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July 31, 2015 (Revised October 9, 2015)
Project No. 04.B3033006.12

Carpinteria Valley Water District
Post Office Box 578
Carpinteria, California 93014

Attention: Mr. Charles Hamilton, General Manager

Subject: Carpinteria Groundwater Basin, Annual Report for 2014

Dear Mr. Hamilton:

This annual report presents a summary and description of groundwater conditions in the Carpinteria groundwater basin (basin) for calendar year 2014. This annual report has been prepared to assist the Carpinteria Valley Water District (District) in its ongoing efforts (pursuant to its AB3030 Groundwater Management Plan) to manage the groundwater resources of the basin and provide information on water level and water quality conditions to all users of groundwater in the basin. The intent of the annual report is to provide a brief narrative and graphics that document the "health" of the basin's groundwater resources, trends in groundwater levels and water quality, information on land use, and annual groundwater pumpage. Information on the development of the program, selection of wells to be sampled, and surface water sampling points, etc., is available in prior reports prepared for the District.

Four oversized plates, summarizing the groundwater conditions of the basin, form an integral part of the report. These plates are updated annually and are included in each annual report. A summary of the information presented on each plate is provided as follows:

- Plate 1 - Water Level Hydrograph Map, May 2014 depicts wells in the basin used for purposes of water level measurements and to assess changes in groundwater in storage. This map shows the physical limits of the groundwater basin, locations of several key wells, historical variations in water levels, and water level contours during May 2014.
- Plate 2 - Water Level Hydrograph Map, October 2014 depicts water level contours during October 2014.
- Plates 3 and 4 – Chemical Hydrograph Map (Western Extent) and Chemical Hydrograph Map (Eastern Extent), respectively, depict the approximate locations of wells that are used to monitor water quality in the basin. These two maps show trends of several important water quality constituents for groundwater and surface water that are routinely obtained as part of the semiannual water quality data collection program. The data presented include concentrations and spatial distributions of total dissolved solids (TDS), nitrate, and chloride.

PRECIPITATION

Groundwater recharge occurs by direct infiltration of precipitation, streambed percolation, irrigation return flow, and to a limited extent, by underflow from the "hill and mountain" area. Precipitation in Carpinteria as measured at the Carpinteria Fire Station for calendar year 2014 was 9.3 inches, which was approximately half of the 20-year average of 19.0 inches. Precipitation data at the Carpinteria Fire Station have been collected continually since 1949, since when the average annual precipitation has been 19.4 inches.

Cumulative departure from average precipitation is presented in graphical form on Figure 1. The departure from average precipitation is the difference between precipitation in a specific year and the average precipitation for the period. Figure 1 depicts the sum of these departures over time (cumulative). The cumulative departure curve depicts periods of subsequent wet and dry periods by combining annual deviations from average conditions, "stacking" changes from subsequent years. Based on the cumulative departure from average precipitation, there have been a series of cyclic wet and dry periods. A summary of the hydrologic cycles since 1949 is provided in Table 1 – Summary of Precipitation Data.

Table 1. Summary of Precipitation Data

Time Period, Calendar Years	Hydrologic Condition	Duration, Years	Cumulative Departure, Inches	Average Decline or Rise, Inches/Year
1949 – 1961	Dry	13	-49	-3.8
1962 – 1977	Alternating Wet and Dry	16	14	0.9
1978 – 1983	Wet	6	62	10.4
1984 – 1990	Dry	7	-44	-6.3
1991 –1998	Wet	8	74	9.3
1999 – 2014	Dry	16	-58	-3.6

Based on the 65 years of precipitation data, there have been extended dry periods punctuated by brief, but relatively intense, wet periods. The wet periods occurred between 1978 and 1983 (six years) and again between 1991 and 1998 (eight years). The dry periods have occurred between 1949 and 1961 (13 years) and again between 1984 and 1990 (seven years). The current dry cycle has now lasted from 1999 to 2014 (16 years).

- During the 1949 to 1961 dry period, the cumulative departure from average annual rainfall declined by 49 inches (or 3.8 inches per year).
- During the dry period of 1984 to 1990, the cumulative rainfall declined by 44 inches (or 6.3 inches per year).
- During the current dry period of 1999 to 2014, the cumulative rainfall has declined by 58 inches (or 3.6 inches per year).

Groundwater Levels

Water level measurements were made by District staff on a bimonthly basis for approximately 31 wells in the basin during 2014. The locations of these wells are shown on Plates 1 and 2. Using groundwater level data from the District, hydrographs were prepared for 18 key wells, which are shown on Plates 1 and 2. The data from approximately 22 wells were then used to prepare groundwater elevation contours, which are shown on Plate 1 for the May 2014 period and on Plate 2 for the October 2014 period. The contours are representative of groundwater elevations within wells perforated across several depth zones, therefore, the contours represent a composite of many different depth zones, not groundwater elevations in a single, common aquifer. As is usual, several wells included in the water-level measurement program or nearby wells were being pumped and the water levels in surrounding wells were influenced by pumping wells at the time of the water level measurements.

During May 2014 (Plate 1) the pumping depression present in the central portion of the basin generally in the vicinity of the District office and High School well persisted and deepened. The pumping trough, associated with groundwater pumpage, was as deep as 13 to 23 feet below sea level in the central portion of the basin. At that time, the groundwater level near the coast was below sea level, as measured in shallow Well -30D1 (5.5 feet below sea level) and in Well -23A2 (0.7 feet below sea level). Water levels throughout the District fell during the second half of calendar year 2014 as is usual in response to below average rainfall.

During October 2014, the time period presented on Plate 2, the apparent pumping depression in the central part of the District continued to be evident to a greater degree than during May due to seasonal groundwater pumpage, as is common during the fall. During the October water level measurements, the pumping trough was as deep as 25 to 33 feet below sea level in the central portion of the basin. At that time, water levels at the coast lowered to a level between 13 feet below sea level in shallow Well -30D1. Water elevations measured in Well -23A2 in the far western portion of the basin, were more than 115 feet below sea level, which represents two months of pumping of that well prior to the measurement period. The only other well included in the groundwater level measurement program in the general area of the coast is Well -19M3, which is located 2,700 feet inland from the coast and is very shallow (56 feet) which, during October 2014, was pumping. At a location 1,400 feet further inland from Well -19M3, at Well -19F4, groundwater levels were below sea level during the fall measurement period.

As in previous years, which have exhibited similar water level declines near the coast, there is no documented evidence of sea water intrusion in the basin.

Water level data from the 20-year period including the years 1995 to 2014 indicate that water levels are commonly higher in the winter and spring due to recharge from precipitation and seasonal reduction in groundwater pumpage, and relatively lower in summer and fall due to pumping of groundwater from wells within the District. In general, the hydrographs presented on Plates 1 and 2 illustrate that during the 8-year period of 2006 through 2014, water levels in Storage Unit No. 1 have locally declined by as much as 60 feet, and in the far eastern portion of the District, groundwater levels have declined by as much as 70 feet. Average annual groundwater pumping in the basin over the five-year period between 2010 and 2014 (inclusive) was about 3,770 acre-feet per year (afy).

Although there are a limited number of wells monitored in Storage Unit No. 2, available data indicated water levels appear to have declined by as much as 25 feet since 2006. This relatively limited decline in groundwater levels is likely due to the limited amounts of groundwater pumped from this storage unit.

Groundwater Use

Groundwater pumpage in the basin occurs both from District production wells (see Plates 1 and 2) and from about 100 private wells. Pumpage from District wells is metered. The District delivers imported water and local groundwater to numerous agricultural parcels of known acreage and crop type (lemon, avocado, greenhouse, and flower fields). Based on these metered deliveries, unit water use values for various crop types are used to estimate private groundwater pumpage. Based on these calculations, a private pumpage estimate of 3,168 acre-feet was calculated. Summaries of District groundwater pumpage and imported water amounts for 2014 are included in Appendix A - Supporting Data "Public Water System Statistics".

Groundwater pumpage from the basin by the District in calendar year 2014 was 1,433 acre-feet. Water purchased and imported into the District in calendar year 2014 was 3,122 acre-feet. The volume of groundwater pumpage by the District was approximately 46 percent above 20-year District average of about 1,000 afy. Groundwater pumpage in the District between calendar years 1995 and 2014 is presented in Figure 2 - Water Use and Precipitation Data, Carpinteria Valley, and in Table 2 - Water Use and Precipitation Data. Imported water volumes (Casitas Municipal Water District, State Project Water, and Lake Cachuma water) and seasonal precipitation totals are also provided in Appendix A. As indicated, groundwater pumpage from the basin between 1995 and 2014 has averaged about 3,580 afy, and ranged from as low as 2,484 afy acre-feet during 2001, to as high as 4,601 acre-feet during 2014. The District pumpage during 2014 was 31 percent of the total pumpage, which was within the historical typical District's pumpage between about one quarter and one third of the total groundwater pumped.

Table 2. Water Use and Precipitation Data

Calendar Year	Rainfall (inches)	Estimated Private Pumpage (acre-feet)	Metered District Pumpage (acre-feet)	Imported Water (acre-feet)	Total Pumpage (acre-feet)	District Use (percent)
1995	41.35	2,418	1,340	2,995	3,758	36
1996	25.86	2,597	1,410	2,896	4,007	35
1997	19.98	2,504	1,242	3,429	3,746	33
1998	41.35	2,481	469	3,549	2,950	16
1999	8.91	2,400 [1]	535	3,907	2,935	18
2000	18.99	2,400 [1]	1,210	2,959	3,610	34
2001	24.23	2,400 [1]	84	3,497	2,484	3
2002	12.28	3,116	662	3,774	3,778	18
2003	14.62	2,596	446	3,769	3,042	15
2004	19.42	2,698	1,265	3,884	3,963	32
2005	27.20	2,183	940	3,693	3,123	30
2006	16.86	2,270	1,142	3,147	3,412	33
2007	9.67	2,606	1,340	2,684	3,946	34
2008	19.22	2,865	1,074	2,842	3,939	27
2009	14.39	2,596	1,488	2,835	4,084	36
2010	26.30	2,294	742	3,157	3,036	24
2011	14.56	2,428	1,365	2,673	3,793	36
2012	12.43	2,896	1,192	3,356	4,088	29
2013	3.86	3,060	312	4,513	3,372	9
2014	9.28	3,168	1,433	3.122	4,601	31
Mean	19.04	2,594	985	3,334	3,579	27
Maximum	41.35	3,116	1,488	4,513	4,601	36
Minimum	3.86	2,183	84	2,673	2,484	3

Notes: 1) 1999 to 2001 private pumpage estimated based on long-term average.

The estimates of the safe yield for the groundwater basin have been reassessed several times during the past 30 years. Most recently in 2012 Pueblo Water Resources, Inc. completed a modeling study of the District's groundwater basin and arrived at a revised "practical rate of withdrawal," or "operational yield" of the basin of 3,600 to 4,200 afy based on long-term hydrologic conditions. Prior to the most recent estimate, a value of 4,500 to 5,000 afy was considered the "safe yield" of the basin, (GTC, 1976 and 1986). An independent review of this value was performed in 2003 (Integrated Water Resources), the results of which reasserted that a basin "safe yield" in the range of 4,500 to 5,000 afy. Since that time, the District has discontinued reference to "safe yield" but has instead referred to an "operational yield," which is understood as a range of long term average annual pumpage at which no undesirable effects will occur.

The total groundwater pumpage of 4,601 afy during 2014 slightly exceed the lower limit of the prior "safe yield" range of 4,500 to 5,000 afy, and the upper limit of the current "operational yield" of 4,200 afy. The 2014 groundwater pumpage was the only exceedance of the upper limit of the operational safe yield during the most recent 20-year period. The average pumpage for the 20-year period of 3,579 afy was slightly below the above the lower bound of the current "operational yield" of 3,600 afy.

During 2015, an update to a long-term hydrologic budget for the groundwater basin was updated for the period of water year 2014 (ending in October 2014). The hydrologic budget update indicated that during the most-recent 3-year period between water years 2012 and 2014, the groundwater basin experienced a net storage depletion of approximately 7,545 acre-feet. Notably, the data presented during the 3-year period, which occurred during a dry hydrologic condition, generally supports the trends of groundwater pumpage and precipitation presented in this report, although that report is based on a water year basis (Tables 1, 2 and Figure 2). The memo report is included in the appendix.

GROUNDWATER QUALITY

Groundwater quality in the basin is monitored by collecting samples from as many as 30 wells and 6 surface water stations on a biannual basis (spring and fall) in a data collection program initiated by the District in 1999. Laboratory analyses performed included a full range of inorganic chemical constituents typically referred to as "Irrigation Suitability Analysis."

Overall, groundwater quality in the basin continues to be suitable for most purposes. Groundwater in the basin is generally characterized as calcium bicarbonate in chemical nature and locally demerited by the presence of elevated nitrate and chloride concentrations in shallow aquifers in Sections 19 and 20 of the basin. Other than slightly elevated chloride concentrations present in Well 30D1, which have moderated since 2011, the groundwater quality was stable with no long-term trends toward impairment. Historical concentrations of total dissolved solids (TDS), nitrate, and chloride are presented on Plates 3 and 4, and a brief discussion of these data are presented as follows:

- TDS concentrations for most wells ranged from 482 to 2,060 milligrams per liter (mg/L) in 2014.
- Nitrate concentrations (as nitrate) ranged from 0.5 to 253 mg/L in 2014.
  - The highest concentration of nitrate of 253 mg/L was observed in Well -19M1, where in 2005 nitrate concentrations have exceeded 400 mg/. Since 2005, nitrate concentrations have declined to as low as 68 mg/L.
  - By contrast, nitrate concentrations within Well -19E1 were much lower, with a maximum concentration of 25 mg/L during 2014.
  - Nitrate concentrations within Well -28F7 (Lyons Well) have been rising for the past several decades to a value of 39 mg/L in 2013, but have declined slightly to 33.2 mg/L in 2014.
- Chloride concentrations ranged from 22 to 430 mg/L in 2014.
  - Wells -19E1 and -19M1 had maximum chloride concentrations during 2014 of 430 and 375 mg/L, respectively. Well -19E1 is located approximately 900 feet north and is relatively shallow; the well is 204 feet deep and likely has very shallow perforations, although the actual depth interval is unknown. As in past years, comparison of water quality data from the two wells shows that, although chloride concentrations are higher than many monitored wells, neither nitrate nor TDS in Well -19E1 are as elevated as those in Well -19M1.

- Chloride concentrations within Well -30D1, located near the coast and originally completed to a depth of 210 feet, have been rising since 2008 from a concentration of less than 30 mg/L to almost 80 mg/L in 2011, since when concentrations have moderated to below 74 mg/L in 2014. Neither nitrate nor TDS concentrations have been elevated in Well -30D1 since 2008 relative to wells located in the central portion of the basin. Because the depths of the perforated interval in the well are not known, and because it has been noted that the measured total depth of the well is much shallower than 210 feet, this well is not considered an appropriate "sentinel" well for early warning of seawater intrusion.

SUMMARY AND CONCLUSIONS

Based on the data for 2014 and the preceding years, aquifers in the Carpinteria basin continue to be adequately recharged during average to above average precipitation years, and provide a generally high quality of groundwater for the prevailing usages. During the spring and fall of 2014 water levels in the central part of Storage Unit No. 1 declined to elevations as deep as 23 to 33 feet below sea level, respectively. Groundwater pumpage from the basin in 2014 was estimated to be approximately 4,601 afy, which exceeded the upper limit of the current "operational yield" of 4,200 afy. During 2014, pumpage increased 36 percent relative to 2013, which with continued below-average rainfall, caused water levels in the central portion of the basin to decline compared to the previous year. At the coast, the inferred water levels have declined somewhat during 2014 relative to 2013. During the spring of 2014, water elevations were several feet lower than during the spring of 2013. Similarly, water elevations during the fall of 2014 were as much as 8 feet below those of the prior year. Notably, increased pumpage within coastal Well -23A2 for two months prior to the fall synoptic water level measurement induced significant drawdown in that portion of the basin to an elevation well below sea level. Since that time, the increased pumpage has moderated. Additional wells are being sought to supplement water level data gaps in the area.

No adverse water quality conditions or trends are apparent in the basin other than the occurrence of elevated nitrate and chloride ion concentrations in two shallow wells in the western portion of the basin.

We recommend that the data collection program (water levels and water quality) be maintained in its current form going forward with the following modifications:

With the observed depression in water levels in the central and coastal portions of Storage Unit No. 1, the District may consider expanding the water quality monitoring program to include additional wells and more frequent monitoring (perhaps quarterly) in that area for general mineral constituents, particularly chloride ion concentrations. The expanded monitoring should focus on qualified wells (suitable depth and perforated interval) located in Sections 24, 19, 20, 28, and 29.

In conjunction with this increased monitoring, the installation of several monitoring wells located in key areas where hydrogeologic data are lacking should be considered. These additional monitoring wells should be designed to monitor groundwater levels and groundwater quality and levels in aquifers A though C and be provided with dedicated transducers to collect groundwater water level and electrical conductivity data (such as In-Situ Aqua Troll 200s or CTD-Divers).

With the continuation of groundwater levels that are slightly below sea level near the coast in the shallow well -30D1 and the associated possibility of seawater intrusion, the District should consider installation of so-called "sentinel" wells at the coast completed to the depths of the four primary aquifers. The monitoring wells should be provided with dedicated pressure and conductivity transducers to monitor temporal changes in water quality. Data from the sentinel wells should be collected regularly (monthly or quarterly) and graphs developed to depict any trends in groundwater level and quality (i.e., conductivity measurements as an early indicator of possible seawater intrusion into the basin).

CLOSURE

This report has been prepared for the exclusive use of the Carpinteria Valley Water District and their agents for specific application to the conditions of groundwater supply and quality in the Carpinteria groundwater basin in Carpinteria, California. The findings and conclusions presented herein were prepared in accordance with generally accepted hydrogeologic engineering practices. No other warranty, express or implied, is made.

Sincerely,

FUGRO CONSULTANTS, INC.

Timothy A. Nicely, CHg
Senior Hydrogeologist

Attachments: Figure 1 - Cumulative Departure from Average Precipitation
Figure 2 - Water Use and Precipitation Data
Plate 1 - Water Level Hydrograph Map, May 2014 Period
Plate 2 - Water Level Hydrograph Map, October 2014 Period
Plate 3 - Chemical Hydrograph Map - Western Extent
Plate 4 - Chemical Hydrograph Map - Eastern Extent
Appendix A - Supporting Data

Copies Submitted: (20) Addressee

REFERENCES

Geotechnical Consultants, Inc. (1976), *Hydrogeologic Investigation of the Carpinteria Ground Water Basin,* consultant's unpublished report prepared for the Carpinteria County Water District, June 11.

_____ (1986), *Hydrogeologic Update, Carpinteria Groundwater Basin*, consultant's unpublished report prepared for the Carpinteria County Water District, July.

Integrated Water Resources, Inc. (IWR, 2003) *Perennial Yield Review of the Carpinteria Valley Groundwater Basin*, consultant's unpublished report prepared for the Carpinteria County Water District, February 25.

Pueblo Water Resources, Inc. (2012) *Carpinteria Groundwater Basin Hydrogeologic Update and Groundwater Model Project*, consultant's unpublished report prepared for the Carpinteria County Water District, June 30.

Pueblo Water Resources, Inc. (2013) *Carpinteria Groundwater Basin Hydrogeologic Budget Update, Water Years 2009 – 2013,* consultant's unpublished report prepared for the Carpinteria County Water District, April 21.

Pueblo Water Resources, Inc. (2015) *Carpinteria Groundwater Basin Hydrogeologic Budget Update, Water Year 2014,* consultant's unpublished report prepared for the Carpinteria County Water District, September 14.

FIGURES

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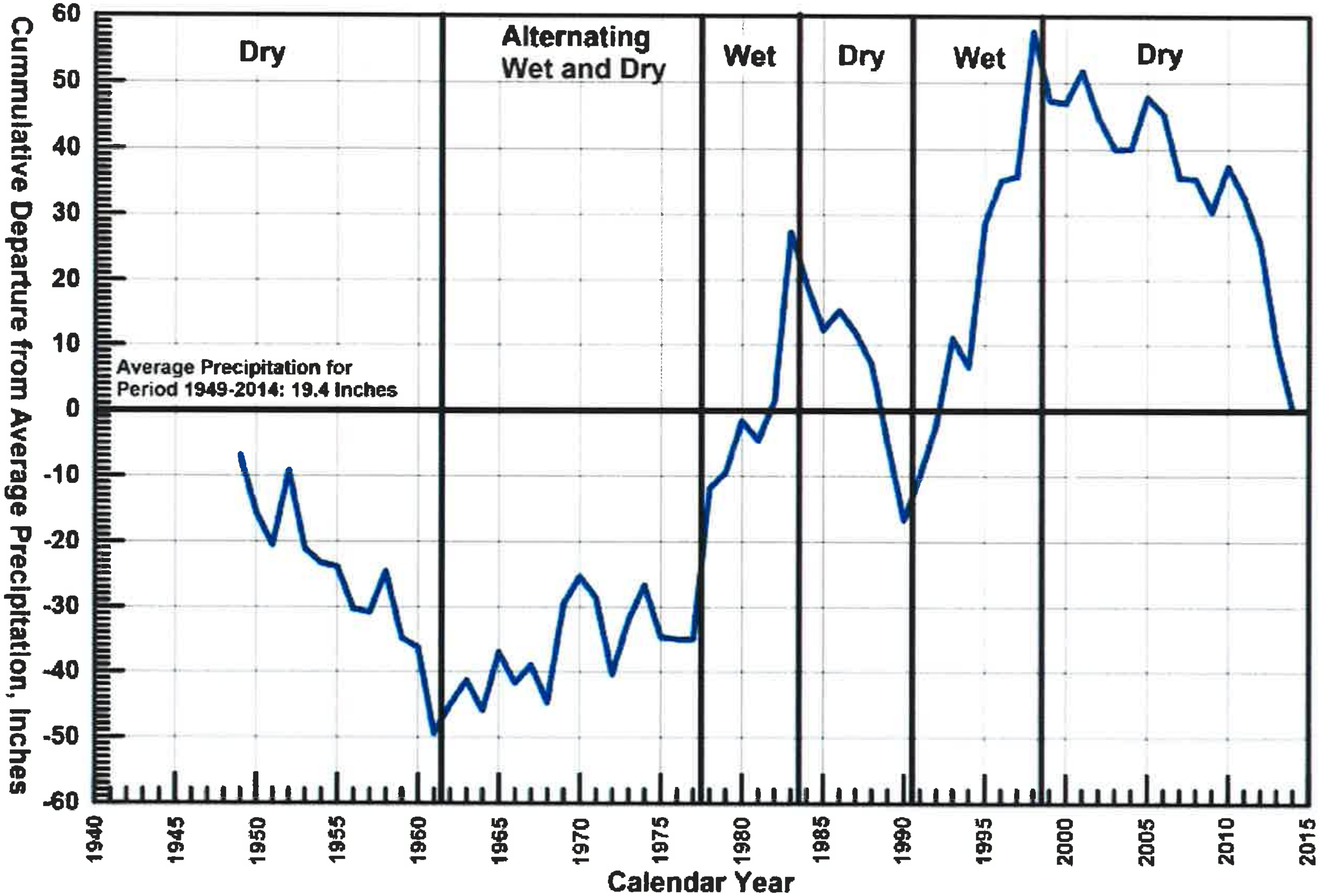
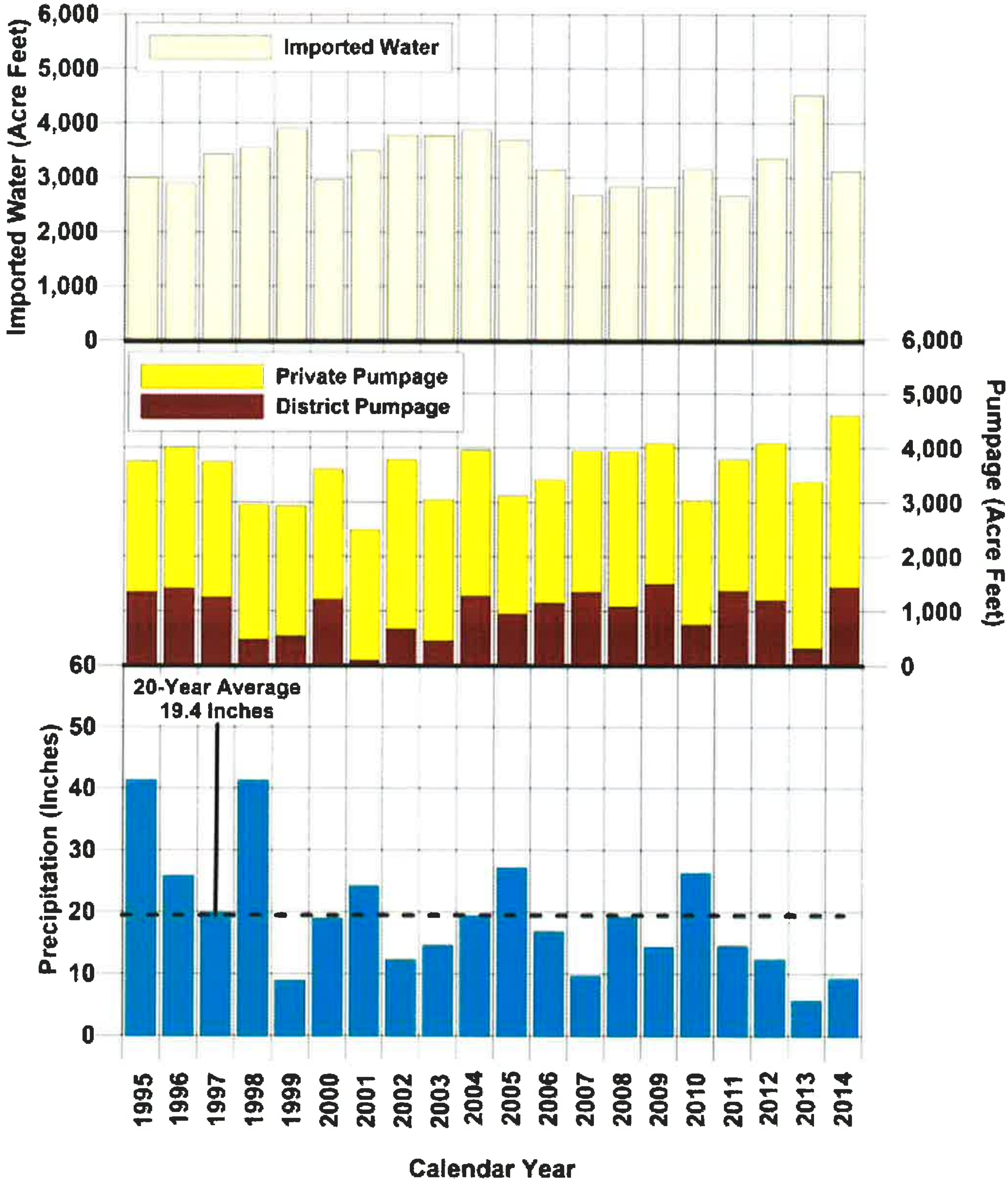
Carpinteria Valley Water District
Project No. 04.3033.006.012



CUMULATIVE DEPARTURE FROM AVERAGE PRECIPITATION
Carpinteria Fire Station
Carpinteria Valley Water District

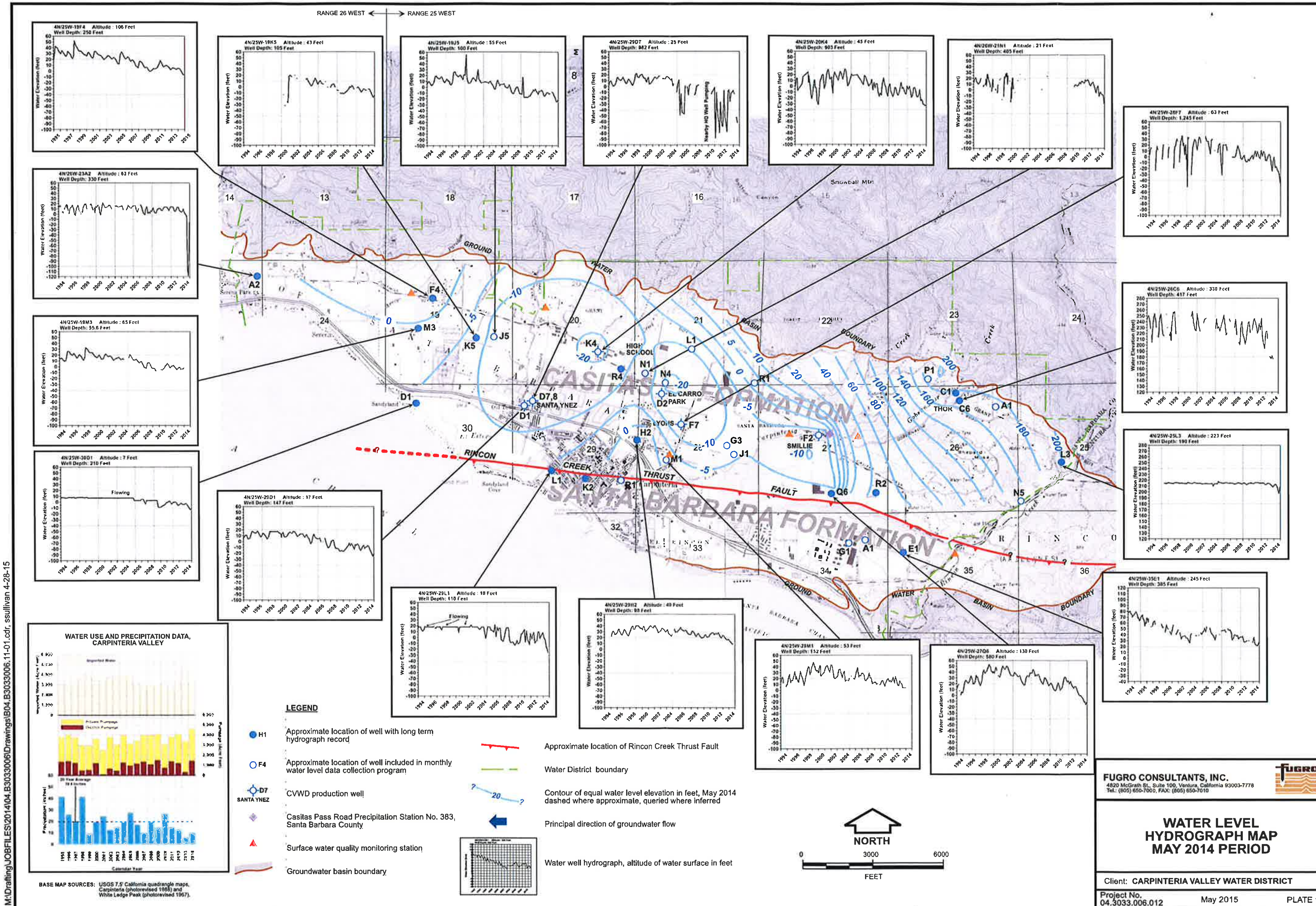
FIGURE 1



WATER USE AND PRECIPITATION DATA
Carpinteria Valley Water District

FIGURE 2

PLATES



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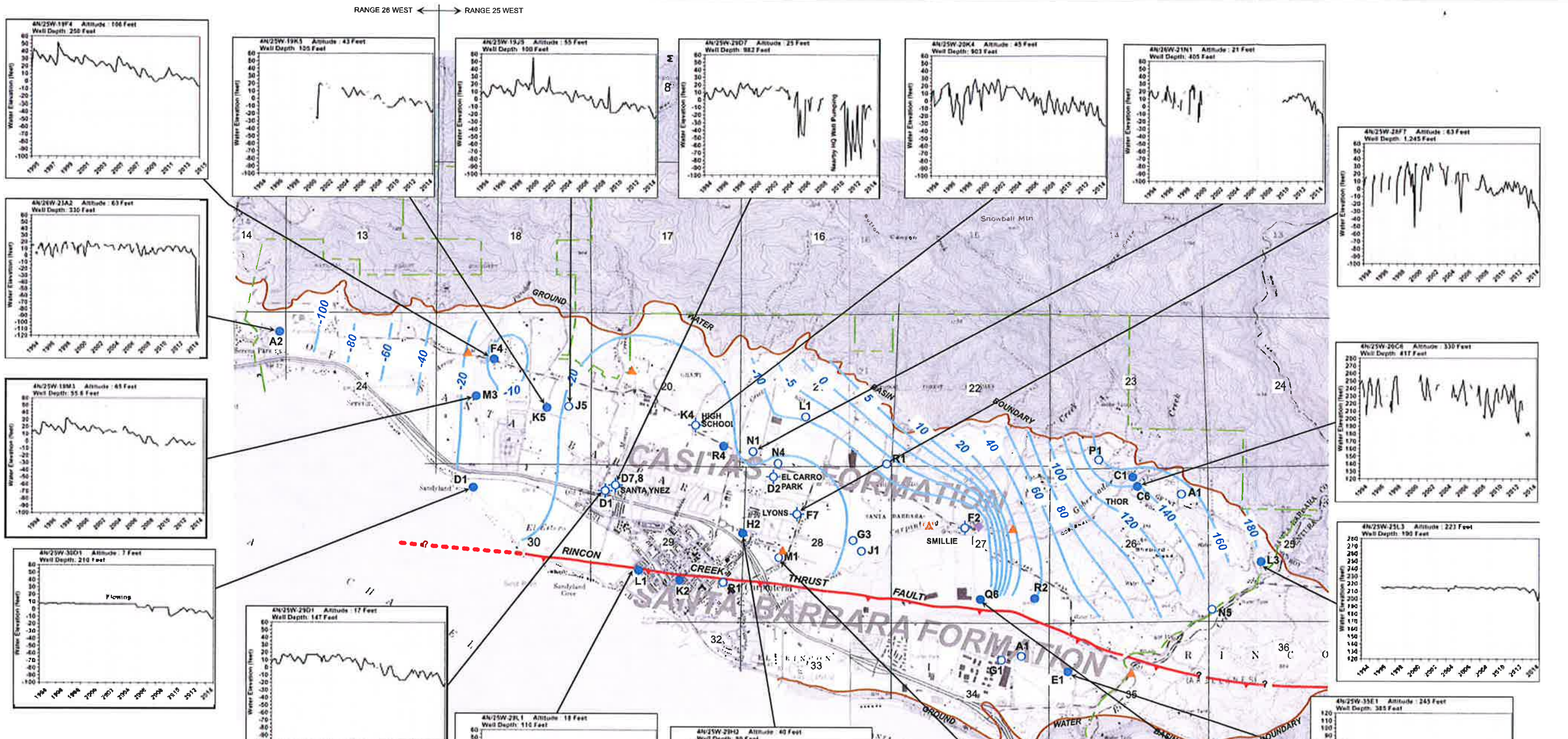

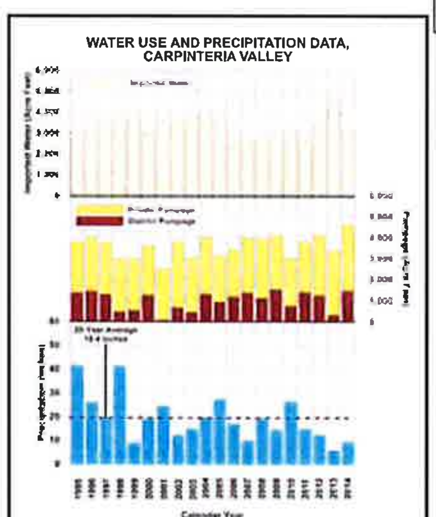

LEGEND

- H1 — Approximate location of well with long term hydrograph record
- F4 — Approximate location of well included in monthly water level data collection program
- D7 SANTA YNEZ — CVWD production well
- Casitas Pass Road Precipitation Station No. 383, Santa Barbara County
- Surface water quality monitoring station
- Groundwater basin boundary
- Approximate location of Rincon Creek Thrust Fault
- Water District boundary
- 20 — Contour of equal water level elevation in feet, October 2014, dashed where approximate, queried where inferred
- Principal direction of groundwater flow
- Water well hydrograph, altitude of water surface in feet

NORTH

0 3000 6000

FEET

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

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WATER LEVEL HYDROGRAPH MAP OCTOBER 2014 PERIOD

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.3033.006.012	May 2015	PLATE 2

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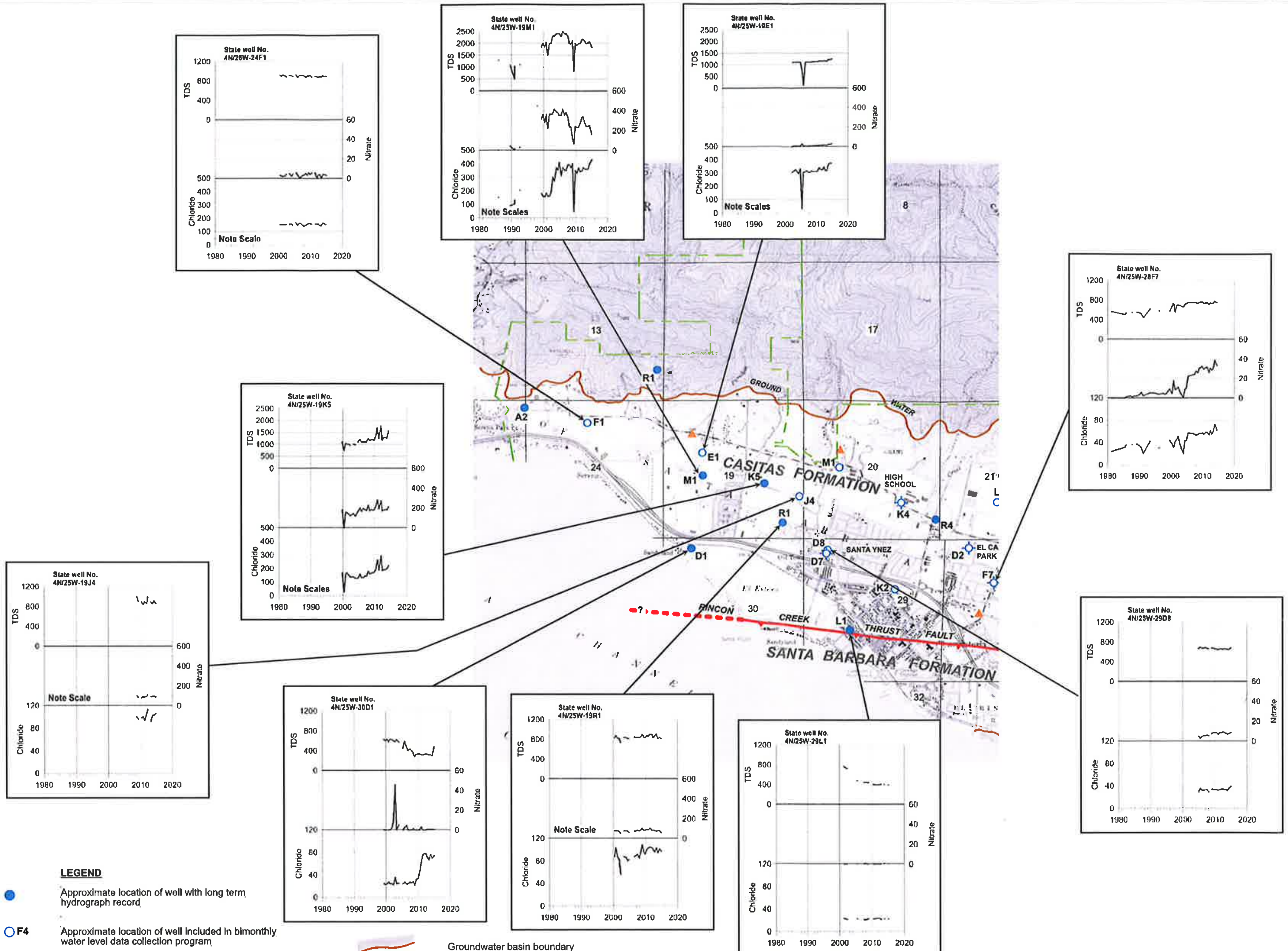

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LEGEND

- ● Approximate location of well with long term hydrograph record
- ○ F4 Approximate location of well included in bimonthly water level data collection program
- D7 CVWD production well
- SANTA YNEZ ◆ Casitas Pass Road Precipitation Station No. 383, Santa Barbara County
- ▲ Surface water quality monitoring station
- Groundwater basin boundary
- Approximate location of Rincon Creek Thrust Fault
- Water district boundary
- Chemical Hydrograph, all constituents in milligrams per liter (mg/l)

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

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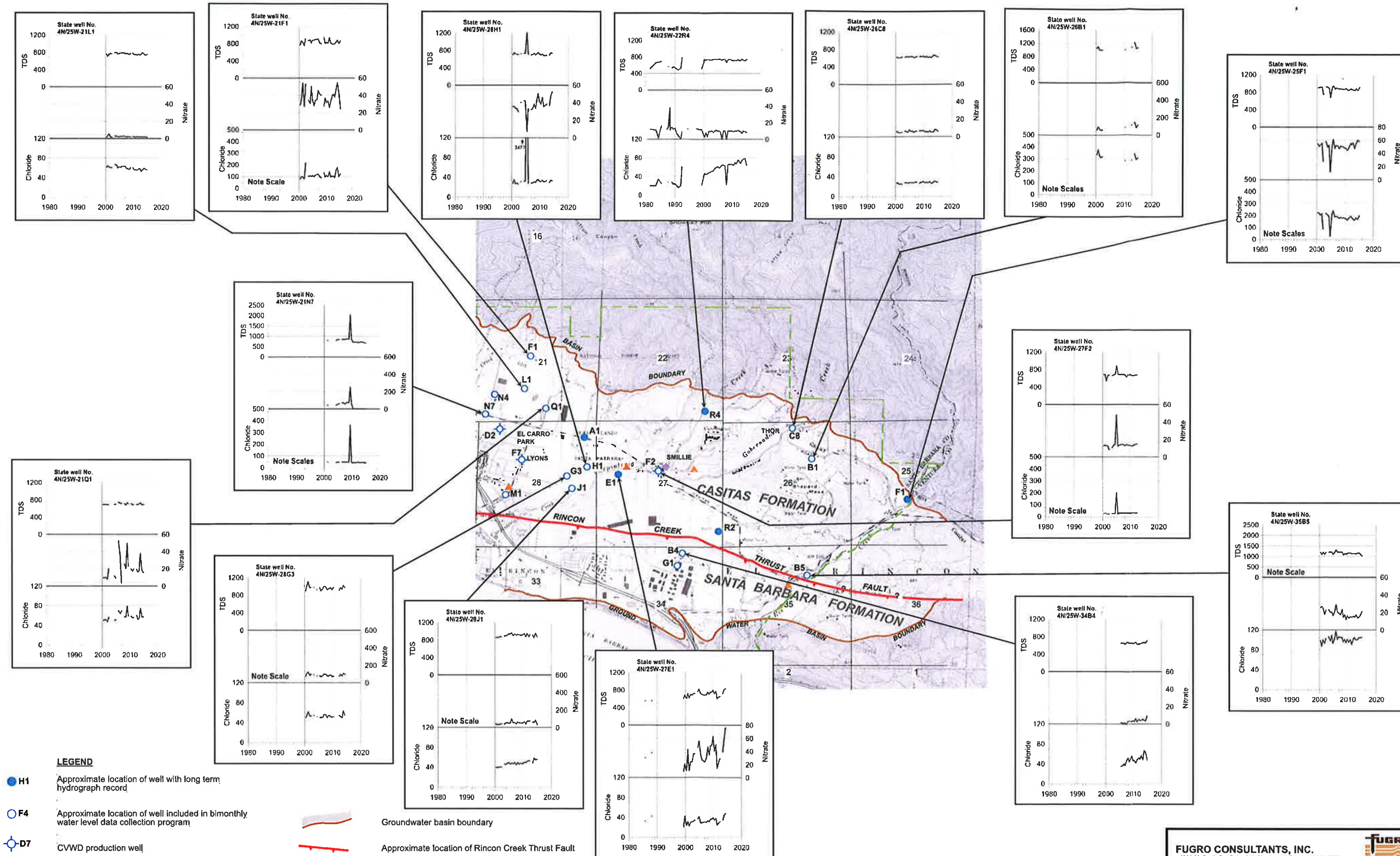
CHEMICAL HYDROGRAPH MAP (WESTERN EXTENT)

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.3033.006.012 | May 2015 | PLATE 3



LEGEND

- H1 — Approximate location of well with long term hydrograph record
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- SANTA YNEZ — Casitas Pass Road Precipitation Station No. 383, Santa Barbara County
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- Chemical Hydrograph, all constituents in milligrams per liter (mg/l)

BASE MAP SOURCES: USGS 7.5' California quadrangle maps, Carpinteria (photorevised 1988) and White Ledge Peak (photorevised 1967).

NORTH

0 3000 6000 FEET

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CHEMICAL HYDROGRAPH MAP (EASTERN EXTENT)

Client: CARPINTERIA VALLEY WATER DISTRICT

Project No. 04.3033.006.012 | May 2015 | PLATE 4

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APPENDIX A
SUPPORTING DATA

TECHNICAL MEMORANDUM
Pueblo Water Resources, Inc.
4478 Market St., Suite 705
Ventura, CA 93003
Tel: 805.644.0470
Fax: 805.644.0480

To:	Carpinteria Valley Water District	Date:	September 30, 2015
Attention:	Bob McDonald, P.E. District Engineer	Project No:	06-0121
Copy to:			
From:	Robert Marks, P.G., C.Hg		
Subject:	Carpinteria Groundwater Basin Hydrologic Budget Update, Water Year 2014		

Introduction

Presented in this Technical Memorandum (TM) is documentation of our findings developed from an update of the hydrologic budget for the Carpinteria Groundwater Basin (CGB) for Water Year 2014. A hydrologic budget for a groundwater basin is an inventory of the various sources of recharge and outflow in the basin, and is expressed by the following equation:

Change in Storage = Inflow - Outflow

where Inflow equals:

- Subsurface Inflow
- Streambed Percolation
- Percolation of Precipitation, and
- Percolation of Irrigation Return Water (pumped and imported);

and Outflow equals:

- Subsurface Outflow
- Gross Groundwater Pumpage, and
- Extraction by Phreatophytes.

The hydrologic budget for the CGB was updated by Pueblo Water Resources, Inc. (PWR) in 2012 for the period of Water Years (WY) 1985 through 2008 as part of the development of a numerical groundwater flow model of the CGB[1]. PWR performed a subsequent update in 2014 covering the 5-year period of WY 2009 through WY 2013 as part of

[1] *Carpinteria Groundwater Basin, Hydrogeologic Update and Groundwater Model Project Final Report*, prepared by Pueblo Water Resources, Inc. for Carpinteria Valley Water District, dated June 30, 2012.

the District's 2013 Annual Report pursuant to its AB3030 Groundwater Management Plan. The subject update for WY 2014 represents a continuation of the District's ongoing effort to maintain an updated hydrologic budget for the CGB.

FINDINGS

The hydrologic budget inventory for the CGB for WY 2014 was updated utilizing the same methods that were developed for the 2012 hydrogeologic update and groundwater model project. Detailed descriptions of the methodologies used for each component of the hydrologic budget are presented in PWR's 2012 report and will not be repeated here. A summary of the updated hydrologic budget for the WY 1985 – 2014 period (30 years) is presented in **Table 1**. The values shown in **Table 1** are also presented graphically on **Figure 1**. Summary descriptions for each component of the hydrologic budget are presented below.

Rainfall

Rainfall is the primary source of inflow/recharge to the basin, whether it falls directly on the basin and percolates vertically downward through the surface soils and into basin sediments, or falls on adjacent watershed areas and flows into the basin via streambed percolation or subsurface inflow. The Santa Barbara County Flood Control District maintains precipitation data from the Carpinteria Fire Station with a period of record from 1949 to the present. Annual rainfall during the 30-year WY 1984 - 2014 period of record is presented on **Figure 2**. As shown, the mean annual rainfall for this 30-year base period is 18.9 inches. Rainfall in WY 2014 was only 5.33 inches, which is approximately 28 percent of the base-period average.

The cumulative departure of annual rainfall from the long-term mean is also plotted on **Figure 2**. The cumulative departure from mean graph is used to identify climatic trends over the period of record. As shown, the cumulative departure curve exhibits a series of cyclic dry and wet periods in the basin over the period of record. The basin has been experiencing an overall dry cycle since WY 1998, and the last three years (WY 2012 through WY 2014) have been particularly dry, with annual rainfall totals generally less than half of the long term average.

Subsurface Inflow

Subsurface inflow is flow from consolidated rocks in the hill and mountain areas adjacent to the CGB. A direct relationship between subsurface inflow and precipitation has been developed, and seasonal subsurface inflow for the WY 1985 – 2014 base period was estimated using this same relationship. As shown in **Table 1**, for WY 2014 303 afy of subsurface inflow was estimated, compared to the 30-year average of 858 afy for the WY 1985 – 2014 period.

Table 1. Hydrologic Budget Summary, WY 1985 – WY 2014

Water Year	Rainfall (in)	INFLOW (acre-feet per year)							OUTFLOW (acre-feet per year)					Change in Storage	
		Subsurface Inflow	Streambed Percolation	Percolation of Precipitation		Percolation of Irrigation Water		Total Inflow	Subsurface Outflow	Groundwater Pumpage		Extraction by Phreatophytes	Total Outflow		
				Recharge Area	Confined Area	Delivered	Pumped			CVWD	Private			Year	Cummulative
1985	15.26	867	57	391	49	58	190	1,612	16	1,836	949	100	2,901	-1,289	-1,289
1986	25.78	1,100	866	4,198	522	80	208	6,973	0	2,032	1,041	100	3,173	3,801	2,511
1987	11.99	681	91	30	4	90	186	1,082	0	2,363	932	100	3,395	-2,314	198
1988	17.34	985	112	731	91	103	213	2,235	0	2,342	1,065	100	3,507	-1,271	-1,074
1989	10.27	584	26	0	0	116	304	1,029	0	2,984	1,520	100	4,604	-3,574	-4,648
1990	8.93	507	4	0	0	246	398	1,155	0	3.413	1,990	100	5,503	-4,347	-8,995
1991	20.11	1,100	758	1,634	203	166	452	4,313	0	3.014	2,261	100	5,375	-1,062	-10,057
1992	25.39	1,100	1,026	4,174	519	140	433	7,392	0	1.560	2,165	100	3,825	3,567	-6,490
1993	37.45	1,100	1,434	5,499	683	177	484	9,378	0	1.261	2,422	100	3,783	5,596	-894
1994	14.43	820	352	278	35	184	564	2,232	0	1.307	2,818	100	4,225	-1,993	-2,887
1995	41.59	1,100	1,746	5,487	660	162	478	9,632	231	1.291	2,389	100	4,011	5,621	2,733
1996	19.55	1,100	894	1,401	168	162	502	4,227	239	1.557	2,510	100	4,406	-178	2,555
1997	18.07	1,027	958	862	104	192	487	3,630	58	1.317	2,437	100	3,912	-282	2,273
1998	51.48	1,100	1,744	5,467	657	149	486	9,602	418	575	2,428	100	3,521	6,081	8,354
1999	9.99	568	434	0	0	292	598	1,891	376	340	2,990	100	3,806	-1,914	6,439
2000	17.47	993	789	740	88	256	621	3,486	86	1.410	3,105	100	4,702	-1,216	5,223
2001	20.43	1,100	1,096	1,692	205	205	652	4,950	202	185	3,259	100	3,746	1,204	6,428
2002	7.66	435	7	0	0	257	621	1,319	196	558	3,103	100	3,957	-2,638	3,790
2003	21.97	1,100	521	2,293	276	245	545	4,981	62	402	2,723	100	3,287	1,694	5,484
2004	9.57	544	2	0	0	277	561	1,384	4	999	2,803	100	3,906	-2,522	2,962
2005	37.56	1,100	1,657	5,366	646	289	412	9,471	0	1.152	2,060	100	3,312	6,159	9,121
2006	18.58	1,056	927	930	112	316	417	3,756	0	1.120	2,083	100	3,302	454	9,575
2007	7.11	404	9	0	0	410	501	1,324	0	1.418	2,507	100	4,025	-2,701	6,874
2008	17.51	995	1,041	683	82	317	561	3,680	0	661	2,806	100	3,567	113	6,987
2009	13.19	749	13	108	13	396	457	1,736	0	1,628	2,284	100	4,012	-2,276	4,711
2010	19.75	1,100	671	1,407	169	335	513	4,196	0	1,053	2,566	100	3,719	476	5,187
2011	24.89	1,100	1,053	3,515	423	324	500	6,915	0	1,236	2,502	100	3,838	3,077	8,265
2012	9.83	559	7	0	0	397	490	1,452	0	1,015	2,451	100	3,566	-2,114	6,151
2013	8.33	473	0	0	0	436	607	1,516	0	643	3,033	100	3,776	-2,260	3,891
2014	5.33	303	11	0	0	463	708	1,485	0	1,014	3,541	100	4,655	-3,171	721
30-Yr. Avg.	18.89	858	610	1,563	190	241	472	3,935	63	1,390	2,358	100	3,911	24	
High	51.48	1,100	1,746	5,499	683	463	708	9,632	418	3.413	3,541	100	5,503	6,159	
Low	5.33	303	0	0	0	58	186	1,029	0	185	932	100	2,901	-4,347	
% of Total		22	16	40	5	6	12	100	2	36	60	3	100		

Streambed Percolation

There are five principal streams in the CGB; Carpinteria, Gobernador, Santa Monica, Arroyo Parida, and Rincon Creeks. Streambed percolation is assumed to occur only where the stream reaches cross the Recharge Area. Once streamflow reaches the Confined Area, the amount of deep percolation to the main groundwater system is assumed to be insignificant. Previous studies developed runoff vs. streambed percolation relationships for each individual stream. As shown in **Table 1** above, streambed percolation for WY 2014 was estimated at 11 afy, which is approximately 2 percent of the 610 afy estimated for the 30-year WY 1985 - 2014 base period.

Percolation of Precipitation

Percolation of precipitation is the most important source of recharge to the basin, accounting for approximately 45 percent of the total inflow. Precipitation recharges the basin principally through deep percolation to the zone of saturation in the Recharge Area. In addition, one of the important findings from calibrating the numerical groundwater flow model of the CGB was that an average of approximately 215 afy (approximately 5 percent of the total inflow) of precipitation percolation in the Confined Area does reach the deep aquifers; therefore, for this update we have also calculated deep percolation in the Confined Area for WY 2014.

The total volume of deep percolation for each year of the base period is shown in **Table 1**. As shown, significant deep percolation only occurs in the wetter years. In years when the average annual rainfall is less than approximately 12 inches, no deep percolation is estimated to occur. Of particular note for this update is that no deep percolation of precipitation is estimated to have occurred during WY 2012 - 2014.

Percolation of Irrigation Water

Percolation of irrigation return water in the CGB is dependent on a variety of factors, including climatic conditions, crop type, and irrigation practices. Studies by the U.S. Soil Conversation Service for Santa Barbara County indicate irrigation efficiencies range from 65 to 70 percent. For purposes of estimating deep percolation of irrigation return water in the CGB, a conservative estimate is that 20 percent of applied water (both pumped and delivered, which includes imported water) percolates into the basin. As shown in **Table 1,** the annual recharge to the basin during WY 2014 from percolation of irrigation water is estimated to be approximately 1,171 afy, which is approximately 65 percent greater than the 30-year average of 713 afy. The greater than average amount of irrigation return water reflects the increased amount of applied water required to support crops during WY 2014 due to the relative lack of rainfall.

Subsurface Outflow

The quantity of subsurface outflow from the CGB is estimated using Darcy's Law, in which the rate of discharge through a given cross section of saturated material is proportional to the hydraulic gradient. The hydraulic gradient is driven by water-levels in the basin, and outflow occurs only when there is a seaward gradient (i.e., when water levels are generally above sea level). The results of the subsurface outflow calculations are shown in **Table 1**. As shown, zero subsurface outflow was estimated during WY 2014 because the seaward gradient between the coast and inland portions of the basin was reversed (i.e., water levels were lower inland than at the coast). It is noted that the existing reversal of the naturally occurring seaward gradient creates conditions for the potential for seawater intrusion into the basin to occur.

Groundwater Pumpage

Groundwater extractions from the CGB occur from both District and private production wells. District well production is metered, and monthly totals of production from the District wells were compiled for WY 2014. Private pumping in the basin is not metered and has been estimated on an annual basis by the District since 1984 utilizing land use survey and water delivery information. As shown in **Table 1**, aggregate pumpage is estimated to have averaged approximately 4,555 afy (1,014 afy from CVWD wells and 3,541 afy from private wells) during the WY 2014. This amount of pumpage is approximately 20 percent greater than 30-year long-term average of approximately 3,748 afy estimated for the WY 1985 – WY 2014 period.

Extraction by Phreatophytes

Phreatophytes are water loving plants (roots extend into the water table) that live in the vicinity of stream channels and in areas of high groundwater. Groundwater consumed by phreatophytes is dependent on many factors, including plant species, vegetative density, climate, soil types and conditions, and depth to groundwater. Direct measurements of consumptive use by phreatophytes in the CGB do not currently exist. By applying the results of study in San Diego County (Blaney and Criddle, 1963), extractions by phreatophytes have been roughly estimated to be approximately 100 afy. As shown in **Table 1**, phreatophytes consumption is estimated to be a relatively insignificant portion (3 percent) of the outflow from the basin.

Changes in Storage

The change in the amount of groundwater in storage depends on the annual water supply surplus or deficiency, as expressed in the water balance equation. As shown in **Table 1**, the total inflow during WY 2014 was estimated at 1,485 afy and the total outflow was estimated at 4,655 afy and, resulting in a net annual storage depletion of approximately 3,171 af.

Figure 3 presents a comparison of the cumulative departure/change curves for both rainfall and basin storage for the 1985 – 2014 base period. As shown, the cumulative change in storage curve understandably trends similarly to the cumulative departure of annual rainfall curve. For example, the plots show the period of the WY 1987 through 1990 drought and the corresponding depletion of storage, followed by the cumulatively wet period of WY 1991 through WY 1998 and the corresponding accumulation of basin storage. The relative lack of rainfall during the recent 3-year drought period of WY 2012 - 2014 corresponds to lower amounts of rainfall and recharge in the basin and a resulting cumulative depletion of storage.

As shown in **Table 1** and on **Figures 1 and 3**, as of WY 2014 the cumulative storage volume in the CGB is still slightly positive relative to basin conditions at the start of the 30-year base period in WY 1985, and particularly compared to the end of the WY 1987 through 1990 drought period, when it was depleted by as much as 11,500 af. However, average annual rainfall during the recent 3-year period of WY 2012 - 2014 was only 7.83 inches, which is approximately 60 percent lower than the long-term average, and has resulted in a net storage depletion of approximately 7,545 af during the period (corresponding to an average rate of approximately 2,515 afy). WY 2015 is on track to be similarly dry, representing a fourth consecutive year of drought conditions, and additional storage depletion in the CGB is likely continuing to occur.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings developed from the subject update to the CGB hydrologic budget for WY 2014, we offer the following conclusions and recommendations:

- Average rainfall during WY 2014 period was approximately 5.33 inches, which is approximately 70 percent less than the long-term average of 18.9 inches and is historically the driest year on record.

- The limited amounts of rainfall during the period correspond to lower-than-average recharge to the CGB. Average total inflow / recharge during WY 2014 is estimated to be approximately 1,485 afy, which is approximately 60 percent less than the long-term average of approximately 3,935 afy.

- Extractions from the basin during WY 2014 are estimated at approximately 4,655 afy, which is approximately 20 percent greater than the long-term average of approximately 3,900 afy.

- As a result of the relatively limited amount of recharge and extractions exceeding the long-term average, 3,171 afy of storage depletion is estimated to have occurred in WY 2014. During the 3-year period from WY 2012 - 2014, a cumulative storage loss of approximately 7,545 af has occurred, corresponding to a storage loss rate of approximately 2,500 afy. Assuming a similar loss of storage occurs in WY 2015, the 4-year cumulative storage depletion for WY 2012 – 2015 would be approximately 10,000 af. This compares to the estimated 4-year cumulative storage depletion during the WY 1987 – 1990 drought of approximately 11,506 af.

- The hydrologic budget for the CGB should be updated on an ongoing basis. Given the current drought conditions are persisting through WY 2015, it is recommended that the hydrologic budget be updated on annual basis until the drought is over. When climatic and basin conditions return to normal, the hydrologic budget should continue to be updated, but perhaps on a less frequent basis (e.g., tri-annually).

- There was no subsurface outflow estimated during the period (no subsurface outflow from the basin has been estimated to have occurred during the last 10 years) due to depressed water levels in the basin. Water levels are as much as 15 feet below sea level in the western portion of basin, an area where the Rincon Creek Fault barrier is located offshore. These basin conditions present a theoretical risk for seawater intrusion to occur in the CGB.

CLOSURE

This Technical Memorandum has been prepared exclusively for Carpinteria Valley Water District for the specific application to the Carpinteria Groundwater Basin Hydrologic Budget Update Project. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeologic practices. No other warranty, express or implied, is made.

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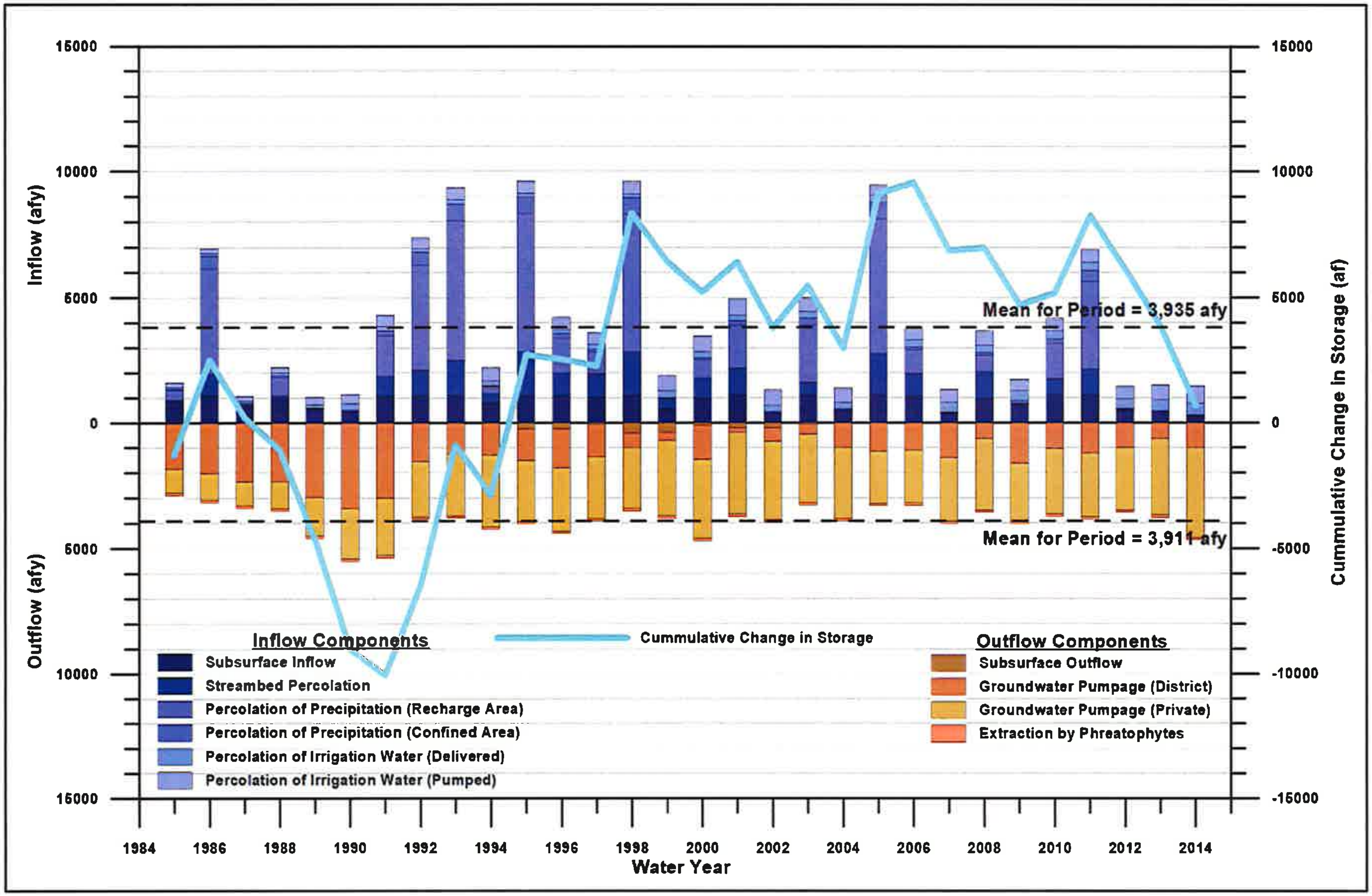
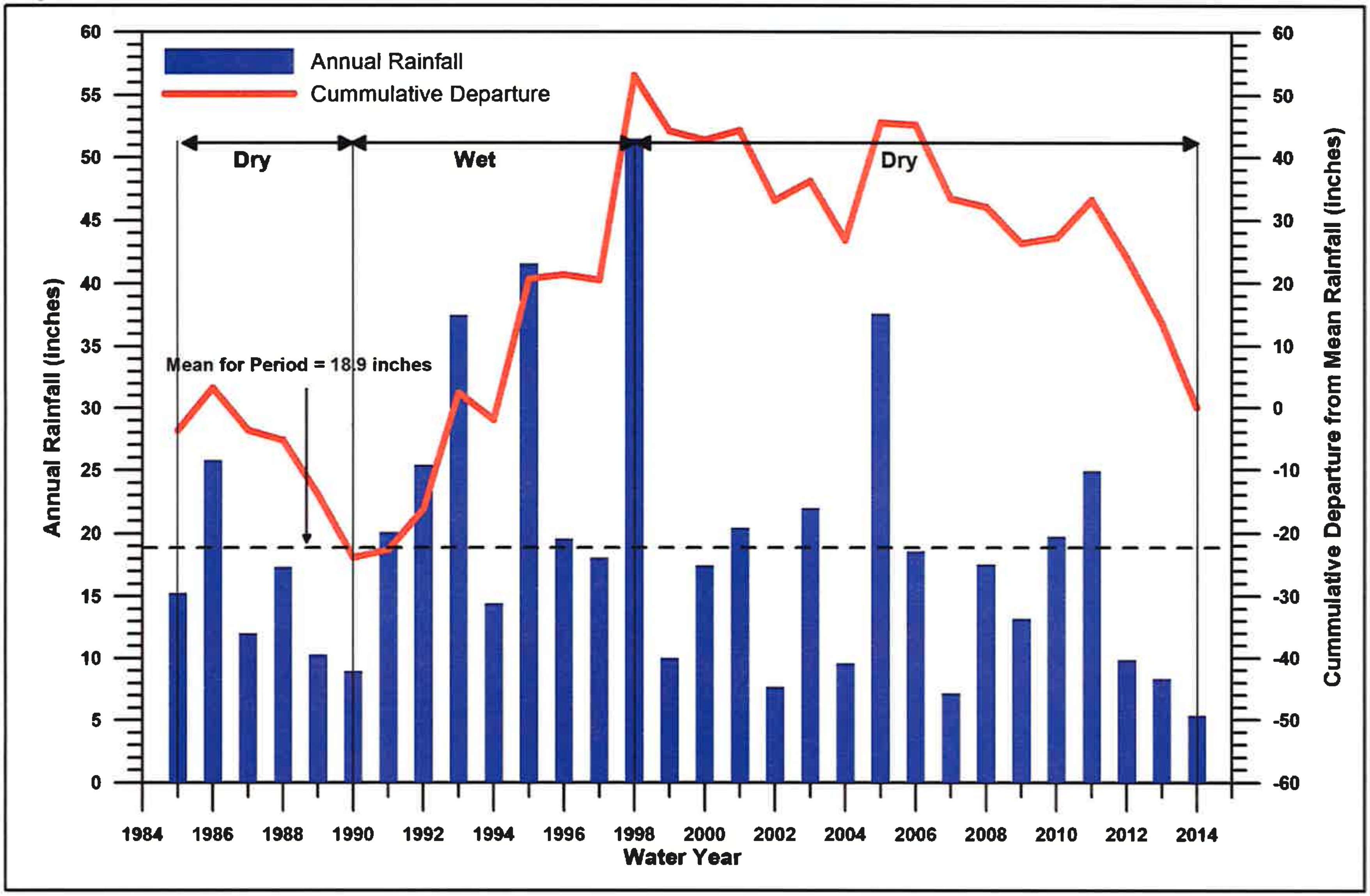
September 2015
Project No. 06-0121



PUEBLO water resources

FIGURE 1. HYDROLOGIC BUDGET SUMMARY FOR WY 1985 - 2014 PERIOD
CGB Hydrologic Budget Update Project
Carpinteria Valley Water District

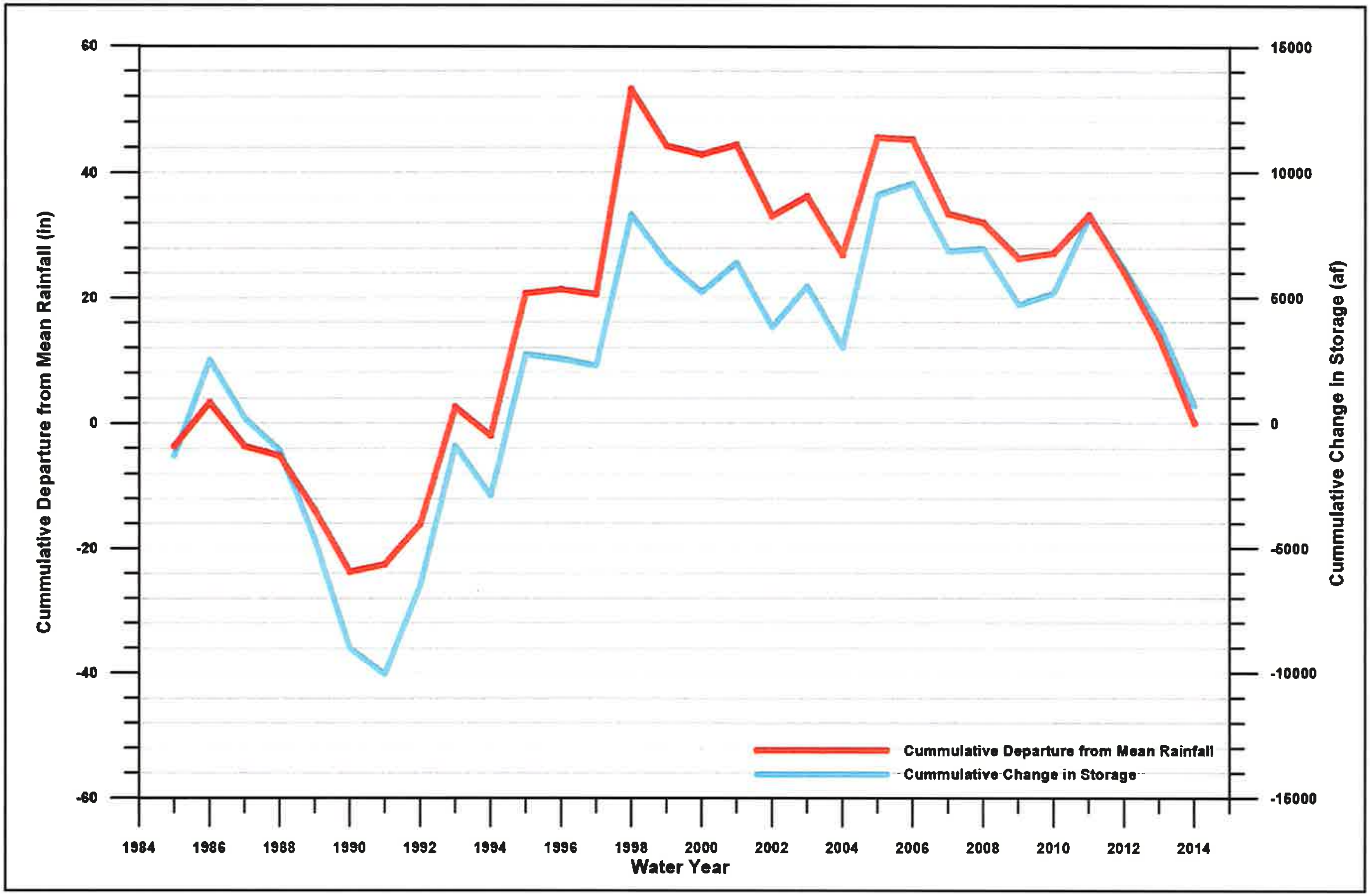
September 2015
Project No. 06-0121



PUEBLO water resources

FIGURE 2. CUMULATIVE DEPARTURE OF ANNUAL RAINFALL - CARPINTERIA FIRE STATION (208)
WY 1985 - 2014
CGB Hydrologic Budget Update
Carpinteria Valley Water District

September 2015
Project No. 06-0121



PUEBLO water resources

FIGURE 3. CUMMULATIVE DEPARTURE/CHANGE CURVE COMPARISON FOR WY 1985 - 2014 PERIOD
CGB Hydrologic Budget Update Project
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