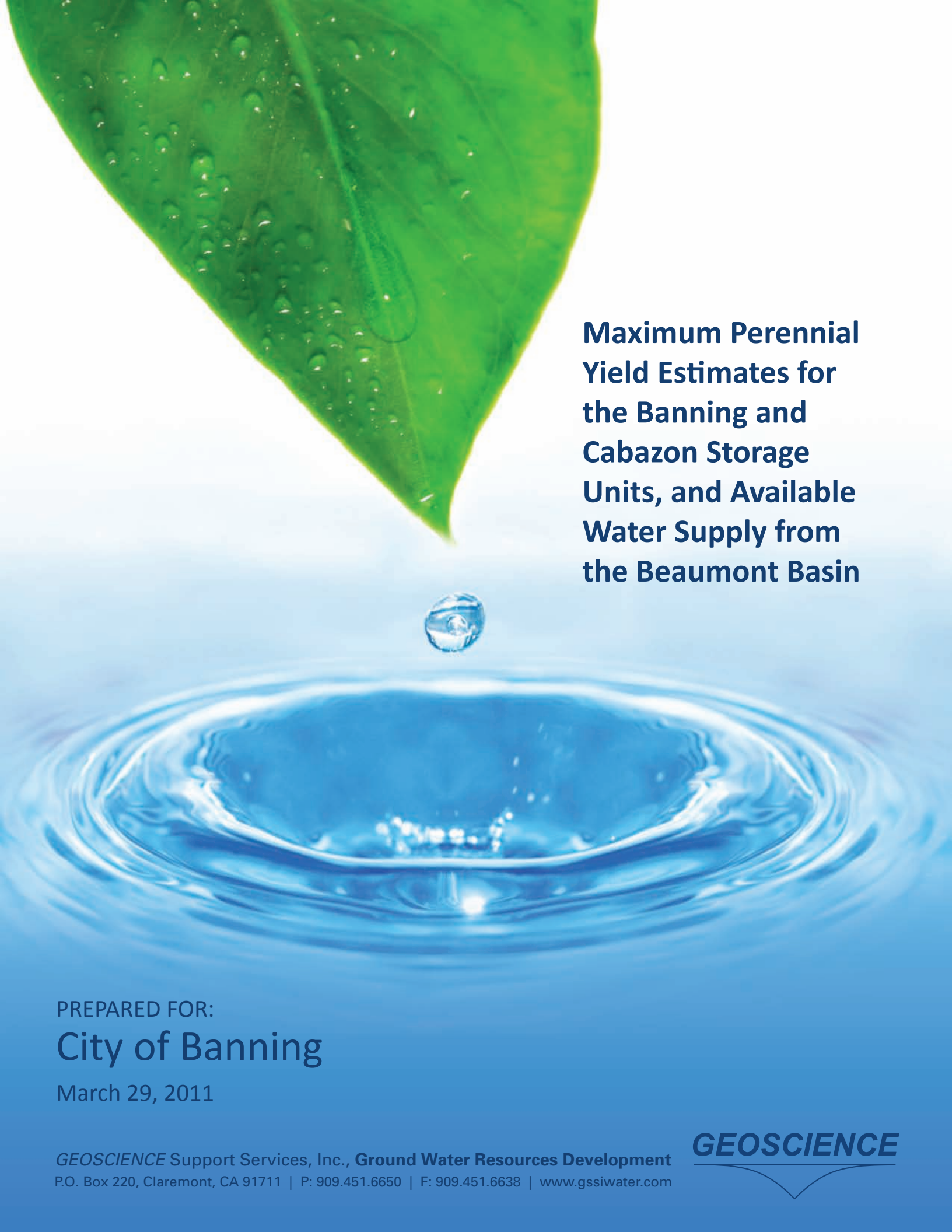
APPENDIX D

Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and Available Water Supply from the Beaumont Basin, Geoscience Support Services, Inc. (March 29, 2011)



Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and Available Water Supply from the Beaumont Basin

PREPARED FOR:

City of Banning

March 29, 2011

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GEOSCIENCE

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN

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MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN

1.0 EXECUTIVE SUMMARY

This report presents the data, findings and conclusions of a geohydrologic study to evaluate the maximum perennial yield for ground water storage units within the City of Banning water resource area. The City of Banning water resource area is located within the San Gorgonio Pass Area, in Riverside County, California. *The maximum perennial yield* is defined as, the long-term average quantity of ground water that can be extracted from a ground water basin on an average annual basis without causing undesirable results, including the gradual reduction of natural ground water in storage over long-term hydrologic cycles, and adverse impact to ground water quality.

Specifically, the Study Area includes an approximately 158-square mile watershed area encompassing the Banning, Banning Bench, Banning Canyon and Cabazon Storage Units. In addition, for water supply planning purposes, this report provides an estimate of long-term supply available from the Beaumont Basin--an adjudicated basin located at the western portion of the City of Banning. The scope of the study included:

1) Comprehensive analysis of previous studies, and collection of current data;
2) Evaluation of data to delineate the aquifer systems in the City of Banning area;
3) Preparation of a geohydrologic basemap;
4) Evaluation of the maximum perennial yield using multiple methods;
5) Assessment of anticipated available water supply from the Beaumont Basin; and
6) Preparation of this report.

Data reviewed to conduct the study and prepare this report included previous investigations in the area, which comprised boring logs, water level data, ground water production data, precipitation, streamflow and ground water quality data. Data were obtained from multiple sources including the City of Banning

Public Works (CBPW), the San Gorgonio Pass Water Agency (SGPWA) the United States Geological Survey (USGS), and the Beaumont Basin Watermaster.

The project area overlies the San Gorgonio Pass Subbasin. The San Gorgonio Pass Subbasin is bounded on the north by the San Bernardino Mountains and on the south by the San Jacinto Mountains. The western boundary of the ground water basin is defined by the surface drainage divide which separates the Whitewater River Drainage Basin on the east from the Santa Ana River Watershed on the west. This divide also forms the basis for the boundary between the Regional Water Quality Control Board designated South Coastal Hydrologic Area on the west from the Colorado River Hydrologic Area on the east. The eastern boundary of the ground water basin is formed by a bedrock constriction at the western boundary of the Indio Subbasin (DWR Bulletin 118).

The San Gorgonio Pass Groundwater Basin includes five hydraulically-connected ground water storage units, which constitute the City of Banning ground water resource area: the Banning Storage Unit, the Banning Bench Storage Unit, the Banning Canyon Storage Unit, the Cabazon Storage Unit, and the Beaumont Storage Unit. A map showing the location of the project area is provided as Figure 1. For purposes of this report, the Beaumont Storage Unit, which was adjudicated in 2004, will not be assessed for maximum perennial yield since the available water supply to the City of Beaumont is set by the Judgment and is to be re-evaluated every 10 years. However, a discussion of potential available water supply from City of Banning water rights in the Beaumont Basin will be provided in Section 8.0 of this report.

The current Storage Unit boundaries used in this analysis are those most recently defined in the 2006 USGS Scientific Investigations Report 2006-5026[1]. The ground water storage units are defined by ground water levels, bedrock outcrops and geologic faults, which were delineated based on significant differences in static water levels between wells or lack of pumping effects observed across storage unit boundaries (USGS 2006). The effect of the faults on ground water movement is not well defined.

[1] The storage unit boundaries were not changed in the previous GEOSCIENCE 2009 report, because the report was an update of the 2003 Safe-Yield Study for the Banning Storage Units only. The current evaluation also addresses the Cabazon Storage Unit and the Beaumont Storage Unit, and for that reason the USGS (2006) boundaries were used.

However, it is generally known that they impede normal flow causing a difference in ground water levels across the fault, but do not prevent flow from crossing the fault.

Ground water recharge to the Banning area is obtained from precipitation infiltrating into the ground within the surface water catchments and particularly in the canyons north of the city. An additional source of recharge is subsurface inflow (i.e. underflow) from storage unit to storage unit, infiltration of Whitewater River diversions in the Banning Canyon, and from percolation of wastewater into the Cabazon Storage Unit.

Analysis of maximum perennial yield for the study area was conducted using the following methods:

- Zero Net Draft Method,
- Hill Method, and
- Hydrologic Budget

For purposes of this study, previous maximum perennial yield values will not be compared to values from this analysis. The reason for this is the ground water storage unit boundaries have been modified, as defined in the 2006 USGS Scientific Investigations Report 2006-5026; therefore, the values representing previous investigations would not be applicable to the current storage unit boundaries.

The following table provides a summary of maximum perennial yield estimates using hydrologic information updated to 2010. The supporting technical data for these values is provided in the following sections of this report.

MAXIMUM PERENNIAL YIELD

[Acre-ft/year]

Storage Unit	Zero Net Draft	Hill Method	Hydrologic Budget	Average
Banning	1,580	680	N/A	**1,130**
Banning Bench	1,980	1,930	N/A	**1,960**
Banning Canyon	4,310	3,830	N/A	**4,070**
Cabazon	N/A	N/A	5,265	**5,265**
Total	**7,870**	**6,440**	**5,265**	**12,425**

Based on the average of maximum perennial yield estimates for the Banning Storage Units (Banning, Banning Bench, and Banning Canyon) and the Cabazon Storage Unit is 7,160 acre-ft/yr and 5,265 acre-ft/yr respectively, for a total of 12,425 acre-ft/yr.

2.0 INTRODUCTION

2.1 Purpose and Scope

This report presents the data, findings and conclusions of a geohydrologic study prepared for the City of Banning by GEOSCIENCE Support Services, Inc. (GEOSCIENCE). The study was conducted to determine the maximum perennial yield of the City of Banning water resource area (see Figure 1 for location) and to determine the anticipated future available water supply from the Beaumont Basin.

Specifically, the study consisted of the following principal phases of work:

1) Comprehensive analysis of previous studies, and collection of current data;
2) Evaluation of data to delineate the aquifer systems in the ground water resource area of the City of Banning;
3) Preparation of a detailed geohydrologic basemap;
4) Evaluation of the maximum perennial yield using multiple methods for the Banning Storage Units;
5) Evaluation of the maximum perennial yield using the hydrologic budget method for the Cabazon Storage Unit;
6) Assessment of anticipated available water supply from the Beaumont Basin; and
7) Preparation of this report.

While the scope of this work focused on the City of Banning area, data from the adjacent areas (such as Beaumont) were also used for areas in which the potential for hydrologic communication between storage units existed. Data reviewed included:

- Driller's logs;
- Geophysical borehole logs;
- Well completion data including total casing depths and screen intervals;
- Pumping test data;
- Well production data;
- Water level data;

- Water quality data;
- Wastewater percolation data;
- Climatic data;
- Geologic reports and maps;
- Previous geohydrologic investigations in the Banning, Beaumont and Cabazon areas; and
- Beaumont Basin Ground Water Adjudication.

2.2 Previous Investigations

Numerous investigations of the water resources of the City of Banning and San Gorgonio Pass have been conducted. One of the earliest investigations of the Beaumont Basin hydrology was conducted in 1938 (Rule, 1938). Several later investigations by the United States Department of Agriculture (USDA) assessed the impact of the Colorado River Aqueduct's San Jacinto Tunnel to the ground water of the San Jacinto Basin (USDA, 1941). In 2006 the USGS issued a *Scientific Investigations Report* which summarized the findings of a calibrated ground-water flow model. The USGS updated ground water storage boundaries previously delineated by Bloyd in 1971 (USGS, 1971) for the Banning and Cabazon Storage Units. Other relevant studies include:

- A Water Resources Investigation and Water System Master Plan for the City of Banning conducted by VTN Consulting in 1973.
- A Water Report for the City of Banning was prepared by C.M. Engineering Associates (1978). This report reviewed the entire water system and outlined improvements, as well as a long-term water plan.
- Boyle Engineering Corporation (1988) carried out a Ground Water Dependable Yield investigation for the San Gorgonio Pass Water Agency.
- GEOSCIENCE Support Services, Inc. (1990) conducted a geohydrologic investigation and well site evaluation in the City of Banning area.
- GEOSCIENCE Support Services, Inc. (1991) prepared the results of drilling, construction, testing, and pump design for four new wells for the City of Banning.
- A Safe Yield Study of the adjacent Beaumont Unit was conducted by Boyle Engineering Corporation (1995).

- San Gorgonio Pass Water Agency's 2000 – 2001 Engineer's Report on water conditions.
- GEOSCIENCE Support Services, Inc. (2003) conducted a geohydrologic investigation to determine maximum perennial yield for the Banning Storage Units.
- An Urban Water Management Plan was prepared by Wildermuth Environmental in 2005.
- San Gorgonio Pass Water Agency's 2008 Annual Report on Water Conditions.
- Riverside County Regional Detention Center Environmental Impact Report prepared by LSA, Associates, Inc. in 2009.
- GEOSCIENCE Support Services, Inc. (GEOSCIENCE, 2009) conducted a geohydrologic investigation to update the maximum perennial yield for the East and West Banning and Banning Bench Storage Units.

Since GEOSCIENCE conducted its 2009 geohydrologic investigation in the City of Banning area, additional water level and production histories have become available. Additional driller's logs have been collected, supplementing lithologic and hydrologic data for the area. Additionally, the storage unit boundaries presented in the 2006 USGS report have become accepted as the refined boundaries by the SGPWA, as evidenced by these boundaries being reflected in their most recent reports.

2.3 Sources of Data

Sources of data used in the present study included driller's logs, geophysical borehole logs, production data, water level data, weather data, pumping test data, wastewater percolation data and water quality data. These were obtained mostly from the City of Banning and other public agencies. Production data for the Cabazon Storage Unit were obtained from SGPWA Conditions of the Basin 2008 report. The Morongo Indian Tribe which pumps water from the Cabazon Storage Unit does not report annual pumping volumes. The pumping data for the Morongo Tribe used for this report was obtained from the Water Supply Assessment conducted for the Riverside County Regional Detention Center prepared by LSA Associates Inc., dated 2009. The data analysis task involved tabulating and summarizing information from documented and undocumented reports, public and private files, as well as personal communication with local and state agencies. Detailed references to sources of data and information are presented in Section 10.0.

3.0 OVERVIEW OF STUDY AREA

3.1 Study Area

The City of Banning and its surrounding water resource area encompass an area of approximately 158-square miles, in the San Gorgonio Pass and within the immediate highland areas of the San Bernardino and San Jacinto Mountains, in Riverside County, California (see Figure 1).

The study area has defined geohydrologic and hydrologic regions. Previous investigations have referred to geologic storage units (such as the Banning, Beaumont, Banning Bench and Cabazon storage units), which were delineated by Bloyd in 1971 based on geologic faults and bedrock outcrops. Since Bloyd's study in 1971, new data has been collected allowing refinement of the storage unit boundaries. The current storage unit boundaries, as defined in the USGS Scientific Investigations Report 2006-5026, are defined by bedrock outcrops and geologic faults, which were delineated based on significant differences in static water levels between wells or lack of pumping effects observed across storage unit boundaries (USGS 2006). The effect of the faults on ground water movement is not well defined; however, it is generally known that they impede but do not completely prevent flow across them.

3.2 Topography and Physiography

The City of Banning is situated at an elevation of approximately 2,500 feet above mean sea level (amsl) in the San Gorgonio Pass between the Transverse and Peninsular Ranges of Southern California (see Figure 1). The City includes portions of Banning Canyon and the Banning Bench[2], and is located north of the San Jacinto Mountains. The tallest mountain peaks in the area are Mt. San Jacinto to the southeast (10,834 feet amsl) and Mt. San Gorgonio to the north (11,502 ft amsl). Surface water flows from the slopes of the steep mountain front drainages out of the canyons to the lowlands of the San Gorgonio Pass. Surface flow is primarily from the San Bernardino Mountains to the north, but also from drainages coming from the San Jacinto Mountains to the south. Surface drainages conduct flow to the San Gorgonio River (see Figure 1).

[2] The Banning Bench comprises tectonically uplifted remnants of an older fan exiting Banning Canyon.

3.3 Climate

The Banning area is generally characterized by a typical Mediterranean climate of hot, dry summers and short, mild, moist winters.

3.3.1 Temperature

Air temperature in the City of Banning area follows a pattern of high summer and low winter temperatures. Winter temperatures are lower than those recorded in the lower basin areas of Southern California as the City of Banning is further inland and lacks the buffering effect from the Pacific Ocean. Average winter temperatures range from high daily temperatures of 60 to 69 degrees Fahrenheit to lows between 39 and 43 degrees Fahrenheit (see Table 1). The summer maximum average temperatures range from 88 to 96 degrees Fahrenheit with the lows from 53 to 59 degrees Fahrenheit (see Table 1).

3.3.2 Precipitation

Long-term annual precipitation in the Banning area is based on data collected at three representative weather stations in and around the Banning water resource area. Long-term annual precipitation was based on the Beaumont station rain gauge from 1888 through 2009 (see Figure 2 and Appendix A). Annual precipitation ranges from a minimum of 6.4 inches (1999) to a maximum of 36.37 inches (1978). The average annual precipitation is 17.77 inches per year. The average annual precipitation at the Banning Bench gauge is 22.31 inches per year (see Figure 2 and Appendix A). The average annual precipitation at the Cabazon gauge is 12.49 inches per year (see Figure 2 and Appendix A). Precipitation in the western portion of the San Gorgonio Pass is slightly higher than in the eastern portion (see Figure 2). This precipitation distribution pattern is due to the rain-shadow effect of the mountains on storms migrating inland from the Pacific Ocean.

Historical annual precipitation and cumulative departure from mean annual precipitation for the above mentioned stations are shown on Figures 3 through 5. The severity and extent of dry and wet periods can be readily observed from the plot of the cumulative summation of departures of annual precipitation from the long-term mean annual precipitation. The data indicate seven cyclical variations in the precipitation pattern from 1888 to 2009 (see Figure 3):

(1) 1893-1904: a dry period,

(2) 1905-1946: a prolonged overall wet period;

(3) 1947 to 1977: a dry period;

(4) 1978 to 1983: a wet period;

(5) 1984 to 1990: a dry period;

(6) 1991-1998: a wet period; and

(7) 1999 to present: a relatively dry period.

3.3.3 Evaporation

Evaporation rates for the Banning area are measured using an evaporation pan located at Beaumont 1E Station (see Figure 2) and are summarized in Table 1. Evaporation at this station is typically highest during the hot and dry summer months (9 to 11 inches) and lower (3 to 4 inches) in the winter months. No significant proportion of days with evaporation data occurred during freezing temperatures so these estimates were not necessary.

3.4 Existing Water Purveyors and Wells

Figure 6 shows the City of Banning production well locations[3]. The table below summarizes the known groundwater users within each ground water storage unit.

[3] Due to the close proximity of wells in some areas, only the section/subsection designations are shown on the Figure. Therefore please note the Township and Range lines shown on the Figure to determine the complete State Well Identification.

GROUND WATER USERS BY STORAGE UNIT

Storage Unit	Groundwater Users
Banning	City of Banning
Banning Bench	City of Banning Private users
Banning Canyon	City of Banning Banning Heights Mutual Water Company Private users
Cabazon	City of Banning Cabazon Water District Desert Hills Premium Outlets Mission Springs Water District Robertson's Ready Mix Morongo Indian Tribe Arrowhead Jenson's Water Company Private users

Source: SGPWA Report on Water Conditions, 2008.

The City of Banning currently operates 21 ground water production wells (personal communication with Mr. Perry Gerdes, 2010). The City also co-owns 3 production wells within the Beaumont Storage Unit. These wells are co-owned and operated by Banning and BCVWD. The City is entitled to half of the water produced from these wells. An additional five wells are available but are not equipped, and one well is abandoned (total of 29 wells). The table below summarizes the number of operable wells owned by the City reported by storage unit.

**SUMMARY OF CITY OF BANNING
ACTIVE PRODUCTION WELLS
(AS OF MAY 2010)**

Storage Unit	Number of Active Wells
Banning	4
Banning Bench	3
Banning Canyon	8
Cabazon	1
Beaumont	8

3.5 Ground Water Production

Table 2 shows annual production values for the City of Banning water resource area by storage unit for Banning, Banning Bench, Banning Canyon, and Cabazon Storage Units which includes extraction by municipal and private users.

Ground water production over the entire Banning water resource area has been increasing steadily since 1959 at an average rate of approximately 92 acre-ft/year (see Figure 7a). Currently, most production for the City of Banning takes place in the Canyon Storage Unit. See Table 2 for annual production values by storage unit.

Well production by the City of Banning within the Banning Storage Unit began in 1992, with the extraction of 406 acre-ft of water. Between 1992 and 2009, the annual extraction from the Banning Storage Unit has increased (on average) approximately 102 acre-ft/yr (see Figure 7b). The greatest amount of production occurred in 2003 with the extraction of approximately 2,381 acre-ft of water in that year. Ground water extraction is the result of production from Wells C-5, M-10, M-11, and M-12.

Annual ground water extraction from the Banning Bench Storage Unit between 1959 and 2009 has decreased at an average rate of approximately 14 acre-ft/yr (Figure 7c). The greatest amount of production occurred in 1983 with the extraction of approximately 4,036 acre-ft of water in that year. Ground water extraction is the result of production from Wells 1, 2, and 3 as well as private producers.

Annual ground water extraction from the Banning Canyon Storage Unit between 1959 and 2009 has increased at an average rate of approximately 13 acre-ft/yr (Figure 7d). The greatest amount of production occurred in 2001 with the extraction of approximately 5,604 acre-ft of water in that year. Ground water extraction is the result of production from the City of Banning Wells 4, 5, 7, 8, 9, 10, 11, and 12, Banning Heights Mutual Water Company and private producers.

Annual ground water extraction from the Cabazon Storage Unit between 1989 and 2009 has increased at an average rate of approximately 217 acre-ft/yr (Figure 7e). The greatest amount of production occurred in 2007 with the extraction of approximately 4,100 acre-ft of water in that year (see Table 2).

Ground water extraction by the City of Banning is the result of production from the City of Banning Well C6. Well C-6 began extraction from the Cabazon Storage Unit in 2004. In addition to City of Banning pumping, Cabazon Water District, Mission Springs Water District as well as private producers also pump from the Cabazon Storage Unit. A summary of ground water producers in the Cabazon Storage Units is provided on Table 3.

4.0 GEOLOGY

4.1 Regional Geology

The City of Banning is located in the San Gorgonio Pass between the Transverse and Peninsular Mountains of Southern California. Faulting and subsequent erosion has resulted in continental alluvial deposits, ranging in age from Tertiary to Quaternary, overlying consolidated basement complex. The basement complex is composed of igneous and metamorphic rocks, specifically the San Jacinto granodiorite, gneisses, schists, and quartz monzonite of pre-Tertiary age. The surrounding mountains in the area are composed of these basement rocks.

The Banning Fault is an important structure within the City of Banning water resource area. The Banning Fault forms the boundary between the Banning Canyon and the Banning Bench Storage Units (see Figure 8a). The Banning Fault zone was characterized by a right-lateral strike-slip displacement during the late Miocene (approximately 10 to 5 million years ago) (USGS, 2006). The USGS describes another fault zone, The San Gorgonio Pass Fault Zone, which includes a group of reverse, thrust, and tear faults which extend westward from the Whitewater area to the Calimesa area. According to the USGS, the fault zone exhibits the same general attitude as the Banning Fault but has no evolutionary relationship. The San Gorgonio Pass Fault Zone has a distinctive zig-zag geometry, which is illustrated by the mapped locations of the Banning, Central Banning and Eastern Banning Barrier Faults (see Figures 8a and 8c). These three concealed faults are delineated based on differences in ground water elevations and lack of observed effects during pumping of wells on the other side of the barrier (USGS, 2006). The Banning, Central and Eastern Banning Barrier Faults bound the Banning Storage unit and form the Banning and Cabazon Storage Unit boundaries reflected in this report.

4.2 Study Area Geology

4.2.1 Bedrock Complex

The bedrock in the Banning area predominantly consists of slightly gneissic granite of pre-Cretaceous age (Ransome, 1932). The consolidated rocks (pTb) in the area are comprised primarily of gneiss, schist, and quartz monzonite (see Figure 8a). Cross-section A-A' presented on Figure 8b depicts the subsurface

relationship between the geologic units described below. The explanation for the geologic symbols shown on Figure 8a and Figure 8b is provided on Figure 8c.

4.2.2 Quaternary Alluvial Deposits

The alluvial deposits in the vicinity of the City of Banning consist of many hundreds of feet of Quaternary and upper Tertiary gravels that were washed from the adjacent San Gorgonio highlands. These alluvial materials are generally poorly sorted sands and gravels, intermingled with silts and clays. Although the material near the surface is comparatively young, true recent alluvium is limited almost entirely to the areas immediately adjacent to washes and gullies. The recent alluvium contains no ground water except in areas where the water table is perched near the surface. Coarser-grained beds within the San Timoteo formation yield significant quantities of water.

Alluvial deposits in the Banning area include three general groups: Quaternary younger alluvium (Qya), Tertiary to Quaternary older alluvium (Qoa), and Tertiary to Quaternary Continental deposits (Qtcv) (see Figures 8a, 8b, and 8c).

The most recent alluvial deposits in the Banning area occur in the valley floor of the Banning Storage Units as younger alluvium (Qya). The younger alluvium consists of unconsolidated, angular boulders, sand and cobbles, and small quantities of silt, clay, and aeolian sand. Depths range from several feet to a maximum of approximately 50 feet.

Older alluvial deposits (Qoa) underlie the Qya. These deposits consist of poorly sorted, unconsolidated clay, silt, sand, and gravel ranging from approximately 10 ft to a maximum of approximately 450 ft in thickness. Qoa deposits are found in stream channels, valley floors, and flood plains over the majority of the Beaumont and Banning Bench Storage Units. Qoa deposits include the old (Qo) and very old deposits (Qvo) shown on Figure 8b. The subsurface units designated as Qsu and Qsl on Figure 8b are not exposed within the study area but are exposed to the northwest near Calimesa. Units Qsu and Qsl are the primary water-bearing units in the study area.

Tertiary to Quaternary Continental deposits (Qtcv) consist of poorly sorted cobbles, sand, silt and clay, and include the San Timoteo Beds of Frick (1921) and some volcanic rocks north of the Banning-Cabazon area.

5.0 GEOHYDROLOGY

5.1 Hydrologic Subunits

The surface water drainage catchment or hydrologic subunits encompassing the City of Banning are present in an area of approximately 158 square miles and include the surface flows from surrounding mountain runoff (see Figure 9). The significance of this hydrologic subunit area is that precipitation falling anywhere within the hydrologic subunit has the potential to contribute to the recharge of the ground water storage units which ultimately supplies water to the City of Banning.

The total drainage catchment tributary to the ground water storage units was delineated using a USGS 10 m x 10 m digital elevation model (DEM) in ESRI ArcView 9.3[4] (ESRI ArcView 9.3 is a Geographic Information System (GIS) software package). Specifically, the drainage catchment was delineated by computing flow directions from the DEM, which was then used by Arc Hydro. Arc Hydro is an ArcGIS-based system geared to support water resources applications to automatically delineate the hydrologic subunits within an area of study.

The area of the watershed catchment was used to calculate the potential water crop specifically for the Cabazon Storage Unit based on the weighted average annual precipitation for each contributing watershed (i.e. Potrero Subunit, Millard Subunit, One Horse Subunit, etc.).

5.2 Ground Water Storage Units

Ground water storage units which have been referred to in numerous investigations have been delineated in the San Gorgonio Pass area of the City of Banning by Bloyd in 1971, which were delineated based on water level differences between wells. Since Bloyd's study in 1971, more data has become available, resulting in refined storage unit boundaries by the USGS in 2006.

[4] ESRI ArcView 9.3 is a Geographic Information System (GIS) software package.

Figure 9 shows the Banning Storage Units, (Banning, Banning Bench and Banning Canyon), and the Cabazon Storage Unit as reflected in the 2006 USGS report in relationship to the hydrologic units. These boundaries, as presented in the 2006 USGS report, have been generally accepted as the refined boundaries by the USGS and SGPWA, as these boundaries are reflected in their most recent reports.

The ground water storage units are hydraulically connected generally across fault boundaries, which imply that the faults which form the storage unit boundaries leak, allowing movement of ground water from one storage unit into the adjacent storage unit. Values of leakance used by the USGS for modeling ground water flow across barriers in the study area were used in this study to estimate flow from the Banning Storage Unit into the Cabazon Storage Unit and for a portion of the underflow from the Banning Bench Storage Unit into the Cabazon Storage Unit. However, a portion of the underflow from the Banning Canyon Storage Unit into Banning Bench Storage Unit and subsequently into the Cabazon Storage Unit occurs through alluvial channel and across the fault mapped at the boundary of the Banning Bench and Cabazon Storage units.

5.3 Surface Water

Surface water in the City of Banning water resource area has an intermittent nature. Temporary runoff occurs after precipitation, ranging from small trickles to flash flooding which occurs usually in winter. Although some streamflow does occur in the steep mountain areas, it percolates rapidly into the sands and gravels in the canyons and San Gorgonio Pass area.

Surface water flow in the watersheds located both north and south of San Gorgonio Pass is tributary to the San Gorgonio River which joins the Whitewater River approximately four miles east of the Cabazon Storage Unit in the Coachella Valley. The San Gorgonio River has two USGS surface water gages (see Figure 2). The upper gage (10256200) has data for the period October 1975 to September 1977; and the lower gage (10256300) only has data for the period February 1981 to September 1981. These data sets did not contain enough data to characterize streamflow patterns for the San Gorgonio River.

Diversion of surface water from the upper reaches of the Whitewater River Drainage into Banning Canyon (Banning Canyon Storage Unit) was initiated in 1913. The diverted water flows along steep mountain slopes for approximately 14 miles in a mostly concrete lined conveyance system known as The

Flume (see Figure 9). Portions of the flume have significantly deteriorated over the years and are in need of repair. Along the flume system, Southern California Edison historically operated two powerhouses to generate hydroelectric power. Banning Heights Mutual Water Company utilizes approximately 1,000 acre-ft/year from below the second powerhouse (see Figure 2). The remainder of the diverted water flows into the San Gorgonio River below the Banning Heights Mutual Water Company abstraction point. Flows have diminished since the 1980's due to a loss of canal system capacity due to deterioration (C.M. Engineering Associates, 1978; San Gorgonio Pass Water Agency, 2002). Since 1961, on average, 1,500 acre-ft/year had been diverted into the Canyon subunit from the Whitewater River (San Gorgonio Pass Water Agency, 2002). Due to damage along sections of the flume, currently, surface flow is diverted into Burnt Canyon to the north, and then back to the Flume upstream of Powerhouse No. 1 where it continues downstream through Powerhouse No. 2 to the reservoir operated by Banning Heights Mutual Water Company. It is uncertain exactly how much of the diverted water is currently recharged into the aquifer of the Canyon subunit as the flows are not metered (personal communication with Mr. Perry Gerdes, 2010).

5.4 Ground Water

5.4.1 Aquifer Systems

The water-bearing rocks in the vicinity of Banning consist of many hundreds of feet of Quaternary and upper Tertiary gravels washed down from the adjacent San Gorgonio highlands. These alluvial materials are generally poorly sorted sand and gravels intermingled with silts and clays. Although the material near the surface is comparatively young, younger alluvium (Qya on Figure 8a) is limited almost entirely to the immediate areas around the washes and gullies. The younger alluvium contains no ground water except in areas where the water table is near the surface.

The older alluvium (Qoa on Figure 8a) occurring at the surface in the Banning areas is of Plio-Pleistocene age and unconformably overlies coarse sand and gravel layers of the San Timoteo Formation (Qtcv). Ground water is present in an upper and lower aquifer system shown as Qsu and Qsl on Figure 8b. The San Timoteo Formation dips underneath the older alluvium at low angles towards the northeast. In general, stratification in the San Timoteo Formation is better developed than the older alluvium with the result of the coarser beds within the formation yielding good quantities of water to wells. The

transmissivity of the aquifers in the Banning Storage Unit is approximately 15,000 - 34,000 gpd/ft based on pumping test data from well C-5. The aquifer ranges in thickness from 40 - 1,200 ft with an average thickness of 600 ft. The hydraulic conductivity ranges from 15 - 60 gpd/ft^2 (2 - 8 ft/day; GEOSCIENCE, 1991). DWR estimates that wells in the San Gorgonio Pass Subbasin can yield 1,000 from the San Timoteo formation. Aquifer transmissivity or hydraulic conductivity data in the Canyon and Banning Bench Storage Units was not available. However, saturated thickness ranges from 30 ft to 160 ft.

5.4.2 Ground Water Occurrence and Movement

The majority of ground water in the Banning area occurs in the permeable alluvial sediments that underlies the valley floors and canyon beds. The aquifers within the younger alluvial sediments are generally unconfined to semi-confined, while ground water within the older alluvial sediments is generally confined beneath sediments of recent deposits.

Ground water flows by gravity drainage from areas of high elevation (the canyons and mountain slopes) into areas of low elevation (see Figure 10), ultimately collecting in the sediments beneath the valley floor. Hydraulic gradients in the canyon areas are relatively steep (approximately 300-500 ft/mile) but flatten out in the valley areas (approximately 90 ft/mile) (see Figure 10).

Ground water in the Banning and Banning Bench subunits generally flows southeast into the west portion of the Cabazon Storage Unit and to a lesser degree enters fractures and joints in the San Jacinto Mountains. Ground water flows east within the Cabazon Storage Unit to the Indio Subbasin.

Due to construction of the San Jacinto tunnel for the Colorado Aqueduct, ground water from the southwest portion of the Cabazon Storage Unit near the vicinity of the east portal of the San Jacinto Tunnel and from crystalline rocks in the San Jacinto Mountains flows into the tunnel through joints and fractures as well as through a series of southeast-trending geologic faults (see Figure 8a). Although the tunnel has been constructed in bedrock and is lined with concrete, an estimated 1,500 acre-ft/year of ground water seeps into the tunnel from the west portion of the Cabazon storage unit (33% of the total 5,000 acre-ft per year tunnel seepage; Boyle, 1995; personal communication, FlowScience, 2001).

5.4.3 Historical Ground Water Level Trends

Historical ground water level hydrographs for wells in the Banning Storage Units and Cabazon Storage Unit are provided in Appendix B. The locations of wells discussed in this investigation are shown on Figure 6. Figure 10 contains insets which show selected hydrographs for the storage units. Static water level elevations have been observed to fluctuate as much as 80 to 100 feet, and when plotted against the cumulative departure from mean precipitation, it is observed that there is a direct relationship of precipitation trends and ground water elevation trends. An increase in cumulative departure is mirrored by an increase in water level elevations, and a decrease in cumulative departure from mean precipitation is mirrored by a decrease in ground water elevations.

5.4.4 Recharge and Discharge

Ground water recharge in the Banning area occurs through infiltration and percolation of rainfall and surface runoff in stream channels that flow from local mountains and hills. Recharge to the Banning and Cabazon Storage Units occurs through underflow from the Beaumont Storage Unit in the western part of the study area. Additionally, underflow from the Banning Canyon Storage Unit flows into the Banning Bench, and from the Banning Bench to the Cabazon Storage Unit.

The majority of the rainfall in the lower basin elevations (valleys) is evaporated or taken up by plants before it enters the ground water system. The primary sources of replenishment to the ground water basins are infiltration of precipitation at the higher watershed elevations and surface water infiltration in the streams and drainages during major storm events or prolonged periods of high precipitation.

Recharge rates are generally highest during spring runoff when soils are saturated, temperatures are low and vegetation is inactive. Recharge is minimal during summer when most precipitation is transpired back to the atmosphere. In the fall, recharge rates increase again as photosynthesis shuts down. Frost during the winter months precludes recharge.

The primary source of ground water discharge in the storage units is pumping, and subsurface outflow into the downstream storage units; a minor amount of ground water discharge is lost by evapotranspiration. Ground water flows out of the eastern end of the Cabazon Storage Unit at a bedrock constriction at the boundary with the Indio Subbasin. The amount of ground water outflow is a

function of the saturated thickness or depth to water. As discussed in the previous section, ground water levels follow the trend of rainfall. Therefore ground water level rises occurring during wet climactic cycles would result in increased outflow at the eastern end of the Cabazon Storage Unit. In addition to subsurface outflow, water is lost from the Cabazon Storage Unit through the San Jacinto Mountains (through joints and fractures).

5.4.4.1 Infiltration of Treated Wastewater, Cabazon Storage Unit

The City of Banning operates recycled water infiltration basins in the Cabazon Storage Unit. The infiltration basins receive secondary effluent water from the wastewater treatment plant which was constructed in 1968[5] and is operated by United Water Service, a public/private partnership. The average amount of effluent infiltrated between 2000 and 2009 is 2,655 acre-ft/yr. The following table is a summary of effluent discharges to the infiltration basins from 2000 to 2009.

SECONDARY EFFLUENT DISCHARGES INTO THE CABAZON STORAGE UNIT

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Acre-ft/yr	2,568	2,532	2,538	2,547	2,602	2,974	2,955	2,737	2,639	2,461

Source: City of Banning Public Works, 2010

The Wastewater infiltration basins are located approximately 1,500 feet southwest of Well R-1 (see Figure 6). Well R-1 was constructed with the intent of capture and distribution of secondary treated effluent after it has had residence time in the subsurface sediments. Discharge from the well will be placed into a recycled water system for use within the City of Banning.

[5] Page 3 of Initial Study/Mitigated Negative Declaration Wastewater Treatment Plant Expansion and Phase I Recycled Water System, May, 2008

5.4.4.2 Infiltration of Surface Water in Banning Canyon

When surface flow is present in Banning Canyon, flows are diverted by the City of Banning into off-stream recharge basins to facilitate ground water recharge (see Figure 2). According to the City of Banning, Department of Public Works (personal communication with Mr. Perry Gerdes, 2008), the off-stream infiltration basins are located in Banning Canyon approximately one mile north of the Banning Bench Storage Unit (see Figure 6). The basin surfaces were scarified (breaking up the surface of topsoil) in 2006 and surface water from San Gorgonio River has been diverted into the basins since that time. The basins are un-gauged and there has been no recordation of the volume of water that has been infiltrated into the basins. The infiltration basins are located north of the Banning Fault which forms the north boundary of the Banning Bench Storage Unit. The contribution of the infiltration basins to subsurface flow into the Banning Bench Storage unit is unknown since no gauge is currently present at the percolation basins. It is estimated that approximately 350 acre-ft/yr exit the Banning Canyon and Banning Bench Storage Units into the Cabazon Storage unit in the form of subsurface flow, or underflow.

5.4.5 Ground Water Storage

The amount of ground water in storage within the City of Banning water resource area (not including Beaumont Storage Unit) is estimated to be approximately 1.1 – 1.2 million acre-ft. This volume was estimated using ArcView GIS 10 Spatial Analyst[6] to calculate the saturated thickness within each storage unit and multiply by the estimated effective porosity (i.e. specific yield). The table below summarizes the ground water storage available to the City.

[6] ArcView GIS 10 Spatial Analyst is a Geographic Information System (GIS) software package.

GROUND WATER STORAGE AVAILABLE TO THE CITY OF BANNING

IN BANNING AND CABAZON STORAGE UNITS

Ground Water Storage Unit	Ground Water Basin Area [acres]	Average Saturated Thickness [ft]	Effective Porosity [%]	Ground Water Storage [acre-ft][7]
Banning	2,489	600	15 – 17	211,000 – 240,000
Banning Bench	3,753	30	15 – 17	1,200– 1,500
Banning Canyon	1,058	161	15 – 17	12,000 – 13,500
Cabazon[8]	17,222	350	15 – 17	880,000 – 1,000,000

The surface area of the ground water basins (excluding bedrock) was calculated using the polygonal area feature of the geographic information system (GIS) from the Storage Unit boundaries (USGS, 2006). Saturated thickness was estimated based on the depth between the current (2010) ground water levels and depth to bedrock. Depth to bedrock was estimated from lithology logs, of which only two encountered bedrock. Wells in the central parts of the basin do not intercept bedrock; as such, it is assumed that the depth to bedrock is (1) greater than the total depth of known wells in these locations, and (2) decreases towards the edges of the basin. In the Banning Storage Unit, bedrock was encountered at a depth of approximately 1,400 ft below ground surface (ft bgs). In the Cabazon Storage Unit, wells did not encounter bedrock but ranged in total depth from 500 to 1,200 ft bgs. Depth to bedrock in the Banning Canyon and Banning Bench are anticipated to be approximately 110-150 ft bgs. Water level elevations used to calculate storage are shown on Figure 10. Based on these data, the conservative saturated thickness for the Banning Storage Unit is estimated to average approximately 600 ft ranging between thicknesses of 35 – 1,170 ft. Estimates for the Banning Bench saturated thickness averages approximately 30 ft, ranging from 1 – 60 ft. The City' Banning Bench wells are

[7] As a reference, the full capacity of MWD's Diamond Valley Reservoir is 800,000 acre-ft.

[8] The volume of storage is approximate since the data confirming the depth to the base of the aquifer in the Cabazon Storage Unit is lacking.

located in Banning Canyon in the Banning Bench Storage Unit, saturated thickness may be greater outside the canyon area. Saturated thickness in the Banning Canyon Storage Unit averages approximately 160 ft, ranging from 2 – 360 ft. The average saturated thickness in the Cabazon Storage Unit is approximately 350 ft, ranging from 1 – 700 ft thick.

The effective porosity for the saturated sediments was determined by calculating the sand/clay ratio based on lithologic logs from seven wells in different parts of the Banning and Cabazon Storage Units. The average sand/clay ratio is approximately 60/40 which when weighted to the corresponding aquifer materials results in an average effective porosity of approximately 17 to 20 percent. A conservative value of effective porosity of 15 to 17 percent was used to estimate ground water storage volume (see above table).

5.4.6 Water Quality

Water quality is considered very good in the Banning area, with current total dissolved solids (TDS) concentrations (Spring 2009) ranging from approximately 140 to 250 milligrams per liter (mg/L). Figure 11 shows the spatial distribution of TDS in the City of Banning water resource area. The variation of TDS concentrations in wells within close proximity to one another can likely be explained by storm events flushing out the surrounding valleys which have a variation in rock type and TDS concentrations. (See Appendix C for summary of selected water quality tabulated parameters).

Most other water quality concentrations, including nitrate (as NO_3), are currently under the maximum contaminant level (MCL) or action levels. Historically, the only constituents occurring above MCLs were iron and aluminum in most wells. Lead was also detected in Wells 5, 8, 11, 12 and C3 above the US EPA Treatment Technique value which requires systems to control the corrosiveness of their water. If more than 10% percent of tap water samples exceed the action level, water systems must take additional steps. Lead has not been detected above the Treatment Technique value in any wells since 2006 (see Appendix C). Fluoride was also detected above the Secondary MCL in Well C3 in March of 1994.

Water quality samples were taken during drilling and construction of Well R-1 in 1990 (see Figure 6 for location). Well R-1 is located 1,500 feet southeast of the City's Wastewater Treatment Plant. Four aquifer zone tests were conducted within the following intervals:

Zone 1 - 600 to 620 ft bgs,
Zone 2 - 550 to 570 ft bgs,
Zone 3 - 480 to 500 ft bgs, and
Zone 4 - 410 to 430 ft bgs.

The results of the water quality testing were reviewed for this investigation to assess whether secondary effluent from the WWTP was impacting the ground water quality in the aquifer. The results of the water quality testing are provided in Appendix C. Total dissolved solids (TDS) concentration in the lower three intervals is similar to that of other City of Banning Wells [which is lower than 250 mg/L]. TDS in Zone 4 (shallowest zone at 410-430 feet bgs) had a concentration exceeding the maximum contaminant level (MCL) of 500 mg/L. Additionally Iron exceeds the MCL in all zones and Manganese exceeds the MCL in Zone 4. However, the high iron and manganese concentrations may in part be due to adsorption onto fine sediment particles[9] due to sample collection from the zones. The USGS installed a nested monitoring well system (multiple wells screened at various depths) north of the City of Banning Wastewater Treatment Plant near the Interstate 10 Freeway (see Figure 6 for location). Ground water collected from Well 3S/1E - 11F4 screened between 600 and 610 feet bgs had a TDS concentration of 338 mg/L and elevated nitrate, iron, and manganese concentrations. (See water quality results in Appendix C). Ground water samples collected from screens below this depth had decreasing TDS concentrations with depth. The TDS concentrations ranged from 296 mg/L (680 ft bgs) to 232 mg/L (1,060 ft bgs).

According to Parsons (Parsons, 2008), the TDS ranged from 336 to 461 mg/L between 2004 and 2007 with an average of 379 mg/L during that period. These values are below the values detected during shallow zone testing suggesting that either TDS concentrations from the effluent were greater prior to 1990 or there is another source for the elevated TDS in the shallow portion of the aquifer. The incomplete record of ground water levels in City of Banning Well R1 does not allow assessment of the affect on ground water levels due to infiltration of wastewater in the Cabazon Storage Unit.

[9] More recent zone testing protocol developed by GEOSCIENCE uses 0.45 micron filters during field sample collection to eliminate the potential for elevated metals due to sediment in the sample water.

6.0 METHODOLOGY FOR DETERMINATION OF MAXIMUM PERENNIAL YIELD

Maximum perennial yield is defined as the maximum amount of ground water that can be extracted on an average annual basis without causing environmental damage or adverse impacts. This maximum amount is a function of the amount of ground water recharge that the aquifers receive from precipitation, underflow, artificial recharge, local irrigation and return flows on an average annual basis.

Calculation of maximum perennial yield involves relating geohydrologic and operational factors in a quantitative form. It requires a detailed understanding of the basin's inflow terms (including precipitation, infiltration, and other recharge), and outflow terms (including exploitation, evapotranspiration, and losses to the surface and/or adjacent ground water reservoirs). The reliability of any maximum perennial yield calculation is a direct function of the accuracy and comprehensiveness of the data available for the area, and any assumptions upon which the various calculations are based.

The methodology used to calculate the maximum perennial yield relied upon:

1) Complete and correct geohydrologic data (current and historical);
2) A thorough understanding of the geologic and hydrologic parameters for the study area; and
3) Independent maximum perennial yield calculations based on two methods, thereby allowing a comparison of safe yield estimates.

The following sections describe in detail the methodology used in determining the final safe yield estimates.

6.1 Data Collection

The data collection and compilation procedures were designed to ensure data accuracy and thoroughness. For this project, data collection consisted of two phases:

1) Obtaining historic data for municipal water purveyors and private water users within the study area (data obtained from CBPW, SGPWA and DHS); and
2) Supplementing the information with data from previous investigations (geologic and hydrologic) and other agencies within the area.

A rigorous date analysis and review was conducted. Where possible, both the original field data and the resulting tabular compilations and reports were obtained. This was done in order to identify mistakes and/or inconsistencies within the original data as well as to analyze estimations used during the original data collection. Data compilation consisted of three principal phases:

- Data entry (including updating and revising GEOSCIENCE's existing City of Banning area data);
- Data checking (to minimize typographical or data entry errors); and
- Analysis of data for incongruous and statistically inconsistent data.

The analysis phase of data compilation included identification of missing data and incorporation of estimates where actual data was not available.

6.2 Field Investigations

In 2003, GEOSCIENCE conducted a field investigation to accurately determine the coordinates of all the City of Banning wells. The well locations were determined using a global positioning system (GPS) which recorded the coordinates in North American Datum (NAD) of 1983. Two GPS units were utilized in order to verify each other, and thus ensure greater accuracy.

6.3 Initial Data Analysis

Initial data analysis consisted of delineation of hydrologic subunits (watersheds) and aquifers within the study area, and preparation of the geohydrologic basemap.

The hydrologic subunits were delineated using the hydrologic modeling extension for ArcView GIS. This hydrologic modeling extension provides functionality to delineate watersheds from a DEM (a grid data source representing elevation), and calculates physical and geometric properties of the subunits. The subunits to be used for this study have been named according to the associated creek (see Figure 9).

6.4 Calculation of Maximum Perennial Yield – Banning Storage Units

To estimate the amount of ground water development possible in the Banning Storage Units (Banning, Banning Bench and Banning Canyon), two methods of calculating maximum perennial yield were used in

the assessment for the City of Banning water resource area. Each method represents a varied approach, thereby resulting in a cross check on the final safe yield estimate.

The methods considered during the assessment of the maximum perennial yield were:

- Zero Net Draft Method; and
- Hill Method

The Zero Net Draft and Hill methods consider total production and its effect on water level elevations and are direct means to evaluation of the ground water conditions assessed based on extensive historical pumping and ground water level data.

6.4.1 Method of Zero Net Draft

The Method of Zero Net Draft (Chow, 1964) is a useful technique for estimating maximum perennial yield. This method involves plotting average depth to water for a selected period of time and comparing it to ground water production for the same period. If the mean ground water elevation at the beginning and end of the period is the same, the production during the period is taken as a measure of the maximum perennial yield.

6.4.2 Hill Method

The Hill Method (Chow, 1964) is a simplification of the Equation of Hydrologic Equilibrium. By plotting annual change in ground water elevations against annual draft, Hill measured the maximum perennial yield as the draft corresponding to a zero change in elevation. For the maximum perennial yield to be representative, using the Hill Method, the precipitation should approximate the long-term mean.

6.5 Calculation of Maximum Perennial Yield – Cabazon Storage Unit

The Zero Net Draft Method and the Hill Method were not used to evaluate the maximum perennial yield for the Cabazon Storage Unit because of the limited available historical pumping data and the limited availability of ground water level data representative of the entire storage unit. Therefore, an

Estimate of the maximum perennial yield for the Cabazon Storage Unit was developed using the equation of hydrologic equilibrium[10] namely:

INFLOW = OUTFLOW +/- CHANGE IN STORAGE

The hydrologic period selected for the water balance was the long term average represented by hydrologic conditions for the year 2003 (USGS, 2006). However, as data were available for the ground water pumping and recharge of treated wastewater from 2003 through 2009, these values were used. As this period was somewhat below normal, to be conservative, the highest values of pumping and average annual recharge of treated wastewater were used in the balance. As was done for the Banning Storage Units, the boundary for the Cabazon Storage Unit (used for this analysis) was obtained from the USGS - SIR 2006-5026 dated 2006.

6.5.1 Inflow terms for Water Balance

Inflow from Cabazon Basin consists of subsurface inflow from the Banning and Banning bench Storage Units, Mountain front and areal recharge from the upstream tributary drainages, and percolation of treated wastewater at the City of Banning Wastewater Treatment Plant.

6.5.1.1 Subsurface Inflow Banning Storage Unit

The underflow was calculated using the continuity equation and Darcian velocity:

$$Q=Av=Lb(K'/b')\,\Delta h / 119.34$$

where:

Q = subsurface flow [acre-ft/yr]

A = cross sectional area of flow area of flow [ft^2]

$v = K'\Delta h/b'$

L= length along boundary (ft) = 11,500 ft

b = saturated thickness (ft) = 740 ft

K'/b' = leakance[11] = 6.0×10^{-4} /day (Layer 1, at thickness 420 ft)

[10] Also known as a water balance, a hydrologic balance, or a water budget.

[11] Leakance values were obtained from USGS model values for Layers 1 and 2 along ground water barrier F6 (see Figure 39 and Table 10, USGS,2006)

$= 7.0 \times 10^{-4}$ (Layer 2 at thickness 320 ft)

Δh = change in hydraulic head across boundary (50 ft)

Using the above relationship and values, the underflow from the Banning Storage Unit to the Cabazon Storage Unit was calculated to be approximately 2,300 acre-ft/yr.

6.5.1.2 Subsurface Inflow Banning Bench Storage Unit

Underflow estimates through the alluvium at the mouth of Banning Canyon and across the fault which forms the eastern storage unit boundary between Banning Bench and Cabazon Storage Units was again, calculated using continuity equation and Darcian velocity for calculating underflow.

The underflow at the mouth of Banning Canyon at the boundary of the Cabazon Storage Unit:

$$Q = Av / 119.34,$$

where:

Q = subsurface flow [acre-ft/yr]

v = Kdh/dx

K = hydraulic conductivity (10 ft/day)[12]

dh/dx = hydraulic gradient (0.05)

A = cross sectional area of flow (60,000 ft^2)

Using the relationship and values above, the subsurface outflow from the Banning Bench Storage Unit at the mouth of Banning Canyon was estimated to be approximately 250 acre-ft/yr.

Subsurface outflow leaking across the fault at the storage unit boundary east of the mouth of Banning Canyon was estimated using the continuity equation and Darcian velocity:

$$Q=Av=Lb(K'/b') \Delta h / 119.34$$

[12] Table 10, USGS 2006

where: Q = subsurface flow [acre-ft/yr]

A = cross sectional area of flow (L x b)[ft^2]

v = K'Δh/b'

L= length of fault boundary (11,500 ft)

b = saturated thickness (40 ft)

K'/b' = leakance (6.5×10^{-4}/day)[13]

Δh = change in hydraulic head across boundary (40 ft)

Using the above equation and values, the underflow along the eastern portion of the Banning Bench Storage Unit to the Cabazon Storage Unit was estimated to be approximately 100 acre-ft/yr. The total underflow from the Banning Bench into the Cabazon Storage Unit was estimated to be approximately 350 acre-ft/yr (250 acre-ft/yr + 100 acre-ft/yr).

6.5.1.3 Mountain Front Runoff and Areal Recharge from Upstream Tributary Drainages

Mountain front runoff and areal recharge were estimated based on the weighted average precipitation falling within the Cabazon Storage Unit and tributary catchment areas. The Calibrated USGS model (SIR-2006-5026) estimated mountain front recharge within the USGS model area to be 2,674 acre-ft/yr over a catchment area of 17,442 acres. This is approximately 8% of the weighted average annual rainfall for the model watershed area (21.9 inches per year).

The watershed areas for the upstream drainages were determined using GIS (see Section 5.1) and are shown on Figure 9. The area of each tributary watershed is tabulated on Table 4. The weighted average annual rainfall for the total watershed areas tributary to Cabazon Storage Unit was calculated to be 130,755 acre-ft[14]. The mountain front and areal recharge contribution to the water balance was estimated as 8% of the weighted average annual precipitation over the watershed, or 10,460 acre-ft/yr.

[13] Average of 6.0×10^{-4}/day for Layer 1 and 7.0×10^{-4}/day for Layer 2.

[14] Although the Banning Canyon Watershed is tributary to the Cabazon Storage Unit, it was not included in this calculation since underflow from Banning Canyon/ Banning Bench is treated as a separate underflow inflow term to the Cabazon Storage Unit.

6.5.1.4 Infiltration of Wastewater Flows

For the years 2000 through 2009, the average annual volumes of wastewater flows of 2,655 acre-ft/yr was used as the inflow term in the water balance (See Section 3.3.3).

6.5.2 Outflow Terms for Water Balance

Outflow from Cabazon Basin consists of ground water pumping and subsurface outflow to the Indio Subbasin and outflow to the San Jacinto Tunnel.

6.5.2.1 Ground Water Pumping

Table 3 provides a tabulation of ground water pumping from the Cabazon Storage Unit, including pumping from Potrero and Millard Canyons which are tributary to the Cabazon Storage Unit. The greatest amount of pumping from the Cabazon Unit occurred in 2007 and was approximately 4,160 acre-ft. Average production for the period from 2003-2009 is approximately 3,360 acre-ft/yr. The ground water pumping values are approximate, as the Morongo Tribe does not report their annual pumping volumes.

6.5.2.2 Subsurface Outflow to Indio Subbasin

The California Department of Water Resources estimates that underflow from the Cabazon Storage Unit to the Indio Subbasin is approximately 9,000 acre-ft/yr (USGS, 1978, 1992, DWR, 2004).

6.5.2.3 Subsurface Outflow to San Jacinto Tunnel

As stated previously, although the tunnel has been constructed in bedrock and is lined with concrete, an estimated 1,500 acre-ft/year of ground water seeps into the tunnel from the west portion of the Cabazon storage unit (33% of the total 5,000 acre-ft per year tunnel seepage; Boyle, 1995; personal communication, FlowScience, 2001).

7.0 ESTIMATES OF MAXIMUM PERENNIAL YIELD

This section presents the summary of analyses and the results of the maximum perennial yield estimates for the four Storage Units included in this study:

1) Banning Storage Unit,
2) Beaumont Storage Unit,
3) Banning Bench Storage Unit, and
4) Cabazon Storage Unit.

7.1 Banning Storage Unit

The Banning Storage unit lies south of the Banning Bench Storage Unit and east of the Beaumont Storage Unit (see Figure 1). The total surface area is approximately 2,489 acres. The area is underlain by alluvial sediments, with bedrock occurring to the north in the San Bernardino Mountains. The City of Banning currently operates four active production wells within the Banning Storage Unit, Wells M10, M11, M12 and C-5. The City of Banning estimates a design capacity of 3,500 gpm for the above mentioned wells based on historical water use records (Banning, 2010).

7.1.1 Zero Net Draft Method – Banning Storage Unit

Figure 12 shows a plot of ground water levels and annual pumping from wells in the Banning Storage Unit (Wells M10, M11, M12 and C-5). A review of Figure 12 indicates that ground water levels in December 2003 were similar to levels in December 2009 (see Appendix B). During this period, the average annual ground water production was 1,582 acre-ft/year.

7.1.2 Hill Method – Banning Storage Unit

Figure 13 shows a plot of the average annual change in ground water elevations in the Banning Storage Unit Production Wells (Well M10, M11, M12 and C-5) versus annual extraction within the Storage Unit. As shown on the figure, the maximum perennial yield was calculated using the best-fit line through the data, namely:

$$y = -0.0067x + 4.5282$$

where:

y = Annual Change in Ground Water Elevation [ft]

x = Annual Extraction [acre-ft]

Using this method, the maximum perennial yield is estimated as the production for an average water level change of zero (i.e. y = 0), or 676 acre-ft/year (4.5282/0.0067).

7.2 Banning Bench Storage Unit

The Banning Bench Storage Unit is located to the north of the Banning Storage Unit (see Figure 1). The total surface area of the storage unit is approximately 3,753 acres. The City of Banning currently operates three production wells within the Banning Bench, Wells 1, 2 and 3 with a total design capacity of 3,650 gpm, based on historical water use records (Banning, 2010)..

7.2.1 Zero Net Draft Method – Banning Bench Storage Unit

Ground water levels from City of Banning Wells 1, 2 and 3 located within the Banning Bench Storage Unit were used to evaluate the historic time period when the ground water levels were similar. City of Banning Wells 1, 2 and 3 indicate that ground water elevations in January 1979 and December 2009 were similar (see Appendix B). The average annual ground water production within the Banning Bench Storage Unit during this time period was approximately 1,982 acre-ft/year (see Figure 14).

7.2.2 Hill Method – Banning Bench Storage Unit

Figure 15 shows a plot of the average annual change in ground water elevations in the Banning Bench Storage Unit Production Wells (Well 1, 2, and 3,) versus annual extraction within the Storage Unit. As shown on the figure, the maximum perennial yield was calculated from the best-fit line through the data:

y = -0.0046x + 8.8834

where:

y = Annual Change in Ground Water Elevation [ft]

x = Annual Extraction [acre-ft]

The maximum perennial yield was estimated as the annual extraction corresponding to a zero change in ground water elevation, or approximately 1,931 acre-ft/year (8.8834/0.0046).

7.3 Banning Canyon Storage Unit

The Banning Canyon Storage Unit is located to the north of the Banning Bench Storage Unit (see Figure 1). The total surface area of the Storage Unit is approximately 1,058 acres. The primary surface water drainage feature within this Storage Unit is the San Gorgonio River. The canyon bottom comprises alluvium and the canyon sides are bedrock. Most of the City of Banning's ground water is produced from the aquifer within this subunit. The City of Banning estimates a design capacity of 8,600 gpm for the above mentioned wells based on historical water use records (Banning, 2010).

7.3.1 Zero Net Draft Method - Banning Canyon Storage Unit

Representative wells within the Banning Canyon Storage Unit were used to evaluate the time period when the ground water levels were similar. Ground water level plots for City of Banning Wells 4, 5, 6, 7, 8, 9, 10, 11 and 12 indicate that the ground water elevations in January 1984 and December 2000 were similar (see Appendix B). The average annual ground water production within the Storage Unit during this time period was approximately 4,310 acre-ft/year (see Figure 16).

7.3.2 Hill Method – Banning Canyon Storage Unit

Figure 17 shows a plot of the average annual change in ground water elevations in the Banning Canyon Storage Unit Production Wells (Well 4, 5, 6, 7, 8, 9, 10, 11 and 12) versus annual extraction within the Storage Unit. As shown on the figure, the maximum perennial yield was calculated from the best-fit line through the data:

$$y = -0.0054x + 20.678$$

where:

y = Annual Change in Ground Water Elevation [ft]

x = Annual Extraction [acre-ft]

The maximum perennial yield was estimated as the annual extraction corresponding to a zero change in ground water elevation, or approximately 3,829 acre-ft/year (20.678/0.0054).

7.4 Hydrologic Budget – Cabazon Storage Unit

Ground water recharge to the Cabazon Storage Unit is obtained from precipitation infiltrating into the ground within the surface water catchments tributary to the unit and from subsurface inflow from the Banning and Banning Bench/Canyon Storage Units. Percolation of secondary treated wastewater from the City of Banning Wastewater Treatment Plant in also included as a recharge term. Outflow terms include pumping, and subsurface outflow to the Indio area.

7.4.1 Inflow Terms – Cabazon Storage Unit

Ground water recharge to the Cabazon Storage Unit is from precipitation infiltrating within surface water catchments tributary to the unit as well as subsurface inflow from the Banning and Banning Bench/Canyon Storage Units. Percolation of secondary treated wastewater from the City of Banning's Wastewater Treatment Plant in also included as a recharge term.

7.4.1.1 Inflow Terms

- Subsurface inflow from the Banning Storage Unit was calculated using hydrologic parameters provided in USGS (2006) for 2003 average year conditions (approximately 2,300 acre-ft/yr).
- Subsurface inflow from the Banning Bench/Canyon Storage Units (was estimated from an underflow calculation through the alluvium of Banning Canyon) (approximately 350 acre-ft/yr).
- Mountain front runoff and areal recharge to all watersheds tributary to the Cabazon Storage Unit was estimated based on 8% of the weighted average annual precipitation for the Cabazon Storage Unit and tributary drainage areas (10,460 acre-ft/yr).
- Percolation of treated wastewater (i.e. secondary Effluent from the City of Banning Wastewater Treatment Plant between 1999 - 2009 (2,655 acre-ft/yr).

TOTAL AVERAGE INFLOW = approximately 15,765 acre-ft/yr

7.4.2 Outflow Terms – Cabazon Storage Unit

Ground water outflow from the Cabazon Storage Unit includes ground water pumping, subsurface outflow to the Indio Subbasin, and subsurface outflow to the San Jacinto Tunnel. The ground water outflow terms are summarized below:

7.4.2.1 Outflow Terms

- Annual ground water pumping for the Cabazon Storage Unit, and Millard and Potrero Canyons (3,460 acre-ft/yr)[15].
- Subsurface outflow to the Indio Subbasin (9,000 acre-ft/yr).
- Outflow to the San Jacinto Tunnel (1,500 acre-ft/yr).

TOTAL AVERAGE OUTFLOW = 14,600 acre-ft/yr

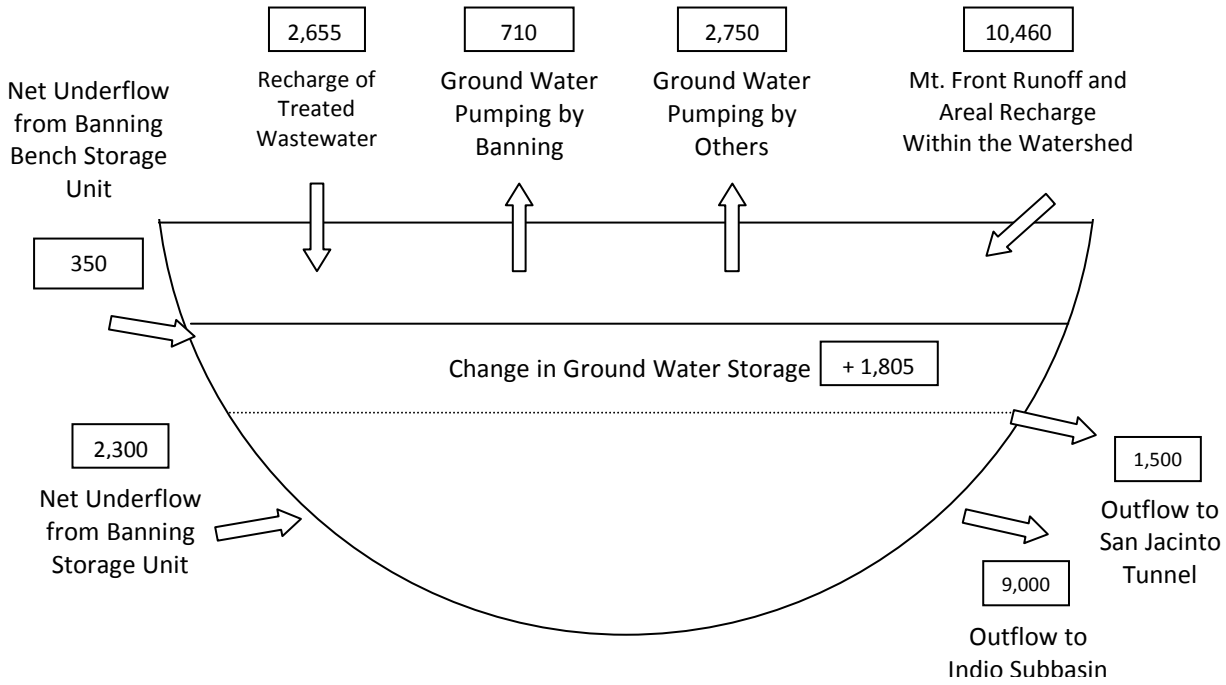
Hydrologic Budget - Cabazon Storage Unit
Acre-ft/yr

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
INFLOW					OUTFLOW			
Underflow from Banning Storage Unit	Underflow from Banning Bench Storage Unit	Mountain Front Runoff and Areal recharge	Recharge of Treated Wastewater	Total Inflow	Subsurface Outflow to Indio Subbasin and the San Jacinto Tunnel	Ground Water Pumping	Total Outflow	Average Annual Change in Storage
2,300	350	10,460	2,655	15,765	10,500	3,460	13,960	1,805

Note:
[1] Determined from 2003 USGS Modeled outflow for the Banning Storage Unit.
[2] Calculated underflow across the storage unit boundary at Banning Canyon and underflow across the mountain front fault along the storage unit boundary.
[3] Basin recharge estimated as 8% of the average annual precipitation in the Cabazon Storage Unit and the upstream watersheds.
[4] Percolation of secondary treated wastewater from the City of Banning Wastewater Treatment Plant.
[5] = [1] + [2] + [3] + [4].
[6] DWR Bulletin 118 *San Gorgonio Pass Ground Water Basin 2004.*
[7] Average ground water extraction from the Cabazon Storage Unit, and Millard and Potrero Canyons.
[8] = [6] + [7].
[9] = [5] - [8].

[15] Based on the average pumping during the period 2003 to 2009.

Average Hydrologic Balance
Cabazon Storage Unit
(Acre-ft/yr)



7.4.3 Change in Storage

Review of historical ground water levels and historical precipitation for the Cabazon Storage Unit indicates that ground water levels closely follow the pattern of rainfall (see Figure 10 and Hydrographs in Appendix B). Ground water level records for Wells 3S/3E–7M1 and 8M1 for periods ranging from 1946 through 2009 (which includes wet, dry and average precipitation) show that ground water levels decline during dry periods and rise during wet periods. Overall, the long-term change in ground water in storage (based on the hydrographs and precipitation – see Appendix B) appears to remain the same (i.e. no long-term declines or increases).

7.4.4 Additional Water Supply from the Cabazon Storage Unit

Available water supply from the Cabazon Storage Unit above existing production is approximately 1,805 acre-ft/yr (on average). The City of Banning Well C-6 annually extracts approximately 710 acre-ft/yr on average since it came online in 2004. The City estimates that the total design capacity for Well C-6 is 900 gpm or 1,450 acre-ft/yr based on historical production records (City of Banning, 2010). If the City utilizes Well C-6 at full capacity (1,450 ac-ft/yr) an additional 350 acre-ft/yr is available if an additional well is constructed. The closest non-City of Banning pumping well to Well R-1 is located approximately one mile away. Based on a storage coefficient of between 0.15 and 0.17 and a transmissivity of 49,900 gpd/ft[16], additional pumping from R-1 could result in an drawdown at the closest well of approximately 1.2 to 1.4 feet after one year of continuous pumping from R-1. This additional drawdown would not result any significant impact to the well or operation of the well. If an additional well is constructed to maximize use of the Cabazon Storage Unit for ground water development, the well can be located so as to not result in impacts to existing wells.

Additional water supply for the Cabazon Storage Unit may also be developed by reducing subsurface outflow to the Indio Subbasin. This could be achieved using a series of wells which changes hydraulic gradients near the eastern Cabazon Storage Unit boundary and reduces ground water flowing eastward to the Indio Subbasin. For example, if hydraulic control is achieved whereby an average subsurface outflow to the Indio Subbasin is reduced by 25%, an additional 2,250 acre-ft/yr of potential production could be available in the Cabazon Storage Unit. This amounts to an additional annual extraction of approximately 4,055 acre-ft/yr above the existing production without causing a long-term decline in storage.

[16] GEOSCIENCE, 1991

8.0 ANTICIPATED FUTURE WATER SUPPLY BEAUMONT BASIN

Pursuant to the Beaumont Basin Judgment (Superior Court of the State of California for the County of Riverside, 2004), the City has the right to pump 5,910 acre-ft annually (see Appendix D) until the year 2014 at which time the Beaumont Basin Watermaster shall re-evaluate the safe yield of the basin. The allotted 5,910 acre-ft/yr pumping rights to the City of Banning is comprised of:

- 882 acre-ft/yr which is 31.43% of the remainder of the Beaumont Basin safe yield (8,650 acre-ft/yr) is an initial estimate of appropriative rights (see Column 4 of Exhibit C of the Judgment) after appropriations by overlying producers (5,845 acre-ft/yr) and,
- 5,029 acre-ft/yr which is 31.43% of the controlled overdraft/temporary surplus or annual operating yield of 16,000 acre-ft/yr for a total of 160,000 acre-ft over the ten year period of 2004 to 2014.

If the overlying producers increase or reduce production in the future, or if water districts provide direct service to the appropriators within their service areas, then the City's 882 acre-ft/yr will change. In the Sixth Annual Report of the Beaumont Basin Watermaster, dated April 2010, it was reported that less water has been extracted from the basin than anticipated. In addition, the Beaumont Basin Watermaster Biennial Engineer's Report – July 2003 through June 2008, states that the estimated safe yield of the basin may be approximately 10,290 acre-ft/yr[17] rather than the 8,650 acre-ft/yr, which was stipulated as the initial estimate in the Judgment for the first 10-year period. However, a change in the safe yield for Beaumont Storage Unit can only occur after re-evaluation of the basin by the Watermaster scheduled every 10 years.

Table 5 of the Sixth Annual Beaumont Basin Watermaster Report, 2010 states that the City of Banning has an allocation of unused overlying water of 1,405, 1,645, 1,659, 1,618, 1,830, and 1,805 acre-ft for the years 2008/09, 2009/10, 2010/11, 2011/12, 2012/13, and 2013/14 respectively. These values are derived from 31.43% of the actual amount produced by the overlying producers from the period 2003/04 to 2007/08 (5 years) and applied at the beginning of the subsequent 5- year period. The

[17] Page 4-4, Biennial Engineers Report – July 2003 through June 2008, Beaumont Basin Watermaster

following table provides an estimate of the projected volume of the City of Banning ground water in storage within the Beaumont Basin which is their estimated production right.

The City of Banning's
Ground Water in Storage within the Beaumont Basin (Production Right)

Year	Appropriative Rights After Overlying Producers[1]	Controlled Overdraft of Annual Operating Yield[2]	Recharge of SWP[3]	Banning Production from Beaumont Storage Unit[4]	Transfers Among Appropriators[5]	Estimated Total Water in Storage[6] (Production Right)
2004	0	5,029	0	3,605		1,424
2005	0	5,029	0	1,879		4,575
2006	0	5,029	0	2,012	1,500	9,092
2007	0	5,029	0	2,962		11,159
2008	0	5,029	0	3,417		12,771
2009	1,492	5,029	1,200	2,355		18,138
2010	1,645	5,029	1,200	1,372		24,640
2011	1,659	5,029	1,298	2,514		30,111
2012	1,618	5,029	1,298	2,514		35,541
2013	1,830	5,029	1,298	2,514		41,184
2014	1,805	0	2,595	2,514		43,069
2015	1,805	0	2,595	2,514		44,955
2016	1,805	0	2,595	2,514		46,841
2017	1,805	0	2,595	2,514		48,726
2018	1,805	0	2,595	2,514		50,612
2019	1,805	0	2,595	2,514		52,498
2020	1,635	0	2,595	2,514		54,214
2021	1,613	0	2,595	2,514		55,907
2022	1,591	0	2,595	2,514		57,579
2023	1,569	0	2,595	2,514		59,229
2024	1,547	0	2,595	2,514		60,856
2025	1,478	0	2,595	2,514		62,415
2026	1,456	0	2,595	2,514		63,952
2027	1,434	0	2,595	2,514		65,466
2028	1,411	0	2,595	2,514		66,958
2029	1,389	0	2,595	2,514		68,428
2030	1,328	0	2,595	2,514		69,837
2031	1,306	0	2,595	2,514		71,223
2032	1,284	0	2,595	2,514		72,588
2033	1,262	0	2,595	2,514		73,931
2034	1,240	0	2,595	2,514		75,251
2035	1,194	0	2,595	2,514		76,526

- It should be noted that there is a discrepancy between the reported City of Banning unused overlying water right allocation in 2009 as reported by the Sixth Annual Beaumont Basin Watermaster Report (1,405 acre-ft) and the value of 1,492 acre-ft as listed in the Draft Beaumont Management Zone Maximum Benefits Program Modeling Scenarios, 2011 Appendix A-3.

1 Projected allocation of pumping rights per Appendix A-3 ("Projected Allocation of Pumping Rights for the 2004 Beaumont Basin Judgment") of the Draft Beaumont Management Zone Maximum Benefits Program Modeling Scenarios, prepared by Wildemuth Environmental, Inc. dated March 18, 2011.

[2] Controlled overdraft assigned by the Beaumont Basin Judgment for the ten year period 2004 through 2012 (Exhibit C in Appendix D).

[3] State Water project purchases reported by Watermaster for 2009 year. Values for purchases for 2010 year provided by the City of Banning. Projected Purchases (2011-2035) assumed to be 25% of annual delivery to SGPWA anticipated by the SWP Reliability Report (60% of the maximum annual delivery of 8,650 acre-ft per year until 2013, when EBXII is assumed be online, 17,300 will be accessible).

[4] City of Banning production as reported by the City of Banning for years 2004-2010 which includes water received from BCVWD, extracted from the Beaumont Storage Unit. For years 2011 through 2020, City of Banning pumping is assumed at the average annual pumping value 2,514 acre-ft/yr.

[5] Transfer reported by Watermaster in the Sixth Annual Report of the Beaumont Basin Watermaster dated 2010.

[6] Sum of columns 1, 2, 3 and 5 minus column 4, the product is added to the previous year Estimated Total Water in Storage.

For the purposes of providing projected water supplies from the Beaumont Basin, it is anticipated that the City will extract an average of 2,514 ac-ft/yr, (average City production since adjudication in 2004, as reported by the City of Banning, 2011) however, as demand increases, additional water will be extracted as needed from the Beaumont Storage Unit to meet demand.

Watermaster is required by law[18] to re-determine the safe-yield of the Beaumont basin at least every 10 years beginning 10 years after the date of the entry of the Judgment (2004) or at the year 2014. Pursuant to the Judgment, the City is allowed to pump sufficient water from the Beaumont Basin in order to meet its water demand. Should this amount exceed the City's rights, the Beaumont Basin Watermaster has an obligation to replenish the overproduction.

8.1 The City of Banning's Current and Projected Ground Water Supply

The following table summarizes the current and projected available water supply from the Banning, Cabazon and Beaumont Storage Units available to the City of Banning as well as projected available water supply in 2014. Available water supply for the Beaumont Basin beyond 2014 will be a function of:

1. Ground water recharge credit,
2. The amount of pumping by overlying producers, and
3. The remaining operating yield available to the City.

[18] Beaumont Basin Judgment, VI Administration (5)(Y)

However, the following table provides an estimate of potential water supply from the Beaumont Storage Unit based on accruing an amount of ground water in storage from the un-used portion of ground water from adjudicated rights in the Beaumont Storage Unit.

CITY OF BANNING CURRENT AND PROJECTED GROUND WATER SUPPLY

(AVERAGE YEAR CONDITIONS)

Storage Unit	Year 2010	Year 2015
Banning	1,130	1,130
Banning Bench	1,960	1,960
Banning Canyon	4,070	4,070
Cabazon	2,515[19]	2,515
Beaumont	2,514[20]	2,514
Beaumont Basin - Recharge (SWP)	**1,200**[21]	**2,595**[22]
Total Ground Water Supply Per Year	**13,368**	**14,793**

[19] Cabazon Production includes approximately 1,805 acre-ft/yr of potential additional pumping reported in this technical memorandum and 710 acre-ft/yr which has been the average annual production from the City of Banning Well C-6 (as reported by the City of Banning)
[20] City of Banning production as reported by Watermaster in the Sixth Annual Report of the Beaumont Basin Watermaster dated 2010. For years 2011 through 2035, City of Banning pumping is assumed at the average annual pumping value (2,514 acre-ft/yr).
[21] 2010 City of Banning purchases of SWP water from SGPWA to recharge in the BCVWD spreading grounds on Noble Creek.
[22] Projected values assume Banning will receive 25% of SWP water received by the SGPWA, DWR SWP Reliability Report estimates SGPWA will receive 60% of the maximum annual delivery. SGPWA is entitled to 8,650 acre-ft per year until 2013 (when EBXII is assumed to be online) when the full allotment of 17,300 acre-ft/yr can be utilized.

9.0 SUMMARY AND RECOMMENDATIONS

9.1 Summary

The table below provides a summary of the available water supply to the City of Banning. The water supply from the Banning Storage Units (Banning, Banning Bench, and Banning Canyon) represents the maximum perennial yield for those storage units since the City of Banning is the major producer in those storage units. The available water supply from the Cabazon Storage unit represents additional water supply that can be developed from the storage unit as determined from this study (see Section 7.4).

AVAILABLE WATER SUPPLY FROM BANNING STORAGE UNITS

AND CABAZON STORAGE UNIT

Acre-ft/year

Storage Unit	Zero Net Draft	Hill Method	Hydrologic Budget	Average
Banning	1,580	680	N/A	1,130
Banning Bench	1,980	1,930	N/A	1,960
Banning Canyon	4,310	3,830	N/A	4,070
Total of All Banning Storage Units	**7,870**	**6,440**	**N/A**	**7,160**
Cabazon	**N/A**	**N/A**	**2,515**[23]	**2,515**

[23] The water supply available to the City of Banning from the Cabazon Storage Unit equals average production from Well C-6 (710 acre-ft/yr) plus the average annual change in storage of 1,805 acre-ft/yr.

- The average maximum perennial yield for the Banning Storage Units (Banning, Banning Bench and Banning Canyon) is approximately 7,160 acre-ft/yr. Production within these Storage Units for 2009 is approximately 6,500 acre-ft.
- The Hydrologic Budget for the Cabazon Storage Unit indicates that approximately 1,805 acre-ft/yr above current ground water production might be available for future development. Current production within the Cabazon Storage Unit is approximately 3,460 acre-ft for 2009, of which 710 acre-ft/yr is by the City of Banning.
- Ground water level records taken from the Cabazon Storage Unit for periods ranging from 1946 through 2009 (which includes wet, dry and average precipitation) show that ground water levels decline during dry periods and rise during wet periods.
- Overall, the long-term change in ground water in storage for the Cabazon Storage Unit (based on the hydrographs and precipitation) appears to remain the same (i.e. no long-term declines or increases).
- Further ground water development can take place in the Cabazon Storage Unit to achieve hydraulic control to decrease the amount of outflow to the Indio Subbasin.
- The Beaumont Basin Watermaster report, dated April 2010, reported that less water has been extracted from the basin than anticipated. An estimated safe yield of the basin may be approximately 10,290 acre-ft/yr, which could result in a greater allocation of water to the City of Banning.
- The amount of ground water in storage within the City of Banning area, not including the Beaumont Storage Unit which falls within the City of Banning water resource area, is estimated to be approximately between 1.1 – 1.2 million acre-ft.

9.2 Recommendations

- To increase the available water supply, continuing and/or increasing the diversion of water from the Whitewater River into the Banning Canyon from the Flume (Canyon subunit) should be pursued. A maximum water right of 13.26 cfs exists for the diversion.
- Diversions to Banning Canyon should be gauged as well as diversion from the San Gorgonio River into the off-stream recharge basins in Banning Canyon.

- The ground water levels in Well R-1 should be included as part of the monitoring effort of the City of Banning. In addition, ground water quality data should be collected on an annual basis to allow development of ground water quality trends in this area of the Cabazon Storage Unit.
- Ground water pumping should be managed in order to develop a continuing history of ground water extractions in the unadjudicated storage units of the San Gorgonio Pass Ground Water Basin (Banning, Banning Bench, Banning Canyon, and Cabazon Storage Units).
- Potential capture of stormwater run-off from mountain front watersheds as well as capture of urban run-off should be included in long-term planning for development of additional water supply.
- For the future, managing the ground water basin through an annual ground water audit should be considered for long-term planning and operation. This process involves evaluating ground water level trends, production rates, ground water quality or other aquifer/well/pump considerations from the previous year (through use of a on-going ground water monitoring and data collection system). The water audit should be performed six months prior to the start of the water accounting year, and information from this audit will be used to make recommendations for pumping in the following year.[24] This management approach focuses more on maintaining ground water levels within acceptable limits rather than maintaining pumping within a predetermined safe yield; although refinement of the safe yield is part of the audit process.
- Future ground water management strategy should include development of a ground water model to allow accurate simulation of ground water flow and ground water quality (including potential impacts by recharge of recycled water) in the City of Banning ground water resource area.

[24] Typical water accounting years may be the "actual" water year, October 1 to September 30 or, fiscal years such as July 1 to June 30.

10.0 REFERENCES

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FIGURES

GEOSCIENCE

CITY OF BANNING

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN

T.1 S.
T.2 S.
T.2 S.
T.3 S.

San Bernardino County
Riverside County
San Bernardino Mountains
Plume
CANYON STORAGE UNIT
BANNING BENCH STORAGE UNIT
BEAUMONT STORAGE UNIT
BANNING STORAGE UNIT
CABAZON STORAGE UNIT
INDIO STORAGE UNIT
Beaumont
Banning
Cabazon
San Jacinto Mountains
San Jacinto Tunnel
Colorado River Aqueduct
Dutton St
Nicolet St
Bellflower Ave
Brookside Ave
Mesa St
Bluff St
Oak Valley Pkwy
Highland Springs Ave
Sunset Ave
E 8th St
E 6th St
Ramsey St
W Wilson St
E Wilson St
E George St
E Ramsey St
W Ramsey St
E Lincoln St
W Westward Ave
S 22nd St
N San Gorgonio Ave
N Hargrave St
N Hathaway St
E Repplier Rd
Morongo Rd
Field Rd
Seminole Dr
Apache Trl
Main St
Bonita Ave
Broadway St
Indian St
Cottonwood Dr
Fun Lakes Blvd
10
243

R.1 W. | R.1 E. | R.1 E. | R.2 E. | R.2 E. | R.3 E.

REGIONAL SETTING

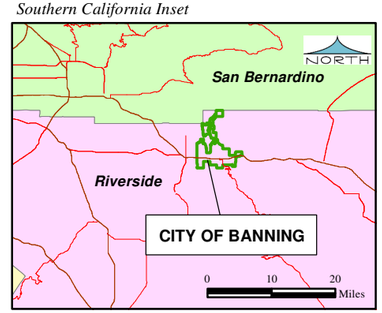
EXPLANATION

- City of Banning Boundary
- County Boundary
- Colorado River Aqueduct
- San Jacinto Tunnel

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon
- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

Southern California Inset



NORTH
0 3,500 7,000 Feet

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

Source of Data:
Faults Modified from R.M. Bloyd, Jr.
USGS Water Supply Paper 1999-D, Plate 1, 1971., and
USGS Scientific Investigation Report 2006-5026, Figure 2, 2006.

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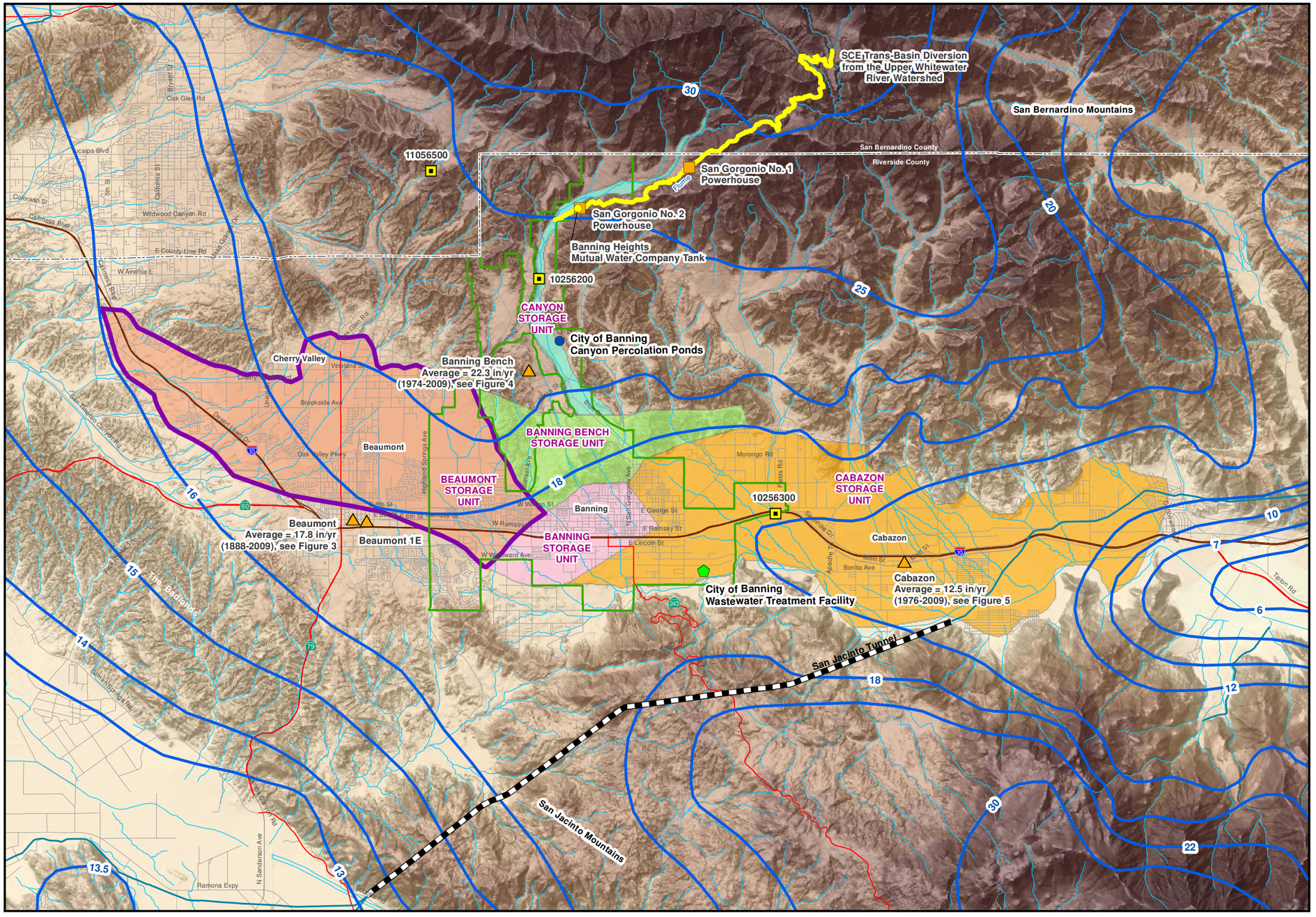
GEOSCIENCE Support Services, Inc.
P.O. Box 220, Claremont, CA 91711
Tel: (909) 451-6650 Fax: (909) 451-6638
www.gssiwater.com

Figure 1

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_1_regional_setting_3-11.mxd

CITY OF BANNING

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN



AVERAGE ANNUAL ISOHYETALS PRECIPITATION AND GAGING STATIONS

EXPLANATION

14 — Mean Annual Precipitation (inches)

Note: Isohyetal map was generated using data from water years 1955-56 to 1979-1980 (Riverside County Flood Control and Water Conservation District, 1983).

Note: See Appendix A for annual precipitation and Figures 3-5 for cumulative departure from mean precipitation for Beaumont Weather Stations.

Cabazon — Riverside County Flood Control and Water Conservation District Weather Station

10256200 — USGS Gaging Station and Site Number

City of Banning Boundary

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon

Adjudicated Ground Water Boundary

County Boundary

Aqueduct

San Jacinto Tunnel

SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

NORTH

0 5,500 11,000 Feet

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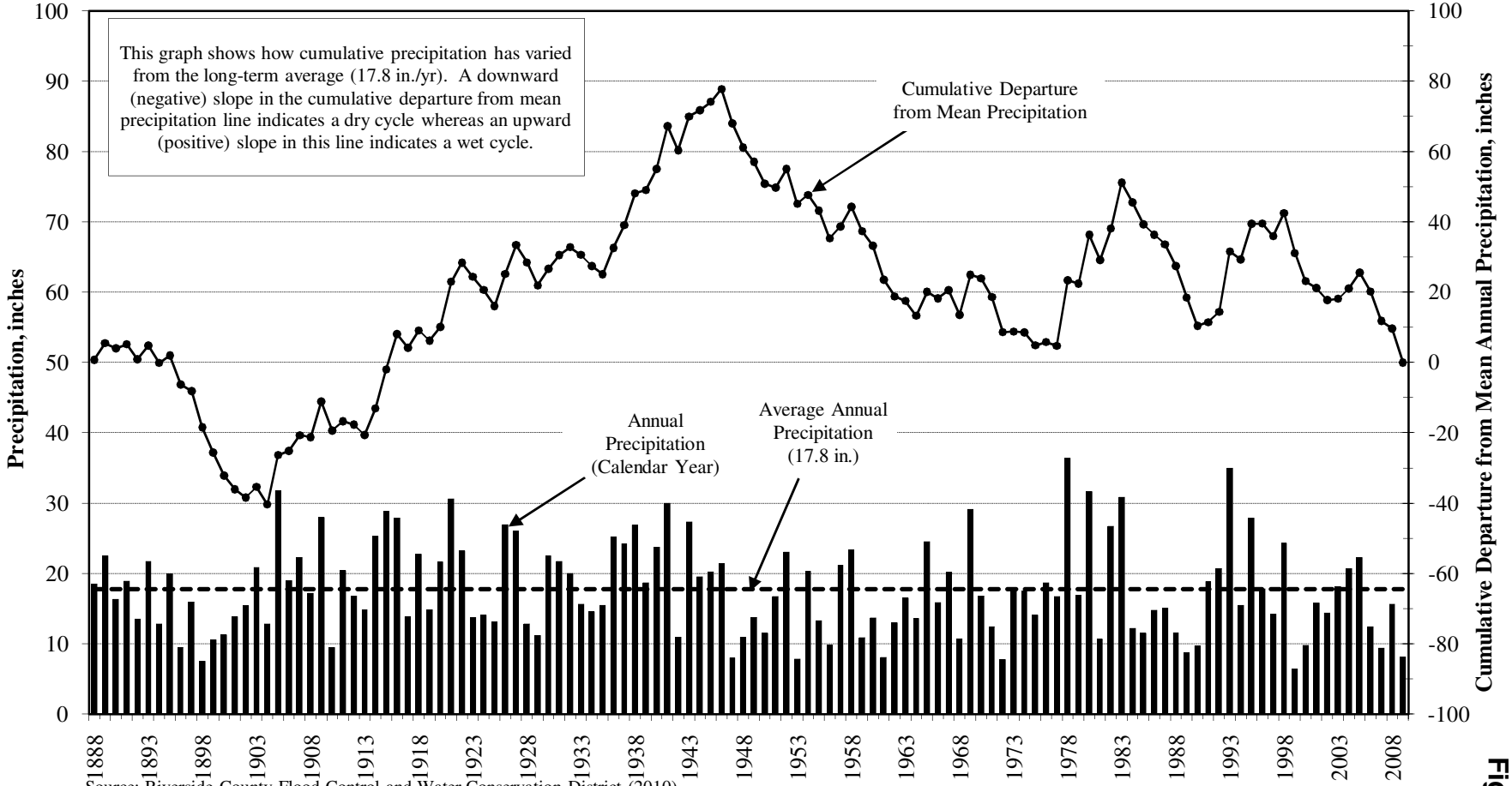
Figure 2

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_4_isohyetals_3-11.mxd

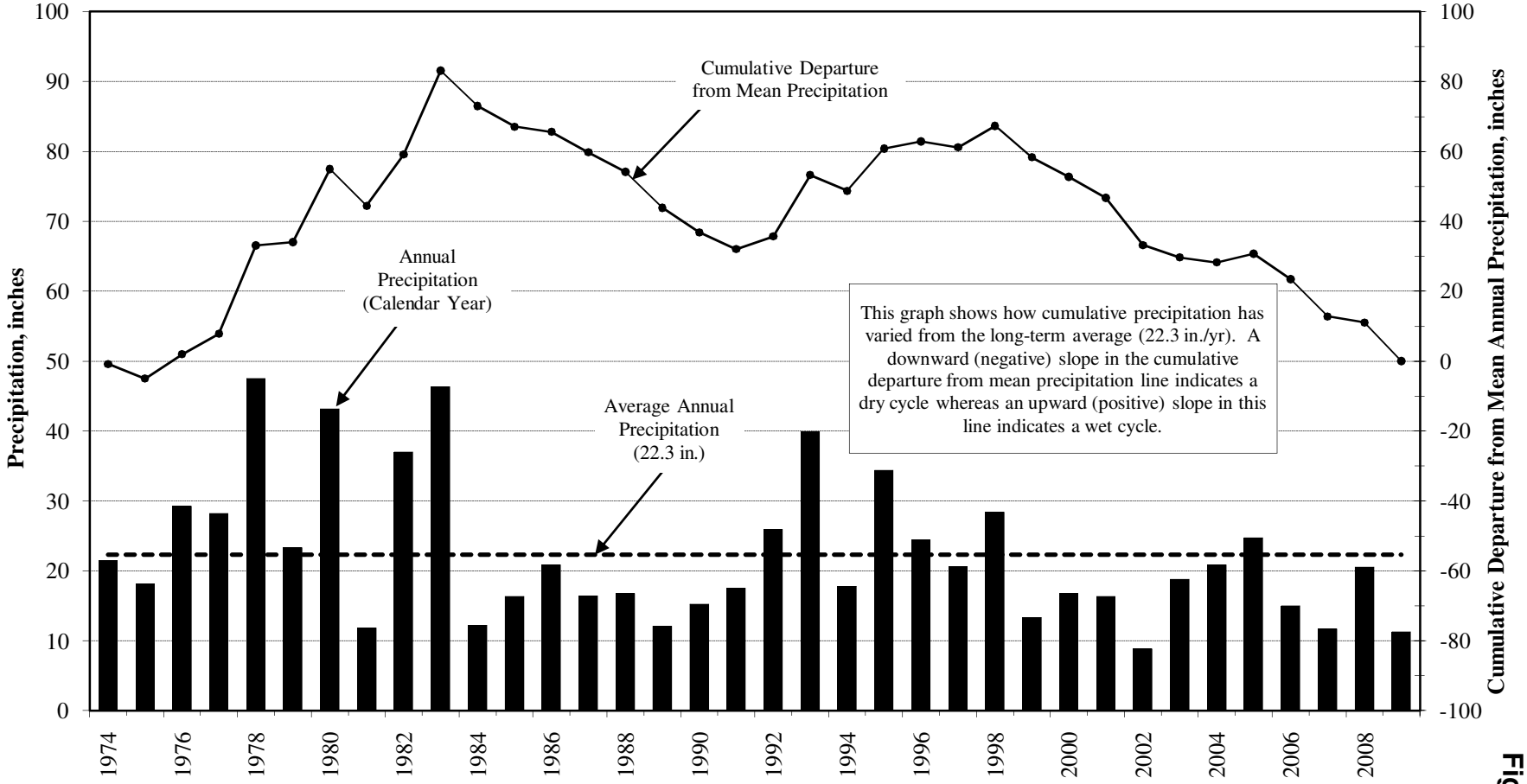
Annual Precipitation and Cumulative Departure From Mean Annual Precipitation
Beaumont Weather Station #013
(1888 to 2009)



Source: Riverside County Flood Control and Water Conservation District (2010).
Note: Data are presented in calendar years.

Figure 3

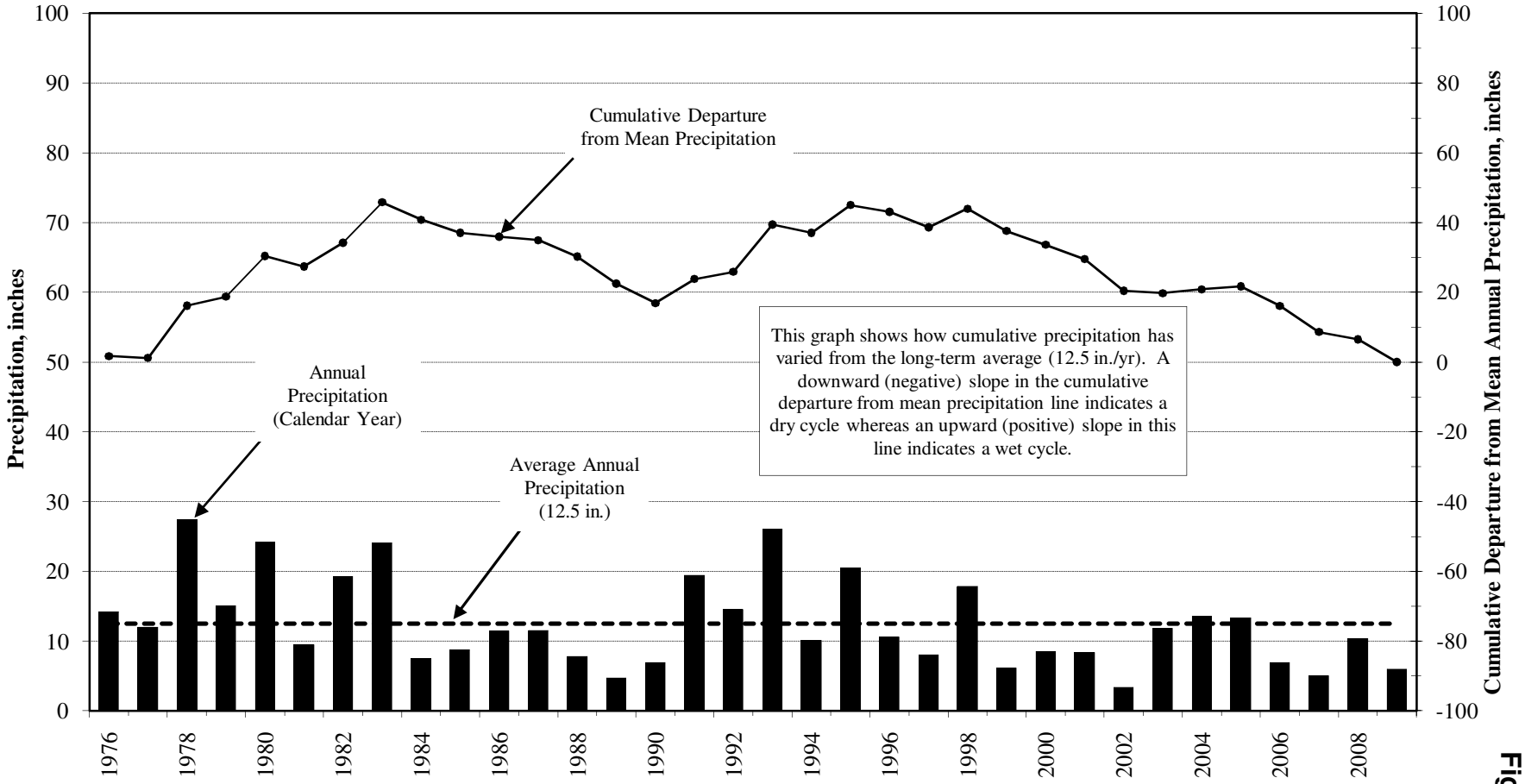
Annual Precipitation and Cumulative Departure From Mean Annual Precipitation
Banning Bench Weather Station #011
(1974 to 2009)



Source: Riverside County Flood Control and Water Conservation District (2010).
Note: Data are presented in calendar years.

Figure 4

Annual Precipitation and Cumulative Departure From Mean Annual Precipitation
Cabazon Weather Station #025
(1976 to 2009)

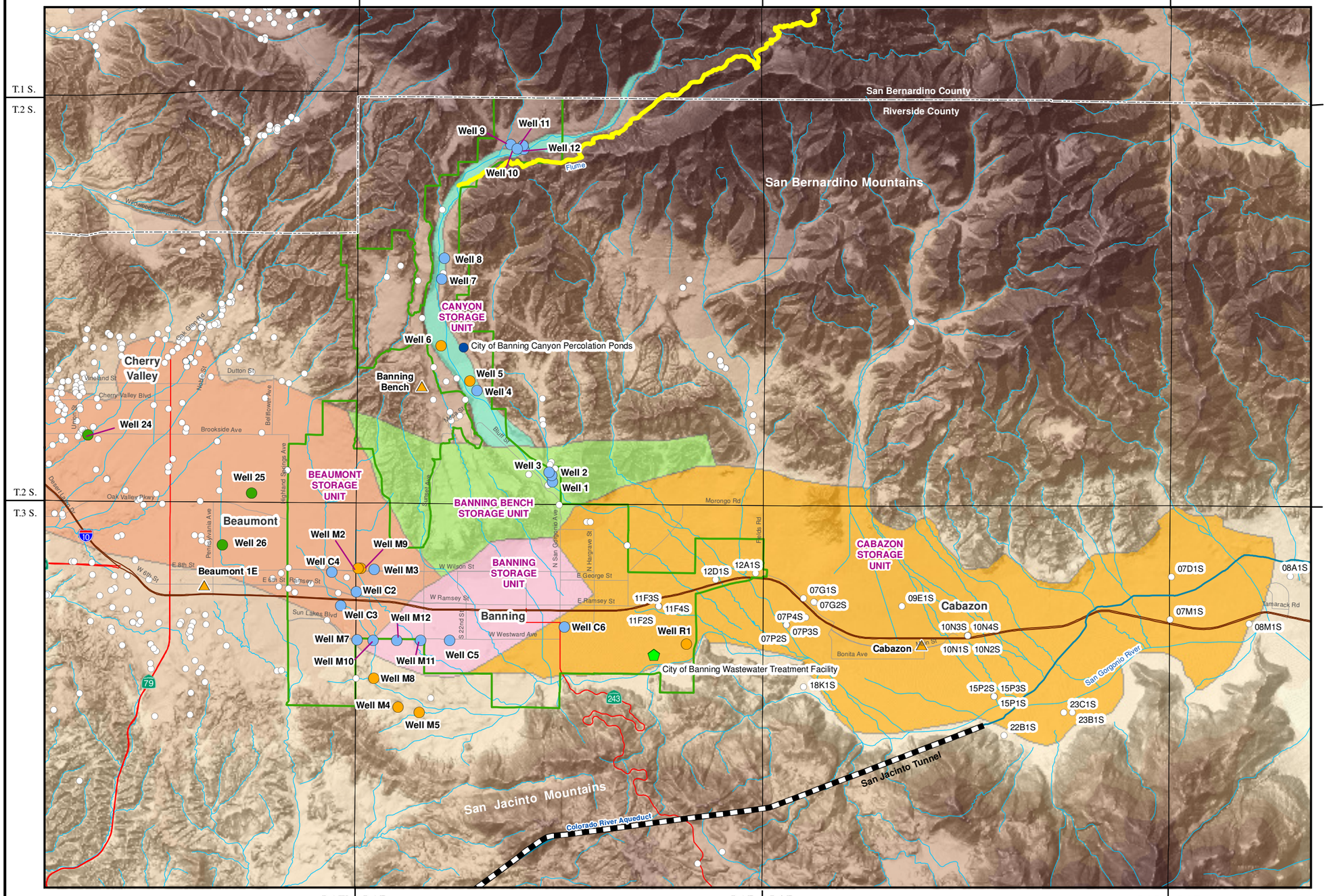


Source: Riverside County Flood Control and Water Conservation District (2010).
Note: Data are presented in calendar years.

Figure 5

CITY OF BANNING

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN



WELL LOCATIONS

EXPLANATION

- Active City of Banning Well
- Inactive City of Banning Well
- Active Wells Co-Owned by the City of Banning and Beaumont Cherry Valley Water District
- Other Wells
- Cabazon — Riverside County Flood Control and Water Conservation District Weather Station
- City of Banning Boundary
- Colorado River Aqueduct
- San Jacinto Tunnel

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon
- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

NORTH

0 4,000 8,000 Feet

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

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Figure 6

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_6_well_locations_3-11.mxd

City of Banning
Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and
Available Water Supply From the Beaumont Basin

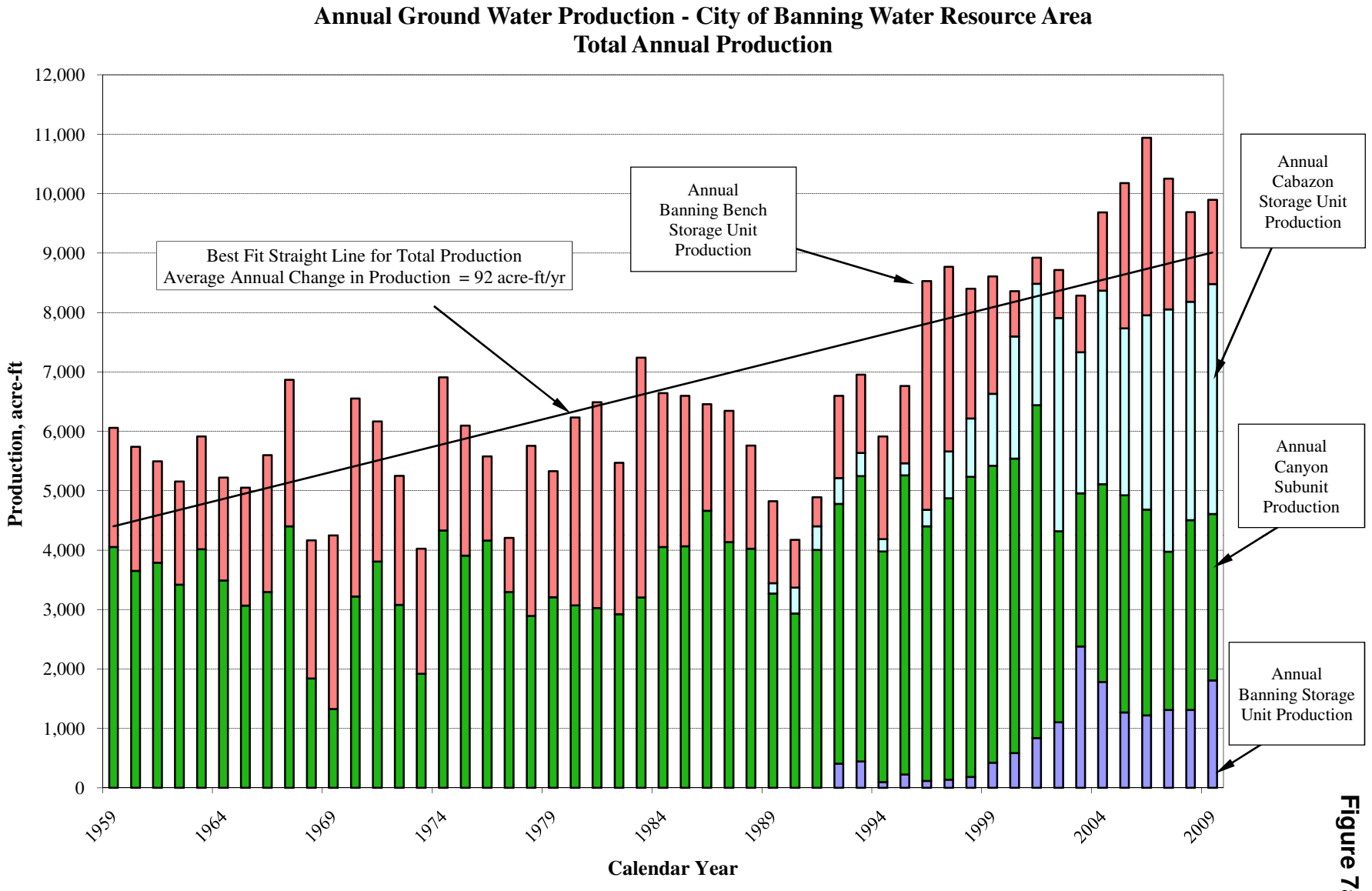


Figure 7a

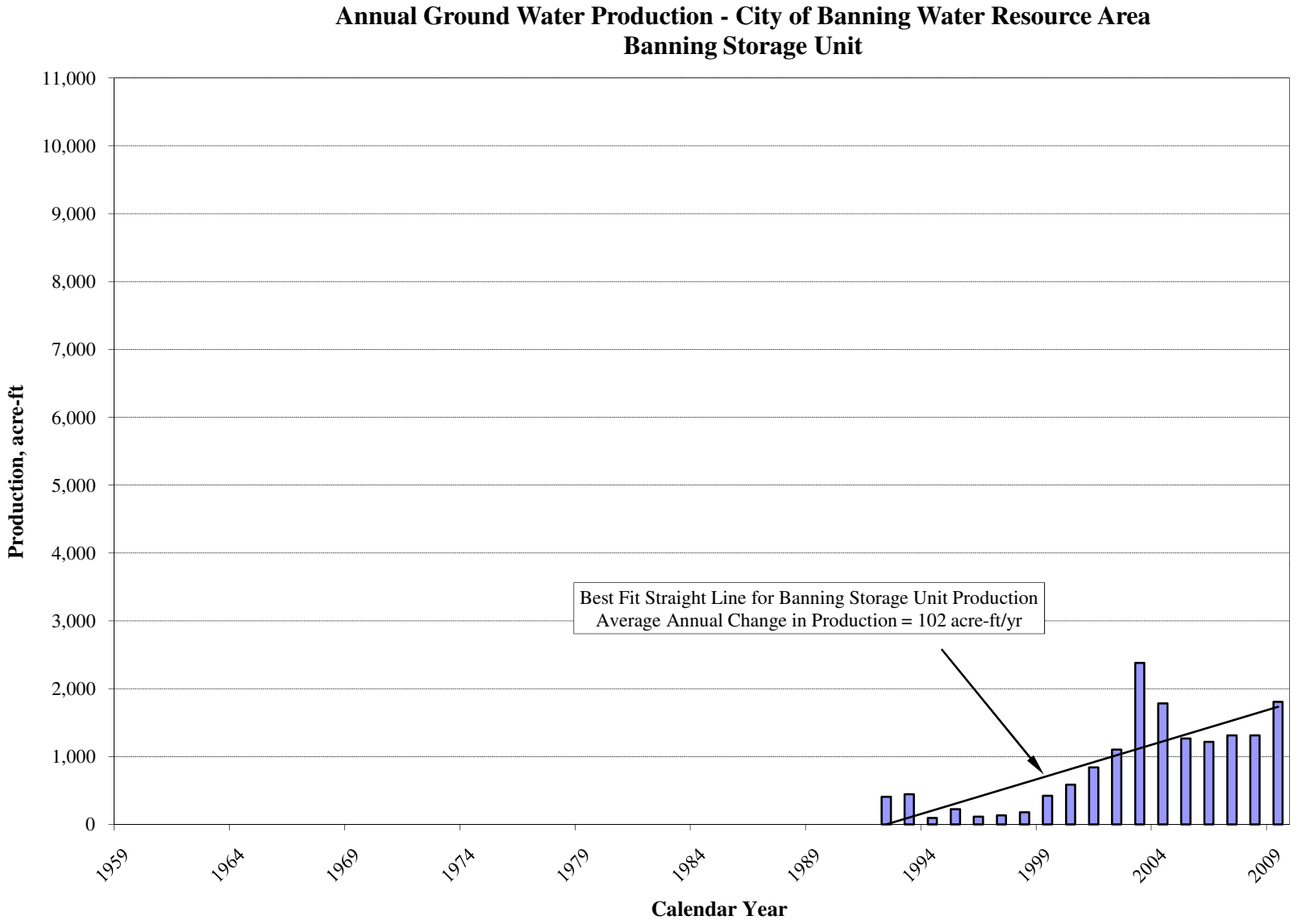

Annual Ground Water Production - City of Banning Water Resource Area
Banning Storage Unit
Production, acre-ft
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Best Fit Straight Line for Banning Storage Unit Production
Average Annual Change in Production = 102 acre-ft/yr
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
Calendar Year

Figure 7b

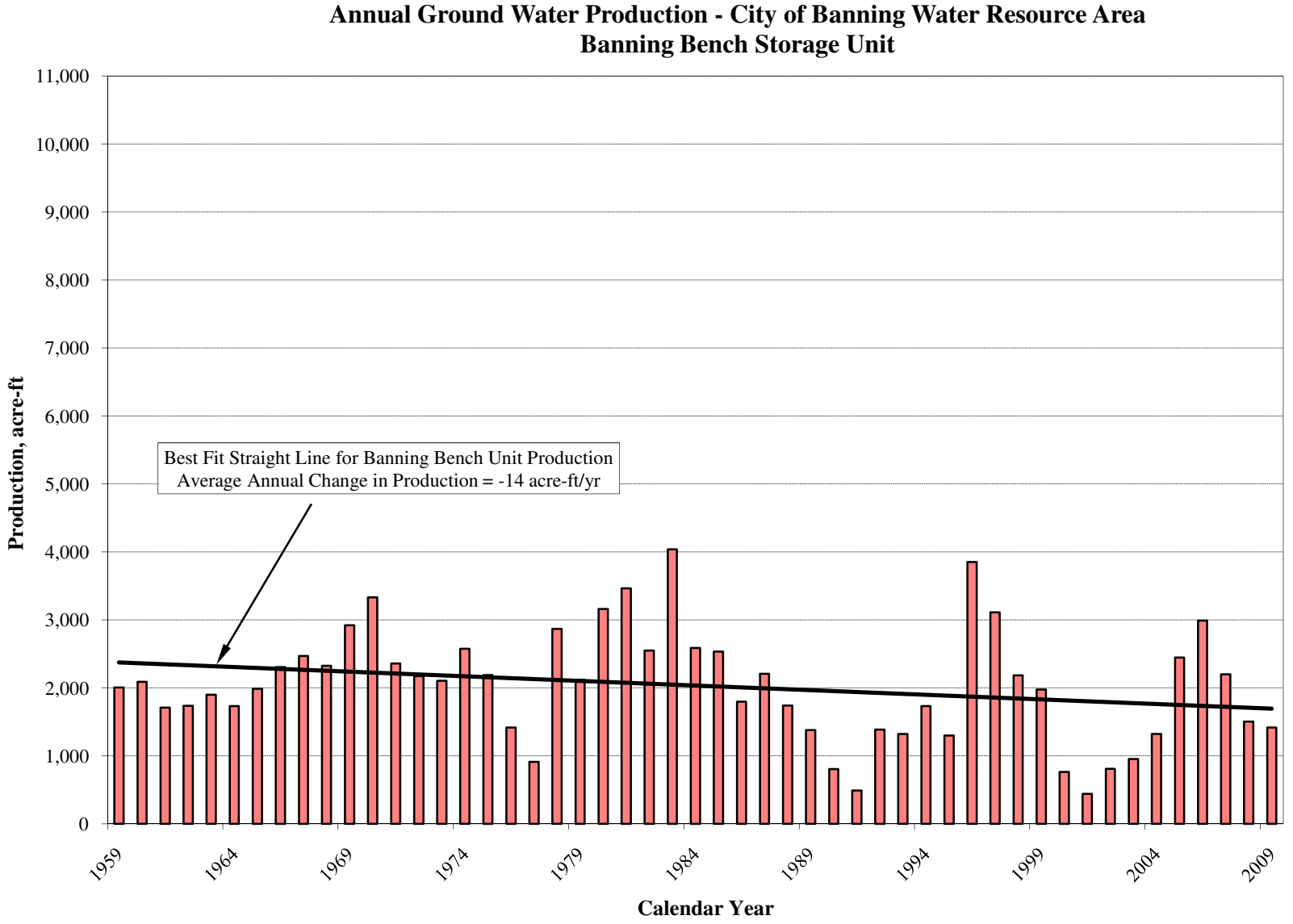

Annual Ground Water Production - City of Banning Water Resource Area
Banning Bench Storage Unit
Production, acre-ft
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Best Fit Straight Line for Banning Bench Unit Production
Average Annual Change in Production = -14 acre-ft/yr
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
Calendar Year

Figure 7c

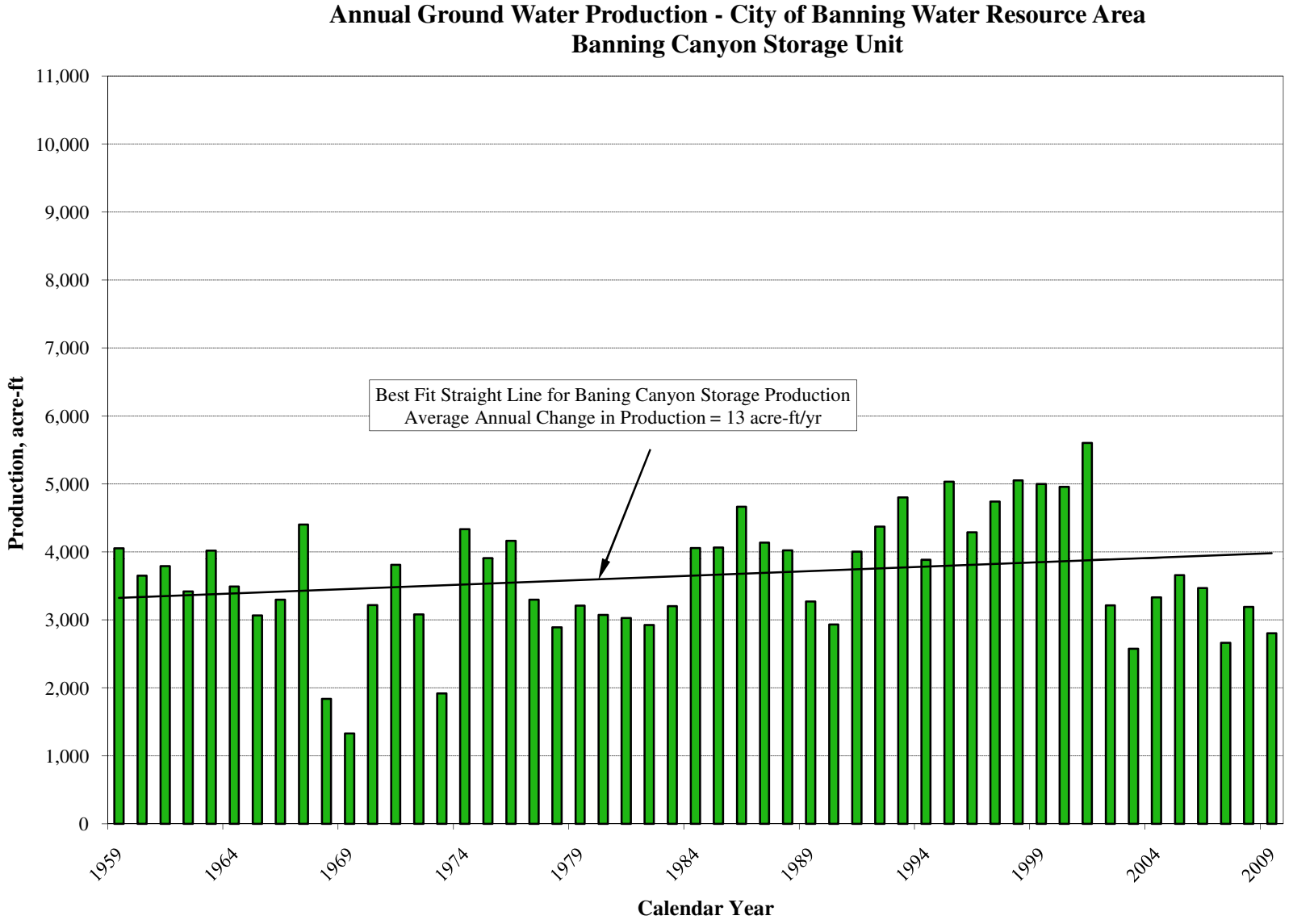

Annual Ground Water Production - City of Banning Water Resource Area
Banning Canyon Storage Unit
Best Fit Straight Line for Baning Canyon Storage Production
Average Annual Change in Production = 13 acre-ft/yr
Production, acre-ft
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
Calendar Year

Figure 7d

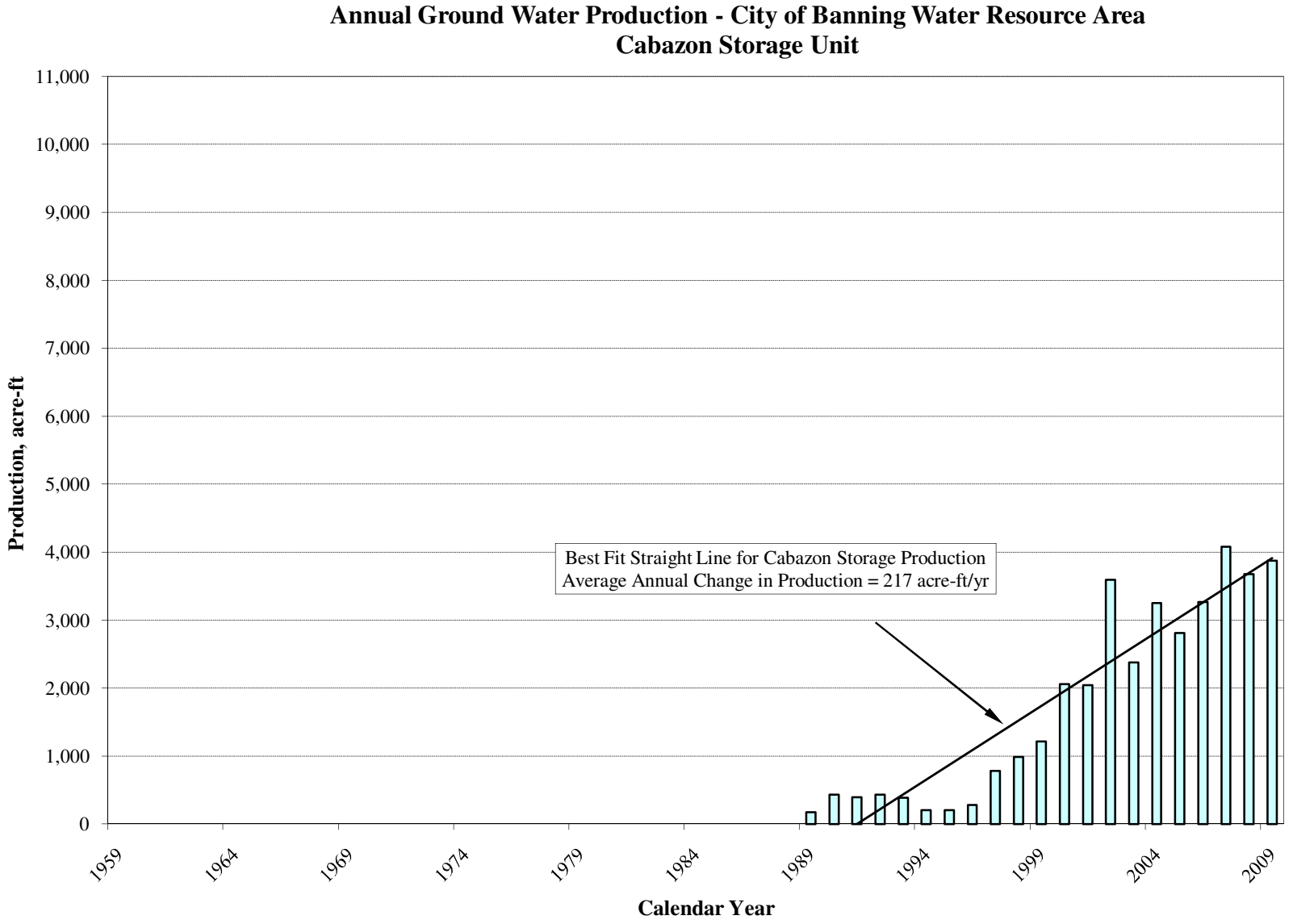
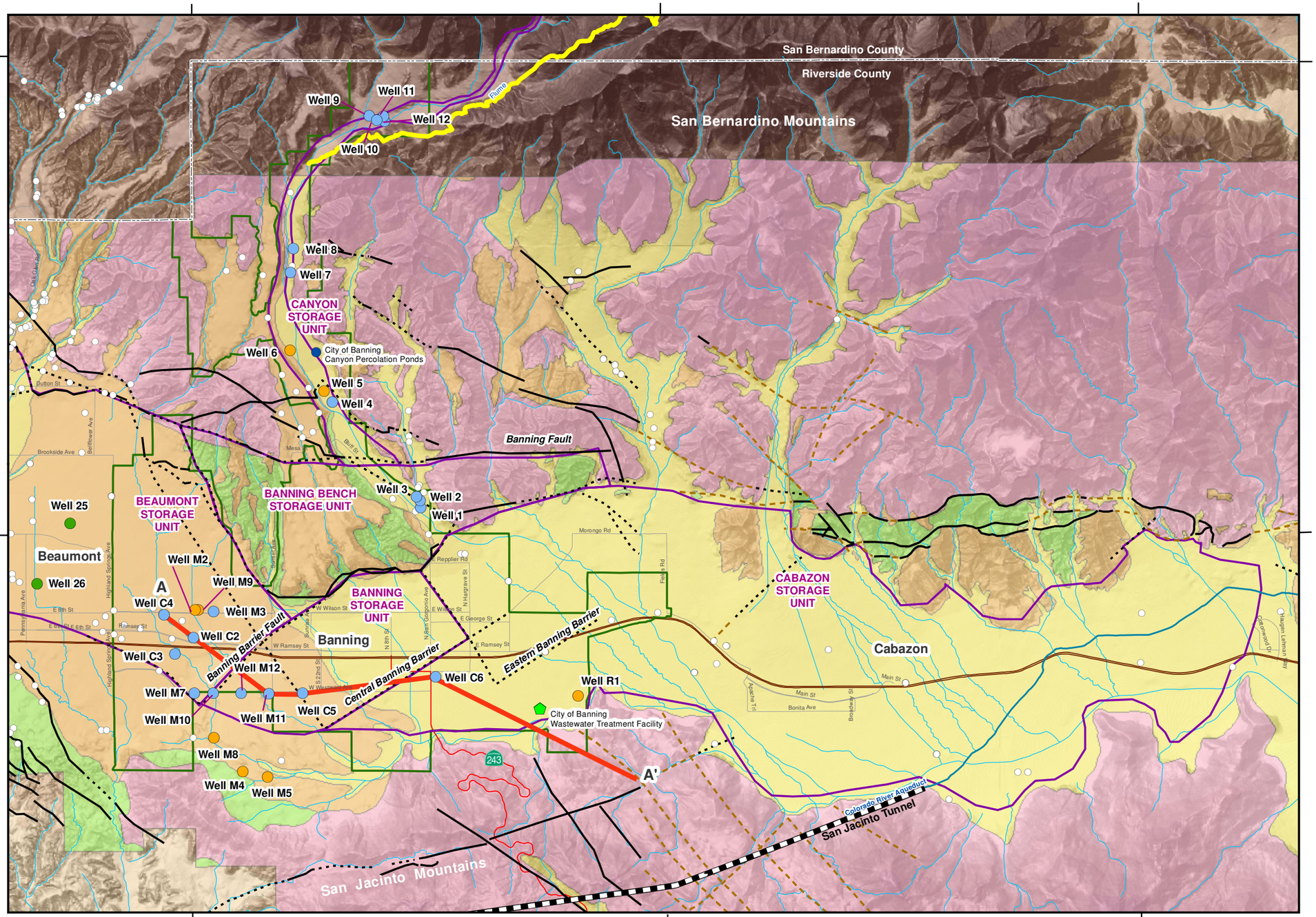

Annual Ground Water Production - City of Banning Water Resource Area
Cabazon Storage Unit
Production, acre-ft
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
Calendar Year
Best Fit Straight Line for Cabazon Storage Production
Average Annual Change in Production = 217 acre-ft/yr

Figure 7e

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN

CITY OF BANNING



SURFICIAL GEOLOGY

EXPLANATION

- Active City of Banning Well
- Inactive City of Banning Well
- Active Wells Co-Owned by the City of Banning and Beaumont Cherry Valley Water District
- Other Wells

Geologic Classifications:

- Qya - Quaternary Younger Alluvium
- Qoa - Tertiary to Quaternary Older Alluvium (equivelent to Qvo and Qo of Fig 8b and 8c)
- Qtcv - Tertiary to Quaternary Continental Formation
- pTb - Pre-Tertiary Basement Complex

Source of Geology:
Modified from R.M. Bloyd, Jr. USGS Water Supply Paper 1999-D, Plate 1, 1971.
(Note: Units Qsu and Qsl shown on Figure 8b and 8c are not exposed in study area)

- Cross Section A-A'
- Ground Water Storage Unit Boundary (Source: USGS, 2006)
- City of Banning Boundary
- County Boundary

Fault Classification

- Surface Fault
- Concealed Fault
- Approximate / Inferred Fault
- Colorado River Aqueduct
- San Jacinto Tunnel
- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

Source of Data:
Faults Modified from R.M. Bloyd, Jr.
USGS Water Supply Paper 1999-D, Plate 1, 1971., and
USGS Scientific Investigation Report 2006-5026, Figure 2, 2006.

NORTH

0 3,500 7,000 Feet

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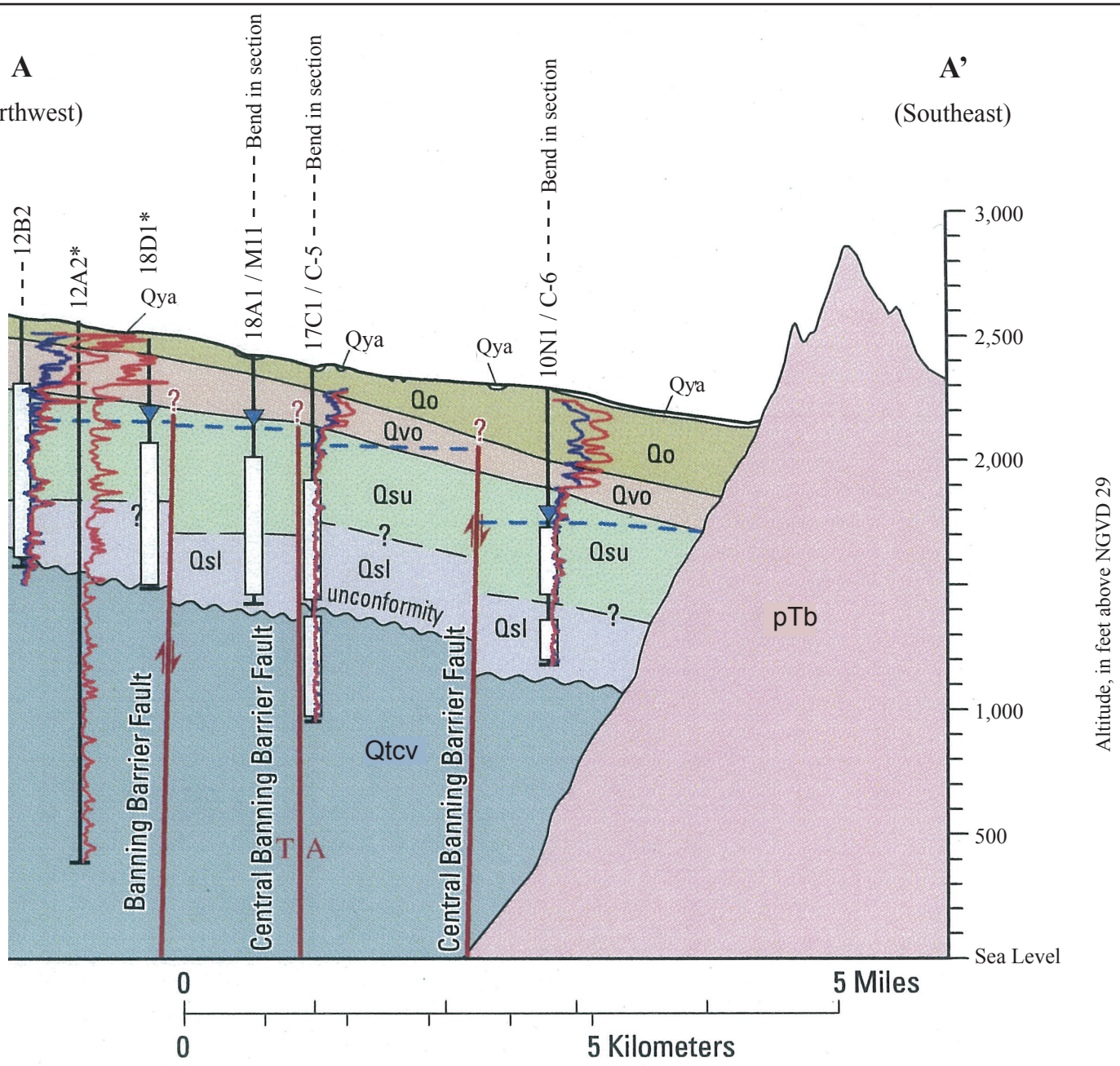
Figure 8a

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_8_geology_3-11.mxd



See Figure 8a for Geologic Map
See Figure 8c for Generalized Geologic Cross Section A-A' Legend

Source: Modified from USGS Geology, Ground-water Hydrology, Geochemistry, and Ground-Water Simulation of the Beaumont and Banning Storage Units, San Gorgonio Pass Area, Riverside County, California, Figure 6. Scientific Investigation Report 2006-5026, 2006.

Note: Geologic classification titles have been modified from the 2006 USGS report for purposes of this report. It should be noted that the descriptions are similar in characteristic.

Projects\City_of_Banning\01) Max_Perennial_Yield Estimates\01) Comprehensive_safe_yield_2010_(also look in 02)\02) Figures\Fig_8b_8c_geologic_x-sec\Fig_8b_usgs_x_sec_11-10.ai

Figure 8b

Drawn:	
Checked:	
Approved:	
Date: 29-Mar-11	

CITY OF BANNING

SCHEMATIC SHOWING
GENERALIZED GEOLOGIC CROSS SECTION A-A'

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EXPLANATION

Surficial deposits
(Holocene to Pleistocene)

- Qya **Younger deposits**[1]
- Qo **Older deposits**[1]
- Qvo **Very old deposits**[1]

Younger sedimentary deposits
(Pleistocene)

- Qsu **Sedimentary deposits**[1] **(upper)**
- Qsl **Sedimentary deposits**[2] **(lower)**

Older sedimentary deposits
(Pleistocene to Pliocene)

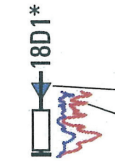
- Qtcv **Older sedimentary deposits**

Crystalline basement rocks
(Pre-Tertiary)

- pTb **Peninsular Ranges-type**

[1] **Upper aquifer in Beaumont and Banning storage units**

[2] **Lower aquifer in Beaumont and Banning storage units**



Well and identifier—Perforated interval shown as white box. Asterisk (*) indicates well projected to cross section
Water level in well (2000)
Short normal (blue) and long normal (red) resistivity logs

Water level—2000

Fault—Arrows indicate direction of vertical displacement. Letters indicate direction of movement of strike-slip fault. T—towards the viewer, A—away from the viewer

See Figure 8b for Generalized Geologic Cross Section A-A' and Figure 8a for cross section location.

Source: USGS Geology, Ground-water Hydrology, Geochemistry, and Ground-Water Simulation of the Beaumont and Banning Storage Units, San Gorgonio Pass Area, Riverside County, California, Figure 6. Scientific Investigation Report 2006-5026. 2006

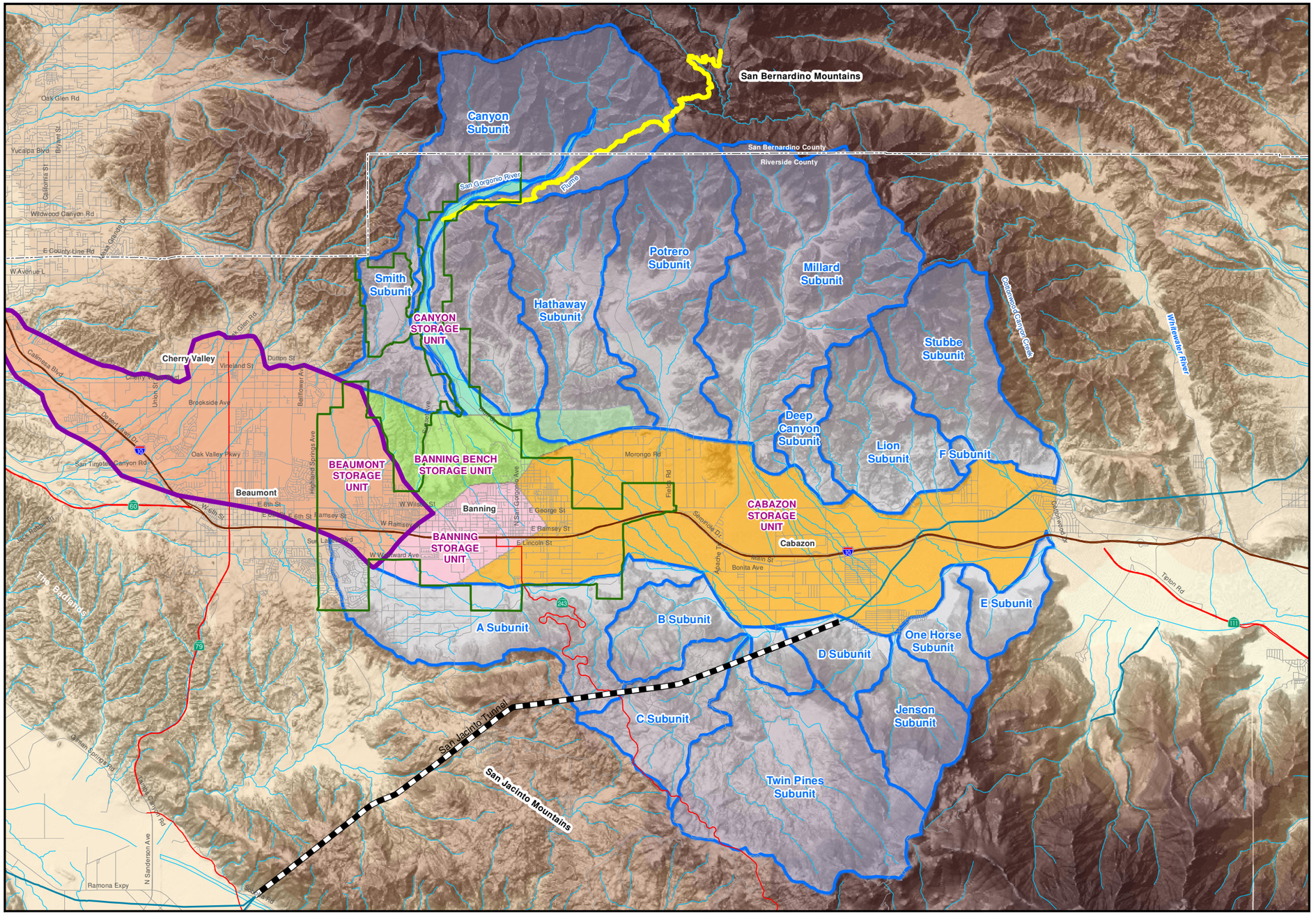
Note: Geologic classification titles have been modified from the 2006 USGS report for purposes of this report. It should be noted that the descriptions are similar in characteristic.

Projects\City_of_Banning\01) Max_Perennial_Yield Estimates\01) Comprehensive_safe_yield_2010_(also look in 02)\02) Figures\Fig_8b_8c_geologic_x-sec\Fig_8c_x_sec_legend_11-10.ai

Figure 8c	Drawn:	CITY OF BANNING	GEOSCIENCE
	Checked:	LEGEND FOR SCHEMATIC SHOWING GENERALIZED GEOLOGIC CROSS SECTION A-A'	GEOSCIENCE Support Services, Incorporated P.O. Box 220, Claremont, CA 91711 Tel: (909) 451-6650 Fax: (909) 451-6638 www.gssiwater.com
	Approved:		
	Date: 29-Mar-11		

CITY OF BANNING

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN



CITY OF BANNING HYDROLOGIC SUBUNITS AND GROUND WATER STORAGE UNITS

EXPLANATION

- City of Banning Boundary
- Hydrologic Subunit Boundary and Designation
- Adjudicated Ground Water Boundary (source: Beaumont Basin Watermaster, 2009)
- Colorado River Aqueduct
- San Jacinto Tunnel

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon
- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

NORTH

0 5,500 11,000 Feet

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Figure 9

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_9_study_area_w_watersheds_3-11.mxd

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN

CITY OF BANNING

T.1 S.
T.2 S.
T.3 S.

R.1 W. | R.1 E. | R.2 E. | R.3 E.

San Bernardino County
Riverside County
San Bernardino Mountains
San Jacinto Mountains
San Jacinto Tunnel
Colorado River Aqueduct
Flume

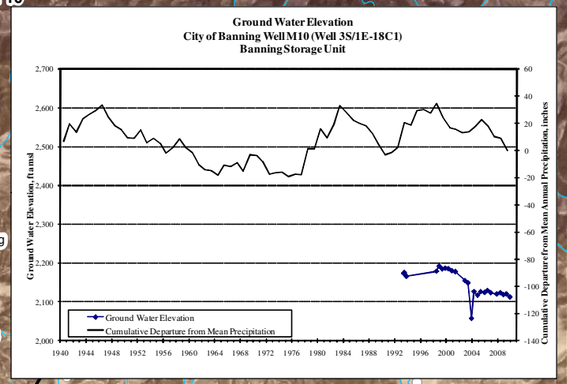
Wells: Well 9, Well 11, Well 12, Well 10, Well 8, Well 7, Well 5, Well 3, Well 2, Well 1, Well M2, Well M9, Well C4, Well M3, Well C2, Well C3, Well M12, Well M7, Well M10, Well M11, Well C5, Well C6, Well R1, Well M8, Well M4, Well M5

CANYON STORAGE UNIT
BEAUMONT STORAGE UNIT
BANNING BENCH STORAGE UNIT
BANNING STORAGE UNIT
CABAZON STORAGE UNIT

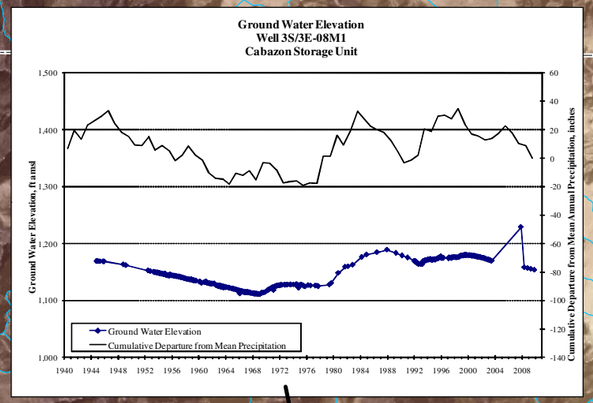
City of Banning Canyon Percolation Ponds
City of Banning Wastewater Treatment Facility

Beaumont
Banning
Cabazon

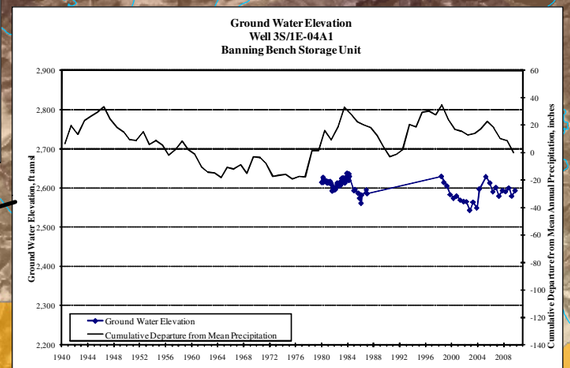
Ground Water Elevation
City of Banning Well M10 (Well 3S/1E-18C1)
Banning Storage Unit



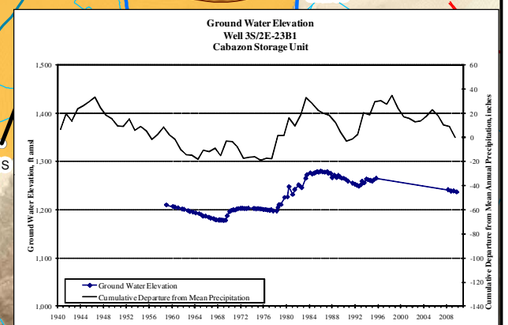
Ground Water Elevation
Well 3S/3E-08M1
Cabazon Storage Unit



Ground Water Elevation
Well 3S/1E-04A1
Banning Bench Storage Unit



Ground Water Elevation
Well 3S/2E-23B1
Cabazon Storage Unit



GROUND WATER ELEVATIONS WINTER 2009/10

EXPLANATION

- Winter 2009/10 Ground Water Elevations, ft amsl
- Water Level Well
- City of Banning Boundary
- Colorado River Aqueduct
- San Jacinto Tunnel

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon

- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

Source of Data:
Faults Modified from R.M. Bloyd, Jr.
USGS Water Supply Paper 1999-D, Plate 1, 1971., and
USGS Scientific Investigation Report 2006-5026, Figure 2, 2006.

NORTH
0 3,500 7,000
Feet

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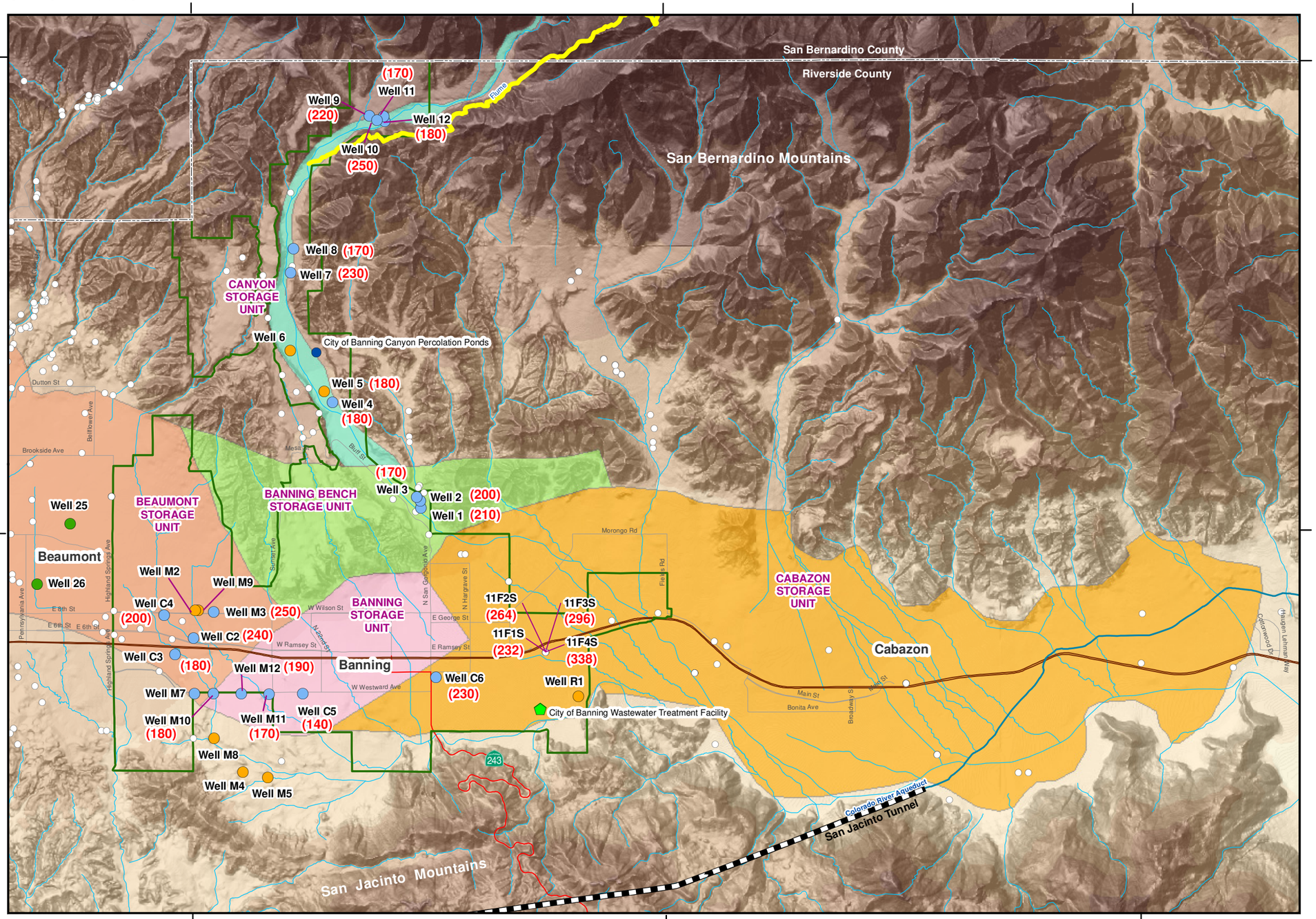
Figure 10

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_10_2010_WL_3-11.mxd

CITY OF BANNING

MAXIMUM PERENNIAL YIELD ESTIMATES FOR THE BANNING AND CABAZON STORAGE UNITS, AND AVAILABLE WATER SUPPLY FROM THE BEAUMONT BASIN



GROUND WATER TOTAL DISSOLVED SOLIDS SPRING 2009

EXPLANATION

- Active City of Banning Well
- Inactive City of Banning Well
- Active Wells Co-Owned by the City of Banning and Beaumont Cherry Valley Water District
- (180) Total Dissolved Solids (Spring 2009) (mg/L)
- Other Wells
- City of Banning Boundary
- Colorado River Aqueduct
- San Jacinto Tunnel

Ground Water Storage Unit Boundary (Source: USGS, 2006)

- Banning Bench
- Banning
- Beaumont
- Cabazon
- Canyon
- SCE Trans-Basin Diversion from the Upper Whitewater River Watershed

Note: Data was unavalible to the Eastern portion of the Cabazon Storage Unit

NORTH

0 3,500 7,000 Feet

29-Mar-11

Prepared by: DWB

Map Projection: UTM 1927 (Zone 11)

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Figure 11

GIS_proj/city_of_banning_per_yield_3-11/0_Fig_11_gw_quality_3-11.mxd

Estimate of Maximum Perennial Yield in the Banning Storage Unit
Wells C-5, M-10, M-11 and M-12
Zero-Net Draft Analysis

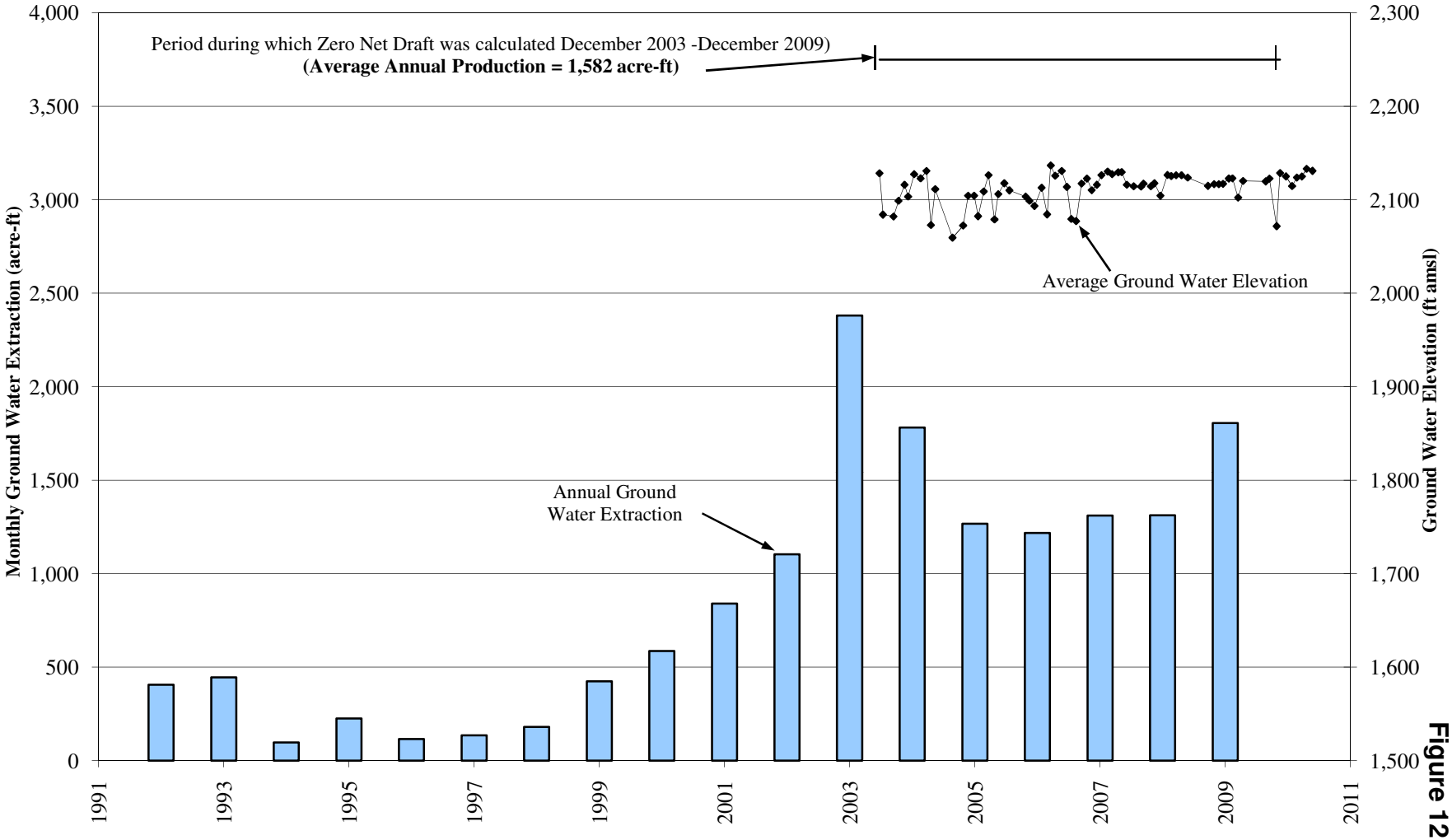


Figure 12

Estimate of Maximum Perennial Yield in the Banning Storage Unit
Wells M10, M11, M12, and C5
Hill Method Analysis
(1992 to 2010)

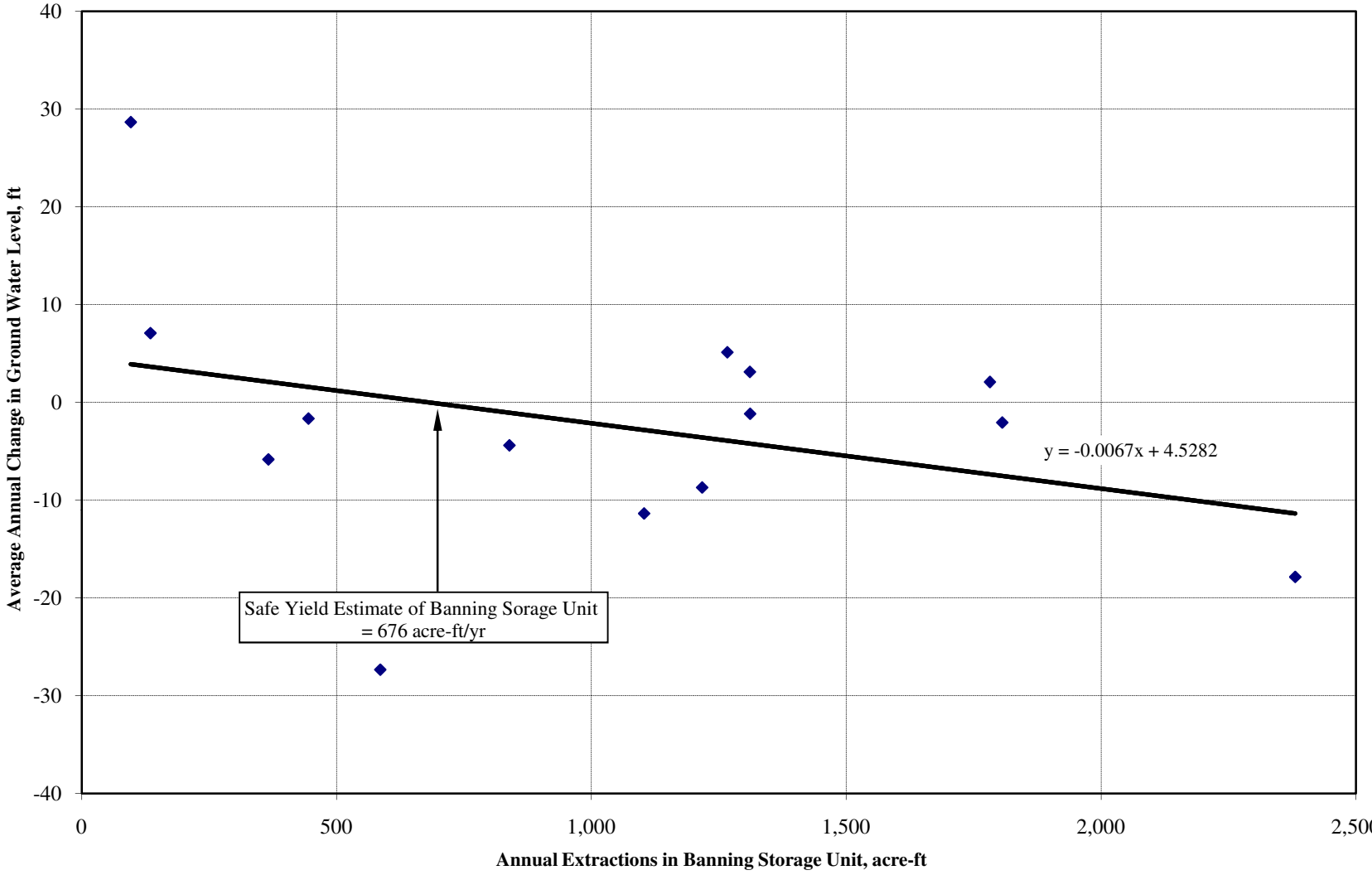


Figure 13

Estimate of Maximum Perennial Yield in the Banning Bench Storage Unit
Wells 1, 2, and 3
Zero-Net Draft Analysis

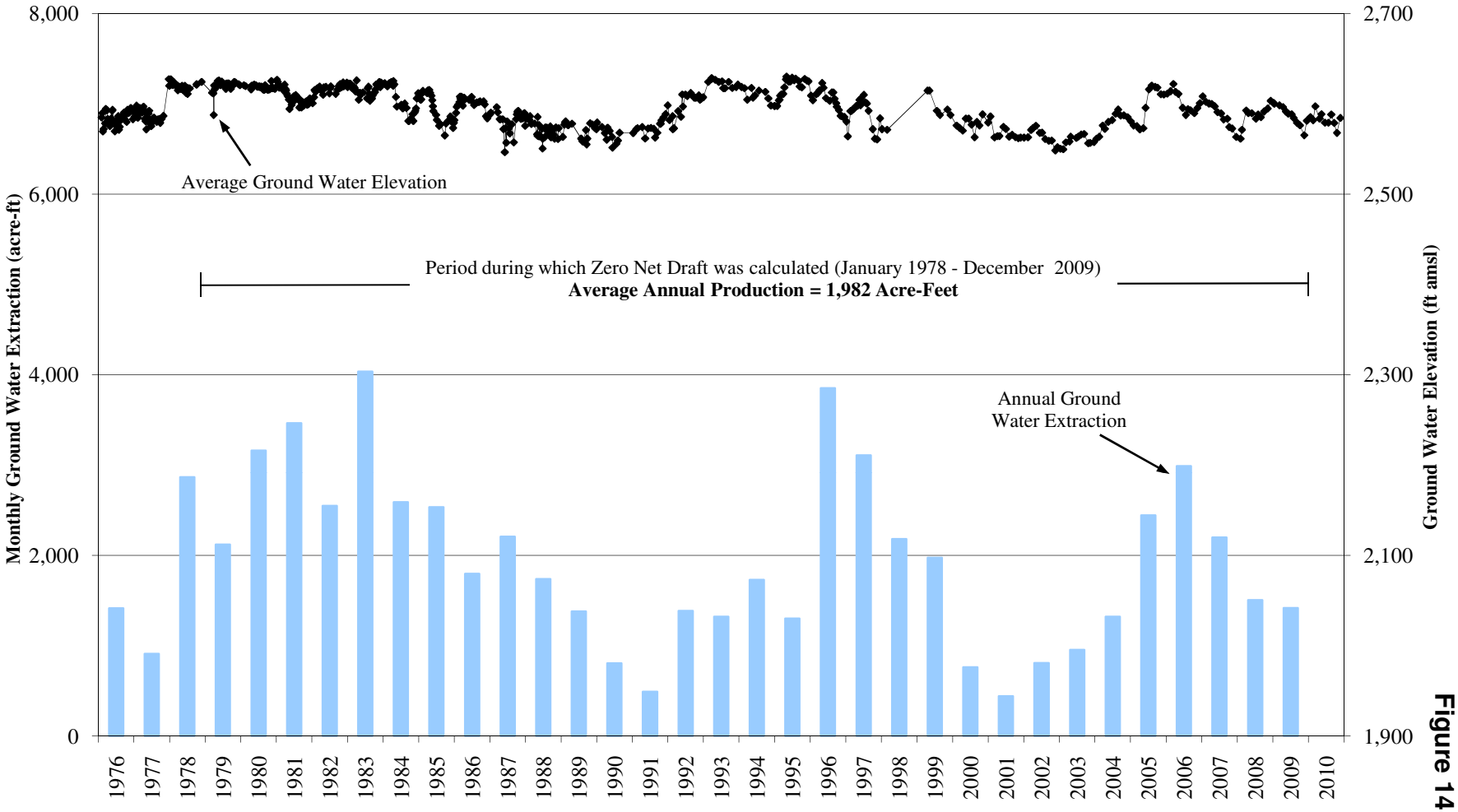


Figure 14

Estimate of Maximum Perennial Yield in the Banning Bench Storage Unit
Wells 1, 2, and 3
Hill Method Analysis
(1977 to 2009)

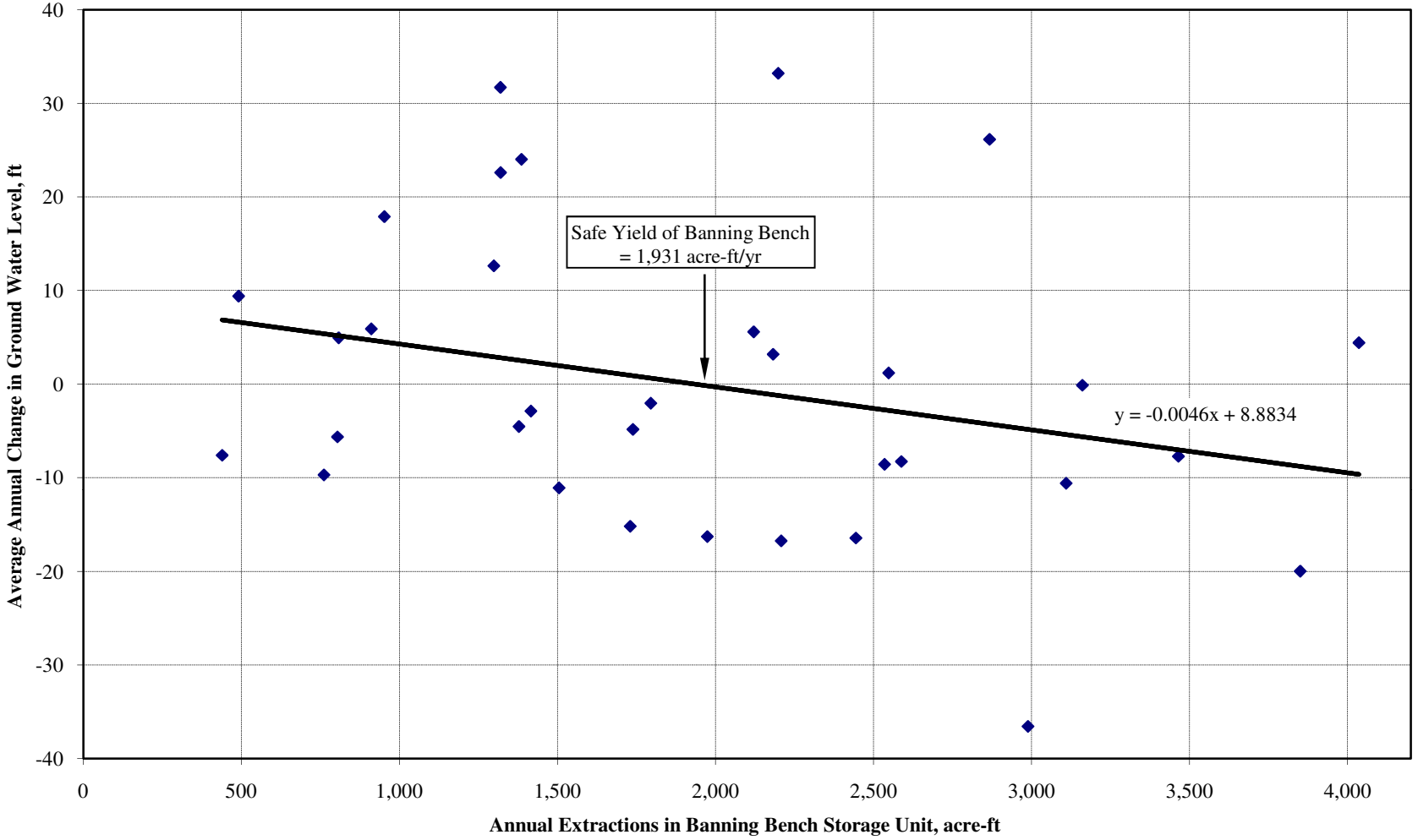


Figure 15

Estimate of Maximum Perennial Yield in the Banning Canyon Storage Unit
Wells 4 through 12
Zero-Net Draft Analysis

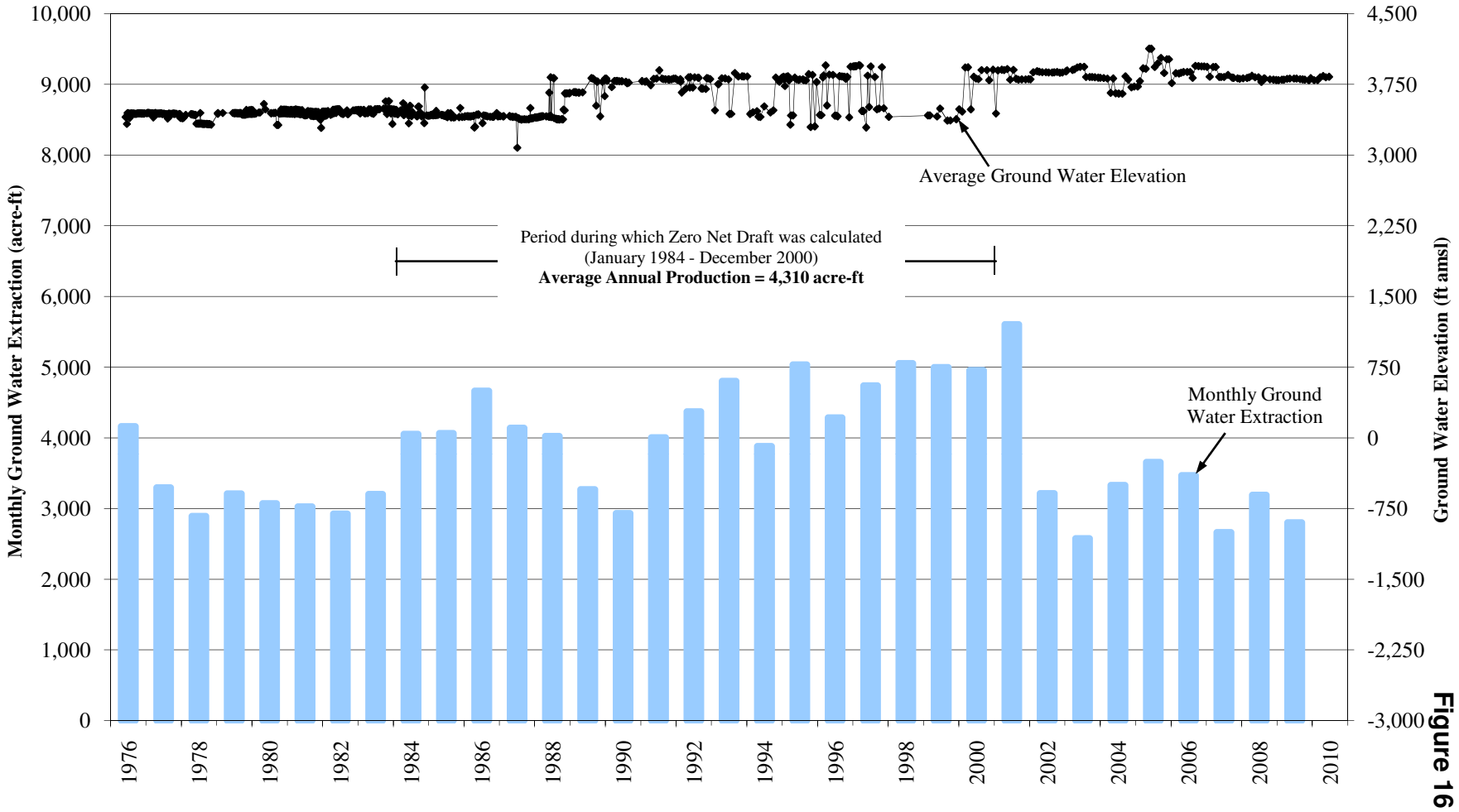


Figure 16

Estimate of Maximum Perennial Yield in the Banning Canyon Storage Unit
Wells 4-12
Hill Method Analysis
(1977 to 2009)

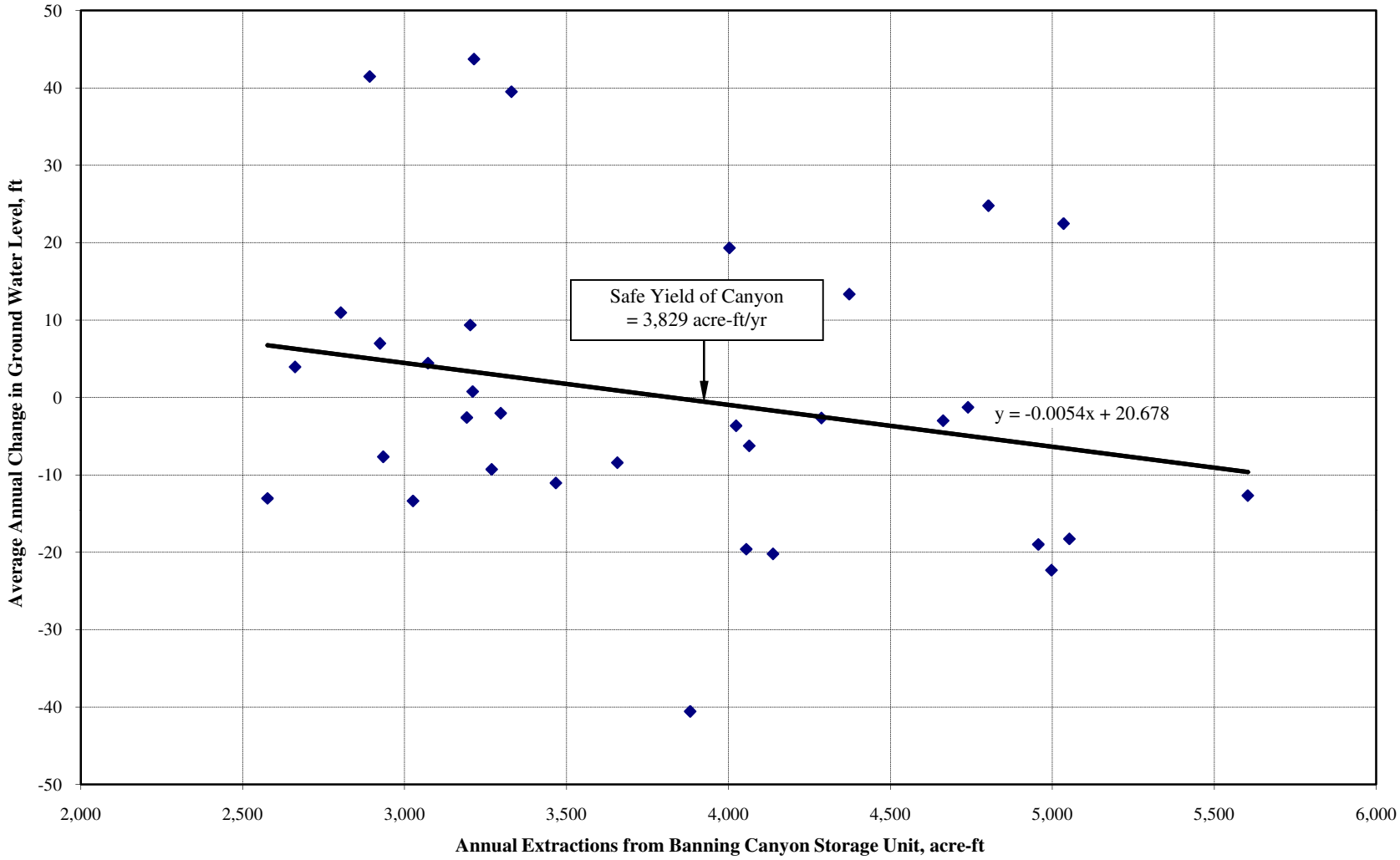


Figure 17

TABLES

City of Banning
Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and
Available Water Supply From the Beaumont Basin

Monthly Precipiation and Evaporation Summaries
Beaumont 1E Station

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum Average Monthly Temperature (F)	60.5	63.6	66.2	72.4	78.7	88.1	95.6	95.5	90.4	80.6	69.3	62
Minimum Average Monthly Temperature (F)	38.6	39.1	40	42.7	47.6	52.6	58.4	58.9	55.8	49.3	43	39.2
Average Monthly Precipitation (in)	3.76	3.44	3.12	1.36	0.63	0.15	0.23	0.21	0.51	0.59	1.65	2.09
Average Maximum Monthly Precipitation (in)	20.37	13.2	11.44	6.53	4.14	1.98	3.06	2.49	4.6	4.6	9.02	10.88
Average Minimum Monthly Precipitation (in)	0	0	0	0	0	0	0	0	0	0	0	0
Average Monthly Evaporation (in)	2.97	3.56	4.79	5.06	7.6	9.14	10.97	10.47	8.85	6.46	5.16	3.56

Temperature and precipitation averaged during 1948 to 2001.

Evaporation averaged from 1948 to 1957

Table 1

Source: EarthInfo Inc. (2009)

City of Banning Water Resource Area Historical Production 1959-2009

	[1]	[2]		[3]		[4]		[5]
Year	**Banning**	**Banning Bench**		**Banning Canyon Subunit**		**Cabazon**		**Total Production**
		City of Banning	**Private Producers**	**City of Banning**	**Other Producers**	**City of Banning**	**Other Producers**	
	[acre-ft]							
1959	*	2,005	*	4,053	*	0	*	**6,058**
1960	*	2,089	*	3,651	*	0	*	**5,740**
1961	*	1,707	*	3,790	*	0	*	**5,497**
1962	*	1,736	*	3,420	*	0	*	**5,156**
1963	*	1,899	*	4,017	*	0	*	**5,916**
1964	*	1,731	*	3,491	*	0	*	**5,222**
1965	*	1,988	*	3,066	*	0	*	**5,054**
1966	*	2,304	*	3,297	*	0	*	**5,601**
1967	*	2,468	*	4,401	*	0	*	**6,869**
1968	*	2,326	*	1,839	*	0	*	**4,165**
1969	*	2,920	*	1,327	*	0	*	**4,247**
1970	*	3,333	*	3,219	*	0	*	**6,552**
1971	*	2,359	*	3,808	*	0	*	**6,167**
1972	*	2,171	*	3,080	*	0	*	**5,251**
1973	*	2,104	*	1,919	*	0	*	**4,023**
1974	*	2,576	*	4,333	*	0	*	**6,909**
1975	*	2,188	*	3,907	*	0	*	**6,095**
1976	*	1,415	*	4,162	*	0	*	**5,577**
1977	*	911	*	3,297	*	0	*	**4,208**
1978	*	2,867	*	2,892	*	0	*	**5,759**
1979	*	2,121	*	3,210	*	0	*	**5,331**
1980	*	3,161	*	3,072	*	0	*	**6,233**
1981	*	3,465	*	3,026	*	0	*	**6,491**
1982	*	2,548	*	2,924	*	0	*	**5,472**
1983	*	4,036	*	3,203	*	0	*	**7,239**
1984	*	2,588	*	4,055	*	0	*	**6,643**
1985	*	2,535	*	4,064	*	0	*	**6,599**
1986	*	1,689	76	4,663	0	0	*	**6,428**
1987	*	2,179	90	4,138	0	0	*	**6,407**
1988	*	1,635	90	4,024	0	0	*	**5,749**
1989	*	1,057	90	3,269	0	0	176	**4,592**
1990	*	561	90	2,934	305	0	434	**4,324**
1991	*	408	90	4,003	204	0	398	**5,103**
1992	406	1,266	90	4,373	230	0	434	**6,799**
1993	445	1,246	75	4,803	30	0	388	**6,987**
1994	96	1,657	75	3,925	31	0	208	**5,992**
1995	225	1,289	75	5,007	27	0	205	**6,827**
1996	115	3,785	65	4,245	42	0	278	**8,530**
1997	135	3,065	45	4,713	27	0	785	**8,769**
1998	180	2,117	65	4,925	128	0	986	**8,401**
1999	424	1,910	65	4,756	242	0	1,212	**8,608**
2000	586	696	65	4,837	120	0	2,055	**8,359**
2001	839	364	75	5,451	153	0	2,040	**8,922**

City of Banning

Table 2

Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and Available Water Supply From the Beaumont Basin

	[1]	[2]		[3]		[4]		[5]
Year	**Banning**	**Banning Bench**		**Banning Canyon Subunit**		**Cabazon**		**Total Production**
		City of Banning	**Private Producers**	**City of Banning**	**Other Producers**	**City of Banning**	**Other Producers**	
	[acre-ft]							
2002	1,103	733	75	2,940	275	0	3,592	**8,718**
2003	2,381	877	75	2,370	207	0	2,374	**8,284**
2004	1,782	1,245	75	3,291	39	323	2,932	**9,686**
2005	1,267	2,369	75	3,577	80	219	2,593	**10,180**
2006	1,217	2,924	65	3,445	22	612	2,655	**10,941**
2007	1,311	2,124	75	2,640	22	1,202	2,957	**10,331**
2008	1,311	1,430	75	3,161	31	914	2,844	**9,766**
2009	1,806	1,341	75	2,767	36	982	2,889	**9,896**

Sources of Data: City of Banning (2010), SGPWA Conditions of the Basin Report (various years) and Riverside County Regional Detention Center EIR, LSA Associates Inc., 2009 report.

Note:

* Values unknown

[1] Banning includes M10, M11, M12 and C-5.

[2] Banning Bench data includes City of Banning Wells 1 through 3 and private producers.

[3] Banning Canyon Storage Unit includes City of Banning Wells 4 through 12, Banning Heights Mutual Water Company and private producers.

[4] Cabazon includes extraction from City of Banning Well C6, Cabazon Water District, Mission Springs Water District as well as private producers within the Cabazon Storage Unit.

[5] Total annual production for the Banning water resource area.

City of Banning
Maximum Perennial Yield Estimates for the Banning and Cabazon Storage Units, and
Available Water Supply From the Beaumont Basin

Cabazon Storage Unit Historical Annual Production 1989 - 2009

Year	Mission Springs Water District[1]	Arrowhead[2]	Cabazon Water Dictrict[3]	Desert Hills Outlets[4]	Robertson's Ready Mix[5]	Morongo Tribe[6]	City of Banning (Well C-6)[7]	Jenson's Water Company[8]	Other[8]	Total
1989	No Data	No Data	No Data	No Data	No Data	No Data		114	62	176
1990	No Data	No Data	No Data	No Data	320	No Data		114		434
1991	No Data	No Data	No Data	No Data	56	No Data		114	228	398
1992	No Data	No Data	No Data	No Data	53	No Data		114	267	434
1993	No Data	No Data	No Data	No Data	56	No Data		114	218	388
1994	No Data	No Data	No Data	No Data	59	No Data		114	35	208
1995	No Data	No Data	No Data	No Data	56	No Data		114	35	205
1996	No Data	No Data	12	No Data	117	No Data		114	35	278
1997	No Data	No Data	441	No Data	195	No Data		114	35	785
1998	No Data	No Data	728	No Data	109	No Data		114	35	986
1999	No Data	No Data	949	No Data	114	No Data		114	35	1,212
2000	159	0	1,200	130	117	300		114	35	2,055
2001	139	256	1,042	136	4	314		114	35	2,040
2002	165	1,366	1,434	146	4	328		114	35	3,592
2003	169	675	882	153	4	342		114	35	2,374
2004	157	823	1,092	169	186	356	323	114	35	3,254
2005	171	595	915	154	139	470	219	114	35	2,812
2006	190	707	824	142	158	485	612	114	35	3,267
2007	206	842	780	143	337	500	1,202	114	35	4,159
2008	164	752	737	138	373	531	914	114	35	3,758
2009	169	752	919	146	192	563	982	114	35	3,871
Average Production [ac-ft/yr]	169	752	854	146	132	419	709	114	67	1,747

[1] Table 2 - San Gorgonio Pass Water Agency Report on Water Conditions (report period 2008) Data for 2009 is the average for previous years.

[2] Table 2 -San Gorgonio Pass Water Agency Report on Water Conditions (report period 2008) Arrowhead values for 2008-2009 are an average of 2001-2007 usage. The location of pumpage is assumed to be in the Morongo Indian Reservation in Potrero Canyon.

[3] Table 2 - San Gorgonio Pass Water Agency Report on Water Conditions (report period 2008) The 2009 value for the Cabazon WD is an average of values from 2000-2008.

[4] Table 2 - San Gorgonio Pass Water Agency Report on Water Conditions (report period 2008). Desert Hills Outlets usage for 2008-2009 were defined as an average from the 2000-2007 interval. 2000 Values obtained from Riverside County Regional Detention Center EIR, LSA Associates Inc., 2009 report.

[5] 1990 to 2008 values are from Table 2 - San Gorgonio Pass Water Agency Report on Water Conditions (various years). The 2009 value reflects an average of 1997-2000 and 2004-2007 values.

[6] Riverside County Regional Detention Center EIR, LSA Associates Inc., 2009 report. Per this report - Morongo tribe does not publish its GW extraction data. The source of water supply information for the 2009 LSA report is: Water Supply Assessment for the Riverside County Regional Detention Center, Krieger & Stewart, November 2009. Therefore, the values 2000-2007 are estimates from the LSA Associates 2009 report. A best fit straight line for data from 2000-2007 was used to determine 2008-2009 values.

[7] C-6 production from City of Banning (well became operational in 2004).

[8] Information for years 1994 to 2009 from Page 22 of Ron Barto and Associates, Hydrogeology of the Cabazon Basin, August 20, 1990. Data for previous years are compiled from various years of the San Gorgonio Pass Water Agency Report on Water Conditions.

Table 3

Watershed Areas Upstream From the Cabazon Storage Unit

Name	Area [acres]	Average Isoheytal Precip [in./yr]	Average Precip [ac-ft/yr]	Average Recharge as 8% of Precip [ac-ft/yr]
Cabazon Storage Unit	17,222	15.17	21771.48	1741.72
Hathaway Subunit	5,805	23.73	11479.39	918.35
Millard Watershed	10,360	24.6	21238.66	1699.09
Potrero Watershed	7,276	24.7	14970.99	1197.68
Deep Canyon Watershed	1,156	17.8	1718.81	137.50
Jenson Watershed	2,667	19.7	4375.54	350.04
Lion Watershed	3,876	18.0	5804.32	464.35
One Horse Watershed	1,574	12.5	1633.12	130.65
Stubbe Watershed	4,801	19.0	7601.88	608.15
Twin Watershed	8,804	25.0	18363.32	1469.07
A Watershed	6,343	17.9	9434.75	754.78
B Watershed	2,919	16.8	4096.11	327.69
C Watershed	2,930	20.7	5045.15	403.61
D Watershed	1,556	15.3	1979.69	158.38
E Watershed	1,366	8.9	1015.11	81.21
F Watershed	170	15.9	226.44	18.12
		Total	**130,755**	**10,460**

Table 4

APPENDICES

GEOSCIENCE

APPENDIX A

Annual Precipitation and Evaporation

GEOSCIENCE

Annual Precipitation and Evaporation

Year	Precipitation Beaumont Station [inches]	Precipitation Banning Bench Station [inches]	Precipitation Cabazon Station [inches]	Evaporation Beaumont 1 E Station [inches]
1888	18.53	-	-	-
1889	22.50	-	-	-
1890	16.29	-	-	-
1891	18.93	-	-	-
1892	13.51	-	-	-
1893	21.67	-	-	-
1894	12.80	-	-	-
1895	19.88	-	-	-
1896	9.48	-	-	-
1897	15.94	-	-	-
1898	7.48	-	-	-
1899	10.54	-	-	-
1900	11.27	-	-	-
1901	13.85	-	-	-
1902	15.40	-	-	-
1903	20.82	-	-	-
1904	12.78	-	-	-
1905	31.79	-	-	-
1906	18.96	-	-	-
1907	22.24	-	-	-
1908	17.18	-	-	-
1909	27.93	-	-	-
1910	9.49	-	-	-
1911	20.41	-	-	-
1912	16.83	-	-	-
1913	14.83	-	-	-
1914	25.33	-	-	-
1915	28.80	-	-	-
1916	27.89	-	-	-
1917	13.81	-	-	-
1918	22.72	-	-	-
1919	14.86	-	-	-
1920	21.66	-	-	-
1921	30.63	-	-	-
1922	23.18	-	-	-
1923	13.74	-	-	-
1924	14.04	-	-	-
1925	13.15	-	-	-
1926	26.92	-	-	-
1927	26.02	-	-	-
1928	12.83	-	-	-
1929	11.19	-	-	-
1930	22.49	-	-	-

Sources of Data: San Gorgonio Pass Water Agency (2003), EarthInfo (2009)

Annual Precipitation and Evaporation

Year	Precipitation Beaumont Station [inches]	Precipitation Banning Bench Station [inches]	Precipitation Cabazon Station [inches]	Evaporation Beaumont 1 E Station [inches]
1931	21.69	-	-	-
1932	20.01	-	-	-
1933	15.59	-	-	-
1934	14.55	-	-	-
1935	15.47	-	-	-
1936	25.25	-	-	-
1937	24.23	-	-	-
1938	26.84	-	-	-
1939	18.65	-	-	-
1940	23.77	-	-	-
1941	29.96	-	-	-
1942	10.94	-	-	-
1943	27.33	-	-	-
1944	19.53	-	-	-
1945	20.20	-	-	-
1946	21.40	-	-	-
1947	7.96	-	-	-
1948	10.91	-	-	-
1949	13.76	-	-	-
1950	11.50	-	-	89.23
1951	16.71	-	-	88.03
1952	23.03	-	-	83.68
1953	7.86	-	-	78.59
1954	20.28	-	-	-
1955	13.30	-	-	70.05
1956	9.89	-	-	66.62
1957	21.14	-	-	-
1958	23.38	-	-	-
1959	10.84	-	-	-
1960	13.65	-	-	-
1961	8.08	-	-	-
1962	13.00	-	-	-
1963	16.47	-	-	-
1964	13.59	-	-	-
1965	24.54	-	-	-
1966	15.88	-	-	-
1967	20.17	-	-	-
1968	10.71	-	-	-
1969	29.13	-	-	-

Sources of Data: San Gorgonio Pass Water Agency (2003), EarthInfo (2009)

Annual Precipitation and Evaporation

Year	Precipitation Beaumont Station [inches]	Precipitation Banning Bench Station [inches]	Precipitation Cabazon Station [inches]	Evaporation Beaumont 1 E Station [inches]
1970	16.82	-	-	-
1971	12.42	-	-	-
1972	7.77	-	-	-
1973	17.97	-	-	-
1974	17.50	21.50	-	-
1975	14.10	18.14	-	-
1976	18.70	29.28	14.19	-
1977	16.69	28.19	11.98	-
1978	36.37	47.56	27.44	-
1979	16.90	23.30	15.1	-
1980	31.61	43.19	24.15	-
1981	10.60	11.80	9.49	-
1982	26.70	36.97	19.26	-
1983	30.80	46.33	24.13	-
1984	12.17	12.21	7.46	-
1985	11.50	16.38	8.73	-
1986	14.80	20.85	11.41	-
1987	15.10	16.44	11.48	-
1988	11.60	16.70	7.77	-
1989	8.80	12.07	4.74	-
1990	9.70	15.27	6.93	-
1991	18.80	17.50	19.4	-
1992	20.70	25.94	14.53	-
1993	34.98	39.92	26.07	-
1994	15.50	17.75	10.09	-
1995	27.90	34.41	20.47	-
1996	17.80	24.38	10.53	-
1997	14.20	20.62	8.02	-
1998	24.32	28.41	17.83	-
1999	6.40	13.33	6.14	-
2000	9.78	16.72	8.53	-
2001	15.80	16.31	8.37	-
2002	14.40	8.80	3.39	-
2003	18.10	18.79	11.83	-
2004	20.68	20.89	13.58	-
2005	22.26	24.77	13.33	-
2006	12.40	15.03	6.9	-
2007	9.40	11.66	5.02	-
2008	15.62	20.55	10.34	-
2009	8.13	11.27	5.98	-
Minimum	**6.40**	**8.80**	**3.39**	**66.62**
Maximum	**36.37**	**47.56**	**27.44**	**89.23**
Average	**17.77**	**22.31**	**12.49**	**79.37**

Sources of Data: San Gorgonio Pass Water Agency (2003), EarthInfo (2009)

APPENDIX B

Well Hydrographs

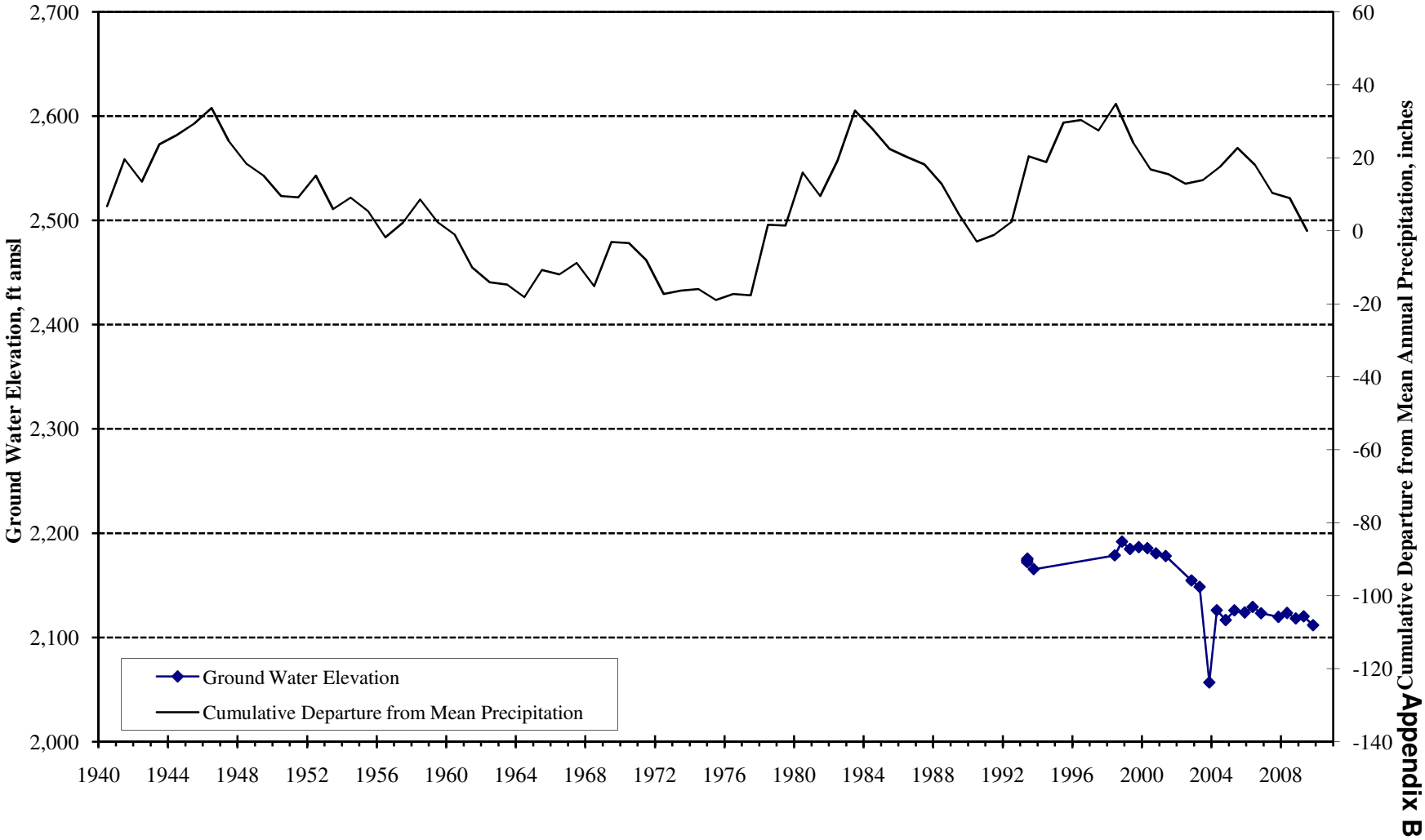
GEOSCIENCE

APPENDIX B

HYDROGRAPHS

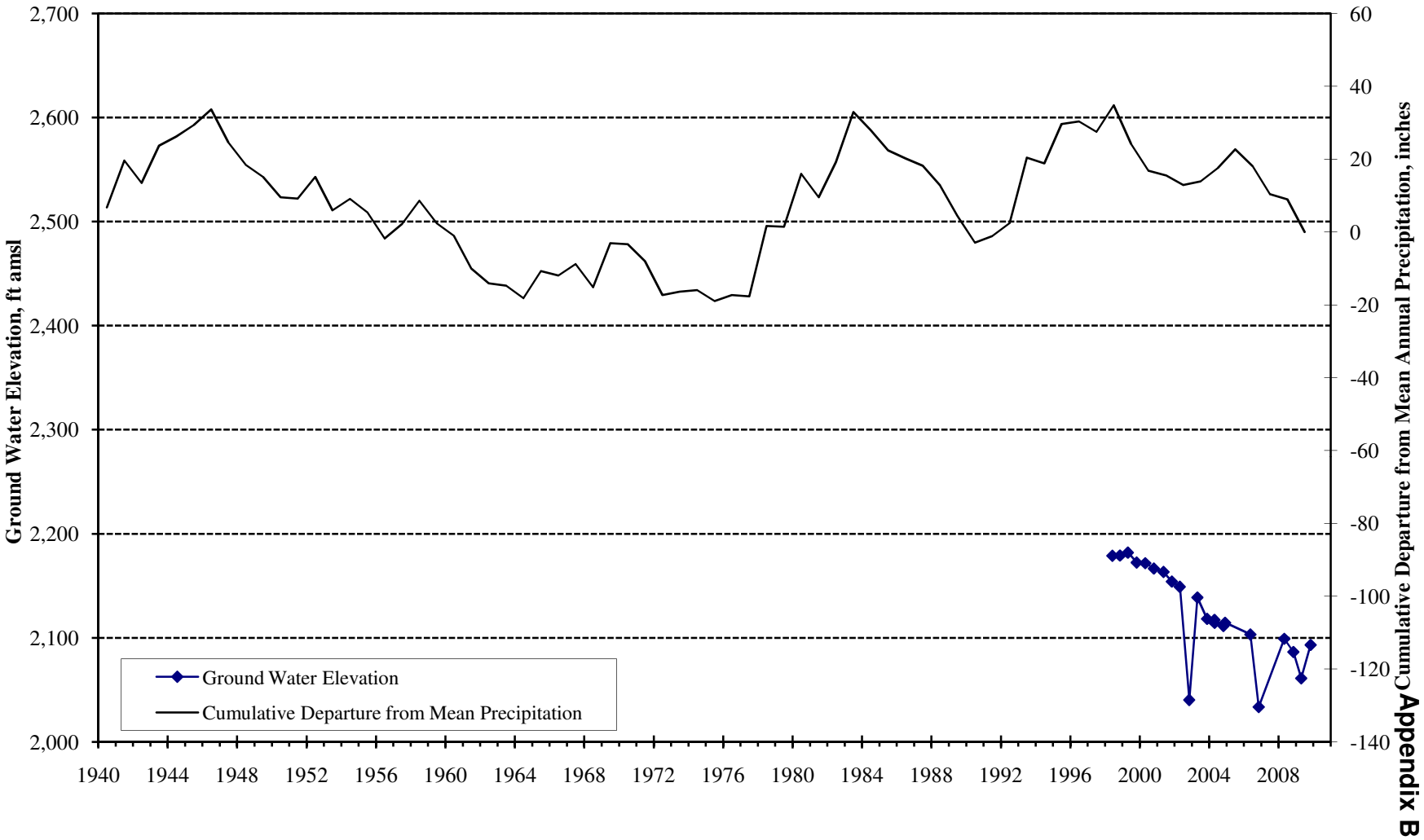
CONTENTS

Ground Water Elevation
City of Banning Well M10 (3S/1E-18C1)
Banning Storage Unit



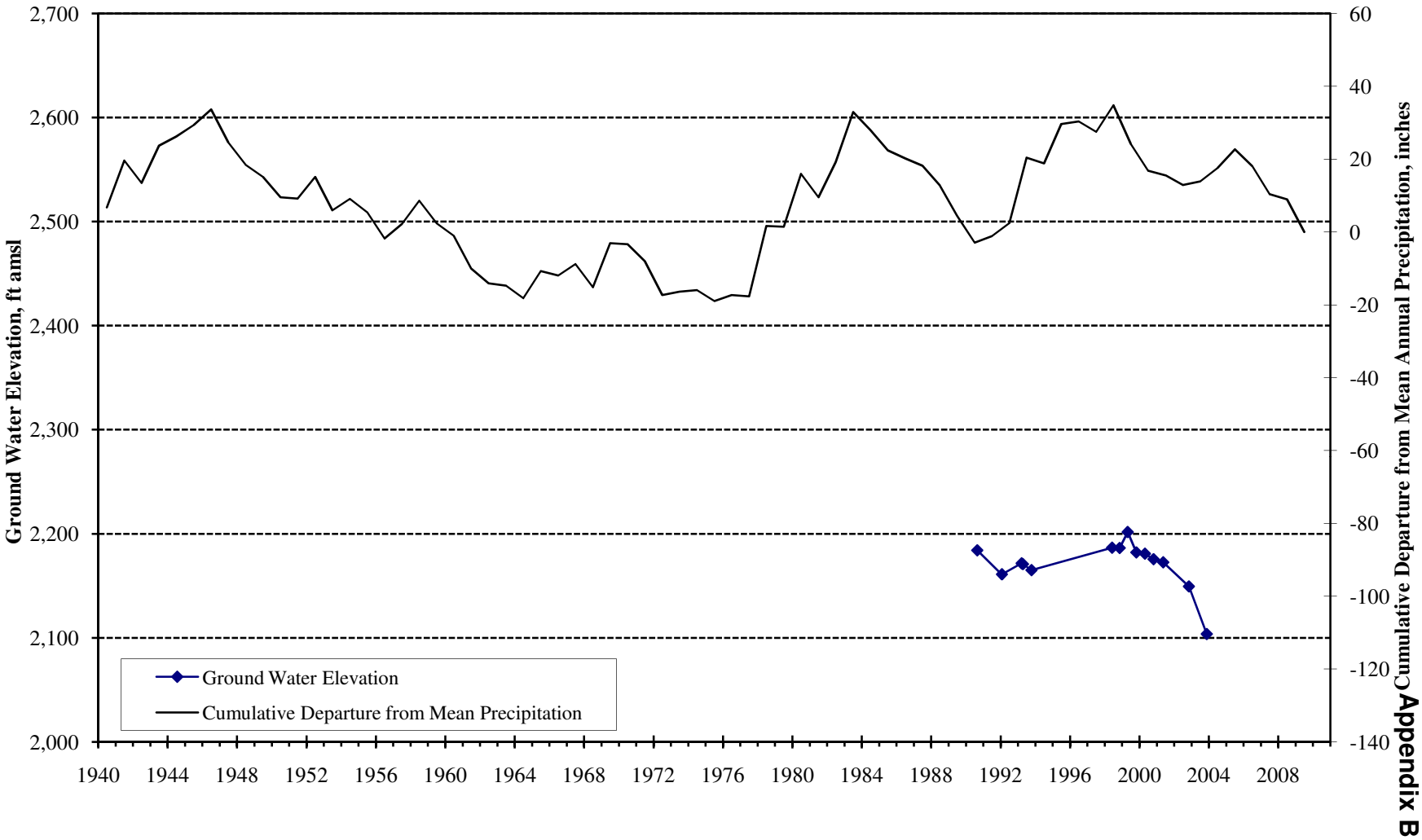
Appendix B

Ground Water Elevation
City of Banning Well M11 (3S/1E-18A1)
Banning Storage Unit



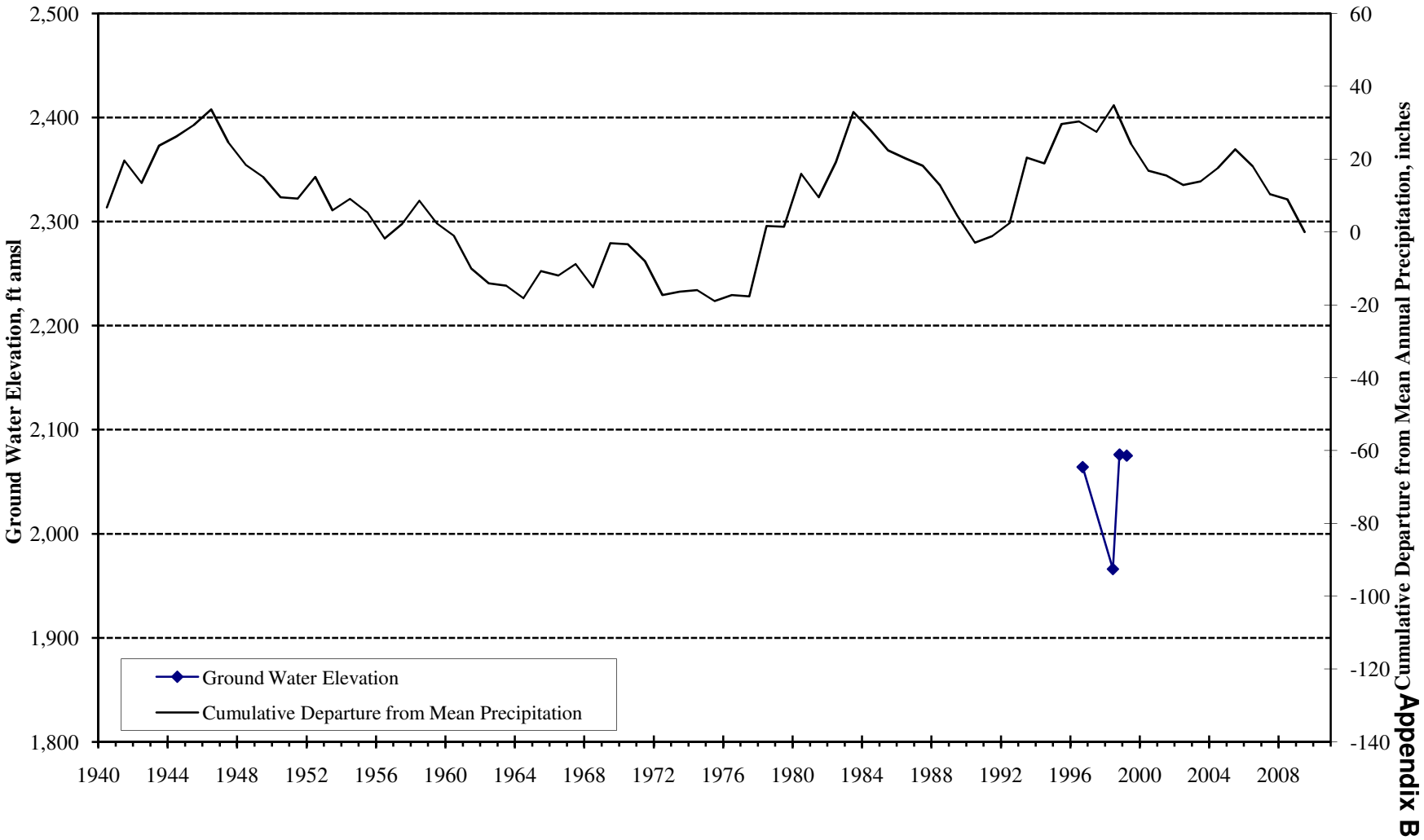
Appendix B

Ground Water Elevation
City of Banning Well M12 (3S/1E-18B1)
Banning Storage Unit



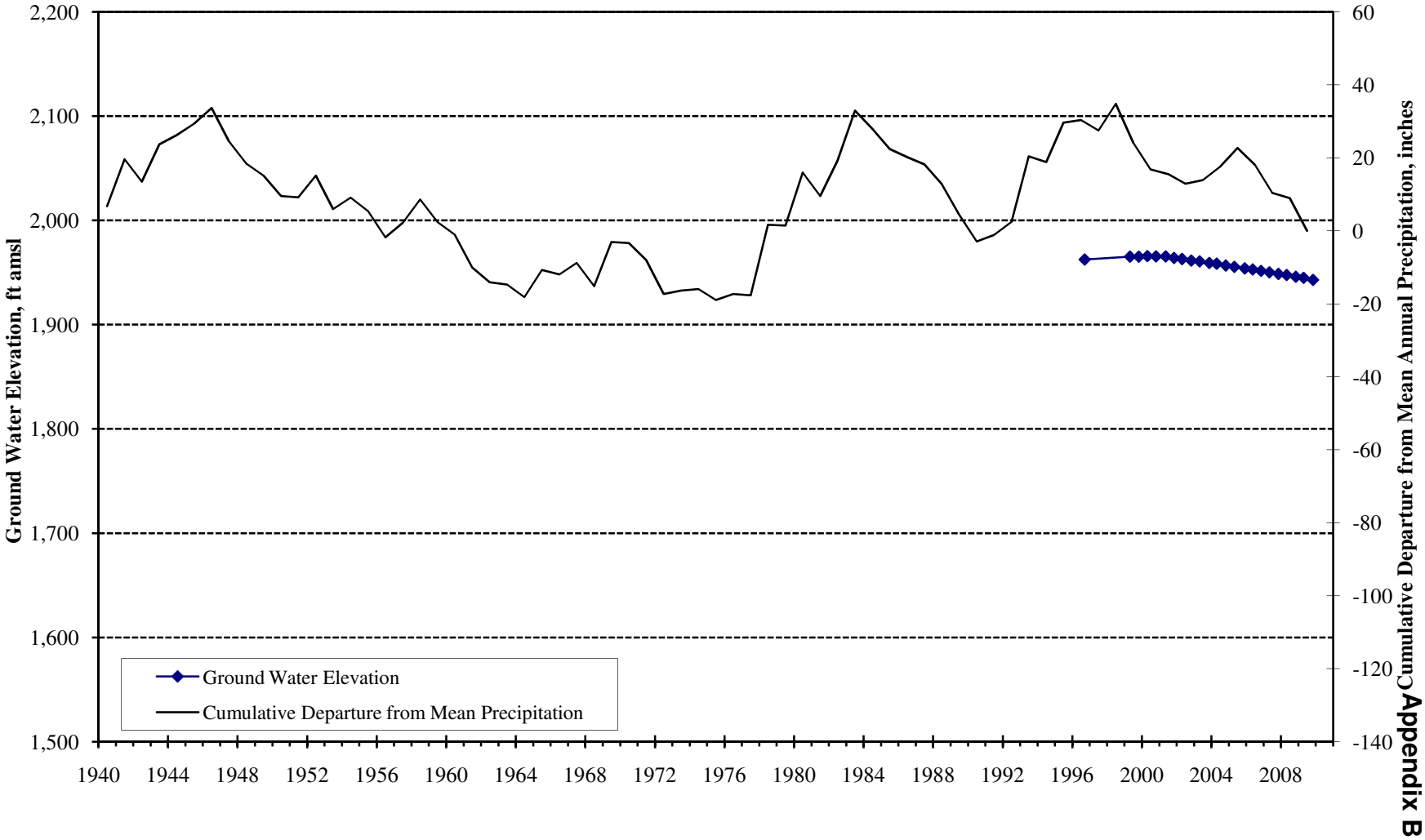
Appendix B

Ground Water Elevation
City of Banning Well C5 (3S/1E-17C1)
Banning Storage Unit



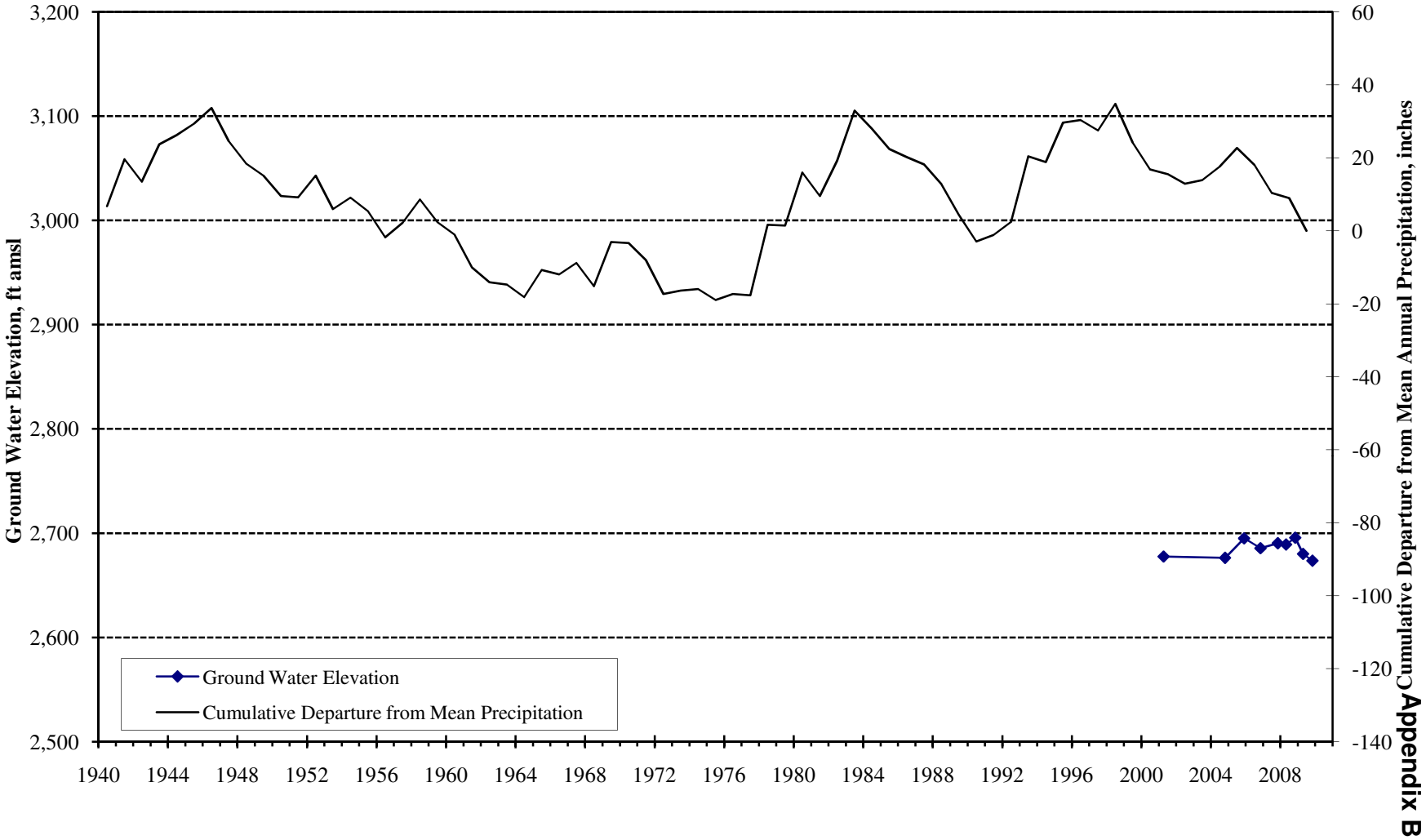
Appendix B

Ground Water Elevation
Well 3S/1E-08M1
Banning Storage Unit



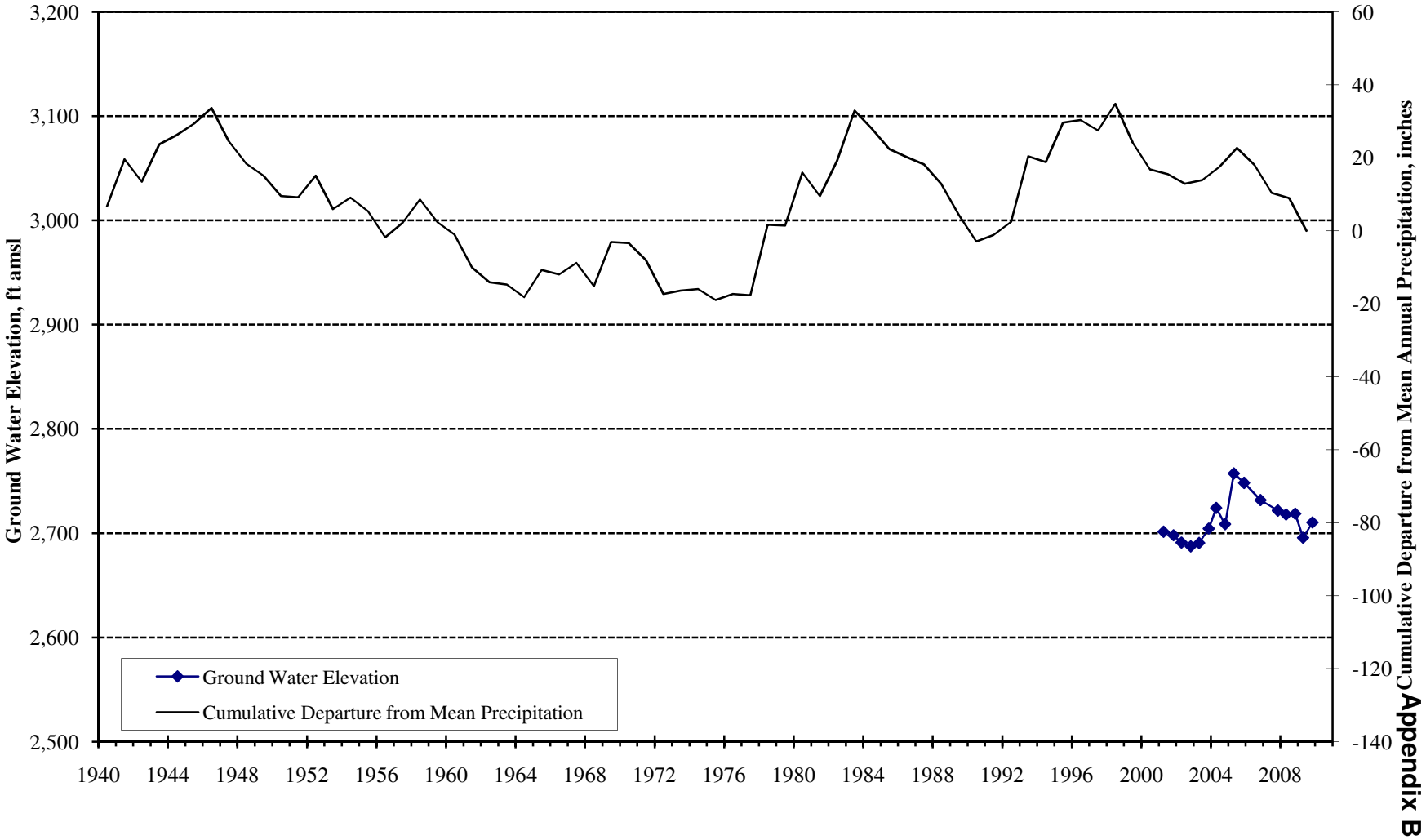
Appendix B

Ground Water Elevation
City of Banning Well 1 (2S/1E-33J1)
Banning Bench Storage Unit



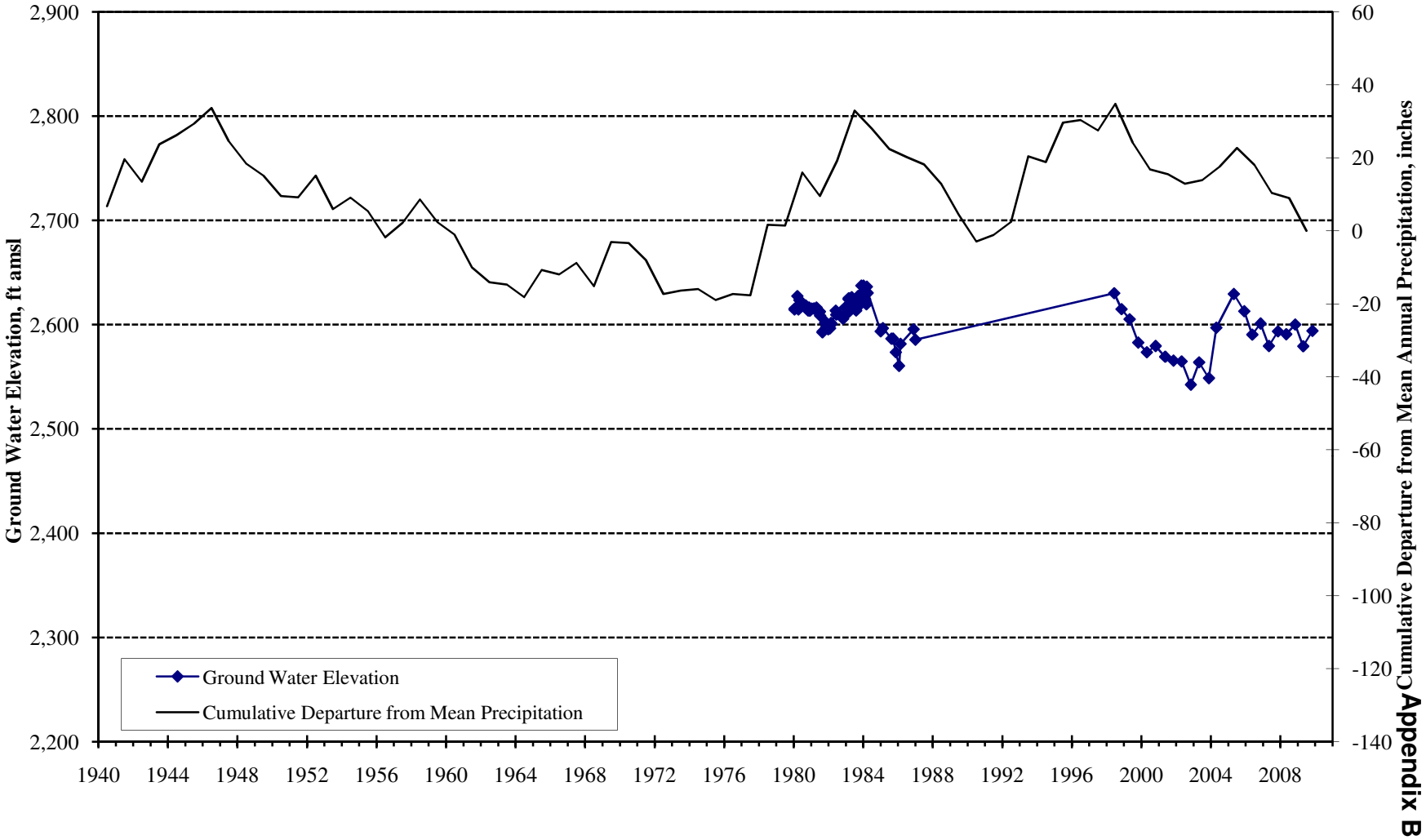
Appendix B

Ground Water Elevation
City of Banning Well 3 (2S/1E-33J2)
Banning Bench Storage Unit



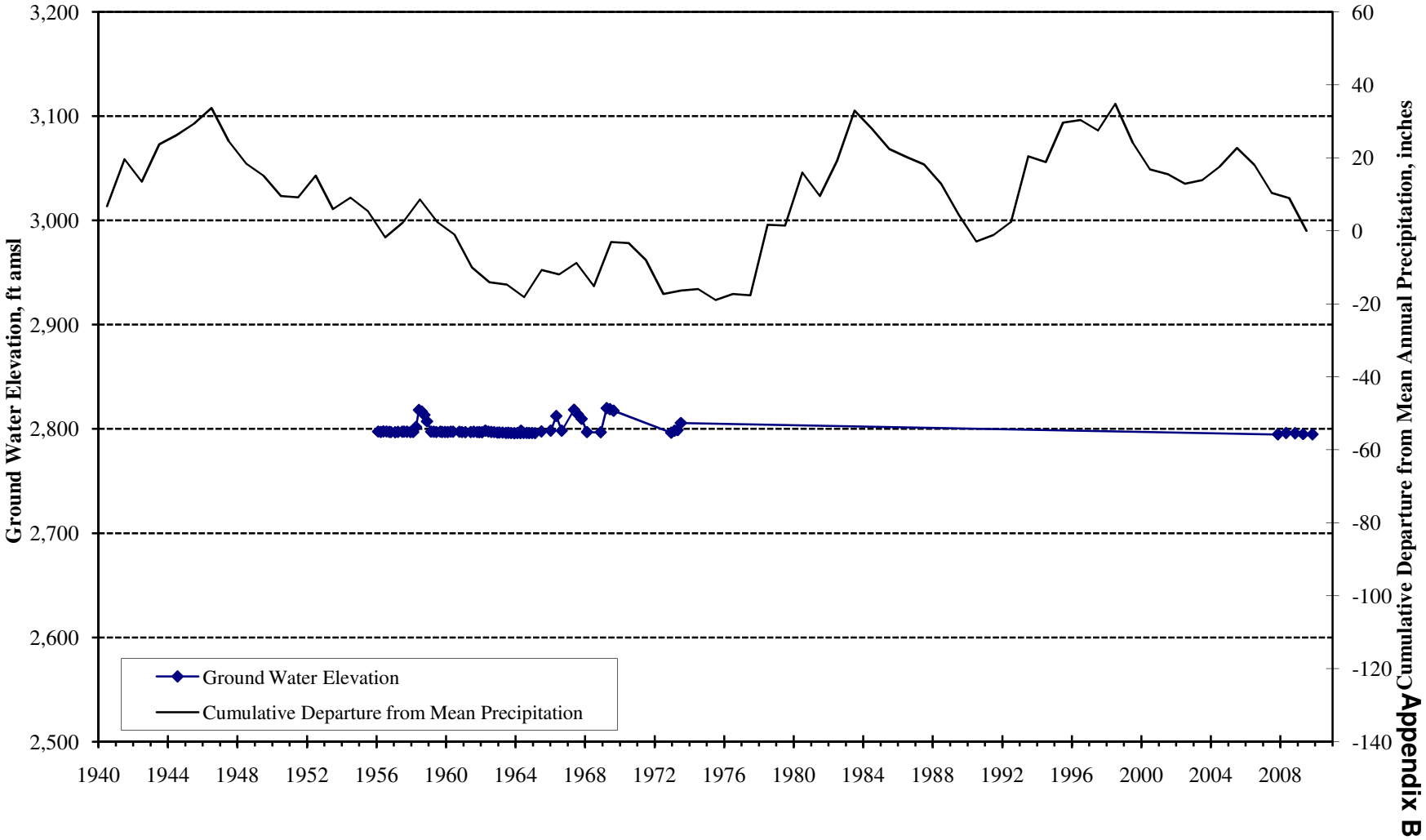
Appendix B

Ground Water Elevation
Well 3S/1E-04A1
Banning Bench Storage Unit



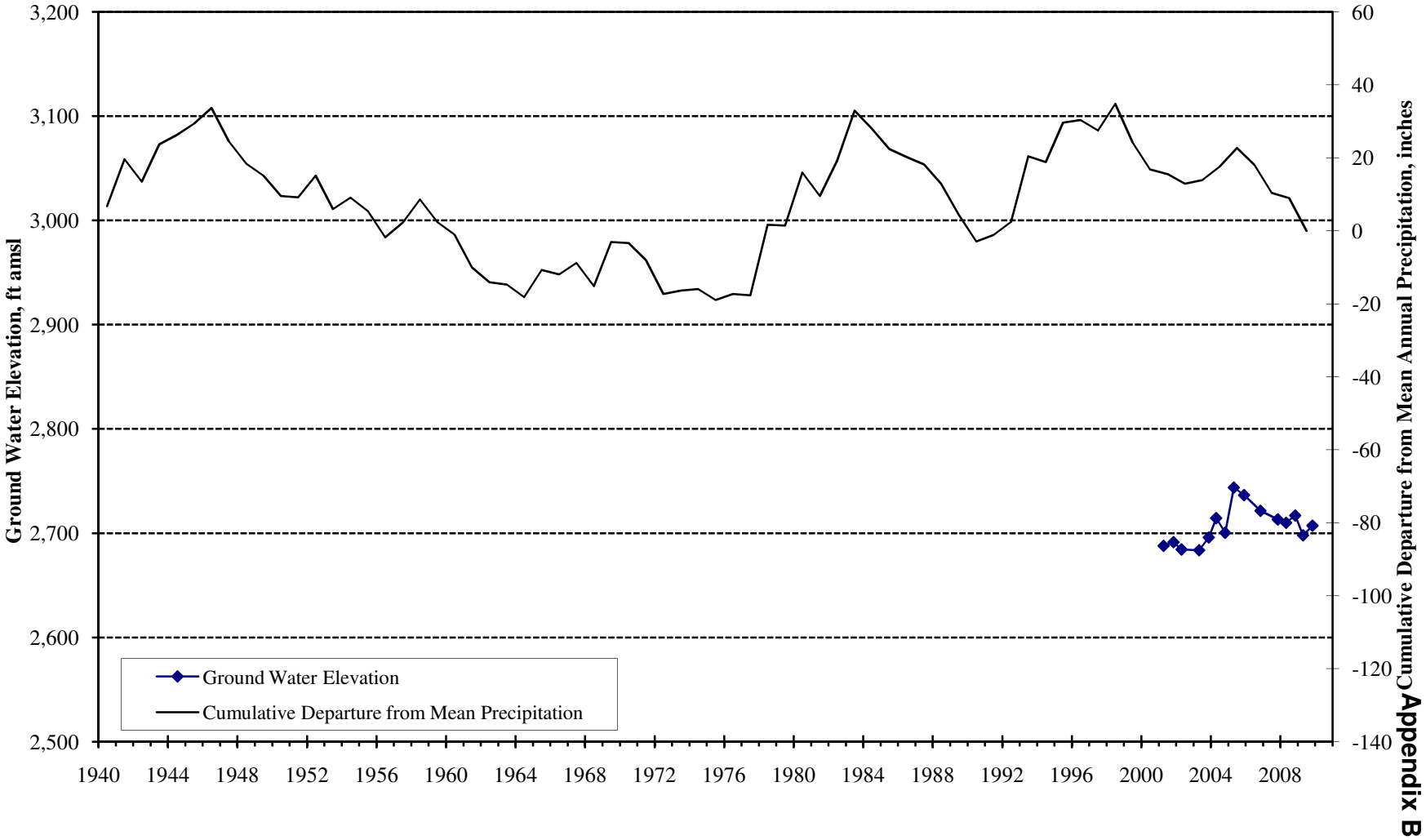
Appendix B

Ground Water Elevation
Well 2S/1E-33K1
Banning Bench Storage Unit



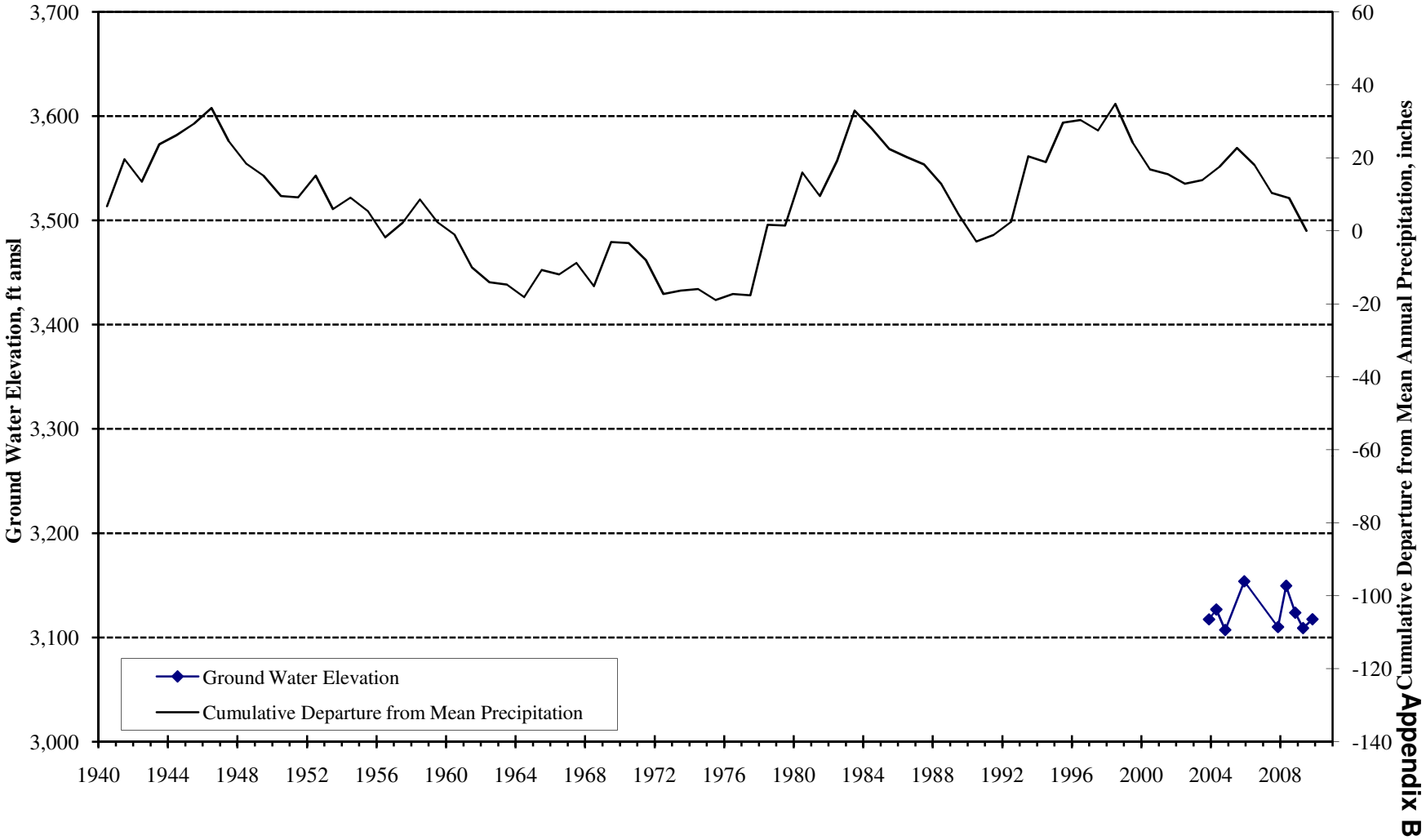
Appendix B

Ground Water Elevation
Well 2S/1E-33J4
Banning Bench Storage Unit



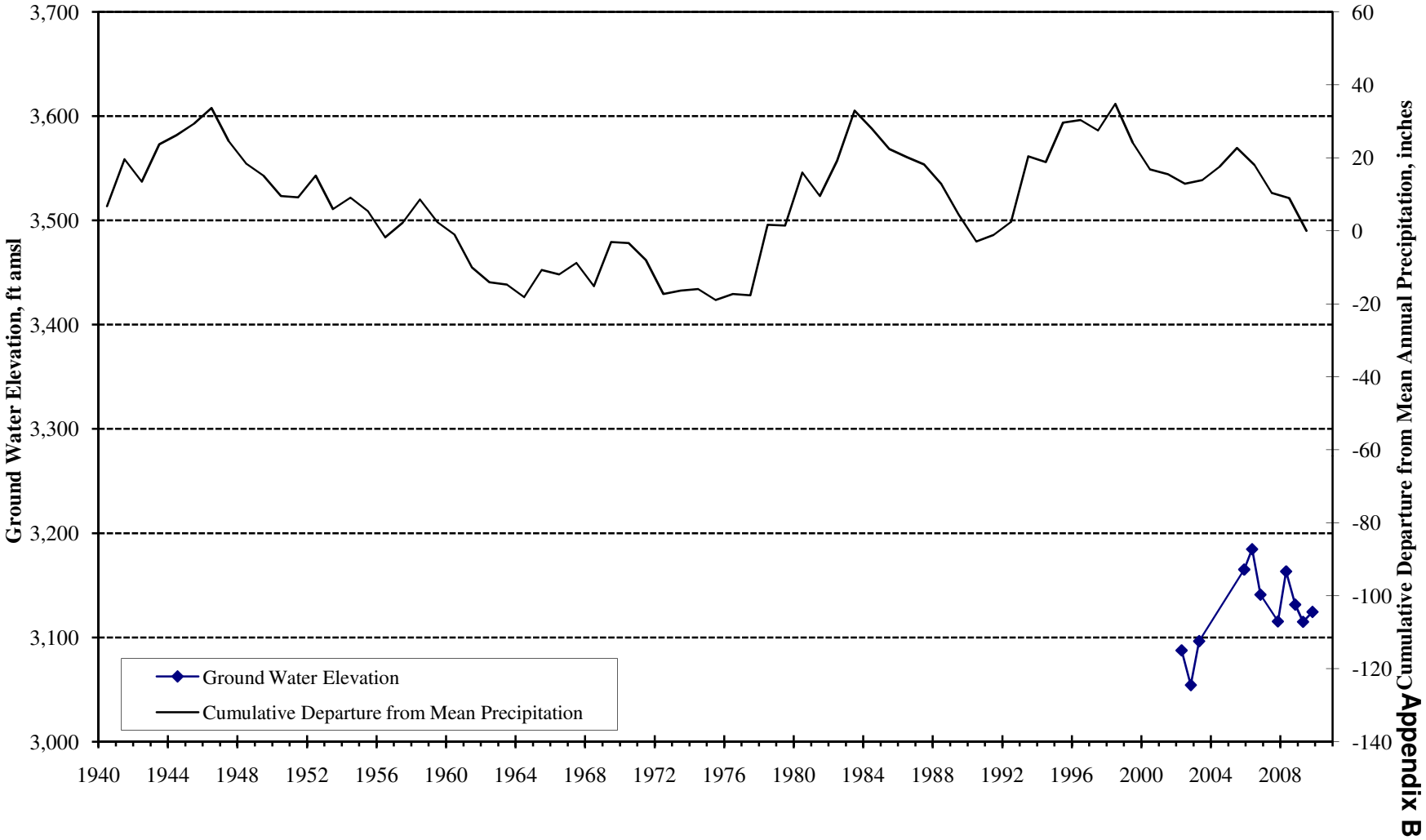
Appendix B

Ground Water Elevation
City of Banning Well 4 (2S/1E-29H1)
Banning Canyon Storage Unit



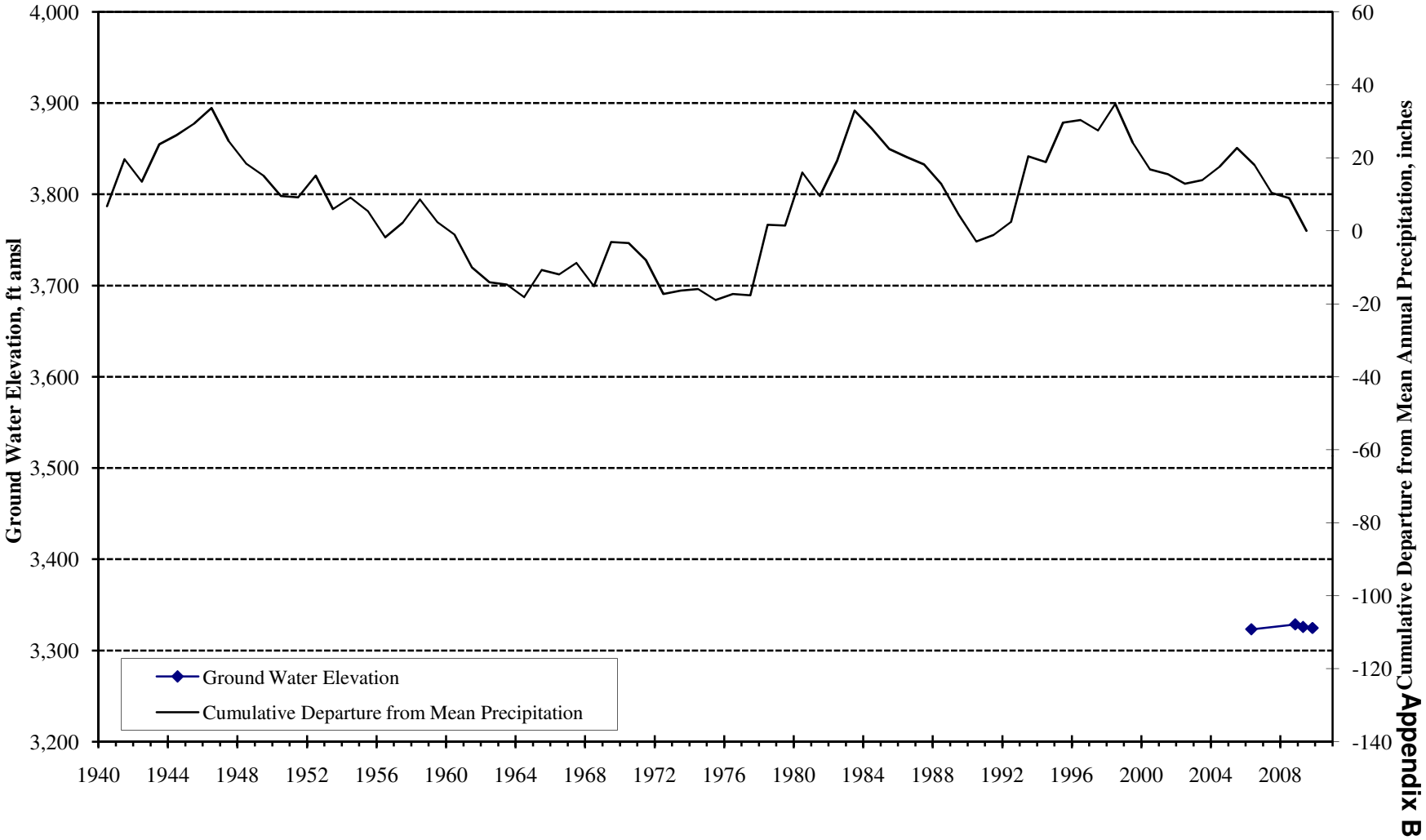
Appendix B

Ground Water Elevation
City of Banning Well 5 (2S/1E-29B1)
Banning Canyon Storage Unit



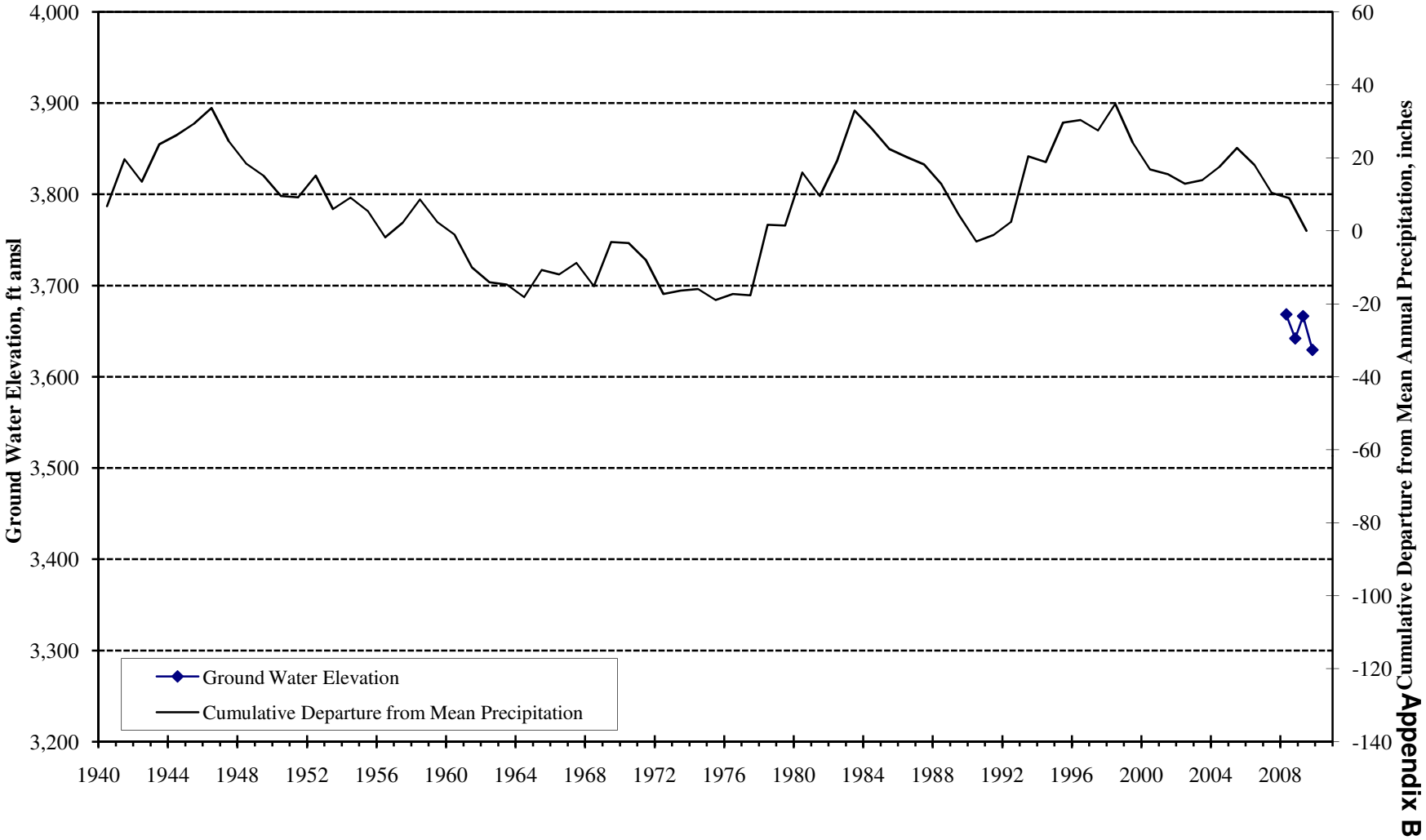
Appendix B

Ground Water Elevation
City of Banning Well 6 (2S/1E-20P1)
Banning Canyon Storage Unit



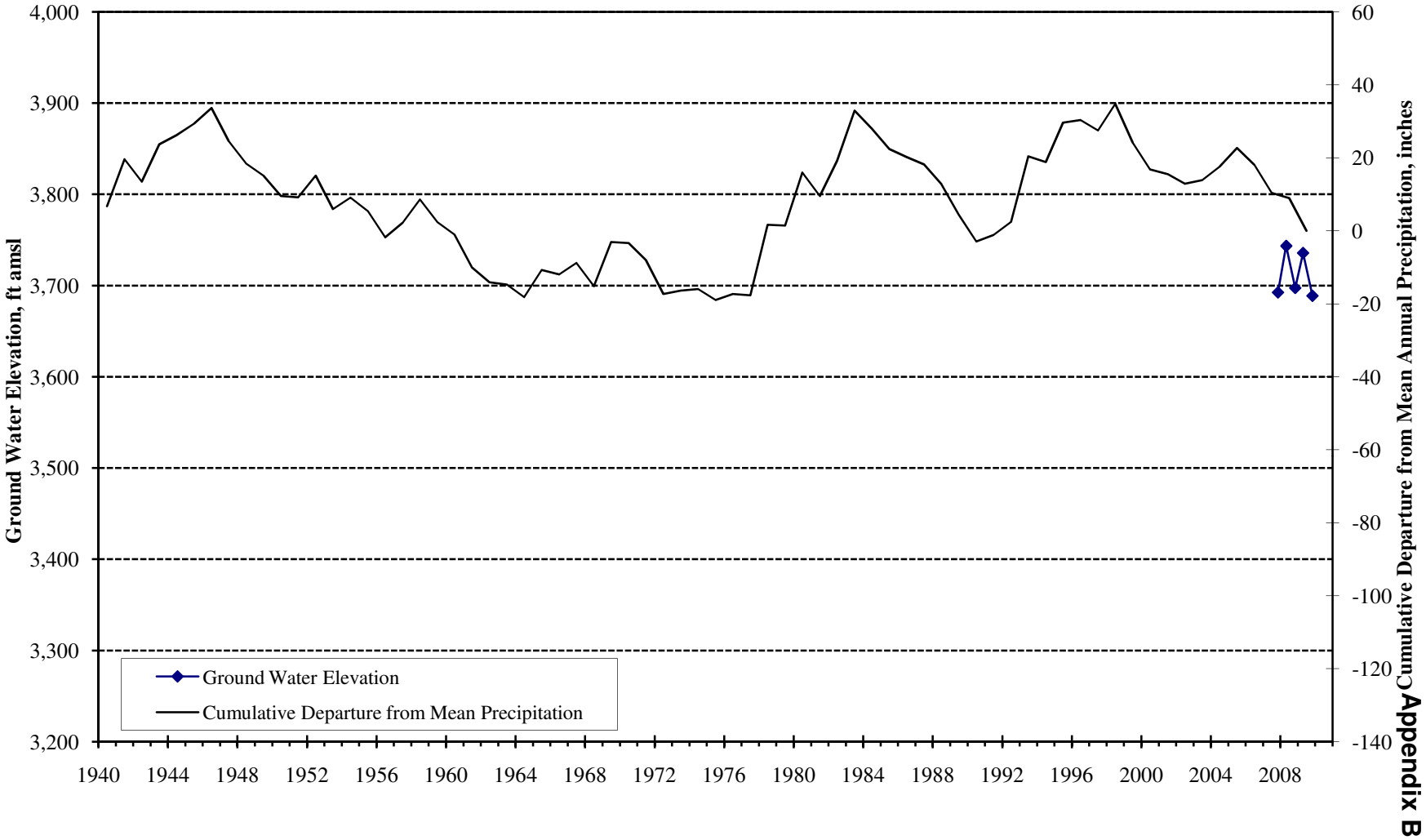
Appendix B

Ground Water Elevation
City of Banning Well 7 (2S/1E-17M1)
Banning Canyon Storage Unit



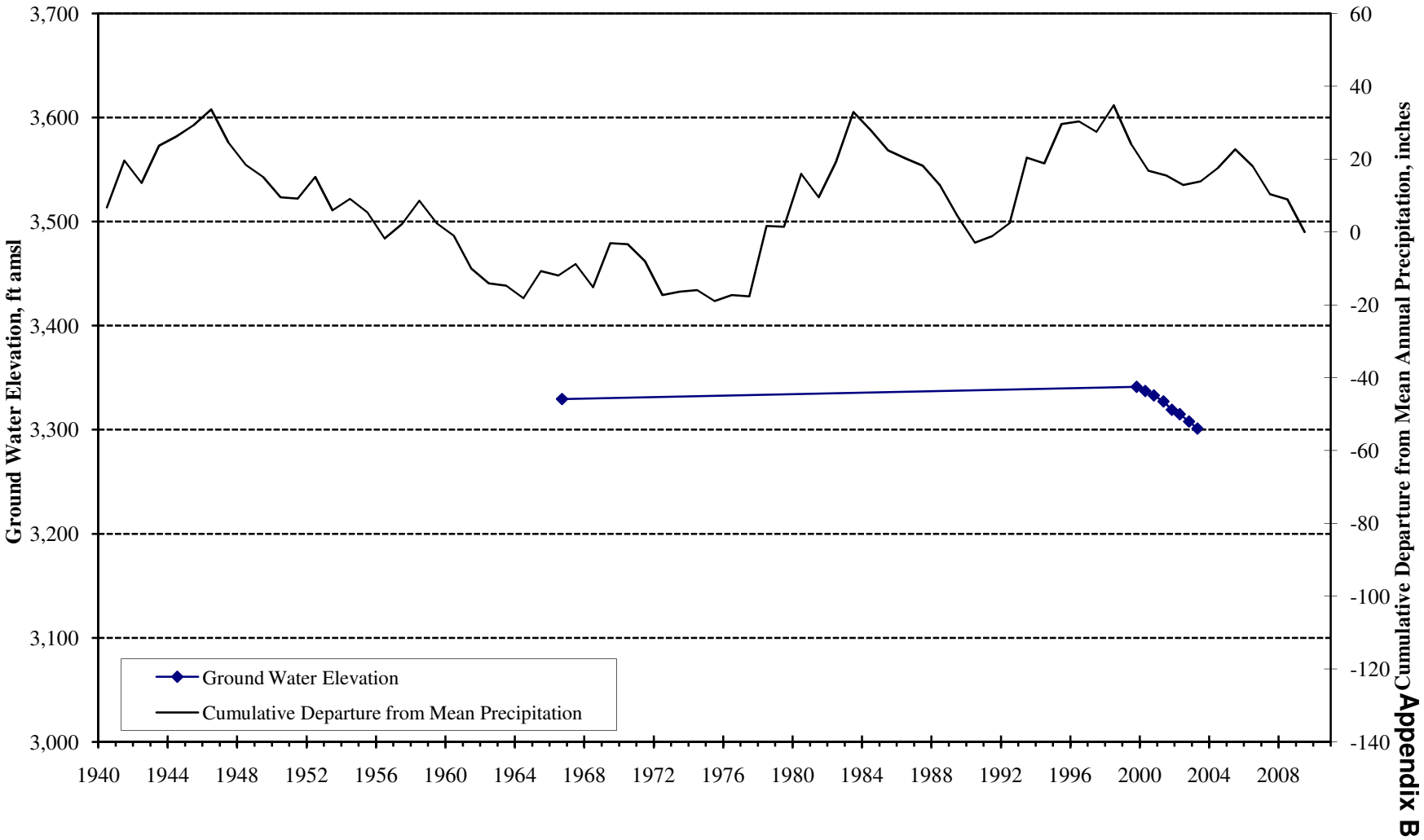
Appendix B

Ground Water Elevation
City of Banning Well 8 (2S/1E-17F2)
Banning Canyon Storage Unit



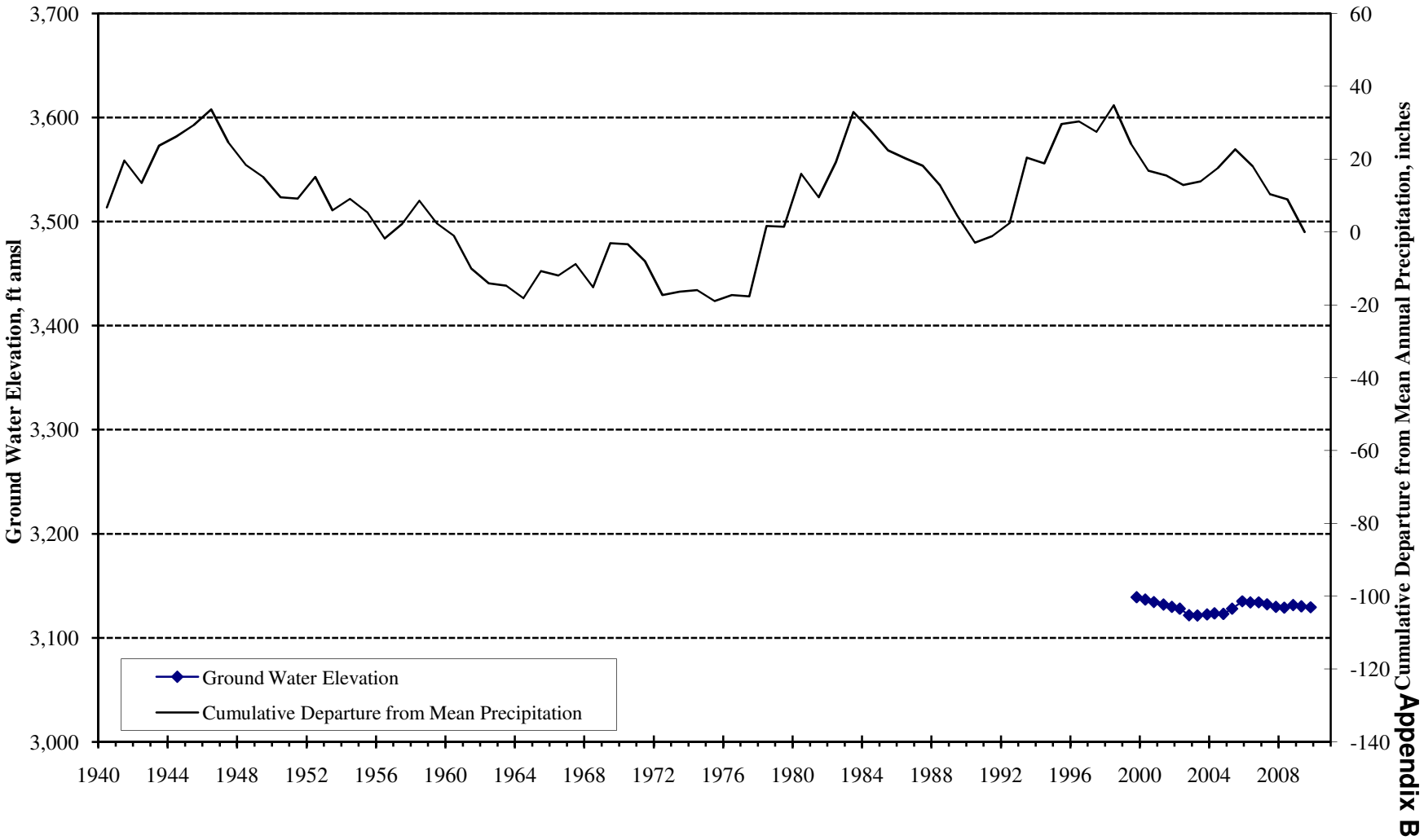
Appendix B

Ground Water Elevation
Banning Heights Mutual Water District Well 2 (2S/1E-29C1)
Banning Canyon Storage Unit



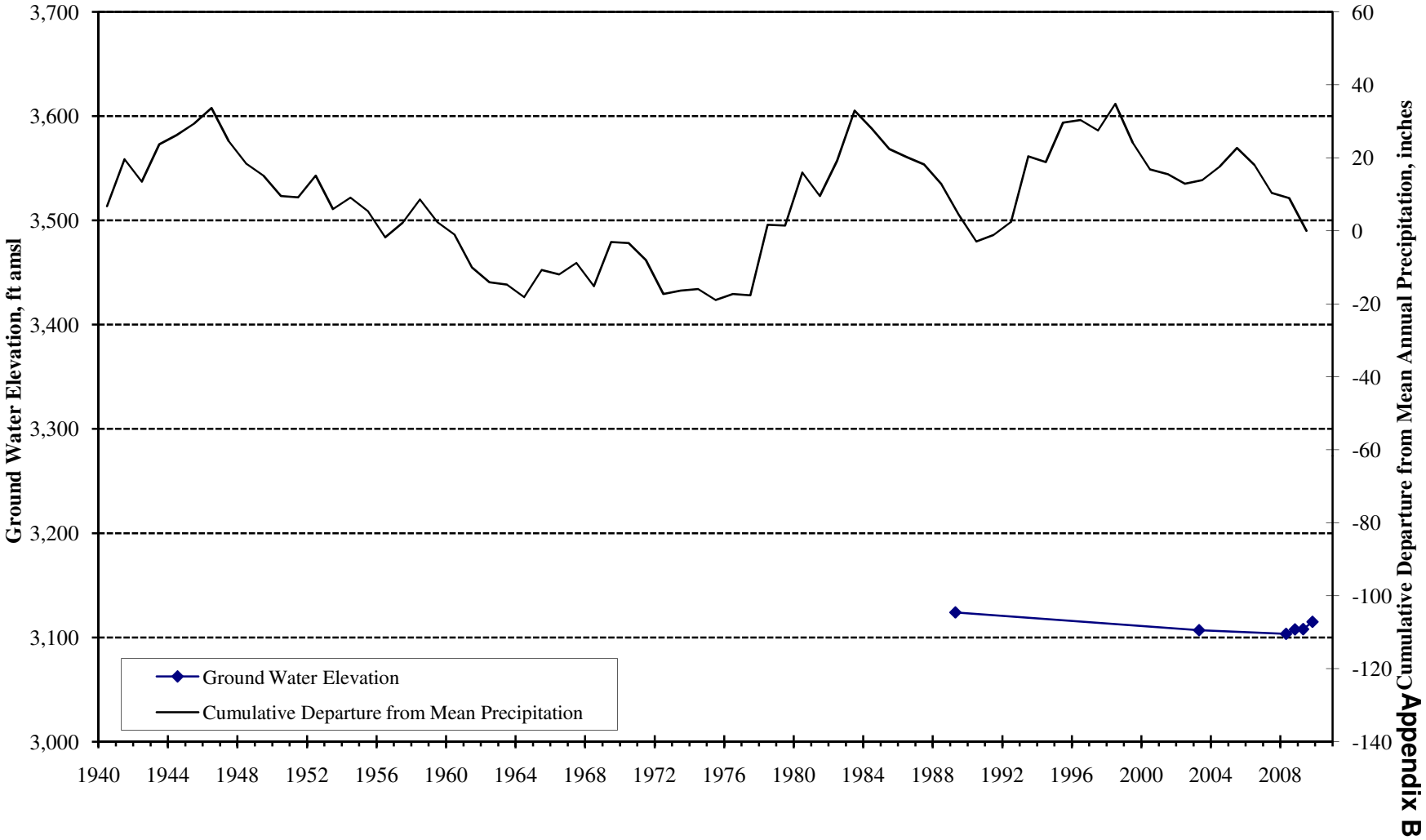
Appendix B

Ground Water Elevation
Banning Heights Mutual Water District Well 3 (2S/1E-29P1)
Banning Canyon Storage Unit



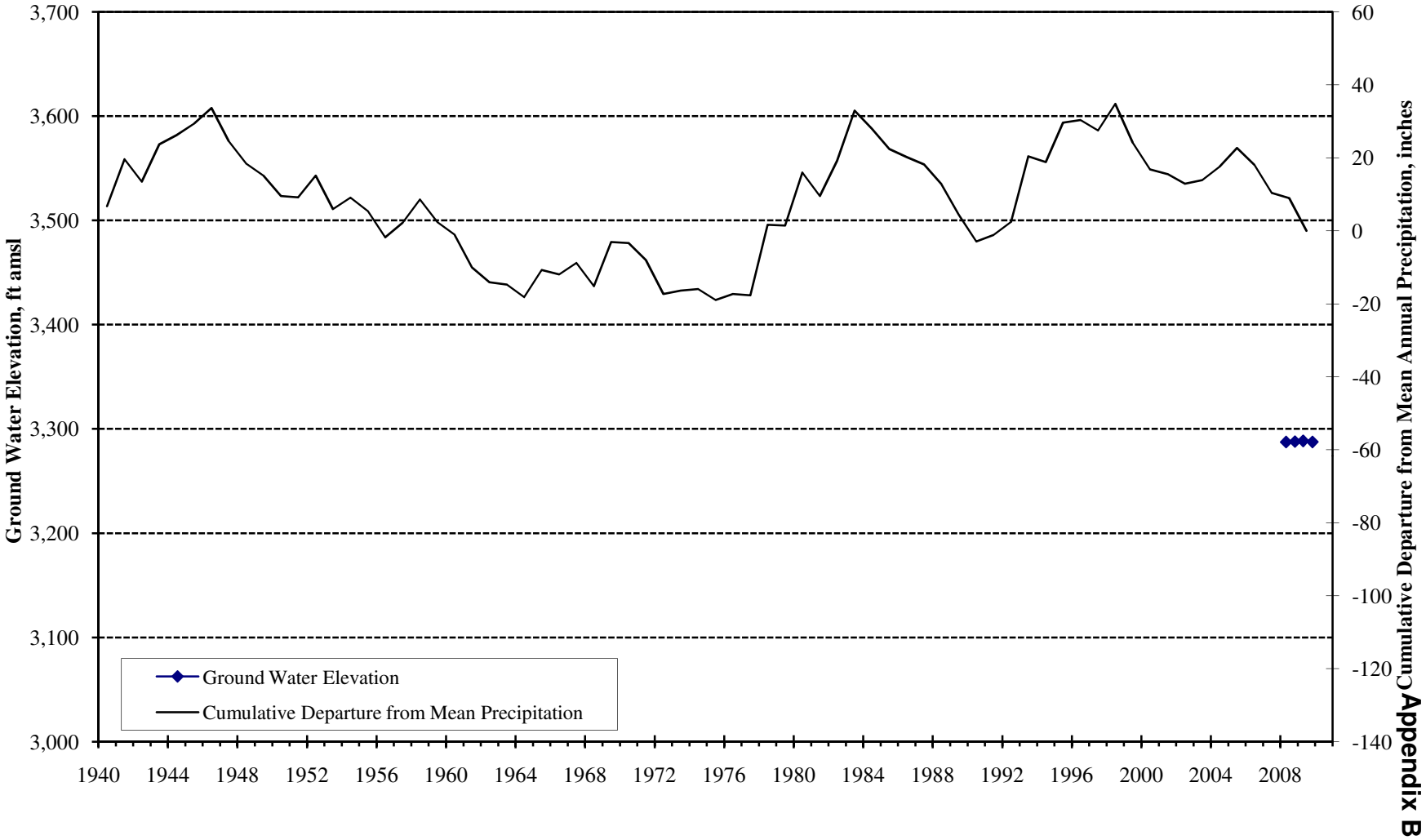
Appendix B

Ground Water Elevation
Well 2S/1E-29K2
Banning Canyon Storage Unit



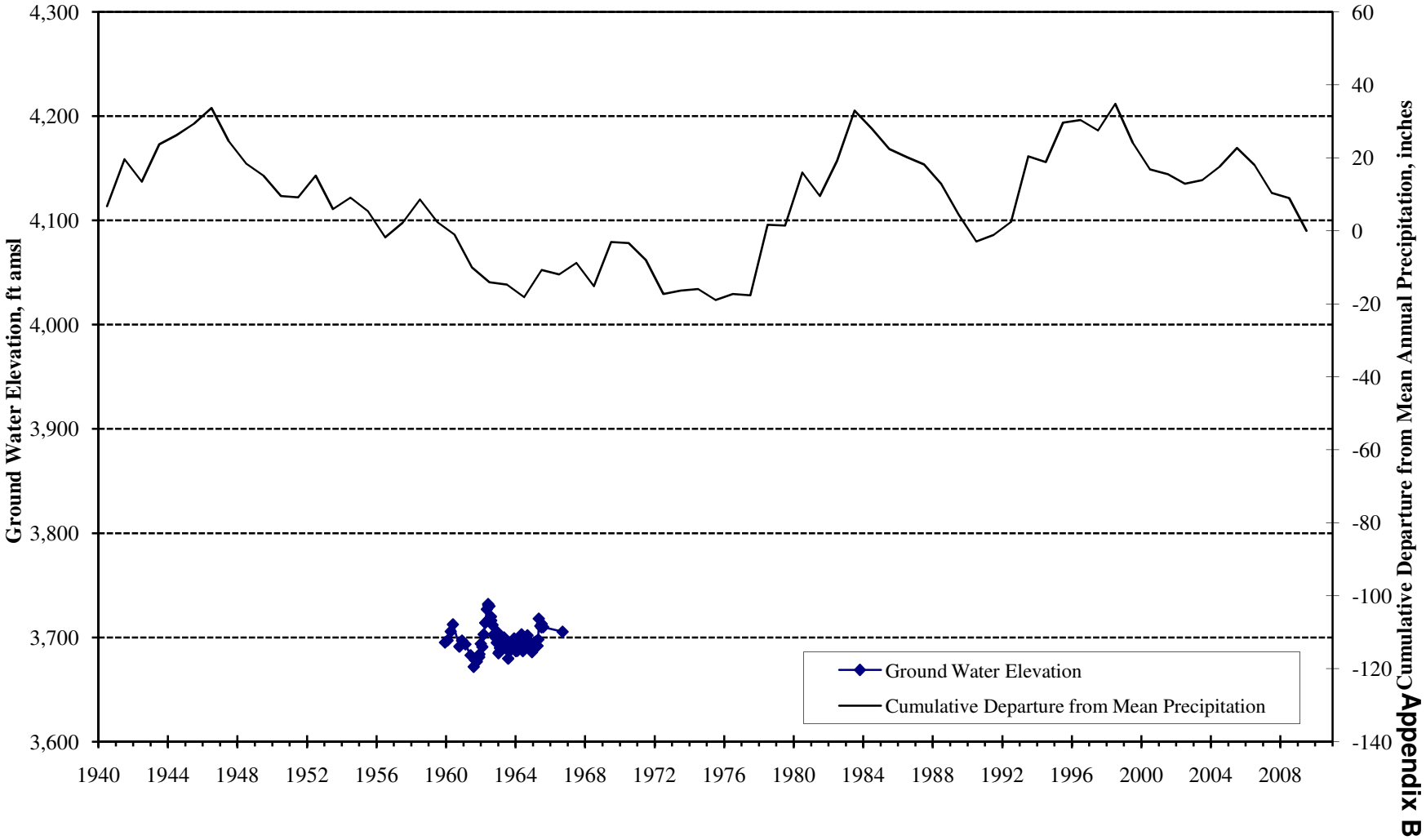
Appendix B

Ground Water Elevation
Well 2S/1E-29G1
Banning Canyon Storage Unit



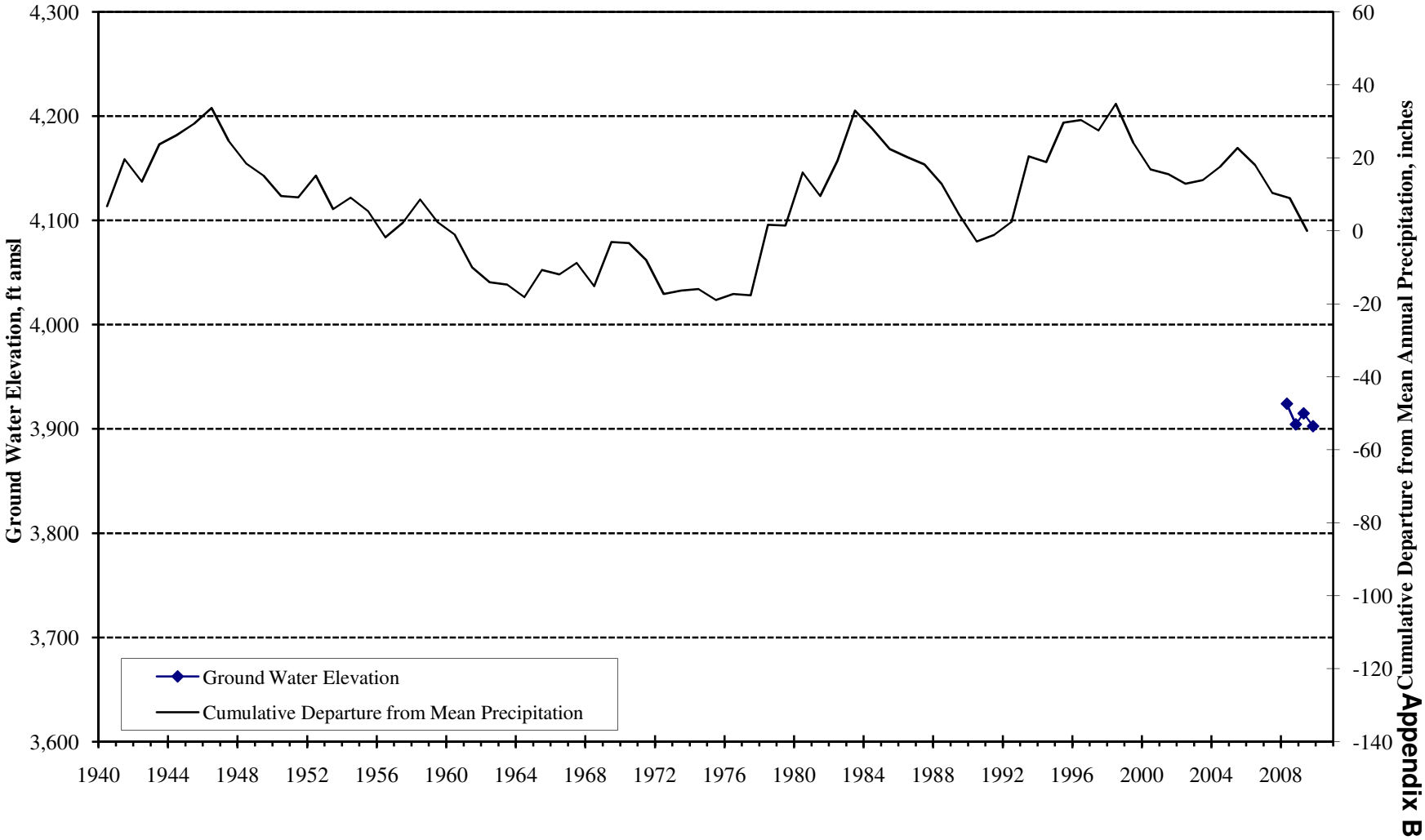
Appendix B

Ground Water Elevation
Well 2S/1E-17F1
Banning Canyon Storage Unit



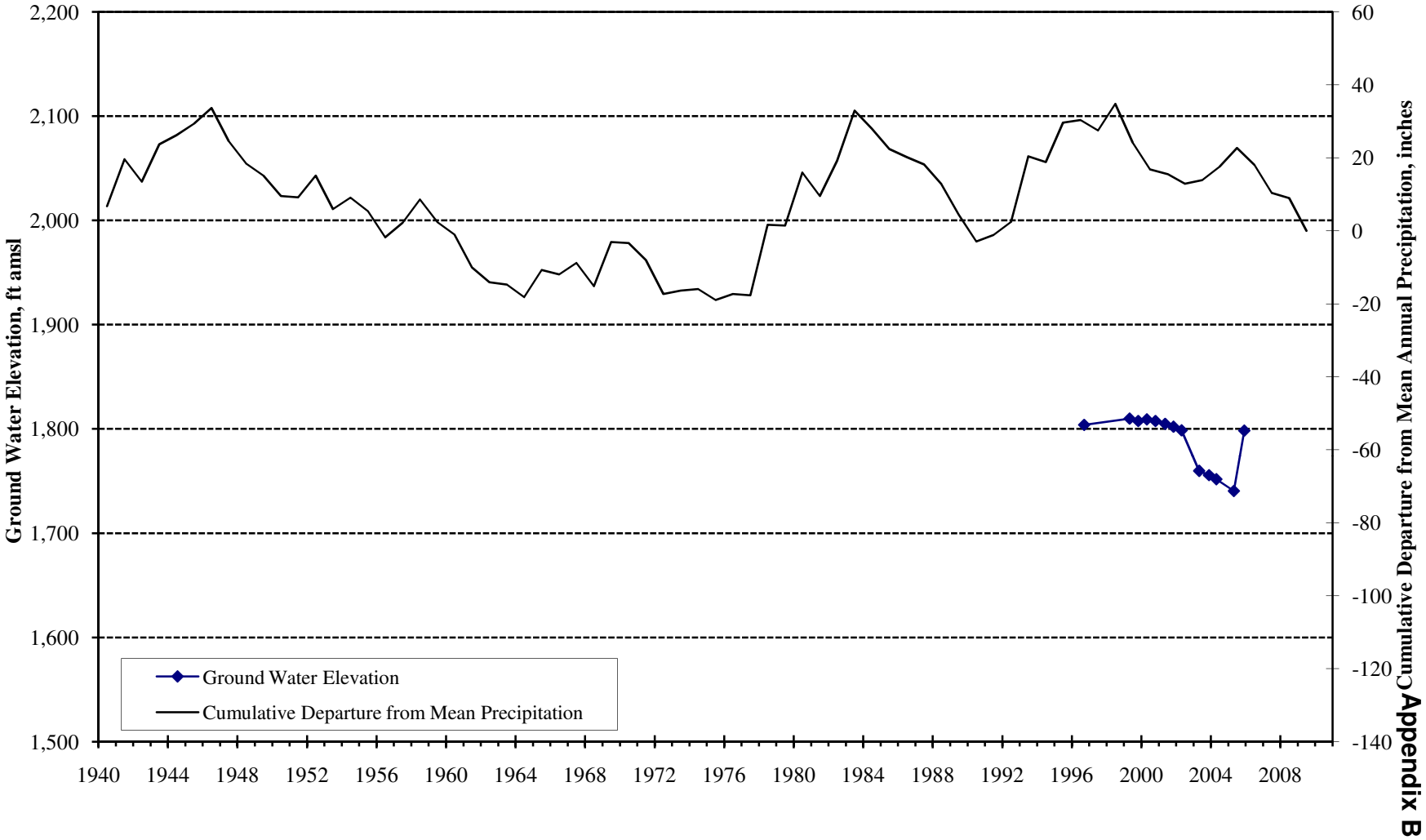
Appendix B

Ground Water Elevation
Well 2S/1E-08M1
Banning Canyon Storage Unit



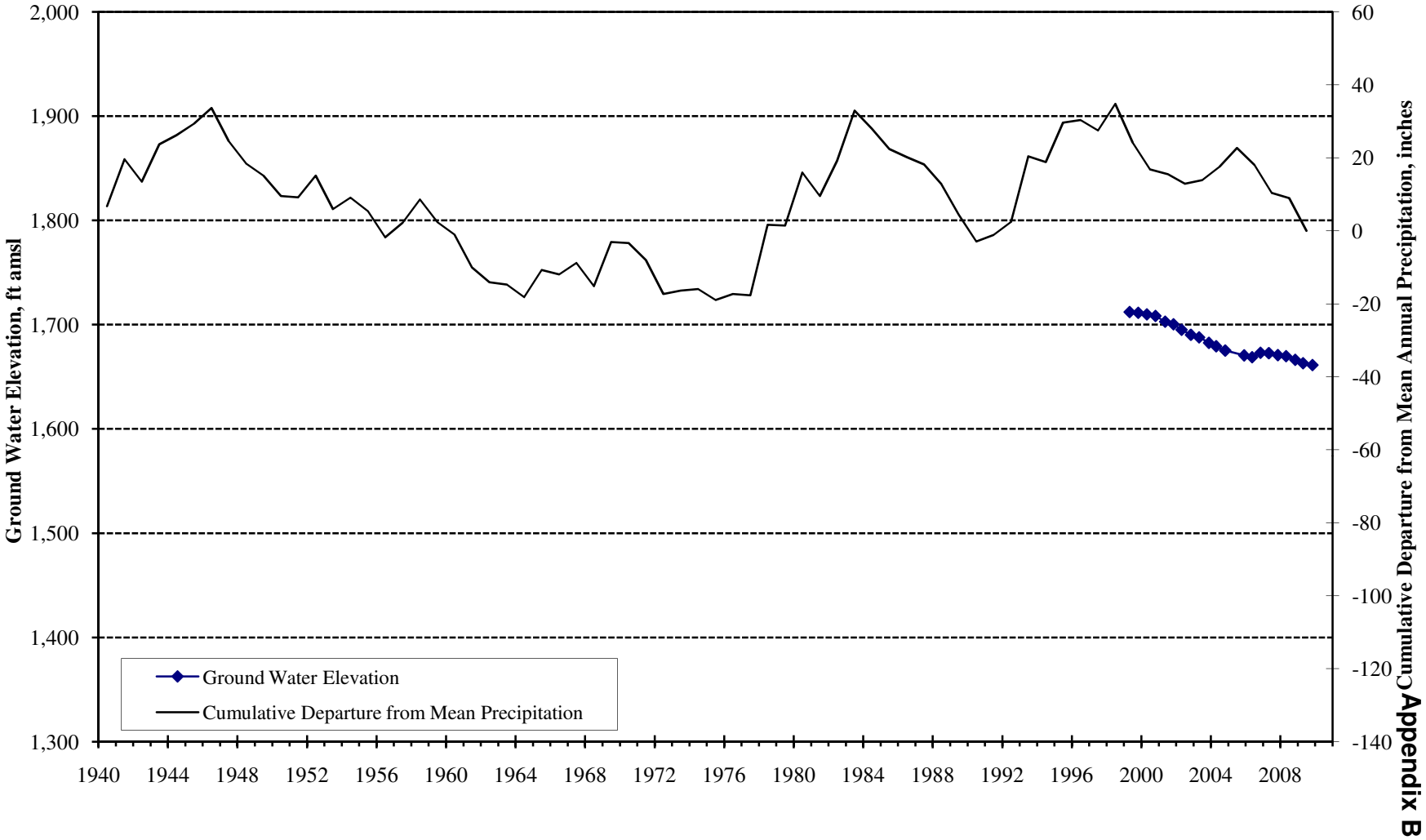
Appendix B

Ground Water Elevation
City of Banning Well C6 (3S/1E-10N1)
Cabazon Storage Unit



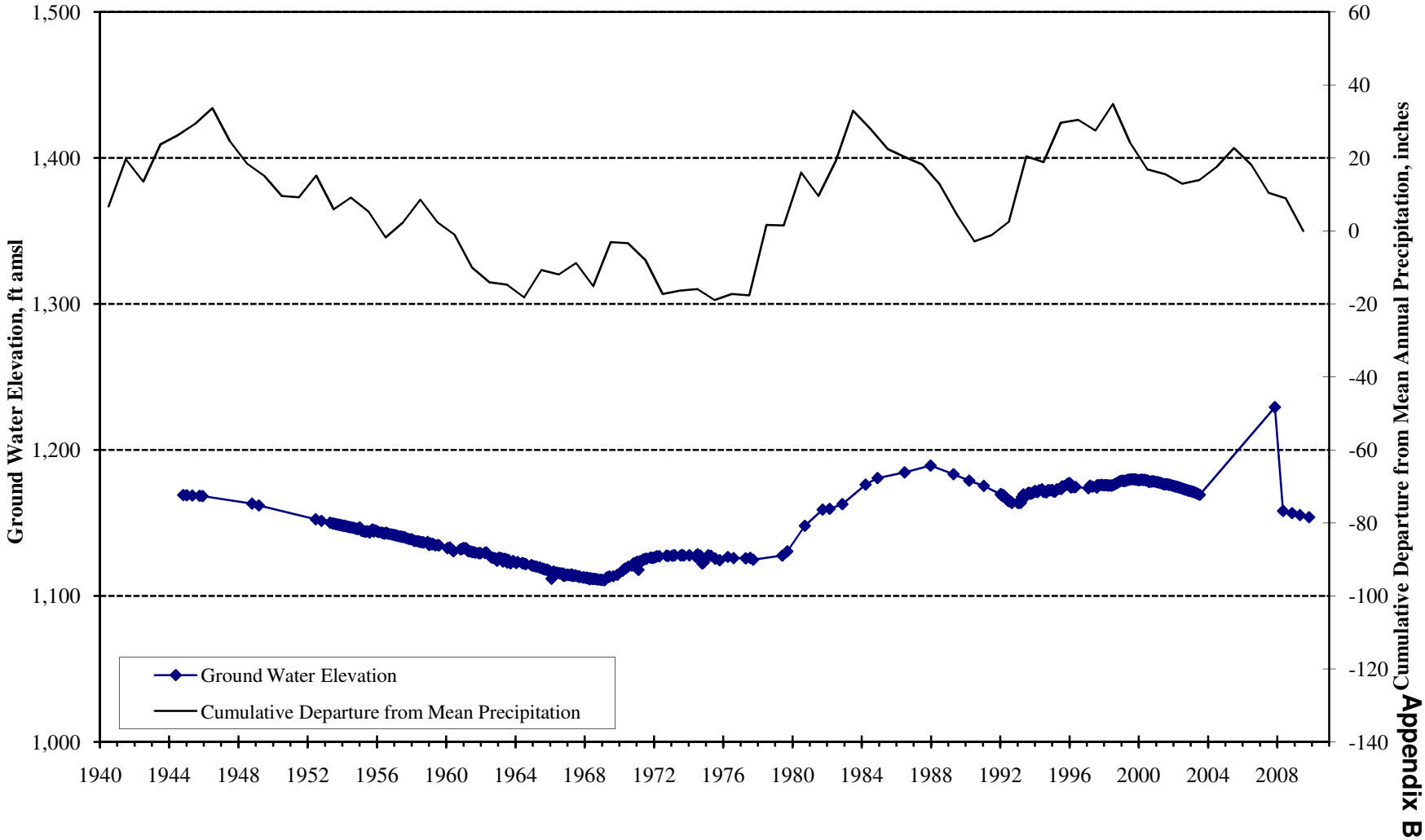
Appendix B

Ground Water Elevation
City of Banning Well R1 (3S/1E-14A1)
Cabazon Storage Unit



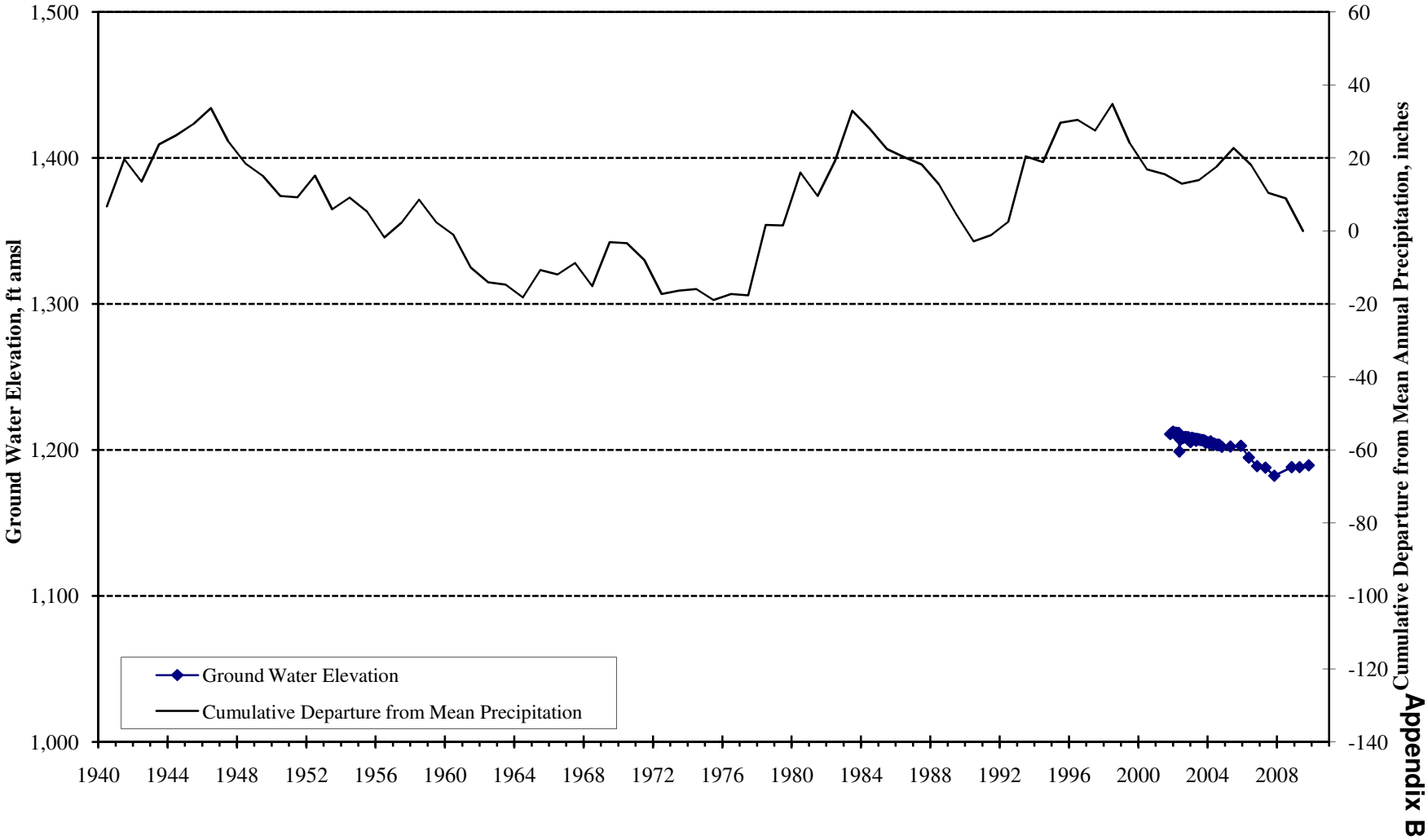
Appendix B

Ground Water Elevation
Well 3S/3E-08M1
Cabazon Storage Unit



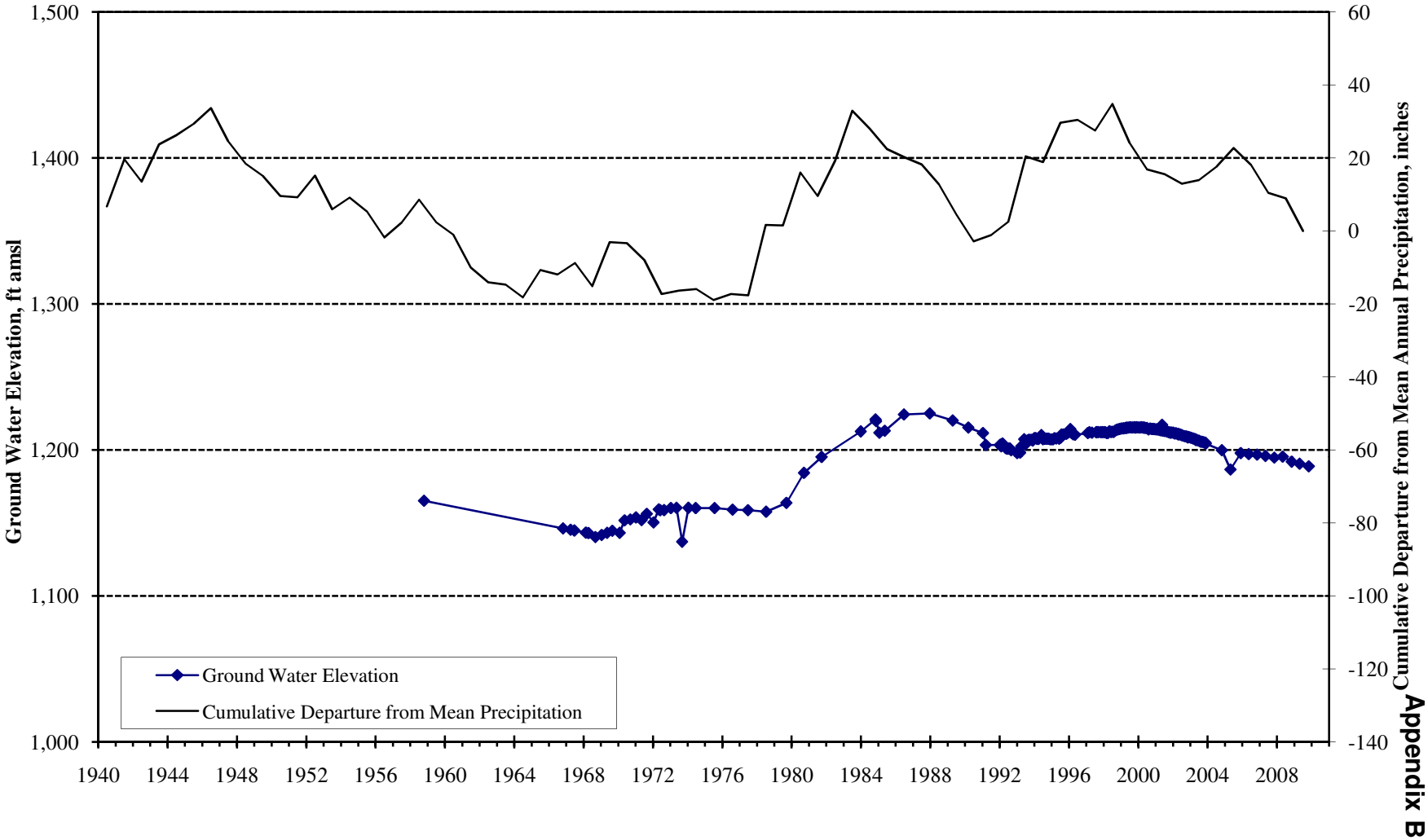
Appendix B

Ground Water Elevation
Well 3S/3E-08A1
Cabazon Storage Unit



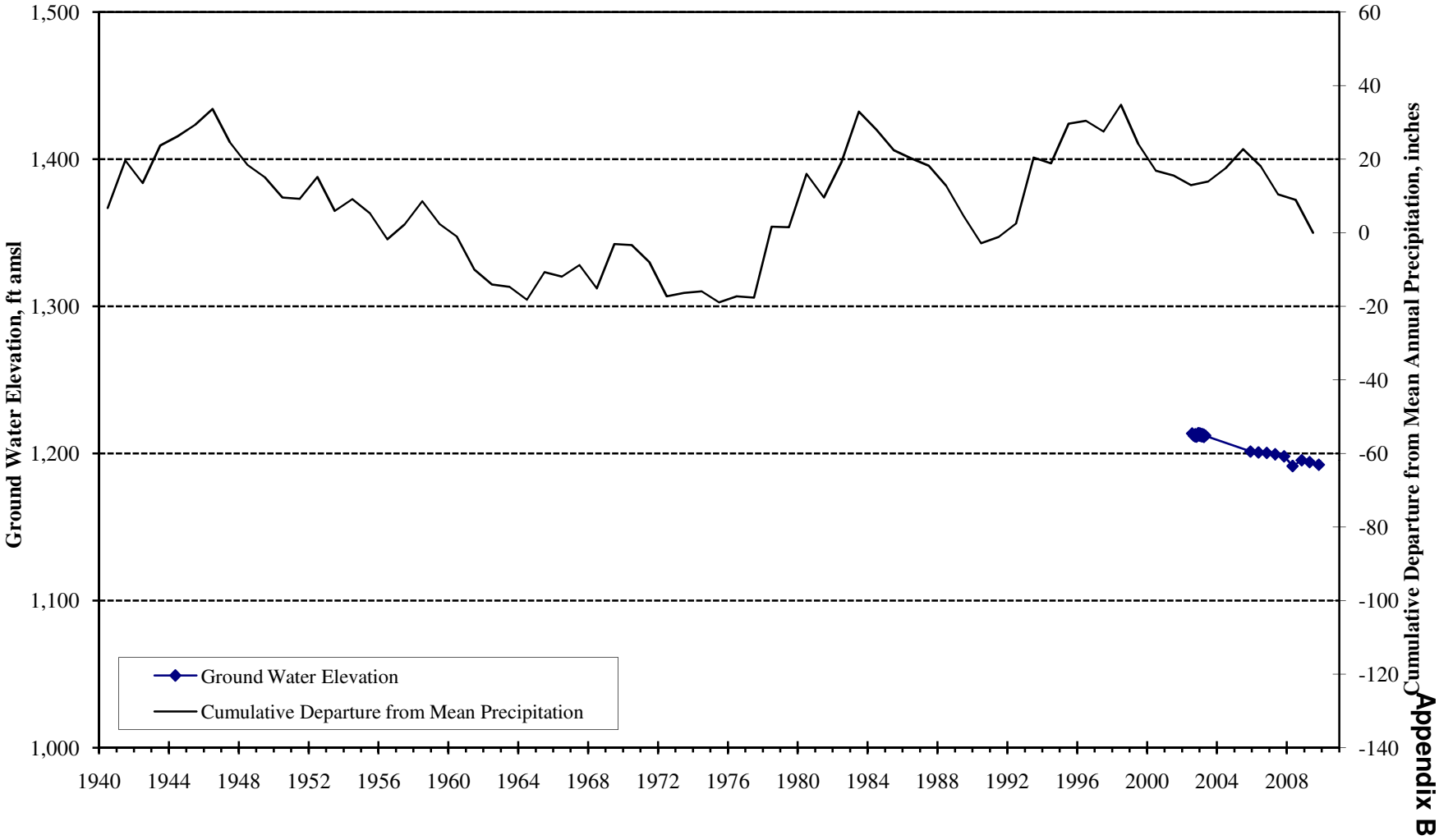
Appendix B

Ground Water Elevation
Well 3S/3E-07M1
Cabazon Storage Unit



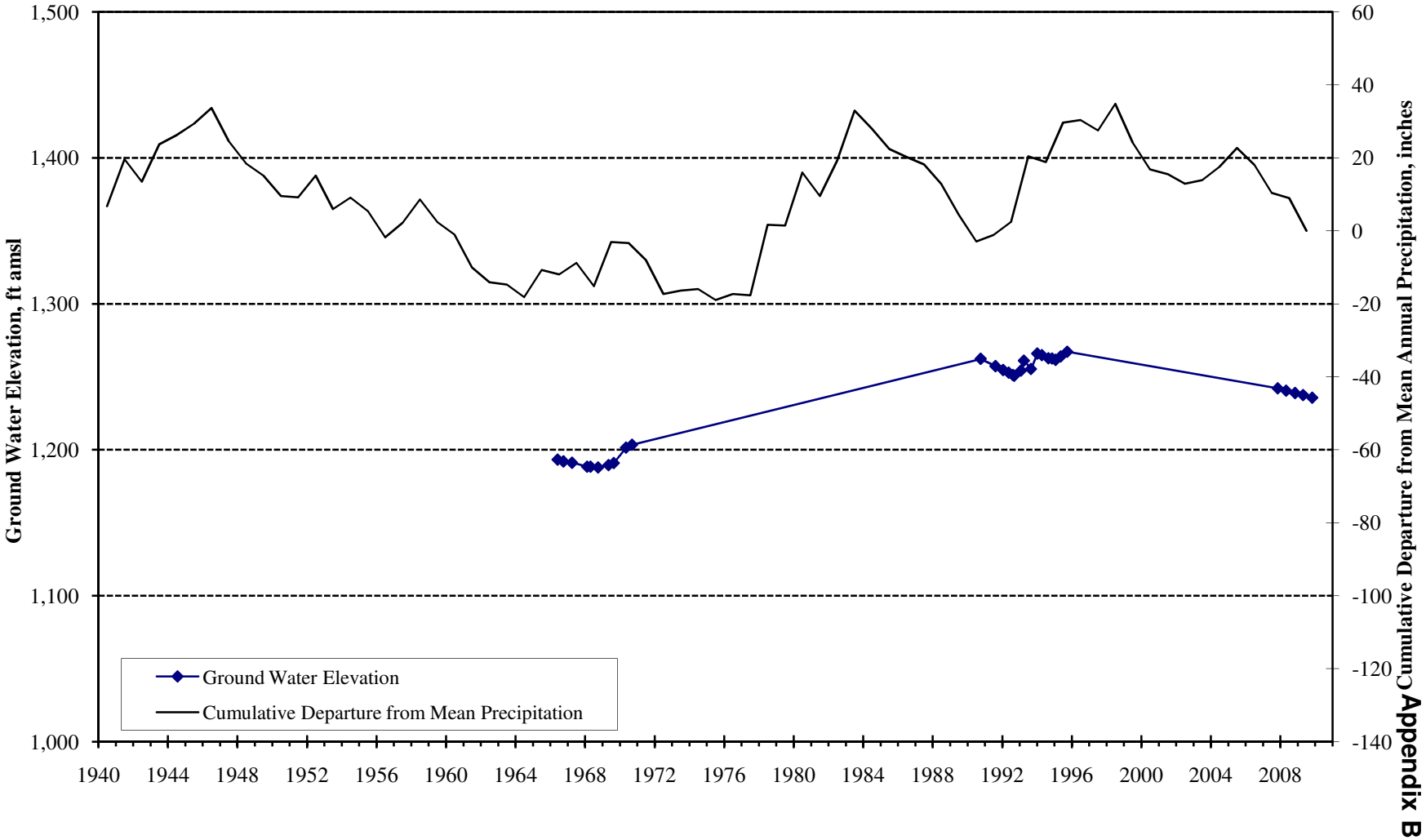
Appendix B

Ground Water Elevation
Well 3S/3E-07D1
Cabazon Storage Unit



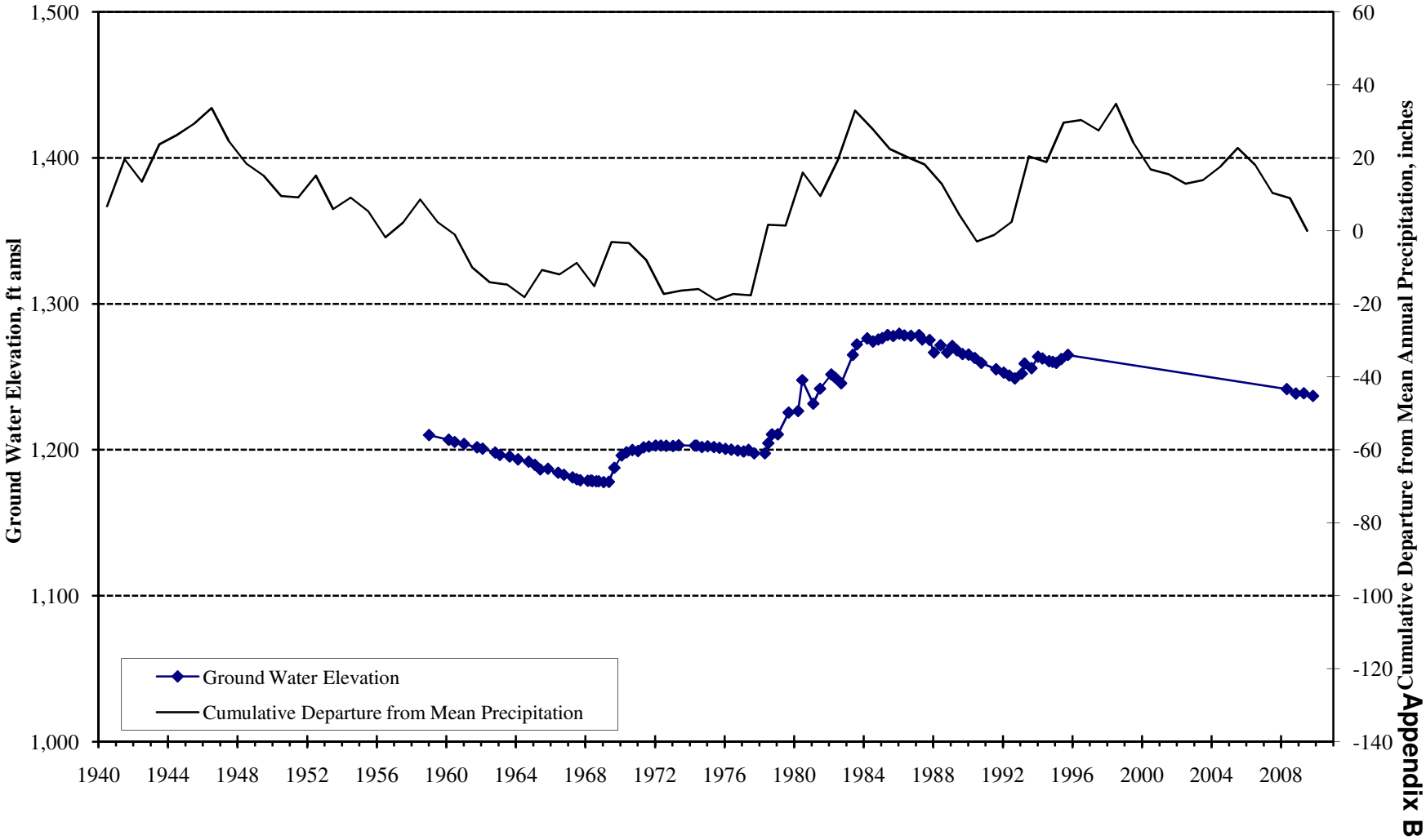
Appendix B

Ground Water Elevation
Well 3S/2E-23C1
Cabazon Storage Unit



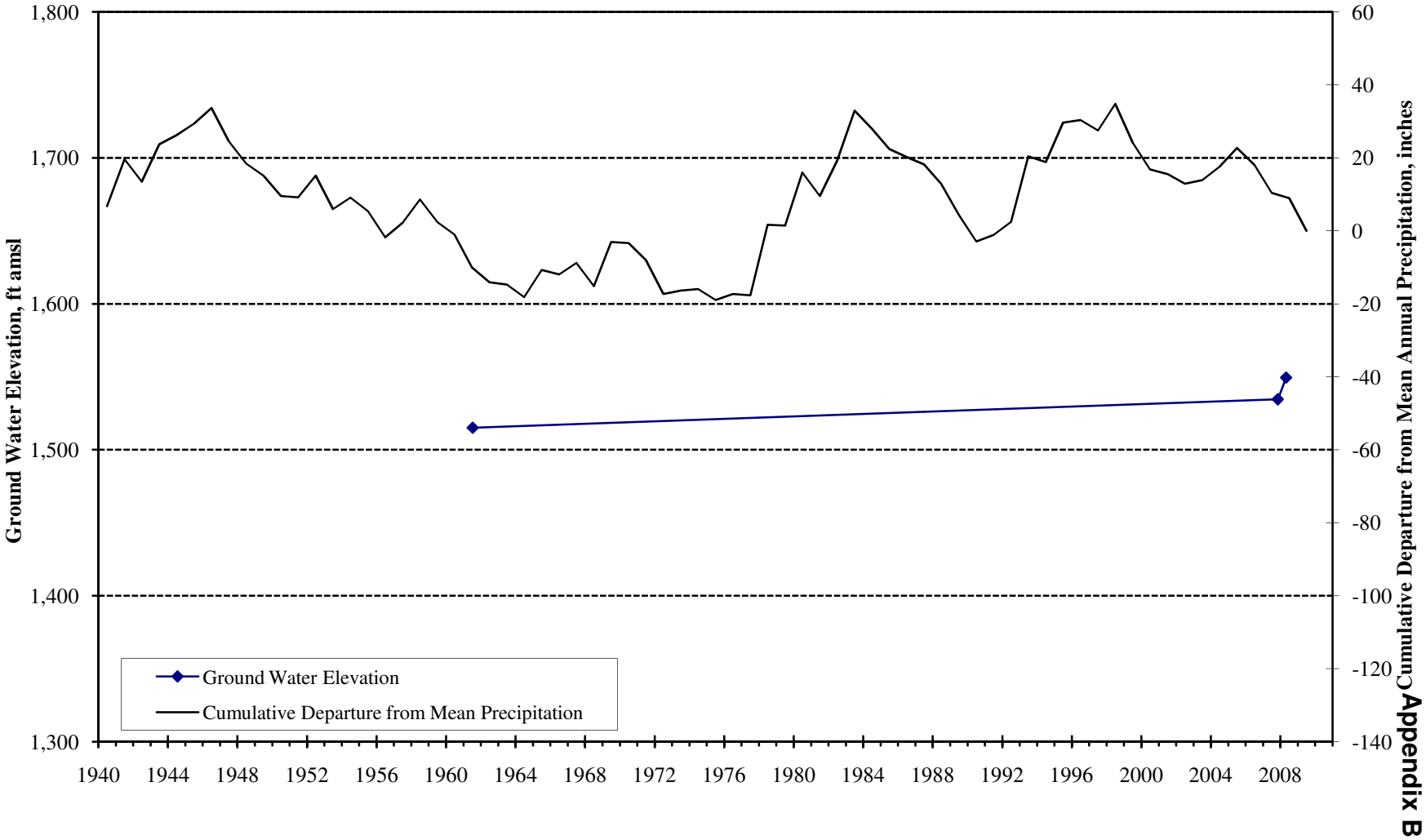
Appendix B

Ground Water Elevation
Well 3S/2E-23B1
Cabazon Storage Unit



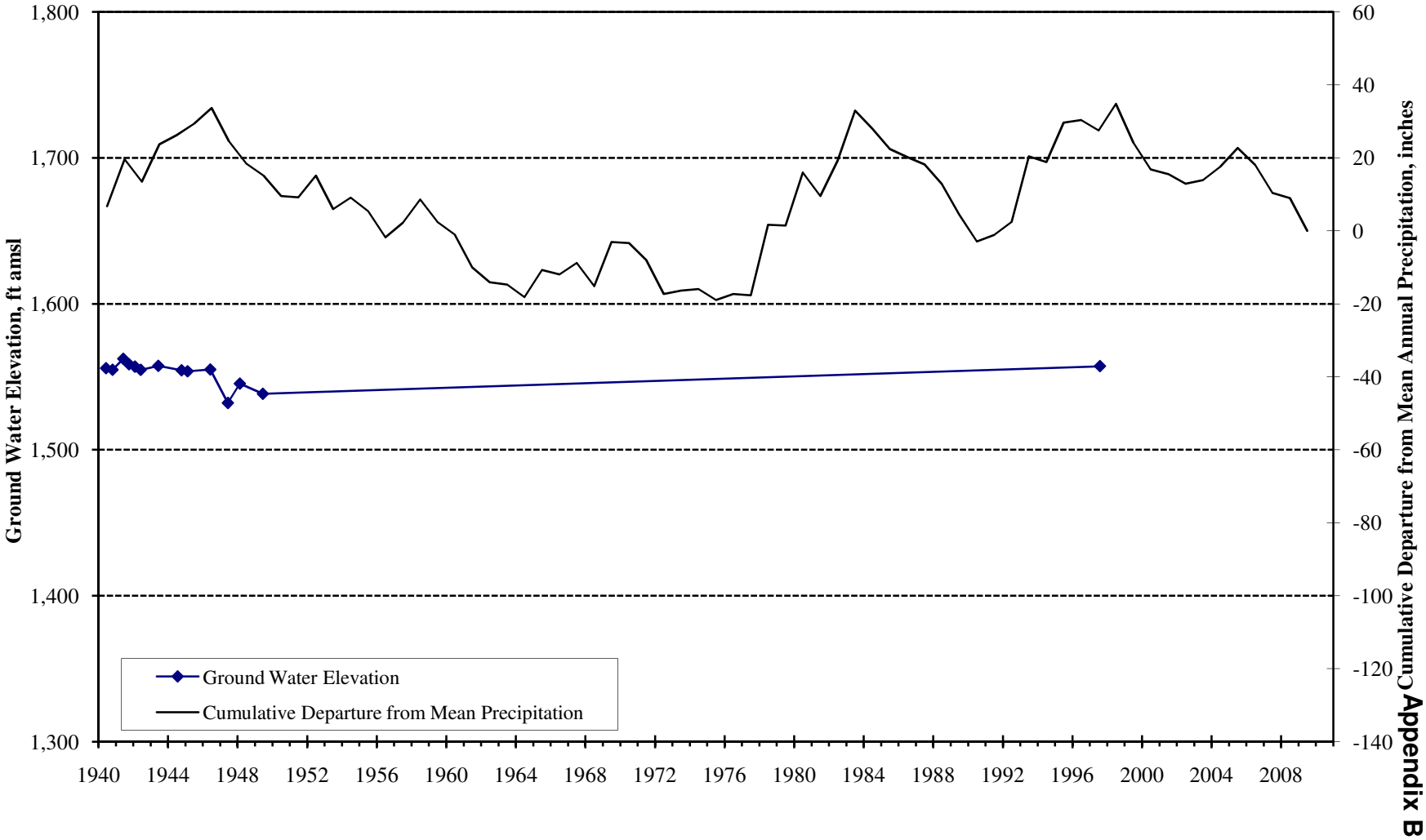
Appendix B

Ground Water Elevation
Well 3S/2E-22B1
Cabazon Storage Unit



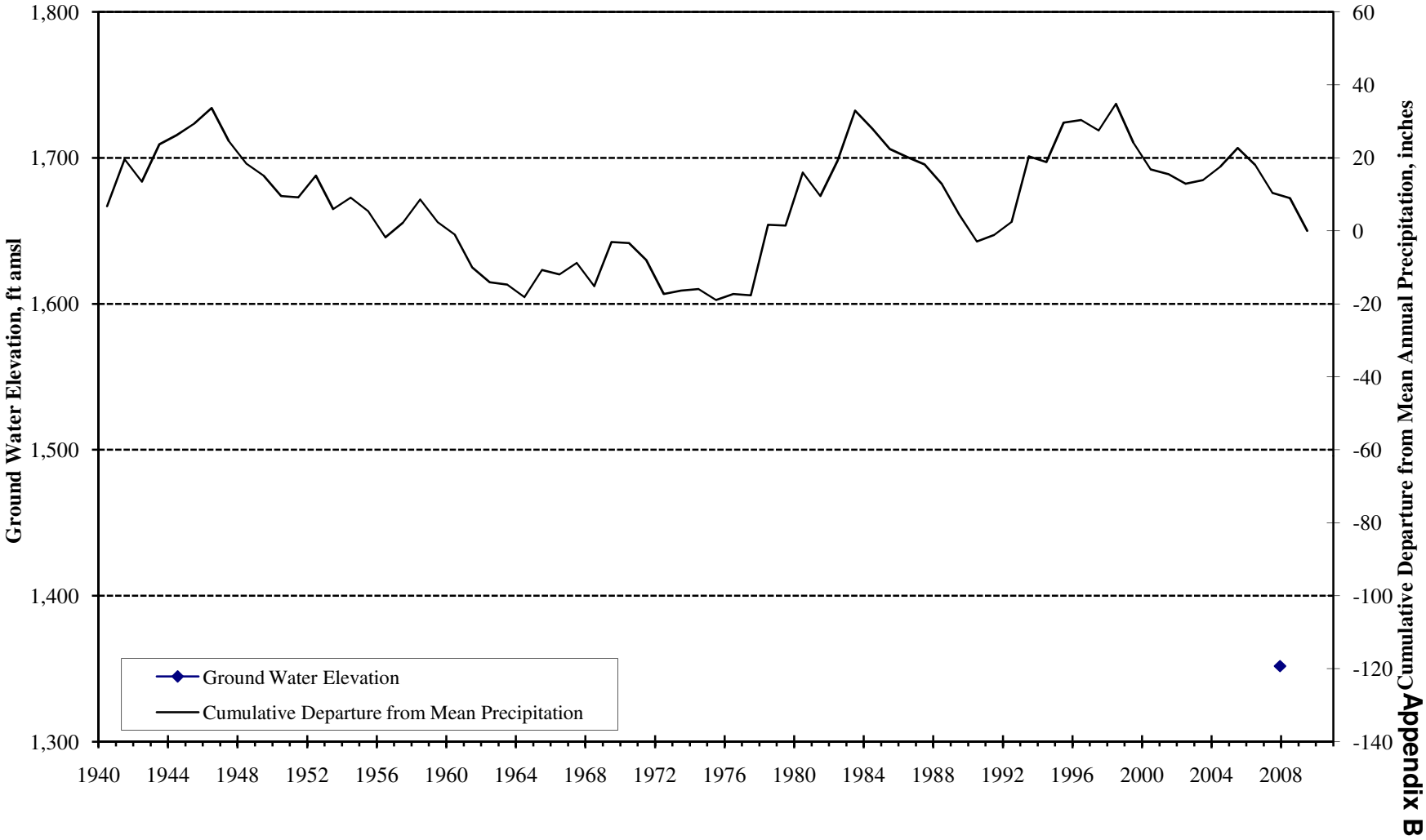
Appendix B

Ground Water Elevation
Well 3S/2E-18K1
Cabazon Storage Unit



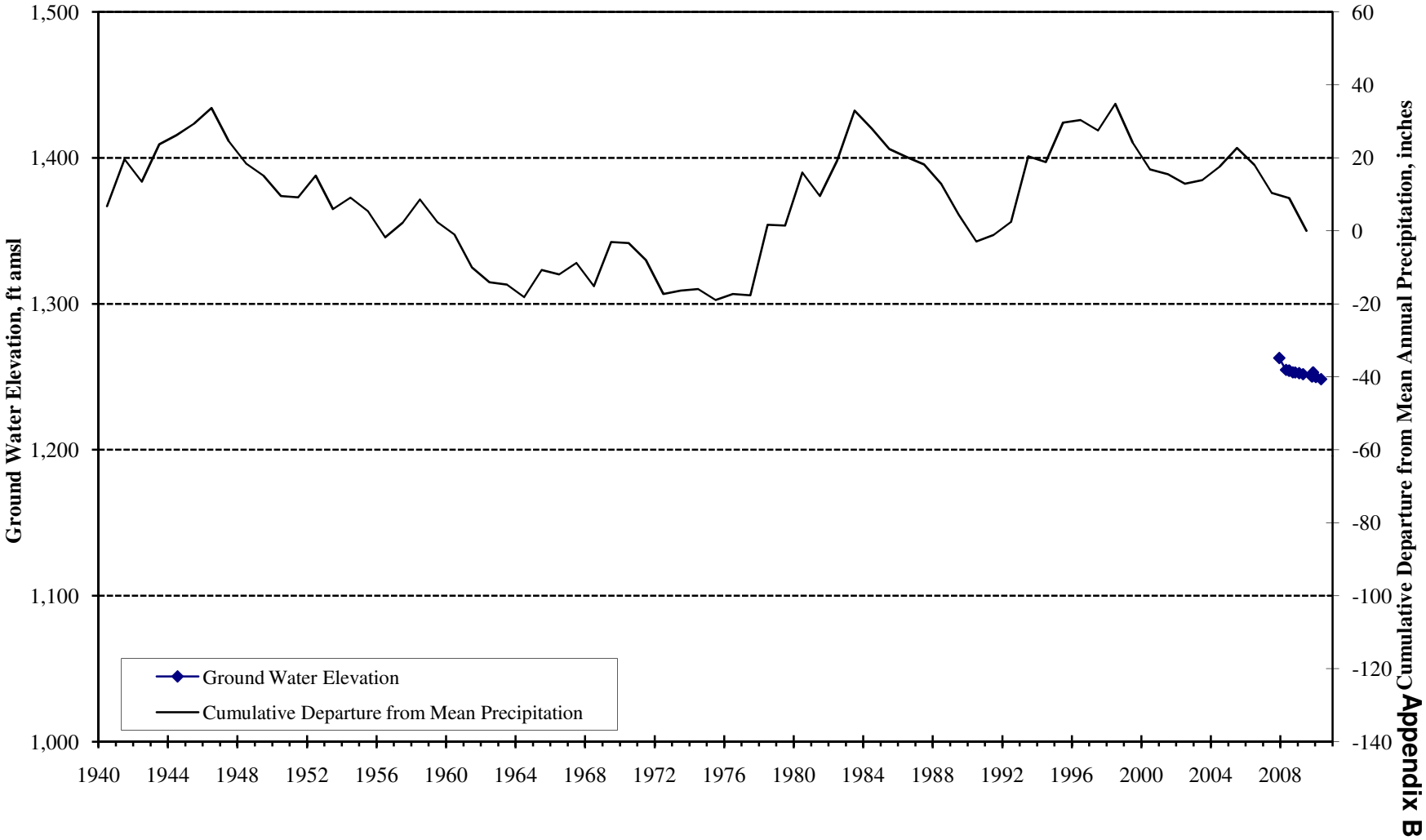
Appendix B

Ground Water Elevation
Well 3S/2E-15P3
Cabazon Storage Unit



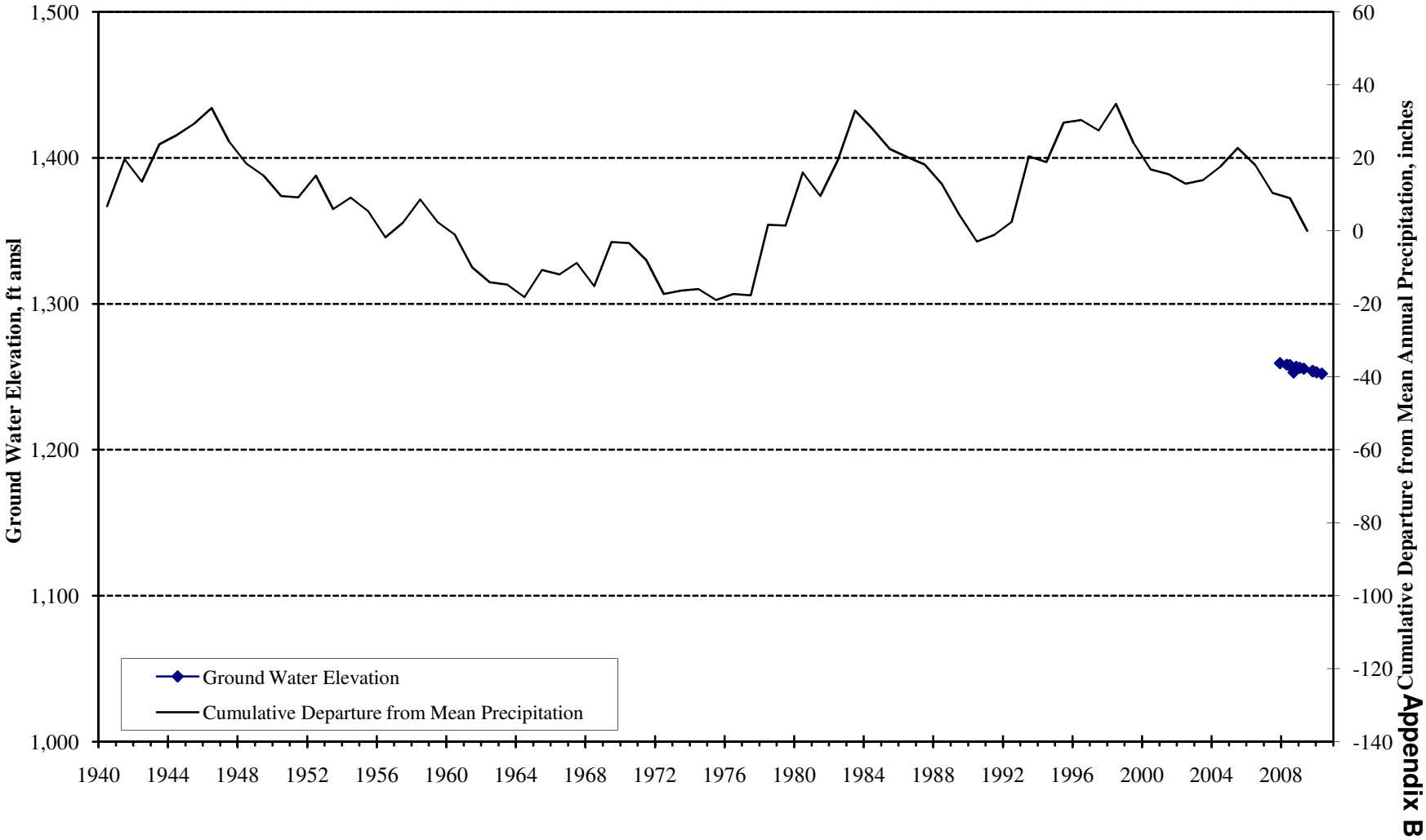
Appendix B

Ground Water Elevation
Well 3S/2E-15P2
Cabazon Storage Unit



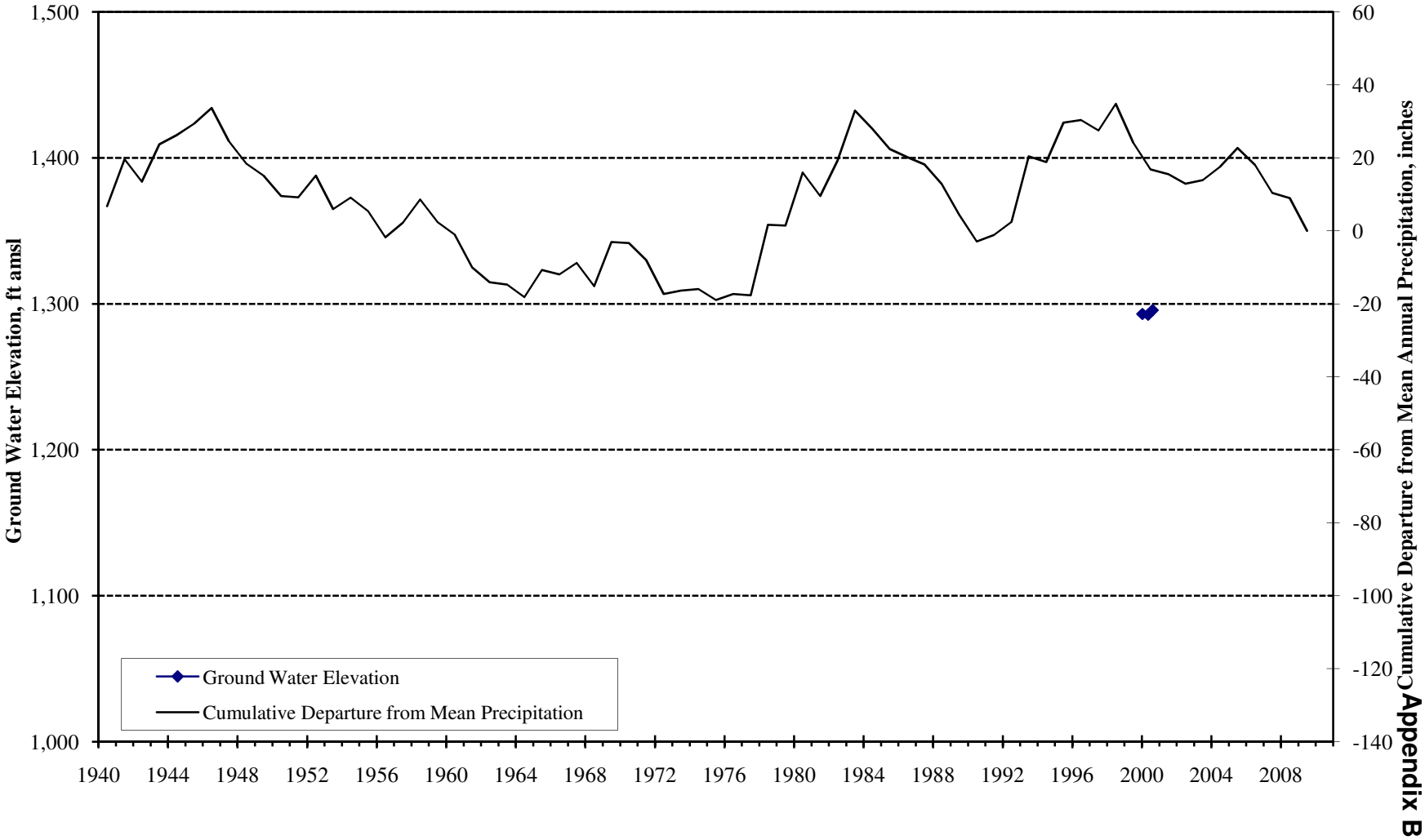
Appendix B

Ground Water Elevation
Well 3S/2E-15P1
Cabazon Storage Unit



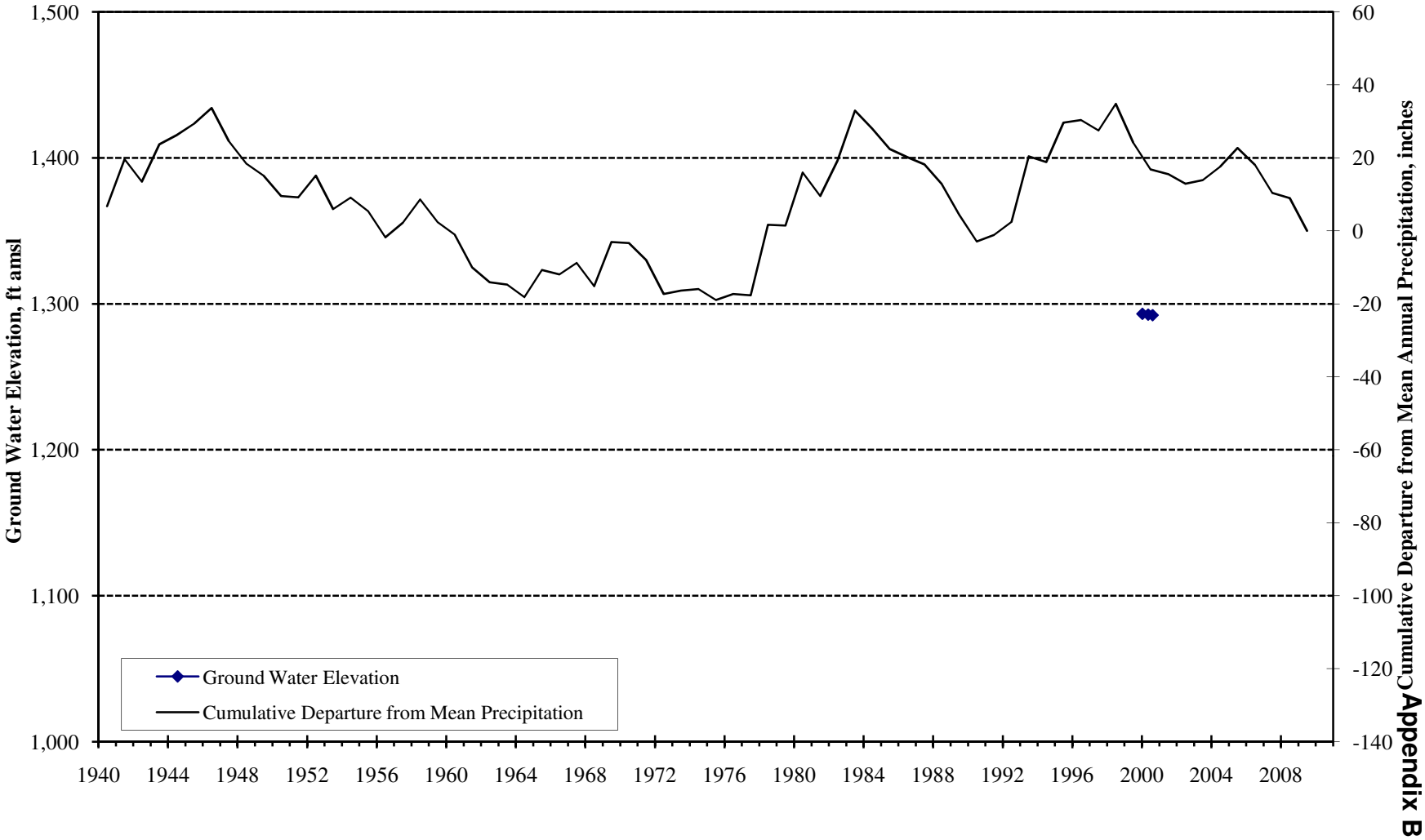
Appendix B

Ground Water Elevation
Well 3S/2E-10N4
Cabazon Storage Unit



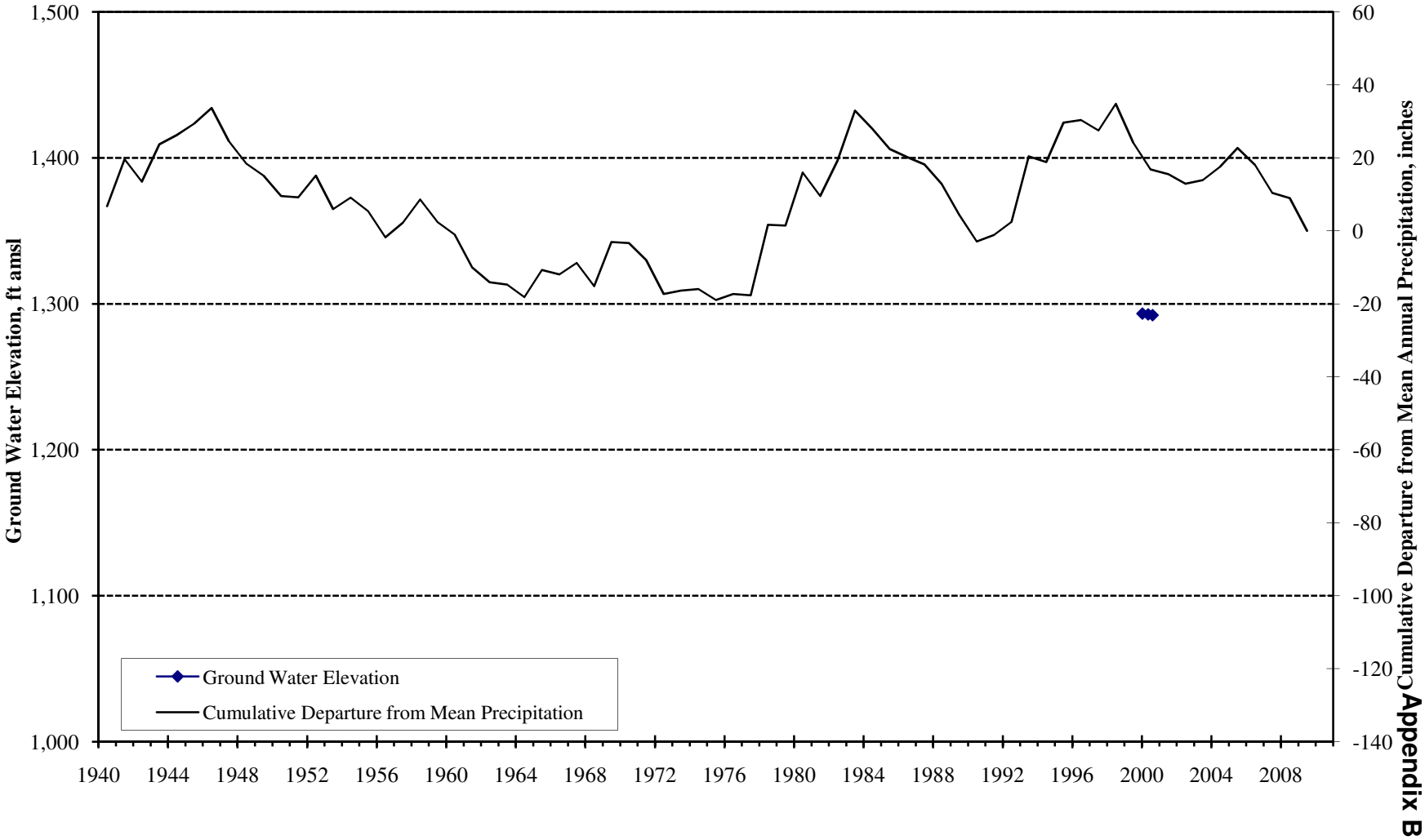
Appendix B

Ground Water Elevation
Well 3S/2E-10N3
Cabazon Storage Unit



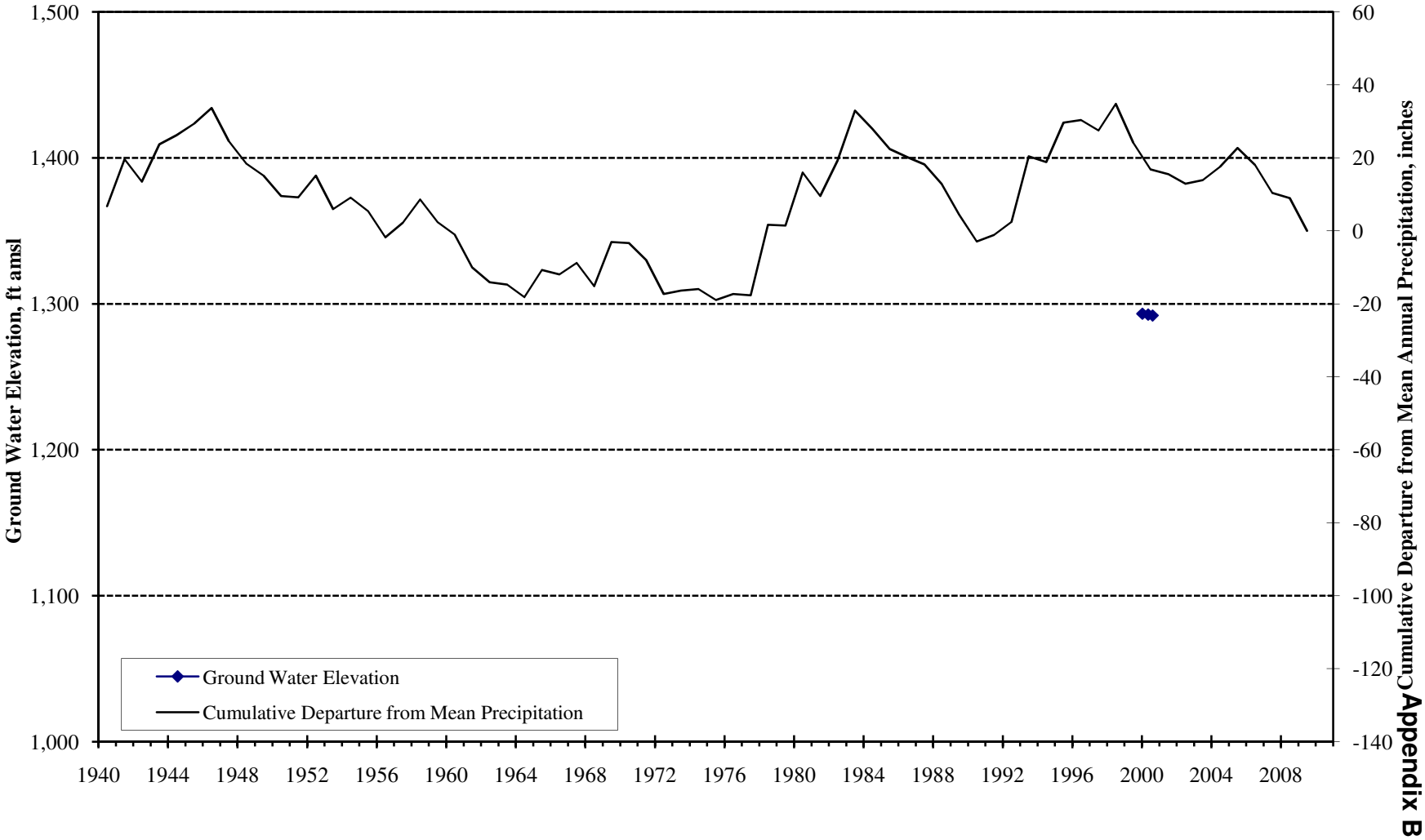
Appendix B

Ground Water Elevation
Well 3S/2E-10N2
Cabazon Storage Unit



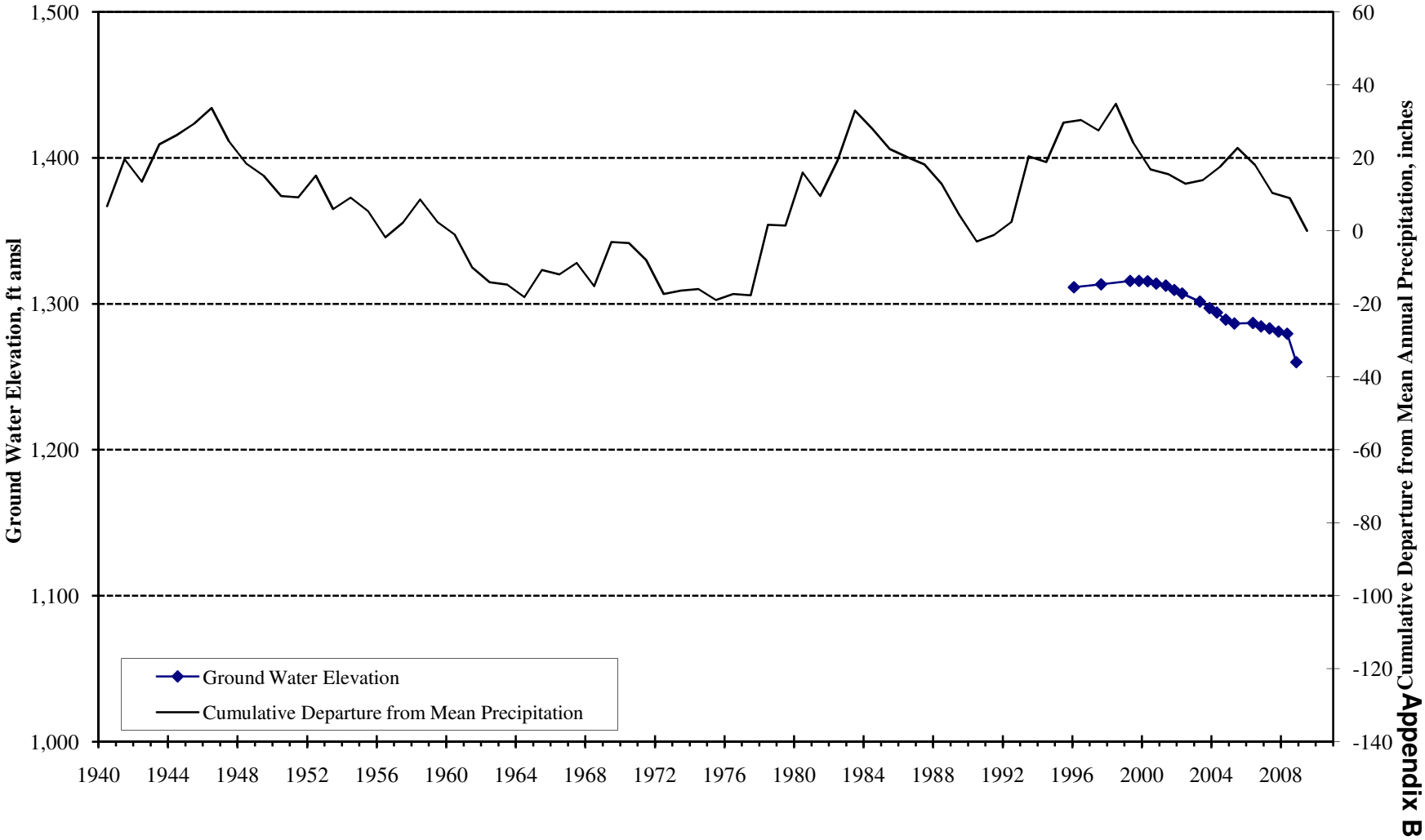
Appendix B

Ground Water Elevation
Well 3S/2E-10N1
Cabazon Storage Unit



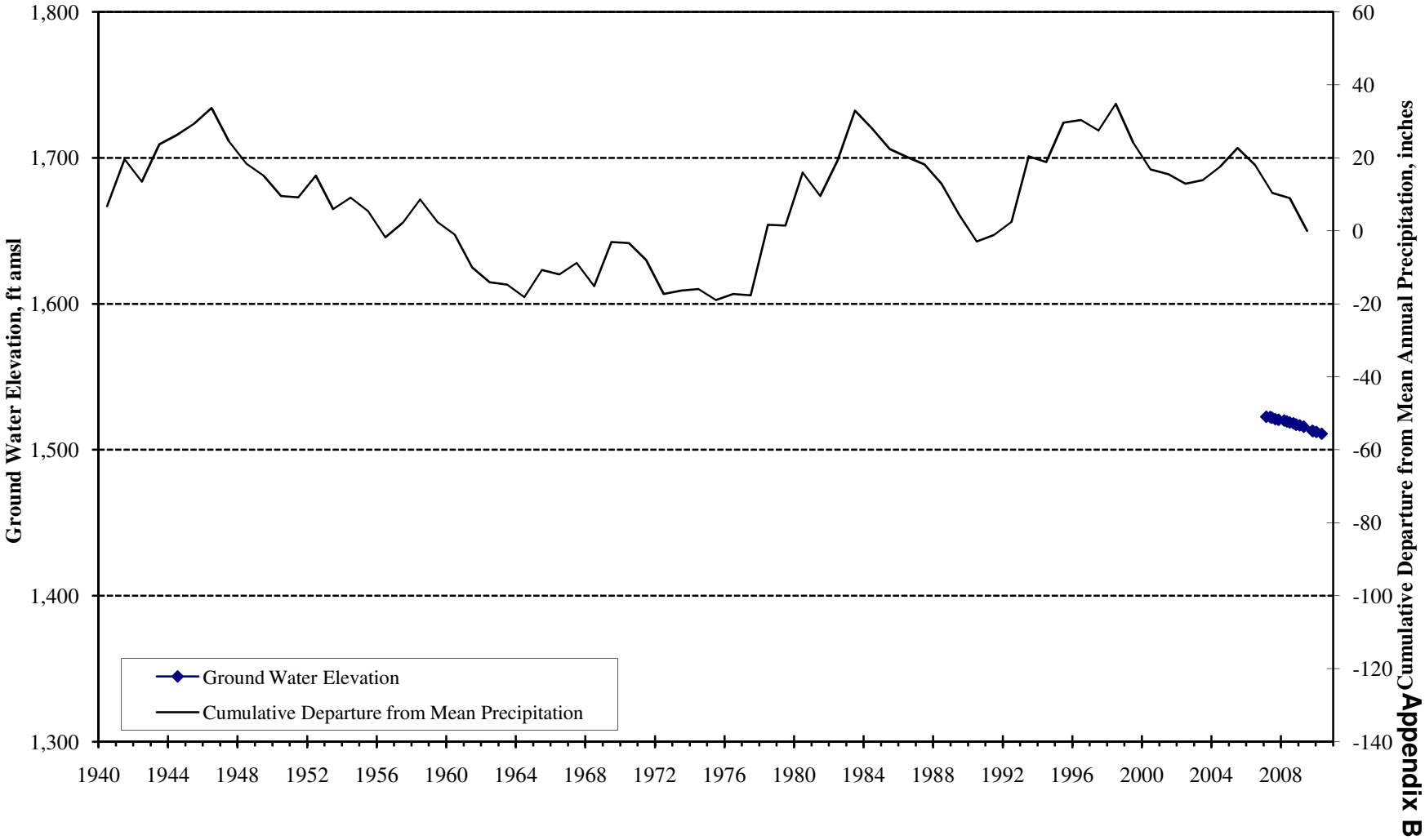
Appendix B

Ground Water Elevation
Well 3S/2E-09E1
Cabazon Storage Unit



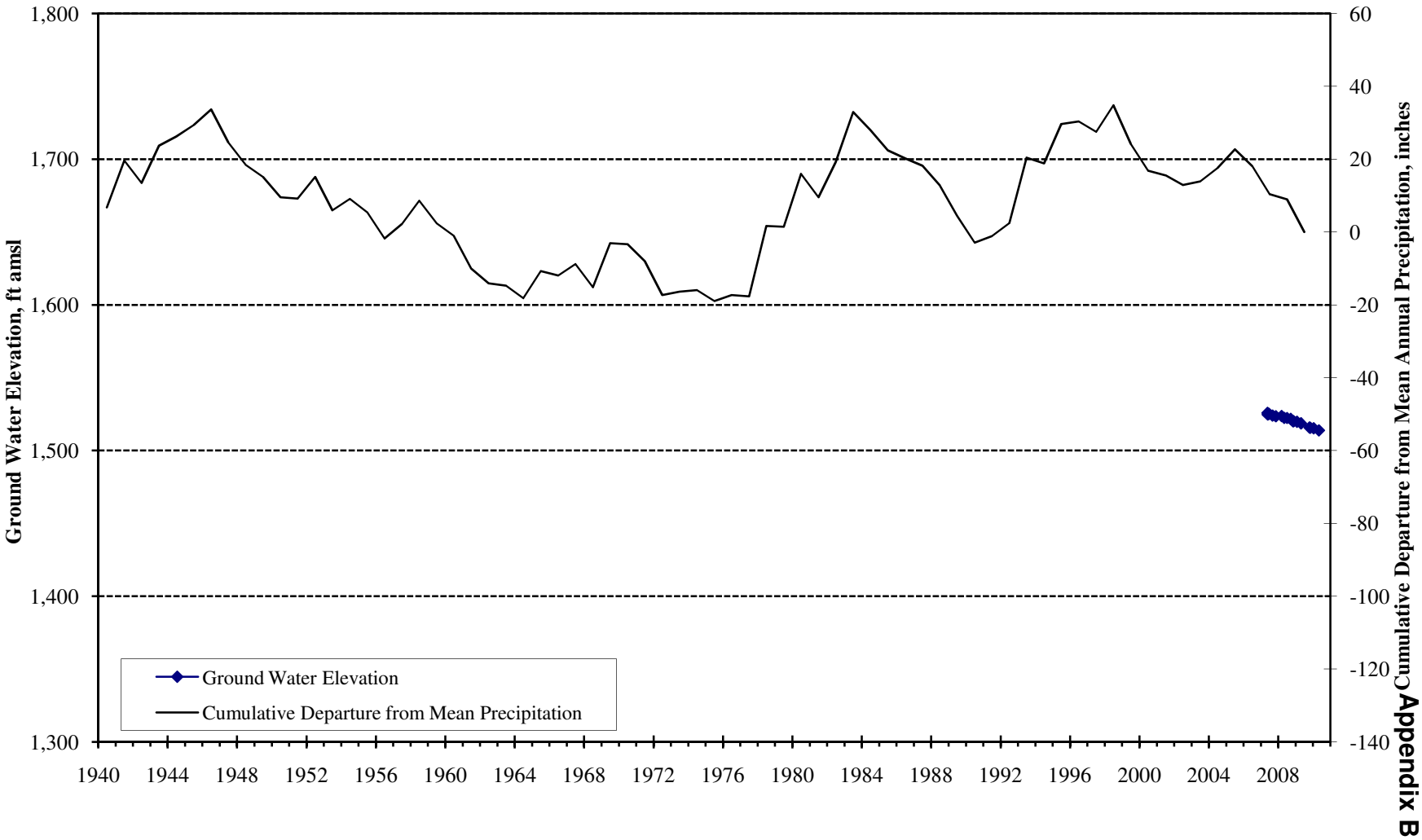
Appendix B

Ground Water Elevation
Well 3S/2E-07P4
Cabazon Storage Unit



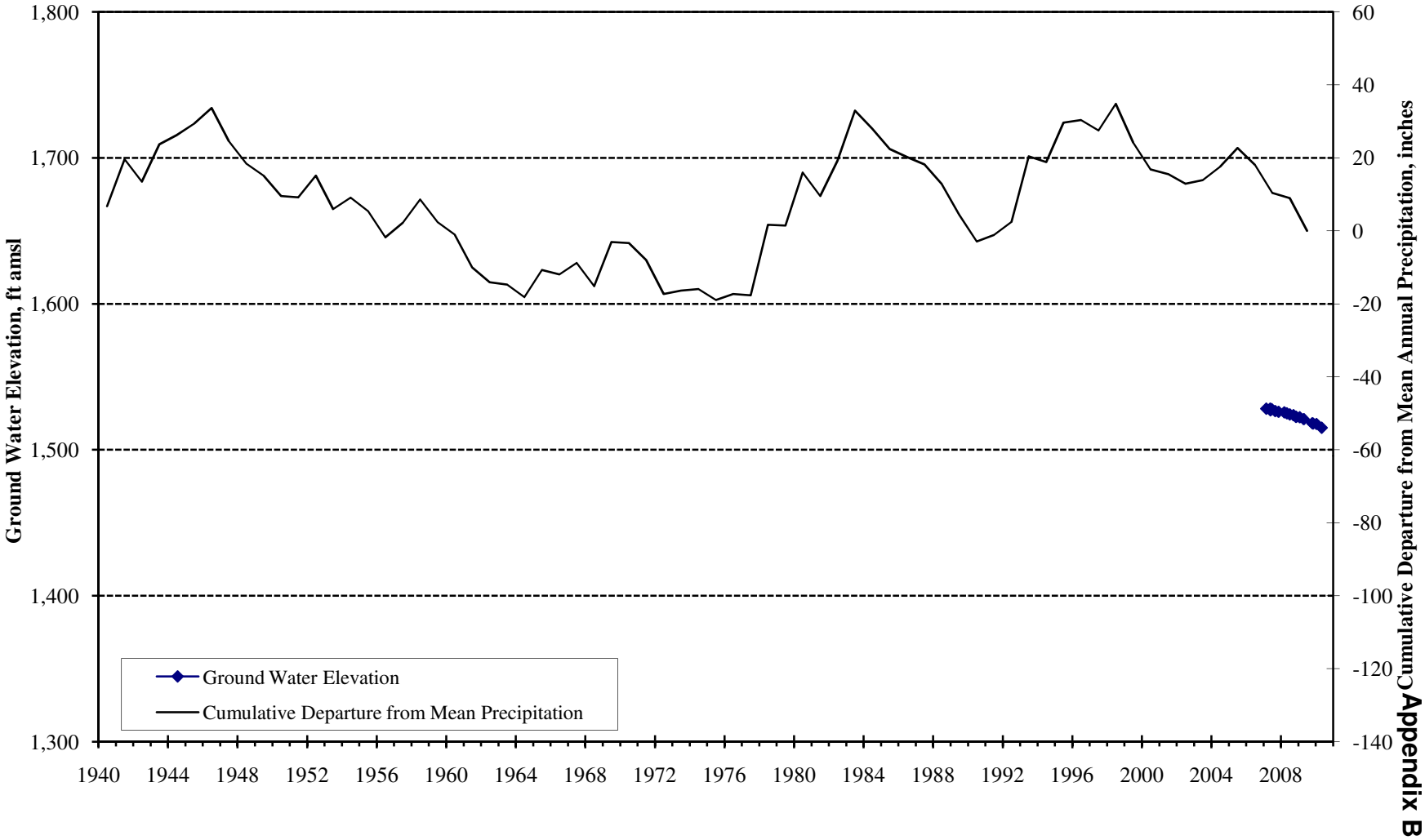
Appendix B

Ground Water Elevation
Well 3S/2E-07P3
Cabazon Storage Unit



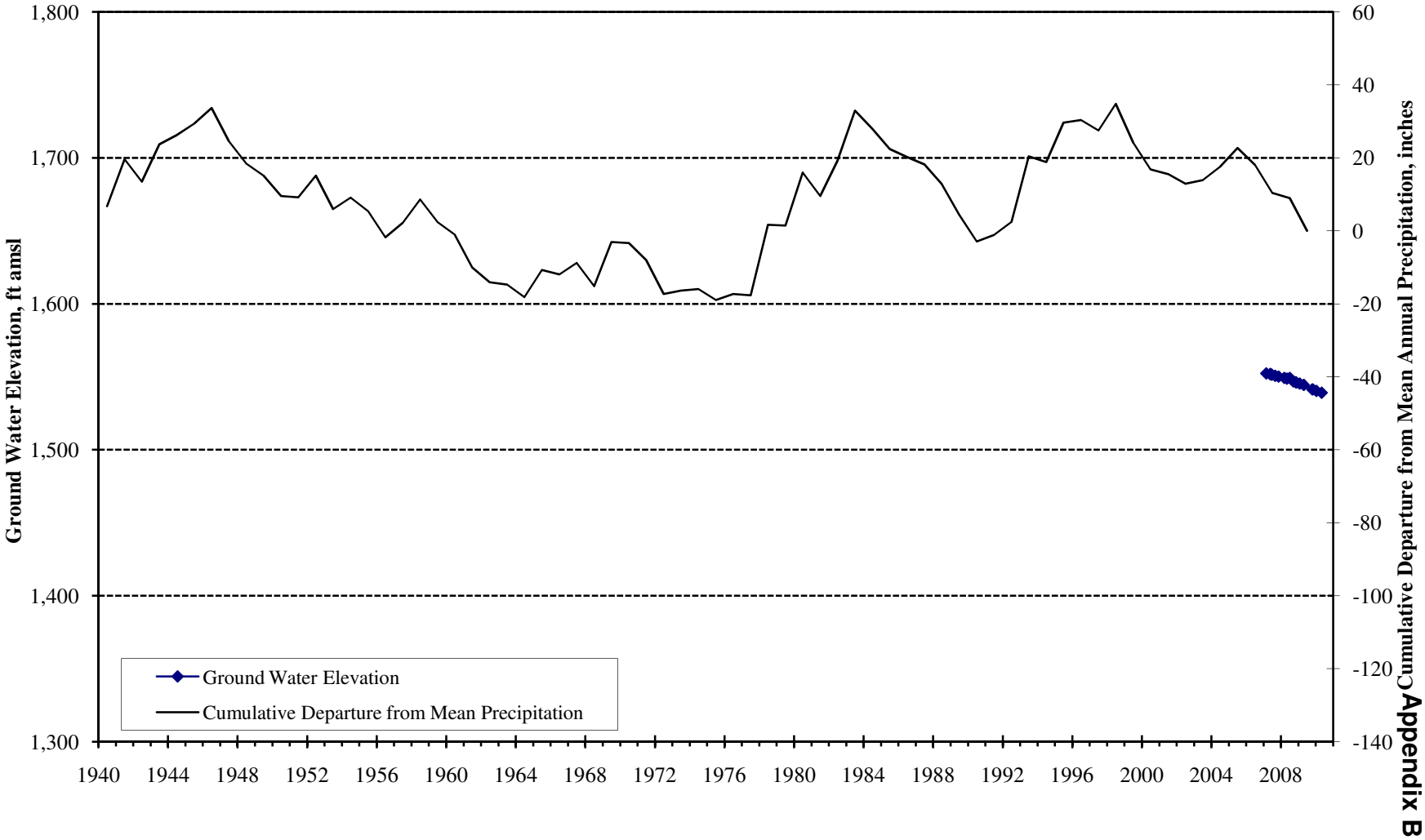
Appendix B

Ground Water Elevation
Well 3S/2E-07P2
Cabazon Storage Unit



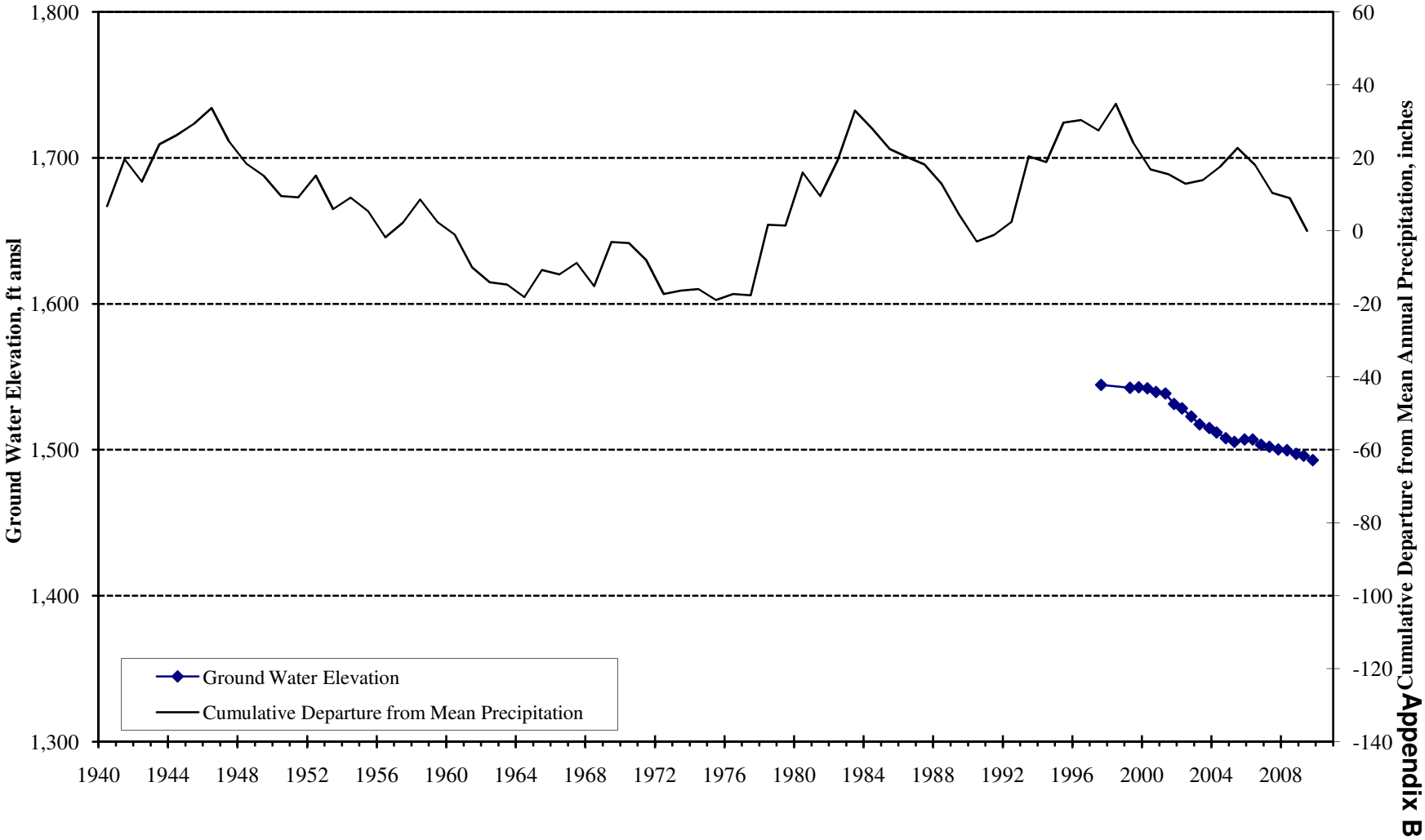
Appendix B

Ground Water Elevation
Well 3S/2E-07P1
Cabazon Storage Unit



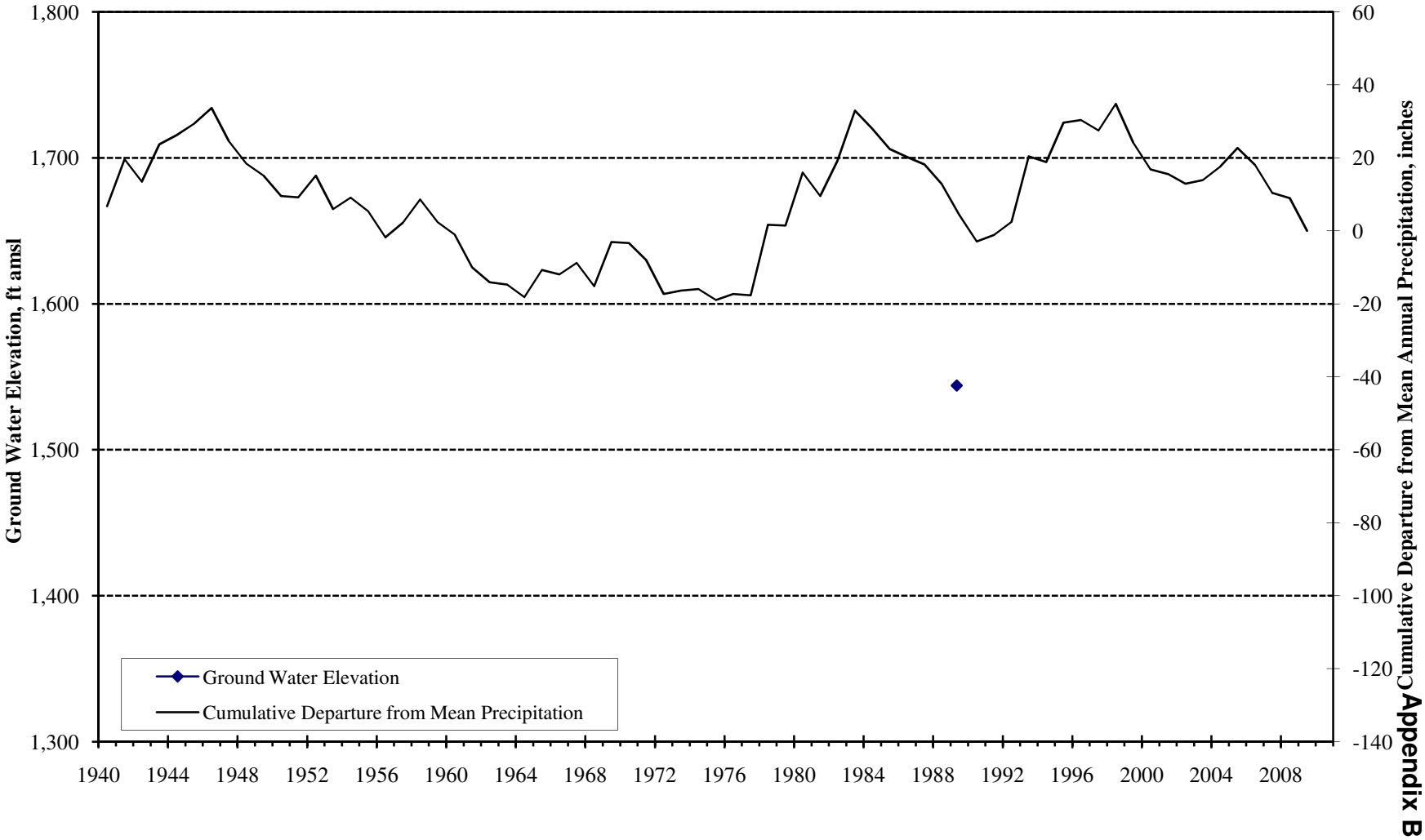
Appendix B

Ground Water Elevation
Well 3S/2E-07K1
Cabazon Storage Unit



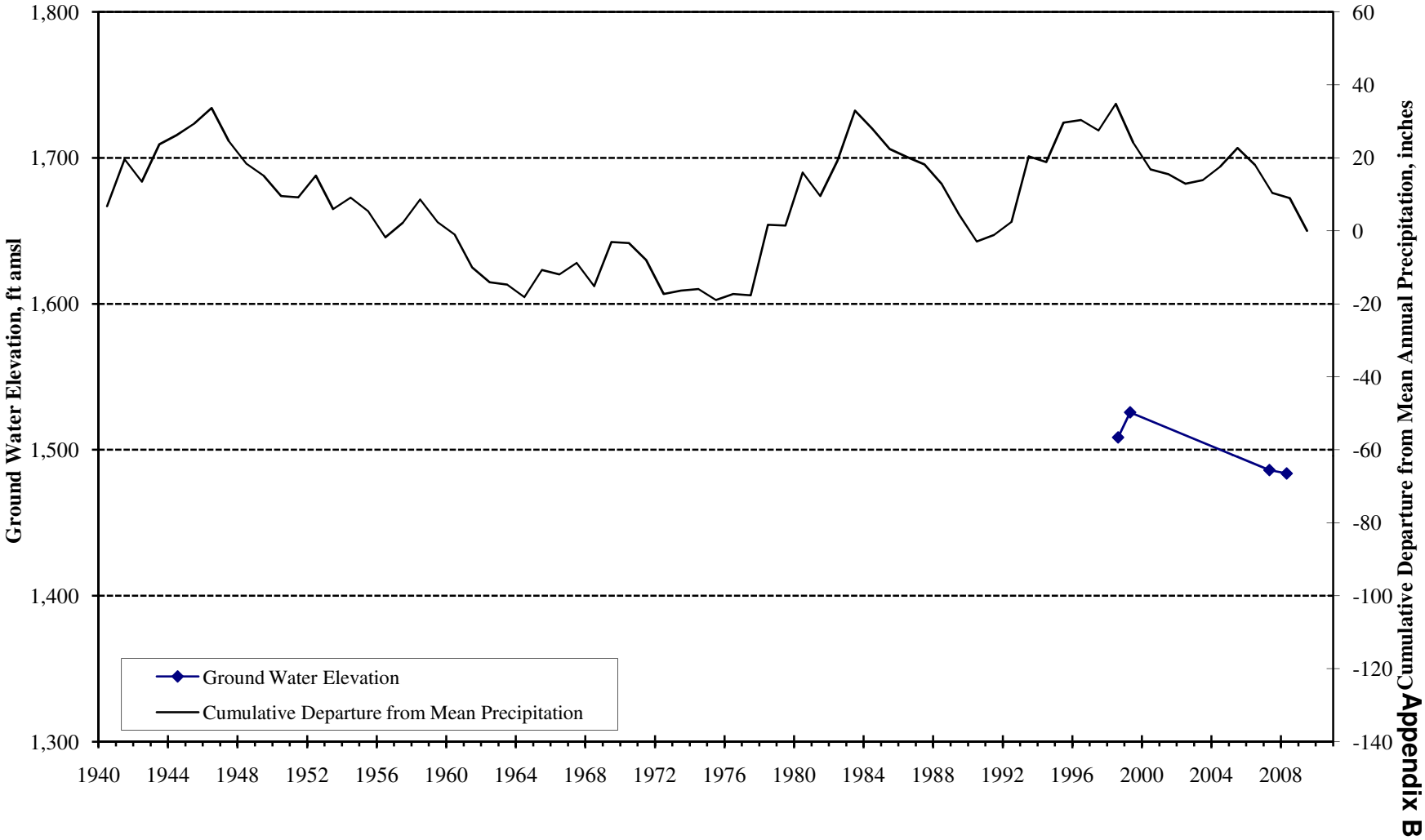
Appendix B

Ground Water Elevation
Well 3S/2E-07H1
Cabazon Storage Unit



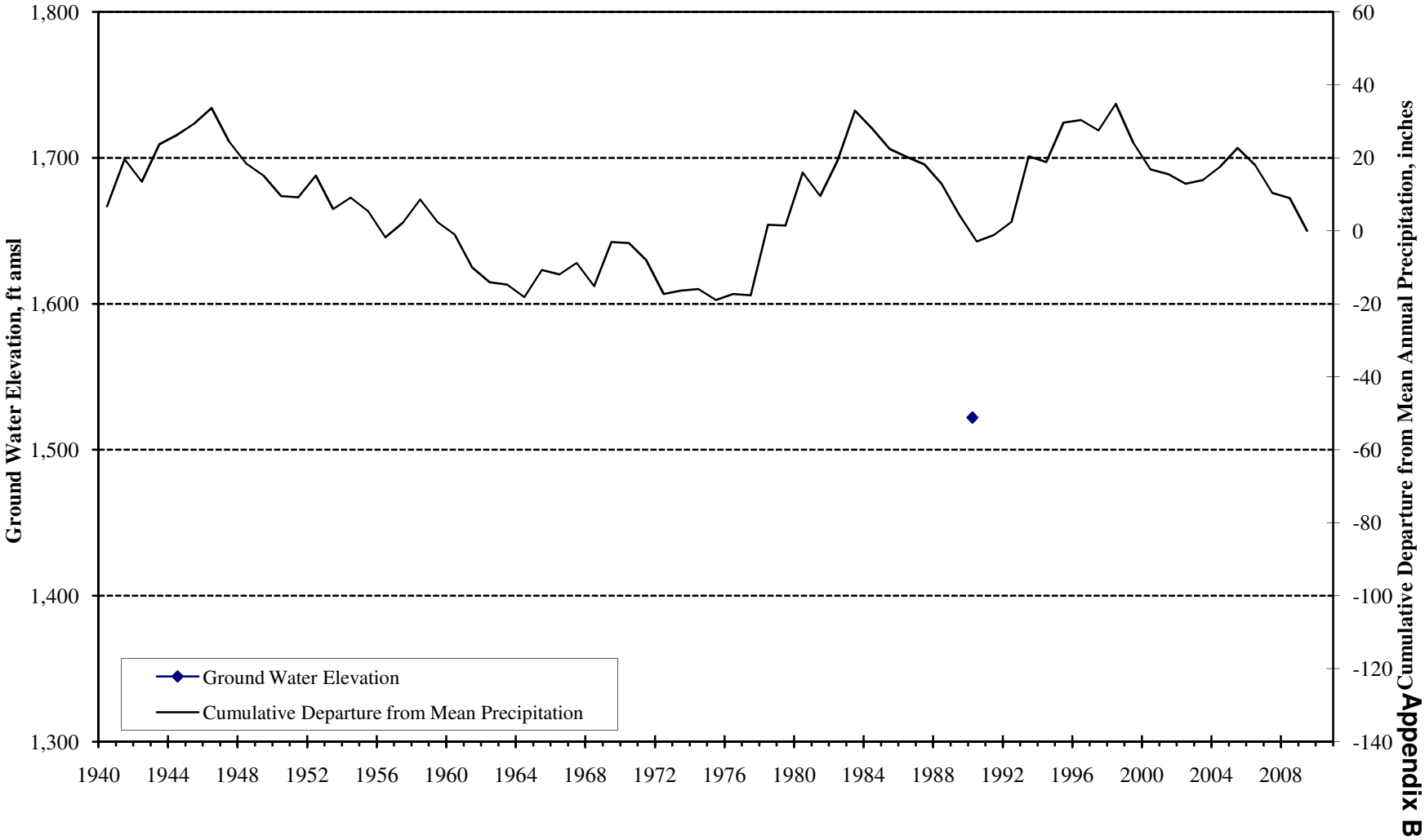
Appendix B

Ground Water Elevation
Well 3S/2E-07G2
Cabazon Storage Unit



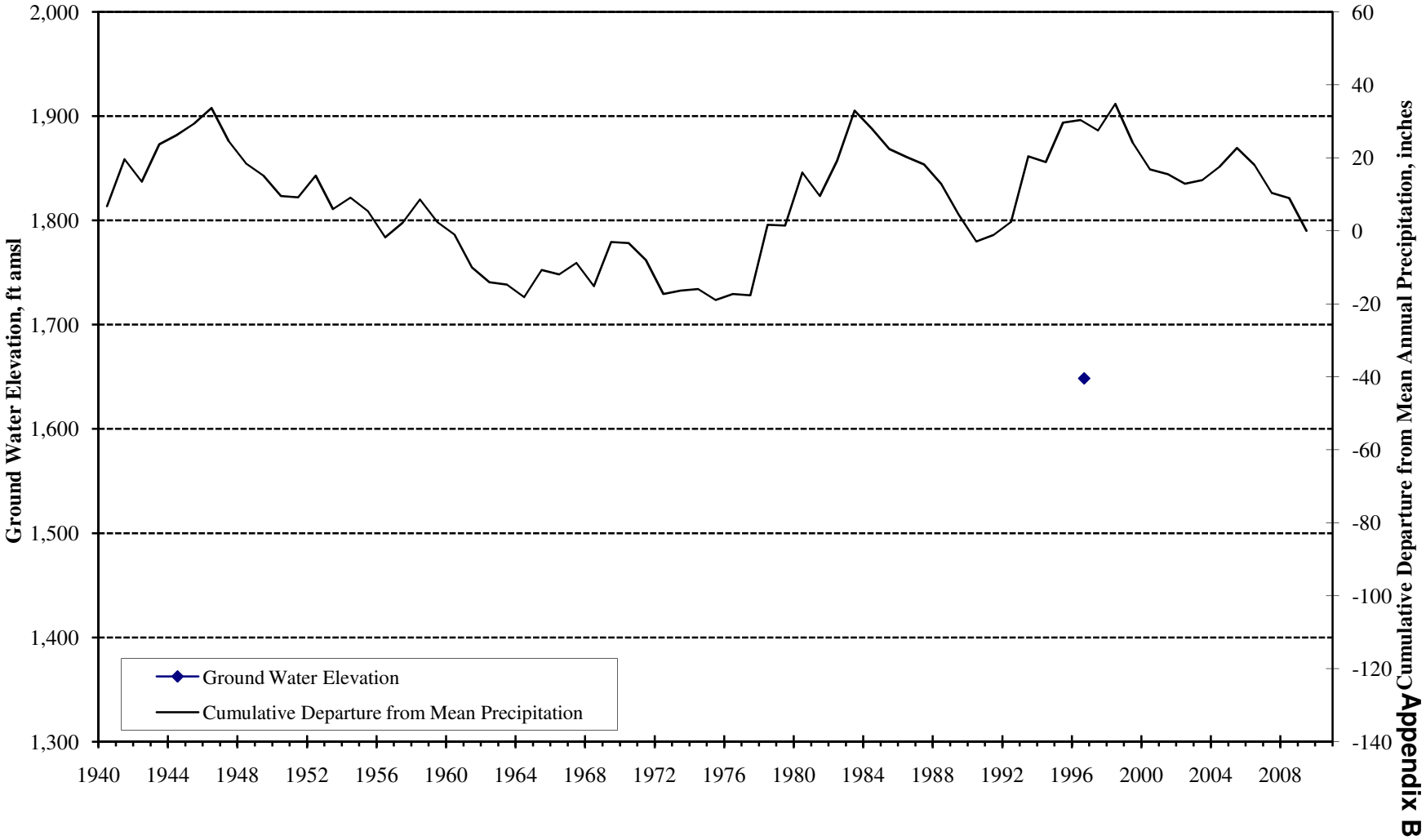
Appendix B

Ground Water Elevation
Well 3S/2E-07G1
Cabazon Storage Unit



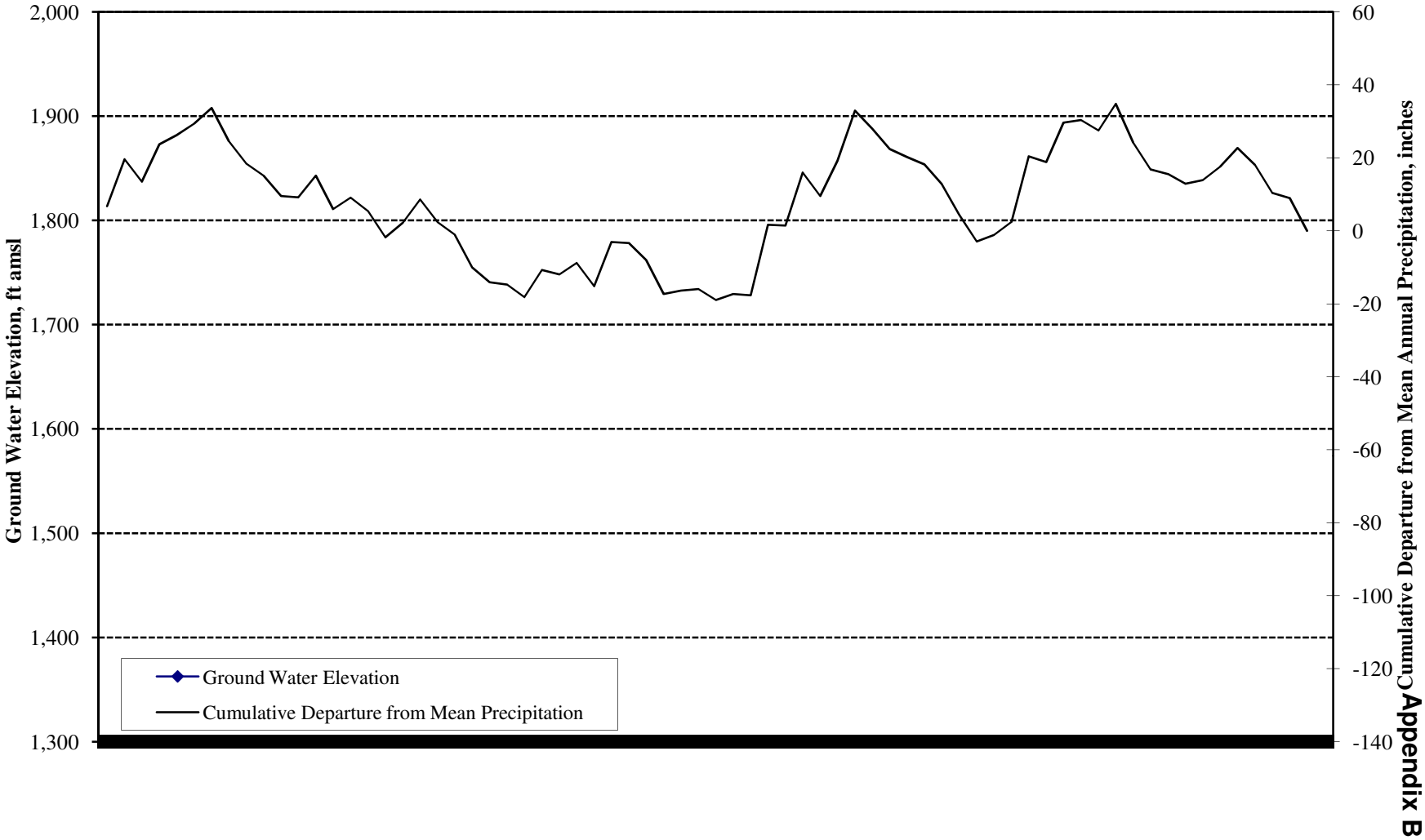
Appendix B

Ground Water Elevation
Well 3S/1E-12D1
Cabazon Storage Unit



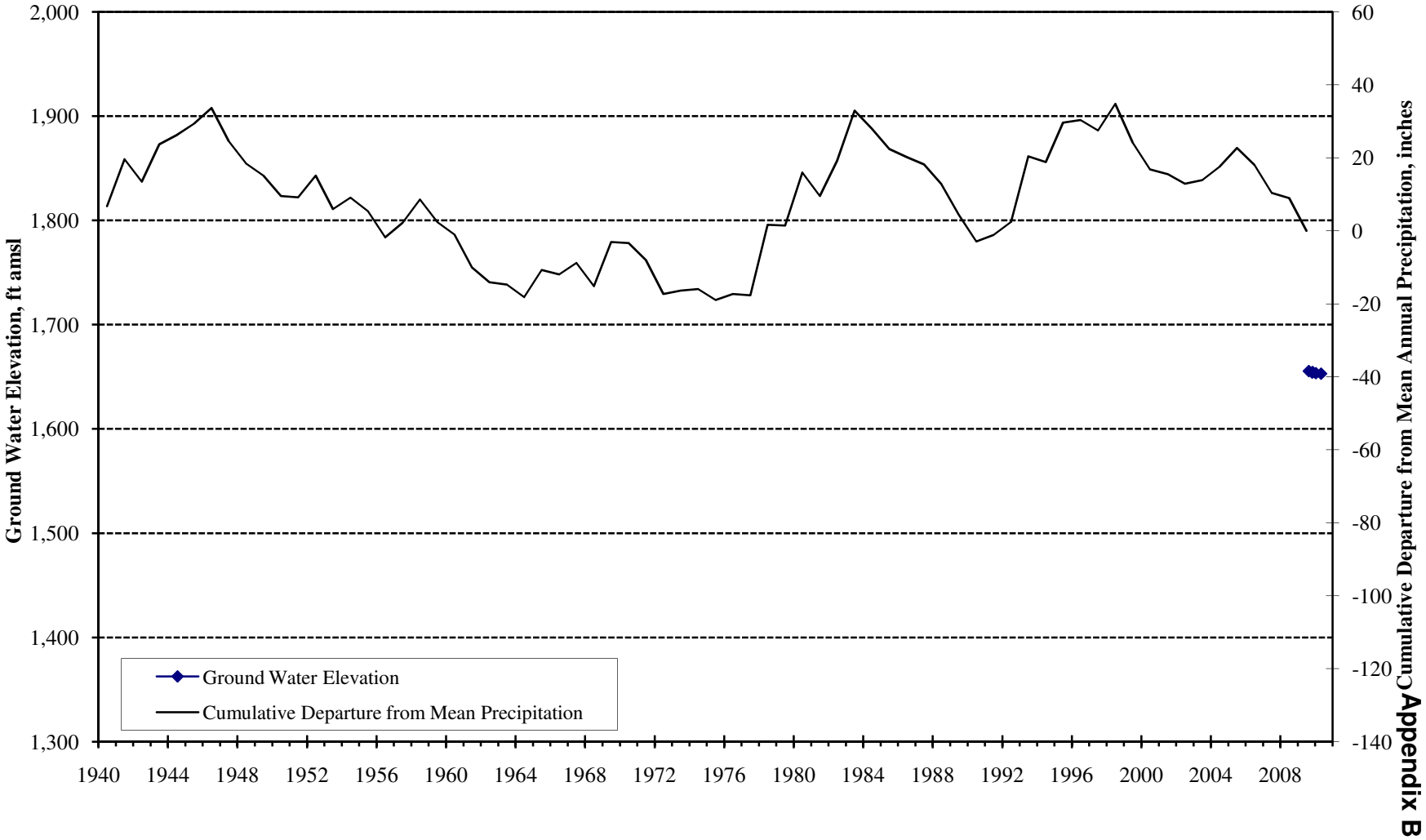
Appendix B

Ground Water Elevation
Well 3S/1E-12A1
Cabazon Storage Unit



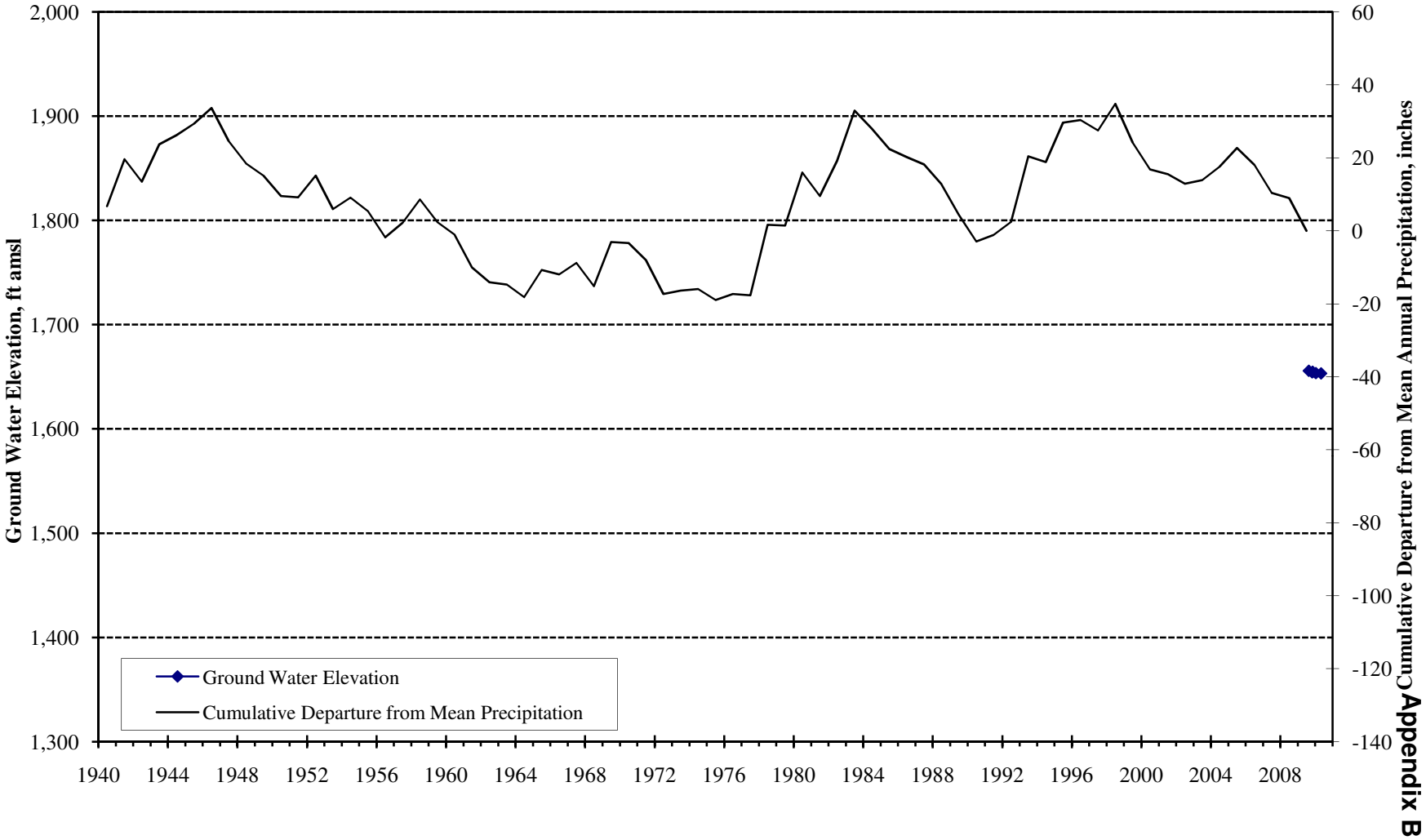
Appendix B

Ground Water Elevation
Well 3S/1E-11F4
Cabazon Storage Unit



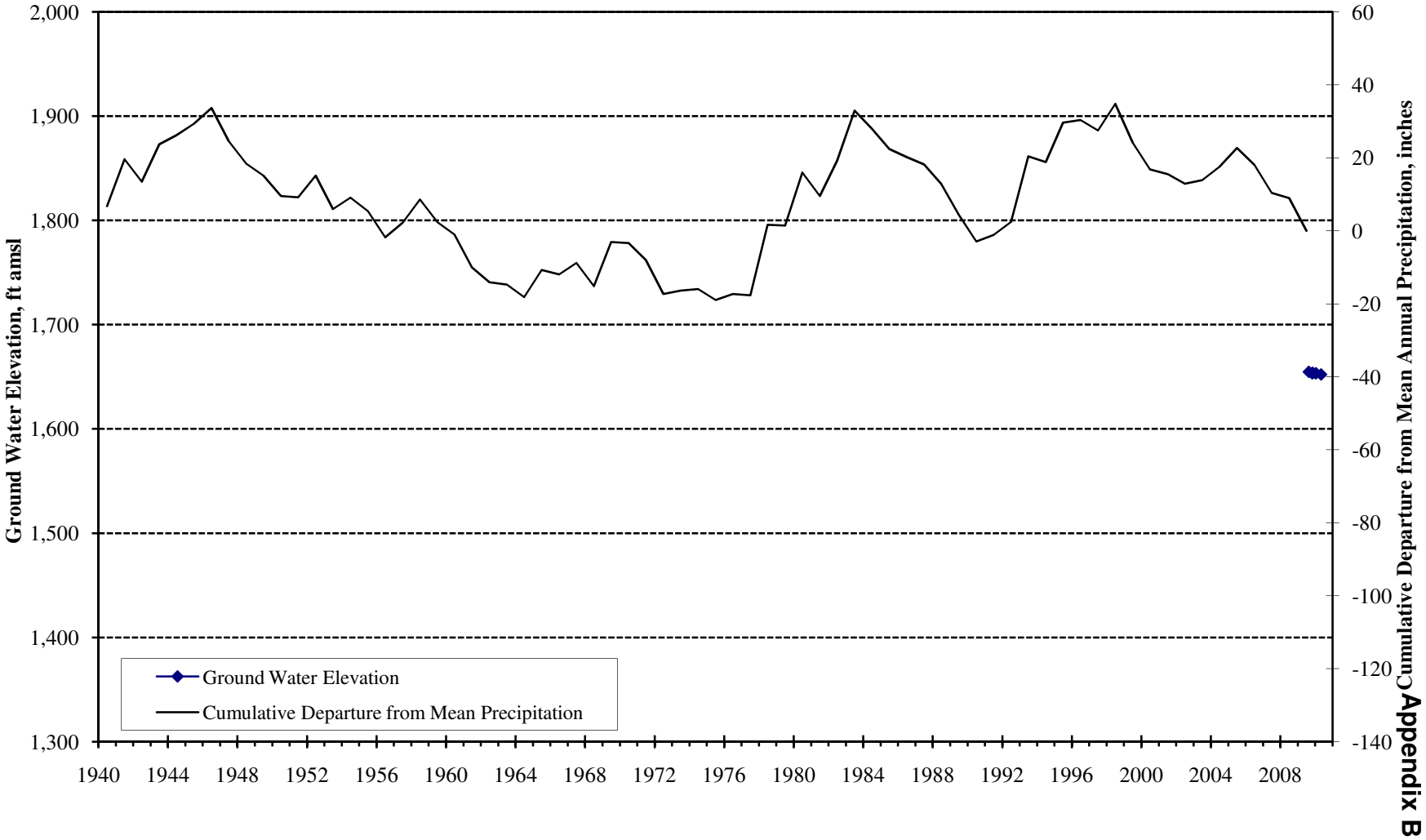
Appendix B

Ground Water Elevation
Well 3S/1E-11F3
Cabazon Storage Unit



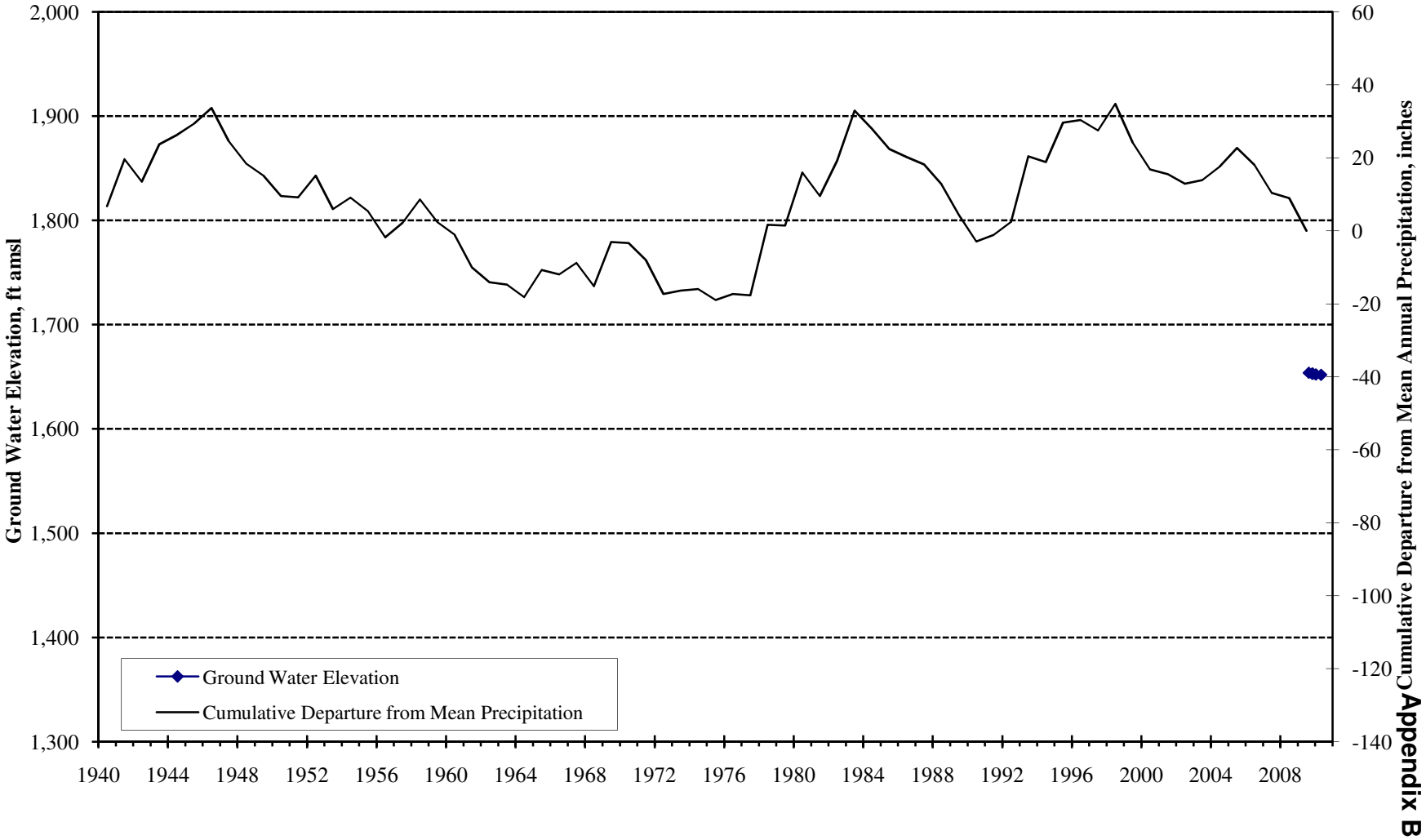
Appendix B

Ground Water Elevation
Well 3S/1E-11F2
Cabazon Storage Unit



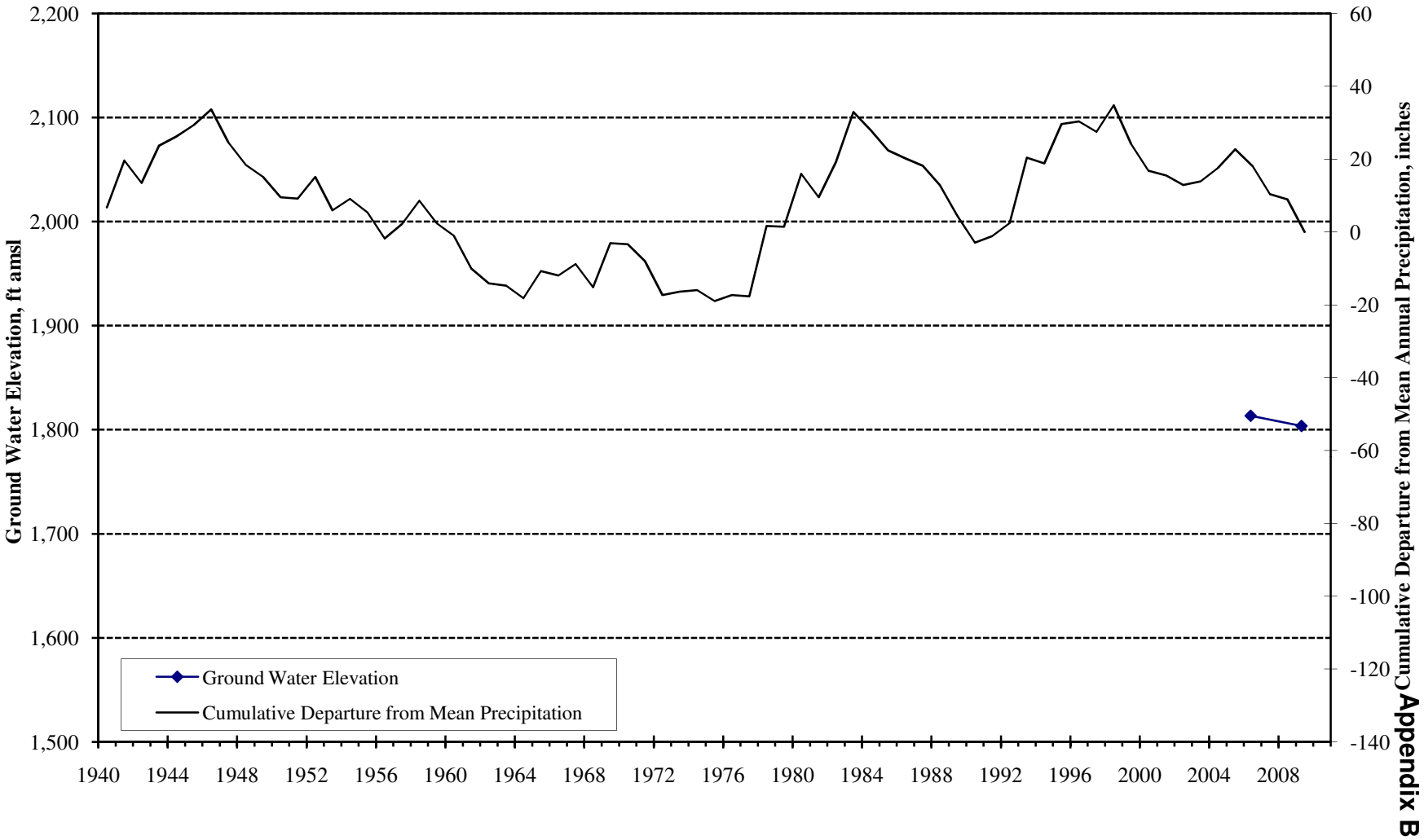
Appendix B

Ground Water Elevation
Well 3S/1E-11F1
Cabazon Storage Unit



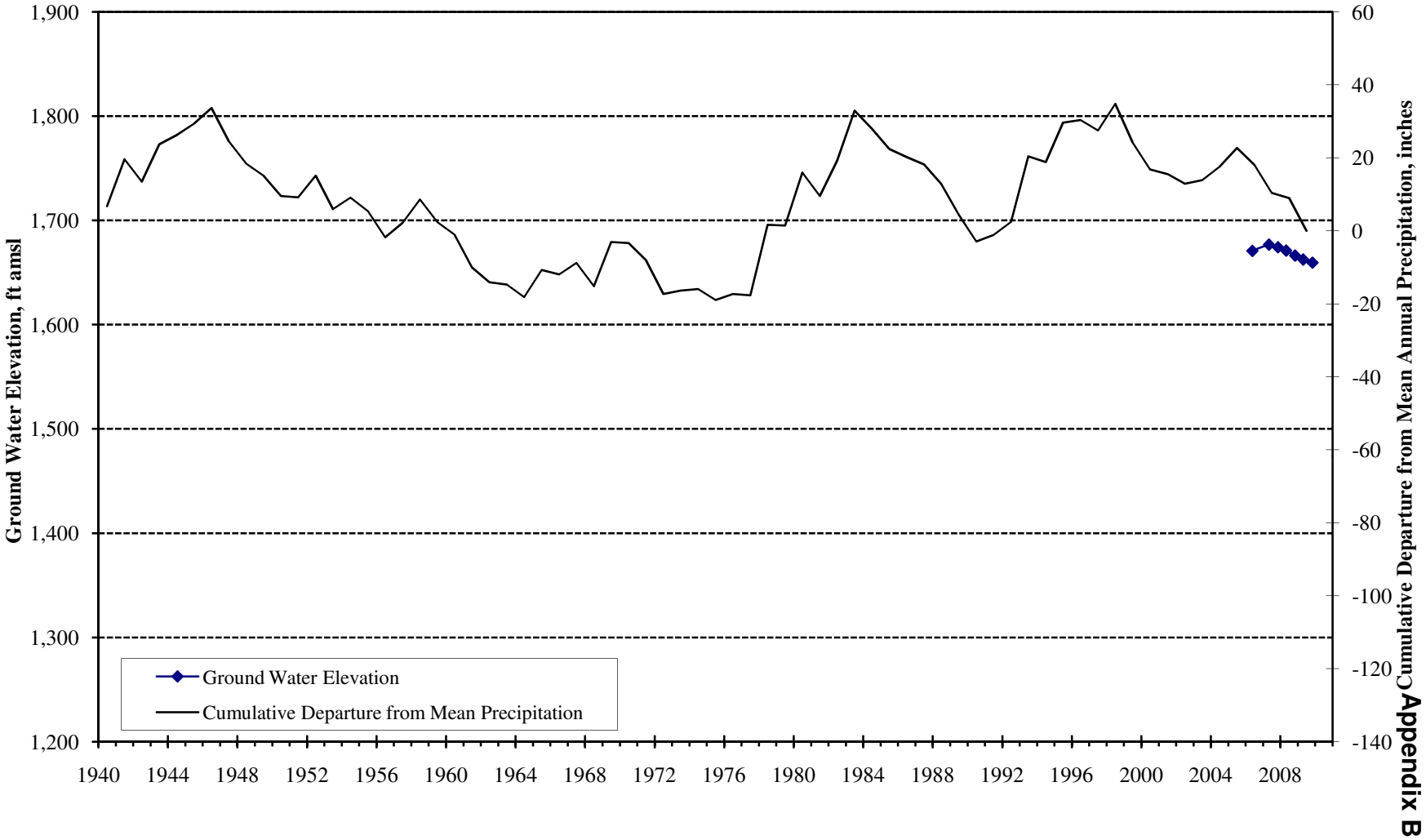
Appendix B

Ground Water Elevation
Well 3S/1E-03J2
Cabazon Storage Unit



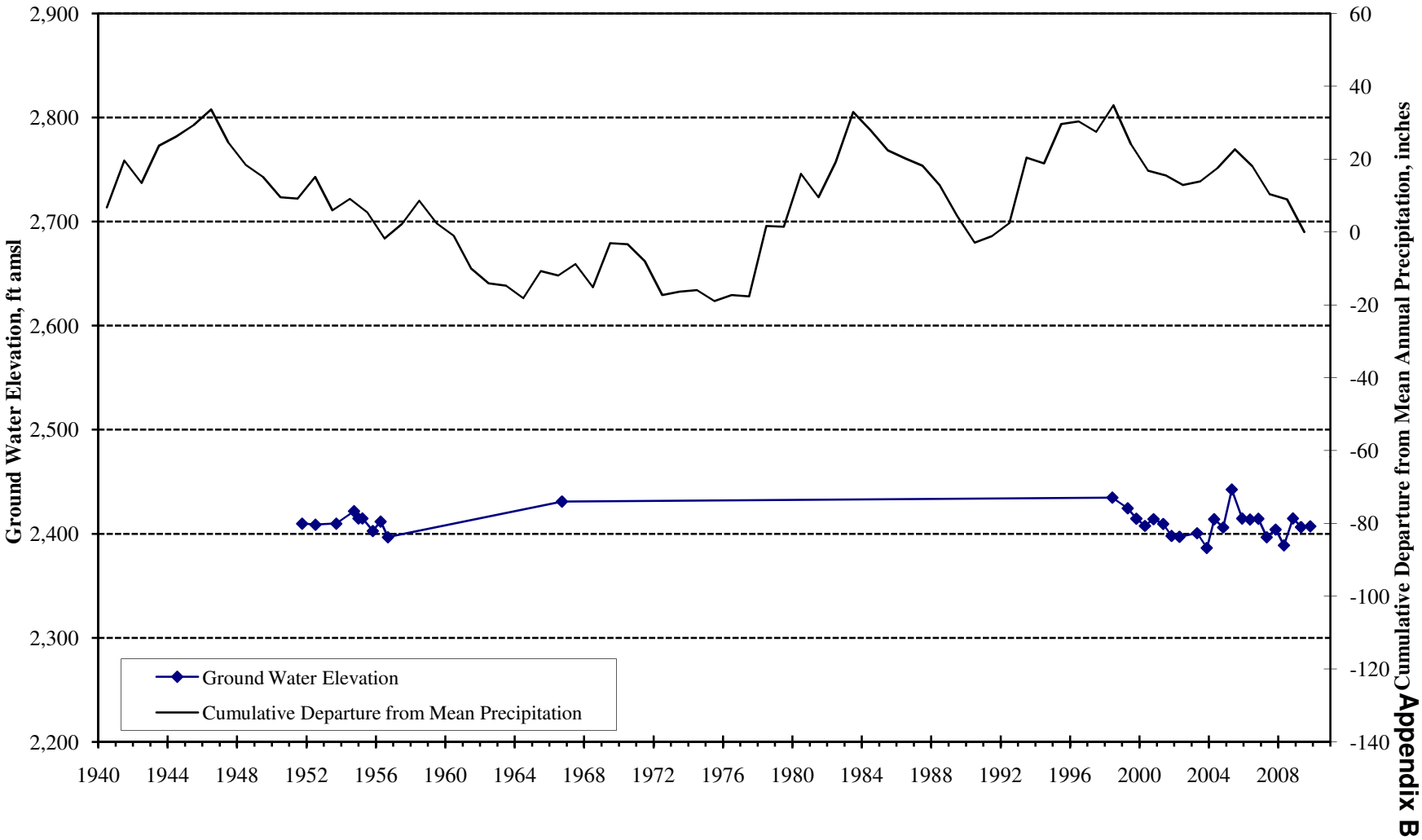
Appendix B

Ground Water Elevation
Well 3S/1E-03J1
Cabazon Storage Unit



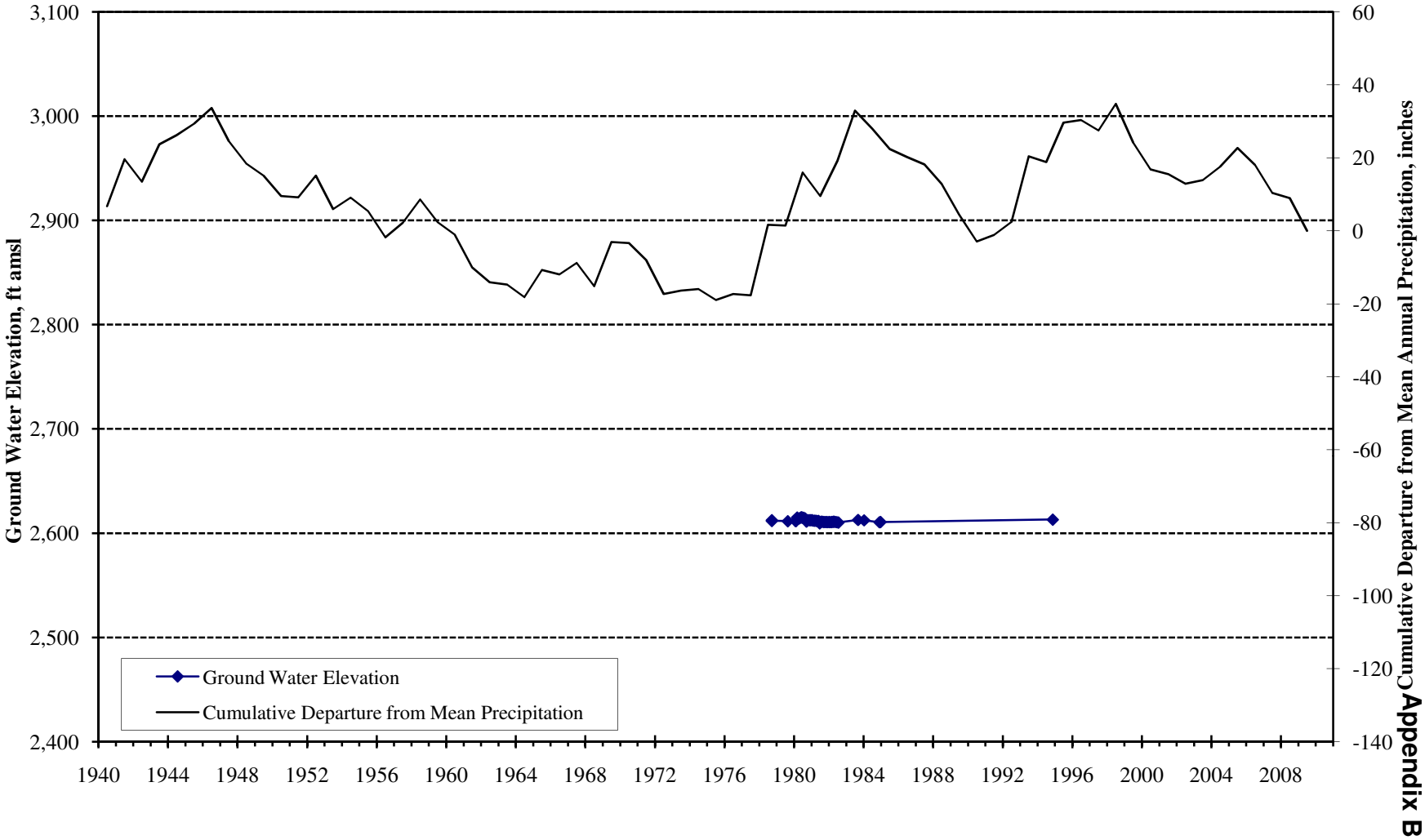
Appendix B

Ground Water Elevation
Well 3S/1E-03C2
Cabazon Storage Unit



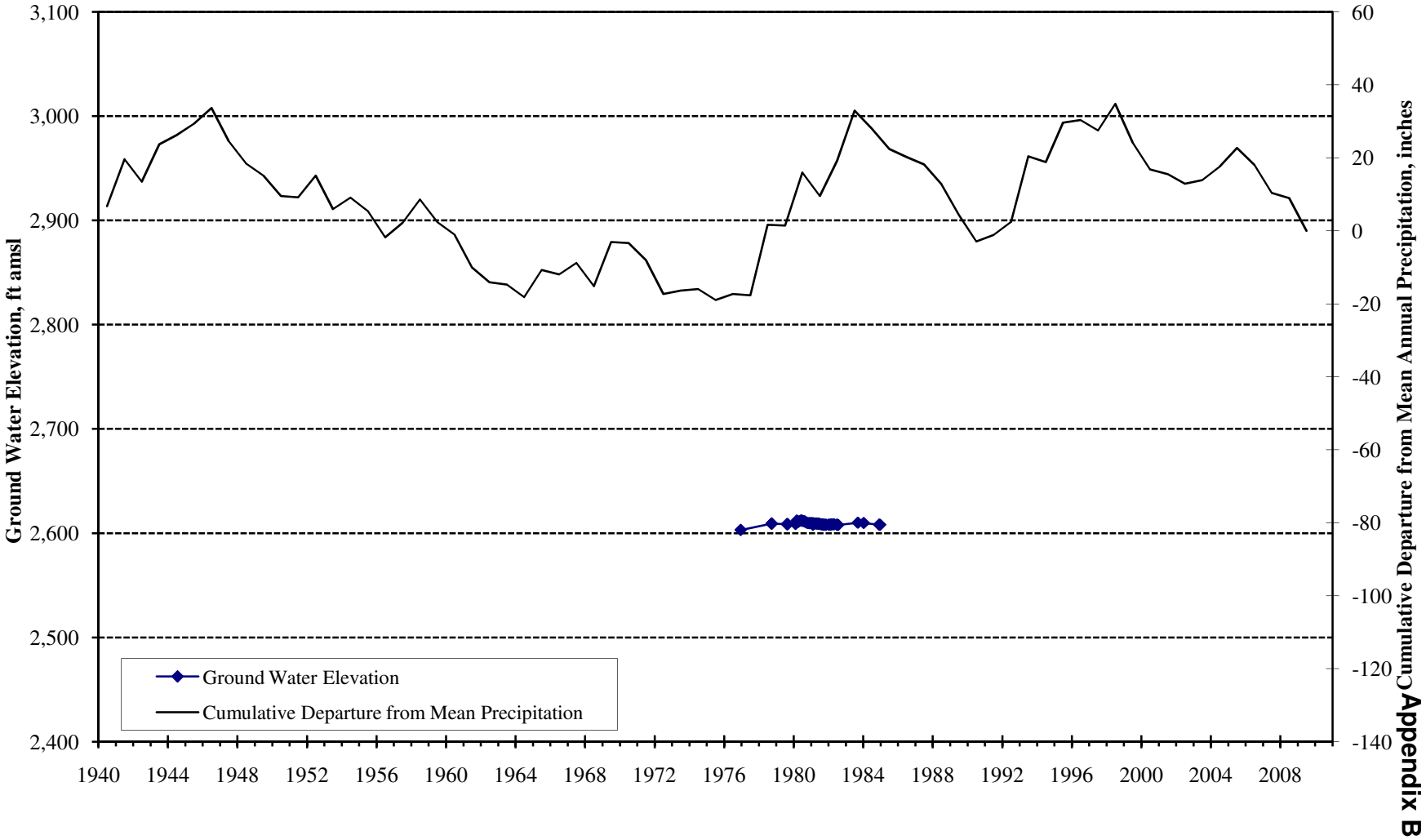
Appendix B

Ground Water Elevation
Well 2S/1E-25R2
Potrero Canyon



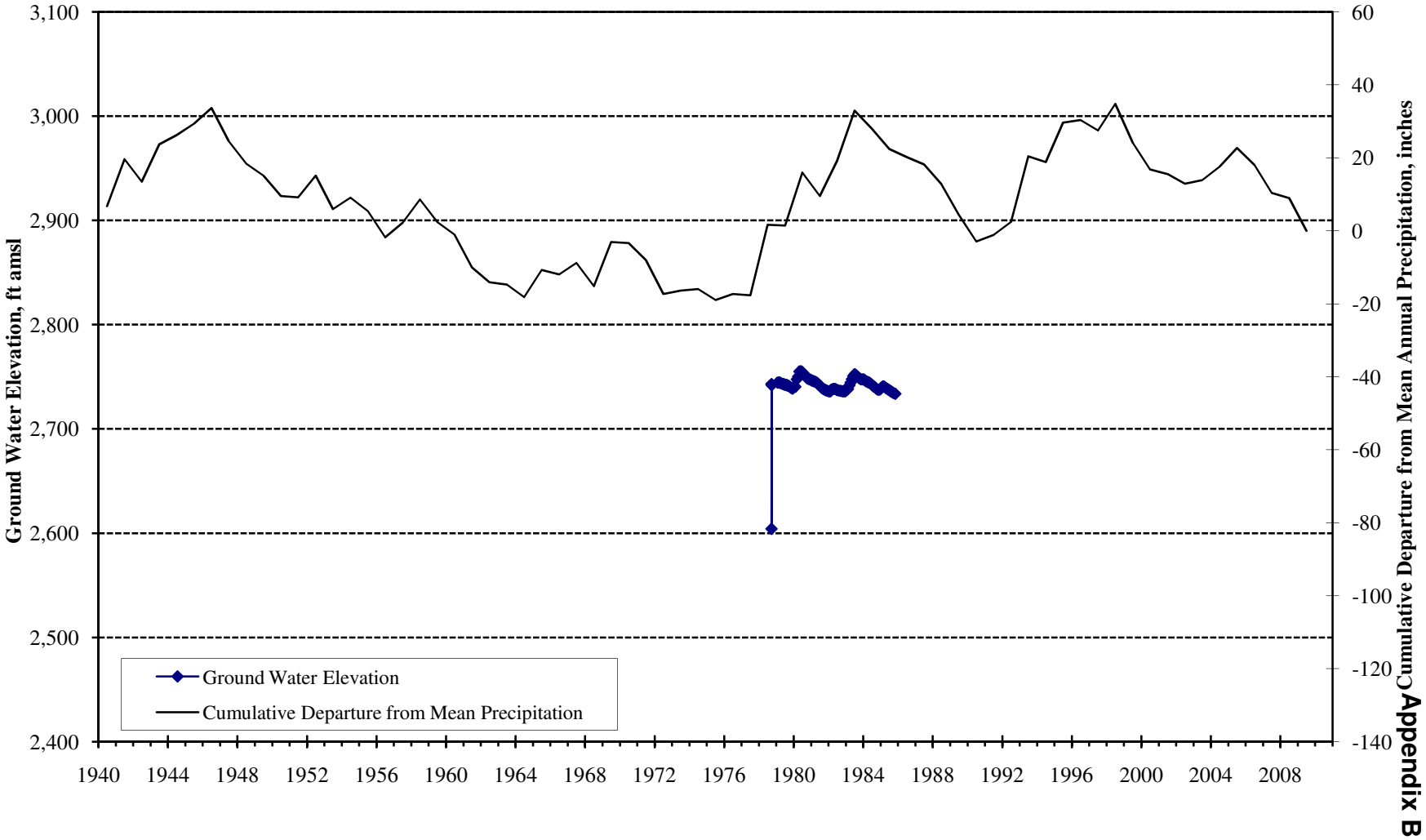
Appendix B

Ground Water Elevation
Well 2S/1E-25R1
Potrero Canyon



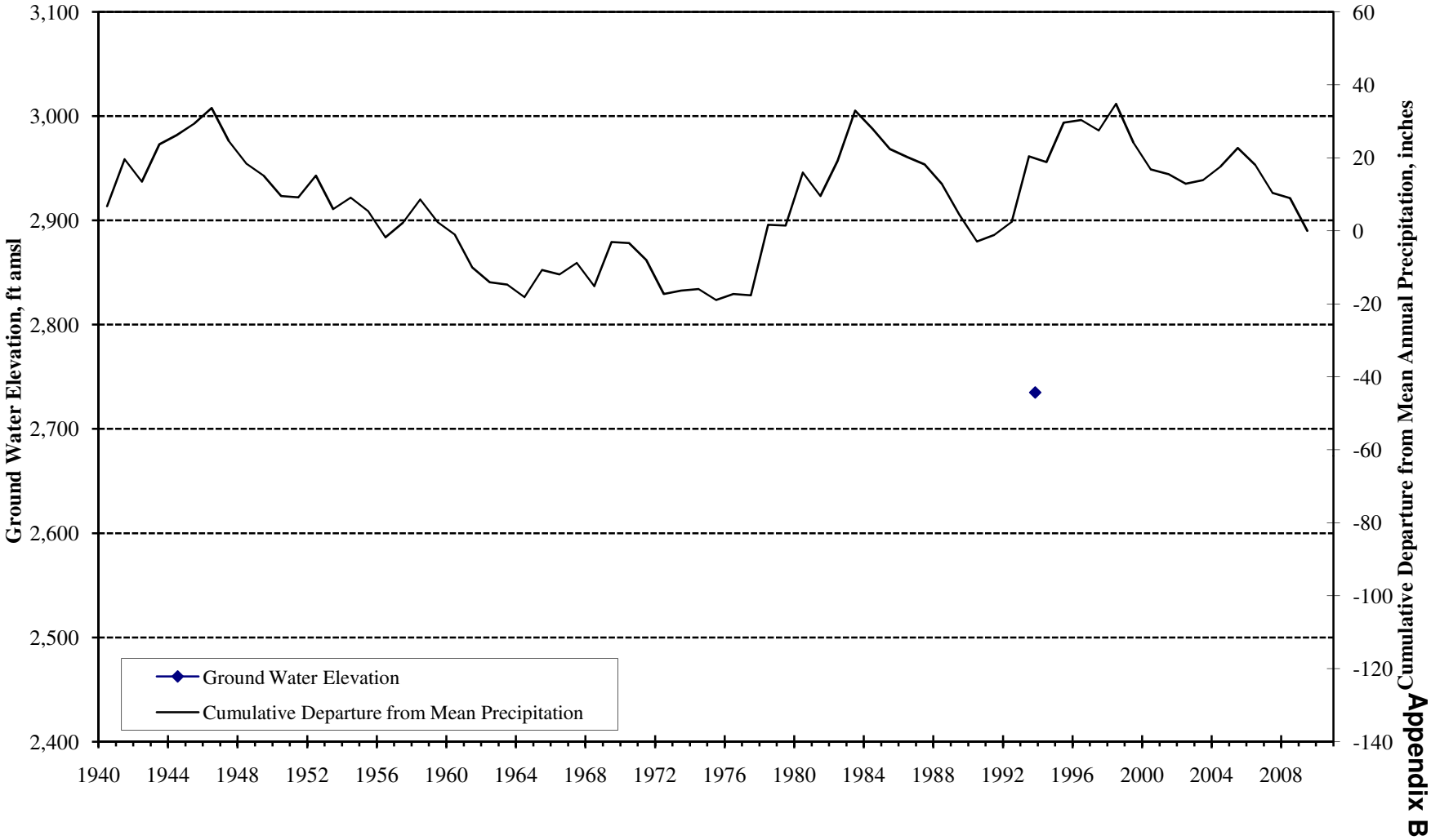
Appendix B

Ground Water Elevation
Well 2S/1E-25J1
Potrero Canyon



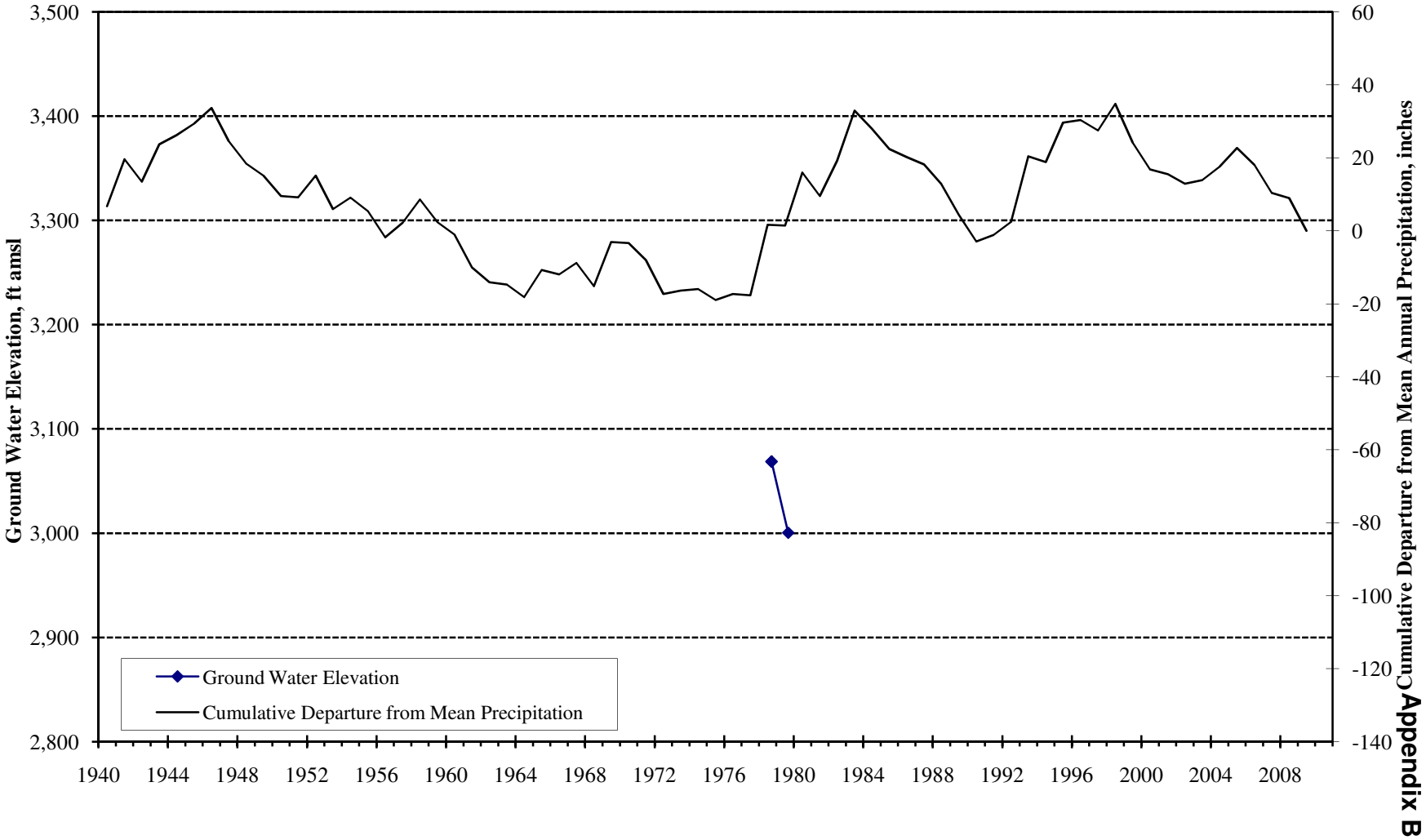
Appendix B

Ground Water Elevation
Well 2S/1E-25H1S NO. 4
Potrero Canyon



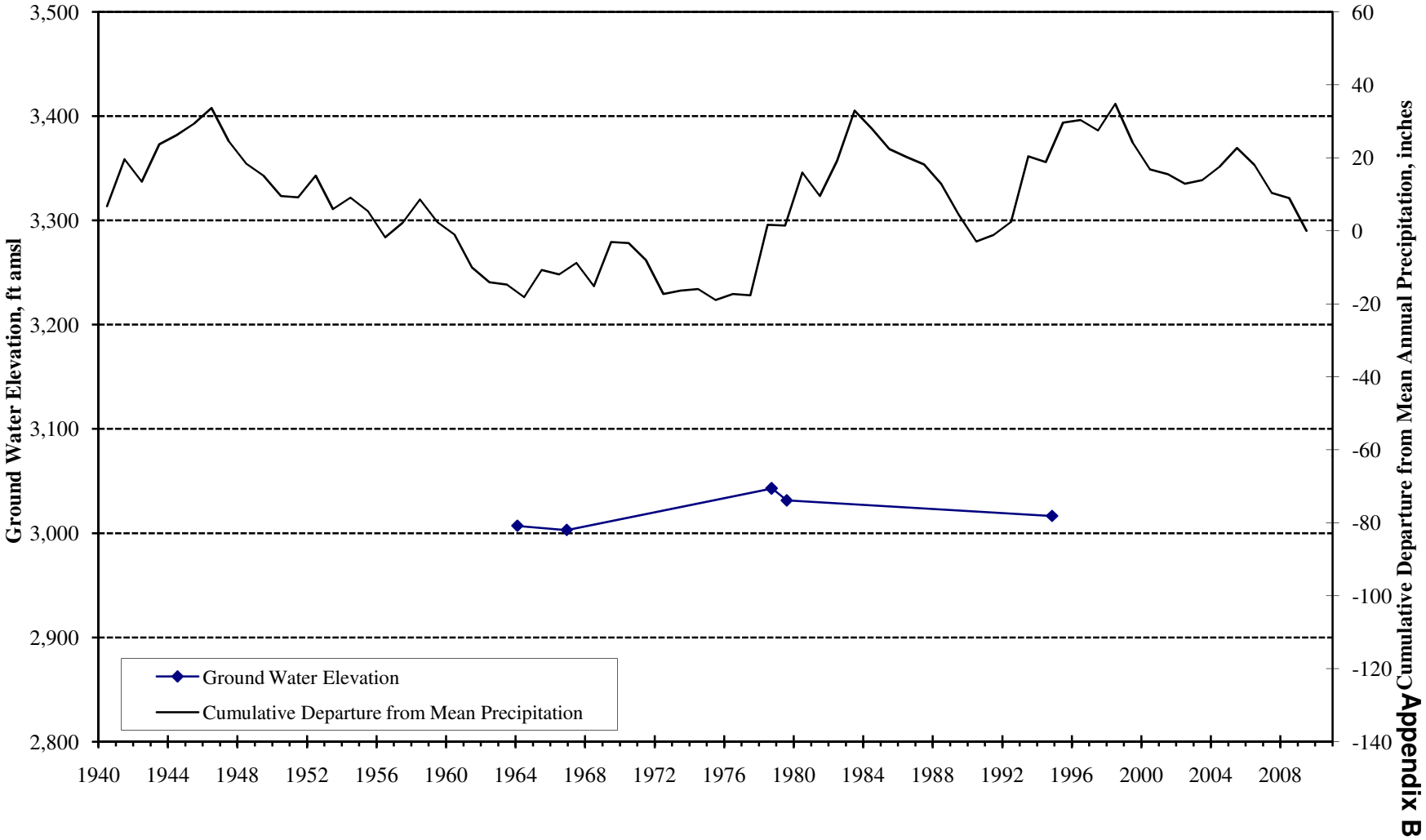
Appendix B

Ground Water Elevation
Well 2S/1E-24P2
Potrero Canyon



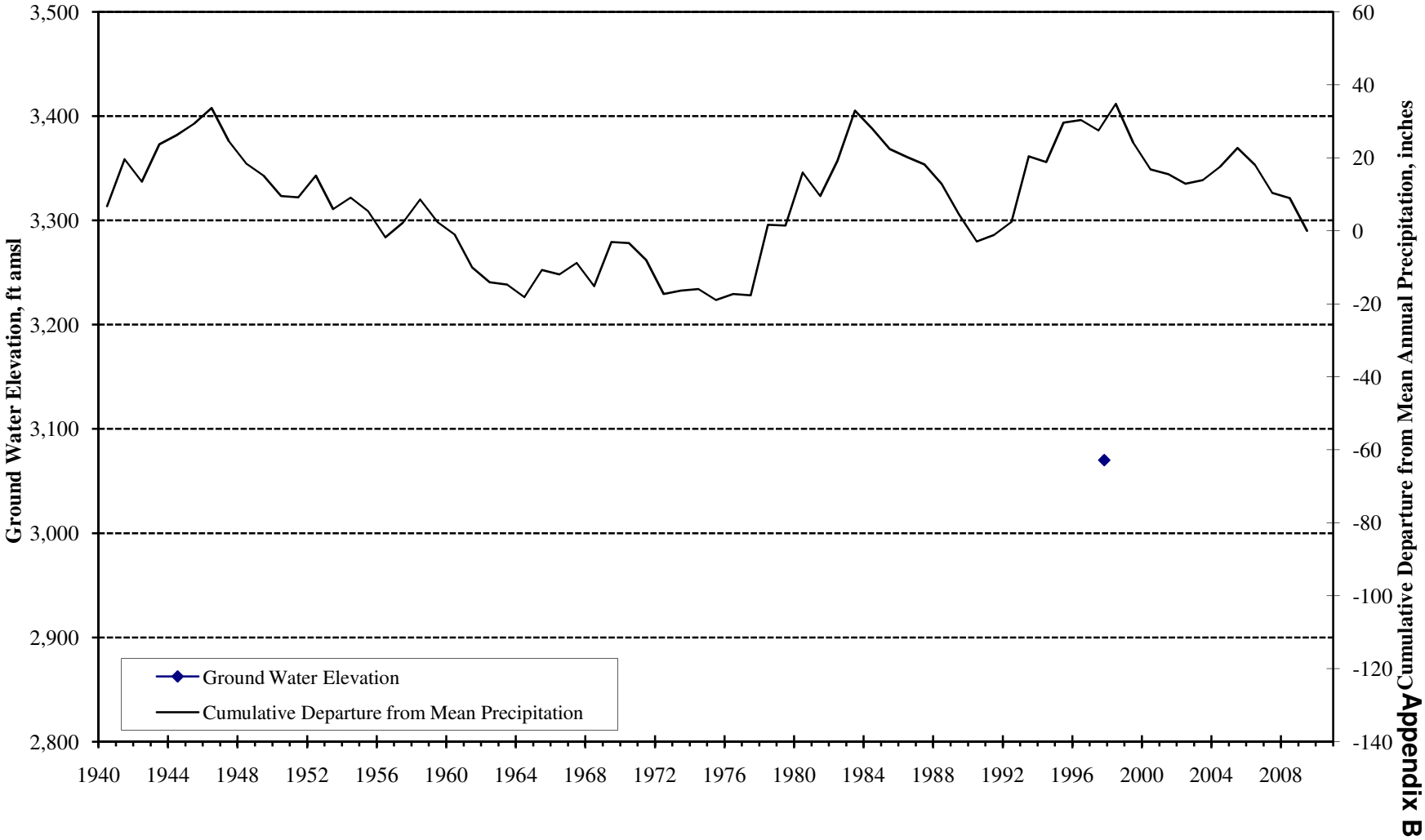
Appendix B

Ground Water Elevation
Well 2S/1E-24P1
Potrero Canyon



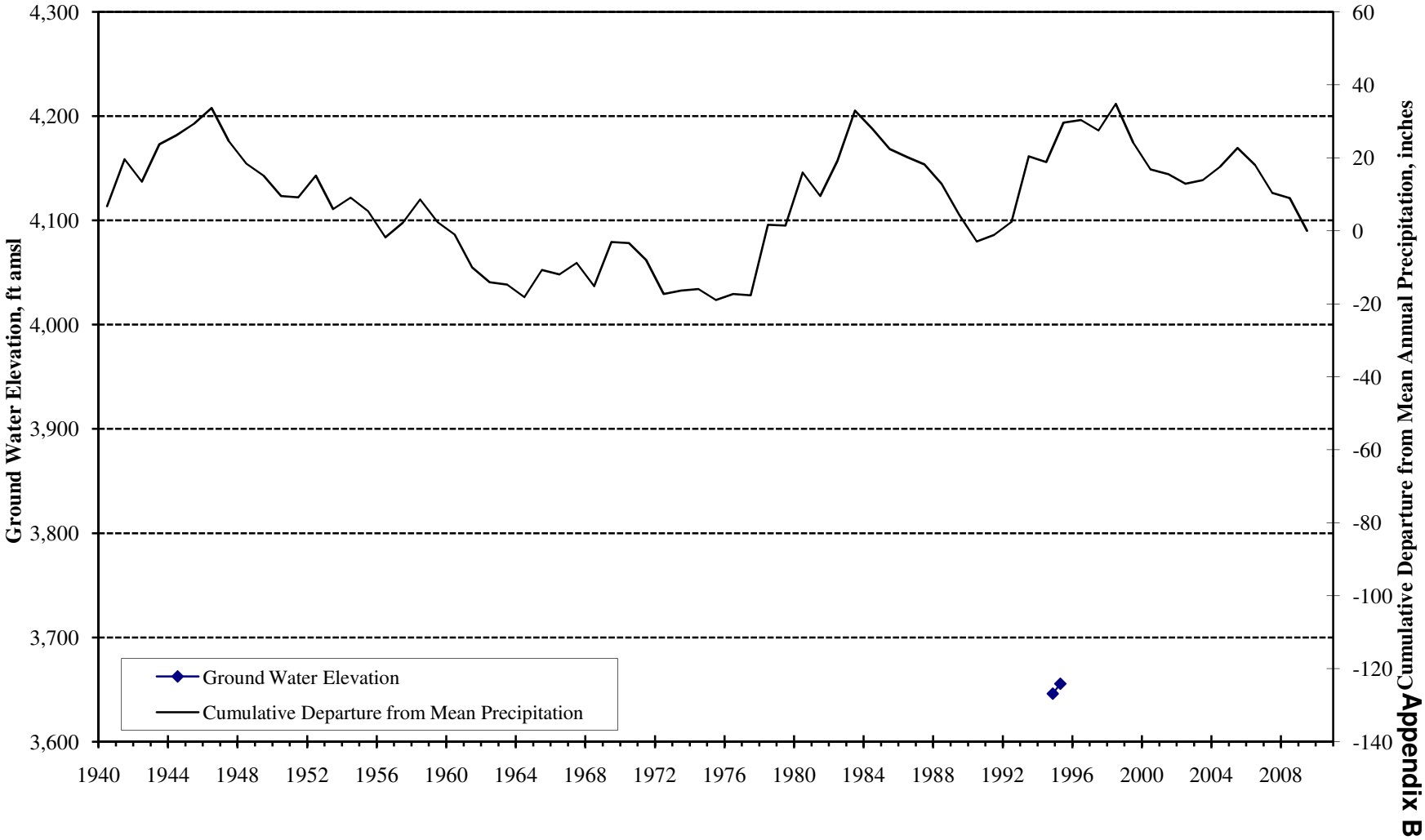
Appendix B

Ground Water Elevation
Well 2S/1E-24N1
Potrero Canyon



Appendix B

Ground Water Elevation
Well 2S/1E-14J1
Potrero Canyon



Appendix B

APPENDIX C

Select Historical Water Quality Data

GEOSCIENCE

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well 01	27-Jun-05			2.4					3.3	190
	29-Jun-05			2.4					3.2	190
	30-Jun-05			2.4					3.9	210
	06-Dec-84		ND	4	ND	0.3	ND	ND	7	135
	30-Jan-94	170		113.49			130	3	6.6	626
	07-Mar-94	ND	ND	10	ND	0.4	ND	ND	2	165
	16-Feb-95			10				3	1.25	290
	26-Oct-95								32	
	05-Sep-96	0	0	3	ND	0.4	0	0	2.7	170
	13-Sep-96		96	14			180		5.2	216
	29-Sep-98			18					15.9	390
	02-Mar-99	0	0	2	ND	0.4	0	0	3	180
	02-Aug-00			26					8	310
	02-Oct-01		2	16.1					12.6	263
	01-Oct-02		ND	16.3					9.1	185
	29-Oct-02	52	0	5.7	ND	0.4	0	0	4	240
	19-Dec-02				ND	1.3				
	25-May-05								6.3	220
	05-Jan-06	ND	ND	2.4	ND	0.4	ND	ND	3.1	190
	20-Apr-06								3.3	
	10-Apr-07								3.2	
	28-Apr-08								3.9	
	27-Jan-09	ND	ND	2.4	ND	0.3	ND	ND	4.5	210
	03-Feb-09				ND	0.6				
City of Banning Well 02	17-Apr-84		ND	7	ND	0.5	ND	ND	3	175
	07-Mar-94	ND	ND	3	ND	0.4	ND	ND	3	170
	05-Sep-96	0	0	7	ND	0.5	0	0	6.2	230
	02-Mar-99	0	0	3	3	0.4	0	0	3	160
	29-Oct-02	0	0	14	ND	1.2	0	0	8	360
	25-May-05			2.6			150		5.6	190
	05-Jan-06	ND	ND	2.6	3	0.4	150	ND	2.8	190

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well 02 cont.	20-Apr-06								6.5	
	17-Apr-07			2.6			150		3.5	190
	28-Apr-08			2.8					6.9	200
	04-Feb-09	ND	ND	2.8	ND	0.5	ND	ND	4.2	200
City of Banning Well 03	06-Dec-84		ND	12	ND	0.6	ND	ND	8	225
	07-Mar-94	ND	ND	2	ND	0.4	130	ND	1	170
	05-Sep-96	0	0	10	ND	0.4	0	0	6.2	260
	02-Mar-99	0	0	3	ND	0.4	0	0	2	150
	19-Dec-02	0	0	15			0	0	9	310
	01-Jan-05			2.3						180
	25-May-05								5.5	190
	05-Jan-06	ND	ND	2.3			ND	ND	2.7	180
	20-Apr-06								7.3	
	10-Apr-07			2.3			150		5.3	180
	01-Jan-08			3.8						170
	28-Apr-08								7.5	
	03-Feb-09	ND	ND	3.8			ND	ND	4.8	170
	05-May-09								5.3	
City of Banning Well 04	13-Jan-84		ND	5	ND	0.4	ND	ND	ND	150
	06-Dec-84		ND	9	ND	0.4	ND	ND	1	160
	09-Mar-94	ND	ND	3	3	0.4	410	ND	2	165
	03-Mar-99	0	0	2	ND	0.3	0	0	ND	180
	25-May-05	ND	ND	2.1	ND	0.4	ND	ND	3.6	180
	11-Jan-06	ND	ND	2.7	ND	0.4	ND	ND	2.8	190
	20-Apr-06								3	
	17-Apr-07			2.7					2.5	
	28-Apr-08								3.6	
	25-Feb-09	ND	ND	2.2		0.4	ND	ND	2.8	180
	01-Jun-09				ND					
City of Banning Well 05	06-Dec-84		ND	7	5	0.5	530	ND	1	165
	10-Mar-94	ND	ND	2	ND	0.3	ND	ND	ND	160
	26-Oct-95								21	
	05-Sep-96	0	0	3	ND	0.3	0	0	2.2	180
	02-Mar-99	0	0	3	ND	0.4	0	0	2	180
	01-Jul-03	0	0	2.7	ND	0.4	0	0		180
	01-Jan-05			2.7			160			
	25-May-05								3.1	170
	11-Jan-06	ND	ND	2.7	3	0.3	160	ND	2.8	190

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well 05 cont.	01-Jan-07			2.7			160			190
	29-Jan-07								2.4	
	29-Jan-08								5.4	
	03-Mar-09	ND	ND	3	ND	0.4	ND	ND	5.5	180
City of Banning Well 06 - DESTROYED	08-Jan-90	200	ND	4	ND	0.4	920	10	16	185
	08-Mar-94	ND	ND	5	ND	0.3	ND	ND	13	210
City of Banning Well 07	06-Dec-84		ND	5	ND	0.4	ND	ND	ND	160
	07-Mar-94	ND	ND	3	ND	0.4	ND	ND	1	175
	05-Sep-96	0	0	2	ND	0.3	0	0	ND	160
	02-Mar-99	0	0	2	ND	0.4	0	0	ND	170
	06-Nov-02	0	0	3.5	ND	0.4	0	0	ND	220
	25-May-05								4.5	220
	09-Jan-06	ND	ND	2.6	ND	0.3	ND	ND	1.8	200
	20-Apr-06								1.9	
	10-Apr-07			2.6					1.4	200
	21-Apr-08								2.3	
	21-Jan-09	ND	ND	1.8	ND	0.4	ND	ND	1.6	230
	19-May-09								1.2	
City of Banning Well 08	06-Dec-84		ND	5	ND	0.5	ND	ND	1	170
	02-Mar-90	ND	ND	2	ND	0.3	730	ND	ND	205
	07-Mar-94	ND	ND	3	ND	0.4	ND	ND	1	185
	05-Sep-96	0	0	3	ND	0.4	0	0	2.2	170
	02-Mar-99	0	0	4	ND	0.4	0	0	ND	160
	19-Dec-02	140	0	3.4	5	0.4	580	0	ND	200
	01-Jan-05			3			180		1.8	290
	25-May-05								2.5	220
	10-Jan-06	ND	ND	3	3	0.4	180	ND	2.2	170
	20-Apr-06								1.8	
	17-Apr-07			3			180		1.5	170
	21-Apr-08								1.7	
	13-Jan-09	ND	ND	4.1	ND	0.4	ND	ND	2.5	170
	26-May-09								ND	
City of Banning Well 09	08-Jan-90	ND	ND	2	ND	0.4	260	ND	ND	210
	08-Mar-94	ND	ND	2	ND	0.5	ND	ND	ND	175
	05-Sep-96	0	0	3	ND	0.4	0	0	ND	200
	01-Jul-02	0	0	11	ND	0.3	0	0	7	250
	05-Nov-02	0	0	2.1	ND	0.4	0	0	ND	200

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well 09 cont.	01-Jan-05			3.3						
	25-May-05								1.5	220
	04-Jan-06	ND	ND	3.3	ND	0.5	ND	ND	2.4	290
	20-Apr-06								2.1	
	17-Apr-07			3.3					2	290
	21-Apr-08								1.2	
	13-Jan-09	ND	ND	1.5	ND	0.5	ND	ND	1.1	220
	26-May-09								ND	
City of Banning Well 10 (LEWIS)	08-Jan-90	ND	ND	1	ND	0.4	50	ND	ND	190
	08-Mar-94	50	ND	2	ND	0.4	ND	ND	1	195
	05-Sep-96	0	0	2	ND	0.4	0	0	2.2	170
	03-Mar-99	60	0	2	3	0.4	130	0	ND	200
	05-Nov-02	0	0	1.7	ND	0.4	0	0	ND	180
	01-Jan-05			1.9						
	25-May-05								1.8	140
	04-Jan-06	ND	ND	1.9	ND	0.4	ND	ND	1.9	180
	20-Apr-06								1.4	
	17-Apr-07			1.9					1.1	180
	21-Apr-08								1.3	
	13-Jan-09	ND	ND	1.2	ND	0.4	ND	ND	1.1	250
	26-May-09								1.2	
City of Banning Well 11	08-Jan-90	ND	ND	1	ND	0.4	90	ND	ND	190
	08-Mar-94	ND	ND	2	ND	0.4	130	ND	ND	175
	05-Sep-96	0	0	1	ND	0.4	270	0	ND	180
	03-Mar-99	0	0	2	3	0.4	110	0	ND	190
	05-Mar-03	0	0	1.3	ND	0.4	140	0	ND	220
	01-Jan-05	120		1.9						
	25-May-05								1.7	170
	04-Jan-06	120	ND	1.9	20	0.4	1200	29	1.8	210
	22-Feb-06						ND			
	20-Apr-06								1.4	
	08-Jun-06				ND					
	17-Apr-07	120		1.9				29	1	210
	21-Apr-08								1.5	
	21-Jan-09	ND	ND	1.2	ND	0.4	ND	ND	1	170
	26-May-09								1.2	

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well 12	29-Jun-05			1.8			140			190
	08-Jan-90	ND	ND	1	ND	0.3	20	ND	ND	195
	08-Mar-94	110	ND	2	ND	0.4	280	ND	ND	180
	05-Sep-96	0	0	2	ND	0.3	100	0	ND	180
	03-Mar-99	0	0	2	ND	0.3	110	0	ND	200
	21-Jul-01	0	0	13	ND	0.7	0	0	8	190
	05-Mar-03	0	0	1.5	ND	0.3	0	0	ND	200
	01-Jan-05			1.8			140			
	25-May-05								1.3	160
	04-Jan-06	ND	ND	1.8	5	0.3	140	ND	1.2	190
	20-Apr-06								1.3	
	17-Apr-07								ND	
	21-Apr-08								1.3	
	21-Jan-09	ND	ND	1.4	ND	0.3	ND	ND	ND	180
	26-May-09								1.2	
City of Banning Well C-02 - ABANDONED	07-Dec-84		ND	14	10	0.4		ND	11	215
City of Banning Well C-02A	10-Jan-86		ND	11	ND	0.2	ND	ND	6	205
	20-Apr-94	250	ND	12	10	0.3	460	ND	7	245
	05-Sep-96	50	0	10	ND	0.4	490	0	6.2	230
	03-Mar-99	0	0	8	ND	0.3	110	0	8	230
	06-Nov-02	0	0	8.3	ND	0.3	0	0	5	260
	01-Jan-05	130		10					9.9	210
	25-May-05								9.7	260
	10-Jan-06	130	ND	10	3	0.3	490	ND	8	210
	06-Feb-06						ND			
	20-Apr-06								9.9	
	24-Apr-07	130		10					5.5	210
	14-Apr-08			8.9					7.1	240
	04-Feb-09	ND	ND	8.9	ND	0.4	ND	ND	7.3	240
	28-Apr-09								7.5	
City of Banning Well C-03	02-Mar-90	ND	ND	11	ND	0.5	30	ND	6	185
	07-Mar-94	120	ND	10	5	0.4	480	ND	6	200
	05-Sep-96	0	0	9	ND	0.4	0	0	5.3	210
	02-Mar-99	360	0	11	10	0.4	440	0	8	170
	06-Nov-02	0	0	10	ND	0.4	0	0	7	220
	25-May-05								6.8	230
	11-Jan-06	ND	ND	10	3	0.4	ND	ND	6.9	180

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well C-03 cont.	20-Apr-06								6.7	
	24-Apr-07			10					4.6	180
	14-Apr-08								6.3	
	04-Feb-09	ND	ND	9.2	ND	0.6	ND	ND	6.7	180
	08-Jun-09								7	
City of Banning Well C-04	07-Mar-94	ND	ND	12	ND	0.3	ND	ND	7	225
	28-Aug-95	ND	ND	13	3	0.3	ND	ND	9	230
	05-Sep-96	0	0	9	ND	0.3	0	0	5.3	220
	09-Dec-96						0			
	02-Mar-99	0	0	9	ND	0.3	0	0	7	210
	06-Nov-02			7.5	ND	0.3		0.004	4	230
	01-Jan-05			9.8					5	210
	11-Jan-06	ND	ND	9.8	ND	0.3	ND	ND	7.4	210
	20-Apr-06								5	
	24-Apr-07			9.8					5.2	210
	14-Apr-08								6.5	
	27-Jan-09	ND	ND	8.8	ND	0.3	ND	ND	6.9	200
	05-May-09								6.5	
City of Banning Well C-05	8-Nov-90	ND	ND	12	ND	1	90	ND	6	180
	7-Mar-94	90	5	17	15	2.4	800	ND	3	180
	28-Aug-95	ND	6	15	3	1.7	ND	ND	5	190
	27-Sep-95					1.7				
	1-Jul-96					1.8				
	5-Sep-96	0	5	13	ND	1.4	0	0	8	180
	9-Dec-96					1.7				
	3-Mar-99	0	7	13	5	2	240	20	5	190
	29-Oct-02			11	ND	1.3			5	190
	11-Jan-06	ND	3.5	13	ND	1.5	ND	ND	5.4	180
	20-Apr-06								5.4	
	17-Apr-07			13					6.1	
	14-Apr-08								5.7	
	3-Feb-09	ND	ND	11	ND	0.2	ND	ND	6	140
	28-Apr-09								5.8	
City of Banning Well C-06	5-Dec-90	ND	ND	14	ND	0.5	70	ND	6	200
	10-Apr-03				3	0.5				
	26-Jul-06	170	ND	14	ND	0.8	480	ND	6.4	240
	22-Aug-06						ND			

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
City of Banning Well C-06 cont.	17-Oct-06	ND		12		0.5	ND		1.8	210
	17-Apr-07			14					8.1	240
	14-Apr-08								7.7	
	19-May-09			12					6.7	230
	24-Jun-09	ND	ND	12	ND	0.5	ND	ND	8.1	230
City of Banning Well M-10	1-Jan-05			11					8.7	160
	31-May-05				ND	0.7				
	12-Jan-06	ND	ND	11	ND	0.7	ND	ND	9.2	160
	20-Apr-06								8.7	
	10-Apr-07			11					9.5	160
	28-Apr-08								8.9	
	24-Jun-09	57	ND	11	5	0.7	480	ND	9.4	180
City of Banning Well M-11	1-Jan-05			8.8			170		5.8	280
	31-May-05				ND	0.4				
	12-Jan-06	ND	ND	8.8	ND	0.3	170	ND	5.8	280
	20-Apr-06								5.8	
	10-Apr-07			8.8			170		4.5	280
	28-Apr-08								3.6	
	27-Jan-09	ND	3.3	7.2	ND	0.7	ND	ND	ND	170
	5-May-09								3.6	
City of Banning Well M-12	1-Jan-05			8.5						
	2-Jan-05								4.6	
	3-Jan-05									180
	31-May-05				ND	0.7				
	12-Jan-06	ND	ND	8.5	ND	0.5	ND	ND	6.8	180
	20-Apr-06								4.6	
	10-Apr-07			8.5					6.3	180
	28-Apr-08								7.1	
	25-Feb-09	ND	ND	9.2		0.8	ND	ND	7.5	190
	23-Apr-09								6.4	
	1-Jun-09				ND					
City of Banning Well M-3	1-Jan-05			16					7.8	280
	31-May-05				3	0.4				
	12-Jan-06	ND	ND	16	ND	0.4	ND	ND	7.2	280

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City of Banning Well M-3 cont.	20-Apr-06								7.8	
	17-Apr-07			16					7.1	280
	14-Apr-08								6.4	
	3-Feb-09	ND	ND	14	ND	0.5	ND	ND	7.5	250
City of Banning Well M-7 - INACTIVE	1-Jan-05								8.9	
	31-May-05				15	0.5				
	20-Apr-06								8.9	
	10-Apr-07								8.7	
	27-May-08	ND	ND	13	ND	0.5	ND	ND	8.5	190
	19-May-09								7.3	
City of Banning Well R-1 (Zone 1) 600 - 620 ft bgs	3-Dec-90			28			190	0.03	24	325
City of Banning Well R-1 (Zone 2) 550 - 570 ft bgs	3-Dec-90			21			460	0.02	27	260
City of Banning Well R-1 (Zone 3) 480 - 500 ft bgs	3-Dec-90			23			420	0.03	29	280
City of Banning Well R-1 (Zone 4) 410 - 430 ft bgs	3-Dec-90			50			800	0.11	22	530
Cabazon Water District Well 01	11-Feb-96			9	0		0	0	8.4	
	13-Aug-96	0	2			0.9			8.9	
	08-Mar-99			10			20	0	12.8	
	05-Apr-99				0					
	28-Feb-00				ND					
	20-May-02					0.7				
	19-May-03				ND					
	04-May-05				ND	0.8				
	11-May-06								7.9	250
	30-Jan-08								7	
	13-Nov-08	ND	ND	8.1	ND	0.7	ND	ND	8.2	210
Cabazon Water District Well 02	06-Dec-95			6	ND		ND	ND	7.1	
	11-Dec-96	130	0			0.4			7.1	
	08-Mar-99			6			0	0	8	
	05-Apr-99				0					
	28-Feb-00				ND					
	20-May-02					0.4				
	19-May-03				ND					
	04-May-05				ND	0.4				

Select Historical Water Quality Constituents in the City of Banning Water Resource Area

Well Name	Date	Aluminum [µg/L] 50 µg/L[1]	Arsenic [µg/L] 6 µg/L[1]	Chloride [mg/L] 250 mg/L[2]	Color [units] 15 color units[2]	Fluoride [mg/L] 2 mg/L[2]	Iron [µg/L] 300 µg/L[2]	Manganese [mg/L] 0.05 mg/L[2]	Nitrate (as NO3) [mg/L] 45 mg/L[1]	TDS [mg/L] 500 mg/L[2]
Cabazon Water District Well 02 cont.	11-May-06								6.8	230
	30-Jan-08								6.5	
	13-Nov-08	ND	ND	5.4	ND	0.4	ND	ND	7.6	220
Cabazon Water District Well 03 (Formerly Jenson Well 01)	26-Nov-86		ND	7	5		ND	ND	ND	
	10-Aug-89	ND	ND	16	ND	0.5	160	ND	21	
	13-Jul-93	ND	ND	13	ND	0.3	ND	ND	13	
	29-Mar-95	ND	ND	25	5	0.3	100	ND	35	
	29-Dec-95	0	0	25	ND	0.3	2300	0	30	
	17-Mar-97	0	0	24	3	0.3	250	0	30	
	27-Apr-98	0	0	21	ND	0.4	0	0	33	
	03-Jun-09								23	
	11-Aug-09								20	
Cabazon Water District Well 04	26-Nov-86		ND	7	5	0.1	90	ND	ND	
	10-Aug-89	ND	ND	14	ND	0.5	80	ND	10	
Cabazon Water District Well 04 (Formerly Jenson Well 02) - DESTROYED cont.	22-Sep-93	ND	ND	15	10	0.3	650	ND	11	
	29-Mar-95	ND	ND	12	3	0.3	100		11	
	29-Dec-95	0	0	12	ND	0.3	1000	0	9	
	17-Mar-97	0	0	13	10	0.5	690	0	8	
USGS monitoring Well 3S/1E-11F1	16-Jul-09	8.5	0.43	13.5		0.39	2*	0.7		232
USGS monitoring Well 3S/1E-11F2	16-Jul-09	5.3	1.3	15.2		0.42	2	3.6		264
USGS monitoring Well 3S/1E-11F3	16-Jul-09	6.5	0.85	15.2		0.49	2*	3.8	25.9*	296
USGS monitoring Well 3S/1E-11F4	16-Jul-09	17.9	5.1	13.8		0.44	10	1.2	39.7	338

* Estimated Value as displayed on USGS water Quality Website

Note: ND = Not Detected

Shaded cells exceed Maximum Contamination Level (MCL)

Values of zero were as reported by the California Department of Human Services

[1] Primary MCL

[2] Secondary MCL

[3] US EPA Treatment Technique Value

APPENDIX D

Appropriators and Their Water Rights

Exhibit C of the Beaumont Basin Judgment

GEOSCIENCE

Exhibit C
Appropriators and Their Water Rights

(1) Producer	(2) Average Production during 1997-2001 (acre-ft/yr)	(3) Share of Safe Yield Allocated to Appropriators	(4) Initial Estimate of Appropriate Rights[1] (acre-ft/yr)	(5) Controlled Overdraft and Supplemental Water Recharge Allocation [2] (acre-ft/yr)	(6) Operating Yield (acre-ft/yr)
Banning, City of	2,170	31.43%	882	5,029	5,910
City of Beaumont	0	0.00%	0	0	0
Beaumont Cherry Valley Water District	2,936	42.51%	1,193	6,802	7,995
South Mesa Water Company	862	12.48%	350	1,996	2,346
Yucaipa Valley Water District	938	13.58%	381	2,173	2,554
Totals	6,906	100.00%	2,805	16,000	18,805

Note 1 – Based on a 8,650 acre-ft/yr safe yield

Note 2-- Controlled overdraft will not exceed 160,000 acre-ft during for first ten years of operation under the physical solution.

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