Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

February 2015

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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Prepared for
Napa County

Prepared by

LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

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EXECUTIVE SUMMARY

ES 1 INTRODUCTION

Groundwater and surface water are highly important natural resources in Napa County. Together, the County and other municipalities, water districts, commercial and industrial operations, the agricultural community, and the general public, are stewards of the available water resources. Everyone living and working in Napa County has a stake in protecting the county's groundwater resources, including groundwater supplies, groundwater quality, and associated watersheds (GRAC, 2014).

Long-term, systematic monitoring programs are essential to provide data that allow for improved evaluation of water resources conditions and to facilitate effective water resources planning. For this reason, Napa County embarked on a countywide project referred to as the "Comprehensive Groundwater Monitoring Program, Data Review, and Policy Recommendations for Napa County's Groundwater Resources" (Comprehensive Groundwater Monitoring Program) in 2009, to meet action items identified in the 2008 General Plan update. The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information.

The *Napa County Groundwater Monitoring Plan 2013* (Plan) was prepared to formalize and augment groundwater monitoring efforts conducted as part of the Comprehensive Groundwater Monitoring Program. The Plan recommended annual reports on groundwater conditions and modifications to the countywide groundwater monitoring program as needed. Additionally, the Plan recommended a comprehensive triennial report. This report is the first Annual Report – *Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM*[1] *Update* (Report).

In addition to providing an update on groundwater level conditions and monitoring program modifications, this Report summarizes available background information in order to serve as a common reference for future annual reports.

ES 2 GROUNDWATER MONITORING GOALS AND OBJECTIVES

The California Department of Water Resources (DWR) has identified the major groundwater basins and subbasins in and around Napa County. The basins include the Napa-Sonoma Valley (which in Napa County includes the Napa Valley and Napa-Sonoma Lowlands Subbasins), Berryessa Valley, Pope Valley, and a small part of the Suisun-Fairfield Valley Groundwater Basins (**Figure ES-1**). For purposes of local planning, understanding, and studies, the County has been subdivided into a series of groundwater subareas (**Figure ES-2**). These subareas were delineated based on the main watersheds, groundwater basins, and the County's environmental resource planning areas.

Water level and quality objectives established for the countywide Comprehensive Groundwater Monitoring Program are linked to 1) the County's General Plan goals and action items presented in **Section 3.1** of this Report, and 2) hydrogeologic conditions and potential areas of concern (LSCE, 2013a).

The focus of the countywide groundwater level monitoring includes the following objectives:

[1] CASGEM is the California Statewide Groundwater Elevation Monitoring program implemented under Water Code Part 2.11 Groundwater Monitoring and administered by DWR.

- Expand groundwater level monitoring in priority County subareas to improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify hydraulic connections in aquifer systems and aquifer-specific groundwater conditions, especially in areas where short- and long-term development of groundwater resources are planned;
- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation, surface water seepage to groundwater, groundwater discharge to streams) or induced factors (e.g., pumping, purposeful recharge operations) that affect groundwater levels and trends;
- Identify appropriate monitoring sites to further evaluate groundwater-surface water interaction and recharge/discharge mechanisms, including whether groundwater utilization is affecting surface water flows;
- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and
- Generate data to better estimate groundwater basin conditions and assess local current and future water supply availability and reliability; update analyses as additional data become available.

Based on the analysis of existing groundwater data and conditions described in the report *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011a) and with input received from the Groundwater Resources Advisory Committee (GRAC), the key objectives for future groundwater level monitoring for each subarea are summarized in LSCE (2013a) and **Section 3** of this Report.

ES 3 SUSTAINABLE GROUNDWATER MANAGEMENT ACT

In September 2014, the California Legislature passed the Sustainable Groundwater Management Act (Act). This new Act changes how groundwater is managed in the state. The Act defines "sustainable groundwater management" as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (Section 10721 (u)). Undesirable results, as defined by the Act, means one or more effects caused by groundwater conditions occurring throughout the basin (Section 10721 (w)) (see **Section 6.2**).

As noted in **Section 2** of this Report the Act applies to basins or subbasins that DWR designates as medium- or high-priority basins. Previously under the California Statewide Groundwater Elevation Monitoring Program (CASGEM), DWR ranked California's basins and subbasins. In Napa County, the Napa Valley Subbasin was ranked medium priority. All other Napa County subbasins were ranked as low or very low priority basins (**Figure ES-1**).

For most basins designated by DWR as medium or high priority, the Act requires the designation of groundwater sustainability agencies (GSA) and the adoption of groundwater sustainability plans (GSP); however, there is an alternative to a GSP, provided that the local entity (entities) can meet certain requirements. When required, GSPs must be developed to eliminate overdraft conditions in aquifers and to return them to a condition that assures their long-term sustainability within twenty years of GSP implementation. The Act does not require the development of a GSP for basins that DWR ranks as low- or very low-priority basins; GSPs are voluntary for these basins.

As applicable, the Act requires that a GSA be identified for medium- and high-priority groundwater basins by June 30, 2017. Counties are presumed to be the GSA for unmanaged areas of medium and high priority basins (Section 10724). However, counties are not required to assume this responsibility. When no entity steps forward, this can lead to state intervention (Section 10735 *et seq*.).

In addition to imposing a number of new requirements on local agencies related to groundwater management, the Act also provides for state intervention – a “backstop” – when local agencies are unwilling or unable to manage their groundwater basin (Section 10735 *et seq*.).

Under the new Act, Section 10733.6, a local entity (or entities) can pursue an Alternative to a GSP provided that certain sustainability objectives are met. An Alternative to a GSP may include:

> (b) (3) “An analysis of basin conditions that demonstrates that the basin has operated within its sustainable yield over a period of at least 10 years. The submission of an alternative described by this paragraph shall include a report prepared by a registered professional engineer or geologist who is licensed by the state and submitted under that engineer’s or geologist’s seal.”

The County would need to submit the alternative plan no later than January 1, 2017, and every five years thereafter.

(d)The assessment required by subdivision (a) shall include an assessment of whether the alternative is within a basin that is in compliance with Part 2.11 (commencing with Section 10920). If the alternative is within a basin that is not in compliance with Part 2.11 (commencing with Section 10920), the department shall find the alternative does not satisfy the objectives of this part.

ES 4 GROUNDWATER MONITORING NETWORK DESIGN AND DEVELOPMENT

The total number of sites where groundwater level monitoring was conducted in Napa County increased to 115 in 2014 from 87 sites reported in the 2011, when the number of monitored sites was most recently determined (LSCE, 2013a) (**Table ES-1** and **Figure ES-3**). The overall increase in the number of monitored sites is attributable to the efforts of Napa County with support from the GRAC, as described in **Sections 4.1.1 and 4.2**.

A total of 48 wells were volunteered as candidates for inclusion in the Comprehensive Groundwater Monitoring Program during 2013 and 2014. Of those 48 candidate wells, 30 were subsequently selected for continued monitoring as part of the Comprehensive Groundwater Monitoring Program.

The geographical extent of groundwater level monitoring also increased in 2014 compared to 2011 (**Table ES-1**). The number of sites monitored increased in all five Napa Valley Floor (NVF) Subareas and in the Carneros Subarea. New monitoring sites were also added in previously unmonitored subareas including, the Angwin, Eastern Mountains, and Western Mountains Subareas.

Table ES-1 Current Groundwater Level Monitoring Sites in Napa County by Groundwater Subarea

Groundwater Subarea	Number of Monitored Sites Through 2011	Number of Monitored Sites, Fall 2014
Napa Valley Floor-Calistoga	6	10
Napa Valley Floor-MST	29	27
Napa Valley Floor-Napa	18	21
Napa Valley Floor-St. Helena	12	14
Napa Valley Floor-Yountville	9	12
Carneros	5	12
Jameson/American Canyon	1	1
Napa River Marshes	1	1
Angwin	0	5
Berryessa	3	2
Central Interior Valleys	1	1
Eastern Mountains	0	3
Knoxville	1	0
Livermore Ranch	0	0
Pope Valley	1	1
Southern Interior Valleys	0	0
Western Mountains	0	2
Unknown[1]	0	3
Total Sites	**87**	**115**

[1] As of January 2015 three sites in the GeoTracker regulated groundwater monitoring network were reporting groundwater level data, but had not yet reported location information for the monitored wells.

ES 4.1 Local Groundwater Assistance Grant Program Monitoring

Funding from the DWR 2012 Local Groundwater Assistance Grant Program enabled Napa County to construct ten monitoring wells at five sites in Napa Valley in September 2014. These wells comprise the groundwater monitoring facilities for the Napa County Surface Water-Groundwater Monitoring Project.

Initial data collected at the five sites are summarized in **Table ES-2**. These data relate manual measurement of groundwater levels from October 2014 through January 2015, where available.

Connectivity between groundwater and surface water is indicated at Sites 1 and 4 for the available period of record (**Table ES-2**). The positive connectivity values at these sites show that groundwater levels were above the streambed, which also suggests a groundwater flow in the direction of the streambed at that site. Data from Sites 2, 3, and 5 show that groundwater levels were below the streambed, which at larger magnitude (i.e., more negative) indicates disconnection between surface water and groundwater. Slightly negative connectivity values may indicate a disconnection or flow from surface water to groundwater.

Table ES-2 Summary of Initial Data from Napa County Surface Water-Groundwater Monitoring Sites

Site	Date	Streambed/ GroundwaterConnectivity Groundwater Elevation Relative to Streambed Elevation (ft.)
Site 1 Napa River at Napa	10/20/2014	**8.70**
Site 2 Dry Creek at Washington St	10/20/2014	**-11.30**
Site 2 Dry Creek at Washington St	12/10/2014	**-5.31**
Site 3 Napa River at Oak Knoll Ave	10/20/2014	**-3.50**
Site 4 Napa River at Yountville Cross Rd	10/23/2014	**0.77**
Site 4 Napa River at Yountville Cross Rd	12/10/2014	**2.38**
Site 5 Napa River at St. Helena	10/20/2014	**-6.96**
Site 5 Napa River at St. Helena	12/10/2014	**-2.35**
Site 5 Napa River at St. Helena	1/6/2015	**-1.97**
NOTE: Positive Streambed/Groundwater Connectivity values indicate connectivity and flow of groundwater towards the streambed. Negative Streambed/Groundwater Connectivity values indicate flow from the riverbed into groundwater (if connected) or a disconnection between surface water and groundwater.		

ES 5 SUMMARY OF CONDITIONS AND RECOMMENDATIONS

Groundwater level trends in the Napa Valley Subbasin of the Napa-Sonoma Valley Groundwater Basin are stable in the majority of wells with long-term groundwater level records. While many wells have shown at least some degree of response to the drought conditions in 2013 and 2014, the water levels observed in recent years are generally higher than groundwater levels in the same wells during the 1976 to 1977 drought. Elsewhere in the County long-term groundwater level records are limited, with the exception of the MST Subarea. Groundwater level declines observed in the MST Subarea as early as the 1960s and 1970s have moderated in some wells since about 2008, while other wells continue to experience declining groundwater levels. The observation that groundwater level responses differ within the MST Subarea and even within the north, central, and southern sections of this subarea indicate that localized conditions, whether geologic or anthropogenic in nature, might be the primary influence on conditions in the subarea at this time.

Although groundwater level trends are stable in the majority of wells, periods of year to year declines in groundwater levels have been observed in a few wells in the Napa Valley Floor Subareas. These wells are located near the Napa Valley margin in the eastern Napa Subarea (NapaCounty-75), southwestern Yountville Subarea (NapaCounty-135) and southeastern St. Helena Subarea (NapaCounty-132) (**Figure ES-2**). In addition to proximity to previously identified cones of depression in the MST Subarea at NapaCounty-75, these wells are also located in areas with relatively thin alluvial deposits.

Groundwater level declines in these wells could have one or more contributing factors, including variations in precipitation and weather patterns and/or changes in the level of pumping at the monitored well or in the vicinity of the monitored well.

ES 5.1 Ongoing Vetting and Review of Potential Monitoring Sites

Based on available well construction information, pre-existing hydrogeologic information, and monitoring priorities described in the 2013 Napa County Groundwater Monitoring Plan, 30 of the 48 candidate wells are recommended for continued monitoring (**Table ES-3**). Fifteen of the candidate wells were determined to have insufficient data with which to make a final determination on suitability for inclusion in the County monitoring networks. These wells are recommended for one year of additional groundwater level monitoring while additional well construction information is sought.

ES 5.2 Data Gap Refinement

Groundwater levels in some monitored wells located closer to the Napa Valley margin show signs of decreasing groundwater level trends. In order to consider the full range of possible causes for these declines, additional information will be needed. Recommended actions include a review of land use data in these areas, conversations with the well owners regarding changes to the pattern of pumping at the well over time, and more frequent data collection.

ES 5.3 Coordination with Other Monitoring Efforts

Coordination with other county departments and other agencies that monitor groundwater data or receive groundwater data could provide an additional source of data in places where data are limited. Several local agencies, including Town of Yountville, City of St. Helena, City of Napa, already monitor groundwater levels at locations around the County.

Table ES-3 Summary of Groundwater Level Monitoring Objectives and Future Monitoring Needs

Subarea	Future GW Level Monitoring (Relative Priority)		Monitoring Needs	Key Monitoring Objectives[1]	Candidate Wells Selected for Future Monitoring	Additional Vetting of Candidate Wells Needed	Additional Candidate Wells Needed to Meet Key Objectives
Napa Valley Floor-Calistoga	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**1**	**Yes**	**Yes**
Napa Valley Floor-MST	**H**	**R**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**2**	**No**	**Yes**
Napa Valley Floor-Napa	**H**	**R**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**6**	**Yes**	**Yes**
Napa Valley Floor-St. Helena[4]	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**6**	**Yes**	**Yes**
Napa Valley Floor-Yountville	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**1**	**Yes**	**Yes**
Carneros	**H**	**E**	**B**	**Conditions, Trends, Wtr Budget, Saltwater**	**2**	**Yes**	**No**
Jameson/American Canyon	M	E	B	Conditions, Trends, Wtr Budget, Saltwater	1	No	Yes
Napa River Marshes	M	E	SP, SW	Conditions, Trends, Wtr Budget, Saltwater	0	No	Yes
Angwin	M	E	B	Conditions, Trends, Wtr Budget	4	Yes	No
Berryessa	L	E	B	Conditions, Trends (includ. CASGEM)	0	No	Yes
Central Interior Valleys	L	E	B	Conditions, Trends	1	No	No
Eastern Mountains	L	E	B	Conditions, Trends	3	Yes	No
Knoxville	L	E	B	Conditions, Trends	0	No	Yes
Livermore Ranch	L	E	B	Conditions, Trends	0	No	Yes
Pope Valley	L	E	B	Conditions, Trends (includ. CASGEM)	1	Yes	Yes
Southern Interior Valleys	L	E	B	Conditions, Trends	0	No	Yes
Western Mountains	L	E	B	Conditions, Trends	2	No	No
				Total	**30**		

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells coordinated with recent geologic investigations that are or will be conducted)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs:
SP = Improve horizontal and/or vertical spatial distribution of data, including for the purpose of identifying such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage;
SW =identify appropriate monitoring site to evaluate surface water -groundwater recharge/discharge mechanisms;
B = Basic data needed to accomplish groundwater level monitoring objectives

1 INTRODUCTION

1.1 Purpose

Groundwater and surface water are highly important natural resources in Napa County. Together, the County and other municipalities, water districts, commercial and industrial operations, the agricultural community, and the general public, are stewards of the available water resources. Everyone living and working in Napa County has a stake in protecting the county's groundwater resources, including groundwater supplies, quality, and associated watersheds (GRAC, 2014). Without sustainable groundwater resources, the character of the County would be significantly different in terms of its economy, communities, rural character, ecology, housing, and lifestyles.

Similar to other areas in California, businesses and residents of Napa County face many water-related challenges including:

- Sustaining the quality, availability and reliability of local and imported water supplies;
- Meeting challenges arising during drought conditions;
- Avoiding environmental effects due to water use; and
- Changes in long-term availability due to global warming and/or climate change.

To address these challenges, long-term, systematic monitoring programs are essential to provide data that allow for improved evaluation of water resources conditions and to facilitate effective water resources planning. In 2009, Napa County embarked on a countywide project referred to as the "Comprehensive Groundwater Monitoring Program, Data Review, and Policy Recommendations for Napa County's Groundwater Resources" (Comprehensive Groundwater Monitoring Program), to meet identified action items in the 2008 General Plan update. The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information.

On June 28, 2011, the Napa County Board of Supervisors adopted a resolution to establish a Groundwater Resources Advisory Committee (GRAC), and an outreach effort for applicants began. On September 20, 2011, the Board of Supervisors appointed 15 residents to the GRAC, and the GRAC held its first organizational meeting on October 27, 2011. The members represent diverse interests, including environmental, agricultural, development, and community interests.

The GRAC was created to assist County staff and technical consultants with recommendations regarding:

- Synthesis of existing information and identification of critical data needs;
- Development and implementation of an ongoing non-regulatory groundwater monitoring program;
- Development of revised well pump test protocols and related revisions to the County's groundwater ordinance;
- Conceptualization of hydrogeologic conditions in various areas of the County and an assessment of groundwater resources as data become available;
- Development of groundwater sustainability objectives that can be achieved through voluntary means and incentives; and

- Building community support for these activities and next steps.

From January 2012 until January 2013, the GRAC reviewed and provided feedback on the development of the *Napa County Groundwater Monitoring Plan 2013* (Plan) (LSCE, 2013a). The Plan was prepared to formalize and augment groundwater monitoring efforts [levels and quality] to better understand the groundwater resources of Napa County, aid in making the County eligible for public funds administered by the California Department of Water Resources (DWR), and regularly evaluate trends to identify changes in levels and/or quality and factors related to those changes that warrant further examination to ensure sustainable water resources. The Plan included refinement of criteria used to identify priority monitoring areas and a proposed expanded monitoring network.

The Napa County groundwater monitoring program relies on both publicly-owned and volunteered private wells. To fulfill its mission and garner community interest and support, the GRAC developed a Communication and Education Plan, designed to implement the Plan through voluntary participation. This effort included the development of an outreach brochure and a series of fact sheets on specific topics.

Some of the many activities accomplished by the GRAC over a two and a half year period included:

- Provided updates to agriculture industry groups, environmental organizations and others;
- Led and supported outreach efforts to well owners for volunteer monitoring wells which has been very successful in adding new wells to the Napa County groundwater monitoring program;
- Held a joint public outreach meeting of the GRAC and Watershed Information Center and Conservancy (WICC) Board (July 25, 2013);
- Reviewed and recommended modifications to the Napa County Water Availability Analysis and Groundwater Ordinance; and
- Developed and approved Groundwater Sustainability Objectives (GRAC, 2014).

The Plan recommended annual reports on groundwater conditions and modifications to the countywide groundwater monitoring program as needed. Additionally, the Plan recommended a comprehensive triennial report. This report is the first Annual Report – *Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM*[2] *Update* (Report).

1.2 Organization of Report

This Report summarizes activities implemented as part of the County's Comprehensive Groundwater Monitoring Program to improve the understanding of groundwater resource conditions and availability. This Report summarizes groundwater monitoring needed to fill the data gaps (i.e., relatively higher monitoring priorities) that were established in the Plan, recommendations made to address these priorities, and activities implemented since 2013. This Report also summarizes the overarching groundwater level and quality monitoring objectives defined by the County and the GRAC. These objectives provide the framework necessary to ensure that the data collected from the countywide monitoring facilities can address these objectives.

[2] CASGEM is the California Statewide Groundwater Elevation Monitoring program implemented under Water Code Part 2.11 Groundwater Monitoring and administered by DWR.

This Report includes the following sections:

Section 2: Hydrogeology of Napa County

- DWR Basins/Subbasins and County Subareas
- Summary of Geology and Groundwater Resources
- Overview of Recent Groundwater Studies and Programs
- Groundwater Monitoring Priorities
- Summary of Recommendations from Recent County Studies

Section 3: Groundwater Resources Goals and Monitoring Objectives

- Napa County Water Resources Goals and Policies
- Groundwater Level Monitoring Objectives
- Groundwater Quality Monitoring Objectives

Section 4: Groundwater Monitoring Network Design and Development

- Groundwater Level Monitoring
- Local Groundwater Assistance Grant Program Monitoring

Section 5: Groundwater Level Trends and Flow Directions

- Napa Valley Floor Subareas
- Subareas South of the Napa Valley Floor
- Subareas East and West of the Napa Valley Floor
- Angwin and Pope Valley Subareas

Section 6: Coordination and Collaboration

- Integrated Regional Water Management Plans
- Groundwater Sustainability
- Napa County Watershed Information Center and Conservancy

Section 7: Summary and Recommendations

- Ongoing Vetting and Review of Potential Monitoring Sites
- Data Gap Refinement
- Coordination with Other Monitoring Efforts

2 HYDROGEOLOGY OF NAPA COUNTY

This section summarizes the countywide geologic and hydrologic setting, and includes information about DWR groundwater basin/subbasin delineations and a description of the Napa County groundwater monitoring subareas. The studies that form the basis of the understanding of County hydrogeology are referenced, including the work for the *Updated Hydrogeologic Conceptualization and Characterization of Conditions* (LSCE and MBK, 2013).

2.1 DWR Basins/ Subbasins and County Subareas

DWR has identified the major groundwater basins and subbasins in and around Napa County. The basins include the Napa-Sonoma Valley (which in Napa County includes the Napa Valley and Napa-Sonoma Lowlands Subbasins), Berryessa Valley, Pope Valley, and a small part of the Suisun-Fairfield Valley Groundwater Basins (**Figure 2-1**). These basins and subbasins are generally defined based on boundaries to groundwater flow and the presence of water-bearing geologic units. These groundwater basins defined by DWR are not confined within county boundaries, and DWR-designated “basin” or “subbasin” designations do not cover all of Napa County.

Groundwater conditions outside of the DWR-designated areas are also very important in Napa County. An example of such an area is the Milliken-Sarco-Tulucay (MST) area, a locally identified groundwater deficient area. For purposes of local planning, understanding, and studies, the County has been subdivided into a series of groundwater subareas (**Figure 2-2**). These subareas were delineated based on the main watersheds, groundwater basins, and the County’s environmental resource planning areas. These subareas include the Knoxville, Livermore Ranch, Pope Valley, Berryessa, Angwin, Central Interior Valleys, Eastern Mountains, Southern Interior Valleys, Jameson/American Canyon, Napa River Marshes, Carneros, Western Mountains Subareas and five Napa Valley Floor Subareas (Calistoga, St. Helena, Yountville, Napa, and MST).

DWR has given the Napa Valley Subbasin a “medium priority”[3] ranking according to the criteria specified in California Water Code Part 2.11 Groundwater Monitoring (i.e., this relates to the CASGEM program).

2.2 Summary of Geology and Groundwater Resources

2.2.1 Previous Studies

Previous hydrogeologic studies of Napa County and also mapping efforts are divisible into geologic studies and groundwater studies. The more significant studies and mapping efforts are mentioned in this section. **Table 2-1** shows the chronological sequence of these efforts that span more than six decades. Weaver (1949) presented geologic maps which covered the southern portion of the county and provided a listing of older geologic studies. Kunkel and Upson (1960) examined the groundwater and geology of the northern portion of the Napa Valley. DWR (Bulletin 99, 1962) presented a reconnaissance report on the geology and water resources of the eastern area of the County; Koenig (1963) compiled a regional geologic map which encompasses Napa County. Fox and others (1973) and Sims and others (1973) presented more detailed geologic mapping of Napa County. Faye (1973) reported on the

[3] As part of the CASGEM Program, DWR has developed the Basin Prioritization process. The California Water Code (§10933 and §12924) requires DWR to prioritize California’s groundwater basins and subbasins statewide. As such, DWR developed the CASGEM Groundwater Basin Prioritization Process. Details are available at http://www.water.ca.gov/groundwater/casgem/basin_prioritization.cfm.

groundwater of the northern Napa Valley. Johnson (1977) examined the groundwater hydrology of the MST area.

Helley and others (1979) summarized the flatland deposits of the San Francisco Bay Region, including those in Napa County. Fox (1983) examined the tectonic setting of Cenozoic rocks, including Napa County. Farrar and Metzger (2003) continued the study of groundwater conditions in the MST area.

Wagner and Bortugno (1982) compiled and revised the regional geologic map of Koenig (1963). Graymer and others (2002) presented detailed geologic mapping of the southern and portions of the eastern areas of the County, while Graymer and others (2007) compiled geologic mapping of the rest of Napa County.

In 2005 to 2007, DHI Water & Environment (DHI) contributed to the 2005 *Napa County Baseline Data Report* (DHI, 2006a and Jones & Stokes et al., 2005) which was part of the County's General Plan update (Napa County, 2008). A groundwater model was developed by DHI in conjunction with the Napa Valley and Lake Berryessa Surface Water models to simulate existing groundwater and surface water conditions on a regional basis primarily in the North Napa Valley and the MST and Carneros Subareas (DHI, 2006b). A 2007 technical memorandum, *Modeling Analysis in Support of Vineyard Development Scenarios Evaluation* (DHI, 2007), was prepared to document the groundwater model update which was used to evaluate various vineyard development scenarios.

Additional geologic maps, groundwater studies, and reports are listed in the references of the *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011a). Additional work has been conducted to update the conceptualization and characterization of hydrogeologic conditions particularly for the Napa Valley Floor (LSCE and MBK, 2013 and LSCE, 2013b).

A new project, "Napa County Groundwater/Surface Water Monitoring Facilities to Track Resource Interrelationships and Sustainability", is currently underway (LSCE, in progress). This project, which is supported through grant funding from DWR, involves the installation of shallow dual-completion groundwater monitoring facilities at five sites adjacent to the Napa River system. The goals of the project are to implement groundwater and surface water monitoring to characterize the interrelationship between these water resources in Napa Valley. The project includes gathering data to:

1. Assess the response to surface water and groundwater use and the potential effect of future climate changes, and
2. Ensure water resources sustainability for the natural environment and future generations. The facilities will enable the collection of new data to augment existing monitoring activities and datasets and will fill groundwater data gaps previously identified by Napa County.

Table 2-1 Summary and Chronology of Hydrogeologic and Geologic Studies and Mapping Efforts in Napa County

Hydrogeologic and/or Geologic Studies and Mapping Efforts	Year of Report or Map Publication							
	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010-2019
Weaver, 1949	◆ (Report and Map produced)							
Kunkel and Upson,1960			◆ (Report and Map produced)					
DWR, 1962			◆ (Report only)					
Koenig, 1963			◆ (Map only)					
Fox et al., 1973				◆ (Report only)				
Sims et al., 1973				◆ (Map only)				
Faye, 1973				◆ (Report and Map produced)				
Johnson, 1977				◆ (Report only)				
Helley et al., 1979				◆ (Report and Map produced)				
Wagner and Bortugno, 1982					◆ (Map only)			
Fox, 1983					◆ (Report and Map produced)			
Graymer et al., 2002							◆ (Map only)	
Farrar and Metzger, 2003							◆ (Report and Map produced)	
Graymer et al., 2007							◆ (Map only)	
DHI, 2006 and 2007							◆ (Report only)	
LSCE, 2011a								◆ (Report only)
LSCE and MBK, 2013								◆ (Report and Map produced)
LSCE, 2013a								◆ (Report only)
LSCE, 2013b								◆ (Report only)
LSCE, 2014								◆ (Report only)
LSCE, 2015								◆ (Report and Map produced)

◆ (red) = Report and Map produced

◆ (blue) = Report only

◆ (orange) = Map only

2.2.2 Precipitation Monitoring and Water Year Classifications

Infiltration of precipitation has been shown to provide significant groundwater recharge in Napa County, particularly in unconsolidated geologic settings (Kunkel and Upson 1969, LSCE and MBK 2013).

Precipitation records in Napa County date to 1906 at the longest continually operating gauge at the Napa State Hospital. A separate analysis of precipitation data from the Napa State Hospital gauge in Napa (elevation 35 ft) has been shown to have strong linear correlations (i.e., $R^2 \geq 0.90$) with precipitation records from two other gauges in St. Helena (elevation 1,780 ft) and Angwin (elevation 1,815 ft) (2NDNature, 2014). Based on the strength of those correlations, a water year classification scheme was developed to define five water year types in the Napa River Watershed. A frequency analysis was used to define very dry, dry, average, wet, and very wet water year types according to exceedance probabilities calculated from the 104 period of record for precipitation at the Napa State Hospital gauge through water year 2012.

Table 2-2 Napa River Watershed Water Year Classification

Year Type	Water Year Precipitation Total		WY Type Recurrence Interval (years)	Annual Precipitation Exceedance Probability (%)	Number of Years in Period of Record
	Lower (in/yr)	Upper (in/yr)			
Very Dry		13.8	11	≥ 91	9
Dry	> 13.8	19.7	4	≥ 67	26
Average	> 19.7	27.8	3	≥ 33	35
Wet	> 27.8	36.0	4	≥10	25
Very Wet	> 36.0		11	< 10	9

Average Annual Water Year Precipitation = 24.3 in/yr
Water Year Record = 1906 – 2012, no water year data for 1981 - 1983
Source: Table 1 in Napa Watershed Water Year Classification Methodology (2NDNature, 2014)

2.2.3 Summary of Geology and Groundwater Resources

The geology of Napa County can be divided into three broad geologic units based on their ages and geologic nature. These units are: 1) Mesozoic Basement Rocks (pre-65 million years (my)), which underlie all of Napa County, but are primarily exposed in the Eastern County area and the Western Mountains Subarea, 2) Older Cenozoic Volcanic and Sedimentary Deposits (65 my to 2.5 my), including Tertiary Sonoma Volcanics (Miocene and Pliocene; 10 my to 2.5 my) which are found throughout the county, especially in the mountains surrounding Napa Valley, and 3) Younger Cenozoic Volcanic and Sedimentary Deposits (post 2.6 my to present), including the Quaternary alluvium of the Valley Floor. The two primary water-bearing units in the county are the tuffaceous member of the Sonoma Volcanics and the Quaternary alluvium.

Outside of the Napa Valley Floor, percolation of surface water appears to be the primary source of recharge. The rate of recharge within areas such as the MST Subarea has been shown to be significantly higher where streams and tributaries cross highly permeable outcrops (e.g., the tuffaceous member of the Sonoma Volcanics or shallow alluvium). Direct infiltration of precipitation is a major component of recharge in the main Napa Valley. Recharge throughout much of the county is generally limited by underlying shallow bedrock of low permeability. An additional component of groundwater recharge that is less understood is deep percolation through fractured rock and fault zones. This type of recharge can be very difficult to quantify due to the highly variable size and distribution of faults, fractures, and joints in a given area.

Groundwater Occurrence and Quality in the Sonoma Volcanics

Groundwater occurs in the Sonoma Volcanics in Napa County and yields water to wells. Well yields are highly variable from less than 10 to several hundred gallons per minute (gpm). The most common yields are between 10 to 100 gpm. Faye (1973) reported well-test information which showed an average yield of 32 gpm and an average specific capacity of 0.6 gallons per minute per foot of drawdown. From the available well log data, the Tertiary marine sedimentary rocks are poor groundwater producers either for a lack of water or poor water quality (high salinity). At great depths, groundwater quality in the Tertiary marine sedimentary rocks is generally poor due to elevated chloride concentrations.

According to Kunkel and Upson (1960), groundwater in the Sonoma Volcanics is generally of good quality except in three areas. The first area with poor groundwater quality, the Tulucay Creek drainage basin, east of the City of Napa, contains groundwater with elevated iron, sulfate, and boron. The Suscol area, south of the City of Napa, is the second area where some wells exhibit poor quality groundwater due to elevated chloride concentrations, possibly from leakage from salty water in the Napa River, alluvial material above, or the existence of zones of unusually saline connate water deep within the Sonoma Volcanics. The third area of poor groundwater quality, the Calistoga area in the northern end of the Napa Valley, contains isolated wells with naturally occurring elevated chloride, boron, and some trace metal concentrations.

Kunkel and Upson (1960) reported that the principal water yielding units of the Sonoma Volcanics are the tuffs, ash-type beds, and agglomerates. The lava flows were reported to be generally non-water bearing. However, it may be possible that fractured, fragmental, or weathered lava flows could yield water to wells. The hydrogeologic properties of the volcanic-sourced sedimentary deposits of the Sonoma Volcanics are complex and poorly understood.

Groundwater Occurrence in Other Units and in the Quaternary Sedimentary Deposits

Several hundred wells and test holes on record have been drilled into the exposed Huichica Formation. Well yields tend to be low to modest (< 10 gpm to tens of gpm). Only a few known wells on record are completed in the Clear Lake Volcanics near the northern County line. Three wells report high yields of 400 to 600 gpm. Much of the Clear Lake Volcanics to the south appear to be thinner, limited in extent, and in ridge-top locations where possible groundwater production appears to be less likely.

Groundwater production from Quaternary alluvium is variable, with yields ranging from <10 gpm in the East and West mountainous areas to a high of 3,000 gpm along the Napa Valley Floor where the alluvium is thickest (>200 feet). According to Faye (1973), average yield of wells completed in the alluvium is 220 gpm. Many wells drilled in the alluvium within the last 30 years extend beyond the alluvium and into the underlying Cenozoic units. Kunkel and Upson (1960) report that groundwater in the alluvium is generally of good quality. The groundwater is somewhat hard and of the bicarbonate type, with small concentrations of sulfate, chloride, and total dissolved solids. A few isolated areas have increased chloride and boron concentrations.

2.3 Recent Groundwater Studies and Programs

This section summarizes the recently completed studies by Napa County and the recommendations relevant to ongoing groundwater monitoring that were developed.

2.3.1 Napa County's Comprehensive Groundwater Monitoring Program

In 2009, Napa County implemented a Comprehensive Groundwater Monitoring Program to meet action items identified in Napa County's 2008 General Plan update (Napa County, 2008). The program emphasizes developing a sound understanding of groundwater conditions and implementing an expanded groundwater monitoring and data management program as a foundation for future coordinated, integrated water resources planning and dissemination of water resources information. The program (and the Plan (LSCE, 2013a)) covers the continuation and refinement of countywide groundwater level and quality monitoring efforts (including many basins, subbasins and/or subareas throughout the county) for the purpose of understanding groundwater conditions (i.e., seasonal and long-term groundwater level trends and also quality trends) and availability. This information is critical to enable integrated water resources planning and the dissemination of water resources information to the public and state and local decision-makers. Napa County's combined efforts through the Comprehensive Groundwater Monitoring Program along with the related AB 303 Public Outreach Project on groundwater (CCP, 2010) and the efforts of the WICC of Napa County create a foundation for the County's continued efforts to increase public outreach and participation in water resources understanding, planning, and management.

Napa County's Comprehensive Groundwater Monitoring Program involved many tasks that led to the preparation of five technical memorandums and a report on *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011a). This report and the other related documents can be found at: http://www.countyofnapa.org/bos/grac/. The report documents existing knowledge of countywide groundwater conditions and establishes a framework for the monitoring and reporting of groundwater levels and groundwater quality on a periodic basis. The report also summarizes priorities for groundwater level and quality monitoring for each of the county subareas.

As described above, the *Napa County Groundwater Monitoring Plan 2013* (LSCE, 2013a) was prepared to formalize and augment groundwater monitoring efforts [levels and quality] to better understand the groundwater resources of Napa County, aid in making the County eligible for public funds administered by the California Department of Water Resources (DWR), and regularly evaluate trends to identify changes in levels and/or quality and factors related to those changes that warrant further examination to ensure sustainable water resources. The Plan included refinement of criteria used to identify priority monitoring areas and a proposed expanded monitoring network. During Plan implementation, the GRAC led and supported outreach efforts to well owners for volunteer monitoring wells; the GRAC efforts were very successful in adding new wells to the Napa County groundwater monitoring program.

2.3.2 Napa County Statewide Groundwater Elevation Monitoring (CASGEM)

This section describes the DWR California Statewide Groundwater Elevation Monitoring (CASGEM) program. The wells included by the County in the CASGEM program are a *subset* of the overall network of wells monitored in Napa County.

In November 2009, Senate Bill SBX7 – 6 mandated that the groundwater elevations in all basins and subbasins in California be regularly and systematically monitored with the goal of demonstrating seasonal and long-term trends in groundwater elevations. In accordance with the mandate, DWR developed the CASGEM program. DWR is facilitating the statewide program which began with the opportunity for local entities to apply to DWR to assume the function of regularly and systematically collecting and reporting groundwater level data for the above purpose. These entities are referred to as Monitoring Entities.

Wells designated for inclusion in the CASGEM program are for purposes of measuring groundwater levels on a semi-annual or more frequent basis that are representative of groundwater conditions in the state's groundwater basins and subbasins. A key aspect of the program is to make certain elements of the groundwater level information available to the public.

On December 29, 2010, the County applied to DWR to become the local countywide Monitoring Entity responsible for designating wells as appropriate for monitoring and reporting groundwater elevations for purposes of the CASGEM program.

The wells selected by the County for this program are a *subset* of the overall wells monitored, i.e., the County has a much larger overall monitoring network. The County's participation in the CASGEM program complements other pre-existing groundwater monitoring that has been ongoing in Napa County for some time (the overall historical monitoring record began in 1920).

Following confirmation, the County, as the Monitoring Entity, proceeded to identify a *subset* of monitored wells to be included in the CASGEM network and to prepare a CASGEM Network Plan as required by DWR (LSCE, 2011b and LSCE, 2014). At the time the County's CASGEM Network Plan was initially submitted to DWR, fourteen wells were included in the program. DWR formally designated Napa County as the Monitoring Entity for two basins in August 2014, specifically:

- Napa County was designated as the Monitoring Entity for the 2-2.01 Napa Valley Subbasin (medium priority basin)
- Napa County was designated as the Monitoring Entity for the 2-2.03 Napa-Sonoma Lowlands Subbasin in Napa County (very low priority basin)

During the initial CASGEM monitoring year (beginning 2011), the County continued to monitor 14 wells that had already been part of the group of wells where groundwater levels are measured by the County and reported to DWR semi-annually, or are measured directly by DWR. The current 2014 CASGEM network wells are located primarily on the Napa Valley Floor, Carneros Subarea, and in the MST Subarea. Some of these wells do not have sufficient construction details to define which portion of the aquifer system is represented by measured water levels. Additional data gathering and surveying will be performed, and such information will be provided in future annual reports as it becomes available. Depending on the results of the County's evaluation, future actions may include removal and replacement of CASGEM wells with wells that are more representative of local groundwater conditions to better meet the objectives of the CASGEM program and also overall objectives of the County's Comprehensive Groundwater Monitoring Program.

In addition to the CASGEM well network described herein, the County is currently exploring the availability of a monitoring well in the Pope Valley Groundwater Basin[4]. Public outreach is underway

[4] DWR Overall Basin Ranking Score is "0.0"; the very low priority basin ranking range is 0-5.4. http://www.water.ca.gov/groundwater/casgem/pdfs/basin_prioritization/NCRO%2074.pdf

through community organizations and other contacts. The Berryessa Valley Groundwater Basin has a very low DWR priority and extremely small utilization of groundwater[5]. Per discussions with DWR, outreach will continue but no monitoring is planned in this groundwater basin at this time. The County has submitted detailed information to DWR to support consideration of the removal of this basin through a Bulletin 118 update or other appropriate process (LSCE, 2014).

The Suisun-Fairfield Valley Basin and the Napa-Sonoma Lowlands Subbasin are two examples of basins that do not conform to county boundaries, and they are also basins with a DWR low priority designation. While these two basins have low groundwater utilization and less extensive monitoring than other basins, they are situated adjacent to the bay and delta water ways and are important areas to monitor for protection against saltwater intrusion. The Suisun-Fairfield Valley Basin, which is mostly in Solano County and has only a very small area (less than 0.3% of the total basin area) in Napa County, is being monitored in its entirety by Solano County Water Agency as the CASGEM Monitoring Entity for Solano County. The monitoring of Napa-Sonoma Lowlands Subbasin, whose area is shared with Solano County in more equitable portions (63% in Napa County, 37% in Solano County), is anticipated to have monitoring that is coordinated between the two respective Monitoring Entities in the future. Currently, all monitoring is within the Napa County portion of the subbasin; in the future, monitoring in this subbasin will expand as necessary to ensure representative coverage and as coordinated between the two Monitoring Entities.

2.3.3 Updated Conceptualization and Characterization of Hydrogeologic Conditions

In 2012, activities were implemented to update the characterization and conceptualization of hydrogeologic conditions (LSCE and MBK, 2013). This work included: 1) an updated Napa Valley hydrogeologic conceptualization, 2) linking well construction information to groundwater level monitoring data, 3) groundwater recharge characterization and estimates, and 4) surface water/groundwater interrelationships.

The work to update the hydrogeologic conceptualization resulted in a refined understanding of the mechanisms through which water moves in response to the hydrologic cycle, particularly in the aquifer system underlying the main Napa Valley Floor. This involves many complex pathways and also considers many different time scales. As discussed further below, a key County General Plan goal (Napa County, 2008) is to "Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations." The County's groundwater monitoring program is instrumental to accomplishing this goal. The groundwater monitoring data (especially levels) are important for understanding the quantity of water flowing into and from a groundwater basin. Construction of a water budget, also known as a water balance, is a tool scientists can employ to assess the quantity of groundwater in storage. This tool is also used to observe how the quantity of groundwater in storage may vary over time. This tool relies upon a defined accounting unit of volume, for example a groundwater basin or other hydrologic unit of analysis. Measurements of water flowing into and out of the defined unit are used to determine the change in water storage. In the simplest form, the equation for this is:

[5] DWR Overall Basin Ranking Score is "0.0"; the very low priority basin ranking range is 0-5.4. http://www.water.ca.gov/groundwater/casgem/pdfs/basin_prioritization/NCRO%2062.pdf

Inflows – Outflows = Change in Storage

Typical Inflows and Outflows are summarized below (DWR, 2003):

Inflows

- Natural recharge from precipitation;
- Seepage from surface water channels;
- Intentional recharge via ponds, ditches, and injection wells;
- Net recharge of applied water for agricultural and other irrigation uses;
- Unintentional recharge from leaky conveyance pipelines; and
- Subsurface inflows from outside basin boundaries.

Outflows

- Groundwater extraction by wells;
- Groundwater discharge to surface water bodies and springs;
- Evapotranspiration; and
- Subsurface outflow across basin or subbasin boundaries.

Information relating to each of the above inflow and outflow data components provides the best approximation of the change in storage. A simple way of estimating the change in storage in a basin is through the determination of the average change in groundwater elevations over the groundwater basin for a period of time. This change in water levels is then multiplied by the area overlying the basin and also the average specific yield (in the case of an unconfined aquifer system, or storativity in the case of a confined aquifer system). The change in groundwater levels is best determined over a specific study period that considers different water year types (wet, normal, dry, multiple dry years), but it is common for shorter time periods (e.g., one year's spring to spring groundwater elevations) to be used. This simplistic approach to calculating a change in storage does not provide an indication of the total volume of groundwater storage or the storage available for use. Rather, this computation provides a "snapshot" perspective of short-term trends. The quick calculation should only be considered as an indicator; a more complete groundwater balance evaluation is preferred (e.g., groundwater flow model). For example, if stresses on the aquifer system induce additional surface water infiltration, the change in groundwater storage may not be apparent (DWR, 2003).

Updated Napa Valley Geologic Conceptualization

As part of the updated hydrogeologic conceptualization (LSCE and MBK, 2013), eight cross- valley geologic sections were constructed (**Figure 2-3**). About 1,300 water well drillers' reports were reviewed and located on topographic base maps; 191 of these were selected for use in the cross sections. Geologic correlations seen on the cross sections were extended between sections by available well control and surficial geologic maps. From the geologic cross-sections and correlations of other water well drillers' reports, the Quaternary alluvium was separated from underlying units, and an isopach (contours of equal thickness) map was constructed.

The alluvium was divided into three facies according to patterns detected in the lithologic record and used to delineate the depositional environment which formed them: fluvial, alluvial fan, and sedimentary basin (LSCE and MBK, 2013 and LSCE, 2013b). The fluvial facies consists of a thin narrow band of stream channel sands and gravels deposited by the Napa River. The sand and gravel beds tend to be thicker and/or more numerous in the fluvial facies area. They are interbedded with finer-grained clay beds of probable floodplain origin. Wells constructed in the fluvial facies tend to be moderately high yielding (for the valley, roughly 50 to 200 gpm). Local areas where thicker sand and gravel beds are reported, the well yields are the highest in the valley, ranging from about 200 to 2,000 gpm.

These areas with thick sand and gravel beds occur in the Yountville Narrows area, which extends about five miles from Oakville south to Ragatz Lane. Local areas of relatively lower well yield values of 200 to 500 gpm occur to the north and south. Hydraulic properties of these deposits are recorded during airlift testing, and drawdown values are generally not reported. Only a few pump test results have been found, and these are in the high yielding area just north of the Yountville Narrows.

The alluvial plain facies of the Quaternary alluvium extends outward from the central fluvial facies and thins to zero thickness at the edge of the valley sides. These deposits appear to have been deposited as tributary streams and alluvial fans. These deposits appear to consist of interbedded sandy clays with thin beds (less than 10 feet thick) of sand and gravel. Wells constructed in the alluvial plain facies tend to be low yielding, ranging from a few gpm to a few tens of gpm. By at least 1970, most wells drilled on the alluvial plain facies were constructed to deeper depths into the underlying Sonoma Volcanics.

The alluvial facies shows some overlap with the shallowest depths to groundwater, as measured in spring 2010 (**Figures 2-4, 2-5, and 2-6**). These areas of overlap occur generally to the west of the Napa River and adjacent to mapped perennial streams, including Hopper Creek, Sulpher Creek, York Creek, Bale Slough (west of Highway 29), and possibly Dry Creek. These areas represent somewhat likely areas of connection between surface waters (including the Napa River and perennial streams described above) and groundwater.

At the northern end of the lower valley, the sedimentary basin facies of the alluvium occurs. This facies is characterized by fine-grained silt, sand, and clays with thin to scattered thicker beds of sand and gravel. The sedimentary facies is believed to be floodplain deposits that extend to the southern marshland/estuary deposits. As noted, the extent of this facies is poorly known due to lack of well control farther south. Limited information indicates low to moderate well yields of a few gpm to possibly up to 100 gpm. Again, the lack of pump test information makes hydraulic properties of the deposits difficult to assess.

Napa Creek and the Napa River east of Highway 29 in the vicinity of downtown Napa show a connection with groundwater in this portion of the Napa Valley (**Figure 2-6**).

Portions of Napa Valley north of Deer Park Road were not characterized according to their Quaternary alluvium facies by LSCE and MBK (2013). However, depths to groundwater in the vicinity of monitored wells indicate the potential for connection between surface water and groundwater in the vicinity of Garnett Creek and Cyrus Creek in and near Calistoga
(**Figure 2-6**).

Beneath the alluvium is a complex sequence of Tertiary sedimentary deposits (Huichica Formation) and igneous deposits of the Sonoma Volcanics. These units are strongly deformed by folding and faulting and have complex stratigraphic relationships. From the geologic cross-sections, lateral correlations, and surficial map relationships, a structure contour map (elevations) of the top of these units and the subcrop[6] pattern were developed (LSCE and MBK, 2013). From north of the City of Napa and southward, these deposits are dominated by fine-grained basin fill with few sand and gravels of floodplain, estuary origin. North towards Yountville, sedimentary deposits of the Huichica Formation appear to overlie Sonoma Volcanics andesites and tuffs. Sonoma Volcanics and the older Mesozoic Great Valley sequence are exposed in a structural uplift area in the small hills in the Yountville area.

[6] Occurrence of strata in contact with the undersurface of a stratigraphic unit, which in this case includes the strata beneath the alluvium.

Further north, a Sonoma Volcanics andesite flow breccia appears to transition into a sedimentary conglomerate along the center of the valley. This unit is encountered in deep, high yielding wells also completed in the overlying alluvium fluvial facies, but it is not clear if this unit also is high yielding. Overlying the conglomerate/breccia on the east is the Tertiary sedimentary deposits sequence (Huichica Formation) of sandstones and mudstones. To the west of the unit occur older Sonoma Volcanics andesites, tuffs in the south, and possibly younger Sonoma Volcanics tuffs interbedded with Tertiary sedimentary deposits (Huichica Formation) of sand and gravels and clays. All of the Tertiary units beneath the Napa Valley Floor appear to be low to moderately water yielding with poor aquifer characteristics (LSCE and MBK, 2013).

Linking Well Construction Information to Groundwater Monitoring Data

As part of the updated hydrogeologic characterization, existing monitoring well construction data from all available public sources were reviewed to determine the distribution of aquifer-specific monitoring data in Napa Valley. This effort addresses recommendations of the Comprehensive Groundwater Monitoring Program to identify and fill data gaps that will allow for analysis of groundwater occurrence and flow as a more robust understanding of the extent of groundwater resources in the county is developed. A major component of this work has been to identify construction information for previously monitored wells in Napa Valley.

Groundwater level monitoring needs identified through the Comprehensive Groundwater Management Program include improved spatial distribution of groundwater level monitoring, additional characterization of subsurface geologic conditions in county subareas to identify aquifer characteristics, further examination of well construction information to define which portion of the aquifer system is represented by water levels measured in the currently monitored wells (and in many cases to link construction information to the monitored wells), and improve the understanding of surface water/groundwater interactions and relationships.

Groundwater Recharge Characterization and Estimates

Another important feature of the updated hydrogeologic investigation was the development of improved characterization of groundwater recharge in the areas of greatest groundwater development, with an emphasis on Napa Valley. Understanding the volume of and mechanisms driving groundwater recharge in the county are essential in determining where and how much groundwater can be produced without incurring negative impacts (LSCE, 2011a). The high permeability of the alluvial sediments in the Napa Valley permits precipitation and surface water to readily infiltrate and recharge groundwater throughout the majority of the valley. These high permeability soils combined with the large volume of water that flows through the Napa River create the potential for significant recharge to occur under the hydrologic circumstances and hydraulic gradient that allow for recharge from the river to groundwater to occur.

Mass balance and streamflow infiltration methods were used to estimate regional and local recharge. Streamflow infiltration can be characterized by comparing the elevation of surface water to the shallowest adjacent groundwater. Detailed remotely sensed elevation data of the mainstem Napa River and several major tributaries were obtained for this purpose. LiDAR data were paired with previously collected groundwater level data and estimates of areas of greatest recharge potential to estimate the potential for recharge to groundwater.

In addition, mass balance recharge estimates have been developed for the Napa River watershed and major tributary watersheds using a range of available data (LSCE and MBK, 2013). Available records for streamflow, precipitation, land use, and vegetative cover throughout these watersheds have been used to develop spatially-distributed estimates of annual hydrologic inputs and outputs in order to solve for the volume of groundwater recharge at the watershed scale. Key components of this work included quantifying the distribution of precipitation across the land surface, quantifying the amount of water that returns to the atmosphere by evapotranspiration, and quantifying the hydraulic properties of soil and alluvial materials through which water must infiltrate to reach groundwater. Estimates developed through the mass balance approach have been evaluated using a sensitivity analysis to determine the degree to which any individual or set of inputs affects the recharge estimate.

Groundwater-Surface Water Interrelationships

Depth to Groundwater Relative to Stream Thalweg

The groundwater surface elevation and the estimated stream thalweg elevation data are important components for characterizing the groundwater-surface water relationship in the Napa Valley area. The spring 2010 contours of equal groundwater elevation were used to provide a snapshot representation of groundwater conditions with which to compare the vertical relationship between groundwater and surface water (LSCE and MBK, 2013 and LSCE, 2013b). This spatial relationship assisted in developing an understanding of the nature of water exchange between the groundwater and surface water systems. This analysis focused specifically on the degree of connectivity between the Napa River thalweg and the elevation of the regional groundwater surface in the Napa Valley in spring 2010.

Calculated depths to groundwater equal to or above the estimated thalweg alignment indicate that for spring 2010 the interpreted groundwater elevation was above the bottom of the Napa River thalweg. The data suggest areas where a direct connection between the water table and the river may have existed in spring 2010 and where groundwater has the potential to discharge into the stream channel. In other areas, the depth to groundwater is below the bottom of the Napa River thalweg such that surface flows in the river have the potential to percolate and recharge the groundwater system.

Despite the uncertainty in the data in parts of the valley, depths to groundwater (both measured and calculated) show generally shallow groundwater throughout much of the valley, particularly in the northern end of the valley. The calculated depths to groundwater appear to be reasonably represented in the Napa Subarea because this area has the greatest density of monitored sites, particularly along the lower elevation eastern edge. **Figure 2-6** presents the depths to groundwater for Napa Valley based on water level measurement for wells constructed in the alluvial aquifer system (LSCE, 2013b). This figure reflects the generally shallow groundwater levels measured particularly along the axis of the valley.

Other Areas of County

Potential connections between surface water and groundwater in other areas of the county are less well known. Perennial water courses have been mapped by Napa County in other portions of the county with state-designated groundwater basins. In the Pope Valley Groundwater Basin, these include Pope Creek, Burton Creek, and Maxwell Creek. In the small portion of the Suisun-Fairfield Valley Groundwater Basin that extends into Napa County, in the Southern Interior Valley Subarea, Wooden Valley Creek is mapped as a probable perennial stream.

Blueline Stream Locations

Napa County's Planning, Building, and Environmental Services Department maintains a GIS dataset of perennial streams throughout the county, included as a part of the larger "bluelines" shapefile (LSCE, 2013b). The dataset includes both unnamed and 48 named streams, creeks, rivers, and other surface water courses classified as known perennial or probable perennial, see **Figure 2-7**. The known and probable classifications are a subset of all water courses originally digitized from U.S. Geological Survey (USGS) topographic maps of Napa County. Metadata for the dataset describe the known perennial water courses as those determined by "stream reports or other known data sources", while probable perennial water courses are defined as having been determined by "computer analysis of probable streams". As shown in **Figure2-7**, known or probable perennial water courses are present in all Napa County subareas except for the Livermore Ranch, Knoxville, Berryessa, and Jameson/American Canyon Subareas.

2.3.4 Groundwater Monitoring Priorities

Priorities for addressing groundwater level and quality monitoring were presented in the Plan (LSCE, 2013a). This Annual Report summarizes the monitoring needs identified in the Plan.

Groundwater Level Monitoring

In 2014 groundwater level measurements were recorded at a total of 115 sites (measurements began in 1920 for one Napa County monitoring well that is still being monitored). **Table 2-3** and **Figure 2-8** summarize the currently conducted monitoring in each subarea. Also shown in **Table 2-3** are the preliminary ranking and priorities for improving or expanding groundwater level monitoring in each of the designated subareas. Six subareas (including the NVF-Calistoga, NVF-MST, NVF-Napa, NVF-St. Helena, NVF-Yountville, and Carneros Subareas) are given a relatively higher priority. This relative prioritization is based on such factors as data scarcity, the need to improve the spatial distribution of the currently collected data, current population and groundwater utilization relative to other parts of the county, and /or the need to improve understanding of groundwater/surface water interactions. Some factors are given greater consideration in areas that currently use more groundwater than other areas. In mountainous areas where less groundwater development has occurred, where geologic conditions are complicated by basement rocks that are complexly deformed by folding and faulting and are well lithified, and overall there is considerable variability (LSCE, 2011a), future monitoring needs could be considered in coordination with potential or planned development in localized areas. Overall, groundwater level monitoring priorities are to identify seasonal and long-term trends and develop the data that facilitate better understanding of groundwater conditions, including response to such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage.

Groundwater level monitoring needs include improved spatial distribution of groundwater level monitoring, additional characterization of subsurface geologic conditions in each subarea to identify aquifer characteristics, further examination of well construction information to define which portion of the aquifer system is represented by water levels measured in the currently monitored wells, and improve the understanding of groundwater-surface water relationships.

Table 2-3 Groundwater Level Monitoring Sites, Napa County (Current[1] and Future)

Subarea	No. Sites with Current Groundwater Level Data	Future Groundwater Level Monitoring		Monitoring Needs
		Relative Priority	Action (Expand/ Refine)	
Napa Valley Floor-Calistoga	**10**	**H**	E	**SP, SW**
Napa Valley Floor-MST	**27**	**H**	R	**SP, SW**
Napa Valley Floor-Napa	**21**	**H**	R	**SP, SW**
Napa Valley Floor-St. Helena	**14**	**H**	E	**SP, SW**
Napa Valley Floor-Yountville	**12**	**H**	E	**SP, SW**
Carneros	**12**	**H**	E	**B**
Jameson/American Canyon	1	M	E	B
Napa River Marshes	1	M	E	SP, SW
Angwin	5	M	E	B
Berryessa	2	L	E	B
Central Interior Valleys	1	L	E	B
Eastern Mountains	3	L	E	B
Knoxville	0	L	E	B
Livermore Ranch	0	L	E	B
Pope Valley	1	L	E	B
Southern Interior Valleys	0	L	E	B
Western Mountains	2	L	E	B
Unknown	3			
Total	**115**			

[1] "Current" refers to monitored sites with wells measured for levels and/or any water quality parameter with a period of record extending to 2014. “Future” refers to recommended monitoring locations.

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells coordinated with recent geologic investigations that are or will be conducted)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs:
SP = Improve horizontal and/or vertical spatial distribution of data, including for the purpose of identifying such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage;
SW =identify appropriate monitoring site to evaluate surface water -groundwater recharge/discharge mechanisms;
B = Basic data needed to accomplish groundwater level monitoring objectives

2.3.5 Recommendations from Recent County Studies

This Annual Report summarizes the groundwater level monitoring recommendations presented in the Plan (LSCE, 2013a). **Section 4.1.1** describes actions taken to implement the recommendations.

Summary of Recommendations

Groundwater Level Monitoring

Per the priorities discussed in this section, additional groundwater level monitoring wells are recommended in the following subareas:

- NVF-MST
- NVF-Napa
- NVF-St. Helena
- NVF-Yountville
- NVF-Calistoga
- Carneros
- Pope Valley (CASGEM)
- Berryessa Valley (CASGEM)

Additional monitoring in the subareas in the Napa Valley Floor was recommended to improve the horizontal and spatial distribution of groundwater level data to better understand groundwater conditions, including response to such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage.

Additional groundwater level monitoring was also recommended to further evaluate groundwater-surface water interaction and recharge/discharge mechanisms. Dedicated shallow monitoring wells were recommended for construction at appropriate locations, particularly along the main stem of the Napa River.

3 GROUNDWATER RESOURCES GOALS AND MONITORING OBJECTIVES

3.1 Napa County Water Resources Goals and Policies

The County's General Plan (2008, amended June 23, 2009) recognizes, "water is one of the most complex issues related to land use planning, development, and conservation; it is governed and affected by hundreds of federal, state, regional, and local mandates pertaining to pollution, land use, mineral resources, flood protection, soil erosion, reclamation, etc. Every year, the state legislature considers hundreds of bills relating to water issues, and in Napa County, more than two dozen agencies have some say in decisions and regulations affecting water quality and water use."

As part of the General Plan update in 2008, and within the Conservation Element, six goals are set forth relating to the county's water resources, including surface water and groundwater. Complementing these goals are twenty-eight policies and ten water resources action items (one of which is "reserved" for later description). Napa County's six water resources goals are included below (the entire group of water resources goals, policies, and action items is included in LSCE, 2011a).

> **Goal CON-8:** Reduce or eliminate groundwater and surface water contamination from known sources (e.g., underground tanks, chemical spills, landfills, livestock grazing, and other dispersed sources such as septic systems).
>
> **Goal CON-9:** Control urban and rural storm water runoff and related non-point source pollutants, reducing to acceptable levels pollutant discharges from land-based activities throughout the county.
>
> **Goal CON-10:** Conserve, enhance and manage water resources on a sustainable basis to attempt to ensure that sufficient amounts of water will be available for the uses allowed by this General Plan, for the natural environment, and for future generations.
>
> **Goal CON-11:** Prioritize the use of available groundwater for agricultural and rural residential uses rather than for urbanized areas and ensure that land use decisions recognize the long-term availability and value of water resources in Napa County.
>
> **Goal CON-12:** Proactively collect information about the status of the County's surface and groundwater resources to provide for improved forecasting of future supplies and effective management of the resources in each of the County's watersheds.
>
> **Goal CON-13:** Promote the development of additional water resources to improve water supply reliability and sustainability in Napa County, including imported water supplies and recycled water projects.

Addressing the six water resources goals above, Napa County has produced specific General Plan Action Items related to the focus and objective of this Plan. Those action items include:

> **Action Item CON WR-1:** Develop basin-level watershed management plans for each of the three major watersheds in Napa County (Napa River, Putah Creek, and Suisun Creek). Support each basin-level plan with focused sub-basin (drainage-level) or evaluation area-level implementation strategies, specifically adapted and scaled to address identified water resource problems and

restoration opportunities. Plan development and implementation shall utilize a flexible watershed approach to manage surface water and groundwater quality and quantity. The watershed planning process should be an iterative, holistic, and collaborative approach, identifying specific drainage areas or watersheds, eliciting stakeholder involvement, and developing management actions supported by sound science that can be effectively implemented. [Implements Policies 42 and 44]

Action Item CON WR-4: Implement a countywide watershed monitoring program to assess the health of the County's watersheds and track the effectiveness of management activities and related restoration efforts. Information from the monitoring program should be used to inform the development of basin-level watershed management plans as well as focused sub-basin (drainage-level) implementation strategies intended to address targeted water resource problems and facilitate restoration opportunities. Over time, the monitoring data will be used to develop overall watershed health indicators and as a basis of employing adaptive watershed management planning. [Implements Policies 42, 44, 47, 49, 63, and 64]

Action Item CON WR-6: Establish and disseminate standards for well pump testing and reporting and include as a condition of discretionary projects that well owners provide to the County upon request information regarding the locations, depths, yields, drilling and well construction logs, soil data, water levels and general mineral quality of any new wells. [Implements Policy 52 and 55]

Action Item CON WR-7: The County, in cooperation with local municipalities and districts, shall perform surface water and groundwater resources studies and analyses and work toward the development and implementation of an integrated water resources management plan (IRWMP) that covers the entirety of Napa County and addresses local and state water resource goals, including the identification of surface water protection and restoration projects, establishment of countywide groundwater management objectives and programs for the purpose of meeting those objectives, funding, and implementation. [Implements Policy 42, 44, 61 and 63]

Action Item CON WR-8: The County shall monitor groundwater and interrelated surface water resources, using County-owned monitoring wells and stream and precipitation gauges, data obtained from private property owners on a voluntary basis, data obtained via conditions of approval associated with discretionary projects, data from the State Department of Water Resources, other agencies and organizations. Monitoring data shall be used to determine baseline water quality conditions, track groundwater levels, and identify where problems may exist. Where there is a demonstrated need for additional management actions to address groundwater problems, the County shall work collaboratively with property owners and other stakeholders to prepare a plan for managing groundwater supplies pursuant to State Water Code Sections 10750-10755.4 or other applicable legal authorities. [Implements Policy 57, 63 and 64]

Action Item CON WR-9.5: The County shall work with the SWRCB[7], DWR, DPH, CalEPA, and applicable County and City agencies to seek and secure funding sources for the County to develop and expand its groundwater monitoring and assessment and undertake community-based planning efforts aimed at developing necessary management programs and enhancements.

[7] SWRCB is the California State Water Resources Control Board. DPH is the California Department of Public Health.

The County continues to address the General Plan goals and actions. Additionally, through the efforts embarked upon through the implementation of the County's Comprehensive Groundwater Monitoring Program, those persons whose livelihoods depend upon the county's natural resources can help ensure the sustainability of groundwater resources for future generations and the environment.

Based on the GRAC's charge from the Napa County Board of Supervisors and a review of many definitions in published literature, the GRAC (2014) defined "groundwater sustainability" as:

> *Groundwater sustainability depends on the development and use of groundwater in a manner that can be maintained indefinitely without causing unacceptable economic, environmental, or social consequences, while protecting economic, environmental, and social benefits.*

The GRAC concluded that groundwater sustainability is both a goal and a process; most importantly, it is a shared responsibility. Everyone living and working in the county has a stake in protecting groundwater resources, including groundwater supplies, quality, and associated watersheds (GRAC, 2014). The GRAC further found that healthy communities, healthy agriculture and healthy environments exist together and not in isolation. Without sustainable groundwater resources, the character of the county would be significantly different in terms of its economy, communities, rural character, ecology, housing, and lifestyles.

The GRAC also developed a set of groundwater sustainability objectives (GRAC, 2014):

1. Initiate and carry out outreach and education efforts.
    a. Develop public outreach programs and materials to make everyone who lives and works in the County aware that the protection of water supplies is a shared responsibility and everyone needs to participate.
    b. Through education, enable people to take action.
2. Optimize existing water supplies and systems.
    a. Support landowners in implementing best sustainable practices.
    b. Enhance the water supply system and infrastructure – including but not limited to system efficiencies, reservoir dredging, recycled water, groundwater storage and recharge, conjunctive use – to improve water supply reliability.
3. Continue long-term monitoring and evaluation.
    a. Collect groundwater and surface water data and maintain a usable database that can provide information about the status of the county's groundwater and surface water resources and help forecast future supplies.
    b. Evaluate data using best analytical methods in order to better understand characteristics of the county's groundwater and water resources systems.
    c. Share data and results of related analytical efforts while following appropriate confidentiality standards.
4. Improve our scientific understanding of groundwater recharge and groundwater-surface water interactions.
5. Improve preparedness to address groundwater issues that might emerge.

a. Improve preparedness for responding to long-term trends and evolving issues, such as adverse groundwater trends (including levels and quality), changes in precipitation and temperature patterns, and saltwater intrusion.
b. Improve preparedness for responding to acute crises, such as water supply disruptions and multiyear drought conditions.

3.2 Overarching Groundwater Monitoring Objectives

This section describes the water level and quality objectives established for the countywide Comprehensive Groundwater Monitoring Program (LSCE, 2013a). The overarching groundwater monitoring objectives are linked to 1) the County's General Plan goals and action items presented above, and 2) hydrogeologic conditions and potential areas of concern, including (but not limited to):

- Monitoring trends in groundwater levels and storage (e.g., groundwater balance) to assess and ensure long-term groundwater availability and reliability;
- Monitoring of groundwater-surface water interactions to ensure sufficient amounts of water are available to the natural environment and for future generations;
- Monitoring in significant recharge areas to assess factors (natural and human-influenced) that may affect groundwater recharge (including climate change) and also aid the identification of opportunities to enhance groundwater recharge and storage;
- Monitoring to establish baseline conditions in areas of potential saline water intrusion;
- Monitoring of general water quality to establish baseline conditions, trends, and protect and preserve water quality.
- Identify where data gaps occur in the key subareas and provide infill, replacement, and/or project-specific monitoring (e.g., such as may occur for planned projects or expansion of existing projects) as needed; and
- Coordinate with other entities on the collection, utilization, and incorporation of groundwater level data in the countywide Data Management System (DMS).

Although this Report focuses on an update of the groundwater monitoring network and groundwater level trends and conditions, groundwater quality objectives are also included for completeness.

3.2.1 Groundwater Level Monitoring Objectives

The focus of the countywide groundwater level monitoring program includes the following objectives:

- Expand groundwater level monitoring in priority County subareas to improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, especially in areas where short- and long-term development of groundwater resources are planned (this includes additional monitoring of the Tertiary formation aquifer in the area between the NVF-MST Subarea and the northeastern part of the NVF-Napa Subarea to determine whether groundwater water conditions in the NVF-MST are affecting other areas (LSCE and MBK, 2013);
- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation, surface water seepage to groundwater, groundwater discharge to streams) or induced factors (e.g., pumping, purposeful recharge operations) that affect groundwater levels and trends;
- Identify appropriate monitoring sites to further evaluate groundwater-surface water interaction and recharge/discharge mechanisms, including whether groundwater utilization is affecting surface water flows;

- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and
- Generate data to better estimate groundwater basin conditions and assess local current and future water supply availability and reliability; update analyses as additional data become available.

Based on the analysis of existing groundwater data and conditions described in the report *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011a) and with input received from the GRAC, the key objectives for future groundwater level monitoring for each subarea are summarized in the Plan (LSCE, 2013a).

3.2.2 Groundwater Quality Monitoring Objectives

The primary objectives of the countywide groundwater quality monitoring program include (LSCE, 2013a):

- Evaluate groundwater quality conditions in the various county subareas and identify differences in water quality spatially between areas and vertically in the aquifer system within a subarea;
- Detect the occurrence of and factors attributable to natural (e.g., general minerals and trace metals) or other constituents of concern;
- Establish baseline conditions in areas of potential saltwater intrusion, including the extent and natural occurrence and/or causes of saltwater beneath the Carneros, Jameson/American Canyon and Napa River Marshes Subareas;
- Assess the changes and trends in groundwater quality; and
- Identify the natural and human factors that affect changes in water quality.

Based on the analysis of existing groundwater data and conditions described in the report *Napa County Groundwater Conditions and Groundwater Monitoring Recommendations* (LSCE, 2011a) and with input received from the GRAC, the key objectives for future groundwater quality monitoring for each subarea are summarized in the Plan (LSCE, 2013a).

4 GROUNDWATER MONITORING NETWORK DESIGN AND DEVELOPMENT

4.1 Groundwater Level Monitoring

The total number of sites where groundwater level monitoring was conducted in Napa County increased to 115 in 2014 (**Table 4-1)** from 87 sites reported in the 2011 (LSCE, 2013a). **Figures 4-1 and 4-2** show the distribution of sites monitored in 2014 according to the monitoring entity. The overall increase in the number of monitored sites is attributable to the efforts of Napa County with support from the GRAC, as described in **Sections 4.1.1 and 4.2**.

Table 4-1 Current Groundwater Level Monitoring Sites in Napa County by Entity and Monitoring Program

Entity	Reporting Program	Number of Monitored Sites, Fall 2014
Napa County	CASGEM	21
	State Water Data Library	20
	County Volunteer Groundwater Monitoring Program	51
	County Surface Water-Groundwater Monitoring	5
California Department of Water Resources	Volunteered Sites	4
State Water Resources Control Board	GeoTracker	14
	Total Sites	**115**

The geographical extent of groundwater level monitoring also increased in 2014 compared to 2011 (**Table 4-2**). The number of sites monitored increased in all five Napa Valley Floor (NVF) Subareas and in the Carneros Subarea. New monitoring sites were also added in previously unmonitored subareas including the Angwin, Eastern Mountains, and Western Mountains Subareas. Additional summary information for currently monitored sites are provided in **Appendix A**.

Table 4-2 Current Groundwater Level Monitoring Sites in Napa County by Groundwater Subarea

Groundwater Subarea	Number of Monitored Sites Through 2011	Number of Monitored Sites, Fall 2014
Napa Valley Floor-Calistoga	6	10
Napa Valley Floor-MST	29	27
Napa Valley Floor-Napa	18	21
Napa Valley Floor-St. Helena	12	14
Napa Valley Floor-Yountville	9	12
Carneros	5	12
Jameson/American Canyon	1	1
Napa River Marshes	1	1
Angwin	0	5
Berryessa	3	2
Central Interior Valleys	1	1
Eastern Mountains	0	3
Knoxville	1	0
Livermore Ranch	0	0
Pope Valley	1	1
Southern Interior Valleys	0	0
Western Mountains	0	2
Unknown[1]	0	3
Total Sites	**87**	**115**

[1] As of January 2015 three sites in the GeoTracker regulated groundwater monitoring network were reporting groundwater level data, but had not yet reported location information for the monitored wells.

4.1.1 Napa County Monitoring Network

In 2014, Napa County conducted semi-annual groundwater level monitoring at 97 sites across the county, with the majority of sites located within the NVF Subareas. Two sites, NapaCounty-51 and NapaCounty-91 were discontinued as of October 2014 at the owners' request.

In response to the groundwater level monitoring objectives and recommendations contained in the 2013 Plan (LSCE, 2013a), Napa County staff and members of the GRAC have worked to encourage owners of wells in Napa County to volunteer additional wells for the Comprehensive Groundwater Monitoring Program. In 2013, County staff and the GRAC identified 18 Areas of Interest throughout the county to address monitoring priorities for network expansion or refinement (**Table 2-3**).

Members of the GRAC and County conducted a variety of outreach efforts throughout 2013 and 2014 in order to encourage well owners to volunteer existing wells for future monitoring. Outreach efforts included public meetings, County newsletters, press releases, and meetings with individual well owners. Interested well owners were provided with a two-page authorization form and questionnaire that allowed the owners to specify the monitoring network (CASGEM or County Volunteer Groundwater Monitoring Network) in which they agreed to participate. Through these efforts 48 wells were volunteered and taken into consideration as candidates for inclusion into Napa County monitoring networks (**Figure 4-3**).

After compiling any available well construction and groundwater data for the 48 candidate wells, the wells were reviewed for suitability as additions to the Comprehensive Groundwater Monitoring Program. The review considered the location and construction of each well relative to the monitoring priorities in the 2013 Plan and the available information on the hydrogeologic setting in the vicinity of each well. Thirty of the candidate wells were subsequently chosen for continued monitoring as part of the Comprehensive Groundwater Monitoring Program (**Table 4-3**, **Table 4-4**, and **Figure 4-3**).

4-3 Outcome of Candidate Well Review for Napa County Groundwater Monitoring Network Expansion

Groundwater Subarea	Wells Selected for Future Monitoring	Wells Pending Additional Information	Wells Not Selected for Future Monitoring
Napa Valley Floor-Calistoga	1	3	1
Napa Valley Floor-MST	2	0	0
Napa Valley Floor-Napa	6	1	2
Napa Valley Floor-St. Helena	6	2	0
Napa Valley Floor-Yountville	1	2	0
Carneros	2	6	0
Jameson/American Canyon	1	0	0
Angwin	4	1	0
Central Interior Valleys	1	0	0
Eastern Mountains	3	0	0
Pope Valley	1	0	0
Western Mountains	2	0	0
Total Wells	**30**	**15**	**3**

Candidate wells selected for continued monitoring will be added to the appropriate monitoring network, as agreed to by the well owners, in 2015. These wells will be monitored on a semi-annual basis, unless otherwise authorized by the well owners.

Ten additional wells at five sites were also added to the Napa County Comprehensive Groundwater Monitoring Program in 2014. These wells were constructed for monitoring purposes at locations along the Napa River and Dry Creek in order to address the monitoring need identified in the 2013 Plan (**Table 2-3**) for evaluating surface water-groundwater relationships. These monitoring wells are owned by Napa County. Groundwater level and water quality monitoring will be conducted continuously at these sites, augmented by manual measurements collected at least semi-annually. Additional information about these sites is provided in **Section 4.2**.

Table 4-4 Comparison of Candidate Wells and Napa County Comprehensive Groundwater Monitoring Program Needs

Subarea	Future GW Level Monitoring (Relative Priority)		Monitoring Needs	Key Monitoring Objectives[1]	Candidate Wells Areas of Interest	Volunteered Candidate Wells and Surface Water-Groundwater Monitoring Sites				
						Upper Zone, Unconsolidated Alluvium	Deep Zone, Unconsolidated	Consolidated Aquifer	Unknown Aquifer Zone	SW-GW
Napa Valley Floor-Calistoga	H	E	SP, SW	Conditions, Trends, Wtr Budget, SW	14	-	-	-	2	-
					15	1	-	-	2	-
Napa Valley Floor-MST	H	R	SP, SW	Conditions, Trends, Wtr Budget, SW	Other	1	1	-	-	-
Napa Valley Floor-Napa	H	R	SP, SW	Conditions, Trends, Wtr Budget, SW	5	-	-	-	-	-
					6	-	-	-	-	-
					7	2	2	-	-	-
					8	-	2	-	1	-
					Other	-	-	-	-	2
Napa Valley Floor-St. Helena[4]	H	E	SP, SW	Conditions, Trends, Wtr Budget, SW	11	-	-	-	2	-
					12	-	-	-	-	-
					13	-	5	-	1	-
					Other	-	-	-	-	1
Napa Valley Floor-Yountville	H	E	SP, SW	Conditions, Trends, Wtr Budget, SW	9	-	-	-	2	-
					10	-	1	-	-	-
					Other	-	-	-	-	2
Carneros	H	E	B	Conditions, Trends, Wtr Budget, Saltwater	3	-	-	-	3	-
					4	1	-	-	4	-

Jameson/American Canyon	M	E	B	Conditions, Trends,	1	1	-	-	-	-
				Wtr Budget, Saltwater	18	-	-	-	-	-
Napa River Marshes	M	E	SP, SW	Conditions, Trends, Wtr Budget, Saltwater	2	-	-	-	-	-
Angwin	M	E	B	Conditions, Trends, Wtr Budget	16	-	-	5	-	-
Berryessa	L	E	B	Conditions, Trends (includ. CASGEM)		-	-	-	-	-
Central Interior Valleys	L	E	B	Conditions, Trends		-	-	1	-	-
Eastern Mountains	L	E	B	Conditions, Trends		-	-	1	1	-
Knoxville	L	E	B	Conditions, Trends		-	-	-	-	-
Livermore Ranch	L	E	B	Conditions, Trends		-	-	-	-	-
Pope Valley	L	E	B	Conditions, Trends (includ. CASGEM)	17	-	-	-	1	-
Southern Interior Valleys	L	E	B	Conditions, Trends		-	-	-	-	-
Western Mountains	L	E	B	Conditions, Trends		-	-	2	-	
					Total	**6**	**11**	**9**	**19**	**5**

[1] The Groundwater Level Monitoring Objectives shown in this column are “shorthand” descriptors for the objectives explained in Section 3.

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information and as the well may be available for monitoring; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells (coordinate with potential geologic investigations that may be conducted in selected areas)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs: SP = Improve horizontal and/or vertical spatial distribution of data; SW =identify appropriate monitoring site to evaluate surface water -groundwater interrelationships; B = Basic data needed to accomplish groundwater level monitoring objectives

4.1.2 CASGEM Monitoring Network

As of fall 2014 the Napa County CASGEM Monitoring Network included 11 previously monitored wells and 10 wells added through outreach to well owners (**Figure 4-4**). Of these, one was to be discontinued after 2014 because the wells were dry and planned for abandonment. In addition, 10 dual-completion monitoring wells at five sites in Napa Valley are planned for inclusion in the CASGEM monitoring network in 2015. These monitoring wells were constructed by Napa County in fall 2014 as part of the Napa County Surface Water-Groundwater Monitoring Project (see **Section 4.2**). Wells in the CASGEM monitoring network are distributed across all five Napa Valley Floor Subareas (Calistoga, St. Helena, Yountville, Napa, and MST) as well as the Carneros and Angwin Subareas.

4.1.3 DWR Monitoring Network

The DWR currently monitors four wells in Napa County as part of its voluntary groundwater monitoring efforts (**Table 4-1**). Three of these sites are monitored at monthly intervals, while one is monitored semi-annually. These wells are located in each of the Napa Valley Floor subareas, excluding the MST Subarea.

4.1.4 State Water Resources Control Board GeoTracker Network

The State Water Resources Control Board (SWRCB) stores environmental data for regulated facilities in California in their GeoTracker database, including groundwater levels and groundwater quality. Data from these regulated facilities usually consist of data from groundwater monitoring wells (typically shallow) associated with each site location. Groundwater level data are available for 14 GeoTracker sites located throughout Napa County in 2014 (**Table 4-1**). The groundwater level monitoring frequency is typically semi-annual, though more frequent measurements are sometimes recorded. The GeoTracker sites with data reported in 2014 were located in each Napa Valley Floor subarea, excluding the Yountville Subarea, as well as the Berryessa and Napa River Marshes Subareas.

4.2 Local Groundwater Assistance Grant Program Monitoring

Funding from the DWR 2012 Local Groundwater Assistance Grant Program enabled Napa County to construct ten monitoring wells at five sites in Napa Valley in September 2014. These wells comprise the groundwater monitoring facilities for the Napa County Surface Water-Groundwater Monitoring Project. In addition to grant funding from DWR, Napa County is providing matching funds to cover a portion of the monitoring well construction and instrumentation costs.

4.2.1 Monitoring Network

Figure 4-5 shows the location of the five project sites, with four sites along the Napa River and one adjacent to Dry Creek. The five sites selected for the project are within the Napa, Yountville, and St. Helena Subareas of the Napa Valley Floor. These are three of the six subareas where paired surface water-groundwater monitoring was recommended in the 2013 Plan (**Table 2-3**).

Each of the five sites includes one dual-completion monitoring well to enable monitoring of groundwater conditions at specific depth intervals. These dual-completion wells consist of two separate casings in a single borehole. Each casing is independent of the other with distinct total depths and screen intervals. The construction details for each casing were developed based on sites specific hydrogeologic and surface water channel considerations.

In general, groundwater monitoring facilities at each site consist of one shallow casing constructed to represent groundwater conditions at the water table surface and at elevations similar to the adjacent surface water channel. The second casing at each site is constructed to a deeper depth with screen intervals coinciding with aquifer materials and depths likely to be accessed by production wells in the vicinity. Paired casings are separated within the borehole by intermediate seals designed to provide a physical separation such that groundwater conditions reflected by each casing are not influenced by conditions in other portions of the groundwater system.

Initial data collected at the five sites are summarized in **Table 4-5**. These data relate manual measurement of groundwater levels from October 2014 through January 2015, where available. Depths to groundwater are converted to elevations relative to a standard datum in order to compare the groundwater levels to surveyed elevations for the adjacent streambed in feet above mean sea level. Values in the Streambed/Groundwater Connectivity column are the difference between the Groundwater Elevation and Streambed Elevation.

Connectivity between groundwater and surface water is indicated at Sites 1 and 4 for the available period of record (**Table 4-5**). The positive connectivity values at these sites show that groundwater levels were above the streambed, which also suggests a groundwater flow in the direction of the streambed at that site. Data from Sites 2, 3, and 5 show that groundwater levels were below the streambed, which at larger magnitude (i.e., more negative) indicates disconnection between surface water and groundwater. Slightly negative connectivity values may indicate a disconnection or flow from surface water to groundwater.

Table 4-5 Summary of Initial Data from Napa County Surface Water-Groundwater Monitoring Sites

	Date	Streambed Elevation	Groundwater Elevation	Streambed/ Groundwater Connectivity
		Thalweg Elev. from Available Surveys (ft, NAVD88)	Shallow Casing Groundwater Elevation (ft, NAVD88)	Groundwater Elevation Relative to Thalweg Elevation (ft.)
Site 1 Napa River at Napa	10/20/2014	-2.4[1]	6.30	**8.70**
Site 2 Dry Creek at Washington St	10/20/2014	86.20[2]	74.90	**-11.30**
Site 2 Dry Creek at Washington St	12/10/2014	86.20[2]	80.89	**-5.31**
Site 3 Napa River at Oak Knoll Ave	10/20/2014	31.05[3]	27.55	**-3.50**
Site 4 Napa River at Yountville Cross Rd	10/23/2014	75.98[4]	76.75	**0.77**
Site 4 Napa River at Yountville Cross Rd	12/10/2014	75.98[4]	78.36	**2.38**
Site 5 Napa River at St. Helena	10/20/2014	196.00[5]	189.04	**-6.96**
Site 5 Napa River at St. Helena	12/10/2014	196.00[5]	193.65	**-2.35**
Site 5 Napa River at St. Helena	1/6/2015	196.00[5]	194.03	**-1.97**

[1] 2003 NCALM LiDAR (1 meter horizontal resolution)
[2] 2003 NCALM LiDAR, (1 meter horizontal resolution)
[3] Napa RCD, 2007 Oakville to Oak Knoll Thalweg Profile Survey @ US edge of Oak Knoll Ave bridge
[4] Napa RCD, 2007 Oakville to Oak Knoll Thalweg Profile Survey @ DS edge of Yountville Cross Rd Bridge
[5] Flood Profiles in revised FEMA 2012 Letter of Map Revision for St. Helena Protection Project

NOTE: Positive Streambed/Groundwater Connectivity values indicate connectivity and flow of groundwater towards the streambed. Negative Streambed/Groundwater Connectivity values indicate flow from the riverbed into groundwater (if connected) or a disconnection between surface water and groundwater.

5 GROUNDWATER LEVEL TRENDS AND FLOW DIRECTIONS

Groundwater data availability in Napa County varies widely among the subareas. The bulk of the historical and current groundwater level and quality data is located in the Napa Valley Floor Subarea with limited to no data in the other Napa County subareas. This section presents discussions of groundwater levels, with a focus on groundwater level characteristics by subarea.

Napa County received below average precipitation at the Napa State Hospital gauge during water years[8] 2012, 2013, and 2014. Water years 2013 and 2014 registered as Dry years on the County's five stage rating system of Very Dry, Dry, Average, Wet and Very Wet water year types (**Table 5-1**). Since 1949 when most long-term groundwater monitoring records begin, comparable multi-year periods with below average precipitation occurred in 1990 – 1991 (both Dry), 1976 – 1977 (both Very Dry), and 1959 – 1962 (all Dry), 1954 – 1955 (both Dry), and 1947-1949 (all Dry).

Successive years of below average precipitation in water years 2012 through 2014 provide an important context for the review of recent groundwater level trends. **Figure 5-1** depicts both the annual water year precipitation recorded at the Napa State Hospital gauge along with the cumulative departures from the mean water year precipitation value for water years 1970 through 2014. The cumulative departure values calculated for **Figure 5-1** provide a tally of precipitation received relative to the mean value over time.

Notably, the eight-year span from 1987 through 1994, with only one year of above average precipitation, results in a minimum cumulative departure of -39.8 inches (**Figure 5-1**). This protracted period contrasts with the Very Dry years of 1976 and 1977, which although more acute, produced a less severe cumulative departure of -25.7 inches. Groundwater level records from the Napa Valley Floor groundwater subbasin that include both of these time periods generally show the lowest spring groundwater levels in 1977, as compared to the 1987 to 1994 period. This indicates that the subbasin experienced sufficient recharge to maintain relatively stable spring groundwater levels over an eight-year period when precipitation totals were below average on the whole.

From 2009 through 2014 water year types for the Napa River Watershed included equal numbers of dry, average, and wet years (**Table 5-1**). Consecutive wet years in 2010 and 2011 produced positive cumulative departure values (**Figure 5-1**). Consecutive dry years in 2013 and 2014 resulted in declining cumulative departure values, and through 2014 the cumulative departure was -4.8 inches.

[8] A water year is defined as the time from October 1 through the following September 30 and is numbered according to the calendar year on its final day.

Table 5-1 Recent Napa State Hospital Annual Precipitation Totals and Napa River Watershed Water Year Types

Water Year	Annual Precipitation (in)	Water Year Type
2009	21.31	average
2010	28.87	wet
2011	34.99	wet
2012	21.01	average
2013	19.89	dry
2014	19.37	dry

Geologic setting and differences in aquifer zones within a subarea or groundwater subbasin are additional considerations relevant to the interpretation of groundwater levels, particularly for wells constructed entirely or partially within the alluvium in Napa Valley. **Figure 5-2** depicts two wells located relatively near each other at the land surface which exhibit distinct groundwater levels due in part to having been constructed within different aquifer zones. Well 07N05W09Q2 is located near the center of Napa Valley, where the alluvium extends to approximately 200 feet below ground surface (LSCE and MBK, 2013). NapaCounty-138 has a total depth of 321 feet and is located closer to the western edge of Napa Valley in an area where the alluvium extends only about 50 feet below ground surface. The lower static water levels measured in the fall at NapaCounty-138 indicate that the well draws water from a geologic formation below the alluvium. Knowledge of the geologic setting and construction details for a given well are important considerations when interpreting groundwater level data.

Figure 5-3 depicts another example of the influence that aquifer zones can have water levels in wells located in the same area. In this case, the well located east of the Napa River is constructed in the Sonoma Volcanics, while the wells west of the Napa River are constructed within alluvial sediments. Additional discussion of these wells is provided in **Section 5.1.2**.

The groundwater elevation contours described below are derived from available depth to water measurements made in wells. Prior to interpolating groundwater elevations across the valley, depth to water values were converted to groundwater elevation values by subtracting the measured depth to water from the reference point elevation at each monitored well. In this way the depth to water measurements were related to the North American Vertical Datum 1988 (NAVD88) as a standard point of reference. The resulting groundwater elevation values at each well were used to interpolate groundwater elevation contours throughout the Napa Valley Floor and in the MST area. A contour line represents a line of equal elevation of the water surface similar to the way a topographic map contour line shows a line of equal elevation of ground surface. The direction of groundwater flow is perpendicular to the contour lines.

5.1 Napa Valley Floor Subareas

The Napa Valley Floor Subarea is subdivided into five smaller subareas. From north to south these areas are Calistoga, St. Helena, Yountville, Napa, and the MST. The groundwater level conditions in each of these areas are described below.

Over the length of the Napa Valley, groundwater is contained in and moves primarily through the older and younger alluvium from Calistoga to San Pablo Bay, and is assumed for purposes of contouring groundwater data on a regional basis, to represent a single aquifer. Groundwater levels that were determined to represent a non-alluvial part of the aquifer system were excluded from the contouring dataset.

Interpreted groundwater elevation contours for spring and fall 2014 are shown in **Figures 5-4** and **5-5,** respectively. Groundwater elevation contours for Napa Valley spring 2014 appear similar to those developed for spring 2010 (LSCE, 2013b). Contours during both time periods show a generally southeasterly to east-southeasterly groundwater gradient paralleling the valley axis from Calistoga to Yountville with similar groundwater elevation ranges. In the Napa Subarea, contours indicate a slightly more eastward flow direction in spring 2014 than in 2010. Through the Valley, groundwater elevations in spring 2014 ranged from above 380 feet near Calistoga to less than -30 feet along the Napa River near the Soda Creek Fault.

5.1.1 Napa Valley Floor – Calistoga and St. Helena Subareas

The hydrographs for the representative wells illustrated on **Figure 5-6** show groundwater elevations and corresponding depth to groundwater from 1970 to present, as available. Groundwater levels have been generally stable over time in the Calistoga Subarea and northern portion of the St. Helena Subarea. Groundwater levels in the representative wells are frequently very shallow at less than ten feet below the ground surface in the spring. Minor seasonal declines of about 10 feet occur in the fall in the Calistoga Subarea. Groundwater levels in well 8N6W10Q1 have been lower in the late September to December timeframe in six years since 2001. However, in every year since 1970, including 2014, groundwater levels returned to within 10 feet of the ground surface.

Elsewhere in the St. Helena Subarea, groundwater levels exhibit greater seasonal declines of about 20 feet. Groundwater levels at well 7N5W09Q2 have remained relatively stable although somewhat susceptible to dry years. An example of this occurred in 1976 and 1977, two Very Dry years in the Napa River Watershed. In 1976, the spring groundwater level measurement was 19.3 feet below ground surface, lower by more than 10 feet from the prior spring. In 1977, the spring groundwater level measurement was 27.2 feet below ground surface, down almost 8 feet from the spring 1976 measurement. Spring water levels in the same well in 2013 and 2014 were 13.8 feet and 18.6 feet below ground surface, respectively; the spring 2013 and 2014 levels are above the levels measured in 1976 and 1977.

Groundwater level measurements in well NapaCounty-132 have shown a slight downward trend since the mid-2000s, along with some anomalous responses that indicate a need for a better understanding of the data record and any outside factors that may have contributed to the decline. For example, while the spring 2014 groundwater level measurement of 25.65 feet below ground surface was among the lowest on record, the lowest observed spring water level was in 1997 at 42.2 feet below ground surface. However, in spring 1976 and spring 1977 water levels showed only modest declines to 15 and 19 feet below ground surface, respectively.

5.1.2 Napa Valley Floor – Yountville and Napa Subareas

The representative hydrographs shown in **Figure 5-7** show groundwater elevations and corresponding depths to water in the Yountville and Napa Subareas. Long-term groundwater elevations have remained for the most part stable in the Yountville Subarea. In the Yountville Subarea, the depth to groundwater in the spring is generally less than ten feet, similar in nature to the Calistoga and St. Helena Subareas to the north. Seasonal fluctuations vary by proximity to the center of the valley. Along the western and eastern edges of the subarea, levels are more subject to larger seasonal fluctuations. Groundwater elevations in the center of the valley fluctuate seasonally approximately 10 to 25 feet, and near the edge of the valley fluctuate approximately 25 to 35 feet.

In the Napa Subarea, depth to water ranges from about 20 to 50 feet below ground surface during the spring. Seasonal groundwater elevations in this subarea generally fluctuate from 10 to 40 feet. Long-term trends have been generally stable with the exception of the northeastern area at well NapaCounty-75 where there has been a 10 to 30 foot decline over the past 15 years. This well is located east of the Napa River and adjacent to the MST Subarea. It appears that the decline in water levels at this well may indicate that the cone of depression in the MST Subarea is expanding westward.

Well NapaCounty-75 is located just east of the Napa River and west of Soda Creek fault (i.e., the well that shows a Spring 2014 groundwater elevation of – 11.9 ft, msl) is constructed to a depth of 205 feet and is completed in the Sonoma Volcanics formation. The Sonoma Volcanics formation is also present in the MST Subarea to the east, where previous monitoring has shown several pumping depressions (LSCE, 2011a). The two nearest monitoring wells located west of the Napa River in the northeastern Napa Subarea constructed to depths of 120 feet or less and are completed in the alluvium. These wells have shown stable groundwater level trends. The monitoring well in the alluvium that is closest to the well constructed in the Sonoma Volcanics has shown stable water levels since the 1960s. It appears that the extent of the pumping depression beyond the MST subarea may be limited to the northeastern Napa Subarea east of the Napa River.

In the southwestern part of the Yountville Subarea and at the Napa Valley margin, groundwater levels in well NapaCounty-135 have also declined since the first measurements were recorded in the late 1970s and early 1980s. Groundwater levels appeared to begin stabilizing in the mid-2000s, then were affected more recently by drier years. As with well NapaCounty-132 in the southeastern St. Helena Subarea, the declining groundwater levels observed in this well indicate multiple potential causes. At well NapaCounty-135, the spring to fall groundwater level changes have been larger in magnitude in more recent years, ranging from approximately 30 feet to 50 feet in many years since 2000. Prior spring to fall groundwater level fluctuations in this well were generally 10 feet to 20 feet. This pattern could indicate an increase in the rate of groundwater pumping, either by NapaCounty-135 or other wells in the vicinity. However, even as the spring to fall groundwater level fluctuations have increased in recent years, groundwater levels have fully recovered in many years. The exceptions appear to coincide with single and multiple dry years, such as 2001, 2007 and 2013 to 2014.

5.1.3 Napa Valley Floor – Milliken-Sarco-Tulucay (MST) Subarea

Although designated as groundwater subarea for local planning purposes, the MST is not part of a groundwater basin as mapped by DWR. In the MST, the aquifer system is composed primarily of the Sonoma Volcanics and associated sedimentary deposits. These aquifer materials have different hydraulic properties than the Napa Valley alluvial deposits and the level of communication and connectivity between the two areas is limited. Groundwater levels used for contour mapping in the MST Subarea generally represent conditions of a composite aquifer system as previously described by Farrar and Metzger (2003).

Historically, groundwater flow directions in the MST Subarea were generally from the Howell Mountains in the east toward the Napa River to the west. Beginning in the 1970s, investigators have identified pumping depressions in the northern, central and southern parts of the MST (Johnson 1975, Farrar and Metzger 2003). The current coverage of wells does not extend to the former location of the central (and deepest) pumping depression and therefore flow directions cannot be visualized and evaluated; however, the coverage does extend to the former locations of the northern and southern depressions, and they are shown in the spring and fall 2014 groundwater level contour maps (**Figure 5-8** and **5-9**).

In the northern MST, groundwater flow is generally eastward (unchanged direction since 2008) in the Spring and Fall 2014 with a maximum Spring low of about -50 feet (NAVD88) in the northeastern MST (15 feet lower than Spring 2008). In the southern MST, groundwater flow continues to be generally northwest (unchanged direction since 2008) in the spring and fall 2014 with a maximum spring low of about -30 feet (NAVD88) in the southern MST (25 feet lower than in spring 2008); however, the western portion of this area has no coverage of wells with water levels which would be necessary to define the extent of the pumping depression.

Representative hydrographs for the MST illustrated on **Figures 5-10 and 5-11** show groundwater elevations and corresponding depth to groundwater since 1970 in the northern (**Figure 5-10**) and central/southern parts of the MST (**Figure 5-11**). In the northern MST, groundwater levels were stable throughout the late seventies until the mid-1980s (1986), at which time a decline of about 10 to 40 feet occurred. Following this decline, groundwater levels stabilized until the late 1990s to early 2000s. After that time, groundwater levels experienced a gradual decline of about 10 to 30 feet until approximately 2008. After 2008 groundwater levels have shown signs of stabilizing in three of four currently monitored wells in the northern MST (NapaCounty-2, NapaCounty-56, and NapaCounty-122), while NapaCounty-43 has shown continued declines, possibly resulting from recent dry years. Depth to groundwater in the northern part of the MST Subarea currently ranges from about 60 to 200 feet.

An important feature within the northern part of the MST is the Soda Creek Fault that several previous investigators have described as an occasional barrier to groundwater flow. It is described by Weaver (1949) as a normal fault with more than 700 feet vertical displacement downward on the western side. Johnson (1977) and Farrar and Metzger (2003) describe groundwater elevations were about 10 feet higher on the eastern side of the fault during their respective study periods. Recent measurements (post-2000) indicate that groundwater levels are about 20 to 30 feet higher on the eastern side of the fault.

Along Hagen Road, located between the northern and central areas of the MST, groundwater level records are insufficient to make conclusions about long-term trends. Recent data show declining groundwater levels in this area of the MST. Along Sarco Creek/Hagen Road, land surface gradually rises in an eastward direction. In this area, the depth to groundwater in multiple wells along Hagen Road (and along First Avenue) is currently greater than 200 feet, where historically it was about 20 feet below ground surface in the 1960s and 1970s. With limited available data, it appears that there is a constant rate of groundwater level decline of about 3 feet per year over the last fifteen years.

In **Figure 5-11**, groundwater elevations in the central portion of the MST and near North Avenue show a greater rate of decline and total decline of groundwater elevations over time as compared to wells located further south. The groundwater elevations in the central portion of the MST began to decline in the 1950s and currently have declined up to 250 feet in some locations. The central portion of the MST also corresponds to an area in which the primary aquifer of the Sonoma Volcanics, the tuffaceous member of that unit, is not present. The recent trends in the central MST are similar to those described above in the northern MST along Hagen Road. Based on the groundwater level trends and local geologic conditions, some of these trends may be the result of variations in geologic conditions or increasing levels of development relative to conditions 40 to 50 years ago.

Groundwater levels in the southern portion of the MST, especially south of Coombsville Road, were generally stable until the late 1990s and early 2000s, when a decline of about 10 to 30 feet occurred in some locations. Groundwater levels have shown signs of stabilizing in these wells since about 2008.

5.2 Subareas South of the Napa Valley Floor

South of the Napa Valley Floor the only subareas with current groundwater level monitoring sites in 2014 were the Carneros and Jameson/American Canyon Subareas.

In 2014, the Carneros Subarea had four current groundwater level monitoring sites.
The longest period of record among them extended back to October 2011. Monitoring began at the other three wells in 2012. All four monitored wells are located in the southern half of the subarea at land surface elevations between 100 feet to 25 feet (NAVD88). Patterns of groundwater level fluctuations in these wells have shown annual variations of approximately 5 feet from spring to fall, with groundwater elevations ranging from about 20 feet, relative to mean sea level, to -5 feet, relative to mean sea level. Depths to groundwater below ground surface have varied more widely from 10 feet to 100 feet.

In the Jameson/American Canyon Subarea the only current groundwater level data are from one well recently volunteered for monitoring. Spring and fall measurements recorded in that well in 2014 found depths to groundwater ranging from 6 feet in the spring to 14 feet in the fall.

5.3 Subareas East and West of the Napa Valley Floor

The Eastern Mountains and Western Mountains Subareas flank the Napa Valley Floor Subareas and comprise the uplands of the Napa River Watershed. The geology of these large subareas is complex and highly variable. Recent efforts to expand the Napa County monitoring network have identified five new volunteered monitoring wells between the two subareas (**Table 4-2**).

Groundwater level monitoring data for these wells are only available for spring and fall 2014, with three of the five wells having only one measurement recorded. The depths to groundwater in these wells ranged from 44 feet to 240 feet from ground surface elevations ranging from 390 feet to 1660 feet, mean sea level.

5.4 Angwin and Pope Valley Subareas

In 2014, groundwater level monitoring in the Angwin and Pope Valley Subareas was performed by Napa County at recently volunteered wells. In the Angwin Subarea five wells were volunteered, while one well was volunteered in the Pope Valley Subarea.

Groundwater level monitoring data for the Angwin Subarea wells are only available for spring and fall 2014. Depths to groundwater in these wells ranged from 107 feet to 207 feet from ground surface elevations ranging from 1690 feet to 1860 feet, mean sea level.

The only groundwater level monitoring data point for the single volunteered well in Pope Valley is from fall 2014, when the depth to groundwater was measured to 16 feet below ground surface.

6 COORDINATION AND COLLABORATION

6.1 Integrated Regional Water Management Plans

Integrated Regional Water Management (IRWM) is defined by DWR as "a collaborative effort to identify and implement water management solutions on a regional scale that increase self-reliance, reduce conflict, and manage water to concurrently achieve social, environmental, and economic objectives" (DWR, 2015a).

6.1.1 Napa County's Participation in San Francisco Bay Area and Westside IRWMPs

In 2005, the County formed the Napa County regional water management group (RWMG), a working group of local water agencies, where the Napa County Flood Control and Water Conservation District served as the lead agency. The County RWMG worked together to draft the Napa-Berryessa Integrated Regional Water Management Plan (IRWMP) Functional Equivalent (Napa-Berryessa Regional Water Management Group, 2005).

In 2009, DWR established IRWM regions that have been accepted through the Regional Acceptance Process (DWR, 2009). Currently, there are two formally accepted regions that include Napa County; these regions are: 1) the San Francisco Bay Area Region (which covers the generally southern part of Napa County and focuses on the Napa River and Suisun Creek watersheds), and 2) the Westside Sacramento Region (which covers the generally northern part of Napa County and focuses on the Putah Creek/Lake Berryessa watershed; the Westside Region also covers parts of Yolo, Solano, Lake, and Colusa Counties).

The County has contributed to two larger regional IRWMPs. The County actively collaborated with the San Francisco Bay and Westside RWMGs to update the IRWMP for the San Francisco Bay (Kennedy Jenks et al., 2013) and to develop a new IRWMP for the Westside Sacramento Region (Kennedy Jenks, 2013). The County's representation and participation in the San Francisco Bay and Westside IRWMPs enables further coordination and sharing of information on water resources management planning programs and projects (particularly those that are a high priority for the County) and other information for IRWMP grant funding and implementation.

6.2 Groundwater Sustainability

In September 2014, the California Legislature passed the Sustainable Groundwater Management Act (Act) (DWR, 2015b). This new Act changes how groundwater is managed in the state. The Act defines "sustainable groundwater management" as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (Section 10721 (u)). Undesirable results, as defined by the Act, means one or more of the following effects caused by groundwater conditions occurring throughout the basin (Section 10721 (w)):

(1) Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

(2) Significant and unreasonable reduction of groundwater storage.

(3) Significant and unreasonable seawater intrusion.

(4) Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.

(5) Significant and unreasonable land subsidence that substantially interferes with surface land uses.

(6) Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

6.2.1 DWR Prioritization of Groundwater Basins

As noted in **Section 2** of this Report, DWR has prioritized groundwater basins and subbasins in accordance with the requirements of Water Code Section 10933. The Act applies to basins or subbasins that DWR designates as medium- or high-priority basins. Previously under CASGEM, DWR ranked California's basins and subbasins. In Napa County, the Napa Valley Subbasin was ranked medium priority. All other Napa County subbasins were ranked as low or very low priority basins.

Under the Act, DWR must review and update the ranking of each of the basins or subbasins as a very low-, low-, medium-, or high-priority basin based on requirements contained in Section 10933. DWR is required to complete its initial ranking by January 31, 2015, though these rankings have not yet been published. Because of the expediency of this requirement, DWR's CASGEM basin rankings were used to meet this requirement.

Under the new Act, DWR must also consider adverse impacts on local habitat and local streamflows. The factors for basin ranking and prioritization include:

- Overlying population;
- Projected growth of overlying population;
- Public supply wells;
- Total wells;
- Overlying irrigated acreage;
- Reliance on groundwater as the primary source of water;
- Impacts on the groundwater, including overdraft, subsidence, saline intrusion, and other water quality degradation; and
- Any other information determined to be relevant, including adverse impacts on local habitat and local streamflows.

For most basins designated by DWR as medium or high priority, the Act requires the designation of groundwater sustainability agencies (GSA) and the adoption of groundwater sustainability plans (GSP); however, there is an alternative to a GSP, pending the local entity (entities) can meet the requirements. When required, GSPs must be developed to eliminate overdraft conditions in aquifers and to return them to a condition that assures their long-term sustainability within twenty years of GSP implementation.

The Act does not require the development of a GSP for basins that DWR ranks as low- or very low-priority basins; GSPs are voluntary for these basins. The Act's planning requirements also do not apply to adjudicated groundwater basins that are managed by the courts. As discussed below, under certain groundwater basin conditions, local entities can pursue an Alternative Report (i.e., a document other than a GSP).

As applicable, the Act requires that a GSA be identified for medium- and high-priority groundwater basins by June 30, 2017. Counties are presumed to be the GSA for unmanaged areas of medium- and high priority basins (Section 10724). However, counties are not required to assume this responsibility. When no entity steps forward, this can lead to state intervention (Section 10735 *et seq*.).

The Act requires GSAs for medium- and high-priority basins to adopt a GSP by January 31, 2022 (Section 10720.7). For basins subject to critical overdraft conditions, the GSP must be adopted by January 31, 2020.

Upon adoption of a GSP, the designated GSA must submit the GSP to DWR for review. The Act gives DWR until June 1, 2016 to develop regulations for evaluating GSPs. It is anticipated that as DWR develops regulations for GSPs, DWR will also identify the elements and supporting information necessary for Alternative Submittals, i.e., Alternatives to GSPs.

Upon completion of its review of a GSP, DWR has the power to request changes to the GSP to address deficiencies. DWR is required to re-evaluate GSPs every five years to ensure continued compliance and sufficiency. After adoption of a GSP, the GSA must submit to DWR an annual compliance report containing basin groundwater data, including groundwater elevation data, annual aggregated extraction data, surface water supply for or available for use for groundwater recharge or in-lieu use, total water use, and any changes in groundwater storage (Section 10728).

In addition to imposing a number of new requirements on local agencies related to groundwater management, the Act also provides for state intervention – a “backstop” – when local agencies are unwilling or unable to manage their groundwater basin (Section 10735 *et seq*.).

6.2.2 Alternatives to GSPs

Under the new Act, Section 10733.6, a local entity (or entities) can pursue an Alternative to a GSP under the following circumstances:

(a) If a local agency believes that an alternative described in subdivision (b) satisfies the objectives of this part, the local agency may submit the alternative to the department for evaluation and assessment of whether the alternative satisfies the objectives of this part for the basin.

(b) An alternative is any of the following:

(1) A plan developed pursuant to Part 2.75 (commencing with Section 10750) or other law authorizing groundwater management.

(2) Management pursuant to an adjudication action.

(3) An analysis of basin conditions that demonstrates that the basin has operated within its sustainable yield over a period of at least 10 years. The submission of an alternative described by this paragraph shall include a report prepared by a registered professional engineer or geologist who is licensed by the state and submitted under that engineer’s or geologist’s seal.

(c) A local agency shall submit an alternative pursuant to this section no later than January 1, 2017, and every five years thereafter.

(d) The assessment required by subdivision (a) shall include an assessment of whether the alternative is within a basin that is in compliance with Part 2.11 (commencing with Section 10920). If the alternative is within a basin that is not in compliance with Part 2.11 (commencing with Section 10920), the department shall find the alternative does not satisfy the objectives of this part.

More details about the Act are available at http://www.water.ca.gov/groundwater/sgm/index.cfm.

6.3 Napa County Watershed Information Center and Conservancy

The Watershed Information Center and Conservancy (WICC) Board was established in 2002 to serve as an advisory committee to Napa County Board of Supervisors – assisting with the Board's decision making and serving as a conduit for citizen input by gathering, analyzing, and recommending options related to the management of watershed resources (WICC, 2015). The WICC has achieved significant accomplishments in its 12-year history – both alone and in partnership with nonprofits, public agencies, and private landowners.

The WICC has five goals, including (WICC, 2015):

- Goal 1: Coordinate and facilitate watershed planning, research, and monitoring efforts among Napa County organizations, agencies, landowners and citizens.
- Goal 2: Strengthen and expand community understanding, connections and involvement to improve the health of Napa County's watersheds.
- Goal 3: Support informed decision-making on topics that affect the health of Napa County's watersheds.
- Goal 4: Improve WICC Board efficiency and effectiveness.
- Goal 5: Explore additional funding opportunities to support the goals of the WICC.

Additionally, Subgoal 1B to Goal 1 includes the WICC serving as the local clearinghouse for groundwater resource data, mapping, and monitoring (Implements: Napa County General Plan Action Item CON WR-4). As part of developing education and outreach for the community regarding groundwater conditions, the WICC is expanding groundwater information on the WICC website at www.napawatersheds.org. This new initiative involves adding groundwater summary data and graphs for the County's groundwater basins and/or subareas that are already delineated on the website's maps. Specifically, the WICC plans to establish a portion of the WICC website dedicated to groundwater. Data and information are planned to be at a watershed scale and not be project or parcel specific. Information is likely to include:

- Updates on groundwater resource issues locally and throughout California.
- Articles explaining key technical issues related to groundwater.
- Updates on groundwater mapping and monitoring in Napa County.
- Provide educational materials and resources on groundwater recharge areas and ways to improve these areas.
- Report on the Napa County Voluntary Groundwater Level Monitoring Program.

7 SUMMARY AND RECOMMENDATIONS

Groundwater level trends in the Napa Valley Subbasin of the Napa-Sonoma Valley Groundwater Basin are stable in the majority of wells with long-term groundwater level records. While many wells have shown at least some degree of response to the drought conditions in 2013 and 2014, the water levels observed in recent years are generally higher than groundwater levels in the same wells during the 1976 to 1977 drought. Elsewhere in the county long-term groundwater level records are limited, with the exception of the MST Subarea. Groundwater level declines observed in the MST as early as the 1960s and 1970s have moderated in some wells since about 2008, while other wells continue to experience declining groundwater levels. The observation that groundwater level responses differ within the MST Subarea and even within the north, central, and southern sections of this subarea indicate that localized conditions, whether geologic or anthropogenic in nature, might be the primary influence on conditions in the subarea at this time.

Although groundwater level trends are stable in the majority of wells, periods of year to year declines in groundwater levels have been observed in a few wells in the Napa Valley Floor Subareas. These wells are located near the Napa Valley margin in the eastern Napa Subarea (NapaCounty-75), southwestern Yountville Subarea (NapaCounty-135) and southeastern St. Helena Subarea (NapaCounty-132). In addition to proximity to previously identified cones of depression in the MST Subarea at NapaCounty-75, these wells are also located in areas with relatively thin alluvial deposits.

Groundwater level declines in these wells could have one or more contributing factors, including variations in precipitation and weather patterns and/or changes in the level of pumping at the monitored well or in the vicinity of the monitored well. The observed declines could also be a reflection of the limits of semi-annual data collection at these wells, particularly if the timing of groundwater recharge at their location varies relative to other locations in the subarea due to differences in geologic setting. Recommendations provided below are intended to address the gaps in understanding regarding potential contributing factors to the groundwater level trends observed in these wells.

In 2014, the total number of sites where groundwater level monitoring occurred in Napa County increased to 115 (**Table 4-2**) from 87 sites in 2011, as documented in the 2013 Plan (LSCE, 2013a). The overall increase in the number of monitored sites is attributable to the efforts of Napa County with support from the GRAC to expand the network of volunteered wells monitored by the County. Monitoring conducted or reported by entities other than Napa County, namely the DWR and SWRCB, decreased from 35 sites in 2011 to 18 sites in 2014.

Members of the GRAC and Napa County staff conducted a variety of outreach efforts throughout 2013 and 2014 in order to educate county residents about the County's Comprehensive Groundwater Monitoring Program and to encourage well owners to volunteer existing wells for future monitoring. Through these efforts, 48 wells located across 12 groundwater subareas were volunteered and taken into consideration as candidates for inclusion in Napa County's monitoring networks (**Table 4-3**). Thirty wells are recommended for future monitoring by the County, with others possible pending additional information such as the total depth of the well, which could be measured during the next round of water level measurement. **Table 7-1** summarizes the results of the candidate well review and indicates where additional wells are needed.

Table 7-1 Summary of Groundwater Level Monitoring Objectives and Future Monitoring Needs

Subarea	Future GW Level Monitoring (Relative Priority)		Monitoring Needs	Key Monitoring Objectives[1]	Candidate Wells Selected for Future Monitoring	Additional Vetting of Candidate Wells Needed	Additional Candidate Wells Needed to Meet Key Objectives
Napa Valley Floor-Calistoga	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**1**	**Yes**	**Yes**
Napa Valley Floor-MST	**H**	**R**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**2**	**No**	**Yes**
Napa Valley Floor-Napa	**H**	**R**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**6**	**Yes**	**Yes**
Napa Valley Floor-St. Helena[4]	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**6**	**Yes**	**Yes**
Napa Valley Floor-Yountville	**H**	**E**	**SP, SW**	**Conditions, Trends, Wtr Budget, SW**	**1**	**Yes**	**Yes**
Carneros	**H**	**E**	**B**	**Conditions, Trends, Wtr Budget, Saltwater**	**2**	**Yes**	**No**
Jameson/American Canyon	M	E	B	Conditions, Trends, Wtr Budget, Saltwater	1	No	Yes
Napa River Marshes	M	E	SP, SW	Conditions, Trends, Wtr Budget, Saltwater	0	No	Yes
Angwin	M	E	B	Conditions, Trends, Wtr Budget	4	Yes	No
Berryessa	L	E	B	Conditions, Trends (includ. CASGEM)	0	No	Yes
Central Interior Valleys	L	E	B	Conditions, Trends	1	No	No
Eastern Mountains	L	E	B	Conditions, Trends	3	Yes	No
Knoxville	L	E	B	Conditions, Trends	0	No	Yes
Livermore Ranch	L	E	B	Conditions, Trends	0	No	Yes
Pope Valley	L	E	B	Conditions, Trends (includ. CASGEM)	1	Yes	Yes
Southern Interior Valleys	L	E	B	Conditions, Trends	0	No	Yes
Western Mountains	L	E	B	Conditions, Trends	2	No	No
				Total	**30**		

L = Low Priority; add groundwater level monitoring based on areas of planned future groundwater development

M = Medium Priority; add groundwater level monitoring

H = High Priority; add groundwater level monitoring

E = Expand current monitoring network; possible alternatives for additional monitoring wells include 1) wells historically monitored by DWR/USGS/Others, preferably with well construction information; 2) existing water supply wells (e.g., private/commercial) with well construction information; 3) new dedicated monitoring wells coordinated with recent geologic investigations that are or will be conducted)

R = Refine current monitoring network (link well construction information to all monitored wells, as possible)

Monitoring Needs:
SP = Improve horizontal and/or vertical spatial distribution of data, including for the purpose of identifying such factors as climate change and to identify opportunities for enhanced groundwater recharge and storage;
SW =identify appropriate monitoring site to evaluate surface water -groundwater recharge/discharge mechanisms;
B = Basic data needed to accomplish groundwater level monitoring objectives

7.1 Ongoing Vetting and Review of Potential Monitoring Sites

Based on available well construction information, pre-existing hydrogeologic information, and monitoring priorities described in the 2013 Plan, 30 of the 48 candidate wells are recommended for continued monitoring. Fifteen of the candidate wells were determined to have insufficient data with which to make a final determination on suitability for inclusion in Napa County's monitoring networks. These wells are recommended for one year of additional groundwater level monitoring while additional well construction information are sought. Additional well construction information could include manually sounding the total well depth during the next round of groundwater level measurements and reviewing Well Completion Reports for wells in the vicinity, as available from DWR.

7.2 Data Gap Refinement

Groundwater levels in some monitored wells located closer to the Napa Valley margin show signs of decreasing groundwater level trends. In order to consider the full range of possible causes for these declines, additional information will be needed. Recommended actions include a review of land use data in these areas, conversations with the well owners regarding changes to the pattern of pumping at the well over time, and more frequent data collection. More frequent data collection could be accomplished, pending agreement by the well owner, by monthly manual groundwater level measurements or installation of continuously recording pressure transducers. Pressure transducers would be the preferred option from a data analysis perspective. By recording data on a frequent basis, it is possible to more accurately observe the high and low groundwater levels over the course of a year.

Additional data gaps exist in subareas where no monitoring is currently conducted or, as with the Carneros and MST subareas, the distribution of currently monitored wells omits portions of the subarea.

7.3 Coordination with Other Monitoring Efforts

Coordination with other county departments and other agencies that monitor groundwater data or receive groundwater data could provide an additional source of data in places where data are limited. Several local agencies, including Town of Yountville, City of St. Helena, City of Napa, already monitor groundwater levels at locations around the county. Coordination with these entities could also improve the quality of data collected if cooperating agencies can standardize data collection methods.

7.4 Existing Activities in the MST Subarea

In 1999 the County passed a Groundwater Ordinance which, among other things, limited approval of discretionary permits in the MST Subarea to those projects that could meet the "Fair Share" requirement of 0.3 acre-foot/per acre of land. In 2004, discretionary approvals were further limited to those projects that could meet a "no net increase" standard. These actions were intended to slow the decline of water levels in the MST Subarea while a more permanent solution could be found.

It was recognized at the time that these actions by themselves would not “fix” the problem, but were a good step given the constraints of land use and groundwater law. It is reasonable to assume that these actions restricting increased use of groundwater have had beneficial impacts. However, ministerial projects (such as a single family home on a parcel without any other development, or Track II replants) were not so regulated, nor were existing (pre-1999) water users regulated.

In 2014 construction commenced on a pipeline that will deliver tertiary treated recycled waste water to the MST Subarea. It is expected that customers for approximately 400 acre-feet of recycled water will commence receiving deliveries upon completion of the pipeline in 2016. The pipeline capacity allows for delivery of up to 2,000 acre-feet of water. If customer demand for the recycled water increases, as anticipated, this new source of supply may further offset demand for groundwater in the subarea. Continued monitoring of groundwater levels is required to determine if these actions are sufficient.

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FIGURES

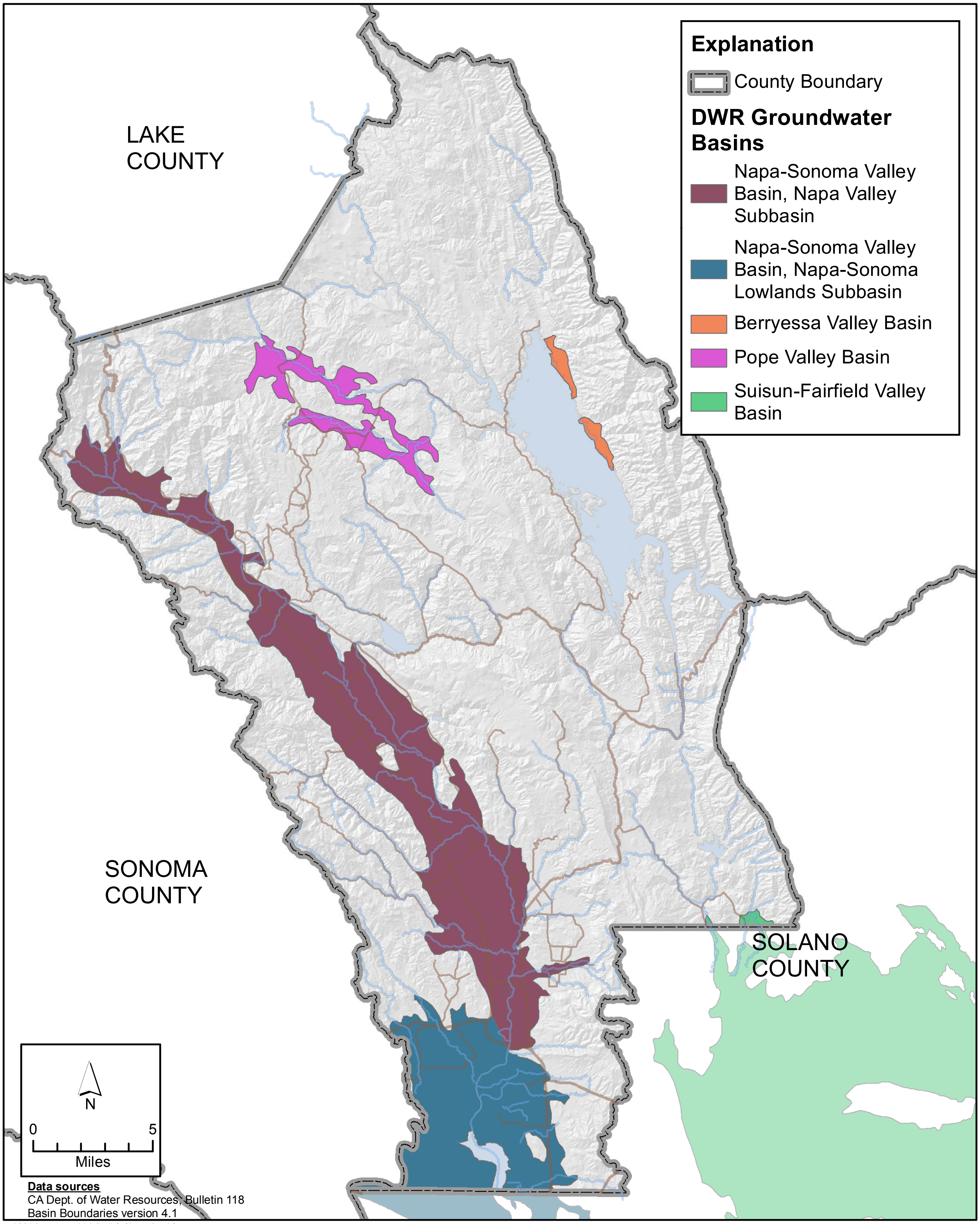

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FIGURE ES-1

Napa County Groundwater Basins

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

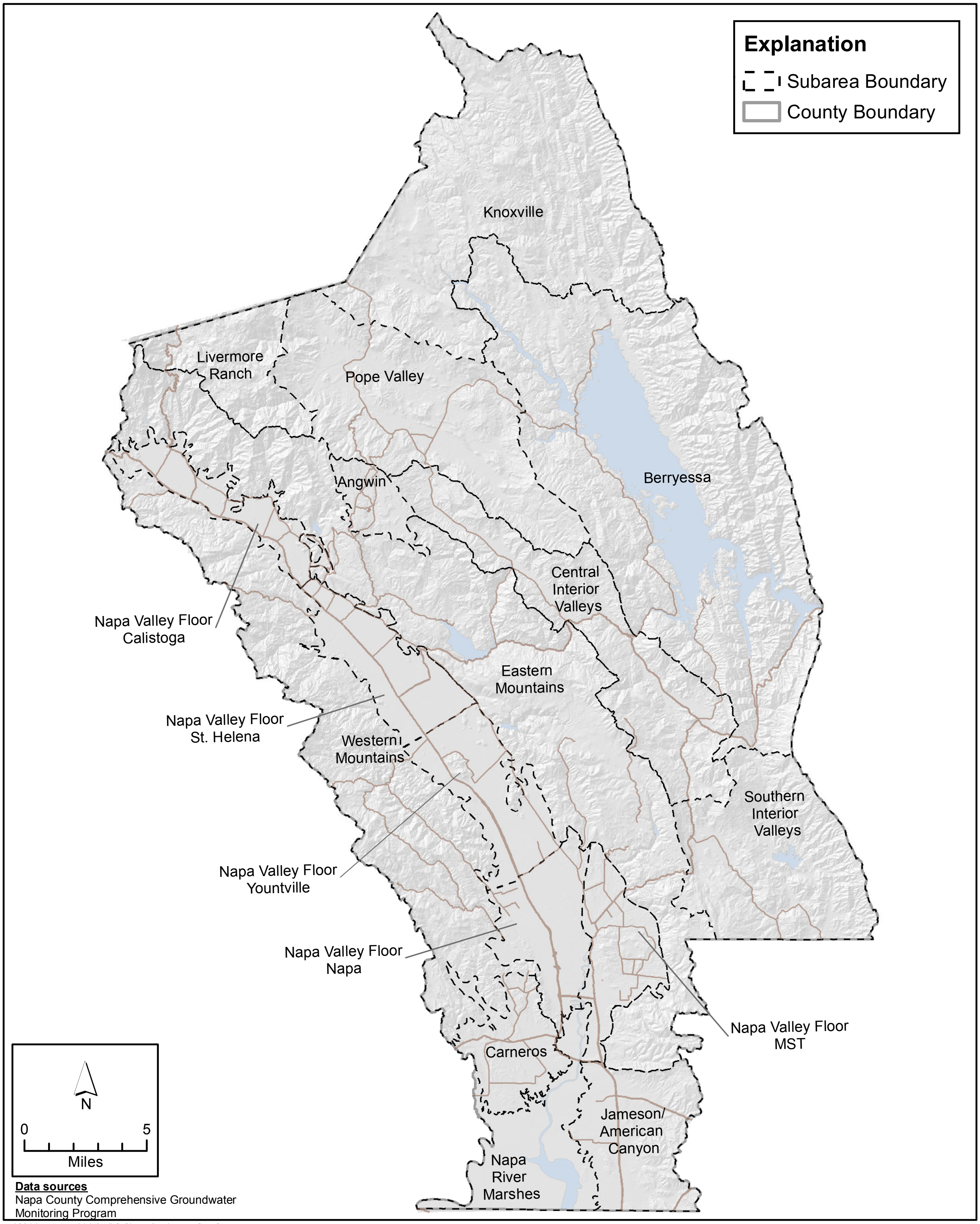

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FIGURE ES-2

Napa County Groundwater Subareas

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

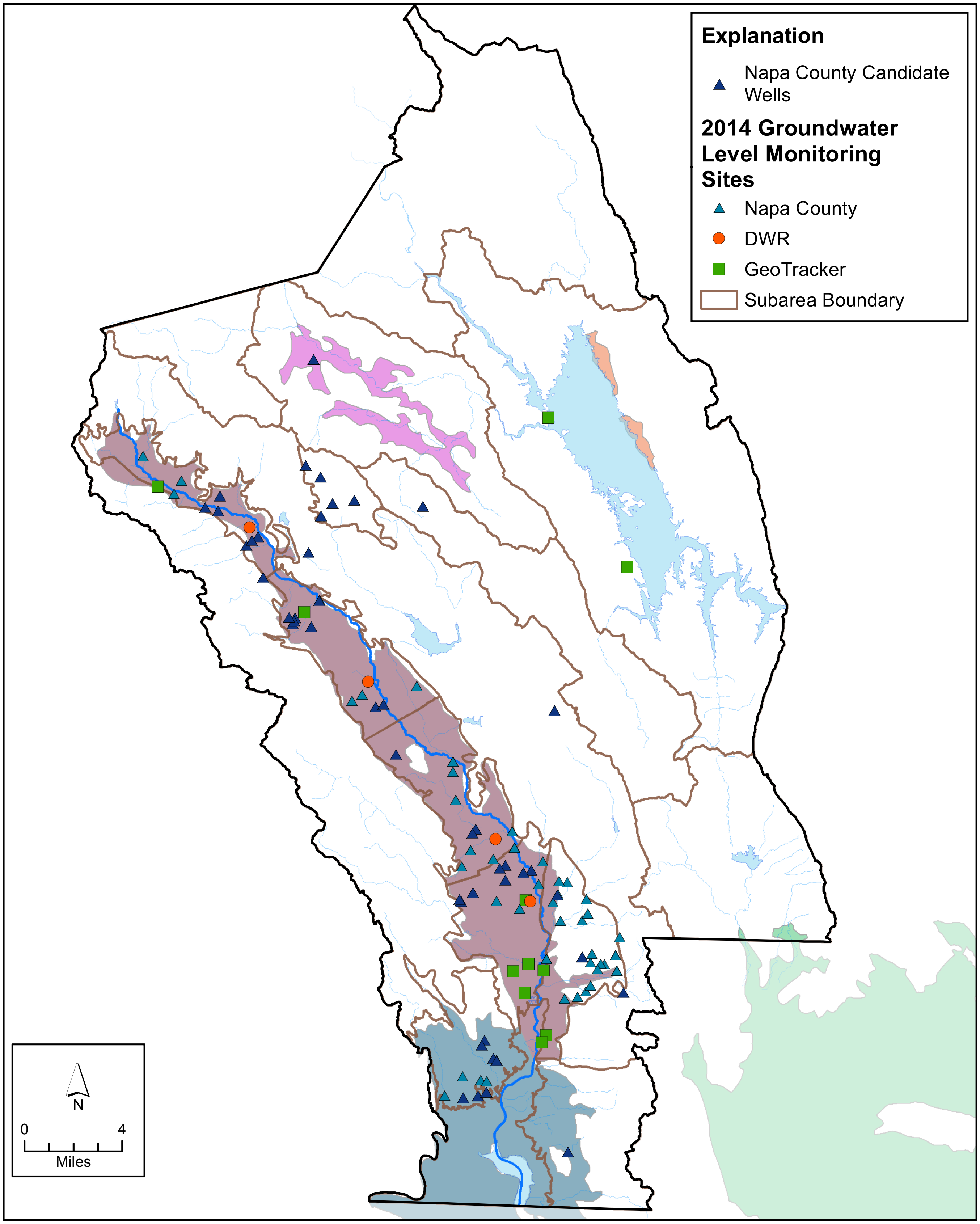

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FIGURE ES-3
Current Groundwater Level Monitoring Sites in Napa County, by Entity and Program

Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

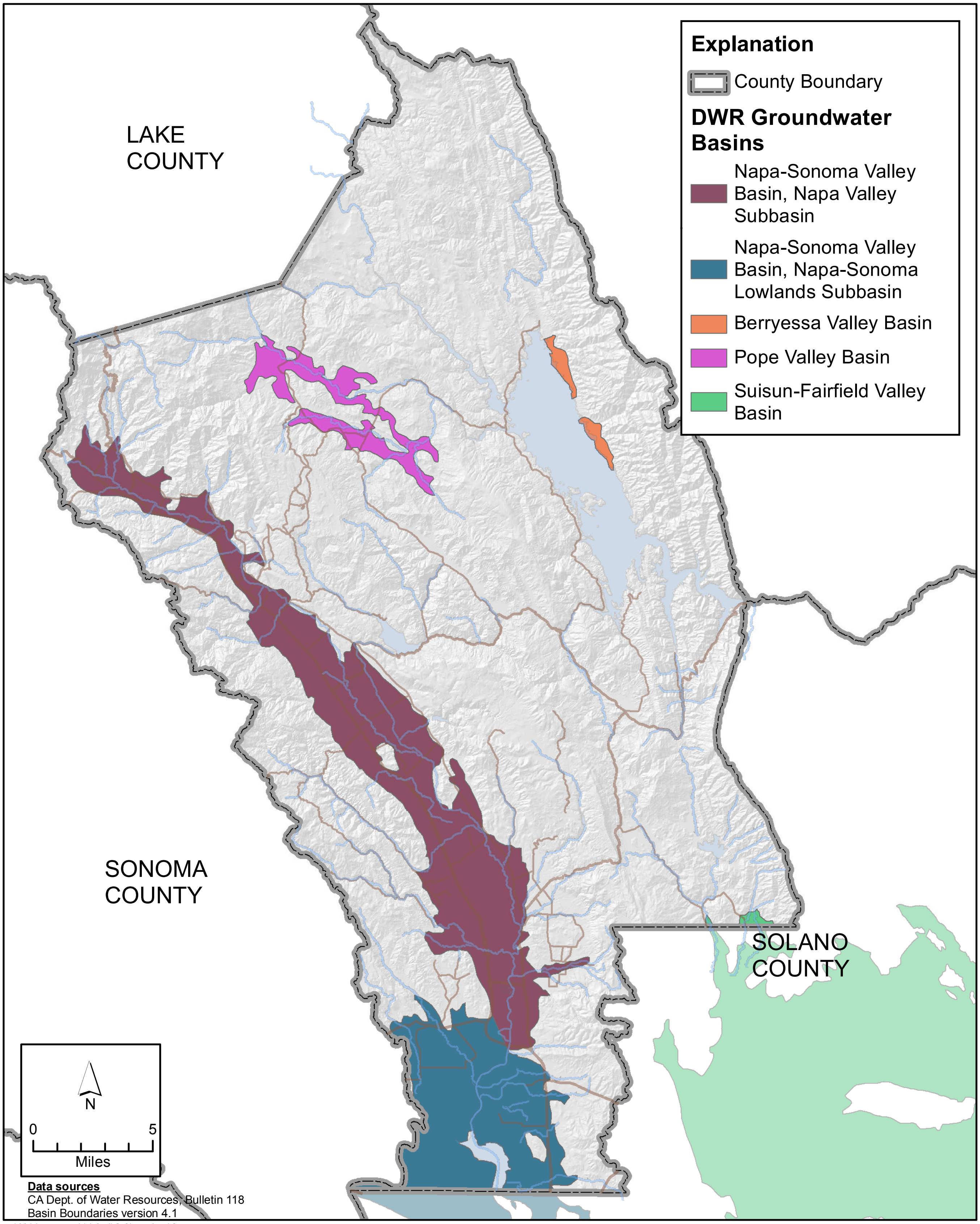

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FIGURE 2-1

Napa County Groundwater Basins

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

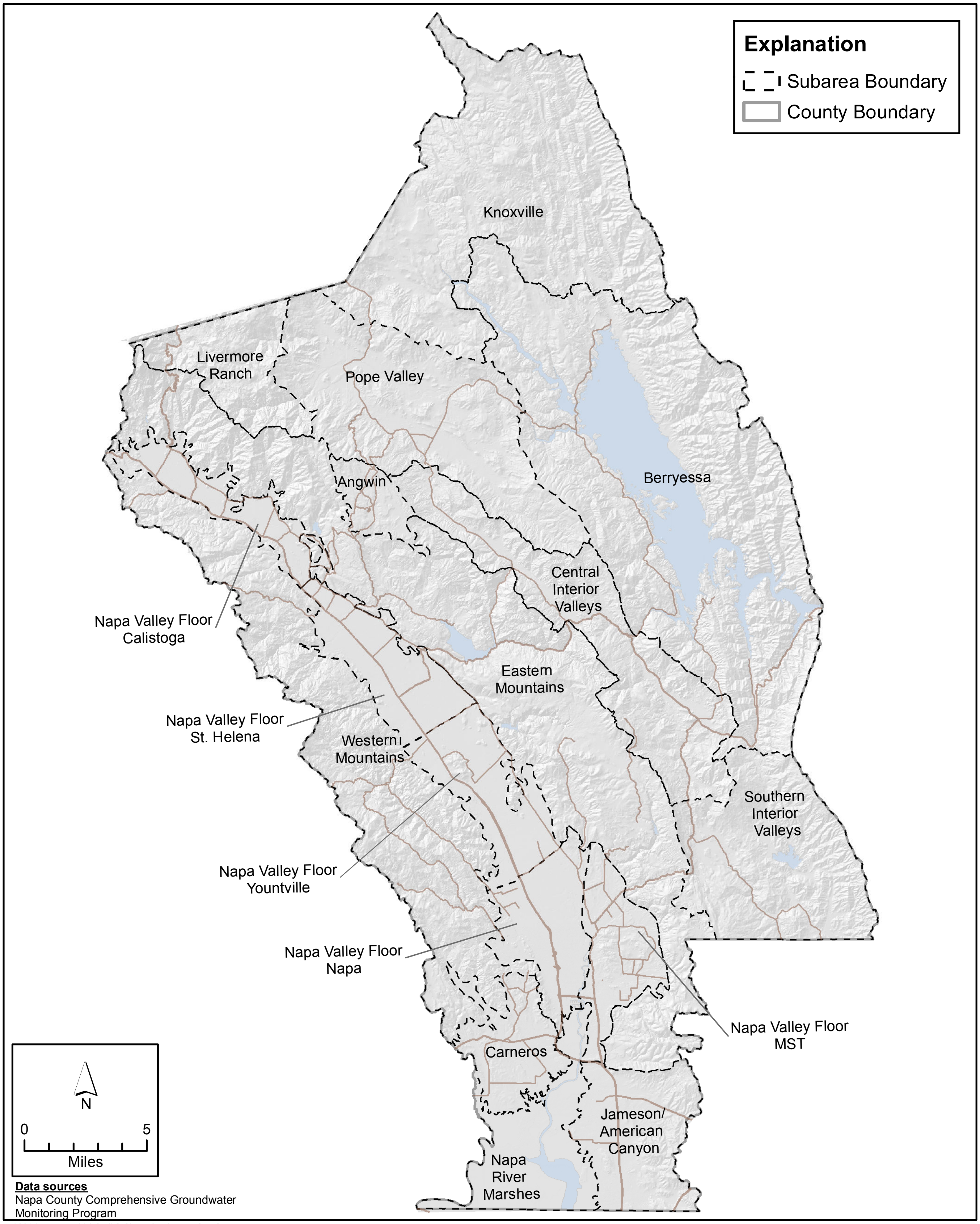

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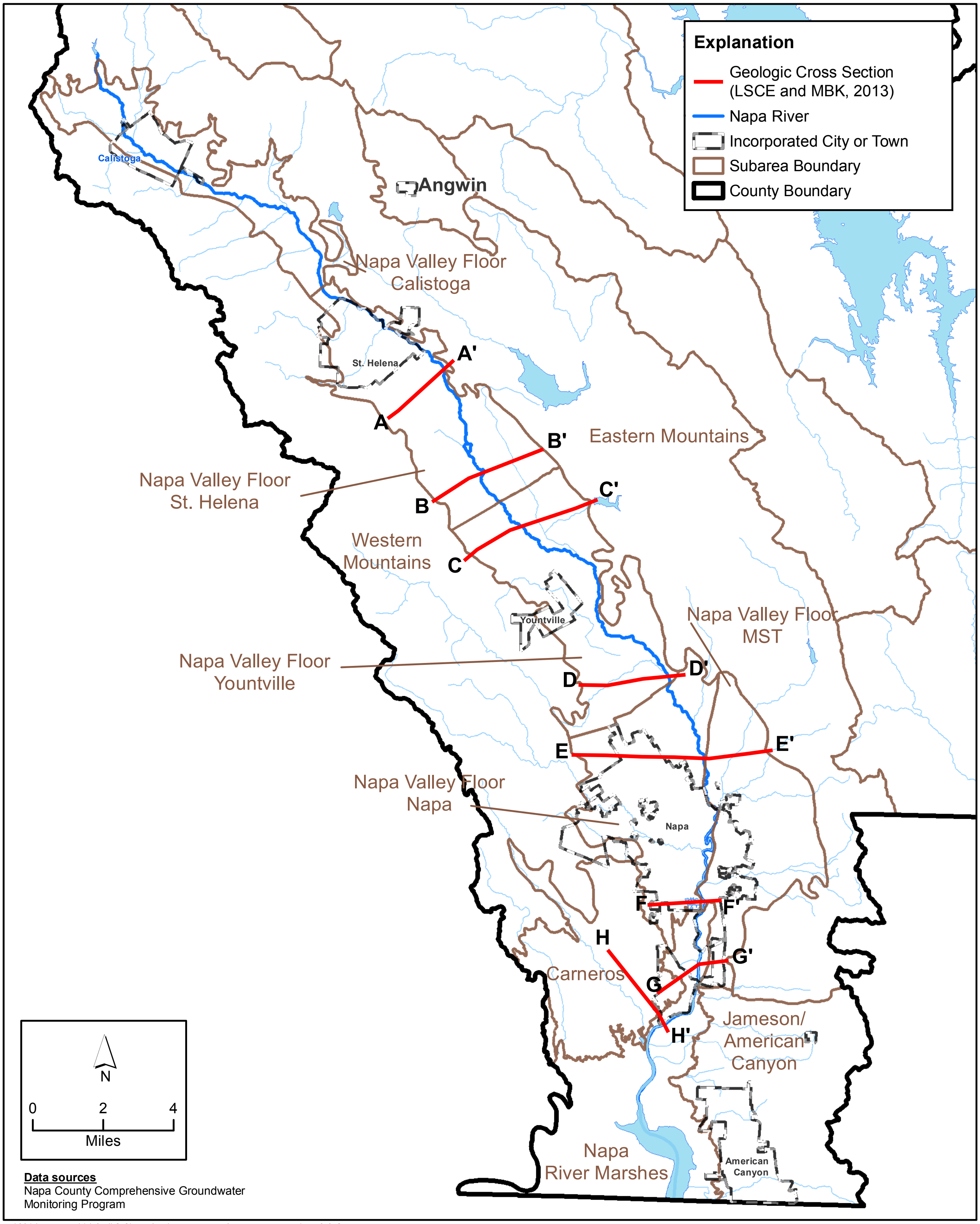
FIGURE 2-2

Napa County Groundwater Subareas

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update



Data sources
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FIGURE 2-3

Geologic Cross Section Location Map

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

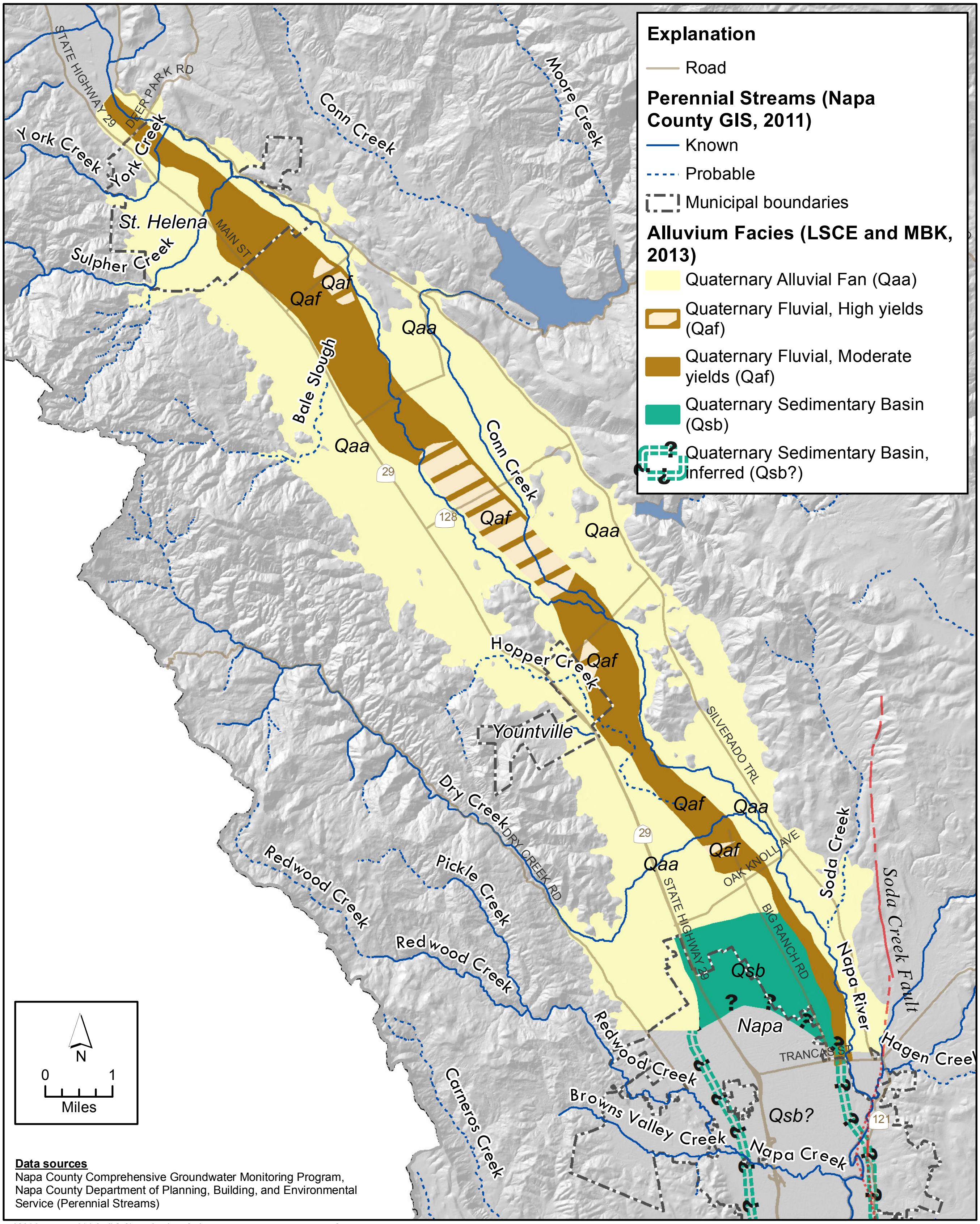

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FIGURE 2-4
Perennial Surface Watercourses and Alluvium Facies, Napa Valley Floor

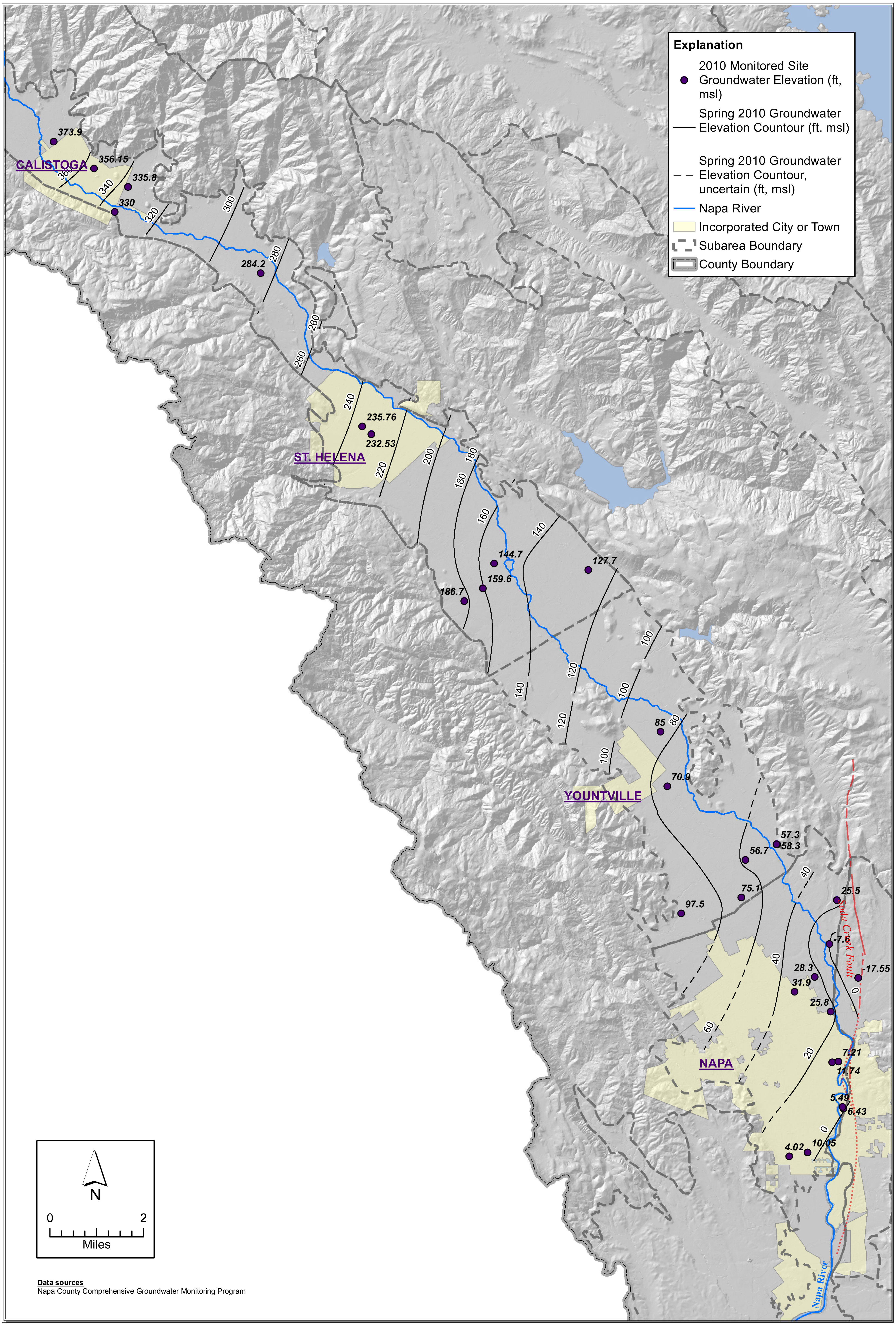

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FIGURE 2-5
Contours of Equal Groundwater Elevation Napa Valley, Spring 2010

Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

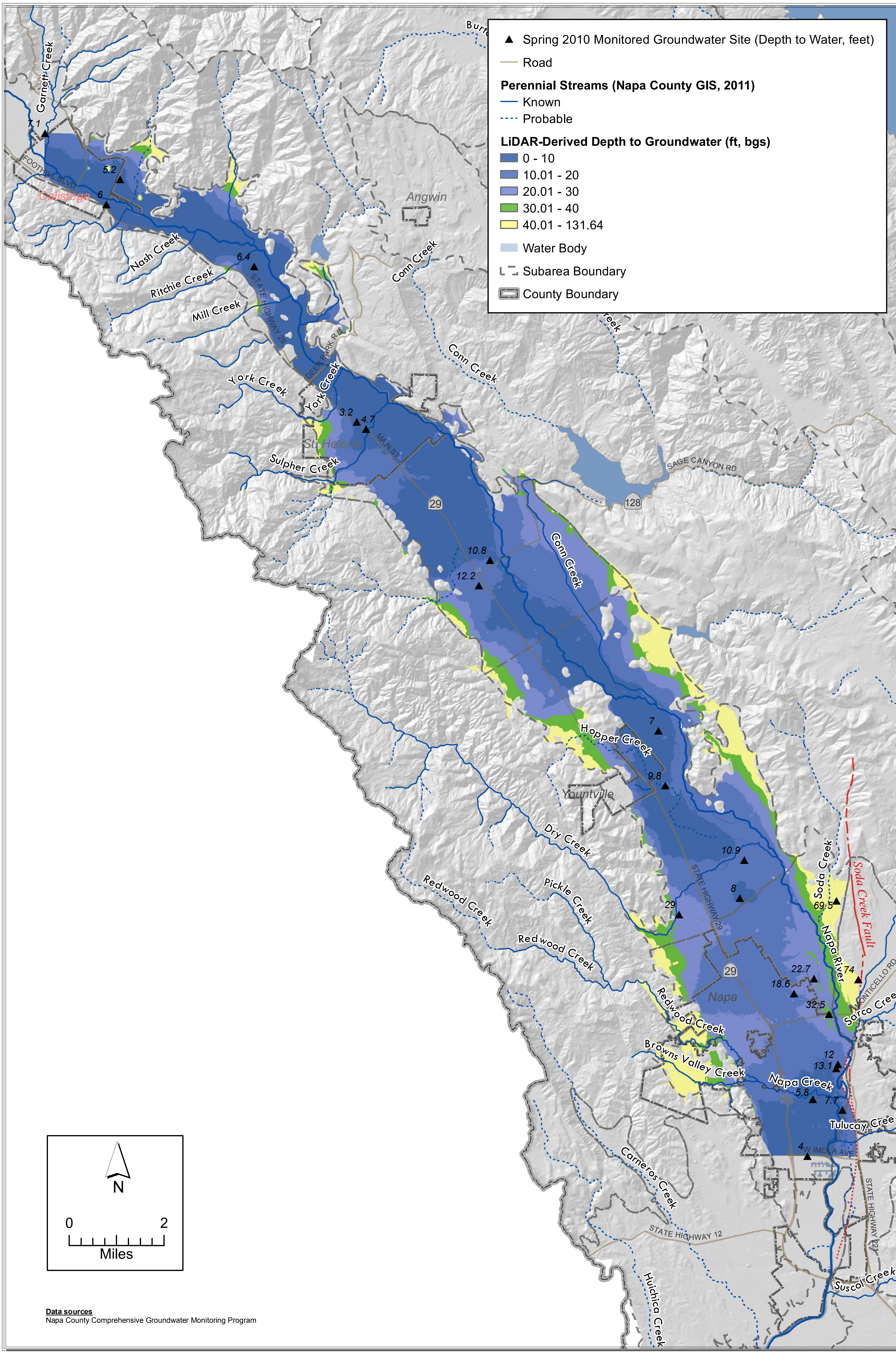

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FIGURE 2-6
Spring 2010 Calculated Depth to Groundwater, Napa Valley Floor

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

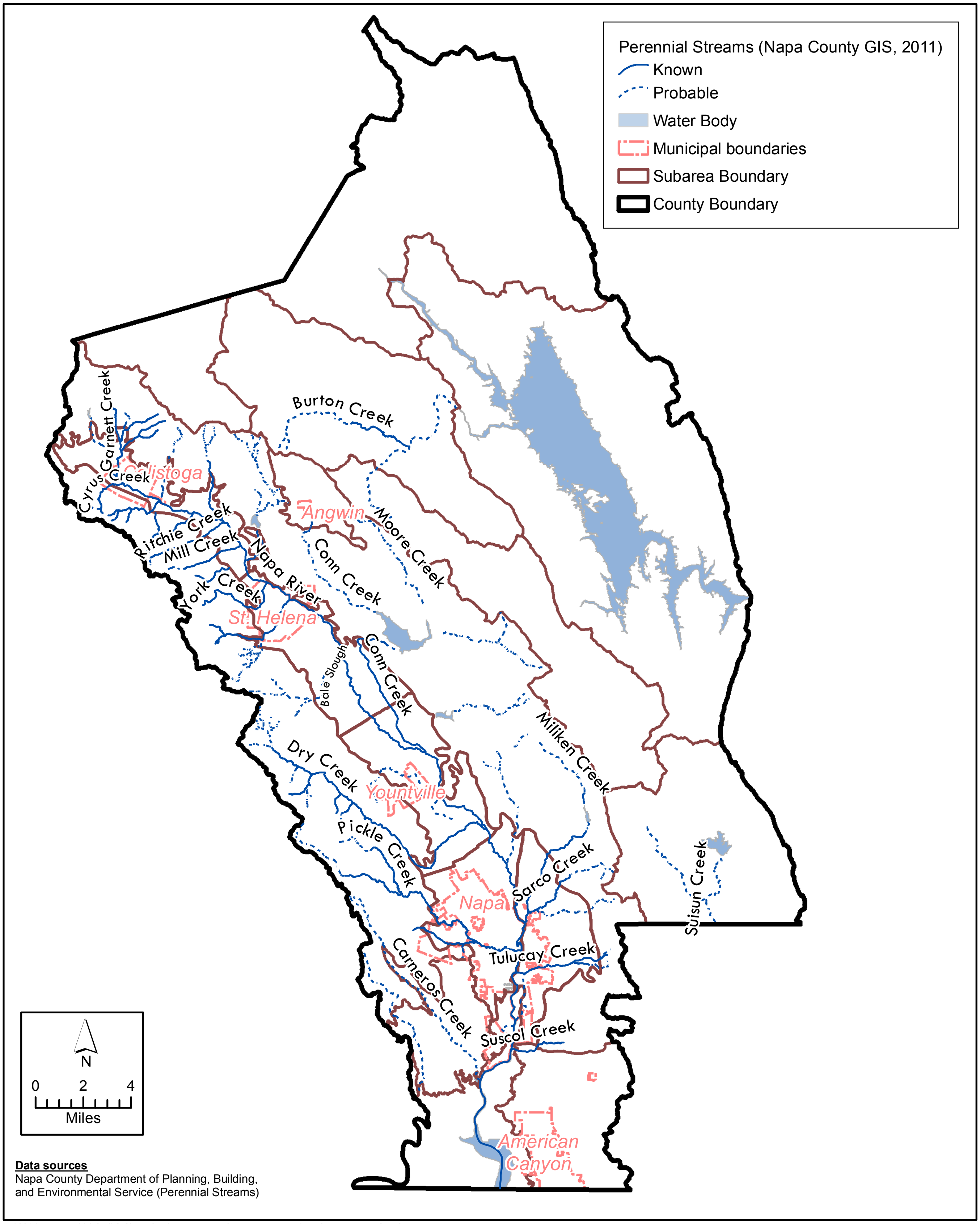

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FIGURE 2-7
Known and Probable Perennial Surface Water Courses in Napa County

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

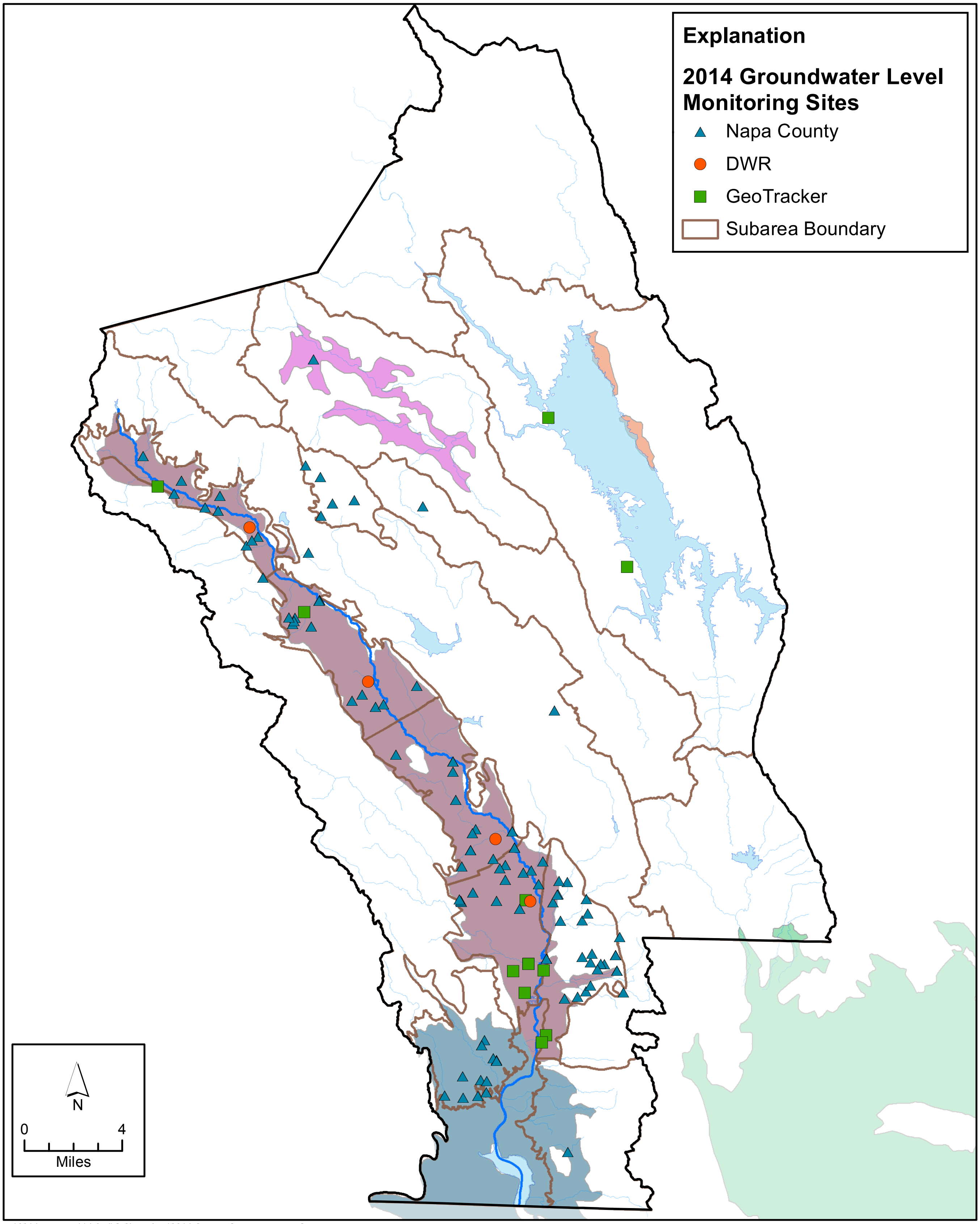

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FIGURE 2-8
Current Groundwater Level Monitoring Sites in Napa County, by Entity and Program

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

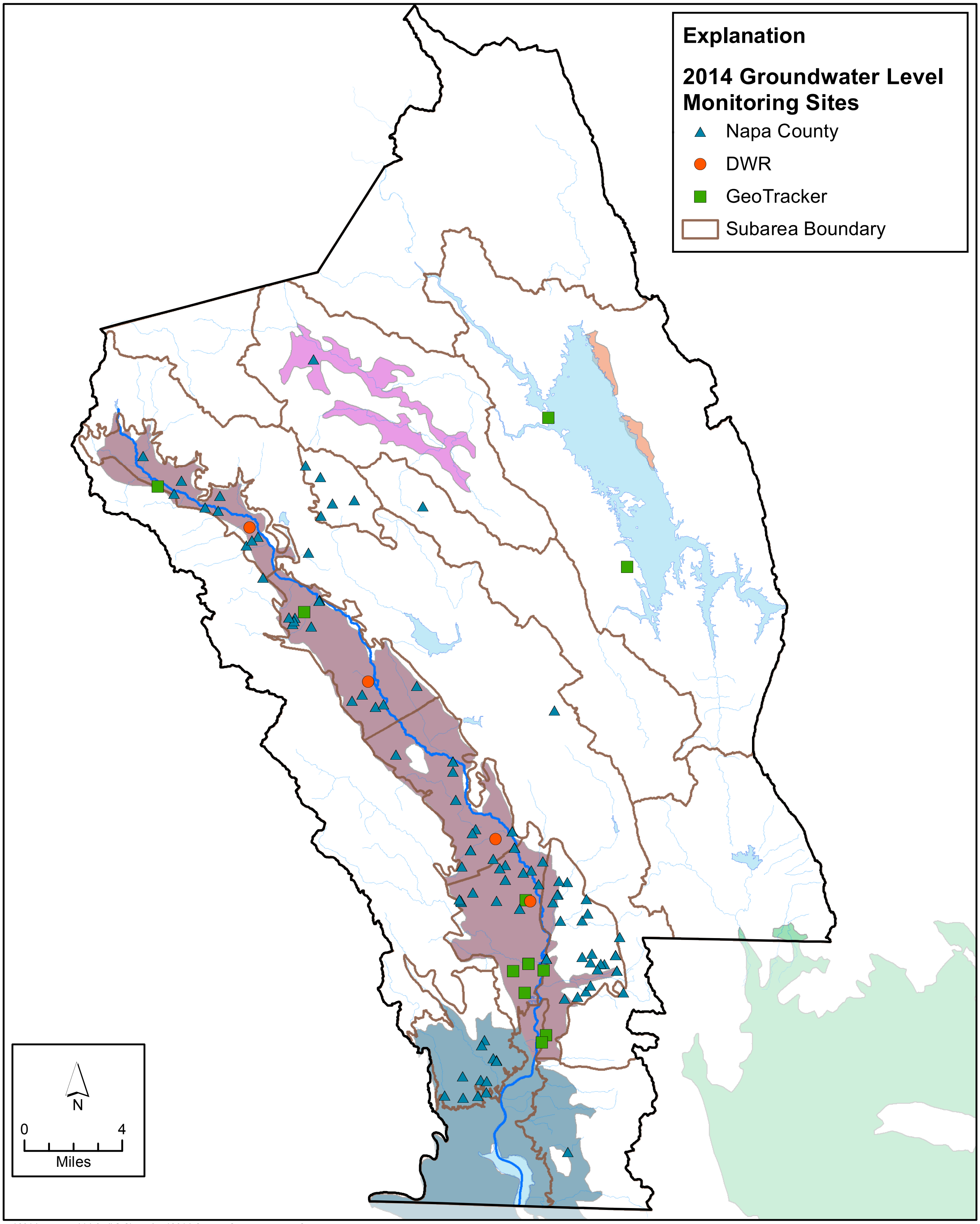

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FIGURE 4-1
Current Groundwater Level Monitoring Sites in Napa County, by Entity and Program

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

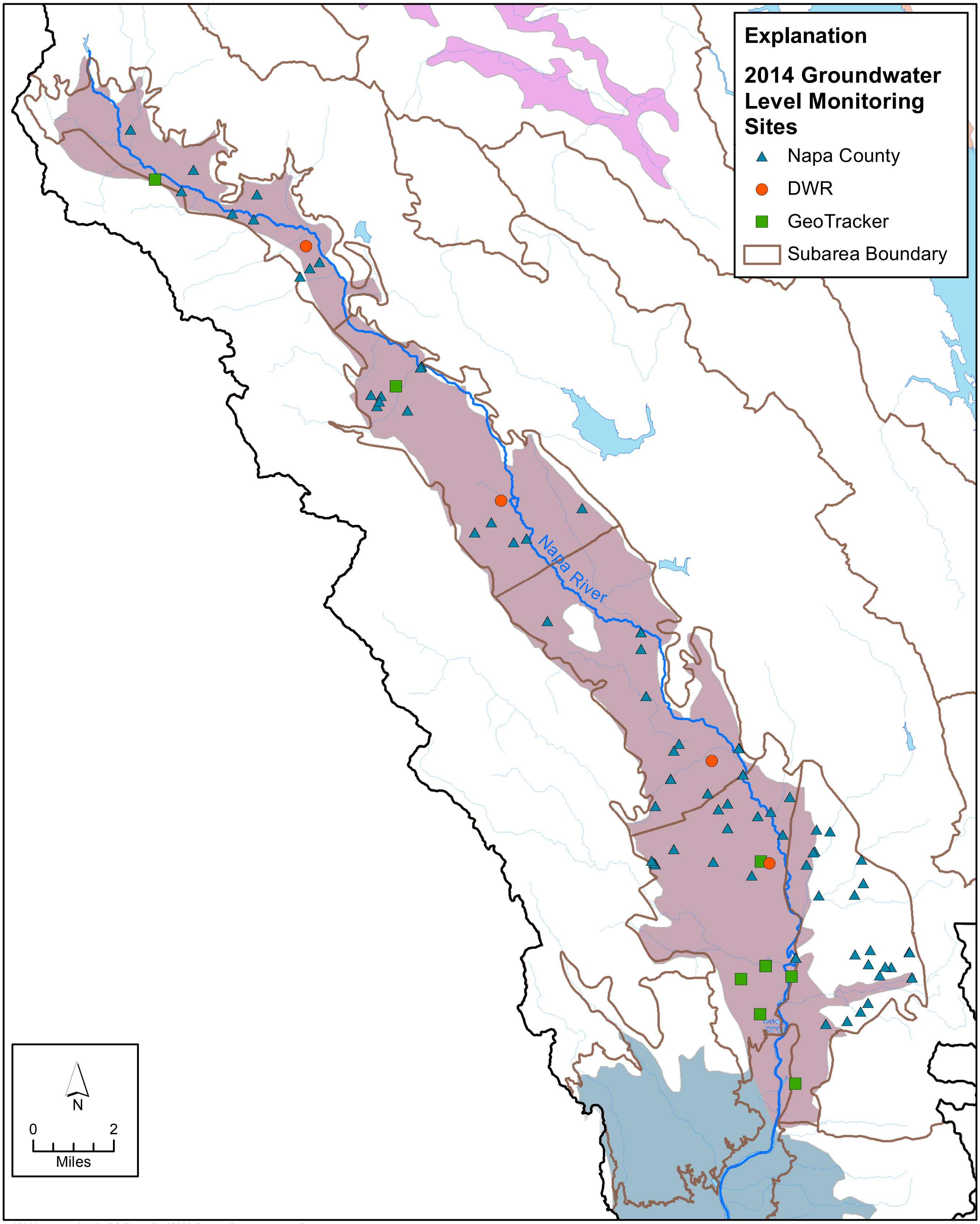

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FIGURE 4-2
Current Groundwater Level Monitoring Sites in Napa Valley Floor, by Entity and Program

Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

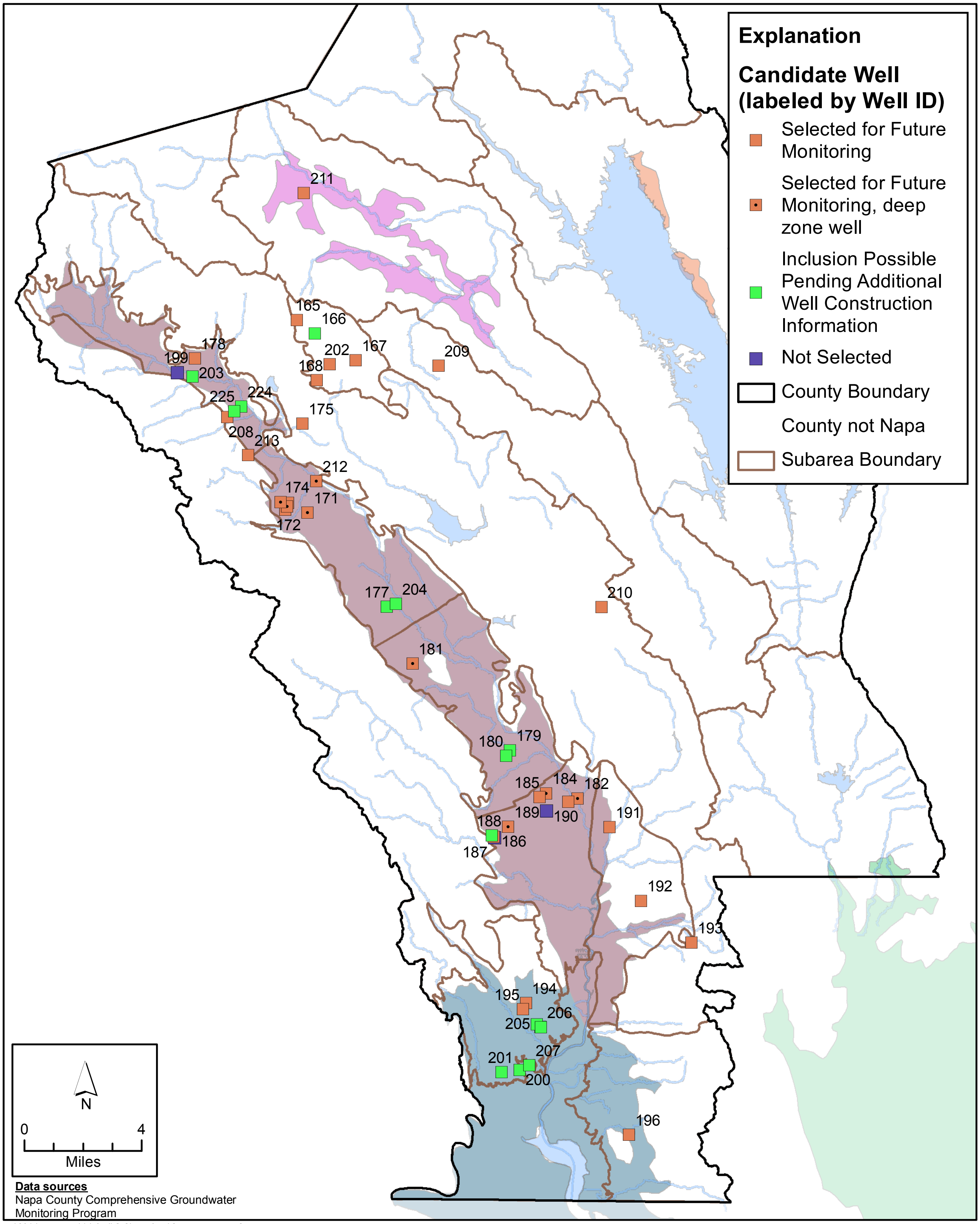

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FIGURE 4-3
2013 and 2014 Volunteered Wells and Recommendations for Future Monitoring

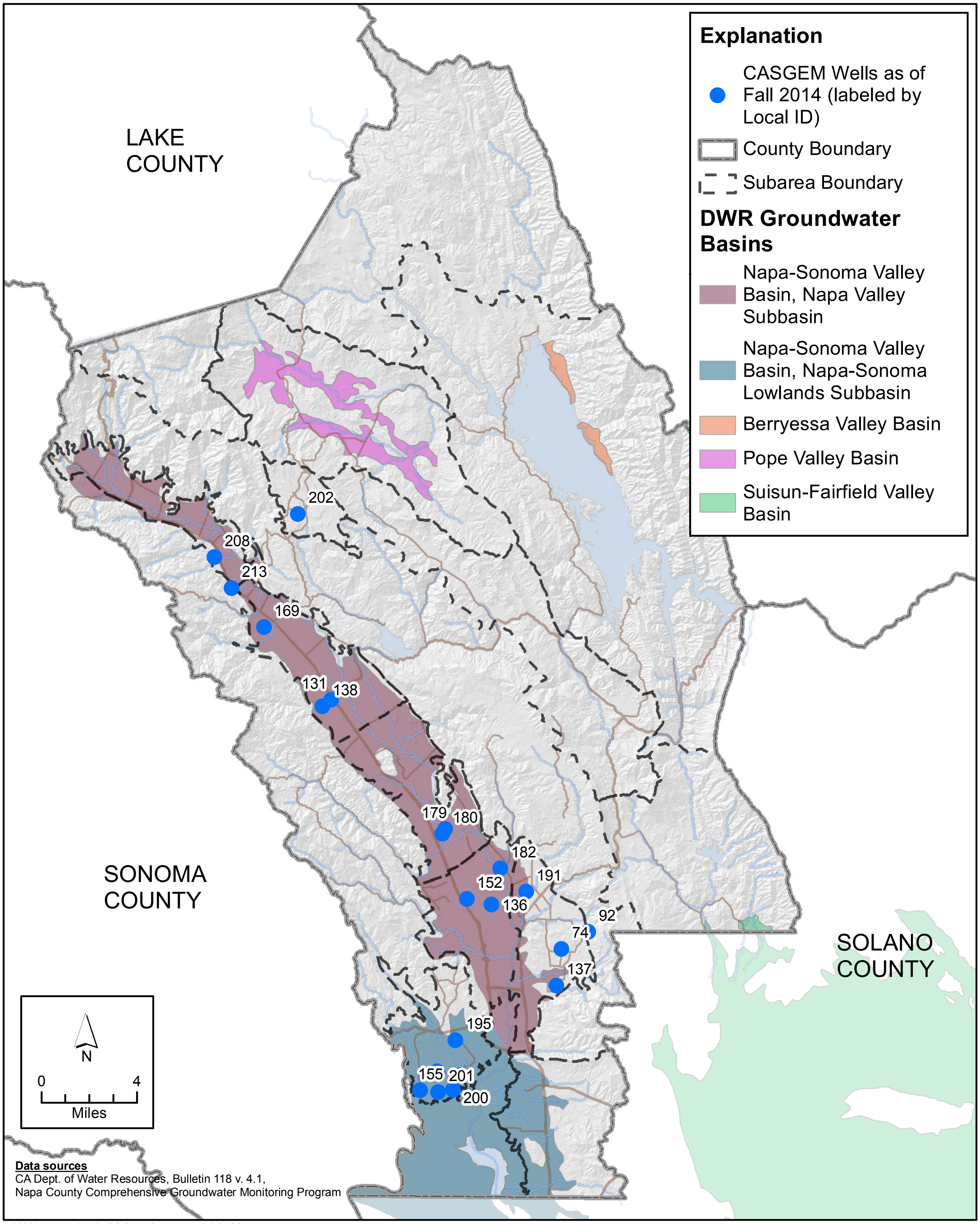

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FIGURE 4-4
Well Location Map for CASGEM Program, Napa County, CA

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

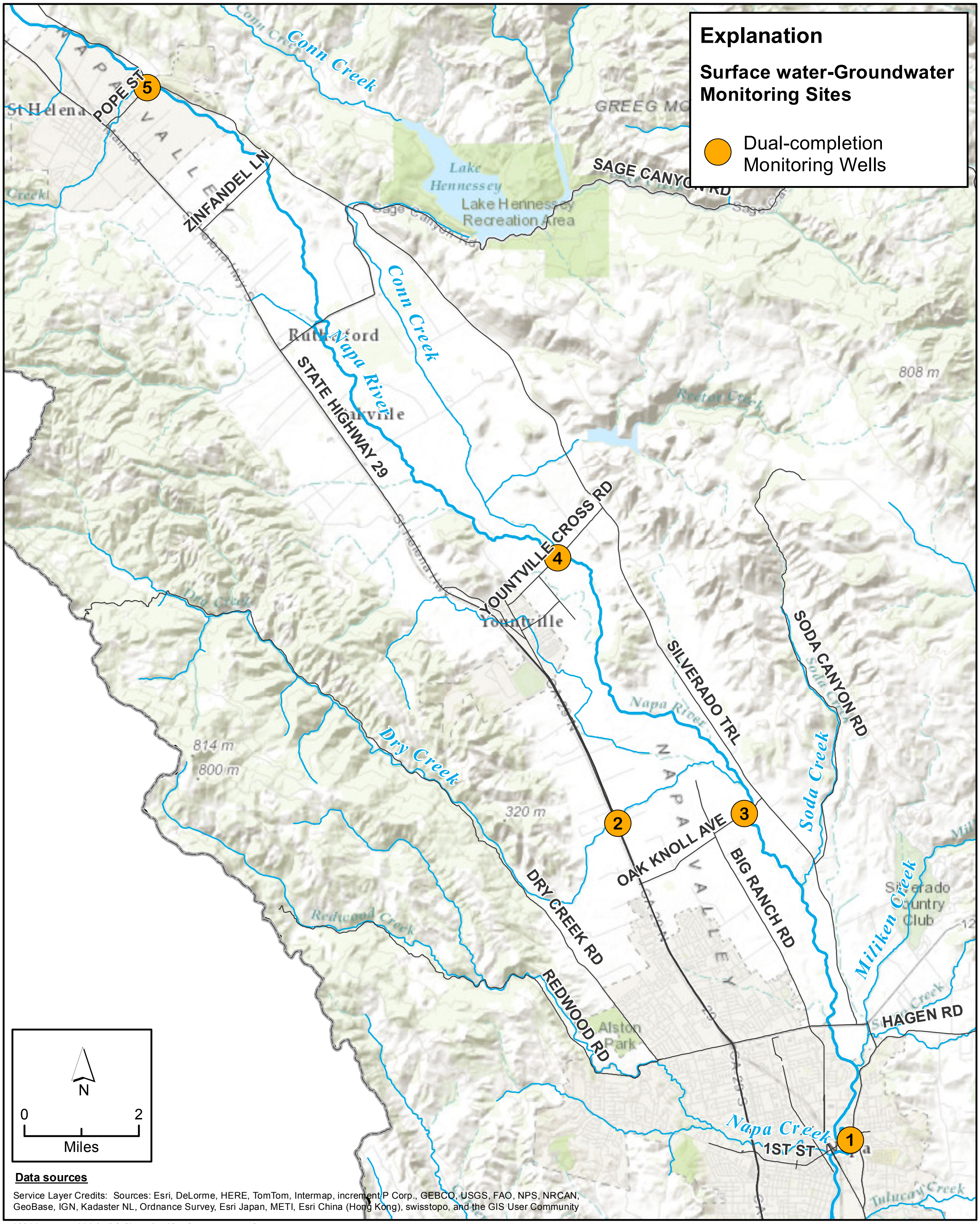

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FIGURE 4-5
Napa County Surface Water-Groundwater Monitoring Sites

Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

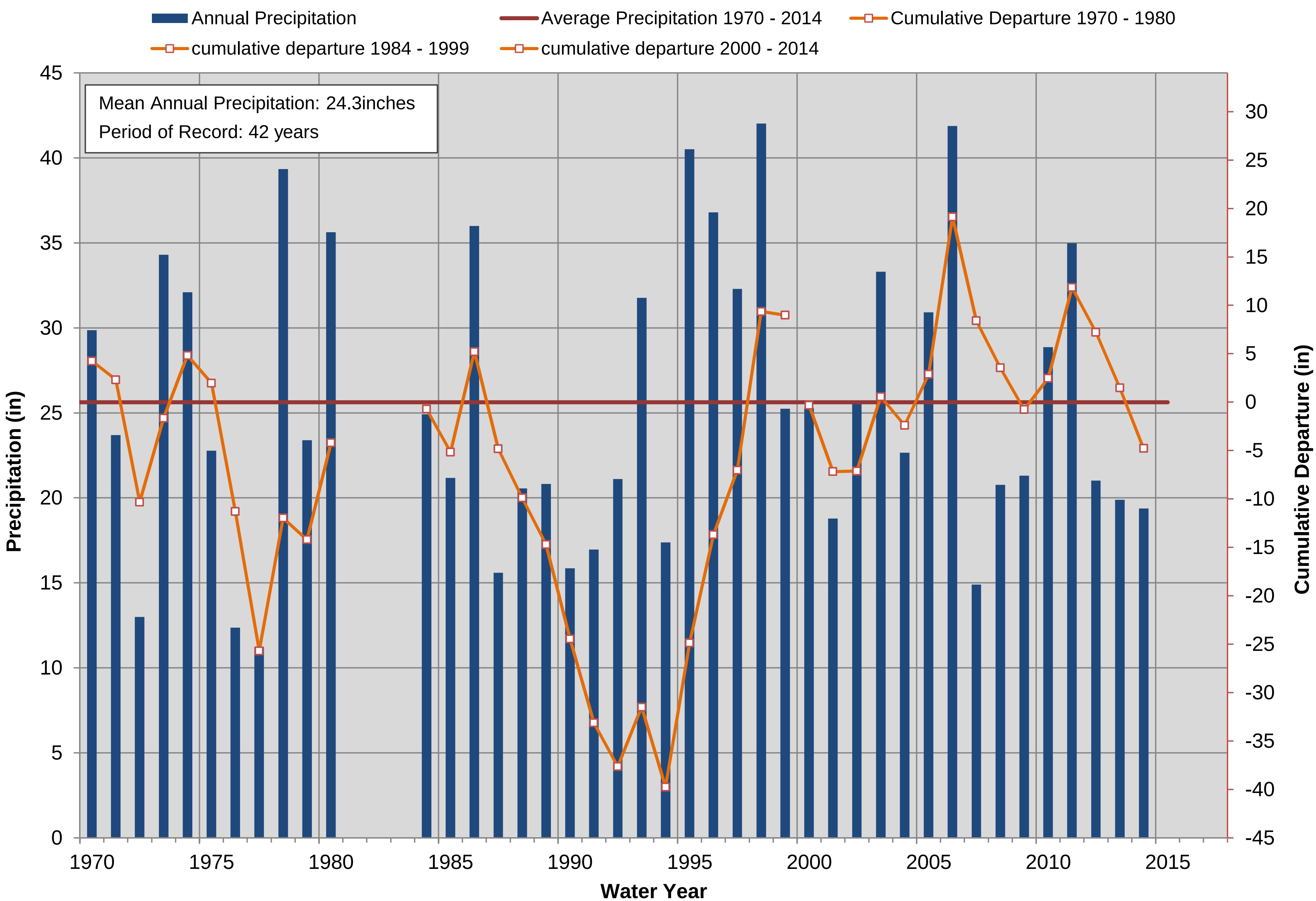

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Figure 5-1

Napa State Hospital Annual Precipitation and Cumulative Departure (CDEC: NSH)

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

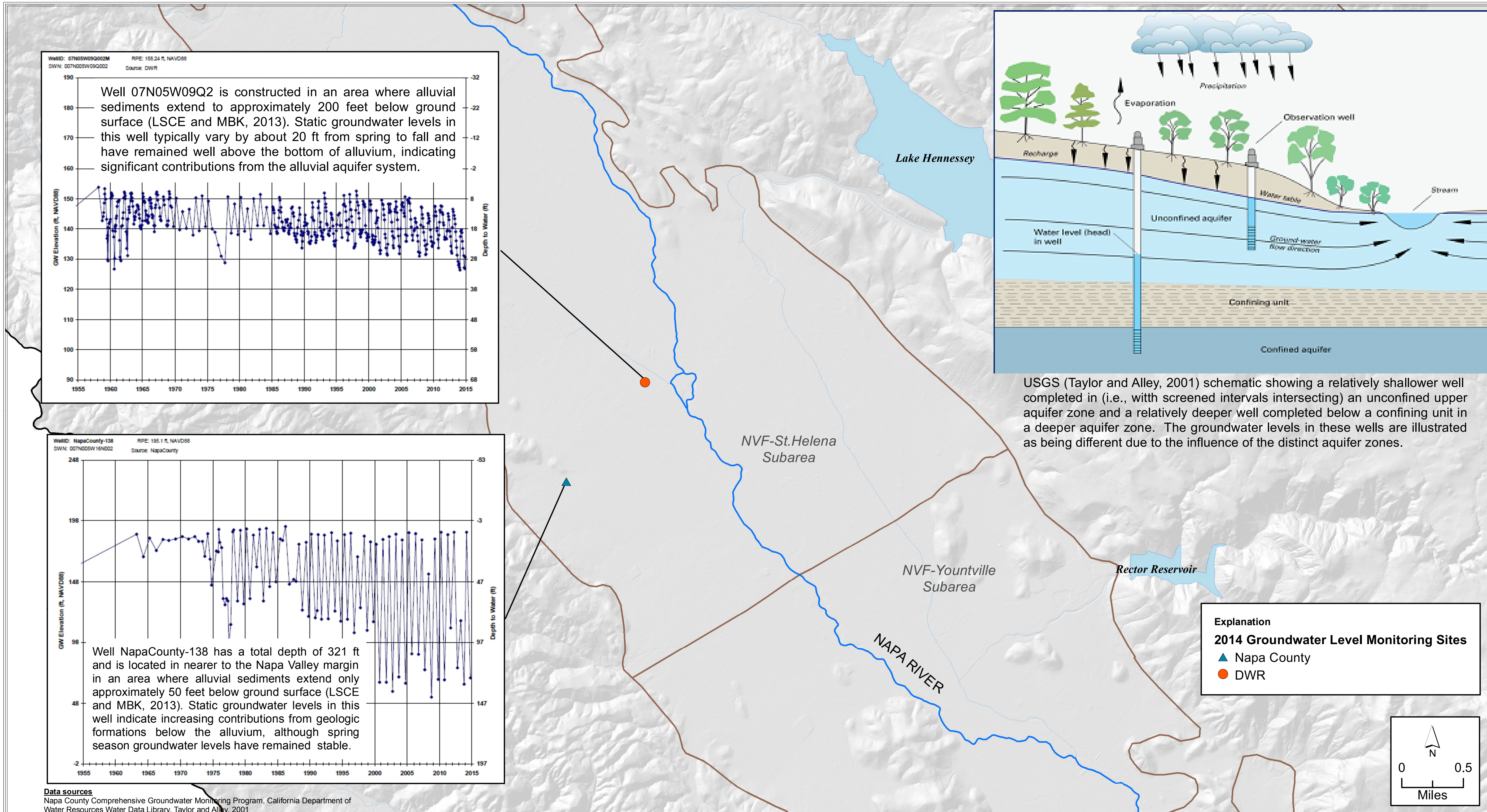

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FIGURE 5-2

Southern St. Helena Subarea Aquifer Zone Schematic and Representative Hydrographs

Napa County Comprehensive Groundwater Monitoring Program 2014 Annual Report and CASGEM Update

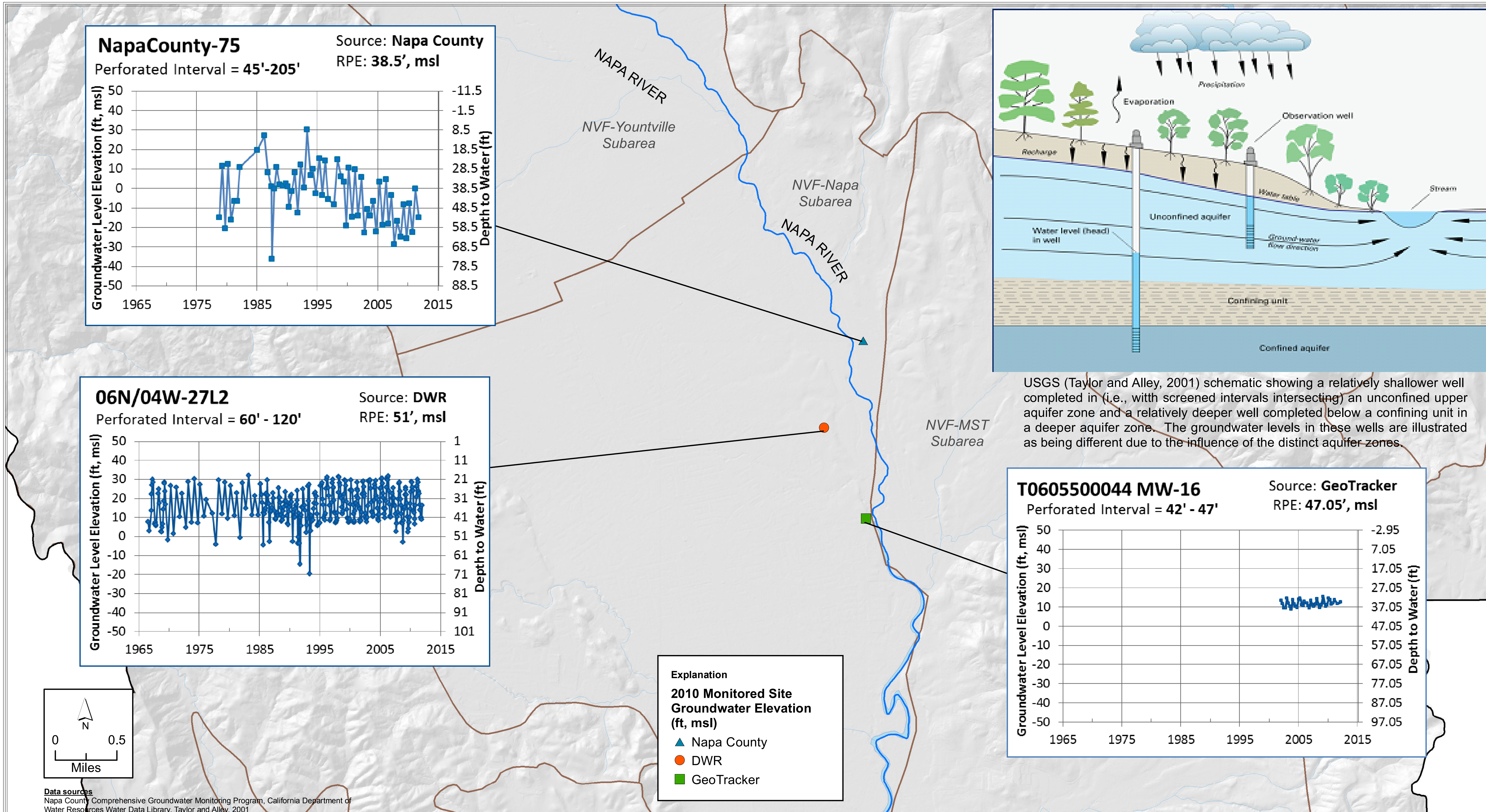

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FIGURE 5-3

Northeast Napa Subarea Aquifer Zone Schematic and Representative Hydrographs

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

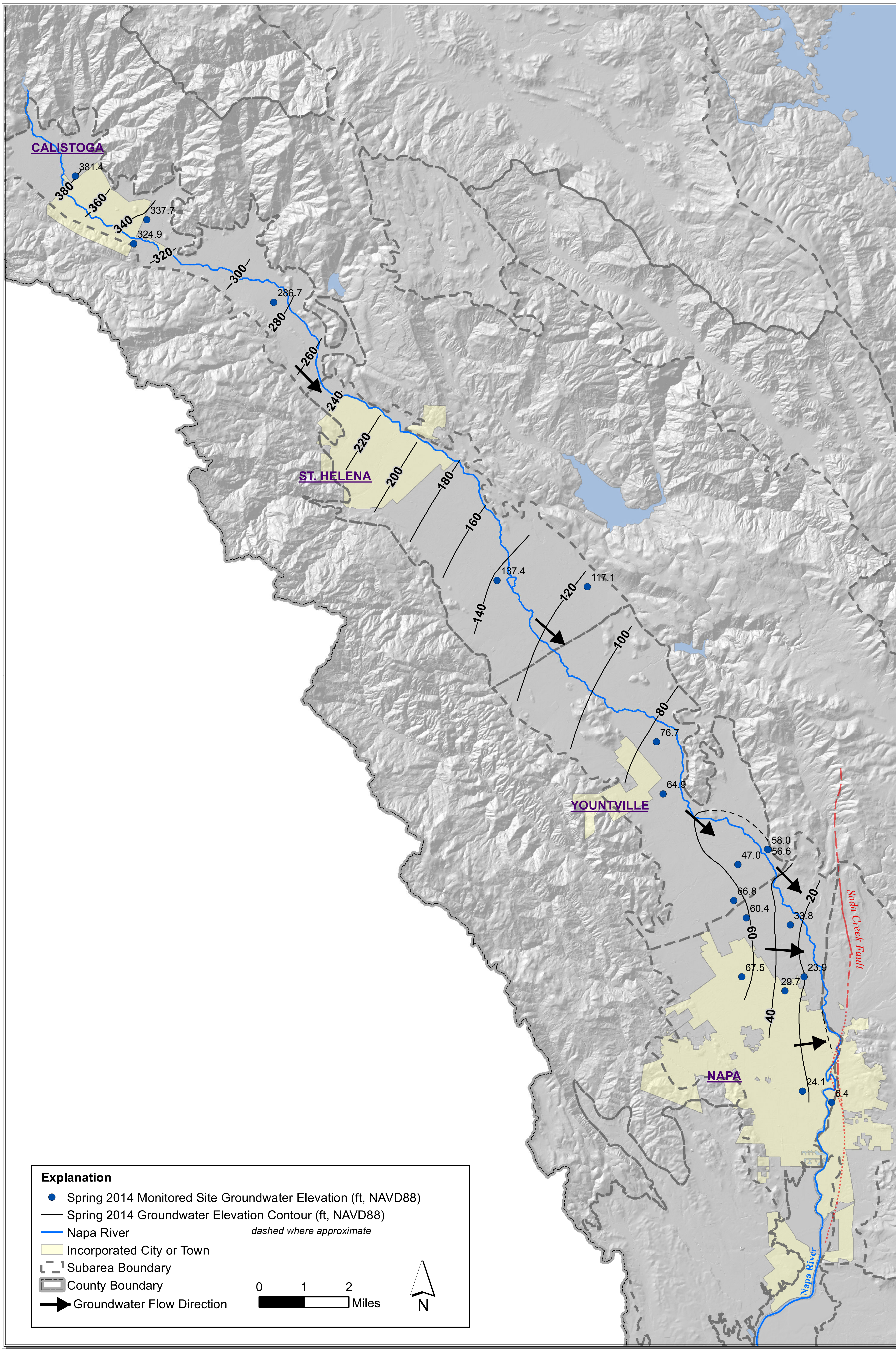

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FIGURE 5-4
Contours of Equal Groundwater Elevation
Napa Valley, Spring 2014

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

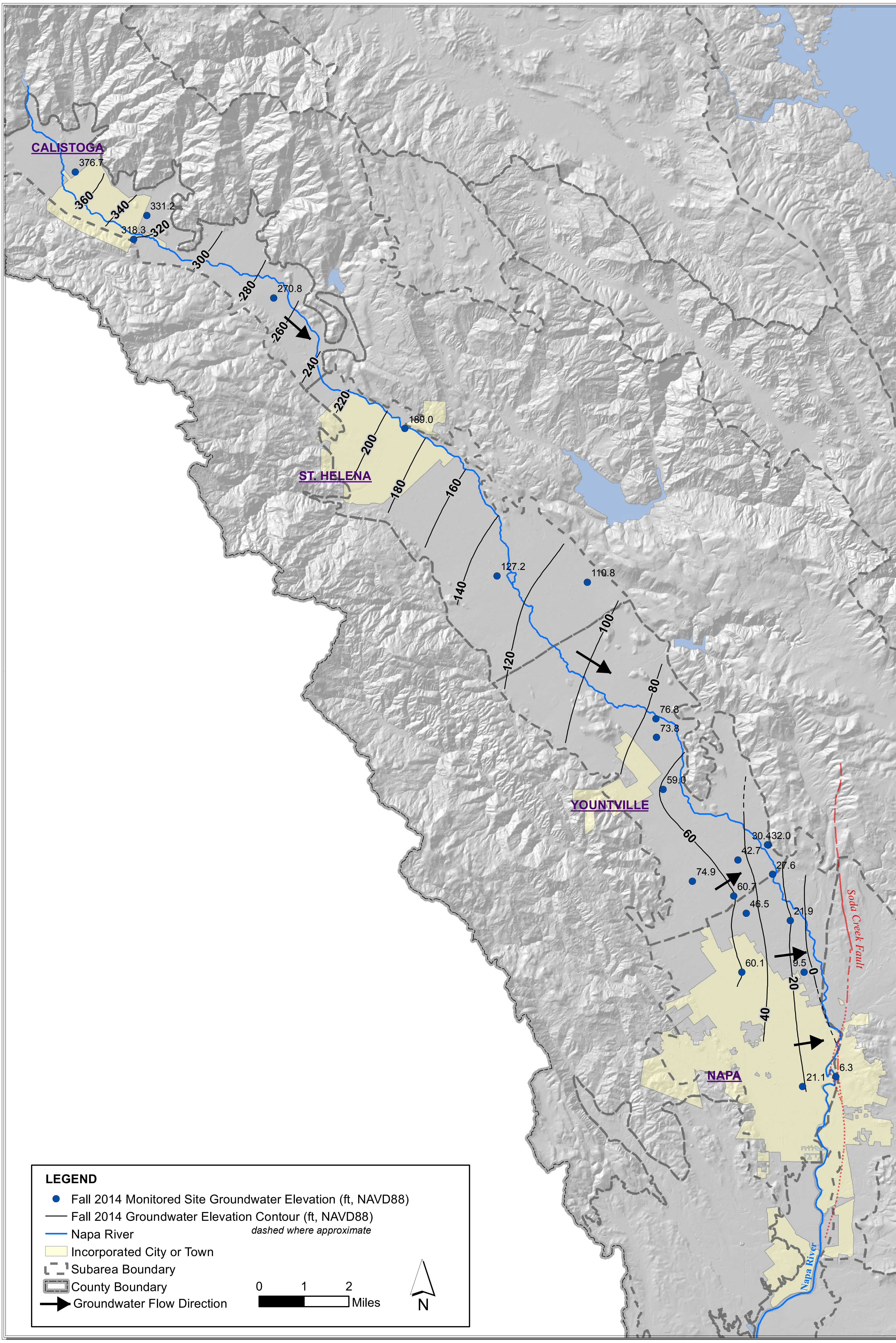

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FIGURE 5-5
Contours of Equal Groundwater Elevation
Napa Valley Floor, Fall 2014

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

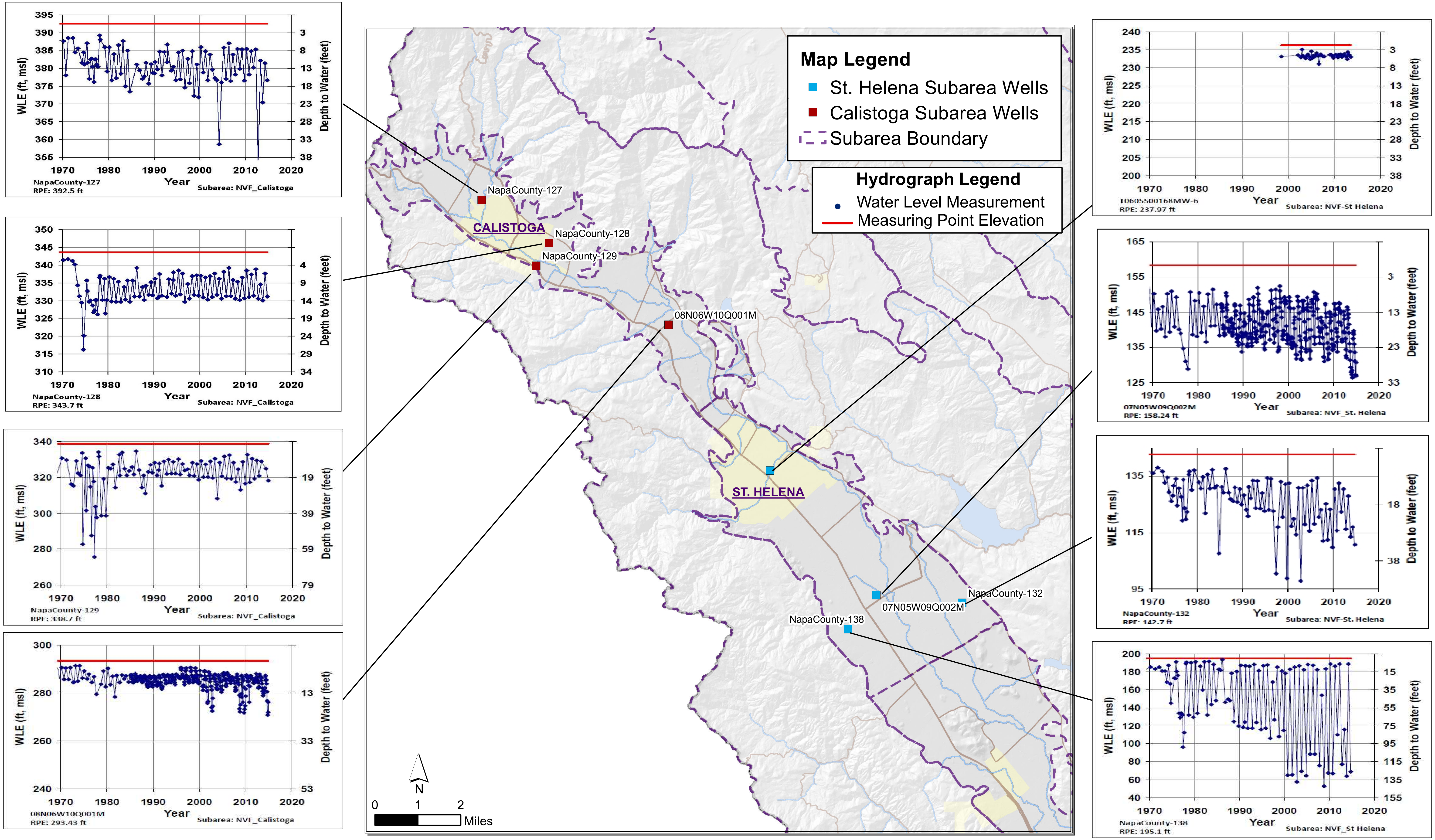

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FIGURE 5-6
Representative Groundwater Hydrographs Northern Napa Valley

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

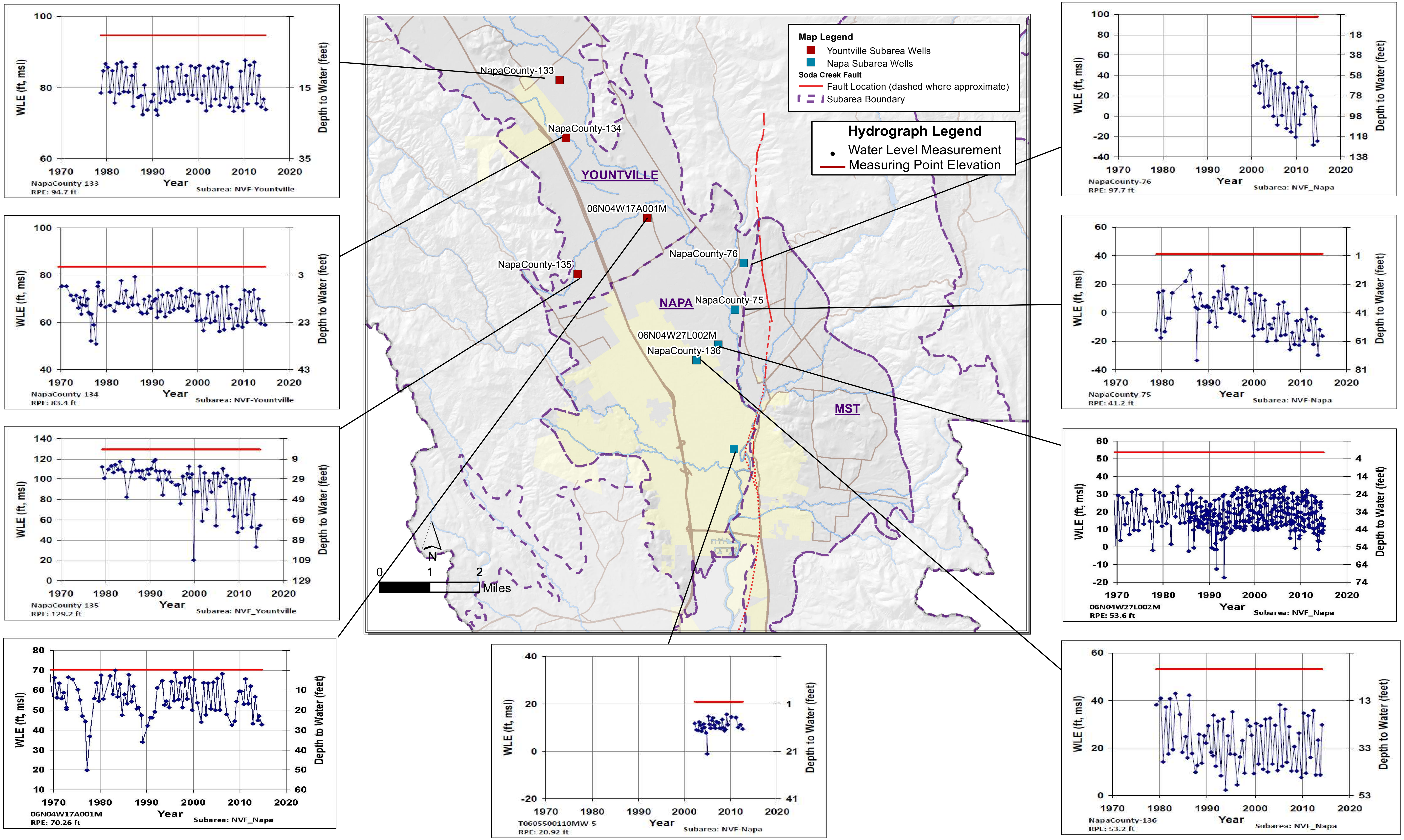

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FIGURE 5-7
Representative Groundwater Hydrographs Southern Napa Valley

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

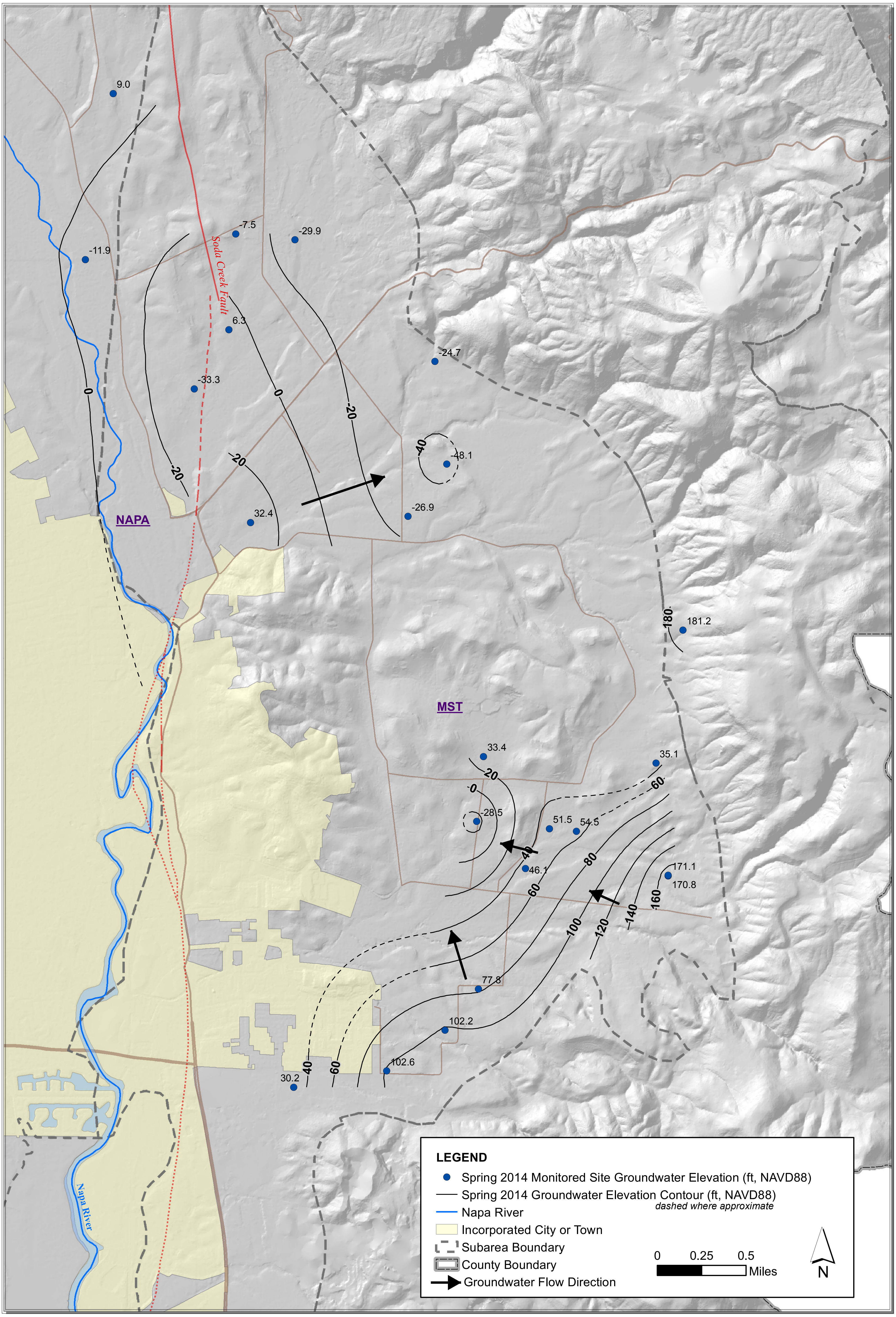

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FIGURE 5-8
Contours of Equal Groundwater Elevation
MST Subarea, Spring 2014

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

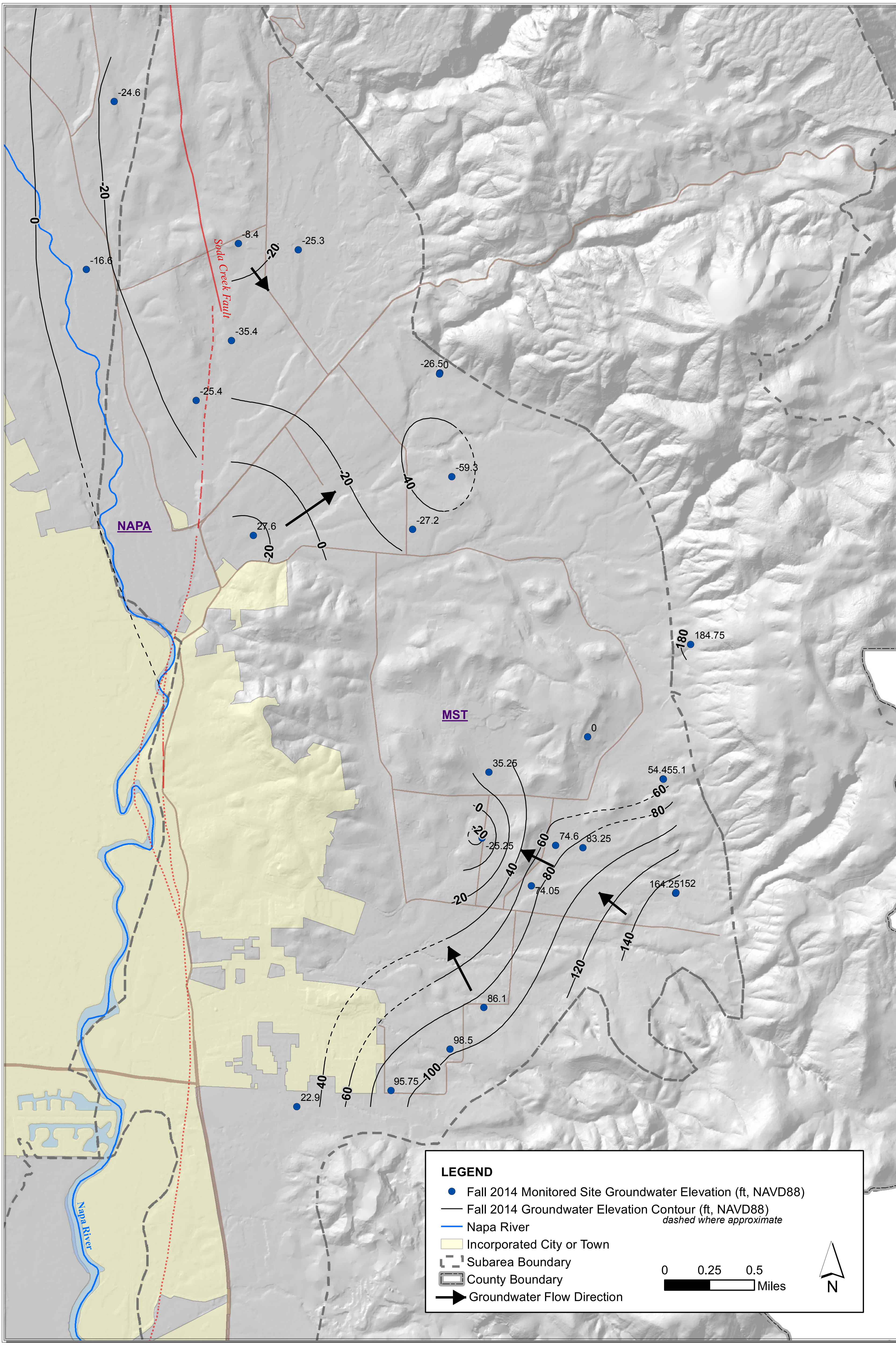

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FIGURE 5-9
Contours of Equal Groundwater Elevation
MST Subarea, Fall 2014

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

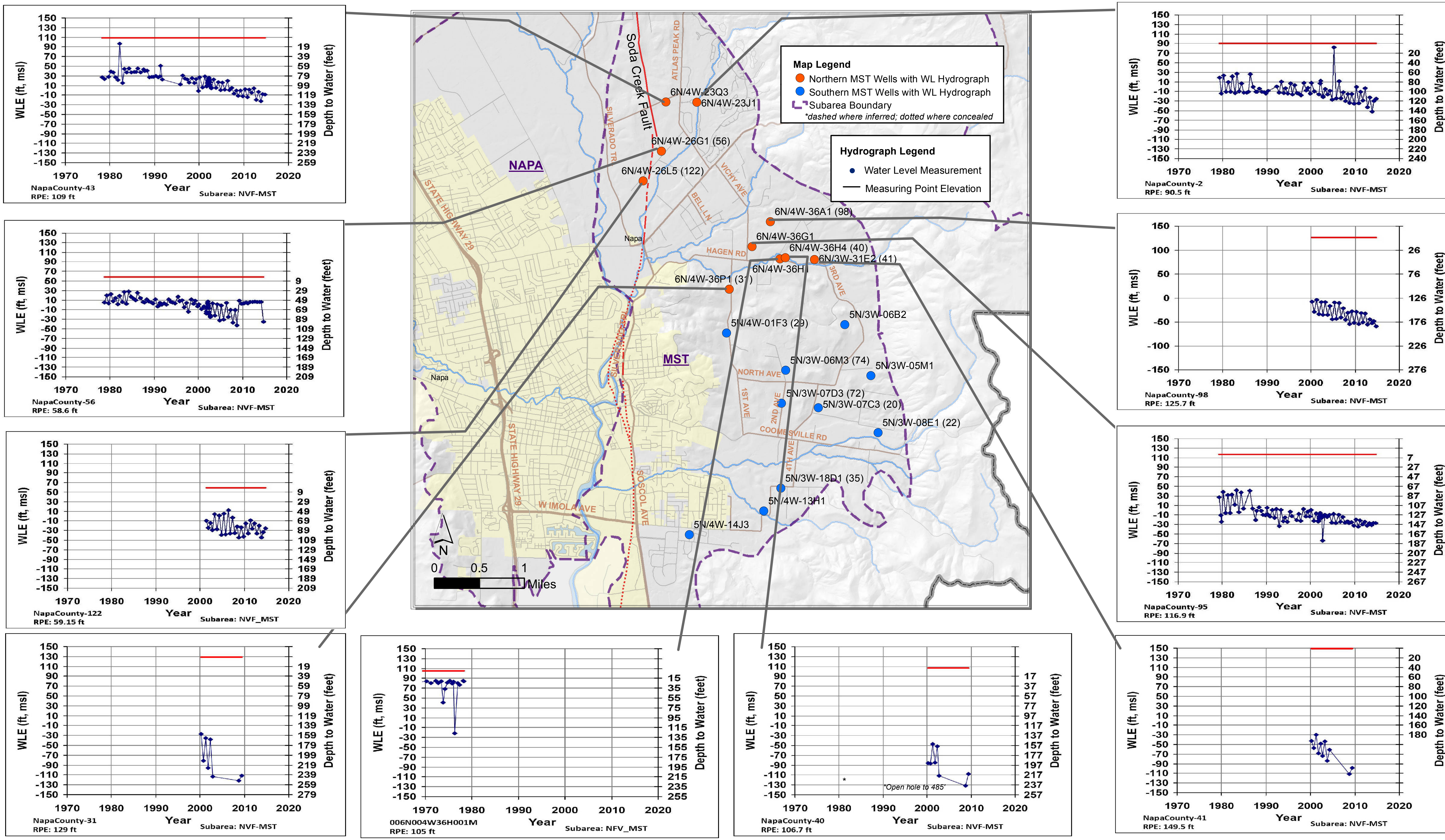

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FIGURE 5-10

Representative Groundwater Hydrographs Northern MST Area

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

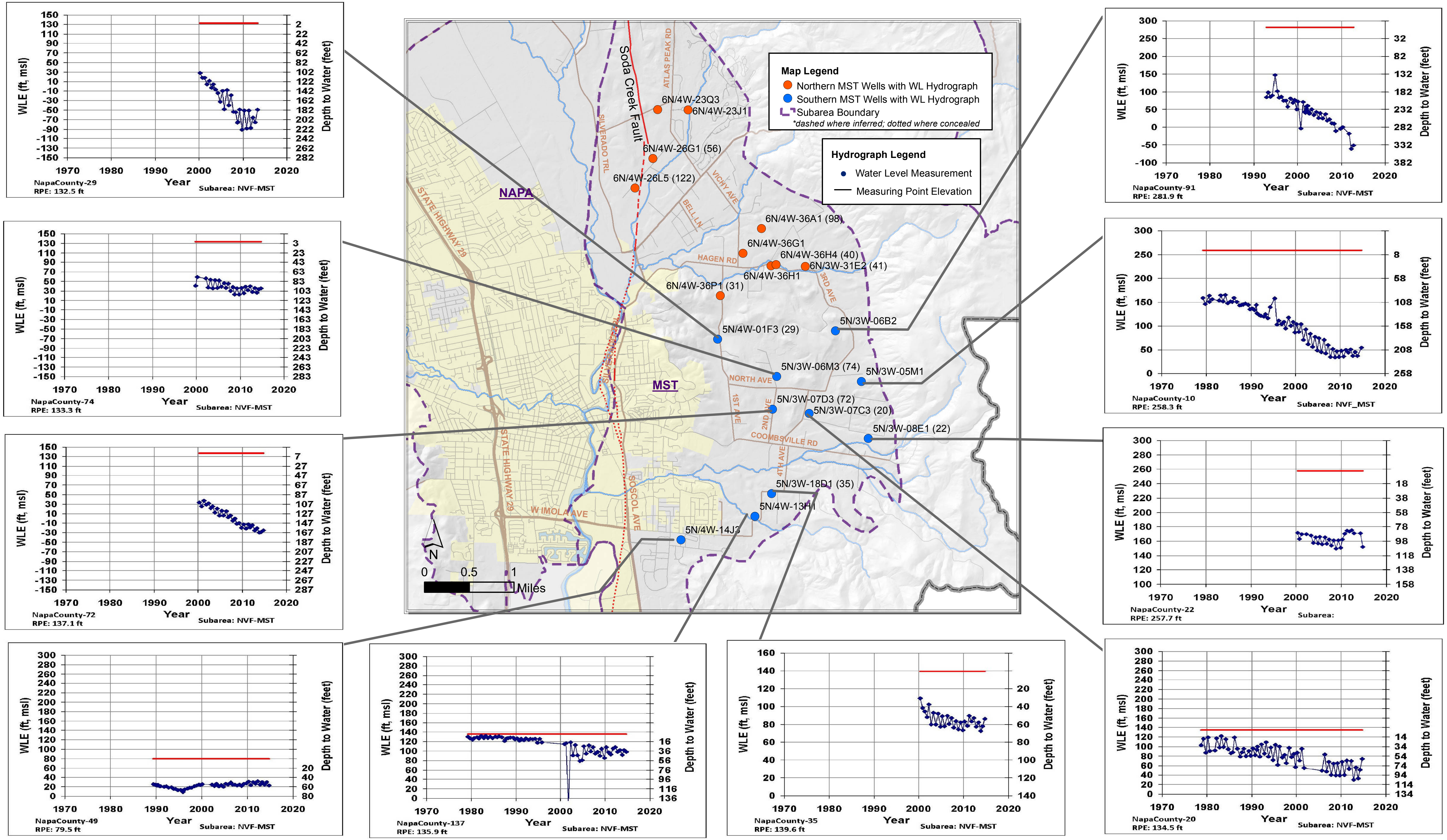

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FIGURE 5-11
Representative Groundwater Hydrographs Southern MST Area

Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

APPENDIX A
Summary of Current Groundwater Level Monitoring Locations

Appendix A
Summary of Current Groundwater Level Monitoring Locations
Napa County Comprehensive Groundwater Monitoring Program
2014 Annual Report and CASGEM Update

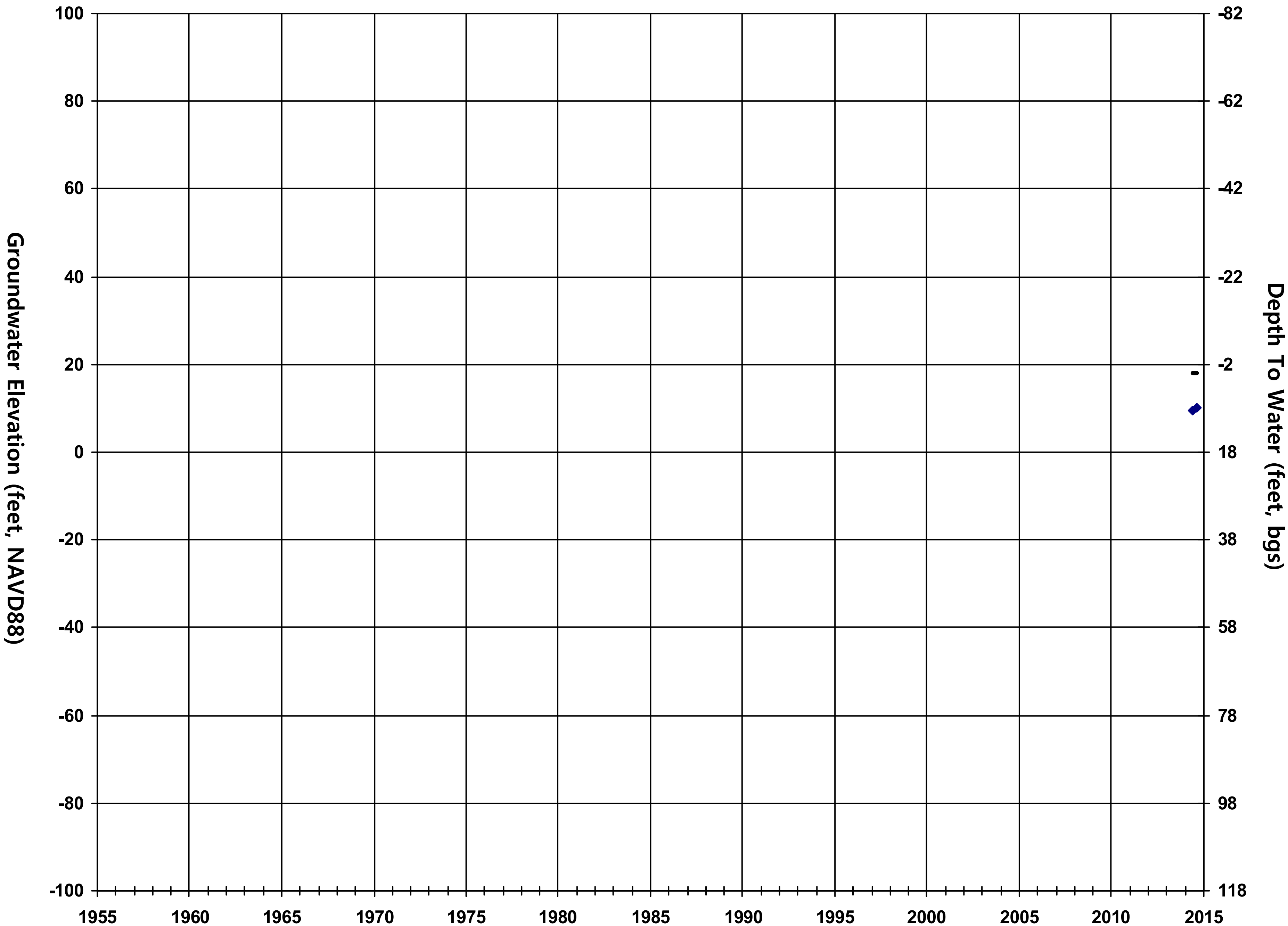
Subarea	SWN	WellID	Network as of 2014	Period of Record
Berryessa	T0605500304	multiple	Geotracker	2010-2014
	T0605591908	multiple	Geotracker	2009-2014
Carneros	004N004W05C001M	NapaCounty-150	Voluntary	2011-2014
Carneros	004N004W05A001M	NapaCounty-153	CASGEM	2012-2014
Carneros	005N004W31R001M	NapaCounty-154	CASGEM	2012-2014
Carneros	004N004W06M001M	NapaCounty-155	CASGEM	2012-2014
Not Designated	L10001344067	multiple	Geotracker	2004-2014
Not Designated	L10003756160	multiple	Geotracker	1990-2014
Not Designated	T0605500200	multiple	Geotracker	2014-2014
Napa River Marshes	L10002804480	multiple	Geotracker	2005-2014
NVF-Calistoga	009N007W25N001M	NapaCounty-127	Voluntary	1962-2014
NVF-Calistoga	009N006W31Q001M	NapaCounty-128	Voluntary	1962-2014
NVF-Calistoga	008N006W06L004M	NapaCounty-129	Voluntary	1962-2014
NVF-Calistoga	008N006W10Q001M	08N06W10Q001M	Monthly - DWR	1949-2014
NVF-Calistoga	T0605500250	multiple	Geotracker	2005-2014
NVF-MST	005N003W05M001M	NapaCounty-10	Voluntary	1979-2014
NVF-MST	005N003W07B00_My	NapaCounty-118	No Reporting County Only	2001-2014
NVF-MST	006N004W26L00_M	NapaCounty-122	No Reporting County Only	2001-2014
NVF-MST	005N004W13H001M	NapaCounty-137	CASGEM	1979-2014
NVF-MST	006N004W25G00_M	NapaCounty-142	No Reporting County Only	2001-2014
NVF-MST	005N003W05M00_M	NapaCounty-148	Voluntary	2009-2014
NVF-MST	005N003W08E00_M	NapaCounty-149	No Reporting County Only	2010-2014
NVF-MST	005N004W13G004M	NapaCounty-18	No Reporting County Only	2000-2014
NVF-MST	006N004W23J001M	NapaCounty-2	Voluntary	1979-2014
NVF-MST	005N003W07C003M	NapaCounty-20	Voluntary	1978-2014
NVF-MST	005N003W08E001M	NapaCounty-22	No Reporting County Only	2000-2014
NVF-MST	005N003W18D001M	NapaCounty-35	No Reporting County Only	2000-2014
NVF-MST	006N004W23Q003M	NapaCounty-43	Voluntary	1978-2014
NVF-MST	005N004W14J003M	NapaCounty-49	Voluntary	1989-2014
NVF-MST	006N004W25G001M	NapaCounty-51	No Reporting County Only	2000-2014
NVF-MST	006N004W26G001M	NapaCounty-56	Voluntary	1978-2014
NVF-MST	006N004W35G005M	NapaCounty-69	No Reporting County Only	2000-2014
NVF-MST	005N003W07D003M	NapaCounty-72	No Reporting County Only	2000-2014
NVF-MST	005N003W06M001M	NapaCounty-74	CASGEM	1999-2014
NVF-MST	005N003W07F003M	NapaCounty-81	No Reporting County Only	2000-2014
NVF-MST	005N003W06B002M	NapaCounty-91	CASGEM	1992-2014
NVF-MST	005N003W06A001M	NapaCounty-92	CASGEM	1999-2014
NVF-MST	006N004W36G001M	NapaCounty-95	Voluntary	1979-2014
NVF-MST	006N004W36A001M	NapaCounty-98	No Reporting County Only	2000-2014
NVF-MST	L10002804480	multiple	Geotracker	2005-2014
NVF-Napa	006N004W27N001M	NapaCounty-136	CASGEM	1979-2014
NVF-Napa	006N004W28Mx	NapaCounty-152	CASGEM	2012-2014
NVF-Napa		NapaCounty-214s-swgw1	Surface Water/Groundwater	2014-2014
NVF-Napa		NapaCounty-218s-swgw3	Surface Water/Groundwater	2014-2014
NVF-Napa	006N004W27L002M	06N04W27L002M	Monthly - DWR	1966-2014
NVF-Napa	006N004W22R001M	NapaCounty-75	Voluntary	1978-2014
NVF-Napa	006N004W15R003M	NapaCounty-76	No Reporting County Only	2000-2014
NVF-Napa	SL0605536682	multiple	Geotracker	2005-2014
NVF-Napa	T0605500009	multiple	Geotracker	2005-2014
NVF-Napa	T0605514064	multiple	Geotracker	2005-2014
NVF-Napa	T0605547200	multiple	Geotracker	2008-2014
NVF-Napa	T0605575085	multiple	Geotracker	2009-2014
NVF-St. Helena	007N005W16L001M	NapaCounty-131	CASGEM	1963-2014
NVF-St. Helena	007N005W14B002M	NapaCounty-132	Voluntary	1962-2014
NVF-St. Helena	007N005W16N002M	NapaCounty-138	CASGEM	1949-2014
NVF-St. Helena		NapaCounty-222s-swgw5	Surface Water/Groundwater	2014-2014
NVF-St. Helena	007N005W09Q002M	07N05W09Q002M	Monthly - DWR	1949-2014
NVF-St. Helena	T0605500061	multiple	Geotracker	2005-2014
NVF-Yountville	006N004W09Q001M	NapaCounty-125	Voluntary	1979-2014
NVF-Yountville	006N004W09Q002M	NapaCounty-126	Voluntary	1984-2014
NVF-Yountville	007N004W31M001M	NapaCounty-133	Voluntary	1978-2014
NVF-Yountville	006N004W06L002M	NapaCounty-134	Voluntary	1963-2014
NVF-Yountville	006N004W19B001M	NapaCounty-135	Voluntary	1979-2014
NVF-Yountville	006N004W17R002M	NapaCounty-139	Voluntary	1978-2014
NVF-Yountville	006N004W17A001M	06N04W17A001M	Semi-annual - DWR	1949-2014
NVF-Yountville		NapaCounty-216s-swgw2	Surface Water/Groundwater	2014-2014
NVF-Yountville		NapaCounty-220s-swgw4	Surface Water/Groundwater	2014-2014

APPENDIX B

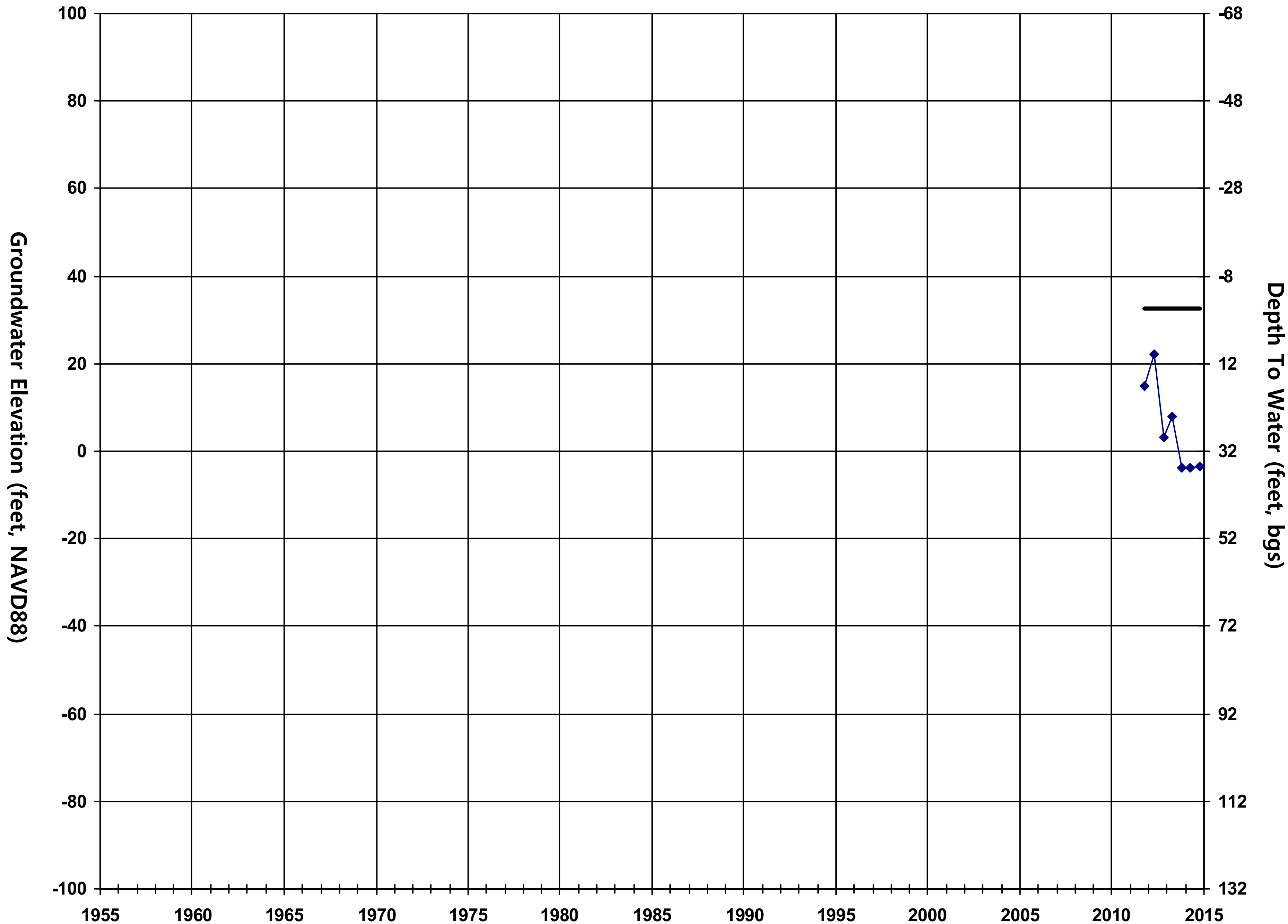
Groundwater Level Hydrographs for Current Monitoring Locations

WellID: T0605500200MW-1 RPE: 18.16 Subarea:

SWN: Unknown Source: Geotracker Aq_Desig: NA

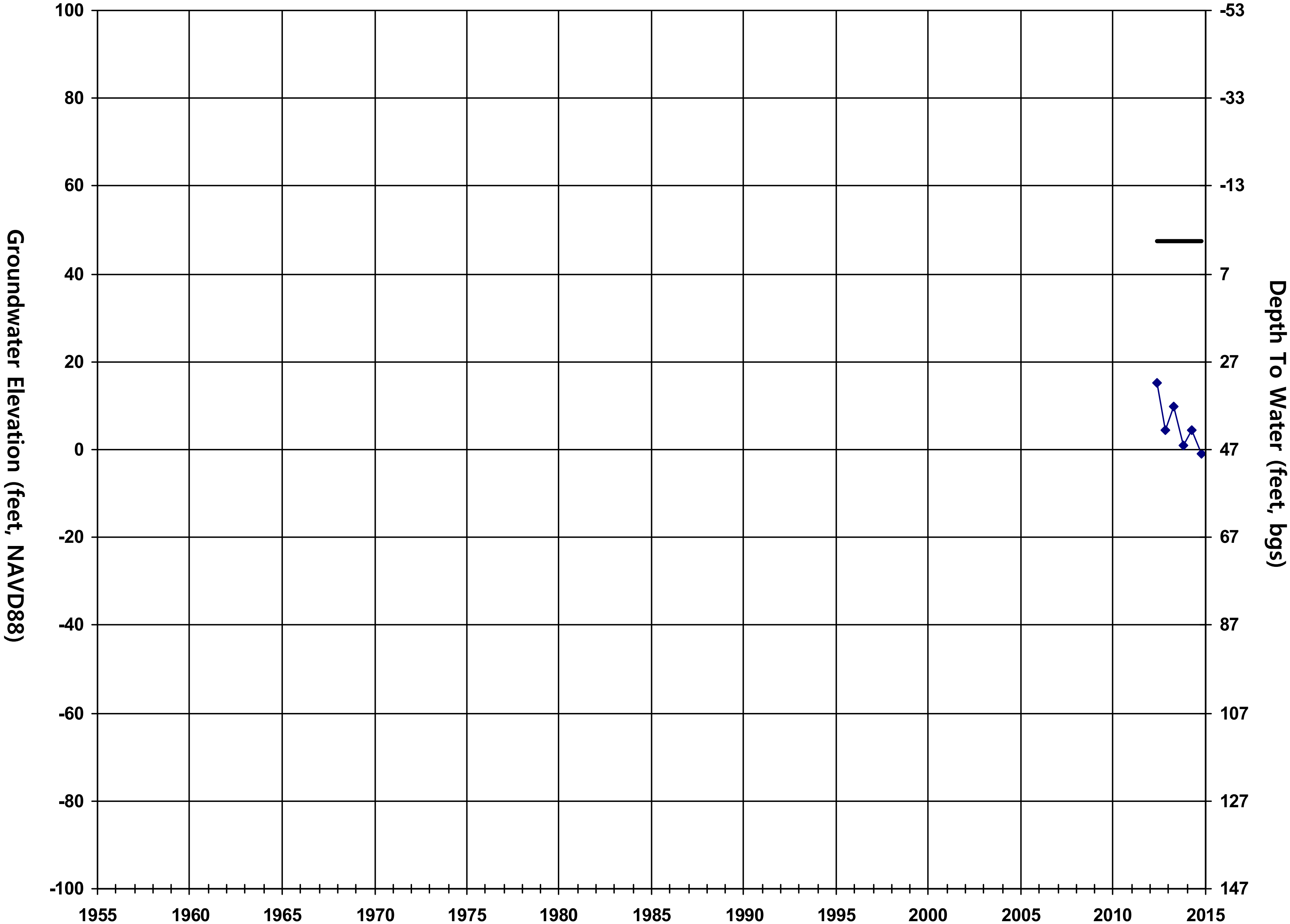


WellID: NapaCounty-150 RPE: 32.7 Subarea: Carn
SWN: 004N004W05C001M Source: NapaCounty Aq_Desig: NA

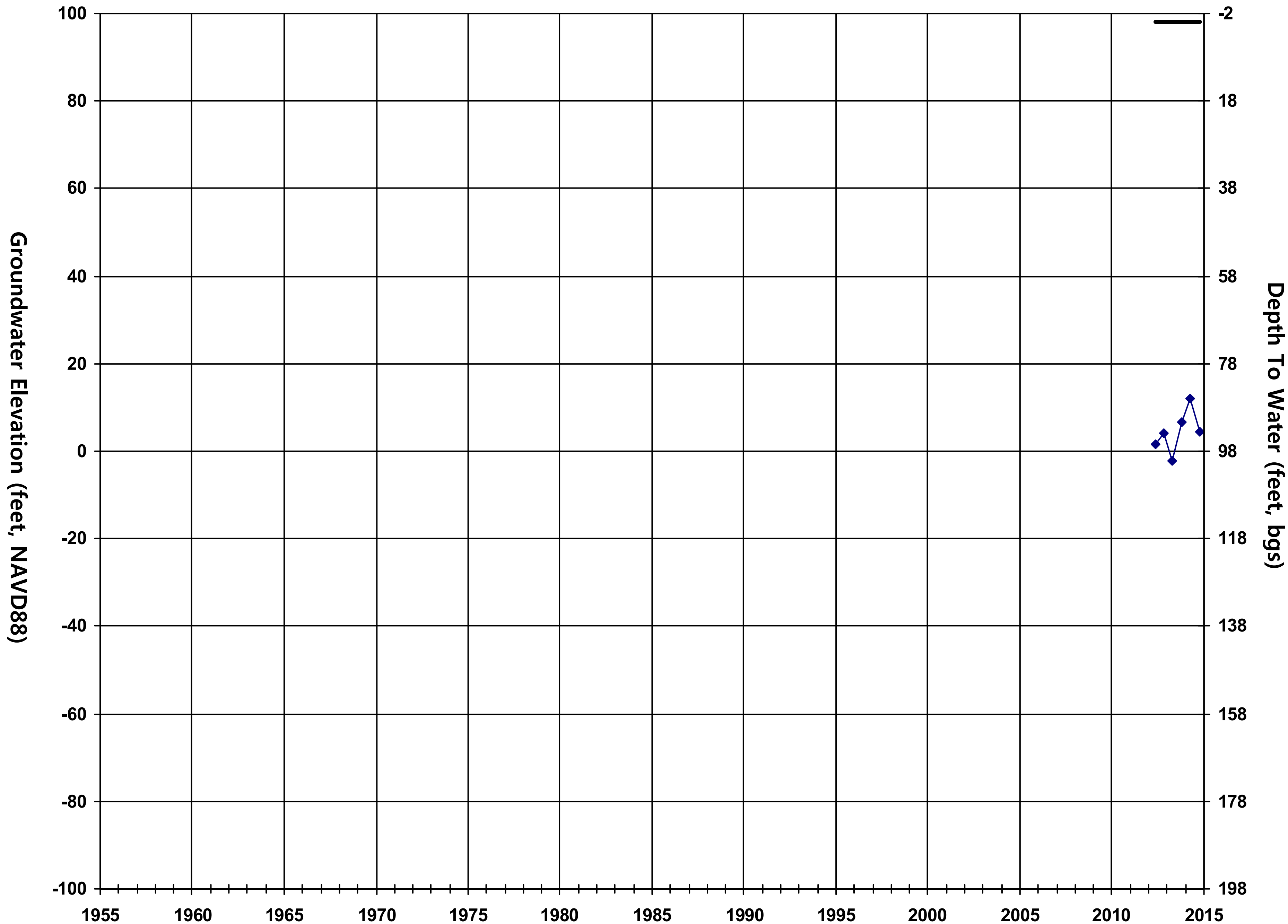


WellID: NapaCounty-153 RPE: 47.35 Subarea: Carn

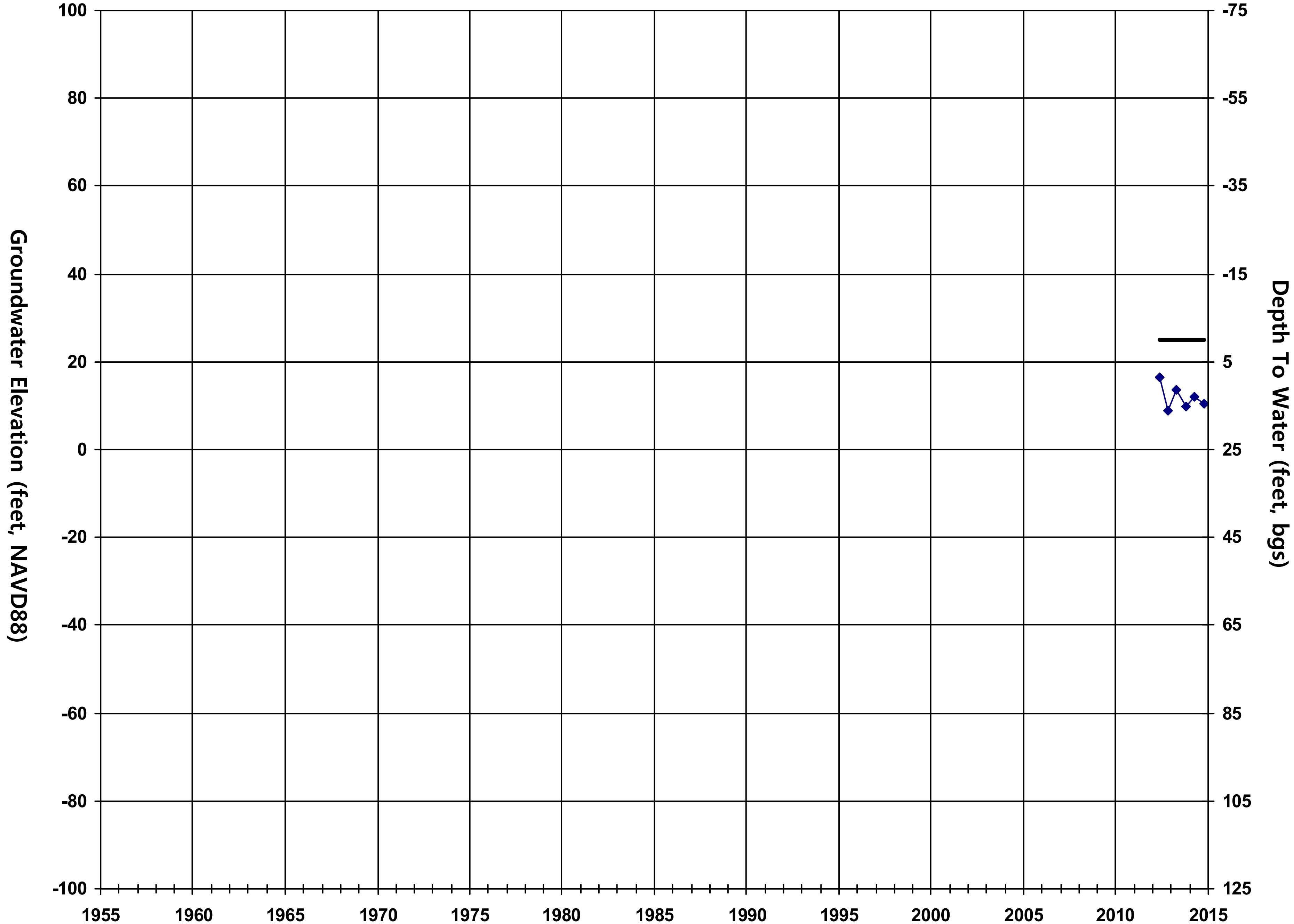
SWN: 004N004W05A001M Source: NapaCounty Aq_Desig: TQsb



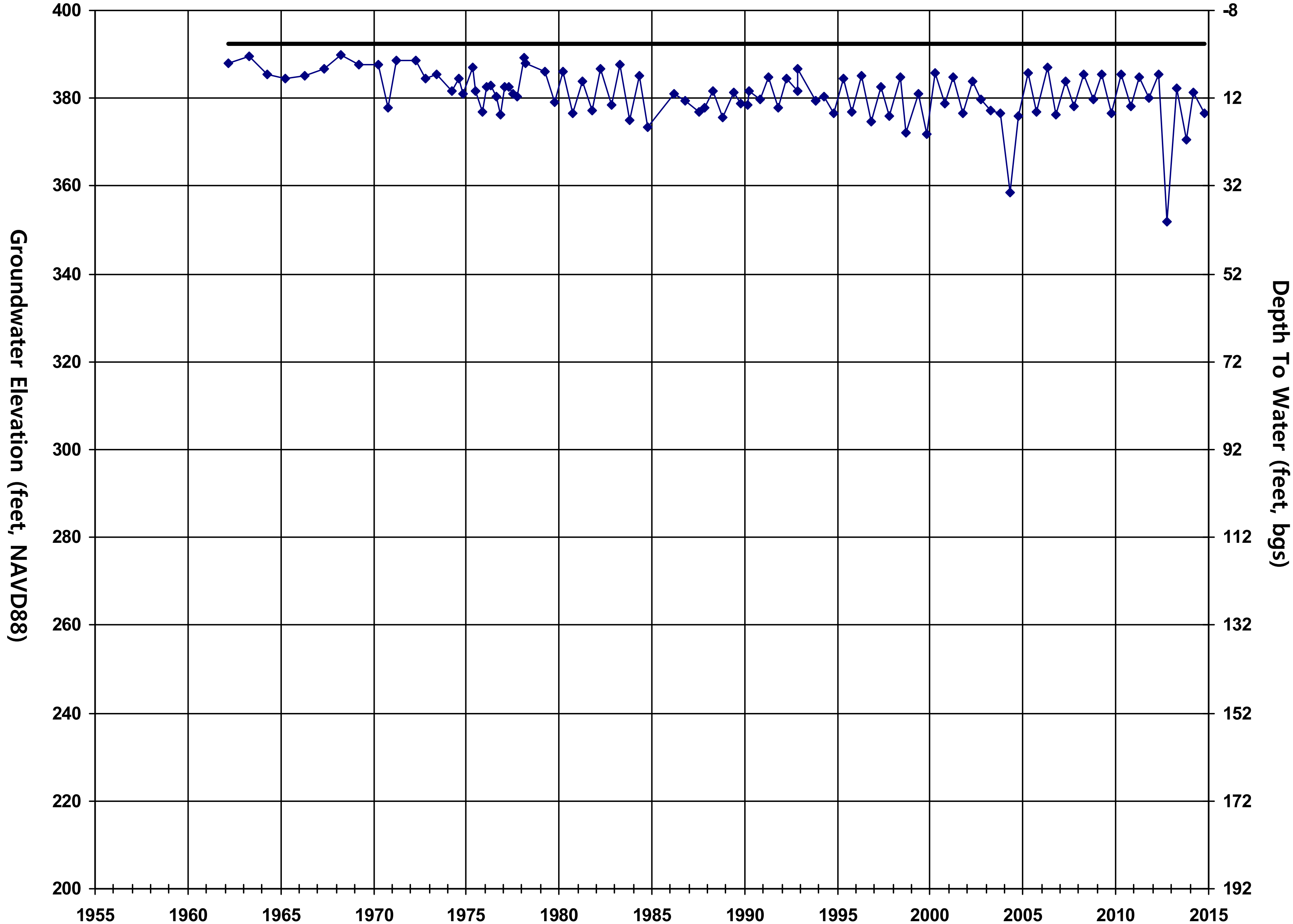
WellID: NapaCounty-154 RPE: 98 Subarea: Carn
SWN: 005N004W31R001M Source: NapaCounty Aq_Desig: TQsb



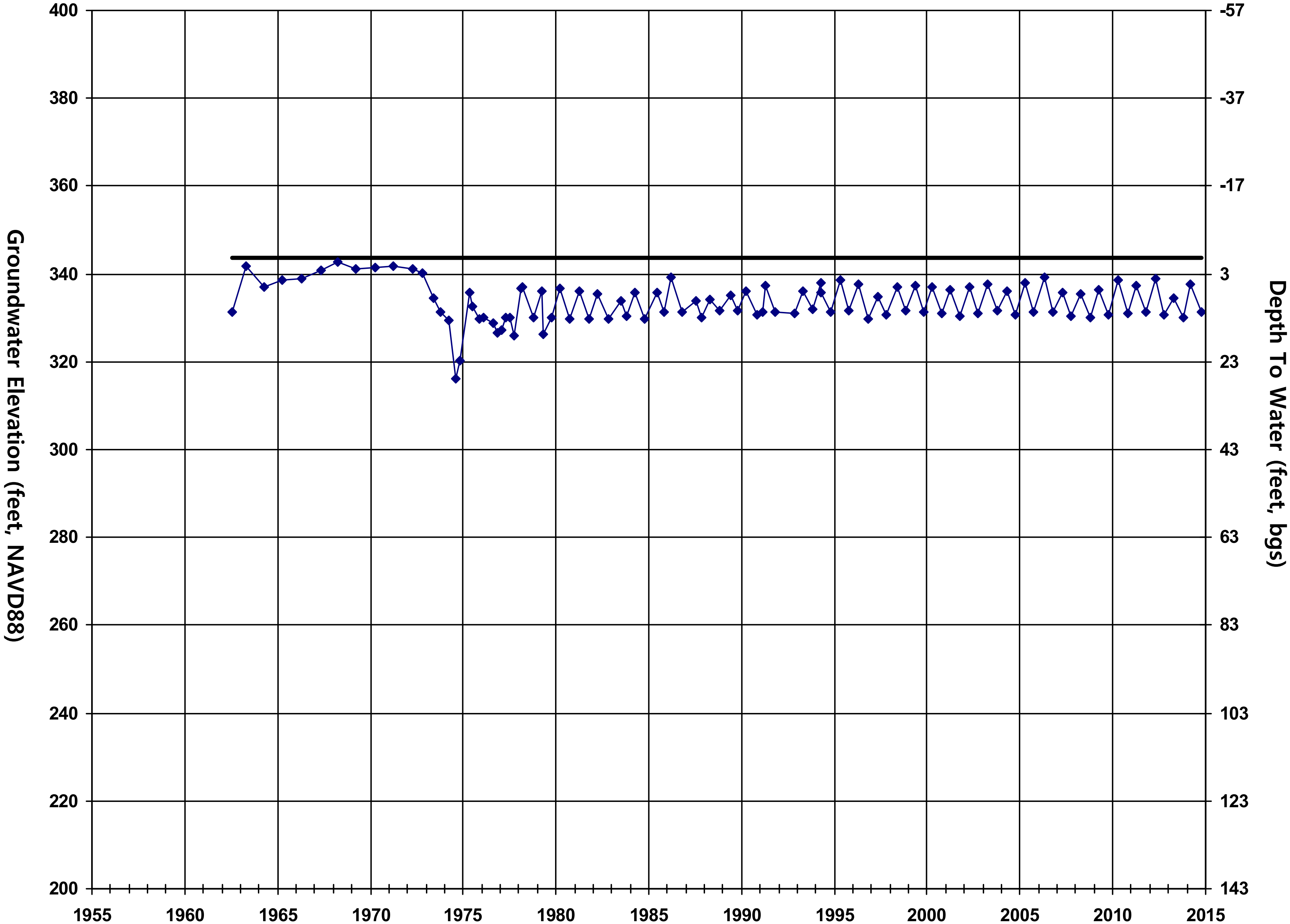
WellID: NapaCounty-155 RPE: 25 Subarea: Carn
SWN: 004N004W06M001M Source: NapaCounty Aq_Desig: TQsb



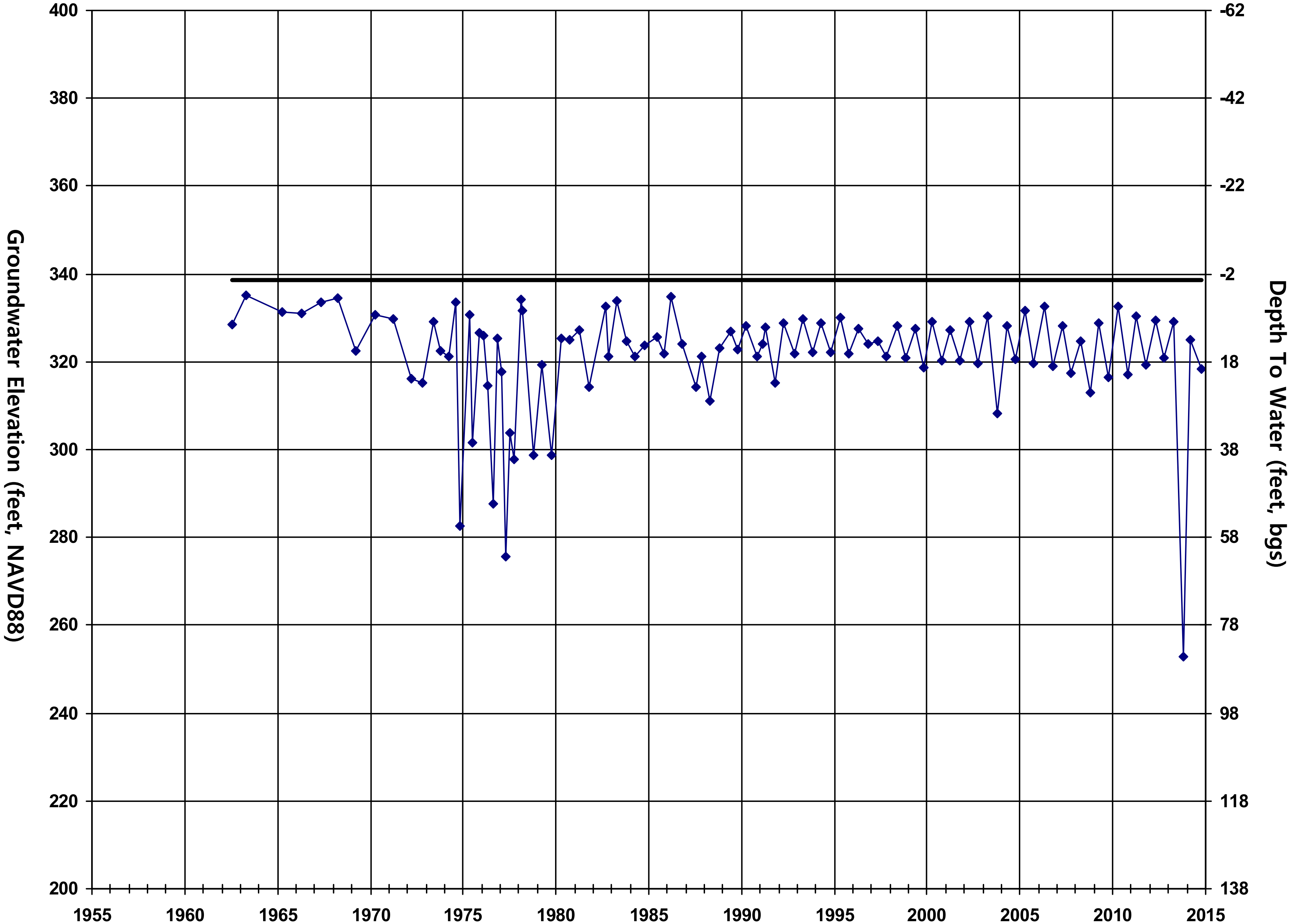
WellID: **NapaCounty-127** RPE: 392.5 Subarea: NVF_Calis
SWN: 009N007W25N001M Source: NapaCounty Aq_Desig: NA



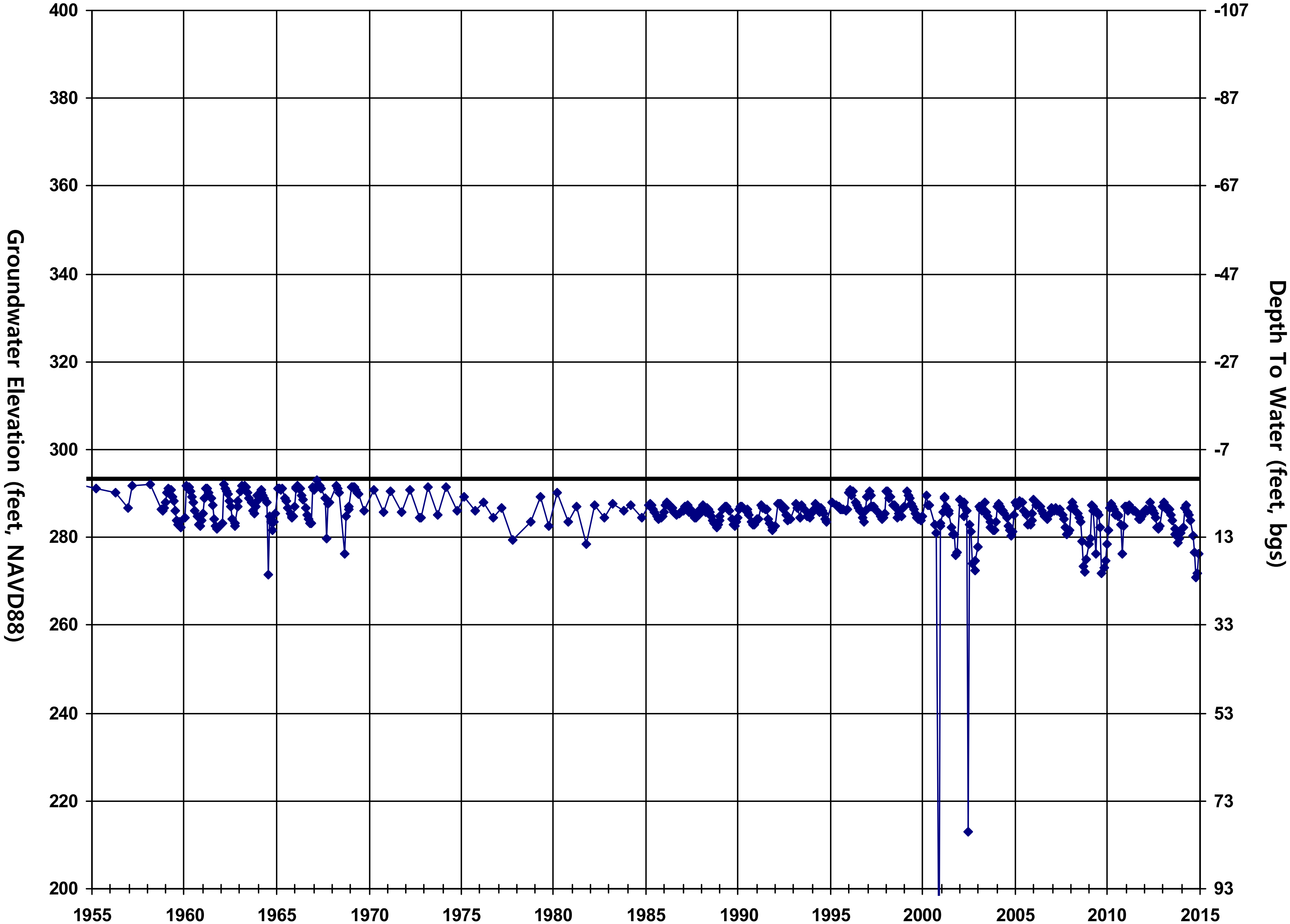
WellID: NapaCounty-128 RPE: 343.7 Subarea: NVF_Calis
SWN: 009N006W31Q001M Source: NapaCounty Aq_Desig: NA



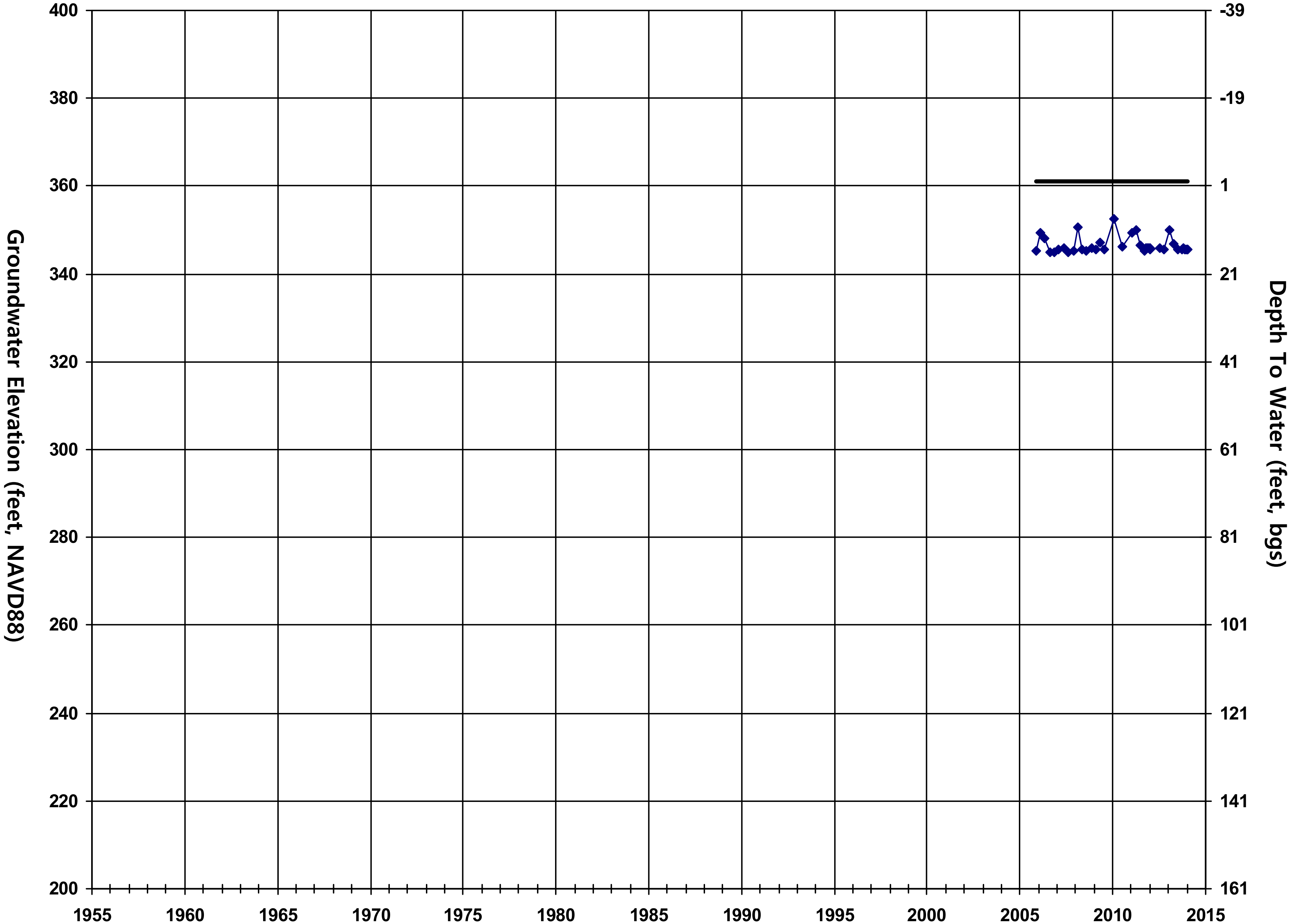
WellID: NapaCounty-129 RPE: 338.7 Subarea: NVF_Calis
SWN: 008N006W06L004M Source: NapaCounty Aq_Desig: NA



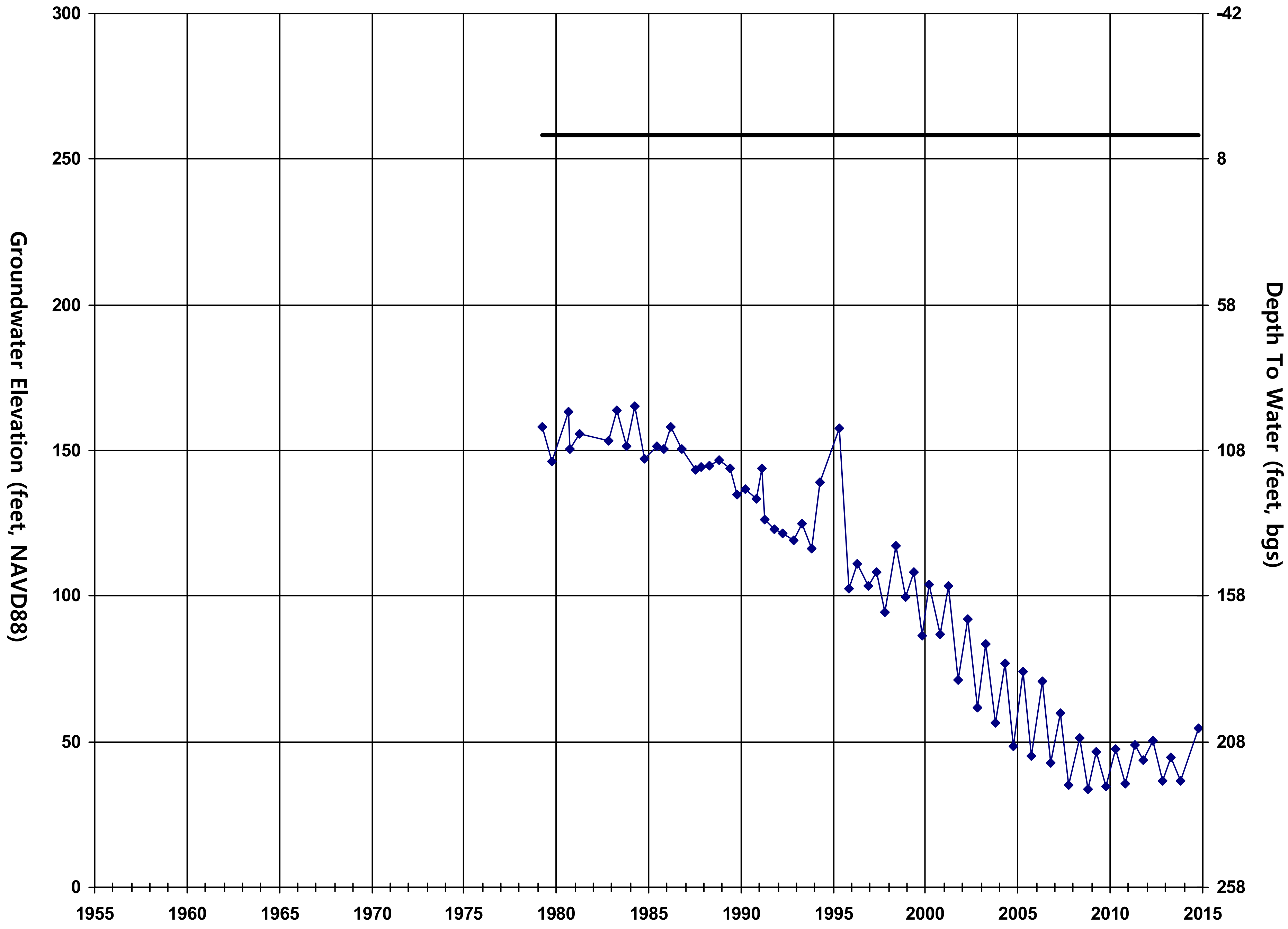
WellID: 08N06W10Q001M RPE: 293.43 Subarea: NVF_Calis
SWN: 008N006W10Q001M Source: DWR Aq_Desig: NA



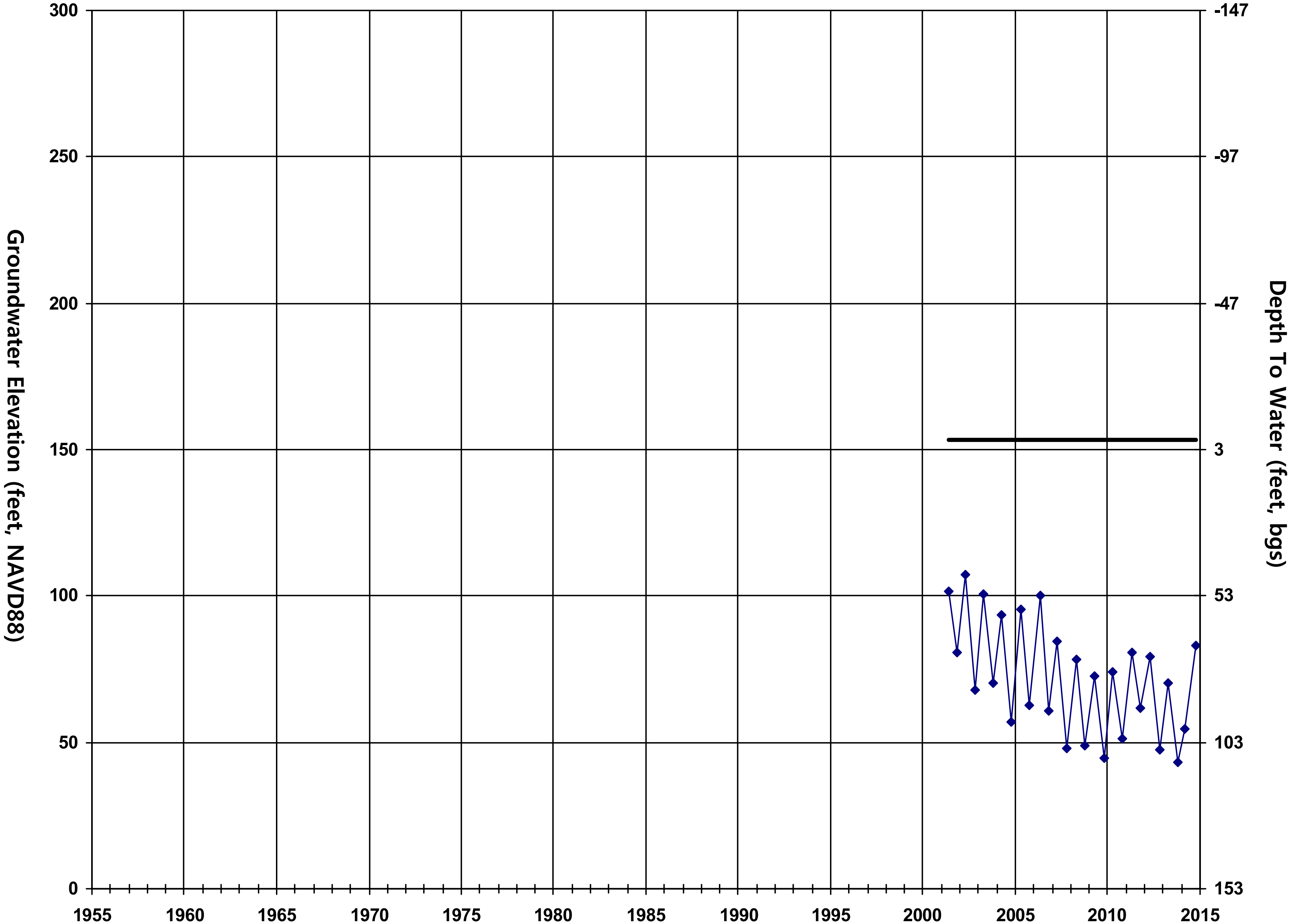
WellID: T0605500250MW-1 RPE: 361.09 Subarea: NVF_Calis
SWN: Unknown Source: Geotracker Aq_Desig: NA



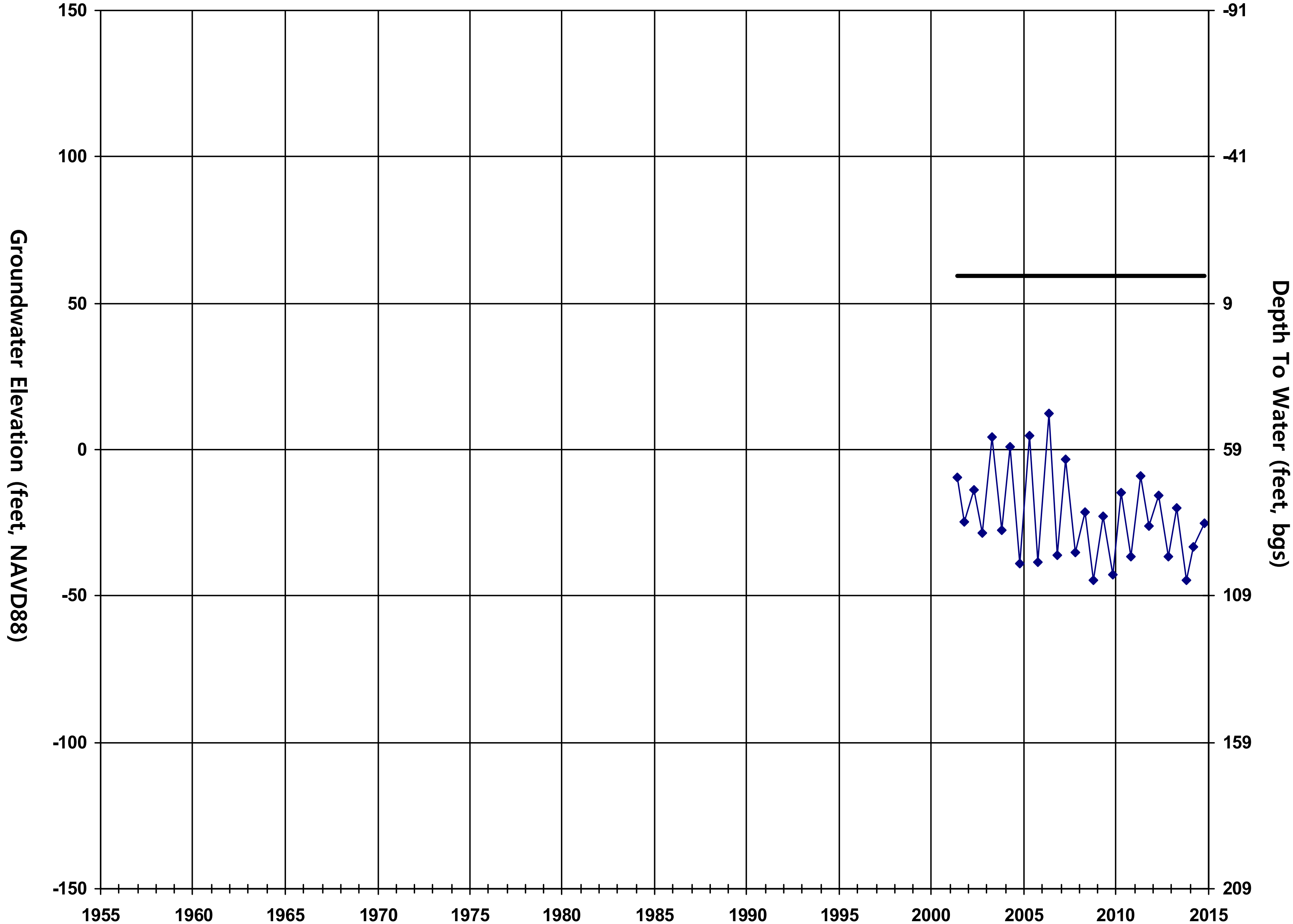
WellID: NapaCounty-10 RPE: 258.3 Subarea: NVF_MST
SWN: 005N003W05M001M Source: NapaCounty Aq_Desig: NA



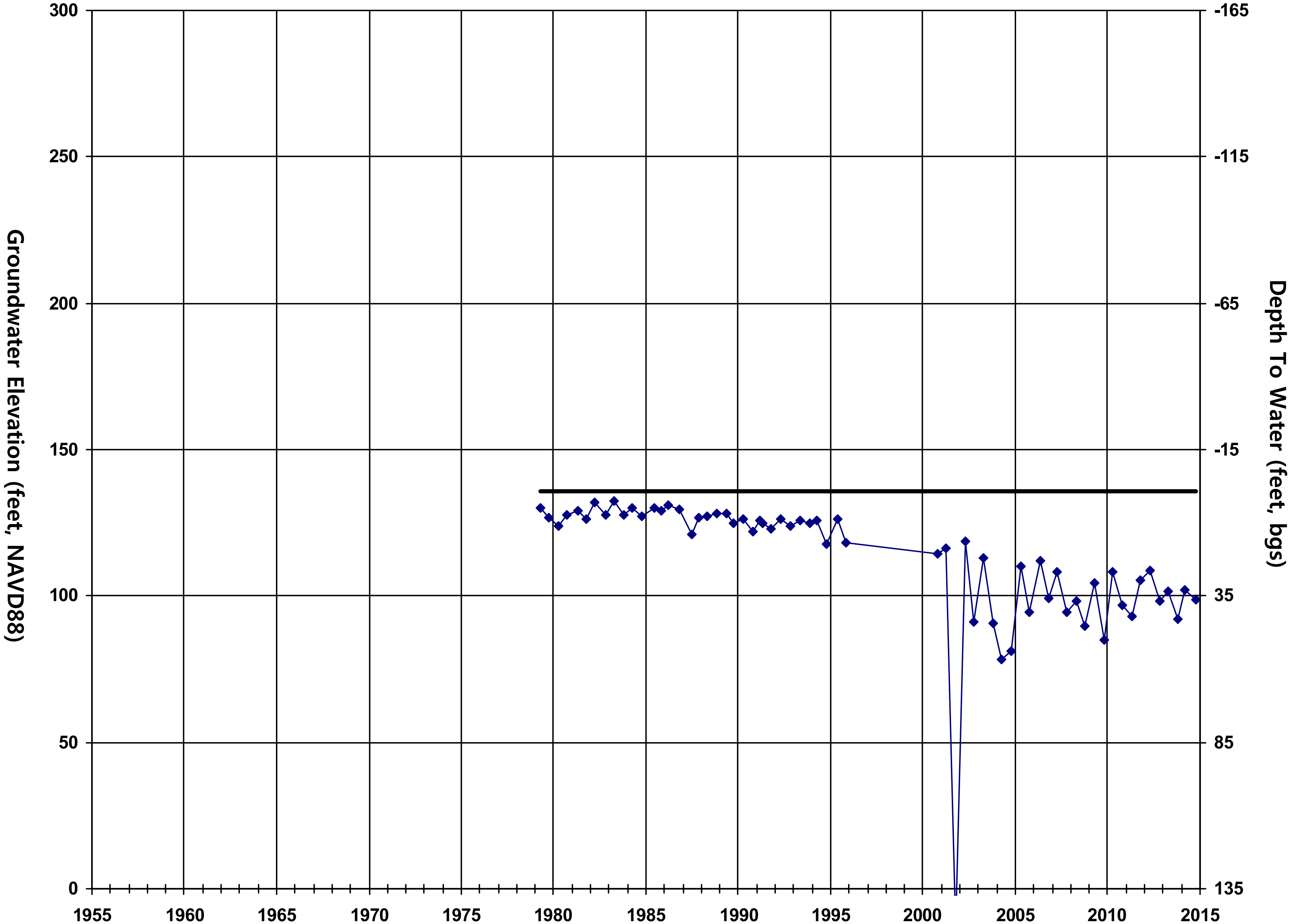
WellID: NapaCounty-118 RPE: 153.15 Subarea: NVF_MST
SWN: 005N003W07B00_My Source: NapaCounty Aq_Desig: NA



WellID: **NapaCounty-122** RPE: 59.15 Subarea: NVF_MST
SWN: 006N004W26L00_M Source: NapaCounty Aq_Desig: NA

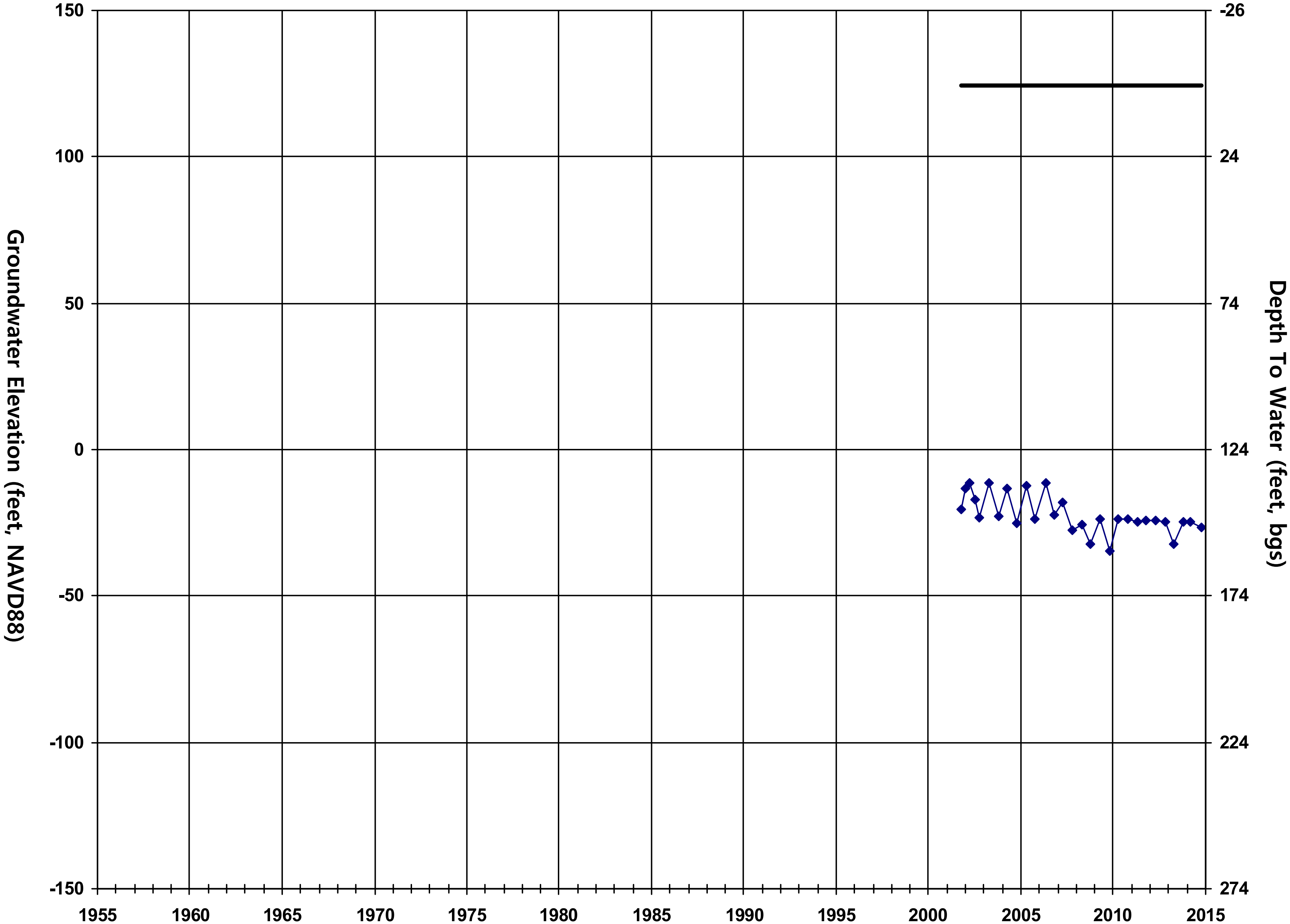


WellID: NapaCounty-137 RPE: 135.9 Subarea: NVF_MST
SWN: 005N004W13H001M Source: NapaCounty Aq_Desig: NA

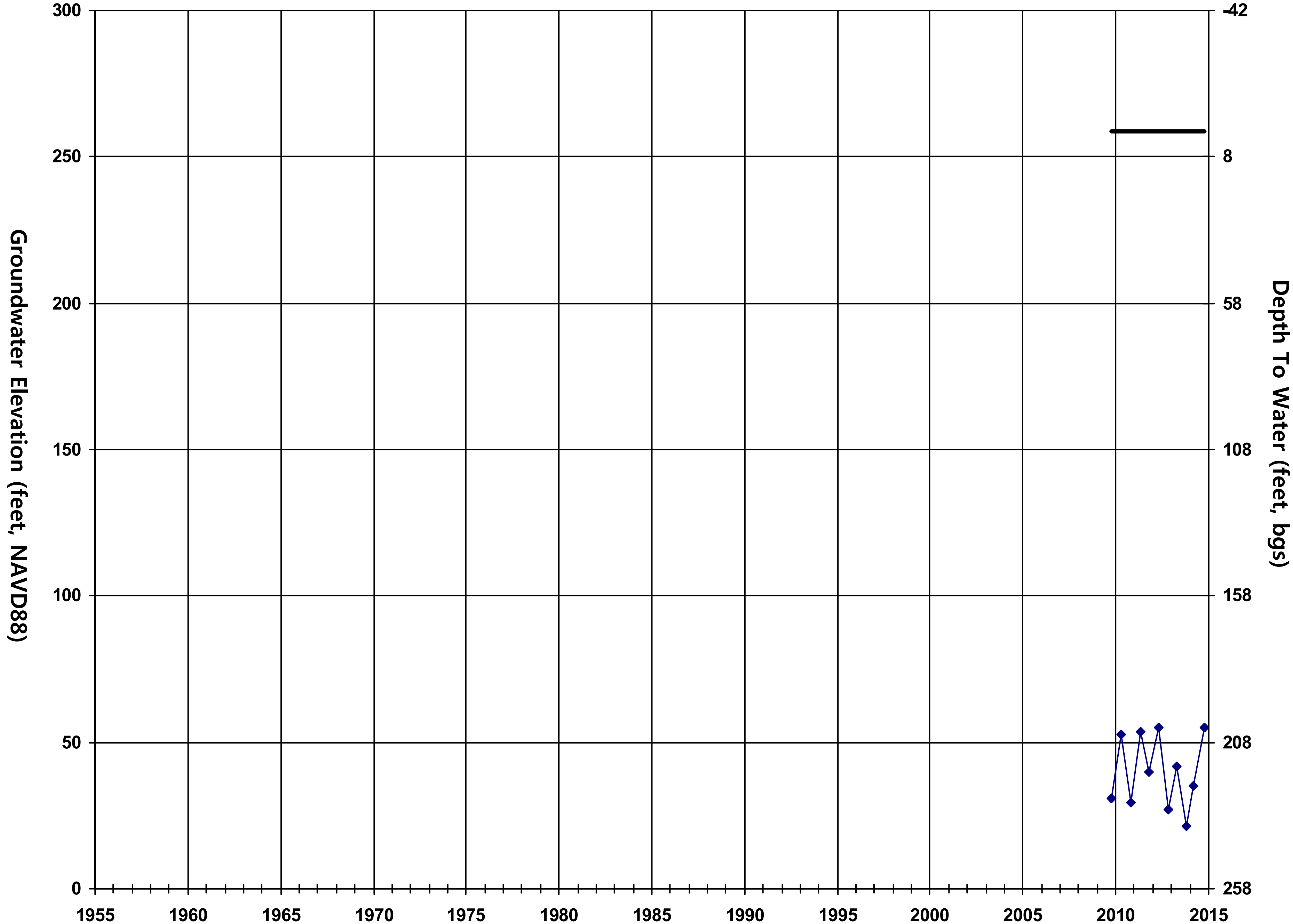


WellID: NapaCounty-142 RPE: 124.2 Subarea: NVF_MST

SWN: 006N004W25G00_M Source: NapaCounty Aq_Desig: NA

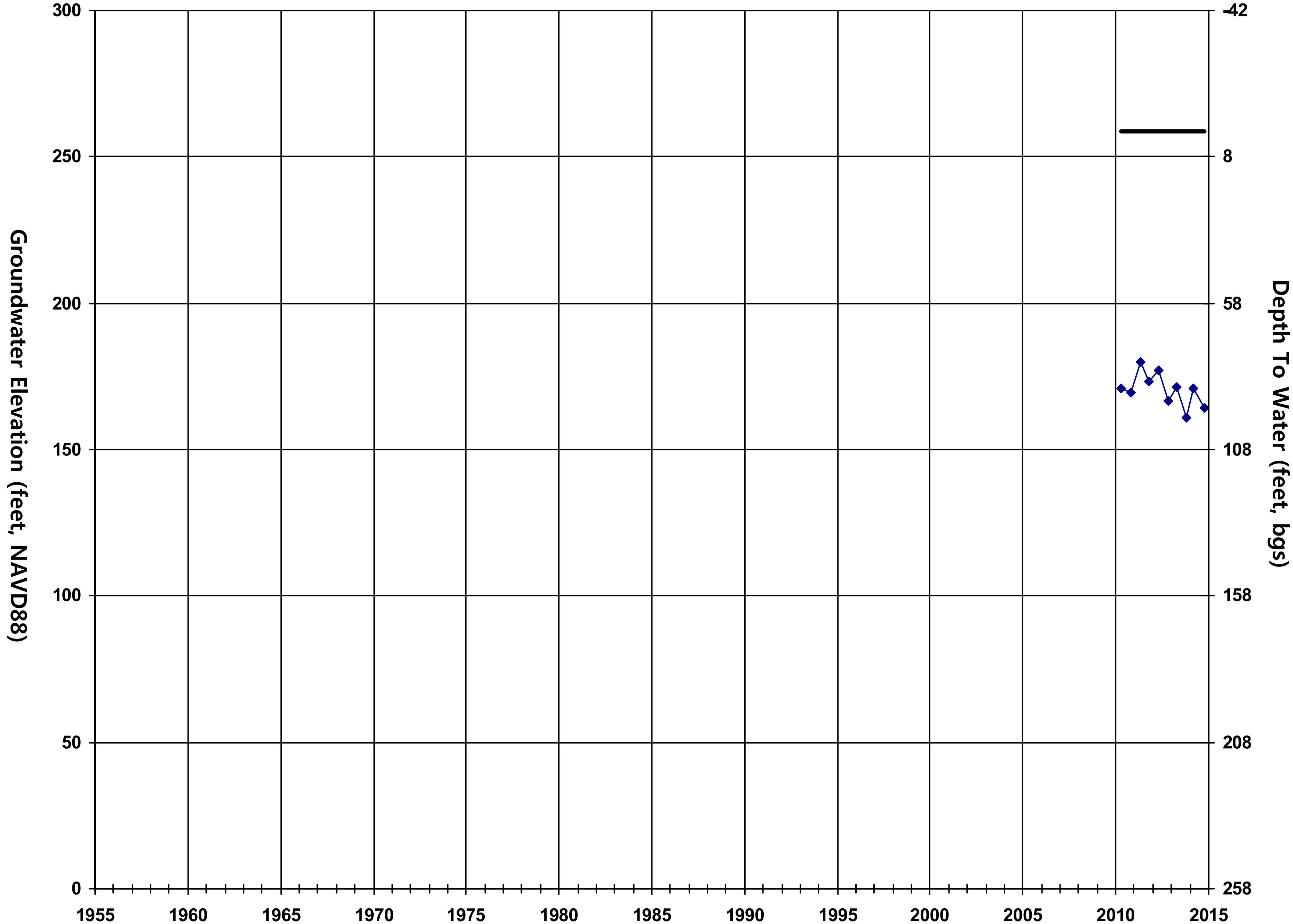


WellID: NapaCounty-148 RPE: 258.6 Subarea: NVF_MST
SWN: 005N003W05M00_M Source: NapaCounty Aq_Desig: NA



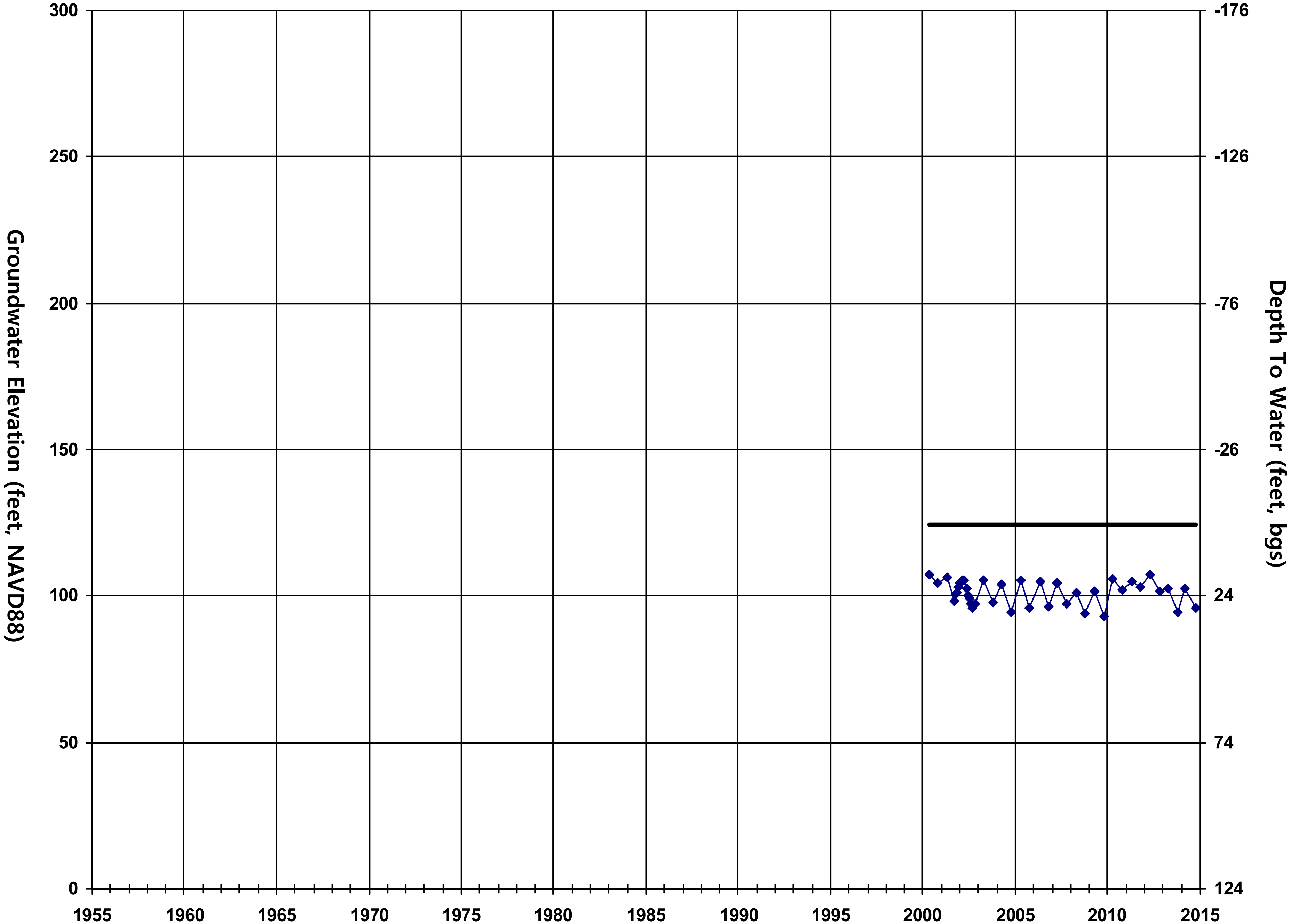
WellID: NapaCounty-149 RPE: 258.9 Subarea: NVF_MST

SWN: 005N003W08E00_M Source: NapaCounty Aq_Desig: NA

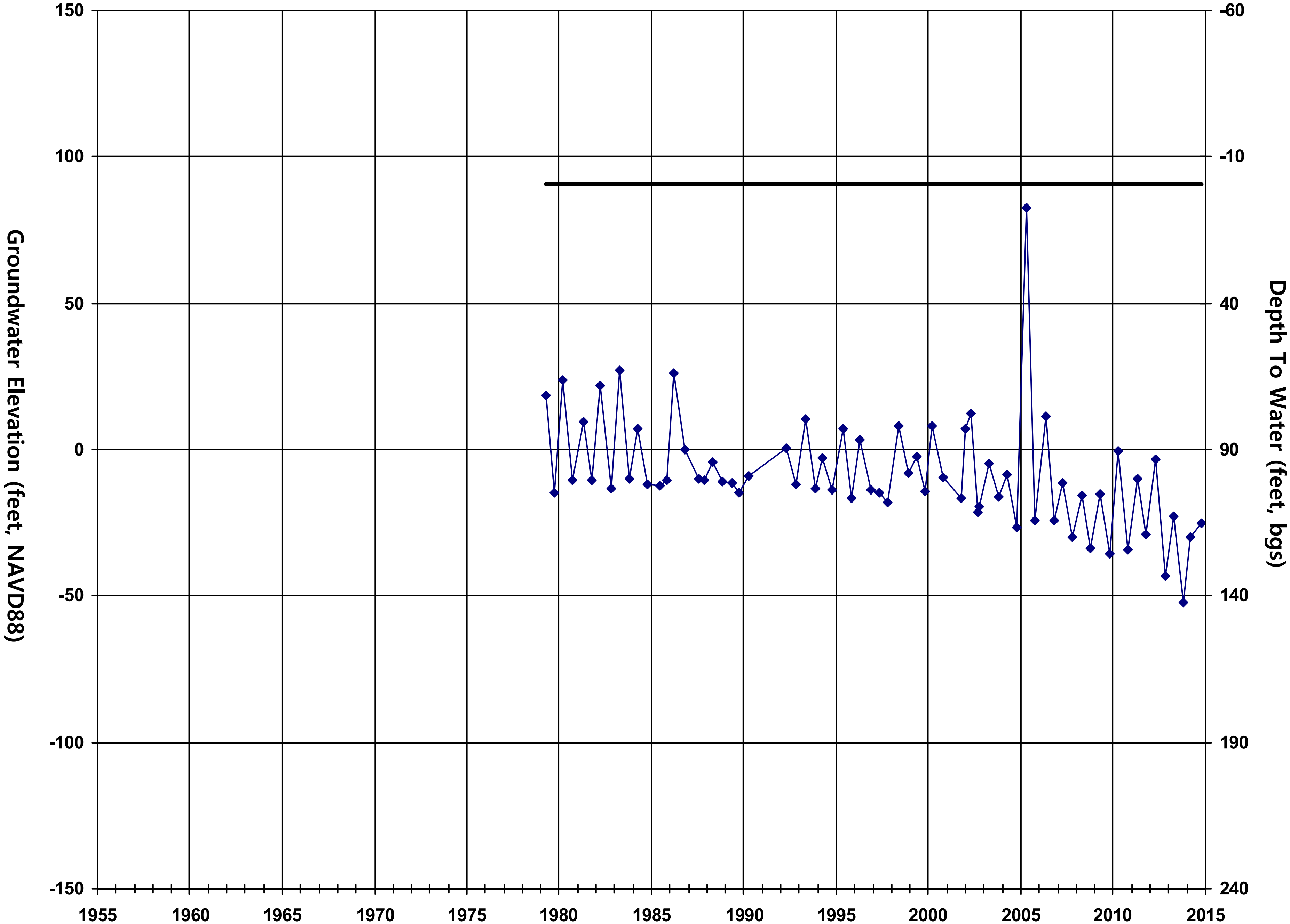


WellID: NapaCounty-18 RPE: 124.3 Subarea: NVF_MST

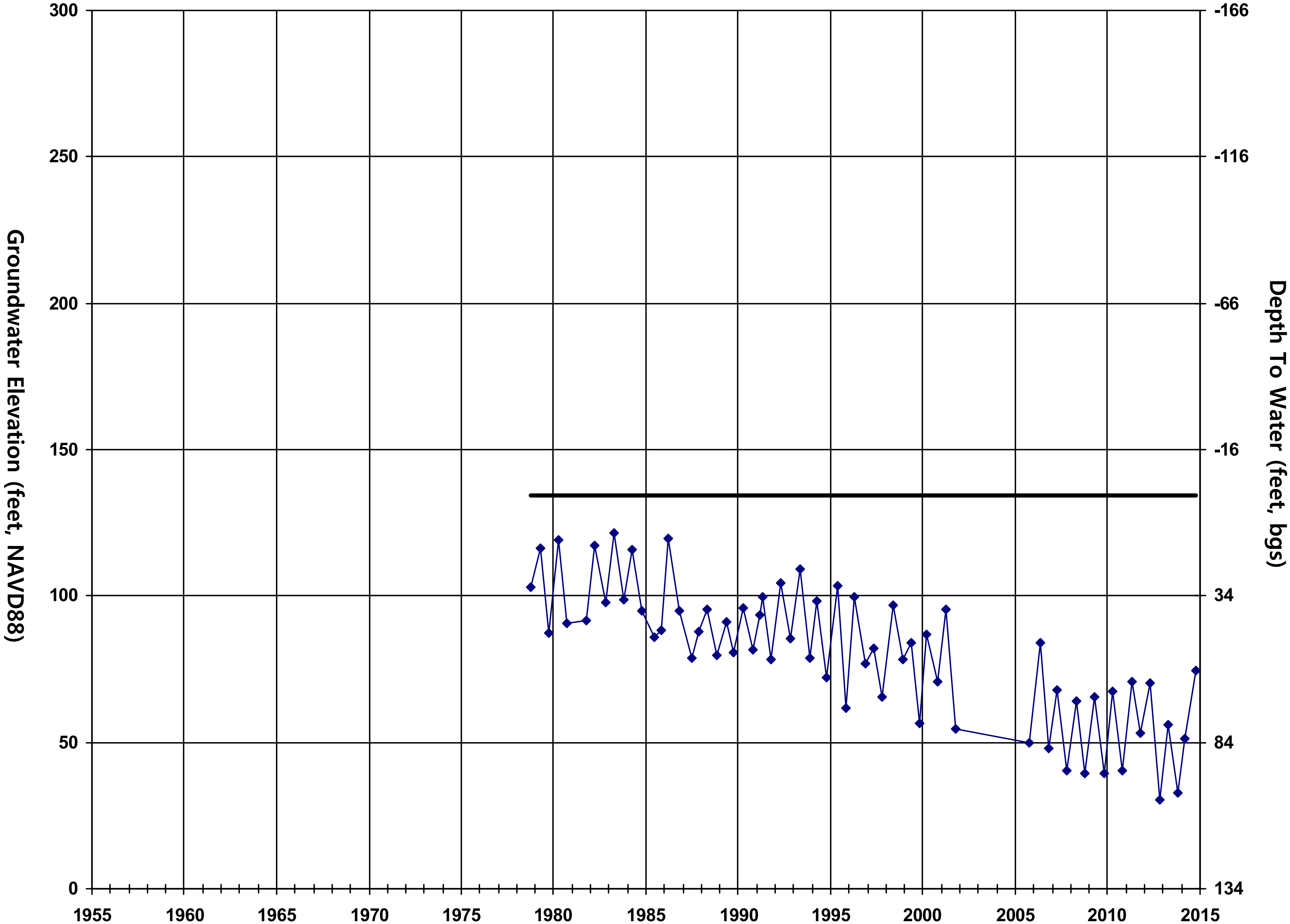
SWN: 005N004W13G004M Source: NapaCounty Aq_Desig: NA



WellID: NapaCounty-2 RPE: 90.5 Subarea: NVF_MST
SWN: 006N004W23J001M Source: NapaCounty Aq_Desig: NA

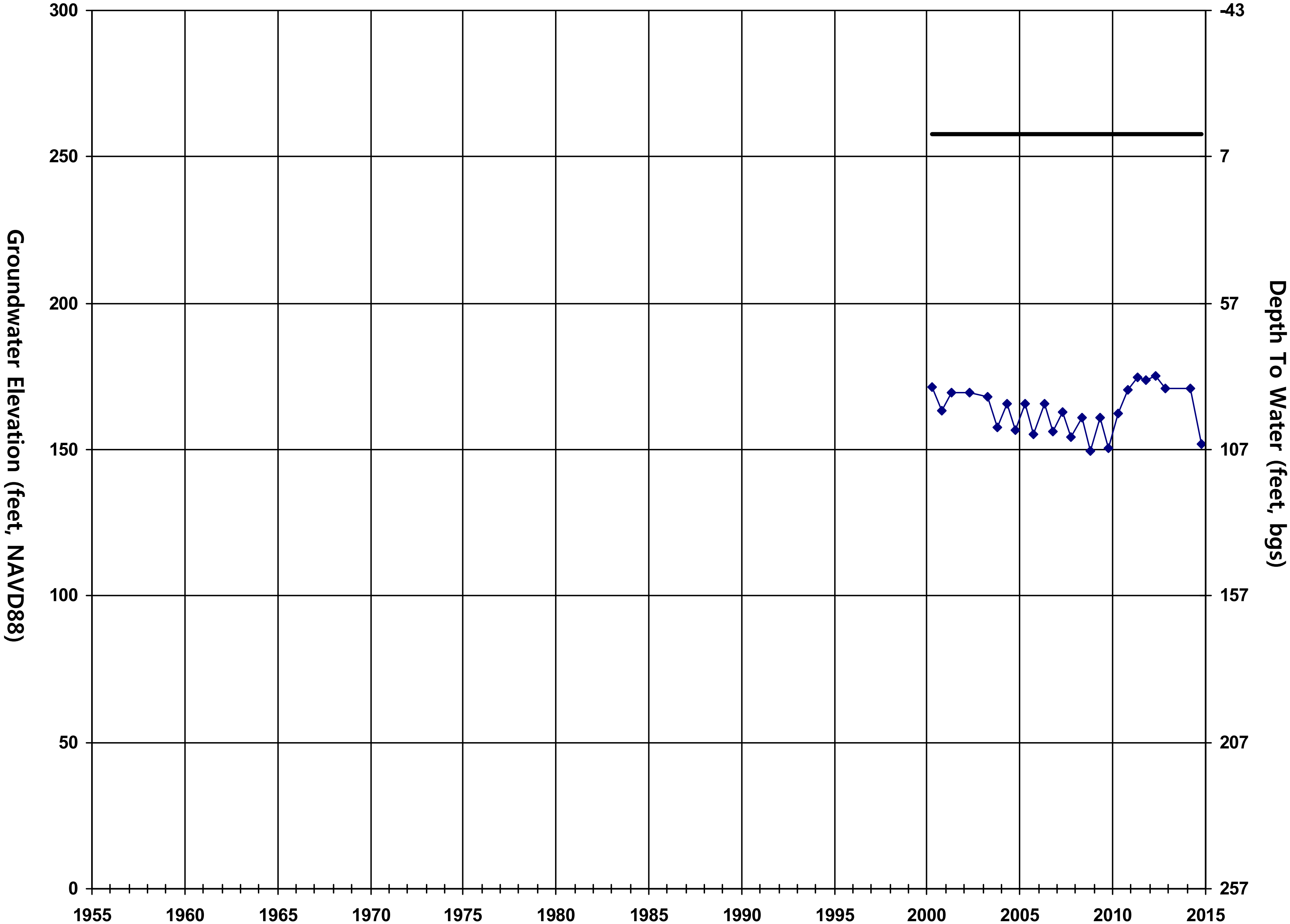


WellID: NapaCounty-20 RPE: 134.5 Subarea: NVF_MST
SWN: 005N003W07C003M Source: NapaCounty Aq_Desig: Tsvd

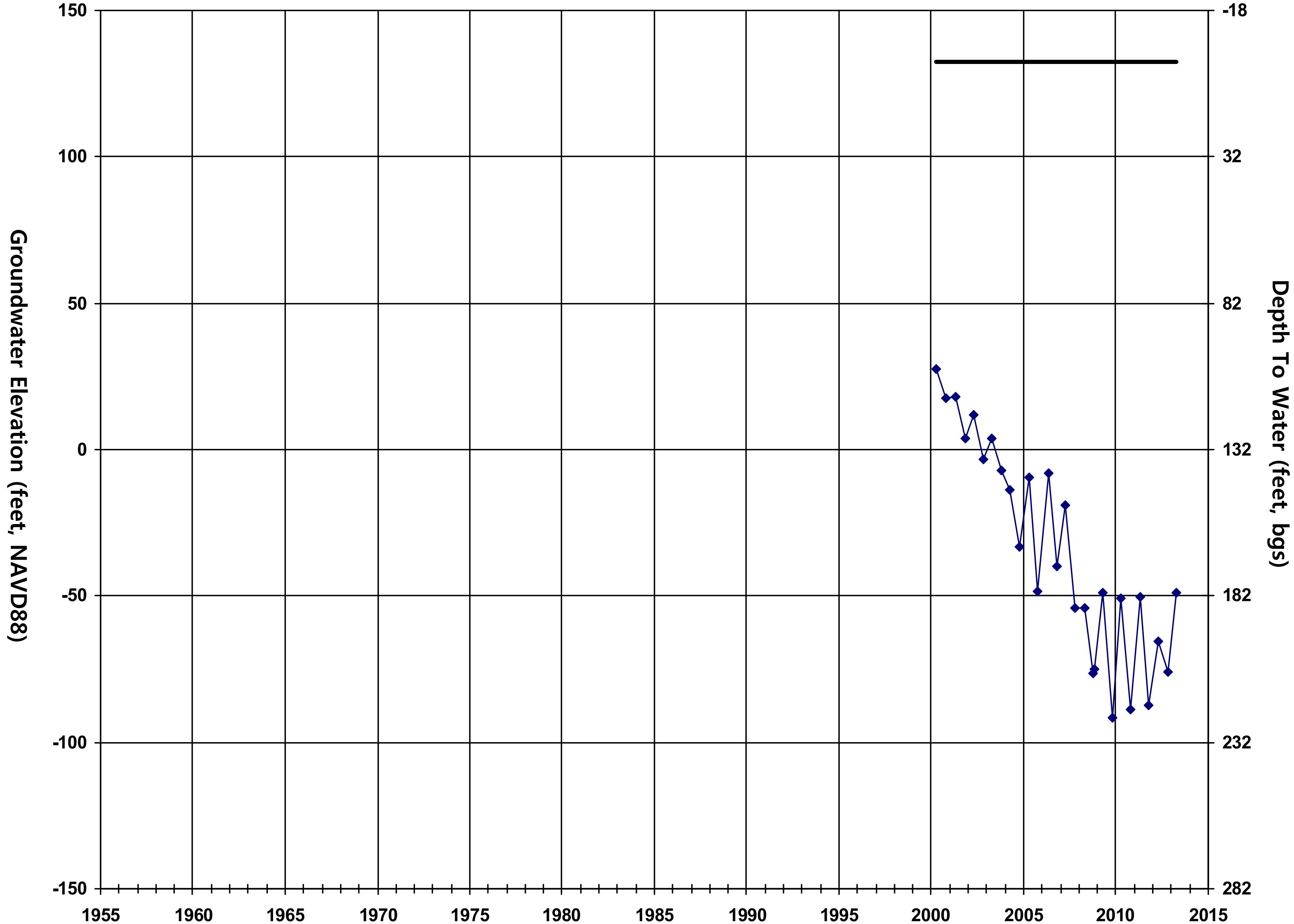


WellID: **NapaCounty-22** RPE: 257.7 Subarea: NVF_MST

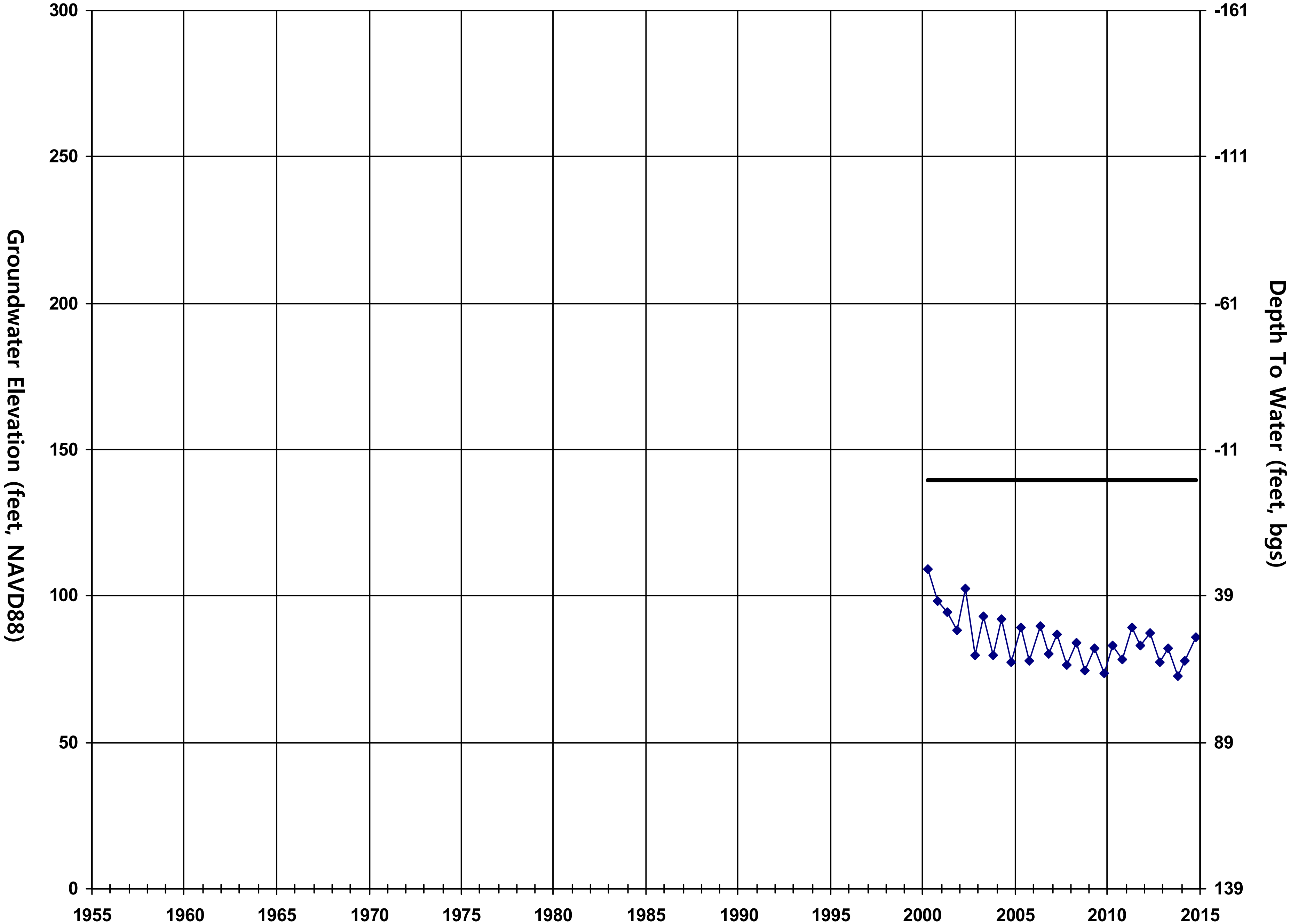
SWN: 005N003W08E001M Source: NapaCounty Aq_Desig: NA



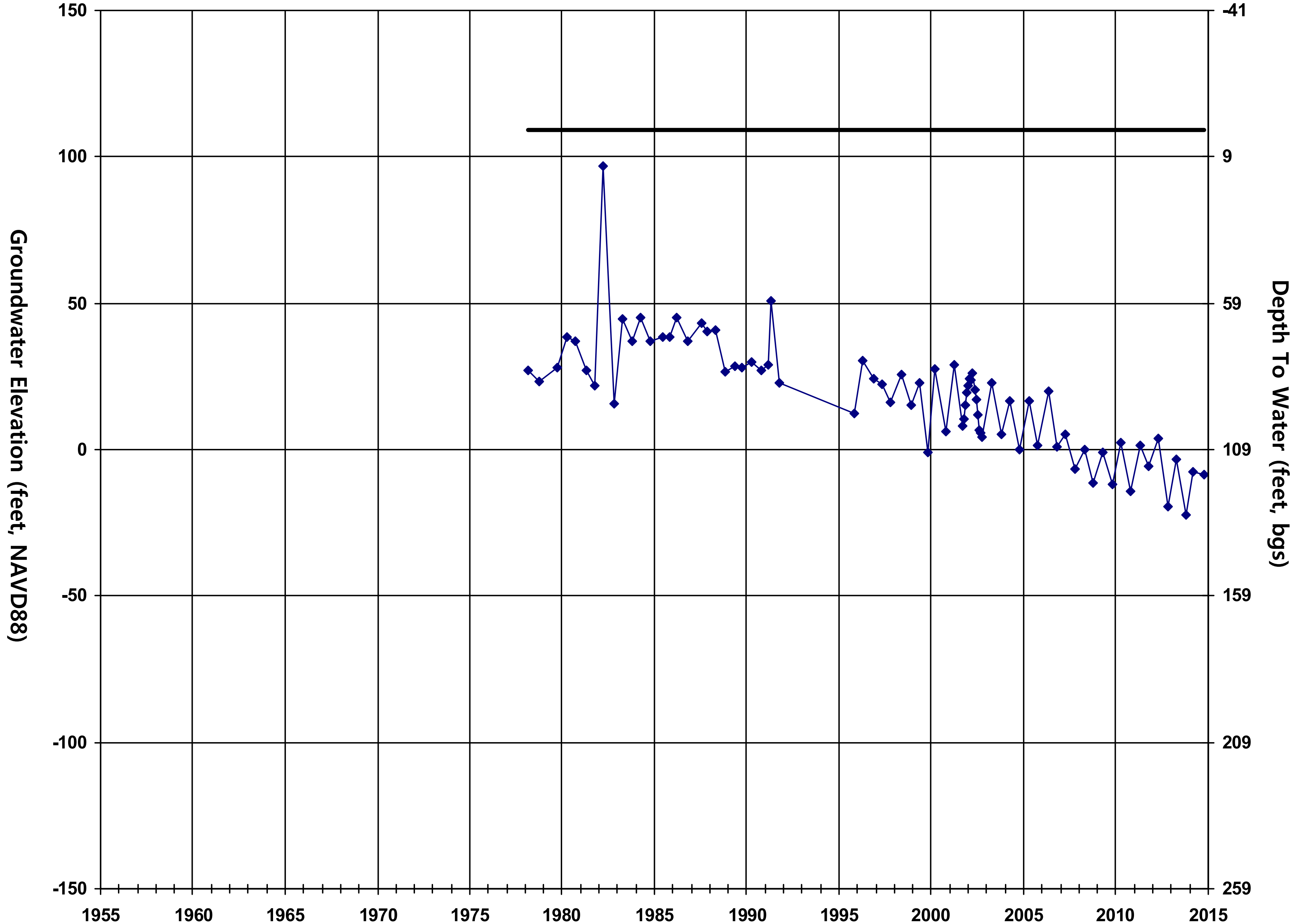
WellID: NapaCounty-29 RPE: 132.8 Subarea: NVF_MST
SWN: 005N004W01F003M Source: NapaCounty Aq_Desig: NA



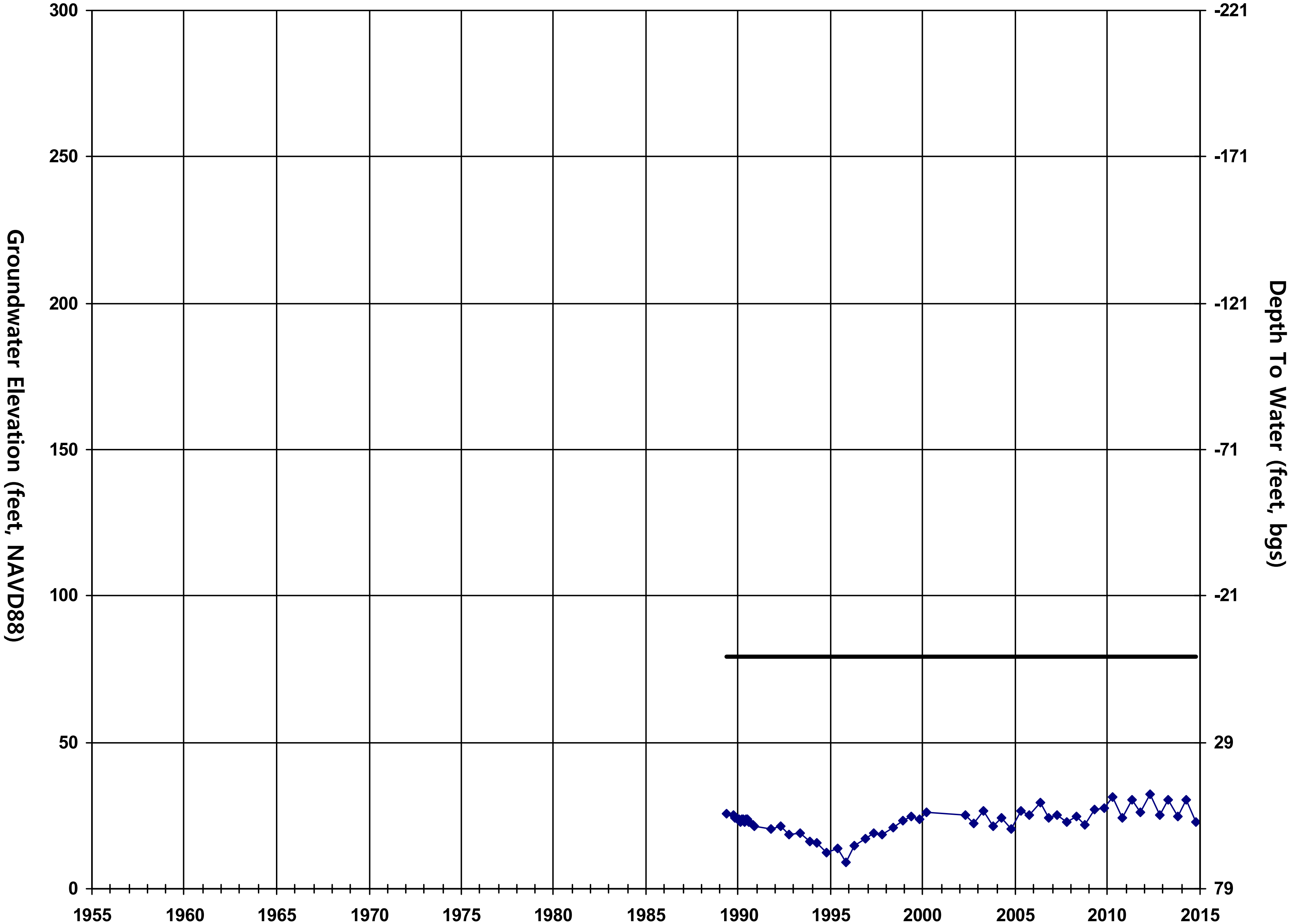
WellID: NapaCounty-35 RPE: 139.6 Subarea: NVF_MST
SWN: 005N003W18D001M Source: NapaCounty Aq_Desig: NA



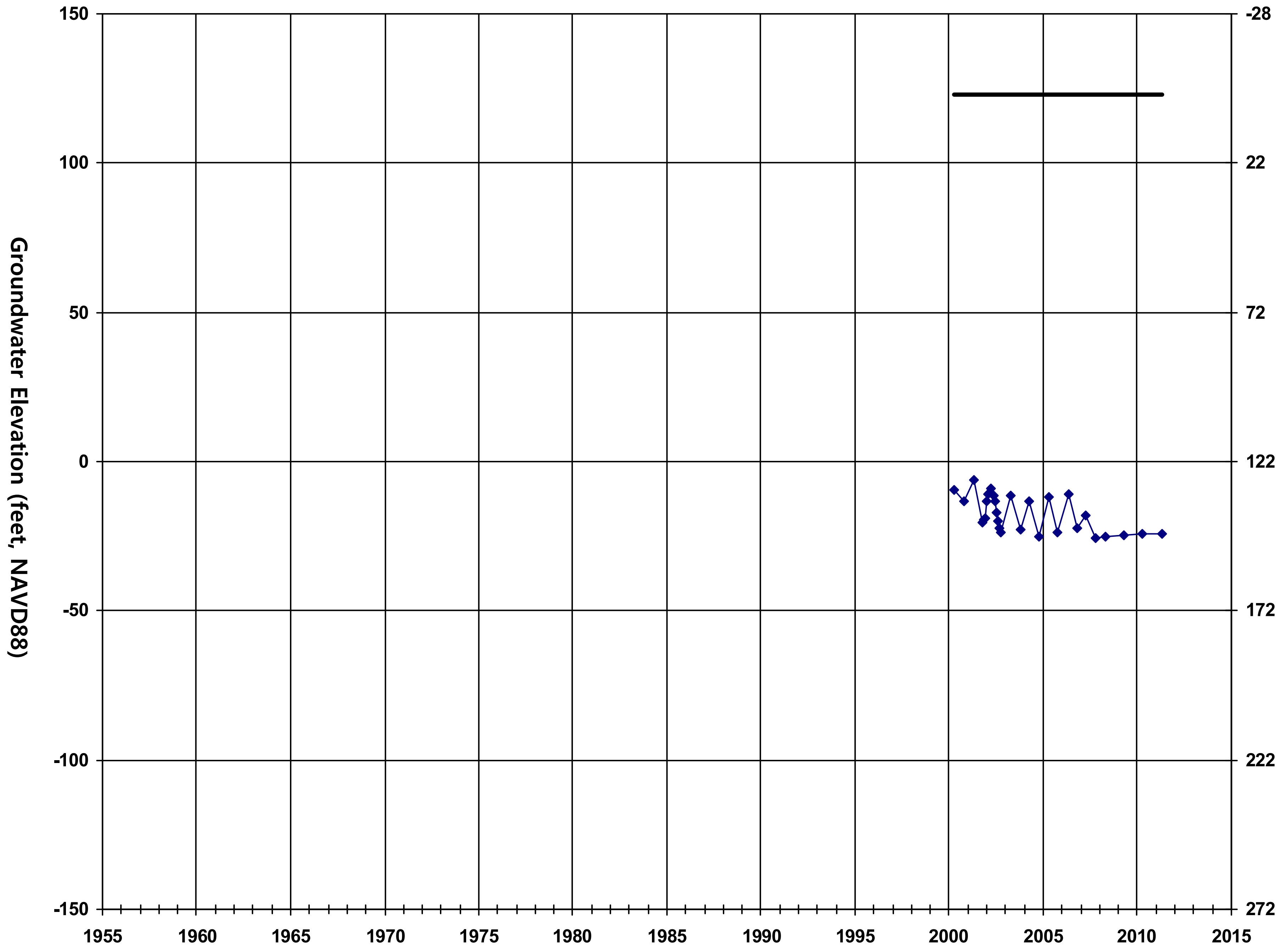
WellID: **NapaCounty-43** RPE: 109 Subarea: NVF_MST
SWN: 006N004W23Q003M Source: NapaCounty Aq_Desig: NA



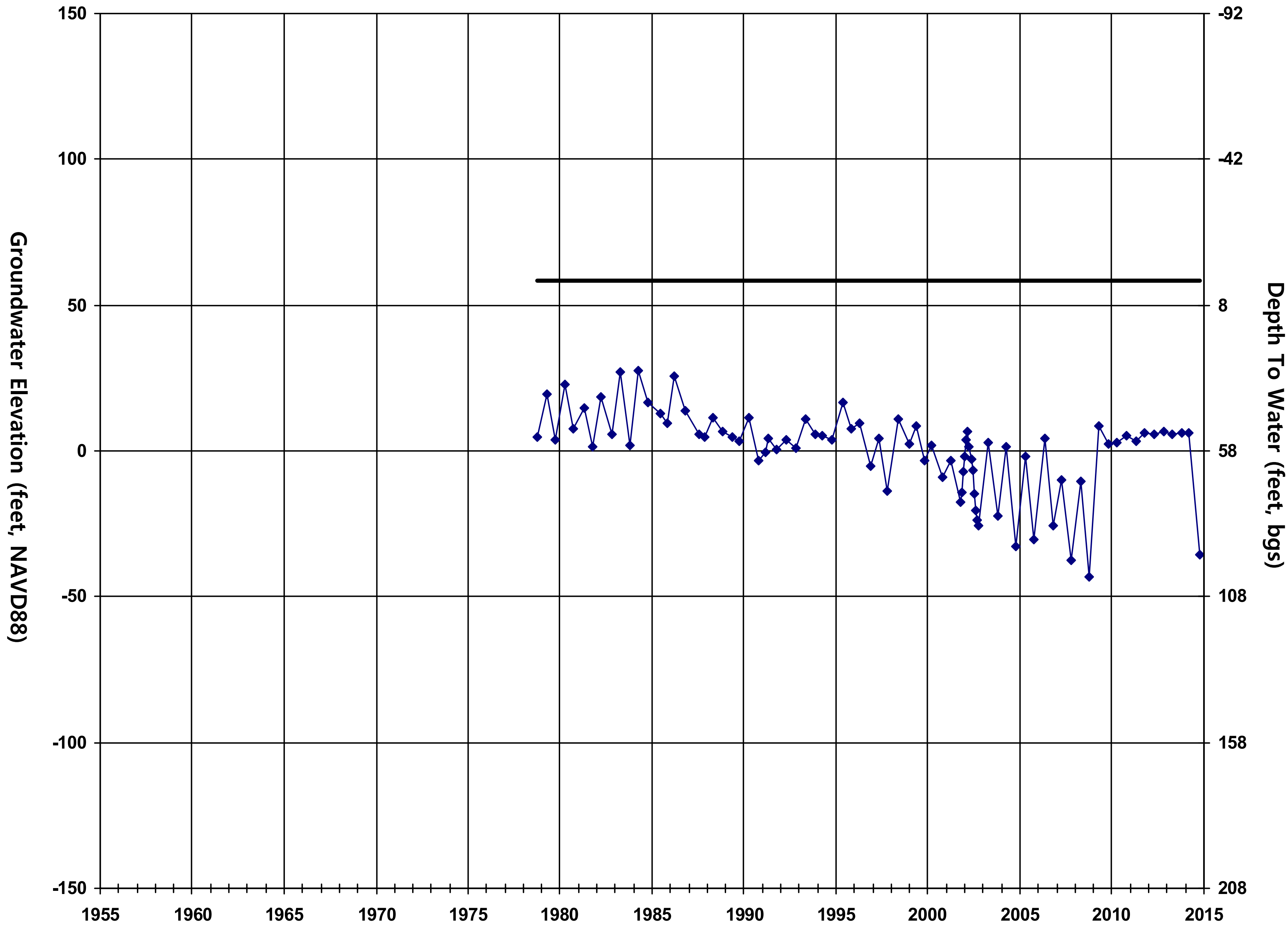
WellID: NapaCounty-49 RPE: 79.5 Subarea: NVF_MST
SWN: 005N004W14J003M Source: NapaCounty Aq_Desig: NA



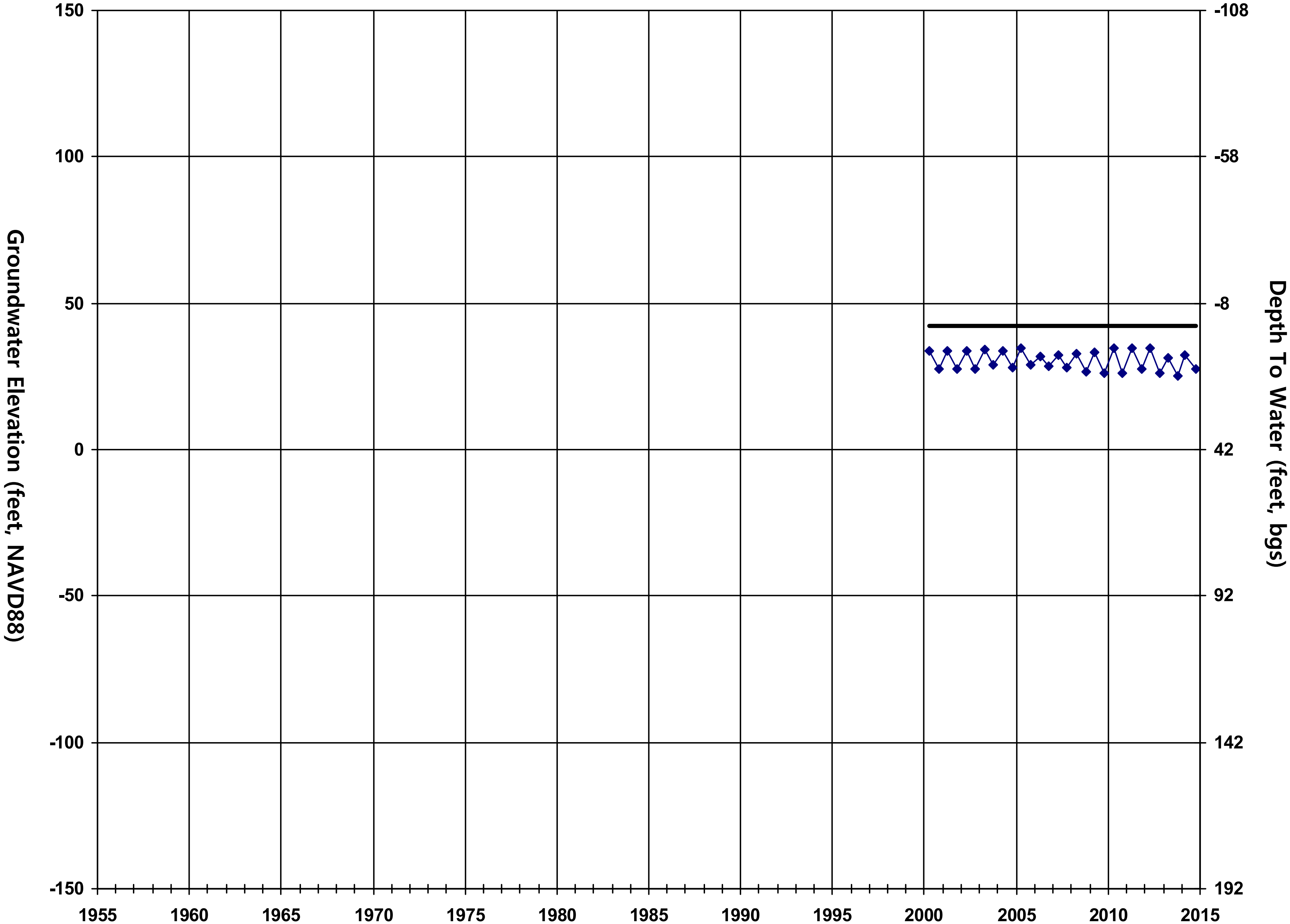
WellID: NapaCounty-51 RPE: 122.9 Subarea: NVF_MST
SWN: 006N004W25G001M Source: NapaCounty Aq_Desig: NA



WellID: **NapaCounty-56** RPE: 58.6 Subarea: NVF_MST
SWN: 006N004W26G001M Source: NapaCounty Aq_Desig: Tss/h

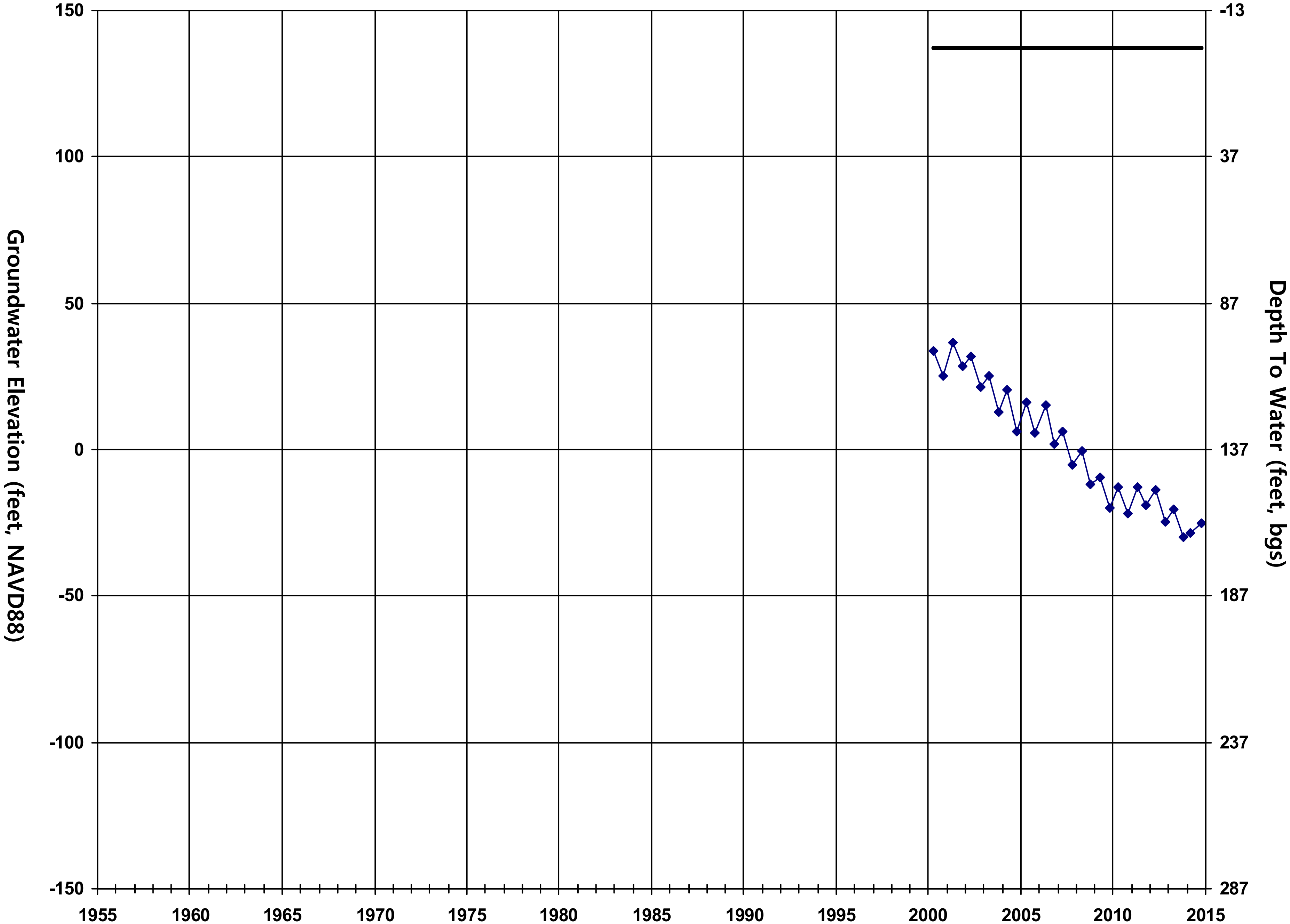


WellID: NapaCounty-69 RPE: 42.1 Subarea: NVF_MST
SWN: 006N004W35G005M Source: NapaCounty Aq_Desig: NA



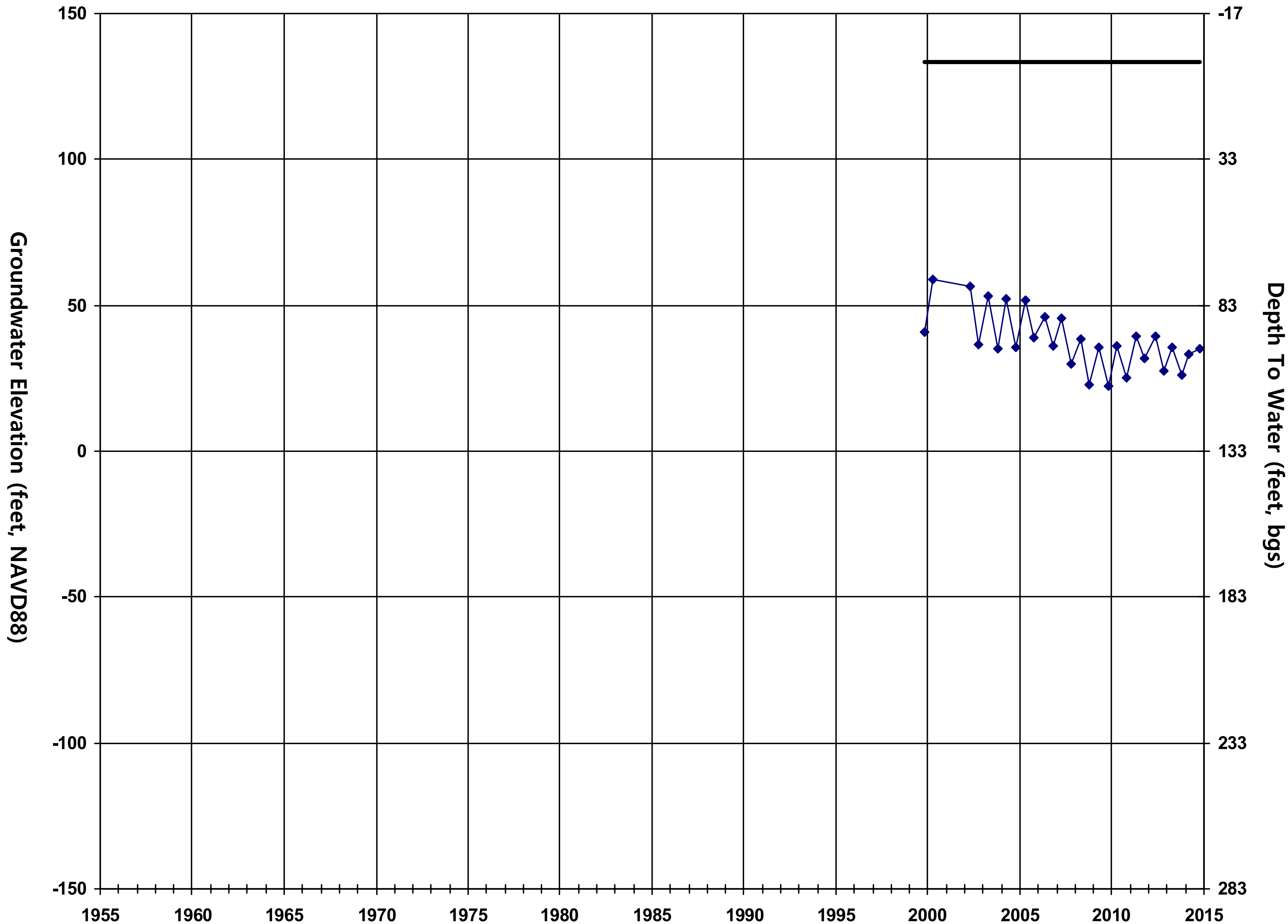
WellID: NapaCounty-72 RPE: 137.1 Subarea: NVF_MST

SWN: 005N003W07D003M Source: NapaCounty Aq_Desig: NA



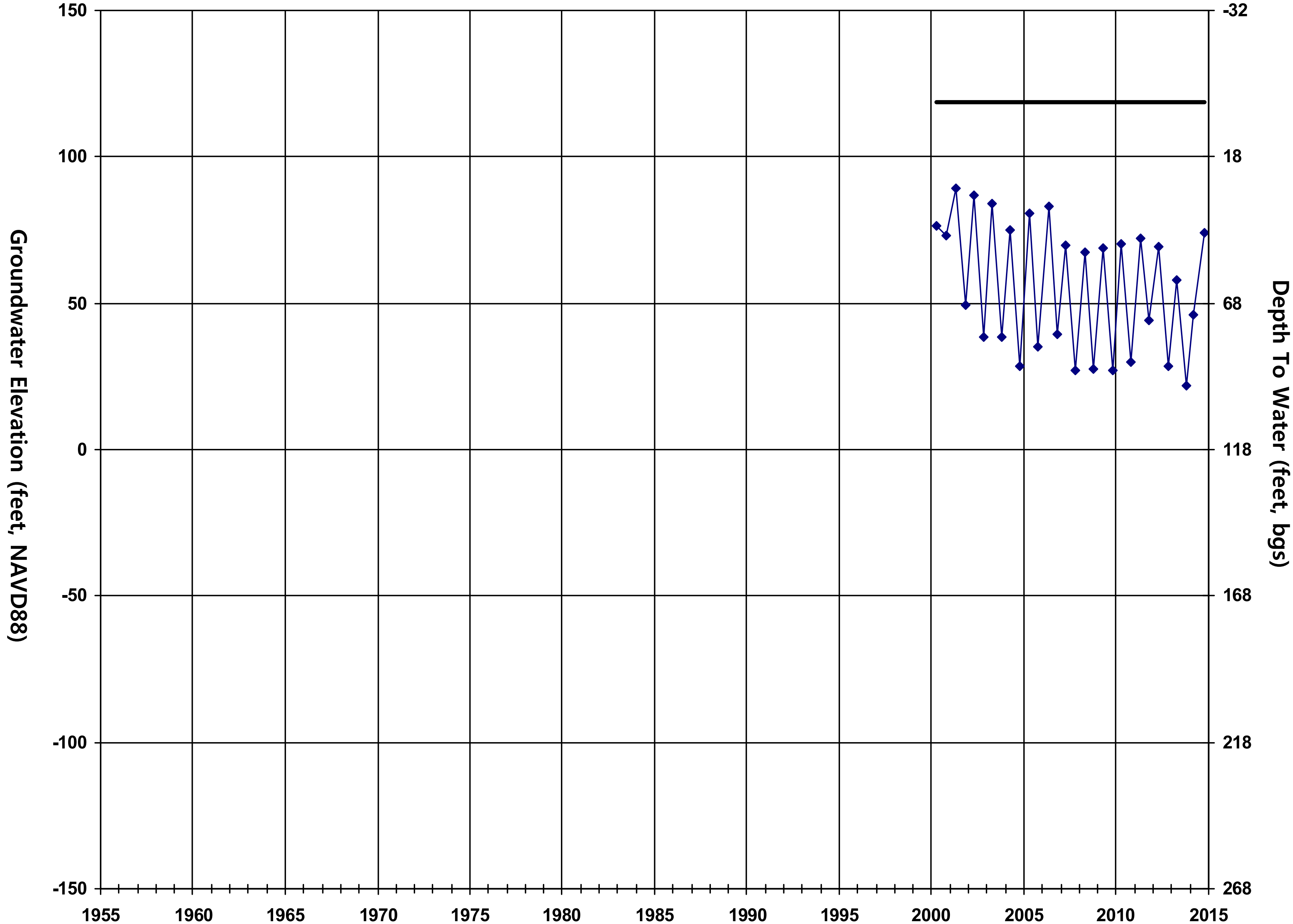
WellID: NapaCounty-74 RPE: 133.3 Subarea: NVF_MST

SWN: 005N003W06M001M Source: NapaCounty Aq_Desig: NA

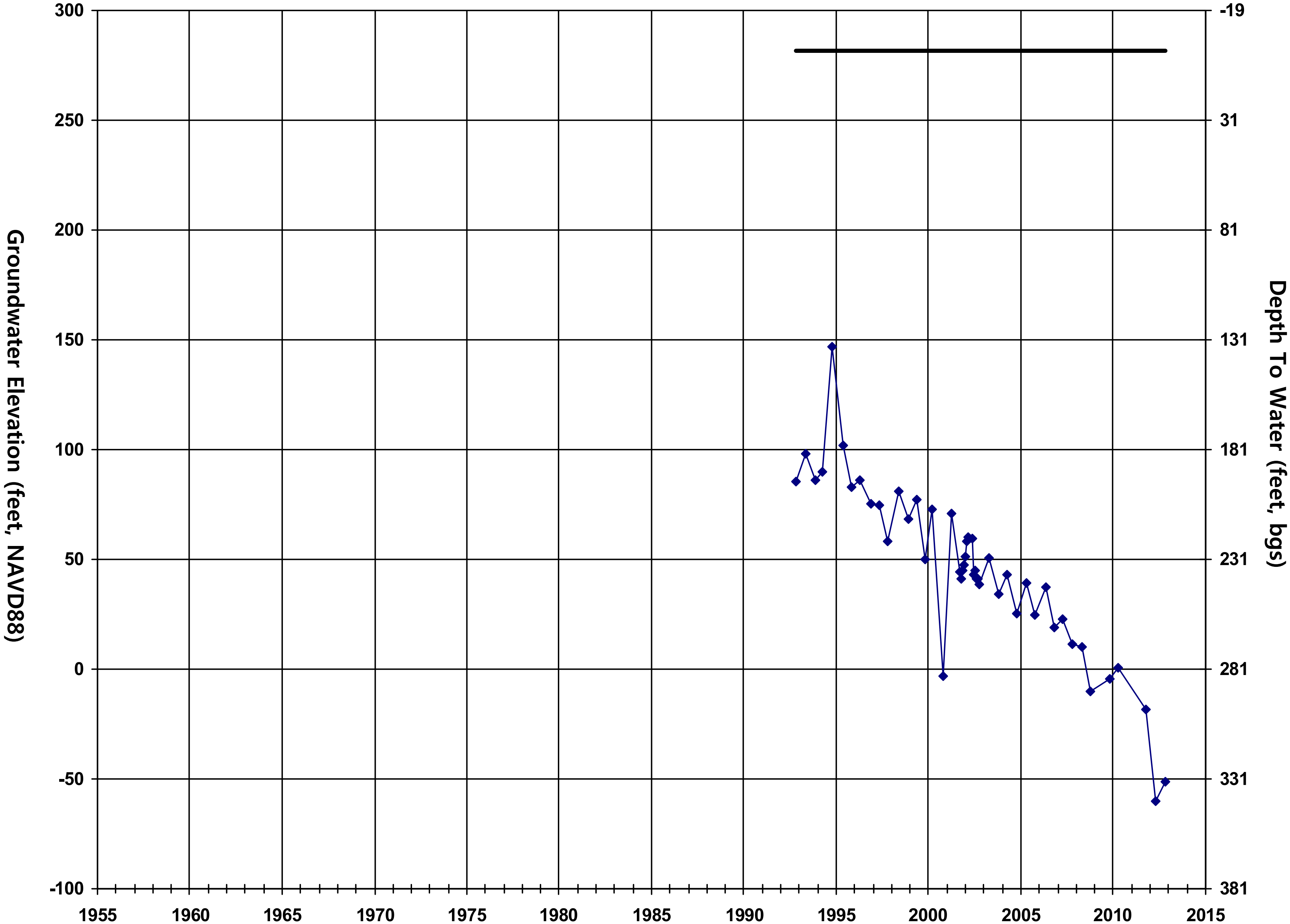


WellID: NapaCounty-81 RPE: 118.6 Subarea: NVF_MST

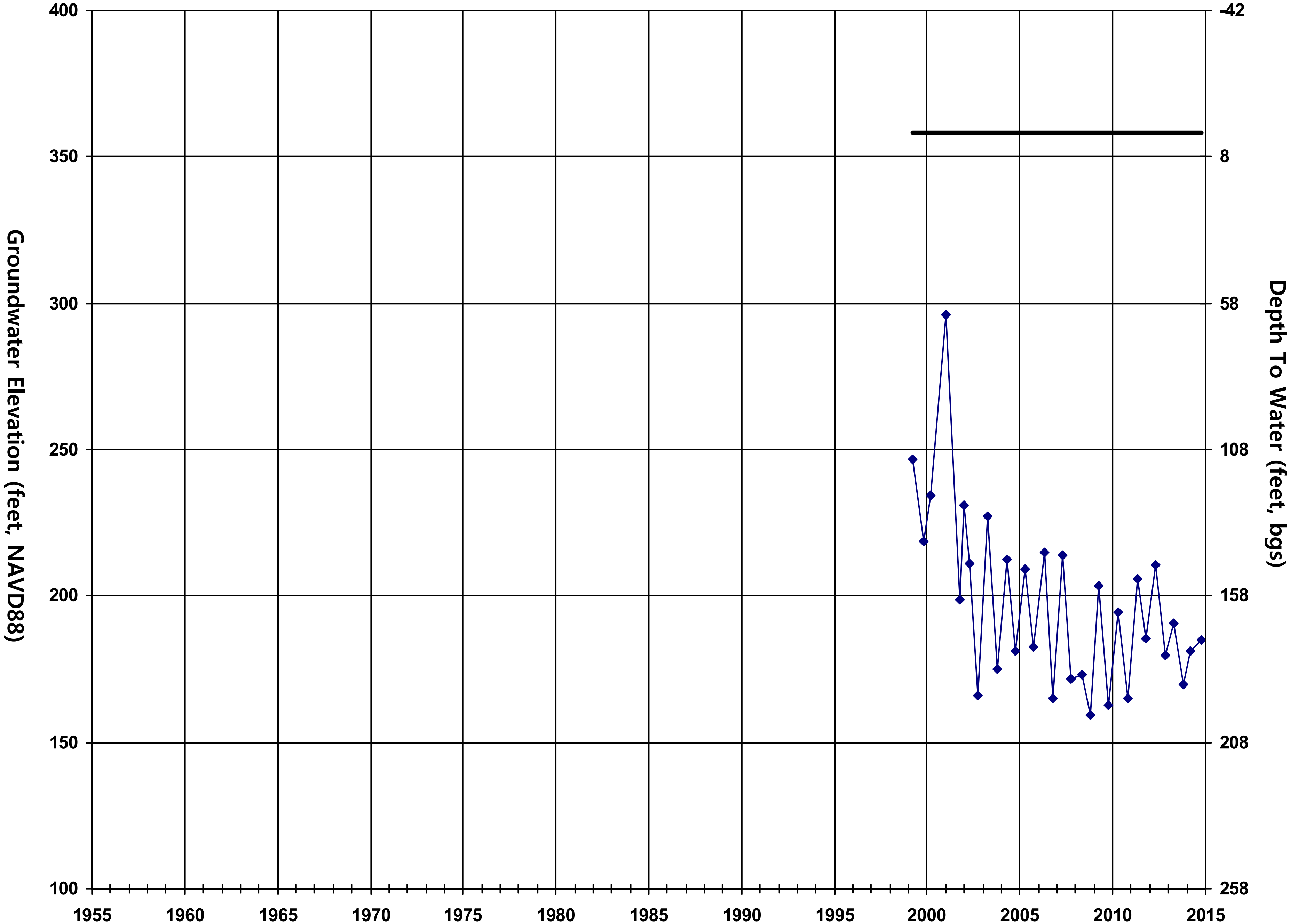
SWN: 005N003W07F003M Source: NapaCounty Aq_Desig: NA



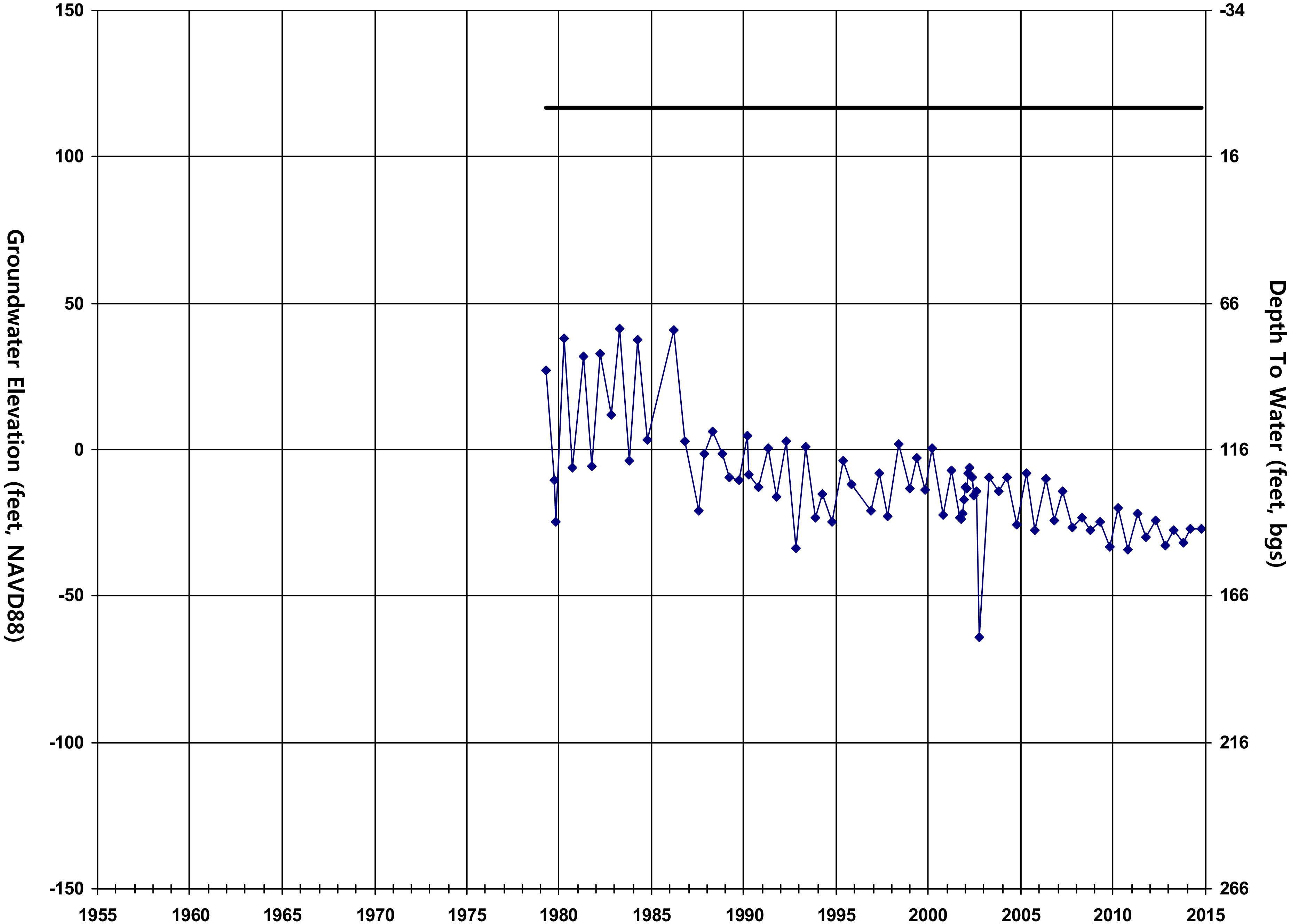
WellID: NapaCounty-91 RPE: 281.9 Subarea: NVF_MST
SWN: 005N003W06B002M Source: NapaCounty Aq_Desig: Tsvt, outcrops to E,



WellID: NapaCounty-92 RPE: 358.2 Subarea: NVF_MST
SWN: 005N003W06A001M Source: NapaCounty Aq_Desig: NA

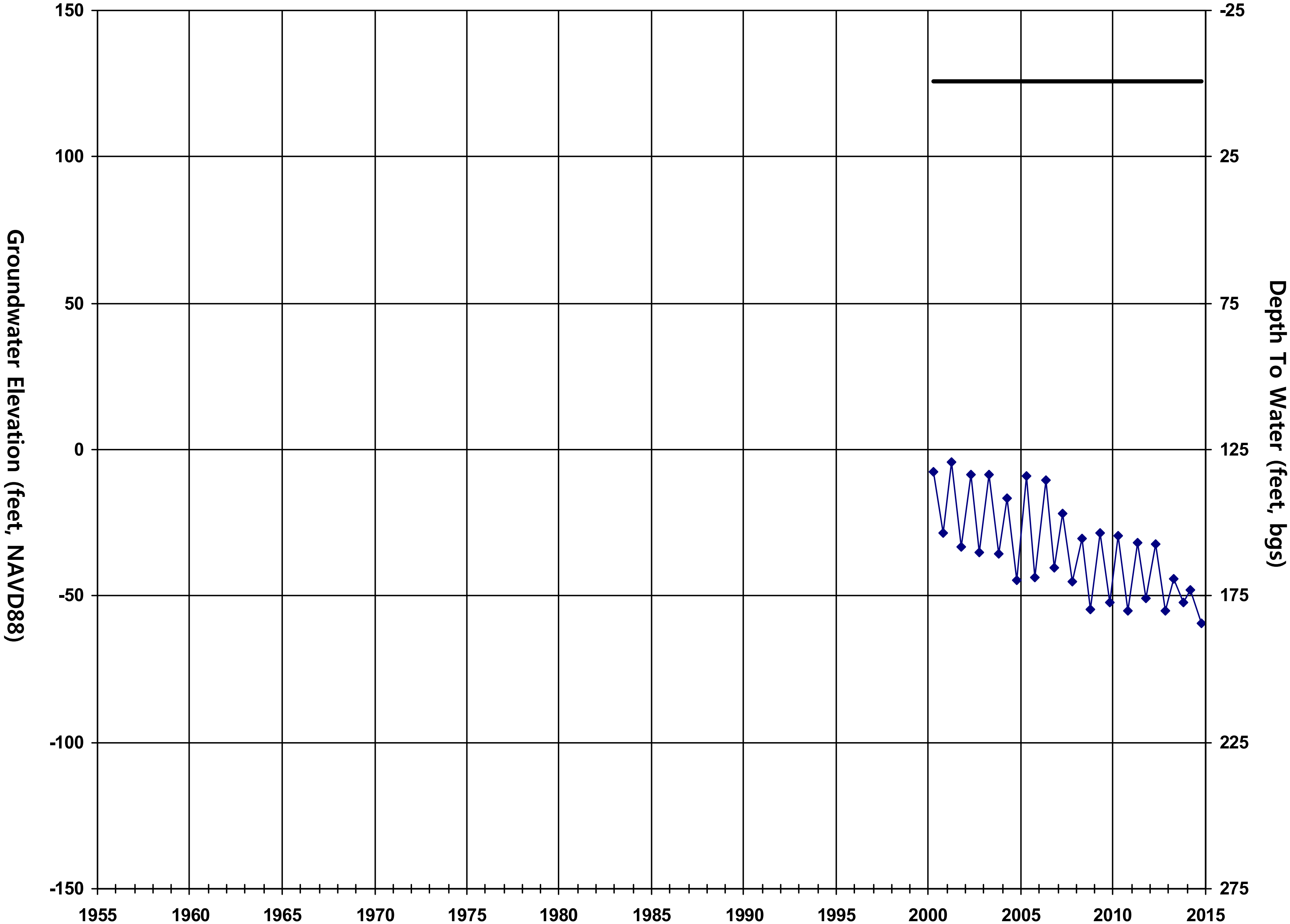


WellID: NapaCounty-95 RPE: 116.9 Subarea: NVF_MST
SWN: 006N004W36G001M Source: NapaCounty Aq_Desig: Tsvt, outcrops to SE

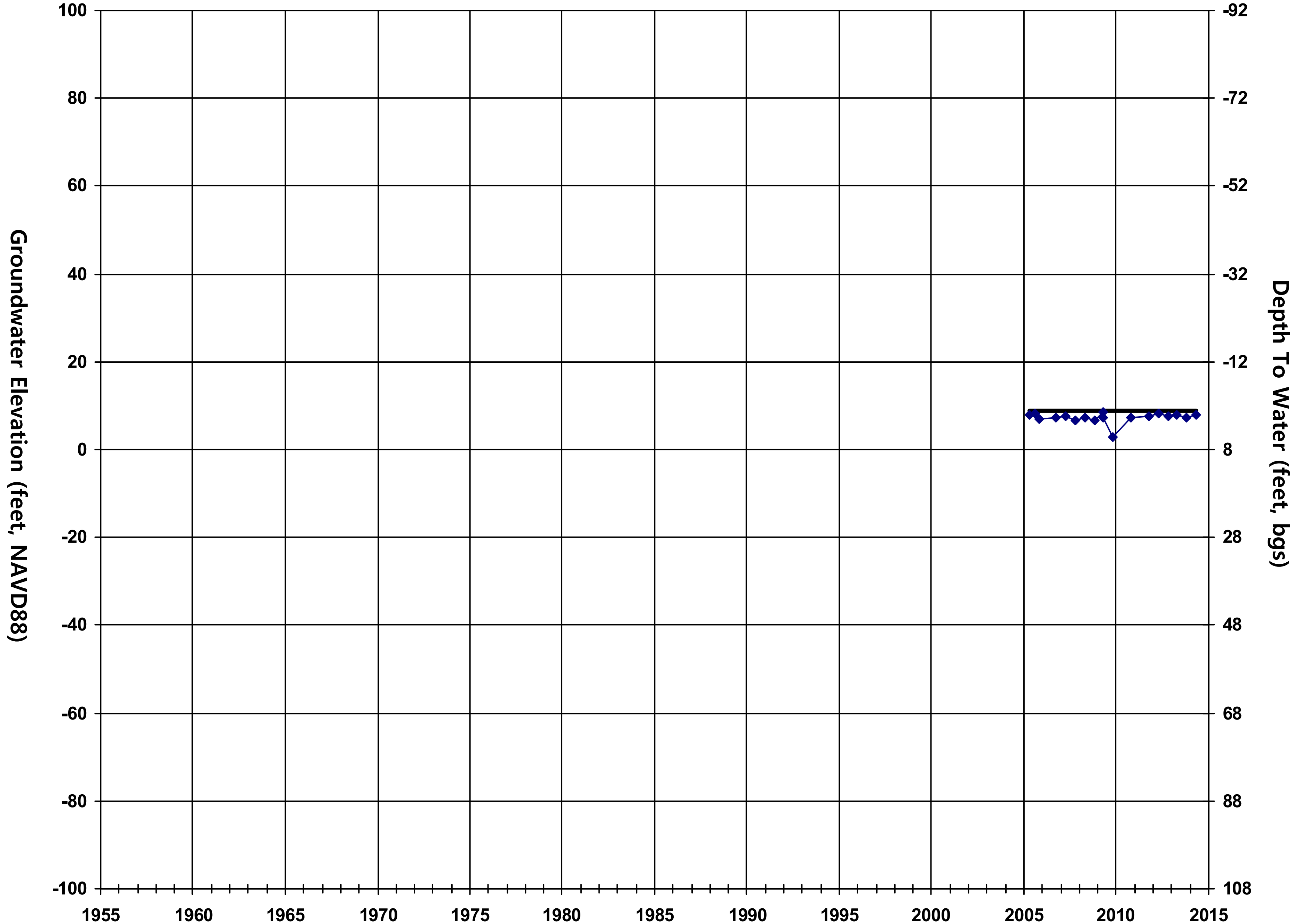


WellID: NapaCounty-98 RPE: 125.7 Subarea: NVF_MST

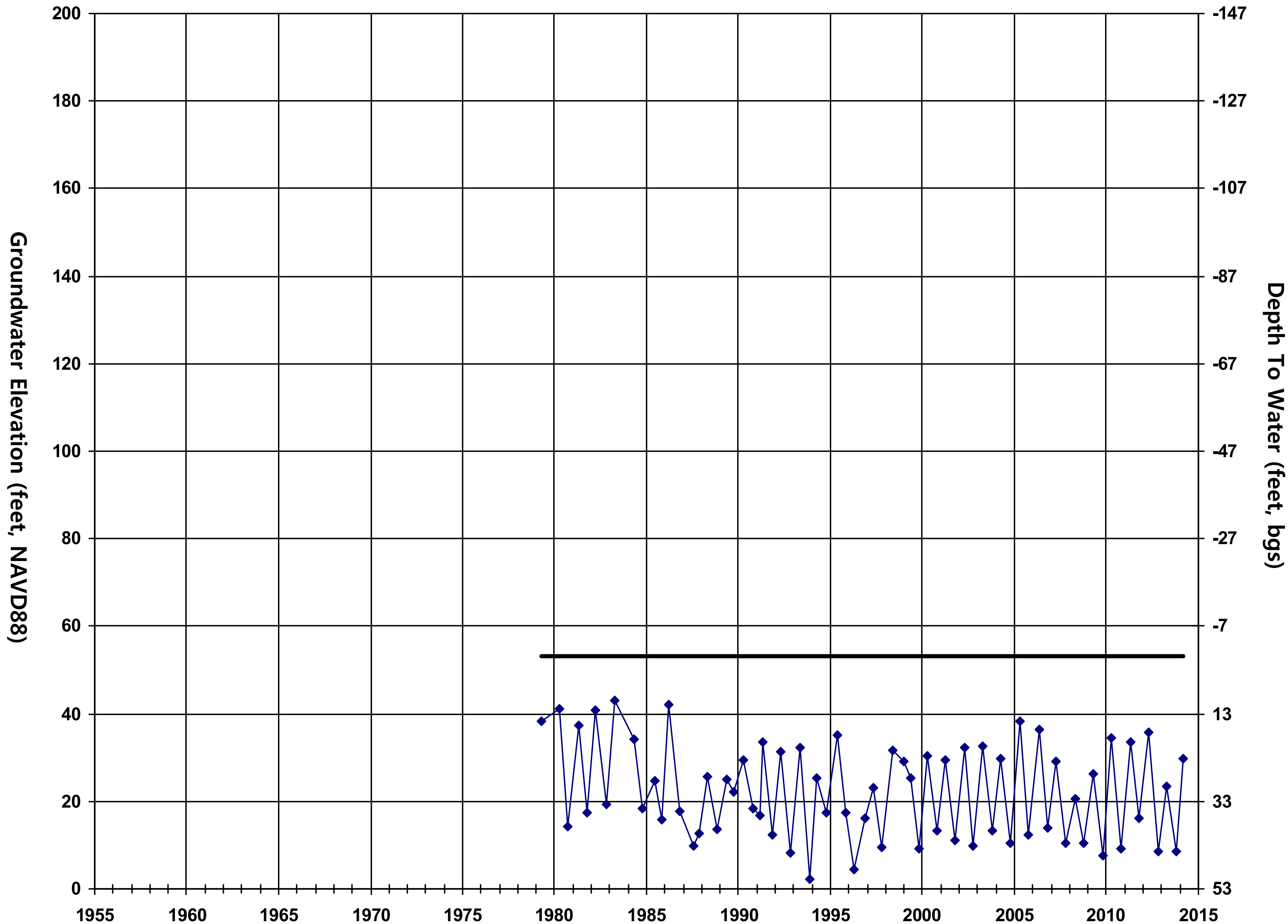
SWN: 006N004W36A001M Source: NapaCounty Aq_Desig: NA



WellID: **L10002804480DW-1** RPE: 8.73 Subarea: NVF_MST
SWN: Unknown Source: Geotracker Aq_Desig: NA

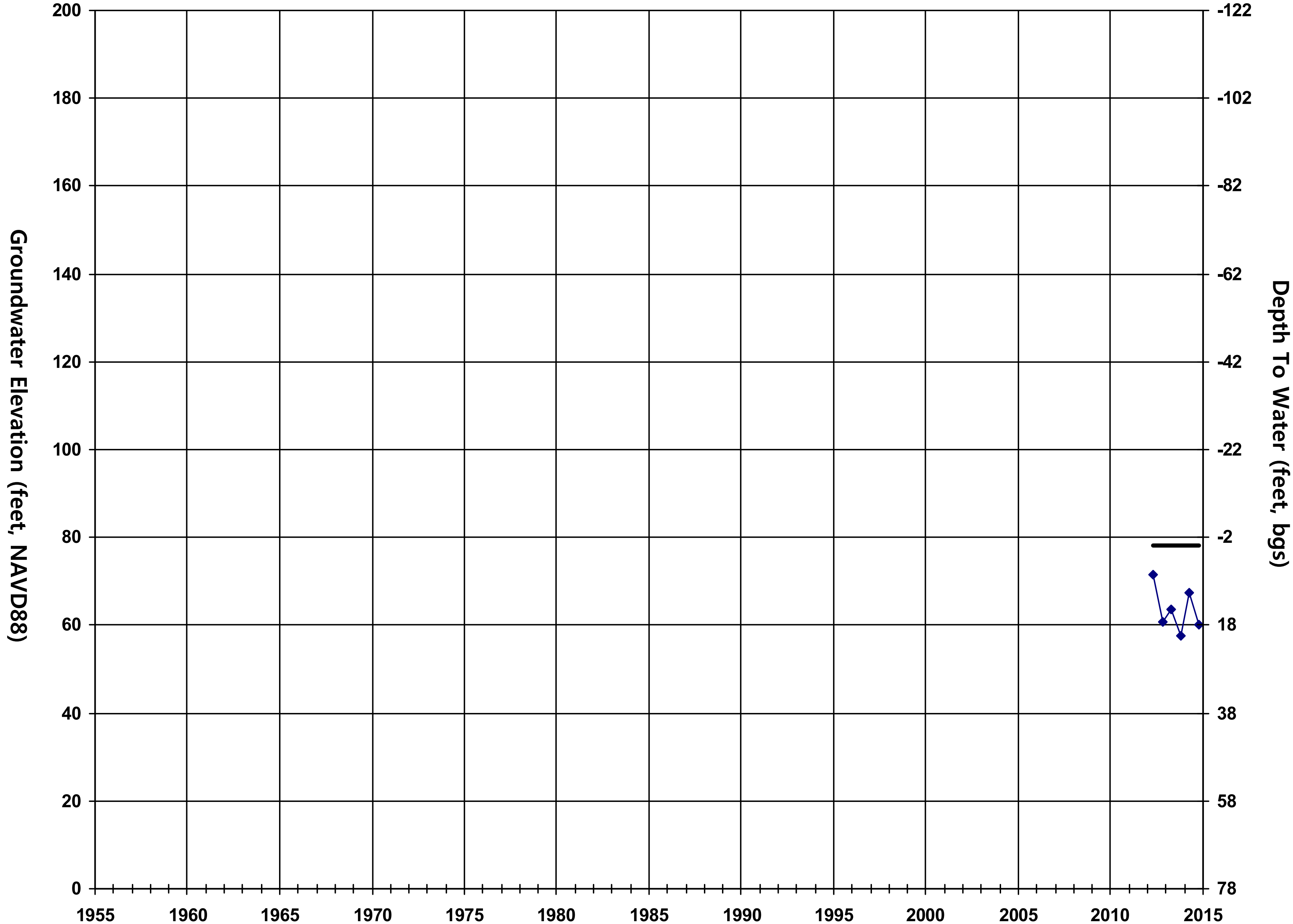


WellID: NapaCounty-136 RPE: 53.2 Subarea: NVF_Napa
SWN: 006N004W27N001M Source: NapaCounty Aq_Desig: NA

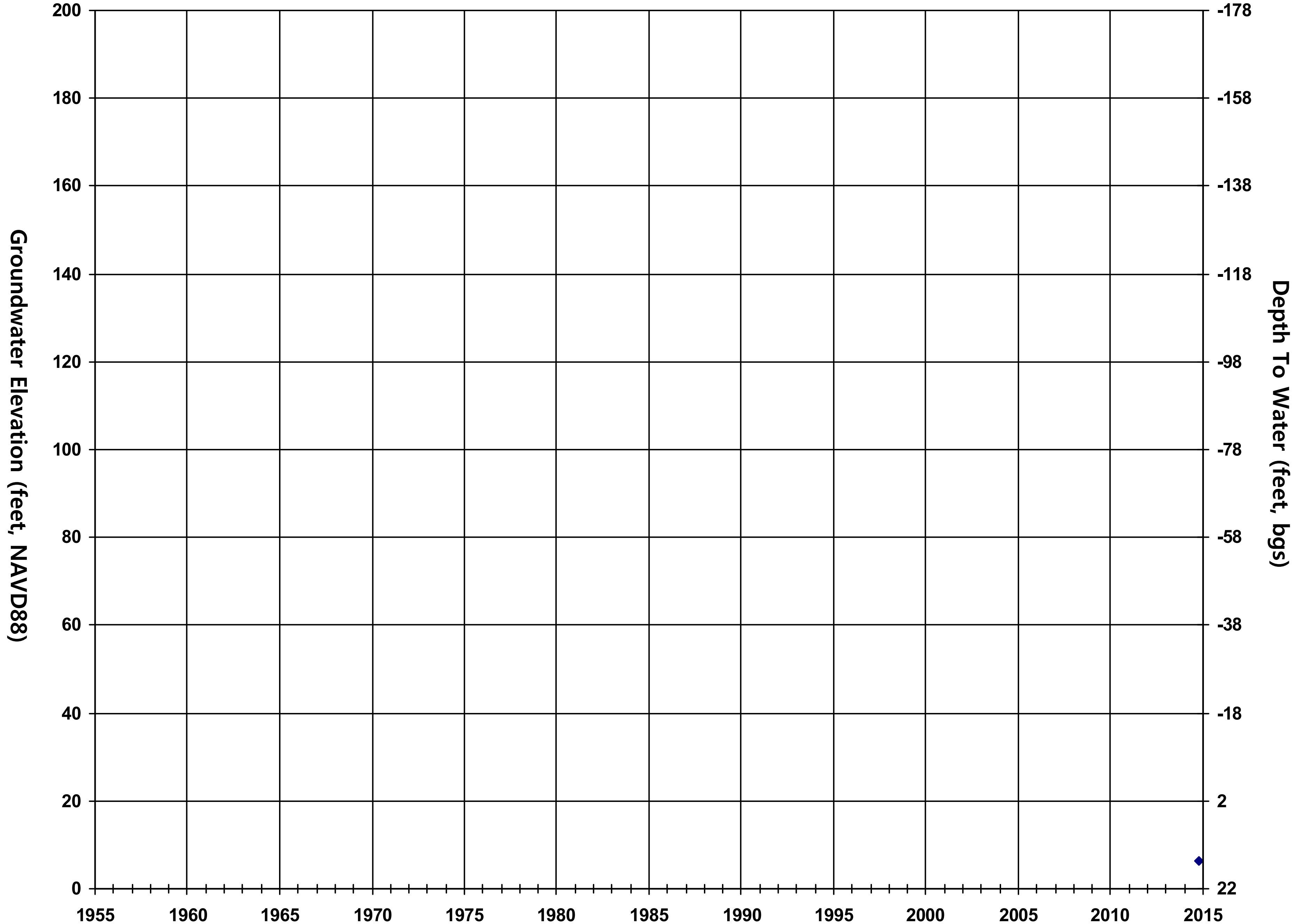


WellID: NapaCounty-152 RPE: 78.3 Subarea: NVF_Napa

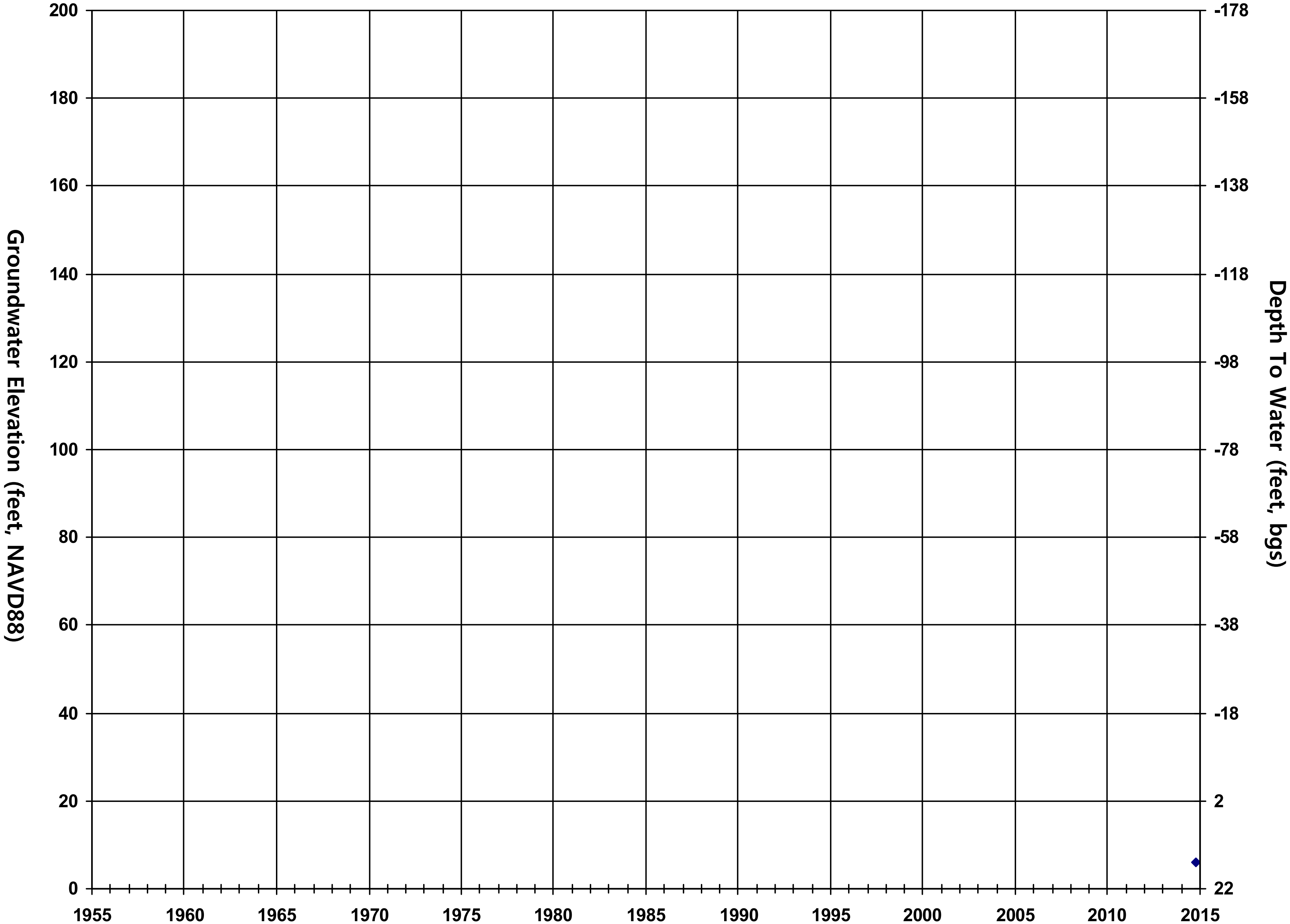
SWN: 006N004W28Mx Source: NapaCounty Aq_Desig: NA



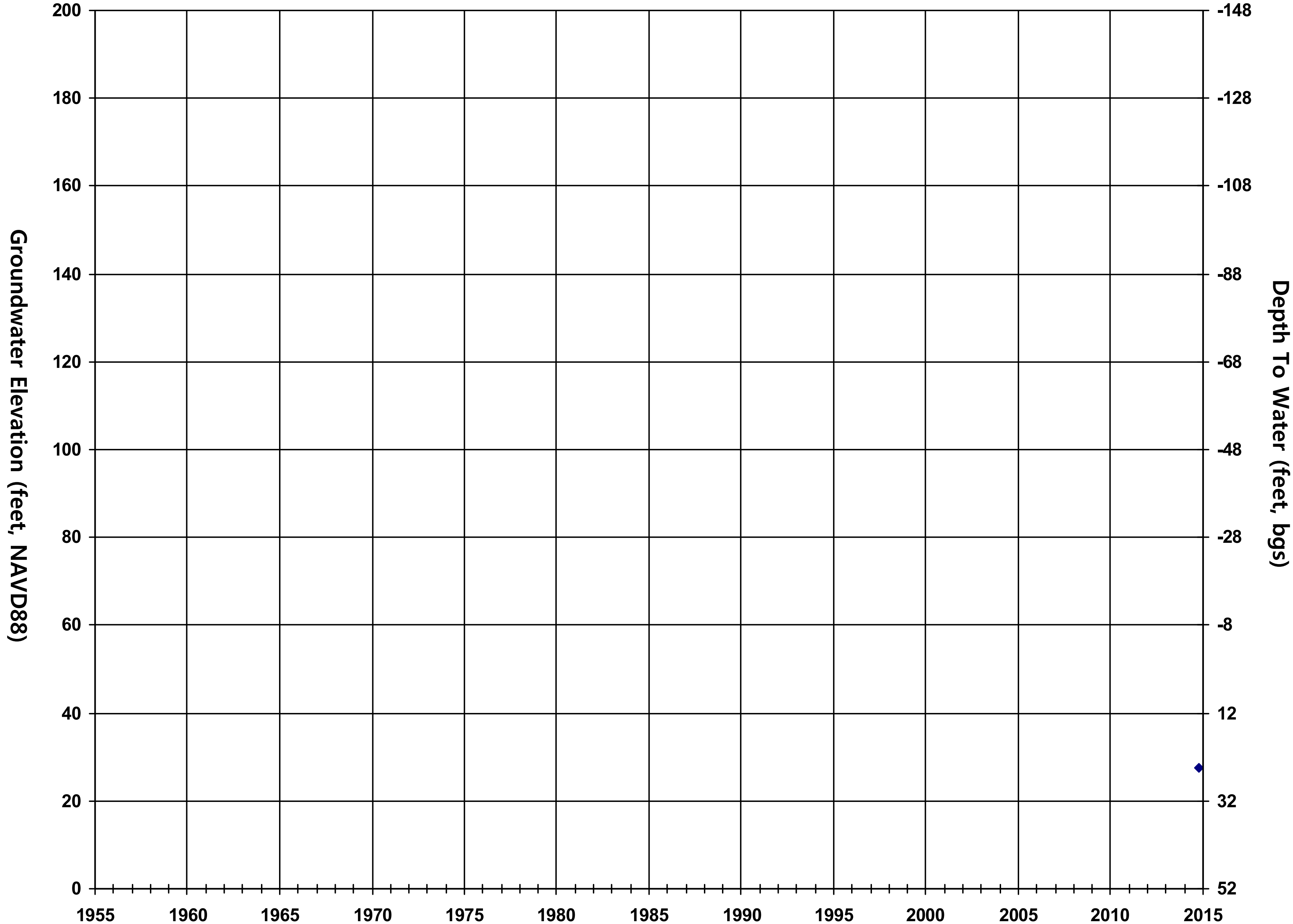
WellID: **NapaCounty-214s-swgw1** RPE: 22.1 Subarea: NVF_Napa
SWN: Unknown Source: NapaCounty Aq_Desig: NA



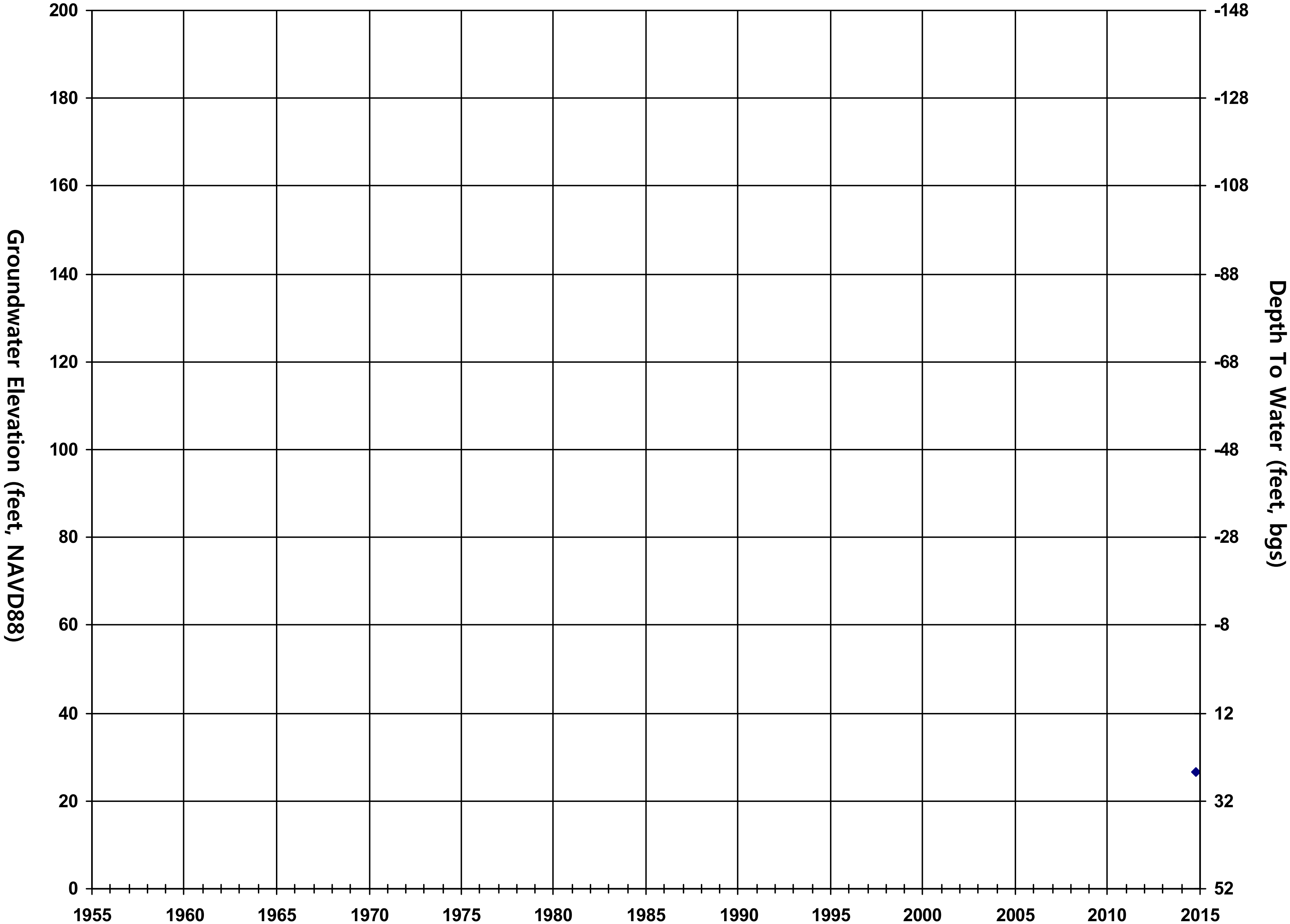
WellID: NapaCounty-215d-swgw1	RPE: 22.05	Subarea:	NVF_Napa
SWN: Unknown	Source: NapaCounty	Aq_Desig:	NA



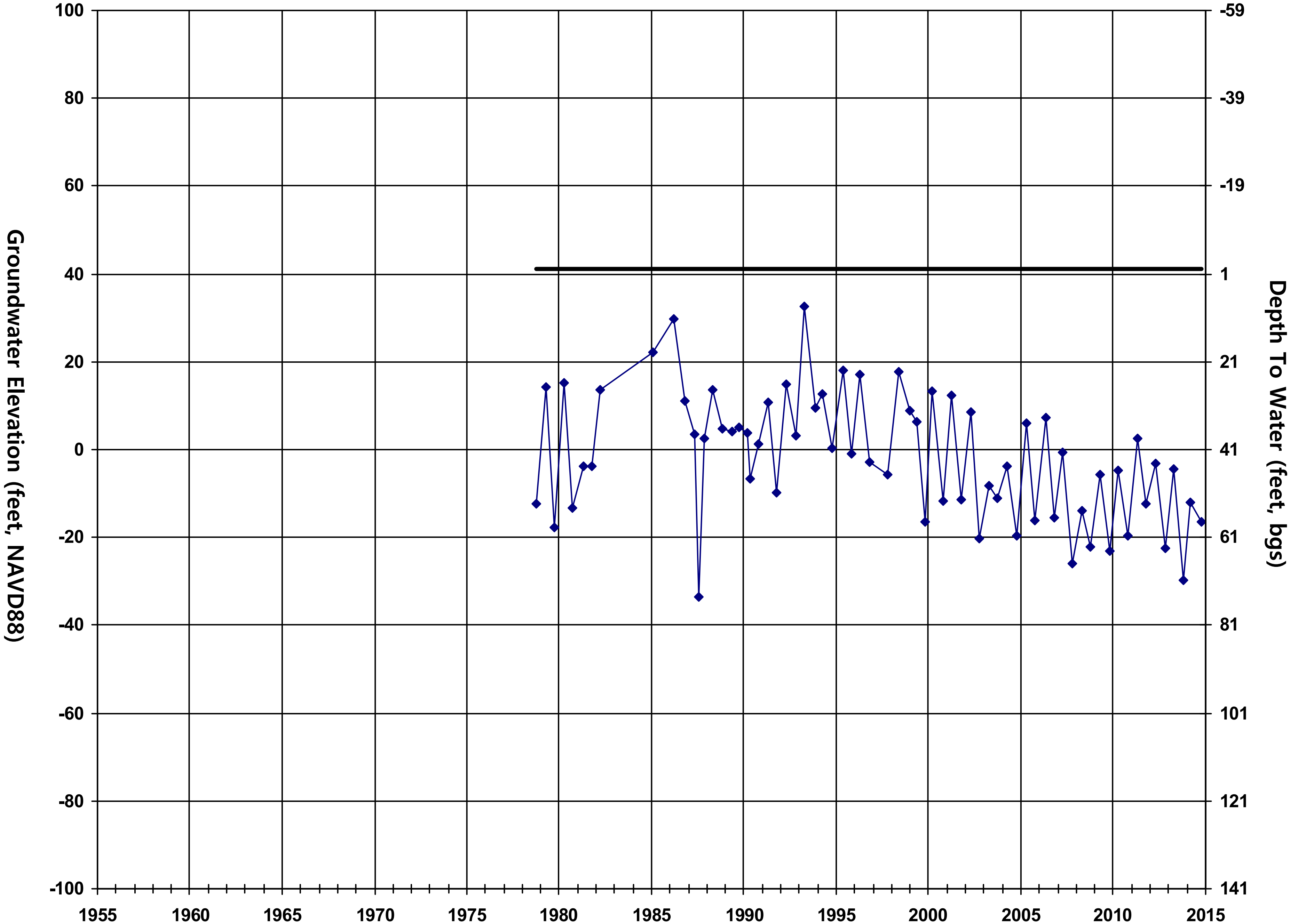
WellID: NapaCounty-218s-swgw3 RPE: 52.8 Subarea: NVF_Napa
SWN: Unknown Source: NapaCounty Aq_Desig: NA



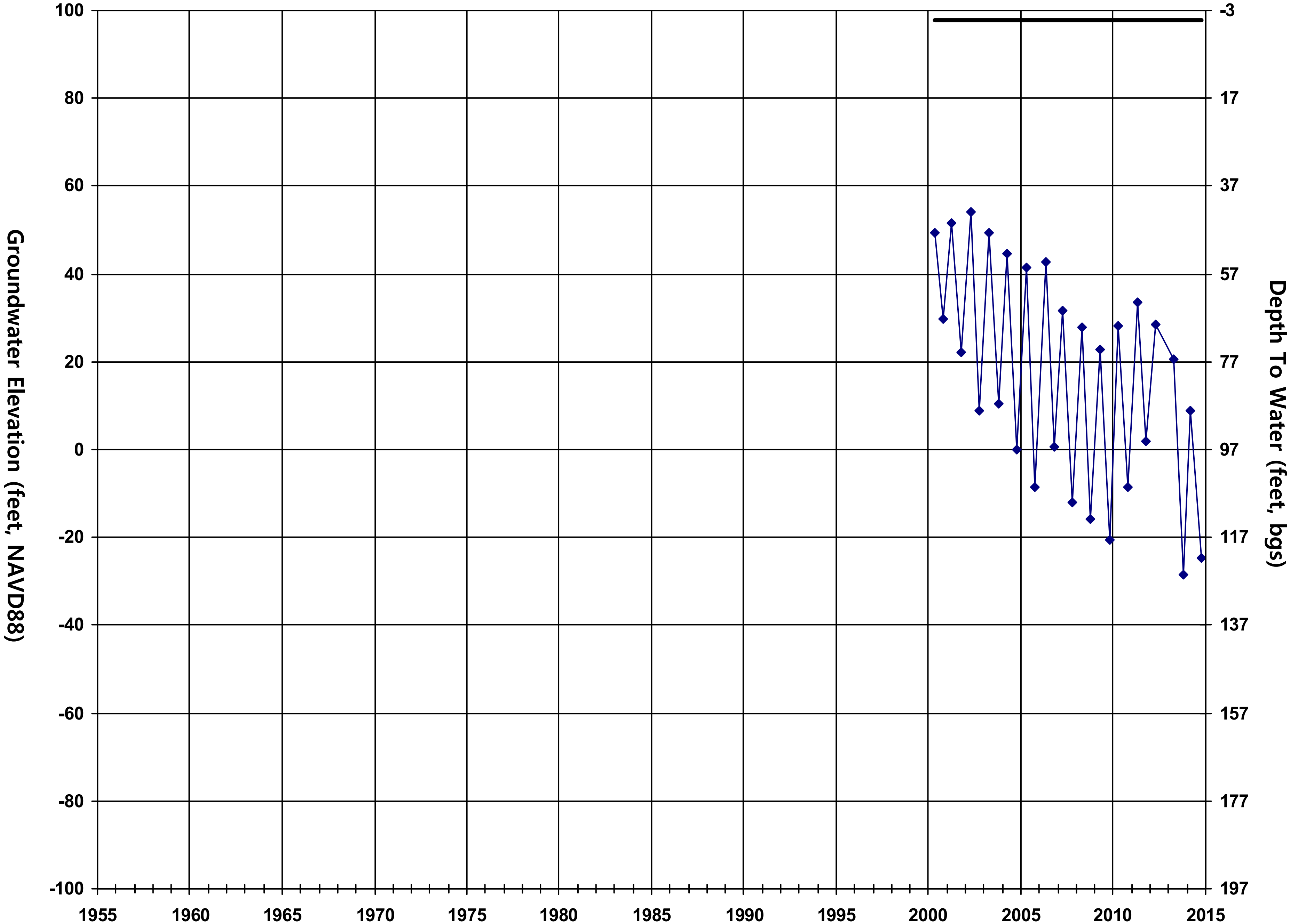
WellID: NapaCounty-219d-swgw3 RPE: 52.75 Subarea: NVF_Napa
SWN: Unknown Source: NapaCounty Aq_Desig: NA



WellID: NapaCounty-75 RPE: 41.2 Subarea: NVF_Napa
SWN: 006N004W22R001M Source: NapaCounty Aq_Desig: Qa, Tss/h?



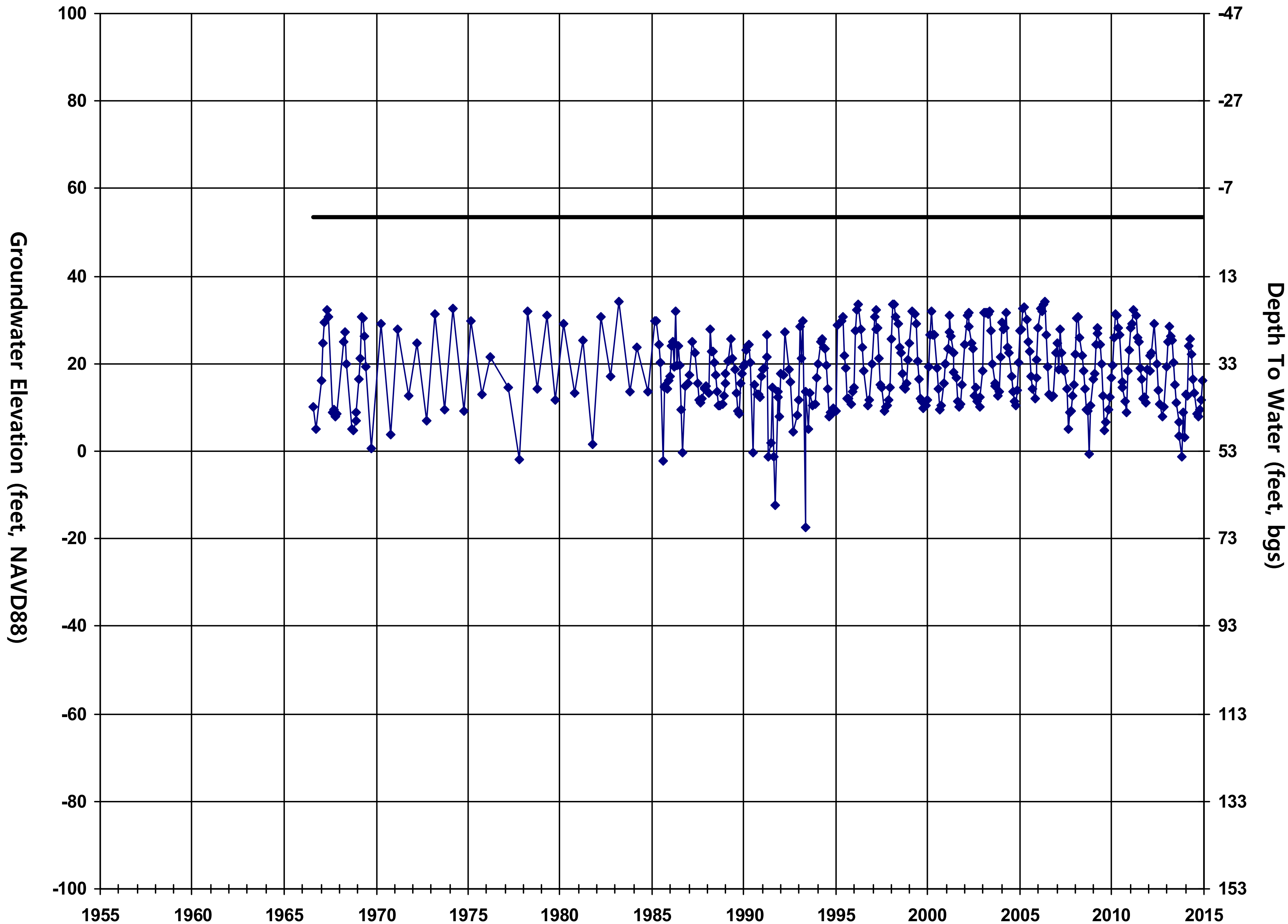
WellID: NapaCounty-76 RPE: 97.7 Subarea: NVF_Napa
SWN: 006N004W15R003M Source: NapaCounty Aq_Desig: NA



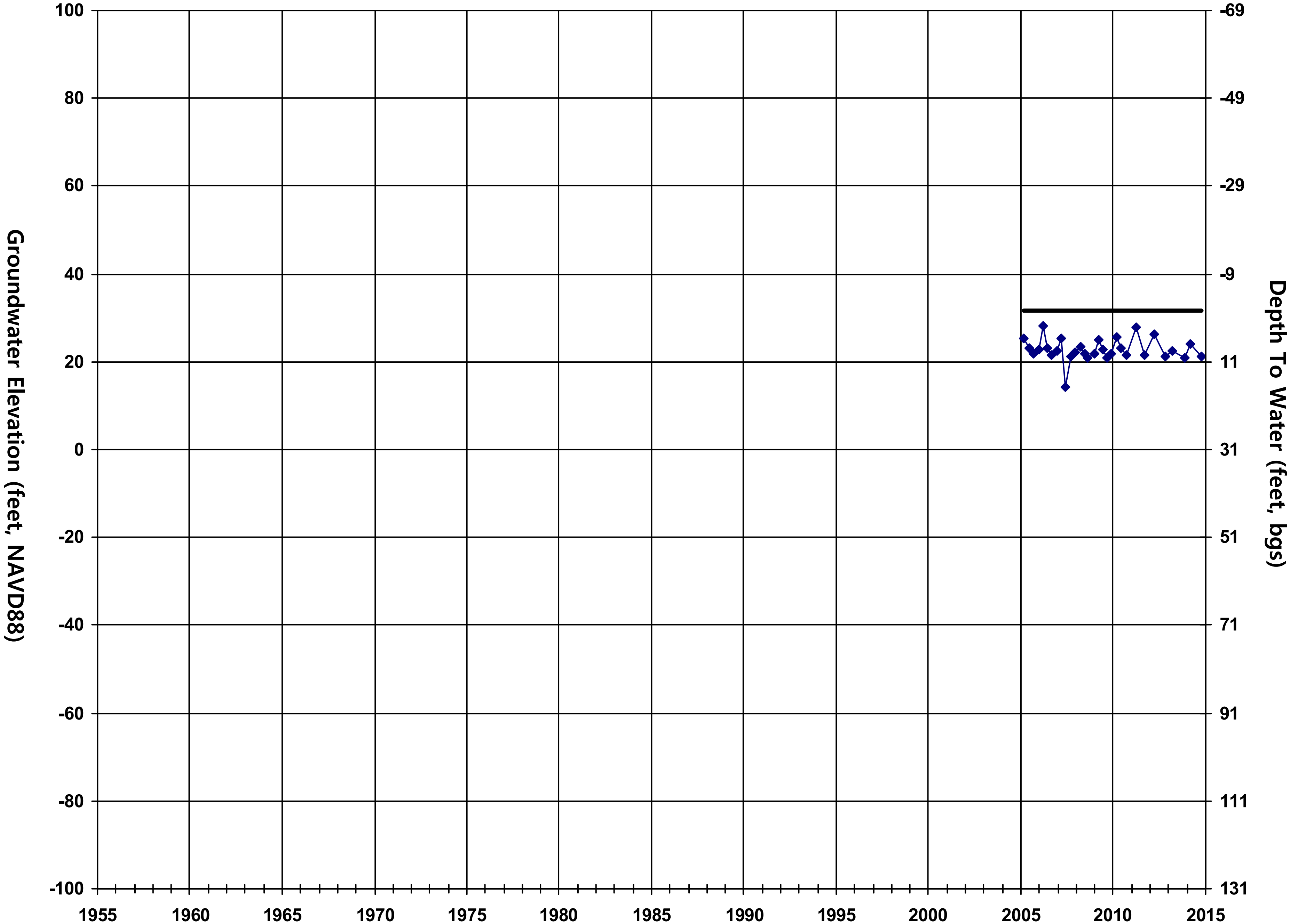
WellID: **06N04W27L002M**
SWN: 006N004W27L002M

RPE: 53.6
Source: DWR

Subarea: NVF_Napa
Aq_Desig: Qa

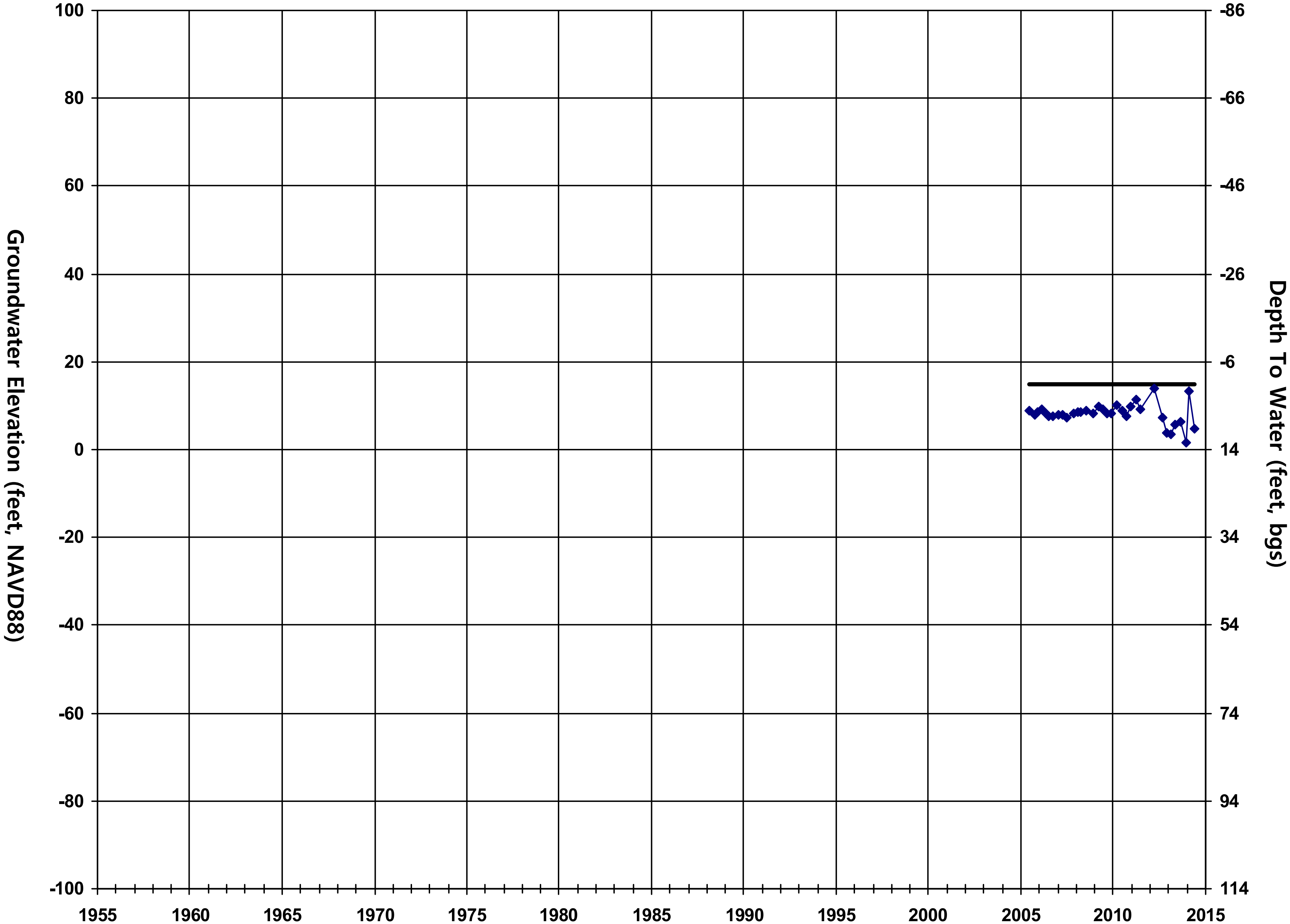


WellID: SL0605536682MW-1 RPE: 31.63 Subarea: NVF_Napa
SWN: Unknown Source: Geotracker Aq_Desig: NA

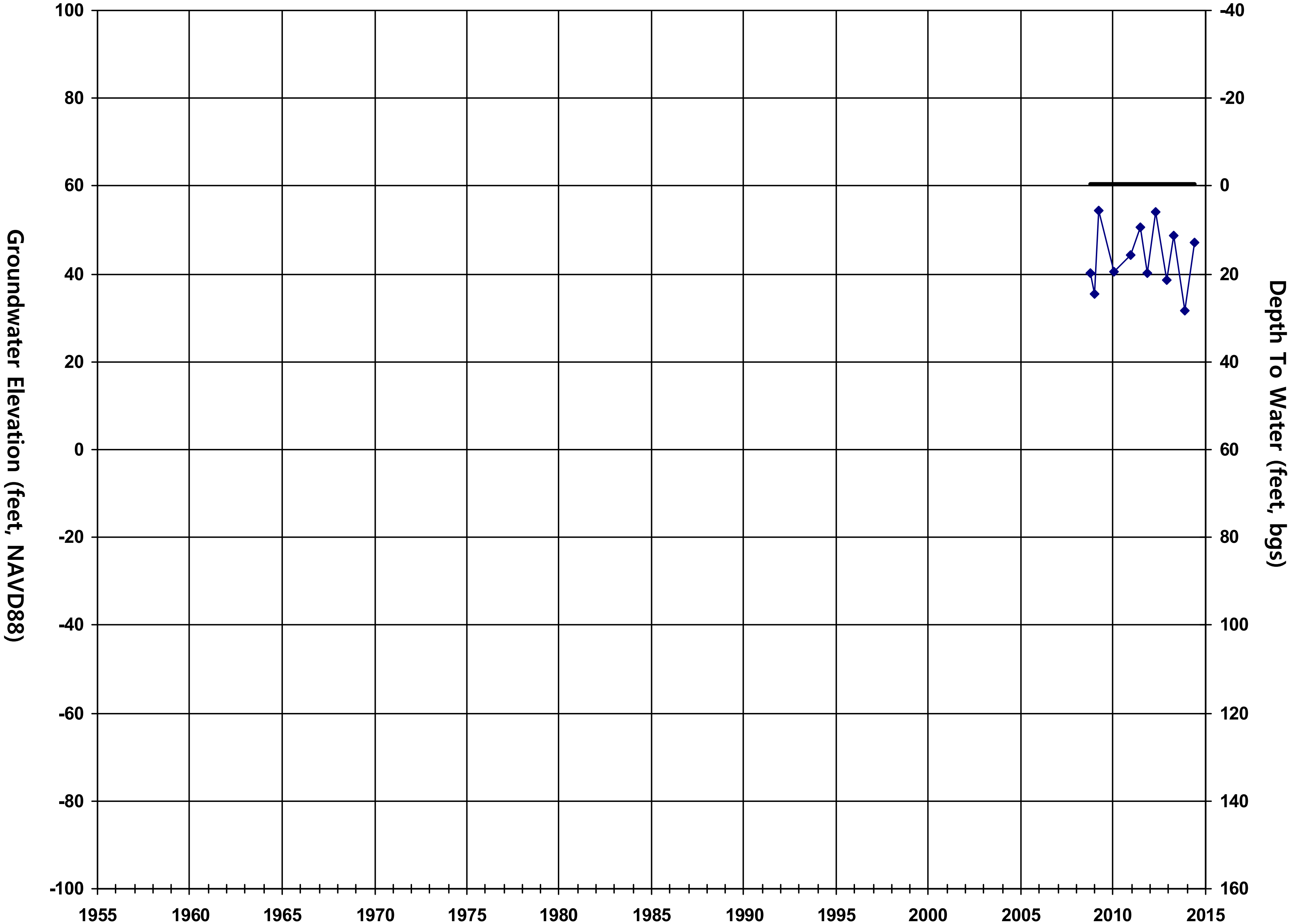


WellID: T0605514064MW1 RPE: 14.72 Subarea: NVF_Napa

SWN: Unknown Source: Geotracker Aq_Desig: NA

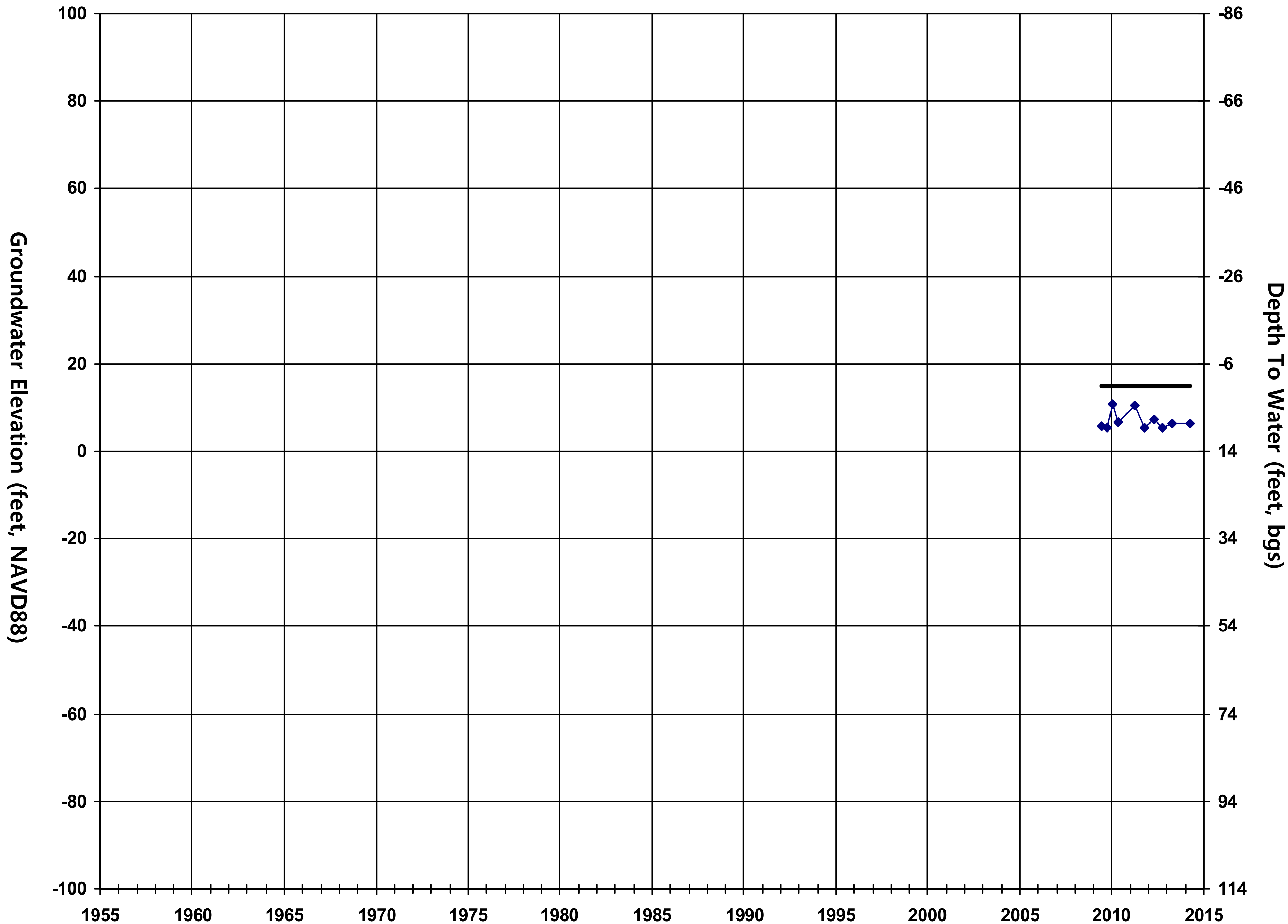


WellID: T0605547200MW-1 RPE: 60.54 Subarea: NVF_Napa
SWN: Unknown Source: Geotracker Aq_Desig: NA



WellID: T0605575085MW-1 RPE: 14.92 Subarea: NVF_Napa

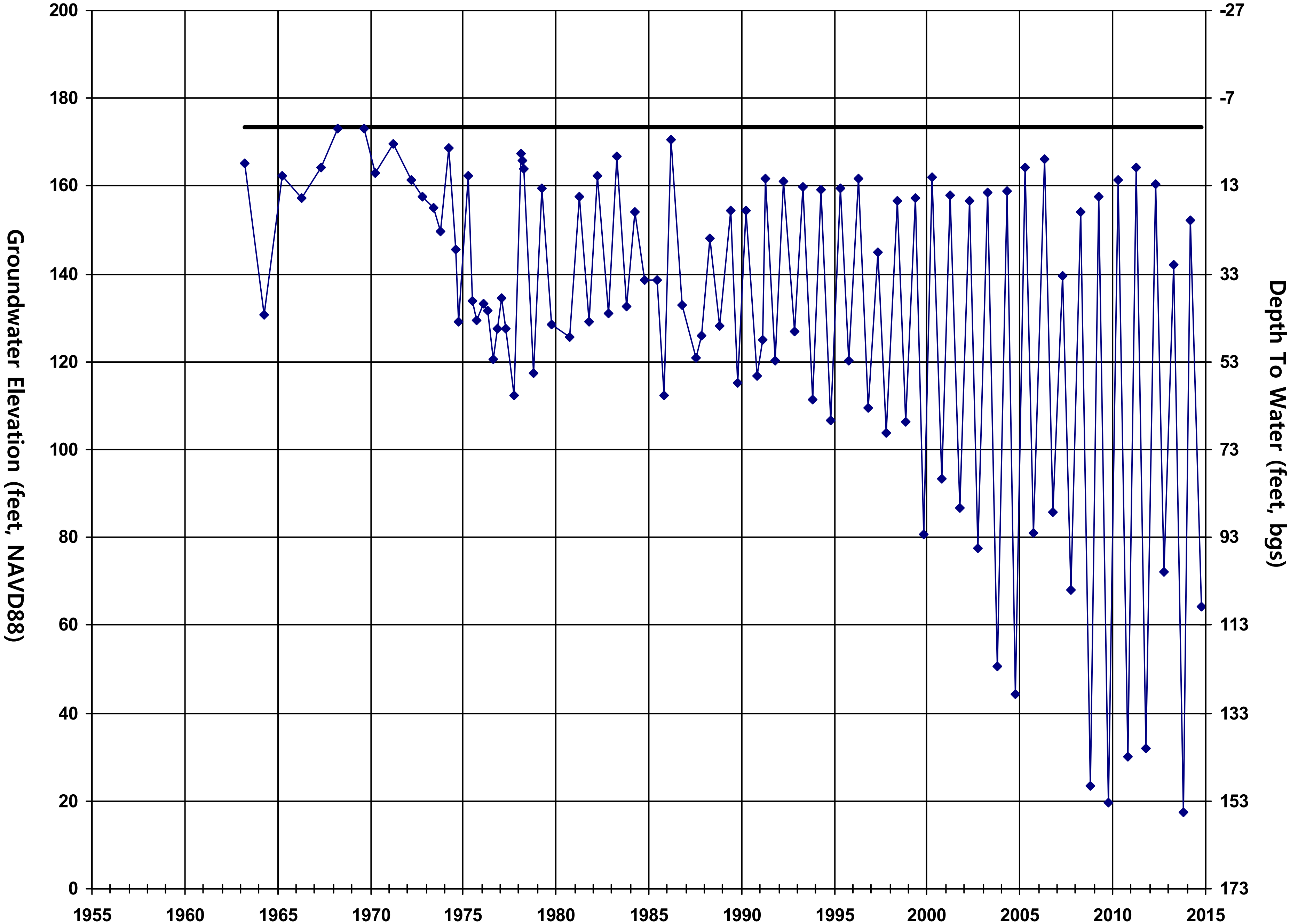
SWN: Unknown Source: Geotracker Aq_Desig: NA



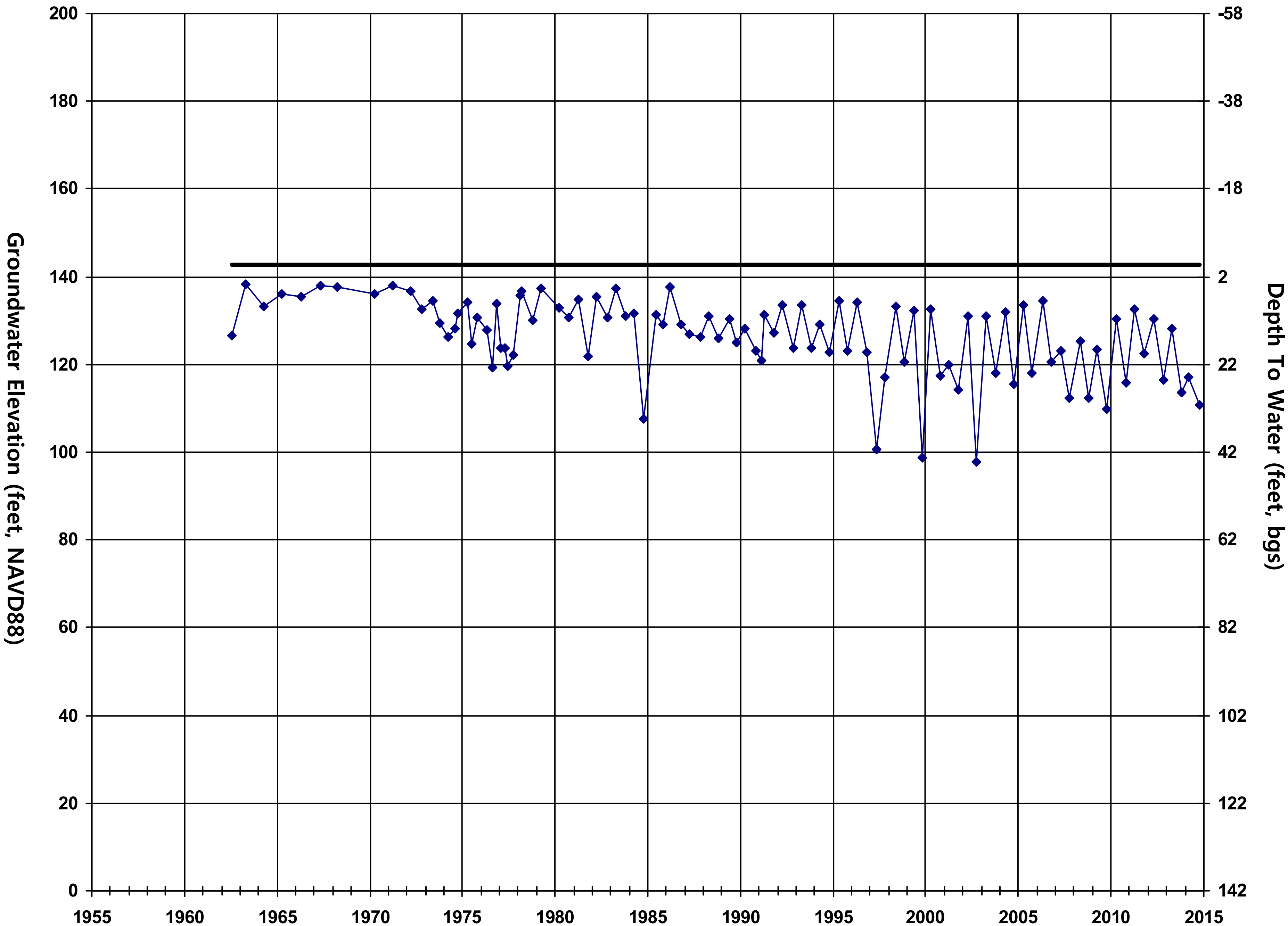
WellID: NapaCounty-131
SWN: 007N005W16L001M

RPE: 173.5
Source: NapaCounty

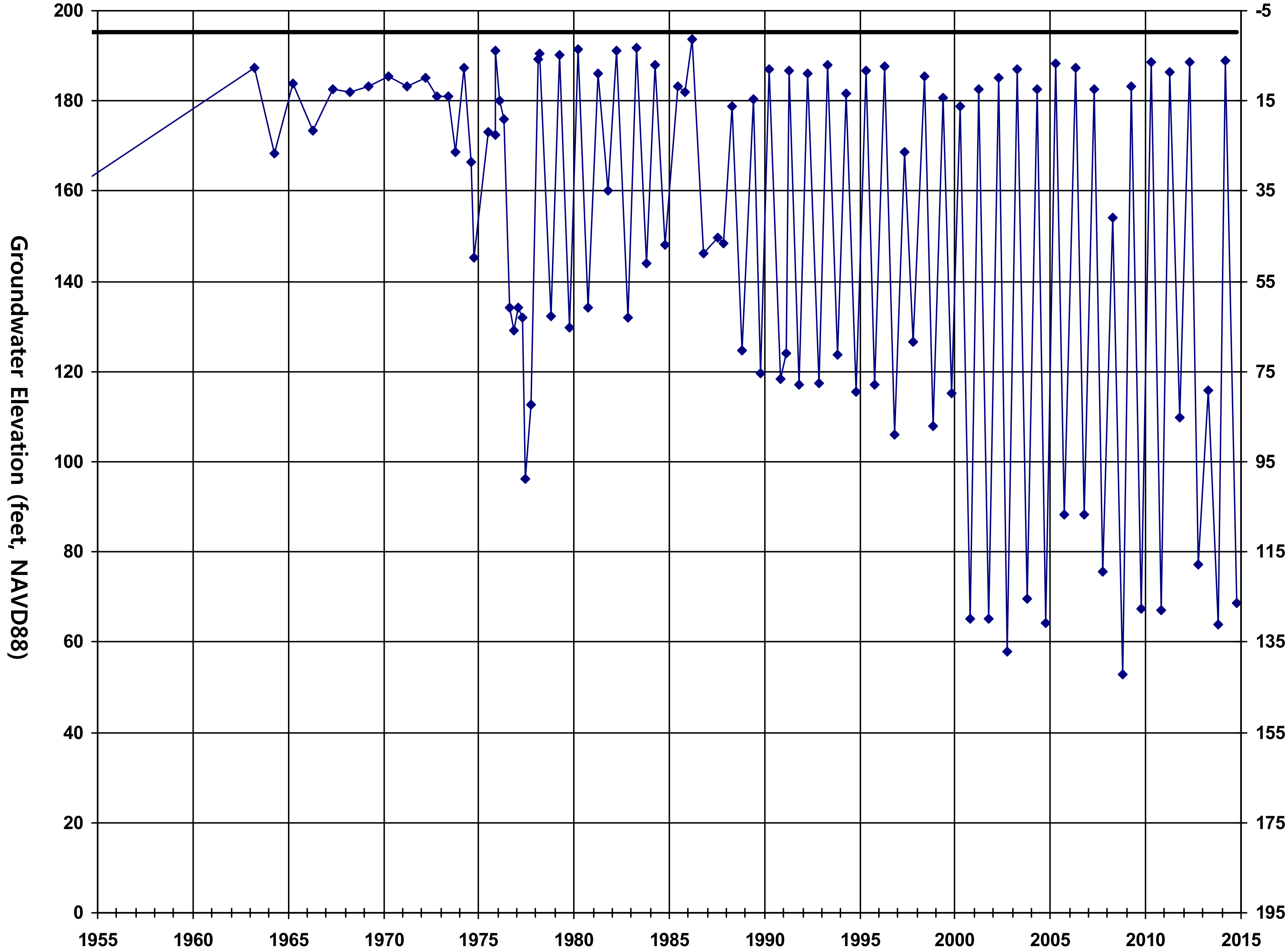
Subarea: NVF_SH
Aq_Desig: NA



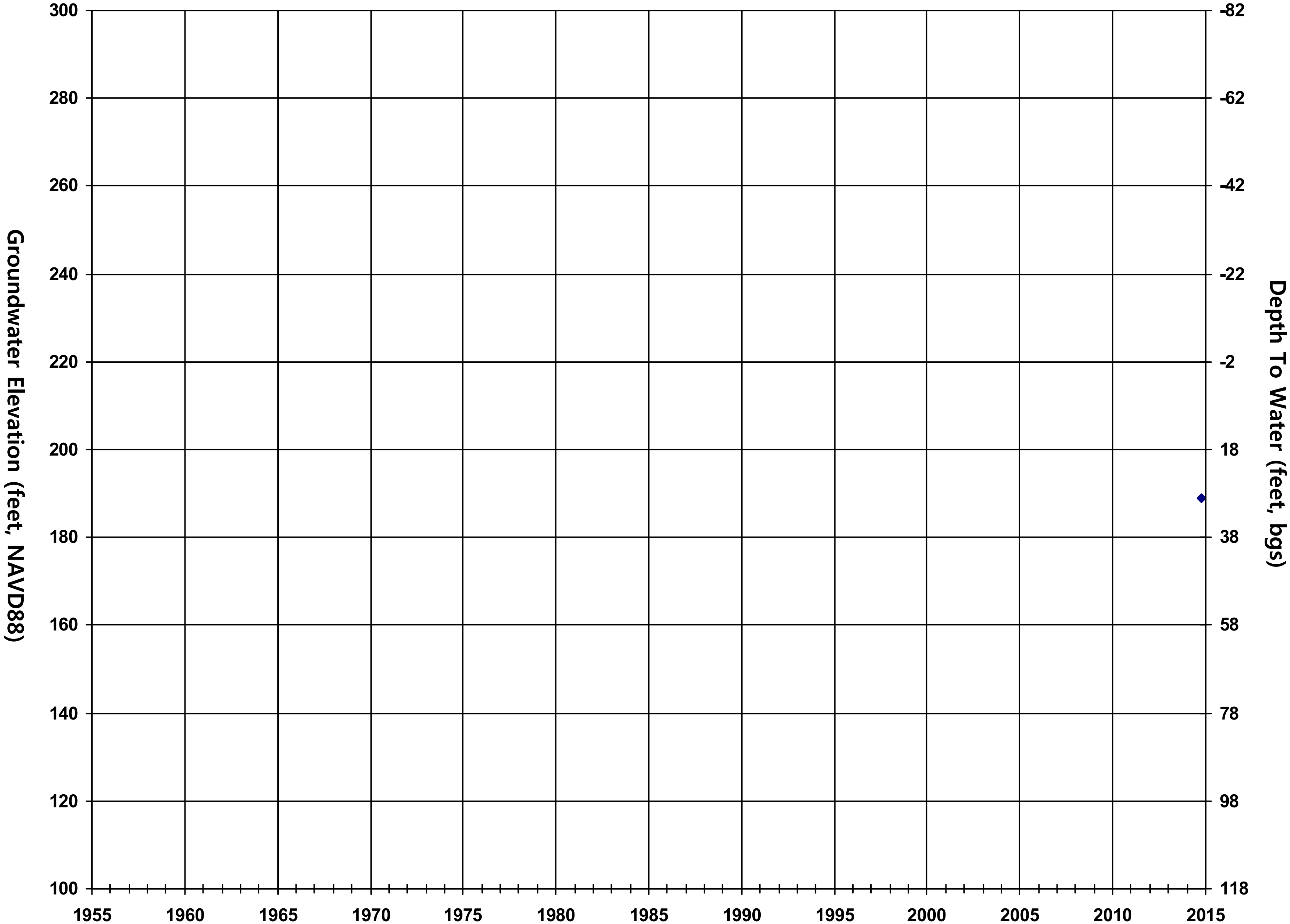
WellID: NapaCounty-132 RPE: 142.7 Subarea: NVF_SH
SWN: 007N005W14B002M Source: NapaCounty Aq_Desig: Qa, Tsvab



WellID: NapaCounty-138 RPE: 195.1 Subarea: NVF_SH
SWN: 007N005W16N002M Source: NapaCounty Aq_Desig: NA

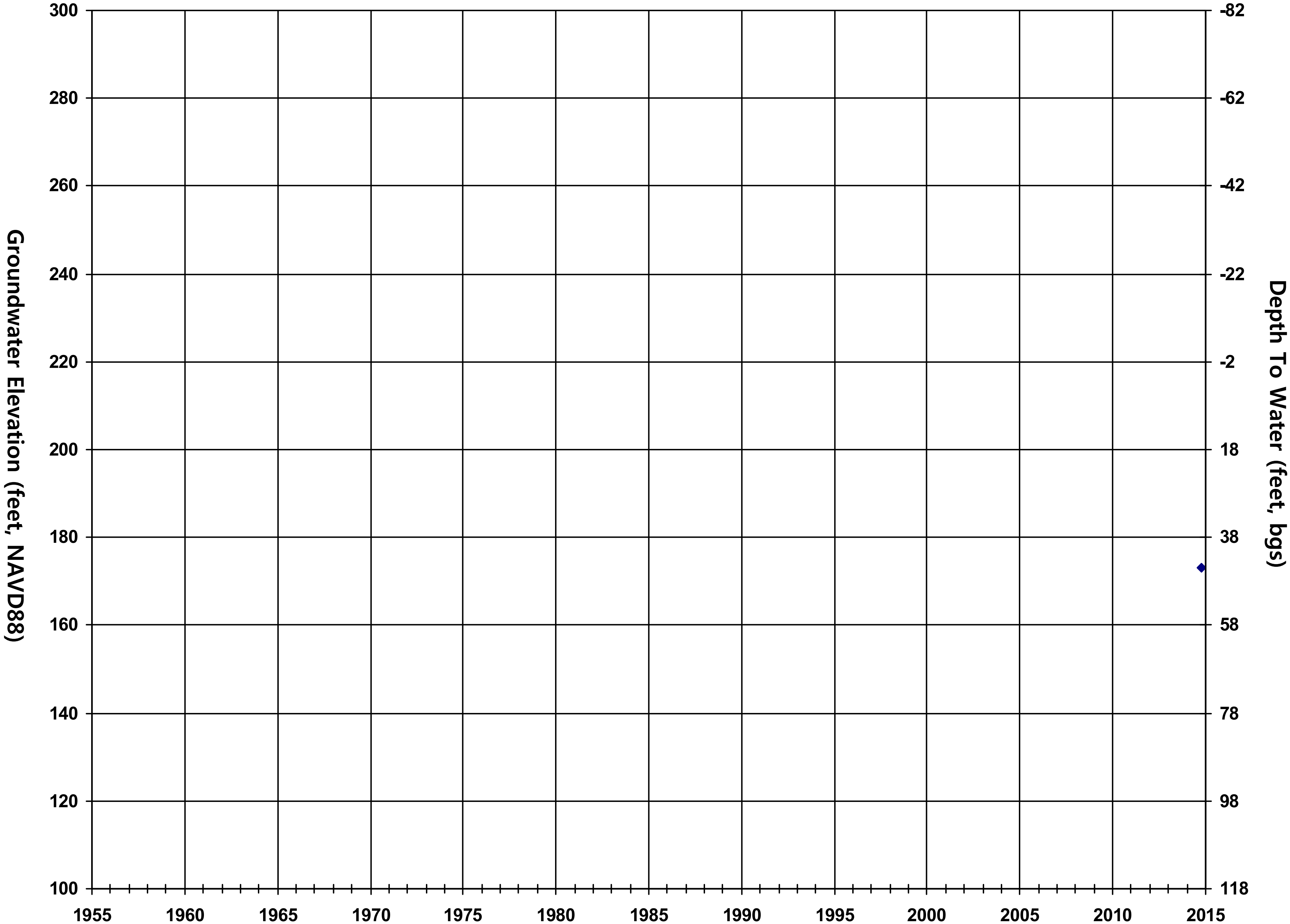


WellID: NapaCounty-222s-swgw5 RPE: 218.5 Subarea: NVF_SH
SWN: Unknown Source: NapaCounty Aq_Desig: NA



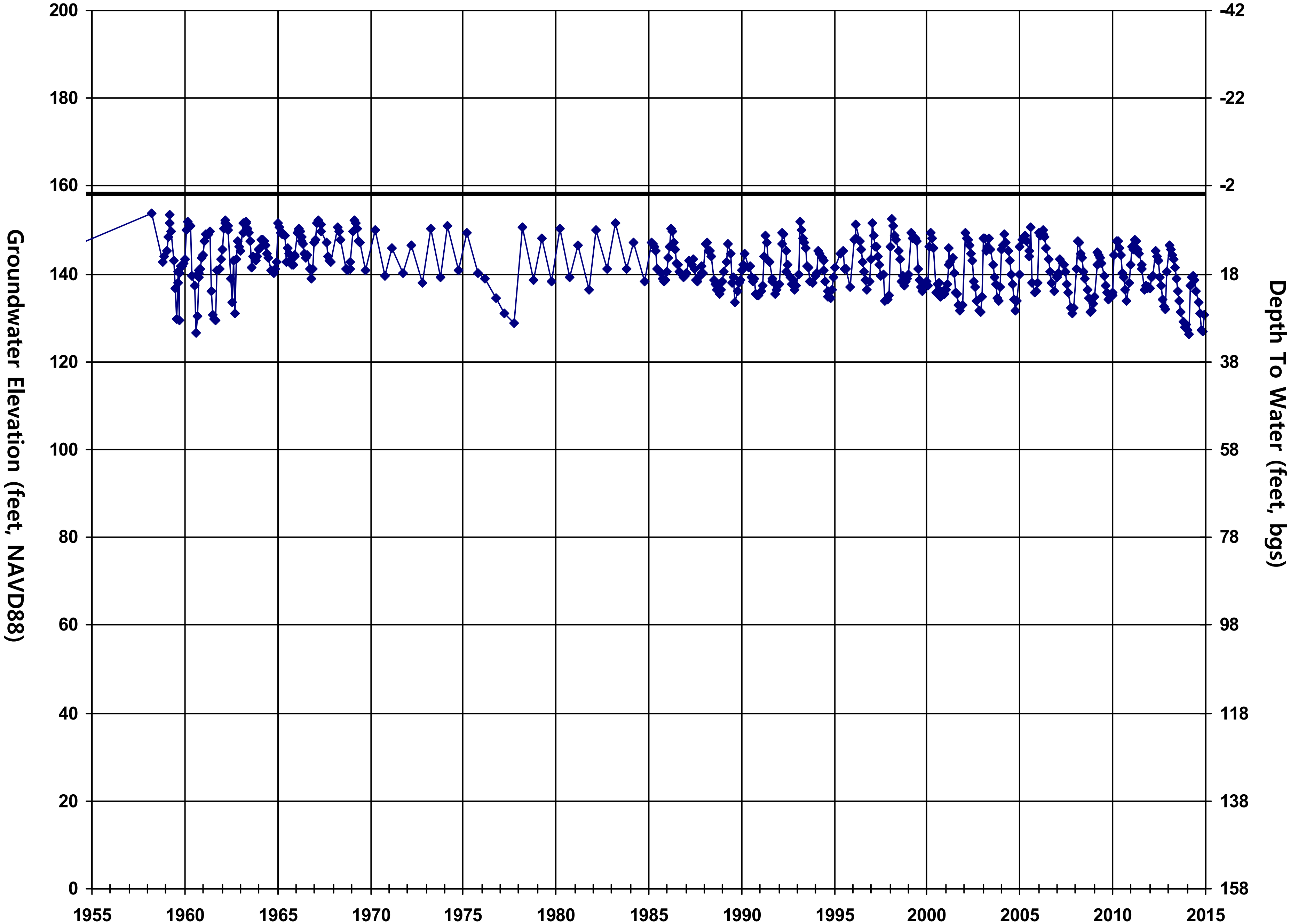
WellID: NapaCounty-223d-swgw5 RPE: 218.55 Subarea: NVF_SH

SWN: Unknown Source: NapaCounty Aq_Desig: NA



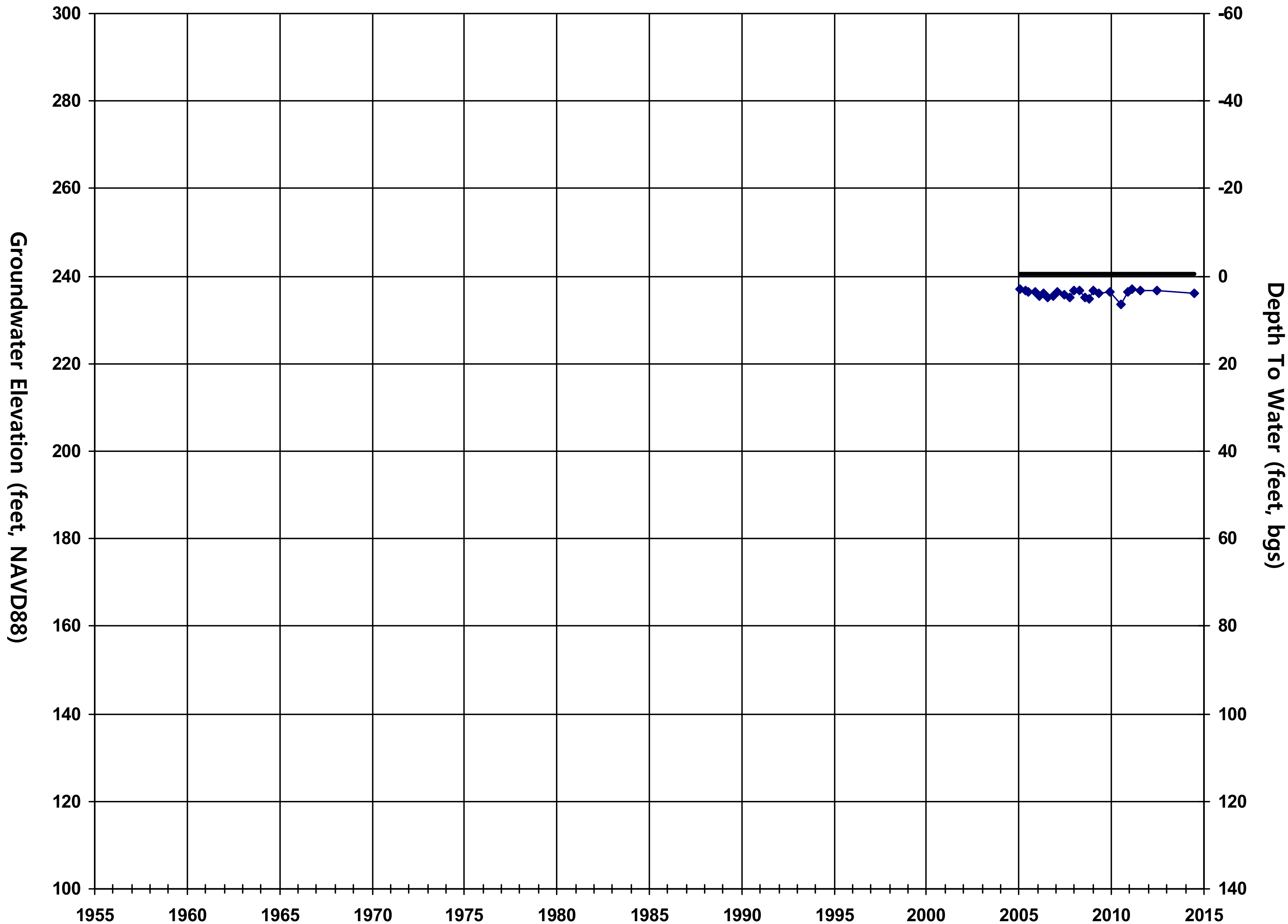
WellID: 07N05W09Q002M RPE: 158.24 Subarea: NVF_SH

SWN: 007N005W09Q002M Source: DWR Aq_Desig: NA

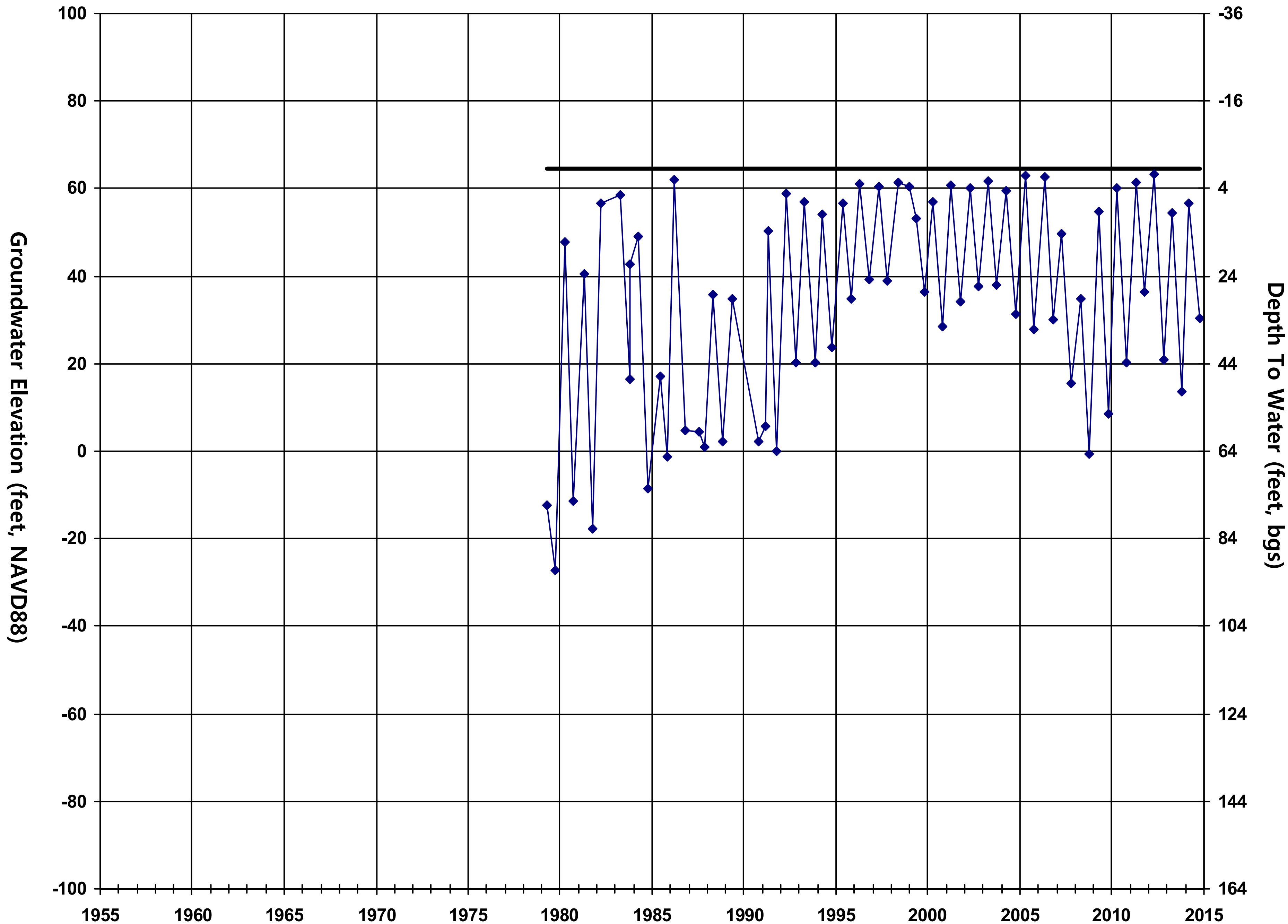


WellID: T0605500061MW-1 RPE: 240.58 Subarea: NVF_SH

SWN: Unknown Source: Geotracker Aq_Desig: NA

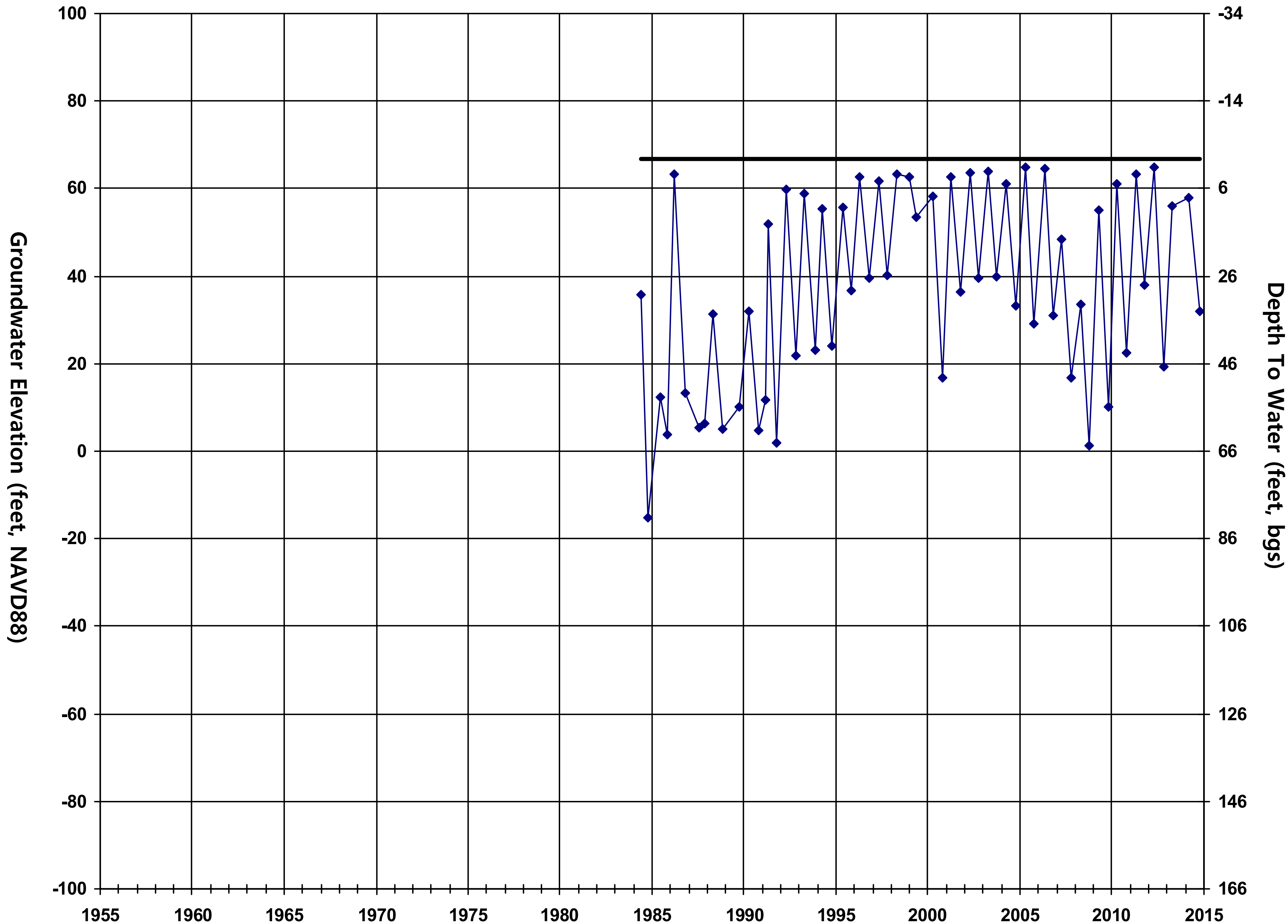


WellID: NapaCounty-125 RPE: 64.6 Subarea: NVF_Yount
SWN: 006N004W09Q001M Source: NapaCounty Aq_Desig: Tsva

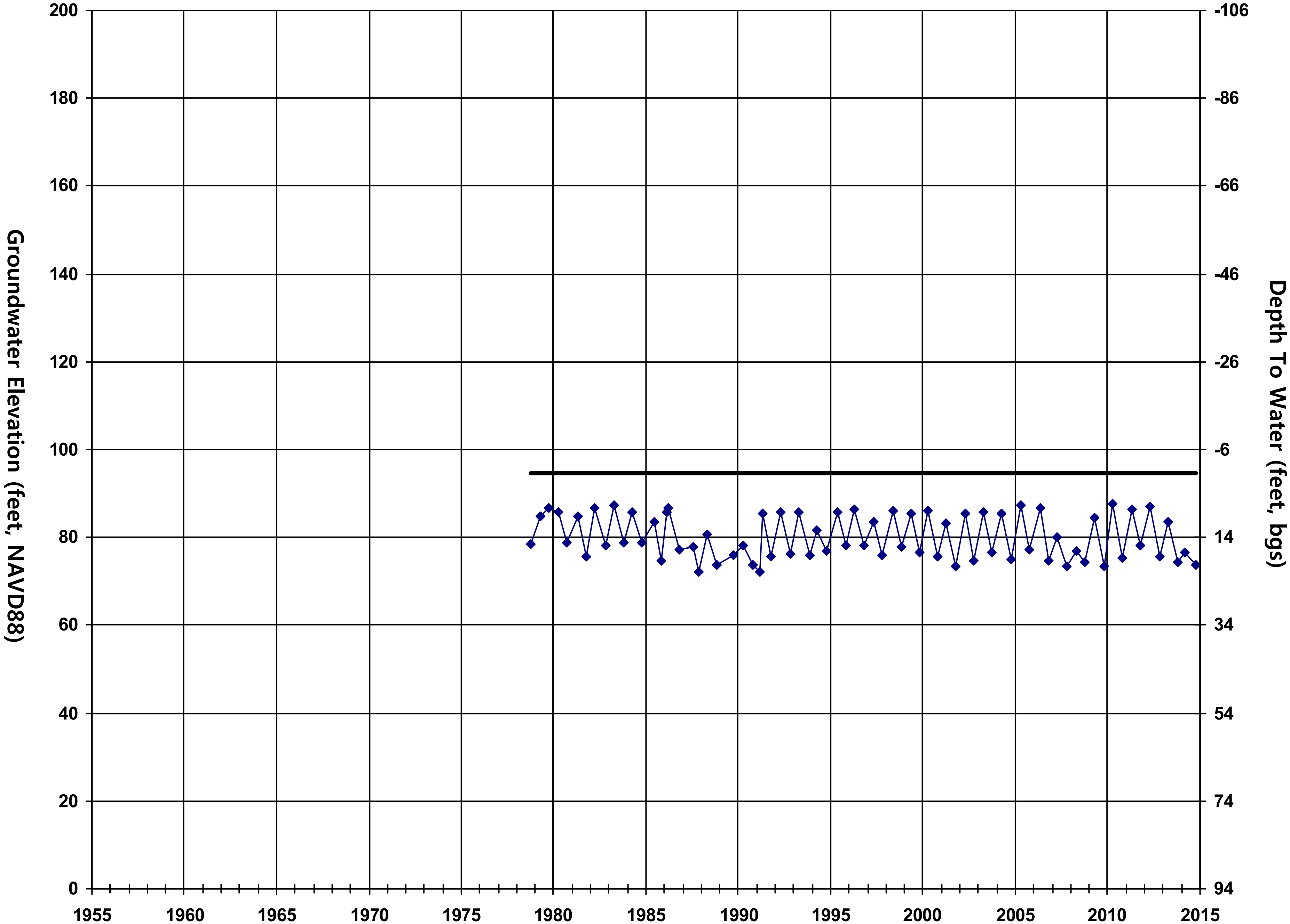


WellID: NapaCounty-126 RPE: 66.7 Subarea: NVF_Yount

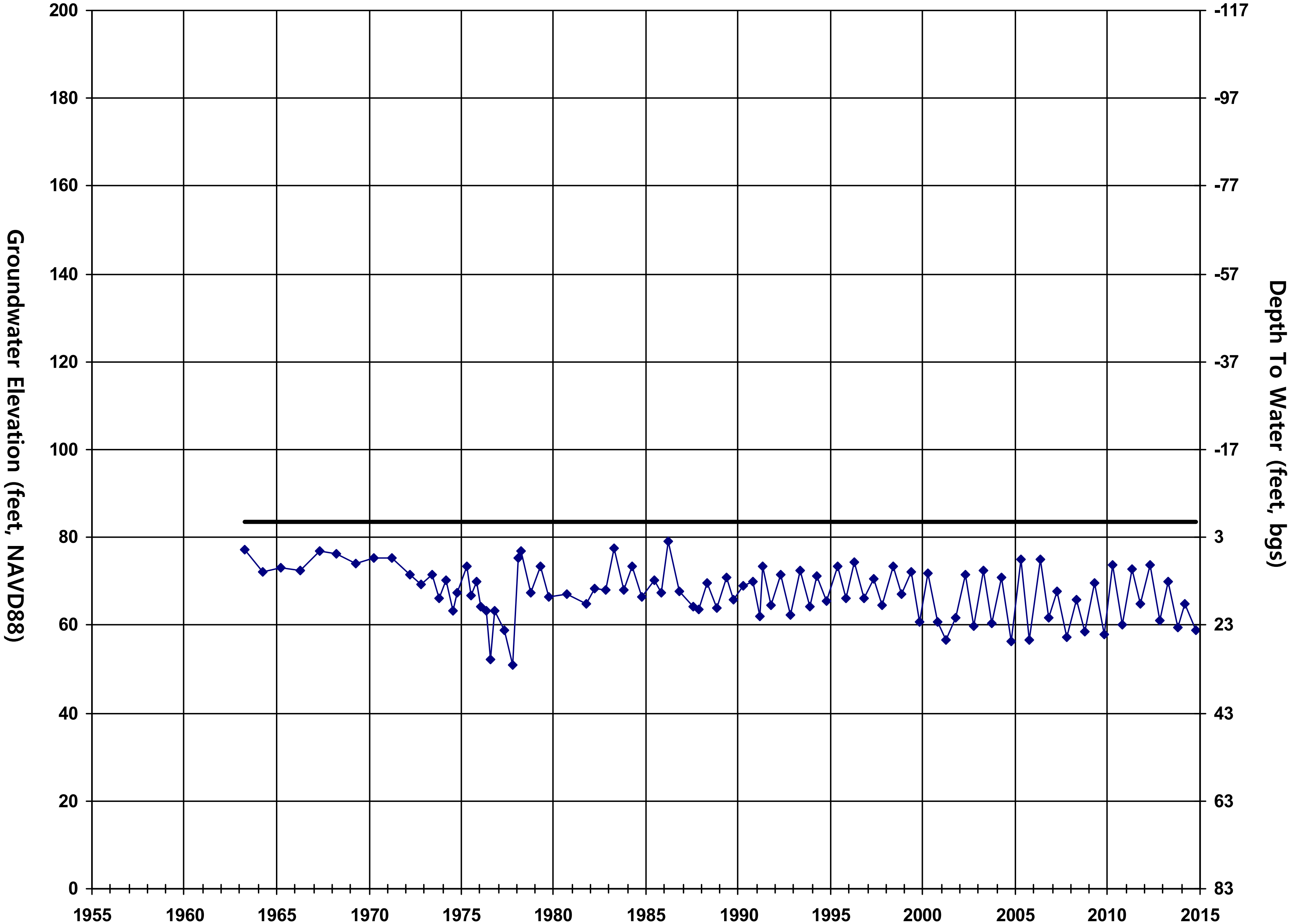
SWN: 006N004W09Q002M Source: NapaCounty Aq_Desig: Tsva



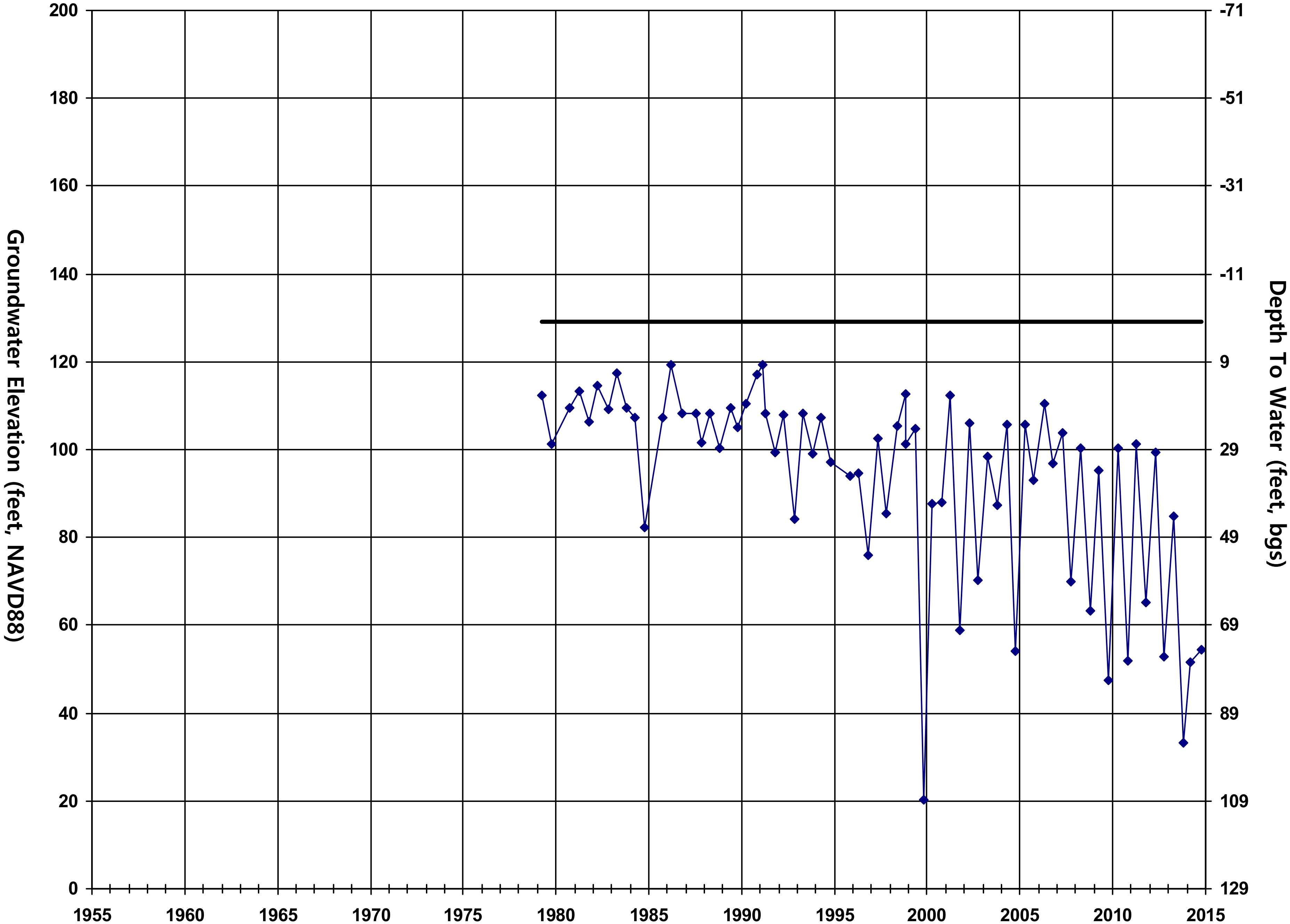
WellID: NapaCounty-133 RPE: 94.7 Subarea: NVF_Yount
SWN: 007N004W31M001M Source: NapaCounty Aq_Desig: Qa



WellID: NapaCounty-134 RPE: 83.4 Subarea: NVF_Yount
SWN: 006N004W06L002M Source: NapaCounty Aq_Desig: NA

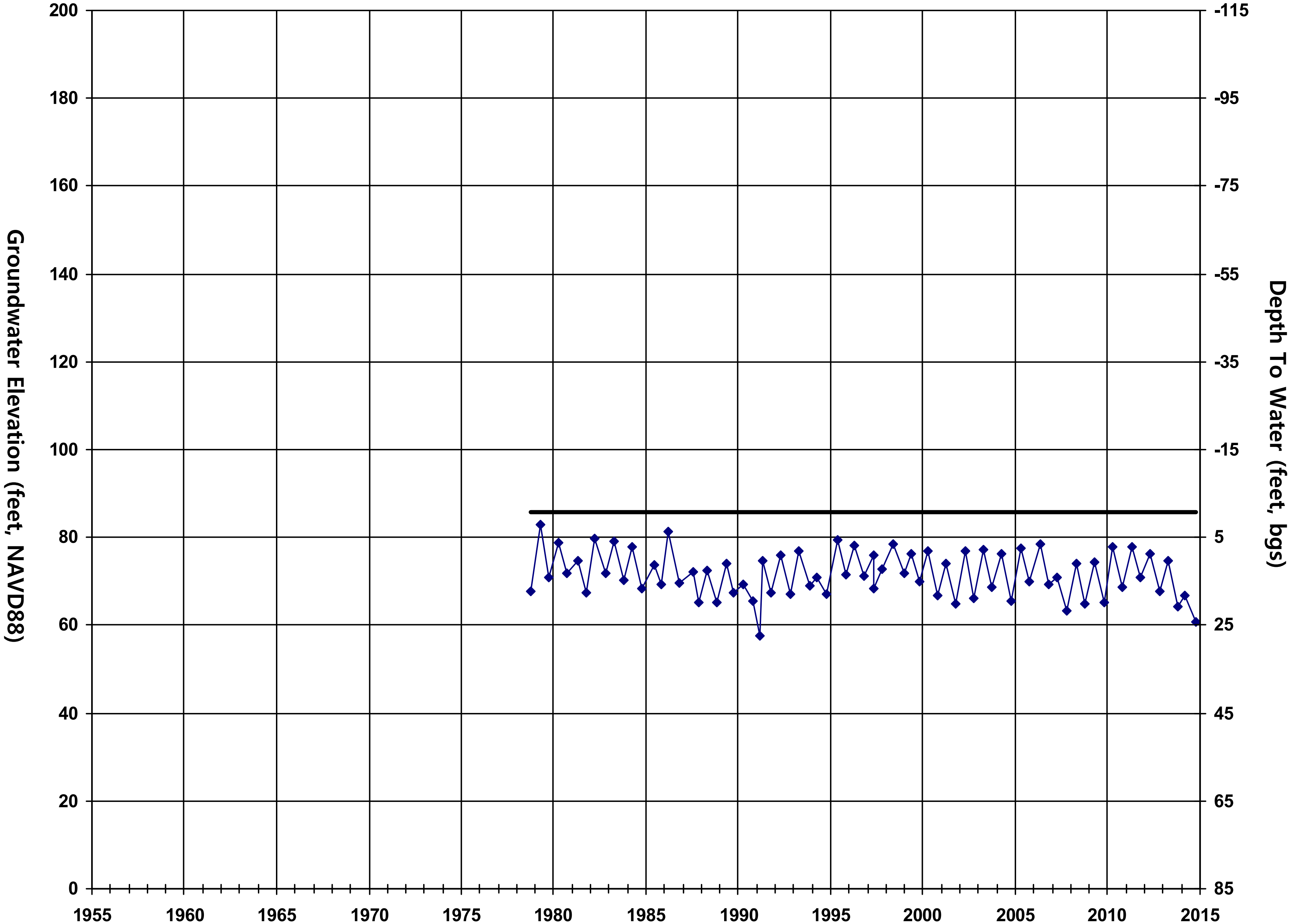


WellID: NapaCounty-135 RPE: 129.2 Subarea: NVF_Yount
SWN: 006N004W19B001M Source: NapaCounty Aq_Desig: NA



WellID: NapaCounty-139 RPE: 85.8 Subarea: NVF_Yount

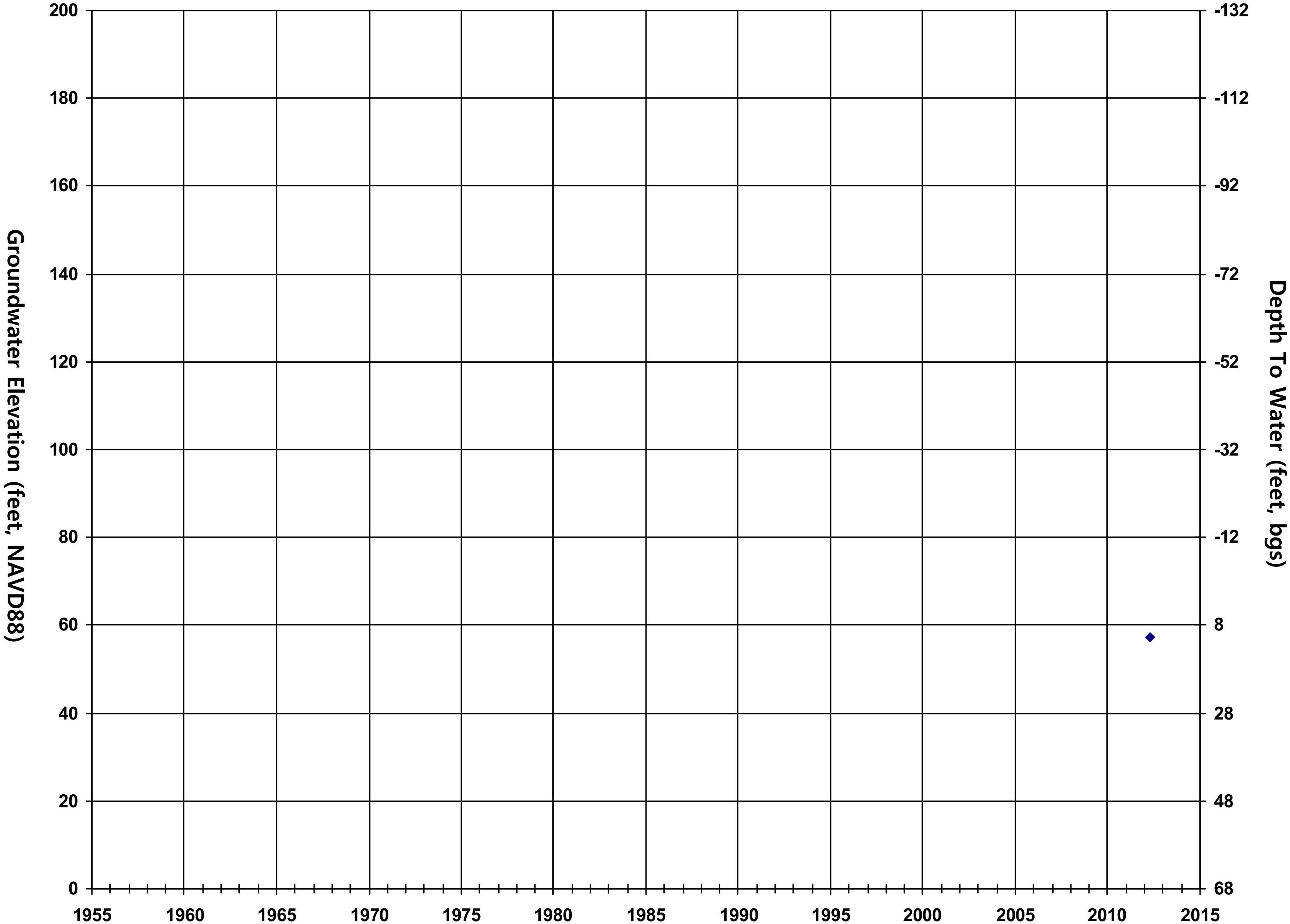
SWN: 006N004W17R002M Source: NapaCounty Aq_Desig: Qa



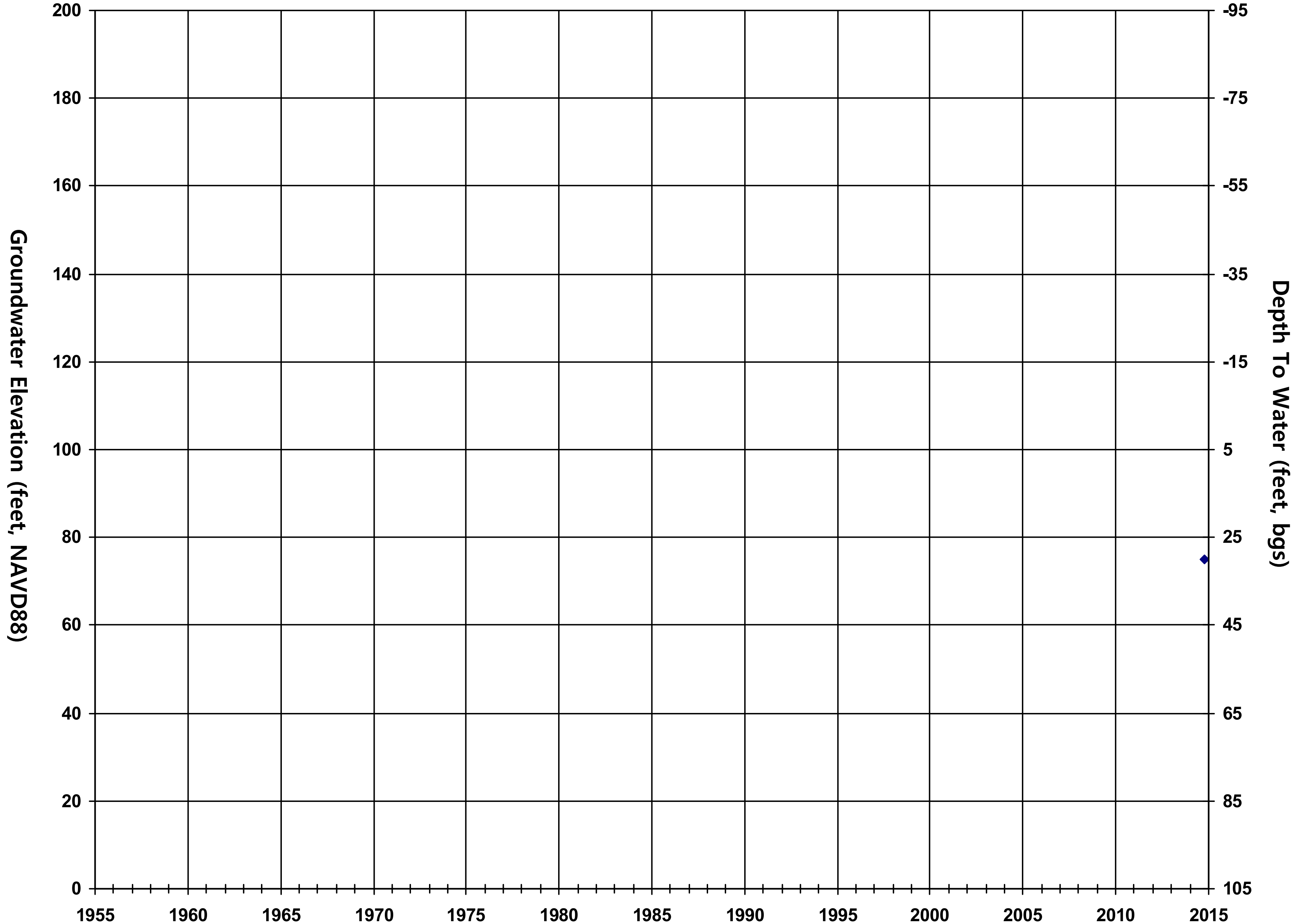
WellID: NapaCounty-151
SWN: 006N004W17Ax

RPE: 68.3
Source: NapaCounty

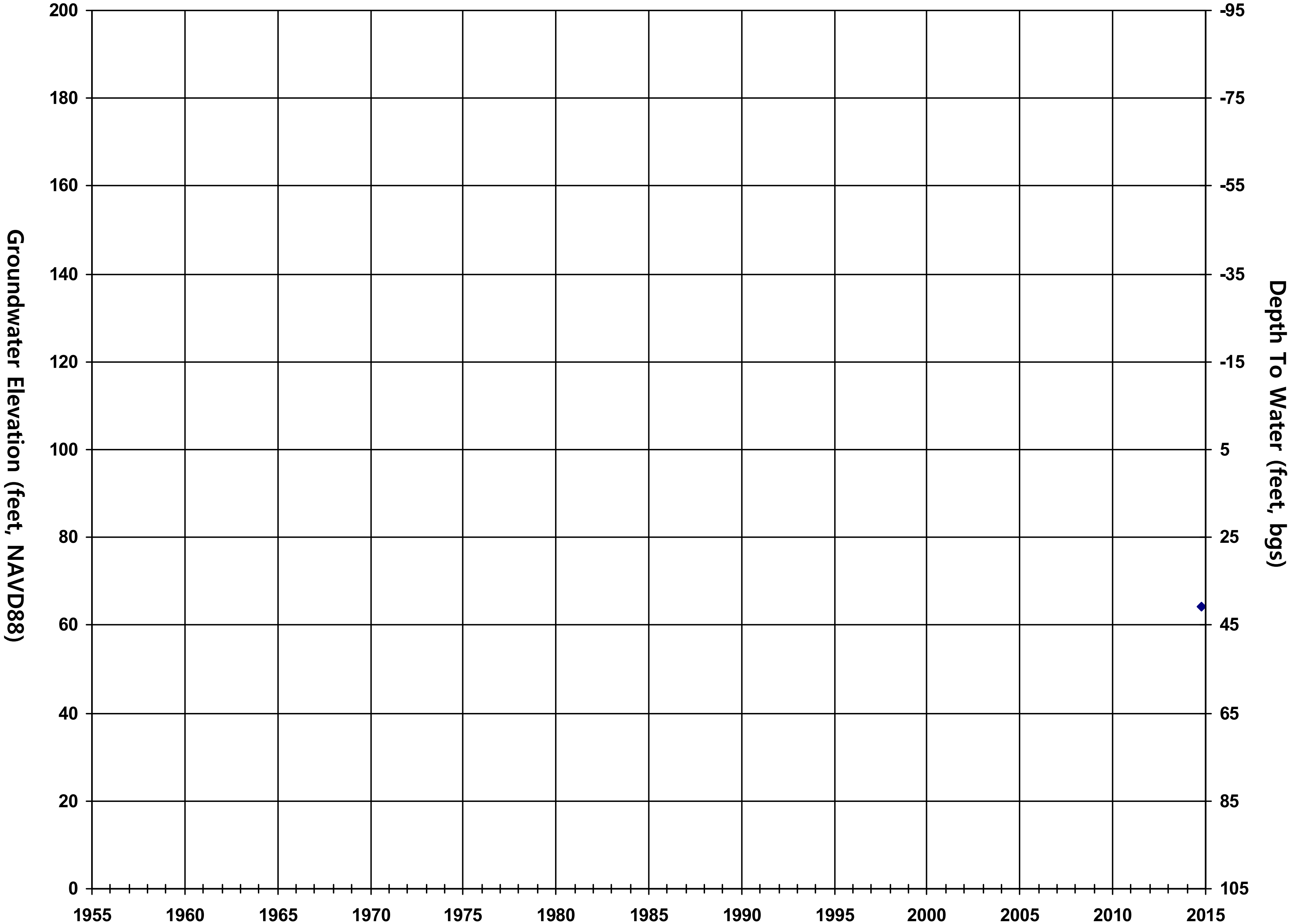
Subarea: NVF_Yount
Aq_Desig: NA



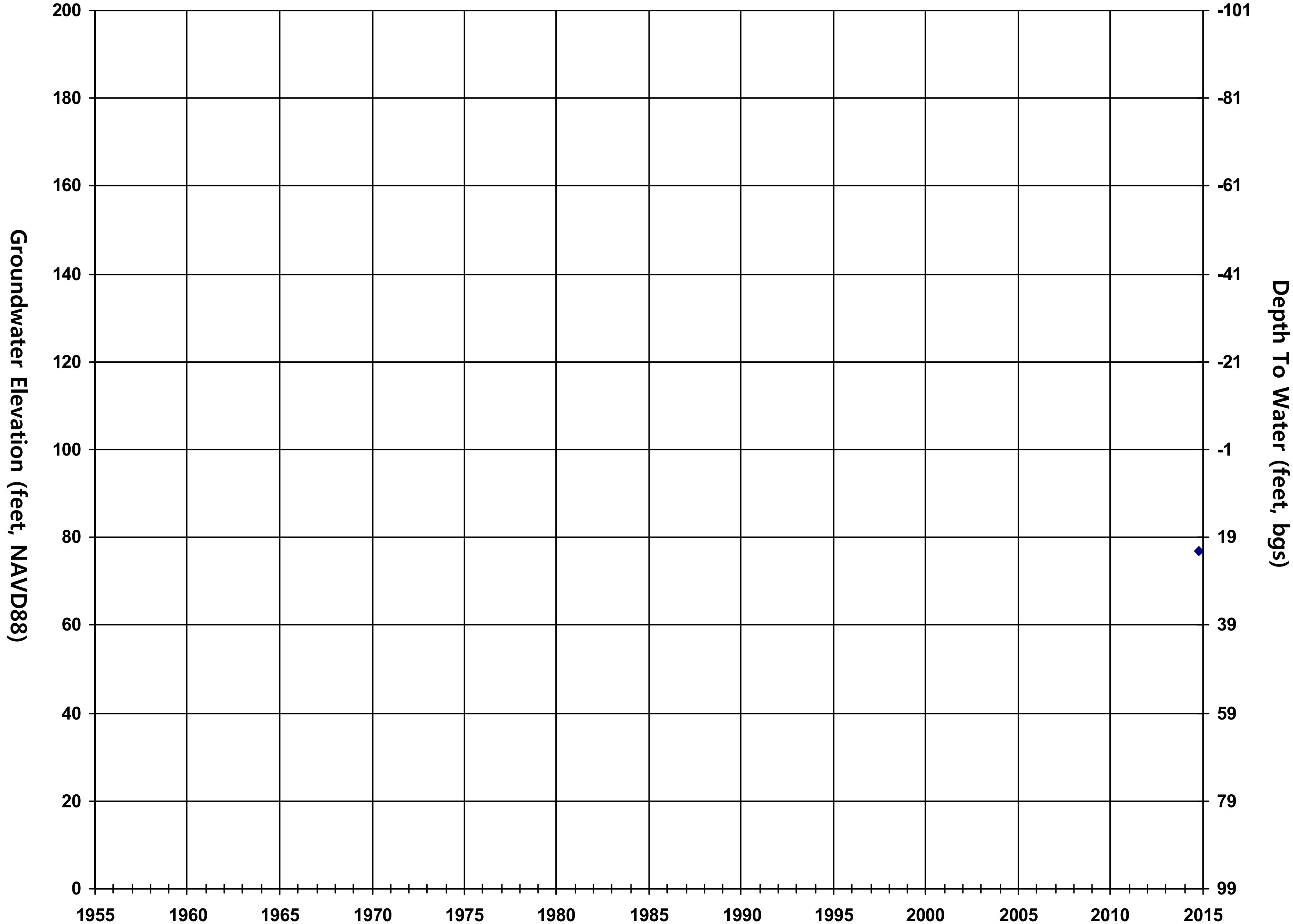
WellID: **NapaCounty-216s-swgw2** RPE: 105.8 Subarea: NVF_Yount
SWN: Unknown Source: NapaCounty Aq_Desig: NA



WellID: **NapaCounty-217d-swgw2** RPE: 105.8 Subarea: NVF_Yount
SWN: Unknown Source: NapaCounty Aq_Desig: NA

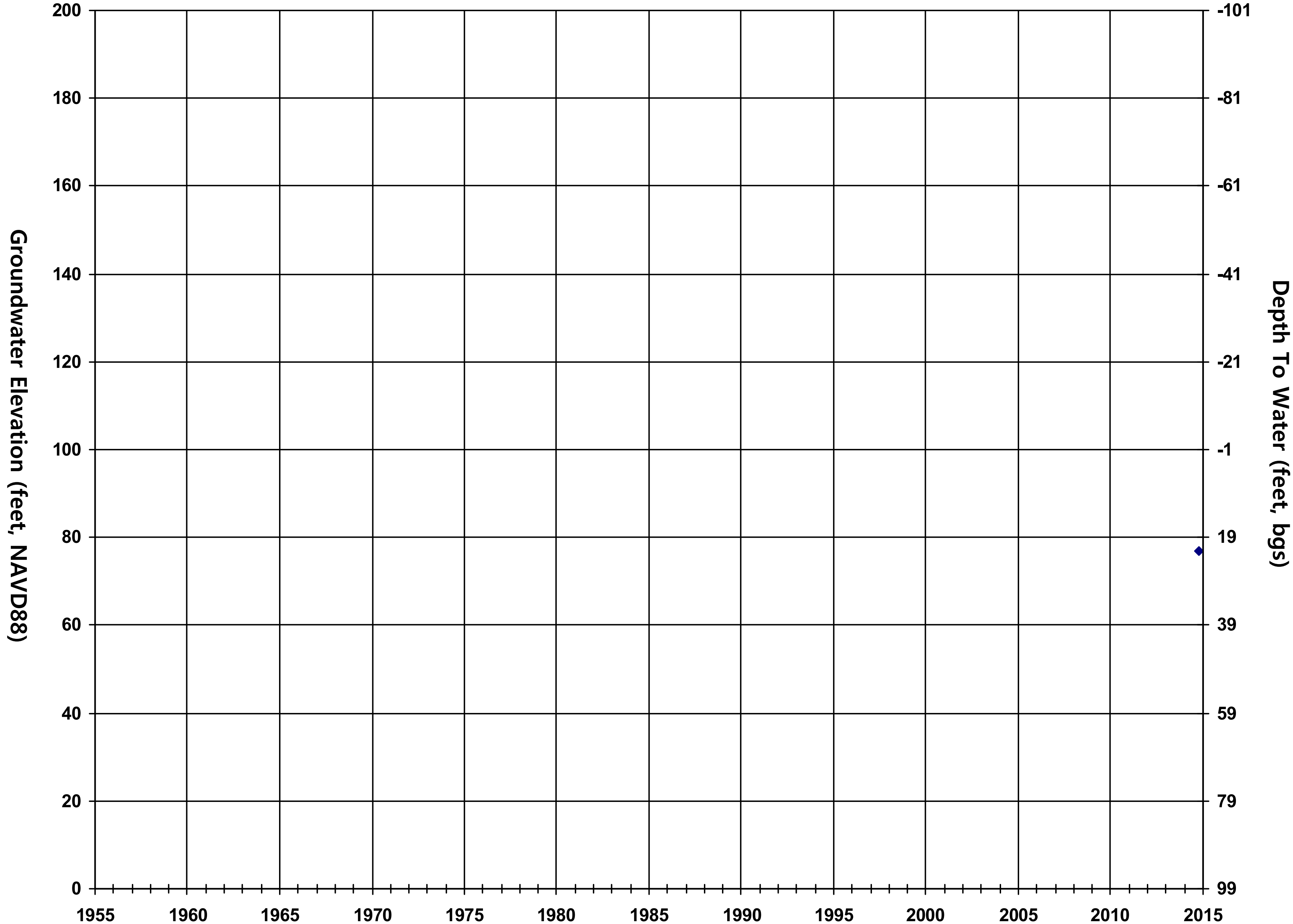


WellID: NapaCounty-220s-swgw4 RPE: 99.7 Subarea: NVF_Yount
SWN: Unknown Source: NapaCounty Aq_Desig: NA

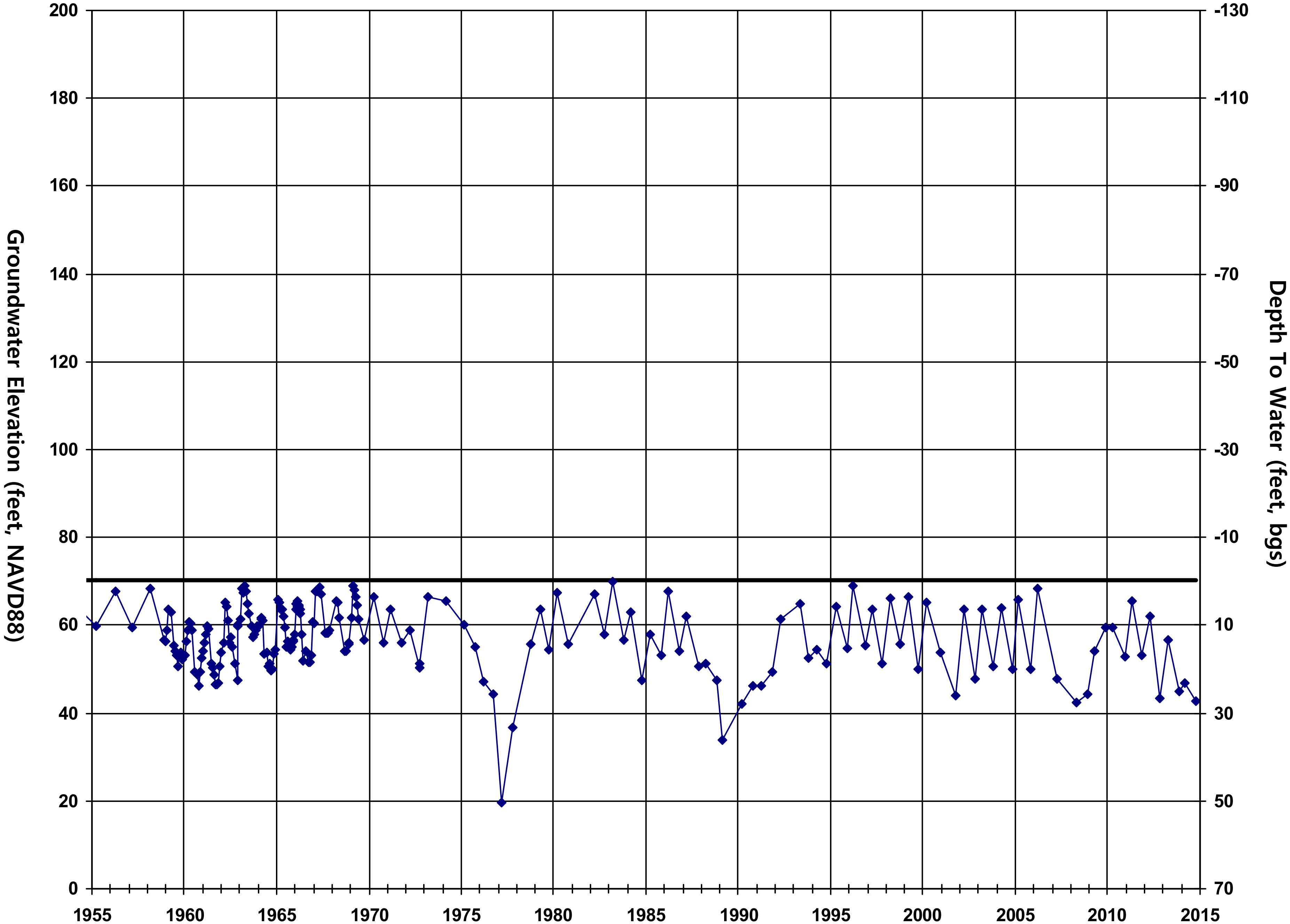


WellID: NapaCounty-221d-swgw4 RPE: 99.7 Subarea: NVF_Yount

SWN: Unknown Source: NapaCounty Aq_Desig: NA



WellID: 06N04W17A001M RPE: 70.26 Subarea: NVF_Yount
SWN: 006N004W17A001M Source: DWR Aq_Desig: NA



APPENDIX C
Napa County Procedure for Measuring Groundwater Levels

NAPA COUNTY PROCEDURE FOR MEASURING THE DEPTH TO WATER IN MONITORING AND PRODUCTION WELLS

Purpose

To obtain an accurate dated and timed measurement of the static depth to water in a well that can be converted into a water level elevation in reference to a commonly used reference datum (e.g., NAVD 1988). In this context, static means that the water level in the well is not influenced by pumping of the well. For comparability, measurements should be obtained according to an established schedule designed to capture times of both highest and lowest seasonal water level elevations. Also for comparability, measurements during a particular field campaign should be obtained consecutively and without delay within the shortest reasonable time.

Measurement Procedure

- If a well is being pumped, do not measure; return later, but not sooner than 60 minutes and preferably after 24 hours (see below "Special Circumstances" for additional instructions).
- Turn on water level indicator signaling device and check battery by hitting the test button.
- Remove access plug or well cap from the well cover and lower probe (electric sounder) into the well.
- When probe hits water a loud "beep" will sound and signal light will turn red.
- Retract slightly until the tone stops.
- Slowly lower the probe until the tone sounds.
- Note depth measurement at rim (i.e., the surveyed reference point for water level readings) of well to the nearest 0.01 foot and rewind probe completely out of well.
- Remove excess water and lower probe once again into well and measure again.
- If difference is within ±0.02 foot of first measurement, record measurement.
- If difference is greater repeat the same procedure until three consecutive measurements are recorded within ± 0.02 foot.
- Rewind and remove probe from well and replace the access plug or well cap in the well cover.
- Clean and dry the measuring device/probe and continue to next well.

Special Circumstances

Oil Encountered in Well

If oil is detected in the well structure, the depth to the air-oil interface is measured. To obtain such a measurement, the electric sounder is used similar to the way chalked steel tapes were traditionally used for depth-to-water measurements.

1. Lower the cleaned probe well below the air-oil interface (e.g., 1 foot). Read and record the depth at the reference point (since this depth is chosen somewhat arbitrarily by the field technician, an even number can be chosen, e.g., 37.00 feet). This measurement is the length of cable lowered into the well and corresponds to a line that the oil leaves on the probe or cable (i.e., the oil inundation line). Above this line, smudges of oil may appear on the cable. Below this line, the cable/probe is completely covered with oil. If the probe is lowered too far, completely penetrates the oil, and is far submerged in the water below the oil, parts of the probe/cable below the oil inundation line may also appear smudgy.
2. Retrieve probe, identify and record the oil inundation line on the cable (e.g., 2.72 feet). This measurement does not reflect the thickness of the oil. It reflects the length of the cable below the air-oil interface.
3. Compute the depth to oil by subtracting the length of line below the air-oil interface from the corresponding measurement at the reference point: Depth to oil = 37.00 feet – 2.72 feet = 34.28 feet.

Since oil has a slightly smaller density than water, a depth-to-oil measurement will always be smaller than a corresponding depth-to-water measurement in the same well if oil were not present. Depth-to-oil measurements yield a reasonable approximation to depth-to-water measurements unless the oil thickness is great. For each foot of oil in the well casing, the depth-to-oil measurement will be approximately 0.12 foot smaller than a corresponding depth-to-water measurement if oil were not present.

Pumping Water Level on Arrival

If well is being pumped, do not measure. Return later when the water level has stabilized. Using past field notes, the field technician will use his/her experience to determine the appropriate duration necessary for static measurements. Upon returning to the well site (at a location where pumping was previously noted on the same day), the technician will measure the water level. The technician will have available historical water level data to determine whether the measurement is consistent with past measurements. If the initial measurement appears anomalous, the technician will measure water levels every 10 minutes over a period of 30 minutes.[8] If measurements vary significantly from past measurements (taking into account seasonal variations), the technician will note the circumstances (i.e., the date and time when the well was first visited, total time it was pumping (if known), when it was shutoff, when the technician returned, and subsequent water level measurements [on the same day, or as the case may be based on experience, the day immediately following]). Subsequent consideration of pumping effects at a site-specific well location will be addressed as necessary.

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[8] During this period, if the groundwater level difference is greater [than +/- 0.02 feet], repeat the same procedure until three consecutive measurements are recorded within ± 0.02 foot.