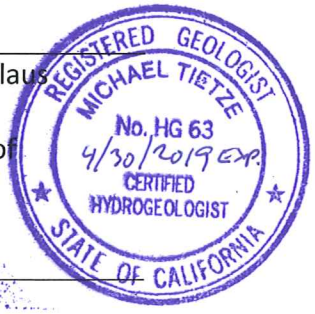
MEMORANDUM

SUBJECT:	Evaluation of Groundwater Level Trends in Northern Triangle Area, Stanislaus County, California
TO:	Walter Ward, Water Resources Manager, Stanislaus County Department of Environmental Resources
FROM:	Juliet Hutchins and Mike Tietze, CHG, JJ&A
DATE:	October 27, 2017



In this memorandum, Jacobson James & Associates (JJ&A) presents an evaluation of available groundwater level trend data in the northeastern area of Stanislaus County north of the Stanislaus River (the Northern Triangle) to assess whether existing groundwater level trends constitute "*chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon*" as defined in Section 9.37.030(9)(a) of the Stanislaus County Groundwater Ordinance and the Sustainable Groundwater Management Act (SGMA).

Background:

The guidelines developed for implementation of discretionary well permitting under Stanislaus County's groundwater ordinance (Chapter 9.37 of the County Code; hereinafter the Ordinance) define a Groundwater Level Management Zone as an area where installation of new wells would contribute to, or, in the absence of direct data can be reasonably inferred to contribute to, a condition of Critical Overdraft, which is *"... when present water management practices would probably result in significant adverse overdraft-related environmental, social, or economic impacts"* (DWR, 1980). This would include any area where "Undesirable Results," as defined in the Ordinance are occurring or can be reasonably anticipated that lie within the unincorporated portions of the County and outside the jurisdiction of any water agency in compliance with a groundwater management plan. In such areas, an applicant proposing installation of a new well that is not exempt from the Ordinance is required to submit a Groundwater Extraction Offset Plan that describes how groundwater extraction from the well will be offset, resulting in no net additional groundwater demand. Alternatively, the applicant must conduct a Groundwater Resources Investigation and implement a Groundwater Level Monitoring Program that demonstrates the proposed extraction will not result in, or contribute to, Undesirable Results.

Groundwater development in the Northern Triangle has occurred primarily to support irrigated agriculture, which remains relatively sparse, except in the southwestern portion of the area and near the Stanislaus River. The principal aquifers underlying the Northern Triangle occur within semi-consolidated to consolidated sediments and rocks of the Miocene Mehrten Formation, the Pliocene Laguna Formation and the Pleistocene Turlock Lake Formation, and are, on average, approximately 500 feet thick or more. The aquifer formations comprise proximal alluvial fan and volcano-fluvial facies, and contain paleosols and fine grained layers that impede vertical flow and result in semi-confined to confined conditions in the lower portions of the aquifer system. The aquifer matrix is not generally very compressible, and subsidence has not been reported in the Northern Triangle (DWR, 2017). The region consists of a rolling upland that is deeply incised by the major rivers that drain the Sierra Nevada, including the Stanislaus River on the south side and the Calaveras River to the north. Both of these

rivers are hydraulically connected to the regional groundwater aquifers (Brush, et al., 2013). Other drainages and surface water bodies that occur in the upland areas are locally connected to perched groundwater, but are not known to be connected to regional aquifers. The upland areas are relatively old surfaces that are underlain by well developed duripan soils that limit areal recharge.

Approach:

Groundwater level data were downloaded from the California Statewide Groundwater Elevation Monitoring (CASGEM) database for wells within and adjacent to the Northern Triangle. The Northern Triangle was divided into study subareas that correspond with grid elements used in the Department of Water Resource's C2VSim groundwater model (Brush, et al., 2013). Trends were evaluated for each grid element based on the following considerations:

- Trends were mapped to assess the spatial distribution of drawdown and its relationship to areas of potential discharge (pumping) and recharge;
- Trends were compared to cumulative departure from average precipitation at the Modesto Irrigation District meteorological station to identify the potential effects of climate on recharge and discharge; and
- Trends were compared to irrigated acreage reported in C2VSim to assess the potential relationship between agricultural development, groundwater pumping and drawdown.

Based on the hydrogeologic setting of the Northern Triangle, the primary potential Undesirable Result that could occur from groundwater extraction would be the "***chronic lowering of groundwater levels*** *indicating a* ***significant and unreasonable depletion of supply*** *if continued over the* ***planning and implementation horizon***" (emphasis added). The purpose of this analysis is to evaluate whether chronic, significant and unreasonable drawdown is occurring or may be expected to occur in the future during the planning and implementation horizon under current trends. To make this determination, the following approach was applied to further evaluate the hydrograph trends in each grid element.

- ***Determine if Drawdown is Chronic.*** Overdraft during a period of drought is not sufficient to establish a chronic ¶ÖÝßÆ of groundwater levels if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods. As such, drawdown was assumed to be chronic when regional drawdown did not recover over a period of years that includes both wet and dry periods. Based on a typical anticipated well life of up to approximately 40 years,[1] hydrograph data since 1977[2] were assessed to determine whether drawdown is chronic. In the absence of other Undesirable Results, drawdown prior to this period was not considered relevant to the analysis.

[1] Although a well may still be usable after a period of 40 years, it is reasonable to assume that most wells will need rehabilitation, deepening, or replacement to maintain their original capacity after they have been operated 40 years.
[2] 1977 was selected as the beginning of the trend analysis period for this evaluation because general hydrograph trends for many wells in the area were observed to change after this time. It should be noted that this is different from the baseline for assessing sustainability under SGMA, which may be as late as November 2014, the date that the legislation was adopted.

- ***Determine if Drawdown is Significant.*** Drawdown was assumed to be potentially significant when it was determined to be chronic, and, if continued, would interfere with the ability of well operators in the area to support existing or permitted land uses, or would substantially increase the cost to extract groundwater to uneconomical levels. A foreseeable drawdown of less than 10% of the available aquifer thickness is considered less than significant under the guidelines developed to implement the County's discretionary well permitting program, as long as other Undesirable Results are not occurring. Thus, hydrograph data were evaluated to determine whether trends after 1977 would result in a cumulative drawdown exceeding 50 feet over the planning and implementation horizon of the study (see below) by fitting the data with a least-squares logarithmic trend line.[3] In addition, consideration was given to whether or not diminished well yields or wells going dry have been reported in the grid element.
- ***Determine if Drawdown is Unreasonable.*** A full evaluation of groundwater extraction under California's Reasonable Use Doctrine is beyond the scope of this study (Wilson, 2011); however, for the purposes of this analysis, it was assumed that groundwater extraction is reasonable as long as the extracted groundwater is put to beneficial use within the County, is generally consistent with the statements of County policy contained in Section 9.37.020 of the Ordinance, and promotes the public welfare and sustainable groundwater management. At this time, we understand the County is not aware of any groundwater use in the Northern Triangle that would constitute unreasonable use under these criteria; however, it is assumed that any significant drawdown, as determined based on the above criteria, would result in an "unreasonable means of diversion" as envisioned in the Reasonable Use Doctrine.
- ***Planning and Implementation Horizon.*** For the purposes of this analysis, a planning horizon equal to that required under the SGMA (50 years) is used to evaluate whether current drawdown rates are significant. As such, if cumulative drawdown between 2017 and 2067 is 50 feet or more, it is considered potentially significant.

Findings:

An index map showing the locations of the grid elements evaluated in the Northern Triangle is presented as Figure 1. For each grid element, the locations of wells used in the assessment and associated hydrographs are shown on Figures 2A through 11A, drawdown relative to cumulative departure from mean precipitation is graphed on Figures 2B through 11B, drawdown relative to irrigated acreage through 2009 extracted from the DWR's C2VSim model is graphed on Figures 2C through 11C, and drawdown trends after 1977 and extrapolated forwards to 2067 are graphed in Figures 2D through 11D. The results of the hydrograph analysis are summarized in Table 1. An evaluation of whether drawdown is chronic, significant and

[3] We selected 10% of available aquifer thickness as a reasonably conservative significance threshold in this setting based on the currently available data regarding hydrogeology, aquifer response, and well completion depths in the area. More detailed analysis may support a different standard. For example, drawdown greater than 50 feet has occurred in similar settings in the southeastern portion of the County without other reported undesirable results, and, although of potential concern if continued, has not resulted in water levels falling to uneconomical depths. Since the rate of drawdown under a given set of stresses and boundary conditions may be expected to decrease over time, a log decay curve was fitted to the data and extrapolated to assess future trends through 2067 if current conditions persist.

unreasonable, and whether the grid elements should be qualified as Groundwater Level Management Zones based on the above analysis is summarized in Table 2. Principal findings include the following:

- Declining groundwater level trends were noted throughout the areas where long-term data are available, but the rates of groundwater level decline generally decreased or stabilized after 1977. The greatest groundwater level declines were recorded in the northern and southwestern portions of the area, with total drawdowns of 50 to 90 feet observed since the 1940s in some areas. These data lead to the conclusion groundwater levels may be influenced by outside areas.
- Groundwater level declines were generally correlated with increases in irrigated acreage, especially prior to 1977, and groundwater level stabilization was generally correlated with stabilization or decrease in irrigated acreage. In some areas in the southern portion of the area that are served by surface water from Oakdale Irrigation District (OID), a decrease in irrigated acreage in the late 1980s may be correlated with a decrease in groundwater levels, suggesting that application of surface water as a source of irrigation supply is a significant source of recharge in some areas.
- Groundwater levels in many areas showed a sharp decline during the 1977 drought and the 2011 to 2015 drought. This was especially true in areas receiving surface water from the Oakdale Irrigation District, where reliance on groundwater tends to increase primarily during times of drought. Groundwater level declines during drought periods are less pronounced further to the north, where surface water is less available.
- Groundwater level recovery after the 1977 drought took six to eight years. This is an indication that groundwater extraction during this time significantly exceeded recharge rates.
- Chronic groundwater level decline has been observed in some areas in the north and southwest portions of the Northern Triangle.
- Projection of groundwater level trends over a 50-year planning and implementation horizon (2017 to 2067) indicates that groundwater level decline was generally less than significant, but could exceed a significance threshold of 50 feet in Grid Element 568 if current trends continue (i.e., even if no new groundwater extraction is added). During the recent drought, some wells in the vicinity of Valley Home in this element were reported as going dry. Designation of this area as a Groundwater Level Management Zones is therefore prudent pending further analysis. However, it should be noted that future analysis could indicate current groundwater depletion rates in this area are sustainable and/or that groundwater levels will stabilize.

References:

Brush, C.F., Dogrul, E.C., and Kadir, T.N., *2013*. Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), Version 3.02-CG.

California Department of Water Resources (DWR), 1980. Groundwater Basins in California, A Report to the Legislature in Response to Water Code Section 12924: Bulletin 118-80.

DWR, 2017. Groundwater Information Center Interactive Mapping Application: http://www.water.ca.gov/groundwater/MAP_APP/index.cfm.

Wilson, Craig, 2011. The Reasonable Use Doctrine and Agricultural Water Use Efficiency, A Report to the State Water Resources Control Board and the Delta Stewardship Council.

TABLES

Table 1
SUMMARY OF GROUNDWATER LEVEL ANALYSIS BY C2VSim GRID ELEMENT
Northern Triangle, Stanislaus County

Element Number/Figures	Number of CASGEM Wells Within or Near Element Number		Period of Record of CASGEM Wells Within Element Number	Number of CASGEM Wells Within a Water District	Source of Surface Water Within Element Number	Groundwater Level Trend	Groundwater Level Trend Compared to Reported Irrigated Acreage in C2VSim	Groundwater Level Trend Compared to Climate (Cumulative Departure from Mean Precipitation at MID Meteorological Station)
	Within or Near Grid Element	CASGEM ID						
568/Figures 2A, 2B and 2C	2 total		1948 - 2016	None	Riparian diversions from Calaveras River on north side of element area	Groundwater levels show an overall declining trend with some periods of stability. Total declines are 40 to 50 feet (0.6 to 0.7 feet/year). Declines since 1997 generally range from about 5 to 10 feet.	Irrigated acreage increased from 1935 to the early 1960's, then remained relatively stable. Groundwater levels continued to decline when irrigated acreage stabilized.	Possible slight correlation between groundwater level declines and dry periods, and groundwater level recovery/stability during wet periods, but the correlation is weak and inconsistent.
	Near	03N09E36G001M	1948 - 2010	No				
	Near	03N09E25R001M	1948 - 2016	No				
587/Figures 3A, 3B and 3C	2 total		1949 - 2013	None	Rock Creek Water District, Duck Creek, Rock Creek	Groundwater levels declined steadily from about 1950 to 1980 (~90 feet total) and have been relatively stable since, with variability of +/- 20 tp 40 feet and declines during the recent drought.	Groundwater level declines are strongly correlated with an increase in irrigated acreage, and stabilization with a decrease in irrigated acreage.	Possible slight correlation between groundwater level declines and dry periods (e.g., late 1980s, 2010-2015) and recovery during wet periods (e.g., early 1980s)
	Near	01N09E01C001M	1989 - 2013	No				
	Near	01N09E13D001M	1949 - 2013	No				
597/Figures 4A, 4B and 4C	6 total		1940 - 2017	None	Farmington Flood Control Basin and associated creeks (Rock, Telegraph and Littlejohn), Rock Creek Water District	Mostly declining groundwater level trends prior to 1980 (40 to 50 feet total), and relatively stable trends with some shorter term variations since then.	Declining groundwater levels are correlated with a period of increasing irrigated acreage and generally stabilized when irrigated acreage stabilized.	Groundwater levels generally declined during dry periods in the late 1980s and 2010-2015, and recovered during wet periods in the early 1980s and late 1990s.
	Near	01N09E26A001M	1985 - 2017	No				
	Near	01N09E36P001M	1960 - 2006	No				
	Within	01N10E32Q001M	1978 - 2017	No				
	Within	01S10E04C001M	1971 - 2017	No				
	Within	01S10E05H001M	1948 - 1993	No				
	Within	01S10E06Q001M	1940 - 2006	No				
598	0 total		NA	NA	Telegraph Creek, Littlejohn Creek	Unknown	NA	NA
601/Figure 5A, 5B and 5C	7 total		1940 - 2017	7 wells	Oakdale Irrigation District, Woodward Reservoir	Groundwater levels decline 20 to 30 feet in the 1940s and 50s and an additonal an additional 20 to 30 feet through the early 1990s, with periods of short term variability. Since the 1990s, groundwater levels were relatively stable until the 2010-2015 drought.	Possible correlation between increasing irrigated acreage through the mid 1970s and declining groundwater levels. There is a possible inverse correlation between declining water levels in the late 1980s and a decrease in irrigated acreage during that time.	There is a pronounced drop in water levels in nearly all wells during the 1977 drought, recovery during the early 1980s, and drop during the recent (2011-2015) drought. There is a possible correlation between declining water levels in the late 1980s and a mostly dry period during that time.
	Within	01S10E18M001M	1952 - 2014	Yes - OID				
	Within	01S10E19C001M	1940 - 1994	Yes - OID				
	Within	01S10E19L001M	1944 - 2017	Yes - OID				
	Within	01S10E08L001M	1944 - 2014	Yes - OID				
	Within	01S10E16Q001M	1947 - 2014	Yes - OID				
	Within	01S10E20G001M	1948 - 2014	Yes - OID				
	Within	01S10E22Q001M	1950 - 2014	Yes - OID				

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SUMMARY OF GROUNDWATER LEVEL ANALYSIS BY C2VSim GRID ELEMENT
Northern Triangle, Stanislaus County

Element Number/Figures	Number of CASGEM Wells Within or Near Element Number		Period of Record of CASGEM Wells Within Element Number	Number of CASGEM Wells Within a Water District	Source of Surface Water Within Element Number	Groundwater Level Trend	Groundwater Level Trend Compared to Reported Irrigated Acreage in C2VSim	Groundwater Level Trend Compared to Climate (Cumulative Departure from Mean Precipitation at MID Meteorological Station)
	Within or Near Grid Element	CASGEM ID						
602/ Figure 6A, 6B and 6C	1 total		1995 - 2012	None	Oakdale Irrigation District, Woodward Reservoir	Groundwater levels are relatively stable for the period of record (1995 - 2012)	Irrigated acreage has been stable during the period of record.	No short-term correlation between climate and groundwater levels is apparent.
	Within	01S10E23H001M	1995 - 2012	No				
603/ Figure 7A, 7B and 7C	1 total		2017	None	Martells Creek	Insufficient data	Only one groundwater level data point, unable to compare. Irrigated acreage is low and relatively stable from late 70's through 2009.	Unable to compare precipitation cumulative departure trend against single groundwater level data point.
	Within	51301	2017	No				
614/ Figure 8A, 8B and 8C	11 total		1940 - 2017	9 wells	Oakdale Irrigation District, Stanislaus River	Groundwater levels decreased by 10-15 feet from 1940-1950, then were relatively stable until 1985 with short term fluctuations. Between 1985 and 1990, groundwater levels fell by an additional 10-15 feet, then remained relatively stable until 2010-2015, when they fell an additional 10 to 20 feet.	Irrigated acreable increased through the mid-1970s, then decreased unitl 1990, and increased again slightly until 2009. Decreasing groundwater levels between 1985 and 1990 may be correlated with a decrease in irrigated acreage during that time period.	There is a pronounced drop in water levels in nearly all wells during the 1977 drought, recovery during the early 1980s, and drop during the recent (2011-2015) drought. There is a possible correlation between declining water levels in the late 1980s and a mostly dry period during that time.
	Within	01S10E33J001M	1947 - 2006	Yes - OID				
	Within	02S10E04H001M	1940 - 1994	Yes - OID				
	Within	02S10E05N001M	1944 - 2017	Yes - OID				
	Within	01S10E33E001M	1944 - 1994	Yes - OID				
	Within	01S10E28J001M	1946 - 2006	Yes - OID				
	Within	01S10E27Q001M	1952 - 2017	No				
	Within	01S10E34R001M	1952 - 2017	No				
	Within	02S10E02C001M	1947 - 2014	Yes - OID				
	Within	02S10E02P001M	1949 - 2017	Yes - OID				
	Within	02S10E09E001M	1997 - 2014	Yes - OID				
	Within	02S10E08H001M	1945 - 2014	Yes - OID				
615/Figure 9A, 9B and 9C	4 total		1944 - 2017	3 wells	Oakdale Irrigation District, Stanislaus River	Groundwater levels decreased by 5-10 feet in the 1940s and 50s, then were relatively stable until 1985 with short term fluctuations. Between 1985 and 1990, groundwater levels fell by an additional 10 to 15 feet, then remained relatively stable until 2010-2015, when they fell an addiitonal 5 to 20 feet.	Irrigated acreage increased through approximately 1980, then remained relatively stable with exception of a drop in the late 1980s. Decreasing groundwater levels between 1985 and 1990 may be correlated with this decrease.	There is a pronounced drop in water levels during the 1977 drought, recovery during the early 1980s, and drop during the recent (2011-2015) drought. There is a possible correlation between declining water levels in the late 1980s and a mostly dry period during that time.
	Within	01S10E26J001M	1950 - 2017	Yes - OID				
	Within	01S10E27R001M	1952 - 1997	No				
	Within	01S10E35F001M	1999 - 2014	Yes - OID				
	Within	02S10E01E001M	1944 - 2014	No				

Table 1
SUMMARY OF GROUNDWATER LEVEL ANALYSIS BY C2VSim GRID ELEMENT
Northern Triangle, Stanislaus County

Element Number/Figures	Number of CASGEM Wells Within or Near Element Number		Period of Record of CASGEM Wells Within Element Number	Number of CASGEM Wells Within a Water District	Source of Surface Water Within Element Number	Groundwater Level Trend	Groundwater Level Trend Compared to Reported Irrigated Acreage in C2VSim	Groundwater Level Trend Compared to Climate (Cumulative Departure from Mean Precipitation at MID Meteorological Station)
	Within or Near Grid Element	CASGEM ID						
616/ Figure 10A, 10B and 10C	2 total		1999 - 2017	1 well	Oakdale Irrigation District, Stanislaus River, Littlejohn Creek	Groundwater levels were generally stable, except for increased fluctuation decline of up to 20 feet from 2012-2015.	Irrigated acreage was generally stable during the hydrograph period of record. No correlation was observed.	Groundwater levels declined by 10 to 20 feet during dry periods.
	Within	51298	2017	No				
	Within	01S11E25N001M	1999 - 2016	Yes - OID				
617/ Figure 11A, 11B and 11C	2 total		1971 - 1972	None	Oakdale Irrigation District, Stanislaus River, Littlejohn Creek	Insufficient data	NA	NA
	Within	01S11E14F001M	1971 - 1972	No				
	Within	01S12E29D001M	1972	No				

Notes:
OID = Oakdale Irrigation District
NA = Not available/not applicable

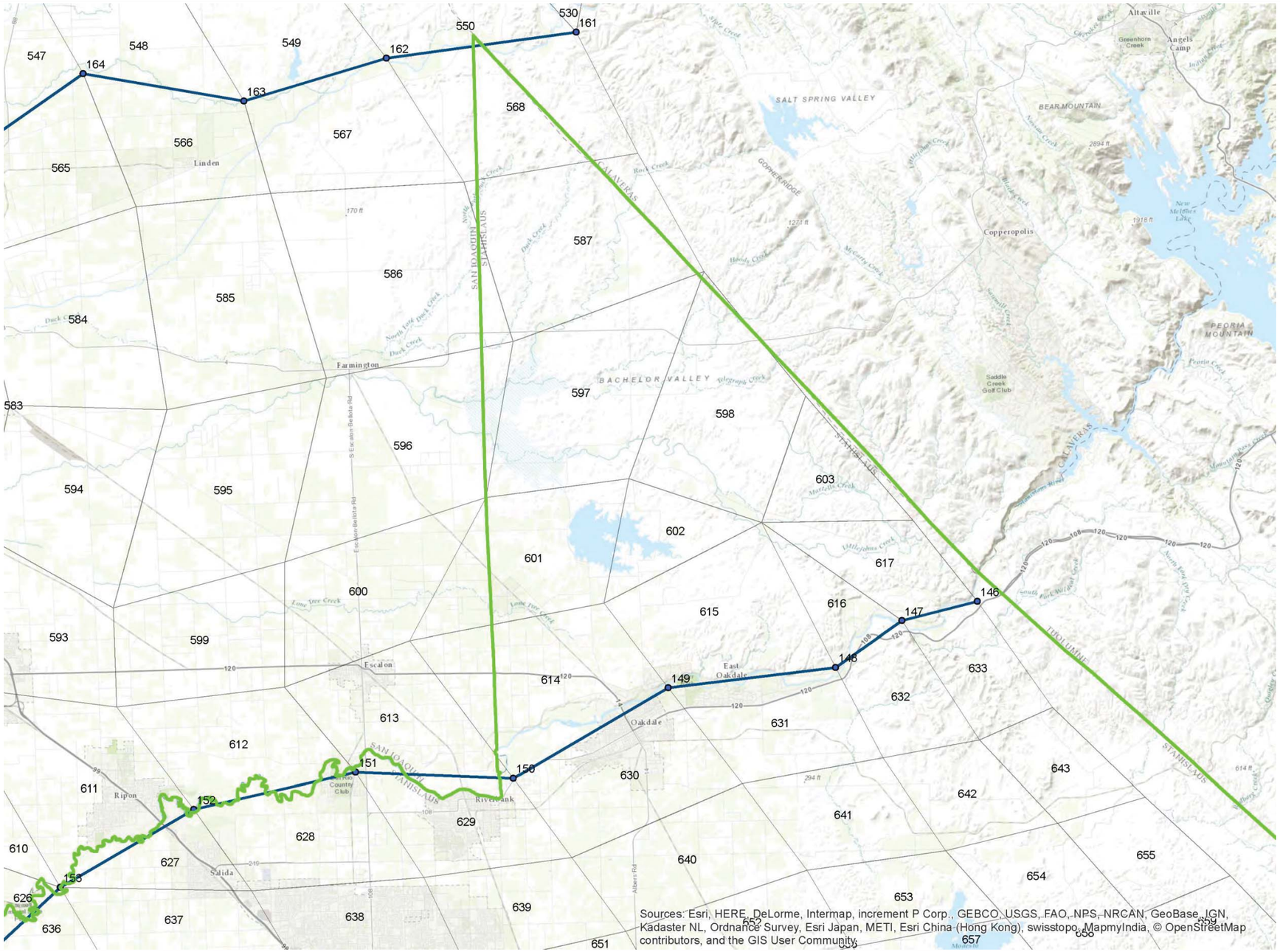
Table 2
SUMMARY OF EVALUATION FINDINGS
Northern Triangle, Stanislaus County

Element Number	Is there substantial evidence of chronic groundwater level decline since 1977?	Is there substantial evidence that significant depletion of supply could occur through the planning and implementation horizon?	Is there evidence that unreasonable depletion of supply could occur through the planning and implementation horizon?	Groundwater Level Management Zone?
568	Yes Groundwater levels show a long-term declining trend during both wet and dry periods. They have fallen during dry periods (e.g., 1977 and 2011-2015 and partially recovered afterwards, but overall trends are declining	No Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown is predicted to be 25 to 30 feet if current trends continue.	No Significant future groundwater level declines are possible.	No
587	No Groundwater levels declined steadily prior to 1977, but have been relatively stable since then, with some significant short-term fluctuations (+/- 40 to 60 feet).	No Wells show a fluctuting but stable trend, and extrapolation of linear trends over the planning and implementation horizon suggests groundwater levels will remain relatively stable on average.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
597	Yes Groundwater levels have been relatively stable to somewhat declining since 1977, but have fluctuated (+/- 20 to 40 feet). An overall declining trend, when combined with long term declines prior to 1977, is suggestive of chronic water level decline.	No Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown is predicted to range from approximately 5 to 15 feet if current trends continue.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
598	Insufficient Data	Insufficient Data	Insufficient Data	No
601	Yes Groundwater levels display an overall declining trend, though the rate of decline has decreased since 1977. They have fallen during dry periods (e.g., 1977 and 2011-2015) with incomplete recovery during intervening wetter periods.	Yes Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown exceeding 50 feet may occur in some areas if current trends continue. Some wells have gone dry in the vicinity of Valley Home in this element.	Yes Significant future groundwater level declines are possible.	Yes

Table 2
SUMMARY OF EVALUATION FINDINGS
Northern Triangle, Stanislaus County

Element Number	Is there substantial evidence of chronic groundwater level decline since 1977?	Is there substantial evidence that significant depletion of supply could occur through the planning and implementation horizon?	Is there evidence that unreasonable depletion of supply could occur through the planning and implementation horizon?	Groundwater Level Management Zone?
602	No Groundwater levels have been relatively stable during the period of record.	No Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown is predicted to be approximately 15 feet if current trends continue.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
603	Insufficient Data	Insufficient Data	Insufficient Data	No
614	Yes Groundwater levels display an overall declining trend. They have fallen during dry periods (e.g., 1977 and 2011-2015) with incomplete recovery during wetter periods.	No Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown may reach approximately 20 to 25 feet if current trends continue.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
615	Yes Groundwater levels display an overall declining trend, with three of four wells showing a declining trend since 1977. Levels have fallen during dry periods (e.g., 1977 and 2011-2015) with incomplete recovery during wetter periods.	No Extrapolaton of linear trends over the planning and implementation horizon indicates drawdown may reach approximately 20 to 25 feet if current trends continue.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
616	No Groundwater levels have been relatively stable during the period of record.	No Extrapolaton of linear trends over the planning and implementation horizon suggests groundwater levels will remain relatively stable if current trends continue.	No Groundwater level declines are anticipated to be less than significant and no Undesirable Results have been reported.	No
617	Insufficient Data	Insufficient Data	Insufficient Data	No

FIGURES



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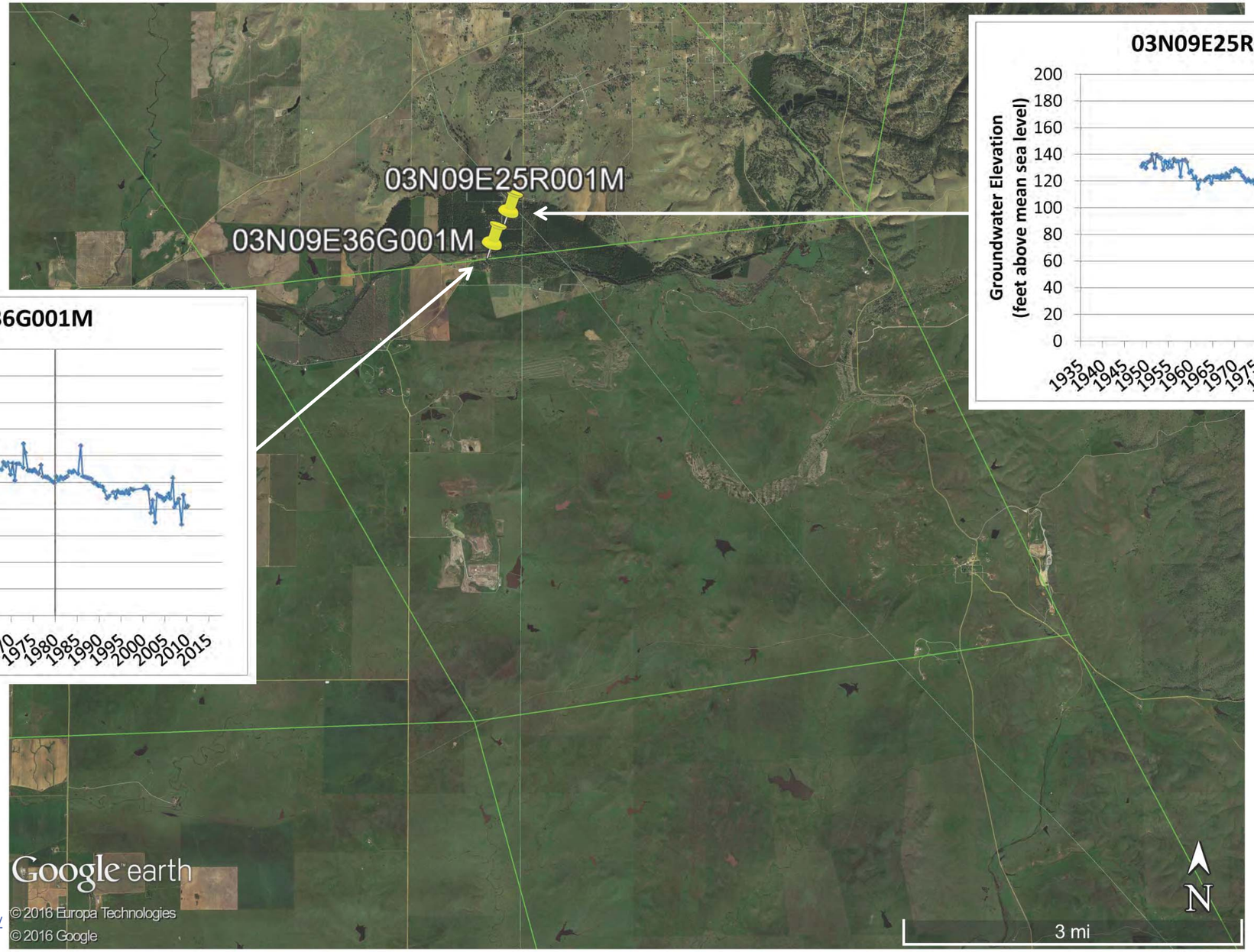
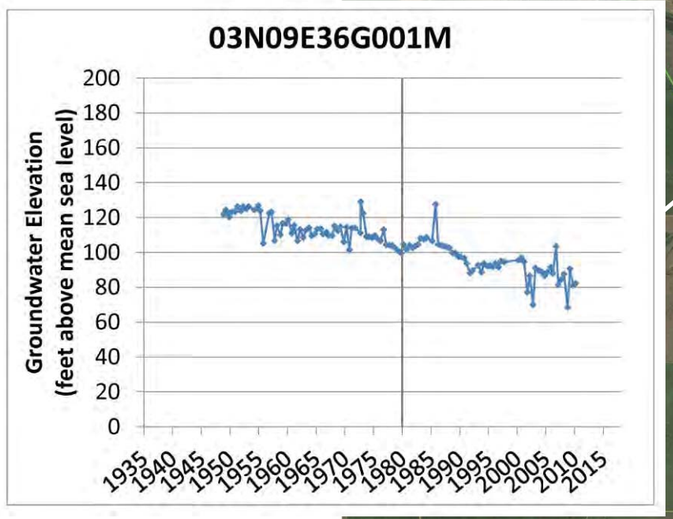
STANISLAUS COUNTY, CALIFORNIA

PROJECT NO.	*DATE*	*DRAWN BY*	*APPR. BY*
StanCo-001	*6/8/17*	*JH*	

FIGURE 1

Hydrograph Analysis Location Index Map





CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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STANISLAUS COUNTY, CALIFORNIA

PROJECT NO	DATE	DRAWN BY	APPR. BY
StanCo-001-7.4.	5/26/2017	JH	MT

FIGURE 2A

Hydrographs for Wells Located Near Grid Element 568

FIGURE 2B

HYDROGRAPHS WITH PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 568

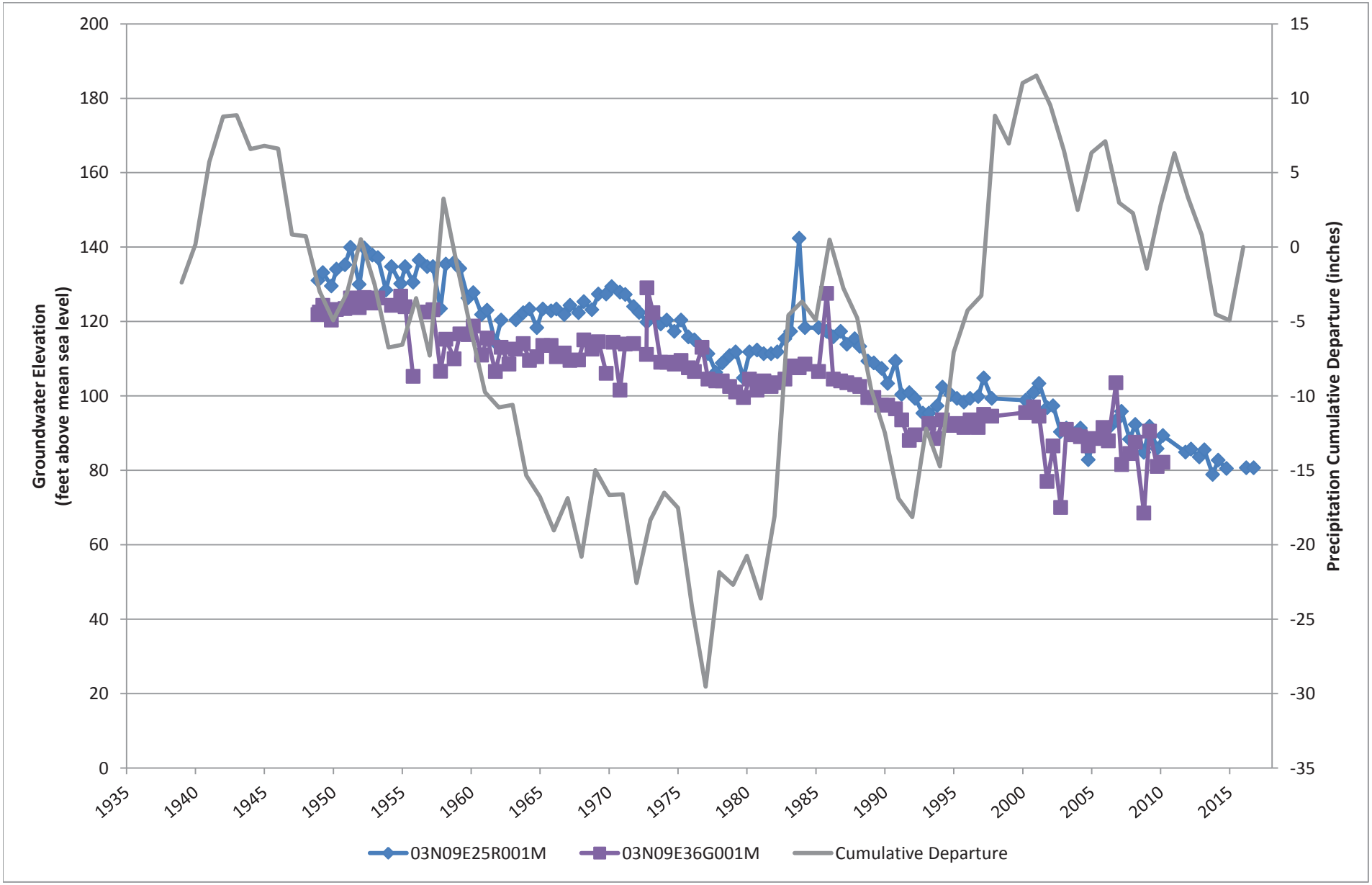

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FIGURE 2C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 568

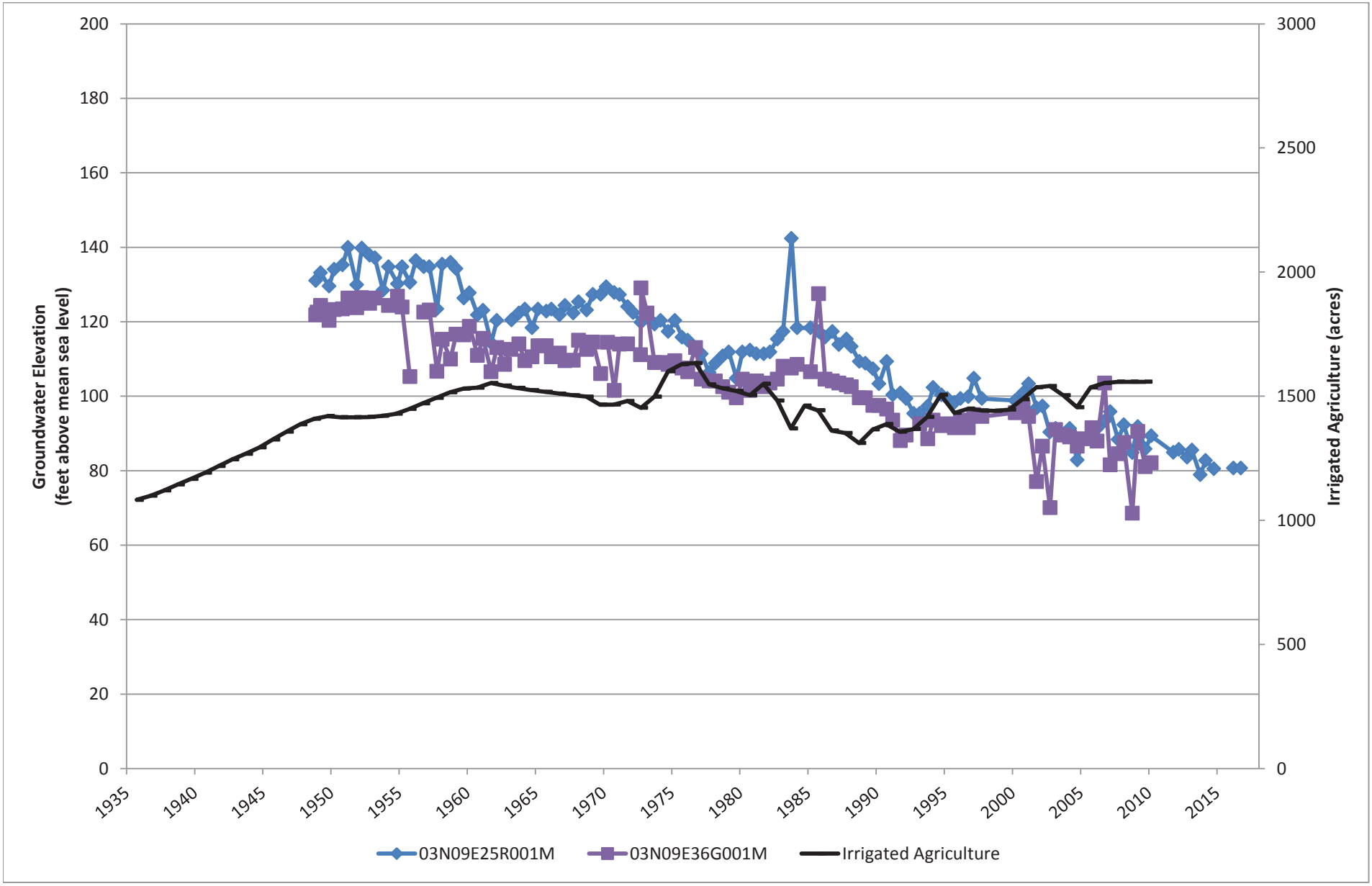

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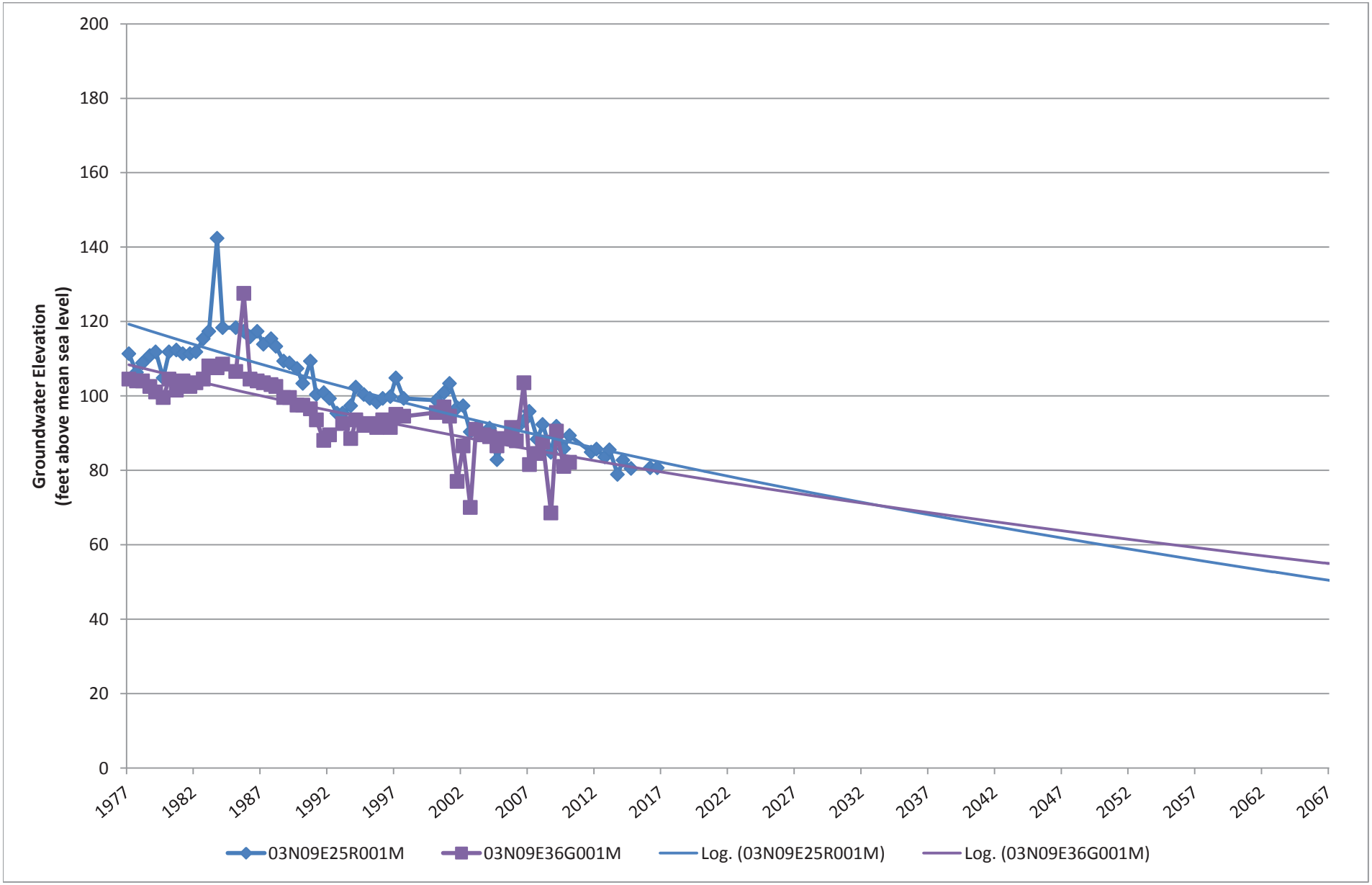
FIGURE 2D

HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 568



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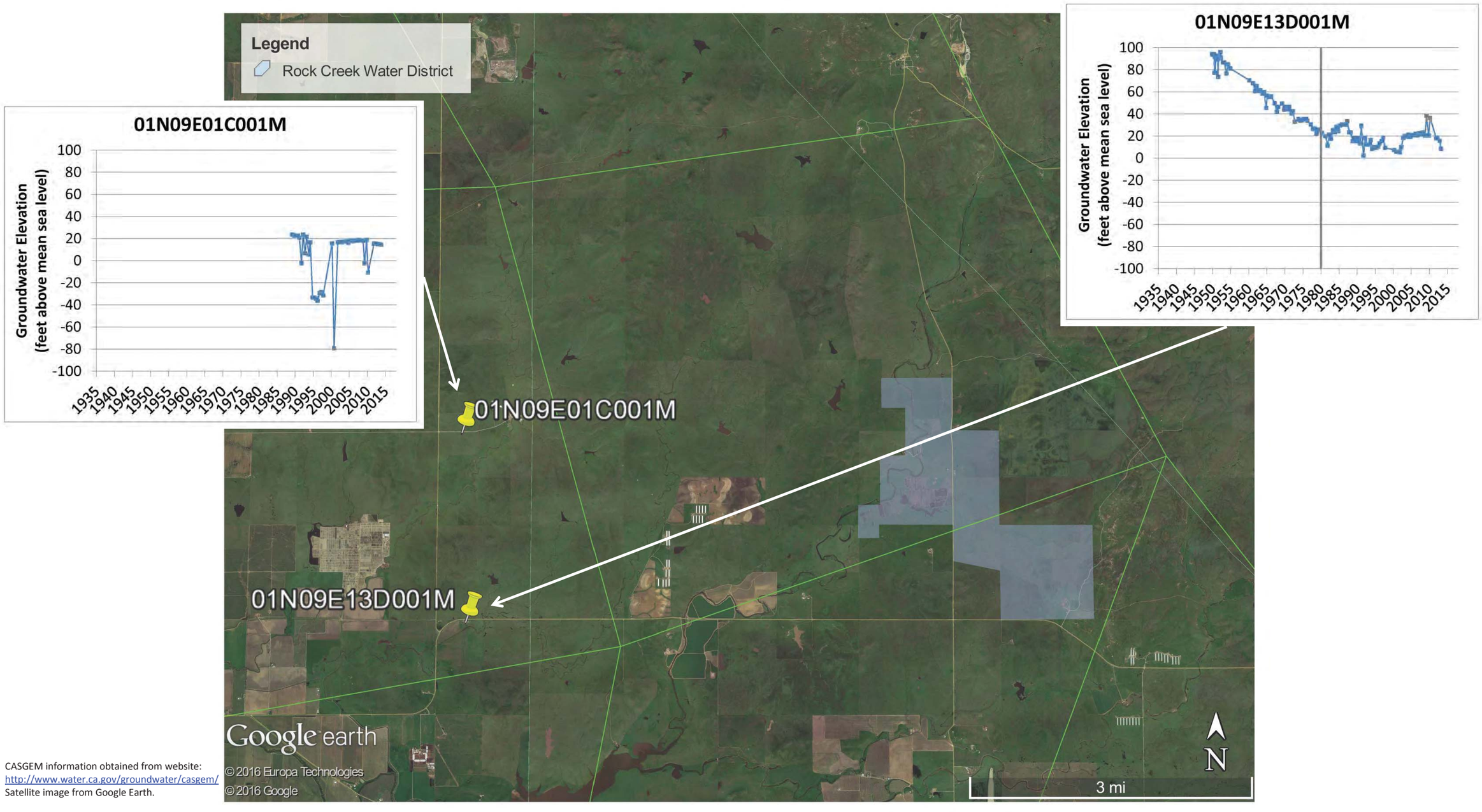

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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PROJECT NO.	DATE	DRAWN BY	APPR. BY
StanCo-001-7.4	5/25/2017	JH	MT

FIGURE 3A

Hydrographs for Wells Located Near Grid Element 587

FIGURE 3B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 587

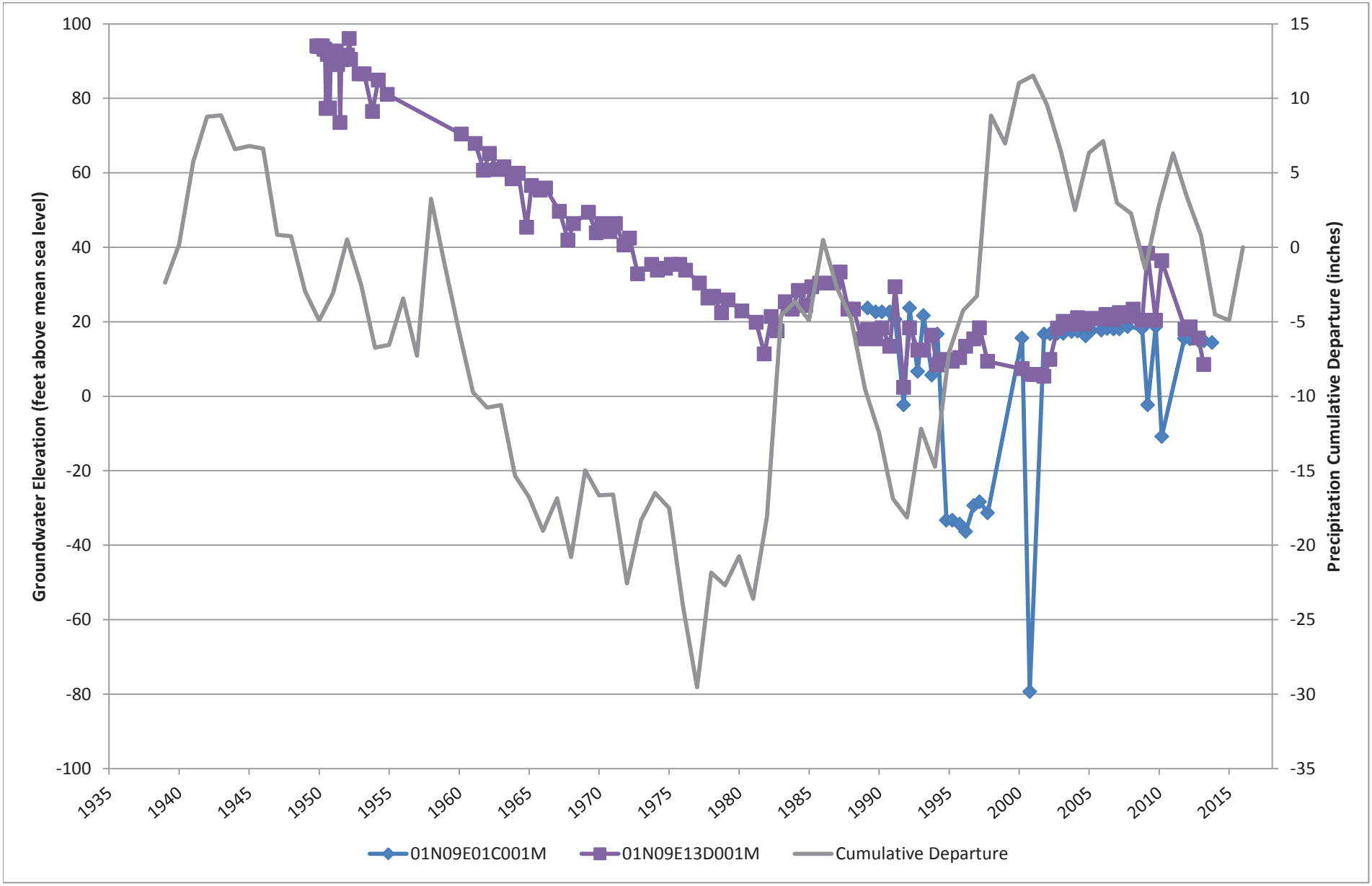

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FIGURE 3C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 587

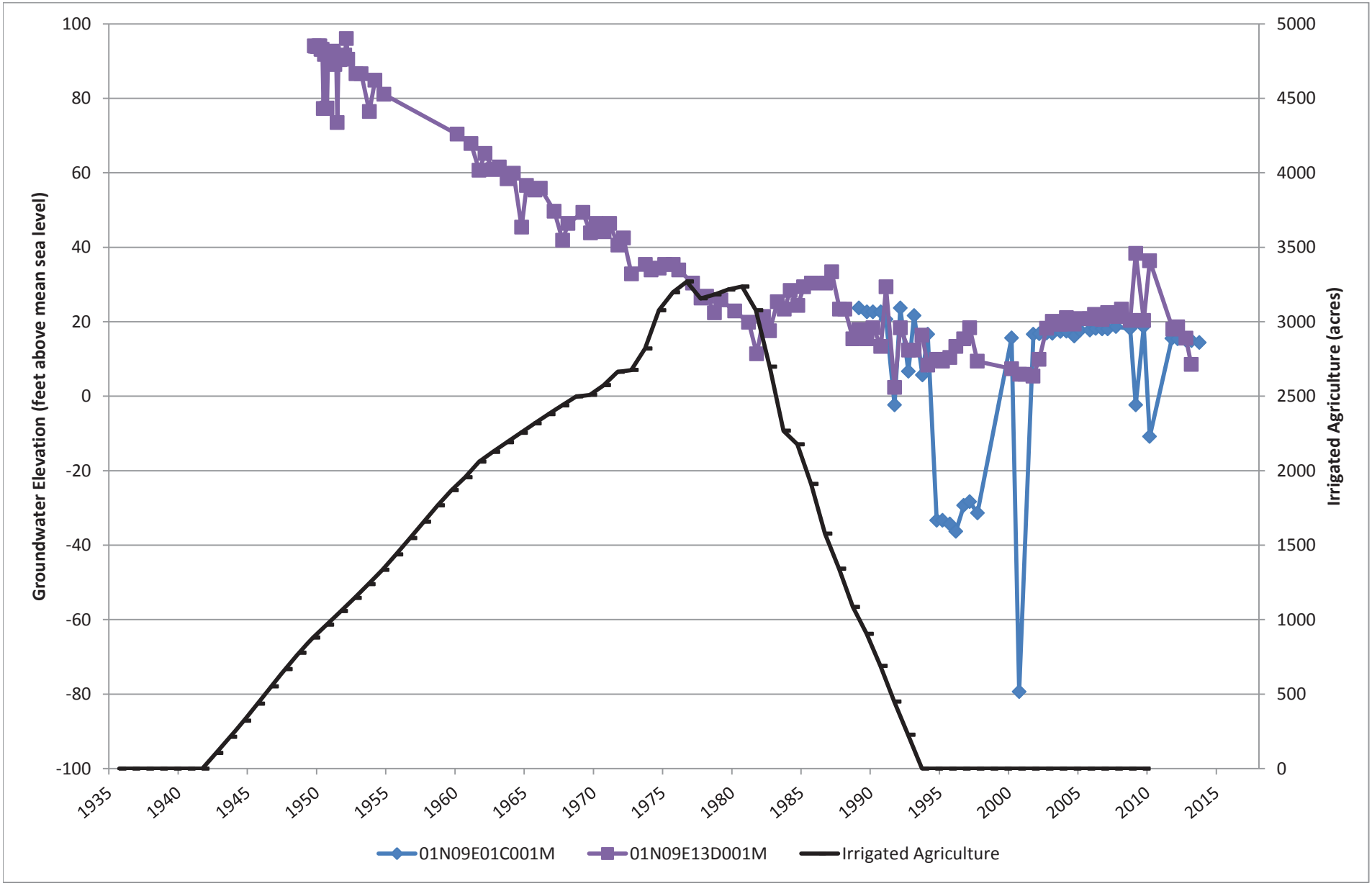

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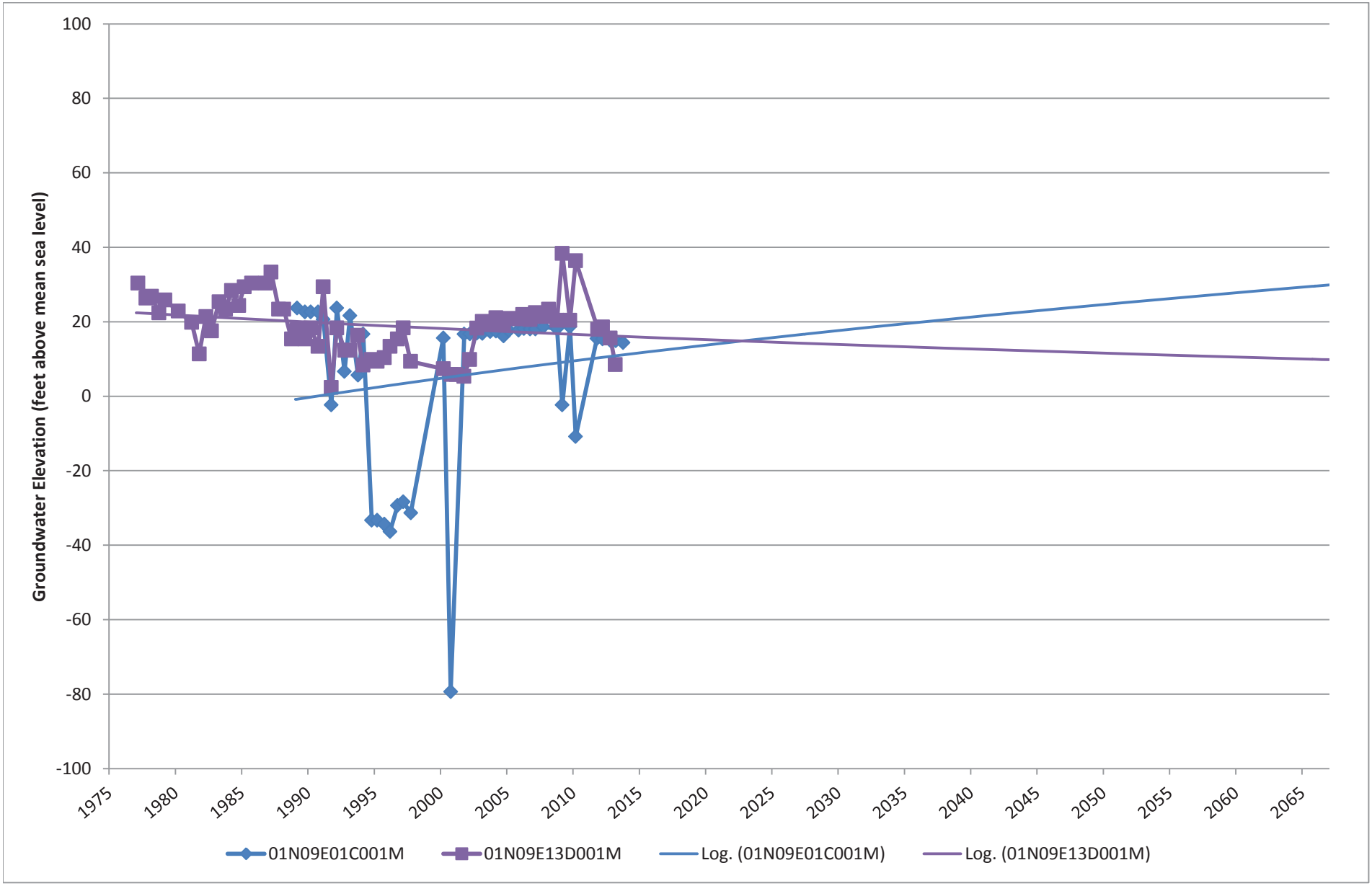
FIGURE 3D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 587



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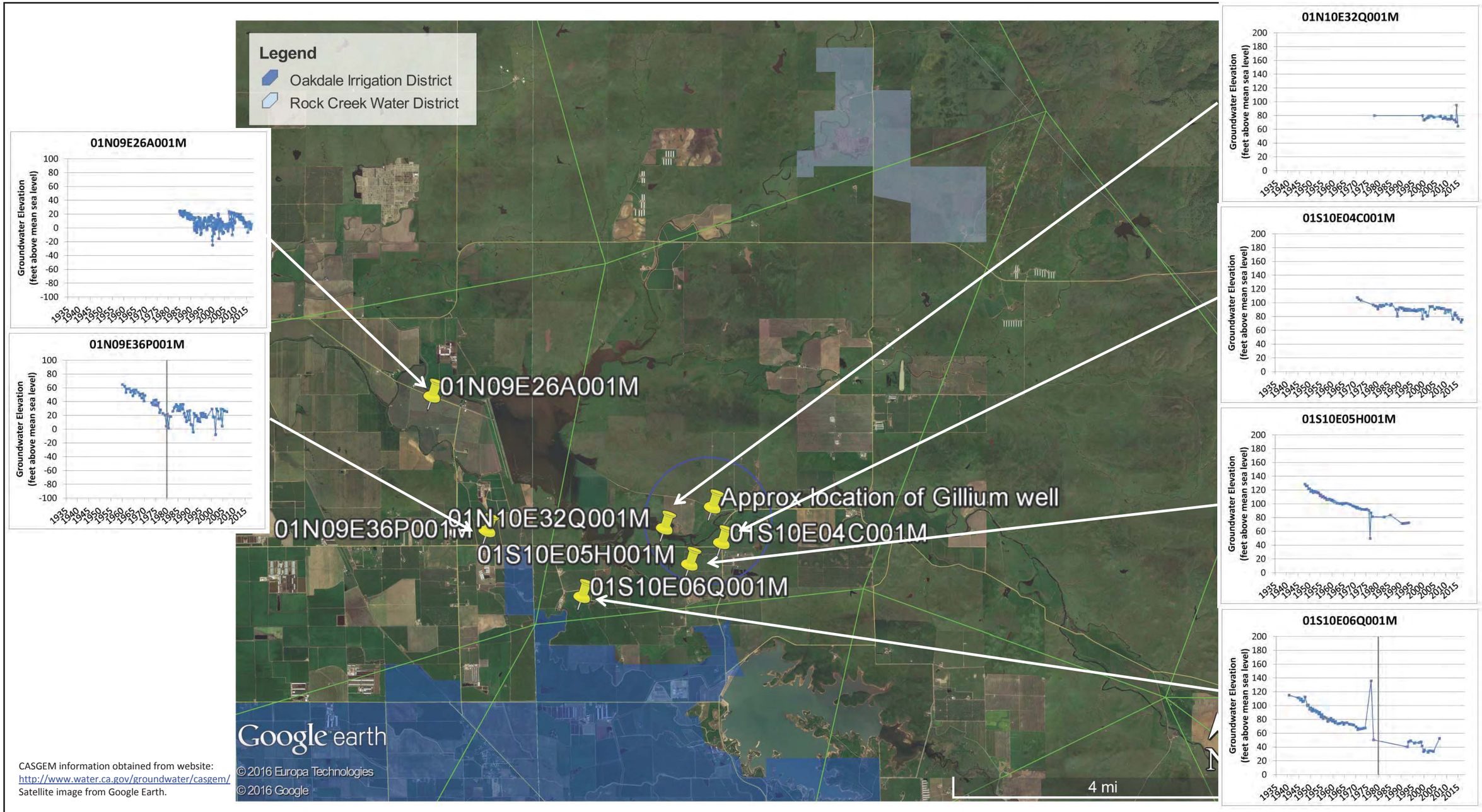

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
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FIGURE 4A

Hydrographs for Wells Located in and Near Grid Element 597

FIGURE 4B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 597

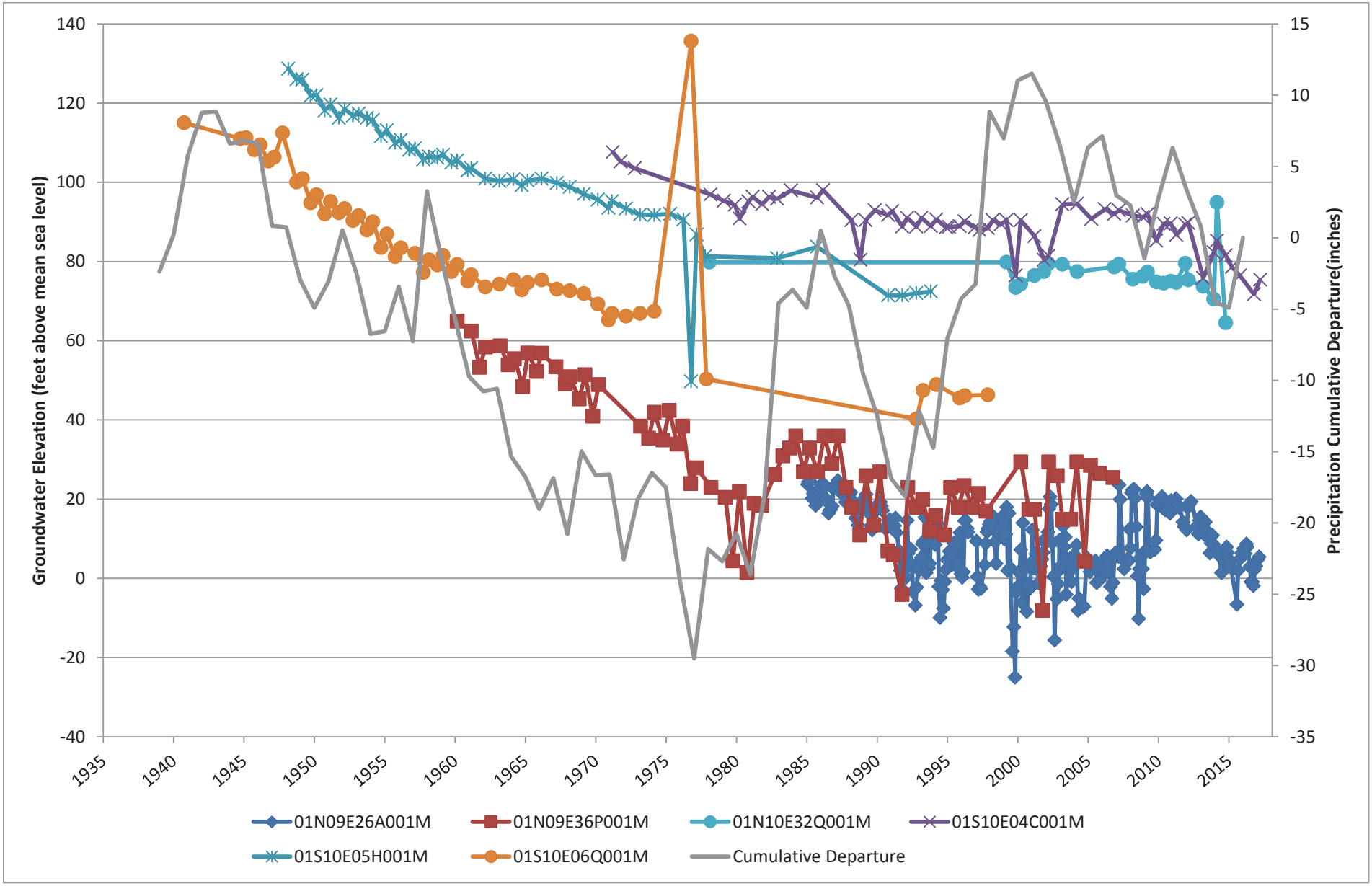

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FIGURE 4C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 597

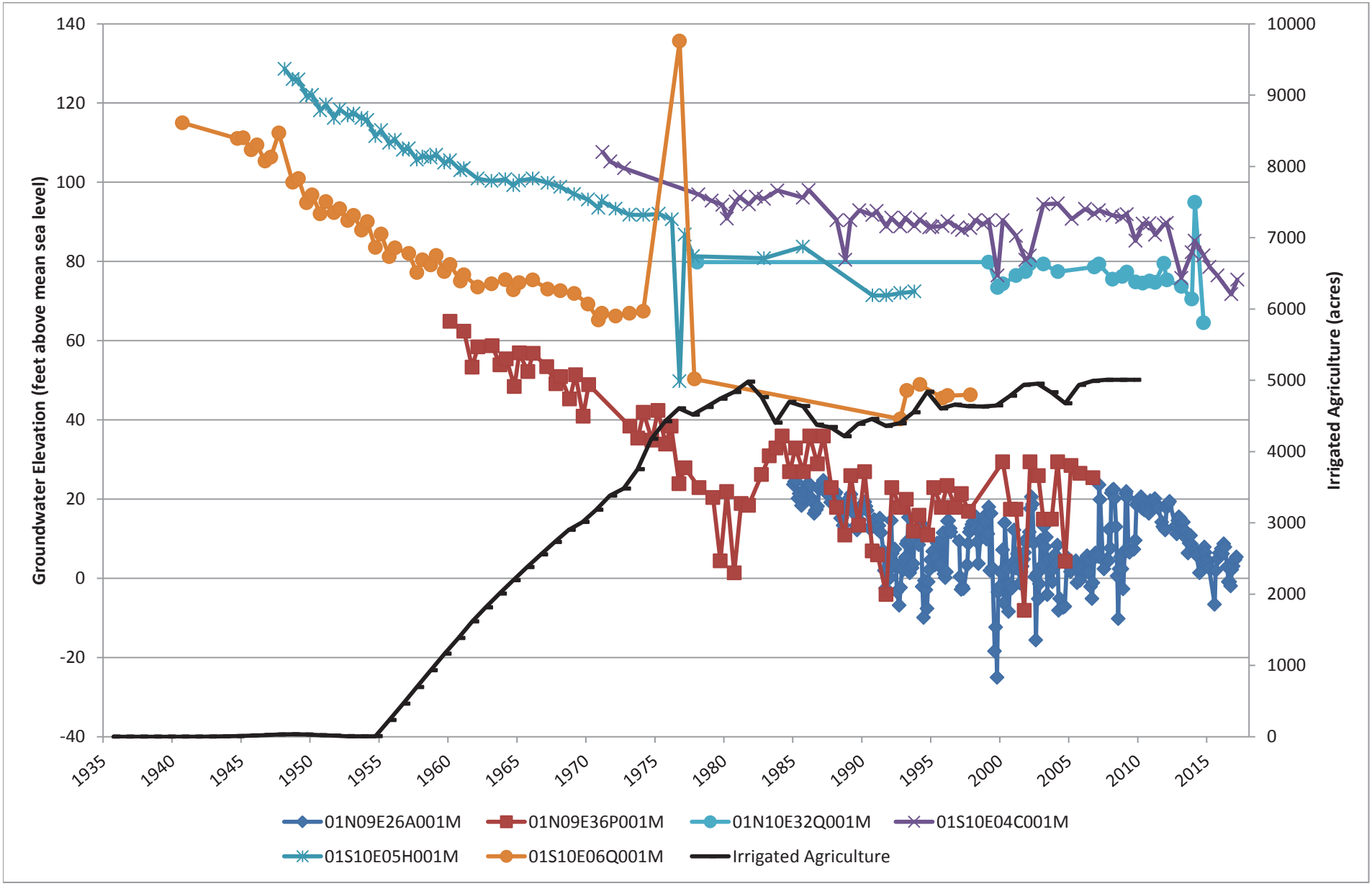

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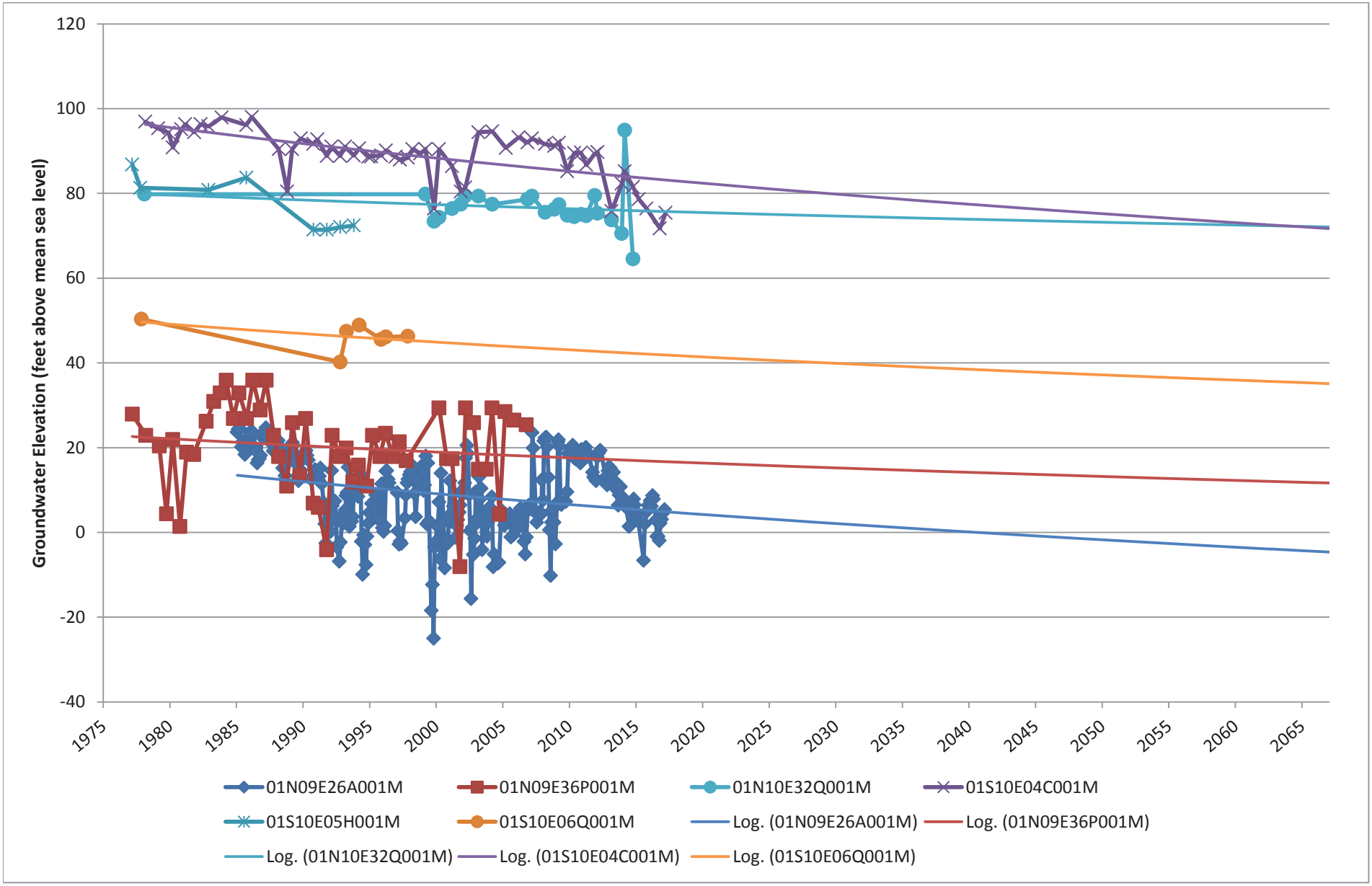
FIGURE 4D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 597



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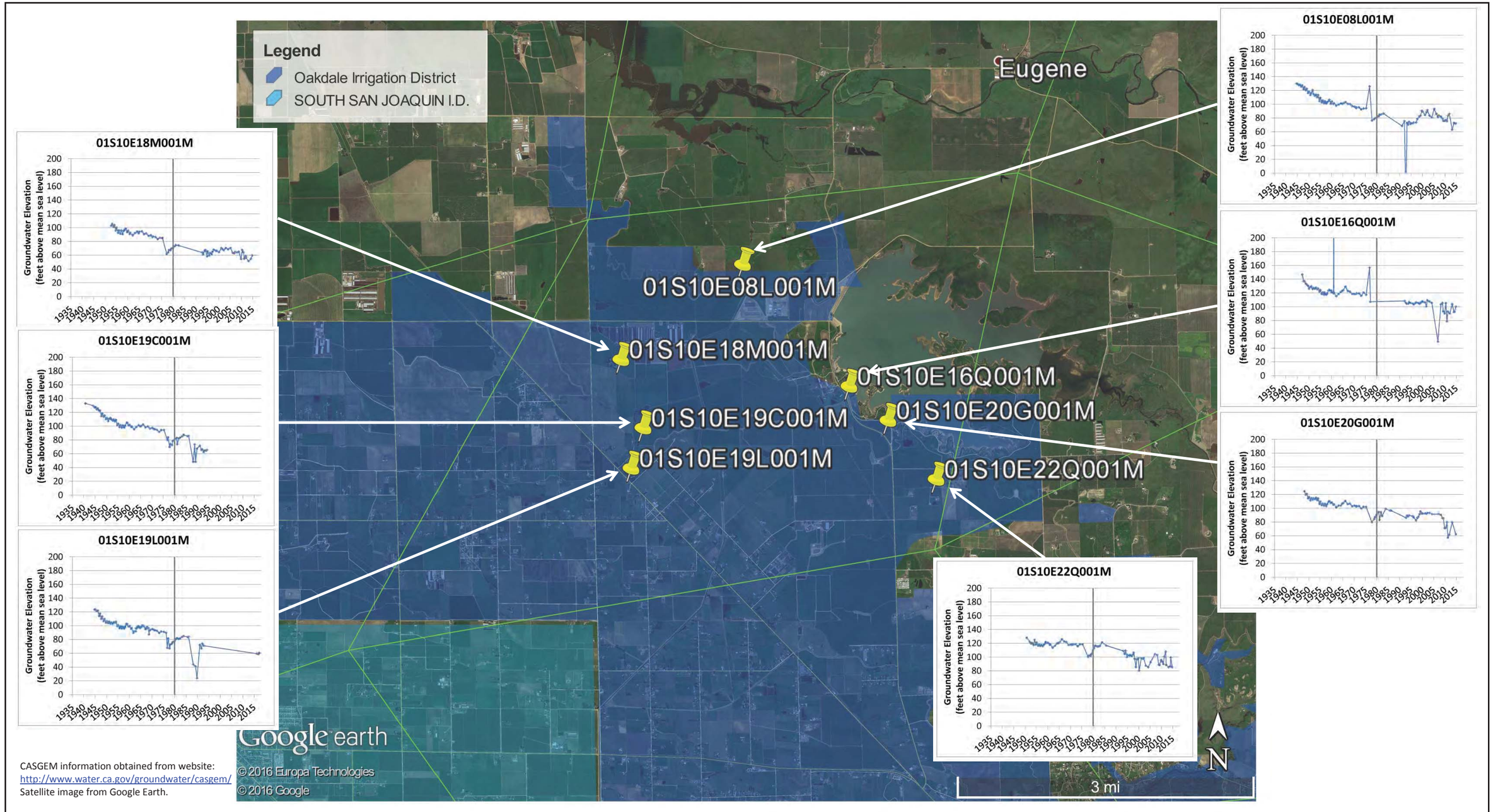

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
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FIGURE 5A

Hydrographs for Wells Located in Grid Element 601

FIGURE 5B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 601

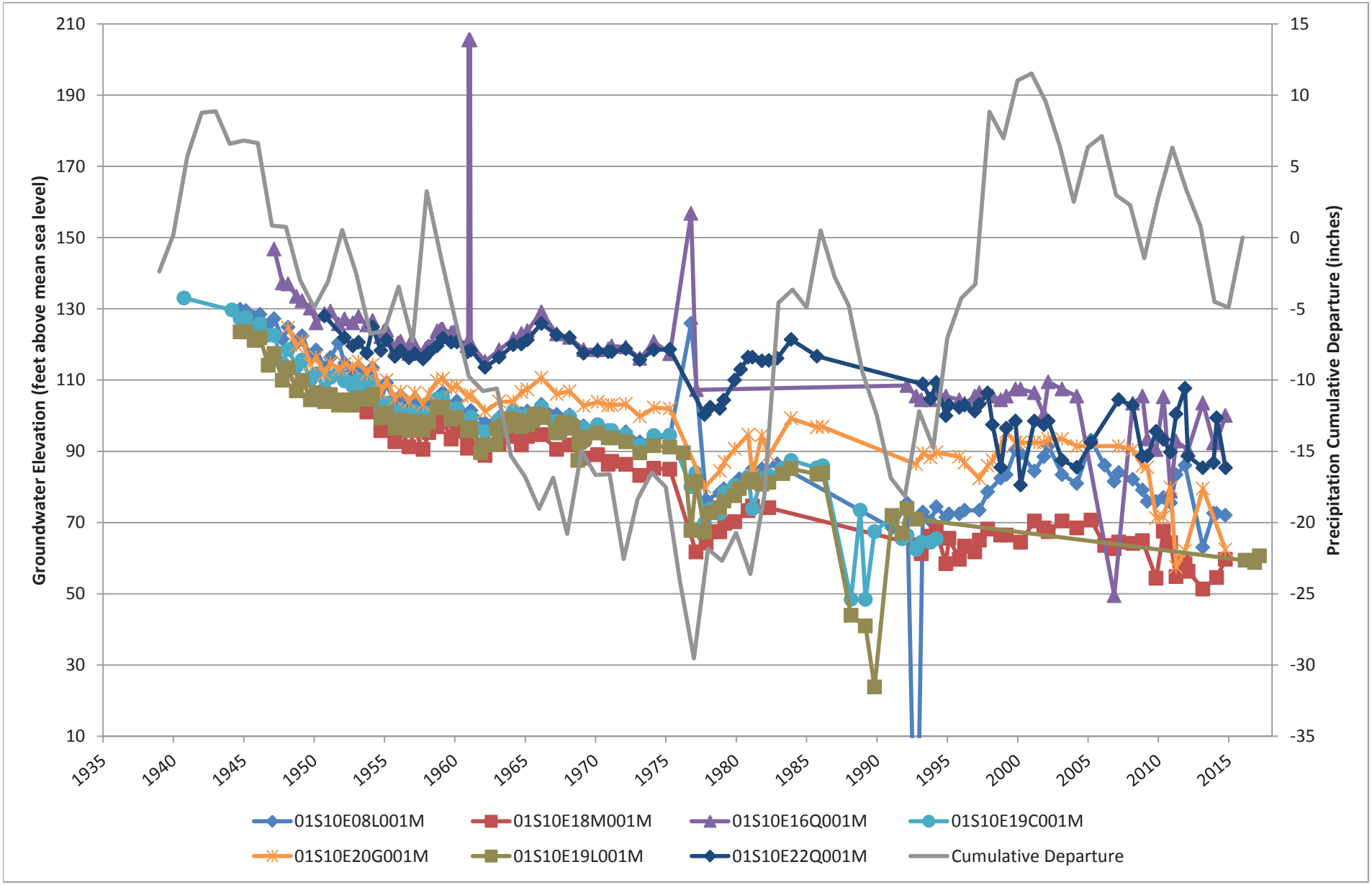

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FIGURE 5C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 601

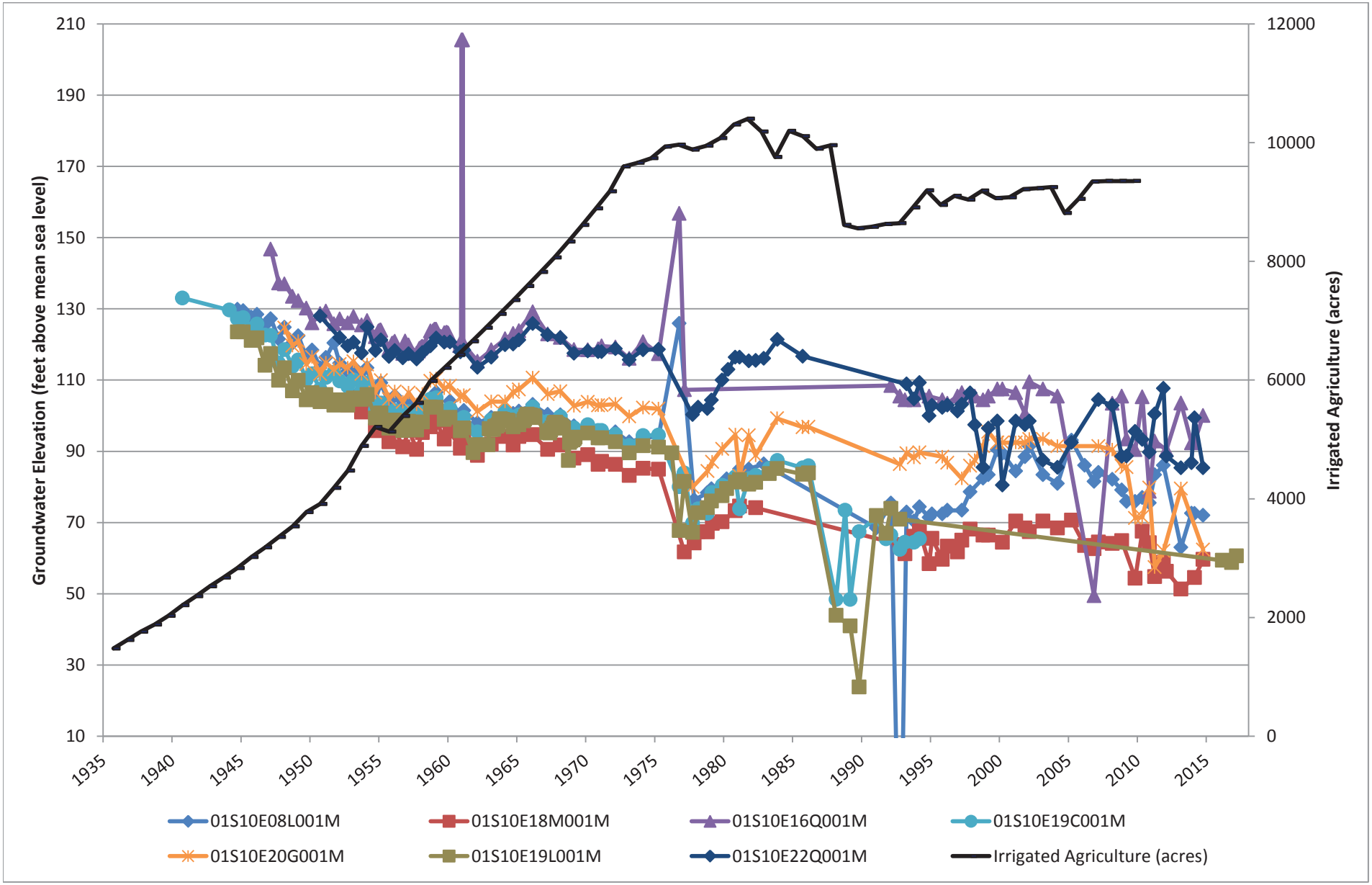

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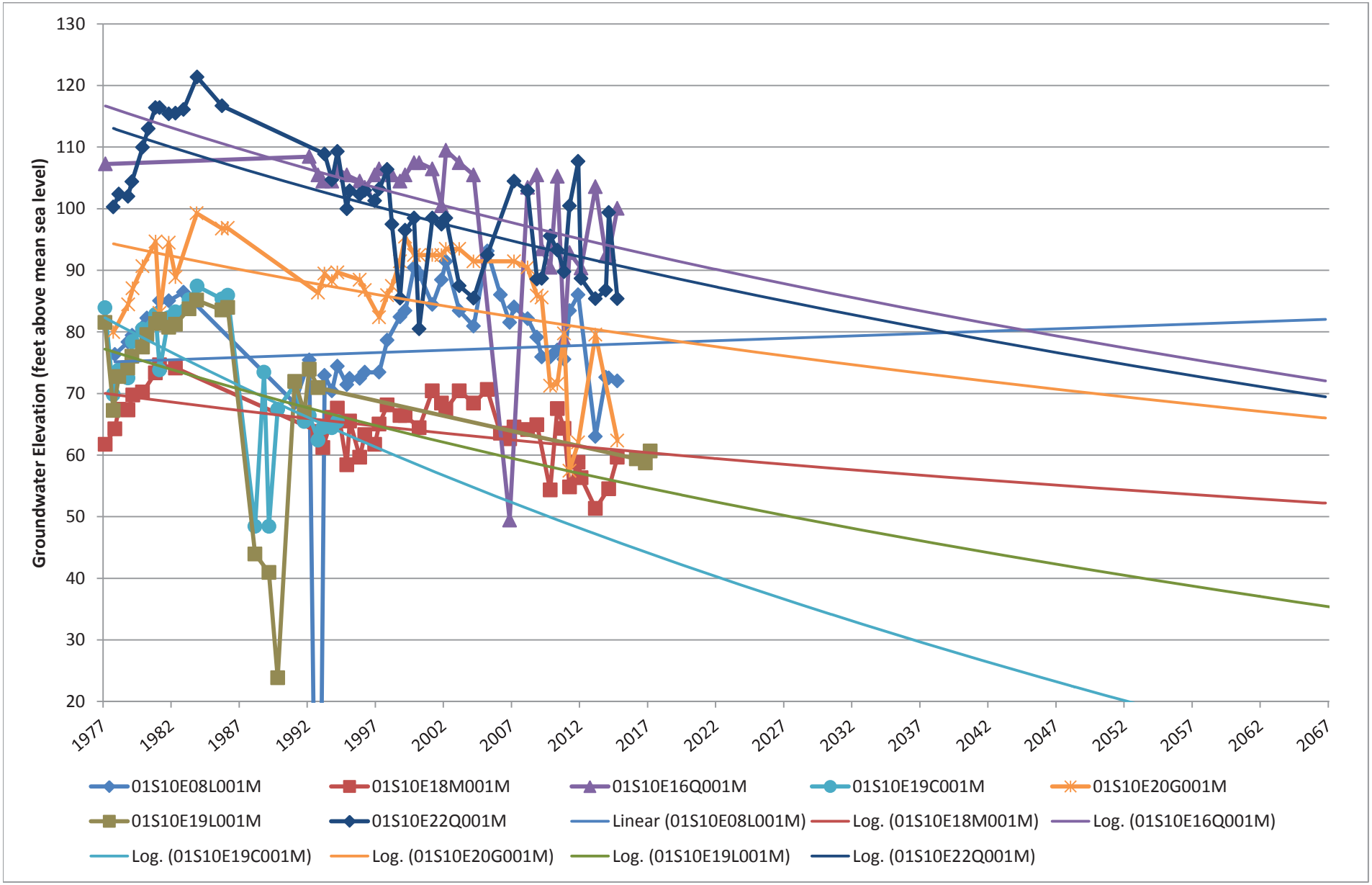
FIGURE 5D
HYDROGRAPHS TREND ANALYSIS FOR GRID ELEMENT 601



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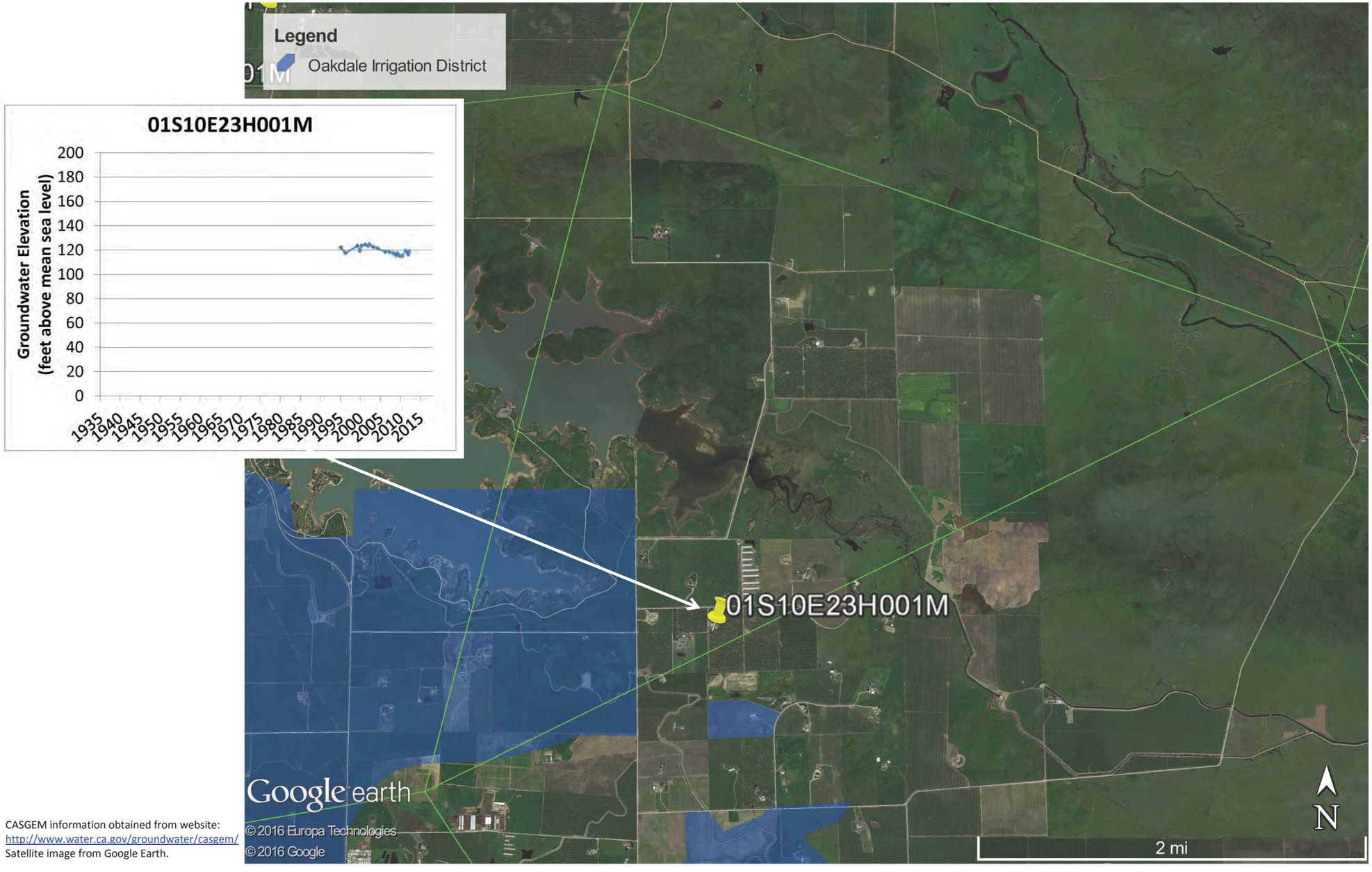

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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FIGURE 6A

Hydrograph for Well Located in Grid Element 602

FIGURE 6B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 602

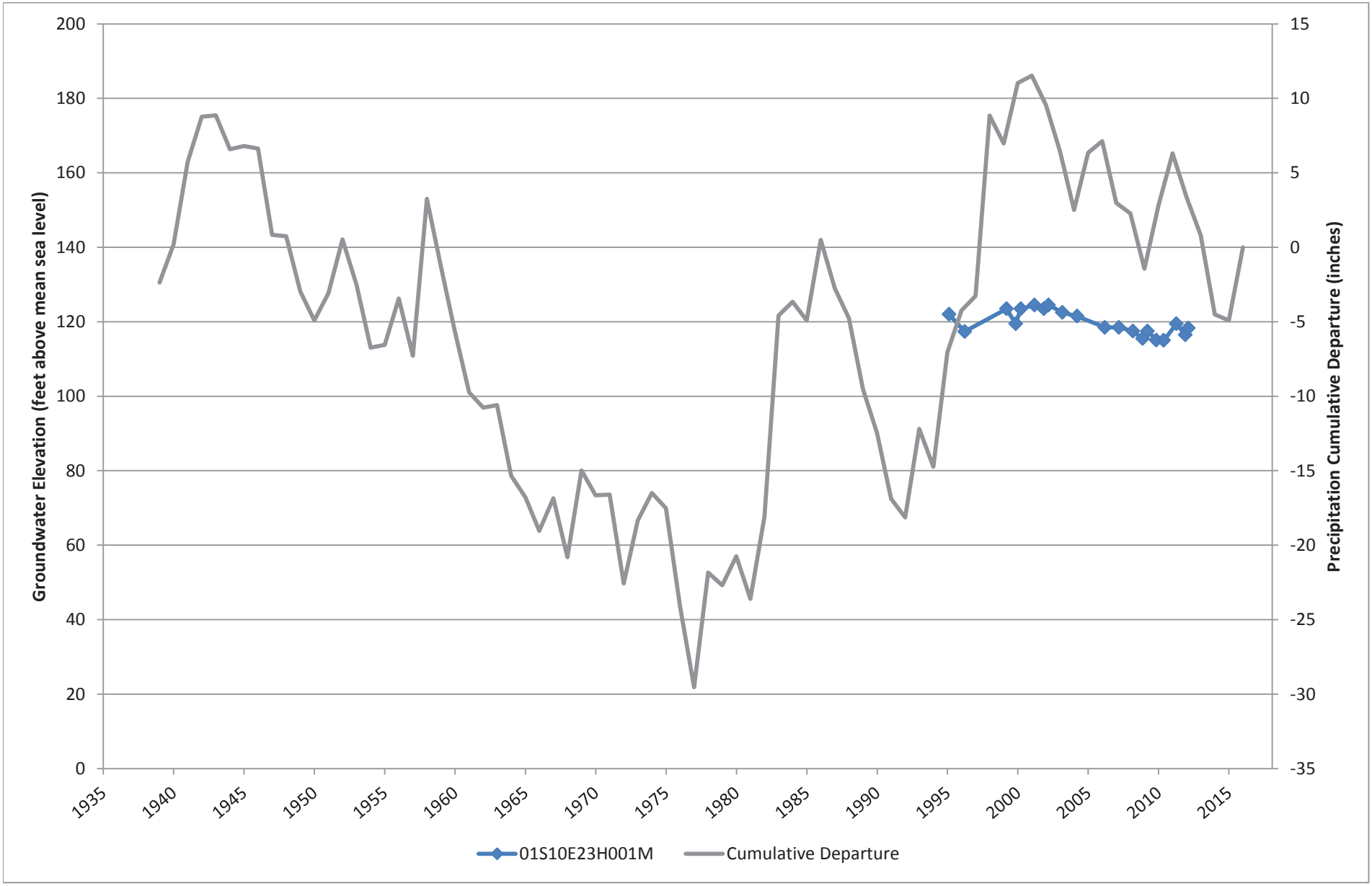

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FIGURE 6C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 602

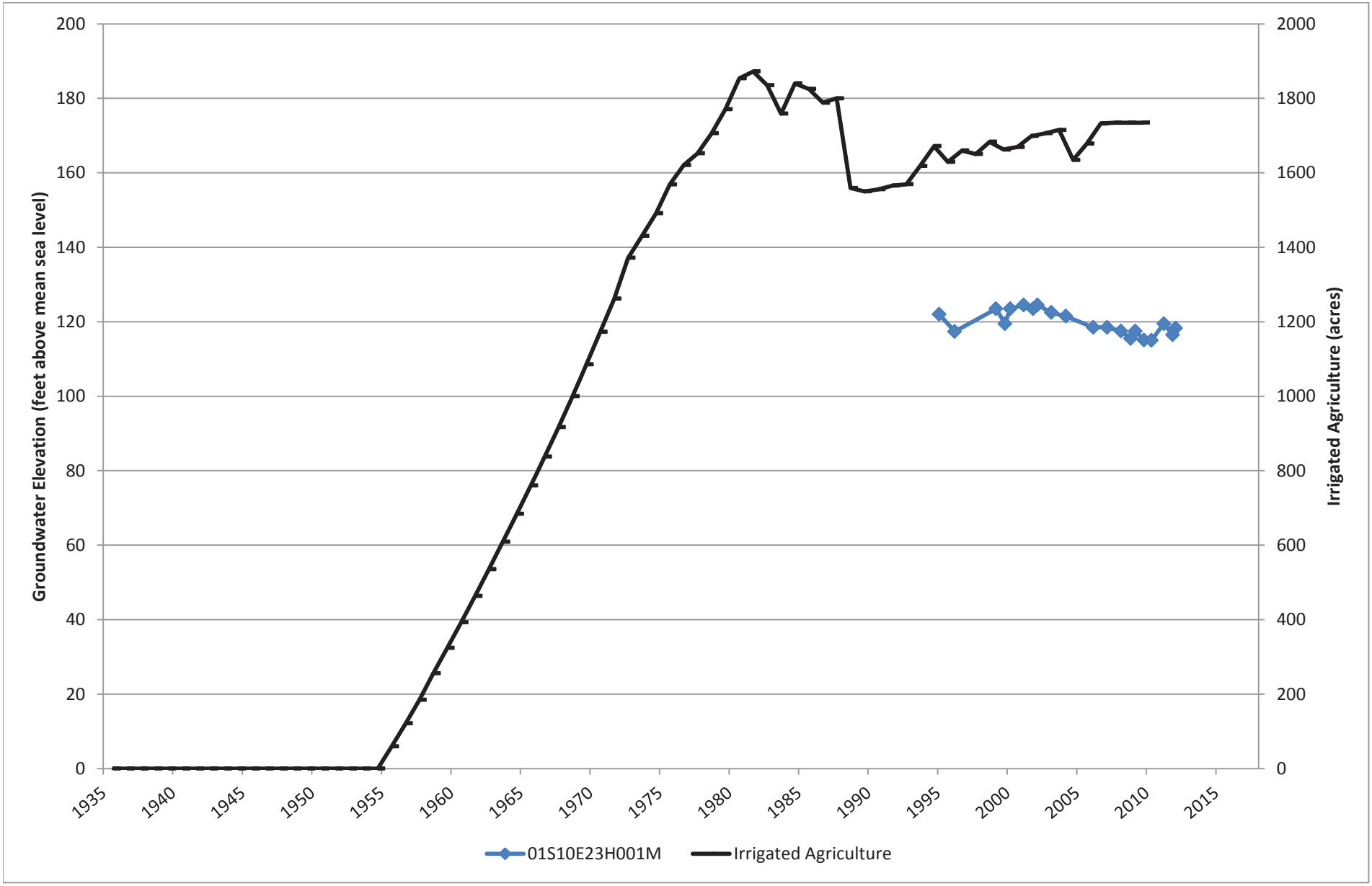

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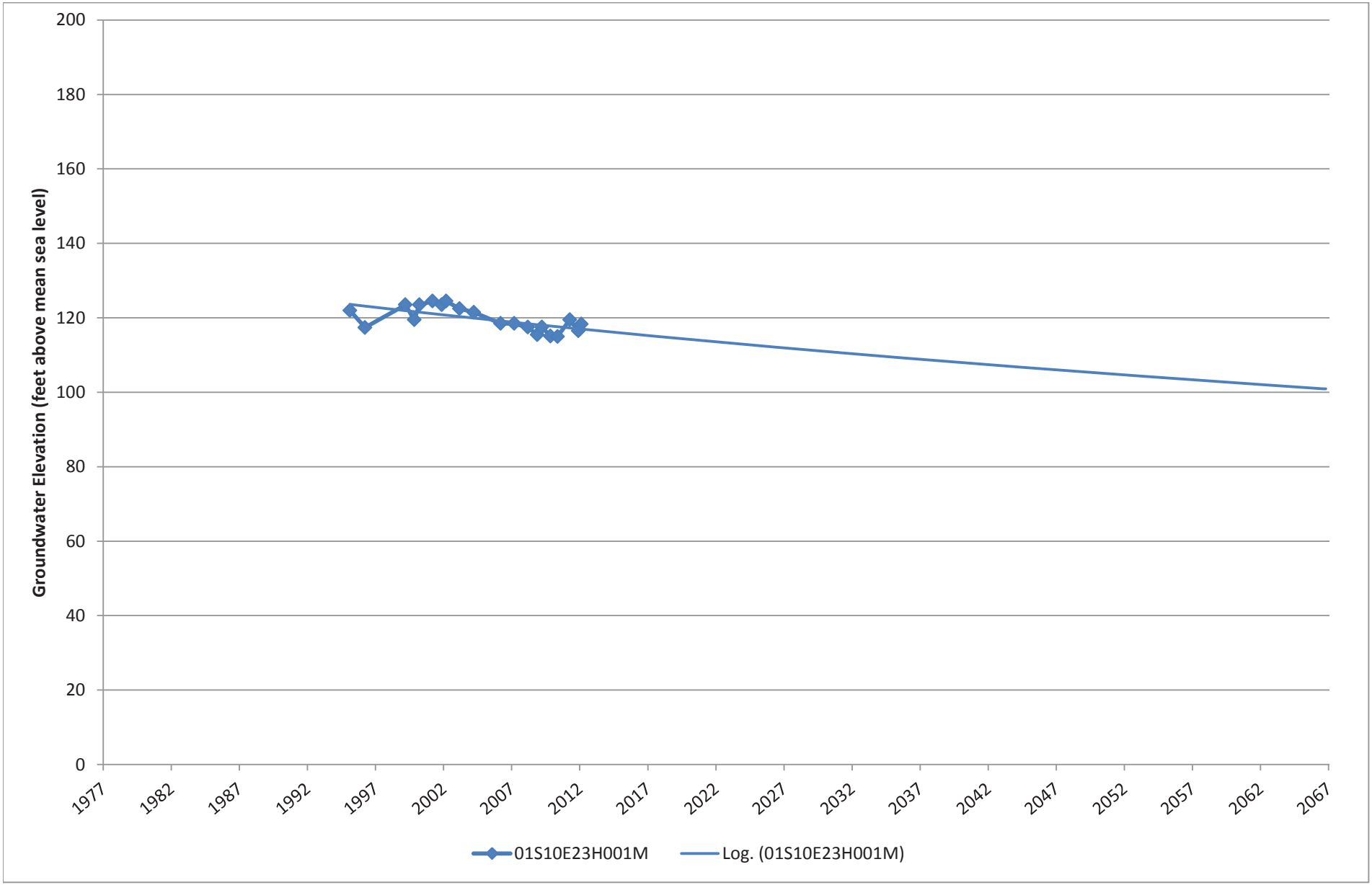
FIGURE 6D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 602



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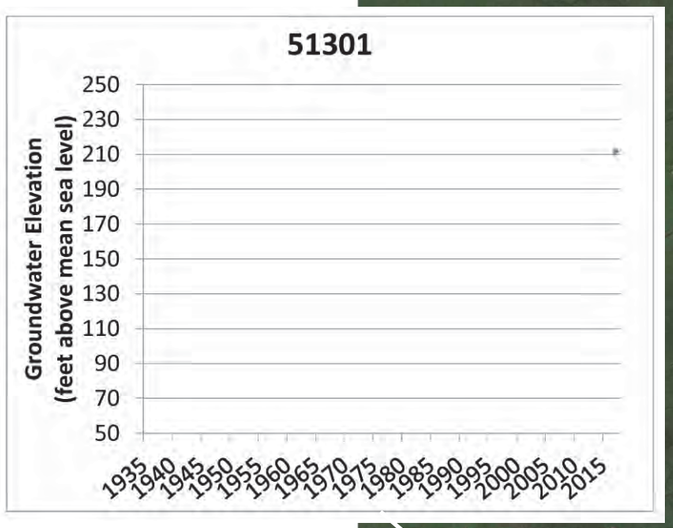

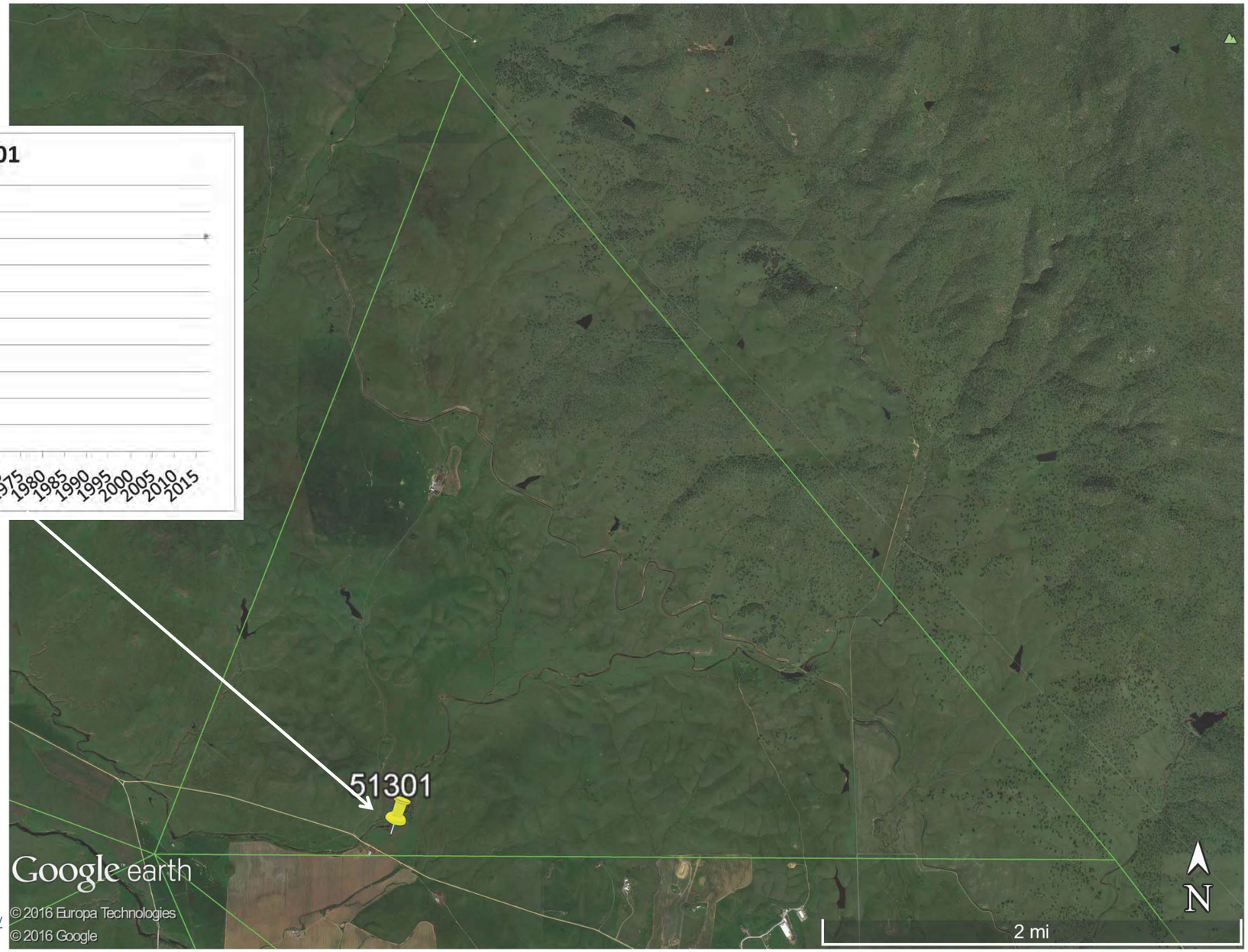

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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FIGURE 7A

Hydrograph for Well Located in Grid Element 603

FIGURE 7B
HYDROGRAPH AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 603

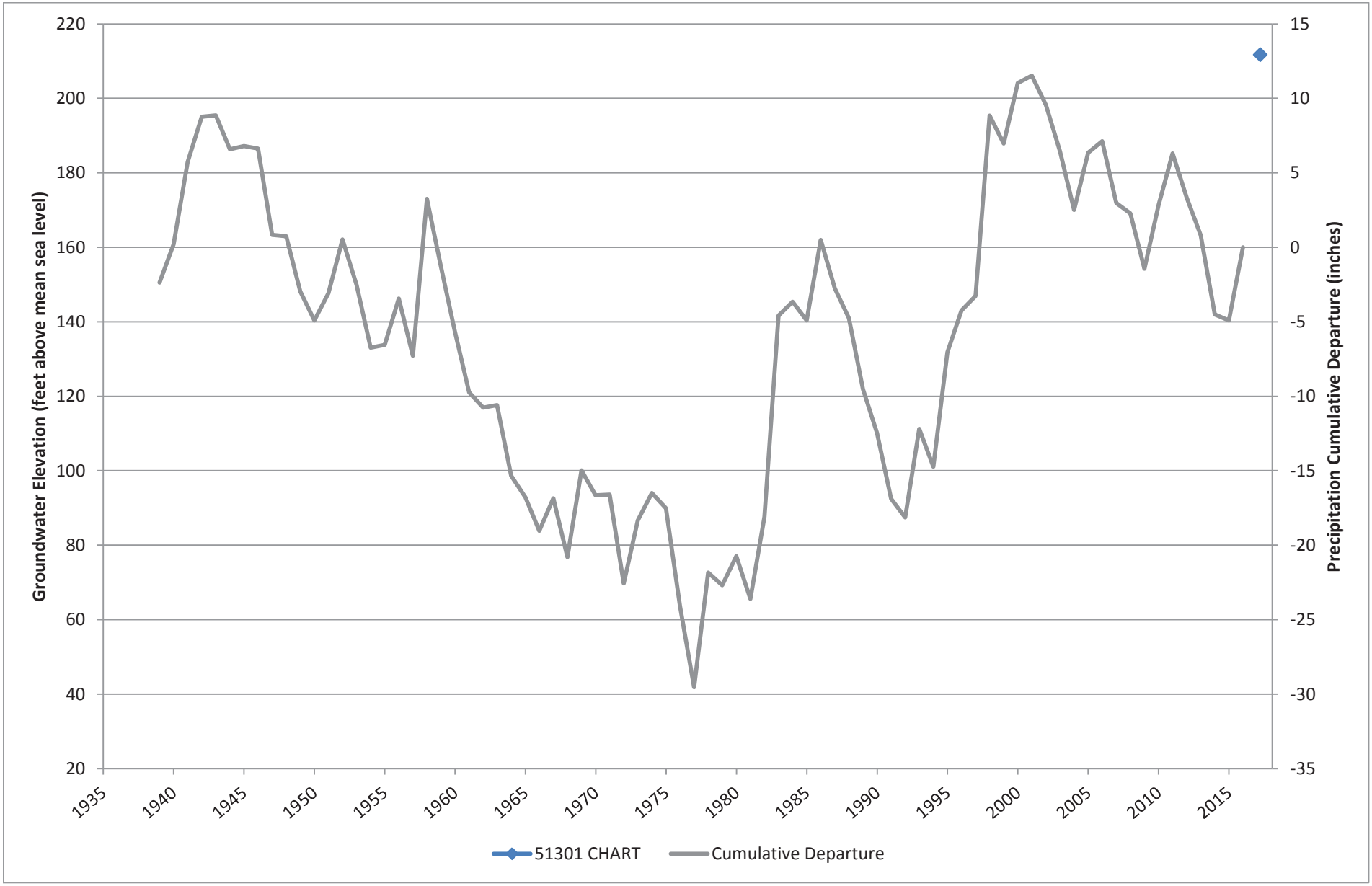

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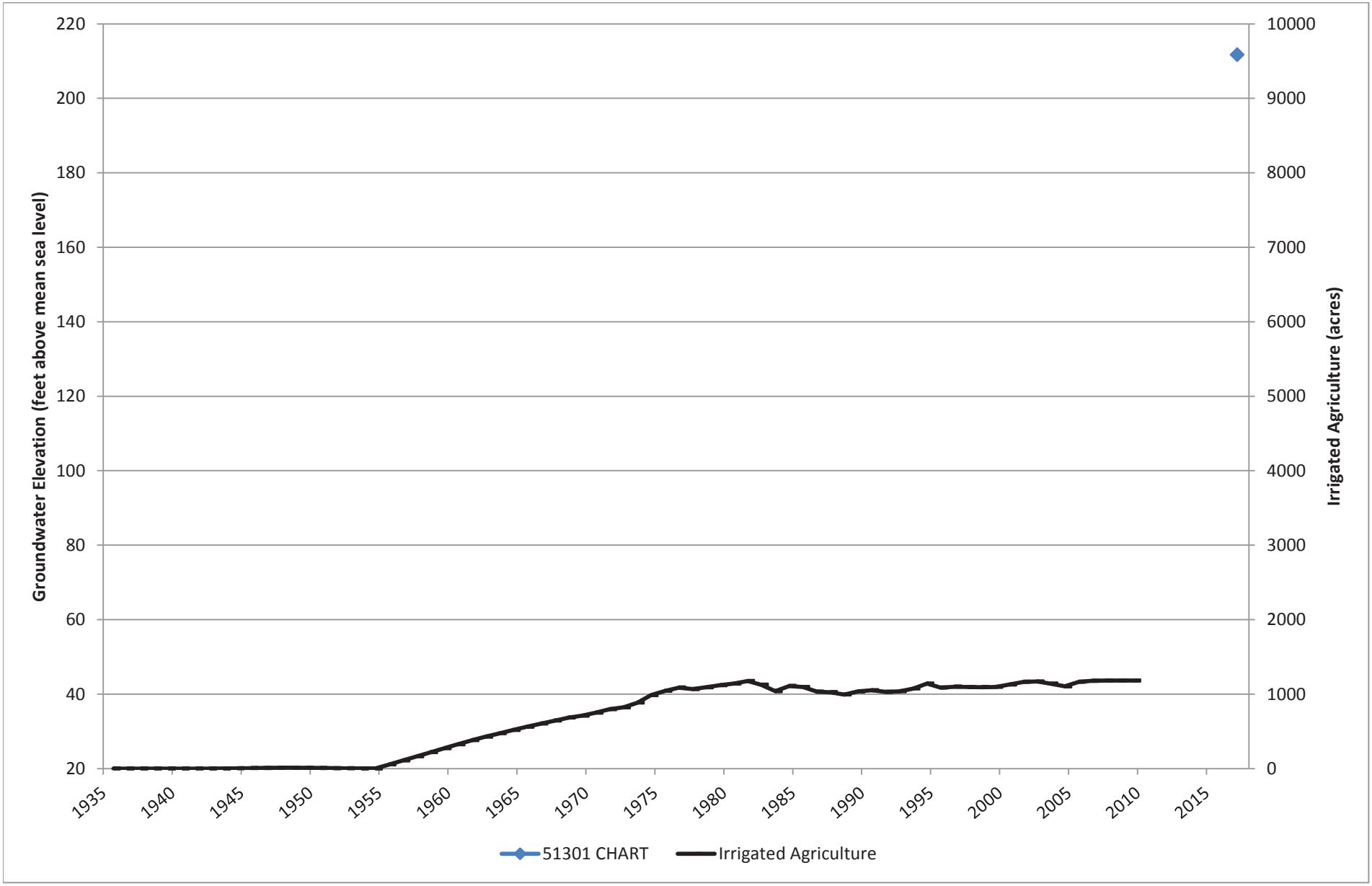
FIGURE 7C
HYDROGRAPH AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 603



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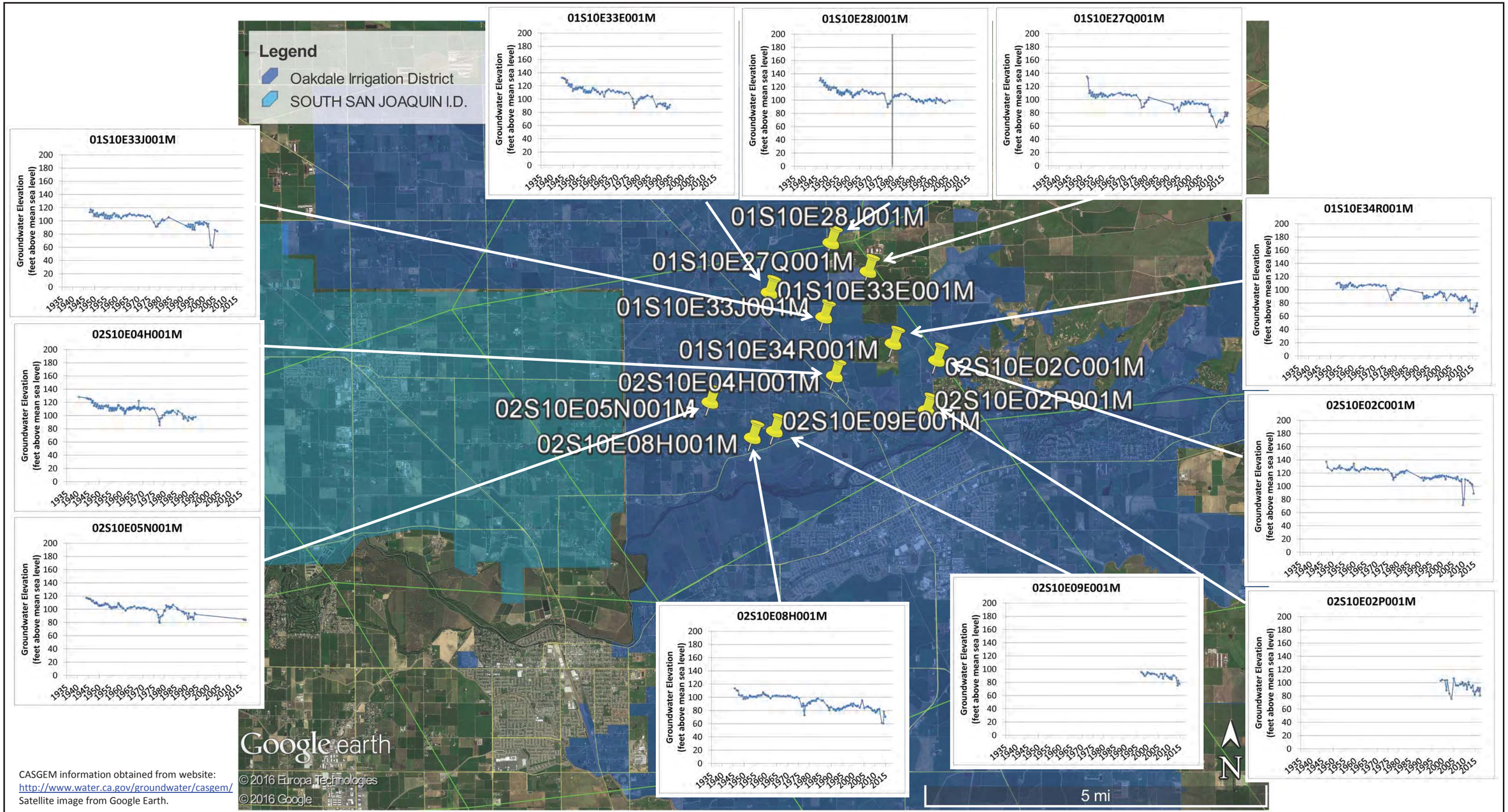

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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FIGURE 8A

Hydrographs for Wells Located in Grid Element 614

FIGURE 8B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 614

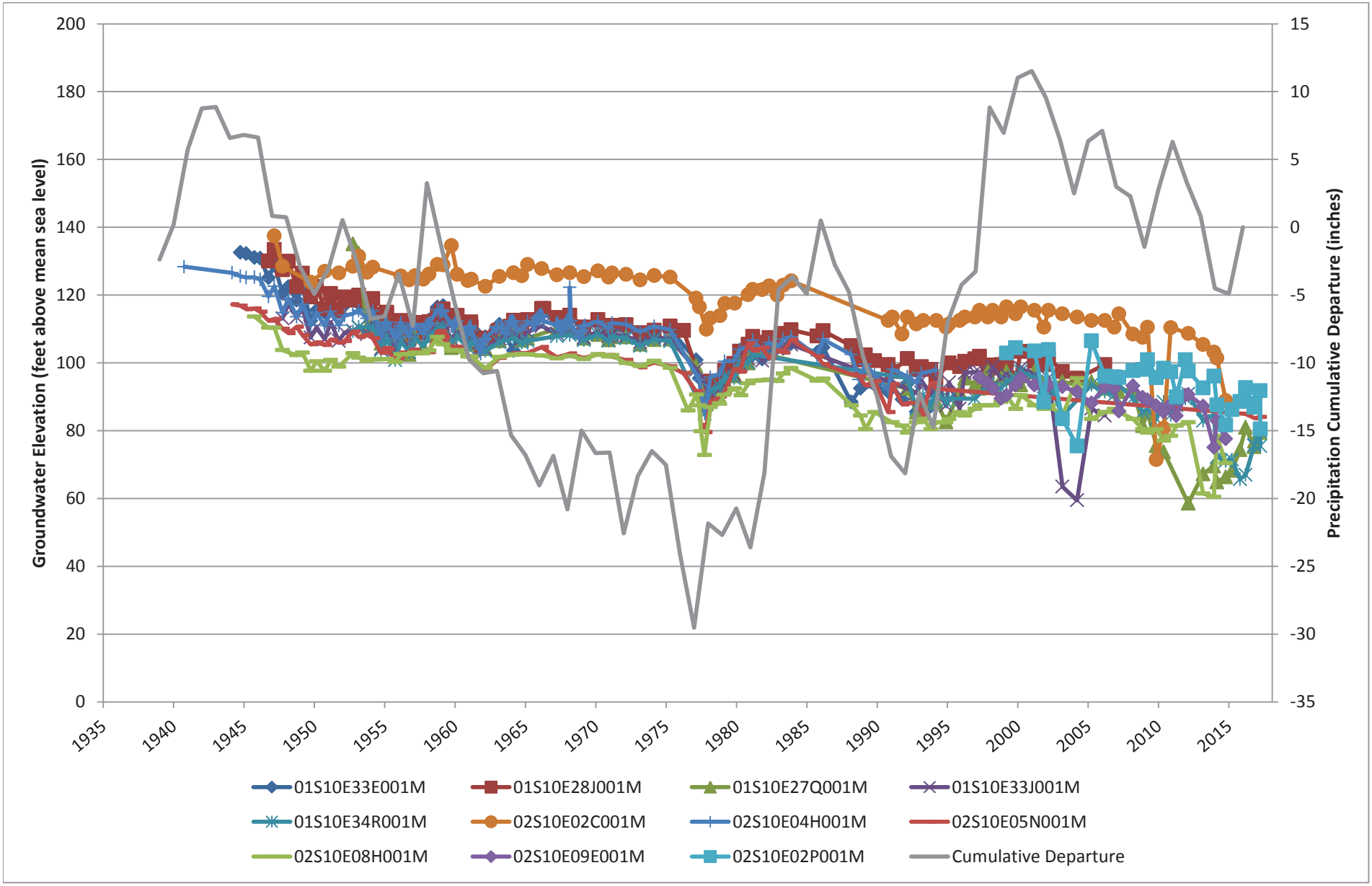

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FIGURE 8C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 614

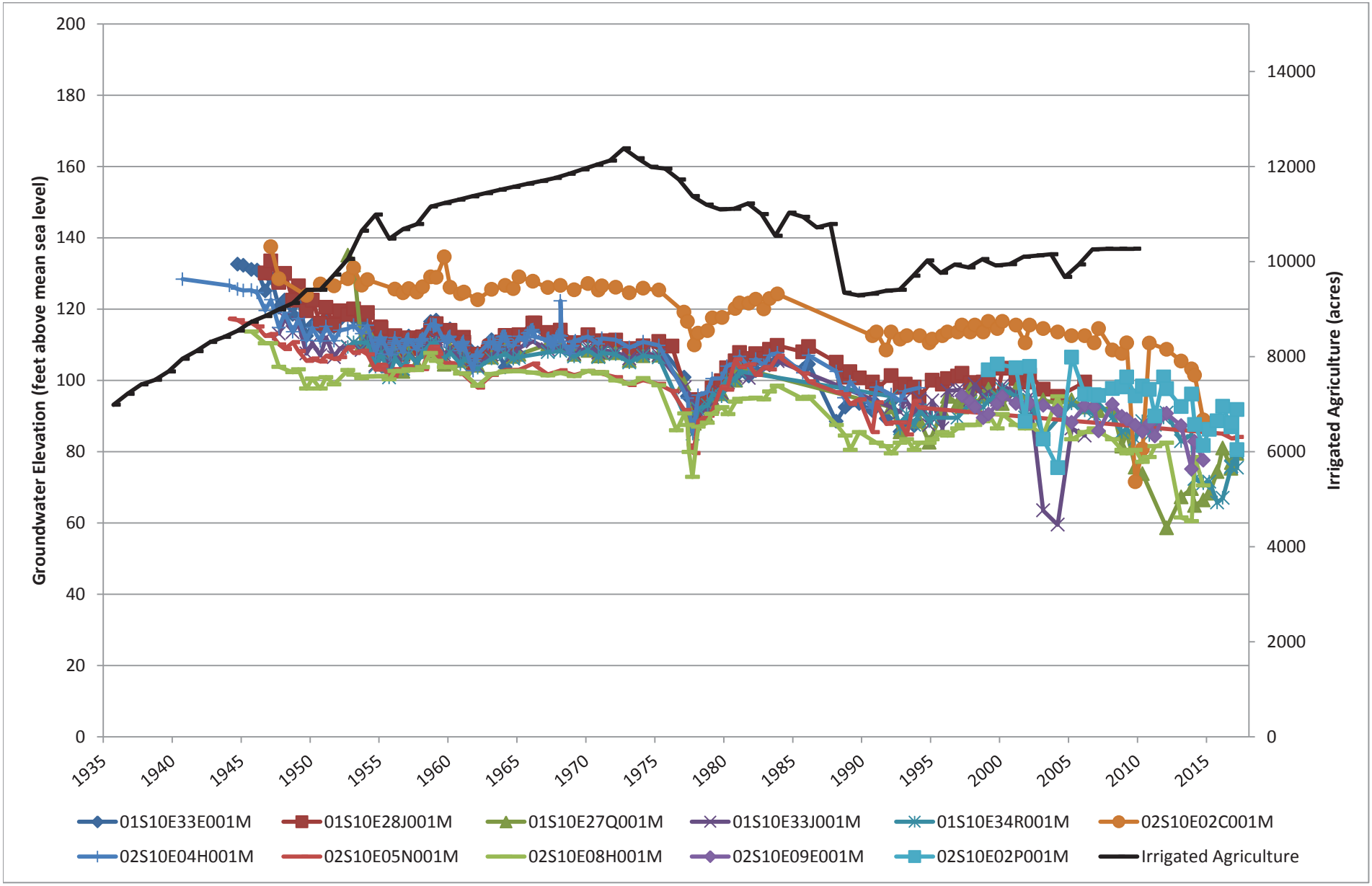

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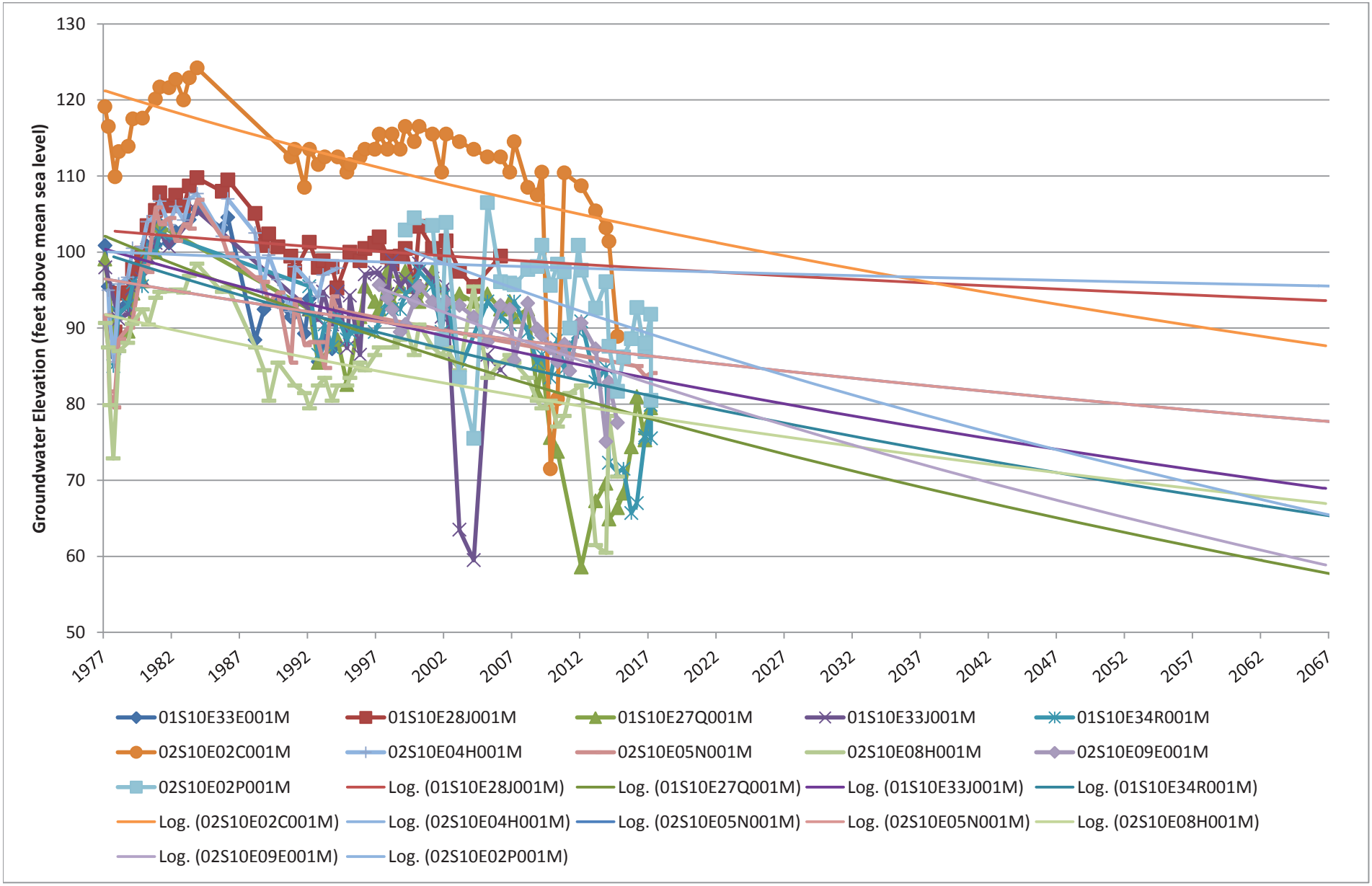
FIGURE 8D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 614



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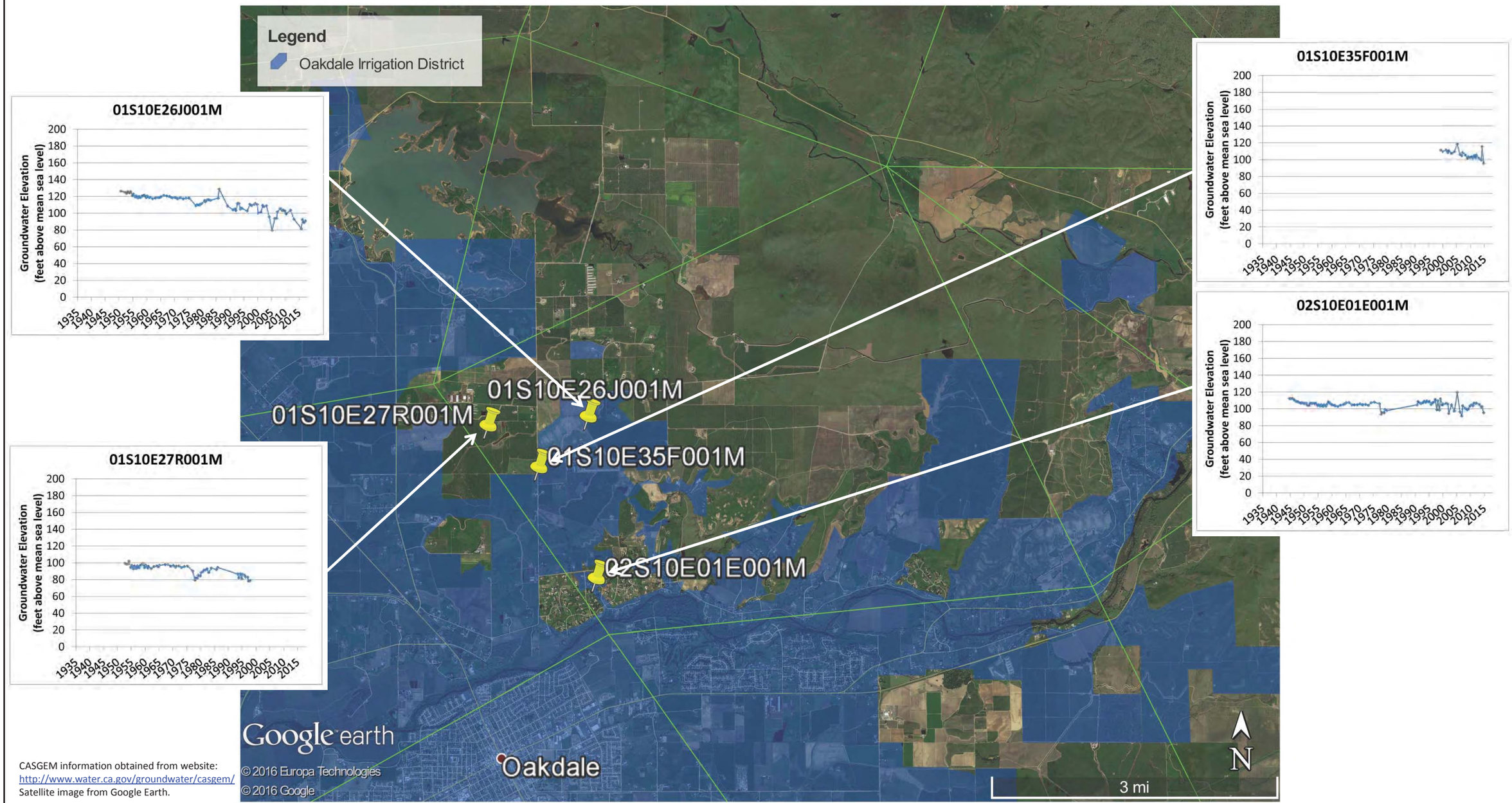

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
Satellite image from Google Earth.

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FIGURE 9A

Hydrographs for Wells Located In Grid Element 615

FIGURE 9B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 615

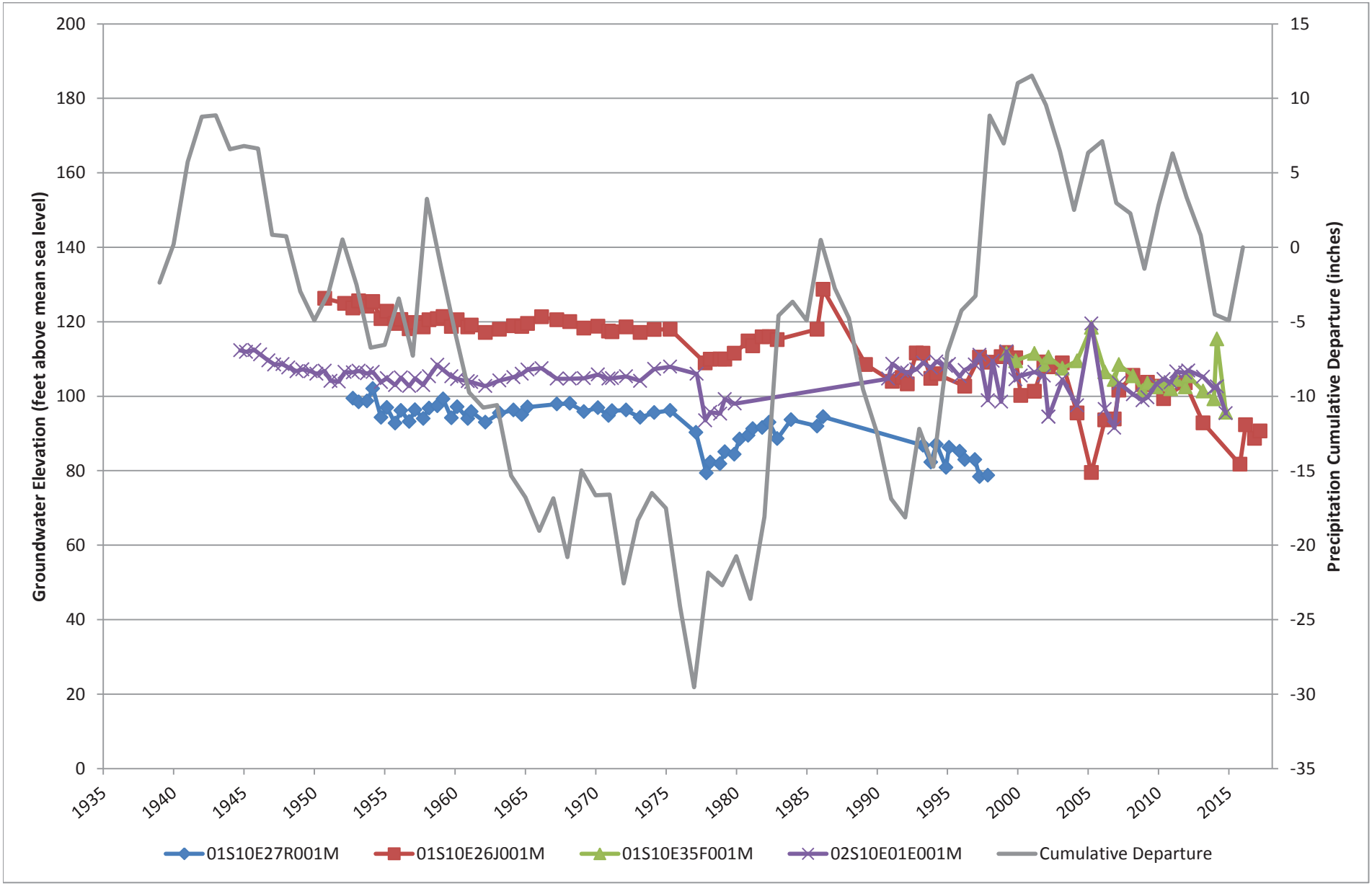

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FIGURE 9C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 615

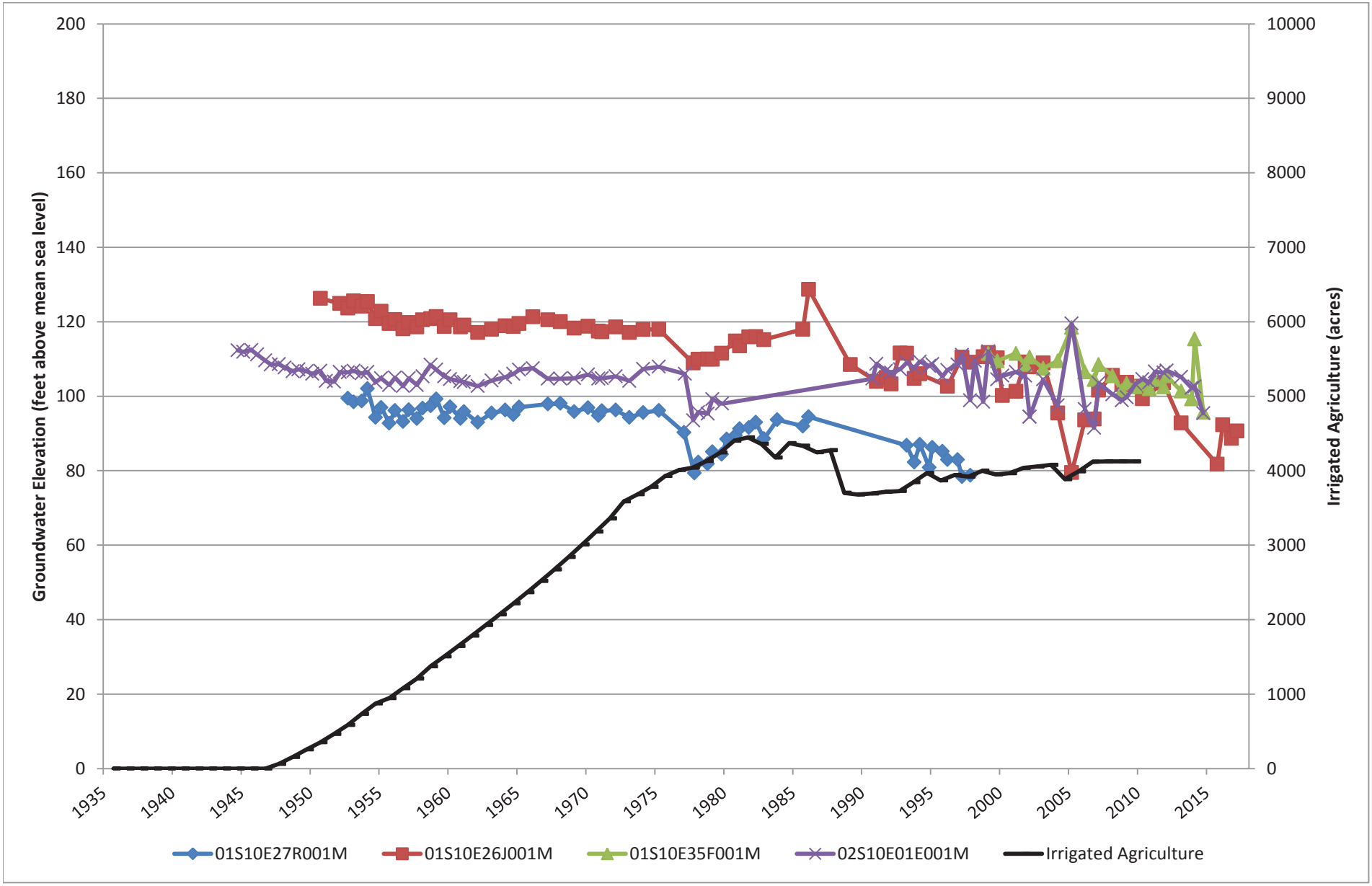

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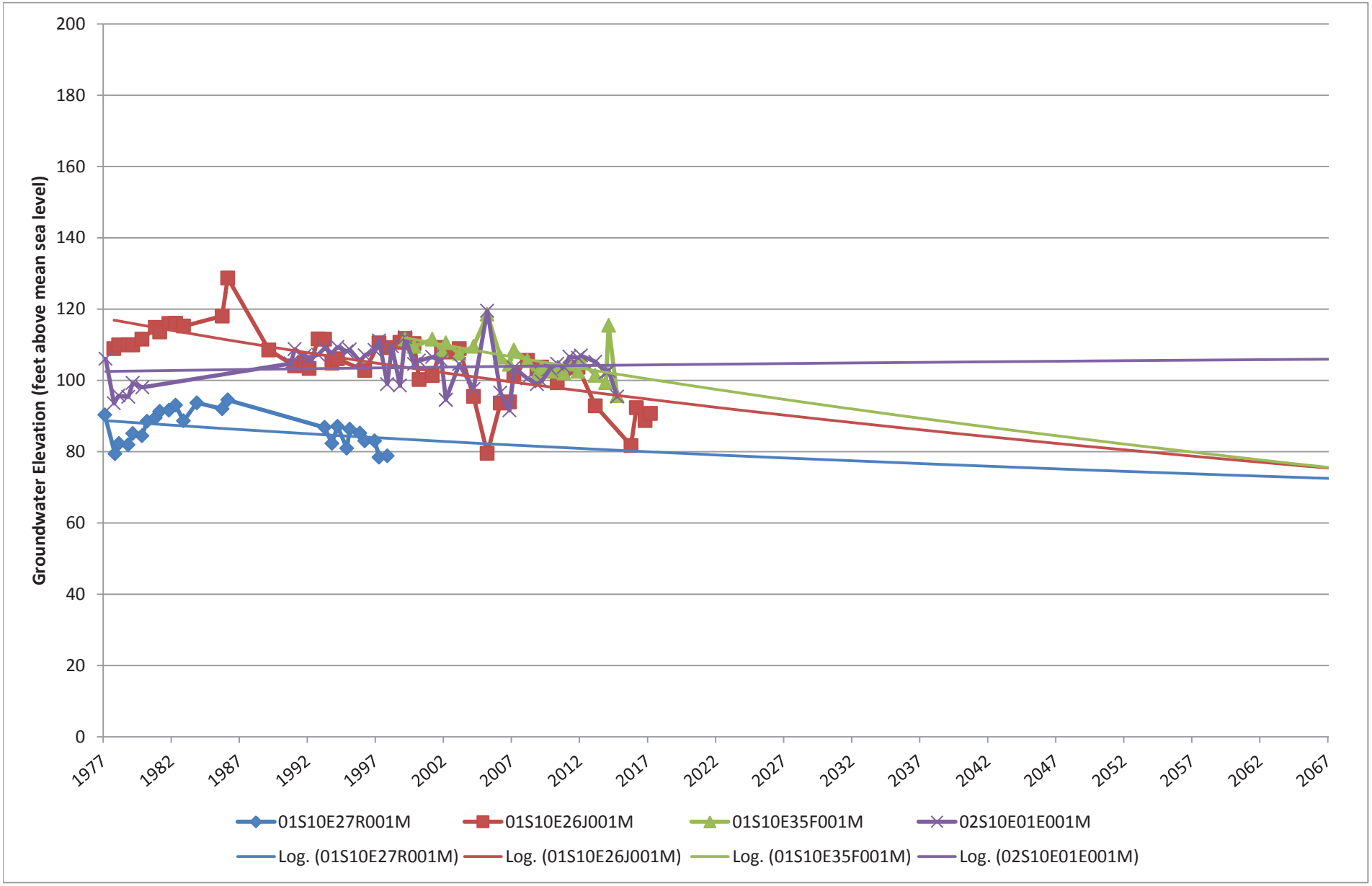
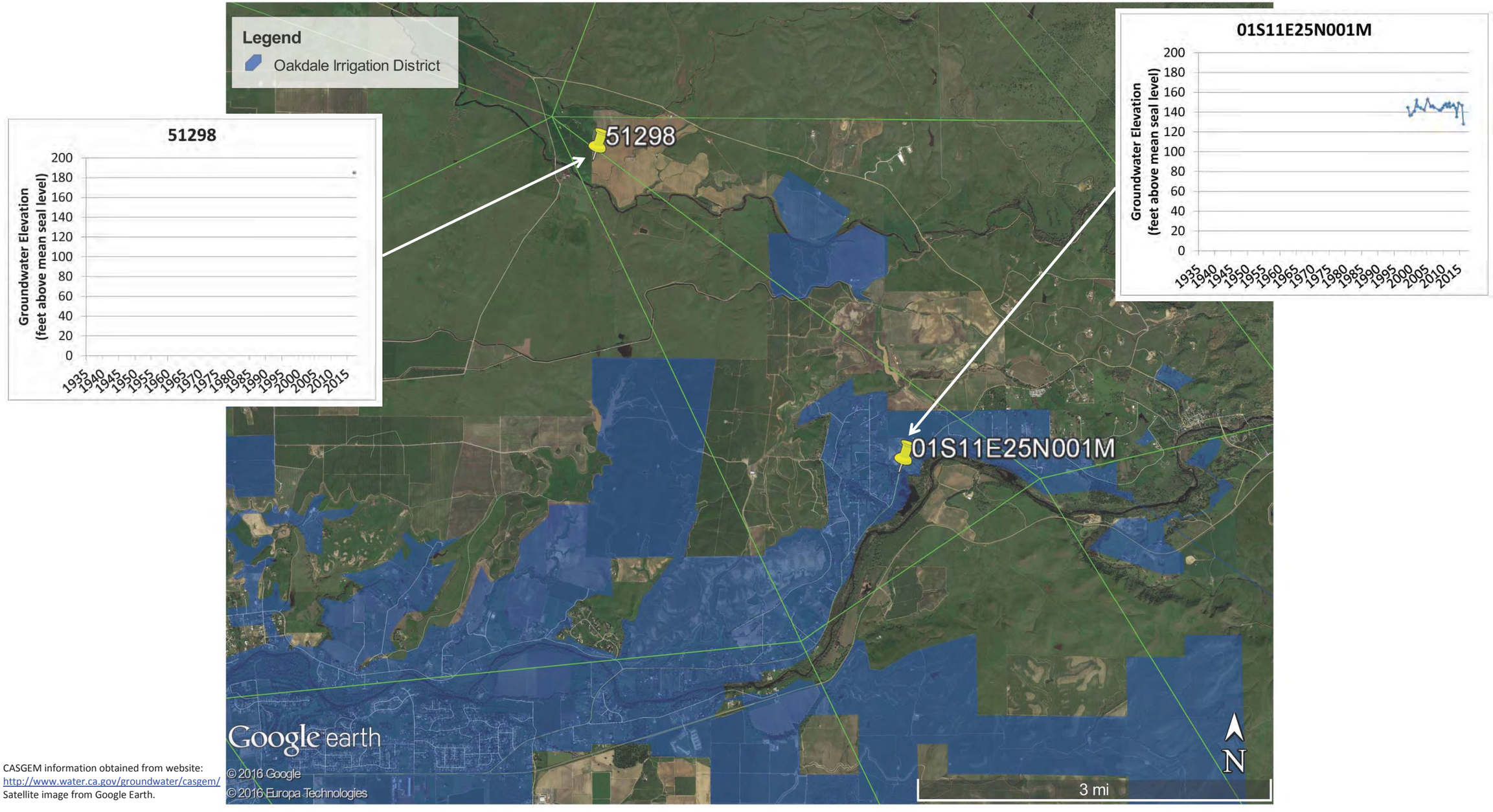
FIGURE 9D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 615





CASGEM information obtained from website:
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FIGURE 10A

Hydrographs for Wells Located in Grid Element 616

FIGURE 10B
HYDROGRAPHS AND PRECIPITATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 616

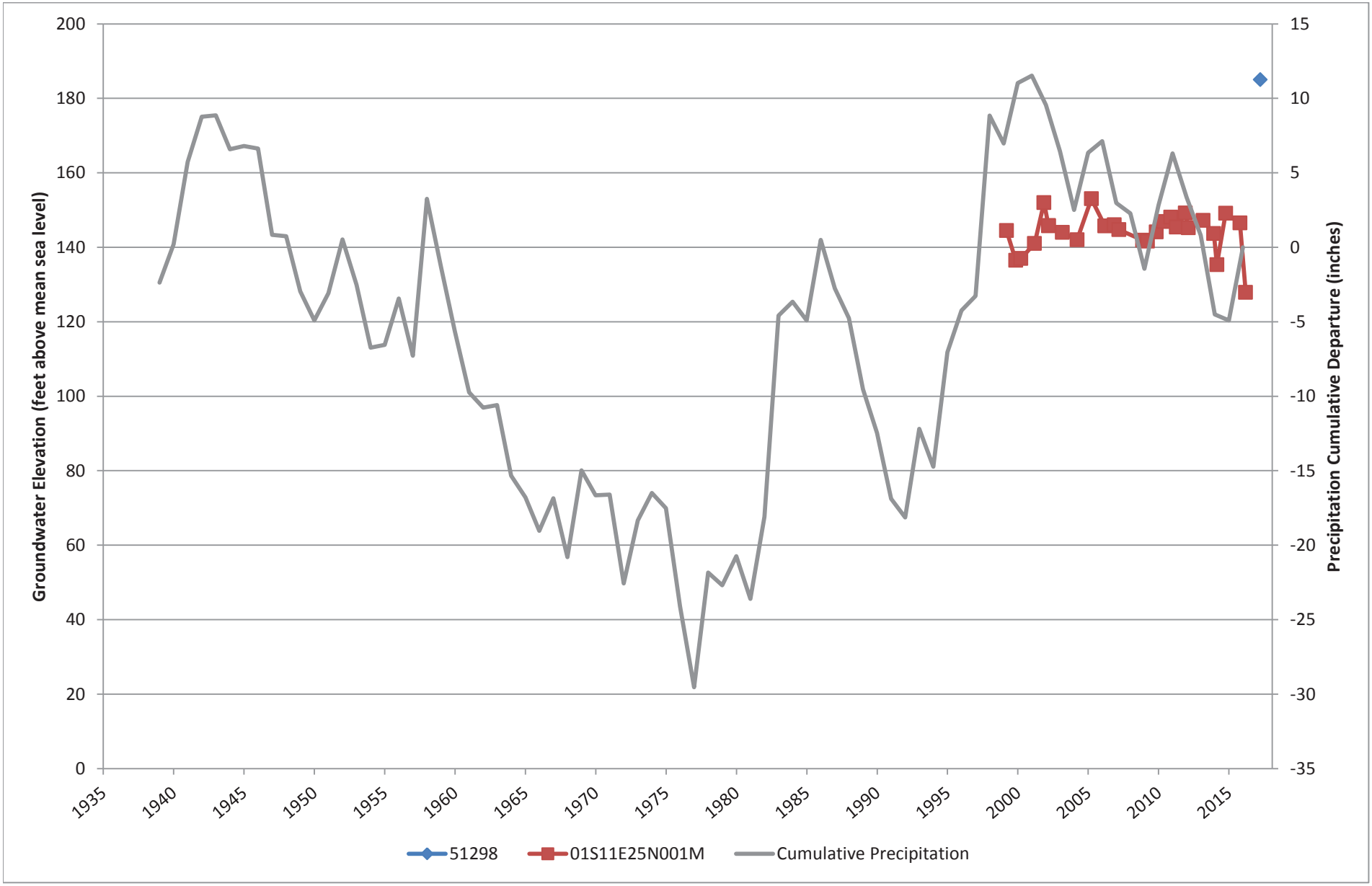

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FIGURE 10C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 616

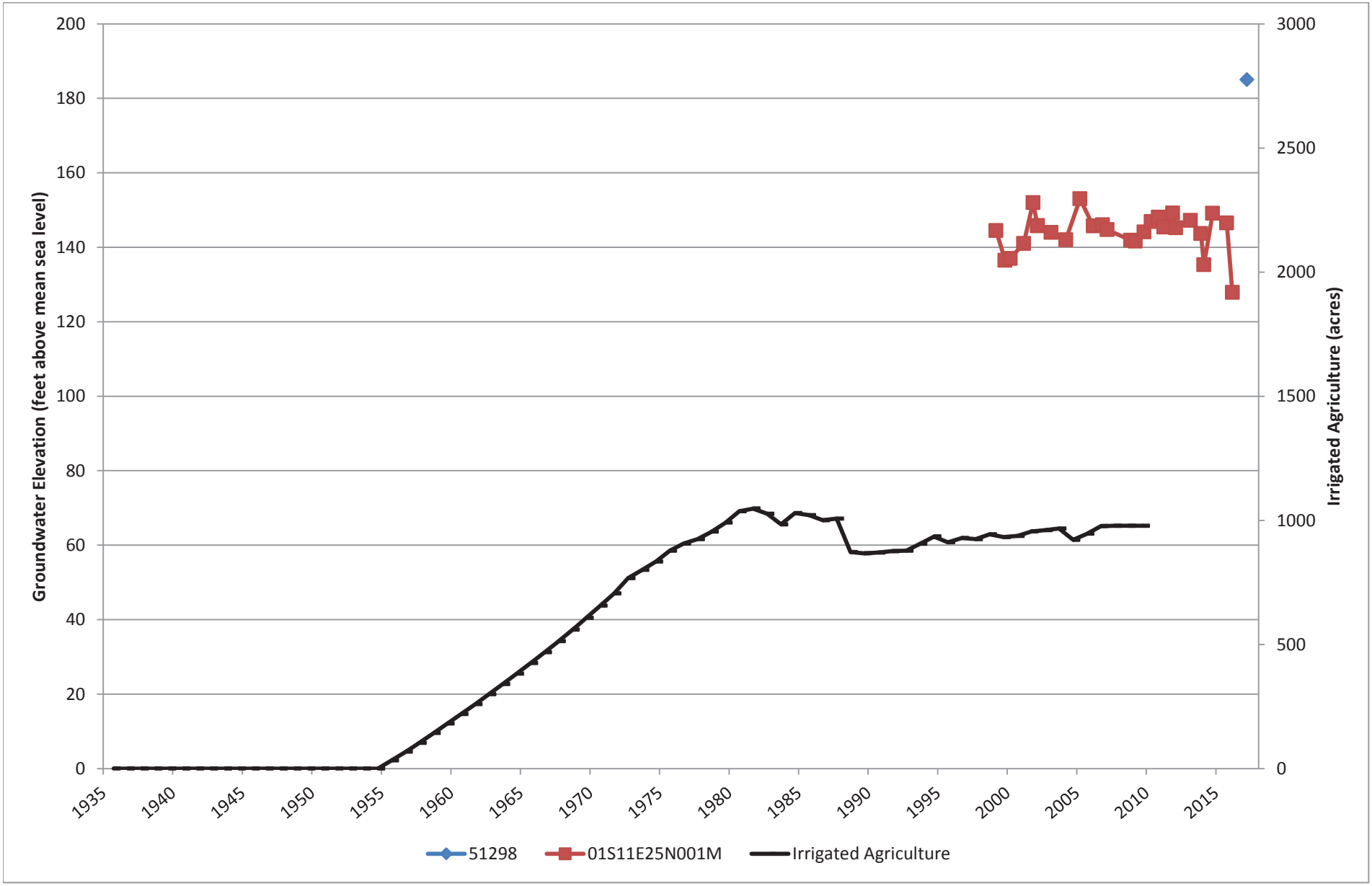

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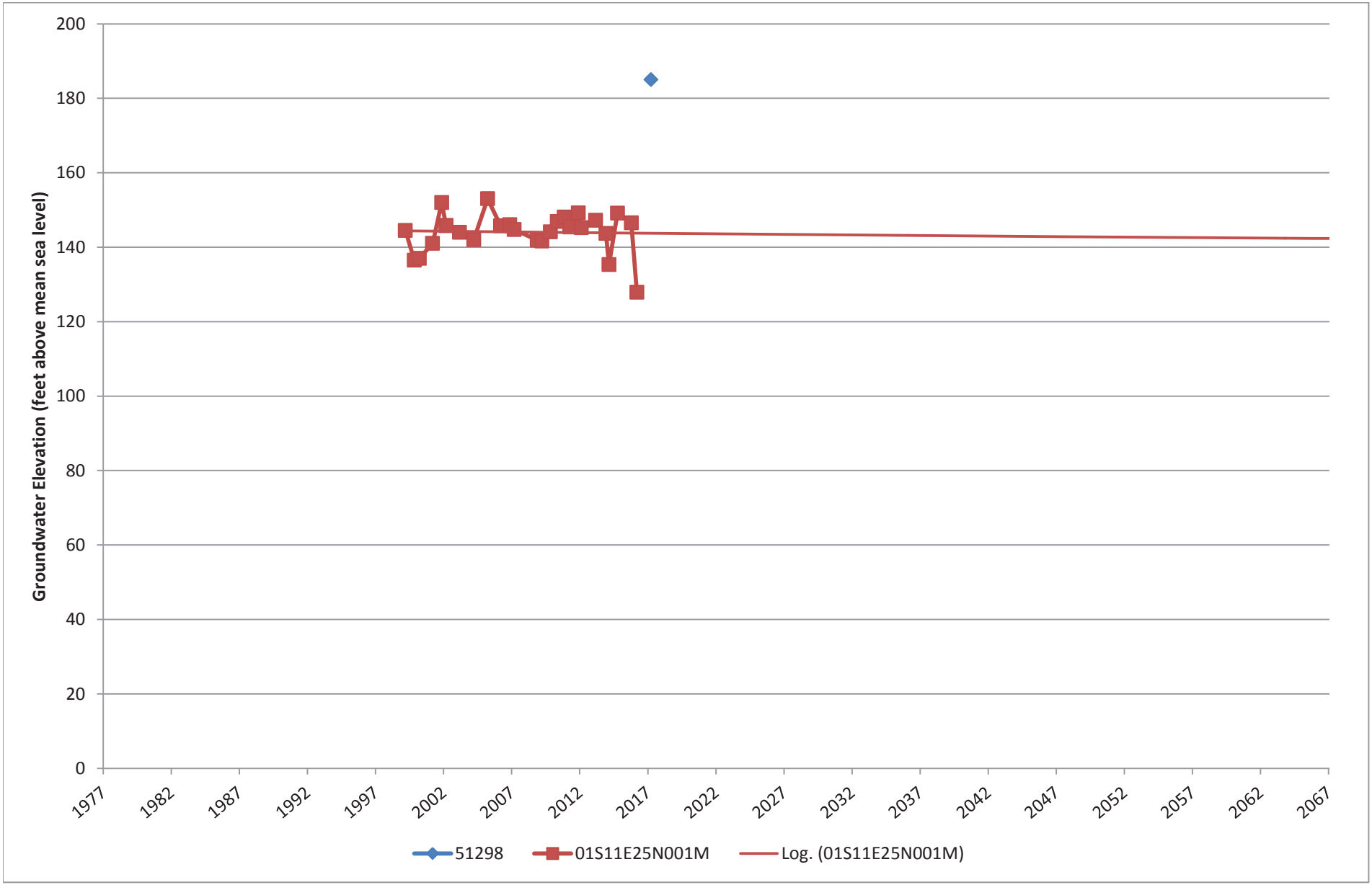
FIGURE 10D
HYDROGRAPH TREND ANALYSIS FOR GRID ELEMENT 616



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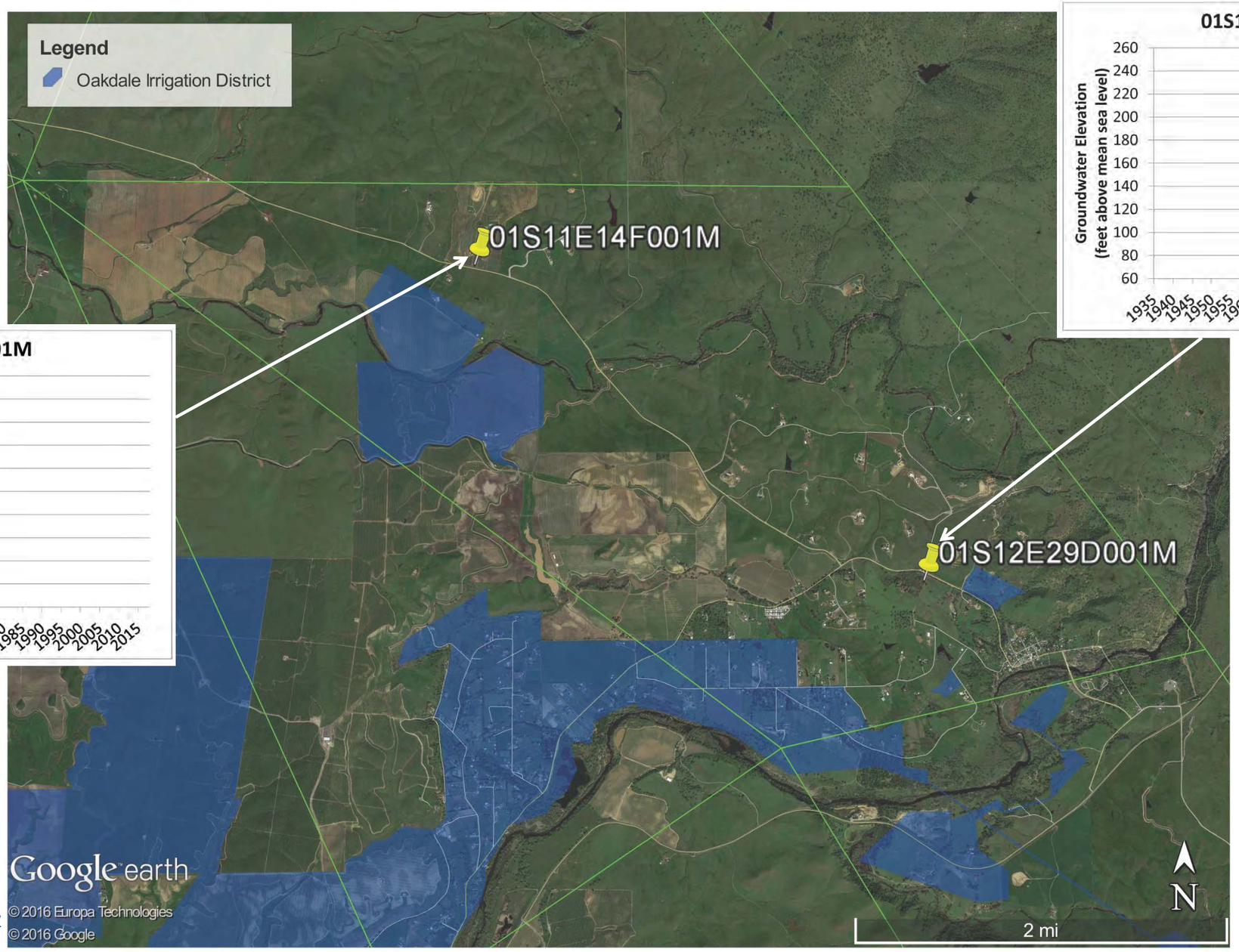

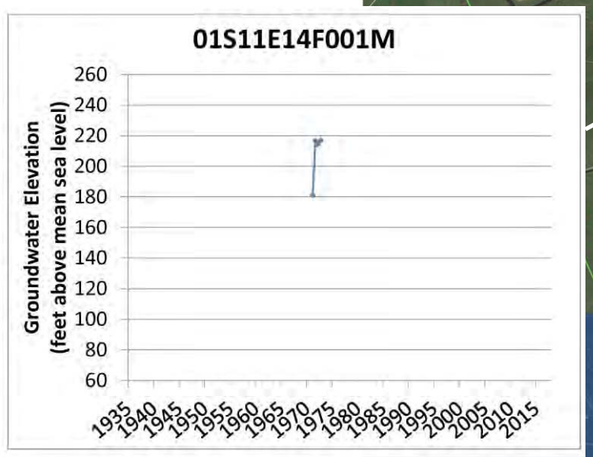

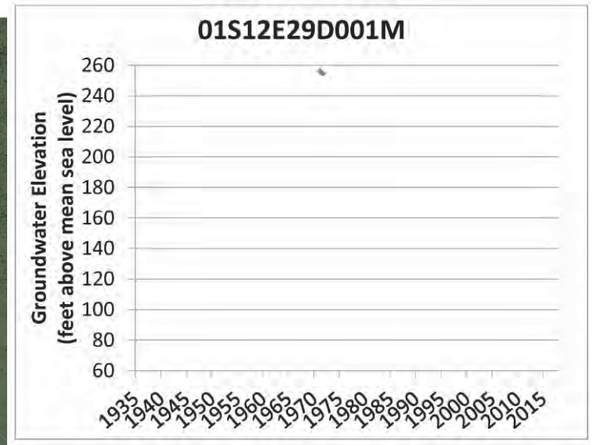

CASGEM information obtained from website:
http://www.water.ca.gov/groundwater/casgem/
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FIGURE 11A

Hydrographs for Wells Located in Grid Element 617

FIGURE 11B
HYDROGRAPHS AND PRECIPIATION CUMULATIVE DEPARTURE FOR GRID ELEMENT 617

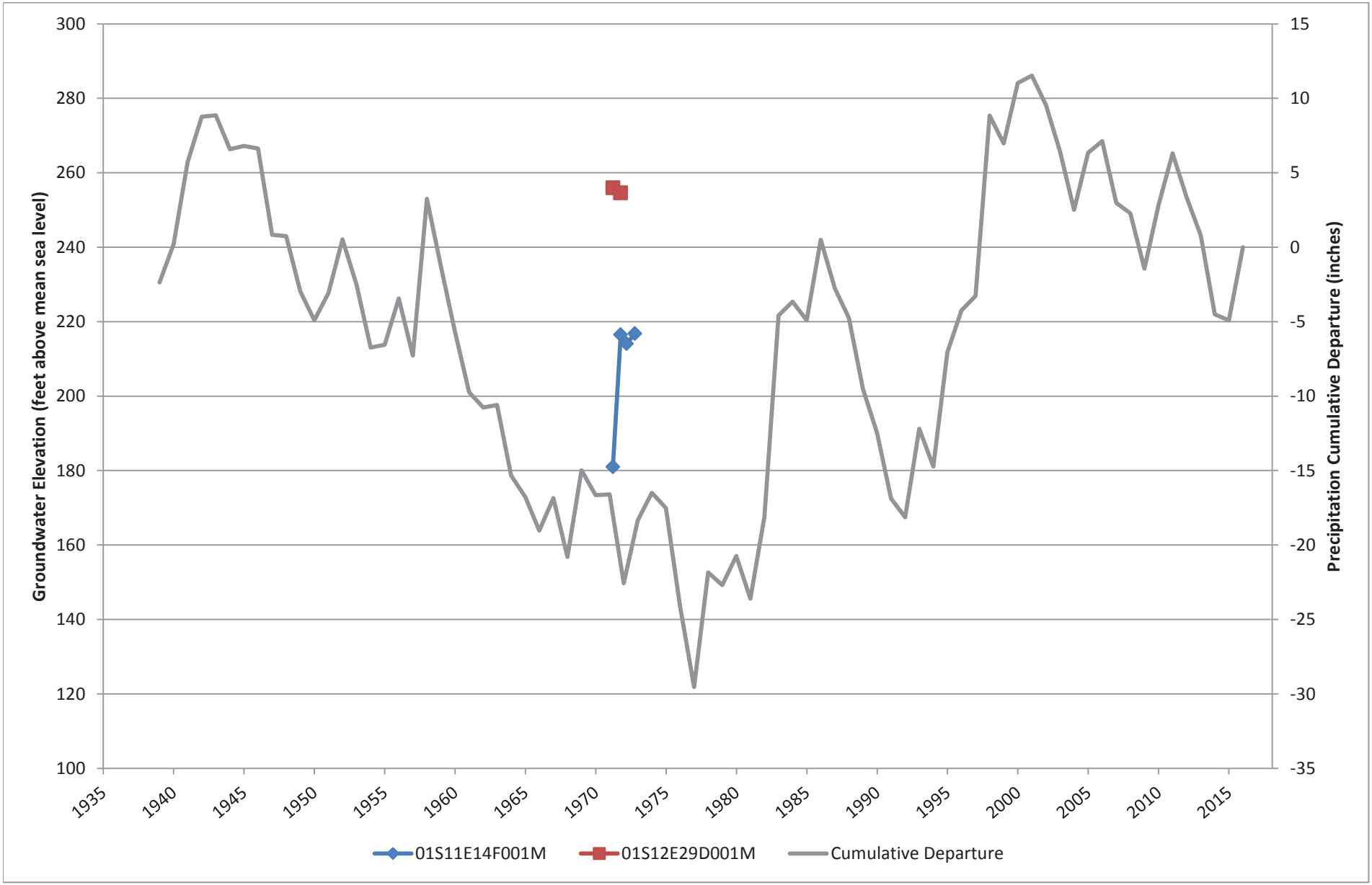

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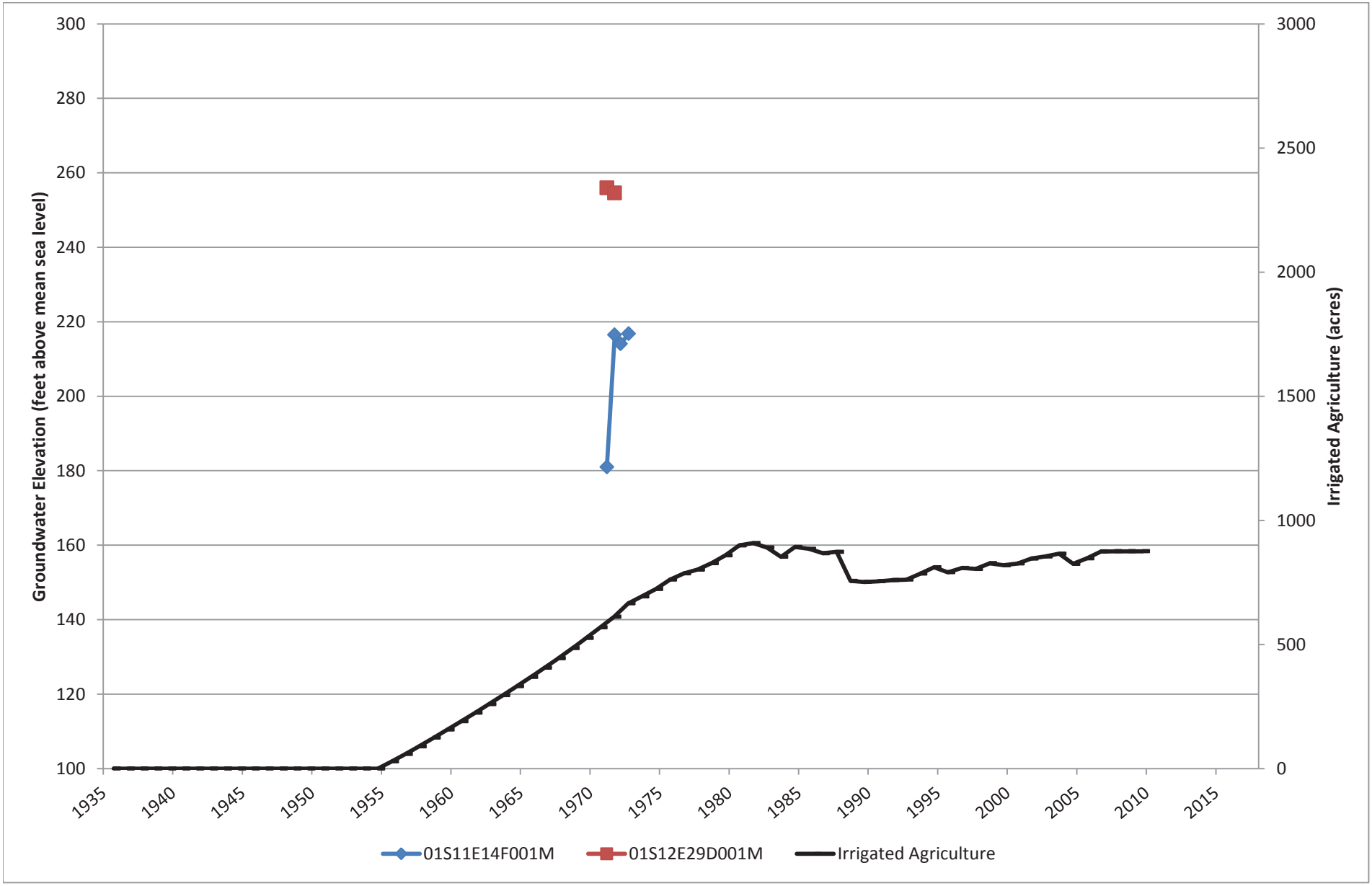
FIGURE 11C
HYDROGRAPHS AND IRRIGATED AGRICULTURE FOR GRID ELEMENT 617



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