Sonoma Valley Groundwater Management Program

2009 ANNUAL REPORT

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EXECUTIVE SUMMARY

This report provides a summary of the progress and results of the second year of implementation of the voluntary, non-regulatory Sonoma Valley Groundwater Management Program (GMP) and presents a summary of planned and proposed activities for 2010.

Groundwater resources have long played a significant role in the development, growth and sustainability of the Sonoma Valley, with more than half the water demand in a given year met by local groundwater resources. With increasing local demands, assuring sustainable groundwater supplies in the Sonoma Valley may be difficult unless appropriate actions are taken in the near future. To help balance increasing demand with finite supplies, the GMP identifies a range of water management options, including groundwater recharge projects and increasing water conservation and water use efficiency.

The GMP is being implemented under the Sonoma Valley Groundwater Management Plan (Plan), which was developed in 2007 in coordination with the Sonoma County Water Agency (Agency), the Valley of the Moon Water District (VOMWD), and City of Sonoma (City) through a collaborative and cooperative process that also included a broad range of local stakeholders, including representatives from the local agriculture, dairies, government, private business enterprises, environmental groups, and domestic well users. These stakeholders have continued their involvement in the GMP through ongoing participation on the Basin Advisory Panel (Panel) that meets quarterly, and through a Technical Advisory Committee (TAC) that meets monthly, providing guidance on the implementation of the GMP. Implementation of the GMP has been structured to encourage an open, collaborative and cooperative process for groundwater management activities and to maximize coordination of the many actions envisioned by the Panel. The elements of the Sonoma Valley GMP, including Basin Management Objectives (BMOs), have been grouped into the following five Plan Component Actions:

1. Stakeholder Involvement
2. Monitoring Program
3. Groundwater Resource Protection
4. Groundwater Sustainability
5. Planning Integration

These actions are collectively designed to attain the stated goal of the GMP, which is:

> "***to locally manage, protect, and enhance groundwater resources for all beneficial uses, in a sustainable, environmentally sound, economical, and equitable manner for generations to come***".

2009 GMP Progress

A significant number of accomplishments and progress have been made during the second year of implementation of the GMP. Activities performed in support of the GMP in 2009 have addressed each of the five Plan Component Actions, as summarized below.

Stakeholder Involvement:

- Conducted outreach and briefings including quarterly Panel meetings, monthly TAC meetings, several targeted briefings, and focused outreach for expanding the monitoring network with additional volunteer wells;
- Communicated meeting announcements and supporting materials in advance to stakeholders, and maintaining the project website (http://sonomacountywater.org/projects/svgroundwater/);
- Produced a video highlighting the Sonoma Valley GMP; and
- Coordinated with local media to provide press releases on key events and milestones for the GMP, including publication of the 2008 Annual Report, solicitation for additional groundwater level measurement volunteers, announcement of the First Annual Sonoma Valley GMP Water Conservation Award Winners, and description of groundwater recharge efforts being undertaken through the GMP.

Monitoring Program:

- Performed coordinated groundwater level monitoring in the spring and fall 2009;
- Expanded the voluntary groundwater-level monitoring network to include 37 additional volunteer wells bringing the total number of voluntary wells to 133 in Sonoma Valley (refer to Figure ES-1);
- Instrumented select wells for the collection of continuous groundwater-level measurements;
- Incorporated available groundwater-level data from the State Water Resources Control Board's Geotracker website for 22 locations in Sonoma Valley;
- Performed additional evaluation of available well construction and location information for wells included in the monitoring program to better account for vertical variations in groundwater conditions within the basin;
- Continued monitoring and evaluation of the Kenwood and Agua Caliente stream gages on Sonoma Creek; and
- Enhanced the web-based data management system (WEBH2O) to streamline the data entry process and increase its use.

Groundwater Quality Protection:

- Added additional wells in the southern portion of Sonoma Valley in areas identified as potentially subject to saline intrusion in the 2006 USGS report, which will provide additional data to further assess potential saline intrusion;
- Developed plans for a long-term water quality monitoring program comprised of 12 wells previously monitored by DWR and 6 to 8 additional wells in southern Sonoma Valley coupled with available water quality data from public water systems; and

- Initiated preparation of a private well owner's which includes well owner responsibilities, information on well construction and well maintenance, water quality protection, water quality sampling and treatment, and resources for well owners.

Improve Groundwater Sustainability:

- Received an update to the Sonoma Valley Groundwater Flow Model completed by a graduate student at Stanford University, which included development of a soil moisture budget model and extension of the area of recharge to the MODFLOW model to encompass entire Sonoma Creek Watershed;
- The "Slow It, Spread It, Sink It" guidebook has been developed by the Southern Sonoma County Resource Conservation District with input from the Panel and TAC to serve as a resource guide for property owners to implement projects that promote stormwater retention and groundwater recharge;
- The Sonoma Valley recharge mapping project was initiated by the Sonoma Ecology Center in late 2009 as part of an AB303 grant from the California Department of Water Resources (DWR);
- A pilot program to evaluate unincorporated area water conservation programs for areas within the Sonoma Valley that currently do not have formal conservation programs was initiated in 2009 under a $25,000 grant obtained by the Agency from North Bay Watershed Association (NBWA);
- In 2009 the Panel developed a Water Conservation Awards Program that recognized several members and groups from Sonoma Valley for extraordinary levels of water conservation; and
- Activities conducted in 2009 related to the Sonoma Valley Recycled Water Project (SVRWP) included substantial completion of a financial/economic feasibility analysis for the project and design work for the first segment of the proposed recycled water trunk main. Increased use of recycled water is one of the primary strategies identified in the GMP for sustaining groundwater supplies in Sonoma Valley.

Planning Integration:

- Regular meetings of local stakeholders and government agencies associated with implementing the GMP in 2009 have been used for forums for planning and program integration.

2009 Hydrologic Conditions

The results of monitoring performed in 2009 indicate the following:

- 2009 was the third consecutive year of below average rainfall, with a total of 18.61 inches of precipitation measured at the City of Sonoma rain gage;
- Consistent with the below average precipitation in 2009, the total annual discharge of Sonoma Creek measured at the Agua Caliente gage in 2009 was 22,511 acre-ft, which is lower than the 34-year mean discharge recorded at this location of 51,839 acre-ft per year;

- Based on the review of available well construction data, wells included in the groundwater-level monitoring program were categorized as shallow-zone (less than 200-feet deep) or deeper-zone (greater than 200-feet deep) in order to assist in the evaluation of groundwater-level data collected from different depths (and aquifer zones);
- Groundwater level trends for shallow-zone wells are generally stable and predominantly remain above sea level;
- The two primary groundwater pumping depressions described in the 2006 USGS report are most apparent in the deeper zone (greater than 200 foot depth). Southeast of the City of Sonoma measured groundwater levels are as low as 116 feet below sea level and southwest of El Verano groundwater levels are as low as 45 feet below sea level in deeper zone wells; and
- Some deeper zone wells in localized areas have exhibited sustained declining trends of up to two feet per year.

2010 GMP Planned and Proposed Activities

Activities planned and proposed for continuing implementation of the GMP in 2010 include the following elements:

- **Stakeholder Involvement** will continue to provide the foundation for implementing the GMP through the following activities:
  - Continuing regular quarterly BAP and monthly TAC meetings, outreach and briefings of stakeholder groups on GMP progress and activities; and
  - Work with local media to provide press releases on key events and milestones

- Continuation of the development and expansion of the **Monitoring Program** will further assist in filling key data gaps. Programs planned to address this component include:
  - Perform coordinated semiannual groundwater level monitoring and continue to expand the monitoring network to include more volunteer wells. Efforts will be focused on targeting deep-zone wells in the areas identified on Figure ES-1;
  - Install and monitor two new multi-depth monitoring wells in southern Sonoma Valley using grant funds recently released by DWR;
  - Continue monitoring and evaluating the two Sonoma Creek stream gages;
  - Develop plan for subsidence monitoring; and
  - Perform seepage runs of Sonoma Creek and its tributaries on a semiannual basis to better assess the interaction between surface water and groundwater in Sonoma Valley.

- The following **Groundwater Quality Protection** activities will identify and help address potential water quality issues:
  - Complete the well owners guide and distribute to private well owners;
  - Resume and expand DWR's historical water quality monitoring program in Sonoma Valley, including sampling of the two new multi-depth wells; and

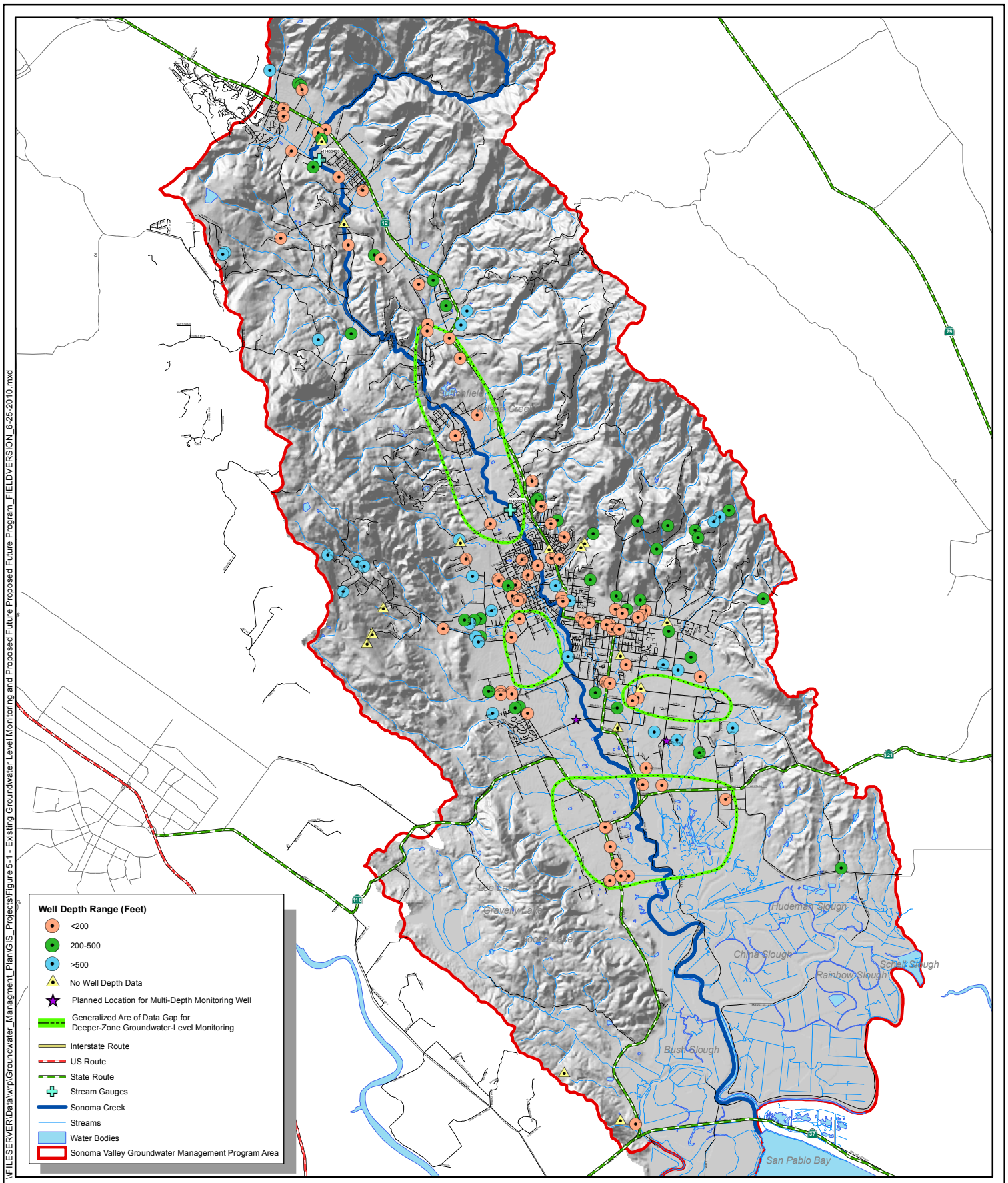
- Develop a cooperative long-term groundwater quality monitoring program using existing data collection efforts by water purveyors, mutual water companies, and small distribution systems.

- **Groundwater Sustainability** efforts will improve conservation efforts in Sonoma Valley and will endeavor to identify groundwater recharge areas for future recharge planning through the following activities:
  - Complete groundwater recharge mapping using AB303 grant funds;
  - Complete unincorporated area water conservation assessments, prepare report and evaluate opportunities for grant funding for incentives;
  - Complete Slow-it, Spread-it, Sink-it Guidebook and distribute to Sonoma Valley stakeholders;
  - Initiate upgrade of the existing groundwater flow model to a fully coupled surface water/groundwater flow model;
  - Initiate the Groundwater Banking Program Feasibility Study to assess options to optimize the use of winter-time water from the Russian River for storage in the Sonoma Valley groundwater basin for subsequent use in the summertime or during drought periods;
  - Initiate a Watershed Planning Study to assess multi-benefit projects that can both mitigate flood hazards and enhance groundwater recharge;
  - Develop pilot project(s) for stormwater capture and recharge; and
  - Continue supporting implementation of recycled water programs in the Sonoma Valley.

- **Planning Integration** will provide opportunities for developing additional plans and mechanisms for sustaining Sonoma Valley's groundwater resources.

2010 GMP Funding

Pursuant to a Three-Year Cooperative Agreement executed in September 2009, program staffing and management will be funded collectively by the Agency, City, VOMWD, Sonoma County, Sonoma County Agricultural Preservation and Open Space District, and Sonoma Valley County Sanitation District. A substantial number of additional activities will continue to be conducted through the voluntary time of Panel members, TAC members, and volunteer monitors. Due to economic uncertainties and other budgetary constraints, it is apparent that 2010 will be a challenging year in terms of program funding. Nevertheless, additional outside funding opportunities, such as state grants under AB303, will need to be obtained for some of the proposed activities.



Sonoma Valley
Groundwater Management Program

Groundwater Level Monitoring Network
Planned Wells and Data Gap Areas

June 24, 2010

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Figure ES-1

Figure ES-1 Groundwater Level Monitoring Network Planned Wells and Data Gap Areas

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1. Introduction

This 2009 Annual Report presents an update on the progress of the Sonoma Valley Groundwater Management Program (GMP) during 2009. The Sonoma Valley GMP is being implemented in accordance with the Sonoma Valley Groundwater Management Plan (Plan), which was completed in 2007 by a broad coalition of local stakeholders. The Plan was prepared to inform and guide the Sonoma County Water Agency (Agency), as the lead agency, as well as stakeholders and other interested parties for the purpose of maintaining a sustainable, high-quality groundwater resource for the users of the groundwater basin underlying the Sonoma Valley (Figure 1-1).

This report covers the second year of implementation of the Sonoma Valley GMP and is organized as follows:

- Section 1 provides the purpose of this annual report and background information on the Plan, including the GMP organization and structure;
- Section 2 presents a summary of activities conducted in 2009;
- Section 3 provides an update on 2009 Sonoma Valley hydrologic conditions;
- Section 4 presents an assessment of 2009 GMP activities relative to the basin management objectives; and
- Section 5 provides an overview of GMP activities planned for 2010.

1.1 Purpose of the Annual Report

The purpose of this Annual Report is: (1) to summarize and document the activities conducted and accomplishments achieved in 2009; (2) to provide an overview of groundwater conditions and monitoring results during 2009; (3) to assess whether management activities are achieving basin management objectives; and (4) to present a summary of planned future management activities. This Annual Report is also intended to be a tool for updating and obtaining feedback from stakeholder constituency groups and other interested parties on various aspects of the Sonoma Valley GMP, including the progress made to date on Plan implementation and plans for the future.

1.2 Overview of Sonoma Valley Groundwater Management Plan

1.2.1. Description of Plan Area

The area subject to the Plan and GMP is shown in Figure 1-1, and lies within the San Francisco Bay Hydrologic Region. The GMP area encompasses the Sonoma Creek Watershed and includes the Sonoma Valley and the southern portion of the Kenwood Valley, designated groundwater basins 2-2.02 and 2-19, respectively, as determined by the California Department of Water Resources (DWR). For the purposes of this report, the GMP Area is the Sonoma Valley and includes the City of Sonoma and communities of El Verano, Boyes Hot Springs, Glen Ellen, Kenwood, and the southernmost portions of Oakmont.

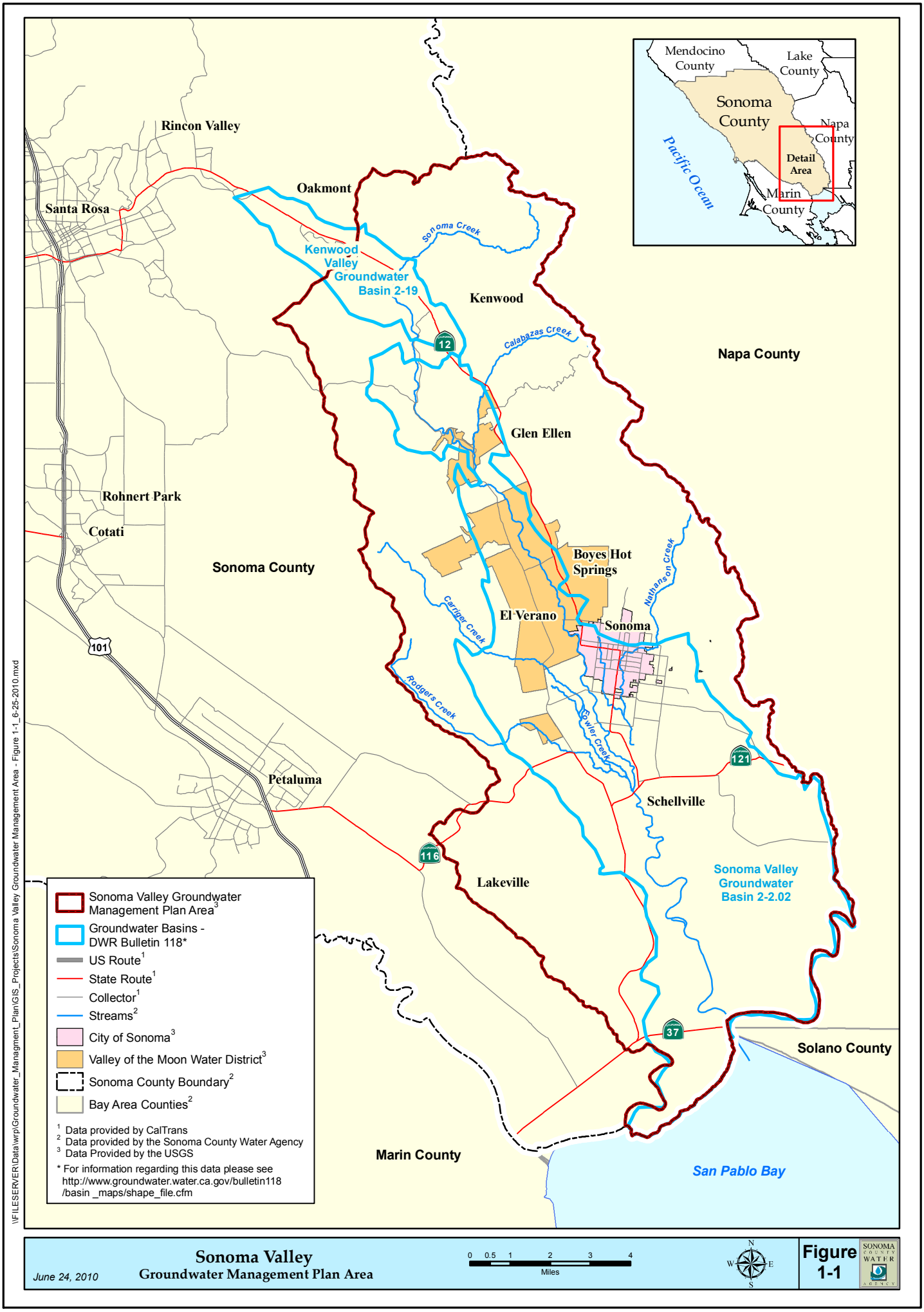


Figure 1-1 Sonoma Valley Groundwater Management Program Area

1.2.2. Background of Plan

Groundwater resources have long played a significant role in the development, growth and sustainability of the Sonoma Valley, with more than half the water demand in a given year met by local groundwater resources. With increasing demand on finite local groundwater supplies, stored groundwater in the Sonoma Valley has been and will continue to be depleted without appropriate actions being taken in the near future. In response, the Plan was developed in coordination with the Agency, the Valley of the Moon Water District (VOMWD) and the City of Sonoma (City) under a collaborative and cooperative process that included a broad range of 20 stakeholders participating on the Basin Advisory Panel (Panel). The Panel consists of representatives from local agriculture, dairies, government, private business enterprises, environmental groups, and domestic well users. The Plan was adopted by the Agency, City, VOMWD, and the Sonoma Valley County Sanitation District in late 2007. Additionally, letters of support and endorsement for the Plan were received from the Sonoma Valley Vintners & Growers Alliance, the Sonoma Ecology Center, the Mission Highlands Mutual Water Company, and the Sonoma County Water Coalition. The Plan identifies a range of water management options, including groundwater recharge and greater conservation, to help balance water demand with water supply.

The Plan was prepared under the authority of the Groundwater Management Act, California Water Code (Water Code) § 10750 *et seq.*, originally enacted as Assembly Bill (AB) 3030 in 1992 to encourage voluntary, non-regulatory groundwater management at the local level.

1.2.3. Lead Agency, Basin Advisory Panel and Technical Advisory Committee

The Agency is the lead agency and is responsible for managing GMP activities and progress. The lead agency directs and is responsible for all GMP studies, projects, and programs it directly or indirectly finances. The lead agency coordinates with Sonoma Valley stakeholders through the Panel, who provide input and direction to the lead agency in implementing the GMP. The VOMWD and the City, in coordination with the lead agency and the Panel, also undertake actions identified in the Plan. In addition, a Technical Advisory Committee (TAC) provides technical support to the Panel and the Agency.

1.2.4. GMP Goal, Basin Management Objectives, Management Components and Actions

The stated goal of the Sonoma Valley GMP, as presented in the Plan is:

> *To locally manage, protect, and enhance groundwater resources for all beneficial uses in a sustainable, environmentally sound, economical, and equitable manner for generations to come.*

The purpose of the GMP is to serve as the initial framework for integrating the many independent groundwater management activities to meet this goal.

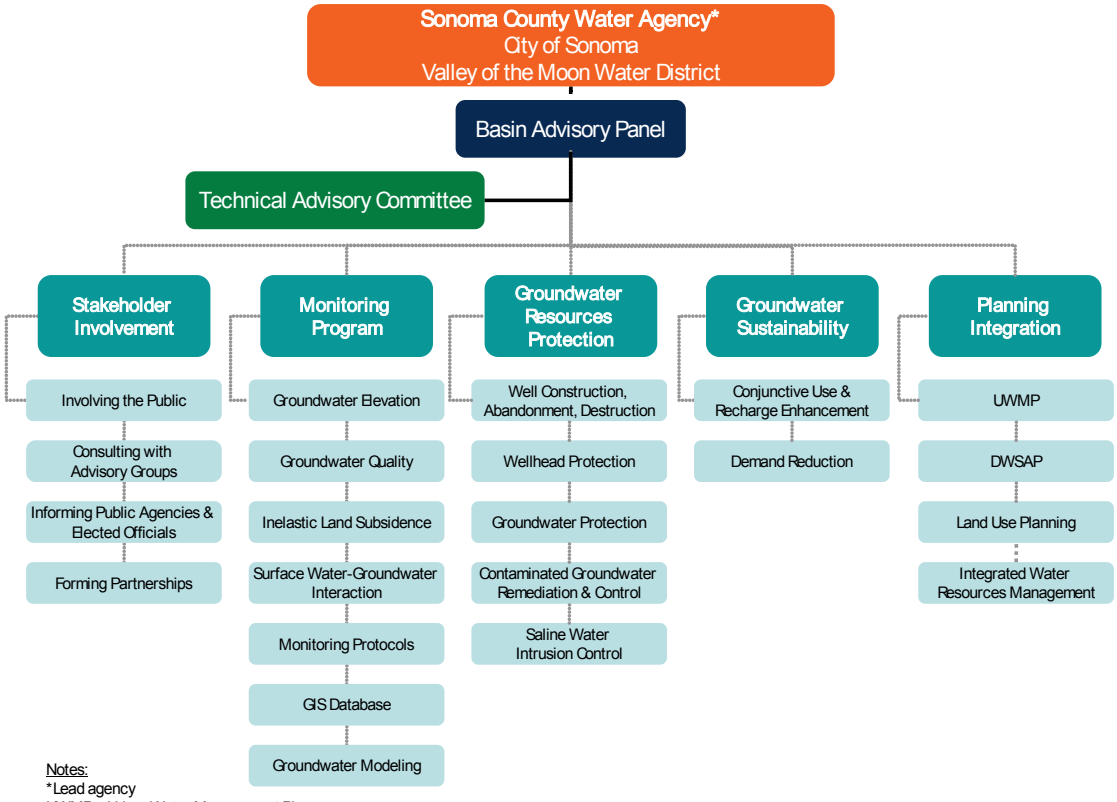
As part of the Plan, Basin Management Objectives (BMOs) were developed by the Panel to provide measurable and verifiable accomplishments for meeting the overall goal of the Plan. The following ten BMOs provide the foundation for achieving the Plan's goal:

- **BMO-1** Maintain groundwater elevations for the support of beneficial uses of groundwater and to protect against inelastic land subsidence.
- **BMO-2** Improve water use efficiency and conservation.
- **BMO-3** Identify and protect groundwater recharge areas and enhance the recharge of groundwater where appropriate.
- **BMO-4** Manage groundwater in conjunction with other water sources.
- **BMO-5** Protect groundwater quality for beneficial uses including minimizing saline intrusion.
- **BMO-6** Protect against adverse interactions between groundwater and surface water flows.
- **BMO-7** Improve the community's awareness of groundwater planning, water resources, and legal issues.
- **BMO-8** Improve the groundwater database and basin understanding through consistent monitoring and additional surveys, and improve basin analytical tools including the groundwater simulation model.
- **BMO-9** Manage groundwater with local control.
- **BMO-10** Explore, identify and maximize non-regulatory approaches to manage the groundwater resource.

The Plan includes a variety of components that are required by Water Code § 10753.7, recommended in DWR Bulletin 118 California's Groundwater (DWR 2003), and identified as optional programs under Water Code § 10753.8. These components are grouped into five general categories termed Plan Component Actions:

1. Stakeholder Involvement
2. Monitoring Program
3. Groundwater Resource Protection
4. Groundwater Sustainability
5. Planning Integration

Management actions for each Plan Component Action form the foundation for meeting the BMOs and goal. Management actions, management components, and the Sonoma Valley GMP organization are illustrated in Figure 1-2. Details on the GMP actions are provided in the Plan, which is available for review at http://sonomacountywater.org/projects/svgroundwater/. For further information, contact Marcus Trotta, SCWA (707) 547-1978, mtrotta@scwa.ca.gov.



Notes:
*Lead agency
UWMP – Urban Water Management Plan
DWSAP – Drinking Water Source Assessment and Protection
The Technical Advisory Committee (TAC) includes members from the Basin Advisory Panel (Panel) and other entities and reports to the Panel.

Figure 1-2 Groundwater Management Program Implementation Organization Chart

2. 2009 Sonoma Valley Groundwater Management Program Activities and Progress

This section presents a summary of Sonoma Valley GMP activities conducted and accomplishments achieved in 2009. These activities are grouped and described according to the five Plan Component Actions described in Section 1.2.4, above.

2.1 Component 1 - Stakeholder Involvement

Active stakeholder involvement forms the foundation for a continued, successful collaborative process of decision-making and actions during GMP implementation. Stakeholder interests represented on the Panel include economic, agricultural, environmental, local agencies with jurisdiction in Sonoma Valley, land use, residential groundwater users, special districts, with a broad geographic distribution across the Sonoma Valley. A public outreach plan was developed in 2008 by the Center for Collaborative Policy to guide the process by which stakeholders stay informed about and provide input on the implementation of the GMP, share information through briefings and the media, and inform the community and other interested parties on GMP implementation. Stakeholder involvement activities completed during 2009 were conducted pursuant to the outreach plan and are summarized below.

- **Outreach and briefings** – In addition to quarterly Panel meetings and monthly TAC meetings, several targeted briefings, focused outreach, and informational talks at events and conferences were conducted in 2009, including the following:
    - February 10, 2009 presentation at the Sonoma Ecology Center's Water Wisdom Workshop in Sonoma;
    - February 26, 2009 presentation at the Groundwater Resources Association of California's (GRA) Groundwater Monitoring Conference in Anaheim;
    - July 16, 2009 presentation at the Wine Country Water Summit in Rohnert Park; and
    - September 6, 2009 poster presentation at the GRA Biennial Conference in Sacramento.

Additionally, the following organizations received informational briefings on the GMP in 2009:

- City of Sonoma
- County of Sonoma Board of Supervisors
- North Bay Watershed Association;
- Sonoma Ecology Center
- Sonoma County Water Coalition
- Sonoma Ranch Homeowners Association
- Sonoma Valley Citizens Advisory Commission
- Southern Sonoma County Resource Conservation District
- Valley of the Moon Alliance
- Valley of the Moon Water District

- **Communications** - Communications conducted in 2009 included sending out announcements and supporting materials in advance of regular meetings to stakeholders, maintaining email distribution lists of stakeholders, and updating the project website (http://sonomacountywater.org/projects/svgroundwater/). In addition, a ten-minute video featuring the Sonoma Valley GMP and many Panel members was produced and displayed at the Association of California Water Agencies Fall 2009 Conference and made available for viewing on the project website.

- **Media** – GMP staff, Panel members, and local stakeholders worked with local media to provide press releases on key events and milestones for the GMP. In 2009, press releases focused on publication of the 2008 Annual Report, solicitation for additional groundwater level measurement volunteers, announcement of the First Annual Sonoma Valley GMP Water Conservation Award Winners, and description of groundwater recharge efforts being undertaken through the GMP.

2.2 Component 2 - Monitoring Program

The long-term groundwater-level monitoring program for the GMP was developed in the 2007 Plan, initially implemented in 2008, and has expanded in terms of the number of monitored wells. Expansion of the program has been accomplished mainly through public outreach and education to private well owners who have volunteered to be monitored. The majority of wells monitored in the program are voluntary private wells, with a smaller but significant portion of publicly-owned water supply wells. The groundwater-level monitoring program is a critically important component of the GMP and serves as a foundation to develop and improve decision-analysis tools, identify and forecast trends and guide the design, implementation and monitoring of groundwater management and protection programs. Approximate locations of wells included in the monitoring program on Figure 2-1 and the formation and expansion of the monitoring program over the past three years is summarized below:

- 2007 – The monitoring program was formed from previously existing groundwater-level monitoring programs in Sonoma Valley, comprising a total of 55 wells monitored by DWR (10 wells as of 2007), the City (12 wells as of 2007), and VOMWD (34 wells as of 2007).
- 2008 – 41 voluntary private wells were added for a total of 96 wells in the program.
- 2009 –37 voluntary private wells were added bringing the total number of wells included in the voluntary groundwater-level monitoring program to 133. Additionally, groundwater-level data from 22 contaminant sites were included incorporated into the monitoring program.

2.2.1. Coordinated Groundwater Level Data Collection

The coordination of groundwater level data collection was initiated at the beginning of 2008 and continued in 2009. The coordinated collection of groundwater-level data from these various monitoring efforts included the performance of synchronized groundwater-level monitoring events in the Spring (April) and Fall (October/November) when groundwater levels are typically at their highest and lowest, respectively. The

groundwater monitoring events were conducted by DWR, the City, VOMWD, the Agency and trained private volunteers.

2.2.2. Enhancements to Groundwater-Level Monitoring Program

Several actions, as summarized below, were completed in 2009 to enhance groundwater-level monitoring efforts in the Sonoma Valley.

- **Expansion of the Voluntary Groundwater-level Monitoring Network**
  Outreach efforts resulted in the addition of 37 voluntary private wells to the existing monitoring network.

- **Incorporation of Available Data from the SWRCB Geotracker Database**
  Groundwater level data for an additional 22 wells were obtained and evaluated from the SWRCB Geotracker website (http://geotracker.swrcb.ca.gov), which manages data from numerous groundwater monitoring wells located at LUFT and other contaminant sites. Groundwater-level data is available on a quarterly or semi-annual basis for the majority of these sites with the period of record varying for each site with available data for several sites extending back to the early 1990's and the majority of available data representing the 2000 to 2009 time frame. For each site, a representative well was selected for groundwater-level hydrographs and for inclusion in groundwater-level contour maps, based on the longest period of record and exhibited groundwater-level trends generally consistent with other wells from the site.

- **Instrumentation of Select Wells for the Collection of Continuous Groundwater-level Data**
  In 2009, the Agency instrumented a subset of five wells with electronic pressure transducers to facilitate the collection of continuous groundwater-level measurements. Data obtained from these wells is being evaluated to further assess seasonal and short-term groundwater level fluctuations.

- **Additional Evaluation of Available Well Construction and Location Information**
  Available groundwater-level monitoring program well construction information was reviewed and assessed to assist in the evaluation of groundwater-level data collected from different depths (and aquifer zones). Wells were subdivided according to well-screen depth or well total completion depth into the following three categories: (1) less than 200-feet below ground surface (bgs); (2) 200 to 500 feet bgs; and (3) greater than 500 feet bgs. These categories are used to graphically display groundwater-level trends and groundwater flow patterns, as described in Section 3.3. Additionally, volunteers used Global Positioning System (GPS) equipment loaned to the program by the Sonoma Ecology Center to survey the approximate horizontal locations of wells included in the Voluntary Groundwater-Level Monitoring Program.

- **Enhancements to Data Management System**
  WEBH2O, a web-hosted environmental information management system that combines database features with geographic information system (GIS) and technical analysis tools, is utilized as the main repository for groundwater level data collected

as part of the monitoring program. Enhancements made to the data management system in 2009 included streamlining the data input process and adding functions to simplify the addition of new monitoring locations.

- **Stream-Gaging of Sonoma Creek**
  Monitoring and evaluation of streamflow data for Sonoma Creek at both the Kenwood and Agua Caliente Gages was performed in 2009. Stream gaging of Sonoma Creek includes obtaining a continuous record of stage (height of water at the gage location), obtaining periodic measurements of discharge rate (quantity of water passing through the gage), and using these measurements to estimate streamflow at the gaging stations.

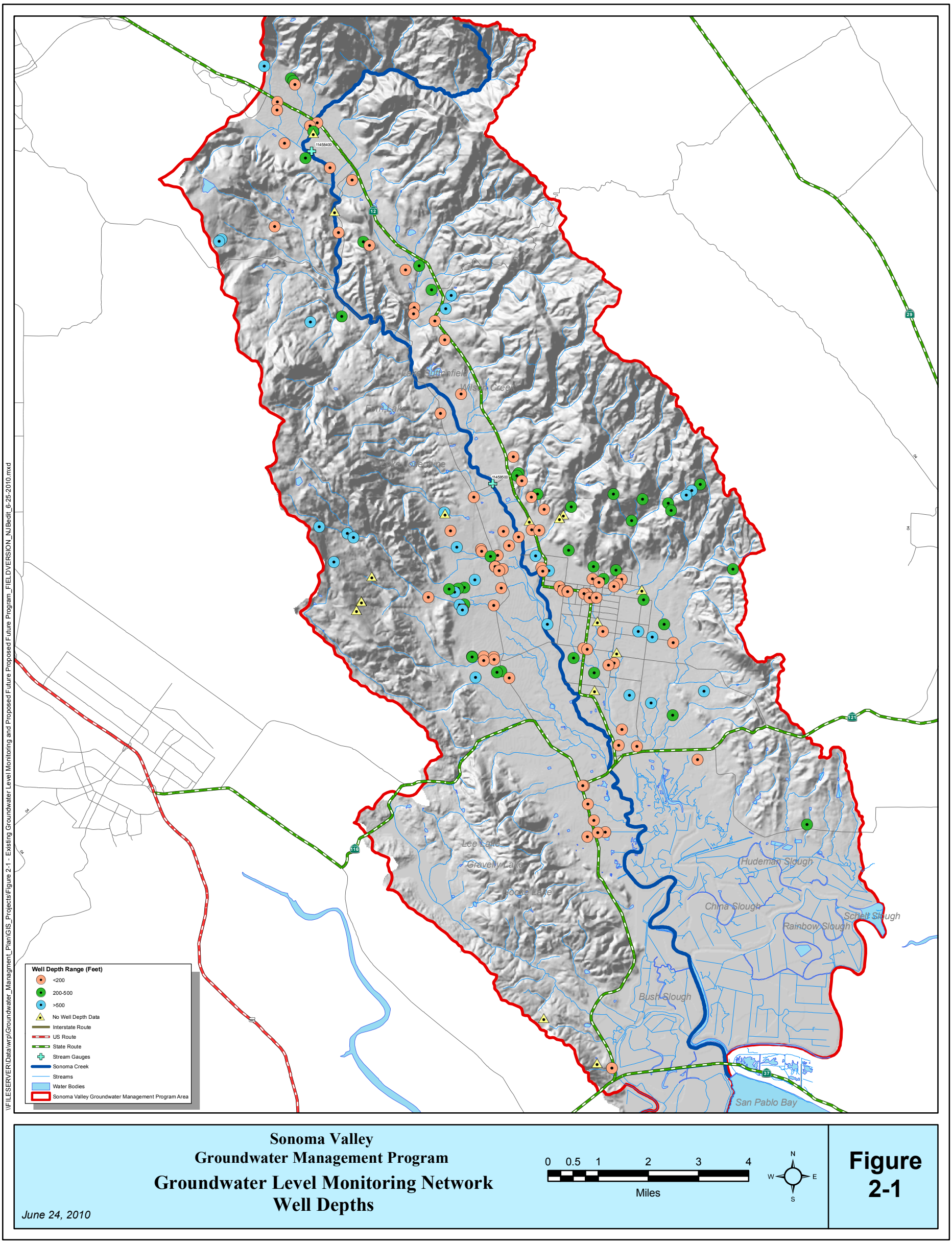


Figure 2-1 Groundwater-Level Monitoring Network

2.3 Component 3 - Groundwater Quality Protection

Groundwater quality protection is a key component for ensuring a sustainable groundwater resource in the Sonoma Valley. As described in the Plan, groundwater quality protection includes both the prevention and minimization of groundwater quality degradation, as well as measures for the mitigation of groundwater contamination. The primary focus of 2009 work in this component was, as described below, the continued monitoring of potential saline intrusion, planning for a long-term water quality monitoring program, and development of a private well owner's guide.

- **Additional Wells in Southern Sonoma Valley added to Voluntary Groundwater-level Monitoring Program**
  Eight wells were added to the Voluntary Groundwater-level Monitoring Program in the southern portions of Sonoma Valley in areas identified as potentially subject to saline intrusion in the 2006 USGS report. The monitoring of groundwater levels (and select wells for water quality) in these wells will provide data to further evaluate the potential for saline intrusion in southern Sonoma Valley.

- **Development of Long-Term Water Quality Monitoring Program**
  To address water quality issues identified as potential concern in the 2006 USGS SIR report, including salinity intrusion from San Pablo Bay in the southern portions of Sonoma Valley and localized geothermal water upwelling, a long-term groundwater quality monitoring program is under development. A water quality monitoring program formerly performed by DWR is being resumed and expanded. Staff and TAC members coordinated with DWR representatives to identify the 12 wells in Sonoma Valley that were historically monitored for water quality (on a periodic basis) and recommend additional wells that could be included in the program (primarily in southern Sonoma Valley). Additionally, staff obtained limited existing water quality data collected by public water suppliers (the City, VOMWD), small water systems, and mutual water companies which can be incorporated into the program.

- **Development of Well Owner's Guide**
  A well owner's guide is under development for distribution to private well owners. The guide includes well owner responsibilities, information on well construction and well maintenance, water quality protection, water quality sampling and treatment. The guide also provides resources and contact information for local, state and federal agencies, analytical laboratories, and private organizations for additional well-related information and assistance. The well guide is a compilation of existing well-related documents and is customized for the local stakeholders.

2.4 Component 4 - Groundwater Sustainability

To ensure a long-term, viable, sustainable supply of groundwater, the GMP seeks to increase the amount of groundwater in storage in the Sonoma Valley over the long term.

As part of the Plan analysis, several conceptual water management options were considered using the Sonoma Valley groundwater model developed by the U.S. Geological Survey including stormwater recharge, groundwater banking, increased recycled water use, and increased conservation. Results of the modeling indicate that each of these water management options is necessary for increasing the amount of groundwater storage in Sonoma Valley. To improve the sustainability of water resources in the Sonoma Valley, the Agency, VOMWD and the City have continued to pursue and investigate appropriate water management options that include additional surface water supplies, implementation of the California Urban Water Conservation Council (CUWCC) water conservation elements, conjunctive use opportunities, agricultural conservation and increased use of recycled water.

Specific activities that were conducted in 2009 that can contribute to groundwater sustainability include:

- **Updated Groundwater Flow Model**
  As part of a Master of Science Thesis for the Department of Geological and Environmental Sciences at Stanford University, an update to the Sonoma Valley Groundwater Flow model was completed in December 2008 and received by staff in 2009. The update was performed by Jacob Bauer who received guidance and input on the groundwater flow model update from the USGS. The primary updates to the model included development of a new recharge model based on a soil moisture budget model and extension of the area of recharge to the MODFLOW model to encompass entire Sonoma Creek Watershed. Mountain-front recharge in the Sonoma Creek Watershed originating in the highland areas outside the model domain was added to the model and accounted for separately from aerial recharge (from direct precipitation) within the model domain. Additionally, the calibration time-period was extended to 2006 and baseflow in tributaries to Sonoma Creek was added to the model.

- **Slow-it, Spread-it, Sink-it Guidebook**
  A guidebook drafted by the Southern Sonoma County Resource Conservation District (SSCRCD) with input from the Panel and TAC has been prepared to serve as a resource for private property owners to implement green projects that promote stormwater retention and ground water recharge.

- **Groundwater Recharge Mapping**
  The Sonoma Valley recharge mapping project was initiated in late 2009 and will be completed in 2010, as part of a grant awarded for AB303 funds through the California Department of Water Resources. While the grant was initially awarded in 2008, funding was frozen on the grant due to state budgetary constraints.

- **Site Visits of Potential Groundwater Recharge Projects**
  Groundwater recharge at individual properties was the subject of numerous TAC site visits and discussions. Site visits included ranches and vineyards and private residences to look at current practices for surface water drainage management

controls, water retention, rainfall harvesting, soil erosion issues and possible recharge options.

- **Unincorporated Area Water Conservation Assessments**
  A pilot program to evaluate water conservation programs for areas within the Sonoma Valley that currently do not have formal conservation programs (unincorporated areas) was initiated in 2009 under a $25,000 grant obtained by the Agency from NBWA. The pilot program includes conducting residential and agricultural site assessments involving water use surveys to educate private well users (residential and agricultural water users) regarding water conservation practices. The site assessments will provide information that can be used to develop future water conservation and efficiency programs and incentives for well users throughout the NBWA service area. Conservation materials will also be developed for distribution at local events within unincorporated areas to educate residents and businesses about the need for and benefits of water conservation. To date, 13 residential and 3 agricultural site assessments have been conducted. Upon completion of all remaining assessments, results of the activities will be documented and used to identify grant funding opportunities to encourage and incentivize conservation practices.

- **Water Conservation Awards Program**
  In 2009 the Panel developed a Water Conservation Awards Program that recognized several members and groups from Sonoma Valley for extraordinary levels of water conservation. The award winners included a Sonoma family (the Goodman family), Sonoma Valley High School, Sonoma Ecology Center, Benziger Family Winery, Deerfield Ranch Winery, and Gundlach Bundschu Winery. The award winners were honored at the November 2009 Panel meeting and received certificates of appreciation, in addition to presenting their water conservation achievements.

- **Recycled Water**
  The increased use of recycled water is one of the primary strategies identified in the GMP for sustaining groundwater supplies in Sonoma Valley. The Sonoma Valley Recycled Water Project (SVRWP) is intended to reduce the discharge of treated wastewater to surface waters and provide a reliable alternative source of water for agricultural and urban use in Sonoma Valley. The SVRWP will reduce reliance on other regional water supplies, including groundwater, by utilizing tertiary treated recycled water from the SVCSD wastewater treatment facility that would otherwise be discharged into San Pablo Bay. Activities conducted in 2009 included substantial completion of a financial/economic feasibility analysis for the project and design work for the first segment of the proposed recycled water trunk main (extending from the Sonoma Valley Treatment Plant to the vicinity of Watmaugh Road).

2.5 Component 5 - Planning Integration

Planning integration involves making decisions and taking actions while considering multiple viewpoints of how groundwater and other related resources should be managed in the Sonoma Valley. Such integration also promotes resource enhancements and

reliability, operational efficiency, cost savings, and in some cases generates larger system and environmental benefits. The Agency, VOMWD and the City, are implementing integrated management in the region through cooperation to manage Russian River surface water resources, participation and joint funding of a Groundwater Banking Feasibility Study Program, participation in the CUWCC Memorandum of Understanding (MOU) for water conservation, the recycled water program, the Sonoma Creek Watershed Enhancement project, and implementation of this GMP. Additionally, continued efforts and discussions at the GMP Panel, TAC, outreach meetings and focused briefings facilitate opportunities for all stakeholders in Sonoma Valley to provide input on these integrated planning programs.

2.6 2009 Program Funding

In September 2009, a Cooperative Funding Agreement was entered into between the Agency, the City, VOMWD, the Sonoma Valley County Sanitation District, the Sonoma County Agricultural Preservation and Open Space District, and the County of Sonoma to fund an additional three years of the GMP (Fiscal Years 2009/2010 through 2011/2012). Additionally, stakeholder involvement included participation in the Panel and TAC meetings and briefings, as well as water-level monitoring, field investigations, and development of future demonstration projects, all through voluntary contributions of their own time and resources for the benefit of the overall program.

3. Summary of 2009 Hydrologic Conditions

This section provides a summary of hydrologic conditions for Sonoma Valley during 2009 based on precipitation, stream flow, and groundwater data collected in 2009.

3.1 Climate Conditions

The climate of the study area is Mediterranean, with moderate temperatures and distinct wet and dry seasons. About 90 percent of the annual precipitation occurs during the months of November through April. Mean annual precipitation at Sonoma averaged 29.8 inches during the 50-year period from 1953 through 2002 (USGS SIR 2006-5092), as calculated from rainfall measurements collected at the California Irrigation Management Information System (CIMIS) Station SONOMA.C (NCDC #8351, Sonoma). This station is located approximately 0.5 miles northwest of the Sonoma Post Office at latitude 38°17’55” N, longitude 122°27'43"W, elevation 97 ft (NGVD 29). While the rainfall pattern is generally consistent throughout Sonoma Valley, rainfall amounts can vary considerably throughout Sonoma Valley based on elevation and geographic location within the valley.

Figure 3-1 presents the annual precipitation measured at the City of Sonoma rain gage from 1953 through 2009 (UC IPM Online). As shown in Figure 3-1, annual precipitation at the City of Sonoma rain gage can deviate significantly from the 50-year average of 29.8 inches. Additionally, rainfall varies quite significantly across the watershed, on an annual and per event basis, and there are very few rainfall gages available. As indicated in Figure 3.1, 2009 was the third consecutive year of below average rainfall, with a total of 18.61 inches of precipitation measured at the City of Sonoma rain gage. The majority of the rainfall for 2009 fell during the months of February, March, October, and December, as shown in Figure 3-2. The maximum daily rainfall for the year was 1.98 inches measured on October 13, 2009.

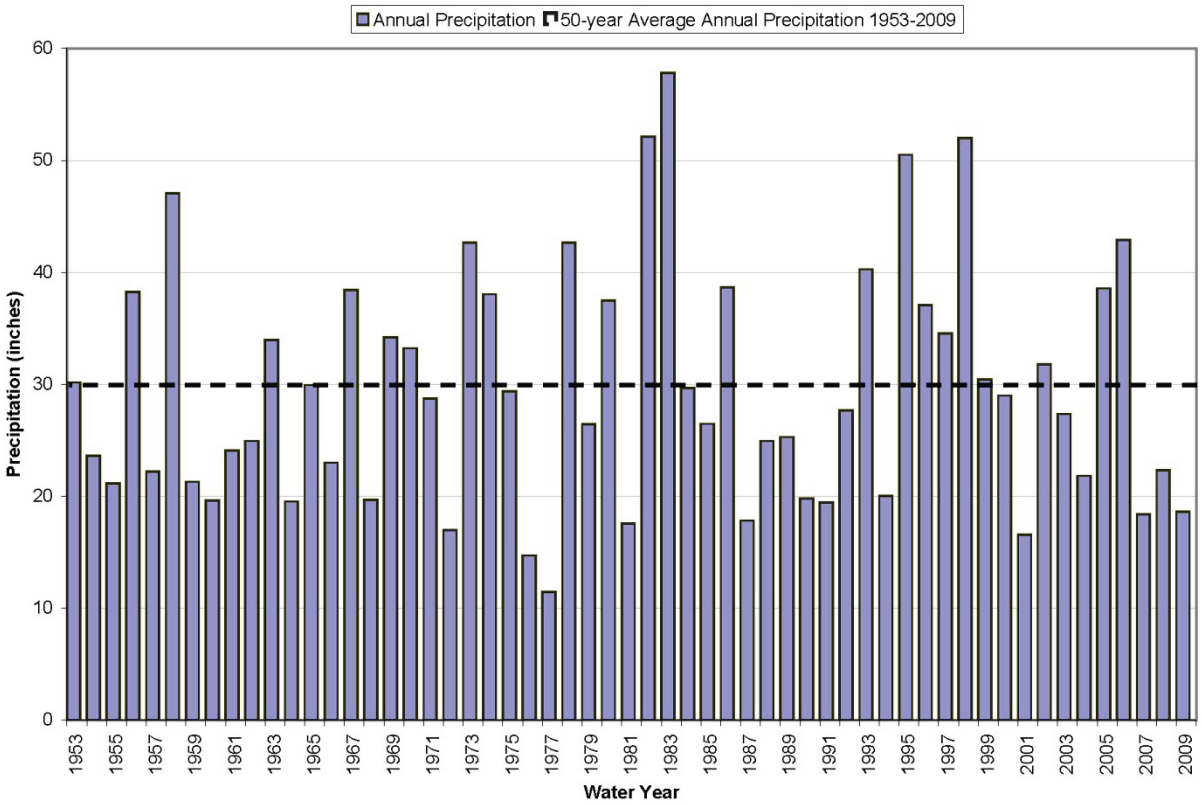


Figure 3-1 Annual Precipitation and 50-Year Average Precipitation for 1953-2009 at City of Sonoma, Sonoma County, California

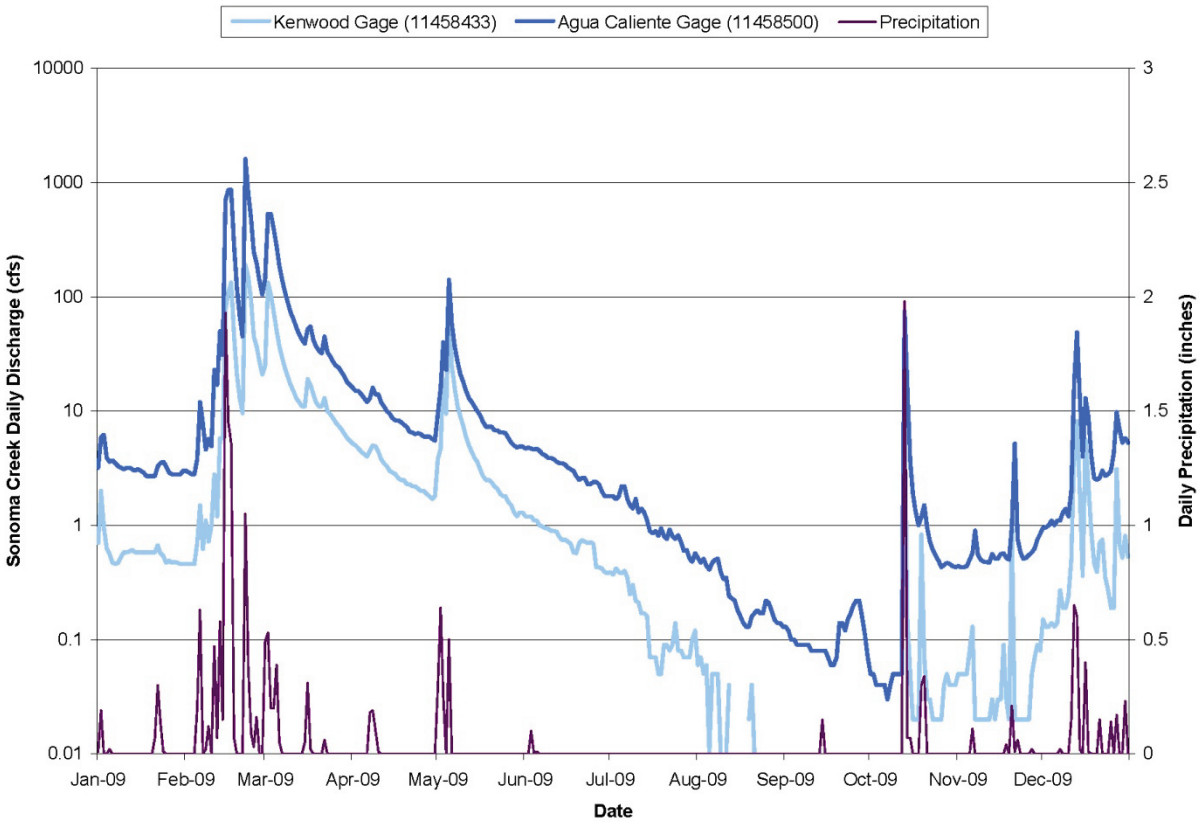
3.2 Surface Water Conditions

Discharge in Sonoma Creek is gaged near the middle part of the valley at the Agua Caliente Avenue bridge near Agua Caliente (USGS station number 11458500), and near Kenwood (USGS station number 11458433) (as shown in Figure 2-1). The Kenwood stream gage was installed in the fall of 2008 and does not have a long-term record.

The Agua Caliente gage operated from 1955 through 1981 and was then temporarily discontinued until 2001 when it was restarted. Discharge measured at the Agua Caliente gage varies considerably seasonally and inter-annually, as shown in the graph of daily discharge in cubic feet per second (Figure 3-3). The mean annual discharge of Sonoma Creek at the Agua Caliente gage is 51,839 acre-ft, on the basis of records for water years 1956–81 and 2002–08 (1 acre foot = 43,560 cubic feet = 325,900 gallons). A maximum annual discharge of 123,402 acre-ft was measured in 2006, and a minimum discharge of 1,002 acre-ft was measured in 1977. Compared to the mean, total annual discharge of Sonoma Creek measured at the Agua Caliente gage in 2009 was relatively lower with a discharge of 22,511 acre-ft, which is consistent with the lower than average precipitation measured in 2009. Total annual discharge of Sonoma Creek at the Kenwood gage in 2009 was 4,296 acre-ft, indicating that between Kenwood and Agua Caliente, Sonoma

Creek gained approximately 18,215 acre-ft (likely from a combination of tributary inflows and groundwater seepage).

In most water years, discharge does not increase markedly until November or December, after which it begins to rapidly decrease in April or May in response to the normal annual cycle of precipitation. In 2009, the discharge pattern was relatively normal, with the peak flows occurring in February and March, and appreciable discharge declines commencing in late May. Streamflow at the Kenwood gage declined to immeasurable flow from mid-August through mid-October, while streamflow at the Agua Caliente gage declined to approximately 0.1 cfs during the same time period.



Notes:

- Average daily Sonoma Creek flow rate data is provided on the USGS National Water Information System (NWIS) website based on data collected at the USGS stream gage 11458500 located in Agua Caliente, California
- Average daily precipitation data measured at CIMIS Station SONOMA.C (NCDC #8351, Sonoma) provided by the UC IPM Online website.

Figure 3-2 2009 Daily Precipitation at City of Sonoma, Sonoma County, California, and Daily Mean Discharge of Sonoma Creek Measured at the Agua Caliente Stream Gage

3.3 Groundwater Conditions

This section presents the results of the groundwater level monitoring program in the Sonoma Valley performed as part of the GMP (see Section 2.2). As summarized in Section 2.2, additional analysis of available well construction information was conducted in 2009. Available well construction data was reviewed and evaluated for groundwater-level monitoring program wells in order to assist in the evaluation of groundwater-level data collected from different depths (and aquifer zones). To maintain consistency with the approach utilized in the 2006 USGS report, wells were subdivided according to their well-screen depth or total depth into the following three categories: (1) less than 200-feet deep; (2) 200 to 500 feet deep; and (3) greater than 500 feet deep. As indicated on Figure 2-1, 73 wells are less than 200-feet deep, 40 wells are between 200 to 500 feet deep, and 22 wells are greater than 500 feet deep. Well construction information could not be identified for 20 groundwater-level monitoring program wells. Due to the limited number of wells that are greater than 500 feet deep, for the purposes of preparing depth-specific groundwater-level hydrographs and groundwater-level contour maps, wells were grouped into two categories: (1) less than 200-feet deep; and (2) greater than 200-feet deep.

3.3.1. Groundwater Level Elevations

Groundwater level elevation contour maps for Fall 2009 in both shallow wells (less than 200-feet deep) and deeper wells (greater than 200-feet deep) are shown in Figures 3-3 and 3-4, respectively. Groundwater-level elevation contour maps were not prepared for Spring 2009, as a smaller dataset was available for this time period and review of the data indicates that the general groundwater flow patterns in Spring 2009 are similar to Fall 2009. Spring 2009 groundwater level elevations ranged from approximately:

- 467 feet mean sea level (msl) in the north end of the Sonoma Valley to -1 feet msl in the south end measured in shallow wells; and.
- 468 feet msl in the north end of the Sonoma Valley to -98 feet msl in southern Sonoma Valley measured in deeper wells.

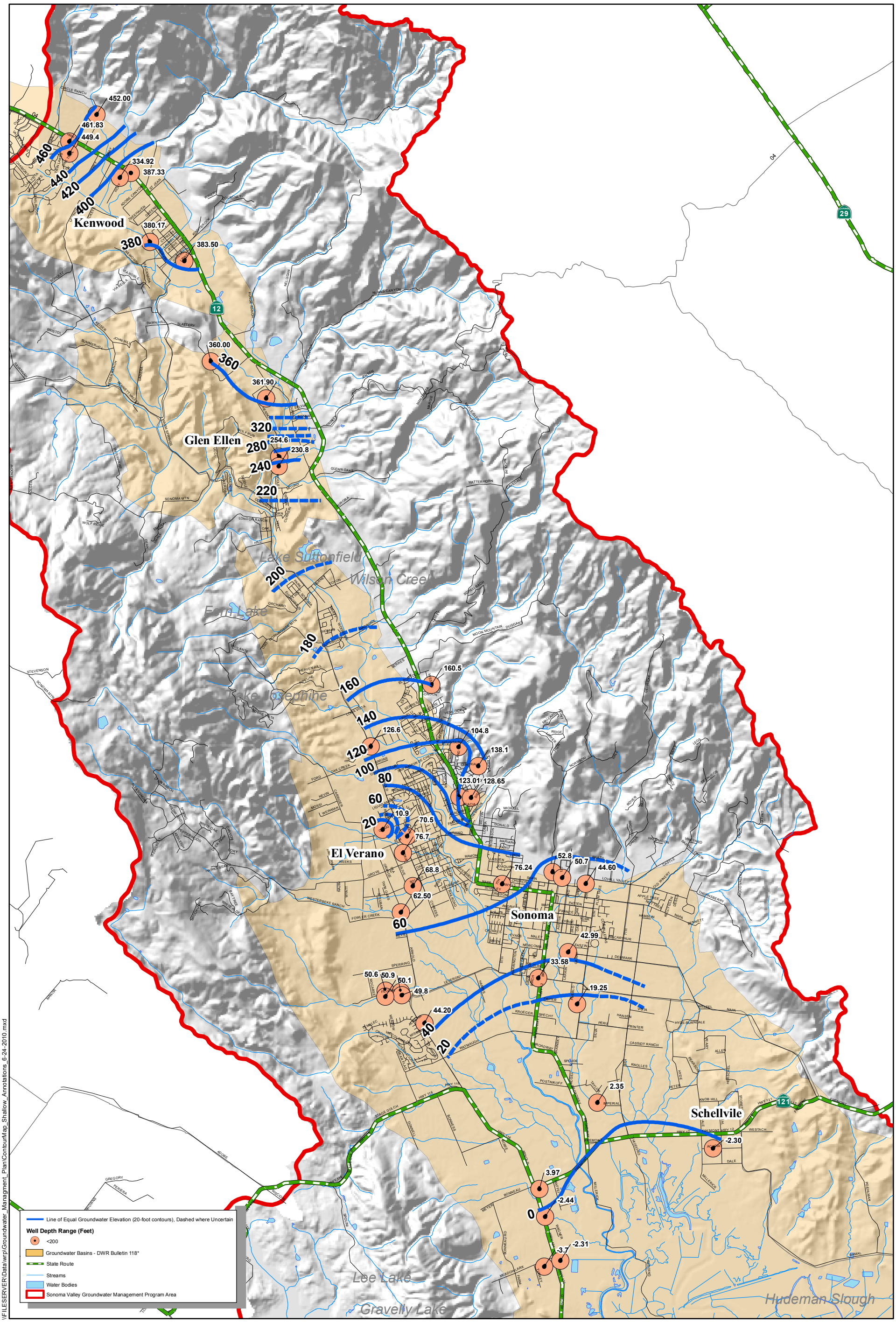
As indicated in Figures 3-3 and 3-4, Fall 2009 groundwater level elevations ranged from:

- 461 feet msl in the north end of the Sonoma Valley to -4 feet msl in the south end measured in shallow wells; and.
- 469 feet mean sea level (msl) in the north end of the Sonoma Valley to -116 feet msl in the south end measured in deeper wells.

The Fall 2009 groundwater-level contour maps in both the shallow and deeper zones indicate that groundwater flows from recharge areas in the mountains toward the valley axis, in a generally southern direction towards San Pablo Bay. Comparison of the shallow and deeper groundwater-level contour maps indicates that groundwater elevations in the deeper zone: (1) are approximately equivalent to groundwater elevations in portions of northern Sonoma Valley; and (2) range up to 100 feet lower than groundwater elevations in the shallow-zone in portions of southern Sonoma Valley. The two groundwater pumping depressions described in the 2006 USGS report are most apparent in the deeper zone groundwater level contour maps (Figure 3-4). Southeast of

the City of Sonoma, measured groundwater levels ranged up to 116 feet below sea level and southwest of El Verano groundwater levels ranged up to 45 feet below sea level in deeper zone wells.

It is important to note that groundwater elevations measured in nearby wells can be highly variable due to differences in well design (i.e., the depth and length of well screen intervals) and the spatial variations in aquifer materials (which can vary abruptly due to the complex geologic conditions and numerous fault zones present in Sonoma Valley). Therefore, the associated groundwater level contour maps represent generalized groundwater level flow patterns and should not be used to interpret more localized or site-specific conditions.

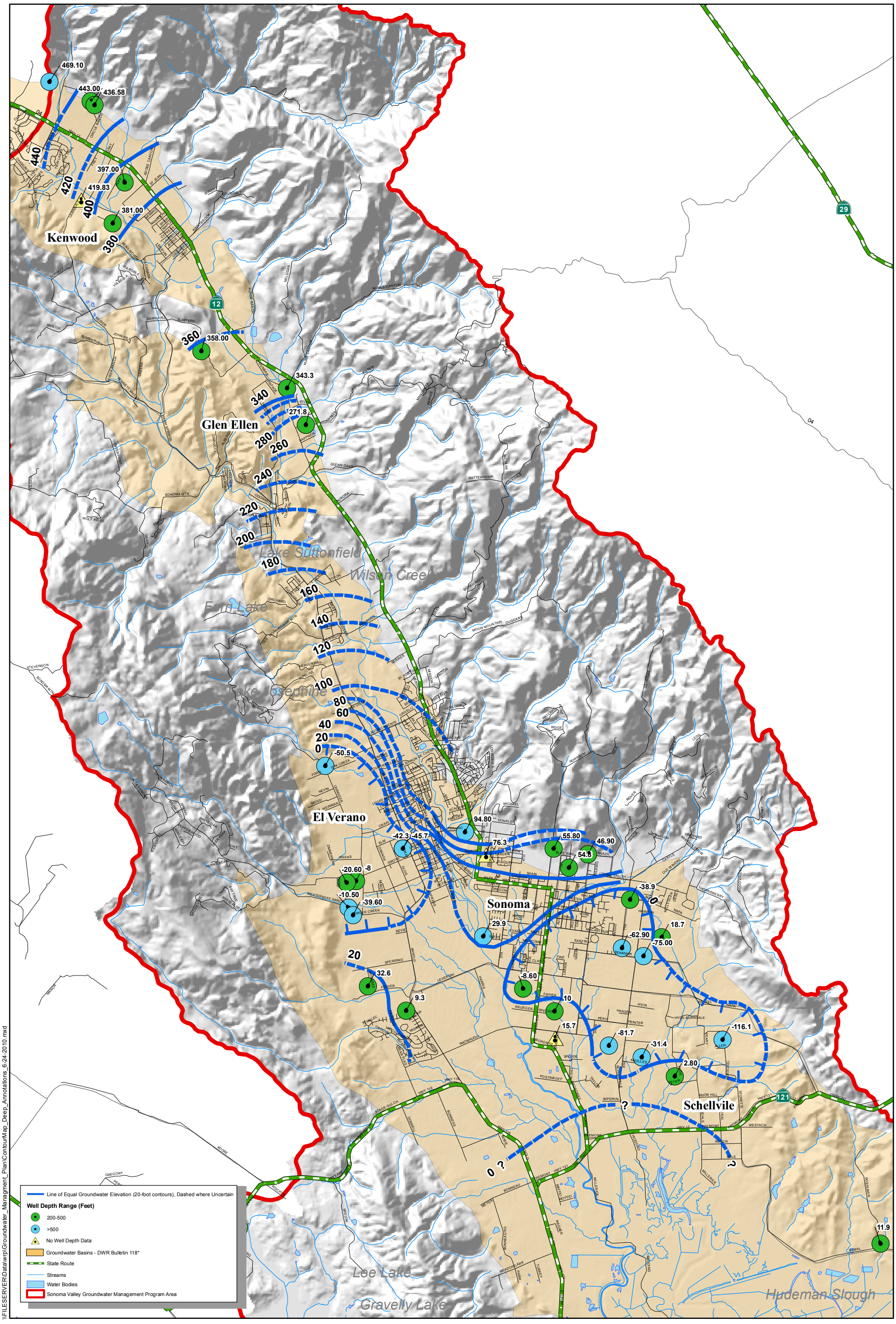


Sonoma Valley
Groundwater Management Program
Generalized Groundwater Level Contour Map
Shallow Zone
Fall 2009

June 24, 2010

Figure 3-3

Figure 3-3 Generalized Groundwater Level Contour Map - Shallow-Zone



Sonoma Valley
Groundwater Management Program
Generalized Groundwater Level Contour Map
Deep Zone
Fall 2009

June 24, 2010

0 0.5 1 2
Miles

N W E S

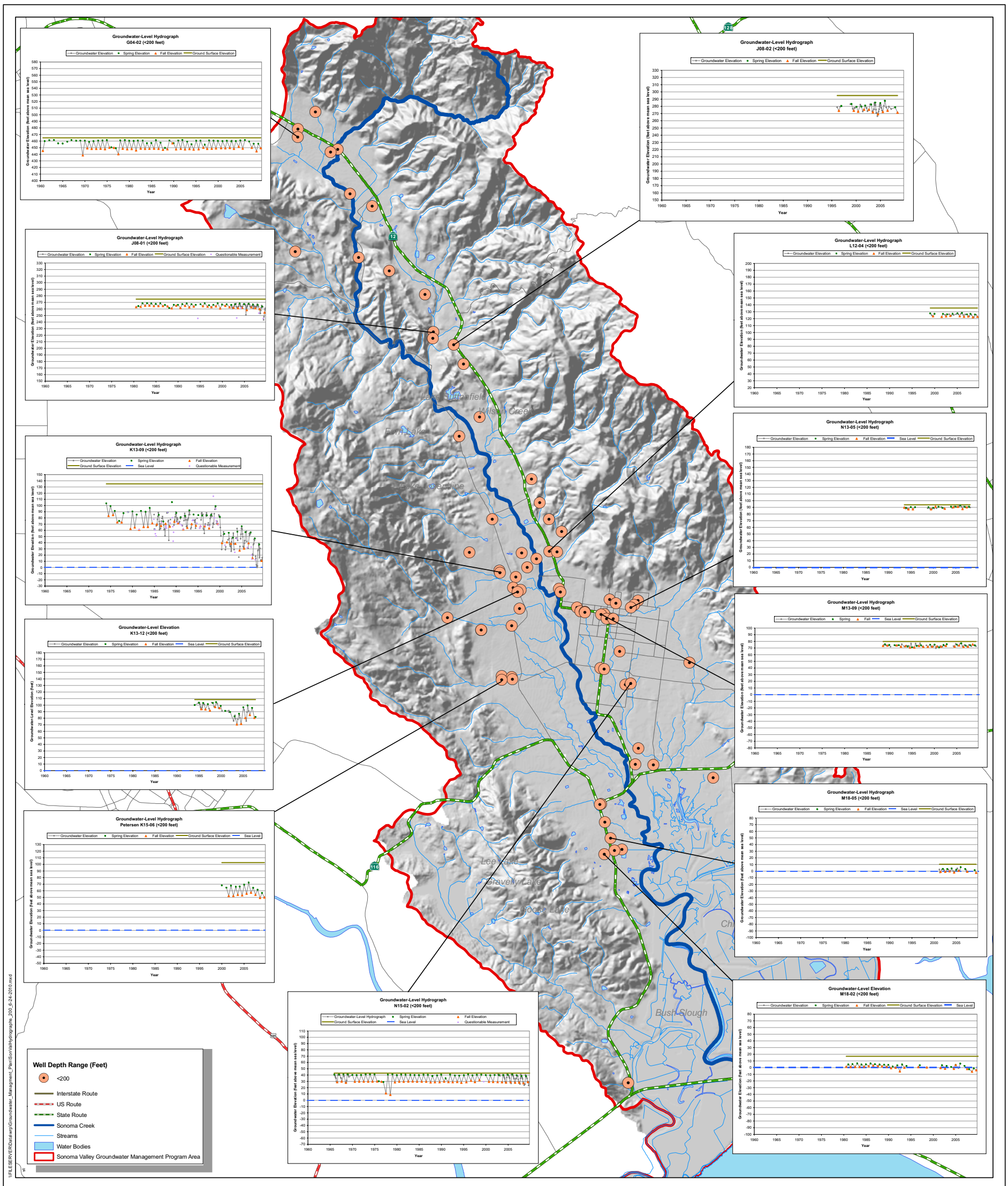
Figure 3-4

Figure 3-4 Generalized Groundwater Level Contour Map - Deeper-Zone

3.3.2. Groundwater Level Trends

Groundwater level trends are provided in Figures 3-5 and 3-6 for the shallow and deeper-zone wells, respectively, showing a select number of well hydrographs distributed throughout the valley. These hydrographs present the change in groundwater elevation (vertical axis in feet) over time (horizontal axis in years). On the hydrographs spring groundwater-level data are depicted in green and fall groundwater-level data are shown in red. As indicated on Figure 3-5, groundwater level trends for shallow-zone wells are generally stable and predominantly remain above sea level. Groundwater-level declines in shallow-zone wells are limited to a well located in the El Verano area where groundwater levels have declined approximately 60 feet from 1999 to 2009. As indicated in Figure 3-6, declining groundwater level trends are more pervasive in deeper-zone wells, with wells in the El Verano Area and southeast of the City of Sonoma trending below sea level. Numerous well hydrographs shown on Figure 3-6 exhibit groundwater level declines ranging up to 80 feet over the last 30 years.

Many of the hydrographs have less than 10 years of monitoring record, making it unclear whether these are long-term trends, recent accelerated declines, a reflection of the dry years in 2000 and 2007 through 2009 or some combination. Most of the groundwater level declines are considered to likely have resulted from increased groundwater withdrawals in localized areas (USGS 2006). During 2009, groundwater elevations were generally lower than historical groundwater elevations throughout Sonoma Valley likely due to the relatively low amounts of precipitation in 2007 through 2009.



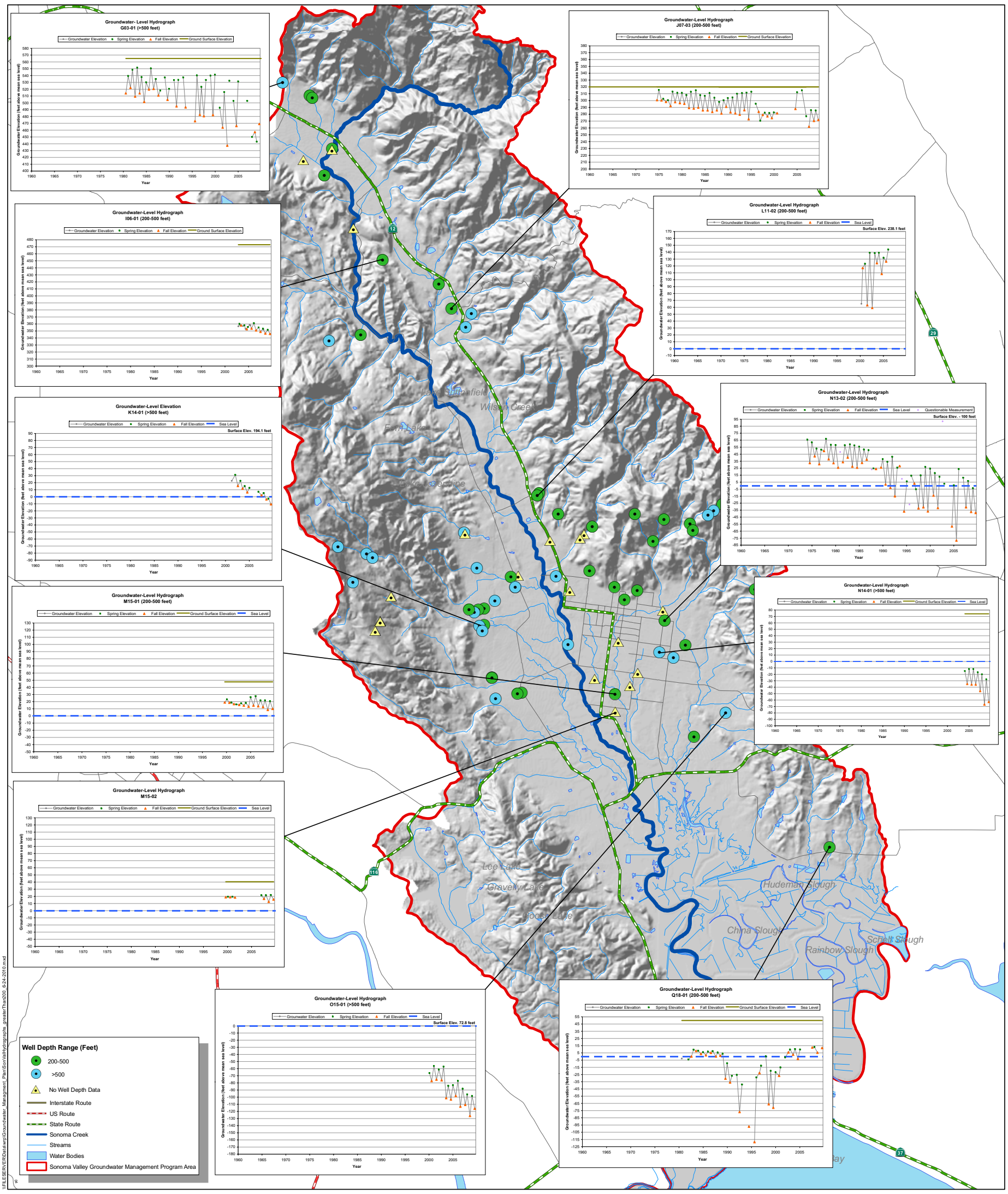
Sonoma Valley
Groundwater Management Program

Selected Hydrographs
Shallow Wells (<200 Feet)

June 24, 2010

Figure 3-5

Figure 3-5 Selected Hydrographs - Shallow Wells



Sonoma Valley
Groundwater Management Program

Selected Hydrographs
Deep Wells (>200 Feet)

0 0.5 1 2 3 4 5
Miles

N W E S

Figure 3-6

June 24, 2010

Figure 3-6 Selected Hydrographs - Deeper Wells

4. Management Actions and Progress on Plan Component Actions

Substantial progress toward implementing plan component actions was accomplished in 2009, the second year of implementation of the Sonoma Valley GMP. The accomplishments made and programs planned for 2010 and beyond are identified in Table 4-1 and 4-2.

Table 4-1 Management Componenets and Actions - Progress and Plans

Management Components/Actions	Year 1	Completed	Year 2	Completed	Year 3	Relative Cost
4 Stakeholder Involvement						
4.1.1 Involving the Public						
-- Meetings, coordination, and communication	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
3 Develop Public Outreach Plan for implementation	❖	√		√		----
4.1.2 Advisory Groups						
1 Reform Panel, form TAC, and hold TAC monthly meetings	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
4 Hold Quarterly Meetings with the Panel	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
4.1.3 Informing Public Agencies and Stakeholders						
-- Meetings, coordination, and communication	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
4.1.4 Partnerships & Coordination						
-- Meetings, coordination, and communication	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
3 Seek grant funding for Plan actions	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
4 Monitoring Program						
4.2.2 Groundwater Elevation Monitoring						
5 Groundwater Elevation Monitoring & Expand Volunteer Wells	❖ ❖	√	❖ ❖	√	❖ ❖	----
6 Project - Install New Multi-depth Monitoring Wells		**1**		**1**	❖	
4.2.3 Groundwater Quality Monitoring						
3 Groundwater Quality Monitoring- Compile Existing Data	❖ ❖		❖ ❖	√	❖ ❖	----
4.2.4 Land Subsidence Monitoring						
1 Study - Establish Long-Term Monitoring Program for Land Subsidence					❖	$
4.2.5 Surface Water-Groundwater Interaction Monitoring						
3 Study - Tracer Test and Modeling					❖ ❖ ❖ ❖	$$$
4 Study - Stable Isotope Analysis	❖	√			❖ ❖ ❖ ❖	$$
5 Project - Install and Maintain New Stream Gauge	❖ ❖	√	❖ ❖	√		
6 Project - Conduct Seepage Runs and Install Piezometers				2	❖ ❖	$$$
4.2.6 Monitoring Protocols						
-- Adopt and implement protocols & monitoring program	❖ ❖	√				
4.2.7 Central GIS Data Management System						
6 Study - GIS Mapping of Drainage Network					❖ ❖ ❖ ❖	$$
7 Study - Additional GIS Layers & Analysis					❖ ❖ ❖ ❖	$$
8 Pilot- WEBH2O Web-Based Data Management System	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	
4 Groundwater Quality Protection						
4.3.1 Well Construction, Abandonment, and Destruction						
5 Study - Obtain Better information during Well Installations	❖ ❖				❖ ❖ ❖ ❖	----
6 Study - Conduct Well/Abandoned Well Survey					❖	$$
7 Project - Develop Guide for Well Owners			❖ ❖ ❖ ❖	√	❖ ❖	
4.3.2 Wellhead Protection						
1 Incorporate Information from DWSAP Plans	❖ ❖					
4.3.3 Control Migration and Remediation of Contaminated Groundwater						
1 Provide Well Owners with County Guide	❖					
-- Incorporate & Distribute Information on Sources						
4.3.4 Control of Saline Water Intrusion						
3 Study - Salinity Sources and Distribution					❖ ❖	$
4 Study - Seawater Intrusion Mitigation Measures					❖ ❖ ❖ ❖	$$$
4 Groundwater Sustainability						
4.4.1 Stormwater Recharge						
1 Study - Groundwater Recharge Area Mapping & Analysis	❖ ❖	**1**	❖	2	❖ ❖ ❖	$
2 Study - Recharge Area Alternatives					❖ ❖	$$
3 Project - Public Outreach Program	❖ ❖	1	❖ ❖	2	❖ ❖	$
4 Study - Recapture Unused Groundwater						
5 Study/Pilot - Feasibility Analysis/Pilot Stormwater Capture & Recharge				2	❖ ❖ ❖ ❖	$$$
4.4.2 Groundwater Banking						
1 Study - Conduct Groundwater Banking/Conjunctive Use Assessment					❖ ❖ ❖ ❖	$$$
2 Study/Pilot - Feasibility Analysis/Pilot Groundwater Banking						
4.4.3 Recycled Water Supply						
1 Study - Evaluate Graywater					❖ ❖ ❖ ❖	$$$
2 Project - Recycled Water for Irrigation					❖ ❖ ❖ ❖	$$$
3 Study - Evaluate Recycled Water Groundwater Recharge Feasibility					❖ ❖ ❖ ❖	$$
4.4.4 Conservation & Demand Reduction						
1 Continue Implementing BMPs & Report Annually	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	√	❖ ❖ ❖ ❖	----
2 Water Conservation BMPs for Non-Viticulture Agriculture						
3 Encourage Additional Conservation and Best Practices for Viticulture					❖ ❖ ❖ ❖	$
4 Study - Voluntary Water Conservation BMPs for Uninc. Areas		**1**	❖ ❖ ❖ ❖	√		
5 Project - Landscape Irrigation Efficiency					❖ ❖ ❖ ❖	----
6 Pilot/Project - Stormwater Capture and Reuse for Irrigation					❖ ❖ ❖ ❖	$$
4.4.5 Groundwater Modeling						
1 Study - Update Land Cover Map & Water Use Estimates					❖ ❖ ❖	$$
2 Study - Recharge and Infiltration Modeling					❖ ❖ ❖	$$
3 Project - Improve Groundwater Flow Model			❖ ❖			$$
5 Planning Integration						
4 Project - Develop Multi-Beneficial Projects for Flood Hazards				2	❖ ❖ ❖ ❖	$$$
5 Implementation Administration						
Implementation Prioritization and Financing	❖	√		√		
Annual Plan Implementation Report		√	❖	√	❖	----
Future Review					❖ ❖	----

Notes:

---- - Funded action

$$$ - Unfunded action; indicates relative order magnitude cost

1 - Obtained funding in 2008, implementation in 2009-2010.

2 Initiated in 2009, implement in 2010

Table 4-2 Groundwater Management Program Progress in 2009 and Plans for 2010

Basin Management Objective	Progress to Date	Plans for 2010 and Future
BMO-1 Maintain groundwater elevations for the support of beneficial uses of groundwater and to protect against inelastic land subsidence.	Public outreach and stakeholder involvement on groundwater, increased voluntary monitoring, and obtained funding for two new multi-depth wells.	Public outreach and stakeholder involvement on groundwater, increased voluntary monitoring, and install two new multi-depth wells.
BMO-2 Improve water use efficiency and conservation.	Conducted conservation assessments for unincorporated areas with NBWA grant.	Complete a report on assessment results. Pursue grants for incentive programs.
BMO-3 Identify and protect groundwater recharge areas and enhance the recharge of groundwater where appropriate.	Initiated recharge study, including updating GIS coverages.	Completion of recharge study, start stormwater recharge pilot and groundwater banking feasibility study in 2010.
BMO-4 Manage groundwater in conjunction with other water sources.	Under the GMP, groundwater is being managed in conjunction with other water resources.	Continue implementation of the GMP with studies and pilots on stormwater, and recharge opportunities.
BMO-5 Protect groundwater quality for beneficial uses including minimizing saline intrusion.	Coordinated monitoring efforts and increased number of wells through voluntary efforts, incorporated selected water quality data from public water systems.	Continue coordinating monitoring efforts and increase number of wells through voluntary efforts, and install two new multi-depth monitoring wells.
BMO-6 Protect against adverse interactions between groundwater and surface water flows.	Continued stream gage monitoring of the Sonoma Creek watershed.	Continue stream gage monitoring of Sonoma Creek watershed; further consider possible additional groundwater-surface water studies.
BMO-7 Improve the community's awareness of groundwater planning, water resources, and legal issues.	Public outreach and stakeholder involvement through Panel and TAC meetings, newsletters, fact sheets, press releases and GMP website.	Continue public outreach and stakeholder involvement through Panel and TAC meetings, newsletters, fact sheets, press releases and the GMP website.
BMO-8 Improve the groundwater database and basin understanding through consistent monitoring and additional surveys, and improve basin analytical tools including the groundwater simulation model.	Enhanced and utilize WebH2O as a web-hosted repository of groundwater data. Coordinated monitoring efforts, conducted volunteer training, increased number of wells through voluntary efforts, received update of groundwater flow model.	Continue using WebH2O. Continue coordination and efforts to increase number voluntary wells; install two new multi-depth monitoring wells. Upgrade groundwater model to fully-coupled surface water-groundwater flow model.
BMO-9 Manage groundwater with local control.	Continued implementation of GMP.	Continue implementation of GMP
BMO-10 Explore, identify and maximize non-regulatory approaches to manage the groundwater resource.	Continued implementation of GMP.	Continue implementation of GMP

5. Proposed 2010 Program and Funding

This section provides a description of planned and proposed Sonoma Valley GMP activities for 2010 and a discussion of funding sources for 2010.

Activities and actions are recommended to be conducted in 2010 based on the BMOs identified in the Plan and subsequent stakeholder involvement. These activities and actions are described in the following sections and grouped according to the Plan Component Actions (i.e., Stakeholder Involvement, Monitoring Program, Groundwater Quality Protection, Groundwater Sustainability, and Planning Integration).

5.1 Component 1 - Stakeholder Involvement

Stakeholder involvement will continue to provide the foundation for the collaborative process of decision-making and actions during GMP implementation. Key tasks planned for 2010 are discussed below.

- **Continue to update and improve the public outreach plan under the GMP**
  The public outreach plan will continue to be updated to share information and demonstrate progress in GMP implementation. Such outreach activities identified in the plan, which was developed and initiated in 2008, include briefings, communications, and media activities.

- **Expand outreach and conduct briefings** - Quarterly Panel meetings, monthly TAC meetings, several targeted briefings, and focused outreach for water conservation, stormwater capture and recharge, and groundwater banking will continue to be implemented. The focused monitoring work group and funding work group will also continue to meet, as needed.

- **Communications** – Communications will be heightened by preparing and disseminating this annual report, sending out meeting announcements and supporting materials in advance to stakeholders, providing periodic informational newsletters and progress reports, developing and distributing fact sheets on the volunteer groundwater monitoring program, maintaining email distribution lists of Sonoma Valley stakeholders, including the Panel and TAC, and maintaining the project website.

- **Media** - GMP staff and stakeholders will further develop relationships and work with local media to provide press releases on key events and milestones for the GMP.

5.2 Component 2 - Monitoring Program

- **Install two dedicated multi-level monitoring wells**
  Two multi-depth monitoring wells will be installed in 2010 in the southern Sonoma Valley under an AB303 grant awarded to the Agency in 2008 (note: the grant funds

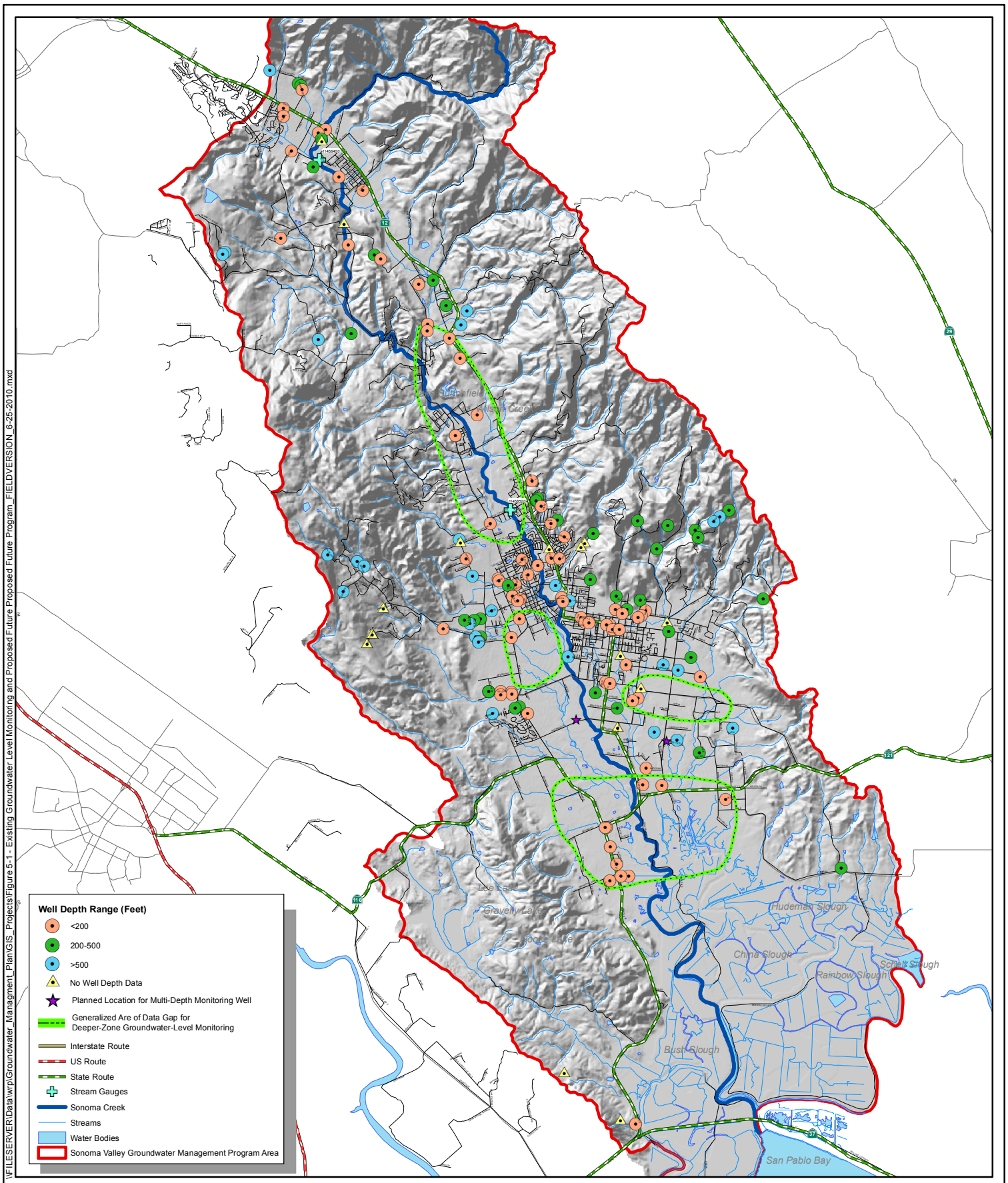
were recently released by DWR after being frozen due to state budgetary constraints). The objectives of the wells are to monitor water levels and salinity at several depth intervals in the southern portions of Sonoma Valley (see Figure 5-1).

- **Continue to expand the groundwater monitoring network and perform groundwater level monitoring**
  Coordinated groundwater-level monitoring events will be continued through the performance of spring and fall water level measurements in 2010, and this will incorporate the two new multi-depth monitoring wells, and any additional voluntary monitoring wells added in 2010. Priority for adding additional wells into the groundwater-level program should focus on deep-zone wells in the following areas: (1) between Kenwood and Glen Ellen; (2) southeast of El Verano; (3) southeast of the City of Sonoma; and (4) southern Sonoma Valley (vicinity of Highway 121 and Bonneau Road), as indicated on Figure 5-1. The addition of wells to the monitoring program in other areas of Sonoma Valley with sparse monitoring coverage (e.g., within the northwestern and northeastern upland areas) should also continue to be pursued and incorporated into the program.

- **Continue stream gaging of Sonoma Creek**
  The two stream gages on Sonoma Creek will continue to be used to collect stream flow data in Sonoma Valley in 2010. Stream gage data is extremely useful in measuring flow, flood prediction, water management, and facilitating the estimation of groundwater recharge and discharge in the area.

- **Surface Water – Groundwater Interaction Study for Sonoma Creek - Conduct Seepage Runs**
  Seepage runs will be conducted by the USGS and Agency in 2010 during the spring and fall (to coincide with groundwater-level measurement events). Seepage runs consist of instantaneous stream discharge measurements within Sonoma Creek and several tributaries to better understand the interaction of surface water and groundwater within the Sonoma Creek watershed and to assist in quantifying recharge of groundwater in the Sonoma Valley. The information obtained from this study would be used to refine gains and losses along reaches of Sonoma Creek, spatially and temporally, in the existing USGS MODFLOW model. This model improvement will enhance the understanding of recharge mechanisms in the valley.

- **Develop plan for future subsidence monitoring**
  While land subsidence has not been identified as an issue in Sonoma Valley, based on work completed during development of the plan and surveying in 2007, land subsidence monitoring is a GMP action that will be conducted periodically to monitor the potential for lowering of the land surface due to groundwater extractions. A long term, monitoring program will be developed to assess the potential for land subsidence related to groundwater extractions. This will include coordination with VOMWD and the City to assess if there are additional and/or other suitable benchmarks in the Sonoma Valley to aid in monitoring for potential land subsidence.



Sonoma Valley
Groundwater Management Program

Groundwater Level Monitoring Network
Planned Wells and Data Gap Areas

June 24, 2010

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Figure 5-1

Figure 5-1 Planned Wells and Data Gap Areas

5.3 Component 3 - Groundwater Quality Protection

- **Conduct depth-specific salinity monitoring in southern Sonoma Valley**
  As discussed in Section 5.2, two multi-level monitoring wells are planned for installation in 2010, which will be used to monitor potential salinity intrusion in southern Sonoma Valley.

- **Complete and distribute well owners information guide**
  The well owners guide (Section 2.3) will be completed and distributed in 2010 to Sonoma Valley stakeholders through the website, email, and hard copy as available.

- **Implement long-term water quality monitoring program (funding dependent)**
  Funding dependent, the long-term water quality monitoring program developed in 2009 (Section 2.3) will be implemented in 2010 to improve long-term monitoring of salinity and other components including boron, manganese, iron and nitrate.

5.4 Component 4 - Groundwater Sustainability

- **Initiate Upgrade of Existing Sonoma Valley Groundwater Flow Model**
  The Agency is planning to initiate a project to enhance and improve the groundwater flow model, addressing limitations in recharge, discharge, and the conceptual hydrogeologic model. The focus of this effort would be to develop a surface water model and further compile and thoroughly analyze existing lithologic data from water well logs in the valley and update the regional conceptual model and flow model. The work will be conducted by the USGS starting in 2010, and the final product will be a fully-coupled surface water/groundwater flow model.

- **Slow-it, Spread-it, Sink-it Guidebook**
  The Slow-it, Spread-it, Sink-it Guidebook (Section 2.4) will be completed and distributed in 2010 to Sonoma Valley stakeholders through the website, email, and hard copy as available.

- **Groundwater Recharge Mapping**
  The groundwater recharge mapping project initiated in late 2009 (Section 2.4), will be completed and reported in 2010.

- **Unincorporated Area Water Conservation Assessments**
  Results of the unincorporated area water conservation assessment activities (Section 2.3) will be reported in 2010, used to identify grant-funding opportunities for conservation, and to summarize the results of the assessments and other efforts.

- **Groundwater Banking Feasibility Study**
  A groundwater banking feasibility study including the Santa Rosa Plain and Sonoma Valley basins will be initiated in 2010. Conceptually, the groundwater banking program would involve the diversion and transmission of surplus Russian River water produced at the Agency's existing production facilities for storage in the Santa Rosa Plain Groundwater Basin and/or Sonoma Valley Groundwater Basin during wet weather conditions (i.e., the winter and spring seasons) for subsequent recovery and use during dry weather conditions (i.e., the summer and fall seasons) or emergency situations. The study is being funded by the Agency, City, and VOMWD along with several of the Agency's Water Contractors in the Santa Rosa Plain (Town of Windsor and Cities of Cotati and Rohnert Park). Informational updates will be presented to the TAC during 2010 and input on the study will be solicited through regular GMP TAC and BAP meetings.

- **Conduct Watershed Planning Study**
  The Agency is planning to initiate a study in fall 2010 to evaluate the feasibility of implementing multi-benefit projects that will provide storm water detention and groundwater recharge, while maximizing opportunities for flood control, water quality enhancement, and potential open space benefits. Currently, projects in the Petaluma River, Santa Rosa Plain, and Sonoma Creek watersheds are under consideration. Informational updates will be presented to the TAC during 2010 and input on the study will be solicited through regular GMP TAC and BAP meetings.

- **Develop pilot project for stormwater capture and recharge (funding dependent)**
  Recharge of surplus flows from Sonoma Creek and its tributaries is a desirable goal, based on discussions at the 2008-2009 Panel and TAC meetings, and during development of the Plan. Conceptual design and implementation of pilot projects, discussed in 2009, will be further considered in 2010.

- **Recycled Water**
  Activities planned for 2010 related to the SVRWP include the design of recycled water storage ponds and pumping facilities, as well as initiation of construction activities for the first segment of the proposed recycled water trunk main (extending from the Sonoma Valley Treatment Plant to the vicinity of Watmaugh Road).

5.5 Component 5 - Planning Integration

Planning integration through efforts and discussions will be continued at the GMP Panel, TAC, outreach meetings and focused briefings to facilitate integrated planning and coordination at the basin and regional scale.

5.6 2010 Annual Plan Implementation Report

The Agency will report on 2010 implementation progress in an annual report in 2011 that summarizes the groundwater conditions in the Sonoma Valley. This report will include the following information:

- Activities and progress made in implementing the Plan
- Groundwater conditions and monitoring results and trends of groundwater levels and quality
- Information on the improved characterization of the Sonoma Valley through continued data collection and analysis
- An update of whether management actions are meeting BMOs
- Any plan component changes, including modification of BMOs during the period covered by the report
- An outline of future Sonoma Valley management actions

5.7 2010 Funding

Currently funded programs include ongoing stakeholder involvement, groundwater elevation monitoring program, stream gage monitoring, and water conservation programs, which are currently funded collectively by Agency, City, VOMWD, Open Space District, Sonoma Valley County Sanitation District, and the County and volunteer services from several BAP and TAC members. The groundwater monitoring program water level data collection is largely completed by local volunteers.

It is worth further noting that the funding for the two new well installations and groundwater recharge study, which were awarded under the AB303 grant program in 2008, was temporarily suspended in 2009 by the State of California pending resolution of state budgetary issues. Recently the suspension was lifted and the wells will be installed in 2010.

For many proposed actions for 2010, funding mechanisms would need to be identified and pursued. Potential funding mechanisms include state grants, such as AB303 and the Integrated Regional Water Management Program grants. Considering the current economic situation, obtaining additional grant funding is going to be perhaps more challenging at least in the near term, and may require being more resourceful and innovative to secure funding in the next few years.

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Appendix A

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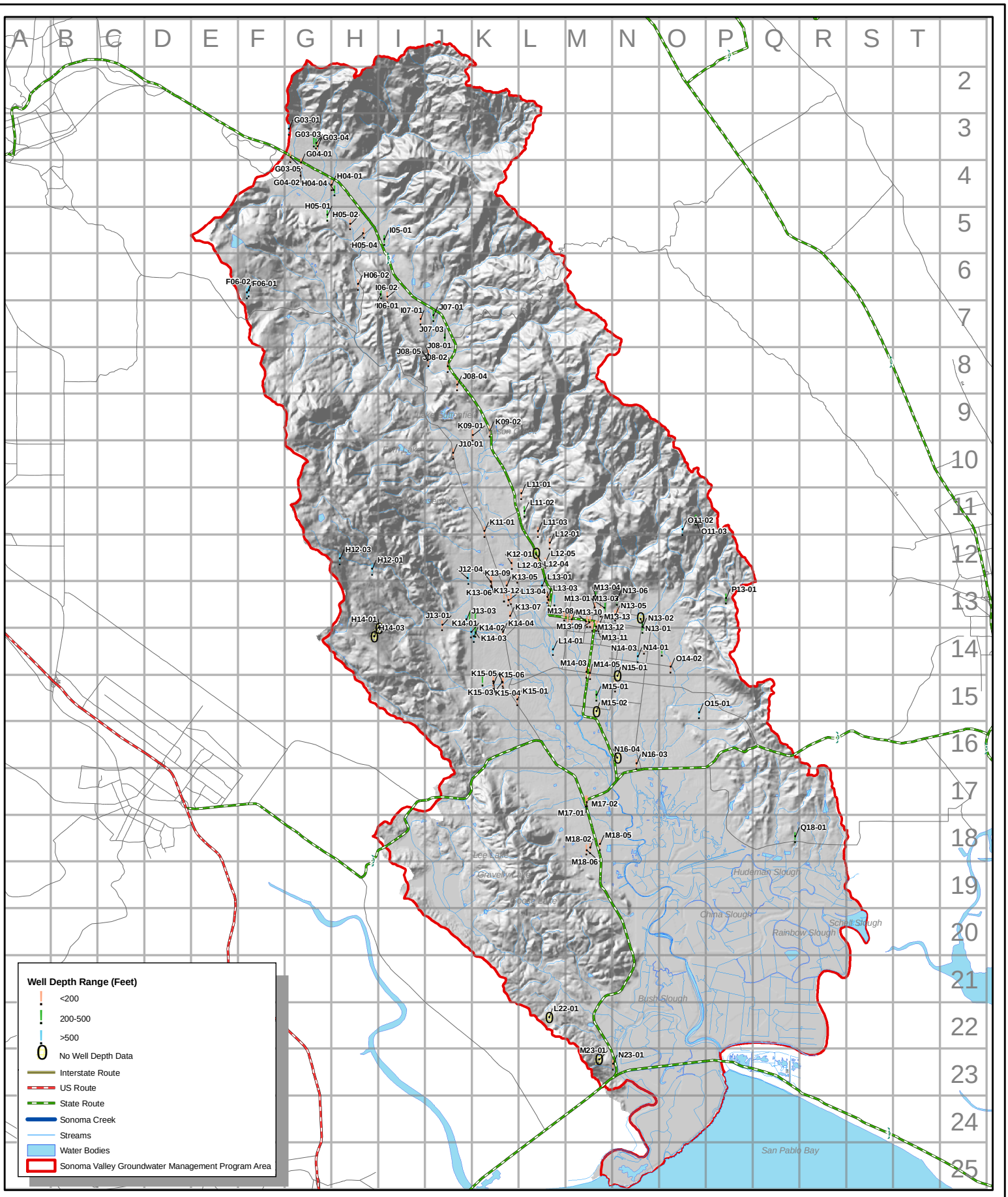

DRAFT

Sonoma Valley
Groundwater Management Program

Groundwater Level Monitoring Network
Wells With Hydrographs

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Figure A-1

Groundwater Hydrographs

Less Than 200 Feet Deep

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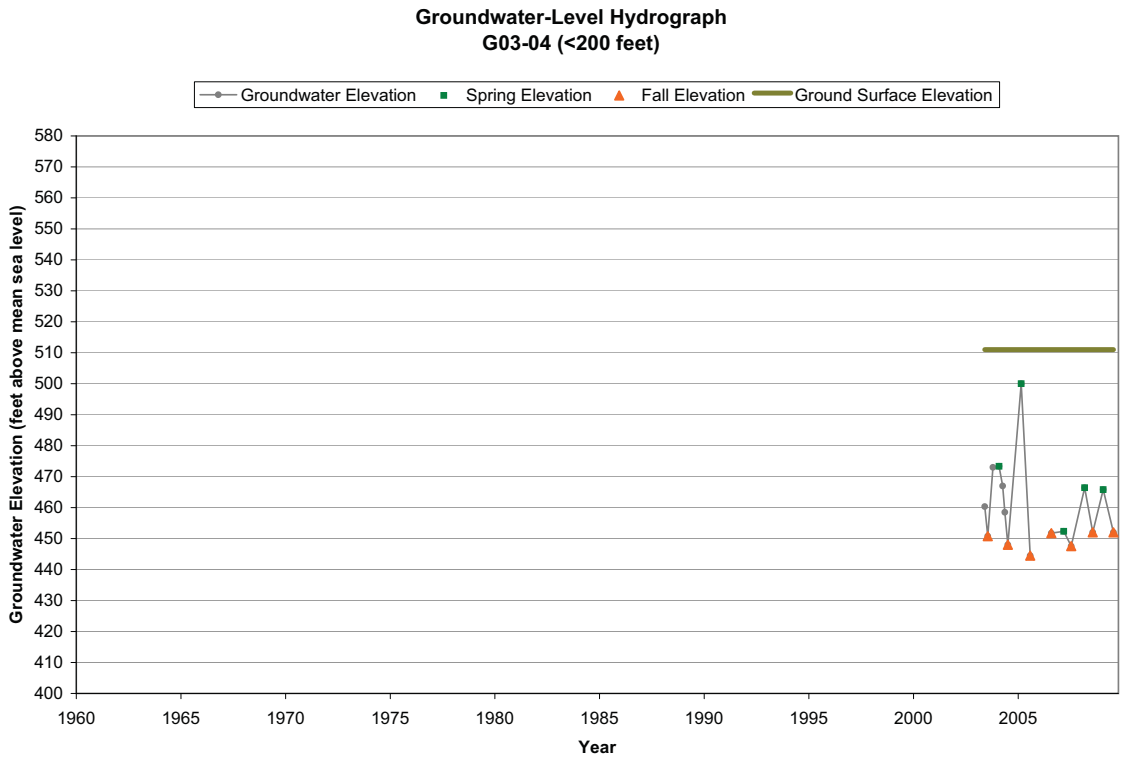
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Groundwater Elevation (feet above mean sea level)
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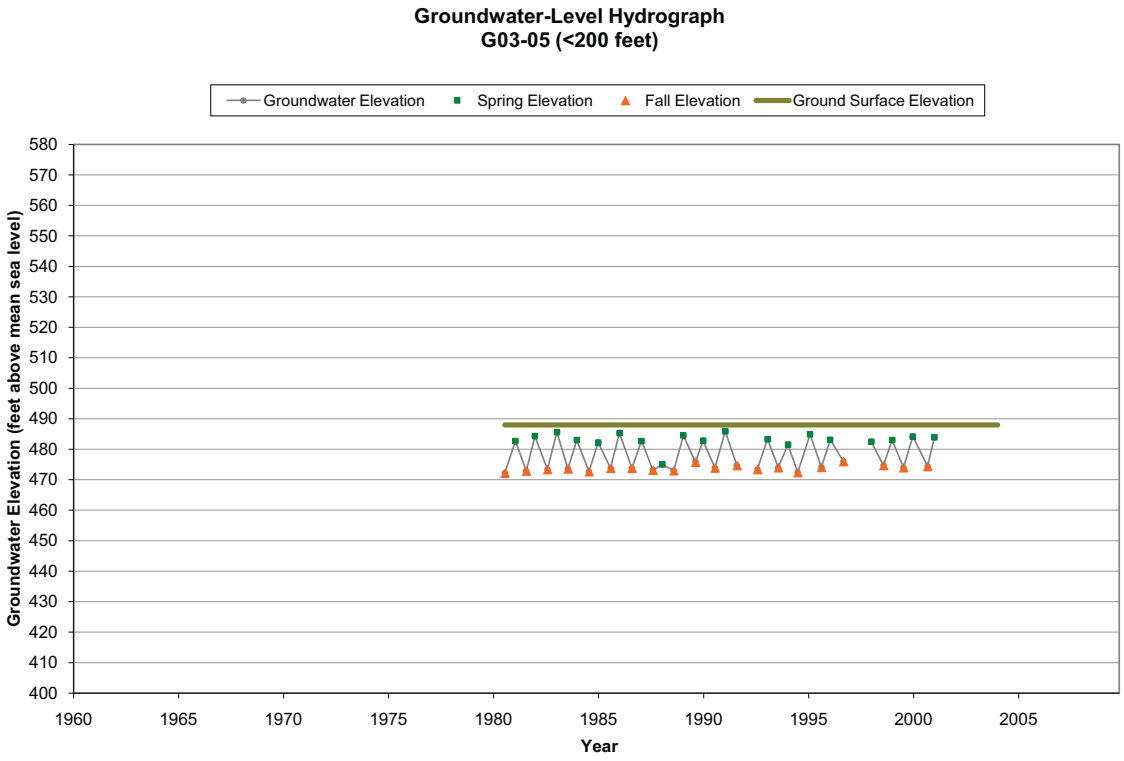
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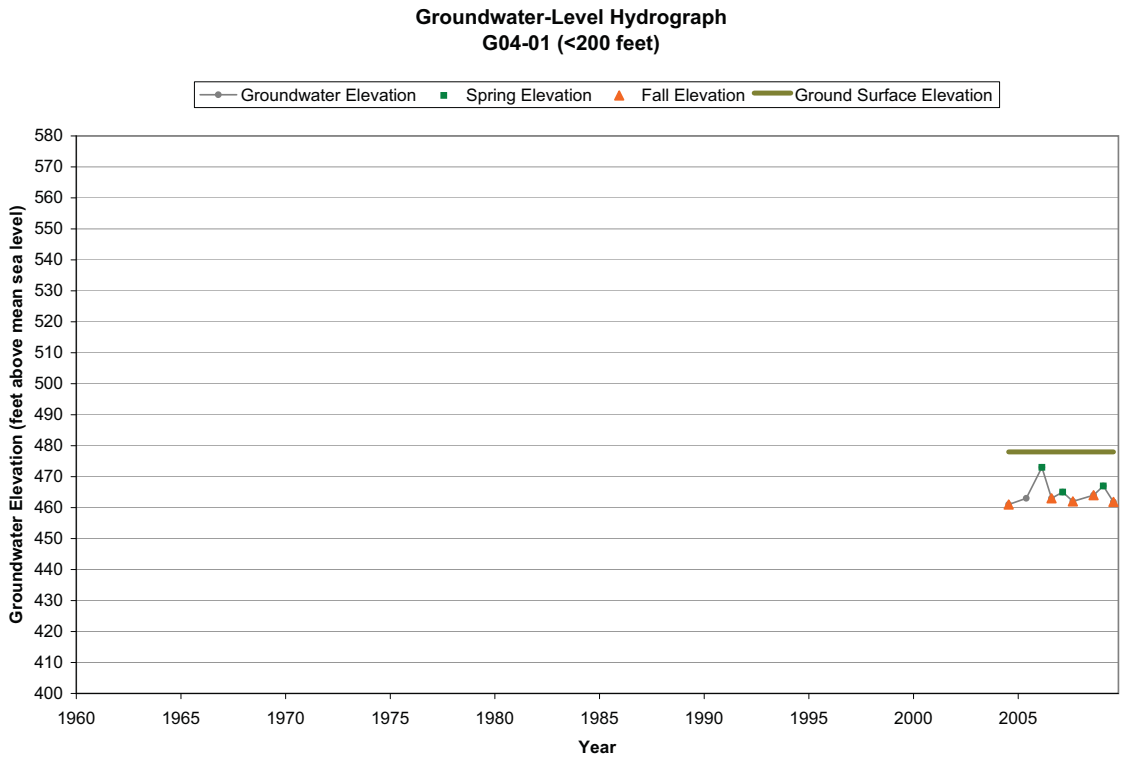
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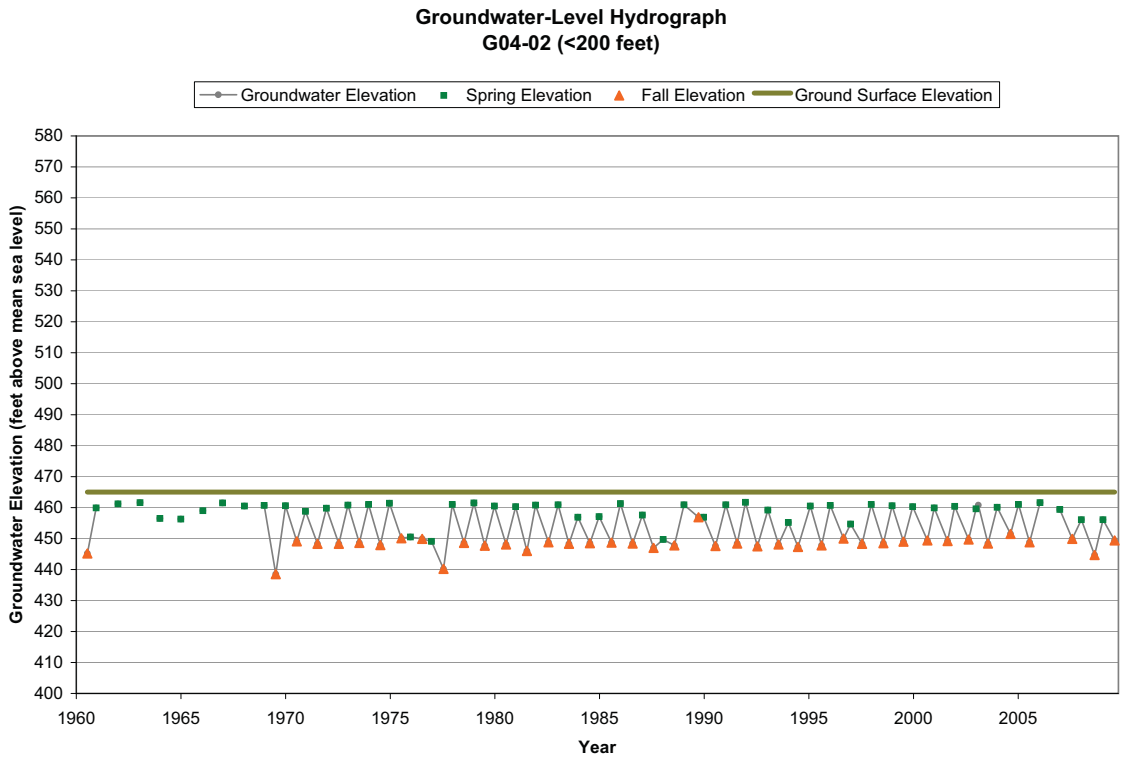
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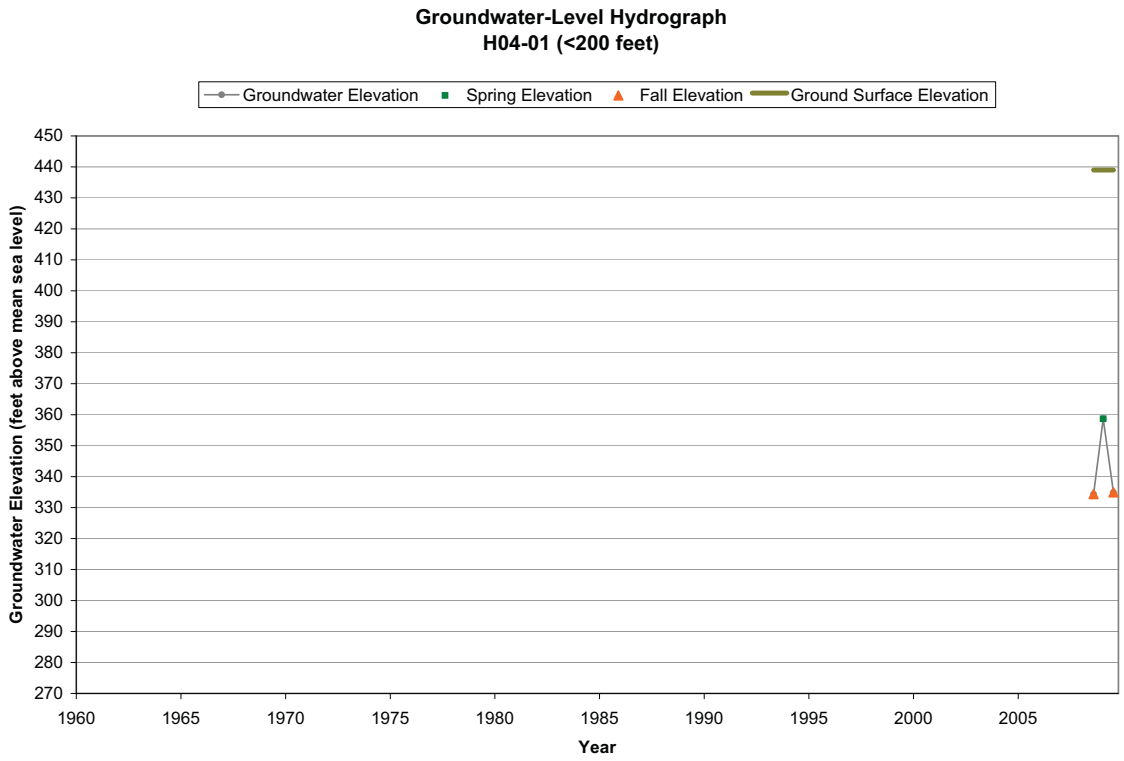
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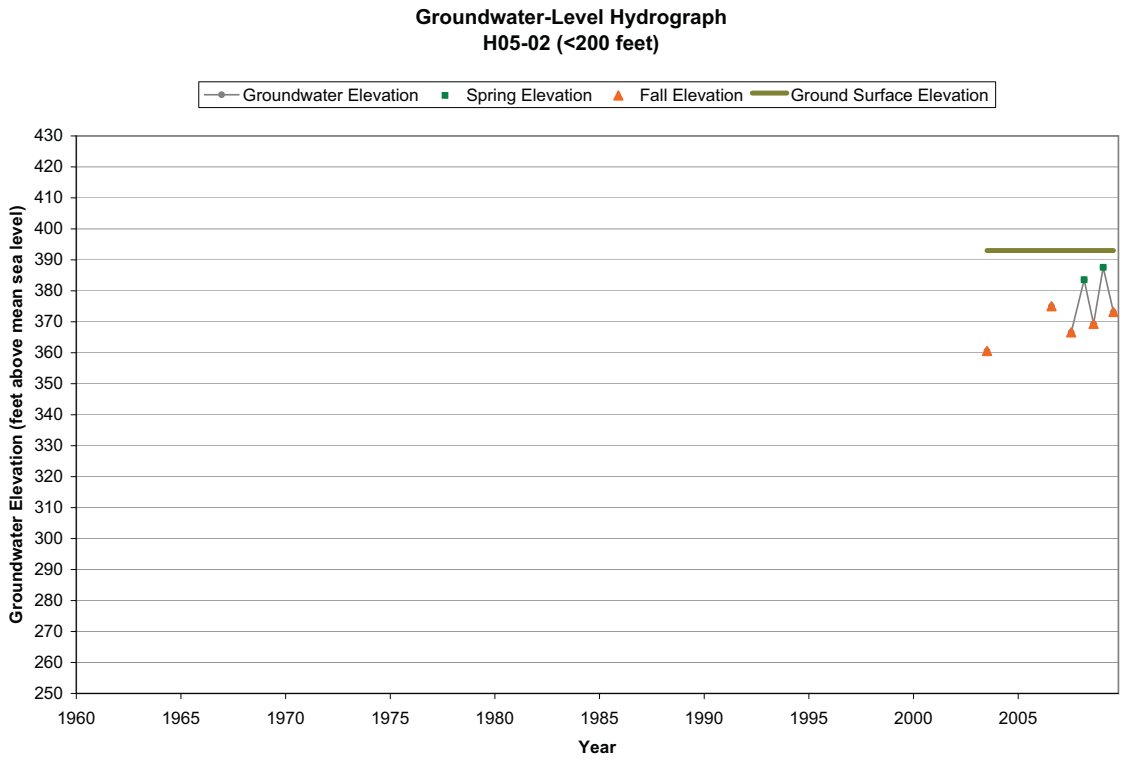
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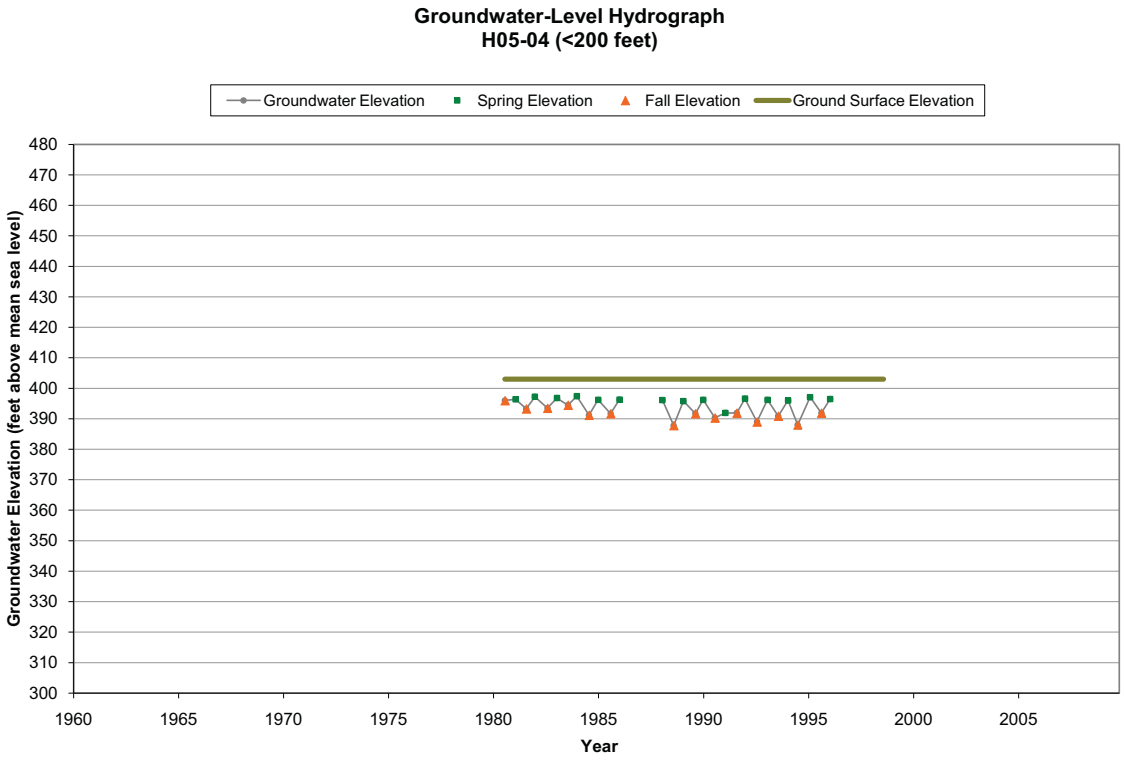
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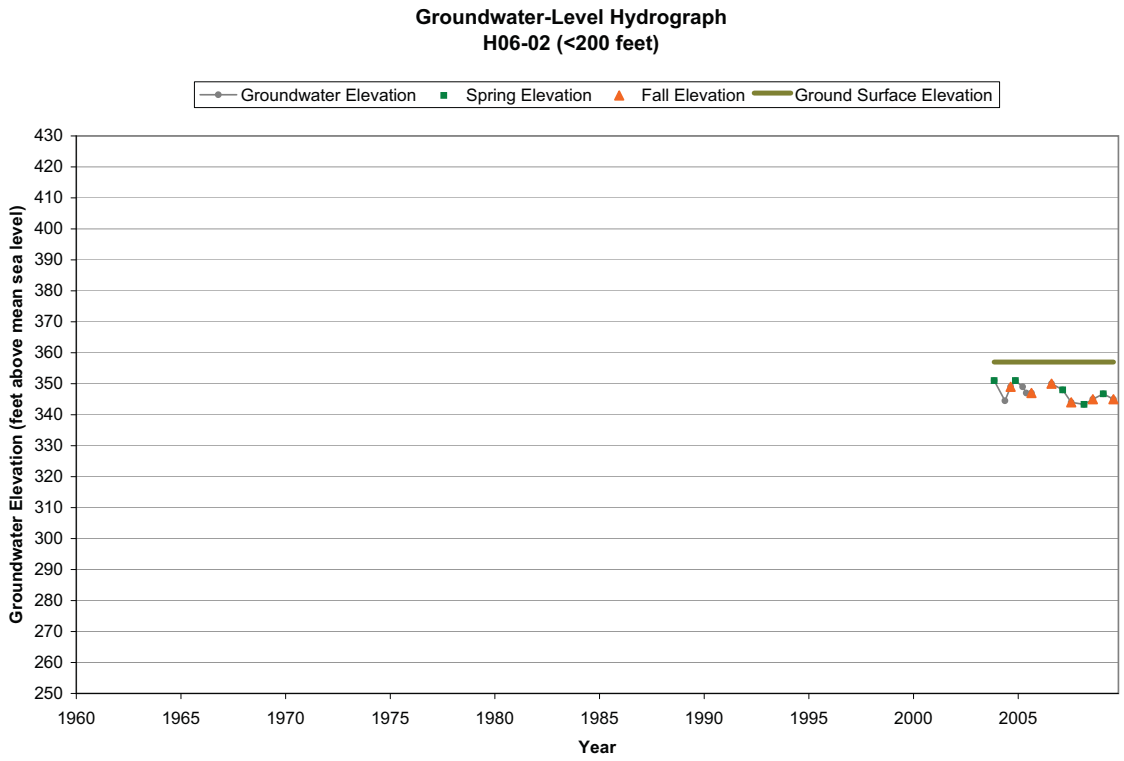
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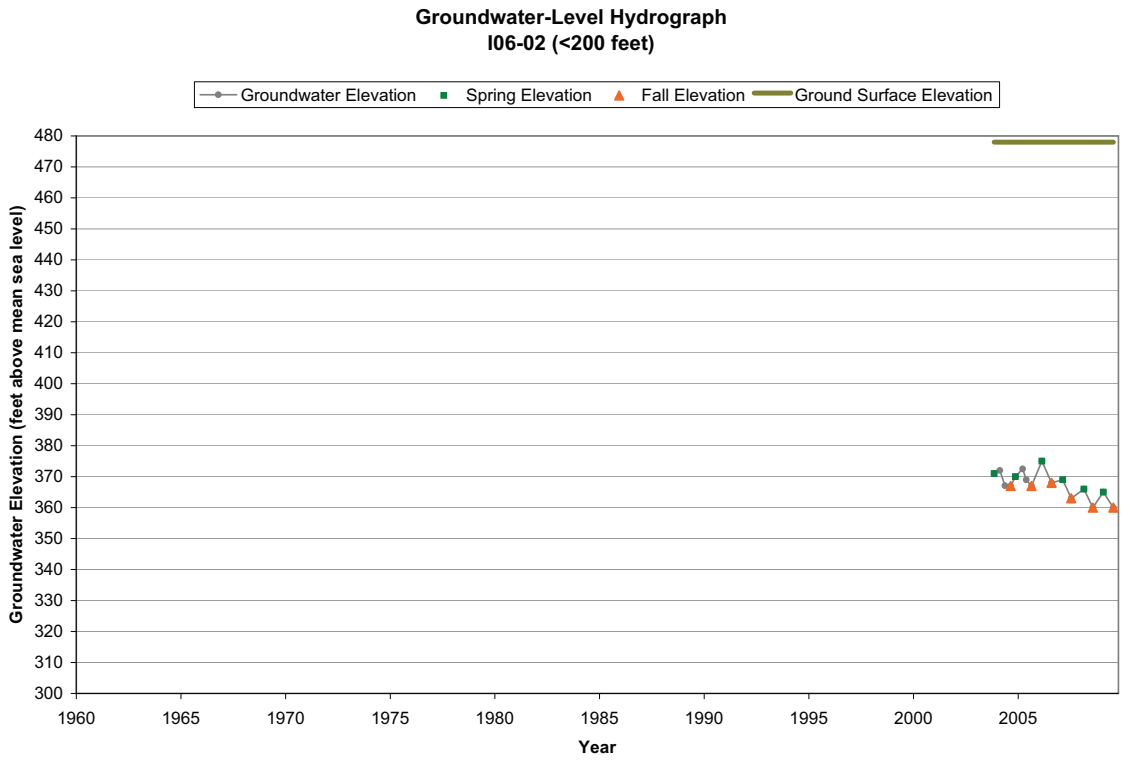
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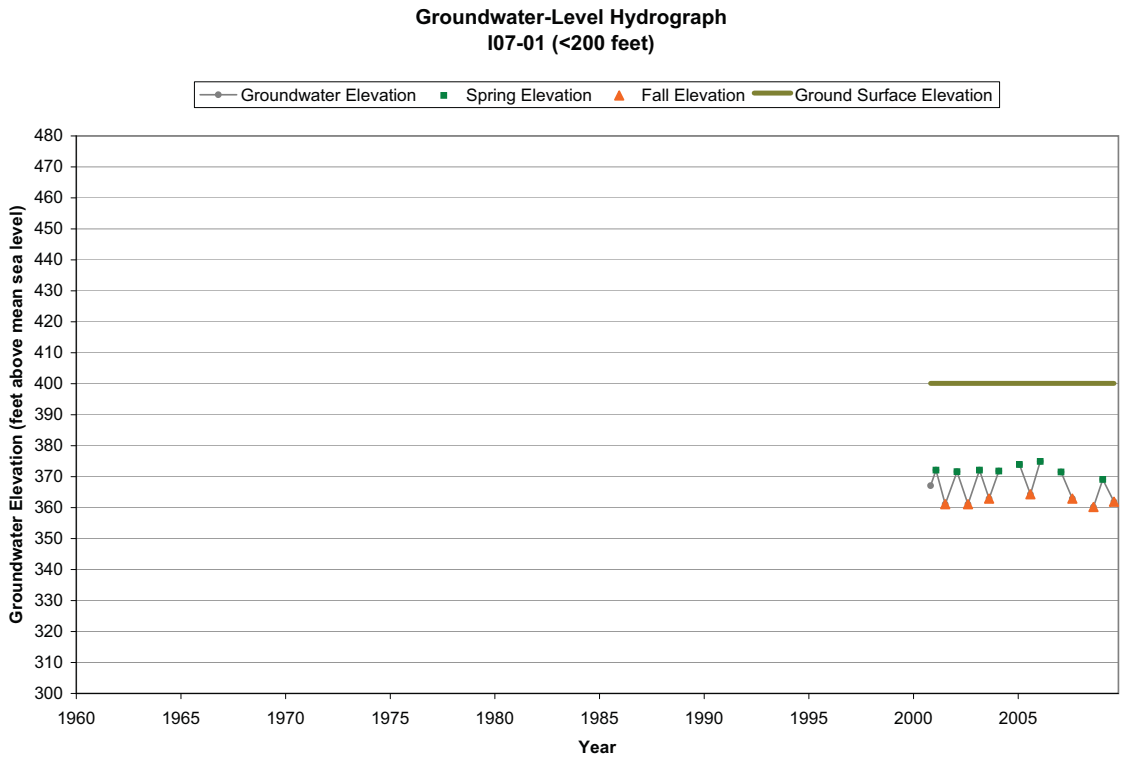
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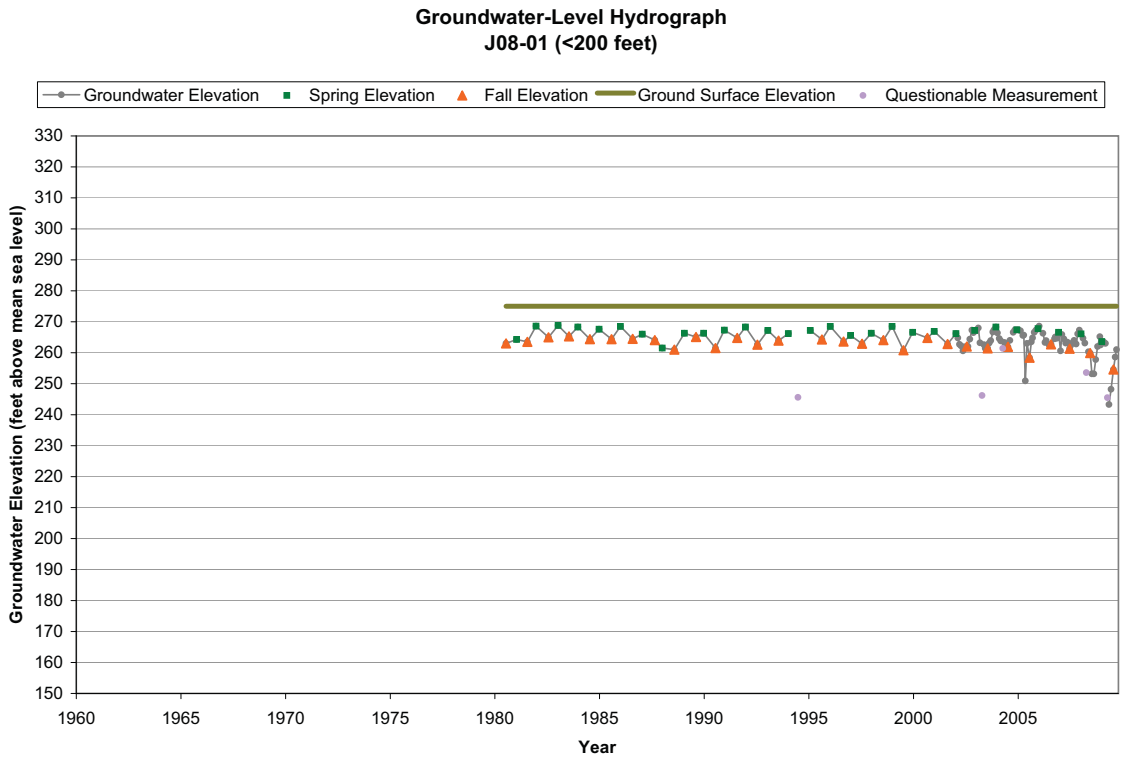
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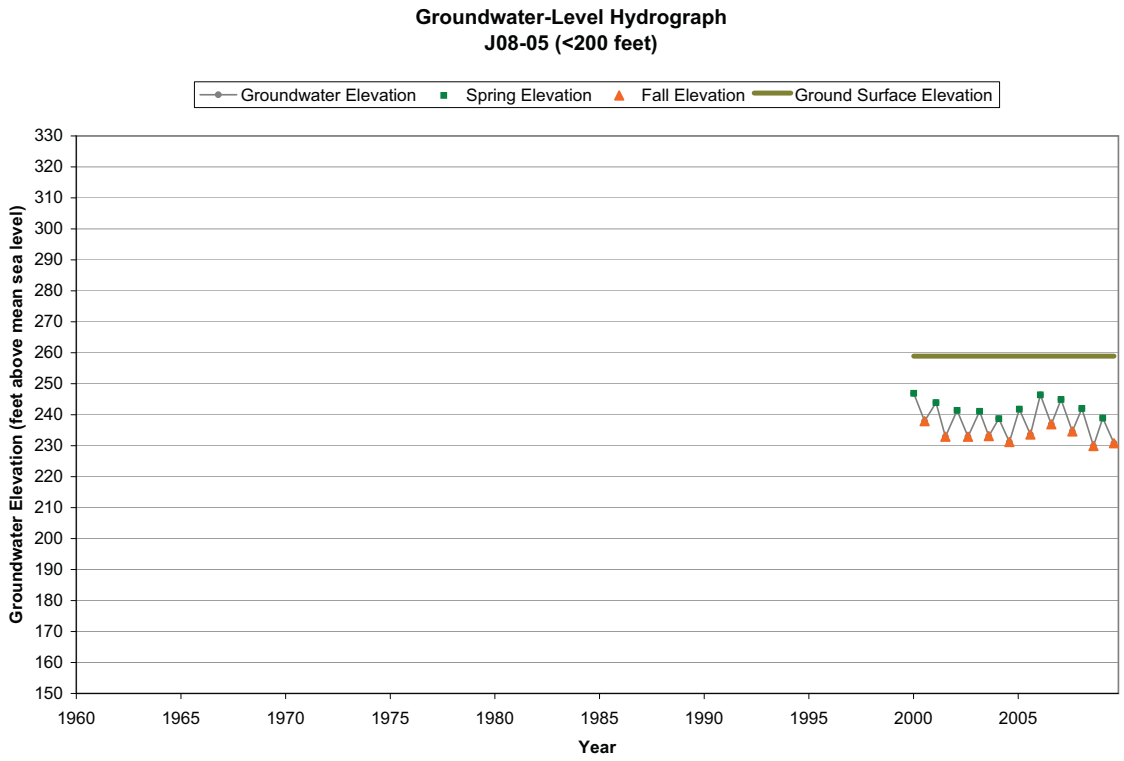
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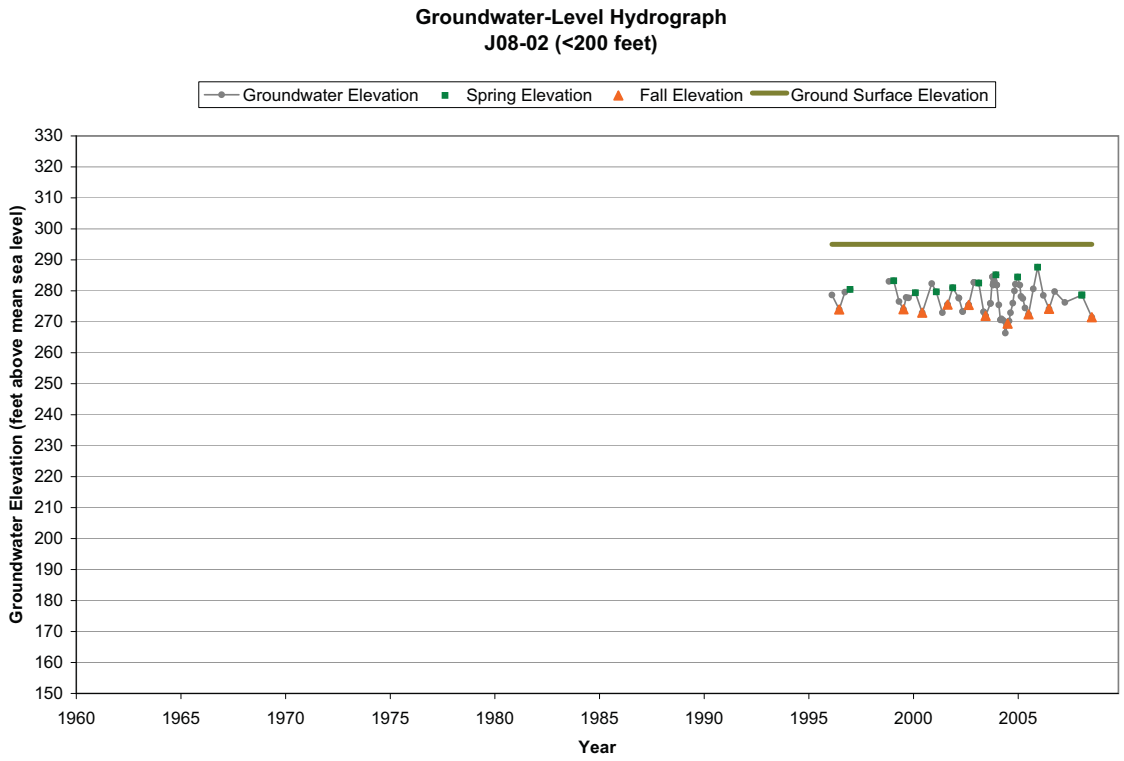
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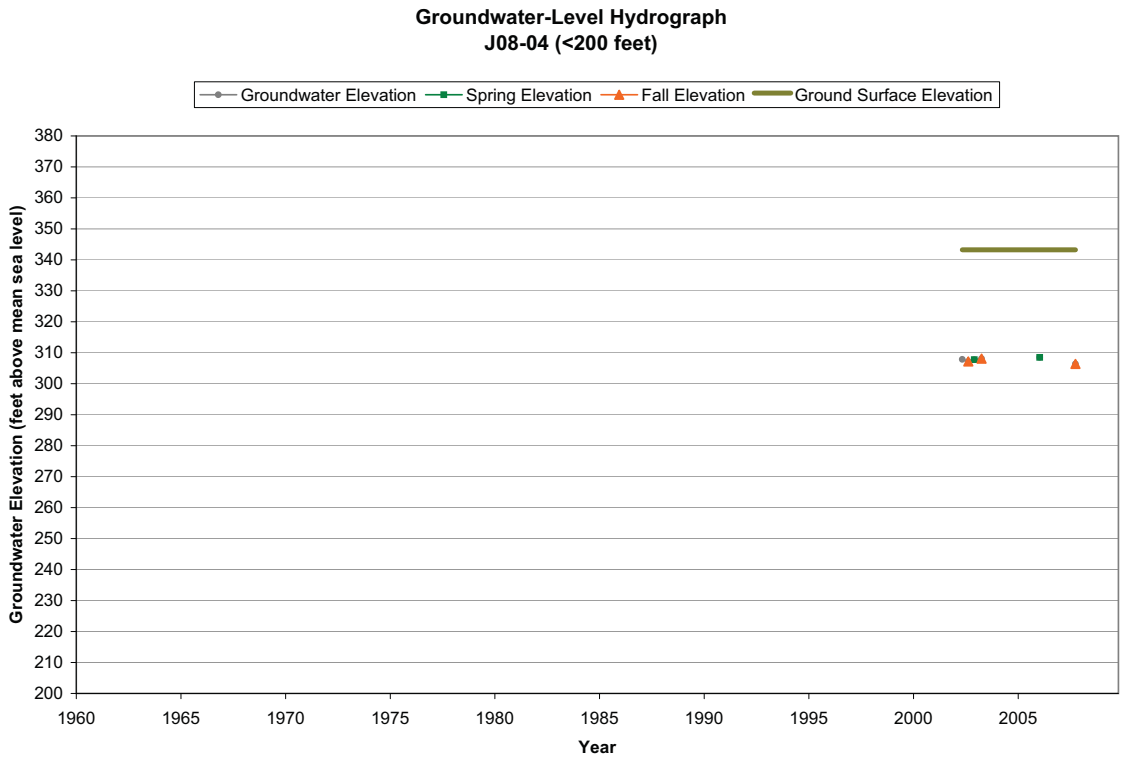
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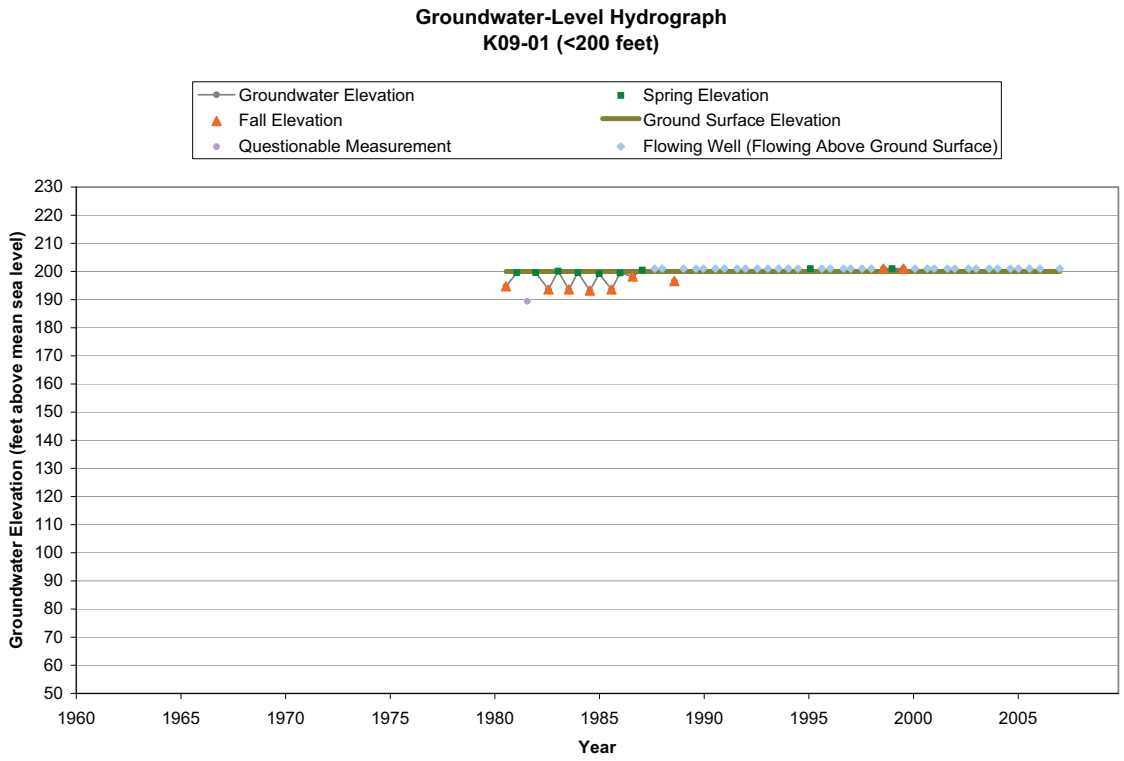
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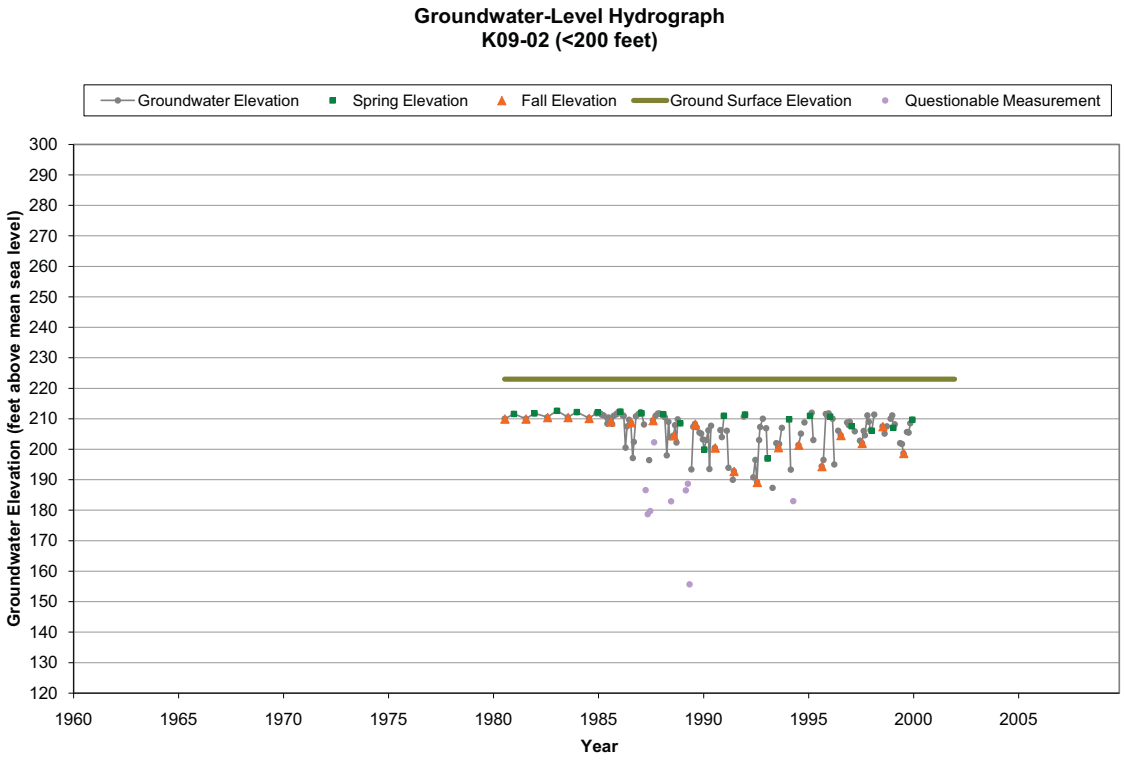
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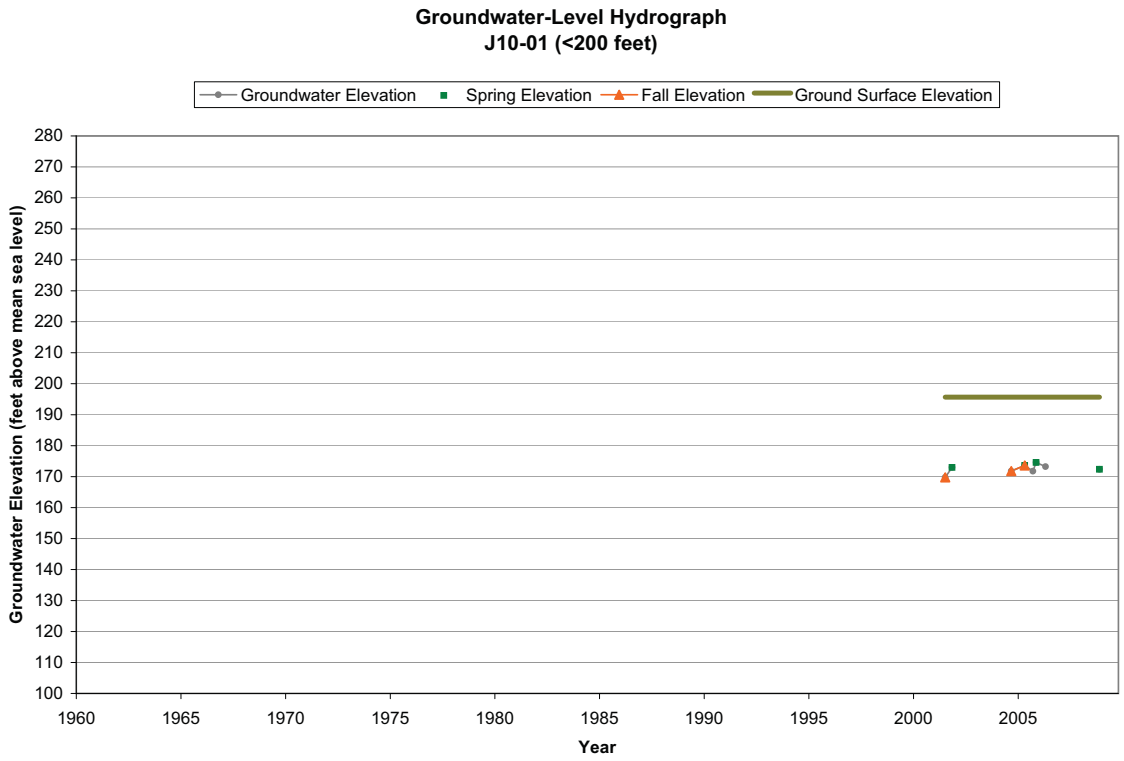
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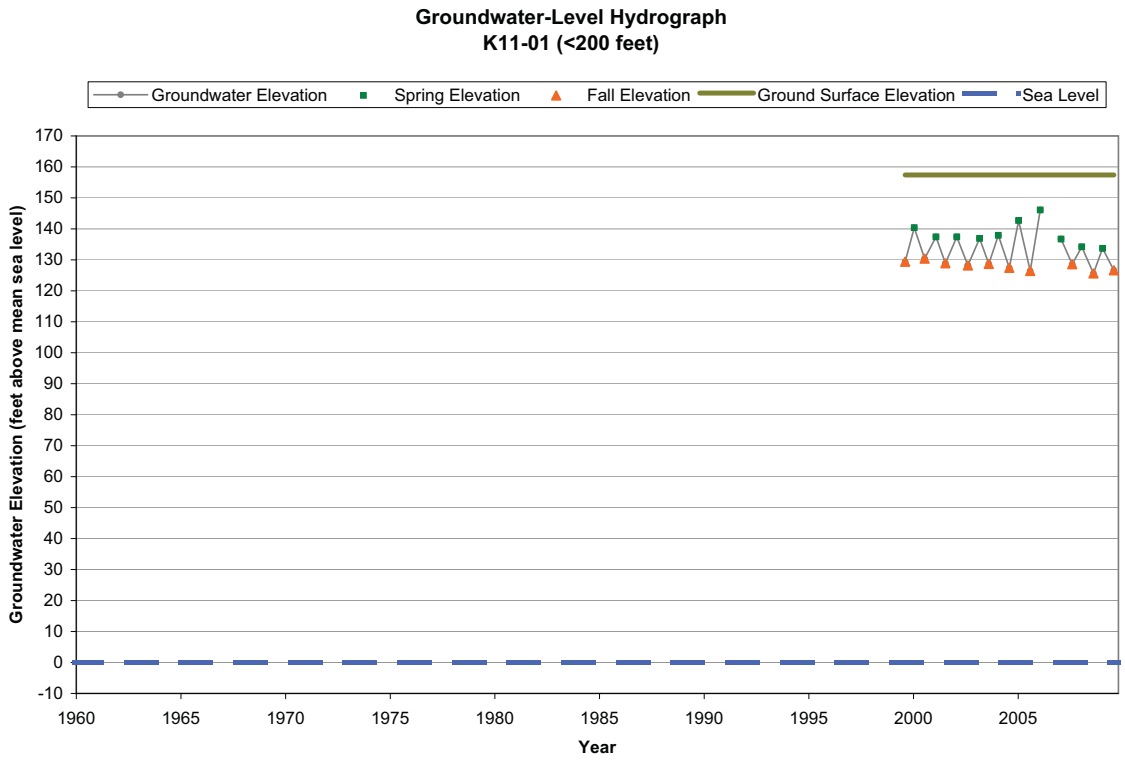
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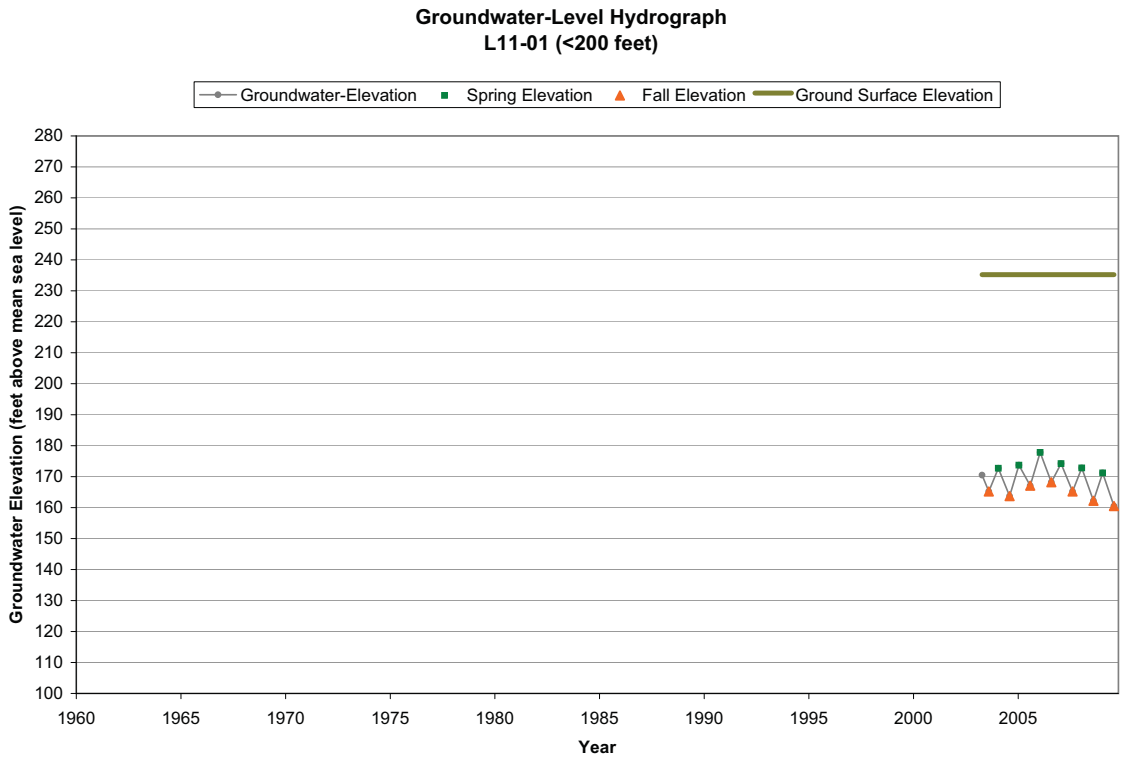
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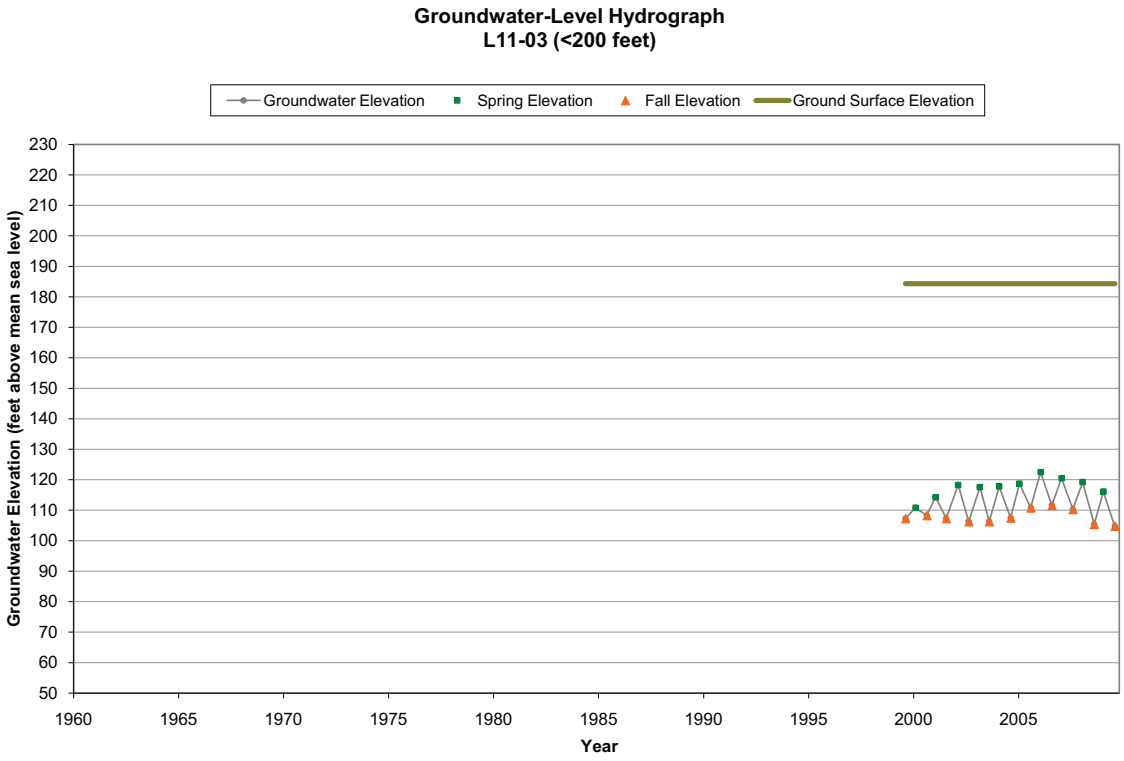
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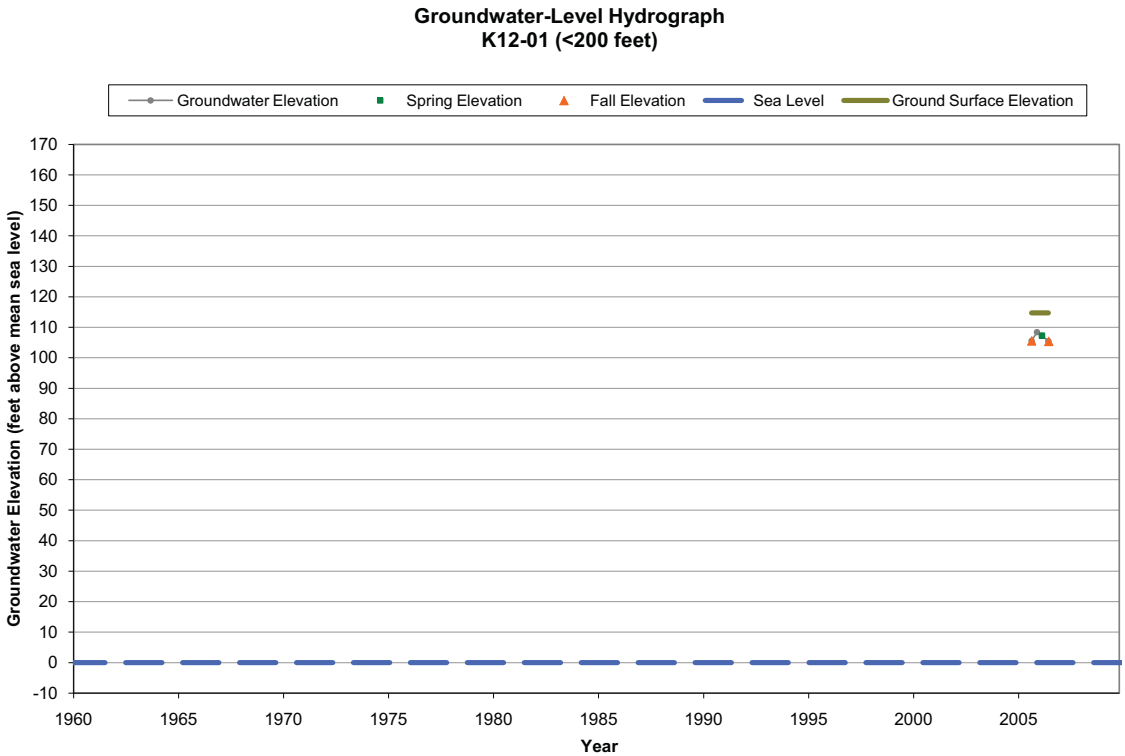
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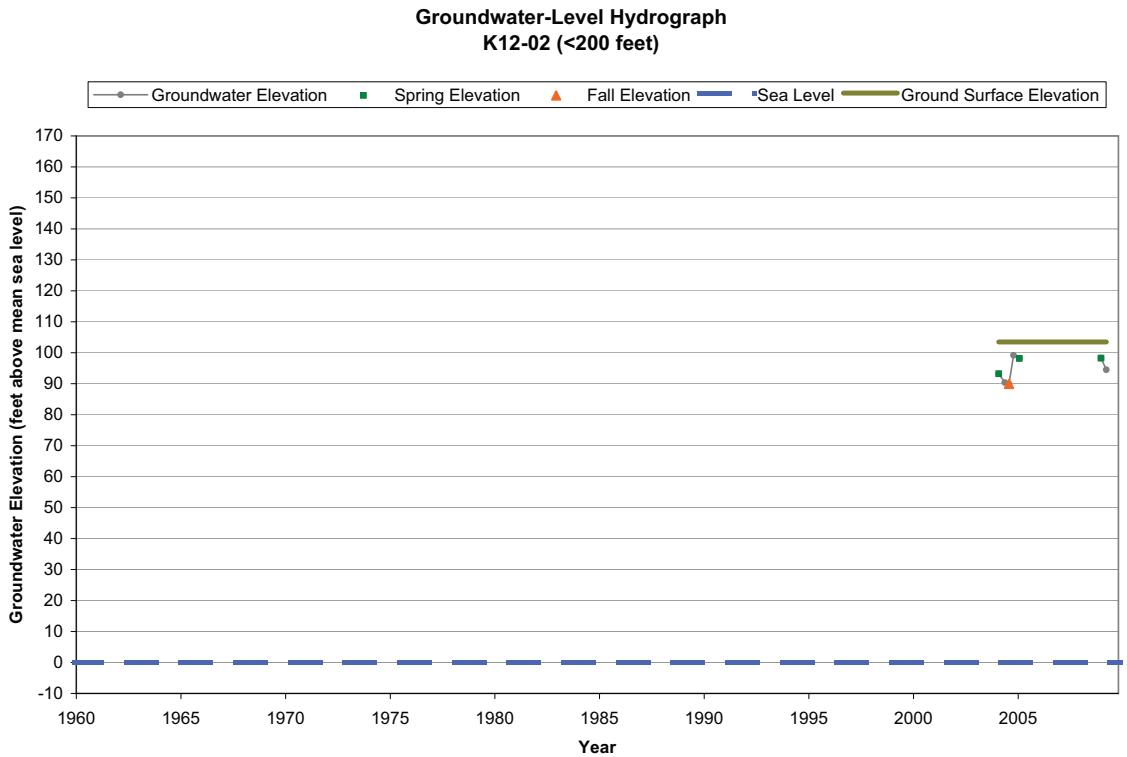
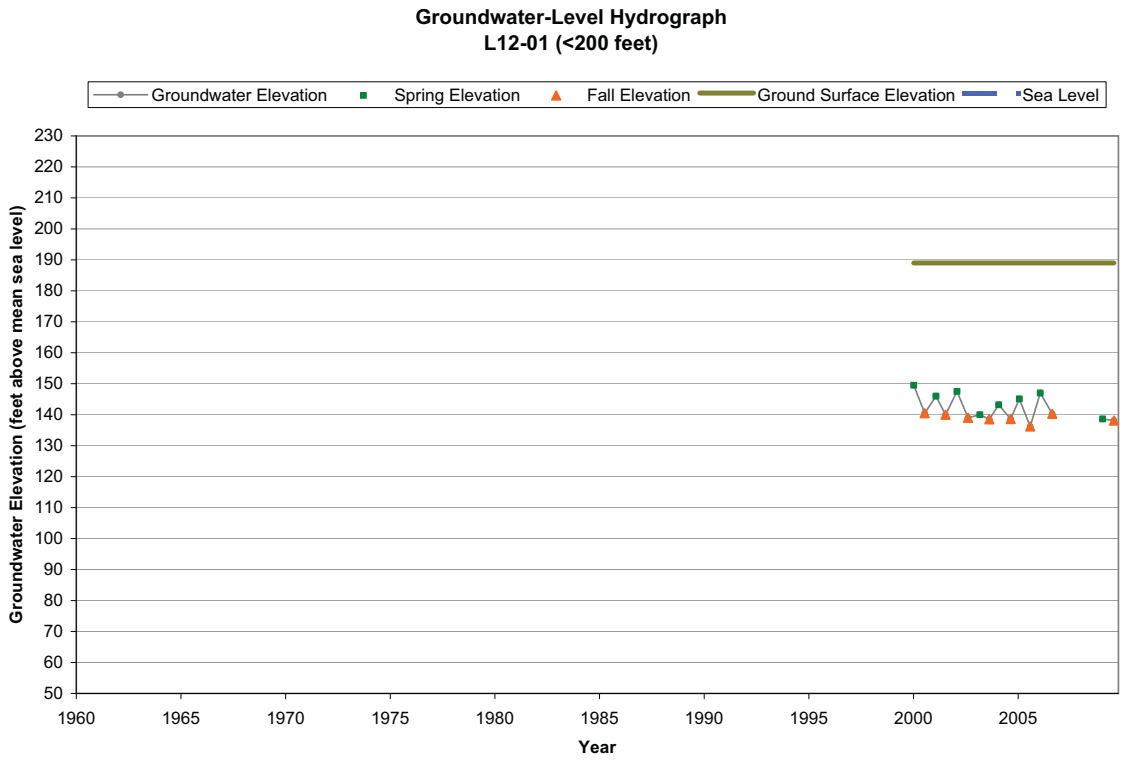
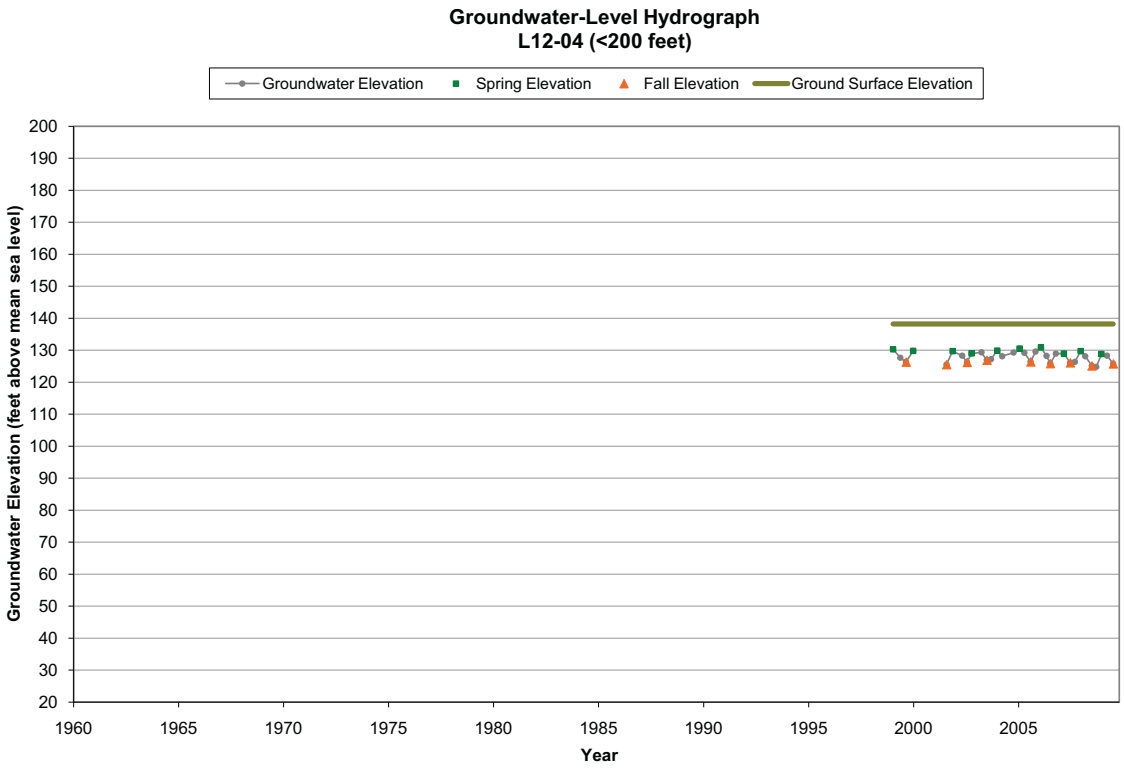
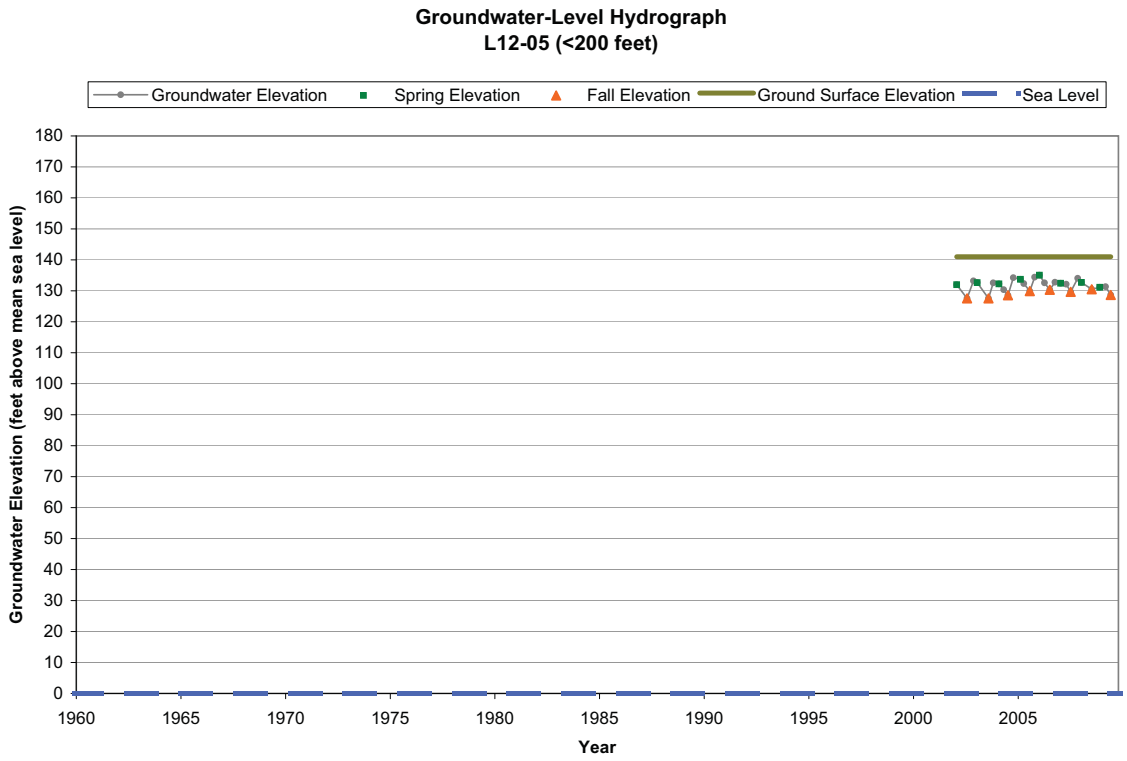
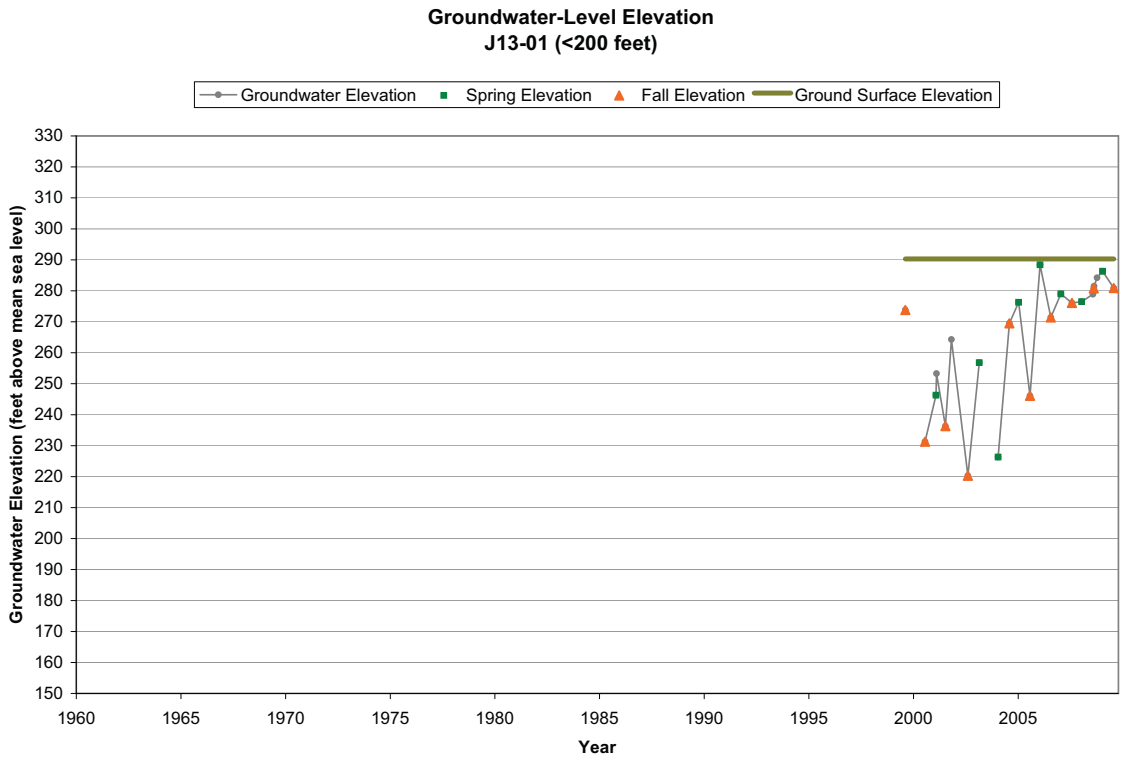
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

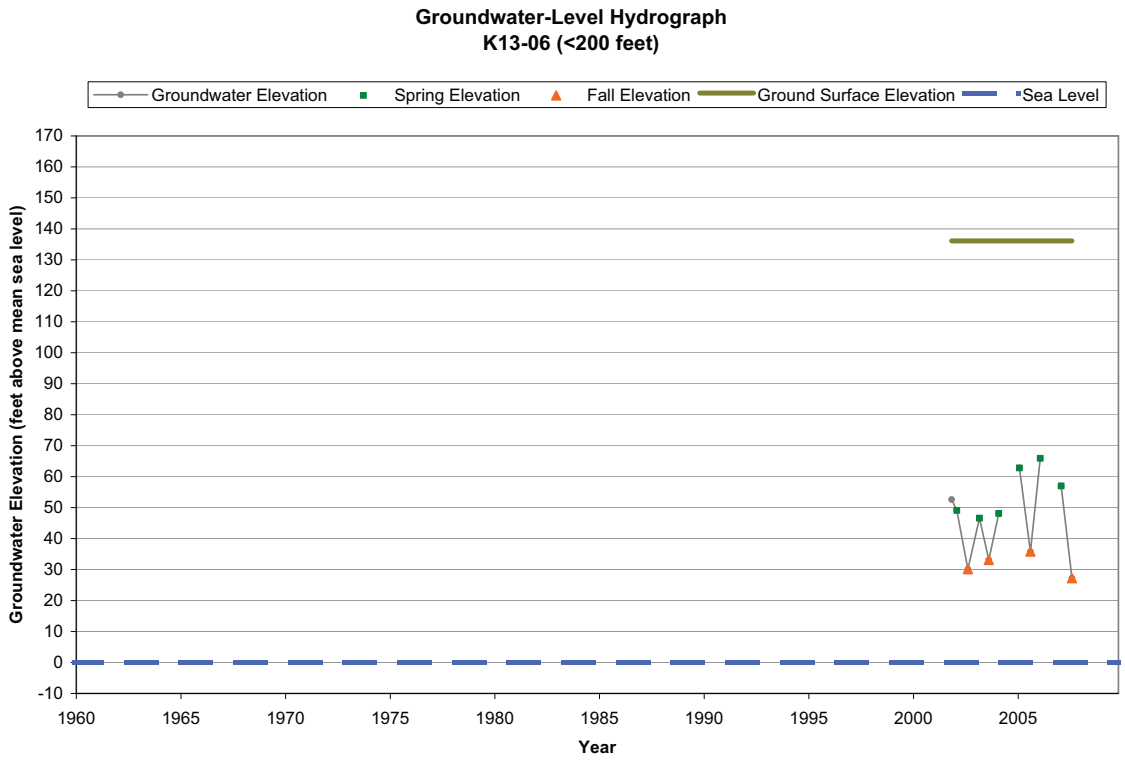

Groundwater-Level Hydrograph
K12-02 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

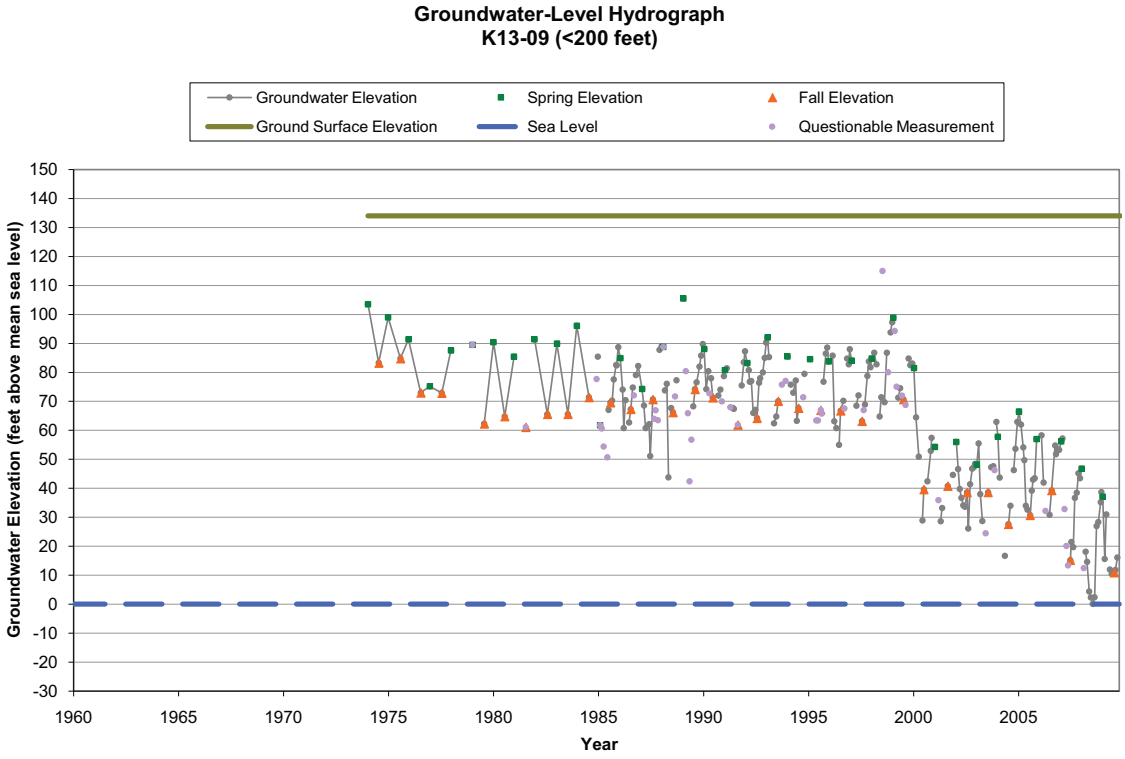

Groundwater-Level Hydrograph
L12-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

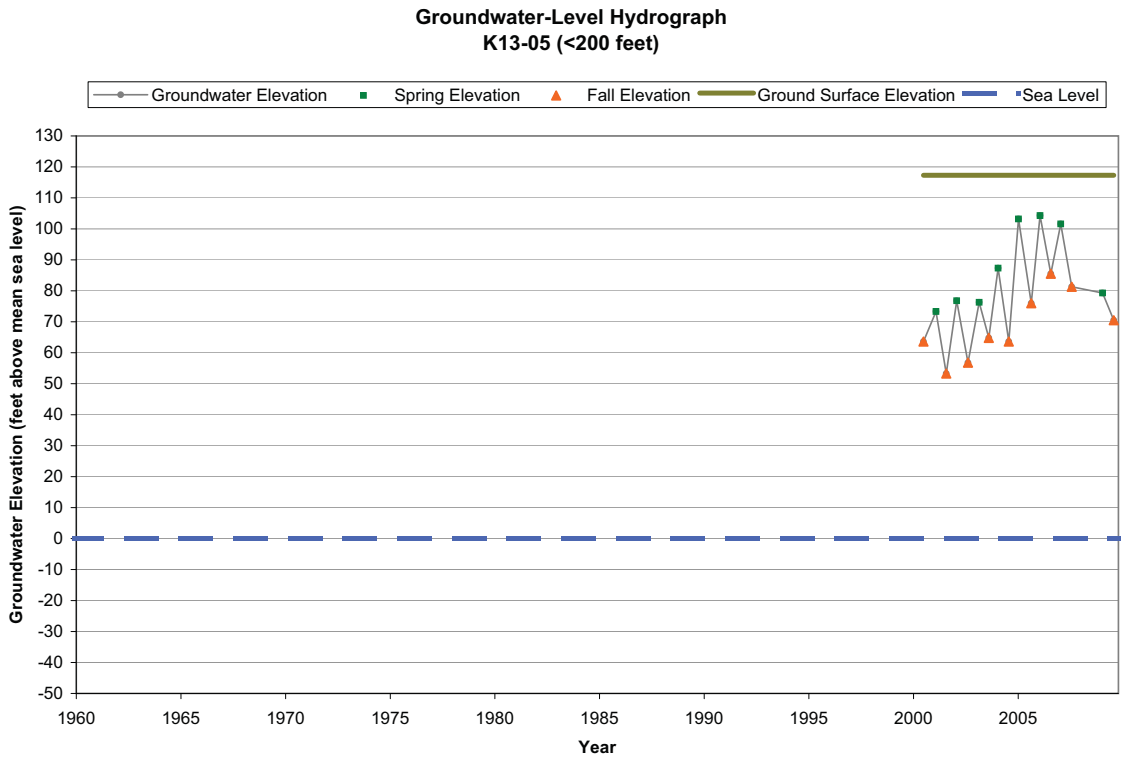

Groundwater-Level Hydrograph
L12-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

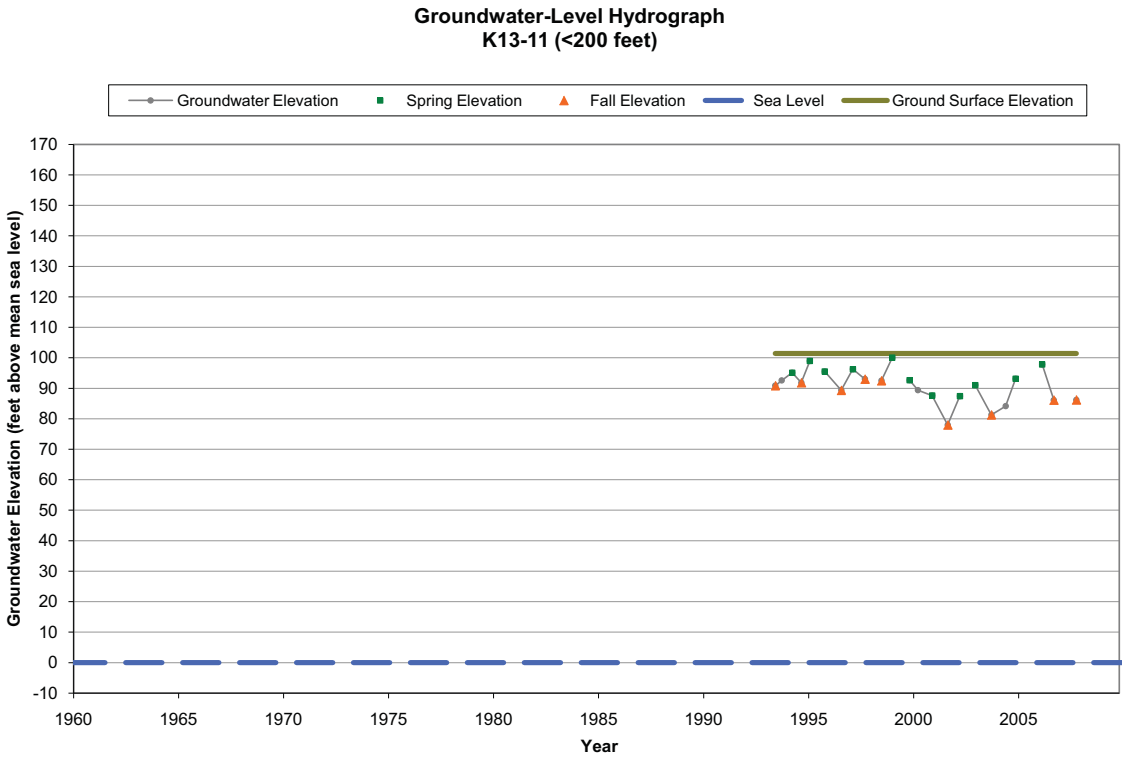

Groundwater-Level Hydrograph
L12-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

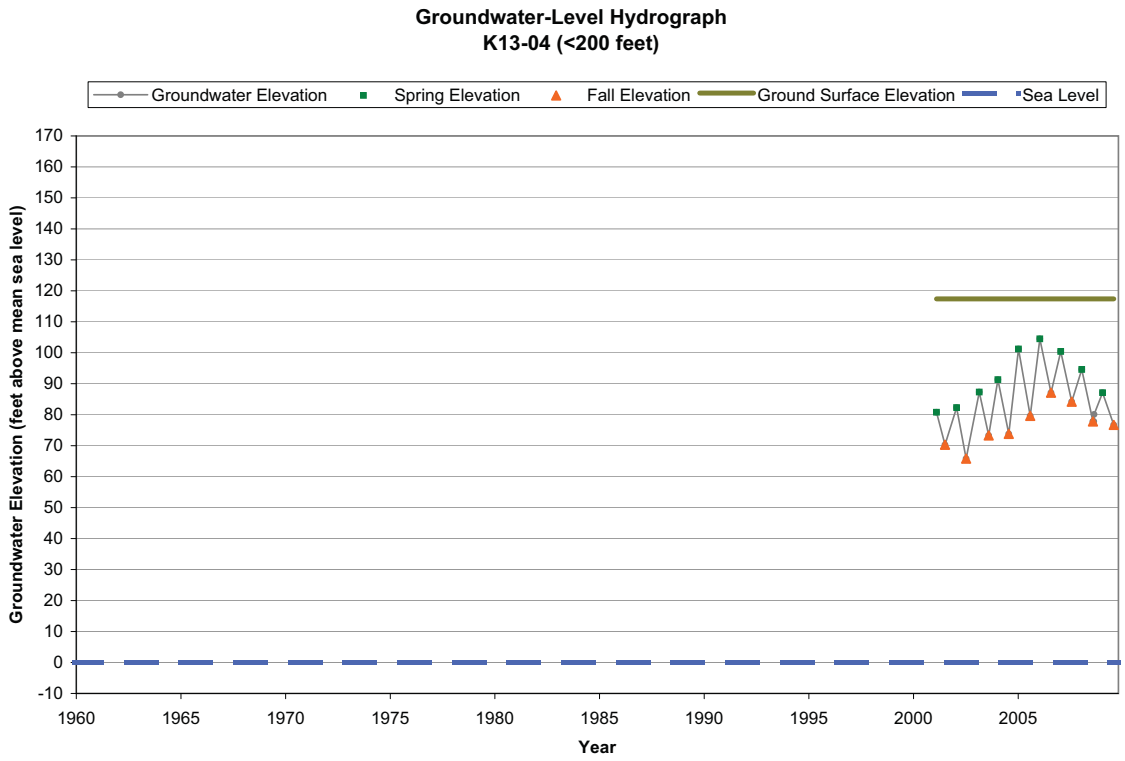

Groundwater-Level Elevation
J13-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

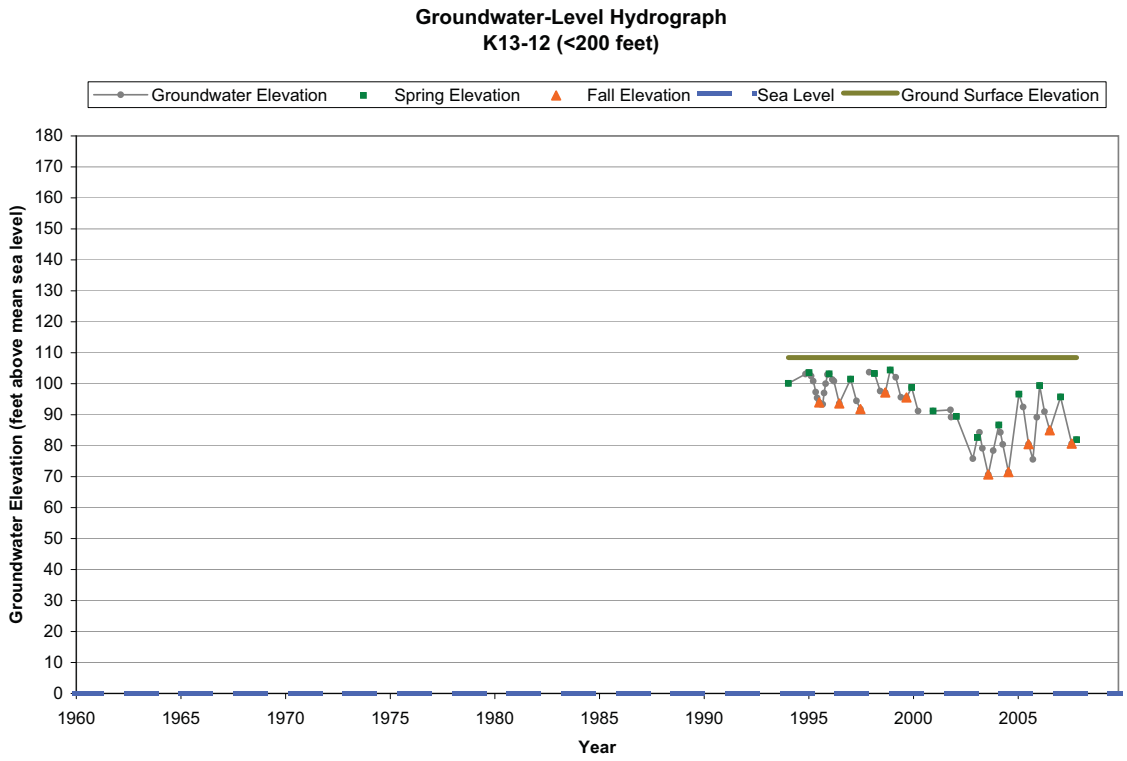

Groundwater-Level Hydrograph
K13-06 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year

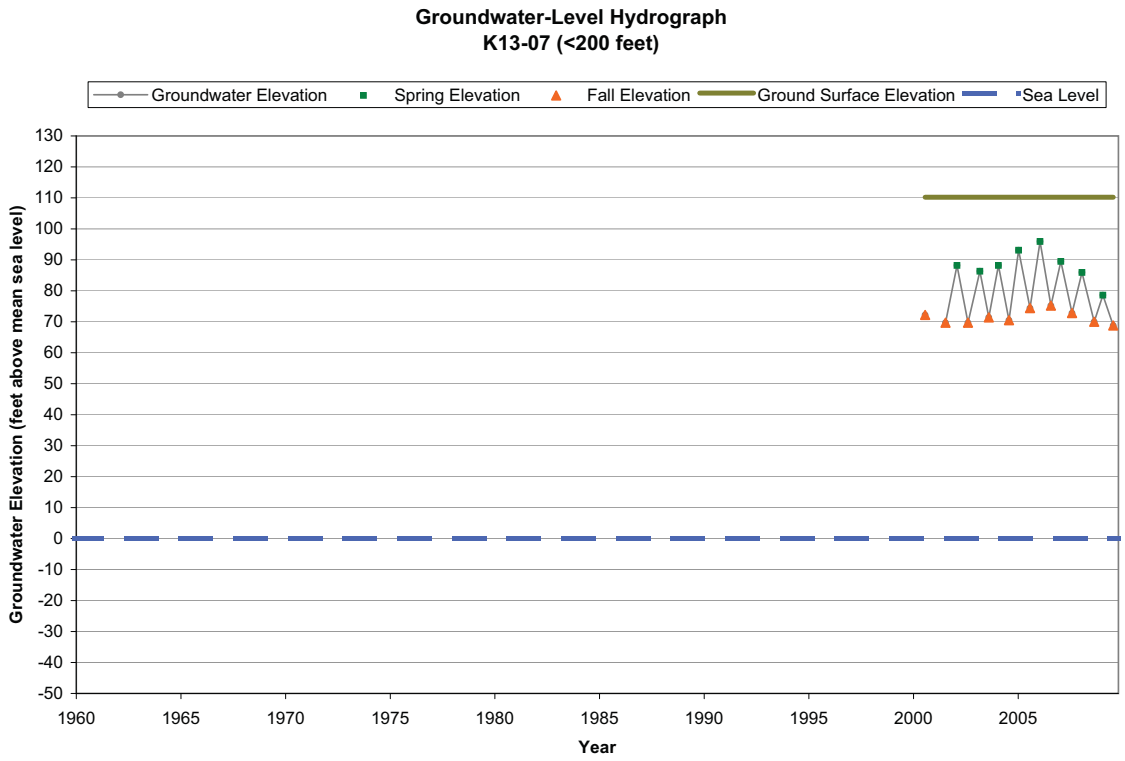

Groundwater-Level Hydrograph
K13-09 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Questionable Measurement
Groundwater Elevation (feet above mean sea level)
Year

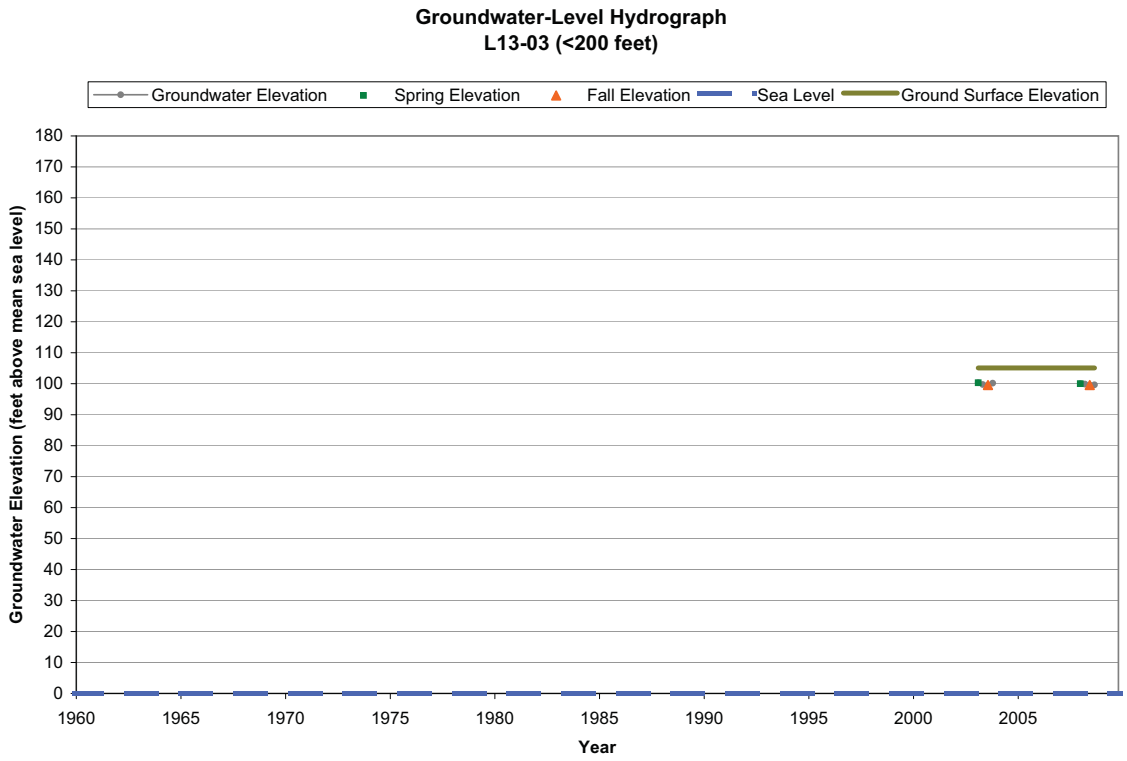

Groundwater-Level Hydrograph
K13-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

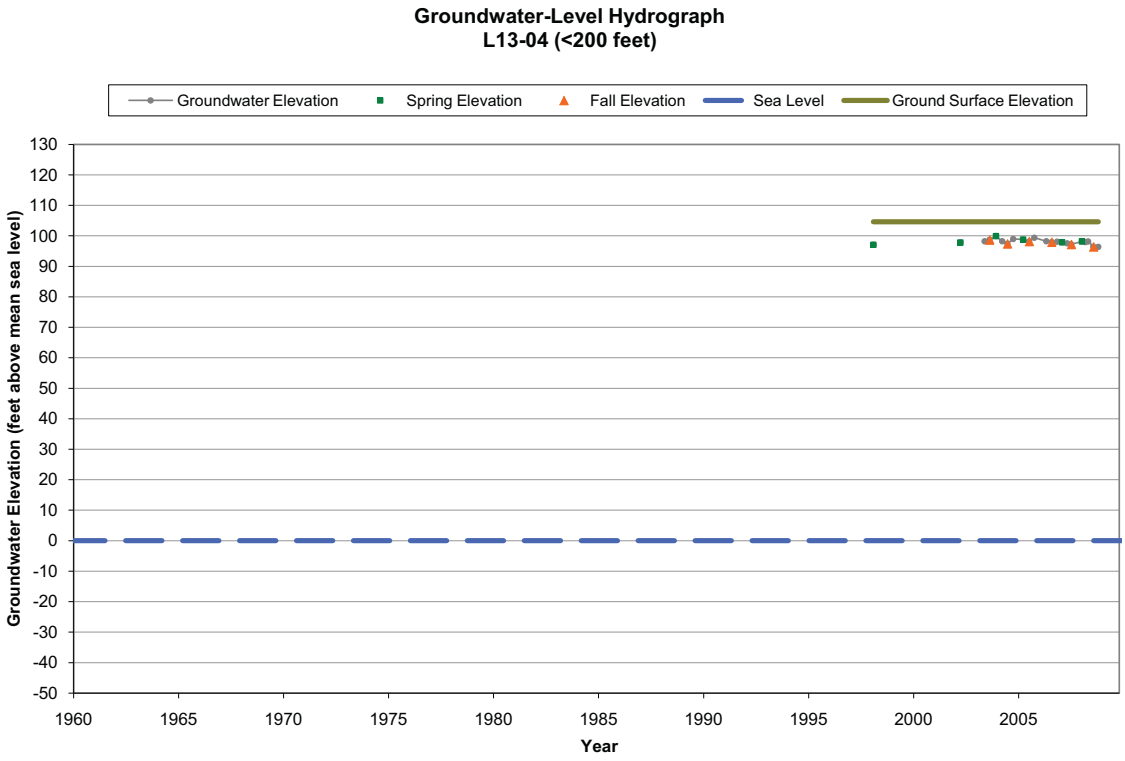

Groundwater-Level Hydrograph
K13-11 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

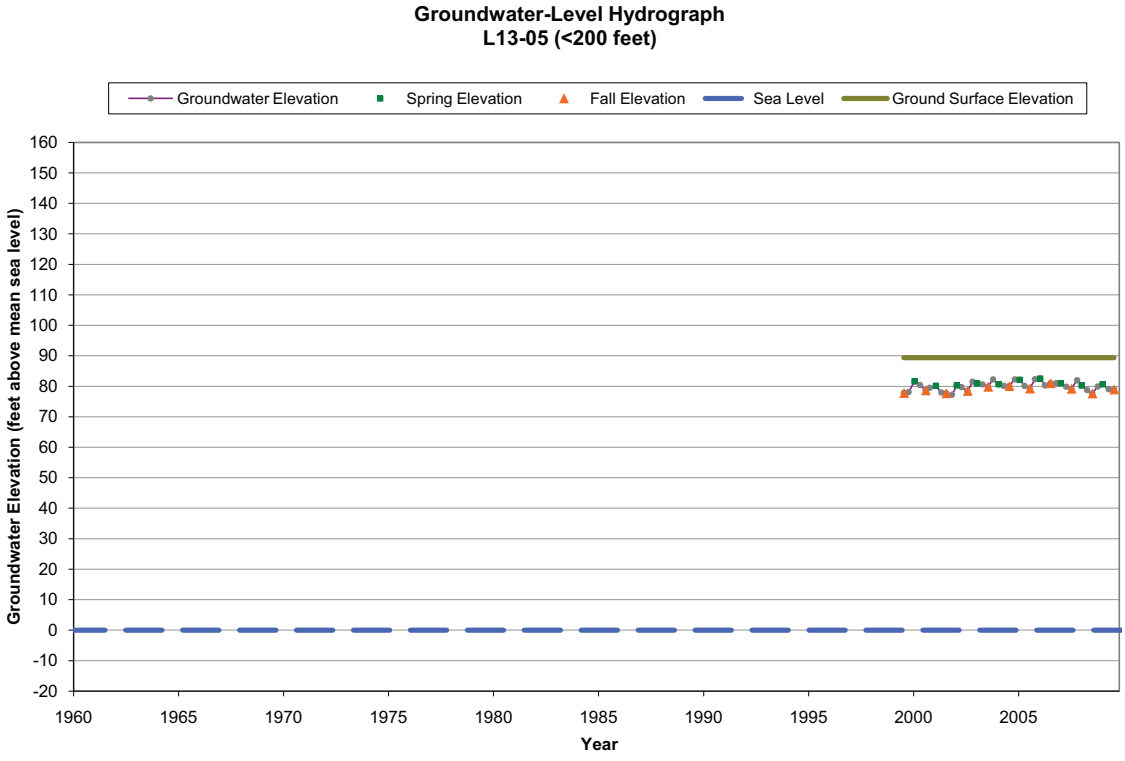

Groundwater-Level Hydrograph
K13-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year

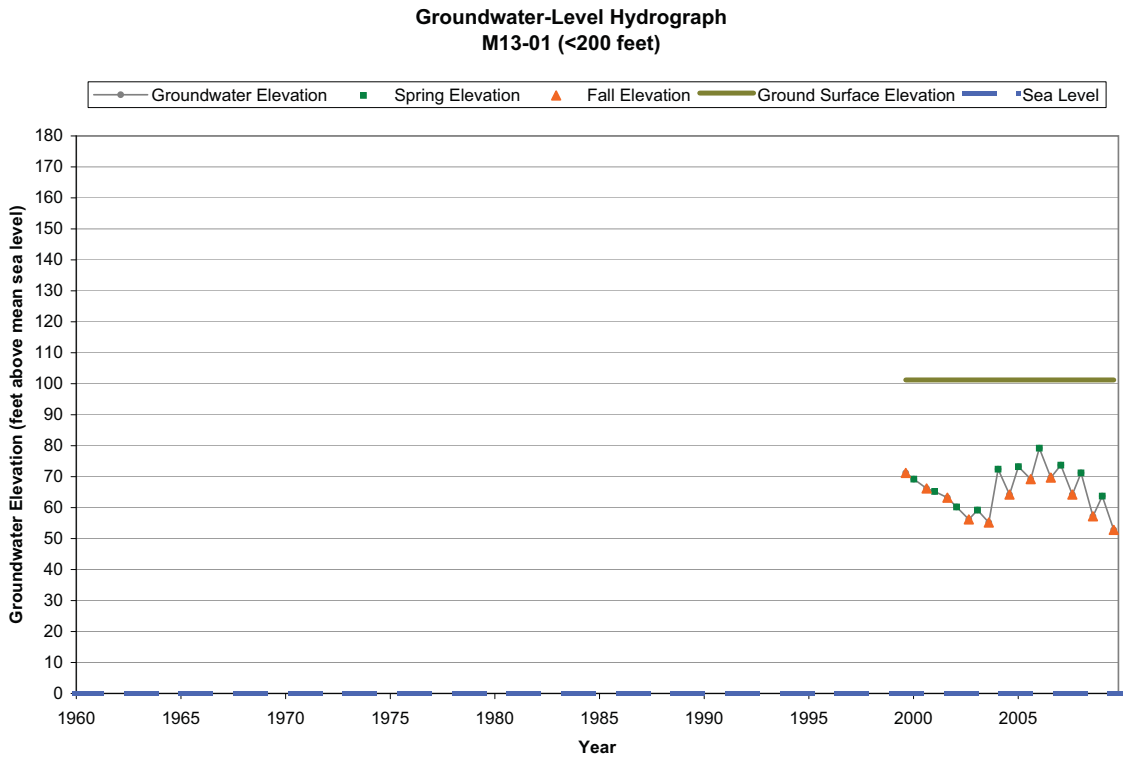

Groundwater-Level Hydrograph
K13-12 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
Year

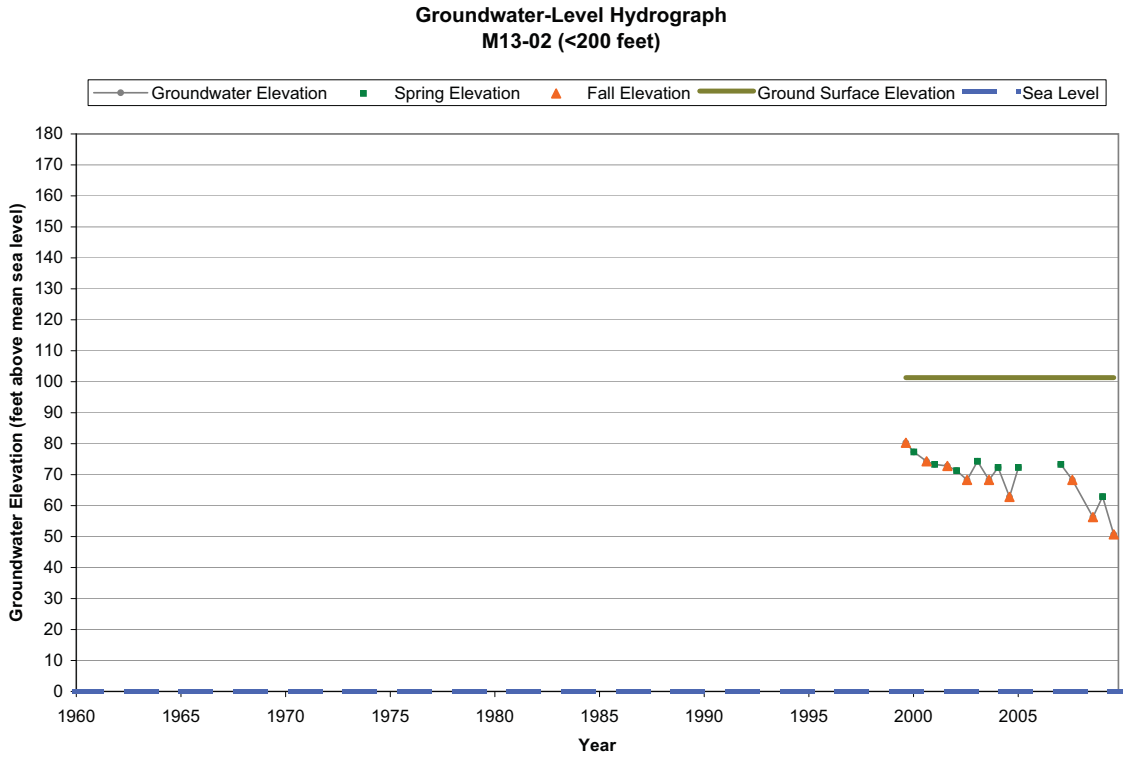

Groundwater-Level Hydrograph
K13-07 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

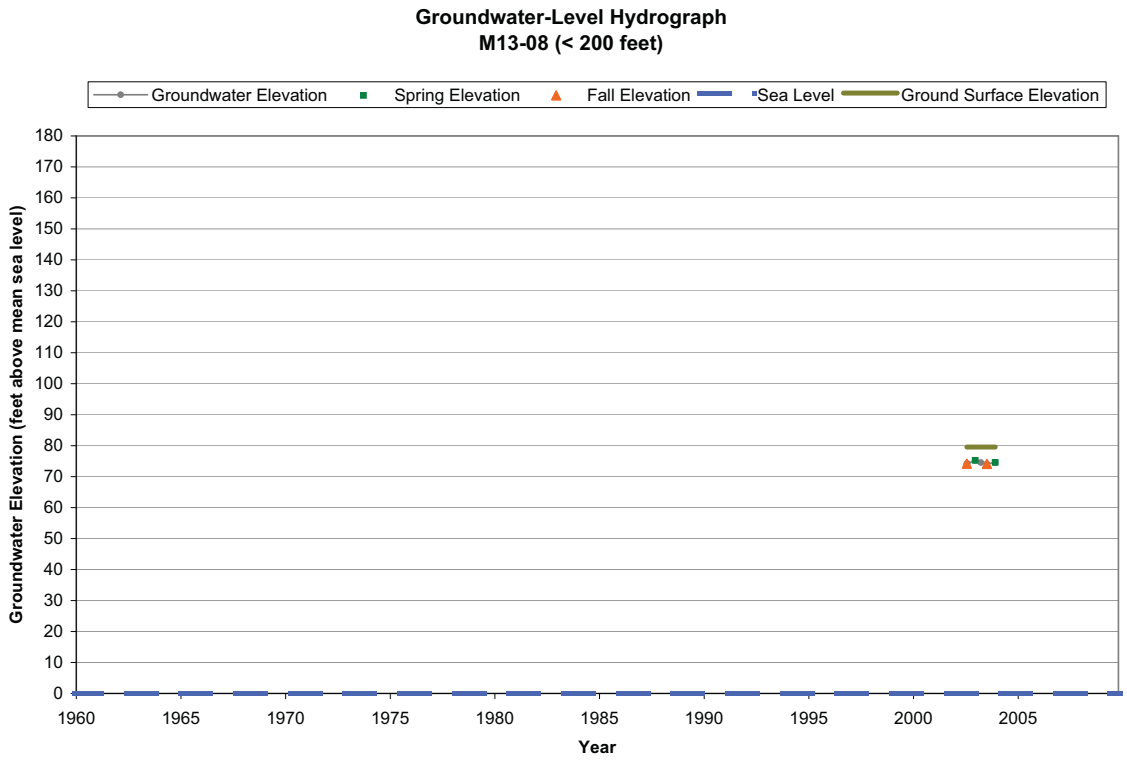

Groundwater-Level Hydrograph
L13-03 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

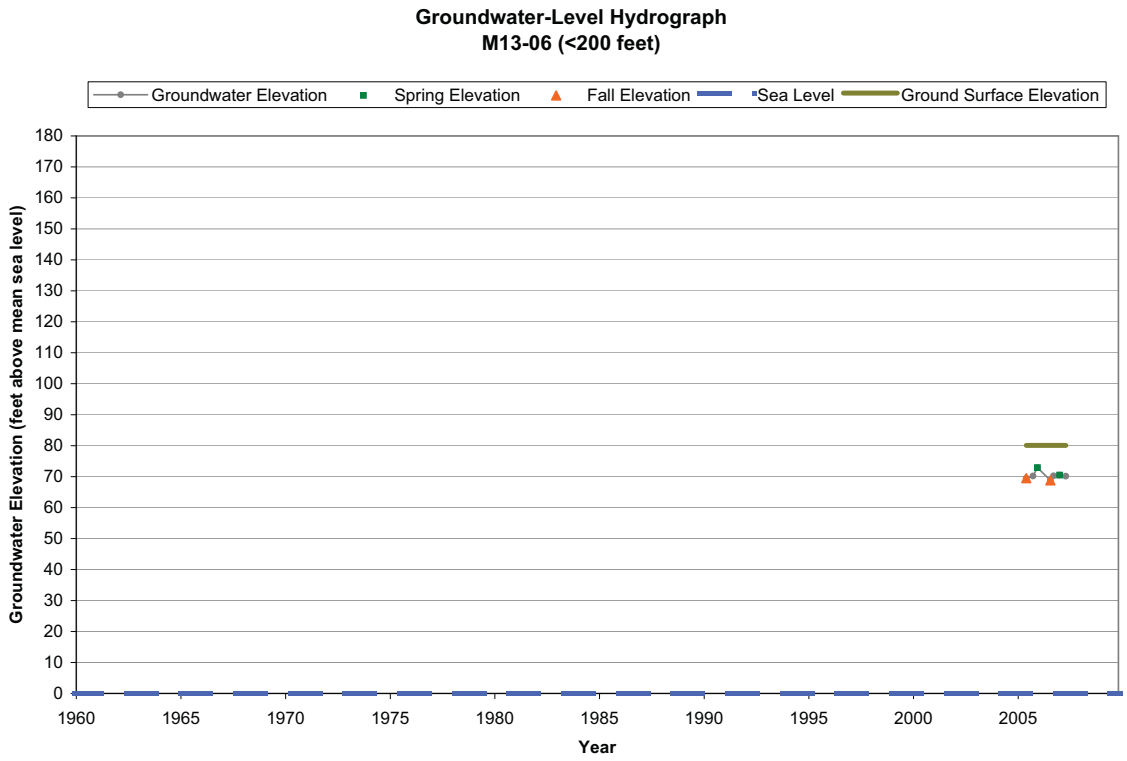

Groundwater-Level Hydrograph
L13-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

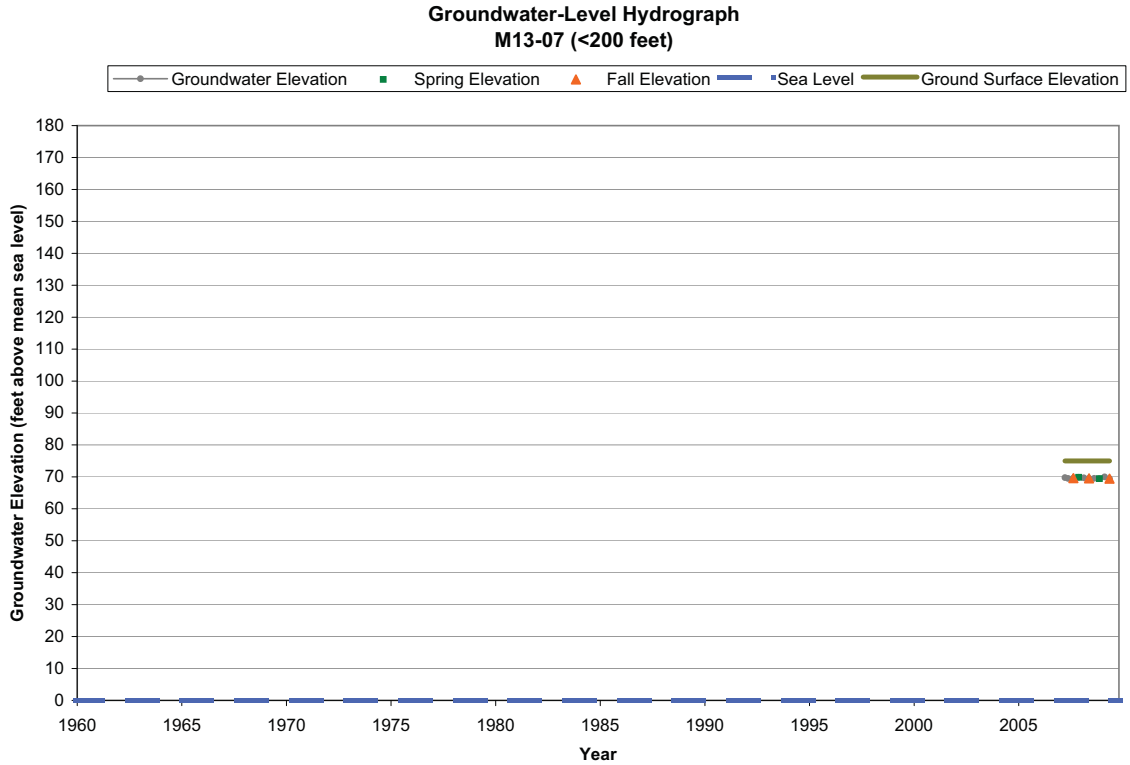

Groundwater-Level Hydrograph
L13-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

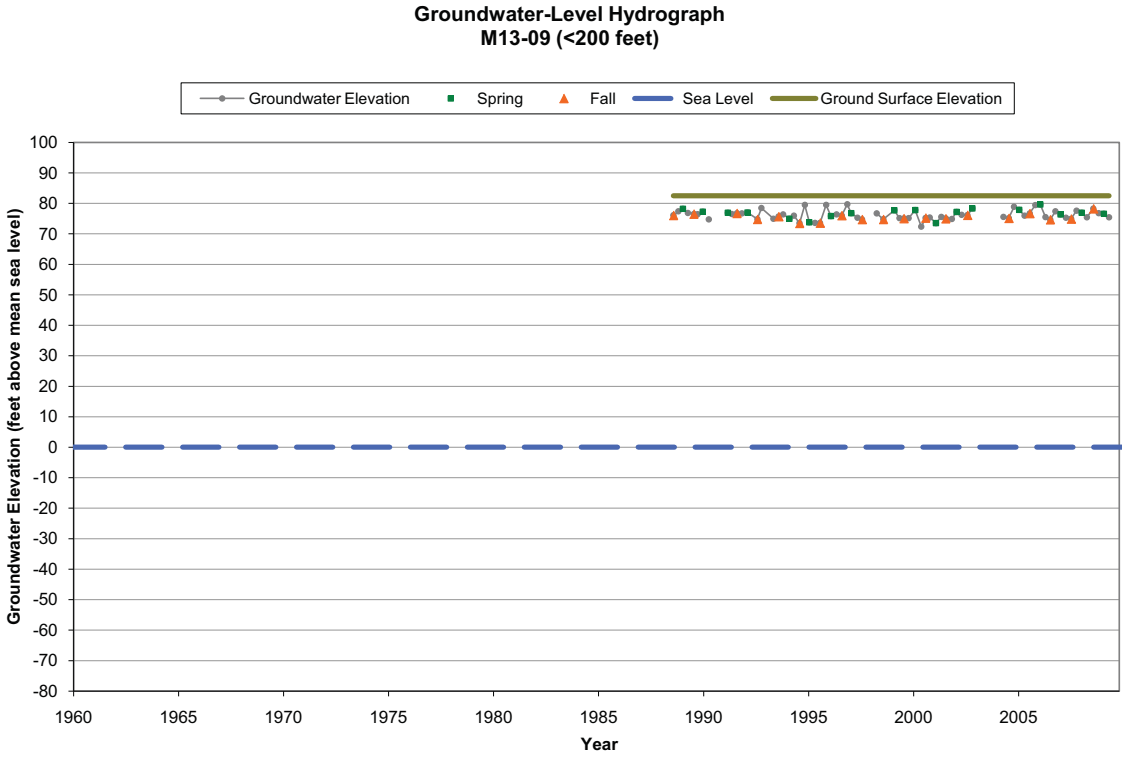

Groundwater-Level Hydrograph
M13-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year

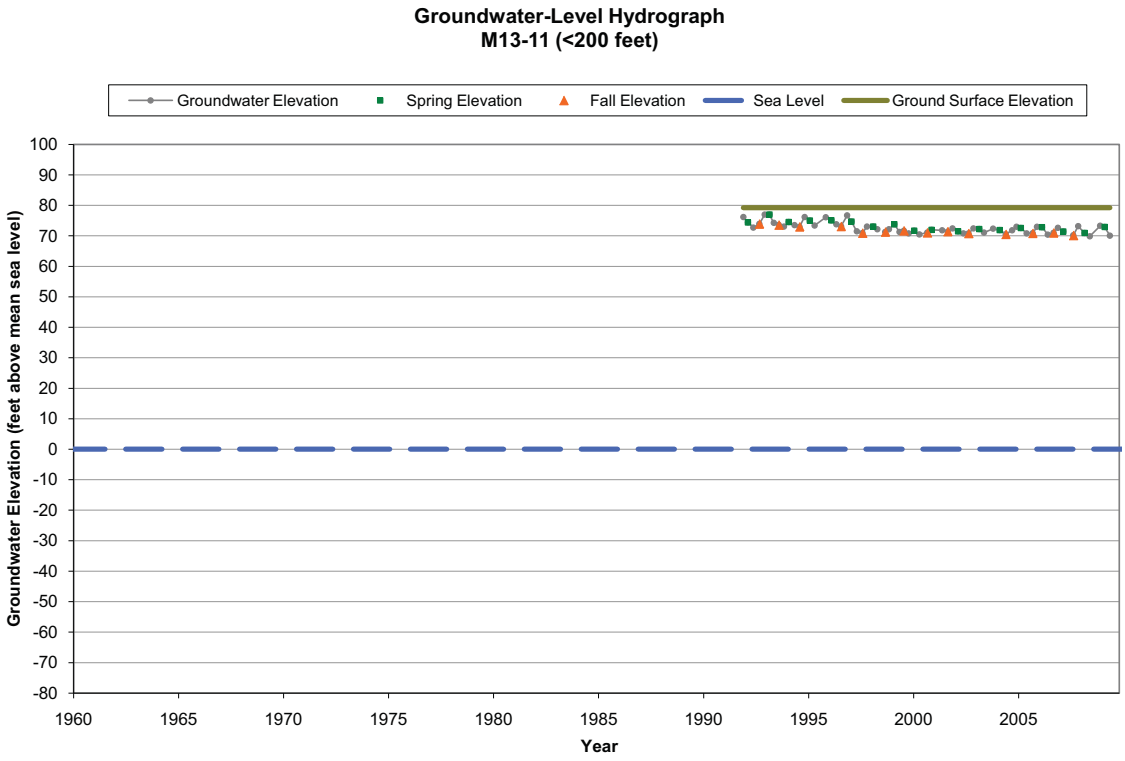

Groundwater-Level Hydrograph
M13-02 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year

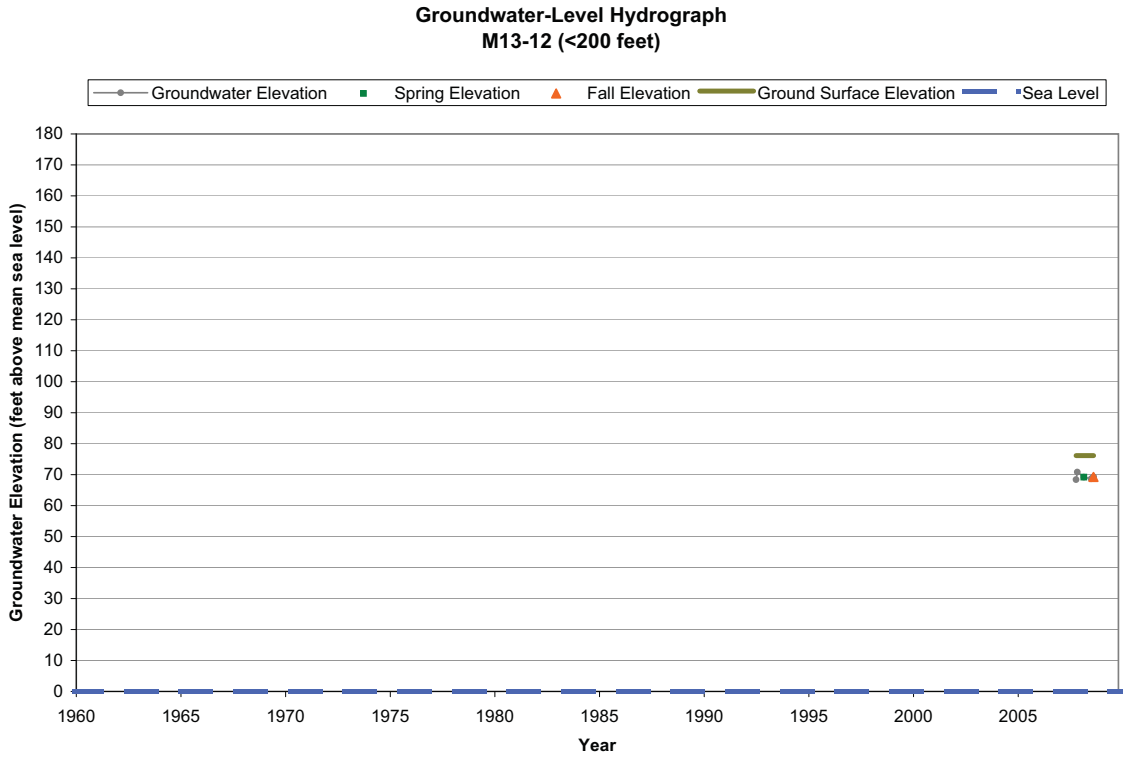

Groundwater-Level Hydrograph
M13-08 (< 200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

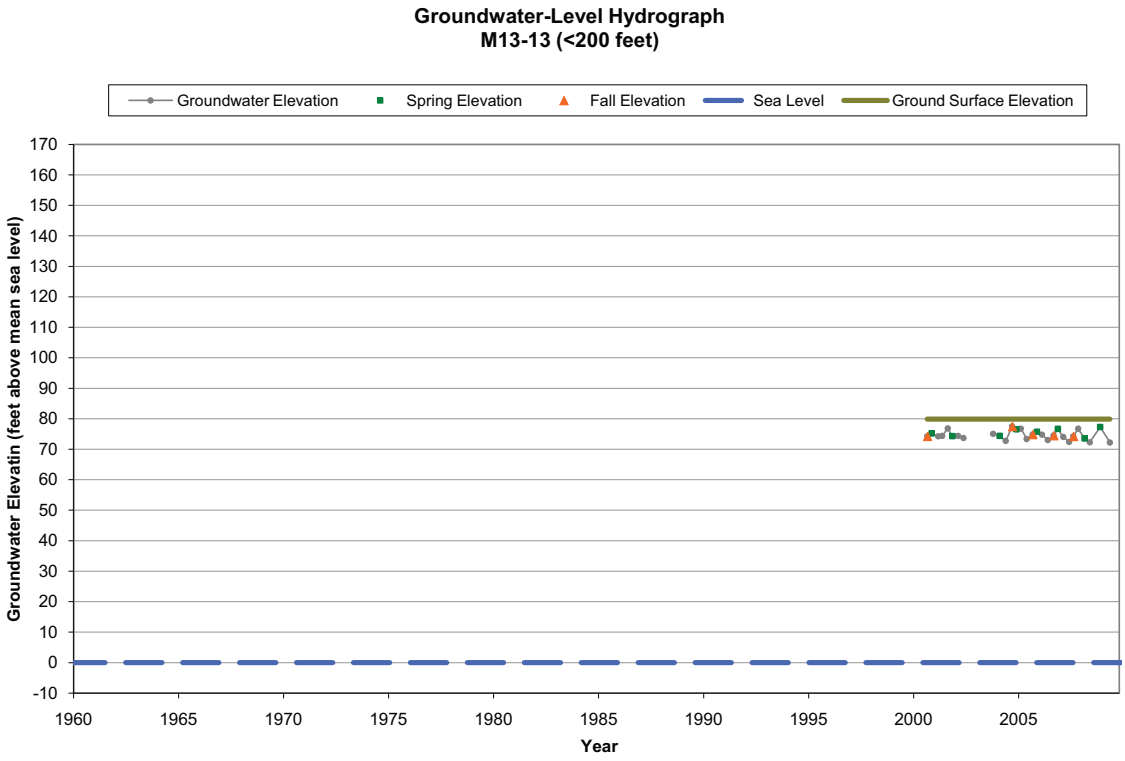

Groundwater-Level Hydrograph
M13-06 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

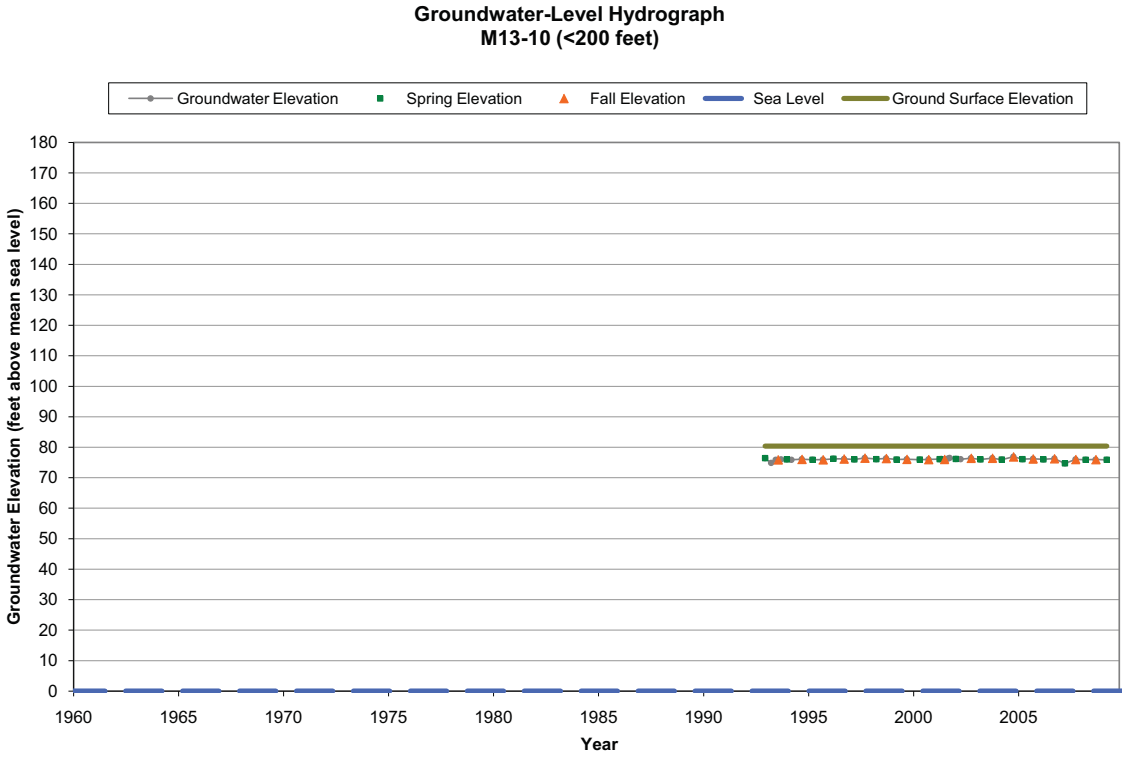

Groundwater-Level Hydrograph
M13-07 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

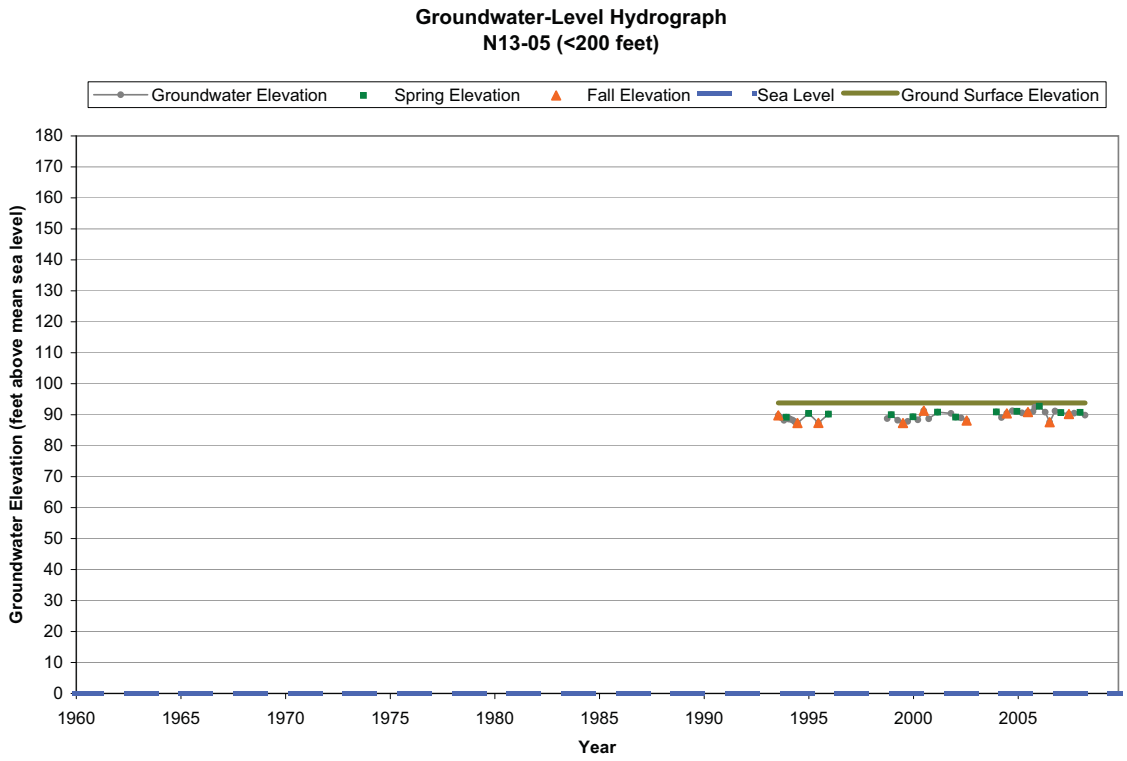

Groundwater-Level Hydrograph
M13-09 (<200 feet)
Groundwater Elevation
Spring
Fall
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

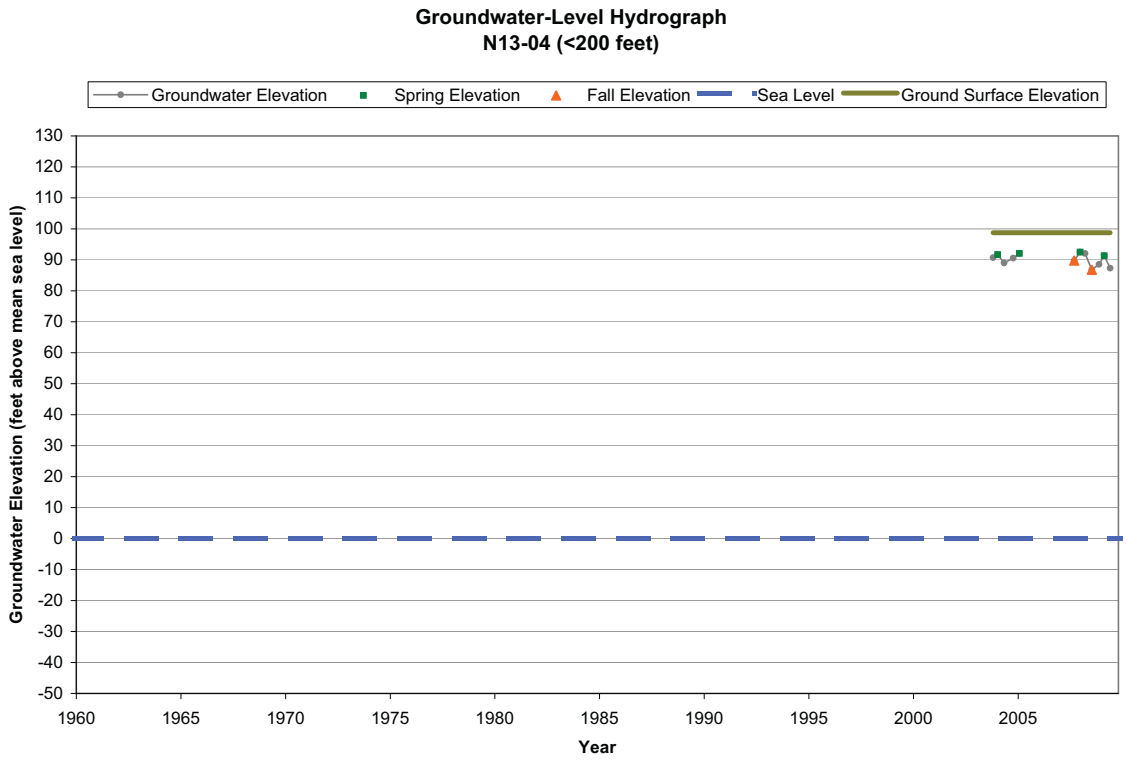

Groundwater-Level Hydrograph
M13-11 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

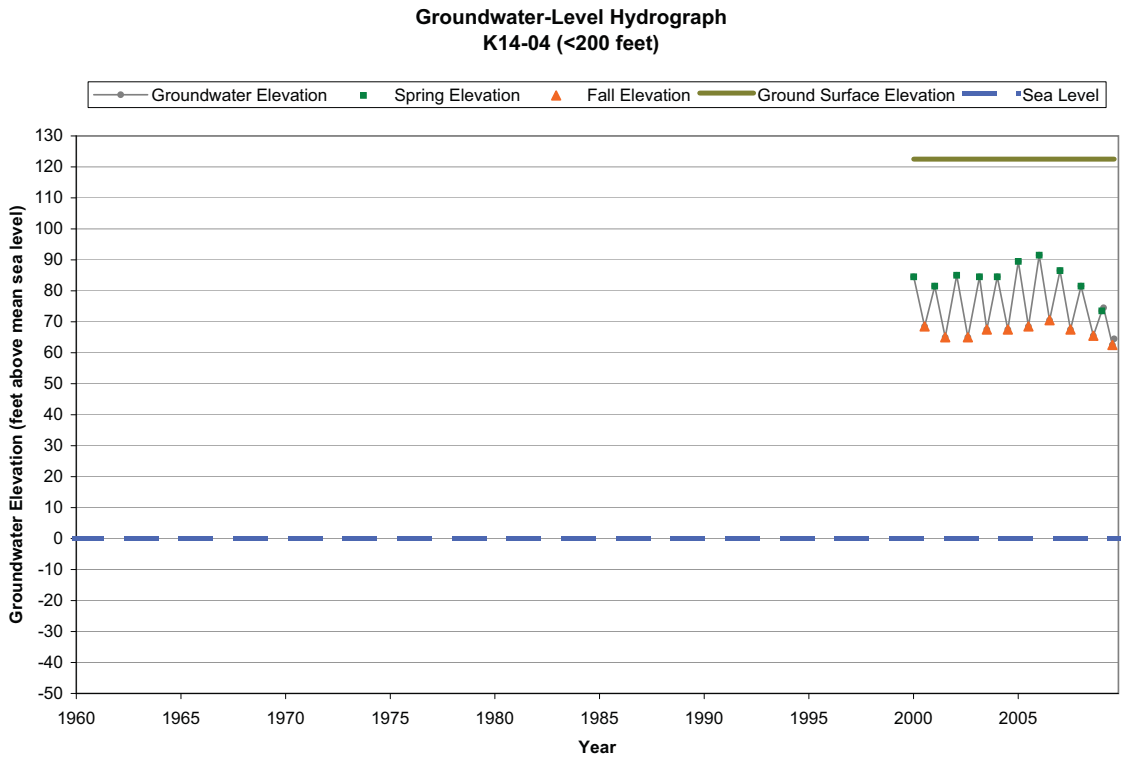

Groundwater-Level Hydrograph
M13-12 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M13-13 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevatin (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M13-10 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
N13-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
N13-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
K14-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
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-50
1960
1965
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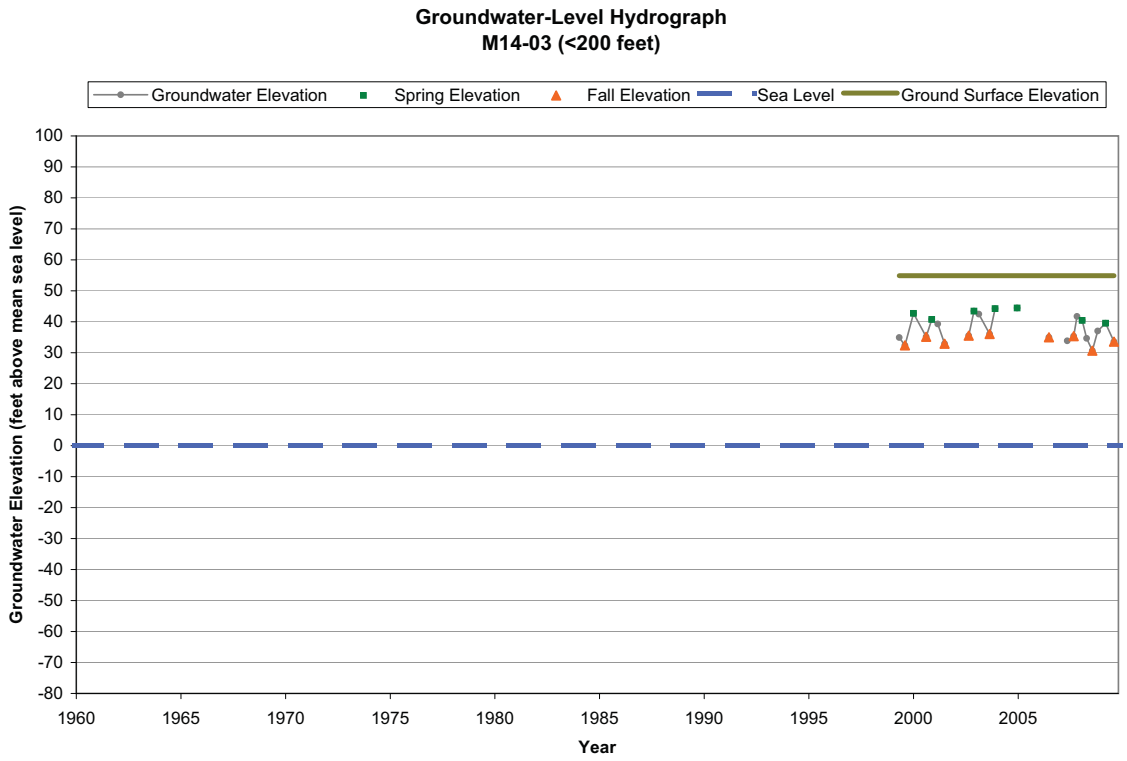
Year


Groundwater-Level Hydrograph
M14-03 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
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-80
1960
1965
1970
1975
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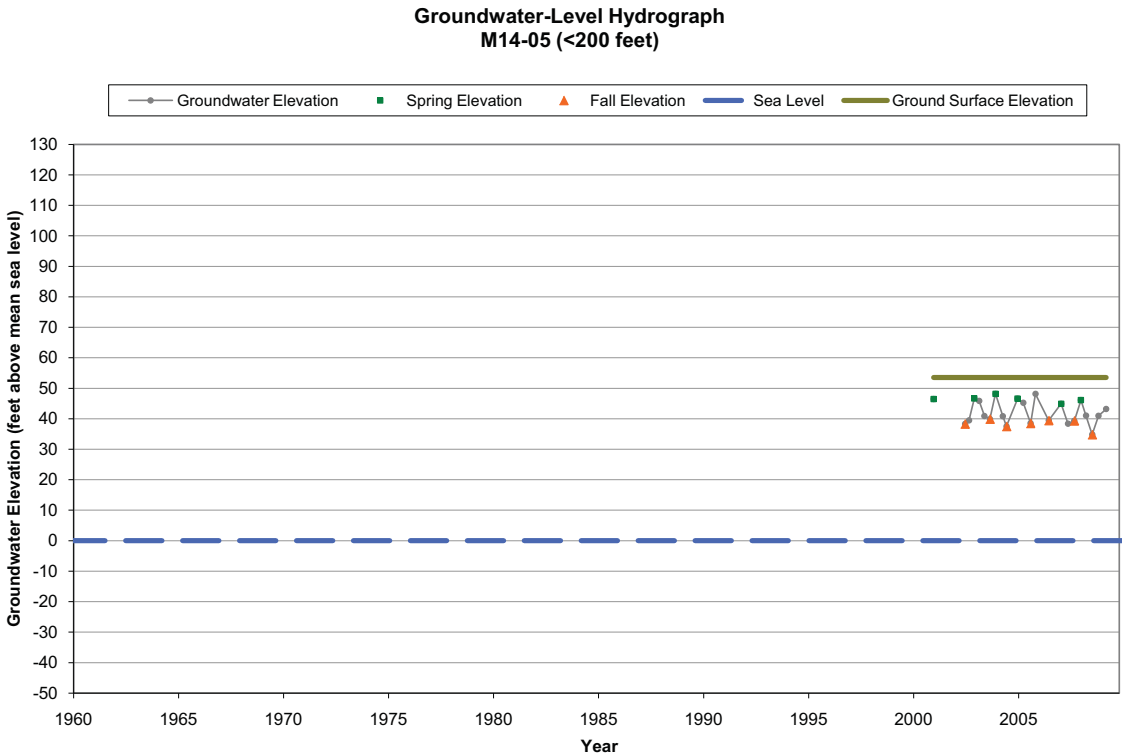
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M14-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
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-50
1960
1965
1970
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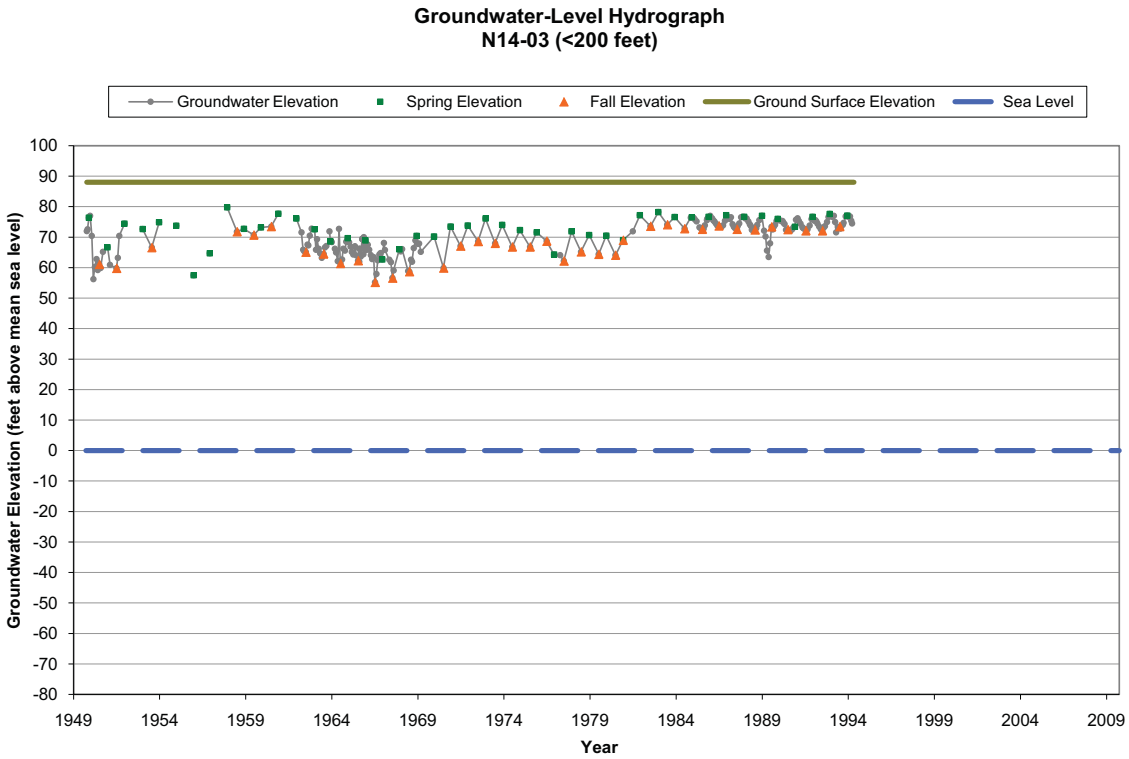
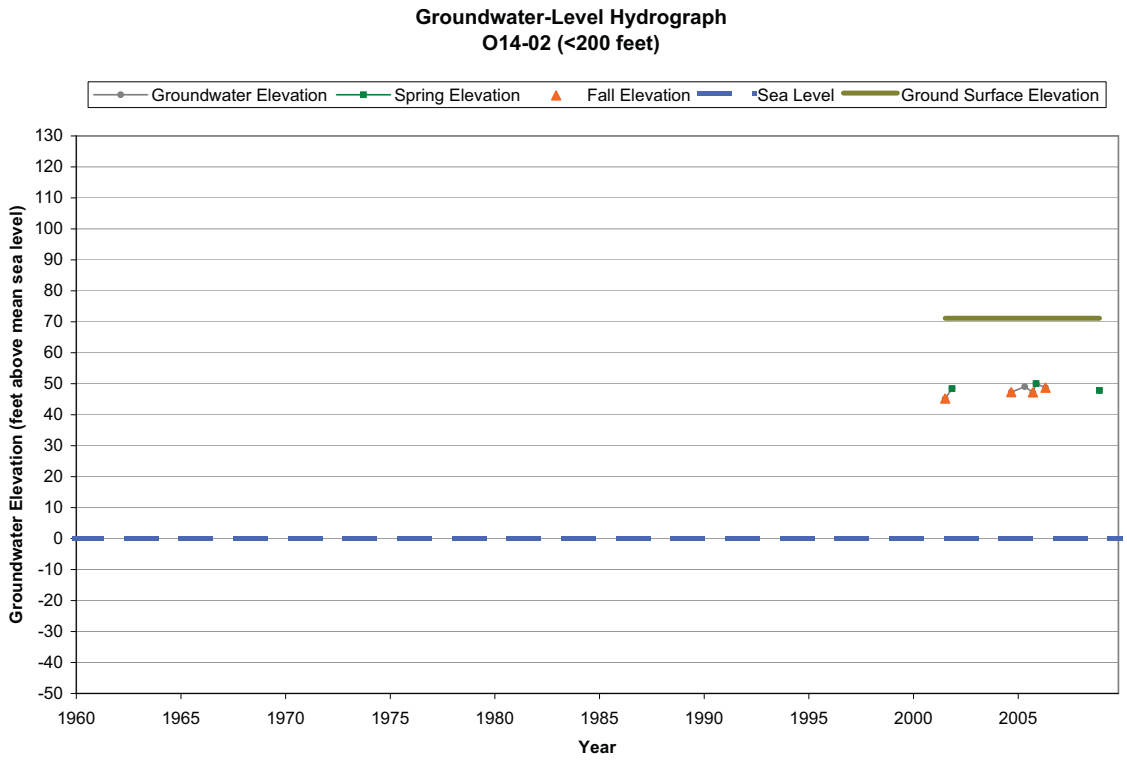
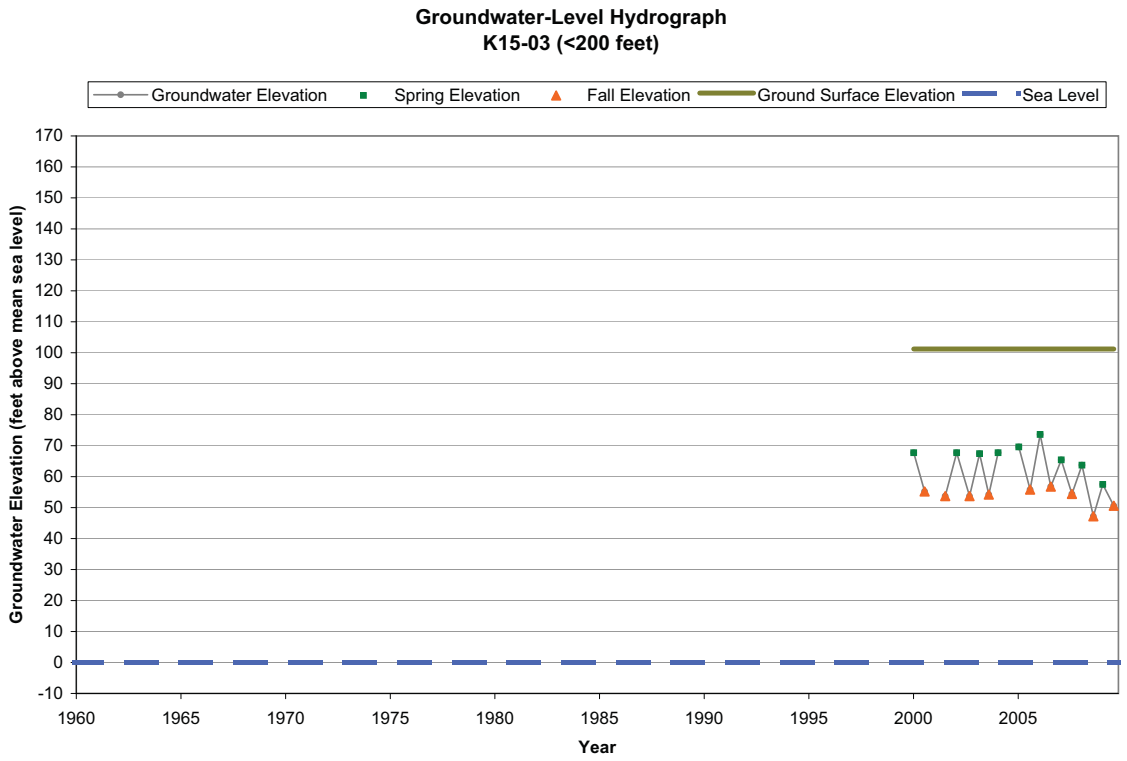
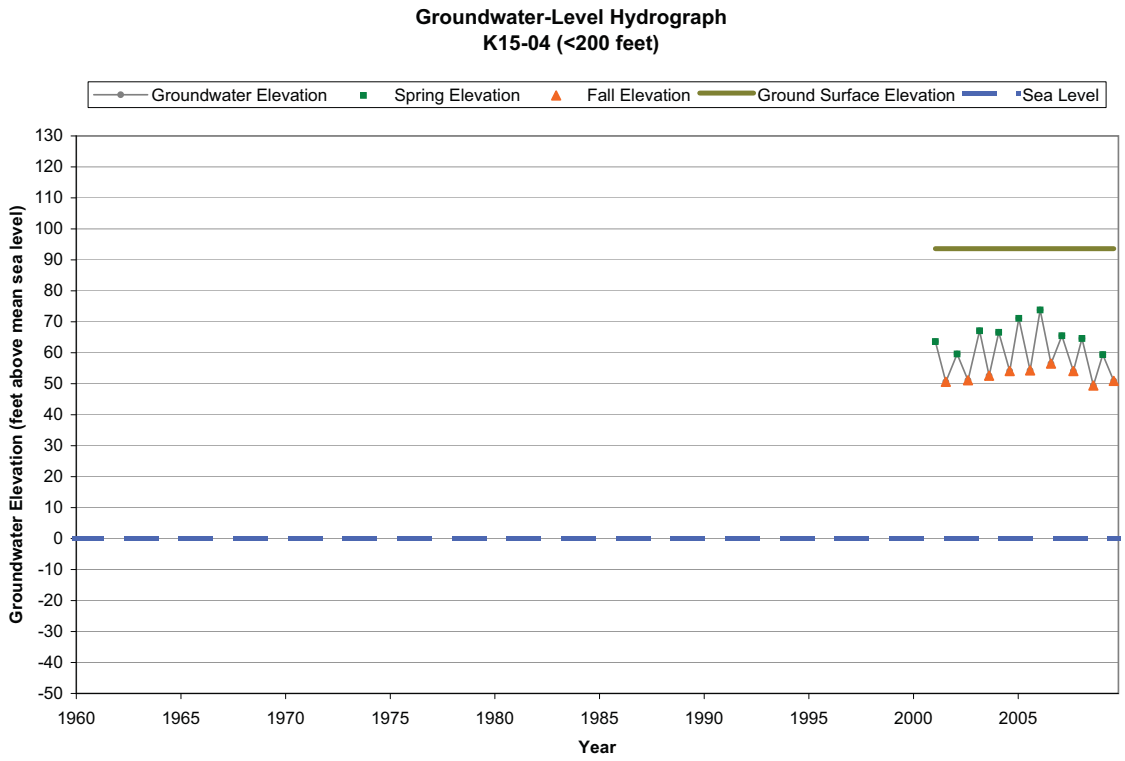
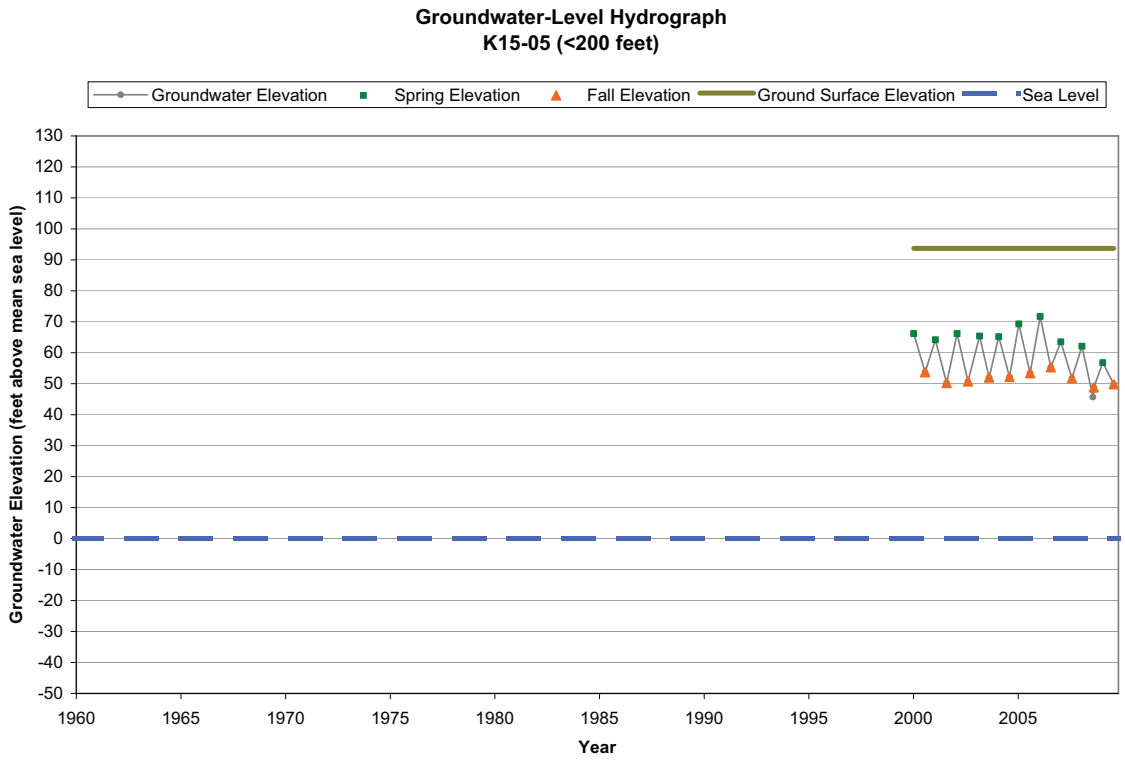
2005
Year

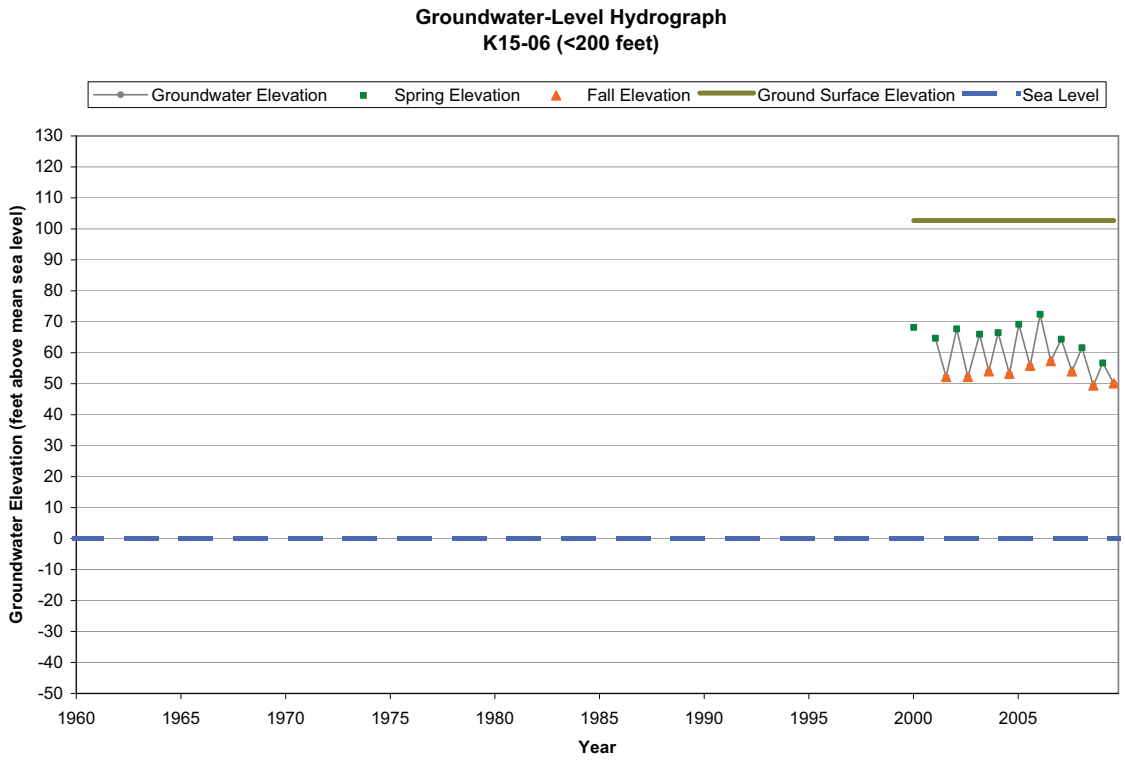

Groundwater-Level Hydrograph
N14-03 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1949
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
2009
Year

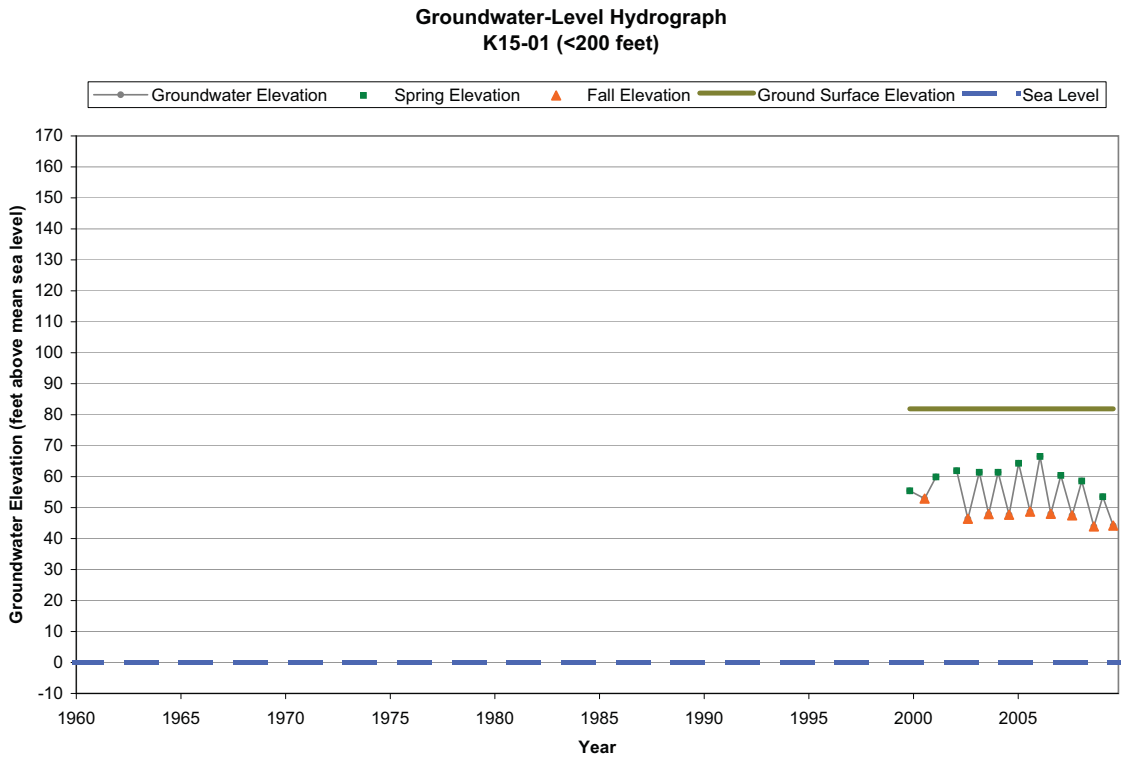

Groundwater-Level Hydrograph
O14-02 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

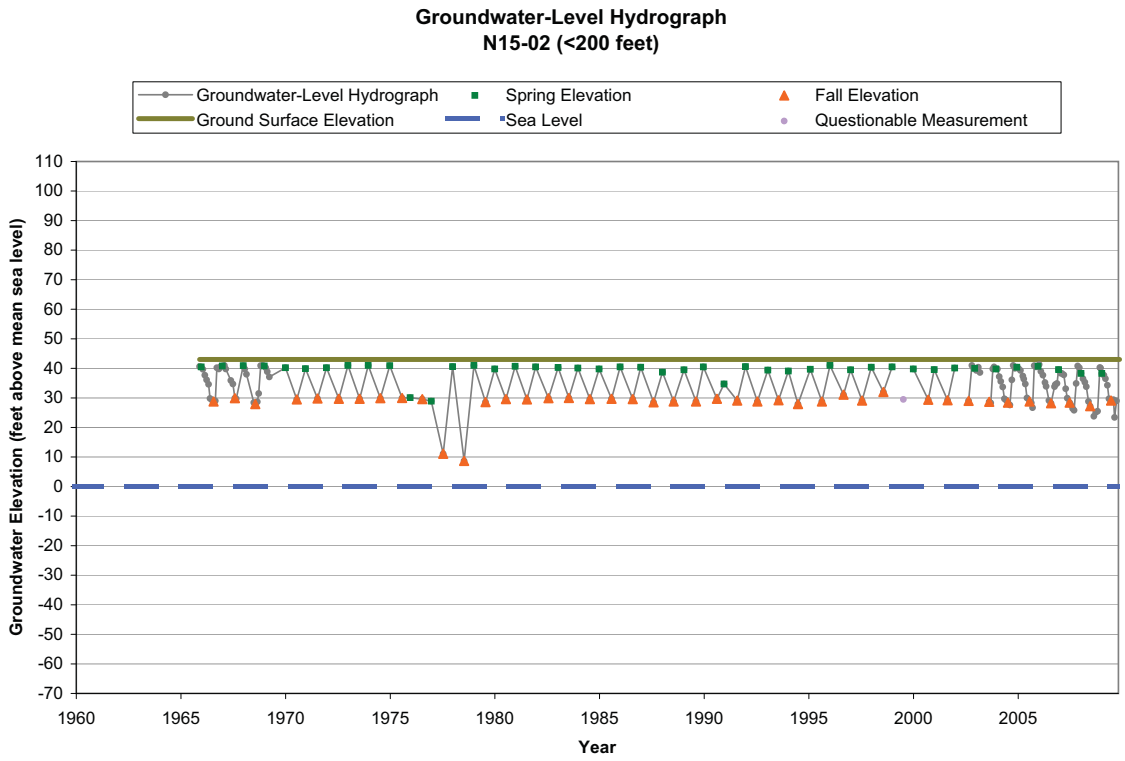

Groundwater-Level Hydrograph
K15-03 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

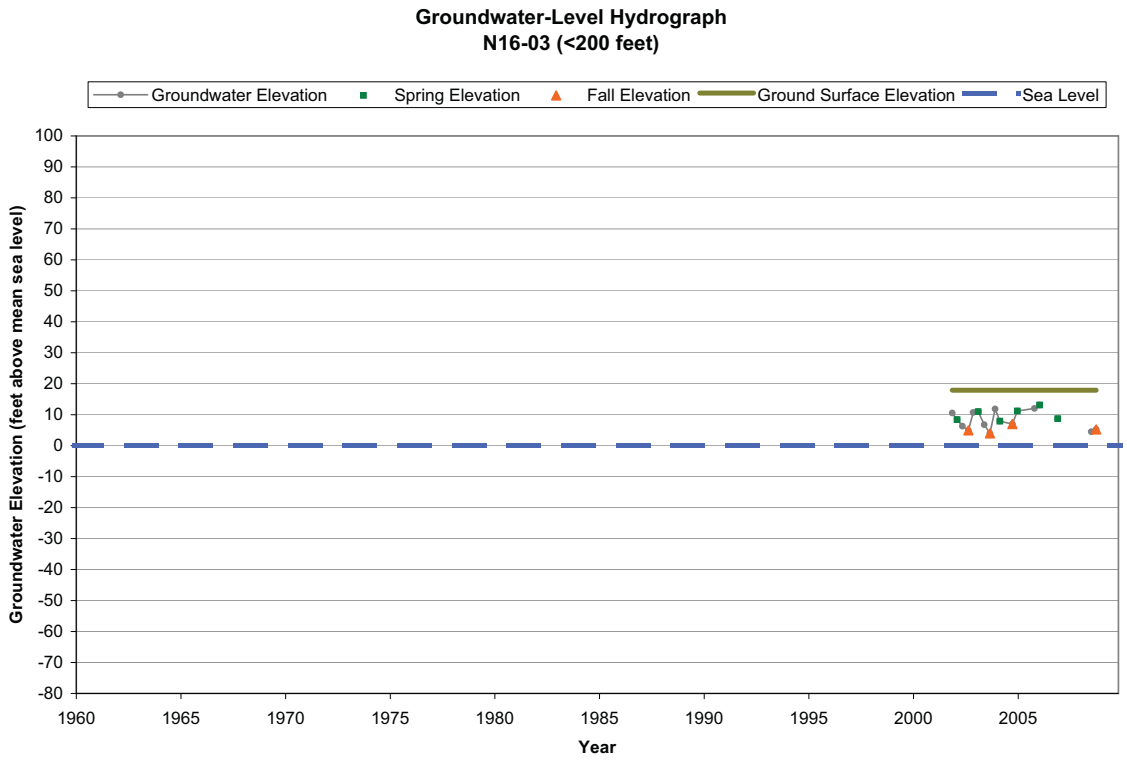

Groundwater-Level Hydrograph
K15-04 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

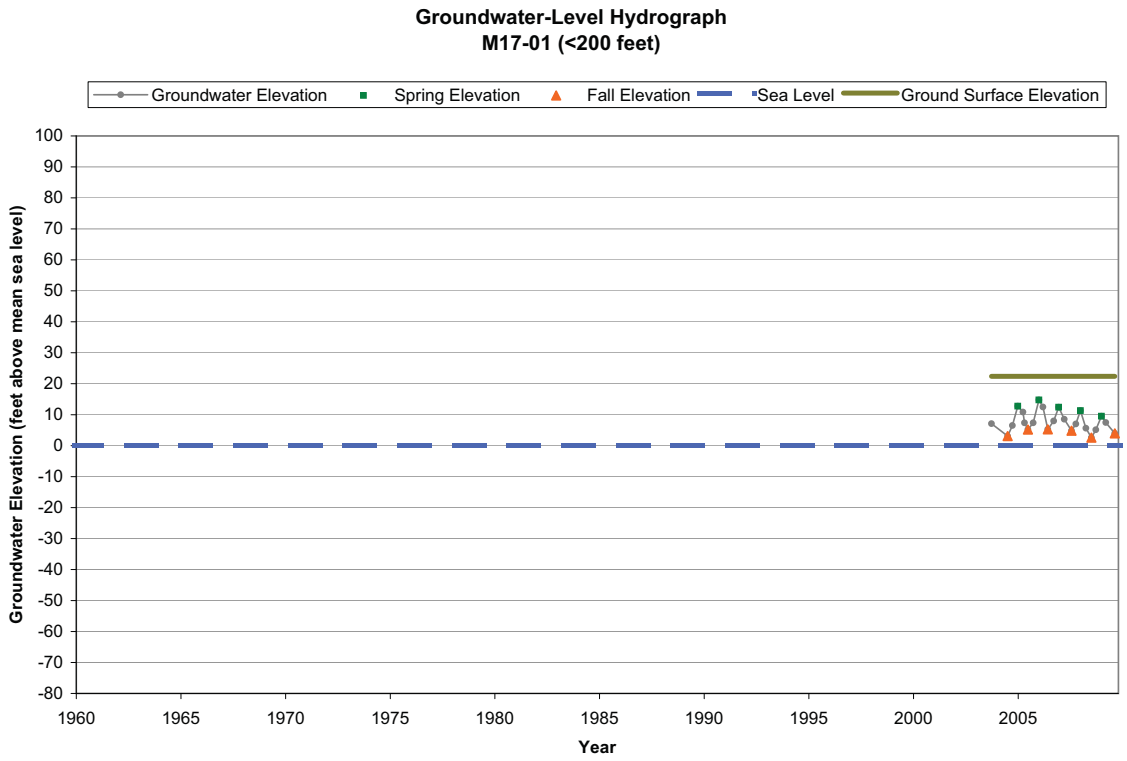

Groundwater-Level Hydrograph
K15-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

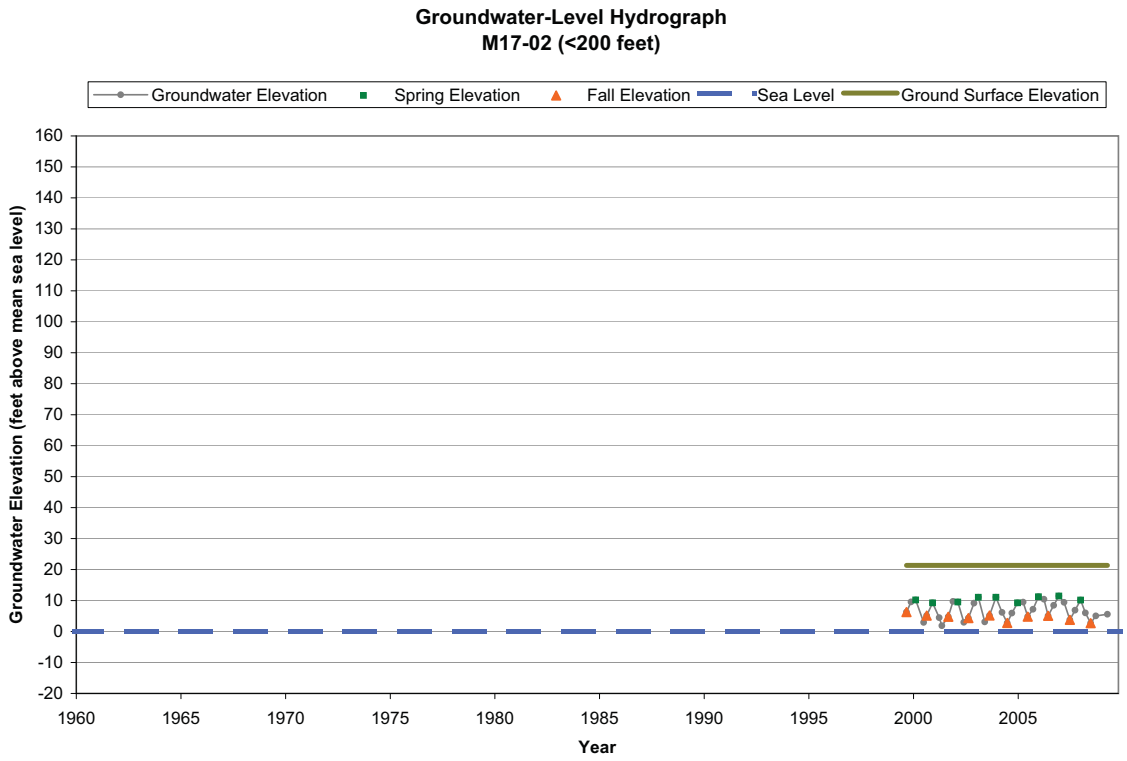

Groundwater-Level Hydrograph
K15-06 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

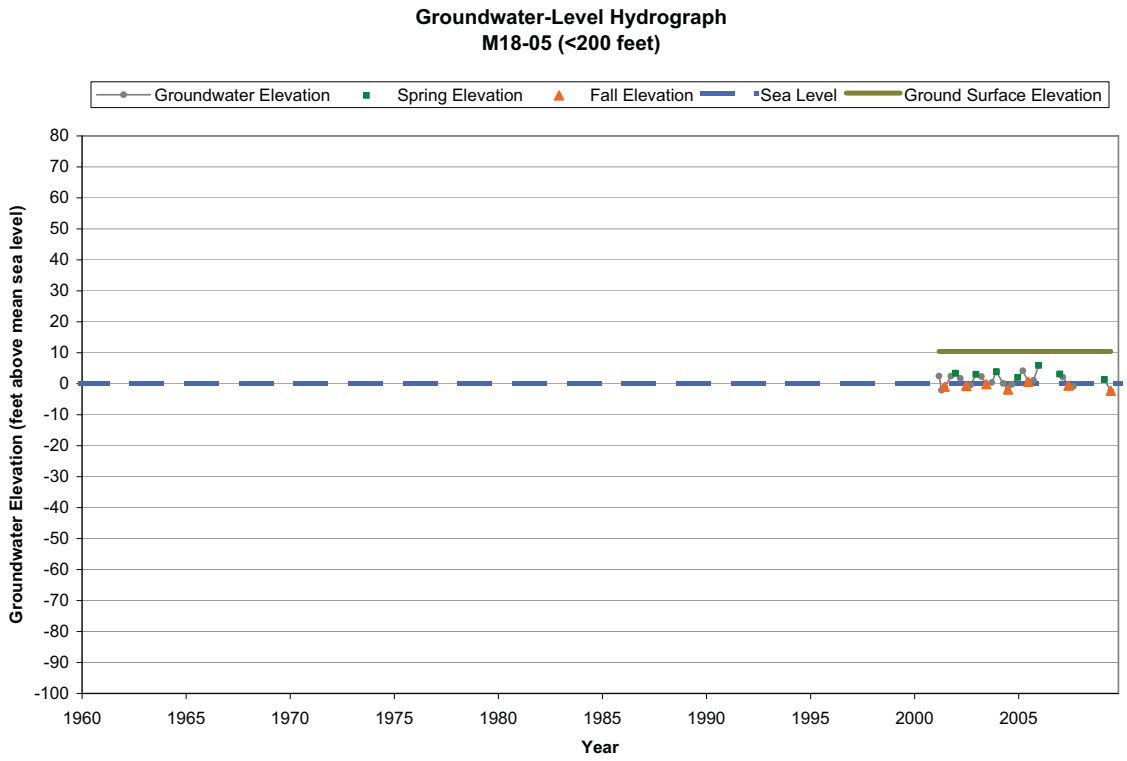

Groundwater-Level Hydrograph
K15-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

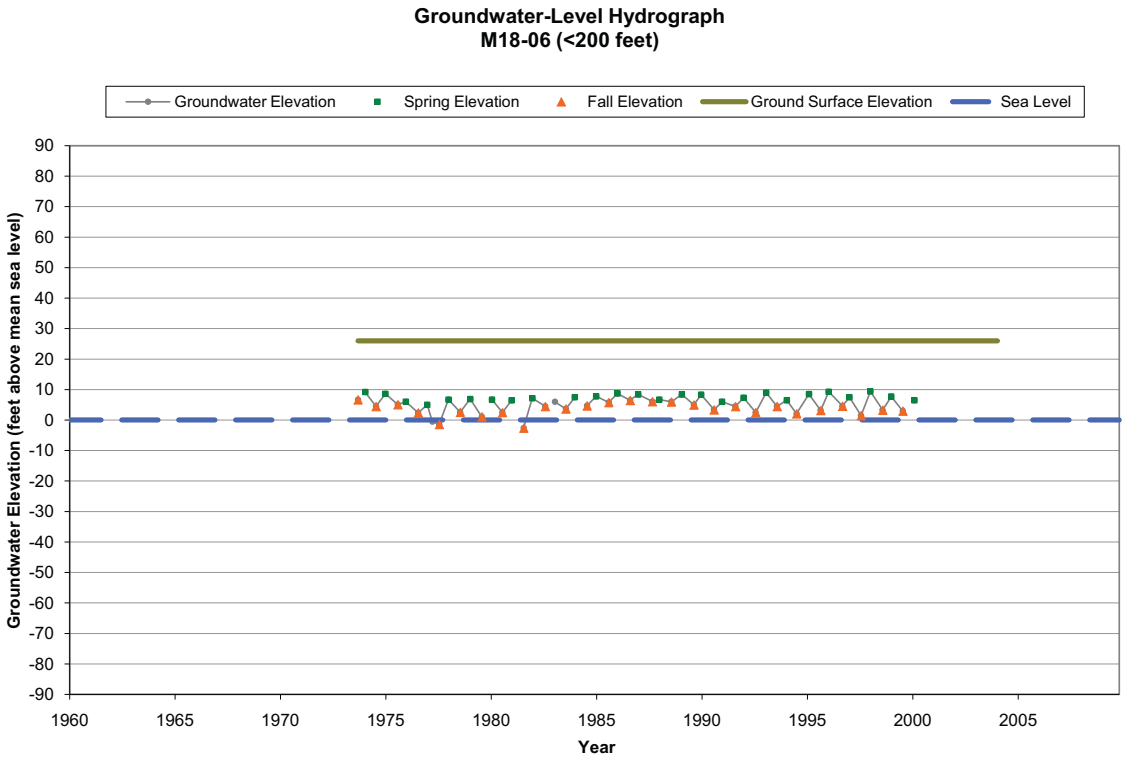

Groundwater-Level Hydrograph
N15-02 (<200 feet)
Groundwater-Level Hydrograph
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Questionable Measurement
Groundwater Elevation (feet above mean sea level)
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

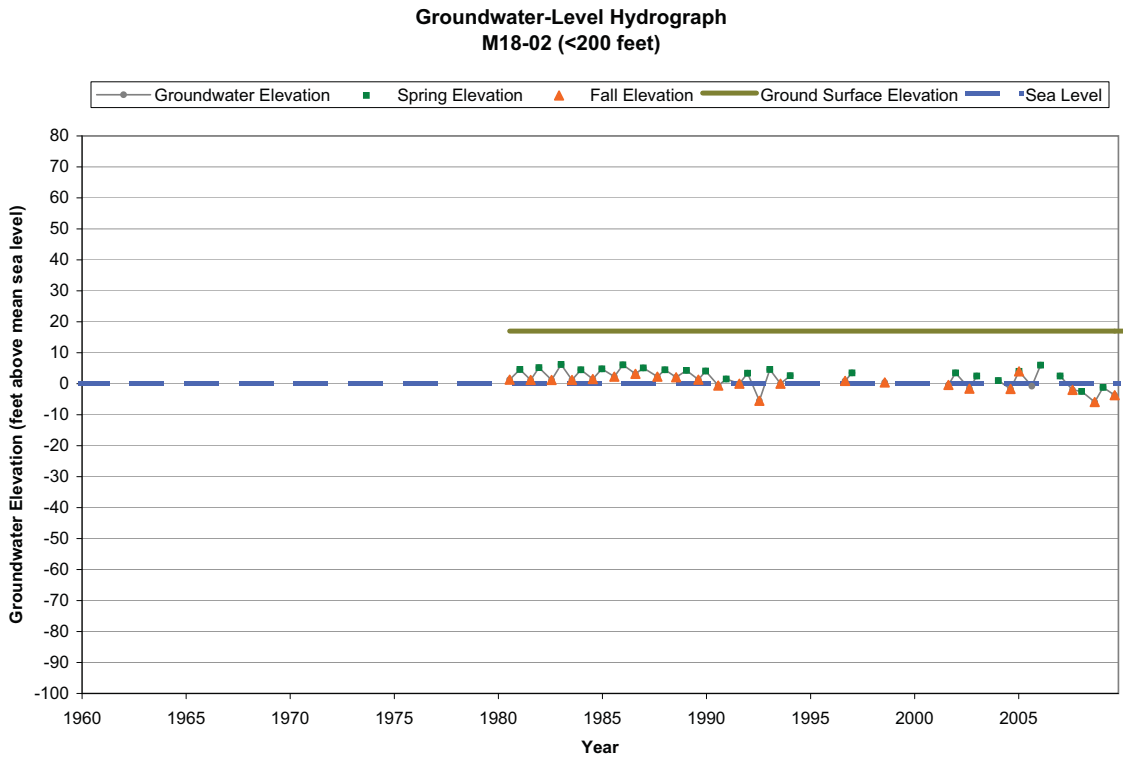

Groundwater-Level Hydrograph
N16-03 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

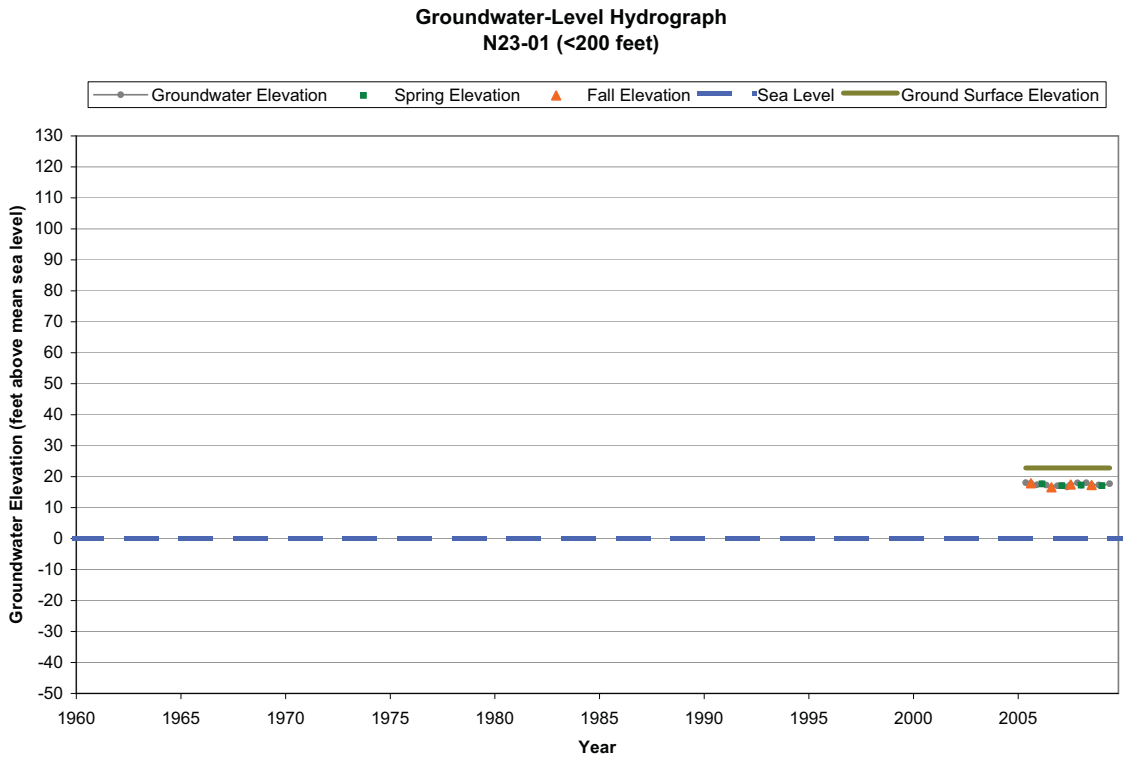

Groundwater-Level Hydrograph
M17-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M17-02 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M18-05 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M18-06 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M18-02 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
N23-01 (<200 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

Groundwater Hydrographs

200 – 500 Feet Deep

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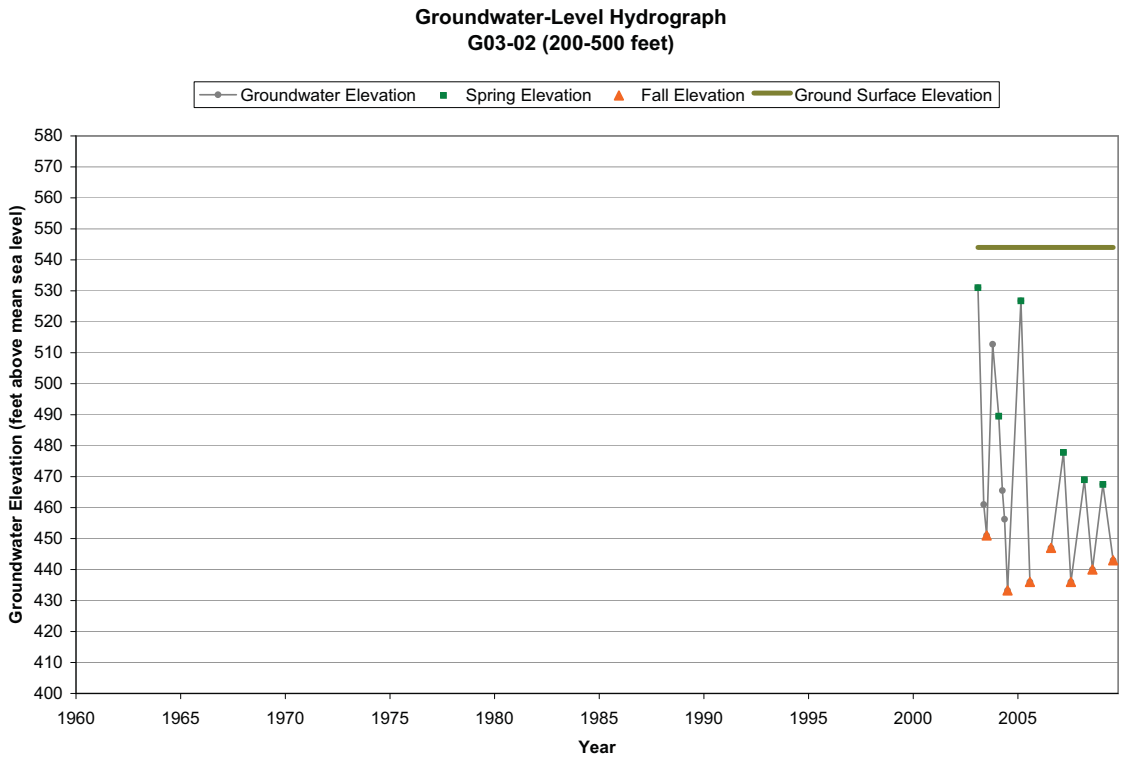
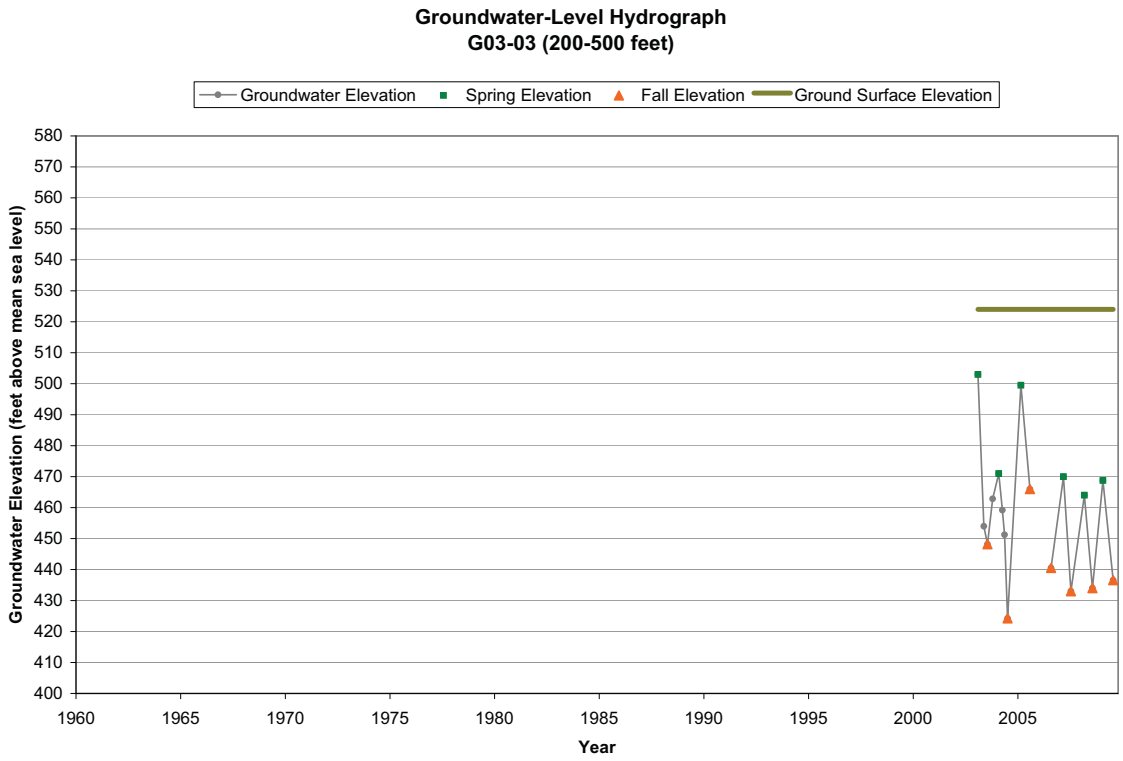
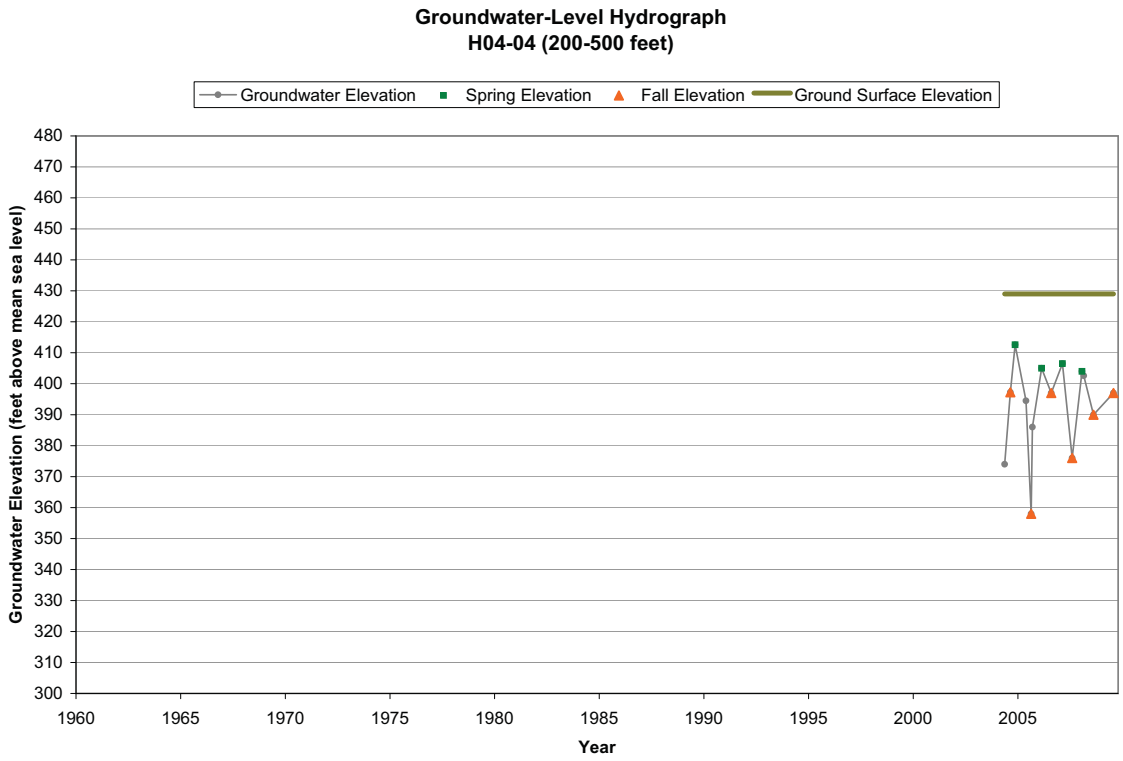
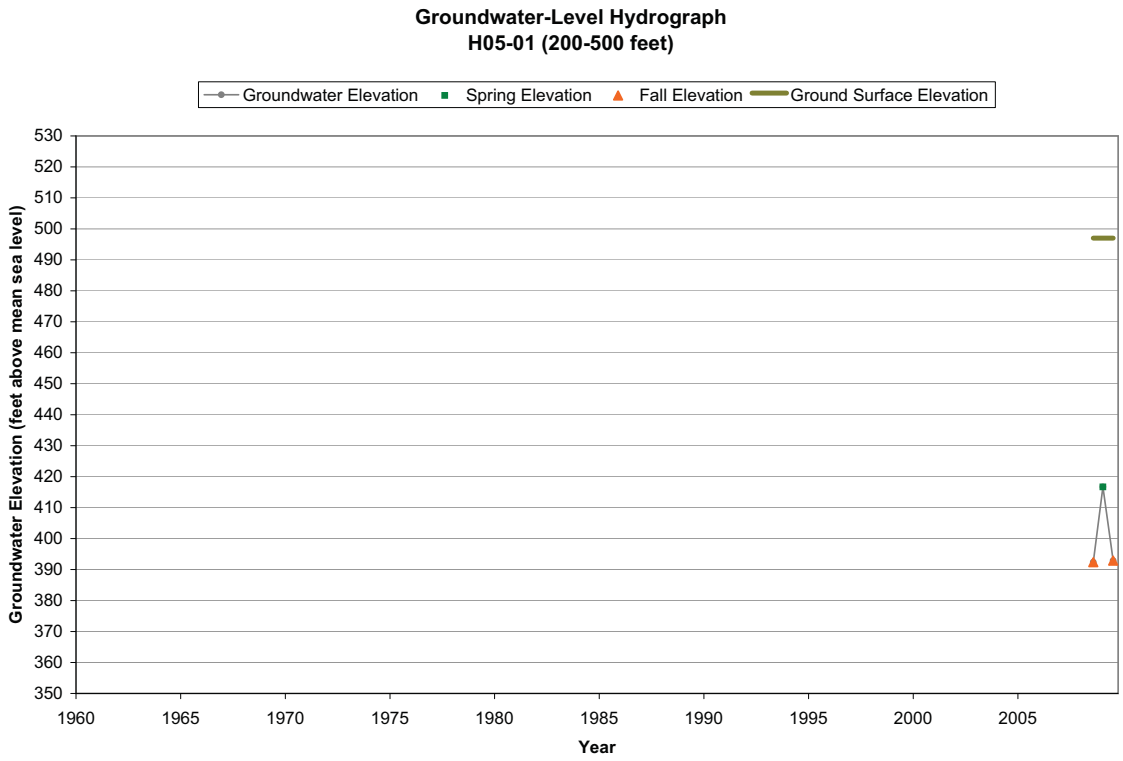
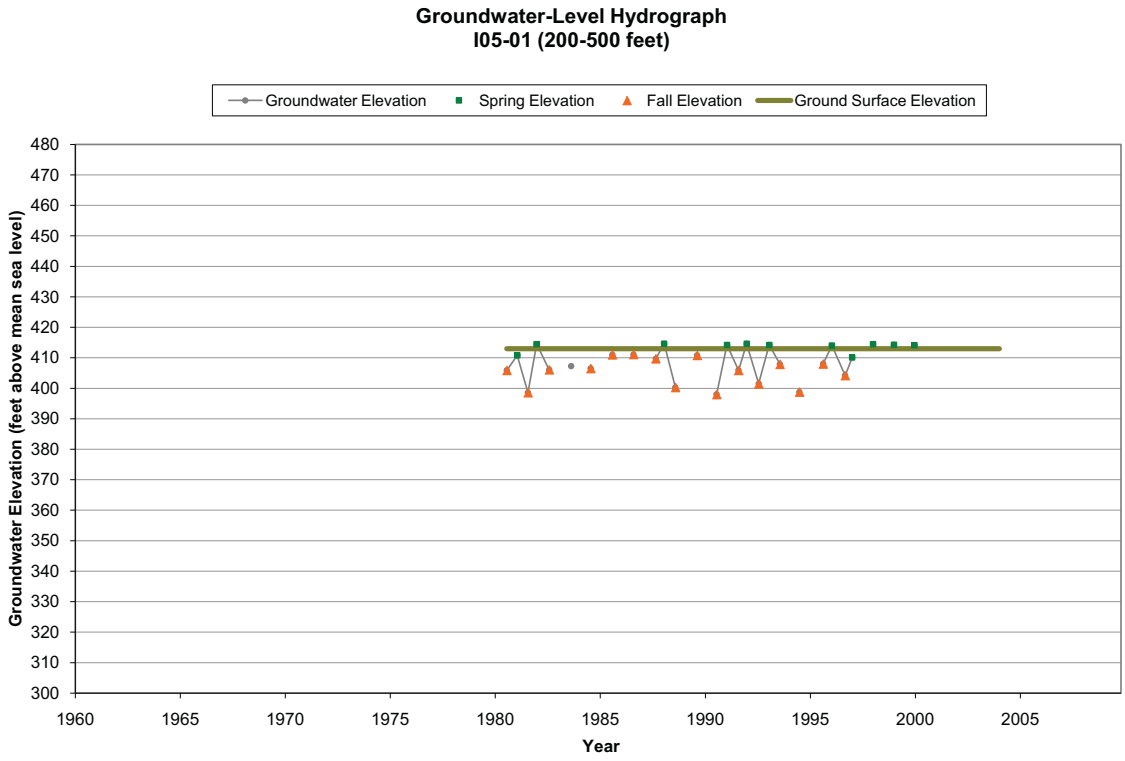
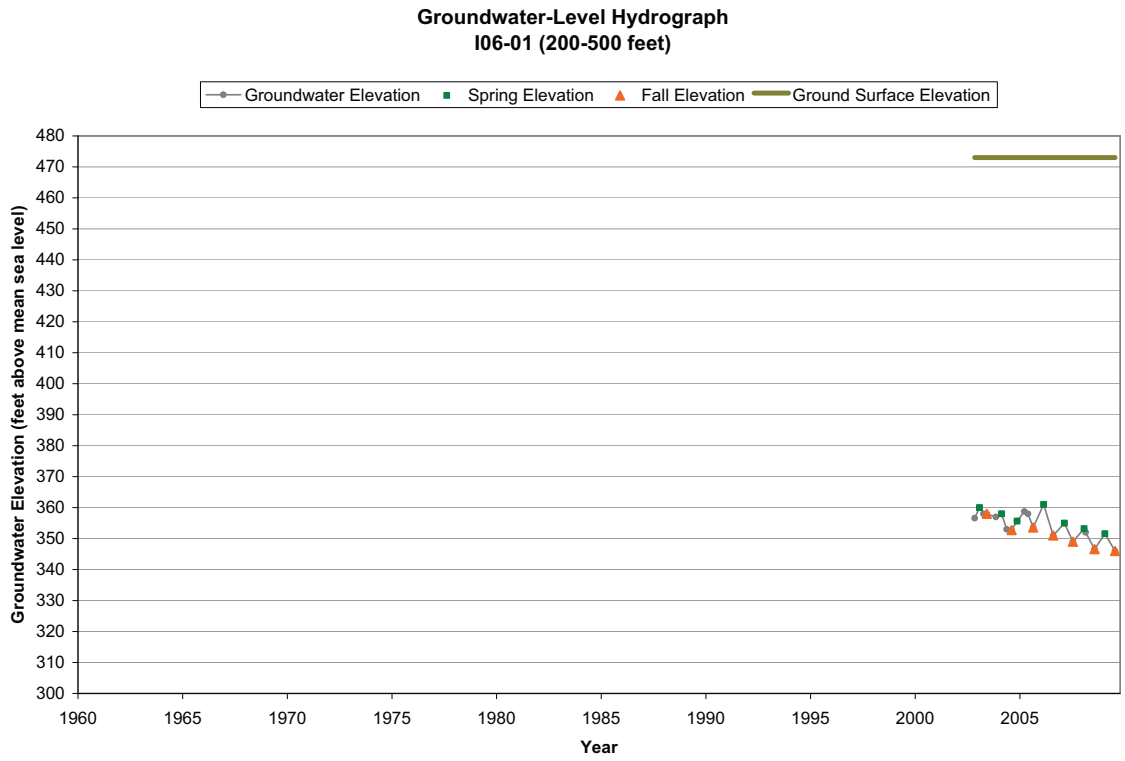

Groundwater-Level Hydrograph
G03-02 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

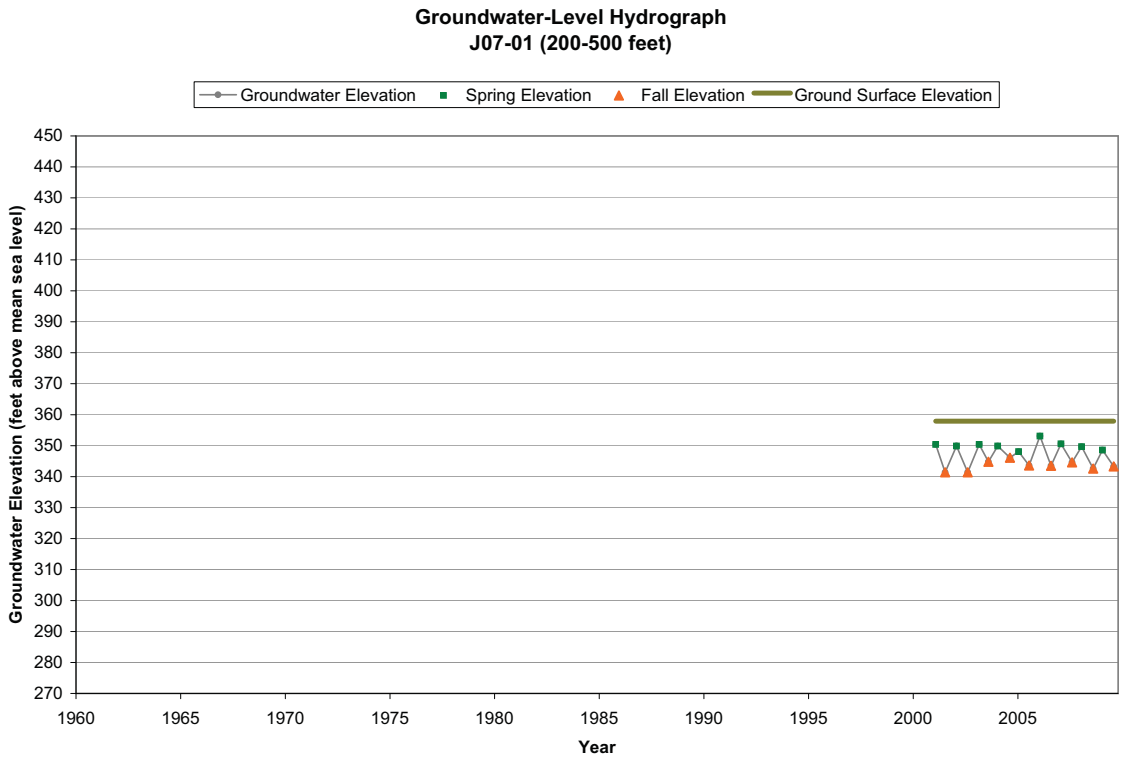

Groundwater-Level Hydrograph
G03-03 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

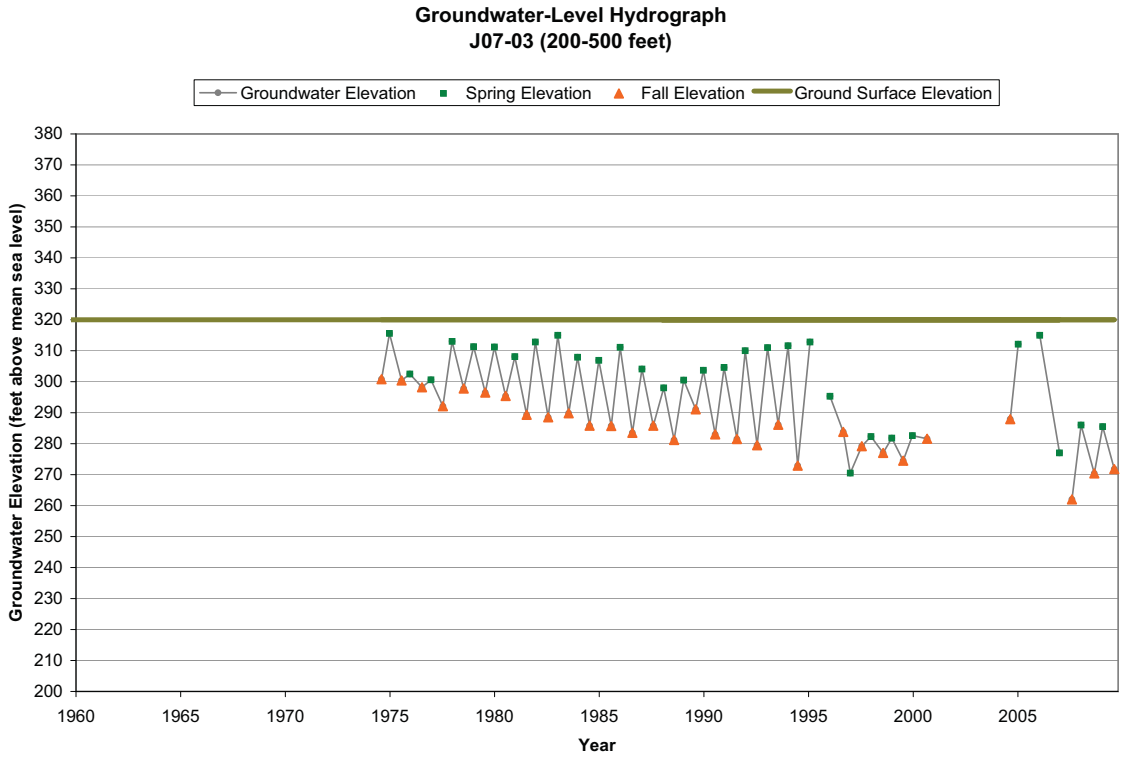

Groundwater-Level Hydrograph
H04-04 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

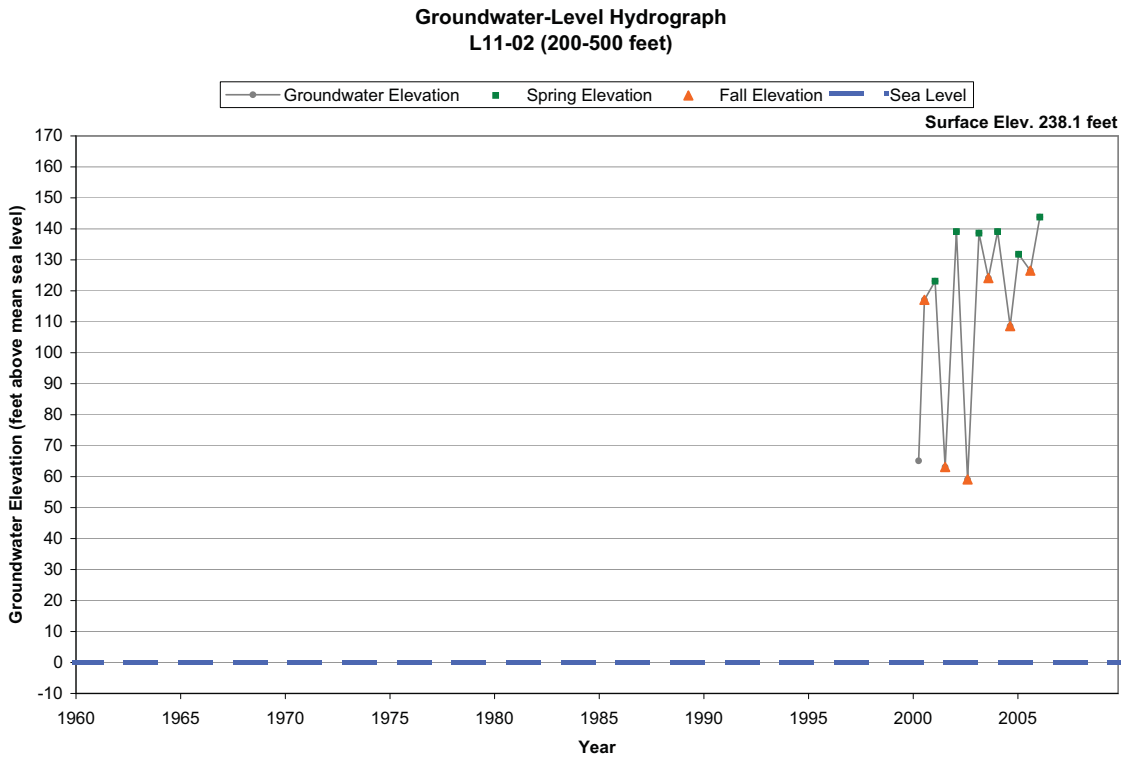

Groundwater-Level Hydrograph
H05-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

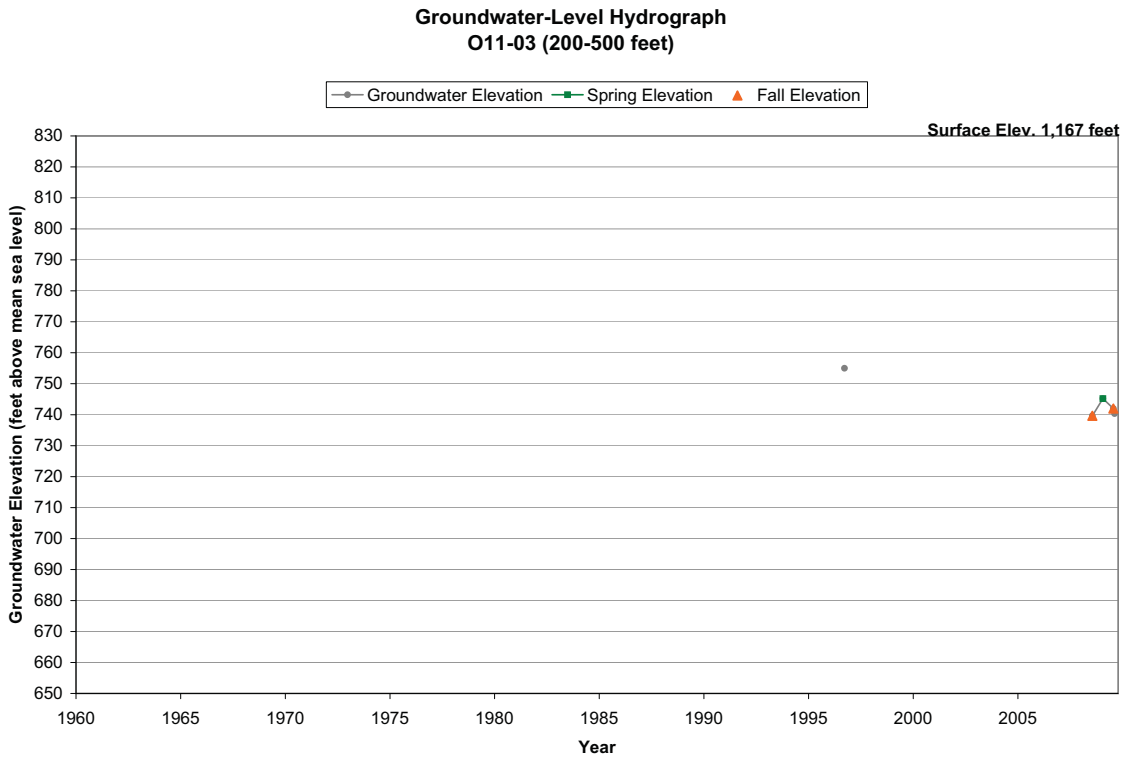

Groundwater-Level Hydrograph
I05-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

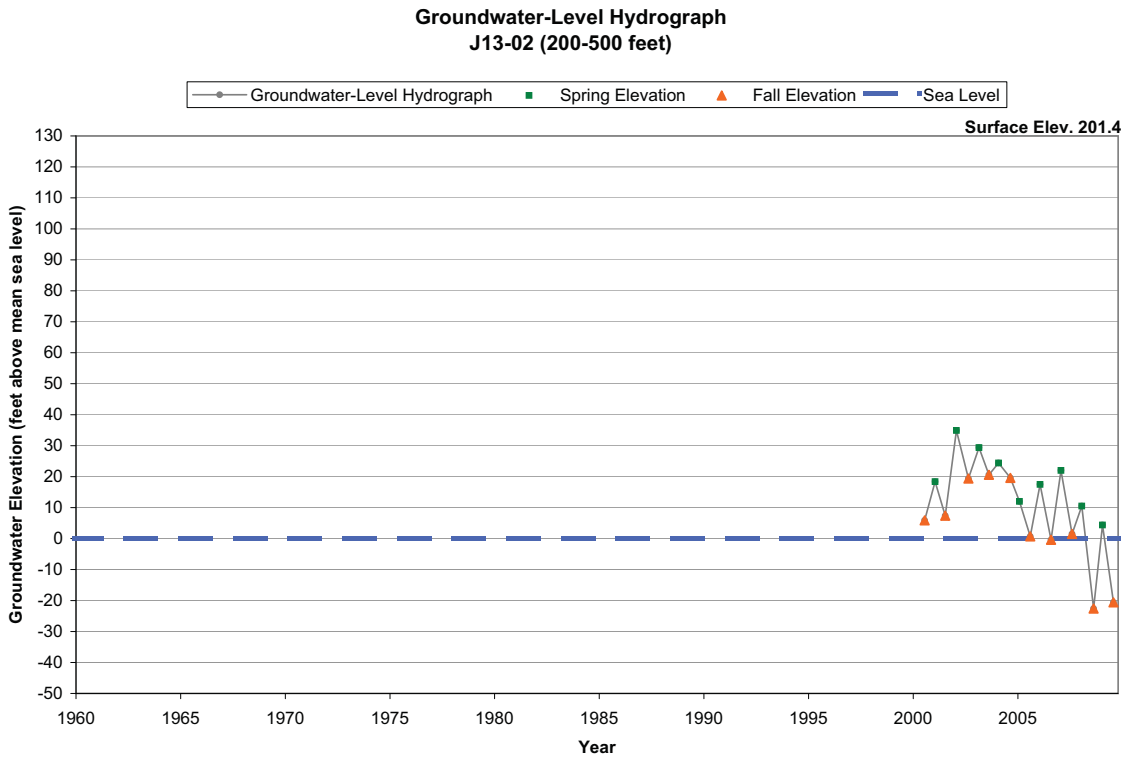

Groundwater-Level Hydrograph
I06-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J07-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
450
440
430
420
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J07-03 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
L11-02 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 238.1 feet
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
O11-03 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,167 feet
Groundwater Elevation (feet above mean sea level)
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J13-02 (200-500 feet)
Groundwater-Level Hydrograph
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 201.4
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
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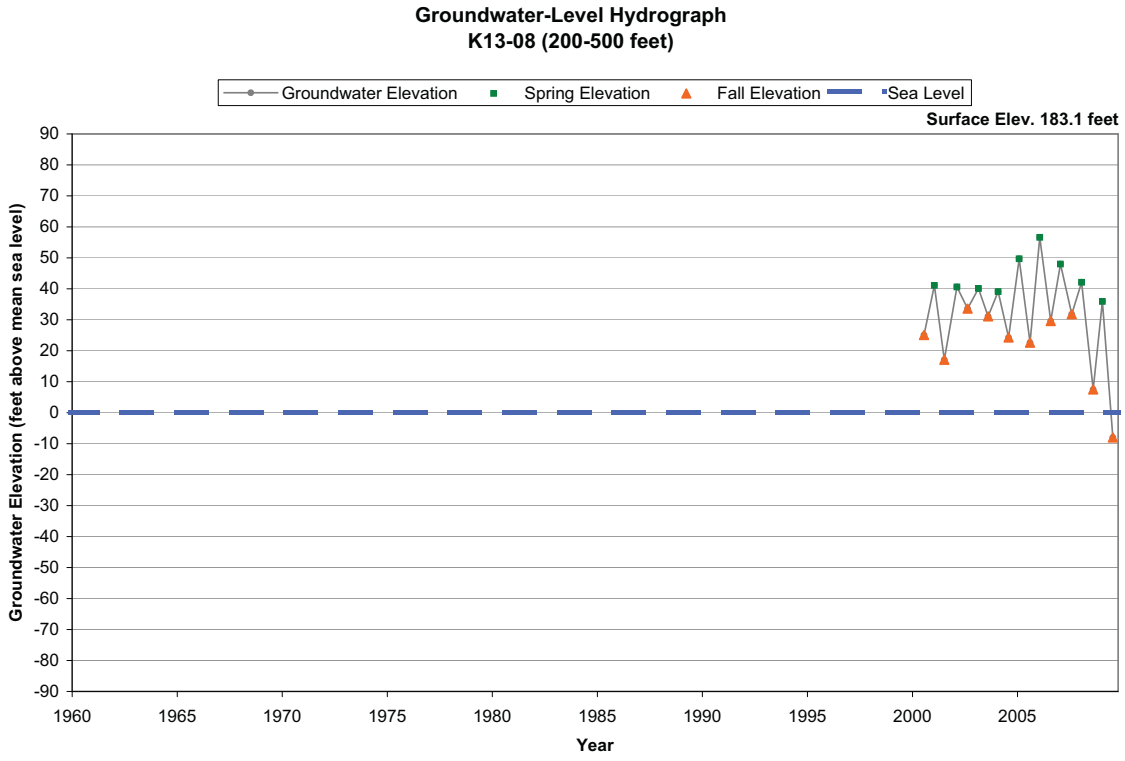
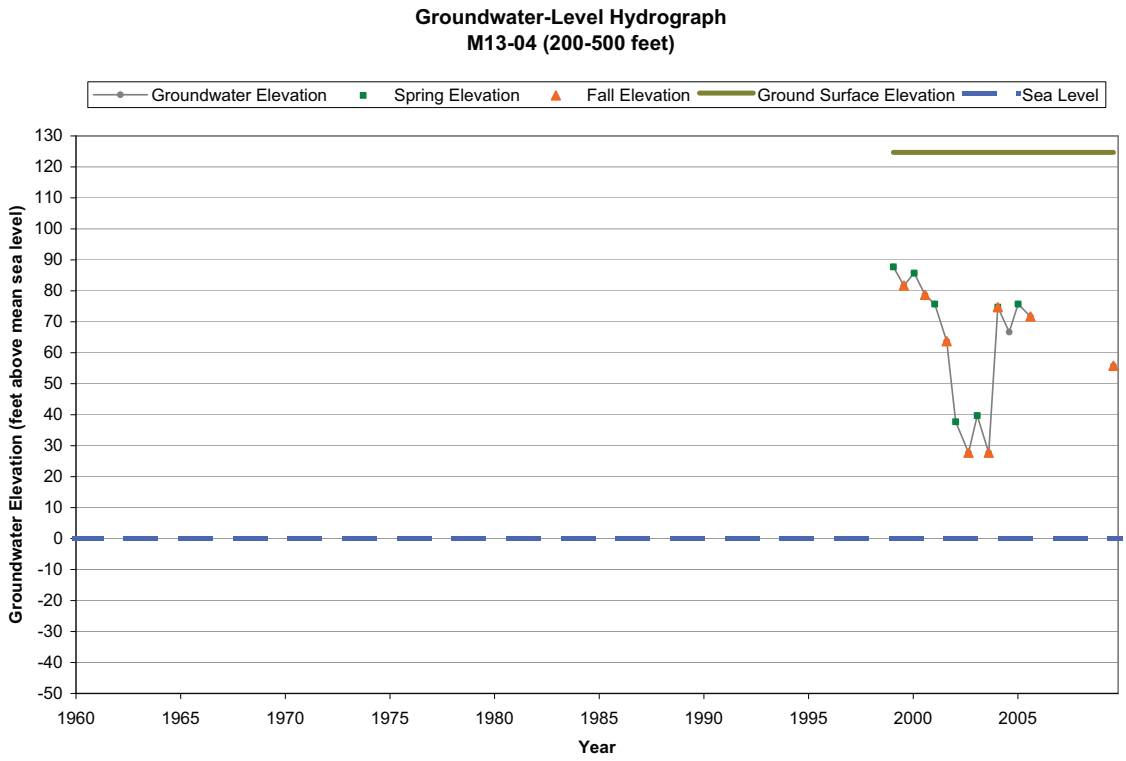
1995
2000
2005
Year


Groundwater-Level Hydrograph
K13-08 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 183.1 feet
Groundwater Elevation (feet above mean sea level)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M13-04 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
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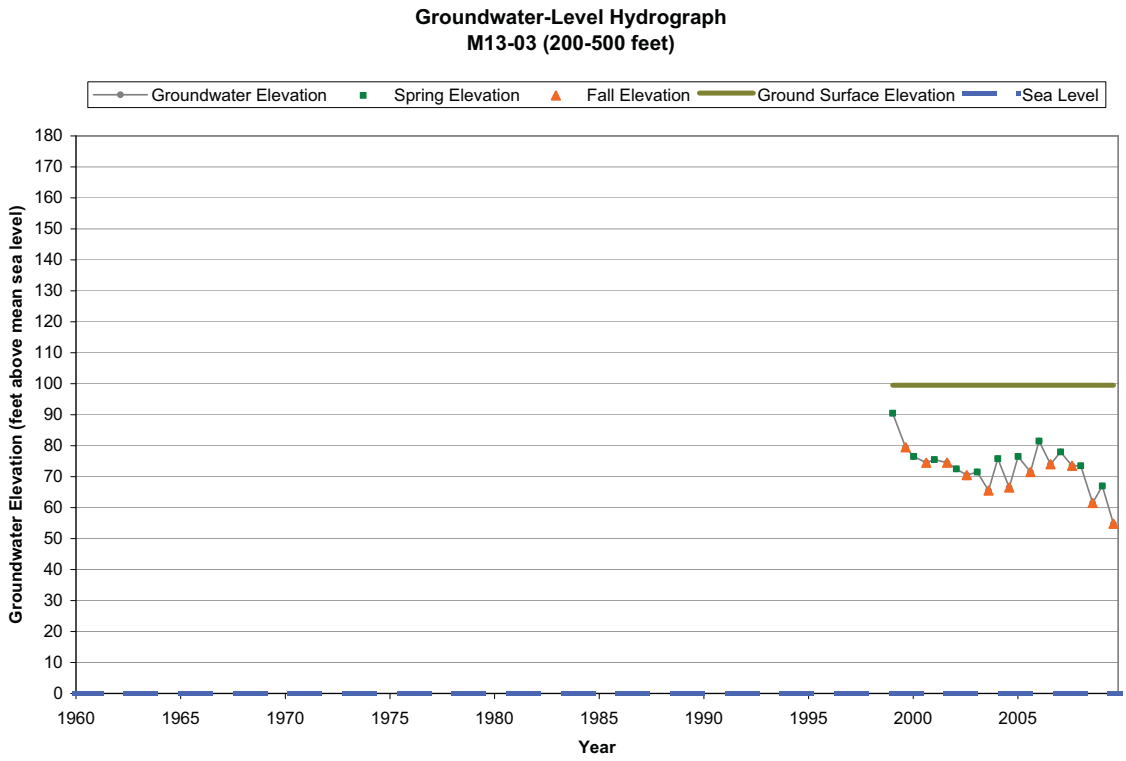
Year


Groundwater-Level Hydrograph
M13-03 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
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1970
1975
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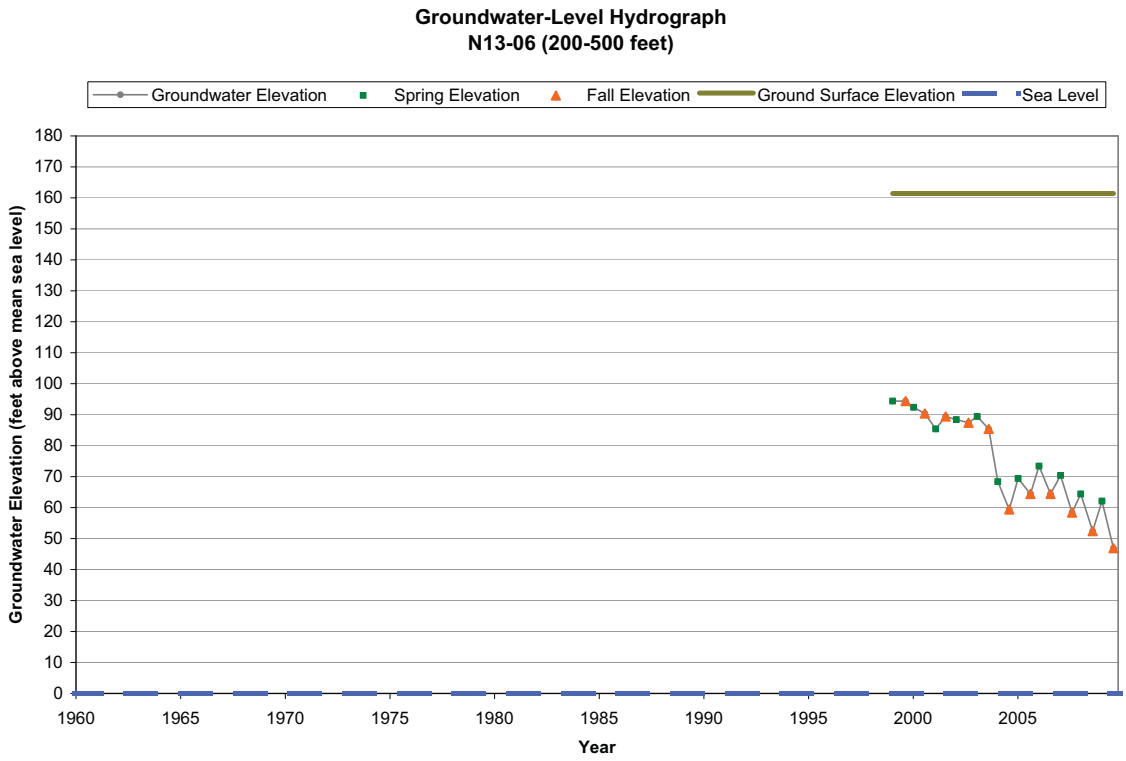
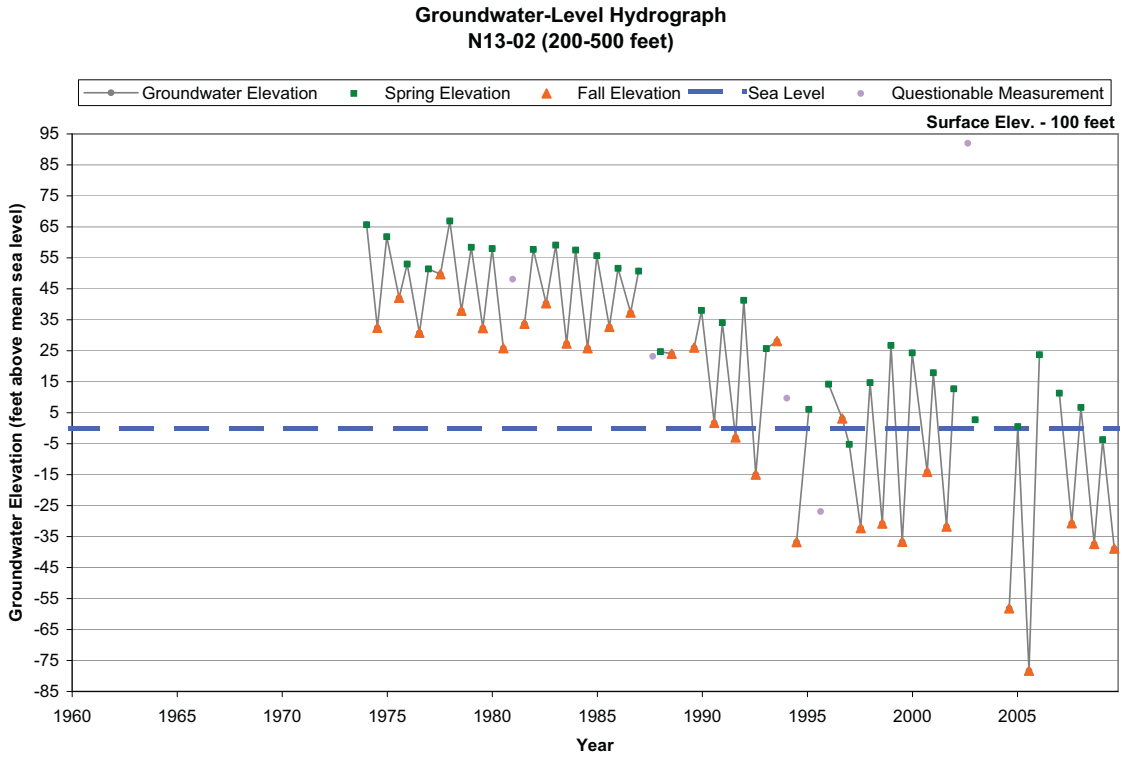
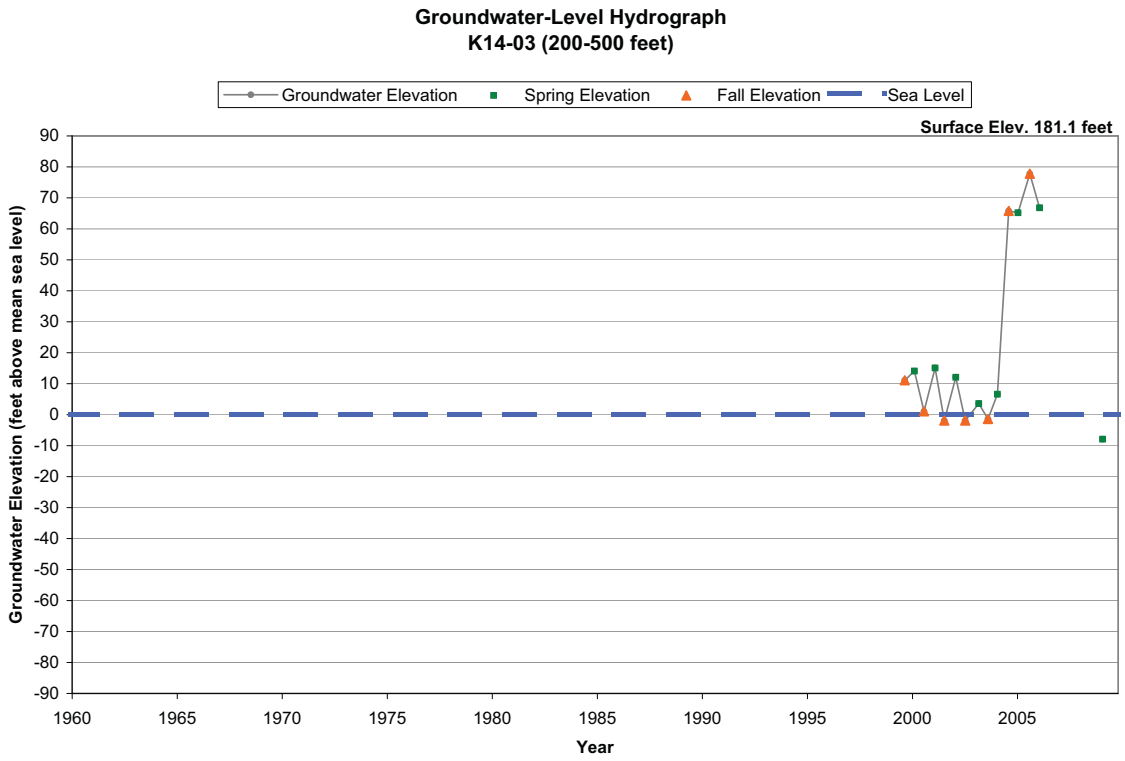
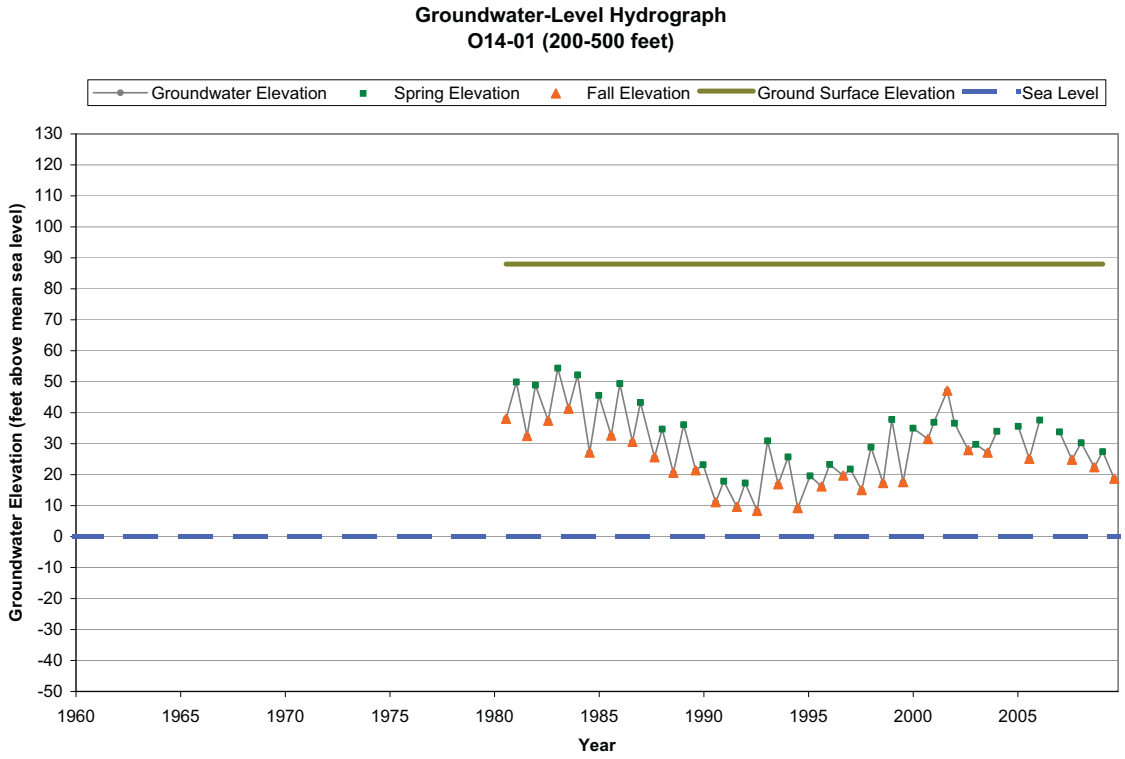
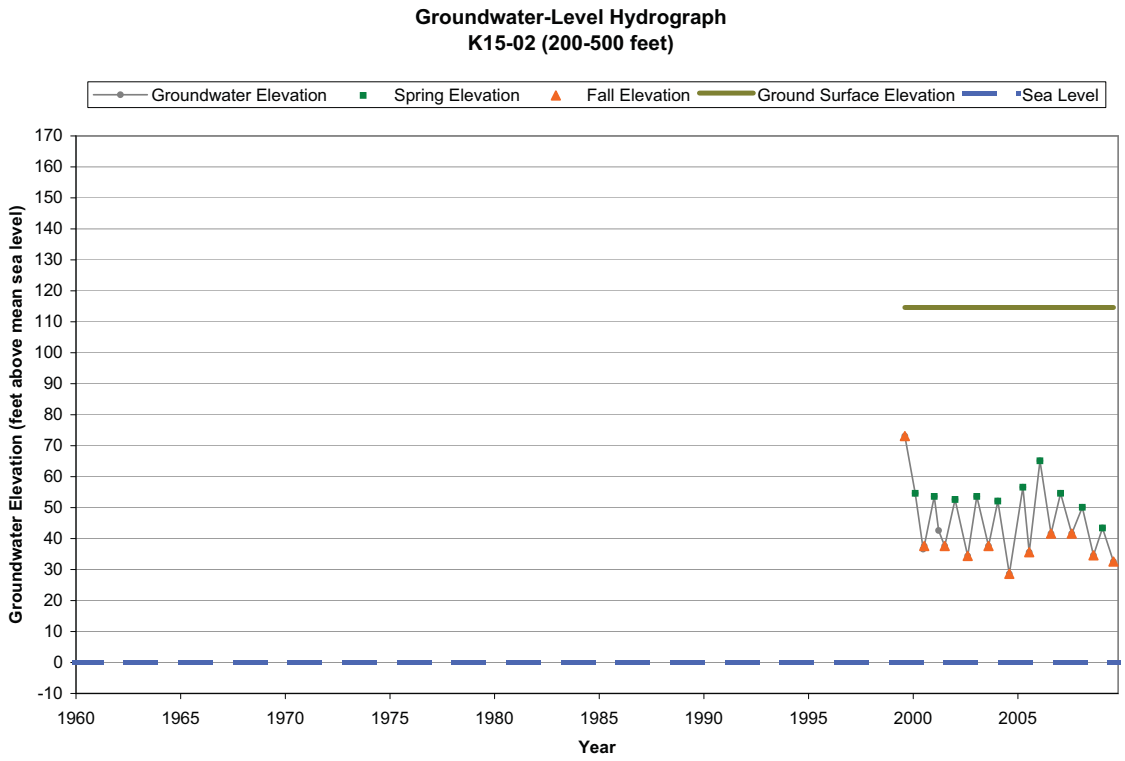
1985
1990
1995
2000
2005
Year

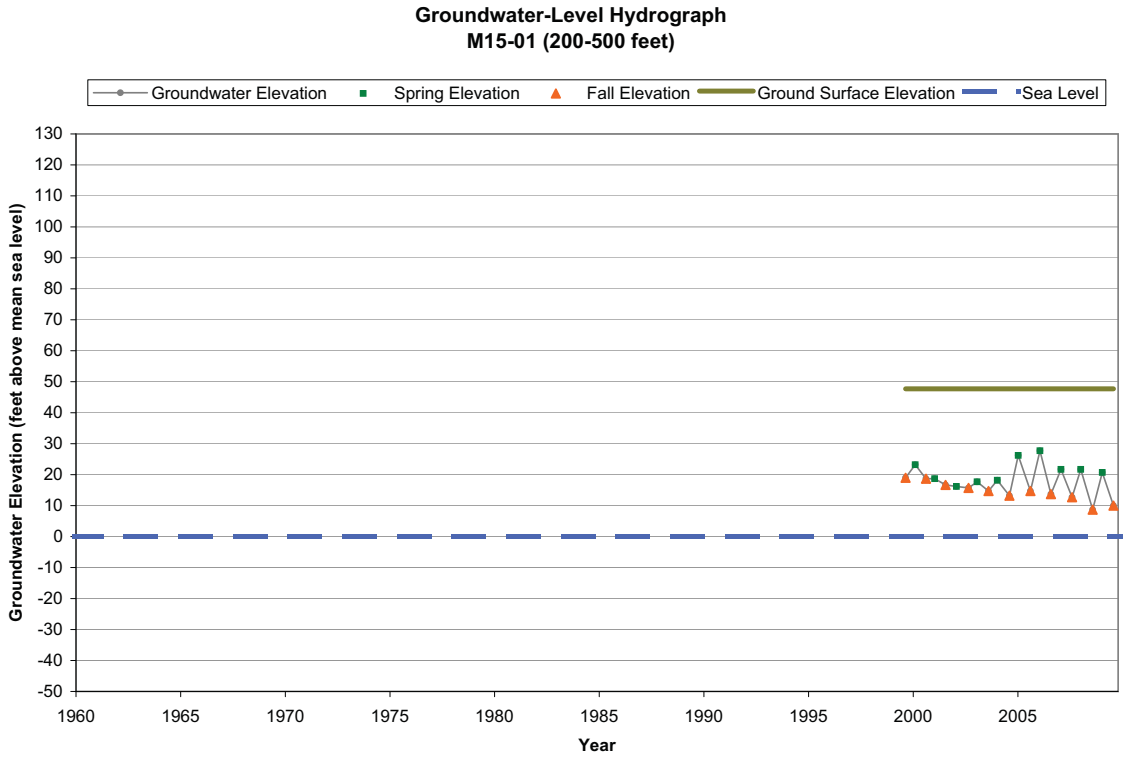

Groundwater-Level Hydrograph
N13-06 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year


Groundwater-Level Hydrograph
N13-02 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Questionable Measurement
Surface Elev. - 100 feet
Groundwater Elevation (feet above mean sea level)
Year


Groundwater-Level Hydrograph
K14-03 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 181.1 feet
Groundwater Elevation (feet above mean sea level)
Year


Groundwater-Level Hydrograph
O14-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
Year


Groundwater-Level Hydrograph
K15-02 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
M15-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
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-10
-20
-30
-40
-50
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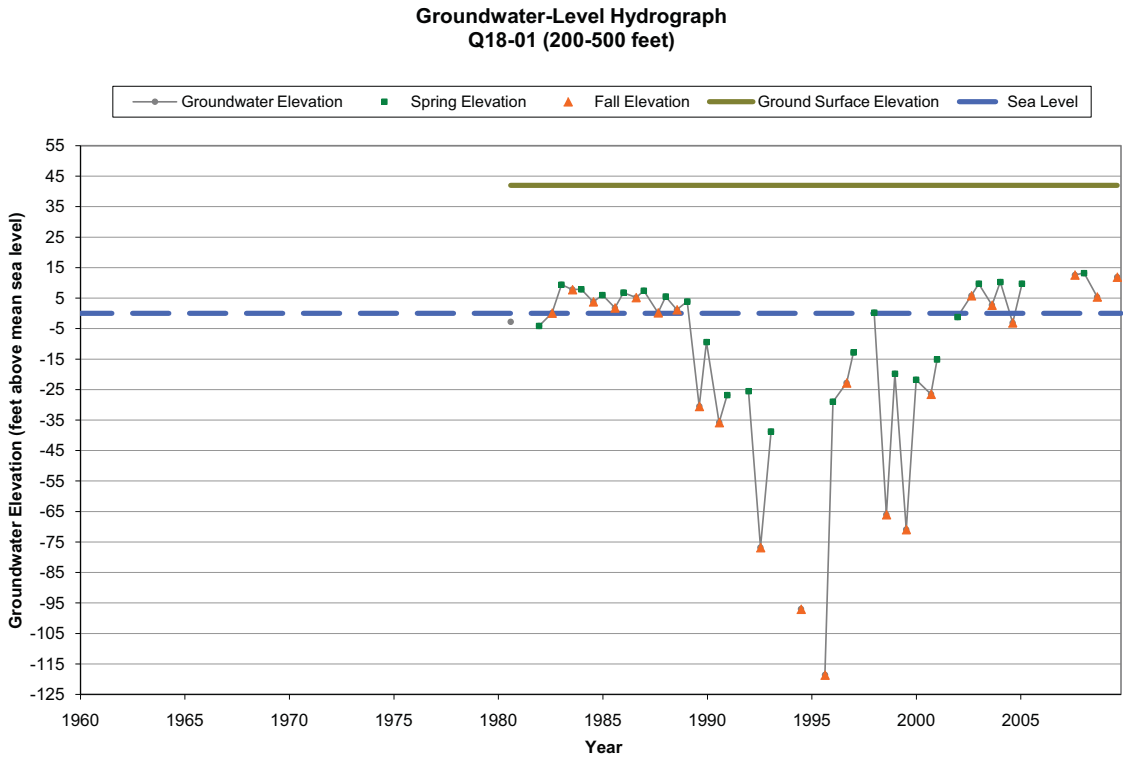
1995
2000
2005
Year


Groundwater-Level Hydrograph
Q18-01 (200-500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
55
45
35
25
15
5
-5
-15
-25
-35
-45
-55
-65
-75
-85
-95
-105
-115
-125
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

Groundwater Hydrographs

Greater Than 500 Feet Deep

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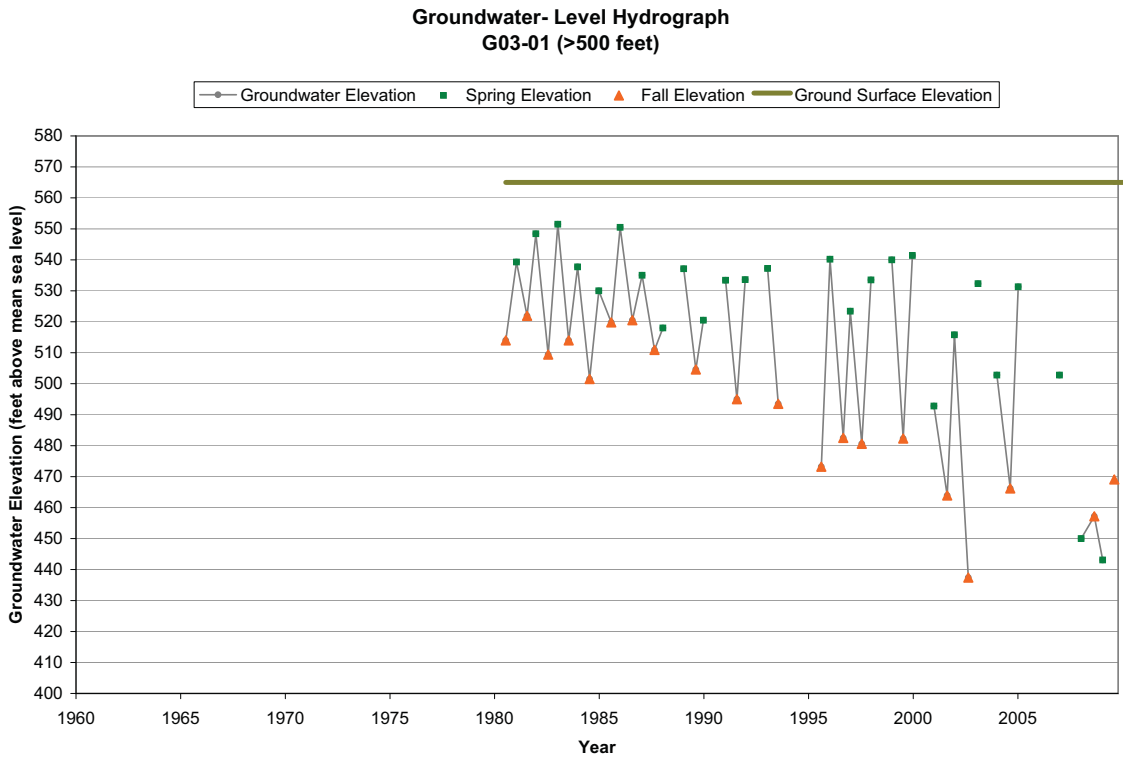
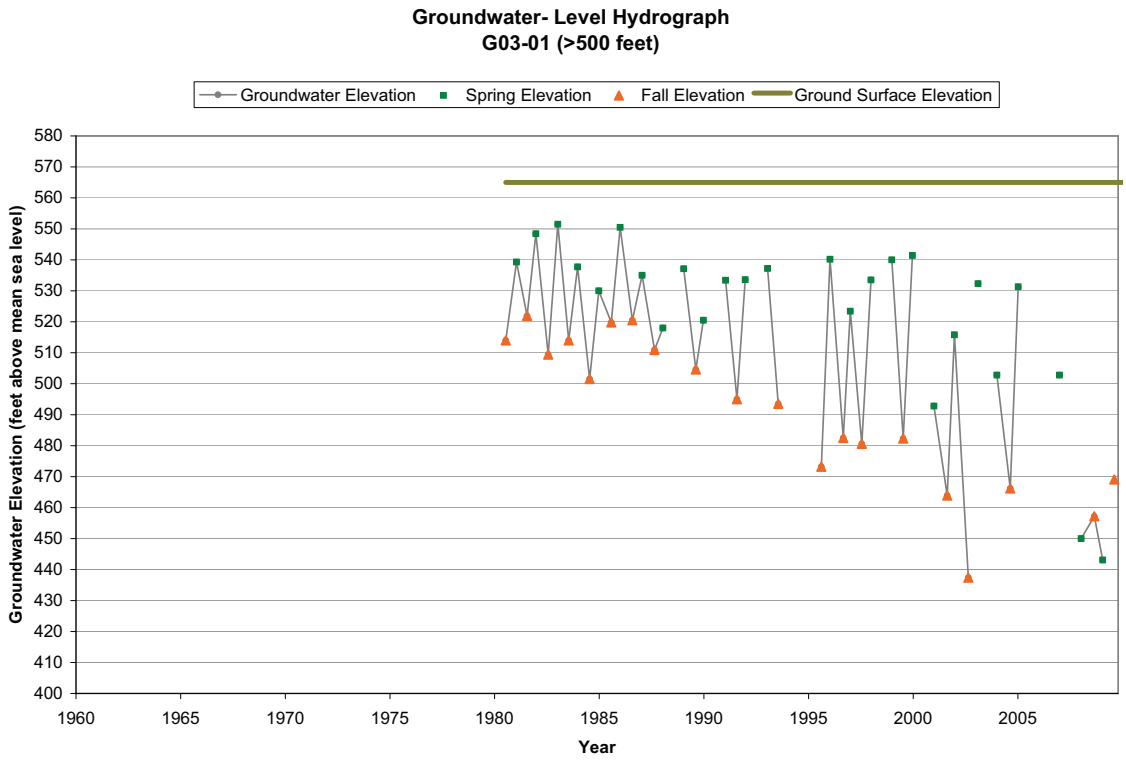
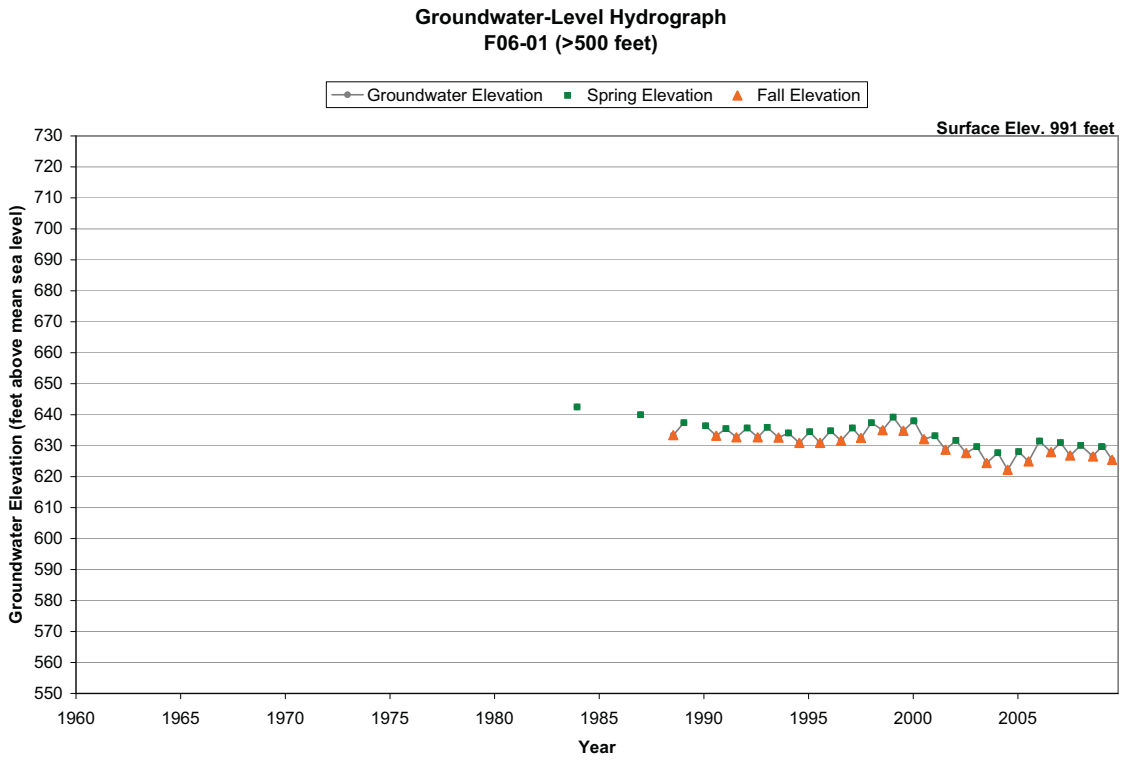
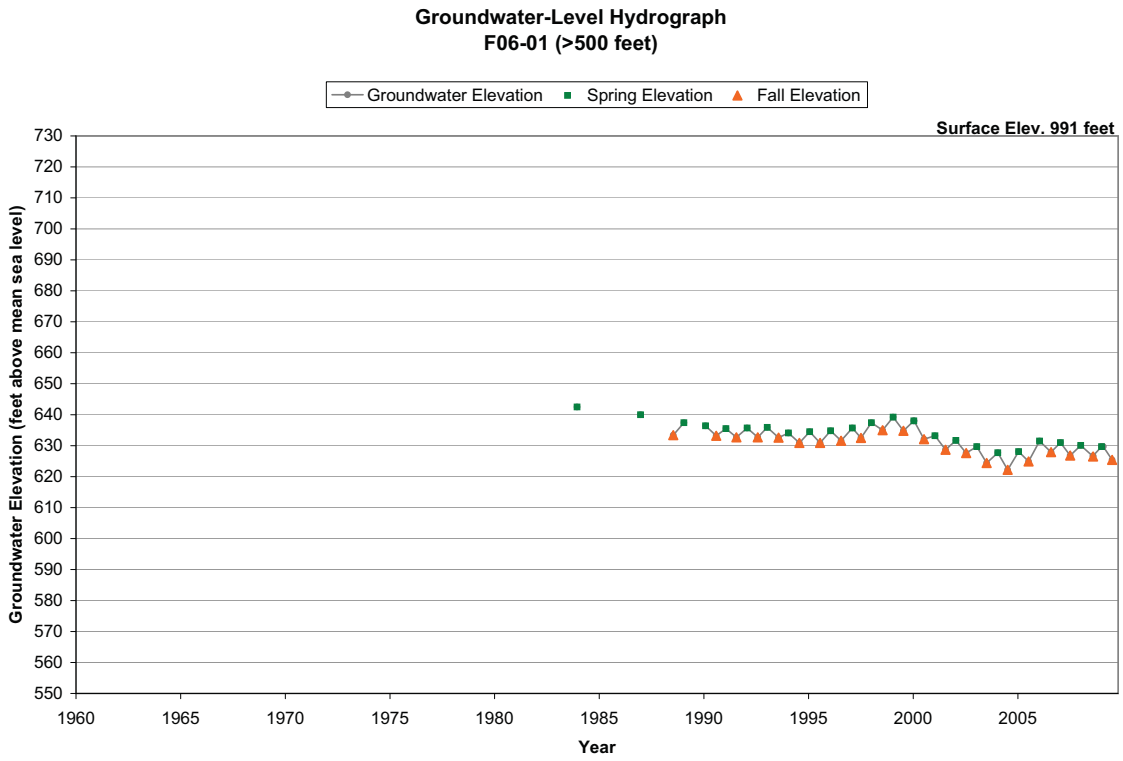

Groundwater- Level Hydrograph
G03-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater- Level Hydrograph
G03-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
F06-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 991 feet
Groundwater Elevation (feet above mean sea level)
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
F06-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 991 feet
Groundwater Elevation (feet above mean sea level)
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
1960
1965
1970
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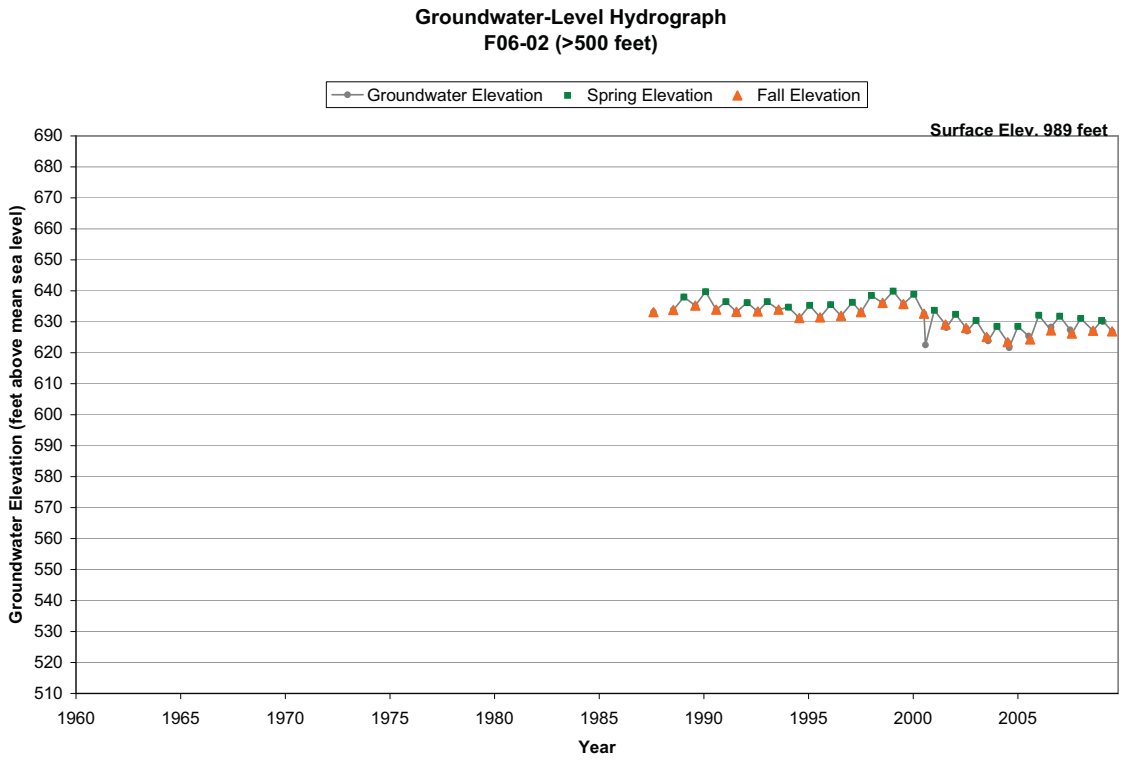
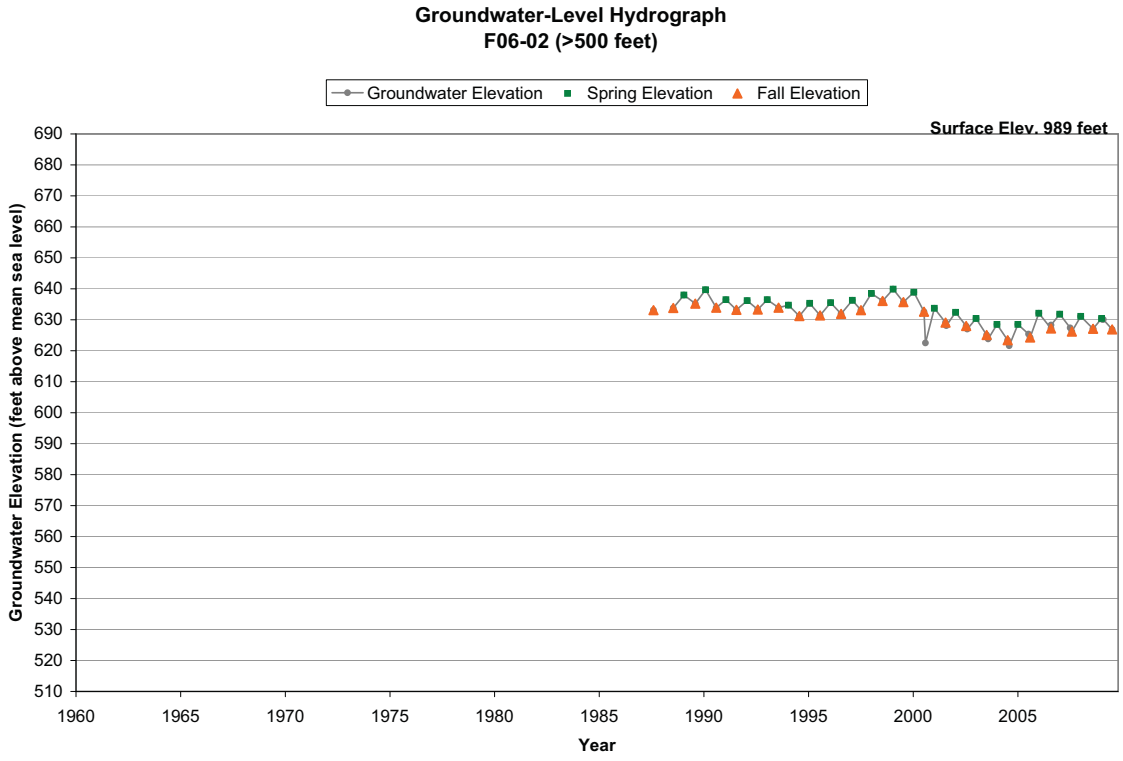
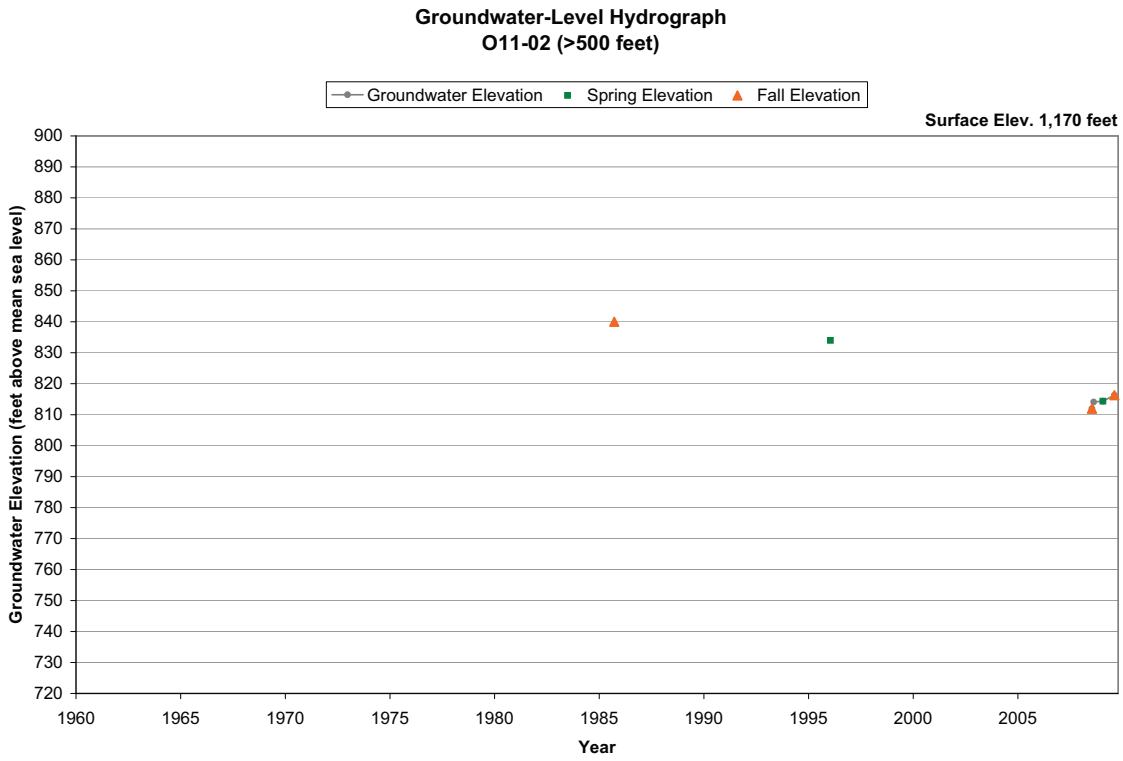
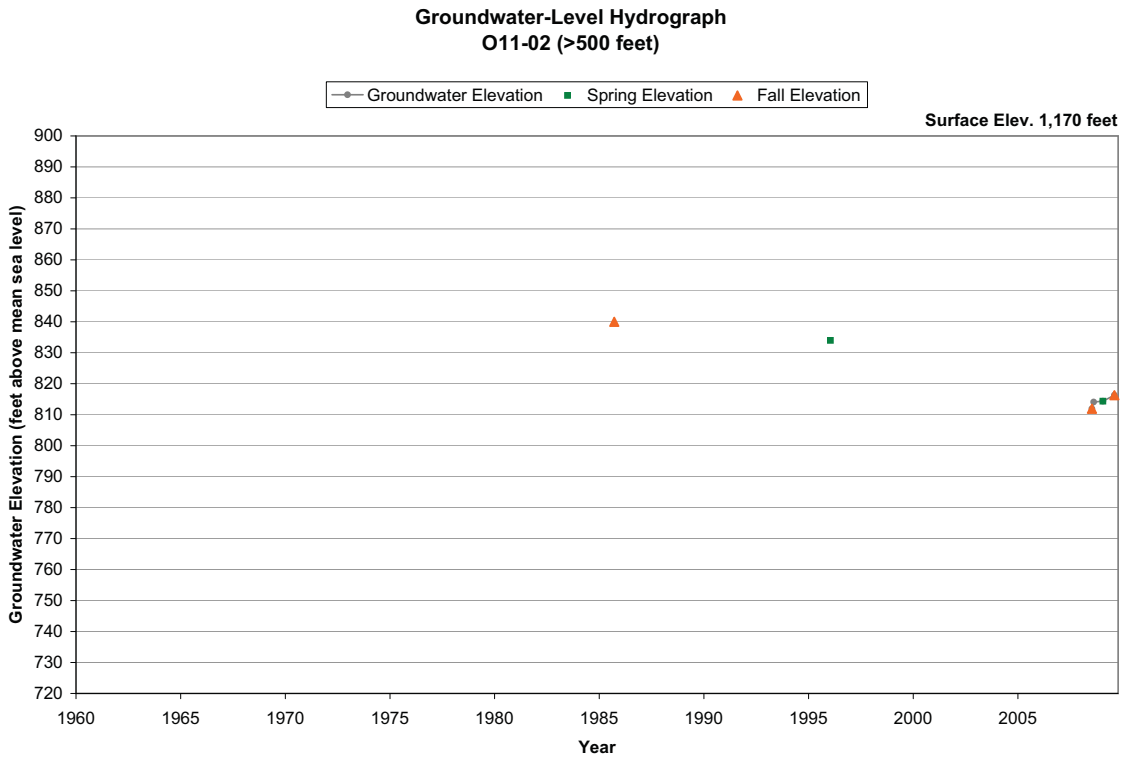
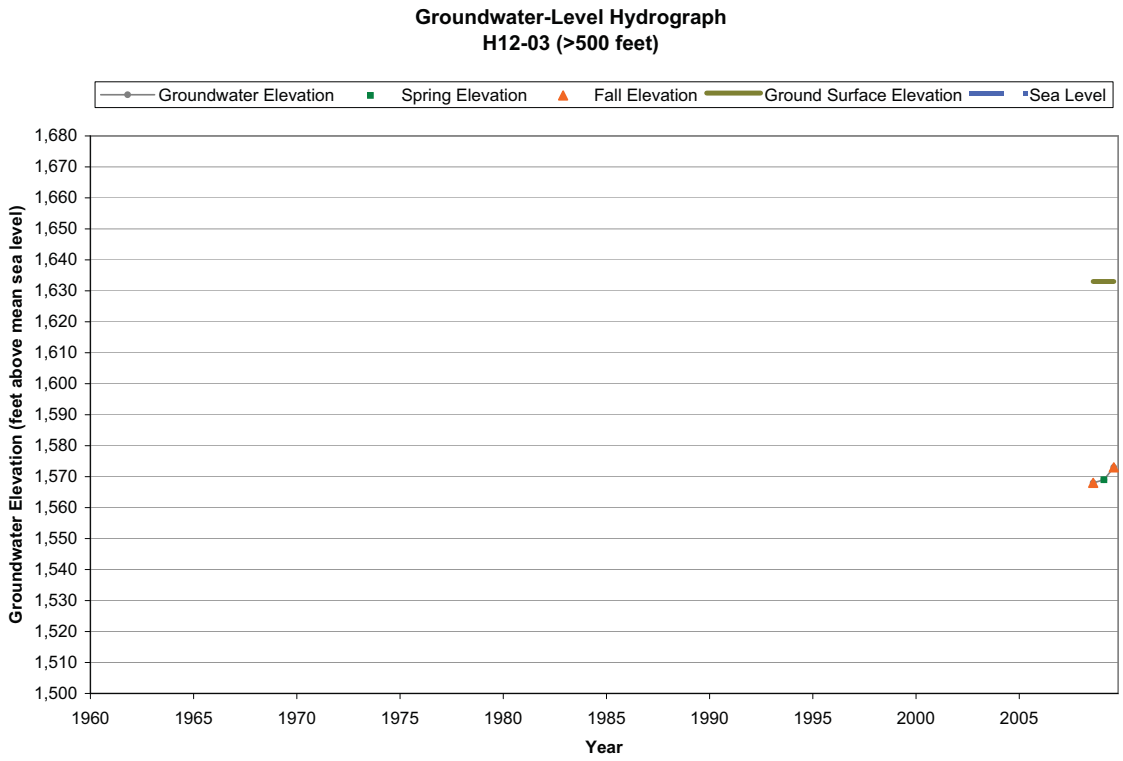
1980
1985
1990
1995
2000
2005
Year

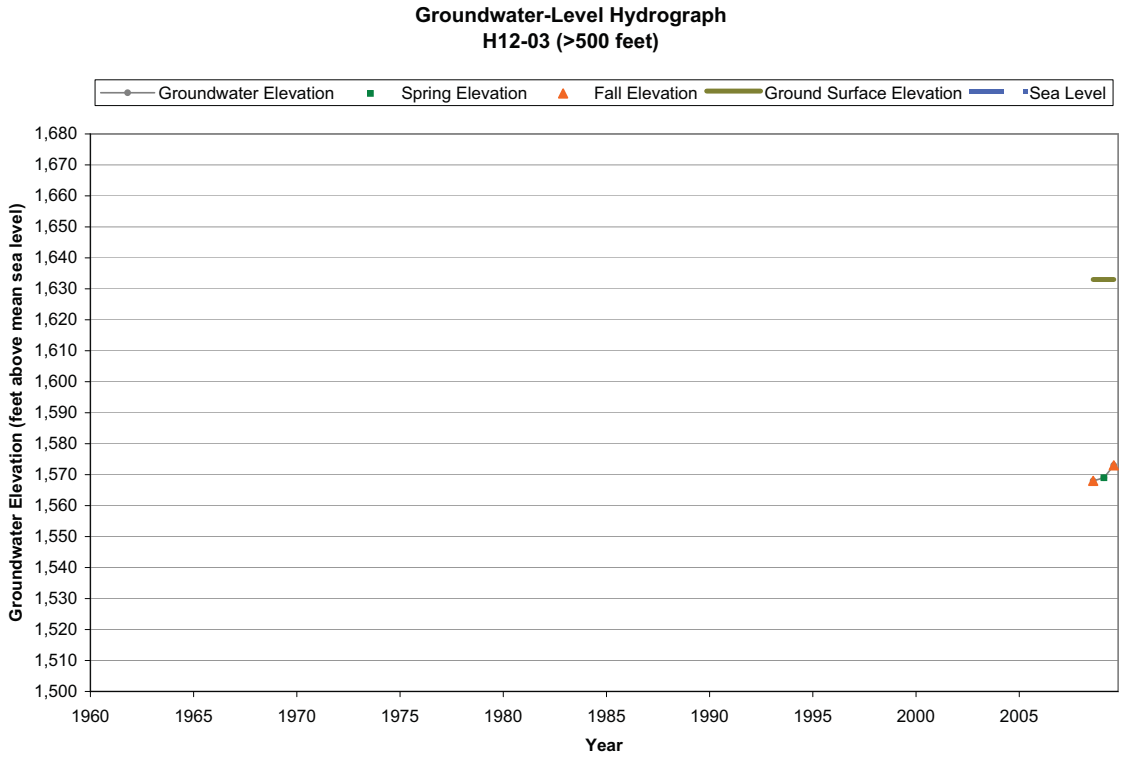

Groundwater-Level Hydrograph
F06-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 989 feet
Groundwater Elevation (feet above mean sea level)
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

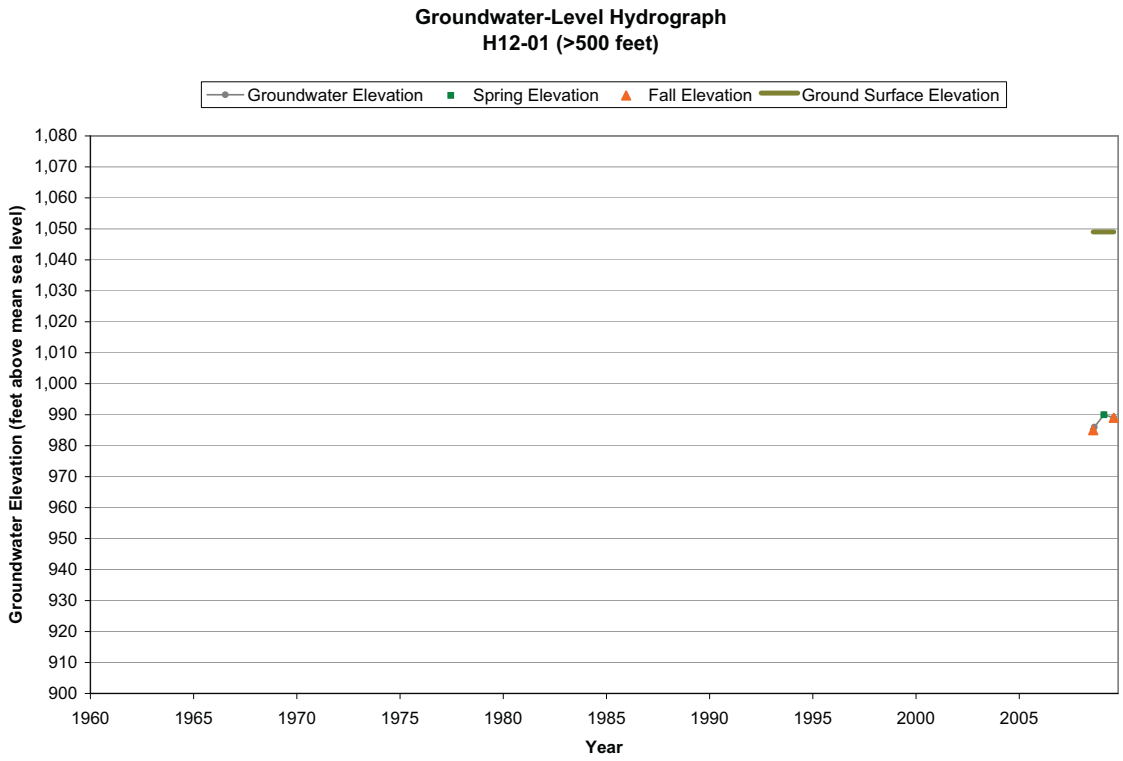

Groundwater-Level Hydrograph
F06-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 989 feet
Groundwater Elevation (feet above mean sea level)
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

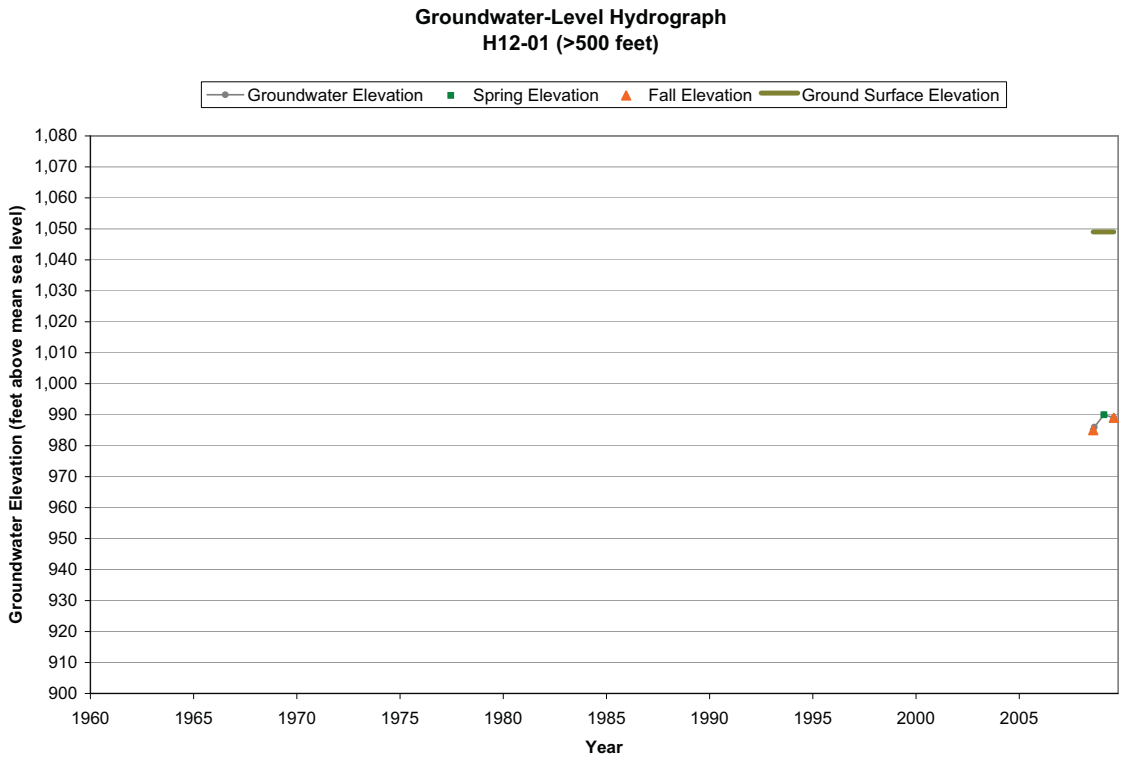

Groundwater-Level Hydrograph
O11-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,170 feet
Groundwater Elevation (feet above mean sea level)
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

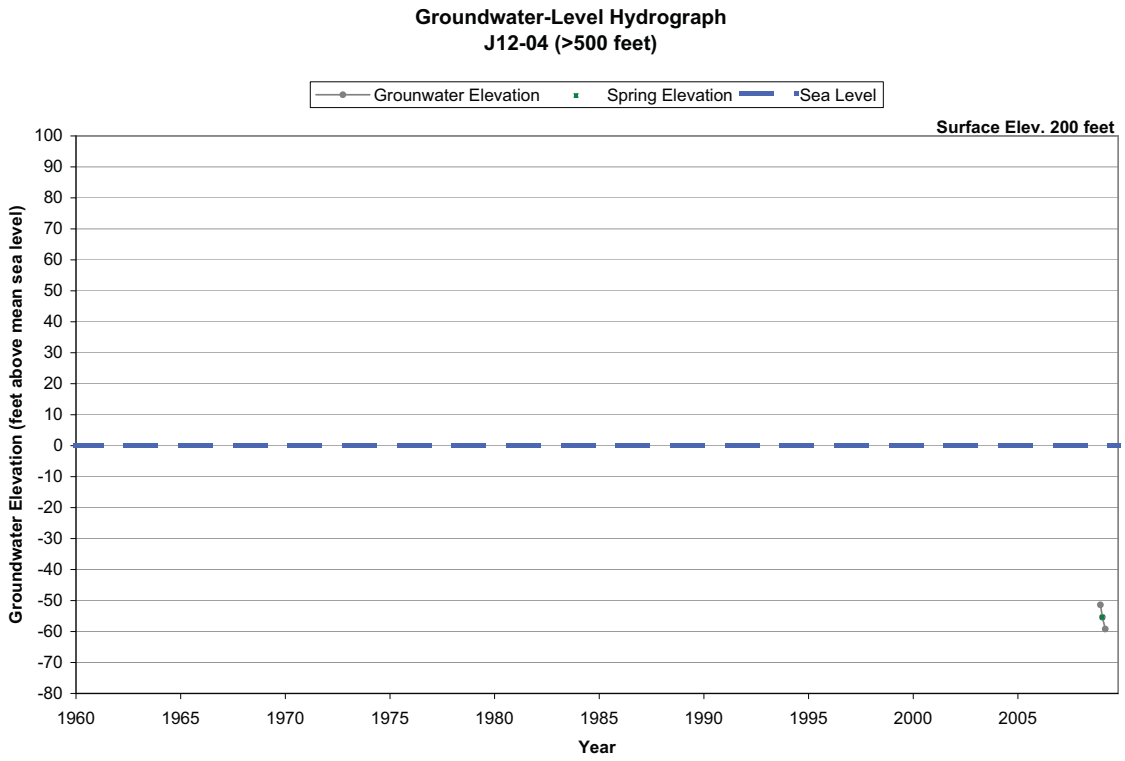

Groundwater-Level Hydrograph
O11-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,170 feet
Groundwater Elevation (feet above mean sea level)
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year

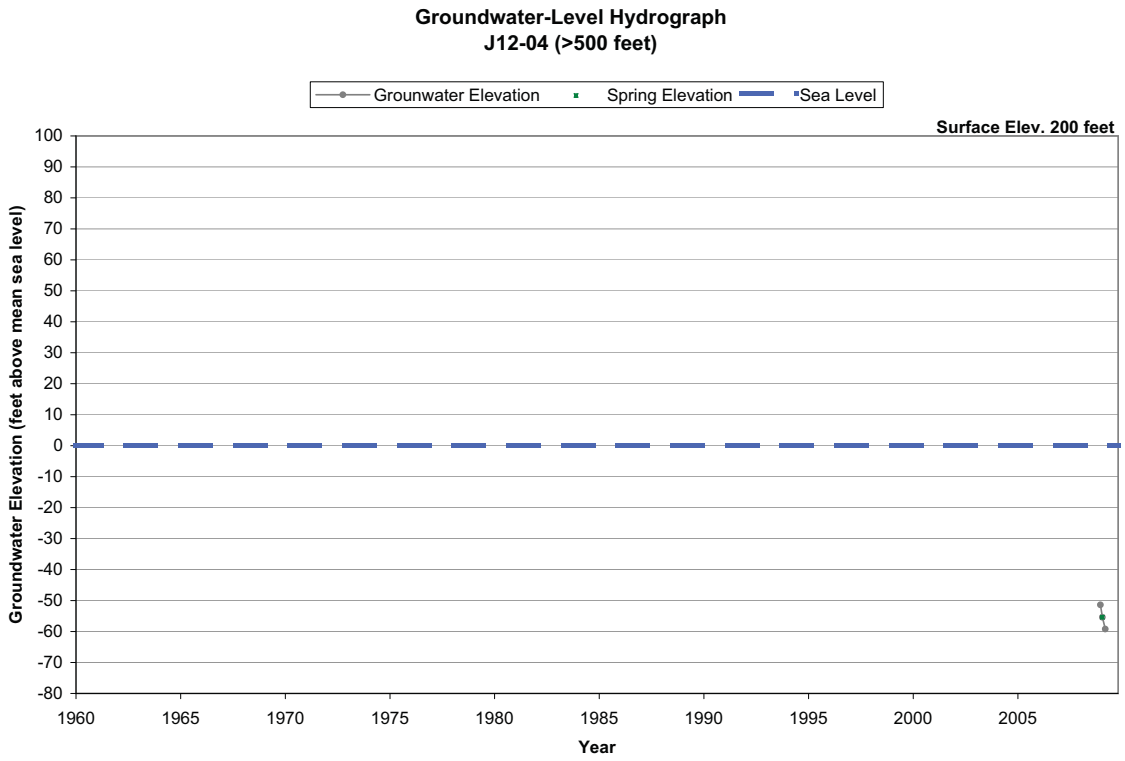

Groundwater-Level Hydrograph
H12-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
1,680
1,670
1,660
1,650
1,640
1,630
1,620
1,610
1,600
1,590
1,580
1,570
1,560
1,550
1,540
1,530
1,520
1,510
1,500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
H12-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
1,680
1,670
1,660
1,650
1,640
1,630
1,620
1,610
1,600
1,590
1,580
1,570
1,560
1,550
1,540
1,530
1,520
1,510
1,500
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
H12-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
1,080
1,070
1,060
1,050
1,040
1,030
1,020
1,010
1,000
990
980
970
960
950
940
930
920
910
900
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
H12-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level)
1,080
1,070
1,060
1,050
1,040
1,030
1,020
1,010
1,000
990
980
970
960
950
940
930
920
910
900
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J12-04 (>500 feet)
Grounwater Elevation
Spring Elevation
Sea Level
Surface Elev. 200 feet
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J12-04 (>500 feet)
Grounwater Elevation
Spring Elevation
Sea Level
Surface Elev. 200 feet
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
1960
1965
1970
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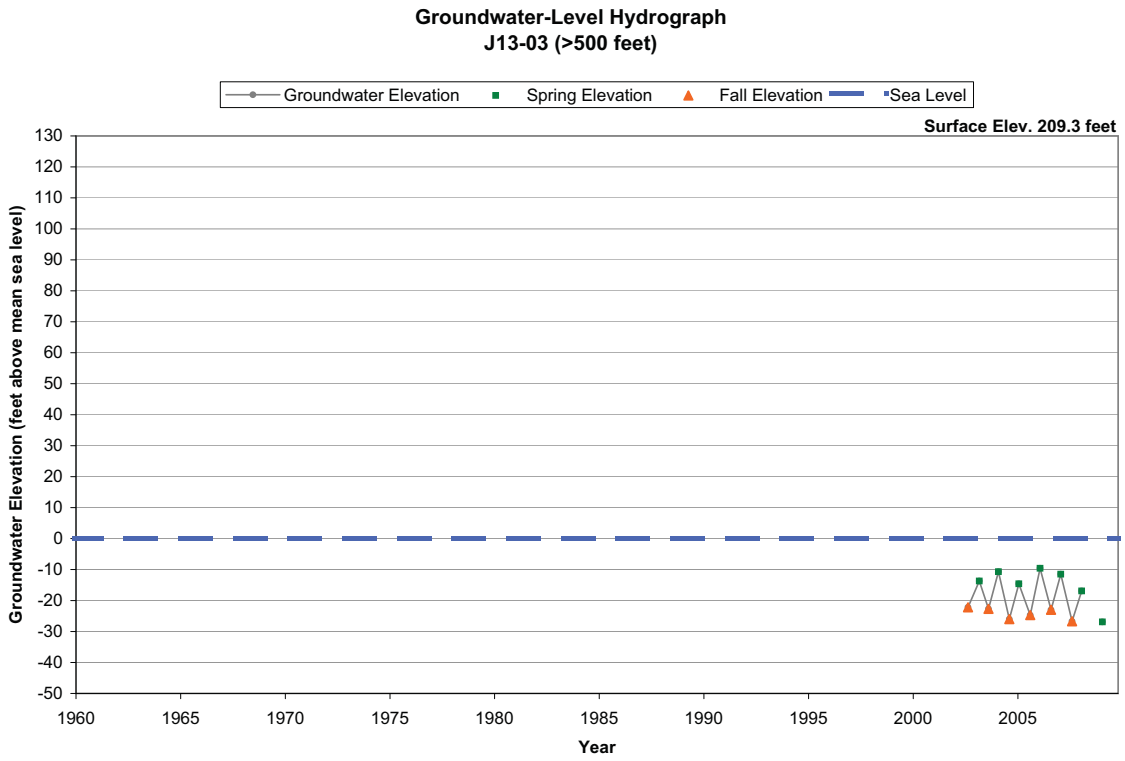
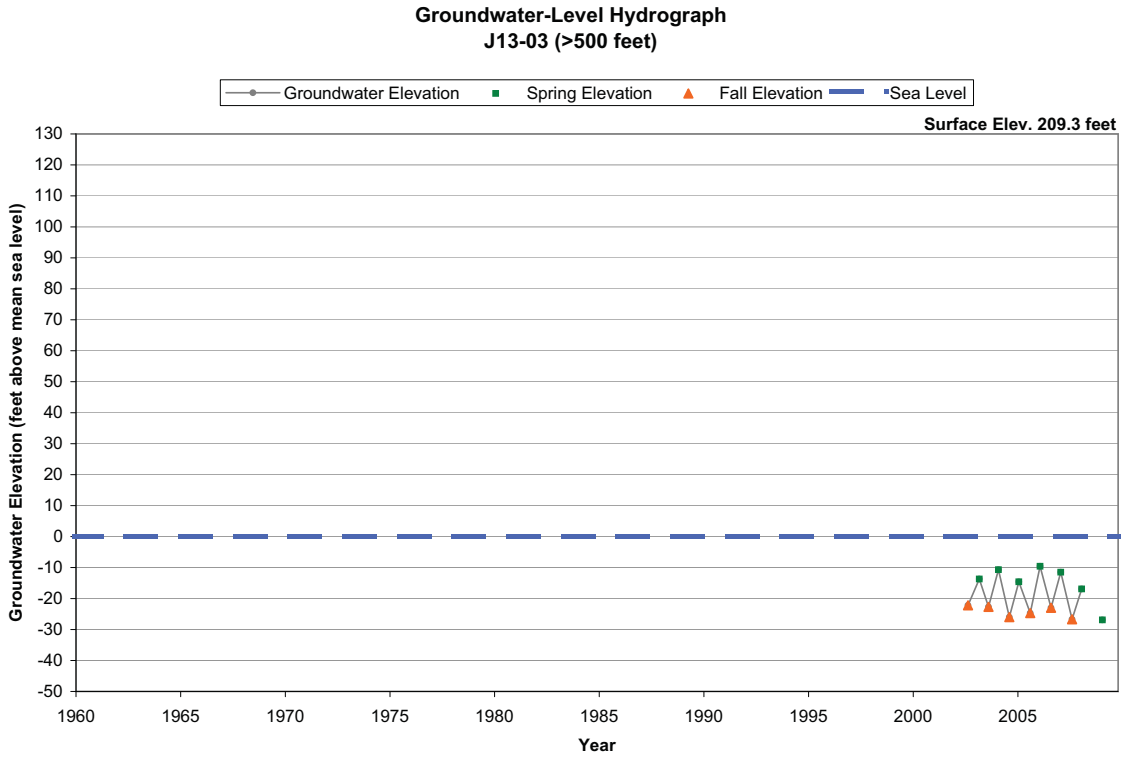
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J13-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 209.3 feet
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
J13-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 209.3 feet
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
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1960
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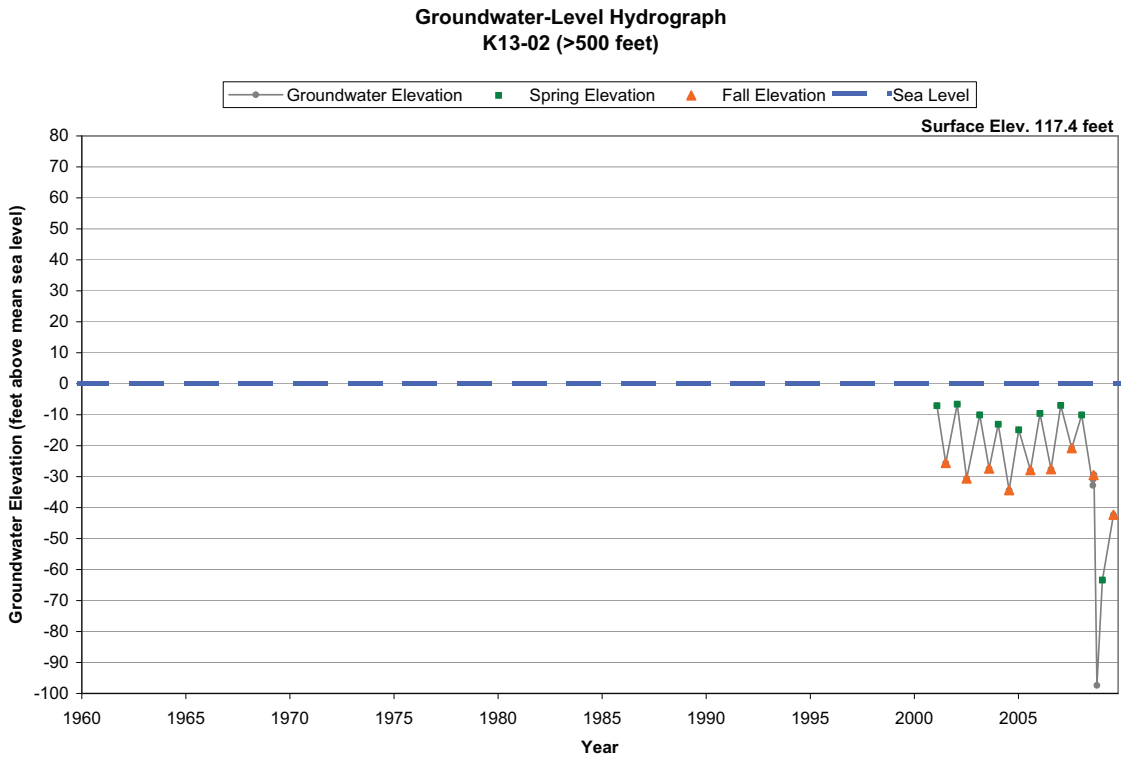
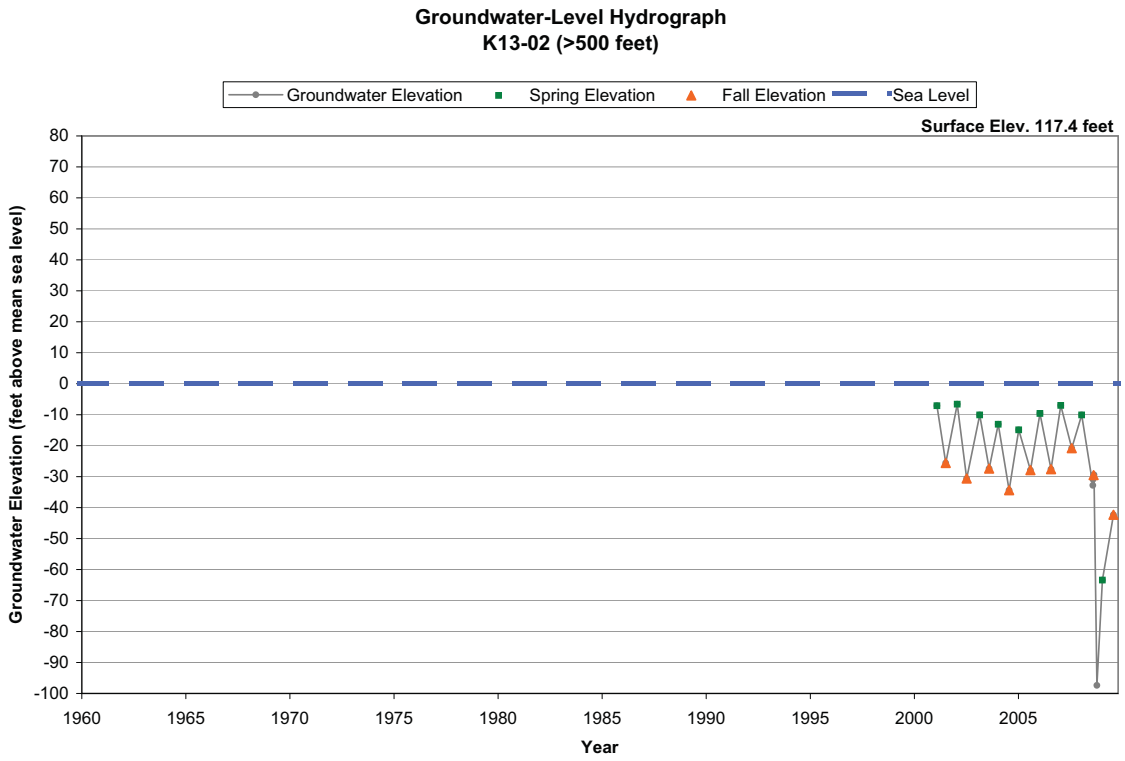
Year


Groundwater-Level Hydrograph
K13-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 117.4 feet
Groundwater Elevation (feet above mean sea level)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
K13-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 117.4 feet
Groundwater Elevation (feet above mean sea level)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
1960
1965
1970
1975
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1985
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1995
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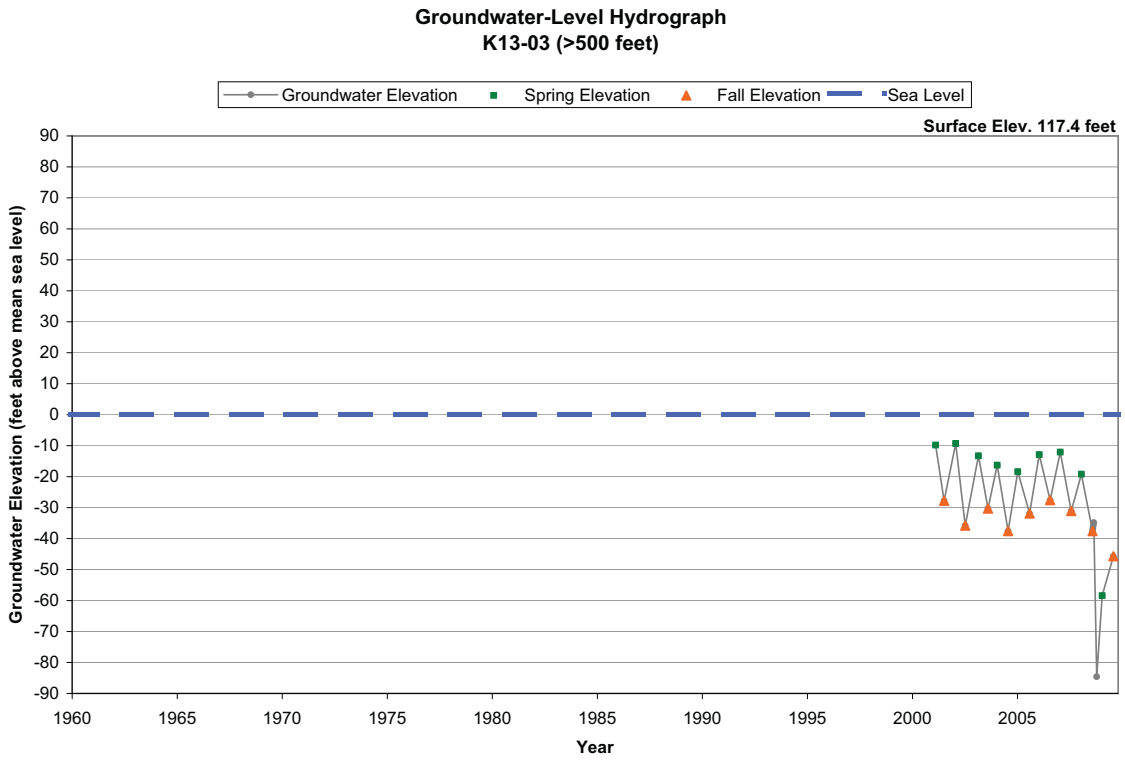
2005
Year


Groundwater-Level Hydrograph
K13-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 117.4 feet
Groundwater Elevation (feet above mean sea level)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1960
1965
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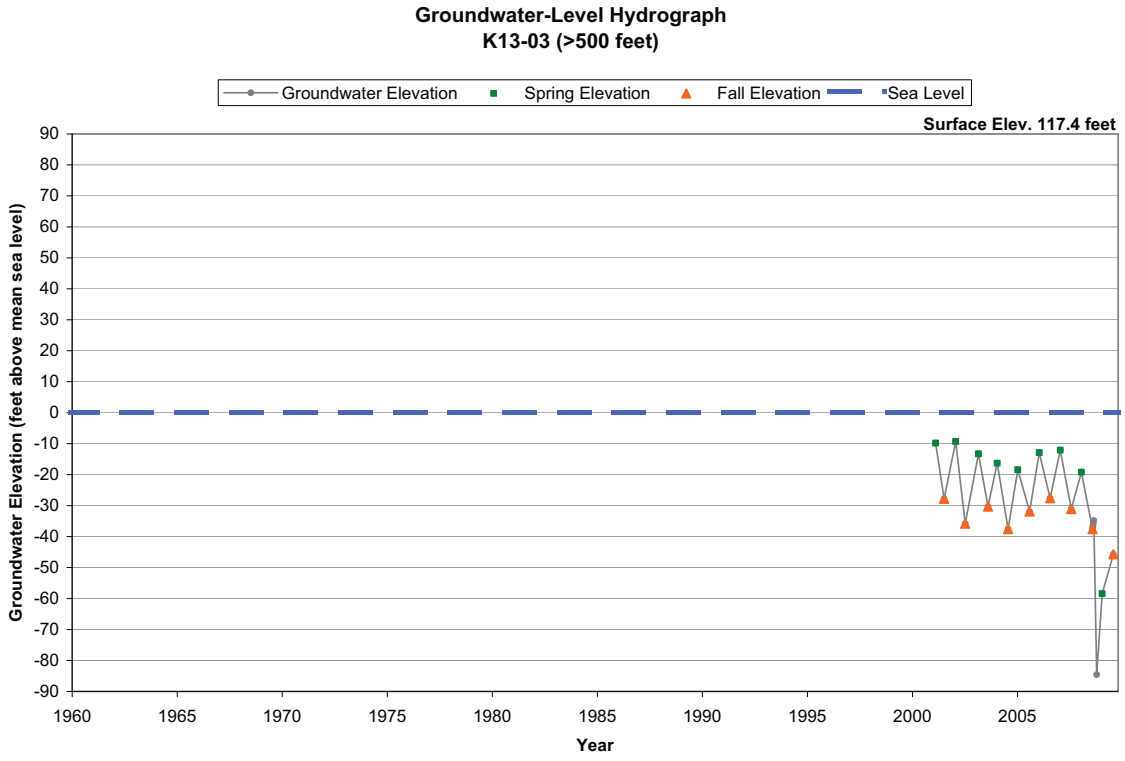
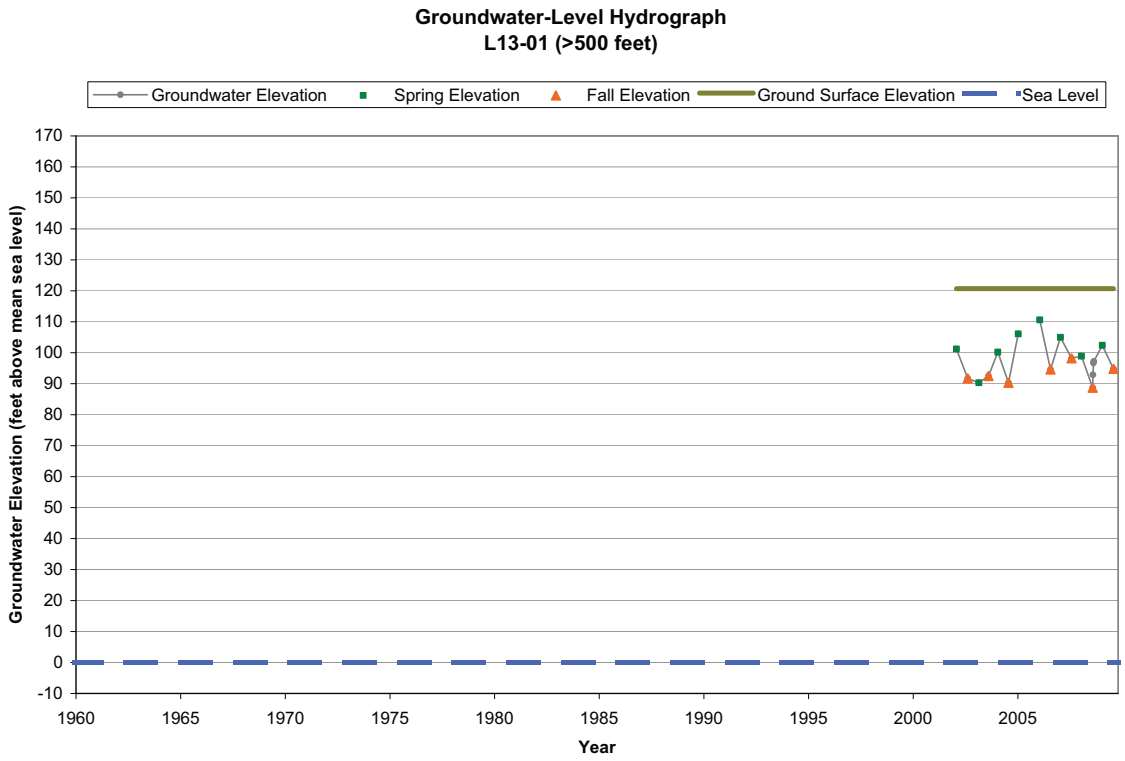
Year


Groundwater-Level Hydrograph
K13-03 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 117.4 feet
Groundwater Elevation (feet above mean sea level)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
L13-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
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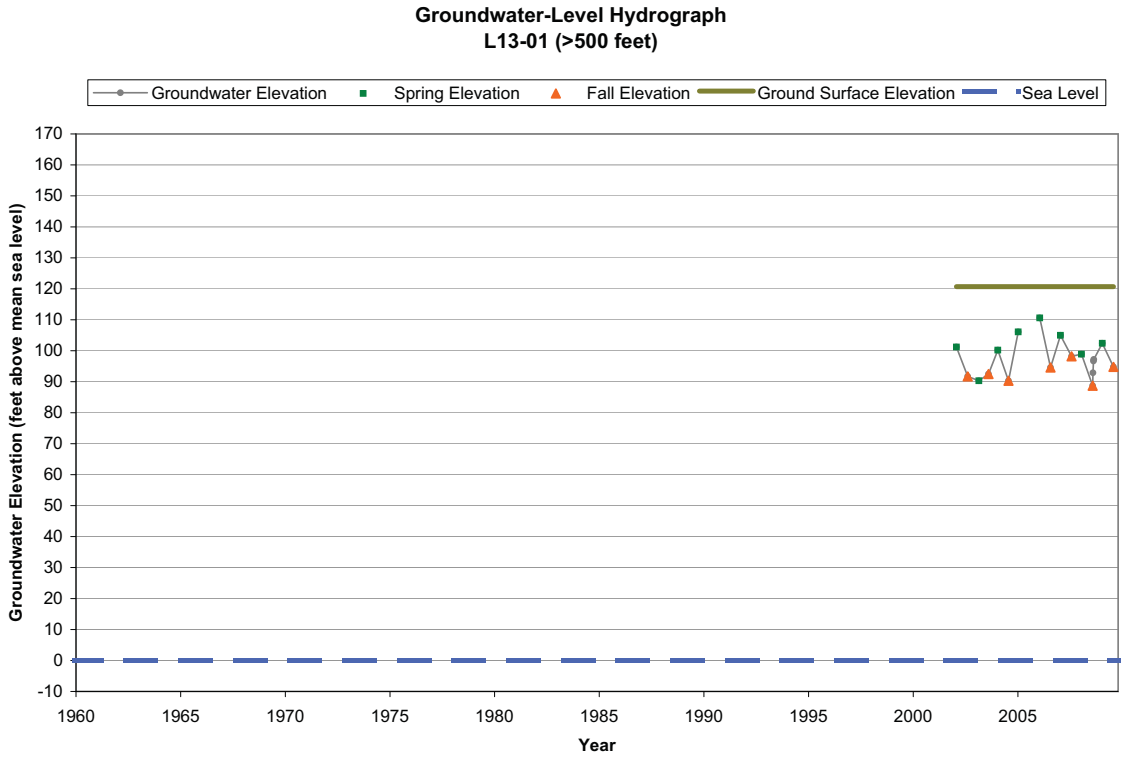
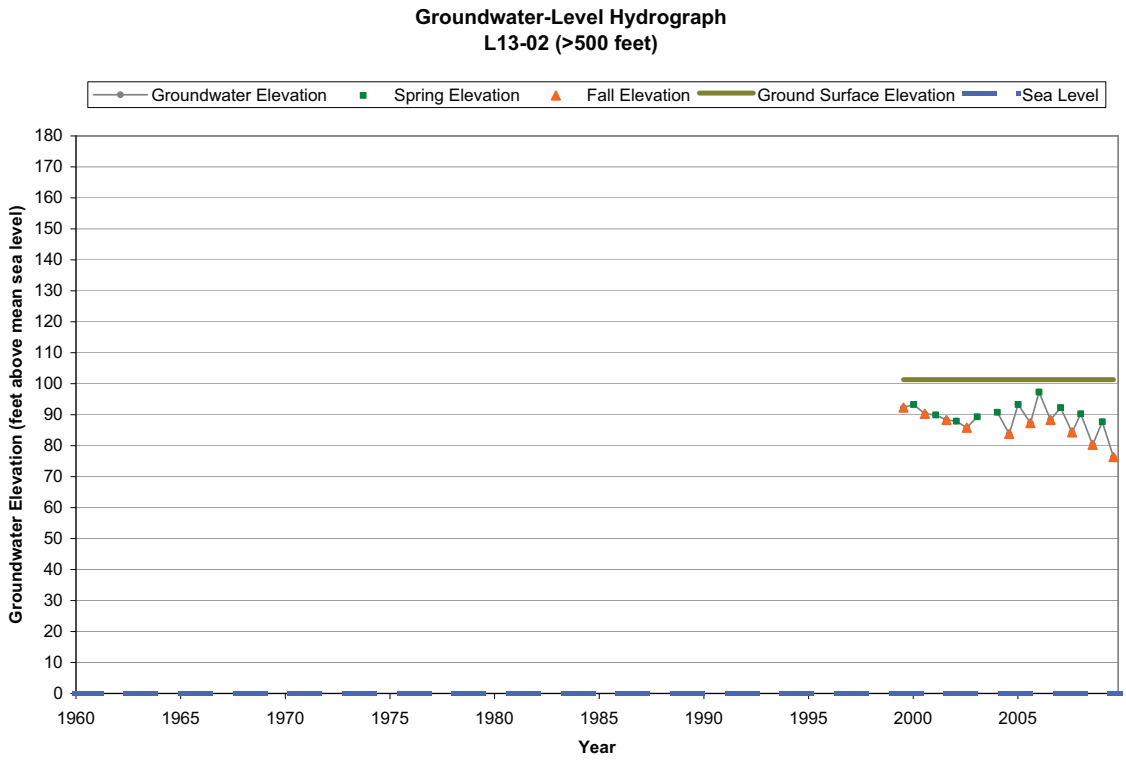
Year


Groundwater-Level Hydrograph
L13-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year


Groundwater-Level Hydrograph
L13-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
90
80
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1965
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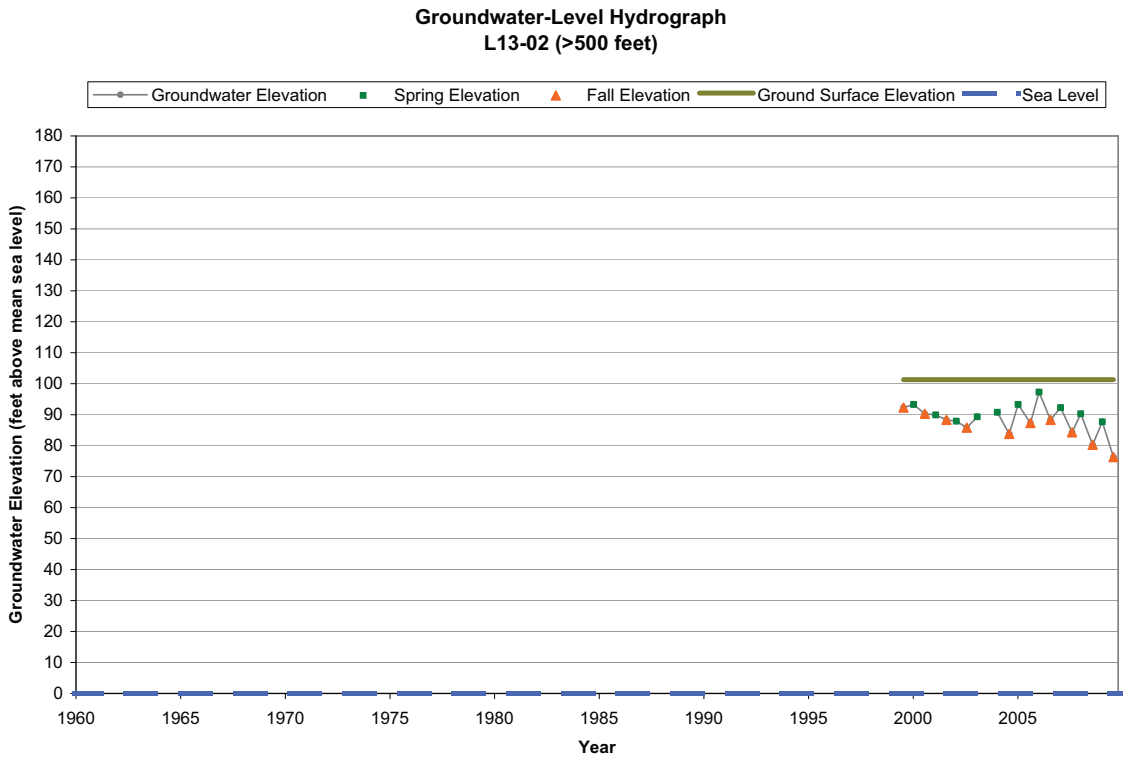
2005
Year


Groundwater-Level Hydrograph
L13-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
180
170
160
150
140
130
120
110
100
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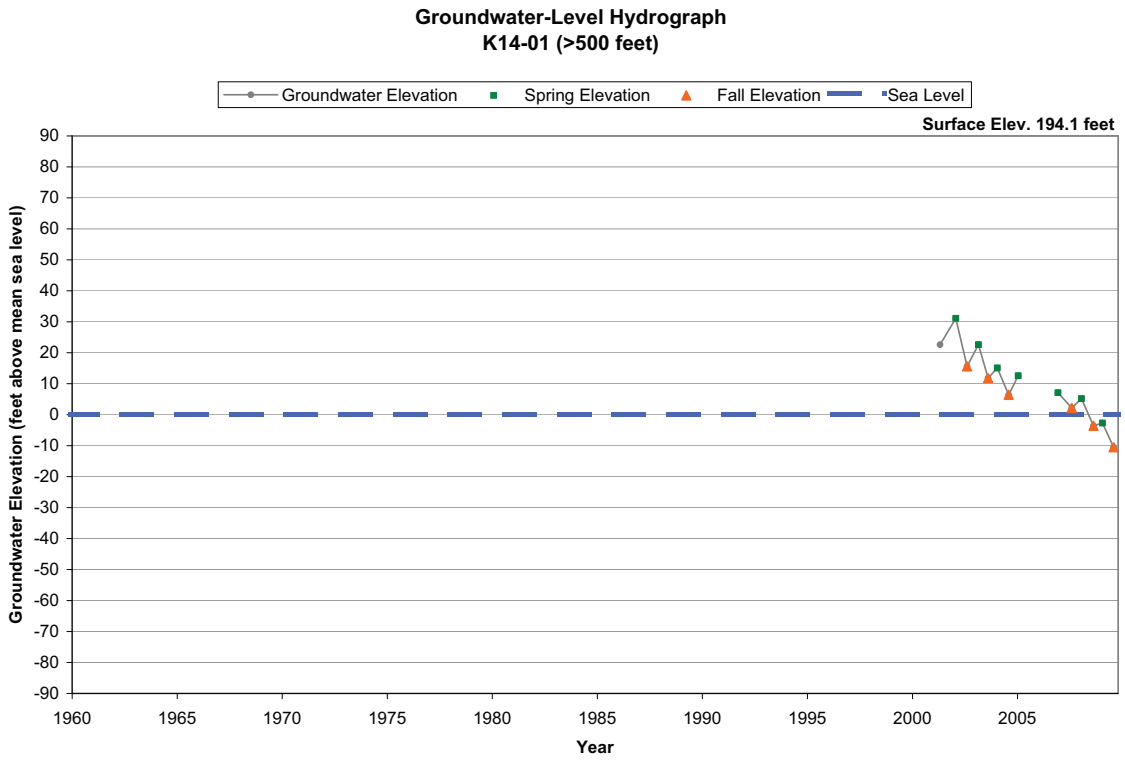
Year


Groundwater-Level Hydrograph
K14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 194.1 feet
Groundwater Elevation (feet above mean sea level)
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
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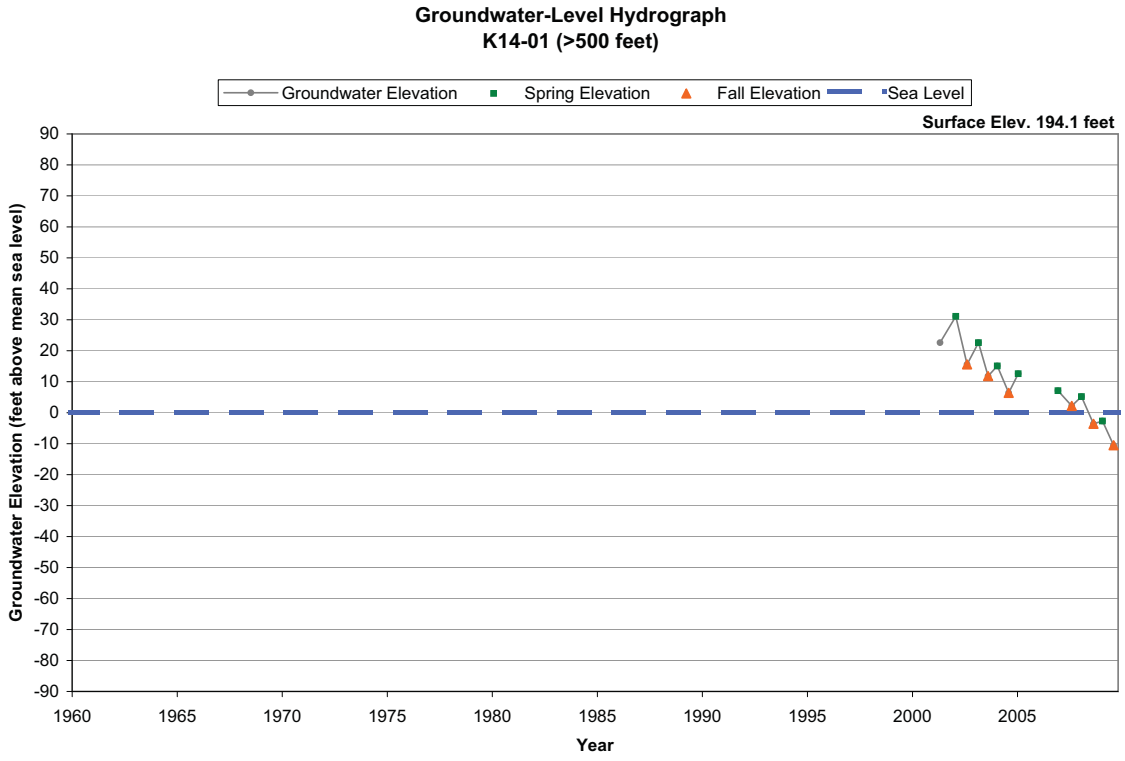
Year


Groundwater-Level Hydrograph
K14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 194.1 feet
Groundwater Elevation (feet above mean sea level)
90
80
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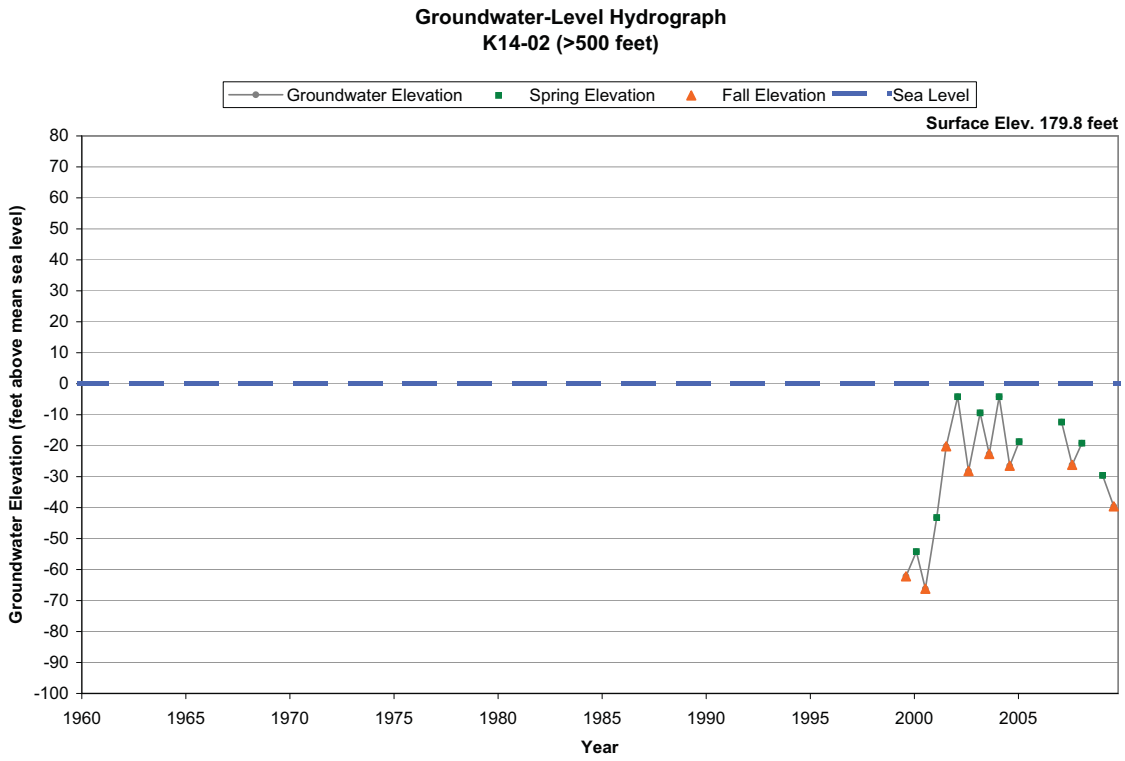
Year


Groundwater-Level Hydrograph
K14-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 179.8 feet
Groundwater Elevation (feet above mean sea level)
80
70
60
50
40
30
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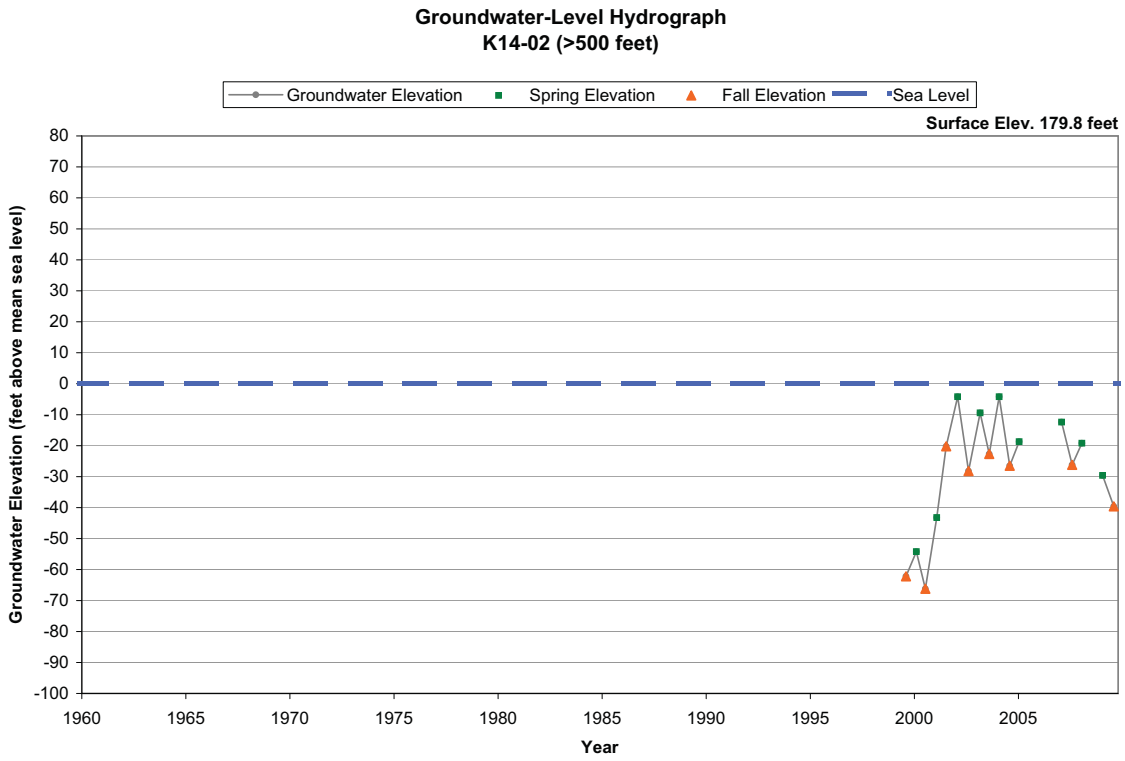
Groundwater-Level Hydrograph
K14-02 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 179.8 feet
Groundwater Elevation (feet above mean sea level)
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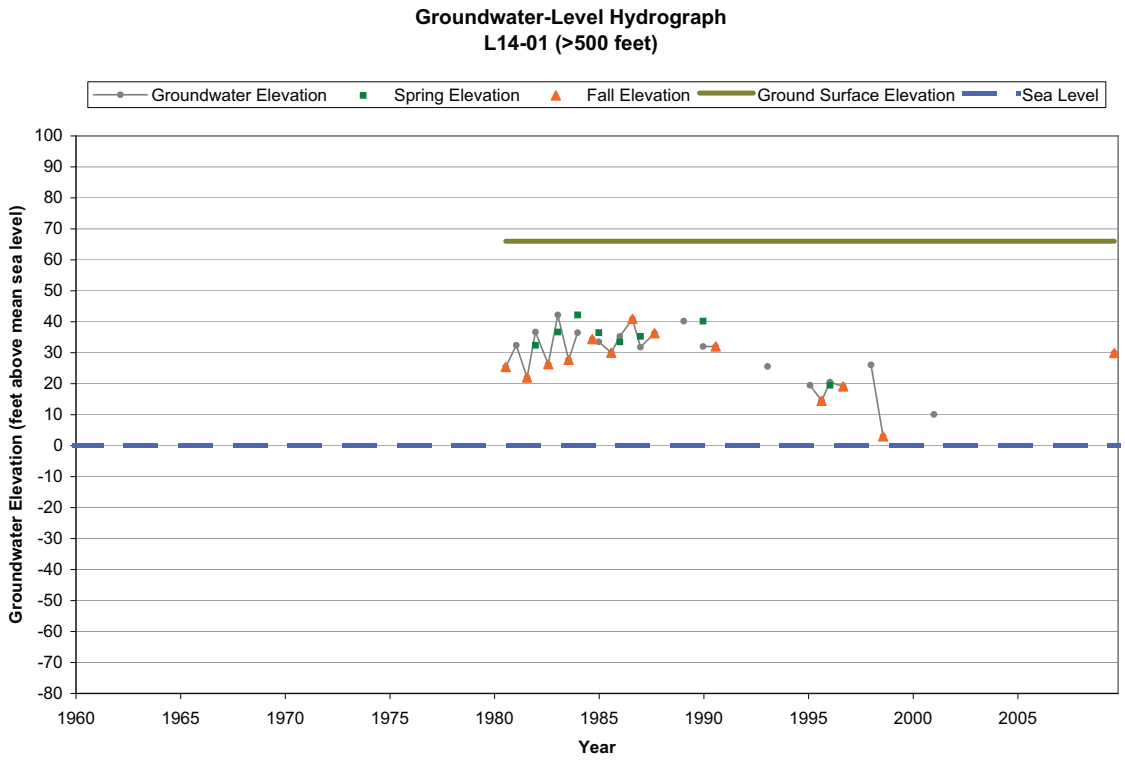
Groundwater-Level Hydrograph
L14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
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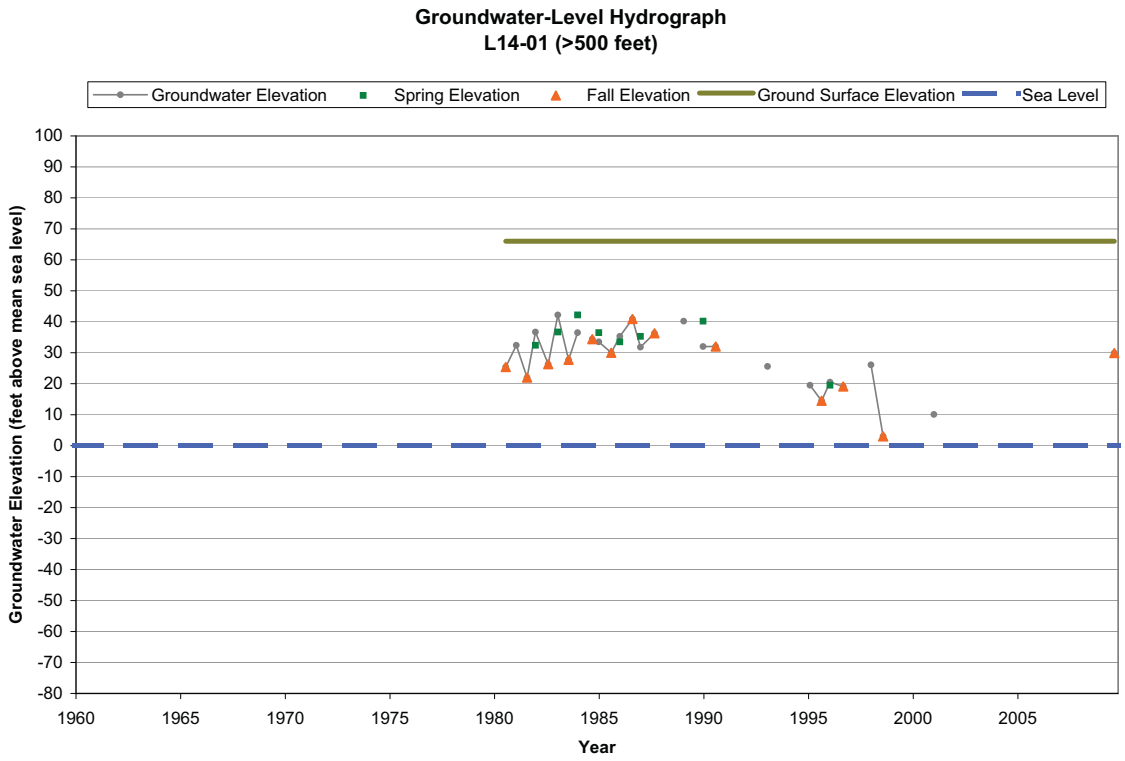
Groundwater-Level Hydrograph
L14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
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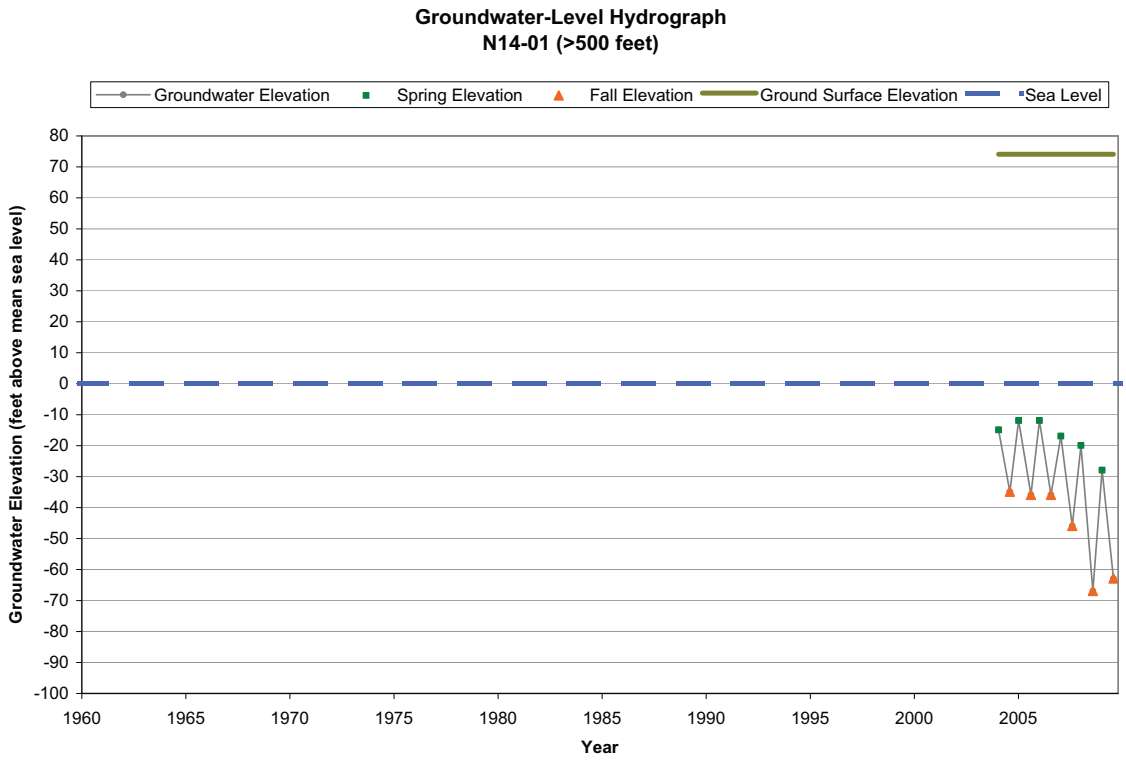
Groundwater-Level Hydrograph
N14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
80
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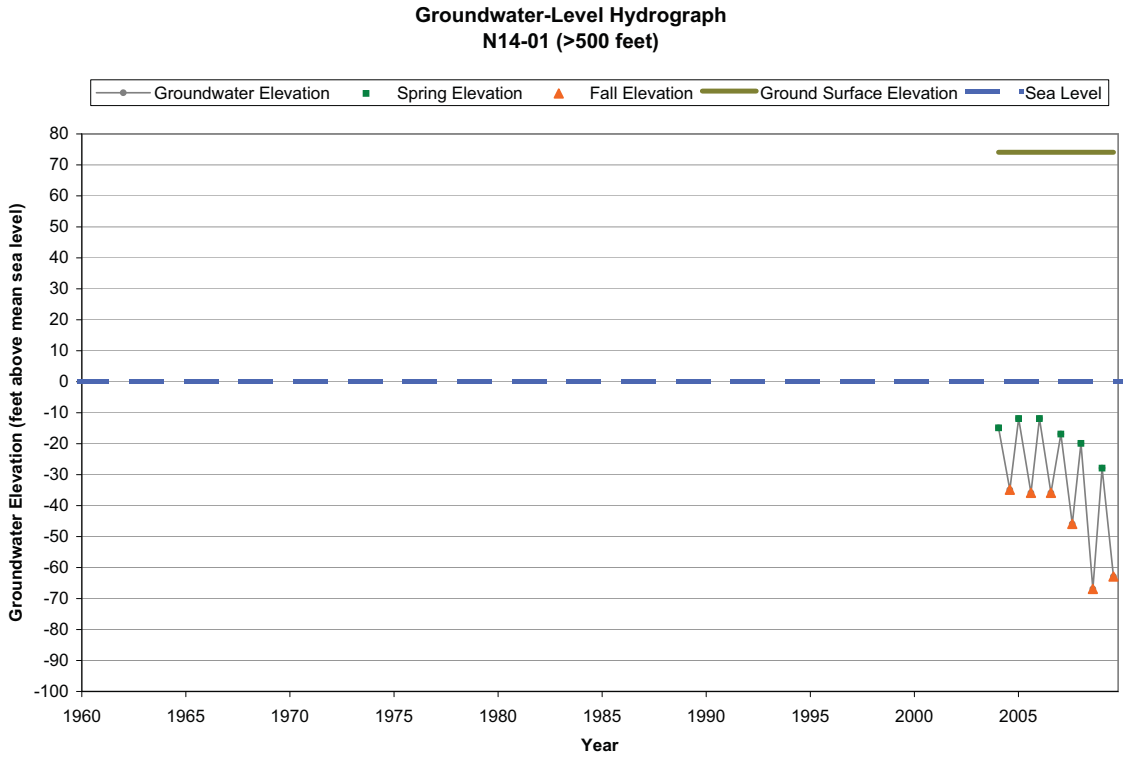
Year


Groundwater-Level Hydrograph
N14-01 (>500 feet)
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
80
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60
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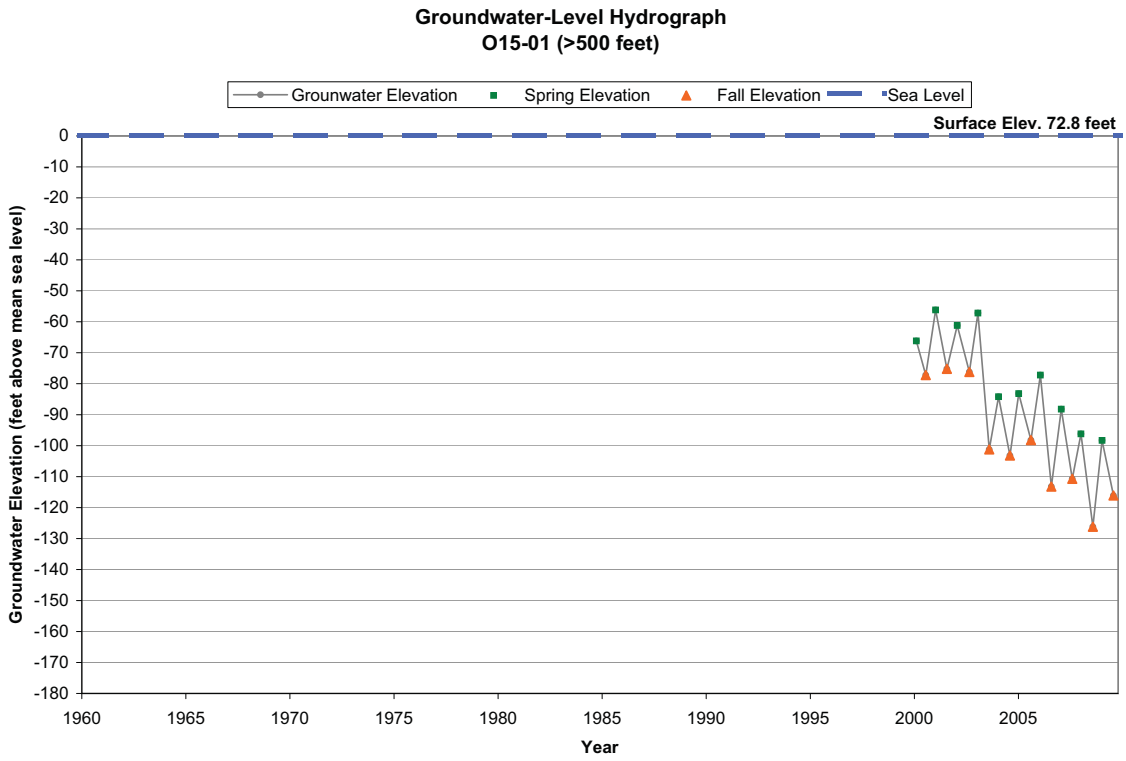
Year


Groundwater-Level Hydrograph
O15-01 (>500 feet)
Grounwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 72.8 feet
Groundwater Elevation (feet above mean sea level)
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
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-180
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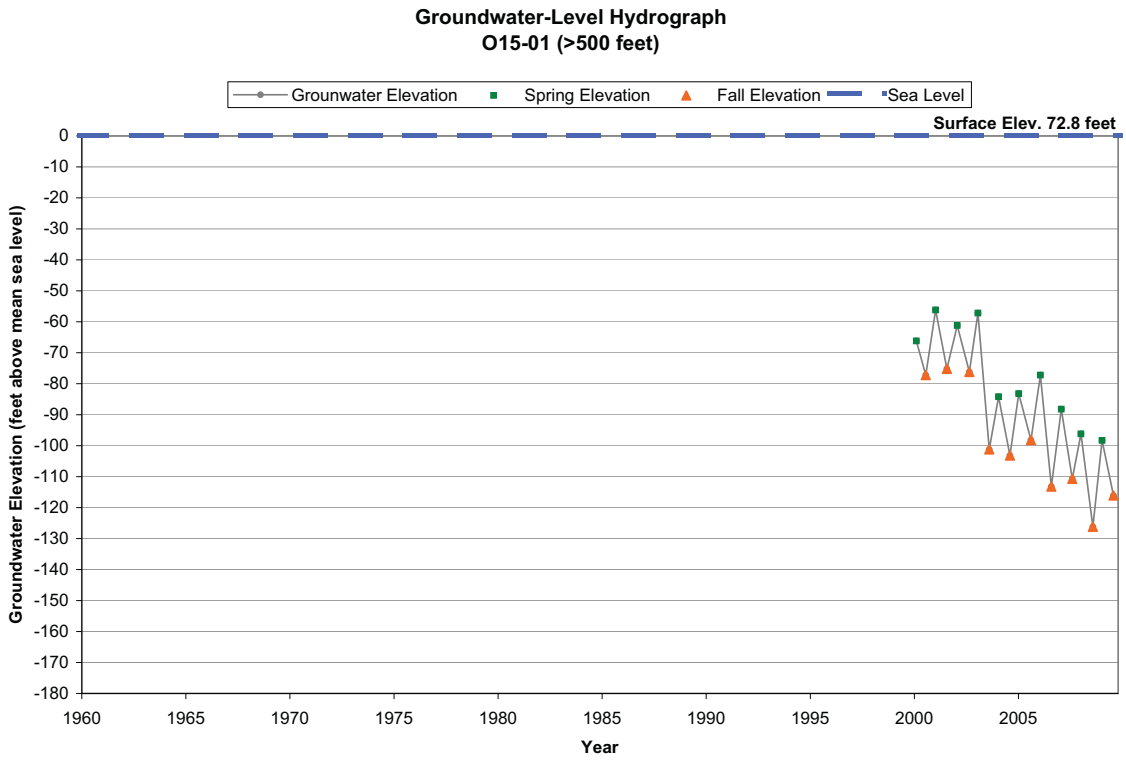
Year


Groundwater-Level Hydrograph
O15-01 (>500 feet)
Grounwater Elevation
Spring Elevation
Fall Elevation
Sea Level
Surface Elev. 72.8 feet
Groundwater Elevation (feet above mean sea level)
0
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Year

Groundwater Hydrographs

Unknown Depth

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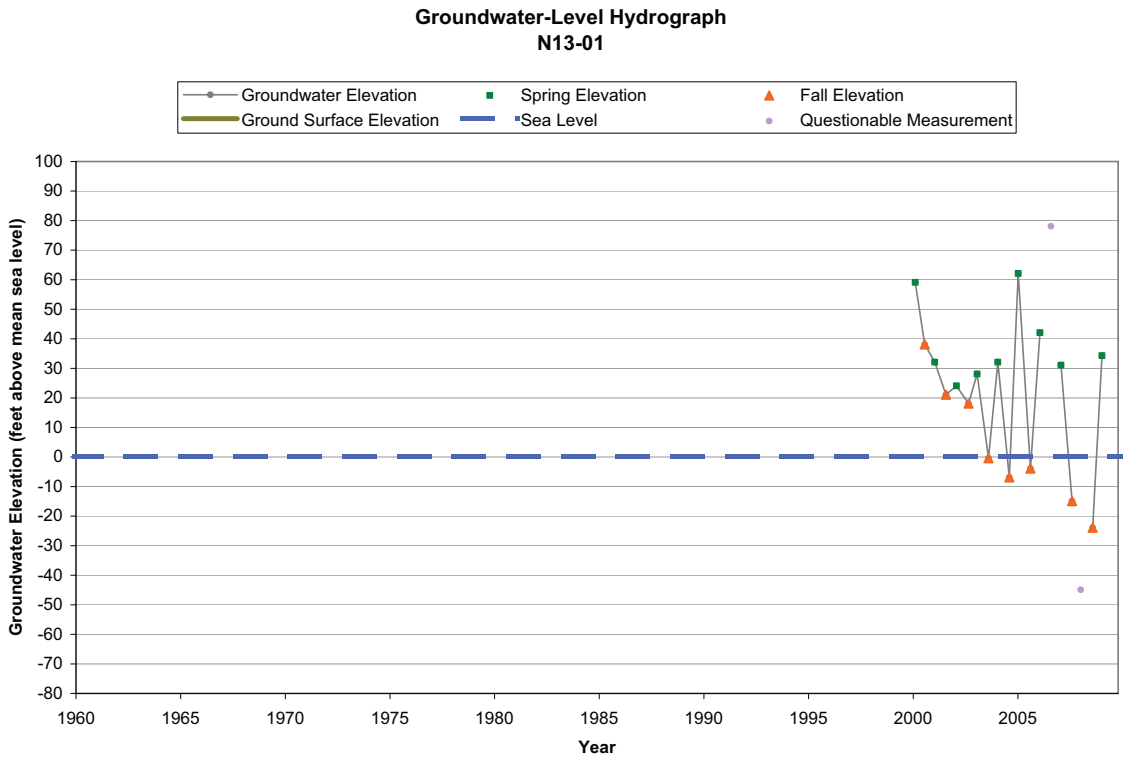
Groundwater-Level Hydrograph
N13-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Questionable Measurement
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
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-10
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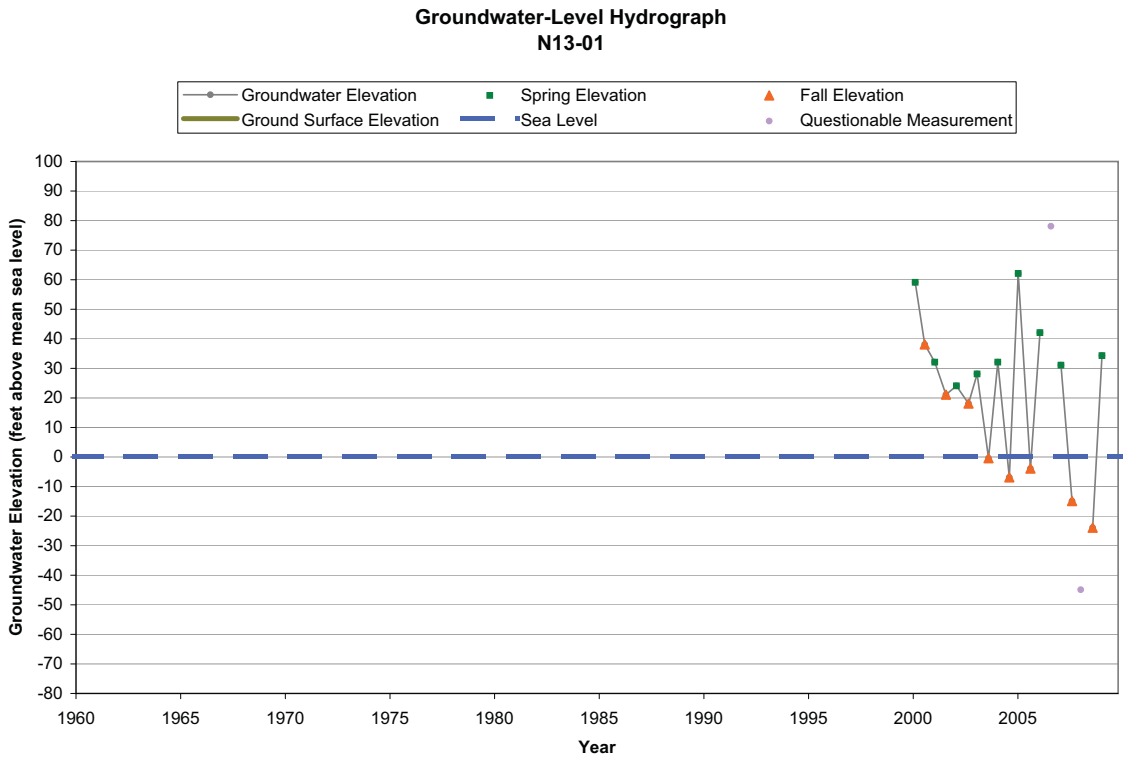
Year


Groundwater-Level Hydrograph
N13-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Questionable Measurement
Groundwater Elevation (feet above mean sea level)
100
90
80
70
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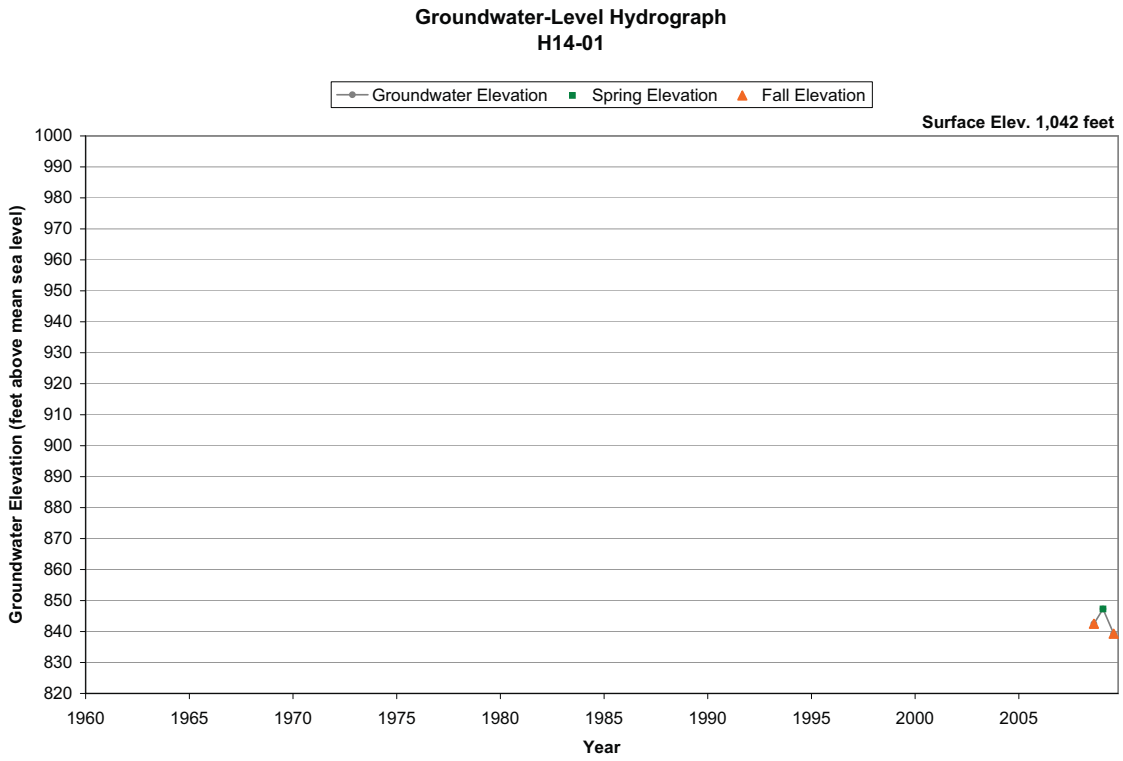
Groundwater-Level Hydrograph
H14-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,042 feet
Groundwater Elevation (feet above mean sea level)
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
860
850
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820
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1965
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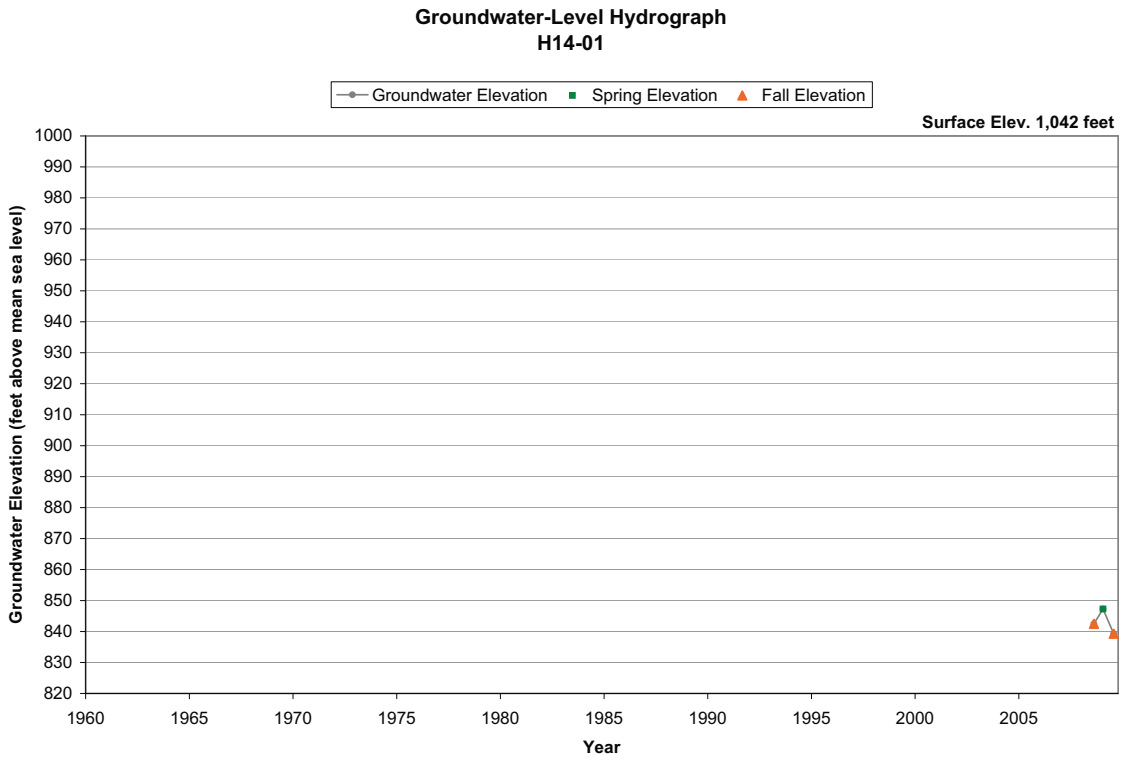
2000
2005
Year


Groundwater-Level Hydrograph
H14-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,042 feet
Groundwater Elevation (feet above mean sea level)
1000
990
980
970
960
950
940
930
920
910
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880
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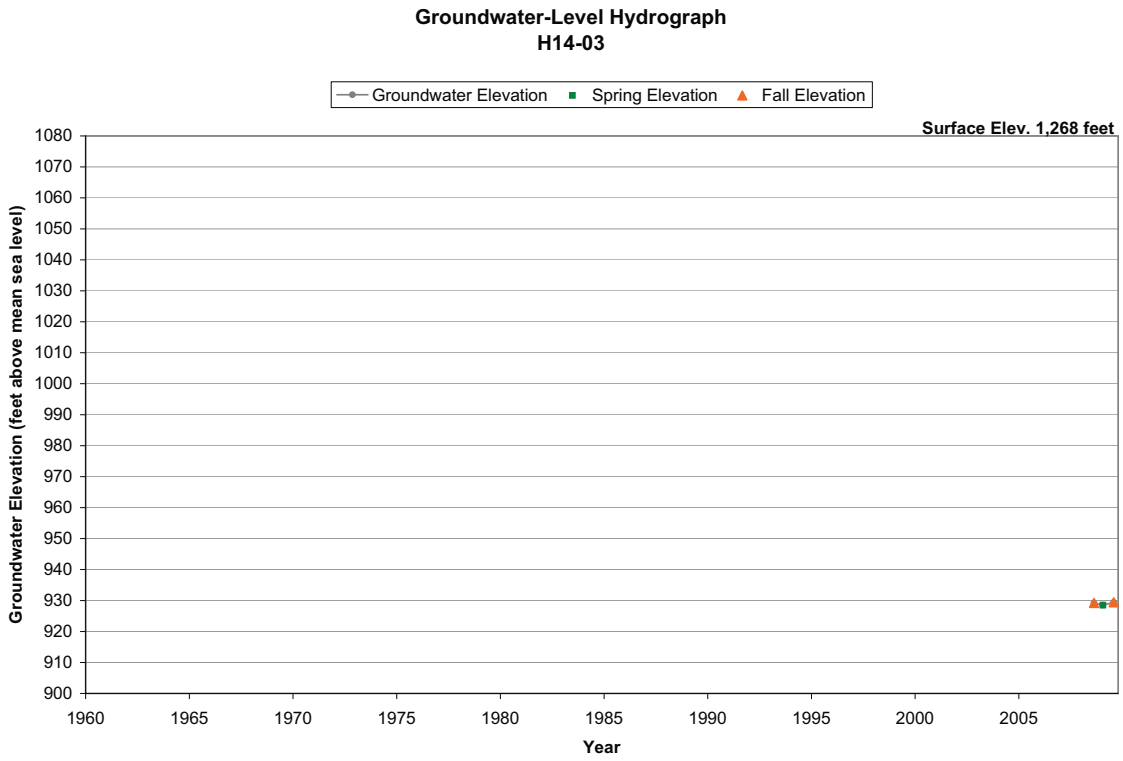
Year


Groundwater-Level Hydrograph
H14-03
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,268 feet
Groundwater Elevation (feet above mean sea level)
1080
1070
1060
1050
1040
1030
1020
1010
1000
990
980
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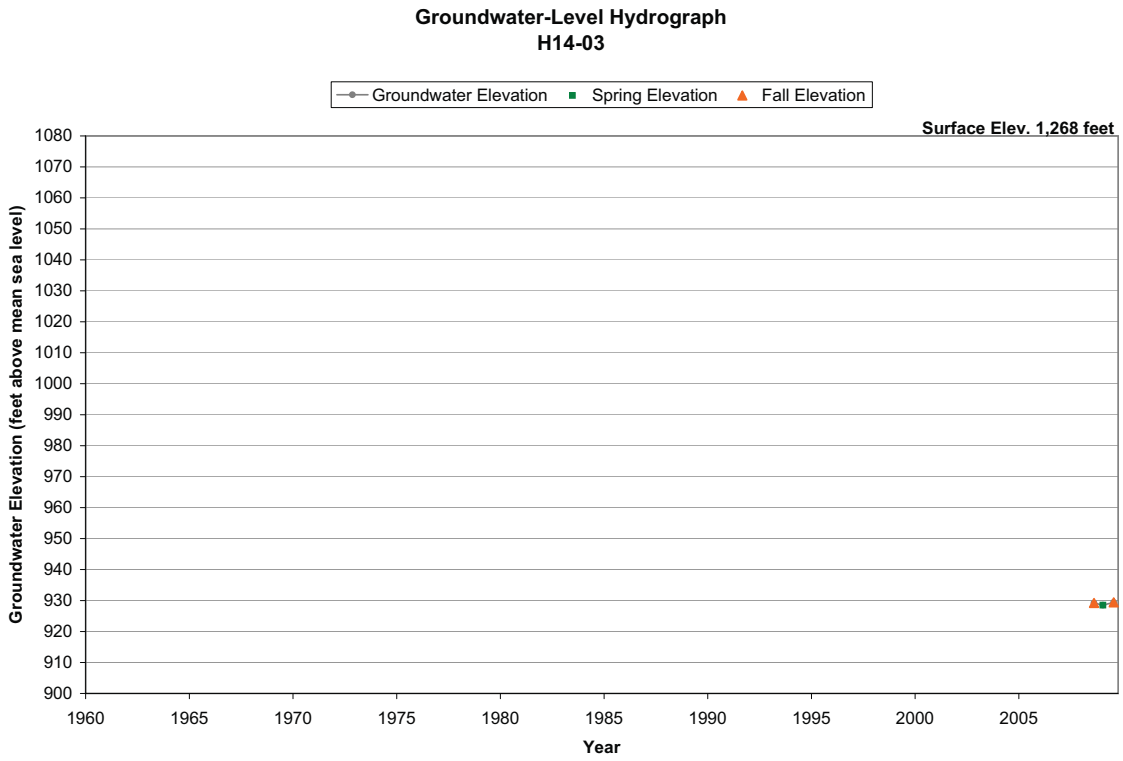
Year


Groundwater-Level Hydrograph
H14-03
Groundwater Elevation
Spring Elevation
Fall Elevation
Surface Elev. 1,268 feet
Groundwater Elevation (feet above mean sea level)
1080
1070
1060
1050
1040
1030
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1010
1000
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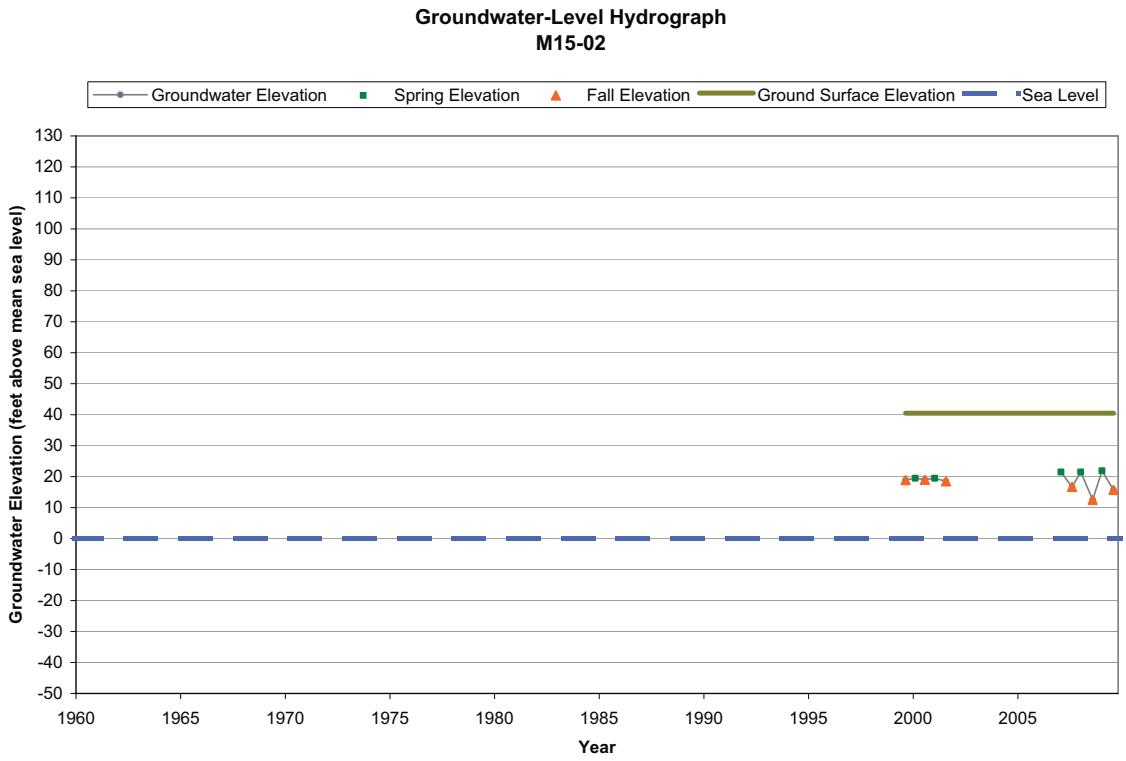
Year


Groundwater-Level Hydrograph
M15-02
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
80
70
60
50
40
30
20
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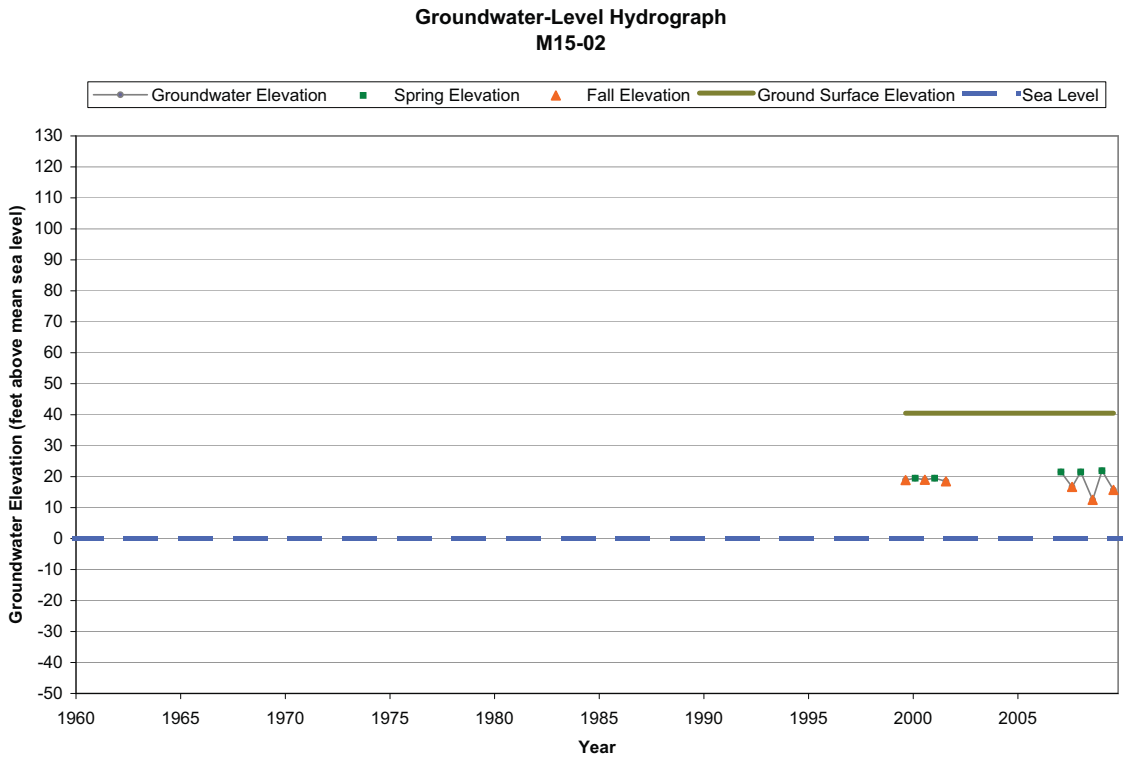
Year


Groundwater-Level Hydrograph
M15-02
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
130
120
110
100
90
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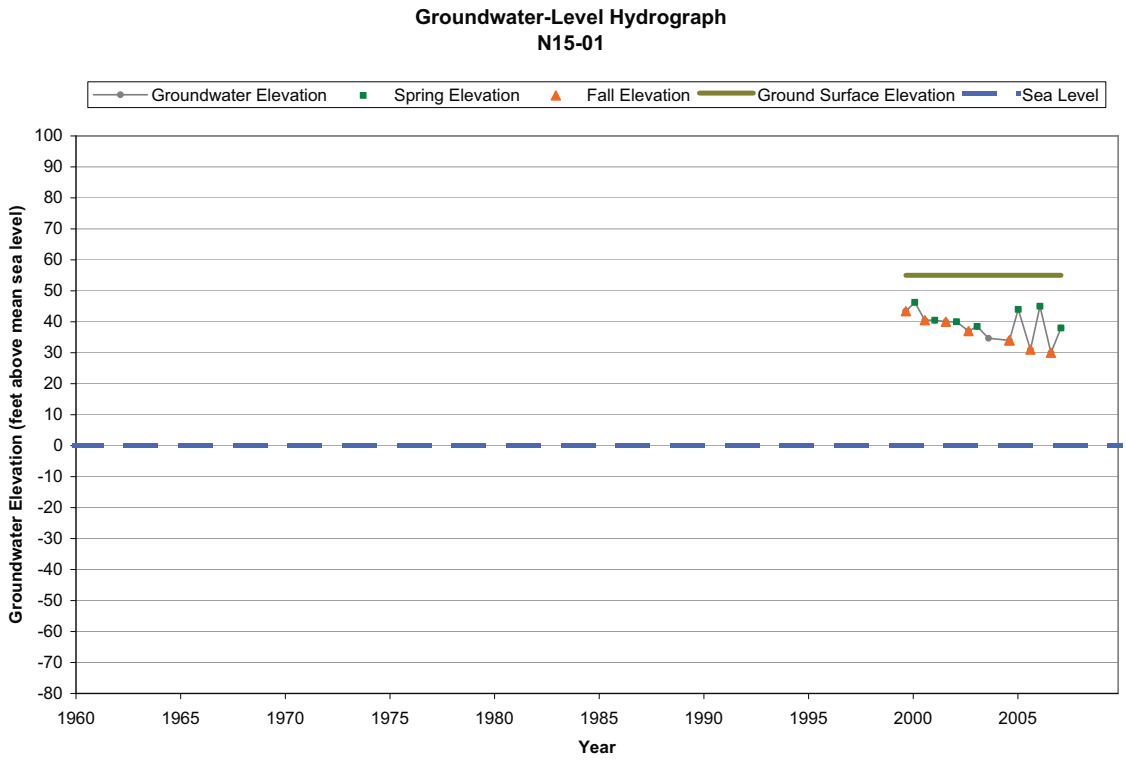
Groundwater-Level Hydrograph
N15-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
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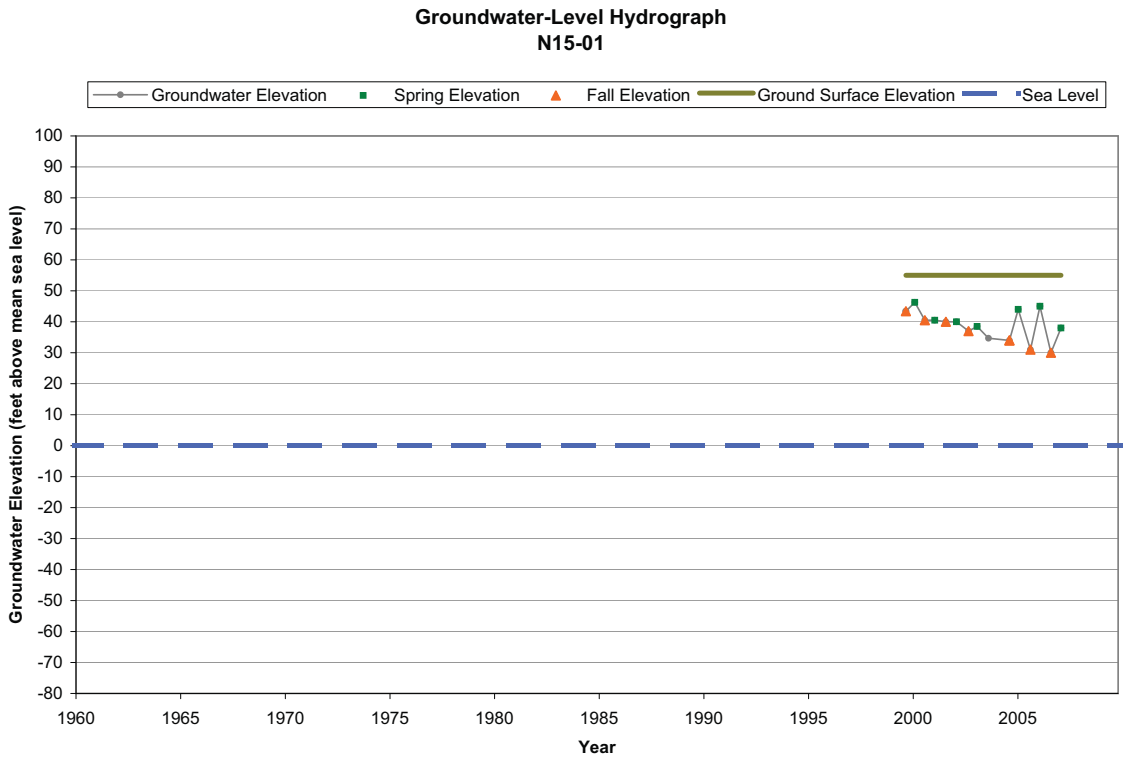
Groundwater-Level Hydrograph
N15-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
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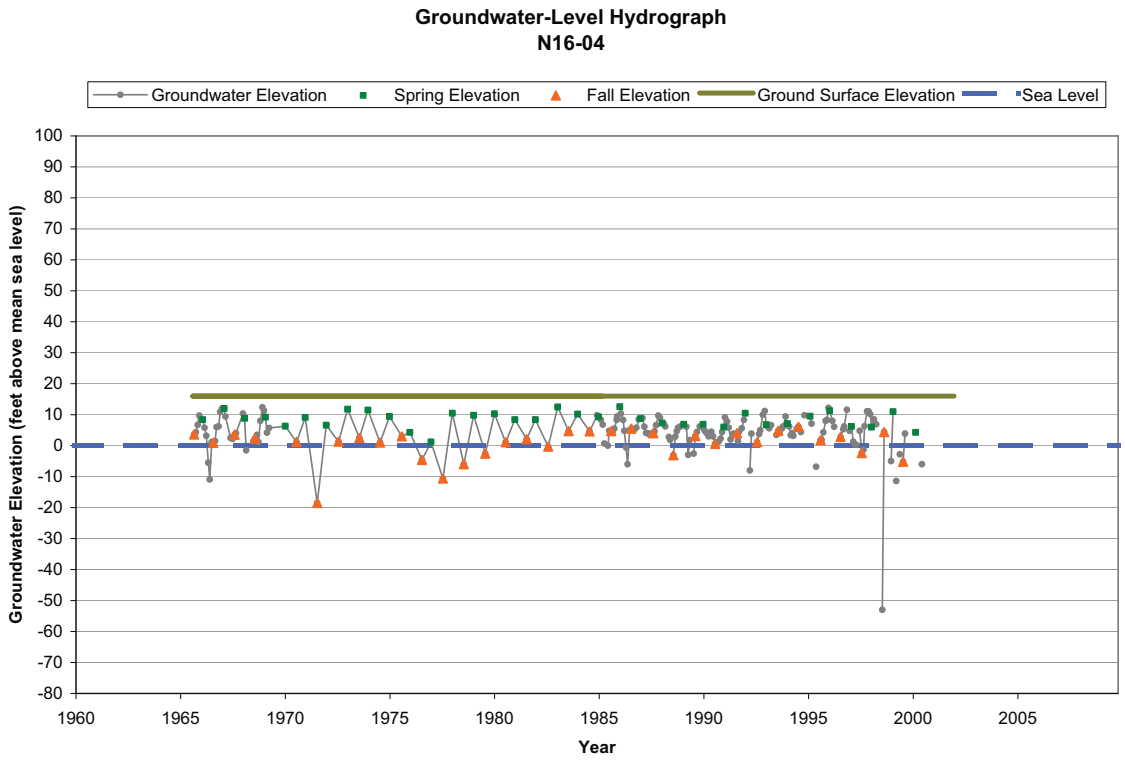
Groundwater-Level Hydrograph
N16-04
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
50
40
30
20
10
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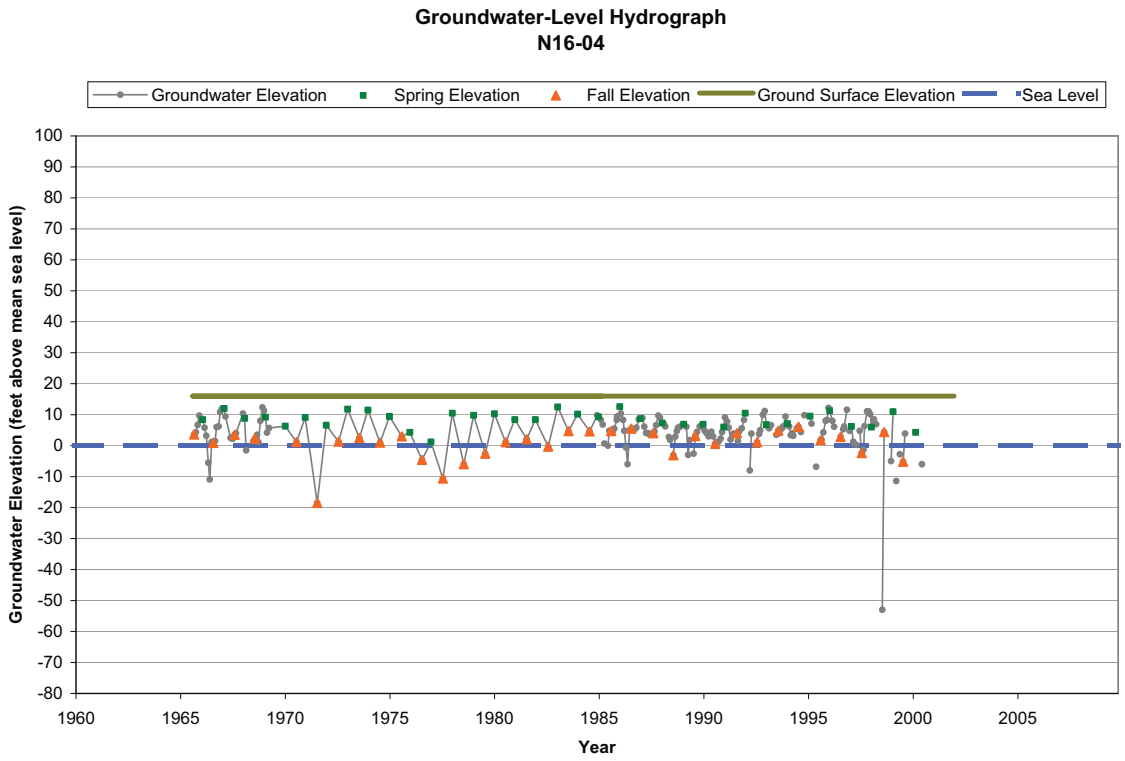
Groundwater-Level Hydrograph
N16-04
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Sea Level
Groundwater Elevation (feet above mean sea level)
100
90
80
70
60
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30
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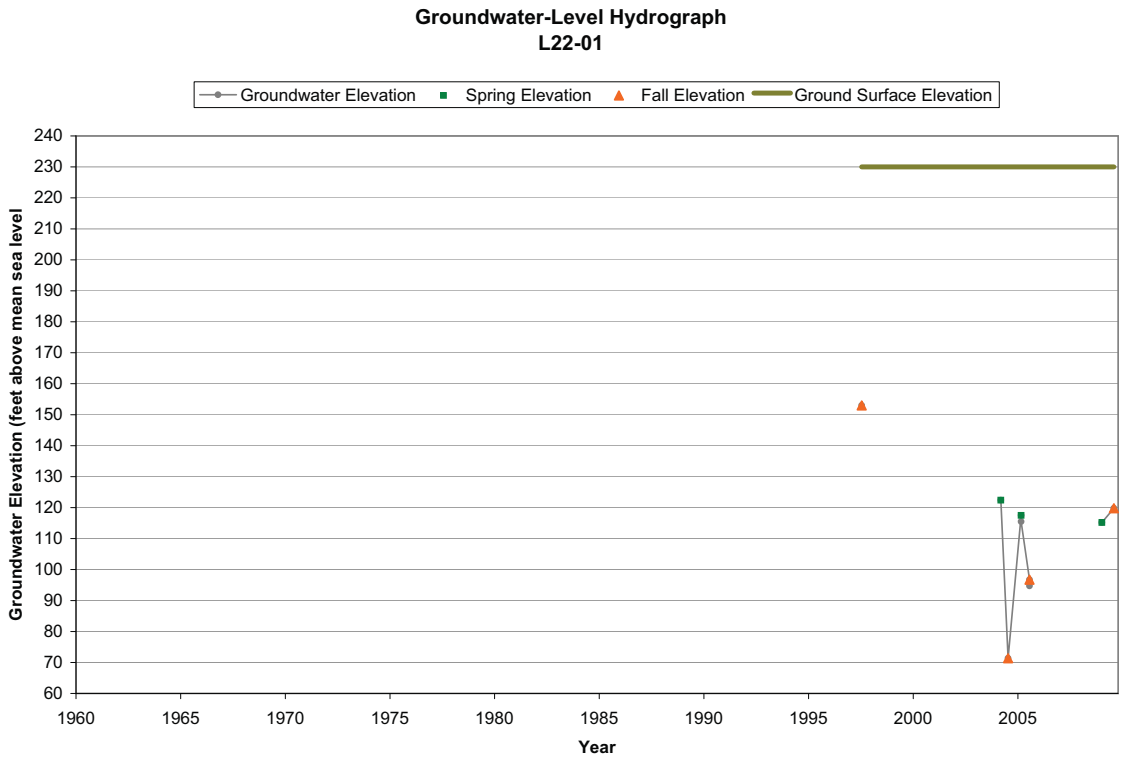
Groundwater-Level Hydrograph
L22-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level
240
230
220
210
200
190
180
170
160
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140
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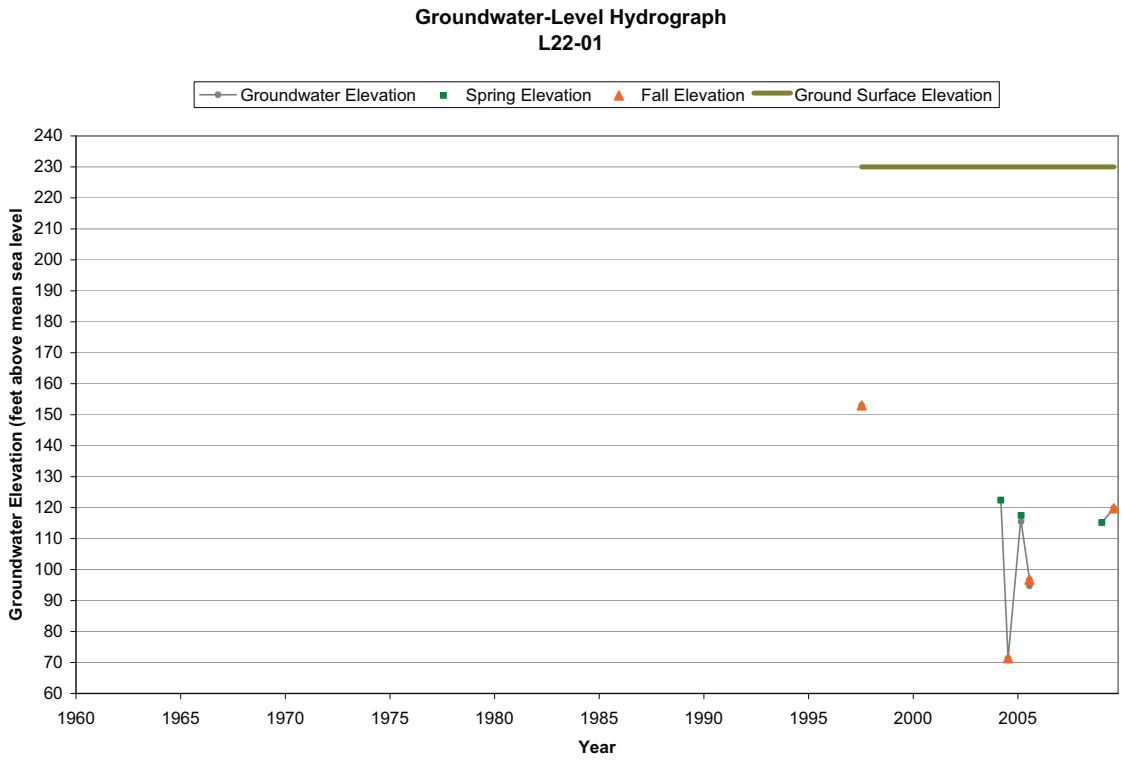
Year


Groundwater-Level Hydrograph
L22-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level
240
230
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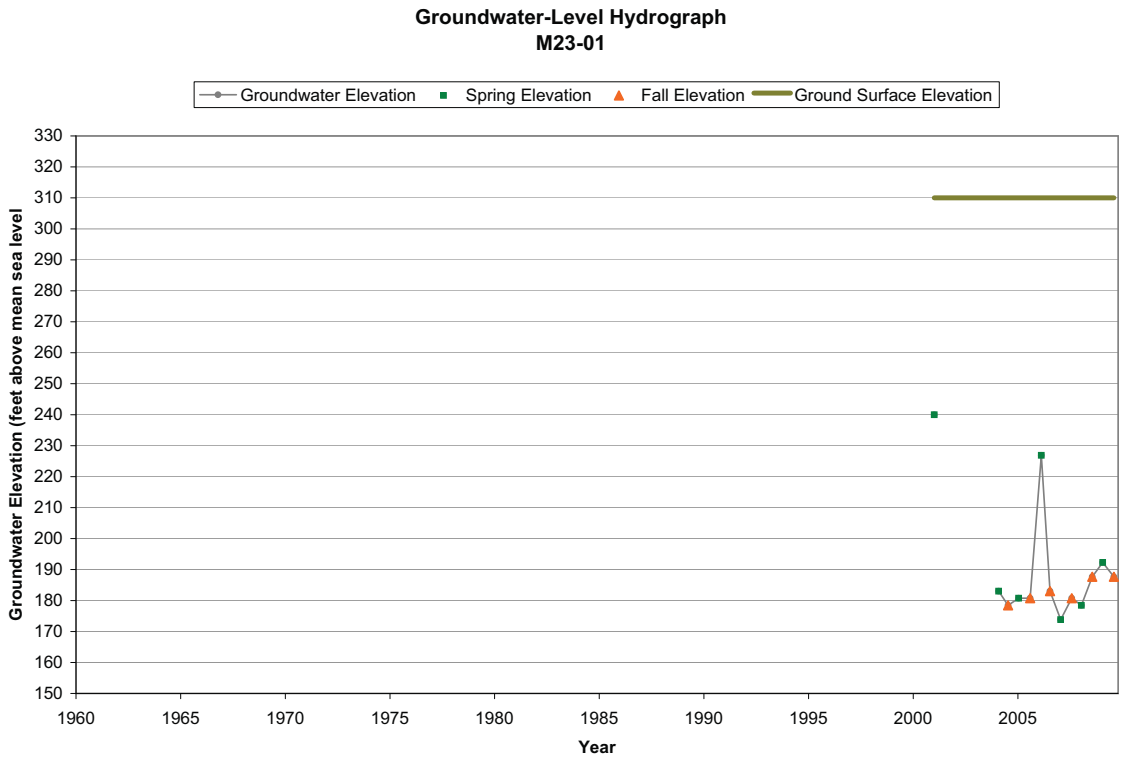
Groundwater-Level Hydrograph
M23-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level
330
320
310
300
290
280
270
260
250
240
230
220
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200
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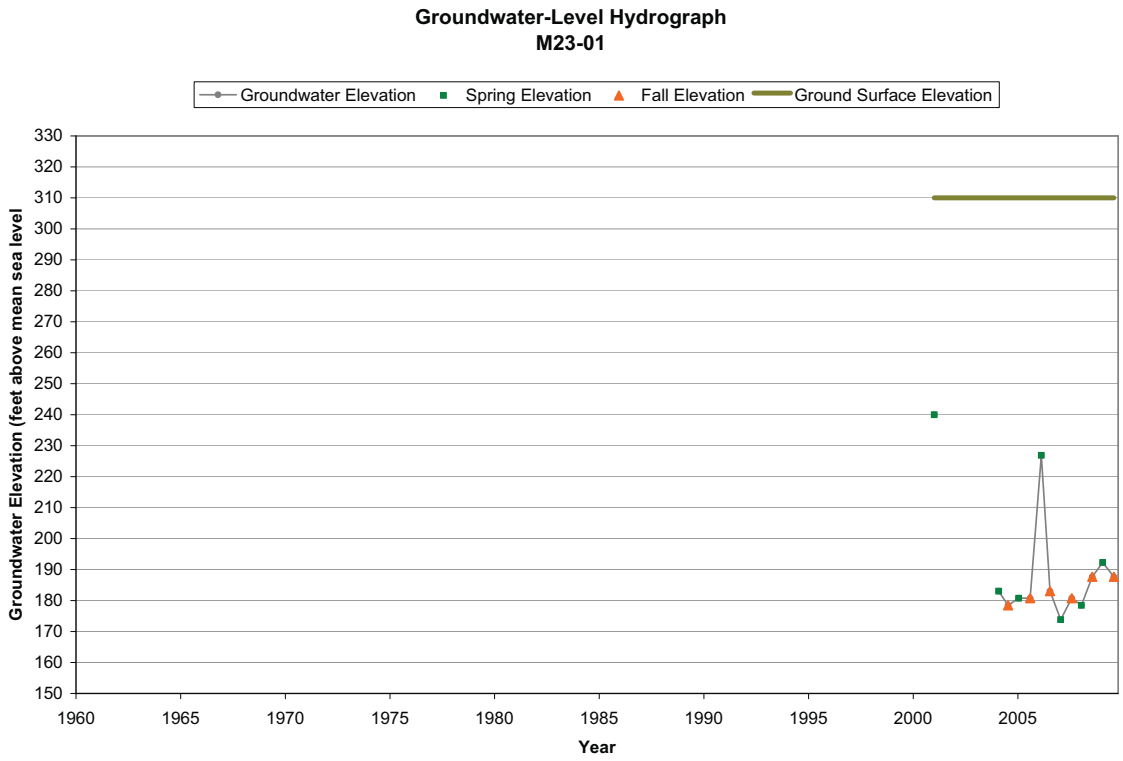
Year


Groundwater-Level Hydrograph
M23-01
Groundwater Elevation
Spring Elevation
Fall Elevation
Ground Surface Elevation
Groundwater Elevation (feet above mean sea level
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