Big Valley Management Area Basin Management Objective Development Guidance Document

Prepared for

Lassen County, CA

August 5, 2011

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139893

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List of Abbreviations

bgs	*below ground surface*
BMOs	*Basin Management Objectives*
BoS	*Board of Supervisors*
cfs	*cubic feet per second*
DWR	*Department of Water Resources*
ft	*feet*
GWC	*Groundwater Committee*
GWMP	*Groundwater Management Plan*
HLFZ	*Honey Lake Fault Zone*
msl	*mean sea level*
NGVD	*National Geodetic Vertical Datum*
NWIS	*National Water Information System*
TAC	*Technical Advisory Committee*
TDS	*total dissolved solids*

Section 1

Introduction

Groundwater resources have long played an important role in the development, growth, and sustainability of Lassen County and its residents. It is a source of drinking water, irrigation water for the agricultural community, and supports important environmental needs through its interaction with surface water and related habitat. Local groundwater users and the County work collaboratively to manage and protect groundwater resources for current and future generations. However, driven by evolving demands for groundwater within and adjacent to Lassen County, groundwater management continues to increase in complexity and scope; specifically, past and current projects to develop and export groundwater in Nevada from interstate basins shared with Lassen County may impact Lassen County residents reliant on these groundwater basins. As a result, the Board of Supervisors (BoS) directed development of a Groundwater Management Plan (GWMP) for Lassen County.

The GWMP formalizes and directs the County's commitment to pursue sustainable and beneficial groundwater development and use by its residents. The GWMP also clearly articulates the County's expectations for groundwater management by entities beyond the County's jurisdiction and share groundwater resources with the County. The GWMP directs the County to develop Basin Management Objectives (BMOs). BMOs represent a proactive method of groundwater management that is supported by the BoS, staff, and local groundwater users who participated in the development of the GWMP.

This document presents the process for developing BMOs for the Big Valley management area. This document contains details about the BMO program, groundwater information on use and monitoring, recommendations for key wells and action levels for use by management area stakeholders to select key monitoring wells and set action levels for the selected key wells, and general water quality and subsidence information and recommendations.

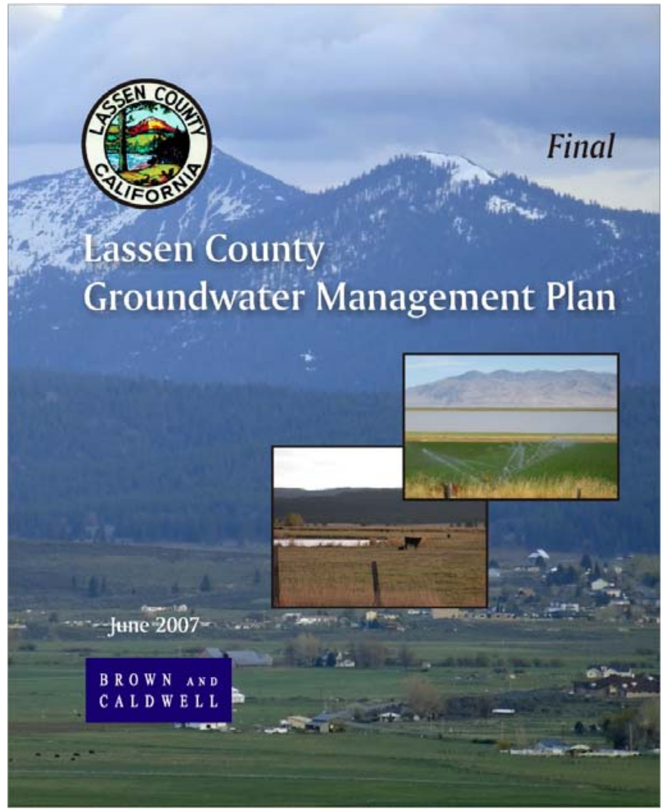
This document presents

- Descriptions of the BMO program
- Descriptions of the Big Valley management area
- Information on groundwater monitoring
- Recommendations for setting BMO key wells and action levels for key wells

The BMO program detects declines in groundwater levels that, when exceeded, call for actions to be taken to investigate, notify, and remedy the decline, as appropriate. The County will be holding meetings in each management area to discuss the BMO program and to identify and formalize selection of key wells and action levels for each management area. The County desires that BMOs reflect local stakeholders' in-depth knowledge and management objectives for their management area. Ultimately, it is the County's desire to have BMOs that are understood and supported by groundwater users in the respective management area.

1.1 Groundwater Management Plan

Lassen County developed a GWMP with the goal of maintaining or enhancing groundwater quantity and quality, thereby providing a sustainable, high-quality supply for agricultural, environmental, and urban use into the future that remains protective of the health, welfare and safety of residents. The GWMP seeks to achieve this goal by identifying management objectives and supporting implementation items that help the County achieve the GWMP's goal.



GWMP development was supported by a Working Group comprised of individuals with extensive knowledge of local groundwater-related issues, objectives, conditions, and needs. The Working Group assisted plan development by serving in an advisory role. The County convened four meetings of the Working Group during GWMP development. The Lassen County BoS held a public hearing to adopt the GWMP on March 13, 2007, and unanimously adopted the Plan following the public hearing.

Through GWMP implementation, the County is performing activities related to the Plan's components which include; development of BMOs, groundwater monitoring, groundwater resource protection, groundwater sustainability, stakeholder involvement, integrated planning, and GWMP reporting and updating.

BMOs are being developed as a GWMP implementation component. BMOs represent a locally-driven, proactive method of groundwater management. They are flexible guidelines for the management of groundwater resources that describe locally developed objectives at the basin or sub-area scale and specific actions to be taken by stakeholders to meet them. BMOs are a proactive alternative to managing groundwater by safe yield methods which require a tremendous amount of data. BMOs were initially described in the GWMP with an Introduction to the BMO Process of Groundwater Management.

1.2 Basin Management Objectives

BMOs are flexible guidelines for the management of groundwater resources that describe a specific process that leads to actions by the County to meet locally developed objectives at the basin or sub-area scale. They are used proactively to manage groundwater on a level by local groundwater users and elected officials working together. BMOs include the development of local groundwater management objectives and monitoring of the groundwater basin health to assure the water use is consistent with defined local objectives. The BMO program is being developed and implemented under direction provided by the BoS.

The BMO program has been developed to overcome the problems of defining safe yield. Safe yield programs attempt to define the amount of groundwater recharge that occurs and use that information as a limit for pumping. This is problematic because recharge rates to groundwater basins are difficult to measure or estimate and are highly variable. Recharge to a groundwater basin is affected by numerous factors including the amount of precipitation, interaction between groundwater and surface water, and the overall permeability of the aquifer system. Recharge is less during a year with below average precipitation or can decrease if stream beds that recharge groundwater lose permeability. Since groundwater recharge is variable, the concept of safe yield is less than ideal.

The County, while working with a BMO working group, has identified 12 management areas, identified in Figure 1-1. The County has also developed complementary documents for each of the 12 management areas.

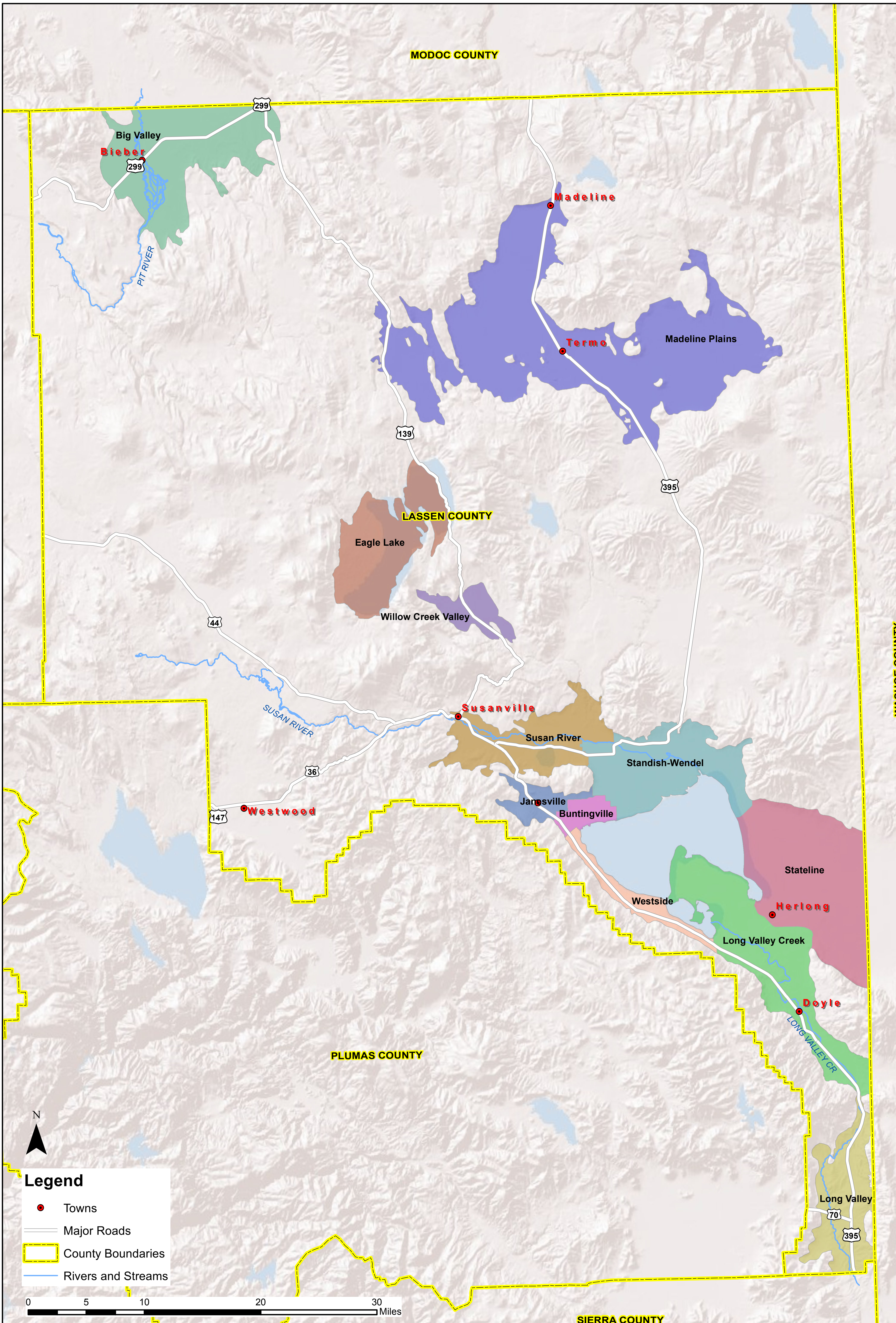


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Figure 1-1

1.3 Basin Management Objective Structure

The BMO program as implemented in Lassen County enlists committees to report groundwater levels, investigate exceedances, and recommend exceedance actions when action levels selected by management area representatives are exceeded for key wells. This investigation, recommendation, and action process is described in the document *Basin Management Objective Structure Technical Memorandum* available from the project website at: http://www.lassenbmo.com.

Each committee performs a specific role in the BMO process. The Technical Advisory Committee (TAC) is comprised of technical experts that understand and work with groundwater. The TAC is generally responsible for producing annual monitoring reports, investigating exceedances, and providing recommendations to the Groundwater Committee (GWC). The GWC is a representative body made up of management area representatives, and is responsible for reviewing TAC input, carrying out some BMO actions, and reporting to the Lassen County BoS to recommend additional actions if necessary. The BoS considers GWC recommendations and acts based on the GWC's recommendations as appropriate. Figure 1-2 illustrates the structure of the committees.

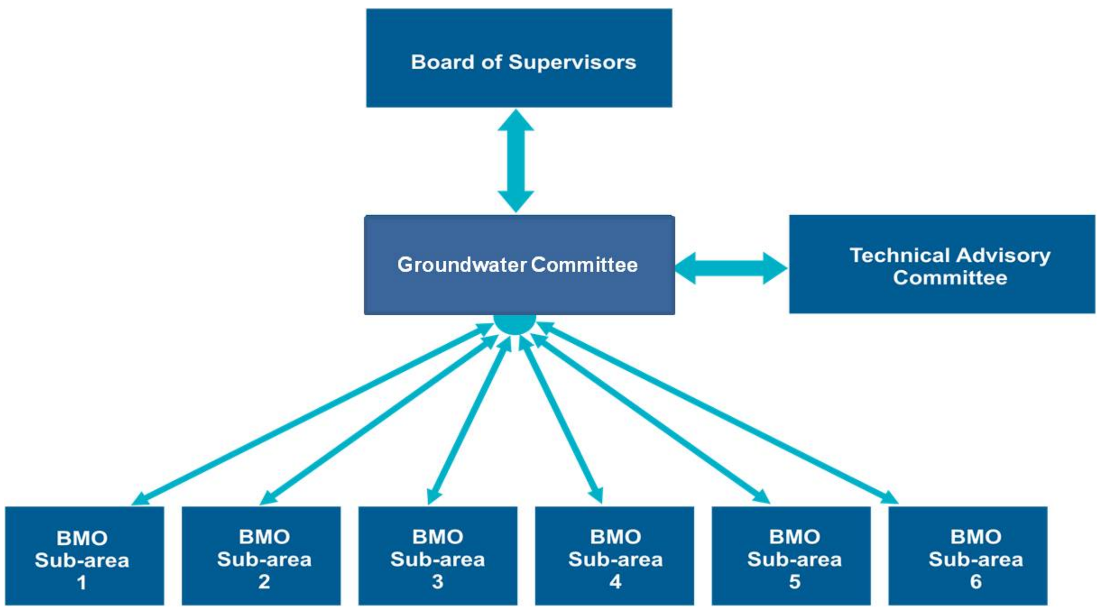

Figure 1-2. Overall BMO Committee Structure

1.3.1 The Basin Management Objective Process

The TAC will produce an annual report that describes groundwater monitoring activities, monitoring results and any exceedances of groundwater levels that fall below the designated Tier 1 or Tier 2 action levels in key wells. In both tiers of action levels, the exceedance cycle is started. In both tiers, the exceedance cycle process is the same, with the exception, that in the case of a Tier 2 action level exceedance, the GWC must take additional considerations.

In the exceedance cycle, the TAC investigates possible causes of the exceedance, and makes recommendations to the GWC that indicate whether the exceedance is a concern for the long term trend of groundwater in the management area or not. If it is, the TAC also recommends an exceedance action to the GWC. The GWC then recommends continued monitoring if the exceedance is not indicative of a long term regional trend, or implements the exceedance action if the action is within the GWC's authority, or recommends the exceedance action to the BoS if the action is beyond the GWC's authority. The BoS then considers the GWC recommended exceedance action, and then takes actions as the BoS deems to be appropriate.

The exceedance cycle returns to monitoring only when groundwater elevations are measured to be higher than action levels. If groundwater levels in key wells stay below Tier 1 action levels, the exceedance cycle is continued the following year. If groundwater levels fall below Tier 2 action levels for two consecutive years, the exceedance cycle is continued, and the GWC is required to consider Tier 2 actions and present to the BoS the results of their consideration.

1.3.2 Technical Advisory Committee

The TAC will provide a depth of technical understanding of groundwater within Lassen County's management areas. The TAC's members will interpret groundwater monitoring data and provide input into the investigation of BMO exceedances and update BMOs as the BMO program is implemented. The TAC is a Brown act compliant committee, and meetings of the TAC may be attended by the public. The TAC is responsible for reviewing monitoring activities and data, identifying BMO exceedances, preparing the annual BMO groundwater monitoring report, investigating exceedances, and recommending actions to the GWC.

The TAC will meet as necessary, not less than once per calendar year, and will report to the GWC as necessary, not less than once per calendar year. Coordination of TAC meetings will be performed by the County.

1.3.3 Groundwater Committee

The GWC is the representative body of management area stakeholders, and is responsible for reviewing the annual BMO groundwater monitoring report, reviewing TAC recommendations, implementing tier 1 exceedance actions, recommending exceedance actions beyond GWC purview to the BoS, and communicating the output of the BMO program to the BoS.

The GWC will consist of twelve (12) committee members. Committee members will consist of one representative for each management area (Figure 1-1) and one Lassen County Representative, with the exception of the Stateline and Long Valley Creek management areas, which will share one representative due to the limited population in the Stateline management area.

GWC members will be appointed by the BoS. Initial GWC composition will be recommended to the BoS by the BMO Working Group. Subsequently, public announcements of GWC position availability will be made, and people who wish to be considered for the GWC will need to submit a letter of interest and summary of qualifications to the GWC for consideration. The GWC will then select new members through a majority vote and then recommend new members for approval by the BoS. GWC members will serve in two year terms.

The GWC will report to the BoS as necessary, not less than once per calendar year. The GWC will meet as necessary, not less than once per calendar year. GWC meetings will be Brown Act compliant meetings, and the public may attend GWC meetings. Coordination of GWC meetings will be performed by the County.

1.3.4 Board of Supervisors

The BoS is the lead of County government and as such, performs administrative tasks as well as the legislative functions of County government. The BoS in Lassen County is a five member board, elected from five different supervisorial districts. Due to the BoS's position as the head of County government, the BoS is the final decision making body of the BMO program.

The BoS will receive reports from the GWC, review the BMO groundwater monitoring report, and consider exceedance actions recommended by the GWC at its discretion. The BoS will receive BMO status reports from the GWC at least once per year, with additional input from the GWC as necessary. The BMO ordinance cannot expand the power of the BoS, and only defines and provides guidance to the BoS on groundwater management issues.

1.3.5 Potential Exceedance Actions

This section describes the potential actions proposed under the BMO structure given that an exceedance of action levels has been observed. The following section is divided into two primary sections based upon the level of severity of the required actions. The first level, Tier 1 actions, will typically be performed by the GWC and generally will not require BoS approval. Tier 2 actions will require BoS review, consideration, and support to implement.

1.3.5.1 Tier 1 Actions – Implemented by the Groundwater Committee

Tier 1 actions will be implemented after identification of a BMO exceedance in a management area is investigated and evaluated to be representative of a long term regional trend. Tier 1 actions are informative and investigative by nature. These actions can be used individually or together based on decisions by the TAC or GWC. Tier 1 actions may include but are not limited to:

- **Hold TAC meetings to discuss exceedance** – Additional TAC meetings may be held to discuss BMO exceedances. The review will include discussion of the accuracy and validity of the observation data, review of recent and historic water level data, comparison to other basins within Lassen County, comparison to regional groundwater data, and discussion of known or perceived potential explanations for the exceedance. The result of these meetings should be a conclusion to the validity of the observed exceedance accompanied with potential recommended actions for consideration by the GWC.
- **Identify a Specific Action Level for Review** – If investigation by the TAC reveals that an action level in a key well is set at a level that is not consistent with identifying a long term negative regional trend, the action level may be marked for review during the periodic updating and review process.
- **Hold GWC meetings to discuss exceedance** – This meeting should follow the additional TAC meetings described above and include a review of the conclusions of the TAC. The GWC will further consider the recommended actions of the TAC and determine if the recommended actions merit additional discussion with the BoS.
- **Hold management area meetings to discuss exceedance** – This action would hold discussions with local management areas where exceedances are observed. These meetings may focus on further investigation to identify potential causes for the exceedances. Furthermore, these meetings would allow for clear communication with the land owners and users to explain the observed conditions.
- **Contact water users in management area to notify of problem** – This action may include mailings or flyers to notify users within each area of the observed exceedances and provide potential voluntary conservation measures.
- **Notify public of groundwater issue via press release and/or website** – This action would allow for communication of the observed exceedance with the public and can provide voluntary conservation measures.
- **Increase monitoring** – This action would propose increased monitoring in the management area where a BMO exceedance is occurring, and may include the following changes in monitoring:
  - Increase monitoring frequency / install dataloggers in monitoring wells
  - Increase monitoring grid size / more locations
  - Consider monitoring for land subsidence
- **Solicit voluntary actions -** This action would solicit voluntary conservation, pump scheduling or other programs with management area groundwater users.

1.3.5.2 Tier 2 Actions – Implemented by the Board of Supervisors

Based on the severity of the negative long term regional trend identified by BMO exceedances and TAC investigation, it may be necessary to take actions beyond Tier 1 actions. Tier 2 actions are stringent actions taken to protect groundwater resources. Tier 2 actions will likely require considerable discussion through the TAC, GWC and BoS prior to implementation. The GWC will present a recommendation of a Tier 2 action or multiple Tier 2 actions to be implemented in an effort to reduce a negative long term regional trend in groundwater levels and continued exceedance of BMOs. The BoS will evaluate the recommendations of the GWC and potentially direct the most appropriate implementation method or approach at its discretion. These actions may be politically charged discussions, and as such fall to the purview of the BoS. Tier 2 actions will follow all federal and state laws, as appropriate. Tier 2 actions include but are not limited to:

- **Establish a groundwater recharge program** – The recharge program can vary greatly ranging from solutions of flooding of fields for infiltration to groundwater injection wells to physically inject water back into the aquifer.
- **Establish in-lieu recharge programs** – These programs allow for substitution or reallocation of surface water to offset groundwater pumping, and require a surface water source to replace the groundwater that would be pumped.
- **Establish a well spacing ordinance** – This action establishes criteria for well spacing. Well spacing limits the number of wells within a defined space. If a defined well spacing is applied in regions with a large number of existing wells, the well spacing ordinance can prevent the installation of new wells in those areas. This action can be implemented through the County or City well permitting process and will reduce increased future groundwater pumping stresses in specific areas.
- **Establish requirements and review of development approvals**– This action would require or restrict proposed development. This action could require developers to further substantiate the impacts of the development to the regional groundwater aquifer including increased demand and documented supply, or may otherwise restrict development in areas experience a negative long term regional trend.

1.4 Document Contents

This document describes the BMO program, provides a description of the management area, explains the process for setting BMOs including selecting key wells and action levels, and provides recommended BMOs for the management area. The County has developed guidance documents for all 12 management areas. Each document describes the management area at a similar level of detail to this document. Recommended BMOs have been developed using science-based methods to arrive at initial recommendations for each management area. These draft recommended BMOs have been recommended to facilitate and catalyze a public process of developing BMOs in each management area. This document consists of four sections:

Section 1: Introduction – This section describes the BMO program and provides information on document contents.

Section 2: Big Valley Management Area – This section describes the physical conditions in the Big Valley, including geology, land use, and groundwater well infrastructure.

Section 3: Setting Groundwater Level Basin Management Objectives – This section describes groundwater monitoring in the management area, provides a description of how to select key wells and action levels, and provides recommended key wells and action levels for the area.

Section 4: Groundwater Quality and Subsidence – This section discusses groundwater quality and subsidence in the context of the BMO program.

Section 2

Big Valley Management Area

The Big Valley management area is located in Big Valley, in the northwestern corner of Lassen County. The Big Valley management area is bound by the Lassen-Modoc county line to the north, the Big Valley Mountains to the west, and Barber Ridge to the northeast. The Pit River drains out of the southern part of the management area. The region is generally flat and gently slopes to the south and toward the Pit River, with elevations ranging from 4,110 ft mean sea level (msl) to 4,280 ft msl.

The main surface water bodies in the area are Pit River and Ash Creek. The major population in the management area is Bieber, population 312 according to 2010 U.S. Census Bureau. Highway 299 trends southwest to northeast through the management area.

Northwestern Lassen County is mostly native sagebrush-dominated vegetation with some pasture and rangelands in developed valleys. Vegetation is sparse and drought resistant. Average precipitation and snow levels, reported by the Western Desert Research Institute at the Adin Ranger Station, northeast of Big Valley, is about 15 inches of rain and up to 45 inches of snow annually. Precipitation trends are consistent with the semi-arid, Mediterranean-type climate of California, characterized by heaviest precipitation in winter and spring months and little to no precipitation during summer months.

2.1 Geology

Lassen County is the convergence of four major geologic provinces, the Sierra Nevada, the Basin and Range, the Cascade Range, and the Modoc Plateau. The Big Valley management area is part of the Modoc Plateau, which is formed by repeated eruptions of basaltic volcanic material. The basin is also bound by normal faults on the southwest, a result of Basin and Range extensional activity. The region was part of an extensive area of lakes bordered by volcanoes, and the Big Valley is a former lake basin drained by the Pit River (Brown and Caldwell, 2007).

The depositional history of the region is characterized by alternating periods of ash and other pyroclastic deposits, basalt from volcanic eruptions, and lake deposits (Brown and Caldwell, 2007). Sediments and sedimentary rocks in the Big Valley are volcanic in origin and have been redistributed in the valley by the Pit River and other streams. Most shallow sediments are stream deposits consisting of poorly consolidated materials including clay, silt, sand, and gravel, originating from the Pit River and its tributaries. The stream deposits are not uniformly continuous and have variable thicknesses and porosity and interfinger with alluvial fan deposits from the ridges surrounding the basin (Department of Water Resources [DWR], 2003). These loose sediments overlay lake deposits that originate from prehistoric volcanic lake basins.

Land in the Big Valley management area is predominately native habitat with well developed agriculture throughout the western and central regions of the valley. Areas along Highway 395 are utilized for pasture and a variety of crop types in the western and central part of the area. Residential land is focused in Bieber and distributed throughout the management area. Figure 2-1 presents land use in the Big Valley management area.

Irrigated agriculture in the Big Valley management area is used for pasture and a variety of crops. Figure 2-2 presents land use by water source. Water use for pasture and agriculture in the area is provided by both surface and groundwater sources. Surface water is used more predominantly in the northern part of the management area, and on the western side of the Pit River. Groundwater is used throughout the management area, but use is concentrated on the eastern side of the Pit River and extends north through the central part of the management area following Highway 299.

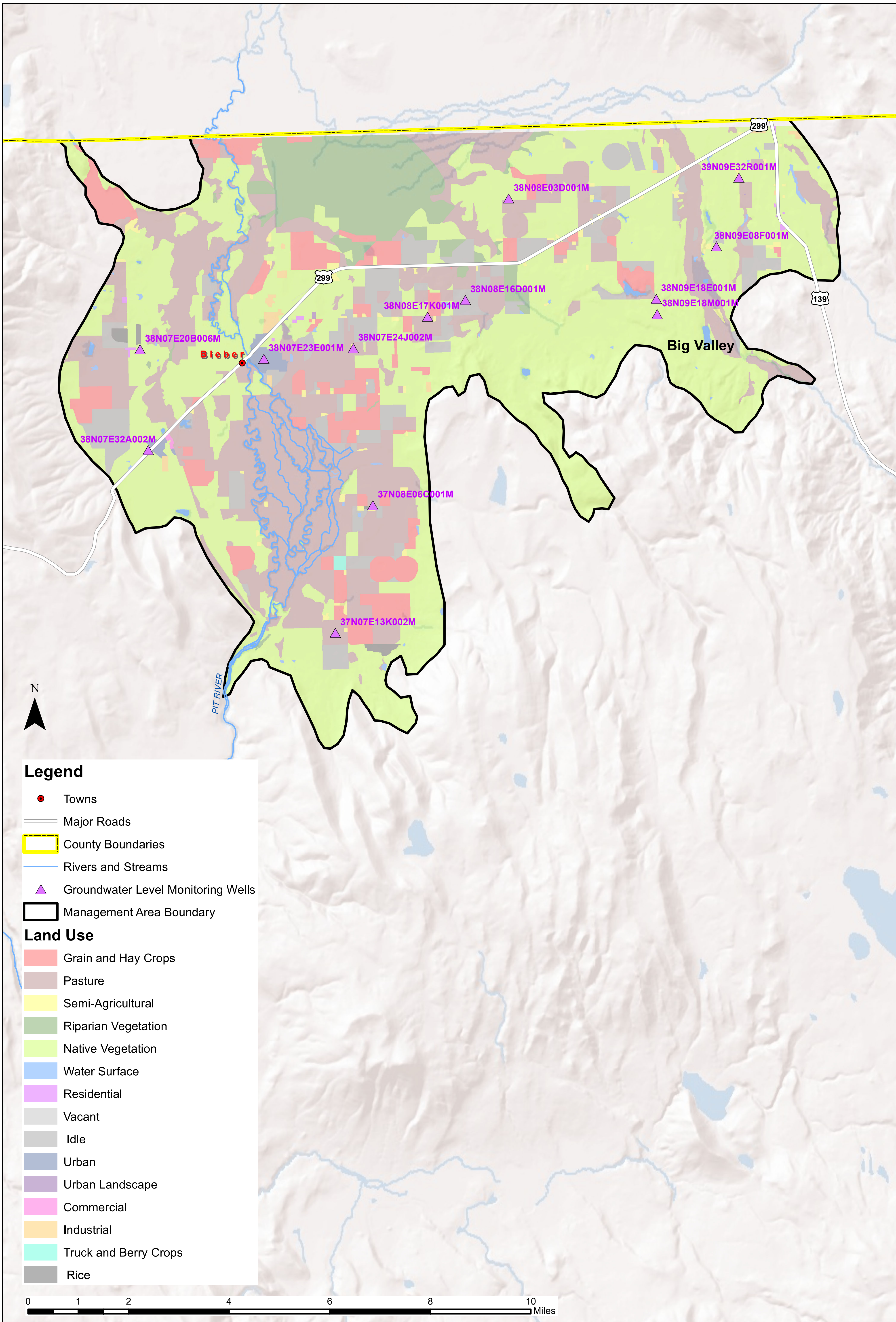

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Figure 2-1

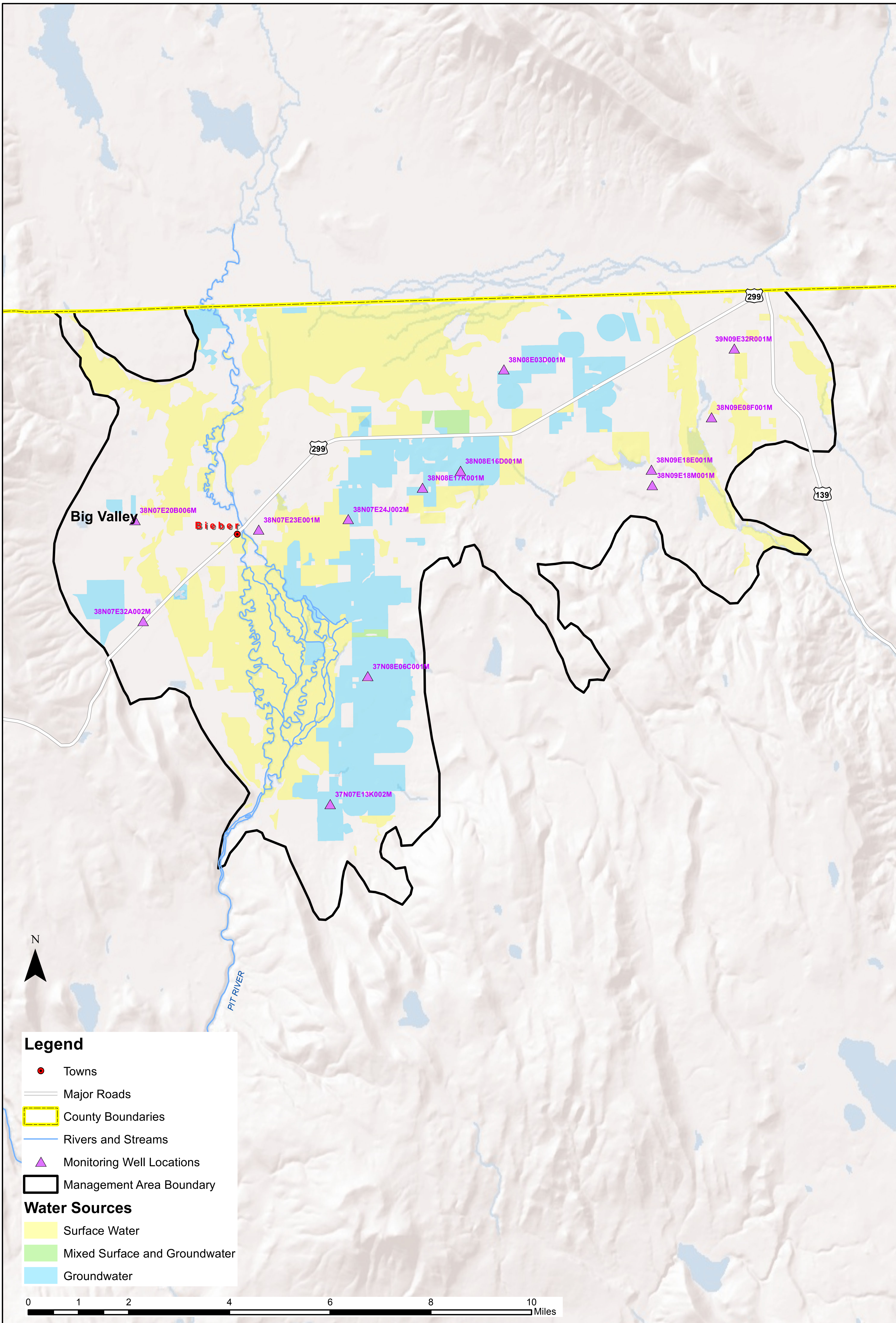

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Figure 2-2

The main surface water body in the Big Valley management area is the Pit River, which flows north to south through the western side of the management area. The Pit River flows year round through the management area. The most recent applicable stream gauge data is from the Pit River near the Canby, California station, located north of the management area in Modoc County. Average estimated discharge for winter months is around 90 cubic feet per second (cfs), with peak flows in June and July corresponding to winter snowmelt and lowest flows typically occurring in September and October. Data for this station (number 1148500) is from U.S. Geological Survey National Water Information System (NWIS) website, and is available from 1904 to 1994.

2.2 Groundwater Well Infrastructure

Well depth, approximate location, and well use information was obtained from DWR's well completion report database and utilized to identify the existing well infrastructure in the Big Valley management area. DWR's database contains information on the majority of wells drilled after 1947. Wells drilled prior to 1947 are generally not included and some wells drilled after 1947 may not have been reported to DWR (potentially up to 30%), and therefore are not included in the database or this summary.

The DWR database reports a total of 377 wells within the Big Valley management area. Types of wells reported in the area include a variety of uses as indicated in Figure 2-3. Most (145) groundwater wells in the Big Valley management area are used for irrigation. There are 130 domestic wells in the area, and 37 monitoring wells. The average depth of wells in the management area is 331 ft, with minimum depth of 10 ft and maximum depth of 1,231 ft. Wells classified as "other" or "unknown" in Figure 2-3 are either classified as "other" or "unknown" in the well log database, or are injection and monitoring wells.

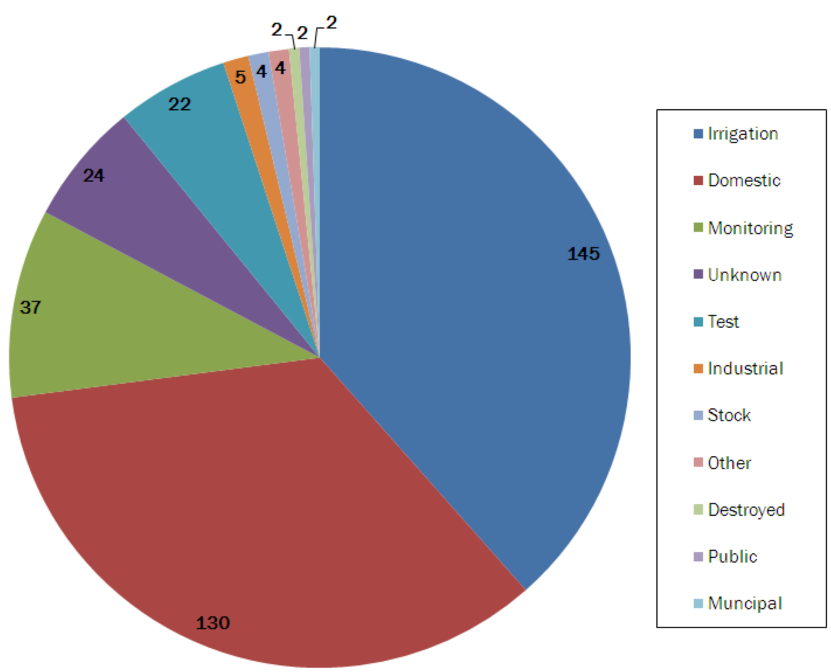


Figure 2-3. Big Valley Wells by Type

Figure 2-4 presents a graph that illustrates well depth range and cumulative frequency depth distribution for domestic and irrigation wells in the Big Valley Management area. The left (vertical) axis, cumulative frequency, shows the percent of all wells that are shallower than the line. The right (horizontal) axis shows well depth. For example, this graph shows that approximately 50% of both domestic and irrigation wells in the Big Valley management area are shallower than 275 ft deep. The majority of domestic wells are shallower than 300 ft though depths reach 900 ft. Irrigation wells are generally deeper than 200 ft, with the majority between 300 ft and 800 ft. The steady increasing line of the cumulative frequency curve illustrates the distribution of wells at a wide range of depths in the management area. In general, the cumulative frequency curve shows that:

- 26% of domestic and irrigation wells in the area are shallower than 150 ft deep,
- 55% of domestic and irrigation wells in the area are shallower than 300 ft deep, and
- 91% of domestic and irrigation wells in the area are shallower than 700 ft deep.

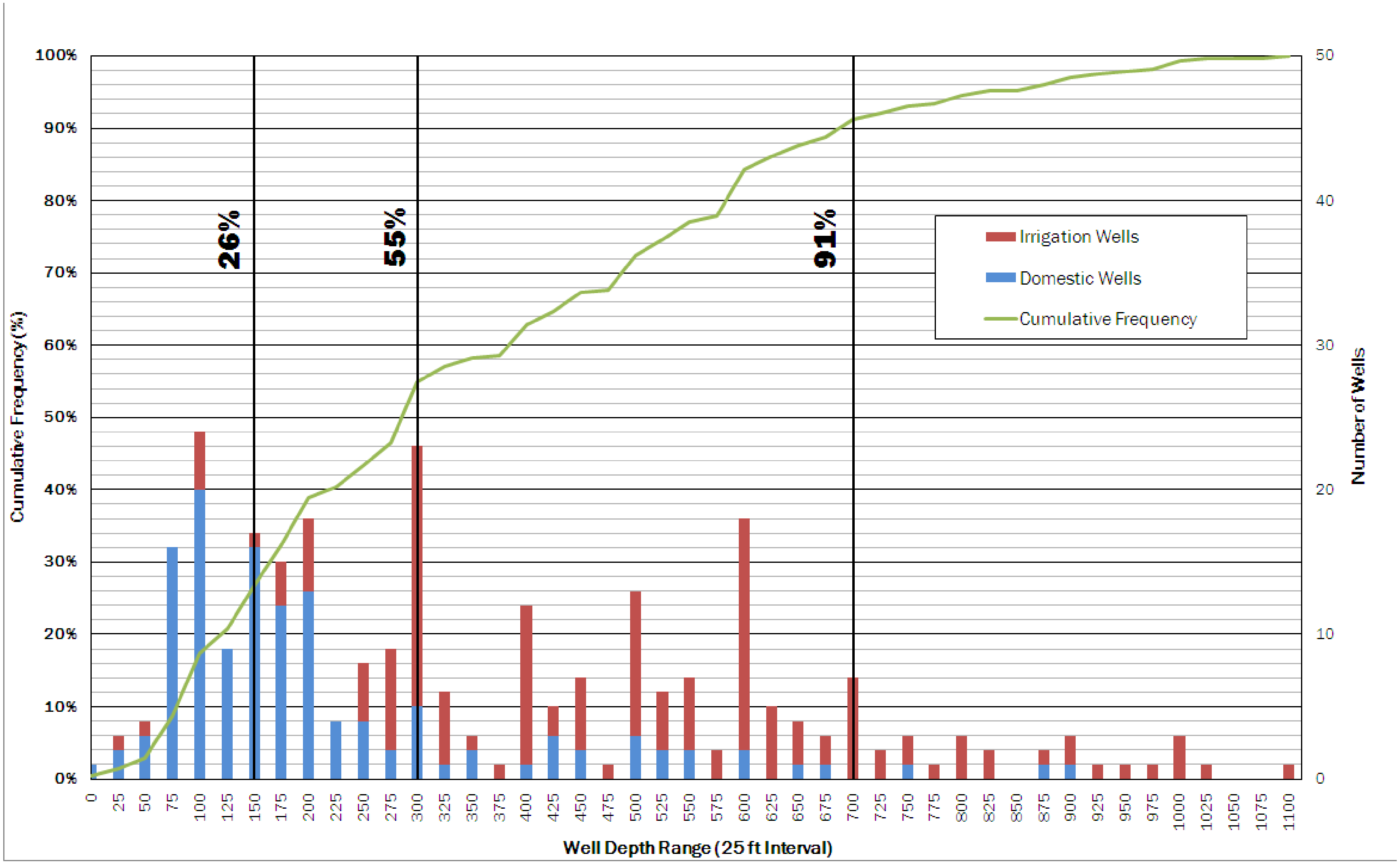


Figure 2-4. Depth Distribution of Domestic and Irrigation Wells in Big Valley Management Area

Section 3

Setting Groundwater Level Basin Management Objectives

Developing BMOs requires knowledge of groundwater and wells in the management basin and selection of key wells to be used for future monitoring. Key monitoring wells are selected based on a variety of factors including location, well construction, proximity to surface water, and distribution within the management area. Water level data from key wells are used for developing action levels for groundwater management as part of the County's BMO program.

3.1 Groundwater Level Monitoring Overview

Groundwater monitoring data are used to select key wells and establish action levels as part of the BMO program for management of groundwater resources in Lassen County. A monitoring well network with a regular monitoring schedule provides data that will be used for analysis of long-term water level trends. Groundwater levels in basins are typically cyclic on an annual basis, higher in the spring and lower in the summer and fall seasons. The cyclic nature of groundwater levels is due to groundwater use and recharge patterns. Groundwater pumping typically peaks during the summer growing season, and slows in the winter. Comparisons of groundwater levels in specific wells from the spring seasons of consecutive years can indicate groundwater trends, such as lowering of the groundwater table during a drought period.

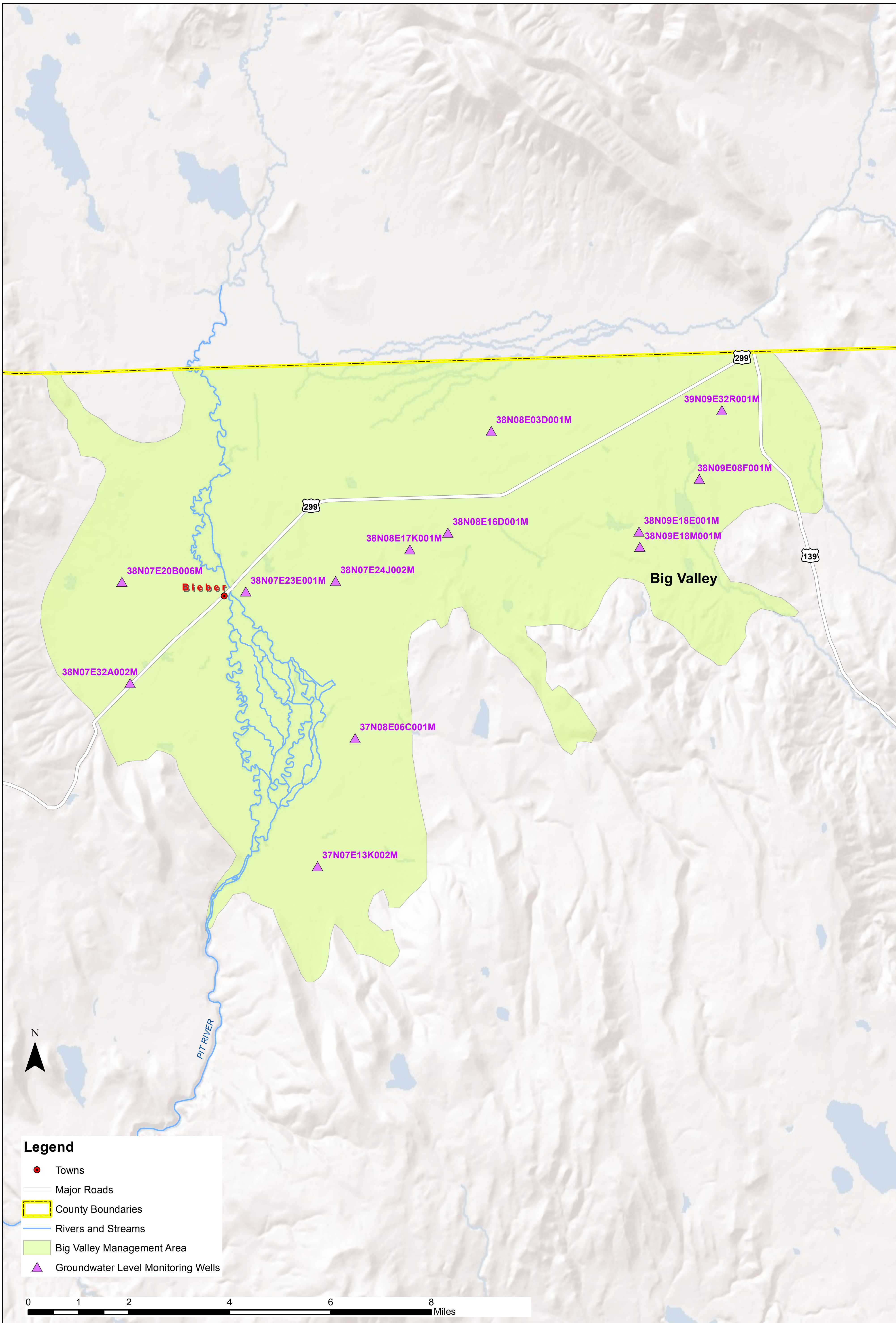
Groundwater level monitoring in Lassen County is performed by the DWR Northern District on a semiannual basis, in March and October. DWR currently monitors a network of 121 wells in Lassen County, of which 13 wells are in the Big Valley management area.

DWR publishes groundwater levels online in the Water Data Library (http://www.water.ca.gov/waterdatalibrary/) with current hydrographs showing groundwater levels records for the duration of their monitoring program. Most hydrographs span from 1980 to the present and include field notes explaining field conditions, such as pumping or accessibility issues that may affect measurements.

DWR monitoring is used because it is generally the best available groundwater level information available. Monitoring performed under DWR oversight has a long period of record, reliable reporting and quality control methodologies, and measurements taken by scientists and engineers.

The distribution of monitoring wells in the management area is shown in Figure 3-1. The construction and period of record information for the 13 wells in the Big Valley management area are shown below in Table 3-1. Hydrographs for all 13 monitoring wells from the DWR water data library are presented in Appendix A.

The monitoring wells are numbered using the state well numbering system, which identifies each well by its location according to the township, range, section, and tract system. Figure 3-2 illustrates the state well numbering system. In this numbering system, an example well number would be 25N05W17A001M, where the 25N indicates the township, the 05W indicates the range, the 17 indicates the section number, the A indicates the tract portion of the section, the 001 indicates that this is the first well installed in that area.



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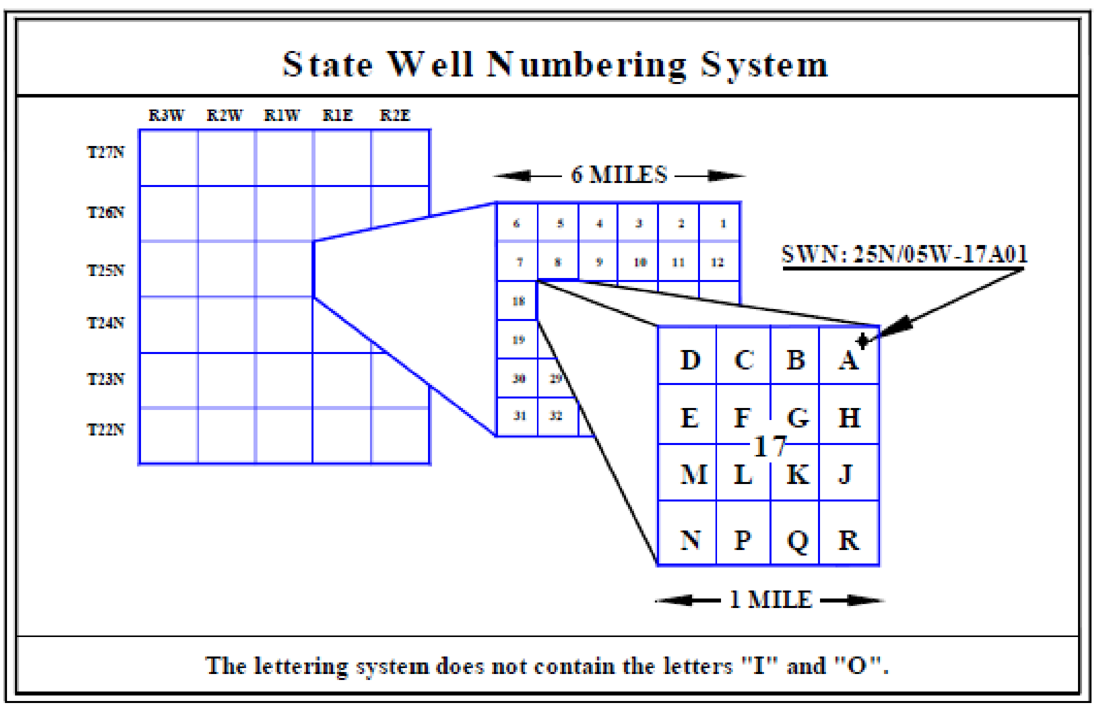
	TITLE Groundwater Level Monitoring Wells	DATE 4/21/2011	

Table 3-1. Big Valley Management Area Monitoring Wells

Well	Use	Period of Record	Depth (feet bgs)	Top Perforation (feet bgs)	Bottom Perforation (feet bgs)
38N07E32A002M	Unused	1978 - Present	49	NA	NA
38N07E20B006M	Domestic	1959 - Present	183	41	183
37N07E13K002M	Irrigation	1981 - Present	260	20	260
37N08E06C001M	Irrigation	1981 - Present	440	20	440
38N07E23E001M	Domestic	1978 - Present	84	28	84
38N07E24J002M	Irrigation	1978 - Present	192	0	192
38N08E17K001M	Domestic	1957 - Present	180	150	180
38N08E16D001M	Irrigation	1981 - Present	491	100	250
38N08E03D001M	Irrigation	1981 - Present	300	280	300
38N09E18M001M	Irrigation	1980 - Present	280	40	280
38N09E18E001M	Irrigation	1980 - Present	520	21	520
38N09E08F001M	Unused	1978 - Present	217	26	217
39N09E32R001M	Irrigation	1981 - Present	NA	NA	NA

NA – Data Not Available

Source: DWR, 2011



Source: Department of Water Resources, Northern District

Figure 3-2. State Well Numbering System

3.1.1 Groundwater Well Terminology Overview

This section provides an overview of a typical monitoring well, as well as descriptions of commonly used groundwater well and monitoring terms.

Most wells are drilled to a certain depth to ensure the desired well yield, or to monitor a specific geologic formation. A combination of casing and perforated well casing is then inserted into the well hole. The perforated well casing, sometimes referred to as a well screen, is normally placed in the most productive formation, at the desired monitoring depth, or in a specific geologic formation. In some wells, multiple casings and screened intervals are installed, creating a “multicompletion well.” Multicompletion wells monitor groundwater at different depths.

Figure 3-3 shows a typical well. The following definitions explain the measurements listed in the well data:

- The total depth of the well is the distance from the ground surface to the bottom of the well hole.
- The top perforation is the depth from the ground surface to the well’s shallowest perforation, which is the shallowest point water can enter the well casing.
- The bottom perforation is the well’s deepest perforation, which is the deepest point water can enter the well casing.
- The distance between the top perforation and the bottom perforation is known as the screened interval.
- The depth to water is the distance from the ground surface to the surface of water in the well.
- The water surface elevation is the elevation of water in the well above National Geodetic Vertical Datum (NGVD), also known as mean sea level (msl). This number is different than depth to water.
- The geologic formation at top perforation is the uppermost formation that can contribute water to the well. The geologic formation at bottom perforation is the lowermost formation that can contribute water to the well.

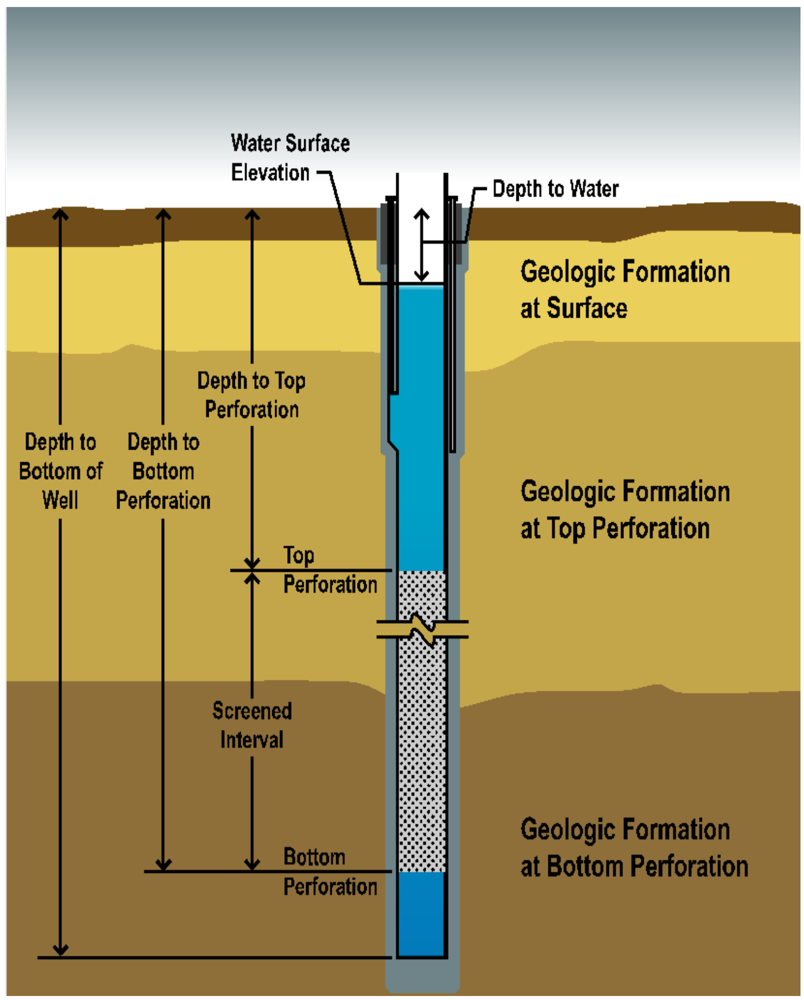


Figure 3-3. Well Completion Diagram

3.2 Key Well Selection

3.2.1 Key Well Selection Methodology

Key monitoring wells are wells chosen for their representativeness of groundwater conditions within the management area. Key wells are selected through a process that considers: location, period of record, well depth and well construction

- **Location:** Key wells should be distributed as evenly as possible throughout the management area. Key monitoring wells selected for a management area should be away from surface water bodies and should be located near the predominant land uses in the area.
- **Period of Record:** Key wells should have a long period of record and ideally will have been monitored for at least 15 years. Long term monitoring records show how that particular monitoring well's groundwater levels are affected by drought periods, which is essential for determining appropriate action levels. Monitoring wells with records that do not reflect known drought periods are less valuable as key wells, as well as monitoring wells with many measurements indicated as questionable by the monitoring agency.
- **Well Depth and Construction:** Whenever possible, key monitoring wells should have similar construction to the existing well infrastructure in the management area. This ensures that the BMO program is monitoring the same aquifer that is being used by local well owners.

3.2.2 Key Well Selection and Recommendations

For the Big Valley management area, groundwater level measurement data was available for thirteen wells. Each of the wells was evaluated using the criteria discussed above, and five key wells were selected. The locations of these wells are presented in Figure 3-4. Each of the proposed wells has a period of record of more than 20 years, with monitoring records that responded to the drought periods of the late 1980s and early 1990s. The wells are well spaced across the upper and lower valley and the monitoring wells are of similar depth to the majority of wells in the area, as well as being used for both domestic and irrigation uses. Each well is described in detail below:

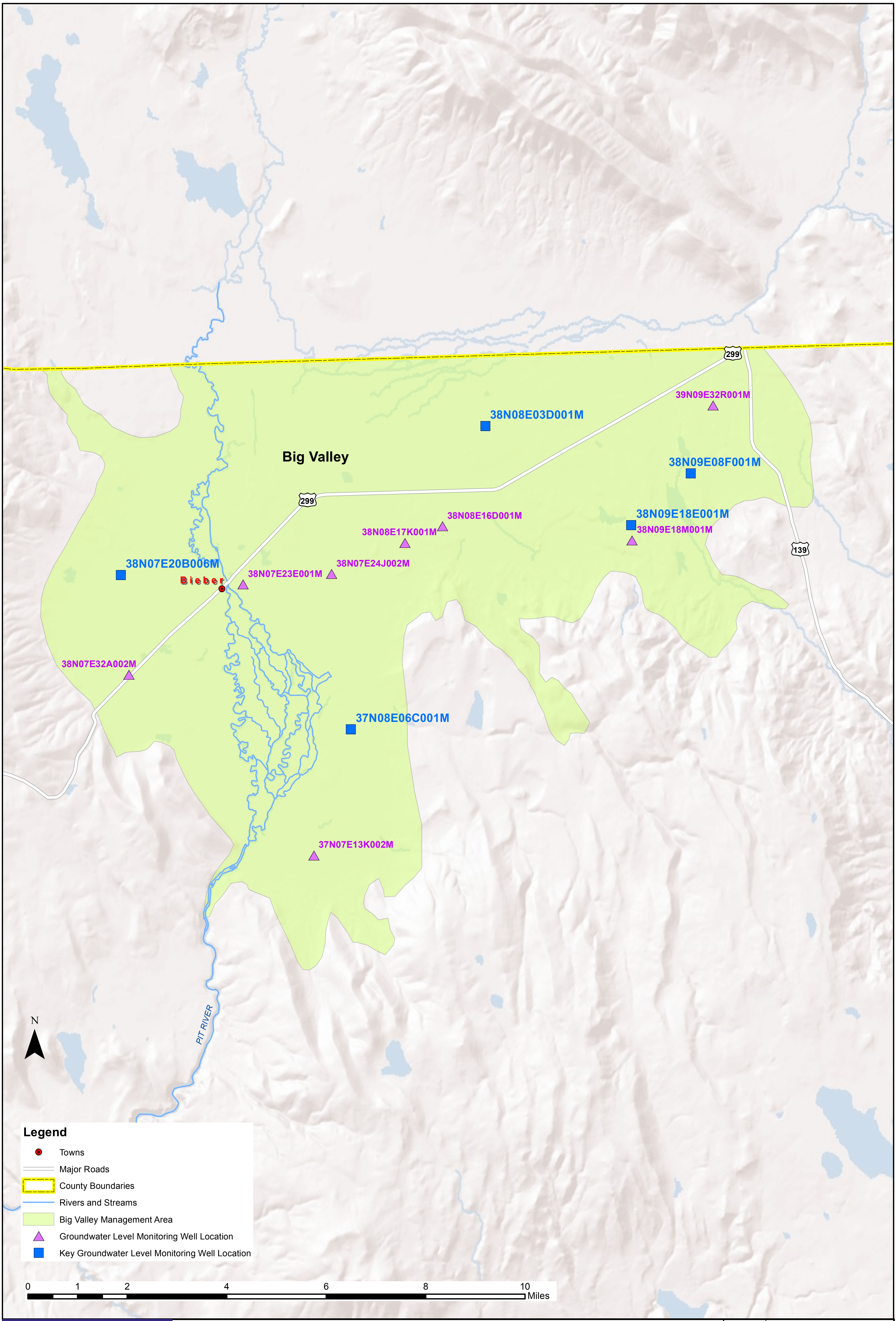
38N07E20B006M – This monitoring well is the western part of the management area and is designated for domestic use. This well is 183 ft deep with screened interval from 41 ft bgs to 183 ft bgs. The well is located around native vegetation, pasture, and other crops, and water supplies in the area come from groundwater. Monitoring records are available from 1959 to present and show consistent collection of water level measurements.

37N08E06C001M – This monitoring well is in the southern part of the management area and is an irrigation well. This well is 440 ft deep with a screened interval between 20 ft bgs and 440 ft bgs. Nearby land is used for a variety of agricultural uses and water supplies in the area are from ground water. Monitoring records are available from 1981 to present.

38N08E03D001M – This monitoring well is located in the northern part of the management area in an area used for pasture and is an irrigation well. Water supplies in the area come from groundwater. This well is 300 ft deep, with a screened interval from 280 ft bgs to 300 ft bgs. Monitoring records are available from 1981 to present.

38N09E18E001M – This monitoring well is located in the eastern part of the management area. Water supplies in the area are from surface water. The well is used for irrigation use and is 520 ft deep with screened interval from 21 ft bgs to 520 ft bgs. Monitoring records are available from 1980 to present.

38N09E08F001M – This monitoring well is located in the northeastern part of the management area in an area of native vegetation used for pasture and is designated unused. Water supplies come from surface water. This well is 217 ft deep, with a screened interval from 26 ft to 217 ft bgs. Monitoring records are available from 1978 to present.



Brown AND Caldwell

SITE	PROJECT	
Big Valley Management Area	139893	Figure 3-4
TITLE	DATE	
Key Groundwater Level Monitoring Wells	4/21/2011	

3.3 Selection Season of Measurement

Groundwater levels fluctuate seasonally, and measurements from different seasons provide different snapshots of groundwater conditions. Spring measurements are typically made in March and provide information on whether the basin has recharged during the wet season to elevations observed in previous years. Typically, spring water levels are the highest water levels observed during the year. Fall water elevation measurements provide information about decreased water levels during groundwater pumping and illustrate the cumulative pumping impacts within an area during a season, producing the lowest annual water levels. Spring levels indicate groundwater recovery or recharge following winter precipitation, which is why they are the preferred season to track groundwater issues. For this management area, we recommend spring groundwater elevation measurements be used in BMO evaluations.

3.4 Selection of Action Levels

A key element of developing BMOs is to set action levels for each key monitoring well in a management area. Action levels are selected so that, if reached, they indicate that groundwater problems may exist will be investigated by the TAC and may require GWC or BoS action. It is an important goal of action level selection to avoid setting levels that require action too soon, too often, or too late.

Action levels consist of a determined groundwater elevation in the each of the management area's selected key wells during a season of measurement. Reaching the action level begins the process of BMO management, starting with identification in the BMO annual report and investigation by the TAC, as described in Section 2 of this document. Selection of action levels aids management area groundwater users with groundwater management by:

- Maintaining groundwater at an elevation that promotes the continued economical use of groundwater for irrigation, domestic, and municipal needs.
- Protecting groundwater supplies for current and future domestic and irrigation use.
- Maintaining a stable level of groundwater in storage to ensure adequate drinking water and agricultural supplies during future drought periods.
- Reviewing groundwater monitoring records aid in identifying conditions that are related to declines in groundwater levels.

3.4.1 Recommended Action Levels

Recommended action levels for the Big Valley management area were selected using monitoring information for the five selected key wells. The recommended methodology for the selection of action levels has been selected because this method is sensitive to the differences in key well's responses to drought periods, is easy to use and understand, and selects an action level that identifies potential problems before they become serious problems.

The methodology for calculating the recommendation levels is calculated by using a percent of range methodology. For the Tier 1 action level, ten percent of the difference between historic high and low water level measurements (known as the range of spring measurements) is added to the historic low (the lowest measurement on record for that key well). For the Tier 2 action level, twenty percent of the range of spring measurements is subtracted from the historic low, resulting in an action level that is lower than any previous measurement in that key well. The Tier 2 action level also has a time component and is only exceeded when measurements stay below the Tier 2 level for two or more consecutive years.

For example, if the historic high spring water level is 100 ft msl, and the historic low spring water level is 50 ft msl, the difference or range of the measurements in that well would be 50 ft, and ten percent of the range of spring water levels (10% of 50) is 5 ft. For the Tier 1 action level, the 5 ft is added to the historic low water level (50 ft) to create a Tier 1 action level of 55 ft msl. For the Tier 2 action level, the 10 ft (20% of 50 ft) is subtracted from the historic low to create a Tier 2 action level of 40 ft msl.

Hydrographs for five key wells for the Big Valley management system were evaluated and action levels calculated for each well. Hydrographs for each key well showing spring and fall water level measurements and hydrographs with spring water levels and corresponding action levels are shown in Figures 3-5 to 3-14. Historic high and low water levels for the period of record for each key well, along with the corresponding action level, are shown in Table 3-2.

Groundwater levels in the Big Valley management area are currently at or near historically low levels. In four wells, 38N07E20B006M, 37N08E06C001M, 38N08E03D001M, and 38N09E18E001M, recent measurements of 4087.6 ft bgs, 4079.0 ft bgs, 4122.8 ft bgs, and 4214.8 ft bgs for the wells, respectively, are below the Tier 1 Action Level. If adopted by management area stakeholders as recommended, these wells are likely to begin the exceedance cycle, as described in Section 2, beginning with identification of the exceedance in the annual report. One well, 38N09E08F001M, is above the Tier 1 Action level, but shows decreasing water levels over recent measurements.

Table 3-2. Historic High and Low Measurements in Key Wells in the Big Valley Management Area

Well Name	Historic High Spring Measurement (ft msl)	Historic Low Spring Measurement (ft msl)	Range of Spring Measurements	Tier 1 Action Level (ft msl)	Tier 2 Action Level (ft msl)
38N07E20B006M	4,113.3	4,086.7	26.6	4,089.4	4,081.4
37N08E06C001M	4,123.4	4,079.0	44.4	4,083.4	4,070.1
38N08E03D001M	4,145.2	4,122.8	22.4	4,125.0	4,118.3
38N09E18E001M	4,230.7	4,214.8	15.9	4,216.39	4,211.62
38N09E08F001M	4,226.4	4,217.7	8.7	4,218.57	4,215.96

ft msl – feet above mean sea level

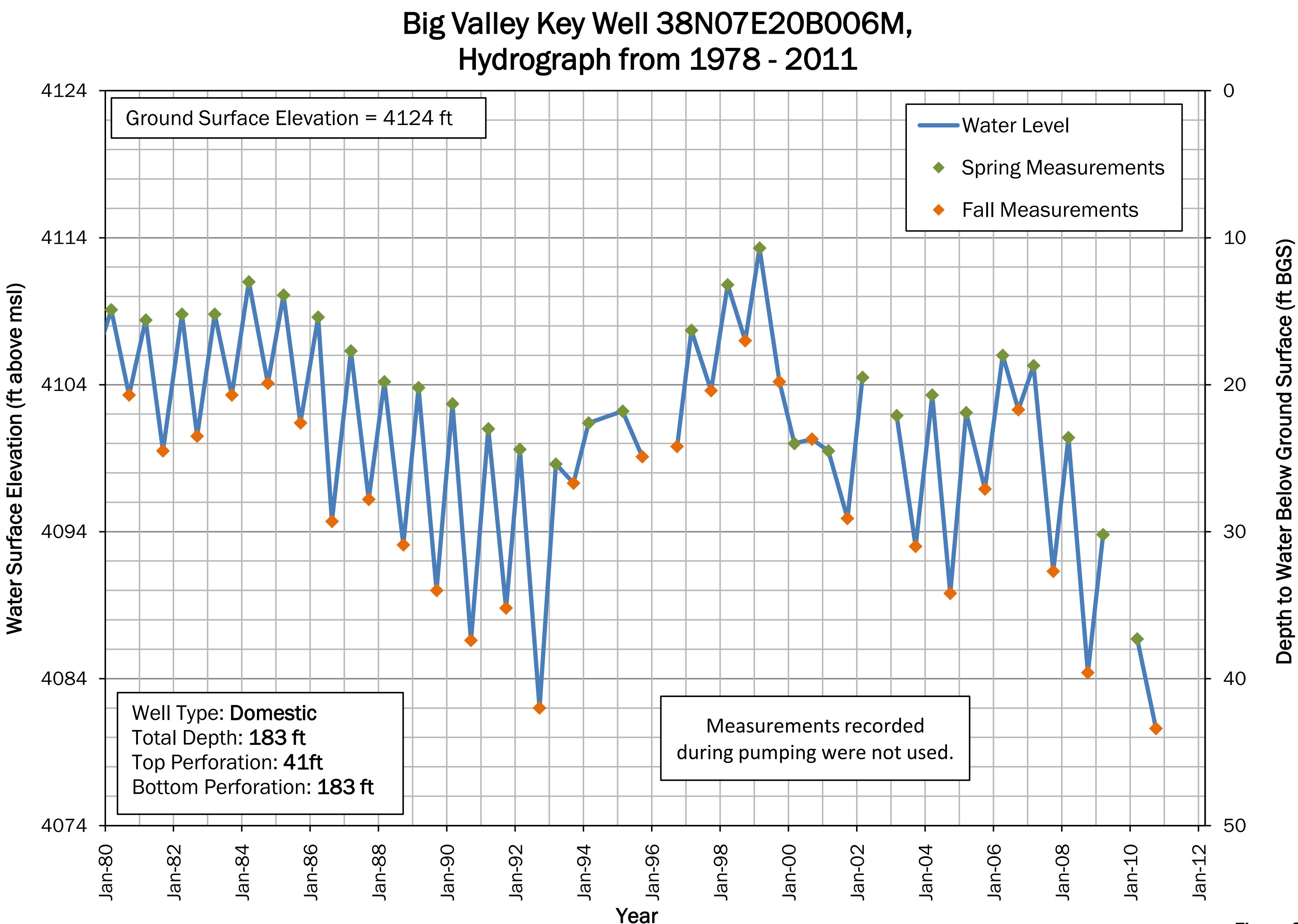


Figure 3-5
Hydrograph of Key Well 38N07E20B006M

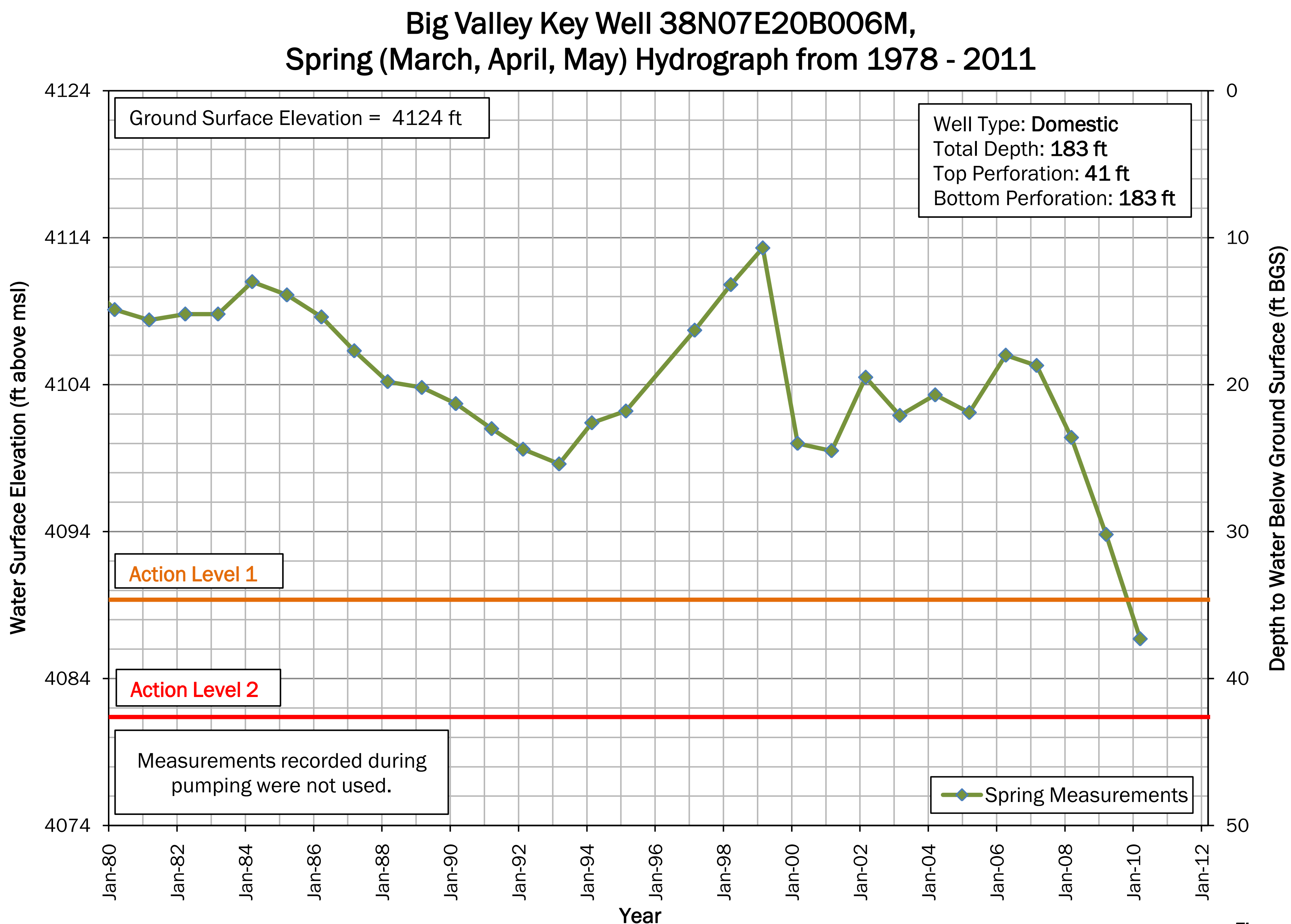


Figure 3-6
Spring Hydrograph of Key Well 38N07E20B006M

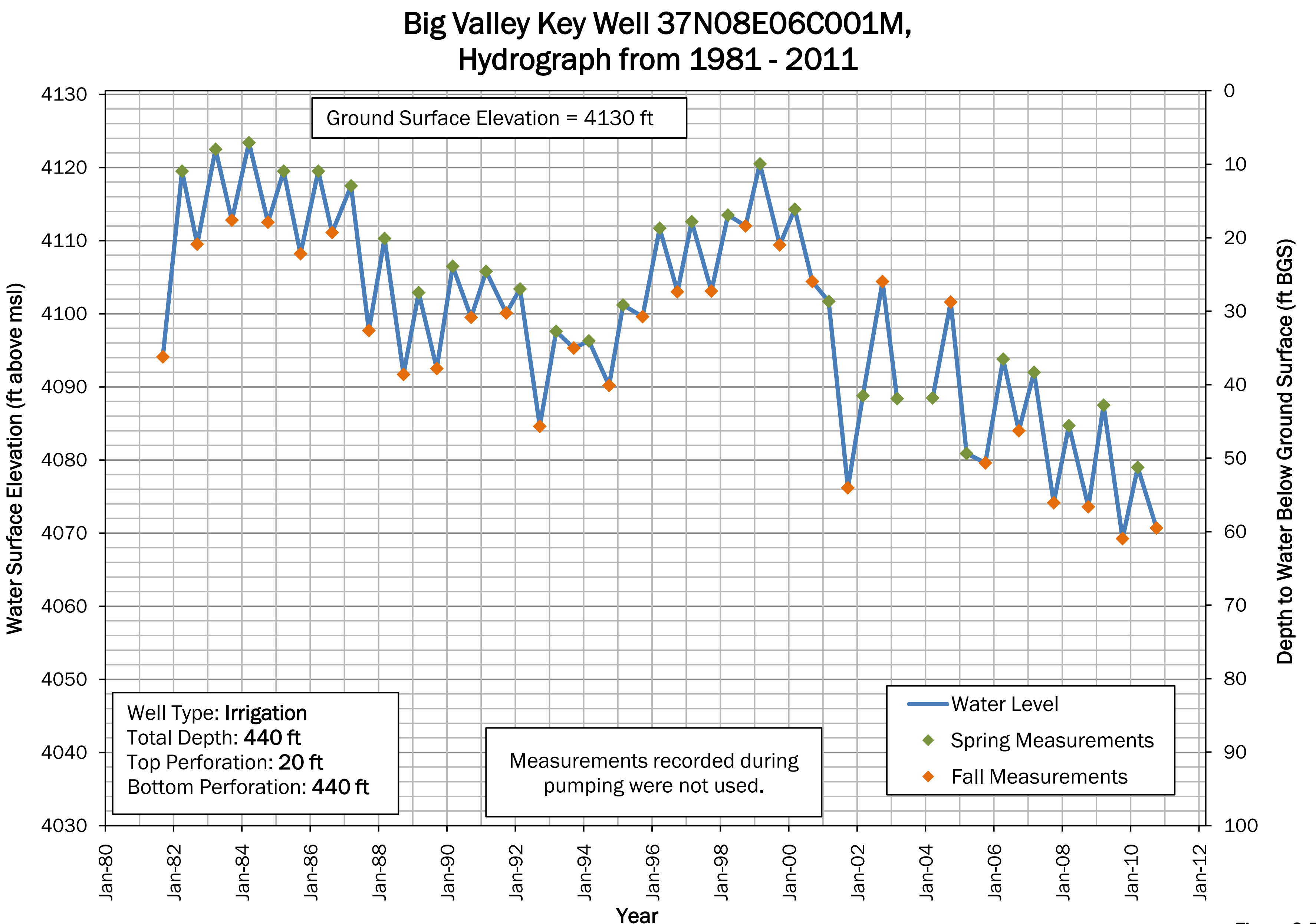


Figure 3-7
Hydrograph of Key Well 37N08E06C001M

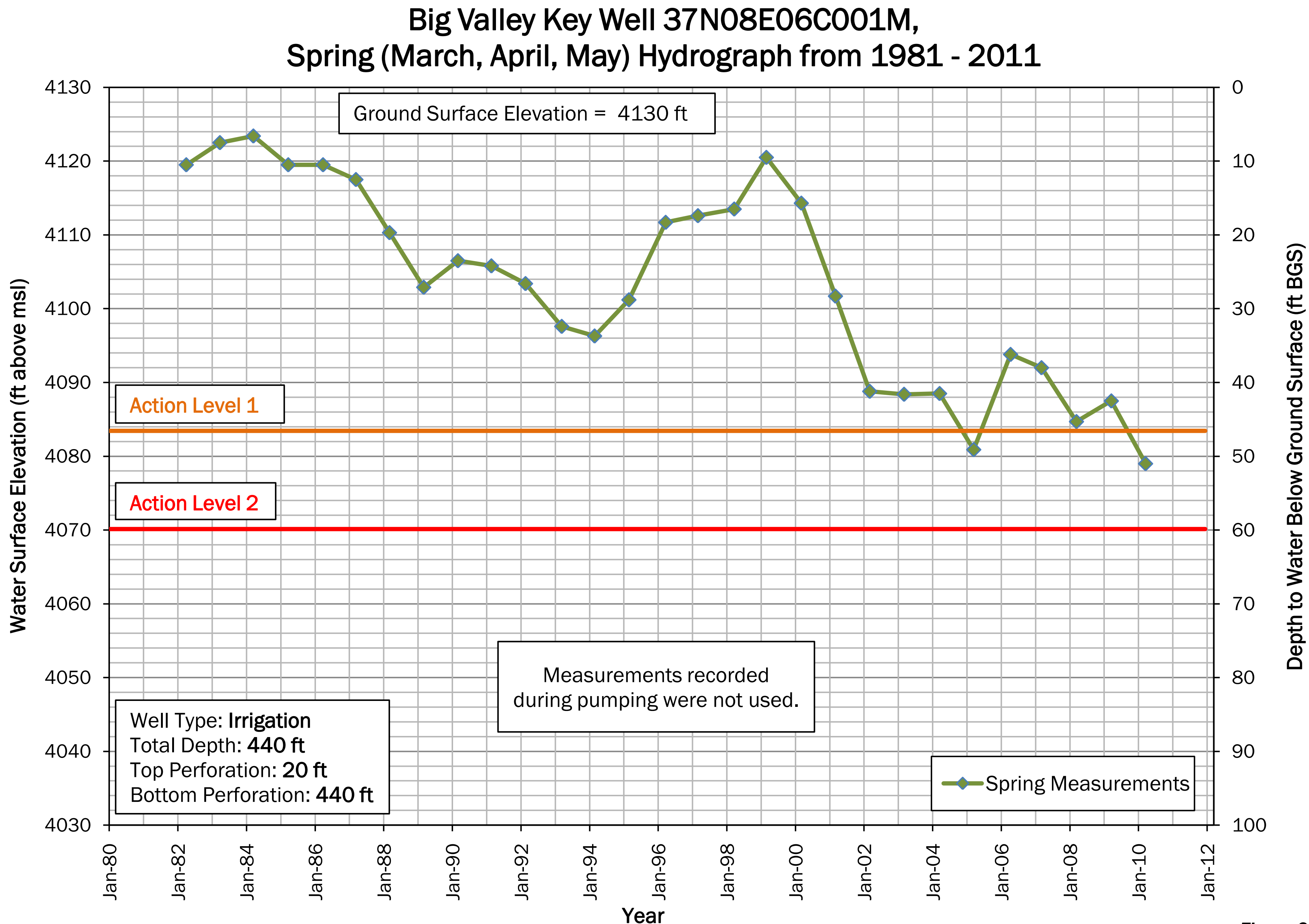


Figure 3-8
Spring Hydrograph of Key Well 37N08E06C001M

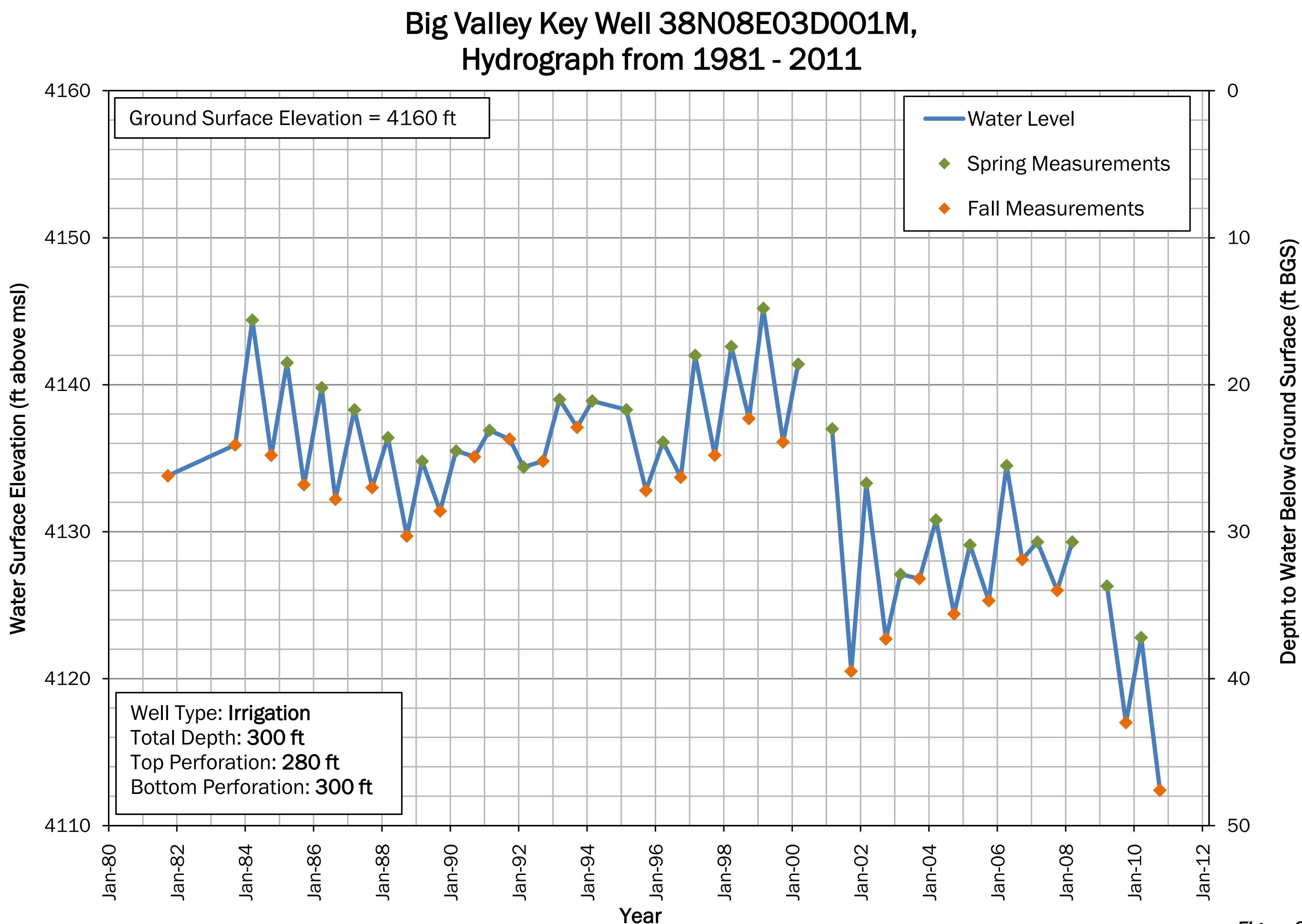


Figure 3-9
Hydrograph of Key Well 38N08E03D001M

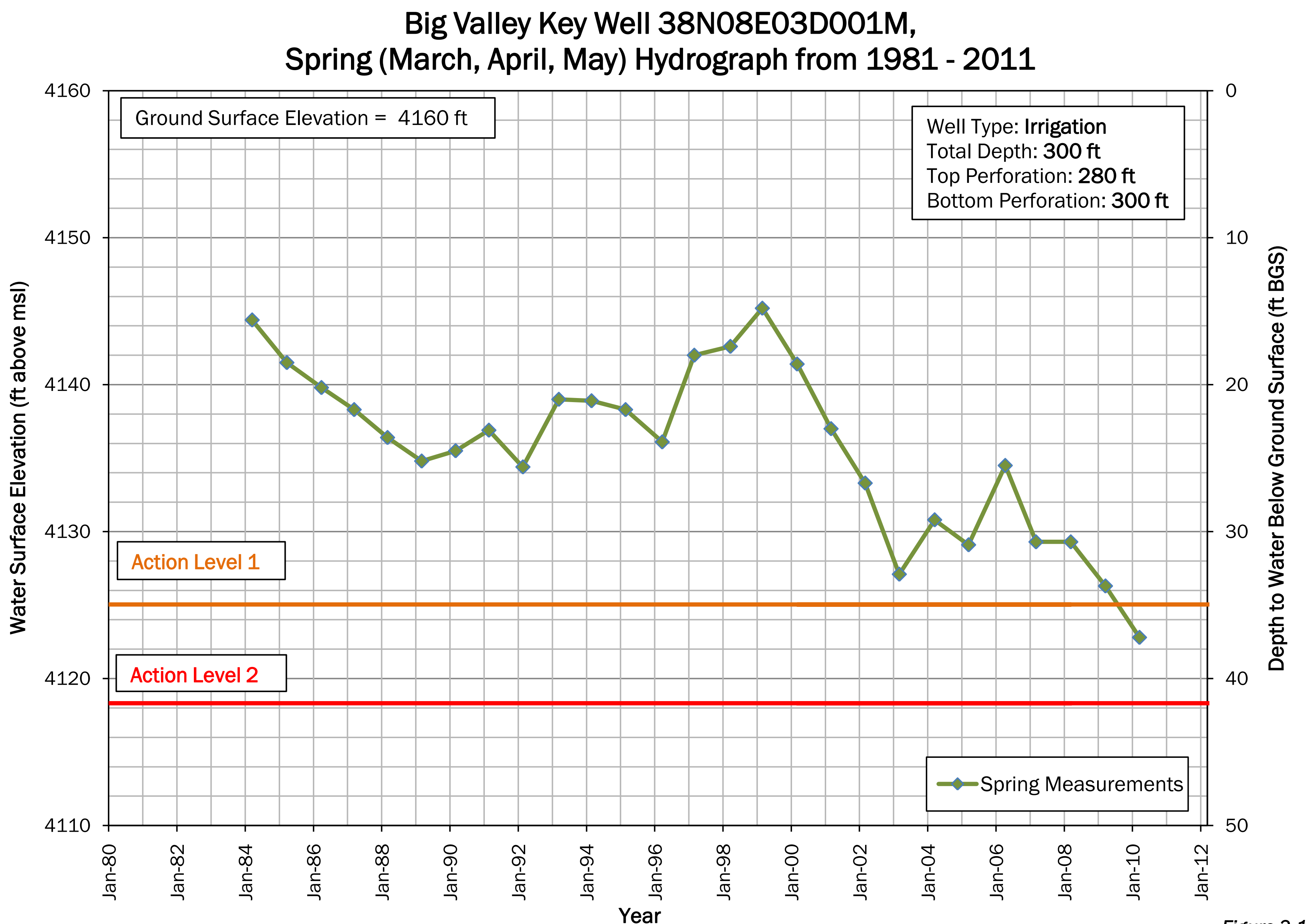


Figure 3-10
Spring Hydrograph of Key Well 38N08E03D001M

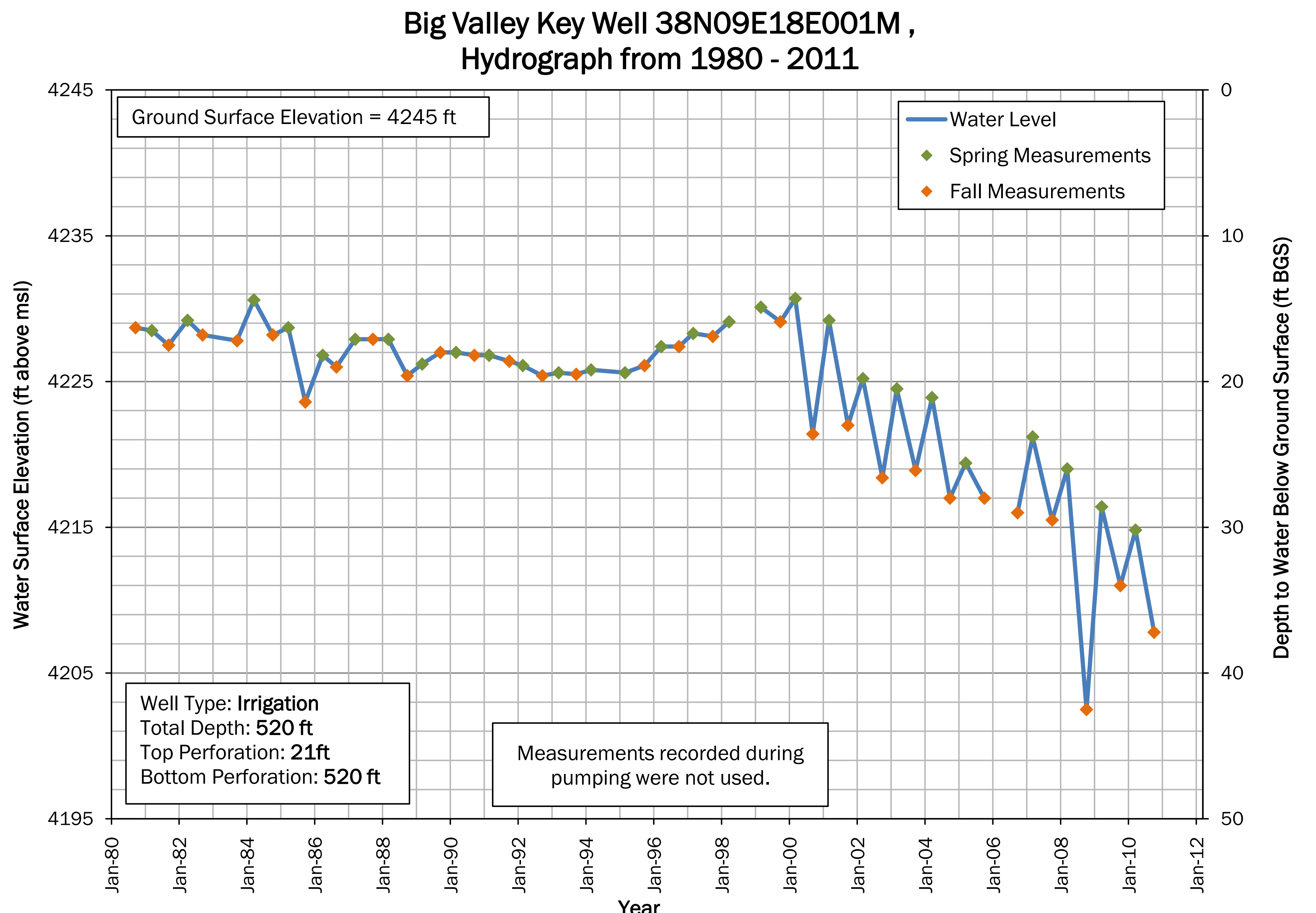


Figure 3-11
Hydrograph of Key Well 38N09E18E001M

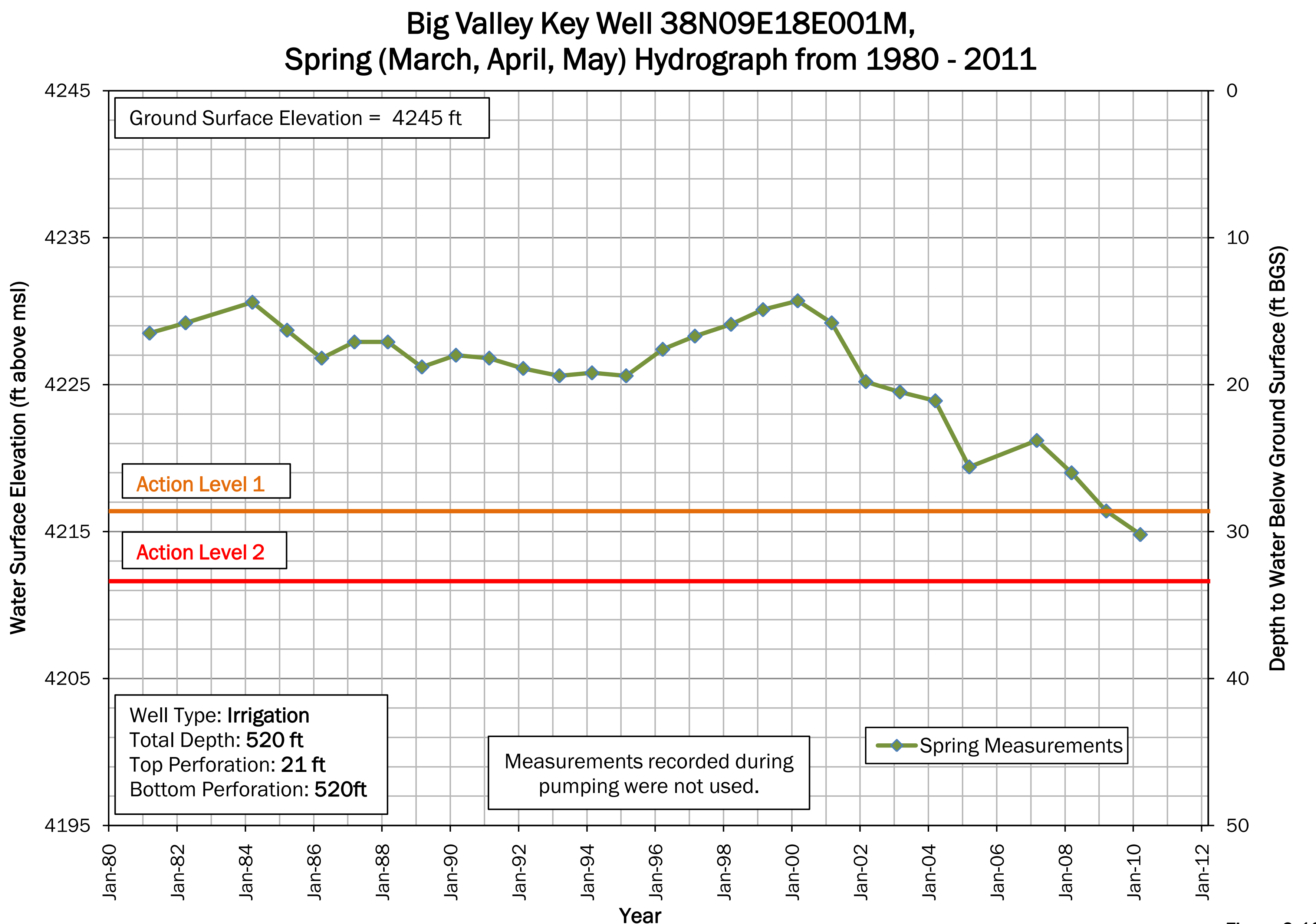


Figure 3-12
Spring Hydrograph of Key Well 38N09E18E001M

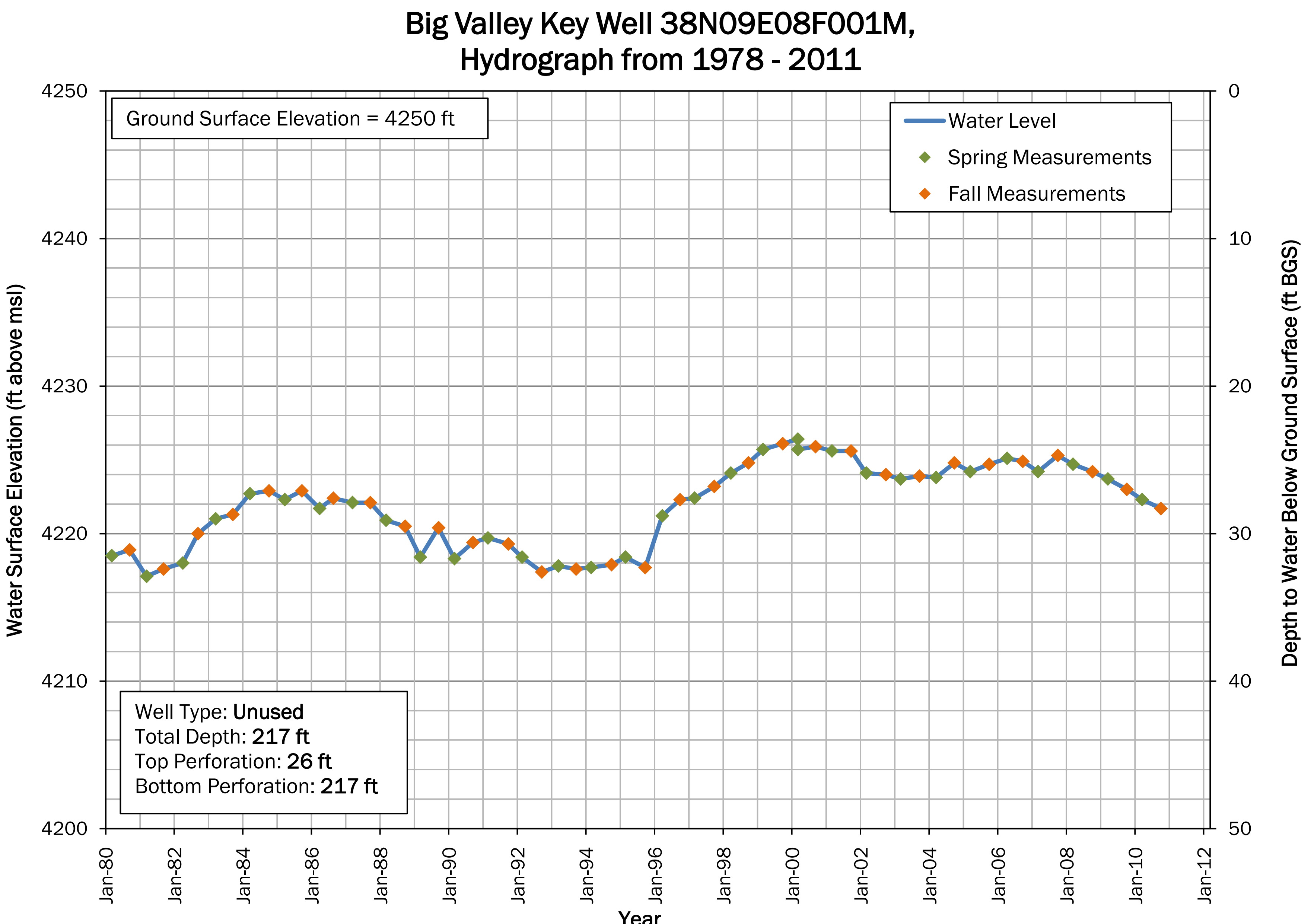


Figure 3-13
Hydrograph of Key Well 38N09E08F001M

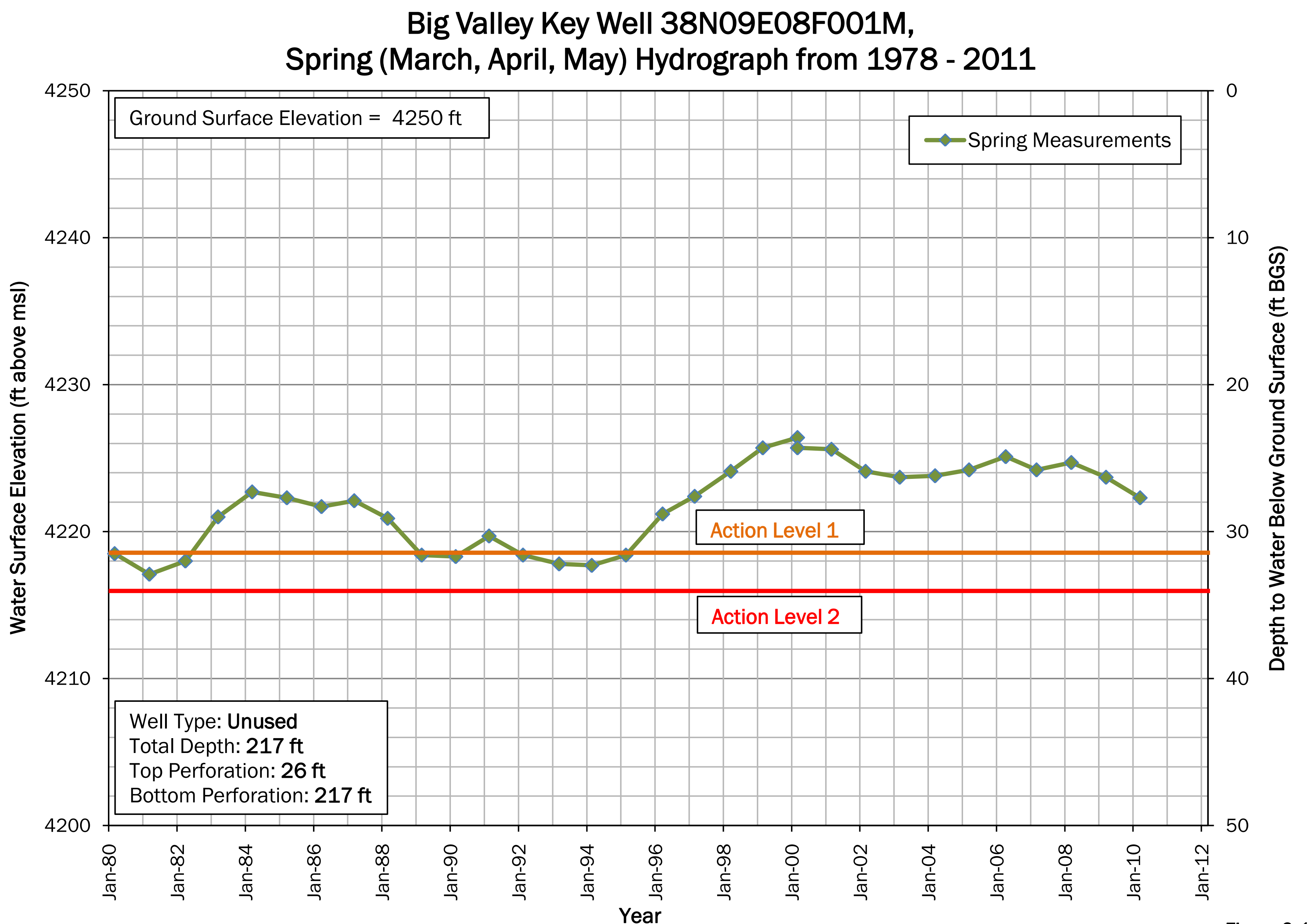


Figure 3-14
Spring Hydrograph of Key Well 38N09E08F001M

Section 4

Groundwater Quality and Subsidence

Groundwater quality and subsidence are considered when developing BMOs for each management area, however, due to the limited amount of available data and complex nature of water quality concerns, groundwater quality and subsidence are approached from a qualitative perspective. Groundwater quality from a countywide groundwater management perspective is focused on groundwater quality information that is indicative of overall groundwater basin conditions, and because of this, is not focused on individual anthropogenic contaminants. Localized anthropogenic groundwater quality contaminants fall under the jurisdiction of the Lahontan Regional Water Quality Control Board (LRWQCB). Additional information on groundwater quality that falls under the LRWQCB's jurisdiction is available from their website at: http://www.waterboards.ca.gov/lahontan/.

To date, no groundwater quality data is available for the Big Valley management area according to DWR.It is recommended that a groundwater quality surveillance plan be developed for Big Valley as part of the BMOs, and water quality samples be taken from areas of concern. These locations may include areas near heavy agricultural use, near concentrated domestic well use, and near industrial or other significant land uses.

The analysis recommended in this document will provide a starting point from which to observe any shifts in water quality that may provide supporting evidence of changing groundwater conditions. The intent of including water quality within the BMOs is to provide for a long term monitoring and reporting of subtle or significant changes that may occur within a given basin. Primarily, the BMOs are directed at monitoring water levels in the management area, but long term declines in groundwater levels may also affect water quality. Changes in water quality can provide further indication that a perceived change in water level may be significant and require some management action. Future groundwater monitoring by DWR should be reviewed and considered during the BMO review process, as feasible.

Because of the scarcity and lack of current groundwater quality data, qualitative BMOs for water quality are recommended. In the future, additional water quality information may become available, and when possible, the TAC and GWC should review the new groundwater quality information and compare it to the baseline identified in this document. If significant changes are detected in groundwater quality, the TAC and GWC will consider actions to investigate the problem, consider actions to remedy the problem, and implement the appropriate actions.

4.1 Land Subsidence

The BMO program is required to address inelastic land subsidence that may be caused by groundwater extraction. Inelastic land subsidence caused by groundwater extraction is defined as compaction of subsurface sediments, specifically clays and silts that occurs under certain conditions when the subsurface is dewatered. Dewatering clays and silts removes water from the spaces between the grains of clay and allows them to compact, lowering the ground surface above the sediments being compacted. Initially and qualitatively, subsidence is often detected on the surface primarily by comparing the tops of groundwater wells to the surrounding ground. As subsidence occurs, the ground will settle, but the bottom of the well is below the sediments that are compacting, does not settle, the top of the well will be higher than the ground around it and appear to "stick up" higher than when it was initially placed.

Lassen County is not currently monitored for subsidence because subsidence has not historically been a concern. While subsidence has not yet affected Big Valley management area, it could in the future if groundwater levels experience declines. Inelastic land subsidence will be addressed through the mechanism developed for groundwater level BMOs. Exceedance actions to increase monitoring for subsidence are listed as Tier 1 exceedance actions, and will be considered by the TAC, GWC, and BoS, as necessary during BMO implementation.

Section 5

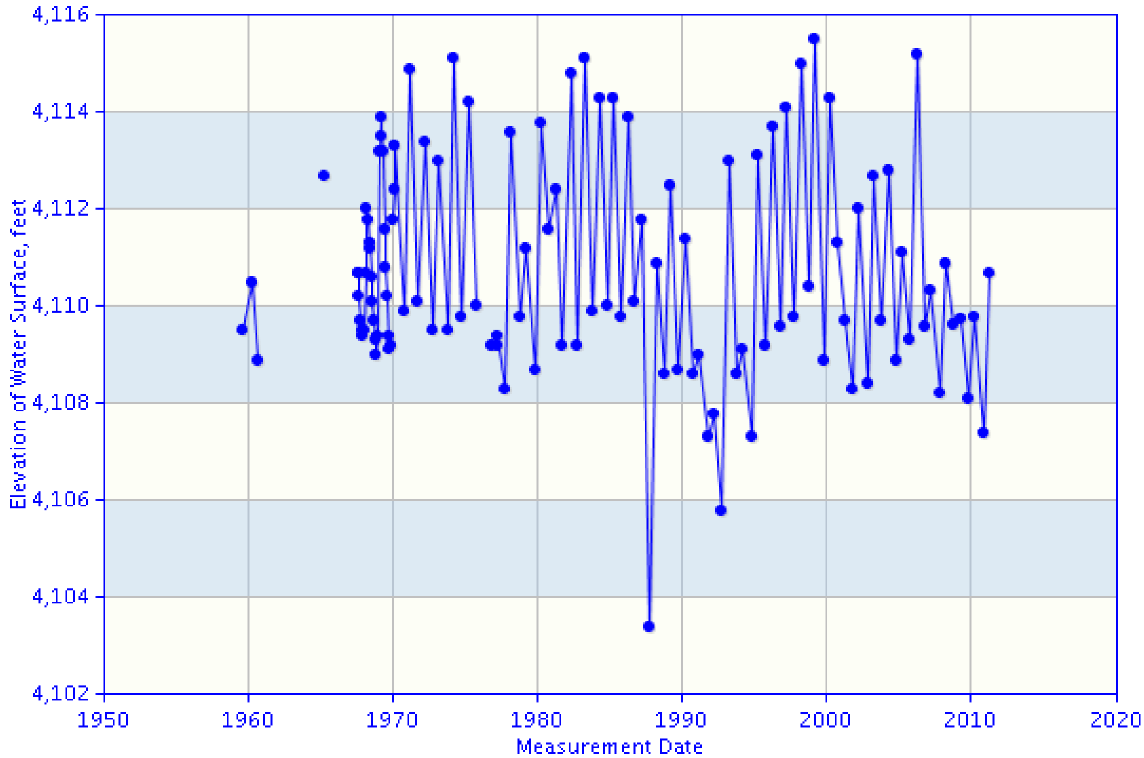
References

Brown and Caldwell. 2007. Lassen County Groundwater Management Plan. Lassen County.

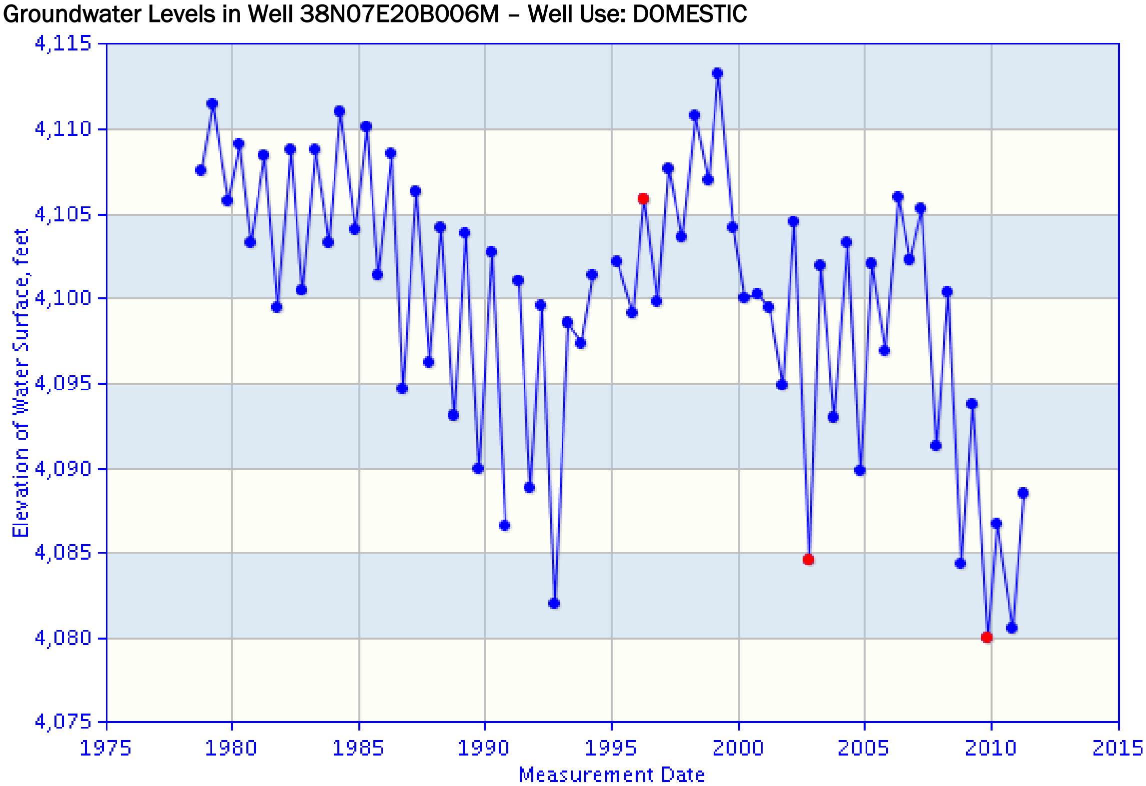
California Department of Water Resources. 2003. Bulletin 118. *California's Groundwater*.

Appendix A: Monitoring Well Hydrographs

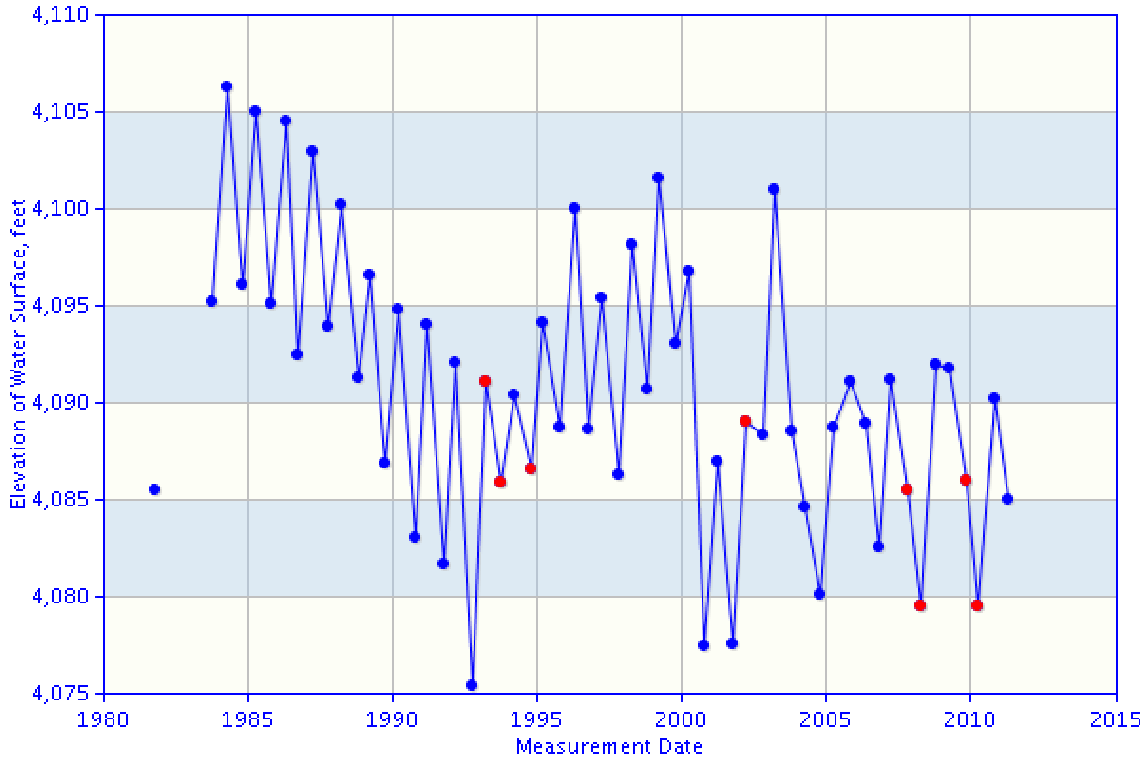
Groundwater Levels in Well 38N07E32A002M – Well Use: UNUSED



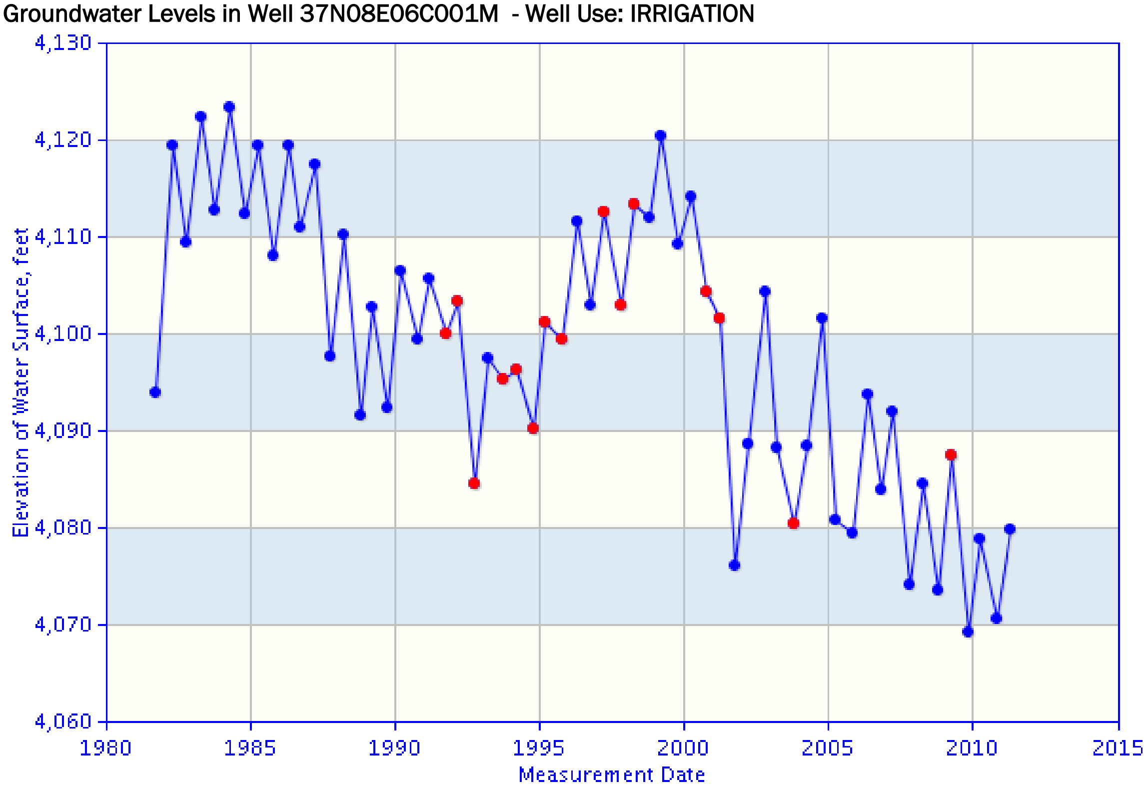
Groundwater Levels in Well 38N07E20B006M – Well Use: DOMESTIC



Groundwater Levels in Well 37N07E13K002M – Well Use: IRRIGATION

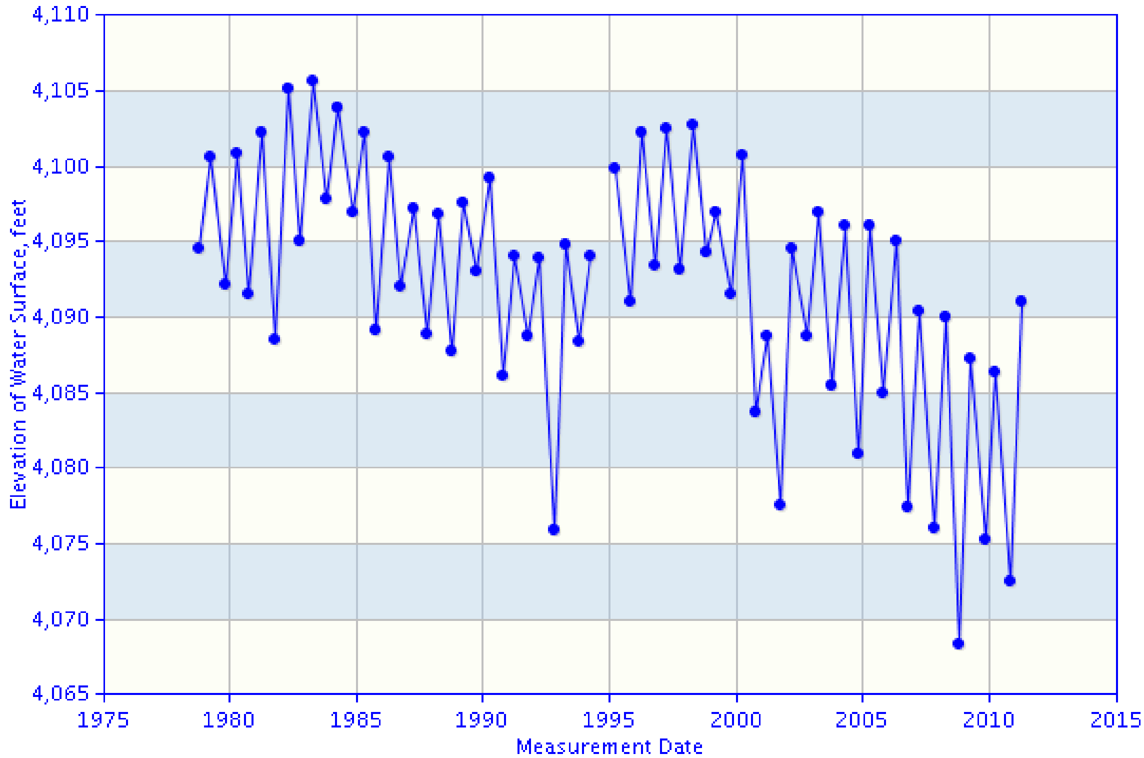


Groundwater Levels in Well 37N08E06C001M - Well Use: IRRIGATION

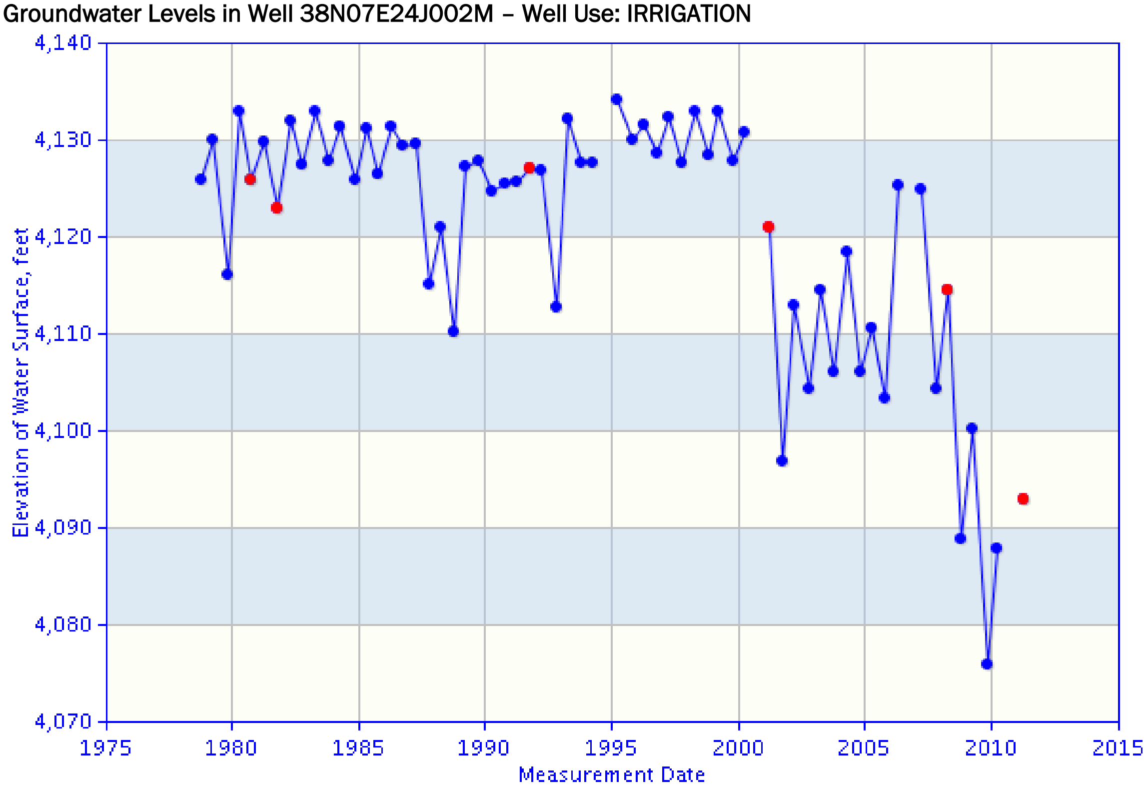


Red data points –Oil or foreign substance in casing

Groundwater Levels in Well 38N07E23E001M – Well Use: DOMESTIC

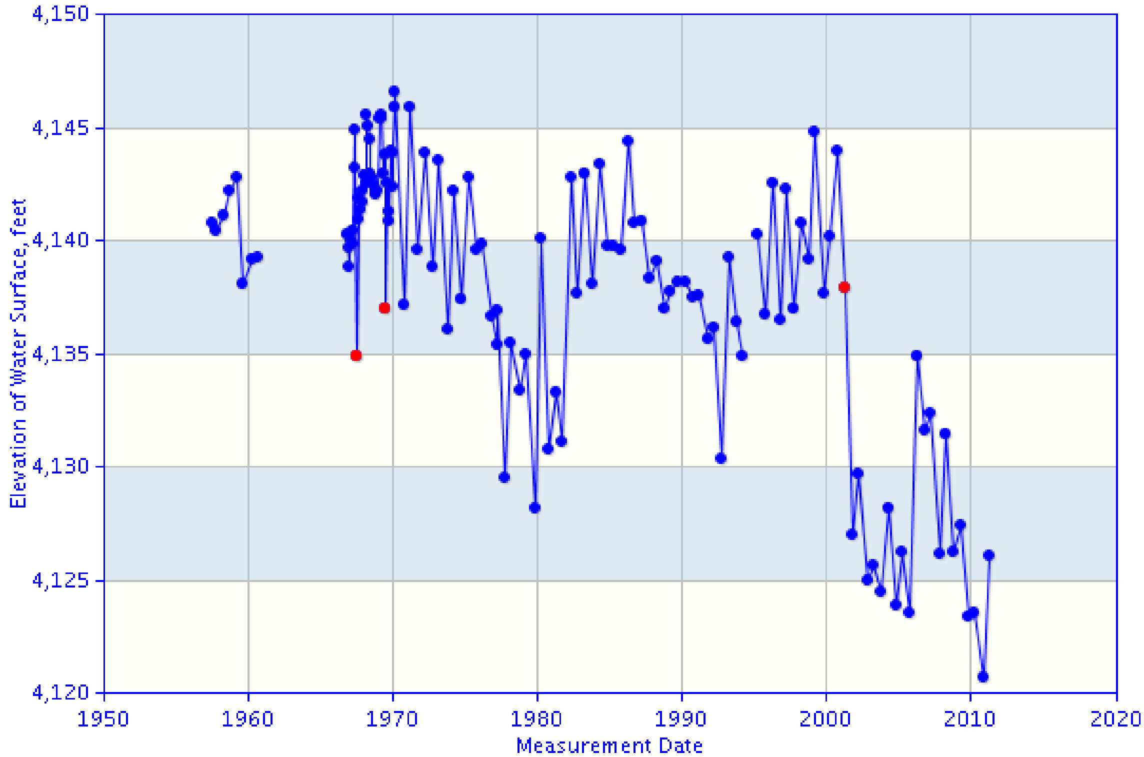


Groundwater Levels in Well 38N07E24J002M – Well Use: IRRIGATION



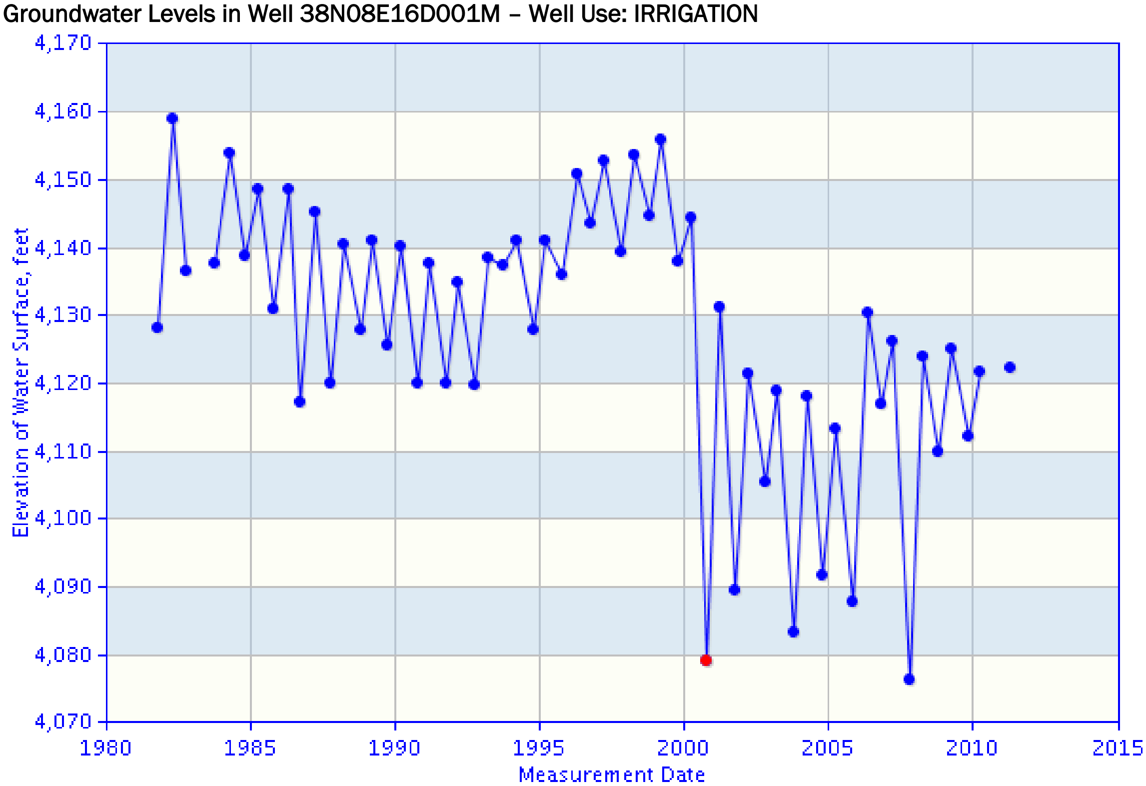
Red data points 2000-2010 – Codes 6,8,9: other, oil or foreign substance in casing, temporarily inaccessible

Groundwater Levels in Well 38N08E17K001M – Well Use: DOMESTIC

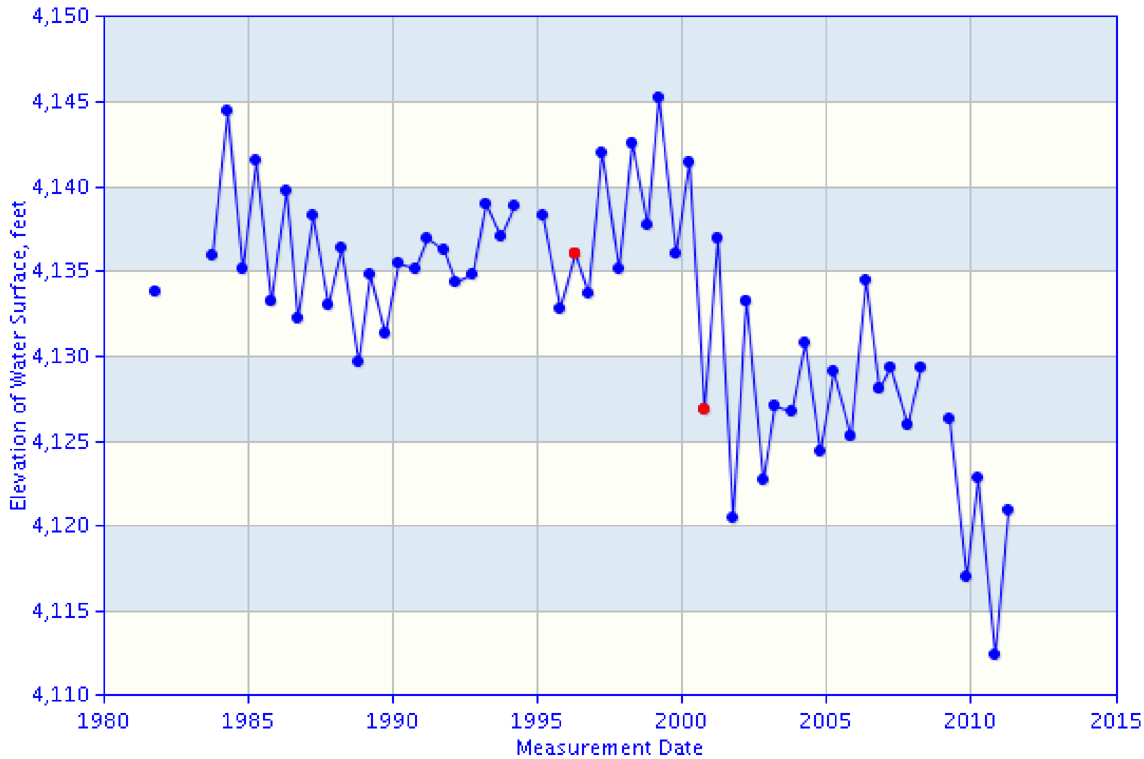


Red data points – pumped recently

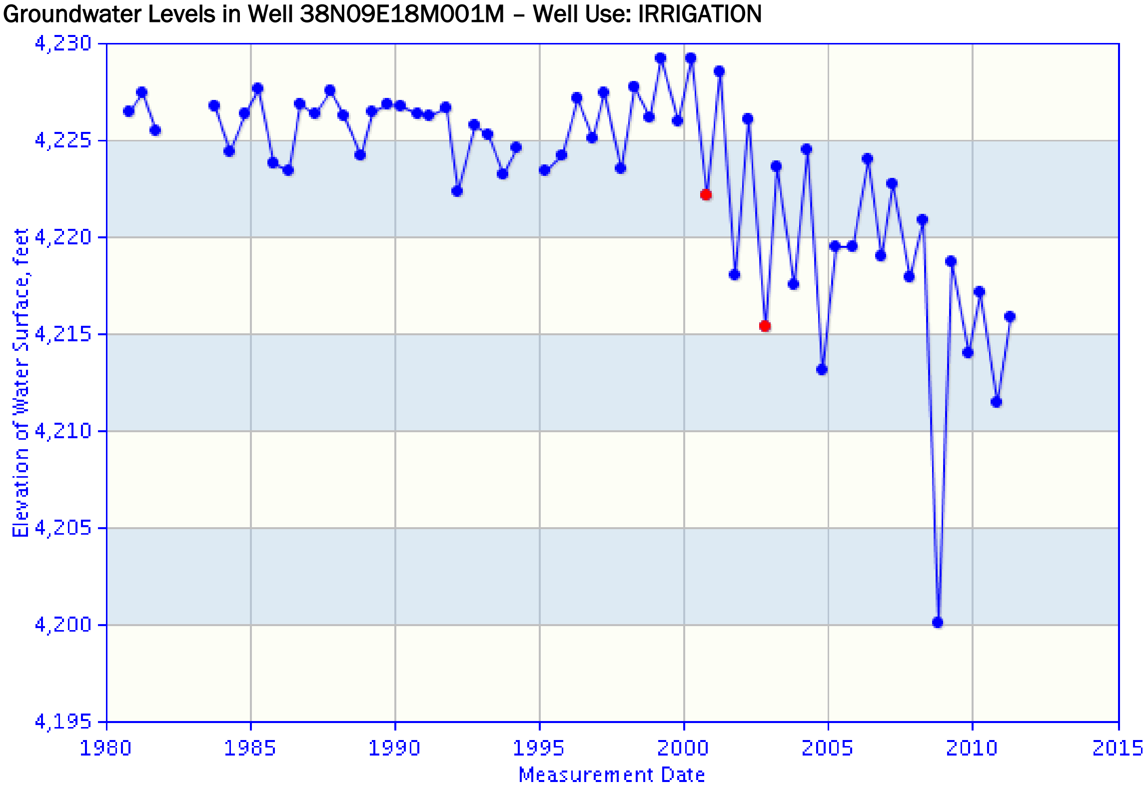
Groundwater Levels in Well 38N08E16D001M – Well Use: IRRIGATION



Groundwater Levels in Well 38N08E03D001M – Well Use: IRRIGATION



Groundwater Levels in Well 38N09E18M001M – Well Use: IRRIGATION



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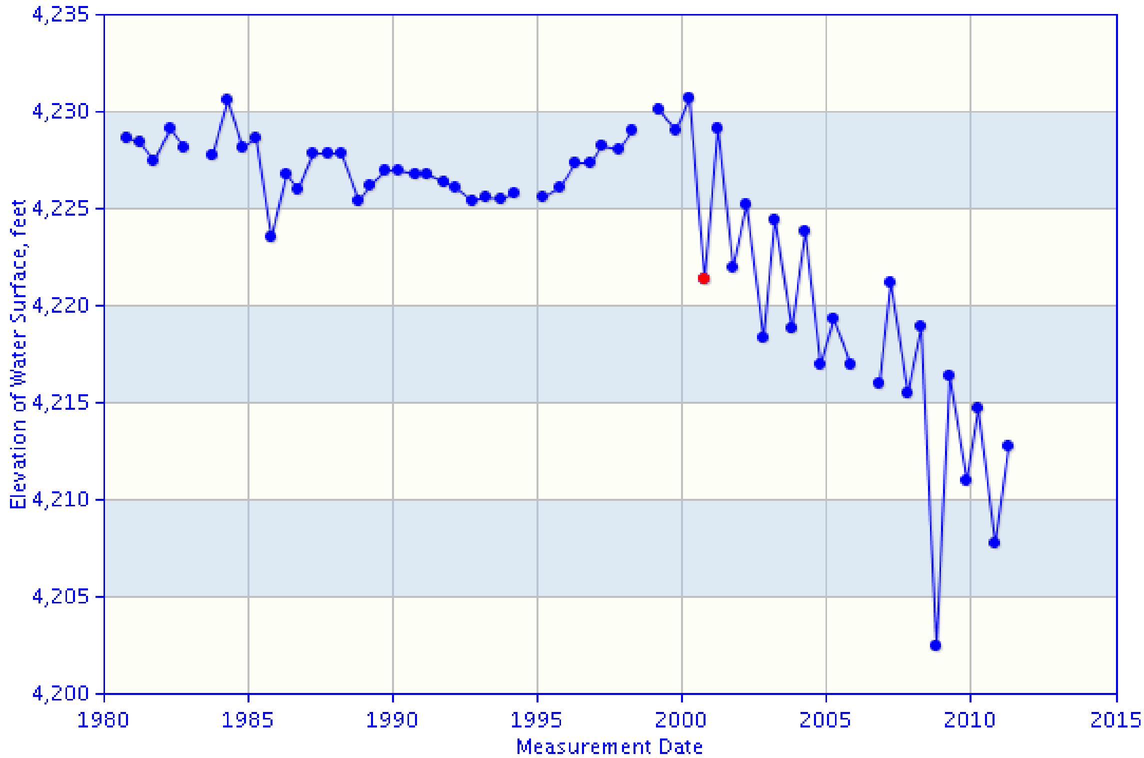
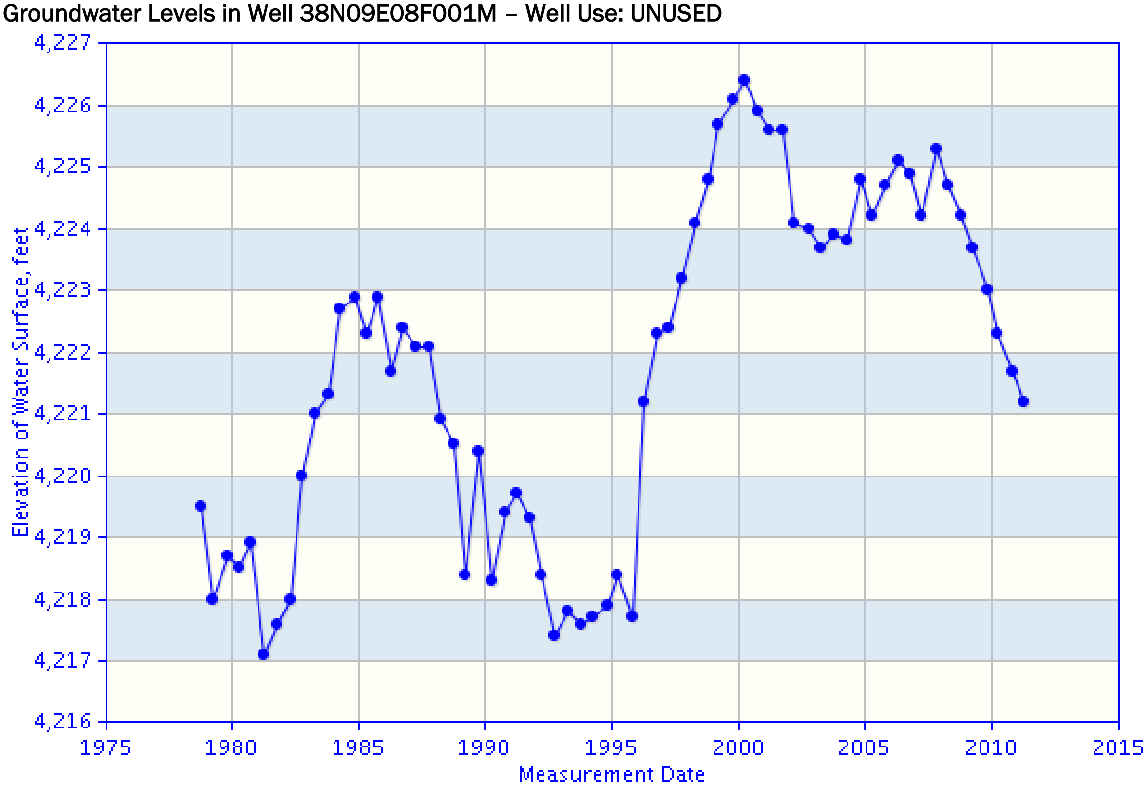
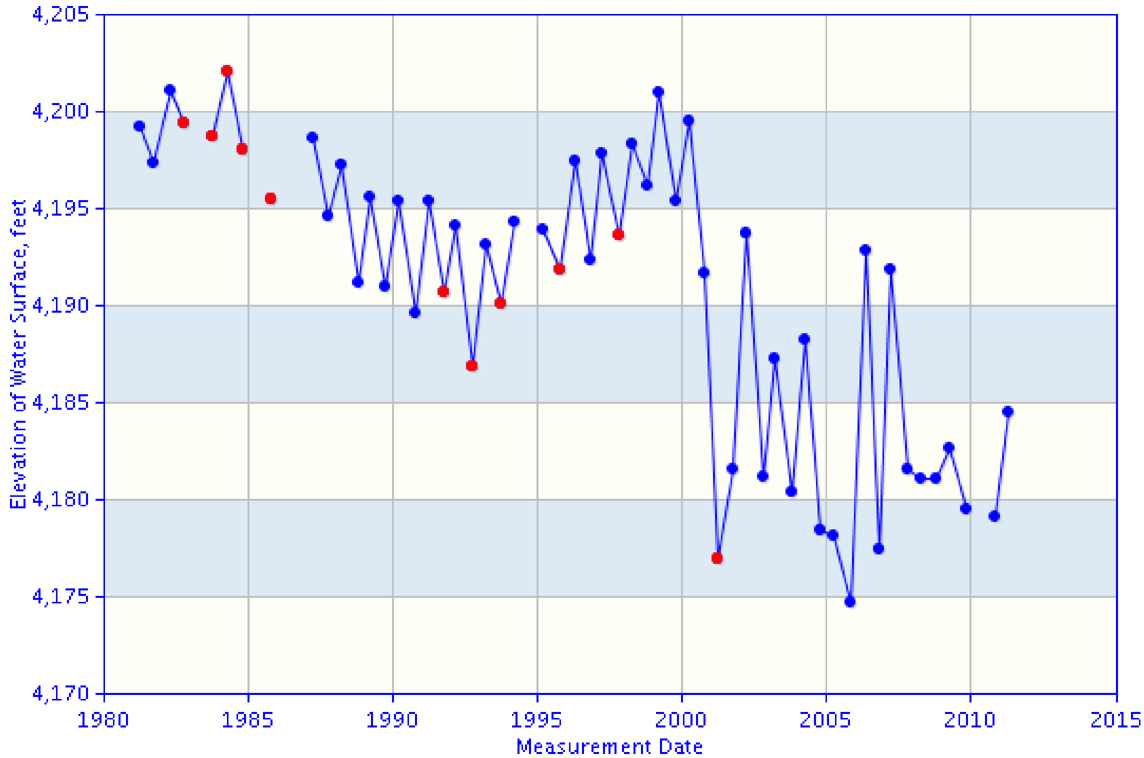


Groundwater Levels in Well 38N09E08F001M – Well Use: UNUSED



Groundwater Levels in Well 39N09E32R001M – Well Use: IRRIGATION



Red data points –Oil or foreign substance in casing