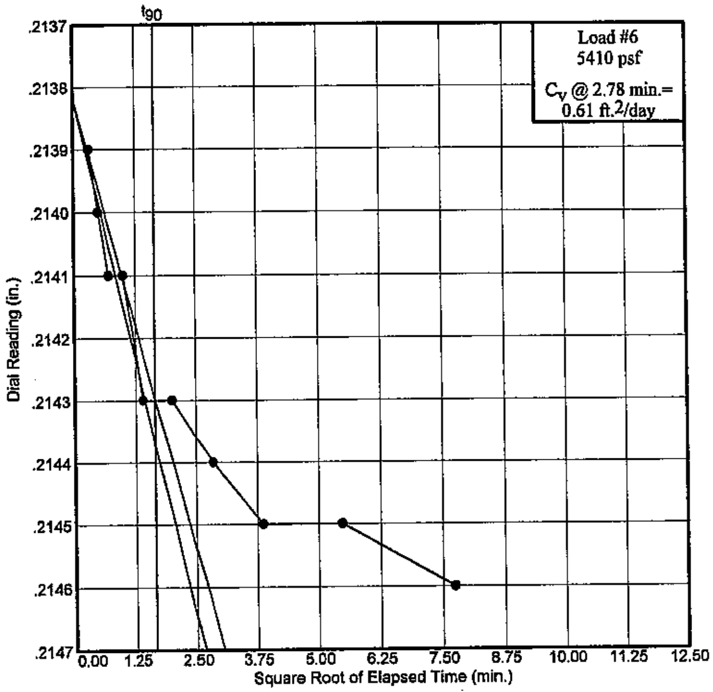
SOILS ENGINEERING, INC.

Figure B-3

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-020B



Dial Reading vs. Time

SOILS ENGINEERING, INC.

Figure B-3

CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35917
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-03-020B
Description: POORLY-GRADED SAND
Location: B-03-020B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SP **AASHTO:** N/A **Figure No.:** B-3
Testing Remarks: Test Date: 07/27/11
Tested By: AL
Sample No: 35917

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 174.70 g.	**Consolidometer #** = 1	**Wet w+t** = 175.40 g.
Dry w+t = 154.40 g.		**Dry w+t** = 154.40 g.
Tare Wt. = 41.50 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 41.50 g.
Height = .91 in.	**Height** = .91 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 133.20 g.	**Defl. Table** = Con # 1	
Moisture = 18.0 %	**Ht. Solids** = 0.5479 in.	**Moisture** = 18.6 %
Wet Den. = 118.1 pcf	**Dry Wt.** = 112.90 g.	**Dry Wt.** = 112.90 g.*
Dry Den. = 100.1 pcf	**Void Ratio** = 0.652	**Void Ratio** = 0.631
Ovrbrdn. = 336 psf	**Saturation** = 73.0 %	

*** Final dry weight used in calculations**

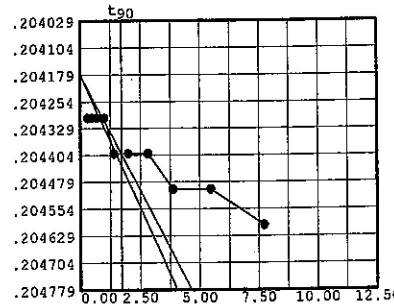
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.652	
335	0.20630	0.00170	0.59		0.644	0.5 Comprs.
670	0.21140	0.00230	0.58		0.636	1.0 Comprs.
1340	0.21300	0.00280	2.21		0.634	1.1 Comprs.
water	0.21350	0.00280			0.633	1.2 Comprs.
2680	0.21570	0.00360	0.08		0.630	1.3 Comprs.
5410	0.21940	0.00480	0.61		0.626	1.6 Comprs.
2680	0.21830	0.00420			0.627	1.6 Comprs.
1340	0.21730	0.00370			0.628	1.5 Comprs.
670	0.21620	0.00330			0.629	1.4 Comprs.
335	0.21460	0.00300			0.631	1.3 Comprs.

C_c = 0.02 P_c = 2079 psf C_s = 0.00
Heave percentage = -0.1

Pressure: 335 psf **TEST READINGS** **Load No. 1**

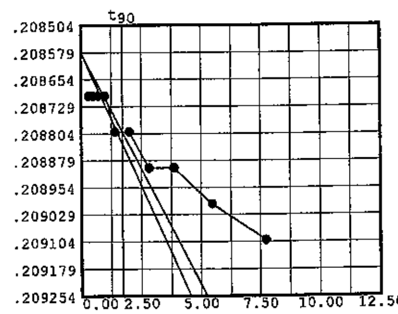
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20000	11	60.00	0.20630
2	0.10	0.20600			
3	0.25	0.20600			
4	0.50	0.20600			
5	1.00	0.20600			
6	2.00	0.20610			
7	4.00	0.20610			
8	8.00	0.20610			
9	15.00	0.20620			
10	30.00	0.20620			



Void Ratio = 0.644 **Compression** = 0.5 %
D_0 = 0.20418 D_{90} = 0.20440 D_{100} = 0.20442
C_v **at 2.9 min.** = 0.59 ft.^{2}/day

Pressure: 670 psf **TEST READINGS** **Load No. 2**

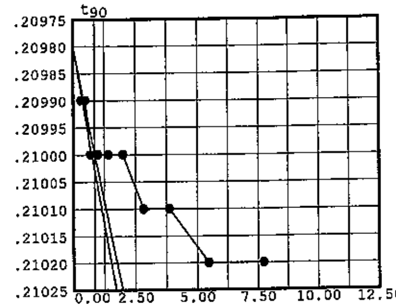
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20630	11	60.00	0.21140
2	0.10	0.21100			
3	0.25	0.21100			
4	0.50	0.21100			
5	1.00	0.21100			
6	2.00	0.21110			
7	4.00	0.21110			
8	8.00	0.21120			
9	15.00	0.21120			
10	30.00	0.21130			



Void Ratio = 0.636 **Compression** = 1.0 %
D_0 = 0.20858 D_{90} = 0.20880 D_{100} = 0.20882
C_v **at 2.9 min.** = 0.58 ft.^{2}/day

Pressure: 1340 psf **TEST READINGS** **Load No. 3**

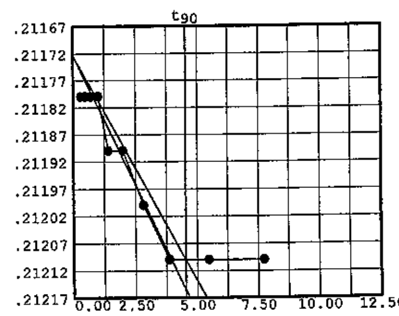
No.	Elapsed Time	Dial Reading
1	0.00	0.21140
2	0.10	0.21270
3	0.25	0.21270
4	0.50	0.21280
5	1.00	0.21280
6	2.00	0.21280
7	4.00	0.21280
8	8.00	0.21290
9	15.00	0.21290
10	30.00	0.21300
11	60.00	0.21300



Void Ratio = 0.634 **Compression** = 1.1 %
D_0 = 0.20980 D_{90} = 0.21000 D_{100} = 0.21002
C_v **at 0.8 min.** = 2.21 ft.^{2}/day

Pressure: 2680 psf **TEST READINGS** **Load No. 5**

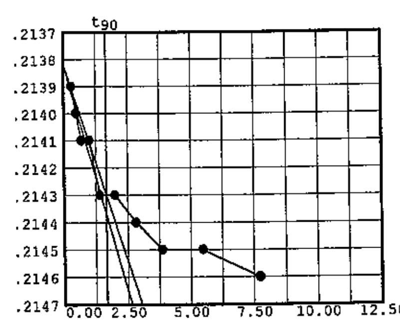
No.	Elapsed Time	Dial Reading
1	0.00	0.21350
2	0.10	0.21540
3	0.25	0.21540
4	0.50	0.21540
5	1.00	0.21540
6	2.00	0.21550
7	4.00	0.21550
8	8.00	0.21560
9	15.00	0.21570
10	30.00	0.21570
11	60.00	0.21570



Void Ratio = 0.630 **Compression** = 1.3 %
D_0 = 0.21172 D_{90} = 0.21210 D_{100} = 0.21214
C_v **at 20.6 min.** = 0.08 ft.^{2}/day

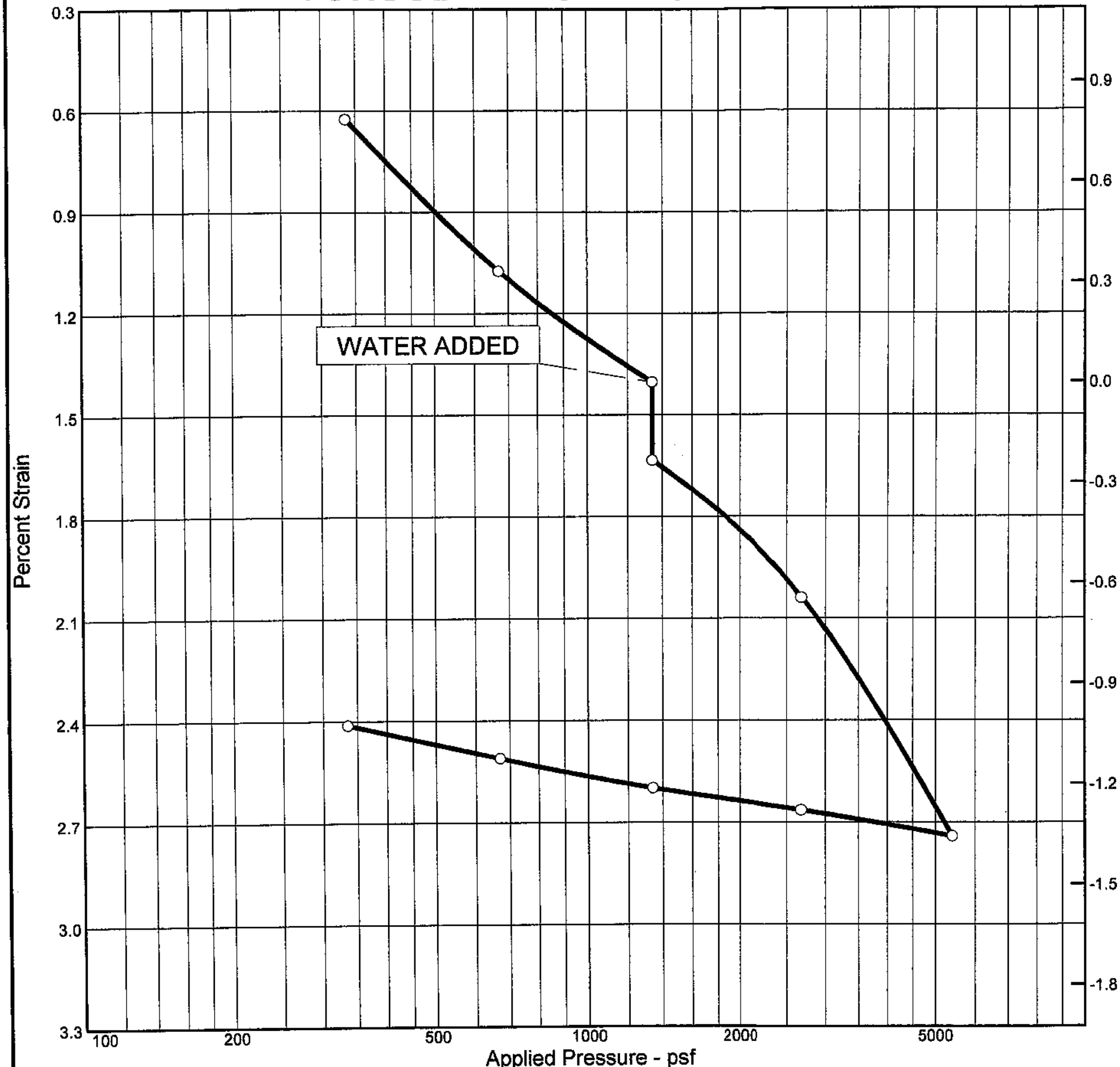
Pressure: 5410 psf **TEST READINGS** **Load No. 6**

No.	Elapsed Time	Dial Reading
1	0.00	0.21570
2	0.10	0.21870
3	0.25	0.21880
4	0.50	0.21890
5	1.00	0.21890
6	2.00	0.21910
7	4.00	0.21910
8	8.00	0.21920
9	15.00	0.21930
10	30.00	0.21930
11	60.00	0.21940



Void Ratio = 0.626 **Compression** = 1.6 %
D_0 = 0.21382 D_{90} = 0.21430 D_{100} = 0.21435
C_v **at 2.8 min.** = 0.61 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
70.1 %	19.8 %	94.5	N/A	N/A	2.65	336	2840	0.04	0.00		-0.2	0.750

MATERIAL DESCRIPTION	USCS	AASHTO
SILTY SAND Location: B-03-060B	SM	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-060B

Remarks:
Test Date: 07/21/11
Tested By: AL
Sample No: 35925

CONSOLIDATION TEST REPORT

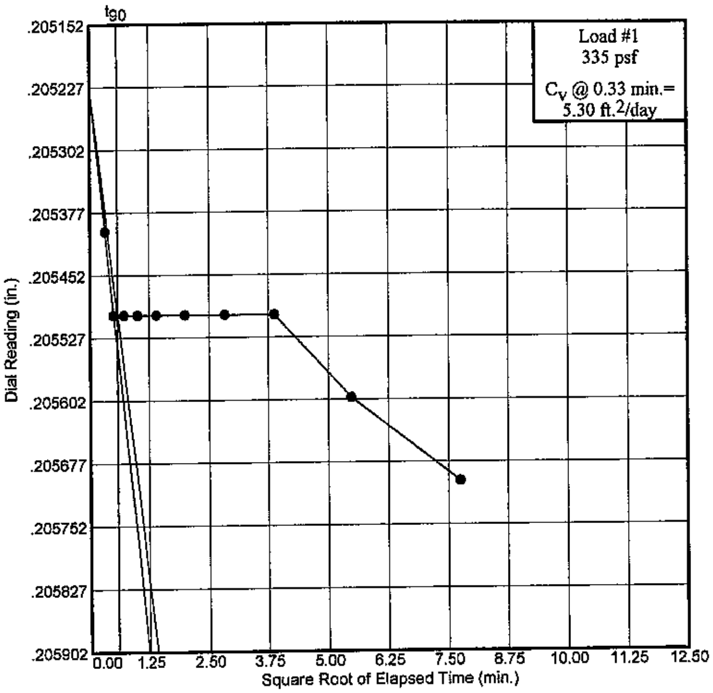
SOILS ENGINEERING, INC.

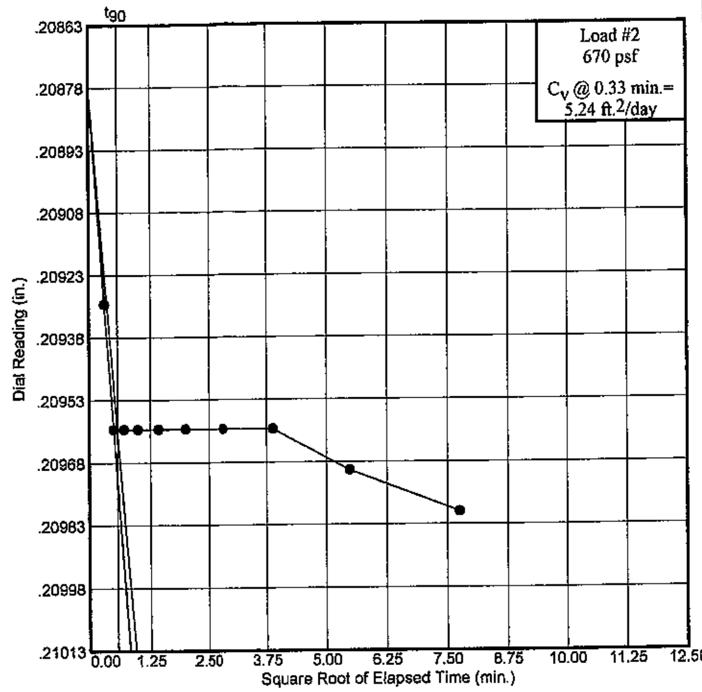
Figure B-4

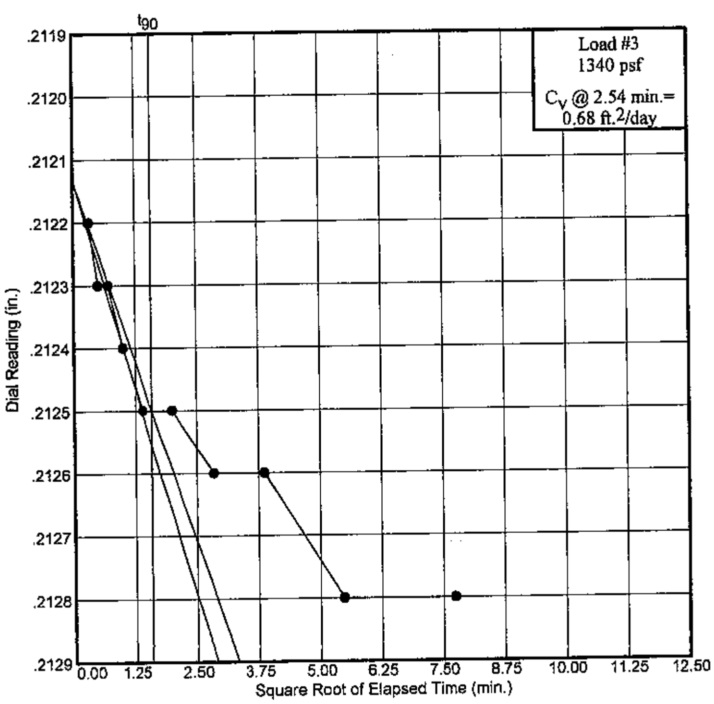
Dial Reading vs. Time

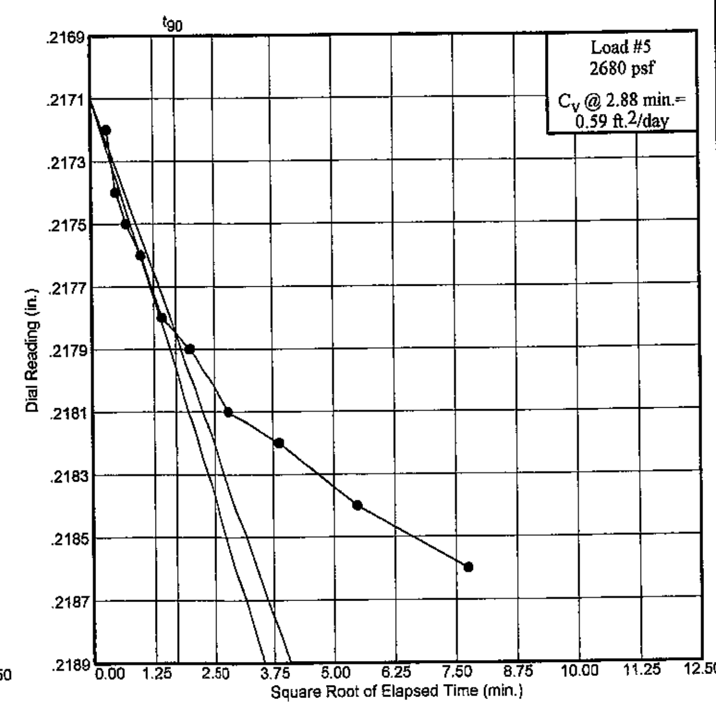
Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-060B









Dial Reading vs. Time

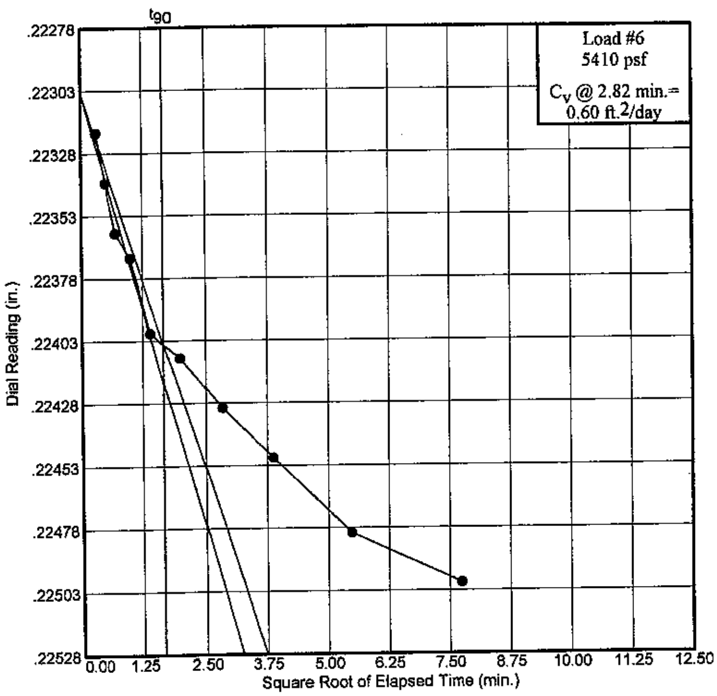
SOILS ENGINEERING, INC.

Figure B-4

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-03-060B



CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35925
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-03-060B
Description: SILTY SAND
Location: B-03-060B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SM **AASHTO:** N/A **Figure No.:** B-4
Testing Remarks: Test Date: 07/21/11
Tested By: AL
Sample No: 35925

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 171.00 g.	**Consolidometer #** = 3	**Wet w+t** = 176.20 g.
Dry w+t = 149.70 g.		**Dry w+t** = 149.70 g.
Tare Wt. = 42.30 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 42.30 g.
Height = .91 in.	**Height** = .91 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 128.70 g.	**Defl. Table** = Con # 3	
Moisture = 19.8 %	**Ht. Solids** = 0.5212 in.	**Moisture** = 24.7 %
Wet Den. = 113.3 pcf	**Dry Wt.** = 107.40 g.	**Dry Wt.** = 107.40 g.*
Dry Den. = 94.5 pcf	**Void Ratio** = 0.750	**Void Ratio** = 0.708
Ovrbrdn. = 336 psf	**Saturation** = 70.1 %	

*** Final dry weight used in calculations**

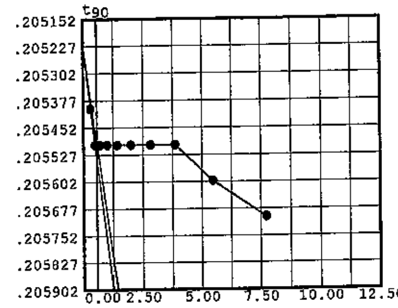
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.750	
335	0.20620	0.00050	5.30		0.739	0.6 Comprs.
670	0.21060	0.00080	5.24		0.731	1.1 Comprs.
1340	0.21420	0.00140	0.68		0.725	1.4 Comprs.
water	0.21630	0.00140			0.721	1.6 Comprs.
2680	0.22090	0.00230	0.59		0.714	2.0 Comprs.
5410	0.22850	0.00350	0.60		0.702	2.7 Comprs.
2680	0.22710	0.00280			0.703	2.7 Comprs.
1340	0.22590	0.00220			0.704	2.6 Comprs.
670	0.22470	0.00180			0.706	2.5 Comprs.
335	0.22350	0.00150			0.708	2.4 Comprs.

C_c = 0.04 P_c = 2840 psf C_s = 0.00
Heave percentage = -0.2

Pressure: 335 psf **TEST READINGS** **Load No. 1**

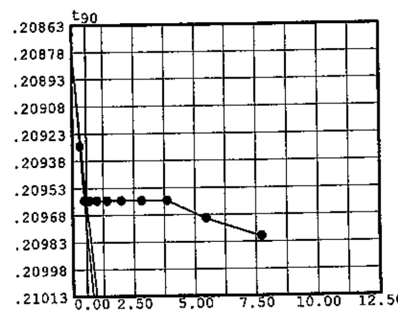
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20000	11	60.00	0.20620
2	0.10	0.20590			
3	0.25	0.20600			
4	0.50	0.20600			
5	1.00	0.20600			
6	2.00	0.20600			
7	4.00	0.20600			
8	8.00	0.20600			
9	15.00	0.20600			
10	30.00	0.20610			



Void Ratio = 0.739 **Compression** = 0.6 %
D_0 = 0.20523 D_{90} = 0.20550 D_{100} = 0.20553
C_v **at 0.3 min.** = 5.30 ft.^{2}/day

Pressure: 670 psf **TEST READINGS** **Load No. 2**

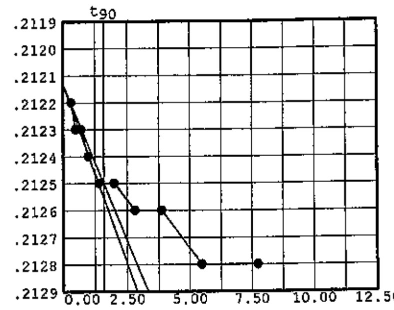
No.	Elapsed Time	Dial Reading	No.	Elapsed Time	Dial Reading
1	0.00	0.20620	11	60.00	0.21060
2	0.10	0.21010			
3	0.25	0.21040			
4	0.50	0.21040			
5	1.00	0.21040			
6	2.00	0.21040			
7	4.00	0.21040			
8	8.00	0.21040			
9	15.00	0.21040			
10	30.00	0.21050			



Void Ratio = 0.731 **Compression** = 1.1 %
D_0 = 0.20878 D_{90} = 0.20960 D_{100} = 0.20969
C_v **at 0.3 min.** = 5.24 ft.^{2}/day

Pressure: 1340 psf — **TEST READINGS** — **Load No. 3**

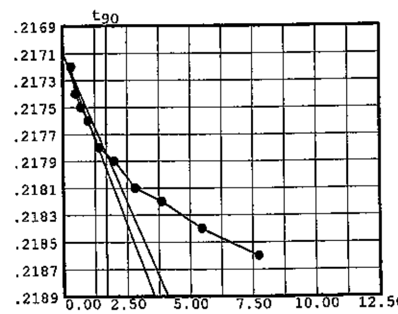
No.	Elapsed Time	Dial Reading
1	0.00	0.21060
2	0.10	0.21360
3	0.25	0.21370
4	0.50	0.21370
5	1.00	0.21380
6	2.00	0.21390
7	4.00	0.21390
8	8.00	0.21400
9	15.00	0.21400
10	30.00	0.21420
11	60.00	0.21420



Void Ratio = 0.725 **Compression =** 1.4 %
D_0 = 0.21213 D_{90} = 0.21250 D_{100} = 0.21254
C_v **at 2.5 min.** = 0.68 ft.^{2}/day

Pressure: 2680 psf — **TEST READINGS** — **Load No. 5**

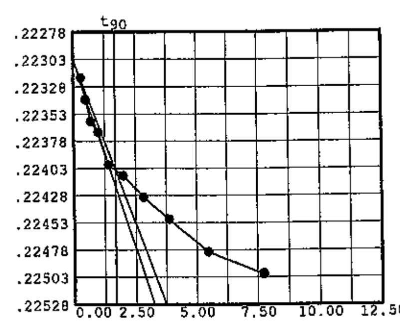
No.	Elapsed Time	Dial Reading
1	0.00	0.21630
2	0.10	0.21950
3	0.25	0.21970
4	0.50	0.21980
5	1.00	0.21990
6	2.00	0.22010
7	4.00	0.22020
8	8.00	0.22040
9	15.00	0.22050
10	30.00	0.22070
11	60.00	0.22090



Void Ratio = 0.714 **Compression =** 2.0 %
D_0 = 0.21710 D_{90} = 0.21785 D_{100} = 0.21793
C_v **at 2.9 min.** = 0.59 ft.^{2}/day

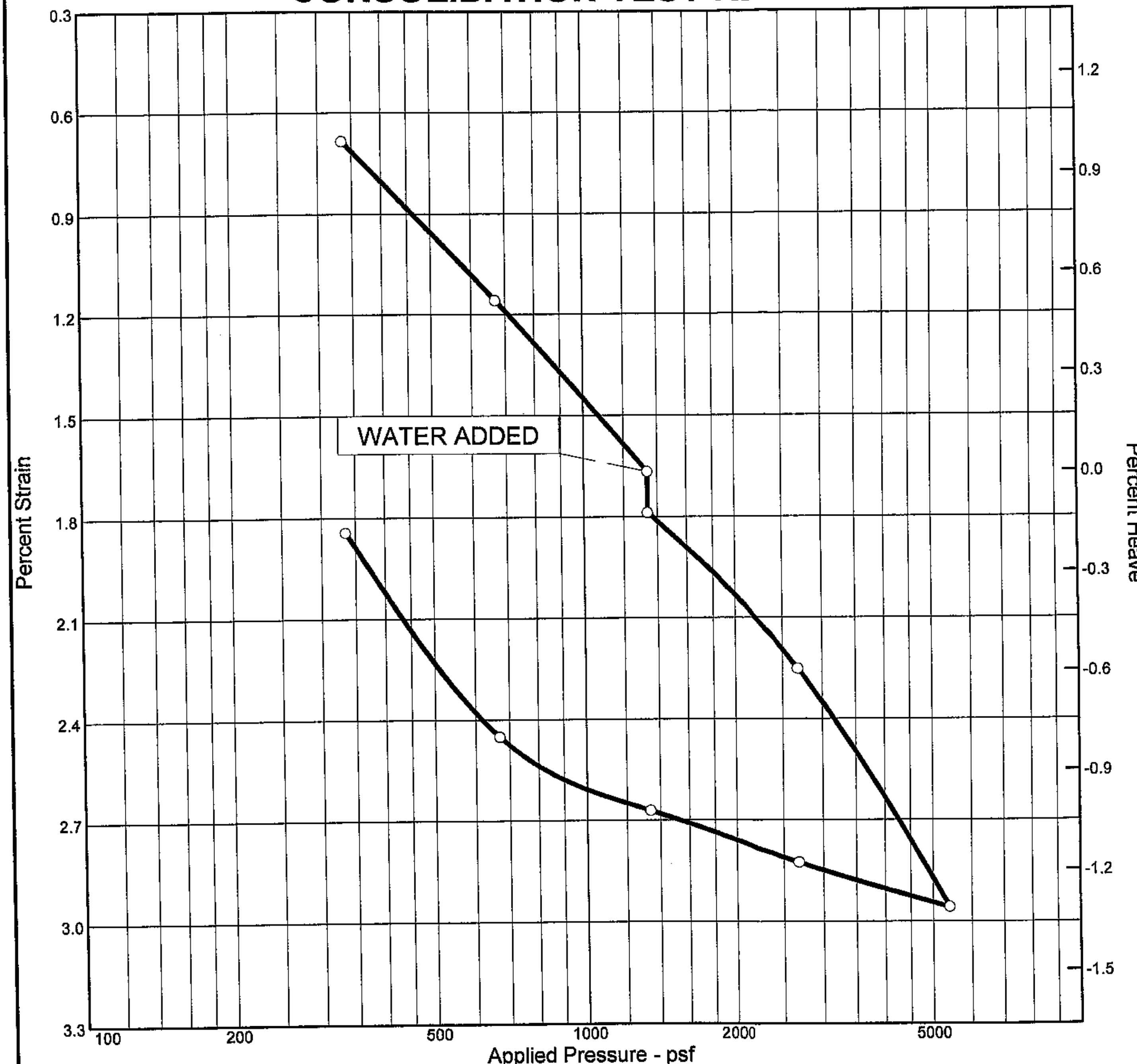
Pressure: 5410 psf — **TEST READINGS** — **Load No. 6**

No.	Elapsed Time	Dial Reading
1	0.00	0.22090
2	0.10	0.22670
3	0.25	0.22690
4	0.50	0.22710
5	1.00	0.22720
6	2.00	0.22750
7	4.00	0.22760
8	8.00	0.22780
9	15.00	0.22800
10	30.00	0.22830
11	60.00	0.22850



Void Ratio = 0.702 **Compression =** 2.7 %
D_0 = 0.22304 D_{90} = 0.22405 D_{100} = 0.22416
C_v **at 2.8 min.** = 0.60 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
89.8 %	28.1 %	90.4	N/A	N/A	2.65	336	2814	0.04	0.02		-0.1	0.830

MATERIAL DESCRIPTION	USCS	AASHTO
WELL-GRADED SAND Location: B-05-030B	SW	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-05-030B

Remarks:
Test Date: 07/21/11
Tested By: AL
Sample No: 35959

CONSOLIDATION TEST REPORT

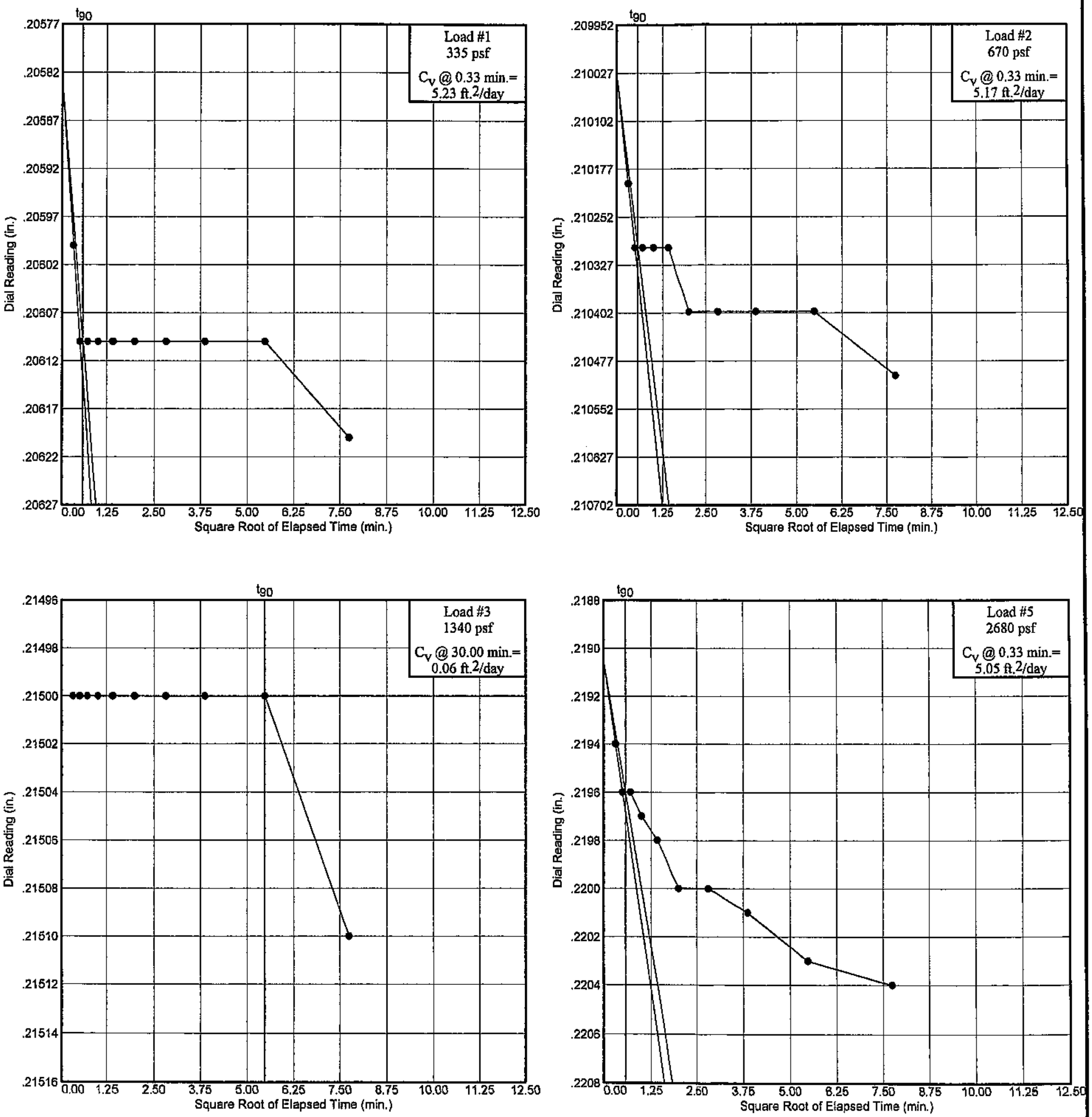
SOILS ENGINEERING, INC.

Figure B-5

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-05-030B



Dial Reading vs. Time

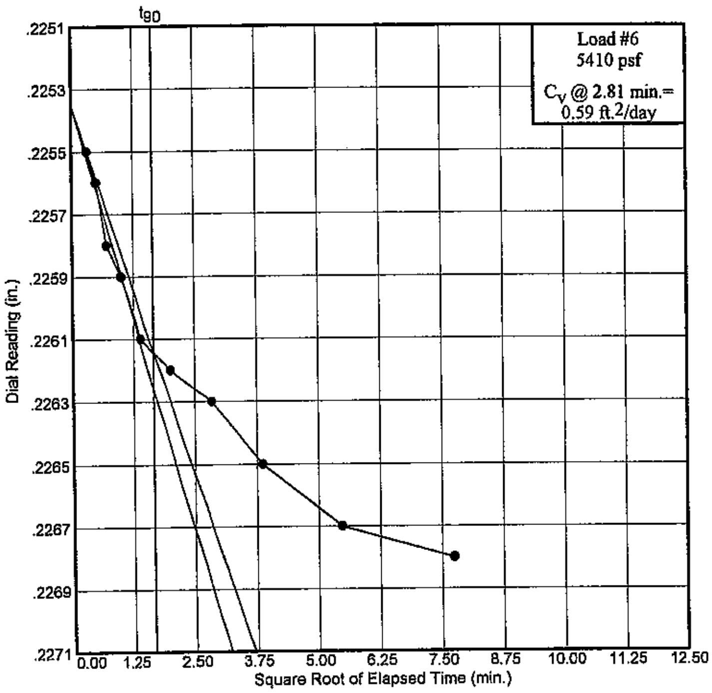
SOILS ENGINEERING, INC.

Figure B-5

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-05-030B



Dial Reading vs. Time

SOILS ENGINEERING, INC.

Figure B-5

CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35959
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-05-030B
Description: WELL-GRADED SAND
Location: B-05-030B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SW **AASHTO:** N/A **Figure No.:** B-5
Testing Remarks: Test Date: 07/21/11
Tested By: AL
Sample No: 35959

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 173.00 g.	**Consolidometer #** = 4	**Wet w+t** = 174.70 g.
Dry w+t = 144.30 g.		**Dry w+t** = 144.30 g.
Tare Wt. = 42.30 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 42.30 g.
Height = .91 in.	**Height** = .91 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 130.70 g.	**Defl. Table** = Con # 4	
Moisture = 28.1 %	**Ht. Solids** = 0.4950 in.	**Moisture** = 29.8 %
Wet Den. = 115.8 pcf	**Dry Wt.** = 102.00 g.	**Dry Wt.** = 102.00 g.*
Dry Den. = 90.4 pcf	**Void Ratio** = 0.830	**Void Ratio** = 0.797
Ovrbrdn. = 336 psf	**Saturation** = 89.8 %	

*** Final dry weight used in calculations**

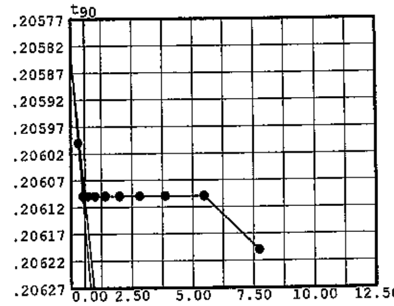
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.830	
335	0.20680	0.00060	5.23		0.818	0.7 Comprs.
670	0.21150	0.00100	5.17		0.809	1.2 Comprs.
1340	0.21690	0.00180	0.06		0.800	1.7 Comprs.
water	0.21800	0.00180			0.798	1.8 Comprs.
2680	0.22340	0.00300	5.05		0.789	2.3 Comprs.
5410	0.23150	0.00470	0.59		0.776	3.0 Comprs.
2680	0.22960	0.00400			0.779	2.8 Comprs.
1340	0.22750	0.00330			0.781	2.7 Comprs.
670	0.22510	0.00290			0.785	2.5 Comprs.
335	0.21930	0.00260			0.797	1.8 Comprs.

C_c = 0.04 P_c = 2814 psf C_s = 0.02
Heave percentage = -0.1

Pressure: 335 psf — **TEST READINGS** — **Load No. 1**

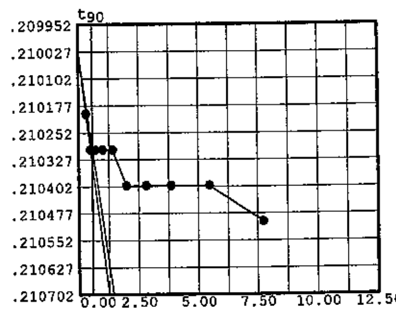
No.	Elapsed Time	Dial Reading
1	0.00	0.20000
2	0.10	0.20660
3	0.25	0.20670
4	0.50	0.20670
5	1.00	0.20670
6	2.00	0.20670
7	4.00	0.20670
8	8.00	0.20670
9	15.00	0.20670
10	30.00	0.20670
11	60.00	0.20680



Void Ratio = 0.818   **Compression** = 0.7 %
D_0 = 0.20583 D_{90} = 0.20610 D_{100} = 0.20613
C_v **at 0.3 min.** = 5.23 ft.^{2}/day

Pressure: 670 psf — **TEST READINGS** — **Load No. 2**

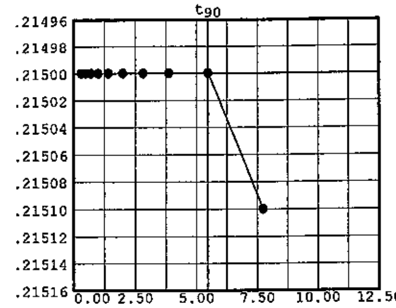
No.	Elapsed Time	Dial Reading
1	0.00	0.20680
2	0.10	0.21120
3	0.25	0.21130
4	0.50	0.21130
5	1.00	0.21130
6	2.00	0.21130
7	4.00	0.21140
8	8.00	0.21140
9	15.00	0.21140
10	30.00	0.21140
11	60.00	0.21150



Void Ratio = 0.809   **Compression** = 1.2 %
D_0 = 0.21003 D_{90} = 0.21030 D_{100} = 0.21033
C_v **at 0.3 min.** = 5.17 ft.^{2}/day

Pressure: 1340 psf	TEST READINGS	Load No. 3

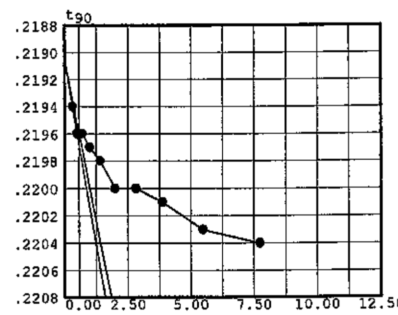
No.	Elapsed Time	Dial Reading
1	0.00	0.21150
2	0.10	0.21680
3	0.25	0.21680
4	0.50	0.21680
5	1.00	0.21680
6	2.00	0.21680
7	4.00	0.21680
8	8.00	0.21680
9	15.00	0.21680
10	30.00	0.21680
11	60.00	0.21690



Void Ratio = 0.800 **Compression** = 1.7 %
D_0 = 0.21500 D_{90} = 0.21500 D_{100} = 0.21500
C_v **at 30.0 min.** = 0.06 ft.^{2}/day

Pressure: 2680 psf	TEST READINGS	Load No. 5

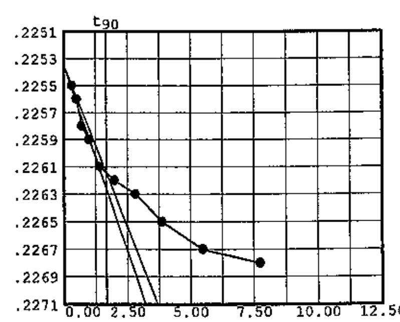
No.	Elapsed Time	Dial Reading
1	0.00	0.21800
2	0.10	0.22240
3	0.25	0.22260
4	0.50	0.22260
5	1.00	0.22270
6	2.00	0.22280
7	4.00	0.22300
8	8.00	0.22300
9	15.00	0.22310
10	30.00	0.22330
11	60.00	0.22340



Void Ratio = 0.789 **Compression** = 2.3 %
D_0 = 0.21906 D_{90} = 0.21960 D_{100} = 0.21966
C_v **at 0.3 min.** = 5.05 ft.^{2}/day

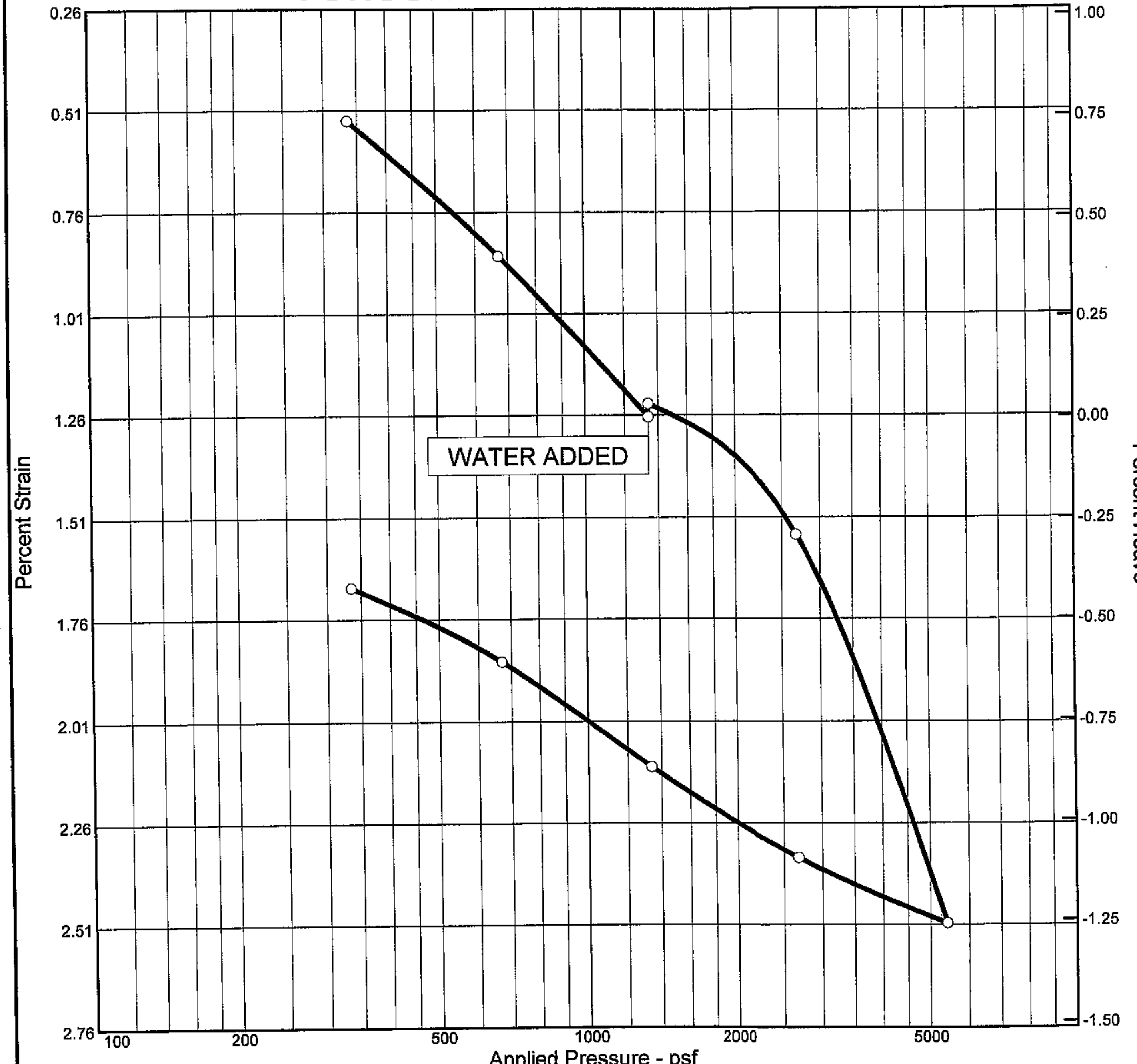
Pressure: 5410 psf	TEST READINGS	Load No. 6

No.	Elapsed Time	Dial Reading
1	0.00	0.22340
2	0.10	0.23020
3	0.25	0.23030
4	0.50	0.23050
5	1.00	0.23060
6	2.00	0.23080
7	4.00	0.23090
8	8.00	0.23100
9	15.00	0.23120
10	30.00	0.23140
11	60.00	0.23150



Void Ratio = 0.776 **Compression** = 3.0 %
D_0 = 0.22535 D_{90} = 0.22614 D_{100} = 0.22623
C_v **at 2.8 min.** = 0.59 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
92.6 %	23.0 %	99.7	N/A	N/A	2.65	336	2710	0.05	0.01	184	0.0	0.660

MATERIAL DESCRIPTION	USCS	AASHTO
SILTY SAND Location: B-05-070B	SM	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-05-070B

Remarks:
Test Date: 07/21/11
Tested By: AL
Sample No: 35968

CONSOLIDATION TEST REPORT

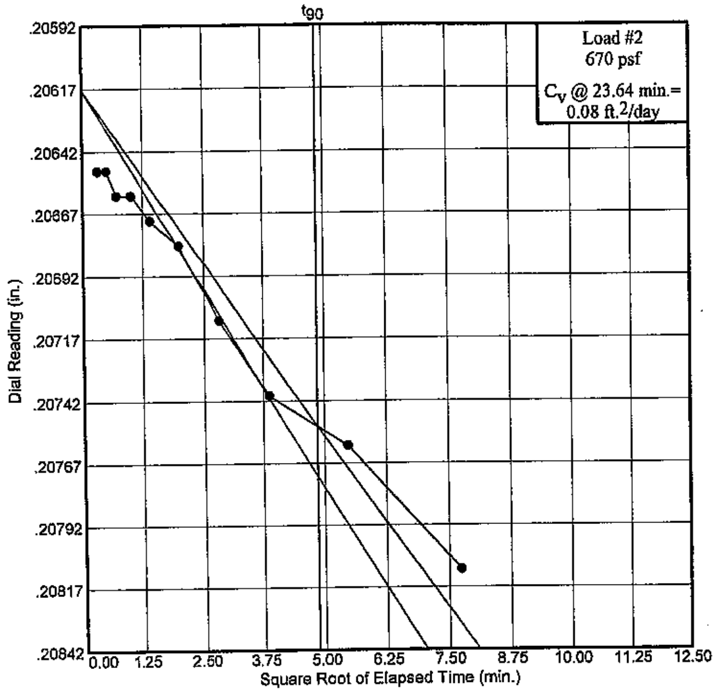
SOILS ENGINEERING, INC.

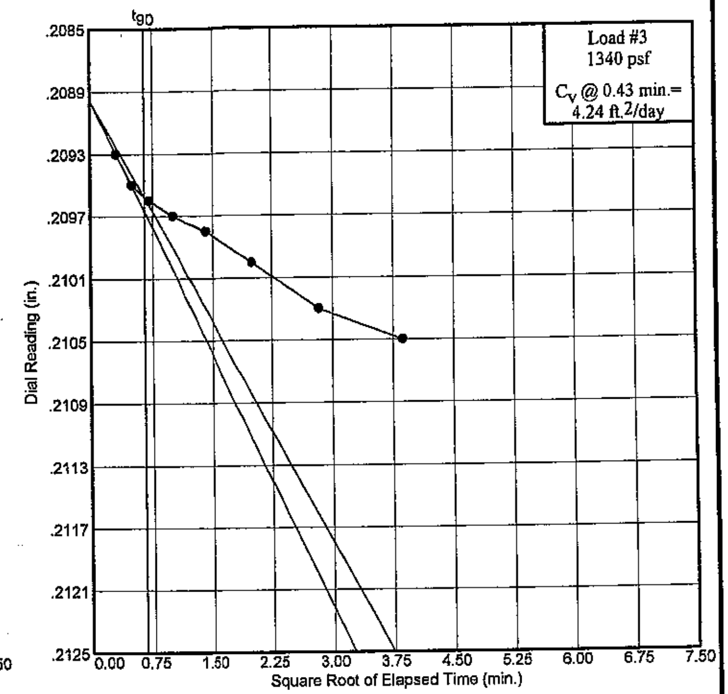
Figure B-6

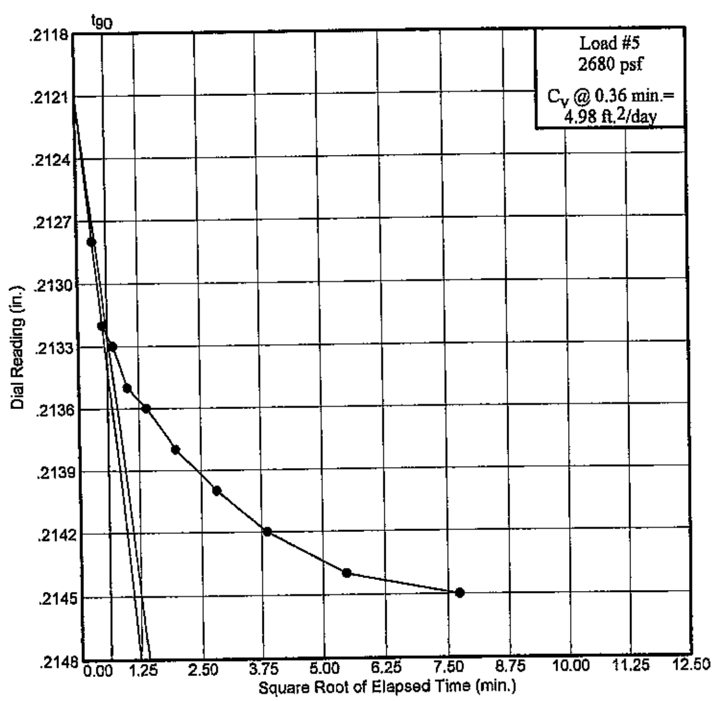
Dial Reading vs. Time

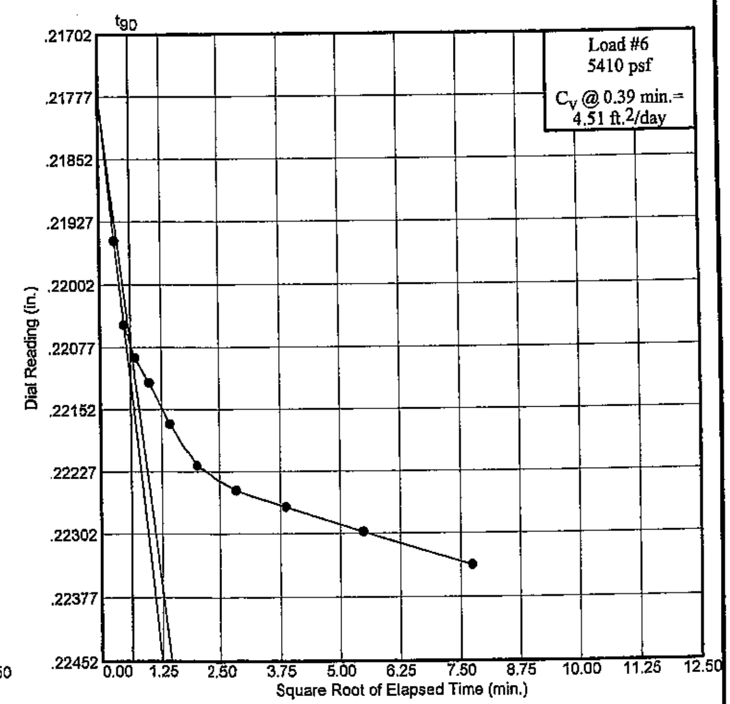
Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-05-070B









Dial Reading vs. Time

SOILS ENGINEERING, INC.

Figure B-6

CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 35968
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-05-070B
Description: SILTY SAND
Location: B-05-070B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SM **AASHTO:** N/A **Figure No.:** B-6
Testing Remarks: Test Date: 07/21/11
Tested By: AL
Sample No: 35968

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 184.70 g.	**Consolidometer #** = 2	**Wet w+t** = 185.30 g.
Dry w+t = 158.00 g.		**Dry w+t** = 158.00 g.
Tare Wt. = 42.10 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 42.10 g.
Height = .93 in.	**Height** = .93 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 142.60 g.	**Defl. Table** = Con # 2	
Moisture = 23.0 %	**Ht. Solids** = 0.5624 in.	**Moisture** = 23.6 %
Wet Den. = 122.7 pcf	**Dry Wt.** = 115.90 g.	**Dry Wt.** = 115.90 g.*
Dry Den. = 99.7 pcf	**Void Ratio** = 0.660	**Void Ratio** = 0.632
Ovrbrdn. = 336 psf	**Saturation** = 92.6 %	

*** Final dry weight used in calculations**

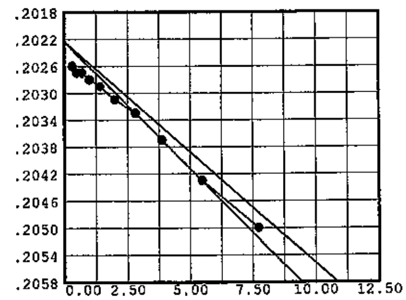
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.660	
335	0.20570	0.00070			0.651	0.5 Comprs.
670	0.20900	0.00090	0.08		0.645	0.9 Comprs.
1340	0.21320	0.00140	4.24		0.639	1.3 Comprs.
water	0.21290	0.00140			0.639	1.2 Comprs.
2680	0.21680	0.00230	4.98		0.634	1.6 Comprs.
5410	0.22700	0.00360	4.51		0.618	2.5 Comprs.
2680	0.22490	0.00300			0.621	2.3 Comprs.
1340	0.22220	0.00240			0.624	2.1 Comprs.
670	0.21950	0.00210			0.629	1.9 Comprs.
335	0.21680	0.00110			0.632	1.7 Comprs.

C_c = 0.05 P_c = 2710 psf C_s = 0.01
Swell Pressure = 184 psf
Heave percentage = 0.0

Pressure: 335 psf **TEST READINGS** **Load No. 1**

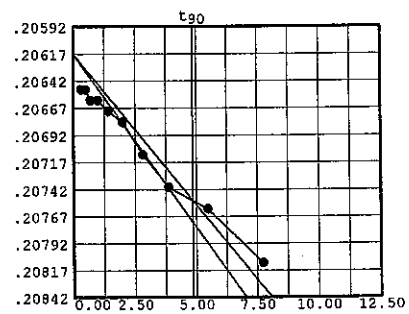
No.	Elapsed Time	Dial Reading
1	0.00	0.20000
2	0.10	0.20330
3	0.25	0.20340
4	0.50	0.20340
5	1.00	0.20350
6	2.00	0.20360
7	4.00	0.20380
8	8.00	0.20400
9	15.00	0.20440
10	30.00	0.20500
11	60.00	0.20570



Void Ratio = 0.651 **Compression** = 0.5 %

Pressure: 670 psf **TEST READINGS** **Load No. 2**

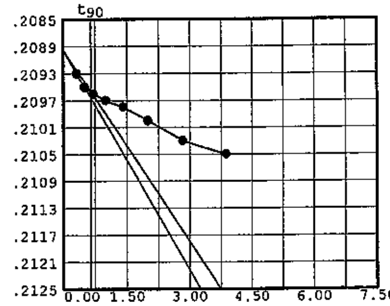
No.	Elapsed Time	Dial Reading
1	0.00	0.20570
2	0.10	0.20740
3	0.25	0.20740
4	0.50	0.20750
5	1.00	0.20750
6	2.00	0.20760
7	4.00	0.20770
8	8.00	0.20800
9	15.00	0.20830
10	30.00	0.20850
11	60.00	0.20900



Void Ratio = 0.645 **Compression** = 0.9 %
D_0 = 0.20617 D_{90} = 0.20752 D_{100} = 0.20767
C_v **at 23.6 min.** = 0.08 ft.^{2}/day

Pressure: 1340 psf **TEST READINGS** **Load No. 3**

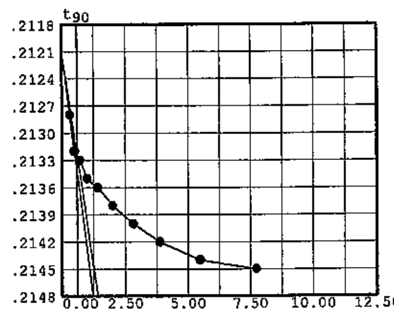
No.	Elapsed Time	Dial Reading
1	0.00	0.20900
2	0.10	0.21070
3	0.25	0.21090
4	0.50	0.21100
5	1.00	0.21110
6	2.00	0.21120
7	4.00	0.21140
8	8.00	0.21170
9	15.00	0.21190
10	30.00	0.21260
11	60.00	0.21320



Void Ratio = 0.639 **Compression** = 1.3 %
D_0 = 0.20896 D_{90} = 0.20957 D_{100} = 0.20964
C_v **at 0.4 min.** = 4.24 ft.^{2}/day

Pressure: 2680 psf **TEST READINGS** **Load No. 5**

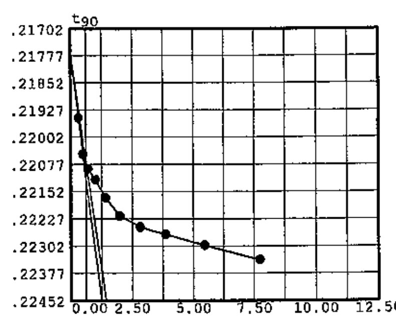
No.	Elapsed Time	Dial Reading
1	0.00	0.21290
2	0.10	0.21510
3	0.25	0.21550
4	0.50	0.21560
5	1.00	0.21580
6	2.00	0.21590
7	4.00	0.21610
8	8.00	0.21630
9	15.00	0.21650
10	30.00	0.21670
11	60.00	0.21680



Void Ratio = 0.634 **Compression** = 1.6 %
D_0 = 0.21211 D_{90} = 0.21325 D_{100} = 0.21337
C_v **at 0.4 min.** = 4.98 ft.^{2}/day

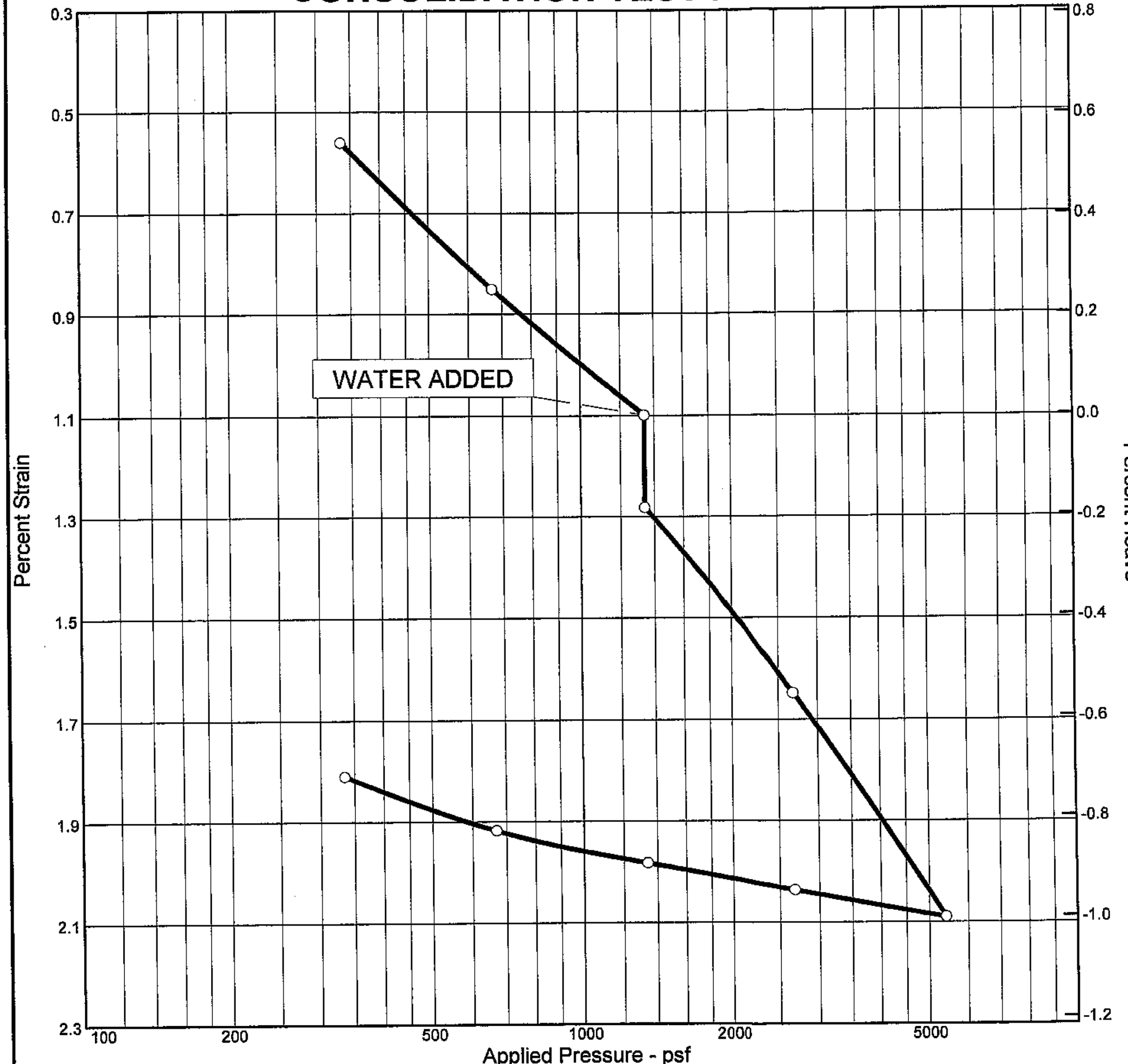
Pressure: 5410 psf **TEST READINGS** **Load No. 6**

No.	Elapsed Time	Dial Reading
1	0.00	0.21680
2	0.10	0.22310
3	0.25	0.22410
4	0.50	0.22450
5	1.00	0.22480
6	2.00	0.22530
7	4.00	0.22580
8	8.00	0.22610
9	15.00	0.22630
10	30.00	0.22660
11	60.00	0.22700



Void Ratio = 0.618 **Compression** = 2.5 %
D_0 = 0.21778 D_{90} = 0.22074 D_{100} = 0.22107
C_v **at 0.4 min.** = 4.51 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P_c (psf)	C_c	C_s	Swell Press. (psf)	Heave %	e_o
Sat.	Moist.											
97.5 %	21.4 %	104.6	N/A	N/A	2.65	336	2749	0.02	0.00		-0.2	0.582

MATERIAL DESCRIPTION	USCS	AASHTO
POORLY-GRADED SAND Location: B-08-040B	SP	N/A

Project No. 11-13636 **Client:** Buena Vista Water Storage District

Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-08-040B

Remarks:
Test Date: 07/27/11
Tested By: AL
Sample No: 36000

CONSOLIDATION TEST REPORT

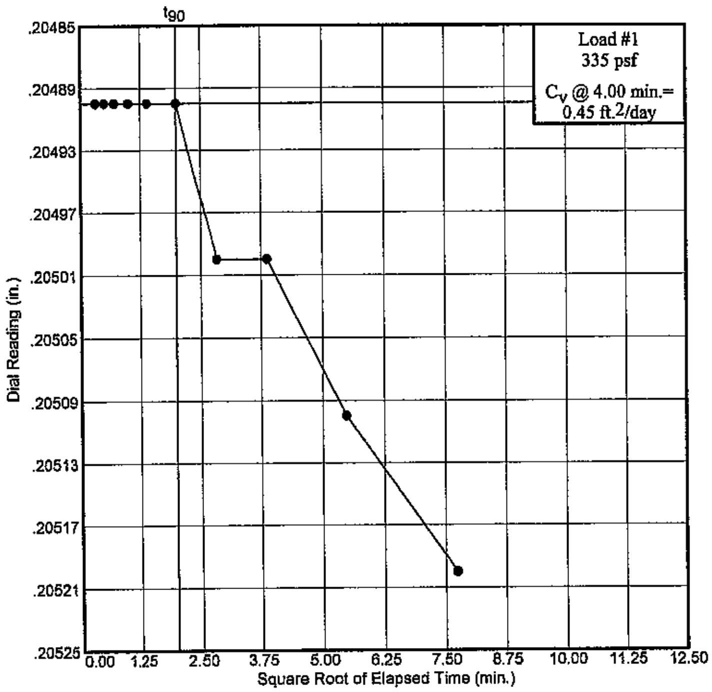
SOILS ENGINEERING, INC.

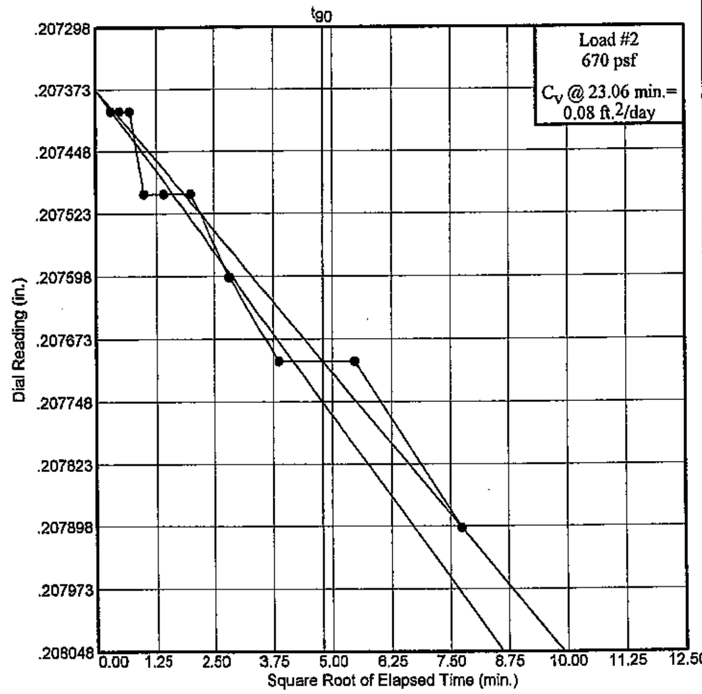
Figure B-7

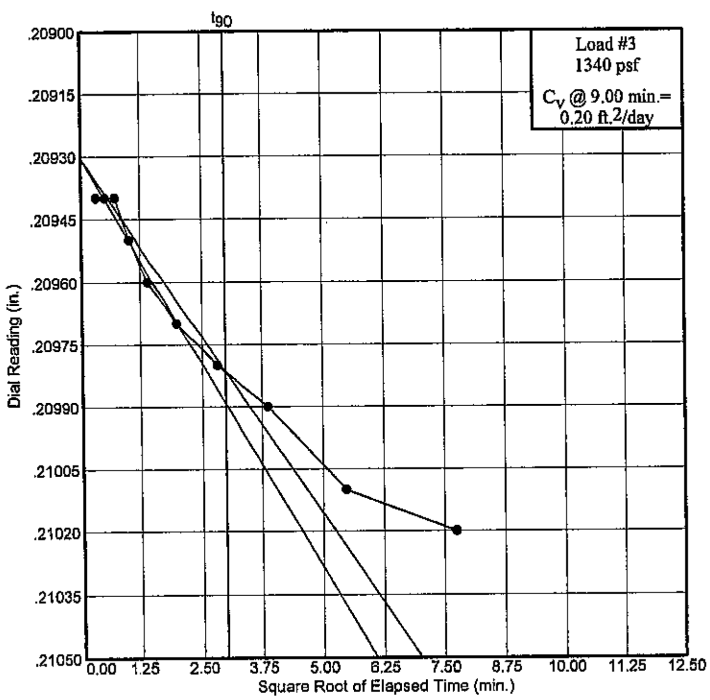
Dial Reading vs. Time

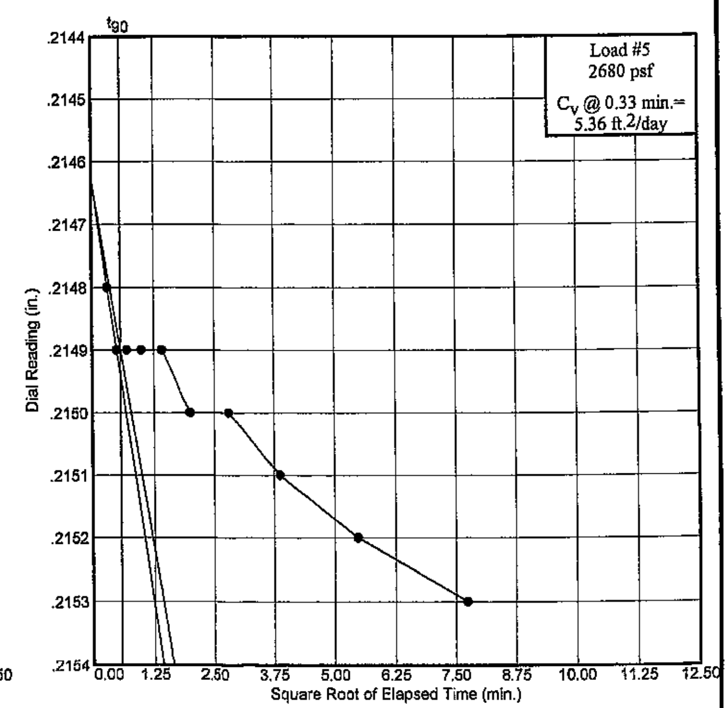
Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-08-040B









Dial Reading vs. Time

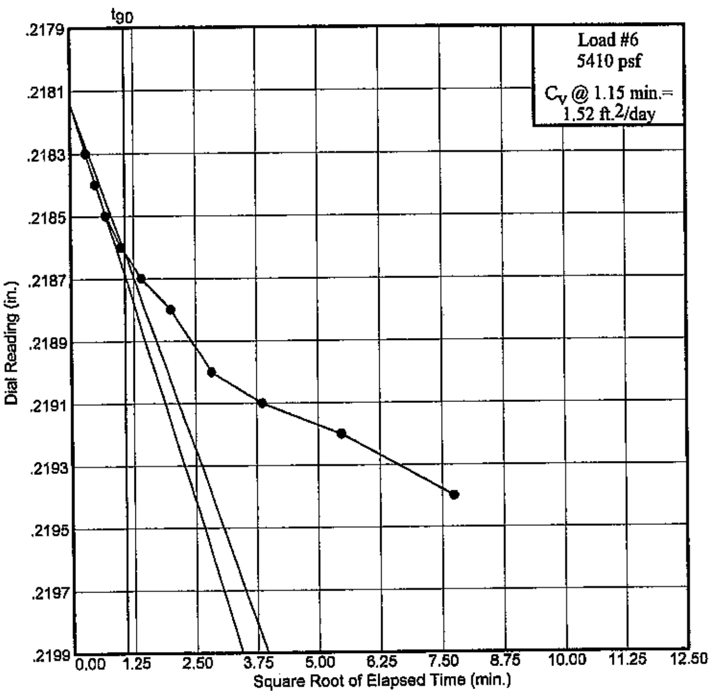
SOILS ENGINEERING, INC.

Figure B-7

Dial Reading vs. Time

Project No.: 11-13636
Project: HECA Well Field Phase 2; Buttonwillow, CA

Location: B-08-040B



CONSOLIDATION TEST DATA

Client: Buena Vista Water Storage District
Project: HECA Well Field Phase 2; Buttonwillow, CA
Project Number: 11-13636

Sample Data

Source:
Sample No.: 36000
Elev. or Depth: **Sample Length(in./cm.):**
Location: B-08-040B
Description: POORLY-GRADED SAND
Location: B-08-040B
Tube Sample
Liquid Limit: N/A **Plasticity Index:** N/A
USCS: SP **AASHTO:** N/A **Figure No.:** B-7
Testing Remarks: Test Date: 07/27/11
Tested By: AL
Sample No: 36000

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 189.00 g.	**Consolidometer #** = 3	**Wet w+t** = 189.90 g.
Dry w+t = 163.10 g.		**Dry w+t** = 163.10 g.
Tare Wt. = 42.20 g.	**Spec. Gravity** = 2.65	**Tare Wt.** = 42.20 g.
Height = .93 in.	**Height** = .93 in.	
Diameter = 2.46 in.	**Diameter** = 2.46 in.	
Weight = 146.80 g.	**Defl. Table** = Con # 3	
Moisture = 21.4 %	**Ht. Solids** = 0.5867 in.	**Moisture** = 22.2 %
Wet Den. = 127.0 pcf	**Dry Wt.** = 120.90 g.	**Dry Wt.** = 120.90 g.*
Dry Den. = 104.6 pcf	**Void Ratio** = 0.582	**Void Ratio** = 0.553
Ovrbrdn. = 336 psf	**Saturation** = 97.5 %	

*** Final dry weight used in calculations**

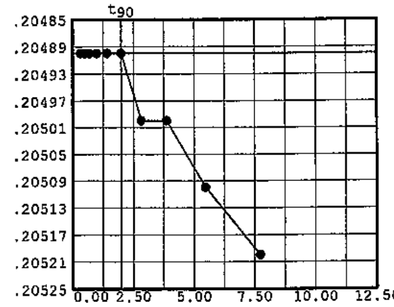
End-of-Load Summary

Pressure (psf)	Final Dial (in.)	Machine Defl. (in.)	C_v (ft.^{2}/day)	C_α	Void Ratio	% Compression /Swell
start	0.20000				0.582	
335	0.20570	0.00050	0.45		0.573	0.6 Comprs.
670	0.20870	0.00080	0.08		0.569	0.9 Comprs.
1340	0.21160	0.00140	0.20		0.565	1.1 Comprs.
water	0.21330	0.00140			0.562	1.3 Comprs.
2680	0.21760	0.00230	5.36		0.556	1.6 Comprs.
5410	0.22290	0.00350	1.52		0.549	2.1 Comprs.
2680	0.22170	0.00280			0.550	2.0 Comprs.
1340	0.22060	0.00220			0.551	2.0 Comprs.
670	0.21960	0.00180			0.552	1.9 Comprs.
335	0.21830	0.00150			0.553	1.8 Comprs.

C_c = 0.02 P_c = 2749 psf C_s = 0.00
Heave percentage = -0.2

Pressure: 335 psf **TEST READINGS** **Load No. 1**

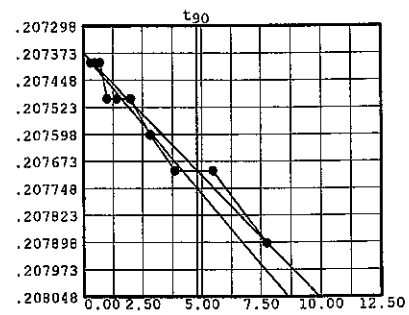
No.	Elapsed Time	Dial Reading
1	0.00	0.20000
2	0.10	0.20540
3	0.25	0.20540
4	0.50	0.20540
5	1.00	0.20540
6	2.00	0.20540
7	4.00	0.20540
8	8.00	0.20550
9	15.00	0.20550
10	30.00	0.20560
11	60.00	0.20570



Void Ratio = 0.573 **Compression** = 0.6 %
D_0 = 0.20490 D_{90} = 0.20490 D_{100} = 0.20490
C_v **at 4.0 min.** = 0.45 ft.^{2}/day

Pressure: 670 psf **TEST READINGS** **Load No. 2**

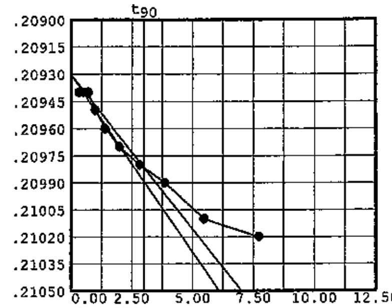
No.	Elapsed Time	Dial Reading
1	0.00	0.20570
2	0.10	0.20820
3	0.25	0.20820
4	0.50	0.20820
5	1.00	0.20830
6	2.00	0.20830
7	4.00	0.20830
8	8.00	0.20840
9	15.00	0.20850
10	30.00	0.20850
11	60.00	0.20870



Void Ratio = 0.569 **Compression** = 0.9 %
D_0 = 0.20737 D_{90} = 0.20770 D_{100} = 0.20774
C_v **at 23.1 min.** = 0.08 ft.^{2}/day

Pressure: 1340 psf | TEST READINGS | Load No. 3

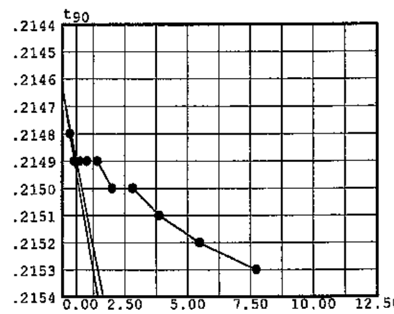
No.	Elapsed Time	Dial Reading
1	0.00	0.20870
2	0.10	0.21080
3	0.25	0.21080
4	0.50	0.21080
5	1.00	0.21090
6	2.00	0.21100
7	4.00	0.21110
8	8.00	0.21120
9	15.00	0.21130
10	30.00	0.21150
11	60.00	0.21160



Void Ratio = 0.565 Compression = 1.1 %
D_0 = 0.20931 D_{90} = 0.20982 D_{100} = 0.20987
C_v at 9.0 min. = 0.20 ft.^{2}/day

Pressure: 2680 psf | TEST READINGS | Load No. 5

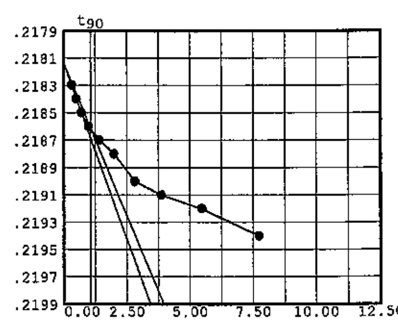
No.	Elapsed Time	Dial Reading
1	0.00	0.21330
2	0.10	0.21710
3	0.25	0.21720
4	0.50	0.21720
5	1.00	0.21720
6	2.00	0.21720
7	4.00	0.21730
8	8.00	0.21730
9	15.00	0.21740
10	30.00	0.21750
11	60.00	0.21760



Void Ratio = 0.556 Compression = 1.6 %
D_0 = 0.21463 D_{90} = 0.21490 D_{100} = 0.21493
C_v at 0.3 min. = 5.36 ft.^{2}/day

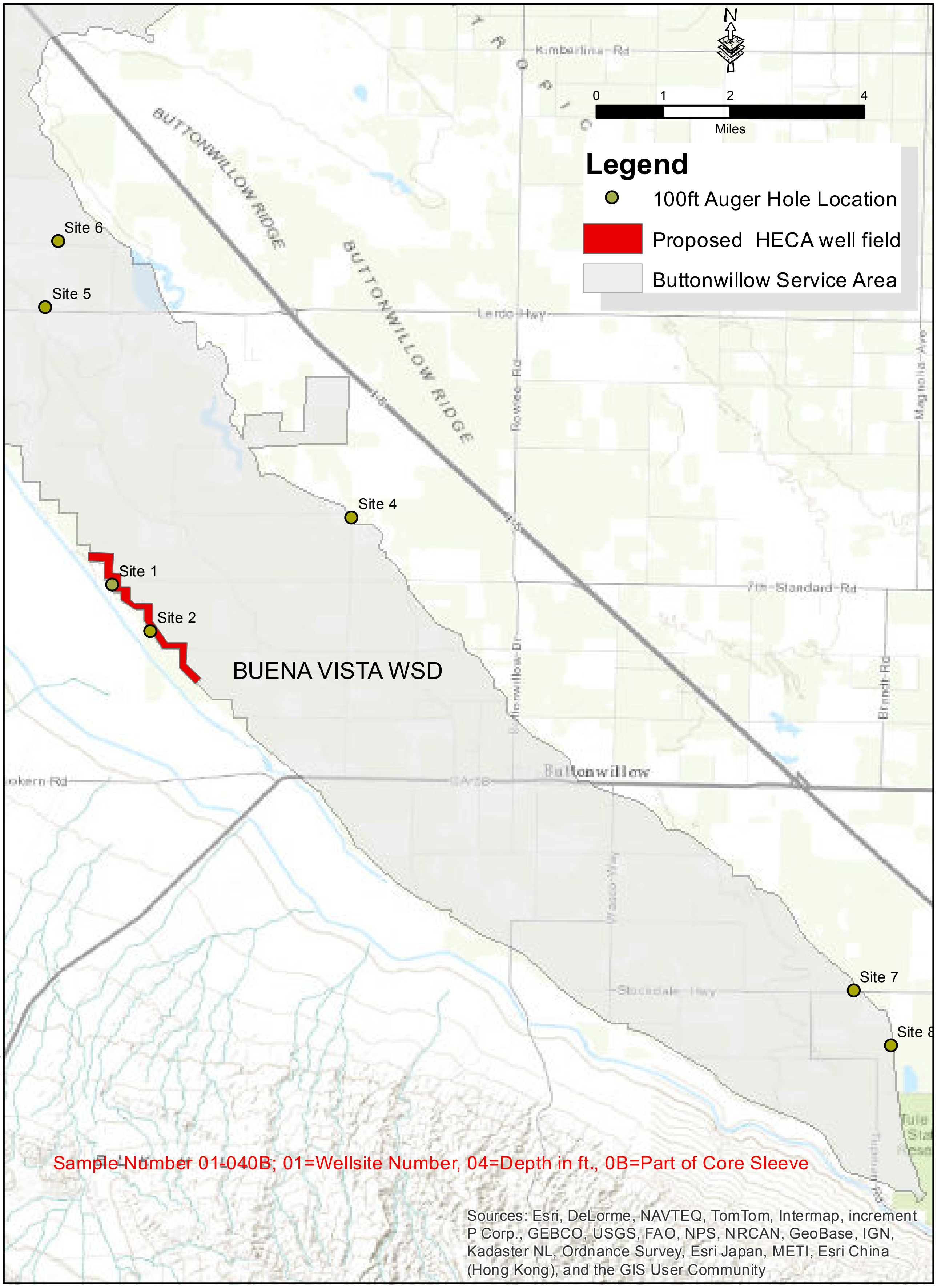
Pressure: 5410 psf | TEST READINGS | Load No. 6

No.	Elapsed Time	Dial Reading
1	0.00	0.21760
2	0.10	0.22180
3	0.25	0.22190
4	0.50	0.22200
5	1.00	0.22210
6	2.00	0.22220
7	4.00	0.22230
8	8.00	0.22250
9	15.00	0.22260
10	30.00	0.22270
11	60.00	0.22290



Void Ratio = 0.549 Compression = 2.1 %
D_0 = 0.21814 D_{90} = 0.21862 D_{100} = 0.21867
C_v at 1.2 min. = 1.52 ft.^{2}/day

2011 HECA Well Field Phase-2



Document Path: \\BVWSD\Company\HECA\CEC Data Request Response\2011 HECA well Field Phase 2.mxd

Author: O Ogunjobi

Attachment 6.

Groundwater Status and Management Plan for BVWSD.

Sept 9, 1997

Revised May 14, 2002

GROUNDWATER STATUS AND MANAGEMENT PLAN

FOR

BUENA VISTA WATER STORAGE DISTRICT
Buttonwillow, California

September 9, 1997
Revised May 14, 2002

1942 - 2002
60 yrs of
ENGINEERING EXCELLENCE
BOYLE

BOYLE ENGINEERING CORPORATION

GROUNDWATER STATUS AND MANAGEMENT PLAN
BUENA VISTA WATER STORAGE DISTRICT

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INTRODUCTION

Goal. It is the goal of Buena Vista Water Storage District to provide the landowners and water users of the District with a reliable, affordable, and usable surface and groundwater supply. In response to this goal, the District prepared a groundwater management plan as authorized by AB 255 in September 1997 to use as a guide in accomplishing this task. The District's Groundwater Status and Management Plan describes the District's plan to protect groundwater levels and quality in the present and over the long-term, keep groundwater use costs to a minimum, maintain groundwater control at the local level, document existing conditions, and initiate necessary programs and studies.

The years since the District's plan was completed have included two years of above normal hydrology (1997 and 1998) and three years of below normal hydrology (1999, 2000 and 2001). **The District, per Board Resolution No. 3832 (see Appendix H), has now prepared this update to the groundwater management plan to show current conditions and operations since the previous plan was completed. It is the District's goal to continue to facilitate programs that benefit and protect the groundwater basin.**

History. The Buena Vista Water Storage District lies in the trough of California's southern San Joaquin Valley as shown in Appendix A. The District lands are within a portion of the lower Kern River watershed, where historic runoff created the heavy clay soils from former swamp and overflow lands north of Buena Vista Lake. The area lies on the western side of the valley floor, about 16 miles west of the city of Bakersfield. It includes the former Buena Vista Lake Bed, now farmed by J.G. Boswell Company, and that portion of the swamp and overflow lands between the townsites of Tupman and Lost Hills. The unincorporated townsite of Buttonwillow (pop. 1500), being the hub of local farm activity, is situated in the geographical center of the project area. The District's water service area, which excludes the Buena Vista Lake lands, under jurisdiction of the Henry Miller Water District, contains 48,443 acres (49,057 assessed acres) of agricultural land. Approximately 45,000 acres of the District have been developed, and about 40,000 acres are annually farmed to field and row crops. The service area is physically divided into two distinct locations. The major portion situated north of Buena Vista Lake is known as the Buttonwillow service area. The much smaller area , east of Buena Vista Lake, is known as the Maples service area.

The area which the District now serves was originally developed by two former meat supply merchants from San Francisco, namely Henry Miller and Charles Lux. In the early 1870's, these two men joined forces and set out to build a cattle and sheep empire in the San Joaquin Valley. Extensive land holdings were acquired via the "Swamp and Overflow Act", the most productive Kern County portions of which are now within the Buena Vista Water Storage District. Miller and Lux's vast agricultural activities required farm help by way of tenant families many of whom immigrated from Italy. Surface water supplies diverted from the adjoining Kern River and from surface storage within Buena Vista Lake were used to develop lands north of and surrounding the lake, depending on its water levels.

Irrigation activities from the Kern River, in and around the Bakersfield area, were first undertaken during the late 1850's, when small private ditches diverted water for the irrigation of grains. As the upstream diversions increased, controversies over the water arose, which resulted in lengthy litigation between upper and lower river users. Much of today's California appropriative and riparian water rights law resulted from the Supreme Court's decision in the Lux vs. Haggin case. The ruling created what is now known as the "California Doctrine" which recognizes both riparian and appropriative water rights. Despite the court's decision, the dispute continued and was finally settled via the historic Miller-Haggin Agreement of July 28, 1888. This agreement, where both appropriative and riparian rights were recognized, continues to be the basis by which the flow of the Kern River is divided among "First and Second Point" interests. The "Second Point" interests, namely Miller and Lux, received about one-third of the river flows from March through August. A subsequent amendment also apportioned to Second Point some of the high runoff winter flows. The Second Point right equates to an average entitlement of about 158,000 acre-feet per year, delivered by First Point interests to Second Point of Measurement undiminished by delivery losses.

After the death of Henry Miller in 1916, Miller and Lux Land Company began selling much of their lands to the tenant farmers. Miller and Lux and the new landowners soon realized that a facilitator would be needed to represent the many vested interests of the water right. The Buena Vista Water Storage District was organized in July, 1924 and began operations following its 1927 Project Report. The Buena Vista project provided for the acquisition of the irrigation and drainage systems owned by Miller and Lux and for the distribution of the Second Point water rights that were tied to lands. The project also provided for added facilities to improve the distribution of the surface water supply. With completion of the District's 1927 project, the lands within the District were further developed for intensive agricultural use. Presently, the principal crops being produced are cotton, grain, sugar beets, and alfalfa. Cotton is by far the dominate crop, making up about 85% of the annual cropping pattern.

The main and lateral service canals provide surface deliveries from the higher east and west boundaries toward the center and to the north of the District. The District's topography naturally provided for drainage through the center of the District as the land surface falls to the north toward Tulare Lake via the historic low point slough which is now the Main Drain Canal, used to collect tailwater flows. Tail water flows are reclaimed by the District and its landowners with the remainder used north of the District for farming by separate agreement. Early in the area's agricultural development, Miller & Lux developed the Kern River Flood Channel to divert high flows destined for Tulare Lake and allow reclamation of what is now District lands. As land was developed for more intensive agricultural use, additional canals were incorporated into the distribution system to fulfill irrigation demands.

In 1973, the District contracted with the State Department of Water Resources (DWR) via the Kern County Water Agency (KCWA) for an additional surface water supply. The contract provided for an annual firm entitlement of 21,300 acre feet and surplus entitlement of 3,750 acre feet. The District currently has access to five turnouts from the California Aqueduct, that provide the system with about 850 cubic feet per second of added gravity inflow capacity directly into the District's distribution system. The District's geographic location, with respect to the California Aqueduct and other Kern County Water Agency member units, provides the opportunity for exchanges of the District's Kern River water for east side member unit's State water. The District has also been a historic user of surplus Friant-Kern Canal flows to serve irrigation demands and for groundwater recharge programs.

Even though District landowners are fortunate to possess valuable Kern River water rights and a State water contract, the average supply only provides for about two-thirds of their crop needs. The remaining demands are filled via landowner wells. Annual groundwater replenishment via District canal losses and intentional recharge serve to offset overall District pumping and thus maintain groundwater levels within the District. Over the 1962-2000 period, the District's operations have resulted in an annual positive groundwater balance of 44,500 acre-feet. Therefore, even though the southern San Joaquin Valley has been classified by the State Department of Water Resources as a critically overdrafted groundwater basin, this District has historically been able to achieve a positive groundwater balance. This District has also participated in groundwater banking programs, purchased other supplemental surface supplies, and developed irrigation tailwater recovery programs to insure its long term positive balance within the groundwater basin. The District also monitors both shallow and deep groundwater characteristics in an effort to better understand and manage this important groundwater resource. These efforts are described in the following sections.

Geology. The District, as is much of The San Joaquin Valley, has been filled with deposits of alluvial sediment from both the eastern Diablo coastal range and the western Sierra Nevada mountains. The Diablo range contributes marine sandstone and shale while the Sierra contributes granitic, sedimentary, and metamorphic rock. It is common for the top 0-10 feet of soil to be of the Lokern Series which is very clayish and poorly drained in nature. The formations below are coarse textured sediments in-laid with various thin clay layers. A predominant Corcoran Clay layer does not appear to divide the aquifer below, as in much of the San Joaquin Valley to the north. Thus the aquifer, below the District, reacts as a combination of an unconfined and semiconfined system.

MONITORING PROGRAMS

The landowners of the District have long realized the importance of their groundwater supply. District staff, as directed by the Board of Directors, began monitoring the groundwater as early as the 1940's. Today the District not only maintains explicit surface water delivery records, but comprehensive groundwater monitoring records as well. Both of these programs have progressed with new technologies as new concerns for our basin's protection materialize. The goal of groundwater monitoring is to identify the causes of and find solutions to increasing pumping depths, perched water tables, and groundwater quality degradation. Of course, pumping costs increase as the depth to groundwater increases. Crop yields suffer due to shallow, saline groundwater continually in the root zone. Crop yields also decrease as groundwater quality degrades. Table 1 shows water quality guidelines in relation to crop yield reductions. The cause and effect relationship of such groundwater and water quality parameters provides for better management decisions. Current District groundwater monitoring locations are shown in Appendix A.

Table 1. Guidelines for Water Quality

Water Quality Criteria	Degree of Problem		
	None	Increasing	Severe
Salinity			
EC (microS/cm)	< 750	750 - 3000	>3000
TDS (mg/L)	< 450	450 - 1800	> 1800
Permeability			
EC (microS/cm)	> 500	500 - 200	< 200
TDS (mg/L)	> 360	360 - 120	<120
Specific Toxicity			
Sodium (adj SAR)	< 3	3 - 9	> 9
Boron (mg/L)	< 0.75	0.75 - 2.0	> 2.0

From Ayers and Westcot, 1976

Production Well Surveys. The District currently measures the water levels in 57 of more than 200 grower and district production wells quarterly. Water quality samples are taken from these wells for irrigation constituent analysis when possible. These analyses indicate the levels of the constituents shown in Table 1 as well as many other vital indicators. All 200 of the wells within the District are monitored and classified every five years. Recorded data includes well location, state of use, depth to water, and any available pumping equipment physical characteristics.

Monitor Wells. Currently there are 19 designated monitoring wells throughout the District (locations shown on map in Appendix A). All of the monitor wells are measured for water levels quarterly and pumped to obtain samples for irrigation analysis semiannually.

Shallow Piezometers. The District, in conjunction with the Department of Water Resources (DWR), has also installed 104 shallow piezometers, designed to assist in monitoring the shallow groundwater table within the northern portion of the District (locations shown on map in Appendix A). These 20 foot deep completely perforated wells measure the groundwater found in the upper zone of the soil profile. They are measured for water levels quarterly and for salinity levels annually by means of a down-the-hole electroconductivity meter. This data provides the information needed to plot shallow groundwater level contours to denote annual fluctuations as well as changes over time for both water levels and groundwater quality.

Crop Surveys. Crop surveys provide data so that water demands can be better quantified. For that reason District staff annually produce crop survey maps. These maps are compiled in numerical spreadsheets so that total specific crop acreage can be calculated. Crop data are then graphically plotted. Figure 1 shows how cropping patterns have gradually changed over the past 40 years. A specific tabulation by type of crop is included as Table 2. Alfalfa acreage has remained fairly consistent over the period, while cotton acreage has increased by roughly 85% and grain acreage has decreased by about 60%.

In the last few years, there has been a decline in total cropped acreage as well as a slight increase in grain acreage and decrease in cotton acreage. Sugar beets were fairly consistent over the long term, but the acreage has dropped considerably over the last 5 years. However, cotton is still one of the most valued crops farmed in the District, accounting for about 31,000 of the 40,000 farmed acres, or 78% of total crop acreage, over the last 10 years.

TABLE 2

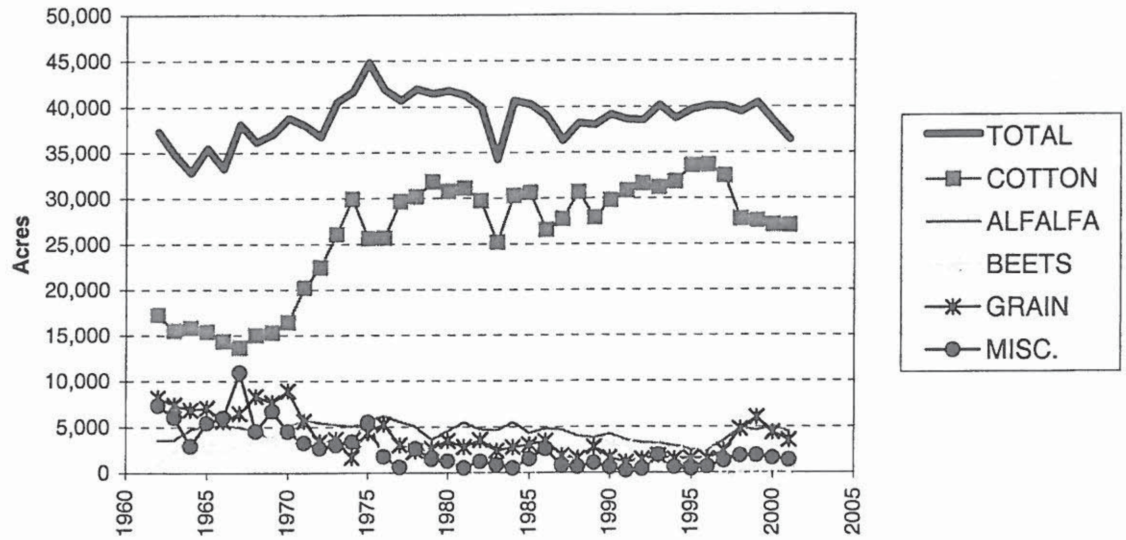
BUENA VISTA WATER STORAGE DISTRICT
HISTORIC CROP PATTERN AND
ESTIMATED CONSUMPTIVE USE OF WATER

YEAR	HISTORIC CROP PATTERN						ESTIMATED CROP CONSUMPTIVE USE	
	COTTON (ACRES)	ALFALFA (ACRES)	BEETS (ACRES)	GRAIN (ACRES)	MISC. (ACRES)	TOTAL (ACRES)	TOTAL (AF)	UNIT (1) (AF/AC.)
1962	17,251	3,555	983	8,173	7,337	37,299	92,000	2.47
1963	15,483	3,571	2,305	7,397	6,043	34,799	86,000	2.47
1964	15,797	4,699	2,512	6,867	2,931	32,806	84,000	2.56
1965	15,392	5,117	2,458	7,069	5,439	35,475	91,000	2.57
1966	14,324	5,087	2,240	5,628	6,006	33,285	87,000	2.61
1967	13,685	5,000	2,045	6,454	10,911	38,095	98,000	2.57
1968	14,995	4,528	3,760	8,323	4,548	36,154	90,000	2.49
1969	15,302	3,769	3,577	7,658	6,713	37,019	91,000	2.46
1970	16,404	5,026	3,932	8,922	4,498	38,782	97,000	2.50
1971	20,198	5,765	3,148	5,628	3,256	37,995	100,000	2.63
1972	22,408	5,466	2,842	3,373	2,679	36,768	99,000	2.69
1973	26,051	5,235	2,628	3,647	3,039	40,600	108,000	2.66
1974	29,908	5,061	1,664	1,634	3,383	41,650	114,000	2.74
1975	25,612	5,433	3,848	4,371	5,521	44,785	118,000	2.63
1976	25,643	6,172	3,020	5,258	1,757	41,850	111,000	2.65
1977	29,630	5,545	1,916	3,018	583	40,692	111,000	2.73
1978	30,165	5,030	1,700	2,383	2,646	41,924	114,000	2.72
1979	31,781	3,573	1,965	2,629	1,461	41,409	110,000	2.66
1980	30,760	4,574	1,700	3,462	1,261	41,757	111,000	2.66
1981	31,063	5,485	1,362	2,802	543	41,255	112,000	2.71
1982	29,728	4,706	803	3,533	1,220	39,990	107,000	2.68
1983	25,163	4,600	1,261	2,383	851	34,258	93,000	2.71
1984	30,288	5,476	1,599	2,788	504	40,655	111,000	2.73
1985	30,599	4,310	795	3,070	1,508	40,282	108,000	2.68
1986	26,530	4,818	1,609	3,435	2,611	39,003	104,000	2.67
1987	27,715	4,685	1,317	1,861	726	36,304	99,000	2.73
1988	30,649	4,023	1,307	1,593	625	38,197	104,000	2.72
1989	27,865	3,840	2,454	2,807	1,046	38,012	101,000	2.66
1990	29,766	4,216	2,974	1,610	572	39,138	106,000	2.71
1991	30,827	3,593	2,857	1,121	208	38,606	104,000	2.69
1992	31,602	3,259	1,884	1,433	377	38,555	104,000	2.70
1993	31,153	3,208	2,062	1,906	1,925	40,254	107,000	2.66
1994	31,799	2,908	2,037	1,491	526	38,761	103,000	2.66
1995	33,569	2,484	1,644	1,726	424	39,847	106,000	2.66
1996	33,784	2,306	1,891	1,899	1,078	40,958	108,000	2.64
1997	32,335	3,558	485	2,389	1,360	40,127	108,000	2.69
1998	27,462	5,097	301	4,731	3,157	40,748	109,000	2.67
1999	27,509	4,655	456	5,998	1,919	40,537	106,000	2.61
2000	26,765	5,069	389	4,591	1,579	38,393	103,000	2.68
2001	26,990	4,417	65	3,701	1,459	36,632	98,000	2.68
AVG:								
1962-2000	25,819	4,474	1,993	3,976	2,635	38,898	103,000	2.65
1991-2000	30,681	3,614	1,401	2,729	1,255	39,679	106,000	2.67

NOTE:

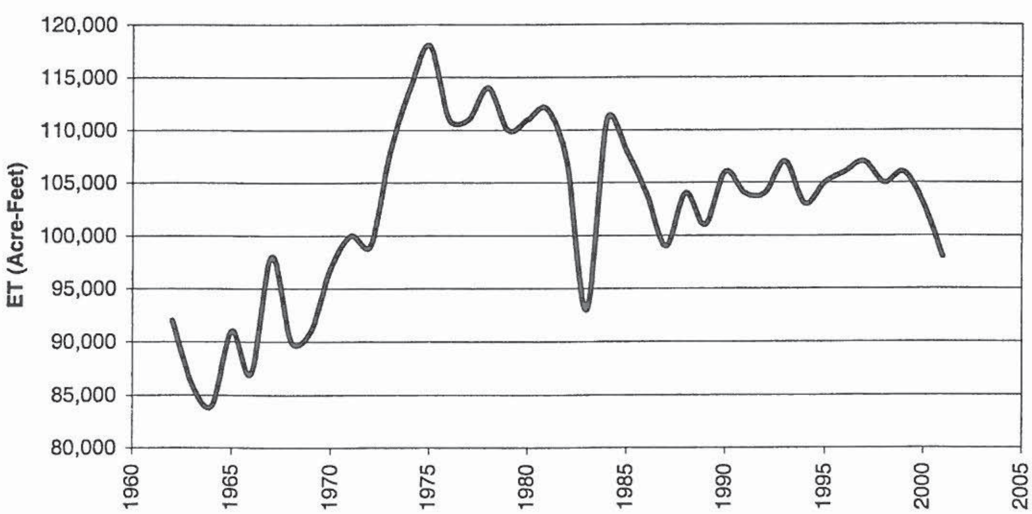
1. Average annual crop consumptive use of water estimated as follows: Cotton - 31.59 inches; Alfalfa - 48.54 inches; Beets - 26.01 inches; Grain - 17.88 inches; Misc. - 30.00 inches.

Figure 1 - BVWSD Cropping Patterns



This cropping data, when combined with local evapotranspiration (ET), is used to determine annual cropping consumptive use amounts. Evapotranspiration (ET) is simply defined as the amount of water that the plant uses for growth (transpiration) and the amount of evaporation from the plant and soil surfaces. The ET values used are average southern San Joaquin Valley values supplied by the Mobile Irrigation Lab and the State Department of Agriculture, Cooperative Extension Service. Total annual ET's for the District are shown in Figure 2. Total crop water demands peaked in the mid 1970's averaging

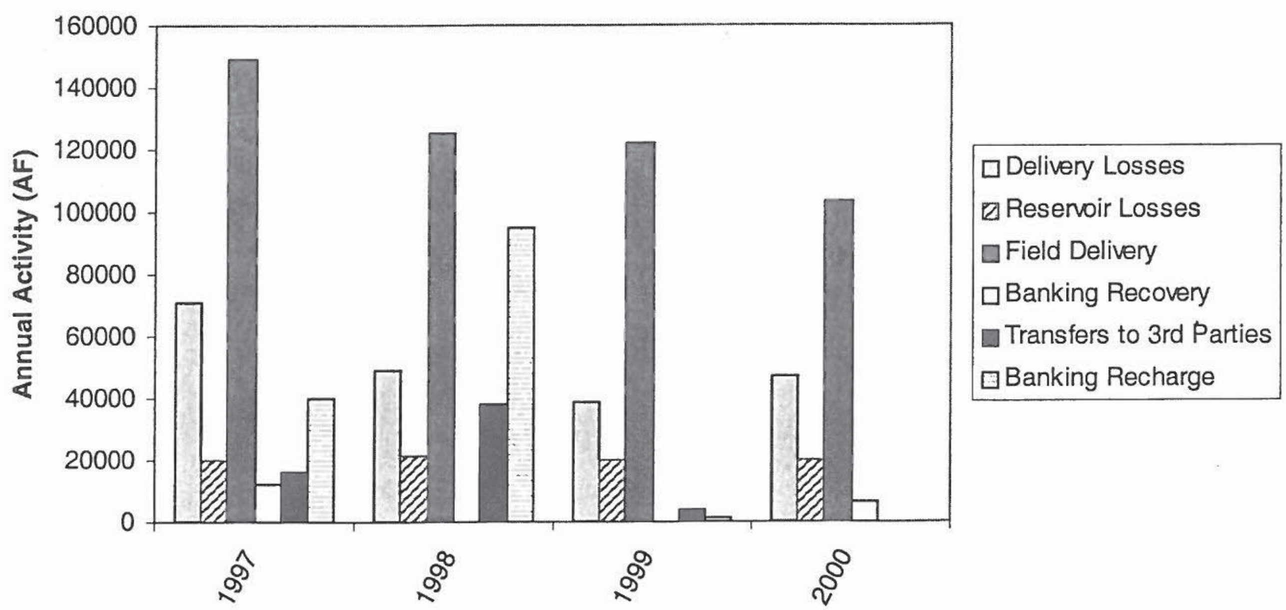
Figure 2 - BVWSD Crop Evapotranspiration



approximately 113,000 acre-feet. However, in the past ten years, total crop demand (ET) has declined to approximately 105,000 acre-feet per year. The ET for 2001 was less than 100,000 acre-feet due to decreased overall cropped acreage.

Surface Delivery Records. In part, surface delivery records are kept so that actual field delivery use can be known. With field delivery data and crop ET data, the estimated pumping, or net extraction from the basin, can be determined. The District's Hydrography Department maintains detailed surface delivery records that show how each acre-foot of District water is utilized. These uses include irrigation, canal losses, intentional recharge, reservoir losses, third party sales, and banking programs. Figure 3 shows an annual breakdown by use for the years 1997 through 2000. The table included in Appendix B shows the breakdown of total District deliveries and utilization.

Figure 3
BVWSD Operations (1997-2000)



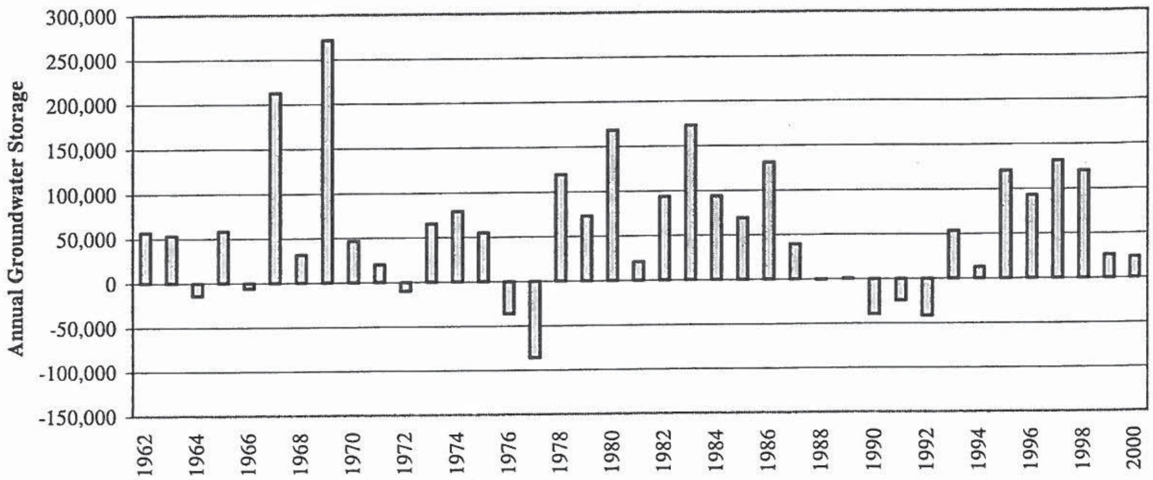
GROUNDWATER STUDIES

Since District groundwater supplies are vital in preserving the Landowner's agricultural interests, groundwater data review is integral to District water management practices. Groundwater balance studies (evaluating overdraft), groundwater depth and quality surveys, and consumptive use projections are a few of the tools used by District staff in making water management decisions.

Groundwater Balance Study. A groundwater balance, reflecting groundwater inflows and outflows (puts and takes) over time, was performed for the District's operations over the 1962-2000 period as shown in Table 3. The "SUPPLY" portion represents all flows such as irrigation deliveries, canal seepage, safe yield, reservoir losses, and intentional groundwater recharge. The District surface supplies and safe yield provide an average of 176,000 acre-feet annually. The "USAGE" portion represents the usage of the District's supplies including evapotranspiration, canal and spreading pond evaporation, spill to north of Highway 46, and water sent to third party groundwater accounts. Third party groundwater accounts include bank accounts for West Kern Water District, in which 95% of the West Kern deliveries to Buena Vista are accounted, and other exportable groundwater accounts, including preconsolidation water.

The difference between the "SUPPLY" and "USAGE" totals represents the annual groundwater balance. During the study period, a period of 112% of the long-term Kern River Index, the District's operations have resulted in an increase in storage of approximately 44,500 acre-feet per year in the groundwater basin. Looking at other periods of near normal hydrology, the resulting increase in storage ranged from about 25,000 to 32,000 acre-feet per year. It is also important to note that Buena Vista has maintained substantial groundwater bank account balances, in the 2800 Acres, Pioneer Project and ID#4, which are not accounted for in this groundwater balance tabulation. These bank accounts are used to fill water supply shortfalls and to provide added peaking capacity during dry years.

Figure 4 - Annual Groundwater Balance



The resultant annual groundwater basin "puts" and "takes" are shown in Figure 4. Using consumptive use calculations, from the crop mapping data and annual surface deliveries, an estimated average of 35,000 acre-feet of groundwater is extracted each year. To compensate for the leaching requirement and irrigation efficiency, the irrigation requirement is assumed to be 130% of the total evapotranspiration requirement.

Water Levels. The water level discussion is divided into 1) shallow zone (based on piezometer measurements), and 2) pumping zone (based on water supply wells and deep monitor wells). First, the shallow zone is discussed, followed by the pumping zone. In each part, the order of the discussion is as follows:

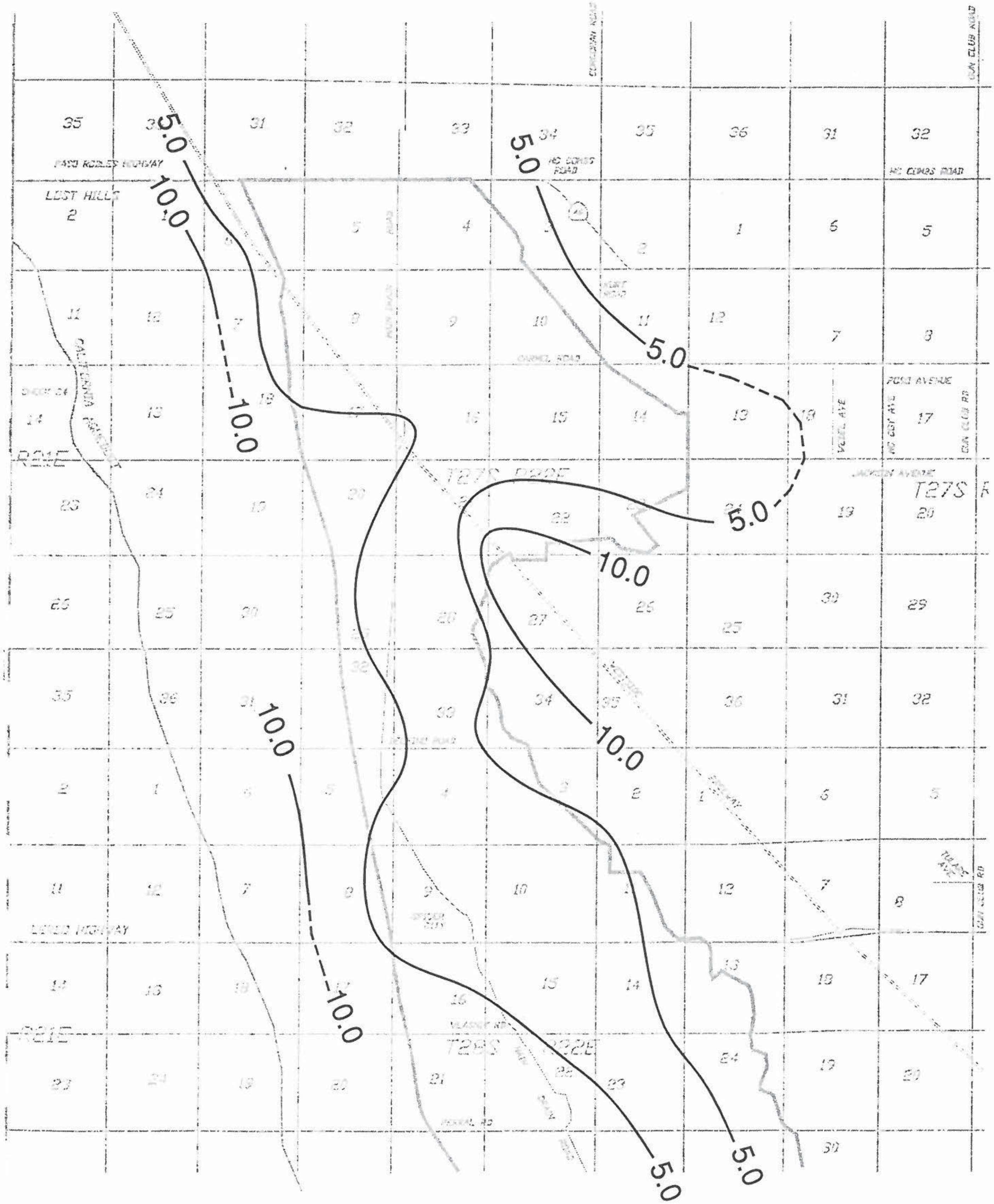
1. Depth to water.
2. Groundwater level elevations and the direction of groundwater flow.
3. Water level hydrographs.

Shallow Zone

Figure 5 is a depth to water map for the shallow zone in the north part of the District for March 2001. This map indicates that shallow groundwater was less than 10 feet deep beneath most of the District north of Perral Road. Depth to shallow

FIGURE 5

Depth to Groundwater March 2001



groundwater was less than five feet beneath much of this area. Depth to the shallow groundwater generally increased to the west and east of the District.

Figure 6 shows water-level elevations and the direction of shallow groundwater flow in March 2001. Water-level elevations were generally highest (exceeding 240 feet) beneath the south part of this area, and were lowest (less than 230 feet) near the north boundary. The direction of shallow groundwater flow was generally to the north.

Appendix C contains water-level hydrographs for the shallow piezometers in this area. The period of record for most of these wells extends back to 1991. Water levels in the piezometers respond to irrigation, and generally rise during the irrigation season and fall after irrigation deliveries cease. Several patterns are evident. The following piezometers had relatively constant (i.e., not rising or falling) water levels during this period: No. 5, 8C, 10A, and Bel 3A. All of these are in the north part of the shallow groundwater area. The following piezometers had rising water levels during this period:

No. 17A, 27, 29, and Bel 15B. All of these are in the south half of the shallow groundwater area. The following piezometers had falling water levels during this period:

No. 2A, and GL No. 9. One of these wells (2A) was near the northwest corner of the District, and the other was east of the District in the Semitropic WSD.

The predominant water-level trend during the past decade for the shallow piezometers has been relatively stable levels beneath the north part of the shallow groundwater area, and rising water levels beneath the south part.

<u>Pumping Zone</u>

Figure 7 shows depth to water in wells tapping the pumping zone in March 2001. Depth to water generally was the least beneath the north part of the District, in the same area where shallow groundwater is present in the piezometers. Depth to water in deep wells was generally less than 20 feet deep in most of this area. South of Seventh Standard Road, depth to water increased to the southeast, from less than 30 to more than 100 feet. This increasing depth coincides with areas where more groundwater is pumped, which is largely where better quality groundwater is present.

Figure 8 shows groundwater level elevations and the direction of groundwater flow in the pumped zone in March 2001. A water-level high was indicated beneath part

FIGURE 6

Groundwater Elevations & Direction of Groundwater Flow March 2001

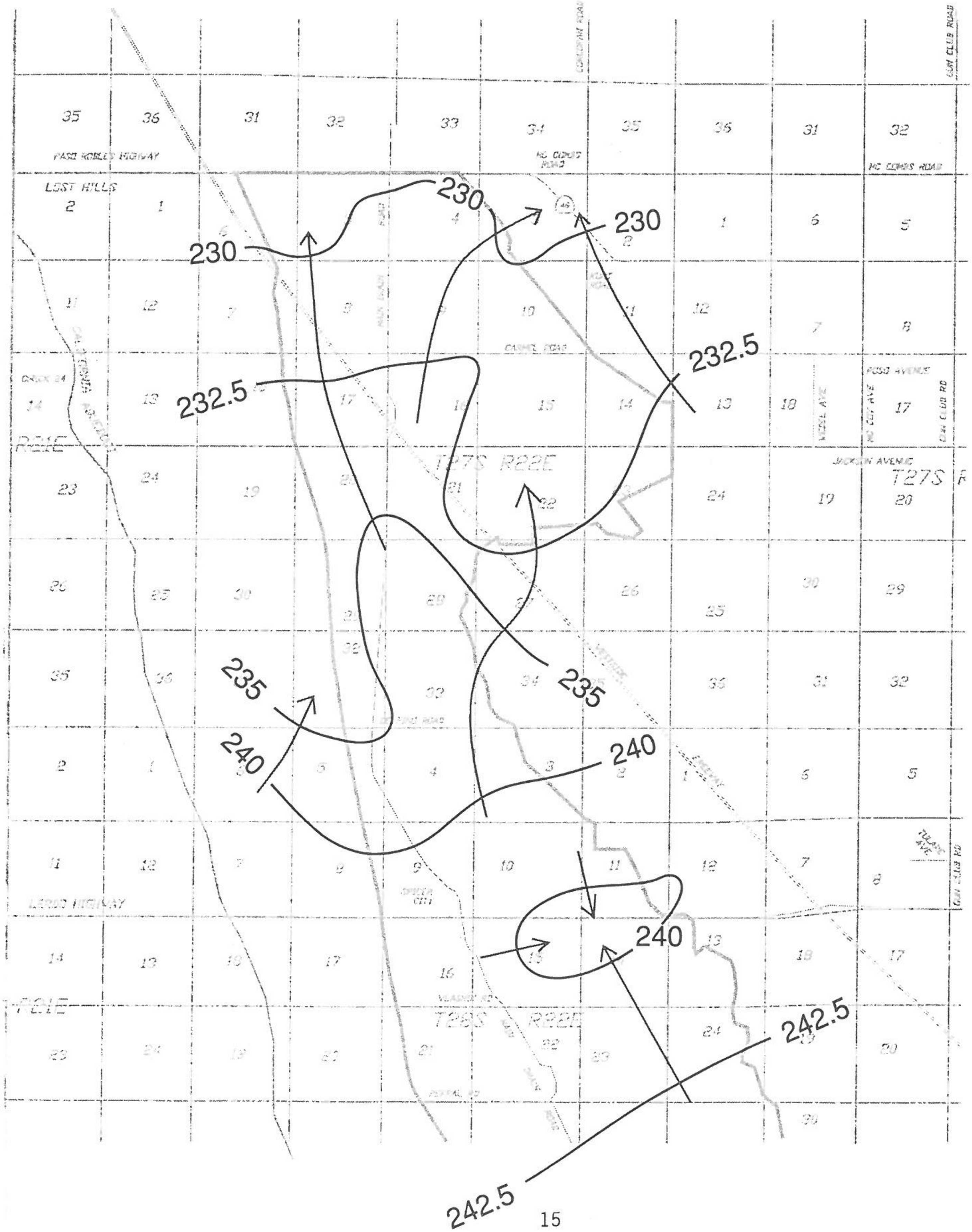


FIGURE 7

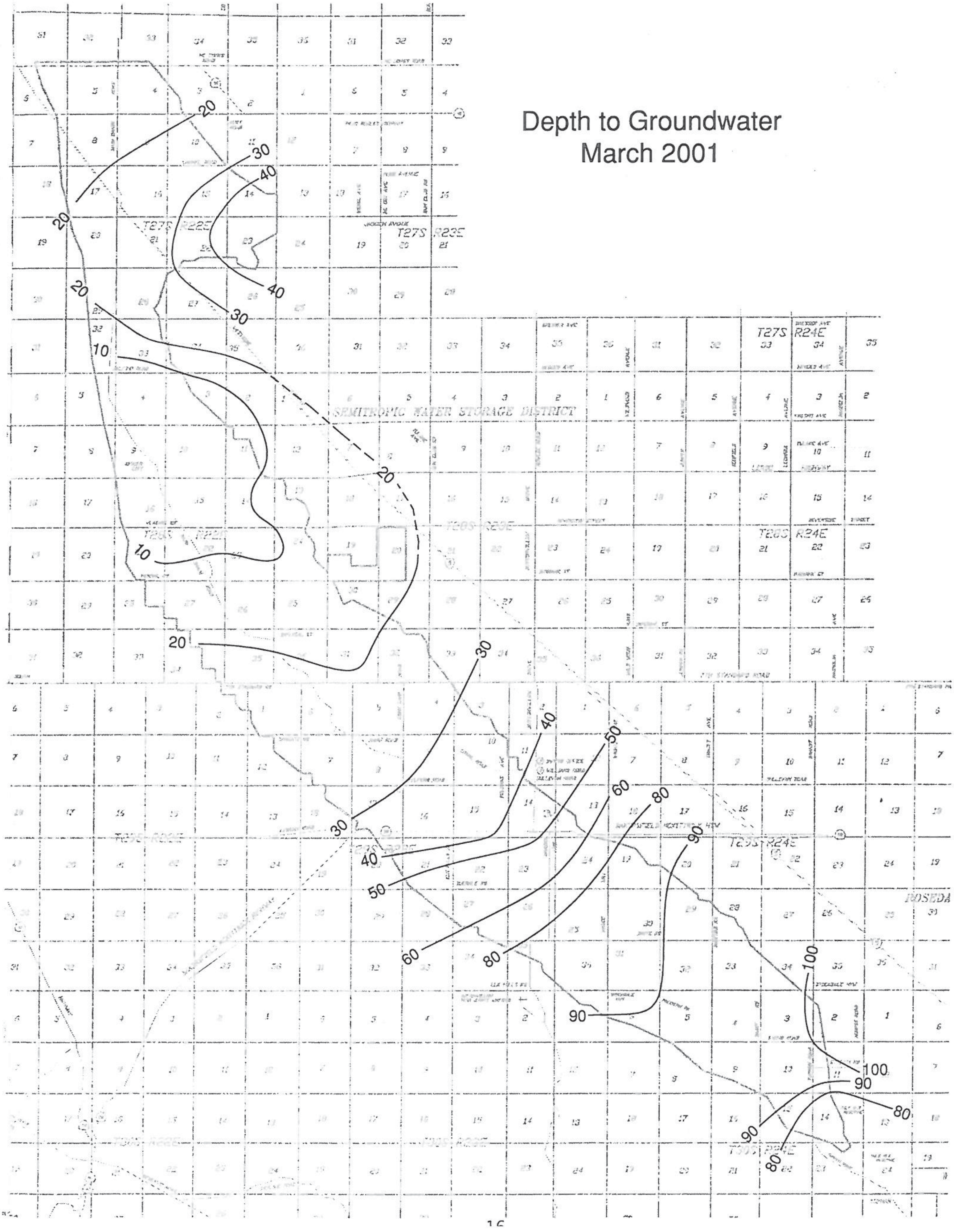
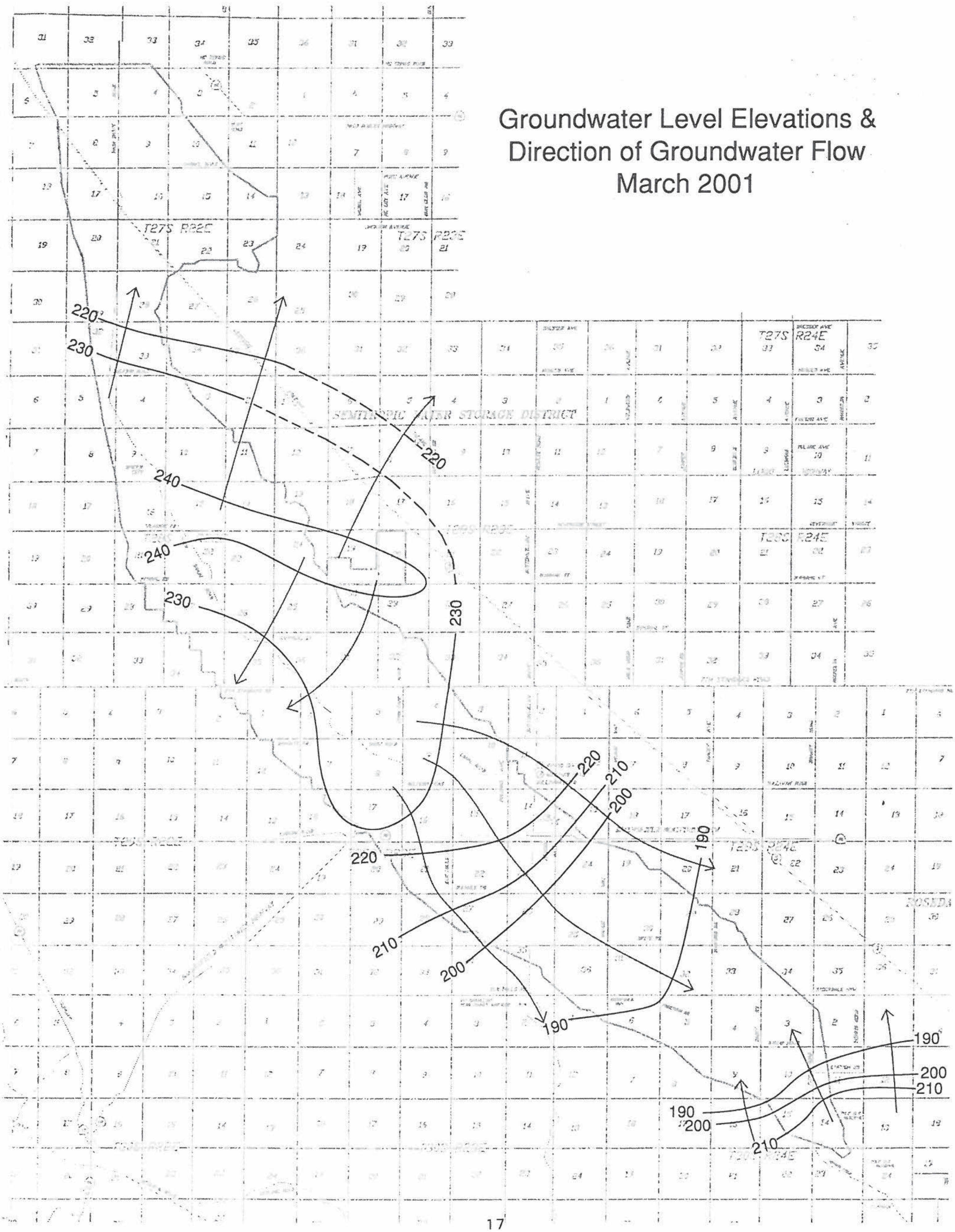

Depth to Groundwater
March 2001
T27S R22E
T27S R23E
T27S R24E
SEMITROPIC WATER STORAGE DISTRICT
T28S R24E
T29S R24E
10
20
30
40
50
60
80
90
100

FIGURE 8



Groundwater Level Elevations & Direction of Groundwater Flow March 2001 of the shallow groundwater area, and groundwater moved mainly to the north-northeast and south-southwest from this high. Water-level elevations for deep wells exceeded 240 feet in this area. Groundwater was flowing out of the District to the northeast and the southwest from this high. In contrast, a water-level depression was present near and south of Stockdale Highway. Water-level elevations in deep wells in this area were less than 190 feet, and groundwater flowed toward this depression from the northwest and southeast. Groundwater was flowing into the District from the south in this area.

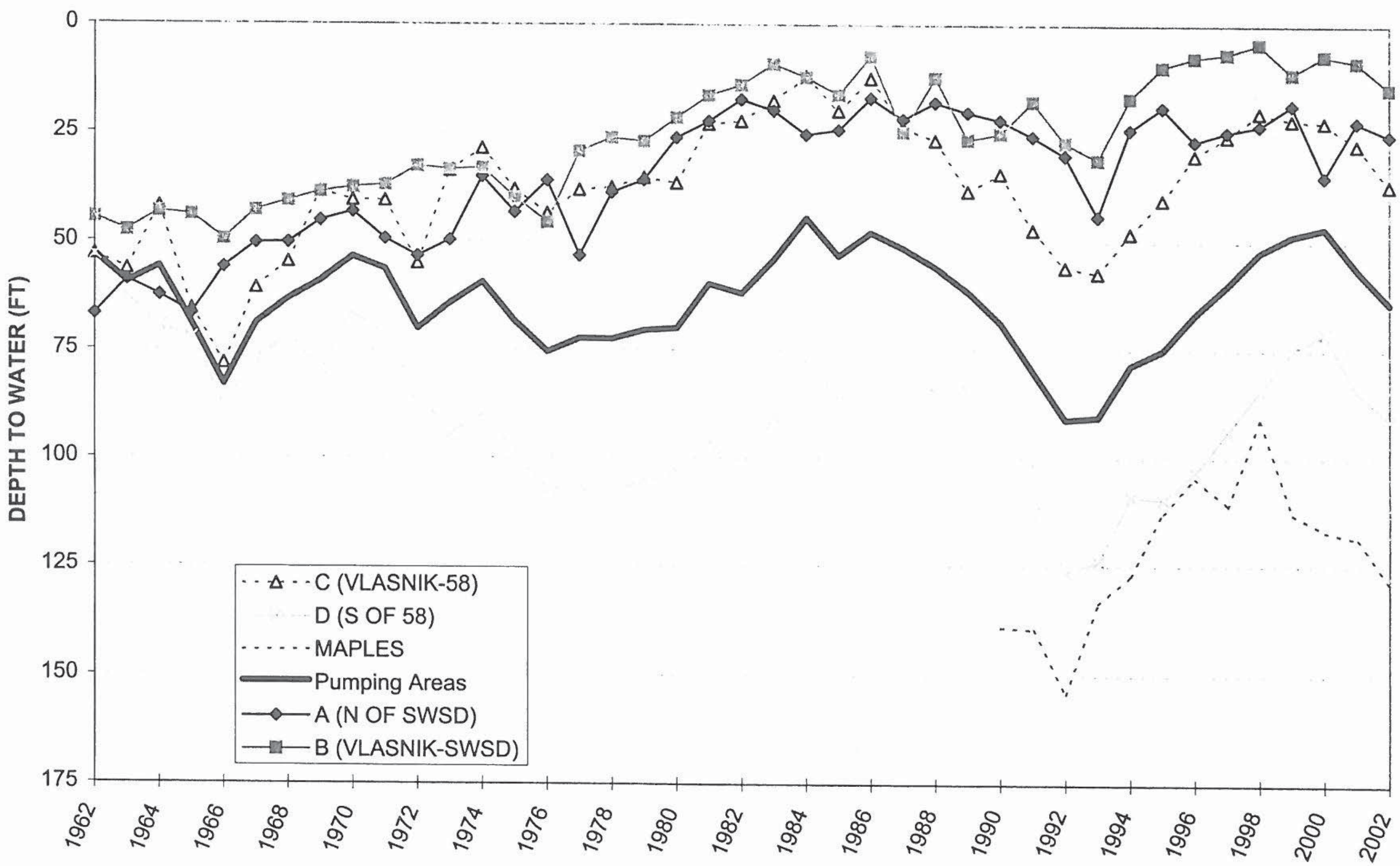
Appendix D contains water-level hydrographs for 24 wells tapping the pumped zone. Most of these extend back to the early 1990s. Figure 9 contains six water-level hydrographs representative of the last four decades. Two major different types are indicated. For Areas A, B, and C, which are in the north part of the District, water levels are shallower, and much less seasonal fluctuation is present. Deep wells in these areas had rising water levels between 1962 and about 1983. Water levels in those wells temporarily fell between 1986 and 1993, coincident with the last major drought. Water levels in these deep wells then recovered between 1993 and 1998, and have been relatively constant since 1998. Water levels in these wells have thus been somewhat influenced by pumping, much of which is either east or south of the northerly area.

Three of the hydrographs (Area D, Maples, and a composite of the pumping areas) generally show a greater depth to water and more fluctuations than the other areas. These hydrographs are representative of the south part of the District. Depth to water was about the same (between about 40 and 65 feet) in all of these areas in 1962, but diverged widely after the mid 1970s. The deepest water levels and greatest water-level declines have been in Area D and the Maples area, because there is more pumping in these areas. Overall, water levels in the south part of the District have been relatively stable since the early 1960s. They have risen during wet periods and fallen during dry periods. The water-level hydrographs do not indicate any groundwater overdraft in the District over the past several years.

Groundwater Quality. Shallow groundwater quality is first discussed, and this is followed by the quality of groundwater in the pumping zone. In each part, the area

FIGURE 9

WATER LEVEL HYDROGRAPH
In BVWSD Production Wells (Spring)



distribution of total dissolved solids (TDS) is discussed first. The changes in groundwater TDS with time are discussed.

Shallow Zone

Figure 10 shows TDS contours for July 2001, based on water samples bailed from the shallow piezometers. The lowest TDS concentrations (less than 1,000 mg/l) were present largely within the District. There were two areas within this larger area where TDS concentrations were less than 1,000 mg/l. TDS concentrations in the shallow groundwater increased to the west and east of the District, and to the south in the area south of Lerdo Highway. Much of the shallow groundwater to the west and the east of the District had TDS concentrations exceeding 4,000 mg/l. The highest TDS concentrations exceeded 10,000 mg/l, and were in shallow groundwater near the northeast corner of the District.

Appendix E contains ten TDS hydrographs for piezometers, generally extending from about 1991 through 2001. Two different trends are shown. The following piezometers had significant increases in TDS concentrations over the period of record: No. 2A, 5, and 17A. All of these piezometers are in the north part of the area. The remaining seven piezometers generally had a relatively constant trend, although No. 10A and 29 showed some increase in TDS concentrations. Many of the TDS values for the piezometers exhibit a very large range. This large variation makes determination of time trends difficult. This is likely due to the small size of the sample being measured. More representative trends could be obtained by pumping the piezometers with a hand pump until electrical conductivity values stabilize. Also, laboratory analyses should be used for TDS concentrations, as opposed to field meter readings, or EC values should be reported.

Pumped Zone

Figure 11 shows TDS concentrations in water from wells tapping the pumped zone. North of Seventh Standard Road, TDS concentrations were lowest (less than 1,000 mg/l), and highest (greater than 2,000 mg/l) to the northwest and far southwest corner (greater than 3,000 mg/l). South of Seventh Standard Road, TDS concentrations were highest to the northwest and lowest to the east.

TDS (mg/L)
July 2001

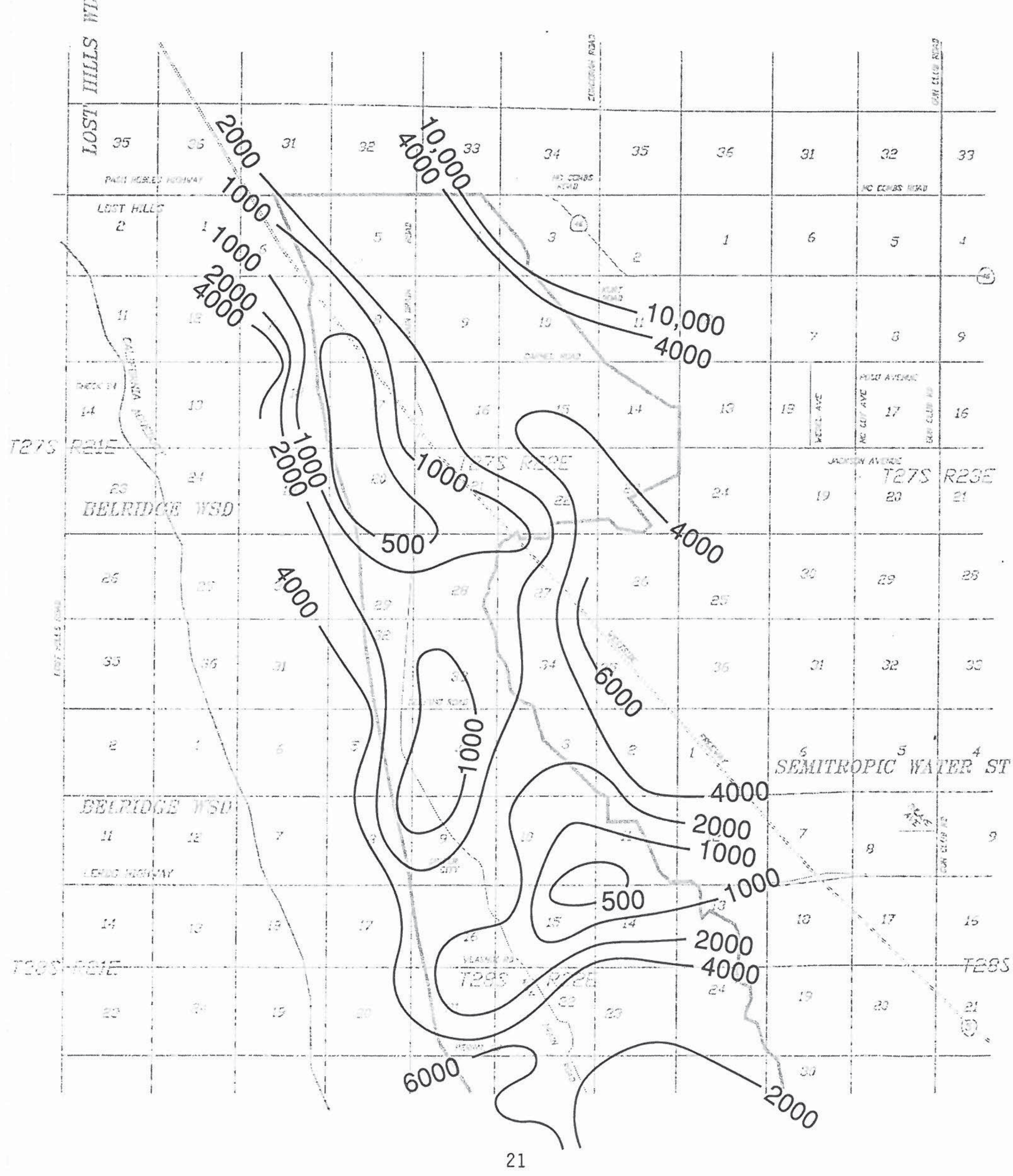


FIGURE 11

TDS (mg/L)
Summer 2001

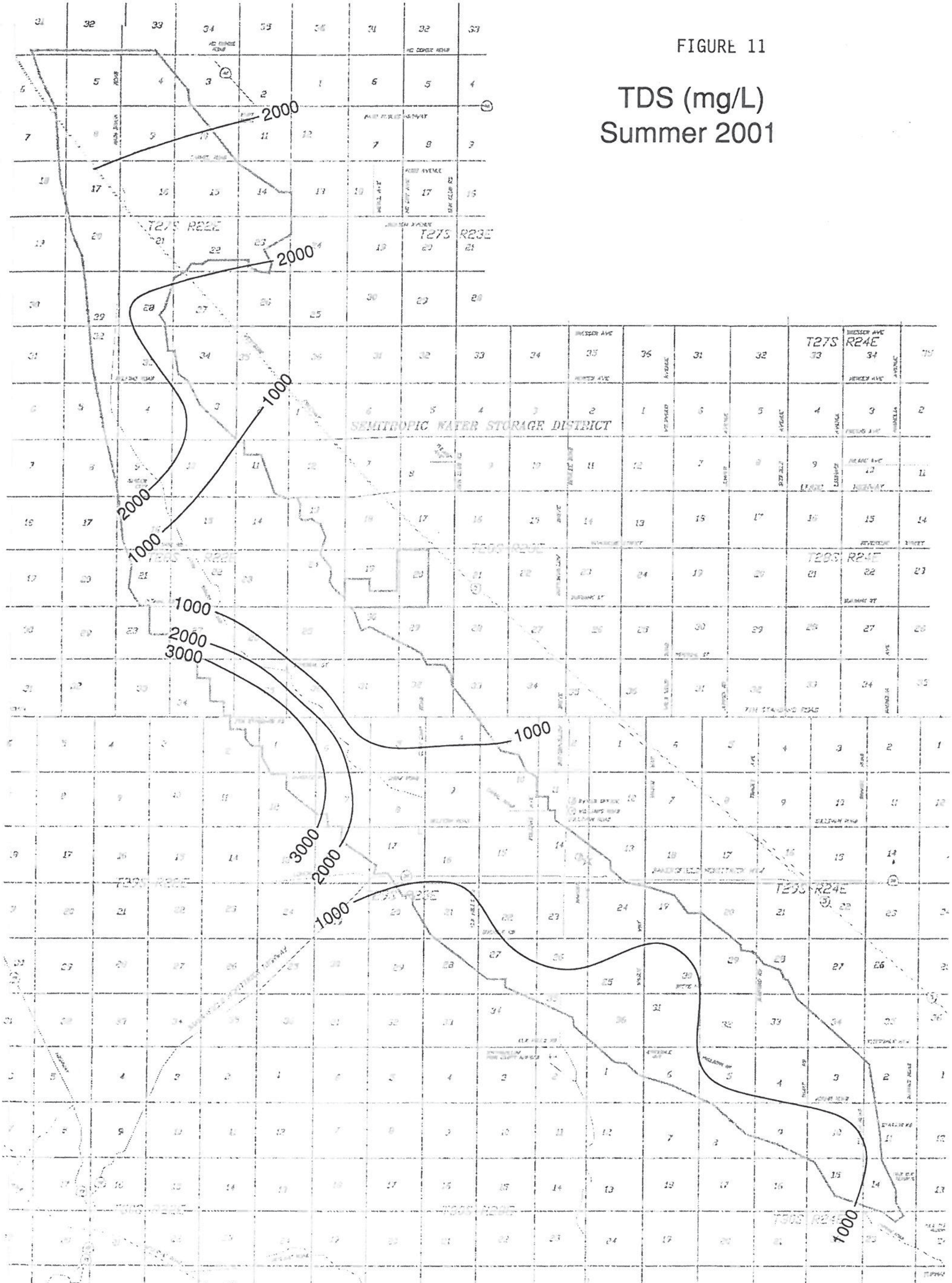
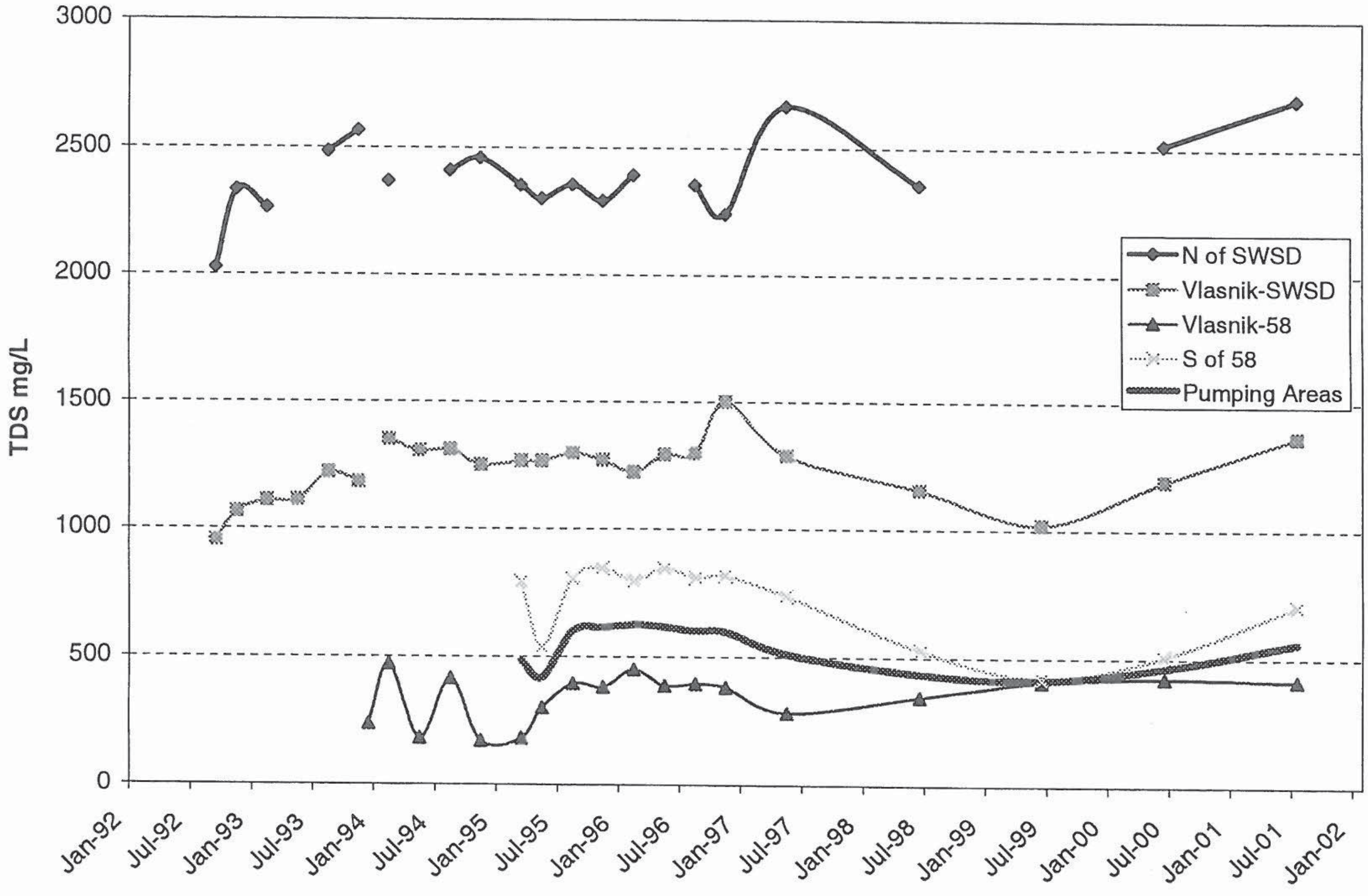


Figure 12 shows average TDS hydrographs for selected parts of the District. The wells monitored north of SWSD have had the highest average TDS concentrations and these gradually increased from 1993-2001. For the Vlasnik-SWSD area, moderate TDS concentrations were present on the average. Average concentrations increased from 1992-1994, were relatively constant from 1994-1997, decreased for 1997-1999, then rose from 1999-2001. Overall, the long-term TDS trend in this area is relatively constant. For the area south of Highway 58, TDS concentrations were relatively low and decreased from 1995-1999. This was followed by increasing values through 2001. The TDS decreases in this area appear to reflect recharge from water-banking projects and other sources. TDS increases appear to reflect less recharge of low TDS water in the area. The combined average hydrograph for the two pumping areas shows less variation and more of a constant long-term trend. More information on some specific wells is discussed in the next section.

Appendix F contains TDS hydrographs for 11 wells. In some cases, the initial or early results were not representative of later periods. For monitor wells, this may be associated with well trauma following installation. Disregarding such values (i.e. for DMW No. 2), TDS concentrations increased significantly in water from the following wells since the early 1990's: DMW No. 4, and 6. Both of these wells are located north of Seventh Standard Road. TDS concentrations apparently decreased significantly in water from the following wells since the early 1990's: DMW No. 3, 8, 10A, 11B, and 12A. Except for DMW No. 3, these wells are located south of Seventh Standard Road. One of the reasons causing these decreases in TDS concentrations south of Seventh Standard Road is likely water banking activities in the Kern Fan, which were expanded following 1993. The low TDS concentrations in the recharged water would tend to decrease TDS concentrations in the groundwater. TDS concentrations in water from the following wells were relatively constant during the period: DMW No. 1, No. 2, 5, 7, 10B, and 11A. TDS concentrations have fluctuated significantly in water for some wells. Examples include: DMW-1, 4, and 6. Part of this may be due to sampling techniques. The large variations make determination of time trends difficult.

Figure 12
BVWSD Monitor Well
Average TDS Hydrograph



Other Reports. The District is a member unit of the Kern County Water Agency and thus is included in various water supply reports performed by the Agency. The Agency's annual "Water Supply Report" accounts for the various water supplies which come into and are destined for use outside of the County, as well as the water quality aspects of these supplies. These supplies include State Water Project water, Central Valley Project water, Kern River water, Friant-Kern water and local groundwater. This report further calculates a water balance given the above information and estimates groundwater pumpage in excess of groundwater recharge. Groundwater recharge activities for banking and for overdraft correction are accounted for as well as pumped extractions from banking programs. This information also provides an overall picture of the County's activities with respect to the groundwater basin and allows the District to compare itself with the remainder of the County.

This District is currently participating in the monitoring committees of two groundwater banking programs, namely the Semitropic Banking Program Monitoring Committee and the Kern Water Bank Monitoring Committee. These Monitoring Committees were formed with the primary purpose of monitoring the recharge and extraction activities of the programs. The committees are tasked with identifying any resulting impacts to adjoining districts, projects or private landowners so that they can formulate recommendations for possible impact avoidance or mitigation. Reports are produced every 2-3 years by these monitoring committees and they include more regional groundwater data as shown in Appendix G.

MANAGEMENT PROGRAMS

This District is able to distribute a portion of it's wet year supplies into the groundwater basin to offset it's landowners dry year groundwater pumping needs and thus be in positive balance with the groundwater basin. Adjoining areas also benefit, as do District landowners, from reduced pumping lifts resulting from the District's recharge activities. The following is a summary of these programs and how they are integrated into the District's operations.

Exchange Programs. This District is geographically located adjacent to the California Aqueduct and low in elevation on the Kern River Fan. The District's Kern River entitlement is thus delivered by gravity from its origin in the Sierra-Nevada mountains north east of Lake Isabella. The District also has access to State Water Project (SWP) water from the California Aqueduct via its member unit contract with the Kern County Water Agency (KCWA). Other KCWA member units in the Bakersfield area also have contracted for SWP water but must pump their entitlements to their service areas upslope and to the east side of the valley via the Cross Valley Canal (CVC). These circumstances lend themselves to an exchange of Buena Vista's Kern River water for east side member units SWP water, thus avoiding or reducing energy use and resultant pumping costs across the valley. This process also frees up CVC canal capacity that would otherwise be necessary for transportation of east side member units SWP water. In order to allow maximum benefit from these exchanges, the District has increased it's SWP capacity by construction of a three pipe siphon Aqueduct Turnout (BV-7) having a capacity of 300 cfs. The District's Aqueduct capacity can now provide approximately 85-90% of peak system demand with a total flow capacity from the Aqueduct of approximately 800 cfs.

Although the exchange programs have provided benefits to the District, salt loading is an issue since SWP water supplies carry more salinity than Kern River water. This aspect is being analyzed and may influence the degree of exchange volume in particular years when salinity level differences are greater.

Banking Programs. This District has participated in several banking programs through the years and continues to do so because of the monetary and dry year water supply benefits. These programs can be done in the form of annual agreements with future payback provisions such as the Improvement District Number 4 (ID4)/BVWSD Advance Deliveries; long term direct recharge agreements with extraction capability such as the Olcese Water District/City of Bakersfield 2800 Acre Agreement; in-lieu programs to facilitate banked extractions by others such as the BVWSD/West Kern Water District (WKWD) SWP Banking Agreement; Kern County Water Agency (KCWA) member unit programs via participation agreements such as the Pioneer Project; or out-of-county banking/payback programs such as the BVWSD/Department of Water Resources (DWR) 1990 Kern Water Bank Local Element Demonstration Program and the CalFed sponsored 2001 Environmental Water Account Program through the DWR. All of these programs have the common element of placing water into the groundwater basin for later recovery and use. However, some programs only involve the exchange of surface water thus avoiding spreading and extraction costs.

The above noted District banking programs generally fall into two categories. The first category would be a program designed to return water to the District during a dry year when District supplies are restricted. The second category would be a program where the District is providing a banking and extraction service for monetary payment or similar benefits. The District wet year supplies have afforded it the ability to enter into both categories of banking programs which in turn allow the District to stretch its wet year supplies into dry year payback deliveries and thus help to even out required groundwater pumping. These programs also allow the District to make more efficient use of its Kern River water supplies over the long term which in turn minimizes the loss of water from the critically overdrafted groundwater basin.

Direct Groundwater Recharge Programs. This District's Kern River entitlement is dependent on the hydrologic cycles as they occur regardless of crop demands. During dry years, landowners must provide the difference between crop demands and District allocated surface deliveries via groundwater pumping from individually owned wells. During wet years, the District is able to satisfy maximum crop demands which eliminates the use of landowner wells. Excess wet year supplies are stored to maximize surface carryover use and followed by direct recharge, to the maximum extent possible, to replenish the groundwater supply. The efficiency of managing this difference between crop demands and available water supplies insures that the District, as a whole, is in positive balance with the groundwater basin.

This District's direct recharge capacity has been increased over the years to best accomplish both banking and overdraft correction on behalf of District landowners. The main recharge areas used by the District, below the Kern River Second Point of Measurement (Enos Lane), are the Kern River Bypass Area, the Kern River channel, the Main Canal, the Outlet Canal, the Tule Elk Reserve area near Tupman, and the upper reach of the Kern River Flood Channel. Recharge capacity has nearly doubled in the Kern River Bypass Area, due to improvements in the West Kern/Buena Vista banking program, and in the Tule Elk Reserve area via additional distribution facilities in sloughs and other low lying areas. The referenced 1962-2000 water supply study reveals that the District's direct diversions to groundwater accounts for an average of 14,500 acre feet per year (exclusive of seepage losses and banking programs) with wet years being as high as 69,000 acre feet and dry years as low as 0 acre feet. District canal and BV Lake seepage losses average approximately 49,000 acre feet per year which, when added to direct recharge, accounts for a total average annual recharge of approximately 63,500 acre feet per year.

It is noteworthy that the total recharge capacity of 250 cfs represents a high percolation rate per acre when compared to other projects. In addition, the District is a recharge participant in the Kern County Water Agency Pioneer Project and shares a first priority access to the total recharge capacity for overdraft correction.

Flood Channel	= 40 cfs
Tule Elk Reserve	= 60 cfs
Outlet Canal	= 25 cfs
Kern River Bypass Area	= 80 cfs
Main Canal	= 15 cfs
Kern River Channel	= 30 cfs
Total	**= 250 cfs = 500 acre feet/day**

The table included in Appendix A shows a breakdown of historic spreading deliveries by area.

Surface Water Storage Facilities. This District had historically stored its spring runoff flows within Buena Vista Lake until the lake bottom lands were freed from the storage right in exchange for conservation storage space in Lake Isabella. This storage space was purchased by the Kern River Interests upon construction of Isabella Dam by the U.S. Army Corps of Engineers. Buena Vista owns 31.6% of the conservation storage space within the reservoir with flood control being the only overriding purpose. This affords the District a maximum summer storage increment of 172,000 acre feet of regulation space with a maximum winter carryover capability of 68,800 acre feet. The District also retained storage rights within Cells 1 & 2 of Buena Vista Lake with a yield, after losses, of approximately 25,000 acre feet. Pursuant to the "Kern River Storage and Use of Water Agreement", the District is afforded use of this facility for wet year storage of excess Kern River entitlement. In addition, the District, via agreement with the County of Kern, maintains regulation storage use of 1,800 acre feet of space within the Buena Vista Aquatic Recreation Area Lakes. Therefore, the District has approximately 96,000 acre feet of surface storage space for regulation of its surface water supplies from one year to the next.

These surface storage rights are very important to the efficient management of the District's Kern River water rights since the April-July runoff period does not coincide with the District's crop irrigation requirements which occur in the January through March pre-irrigation and the June through September summer irrigation periods. The carryover capability within Isabella reservoir and the District's SWP entitlement allow the District to provide a surface water supply for the early pre-irrigation period even though the District's Kern River entitlement normally does not begin until the March-August entitlement period. The reservoir also provides peaking capability and facilitates other management practices such as the previously mentioned exchanges, banking, and recharge activities.

The Buena Vista Aquatic Recreational Area (BVARA) lakes provide the District with a very useful tool in daily operational storage for regulation of both Kern River and SWP flows to the District as well as some valuable surface storage. This facility receives the District's Kern River flows via the Alejandro Canal and SWP flows via turnout BV-3, while directing flows into the District's Outlet canal for use in the Buttonwillow service area. The lakes are also used to serve the Maples area and Henry Miller Water District. per agreement with the County and upon arrangement with Buena Vista.

Surface Water Sales. During wet years the District authorizes the sale of surplus water to reduce or avoid groundwater pumping and generate revenue to offset District operating costs. Generally, surplus water is offered to landowners within the District (for use above surface allocation), to landowners adjacent to the District who rely primarily on groundwater supplies, and to other non-adjacent parties. Such deliveries are beneficial since they correct overdraft, raise pumping levels, and generate revenue.

Water Delivery System. The District's surface water delivery system, some of which is more than a century old, is still quite effective with the improvements that have been made over the years. Most of the District's 125 miles of canals and tailwater drains are unlined. System delivery losses are approximately 30%-35% for the short pre-irrigation run and approximately 28% of total flow, for an average summer run. These loss estimates do not include Outlet Canal seepage. Seepage losses through the unlined canals recharge the primarily unconfined aquifer below. In areas experiencing lateral flow problems from canal seepage, affected landowners occasionally will install interceptor ditches or drain lines to minimize any localized crop damage. District interceptor drain lines are under consideration for alleviating this problem.

The District maintains inflow capability from the Kern River, the Friant Kern Canal, and the California Aqueduct. Kern River and Friant Kern flows are delivered via the Kern River channel, the City's Kern River Canal, and the District's Main, Outlet, and Alejandro Canals. California Aqueduct inflow points include, BV-1B, BV-2, BV-3, BV-6, and BV-7 which provide adequate capacity to operate at near peak demand. This flexibility allows the District access to large amounts of surplus water from various sources. The District is also able to make isolated deliveries to the northern portion of the service area via Aqueduct turnout BV-1B which allows for better water management within the perched water area.

Reclamation Programs. Certain programs have been instituted by the District to better utilize the tailwater supplies collected by the District's drain system. The District currently has six reclamation pumps that lift drain flows from the tailwater reclamation system into the delivery canals for re-use. These pumps are capable of recirculating up to 50 cubic feet per second or 100 acre-feet/day. These District pumps have reclaimed about 8700 acre-feet per year (average 1992-2000), which equates to about 0.2 acre-feet/acre of reclaimed supply that is delivered to the field.

In 1985 the District instituted a program allowing landowners to install similar reclamation pumps that can be used on their farms to increase their surface water allocation. The program is designed to provide two alternatives to the landowner. He may either pay a set rate to the District for the supply reclaimed or trade one acre foot of his surface allocation for each two acre feet of reclaimed supply. This program has been very successful as a means of increasing the efficiency of use of surface allocations in the District and providing additional surface deliveries in the northern portion of the District where groundwater supplies are of lesser quality. These grower reclamation pumps have recirculated about 4000 acre-feet per year (average 1992-2000). The District also encourages landowners to install their own reclamation system which allows them to reclaim their tailwater flows without having to pay a water cost provided the tailwater flows do not enter and flow through District maintained facilities.

Tailwater flows not reclaimed by the above programs pass north of Highway 46 via the Goose Lake Canal. By separate agreement, these flows are captured for farming operations in a portion of the Semitropic. The District receives compensation for use of such supply. Thus, tailwater flows not reclaimed within the District are used beneficially and not lost or wasted. The District also has investigated additional reclamation sites, some of which would involve major improvements that could become cost effective in future years. Efforts are being made to better educate landowners as to the negative impacts of high tailwater flows to encourage higher farm water efficiencies.

Drainage Control and Irrigation Conservation Programs. The northern portion of the District from just south of Lerdo highway to Highway 46 experiences the negative effects of perched groundwater in the root zone of crops. In the early 1980's, the District investigated the possibility of installing drainage improvements to alleviate the problem. However, since evaporation ponds are no longer a practical solution due to environmental concerns, other alternatives must be looked at. The District, in coordination with the Department of Water Resources, the State Water Resources Control Board, and the Soil Conservation Service, has installed a vast network of shallow piezometers to monitor this area. The District has also planted eucalyptus trees in areas to lower perched levels in adjacent farmed areas. A possible solution involves desalination of shallow groundwater for agricultural re-use in exchange for releasing good quality surface water to an urban participant interested in funding the program. The District is currently operating a pilot project that is evaluating larger scale feasibility.

The District has financed programs to encourage better irrigation efficiencies to reduce tailwater flows, reduce deep percolation, and to stretch the available surface water supplies. One example is District monetary support for the local Mobile Irrigation Lab which conducts on-farm irrigation evaluations in order to improve irrigation practices. The District also instituted a cost-share pilot program with Dellavalle Laboratory where a neutron probe is used to evaluate available soil moisture as an aide to irrigation scheduling. Recently the District has begun to sponsor local irrigation training seminars in conjunction with the Natural Resources Conservation Service and the Mobile Irrigation Lab. This will hopefully prove to be a forum for irrigation education for District farmers.

Cloud Seeding Program. In 1980 the Kern River Interests entered into a contract with Atmospherics Incorporated to perform weather modification via cloud seeding. The main purpose of the program is to increase the yield from individual storm events in order to increase seasonal Kern River runoff. According to research data, the cloud seeding efforts can potentially increase runoff yield by as much as 15%. However, an average increased yield over the long term is probably in the range of 3-5% in the southern Sierra Nevada mountains. An increase in seasonal runoff provides more surface water for irrigation purposes and thus decreases the amount of landowner pumping from the basin. Buena Vista will continue to make contributions towards the cloud seeding program to maximize our Kern River entitlement.

Groundwater Well Policies. All well construction and abandonment policies are set and enforced by the Kern County Environmental Health Department's groundwater well ordinance. These policies are stated in the Kern County Well Ordinance and included in the recently completed Kern County Environmental Health Department - Kern County Water Agency Memorandum of Understanding. This District has participated in the development of the above policies in order to insure that a reasonable and effective policy was instituted.

- Continue to work with local, State, and Federal agencies to investigate possible programs associated with agricultural water supplies (groundwater and surface waters) in search of solutions to ongoing problems.

- Continue to participate in regional groundwater monitoring committees (via MOU's) for the purpose of protecting the groundwater basin from impacts caused by recharge and extraction activities.

- Investigate common use areas where compatible facilities and joint operations can facilitate best use of available water supplies and possibly expand water supply opportunities.

- Investigate water management programs (i.e. water sales, direct recharge, and reclamation pumping), and their compatible fee structures to promote best management practices for maximum water use efficiency and groundwater basin protection.

- Continue to develop banking, extraction and groundwater recharge opportunities for maximum use of wet year water supplies for regulation to meet dry period demands with minimal basin impact.

- Evaluate most efficient use of available surface storage areas both at the District and State levels to provide maximum advantage from surface deliveries.

The above described areas will continue to be important to insure that the District uses its available water supplies in the most efficient and beneficial manner. The District's goal is to insure that the farming economy in this area, which depends on the efficient use of available water supplies, will continue to thrive as it has over the past one hundred plus years.

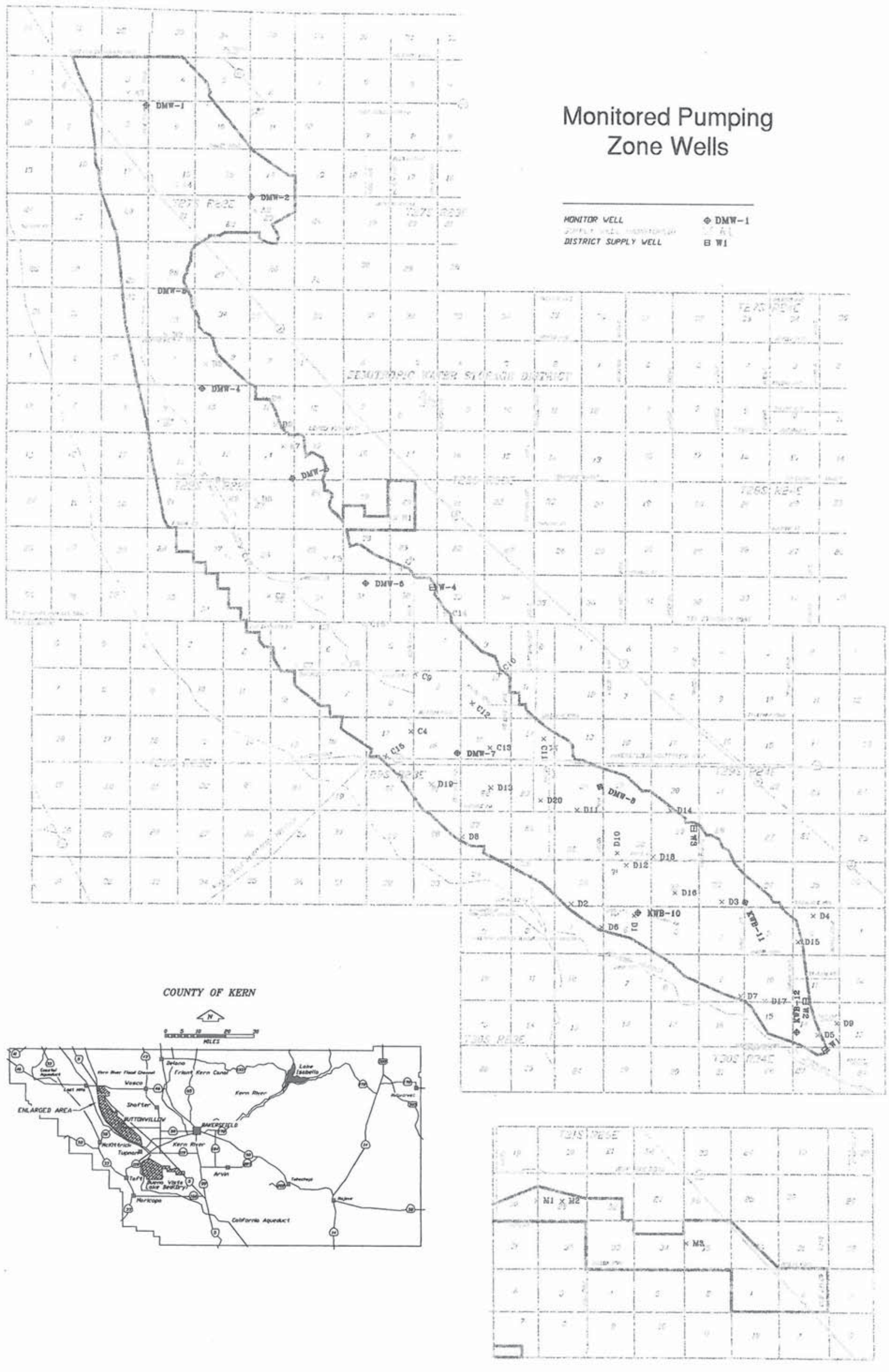
TABLE 3
BUENA VISTA WATER STORAGE DISTRICT
HISTORIC WATER BALANCE

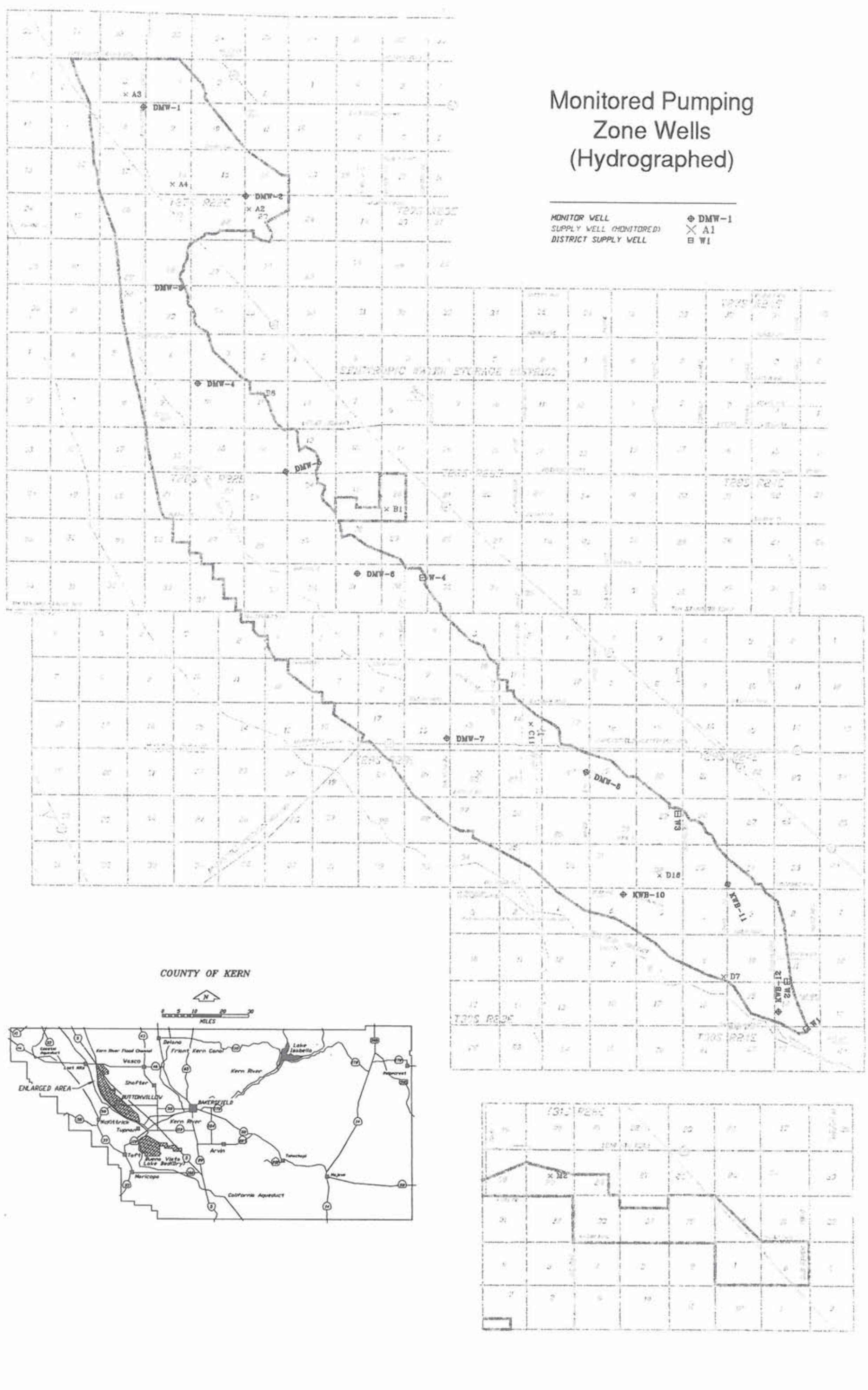
YEAR	[1] KERN RIVER APRIL-JULY RUNOFF % OF MEAN	[2] BV LAKE SEEPAGE LOSSES (AF)	[3] IN-DISTRICT SEEPAGE LOSSES (AF)	[4] FIELD DELIVERIES: SURFACE W/ 2800 AC WELLS (AF)	[5] FIELD DELIVERIES: RECLAIMED WATER (AF)	[6] FIELD DELIVERIES: TOTAL DELIVERIES	[7] DIRECT RECHARGE (AF)	[8] TRANS LOSS KR+OUTLET (AF)	[9] SURFACE WATER SUPPLY (AF)	[10] SURFACE WATER SUPPLY SOURCES: KR SUPPLY (AF)	[11] FK SUPPLY (AF)	[12] BV ST SUPPLY (AF)	[13] WK ST SUPPLY (AF)	[14] 2800 AC WELLS (AF)	[15] SAFE YIELD/ BENEFICIAL PRECIP. (AF)	[16] TOTAL WATER SUPPLY (AF)	[17] CROP WATER USE (AF)	[18] EVAP LOSSES AT 3% (AF)	[19] MAIN DRAIN SPILL TO N OF 46 (AF)	[20] TO 3rd PARTY GNDWTR ACCOUNTS (AF)	[21] TOTAL WATER USE (AF)	[22] ANNUAL WATER BALANCE (AF)	[23] ACCUM WATER BALANCE (AF)	[24] BVWSD GND WTR PUMPING (AF)
1962	109.6	5,034	25,329	74,985	5,529	80,514	0	30,225	135,573	121,748	13,825	0	0	0	15,000	150,573	92,000	1,700	2,925	0	96,625	53,948	53,948	34,000
1963	101.3	776	36,491	70,067	863	70,930	0	18,763	126,097	112,403	13,694	0	0	0	15,000	141,097	86,000	1,700	4,361	0	92,061	49,036	102,984	36,000
1964	38.9	0	18,976	27,894	2,160	30,054	0	8,639	55,509	55,509	0	0	0	0	15,000	70,509	84,000	800	4,115	0	88,915	-18,406	84,578	74,000
1965	97.1	0	40,301	59,972	2,874	62,846	9,891	26,609	136,773	109,468	27,305	0	0	0	15,000	151,773	91,000	2,300	4,542	0	97,842	53,931	138,509	50,000
1966	46.8	1,532	21,275	24,237	1,192	25,429	738	19,124	66,906	63,985	2,921	0	0	0	15,000	81,906	87,000	1,200	5,825	0	94,025	-12,119	126,390	83,000
1967	196.5	7,753	52,415	147,803	3,088	150,891	9,841	82,184	299,996	287,425	12,571	0	0	0	15,000	314,996	98,000	4,300	15,408	0	117,708	197,288	323,678	2,000
1968	52.8	1,181	20,596	67,586	3,421	71,007	0	18,458	107,821	107,821	0	0	0	0	15,000	122,821	90,000	1,200	4,054	0	95,254	27,567	351,245	41,000
1969	371.7	8,877	45,872	129,537	3,089	132,626	59,989	110,097	354,372	354,372	0	0	0	0	15,000	369,372	91,000	6,500	16,077	0	113,577	255,795	607,040	2,000
1970	67.9	732	19,333	87,812	4,982	92,794	0	22,312	130,189	117,431	7,310	5,448	0	0	15,000	145,189	97,000	1,200	9,086	0	107,286	37,903	644,943	28,000
1971	52.0	0	32,896	63,194	6,505	69,699	0	10,390	106,480	81,466	7,787	17,227	0	0	15,000	121,480	100,000	1,300	4,897	0	106,197	15,283	660,226	55,000
1972	27.2	0	25,468	43,937	7,689	51,626	0	5,484	74,889	32,853	0	42,036	0	0	15,000	89,889	99,000	900	740	0	100,640	-10,751	649,475	72,000
1973	153.9	0	29,784	99,258	6,537	105,795	18,740	12,712	160,494	149,082	746	10,666	0	0	15,000	175,494	108,000	1,800	12,137	0	121,937	53,557	703,032	30,000
1974	113.8	0	40,193	116,254	5,313	121,567	10,138	13,780	180,365	160,269	14,773	5,323	0	0	15,000	195,365	114,000	1,900	6,121	0	122,021	73,344	776,376	22,000
1975	82.1	0	35,272	107,049	4,815	111,864	8,255	9,099	159,675	138,781	0	20,894	0	0	15,000	174,675	118,000	1,600	7,384	0	126,984	47,691	824,067	37,000
1976	23.1	0	20,426	36,213	5,767	41,980	1,065	2,690	60,394	40,747	0	19,647	0	0	15,000	75,394	111,000	700	4,463	0	116,163	-40,769	783,298	97,000
1977	20.3	0	1,654	8,149	2,224	10,373	77	0	9,880	5,405	0	4,475	0	0	15,000	24,880	111,000	100	420	0	111,520	-86,640	696,658	129,000
1978	232.7	4,102	41,529	119,712	585	120,297	24,260	31,808	221,411	215,730	0	5,681	0	0	15,000	236,411	114,000	2,900	13,877	0	130,777	105,634	802,292	23,000
1979	89.3	1,060	48,304	112,051	3,415	115,466	11,495	11,665	184,575	128,312	0	41,463	14,800	0	15,000	199,575	110,000	2,100	12,807	14,800	139,707	59,868	862,161	23,000
1980	210.7	1,970	48,492	149,820	1,873	151,693	42,747	33,594	276,623	263,655	0	4,418	8,550	0	15,000	291,623	111,000	3,700	18,295	8,550	141,545	150,078	1,012,239	2,000
1981	53.7	533	47,290	94,584	4,326	98,910	6,389	8,154	156,950	62,319	0	77,631	17,000	0	15,000	171,950	112,000	1,900	12,351	57,000	183,251	-11,301	1,000,938	42,000
1982	169.4	2,394	49,583	129,510	1,470	130,980	33,413	16,107	231,007	168,266	18,741	21,852	22,148	0	15,000	246,007	107,000	3,000	15,904	22,148	148,052	97,955	1,098,893	3,000
1983	328.7	6,282	48,281	124,871	4,502	129,373	48,734	48,209	276,377	245,994	25,819	4,564	0	0	15,000	291,377	93,000	4,400	13,264	20,888	131,552	159,825	1,258,718	2,000
1984	90.0	531	49,638	142,134	4,364	146,498	18,322	10,741	221,366	152,793	2,289	44,748	21,536	0	15,000	236,366	111,000	2,400	16,478	61,536	191,414	44,952	1,303,670	2,000
1985	90.2	0	48,486	113,628	3,657	117,285	13,024	9,038	184,176	132,533	0	30,684	20,959	0	15,000	199,176	108,000	2,100	16,123	20,959	147,182	51,994	1,355,664	18,000
1986	188.5	2,328	42,424	141,390	1,060	142,450	33,349	25,315	244,806	211,616	10,279	2,113	20,798	0	15,000	259,806	104,000	3,000	24,589	22,839	154,428	105,378	1,461,042	2,000
1987	45.0	764	35,304	103,831	4,522	108,353	3,086	4,162	147,147	75,784	0	42,072	23,291	6,000	15,000	162,147	99,000	1,300	14,916	23,291	138,507	23,640	1,484,681	15,000
1988	34.5	0	30,733	76,753	6,764	83,517	216	4,986	112,688	50,627	0	32,350	24,711	5,000	15,000	127,688	104,000	1,100	16,309	24,711	146,120	-18,432	1,466,249	47,000
1989	49.8	0	39,993	65,717	12,950	78,667	3,532	6,280	115,522	59,023	0	24,402	28,959	3,138	15,000	130,522	101,000	1,500	5,080	28,959	136,539	-6,017	1,460,232	48,000
1990	24.1	0	23,787	52,948	7,978	60,926	0	3,961	80,696	21,126	0	26,899	30,429	2,242	15,000	95,696	106,000	800	4,165	30,429	141,394	-45,698	1,414,534	72,000
1991	58.8	0	23,205	43,344	10,171	53,515	0	5,288	71,837	58,600	0	2,127	6,700	4,410	15,000	86,837	104,000	900	4,558	6,700	116,158	-29,321	1,385,213	77,000
1992	38.1	0	27,600	29,366	11,301	40,667	799	2,148	59,913	42,584	0	911	12,414	4,004	15,000	74,913	104,000	900	3,927	12,414	121,241	-46,328	1,338,885	90,000
1993	124.3	0	39,064	102,108	11,175	113,283	30,713	5,064	176,949	90,593	2,848	53,103	30,405	0	15,000	191,949	107,000	2,200	8,641	30,405	148,246	43,703	1,382,588	21,000
1994	40.6	20	37,751	76,193	11,271	87,464	0	7,954	121,918	73,711	0	27,733	20,474	0	15,000	136,918	103,000	1,400	8,404	20,474	133,278	3,640	1,386,228	41,000
1995	197.6	1,342	57,436	130,175	11,018	141,193	50,919	12,457	252,329	185,950	4,479	21,521	40,379	0	15,000	267,329	105,000	3,600	28,394	40,379	177,373	89,956	1,476,184	2,000
1996	127.4	920	43,501	134,678	13,785	148,463	21,423	10,167	210,689	167,936	734	16,422	25,597	0	15,000	225,689	106,000	2,300	23,555	25,597	157,452	68,237	1,544,421	2,000
1997	121.5	199	53,403	137,303	11,461	148,764	36,154	16,677	243,736	211,150	12,407	2,259	17,920	0	15,000	258,736	107,000	3,200	28,118	17,920	156,238	102,498	1,646,919	2,000
1998	241.9	941	33,883	116,790	8,561	125,351	69,048	15,609	236,271	209,901	1,020	8,565	16,785	0	15,000	251,271	105,000	3,600	31,760	23,602	163,962	87,309	1,734,228	6,000
1999	53.7	551	33,706	106,049	15,617	121,666	536	5,839	146,681	54,068	8,942	53,913	29,758	0	15,000	161,681	106,000	1,200	23,067	29,758	160,025	1,656	1,735,884	11,000
2000	65.2	0	40,405	86,916	16,534	103,450	337	6,700	134,358	58,767	0	53,111	22,480	0	15,000	149,358	103,000	1,400	23,083	22,480	149,963	-605	1,735,279	25,000
AVG:																								
1980-00	112.1	894	40,665	102,767	8,303	111,070	19,654	12,307	176,288	123,666	4,169	26,257	21,014	1,181	15,000	191,288	105,048	2,186	16,237	26,240	149,710	41,577		25,238
1990-00	99.4	361	37,613	92,352	11,716	104,067	19,084	8,351	157,762	106,762	2,766	24,233	23,031	969	15,000	172,762	105,091	1,955	17,061	23,651	147,757	25,004		31,727
1986-98	99.4	501	37,545	93,123	9,386	102,509	19,172	9,236	159,577	112,200	2,444	20,037	22,989	1,907	15,000	174,577	104,231	1,985	15,570	23,671	145,457	29,120		32,692
1976-94	100.6	1,052	37,029	90,649	5,757	96,405	14,275	12,482	155,486	110,496	3,157	24,572	15,957	1,305	15,000	170,486	106,316	1,916	11,293	21,374	140,899	29,587		39,684
1972-94	99.5	869	36,272	90,818	5,814	96,633	13,407	12,097	153,463	112,191	3,282	23,730	13,181	1,078	15,000	168,463	106,913	1,852	10,476	17,657	136,898	31,565		39,783
1962-00	108.5	1,277	36,156	91,124	6,267	97,390	14,544	17,756	160,857	125,123	4,833	18,571	11,695	636	15,000	175,857	102,744	2,054	12,057	14,509	131,363	44,494		35,077

NOTES:

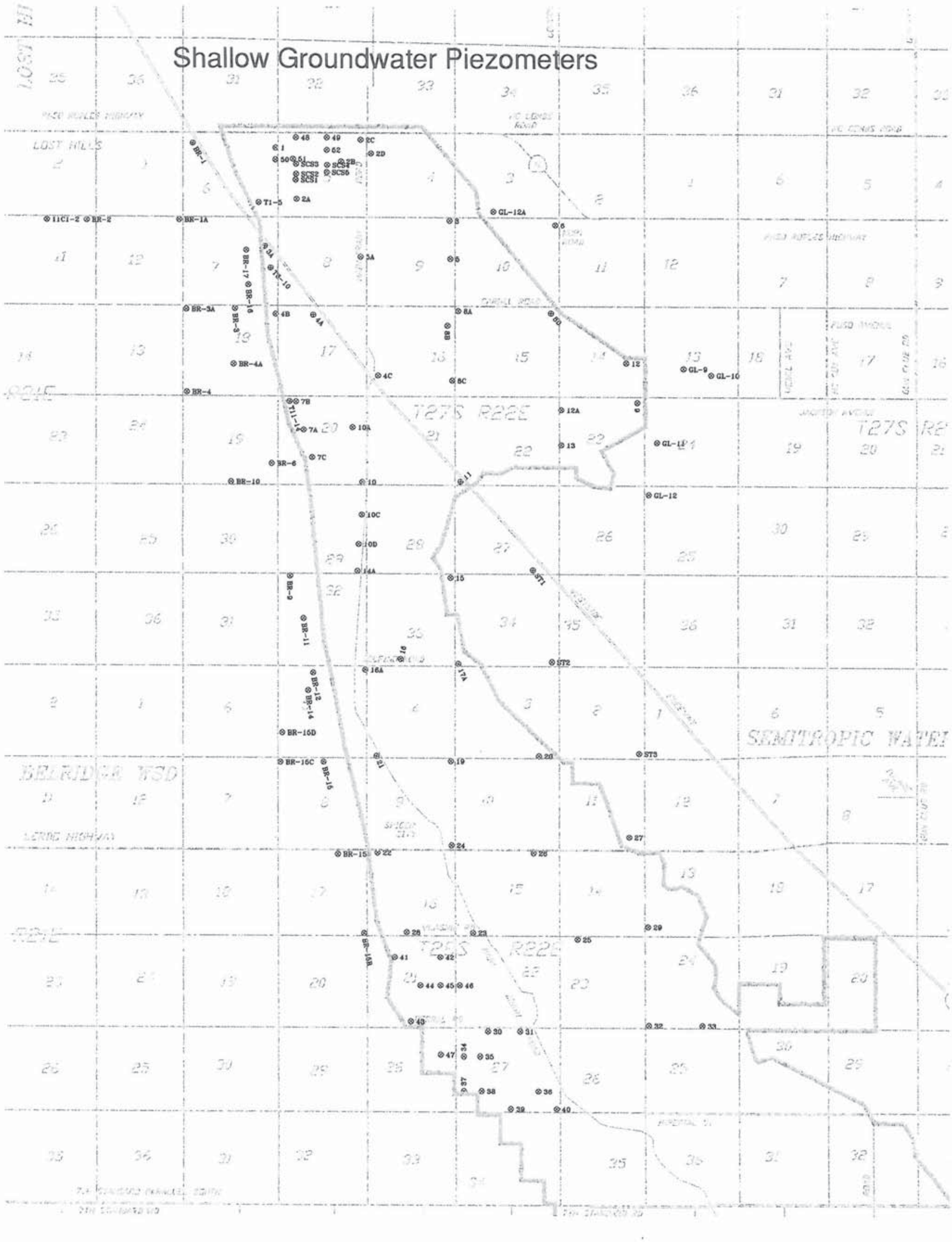
[1] April-July Runoff of the Kern River in % of normal
[2] Buena Vista Lake seepage losses estimated at 20% of total losses.
[3] Gross in-district seepage losses
[4] Net BV surface water deliveries including 2800 Acre well pumping.
[5] Field deliveries of reclaimed water.
[6] Total net field deliveries including 2800 acre well pumping.
[7] Direct spreading generally in the WK/BV program area (KR, Bypass, Main, Outlet, Elk Pen).
[8] Transportation seepage losses in Kern River and Outlet Canal.
[9] = [2]+[3]+[4]+[7]+[8].
[10] Total Kern River Supply (includes 20% of Lake losses).
[11] Total Friant-Kern Supply (includes 20% of Lake losses).
[12] Total BV State Supply (includes 20% of Lake losses).
[13] Total West Kern State Supply.
[14] Total 2800 Acre well pumping.
[15] Safe Yield estimated at 0.3 AF/year.
[16] = Sum of [10] through [15].
[17] Estimated crop water use (consumptive) from Table 2.
[18] Evap losses estimated at 3% of sum of losses above canal head, gross in-district losses, and direct recharge.
[19] Main Drain spill to north of Hwy 46.
[20] 3rd PARTY represents transfer of deliveries to other gw accounts primarliy WK SWP supplies.
[21] = [17]+[18]+[19]+[20].
[22] = [16]-[21].
[23] = [22] + Previous Year [23].
[24] BVWSD groundwater pumping estimated at 130% of crop water use less sum of surface water deliveries and beneficial precipitation (5,000 AF/year).
Minimum groundwater pumping estimated at 2,000 AF/year.

Monitored Pumping Zone Wells

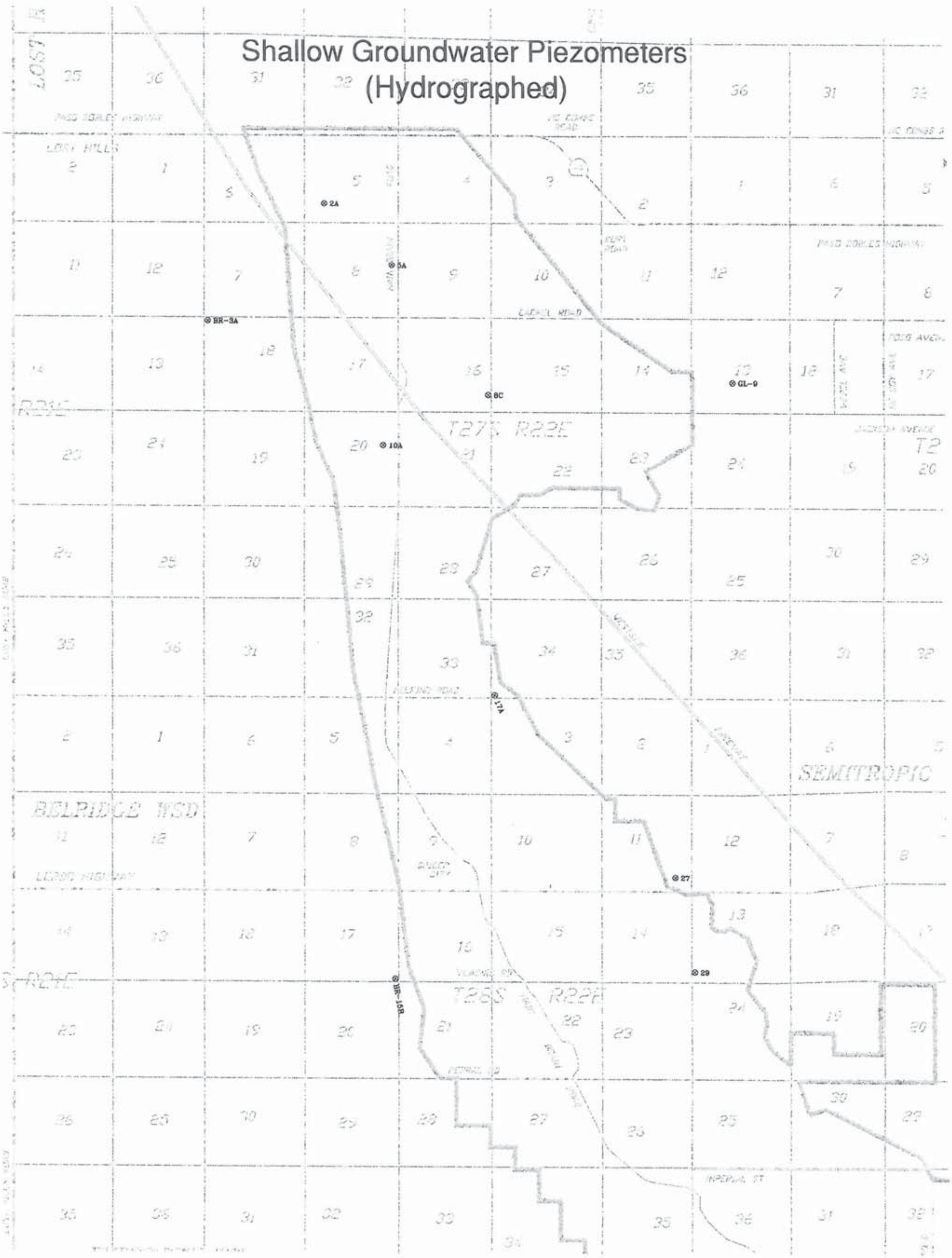



Monitored Pumping
Zone Wells
(Hydrographed)
MONITOR WELL
SUPPLY WELL (MONITORED)
DISTRICT SUPPLY WELL
DMW-1
A1
W1
A3
DMW-2
A2
A4
DMW-4
DMW-6
W-4
B1
DMW-7
DMW-8
W3
D18
KWB-10
KWB-11
D7
KWB-12
W2
W1
A2
SEMITROPIC WATER STORAGE DISTRICT
COUNTY OF KERN
MILES
ENLARGED AREA
BAKERSFIELD
BUTTONWILLOW
Shafter
Wasco
Delano
Kern River
Lake Isabella
Arvin
Taft
Maricopa
California Aqueduct

Shallow Groundwater Piezometers



Shallow Groundwater Piezometers (Hydrographed)



BVWSD DELIVERY DATA

ACRE-FEET

YEAR	%AJ	CROP(AC)	TOTAL BW DELIVERIES	BW DIST WELLS	BW LAND OWN WELLS	BW RECL	TOTAL MAPLES DELIVERIES	MAPLES LAND OWN WELLS	MAPLES LAND OWN RECS	TOTAL SURFACE DELIVERY	TOTAL WELL DELIVERY	ALEJANDRO LOSS	TRANSP. LOSSES	MAIN LOSSES	OUTLET LOSSES
1962	108.8	37299	79053		309	2641	1770			80514	309		17685	9555	2986
1963	100.6	34799	68087			863	2843			70930			7362	10492	909
1964	38.6	32806	29322			2160	732			30054		1263	3528	3848	
1965	96.4	35475	61404			2875	1442			62846		1841	10018	9890	4860
1966	46.4	33285	24933			1192	496			25429		2211	11195	4831	887
1967	195.0	38095	142064			3088	8827			150891		6088	45981	6887	23230
1968	52.4	36154	68877			3421	2130			71007		2143	6043	4522	5750
1969	368.8	37019	127598			3089	5028			132626		5563	81979	7192	15363
1970	67.4	38782	90070			4982	2724			92794		4460	4258	9410	4184
1971	51.6	37995	68101			6800	1721	123		69699	123	394	4172	5824	
1972	27.0	36768	50549			7689	1077			51626		79	1347	1062	2996
1973	152.7	40600	103055			6537	2740			105795			711		12001
1974	112.9	41650	110153			5313	11414			121567			2203		11577
1975	81.5	44785	106374			4815	5490			111864					9105
1976	22.9	41850	40659		355	5767	1749	73		41980	428		48		2642
1977	20.2	40692	9363			2324	1010			10373					
1978	230.9	41924	114842				5455			120297			17237		15110
1979	88.6	41409	110144			3701	5322			115466			25		11640
1980	209.1	41757	145667			1407	6028		117	151695			15366		18260
1981	53.3	41255	91545			4259	7365			98910			17		8355
1982	168.1	39990	123835			1470	7143			130978			618		15489
1983	326.2	34258	122634			3871	6739		125	129373			32819		15592
1984	89.3	40655	138627			4364	7871			146498			627		10114
1985	89.5	40282	111630			3657	5655			117285			167		8871
1986	187.1	39003	135733			1060	6717			142450			10913		14402
1987	44.6	36304	96521		657	4491	6489			102353	657		33		4129
1988	34.2	38197	76184		2378	6871	4711			78517	2378				5163
1989	49.5	38012	76266		5800	13106	5697	634		75529	6434		60		6288
1990	23.9	39138	58215		2615	8879	5371	2287		58684	4902				4257
1991	58.4	38606	52359	448	5689	10659	4218	1335	379	49105	7472	22			5727
1992	37.8	38555	41602	2062	4067	12944	3952	2762	441	36663	8891		29		3202
1993	123.4	40254	108369		222	11624	5221	85	500	113283	307				5064
1994	40.3	38761	83713		1728	10635	6102	623	754	87464	2351		2		7952
1995	196.1	39847	133309		73	9931	7957		758	141193	73		97		12404
1996	126.5	40958	140248		175	13651	8390		310	148463	175				10167
1997	120.6	40127	141268			11401	7496		60	148764					16677
1998	240.0	40748	117795			9833	7556		419	125351					16687
1999	53.3	40537	112538			14265	9128			121666					5839
2000	64.9	38393	96589		855	16578	7716			103450	855				6700
TOTAL	4251.8	1553656	3609295	4980	24923	242213	199492	7922	3863	3773432	37825	24064	274540	73513	324579
AVERAGE															
1962-99	109	38911	92440	66	633	5938	5047	208	102	96578	908	633	8075	1935	8365
1978-99	118	39572	106047	114	1064	7367	6390	351	176	110909	1529	1	3901		10063

YEAR	BW LOSSES	MAPLES LOSSES	TOTAL IN-DIST T LOSSES	TOTAL TRANS LOSSES	BV LAKE & BVARA LOSS	SPREADING RIVER/BYPASS	SPREADING ELK/OUTLET	SPREADING FLOOD CH	SPREADING MAIN	TOTAL SPREADING	BW BV RECS	BW OTHER RECS	MAPLES OTHER RECS	SPILL @ 46
1962	25329		25329	55555	25495						2641			2925
1963	36491		36491	55254	3882						863			4361
1964	18976		18976	27615							2160			4115
1965	39582	720	40302	66911		9891				9891	2875			4542
1966	20545	730	21275	40399	7658	738				738	1192			5825
1967	51265	1150	52415	134601	38765		9841			9841	3088			15408
1968	19881	715	20596	39054	5905						3421			4054
1969	44301	1571	45872	155969	44385	59989				59989	3089			16077
1970	18221	1113	19334	41646	3662						4982			9086
1971	32260	931	33191	43581							6800			4897
1972	24694	774	25468	30952							7689			740
1973	29368	416	29784	42496		12346	6394			18740	6537			12137
1974	38543	1650	40193	53973		10138				10138	5313			6121
1975	33750	1522	35272	44377		8255				8255	4815			7384
1976	20138	310	20448	23138		1065				1065	5767			4463
1977	1754		1754	1754		77				77	2324			420
1978	43138	1171	44309	76656	20510	8876	11867		3517	24260				13877
1979	46396	1908	48304	59969	5302	8143	639		2713	11495	3701			12807
1980	46538	2009	48547	82173	9852	17048	22453		3246	42747	1407		117	18295
1981	46264	1040	47304	55676	2667	446	4005		1938	6389	4259			12351
1982	47961	1622	49583	65690	11969	18383	11251		3833	33467	1470			15904
1983	48450	1503	49953	98364	31409	12933	32382		3419	48734	3871		125	13264
1984	47754	1884	49638	60379	2654	5977	12345			18322	4364			16478
1985	46451	2035	48486	57524		2650	10199		175	13024	3657			16123
1986	40267	2157	42424	67739	11653	12017	19882		1450	33349	1060			24589
1987	35400	763	36163	40325	3818	3086				3086	4491			14916
1988	30040	800	30840	36003		227				227	4933	1938		16309
1989	39043	1256	40299	46647		2393	865		274	3532	9473	3633		5080
1990	24978	685	25663	29920	1000						5307	3572		4165
1991	23595	622	24217	29966							6073	4586	379	4558
1992	29696	529	30225	33456		799				799	7563	5381	441	3927
1993	39167	698	39865	44929	1100	13390	13847	2618	859	30714	9674	1950	500	8641
1994	36135	1899	38034	45988	1170						5910	4725	754	8404
1995	55359	2262	57621	70122	6710	19301	12820	6763	12487	51371	7054	2877	758	28394
1996	42455	1465	43920	54087	4600	16670	668		4085	21423	10062	3589	310	23555
1997	51548	1855	53403	70080	996	16264	13838	3862	2190	36154	8914	2487	60	28118
1998	35697	1033	36730	53417	4706	29447	32222	7446		69115	8078	1755	419	31760
1999	31414	2305	33719	39558	3032	105	431			536	9497	4768		23067
2000	37239	3168	40407	47107			337			337	11541	5037		23083
TOTAL	1380083	46271		2123050	252900	290654	216286	20689	40186	567815	195915	46298	3863	470220
AVERAGE														
1962-99	35338	1197		54630	6655	7649	5683	575	1058	14934	4852	1086	102	11767
1978-99	40352	1432		55394	5598	8553	9078	1034	1827	20397	5492	1876	176	15663

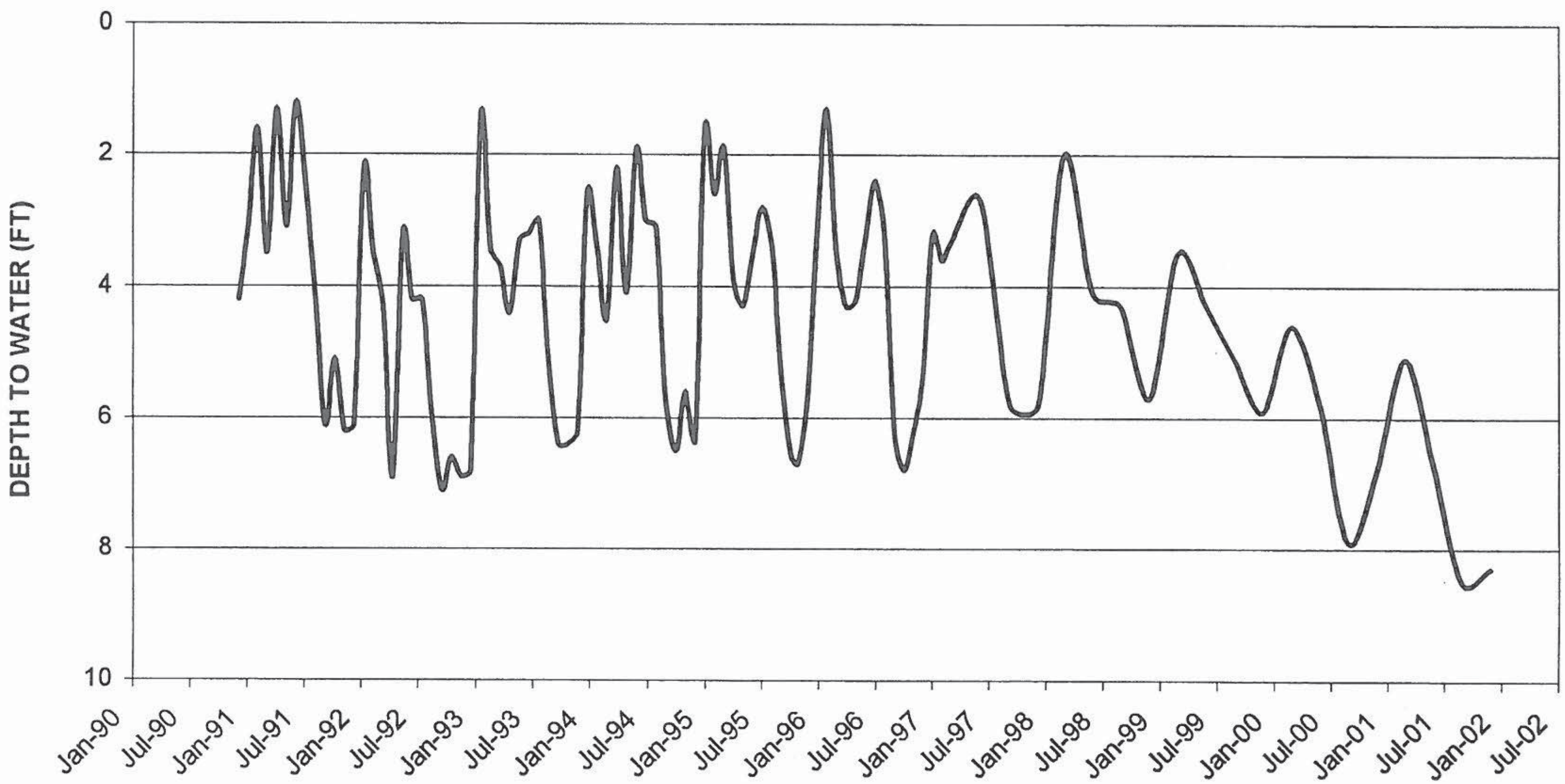
Note: In 1998 Spreading in Bypass / River & Main were combined.

%AJ = KR % OF APRIL-JULY RUNOFF
CROP = ACTUAL BV CROPPED ACREAGE
TOTAL BW DELIVERIES = ALL DELIVERIES MADE BY BV TO BV OR NON-DISTRICTED LANDS
DIST WELLS = DELIVERY OF DISTRICT WELL WATER FROM THE SYSTEM (LOSSES TAKEN OUT)

OTHER WELLS = GENERALLY FARMER WELLS DELIVERED INTO BV SYSTEM
TOTAL SURFACE DEL = TOTAL BW AND MAPLES LESS WELL (RECLAMATION INCLUDED)
TRANS LOSS = LOSS IN KERN RIVER, GENERALLY IN LARGE YEARS
BW & MAPLES RECL = RECLAMATION FIELD DELIVERIES (LOSSES TAKEN OUT)

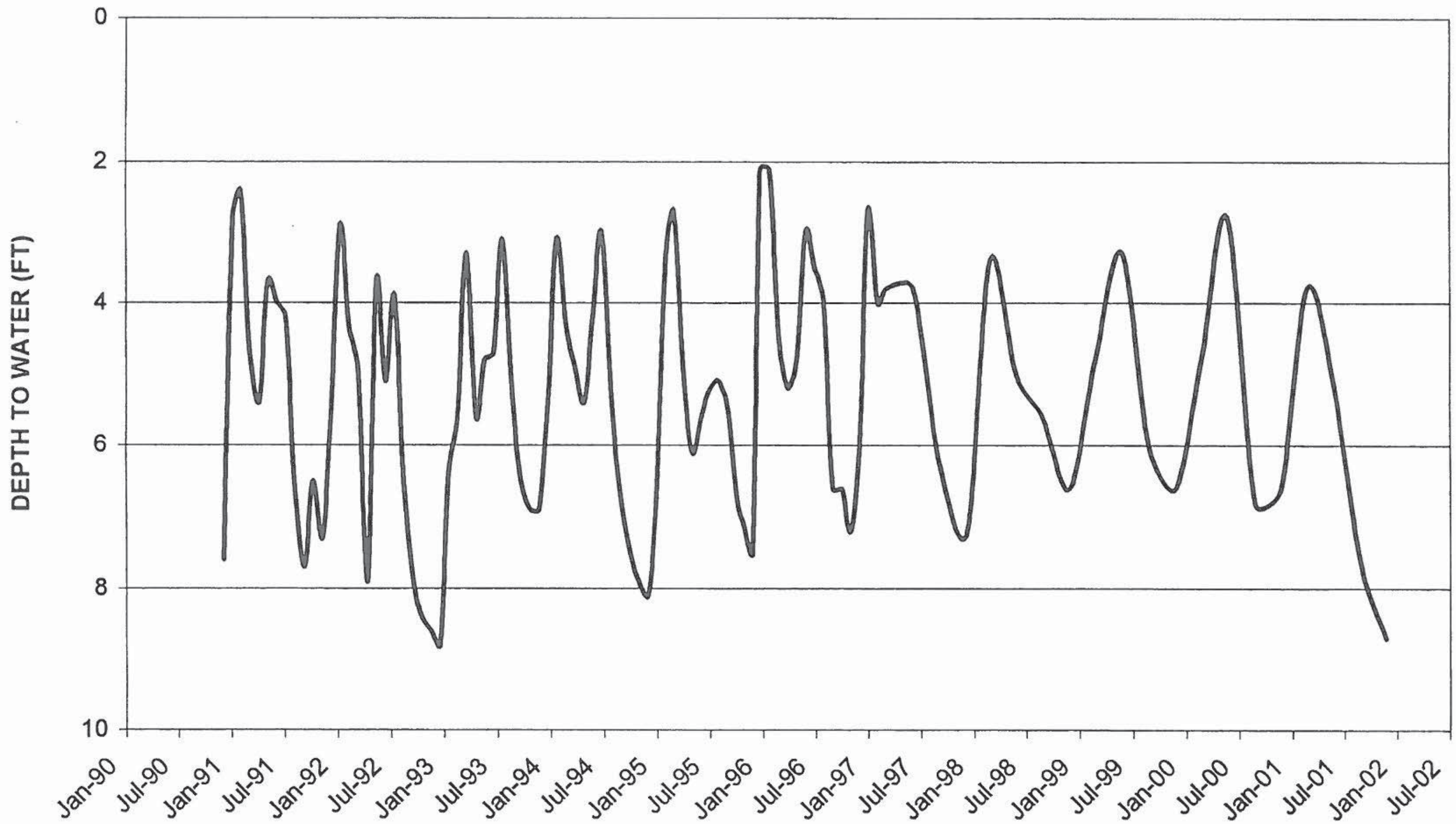
BW & MAPLES RECS = THESE RECLAMATION #S ARE RAW DELIVERIES (LOSSES NOT TAKEN OUT)

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#2A
28-22 11Q GRND. ELEV=233.43 FT



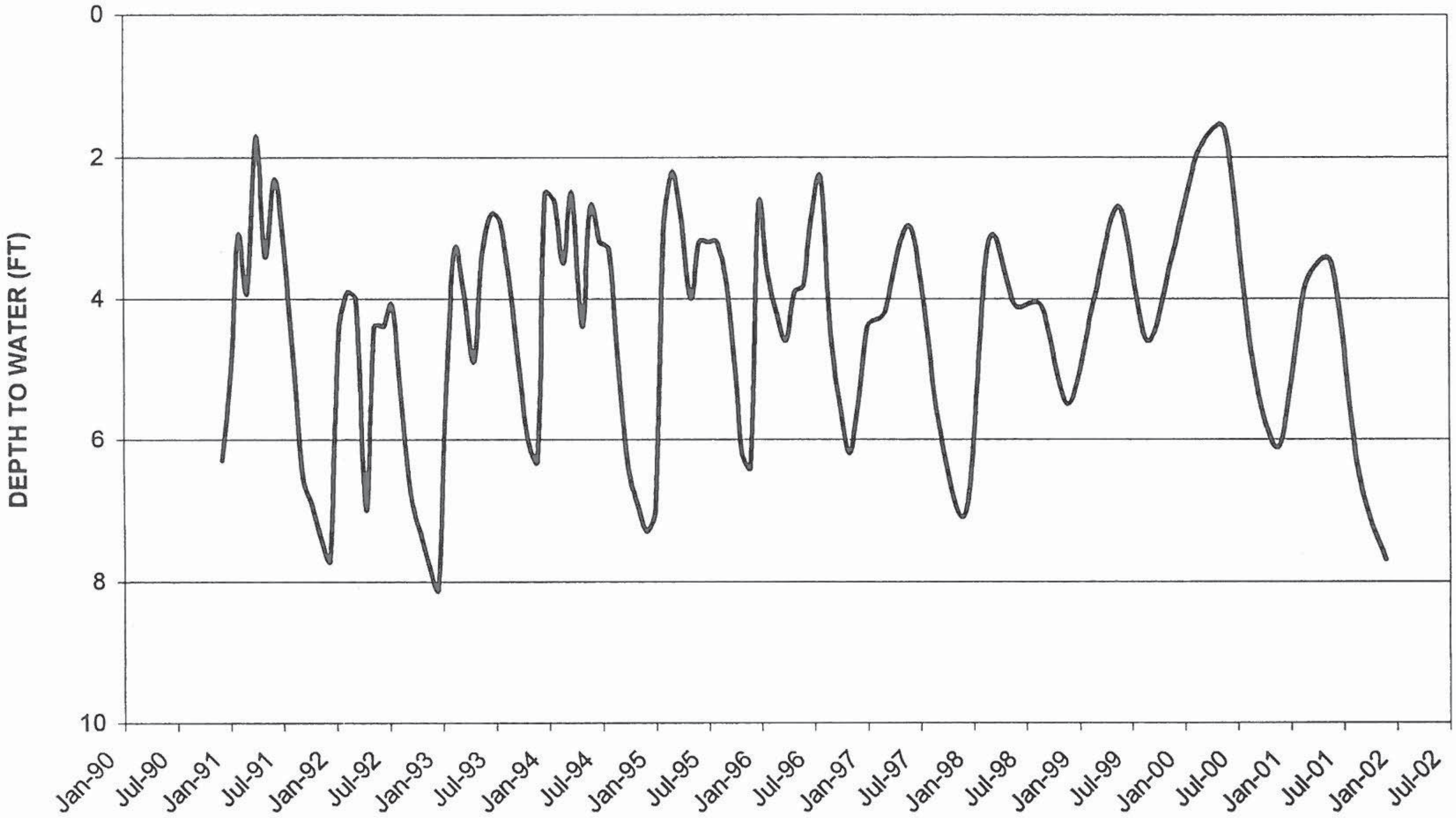
Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#5
27-22 9H GRND. ELEV=235.39 FT

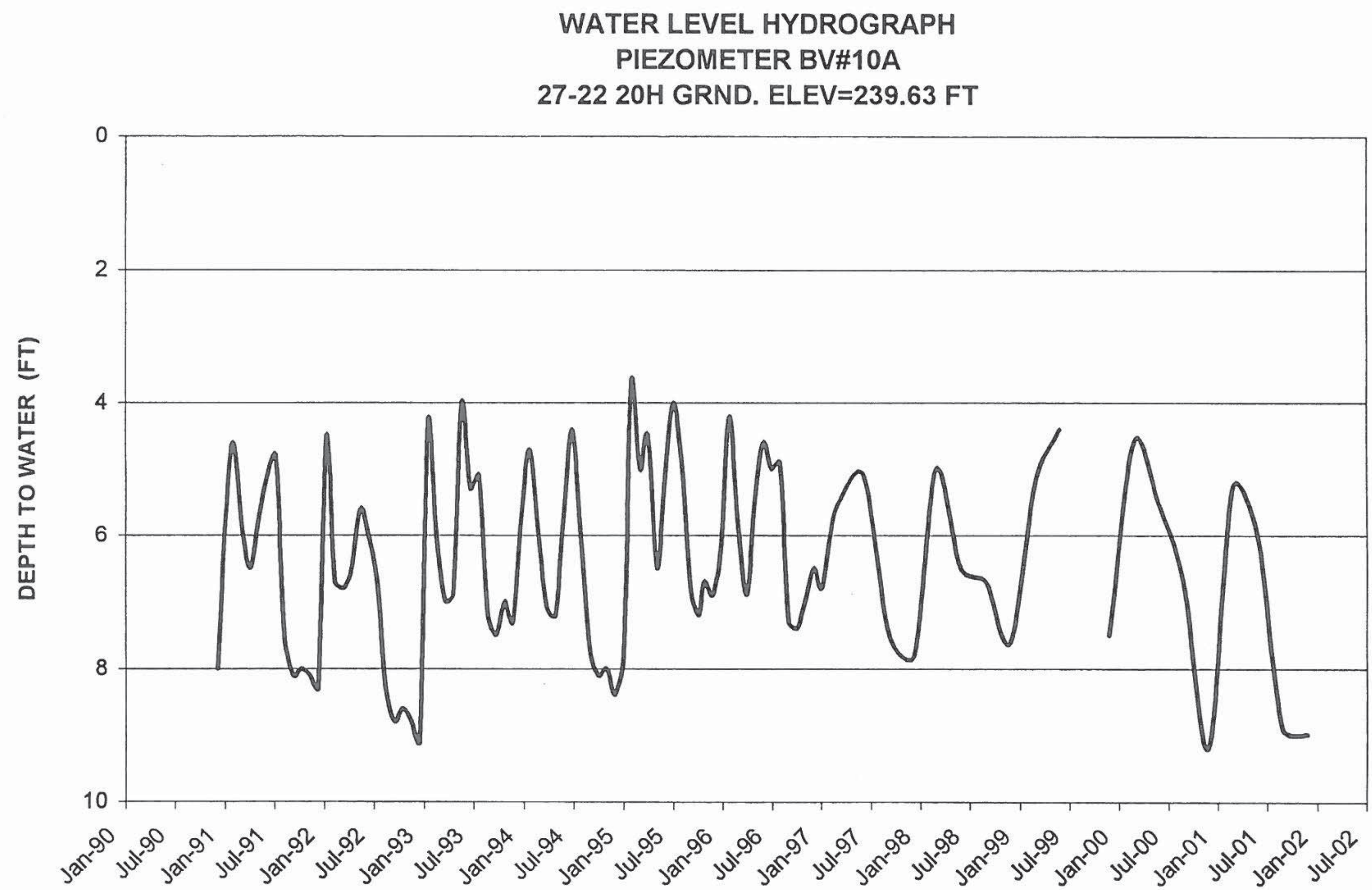


Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#8C
27-22 15N GRND. ELEV=236.06 FT

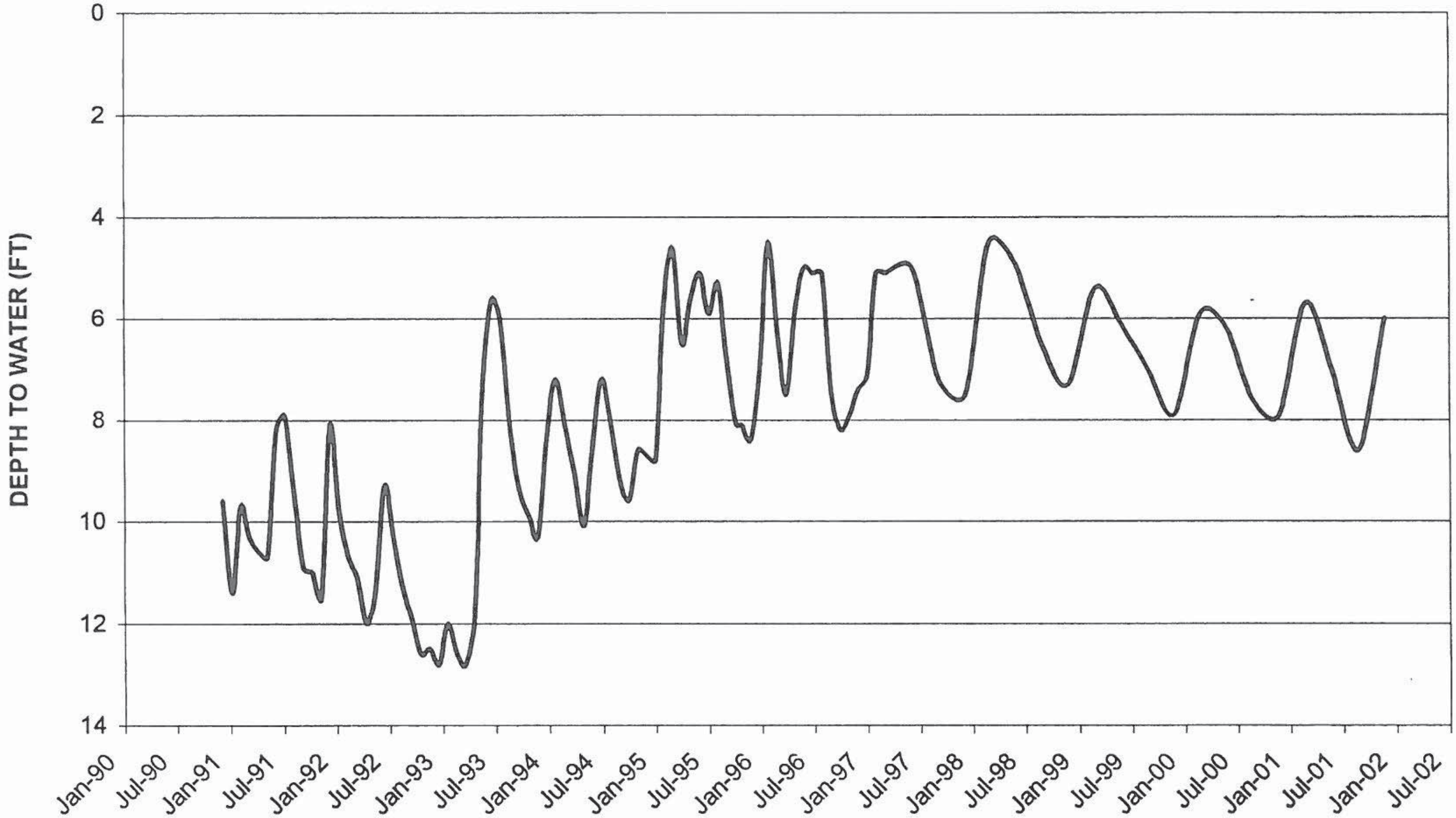


Buena Vista WSD



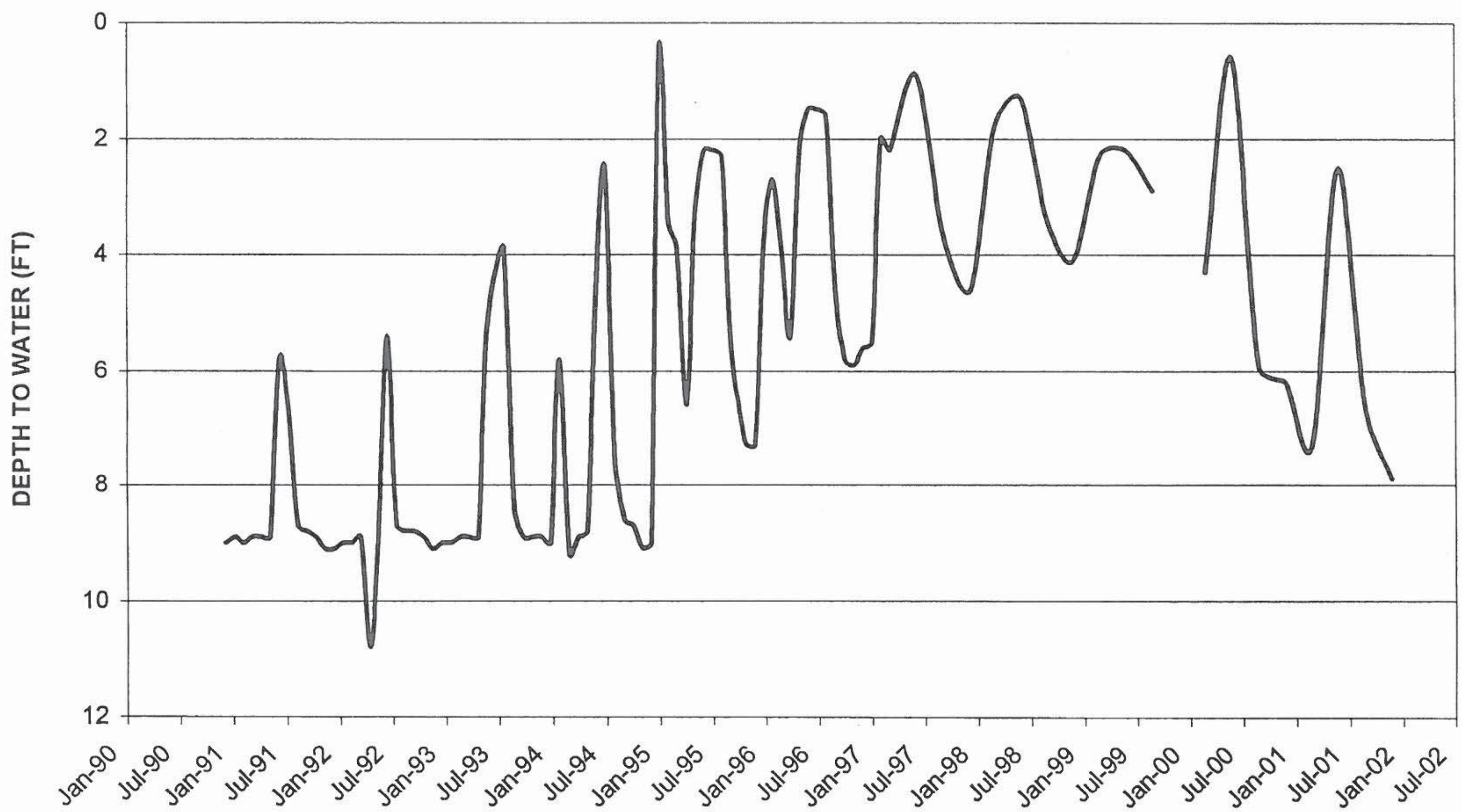
Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#17A
28-22 3D GRND. ELEV=244.28 FT



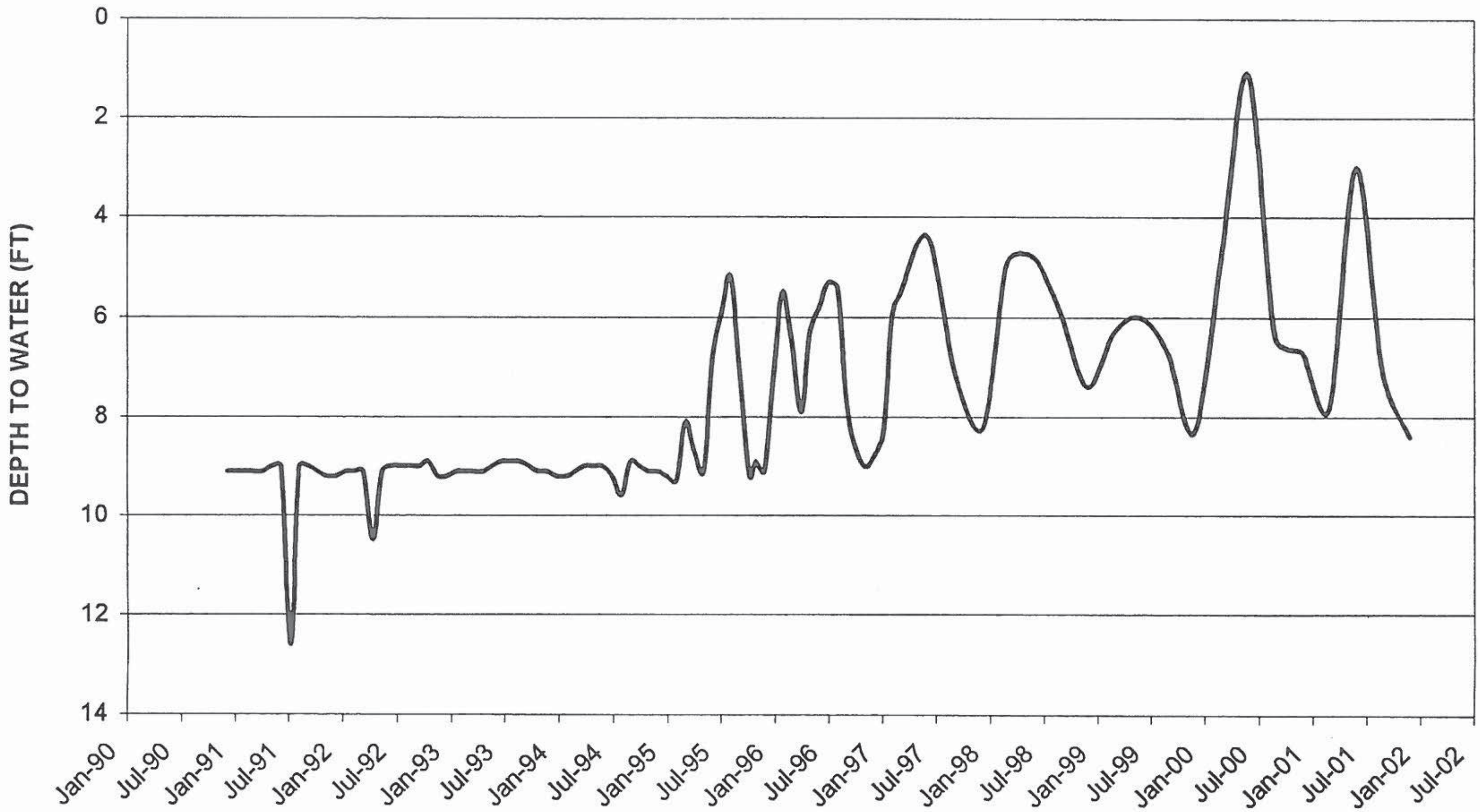
Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#27
28-22 11R GRND. ELEV=247.24 FT



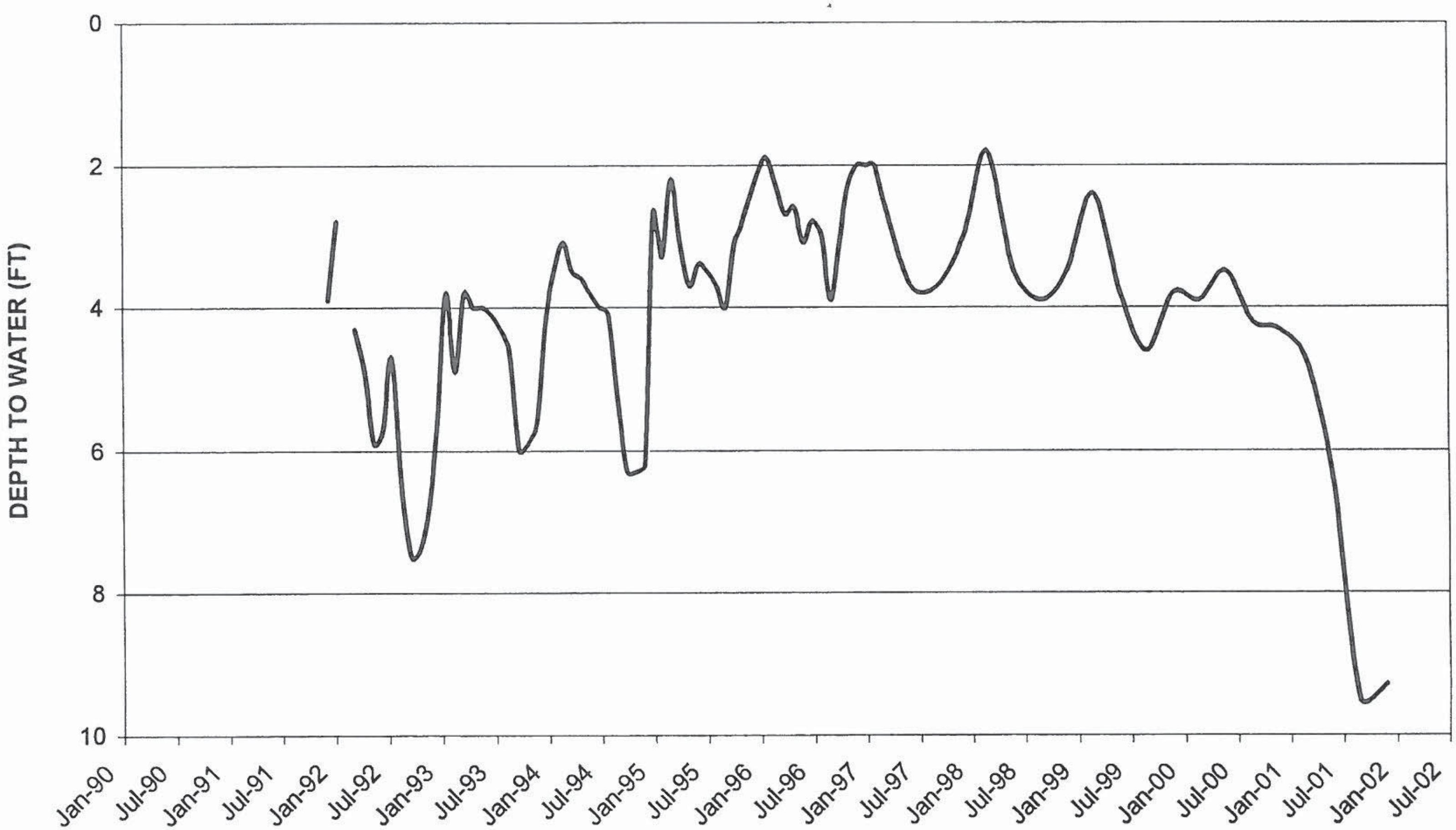
Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BV#29
28-22 13N GRND. ELEV=2251.31FT



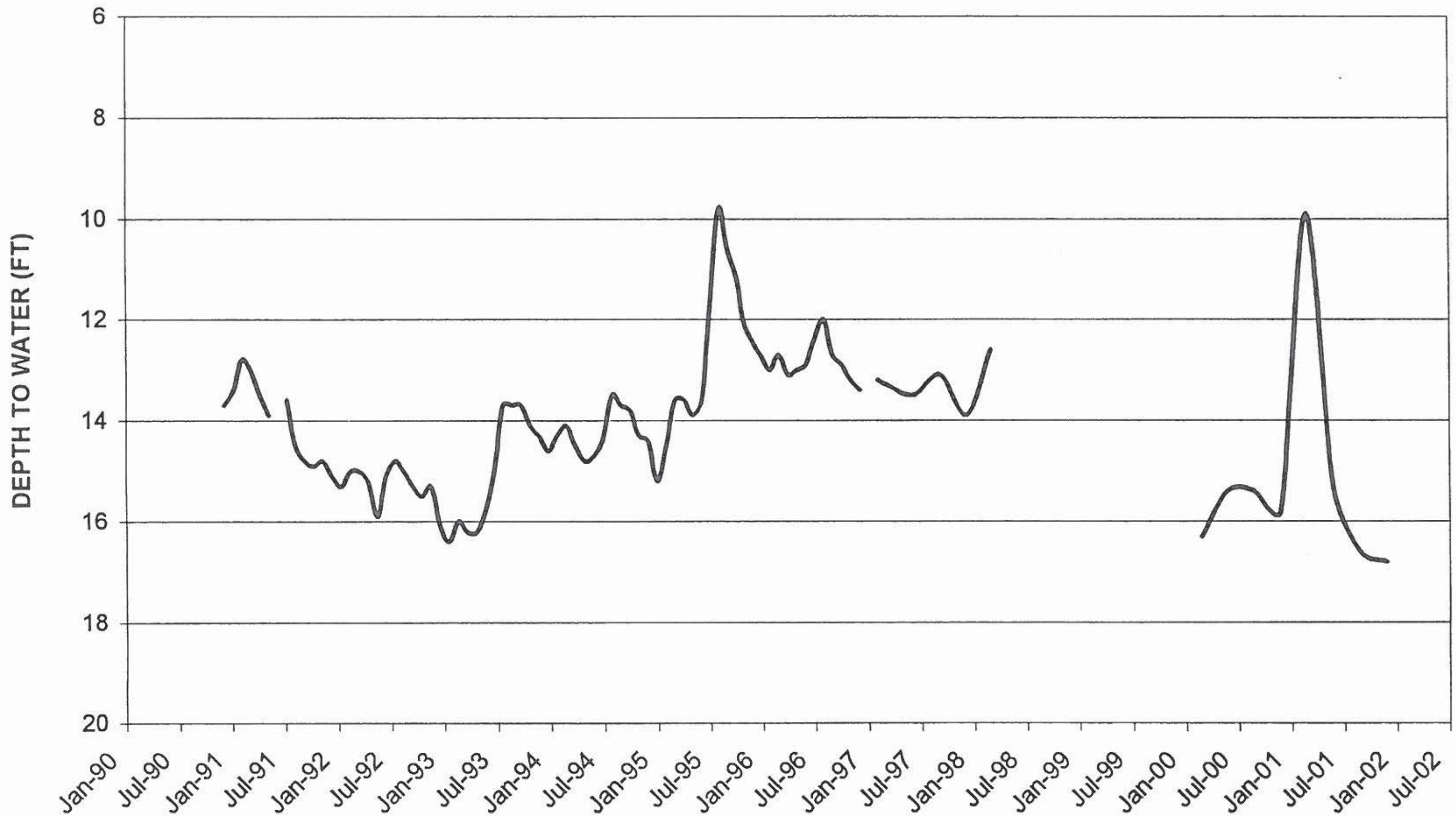
Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER GL#9
27-22 13L GRND. ELEV=235.98 FT

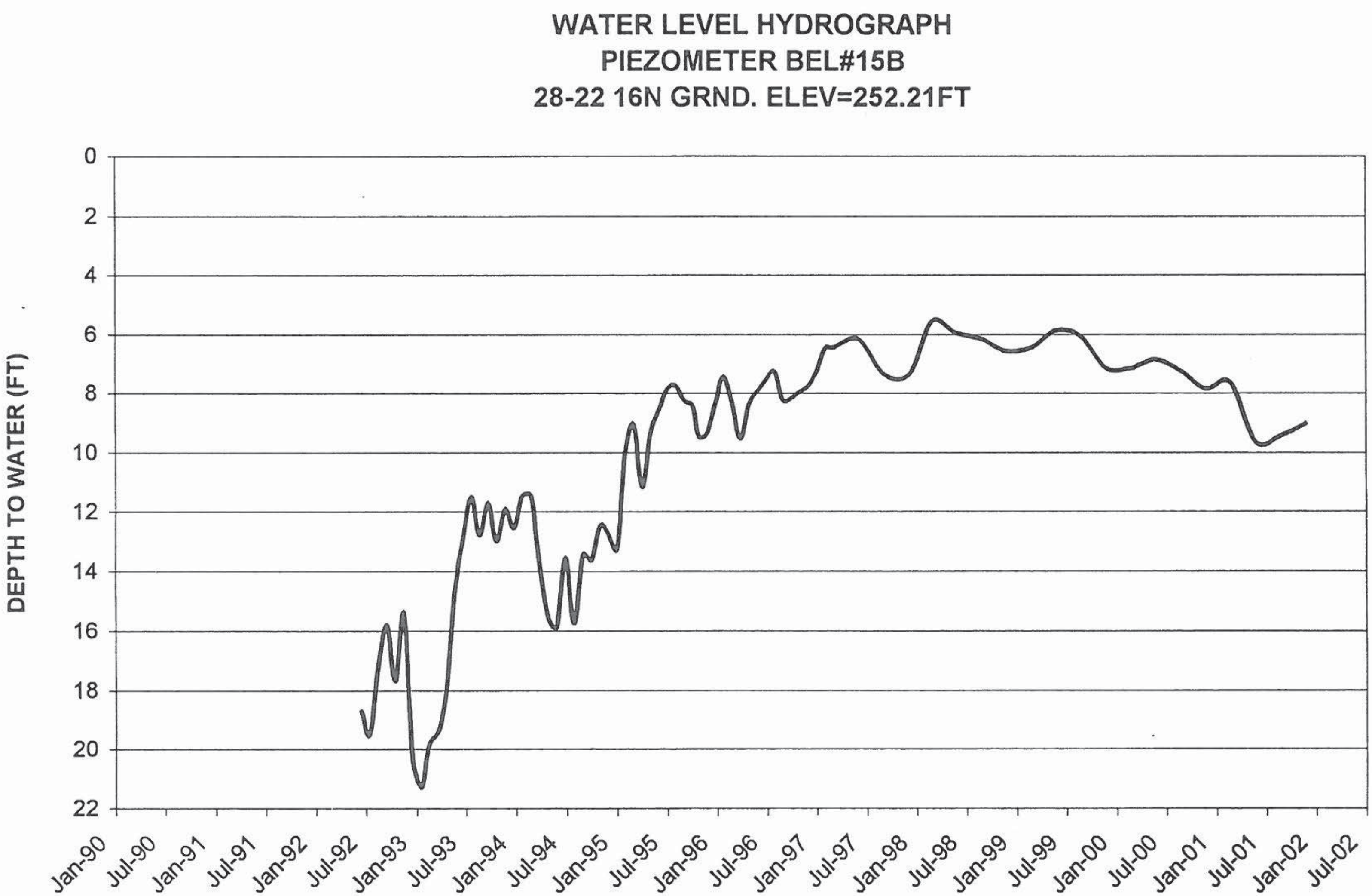


Buena Vista WSD

WATER LEVEL HYDROGRAPH
PIEZOMETER BEL#3A
27-22 7N GRND. ELEV=249.91FT



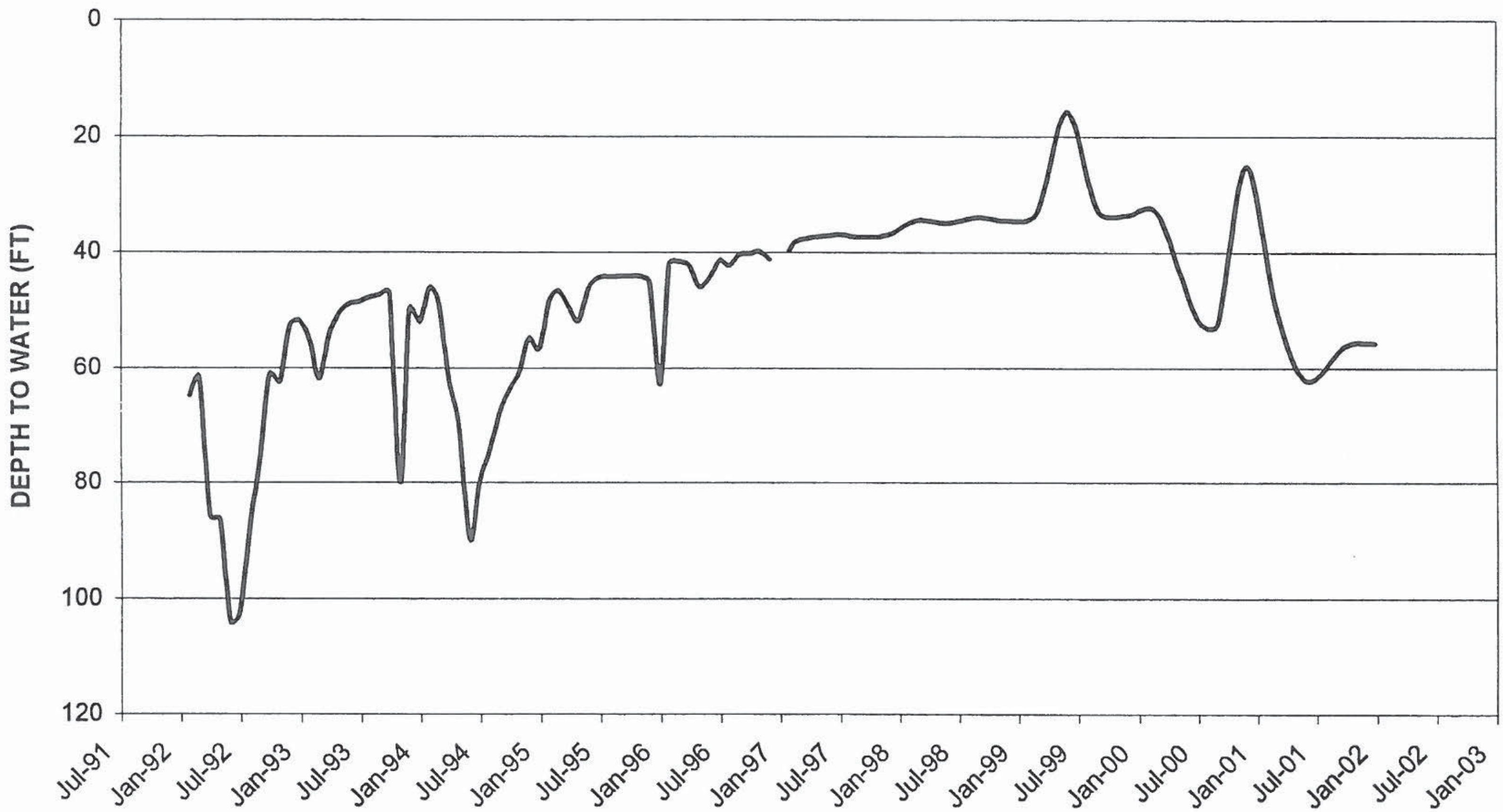
Buena Vista WSD



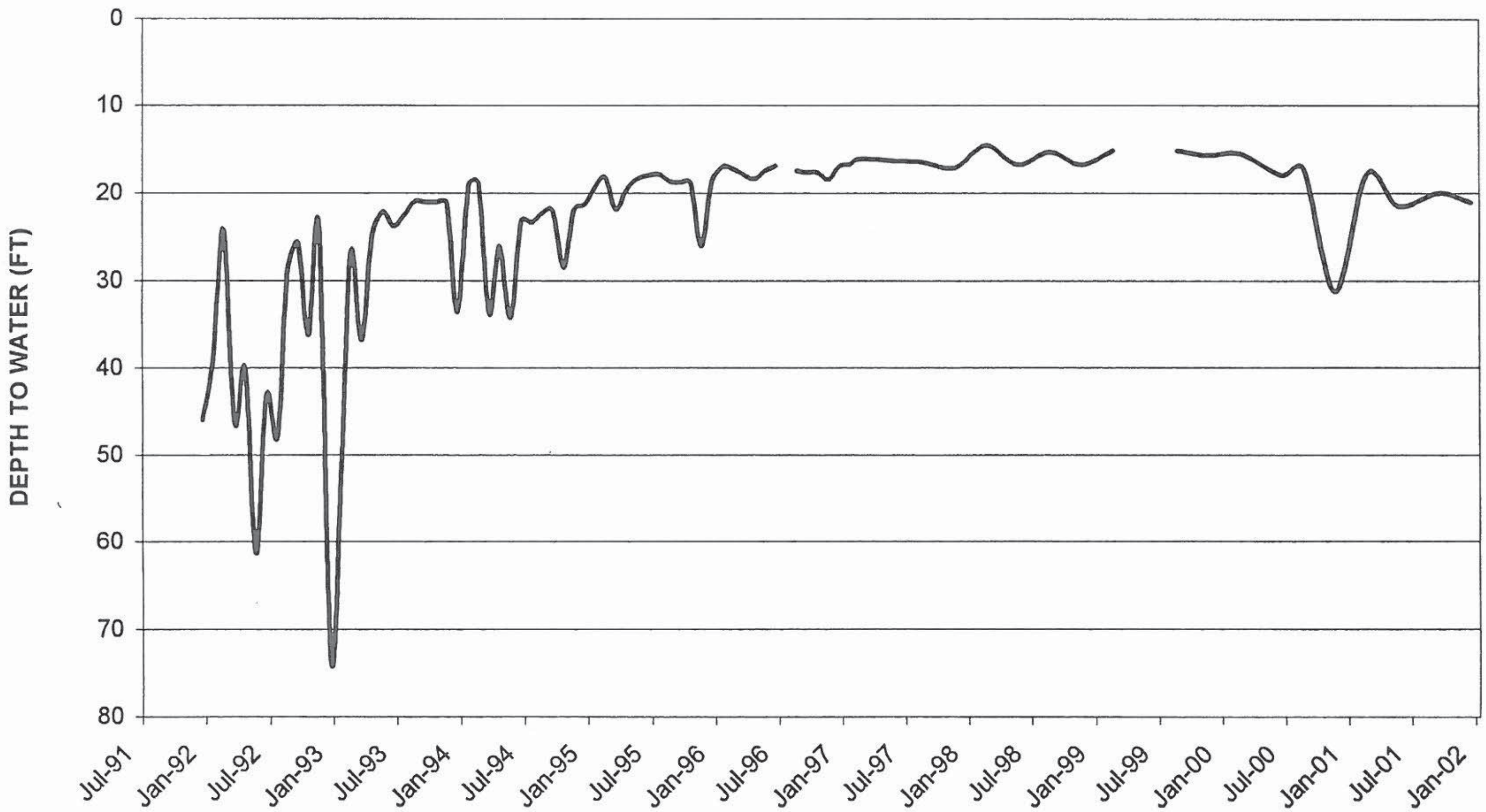
Buena Vista WSD

Appendix D

WATER LEVEL HYDROGRAPH
DMW #2
27-22 23D GRND. ELEV=234.5 FT

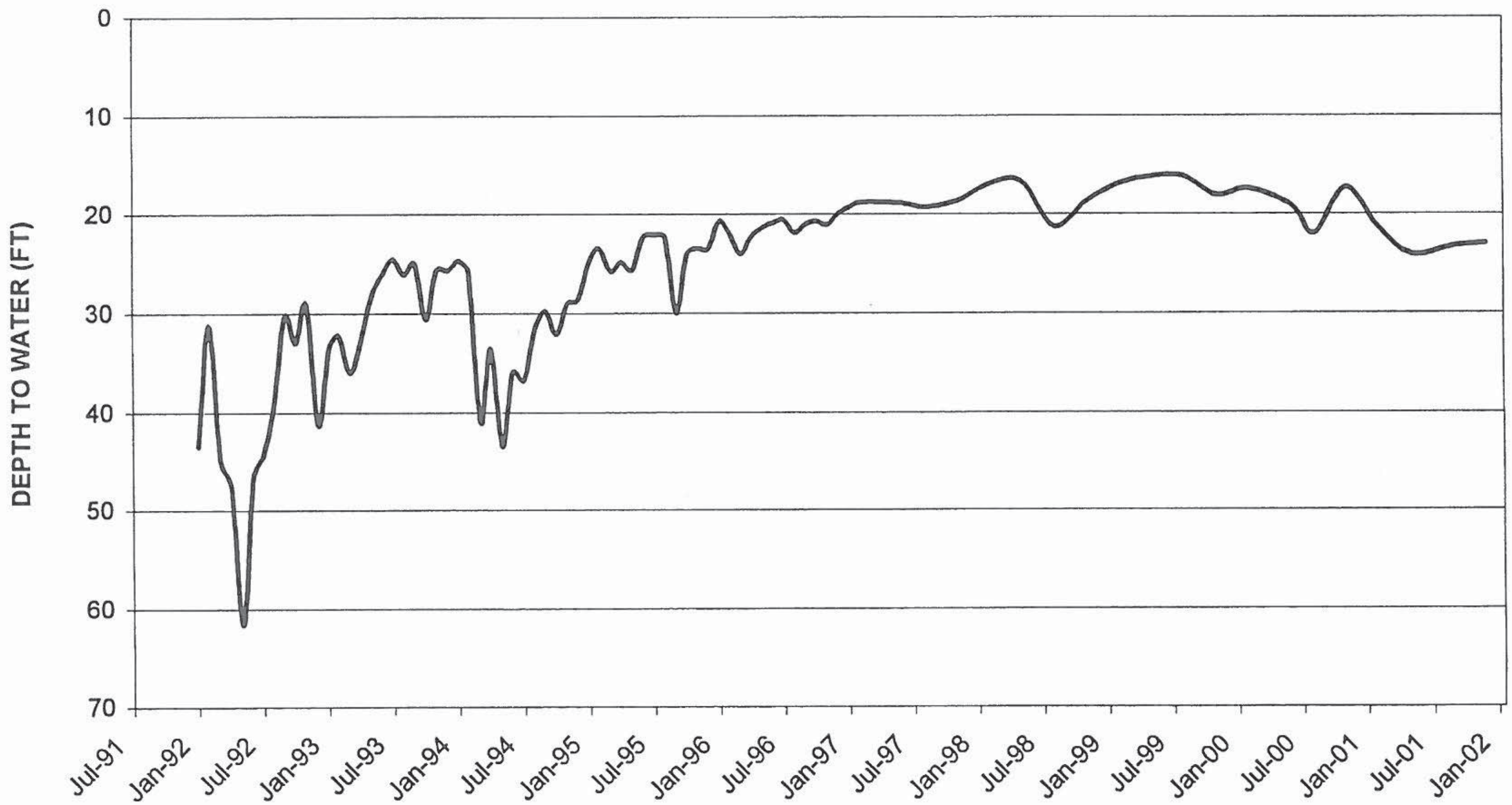


WATER LEVEL HYDROGRAPH
DMW #1
27-22 8A GRND. ELEV=235.7 FT



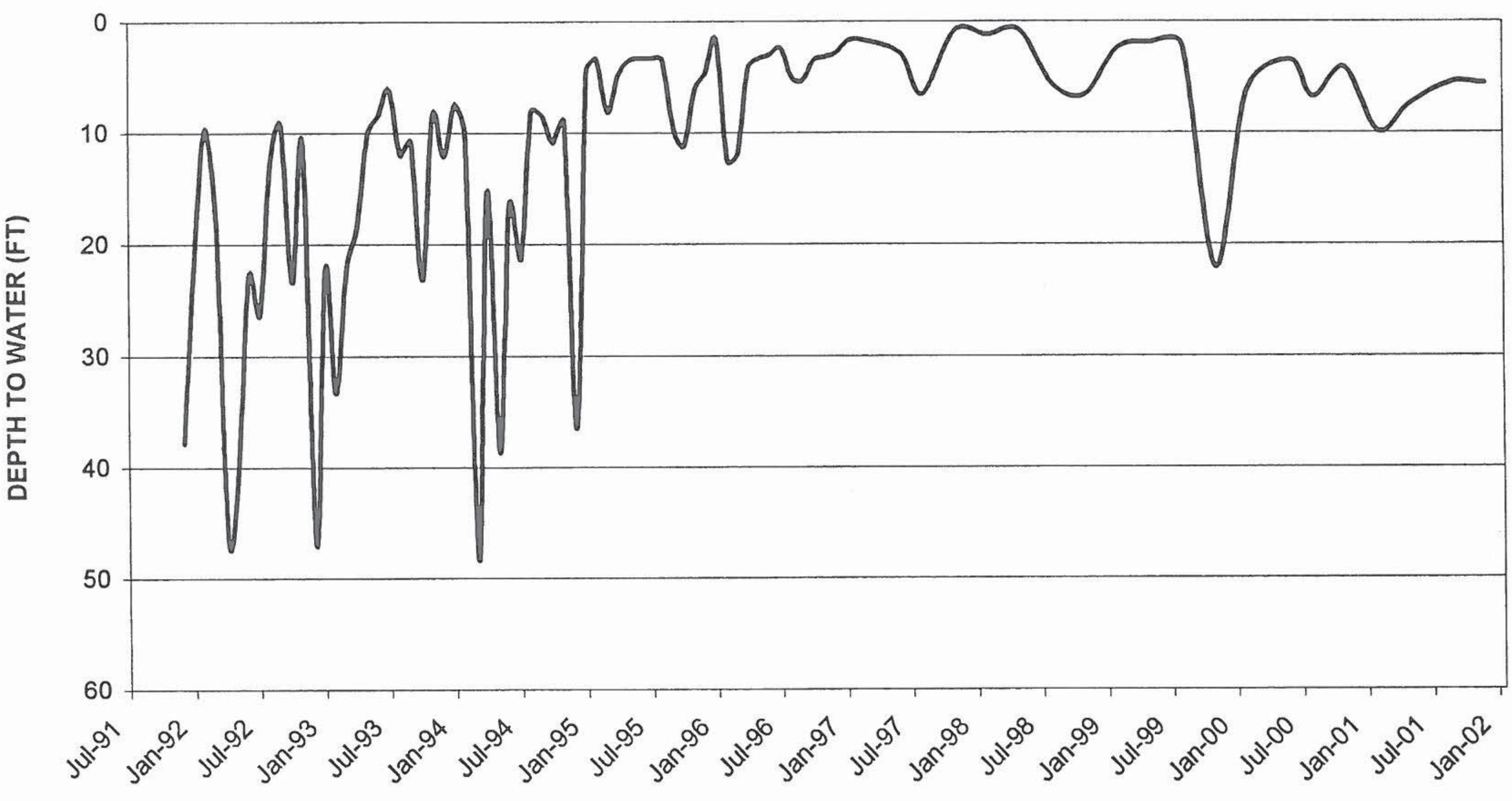
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #3
27-22 33A GRND. ELEV=240.5 FT



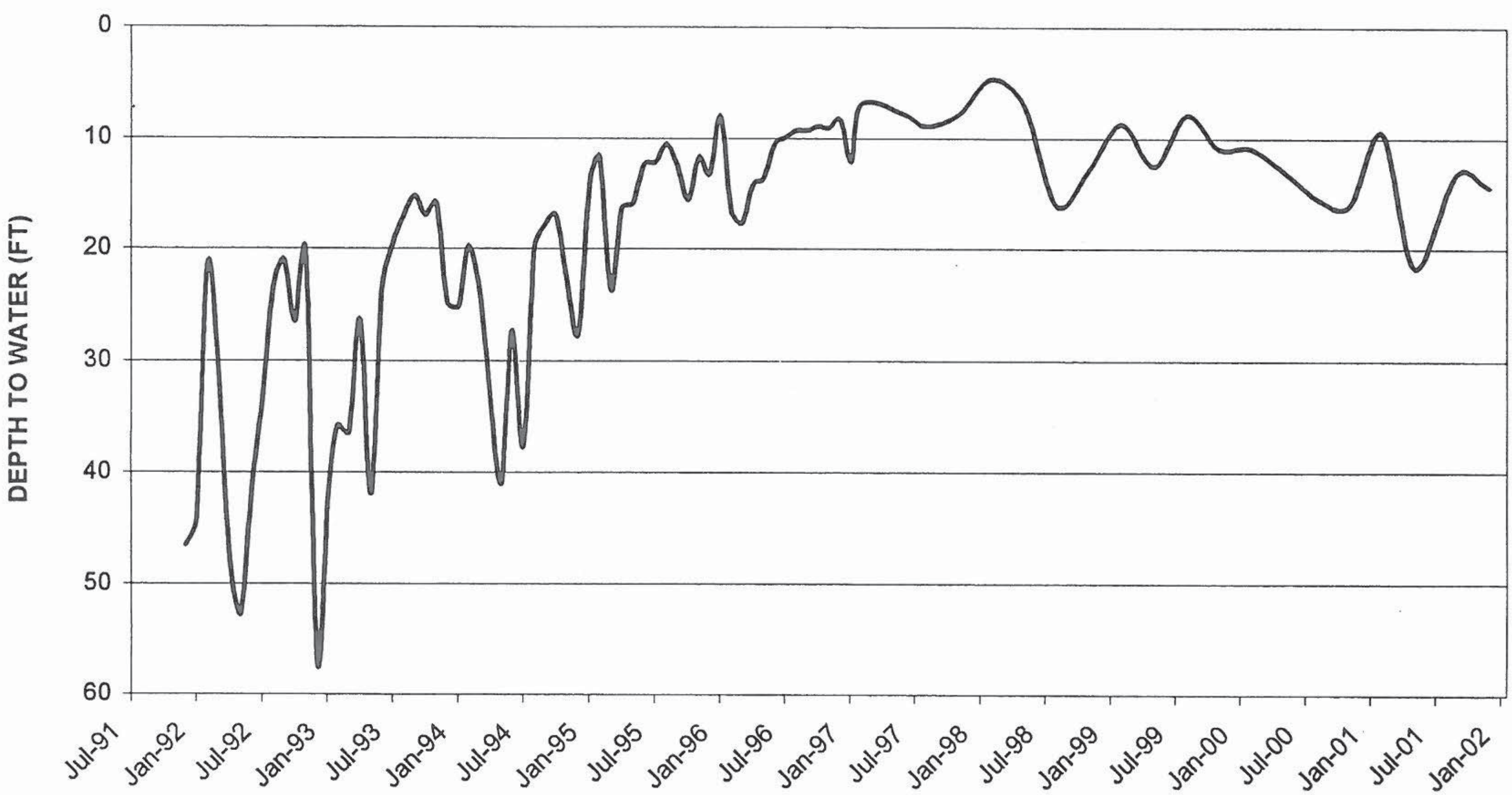
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #4
28-22 10D GRND. ELEV=242.8 FT



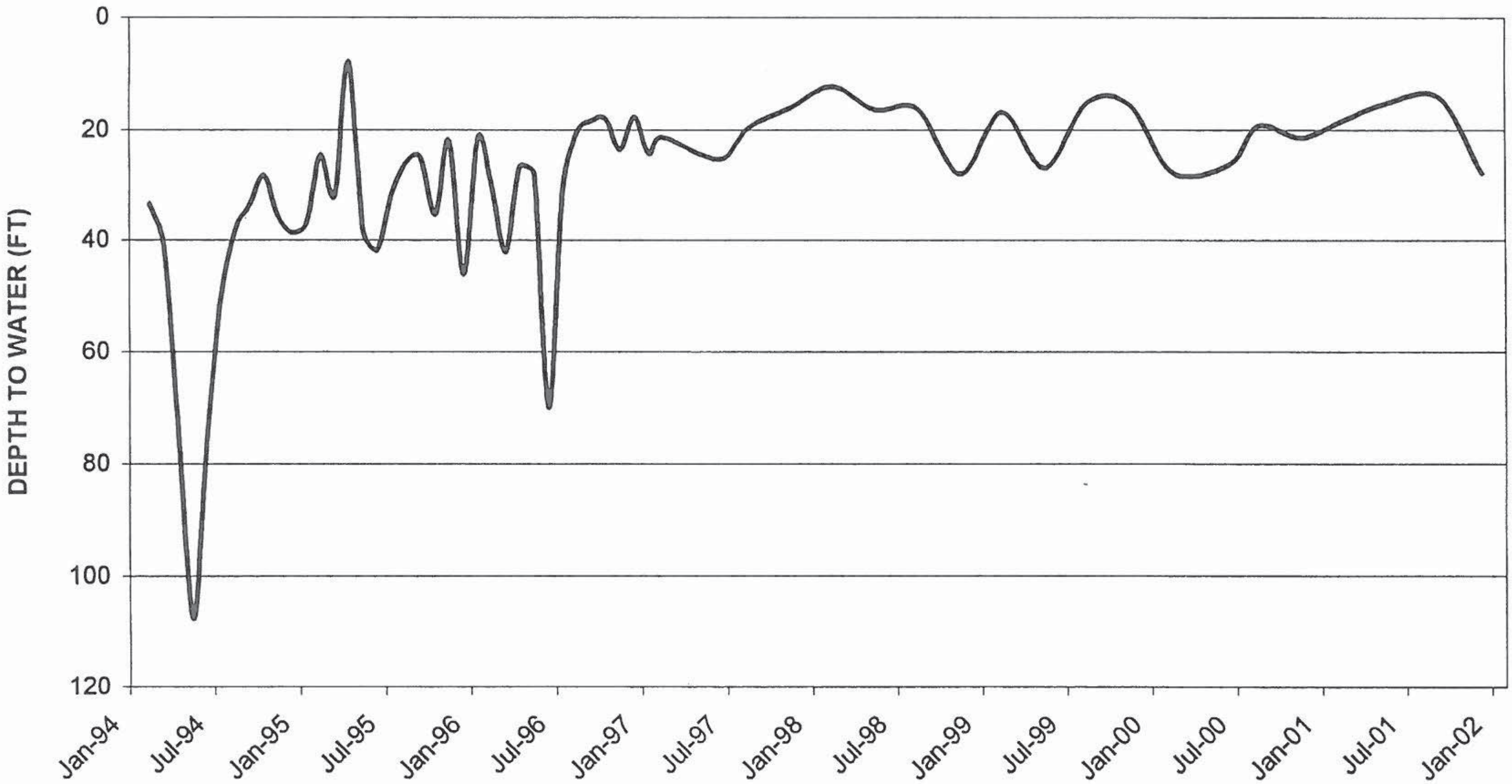
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #5
28-22 14R GRND. ELEV=250.9 FT



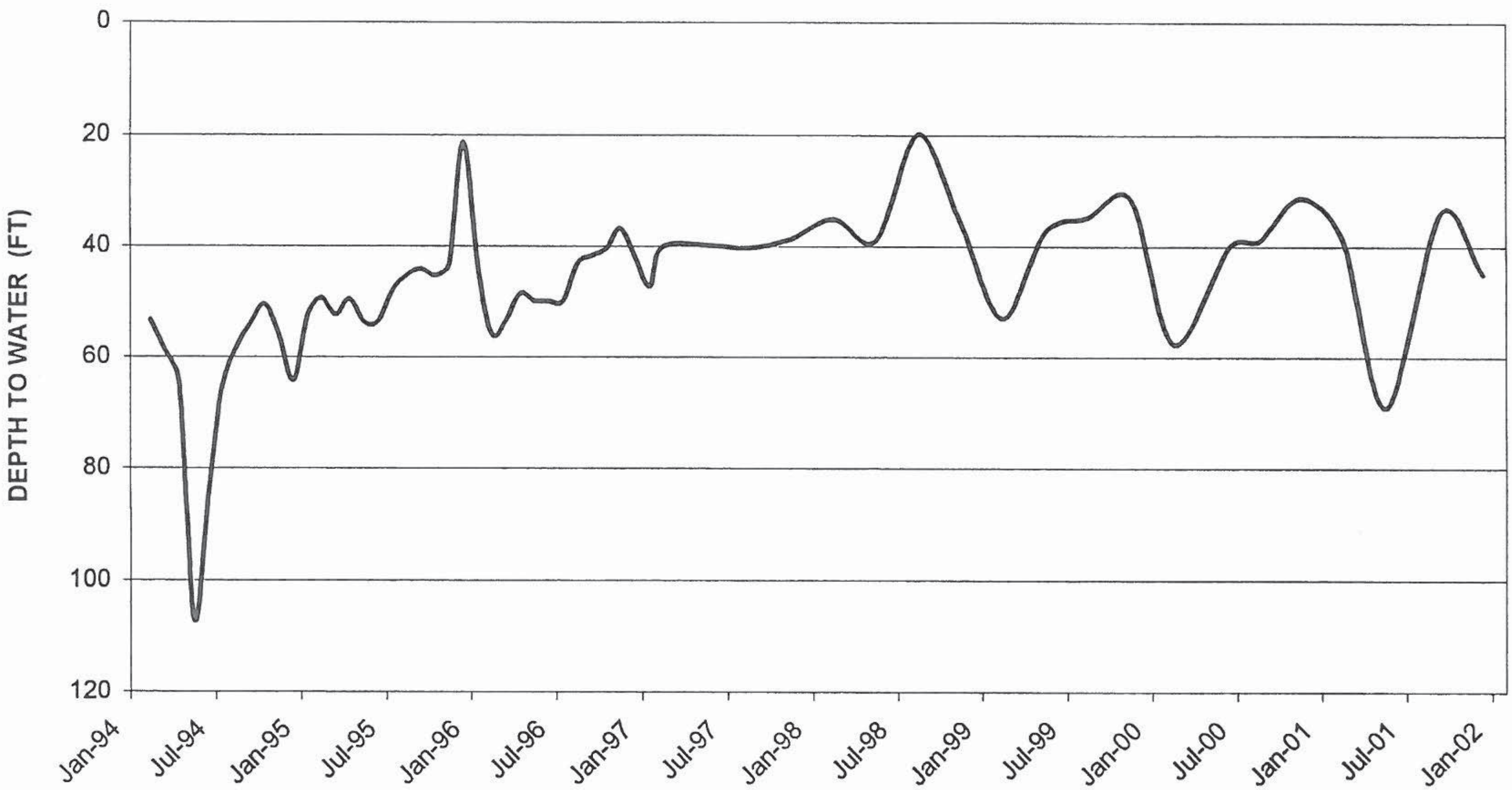
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #6
28-23 31B GRND. ELEV=257.0 FT



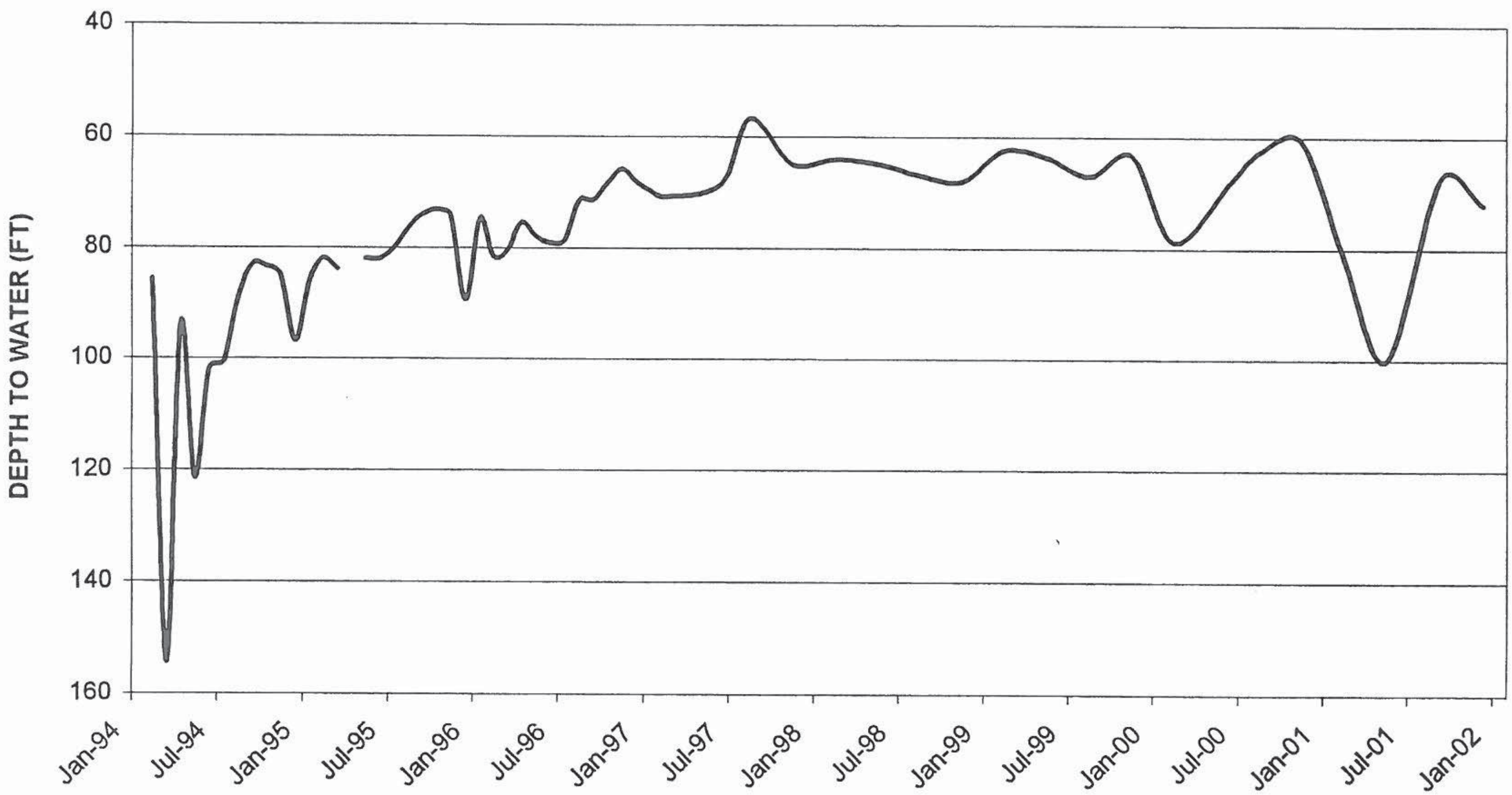
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #7
29-23 16R GRND. ELEV=262.0 FT



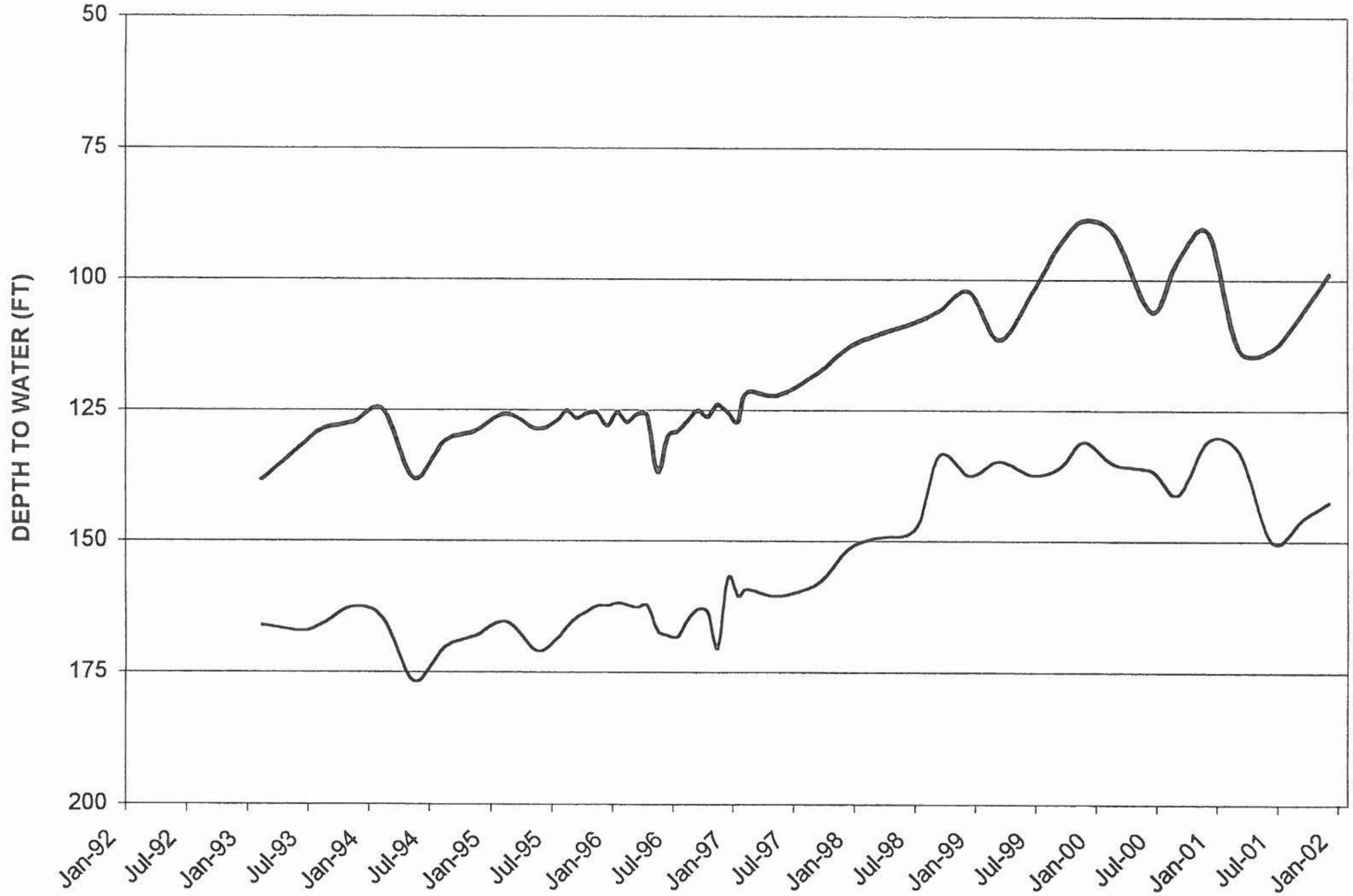
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #8
29-23 24H GRND. ELEV=271.0 FT



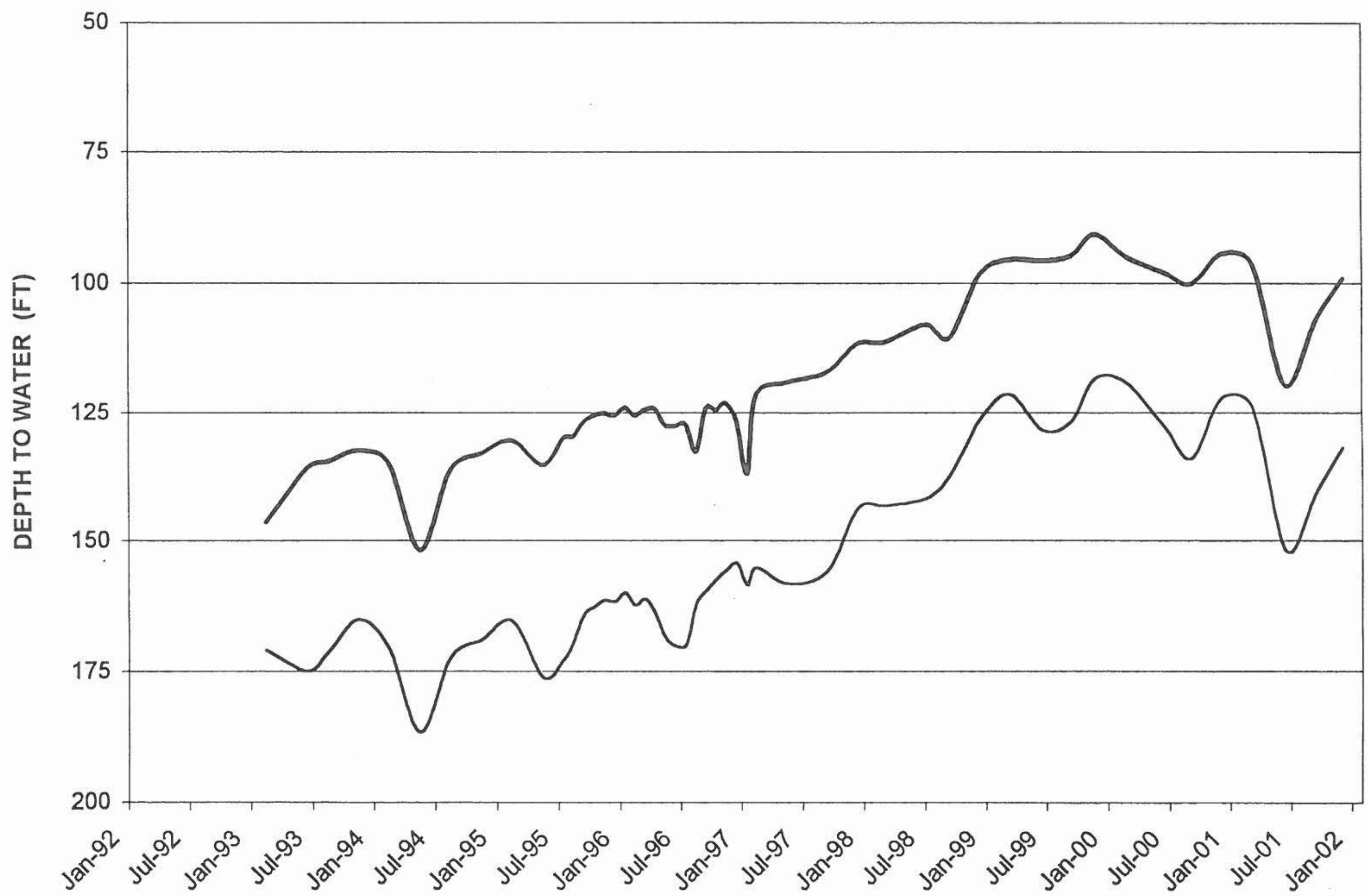
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #10A&B
30-24 06B GRND. ELEV=277.35



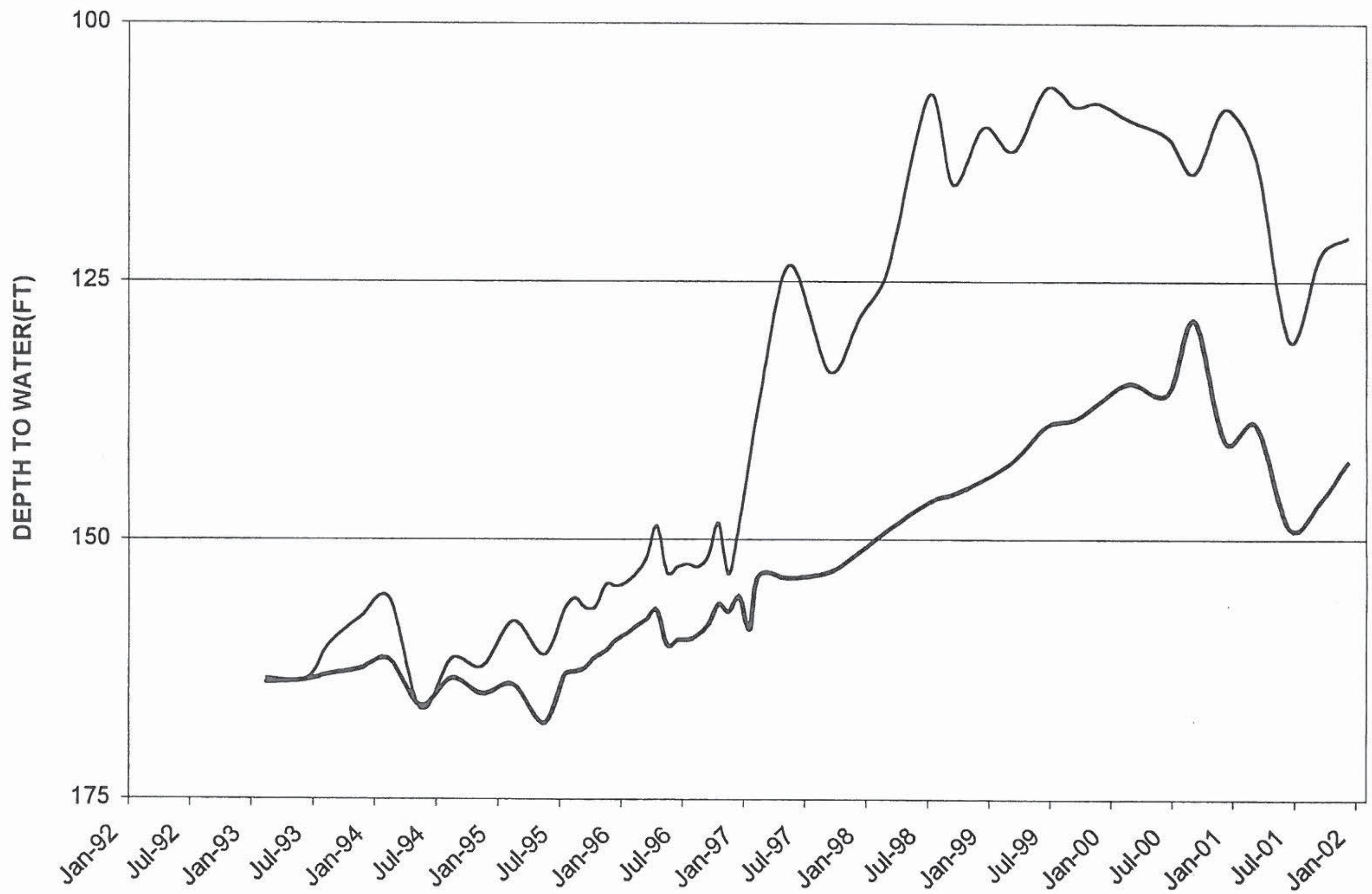
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #11A&B
30-24 34N GRND. ELEV=282.13



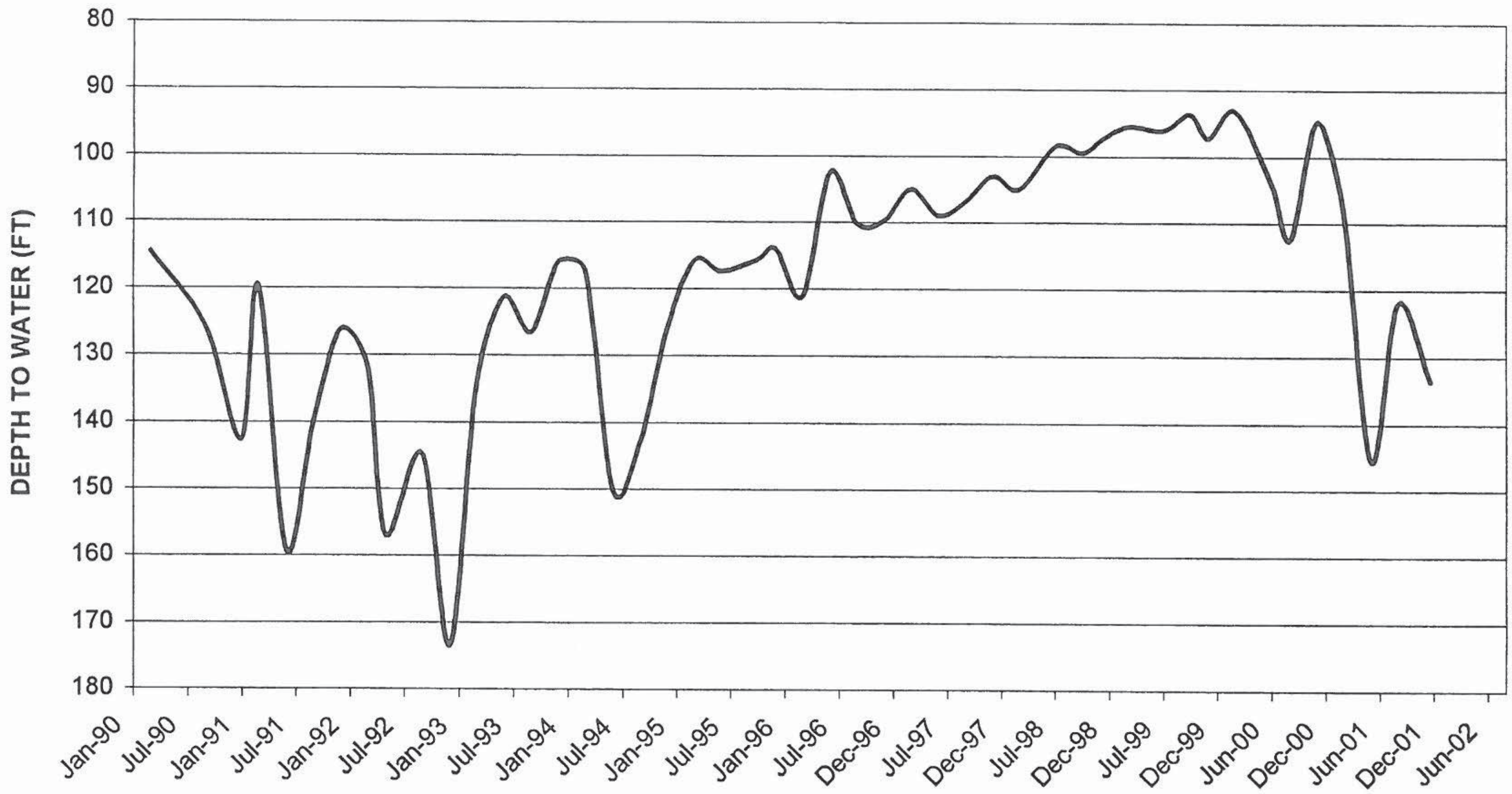
Buena Vista WSD

WATER LEVEL HYDROGRAPH
DMW #12A&B
30-24 14M GRND. ELEV=288.62



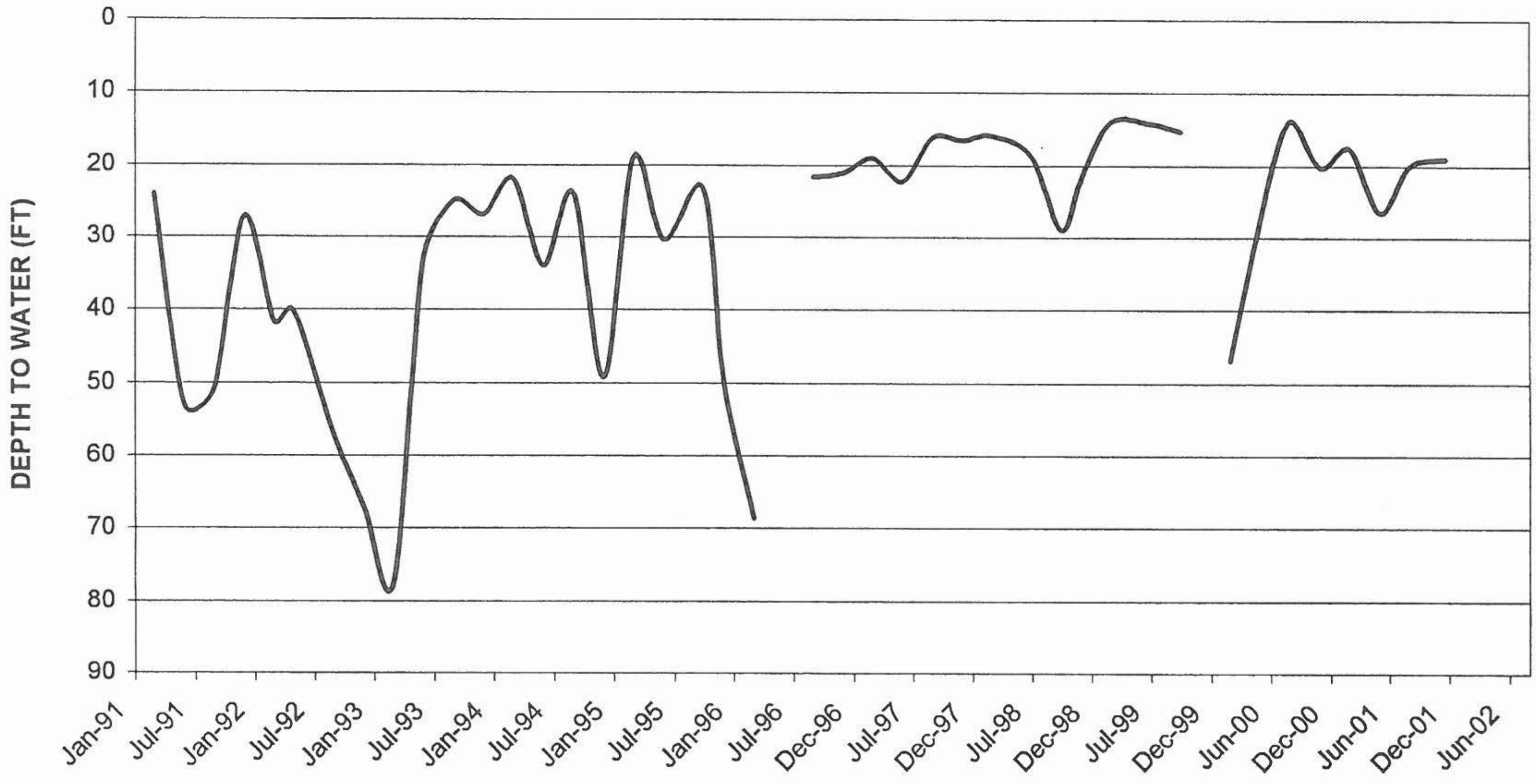
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #A2
27-22 23D1 GRND. ELEV=238.0 FT



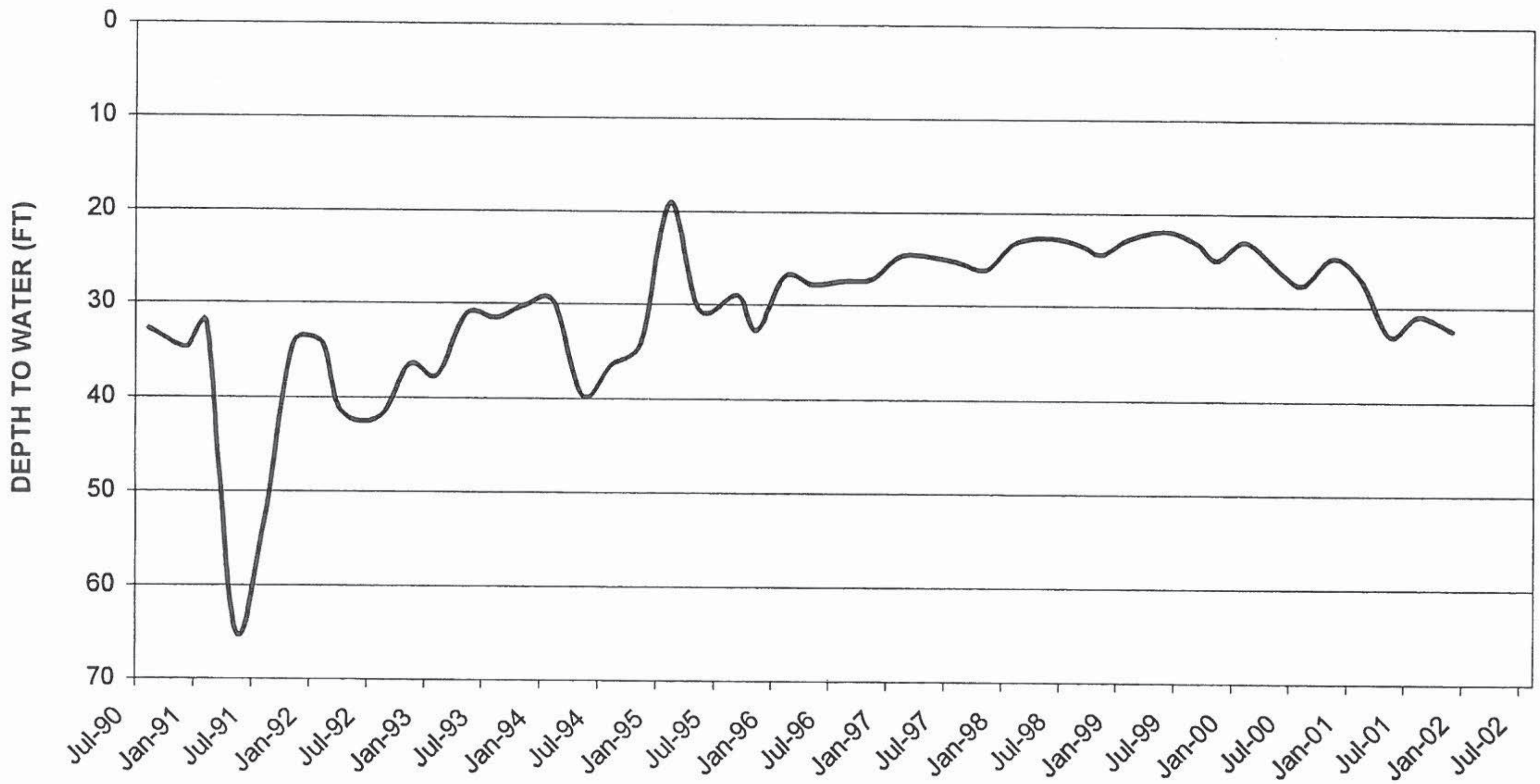
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #A3
27-22 5P GRND. ELEV=236.0 FT



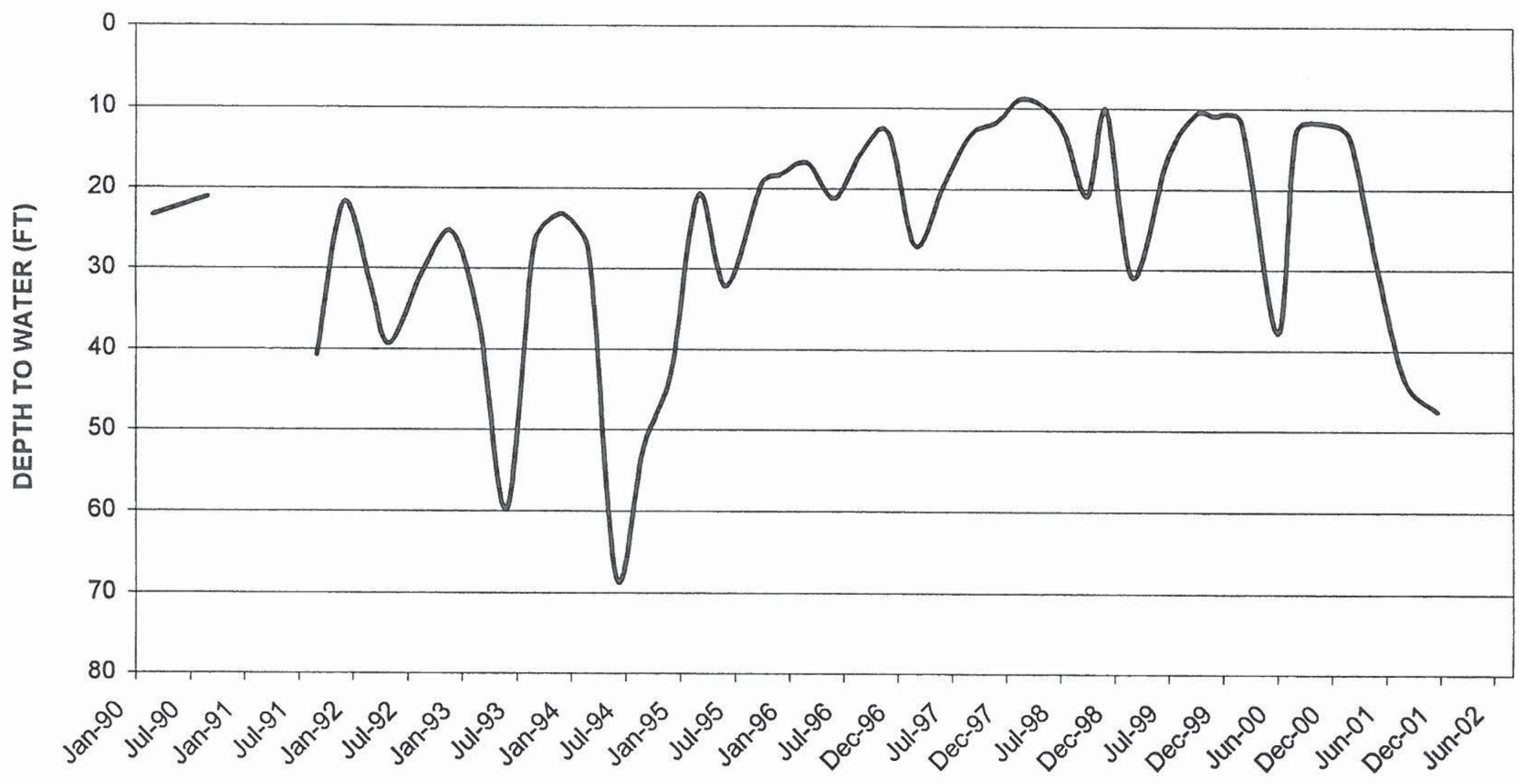
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #A4
27-22 16Q GRND. ELEV=240.0 FT



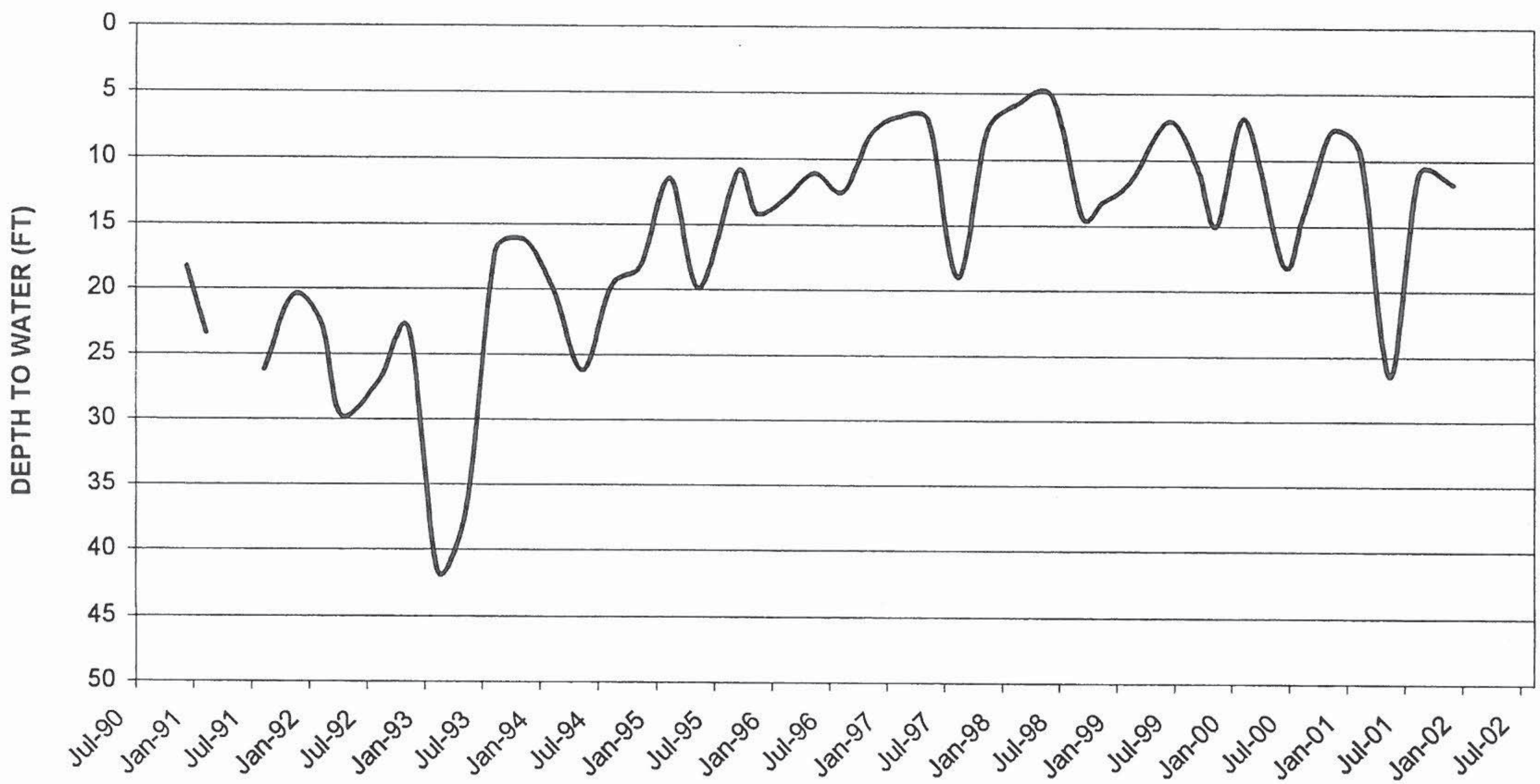
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #B1
28-23 20N1 GRND. ELEV=256.0 FT



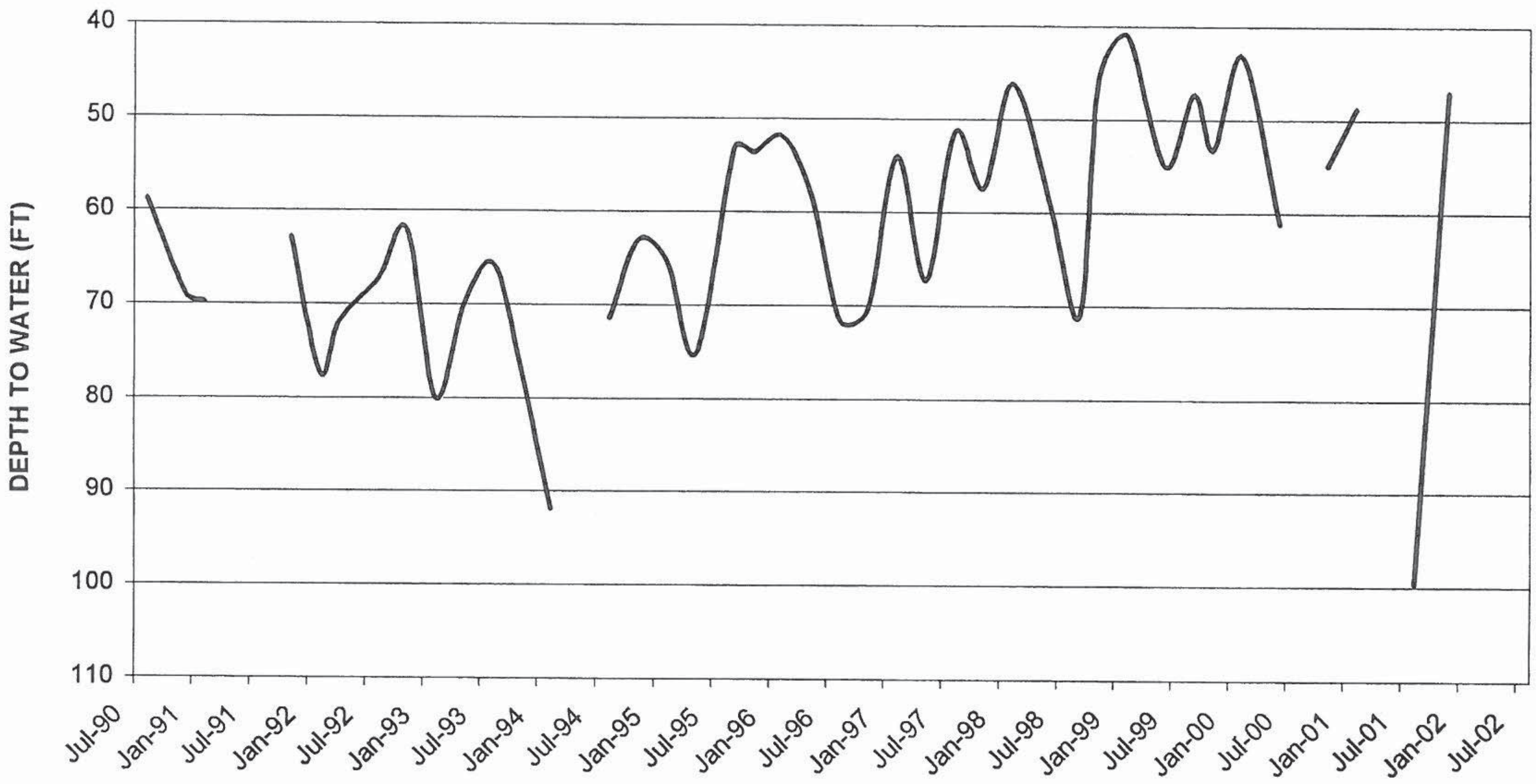
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #B6
28-22 11Q GRND. ELEV=247.0 FT



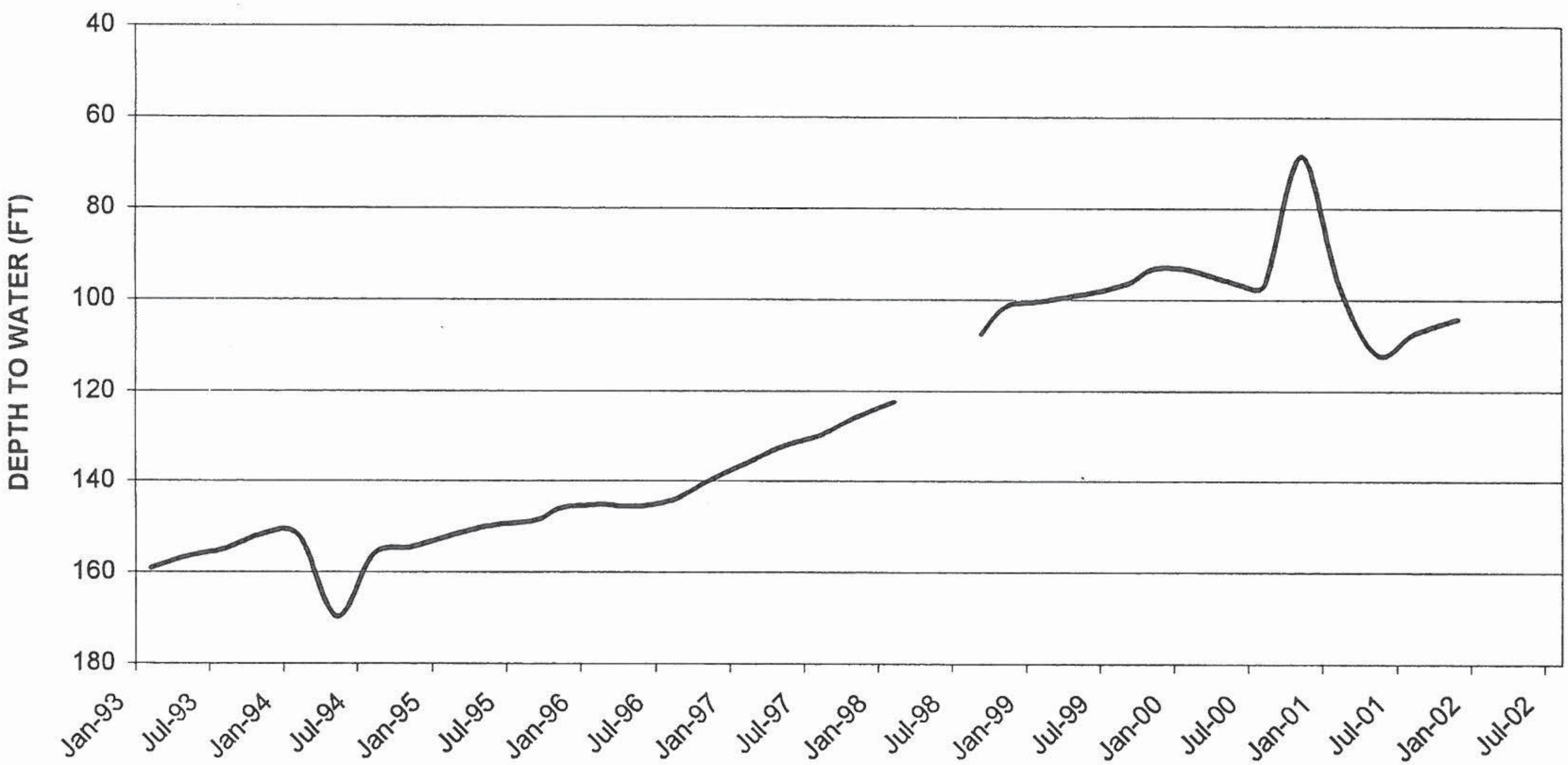
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL #C11
29-23 24P1 GRND. ELEV=269.0 FT



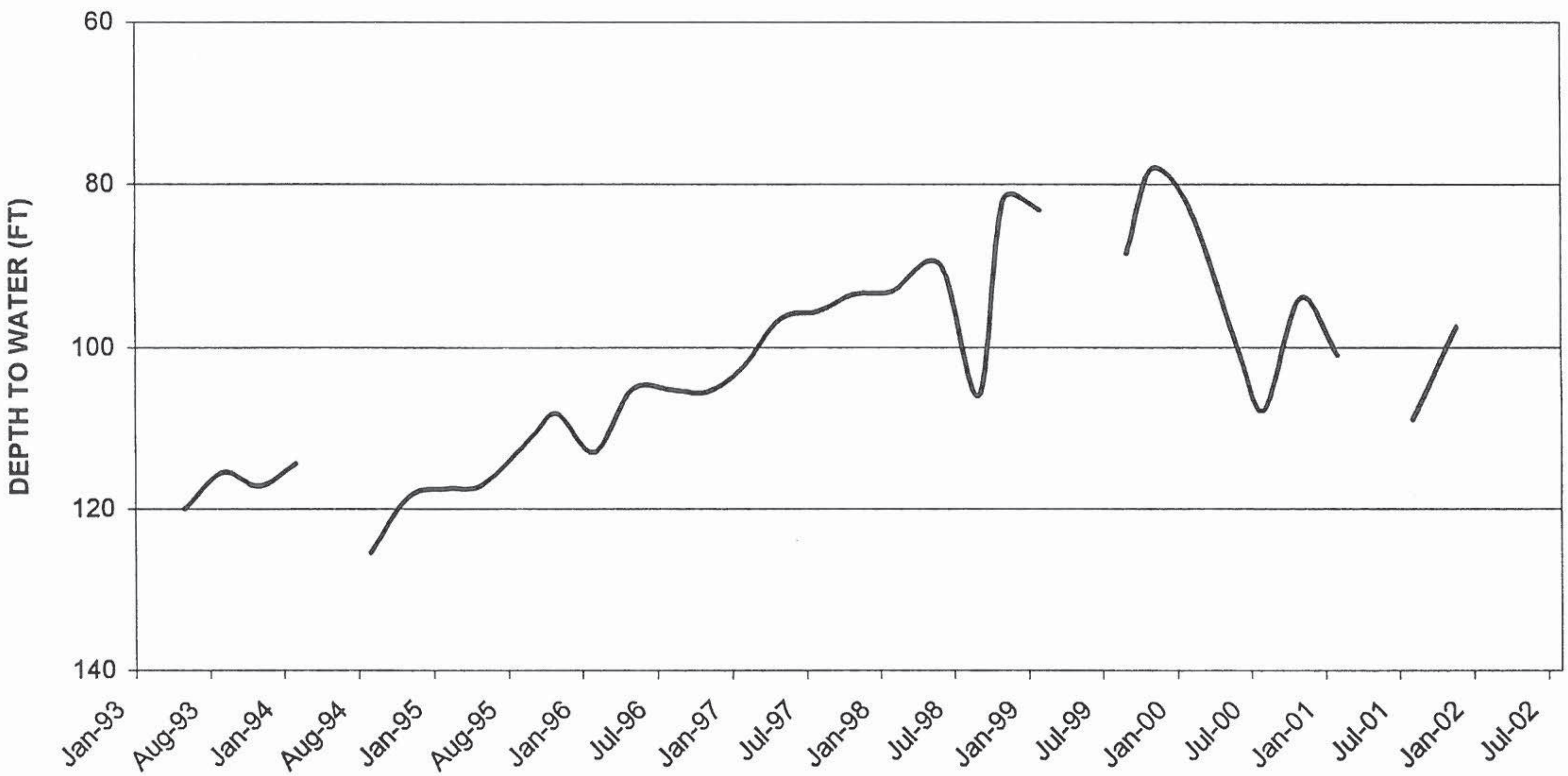
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL D7
30-24 15D GRND. ELEV=285.6 FT



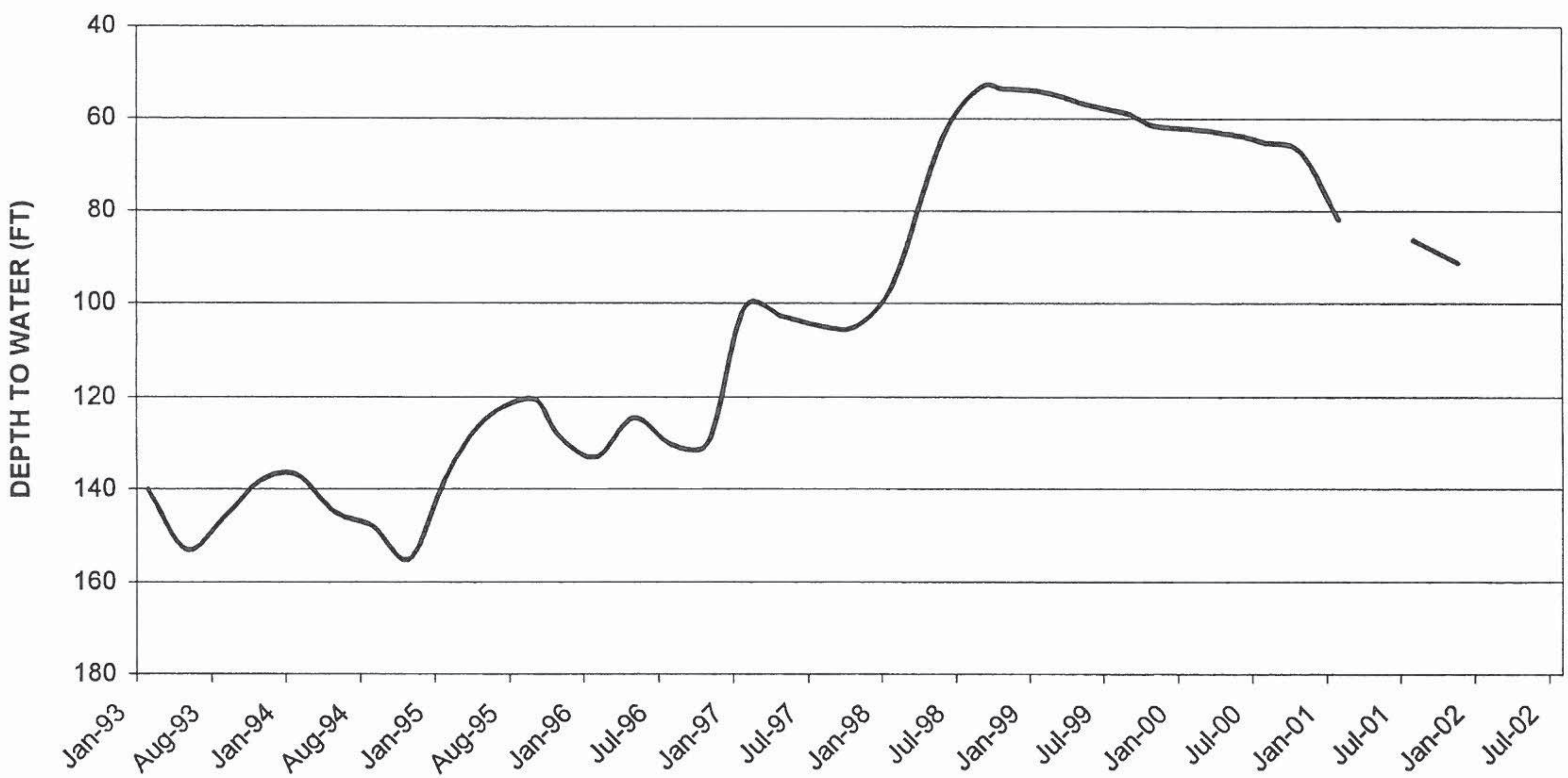
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL D16
29-24 32L GRND. ELEV=280.0 FT



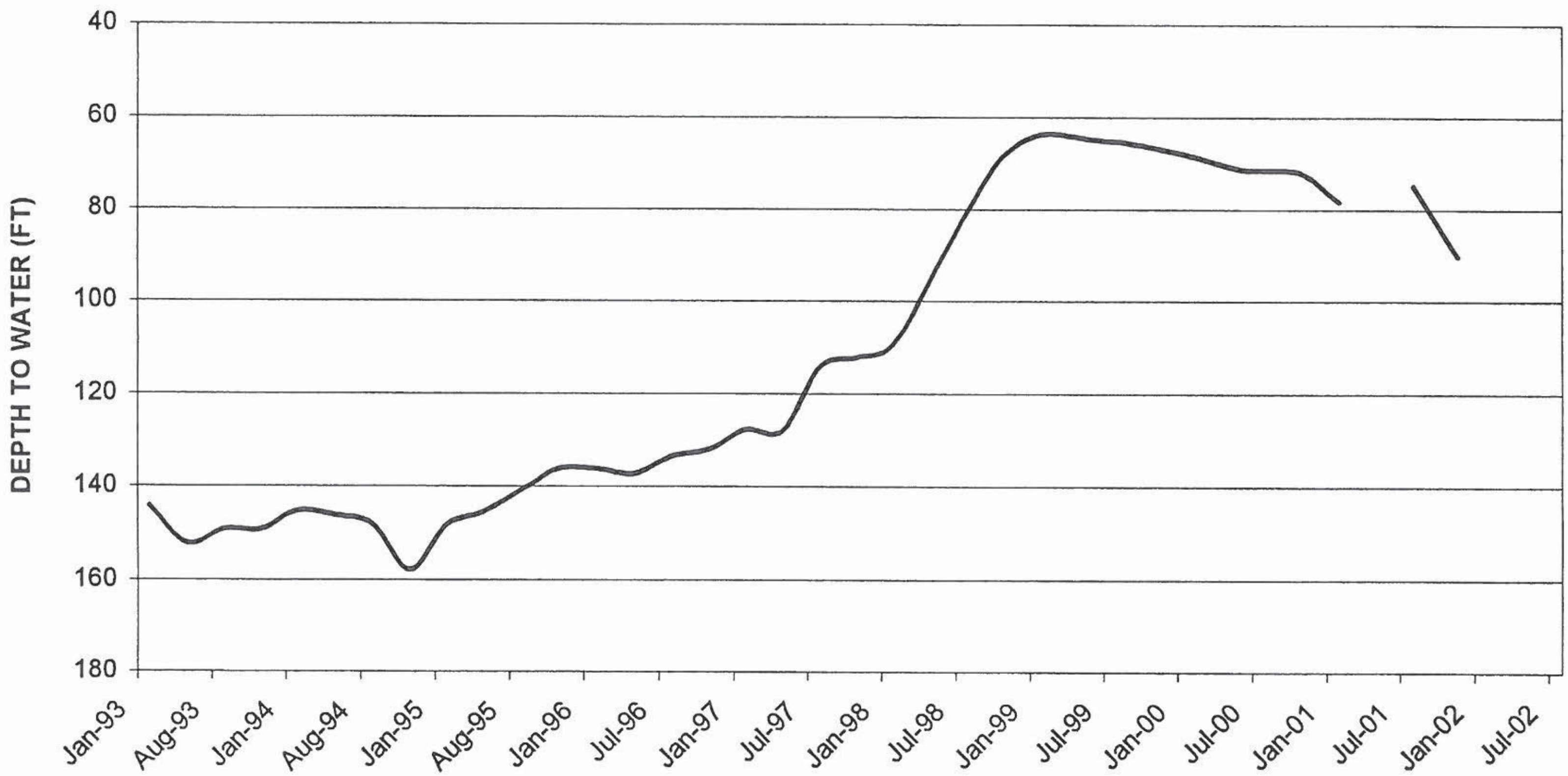
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL W1
30-24 23B GRND. ELEV=293.18 FT



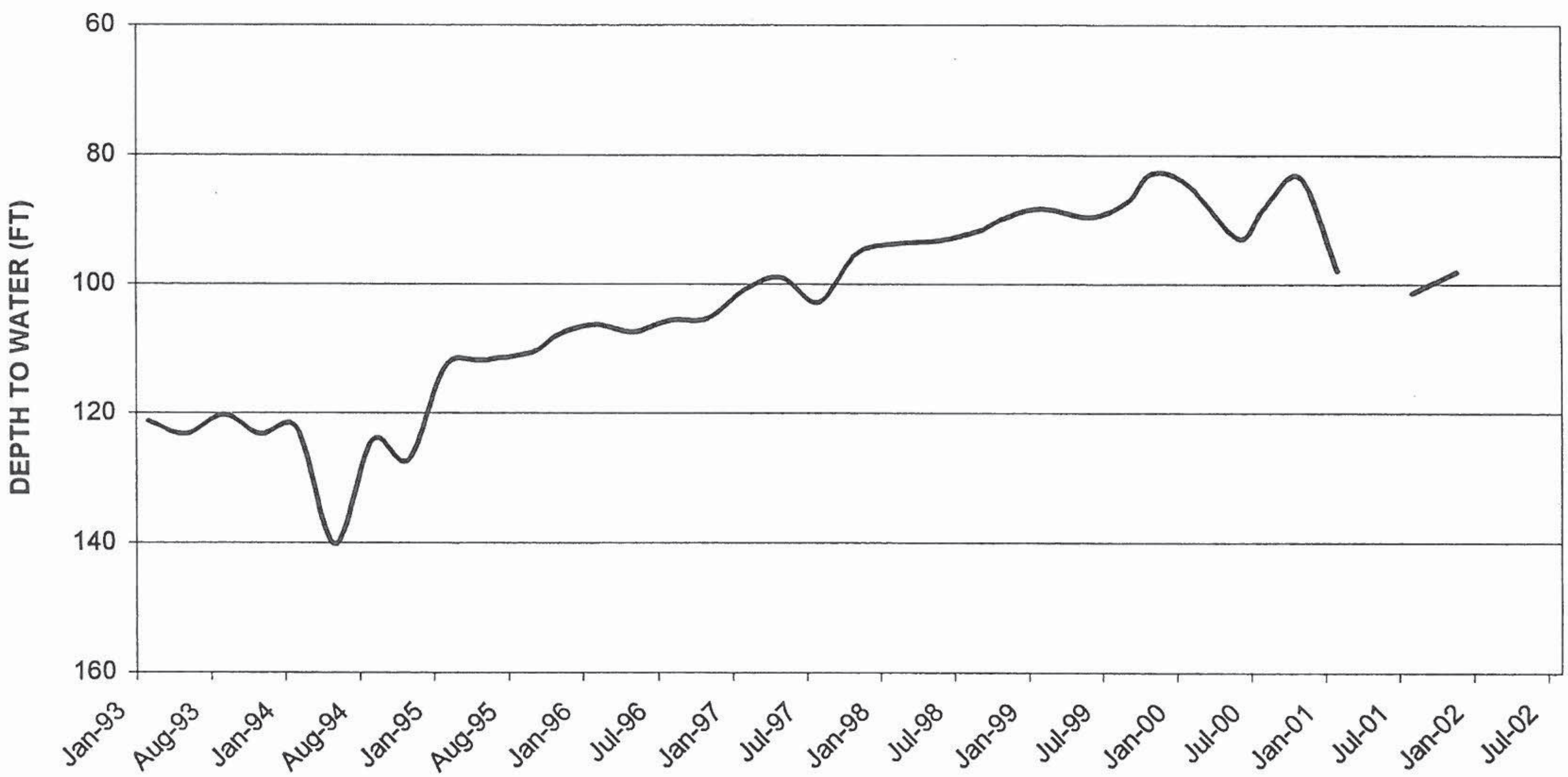
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL W2
30-24 11P GRND. ELEV=291.84 FT



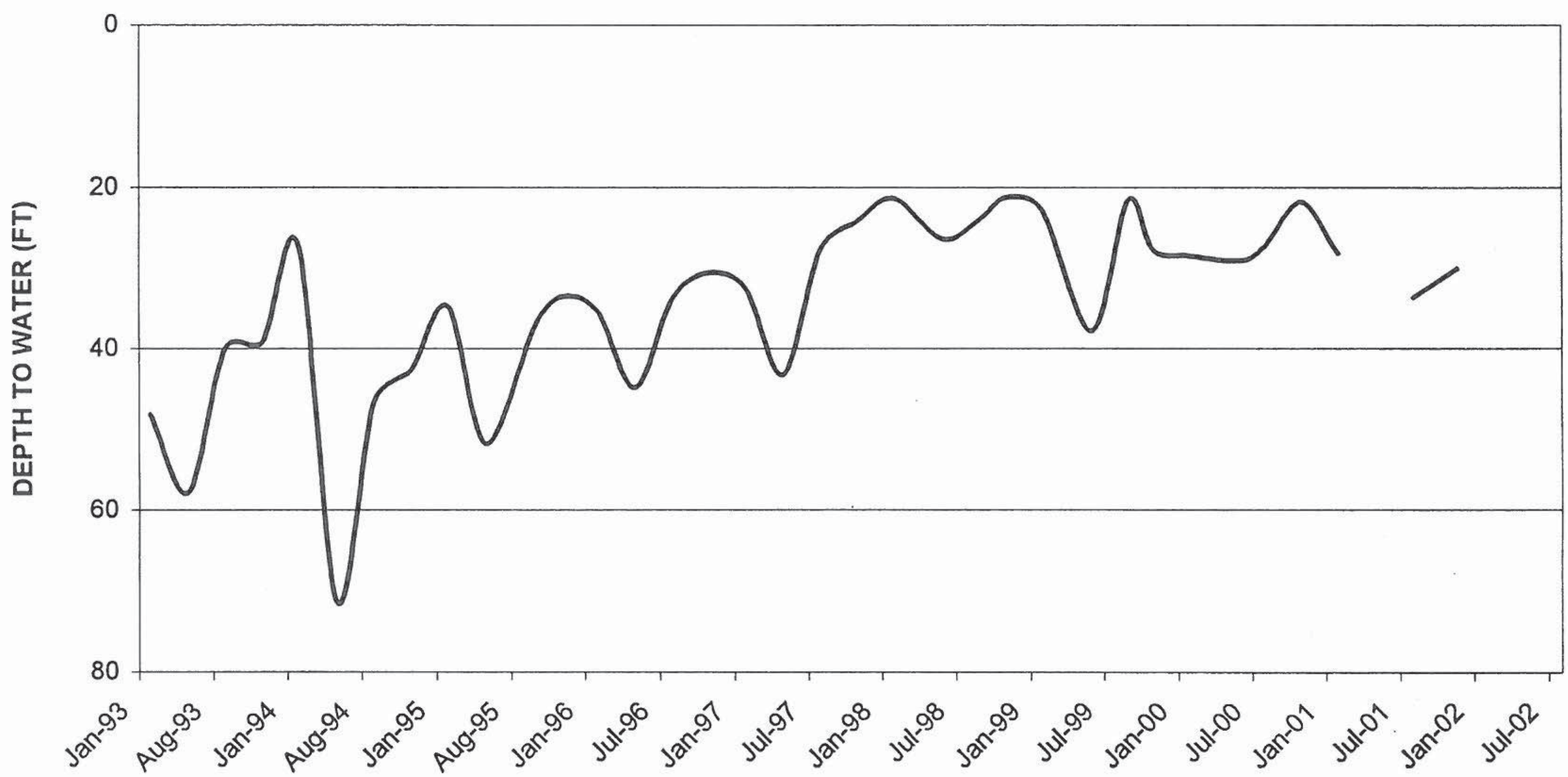
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL W3
29-24 29A GRND. ELEV=279.3 FT



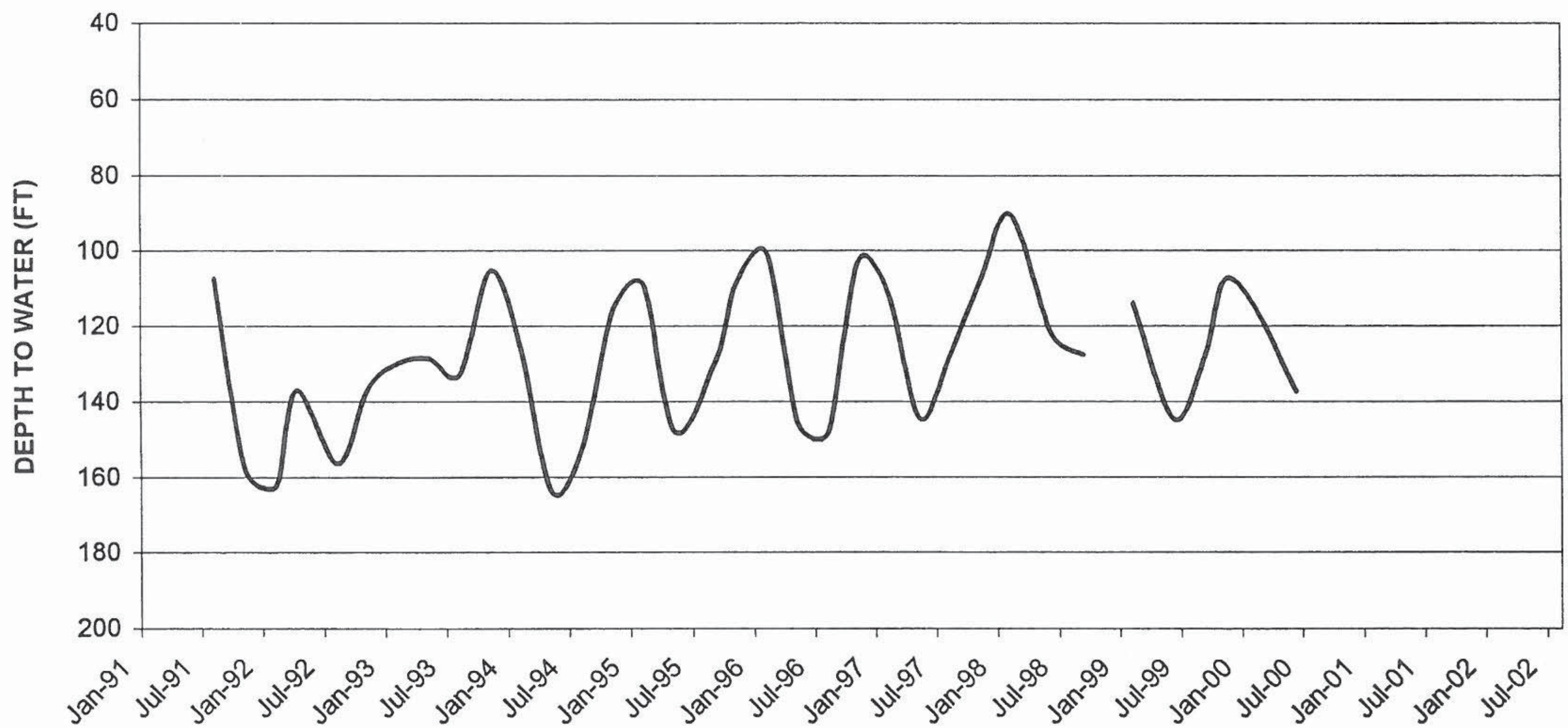
Buena Vista WSD

WATER LEVEL HYDROGRAPH
WELL W4
30-24 23B GRND. ELEV=258.85 FT



Buena Vista WSD

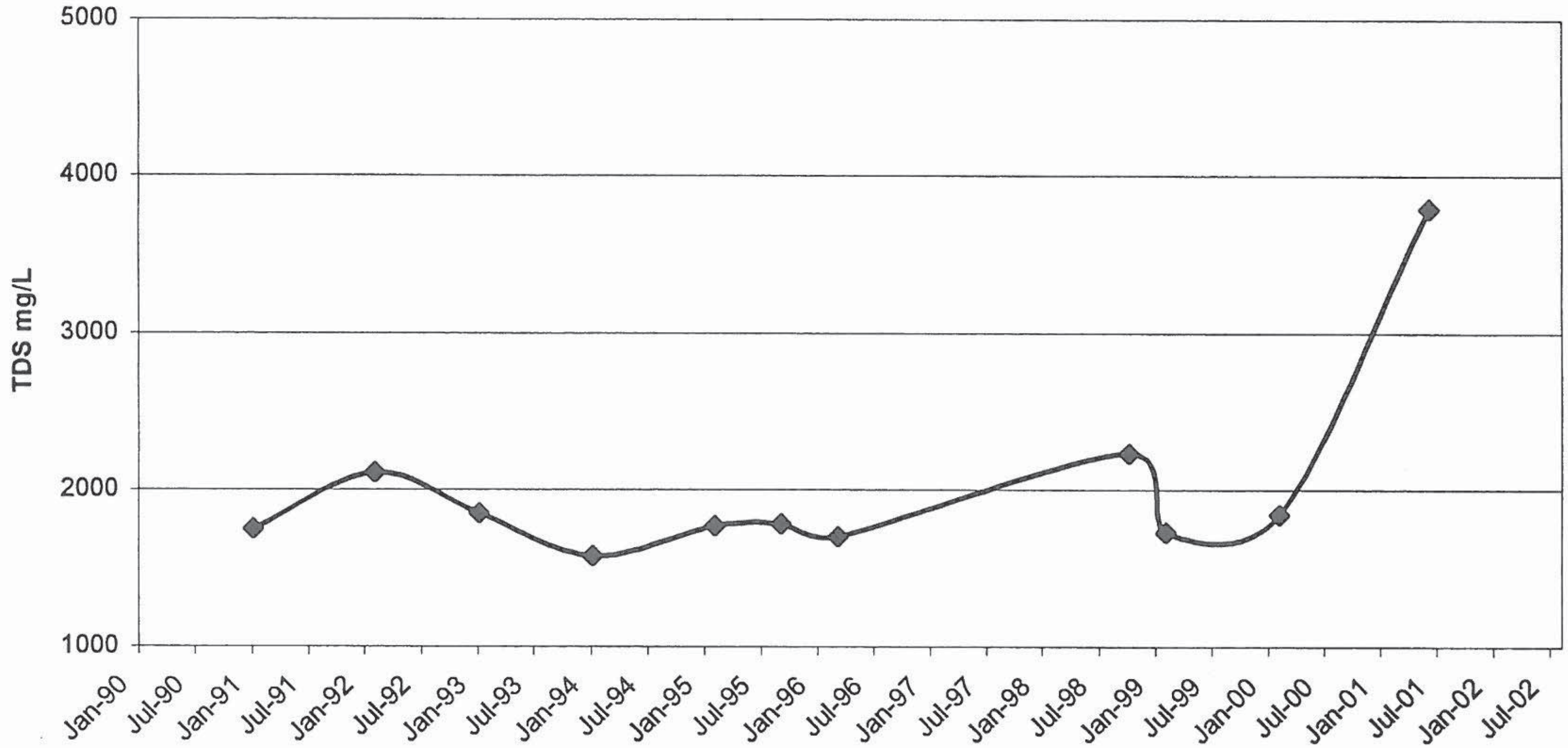
WATER LEVEL HYDROGRAPH
WELL M2
31-26 29L GRND. ELEV=291 FT



Buena Vista WSD

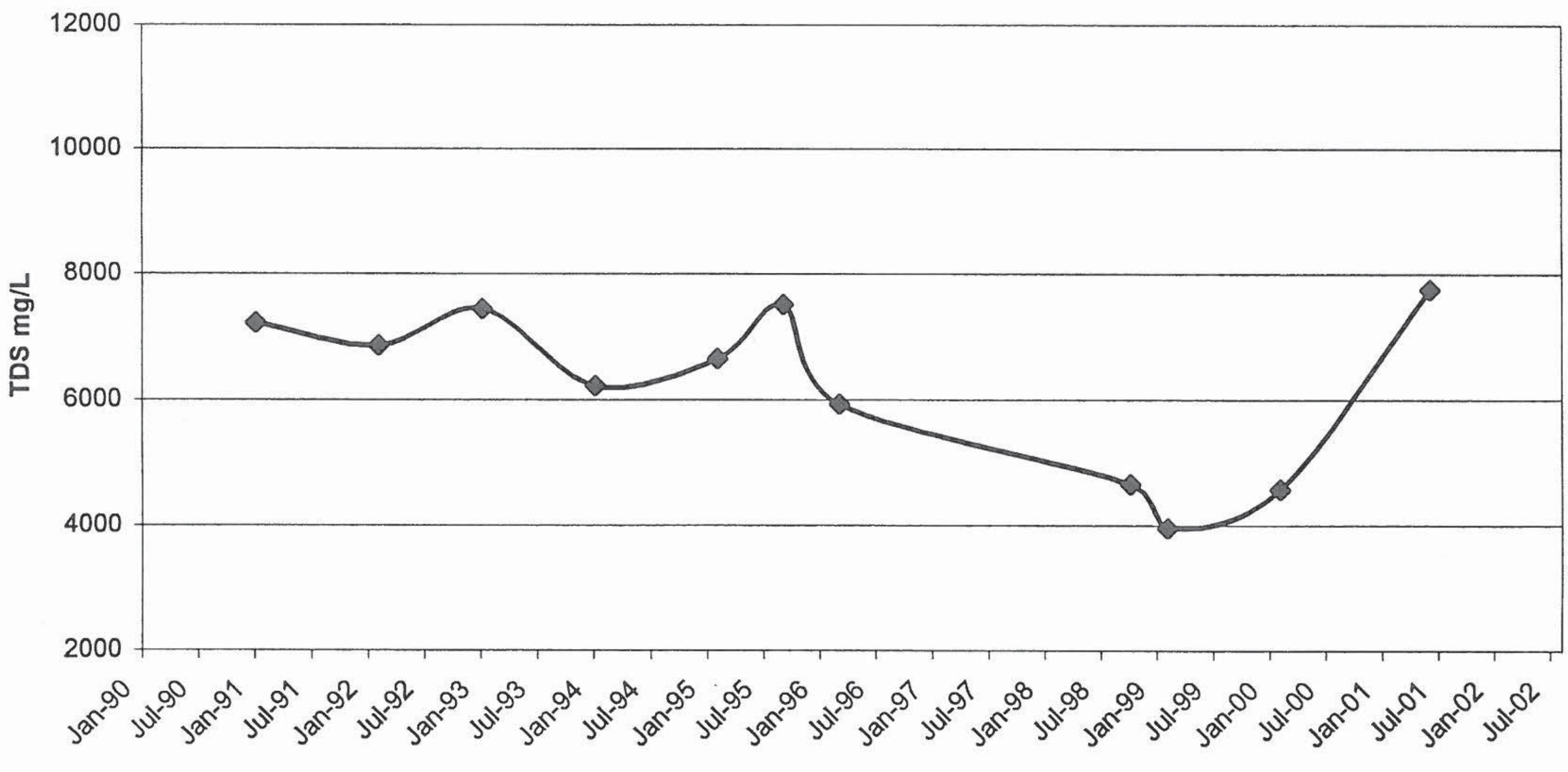
Appendix E

TDS HYDROGRAPH
PIEZOMETER BV#5
27-22 09H



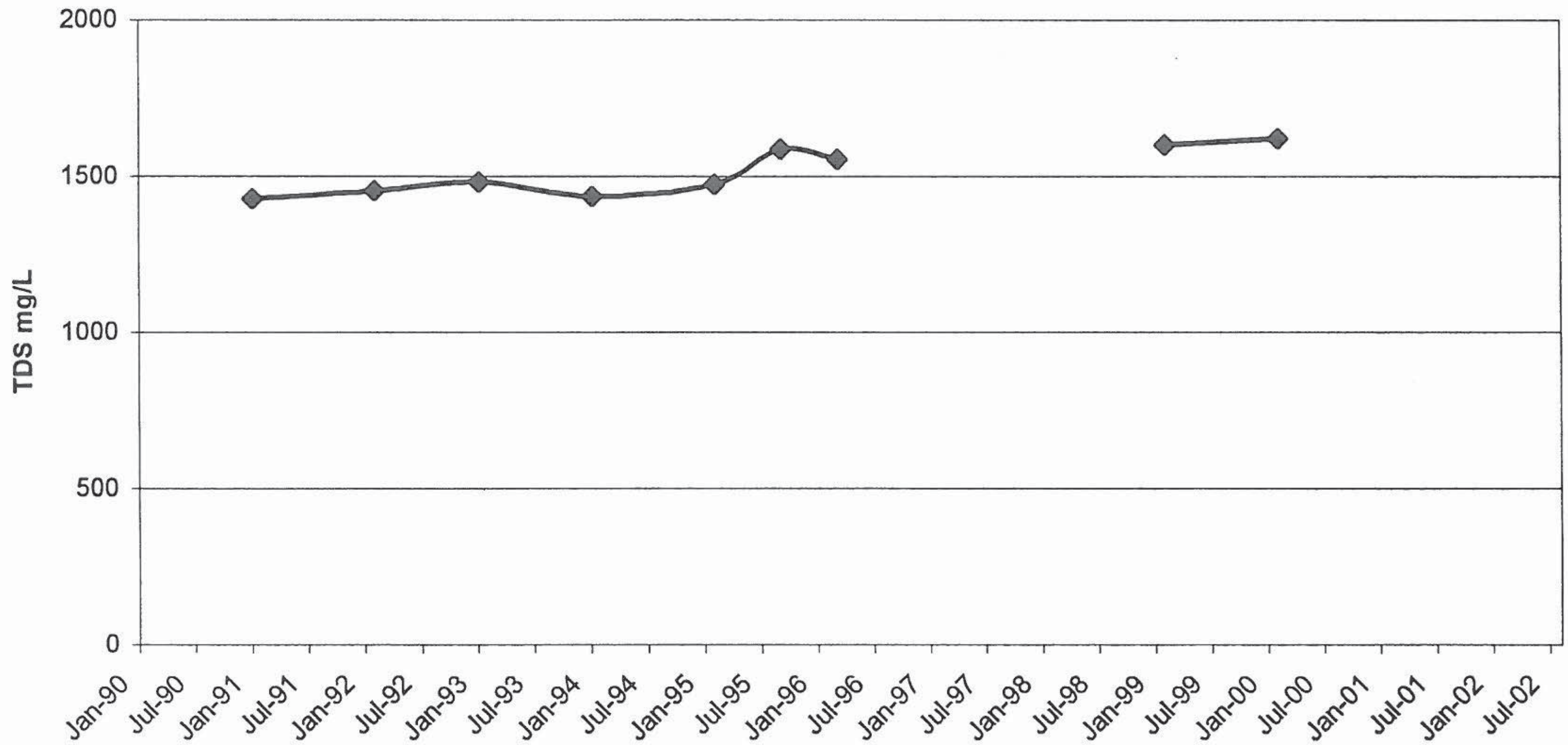
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BV#8C
27-22 15N



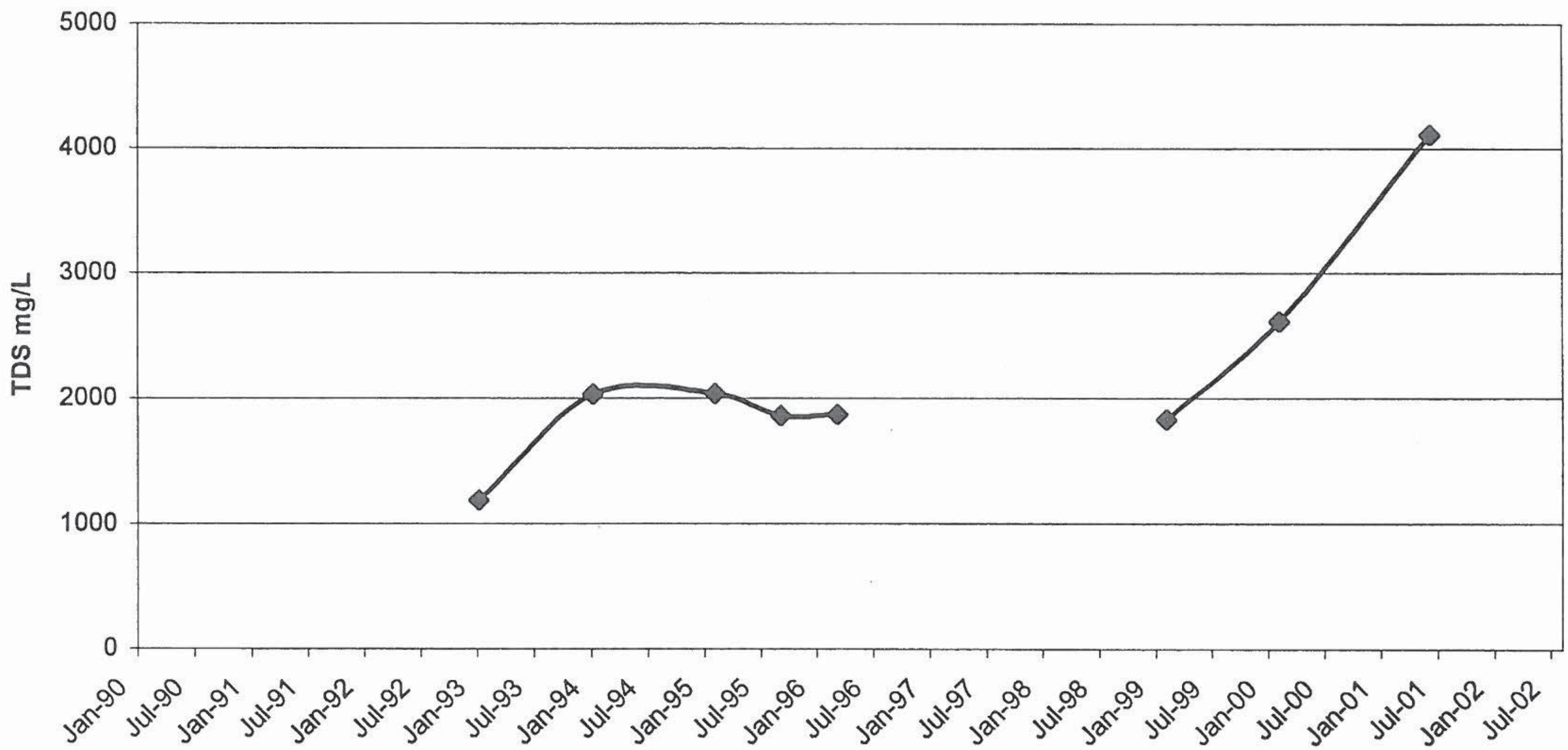
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BV#10A
27-22 20H



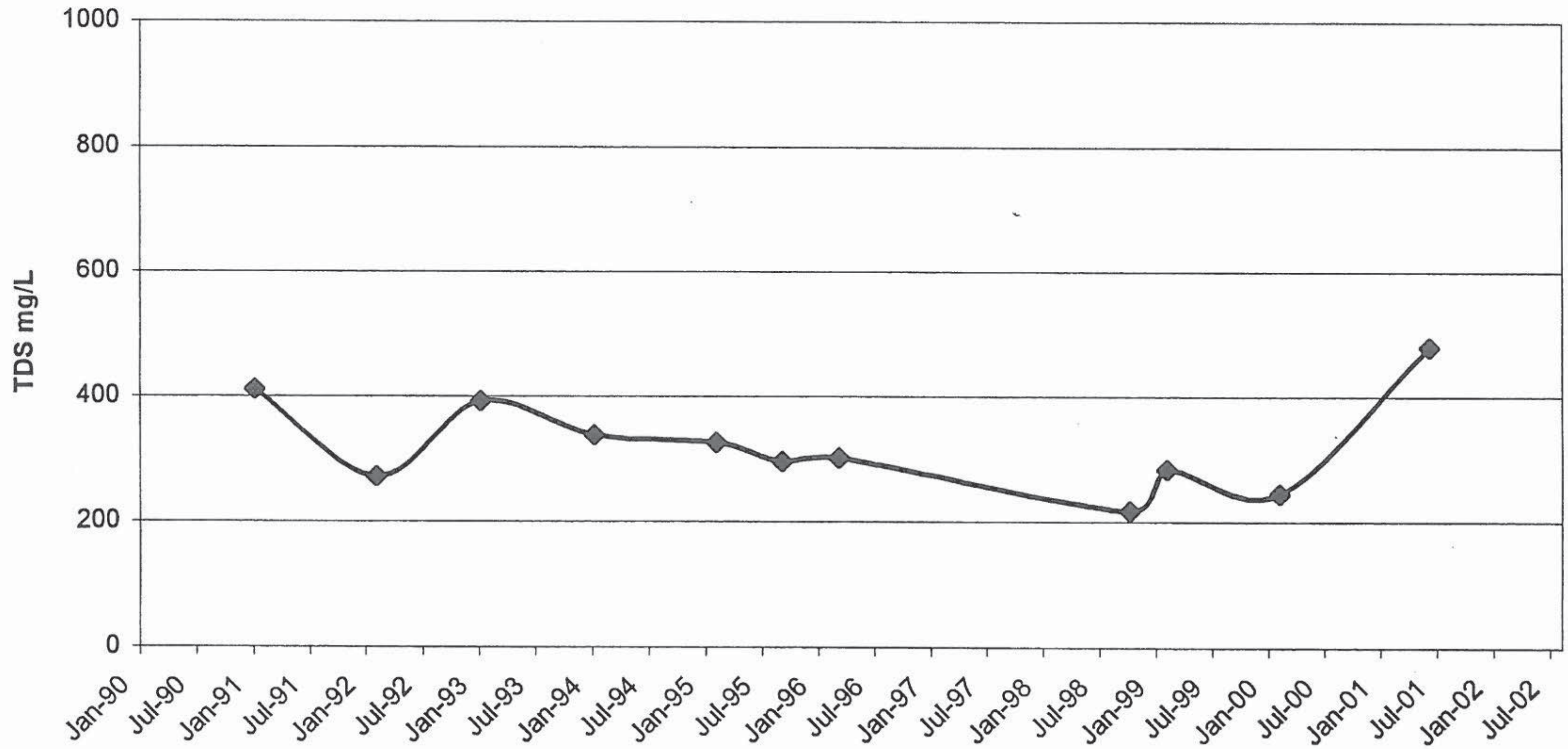
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BV#17A
28-22 3D



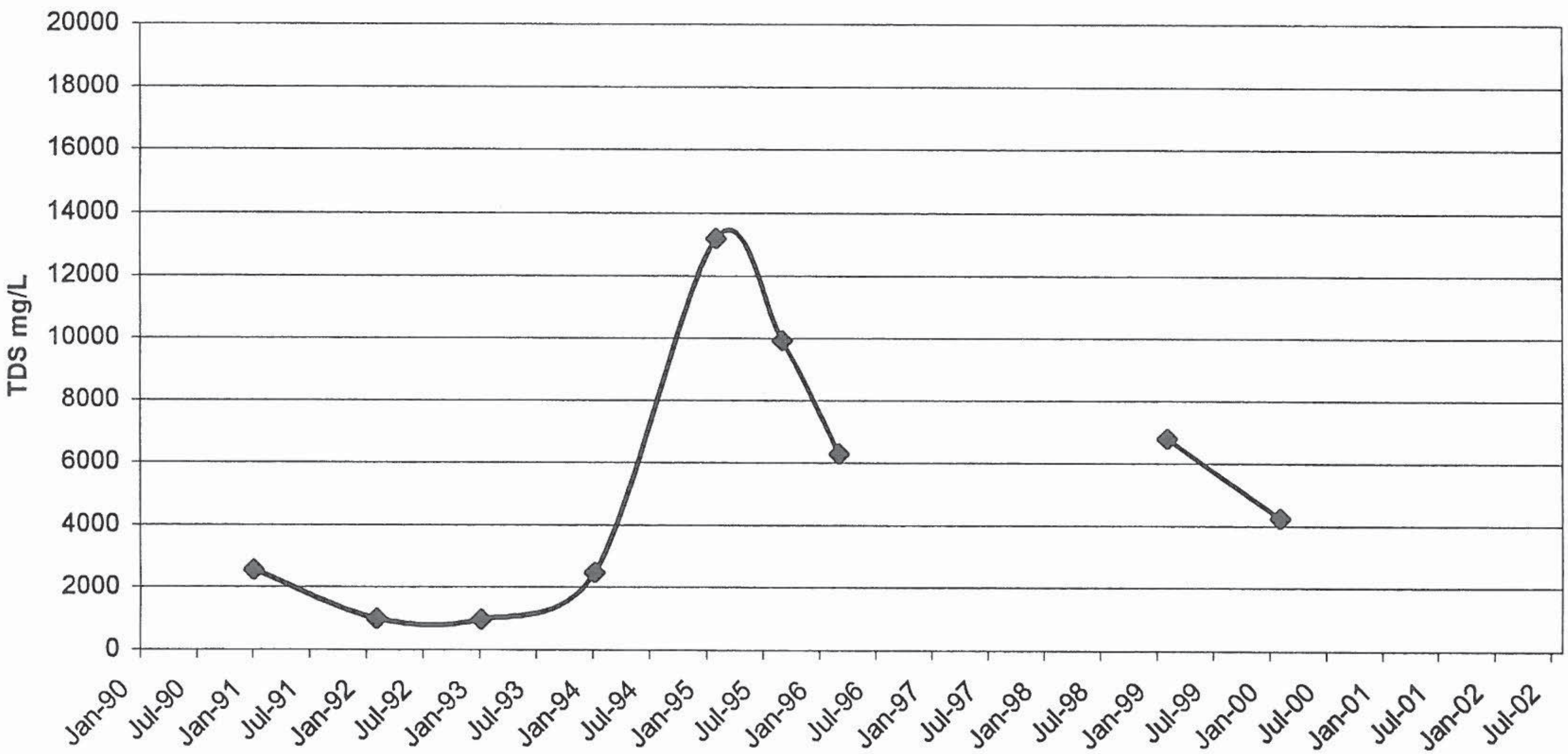
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BV#27
28-22 11R



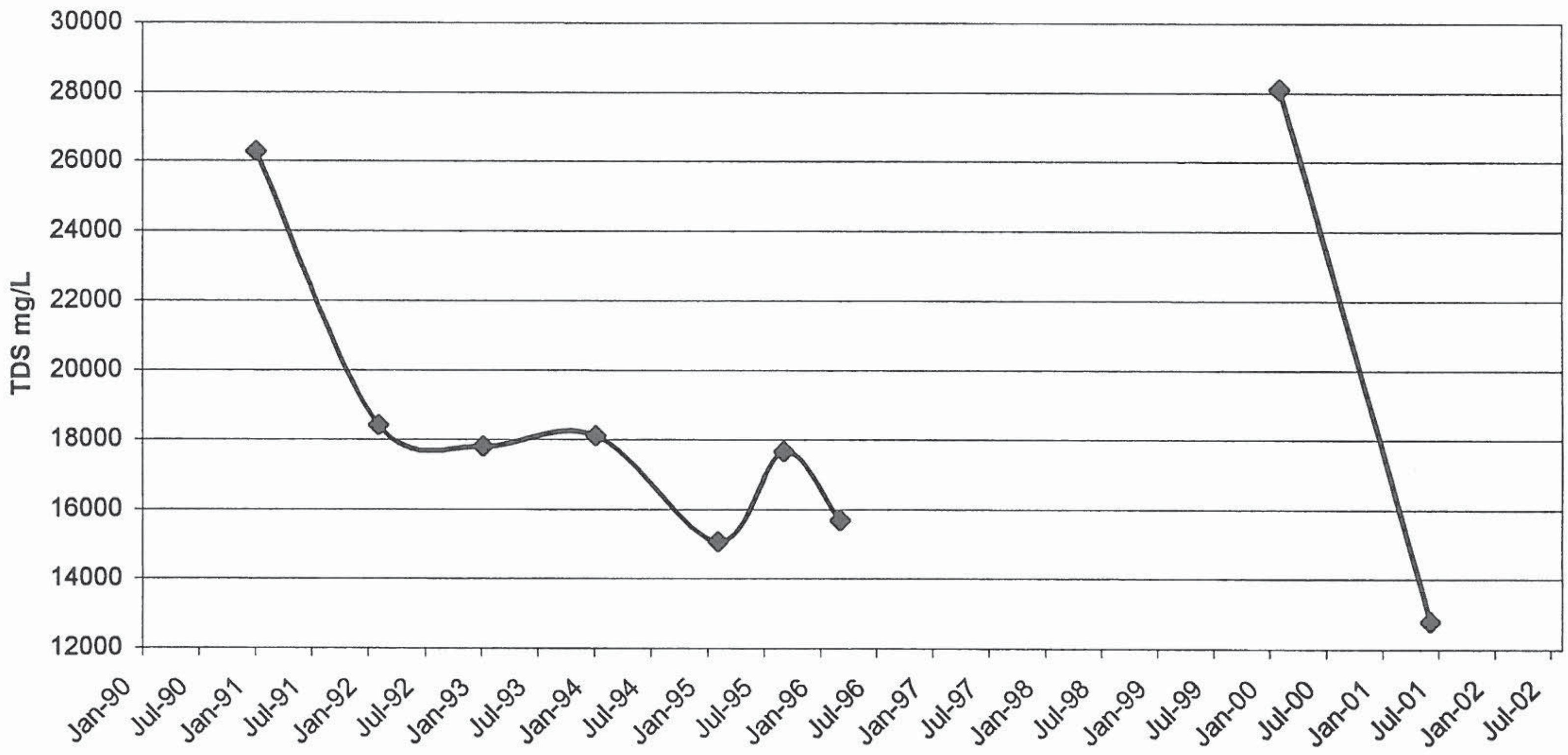
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BV#29
28-22 13N



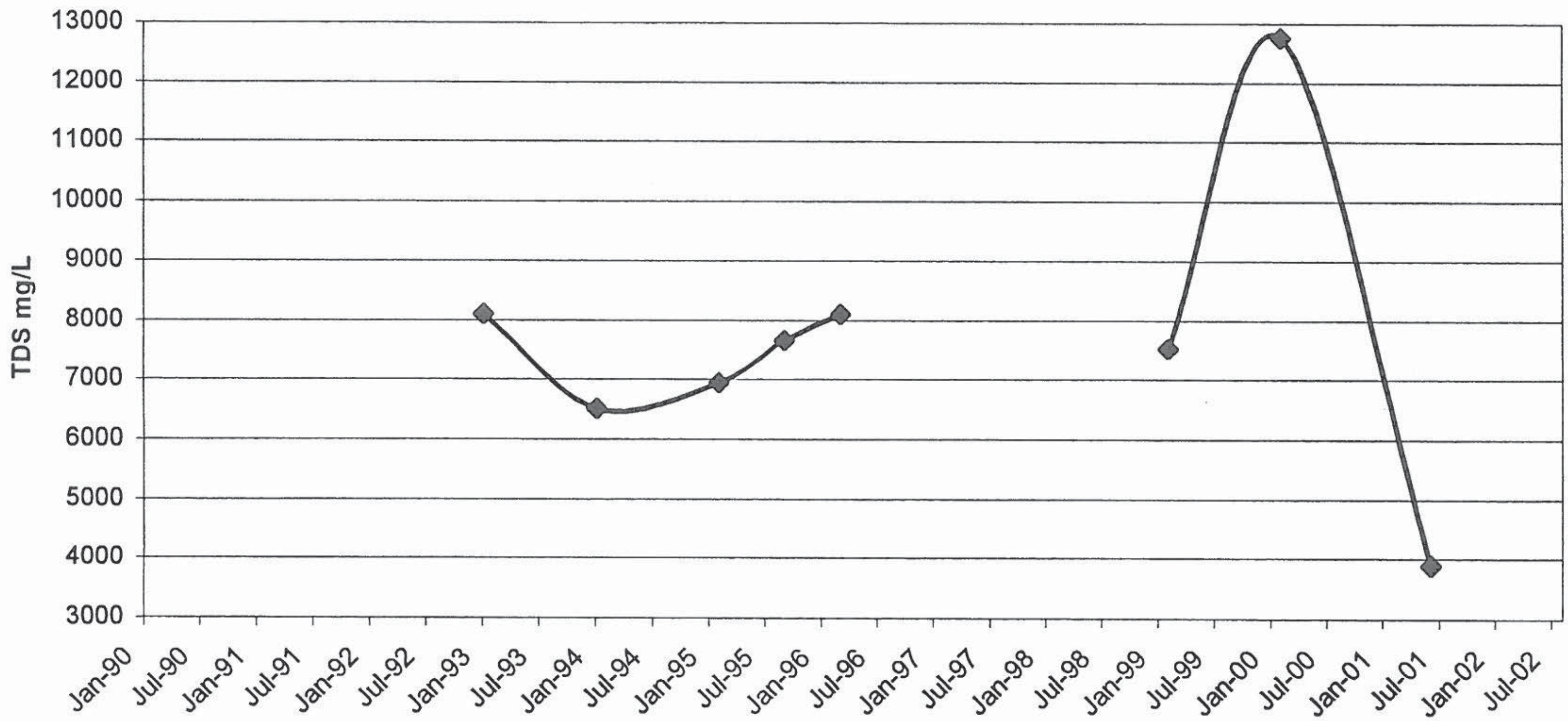
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BEL#3A
27-22 7N



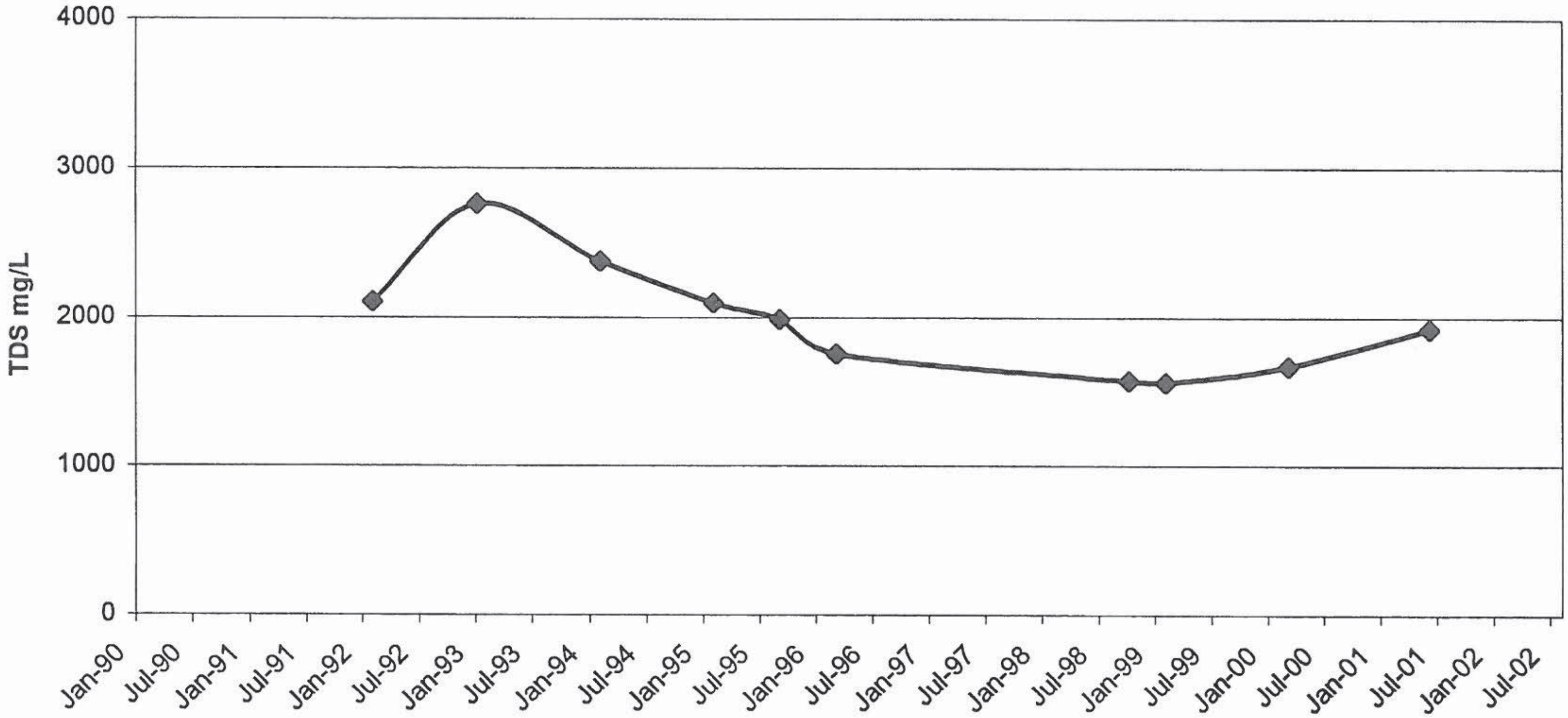
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER BEL#15B
28-22 16N



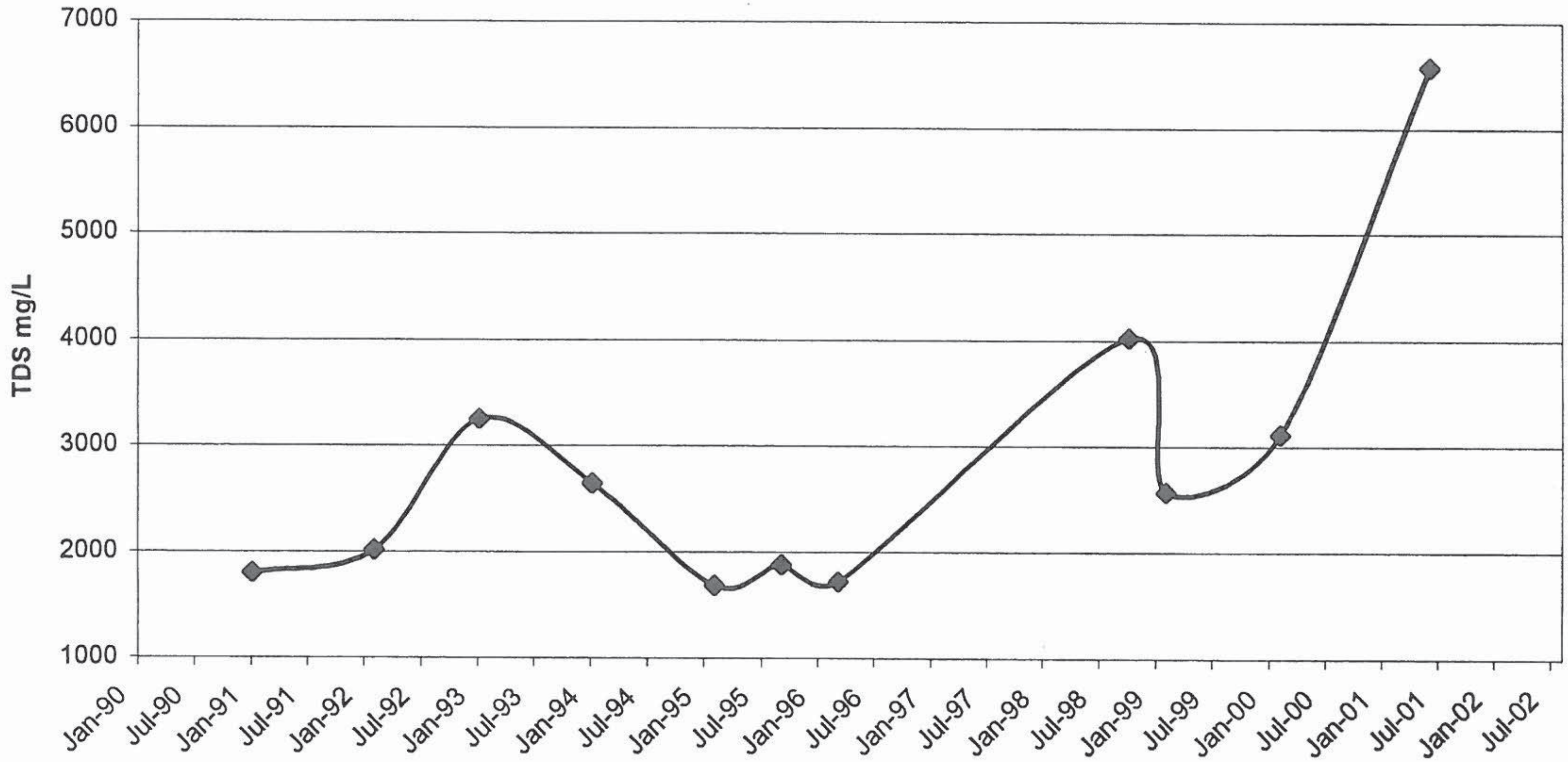
Buena Vista WSD

TDS HYDROGRAPH
PIEZOMETER GL#9
27-22 13L



Buena Vista WSD

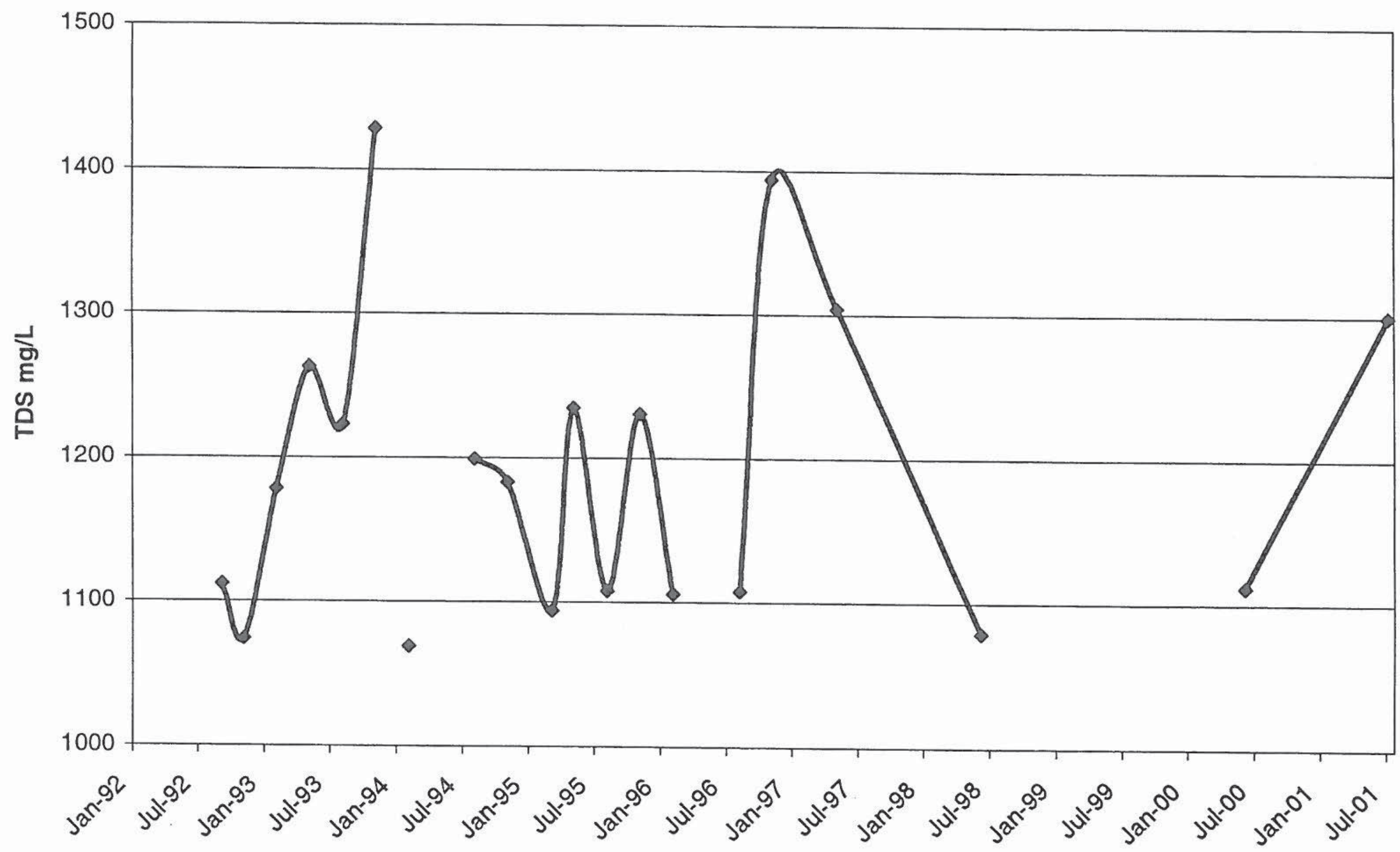
TDS HYDROGRAPH
PIEZOMETER BV#2A
27-22 11Q



Buena Vista WSD

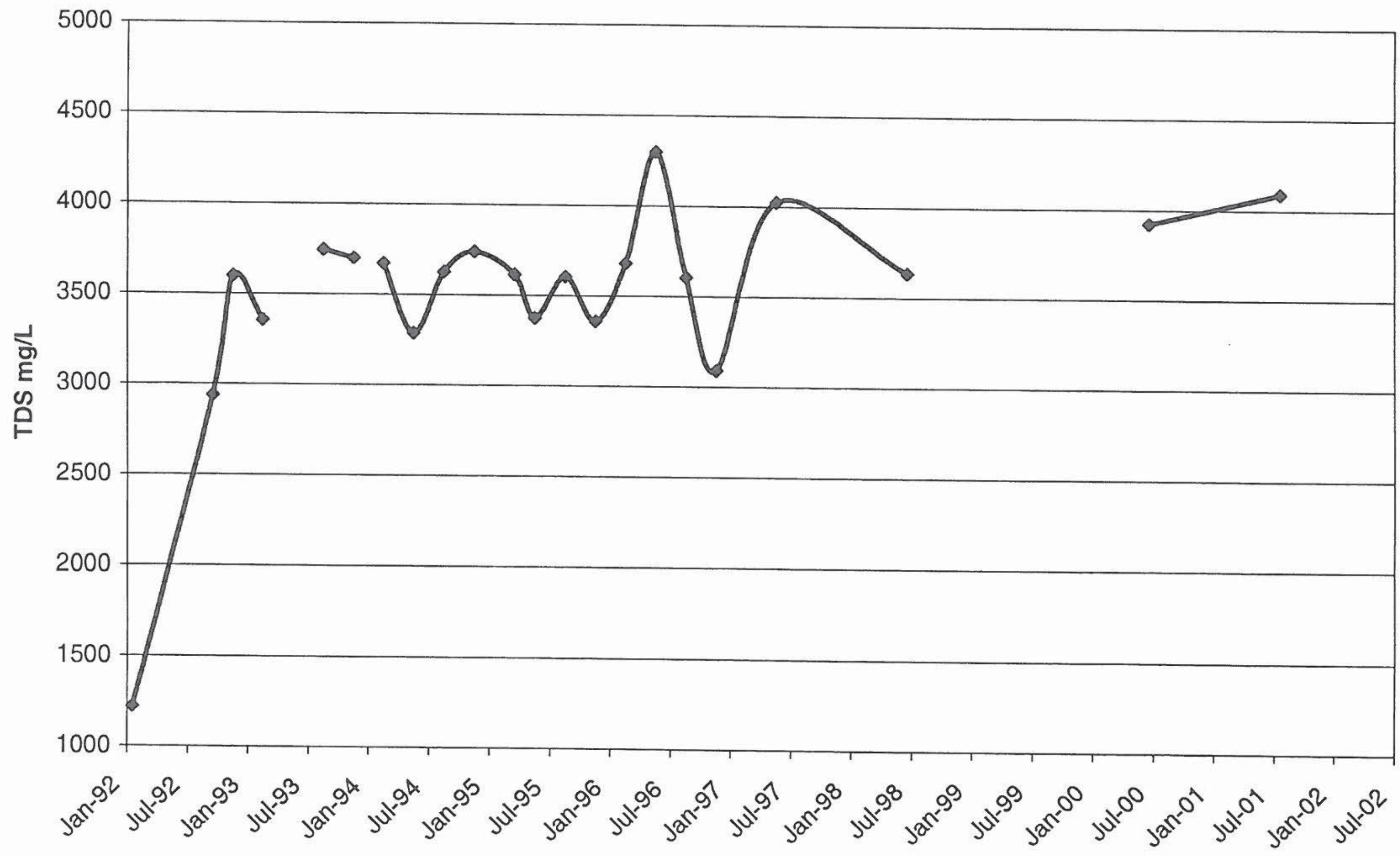
Appendix F

TDS HYDROGRAPH
DMW #1
27-22 8A



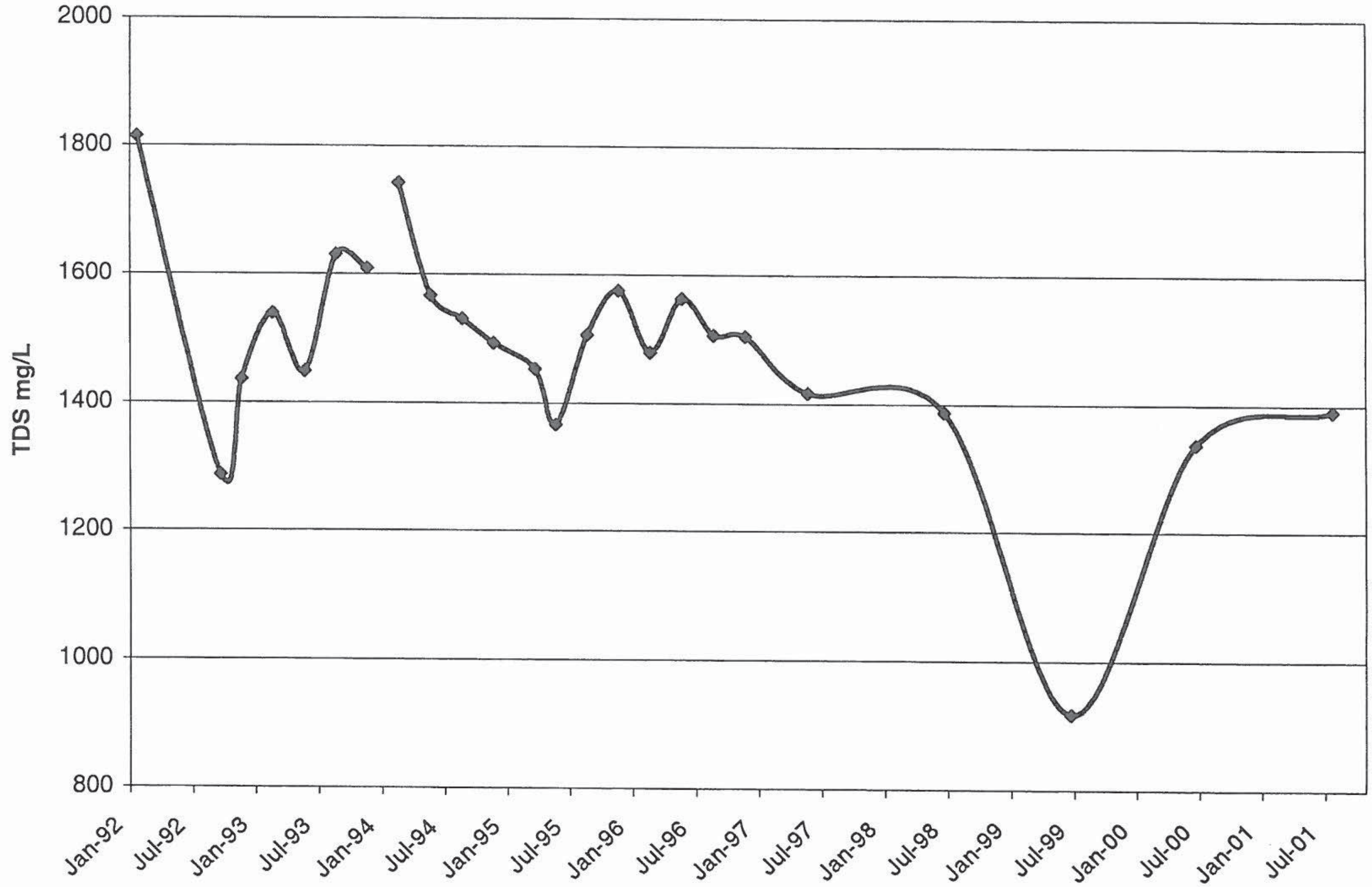
Buena Vista WSD

TDS HYDROGRAPH
DMW #2
27-22 23D

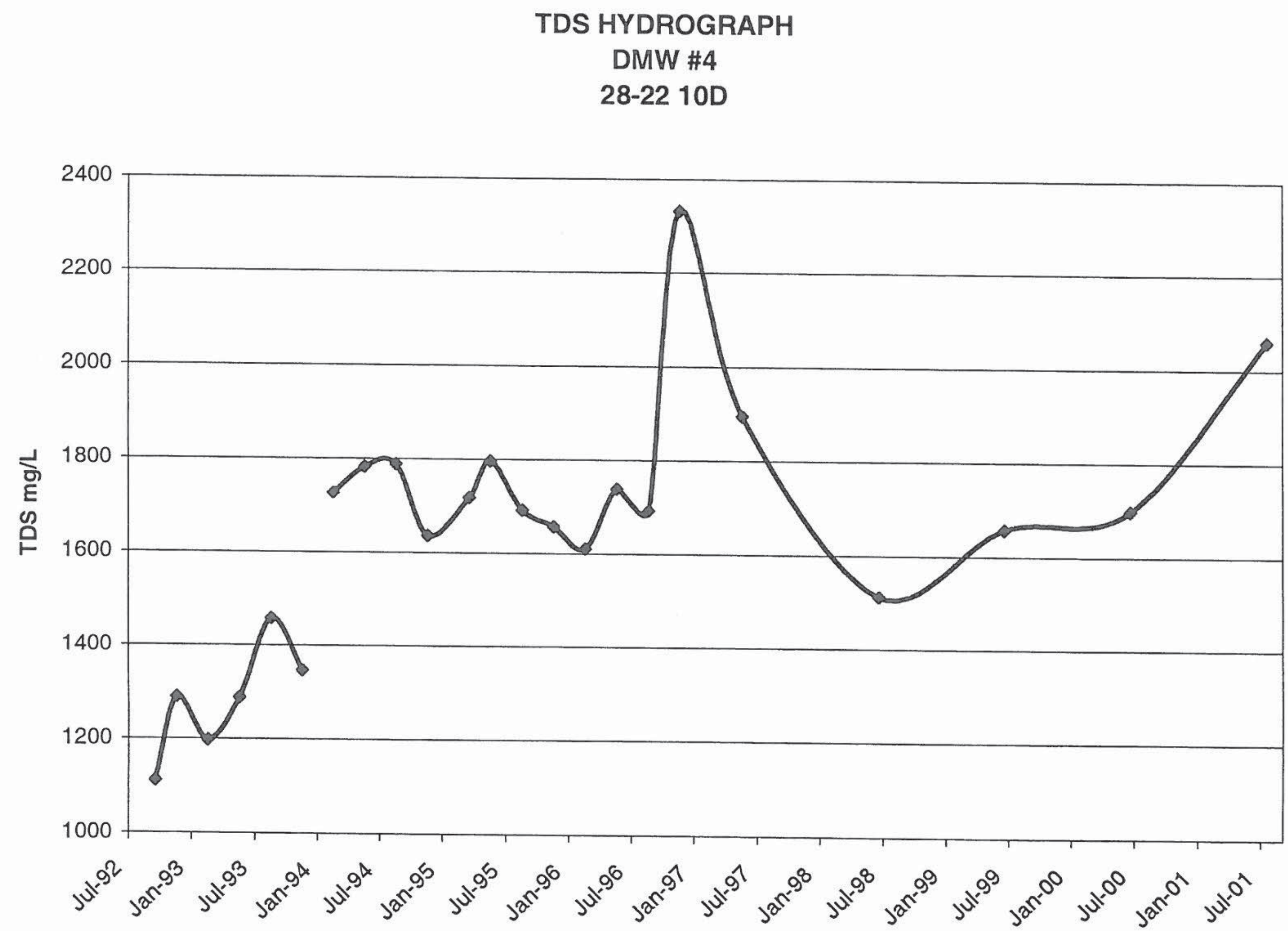


Buena Vista WSD

TDS HYDROGRAPH
DMW #3
27-22 33A

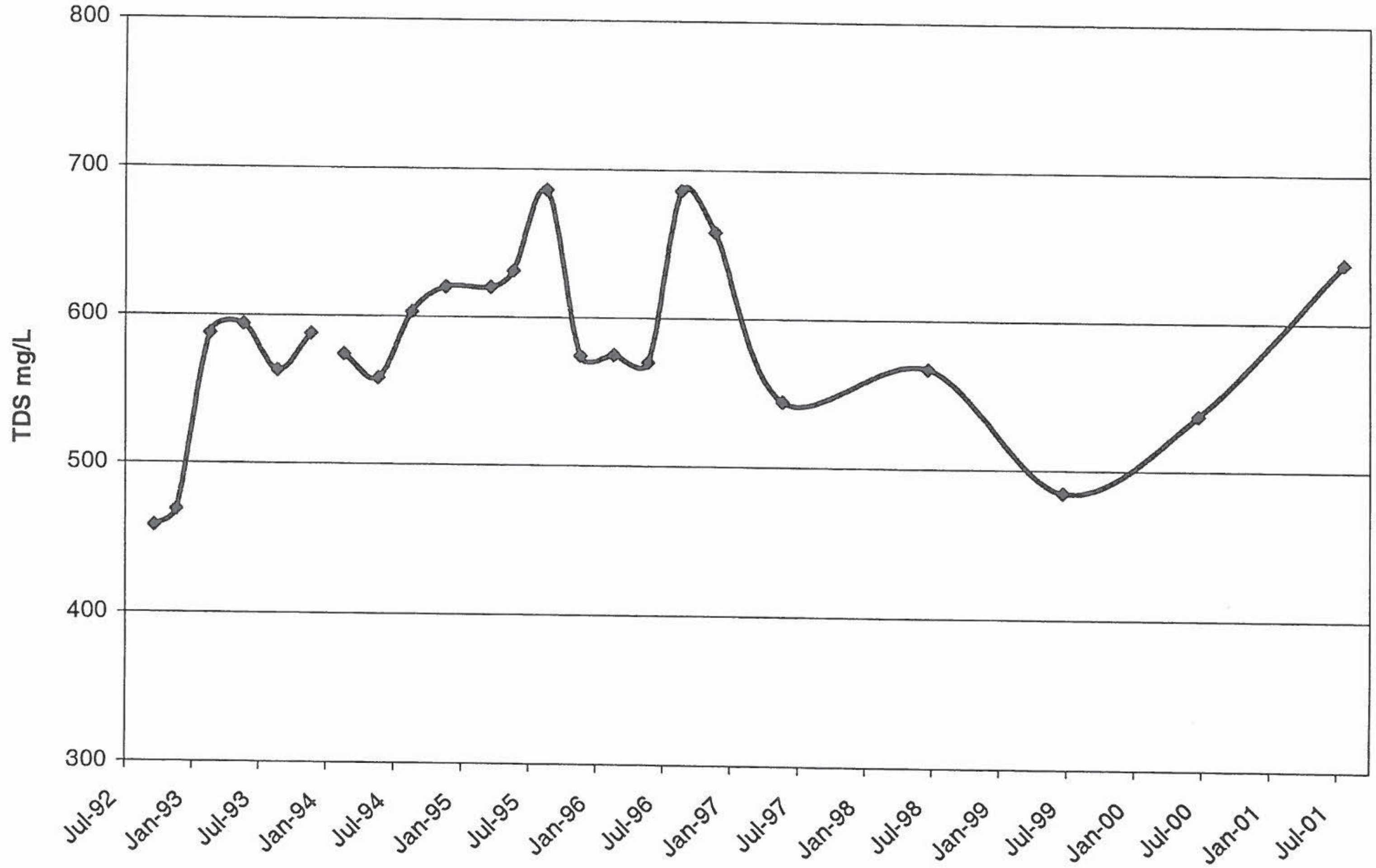


Buena Vista WSD



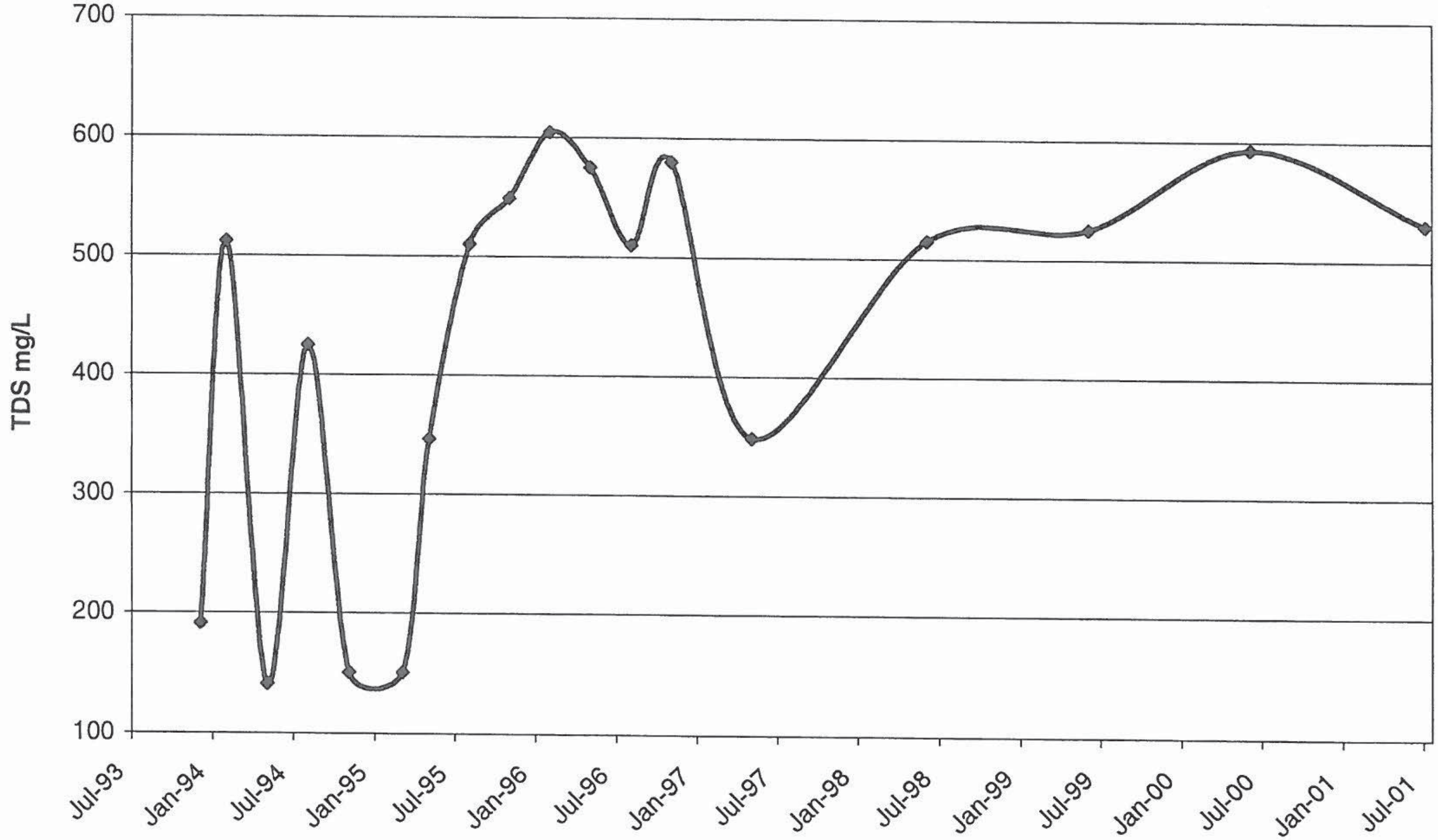
Buena Vista WSD

TDS HYDROGRAPH
DMW #5
28-22 14R



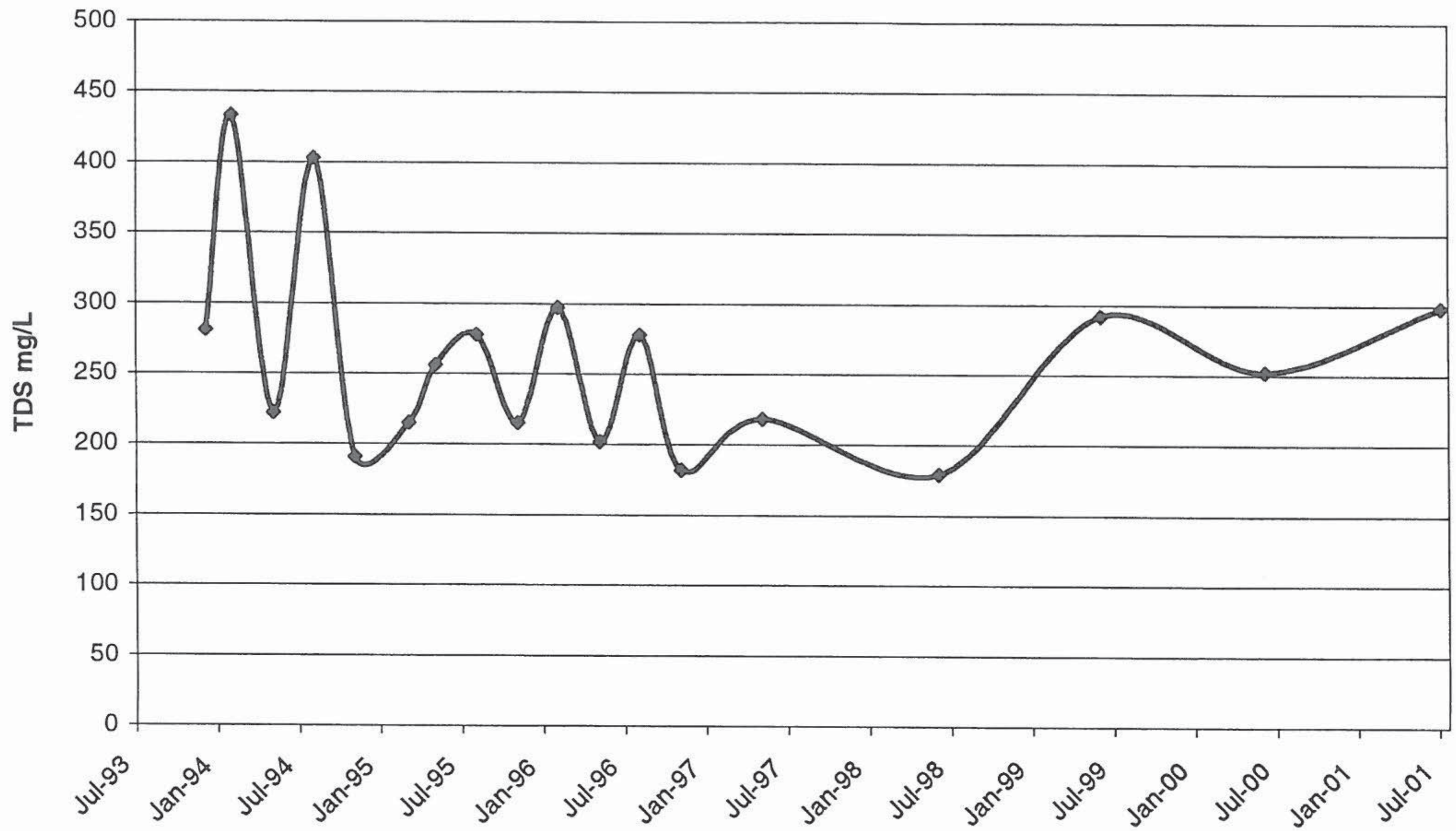
Buena Vista WSD

TDS HYDROGRAPH
DMW #6
28-22 31B



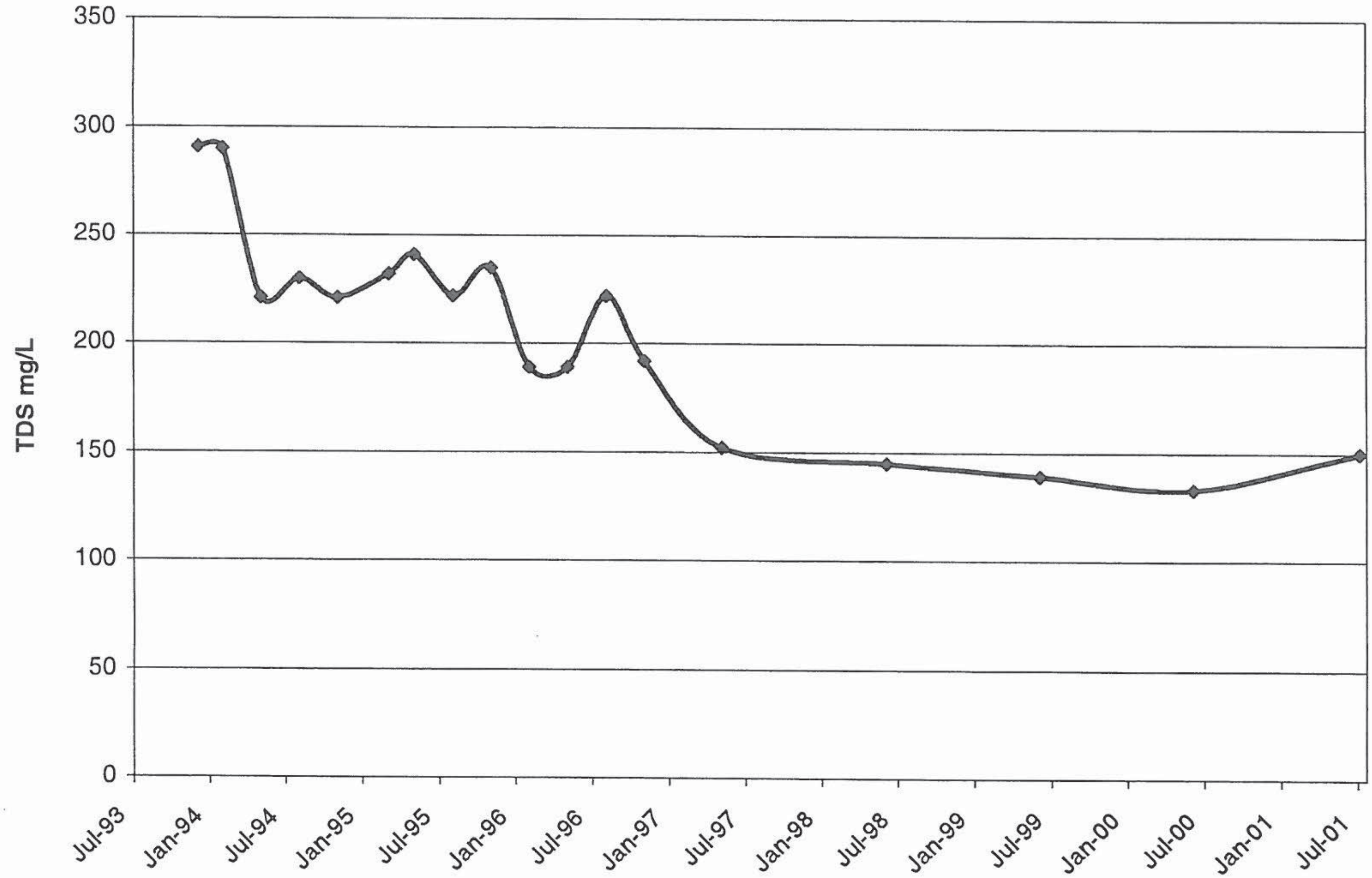
Buena Vista WSD

TDS HYDROGRAPH
DMW #7
29-23 16R

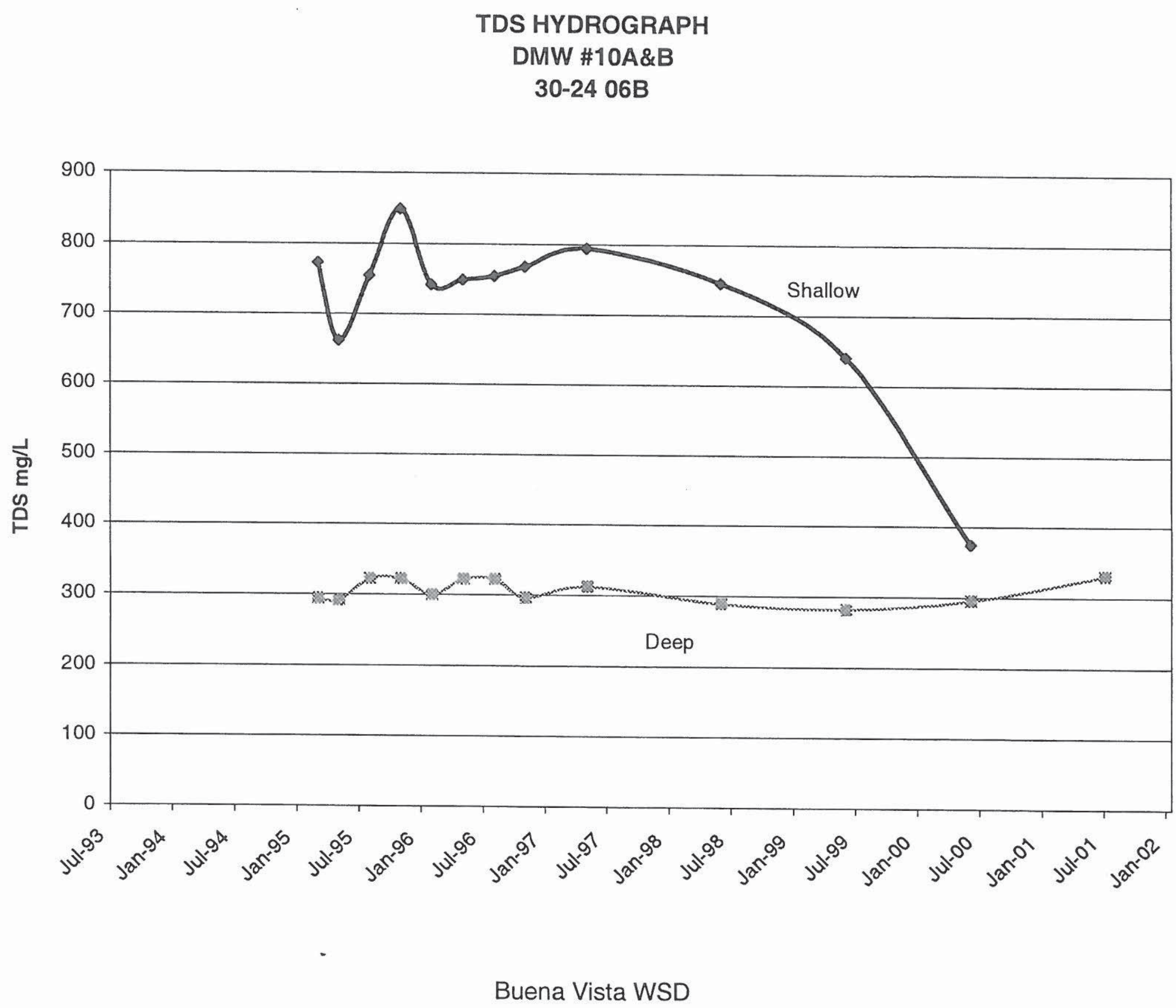


Buena Vista WSD

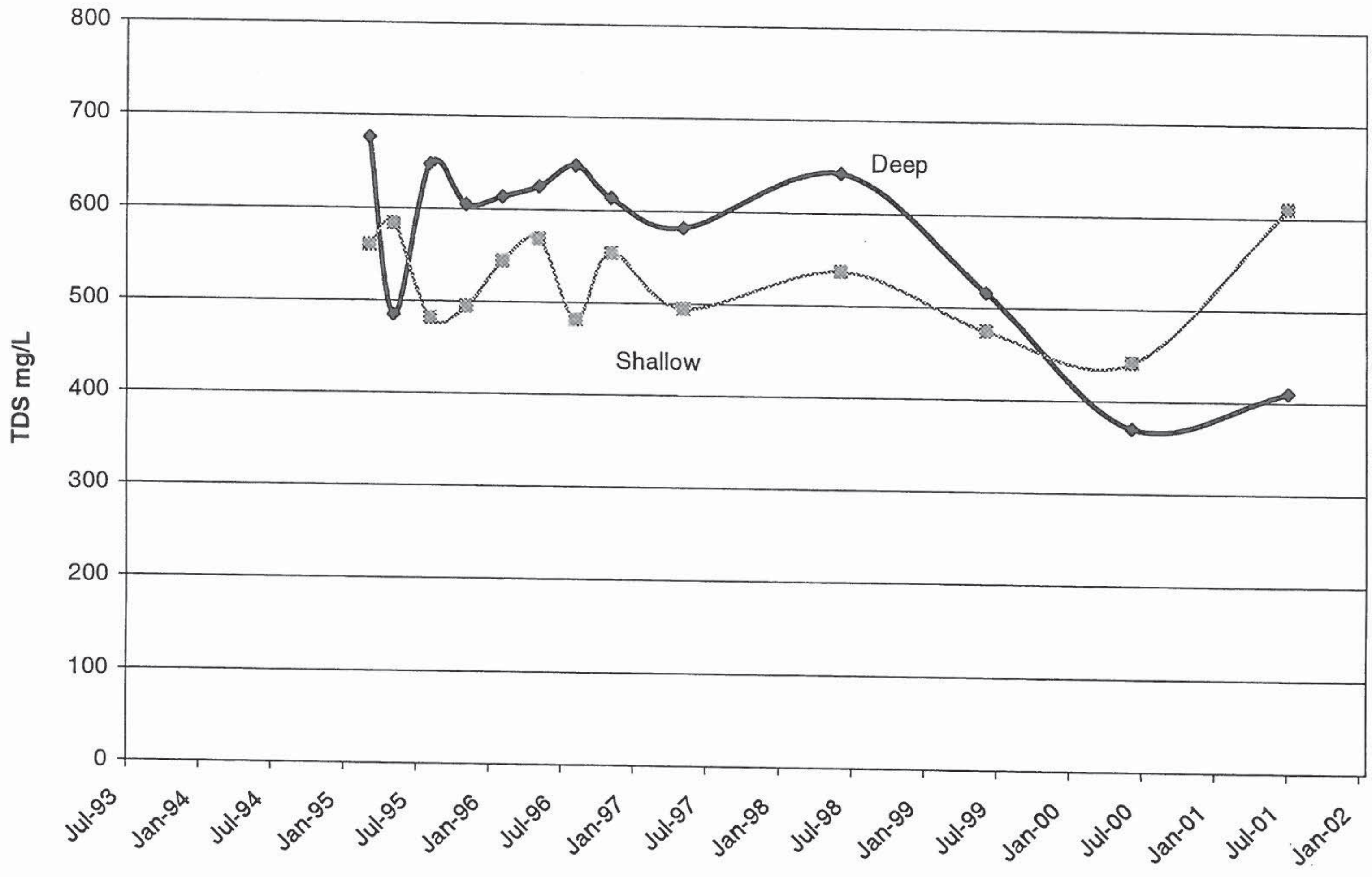
TDS HYDROGRAPH
DMW #8
29-23 24H



Buena Vista WSD

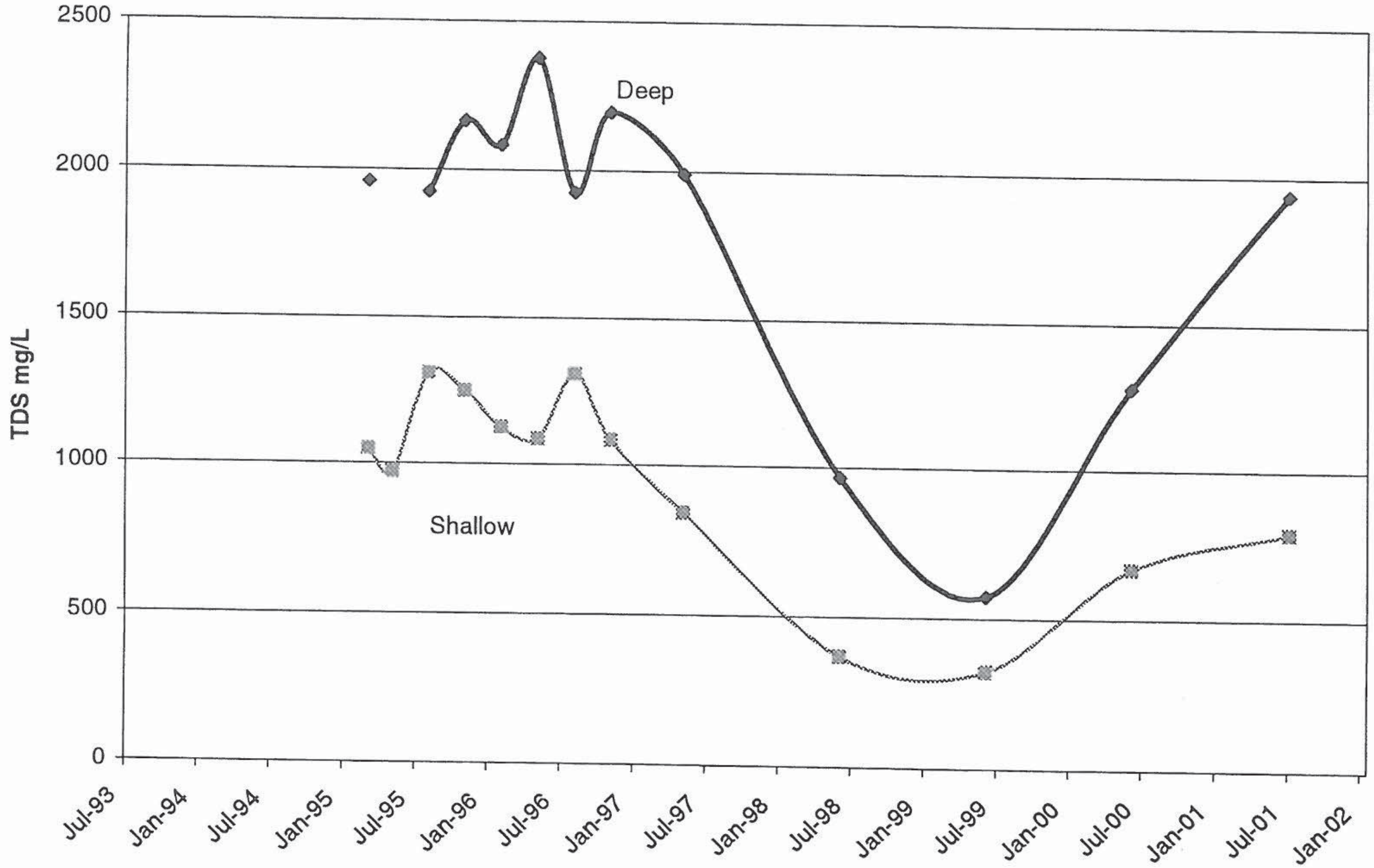

TDS HYDROGRAPH
DMW #10A&B
30-24 06B
TDS mg/L
900
800
700
600
500
400
300
200
100
0
Shallow
Deep
Jul-93
Jan-94
Jul-94
Jan-95
Jul-95
Jan-96
Jul-96
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Buena Vista WSD

TDS HYDROGRAPH
DMW #11A&B
29-24 34N



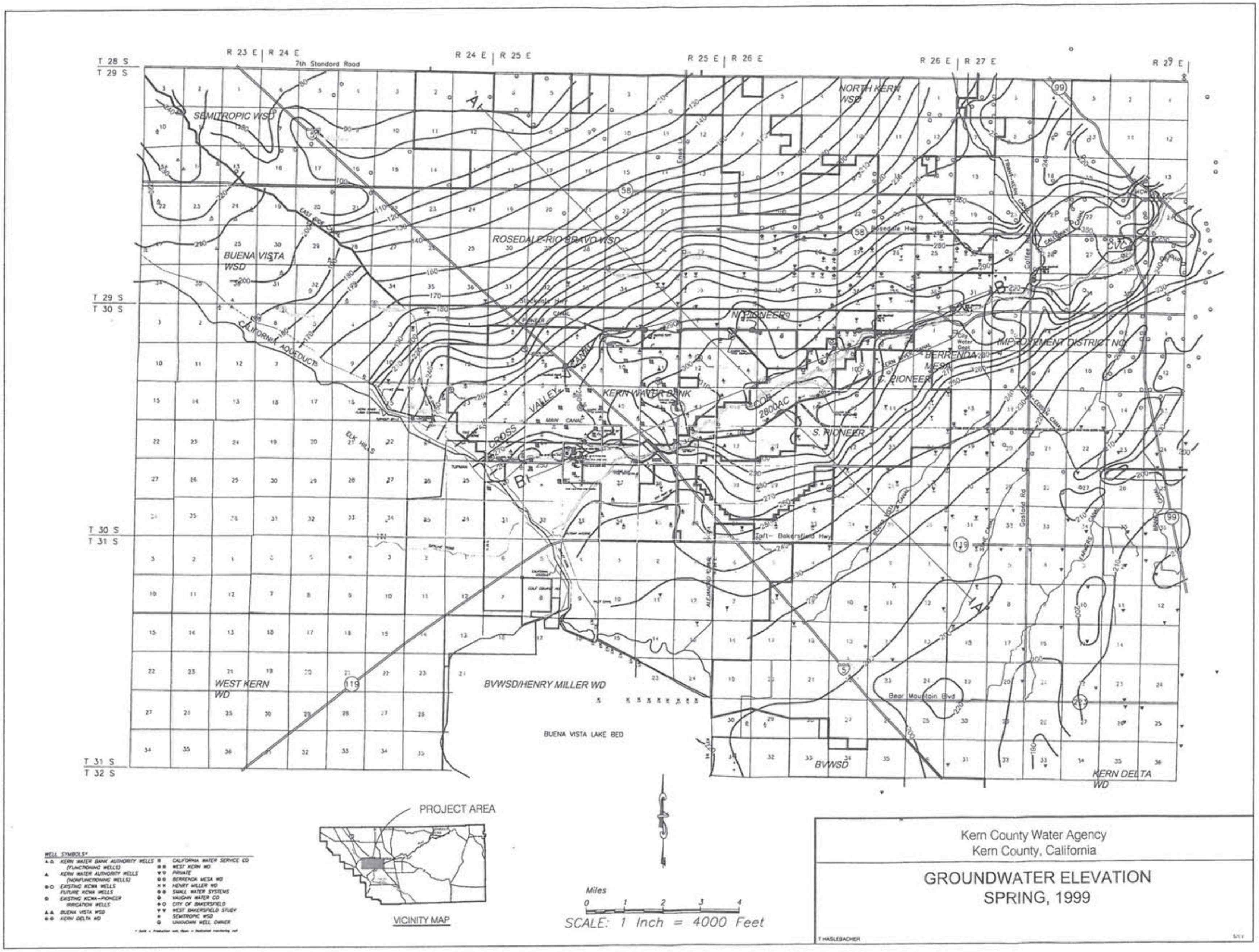
Buena Vista WSD

TDS HYDROGRAPH
DMW #12A&B
30-24 14M

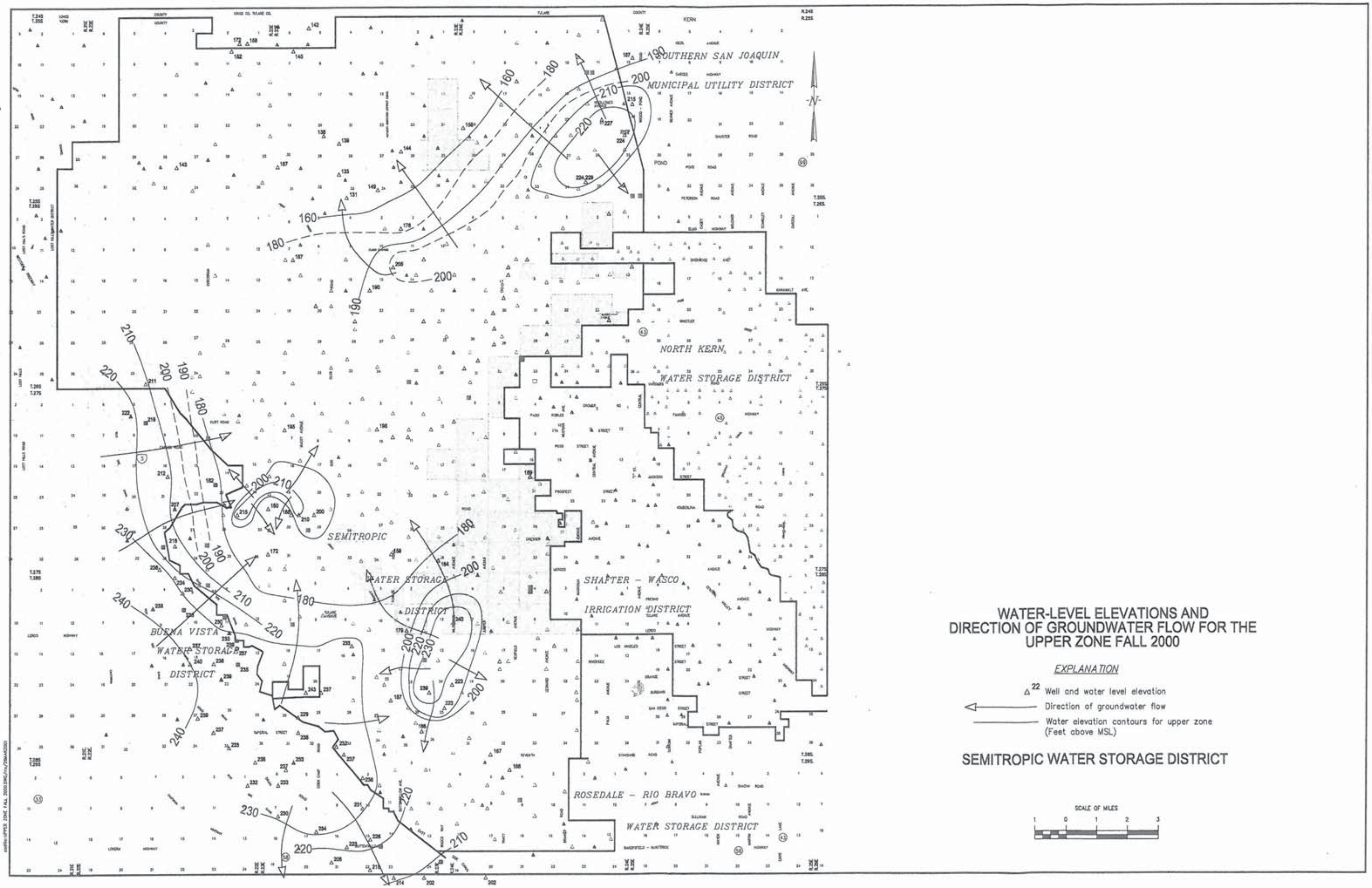


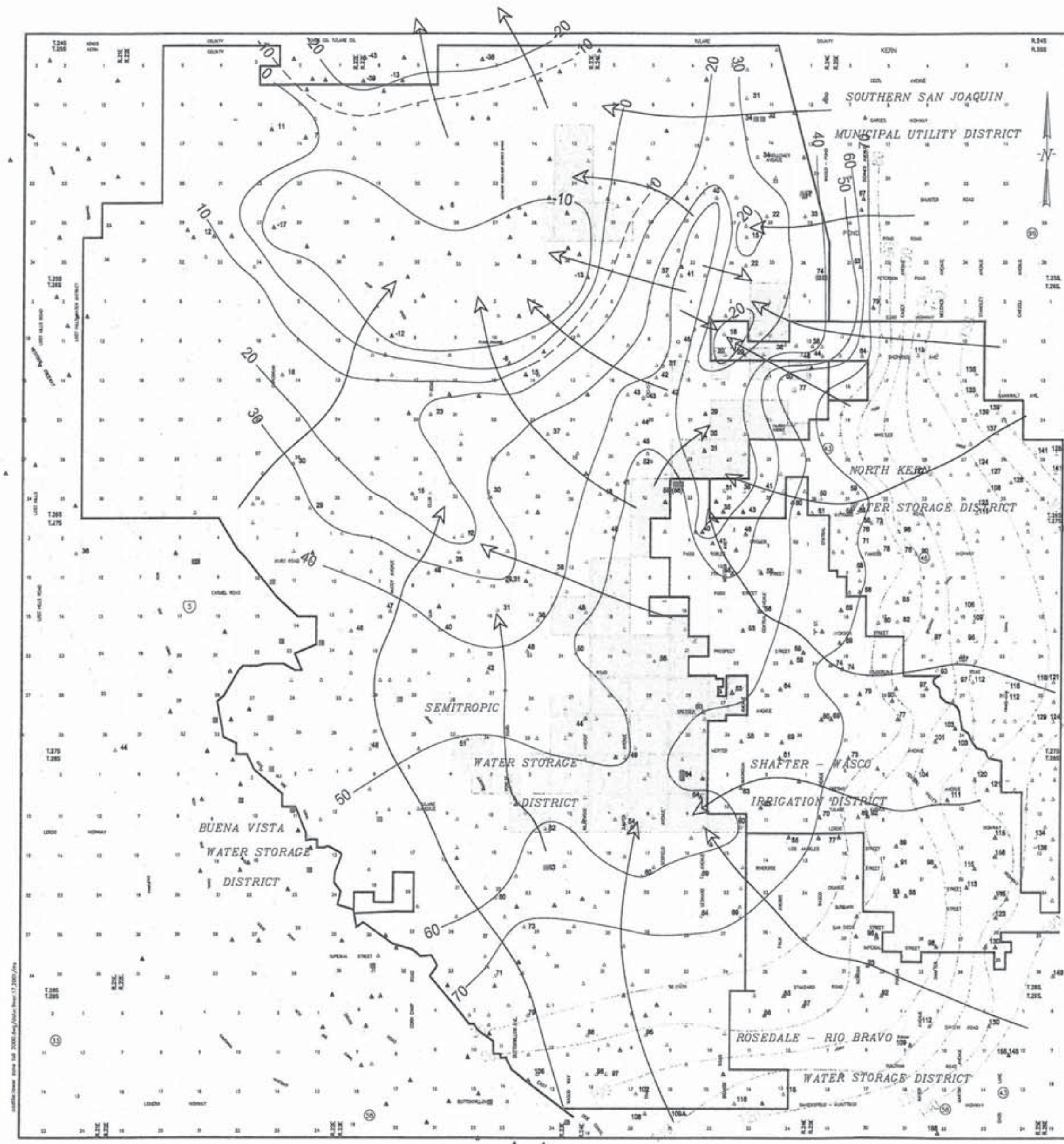
Buena Vista WSD

Appendix G



Kern County Water Agency
Kern County, California
GROUNDWATER ELEVATION
SPRING, 1999
R 23 E | R 24 E
R 24 E | R 25 E
R 25 E | R 26 E
R 26 E | R 27 E
7th Standard Road
T 28 S
T 29 S
T 30 S
T 31 S
T 32 S
SEMITROPIC WSD
BUENA VISTA WSD
ROSEDALE-RIO BRAVO WSD
NORTH KERN WSD
KERN WATER BANK
IMPROVEMENT DISTRICT NO
BERRENDA MESA
S. PIONEER
N. PIONEER
CVC
CALIFORNIA AQUEDUCT
EAST SIDE CANAL
CROSS VALLEY CANAL
MAIN CANAL
ELK HILLS
Taft - Bakersfield Hwy
Rosedale Hwy
Bear Mountain Blvd
Gosford Rd
Enos Ln
BVWSD/HENRY MILLER WD
BUENA VISTA LAKE BED
WEST KERN WD
BVWSD
KERN DELTA WD
PROJECT AREA
VICINITY MAP
WELL SYMBOLS
Miles
0 1 2 3 4
SCALE: 1 Inch = 4000 Feet
T HASLEBACHER


WATER-LEVEL ELEVATIONS AND
DIRECTION OF GROUNDWATER FLOW FOR THE
UPPER ZONE FALL 2000
EXPLANATION
Well and water level elevation
Direction of groundwater flow
Water elevation contours for upper zone
(Feet above MSL)
SEMITROPIC WATER STORAGE DISTRICT
SCALE OF MILES
SOUTHERN SAN JOAQUIN
MUNICIPAL UTILITY DISTRICT
NORTH KERN
WATER STORAGE DISTRICT
SHAFTER - WASCO
IRRIGATION DISTRICT
SEMITROPIC
WATER STORAGE
DISTRICT
BUENA VISTA
WATER STORAGE
DISTRICT
ROSEDALE - RIO BRAVO
WATER STORAGE DISTRICT
-N-



WATER-LEVEL ELEVATIONS AND
DIRECTION OF GROUNDWATER FLOW IN FOREBAY
AREA AND LOWER ZONE
FALL 2000

EXPLANATION

- Δ^{22} Well and water level elevation
- Direction of groundwater flow
- Water elevation contours (ft. above M.S.L.) in forebay area
- 30 Water elevation contours (ft. above M.S.L.) in lower zone

SEMITROPIC WATER STORAGE DISTRICT

SCALE OF MILES

1 0 1 2 3

Appendix H

BUENA VISTA WATER STORAGE DISTRICT
P.O. BOX 756 525 N. MAIN STREET
BUTTONWILLOW, CALIFORNIA 93206
PHONE (661) 324-1101
(661) 764-5510
FAX (661) 764-5053

May 17, 2002

MARTIN N. MILOBAR
ENGINEER - MANAGER

BETTY HARDEN
TREAS./ASST. SECRETARY

Re: Buena Vista Water Storage District 1997, AB255, Groundwater Management Plan Update – May 2002

To Whom It May Concern:

This District has updated the above referenced Plan to include data that was accumulated during the period 1997 through 2001. The information included and revised is found within existing tables, graphs and hydrographs. We have also added a more detailed analysis by a consulting groundwater hydro-geologist explaining the flow of groundwater and other aspects of the data.

The District has determined at it's regularly scheduled Board of Directors meeting on Tuesday, May 14, 2002 that this update merely includes data occurring after the original date of this report and it is prudent that the District include this new data in order to keep the existing Plan up-to-date.

The Plan update was approved via Board Resolution No. 3832 at our Board of Directors meeting on May 14, 2002 and a copy of this resolution can be obtained by requesting it from this office.

Yours very truly,

BUENA VISTA WATER STORAGE DISTRICT

Martin Milobar

Martin N. Milobar
Engineer Manager