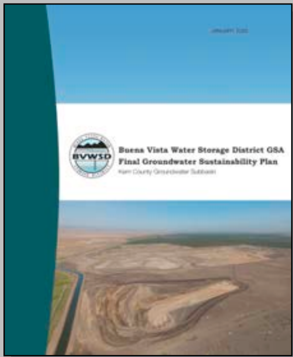
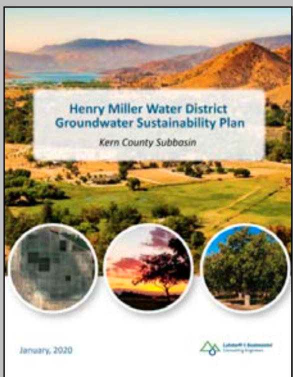
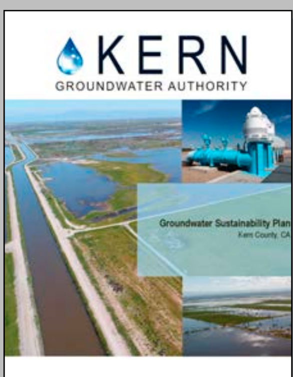
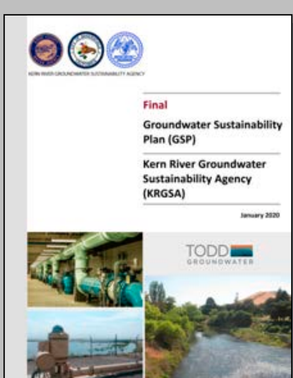
Final

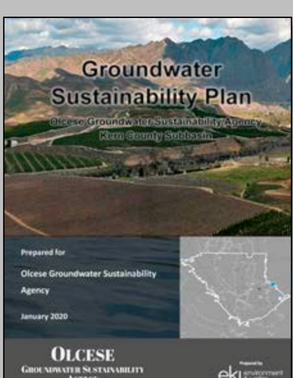
Kern County Subbasin Groundwater Sustainability Plans











Third Annual Report Water Year 2021

March 29, 2022

TODD GROUNDWATER

KERN COUNTY SUBBASIN

GROUNDWATER SUSTAINABILITY AGENCIES

Kern County Subbasin

Basin No. 5-022.14

Groundwater Sustainability Plans (GSPs)

Third Annual Report
Water Year 2021

(October 2020 through September 2021)

FINAL

March 29, 2022

TODD GROUNDWATER

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List of Acronyms

AEWSD	Arvin-Edison Water Storage District
AF	acre feet
AFY	acre feet per year
BCC	Basin Coordination Committee of the Kern County Subbasin
bgs	below ground surface
BMP	Best Management Practices
BVWSD	Buena Vista Water Storage District
CASGEM	California Statewide Groundwater Elevation Monitoring
C2VSim	California Central Valley Groundwater-Surface Water Simulation

C2VSimFG-Kern	California Central Valley Groundwater-Surface Water Simulation Model, Fine-Grid, Kern County Update for the Kern County and White Wolf Subbasin
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
Cawelo WD	Cawelo Water District
CGSA	Cawelo Groundwater Sustainability Agency
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CVC	Cross Valley Canal
CVP	Central Valley Project
CWD	County Water District
DMS	Data Management System
DWR	Department of Water Resources
ENCSD	East Niles Community Services District
ET	Evapotranspiration
EWMA	Eastside Water Management Area
ft	feet
Greenfield CWD	Greenfield County Water District
GSA	Groundwater Sustainability Agency
GSE	Ground Surface Elevation
GSP	Groundwater Sustainability Plan
HMWD	Henry Miller Water District
ID4	Improvement District 4, Kern County Water Agency
IDC	Independent Demand Calculator
InSAR	Interferometric Synthetic Aperture Radar
ITRC	Irrigation Training and Research Center
IWFM	Integrated Water Flow Model
KCWA	Kern County Water Agency
KDWD	Kern Delta Water District
KFMC	Kern Fan Monitoring Committee
KGA	Kern Groundwater Authority
KRGSA	Kern River Groundwater Sustainability Agency
KTWD	Kern-Tulare Water District
KWB	Kern Water Bank
MA	Management Area
MAP	Management Area Plan
METRIC	Mapping EvapoTranspiration at high Resolution with Internalized Calibration
MNP	Monitoring Network Plan

MO	Measurable Objective
MT	Minimum Threshold
msl	mean sea level
NKWSD	North Kern Water Storage District
MNM	Monitoring Network Module, DWR online SGMA portal
PRISM	Parameter-elevation Relationships on Independent Slopes Model
RRBWSD	Rosedale-Rio Bravo Water Storage District
SGMA	Sustainable Groundwater Management Act
SSJMUD	South San Joaquin Municipal Utilities District
Subbasin	Kern County Subbasin (when capitalized)
SWID	Shafter-Wasco Irrigation District
SWP	State Water Project
SWSD	Semitropic Water Storage District
TCWD	Tejon-Castac Water District
WMA	Water Management Area
WDWA	Westside District Water Authority
WKWD	West Kern Water District
WRMWSD	Wheeler Ridge-Maricopa Water Storage District
WY	Water Year, October 1 through September 30

EXECUTIVE SUMMARY

The Kern County Subbasin (Basin No. 5-022.14) is the largest subbasin in the State, has been designated as critically-overdrafted, and is governed by a myriad of water districts, water storage districts, irrigation districts, and municipalities. These agencies manage a complex water supply system, a large portfolio of local and imported water sources, access to flood waters throughout the State, local managed aquifer recharge projects, and numerous large groundwater banking projects, collectively providing both local and State-wide water supply and water quality benefits.

To comply with the Sustainable Groundwater Management Act (SGMA), local agencies organized into eleven Groundwater Sustainability Agencies (GSAs), which coordinated to produce five Groundwater Sustainability Plans (GSPs) covering the entire Subbasin that were submitted to the Department of Water Resources (DWR) in January 2020. Since the GSP submittal, all of the Subbasin GSAs have coordinated to produce one comprehensive Annual Report that covers the entire Kern County Subbasin. This Third Annual Report demonstrates the collective implementation of all five GSPs. **Figure 1** shows the Kern County Subbasin and adjacent subbasins. **Figures 2 and 3** show the 11 Subbasin GSAs and the areas covered by the five GSPs, respectively.

This report covers Water Year (WY) 2021, from October 1, 2020 through September 30, 2021, as the reporting period and represents the third Annual Report for the Subbasin. The purpose of the Annual Report is to provide the required data and analyses to demonstrate that the Kern County Subbasin GSPs are being implemented in a manner that will achieve the sustainability goals that have been developed for the Subbasin and individual GSPs.

Approach

In support of this WY 2021 Annual Report, over 40 agencies have contributed data and information as shown on **Table 1**. Data have been combined and analyzed for use in hydrographs, water level contour maps, and an update of the local C2VSimFG-Kern model. In particular, the C2VSimFG-Kern model provides a technically credible tool to analyze groundwater extractions and changes in groundwater in storage on a basin-wide basis. Various model results are presented from WY 1995 through WY 2021, incorporating the historical period for the GSP water budgets (WY 1995 through WY 2015) and the updated analyses through WY 2021; water year types for that 27-year period are presented on **Figure 6**.

Data templates provided by the DWR are employed for consistent reporting of information and data. A narrative progress report on GSP implementation has also been provided by the GSAs and member agencies; those reports are compiled in Section 7. In addition to the implementation of the individual GSPs, GSAs and member agencies are also coordinating on a collective effort to accomplish GSP implementation activities on a Subbasin-wide basis, including those documented in the Kern County Subbasin Coordination Agreement. These efforts, led by the Basin Coordination Committee (BCC), are also summarized in Section 7.

The Kern County Subbasin GSAs are collectively committed to successful GSP implementation and attainment of Subbasin Sustainability Goals. Substantial compliance with requirements of the Annual Report is demonstrated throughout this report, and additional data are currently being collected to address data gaps.

Groundwater Elevations

Groundwater elevations were compiled from wells in the GSP representative monitoring network for the preparation of hydrographs across the Subbasin (**Figure 5**). Available data, including sustainable management criteria, are presented on more than 200 well hydrographs, compiled in **Appendix A**. The hydrographs are developed within the Subbasin Data Management System (DMS) so that the most complete and current groundwater elevations, ground surface elevation, minimum threshold (MT) and measurable objective (MO) are shown on the hydrographs. A public version of the DMS, including the hydrographs from the GSP representative monitoring network, are accessible to Subbasin GSAs and the public through the KGA website.

Data from the SGMA monitoring network were combined with supplemental water level data from the Kern Fan Monitoring Committee and other local monitoring efforts by Kern County Water Agency (KCWA) to prepare groundwater elevation contour maps. Specifically, KCWA developed water level contour maps for Fall 2020 and Spring 2021 for the Primary Principal Aquifer in the Subbasin (**Figures 7** and **8**).

Three additional Principal Aquifers have been identified in four localized areas within the Subbasin as shown on **Figure 9**. Groundwater elevation contour maps for Fall 2020 and Spring 2021 are provided for the Olcese Sand Principal Aquifer on **Figures 10** and **11**, respectively. Groundwater elevations were posted during Fall 2020 and Spring 2021 for the Santa Margarita Principal Aquifer (**Figure 12**). Data were not available for the Upper Aquifer in the north-central portion of the Subbasin during this reporting period. However, the three local Principal Aquifers are represented in the C2VSimFG-Kern local model and grouped together with the Primary Principal Aquifer in the groundwater extraction data and the change in groundwater in storage analyses.

Groundwater Extractions

Groundwater extraction data for the Kern County Subbasin were compiled using two methods:

- Directly measured groundwater extraction data collected by local water agencies.
- Estimated groundwater extractions using the IWFM Demand Calculator (IDC) tool developed by DWR (Dogrul, Kadir and Brush, 2017), which is dynamically linked to C2VSimFG-Kern.

IDC employs user-specified evapotranspiration (ET) data that are based on monthly satellite data processed by the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2022). Surface water supplies are incorporated based on measured data and regional precipitation (PRISM); using these collective data sets, IDC calculates the groundwater extraction necessary to meet the crop demand. Urban demands in C2VSimFG-Kern are based on agency-supplied extraction data and/or population and per-capita water demand.

Table ES-1 summarizes the Kern County Subbasin groundwater extractions by water use type and measurement method for WY 2021. Additional details on water use types and groundwater extractions are provided in Section 3. **Figure 13** graphically presents historical groundwater extractions from WY 1995 through WY 2021. **Figure 17** shows the areal distribution of total groundwater extraction volumes over the Subbasin during WY 2021.

Table ES-1. Groundwater Extractions in the Kern County Subbasin for Water Year 2021

Groundwater Extraction	Total Groundwater Extractions	Meters Volume	Electrical Records Volume	Land Use Volume	Groundwater Model Volume	Other Methods Volume
Water Use Type	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**
Urban	170,084	154,357	0	15,727	0	0
Industrial	0	0	0	0	0	0
Agricultural	1,809,934	382,699	0	1,427,235	0	0
Managed Wetlands	0	0	0	0	0	0
Managed Recharge	427,543	427,543	0	0	0	0
Native Vegetation	0	0	0	0	0	0
Other	63,594	11,051	0	52,543	0	0
Total	2,471,156	975,650	0	1,495,505	0	0

Surface Water Supply

For the Kern County Subbasin, surface water supplies are measured directly by local water agencies at the point of diversion from a river, stream or canal using measurement devices and monitoring protocols. Surface water data were collected by measurement devices with a high level of accuracy consistent with relevant standards. Measured surface water data were provided by local agricultural districts, urban water purveyors and city water departments for this Annual Report (see **Table 1**). Additional details on surface water supplies are provided in Section 4. A map showing surface water supply infrastructure and features in the Subbasin is provided on **Figure 14.**

Table ES-2. Surface Water Supplies in the Kern County Subbasin for Water Year 2021

Surface Water Supply	Surface Water Supply Volume
Surface Water Supply Source	**Acre-ft**
Central Valley Project	76,149
State Water Project	424,822
Colorado River Project	0
Local Supplies	225,039
Local Imported Supplies	48,023
Recycled Water	51,926
Desalination	0
Other Water Source	121
Total Surface Water Supply	826,080

Total Water Use

Based on data and tables in preceding sections, the total water use in the Subbasin is provided by Water Source Type and Water Use Sector on **Tables ES-3** and **ES-4**. Additional details on the tabulation of Total Water Supply and Use are provided in Section 5.

Table ES-3. Total Water Use by Source Type, Kern County Subbasin, Water Year 2021

Total Water Use	Total Water Supply by Volume
Water Source Type	**Acre-ft**
Groundwater	2,471,156
Surface Water	774,033
Recycled Water	51,926
Reused Water	121
Other Water Source Type	0
Total Water Supply	3,297,235

Table ES-4. Total Water Use by Water Use Sector, Kern County Subbasin, Water Year 2021

Total Water Use	Total Water Use Volume
Water Use Sector	**Acre-ft**
Urban	215,870
Industrial	0
Agricultural	2,467,092
Managed Wetland	18,036
Managed Recharge	74,887
Native Vegetation	0
Other Water Use	491,137
Total Water Use	3,267,023

Section 5 provides a preliminary assessment of changes in water demand in the Subbasin during the GSP implementation period. The METRIC evapotranspiration (ET) data provided by ITRC (Howes, 2022) shows a notable decline in ET demand during WY 2020 and WY 2021 of 200,000 to 300,000 acre-feet compared to the prior period from WY 2013 through 2019 (**Figure 15**). The Subbasin GSAs are currently coordinating on several basinwide management actions to better track and evaluate performance of the GSP implementation over time.

The data presented on **Tables ES-1, ES-2, ES-3 and ES-4** are compiled into the data templates provided by the Department of Water Resources (DWR) and submitted along with this Annual Report for consistent reporting of information and data.

Change in Groundwater in Storage

As required by the GSP regulations, the following figures included in the WY 2021 Annual Report illustrate the changes in groundwater in storage over the Subbasin:

- Graph depicting water year type, groundwater use, the annual and cumulative change in groundwater in storage based on historical data to the greatest extent available, including from January 1, 2015 to the current reporting year.

- Change in groundwater in storage maps for Subbasin Principal Aquifers.

The coordinating GSAs supported updating the C2VSimFG-Kern local model to assist with the change in groundwater in storage analyses. The model results represent the total change in groundwater in storage for the entire Kern County Subbasin that includes all Subbasin Principal Aquifers.

Figure 16 shows the simulated change in groundwater in storage graph for the Kern County Subbasin over the 27-year period from WY 1995 to WY 2021. The graph includes the annual and cumulative change along with the water year type based on the San Joaquin Valley Index (CDEC, 2022). For WY 2021, a critically dry water year type, the groundwater in storage for the Kern County Subbasin **declined** by 1,812,211 acre-feet (AF).

The total change in groundwater in storage over the five-year period from WY 2017 through WY 2021 decreased by 290,373 acre-feet, which is an average decline of 58,075 acre-feet per year. This compares favorably to the historical average annual decline of 277,119 AFY over the 20-year base period (WYs 1995-2014), which is representative of average hydrologic conditions. The five-year period, WY 2017-2021, includes two wet, one below normal, one dry and one critically dry hydrologic water year as represented by the San Joaquin Valley hydrologic conditions (CDEC, 2022).

Figure 18 presents the annual basin-wide change in groundwater in storage map for WY 2021, using the C2VSimFG-Kern model results. The change in groundwater in storage represents the sum of the total inflow components plus the total outflow components. A positive value represents an increase in the volume of groundwater stored in the aquifer that was typified by a rise in groundwater levels whereas a negative represents a decrease in groundwater in storage typified by a decline in groundwater levels.

WY 2021 was rated as a critically dry water year under the San Joaquin Valley Index (CDEC, 2022), and the Kern River Index was 15 percent of average Kern River flows (COB, 2021). Widespread low-level declines are observed over most of the Subbasin with some localized areas of minor increases. The change in groundwater in storage is concentrated in the vicinity of the large groundwater banking operations primarily in the center of the Subbasin. Groundwater elevations in the banking areas historically fluctuate over a range of 200 feet in response to recharge and recovery operations. These operations lead to highly variable year-to-year change in groundwater in storage. Therefore, the concentrated change in storage in the banking areas is a highly-managed activity that plays a key part in maintaining the groundwater sustainability for the Subbasin.

Progress on GSP Implementation

The GSAs and member agencies associated with the five GSPs have provided progress reports on their respective GSP implementation activities for WY 2021. These progress reports provided in Sections 7.2 through 7.7 are organized by the five GSPs, in alphabetical order for the lead GSA. KGA member agencies that have prepared Management Area Plans are listed in alphabetical order within Section 7.5. To facilitate DWR review, a consistent reporting format was established, based on the components listed in the GSP regulations (*§356.2(b)(5)(C)*), as follows:

1) Compliance with Sustainable Management Criteria
    a. GSP Monitoring Activities
    b. Changes in GSP Monitoring Network
    c. Progress in Achieving Interim Milestones
    d. Compliance with Additional Sustainable Management Criteria (including minimum thresholds (MTs) and measurable objectives (MOs))
2) Implementation of Projects and Management Actions
3) Coordination with Stakeholders
4) Summary of Other GSP-related Special Studies or Activities

In brief, all agencies have implemented portions of the GSP and are committed to coordination for sustainable groundwater management. Many GSP monitoring networks have been fully implemented; others are planning new monitoring sites. Some networks represent areas where local groundwater conditions do not have a long monitoring history and, therefore, will provide valuable future information for Subbasin sustainable management.

In addition to the implementation of the individual GSPs, GSAs and member agencies are also coordinating on a collective effort to accomplish GSP implementation activities on a Subbasin-wide basis, including those documented in the Kern County Subbasin Coordination Agreement. These efforts, led by the Basin Coordination Committee (BCC), are also summarized in Section 7.1. The basinwide efforts are summarized below:

- **Coordination on Annual Report Data** - Agencies shared in costs to purchase Subbasin-wide METRIC ET data, available on a monthly basis over the reporting period. Accordingly, this submittal of the Third GSP Annual Report represents completion of an important GSP implementation measure that demonstrates ongoing coordination on a Subbasin-wide basis.
- **Implementation of the Subbasin-wide Data Management System (DMS)** - The Subbasin GSAs are coordinating on the development of a web-based Data Management System (DMS) to support GSP monitoring and analyses (Coordination Agreement, Appendix 5). An initial version of the DMS was released for users on June 10, 2021.
- **Coordination on GSP Monitoring Data** - The Subbasin GSAs continue to coordinate for collecting and reporting of GSP monitoring data. Compilation and reporting of the semi-annual monitoring data are now conducted using the DMS.
- **Land Subsidence Investigations and Monitoring** - The Subbasin GSAs supported implementation of a regional land subsidence investigation to improve the land subsidence monitoring program (Coordination Agreement, Appendix 3). This regional effort was developed

to supplement the local land subsidence monitoring focused on potential impacts to critical infrastructure of regional importance.

- **Subbasin-Wide ET Monitoring** - The Subbasin GSAs are working with Land IQ to develop a scope and budget to expand their ET monitoring service to all irrigated agricultural areas within the Subbasin. Irrigated agriculture represents the largest water use within the Subbasin; this method will improve calculation of ET on a field and crop basis.
- **Scoping for the Basin Study** - Several management actions are included in the Subbasin GSPs to address data gaps and define goals for GSP implementation. The *Kern County Subbasin Study*, or *Basin Study* consists of a systematic, basinwide analysis to address technical data gaps in the hydrogeological conceptual model (HCM), water budgets and model calibration.
- **Planned Improvements to the C2VSimFG-Kern Model** – The existing C2VSimFG-Kern model will be upgraded to a Kern County Subbasin focused model. This approach will provide the framework for a more accurate water budget analysis to support ongoing GSP planning and implementation.
- **Subbasin Native Yield Study** - The native yield of the Subbasin is being developed through ongoing coordination of local water managers, policy makers and stakeholders through consideration of multiple technical, policy, water rights and legal issues. The Basin Study will support these efforts through addressing data gaps and compiling necessary technical data.

1 INTRODUCTION

Following the successful submission of five Groundwater Sustainability Plans (GSPs) in January 2020 that covered the entire Kern County Subbasin (Subbasin), the Groundwater Sustainability Agencies (GSAs) and member agencies began GSP implementation. Since the GSP submittal, all of the Subbasin GSAs have coordinated to produce one comprehensive Annual Report that covers the entire Subbasin in compliance with the Sustainable Groundwater Management Act (SGMA). Since that time, the GSAs and their member agencies have continued both coordinated and individual GSP implementation activities to move the Subbasin toward sustainability. Those efforts, including work on GSP monitoring networks, analyses of groundwater elevations and water budgets, compliance with sustainable management criteria, progress on implementation of projects and management actions, and other activities, are presented in this Third GSP Annual Report for Water Year (WY) 2021. This Third Annual Report demonstrates the collective implementation of all five Subbasin GSPs.

The Kern County Subbasin (Basin No. 5-022.14), which is the largest subbasin in the State, has been designated as critically-overdrafted by DWR. Water in the Subbasin is managed by a myriad of water districts, water storage districts, irrigation districts, and municipalities. These local water agencies organized into 11 GSAs that coordinated on five GSPs that cover the entire Subbasin as required by SGMA. By submitting one Annual Report that covers the entire Subbasin, the GSAs demonstrate their collective GSP implementation for the entire Subbasin. A map of the Subbasin and adjacent subbasins is shown on **Figure 1**. The eleven GSAs and five GSPs are shown on **Figures 2** and **3**, respectively.

A comparison of **Figures 2** and **3** shows the variety of coordination for GSP preparation and implementation in the Subbasin. The GSPs for Buena Vista GSA, Henry Miller GSA, and Olcese GSA each represent one GSP prepared by one GSA. The GSP for the Kern River GSA represents two GSAs (Kern River GSA and Greenfield County Water District). The Kern Groundwater Authority (KGA) GSA covers the remainder of the Subbasin and represents six GSAs coordinating on one GSP. The agencies forming Management Areas within the KGA are shown on **Figure 4**.

This Third GSP Annual Report is being prepared under the guidance of Water Code Section 10728 and GSP regulations (in particular, Article 7, §356). The report combines data and information for the entire Kern County Subbasin, as provided by the GSAs that submitted the GSPs and coordinated in the preparation of this report. As such, this GSP Annual Report is submitted as one comprehensive and coordinated Annual Report that covers the entire Kern County Subbasin.

1.1 PURPOSE OF THE GSP ANNUAL REPORT

The purpose of this Third GSP Annual Report for WY 2021 is to demonstrate implementation of individual GSPs in the Kern County Subbasin in a manner that will achieve the sustainability goals. This Third GSP Annual Report provides an update on the groundwater conditions for WY 2021 (Reporting Period), and documents ongoing progress on GSP implementation.

Data and analyses cover the Reporting Period (October 1, 2020 through September 30, 2021); groundwater elevation hydrographs and the change in groundwater in storage analysis also covers a historical period as required by the regulations. Specifically, these two components are required to use "historical data to the greatest extent available including from January 1, 2015 to the current reporting year." (§356.2 (b)(1)(B) and §356.2 (b)(5)(B)).

1.2 COORDINATED SUBMITTAL

Even before the GSPs were finalized in 2020, the Kern County Subbasin GSAs decided to coordinate on one combined submittal for its GSP annual reports. This successful coordination produced the First Annual Report covering the post-GSP period from WY 2016 through WY 2019, which was submitted to DWR April 1, 2020 in compliance with SGMA requirements. This coordinated process continues in 2022 with the production of this Third Annual Report covering WY 2021. Various coordination steps are summarized below; Subbasin-wide coordination on GSP implementation is summarized in Section 7.1.

1.2.1 Coordinated Historical Data

For the required Annual Report analyses requiring the presentation of historical data (hydrographs and change in groundwater in storage), the Subbasin GSAs are following the same methodology used in the Subbasin GSPs. In the GSPs, a consistent basinwide data set with historical data "to the greatest extent available" was developed for the historical and current study period from WY 1995 through WY 2015. The basinwide water budget analysis was conducted using the integrated surface water-groundwater model, C2VSimFG-Kern[1]. The First Annual Report updated that model from WY 2016 through WY 2019. Each successive annual report provides updates to the historical data for the preceding water year to support consistent analyses. This Third GSP Annual Report updates historical data for the Subbasin through WY 2021.

1.2.2 Basin Coordination Committee

As described in the Kern County Subbasin Coordination Agreement (Coordination Agreement), Subbasin GSAs have organized a Basin Coordination Committee (BCC) to provide a forum to coordinate Subbasin GSP implementation. Specifically, the Coordination Agreement states that coordination activities may include "the development, planning, financing, environmental review, permitting, implementation, and long-term monitoring of the multiple GSPs in the Basin, pursuant to SGMA requirements."

Since GSP submittal in January 2020, the BCC has continued to meet and work on various Subbasin-wide activities for GSP implementation. Although BCC meetings schedules have been modified due to the COVID pandemic, the BCC has convened both in-person and virtually during 2021 to continue the momentum for working together on GSP activities. Progress on GSP Implementation is an ongoing process. During WY 2021, additional projects and management actions envisioned in the Coordination Agreement – as well as in individual GSPs – continue to be initiated. These activities are discussed in more detail in Section 7 *Progress on GSP Implementation*.

1.3 APPROACH

Data and analyses for the GSP Annual Report include compilation of water level data; development of hydrographs and groundwater elevation contour maps; tabulation of groundwater extraction, surface water supply, and total water use data; and analysis of changes in groundwater in storage. Data and analyses cover the Reporting Period of WY 2021 except for hydrographs and changes in groundwater in storage, which are presented from WY 1995 through WY 2021.

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[1] Documentation of the local model, along with water budget results, was included as Appendix 2 in the Subbasin Coordination Agreement.

1.3.1 Data Compilation

Following guidance from Article 7 of the GSP regulations, data were compiled from GSAs, member agencies, and other entities throughout the Subbasin. **Table 1** provides a list of 41 agencies who contributed directly measured or reported data in support of this Annual Report. Groundwater elevation data were used in the development of hydrographs in Section 2. Metered groundwater extractions, surface water supplies and water use data were compiled into the DWR data templates that are reported in Sections 3, 4, and 5. These data were also incorporated into the C2VSimFG-Kern model update, as described in Section 1.3.2, which was used to calculate total groundwater extractions and change in groundwater in storage reported in Section 3 and 6, respectively.

1.3.2 C2VSimFG-Kern Model Update

The Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. Appendices 2 and 4 of the Kern County Subbasin Coordination Agreement include a technical report (Maley and Brush, 2020) on the development and application of C2VSimFG-Kern for these purposes.

To meet the requirements for the Annual Report, C2VSimFG-Kern was updated with new input data for WY 2021. C2VSimFG-Kern is based on the C2VSim Fine Grid Public Beta model (C2VSimFG-Beta) that was released by DWR for SGMA support in May 2018. C2VSimFG-Beta input files were revised to incorporate locally derived managed water supply and demand data to better represent the local water budgets for the Kern County Subbasin (Maley and Brush, 2020).

For this Annual Report model update, WY 2021 data were added to the existing data structure and model input files. In addition, new recovery wells and recharge operations that became operational during the update period were added to the model input. Monthly data were requested and provided by the local agencies through their respective GSA. The monthly data for Kern County Subbasin include:

- Surface water imports and diversions for various uses including agricultural, urban, seasonal refuge, and managed aquifer recharge/groundwater banking.
- Recharge volumes for managed aquifer recharge/groundwater banking operations.
- Measured pumping volumes for managed aquifer recharge/groundwater banking recovery operations for local use and pump-ins to regional aqueducts.
- Urban water supply, both surface water and groundwater, for the larger cities in Kern County Subbasin with emphasis on the Metropolitan Bakersfield Area.
- Stream inflows to the Subbasin for the Kern River and Poso Creek.
- Other locally important water supply or demand data provided by local agencies.

Table 1. List of Kern County Subbasin Agencies Contributing Data

Agency	Metered Groundwater Extractions	Surface Water Supply	Total Water Use	Groundwater Elevations
Agricultural Water Agencies				
Arvin-Edison WSD	X	X	X	X
Belridge WSD		X	X	X
Berrenda Mesa WD		X	X	X
Buena Vista WSD	X	X	X	X
Cawelo WD	X	X	X	X
Eastside WMA	X	X	X	X
Henry Miller WD	X	X	X	X
Kern Delta WD	X	X	X	X
Kern-Tulare WD	X	X	X	X
Lost Hills WD		X	X	X
North Kern WSD	X	X	X	X
Olcese WD	X	X	X	X
Rosedale-Rio Bravo WSD	X	X	X	X
Rosedale Ranch Improvement District		X	X	
Semitropic WSD	X	X	X	X
Shafter-Wasco ID		X	X	X
7th Standard Annex WMA		X	X	X
Southern San Joaquin MUD		X	X	X
Tejon-Castac WD	X		X	X
Wheeler Ridge-Maricopa WSD	X	X	X	X
Urban Water Agencies				
Arvin CSD	X			
Buttonwillow CWD	X			
Cal Water - Bakersfield	X	X	X	X
City of Bakersfield	X	X	X	X
City of Delano	X	X	X	
City of McFarland	X	X	X	
City of Shafter	X	X	X	X
City of Wasco	X	X	X	
East Niles CSD	X	X	X	X
Greenfield CWD	X		X	X
Kern County Water Agency ID4	X	X	X	X
Lamont PUD	X	X	X	X
North of the River Sanitation District	X	X	X	
Oildale MWC	X	X	X	
Vaughn Water Company	X		X	
West Kern WD	X	X	X	X
Other Agencies				
Berrenda Mesa Banking Project	X	X	X	X
County of Kern Parks & Rec. - BVARA	X			
Pioneer Banking Project	X	X	X	X
Kern Water Bank Authority	X	X	X	X
Kern National Wildlife Refuge		X		

In addition, regional data sets were also updated to provide climatic data sets for the C2VSimFG-Kern update. These data sets include the following:

- Precipitation data were updated using publicly available rainfall data for WY 2021. These data were downloaded from the Oregon State University PRISM Climate Group (PRISM, 2022) web site in January 2022.
- ET rates for Kern County were determined using satellite-based data following the same process used for the original C2VSimFG-Kern development (Maley and Brush, 2020). The ET data were developed by the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2022). ITRC uses a modified Mapping of EvapoTranspiration with Internal Calibration (METRIC) procedure to compute actual evapotranspiration using LandSAT Thematic Mapper data (ITRC, 2022).

The agricultural, urban and native vegetation land use areas used the same assumptions as in the projected-future Baseline scenarios for the Kern County Subbasin GSPs (Maley and Brush, 2020). Model input for areas outside of the Kern County Subbasin use data from an analogous water year type. This is the same approach that was used for the projected-future Baseline scenarios for the Kern County Subbasin GSPs (Maley and Brush, 2020).

Based on data provided by the Kern County Agricultural Commissioner, permitted agricultural area in the Subbasin has decreased in WYs 2020 and 2021 (Fankhauser, 2022); therefore, the baseline assumptions were adjusted to reflect this land use change. Future updates will incorporate available land use and crop type data produced by the Kern County Agricultural Commission, individual agencies, and other best available information. The Subbasin GSAs are coordinating to expand their ET monitoring to all irrigated agricultural areas within the Subbasin calculation of ET rates on a field and crop basis. The field-scale ET rates will be incorporated into the basinwide model to improve agricultural demand estimates for the water budget (see Sections 7.1.5 and 7.1.6).

Using WY 1995 to WY 2014 as the base period, C2VSimFG-Kern results show declining groundwater levels and long-term reduction of groundwater in storage. During this period, C2VSimFG-Kern results show an average annual decline in groundwater in storage of 277,114 AFY. Based on these historical C2VSimFG-Kern results, an estimated level of uncertainty of the overall water budget was determined to be on the order of 10% to 20% (Maley and Brush, 2020). Notwithstanding some limitations, C2VSimFG-Kern is considered to be the best available information and well-suited as a planning tool to estimate the impacts of the proposed SGMA projects and management actions on groundwater conditions in the Kern County Subbasin.

The C2VSimFG-Kern water budgets and sustainable yield estimates are based on available data and the current level of model calibration and are considered appropriate to support SGMA planning efforts. C2VSimFG-Kern water budgets are not intended for determination of individual landowner allocations or groundwater rights. Additional technical, policy and legal analysis, along with stakeholder involvement, is necessary to fully quantify the sustainable and native yields in the Kern County Subbasin.

1.3.3 DWR Data Templates

DWR has provided Microsoft Excel data templates for agencies to report their basin-wide groundwater extraction volumes, measurement methods, surface water supplies, and total water use. DWR requires the GSAs to use these templates to provide for consistent statewide reporting of water use. A description of the data provided for these templates is included in the following sections. These include:

- **Part A. Groundwater Extractions** – Description of groundwater extractions by water use sector data (23 CCR §356.2(b)(2)) is presented in Section 3.
- **Part B. Groundwater Extraction Methods** – Description of groundwater extraction measurement methods (23 CCR §356.2(b)(2)) is presented in Section 3.
- **Part C. Surface Water Supply** – Description of surface water supply by water source type (23 CCR §356.2(b)(3)) is presented in Section 4.
- **Part D. Total Water Use** – Description of total water supply and use (23 CCR §356.2(b)(4)) is presented in Section 5.

As part of the submission of this Annual Report, the DWR data templates will be uploaded to the Monitoring Network Module (MNM) on the SGMA Portal, the same system used to upload GSP monitoring data.

1.4 Report Organization

This GSP Annual Report is organized according to the order of topics presented in Article 7 of the GSP regulations. Topics include groundwater elevations, groundwater extractions, surface water supply, total water use, change in groundwater in storage, and a narrative description of progress towards GSP implementation. Also included are an Executive Summary and general information summarized in this first section.

1.5 Limitations

During WY 2021, some monitoring efforts and GSP coordinating activities were limited by the ongoing COVID-19 pandemic. Since March 2020, the state and local health departments have issued various orders regarding shelter-in-place, restrictions on public gatherings, and other agency limitations. Much of the implementation work continued under coordinated virtual meetings and webinars.

Nonetheless, the Kern County Subbasin GSAs have made significant progress with GSP implementation and are collectively committed to achieving sustainable groundwater management. Regularly scheduled meetings/webinars are being reinstated by the Basin Coordination Committee (BCC) and other GSA manager groups leading coordinated Basin-wide GSP activities. Substantial compliance with requirements of the Annual Report is demonstrated throughout this WY 2021 Annual Report.

2 GROUNDWATER ELEVATIONS

The Third Annual Report presents the semi-annual monitoring groundwater elevations measured in the GSP Representative Monitoring Wells for WY 2021 (**Figure 5**). These data have been compiled for the Kern County Subbasin through WY 2021 and presented in Section 3 to provide the following required analyses:

- Preparation of water level hydrographs for GSP Representative Monitoring Wells to illustrate long-term trends and fluctuations and to demonstrate compliance relative to sustainable management criteria.
- Development of water level contour maps for Kern County Subbasin Principal Aquifers, illustrating the seasonal high and seasonal low levels during the Reporting Period of WY 2021 (i.e., Fall 2020 and Spring 2021).

The WY 2021 data were also uploaded to the DWR Monitoring Network Module (MNM) as required in June and December 2021 in compliance with DWR semi-annual reporting requirements (by January 1, 2021 for Fall 2020 water levels and July 1, 2021 for Spring 2021 water levels). The data uploaded to the MNM are now coordinated through the Kern County Subbasin Data Management System (DMS).

2.1 HYDROLOGIC WATER YEAR TYPE

GSP regulations require that hydrographs of groundwater elevations, groundwater use, the annual change in groundwater in storage, and the cumulative change in groundwater in storage be shown with respect to the water year type representative for the Subbasin (§356.2(b)(1)(B) and §356.2(b)(5)(B). The Annual Report includes both the San Joaquin Valley Index and the average Kern River April-July runoff to represent the water year type in the Subbasin.

For the Annual Report, the annual water year type is shown as the San Joaquin Valley Index. The San Joaquin Valley index is calculated as inflow from the Stanislaus, Tuolumne, Merced and San Joaquin Rivers inflow into downstream reservoirs. The WY 2021 San Joaquin Valley Index, calculated by DWR, was 1.3, which is classified as a critically dry water year type (CDEC, 2022). The water year type based on the San Joaquin Valley Index over the historical period from WY 1995 through WY 2021 is shown on the bottom graph on **Figure 6**.

The Kern River annual hydrographic reports calculate the regulated flow, as computed at First Point of Measurement, for the primary runoff period from April through July. This flow rate is also shown as a percentage of the average long-term flow rate for the Kern River since 1894. For WY 2021, the Kern River regulated flow at First Point was 15 percent of the long-term average (COB, 2021). The Kern River April-July runoff percentage for the Kern River is also shown on **Figure 6** to illustrate local Subbasin conditions.

A comparison of the San Joaquin and Kern rivers indices shows relatively good agreement for wet and dry cycles over the historical period from 1995 through 2021. In particular, the recent drought years of 2013, 2014, 2015 and 2021 represent the four most critically dry years in the period for both the Kern River and the San Joaquin Valley. For both the San Joaquin Valley and Kern River, WY 2015 was the driest on record. The last five years of the period represent two wet years (WY 2017 and WY 2019) and three below normal years (WY 2018, WY 2020, and WY 2021) with WY 2021 being a critically dry year. Eight of the last ten years are characterized by the San Joaquin Valley Index as drought years with one Below Normal (BN), three Dry (D), and four Critically Dry (CD) Water Year Types. For each of those eight years, the Kern River hydrographic reports (COB, 2021) indicated flows below 50 percent of its long-term average (**Figure 6**).

2.2 COORDINATED BASIN-WIDE MONITORING

The Kern County Subbasin GSAs have combined the representative monitoring wells from the five Subbasin GSPs into a basin-wide GSP Representative Monitoring Network as shown on **Figure 5**. Although developed locally, networks were combined to facilitate coordination and evaluation of sustainable management criteria across GSP boundaries and throughout the Subbasin.

The Kern County Subbasin GSAs have also coordinated on monitoring protocols, as documented in each of the Subbasin GSPs and in the executed Coordination Agreement. Monitoring protocols considered Best Management Practices (BMPs), CASGEM[2] monitoring protocols, and protocols from other long-established Kern County Subbasin monitoring programs (e.g., the Kern Fan Monitoring Committee). In consideration of the variable monitoring schedules already developed for existing Subbasin programs, the following time frames were included in the protocols to allow monitoring flexibility for collection of seasonal high and low levels as experienced across this large and complex Subbasin.

- *Collection of water level data between the two approved time frames only:*
    - *January 15th to March 30th representing the seasonal high-water levels.*
    - *September 15th to November 15th representing the seasonal low water levels.*

Some GSP monitoring network wells are measured more frequently, either as part of a separate monitoring program or in compliance with GSP-specific requirements. However, groundwater elevation data compiled for the WY 2021 reporting period are incomplete for some wells the network. Some of these wells were either inaccessible or not measured during the approved time frames. In addition, some of the monitoring wells have been recently installed and/or recently added to the network; as such, some wells do not have available historical water level data. The Subbasin GSAs are currently working to address these issues.

Appendix A provides a hydrograph for each of the 203 wells in the GSP Representative Monitoring Network in WY 2021. Each hydrograph label includes the following:

- Name of the reporting agency,
- Common local well name,
- DWR Site Code, and
- Graph identification number (Graph ID).

The DWR Site Code provides a linkage to the well information and water level data already uploaded on the MNM, whereas the local well name allows for easier identification by local agencies. The Graph ID is also included as a well identifier label on each of the hydrographs in **Appendix A** to allow linkage back to **Figure 5**.

[2] California Statewide Groundwater Elevation Monitoring (CASGEM) program.

2.3 HYDROGRAPHS FROM WY 1995 THROUGH WY 2021

Hydrograph development and observations on trends and fluctuations – along with information on compliance with sustainable management criteria – are described below. The groundwater elevation data were used to generate hydrographs for GSP monitoring network wells where Minimum Threshold (MT) and Measurable Objective (MO) – and, in some cases, interim milestones – have been established (**Appendix A**).

2.3.1 Hydrograph Development

Hydrographs in the Third Annual Report are presented for each of the RMWs shown on **Figure 5.** The hydrographs are developed within the Subbasin DMS so that the most complete and current groundwater elevations, well completion data and MT/MOs are used to develop the hydrographs. The hydrographs are publicly available on the Subbasin DMS (see Section 7.1.2)

More than 200 hydrographs have been developed for this Third Annual Report and are presented in a consistent format in **Appendix A**. For each hydrograph, a solid black horizontal line shows the ground surface elevation (GSE), and the MT and MO are represented by orange and gray lines, respectively. Groundwater elevation data are shown in blue. For reference, hydrographs are presented in alphabetical order of the lead GSA in the five GSPs and then alphabetical by monitoring agency; the beginning page numbers in **Appendix A** for each agency's hydrographs as shown on **Table 2**.

To comply with GSP regulations, hydrographs include "historical data to the greatest extent available, including from January 1, 2015, to current reporting year" (§356.2(b)(1)(B)). For the Kern County Subbasin, the time period from WY 1995 through WY 2021 was selected based on the 20-year historical study period (WY 1995 – WY 2014) and updated data through the reporting period (WY 2021). Accordingly, the hydrographs show the historical record of measured groundwater elevations of each well within the 27-year GSP reporting period from WY 1995 through WY 2021. Some wells have a long historical record whereas new monitoring wells may only have a limited number of recent measurements. The water year type for this time period uses the San Joaquin Valley Index as illustrated by the bottom graph on **Figure 6**.

Most of the hydrographs represent the Primary Principal Aquifer, composed of the alluvial continental deposits in the Subbasin. However, three local Principal Aquifers in addition to the Primary Principal Aquifer are represented by the following hydrographs in **Appendix A**:

- Six hydrographs prepared by Kern-Tulare Water District (KTWD) for the Santa Margarita Formation (note that KTWD hydrographs also include wells monitored north of the Kern County Subbasin)
- Six hydrographs prepared by Eastside Water Management Area (EWMA) for the Santa Margarita Formation and the Olcese Sand
- Two hydrographs prepared by Olcese Water District (Olcese WD) for the Olcese Sand.

In compliance with GSP regulations Article 4, the hydrographs are submitted electronically and labeled with a unique site identification number (Site Code and Local Identifier), monitoring agency, and the GSE. In addition, hydrographs have incorporated the same datum and scaling to the greatest extent practical (§352.4(e)). Some vertical scales are adjusted to allow the GSE, MT, and MO to be displayed.

Table 2. Location of Hydrographs in Appendix A by GSA and Agency

GSA	Reporting Agency	Graph ID (Appendix A)
Buena Vista Water Storage District GSA	Buena Vista Water Storage District GSA	A-1 to A-9
Henry Miller Water District GSP	Henry Miller Water District GSA	A-10 to A-14
Kern Groundwater Authority GSA	Arvin-Edison Water Storage District	A-15 to A-30
Kern Groundwater Authority GSA	Cawelo Water District GSA	A-31 to A-37
Kern Groundwater Authority GSA	Eastside Water Management Area	A-38 to A-43
Kern Groundwater Authority GSA	Pioneer GSA	A-44 to A-48
Kern Groundwater Authority GSA	Kern Tulare Water District	A-49 to A-54
Kern Groundwater Authority GSA	North Kern Water Storage District	A-55 to A-62
Kern Groundwater Authority GSA	Rosedale-Rio Bravo Water Storage District	A-63 to A-89
Kern Groundwater Authority GSA	Semitropic Water Storage District	A-90 to A-102
Kern Groundwater Authority GSA	Shafter-Wasco Irrigation District	A-103 to A-112
Kern Groundwater Authority GSA	Southern San Joaquin Municipal Utility District	A-113 to A-122
Kern Groundwater Authority GSA	Tejon Castac Water District	A-123
Kern Groundwater Authority GSA	West Kern Water District	A-124 to A-146
Kern Groundwater Authority GSA	Westside District Water Authority	A-147 to A-149
Kern Groundwater Authority GSA	Wheeler Ridge-Maricopa Water Storage District	A-150 to A-163
Kern River GSA	Kern River GSA	A-164 to A-201
Olcese Water District GSA	Olcese Water District	A-202 to A-203

2.3.2 Water Level Trends and Fluctuations

In general, the groundwater elevation trends seen on the hydrographs for the Primary Principal Aquifer (**Appendix A**) are consistent with the water year types illustrated on **Figure 6**. As a result, groundwater elevation generally declined in response to dry conditions; however, these trends vary across the Subbasin.

Historically, groundwater elevation trends in the Subbasin generally show an increase during the wet periods and a decrease during dry periods. This was observed during the wetter years of WYs 1995-1998, WYs 2005-2006, WYs 2010-2011 and the recent wet years of WY 2017 and WY 2019. During the extended drought period from WY2013 through WY2016, several areas in the Subbasin experienced historic low groundwater elevations.

During these wet years there was an increase in both natural and managed aquifer recharge. Therefore, the increase in groundwater elevations was more pronounced in the areas with managed aquifer recharge and banking operations. Conversely, dry periods have decreased natural recharge but increased recovery of managed aquifer recharge by groundwater pumping. As expected, groundwater elevations generally declined across the Subbasin during these intervening drought years.

WYs 2020 and 2021 were dry and critically dry water years, respectively, based on both the San Joaquin Valley Index and the Kern River flows (**Figure 6**). As anticipated, the areas with the largest change in groundwater elevations in WY 2021 are in the central Subbasin in the vicinity of the Kern Fan banking operations where increased pumping occurred to recover previously recharged groundwater. In the banking areas, groundwater elevations historically fluctuate over 200 feet from wet to drought years as a result of varying recharge and recovery banking operations. The changes in groundwater elevations in WY 2021 are consistent with that pattern. This high variability in groundwater elevations is also reflected in the annual change in groundwater in storage maps where the banking areas (as described in Section 6).

In areas farther away from the managed recharge and recovery operations, the groundwater elevations for WY 2020 and 2021 were generally more stable, representing local recharge and pumping conditions that are mostly within the historical range observed in the well. A few areas even showed increasing groundwater elevations over the past two years. Although some wells experienced new historical lows in the past two years, this was not widespread, and in WYs 2020 and 2021 most wells remained above historical lows.

2.3.3 Compliance with Sustainable Management Criteria

The groundwater elevation data were used to generate water level hydrographs for GSP monitoring network wells. Hydrographs for these wells are provided in **Appendix A** and show the groundwater elevation relative to their assigned MT and MO. Note that the water level declines below MTs occurred in some wells prior to the submission of the GSPs and prior to GSP implementation. Discussion of MT exceedances are provided in the GSA and management area GSP Progress Summaries in Section 7.

As noted above, hydrologic conditions over the last ten years have produced some of the driest conditions on record. Eight of the last ten years are characterized by the San Joaquin Valley Water Year Type as below normal, dry, or critically dry. For each of those eight years, the Kern River regulated flows have been about 50 percent below its long-term average (**Figure 6**).

2.4 GROUNDWATER ELEVATION CONTOURS FOR SUBBASIN PRINCIPAL AQUIFERS

GSP monitoring network data were supplemented with additional local groundwater elevation data to construct groundwater elevation contour maps for the Principal Aquifers in the Subbasin. Supplemental data include wells monitored by the Kern Fan Monitoring Committee and other available water level data. KCWA typically compiles Subbasin data on an annual basis for monitoring conditions in and adjacent to the central Subbasin groundwater banking projects. To provide additional accuracy for water level contour mapping, KCWA combined these additional datasets with the GSP monitoring network data to prepare water level contour maps for the Primary Principal Aquifer, as described in Section 2.4.1 below.

Groundwater elevation data were also provided for two of the three local Principal Aquifers in the Subbasin. All local Principal Aquifers are much more limited in extent than the Primary Principal Aquifer (**Figure 9**) Specifically, Olcese Water District GSA provided contour maps for the Olcese Sand Principal Aquifer in the Olcese GSA. KTWD provided groundwater elevations for the local Santa Margarita Principal Aquifer, although data were not yet sufficient to interpret groundwater elevation contours. In addition, data were not available for remaining local Principal Aquifer areas. The local agencies are working to address data gaps associated with these local Principal Aquifers. The Subbasin GSAs are coordinated on a comprehensive study to address basinwide hydrogeological conceptual model data gaps that will coordinate with the local efforts (see Section 7.1.5)

2.4.1 Primary Principal Aquifer

KCWA provided groundwater elevation contour maps for the Primary Principal Aquifer, which consists mostly of continental alluvial deposits that extend throughout most of the Subbasin. KCWA has been responsible for implementation of the Kern Fan Monitoring Committee program and has constructed similar basin-wide groundwater elevation contour maps for decades. Although KCWA has prepared contour maps for both seasonal highs (Spring) and lows (Fall), more data are typically collected in Spring when water levels are less affected by a long irrigation season and more accurately reflect the natural hydrologic conditions in the Subbasin. For this Third Annual Report, data were compiled and contoured for both Fall 2020 and Spring 2021, as shown on **Figures 7** and **8**, respectively, to comply with the GSP reporting period of WY 2021. Contours are represented as feet with respect to mean sea level (msl). Negative contours represent feet below msl.

As shown on **Figure 7**, groundwater elevations are highest in the southeastern Subbasin along the Sierra Nevada foothills. Groundwater elevations are also relatively high along the Kern River (generally above 200 feet msl), which traverses across the central Subbasin from northeast to southwest (see also **Figure 1**). Kern River water infiltrates alluvial deposits in the channel and local unlined canals to recharge the groundwater basin. Groundwater elevations remain high in the central Subbasin where multiple groundwater banking projects store large volumes of recharged water for subsequent recovery in the areas along the Kern River referred to as the Kern Fan area. As reported in the First Annual Report (WY 2019), more than 1,100,000 acre feet (AF) of water were available for managed aquifer recharge, primarily associated with the Kern Fan banking projects, due to relatively wet conditions in WY 2019.

Groundwater elevation contours on **Figure 7** indicate that groundwater flows radially away from the Kern River area. Within several miles, water levels are more than about 50 feet lower compared to levels in the banking areas. Groundwater elevations below sea level occur beneath a large area in the north-central Subbasin. The lowest water levels (nearly 100 feet below msl) occur long the northern boundary of **Figure 7** near the Subbasin subsurface outflow to adjacent subbasins to the north. Water levels are higher south of the Kern River and are generally above 100 feet msl.

Similar patterns of water levels and groundwater flow directions are indicated for Spring 2021 conditions as shown on **Figure 8**. During this period, water levels in the Kern Fan banking areas are more variable than in Fall 2020 with lower groundwater elevations in some areas due to ongoing recovery pumping. WY 2021 is characterized by groundwater extraction in the banking areas rather than recharge due to limitations on surface water supplies. Some areas north and south of the Kern River are higher in Spring 2021 (**Figure 8**) than in Fall 2020 (**Figure 7**) due, in part, to the migration of previously recharged water from the Kern River and the Kern Fan banking areas.

Even though Spring conditions generally represent a time of higher water levels, **Figure 8** indicates that groundwater elevations remained below sea level in a similar area of the Subbasin in Spring 2021 as compared to Fall 2020. Overall, groundwater elevations are higher than seen on **Figure 7**. For example, the lowest water levels on **Figure 8** are about 80 feet below msl, along the northern boundary compared to more than 100 feet below msl in Fall 2020.

2.4.2 Local Principal Aquifers

Although most of the Subbasin production occurs within the Primary Principal Aquifer, three additional Principal Aquifers have been identified as having local significance. Although the exact extents of these three local Principal Aquifers are not well defined, the aquifers have been identified in four areas of the Subbasin as listed in **Table 3**.

The general extents of these local Principal Aquifers are approximated on **Figure 9**. As shown on the map, most of the local aquifers occur along the northeastern margin of the Subbasin and consist of deeper consolidated units including the Santa Margarita Formation and the Olcese Sand. In those areas, groundwater is produced primarily from the Santa Margarita Formation in KTWD, both the Santa Margarita and Olcese Sand in EWMA, and the Olcese Sand in Olcese WD.

Table 3. Local Principal Aquifers in the Kern County Subbasin

Principal Aquifer	Responsible Agency	Subbasin Area
Olcese Sand	Olcese WD	East, near the Subbasin boundary adjacent to the Kern River
Santa Margarita Formation	Kern-Tulare WD	Northeast
Combined Santa Margarita Formation and Olcese Sand	Eastside WMA	East-Northeast
Upper Aquifer	Semitropic WSD	North-Central

Groundwater elevation contour maps were provided for the Olcese Sand Principal Aquifer by Olcese WD; maps for Fall 2020 and Spring 2021 are presented on **Figures 10** and **11**, respectively. As indicated on **Figure 10**, Fall 2020 groundwater elevations are about 300 feet higher in the Canyon View Ranch Well in the eastern GSA than in wells to the west. A steep hydraulic gradient is evident between the Canyon View Ranch well and the deeper downgradient wells. Groundwater elevations are significantly flatter in Wells #2, #3, and #4. In Spring 2021 (**Figure 11**), groundwater elevations were relatively stable in the Canyon View Ranch Well while water levels rose about 30 feet in other wells. Contours are adjusted slightly to indicate these higher water levels.

For the Santa Margarita Formation beneath Kern Tulare WD, groundwater elevations were available from both the previously-implemented CASGEM program as well as the ongoing GSP monitoring network established by KTWD. For this Third Annual Report, groundwater elevations both within and north of the Subbasin were provided by Kern-Tulare WD and represent conditions for from Fall 2020 and Spring 2021 as shown on **Figure 12**.

As evidenced by the data on **Figure 12**, water levels are variable geographically and not readily conducive to water level contouring. Nonetheless, review of the data shows that water levels rebounded significantly in Spring 2021 compared to Fall 2020 with increases averaging about 40 to 50 feet. The production zone represents a narrow band of Santa Margarita sandstone that is structurally complex. Nonetheless, it provides an important local resource that is being investigated and monitored by Kern-Tulare WD.

In part because of the recent initiation of a groundwater monitoring network, groundwater elevation data from the Eastside Water Management Area were also insufficient for groundwater elevation contour maps. Production in this area is reportedly from both the Santa Margarita Formation and Olcese Sand. Additional hydrogeologic characterization is currently underway to improve the understanding of local groundwater conditions in these local principal aquifers.

In the north central Subbasin, a third local Principal Aquifer has been identified as the Upper Aquifer. This Upper Aquifer has been created by the occurrence of shallow clays that limit downward recharge and locally separate the Upper Aquifer from the Primary Principal Aquifer. Although the Upper Aquifer is not heavily relied on for water supply, the presence of an upper and lower aquifer system is evidenced by differences in water levels. Cross sections and maps presented in the Semitropic WSD Management Area Plan (in the KGA GSP) show the water level differences and limited extent of the Upper Aquifer as a local Principal Aquifer. The estimated extent is shown on **Figure 9**.

With regard to the Upper Aquifer Principal Aquifer in the northern Subbasin, groundwater elevations have been mapped previously as part of the Semitropic Groundwater Banking Project Monitoring Committee. Those maps will continue to be available for local planning and use; however, publicly-available groundwater elevations for WY 2021 were not available. Because almost all groundwater production beneath Semitropic WSD occurs in the lower Principal Aquifer (hydraulically connected to the Primary Principal Aquifer), no significant change in groundwater in storage for the Upper Aquifer is expected. Any local change in groundwater in storage will be documented using the C2VSimFG-Kern modeling as part of this Annual Report.

3 GROUNDWATER EXTRACTIONS

The volume of groundwater extraction in the Kern County Subbasin is provided for WY 2021 per GSP Regulations (23 CCR §356.2(b)(2)). Data presentation follows the DWR data templates that list groundwater extractions by water use sector and identify the method of measurement and accuracy of measurements (**Table 4**). A map of groundwater extractions (**Figure 13**) is provided to illustrate the general location and volume of groundwater extractions in the Kern County Subbasin.

3.1 GROUNDWATER EXTRACTION DATA METHODS

Total groundwater extractions for the Subbasin for WY 2021 have been compiled and summarized for this section. The data were collected using the "best available measurement methods." For the Kern County Subbasin the groundwater extraction data were compiled using two methods:

- Directly measured groundwater extraction data collected by local water agencies.
- Estimated groundwater extractions using the IWFM Demand Calculator (IDC) tool developed by DWR (Dogrul, Kadir and Brush, 2017).

Directly measured groundwater extractions were collected using meters and other appropriate comparable measuring devices by local water agencies (**Table 1**) in accordance with the monitoring protocols of the respective local water agency. These data were compiled and provided by the local water agency to support this Annual Report. These directly measured data were obtained using high-accuracy measuring devices and methodologies (see Section 3.4).

The remaining estimated groundwater extractions are based on DWR's IDC tool (Dogrul, Kadir and Brush, 2017) to estimate agricultural, urban and other pumping. IDC is a standalone module used in the IWFM-based C2VSimFG-Kern model that solves the soil moisture balance in the root zone using local soil properties to compute the monthly agricultural and urban water demand for each model element. If water demand is not satisfied with precipitation and applied surface water, the IDC tool calculates the groundwater pumping needed to eliminate any assumed deficit (Dogrul, Kadir and Brush, 2017). The groundwater extraction calculated by IDC is dynamically linked to the C2VSimFG-Kern to provide the overall pumping data for the groundwater model component.

For the Kern County Subbasin, IDC calculates only the groundwater extraction necessary to meet the crop and soil moisture demand after accounting for the contribution from surface water supplies and precipitation. WY 2021 surface water supplies are based on measured data provided by local agencies (**Table 1**), and regional distribution of WY 2021 precipitation is based on data developed by the PRISM Climate Group based at Oregon State University (PRISM, 2022). The determination of agricultural pumping follows the same approach used for the GSP model-derived water budgets (Maley and Brush, 2020).

IDC calculates agricultural demand based on annual crop type distribution mapping from the Kern County Agricultural Commissioner, member agency data and evapotranspiration (ET) rates for twenty irrigated crop types, the urban areas, and the managed seasonal wetlands at the Kern National Wildlife Refuge. Monthly WY 2021 ET rates were developed by applying the METRIC process to satellite-based data processed at the Irrigation Training & Research Center (ITRC) at California Polytechnic State University, San Luis Obispo (Howes, 2022).

Data provided by the Kern County Agricultural Commissioner (Fankhauser, 2022) noted a decrease in the permitted agricultural area relative to previous years in the Subbasin in WYs 2020 and 2021. In reviewing the IDC results of agricultural demand since the previous annual report, we found that IDC had overestimated agricultural demand in WY 2020 by using the projected future baseline scenario assumptions for crop area. Therefore, in this year's update, we have adjusted the IDC inputs to produce agricultural demand consistent with the Kern County Agricultural Commissioner and ITRC data. As a result, the total agricultural groundwater extractions for WY 2020 were decreased by 290,858 acre-feet to a revised total of 1,544,196 acre-feet. The Subbasin GSA are coordinating on developing improved ET monitoring in the Subbasin to better estimate agricultural demand in the future (see Sections 7.1.5).

Similarly, urban demands in C2VSimFG-Kern are based on agency supplied information and/or regional population and per-capita water demand. Population information was from projected-future baseline population used for the GSPs (Maley and Brush, 2020). The per-capita water demand was recalculated for the metropolitan Bakersfield area based on water supply data provided by the local water purveyors. For areas outside of the metropolitan Bakersfield area, per-capita water demand is based on urban water management plans and available local water use data. IDC calculates urban water demands for specified urban delivery zones, allocates specified surface water and groundwater supplies to meet these demands, and can optionally pump additional groundwater to satisfy unmet urban (indoor and outdoor) demands in each zone following the same approach as used for the GSP model-derived water budgets (Maley and Brush, 2020).

3.2 Summary Extractions By Subbasin For WY 2021

Using the methods described above, the total groundwater extractions in the Kern County Subbasin for WY 2021 were tabulated. **Table 4** summarizes the Kern County Subbasin groundwater extractions by water use type and measurement method for WY 2021.

Table 4. Groundwater Extractions in the Kern County Subbasin for WY 2021

Groundwater Extraction	Total Groundwater Extractions	Meters Volume	Electrical Records Volume	Land Use Volume	Groundwater Model Volume	Other Methods Volume
Water Use Type	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**	**Acre-ft**
Urban	170,084	154,357	0	15,727	0	0
Industrial	0	0	0	0	0	0
Agricultural	1,809,934	382,699	0	1,427,235	0	0
Managed Wetlands	0	0	0	0	0	0
Managed Recharge	427,543	427,543	0	0	0	0
Native Vegetation	0	0	0	0	0	0
Other	63,594	11,051	0	52,543	0	0
Total	2,471,156	975,650	0	1,495,505	0	0

The data show that 2,471,156 acre-feet of groundwater extractions occurred in WY 2021. Following the DWR data templates, the groundwater extractions are presented by water use sector. For the Kern County Subbasin, the water use sectors are described as follows:

- **Urban** – This category includes groundwater extractions for all urban uses including residential, commercial, municipal, industrial, oilfield use, landscaping and other uses. Reported data are provided by urban water purveyors with metered data. Non-reported data are derived from land use assumptions in the IDC tool within the C2VSimFG-Kern groundwater model. The total urban groundwater extraction in the Kern County Subbasin is 170,084 acre-feet which accounts for about 7% of the WY 2021 total pumping in the Kern County Subbasin.
- **Industrial** – Current data do not allow for tabulation of groundwater extraction of industrial water use on a consistent basin-wide basis; therefore, industrial water use is included in the urban water use sector for WY 2021.
- **Agricultural** – These are groundwater extractions for irrigated crops and pasture (including non-district lands). Also included in this category is groundwater used for process water for food processing, dairy and other agricultural uses, which is then applied to nearby crops for disposal. Reported data are pumping by local water agencies for agricultural use within the Kern County Subbasin. Private agricultural pumping is determined using the IDC tool within C2VSimFG-Kern based on the ITRC-METRIC satellite data (Howes, 2022) to determine monthly ET rates. The WY 2021 total agricultural groundwater extraction in the Kern County Subbasin is 1,809,934 acre-feet which accounts for about 73% of the total pumping.
- **Managed Wetlands** – The Kern National Wildlife Refuge has historical groundwater use, but currently relies on surface water supplies. No managed wetland groundwater extractions were reported for WY 2021 for the Kern National Wildlife Refuge.
- **Managed Recharge** – This category includes groundwater extractions from local district-managed recharge operations and large groundwater banking projects that go to water sector uses or are returned to the California Aqueduct or Friant-Kern Canal (i.e., “Pump-In”) as part of a water exchange. Groundwater recovery pumping amounts by local agencies for use within their jurisdiction for a specific water use are listed on **Table 4** under the appropriate water use sector (e.g., agricultural or urban). The total groundwater extraction in the Kern County Subbasin for managed recharge recovery, as defined above, is 427,543 acre-feet, which accounts for about 17% of the WY 2021 total pumping.
- **Native Vegetation** – Currently, no groundwater extractions are used for maintaining native vegetation in the Kern County Subbasin.
- **Other Sector** – This category includes groundwater extractions for water use sectors that do not fit within the categories listed above. Examples include groundwater pumping for use in areas adjacent to the Kern County Subbasin, lake level management, and pumping for unspecified or multiple water-use sectors. The total groundwater extraction for other uses in the Kern County Subbasin is 63,594 acre-feet which accounts for about 3% of the WY 2021 total pumping.

In accordance with 23 CCR §356.2 (b)(2), the user must define the method of measurement (direct or indirect) and the accuracy of measurements. The other criteria required for presenting the groundwater extraction data is by method of measurement. As shown on **Table 3**, the groundwater extractions are categorized into two of the methods listed by DWR. These include:

- **Meters** – direct measurement of groundwater extraction collected by local water agencies using meters and other appropriate measurement device. The total groundwater extraction from metered data in the Kern County Subbasin is 975,650 acre-feet which accounts for about 39% of the WY 2021 total pumping.
- **Land Use Calculation** – indirect estimate of groundwater extractions based on land use methods using the IDC tool (Dogrul, Kadir and Brush, 2017), a component of the C2VSimFG-Kern model for the Kern County Subbasin. The total groundwater extraction based on land use calculations in the Kern County Subbasin is 1,495,505 acre-feet which accounts for about 61% of the WY 2021 total pumping in the basin.

Groundwater extractions presented here represent the current best estimate of groundwater pumping in the Kern County Subbasin. The use of C2VSimFG-Kern, including the IDC tool, provides a consistent, basin-wide method for estimating the unmeasured pumping in accordance with the Kern County Subbasin Coordination Agreement.

3.3 GROUNDWATER EXTRACTIONS MAP

In accordance with 23 CCR §356.2 (b)(2), this Annual Report includes a map (**Figure 13**) illustrating the general location and volume of groundwater extractions. For WY 2021, a total groundwater extractions map was derived from the simulation results of C2VSimFG-Kern. The specified metered pumping is directly input into C2VSimFG-Kern while the IDC tool estimates the unmeasured portion of agricultural and urban pumping based on land use calculations (Maley and Brush, 2020).

Developing a map showing the distribution of groundwater extraction required accessing the groundwater extraction for each element from the binary output files of model results. The model output is the total volume of groundwater extracted within a model element. Because model elements vary in size, the simulated groundwater extraction rate from C2VSIMFG-Kern was normalized to the rate of acre-feet per square mile. These groundwater extraction rates were then interpolated onto a uniform one-square mile grid superimposed over the Kern County Subbasin. Therefore, the model represents the total pumping per square mile over the groundwater basin included in C2VSimFG-Kern.

Figure 13 shows the distribution of total groundwater extractions over the Kern County Subbasin. Because agricultural pumping accounts for 73% of the total WY 2021 groundwater extractions, the pumping distribution generally corresponds to the distribution of irrigated agriculture. The exception is in the northwestern Subbasin where irrigated agriculture depends solely upon imported surface water supplies due to poor local groundwater quality, which is unsuitable for irrigation. In general, groundwater extraction in the irrigated areas ranges between 250 to 2,000 acre-feet per square mile.

Areas of concentrated pumping are typically associated with groundwater banking recovery operations. The areas where groundwater pumping exceeds 2,000 acre-feet per square mile are located in the vicinity of managed aquifer recharge operations where the pumping is recovering previously “banked” surface water for use.

3.4 PART A AND B DWR DATA TEMPLATES

As part of the Annual Report submittal, DWR requires that a series of Excel spreadsheets be completed to summarize key water supply and use volumes for WY 2021 for the entire Subbasin. For groundwater extraction, DWR requires submittal of two spreadsheets with the Annual Report in accordance with 23 CCR §356.2 (b)(2):

- **Part A. Groundwater Extractions** - groundwater extractions for WY 2021 by water use sector (23 CCR §356.2(b)(2))
- **Part B. Groundwater Extraction Methods** - the volume of groundwater extractions for WY 2021 by different measurement methods (23 CCR §356.2(b)(2)).

Data summarized in **Table 4** follow the Part A and B DWR Template reporting requirements for groundwater extractions and were collected using the best available measurement methods.

The accuracy of measurement is required on the DWR templates. For the Kern County Subbasin, the groundwater extractions are based on either reported metered pumping data or simulation results of the C2VSimFG-Kern model. These data were collected by experienced agency staff from agricultural, urban and county water agencies (**Table 1**) in accordance with their monitoring protocols. The measuring devices used by these agencies are considered to be well maintained and consistently monitored; therefore, reported data meet high accuracy levels in compliance with AWWA (2006, 2012) and other relevant standards. In accordance with these standards, meter accuracy is considered high, ranging between 0% and 5%.

Estimated groundwater extractions are based on simulation results of the IDC tool within C2VSimFG-Kern model. The water balance accuracy of the groundwater model is considered medium, approximately ranging between 10% and 20%. Input data based on metering, as noted above, are assumed to have an accuracy of 0% to 5%. The agricultural pumping, which is the largest component of groundwater extraction, is estimated using the ITRC-METRIC based ET Rates. ITRC (Howes, 2022) lists the accuracy of the ET measurements as ranging from 7% to 10%. Land use is based on Kern County Agricultural Commissioner annual land use data including crop type. Soil properties are based on local soil survey data, which have a higher level of uncertainty. Applying a weighted average of these inputs to the overall water budget produces a relative accuracy between 10% and 20% for the land use calculation for agricultural groundwater extractions.

4 SURFACE WATER SUPPLY

The volume of surface water supplies delivered to the Kern County Subbasin is provided for WY 2021 per GSP Regulations (23 CCR §356.2(b)(3). Data are summarized in a table that follows DWR reporting requirements for surface water supplies by water supply source and identifies the method used to determine the reported volume.

4.1 Surface Water Data Methods

Surface water supplies for the Subbasin for WY 2021 were compiled from data collected using the "best available measurement methods." For the Kern County Subbasin, surface water supplies are directly measured by local water agencies at the point of diversion from a river, stream or canal. Water supply from natural sources, (e.g., precipitation and natural runoff) are not included in Section 4. The contribution of these sources to the basin is included in the calculation of the change in groundwater in storage based on the C2VSimFG-Kern model provided in Section 6.

The measured surface water supplies were provided by local agricultural water districts, urban water purveyors and city water departments (**Table 1**) for this Annual Report. These meter data were compiled by local water agencies following their monitoring protocols. Therefore, these data were obtained using a "high accuracy" method consistent with typical accuracy ranges of surface water diversions.

4.2 Surface Water by Source Type

Using the methods described above, the surface water supply by source in the Kern County Subbasin for WY 2021 was tabulated and is summarized in **Table 5**. The water source types are defined in 23 CCR §351 (a-k). The user can identify a different water source type than those predefined by selecting "*other source type*" in the template and providing a description of the source type with the data. **Figure 14** is a map showing the primary surface water supply infrastructure and features in the Kern County Subbasin.

Table 5. Surface Water Supplies in the Kern County Subbasin for WY 2021

Surface Water Supply	Surface Water Supply Volume
Surface Water Supply Source	**Acre-ft**
Central Valley Project	76,149
State Water Project	424,822
Colorado River Project	0
Local Supplies	225,039
Local Imported Supplies	48,023
Recycled Water	51,926
Desalination	0
Other Water Source	121
Total Surface Water Supply	826,080

The data show that 826,080 acre-feet of surface water was supplied to the Kern County Subbasin in WY 2021. Following the DWR templates, the surface water supplies are presented by water source. For the Kern County Subbasin, the water supply sources are described as follows:

- **Central Valley Project (CVP)**: surface water deliveries from the CVP diverted from the Friant-Kern Canal and/or California Aqueduct (westside CVP – Cross Valley Contractors). In WY 2021, 76,149 acre-feet of CVP water were reported as delivered to local agencies in the Kern County Subbasin, representing about 9% of total surface water supplies.
- **State Water Project (SWP)**: surface water deliveries from the SWP diverted from the California Aqueduct. In WY 2021, 424,822 acre-feet of SWP water were reported as delivered to local agencies in the Kern County Subbasin, representing about 51% of total surface water supplies.
- **Colorado River Project**: Currently, no surface water from the Colorado River is delivered to the Kern County Subbasin.
- **Local Supplies**: surface water diversions from local surface water sources. The primary local supply is from the Kern River, but other local surface water diversions are taken from other local sources such as Poso Creek. In WY 2021, 225,039 acre-feet of local surface water were reported as delivered to local agencies in the Kern County Subbasin, representing about 27% of total surface water supplies.
- **Local Imported Supplies:** surface water from local sources imported from areas outside of the Kern County Subbasin. The primary source of local imported water is from treated oilfield produced water. In WY 2021, 48,023 acre-feet of local imported water supplies were delivered to the Kern County Subbasin, representing about 6% of total surface water supplies.
- **Recycled Water:** wastewater and recovered stormwater that is treated and used for either agriculture or groundwater recharge. In WY 2021, 51,926 acre-feet of recycled water were used in the Kern County Subbasin, representing about 6% of total surface water supplies.
- **Desalination Water:** poor-quality surface water or groundwater that is treated to levels where it can be used for irrigated agriculture, urban water supply or groundwater recharge. Currently, no desalination water is available in the Kern County Subbasin; however, proposed SGMA projects include this source as a future water supply.
- **Other Water Source**: surface water obtained from sources other than those listed above or from unspecified sources. In WY 2021, 121 acre-feet of local surface water were delivered to the Kern County Subbasin. This is primarily reuse of tailwater or irrigation return flow that re-enters the local surface water system and is then diverted back for irrigated agriculture water supply, representing less than 1% of total surface water supplies.

The surface water supplies in the Kern County Subbasin can vary from year-to-year due to water year type, statewide water demand and operational considerations. WY 2021 was a critically dry year according to the San Joaquin Valley Index; flows on the Kern River were 15% of the long-term average, which is also consistent with critically dry year conditions.

4.3 PART C DWR DATA TEMPLATE

As part of the Annual Report submittal, DWR requires that a series of Excel spreadsheets be completed to summarize key water supply and use volumes for WY 2021 for the Subbasin. The volume of surface water reported in the template is by water source type. For the surface water supply, DWR requires submittal of one spreadsheet with the Annual Report in accordance with 23 CCR §356.2 (b)(3):

- **Part C. Surface Water Supply** – the surface water supply for WY 2021 based on quantitative data and listed by water source type (23 CCR §356.2(b)(3)).

Data summarized in **Table 5** follow the Part C DWR Template reporting requirements for surface water supply and were collected using the best available measurement methods.

Measurement of surface water supplies for the Kern County Subbasin includes a variety of methods, but all are considered reliable and accurate. Water agencies typically measure surface water deliveries with a combination of weirs and meters that are read and reported by agency staff. Senate Bill x7-7 (SBx7-7) requires flow measurement devices to be maintained within an acceptable range of accuracy that is defined as a volumetric flow measurement within +/- 12% (§597.3(a)(1))). Weirs and meters used in the Kern County Subbasin conform to the SBx7-7 volumetric accounting standards (ITRC, 2012, USBR, 2001, AWWA 2006, 2012) as documented in local water district agricultural water management plans. Procedures employed by water agencies have been standardized to further reduce potential sources of error to range between 1% to 10% depending on the measurement device. In the Part C template, an error range of 5% to 10% is listed as a conservative assumption for this Annual Report.

5 TOTAL WATER USE

The total water supply and use for the Kern County Subbasin is provided for WY 2021 per GSP Regulations 23 CCR §356.2(b)(4). Data are summarized following the DWR data templates for total water supply and use.

5.1 TOTAL WATER SUPPLY BY SOURCE

The total water supply utilizes the same data compiled for WY 2021 groundwater extractions and surface water supplies as presented in Section 3 and 4. The data show a total water use for the Kern County Subbasin of 3,297,235 acre-feet in WY 2021. The total water supply is summarized in **Table 6.** The water supply types shown on **Table 6** are described as follows:

- **Groundwater** includes groundwater extractions for all uses. In WY 2021, the groundwater supply totaled 2,471,156 acre-feet representing about 75% of total supplies in WY 2021.
- **Surface water** includes surface water deliveries for all uses. In WY 2021, the surface water supply totaled 774,033 acre-feet representing about 23% of total water supplies in WY 2021.
- **Recycled water** includes treated wastewater and stormwater for all use. In WY 2021, recycled water supply totaled 51,926 acre-feet representing less than 2% of total water supplies in WY 2021.
- **Reused water** includes reuse of tailwater, or irrigation return flow that re-enters local surface water system and is then diverted back for irrigated agriculture water supply. In WY 2021, reused water supply totaled 121 acre-feet representing less than 0.01% of total water supplies in WY 2021.
- **Other Water Source Type** - No *other* water source type is noted for the Kern County Subbasin.

Table 6. Total Water Supply by Source in the Kern County Subbasin for WY 2021

Total Water Supply	Total Water Supply by Volume
Water Source	**Acre-ft**
Groundwater	2,471,156
Surface Water	774,033
Recycled Water	51,926
Reused Water	121
Other Water Source Type	0
Total Water Supply	3,297,235

In this case, the total surface water supply from Section 4 that is shown distributed by water source in **Table 5** is presented in **Table 6** distributed by water supply type. The total surface water supply shown on **Table 5** is distributed among surface water, recycled water and reused water on **Table 6**.

5.2 TOTAL WATER USE BY WATER USE SECTOR

The data show a total water use for the Kern County Subbasin was 3,267,023 acre-feet in WY 2021. The total water use is summarized by water use sector in **Table 7**, and the water use sectors shown on **Table 7** are described as follows:

- **Urban** includes total water use for all urban water uses including residential, commercial, municipal, industrial, oilfield use, landscaping and other uses. In WY 2021, urban water use totaled 215,870 acre-feet, representing about 7% of the total water use in the Kern County Subbasin.
- **Industrial** includes total water use for industrial use. Current data does not allow for tabulation of industrial water use on a consistent basin-wide basis; therefore, industrial water use is included in the urban water use sector for WY 2021.
- **Agricultural** includes total water use for all agricultural water uses. In WY 2021, agricultural water use totaled 2,467,092 acre-feet, representing about 75% of the total water use in the Kern County Subbasin.
- **Managed Wetlands** includes total water use for maintaining managed wetlands at the Kern National Wildlife Refuge. In WY 2021, managed wetlands water use totaled 18,036 acre-feet, representing about 1% of the total water use in the Kern County Subbasin.
- **Managed Recharge** includes total water use for active recharge at the managed recharge and groundwater banking operations. In WY 2021, managed recharge use totaled 74,887 acre-feet, representing 2% of the total water use in the Kern County Subbasin.
- **Native Vegetation** includes total water use for maintaining native vegetation. In WY 2021, no groundwater extractions or surface water deliveries were used on native vegetation in the Kern County Subbasin.
- **Other Water Use** includes total water use for uses other than those listed above or from unspecified uses. Groundwater recovery pumping from managed recharge operations listed on **Table 3** are also listed here. In WY 2021, Other Water Uses totaled 491,137 acre-feet, representing 15% of the total water use in the Kern County Subbasin.

Table 7. Total Water Use by Sector in the Kern County Subbasin for WY 2021

Total Water Use	Total Water Use Volume
Water Use Sector	**Acre-ft**
Urban	215,870
Industrial	0
Agricultural	2,467,092
Managed Wetland	18,036
Managed Recharge	74,887
Native Vegetation	0
Other Water Use Type	491,137
Total Water Use	3,267,023

The total water use also utilizes the same data that was compiled for WY 2021 groundwater extractions and surface water supplies presented in Sections 3 and 4. In this case, the total urban and agricultural water use is taken from the IDC tool within the C2VSimFG-Kern model. The difference in total water supply and total water use is 30,212 acre-feet representing less than 1% of the total water supply.

5.3 CHANGES IN WATER SUPPLY AND USE DURING GSP IMPLEMENTATION

As the GSP implementation progresses, the Subbasin will be evaluating performance with respect to sustainability. Because agriculture is the largest water use within the Subbasin, emphasis will tend to focus on that sector. A major performance indicator is the water budget, and the primary tools are the ET data based on satellite remote sensing, Kern County Agricultural Commissioner data, and the C2VSimFG-Kern model. The following provides a preliminary assessment of changes in agricultural water use during the GSP implementation period.

- The METRIC ET data provided by ITRC (Howes, 2022) show a notable decline in ET demand within the Subbasin in WY 2020 compared to the prior period from WY 2013 through 2019 on the order of 200,000 to 300,000 acre-feet. In WY 2021, the ET demand increased but was about 50,000 to 100,000 acre-feet less than the comparable droughts years of 2013 through 2015; however, it was similar to WY 2016. **Figure 15** shows the ITRC Metric calculated ET demand for the Subbasin from 2013 through 2021.

- The Kern County Agricultural Commissioner provided data (Fankhauser, 2022) that noted a decrease in the permitted agricultural area in WYs 2020 and 2021 of 6% to 9% relative to the average permitted agricultural area during WY 2015 through 2019.

- Incorporating these data into the C2VSimFG-Kern model produced a reduced simulated agricultural crop demand for WY 2020 of about 290,000 acre-feet.

These data suggest that agricultural water demand decreased in the Subbasin in WY 2020 on the order of 300,000 acre-feet. The large change in the agricultural water demand in WY 2020 may reflect a one-time anomaly. There are multiple potential factors contributing to the observed changes in agricultural water use during WY 2020 including water supply availability, economic factors and pandemic-related issues. However, the Subbasin GSAs also began implementation of their GSP projects and management actions in WY 2020. These changes may also reflect an increased awareness in sustainability such that growers limited prior practices of relying on groundwater during extended drought periods. Although water use increased in WY 2021 relative to WY 2020, indications persist of a potential decrease in agricultural water usage in the Subbasin.

This is a preliminary assessment of factors contributing to changes in the water supply and demand estimates and the Subbasin GSAs during the GSP implementation. The Subbasin GSAs are currently coordinating on several basinwide management actions to improve the ability to determine the ET crop demand, upgrade the C2VSimFG-Kern model and conduct a Basin Study to address data gaps and better calculate water budgets. These projects, summarized in Section 7.1, will allow the Subbasin GSAs to better track and evaluate performance of the GSP implementation over time.

5.4 PART D DWR DATA TEMPLATE

As part of the Annual Report, DWR requires completion of a series of Excel spreadsheets that summarize key water supply and use volumes for WY 2021 for the Subbasin. For the total water use, DWR requires that one spreadsheet be submitted in accordance with 23 CCR §356.2 (b)(3):

- **Part D. Total Water Use** – the total water supply by water use type and total water uses by water use sector for the preceding water year (WY 2021) for the entire Kern County Subbasin (23 CCR §356.2(b)(4)).

Data summarized in **Tables 6** and **7** follow the Part D DWR Template reporting requirements for total water supply and use and were collected using the best available measurement methods.

6 CHANGE IN GROUNDWATER IN STORAGE

GSP regulation §356.2(b)(5) requires inclusion of the following maps and graphs in the Annual Report for the entire Kern County Subbasin:

(A) Change in groundwater in storage maps for each principal aquifer in the basin.

(B) A graph depicting water year type, groundwater use, annual change in groundwater in storage, and cumulative change in groundwater in storage for the basin based on historical data to the greatest extent available, including from January 1, 2015, to the current reporting year.

This section provides a description of the methodology used to develop the required annual change in groundwater in storage maps and graphs.

6.1 METHODOLOGY

The Kern County Subbasin GSAs have coordinated on the approach and documentation (in maps and graphs) of change in groundwater in storage for the entire Subbasin; these were based on the updated C2VSimFG-Kern model results. The Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. C2VSimFG-Kern uses comparable data sets and methodologies over the entire Subbasin that meet the numerous technical requirements for basin-wide coordination in §357.4.

This current approach for continued update and use of the primary DWR modeling tool (with our local Kern County updates for evaluating basin conditions) will maintain consistency of method for presenting the basin-wide change in groundwater in storage. A summary of C2VSimFG-Kern development is provided in Section 1.3.2, and additional documentation is available as Appendix 2 and 4 of the Kern County Subbasin Coordination Agreement (Maley and Brush, 2020).

6.2 GRAPHS OF CHANGE IN GROUNDWATER IN STORAGE

GSP Regulation §356.2(b)(5)(B) requires that the Annual Report include graphs of the following basin-wide information. The graphs are to include historical data, to the greatest extent available, including from January 1, 2015 to the current reporting year. These graphs are to include the following information:

- Water year type (Wet, Above Normal, Below Normal, Dry, Critically Dry)
- Groundwater use
- Annual change in groundwater in storage
- Cumulative change in groundwater in storage

6.2.1 Change in Groundwater in Storage Graph

Figure 16 shows the simulated change in groundwater in storage graph for the Kern County Subbasin over the 26-year period from WY 1995 through WY 2021. For WY 2021, a critically dry water year type, the groundwater in storage declined by 1,812,211 acre-feet. The updated C2VSimFG-Kern results for change in groundwater in storage for the Kern County Subbasin and the water year type based on the San Joaquin Valley Index (CDEC, 2021) are summarized on **Figure 16**.

The total change in groundwater in storage over the five-year period from WY 2017 through WY 2021 was a decrease of 290,373 acre-feet, which is an average decline of 58,075 acre-feet per year. This compares favorably to the historical average change in storage over the 20-year base period (WYs 1995 through 2014) of a decline of 277,119 AFY. During this five-year period, climatic conditions as represented by the San Joaquin Valley includes two wet, one below normal, one dry and one critically dry hydrologic water year (CDEC, 2022).

The variation in the simulated change in groundwater in storage over the historical period generally corresponds with the variation in climatic conditions and surface water supply availability (**Figure 16**). During the periods WY 1995 to WY 1999, WY 2005 to WY 2006 and WY 2011, the groundwater storage volume was stable to increasing, this correlates to the above average rainfall and surface water availability during these times. During the periods WY 2000 to WY 2004, WY 2007 to WY 2010 and WY 2012 to WY 2015, groundwater storage volume decreased, correlated to periods of drought and low surface water availability.

6.2.2 Groundwater Use Graph

For WY 2021, a critically dry water year type, the Kern County Subbasin had a total groundwater use of 2,471,156 acre-feet, of which 73% was for agricultural use, 7% for urban use, 17% for groundwater bank recovery[3] and 3% for other uses. Other uses include local lake level management and water use outside of the Subbasin. **Figure 17** shows the simulated groundwater use based on updated C2VSimFG-Kern model results along with the water year type based on the San Joaquin Valley Index (CDEC, 2022). The total groundwater pumping and distribution by water use for WY 2021 is similar to the other recent critically dry years of WY 2013 through WY 2015.

In general, total groundwater pumping in the Kern County Subbasin is about 20% to 30% lower during wet years than during the dry and below normal water year types. This is primarily driven by the availability of surface water for irrigated agriculture during the wet years which led to a decrease to groundwater pumping. Therefore, higher groundwater use is anticipated for a critically dry year such as WY 2021.

Compared to the other recent critically dry years of WY 2013 through WY 2015, agricultural pumping in WY 2021 was about 9% lower. Urban pumping WY 2021 remains slightly lower than in during the historical period due to increased use of surface water and implementation of water conservation measures. Groundwater pumping for groundwater banking recovery was high in WY 2021, but similar to that for WY 2013 through WY 2015.

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[3] Recovery pumping associated with groundwater banking extracts local and imported water that was recharged in previous years.

6.3 Map of Change in Groundwater in Storage for the Subbasin

GSP regulation §356.2(b)(5)(A) requires inclusion in the Annual Report of an annual change in groundwater in storage map. In the Kern County Subbasin, four principal aquifers were defined; however, three of these principal aquifers are small, localized aquifers that currently have limited data. Therefore, the WY 2021 Annual Report presents the change in groundwater in storage for the entire Subbasin rather than separate estimates for each principal aquifer.

6.3.1 WY 2021 Change in Groundwater in Storage Map

The change in groundwater in storage map was developed following a similar process as used for the groundwater extraction map. The C2VSimFG-Kern binary output files were accessed to extract the change in groundwater in storage for each element and model layer. C2VSimFG-Kern output provides the total volume of storage change within a model element for all four model layers. To compensate for the fact that model elements vary in size, the data were normalized to the rate of acre-feet per square mile. The normalized rates were then interpolated onto a uniform one-square mile grid superimposed over the Kern County Subbasin. The map on **Figure 18** shows the C2VSimFG-Kern model results as the total change in groundwater in storage per square mile over the entire Kern County Subbasin.

Figure 18 presents the annual basin-wide change in groundwater in storage map for WY 2021. The change in groundwater in storage represents the sum of the total inflow components plus the total outflow components. A positive value represents an increase in the volume of groundwater stored in the aquifer, which is physically represented as a rise in groundwater levels whereas a negative represents a decrease in groundwater in storage typified by a decline in groundwater levels.

WY 2021 was rated a critically dry water year under the San Joaquin Valley Index (CDEC, 2022), and the Kern River Index was 15% of average Kern River flows (COB, 2021). The largest change in groundwater in storage is concentrated in the center of the Kern County Subbasin in the vicinity of the large groundwater banking operations along the Kern River. Other areas of concentrated groundwater recovery are noted to the north and southeast near those large managed recharge operations. Widespread, but lesser, declines in groundwater in storage are observed over most other areas of the Subbasin. Some limited areas of slight increases are present south of the Kern River along the southeastern corner of the Subbasin.

Figure 18 illustrates how managed recharge and groundwater banking operations produce the most significant localized changes in groundwater in storage due to the magnitude and concentration of such activities. Agricultural and urban areas show lower magnitude annual changes, but these are more widespread over the Subbasin. Localized recharge along the major streams and from runoff from the surrounding watersheds is significant in wet years but is diminished during the dry years.

6.3.2 Accuracy of Change in Groundwater in Storage Maps

Using WY 1995 to WY 2014 as the base period, C2VSimFG-Kern results show declining groundwater levels and long-term reduction of groundwater storage, with an average-annual decline in groundwater in storage of 277,114 AFY. An estimated level of uncertainty of the overall water budget was determined to be on the order of 10% to 20% for the historical C2VSimFG-Kern results used in the Kern County Subbasin GSPs (Maley and Brush, 2020). This range is based on a weighted average of the simulation results compared to the relative accuracy of the input values (see Section 3.4).

7 PROGRESS ON GSP IMPLEMENTATION

GSP regulations (*§356.2(b)(5)(C)*) require GSAs to describe progress towards implementing a GSP in the Annual Report "including achieving interim milestones, and implementation of projects or management actions." GSPs were submitted to DWR in January 2020 covering the entire Kern County Subbasin. Since that time, a variety of activities have been conducted to implement submitted GSPs – both on an individual GSA/agency level and on a coordinated Subbasin level.

This Section 7 provides the required information on the progress for GSP implementation for the Subbasin in WY 2021. Coordinated activities at the Subbasin level include progress on numerous projects agreed to in the Subbasin Coordination Agreement and managed by the BCC (see Section 1.2.2). Progress on these activities is summarized in Section 7.1. With regard to implementation of the five individual GSPs, GSAs and/or member agencies have provided brief progress reports regarding GSP implementation, which are compiled in Section 7.2 through Section 7.7 below.

7.1 PROGRESS ON SUBBASIN-WIDE COORDINATION FOR GSP IMPLEMENTATION

The BCC and Subbasin GSAs have coordinated on a variety of Subbasin-wide GSP implementation activities as demonstrated by the accomplishments summarized below.

7.1.1 Coordination on Annual Report Data

As documented in previous sections throughout this Third Annual Report, GSAs and associated member agencies in the Subbasin have collaborated and contributed to the technical analyses and the tabulation of water use data that are presented in this report. More than 40 agencies provided data and information to update the C2VSimFG-Kern local model in support of the Annual Report water budgets. Agencies also shared in costs to purchase Subbasin-wide METRIC ET data, available on a monthly basis over the reporting period. Accordingly, this submittal of the Third GSP Annual Report represents completion of an important GSP implementation measure that demonstrates ongoing coordination on a Subbasin-wide basis.

7.1.2 Implementation of the Subbasin-wide Data Management System (DMS)

The BCC and Subbasin GSAs are coordinating on the development of a web-based Data Management System (DMS) to support GSP monitoring and analyses (Coordination Agreement, Appendix 5). The BCC approved selection of GEI Consultants, Inc. (GEI) based on their experience in working with DWR on the development of its online SGMA Portal and MNM, as well as their knowledge of Subbasin GSPs, local groundwater conditions, and monitoring data. The project is being funded by a DWR grant under Round 3 of the Sustainable Groundwater Management (SGM) Grant Program (Proposition 68). Subbasin GSAs coordinated and funded the successful grant application.

In May 2021, GEI began development of a custom SGMA Data Management System (DMS) for the Subbasin. Data were populated in the DMS with SGMA Portal, CASGEM and GAMA historical water level measurements and the DMS was released on June 10, 2021 for users to enter Spring water level measurements. After using the DMS for the first six months, several data cleanup actions were taken, and a QA/QC process was developed to manage future data. Additional modules continue to be built as agency managers work through SGMA implementation and identify modules that enable them to better review and coordinate on data management. Subbasin-wide coordination includes:

- The public version of the DMS is accessible to Subbasin managers and the public through the KGA website. A user manual is provided on the website that provides instructions for use of the DMS features by the public.
- All semi-annual water level measurements are entered into the DMS and reported to the SGMA portal by extracting data that have undergone a QA/QC review and have been shared among agency and GSA managers.
- Water level measurements can be reviewed through a Map Viewer with hydrographs of all RMWs with their respective MOs and MT. These hydrographs also allow users to compare water level trends and sustainability indicators for two or more wells on a single hydrograph.
- Most recently, email notifications were developed to alert agency and GSA managers when an MT exceedance occurs. Managers can also download a report of MT exceedances.
- Work in progress includes auto-importing water quality data from the Division of Drinking Water and Irrigated Lands Regulatory Program to enable water quality and water level trends to be overlayed. This function is expected to be available in spring 2022.

The DMS is designed to meet SGMA requirements; ongoing development is planned to further expand the Kern DMS capability.

7.1.3 Coordination on GSP Monitoring Data

The Subbasin GSAs continue to coordinate for collecting and reporting of GSP monitoring data. The Subbasin GSAs perform semi-annual GSP monitoring for groundwater elevations and water quality in accordance with their respective GSPs. Compilation and reporting of the semi-annual monitoring data are now conducted using the DMS.

All semi-annual water level measurements are entered into the Subbasin DMS. These data are reviewed by the GSA managers for accuracy using the DMS mapping and graphing capability to aid in their review. This early quality assurance/quality control (QA/QC) process allows the data to be checked and corrected before submittal to the DMS and MNM. Once approved, data are moved to the public DMS and reported to the SGMA portal. GSP monitoring data were uploaded to the MNM on the SGMA portal in January and July 2021 during the reporting period for the Third Annual Report (WY 2021).

To further support the GSA managers in tracking the basinwide performance of the GSP monitoring data with respect to their GSP sustainability compliance criteria, the DMS added a feature to email notifications were developed to alert agency and GSA managers when a minimum threshold exceedance occurs. Managers can also download a report of minimum threshold exceedances.

7.1.4 Land Subsidence Investigations and Monitoring

As provided in the Coordination Agreement (Appendix 3), the Subbasin GSAs committed to implementation of a regional land subsidence investigation to improve the land subsidence monitoring program. This regional effort was developed to supplement the local monitoring of land subsidence in each individual GSP and focused on potential impacts to critical infrastructure of regional importance, such as the California Aqueduct and the Friant-Kern Canal. Five areas of interest (AOIs) were identified for further investigation. Currently, the Subbasin GSAs are investigating sources of funding to subsidize efforts to close this data gap at two key AOIs (No. 1 and 3) along the Friant Kern Canal (FKC) and two key AOIs (No. 2 and 4) along the California Aqueduct (**Figure 1**).

Two subsidence studies, conducted in January and April 2020, focused on conditions along the California Aqueduct (between mileposts 195 and 215) in the western Subbasin. Documents reviewed included the 2019 DWR report on the condition of the aqueduct, InSAR data, oilfield operator aquifer exemption submittals to the United States Environmental Protection Agency (USEPA) and the California Regional Water Quality Board (RWQCB), USDA soil types, estimates of agricultural extractions in the WDWA, and oilfield production data submitted to the State. The studies found that the likely cause of subsidence between mileposts 195 and 215 was primarily related to oilfield activities. The results of these two related studies were presented to DWR subsidence program staff in January and April 2020. Going forward, the studies will be used to inform the Subbasin Subsidence Management Plan.

A third subsidence study, conducted in February 2021, updated the InSAR data for the Subbasin. The study consisted of an assessment of the magnitude and potential drivers of land subsidence in the Subbasin between 2015 and 2020. This assessment compared recent InSAR data to measured land subsidence data presented in the Subbasin GSPs.

The study results verified the general subsidence patterns presented in the Subbasin GSPs. Three general areas of land subsidence were identified. The first area is located along the Friant-Kern Canal starting at the northern Subbasin boundary and extending intermittingly to north of Bakersfield. The second AOI is located south of the Kern River. The third area is located along the northern Subbasin boundary, starting approximately four miles west of Delano.

These studies will be utilized to help site future land-based monitoring devices for land subsidence. The study recommended conducting additional InSAR assessments going forward and coordinating with scientists at the Lawrence Berkeley National Laboratory to better characterize the potential for geo-mechanical stresses on Kern Subbasin critical infrastructure (aqueduct, canals, pipelines, high-tension powerlines, etc.) that may be induced by land subsidence.

7.1.5 Subbasin-Wide ET Monitoring

Irrigated agriculture represents the largest water use within the Subbasin. Currently, agricultural water demands are estimated based on evapotranspiration (ET) rates; therefore, ET needs to be estimated as accurately as possible. Several water districts, representing about 25% of the Subbasin area, use a service provided by Land IQ to calculate ET rates based on satellite remote sensing data on a field-by-field basis.

The Kern County Subbasin plans to expand the service provided by Land IQ for all irrigated agricultural areas within the Subbasin. This will provide a consistent basinwide methodology for calculating ET based on local climatic and cropping data. In WY 2021, the Subbasin GSAs have been working with Land IQ to develop a scope and budget for implementing this program.

The Land IQ approach is to provide instrumentation over the agricultural areas within the Subbasin that are not already instrumented. These stations provide improved calculation of ET on a field and crop basis; field data would subsequently be used for the calibration and validation of ET models using satellite imagery. Stations would be installed in areas where improved ET values would support more accurate groundwater extraction estimates, especially in agricultural areas. Once fully instrumented, basinwide ET rates can then be modeled on a field-by-field basis.

A web tool will be used to relay the results each month to the Subbasin GSAs. All of these spatial results significantly enhance the ability to better understand the overall water balance within the subbasin and comply with necessary regulatory requirements. Because the results will be landscape-wide for the Kern Subbasin, they will serve all communities within the subbasin.

7.1.6 Scoping for the Basin Study

The Subbasin GSAs are cooperating on the implementation of their recently completed GSPs. Through ongoing coordination meetings, a consensus was reached that an important next step for GSP implementation is to support local decisionmakers with comprehensive technical information as they work through the policy, legal and water rights issues. To achieve this objective, the scope of the *Kern County Subbasin Study*, or *Basin Study,* was developed.

The Basin Study project description was developed over the past year and includes input provided during several meetings with Subbasin GSAs, policymakers and stakeholders. Using this input, the general approach for the Basin Study evolved into a systematic, basinwide analysis to address technical data gaps in the hydrogeological conceptual model (HCM), water budgets and model calibration. To make the results of the Basin Study more accessible, a series of GIS maps and geodatabases will be developed. Incorporated in the Basin Study are multiple meetings and technical memoranda to provide opportunities to update progress of the technical work and to answer questions, address comments and receive guidance.

Several management actions are included in the Subbasin GSPs to address data gaps and define goals for GSP implementation. A brief summary of these GSP management actions includes the following:

- Improve the understanding of the groundwater response to the implementation of projects and management actions,
- Support sustainable groundwater Supplies of Disadvantaged and Severely Disadvantaged Communities in order to provide "a safe, clean, affordable, and sufficient water supply to meet the needs of California residents, farms, and businesses."
- Address data gaps in the HCM including details on physical properties, geologic structures and confining clay layers that may affect subsurface flow including areas along the Subbasin margins.
- Address data gaps for basinwide and local water budgets.
- Incorporate locally-derived HCM data from the Subbasin GSPs into the model to better represent subsurface groundwater flow and improve the determination of basinwide and local water budgets.
- Improve model calibration to better simulate the implementation of projects and management actions, relationship to minimum thresholds and measurable objectives (MT/MO) and quantify subsurface flow within and out of the Subbasin.

The Basin Study is needed to support future policy decisions for achieving long-term sustainability of groundwater in the Basin. The goal of the Basin Study is to support multiple aspects of future GSP planning and implementation work by the Subbasin GSAs that will provide multiple benefits for a wide range of communities, water users and stakeholders including Underrepresented Communities. The following discussion provides additional details of the proposed approach (along with a scope of services, schedule, and budget) that demonstrate how the Basin Study will meet this goal.

The BCC and Subbasin GSAs are moving forward to prioritize and implement model improvements and are currently reviewing a roadmap that outlines an approach to address data gaps and make other recommended model modifications. The work is anticipated to begin as soon as WY 2022 and result in an improved model in time to support the five-year GSP assessment.

7.1.7 Planned Improvements to the C2VSimFG-Kern Model

The Kern County Subbasin Coordination Agreement refers to the local groundwater-surface water model (C2VSimFG-Kern) as the agreed upon method for generating coordinated water budgets for the Kern County Subbasin. The Subbasin GSPs list management actions for the continued use and update of the C2VSimFG-Kern model. The objective is to improve the understanding of groundwater response to the implementation of projects and management actions, (particularly with reference to MTs and MOs), to determine the native yield of the Subbasin, and to assess subsurface flow within and out of the Subbasin.

The current Subbasin model (C2VSimFG-Kern) remains as the southern extent of the DWR C2VSimFG regional model of the entire Central Valley. For the Basin Study, an upgraded Subbasin-focused Model (IWFM-Kern) will be developed (through improvements to the existing model) to simulate the Kern County Subbasin and local adjacent areas only. This approach will provide the framework for a more accurate water budget analysis to support ongoing GSP planning and implementation. This model upgrade will focus on several outstanding data gaps that include the following actions and model improvements:

- Improve streamflow simulations of the Kern River and Poso Creek
- Improve the geologic characterization of the Kern County portion of the Central Valley
- Improve simulation of deep percolation and small watersheds
- Review and update root zone parameters
- Develop a stand-alone Kern County Subbasin focused model
- Adjust the finite element grid to honor water management boundaries
- Quantify boundary flows around the Subbasin Boundary
- Utilize more complex water management features of IWFM
- Calibrate the improved model for the Subbasin.

The emphasis is to better represent local groundwater elevations in the four principal aquifers and provide higher accuracy in simulating changes in groundwater elevations over time. A key objective of the model recalibration is to improve the simulation of groundwater elevations relative to MT/MOs across the Subbasin and provide improved support to long-term GSP implementation planning. The calibrated IWFM-Kern model will produce an updated historical water budget and change in groundwater in storage estimates for the Subbasin in preparation of the 2025 GSP updates. To support ongoing GSP implementation, updated projected future water budgets will be run for Baseline and Climate Change scenarios over the 50-year planning and implementation horizon. These scenarios provide a basis of comparison for evaluating proposed sustainability management actions and projects over the SGMA planning and implementation horizon.

7.1.8 Subbasin Native Yield Study

One of the management actions listed in the Kern Groundwater Authority (KGA) Umbrella GSP was the development and implementation of a Native Yield Study to refine the understanding and possible future allocation of the available native groundwater yield within the Subbasin. The native yield is the portion of the sustainable yield supplied by the natural, unallocated portion of groundwater recharge. During the process of working through the water budgets for the entire Kern County Subbasin with the

GSAs, the native yield was identified as one of the most critical supply sources to be coordinated. However, questions persist about the underlying data used for preliminary calculations. Because of this, the Subbasin GSAs have agreed to the continued analysis and refinement of the native yield on various fronts including a technical and policy basis.

The native yield of the Subbasin is being developed through ongoing coordination of BCC, Subbasin GSAs and stakeholders. The BCC and Subbasin GSAs are moving forward with the above-referenced Basin Study, anticipated to begin in WY 2022, that will help address data gaps and update the overall Subbasin groundwater budget through a systematic analysis of the available data. This technical data will support the policy makers and stakeholders as they consider the technical, policy, water rights and legal issues necessary to define the components of basinwide groundwater resources used to determine the available native yield.

7.2 PROGRESS ON IMPLEMENTATION OF THE FIVE INDIVIDUAL GSPS IN THE SUBBASIN

To provide consistent information and a reasonable level of effort for the numerous agencies coordinating on this Third GSP Annual Report, the outline below has been used as a guide for the progress report summaries. Responses by each agency are organized around the following topics:

1) Compliance with Sustainable Management Criteria
   a) GSP Monitoring Activities
   b) Changes in GSP Monitoring Network
   c) Progress in Achieving Interim Milestones
   d) Compliance with Additional Sustainable Management Criteria (including minimum thresholds (MTs) and measurable objectives (MOs))
2) Implementation of Projects and Management Actions
3) Coordination with Stakeholders
4) Summary of Other GSP-related Special Studies or Activities

GSAs/member agencies have provided a meaningful narrative that addresses the most significant progress toward implementation; however, narratives are purposefully concise and do not repeat all details associated with each project or management action in the GSP. The reviewer is referred to a more complete description of each project/management action in the respective GSP, as needed.

Changes to the GSP monitoring networks are documented in the individual reports. As required in the Coordination Agreement, the BCC reviewed these changes to the monitoring network to ensure that sustainable management criteria would not likely adversely impact adjacent monitoring being conducted by others, thereby providing coordinated GSP monitoring on a Subbasin level.

Information regarding compliance with sustainable management criteria has been addressed, in part, through the preparation of hydrographs (which also show MTs and MOs) and compliance with these criteria based on recent water level data, where available. That compliance is summarized herein; as noted in Section 2, the compliance hydrographs are provided in **Appendix A**. Hydrographs related to each individual GSP/agency progress report is noted in the associated sections below. Hydrographs are referred to by page number (A-1, A-2, etc.).

The GSP progress reports are presented in alphabetical order by the lead agency of each of the five GSPs (Sections 7.3 through 7.7 below). For the KGA GSP, material is presented in alphabetical order for each of the 15 KGA member agencies that provided a separate Management Area Plan for its service area (see Sections 7.5.1 through 7.5.15 below). Some, but not all, of the KGA member agencies are also separate GSAs.

7.3 BUENA VISTA GSA

1) Compliance with Sustainable Management Criteria

In WY 2021, BVGSA continued to work to meet its GSP goals and work on Subbasin-wide goals such as grants, reporting, and overall coordination.

a) GSP Monitoring Activities

The network of monitoring wells includes all existing District owned monitoring wells which have been in use for many years. Several of these wells are part of the data collected for the Kern Fan Monitoring Committee's monthly hydrographs. The installation of the network is 100 percent complete. The well data is being gathered and entered into the portal. Several wells were removed from the portal as basin monitoring sites. These were piezometers which were measuring perched water and it was realized that they were inappropriate for SGMA monitoring.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP Monitoring Networks in WY 2021.

a) Progress in Achieving Interim Milestones

No interim milestones were required or set. WY 2021 water levels improved in the southern areas of the BVGSA, as expected, due to recharge and less pumping by others.

b) Compliance with Additional Sustainable Management Criteria

Water levels were well above MOs and MTs during the Reporting Period.

2) Implementation of Projects and Management Actions

BVGSA made progress towards implementing several of its planned GSP Projects in Water Year 2021 as summarized by the following:

- **New Recharge Facility**: The BVWSD/BVGSA have 71 acres in escrow to combine with an existing 20-acre area to create another in-District recharge pond. Construction was completed in 2021.
- **New Recharge Facility**: The BVWSD/BVGSA are negotiating terms on the long-term lease (30 years) of 85 acres to create another in-District recharge pond. Construction was completed in 2021.
- **New Recharge Facility**: The BVWSD/BVGSA continue to work through regulatory hurdles in the development of a 2,072 acre water bank. BVWSD is an 85 percent owner of this project. This project is not in District. The DEIR is close to completion.
- **Demand Reduction**: In 2021, BVWSD (similar to BVGSA) paid growers $1,768,500 to fallow 3,537 acres of land at $500/acre. This amounts to approximately 10 percent of the irrigated acreage in the BVWSD/GSA area. It is taking this action despite already being in balance.
- **Demand Reduction**: The District has purchased 280 acres in 2021 in addition to the 600 acres of white lands farmland previously taken it out of production. The farmland taken out of

production in the 280 acres was only 100 acres. This land is not in the District (being annexed though) but is adjacent and is saving the basin another 300 ac-ft of water by taking it out of production

3) Coordination with Stakeholders

BVWSD and BVGSA are in ongoing discussions with the Buttonwillow County Water District (CWD) to assess BVWSD groundwater recharge in the vicinity of groundwater wells that supply water to Buttonwillow CWD for use in their community.

4) Summary of Other GSP-related Special Studies or Activities

- BVGSA is coordinating with the KRGSA and KGA to address a minor GSA boundary issues.
- BVGSA continues to participate in the Subbasin-wide coordinated GSP implementation activities as described above in Section 7.1.

7.4 Henry Miller Water District GSA

2) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Henry Miller GSA during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

GSP monitoring activities in the Henry Miller GSA during WY 2021 consist of the following actions:

- Groundwater level data for all five monitoring wells was successfully collected in the fall and spring for the annual report to represent the seasonal high and low groundwater levels, in accordance with the recommended protocols for the Subbasin.
- Reduction in groundwater storage data was collected in accordance with the recommended protocols for the Subbasin.
- Water quality samples were successfully collected for the monitoring network in accordance with the recommended protocols for the Subbasin. The samples were analyzed for the constituents listed in the GSP.
- The GSA continues to monitor land subsidence by monitoring California Aqueduct Pools 29 and 30.
- Since interconnected surface water does not exist within the GSA, there were no monitoring activities.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP Monitoring Networks in WY 2021.

c) Progress in Achieving Interim Milestones

- With severe drought conditions in 2021, groundwater level reporting data indicate that water levels for monitoring wells in the GSA are on track with interim milestones in some instances and are deeper than interim milestones in other instances. It is expected that the GSA will achieve its interim milestones over the implementation period as the Kern Subbasin experiences seasons of drought, normal, and above normal hydrologic conditions.
- According to available data, interim milestones for reduction in groundwater storage are on track with interim milestones as set forth in the District's GSP.
- The most recently collected groundwater quality reporting data indicate that water quality constituent levels for monitoring wells in the GSA are on track with interim milestones in some instances and have exceeded interim milestones in other instances. It is expected that the GSA will achieve its interim milestones over the implementation period as the Kern Subbasin experiences seasons of drought, normal, and above normal hydrologic conditions.
- Available land subsidence reporting data indicate that the GSA is complying with the interim milestones as set forth in its GSP.

d) Compliance with Additional Sustainable Management Criteria

- Groundwater level reporting data indicate that the GSA is complying with the sustainability criteria as set forth in its GSP and 2021 seasonal groundwater levels were above MTs in all five GSP monitoring network wells.
- According to available data, the GSA is in compliance with MTs for reduction in groundwater storage as set forth in the District's GSP.
- The most recently collected groundwater quality data indicate that the GSA is complying with the MT sustainability criteria.
- Available land subsidence reporting data indicate that the GSA is complying with the MT sustainability criteria as set forth in its GSP.

3) Implementation of Projects and Management Actions

The GSA's sole project is to optimize the recovery of Pioneer Project banked supplies in dry years. While the GSA has not recovered banked water in the Pioneer Project in recent years, it has delivered significant quantities of surface water to the Pioneer Project for banking and overdraft correction in recent years. The GSA has also taken opportunities to purchase supplemental water supplies to increase its recharge activities for the benefit of its Project. Therefore, the GSA has made considerable strides towards the future implementation of its Project by increasing available supplies that could be used to avoid groundwater overdraft and combat declining groundwater levels in the GSA in future years.

4) Coordination with Stakeholders

SGMA related topics were discussed during the District's Board of Directors meetings throughout the year. Stakeholders evaluated District operations and management to assess and pursue actions that would bring long-term sustainability to the District to comply with SGMA.

5) Summary of Other GSP-related Special Studies or Activities

In order to avoid groundwater overdraft within the District with severe drought conditions in 2021, the District took measures to reduce groundwater pumping primarily through demand reduction through the fallowing of land in coordination with the landowners within the District.

In an effort to reduce net historical groundwater use, the District purchased available overdraft correction (ODC) water supplies from previously recharged surface water from local groundwater banking projects that were credited to the District.

Additionally, District staff engaged with other local entities to discuss both ongoing and new Kern Subbasin groundwater and surface water issues that arose throughout the year.

7.5 Kern Groundwater Authority (KGA) GSA

As provided in the KGA GSP Umbrella Document, the KGA prepared the GSP representing its member agencies. In addition, 15 agencies prepared their own Plan as a separate chapter of the umbrella document, each relating to its own Management Area. Accordingly, the KGA member agencies provided separate information regarding GSP implementation. That information is arranged in alphabetical order below by member agency.

7.5.1 Arvin-Edison WSD Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Arvin-Edison WSD Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

In Water Year 2021, Arvin-Edison Water Storage District (AEWSD) has implemented its portion of the Arvin-Edison Management Area GSP Monitoring Network through the following actions:

- Collection of groundwater level RMW data: Water levels were measured at all 15 wells in Fall 2020 and Spring 2021.
- Collection of land surface elevation survey Representative Monitoring Network data: in Fall 2020 and Spring 2021, all five benchmark sites were surveyed.

In addition, Arvin Community Services District (ACSD) has implemented its portion of the Arvin-Edison Management Area GSP Monitoring Network in Water Year 2021 through the following actions:

- Collection of groundwater level RMW data: Water levels were measured at the one well under ACSD's jurisdiction (ACSD Well #14) in Fall 2020 and Spring 2021.
- Collection of groundwater quality RMW samples: Samples were collected from ACSD Well #14 during seasonal low (10/27/2020) and seasonal high (1/26/2021) periods in Water Year 2021.

In addition to the above activities related to the groundwater level, groundwater quality and land subsidence RMWs, AEWSD and ACSD have collected additional groundwater level, groundwater quality, and land surface elevation monitoring data from additional locations throughout the Arvin-Edison Management Area in Water Year 2021 which are being evaluated as part of local SGMA implementation, along with relevant information collected by others.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP RMW networks in Water Year 2021 with the exception of minor clarifications/corrections related to the development of the Data Management System.

c) Progress in Achieving Interim Milestones

Groundwater level data collected from wells in the groundwater level RMW network in the Arvin-Edison Management Area in Fall 2020 and Spring 2021 indicate the following:

- Groundwater levels were greater than (i.e., did not exceed) their respective MT levels in all 16 wells measured in Fall 2020 and Spring 2021.
- Groundwater levels were greater than or equal to their respective MO levels in 8 of 16 wells measured in Fall 2020 and 12 of 16 wells measured in Spring 2021.

The groundwater level monitoring results from Water Year 2021 indicate that Undesirable Results for Chronic Lowering of Groundwater Levels are not occurring in the Arvin-Edison Management Area.[4]

d) Compliance with Additional Sustainable Management Criteria

Compliance with additional (non-groundwater level) Sustainable Management Criteria is as follows:

- Groundwater quality data collected during the seasonal low and seasonal high periods in Water Year 2021 from the single groundwater quality Representative Monitoring Well in the Arvin-Edison Management Area with defined Sustainable Management Criteria indicates that concentrations of arsenic (the water quality parameter for which SMCs have been established) were below (i.e., did not exceed) the MT concentration in one monitoring event, and exceeded the MT Concentration in one monitoring event. Concentrations were greater than (i.e., exceeded) the MO concentration during both events. The temporary occurrence of arsenic concentrations above the MT does not constitute an Undesirable Result for Degraded Water Quality per the Arvin-Edison Management Area Plan.[5]
- Land surface elevation data collected from sites in the land subsidence Representative Monitoring Network showed that cumulative subsidence since June 2018 has occurred in amounts less than the MT amount at all five sites. AEWSD continues to examine the potential cause of subsidence in the vicinity of critical water infrastructure within its Management Area and determine appropriate mitigation actions, if any.

2) Implementation of Projects and Management Actions

AEWSD has made progress towards implementing several of its planned Projects in Water Year 2021. This progress has included an effort to prioritize and score all of its Projects, but more specifically progress was made on the following:

- **P/MA #1 AEWSD Sunset Spreading Works**. Operations and Maintenance (O&M) agreement was approved in February 2021. Earthworks and structures contract was awarded in September

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[4] It is considered an Undesirable Result for Chronic Lowering of Groundwater Levels if Minimum Thresholds are exceeded in 40% or more of the Representative Monitoring Sites (i.e., 7 out of 16 sites) over four consecutive seasonal measurements (i.e., measurements spanning a total of two years, including two seasonal high groundwater level periods and two seasonal low groundwater level periods).

[5] It is considered a local Undesirable Result for Degraded Water Quality within the Arvin-Edison Management Area if the Minimum Threshold in ACSD Well #14 is exceeded for four consecutive seasonal measurements (i.e., measurements spanning a total of two years, including two seasonal high groundwater level periods and two seasonal low groundwater level periods).

2021 with anticipated completion in February 2022. In addition, pump station and pipeline design and construction are anticipated to be completed in late 2022.

- **P/MA #6 On-Farm Recharge**. AEWSD has continued development of its initial 2019 Landowner Recharge program through continued outreach and investigation, including attending various Flood-Managed Aquifer Recharge (Flood-MAR) meetings.
- **P/MA #10 AEWSD Wasteway Basin Improvements**. AEWSD submitted a Notice of Intent application for the CalOES Building Resilient Infrastructure and Communities (BRIC) funding opportunity.
- **P/MA #11 Forest Frick Pipeline/KDWD Eastside Canal Intertie**. AEWSD was awarded a $500,000 USBR WaterSMART Grant to support construction of its Forrest Frick Pipeline/Eastside Canal Intertie. CEQA is complete and NEPA process is near completion with construction anticipated in late 2022.
- **P/MA #14 Conversion of Granite Quarry to Sycamore Reservoir**. AEWSD participated in several meetings with Granite Construction, Tejon Ranch Company, and the County of Kern during Water Year 2021 to discuss the permitting process and next steps for environmental work, if any.
- **P/MA #17 DiGiorgio Unit In-Lieu Banking Program**. AEWSD submitted a USBR WaterSMART Drought Resiliency Project grant application for phase 2 of 5 of the DiGiorgio Unit at $2,000,000 (with a $2,600,00 local cost share). The project would cover an additional 1,025 acres and incorporate 6 wells into the District's distribution.
- **P/MA #18 General In-Lieu Banking Program**. AEWSD submitted a USDA Regional Conservation Partnership Program grant application to support expansion of its gravity pipeline distribution network in the Tejon Unit of its surface water service area. The grant was not awarded. AEWSD has completed preliminary design for two additional In-Lieu units on the north side of the District (Frick and Panama Units). Development of a potential hybrid in-lieu and temporary water service contract is underway and landowner outreach for the two areas will begin soon. On a related matter, AEWSD Board approved the CEQA Negative Declaration for its groundwater service area distribution pipeline expansion project and has completed pipeline alignment and size designs at a 30 percent level.

AEWSD has made progress towards implementing several of its planned Management Actions. This progress has included the following:

- **P/MA #24 Groundwater Extraction Quantification Method**. AEWSD completed installation of groundwater pumping meters at 50 sites under its existing Groundwater Metering grant program.

ACSD has made progress towards implementing several of its planned Projects in Water Year 2021.

- **P/MA #28 Emergency 1,2,3-TCP Treatment Well #12 (EPA Replacement CW-1)**. Well #12 was completed and commissioned in May of 2021. All samples so far have shown no sign of 1,2,3-TCP and Arsenic levels are under the MCL. The well will continue to be sampled on a quarterly basis.
- **P/MA #29 Arsenic Mitigation Project – Phase II**. The Arsenic Mitigation Project Phase II has seen two of the three wells (#16 and #17) completed. Well #18 is waiting on PG&E and its

completion has been delayed due to easement issues and COVID-19. Well #18 is expected to be completed by July 2022. All other components of the project have been completed including a 1-million-gallon storage tank with booster station, 15,000 feet of new conveyance pipe, the abandonment of six old well sites, and SCADA implementation for system automation.

3) Coordination with Stakeholders

AEWSD discusses SGMA matters during its regular monthly Board of Directors meetings. In addition, in Water Year 2021 AEWSD staff participated in the following:

- 38 meetings of the KGA Managers and/or Board of Directors;
- 29 inter-basin meetings with representatives of other GSAs/basins; and
- 31 miscellaneous meetings related to SGMA and groundwater matters with various entities.

AEWSD executed a Memorandum of Understanding (MOU) with the East Niles CSD regarding SGMA management and implementation in October 2020.

AEWSD and other member agencies of the Friant Water Authority reached a Project Cost Share Agreement with USBR to repair the middle reach of the Friant-Kern Canal. A three-year construction window is currently planned, targeting completion in January 2024.

ACSD's stakeholder activities include discussion of SGMA matters during its regular scheduled Board of Directors meetings. In addition, in Water Year 2021 ACSD staff participated in the following:

- 29 meetings of the KGA Managers and/or Board of Directors;
- 14 inter-basin meetings with representatives of other GSAs/basins; and
- 9 miscellaneous meetings related to SGMA and groundwater matters with other entities.

4) Summary of Other GSP-related Special Studies or Activities

In addition to the above activities related to Projects and Management Actions specifically included in the Arvin-Edison Management Area Plan, the following SGMA-related studies and activities were conducted in Water Year 2021:

- Successful completion of a Proposition 218 Election raising General Administrative and General Project Service Charges including commitment to P&MAs;
- Submitted notification materials to DWR regarding AEWSD's decision to become a Groundwater Sustainability Agency within its Kern Management Area and working with neighbors to address potential overlap and/or SGMA implementation agreements;
- Continued analysis of critical water budget components, including agricultural (evapotranspirative) water demands and return flow estimates;
- Coordination with Cal Water Bakersfield and KCWA Improvement District #4 regarding boundary issues and SGMA implementation;
- Continued involvement in review and comment of various water banking CEQA documents potentially affecting AEWSD's Central Valley Project / Friant-Kern Canal surface water supplies from both water quantity and water quality concerns;
- Continued participation in water quality studies related to Friant-Kern Canal Reverse Flow/Pump-Back Program;

- Continued participation in Basin-wide initiatives including the KGA Basin Study, DMS development, and the AEM data collection effort;
- Developed an operations planning tool to help optimize conjunctive use operations;
- Respond to County of Kern well permit applications;
- Reviewed statewide well mitigation policies for development of a local policy;
- Conducted an analysis of well ages to support Sustainability Criteria impacts analysis;
- Developed materials to respond to “Proof of Water” requests associated with Kern County initiative;
- Participated in public awareness initiatives regarding the social benefits of maintaining agricultural economy;
- Assisted Friant Division to effect an exchange of supplies between Millerton Lake and San Luis Reservoir to minimize water supply impact to Friant districts;
- Provided several water supply notification letters to water users to conserve supplies during an extremely dry year;
- Continue to engage in statewide lawsuits that threaten AEWSD’s water supplies;
- Completed an interconnection with neighboring Wheeler-Ridge Maricopa WSD for transfer/exchanges of water supplies; and
- Continued to follow and review DWR and SWRCB responses, comments, and decisions regarding SGMA in other basins throughout the state.

7.5.2 Cawelo GSA Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Cawelo GSA (CGSA) Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

GSP monitoring activities in the Cawelo GSA Management Area during WY 2021 consist of the following actions:

- The monitoring network is a subset of a preexisting groundwater monitoring network and a continuation of the groundwater monitoring efforts in the Cawelo area.
- Fall 2020 and Spring 2021 groundwater levels were obtained at all seven RMWs.
- Groundwater levels are used as a proxy for Reduction in Groundwater Storage in the CGSA Management Area. Fall 2020 and Spring 2021 groundwater levels were obtained at all seven RMWs.
- Water quality samples were collected from all seven RMWs.
- Groundwater levels are used as a proxy for Land Subsidence in the CGSA Management Area. Fall 2020 and Spring 2021 groundwater levels were obtained at all seven RMWs.

b) Changes in GSP Monitoring Network

CGSA has identified a potential eighth RMW that is owned by a local small community water system. Due to ongoing COVID-19 and related public health and safety measures, efforts for direct outreach and interaction have been postponed.

c) Progress in Achieving Interim Milestones

RMW groundwater level data collected within the CGSA Management Area during WY 2021 indicate:

- Groundwater elevations continue to fluctuate near or above the 2025 Interim Milestone for each respective RMW.
- Groundwater elevations were greater than (i.e., did not exceed) their respective MT levels at all seven RMWs in Fall 2020 and Spring 2021.

RMW water quality data collected within the CGSA Management Area during WY 2021 indicate:

- Total dissolved solid (TDS) water quality results were less than (i.e., did not exceed) the MTs at all RMWs.

d) Compliance with Additional Sustainable Management Criteria

Compliance with additional (non-groundwater level) Sustainable Management Criteria in the Cawelo GSA Management Area during WY 2021 is as follows:

- Groundwater level data collected in WY 2021 indicate that no MTs were exceeded; thus, Undesirable Results for Chronic Lowering of Groundwater Levels, Reduction in Groundwater Storage, and Land Subsidence are not occurring in the CGSA Management Area.
- Water quality data collected in WY 2021 indicate that no MTs were exceeded; thus, Undesirable Results for Degraded Water Quality are not occurring in the CGSA Management Area.

2) Implementation of Projects and Management Actions

Progress towards implementing the planned Projects and Management Actions in the Cawelo GSA Management Area includes the following:

- **P1 - New Water Supplies Purchases.** Negotiations continue with potential new program partners to purchase water supplies from outside of the Kern Subbasin area.

- **P2 - Increase Recharge and Banking Capacity**: The Cawelo WD Board of Directors approved the Landowner Groundwater Recharge and Banking Project in 2021 that allows for landowners to develop private groundwater recharge facilities increasing recharge and banking capacity within Cawelo WD. This provides an opportunity for landowners to bank privately-owned surface water and provides Cawelo WD with access to additional recharge and banking facilities (second priority right). Cawelo WD is currently working with interested landowners in Cawelo WD to develop private recharge and banking projects.

- **P3 - New Cawelo GSA Banking Partners**: Negotiations continue with potential new groundwater banking partners. Cawelo WD is currently working with interested landowners in Cawelo WD to develop private recharge and banking projects.

- **<u>P4 - Water Treatment Facilities</u>**: Cawelo WD continues to review and discuss potential water treatment facilities/operations to process treated recycled produced water (RPW) to a level that is safe for crop irrigation.
- **<u>P5 - Friant Pipeline Project</u>**: Construction on Phase 1 (pipeline from Famoso Basins to Friant-Kern Canal) was completed December 2021. Phase 2 (Friant-Kern Canal turn-in/out structure and pump station) is currently in final design. It is anticipated that Phase 2 construction will begin late 2022. To date a total of $1,019,338 has been expended on the project.
- Management Actions, if needed, are scheduled to begin implementation in approximately 2030.

3) Coordination with Stakeholders

- The CGSA holds a public Board of Directors meeting every second Thursday of the month. The agenda is posted on the website and public in attendance are invited to participate and discuss agenda items.
- CGSA participates in the regularly scheduled KGA public board meetings and participates in subbasin wide meetings with other GSAs, MAP members, and other agency representatives.
- Coordination with other neighboring MAPs, Eastern Water Management Area (EWMA) and Kern-Tulare Water District (KTWD), is ongoing to discuss groundwater studies, monitoring, and other joint efforts.

4) Summary of Other GSP-related Special Studies or Activities

CGSA continued to support the DMS planning and development for the Kern Subbasin. Additionally, Cawelo WD contracted with Land IQ in December 2021 to develop monthly field by field estimates of actual evapotranspiration (ET) occurring using remote sensing and field measurement calibration. The ET derived using this method will provide CGSA with more accurate ET data and precipitation data.

7.5.3 Eastside Water Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Eastside Water Management Area (EWMA) during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

<u>Chronic Lowering of Water Levels:</u> EWMA continues to monitor groundwater levels and groundwater quality for seven wells in the RMW network. The EWMA measured groundwater levels monthly from March 2020 through July 2021. After more than a year of monthly data measurements, the EWMA moved to a semiannual groundwater level data measurement period. The EMWA representative network is comprised of the following wells.

- EWMA #04
- EWMA #10
- EWMA #21

- EWAM #23
- EWMA #30
- EWMA #41
- EWMA #49

Since monthly monitoring began in March 2020, water levels in all EWMA RMWs have remained above their MTs, and as of July 2021, five of the seven RMWs have water levels above their measurable objectives (MOs).

Reduction in Groundwater in Storage: Per the EWMA MAP, the historical change in groundwater storage is estimated to range from -13,000 to -23,000 AFY. Groundwater levels have remained fairly stable in the EWMA, but further information is needed to determine pumping contributions by aquifer since most wells are perforated across multiple aquifer zones. The method of estimating the change in groundwater storage in the basin is estimated using the C2VSim model which will be updated as part of the basin hydrologic study expected to be completed by the end of 2024. Until the model update is complete the EWMA will continue use the above estimate for change in groundwater storage with the caveat that this estimate will be refined by the upcoming model update.

Water Quality: The EWMA MAP established SMCs for TDS with a MT set at 750 mg/L and a MO of 500 mg/L and no exceedances occurred during WY 2021.

Land Subsidence: No land-based data are known for subsidence within the EWMA. The KGA is developing a remote-sensing land subsidence monitoring program which will generate data for the entire Kern Subbasin. KGA also plans on directing a basin-wide Subsidence Study in WY 2022, in which the EWMA plans on participating in. These data will be shared with EWMA and will be evaluated as part of ongoing monitoring. Lastly, DWR recently announced new InSAR subsidence data will be available January 28, 2022 and will provide quarterly data.

Interconnected Surface Water: Not applicable in the EWMA.

b) Changes in GSP Monitoring Network

As reported in the WY 2020 Annual Report, EWMA added Well #49 on the eastern boundary of the EWMA and established SMC using a proxy method similar to the other representative well threshold criteria. However, this modification to the representative network was not reflected in the data reported to the DWR Monitoring Network Module but will be added going forward. Additionally, after more than a year of monthly groundwater level measurements (March 2020 through July 2021), the EWMA adjusted its groundwater level measurements to a semiannual basis.

In coordination with adjacent water districts (Cawelo WD and KTWD), EMWA submitted an application for two dedicated monitoring wells near the border of EWMA and Cawelo WD and KTWD. This application was submitted and approved under the DWR Technical Support Services (TSS) program. Data will be shared among these three entities and address data gaps for these areas. While the application was approved, DWR TSS staff indicated program delays due to COVID-19 and operational issues have pushed installation out to 2023 or 2024.

c) *Progress in Achieving Interim Milestones*

Specific interim milestones were not established in the EWMA MAP due to a lack of historical data for most of the wells in its network. At the time the MAP was produced, insufficient data existed to determine water level trends for most of the wells. EWMA expects specific interim milestones to be established during the 2025 GSP update, but meanwhile, water level elevations will be compared to SMC to assess progress toward sustainability.

d) *Compliance with Additional Sustainable Management Criteria*

EWMA established SMCs for groundwater levels and water quality. During WY 2021, no SMC exceedance occurred for groundwater levels or groundwater quality.

2) Implementation of Projects and Management Actions

EWMA made progress towards implementing several of its planned GSP Projects in Water Year 2021 as summarized by the following:

- **Development of oilfield produced water supplies**; Progress continued on the development of oilfield produced water supplies to potentially reduce groundwater demand. Planning meetings continued in 2021 and potential projects are expected to be identified in 2022.
- **Investigation of groundwater quality**. Monthly monitoring of TDS and annual monitoring of TDS and nitrates has occurred. Compilation and analysis of (a) available water quality data, and (b) borehole geophysical data .
- **Native Yield Estimation**: Improved estimation of local (EWMA) native yield by use of additional field-collected data and analysis. Ken Schmidt & Associates completed several hydrogeologic studies in the EWMA which will be incorporated by Todd Groundwater in the basin hydrologic study that will determine the native yield in 2024.
- **Monitor Well Construction**: Construction of aquifer-specific monitoring wells in locations with data gaps, to better understand hydraulic heads and gradients. In coordination with Cawelo WD and KTWD, the EWMA submitted a TSS grant application to drill and construct two dedicated monitoring wells in the EWMA near Hwy 65 to provide information on deeper aquifers. The TSS program was delayed due to operational issues and COVID impacts but are still scheduled to be constructed.
- **Installation of pressure transducers**: Installation of pressure transducers in selected wells of the monitoring network, to collect high-resolution cost-effective data. Monthly monitoring of seven wells is being conducted by a local engineering firm which started in March 2020 and the EWMA is considering the timing for installing transducers in several wells as a pilot project.
- **Surface runoff capture**: Surface runoff capture and enhanced infiltration in impoundments. Minimal progress was made; planning and high-level legal water rights analysis to occur in 2022.

EWMA has made progress towards implementing several of its planned GSP Management Actions. This progress has included the following:

- **Reduction in Agricultural Water Use**: Reduction of irrigated acreage, or modification of irrigation techniques or crop types to reduce water usage. This management action is still being planned. Prior to implementation the sustainable yield needs to be established which is expected to be completed by the end of 2024 via the basin hydrologic study.

- **Groundwater Fees**: No progress was made on determination to assess fees for groundwater use to encourage reduced pumping or curtailment.
- **Water Transfer Credit System**: Discussions have occurred on establishing a system of transferrable water credits and the EWMA developed an internal sustainable yield policy to be used as the basin develops a basin-wide policy. The native and sustainable yield needs to be established prior to implementation which are expected to occur by the end of 2024.

3) Coordination with Stakeholders

EWMA membership consists of a volunteer membership of 47 landowners representing roughly 38,000 acres and is governed by a 7-member, landowner-elected Board of Directors. EWMA maintains direct communication with the Board and membership (email and phone) and holds monthly Board meetings that are open to all EWMA members. EWMA maintains good professional relationships with adjacent water districts (Cawelo WD and KTWD). EWMA has held various technical meetings with Cawelo WD and KTWD to coordinate and discuss groundwater level thresholds, hydrogeologic studies and salinity studies. In addition, EWMA maintains a website where it provides maps of the membership area, the EWMA MAP and information on Board meetings and staff contact information.

4) Summary of Other GSP-related Special Studies or Activities

One important data gap missing in the Kern C2VSim model are the deeper aquifers that many EWMA members rely on for their water supply. These aquifers include the locally productive Santa Margarita, Olcese, and Vedder/Pyramid Hills units. Staff has communicated this model deficiency with Todd Groundwater and were informed that the model would be updated during the basin hydrologic study expected to be completed by the end of 2024.

7.5.4 Kern County Water Agency – Pioneer GSA Management Area

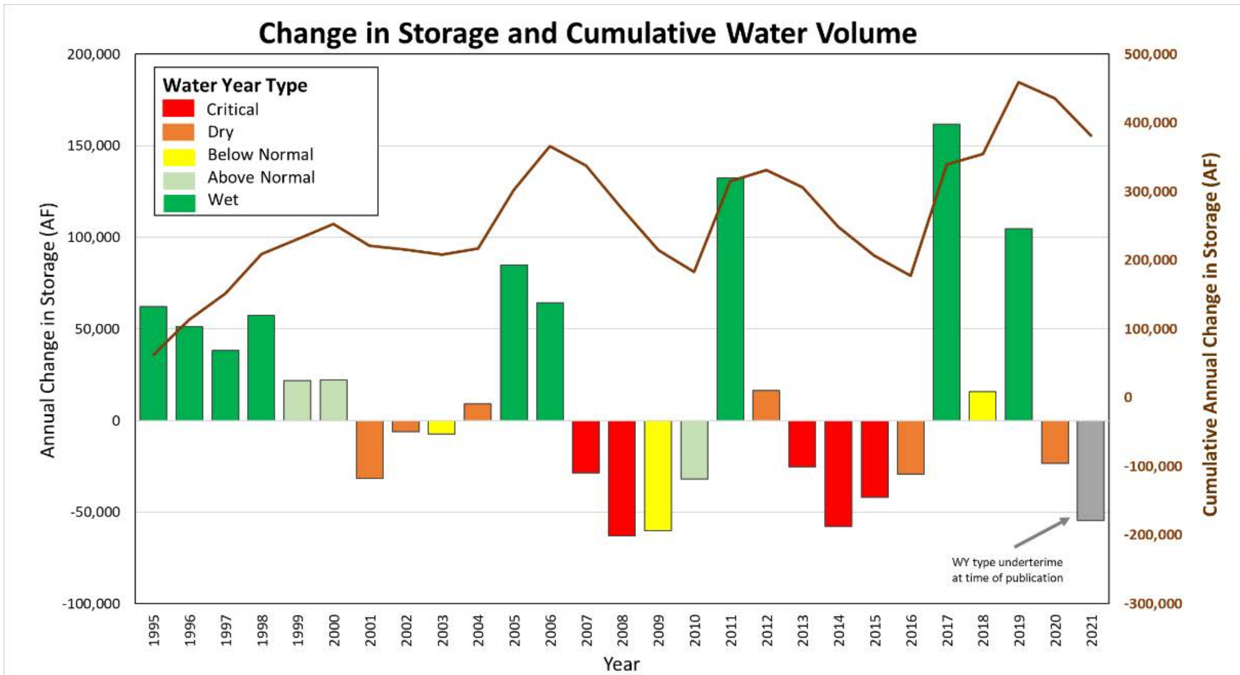
Progress towards compliance with sustainable management criteria in the Kern County Water Agency – Pioneer GSA Management Area during WY 2021 is summarized as follows:

1) Compliance with Sustainable Management Criteria

a) GSP Monitoring Activities

<u>Chronic Lowering of Water Levels:</u> The Pioneer Project records water level data for 42 monitoring and production wells (in the GSA Area. While most of the wells have associated water level data, production well data can be misleading, since measurements can be taken during or after groundwater pumping, which can artificially lower levels below ambient conditions.

Reduction in Groundwater in Storage: The graph provided below shows the change in storage volume by year, water type and cumulative annual change in storage volume for the 28-year period from 1994 to 2021 within the Pioneer GSA boundary.



Water Quality: The Pioneer Project collects water quality data from both production and monitoring wells. As part of Pioneer Project operations, water quality is sampled regularly in production wells. Each well is sampled every nine years on a rotational schedule for Title 22 analysis, and data are added to a blending model that forecasts expected water quality results of the blended water that is entering the SWP from the Pioneer and surrounding projects. Further quarterly water quality sampling is undertaken during extraction/recovery operations on blended water in the CVC and Kern Water Bank Canal to determine efficacy of the model.

Additional water quality sampling for specific constituents occurs on all operating wells during recovery operations and annually on monitoring wells in the Pioneer Project (if accessible). Monitoring wells are sampled for a specified list of constituents and results are shown in the Kern Fan Area Operations and Monitoring Report.

Subsidence Monitoring: Subsidence monitoring for the Pioneer GSA Area includes an extensometer and InSAR remote sensing data. While there are no extensometers in the Pioneer GSA Area, data collected from a DWR-maintained station in the Kern Water Bank will be used in the future, given the extensometer's proximity to the Pioneer GSA Area.

Interconnected Surface Water: Surface water can fall into two categories: natural stream channels and water conveyance infrastructure. The Pioneer GSA Area is bordered to the north by the Central Valley Canal (CVC) and is bisected by the Kern River Canal in the south. Both canals are monitored as part of regular banking activities. Although the Kern River runs through the middle of two Pioneer GSA Area portions, it is not part of the GSA Area. Therefore, there are no surface water features in the Pioneer GSA Area, and no surface water monitoring is needed.

b) Changes in GSP Monitoring Network

There are no changes to the Pioneer GSA's monitoring network for WY2021.

c) Progress in Achieving Interim Milestones

Interim Milestones were not developed for the Pioneer GSA. The Pioneer Project is a banking program which continues to operate sustainably within the Kern Subbasin, and current water levels are above the Minimum Thresholds.

d) Compliance with Additional Sustainable Management Criteria

Due to drought conditions experienced in California during WY2021, managed recovery occurred in the Pioneer GSA area, all monitoring well hydrographs demonstrate that the Pioneer Project is operating above its MTs. However, due to drought conditions, the Pioneer Project is temporarily operating below its MOs as identified in the submitted Chapter GSP. These conditions and operational strategies were anticipated during drought conditions and were incorporated into the methodology used to set thresholds within the Pioneer GSA area. This has allowed the Pioneer GSA to functionally operate within the margin of operational flexibility as described in the submitted Chapter GSP while remaining sustainable through the implementation horizon.

2) Implementation of Projects and Management Actions

The Kern County Water Agency – Pioneer GSA Management Area made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2021 as summarized by the following:

- **New Project: Install Shallow Monitoring Wells on Pioneer (Completed WY2021)**.
  A data gap for shallow groundwater monitoring was identified on the Pioneer Project. Placement of three shallow monitoring wells will allow for shallow groundwater monitoring to a depth of 50 feet bgs. This project was completed during WY2021. Collection of this data has begun and will be incorporated into the representative network during the 2025 update.
- **Management Action 1**: Continued balanced pumping and recharge is the standard operating procedure for the Pioneer GSA. Under this management action, pumping has continued to be balanced by recharge activities in the Pioneer GSA Area. Pioneer GSA has continued to closely monitor water that is pumped from the Subbasin and water that recharges the Subbasin with the goal of a balanced groundwater budget over the long term. The Pioneer Project uses a mix of SWP, Kern River and other imported water supplies for groundwater recharge. In the Pioneer GSA Area, the Pioneer Project has a recharge capacity of 302,000 AFY, and a recovery capacity of 68,415 AFY. Recovery capacity is limited by recovery well capacity. KCWA continues to be responsible for management of the Pioneer Project and is the only agency operating groundwater banking and pumping within the Pioneer GSA Area on behalf of the Participants.

  To ensure the balance between pumping and recharge, all recharge and recovery in the Pioneer GSA Area is accounted for and metered, including recovery from the Pioneer Project that occurs outside the Pioneer GSA Area boundary. This management action has continued to maintain the balance between recharge and pumping through WY 2021 within normal operational expectations and strategies.

3) Coordination with Stakeholders

As a member of the KGA, the Pioneer GSA has participated in outreach efforts through the KGA. For additional details regarding outreach, please refer to the KGA stakeholder and outreach section.

4) Summary of Other GSP-related Special Studies or Activities

As a member of the KGA, the Pioneer GSA has participated in special studies or activities through the KGA. For additional details regarding special activities, please refer to the KGA special studies or activities section.

7.5.5 Kern-Tulare WD (KTWD) Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Kern-Tulare Water District (KTWD) Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

Chronic Lowering of Water Levels: KTWD monitors groundwater levels and quality in three aquifers beneath the district (Continental Deposits, Santa Margarita Formation, and Olcese Sands). The primary source of groundwater within KTWD is from the Santa Margarita Formation, which is a confined aquifer that is hydraulically separate from the remainder of the basin.

The District has been monitoring groundwater levels for all three aquifers in 20 wells (11 wells are measured semi-monthly and 9 wells semi-annually). Six of these wells in the Santa Margarita Formation were selected as the District's RMWs. In 2021, the District collected 69 water level measurements for the RMWs which can be seen on the hydrographs included in the Annual Report.

Water Quality: Groundwater quality data is also collected for all three aquifers from 15 wells within and around the District. Groundwater quality samples are collected during the peak irrigation season when the wells are actively pumping. In 2021, the District collected 8 water quality samples (3 samples represented the Continental Deposits, 3 for the Santa Margarita Formation, and 2 for the Olcese Sands). The remaining wells were not operated in 2021 and the District will attempt to collect samples in the next year.

b) Changes in GSP Monitoring Network

KTWD removed three wells from the groundwater quality network: 24S26E24Q1, 25S27E24M2, and 25S27E30D. These wells were removed primarily due to poor construction characteristics for monitoring. Three wells were also added to the groundwater quality network: 24S26E13H, 25S26E01H, and 25S26E12A2. These wells are located on the District's western edge and were added to better monitor the potential migration of saline water in the Santa Margarita Formation from the west.

c) Progress in Achieving Interim Milestones

As expected for a dry year with a limited amount of surface water supply, groundwater levels for 2021 were below the 2020 Interim Milestone. The interim milestones and MO established in the District's GSP allowed for operational flexibility and took into consideration seasonal and long-term trends and periods of drought. Although groundwater levels decreased from the previous year, none of the wells reached the MT. The lowest groundwater elevation collected was still 60 feet above the MT (-150 feet msl).

The MO for groundwater quality in the Santa Margarita Formation was set at a TDS of 500 mg/L. Samples collected in wells that represent the Santa Margarita Formation all had TDS concentrations well above the MO, ranging from 200-350 mg/L.

d) Compliance with Additional Sustainable Management Criteria

To date, KTWD has not experienced undesirable results for any of the sustainability indicators. No groundwater levels have exceeded the MT of -150 ft msl. No groundwater quality samples have exceeded the MT of 750 mg/L of TDS.

2) Implementation of Projects and Management Actions

The Kern Tulare Water District Management Area made progress towards implementing several of its planned GSP Projects and Management Actions in WY 2021 as summarized by the following:

- **Action 1: Modify District Pricing Structure:** In 2021, the District focused on evaluating the best approach to implement a groundwater charge and has made significant progress. The District proposed a Groundwater Extraction Metering Plan and hosted a landowner workshop to receive input on the procedures of groundwater metering. The District elected to measure groundwater pumping by requiring meters on all groundwater wells by October 31, 2022 and has amended the *Rules and Regulations for the Sale and Distribution of Water* to include the Groundwater Extraction Metering Plan and has retained a contractor to assist with meter installation requirements.

  KTWD is currently in the process of preparing an Engineer's Report which will determine the upper limit of the groundwater extraction fee and will hold a Proposition 218 proceeding later this year to establish the fees. If the fees are approved by landowners, the District intends to start charging for groundwater in January 2023. A "Trial Period" will be conducted to provide landowners with groundwater pumping information from January 1, 2022 to December 31, 2022 in anticipation of the new charge.

- **Action 2: CRC Pipeline Project**: no reportable action.

- **Action 3: In-District Surface Storage**: no reportable action.

3) Coordination with Stakeholders

KTWD holds a public board meeting the second Thursday of every month at 2:30 pm. All Board members are landowners within the District and are the elected representatives of the landowners within the District. In 2021, District staff prepared and distributed additional memos and letters regarding the Groundwater Extraction Metering Plan to involve all landowners and water users in the process. A landowner workshop was hosted on this topic at the September 9, 2021 Board Meeting. Following the Board's adoption of the *Amended Rules and Regulations for the Sale and Distribution of Water*, the District mailed a notice letter along with a full copy of the new document to all landowners. Most recently, the District prepared an informational flyer providing an update on the District's SGMA activities which was mailed out to all landowners and posted on the District's website.

4) Summary of Other GSP-related Special Studies or Activities

The most practical way to reduce groundwater pumping is to maximize surface water deliveries during years of ample supply. Action 1 will provide financial incentives to take deliveries of surface water rather than pump groundwater by charging a groundwater extraction fee. Another aspect of maximizing surface water deliveries is to assure that the District has adequate distribution facilities to meet full irrigation demands. KTWD is currently evaluating its distribution system to identify improvements and funding mechanisms to provide full surface water deliveries to all lands within its service area.

7.5.6 Kern Water Bank Authority (KWBA) Management Area

The Kern Water Bank (KWB) is a storage program within KGAGSA. Although the KWB is not responsible for implementing a GSP, the KWB program is critical to assisting GSAs in achieving sustainable management of the Kern County Subbasin. In addition, the KWB participates in other agencies GSP implementation strategies as referenced throughout Section 7 of this WY 2021 Annual Report; accordingly, this summary of the KWB is provided for context and completeness. KWB members within the Kern County Subbasin include KCWA ID4, SWSD, TCWD, portions of WDWA, and WRMWSD.

SGMA recognizes the uniqueness of storage programs and their role within a GSA in Water Code Section 10726.2.(b) which states: "…the agency shall not alter another person's or agency's existing groundwater conjunctive use or storage program except upon a finding that the conjunctive use or storage program interferes with implementation of the agency's groundwater sustainability plan." The KGA GSA also recognizes this unique aspect of storage programs within its boundaries with the following provision in its Joint Powers Agreement: "the Authority shall not restrict or otherwise limit the extraction of water stored (whether through direct recharge or in lieu deliveries) in the Kern County Subbasin as a part of any banking or recharge project or program, or otherwise seek to regulate the operation any such project or program..."

With respect to environmental documents, DWR developed extensive mitigation measures, including a long-term operations plan, in an Environmental Impact Report for the continued operations of the KWB that reduces potential groundwater impacts to less-than-significant (DWR, 2016). Importantly, the KWB only recovers water previously stored and cannot contribute to basin overdraft. As indicated above, the KWB program is a critical component of the members' ability to reach sustainability as it provides critical dry-year water that reduces their need to pump groundwater. For more information regarding the benefits the KWB provides toward basin sustainability, see Attachment I6 to the KGAGSP.

For the reporting year, the KWBA completed the construction of an additional 1,000 acres of recharge basins, added another 150 cfs of pumping capacity in the KWB canal, and added 2 pump stations to deliver water from the KWB canal to recharge basins. This will allow the KWB to better store wet-year supplies for later beneficial uses by our members.

7.5.7 North Kern WSD and Shafter-Wasco Irrigation District Management Area

1) Compliance with Sustainable Management Criteria

Based on the data provided by NKWSD, SWID, and the cities of Shafter and Wasco for the WY 2021 Annual SGMA Report, the plan area covered by the joint Management Area Plan for NKWSD and SWID is meeting the Sustainable Management Criteria (SMCs) set in the 2020 GSP.

a) GSP Monitoring Activities

NKWSD and SWID continue to implement the GSP Monitoring Network within their respective Management Area boundaries. Water level elevation data was measured and reported for both spring and fall requirements. Water quality samples for constituents of concerns in the Management Areas were collected within two weeks of water level measurements to clearly define impacts groundwater levels have on water quality. In addition to normal monitoring activities, the districts completed the following activities.

- NKWSD continues to estimate ET at the field level through a system of ground-based monitoring stations in conjunction with available satellite data for both the Old District and Rosedale Ranch Improvement District (Rosedale Ranch) Management Areas.
- NKWSD continues to measure surface water deliveries brought into the Management Area, deliveries to each agricultural turnout, and all groundwater extractions at each of the District's metered groundwater production wells. As part of the District's ongoing Water Delivery Improvement project, new water meters, groundwater level sensors, and SCADA instrumentation are being installed at new locations or to upgrade existing equipment.
- NKWSD has updated its subsidence monitoring program along the Friant Kern Canal and implemented annual ground-based surveying.
- SWID continues to use Land IQ to increase accuracy of ET and precipitation measurements by installing and monitoring weather stations to provide ground truthing through satellite data.

b) Changes in GSP Monitoring Network

- The casing in NKWSD's monitoring well 88-03-009 collapsed and a fall groundwater level measurement could not be obtained. NKWSD is moving forward to replace the well in 2022 either with a newly constructed well or selecting an alternative monitoring well in the vicinity.
- There have been no changes to SWID's GSP monitoring network to report for WY 2021.

c) Progress in Achieving Interim Milestones

Groundwater elevations comply with MOs for each representative well.

d) Compliance with Additional Sustainable Management Criteria

- Groundwater elevations are used as a proxy for both groundwater quality and land subsidence. By proxy, the Management Area complies with the interim milestones.

- Per the districts' joint Management Area Plan, the districts will continue to monitor groundwater levels, groundwater quality, and land surface elevations (as an indicator of land subsidence) to address identified data gaps.

2) Implementation of Projects and Management Actions

The North Kern Water Storage District and Shafter-Wasco Irrigation District Management Area made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2021 as summarized by the following:

- **Identify potential groundwater recharge sites within Rosedale Ranch**: NKWSD conducted informational and engineering studies to identify potential groundwater recharge sites within Rosedale Ranch. This information is being used to prepare the Engineer's Report for the District's Proposition 218 election to fund these recharge projects and the acquisition of additional water supplies.
- **Landowner Groundwater Banking program**: NKWSD has developed a Landowner Groundwater Banking program that provides landowners the opportunity to bank and acquire groundwater credits and provides the District with additional groundwater recharge and banking capacity. The program will undergo any necessary environmental review and expected to be adopted in the first half of 2022.
- **Groundwater recharge and recovery programs**: NKWSD continues improvements to conveyance for its groundwater recharge and recovery programs. These improvements include the adoption of the Long-Term TCP Mitigation Project and additional expansion of the District's groundwater banking program, improvements to the District's recovery program, and joint projects with third-party groundwater banking programs.
- **Lining Calloway Canal**: NKWSD completed concrete lining an additional section of the Calloway Canal and continues the lining project into the District boundary to increase surface water reliability and prevent loss from seepage in the unlined canal.
- **Oilfield produce water**: NKWSD continues to beneficially use oilfield produce water and explore acquiring additional supplies.
- **Bell Recharge Project**: SWID has made progress on the Bell Recharge Project. The project has been fully designed and is currently in construction.
- **Leonard Avenue Conveyance Improvement Project**: SWID completed the Leonard Avenue Conveyance Improvement Project in 2021.

3) Coordination with Stakeholders

SGMA related topics were discussed at each District's Board of Directors meetings throughout 2021. Due to COVID-19, remote meetings were made available to the public. NKWSD hosted an additional meeting with a group of RRID landowners to discuss moving forward with potential project implementation and development of an advisory committee.

4) Summary of Other GSP-related Special Studies or Activities

NKWSD and SWID are participating in the Basin Study and Subsidence Study for the Kern Subbasin that is being conducted by the KGA to fill noted data gaps.

7.5.8 Rosedale-Rio Bravo WSD Management Area

As a member of the KGA, RRBWSD prepared a GSP chapter for the KGA GSP covering the Rosedale-Rio Bravo Management Area (RRBMA).

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the RRBMA during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

Chronic Lowering of Water Levels. Groundwater levels were monitored monthly in 20 locations; six of these locations are multi-completion monitoring wells at various depth intervals so that water level information is also available vertically within the Principal Aquifer. The wells are a combination of agricultural, domestic, and dedicated monitor wells of known well construction and offer reliable long-term data.

Reduction in Groundwater Storage. RRBWSD prepares an annual operations report including an updated groundwater balance. For the period of 1995-2020 RRBWSD has a cumulative storage balance of 358,561 AF. In 2020 the overall balance reduced by about 27,000 AF due to dry hydrology.

Water Quality. Groundwater quality was monitored annually in 35 locations, six of these locations are multi-completion monitor wells at various depth intervals so that water level information is also available vertically within the aquifer. The wells are a combination of agricultural, domestic, and dedicated monitor wells of known well construction.

Land Subsidence. RRBWSD participated in the basin-wide subsidence monitoring program, with a focus on critical infrastructure important to the entire Subbasin, such as the California Aqueduct and the Friant-Kern canal, among others.

Interconnected Surface Water. Not applicable.

b) Changes in GSP Monitoring Network

No changes were made in the monitoring network in 2021.

c) Progress in Achieving Interim Milestones

There are two identified interim milestone goals that RRBWSD has set in their GSP. First, is the implementation of management actions and projects (see table below). Second, is to stay in between the MTs and the MOs. If either the South or East Zone averages fall below the MT, this will trigger an undesirable result. If two of the three remaining zones (North, Central, South of the River) averages fall below the MT, this will also trigger an undesirable result.

It is noteworthy that the North and Central Zones show a muted impact from recharge and recovery operations on the banking projects to the south and indicate a steady decline but have leveled out in the 2017-2020 period. Average levels in the North Zone are above the GSP established MTs and levels in the Central Zone are above the MTs. The South of River Zone also depicts large fluctuations consistent with large recharge and recovery cycles on the Kern River Fan. Levels were at the GSP established MTs in 2016-17 but are now rising and approaching the MOs.

The South and East Zones however depict large fluctuations consistent with large recharge and recovery cycles on the Kern River Fan. Levels were at the GSP established MTs in 2016-17, rose to the MOs at the end of 2019, but are now dropping as a result of recent drought.

RRBWSD – GSP Projected Project and Management Action Milestones

	Projects (AFY)		Management Actions (AFY)		Total (AFY)	
	Actual	**Milestone**	**Actual**	**Milestone**	**Actual**	**Milestone**
2020	6,500	5,000	1,250	1,250	7,750	6,250
2021	**6,500**	**5,000**	**1,684**	**1,467**	**8,184**	**6,467**
2025		11,500		5,300		16,800
2030		10,000		1,300		11,300
2035		1,000		1,300		2,300
2040		0		1,300		1,300

d) Compliance with Additional Sustainable Management Criteria

- Chronic Lowering of Water Levels. RRBMA groundwater levels have declined as a result of two consecutive dry years. This has caused the RRBMA to have exceedances in two of the representative monitoring wells (RMW) within the management area. Additionally, three of the double completion RMWs experienced an exceedance in the deep monitoring zone. According to RRBMA GSP, an exceedance in a double completion monitoring well only occurs when both the shallow and deep completed well fall below the minimum threshold. In this instance, only the deep monitoring well experienced an exceedance whereas the shallow monitoring well has not. It is also critical to note that one of the RMW's is located with 1,500 feet of a groundwater banking recovery well which significantly influences groundwater levels. While certain wells within the RRBMA may be in exceedance, the RRBMA is in an undesirable result when 40% of RMW's within the management area over four consecutive bi-annual SGMA required monitoring events have occurred. Currently, the RRBMA is below the 40% average (2 RMW of 19 identified RMW) as identified in the RRBMA GSP and in full compliance with the Sustainable Management Criteria. RRBMA will continue to monitor the RMW 's and continue to report in accordance with SGMA guidelines.
- Reduction in Groundwater Storage. To balance groundwater storage, a Sustainable Yield for the RRBWSD Sub-Management Area is calculated as the sum of Native Yield, Precipitation and Project Water. A 20-year average is used as representative long-term average for Management Action implementation purposes. For the 2001-2020 period, Project Water supplies were approximately 60,436 AFY. District Assessed Acres totals 39,468 acres, resulting in Project Water of 1.53 AF/acre/yr. The Shafter #5 CIMIS Station annual average precipitation is 5.04 inches (0.42 ft) or 17,362 AFY. The KGA has allocated a value of 0.15 AF per acre to all developed lands,

or 6,269 AFY. The total 20-year average Sustainable Yield for RRBWSD calculates to 84,067 AFY or 2.13 AF/acre/yr.

- Water Quality. The current monitoring wells offer reliable long-term data. Data collection has commenced but results have not yet been analyzed. To streamline the semiannual data reporting, KGA developed the DMS for accessing groundwater level data and water quality is a feature that is currently being developed within the DMS.
- Land Subsidence. RRBMA coordinates with the KGA on this effort.
- Interconnected surface water. Not applicable.

2) Implementation of Projects and Management Actions

Project Implementation:

The RRBMA made progress towards implementing several of its planned GSP Projects in Water Year 2021 as summarized by the following:

- **Enns Basins Improvement Project (McCaslin Ponds)**: This project was added in 2019 as an adaptive management action and includes a 195-acre project west of Bakersfield to recharge, store, and recover water. RRBWSD completed relevant environmental analysis and applied for grant funding. Subsequent addenda to a previous conjunctive-use EIR were adopted. WaterSmart grants were awarded in 2020 and 2021 towards development and construction. Almond trees were removed from the property in 2021 and construction plans are 90 percent complete. Construction is scheduled for 2022.
- **Onyx Ranch Project**: This project is connected to RRBWSD-owned lands and water rights in the Kern River Valley. The project involves a change in point of diversion that would bring water supplies to the Kern Subbasin. A Draft EIR was completed and circulated and the FEIR was certified January 2021. During 2021, RRBWSD coordinated with the Kern River Interests for implementation in early 2022.
- **James Groundwater Storage and Recovery Project**: This project is a proposed 2,070-acre project in southwest Bakersfield designed to recharge, store, and recover water to provide a cost-effective and reliable water supply for landowners within RRBWSD. A conceptual design and feasibility analysis was completed in 2019 and awarded grant funding is tentative. Environmental analysis was re-initiated with the distribution of a Notice of Preparation of an EIR in June 2020. Completion of the EIR is anticipated for 2022.
- **Kern Fan Groundwater Storage Project**: This project would develop a regional water bank in the Kern Fan area to store SWP Article 21 water when surface water is abundant. Project status is as follows: a feasibility analysis was completed in March 2020 and a FEIR was certified December 2020. RRBWSD has commenced permitting and design efforts, acquired 164 acres of property for new recharge and recovery, issued and distributed an RFP for design services, and interviewed and selected firms for project implementation.
- **Western Rosedale Lands In-Lieu Service Area Project**: This project includes construction and operation of up to ten miles of water conveyance pipelines, including appurtenant facilities, to provide surface water to agricultural users within a portion of RRBWSD's service area located west of Interstate 5. Project status is shovel ready; feasibility and environmental analysis is complete. No implementation date is known at this time.

- **<u>Ten Section Project</u>**: This project is located within the South of the River Monitoring Zone. A feasibility study of a 200+ acre groundwater recharge, storage and recovery project are currently underway. No implementation date is known at this time.

The RRBMA made progress towards implementing several of its planned GSP Management Actions in Water Year 2021 as summarized by the following:

- **<u>Water Charge Demand Reduction</u>**: This action is being developed that would be imposed on landowners for the use of water over Native Yield, precipitation and Project Water. A web-based water budget platform was completed in 2020 and real-time ET data was incorporated in 2021 allowing users the ability to track their water usage for background information. The Board has directed staff to begin planning for implementation during 2023.
- **<u>RRBWL (White Land) Water Supplies and Demand Imbalance Reduction</u>** This action has been implemented for demand reduction on a linear basis over the planning period of 2020-2040. It is expected that white lands would seek to acquire water supplies for in-lieu and direct groundwater recharge via banking agreements with RRBWSD, or others to offset demands. Environmental analysis is scheduled for 2022 and was implemented on a voluntary basis in 2020. A web-based water budget platform was completed in 2020 to allow users to begin tracking water usage for initial 2020-2024 reduction requirements.
- **<u>RRBWSD 3rd Party Recharge and Storage Program</u>**: This action will be developed by RRBWSD for 3rd party recharge for use in the RRBMA or other downgradient areas in the Kern Subbasin. RRBWSD would offer existing conveyance and recharge facilities in exchange for a portion of the imported water supply and payments of yet-to-be developed costs and/or fees. Program implementation is scheduled for 2022.

The RRBMA made progress towards implementing several of its planned GSP Adaptive Management in Water Year 2021 as summarized by the following:

- To the extent that projects and management actions are unable to prevent undesirable effects that are caused by RRBMA activities, further actions will be evaluated and considered. For example, if either the projects or management actions are unable to produce the projected supplies, or other more cost-effective options are found, the RRBMA may deviate from the actions as described above.
- Because the White Lands are located outside of the political boundaries of RRBWSD, assessment and water charges are not likely to be imposed unless voluntarily created by those landowners. Currently, there is a contractual relationship where RRBWSD provides certain landowners with SGMA compliance methodology. Compliance with demand reduction management action(s) will initially be voluntary in nature. However, to the extent that a landowner refuses to comply, RRBWSD may terminate the contractual relationship that provides the landowner with SGMA compliance and remove the landowner from the RRBMA. During January 2020, RRBWSD offered groundwater for transfer from a potential land fallow program. No RRBWL participants opted to participate. RRBWSD is preparing to make a similar offer in 2022.

3) Coordination with Stakeholders

RRBWSD held monthly Board meetings during all of 2021 which included briefing the Board on SGMA-related activities. Four stakeholder meetings were also held in person at the District’s office with a virtual option due to COVID concerns. RRBMA provided updates on all groundwater monitoring results and on implementation of projects and management actions.

4) Summary of Other GSP-related Special Studies or Activities

RRBMA did not engage in any additional GSP-related studies or activities in 2021, beyond the normal operation and management of groundwater and surface water supplies for the benefit of landowners.

7.5.9 Semitropic WSD Management Area

In 2021, Semitropic Water Storage District (SWSD) GSA continued implementation of its GSP, which is included as a MAP in the KGA GSP. Based on data provided by SWSD for the Annual SMGA Report, the plan area for SWSD is meeting the SMCs set in the 2020 GSP. The following summarizes activities for the SWSD GSA during 2021 toward compliance with SGMA.

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the SWSD GSA during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

SWSD GSA continues to collect data from its dedicated SGMA RMWs, as well as other wells in its management areas. The District utilizes data from these wells to evaluate changes in groundwater conditions associated with water management activities. During 2021, SWSD GSA collected and reported groundwater elevation for its 13 RMWs to the KGA.

Additionally, SWSD conducted annual land use/crop surveys in coordination with ET monitoring performed by Land IQ. Overall, there was a general decrease in irrigated acres and ET volumes over irrigated acres during the monitoring period.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP monitoring network to report for WY 2021.

c) Progress in Achieving Interim Milestones

According to the representative monitoring site hydrographs, updated through 2021, the groundwater levels within the plan area above the MOs set in the 2020 GSP. Therefore, the SWSD GSA is meeting the interim milestones for the management of groundwater levels.

d) Compliance with Additional Sustainable Management Criteria

Per the KGA 2020 GSP, groundwater levels are used as a proxy for both groundwater quality and land subsidence. By proxy, the plan area is meeting its groundwater quality and land subsidence interim milestones.

2) Implementation of Projects and Management Actions

The SWSD GSA made progress towards implementing several of its planned GSP Projects and Management Actions in Water Year 2021 as summarized by the following:

- **Diltz Intertie**: In 2021, SWSD completed the Diltz Intertie Project.
- **Leonard Avenue System**: This project is currently in the design phase with construction expected to begin in 2022.
- **Enhanced Groundwater Recharge**: In 2021, SWSD continues to evaluate subsurface recharge sites throughout the District. Approximately 1,600 acres have been evaluated to date for potential subsurface recharge sites, with 990 acres identified as being suitable for development. The District is currently working with its landowners to develop these recharge projects as well as to identify additional potential recharge sites.
- **Management Action 1 – Landowner Water Budgets**: In 2021, SWSD established landowner water budgets. Landowners were sent individual water budgets and were given opportunity to discuss at two stakeholder meetings held in 2021.
- **Management Action 2 – Tiered Pricing Structure**: In 2021, SWSD began developing a tiered pricing structure for enforcing the established landowner water budgets.

3) Coordination with Stakeholders

SGMA-related topics were discussed at each District's Board of Directors meetings throughout 2021. Stakeholders were given the opportunity to evaluate District operations and management to assess and pursue actions toward achieving long-term sustainability and comply with SGMA. Additionally, two stakeholder meetings were held throughout 2021 to review the District's SGMA progress and to review and discuss the Landowner Water Budgets.

4) Summary of Other GSP-related Special Studies or Activities

The SWSD GSA is participating in multiple special studies/activities through the KGA including the subsidence study for the Kern Subbasin that is being conducted by the KGA and the Kern DMS.

7.5.10 Shafter-Wasco Irrigation District 7th Standard Annexation Management Area

The 7th Standard Annex management area, also referred to as SWID MA-2, consisted of former "white lands" in the Kern County Subbasin that have been annexed into SWID. SWID and the local landowners have made considerable progress toward GSP implementation and SGMA compliance as summarized below.

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the SWID MA-2 during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

- Developed a program with Land IQ to increase the accuracy of ET and precipitation measurements by installing and monitoring weather stations to provide ground truthing the of the satellite data.
- The District began measuring MA-2 Representative Well water levels in Fall of 2019. The hydrographs showed water levels have not fallen below the MOs or MTs.
- Reduction in groundwater in storage of 5,590 AF within the 7th Standard Annex management area.
- The water quality program began in 2019 with sampling and testing. The program calls for testing again in 2022.
- SWID MA-2 is participating in a subsidence study for the Kern Subbasin conducted by the KGA.
- No interconnected surface water is within the 7th Standard Annex management area.

b) Changes in GSP Monitoring Network

The 7th Standard Annex monitoring network was integrated into the existing SWID monitoring program. There were no changes in the monitoring network for the 7th Standard Annex management area.

c) Progress in Achieving Interim Milestones

A goal of 10 percent reduction of the 17,000 AF of overdraft is planned for the first five years. During WY 2021, a total of 1,193 AF, or 7.0 percent of the MA-2 shortfall, was reduced by:

- **Increased the recycled water supply** by over 1.6 percent from North of the River Sanitation District which yielded a 186 AF reduction of shortfall.
- **Implemented a land fallowing program** which reduced demand in WY 2021 by 1,007 AF.

d) Compliance with Additional Sustainable Management Criteria

- No additional criteria.

2) Implementation of Projects and Management Actions

Progress towards compliance with sustainable management criteria in the SWID MA-2 during WY 2021 is summarized as follows:

- **White Land Annexation**: Annexed 10,000 acres of white lands into SWID.
- **Funding:** Organized and held a successful election under Proposition 218 to fund GSP administration and reporting and GSP Projects/Management Actions.
- **Implementation policy:** Developed implementation policies based on the GSP which help manage water supplies to achieve groundwater sustainability.
- **Recharge Project Planning**: Preliminary plans have been developed for construction of two groundwater recharge facilities. One of the projects is expected to be operational in 2023.

3) Coordination with Stakeholders

The SWID MA-2 manager reported at SWID monthly Board meetings during 2021. Meetings were held in person at the SWIDs office in Wasco on the second Wednesday of each month. Updates on KGA activities and implementation of projects and management actions were provided. Notices to landowners and stakeholders were posted on the SWID general website along with relevant materials and meeting dates.

Monthly stakeholder meetings were also held. These meetings provided feedback and direction in developing the projects and management actions for GSP implementation.

4) Summary of Other GSP-related Special Studies or Activities

SWID 7th Standard Annexation Management Area is participating in a subsidence study for the Kern Subbasin being conducted by KGA.

7.5.11 Southern San Joaquin Municipal Utility District Management Area

1) Compliance with Sustainable Management Criteria

Based on the data provided by SSJMUD and the cities of Delano and McFarland for the 2021 Annual SGMA Report, the plan area covered by the SSJMUD Management Area Plan is meeting the SMC established in the 2020 GSP.

a) GSP Monitoring Activities

SSJMUD continues to implement the GSP Monitoring Network in the district's Management Area. Seven irrigation and two municipal wells serve as RMWs. Water level elevation data was measured and reported for both spring and fall requirements. Water quality samples for constituents of concerns in the Management Area were collected within two weeks of water level measurements to clearly define impacts groundwater levels have on water quality.

b) Changes in GSP Monitoring Network

There have been no changes to the GSP monitoring network to report for WY 2021.

c) Progress in Achieving Interim Milestones

Groundwater elevations comply with MOs for each RMW.

d) Compliance with Additional Sustainable Management Criteria

Groundwater elevations are used as a proxy for both groundwater quality and land subsidence. By proxy, the Management Area complies with the interim milestones.

2) Implementation of Projects and Management Actions

Progress towards compliance with sustainable management criteria in the SSJMUD MA during WY 2021 is summarized as follows:

- **New Recharge Project**: In 2021, SSJMUD began preliminary design and environmental permitting on several in-district recharge projects consisting of approximately 200 acres.
- **Intertie Project**: The SSJMUD/NKWSD intertie project began with preliminary design and environmental permitting. The project is estimated to be completed in 2025.

3) Coordination with Stakeholders

SGMA implementation and compliance are reported at the District's Board of Directors meetings.

4) Summary of Other GSP-related Special Studies or Activities

Not applicable.

7.5.12 Tejon-Castac WD - Kern Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Tejon-Castac Water District (TCWD) Kern Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

TCWD has implemented the GSP RMW network for the TCWD-Kern Management Area in WY 2021. Groundwater level data were collected in Fall 2020 (10/10/2020) and Spring 2021 (3/10/2021) in the one well in the groundwater level RMW network.

b) Changes in GSP Monitoring Network

There have been no changes to the TCWD-Kern Management Area Monitoring Network in WY 2021.

c) Progress in Achieving Interim Milestones

Groundwater level data collected from the one well in the groundwater level RMW network in the TCWD Management Area during WY 2021 were greater than the established MT and below the established MO.

d) Compliance with Additional Sustainable Management Criteria

There are no additional sustainable management criteria identified in the TCWD Management Area.

2) Implementation of Projects and Management Actions

With respect to its planned Projects and Management Actions (P/MAs), TCWD has taken the following steps in WY 2021:

- **Conversion of Granite Quarry to Sycamore Reservoir** – No actions were taken on this P/MA in WY 2021, as this P/MA will be initiated only after operations at the Granite Quarry facility cease, which is anticipated to occur within the next few years.
- **Recharge of Carrot Wash Water** – This P/MA is underway and ongoing. In WY 2021, approximately 78.86 AF of carrot wash water were recharged to the groundwater basin under this P/MA.

The TCWD-Kern Management Area is almost entirely covered by and managed under the Tejon Ranch Conservation & Land Use Agreement and associated Ranch Wide Management Plan (RWMP), which includes land use policies and restrictions on groundwater extraction.

3) Coordination with Stakeholders

TCWD has continued to coordinate with interested stakeholders by holding regular meetings of the TCWD Board of Directors which are open to the public. Such meetings were held 5 times in WY 2021. Representatives of TCWD have also attended intra-basin meetings with members of the other GSAs in the Kern County Subbasin for purposes of SGMA implementation and coordination.

4) Summary of Other GSP-related Special Studies or Activities

No additional GSP-related special studies or activities were conducted by TCWD in the Kern County Subbasin in WY 2021, although TCWD is also a member of the White Wolf GSA in the neighboring White Wolf Subbasin and was an active participant in the development of the White Wolf GSP. Other SMGA-related activities by TCWD in the Kern County Subbasin included filing to become a GSA for the portion of its service area within the Kern County Subbasin, which is anticipated to go into effect in early 2022.

7.5.13 West Kern WD GSA Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the West Kern Water District (WKWD) Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

Monitoring frequency for groundwater levels is coordinated Subbasin-wide through the KGA GSP (Umbrella GSP). The Umbrella GSP requires Chapter GSPs to report monitoring twice per year: once between January 15 through March 30 and another between September 15 through November 15. During normal operations, WKWD samples monitoring and production wells on a monthly schedule and has used data collected on this schedule to meet reporting requirements of the Umbrella GSP. WKWD has monitored and will continue to monitor on this schedule to comply with the Umbrella GSP and to provide additional data for GSA planning and monitoring purposes.

The WKWD GSA's groundwater representative monitoring network includes WKWD monitoring wells in its North and South well fields (North Project Management Area and South Project Management Area respectively). In addition, WKWD GSA monitors wells in the Little Santa Maria Valley (LSMV) for purposes describe later in this report. The Western Management Area does not have groundwater use and is not monitored by WKWD. The Lake Management Area, more specifically, the Buena Vista Aquatic Recreation Area (BVARA), was identified in the WKWD GSP as a data gap for groundwater level monitoring. BVARA is owned and maintained by Kern County and efforts to coordinate and increase monitoring and data collection at BVARA are underway, as discussed in further detail below.

b) Changes in GSP Monitoring Network

Groundwater Representative Monitoring Network Updates in North Project Management Area: As discussed in the WY 2020 Annual Report, four monitoring wells were added to the North Project Management Area's representative monitoring network, bringing the total to six representative monitoring wells in that management area.

As required by SGMA regulations, MTs and MOs were established for the additional monitoring sites. MTs and MOs were calculated for the four new monitoring wells in accordance with the North Project Management Area methodology described in *Section 7.4.1 - MTs, MOs, and IMs* of the WKWD Chapter GSP. The stepwise methodology to calculate the MTs is as follows:

Step 1. Identify the minimum and maximum historical groundwater elevation for each completion
Step 2. Calculate 20 percent of the difference between the minimum and maximum historical elevations
Step 3. Subtract the calculated value from the minimum historical value.

The MO was calculated by finding three years of drought usage/storage above the MT. Additional analysis was required when calculating the three-year drought usage/storage value due to apparent localized pumping influences. The calculated values for the MTs and MOs for all representative monitoring sites in the North Project Management Area are listed below:

- WKWD Well 107 - MT set at 56 ft (msl) and MO set at 110 ft msl
- WKWD Well 108 - MT set at 49 ft (msl) and MO set at 93 ft msl
- WKWD Well 209 - MT set at 27 ft (msl) and MO set at 71 ft msl
- WKWD Well 210 - MT set at 4 ft (msl) and MO set at 60 ft msl
- WKWD Well 211 - MT set at 39 ft (msl) and MO set at 80 ft msl
- WKWD Well 212 - MT set at 0 ft (msl) and MO set at 78 ft msl

WKWD Wells Number 209, 210, 211 and 212 were added to the representative monitoring network in WY 2020. These updates to WKWD's groundwater level representative monitoring network have been provided to the Kern Groundwater Authority (GSA) and will be reflected in future updates to the Umbrella GSP and WKWD annual reports.

c) Progress in Achieving Interim Milestones

Groundwater levels for the representative monitoring network are collected during two periods as designated by Subbasin-wide coordination; Fall measurements between September 15 through November 15, and Spring Measurements from January 15 through March 30. Of the 23 representative monitoring network wells, 17 wells are above their MO, and 6 wells are above their MT but below their MO. According to the WKWD Chapter GSP Section 5.4 Chronic Lowering of Groundwater Levels, "an undesirable result would occur when the minimum threshold for groundwater levels is exceeded in at least three adjacent management areas that represent at least 15 percent of the Subbasin, or that represent greater than 30 percent of the Subbasin." Current conditions in the representative wells do not indicate or trigger an undesirable result for Chronic Lowering of Groundwater Levels as currently defined. Through data collection and processing, WKWD has identified some readings that may indicate pumping influences in some of the measurements causing deeper than anticipated readings. These readings are currently being investigated by WKWD and the WKWD GSA, and any changes or additional flag or notes will be attached the appropriate measurements and reflected in the DMS and future Annual Reports.

d) Compliance with Additional Sustainable Management Criteria

The following subsections provide brief updates and compliance status of the remaining sustainable management criteria.

Groundwater Storage: Groundwater levels are used as a proxy for determining changes in groundwater storage. Therefore, the WKWD GSA has used data collected from its groundwater level monitoring network to monitor changes in storage.

Analysis is conducted on groundwater level data and groundwater levels over the previous year have generally decreased, suggesting a decrease in groundwater storage compared to the previous year's Annual Report. According to the WKWD Chapter GSP Section 5.5 Chronic Lowering of Groundwater Levels, "An undesirable result would occur when the volume of storage (i.e., above the groundwater level minimum thresholds) was depleted to an elevation lower than the groundwater level minimum threshold in at least three adjacent management areas that represent at least 15 percent of the Subbasin or represent greater than 30 percent of the Subbasin (as measured by the acreage of each management area)." Recent groundwater levels for 22 of the 23 representative groundwater monitoring wells were reported above the calculated minimum thresholds, meaning the WKWD GSA is still operating within the identified margin of operational flexibility and an undesirable result, as defined, has not been triggered. Further information regarding modeled storage for the Kern Subbasin is included in the KGA Umbrella GSP Annual Report.

Seawater Intrusion: The GSA area is geographically and geologically isolated from the Pacific Ocean, and any other large source of saline water. As a result, the Kern Subbasin is not at risk for seawater intrusion.

Degraded Groundwater Quality: As discussed in detail in the WKWD Chapter GSP Section 3.5, groundwater quality was relatively consistent throughout the measurement period of 1993-2015, including during the drought period and historically low groundwater levels of 2015. This suggests groundwater quality in the Kern Subbasin within the WKWD GSA does not degrade significantly with changes in groundwater elevations. Therefore, it is reasonable that groundwater levels be used as a proxy for the management of degraded groundwater quality in the WKWD GSA area. Groundwater quality in the WKWD GSA is monitored as required for a community water system by state and local regulations.

Land Subsidence: Currently there are no subsidence monitoring stations in the WKWD GSA area. There is one extensometer one mile north of the North Project Management Areas that is monitored by DWR.

InSAR spatial imagery provided by NASA's Jet Propulsion Laboratory is available for the majority of the Kern Subbasin. The combination of extensometer and InSAR spatial imagery provide data about potential land subsidence in the GSA area.

Land subsidence monitoring was identified as a data gap in the Kern County Subbasin Umbrella GSP and any additional data gathering efforts will be a coordinated effort between all member GSAs. WKWD GSA will continue to participate and coordinate with the KGA, as further described in the Management Actions section below.

Depletions of Interconnected Surface Waters: There is little surface water in the WKWD GSA area. All streams are ephemeral and there are currently no surface stream or river gages in the GSA area. The Kern River flows through a small part of the GSA area only during rare high flow events. The Kern River is also considered fully appropriated. Due to these natural and legal characteristics, surface water monitoring is not conducted in the GSA area.

2) Implementation of Projects and Management Actions

Several projects and management actions were identified in the WKWD Chapter GSP that will help achieve sustainability goals for the portion of the Kern Subbasin that lies within the WKWD GSA's boundaries. The following subsection briefly describes projects and their implementation status as well as the status of management actions.

Automatic Meter Reading (AMR) Project: WKWD began installing AMR systems for all industrial and outlying customers in 2015. The annual AMR conversion rate is shown below:

- 2015 233 AMR system installations
- 2016 231 AMR system installations
- 2017 161 AMR system installations
- 2018 641 AMR system installations
- 2019 839 AMR system installations
- 2020 434 AMR system installations
- 2021 274 AMR system installations

From 2015 through 2020, WKWD has installed 2,813 AMR systems on residential and industrial service connections, which represents about 42 percent of WKWD's customers. AMR installation will continue until all connections have been converted.

To further achieve sustainability goals, WKWD plans to install AMR systems on the remainder of its primarily residential customer meters. This project was initiated prior to the development of the Chapter GSP but directly supports the groundwater management goals of the WKWD GSA and was incorporated into the implementation plan. To off-set costs associated with this project, WKWD submitted a $1.1 million WaterSMART Water and Energy Efficiency Grant application to the Bureau of Reclamation in September 2020; unfortunately, the project was not selected for funding. West Kern will continue to pursue other funding sources as the project progresses.

Participation in Delta Conveyance Facility: The Delta Conveyance Facility (DCF) is intended to address the challenges of pumping water from the Delta by diverting water upstream of the current diversion points and conveying it to existing pump stations for the SWP and the Central Valley Project (CVP).

Under current operation, the SWP and CVP are unable to consistently deliver State and federal water contractors their full contract supplies. The Delta Conveyance Facility is intended to address some of the conditions that impact the ability to export water from the Delta.
WKWD will participate in the DCF to increase water supply reliability for its customers. While the exact increase in water supply from the DCF remains uncertain until final design, approvals, and agreements are in place, WKWD anticipates that any water supply benefits from the projects would be allocated in proportion to its level of participation.

The timing and circumstance of implementation of this project is beyond the control of the GSA, because the DCF would be implemented by the State. The U.S. Army Corps of Engineers (USACE) issued a Notice of Intent in August 2020 for the development of an Environmental Impact Report and a preliminary cost assessment has been prepared by the Delta Conveyance Design and Construction Authority. In October 2020, the WKWD Board agreed to fund its portion of the planning and environmental review cost for the DCF.

Buena Vista Aquatic Recreation Area (BVARA) Water Supply Management Coordination: The BVARA boundary is in and adjacent to the WKWD GSA area. The 1,585-acre BVARA is home to two manmade lakes, Lake Webb and Lake Evans, boating facilities, playgrounds and volleyball courts, camp sites, and picnic areas. The lakes lie outside of the GSA area but the park facilities such as picnic areas, restrooms, and parking areas are within the GSA area.

Kern County has a contractual obligation to replenish the lake losses and maintain a “minimum pool” elevation to support BVWSD deliveries to its Maples Service area. With only minor diversions for agricultural use, most water from the lakes evaporates with little percolating into the groundwater basin. Kern County pumps groundwater from wells located within the GSA area to supplement losses at the lakes. Supplemental water delivered to the lakes is included in Subbasin’s water balance. In 2020, WKWD GSA began measuring depth to water in wells at BVARA. Efforts are currently underway to obtain elevation control for the reference points from Kern County.

Due to uncertainty regarding BVARA water demands and groundwater conditions near the extraction wells at BVARA, this project requires ongoing coordination between the GSA and Kern County to understand BVARA’s water management needs and related impacts to the GSA area and Subbasin. WKWD GSA has begun coordination with local stakeholders adjacent to BVARA including Henry Miller WD, Buena Vista WD, KGA, Kern Water Bank Authority, and Kern County to develop an approach for improved management of this area of the Subbasin. Coordination efforts between the WKWD GSA, Kern County, and surrounding local stakeholders will continue into 2022.

Continued Balanced Pumping and Recharge Management Action: Continued balanced pumping and recharge of imported supplies has and will continue to be the operational standard for WKWD. Under this management action, recharge and recovery activity has and will continue to be monitored closely by WKWD to maintain balanced conditions.

Implement Water Shortage Response Plan (WSRP) Management Action: An updated WSRP is incorporated into the WKWD Urban Water Management Plan (UWMP) 2020 Update. The WSRP establishes six levels of response actions to be implemented in times of shortage (Response Level 1 through Response Level 6), with increasing restrictions on water use in response to worsening drought conditions and decreasing available supplies. The policy establishes progressive response levels including regulations to be implemented during times of declared water shortages in order to attain escalating conservation goals. At this time, WKWD has implemented Response Level 1 in response to the Governor's Drought Emergency Order.

Continued Participation in Basin-Wide Coordination Management Action: The WKWD GSA is one of eleven GSAs in the Kern Subbasin. Coordination among these GSAs is necessary for sustainable management of the Subbasin as a whole and has been ongoing during development of the Chapter GSPs. Coordination during GSP development has included regular in-person meetings and calls to discuss sustainability thresholds, potential projects and management actions, plus specific issues and concerns. This management action involves attending KGA manager meetings and coordination meetings which are held monthly, and KGA stakeholder meetings which are held as needed. These meetings, and participation in them, will continue into 2022.

File for Basin Boundary Modification for LSMV Management Action: Basin boundaries define the geographic area included in each groundwater basin. Under SGMA, a process was provided for local agencies to request that DWR revise the boundaries of groundwater basins or subbasins to assist with local governance and control. Requests for modifications can be submitted for either scientific or jurisdictional reasons. Scientific modifications are based on geologic or hydrologic conditions while jurisdictional modifications change boundaries to promote sustainable groundwater management. WKWD GSA will coordinate with local LSMV stakeholders and DWR to determine whether pursuing a basin boundary modification request in late 2022 is warranted.

Continued Monitoring and Sustainable Management of LSMV as Part of WKWD Chapter GSP Management Action: As discussed above, water elevation is currently being recorded bi-annually for 20 monitoring wells within the LSMV. This data is reported to the WKWD GSA and will be provided in annual reports for informational purposes.

3) Coordination with Stakeholders

WKWD conducts monthly board meetings where GSP and SGMA related information and updates are provided. These meetings are open to the public and have publicly posted agendas and meeting minutes (https://www.wkwd.org/menus/board-meeting-agendas.html).

4) Summary of Other GSP-related Special Studies or Activities

WKWD GSA continues to coordinate on basin-wide issues related to subsidence, consumptive use (ET) and better understanding the hydrogeologic complexities of the Kern Subbasin.

7.5.14 Westside District Water Authority Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Westside District Water Authority (WDWA) Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

WDWA staff has been actively preparing for the collection and analysis of groundwater monitoring and testing data pursuant to the WDWA Chapter Groundwater Sustainability Plan (GSP) Monitoring Network Plan (MNP). As the WDMA MAP indicates, there has been a deficiency in groundwater data, due to the poor groundwater quality. As such, there is data lacking on the hydrographs for the MT/MO wells related to water level. This is a data gap that the WDWA seeks to fill with future monitoring.

To facilitate the MNP sampling schedule and ensure representative data, WDWA staff is currently finalizing access agreements and preparing to ground-truth selected monitoring locations to confirm well construction details, well casing access and overall well condition. Wells determined to be deficient for the purpose of the MNP will be replaced with the next closest well that meets MNP criteria for representativeness and well condition. Any replacement well location will be detailed in the relevant Annual Report along with the technical rationale for the change.

b) Changes in GSP Monitoring Network

Beginning in Spring and Fall of 2021, WDWA obtained water level measurements from the wells in the MT/MO network and will continue doing so during the Spring and Fall of each year. One well in Northern Lost Hills will be replaced with an adjacent well about 2 miles west, because it has the ability to monitor depth electronically, and will provide reliable data for years to come. In southern Belridge, one well was removed because the water quality is so poor that the wells are only used for blending, and it is difficult to get a reliable water level measurement due to well quality. WDWA has submitted additional locations for inclusion in pending grant application being submitted to the DWR (part of the KGA application). If the grant application is successful, two nested sets (deep and shallow) monitor wells will be drilled and installed in each member district of the WDWA (total six nested pairs).

The network WDWA began with some wells that have since been destroyed or shut down. WDWA is working with landowners to find suitable replacement wells. The WDWA is currently evaluating additional wells to add to its monitoring network. A preliminary review of the DMS for the WDWA indicates a majority of the “public wells” listed in the DMS either no longer exist or might actually be related to other uses (e.g. oil-related activities). The WDWA is in the process of preparing a plan for accessing the accuracy of the public well locations and numbers in the WDWA. The final plan will be formulated in consultation with key well permitting agencies such as Kern County, DWR and CalGEM.

Currently, WDMA is evaluating two prospective wells about a mile distant to the west between well 7106-63 and the Aqueduct. Given the proximity of all three of these wells to the Aqueduct, and, most importantly, the southern end of the Lost Hills oil field, the WDWA is considering adding at least one of those two other wells that are more proximal to the Aqueduct to the monitoring network. The rationale being oil and produced water extraction at the oil field could be affecting GW levels in well 7106-63.

The anticipated Basin Study and groundwater model update for Kern County Subbasin (Sections 7.1.6 and 7.1.7) will be utilized by the WDWA to review and fine tune current water budget parameters, coordinate with adjacent districts, assess WDWA sustainability goals, project management actions (PMAs), and refine existing MO/MTs as needed.

c) Progress in Achieving Interim Milestones

In WY 2021, groundwater elevation data were collected from three wells in the WDMA in Fall 2020 and Spring 2021. For monitoring well S#14, groundwater levels were above their MT and MO in WY 2021. Monitoring well 7108-66 was added in WY 2021 and its first measurement in Spring 2021 was above the MT and MO. However, groundwater levels for well 7106-63 were below the MT for WY 2021.

Well 7106-63 was added to the monitoring network in the Spring of 2020 without a prior history of water level measurements. Because of the lack of groundwater elevation history at 7106-63, the MO and MT were estimated at 101 and 59 feet msl, respectively, based on the C2VSimFG-Kern model as noted in the WDWA Chapter GSP. The recent Fall 2020 and Spring 2021 represent the first set of reliable measurements for this well. After review of this data, WDMA has not found any indication that the noted exceedance has not impacted beneficial uses in the vicinity of 7106-63. Based on this review of the data, the WDMA plans to recommend adjustment to the MO and MT based on actual groundwater conditions at this location rather than the model results. WDMA will work with the Basin Coordination Committee on making this change and submitting it to DWR.

Pumping in the WDWA for beneficial is limited in WDMA due to the inherit poor groundwater quality found in the Western areas of the Subbasin. The poor groundwater quality is attributable to natural causes related to sediments of marine origin found extensively in the subsurface. Annual groundwater extraction in the WDWA is therefore limited with agricultural use is on the order of 3,000 AFY, used primarily for blending when Aqueduct deliveries are reduced.

d) Compliance with Additional Sustainable Management Criteria

The MNP originally identifies 21 wells that will be monitored annually in summer and winter for groundwater quality and levels. As of 2021, 18 wells are active in the monitoring well network. The WDWA is in the process of finding wells to be added to the monitoring network to increase our ability to measure groundwater quality and levels. The purpose of these wells is to fill the data gaps concerning water level and water quality that exist in the WDWA due to the poor groundwater quality. These wells were originally sampled in Summer 2020. To better align with landowners' operations, groundwater quality now occurs shortly after the wells turn on each year in early Spring, and just before they are turned off in late Fall. This will provide the best information regarding the effects of groundwater pumping on water level and water quality. The groundwater quality data is being collected and maintained and will be presented in the 5-year SGMA update.

2) Implementation of Projects and Management Actions

The WDWA MAP outlined three management actions to be completed over the course of SGMA implementation. All the management actions identified in the WDWA Chapter GSP continue to progress, and additional management actions may be identified as new data becomes available. As of this year, there are no new management actions. The three current management actions as stated in the WDWA Chapter GSP are:

- Collection and analysis of representative hydrogeologic data to remedy a documented lack of groundwater data in the Westside.
- Water resource coordination – due to poor groundwater quality, Westside landowners rely primarily on surface water. As such to further reduce groundwater use and increase drought resiliency, WDWA Districts and their landowners will continue to work cooperatively in pursuing supplemental surface water opportunities, including trades and purchases both between themselves and with parties outside of the WDWA.
- Conjunctive reuse of brackish water as a new source of water supply is in the feasibility study and economic assessment phase. Sources of brackish water under study for treatment and beneficial reuse include groundwater with TDS above 2,000 mg/L and oilfield produced water.

Management Action #1 - Collect Representative Hydrogeologic Data: WDWA staff has been collecting and analyzing groundwater monitoring and testing data pursuant to the MNP. As the WDMA MAP indicates, there has been a historical deficiency in groundwater data, due to the poor groundwater quality. As such, there is data lacking on the hydrographs for the MT/MO wells related to water level. This is a data gap that the WDWA seeks to fill with future monitoring.

Beginning in Spring and Fall of 2020, WDWA obtained water level measurements from the wells in the GSP monitoring network and will continue doing so during the Spring and Fall of each year. One well in NE Lost Hills had no historical data that could be used for an appropriate MT/MO. That well will be removed from the MT/MO network and a nearby well (about 2 miles to the west) with almost identical construction information will be added to the GSP monitoring network, as it has much more historical data that can be used to choose a more representative MT/MO that can be used for SGMA implementation in the future. Monitoring of this well began Spring 2021.

In addition, the MNP identifies 21 wells that will be monitored annually in summer and winter for groundwater quality and levels. The purpose of these wells is to fill the data gaps concerning water level and water quality that exist in the WDWA due to the poor groundwater quality. These wells were originally sampled in Summer 2020. To better coordinate with landowners' operations, groundwater quality sampling going forward will take place shortly after the wells turn on each year in early Spring, and just before they are turned off, in late Fall each year. We believe this will provide the best information regarding the effects of groundwater pumping on water level and water quality. The network WDWA began with contained some wells that have since been destroyed or shut down. As such, we are working with landowners in the WDWA to find representative wells for testing to ensure a full, robust MNP network going forward. The WDWA has also proposed the installation of a number of new monitoring wells for inclusion in the KGA Prop 86 funding application. The groundwater quality data is being collected and maintained and will be presented in the 5-year SGMA update.

Management Action #2 - Water Resource Coordination: Water resource coordination is a well-established and successful practice of water resource management in WDWA. Because of near ubiquitous poor groundwater quality, due to Westside geology, WDWA meets current demand almost exclusively through surface water from the California Aqueduct. Not all surface water is Table A from the State Water Project. WDWA and its landowners work cooperatively to facilitate inter- and intra- WDWA supplemental water purchases and trades. In addition, individual landowners work amongst themselves to determine arrangements for supplemental water.

These ongoing practices have been assimilated into the Chapter GSP and will be expanded as part of GSP implementation to include cooperation with adjacent Groundwater Management Areas, regarding groundwater quality, supply, and elevation data through regular meetings. Other coordination objectives being implemented include the exchange of pertinent groundwater monitoring data, irrigation technology developments and supplemental water demand/supply information. For example, WDWA and its landowners participated in the State Water Project 2021 Dry Year Transfer Program and are currently in negotiations for a 2022 Dry Year Transfer Program. WDWA continues to coordinate MNP groundwater monitoring activities to ensure representative data.

Management Action #3 - Conjunctive Reuse of Naturally Degraded Brackish Groundwater: The feasibility study for the conjunctive reuse of non-conventional water resources such as brackish groundwater and oilfield produced water was completed in late 2021. The treatment and reuse of these underutilized water resources is an important and innovative management action in the WDWA Chapter GSP. The goal of the project is to ultimately treat up to 50,000 AFY of brackish water for multiple beneficial reuses. The completed feasibility study will be presented to the WDWA Board of Directors in 2022 for consideration of implementing a Front End Engineering Design (FEED) Report. If approved by the board, the completed FEED Report will be suitable for preparing project bid documents and applying for State financial assistance. As proposed in the Chapter GSP, a first phase treatment system would be online in 2030, with full production anticipated between 2035 and 2040. Project status will be updated in various future Annual Reports as data become available.

3) Coordination with Stakeholders

As a member of the KGA, the WDWA attended intra-basin meetings with members of the other GSAs in the Kern County Subbasin for purposes of SGMA implementation and coordination.

4) Summary of Other GSP-related Special Studies or Activities

WDWA continues to participate in the coordinated Subbasin-wide GSP implementation activities as described above in Section 7.1.

7.5.15 Wheeler Ridge-Maricopa WSD Management Area

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Wheeler Ridge-Maricopa Water Storage District (WRMWSD) Management Area during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

WRMWSD has implemented GSP Monitoring Network for the Wheeler Ridge-Maricopa Management Area in WY 2021 through the following actions:

- Collection of groundwater level data in Fall 2020 and Spring 2021 in all 14 wells in the groundwater level Representative Monitoring Network.

- The District has requested, but not yet obtained, any updated subsidence information from DWR from the 40 benchmark sites in the land subsidence Representative Monitoring Network in the Wheeler Ridge-Maricopa Management Area.

In addition to the above activities related to the groundwater level and land subsidence Representative Monitoring Networks, WRMWSD has also collected groundwater level and groundwater quality monitoring data from additional locations in WY 2021. These are being evaluated as part of local SGMA implementation, as well as information collected by others (e.g., other public water systems, environmental compliance sites, etc.).

b) Changes in GSP Monitoring Network

There has been one change to the GSP Monitoring Network in WY 2021. RMW 235 failed due to the collapse of its casing. A replacement monitoring well, RMW 235R, is proposed as a replacement.

c) Progress in Achieving Interim Milestones

Groundwater level data were collected from wells in the groundwater level Representative Monitoring Network in the Wheeler Ridge-Maricopa Management Area in Fall 2020 and Spring 2021. The results of this monitoring indicate that groundwater levels in three RMWs (RMW 232, 234 & 235R) fell below their MOs at least once during those three measurements, with RMW 234 falling below its MT in its Fall 2021 measurement. Groundwater levels in all RMWs were greater than their respective MTs and MOs during both the Fall 2019 and Spring 2020 monitoring events. Consistent with the historic drought of 2021, groundwater levels fell across most of the District.

d) Compliance with Additional Sustainable Management Criteria

The District has requested, but not yet obtained, updated subsidence information from DWR from the 40 benchmark sites in the land subsidence Representative Monitoring Network in the Wheeler Ridge-Maricopa Management Area. As such, information with which to gauge compliance with subsidence Sustainable Management Criteria for WY 2021 is unavailable.

2) Implementation of Projects and Management Actions

WRMWSD has made progress towards implementing several of its planned Projects. This progress has included the following:

- **Increase Out-of-District Banking Operations**. Banking projects are a vital part of the District's water portfolio. Banking projects allow the District to utilize excess flows from numerous sources to supplement the District's water supplies in years when its State Water Project supplies are limited. One of those projects is the Kern Water Bank. As a 24.03 percent participant in the Kern Water Bank, the District has increased its Out-of-District Banking Operations in the following manner through the following expansions that occurred in 2020 and 2021:
    - **Increased Kern Water Bank recharge area by 1,025 acres**. Based on a conservative recharge rate of 0.3 AF/day per acre of recharge area over the 1,025 acres, this would enable the Kern Water Bank to increase its recharge capability by approximately 9,225 AF/month.

- **Increased “getaway” capacity from the California Aqueduct by 150 cubic feet per second (cfs).** During unregulated flow events on the California Aqueduct, Kern Water Bank recharge can be limited by conveyance capacity from the California Aqueduct and not by actual recharge capability. The increased conveyance capacity will allow the Kern Water Bank to more fully utilize its recharge capability when excess supplies on the California Aqueduct are available. This increased getaway capacity will allow the Kern Water Bank to increase its recharge capabilities during certain times of the year by nearly 9,000 AF/month.

- **Purchase Additional Supplies**. During WY 2021, the District purchased an additional 11,695 AF of surface delivery in the District (including both the Kern County Subbasin and White Wolf Subbasin). In addition, the District recovered approximately 66,000 AF of banked water from its out-of-District banking projects for delivery in the District.
- **"Thru Delta" Facility**. In 2020, The WRMWSD Board of Directors elected to participate at 32 percent of its State Water Project entitlement (63,100 AF) in the planning phase of the Delta Conveyance Project. Ultimately, participation in the Delta Conveyance Project will allow the District to firm up State Water Project supplies that are continually dropping due to several factors. In addition, participation in the Delta Conveyance Project will give the District further access to additional California Aqueduct supplies. The District continued to fund the planning phase in 2021.

WRMWSD has made progress towards implementing its planned Management Actions. This progress has included the following:

- **Acreage Assessment**. The District continues to study and analyze possible acreage assessments or groundwater pumping charges that could both fund future Projects and Management Actions and provide financial incentives to limit pumping from the groundwater basin. It is anticipated that these analyses will be completed by mid-2022.

3) Coordination with Stakeholders

The District discussed SGMA matters during its normal Board meetings held regularly on the second Wednesday of every month. District staff and Board members also participated in the regular KGA Board meetings as well other KGA meetings.

4) Summary of Other GSP-related Special Studies or Activities

No other GSP-related special studies or activities have occurred in WY 2021.

7.6 KERN RIVER GSA

1) Compliance with Sustainable Management Criteria

a) GSP Monitoring Activities

The current KRGSA GSP monitoring network consists of 38 representative monitoring wells (RMWs) distributed across three Management Areas (MAs), which are based on primary land uses: the Urban MA (approximately 93,350 acres), the Banking MA (approximately 5,045 acres), and the Agricultural MA (approximately 134,100 acres). During the reporting period, 37 of the 38 RMWs were monitored for groundwater elevations and compared to the MTs for sustainable management criteria. One well was inaccessible due to a casing obstruction, as explained in section b) below.

Chronic Lowering of Water Levels and Reduction in Groundwater in Storage***:*** All of these wells are RMWs for the Chronic Lowering of Water Levels and Reduction in Groundwater in Storage sustainability indicators (see KRGSA Hydrographs in **Appendix A**). Monitoring of groundwater elevations are conducted in accordance with the monitoring protocols provided in the KRGSA GSP and coordinated with the Subbasin-wide protocols for monitoring groundwater levels.

Water Quality: Water levels in the RMWs are used as a proxy for the Water Quality sustainability indicator to allow for tracking of water quality impacts that could potentially be related to GSP management of groundwater levels. Declining water levels in the Urban MA were correlated directly to elevated concentrations of naturally occurring arsenic in groundwater. Accordingly, groundwater levels provide a surrogate for increasing arsenic, which is used as an indicator chemical for GSP management purposes. Although municipal wellfields are managing arsenic and other constituents through wellhead treatment, active management of water levels was identified to be a viable strategy for protection of future drinking water supply wells from GSA management impacts.

Land Subsidence**:** Water levels are also used as a proxy for the Land Subsidence sustainability indicator in specified wells in the southern Agricultural MA where historical subsidence has been documented. These groundwater levels are supplemented with InSAR data, which is published annually by DWR and applied as a screening tool for the entire KRGSA. In addition, average InSAR data in 13 square-mile cells are analyzed and reported to the Board annually for tracking of land subsidence rates, including both inside and outside areas of historical subsidence. The KRGSA is also participating in regional subsidence investigation and monitoring activities in the Subbasin coordinated among all Kern County Subbasin GSAs.

Interconnected surface water and seawater intrusion are not applicable to conditions in the KRGSA and no RMWs are required.

b) Changes in GSP Monitoring Network

No changes to the monitoring network occurred during this reporting period. However, two previously inaccessible wells – RMW-017 and RMW-018 – were reinstated into routine monitoring schedules after not being available for monitoring in WY 2020. Since submittal of the GSP, the City of Bakersfield has been working with well owners to secure permission for incorporating these wells into the monitoring program. City staff was granted access to RMW-017 in time to submit groundwater elevations to DWR for Spring and Fall 2021. City staff was subsequently able to gain access to RMW-018 as of Fall 2021

(WY 2022). City staff is also working with the well owner to schedule monitoring in RMW-017 when the well is not actively pumping. Routine monitoring of both RMW-017 and RMW-018 will continue, following the monitoring protocols and reporting procedures as applied to the other wells in the Urban MA.

One monitoring well in the Banking MA – RMW-028 – has been inaccessible recently due to a possible obstruction in the casing. A nearby RMW in the relatively small Banking MA (RMW-029) is capable of monitoring groundwater elevations in this area while the issue is being investigated. A potential replacement well has also been identified for consideration if the well issue cannot be resolved. No official change to the network is proposed at this time.

KRGSA continues to have monitoring challenges with some of the RMWs that are also active pumping wells. Access is difficult when wells are active and inaccurate measurements of static water levels can occur when wells haven't yet recovered after the pump is turned off. The KRGSA continues to search for appropriate replacement wells while also taking steps to improve access to RMWs during times when the well is not operational. These actions are described in item 2) below regarding improvements to the monitoring network. Other mitigation actions by KRGSA managers are also mentioned in *item 1) d)* below.

c) Progress in Achieving Interim Milestones

KRGSA managers recognized the need for operational flexibility to manage water levels in or adjacent to active production wells while improvements to the monitoring network could be considered. Interim milestones (IMs) were selected in equal 5-year increments to achieve MOs. The 5-year interim milestone is designated at 25 percent of the distance from the MT to the MO for each representative monitoring well. More than one-half (about 22 of 38 wells) of the RMWs have groundwater elevations already being managed at or above the initial 5-year IM, even during this extended dry period.

d) Compliance with Additional Sustainable Management Criteria

Chronic lowering of Groundwater Levels: For the semiannual monitoring events in Fall 2020 and Spring 2021 (reporting period of WY 2021), all RMWs in the Banking and Urban MAs were above their respective MTs. In the Agricultural MA, 4 out of the 20 MA RMWs exceeded the MT as described below. These exceedances did not produce undesirable results in the MA as defined in the KRGSA GSP.

- RMW-217 – active production well in the eastern Agricultural MA. The well is located in an area on the eastern edge of the KRGSA near local pumping from both agricultural and small water systems wells.
- RMW-218 – active production well in the southern Agricultural MA. The recent large fluctuations in this well may indicate that groundwater elevations are being influenced by RMW pumping and may not be representative of static water levels.
- RMW-030 – inactive irrigation well in the northeast Agricultural MA. All groundwater elevations measured since the submittal of the GSP have been higher than the historical low in 2018. Since 2018, groundwater levels have been fluctuating within 4 to 8 feet above and below the MT.
- RMW-034 – active production well in eastern Agricultural MA. This active production well is often pumping when field visits are made. Large spikes in water level fluctuations indicate impacts from pumping water levels rather than regional water level declines.

Given the local exceedances in the eastern KRGSA, the KRGSA managers have been taking proactive steps to determine the issues associated with the MT exceedances and mitigate local declines. Recently, KDWD decided to release additional surface water down the Eastside Canal, which is adjacent to some of the RMWs with exceedances. This action allows for operational recharge to occur in the open bottom of the canal and provide benefits to adjacent water levels and wells. KRGSA managers are also working to coordinate with the well owner's pumping schedules to ensure that representative static water levels can be measured. Finally, locations of nearby active wells are being researched and recorded in field notes for a better understanding of local impacts. KRGSA managers are planning additional actions if continued monitoring indicates that groundwater levels have not responded to these initial steps.

The KRGSA – as a participant in the recent KGA SGM grant application for the Subbasin – has applied for grant funding to assist with installation of dedicated monitoring wells to replace some of these active pumping wells. Funding would specifically improve monitoring in disadvantaged communities where many of these pumping RMWs are located.

<u>Land Subsidence</u>: All land subsidence RMW wells have groundwater elevations above MTs, and most elevations are above historical low groundwater levels. Recent InSAR data indicate overall lower rates of vertical displacement compared to WY 2020.

<u>Water Quality</u>: Groundwater elevations are above the MTs in all RMWs for the Urban MA and Banking MA to ensure GSP management is not degrading groundwater quality. As mentioned above, MTs were exceeded in 4 RMWs in the Agricultural MA. Water quality in those areas were reviewed to determine if water quality was being impacted by lower water levels locally.

To conduct this review, the KRGSA GSP makes best use of numerous existing water quality monitoring programs to track arsenic concentrations, the primary indicator constituent for potential degradation. Data are downloaded annually from the GAMA website. At the time of this report, data were available through January 2021 only; as such, the current results provide an initial assessment of WY 2021 conditions. However, these data indicates that arsenic concentrations are similar or lower compared to WY 2020, even near wells with MT exceedances. This will be confirmed when additional data from the reporting period is made available.

2) Implementation of Projects and Management Actions

The KRGSA continues to make progress on GSP implementation and has already realized benefits from several GSP projects. Progress is also being made on additional projects and management actions as summarized in the information below. The section number in the KRGSA GSP that describes the projects and management actions are provided in parentheses by the project/action name for reference.

- **<u>Water Allocation Plan (WAP) – Kern Delta Water District (see KRGSA GSP Section 7.1.1)</u>:** As a direct result of WAP implementation, Kern Delta Water District (KDWD) was able to maximize water supplies during this reporting period by obtaining and actively managing an additional 9,165 AF of transfer water in the District – a supply which would have been previously unavailable before project implementation.

  Because of this additional supply, KDWD was able to redirect 1,037 AF of the 9,165 AF of transfer water to the Eastside canal service area 42 days earlier in the year than anticipated. This action was undertaken to benefit groundwater levels in an area where local declines have occurred during the reporting period. This action will assist with protection of local wells during this drought period (see also, *item 1) d)* above).

- **Kern River Optimized Conjunctive Use – City of Bakersfield (see KRGSA GSP Section 7.1.2):** During WY 2021, KRGSA continued to implement this conjunctive use project through the member agencies' ongoing water operations and maintenance within the City-owned reaches of the Kern River and canals (see discussion in WY 2020 Annual Report). The total amount of water recharged within the City-owned properties from canals, Kern River, City facilities, and 2,800 Acre Groundwater Recharge Facility amounted to 9,485 AF. Although this amount represents less recharge than occurred in WY 2020 (due to the dry water year), this additional recharge provides protection for City and Cal Water wells and adds to drinking water supplies for City residents.

  Also during the reporting period, the City of Bakersfield removed the Rock Crest Weir from the Kern River Channel, which no longer served its original purpose of preventing scour around existing bridge columns. Removal of this weir now allows for unimpeded low river flows and provides more uniform recharge along an extended reach within the Kern River Channel.

- **Expand Recycle Water Use in the KRGSA – City of Bakersfield (see KRGSA GSP Section 7.1.3):** The City of Bakersfield continues to reuse recycled water through its ongoing operations of Wastewater Treatment Plants 2 and 3, reporting 23,417 AF used in WY 2021. Treated effluent from Wastewater Treatment Plant 3 is recycled for multiple purposes, including the application of tertiary treated water for sports park irrigation and the recharge of denitrified water into the groundwater basin via onsite ponds. The City is also conducting a master study for expanding treatment plant capacity to provide increased recycled water for irrigation of nearby City-owned parks.

- **Land Use Conversion – Urbanization of Agricultural Lands (see KRGSA GSP Section 7.1.4):** Although this GSP project was originally envisioned for urbanization of agricultural lands, the primary benefit of the land use conversion project is to reduce water demand through changes in land use. To that end, KDWD purchased 144 acres of irrigated land in 2021 for conversion to managed aquifer recharge. This land use conversion removes 144 acres of previously-irrigated agricultural lands and associated water demand. As mentioned in Section 7.1.4 of the KRGSA GSP, this type of land use conversion supports measurable objectives for all applicable sustainability indicators in the KRGSA, including mitigation of overdraft.

- **ENCSD Water System Consolidation and Other Small Water System Consolidation Projects (see KRGSA GSP Section 7.1.5):** This project involves consolidation of up to six small water systems into the East Niles Community Service District (ENCSD) to provide a more reliable and high-quality water supply to local disadvantaged communities. At the time of this Annual Report, ENCSD has completed environmental review and is awaiting State comments on the submitted agreements for the project. As soon as the State responds, ENCSD is ready to execute the agreements and begin project construction.

  Additional small water system consolidation projects are also being planned in the KRGSA as summarized below.

  - **Consolidation of two small water systems**: The City of Bakersfield is coordinating with the Division of Drinking Water (DDW), University of Sacramento, and Carollo Engineers regarding consolidation of two small water systems located in underrepresented communities. Specifically, plans are moving forward for consolidation of the South Kern

Mutual Water Company and Old River Mutual Water Company into the City's domestic water system for improvements to drinking water quality. A consolidation engineering report was completed during this reporting period. The purpose of the engineering report is to analyze different consolidation options for both cost and feasibility, such as wellhead treatment, new water wells, and new pipelines extending to the communities.

  - **<u>Water system consolidation</u>**: In addition, Lamont Public Utilities District (Lamont PUD) has also been planning to consolidate El Adobe Property Owners Association (El Adobe POA) into the District's water system for several years to improve local drinking water quality in the POA. Lamont PUD completed the CEQA review in 2019 and received emergency grant funding in April 2021 from the State Water Board for a well replacement.

- **<u>Implement Action Plan if Water Levels Fall below MTs (see KRGSA GSP Section 7.2.1)</u>:** As documented in *item 1)d)* above, KRGSA managers are tracking and investigating MT exceedances as they occur in the KRGSA Plan area. Specifically, KRGSA managers have taken steps toward mitigation of potential local water level declines and avoidance of inaccurate static water level measurements in pumping RMWs. Actions include focused operational recharge in nearby canals to manage groundwater levels, coordination of monitoring with well owner pumping schedules, increasing frequency of field visits for tracking RMW pumping, considerations for redistribution of pumping in municipal wellfields, review of permits for new wells, application for grant funding to install dedicated monitoring wells in disadvantaged communities, and other actions.

- **<u>Implement Groundwater Extraction Reporting Program (see KRGSA GSP Section 7.2.4)</u>:** To allow KDWD to better understand local water use and crop demands, the District has invested in an evapotranspiration (ET) analysis program, being developed by Land IQ specifically for field conditions in the District. The Land IQ ET system involves a data-driven model for detailed water use estimation. The analysis includes a ground-truthing component, which greatly improves its accuracy. This program will benefit the District by providing better identification and quantification of water use and demand and allow for indirect estimates of groundwater extraction as the District continues to develop policies and programs to improve groundwater extraction estimation and reporting.

- **<u>Support California Delta Conveyance Project to Preserve Imported Water Supplies (see KRGSA GSP Section 7.2.5)</u>:** ID4 continued funding a share of the Delta Conveyance Project environmental review, planning and design costs at a 100 percent level for 82,946 AF.

- **<u>Incorporate Climate Change Adaption Strategies (see KRGSA GSP Section 7.2.6)</u>:** ID4 developed a 2020 UWMP update that included climate change impacts on the availability of future imported water supplies as provided in DWR's 2019 Delivery Capability Report. ID4's 2020 UWMP update also identified the Cross Valley Canal Extension Lining Project – Pool No. 8 as an implementation project to increase the reliability of water supplies during dry year conditions.

- **<u>Improve Groundwater Monitoring Network (see KRGSA GSP Section 7.2.8)</u>:** As mentioned previously throughout this progress report, the KRGSA managers are making improvements to the current monitoring network. In particular, protocols are being considered to better manage monitoring in actively pumping RMWs. Not only are these wells difficult to access when pumping, but it has also been difficult to determine if water levels have recovered sufficiently after pumps are turned off such that representative static water levels are being measured. Several of the past MT exceedances are in active pumping wells where hydrographs suggest that measurements are being influenced by recent pumping water levels. The objective of the monitoring program is to provide a reasonable representation of water levels in the aquifer rather than to record pumping-influenced water levels in an inefficient production well.

Accordingly, KRGSA managers are taking steps to mitigate these problems, including the following:

- working directly with well owners to coordinate on their operational schedules to access the well during non-pumping periods (e.g., RMW-026),
- increasing measurement frequency to improve measurements of a representative static water level,
- researching data for inactive replacement wells in key areas, and
- applying for grant funds to install dedicated monitoring wells in critical areas.

3) Coordination with Stakeholders

The KRGSA managers have incorporated various methods for interaction with GSP stakeholders. Some of these ongoing efforts are summarized below.

- **Public Board Meetings:** During the reporting period, the KRGSA has continued regular monthly Board meetings that are open to the public and attended by numerous stakeholders in the Subbasin. GPS implementation, including results of the GSP Annual Reports, are presented and discussed in these open meetings. During WY 2021, most meetings were held virtually via webinar platforms as compliance with health department guidance during the COVID-19 pandemic. Recently, meetings have been conducted as in-person meetings with a web-based option to provide flexibility for stakeholder attendance.
- **Public Access to Online Data Management System:** The KRGSA managers have coordinated with all of the Subbasin GSAs for the development of an online Data Management System (DMS). The system serves as a convenient portal for uploading, storing, viewing, and analyzing GSP data. The portal is open to stakeholders and the public for data viewing and contains a mapping feature that allows the public to see GSA boundaries, locations of monitoring sites, and hydrographs of groundwater elevations throughout the Subbasin.
- **KRGSA Informational Mailers and Outreach Letters to Landowners and Stakeholders:** KRGSA managers continue to communicate with stakeholders by providing informational mailers and outreach letters. In June 2021, Kern Delta Water District developed an informational mailing to all landowners in the District. The material provided an introduction to the KRGSA, an overview of SGMA, and resources for more detailed information as needed. In October 2021, ID4 and the City coordinated on development of a similar mailer for stakeholders in the agencies' service areas.

4) Summary of Other GSP-related Special Studies or Activities

- **Agricultural MA Evapotranspiration (ET) Study:** As described in *Item 2)* above, a special study with Land IQ in ongoing for improved estimates of ET in the Agricultural MA. This study supports several of the GSP management actions including the groundwater extraction reporting program.

- **<u>Isabella Dam Improvement Project:</u>** The Isabella Dam improvement project, impacting reservoir storage levels, is expected to be completed in 2022. This will allow for filling of the reservoir to unrestricted levels, which will provide greater storage during peak runoff periods. Consequently, those who contract for storage capacity in Isabella Dam, including the City of Bakersfield, will have restored storage capabilities as an additional water management tool that had previously been restricted since 2006.
- **<u>Additional Studies:</u>** The KRGSA continues to coordinate with the Subbasin GSAs on investigations regarding land subsidence and the key studies proposed for grant funding as part of the recent SGM grant application to DWR.

7.7 Olcese GSA

1) Compliance with Sustainable Management Criteria

Progress towards compliance with sustainable management criteria in the Olcese GSA during WY 2021 is summarized as follows:

a) GSP Monitoring Activities

Olcese GSA has implemented the GSP Representative Monitoring Network for the Olcese GSA Area through the collection of groundwater level data in Fall 2020 and Spring 2021 from the two wells. These wells also support the Reduction in Groundwater Storage sustainability indicator, by proxy.

In addition, Olcese GSA has also collected groundwater level from additional locations (beyond those in the Representative Monitoring Network) in WY 2021 which are being evaluated as part of local SGMA implementation, as well as information collected by others (e.g., other public water systems, environmental compliance sites, etc.).

b) Changes in GSP Monitoring Network

There have been no changes to the GSP Monitoring Network in WY 2021.

c) Progress in Achieving Interim Milestones

Groundwater level data collected from wells in the groundwater level Representative Monitoring Network in the Olcese GSA Area in Fall 2020 and Spring 2021 indicate the following:

- Groundwater levels in both RMWs were greater than their respective MTs during both the Fall 2020 and Spring 2021 monitoring events.
- The groundwater level in one RMW was greater than its respective MO during both the Fall 2020 and Spring 2021 monitoring events, and the groundwater level in the other RMW was above its MO in Spring 2021 and below its MO in Fall 2020.

d) Compliance with Additional Sustainable Management Criteria

As discussed above, groundwater levels in both RMWs were in compliance with their respective Sustainable Management Criteria (i.e., above MTs) throughout WY 2021. No other sustainability indicators besides Chronic Lowering of Groundwater Levels (and Groundwater Storage, by proxy) have established MTs within the Olcese GSA Area.

2) Implementation of Projects and Management Actions

Olcese GSA has made progress in WY 2021 towards implementing one of the Projects included in the Olcese GSP:

- **Non-contingent P/MA #1**: Installation of a shallow monitoring well in the vicinity of Olcese Water District Well #2 for purposes of evaluating potential hydraulic connection between the Olcese Sand Aquifer Unit and the Shallow Alluvium. Olcese GSA installed this well in Summer 2019 and has collected groundwater level monitoring data since Fall 2019, including measurements in Fall 2020 and Spring 2021. Monitoring data was collected manually until November 2020 when a data-logging pressure transducer was installed in the well to collected continuous water level data.

- **Non -contingent Project #3**: Olcese GSA has not yet initiated the non-contingent Project #3 to develop a network of subsidence monitoring locations. However, review of historical and recent survey data, collected on roughly five-year intervals from points along the District's diversion canal off the Kern River has shown very little subsidence (i.e., less than 0.1 feet) since survey records began in 1998, and therefore it has been determined that the current five-year subsidence monitoring frequency is sufficient for SGMA monitoring purposes. Olcese GSA will continue to review survey data as it is collected to determine if increased monitoring for subsidence is warranted in the future.

3) Coordination with Stakeholders

Olcese GSA has continued to coordinate with interested stakeholders by holding regular meetings of the Olcese Water District Board of Directors which are open to the public. Such meetings were held in February, May, August and November 2021. Olcese GSA members have also regularly attended inter-basin meetings with members of the other GSAs in the Kern County Subbasin.

4) Summary of Other GSP-related Special Studies or Activities

As discussed above, the Olcese GSA has begun implementation of its study to assess the degree of hydraulic connection between the shallow alluvium and the Olcese Sand Aquifer Unit (i.e., the principal aquifer underlying the Olcese GSA Area identified in the GSP). The study is based primarily on groundwater level data collected from two wells – one in the shallow alluvium and one in the Olcese Sand Aquifer Unit – using high-frequency data logging transducers. Collection of the transducer-based water level data began in Fall 2020, continued through WY 2021, and is ongoing. Results from the study will be used to inform decisions about sustainable management criteria in the next periodic (5-year) GSP update.

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FIGURES

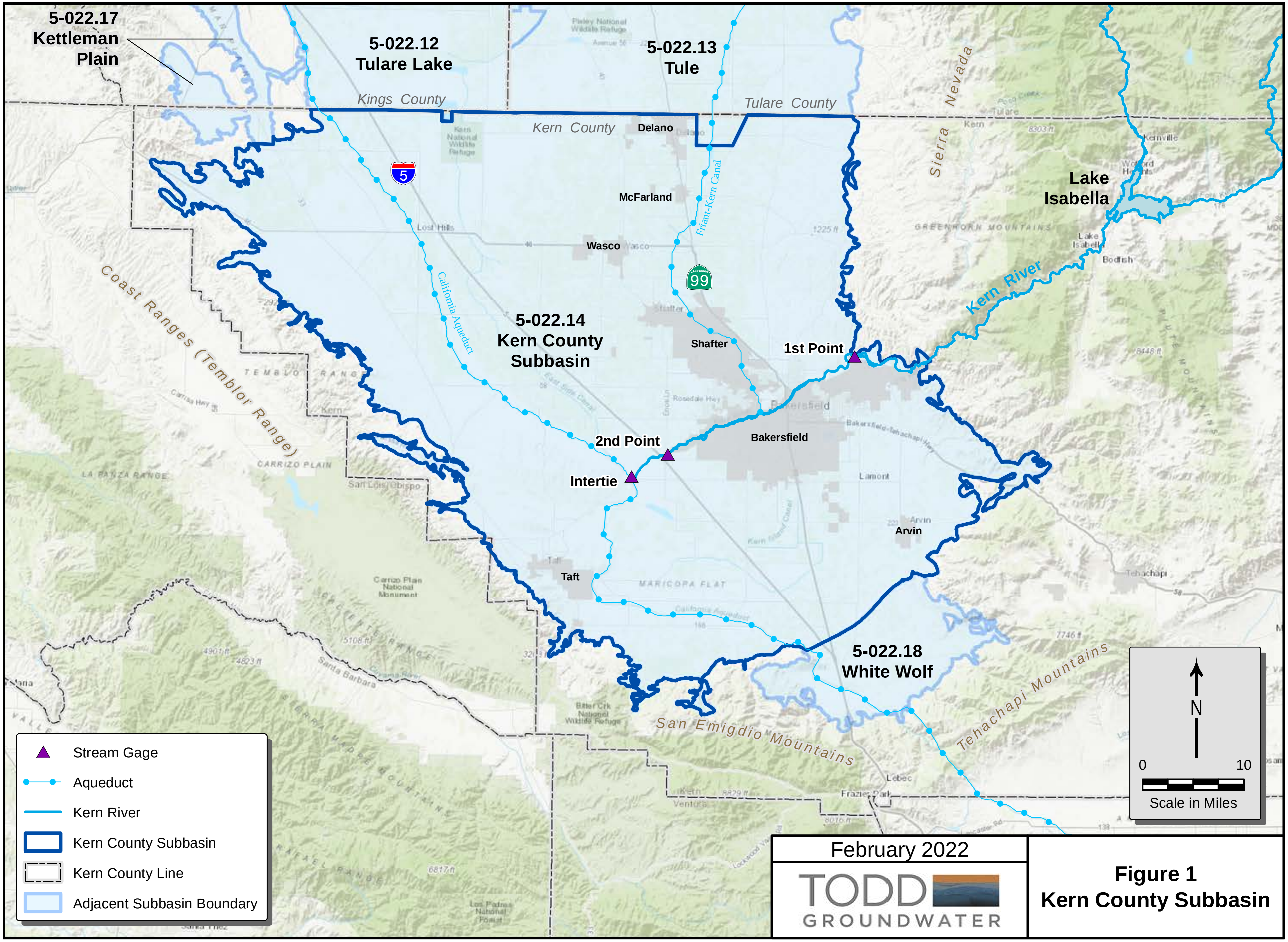


Figure 1
Kern County Subbasin

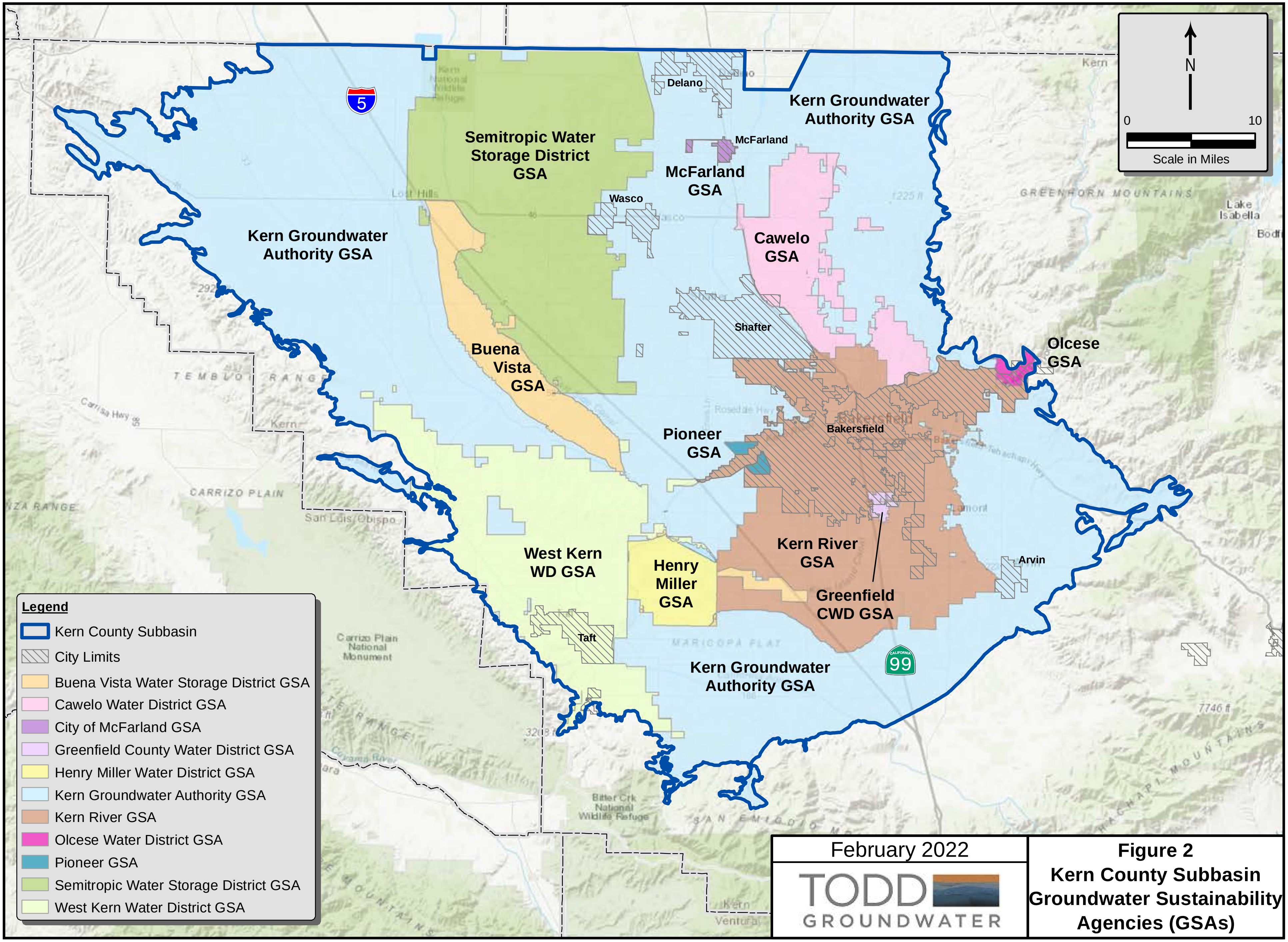


Figure 2
Kern County Subbasin Groundwater Sustainability Agencies (GSAs)

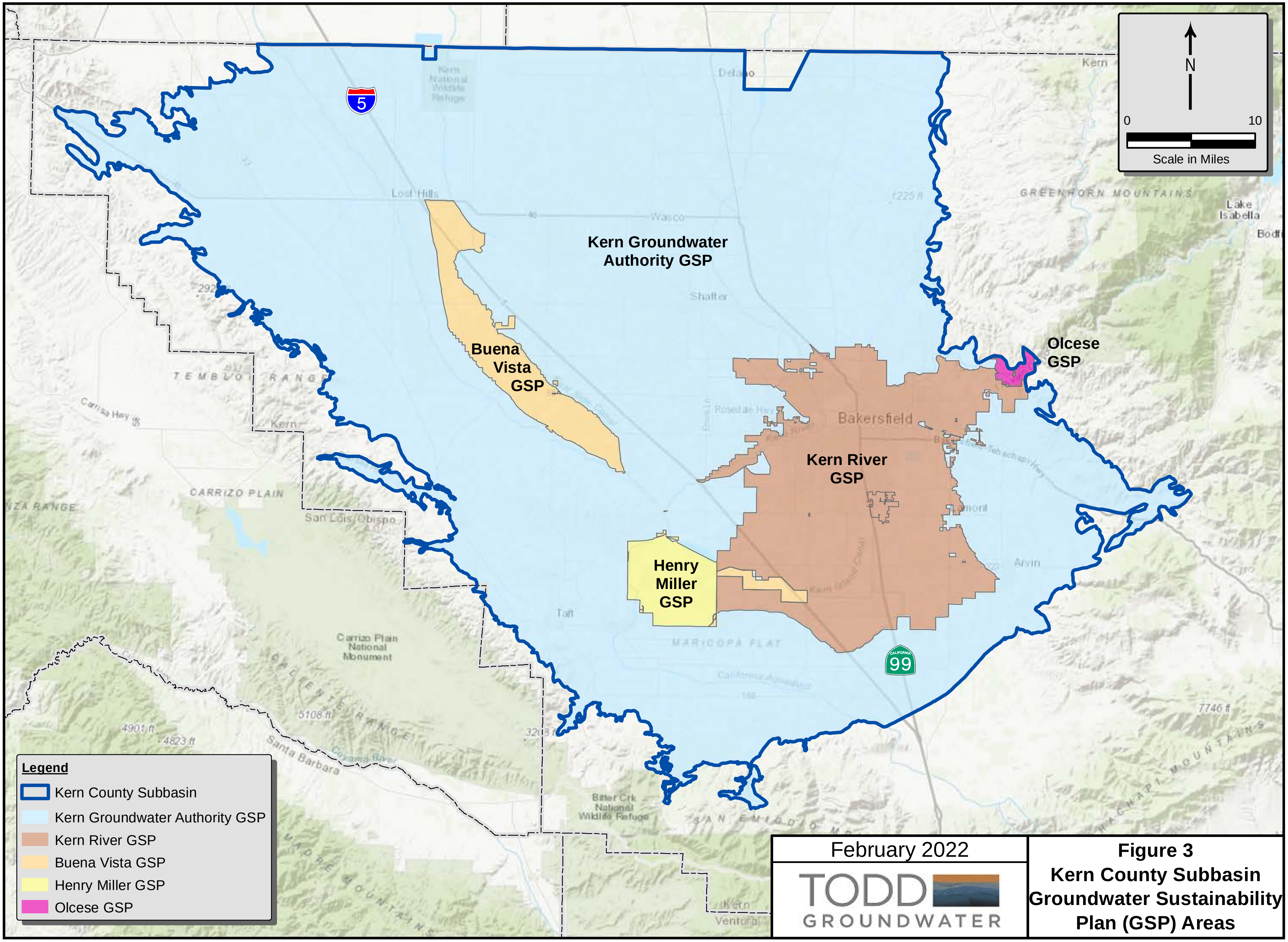


Figure 3
Kern County Subbasin Groundwater Sustainability Plan (GSP) Areas

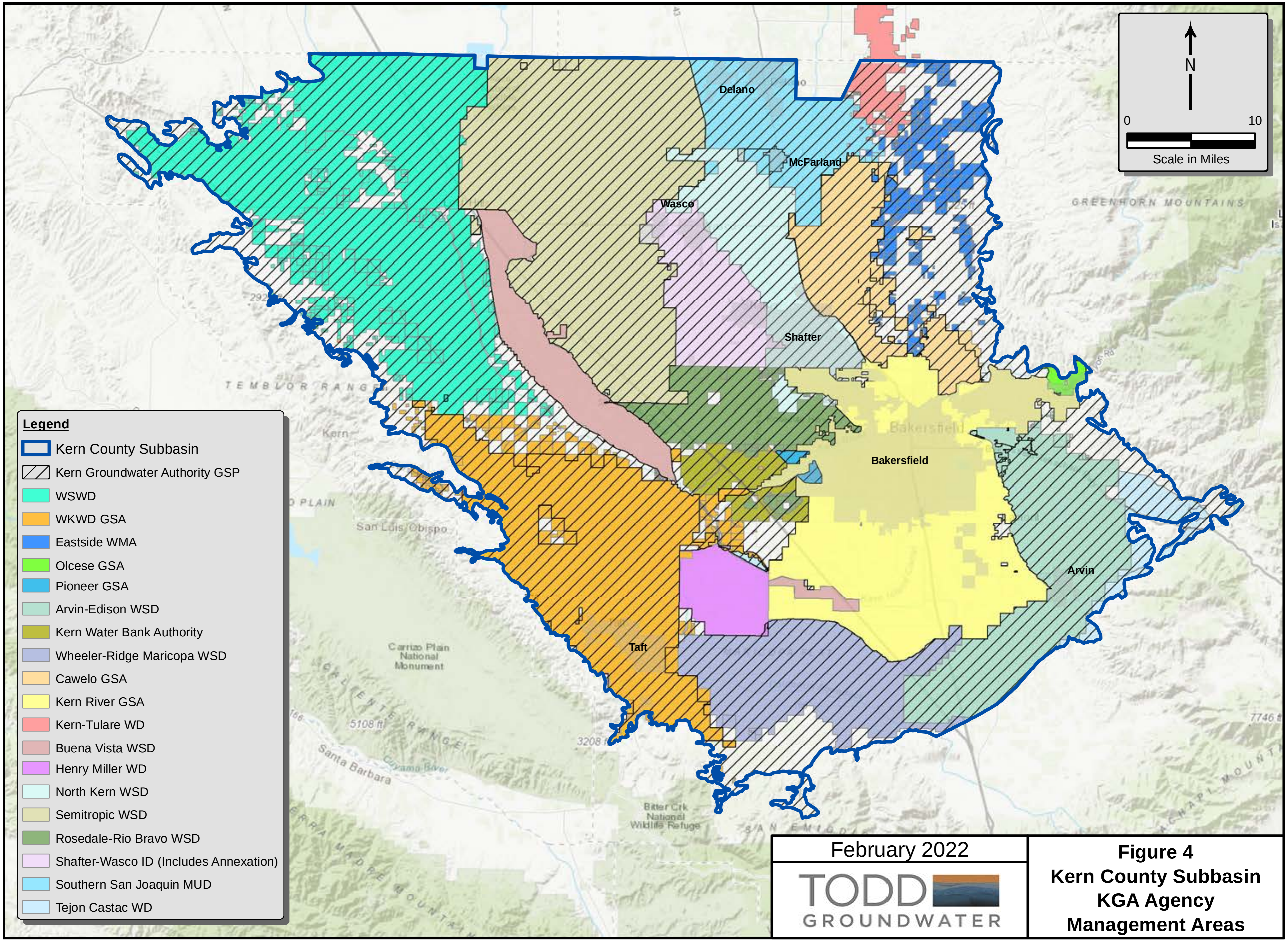


Figure 4
Kern County Subbasin
KGA Agency
Management Areas

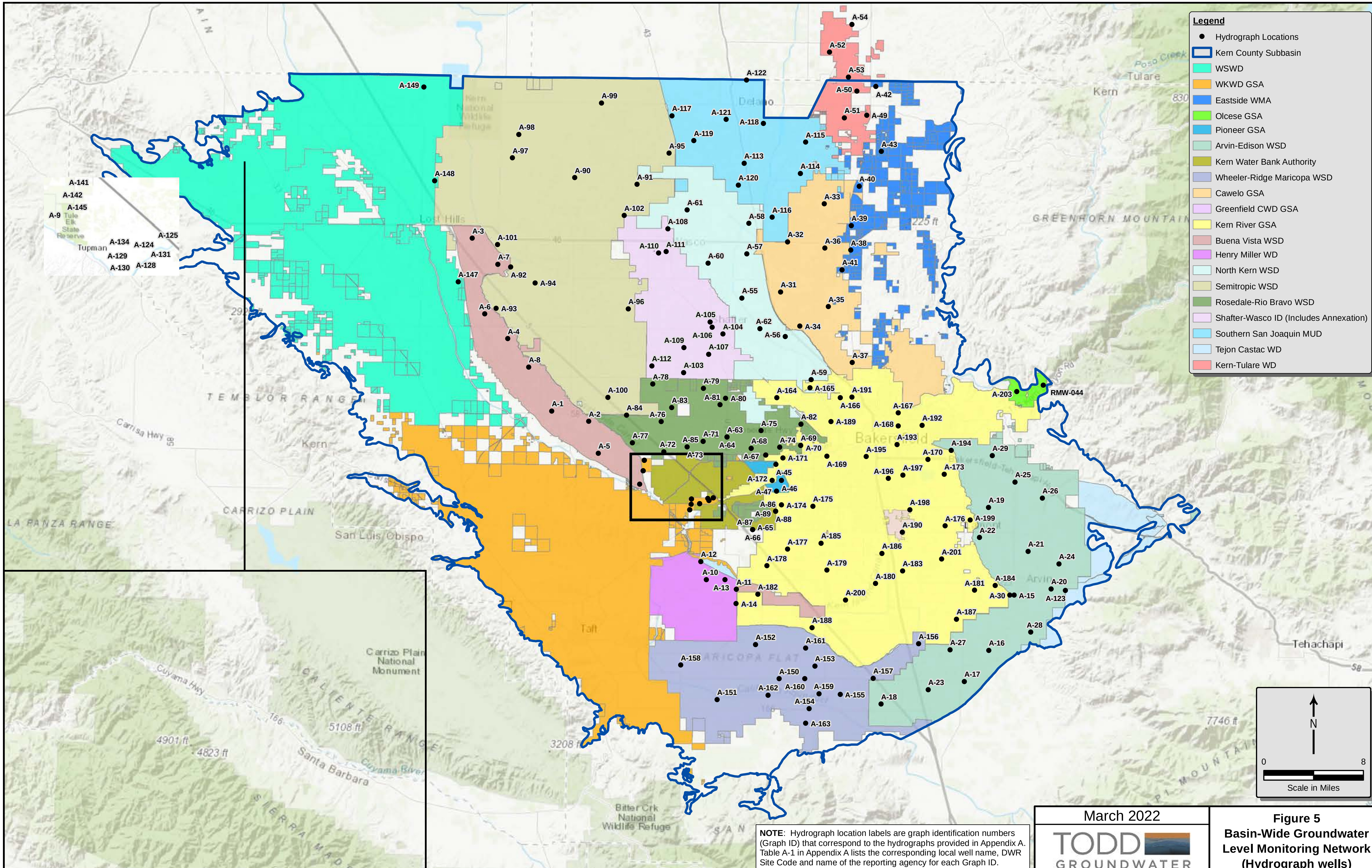
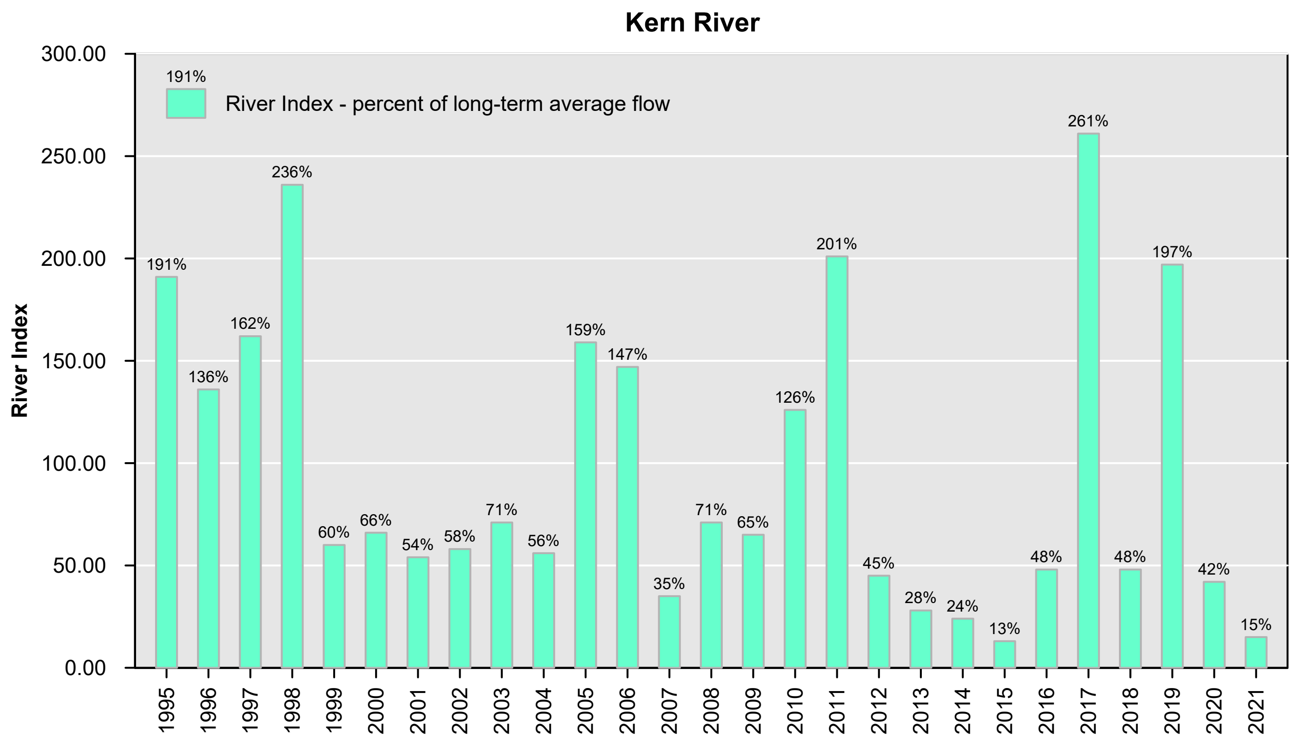
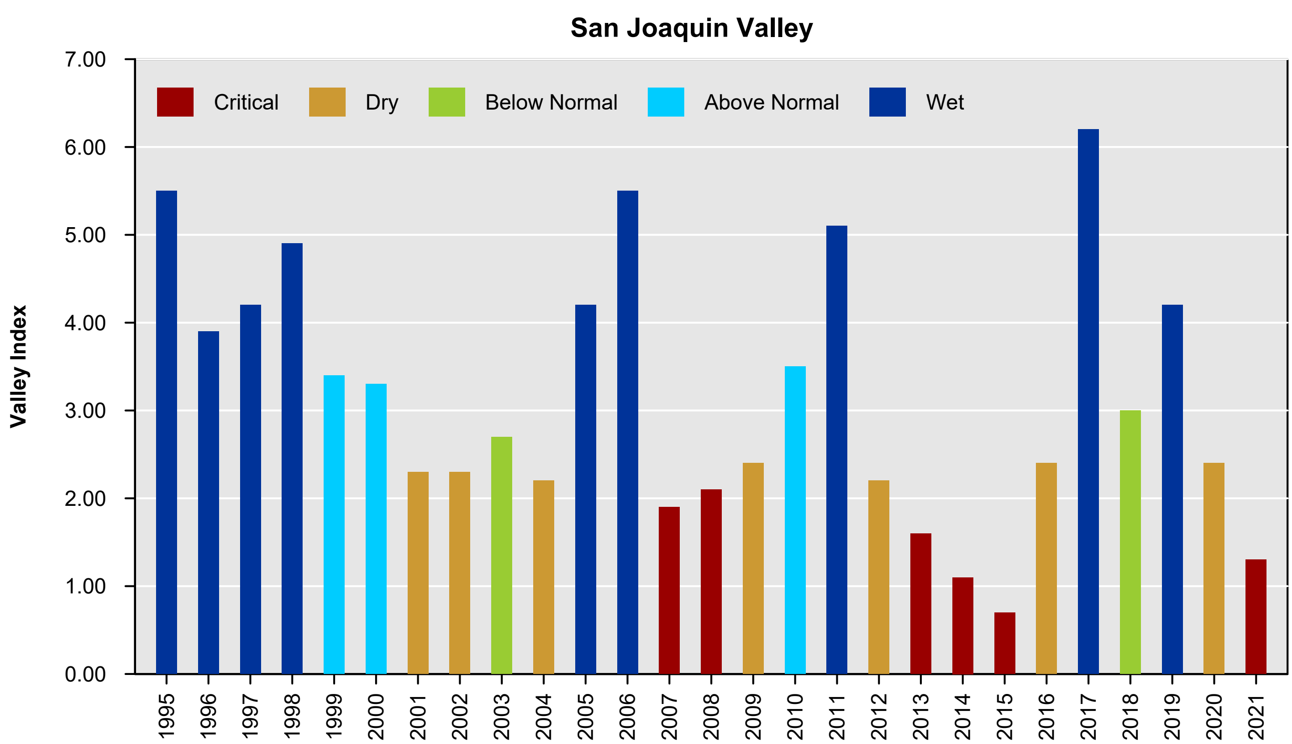


Figure 5
Basin-Wide Groundwater Level Monitoring Network (Hydrograph wells)





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Data Sources:
California Data Exchange Center (CDEC, 2022)
Kern River Hydrographic Reports (2020, 2021, 2022)

February 2022

TODD GROUNDWATER

Figure 6
Water Year Types, Kern River and San Joaquin Valley Indices, WY 1995-2021

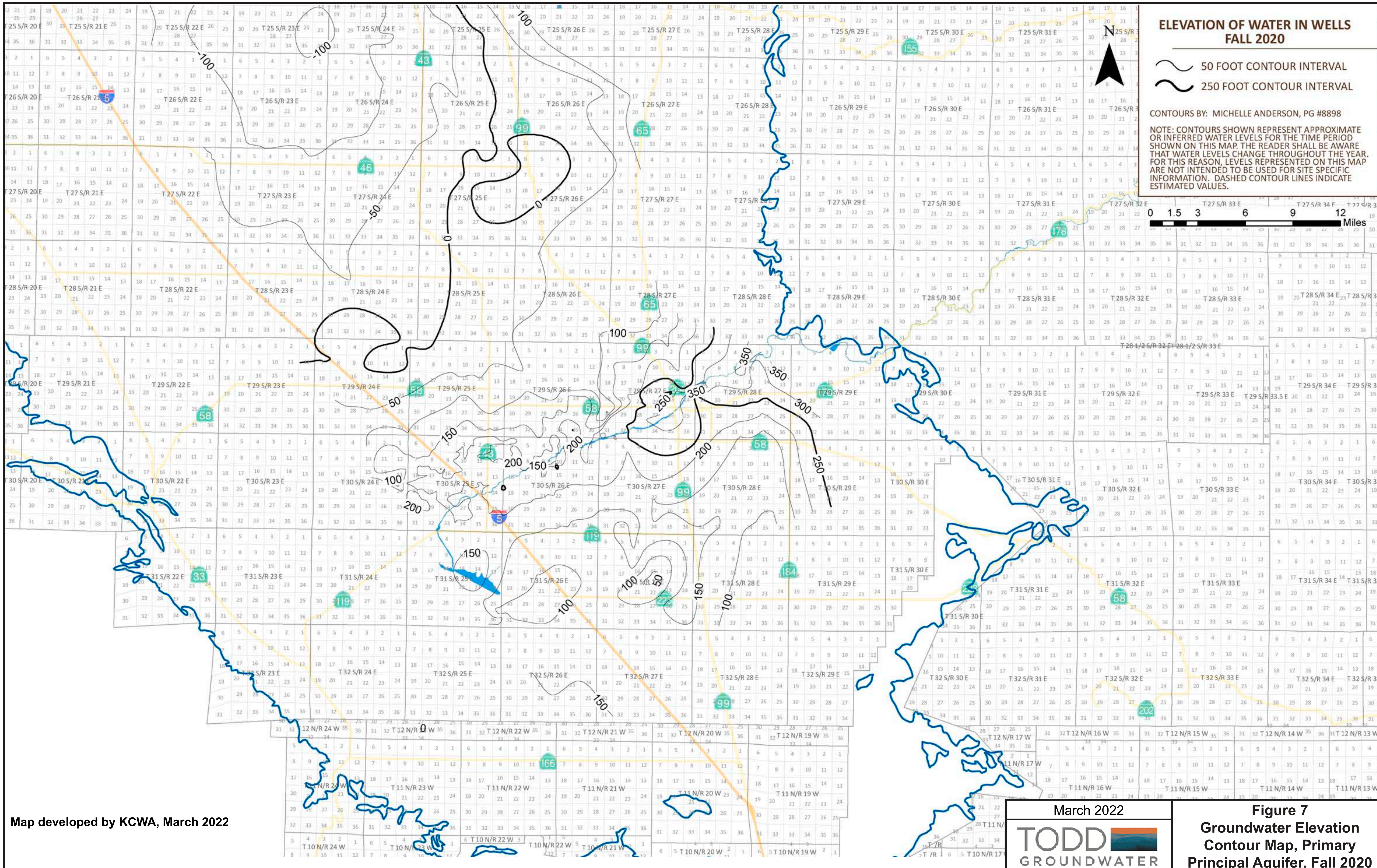


Figure 7
Groundwater Elevation Contour Map, Primary Principal Aquifer, Fall 2020

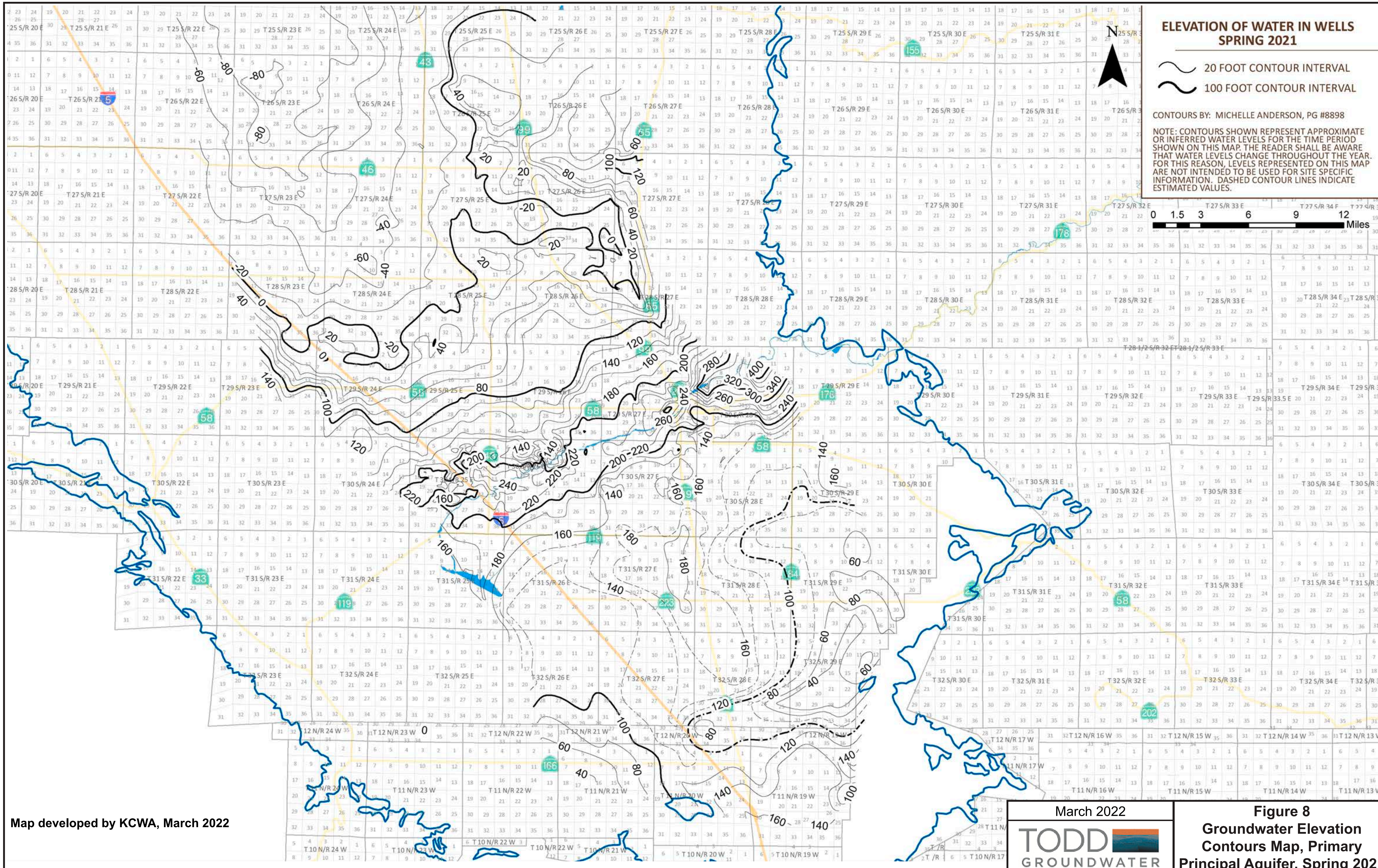
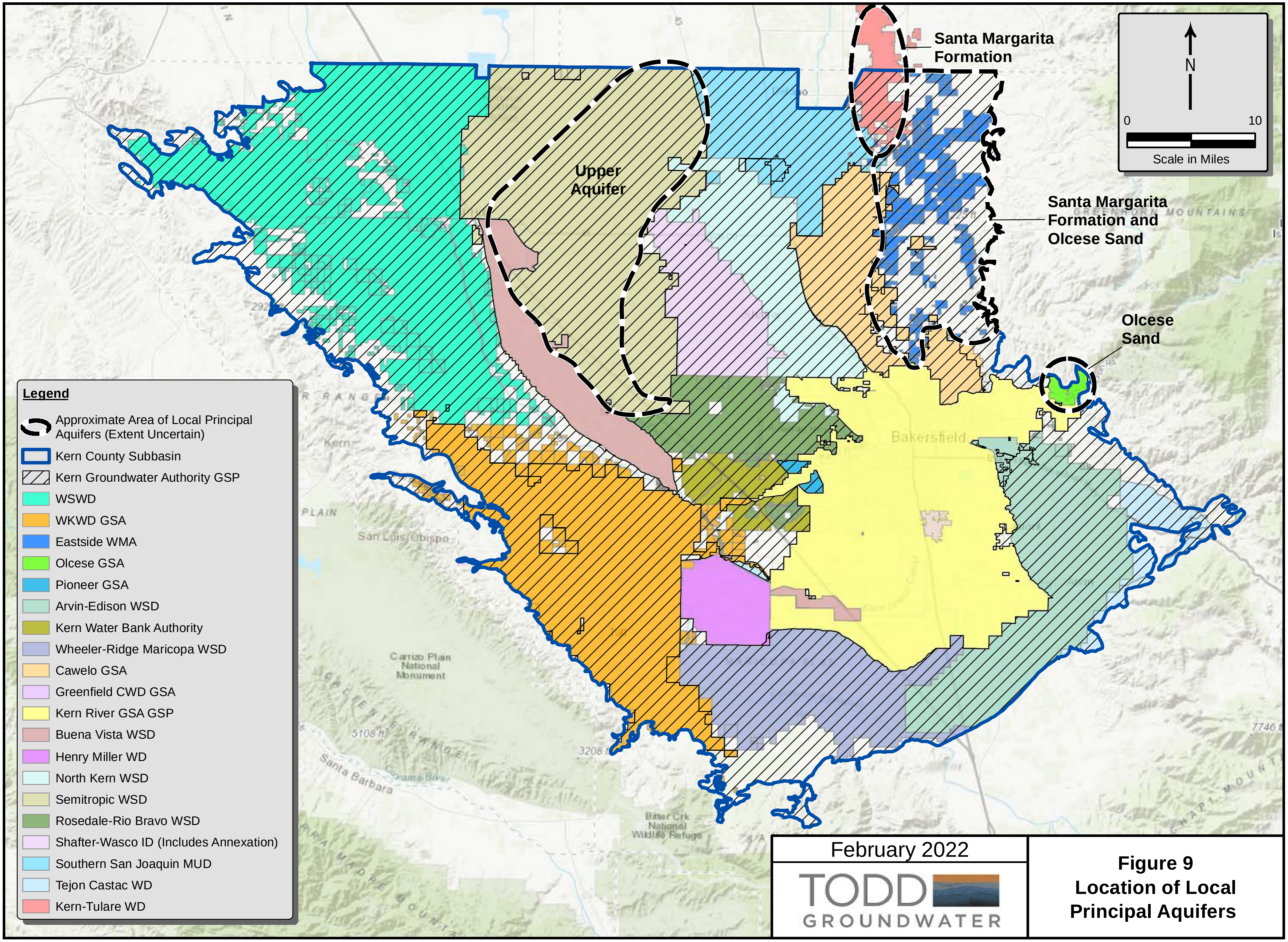


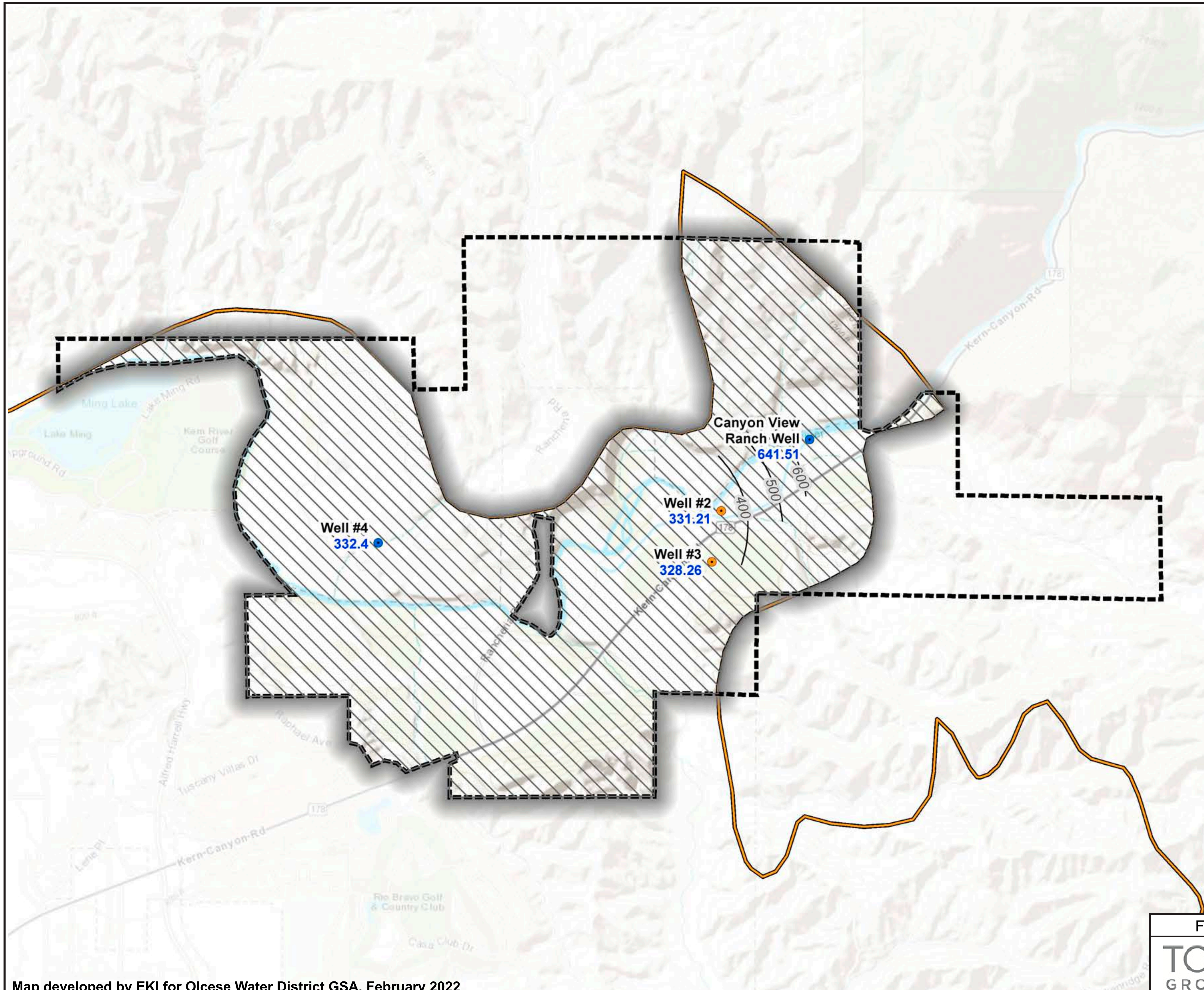
Figure 8
Groundwater Elevation Contours Map, Primary Principal Aquifer, Spring 2021



February 2022

TODD GROUNDWATER

Figure 9
Location of Local Principal Aquifers



Legend

- Olcese Water District
- Olcese Water District GSA
- Kern County Subbasin (DWR 5-022.14)
- GW Level Contour
- GW Level Representative Monitoring Site
- Other GW Level Measurement Location

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GW = groundwater

Notes

1. All locations are approximate.
2. Groundwater levels measured on 18 September 2020.

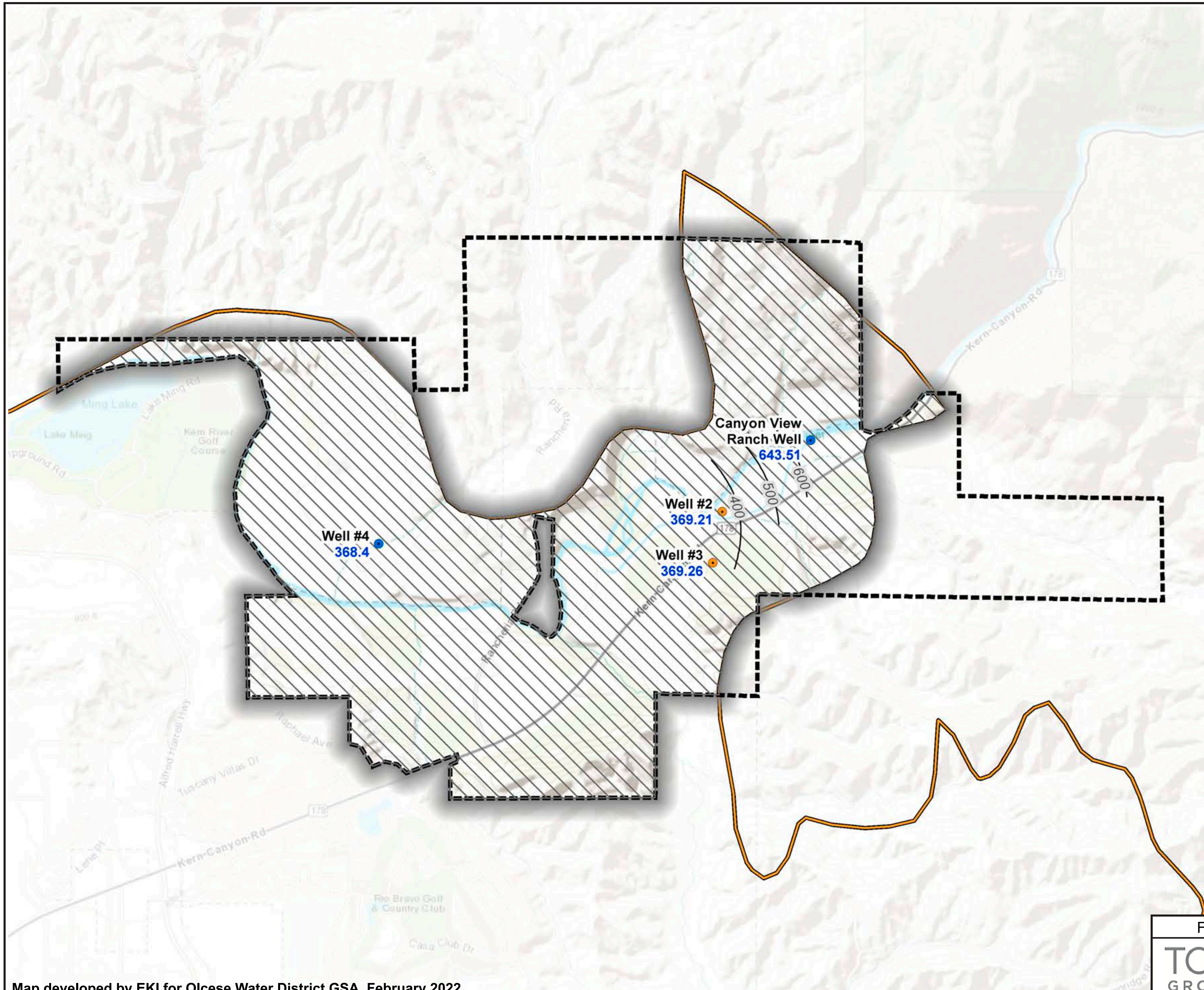
Sources

1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 February 2022.

February 2022

TODD GROUNDWATER

Figure 10
Groundwater Elevation Contour Map, Olcese Sand Principal Aquifer, Fall 2020



Legend
- Olcese Water District
- Olcese Water District GSA
- Kern County Subbasin (DWR 5-022.14)
- GW Level Contour
- GW Level Representative Monitoring Site
- Other GW Level Measurement Location

Abbreviations

DWR = California Department of Water Resources
GSA = Groundwater Sustainability Agency
GW = groundwater

Notes
1. All locations are approximate.
2. Groundwater levels measured on 19 January 2021.

Sources
1. Basemap is ESRI's ArcGIS Online world topographic map, obtained 8 February 2022.

N

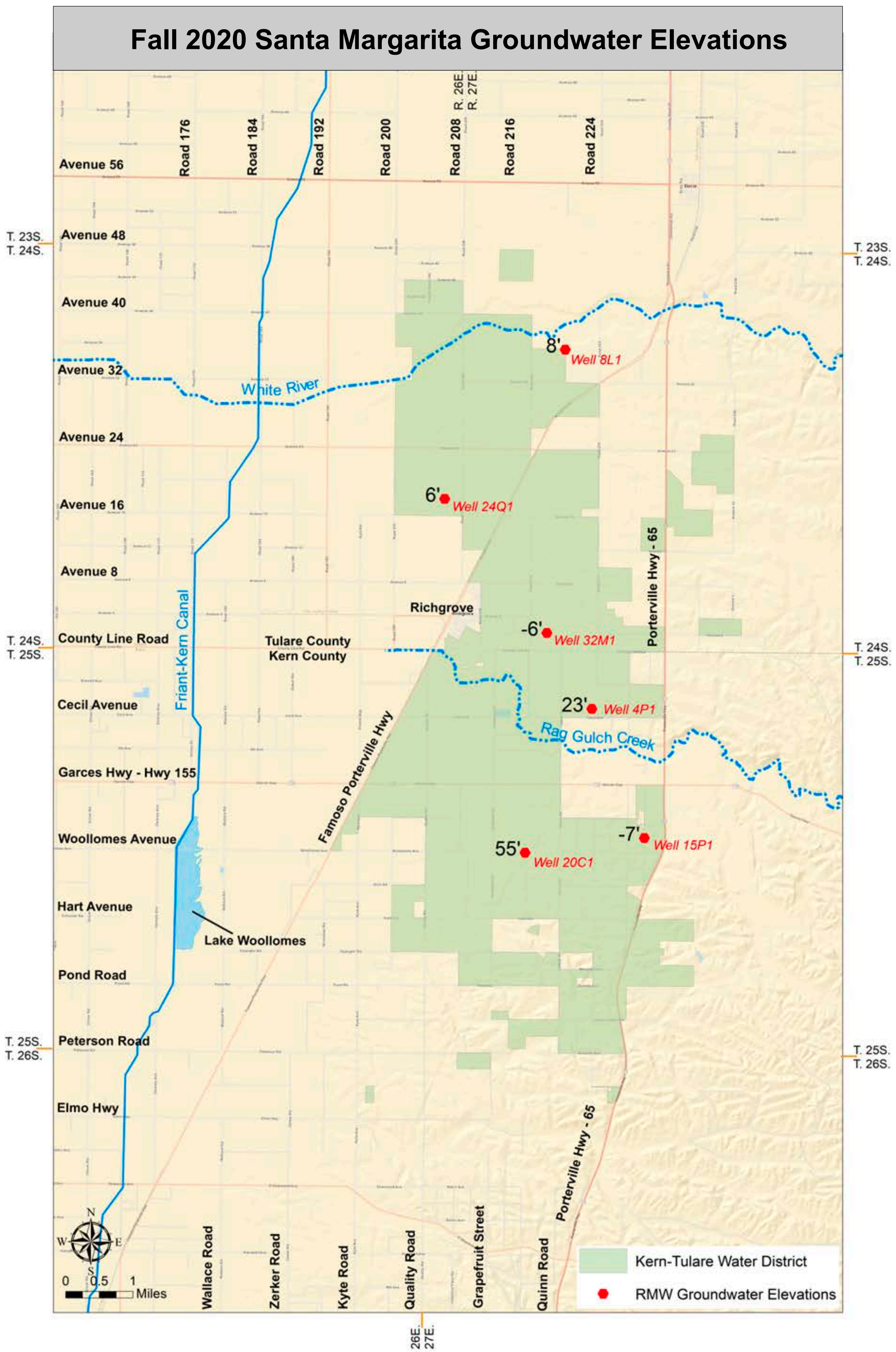
0 0.5 1
Miles

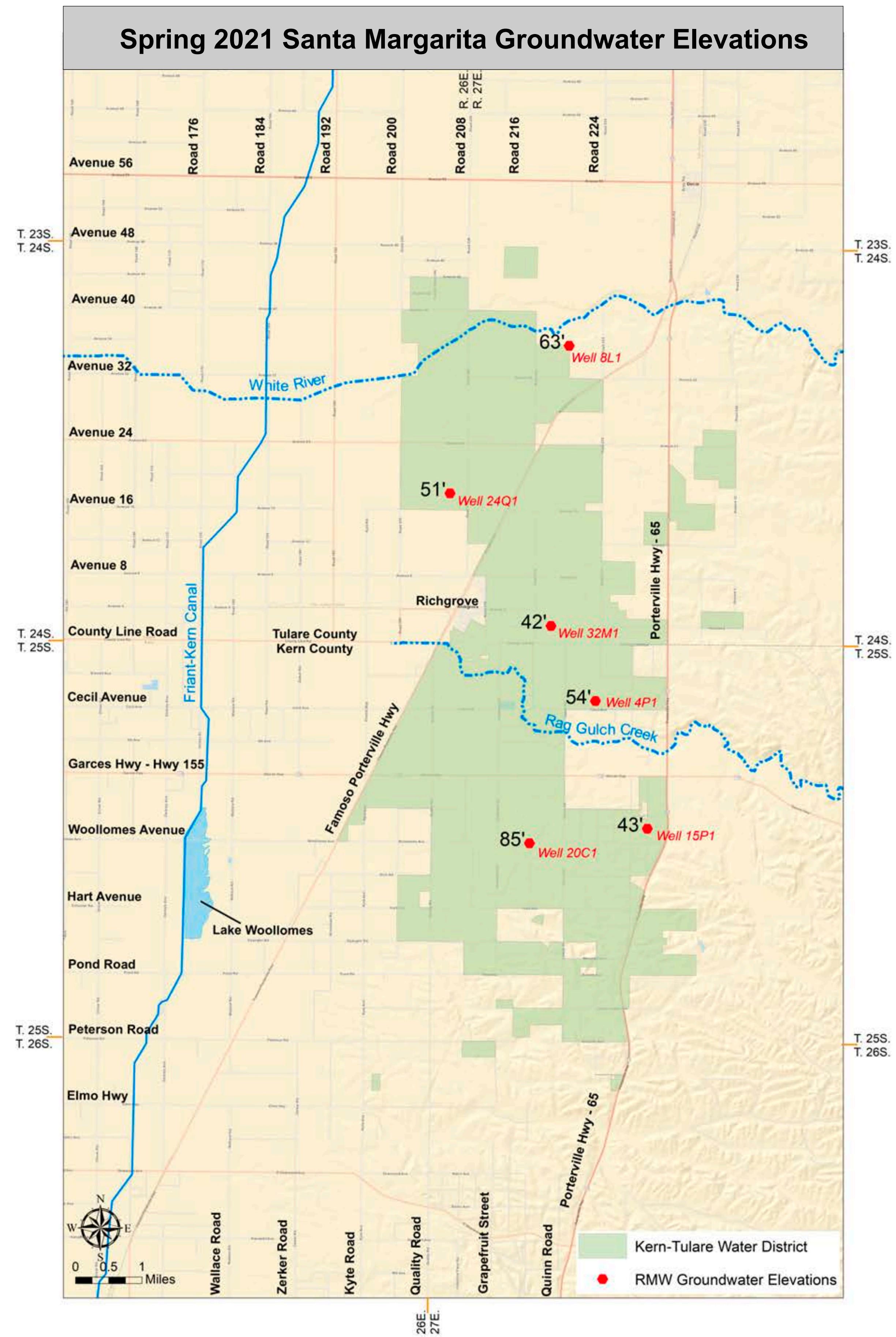
Map developed by EKI for Olcese Water District GSA, February 2022

February 2022

TODD GROUNDWATER

Figure 11
Groundwater Elevation Contour Map, Olcese Sand Principal Aquifer, Spring 2021



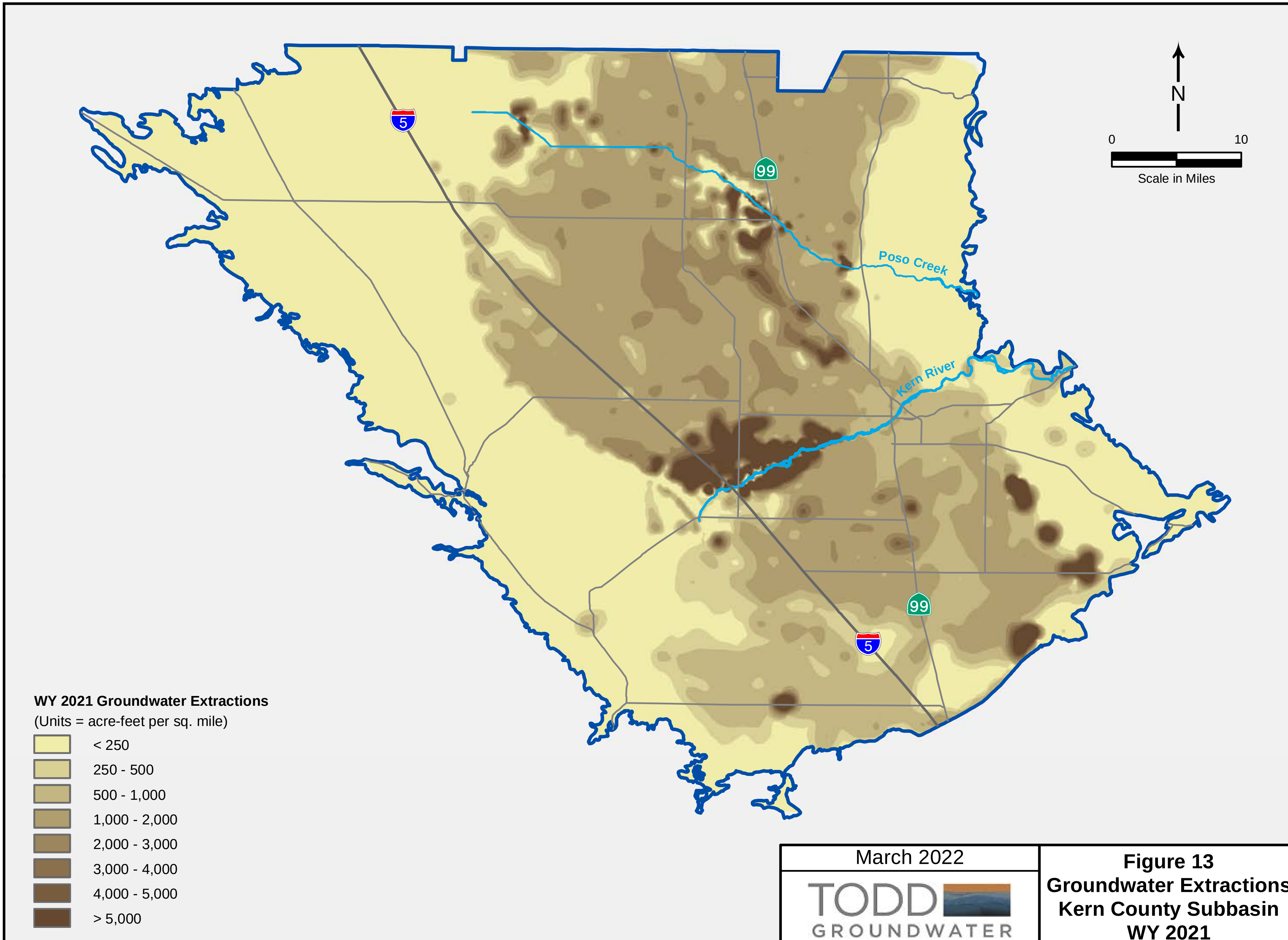


Source:
Kern-Tulare Water District (KTWD),
March 2021.

Figure 12
Groundwater Elevations, Santa Margarita Principal Aquifer, Fall 2020 and Spring 2021

March 2022

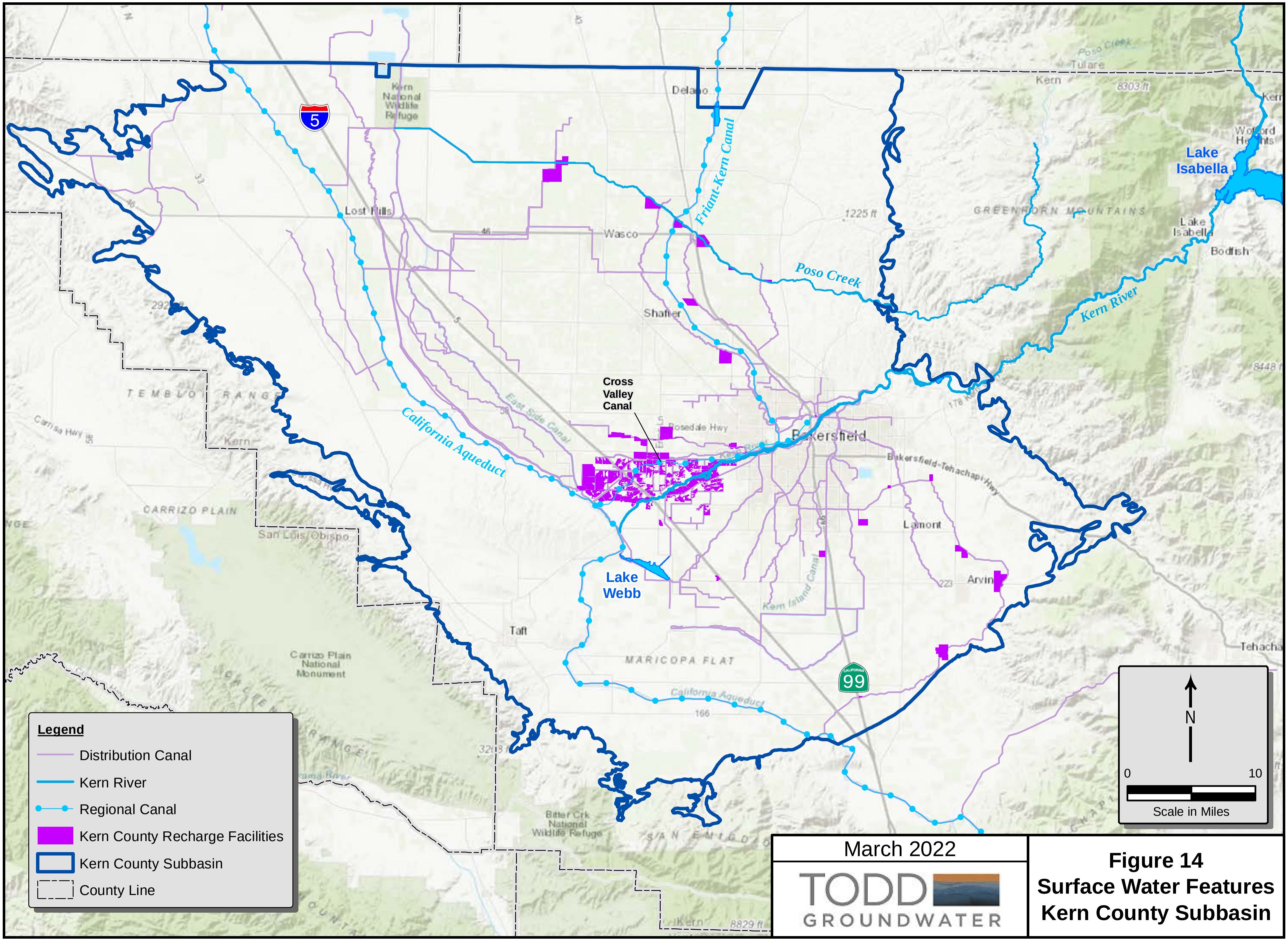
TODD GROUNDWATER



March 2022

TODD GROUNDWATER

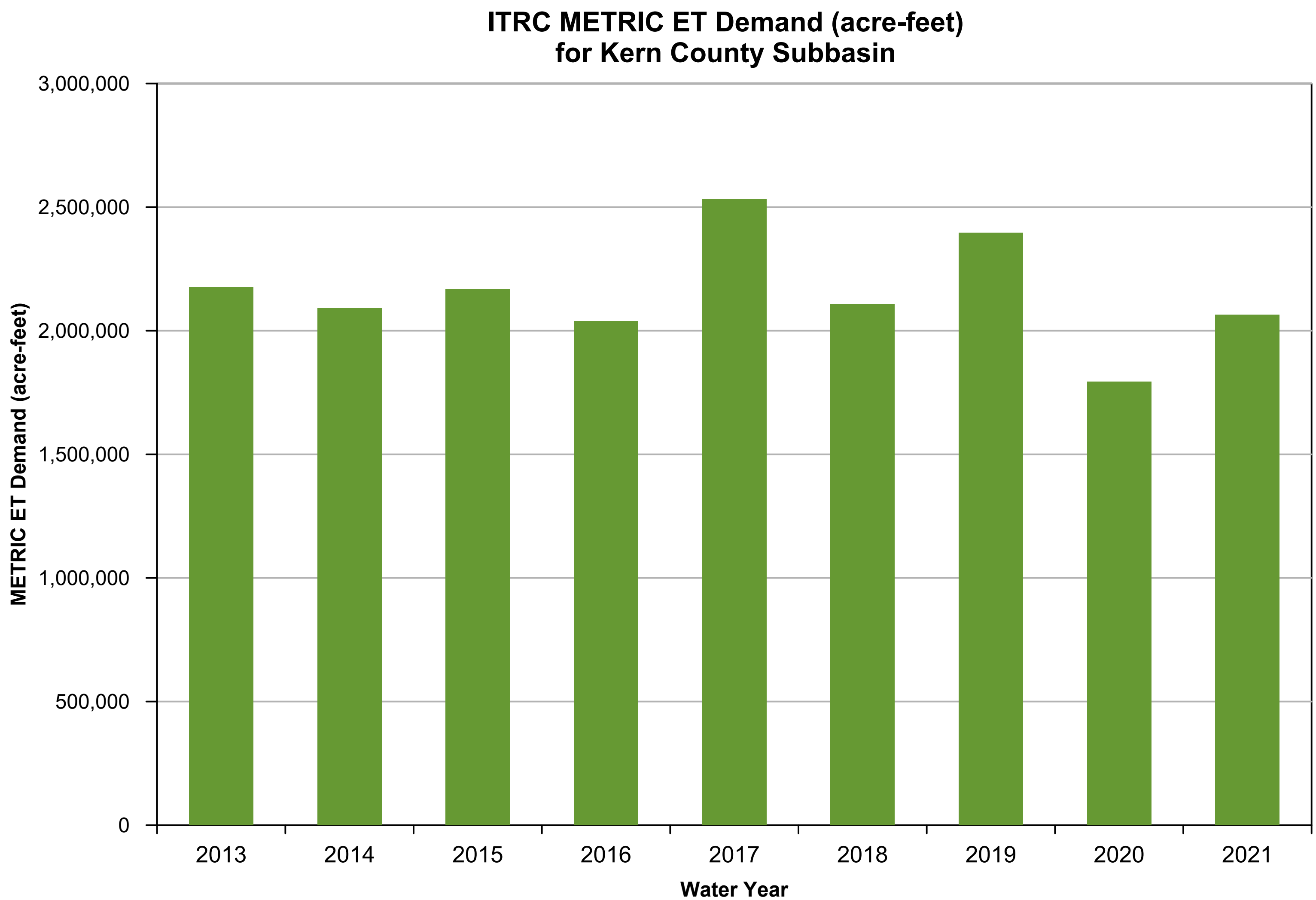
Figure 13
Groundwater Extractions
Kern County Subbasin
WY 2021



March 2022

TODD GROUNDWATER

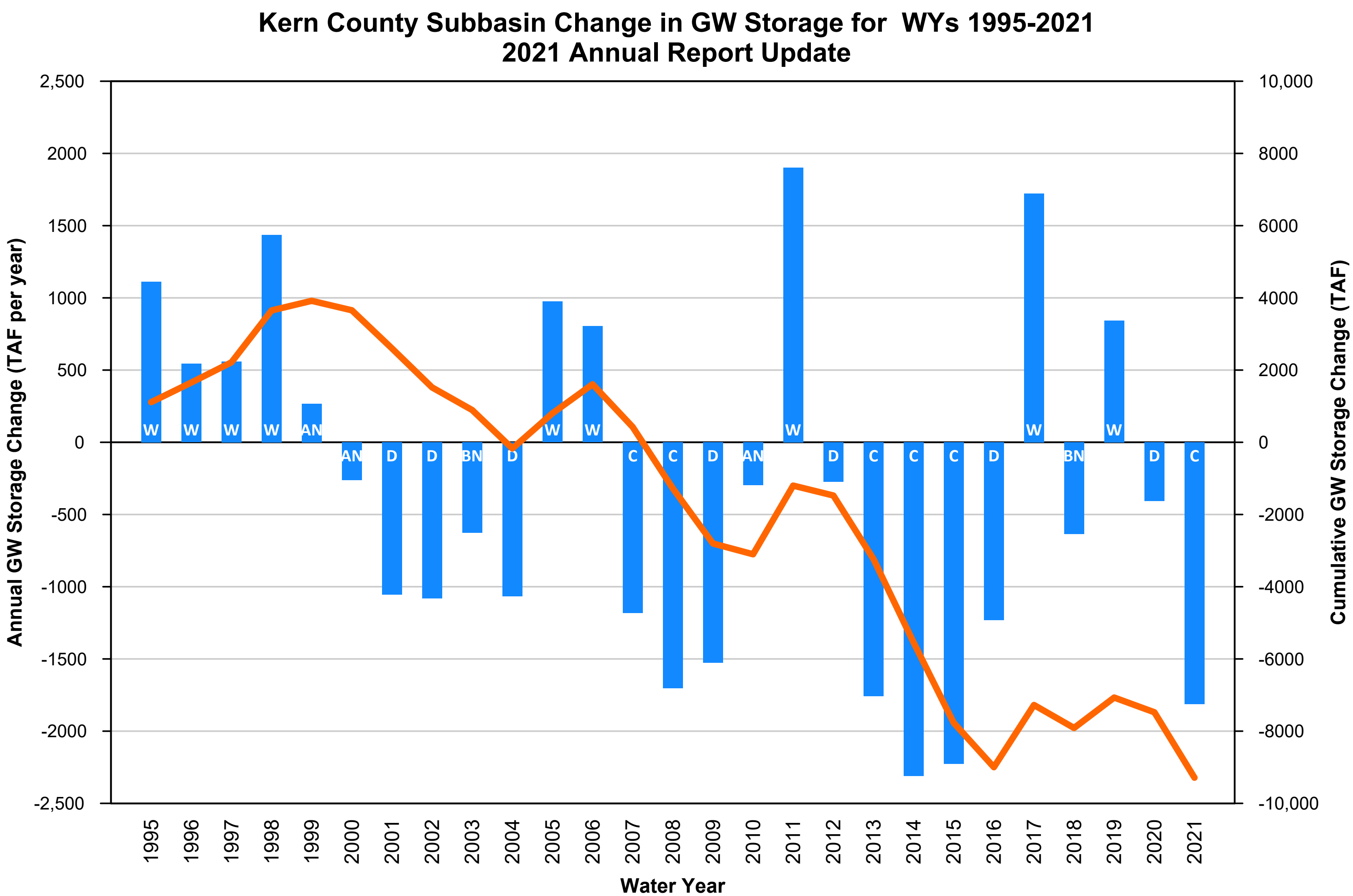
Figure 14
Surface Water Features
Kern County Subbasin



March 2022

TODD GROUNDWATER

Figure 15
ITRC METRIC ET Demand (acre-feet) for Kern County Subbasin



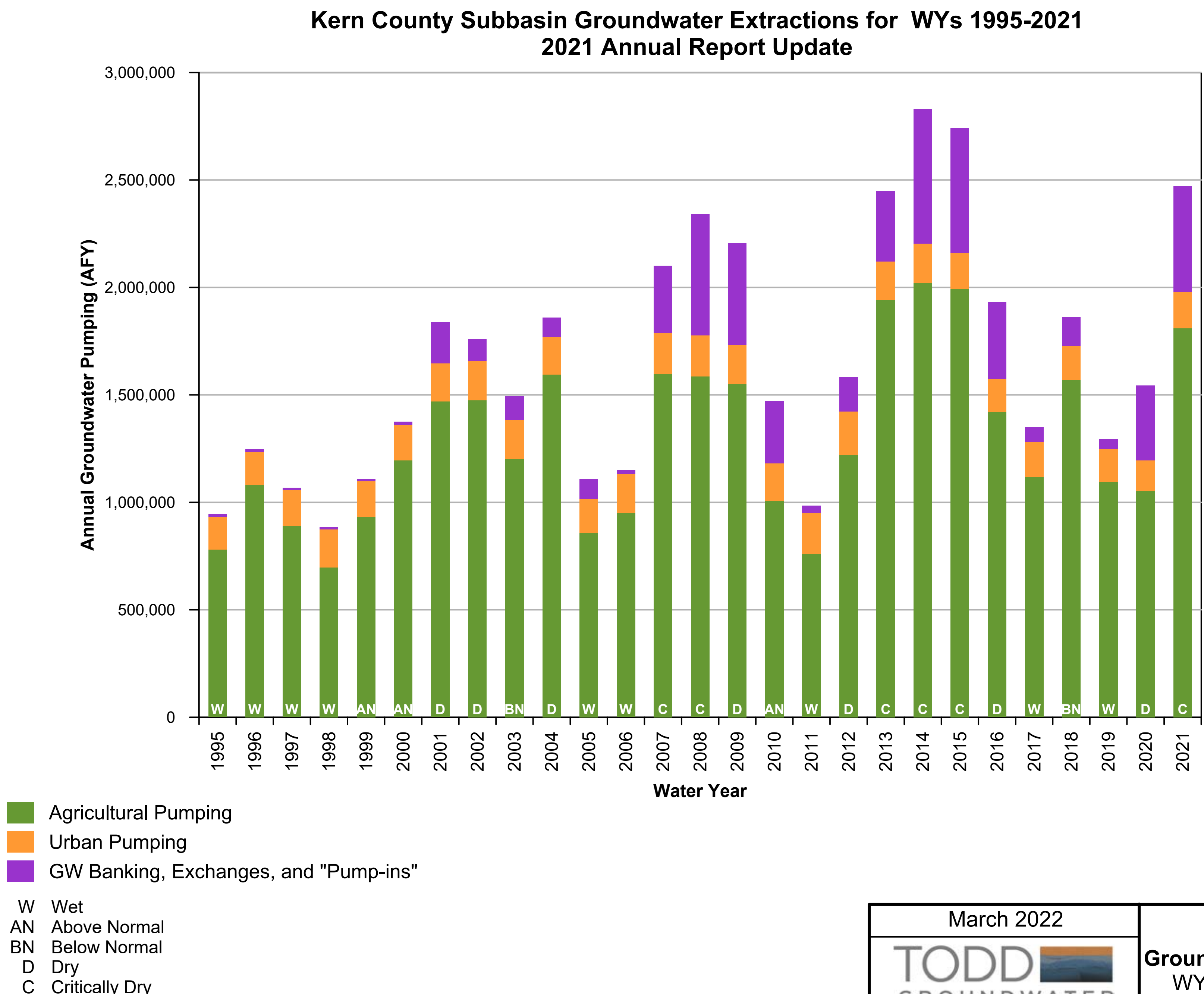
Annual Change in Groundwater Storage (TAF per year)
Cumulative Change in Groundwater Storage (TAF)

W Wet
AN Above Normal
BN Below Normal
D Dry
C Critically Dry

March 2022

TODD GROUNDWATER

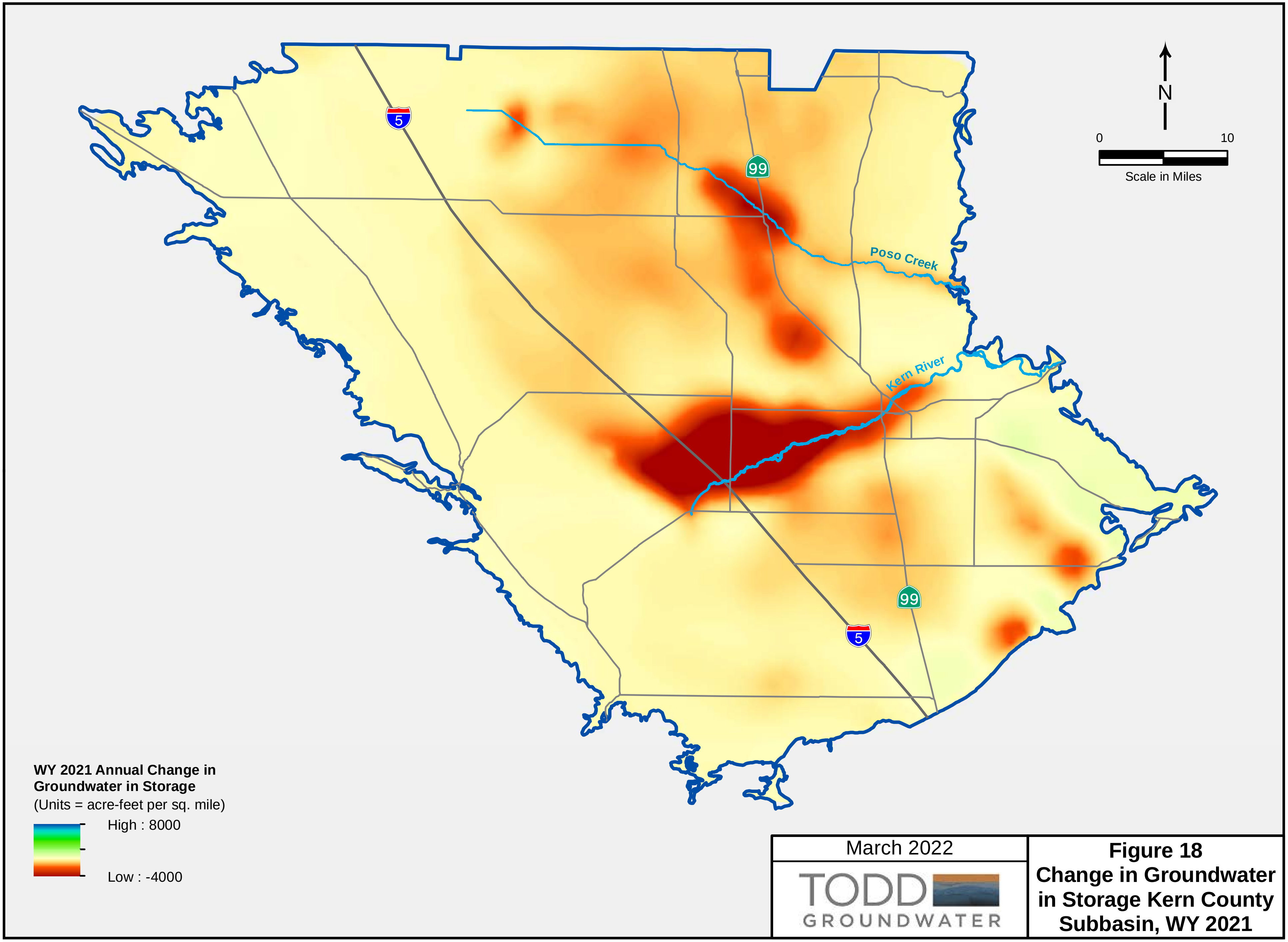
Figure 16
Change in Groundwater in Storage
Kern County Subbasin
WY 1995 – WY 2021



March 2022

TODD GROUNDWATER

Figure 17
Groundwater Extractions
WY 1995 – WY 2021



March 2022

TODD GROUNDWATER

Figure 18
Change in Groundwater in Storage Kern County Subbasin, WY 2021

APPENDIX A

Hydrographs of Groundwater Elevations

GSP Monitoring Network Wells

Kern County Subbasin

WY 2021 Annual Report

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-1	DMW07	Buena Vista Water Storage District GSA	354021N1195011W001	BVGSA
A-2	DMW08	Buena Vista Water Storage District GSA	353905N1194480W001	BVGSA
A-3	DMW01	Buena Vista Water Storage District GSA	356014N1196176W001	BVGSA
A-4	DMW05	Buena Vista Water Storage District GSA	354854N1195648W001	BVGSA
A-5	DMW10a	Buena Vista Water Storage District GSA	353536N1194341W001	BVGSA
A-6	DMW04	Buena Vista Water Storage District GSA	355137N1195985W001	BVGSA
A-7	DMW02	Buena Vista Water Storage District GSA	355716N1195808W001	BVGSA
A-8	DMW06	Buena Vista Water Storage District GSA	354527N1195347W001	BVGSA
A-9	DMW12b	Buena Vista Water Storage District GSA	353187N1193747W001	BVGSA
A-10	HMWD #28	Henry Miller Water District GSA	352086N1192783W001	Henry Miller GSA
A-11	HMWD #26	Henry Miller Water District GSA	351976N1192358W001	Henry Miller GSA
A-12	HMWD #20	Henry Miller Water District GSA	352294N1192865W001	Henry Miller GSA
A-13	HMWD #27	Henry Miller Water District GSA	352088N1192520W001	Henry Miller GSA
A-14	HMWD #18	Henry Miller Water District GSA	351811N1192358W001	Henry Miller GSA
A-15	31S29E34A001M	Arvin-Edison Water Storage District	351944N1188423W001	KGA GSA
A-16	32S29E20H001M	Arvin-Edison Water Storage District	351300N1188781W001	KGA GSA
A-17	32S29E31N001M	Arvin-Edison Water Storage District	350931N1189123W001	KGA GSA
A-18	11N20W05J001S	Arvin-Edison Water Storage District	350669N1190295W001	KGA GSA
A-19	30S29E29A001M	Arvin-Edison Water Storage District	352958N1188807W001	KGA GSA
A-20	31S30E30J001M	Arvin-Edison Water Storage District	352017N1187987W001	KGA GSA
A-21	31S29E12M001M	Arvin-Edison Water Storage District	352452N1188243W001	KGA GSA
A-22	31S29E05E001M	Arvin-Edison Water Storage District	352605N1188932W001	KGA GSA
A-23	12N20W36G001S	Arvin-Edison Water Storage District	350833N1189632W001	KGA GSA
A-24	31S30E17K001M	Arvin-Edison Water Storage District	352311N1187790W001	KGA GSA
A-25	30S29E11N001M	Arvin-Edison Water Storage District	353269N1188418W001	KGA GSA
A-26	30S30E19E001M	Arvin-Edison Water Storage District	353072N1188037W001	KGA GSA
A-27	32S28E23H001M	Arvin-Edison Water Storage District	351300N1189357W001	KGA GSA
A-28	32S29E12P001M	Arvin-Edison Water Storage District	351522N1188199W001	KGA GSA
A-29	29S29E33N001M	Arvin-Edison Water Storage District	353577N1188771W001	KGA GSA
A-30	ACSD Well #14	Arvin-Edison Water Storage District	351942N1188484W001	KGA GSA
A-31	Well 33C	Cawelo Water District GSA	355439N1191781W001	KGA GSA
A-32	Well 4R	Cawelo Water District GSA	356023N1191690W001	KGA GSA
A-33	Well 24R	Cawelo Water District GSA	356469N1191175W001	KGA GSA
A-34	Well 11M	Cawelo Water District GSA	355044N1191502W001	KGA GSA
A-35	Well 6C	Cawelo Water District GSA	355274N1191100W001	KGA GSA

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-36	Well 12H	Cawelo Water District GSA	355954N1191160W001	KGA GSA
A-37	Well 28L	Cawelo Water District GSA	356023N1191691W001	KGA GSA
A-38	EWMA #21	Eastside Water Management Area	355935N1190787W001	KGA GSA
A-39	EWMA #23	Eastside Water Management Area	356220N1190790W001	KGA GSA
A-40	EWMA #30	Eastside Water Management Area	356421N1190690W001	KGA GSA
A-41	EWMA #41	Eastside Water Management Area	355706N1190911W001	KGA GSA
A-42	EWMA #04	Eastside Water Management Area	357840N1190456W001	KGA GSA
A-43	EWMA #10	Eastside Water Management Area	357085N1190370W001	KGA GSA
A-44	30S26E04J002M	Pioneer GSA	353434N1191816W001	KGA GSA
A-45	30S26E04J003M	Pioneer GSA	353434N1191816W002	KGA GSA
A-46	30S26E10P004M	Pioneer GSA	353250N1191739W001	KGA GSA
A-47	30S26E15N003M	Pioneer GSA	353123N1191805W001	KGA GSA
A-48	30S26E04D003M	Pioneer GSA	353543N1191966W001	KGA GSA
A-49	Well 15P1	Kern-Tulare Water District	357503N1190578W001	KGA GSA
A-50	Well 4P1	Kern-Tulare Water District	357781N1190720W001	KGA GSA
A-51	Well 20C1	Kern-Tulare Water District	357464N1190898W001	KGA GSA
A-52	Well 24Q1	Kern-Tulare Water District	358231N1191126W001	KGA GSA
A-53	Well 32M1	Kern-Tulare Water District	357944N1190845W001	KGA GSA
A-54	Well 8L1	Kern-Tulare Water District	358561N1190806W001	KGA GSA
A-55	88-09-009	North Kern Water Storage District	355364N1192330W001	KGA GSA
A-56	88-03-009	North Kern Water Storage District	354921N1191708W001	KGA GSA
A-57	88-21-005	North Kern Water Storage District	355878N1192269W001	KGA GSA
A-58	88-29-014	North Kern Water Storage District	356232N1192245W001	KGA GSA
A-59	99-00-003	North Kern Water Storage District	354424N1191332W001	KGA GSA
A-60	99-00-081	North Kern Water Storage District	355764N1192818W001	KGA GSA
A-61	99-22-084	North Kern Water Storage District	356380N1193124W001	KGA GSA
A-62	Shafter Well 18	North Kern Water Storage District	355010N1192067W001	KGA GSA
A-63	30 Enos Deep	Rosedale-Rio Bravo Water Storage District	353760N1192498W001	KGA GSA
A-64	30 Enos Shallow	Rosedale-Rio Bravo Water Storage District	353760N1192498W002	KGA GSA
A-65	32N Triple	Rosedale-Rio Bravo Water Storage District	352673N1192138W002	KGA GSA
A-66	32N Triple Shallow	Rosedale-Rio Bravo Water Storage District	352673N1192138W001	KGA GSA
A-67	32 Greeley Shallow	Rosedale-Rio Bravo Water Storage District	353618N1192169W001	KGA GSA
A-68	32 Greeley Deep	Rosedale-Rio Bravo Water Storage District	353618N1192169W002	KGA GSA
A-69	37 RRBWSD Shop Deep	Rosedale-Rio Bravo Water Storage District	353620N1191457W001	KGA GSA
A-70	37 RRBWSD Shop Shallow	Rosedale-Rio Bravo Water Storage District	353620N1191457W002	KGA GSA

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-71	27N_MayerShallowE	Rosedale-Rio Bravo Water Storage District	353699N1192856W002	KGA GSA
A-72	20 West I-5	Rosedale-Rio Bravo Water Storage District	353564N1193412W001	KGA GSA
A-73	22 Virgil Bussell	Rosedale-Rio Bravo Water Storage District	353619N1193099W001	KGA GSA
A-74	36 Harvest Ranch	Rosedale-Rio Bravo Water Storage District	353634N1191766W001	KGA GSA
A-75	13 Home Place	Rosedale-Rio Bravo Water Storage District	353824N1192035W001	KGA GSA
A-76	17 Blacco HQ	Rosedale-Rio Bravo Water Storage District	353915N1193454W001	KGA GSA
A-77	19 Parsons	Rosedale-Rio Bravo Water Storage District	353663N1193859W001	KGA GSA
A-78	1 Bushnell	Rosedale-Rio Bravo Water Storage District	354350N1193586W001	KGA GSA
A-79	3 L.R. Stout	Rosedale-Rio Bravo Water Storage District	354309N1192859W001	KGA GSA
A-80	5 RBG School	Rosedale-Rio Bravo Water Storage District	354197N1192544W001	KGA GSA
A-81	6 P. Enns Domestic	Rosedale-Rio Bravo Water Storage District	354121N1192623W001	KGA GSA
A-82	9 Chet Reed	Rosedale-Rio Bravo Water Storage District	353890N1191471W001	KGA GSA
A-83	16 Section 18	Rosedale-Rio Bravo Water Storage District	354090N1193318W001	KGA GSA
A-84	18 Cauzza	Rosedale-Rio Bravo Water Storage District	353986N1193948W001	KGA GSA
A-85	27N Mayer Deep-W	Rosedale-Rio Bravo Water Storage District	353693N1192870W001	KGA GSA
A-86	28J Triple	Rosedale-Rio Bravo Water Storage District	352889N1191814W001	KGA GSA
A-87	32N Triple Deep	Rosedale-Rio Bravo Water Storage District	352674N1192138W001	KGA GSA
A-88	28J Triple Shallow	Rosedale-Rio Bravo Water Storage District	352889N1191814W002	KGA GSA
A-89	28J Triple Deep	Rosedale-Rio Bravo Water Storage District	352889N1191814W003	KGA GSA
A-90	26S-23E-15A1	Semitropic Water Storage District	356736N1194735W001	KGA GSA
A-91	S-14B Cluster 2 of 2	Semitropic Water Storage District	356668N1193841W002	KGA GSA
A-92	S-2	Semitropic Water Storage District	355687N1195623W001	KGA GSA
A-93	S-4	Semitropic Water Storage District	355205N1195821W001	KGA GSA
A-94	S-5	Semitropic Water Storage District	355506N1195271W001	KGA GSA
A-95	S-6	Semitropic Water Storage District	357036N1193392W001	KGA GSA
A-96	S-9A Cluster 1 of 2	Semitropic Water Storage District	355219N1193943W001	KGA GSA
A-97	S-11	Semitropic Water Storage District	356956N1195623W001	KGA GSA
A-98	S-12	Semitropic Water Storage District	357228N1195538W001	KGA GSA
A-99	S-13A Cluster 1 of 2	Semitropic Water Storage District	357609N1194366W001	KGA GSA
A-100	948L02 Cluster1 of 2	Semitropic Water Storage District	354189N1194216W001	KGA GSA
A-101	S-1	Semitropic Water Storage District	355944N1195814W001	KGA GSA
A-102	S-8A Cluster 1 of 2	Semitropic Water Storage District	356305N1194021W001	KGA GSA
A-103	Well 31J	Shafter-Wasco Irrigation District	354494N1193182W001	KGA GSA
A-104	Shafter Well 14	Shafter-Wasco Irrigation District	354943N1192593W001	KGA GSA
A-105	Shafter Well 7	Shafter-Wasco Irrigation District	355080N1192777W001	KGA GSA

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-106	Shafter Well 12	Shafter-Wasco Irrigation District	355020N1192748W001	KGA GSA
A-107	Shafter Well 15	Shafter-Wasco Irrigation District	354705N1192792W001	KGA GSA
A-108	Wasco 12	Shafter-Wasco Irrigation District	356157N1193397W001	KGA GSA
A-109	28S25E19G	Shafter-Wasco Irrigation District	354779N1193145W001	KGA GSA
A-110	Wasco 8A	Shafter-Wasco Irrigation District	355874N1193523W001	KGA GSA
A-111	Wasco 11	Shafter-Wasco Irrigation District	355891N1193417W001	KGA GSA
A-112	28S/24E-35C	Shafter-Wasco Irrigation District	354561N1193595W001	KGA GSA
A-113	SSJMUD-42	Southern San Joaquin Municipal Utility District	356930N1192320W001	KGA GSA
A-114	SSJMUD-59	Southern San Joaquin Municipal Utility District	356820N1191517W001	KGA GSA
A-115	SSJMUD-62	Southern San Joaquin Municipal Utility District	357184N1191449W001	KGA GSA
A-116	SSJMUD-53	Southern San Joaquin Municipal Utility District	356307N1191912W001	KGA GSA
A-117	SSJMUD-8	Southern San Joaquin Municipal Utility District	357470N1193360W001	KGA GSA
A-118	SSJMUD-14	Southern San Joaquin Municipal Utility District	357395N1192052W001	KGA GSA
A-119	SSJMUD-23	Southern San Joaquin Municipal Utility District	357185N1193042W001	KGA GSA
A-120	McFarland Taylor Ave Well	Southern San Joaquin Municipal Utility District	356675N1192402W001	KGA GSA
A-121	Delano 34	Southern San Joaquin Municipal Utility District	357436N1192587W001	KGA GSA
A-122	Delano 30	Southern San Joaquin Municipal Utility District	357898N1192302W001	KGA GSA
A-123	Caratan Well (RMS-1)	Tejon-Castac Water District	352002N1187698W001	KGA GSA
A-124	Well 7	West Kern Water District	352958N1193011W001	KGA GSA
A-125	23M-S	West Kern Water District	353037N1192699W001	KGA GSA
A-126	23M-M	West Kern Water District	353037N1192699W002	KGA GSA
A-127	23M-D	West Kern Water District	353037N1192699W003	KGA GSA
A-128	28E-S	West Kern Water District	352895N1193032W001	KGA GSA
A-129	28E-M	West Kern Water District	352895N1193032W002	KGA GSA
A-130	28E-D	West Kern Water District	352895N1193032W003	KGA GSA
A-131	21R-D	West Kern Water District	352967N1192895W003	KGA GSA
A-132	22K-M	West Kern Water District	353005N1192761W002	KGA GSA
A-133	22K-D	West Kern Water District	353005N1192761W003	KGA GSA
A-134	21L-M	West Kern Water District	353020N1193011W002	KGA GSA
A-135	21R-M	West Kern Water District	352967N1192895W002	KGA GSA
A-136	21L-S	West Kern Water District	353020N1193011W001	KGA GSA
A-137	21L-D	West Kern Water District	353020N1193011W003	KGA GSA
A-138	21R-S	West Kern Water District	352967N1192895W001	KGA GSA
A-139	22K-S	West Kern Water District	353005N1192761W001	KGA GSA
A-140	Well 604	West Kern Water District	353028N1192780W001	KGA GSA

Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

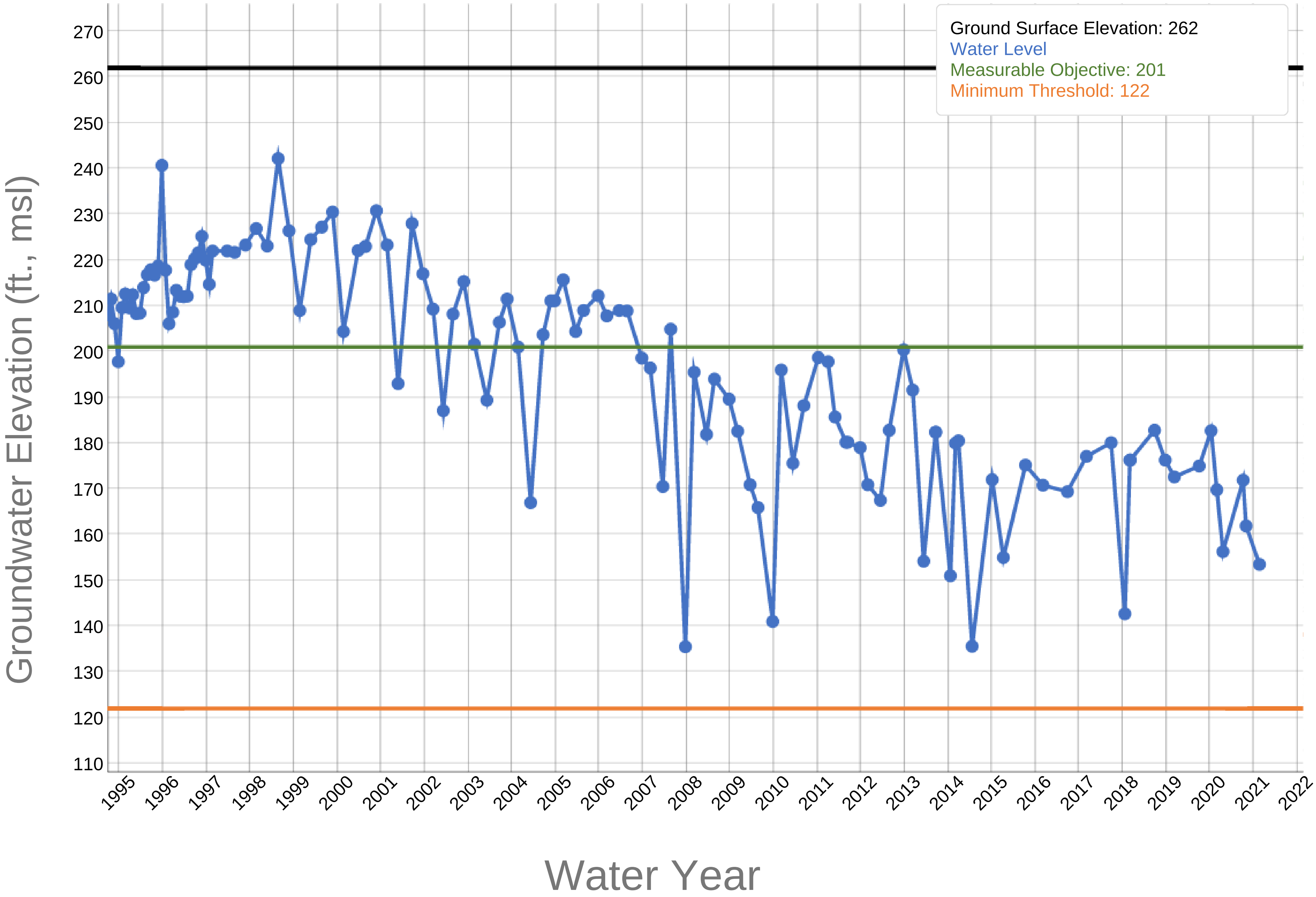
Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-141	NWM1-S	West Kern Water District	353464N1193684W004	KGA GSA
A-142	NWM2-S	West Kern Water District	353342N1193700W004	KGA GSA
A-143	NWM1-M	West Kern Water District	353464N1193684W006	KGA GSA
A-144	NWM1-D	West Kern Water District	353464N1193684W007	KGA GSA
A-145	NWM2-M	West Kern Water District	353342N1193700W006	KGA GSA
A-146	NWM2-D	West Kern Water District	353342N1193700W007	KGA GSA
A-147	7106-63	Westside Districts Water Authority	355505N1196368W001	KGA GSA
A-148	S#14	Westside Districts Water Authority	356675N1196724W001	KGA GSA
A-149	7108-66	Westside Districts Water Authority	357762N1196902W001	KGA GSA
A-150	32S26E34P001M	Wheeler Ridge-Maricopa Water Storage District	350943N1191736W001	KGA GSA
A-151	11N22W06H001S	Wheeler Ridge-Maricopa Water Storage District	350686N1192609W001	KGA GSA
A-152	32S26E20G001M	Wheeler Ridge-Maricopa Water Storage District	351303N1192078W001	KGA GSA
A-153	32S27E30N001M	Wheeler Ridge-Maricopa Water Storage District	351092N1191270W001	KGA GSA
A-154	11N21W09C001S	Wheeler Ridge-Maricopa Water Storage District	350592N1191328W001	KGA GSA
A-155	12N21W35Q001S	Wheeler Ridge-Maricopa Water Storage District	350769N1190871W001	KGA GSA
A-156	32S28E16P001M	Wheeler Ridge-Maricopa Water Storage District	351397N1189767W001	KGA GSA
A-157	32S27E35R001M	Wheeler Ridge-Maricopa Water Storage District	350961N1190435W001	KGA GSA
A-158	32S25E29Q001M	Wheeler Ridge-Maricopa Water Storage District	351083N1193140W001	KGA GSA
A-159	12N21W34N001S	Wheeler Ridge-Maricopa Water Storage District	350772N1191178W001	KGA GSA
A-160	32S26E36P002M	Wheeler Ridge-Maricopa Water Storage District	350947N1191370W001	KGA GSA
A-161	32S26E24K001M	Wheeler Ridge-Maricopa Water Storage District	351304N1191366W001	KGA GSA
A-162	11N22W01D001S	Wheeler Ridge-Maricopa Water Storage District	350750N1191892W001	KGA GSA
A-163	11N21W16E001S	Wheeler Ridge-Maricopa Water Storage District	350428N1191355W001	KGA GSA
A-164	RMW-017	Kern River GSA	354206N1191817W001	Kern River GSA
A-165	RMW-018	Kern River GSA	354344N1191337W001	Kern River GSA
A-166	RMW-019	Kern River GSA	354199N1190931W001	Kern River GSA
A-167	RMW-020	Kern River GSA	354048N1190102W001	Kern River GSA
A-168	RMW-021	Kern River GSA	353898N1190087W001	Kern River GSA
A-169	RMW-025	Kern River GSA	353539N1191118W001	Kern River GSA
A-170	RMW-026	Kern River GSA	353512N1189673W001	Kern River GSA
A-171	RMW-028	Kern River GSA	353508N1191723W001	Kern River GSA
A-172	RMW-029	Kern River GSA	353247N1191870W001	Kern River GSA
A-173	RMW-030	Kern River GSA	353328N1189409W001	Kern River GSA
A-174	RMW-031	Kern River GSA	352964N1191741W003	Kern River GSA
A-175	RMW-032	Kern River GSA	352953N1191285W001	Kern River GSA

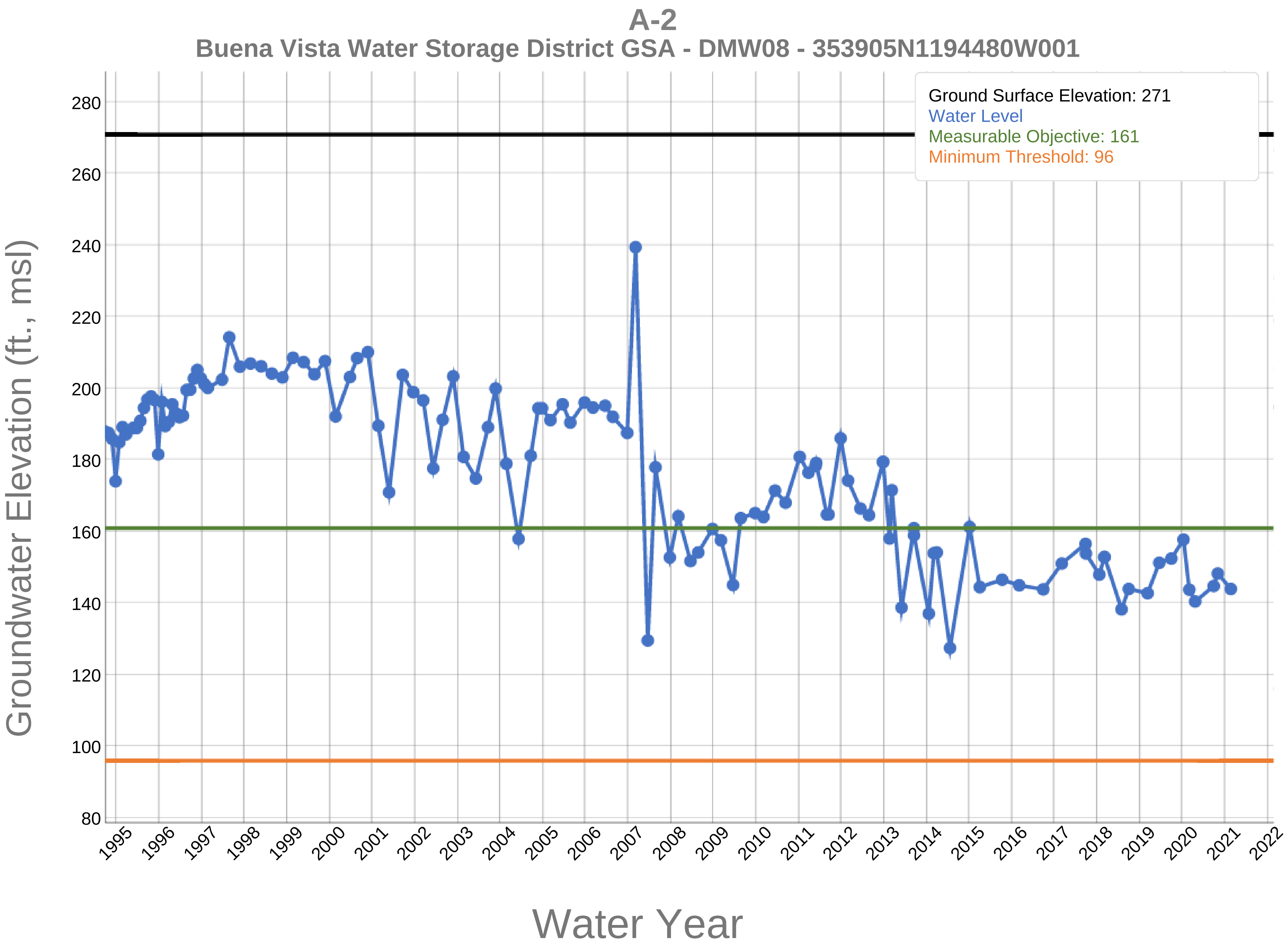
Table A-1 – Identification information for GSP Representative Monitoring Well hydrographs for DWR Basin 5-022-14 (Kern County Subbasin). Graph ID is shown on Figure 5 showing the well location.

Graph ID	Well Name	Reporting Agency	DWR Master Site Code	GSA
A-176	RMW-034	Kern River GSA	352747N1189435W001	Kern River GSA
A-177	RMW-35R	Kern River GSA	352450N1191640W001	Kern River GSA
A-178	RMW-037	Kern River GSA	352269N1191923W001	Kern River GSA
A-179	RMW-038	Kern River GSA	352233N1191281W001	Kern River GSA
A-180	RMW-040	Kern River GSA	352083N1190362W001	Kern River GSA
A-181	RMW-041	Kern River GSA	352027N1188996W001	Kern River GSA
A-182	RMW-042	Kern River GSA	351922N1192052W001	Kern River GSA
A-183	RMW-192	Kern River GSA	352220N1190000W001	Kern River GSA
A-184	RMW-193	Kern River GSA	352080N1188710W001	Kern River GSA
A-185	RMW-195	Kern River GSA	352510N1191160W001	Kern River GSA
A-186	RMW-196	Kern River GSA	352410N1190280W001	Kern River GSA
A-187	RMW-197	Kern River GSA	351656N1189234W001	Kern River GSA
A-188	RMW-200	Kern River GSA	351541N1191289W001	Kern River GSA
A-189	RMW-201	Kern River GSA	353941N1191043W001	Kern River GSA
A-190	RMW-202	Kern River GSA	352662N1190015W001	Kern River GSA
A-191	RMW-209	Kern River GSA	354226N1190748W001	Kern River GSA
A-192	RMW-210	Kern River GSA	353907N1189752W001	Kern River GSA
A-193	RMW-211	Kern River GSA	353681N1190101W001	Kern River GSA
A-194	RMW-212	Kern River GSA	353618N1189334W001	Kern River GSA
A-195	RMW-213	Kern River GSA	353536N1190539W001	Kern River GSA
A-196	RMW-214	Kern River GSA	353286N1190221W001	Kern River GSA
A-197	RMW-215	Kern River GSA	353325N1190016W001	Kern River GSA
A-198	RMW-216	Kern River GSA	352924N1189911W001	Kern River GSA
A-199	RMW-217	Kern River GSA	352800N1189080W001	Kern River GSA
A-200	RMW-218	Kern River GSA	351867N1190820W001	Kern River GSA
A-201	RMW-219	Kern River GSA	352389N1189485W001	Kern River GSA
A-202	Canyon View Ranch	Olcese Water District	354386N1188035W002	Olcese GSA
A-203	Well #4	Olcese Water District	354310N1188411W002	Olcese GSA

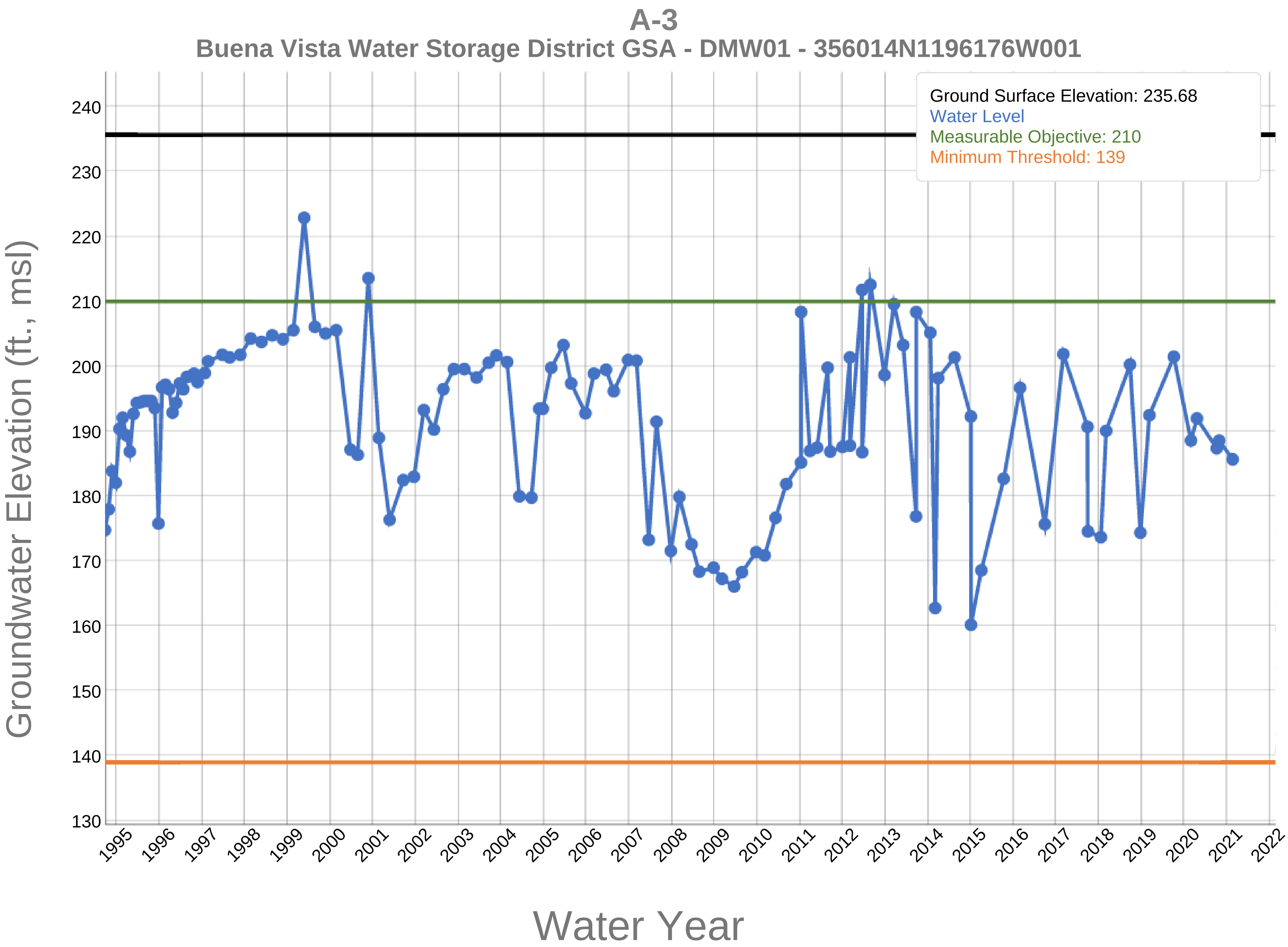
A-1

Buena Vista Water Storage District GSA - DMW07 - 354021N1195011W001





A-2
Buena Vista Water Storage District GSA - DMW08 - 353905N1194480W001
Ground Surface Elevation: 271
Water Level
Measurable Objective: 161
Minimum Threshold: 96
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
100
80
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Water Year


A-3
Buena Vista Water Storage District GSA - DMW01 - 356014N1196176W001
Ground Surface Elevation: 235.68
Water Level
Measurable Objective: 210
Minimum Threshold: 139
Groundwater Elevation (ft., msl)
Water Year
240
230
220
210
200
190
180
170
160
150
140
130
1995
1996
1997
1998
1999
2000
2001
2002
2003
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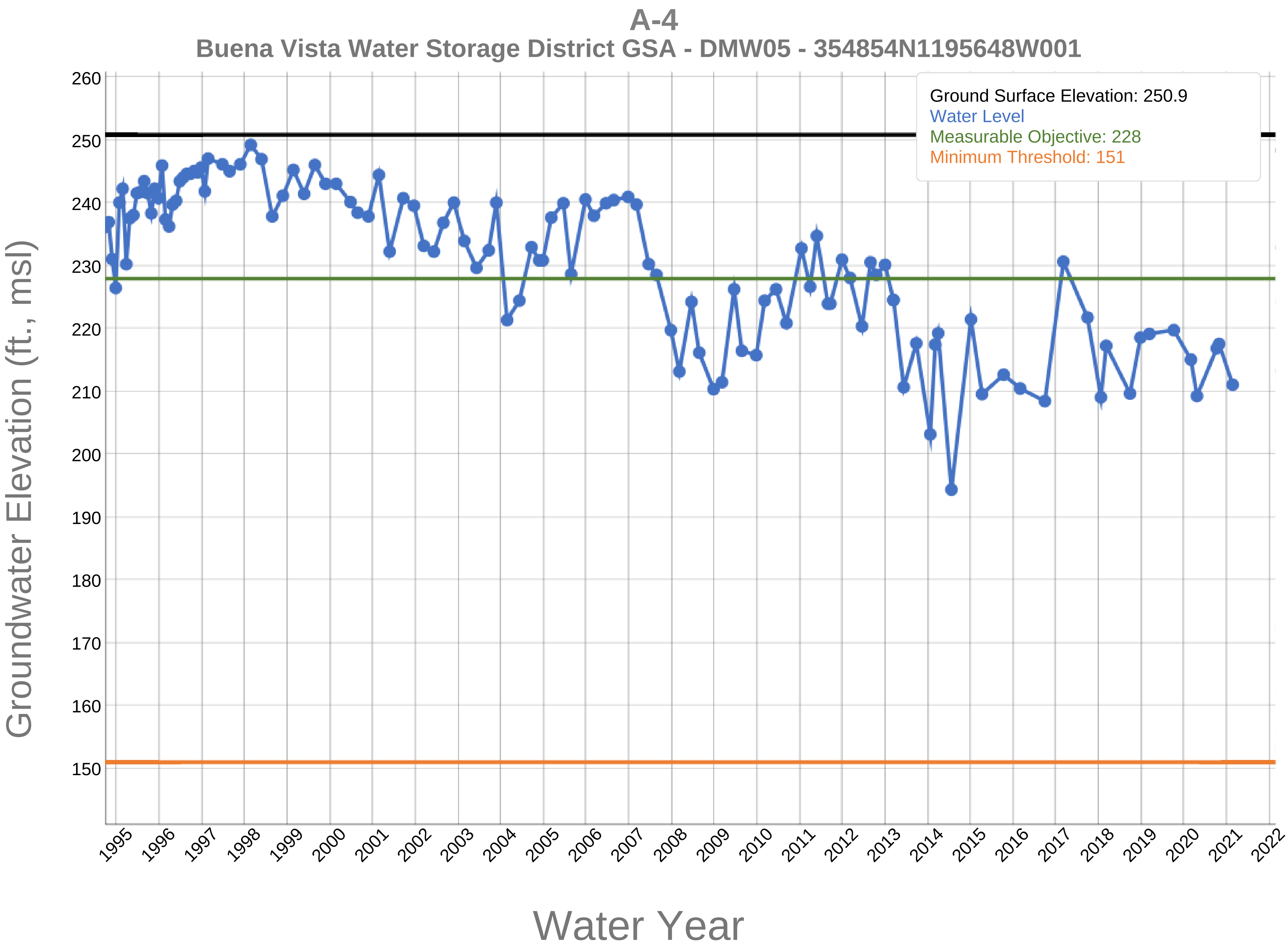
2021
2022


A-4
Buena Vista Water Storage District GSA - DMW05 - 354854N1195648W001
Ground Surface Elevation: 250.9
Water Level
Measurable Objective: 228
Minimum Threshold: 151
Groundwater Elevation (ft., msl)
260
250
240
230
220
210
200
190
180
170
160
150
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
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2009
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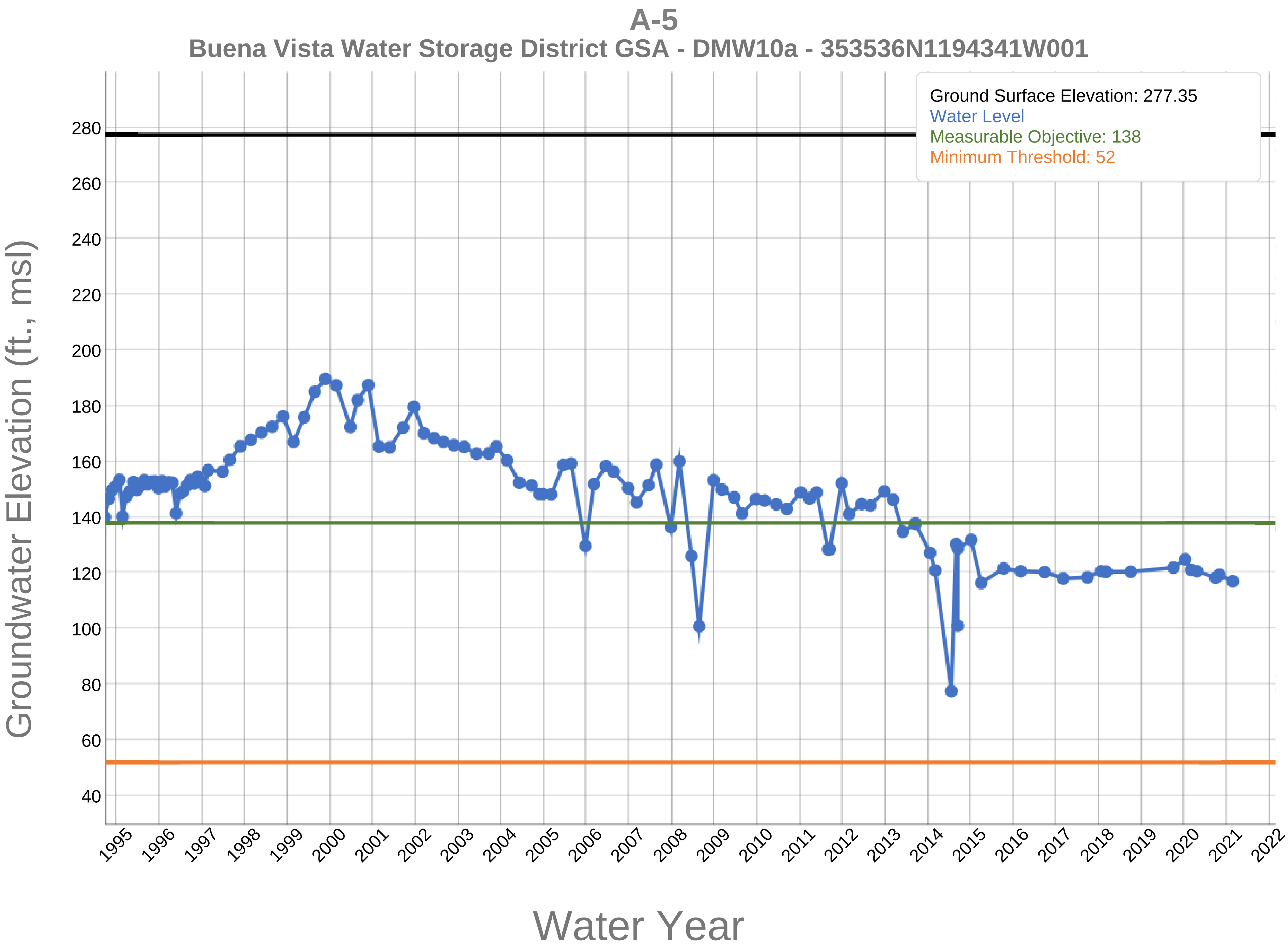
2019
2020
2021
2022
Water Year



A-5
Buena Vista Water Storage District GSA - DMW10a - 353536N1194341W001
Ground Surface Elevation: 277.35
Water Level
Measurable Objective: 138
Minimum Threshold: 52
Groundwater Elevation (ft., msl)
280
260
240
220
200
180
160
140
120
100
80
60
40
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
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2017
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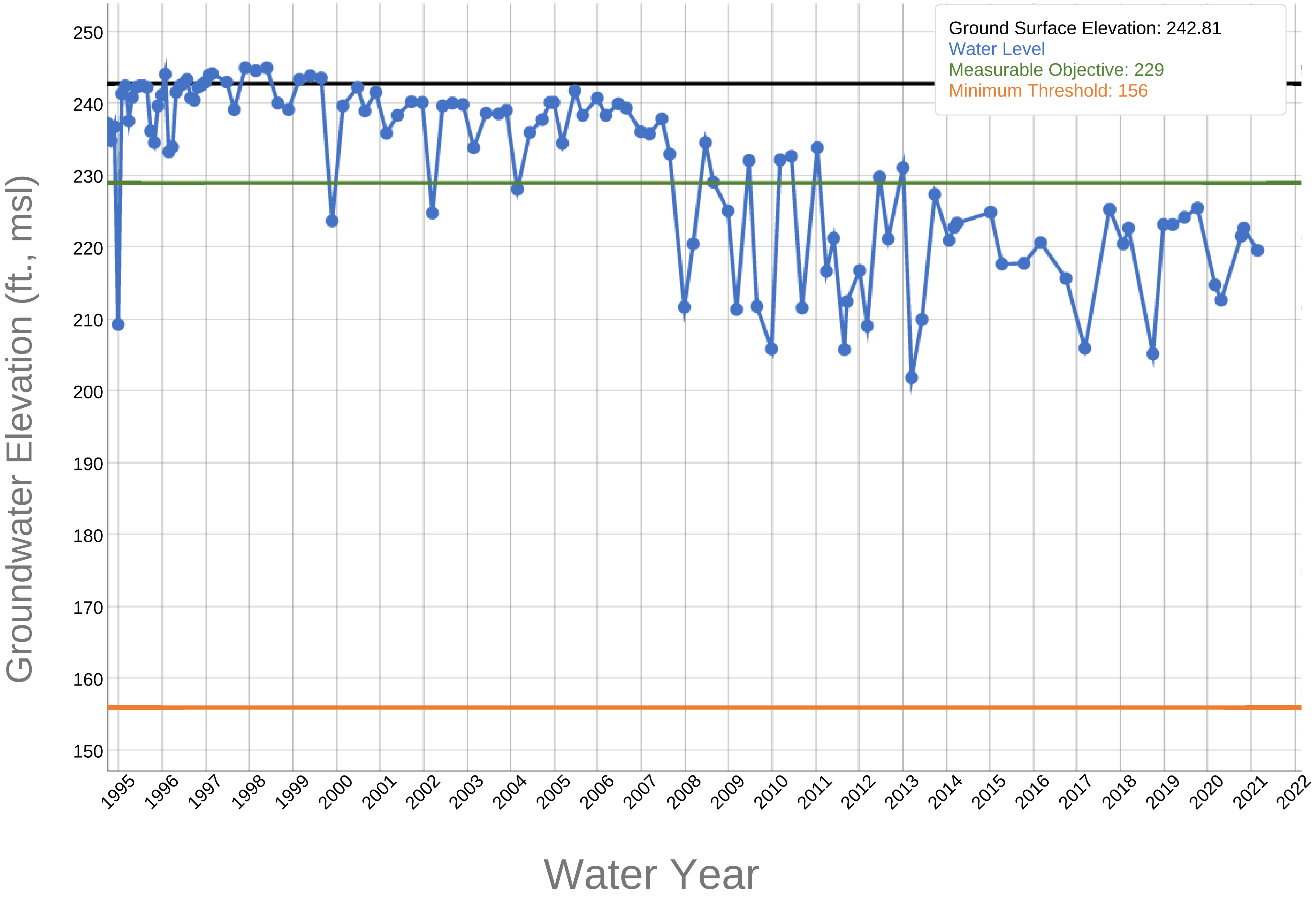
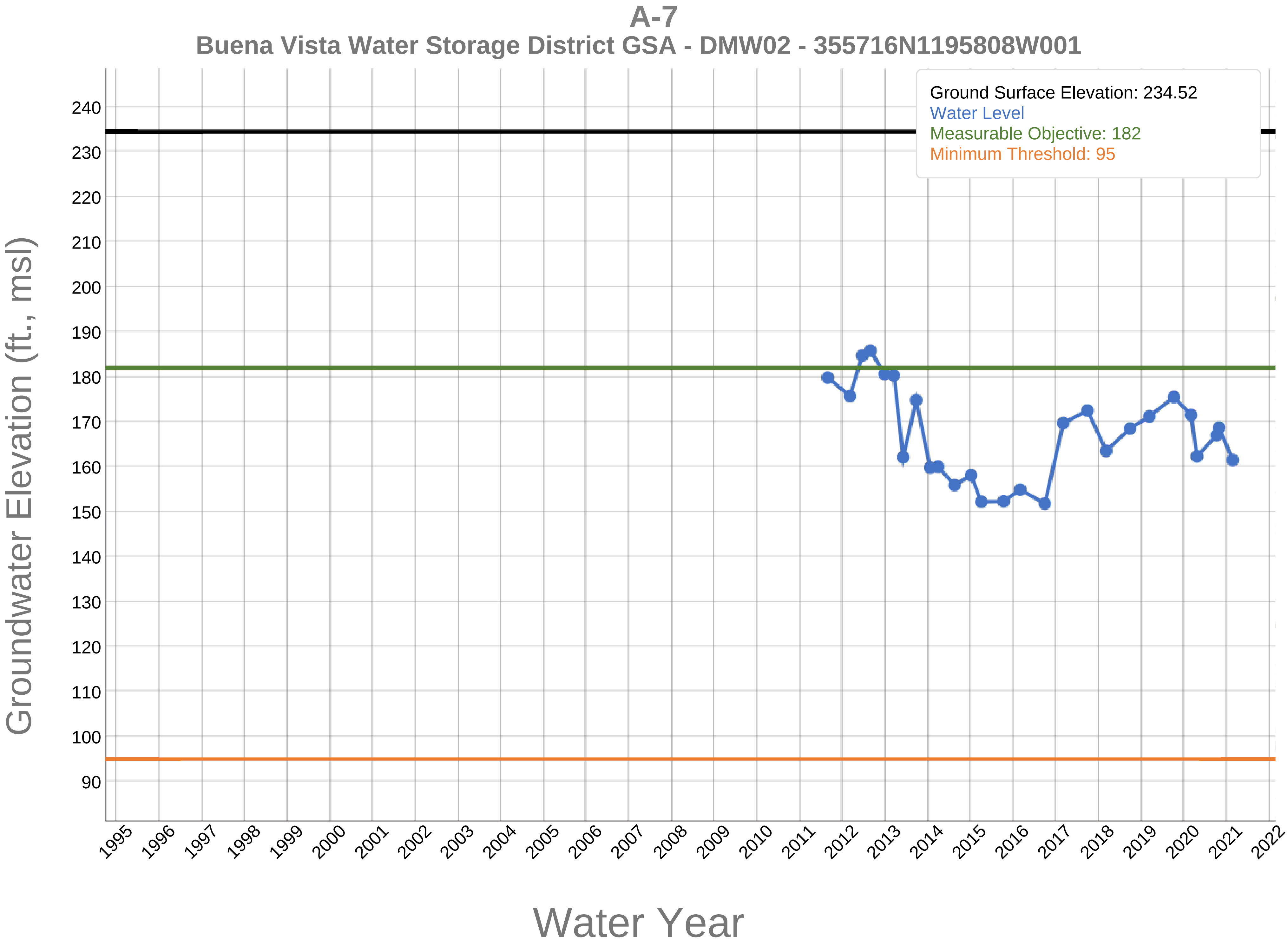
2019
2020
2021
2022
Water Year

A-6

Buena Vista Water Storage District GSA - DMW04 - 355137N1195985W001




A-7
Buena Vista Water Storage District GSA - DMW02 - 355716N1195808W001
Ground Surface Elevation: 234.52
Water Level
Measurable Objective: 182
Minimum Threshold: 95
Groundwater Elevation (ft., msl)
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
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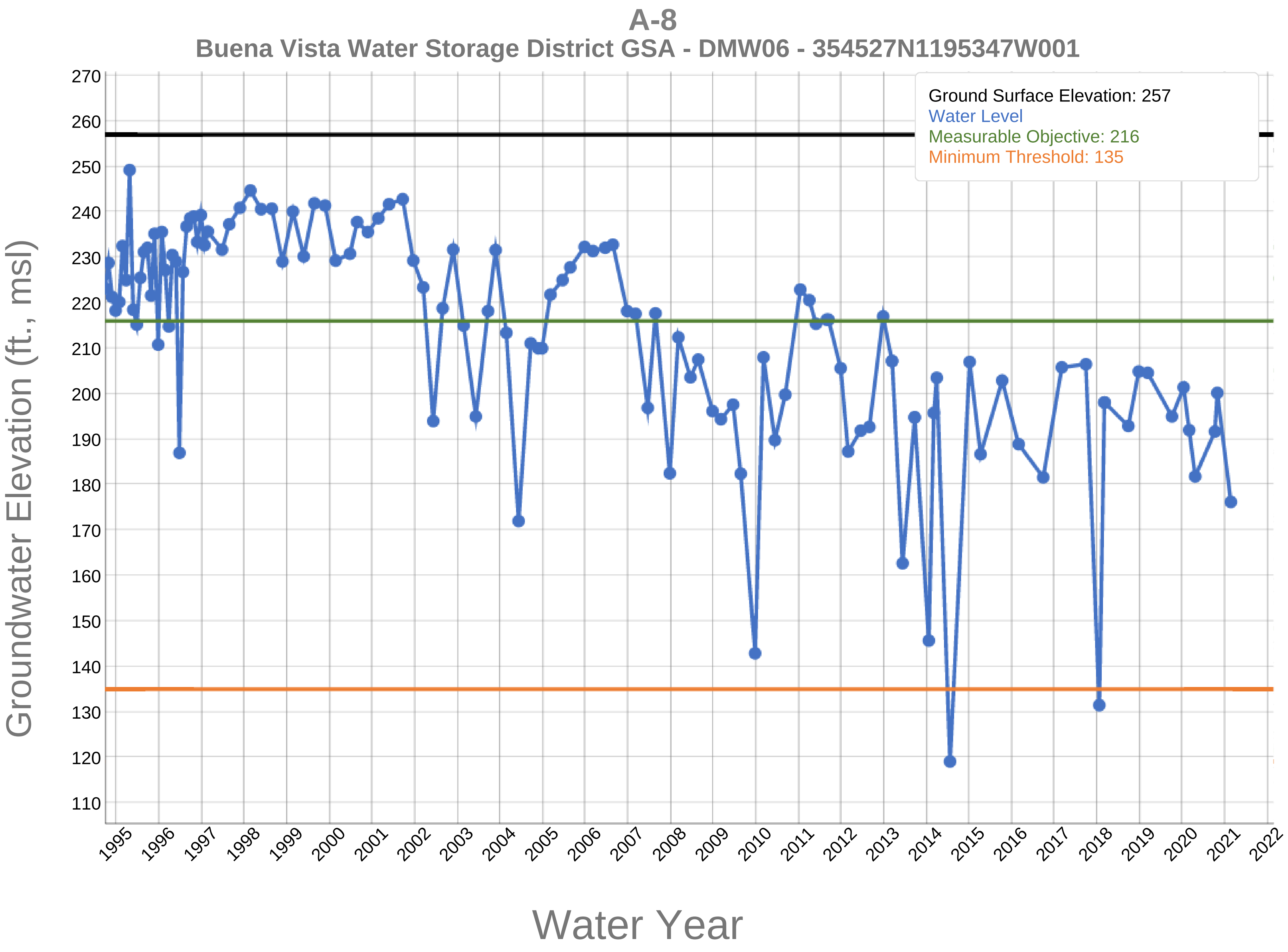
2020
2021
2022
Water Year


A-8
Buena Vista Water Storage District GSA - DMW06 - 354527N1195347W001
Ground Surface Elevation: 257
Water Level
Measurable Objective: 216
Minimum Threshold: 135
Groundwater Elevation (ft., msl)
Water Year
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
1995
1996
1997
1998
1999
2000
2001
2002
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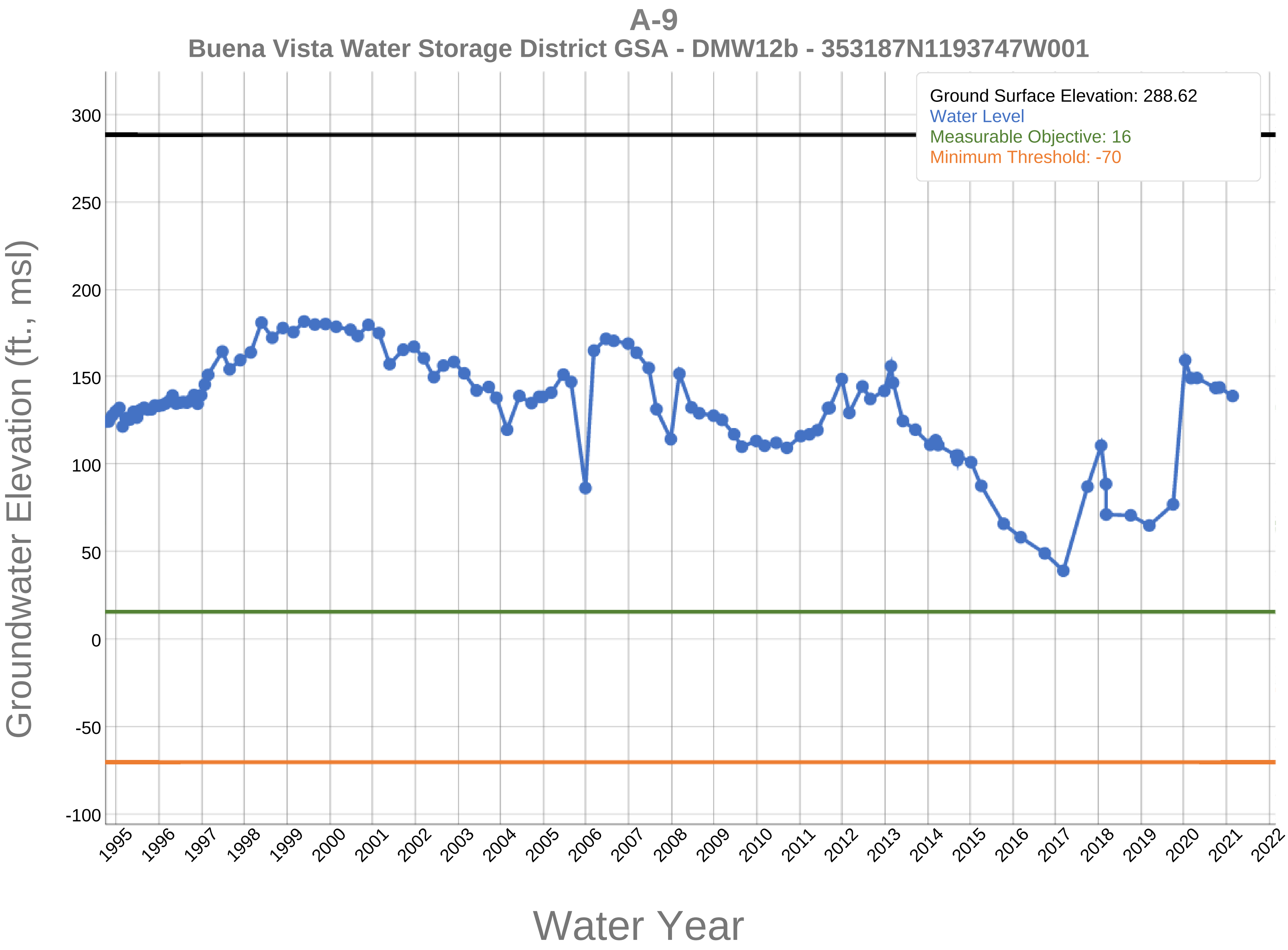
A-9
Buena Vista Water Storage District GSA - DMW12b - 353187N1193747W001
Ground Surface Elevation: 288.62
Water Level
Measurable Objective: 16
Minimum Threshold: -70
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
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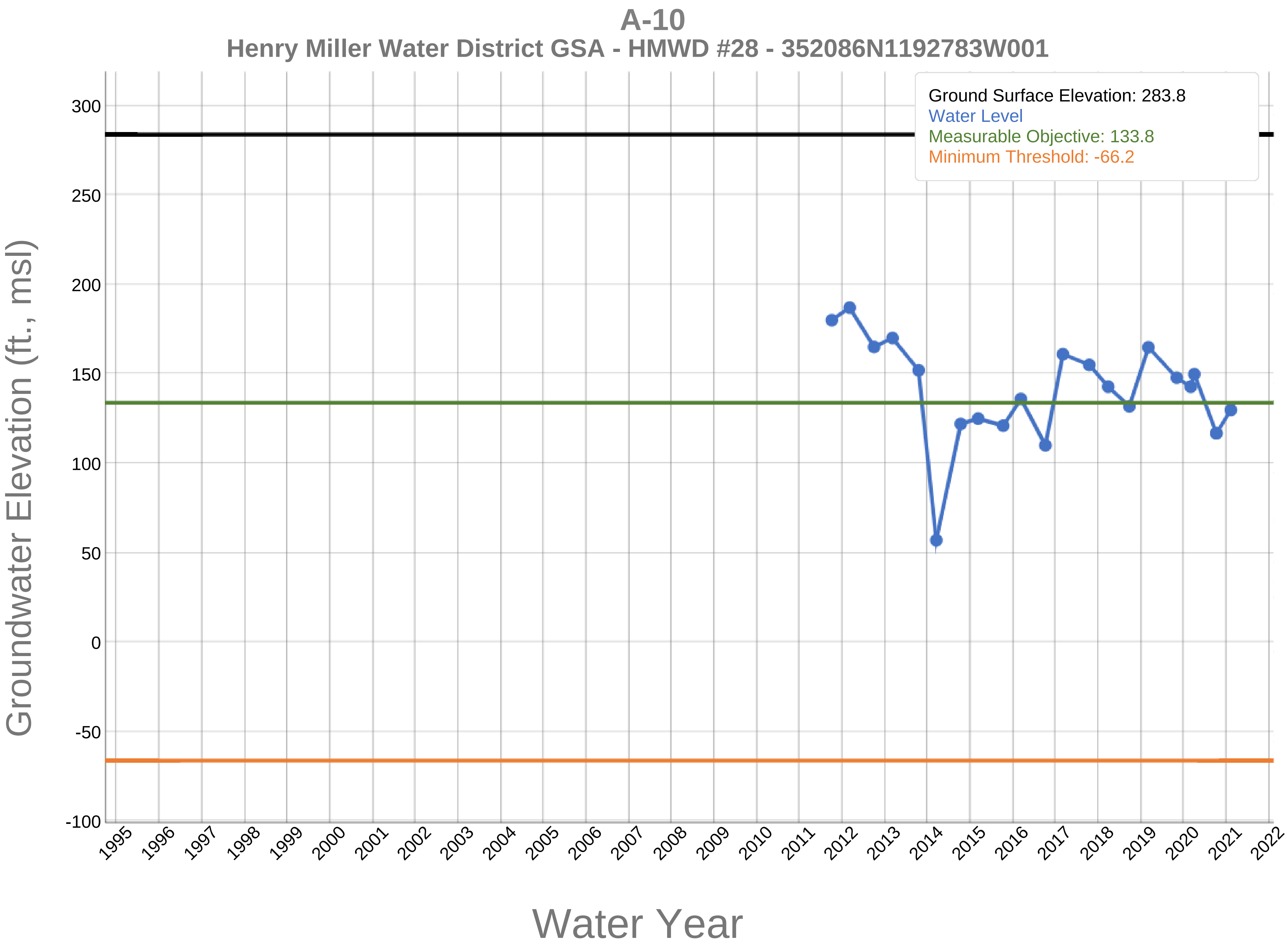
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
Water Year


A-10
Henry Miller Water District GSA - HMWD #28 - 352086N1192783W001
Ground Surface Elevation: 283.8
Water Level
Measurable Objective: 133.8
Minimum Threshold: -66.2
Groundwater Elevation (ft., msl)
Water Year
300
250
200
150
100
50
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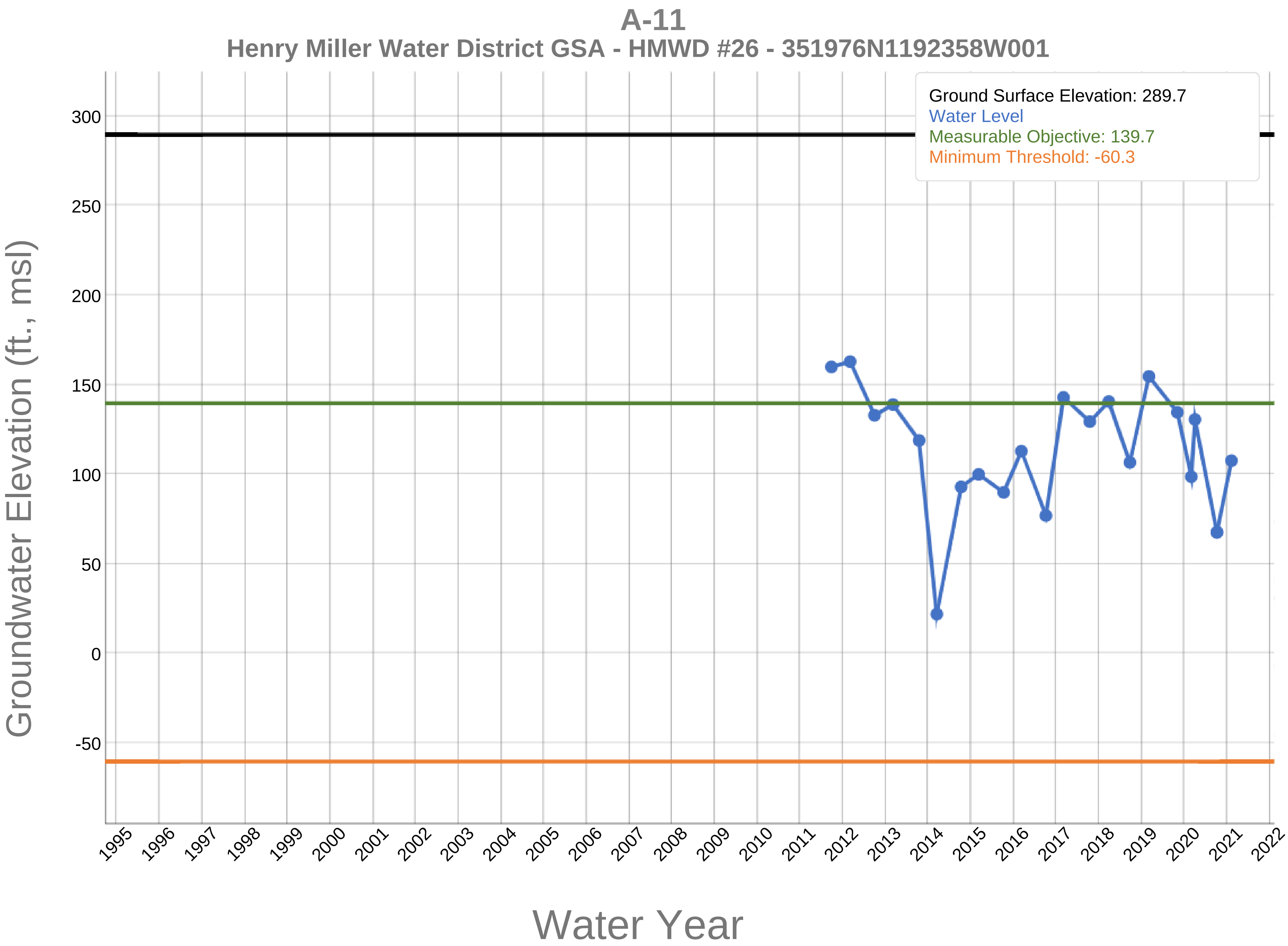
A-11
Henry Miller Water District GSA - HMWD #26 - 351976N1192358W001
Ground Surface Elevation: 289.7
Water Level
Measurable Objective: 139.7
Minimum Threshold: -60.3
Groundwater Elevation (ft., msl)
Water Year
300
250
200
150
100
50
0
-50
1995
1996
1997
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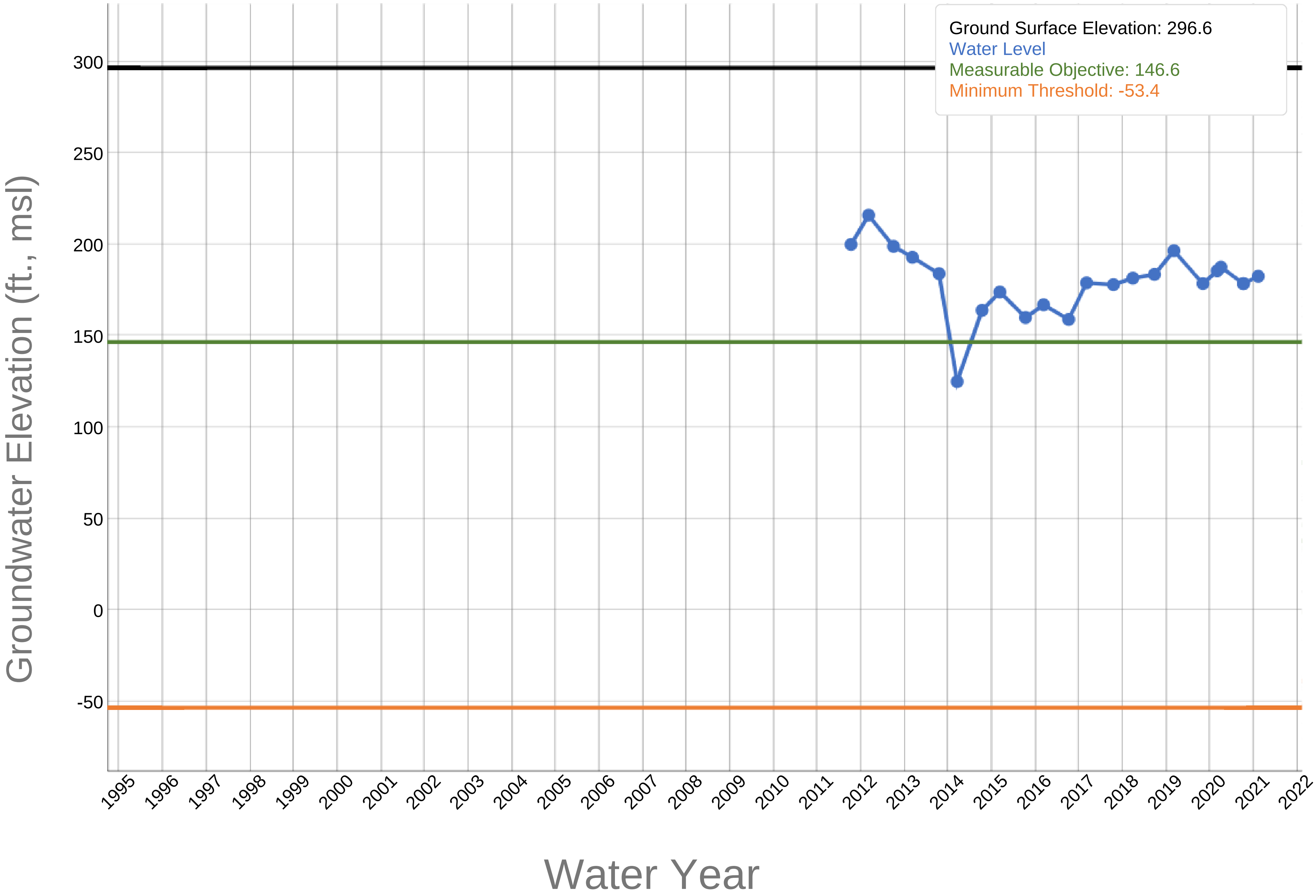
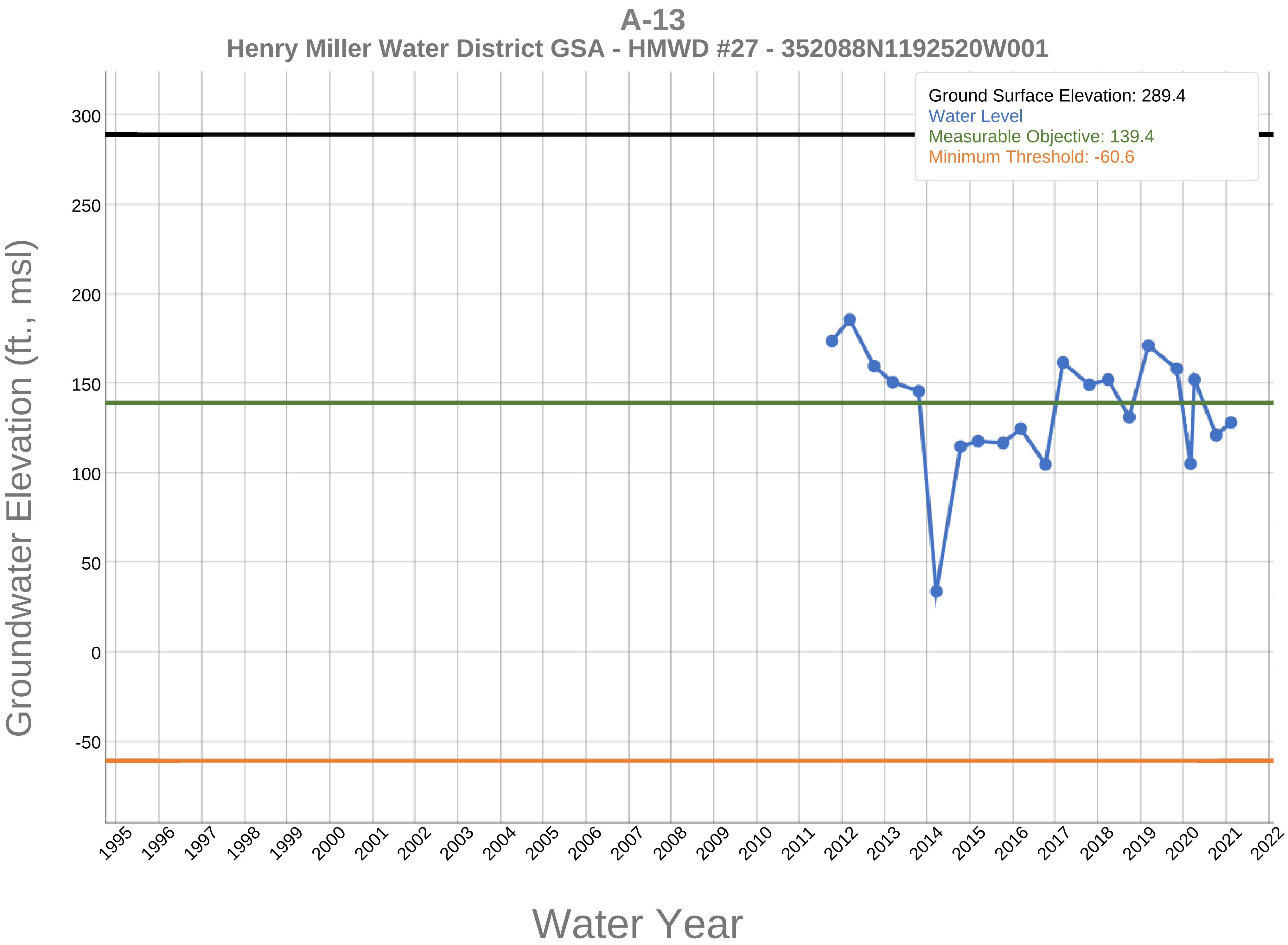
A-12
Henry Miller Water District GSA - HMWD #20 - 352294N1192865W001





A-13
Henry Miller Water District GSA - HMWD #27 - 352088N1192520W001
Ground Surface Elevation: 289.4
Water Level
Measurable Objective: 139.4
Minimum Threshold: -60.6
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
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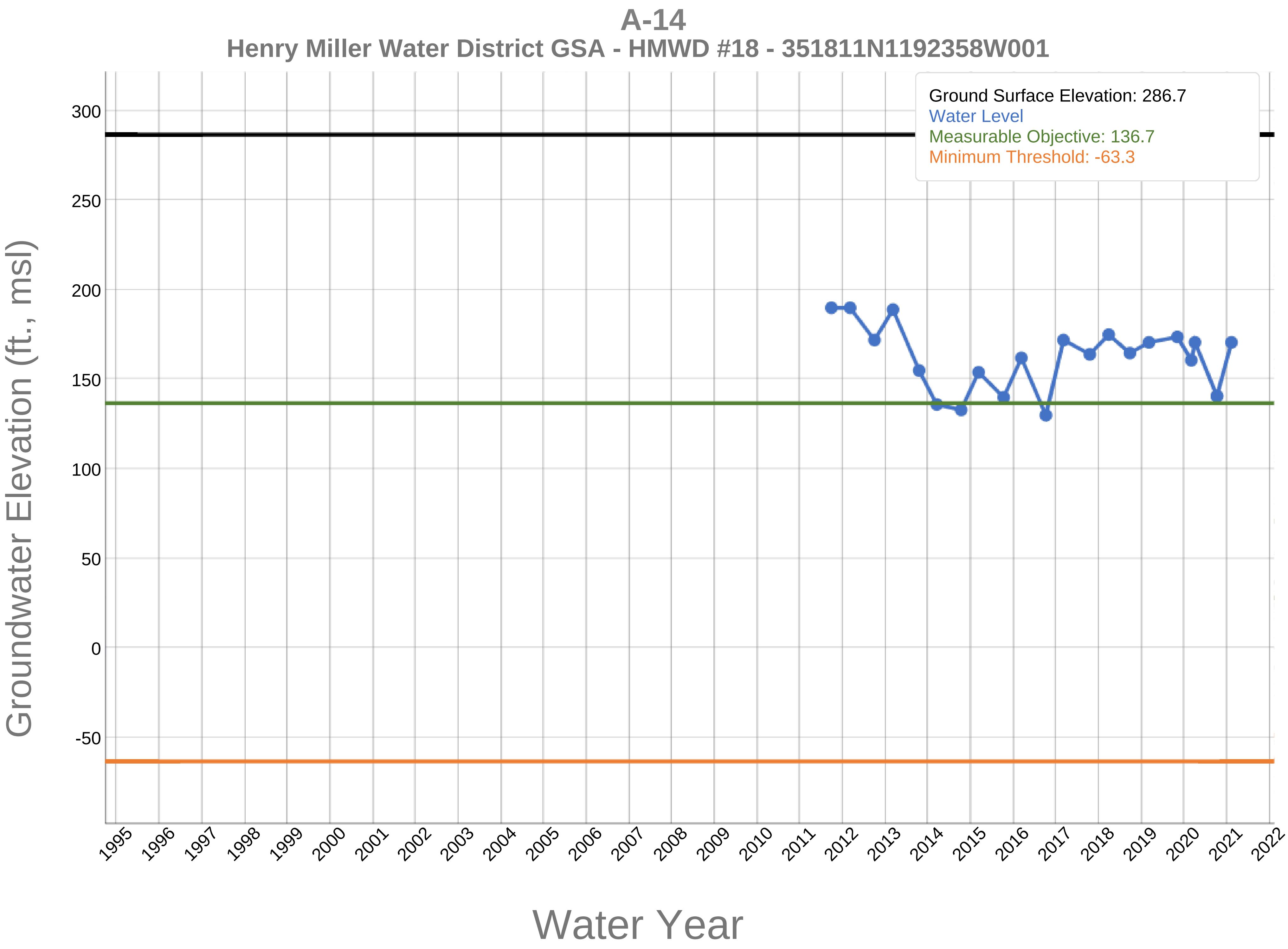
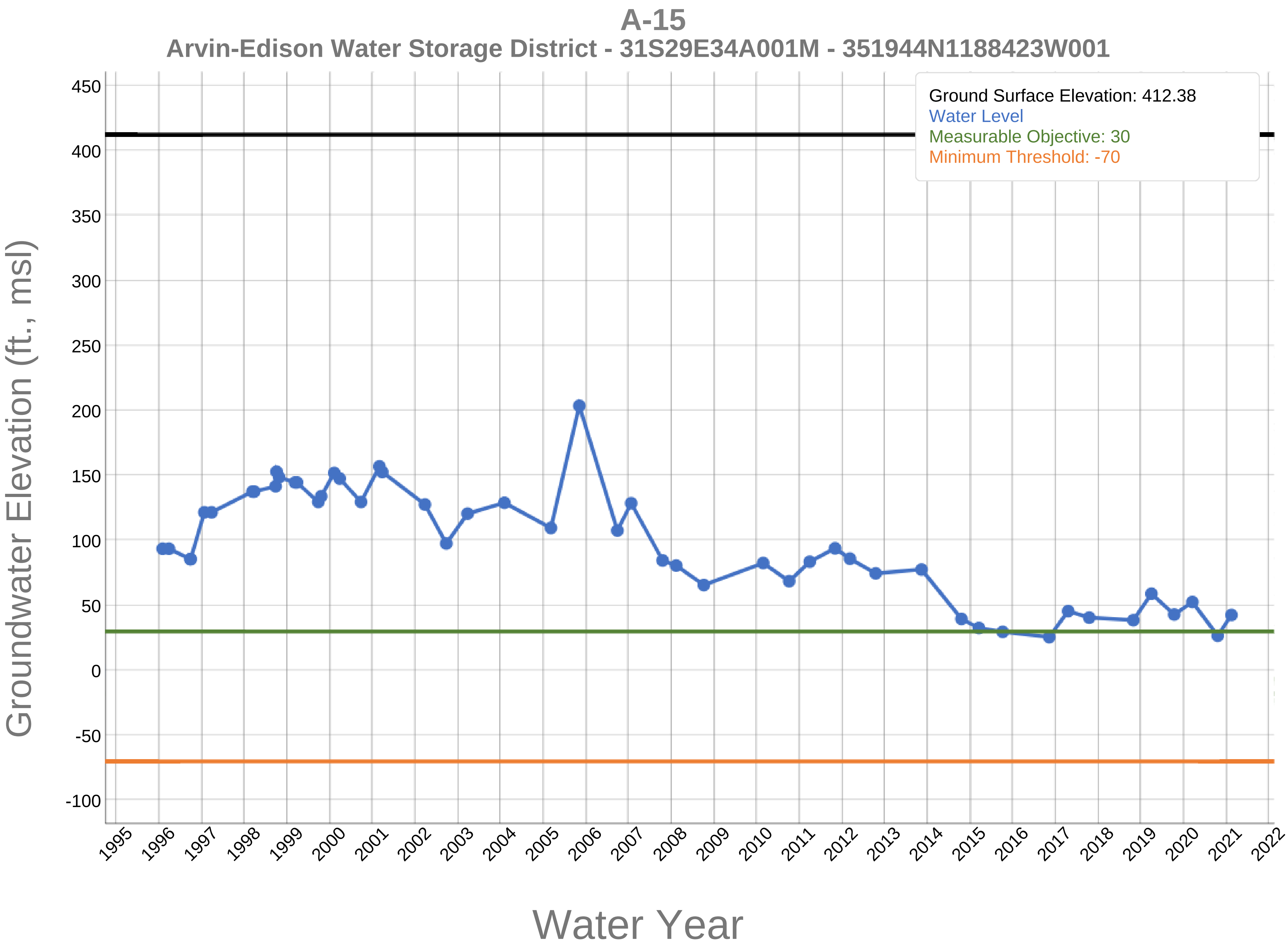
2022
Water Year


A-14
Henry Miller Water District GSA - HMWD #18 - 351811N1192358W001
Ground Surface Elevation: 286.7
Water Level
Measurable Objective: 136.7
Minimum Threshold: -63.3
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Water Year


A-15
Arvin-Edison Water Storage District - 31S29E34A001M - 351944N1188423W001
Ground Surface Elevation: 412.38
Water Level
Measurable Objective: 30
Minimum Threshold: -70
Groundwater Elevation (ft., msl)
Water Year
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
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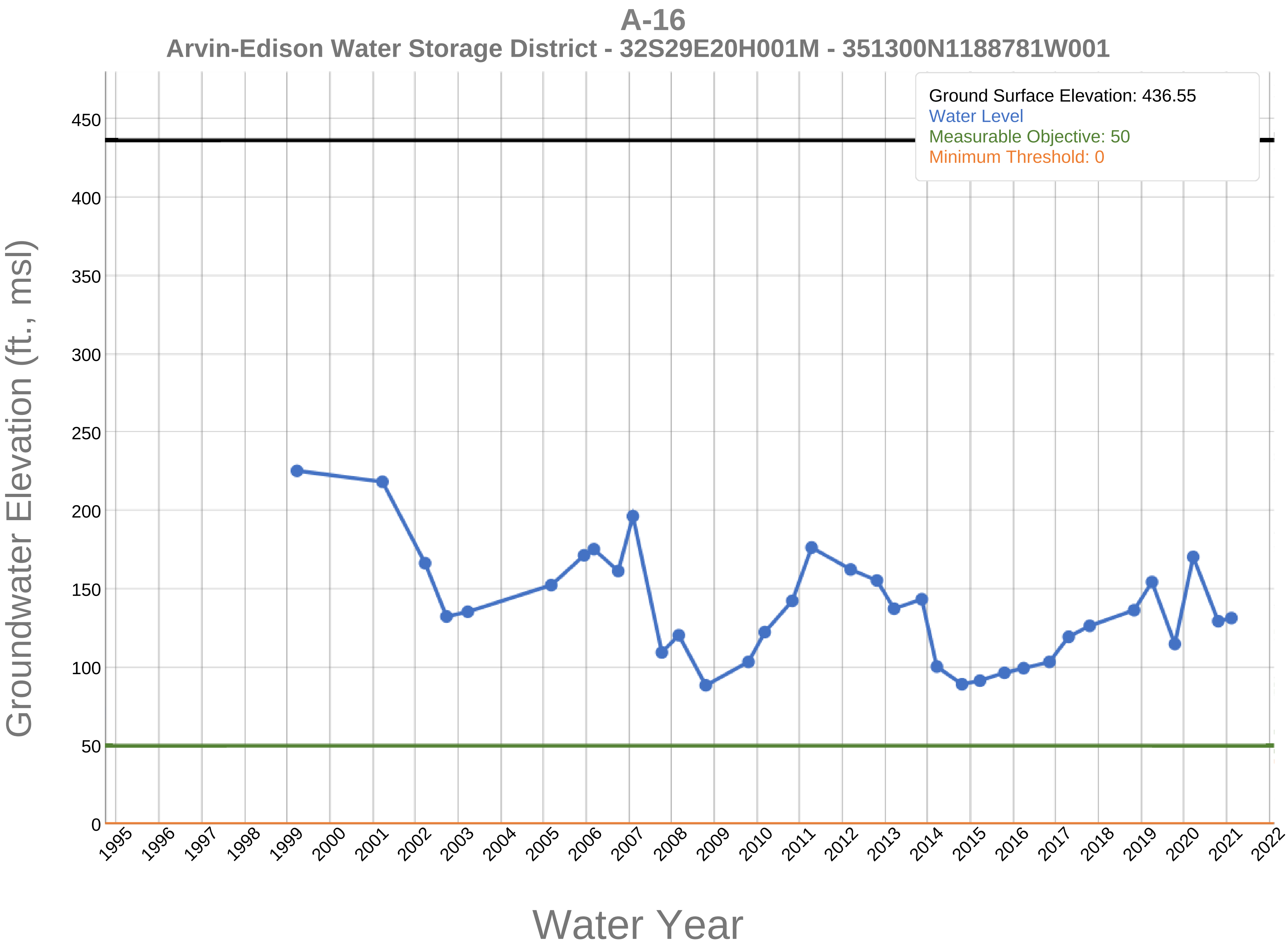
A-16
Arvin-Edison Water Storage District - 32S29E20H001M - 351300N1188781W001
Ground Surface Elevation: 436.55
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
150
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250
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450
1995
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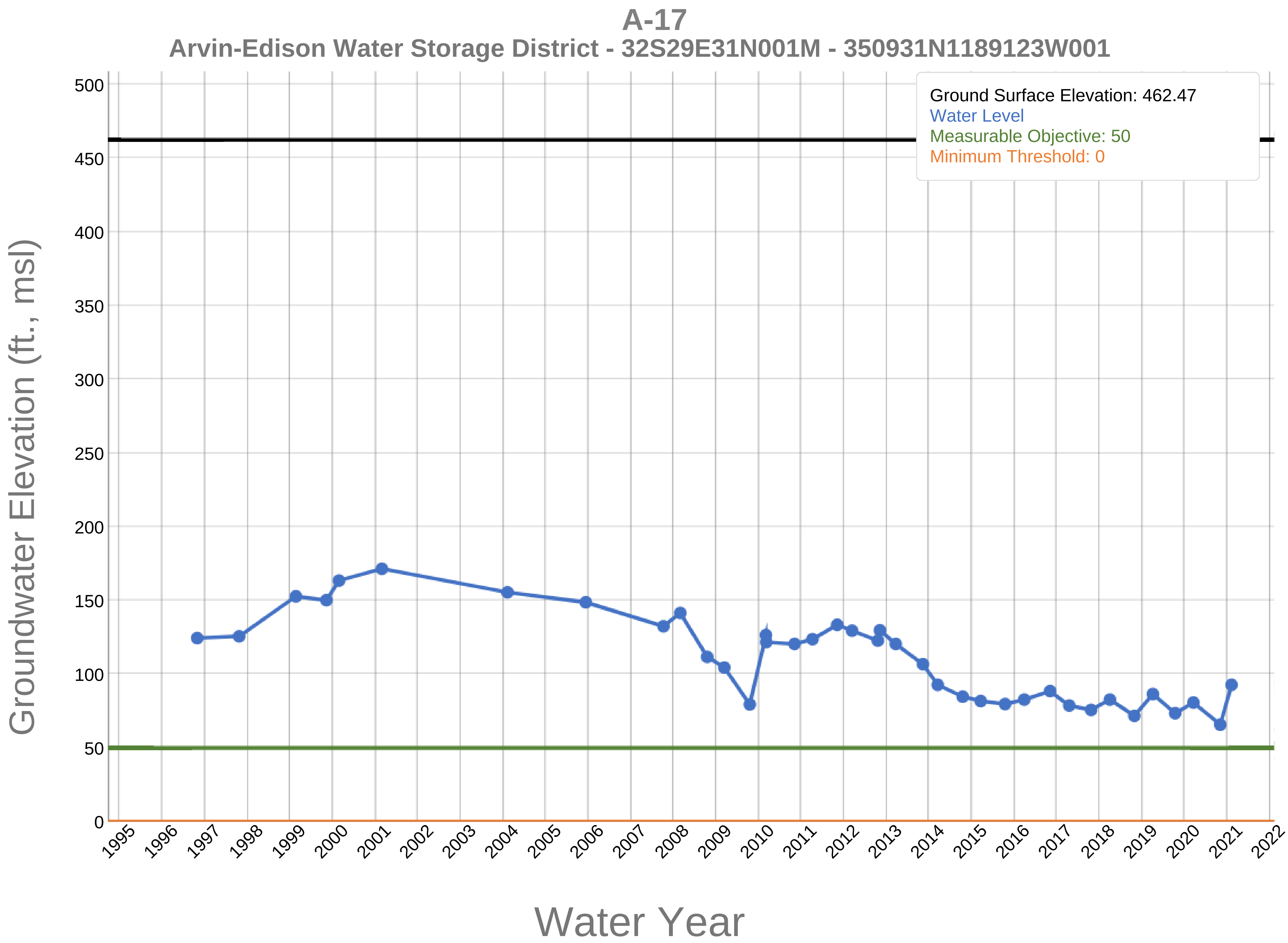
Water Year


A-17
Arvin-Edison Water Storage District - 32S29E31N001M - 350931N1189123W001
Ground Surface Elevation: 462.47
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
50
100
150
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250
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350
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450
500
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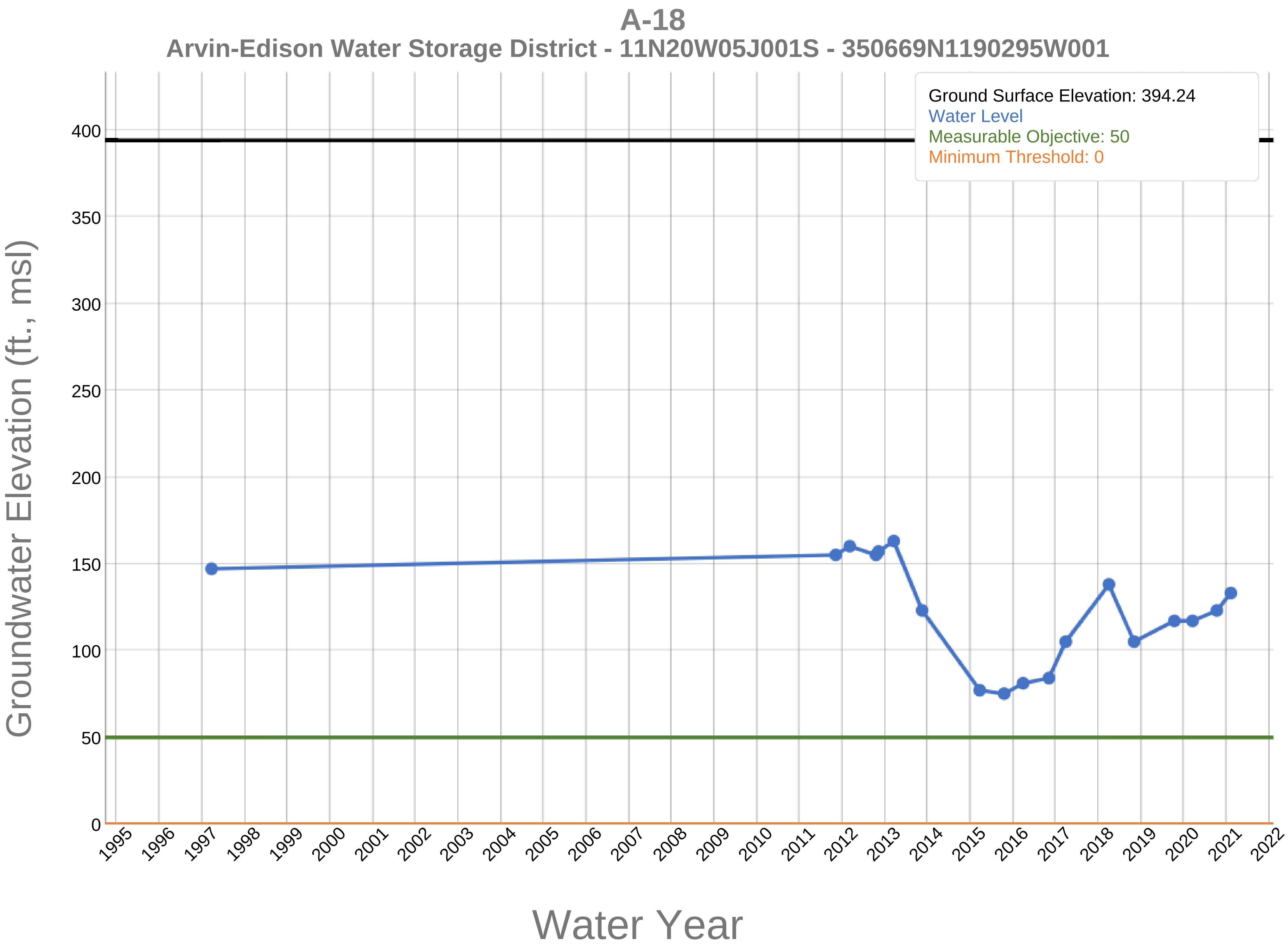
A-18
Arvin-Edison Water Storage District - 11N20W05J001S - 350669N1190295W001
Ground Surface Elevation: 394.24
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
0
50
100
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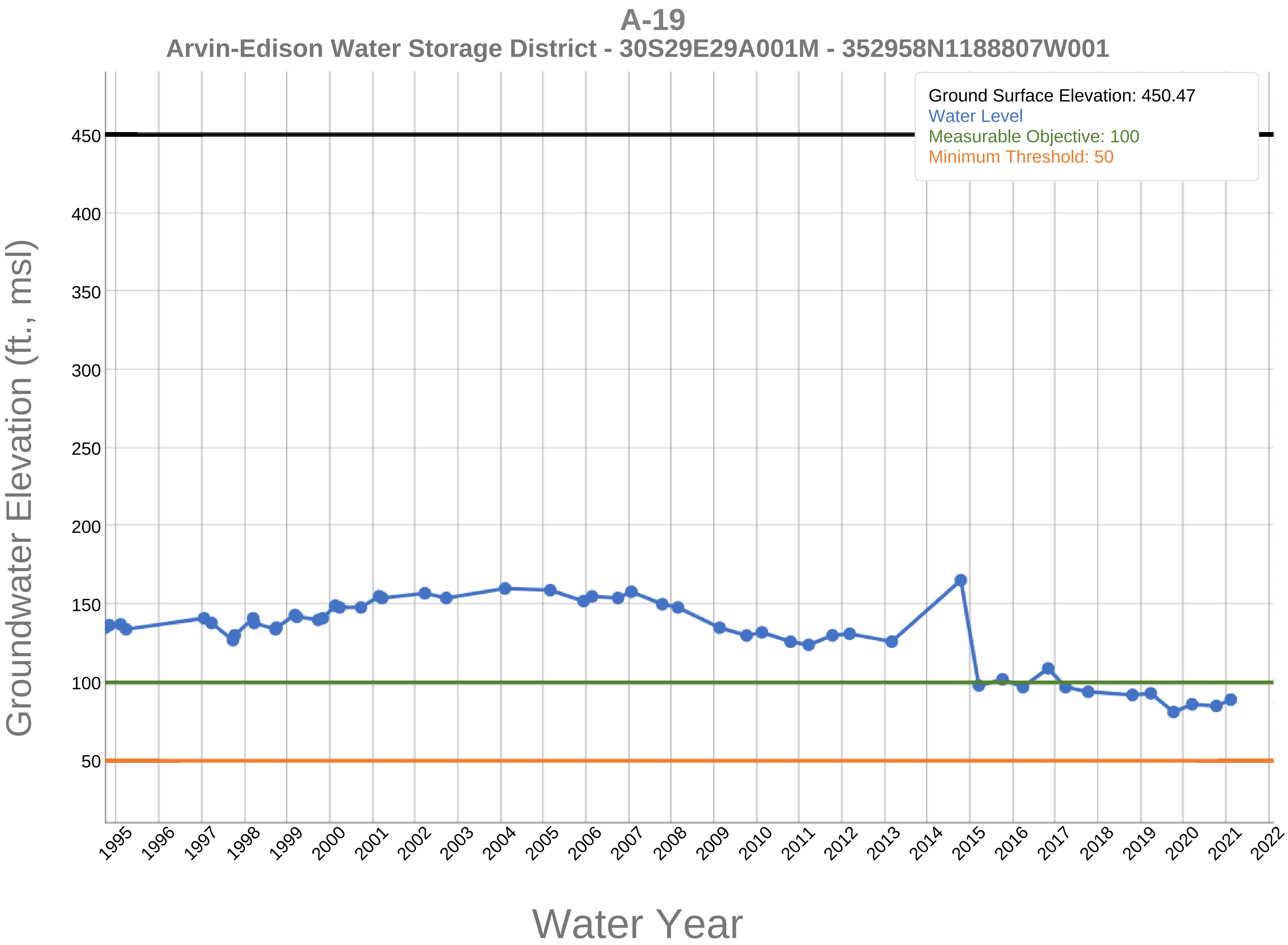
Water Year


A-19
Arvin-Edison Water Storage District - 30S29E29A001M - 352958N1188807W001
Ground Surface Elevation: 450.47
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
450
400
350
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250
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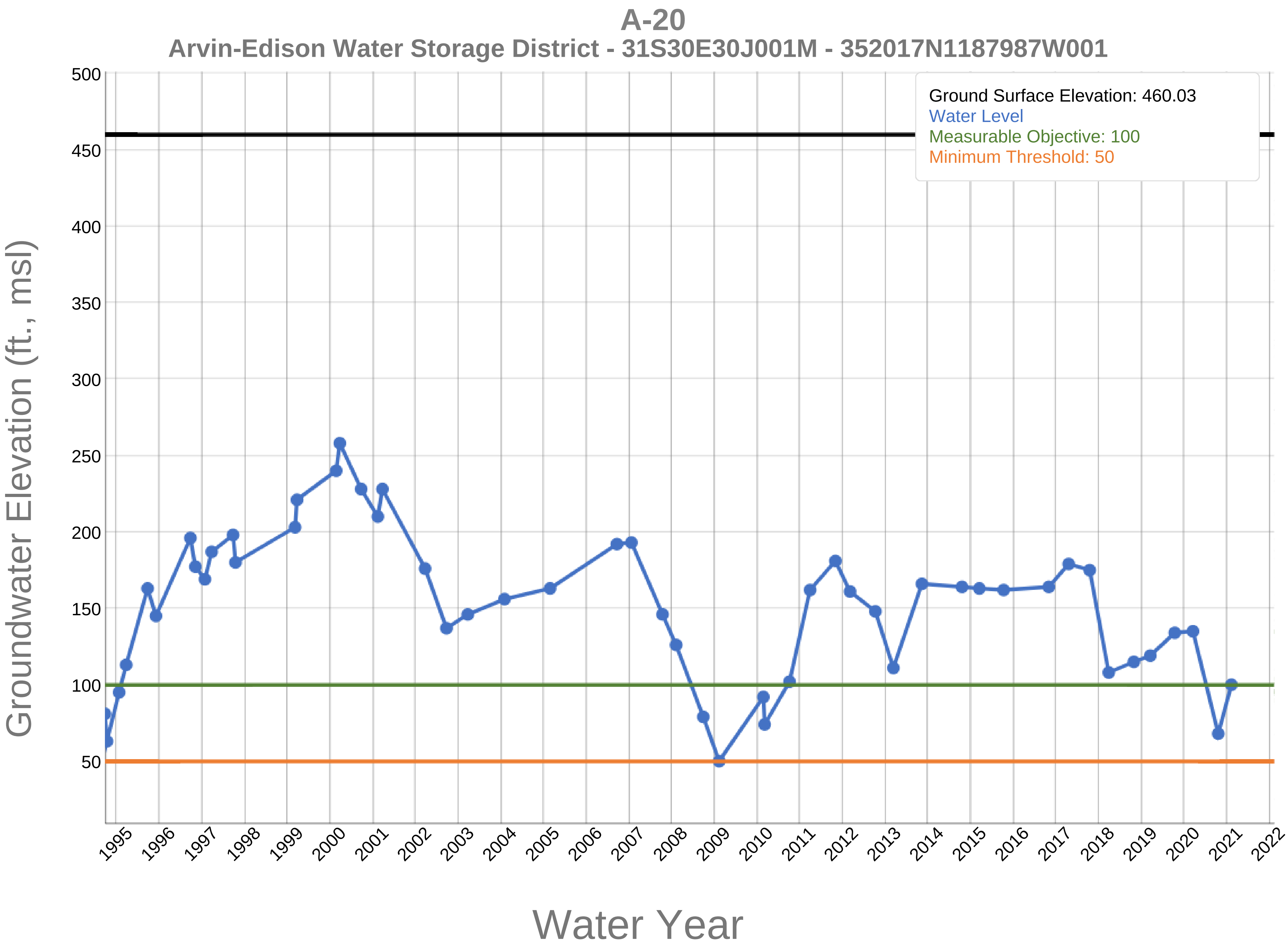
Water Year



A-20
Arvin-Edison Water Storage District - 31S30E30J001M - 352017N1187987W001
Ground Surface Elevation: 460.03
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
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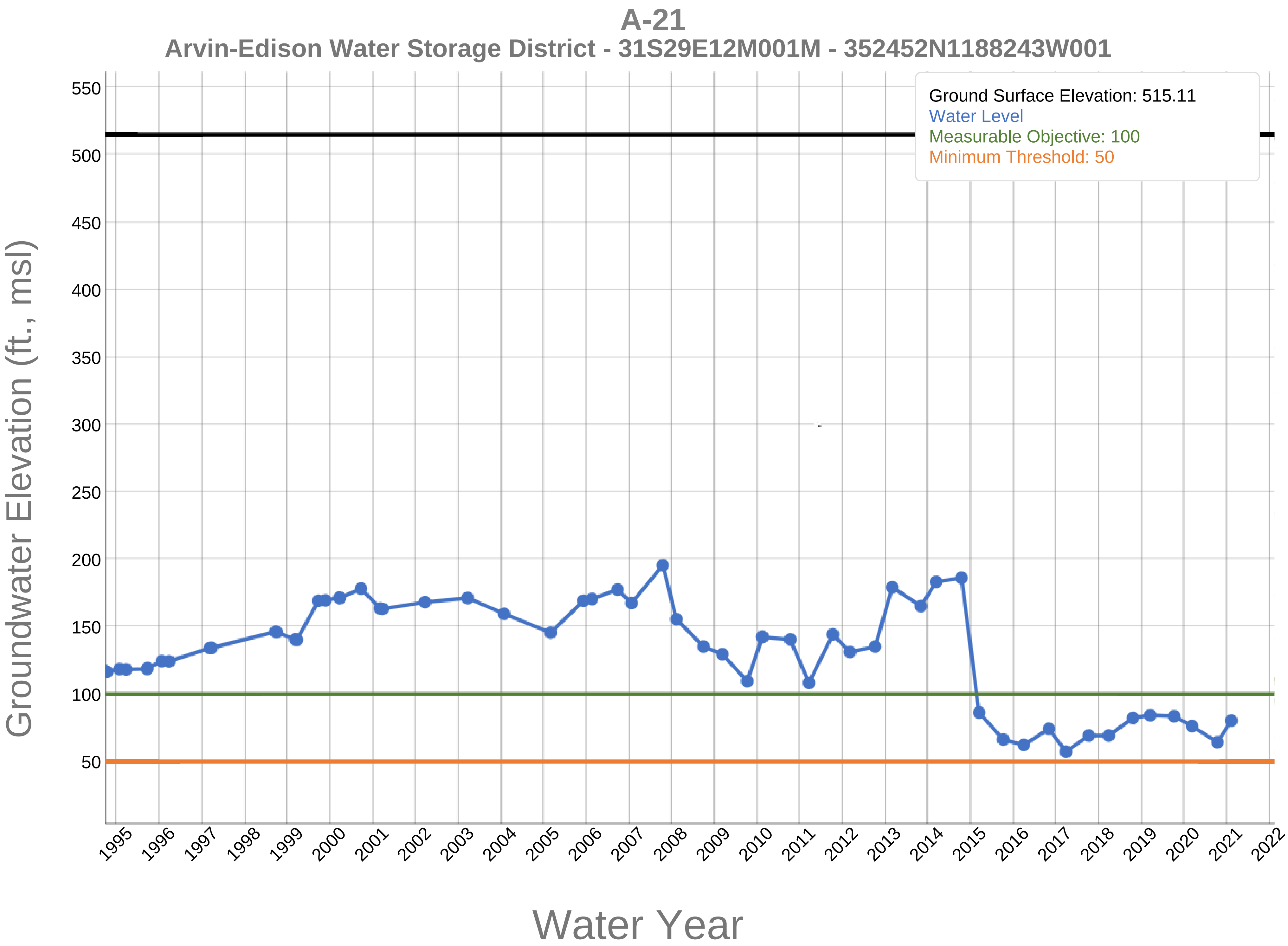
2022
Water Year


A-21
Arvin-Edison Water Storage District - 31S29E12M001M - 352452N1188243W001
Ground Surface Elevation: 515.11
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
550
500
450
400
350
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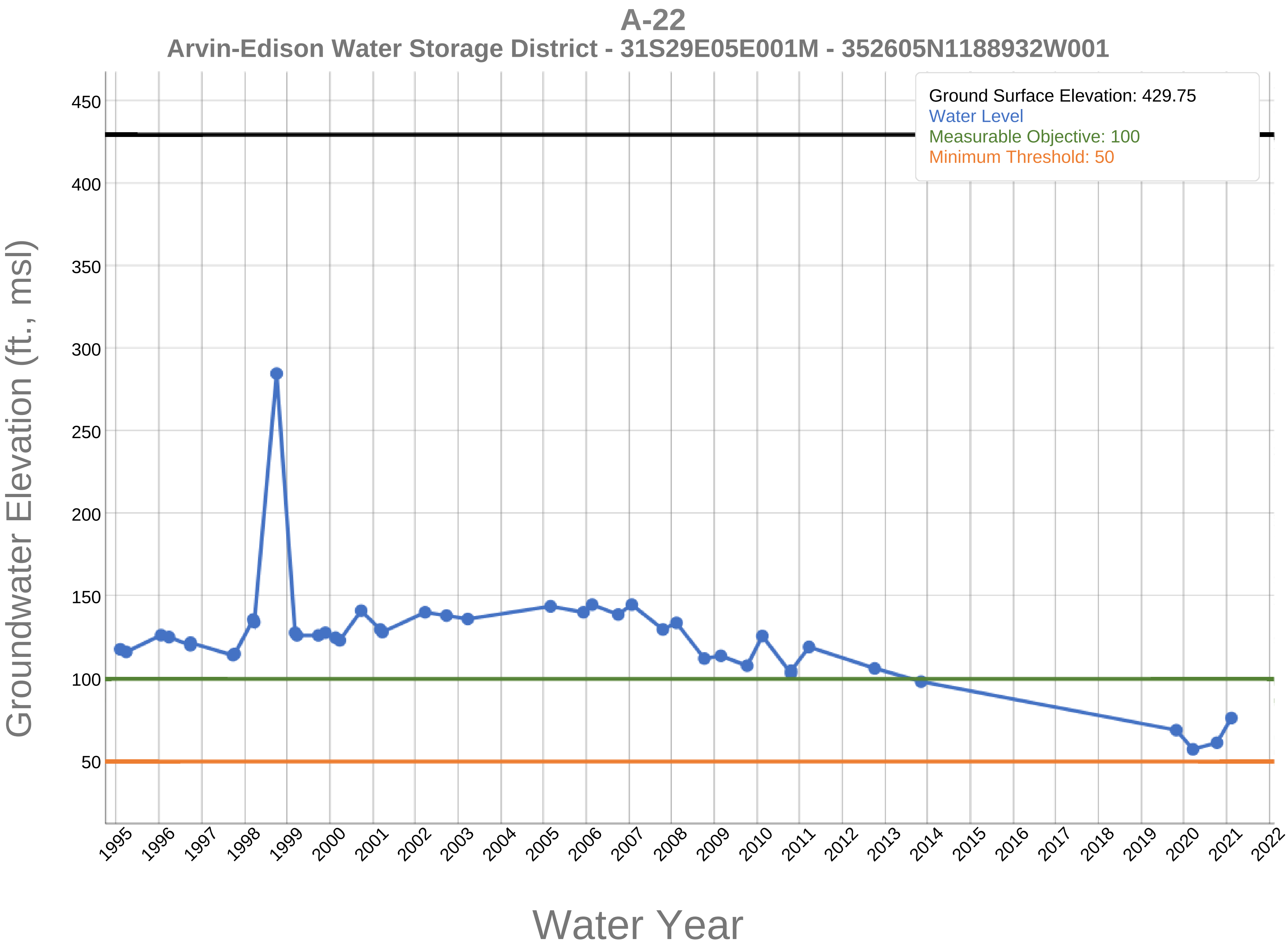
Water Year


A-22
Arvin-Edison Water Storage District - 31S29E05E001M - 352605N1188932W001
Ground Surface Elevation: 429.75
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
Water Year
450
400
350
300
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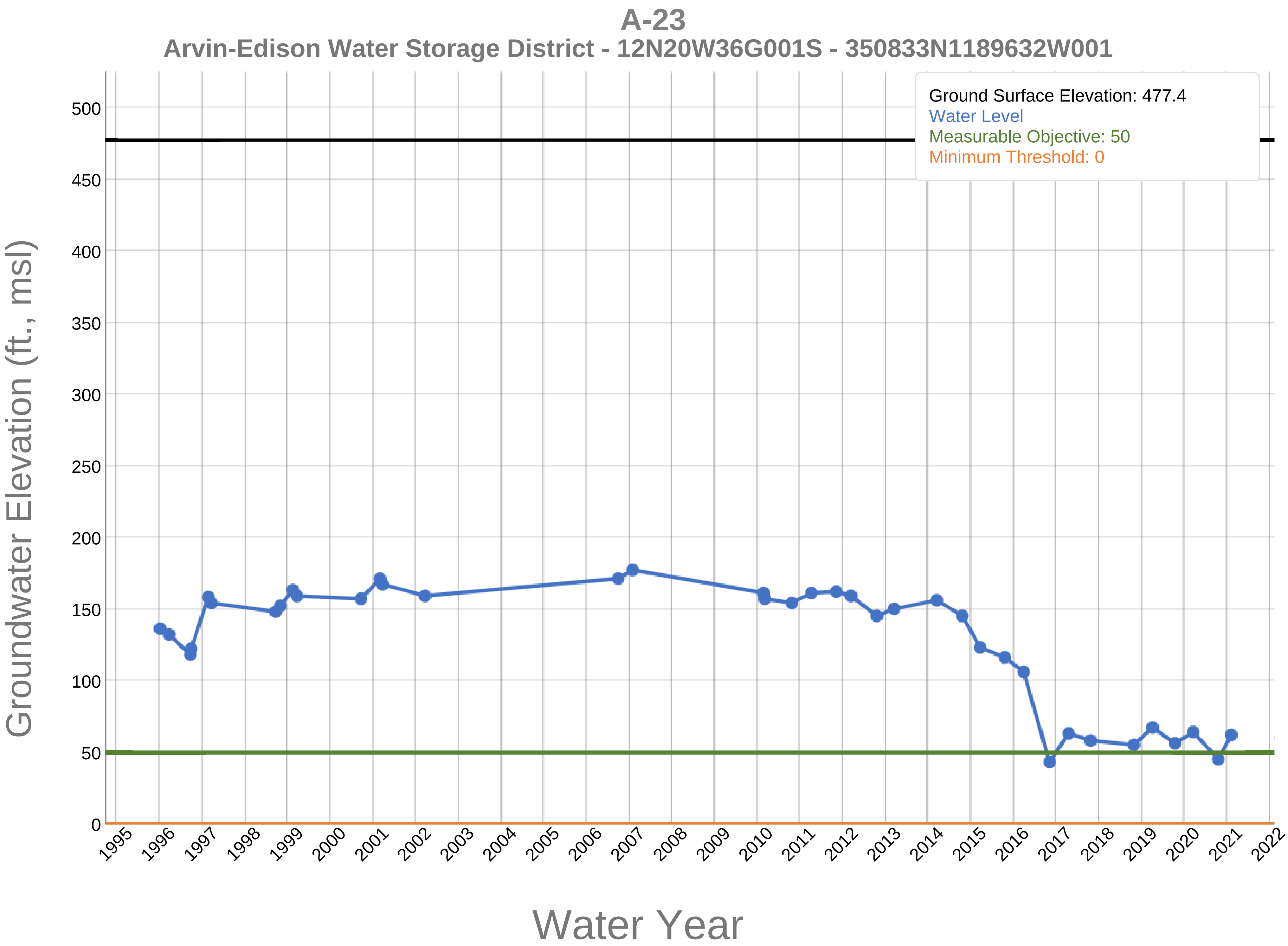
A-23
Arvin-Edison Water Storage District - 12N20W36G001S - 350833N1189632W001
Ground Surface Elevation: 477.4
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
50
100
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250
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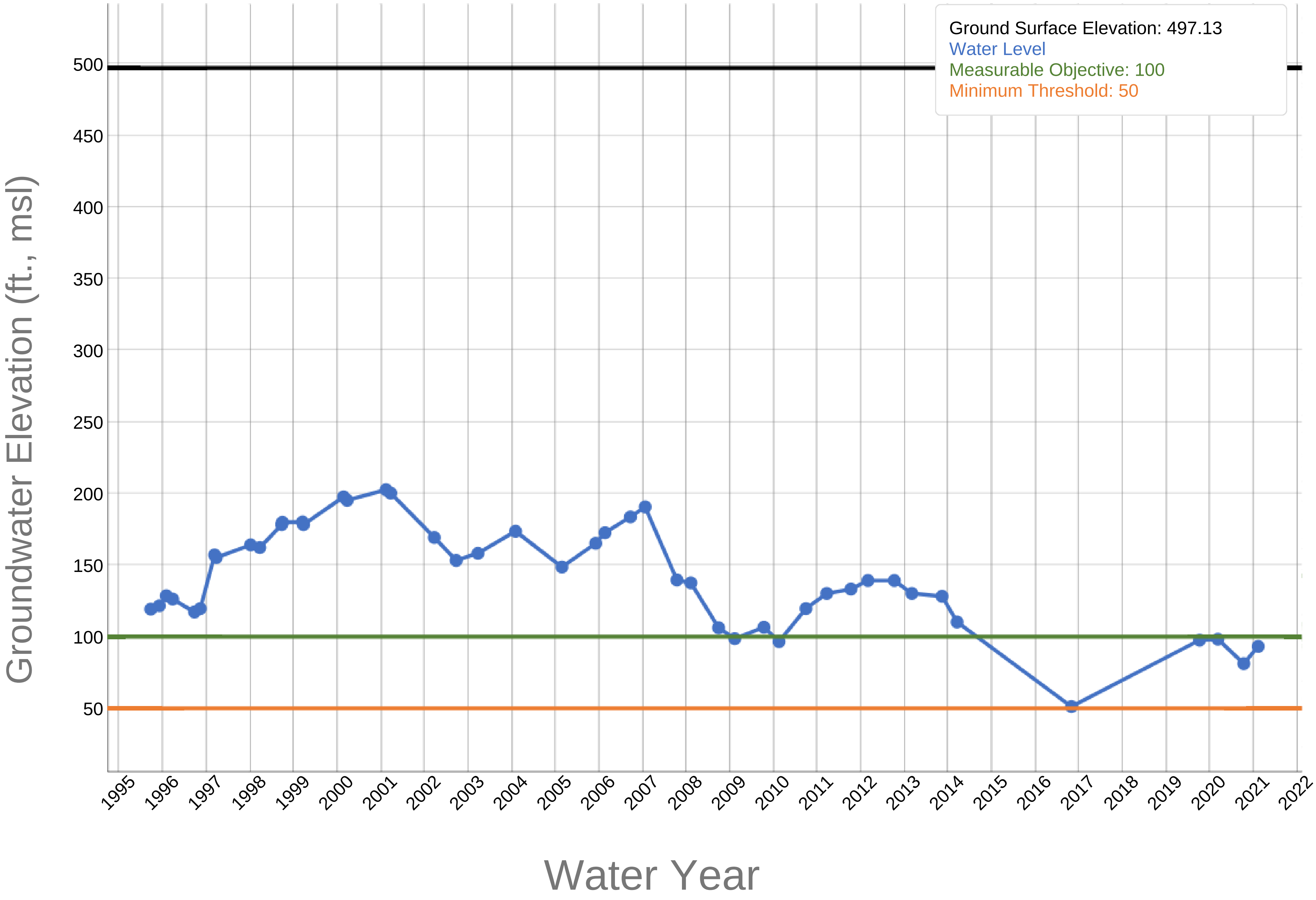
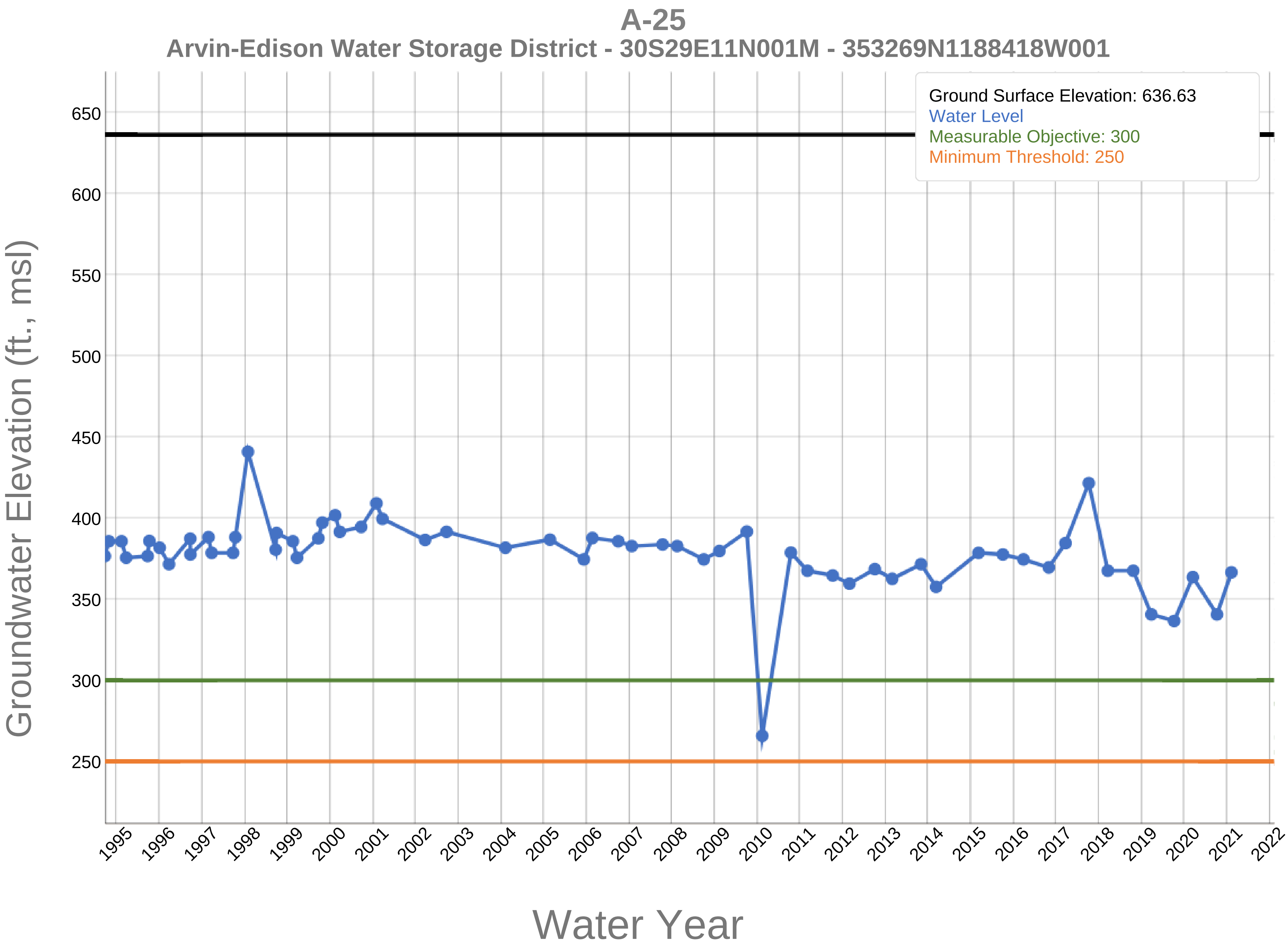
A-24

Arvin-Edison Water Storage District - 31S30E17K001M - 352311N1187790W001





A-25
Arvin-Edison Water Storage District - 30S29E11N001M - 353269N1188418W001
Ground Surface Elevation: 636.63
Water Level
Measurable Objective: 300
Minimum Threshold: 250
Groundwater Elevation (ft., msl)
650
600
550
500
450
400
350
300
250
1995
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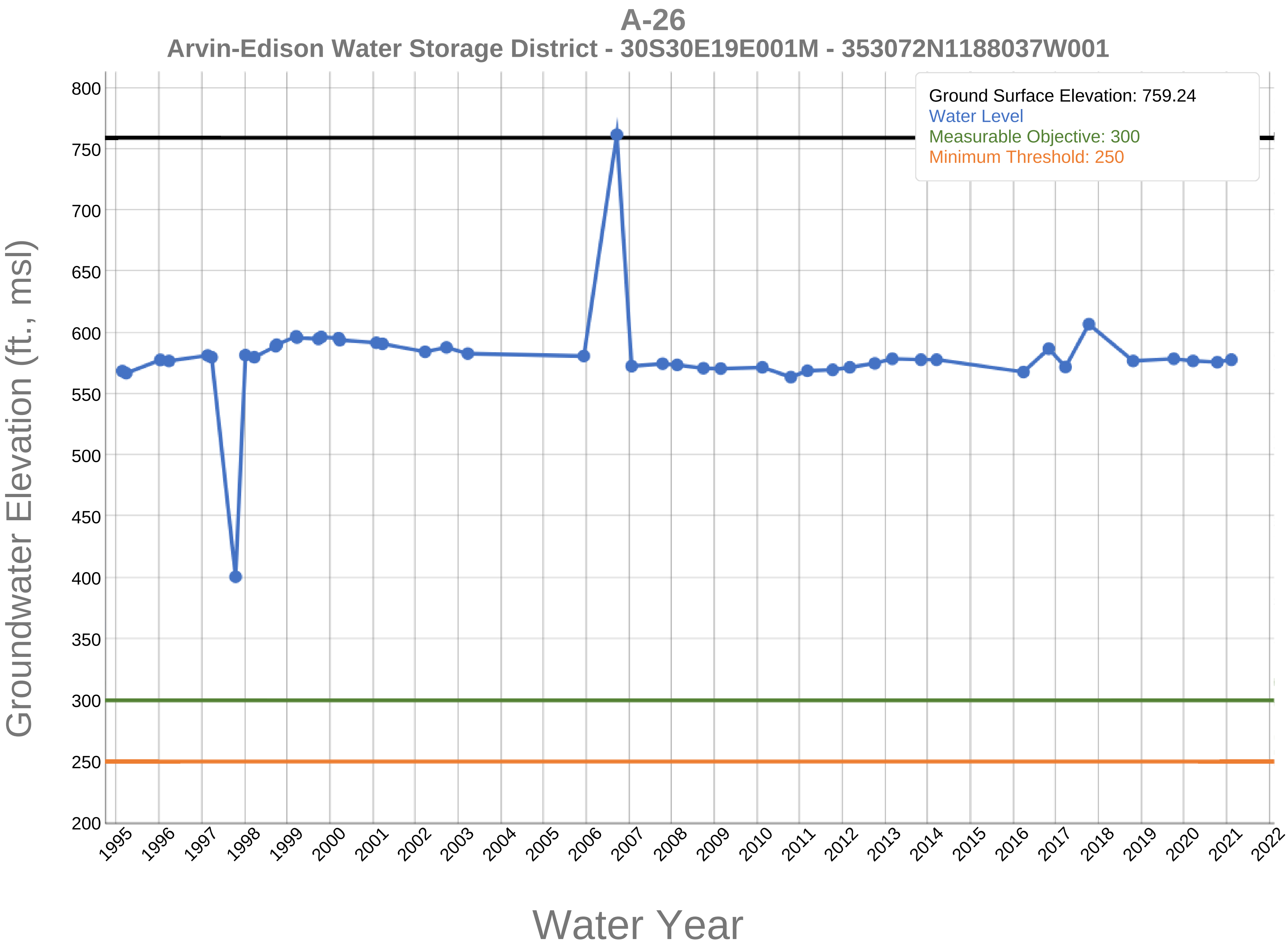
2022
Water Year


A-26
Arvin-Edison Water Storage District - 30S30E19E001M - 353072N1188037W001
Ground Surface Elevation: 759.24
Water Level
Measurable Objective: 300
Minimum Threshold: 250
Groundwater Elevation (ft., msl)
Water Year
800
750
700
650
600
550
500
450
400
350
300
250
200
1995
1996
1997
1998
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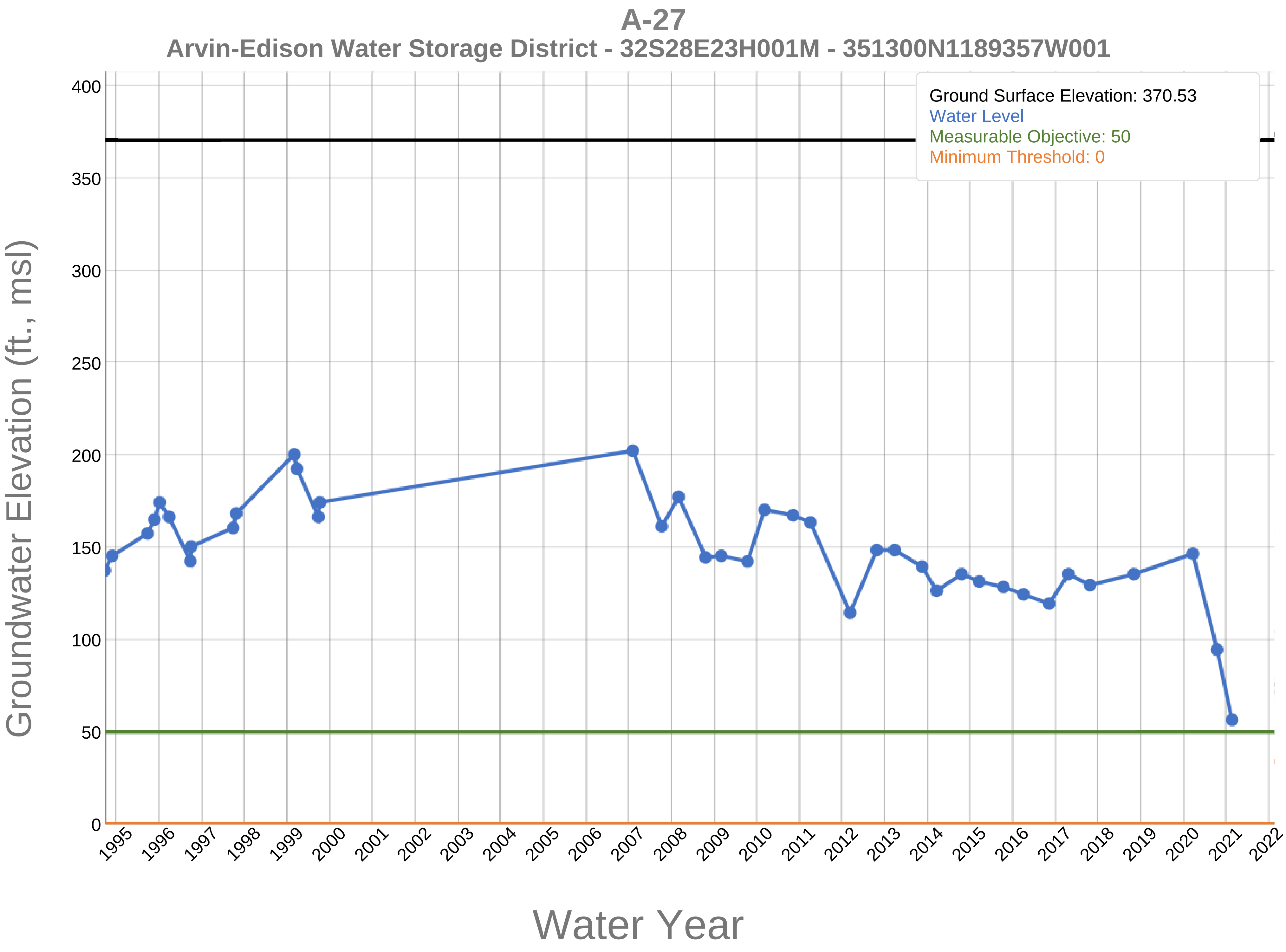
A-27
Arvin-Edison Water Storage District - 32S28E23H001M - 351300N1189357W001
Ground Surface Elevation: 370.53
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
1995
1996
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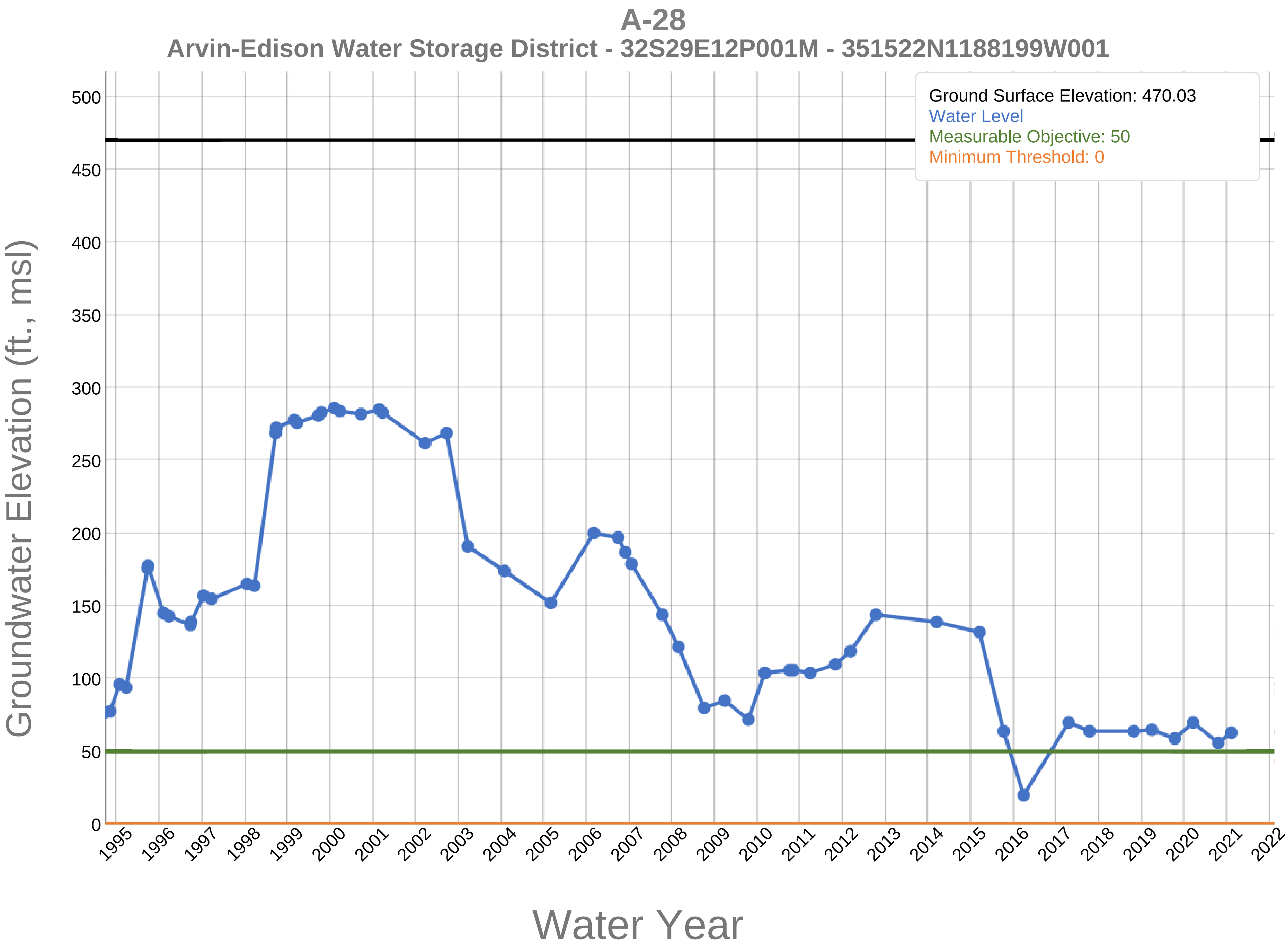
2021
2022
Water Year


A-28
Arvin-Edison Water Storage District - 32S29E12P001M - 351522N1188199W001
Ground Surface Elevation: 470.03
Water Level
Measurable Objective: 50
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
150
100
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0
1995
1996
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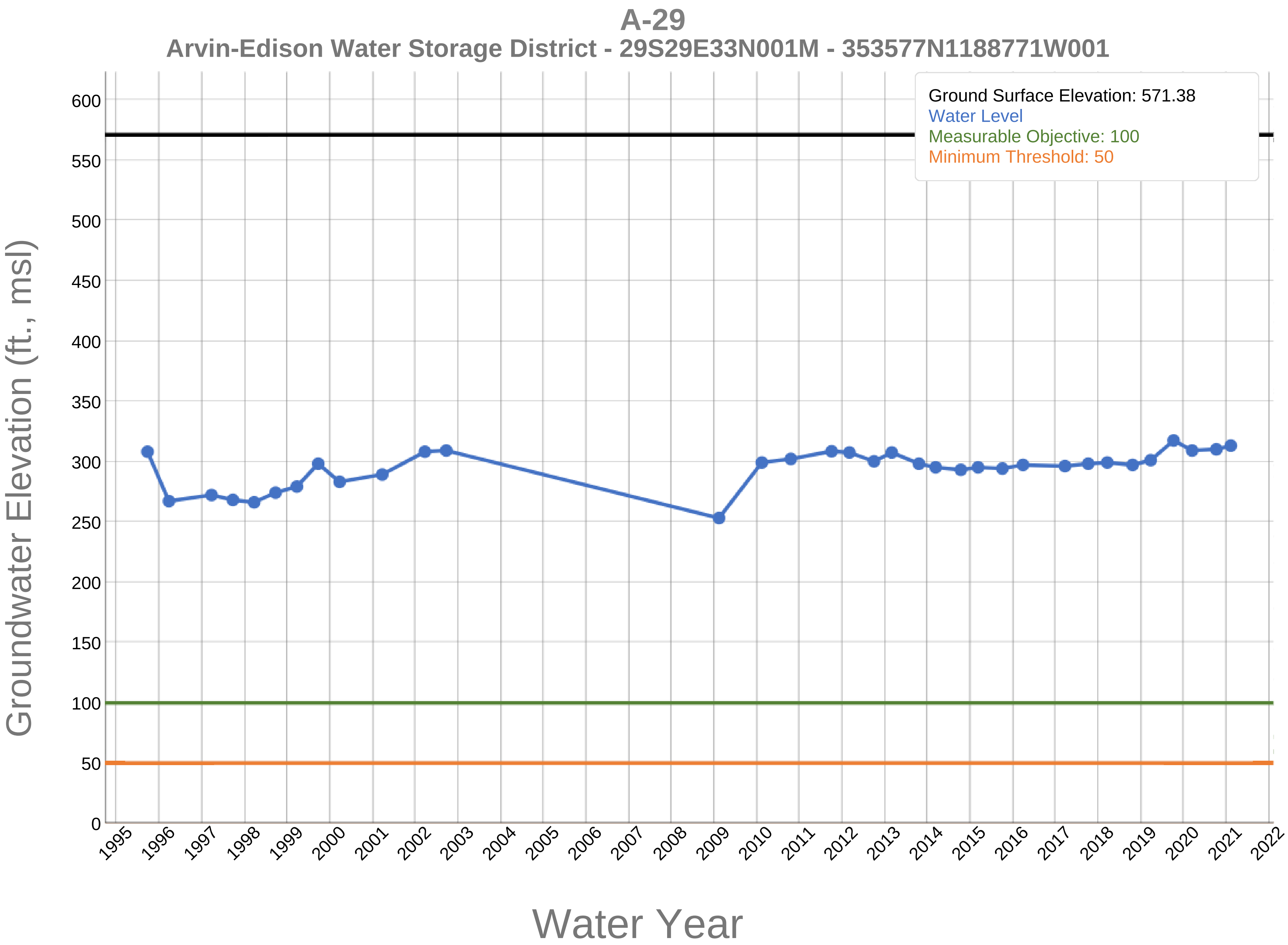
2021
2022
Water Year


A-29
Arvin-Edison Water Storage District - 29S29E33N001M - 353577N1188771W001
Ground Surface Elevation: 571.38
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
200
150
100
50
0
1995
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1997
1998
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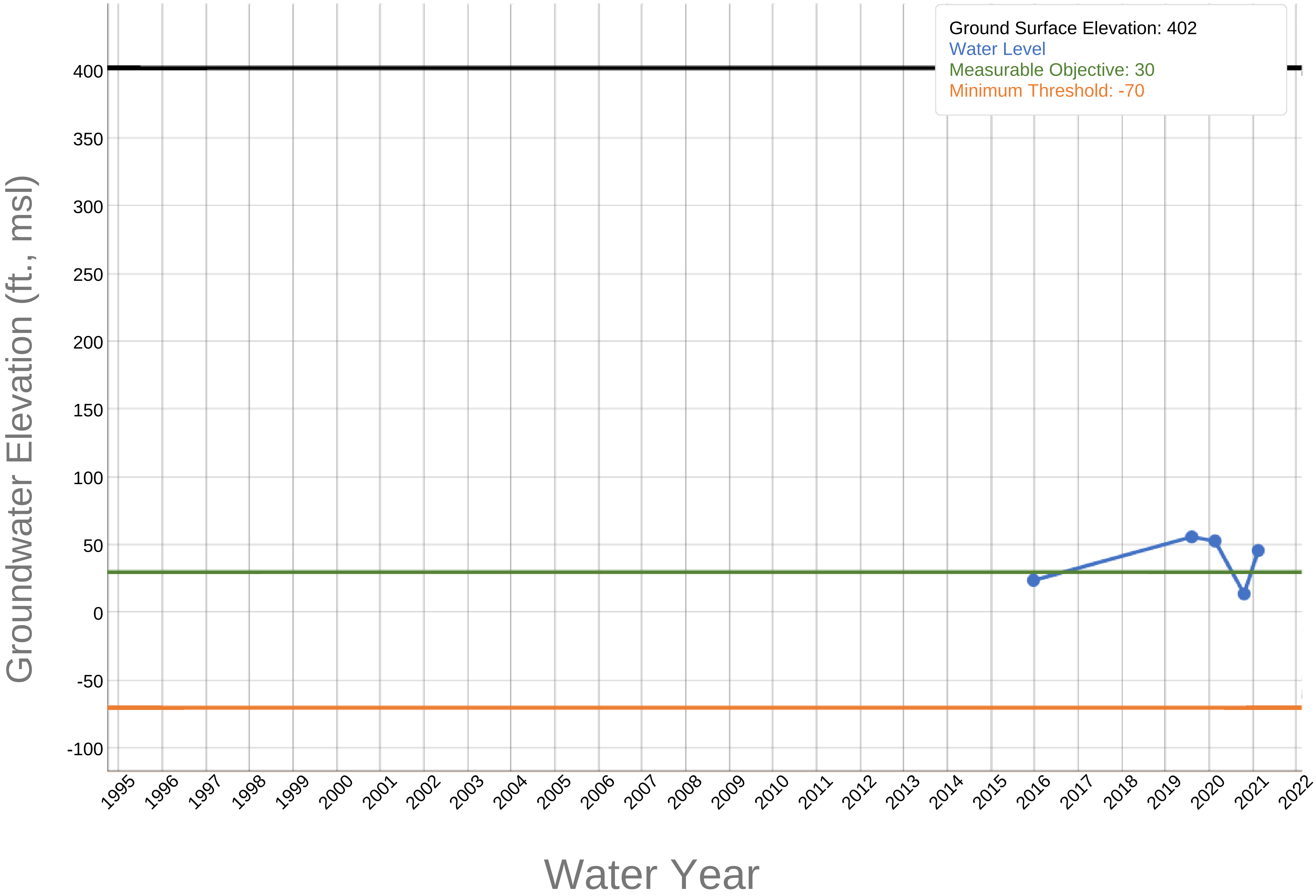
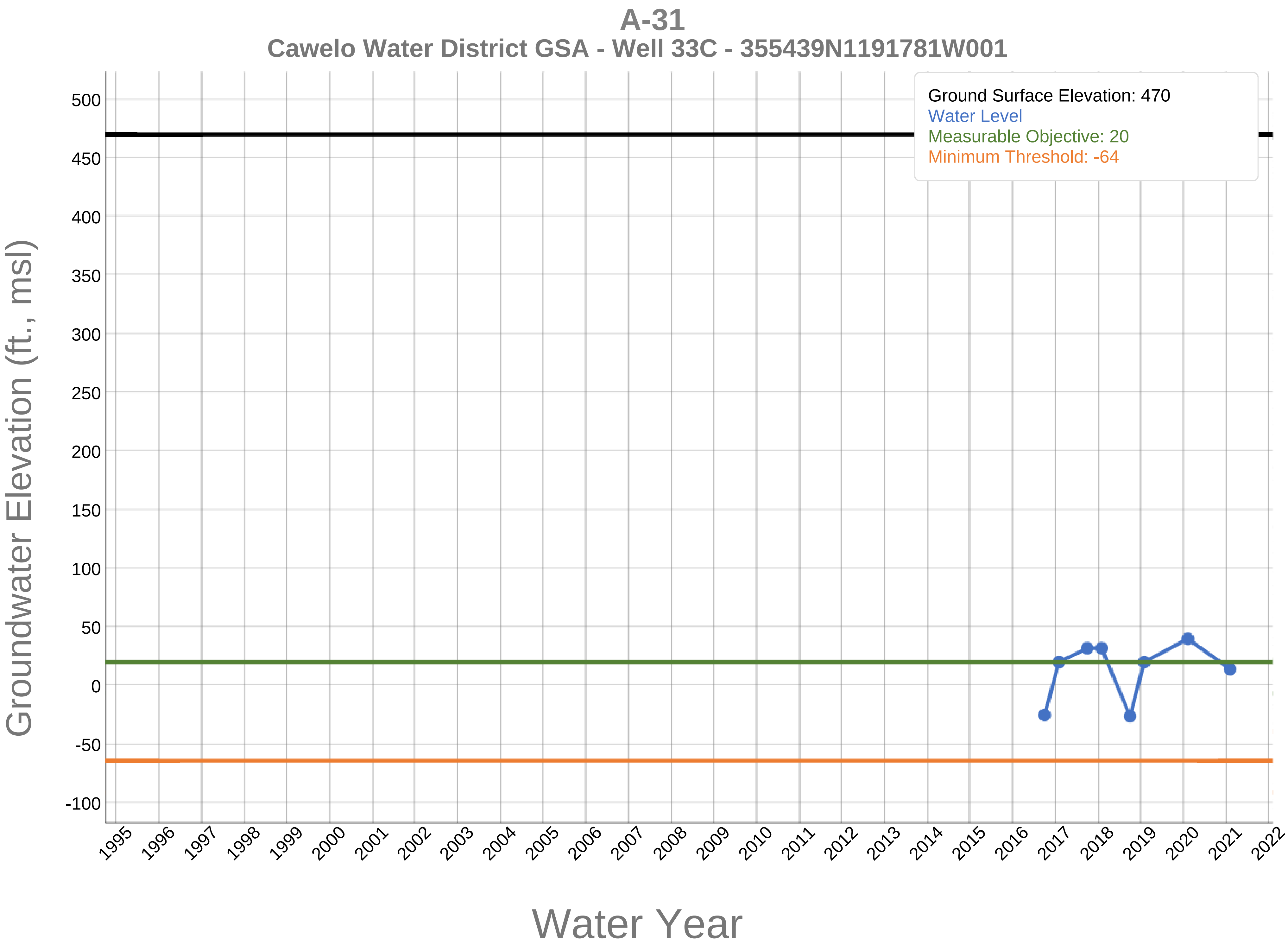
2022
Water Year

A-30
Arvin-Edison Water Storage District - ACSD Well #14 - 351942N1188484W001




A-31
Cawelo Water District GSA - Well 33C - 355439N1191781W001
Ground Surface Elevation: 470
Water Level
Measurable Objective: 20
Minimum Threshold: -64
Groundwater Elevation (ft., msl)
Water Year
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
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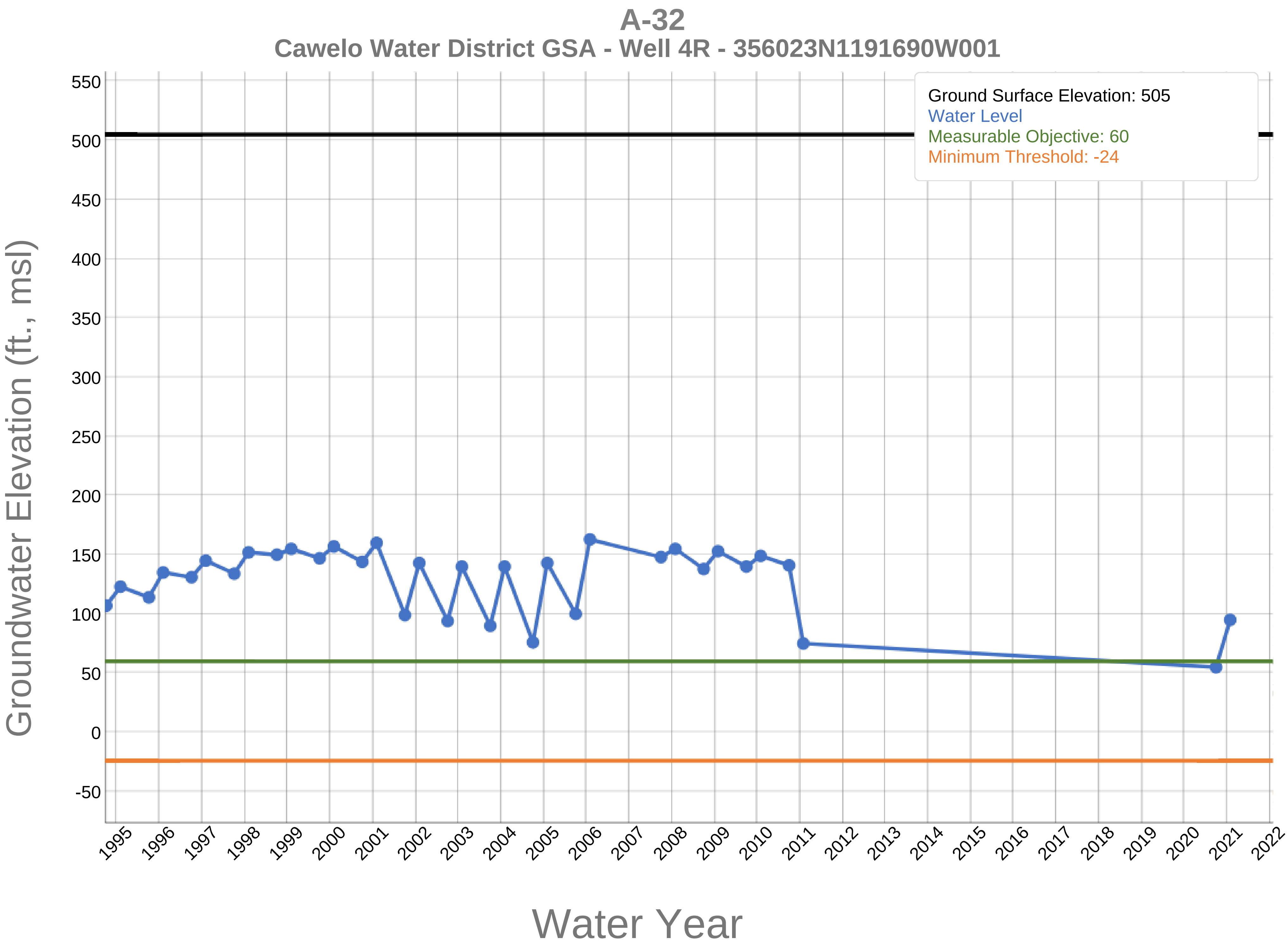
A-32
Cawelo Water District GSA - Well 4R - 356023N1191690W001
Ground Surface Elevation: 505
Water Level
Measurable Objective: 60
Minimum Threshold: -24
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
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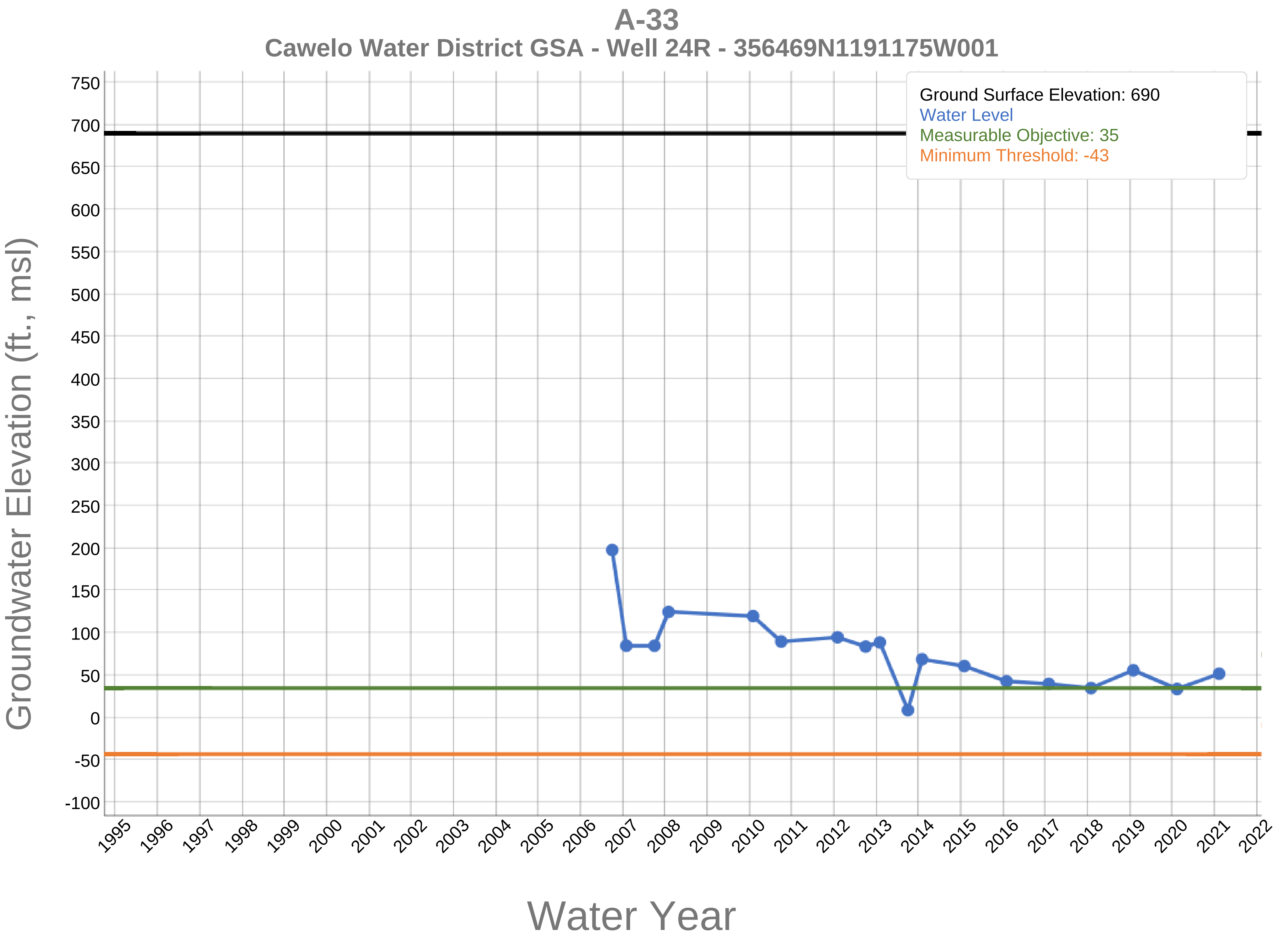
2021
2022
Water Year



A-33
Cawelo Water District GSA - Well 24R - 356469N1191175W001
Ground Surface Elevation: 690
Water Level
Measurable Objective: 35
Minimum Threshold: -43
Groundwater Elevation (ft., msl)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
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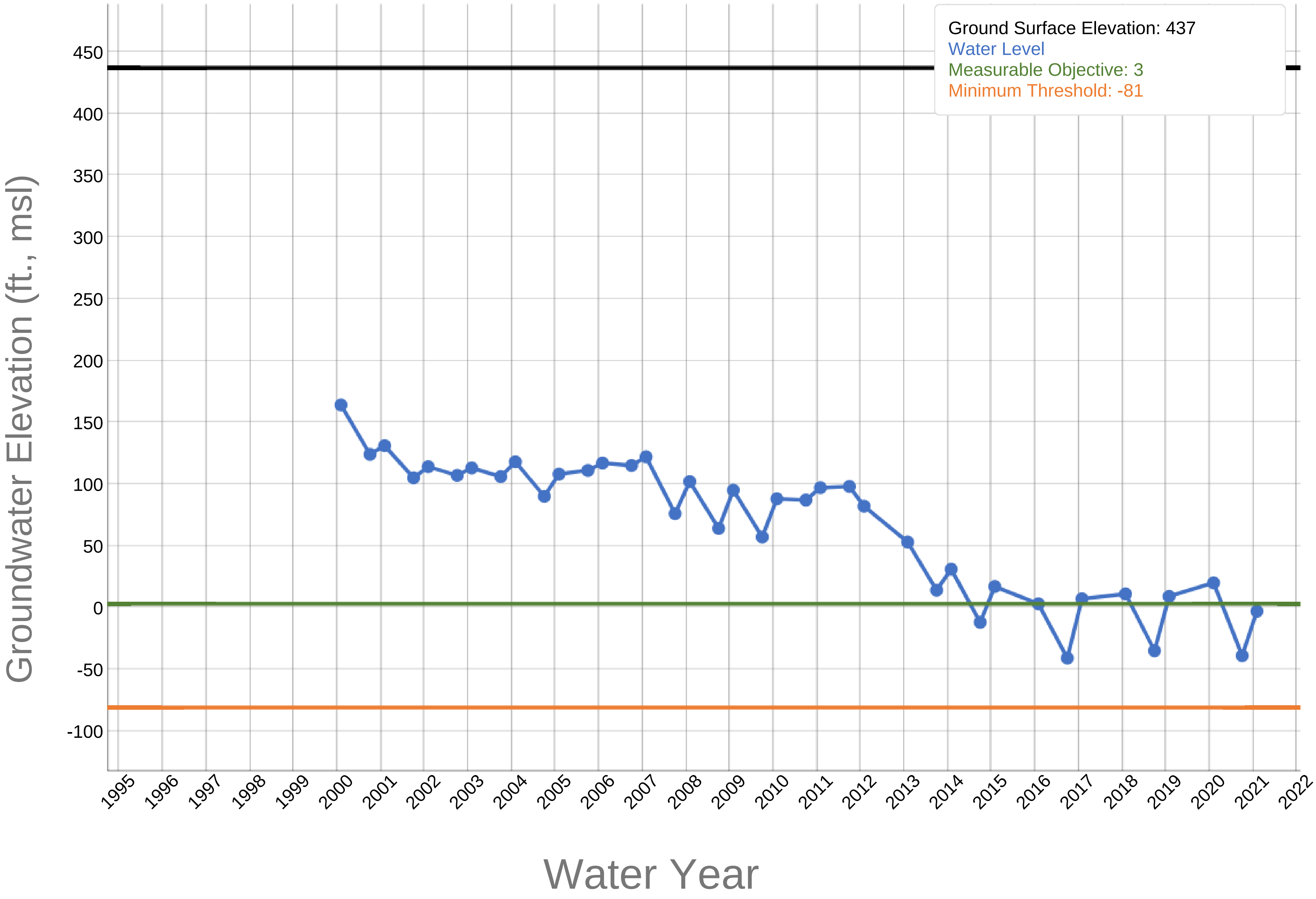
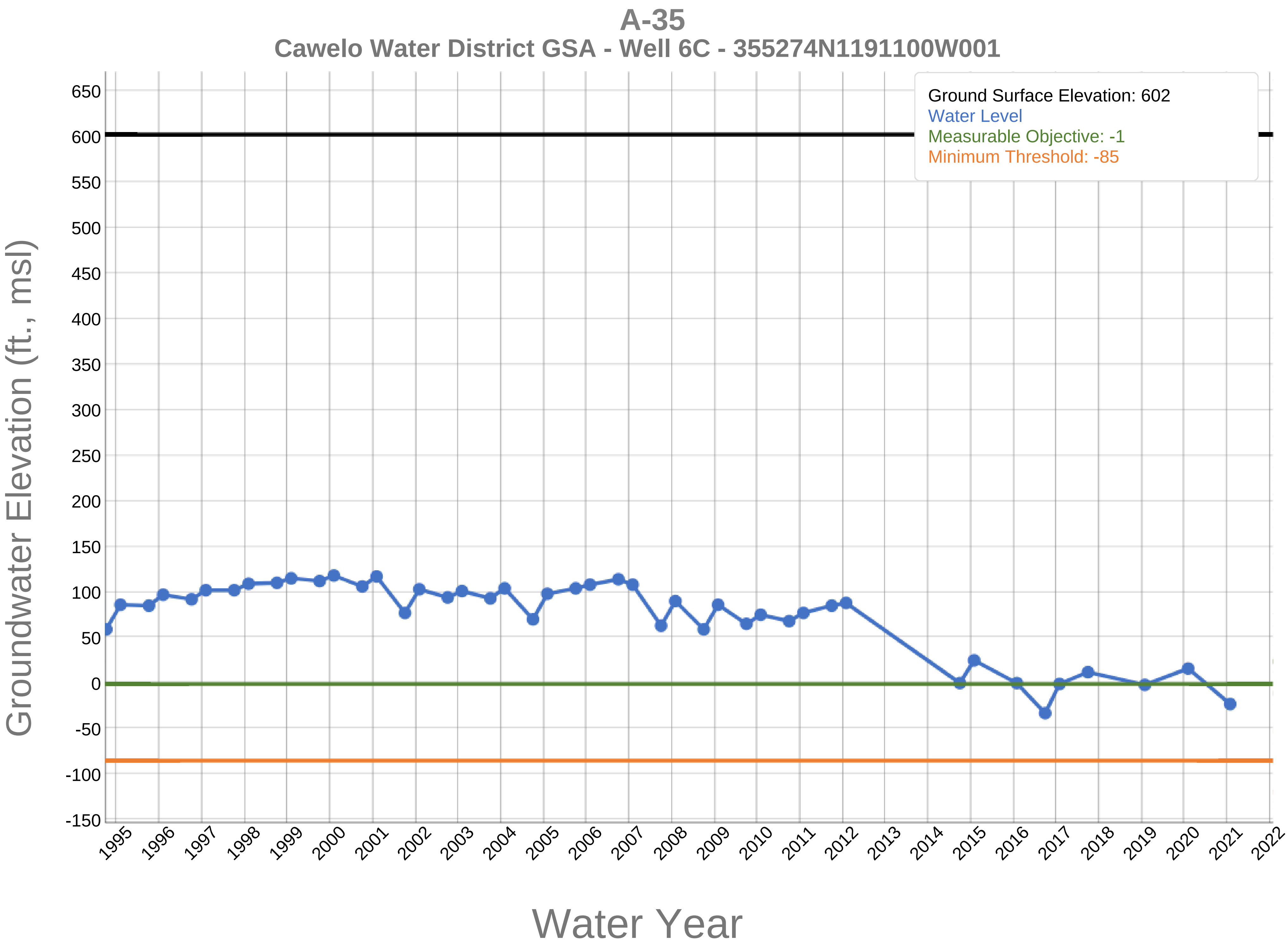
2022
Water Year

A-34

Cawelo Water District GSA - Well 11M - 355044N1191502W001




A-35
Cawelo Water District GSA - Well 6C - 355274N1191100W001
Ground Surface Elevation: 602
Water Level
Measurable Objective: -1
Minimum Threshold: -85
Groundwater Elevation (ft., msl)
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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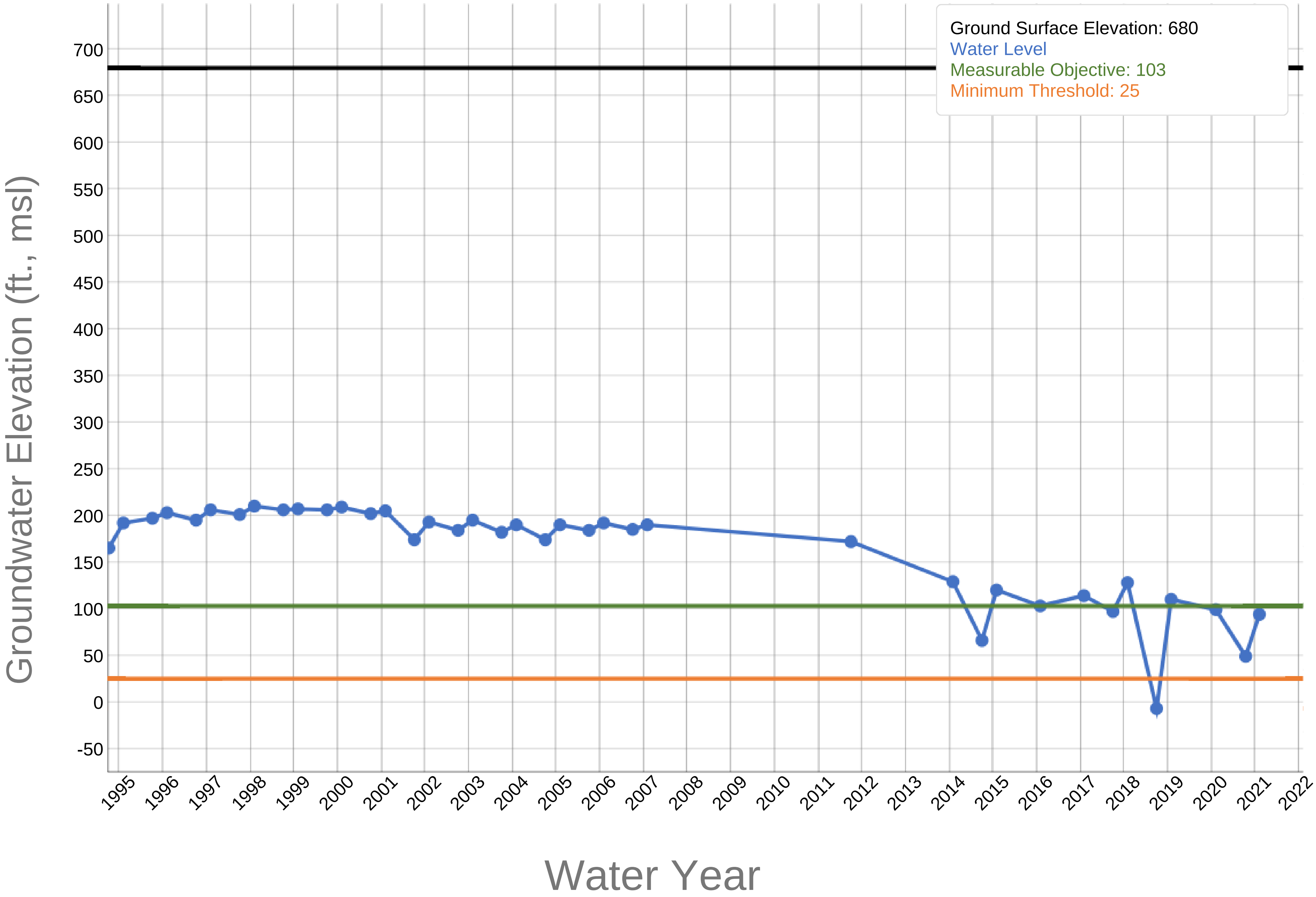
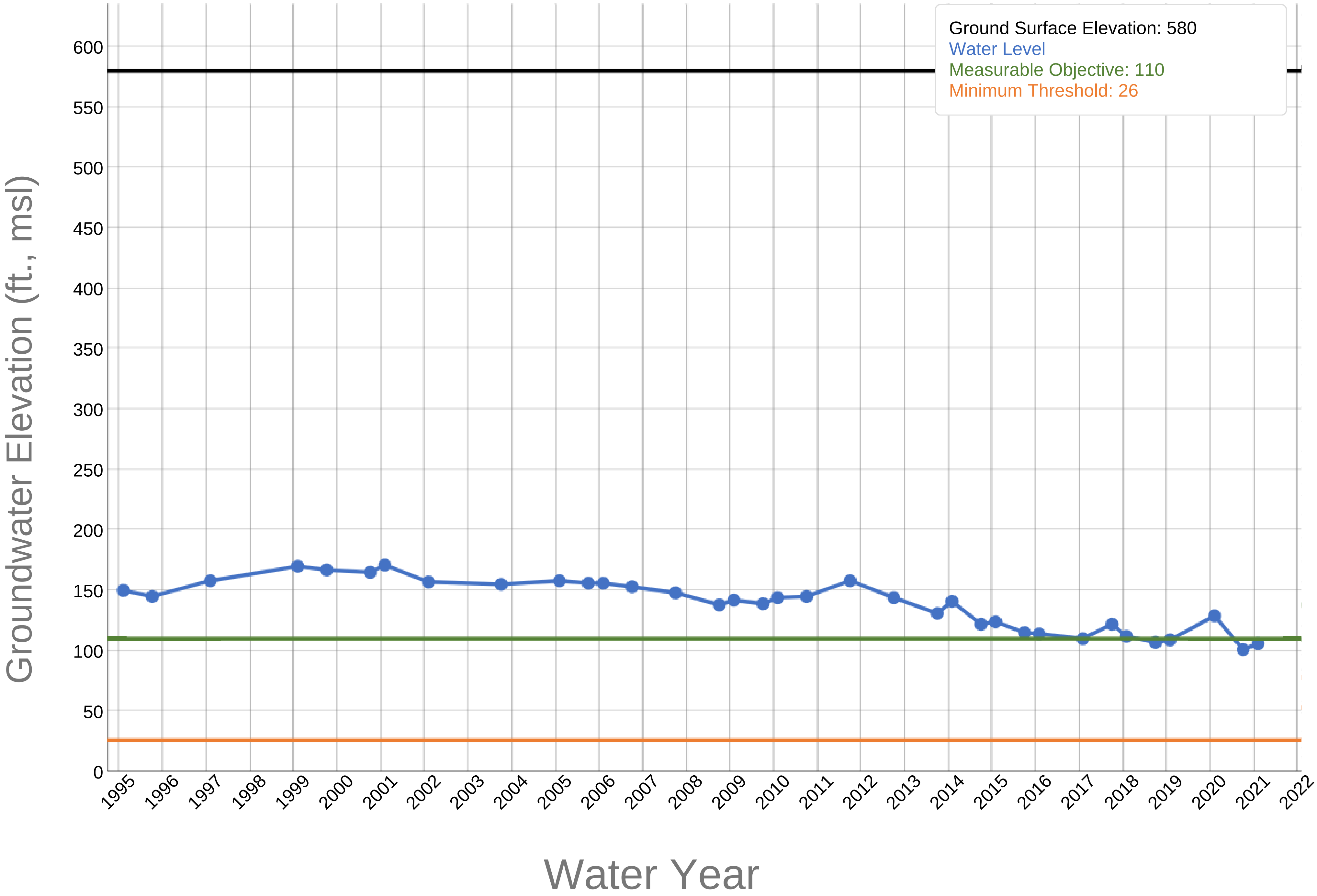
2022
Water Year

A-36
Cawelo Water District GSA - Well 12H - 355954N1191160W001

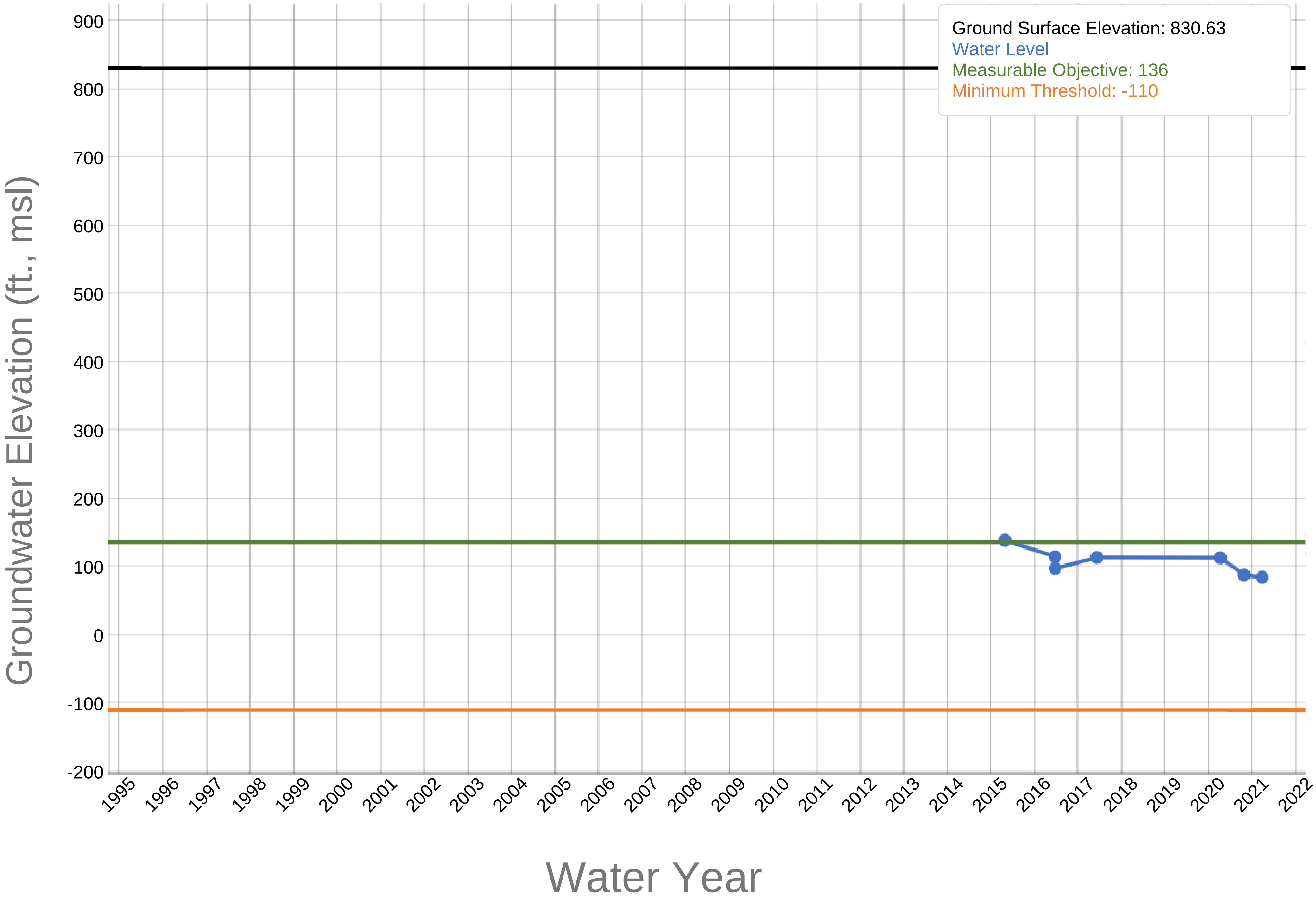


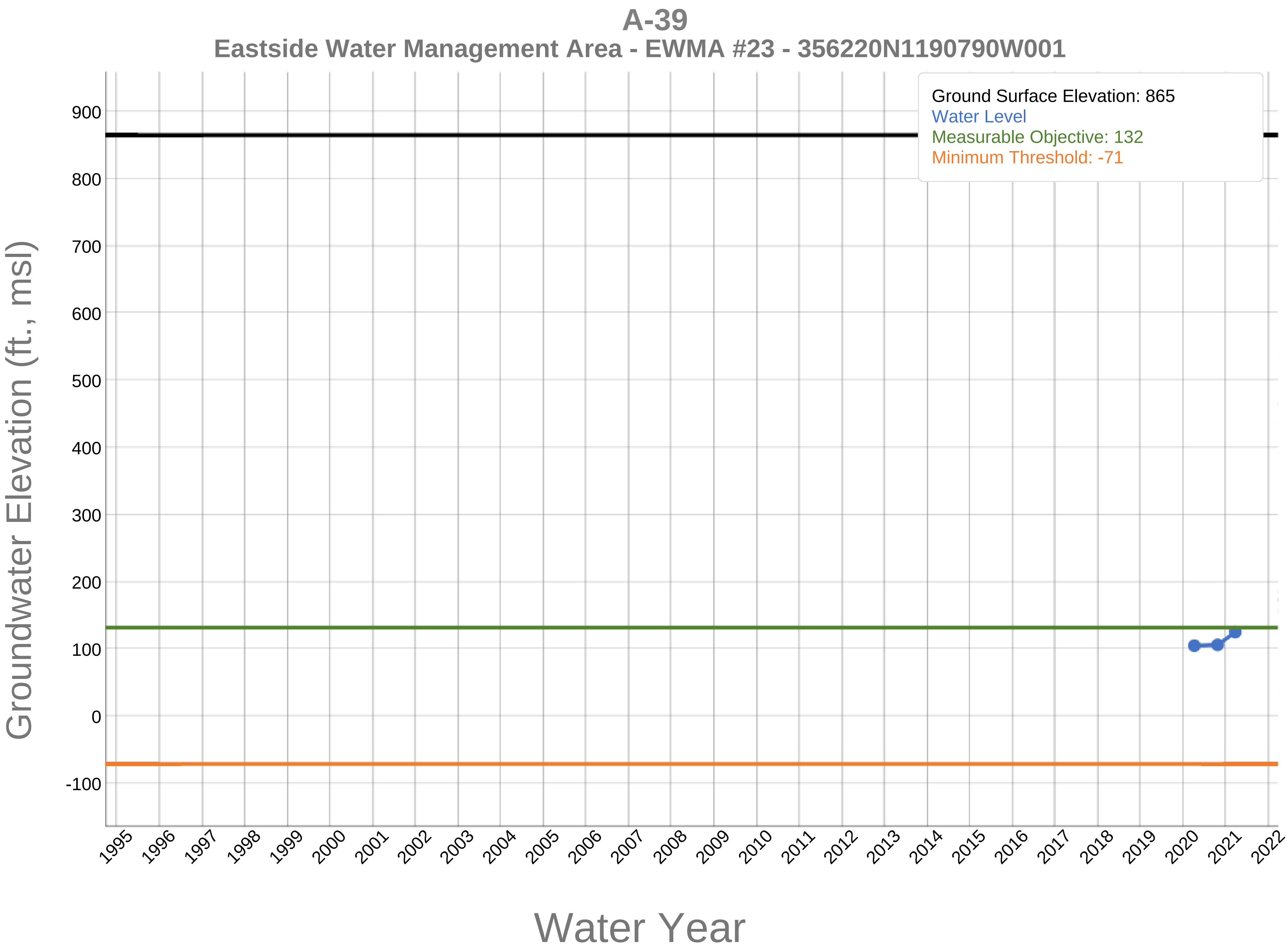
A-37

Cawelo Water District GSA - Well 28L - 356023N1191691W001



A-38
Eastside Water Management Area - EWMA #21 - 355935N1190787W001





A-39
Eastside Water Management Area - EWMA #23 - 356220N1190790W001
Ground Surface Elevation: 865
Water Level
Measurable Objective: 132
Minimum Threshold: -71
Groundwater Elevation (ft., msl)
900
800
700
600
500
400
300
200
100
0
-100
1995
1996
1997
1998
1999
2000
2001
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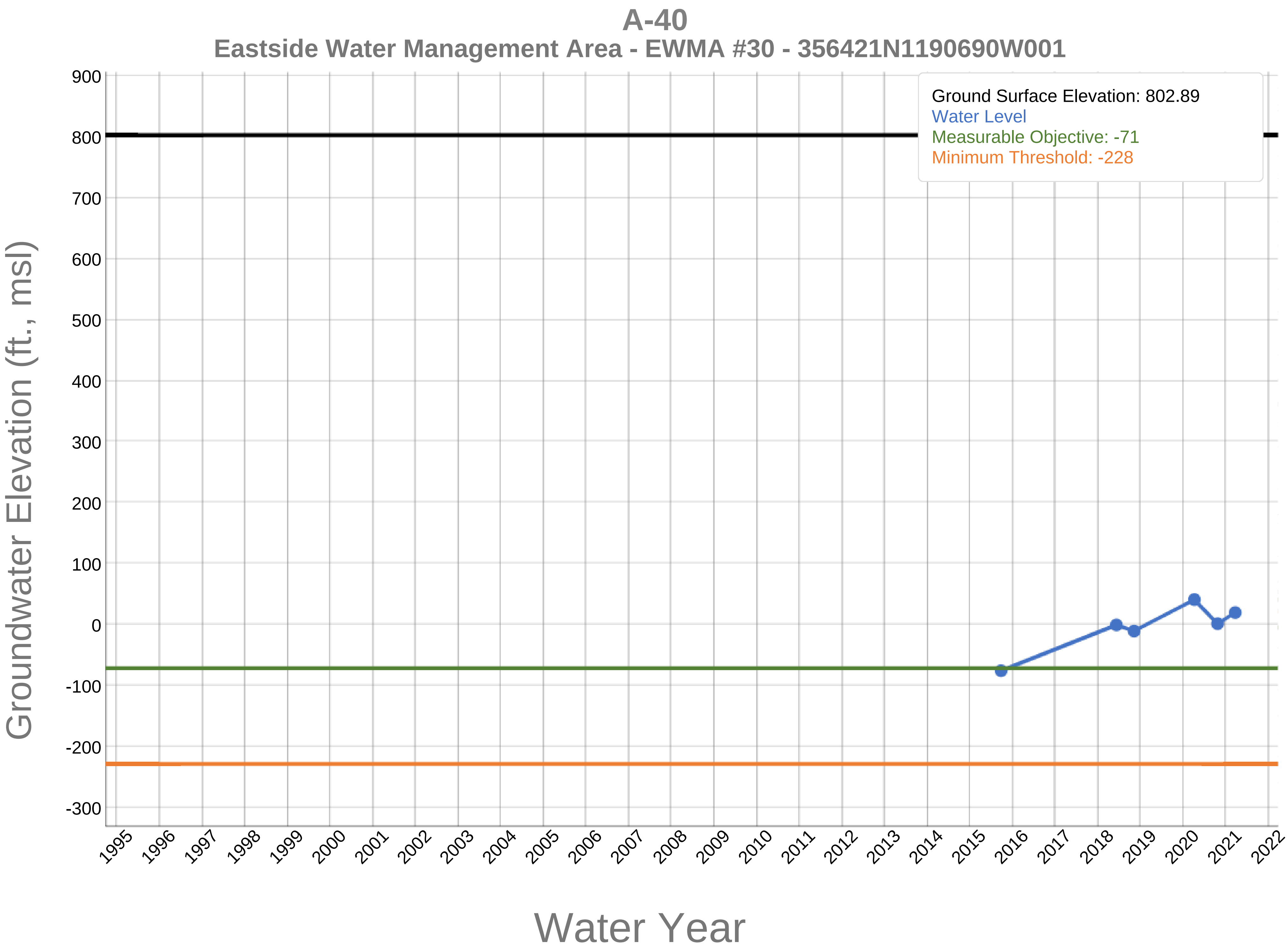
2021
2022
Water Year


A-40
Eastside Water Management Area - EWMA #30 - 356421N1190690W001
Ground Surface Elevation: 802.89
Water Level
Measurable Objective: -71
Minimum Threshold: -228
Groundwater Elevation (ft., msl)
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
1995
1996
1997
1998
1999
2000
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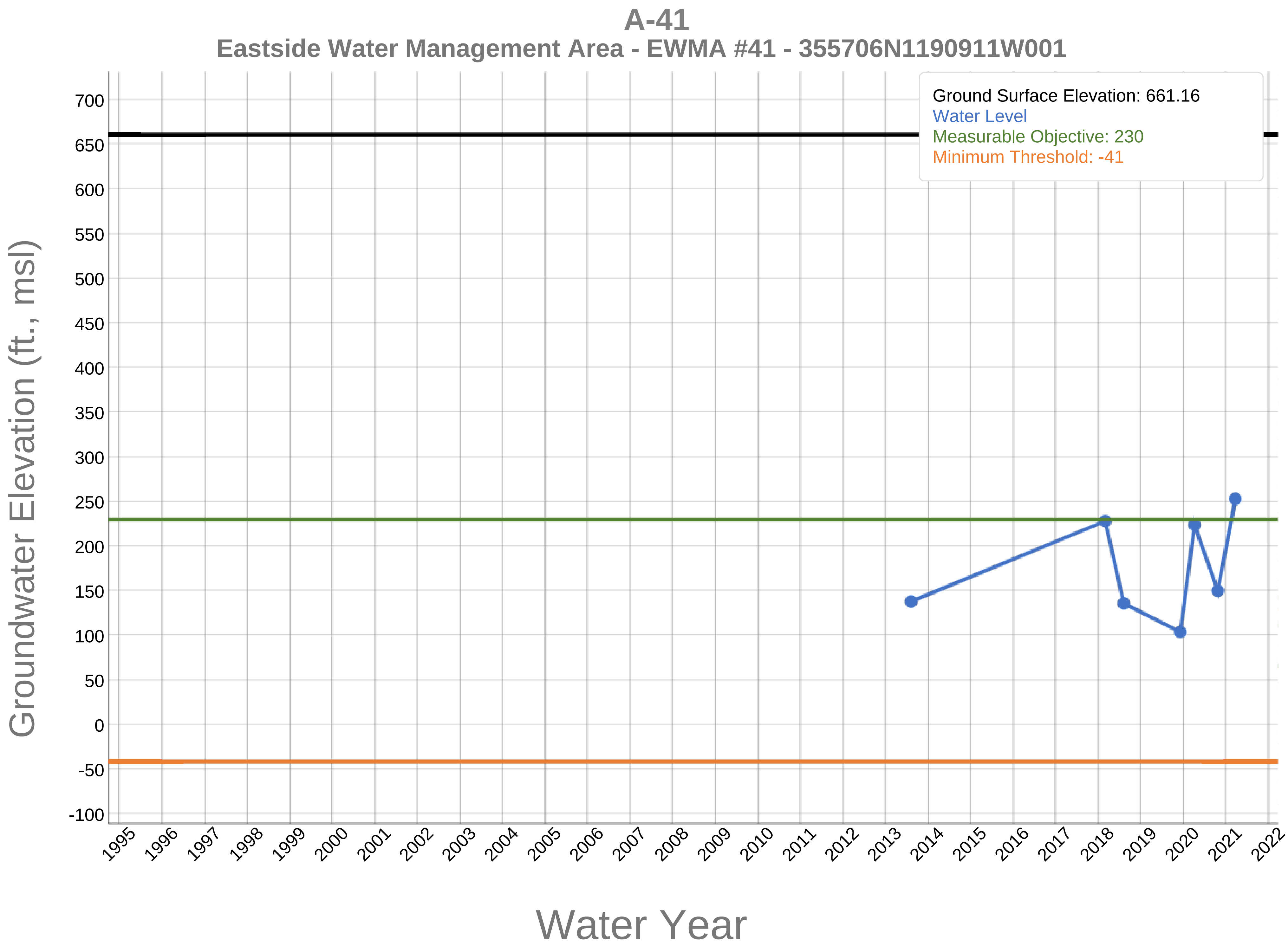
2021
2022
Water Year


A-41
Eastside Water Management Area - EWMA #41 - 355706N1190911W001
Ground Surface Elevation: 661.16
Water Level
Measurable Objective: 230
Minimum Threshold: -41
Groundwater Elevation (ft., msl)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
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2021
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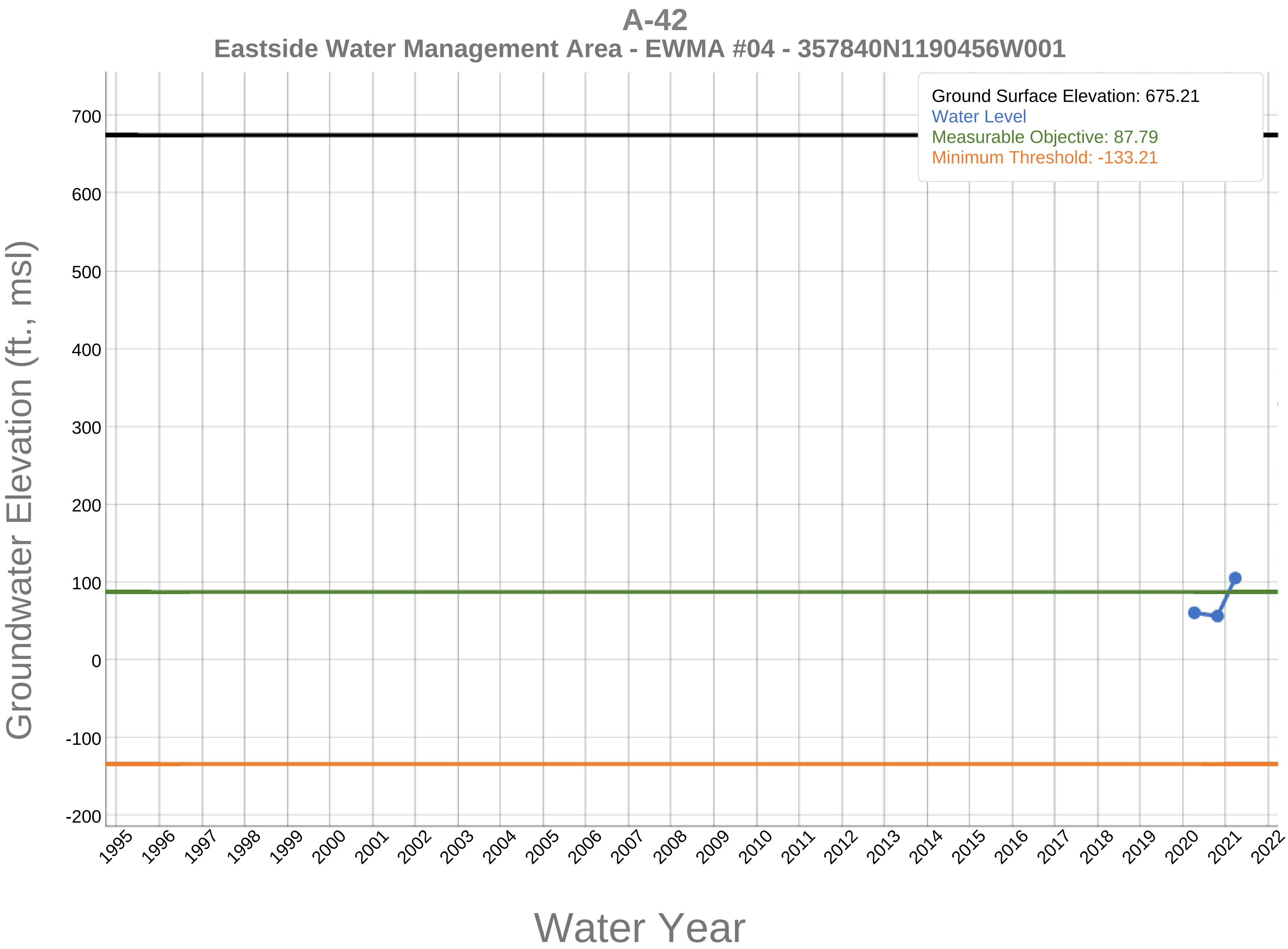
Water Year


A-42
Eastside Water Management Area - EWMA #04 - 357840N1190456W001
Ground Surface Elevation: 675.21
Water Level
Measurable Objective: 87.79
Minimum Threshold: -133.21
Groundwater Elevation (ft., msl)
700
600
500
400
300
200
100
0
-100
-200
1995
1996
1997
1998
1999
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2021
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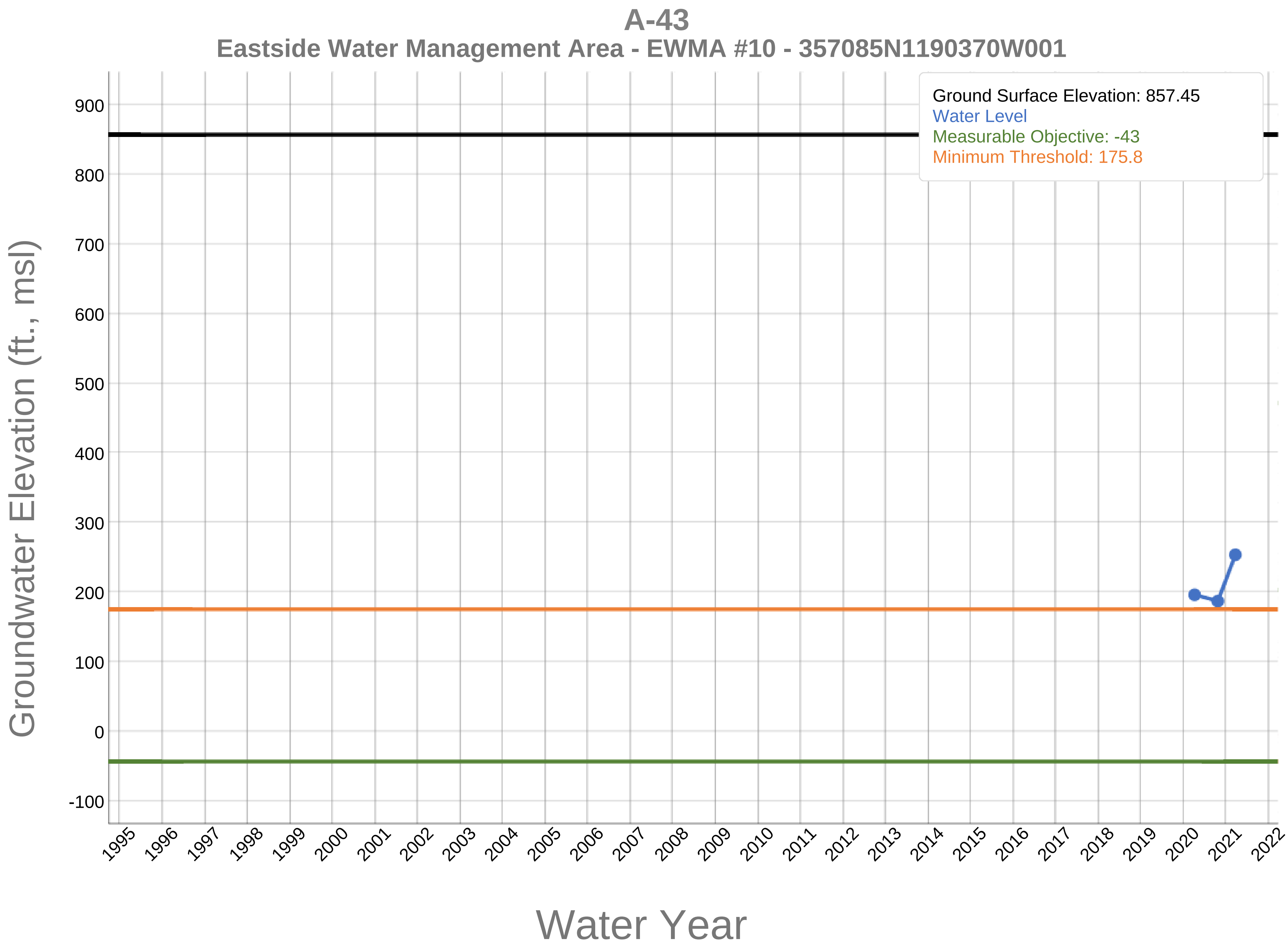
Water Year


A-43
Eastside Water Management Area - EWMA #10 - 357085N1190370W001
Ground Surface Elevation: 857.45
Water Level
Measurable Objective: -43
Minimum Threshold: 175.8
Groundwater Elevation (ft., msl)
900
800
700
600
500
400
300
200
100
0
-100
1995
1996
1997
1998
1999
2000
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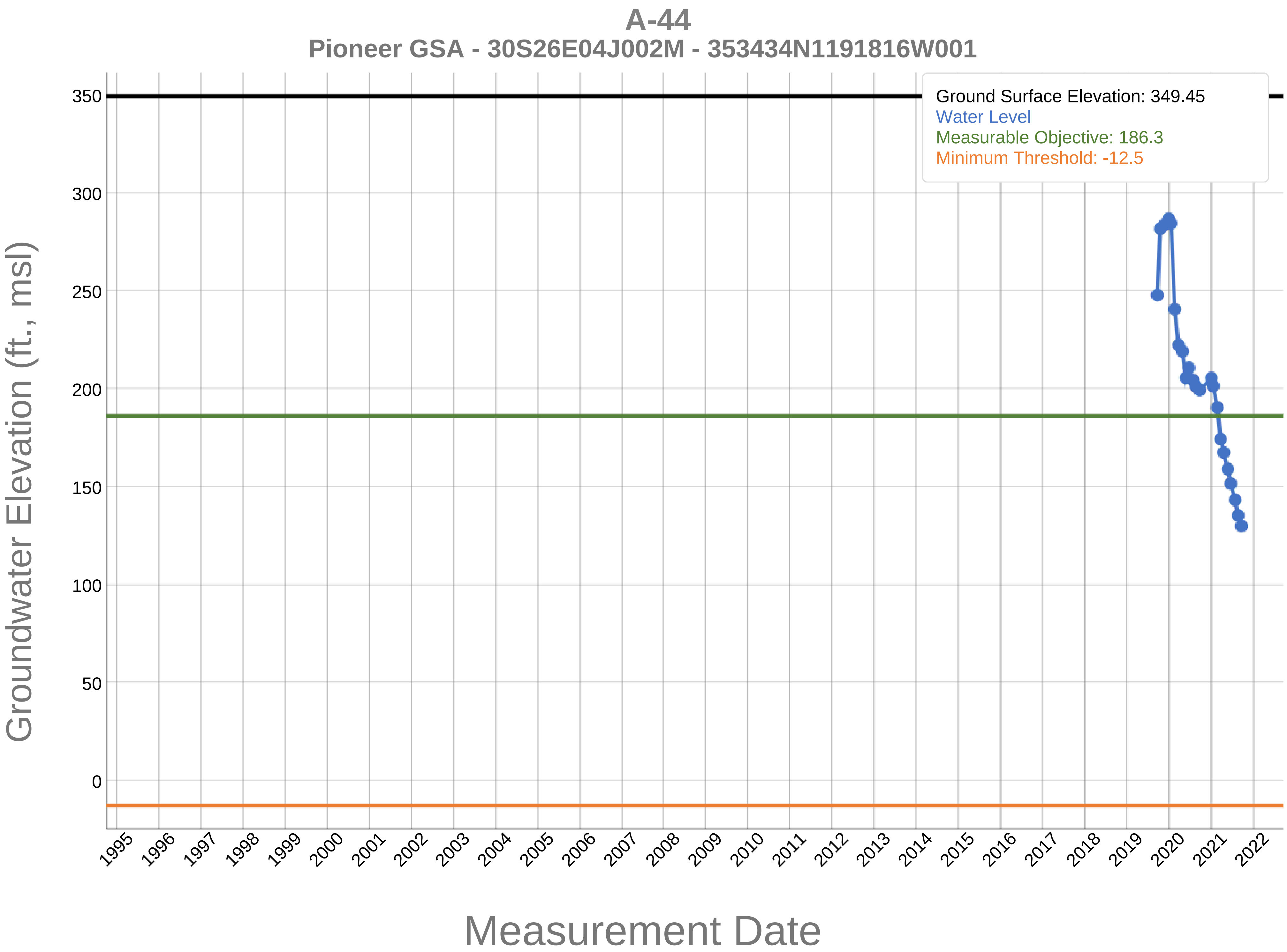
2021
2022
Water Year


A-44
Pioneer GSA - 30S26E04J002M - 353434N1191816W001
Ground Surface Elevation: 349.45
Water Level
Measurable Objective: 186.3
Minimum Threshold: -12.5
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
1995
1996
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1998
1999
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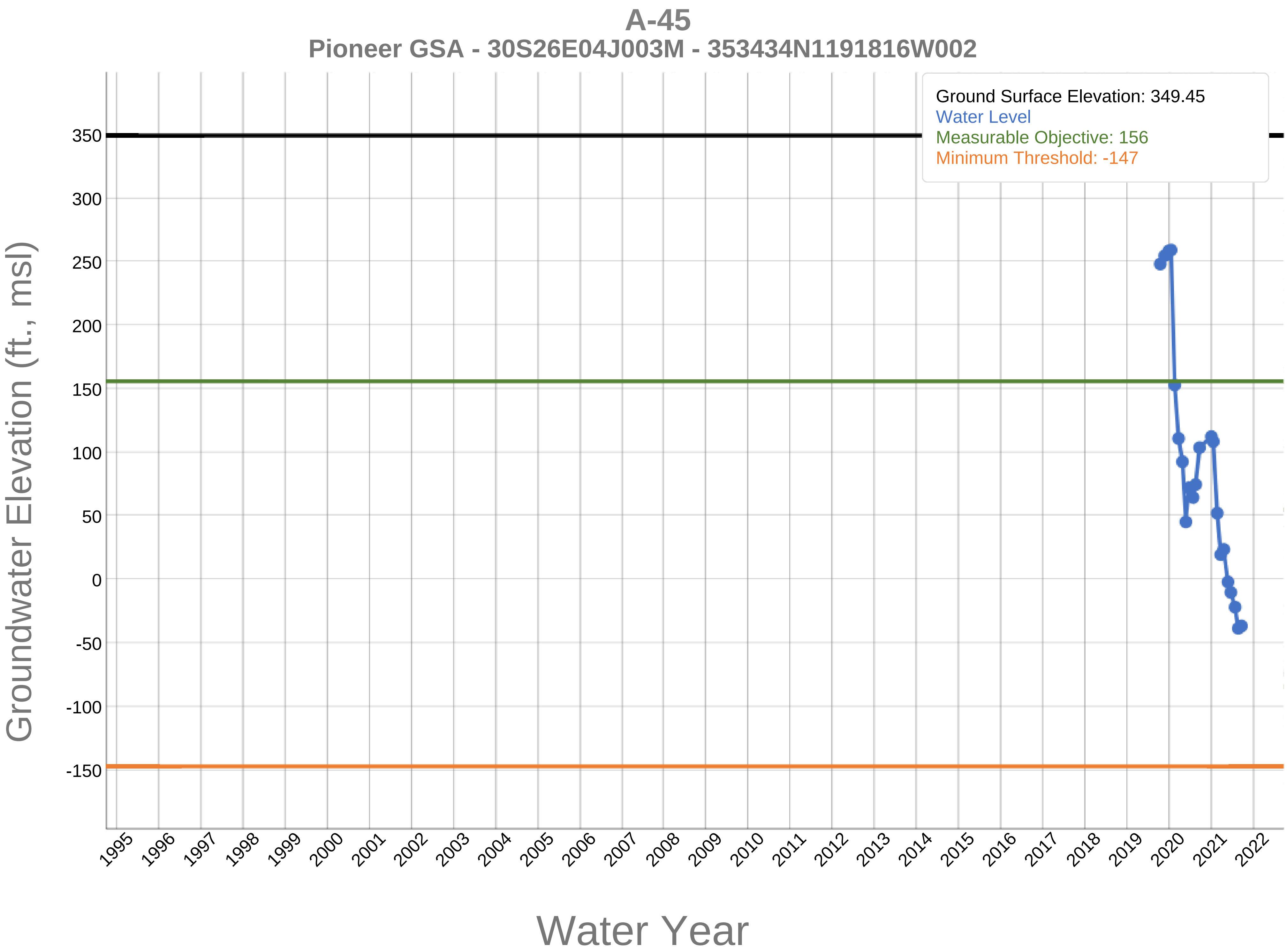
2021
2022
Measurement Date



A-45
Pioneer GSA - 30S26E04J003M - 353434N1191816W002
Ground Surface Elevation: 349.45
Water Level
Measurable Objective: 156
Minimum Threshold: -147
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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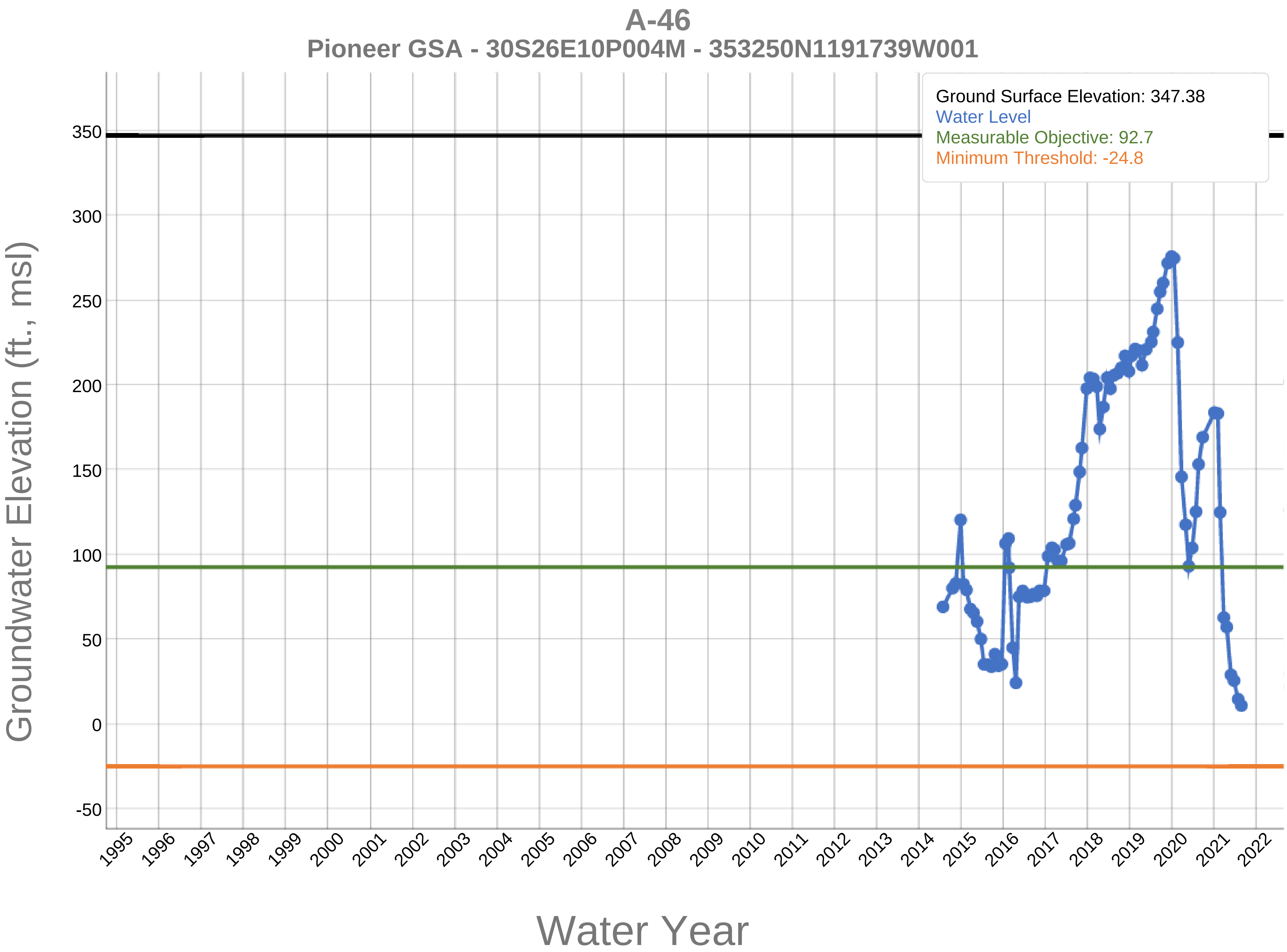
2021
2022
Water Year


A-46
Pioneer GSA - 30S26E10P004M - 353250N1191739W001
Ground Surface Elevation: 347.38
Water Level
Measurable Objective: 92.7
Minimum Threshold: -24.8
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
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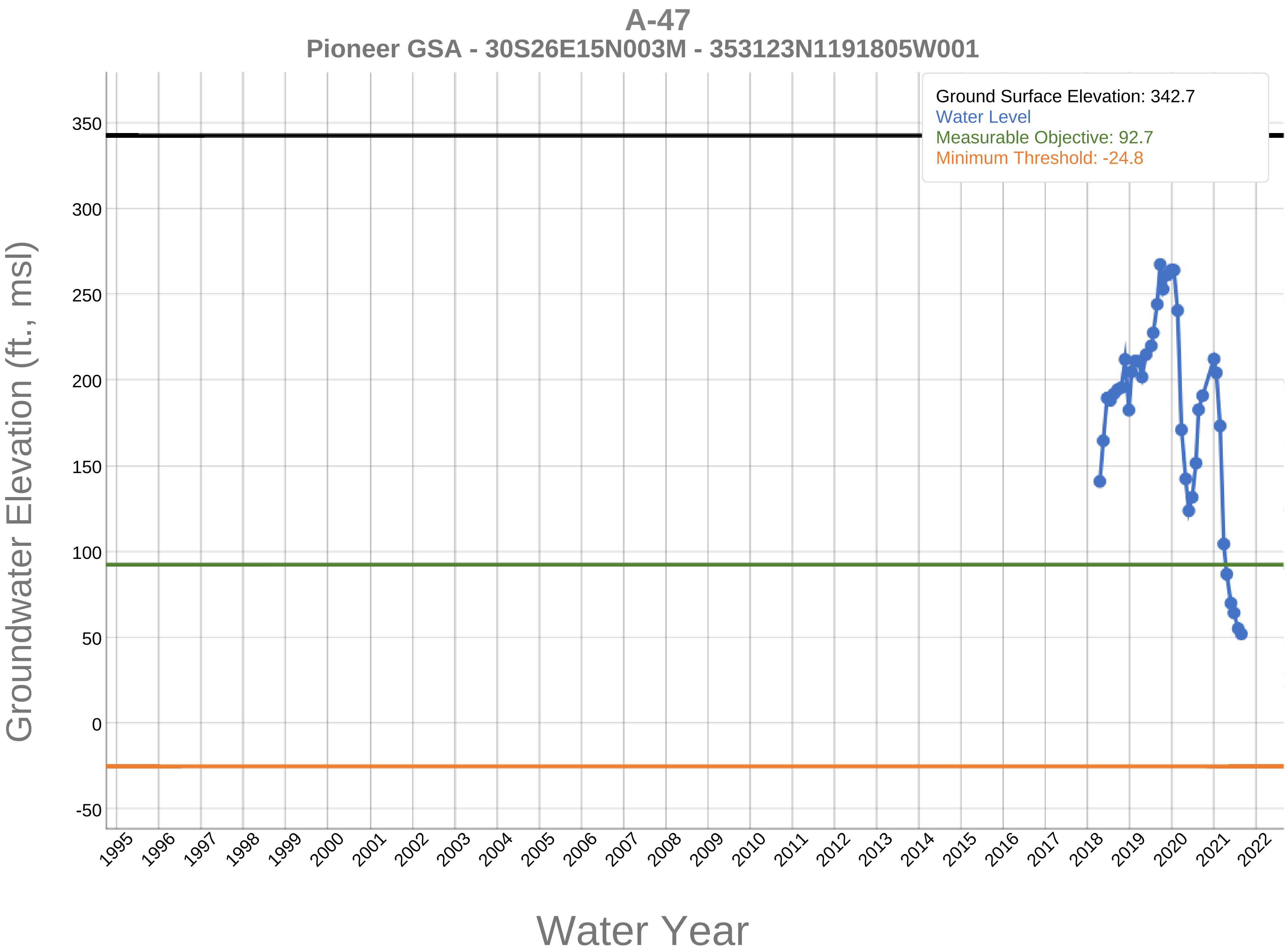
A-47
Pioneer GSA - 30S26E15N003M - 353123N1191805W001
Ground Surface Elevation: 342.7
Water Level
Measurable Objective: 92.7
Minimum Threshold: -24.8
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
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-50
1995
1996
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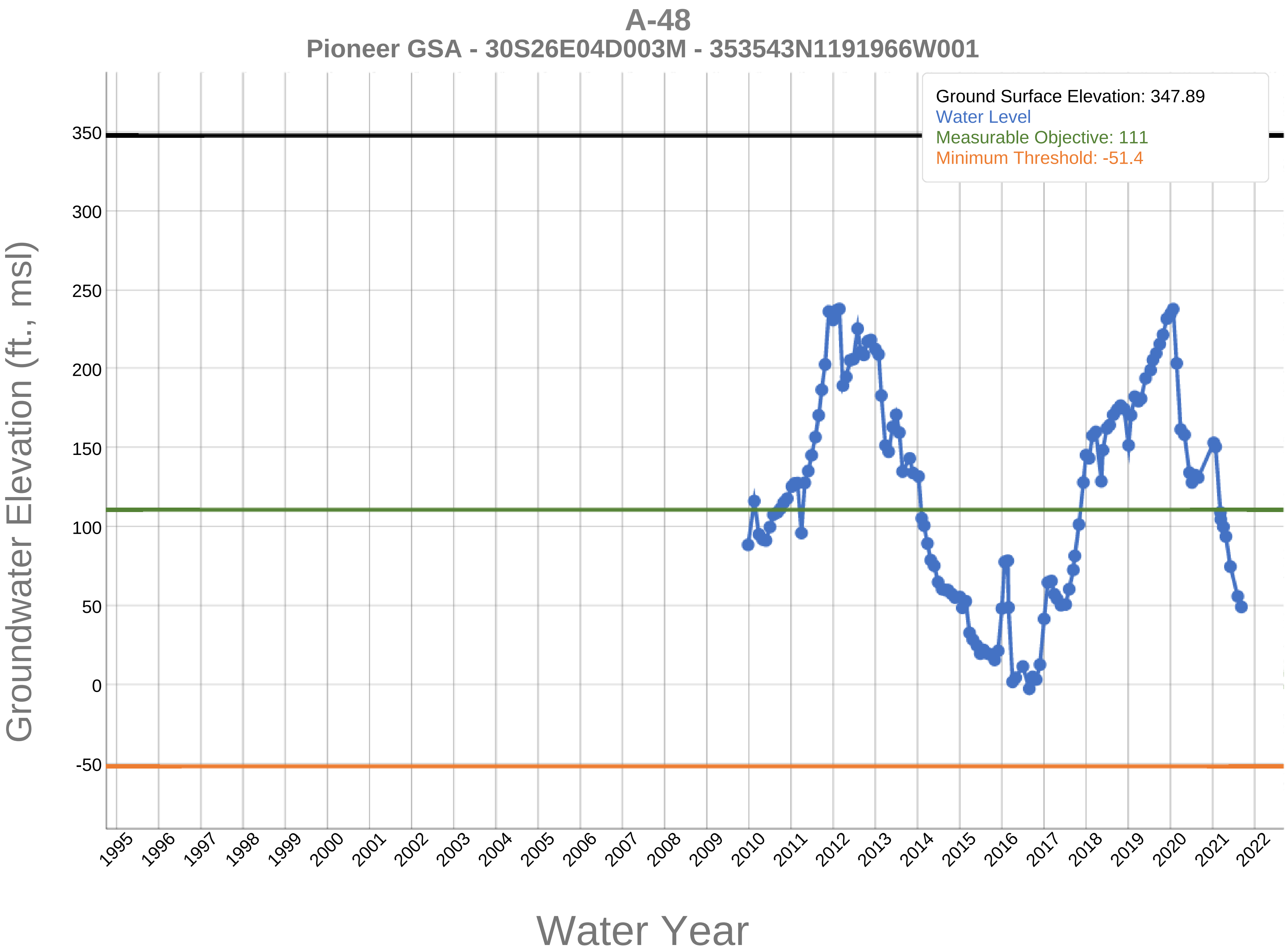
A-48
Pioneer GSA - 30S26E04D003M - 353543N1191966W001
Ground Surface Elevation: 347.89
Water Level
Measurable Objective: 111
Minimum Threshold: -51.4
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
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-50
1995
1996
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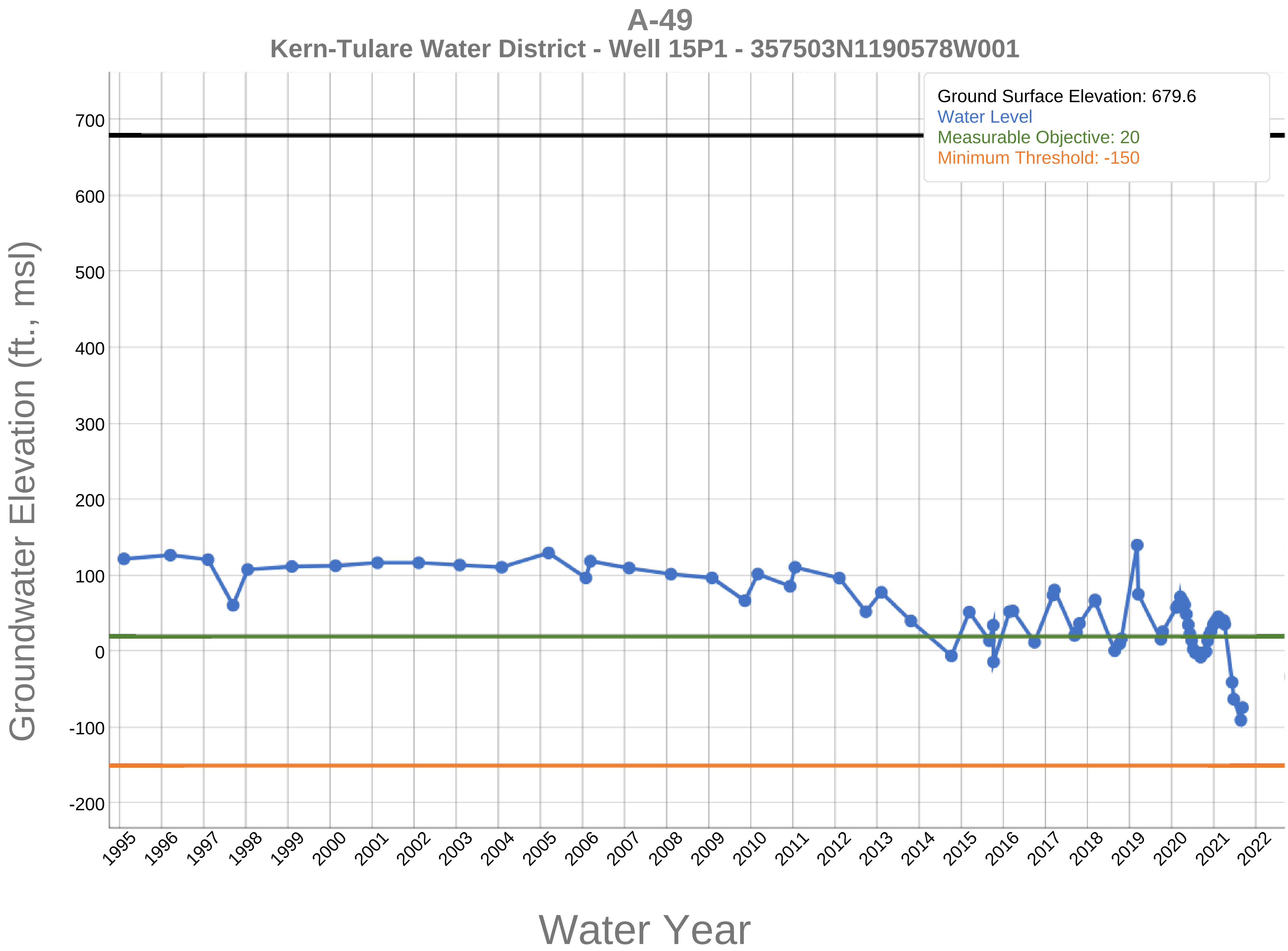
A-49
Kern-Tulare Water District - Well 15P1 - 357503N1190578W001
Ground Surface Elevation: 679.6
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
700
600
500
400
300
200
100
0
-100
-200
1995
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1999
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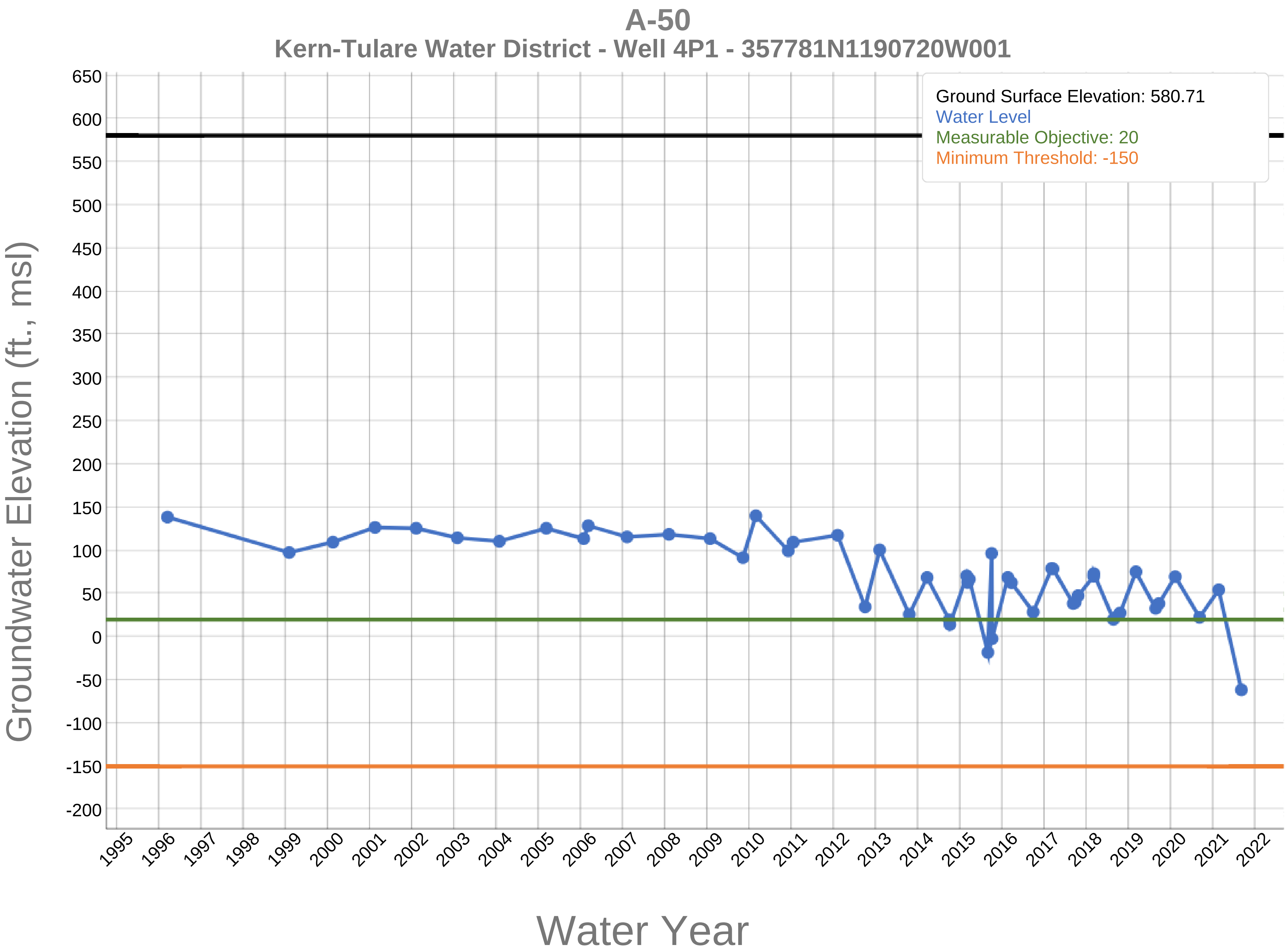
Water Year


A-50
Kern-Tulare Water District - Well 4P1 - 357781N1190720W001
Ground Surface Elevation: 580.71
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
650
600
550
500
450
400
350
300
250
200
150
100
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-50
-100
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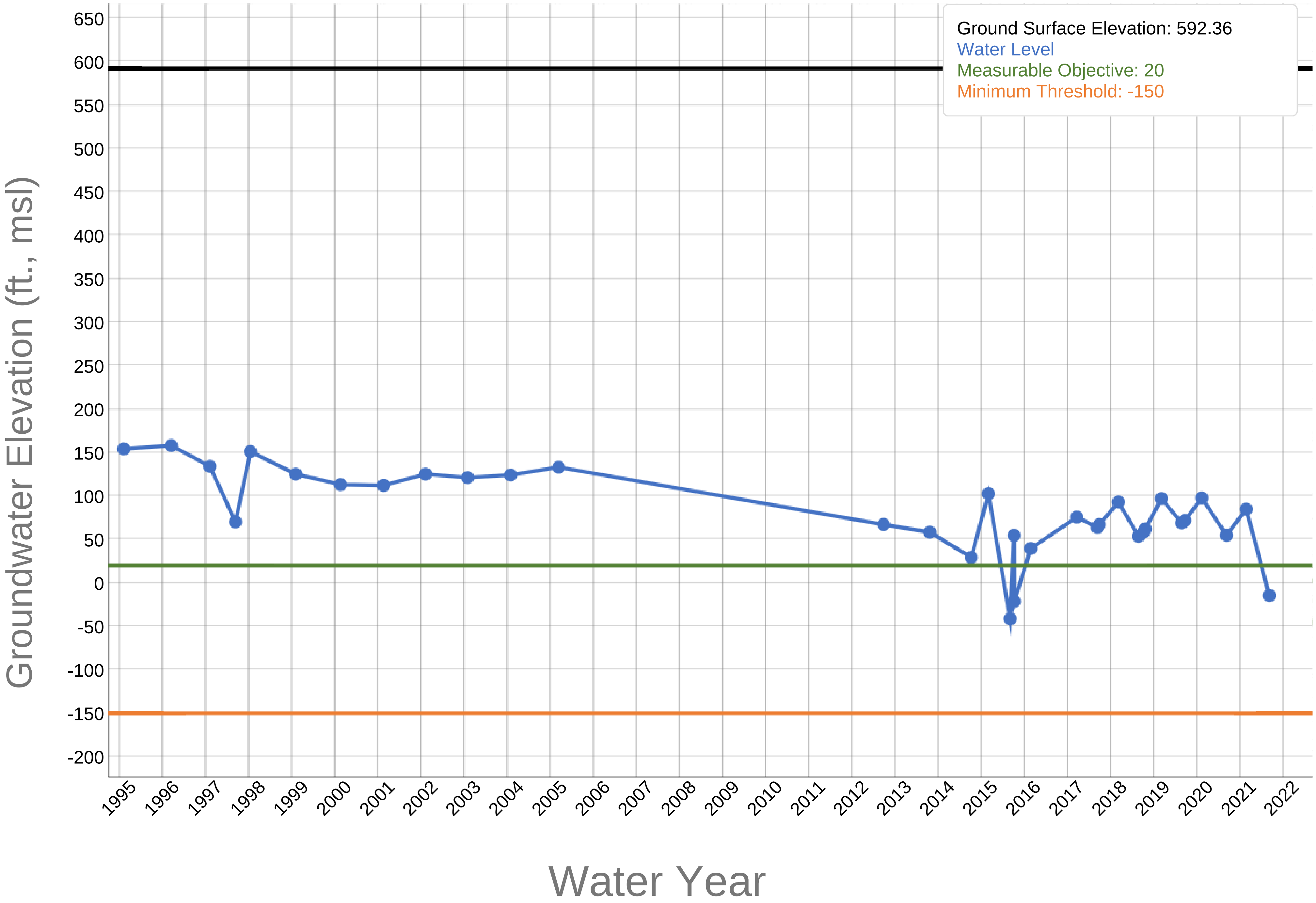
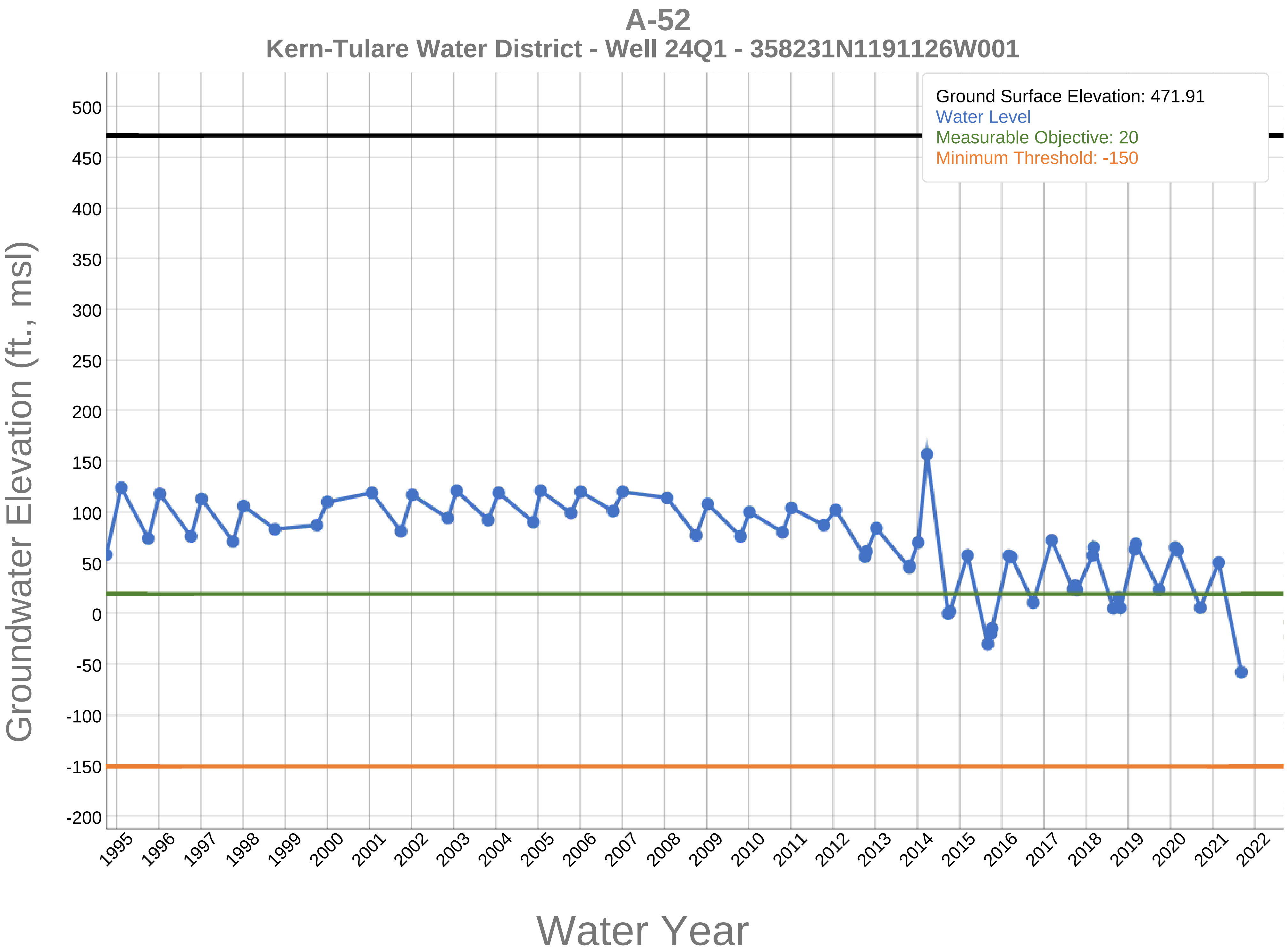
2022
Water Year

A-51

Kern-Tulare Water District - Well 20C1 - 357464N1190898W001




A-52
Kern-Tulare Water District - Well 24Q1 - 358231N1191126W001
Ground Surface Elevation: 471.91
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
150
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-200
1995
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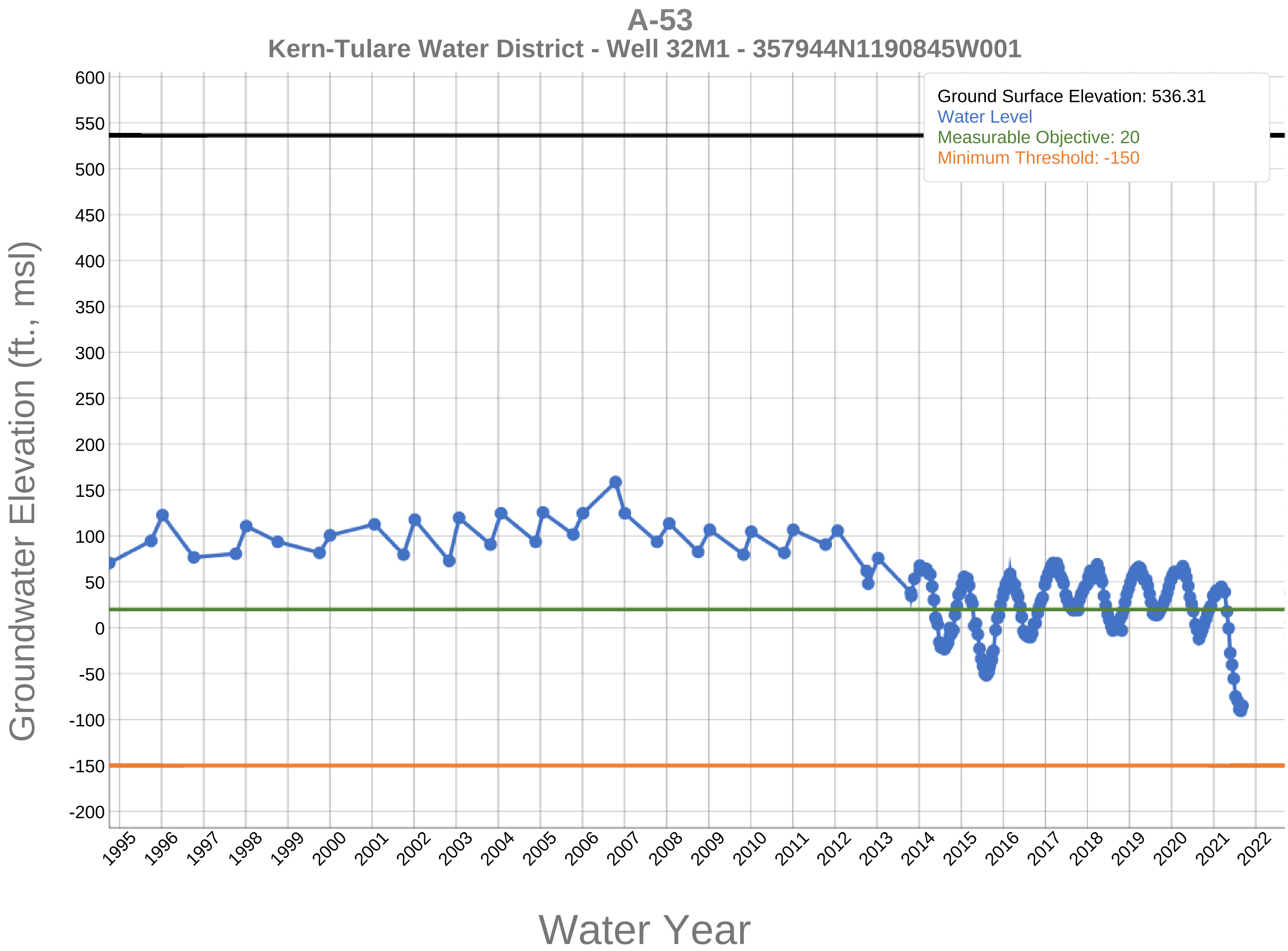
2022
Water Year


A-53
Kern-Tulare Water District - Well 32M1 - 357944N1190845W001
Ground Surface Elevation: 536.31
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
600
550
500
450
400
350
300
250
200
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-100
-150
-200
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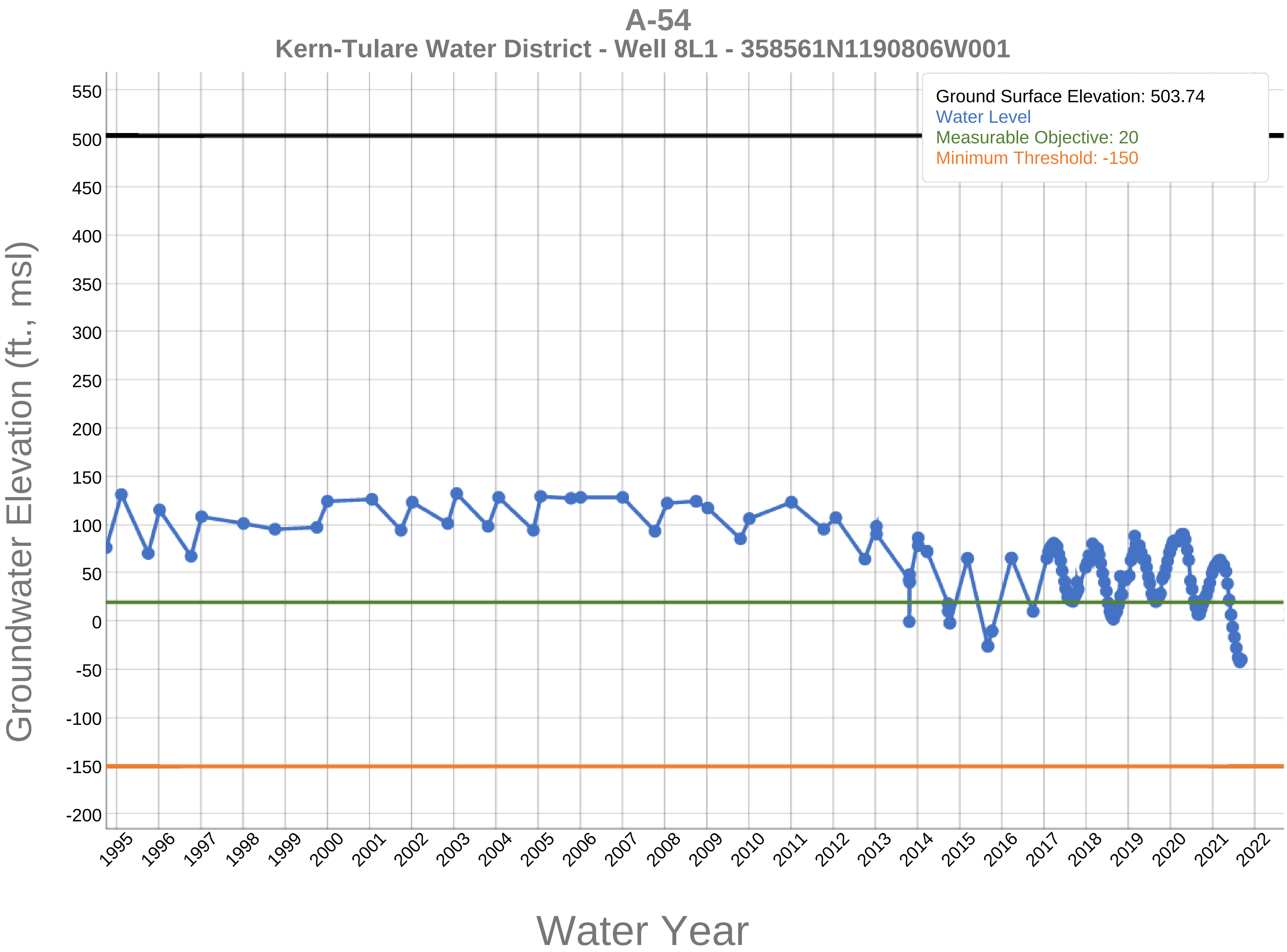
Water Year



A-54
Kern-Tulare Water District - Well 8L1 - 358561N1190806W001
Ground Surface Elevation: 503.74
Water Level
Measurable Objective: 20
Minimum Threshold: -150
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
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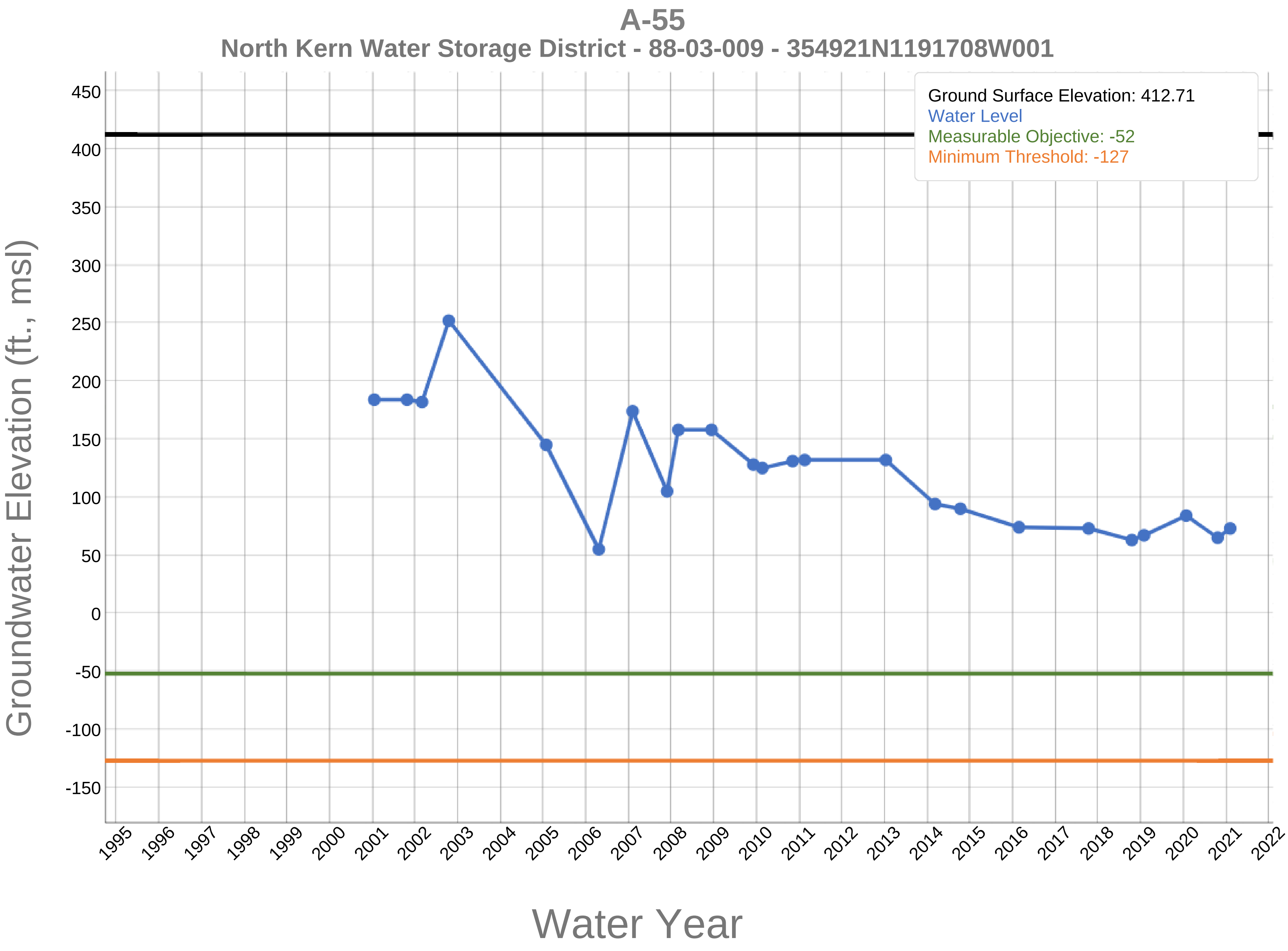
2021
2022
Water Year


A-55
North Kern Water Storage District - 88-03-009 - 354921N1191708W001
Ground Surface Elevation: 412.71
Water Level
Measurable Objective: -52
Minimum Threshold: -127
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
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-50
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-150
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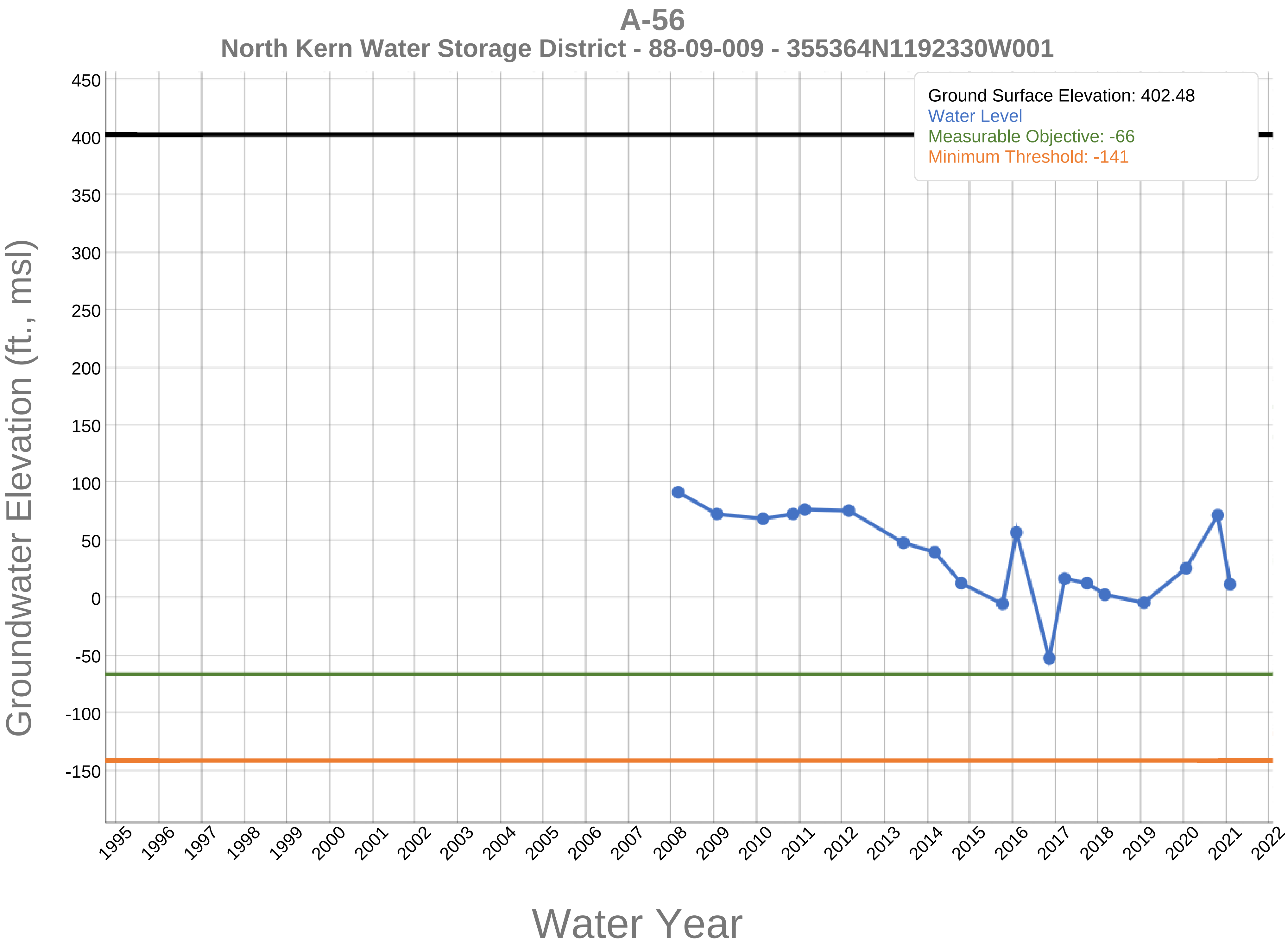
Water Year



A-56
North Kern Water Storage District - 88-09-009 - 355364N1192330W001
Ground Surface Elevation: 402.48
Water Level
Measurable Objective: -66
Minimum Threshold: -141
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
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100
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-50
-100
-150
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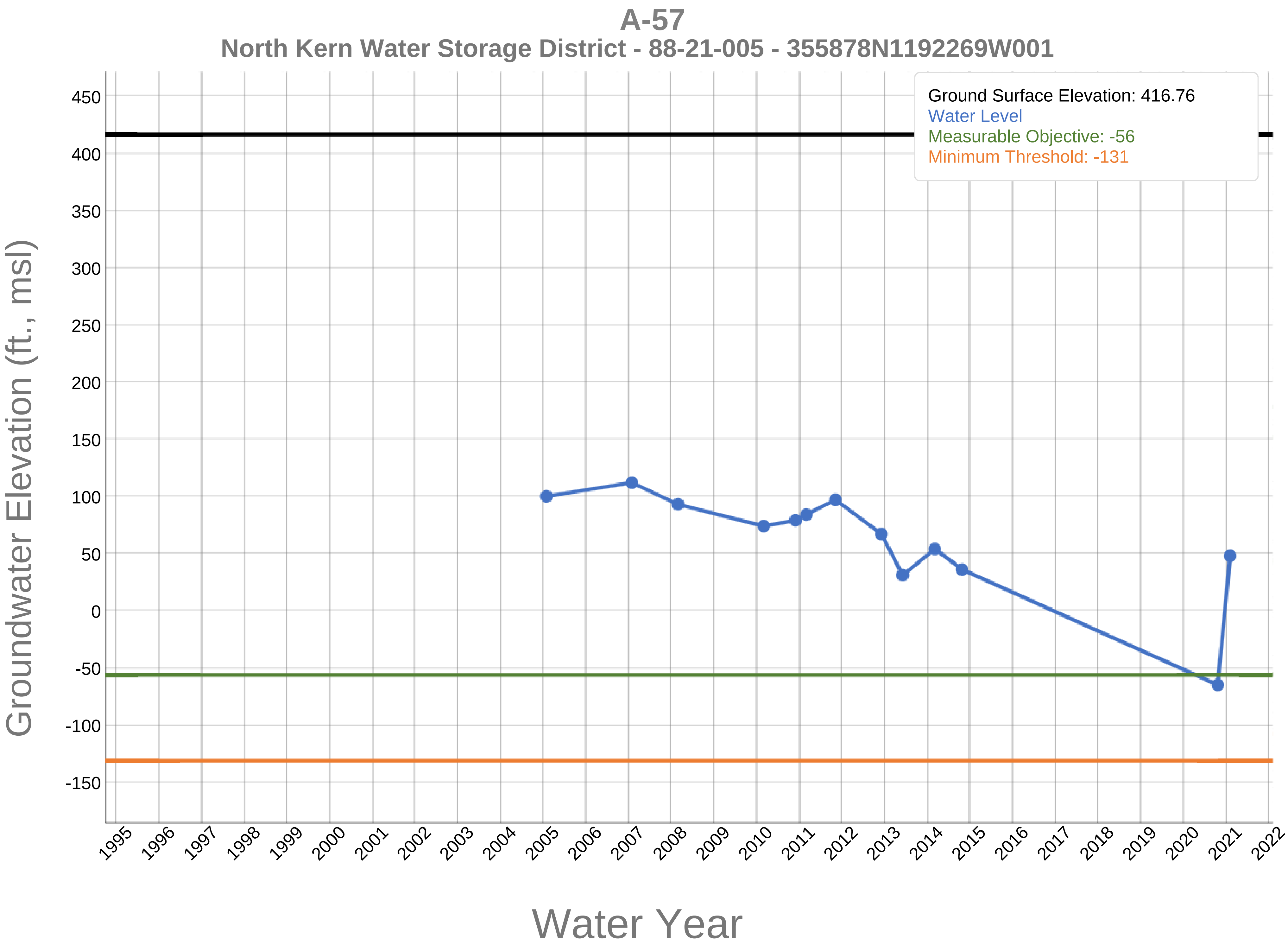
2021
2022
Water Year


A-57
North Kern Water Storage District - 88-21-005 - 355878N1192269W001
Ground Surface Elevation: 416.76
Water Level
Measurable Objective: -56
Minimum Threshold: -131
Groundwater Elevation (ft., msl)
Water Year
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
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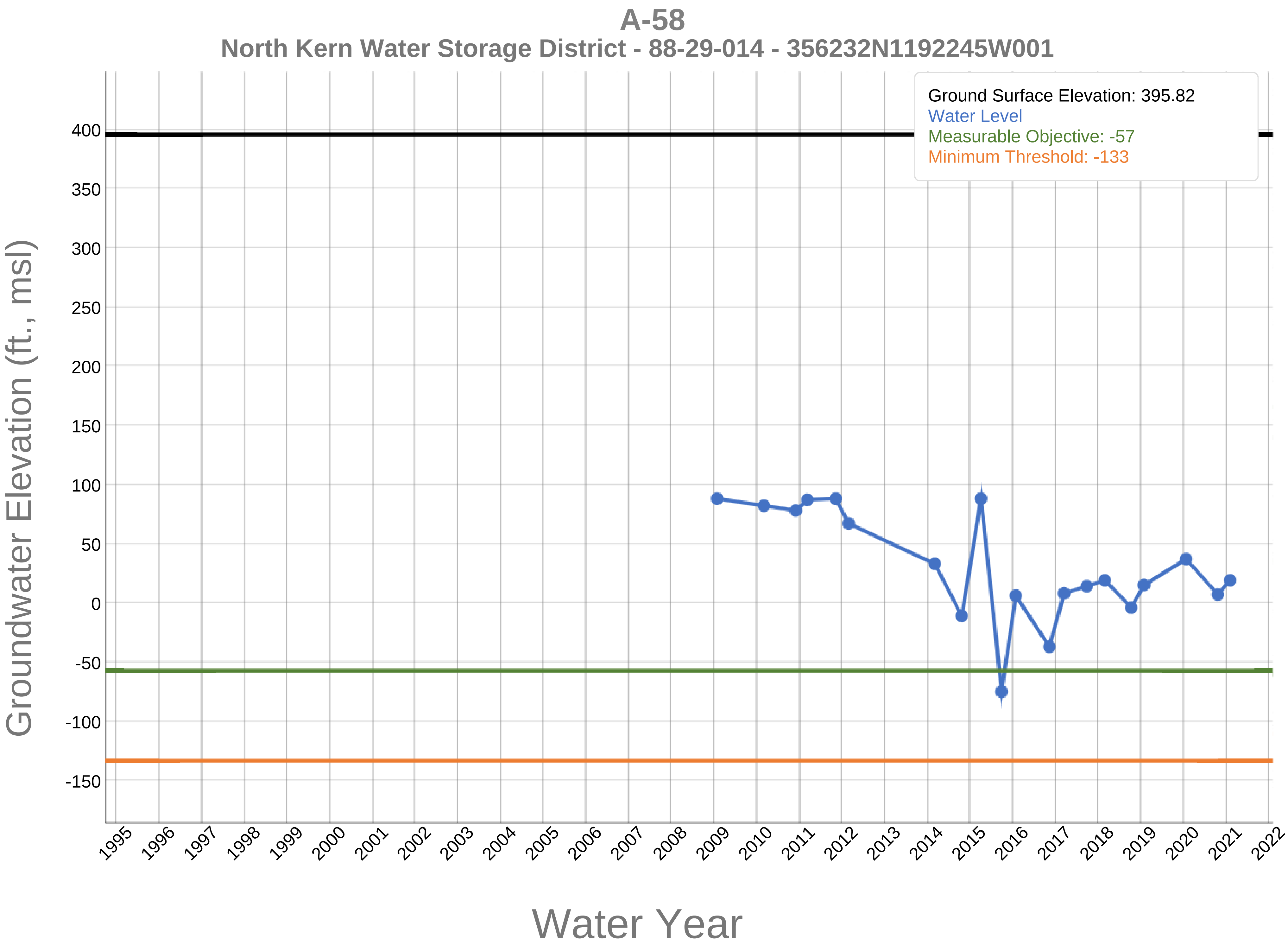
A-58
North Kern Water Storage District - 88-29-014 - 356232N1192245W001
Ground Surface Elevation: 395.82
Water Level
Measurable Objective: -57
Minimum Threshold: -133
Groundwater Elevation (ft., msl)
Water Year
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
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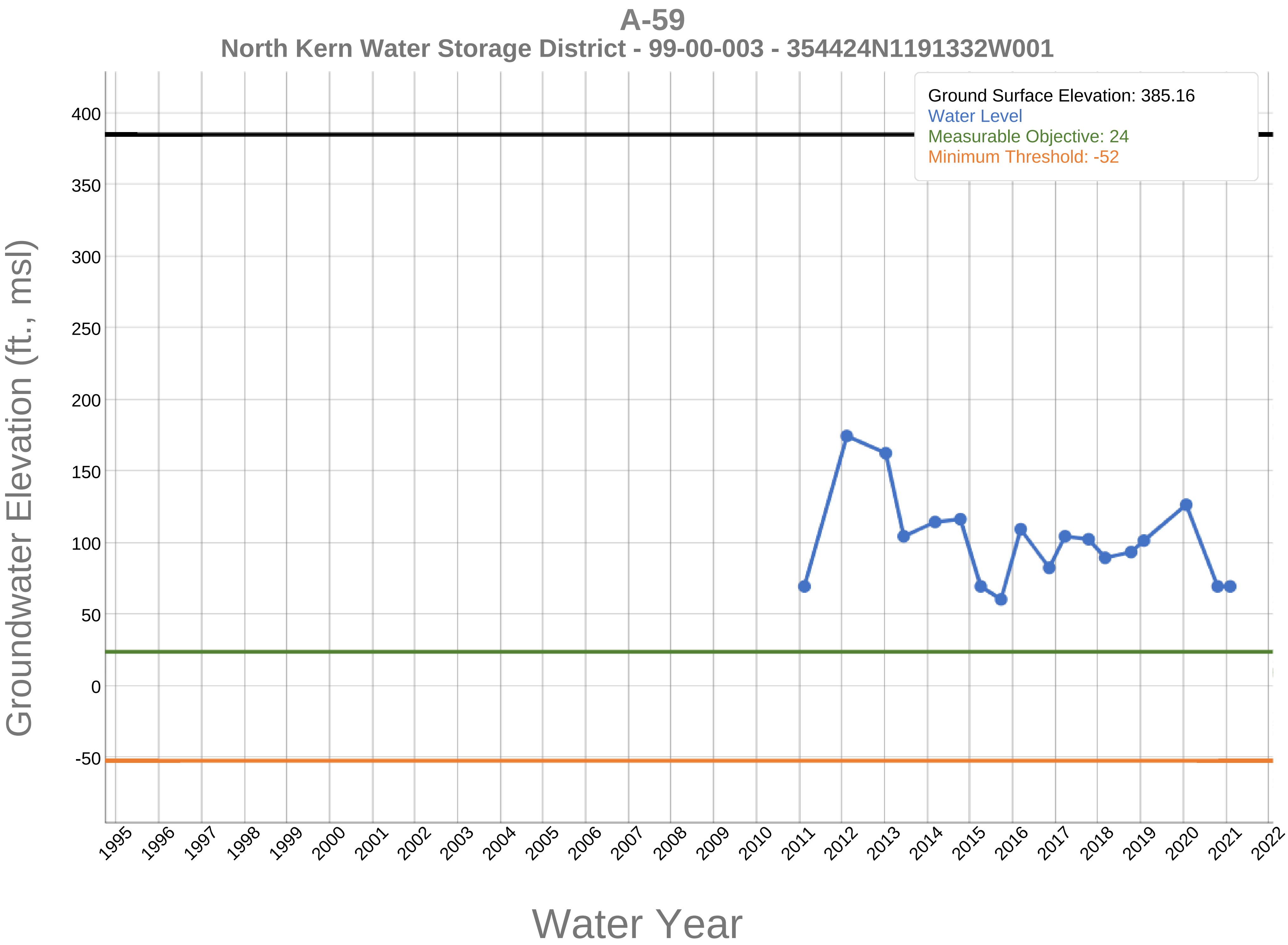
A-59
North Kern Water Storage District - 99-00-003 - 354424N1191332W001
Ground Surface Elevation: 385.16
Water Level
Measurable Objective: 24
Minimum Threshold: -52
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
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-50
1995
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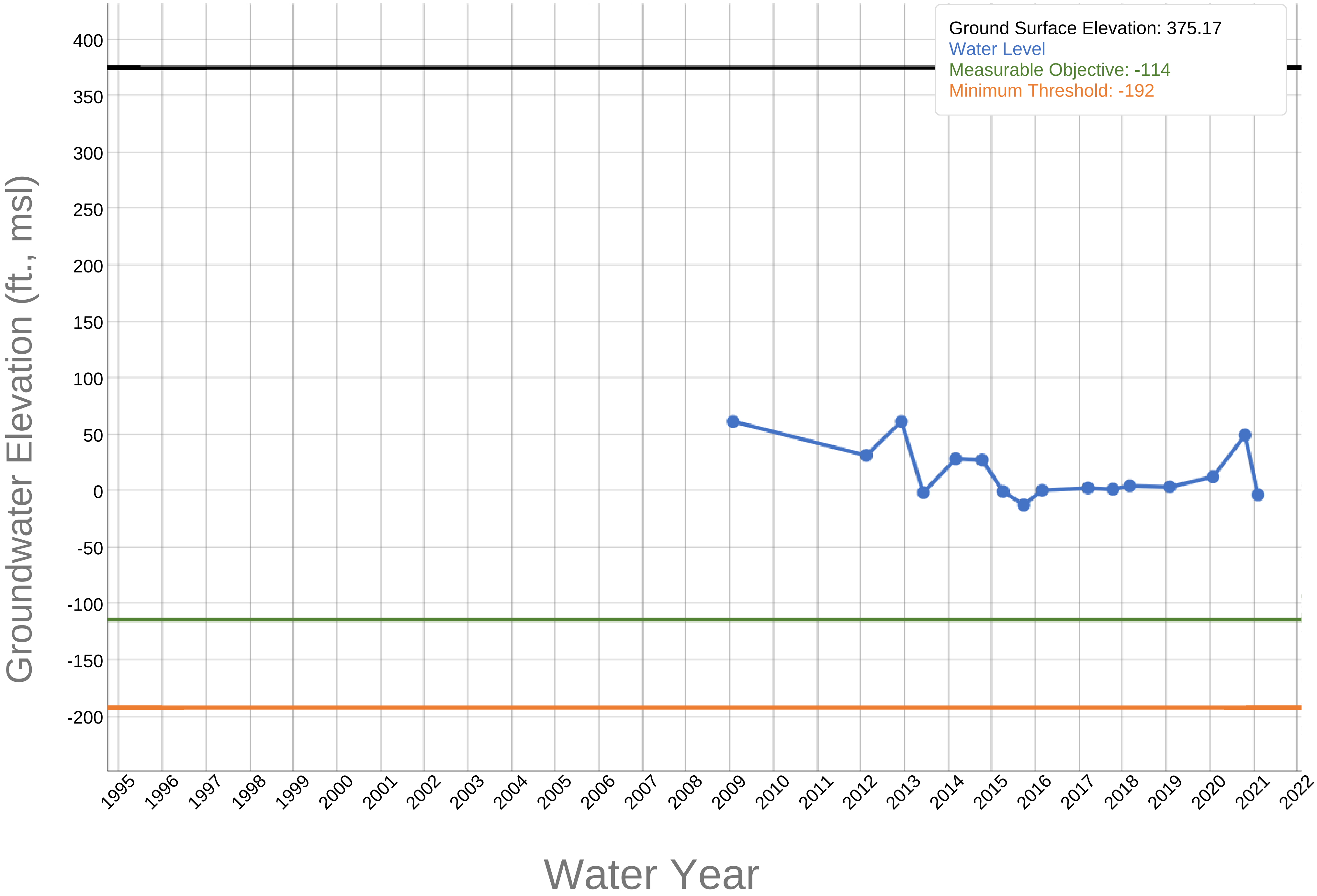
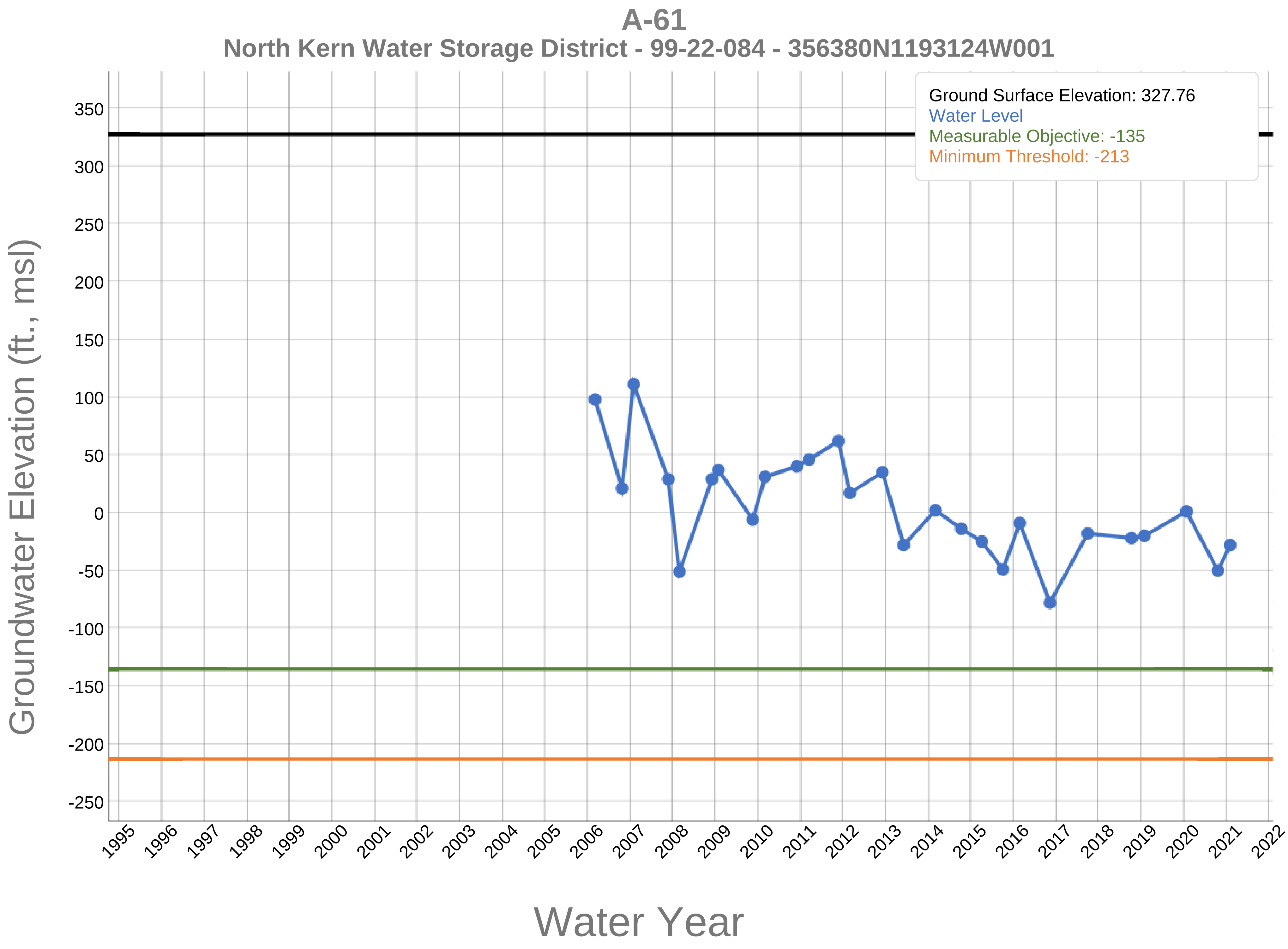
2022
Water Year

A-60
North Kern Water Storage District - 99-00-081 - 355764N1192818W001




A-61
North Kern Water Storage District - 99-22-084 - 356380N1193124W001
Ground Surface Elevation: 327.76
Water Level
Measurable Objective: -135
Minimum Threshold: -213
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
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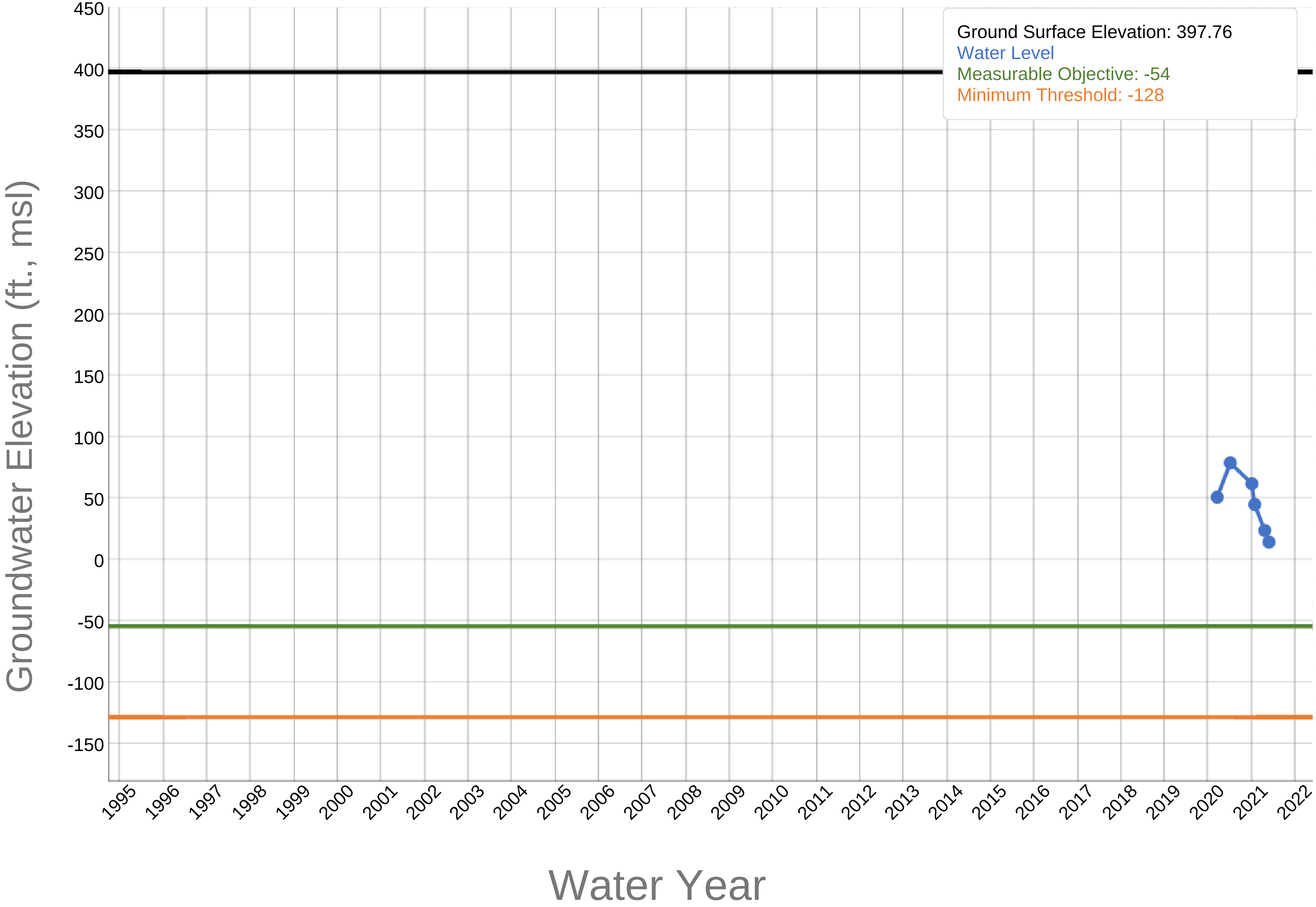
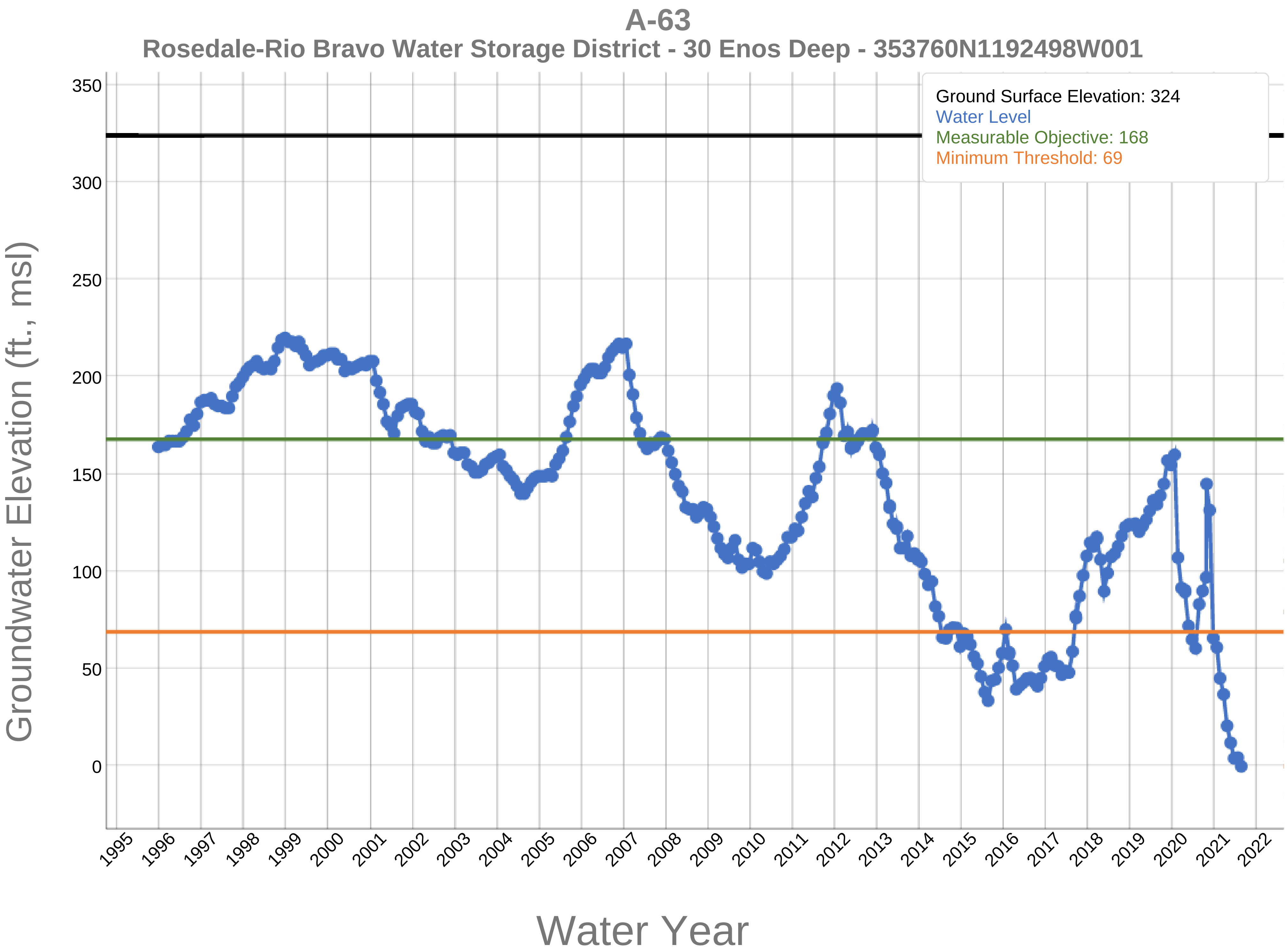
2022
Water Year

A-62

North Kern Water Storage District - Shafter Well 18 - 355010N1192067W001





A-63
Rosedale-Rio Bravo Water Storage District - 30 Enos Deep - 353760N1192498W001
Ground Surface Elevation: 324
Water Level
Measurable Objective: 168
Minimum Threshold: 69
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
1995
1996
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1999
2000
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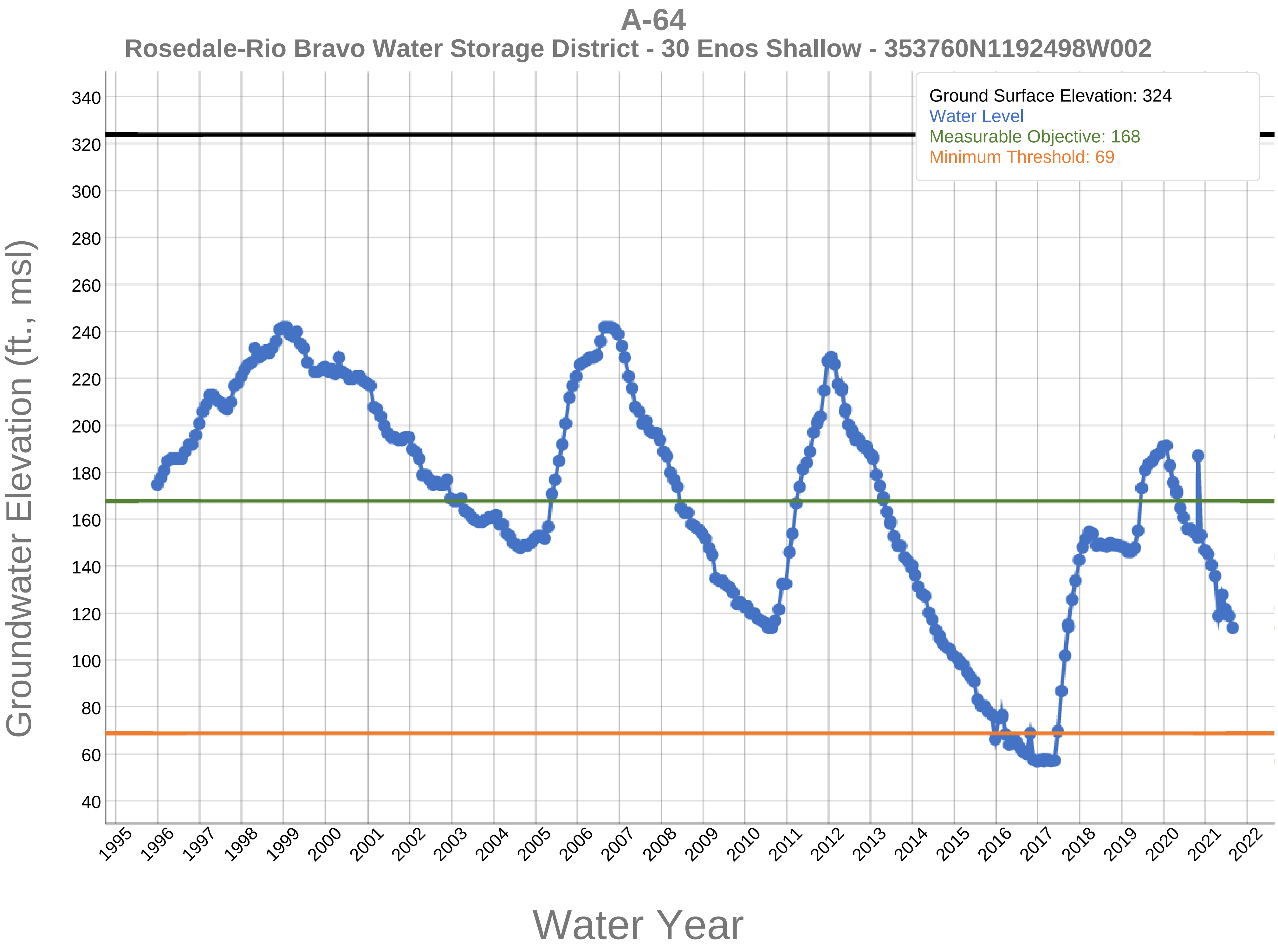
Water Year



A-64
Rosedale-Rio Bravo Water Storage District - 30 Enos Shallow - 353760N1192498W002
Ground Surface Elevation: 324
Water Level
Measurable Objective: 168
Minimum Threshold: 69
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
1995
1996
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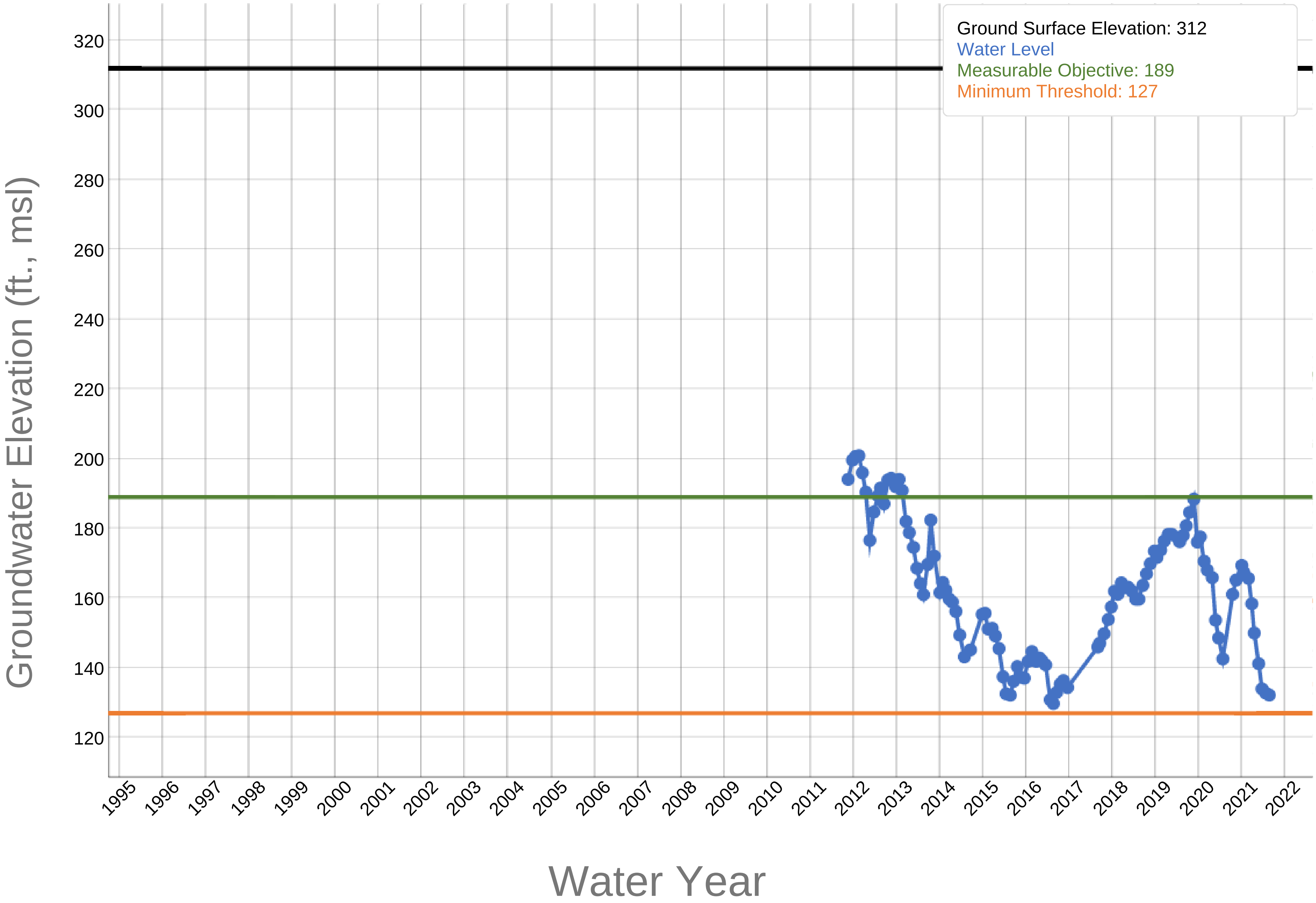
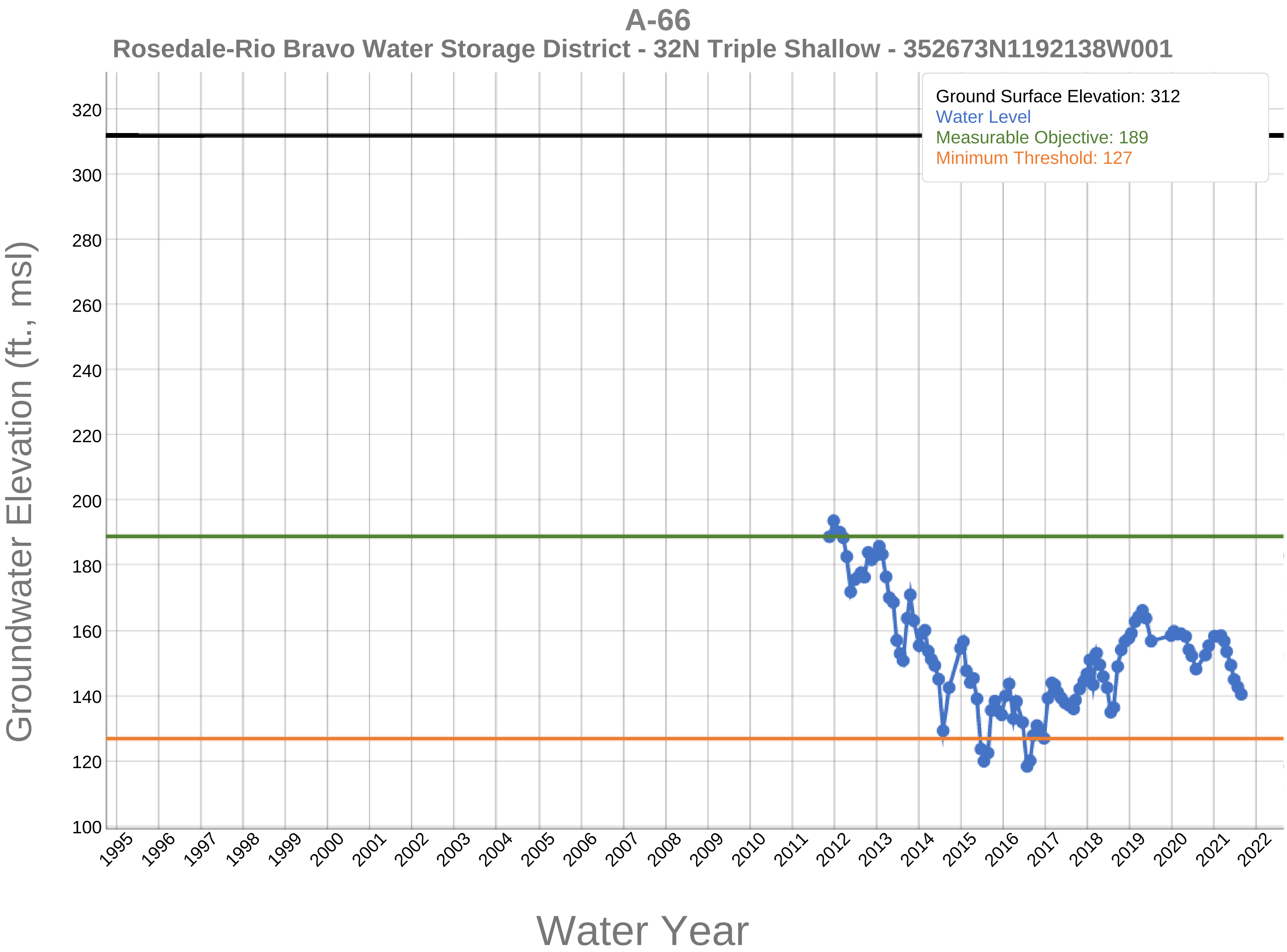
2022
Water Year

A-65
Rosedale-Rio Bravo Water Storage District - 32N Triple - 352673N1192138W002




A-66
Rosedale-Rio Bravo Water Storage District - 32N Triple Shallow - 352673N1192138W001
Ground Surface Elevation: 312
Water Level
Measurable Objective: 189
Minimum Threshold: 127
Groundwater Elevation (ft., msl)
320
300
280
260
240
220
200
180
160
140
120
100
1995
1996
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1998
1999
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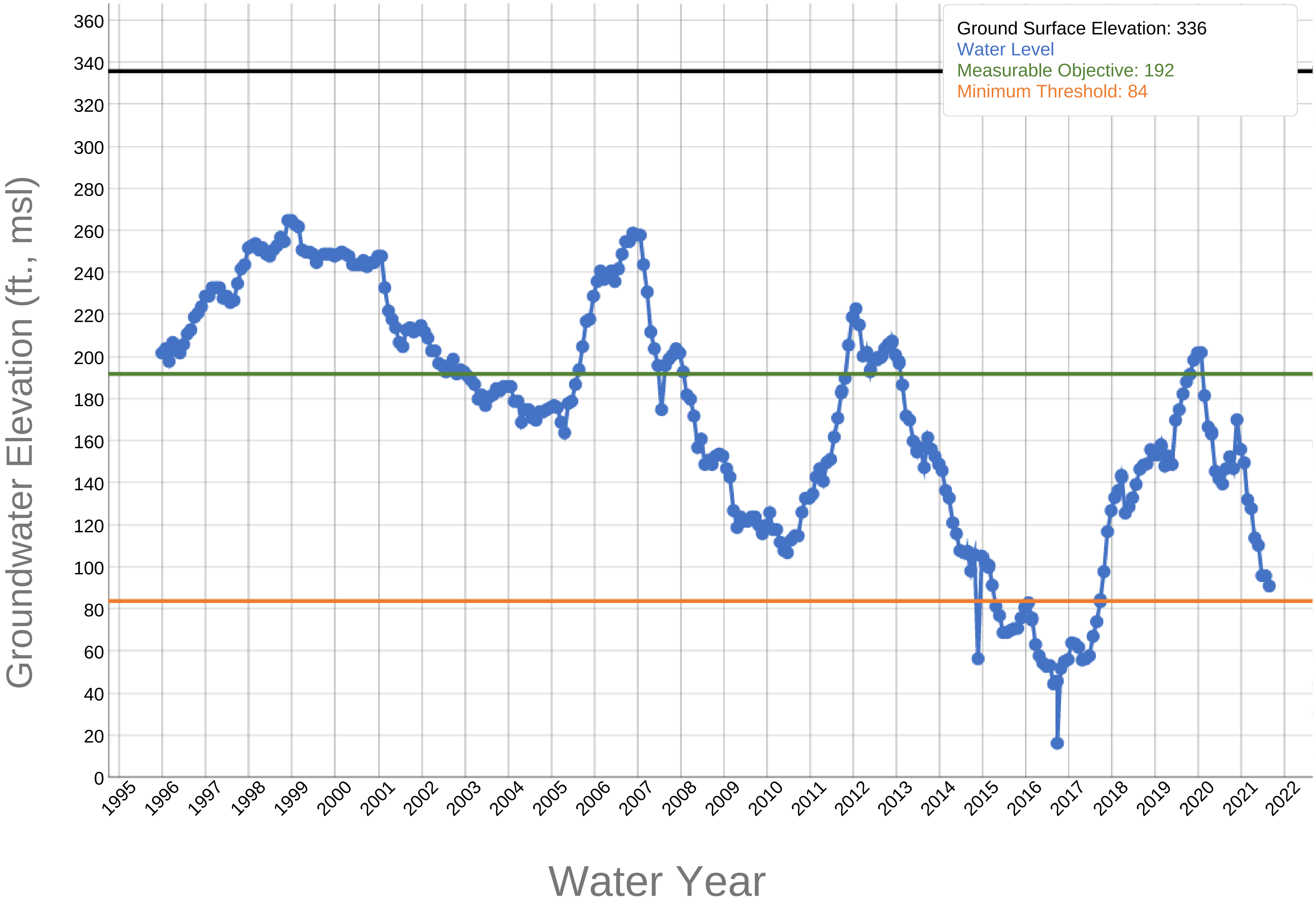
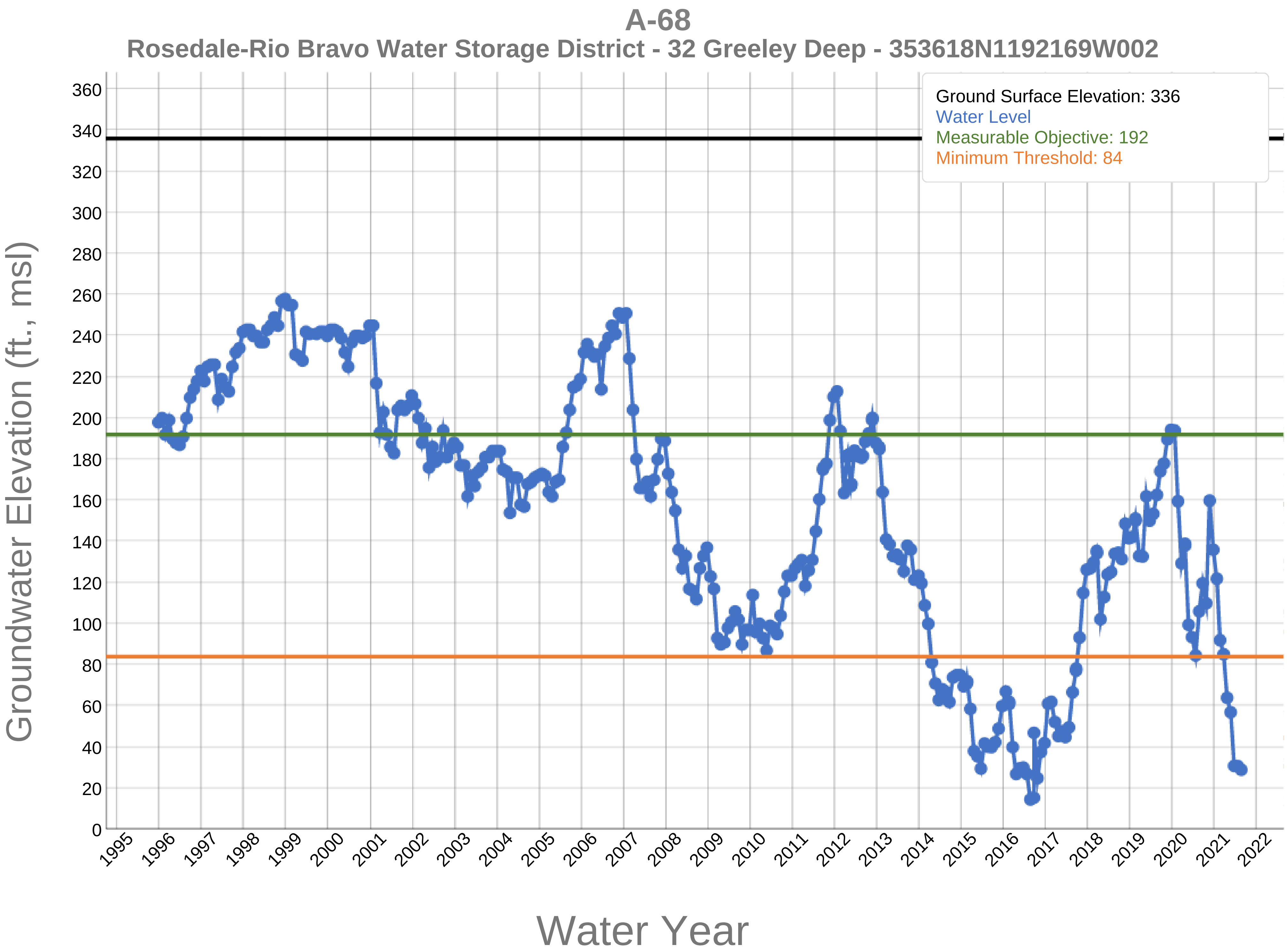
Water Year

A-67

Rosedale-Rio Bravo Water Storage District - 32 Greeley Shallow - 353618N1192169W001




A-68
Rosedale-Rio Bravo Water Storage District - 32 Greeley Deep - 353618N1192169W002
Ground Surface Elevation: 336
Water Level
Measurable Objective: 192
Minimum Threshold: 84
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
1995
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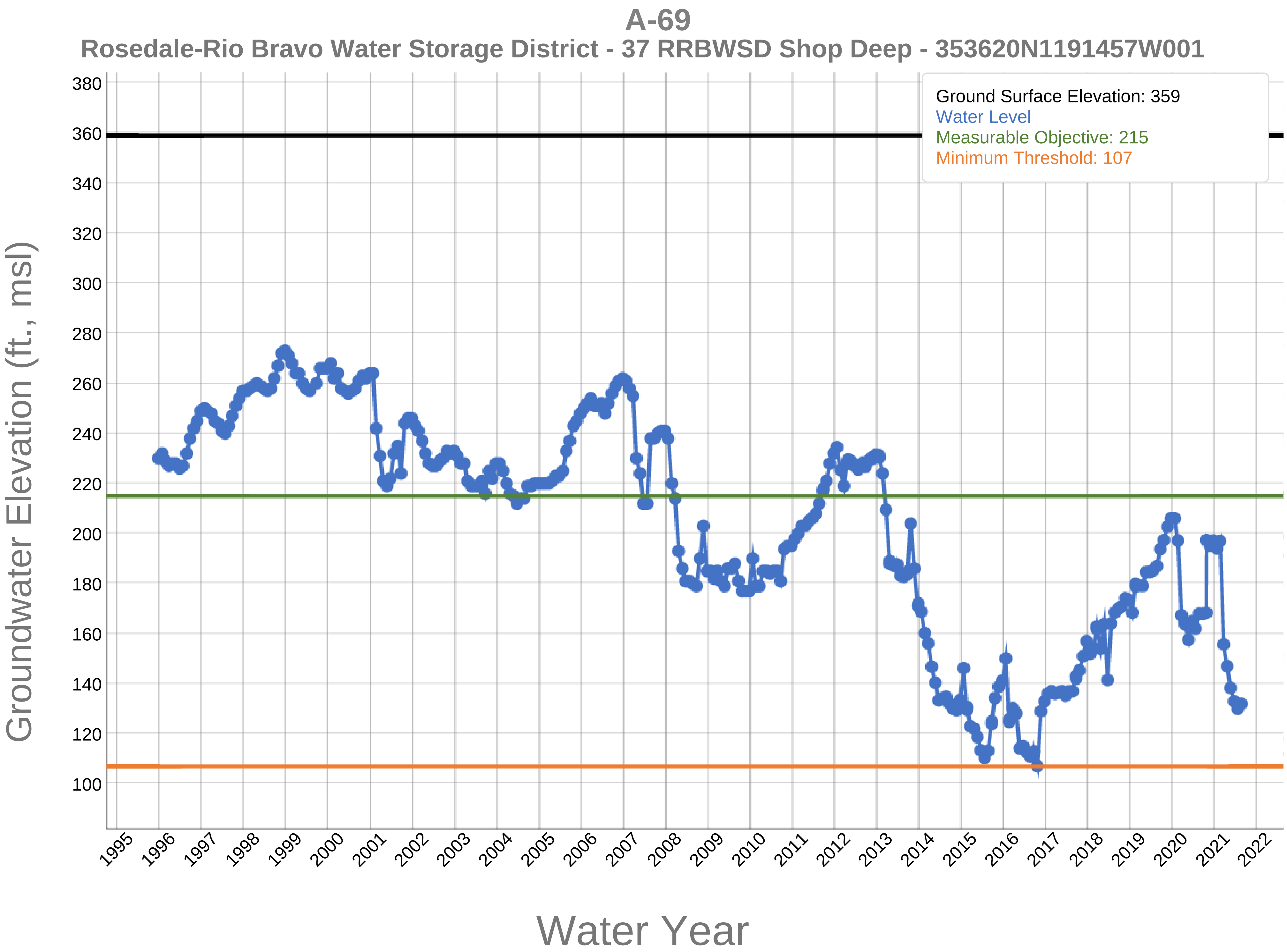
A-69
Rosedale-Rio Bravo Water Storage District - 37 RRBWSD Shop Deep - 353620N1191457W001
Ground Surface Elevation: 359
Water Level
Measurable Objective: 215
Minimum Threshold: 107
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
1995
1996
1997
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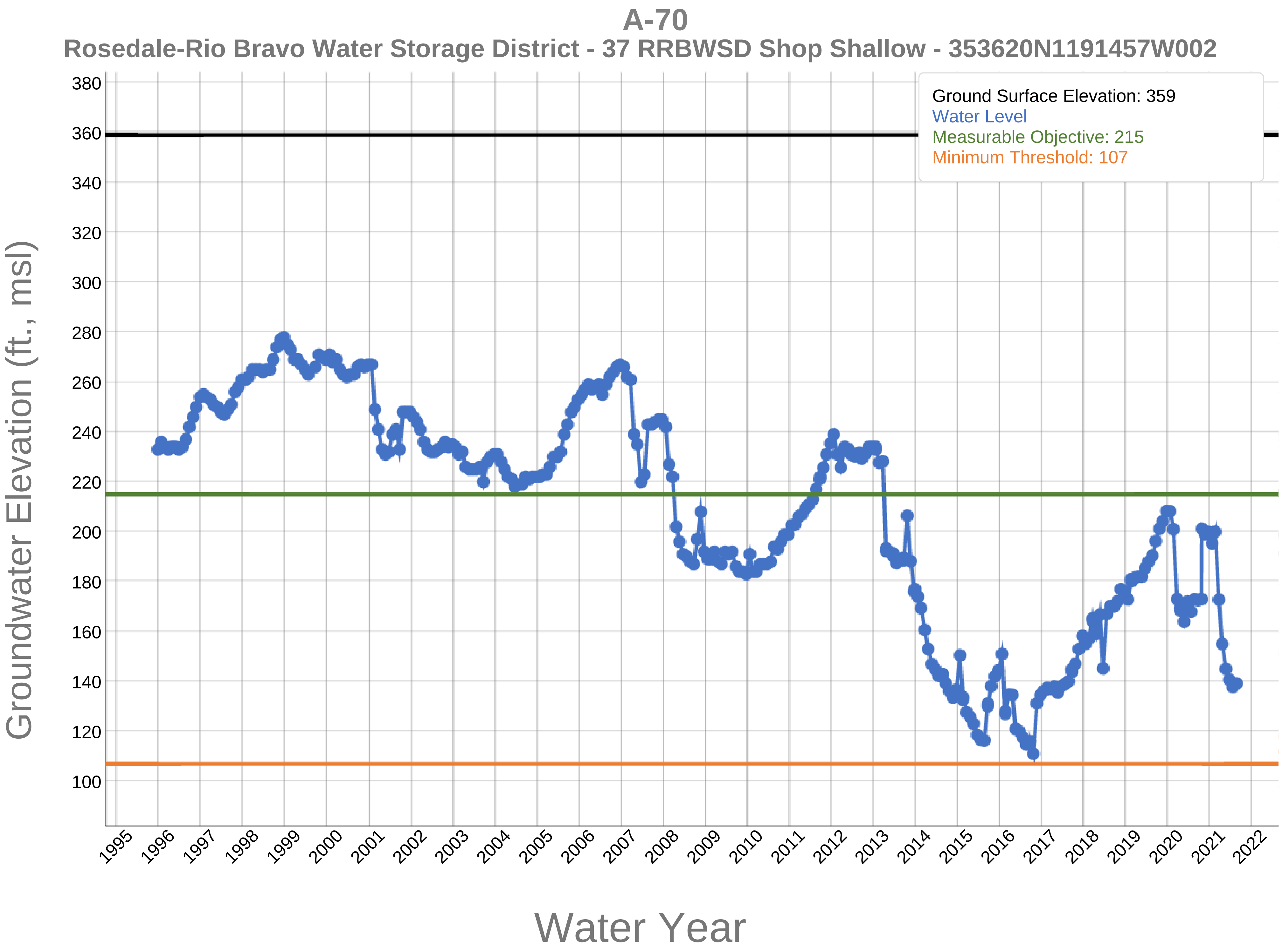
Water Year



A-70
Rosedale-Rio Bravo Water Storage District - 37 RRBWSD Shop Shallow - 353620N1191457W002
Ground Surface Elevation: 359
Water Level
Measurable Objective: 215
Minimum Threshold: 107
Groundwater Elevation (ft., msl)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
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1995
1996
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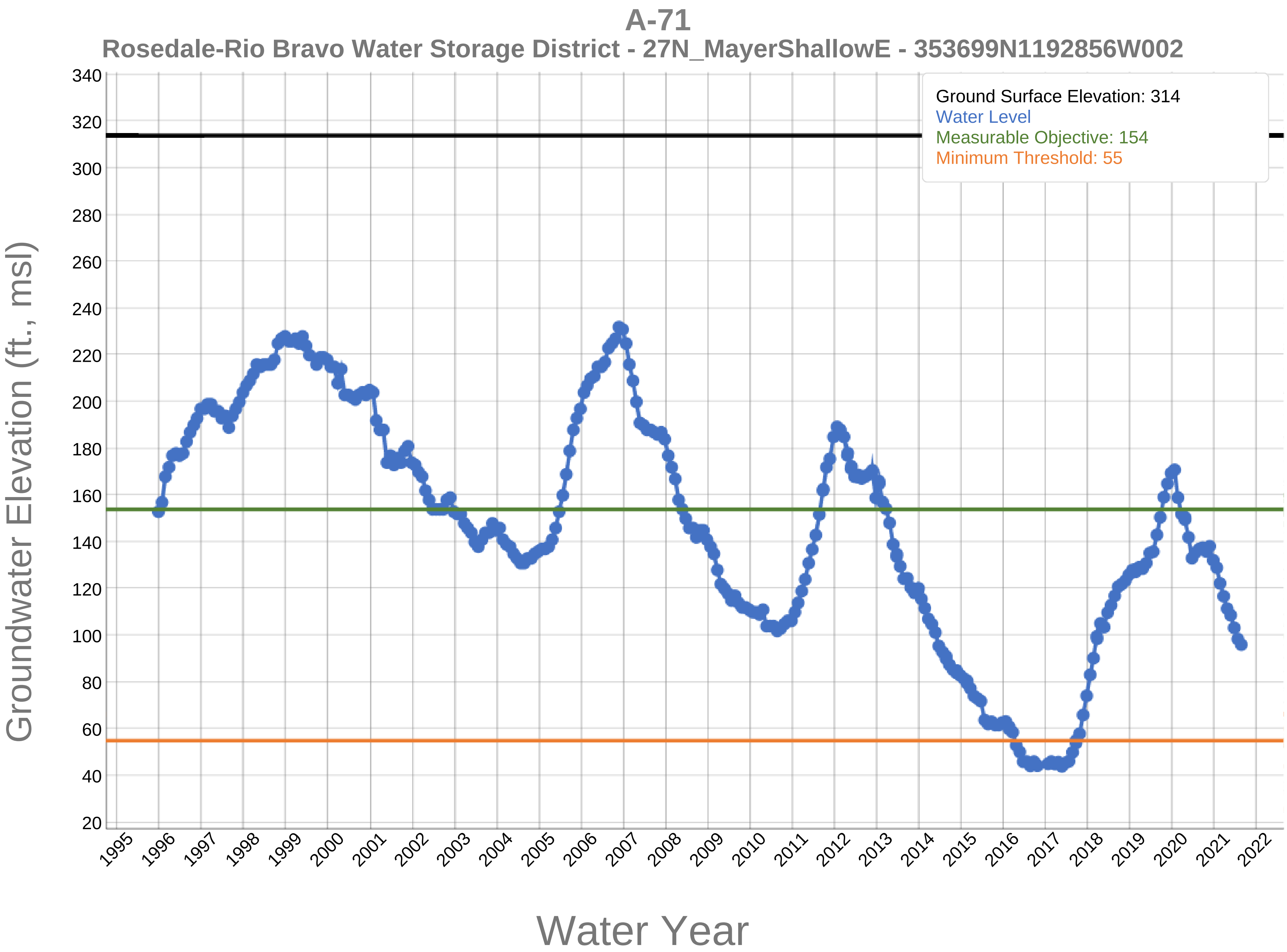
2021
2022
Water Year



A-71
Rosedale-Rio Bravo Water Storage District - 27N_MayerShallowE - 353699N1192856W002
Ground Surface Elevation: 314
Water Level
Measurable Objective: 154
Minimum Threshold: 55
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
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120
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1995
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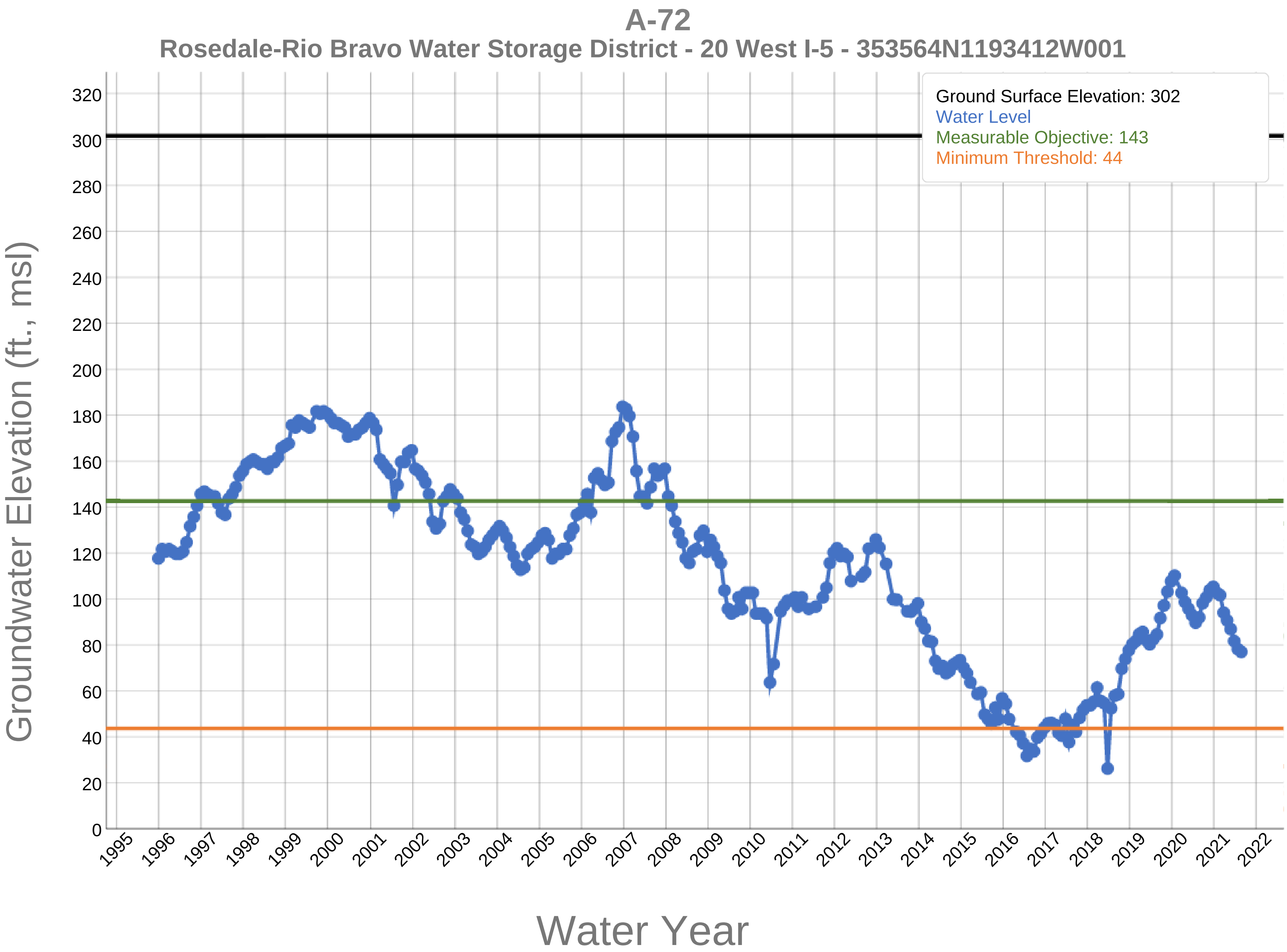
2022
Water Year



A-72
Rosedale-Rio Bravo Water Storage District - 20 West I-5 - 353564N1193412W001
Ground Surface Elevation: 302
Water Level
Measurable Objective: 143
Minimum Threshold: 44
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
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320
1995
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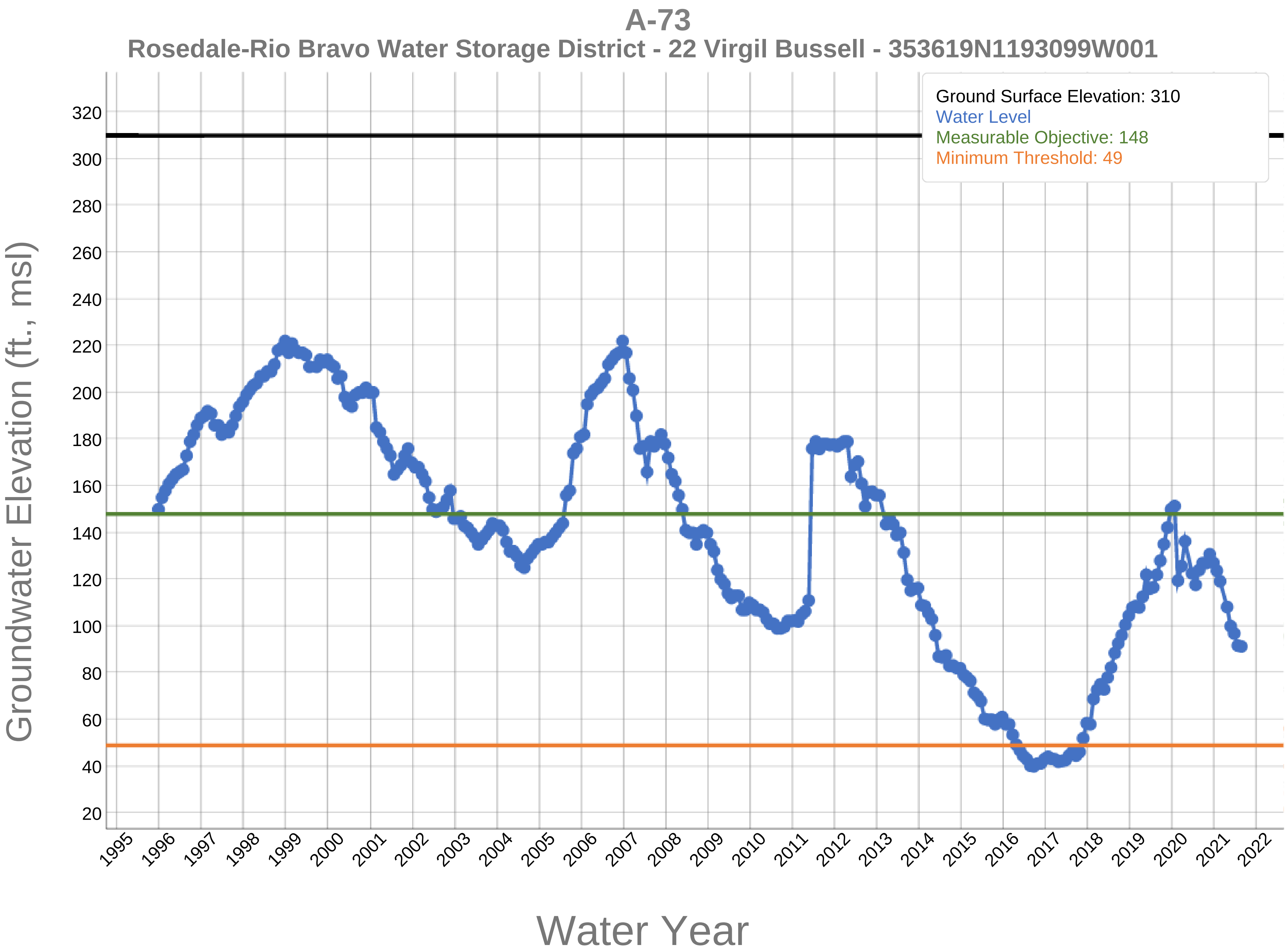
Water Year


A-73
Rosedale-Rio Bravo Water Storage District - 22 Virgil Bussell - 353619N1193099W001
Ground Surface Elevation: 310
Water Level
Measurable Objective: 148
Minimum Threshold: 49
Groundwater Elevation (ft., msl)
Water Year
320
300
280
260
240
220
200
180
160
140
120
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1995
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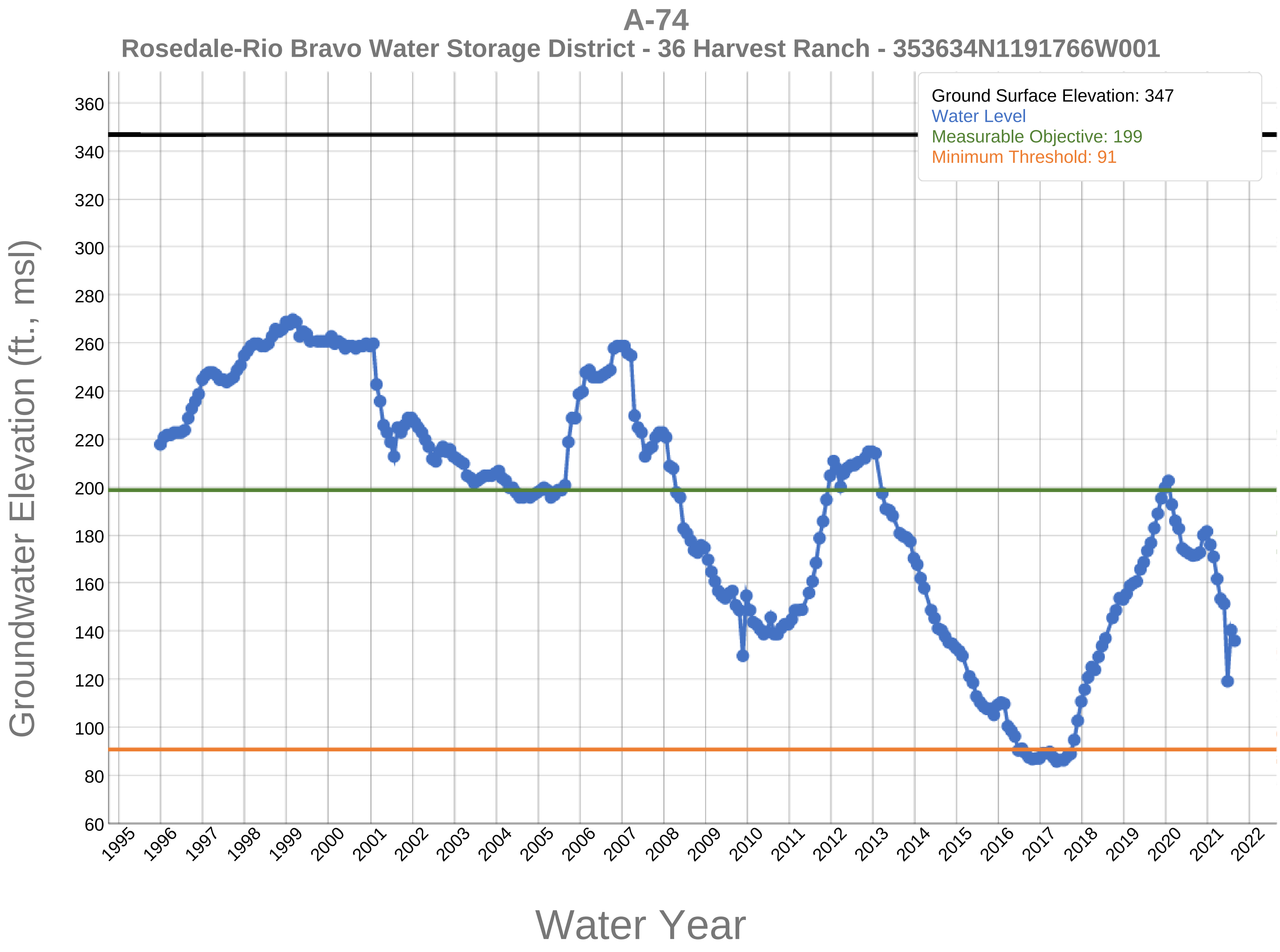
A-74
Rosedale-Rio Bravo Water Storage District - 36 Harvest Ranch - 353634N1191766W001
Ground Surface Elevation: 347
Water Level
Measurable Objective: 199
Minimum Threshold: 91
Groundwater Elevation (ft., msl)
360
340
320
300
280
260
240
220
200
180
160
140
120
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60
1995
1996
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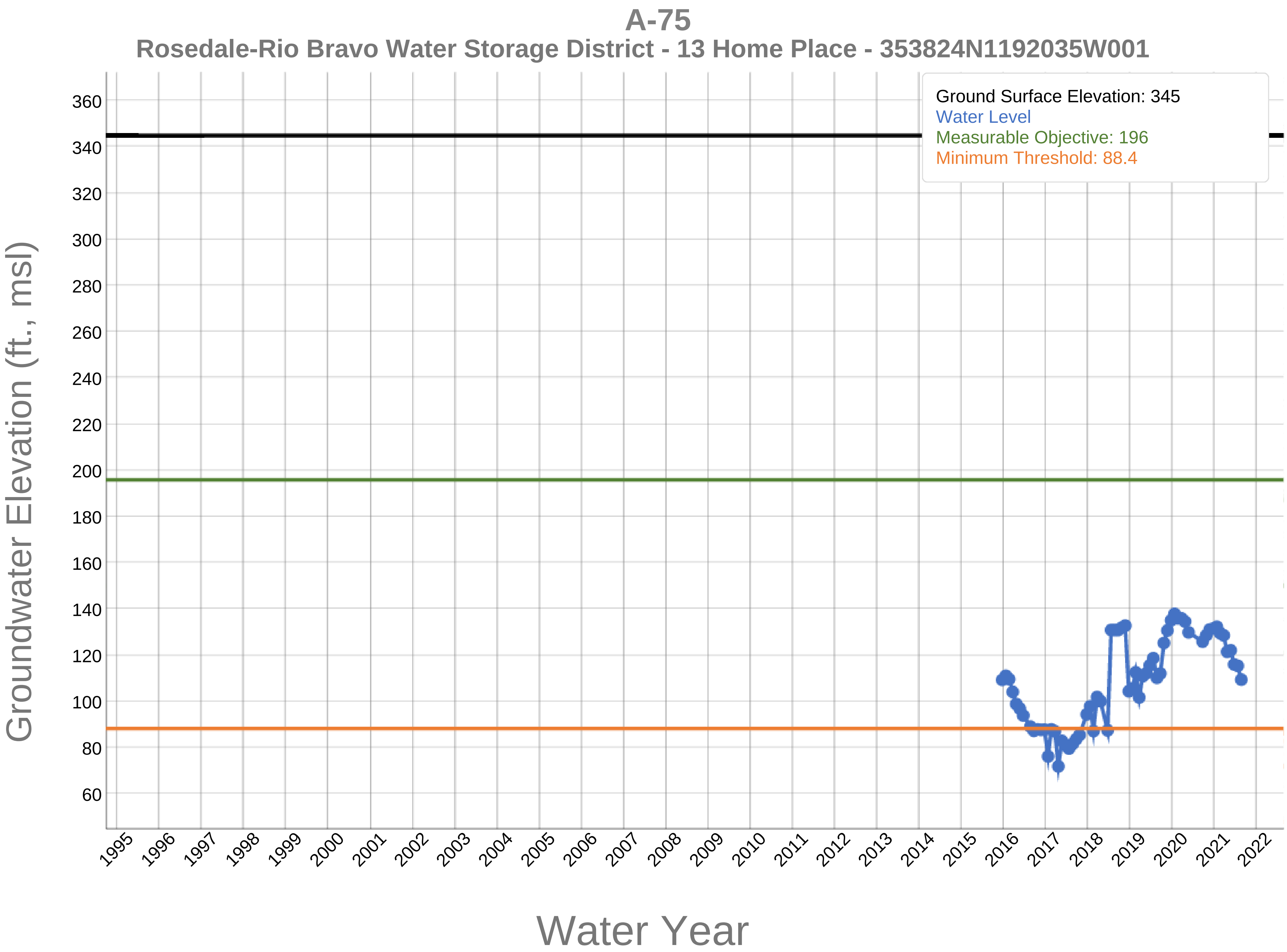
Water Year


A-75
Rosedale-Rio Bravo Water Storage District - 13 Home Place - 353824N1192035W001
Ground Surface Elevation: 345
Water Level
Measurable Objective: 196
Minimum Threshold: 88.4
Groundwater Elevation (ft., msl)
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
1995
1996
1997
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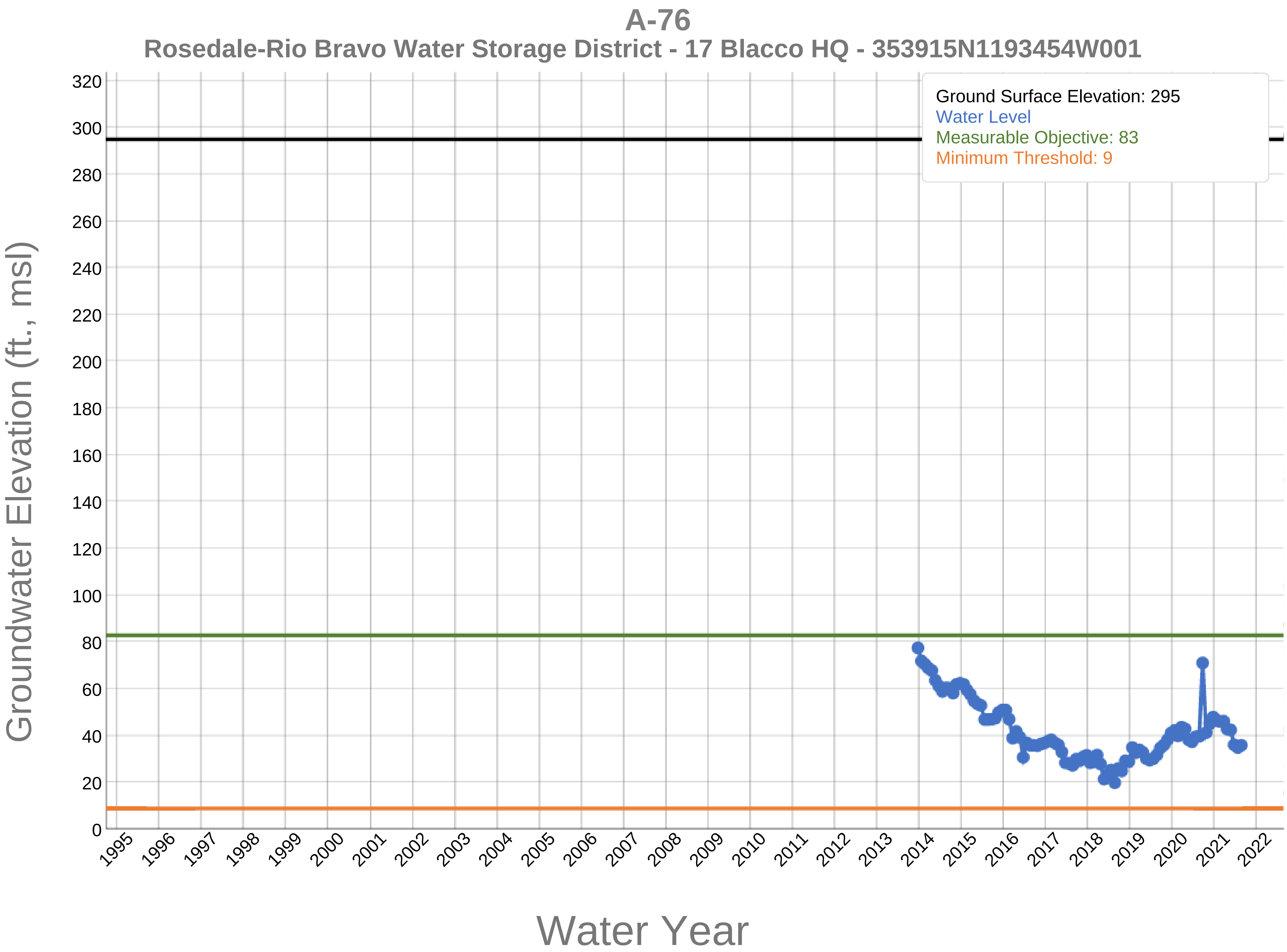
2021
2022
Water Year


A-76
Rosedale-Rio Bravo Water Storage District - 17 Blacco HQ - 353915N1193454W001
Ground Surface Elevation: 295
Water Level
Measurable Objective: 83
Minimum Threshold: 9
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
1995
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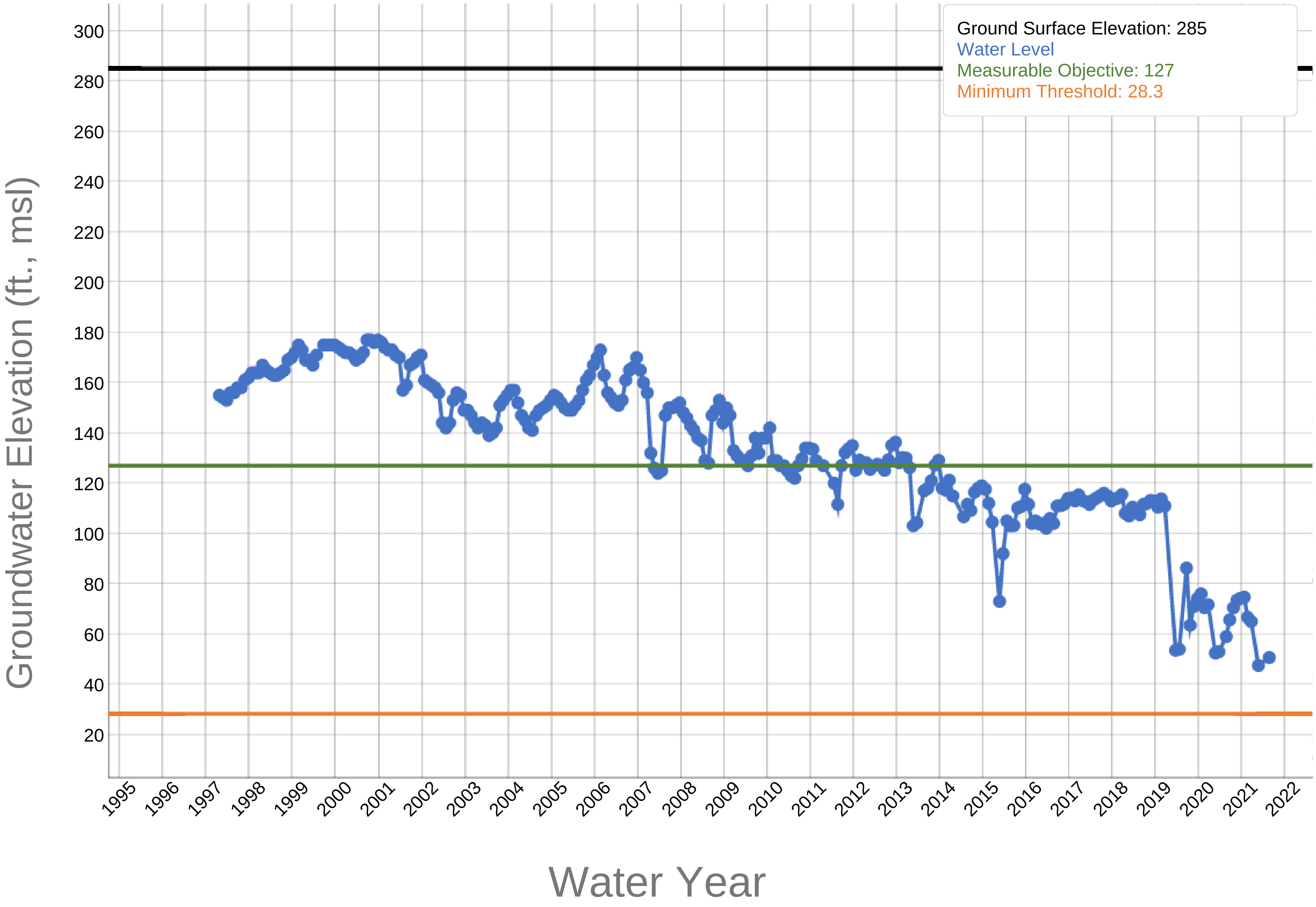
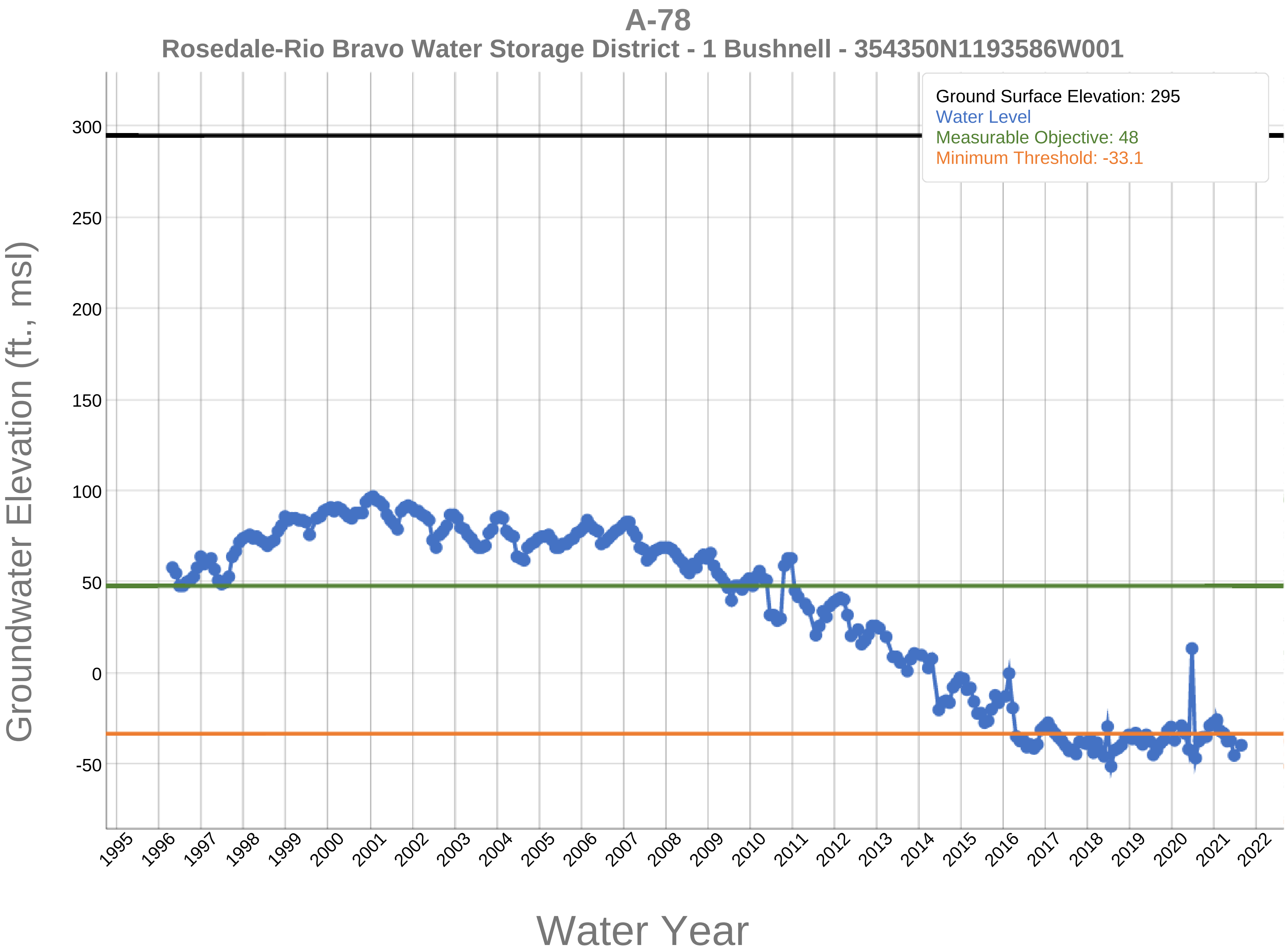
A-77

Rosedale-Rio Bravo Water Storage District - 19 Parsons - 353663N1193859W001





A-78
Rosedale-Rio Bravo Water Storage District - 1 Bushnell - 354350N1193586W001
Ground Surface Elevation: 295
Water Level
Measurable Objective: 48
Minimum Threshold: -33.1
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
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1998
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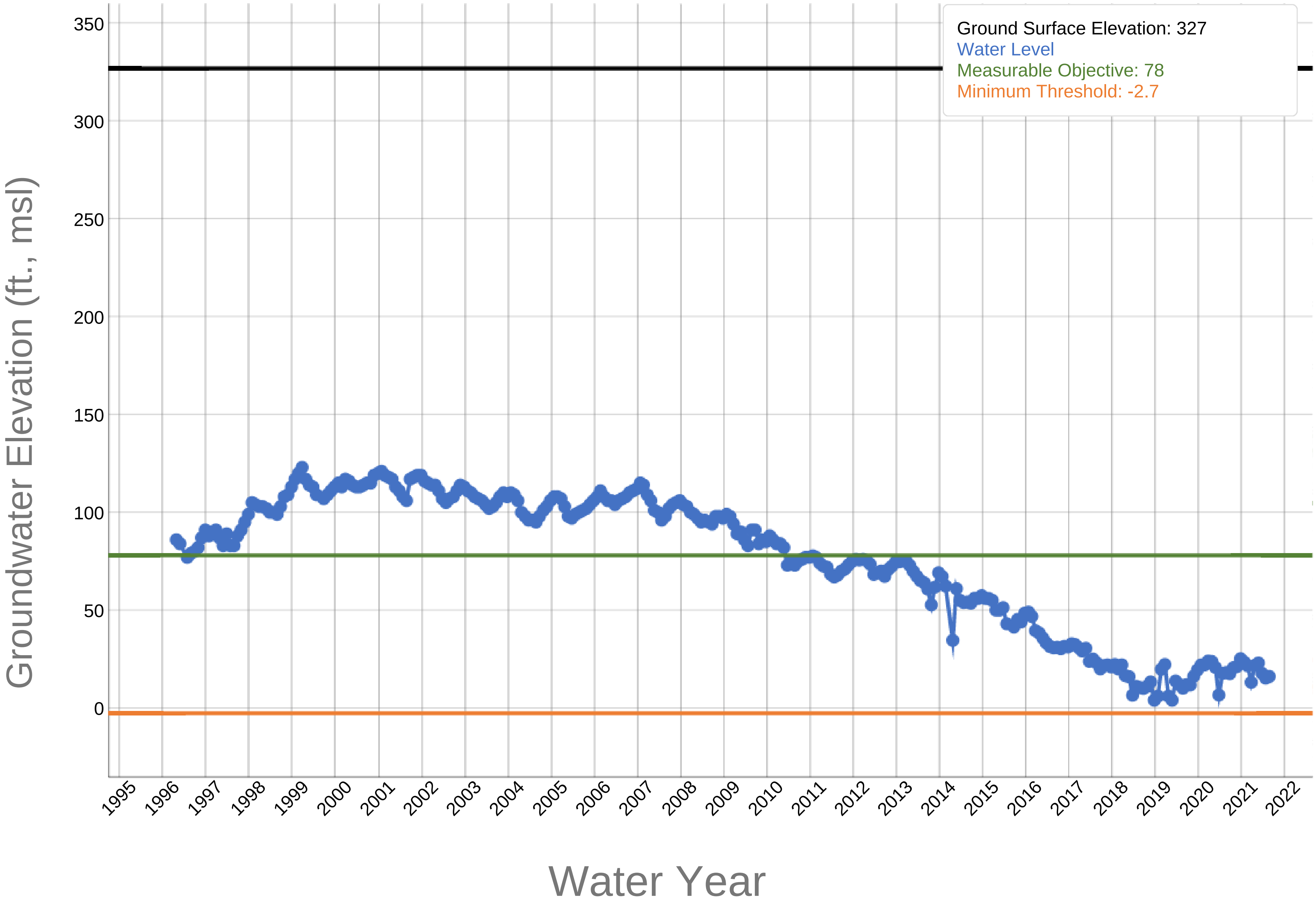
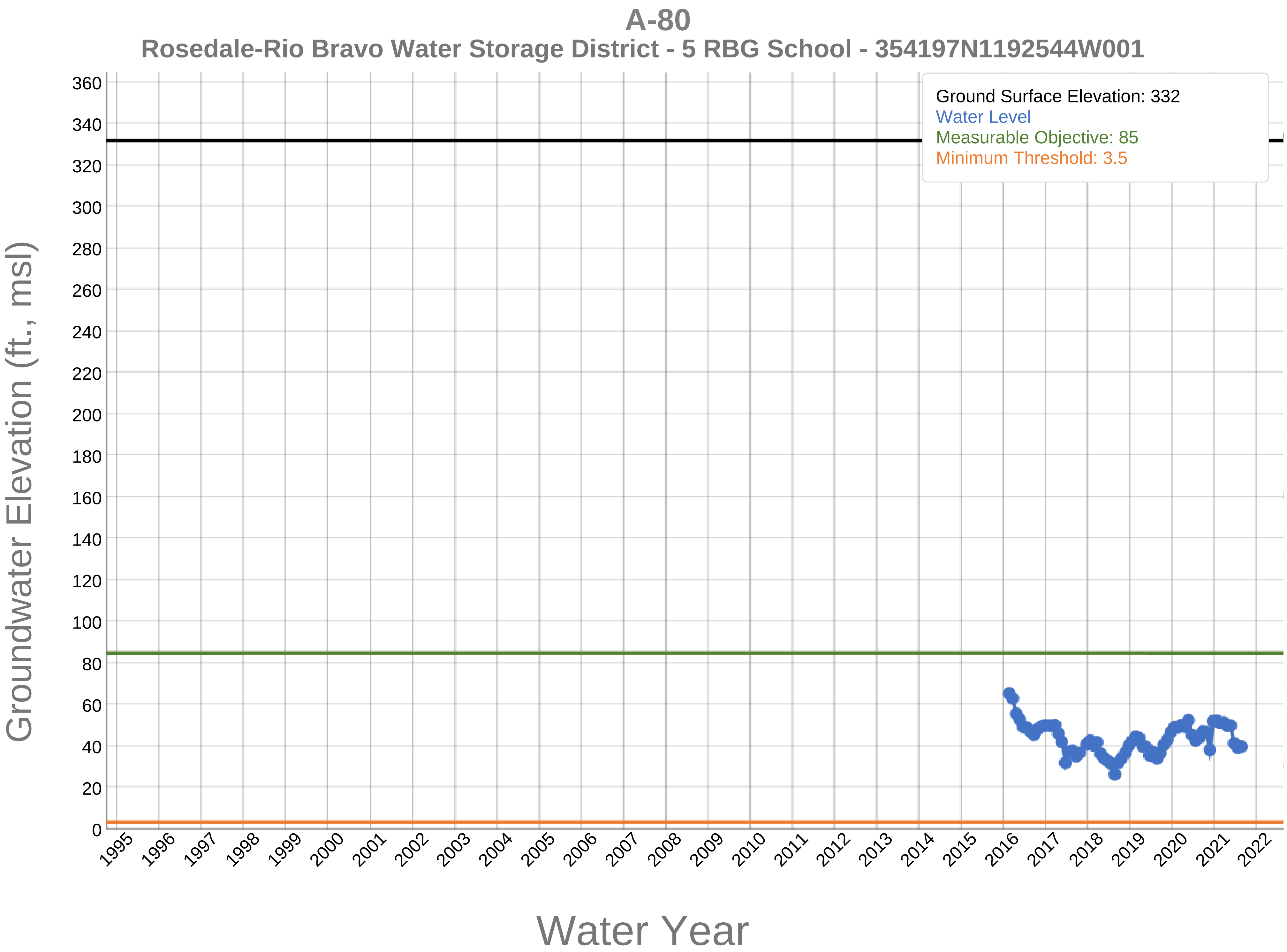
Water Year

A-79

Rosedale-Rio Bravo Water Storage District - 3 L.R. Stout - 354309N1192859W001




A-80
Rosedale-Rio Bravo Water Storage District - 5 RBG School - 354197N1192544W001
Ground Surface Elevation: 332
Water Level
Measurable Objective: 85
Minimum Threshold: 3.5
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
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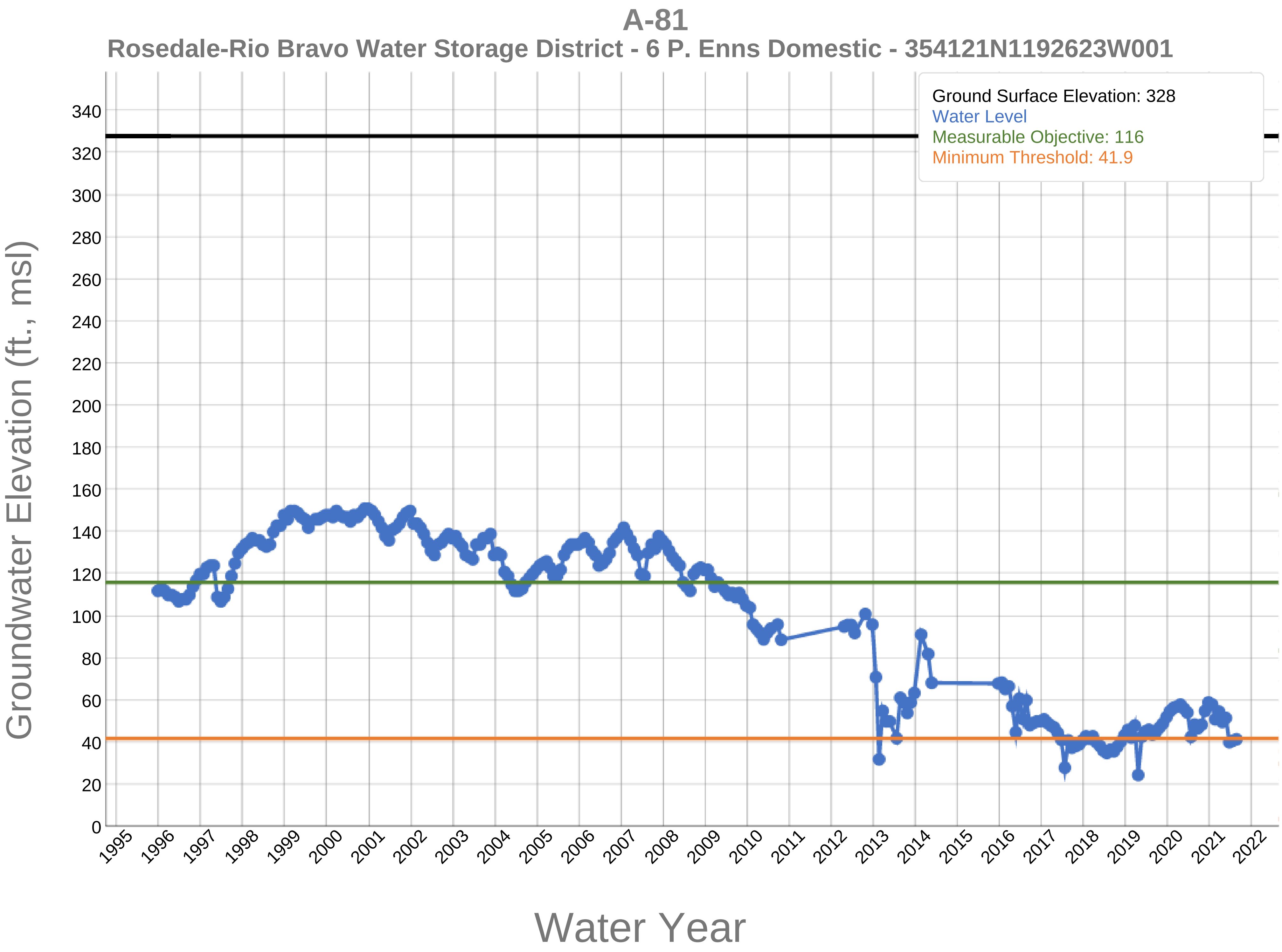

A-81
Rosedale-Rio Bravo Water Storage District - 6 P. Enns Domestic - 354121N1192623W001
Ground Surface Elevation: 328
Water Level
Measurable Objective: 116
Minimum Threshold: 41.9
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
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180
200
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340
1995
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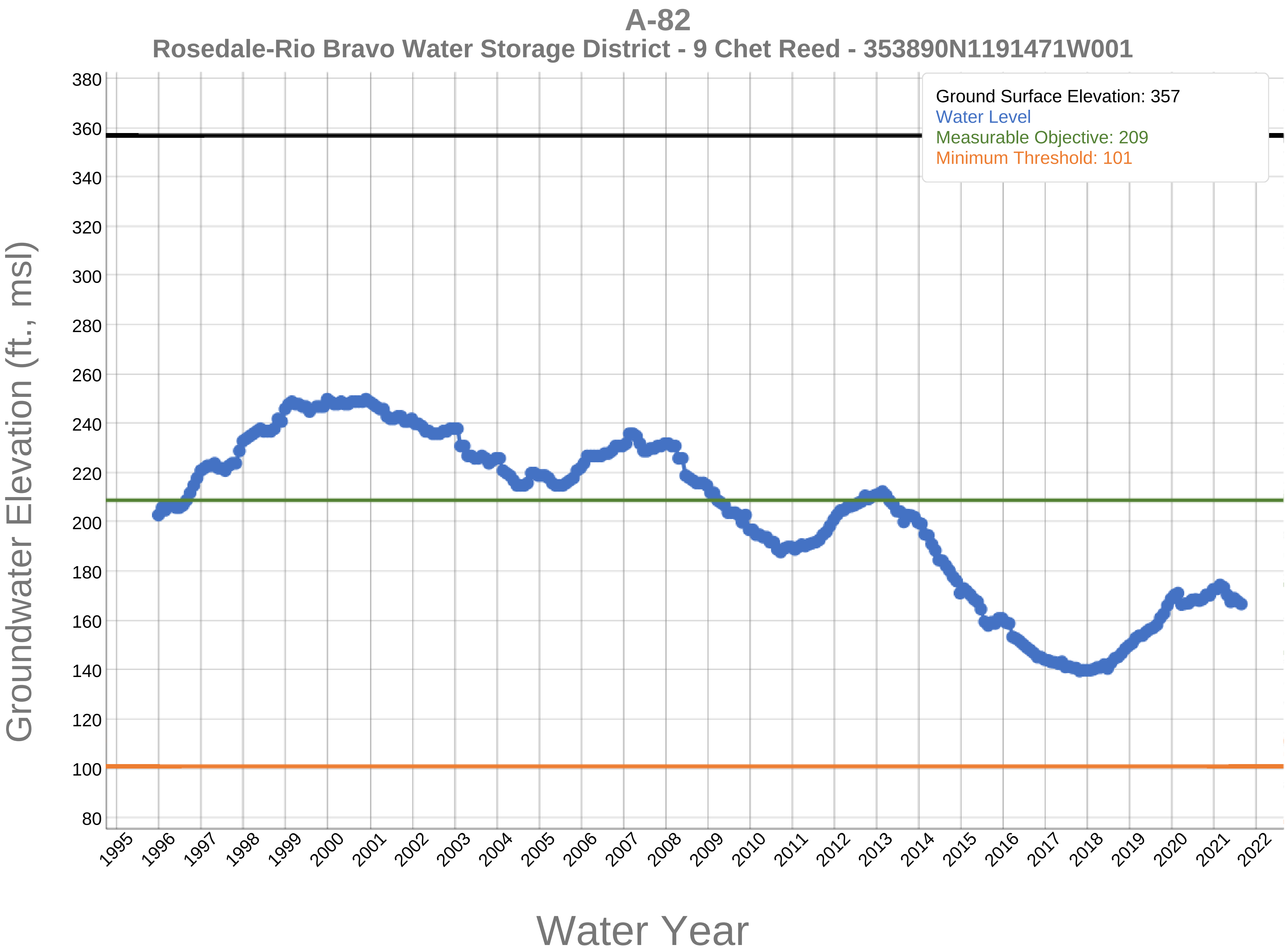
2022
Water Year


A-82
Rosedale-Rio Bravo Water Storage District - 9 Chet Reed - 353890N1191471W001
Ground Surface Elevation: 357
Water Level
Measurable Objective: 209
Minimum Threshold: 101
Groundwater Elevation (ft., msl)
Water Year
380
360
340
320
300
280
260
240
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100
80
1995
1996
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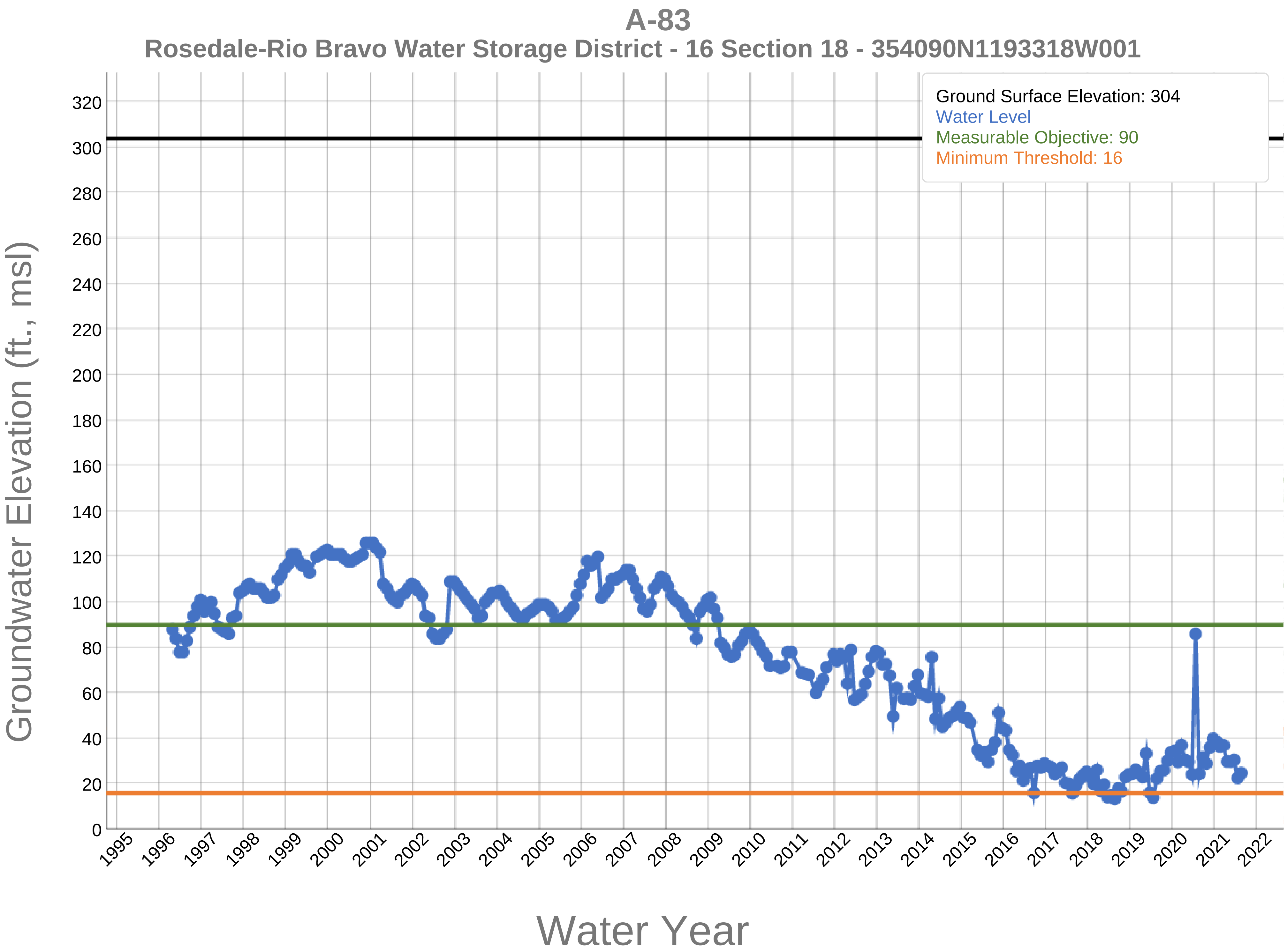
A-83
Rosedale-Rio Bravo Water Storage District - 16 Section 18 - 354090N1193318W001
Ground Surface Elevation: 304
Water Level
Measurable Objective: 90
Minimum Threshold: 16
Groundwater Elevation (ft., msl)
Water Year
0
20
40
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100
120
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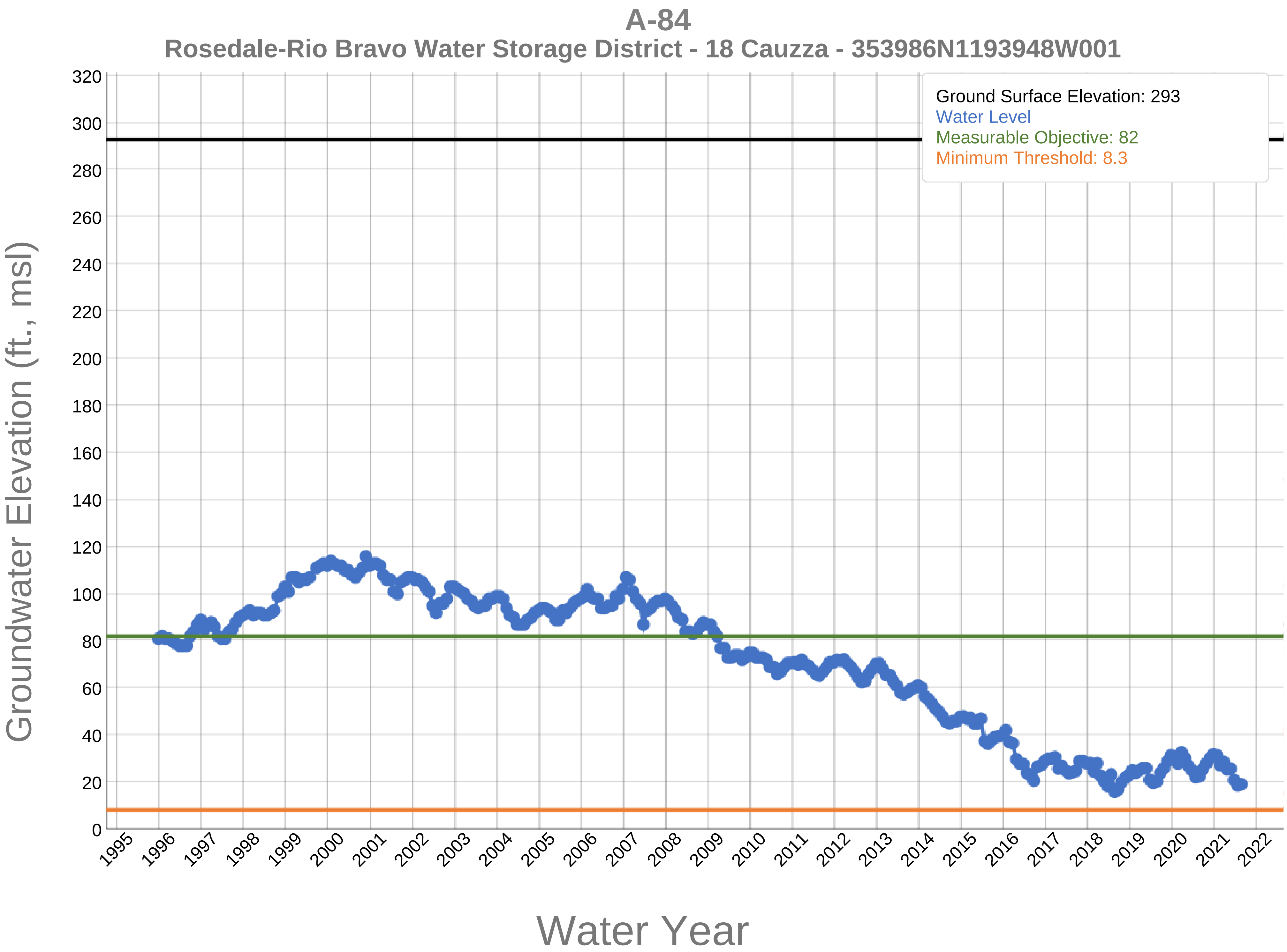
A-84
Rosedale-Rio Bravo Water Storage District - 18 Cauzza - 353986N1193948W001
Ground Surface Elevation: 293
Water Level
Measurable Objective: 82
Minimum Threshold: 8.3
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
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180
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220
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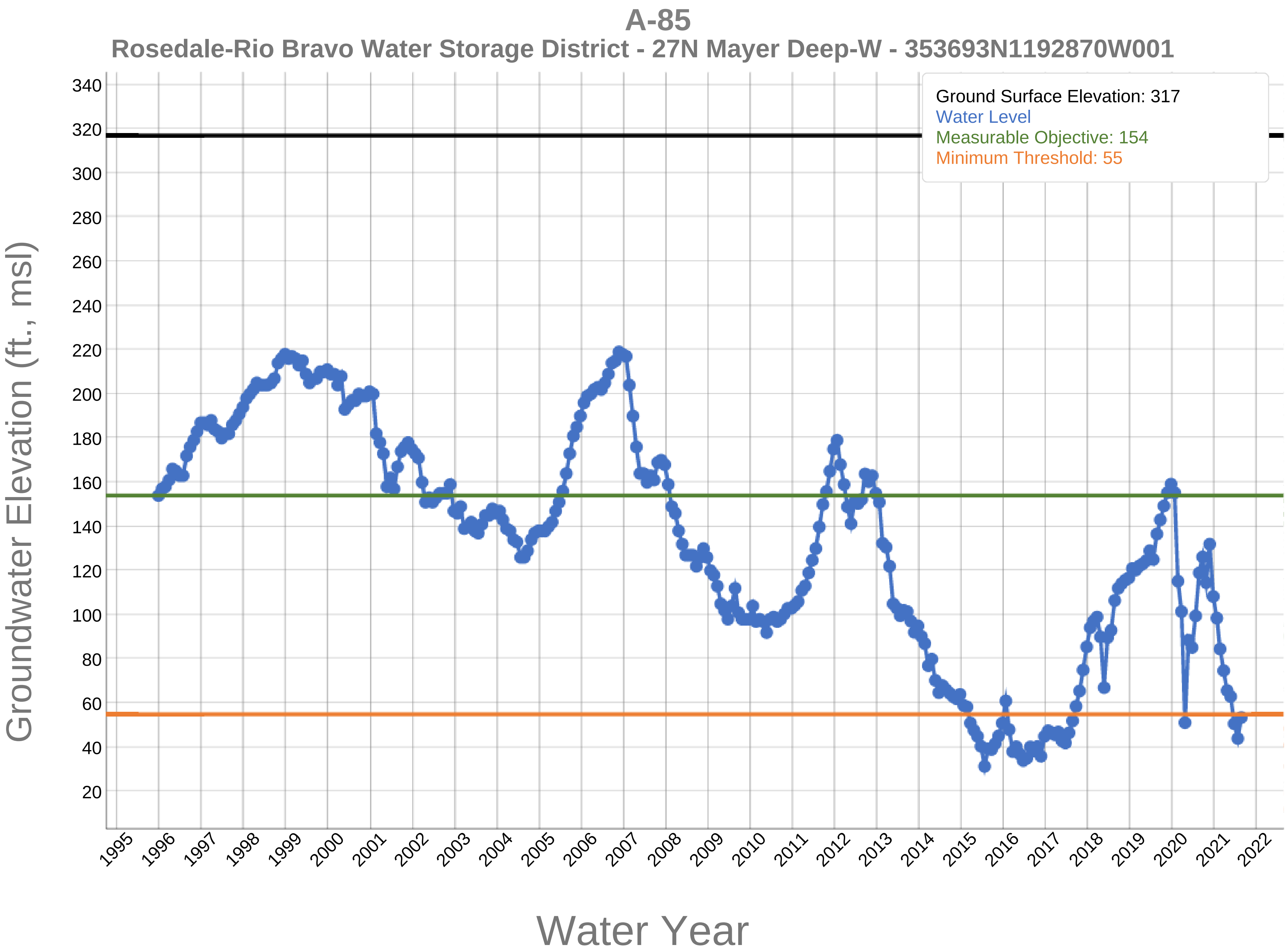
A-85
Rosedale-Rio Bravo Water Storage District - 27N Mayer Deep-W - 353693N1192870W001
Ground Surface Elevation: 317
Water Level
Measurable Objective: 154
Minimum Threshold: 55
Groundwater Elevation (ft., msl)
Water Year
340
320
300
280
260
240
220
200
180
160
140
120
100
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60
40
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1995
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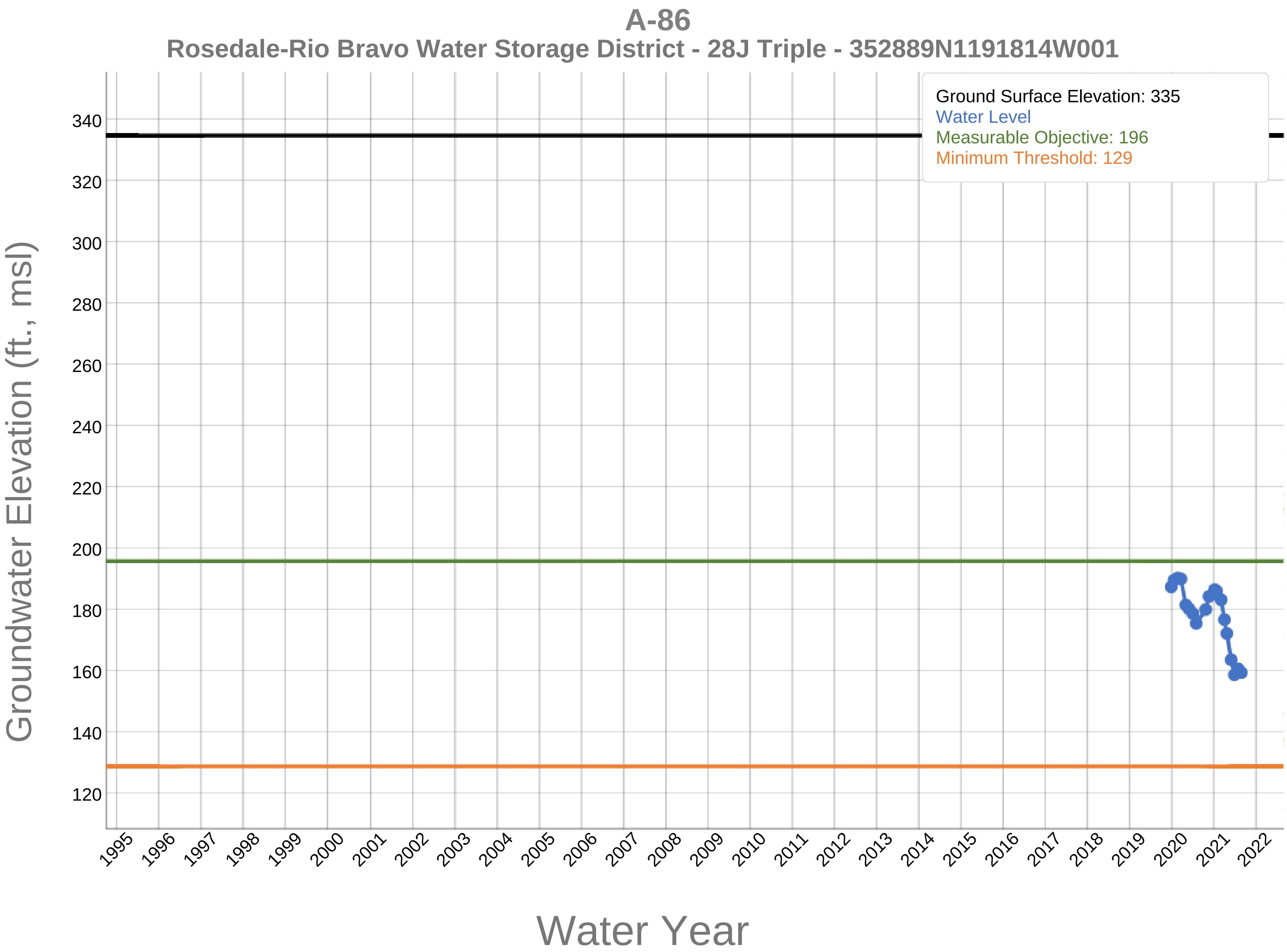
A-86
Rosedale-Rio Bravo Water Storage District - 28J Triple - 352889N1191814W001
Ground Surface Elevation: 335
Water Level
Measurable Objective: 196
Minimum Threshold: 129
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
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200
180
160
140
120
1995
1996
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1998
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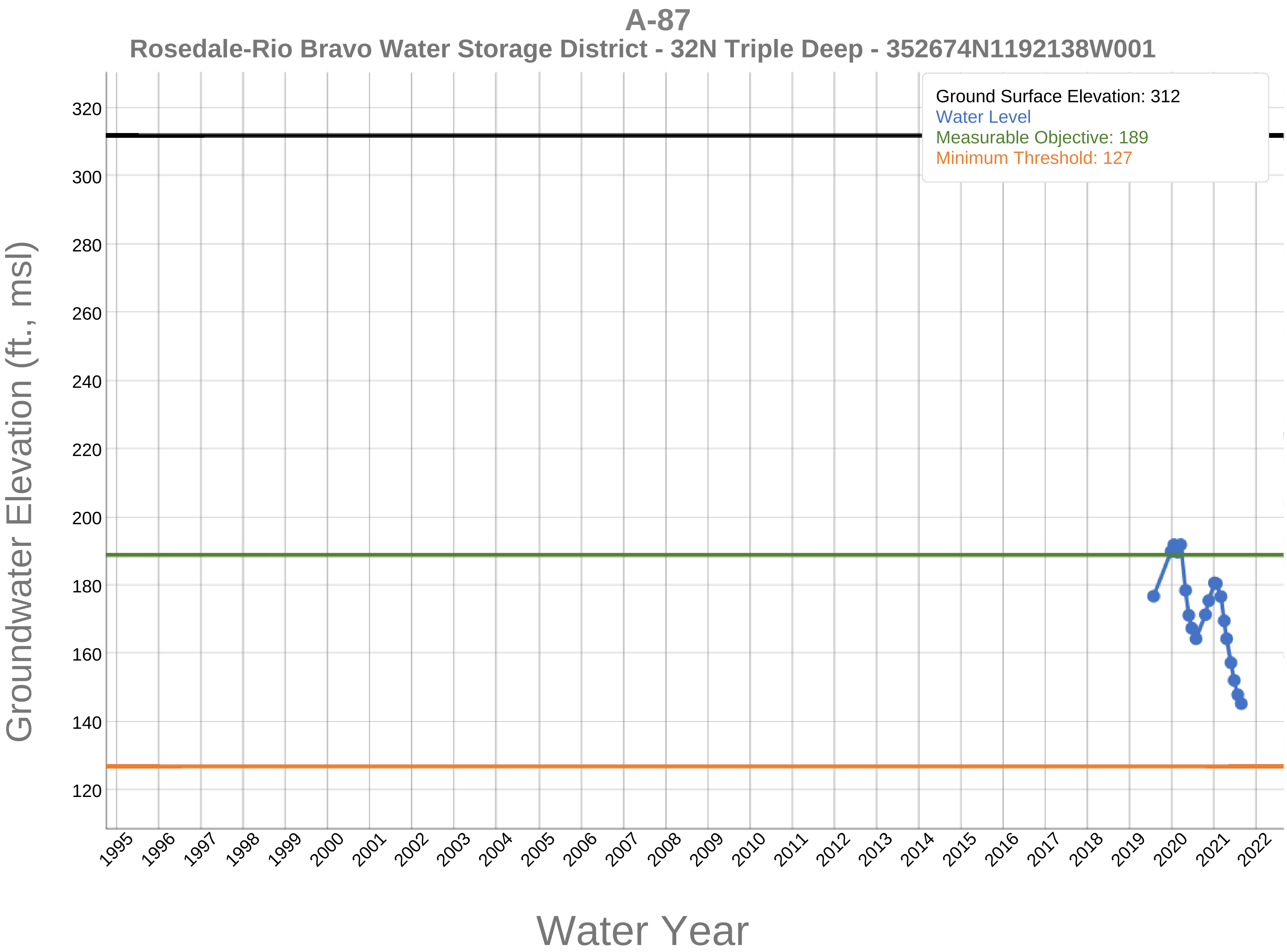
2022
Water Year


A-87
Rosedale-Rio Bravo Water Storage District - 32N Triple Deep - 352674N1192138W001
Ground Surface Elevation: 312
Water Level
Measurable Objective: 189
Minimum Threshold: 127
Groundwater Elevation (ft., msl)
320
300
280
260
240
220
200
180
160
140
120
1995
1996
1997
1998
1999
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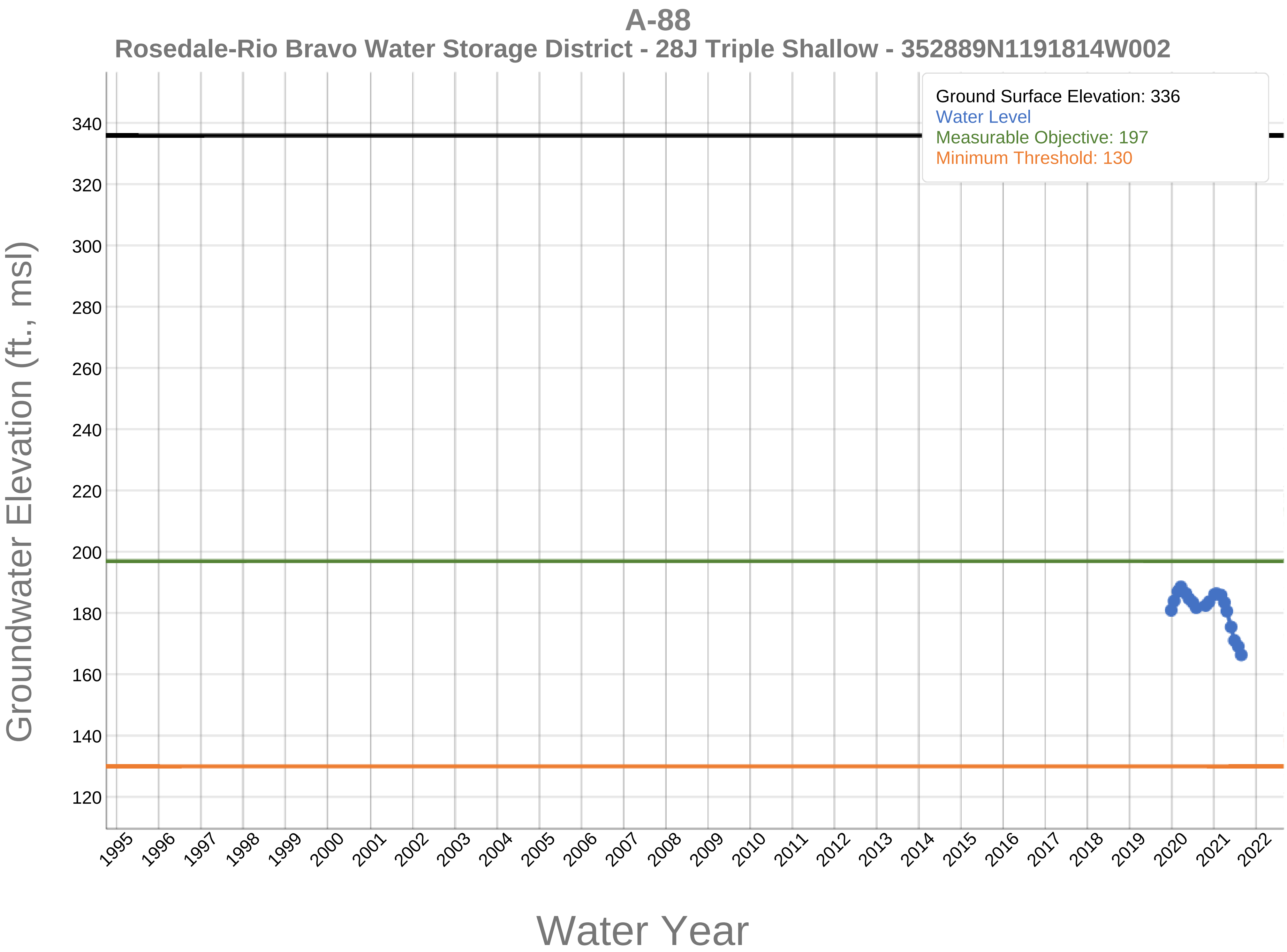
2021
2022
Water Year


A-88
Rosedale-Rio Bravo Water Storage District - 28J Triple Shallow - 352889N1191814W002
Ground Surface Elevation: 336
Water Level
Measurable Objective: 197
Minimum Threshold: 130
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
160
140
120
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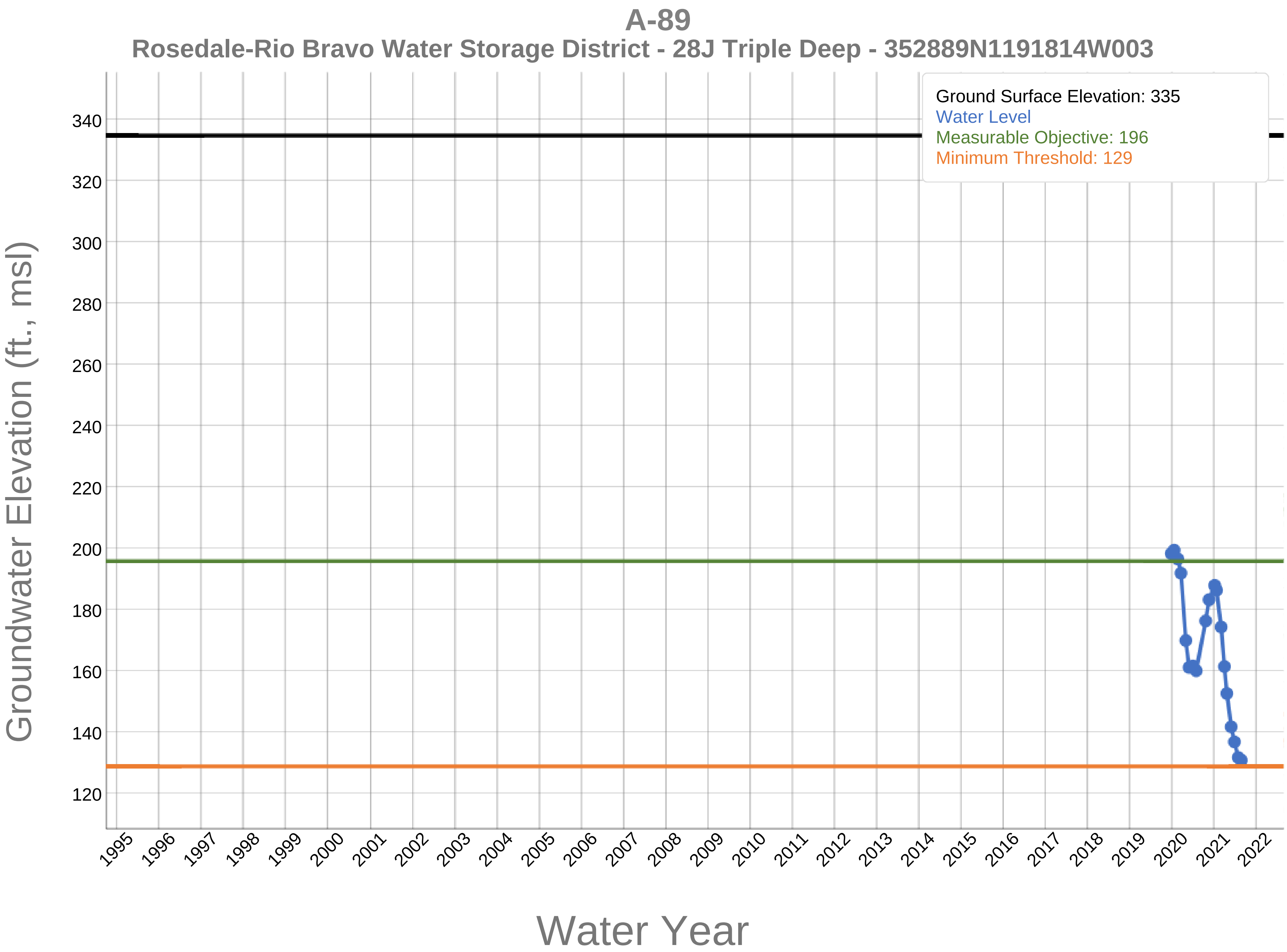
2022
Water Year


A-89
Rosedale-Rio Bravo Water Storage District - 28J Triple Deep - 352889N1191814W003
Ground Surface Elevation: 335
Water Level
Measurable Objective: 196
Minimum Threshold: 129
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
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120
1995
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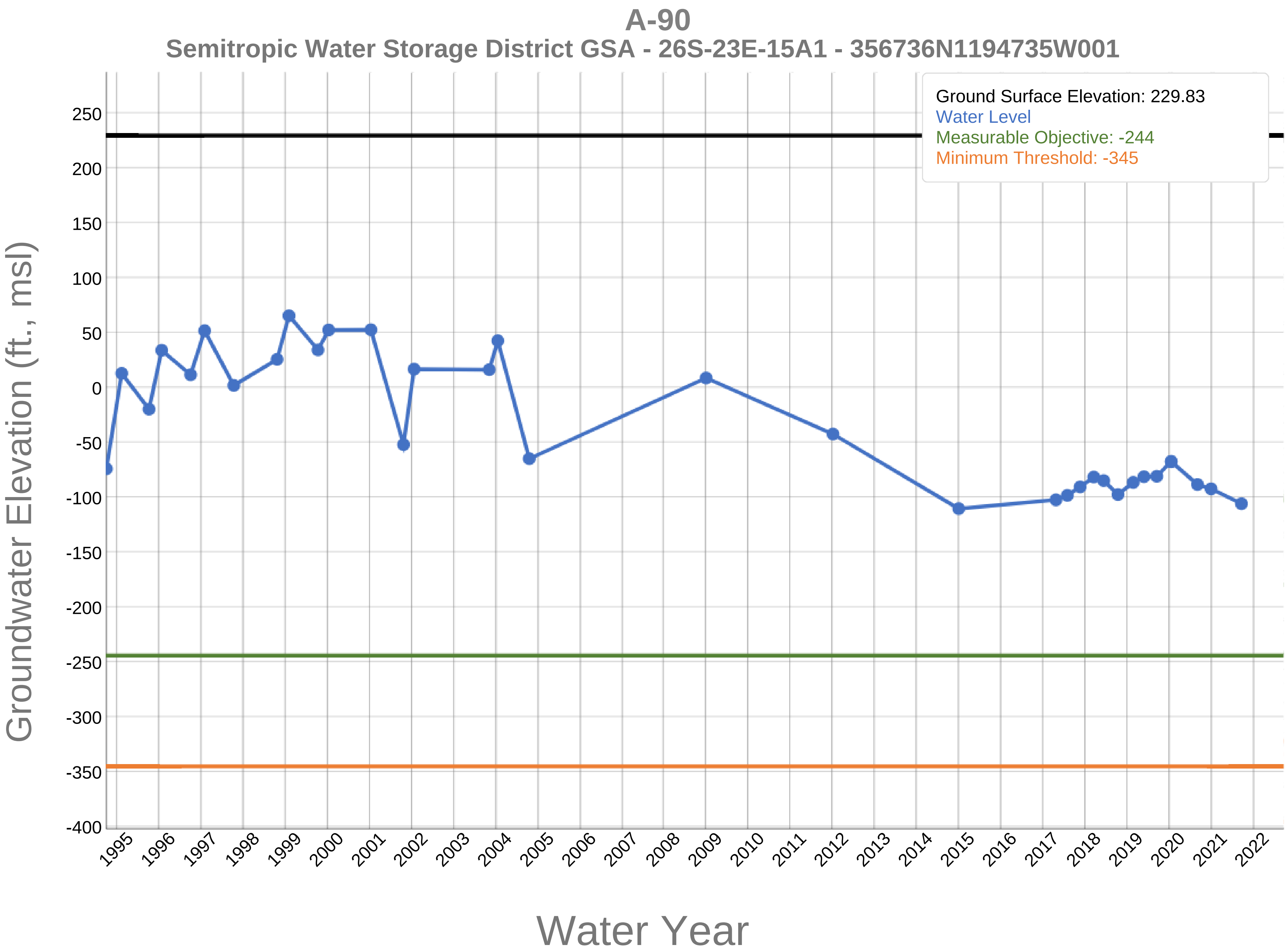
2022
Water Year



A-90
Semitropic Water Storage District GSA - 26S-23E-15A1 - 356736N1194735W001
Ground Surface Elevation: 229.83
Water Level
Measurable Objective: -244
Minimum Threshold: -345
Groundwater Elevation (ft., msl)
Water Year
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
1995
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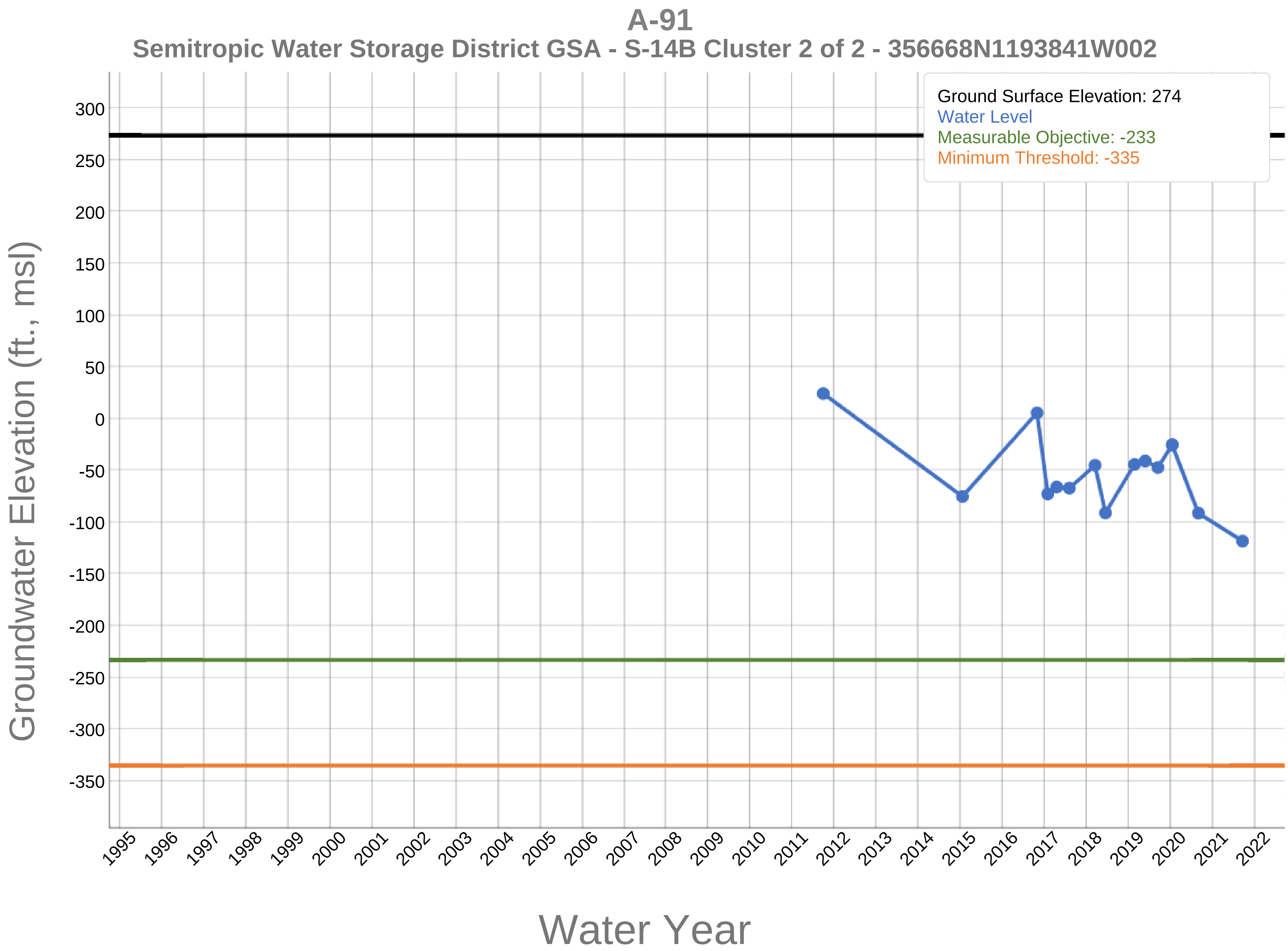
A-91
Semitropic Water Storage District GSA - S-14B Cluster 2 of 2 - 356668N1193841W002
Ground Surface Elevation: 274
Water Level
Measurable Objective: -233
Minimum Threshold: -335
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
1995
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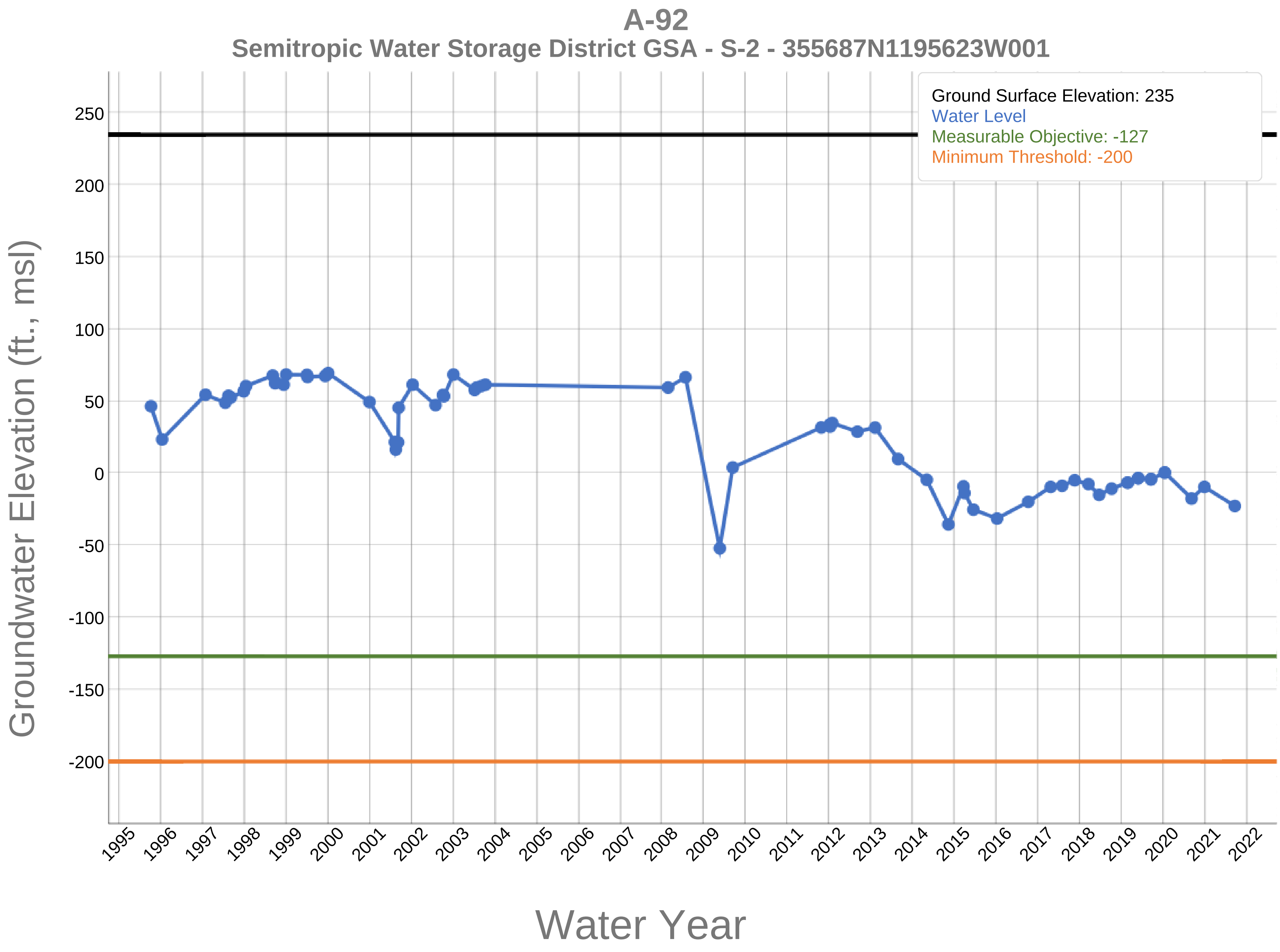
Water Year



A-92
Semitropic Water Storage District GSA - S-2 - 355687N1195623W001
Ground Surface Elevation: 235
Water Level
Measurable Objective: -127
Minimum Threshold: -200
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
1995
1996
1997
1998
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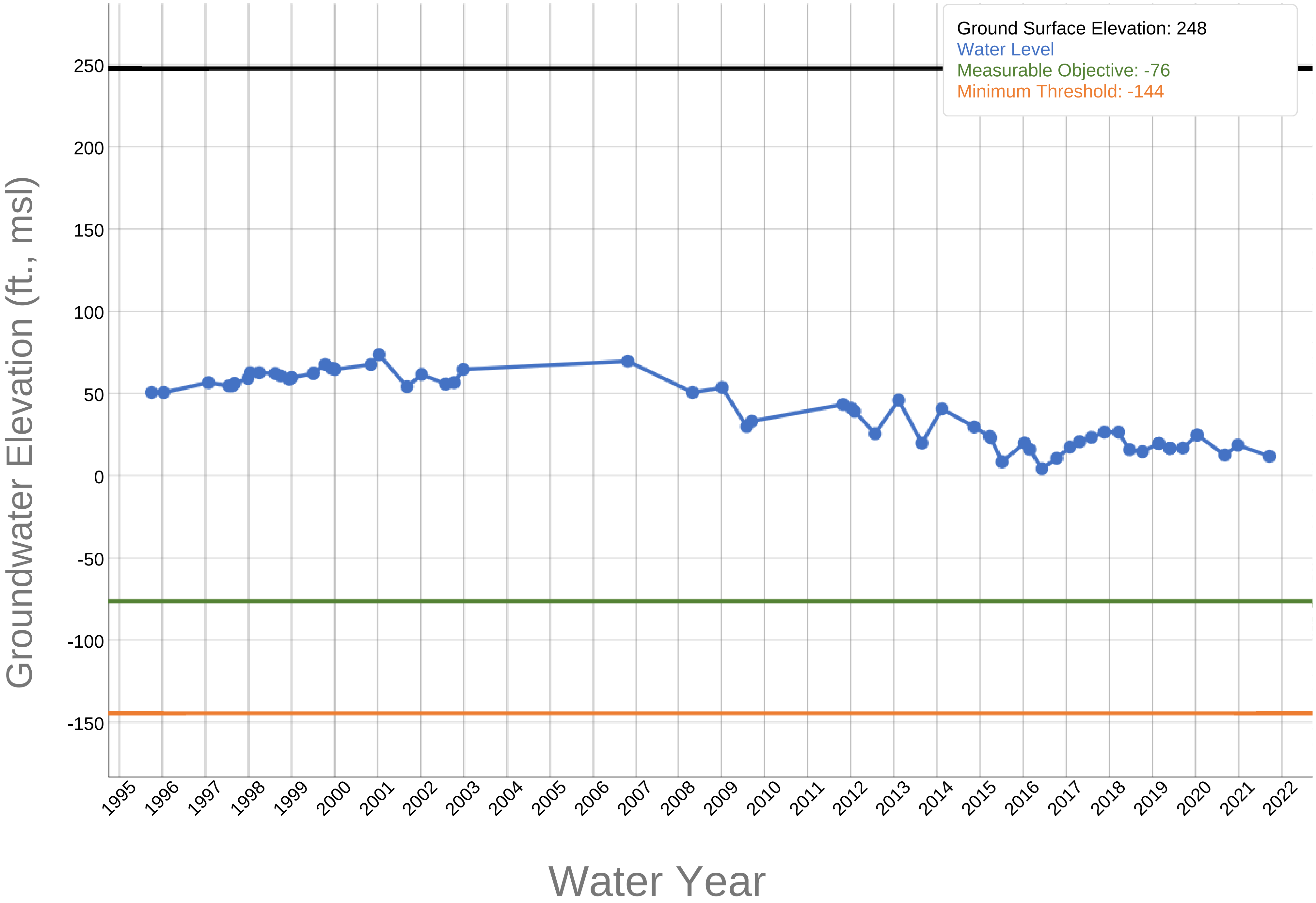
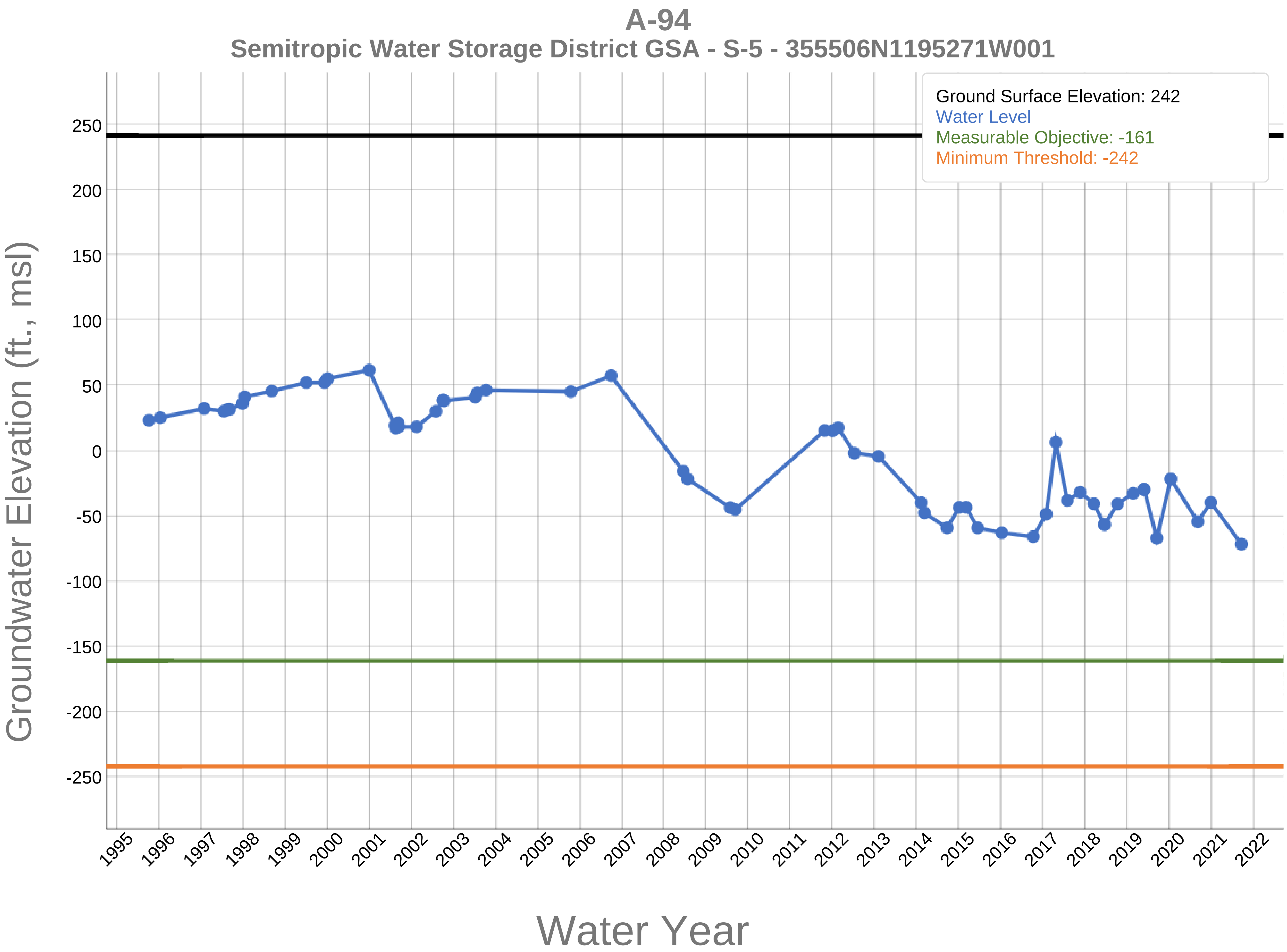
2022
Water Year

A-93

Semitropic Water Storage District GSA - S-4 - 355205N1195821W001




A-94
Semitropic Water Storage District GSA - S-5 - 355506N1195271W001
Ground Surface Elevation: 242
Water Level
Measurable Objective: -161
Minimum Threshold: -242
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
1996
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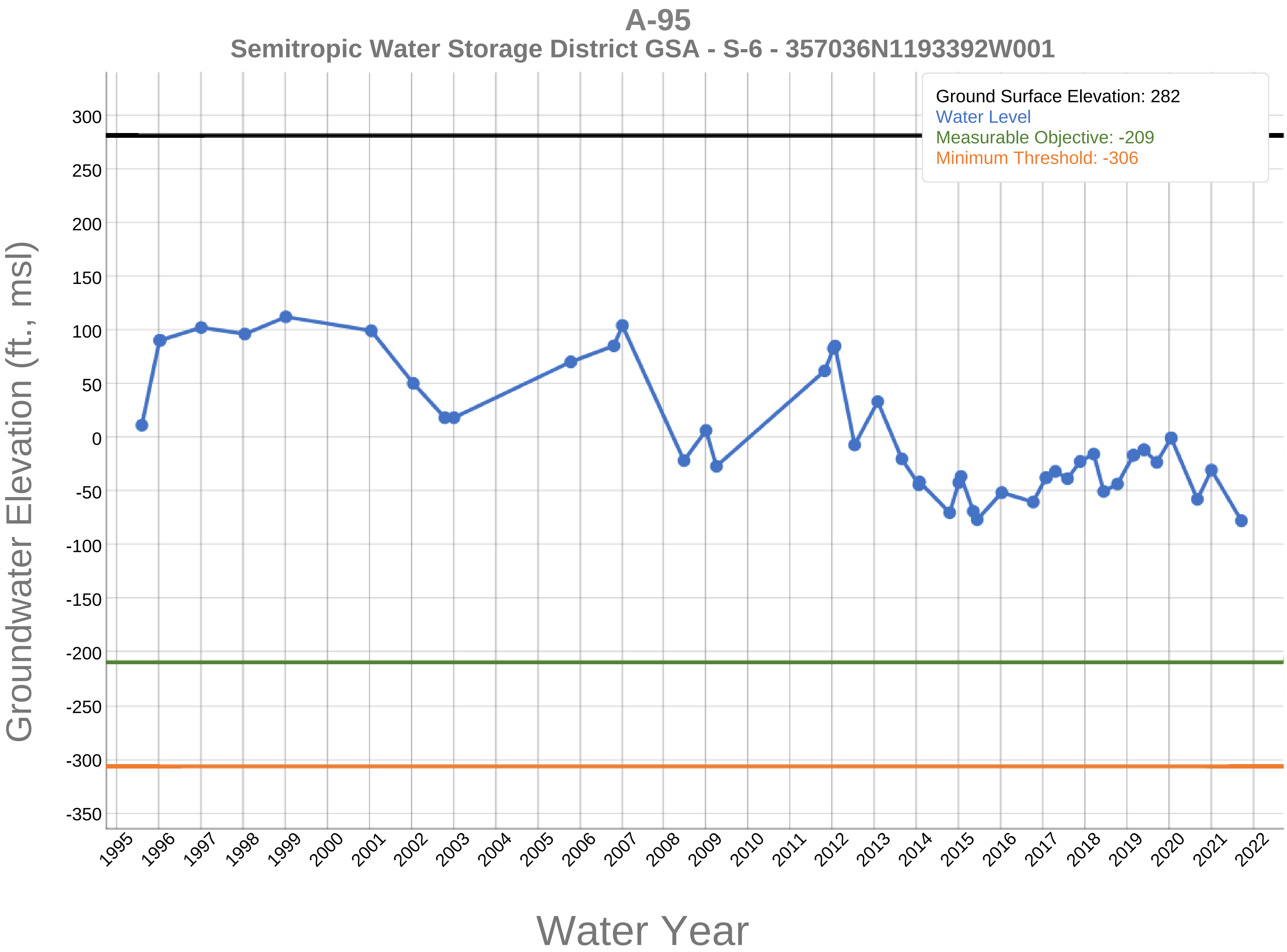
2022
Water Year



A-95
Semitropic Water Storage District GSA - S-6 - 357036N1193392W001
Ground Surface Elevation: 282
Water Level
Measurable Objective: -209
Minimum Threshold: -306
Groundwater Elevation (ft., msl)
Water Year
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
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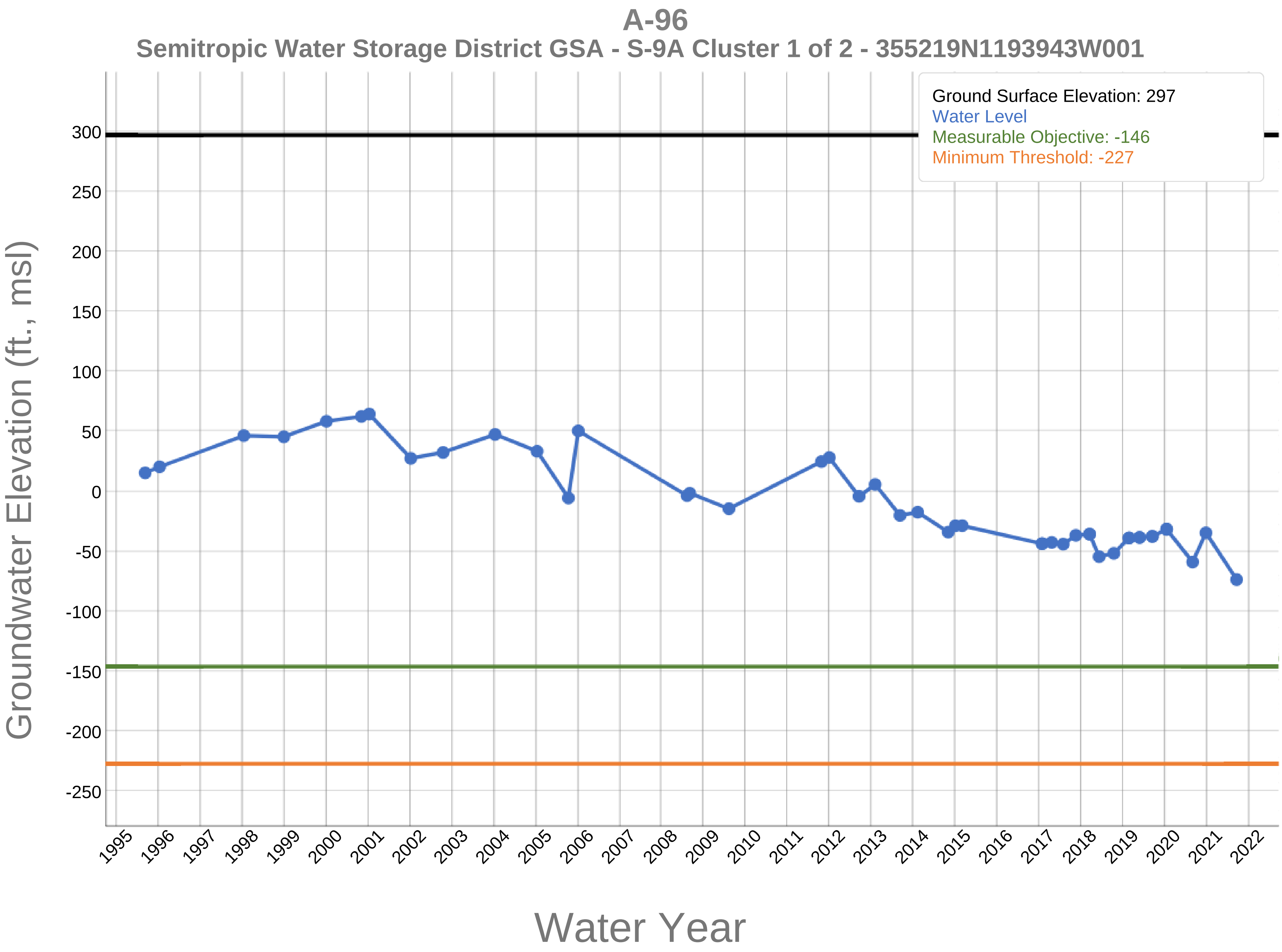
2021
2022



A-96
Semitropic Water Storage District GSA - S-9A Cluster 1 of 2 - 355219N1193943W001
Ground Surface Elevation: 297
Water Level
Measurable Objective: -146
Minimum Threshold: -227
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
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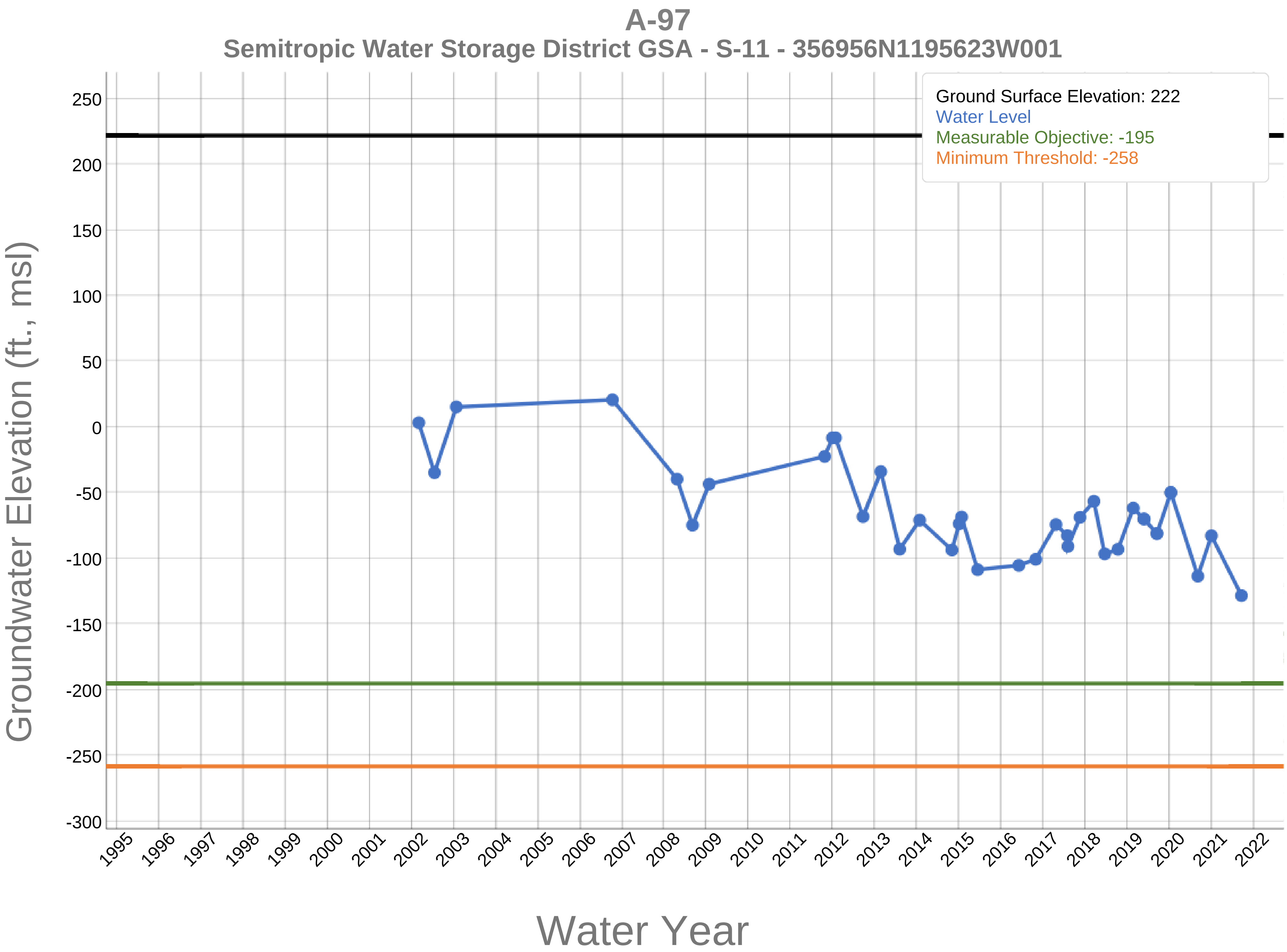
2022
Water Year



A-97
Semitropic Water Storage District GSA - S-11 - 356956N1195623W001
Ground Surface Elevation: 222
Water Level
Measurable Objective: -195
Minimum Threshold: -258
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1995
1996
1997
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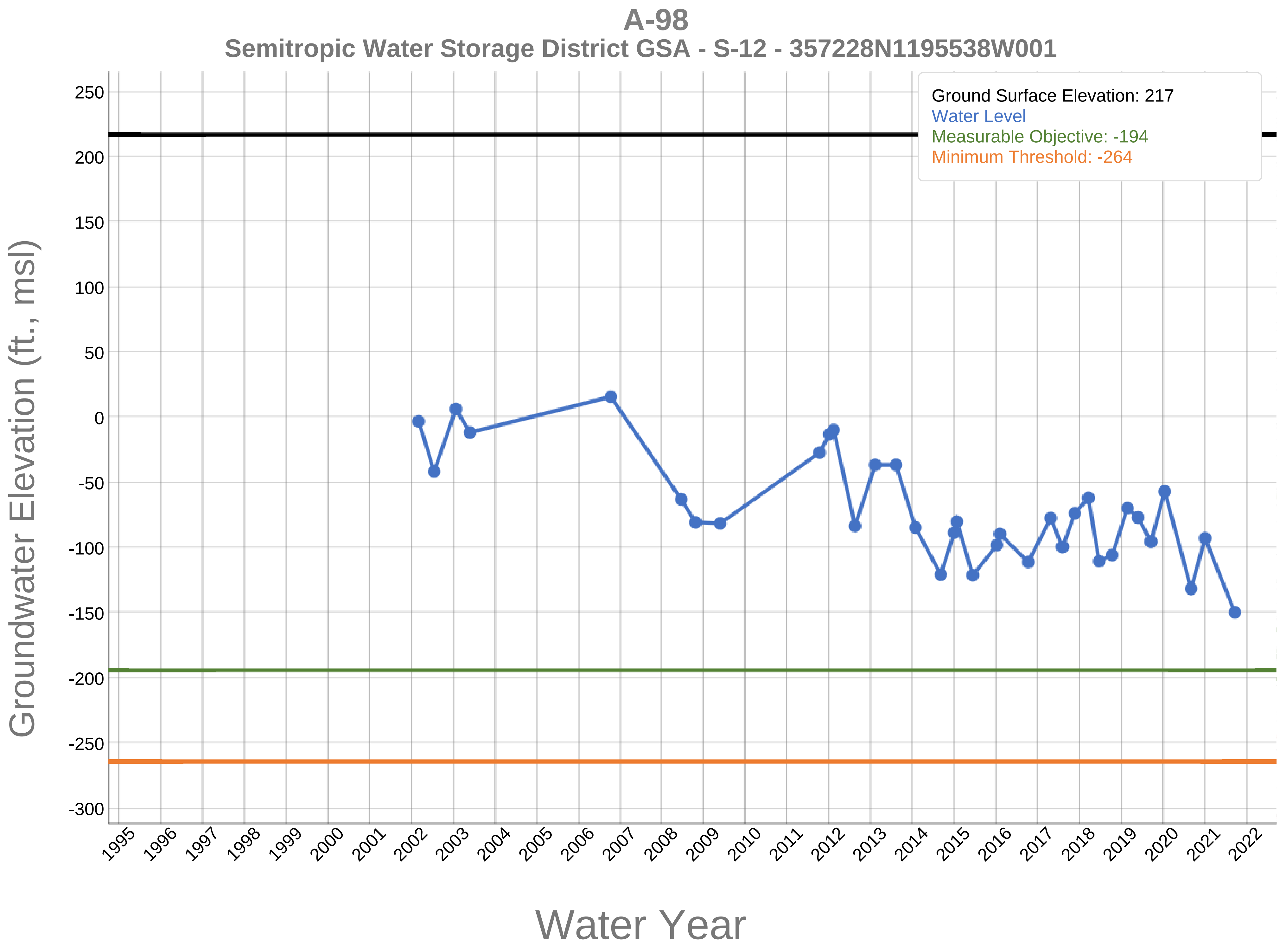
Water Year


A-98
Semitropic Water Storage District GSA - S-12 - 357228N1195538W001
Ground Surface Elevation: 217
Water Level
Measurable Objective: -194
Minimum Threshold: -264
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1995
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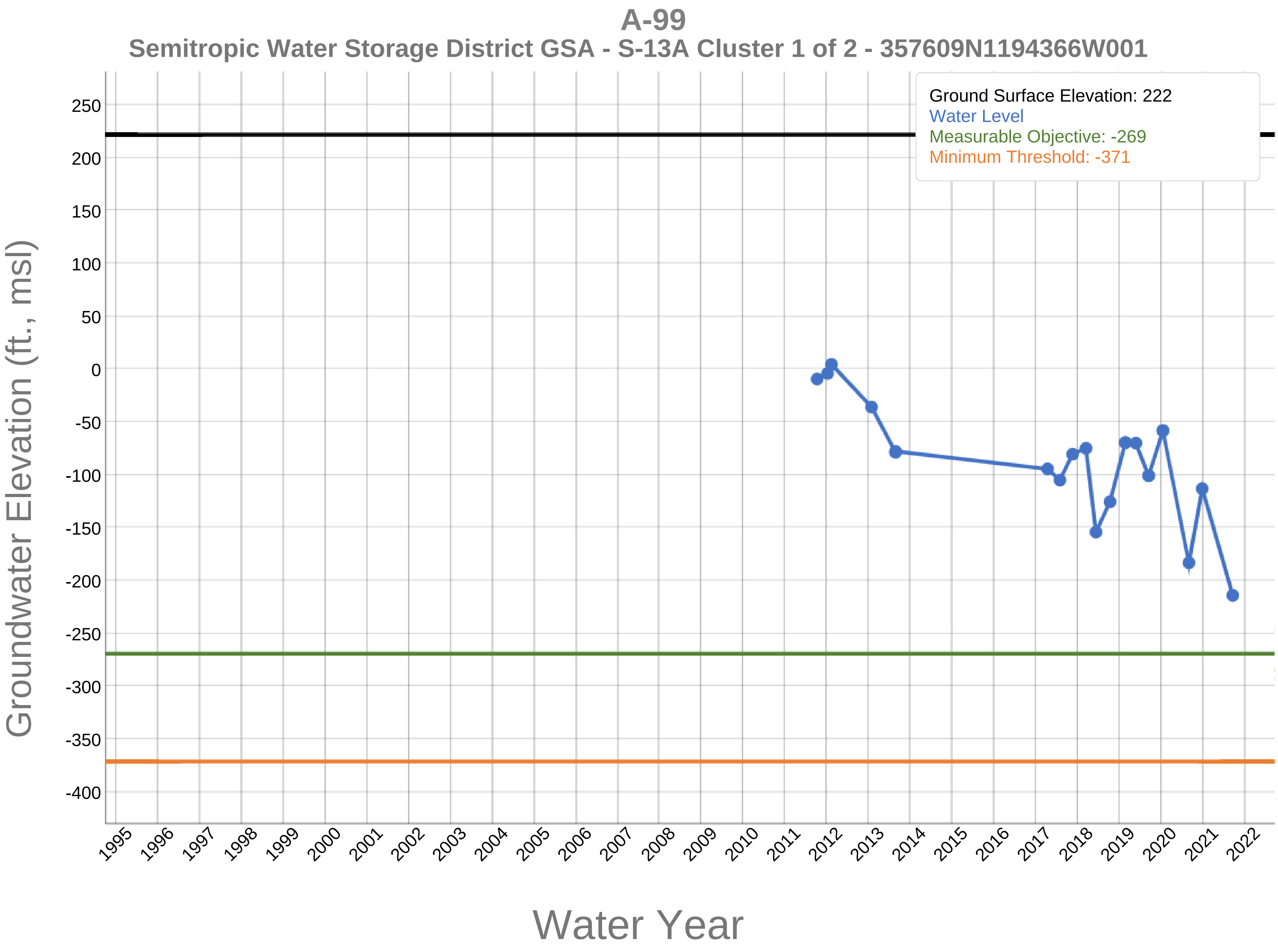
Water Year


A-99
Semitropic Water Storage District GSA - S-13A Cluster 1 of 2 - 357609N1194366W001
Ground Surface Elevation: 222
Water Level
Measurable Objective: -269
Minimum Threshold: -371
Groundwater Elevation (ft., msl)
Water Year
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
-400
1995
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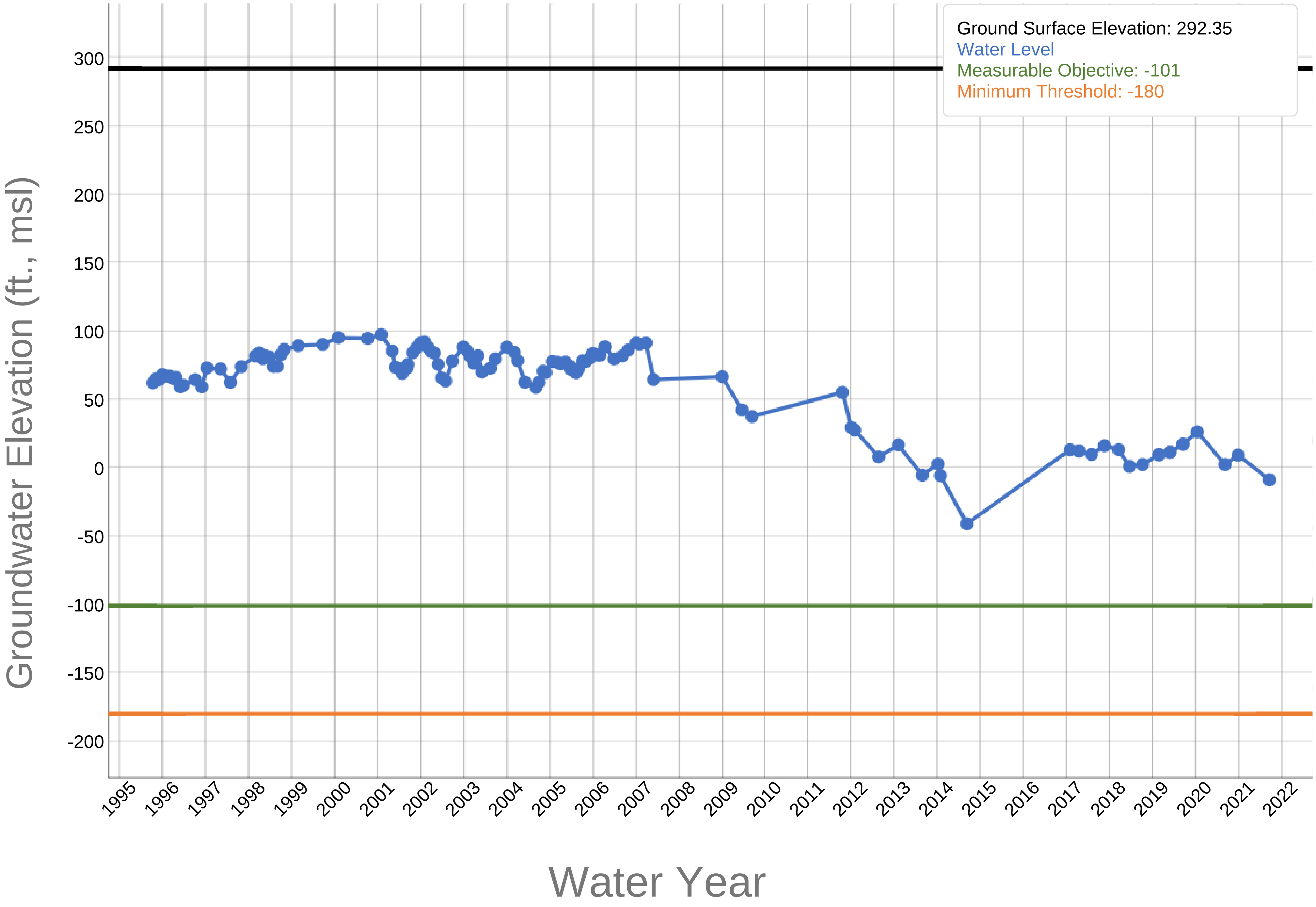
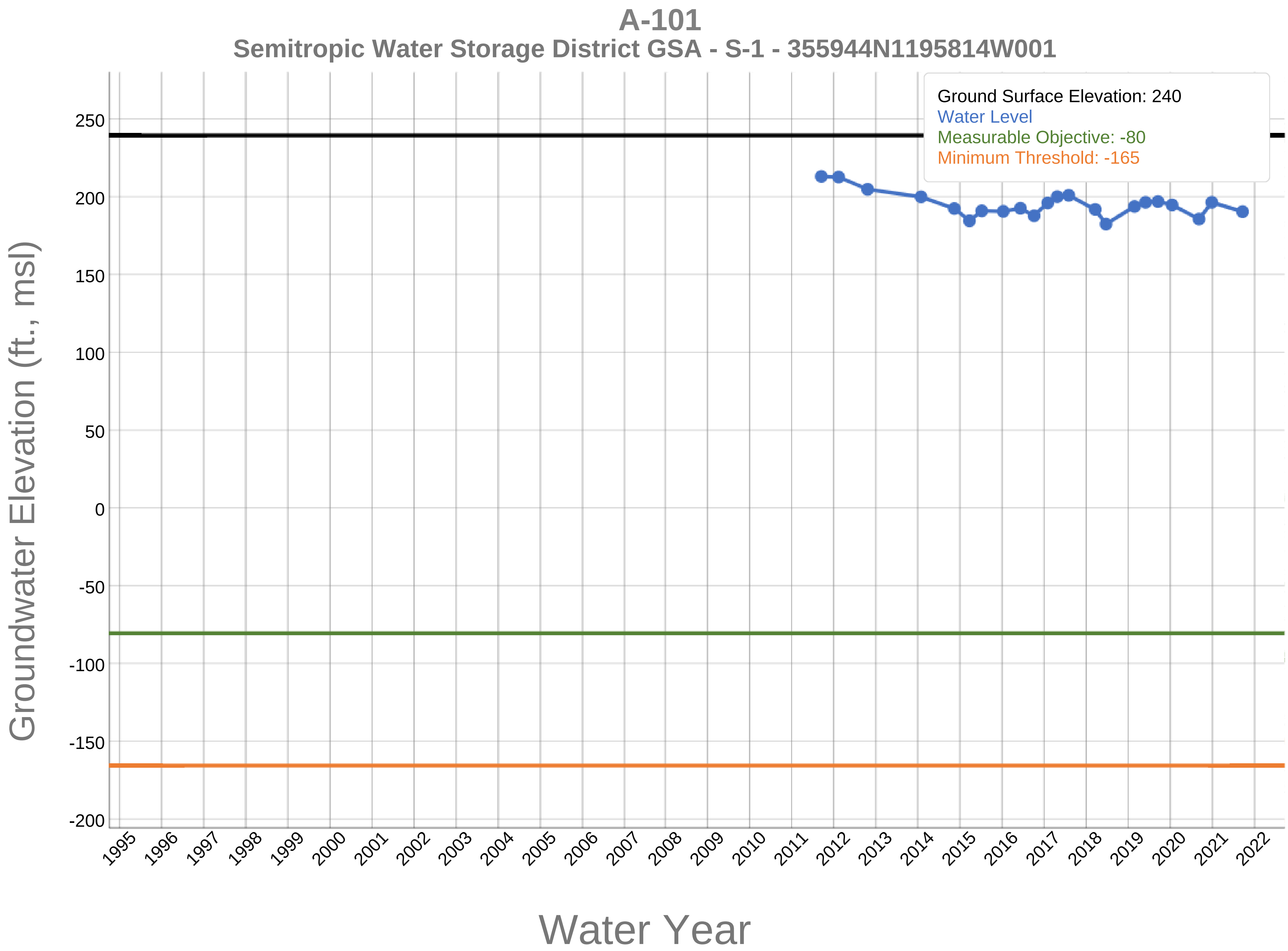
A-100

Semitropic Water Storage District GSA - 948L02 Cluster1 of 2 - 354189N1194216W001





A-101
Semitropic Water Storage District GSA - S-1 - 355944N1195814W001
Ground Surface Elevation: 240
Water Level
Measurable Objective: -80
Minimum Threshold: -165
Groundwater Elevation (ft., msl)
250
200
150
100
50
0
-50
-100
-150
-200
1995
1996
1997
1998
1999
2000
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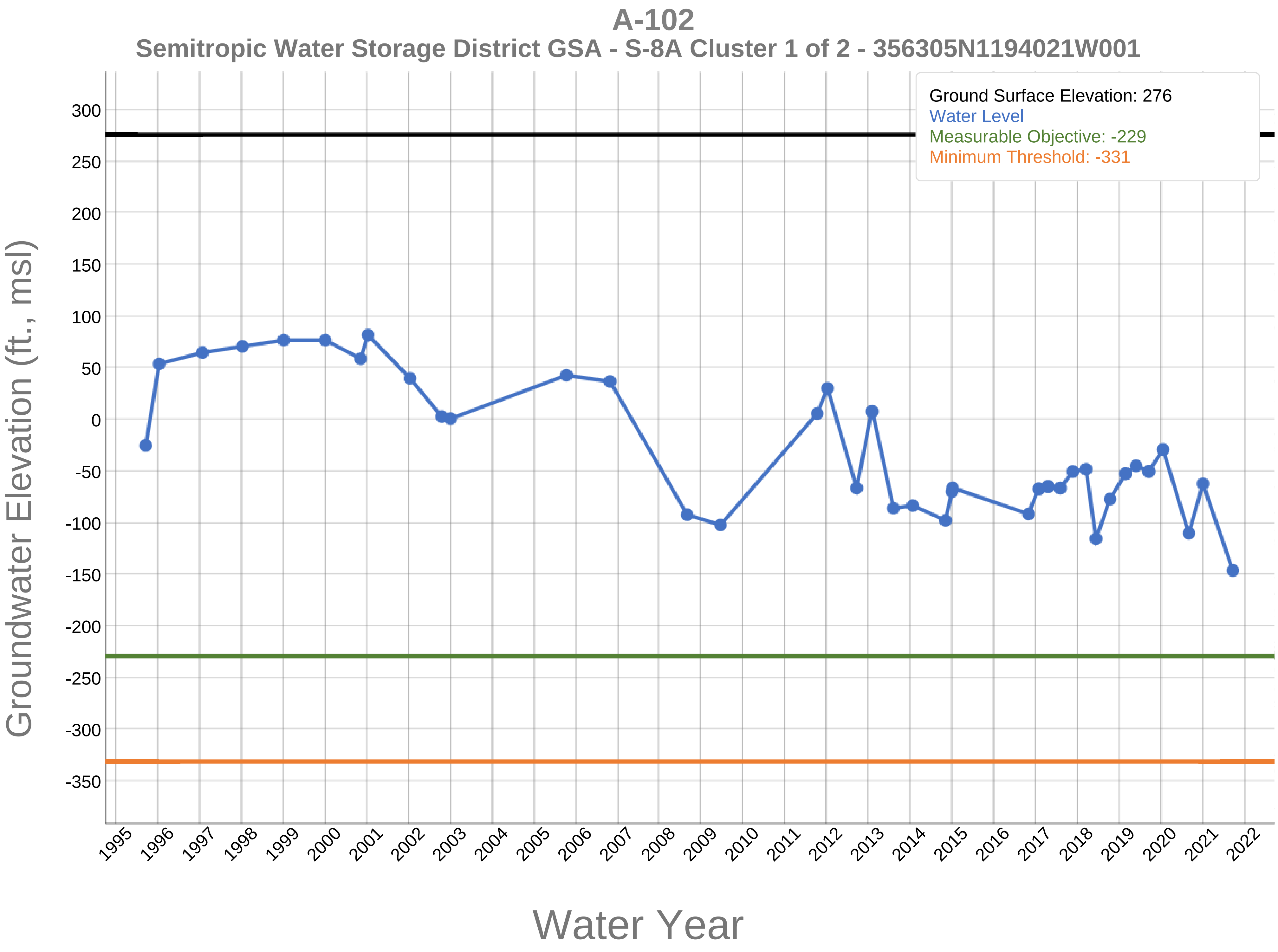
2022
Water Year


A-102
Semitropic Water Storage District GSA - S-8A Cluster 1 of 2 - 356305N1194021W001
Ground Surface Elevation: 276
Water Level
Measurable Objective: -229
Minimum Threshold: -331
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
1995
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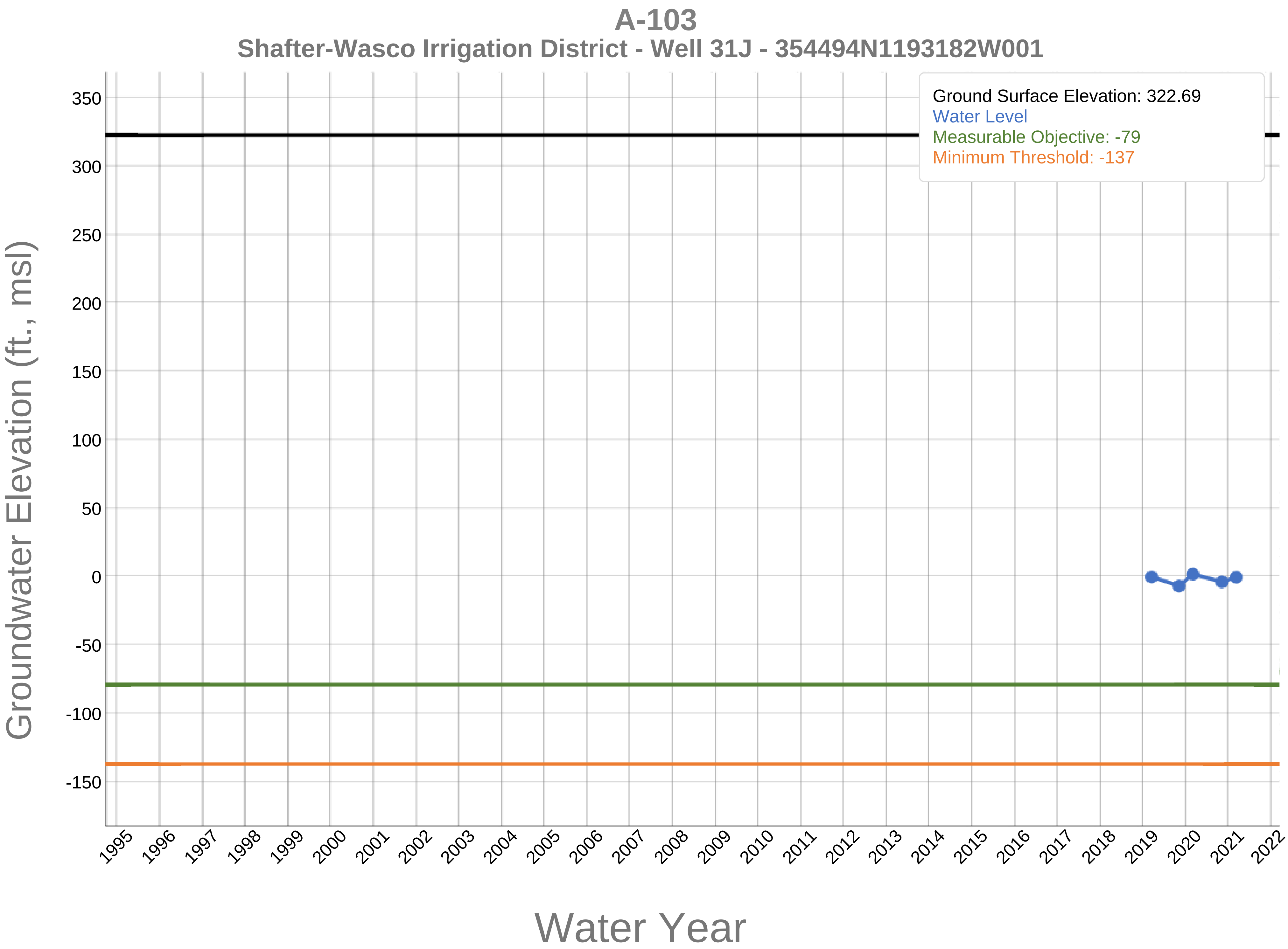
2021
2022
Water Year


A-103
Shafter-Wasco Irrigation District - Well 31J - 354494N1193182W001
Ground Surface Elevation: 322.69
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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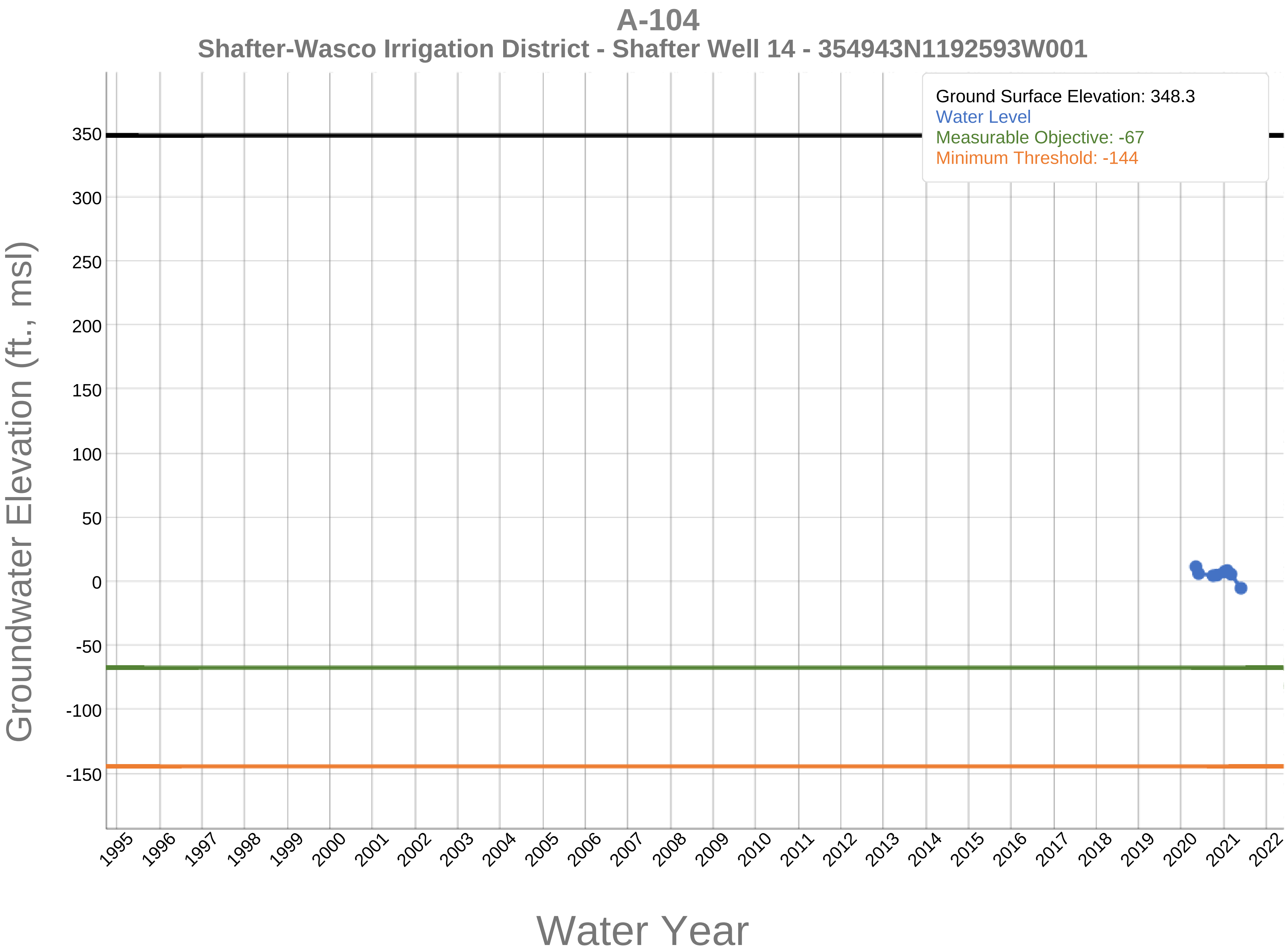
2021
2022
Water Year



A-104
Shafter-Wasco Irrigation District - Shafter Well 14 - 354943N1192593W001
Ground Surface Elevation: 348.3
Water Level
Measurable Objective: -67
Minimum Threshold: -144
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
1999
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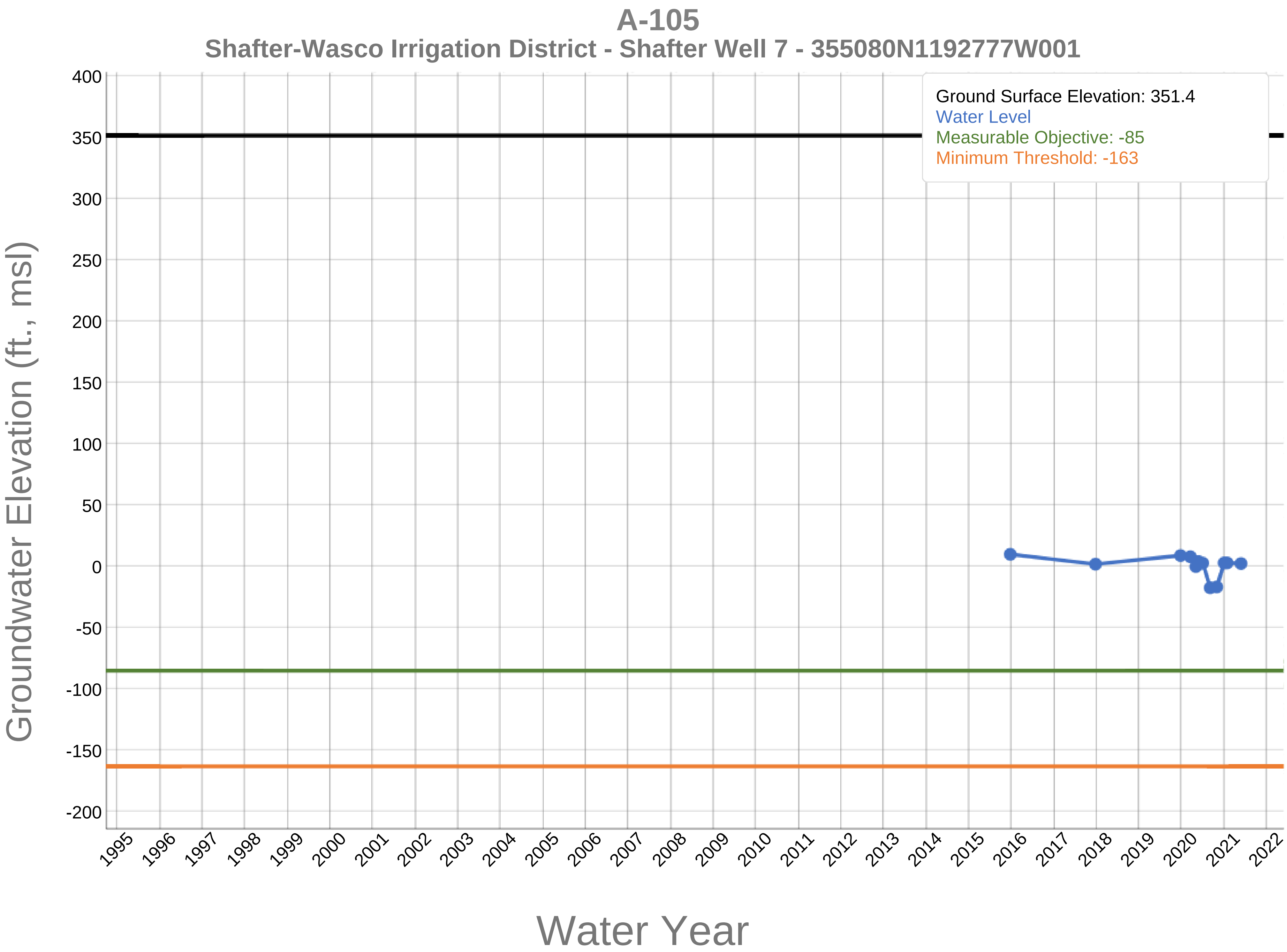
A-105
Shafter-Wasco Irrigation District - Shafter Well 7 - 355080N1192777W001
Ground Surface Elevation: 351.4
Water Level
Measurable Objective: -85
Minimum Threshold: -163
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
-150
-200
1995
1996
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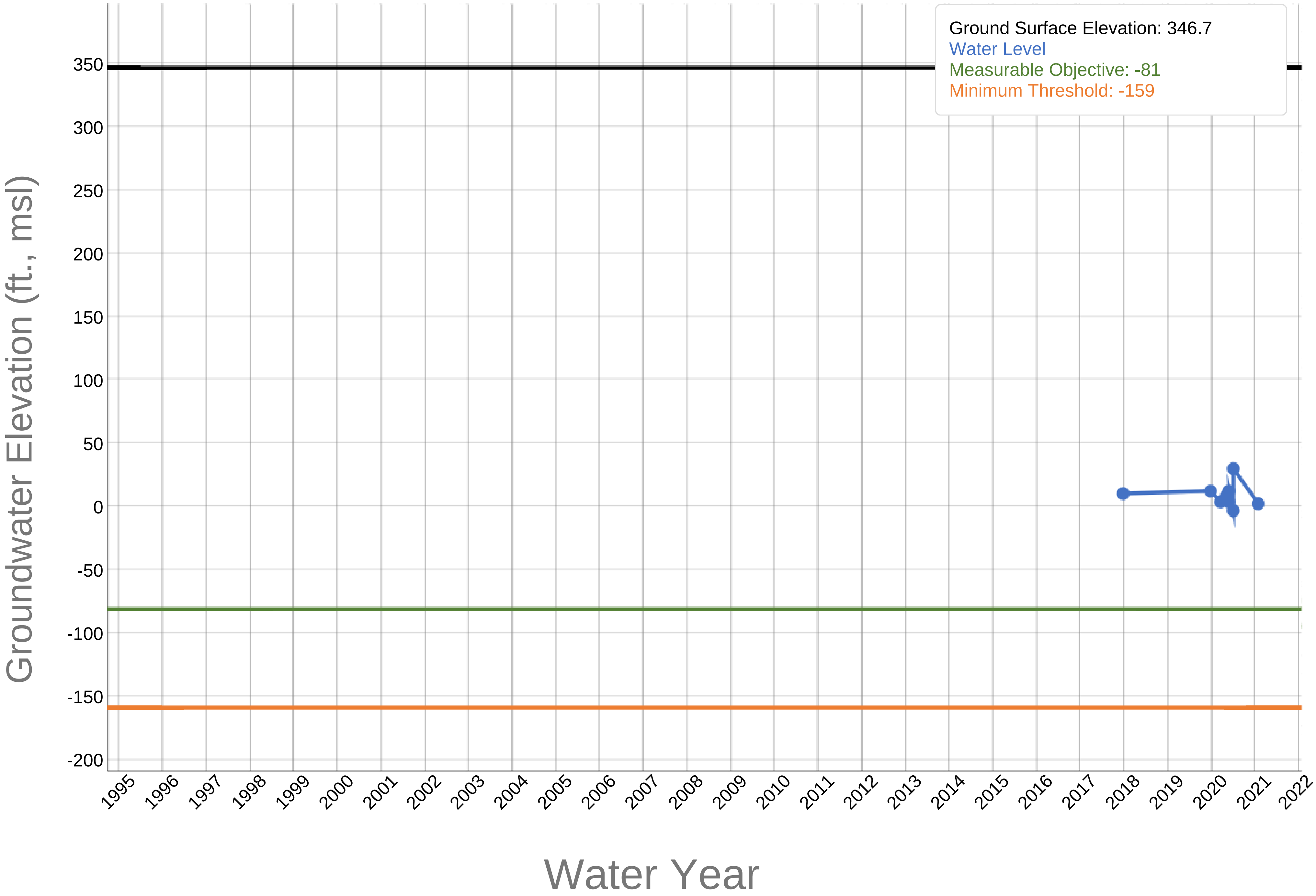
2022
Water Year

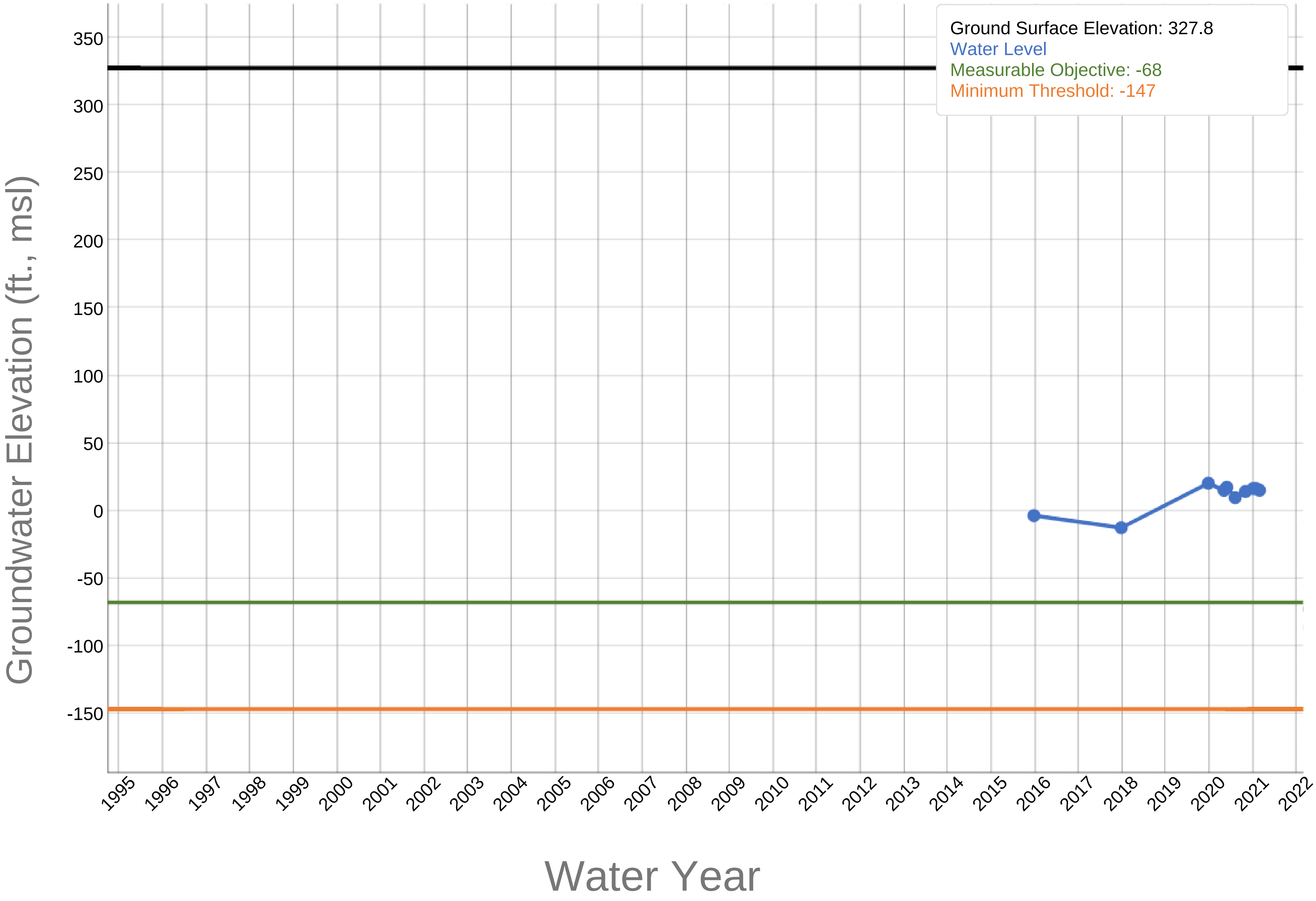
A-106

Shafter-Wasco Irrigation District - Shafter Well 12 - 355020N1192748W001



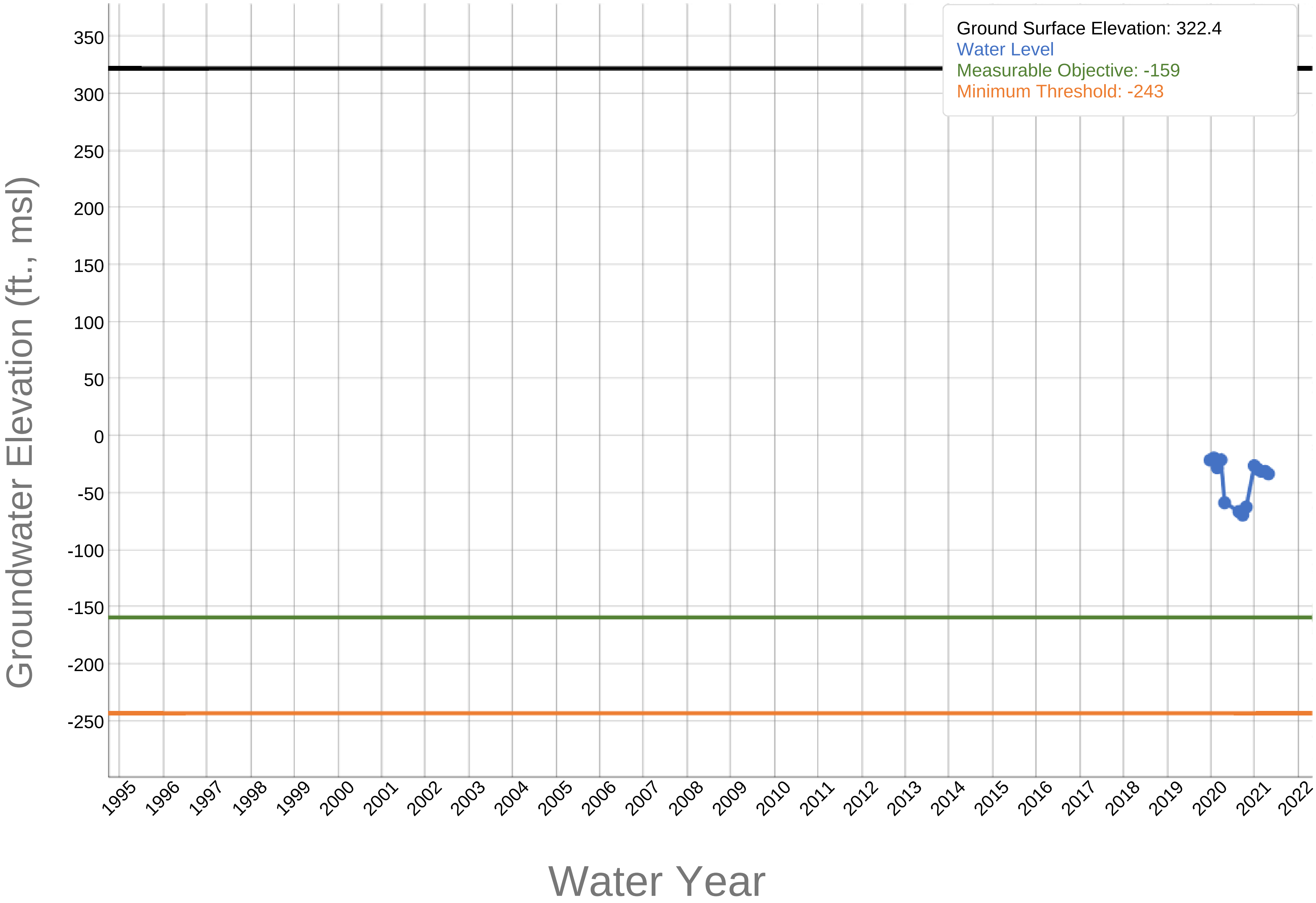
A-107

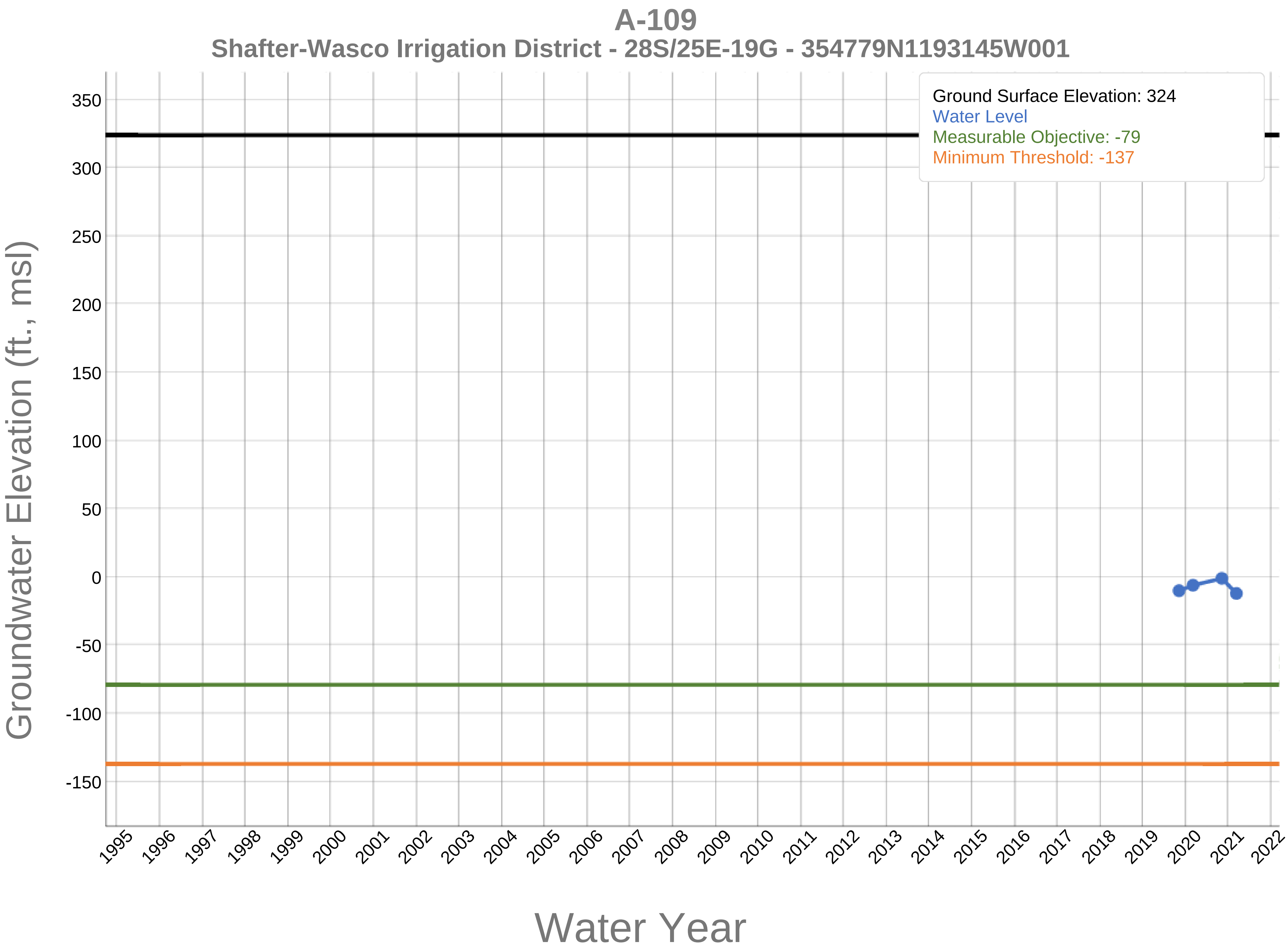
Shafter-Wasco Irrigation District - Shafter Well 15 - 354705N1192792W001



A-108

Shafter-Wasco Irrigation District - Wasco 12 - 356157N1193397W001





A-109
Shafter-Wasco Irrigation District - 28S/25E-19G - 354779N1193145W001
Ground Surface Elevation: 324
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
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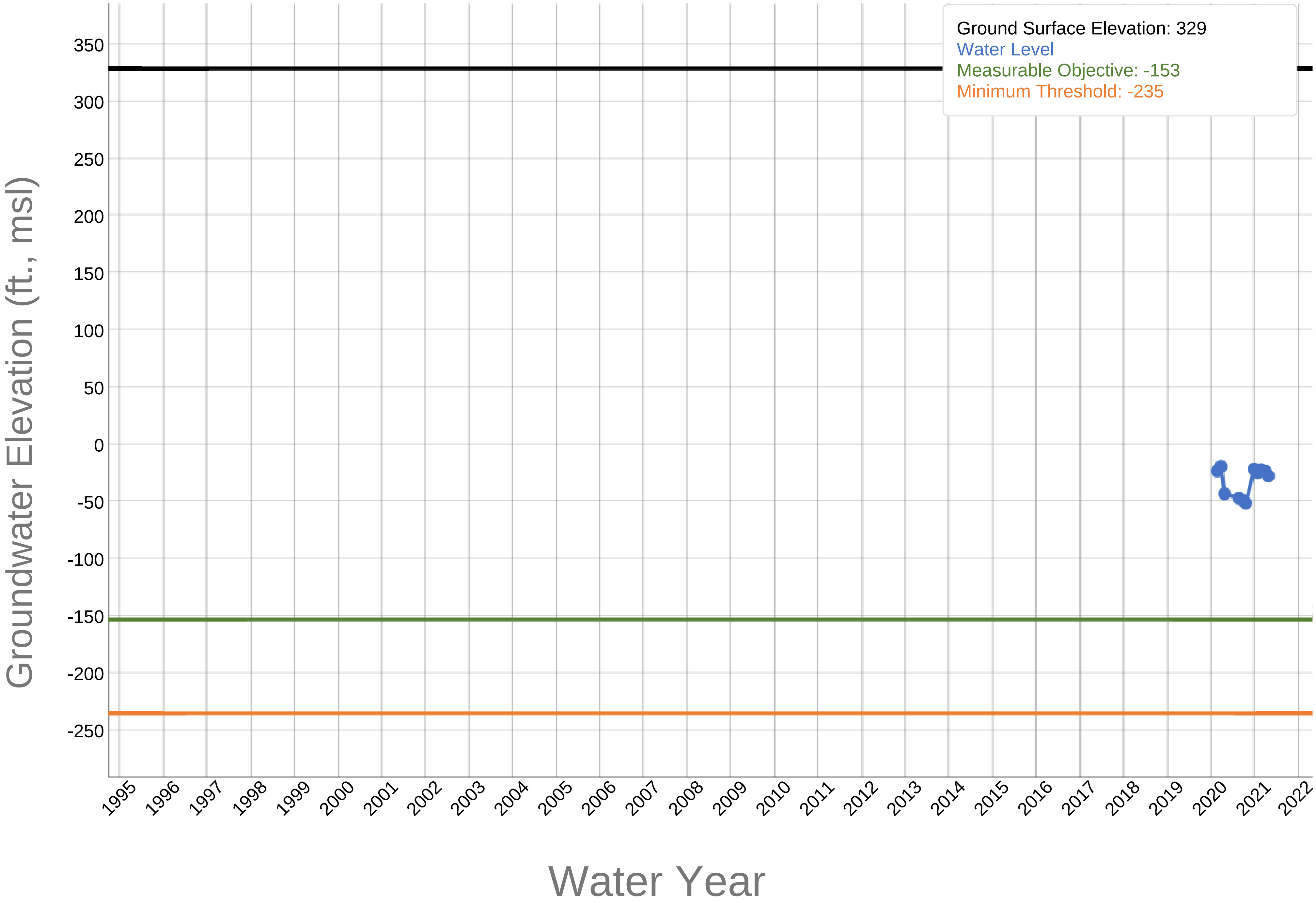
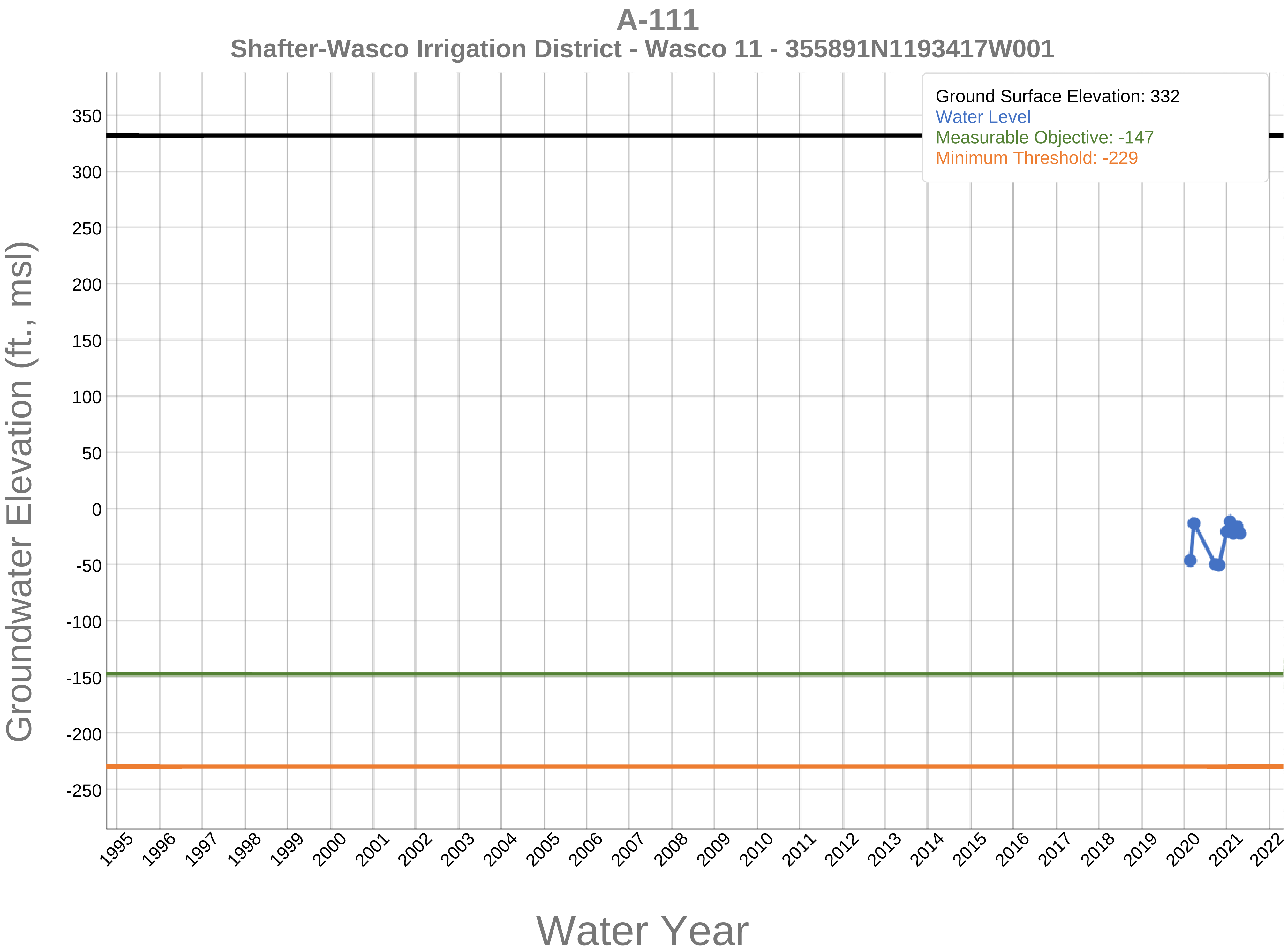
Water Year

A-110

Shafter-Wasco Irrigation District - Wasco 8A - 355874N1193523W001




A-111
Shafter-Wasco Irrigation District - Wasco 11 - 355891N1193417W001
Ground Surface Elevation: 332
Water Level
Measurable Objective: -147
Minimum Threshold: -229
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
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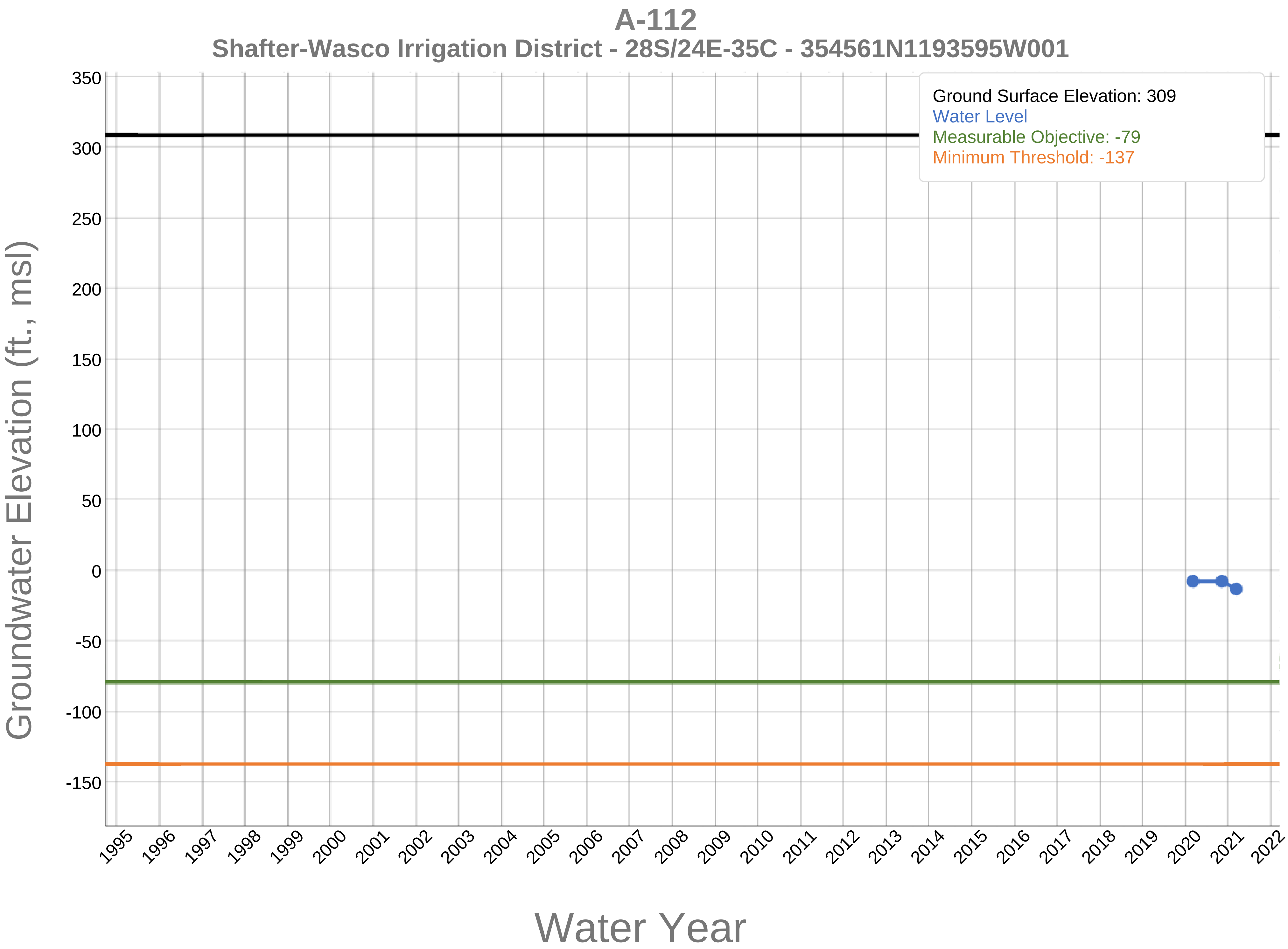
Water Year


A-112
Shafter-Wasco Irrigation District - 28S/24E-35C - 354561N1193595W001
Ground Surface Elevation: 309
Water Level
Measurable Objective: -79
Minimum Threshold: -137
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
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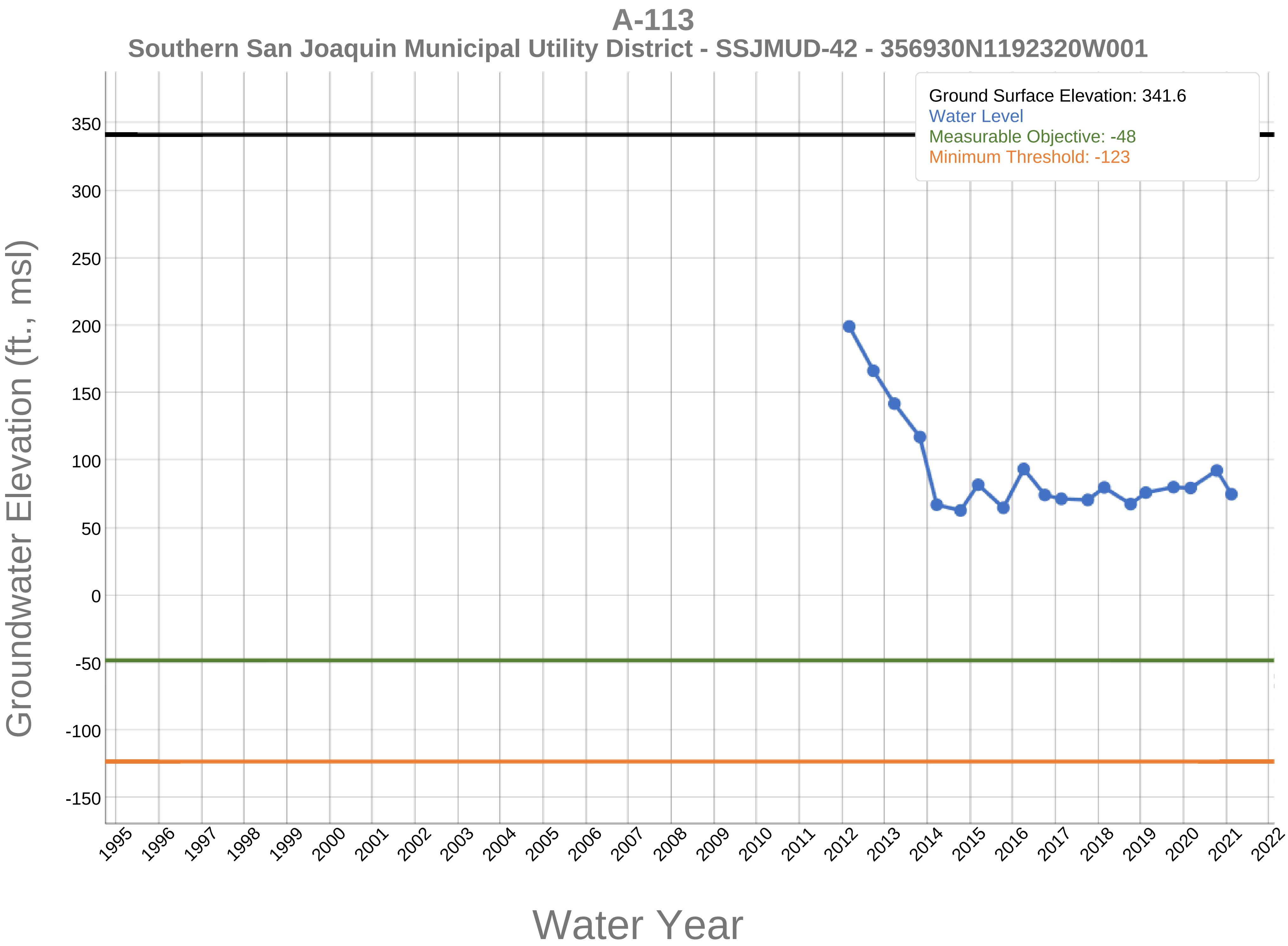
2022
Water Year


A-113
Southern San Joaquin Municipal Utility District - SSJMUD-42 - 356930N1192320W001
Ground Surface Elevation: 341.6
Water Level
Measurable Objective: -48
Minimum Threshold: -123
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
1995
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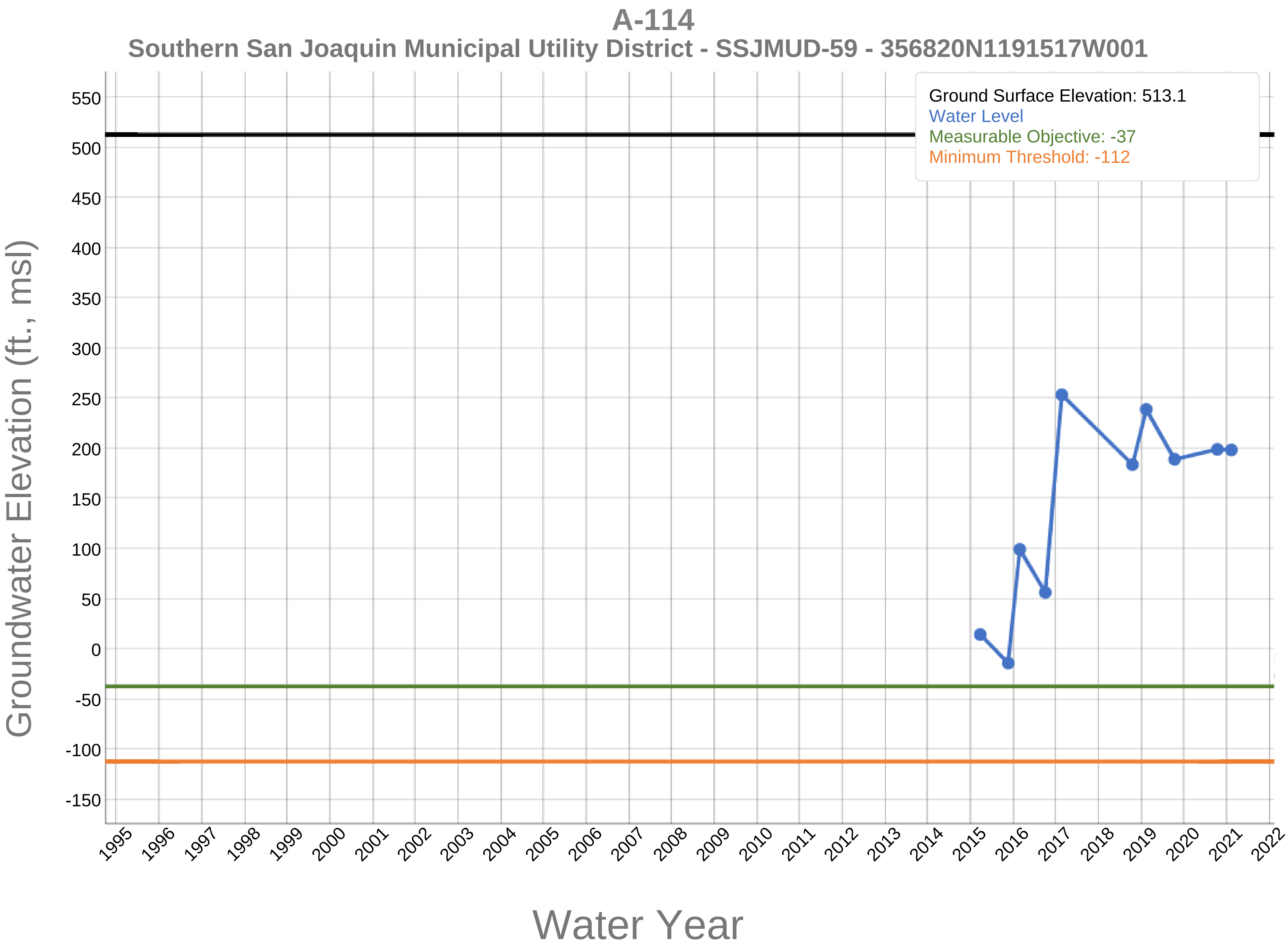
2021
2022
Water Year


A-114
Southern San Joaquin Municipal Utility District - SSJMUD-59 - 356820N1191517W001
Ground Surface Elevation: 513.1
Water Level
Measurable Objective: -37
Minimum Threshold: -112
Groundwater Elevation (ft., msl)
Water Year
550
500
450
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
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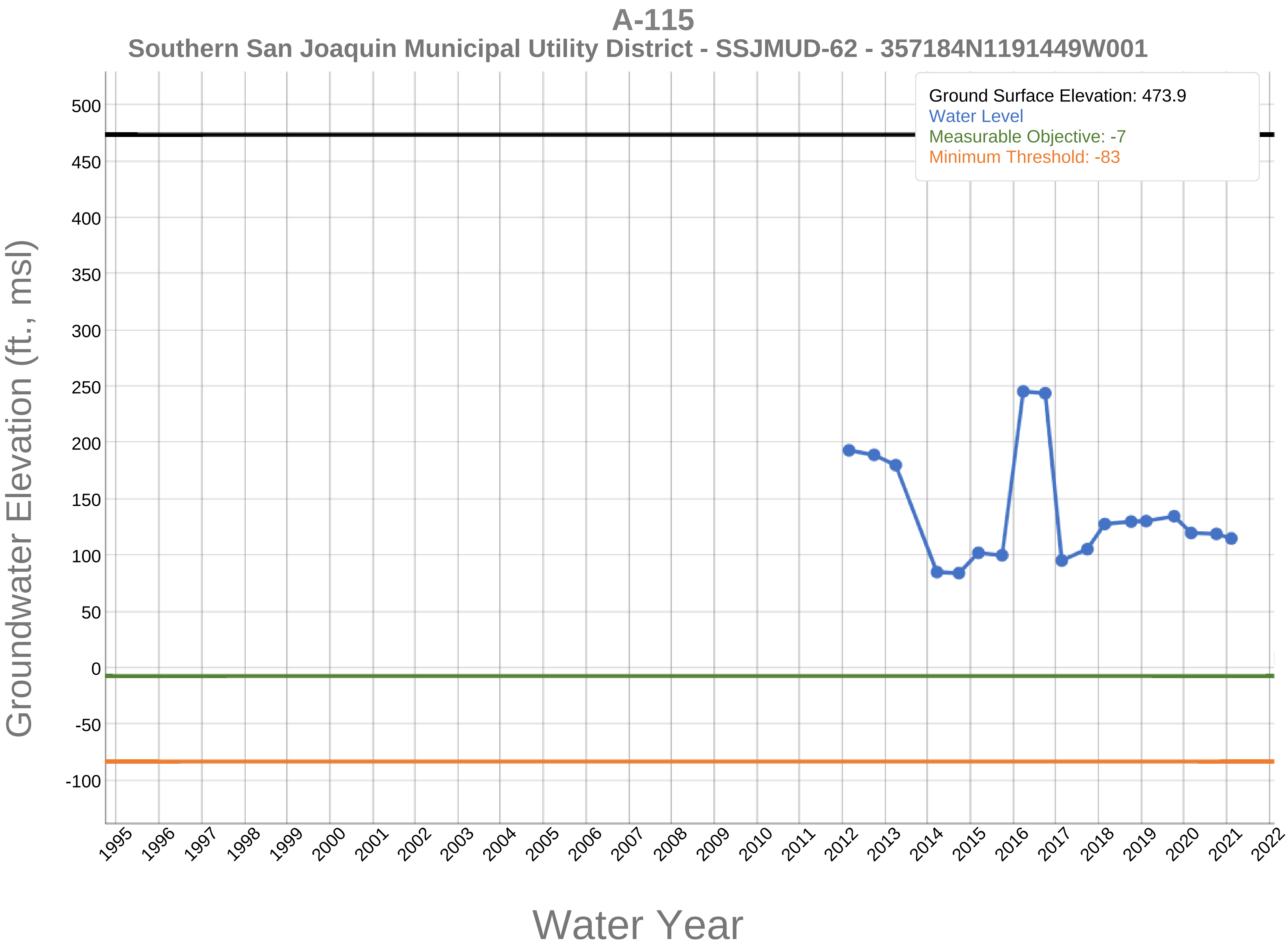

A-115
Southern San Joaquin Municipal Utility District - SSJMUD-62 - 357184N1191449W001
Ground Surface Elevation: 473.9
Water Level
Measurable Objective: -7
Minimum Threshold: -83
Groundwater Elevation (ft., msl)
500
450
400
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
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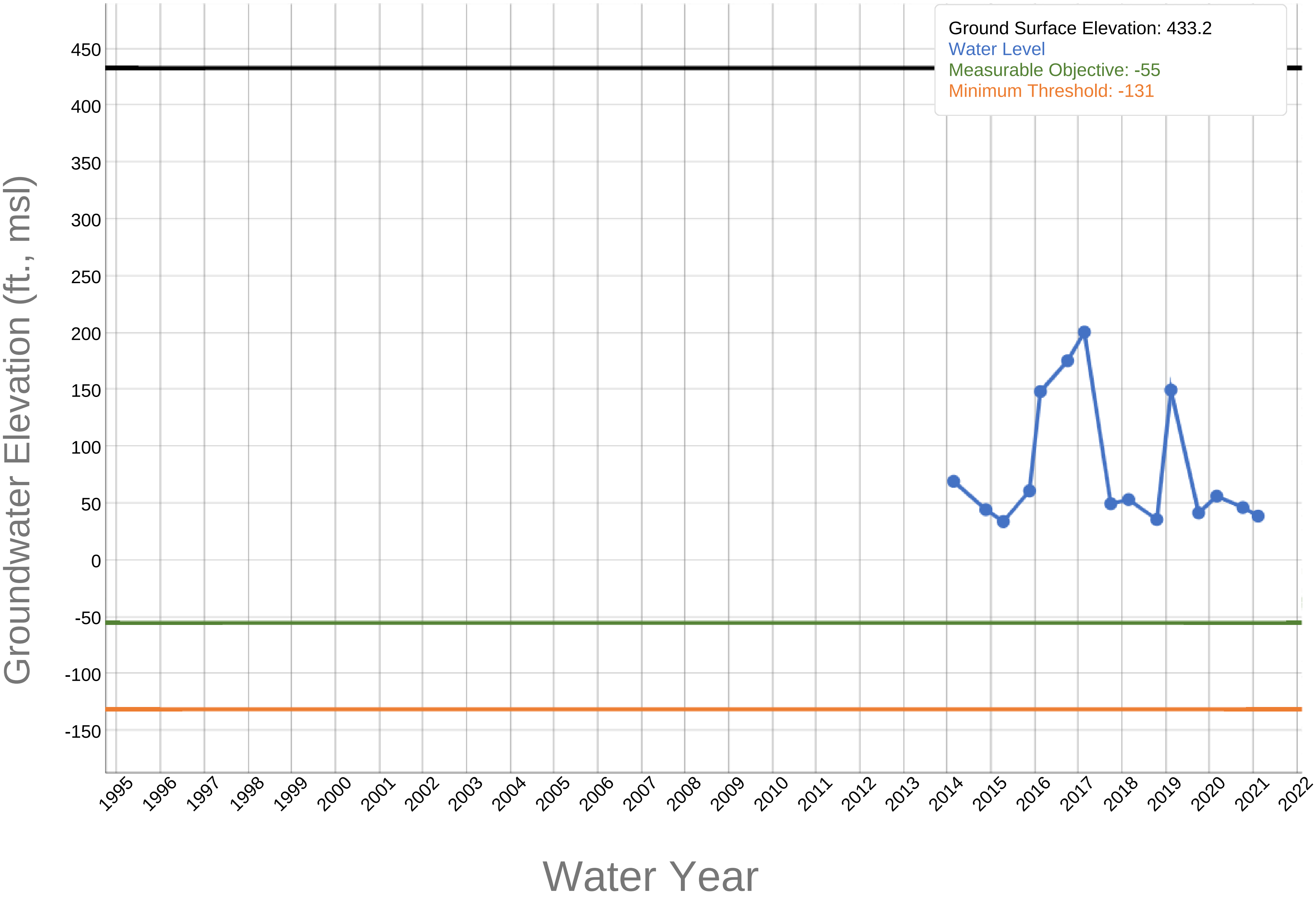
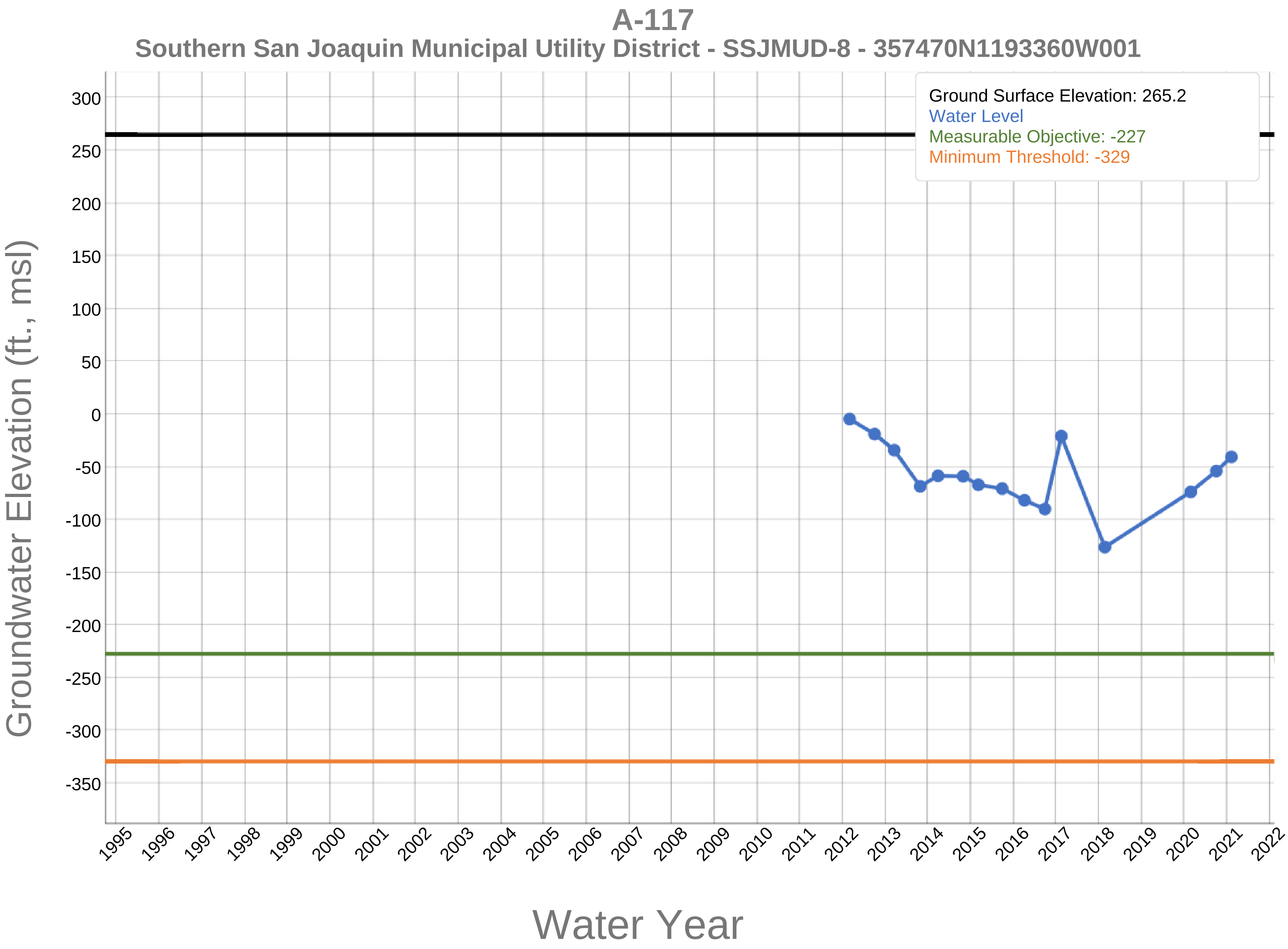
2021
2022
Water Year

A-116
Southern San Joaquin Municipal Utility District - SSJMUD-53 - 356307N1191912W001




A-117
Southern San Joaquin Municipal Utility District - SSJMUD-8 - 357470N1193360W001
Ground Surface Elevation: 265.2
Water Level
Measurable Objective: -227
Minimum Threshold: -329
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
-350
Water Year
1995
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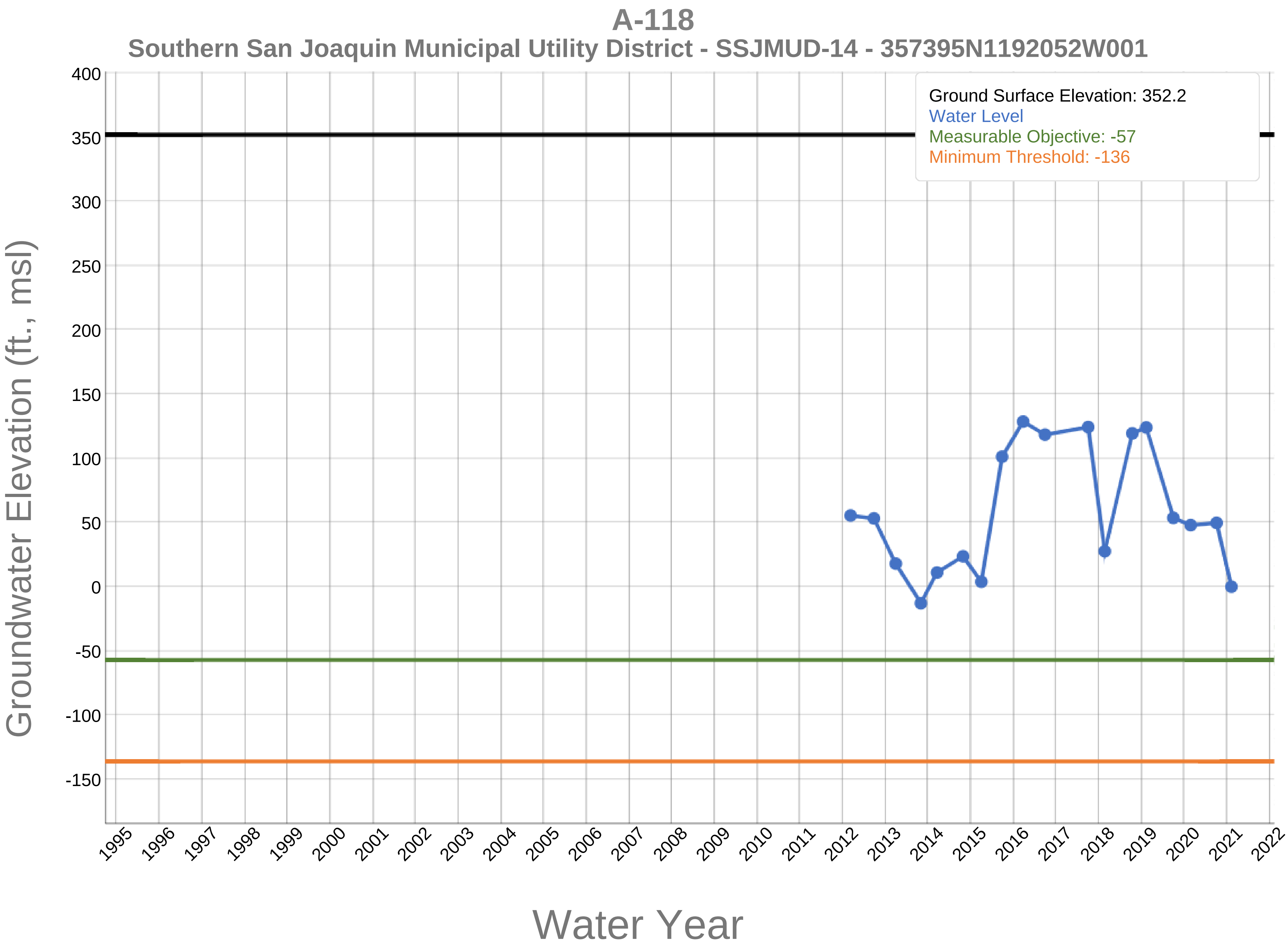
A-118
Southern San Joaquin Municipal Utility District - SSJMUD-14 - 357395N1192052W001
Ground Surface Elevation: 352.2
Water Level
Measurable Objective: -57
Minimum Threshold: -136
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
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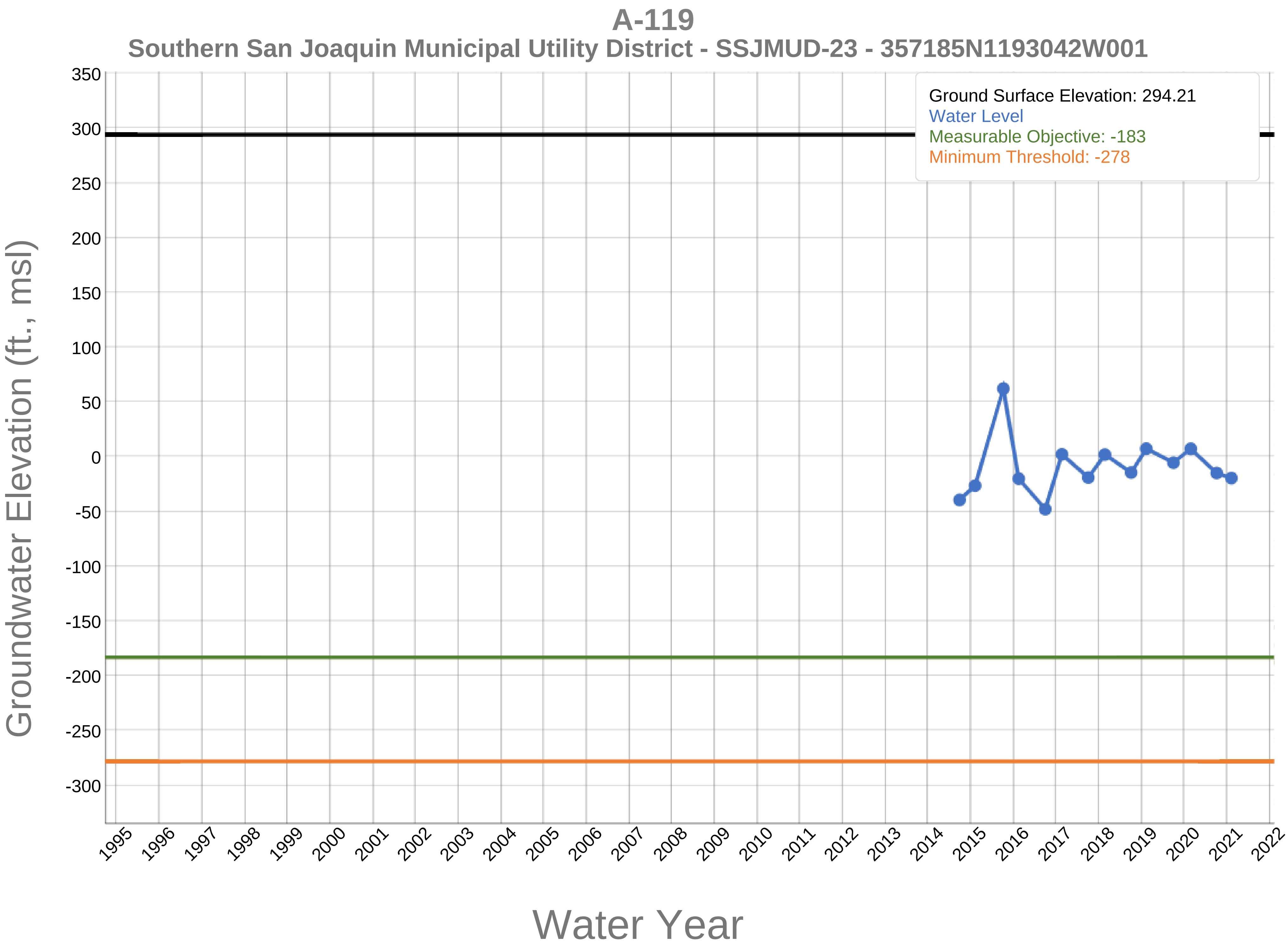
2020
2021
2022
Water Year


A-119
Southern San Joaquin Municipal Utility District - SSJMUD-23 - 357185N1193042W001
Ground Surface Elevation: 294.21
Water Level
Measurable Objective: -183
Minimum Threshold: -278
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
-300
1995
1996
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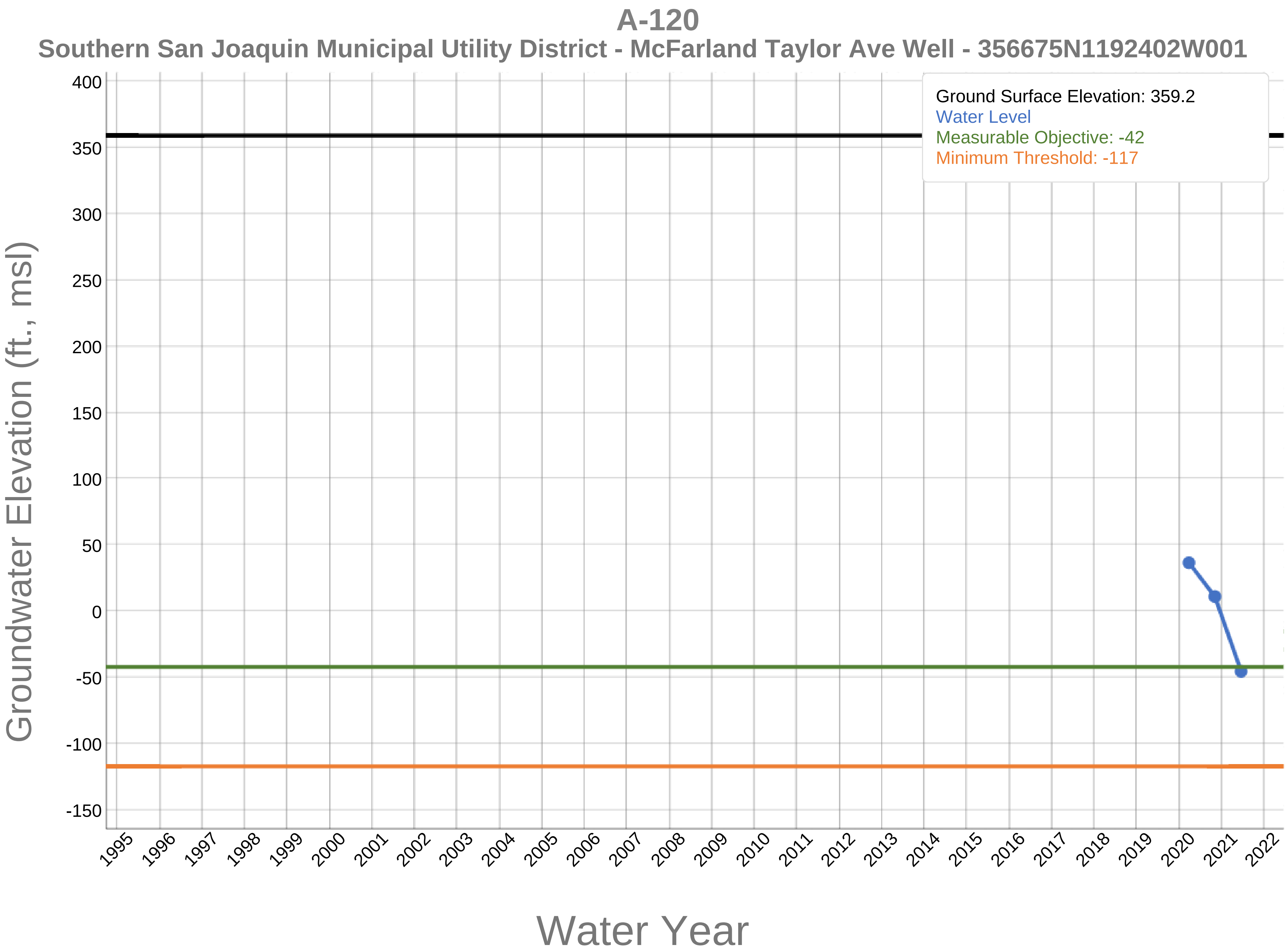
2021
2022
Water Year


A-120
Southern San Joaquin Municipal Utility District - McFarland Taylor Ave Well - 356675N1192402W001
Ground Surface Elevation: 359.2
Water Level
Measurable Objective: -42
Minimum Threshold: -117
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
50
0
-50
-100
-150
1995
1996
1997
1998
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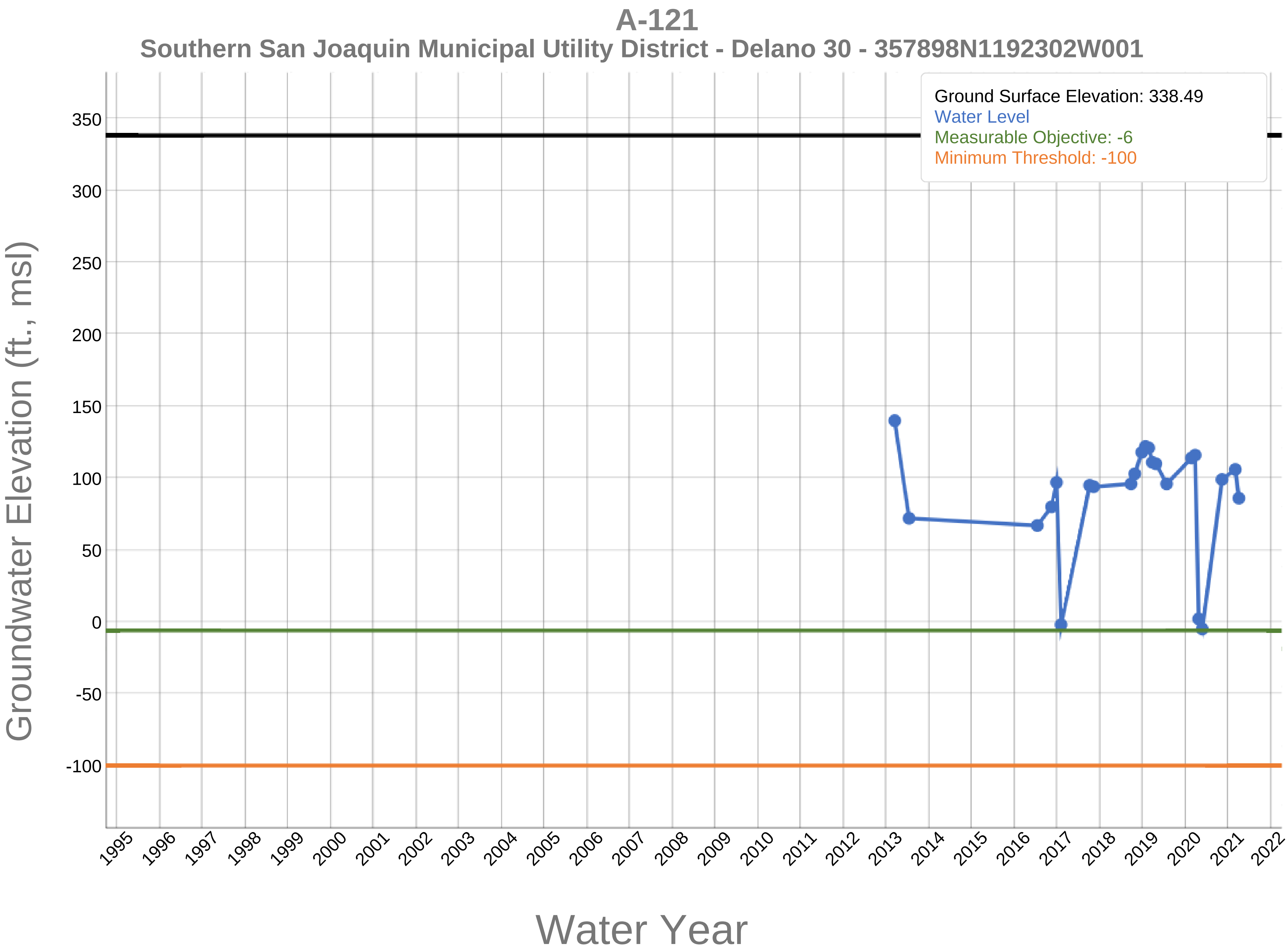
2020
2021
2022
Water Year



A-121
Southern San Joaquin Municipal Utility District - Delano 30 - 357898N1192302W001
Ground Surface Elevation: 338.49
Water Level
Measurable Objective: -6
Minimum Threshold: -100
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
1996
1997
1998
1999
2000
2001
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2003
2004
2005
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2011
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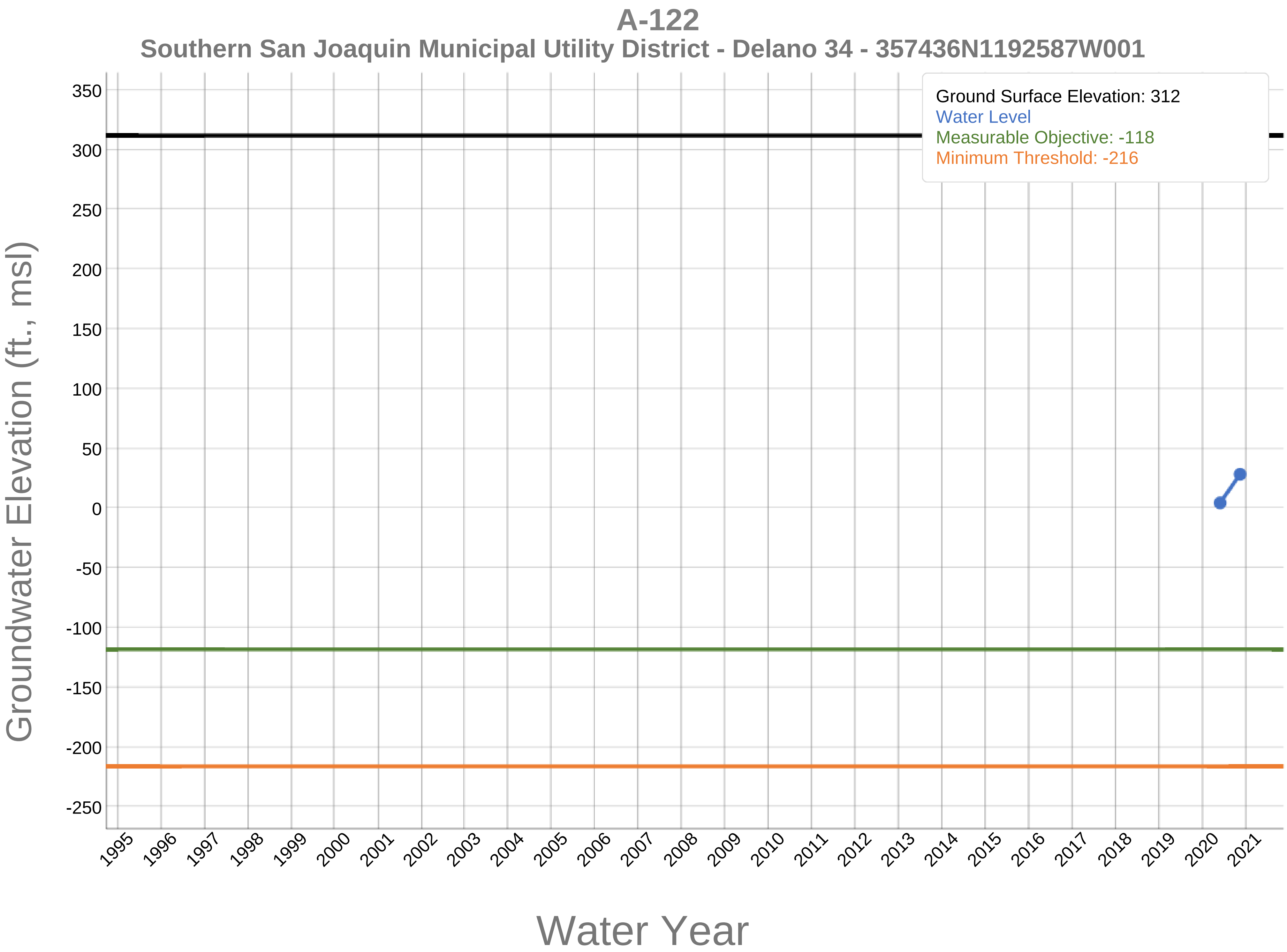
2019
2020
2021
2022
Water Year


A-122
Southern San Joaquin Municipal Utility District - Delano 34 - 357436N1192587W001
Ground Surface Elevation: 312
Water Level
Measurable Objective: -118
Minimum Threshold: -216
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1995
1996
1997
1998
1999
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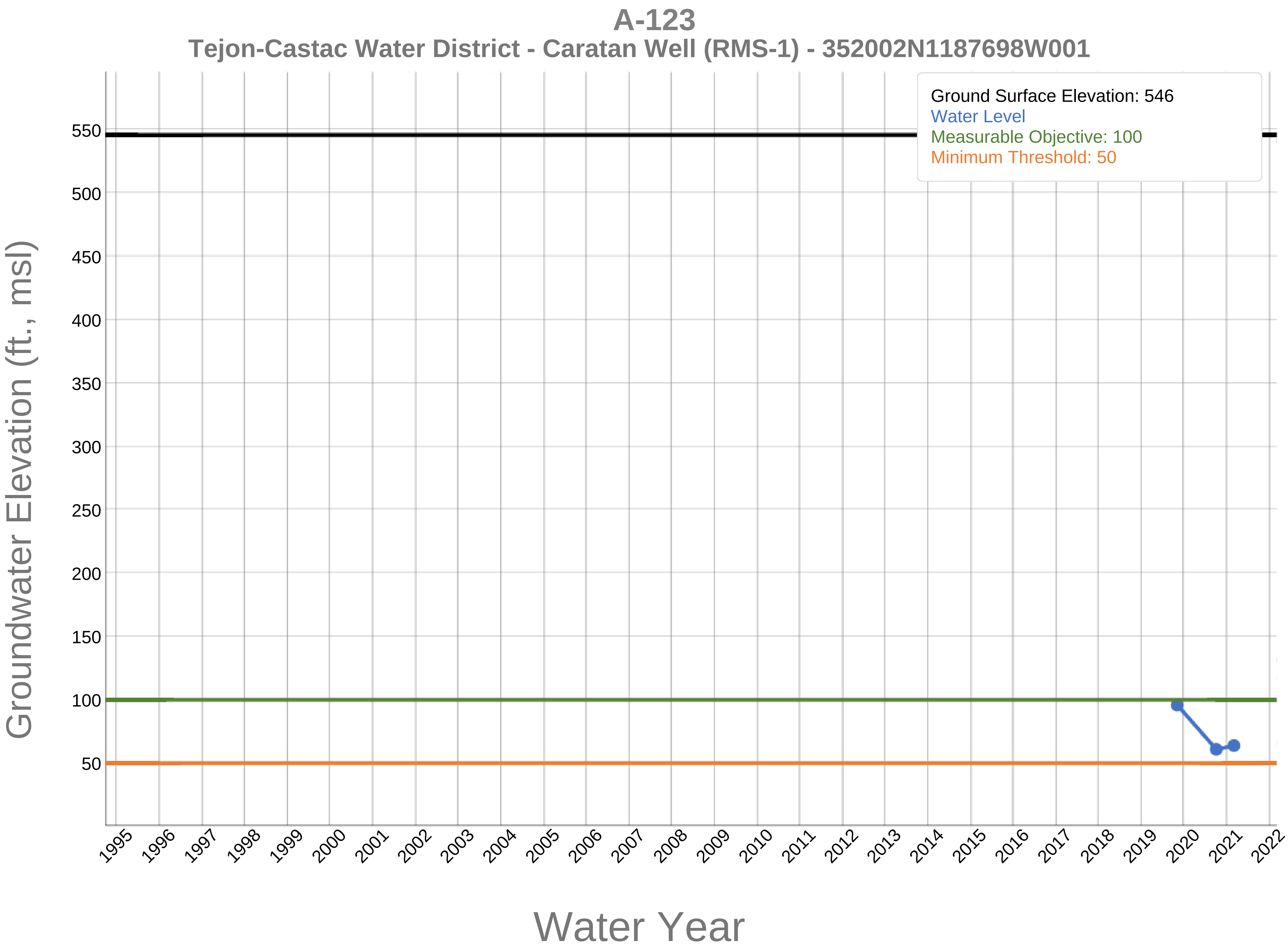
2019
2020
2021
Water Year


A-123
Tejon-Castac Water District - Caratan Well (RMS-1) - 352002N1187698W001
Ground Surface Elevation: 546
Water Level
Measurable Objective: 100
Minimum Threshold: 50
Groundwater Elevation (ft., msl)
Water Year
550
500
450
400
350
300
250
200
150
100
50
1995
1996
1997
1998
1999
2000
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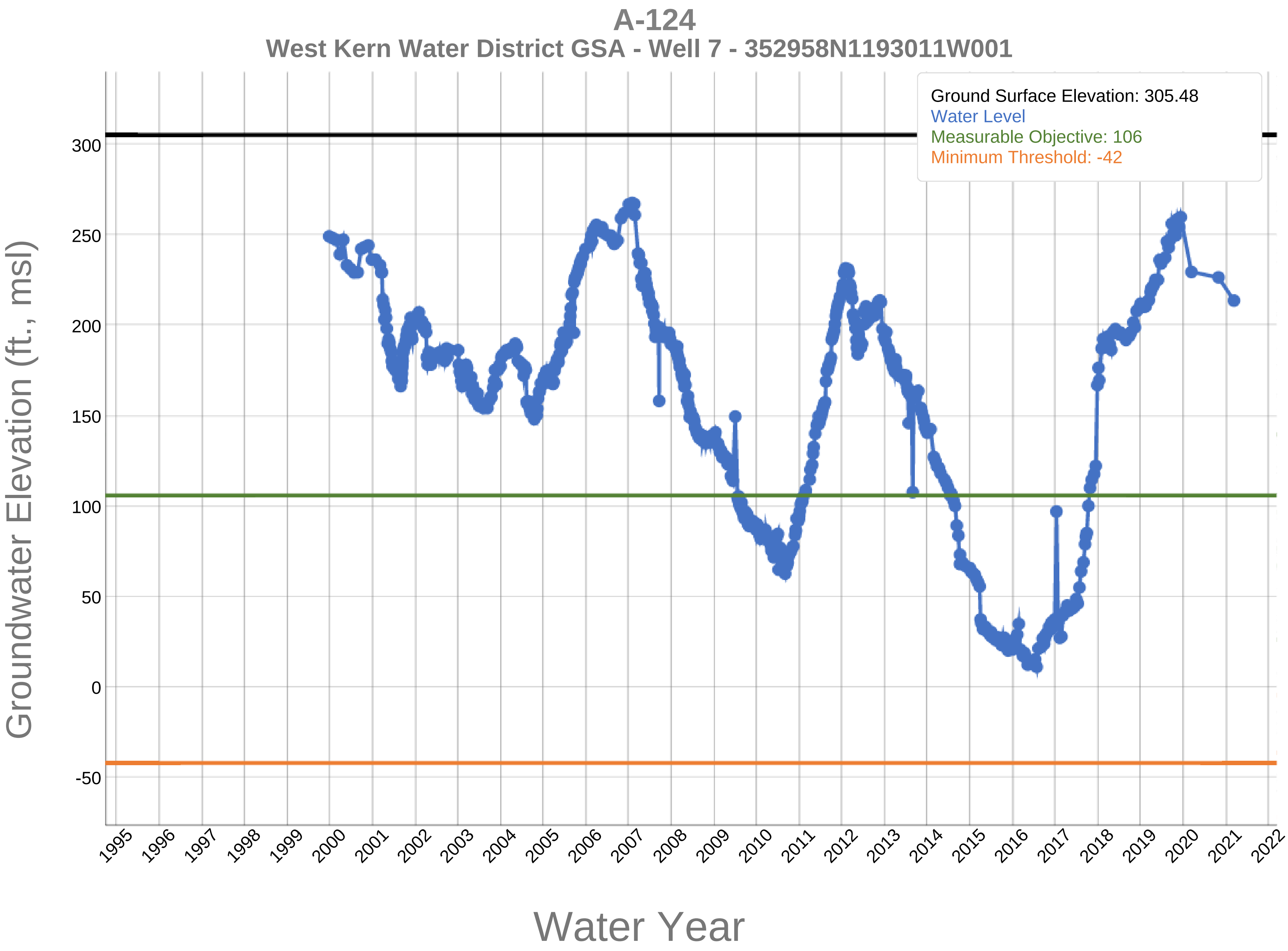
2021
2022


A-124
West Kern Water District GSA - Well 7 - 352958N1193011W001
Ground Surface Elevation: 305.48
Water Level
Measurable Objective: 106
Minimum Threshold: -42
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
2001
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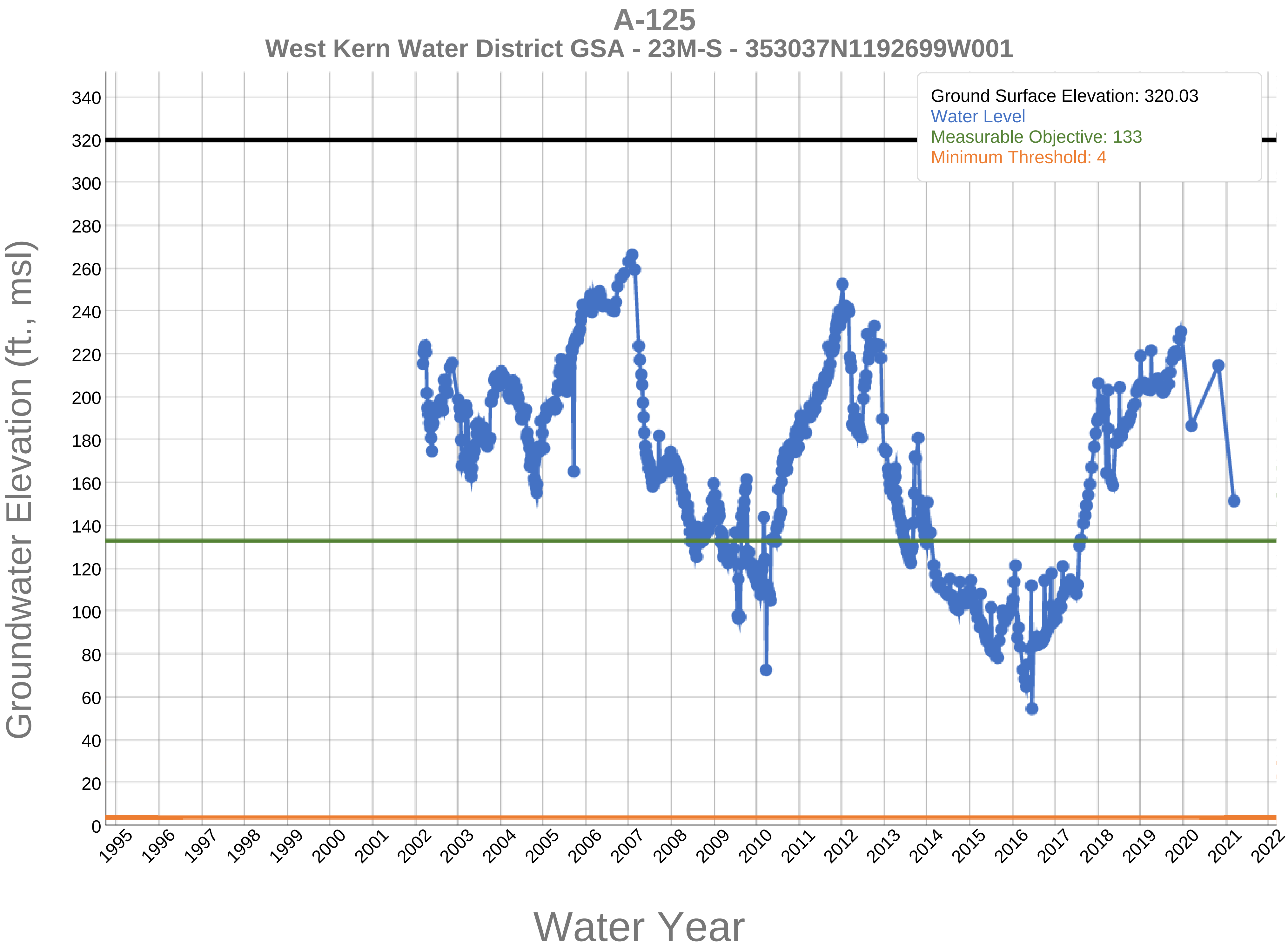
2021
2022
Water Year



A-125
West Kern Water District GSA - 23M-S - 353037N1192699W001
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 133
Minimum Threshold: 4
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
1995
1996
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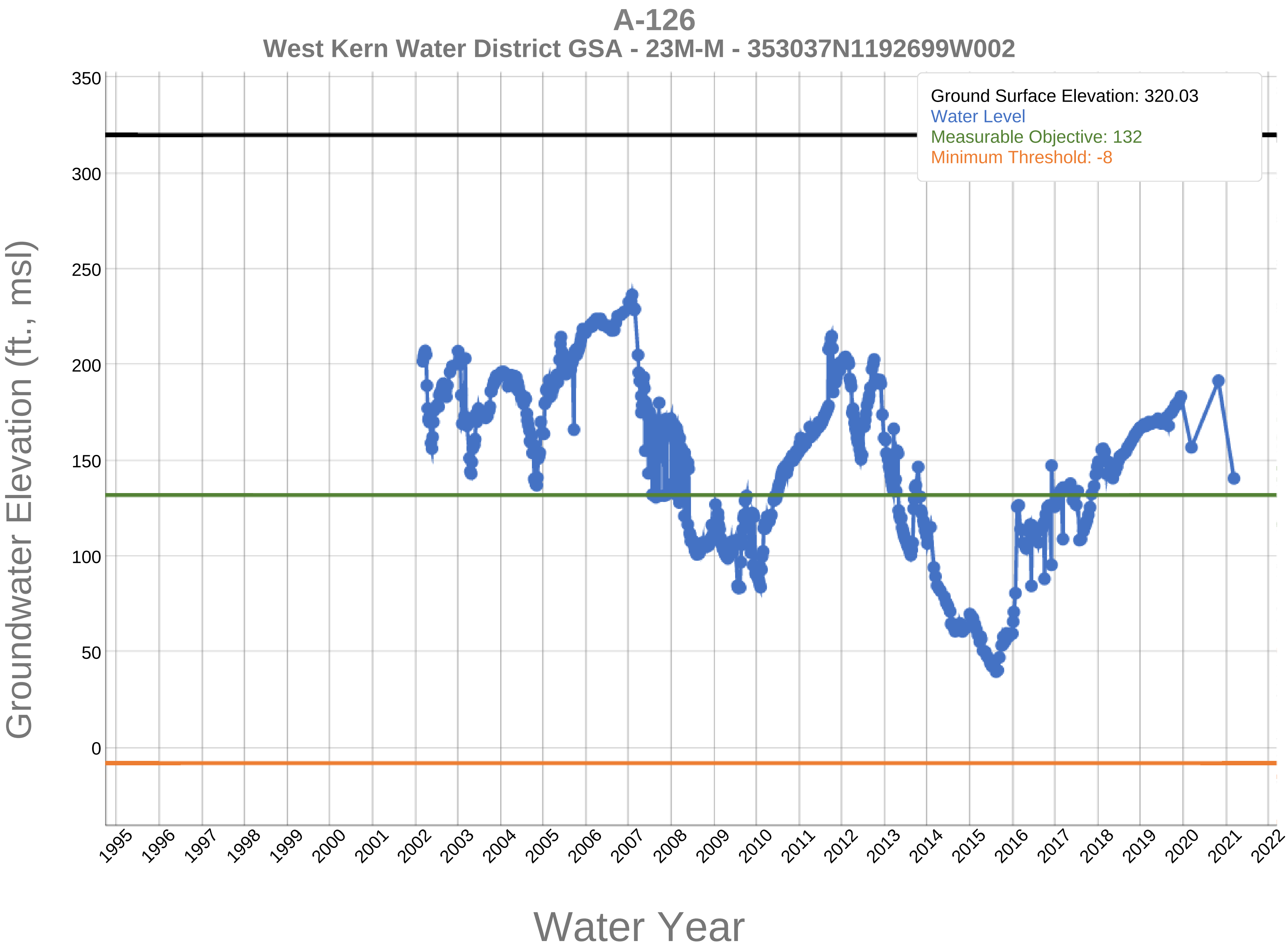
2021
2022
Water Year



A-126
West Kern Water District GSA - 23M-M - 353037N1192699W002
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 132
Minimum Threshold: -8
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
1995
1996
1997
1998
1999
2000
2001
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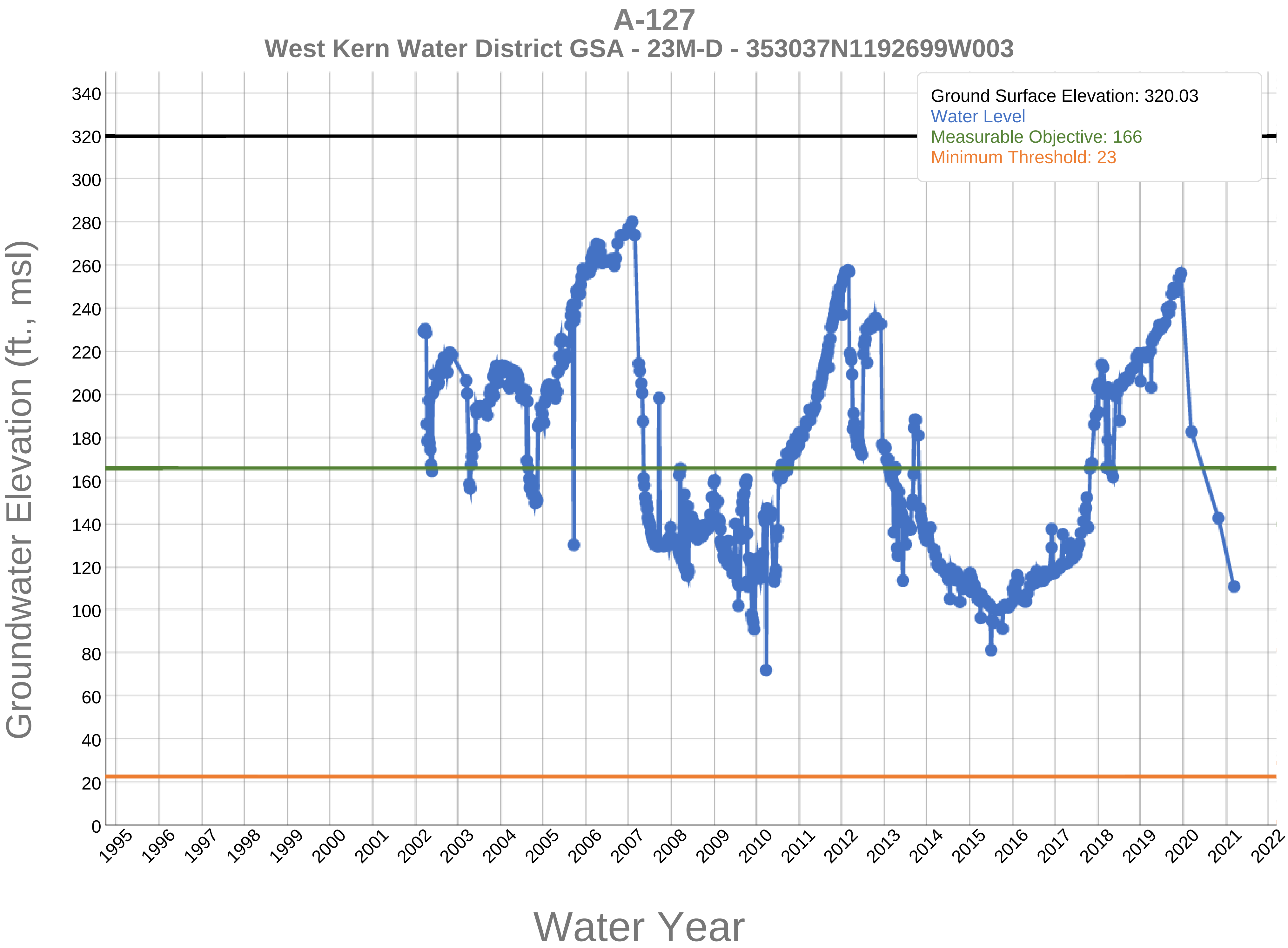
Water Year



A-127
West Kern Water District GSA - 23M-D - 353037N1192699W003
Ground Surface Elevation: 320.03
Water Level
Measurable Objective: 166
Minimum Threshold: 23
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
1995
1996
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1998
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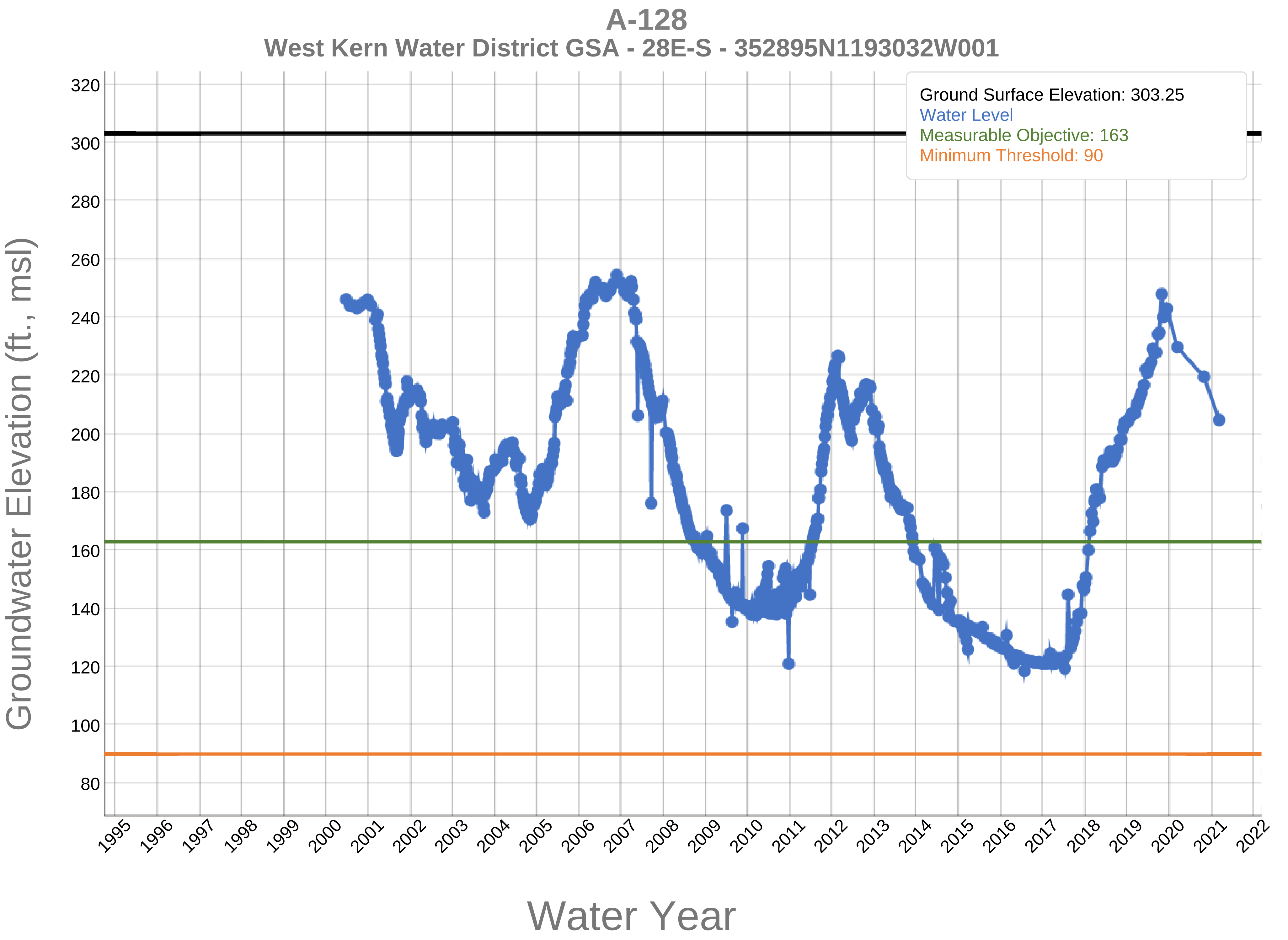
Water Year


A-128
West Kern Water District GSA - 28E-S - 352895N1193032W001
Ground Surface Elevation: 303.25
Water Level
Measurable Objective: 163
Minimum Threshold: 90
Groundwater Elevation (ft., msl)
Water Year
320
300
280
260
240
220
200
180
160
140
120
100
80
1995
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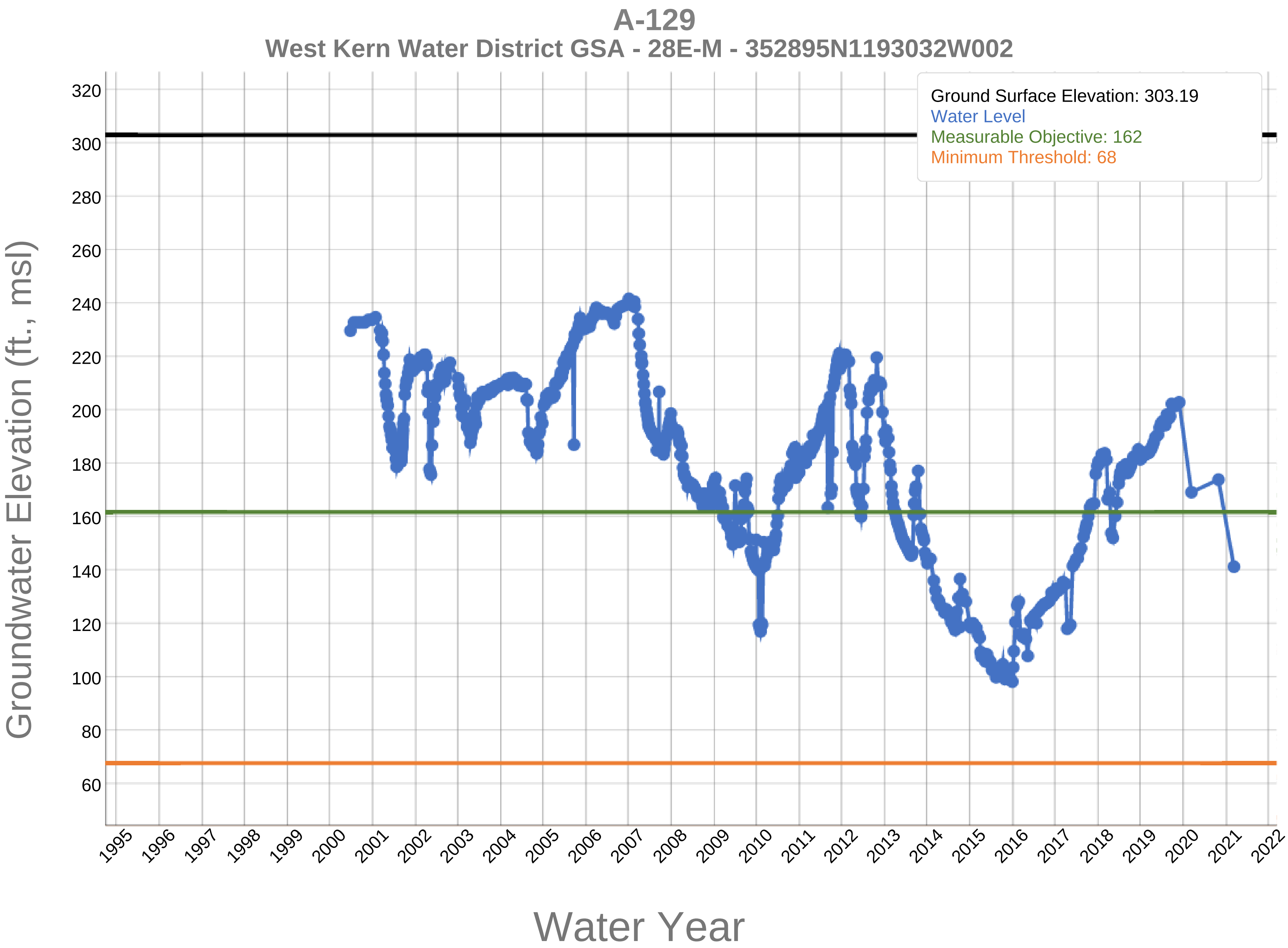
A-129
West Kern Water District GSA - 28E-M - 352895N1193032W002
Ground Surface Elevation: 303.19
Water Level
Measurable Objective: 162
Minimum Threshold: 68
Groundwater Elevation (ft., msl)
Water Year
320
300
280
260
240
220
200
180
160
140
120
100
80
60
1995
1996
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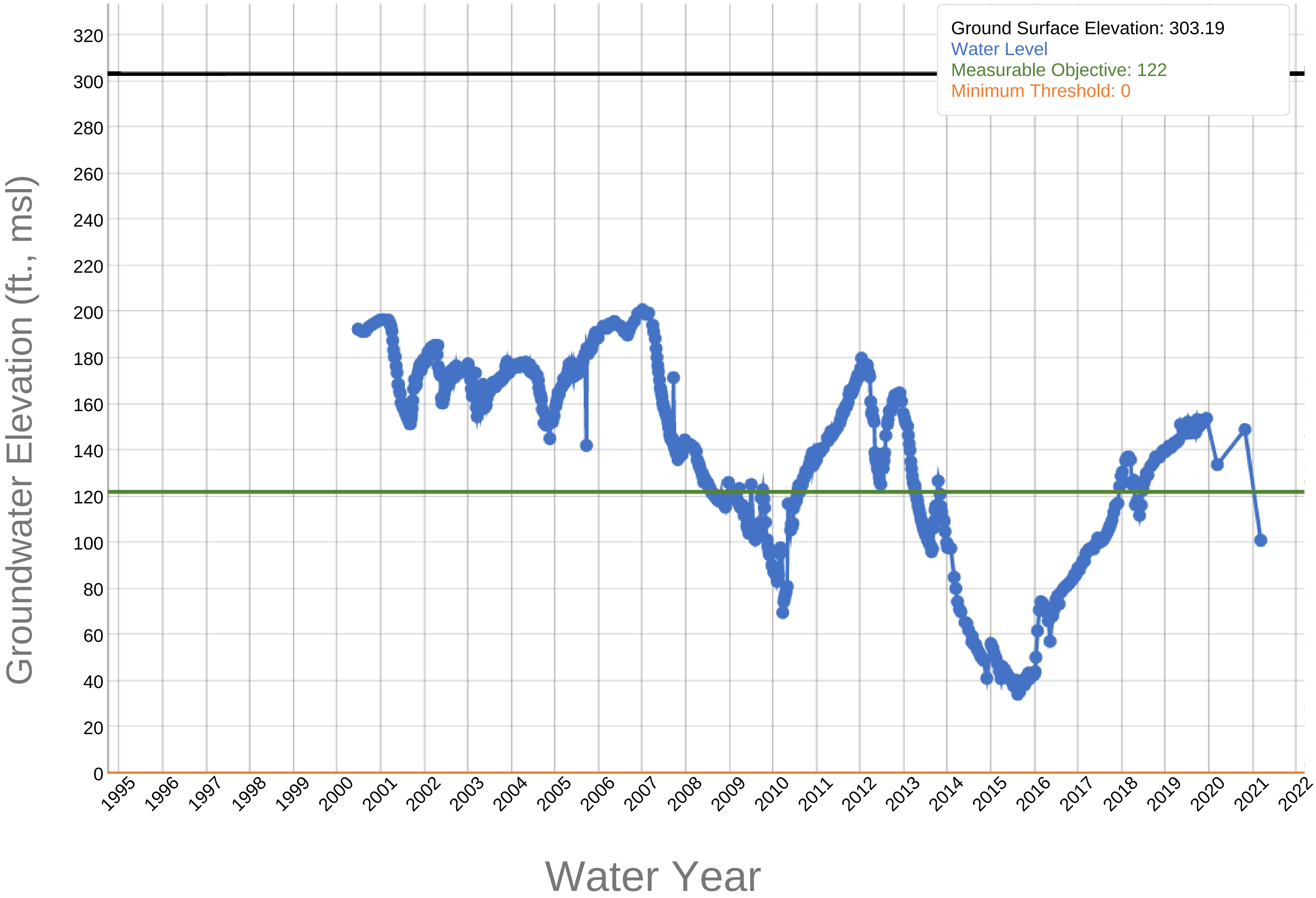
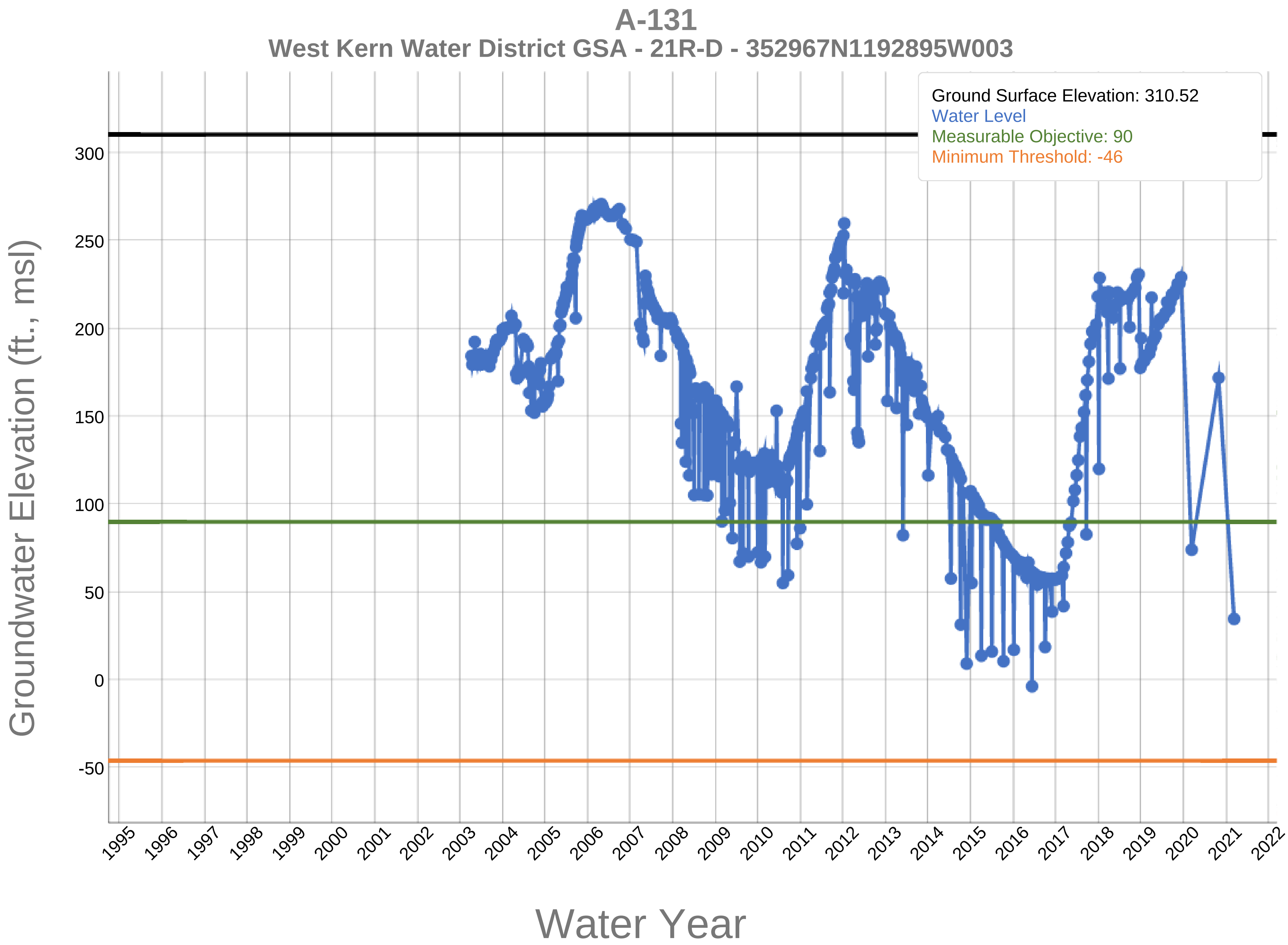
A-130

West Kern Water District GSA - 28E-D - 352895N1193032W003




A-131
West Kern Water District GSA - 21R-D - 352967N1192895W003
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 90
Minimum Threshold: -46
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
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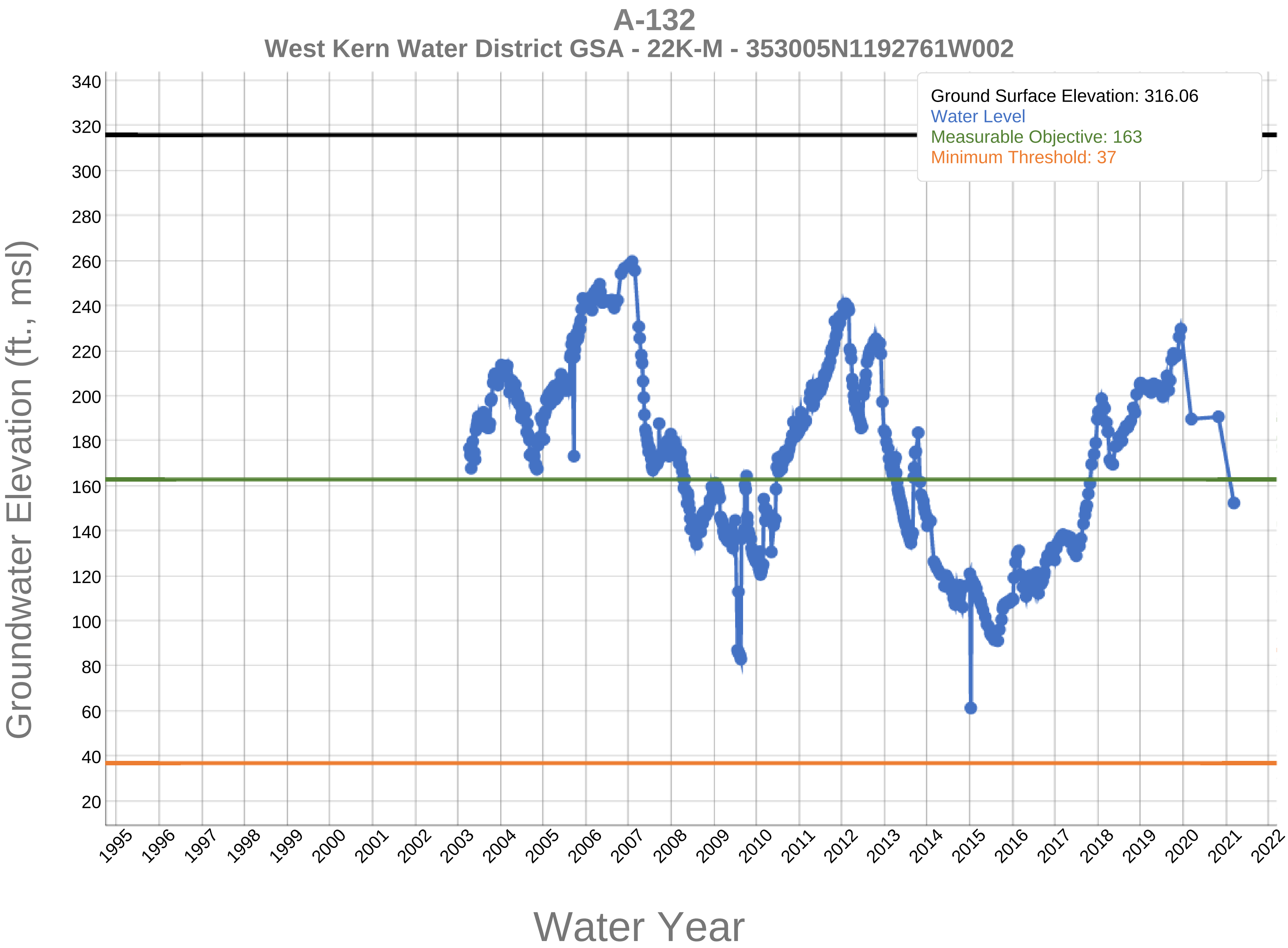
Water Year


A-132
West Kern Water District GSA - 22K-M - 353005N1192761W002
Ground Surface Elevation: 316.06
Water Level
Measurable Objective: 163
Minimum Threshold: 37
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
180
160
140
120
100
80
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1995
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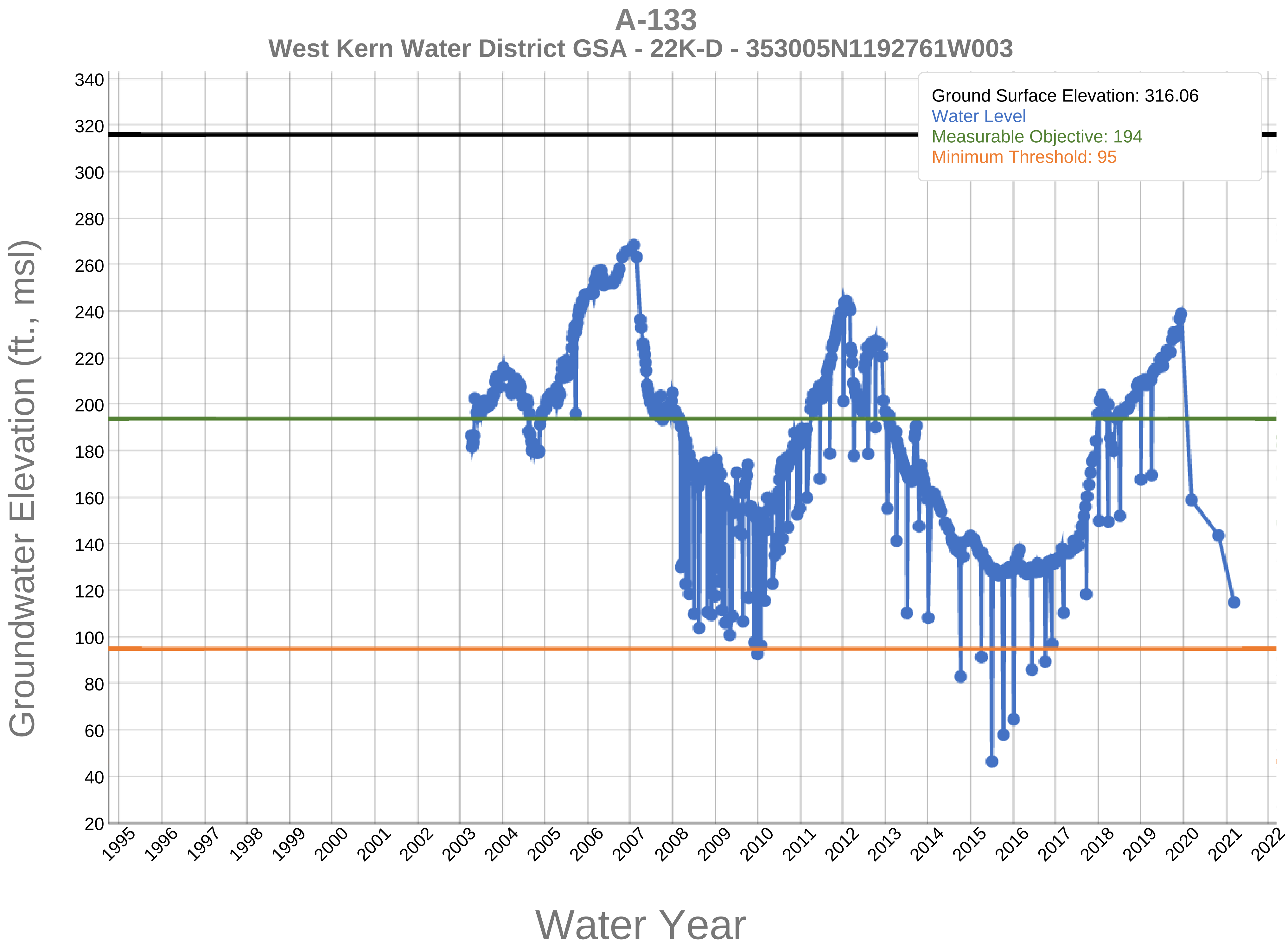
Water Year


A-133
West Kern Water District GSA - 22K-D - 353005N1192761W003
Ground Surface Elevation: 316.06
Water Level
Measurable Objective: 194
Minimum Threshold: 95
Groundwater Elevation (ft., msl)
Water Year
340
320
300
280
260
240
220
200
180
160
140
120
100
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60
40
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1995
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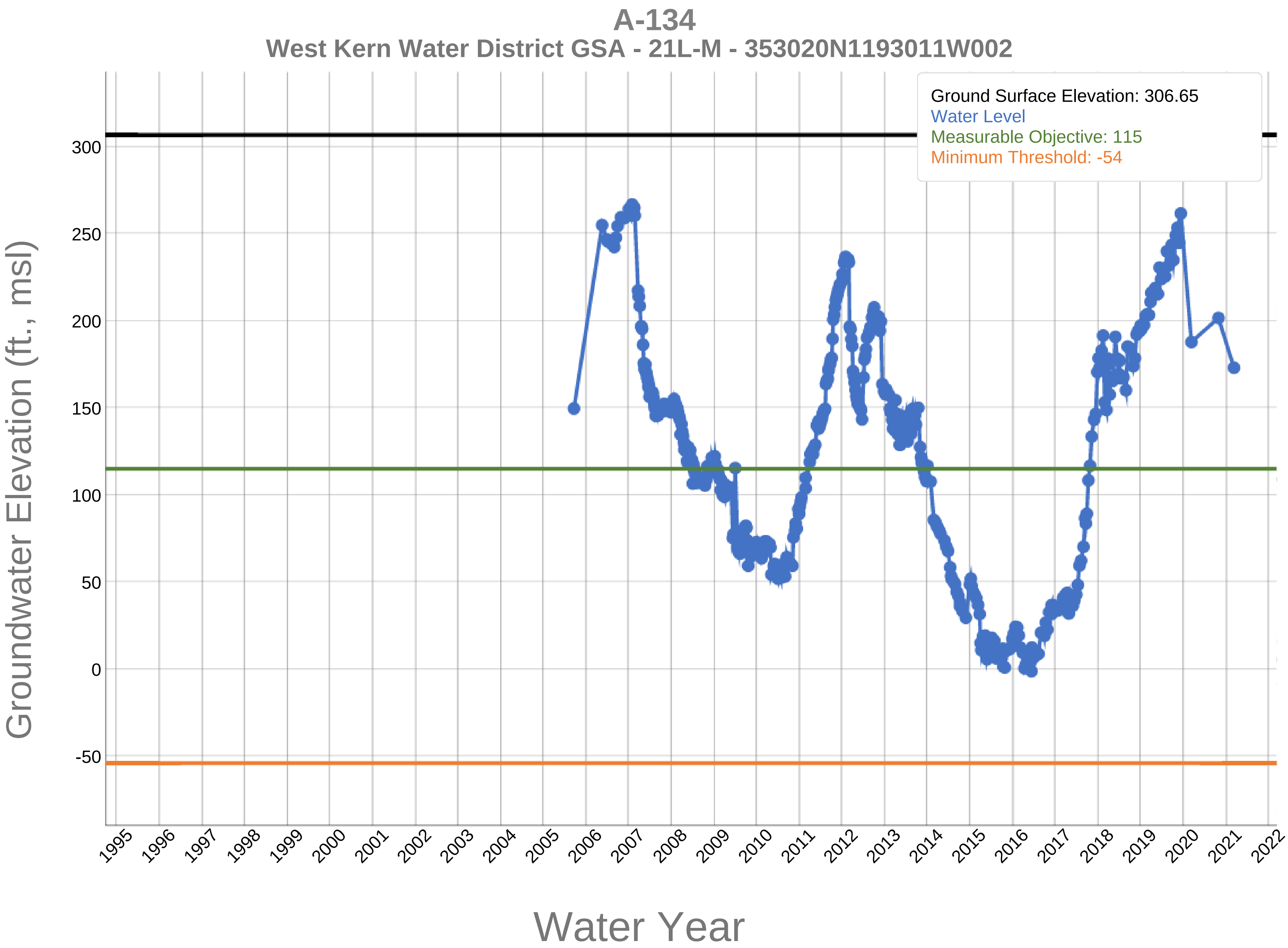
A-134
West Kern Water District GSA - 21L-M - 353020N1193011W002
Ground Surface Elevation: 306.65
Water Level
Measurable Objective: 115
Minimum Threshold: -54
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
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1999
2000
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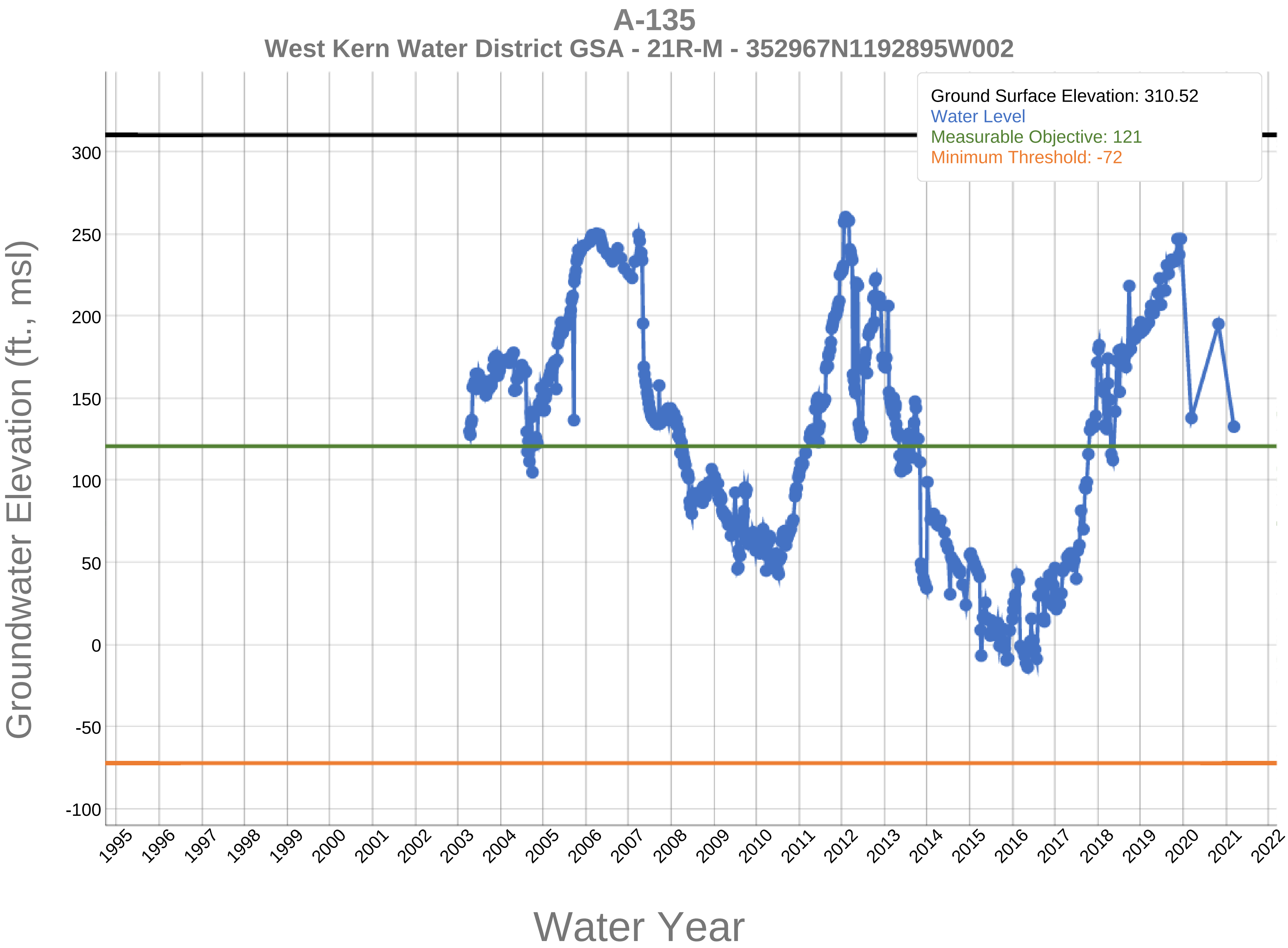
2021
2022
Water Year


A-135
West Kern Water District GSA - 21R-M - 352967N1192895W002
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 121
Minimum Threshold: -72
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
-100
1995
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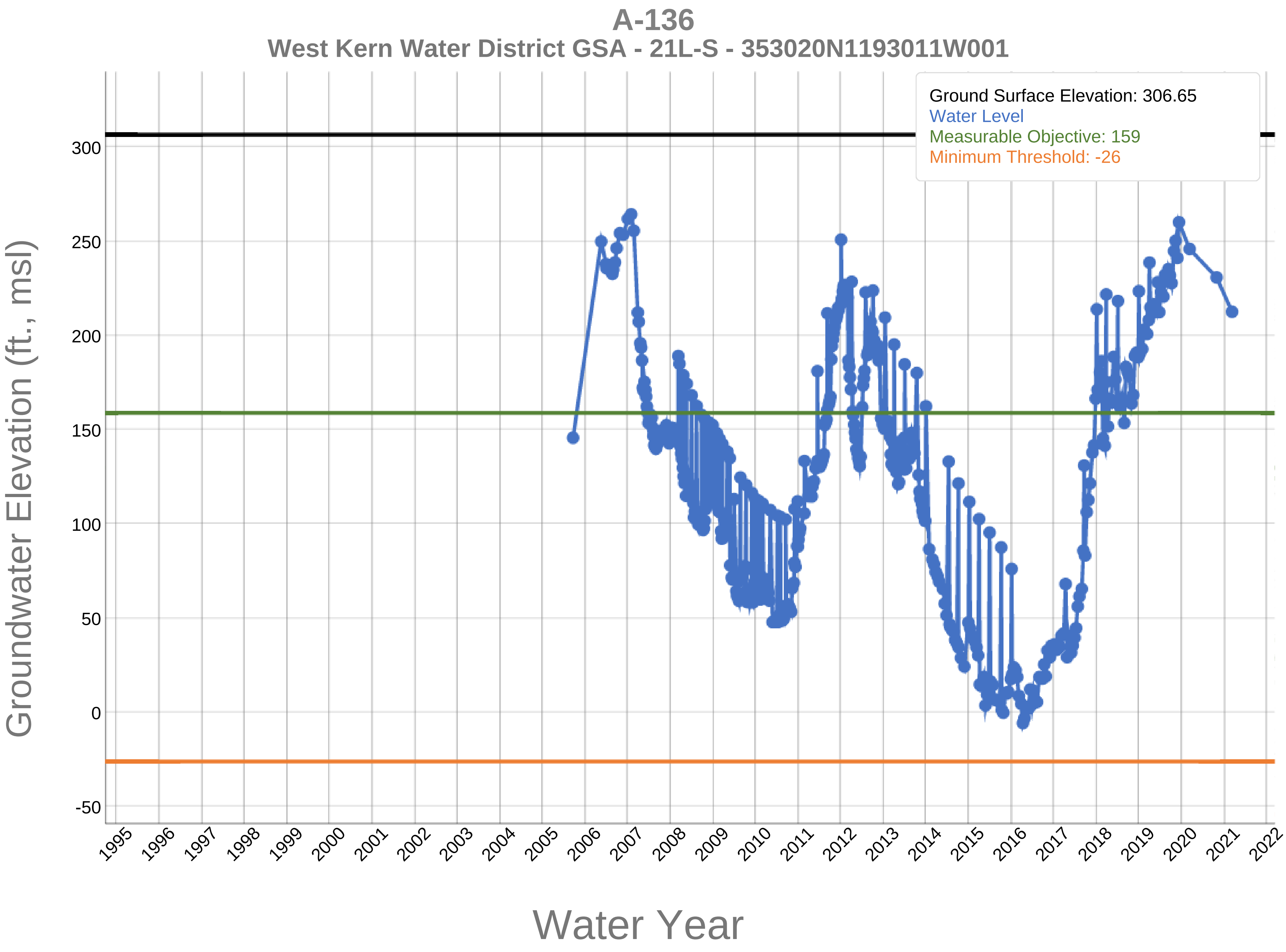
Water Year


A-136
West Kern Water District GSA - 21L-S - 353020N1193011W001
Ground Surface Elevation: 306.65
Water Level
Measurable Objective: 159
Minimum Threshold: -26
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
0
-50
1995
1996
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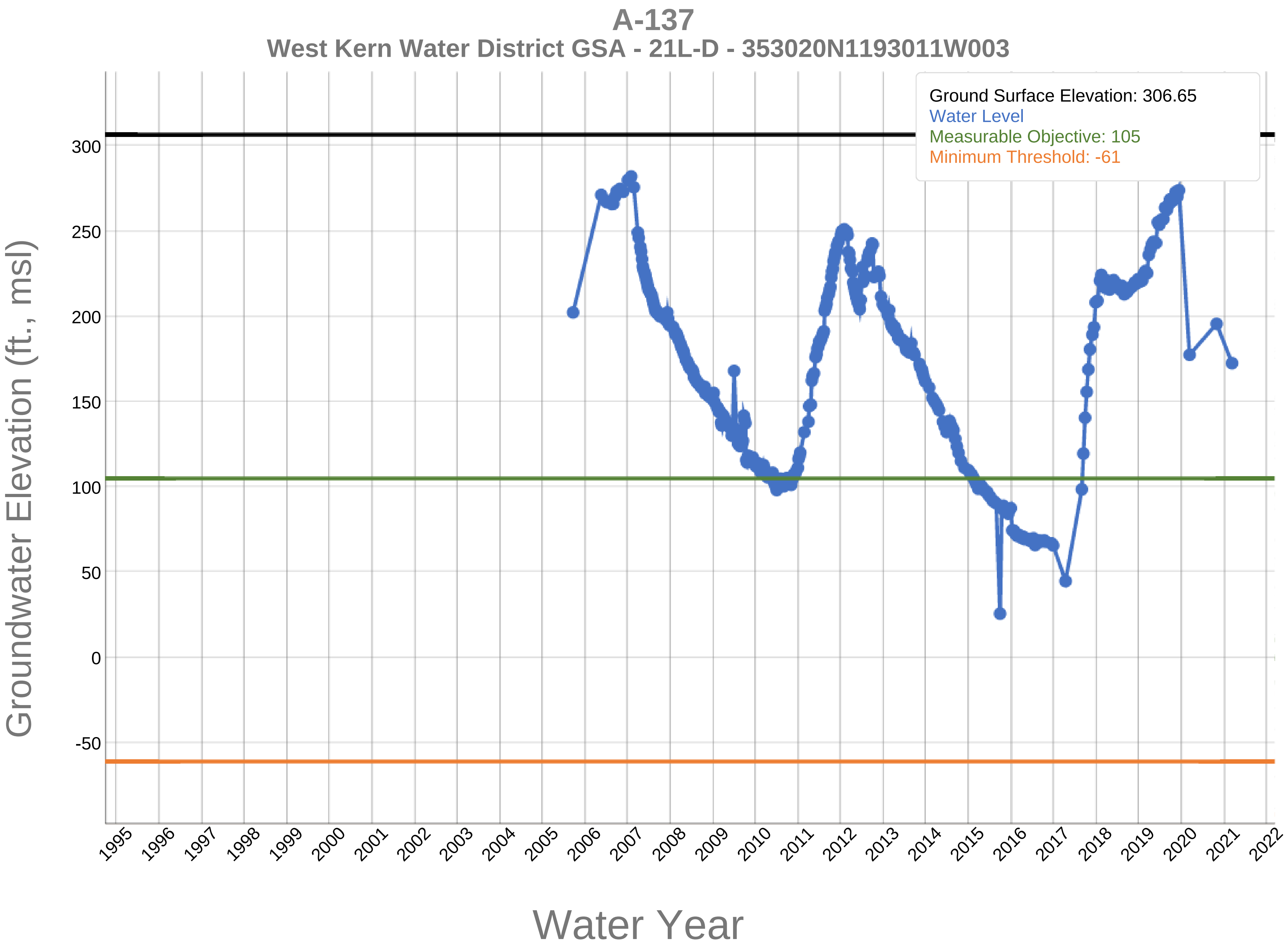
Water Year


A-137
West Kern Water District GSA - 21L-D - 353020N1193011W003
Ground Surface Elevation: 306.65
Water Level
Measurable Objective: 105
Minimum Threshold: -61
Groundwater Elevation (ft., msl)
Water Year
300
250
200
150
100
50
0
-50
1995
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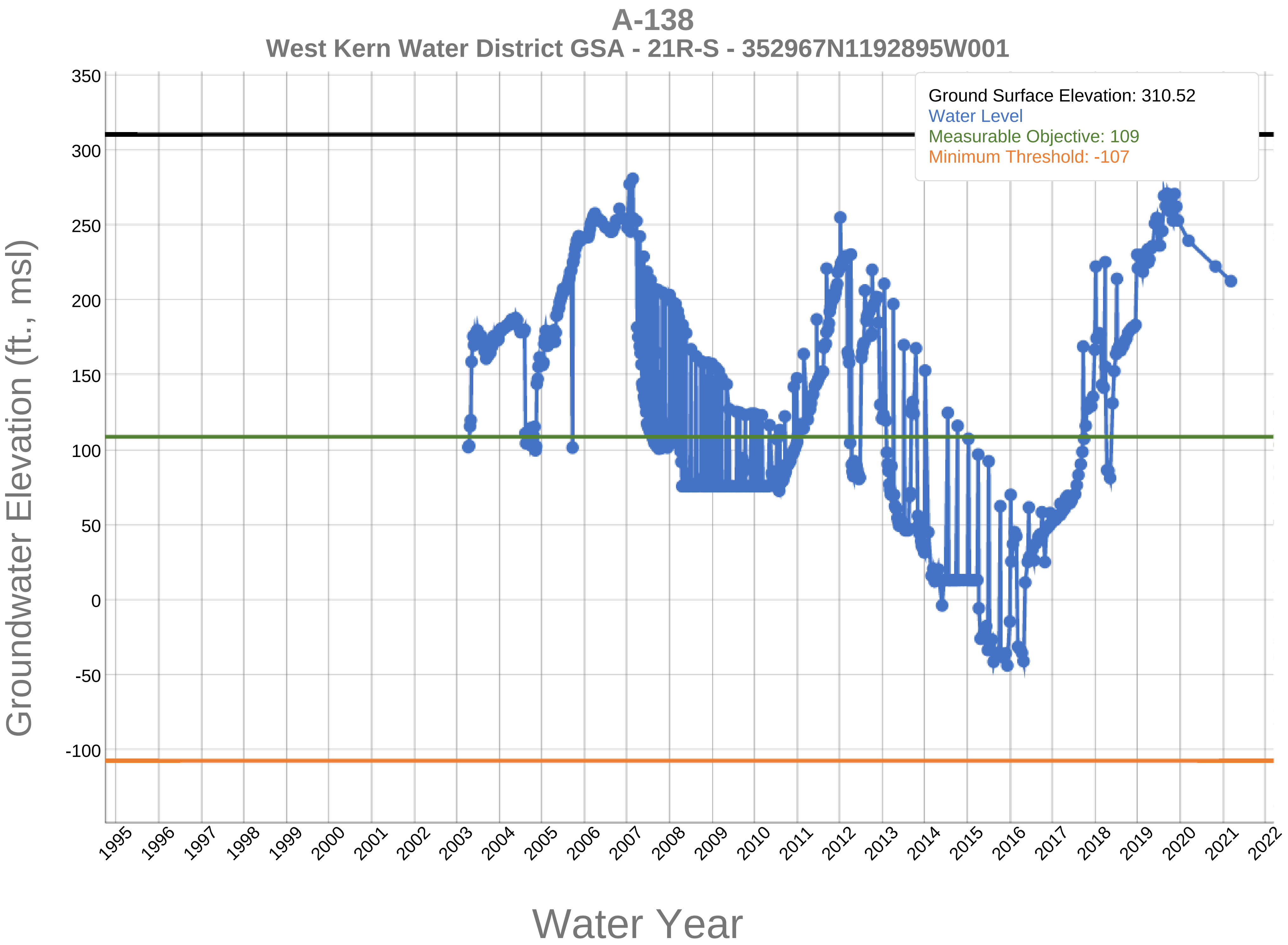

A-138
West Kern Water District GSA - 21R-S - 352967N1192895W001
Ground Surface Elevation: 310.52
Water Level
Measurable Objective: 109
Minimum Threshold: -107
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
-100
1995
1996
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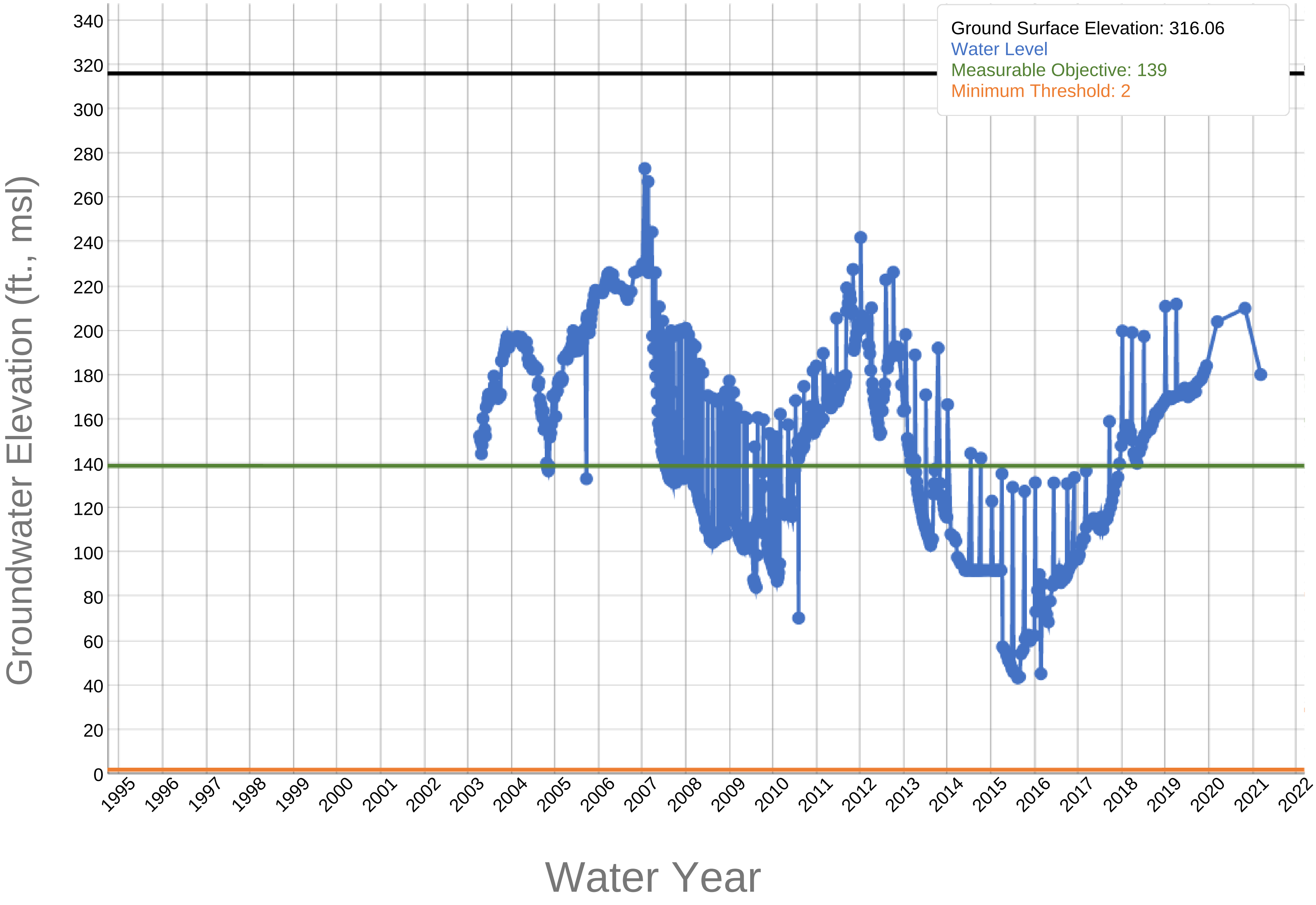
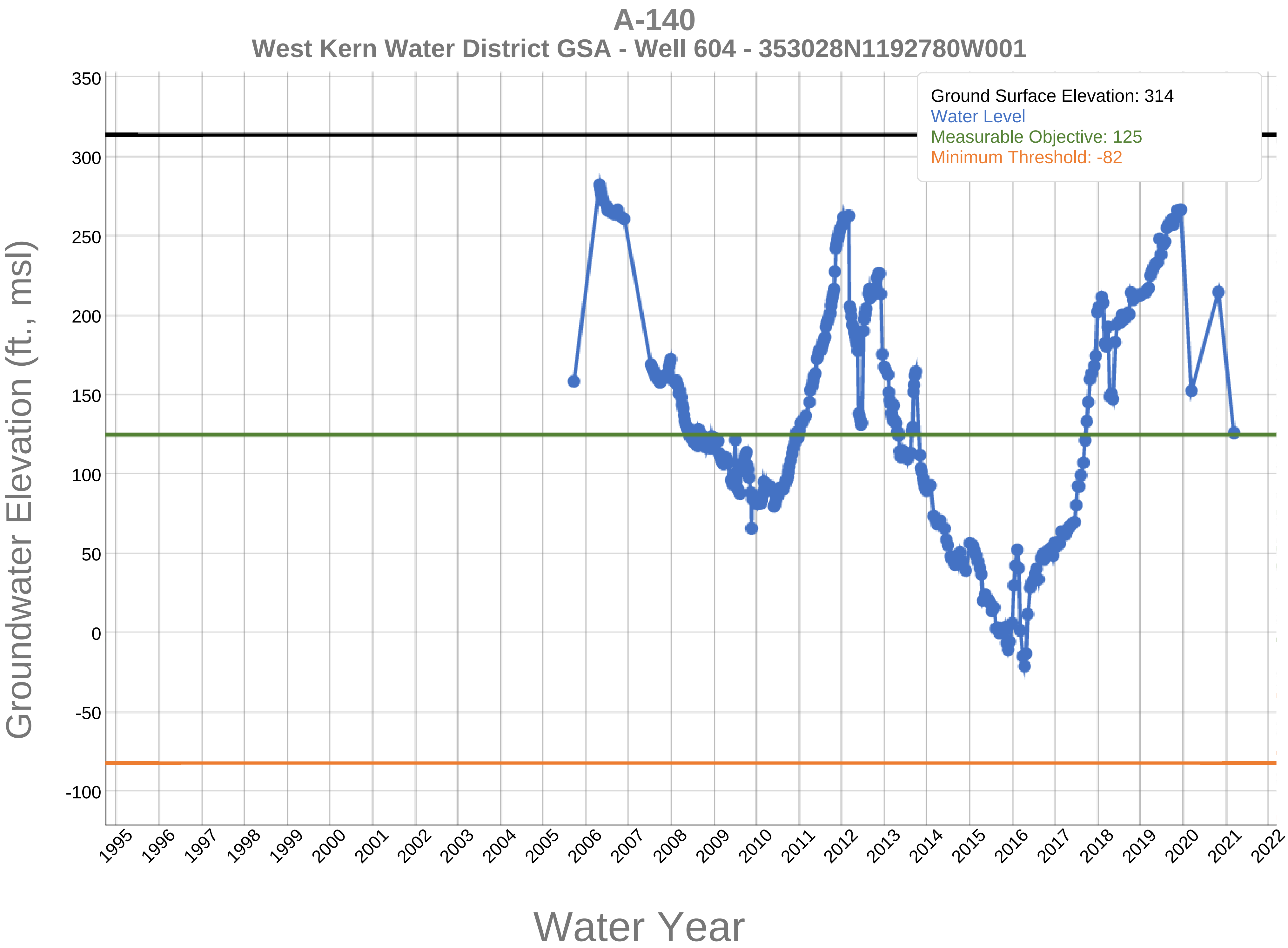
Water Year

A-139

West Kern Water District GSA - 22K-S - 353005N1192761W001




A-140
West Kern Water District GSA - Well 604 - 353028N1192780W001
Ground Surface Elevation: 314
Water Level
Measurable Objective: 125
Minimum Threshold: -82
Groundwater Elevation (ft., msl)
350
300
250
200
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100
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-100
1995
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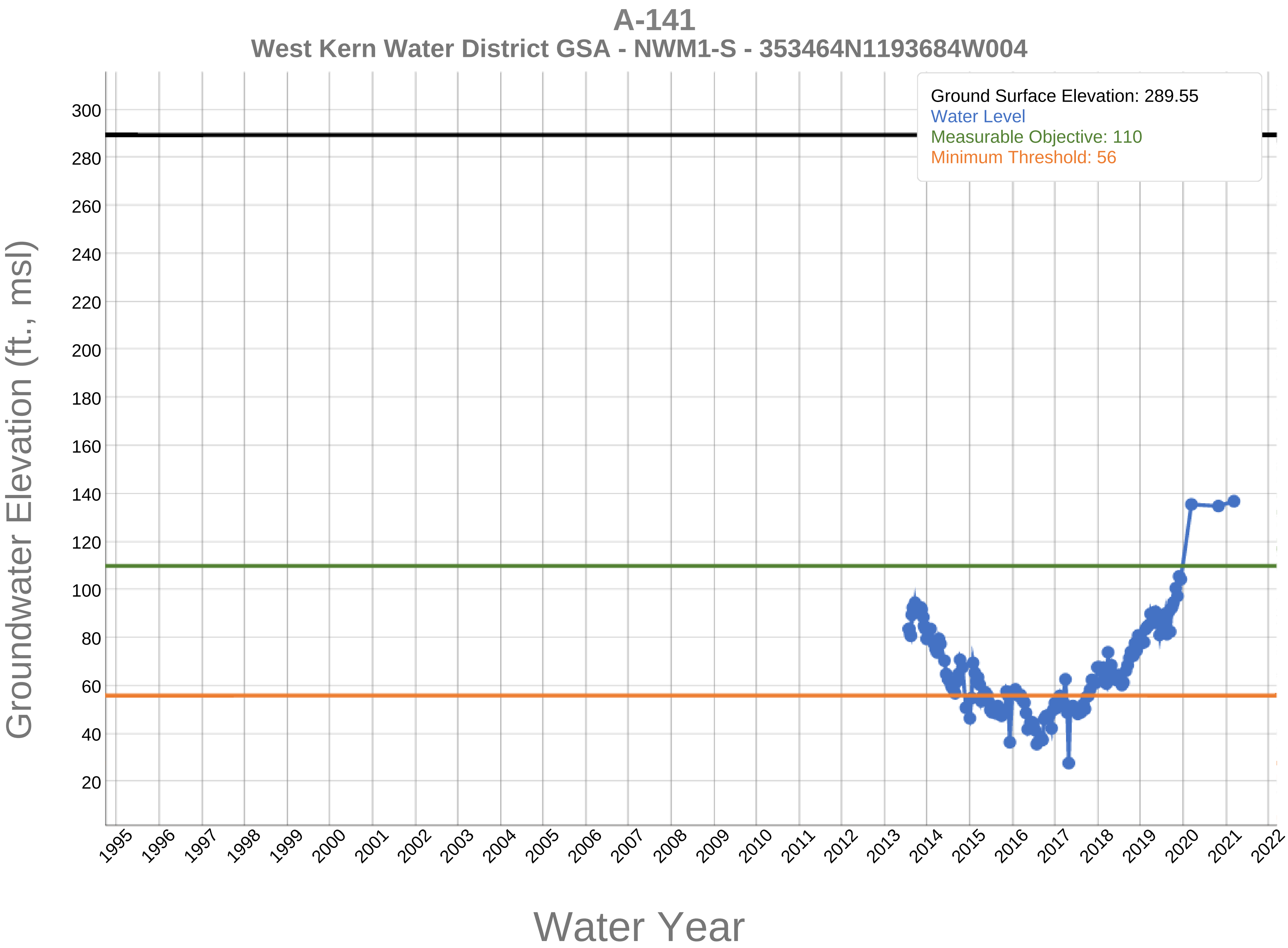
Water Year


A-141
West Kern Water District GSA - NWM1-S - 353464N1193684W004
Ground Surface Elevation: 289.55
Water Level
Measurable Objective: 110
Minimum Threshold: 56
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
80
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1995
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Water Year

A-142
West Kern Water District GSA - NWM2-S - 353342N1193700W004
Ground Surface Elevation: 289.86
Water Level
Measurable Objective: 93
Minimum Threshold: 49
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
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Water Year

A-143
West Kern Water District - NWM1-M - 353464N1193684W006
Ground Surface Elevation: 289.55
Water Level
Measurable Objective: 71
Minimum Threshold: 27
Groundwater Elevation (ft., msl)
Water Year
300
280
260
240
220
200
180
160
140
120
100
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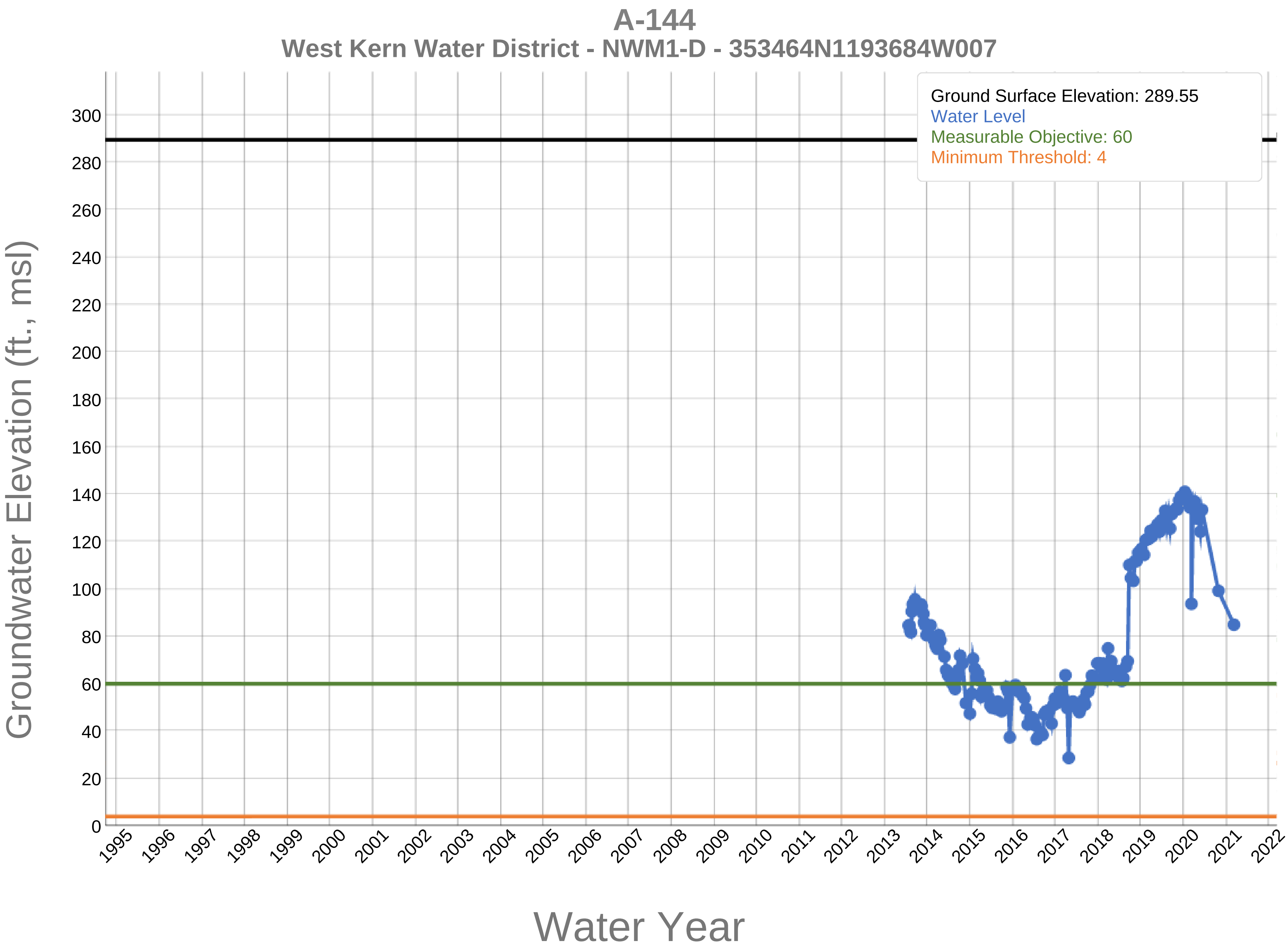
A-144
West Kern Water District - NWM1-D - 353464N1193684W007
Ground Surface Elevation: 289.55
Water Level
Measurable Objective: 60
Minimum Threshold: 4
Groundwater Elevation (ft., msl)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
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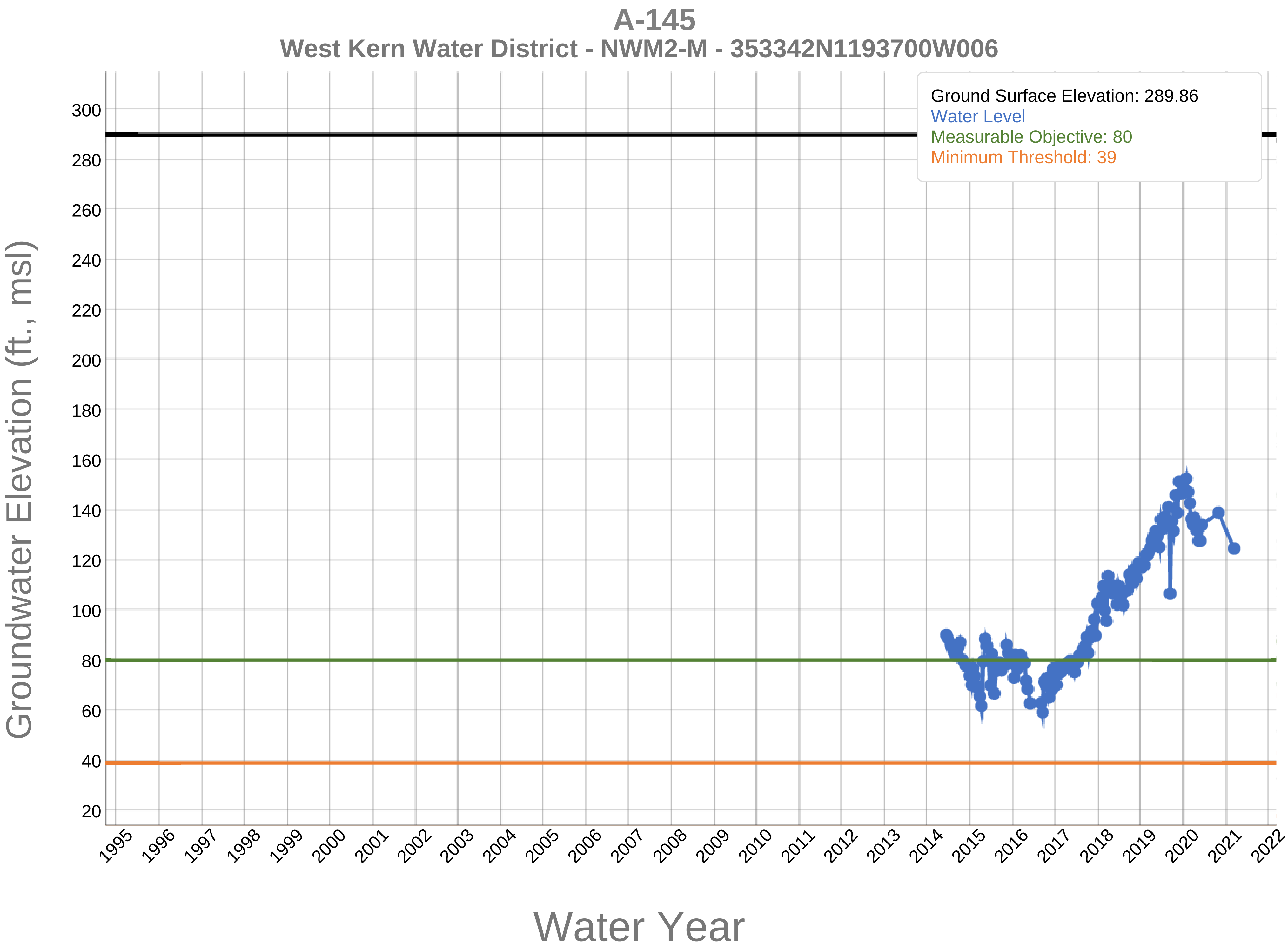
Water Year


A-145
West Kern Water District - NWM2-M - 353342N1193700W006
Ground Surface Elevation: 289.86
Water Level
Measurable Objective: 80
Minimum Threshold: 39
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
120
100
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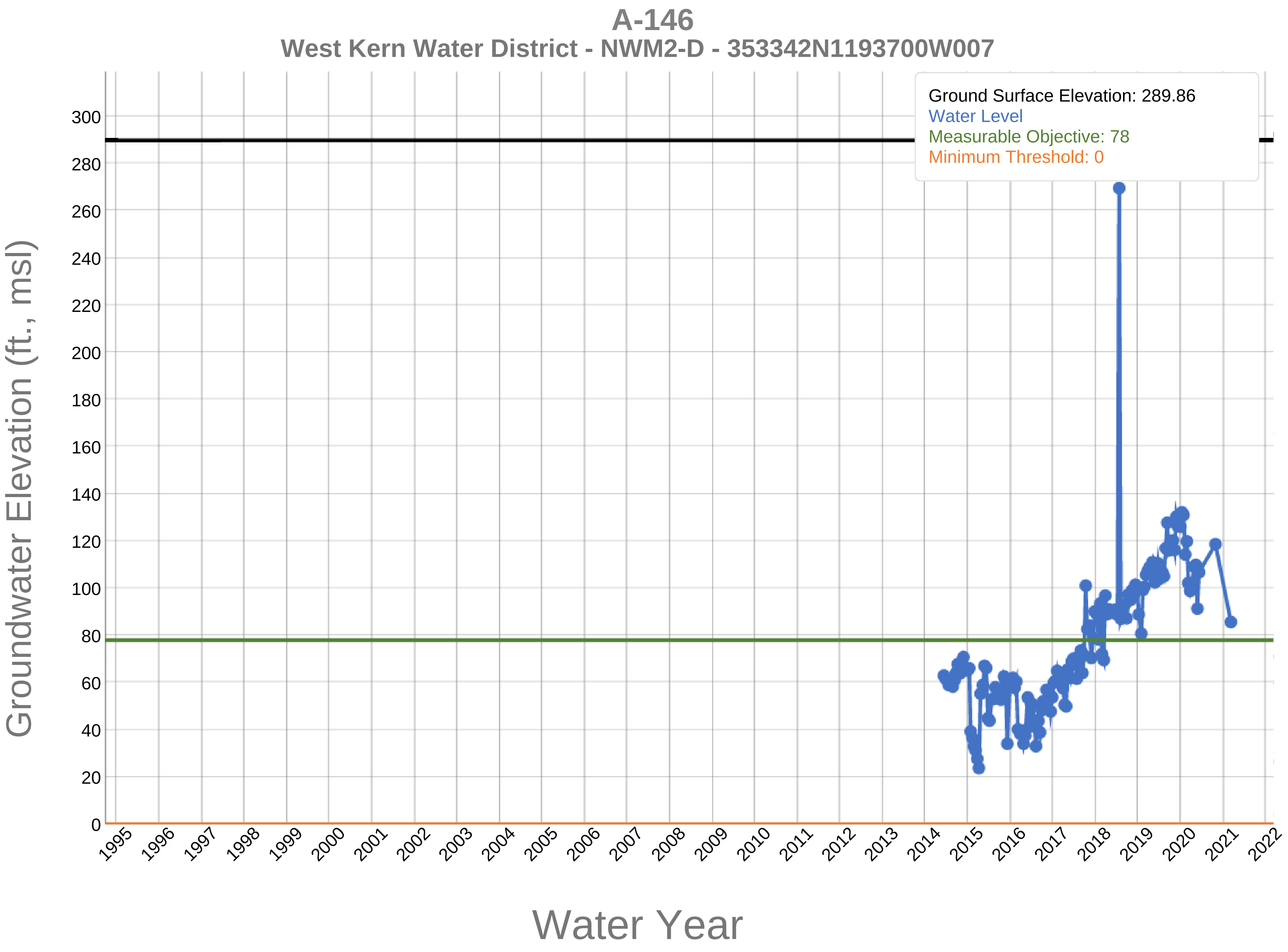
Water Year


A-146
West Kern Water District - NWM2-D - 353342N1193700W007
Ground Surface Elevation: 289.86
Water Level
Measurable Objective: 78
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
160
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200
220
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280
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1995
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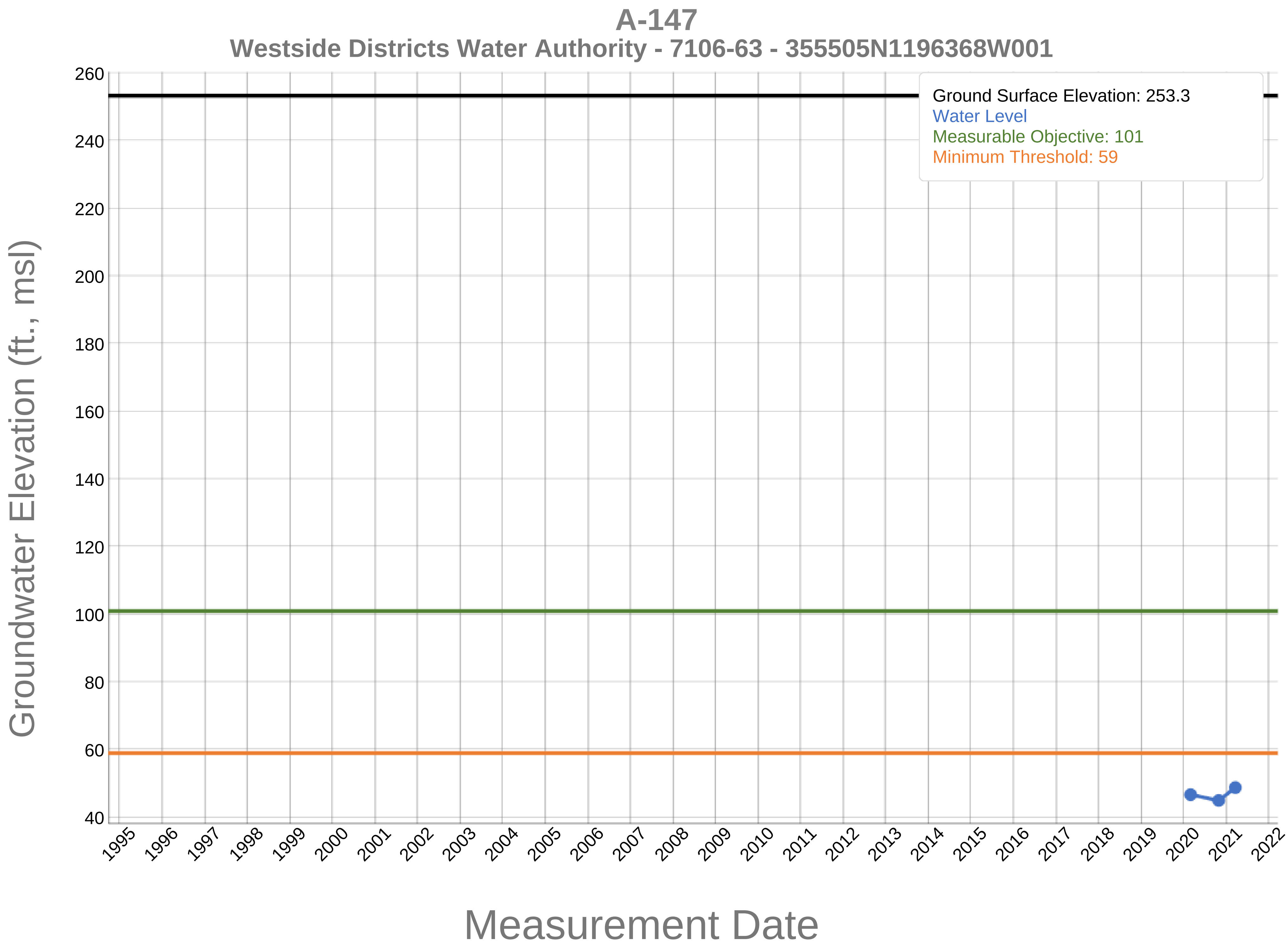
A-147
Westside Districts Water Authority - 7106-63 - 355505N1196368W001
Ground Surface Elevation: 253.3
Water Level
Measurable Objective: 101
Minimum Threshold: 59
Groundwater Elevation (ft., msl)
260
240
220
200
180
160
140
120
100
80
60
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1995
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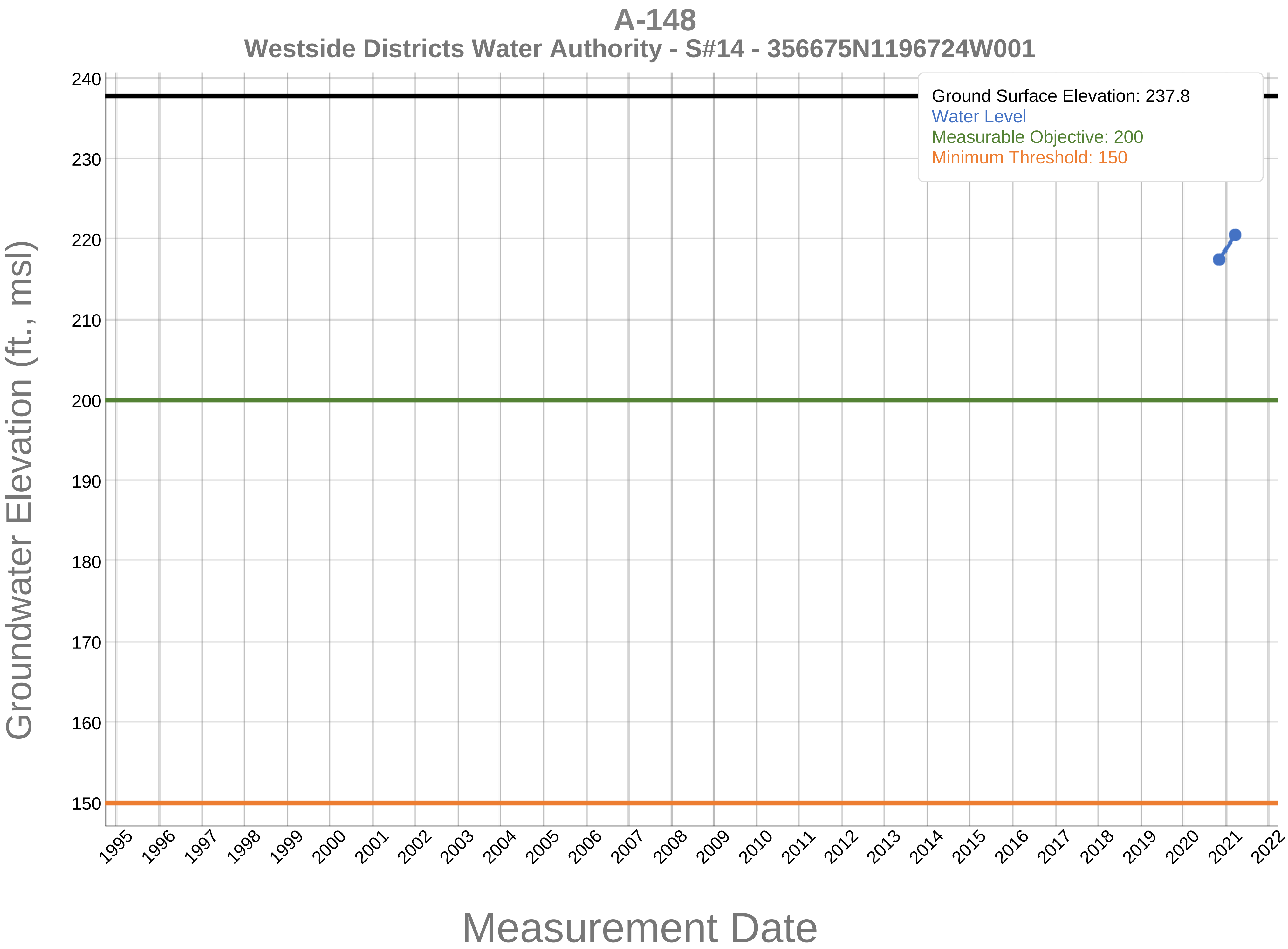
Measurement Date


A-148
Westside Districts Water Authority - S#14 - 356675N1196724W001
Ground Surface Elevation: 237.8
Water Level
Measurable Objective: 200
Minimum Threshold: 150
Groundwater Elevation (ft., msl)
Measurement Date
240
230
220
210
200
190
180
170
160
150
1995
1996
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1998
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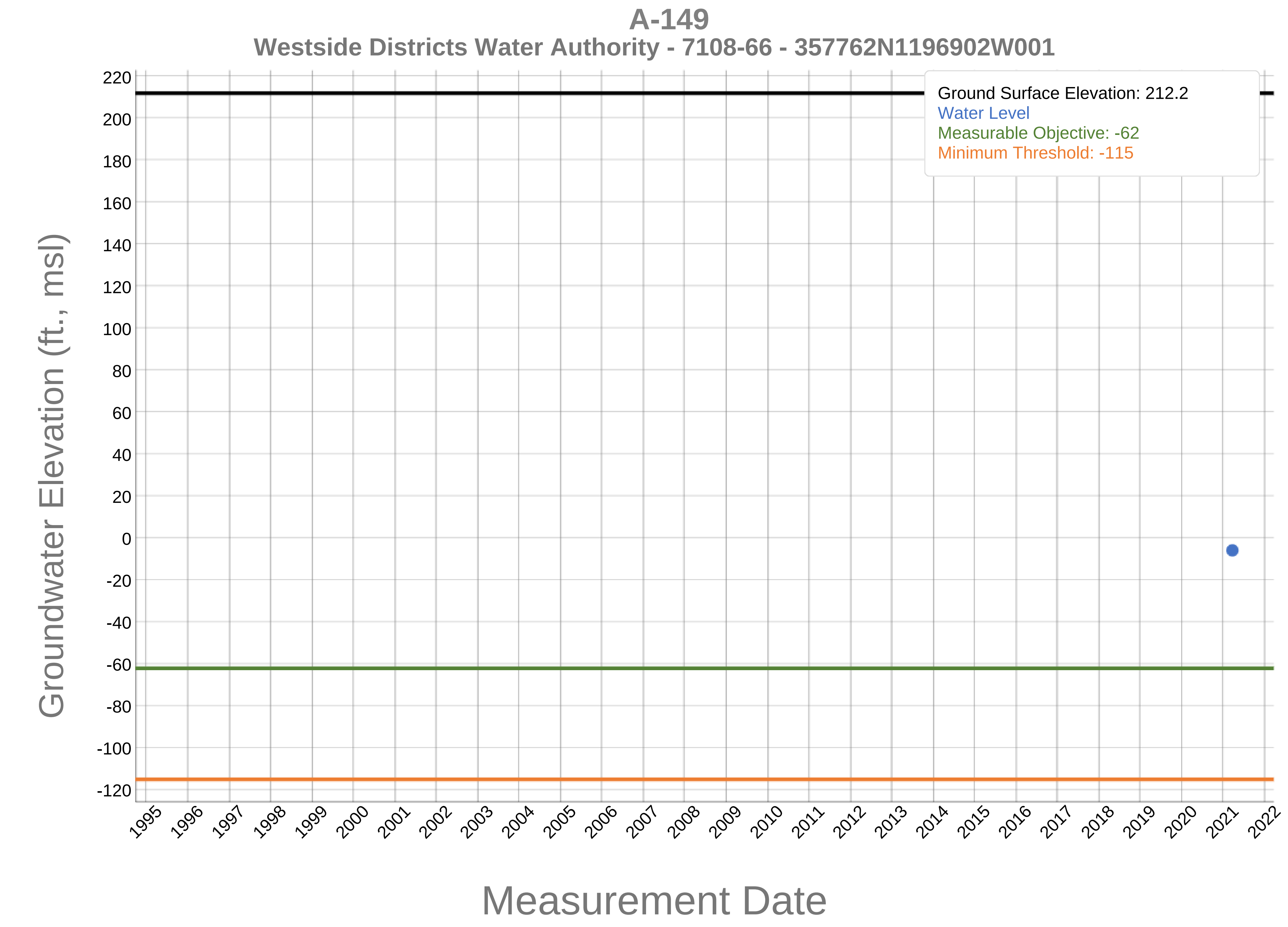

A-149
Westside Districts Water Authority - 7108-66 - 357762N1196902W001
Ground Surface Elevation: 212.2
Water Level
Measurable Objective: -62
Minimum Threshold: -115
Groundwater Elevation (ft., msl)
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
1995
1996
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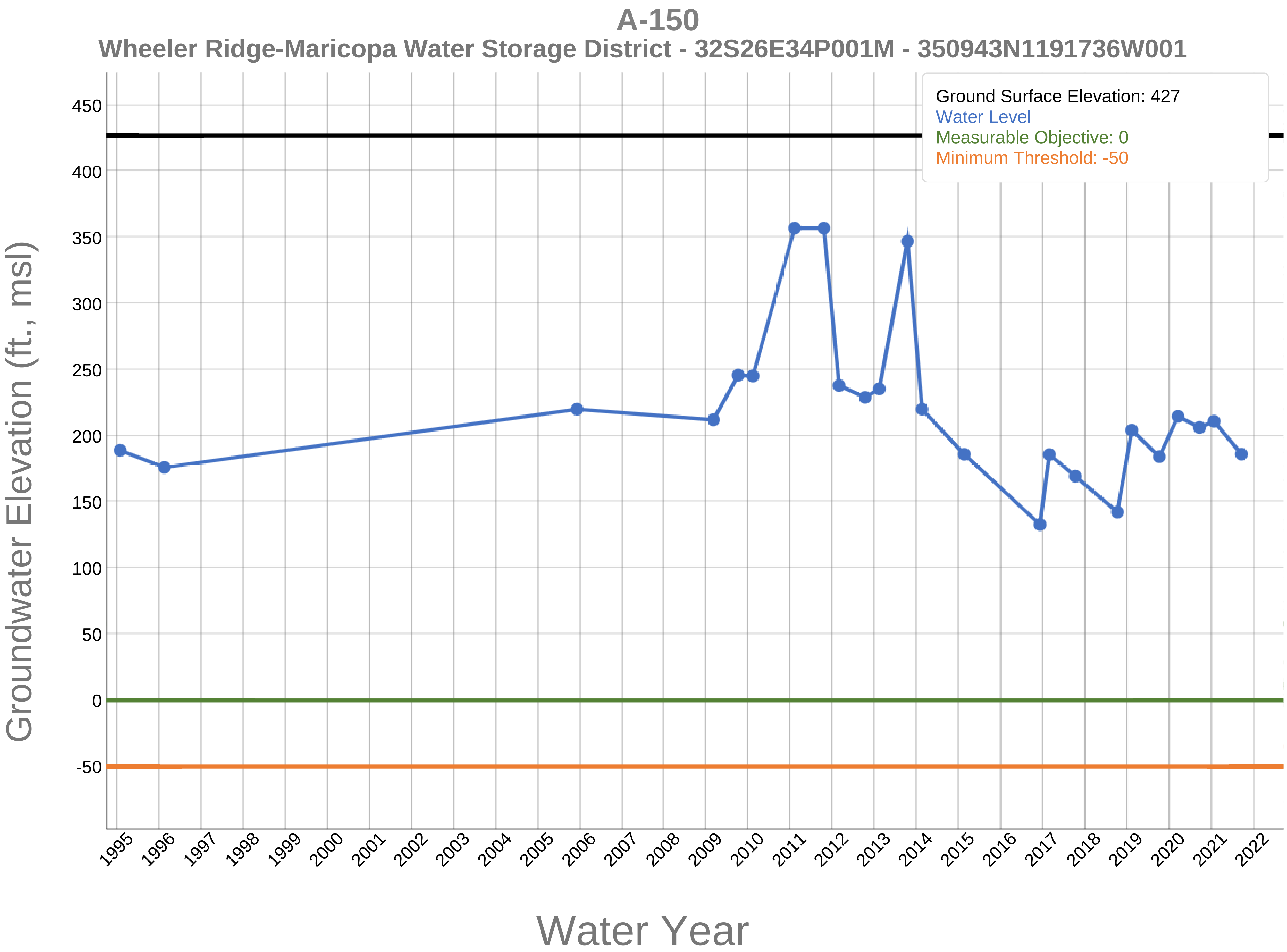
2022
Measurement Date



A-150
Wheeler Ridge-Maricopa Water Storage District - 32S26E34P001M - 350943N1191736W001
Ground Surface Elevation: 427
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
2000
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2021
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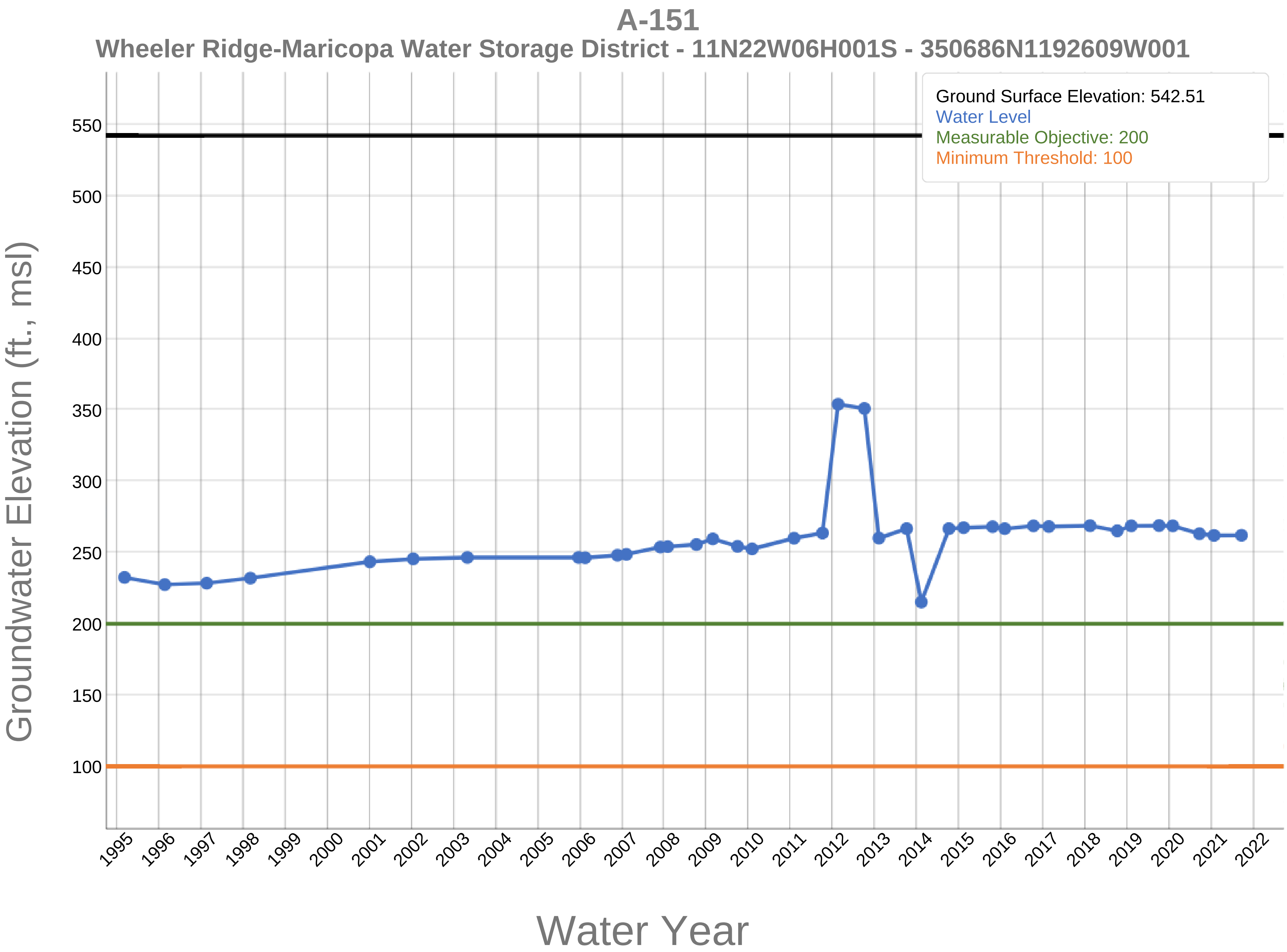
Water Year



A-151
Wheeler Ridge-Maricopa Water Storage District - 11N22W06H001S - 350686N1192609W001
Ground Surface Elevation: 542.51
Water Level
Measurable Objective: 200
Minimum Threshold: 100
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
100
1995
1996
1997
1998
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2000
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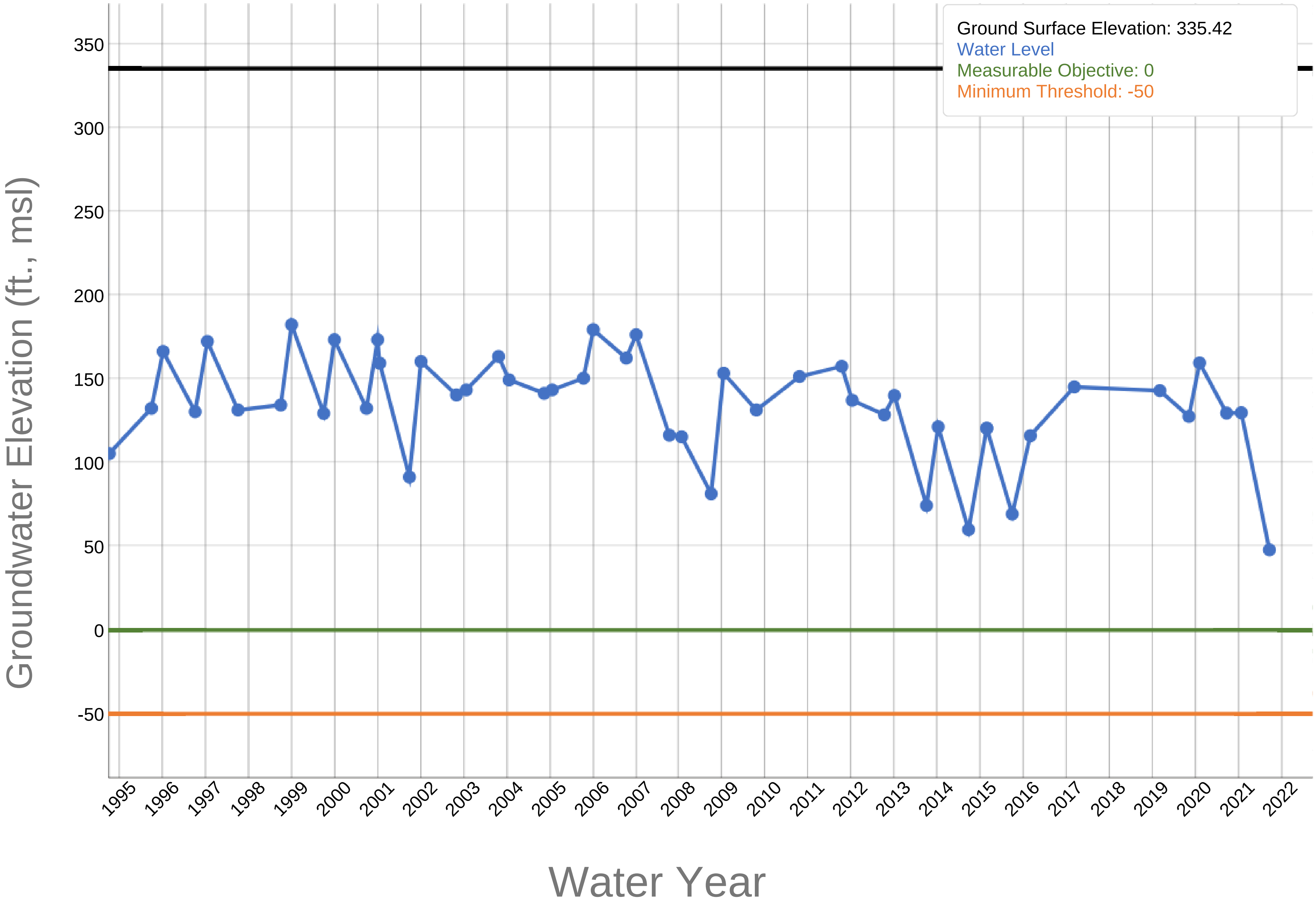
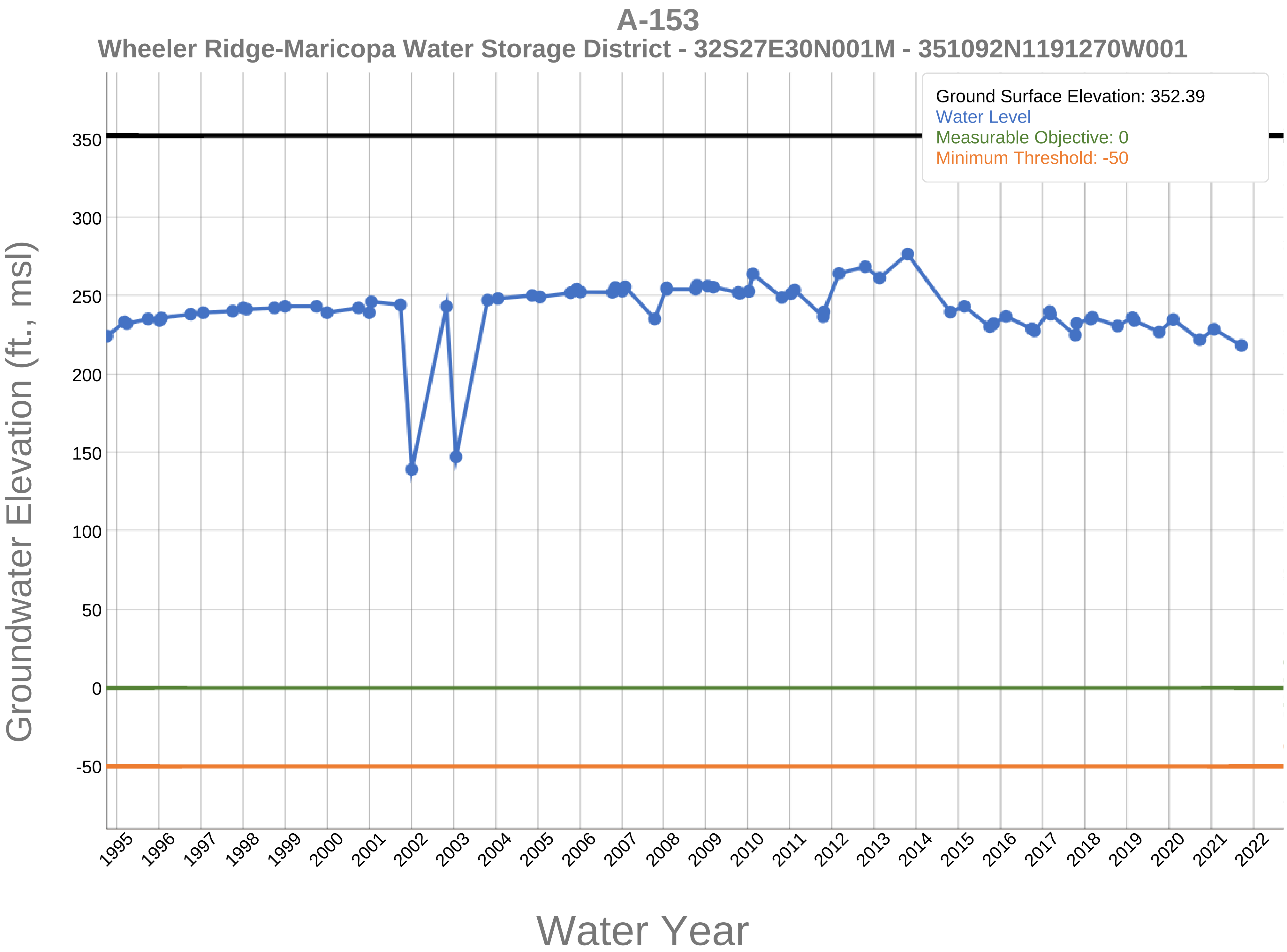
Water Year

A-152

Wheeler Ridge-Maricopa Water Storage District - 32S26E20G001M - 351303N1192078W001





A-153
Wheeler Ridge-Maricopa Water Storage District - 32S27E30N001M - 351092N1191270W001
Ground Surface Elevation: 352.39
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
350
300
250
200
150
100
50
0
-50
1995
1996
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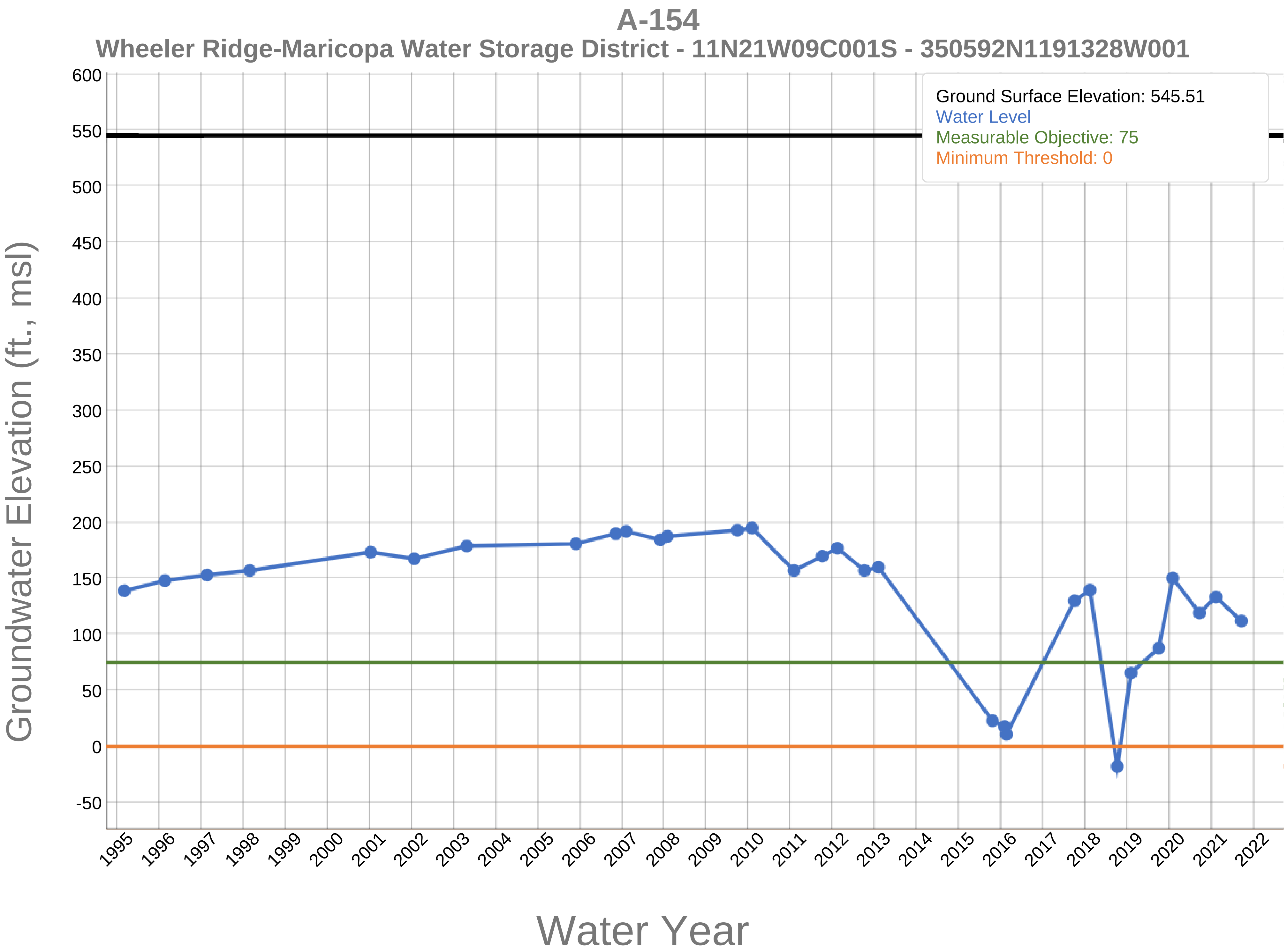
2022
Water Year


A-154
Wheeler Ridge-Maricopa Water Storage District - 11N21W09C001S - 350592N1191328W001
Ground Surface Elevation: 545.51
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
1995
1996
1997
1998
1999
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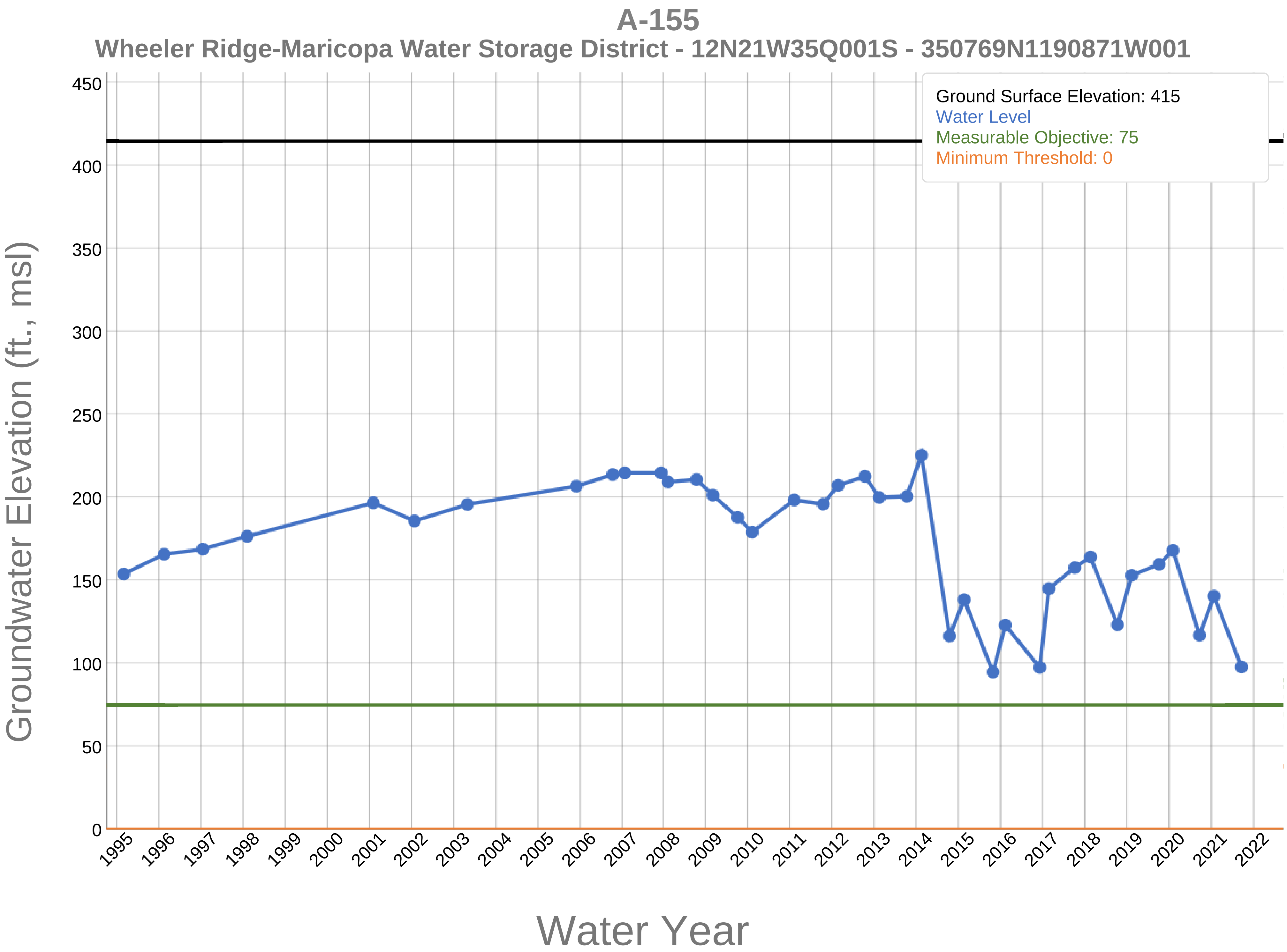
2022



A-155
Wheeler Ridge-Maricopa Water Storage District - 12N21W35Q001S - 350769N1190871W001
Ground Surface Elevation: 415
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
50
100
150
200
250
300
350
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450
1995
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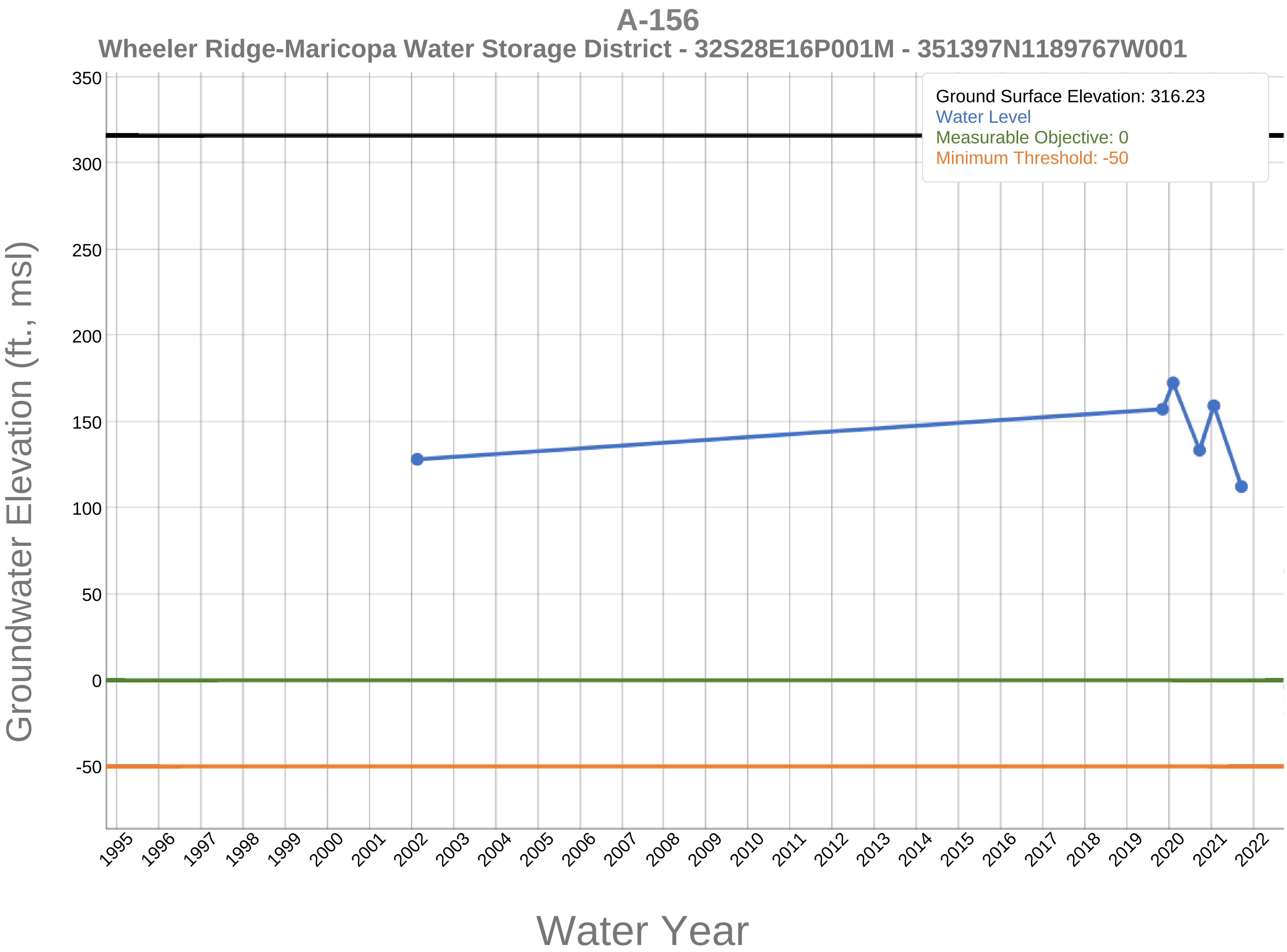

A-156
Wheeler Ridge-Maricopa Water Storage District - 32S28E16P001M - 351397N1189767W001
Ground Surface Elevation: 316.23
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
0
-50
1995
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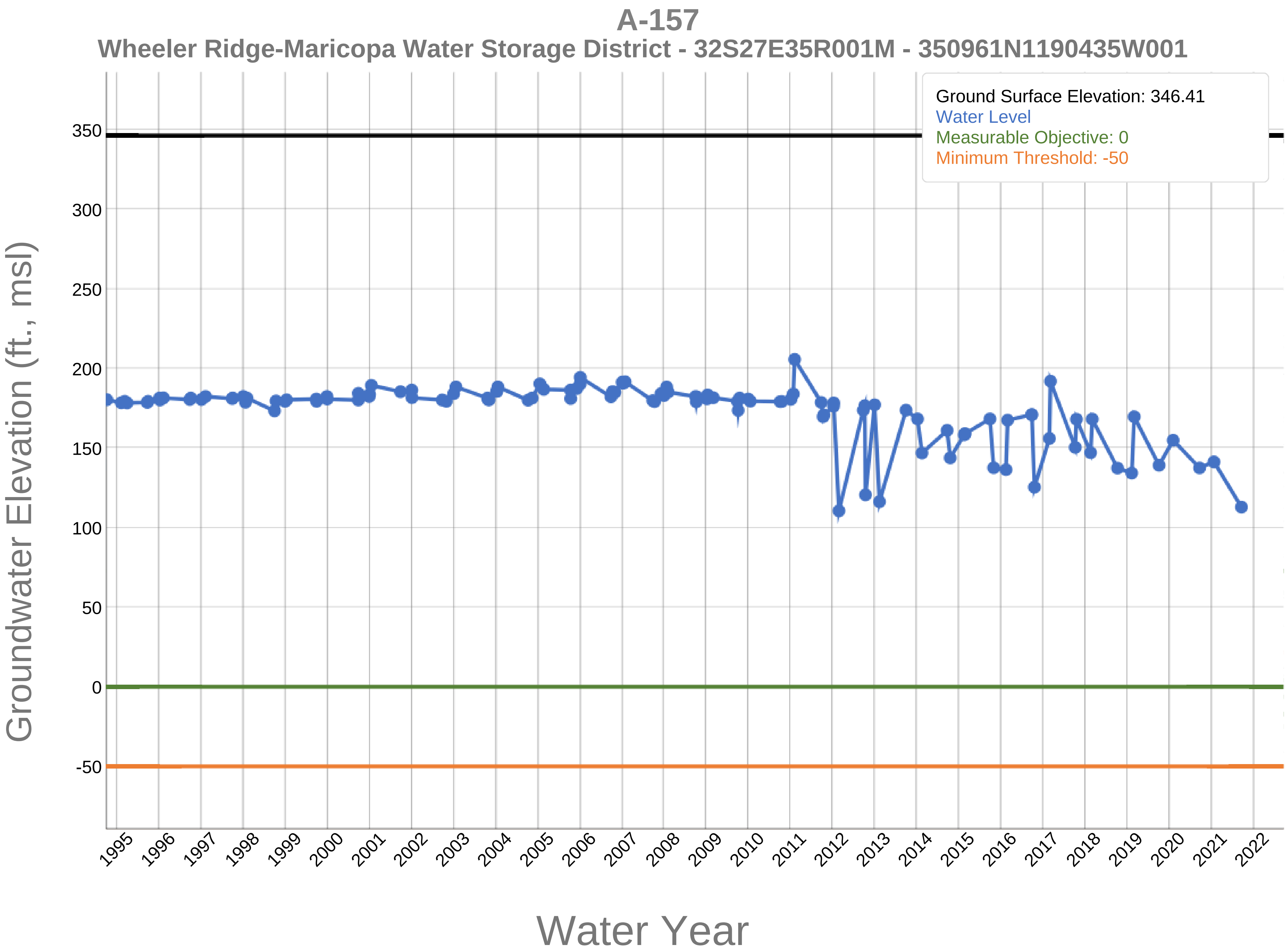

A-157
Wheeler Ridge-Maricopa Water Storage District - 32S27E35R001M - 350961N1190435W001
Ground Surface Elevation: 346.41
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
Water Year
350
300
250
200
150
100
50
0
-50
1995
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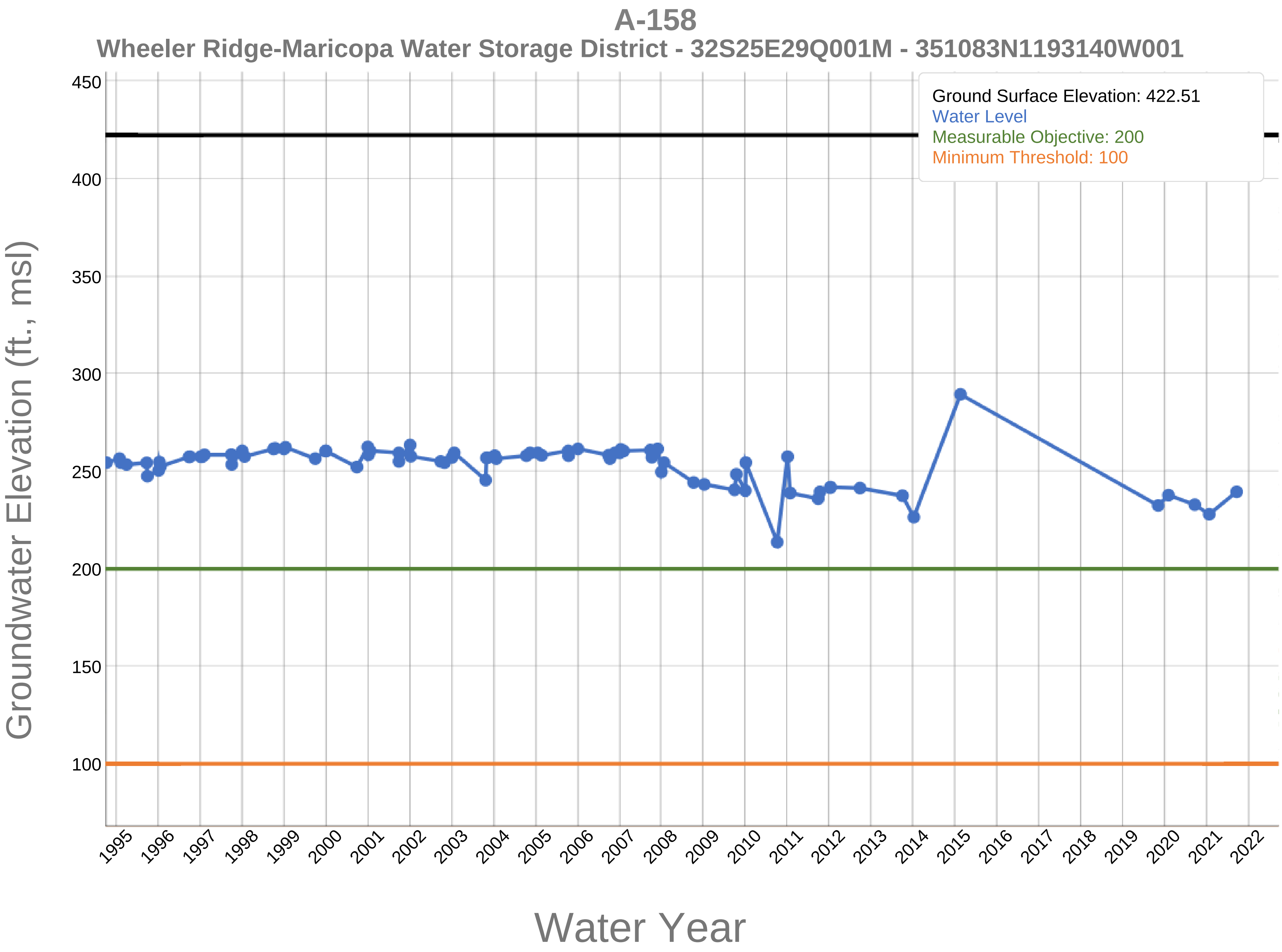
A-158
Wheeler Ridge-Maricopa Water Storage District - 32S25E29Q001M - 351083N1193140W001
Ground Surface Elevation: 422.51
Water Level
Measurable Objective: 200
Minimum Threshold: 100
Groundwater Elevation (ft., msl)
Water Year
450
400
350
300
250
200
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1995
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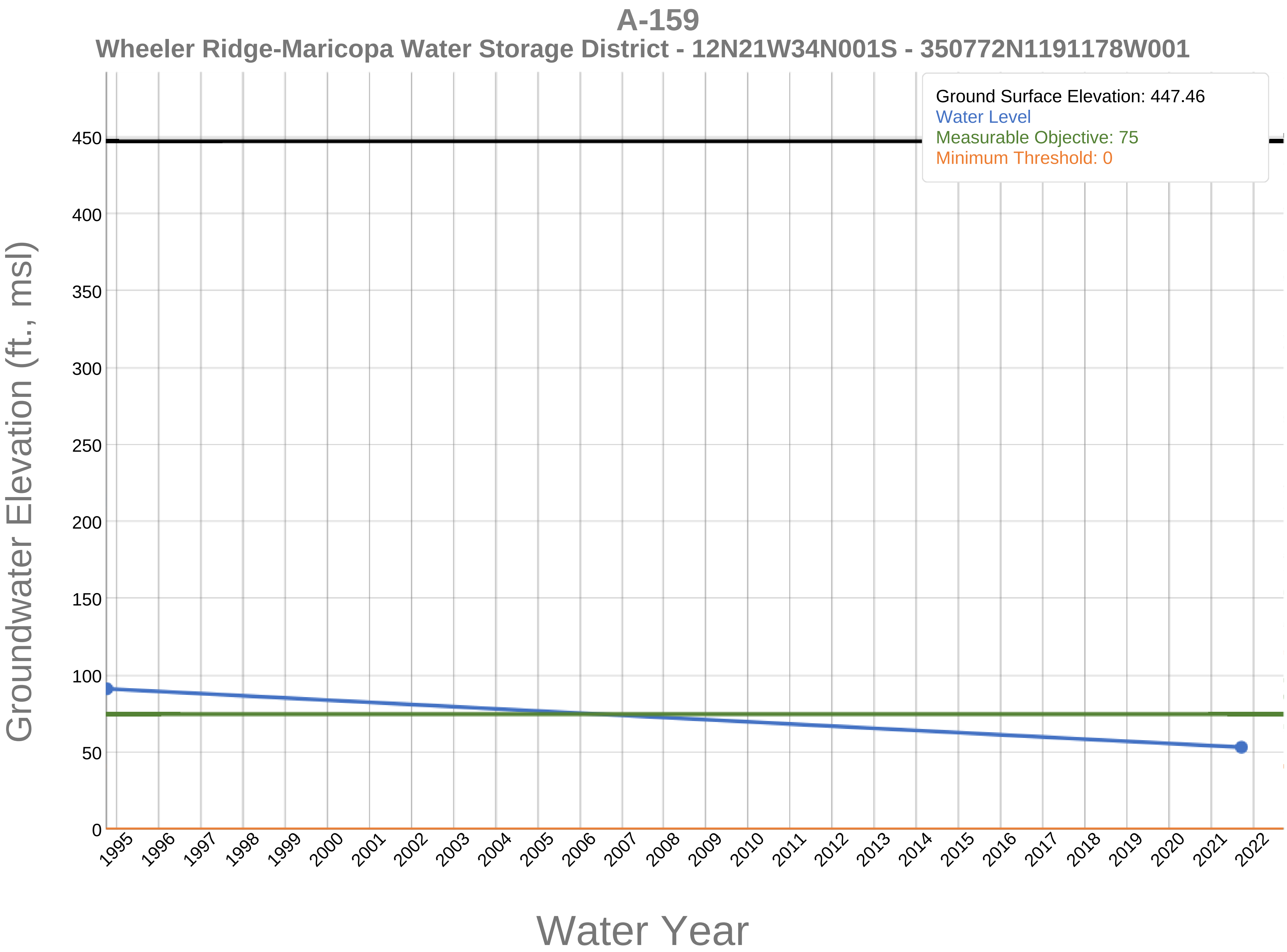

A-159
Wheeler Ridge-Maricopa Water Storage District - 12N21W34N001S - 350772N1191178W001
Ground Surface Elevation: 447.46
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
50
100
150
200
250
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350
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450
1995
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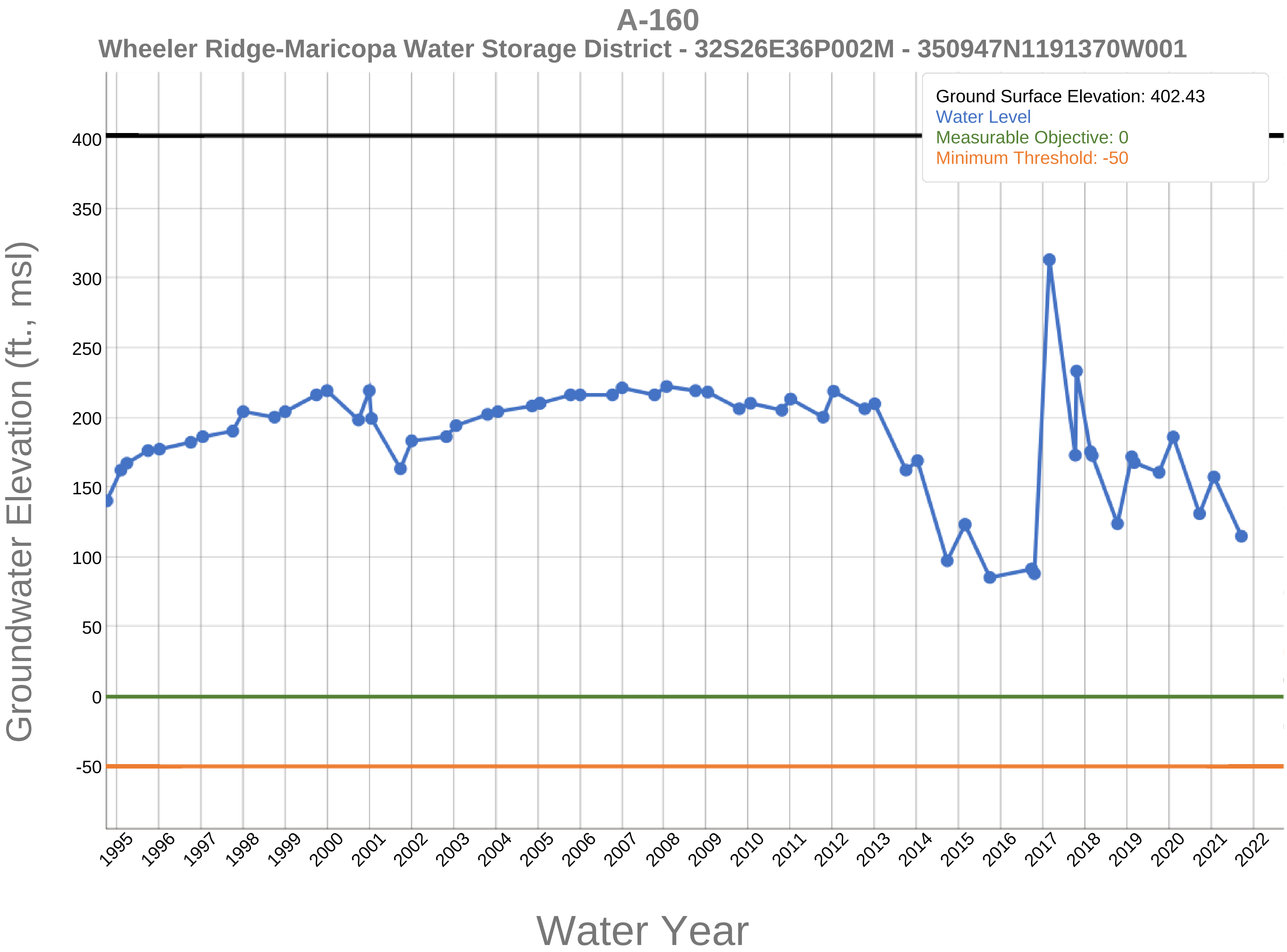

A-160
Wheeler Ridge-Maricopa Water Storage District - 32S26E36P002M - 350947N1191370W001
Ground Surface Elevation: 402.43
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
Water Year
400
350
300
250
200
150
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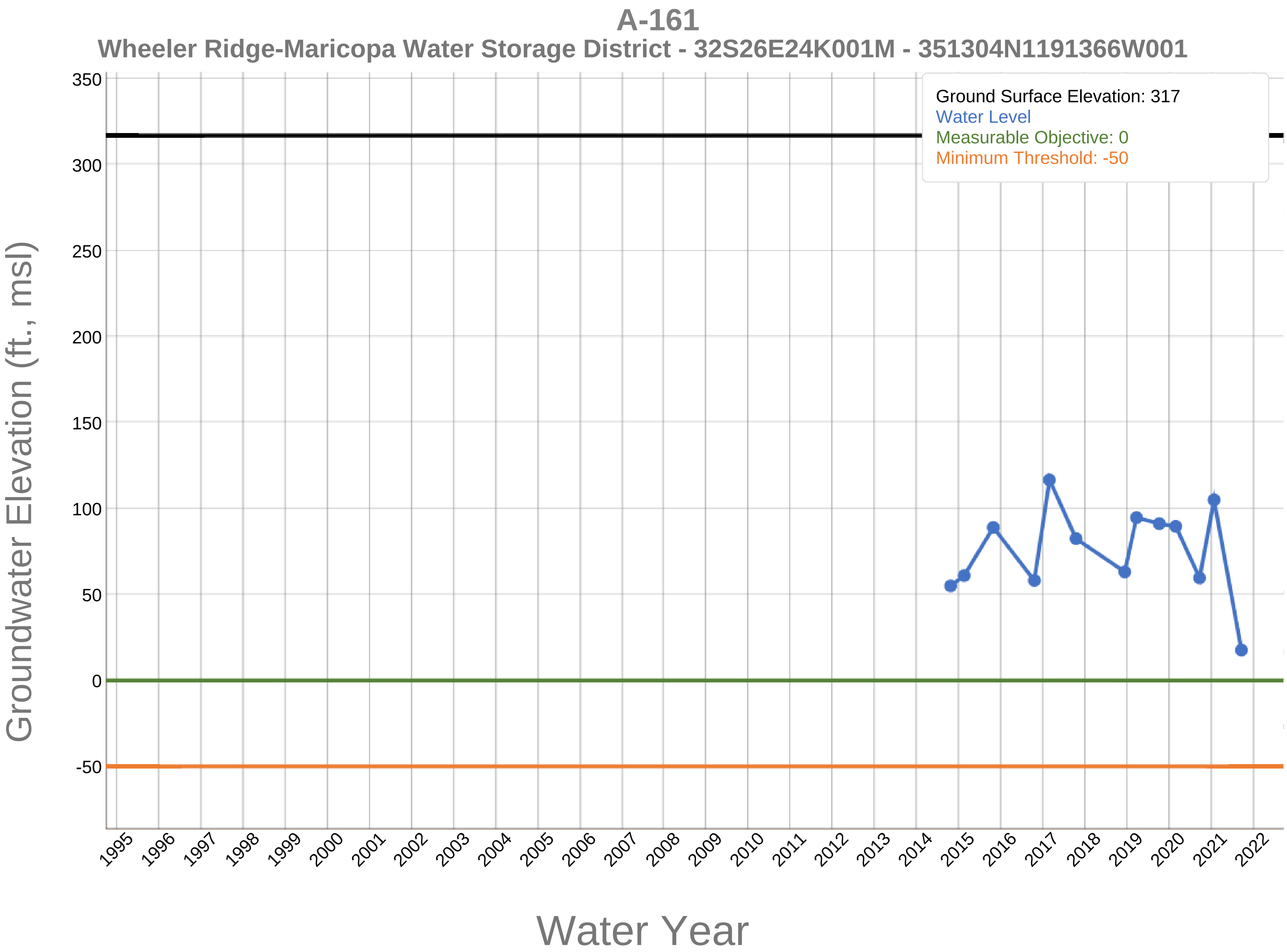
A-161
Wheeler Ridge-Maricopa Water Storage District - 32S26E24K001M - 351304N1191366W001
Ground Surface Elevation: 317
Water Level
Measurable Objective: 0
Minimum Threshold: -50
Groundwater Elevation (ft., msl)
Water Year
350
300
250
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150
100
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-50
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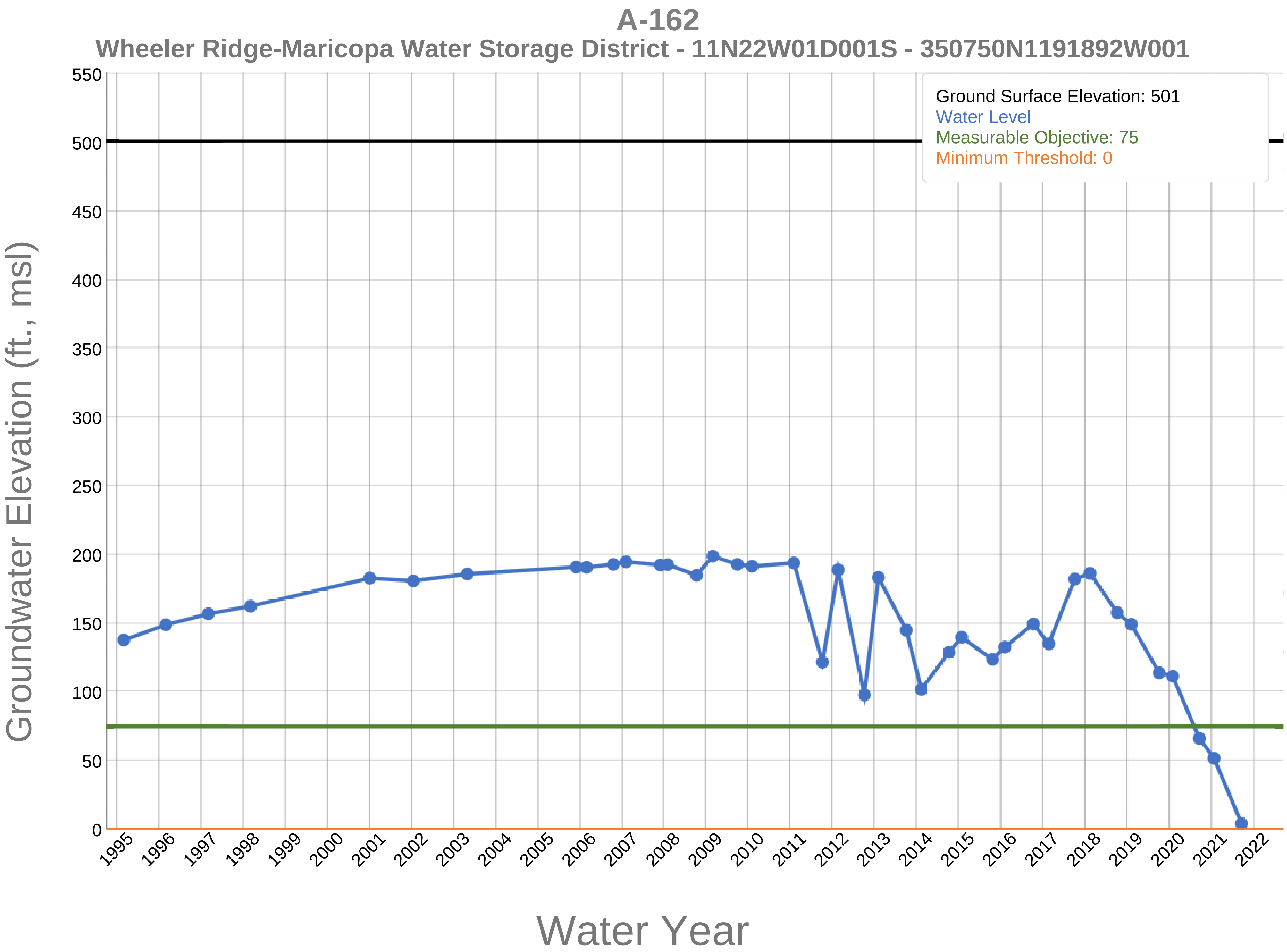
A-162
Wheeler Ridge-Maricopa Water Storage District - 11N22W01D001S - 350750N1191892W001
Ground Surface Elevation: 501
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
Water Year
0
50
100
150
200
250
300
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400
450
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550
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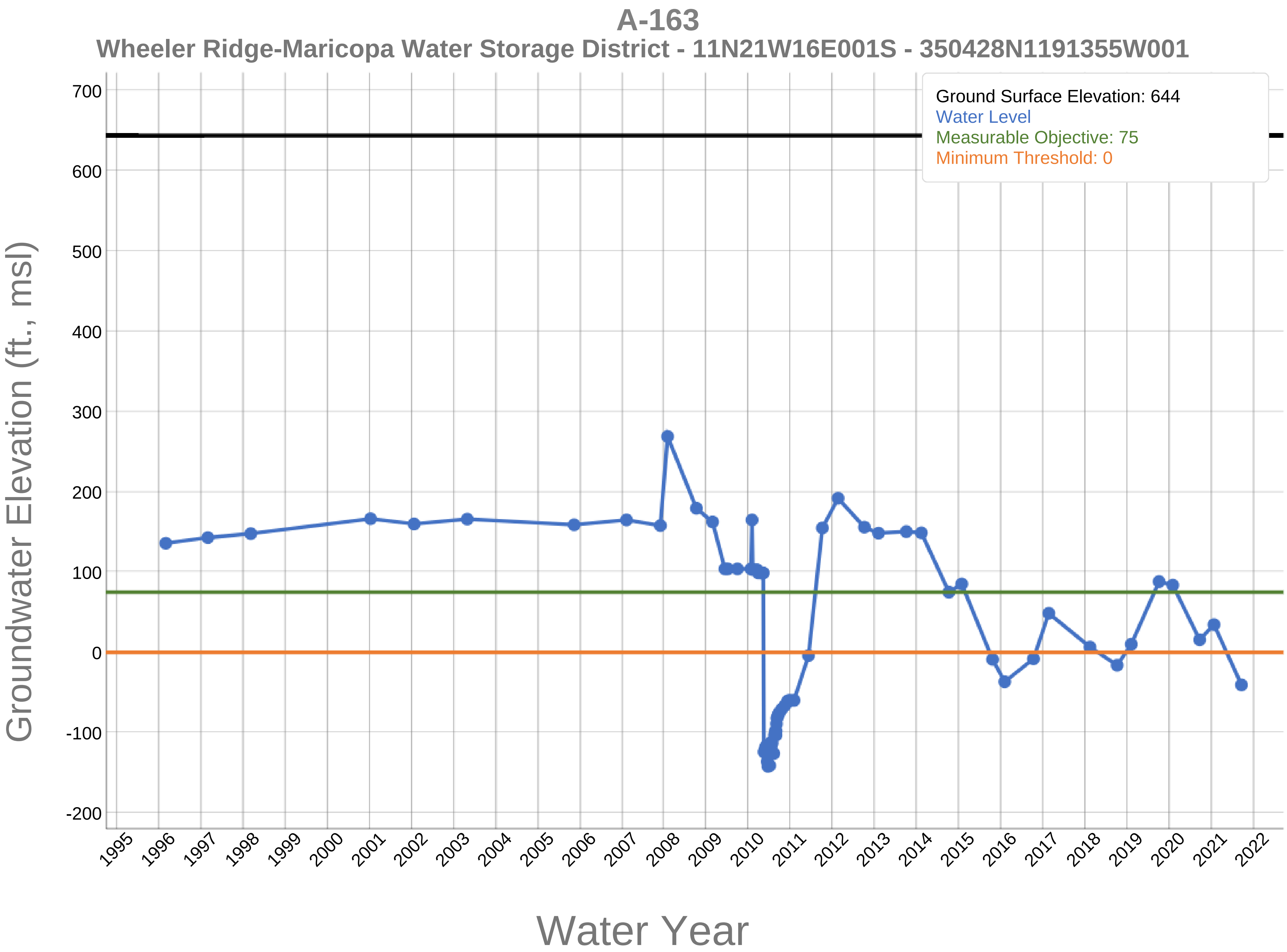

A-163
Wheeler Ridge-Maricopa Water Storage District - 11N21W16E001S - 350428N1191355W001
Ground Surface Elevation: 644
Water Level
Measurable Objective: 75
Minimum Threshold: 0
Groundwater Elevation (ft., msl)
700
600
500
400
300
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-100
-200
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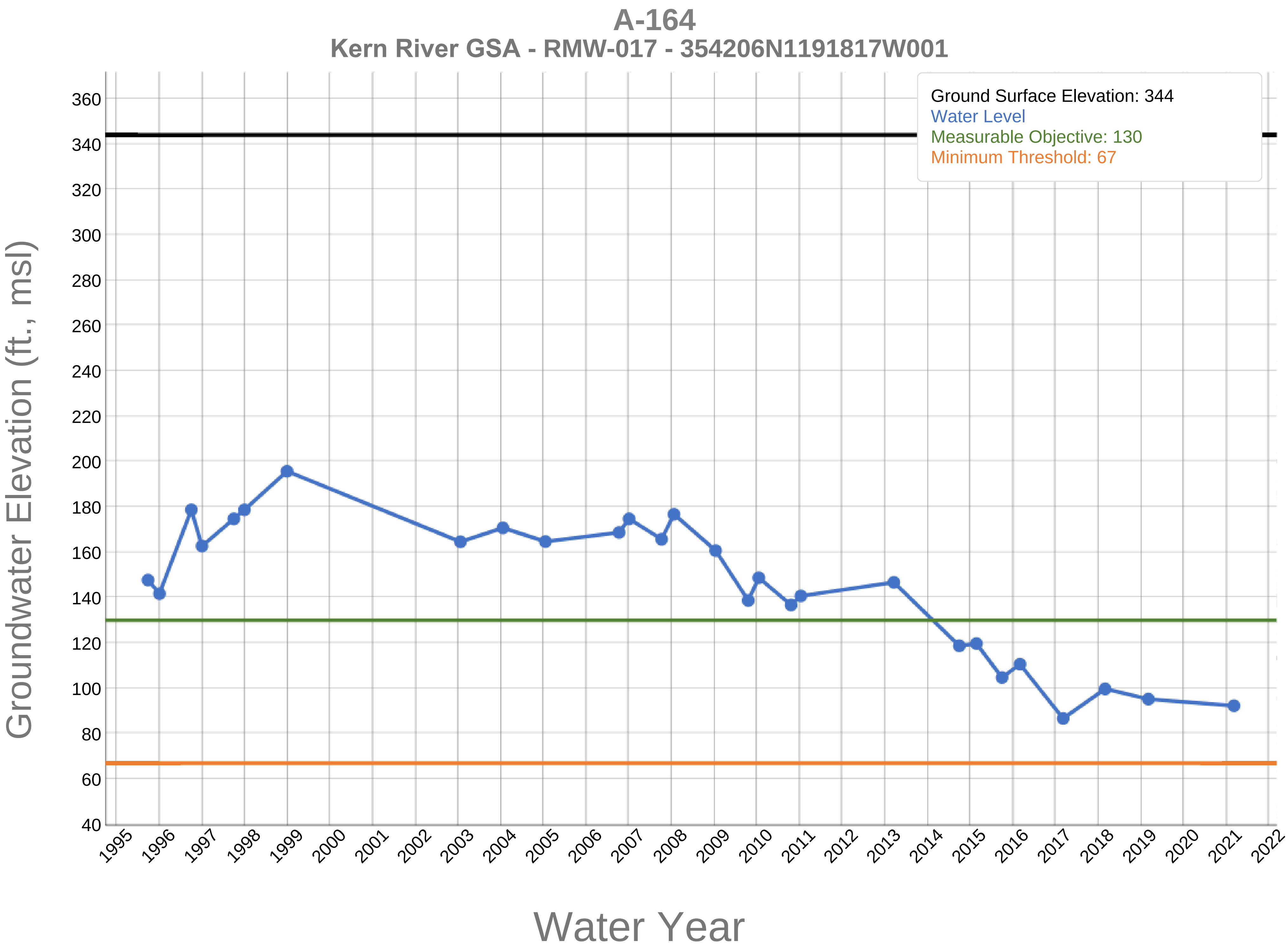
Water Year


A-164
Kern River GSA - RMW-017 - 354206N1191817W001
Ground Surface Elevation: 344
Water Level
Measurable Objective: 130
Minimum Threshold: 67
Groundwater Elevation (ft., msl)
Water Year
360
340
320
300
280
260
240
220
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180
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140
120
100
80
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1995
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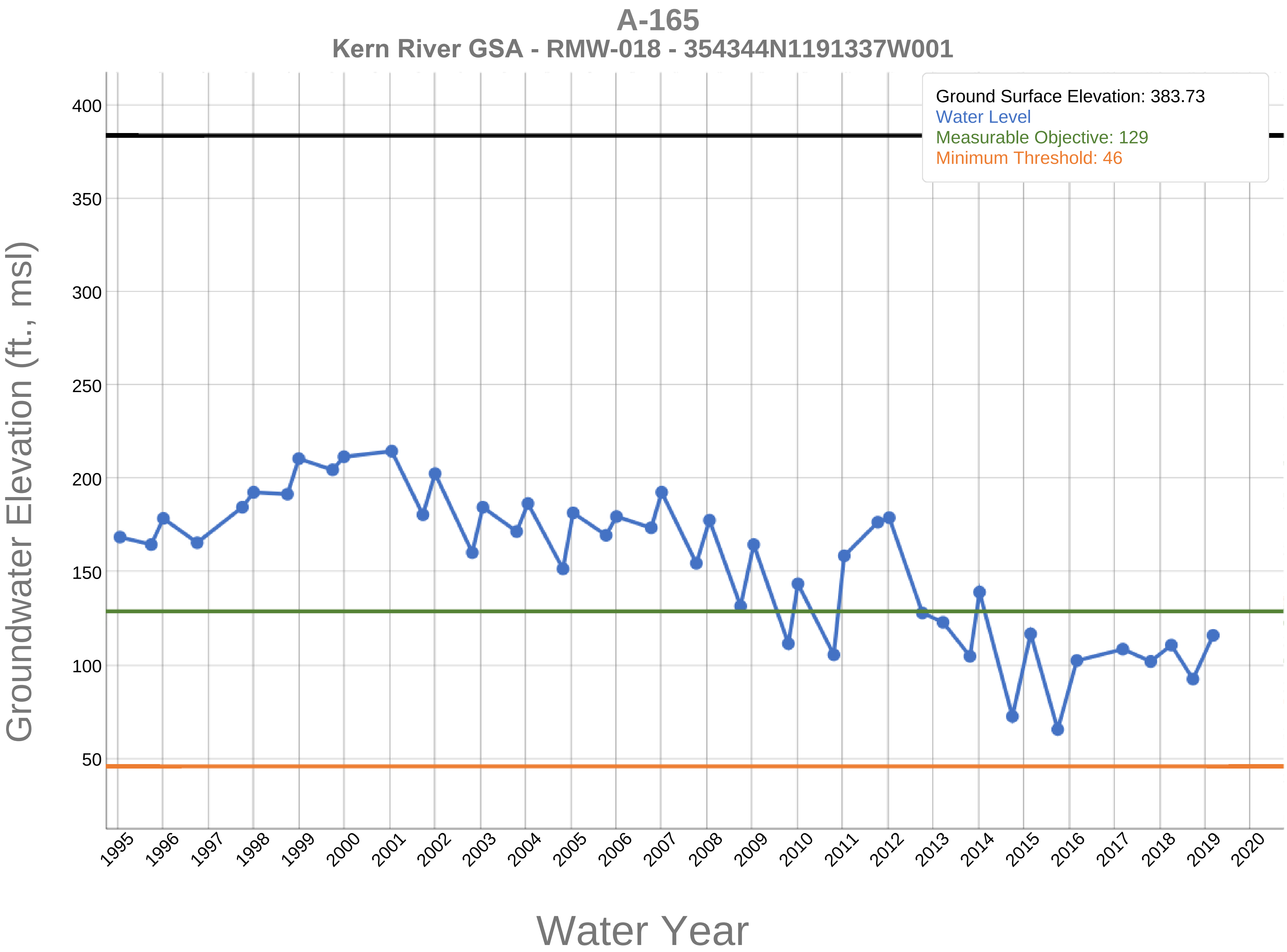
A-165
Kern River GSA - RMW-018 - 354344N1191337W001
Ground Surface Elevation: 383.73
Water Level
Measurable Objective: 129
Minimum Threshold: 46
Groundwater Elevation (ft., msl)
Water Year
400
350
300
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200
150
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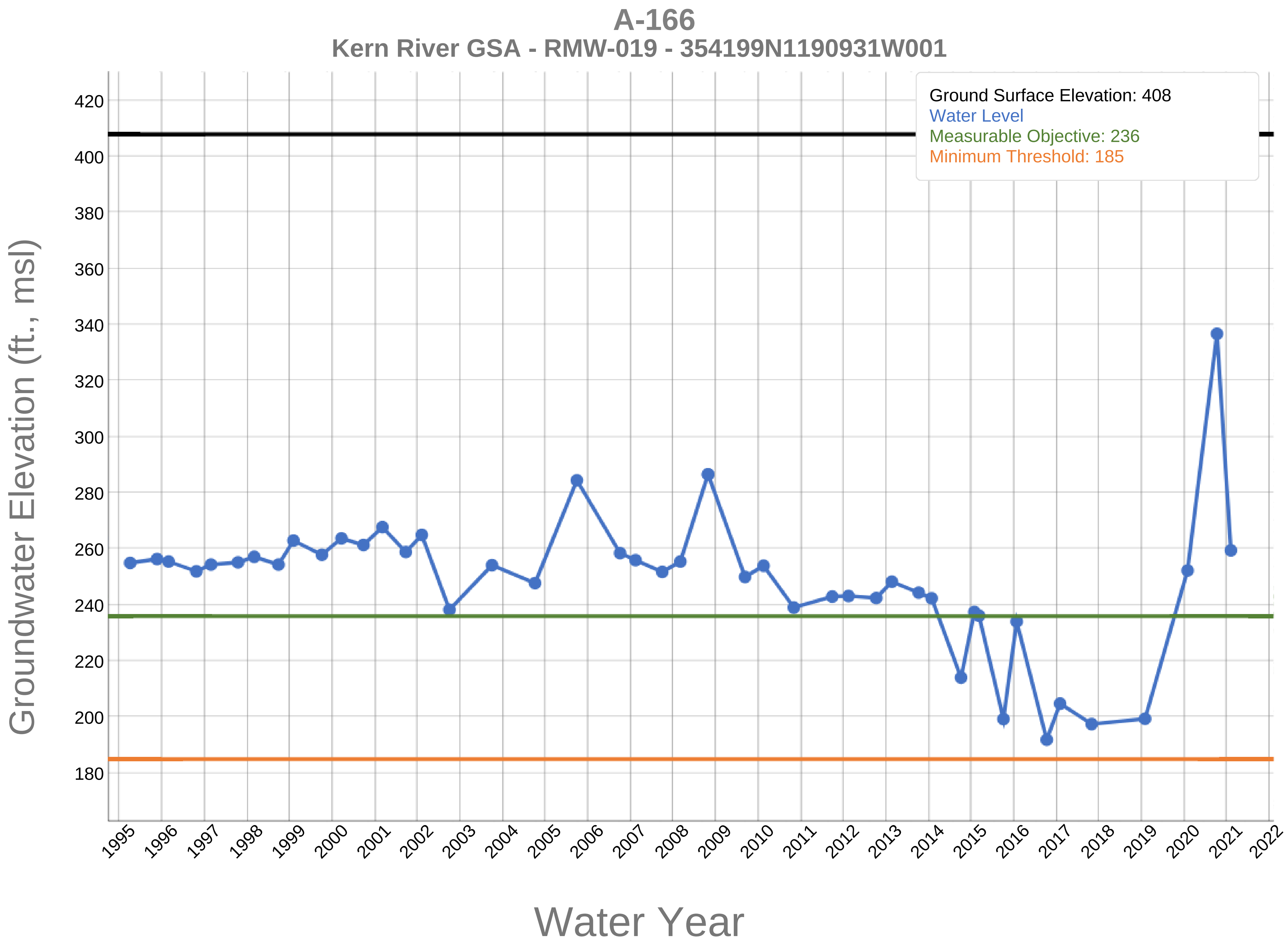
A-166
Kern River GSA - RMW-019 - 354199N1190931W001
Ground Surface Elevation: 408
Water Level
Measurable Objective: 236
Minimum Threshold: 185
Groundwater Elevation (ft., msl)
Water Year
180
200
220
240
260
280
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320
340
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380
400
420
1995
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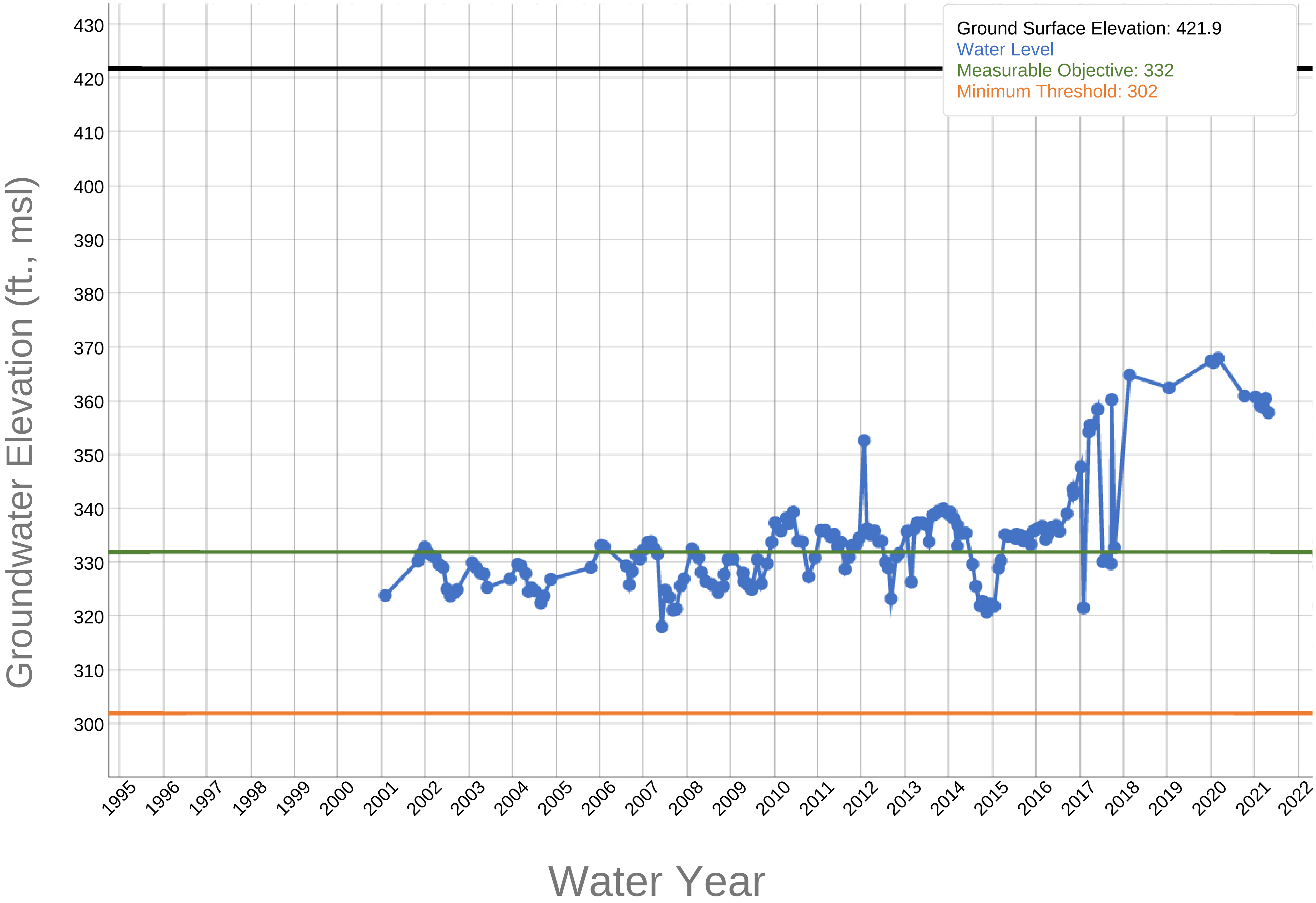
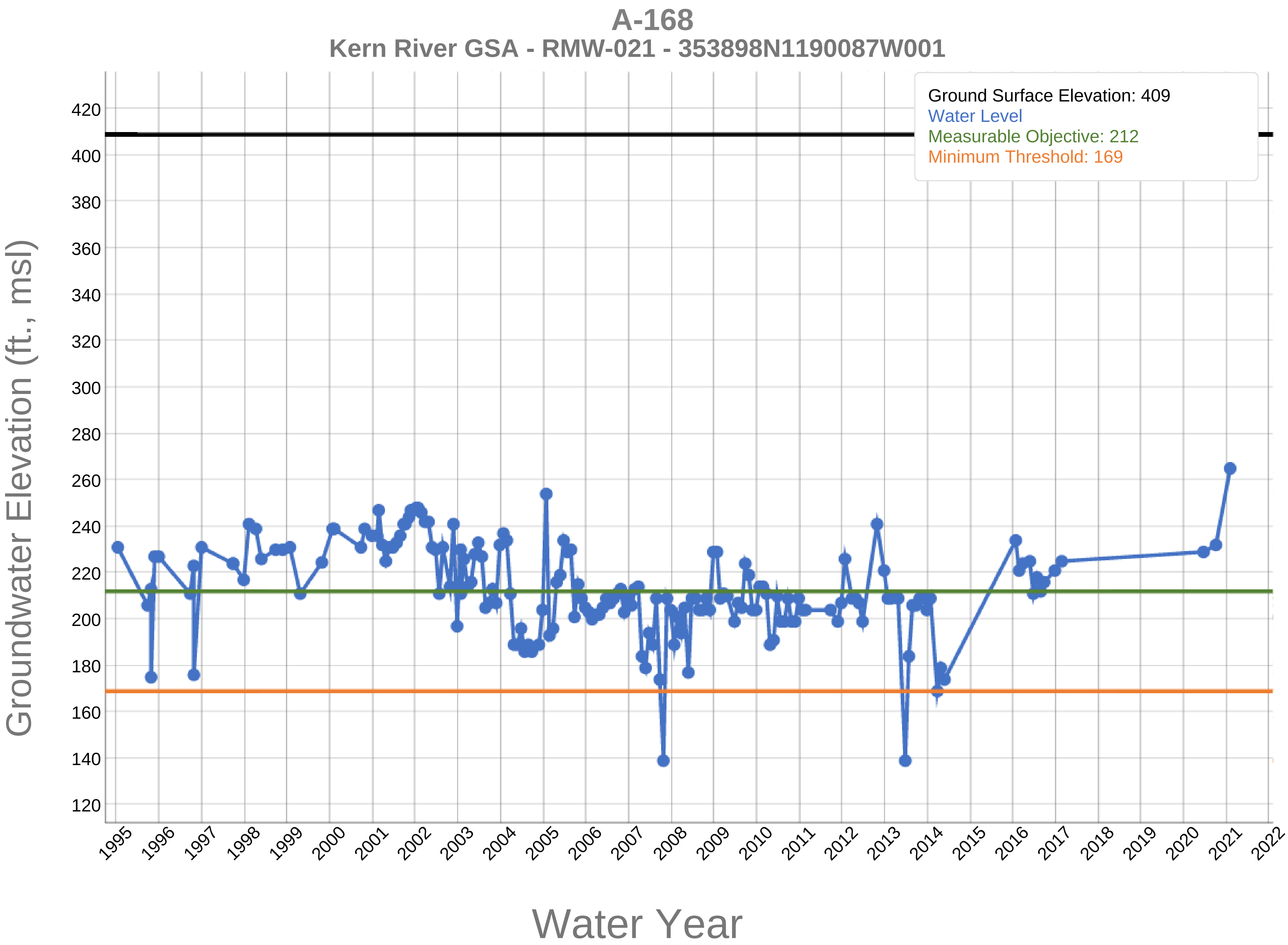
A-167

Kern River GSA - RMW-020 - 354048N1190102W001




A-168
Kern River GSA - RMW-021 - 353898N1190087W001
Ground Surface Elevation: 409
Water Level
Measurable Objective: 212
Minimum Threshold: 169
Groundwater Elevation (ft., msl)
420
400
380
360
340
320
300
280
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180
160
140
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1995
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Water Year


A-169
Kern River GSA - RMW-025 - 353539N1191118W001
Ground Surface Elevation: 374.7
Water Level
Measurable Objective: 215
Minimum Threshold: 150
Groundwater Elevation (ft., msl)
Water Year
380
360
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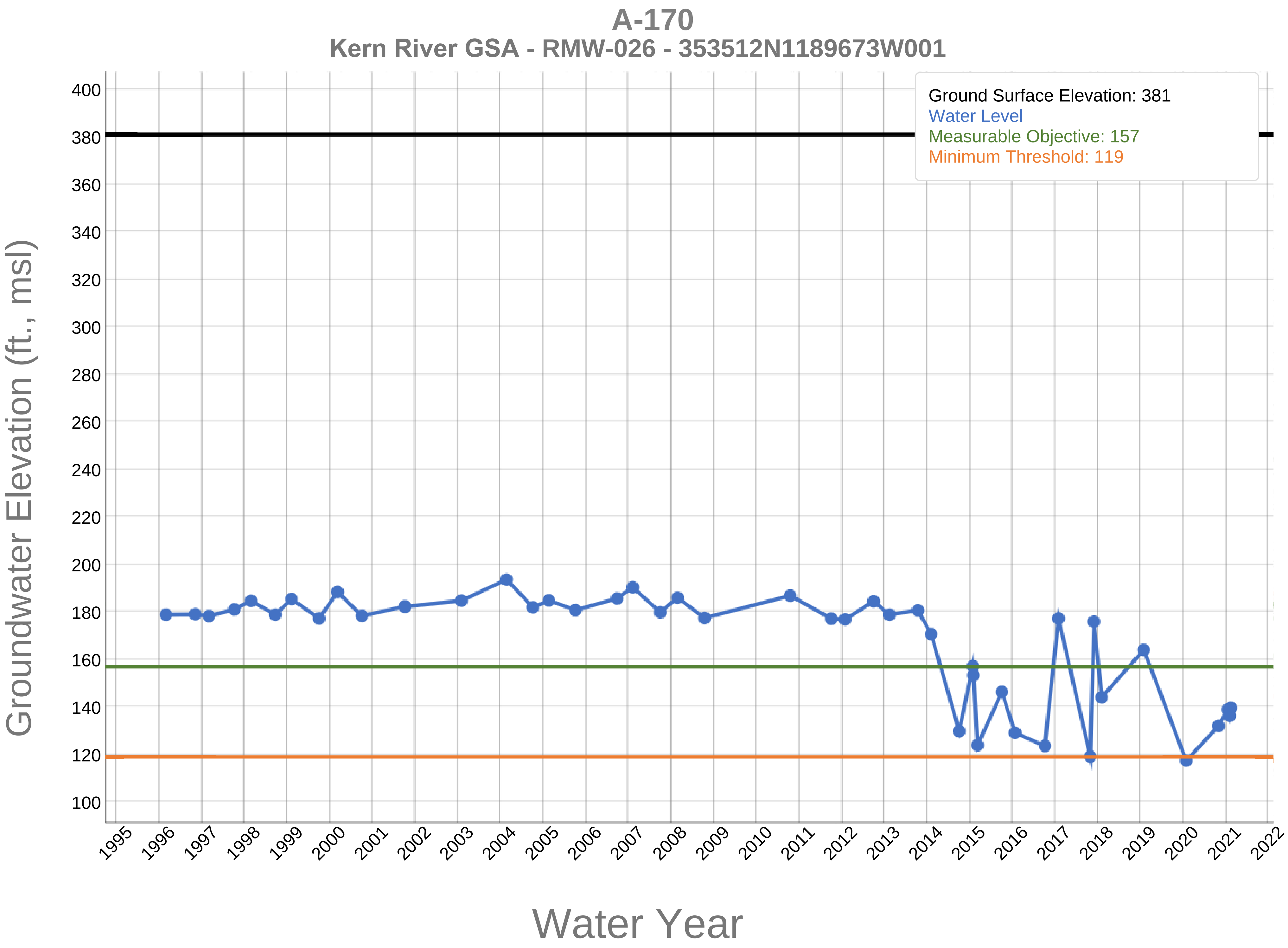
A-170
Kern River GSA - RMW-026 - 353512N1189673W001
Ground Surface Elevation: 381
Water Level
Measurable Objective: 157
Minimum Threshold: 119
Groundwater Elevation (ft., msl)
Water Year
100
120
140
160
180
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220
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340
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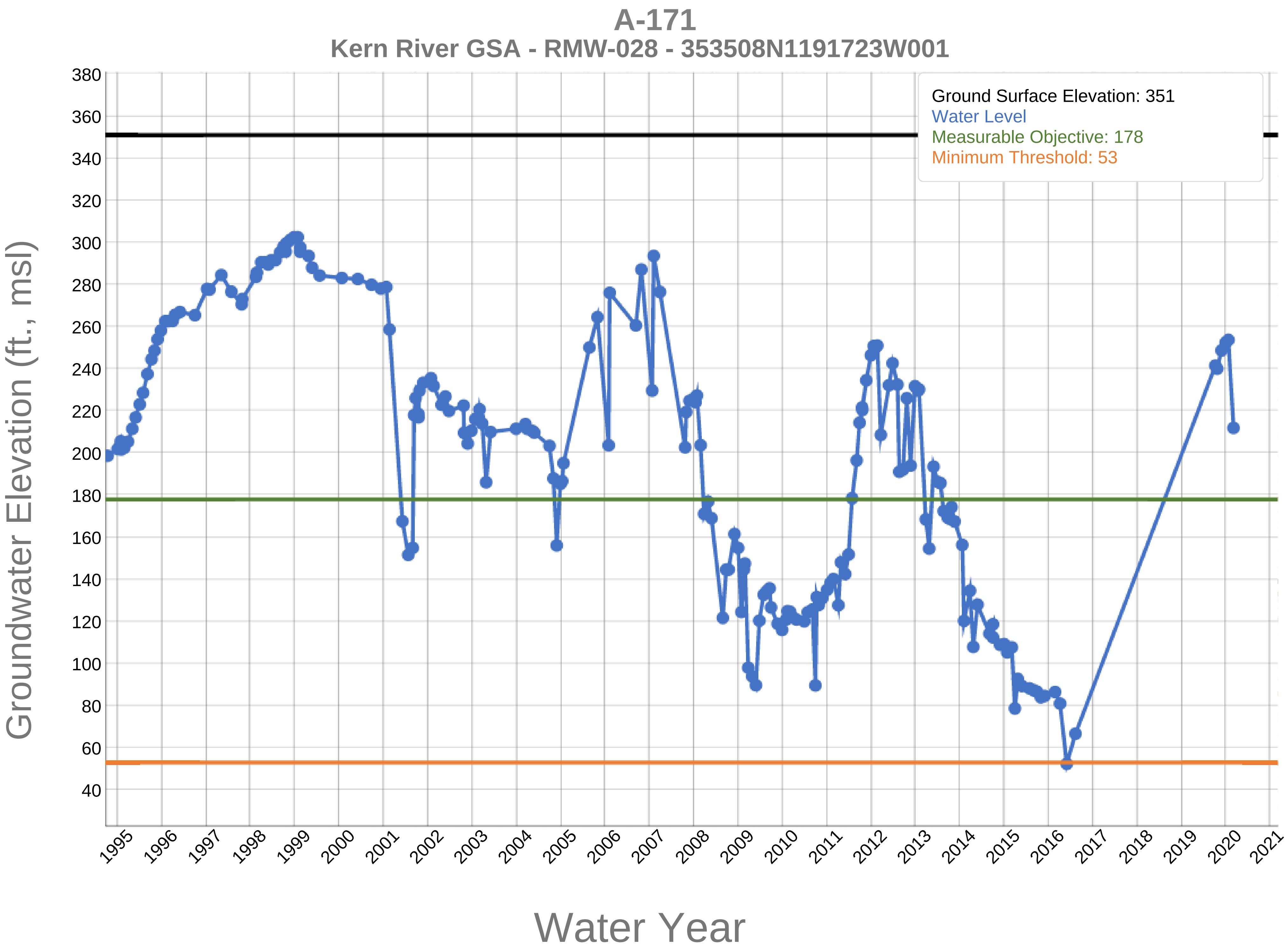
A-171
Kern River GSA - RMW-028 - 353508N1191723W001
Ground Surface Elevation: 351
Water Level
Measurable Objective: 178
Minimum Threshold: 53
Groundwater Elevation (ft., msl)
Water Year
380
360
340
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300
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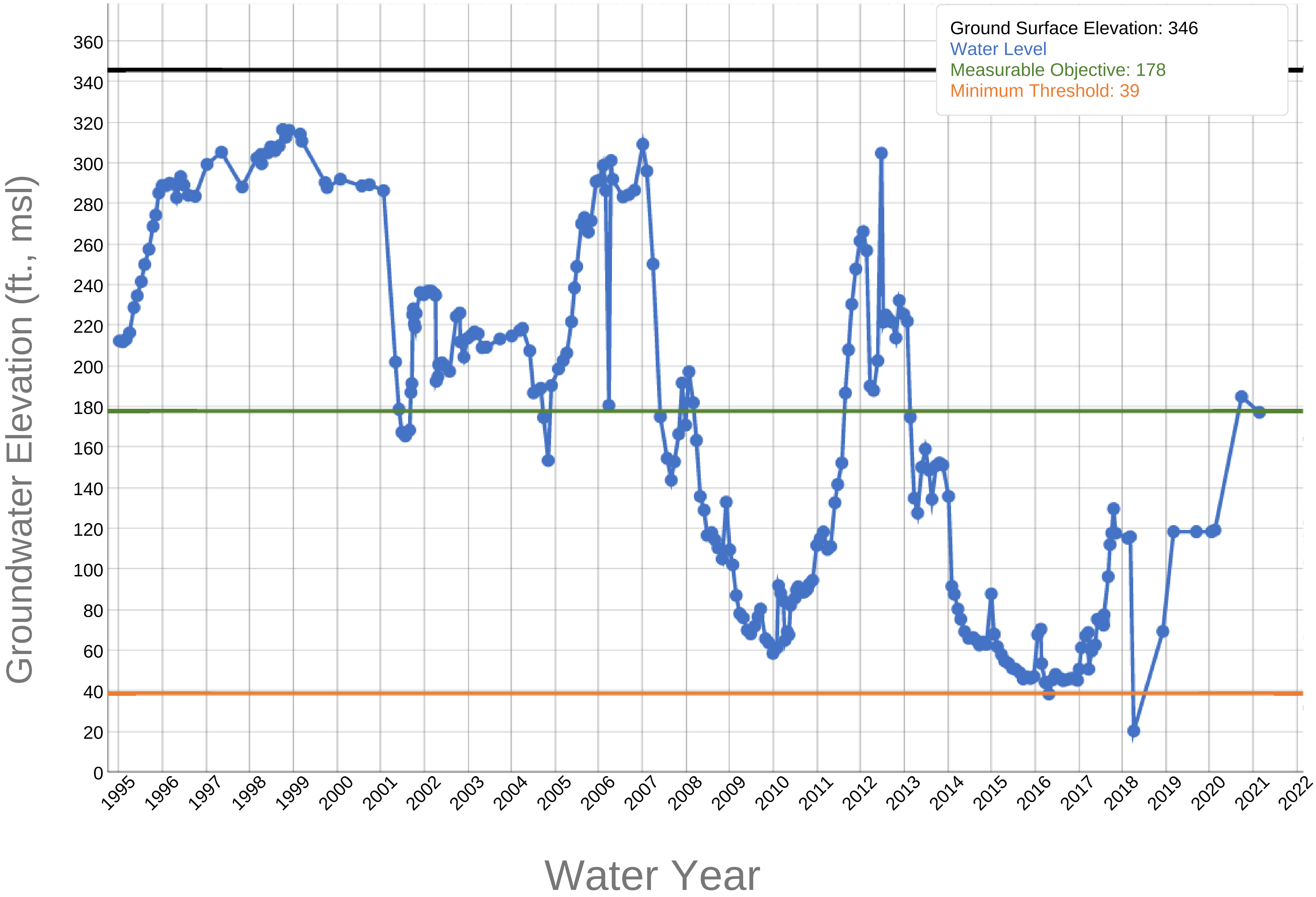
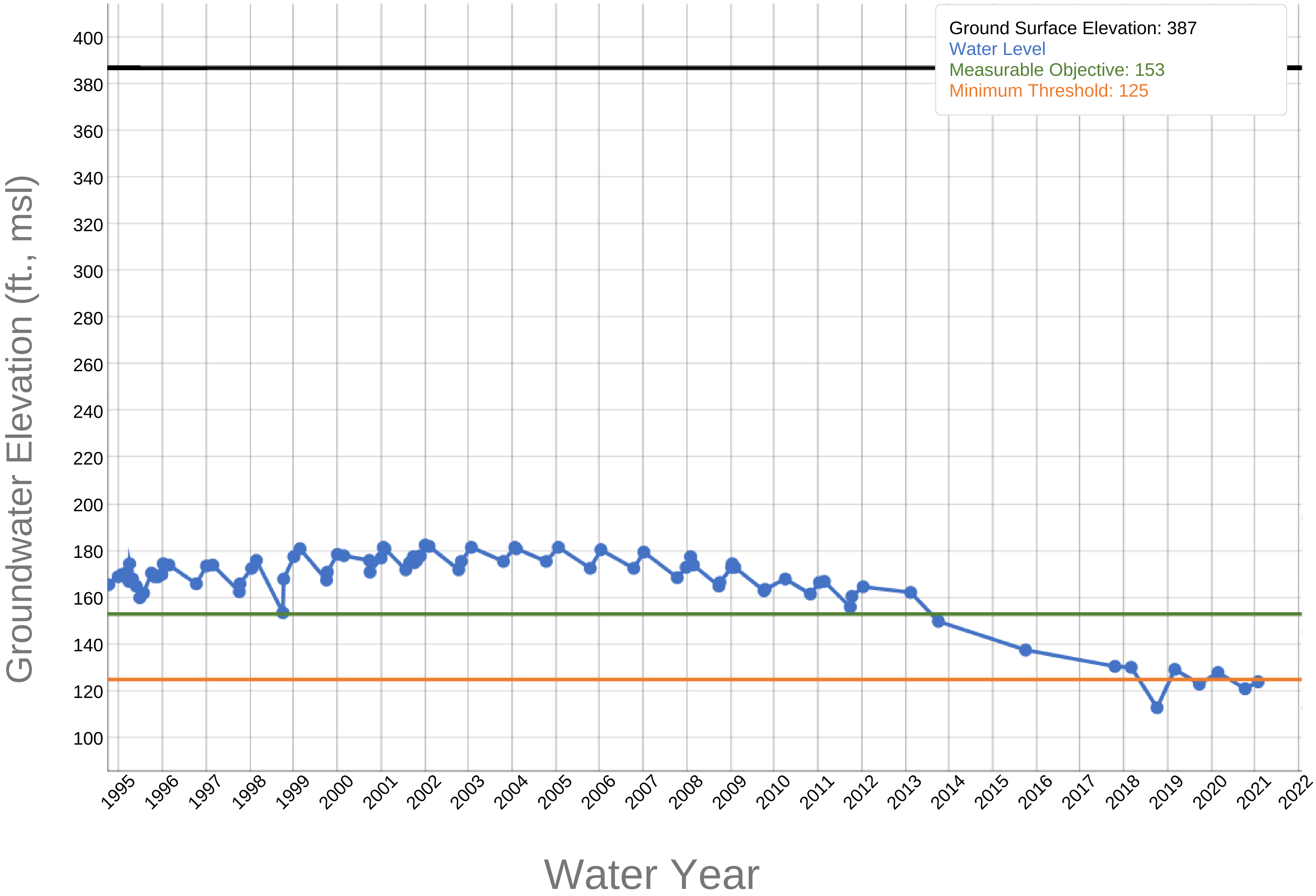
A-172

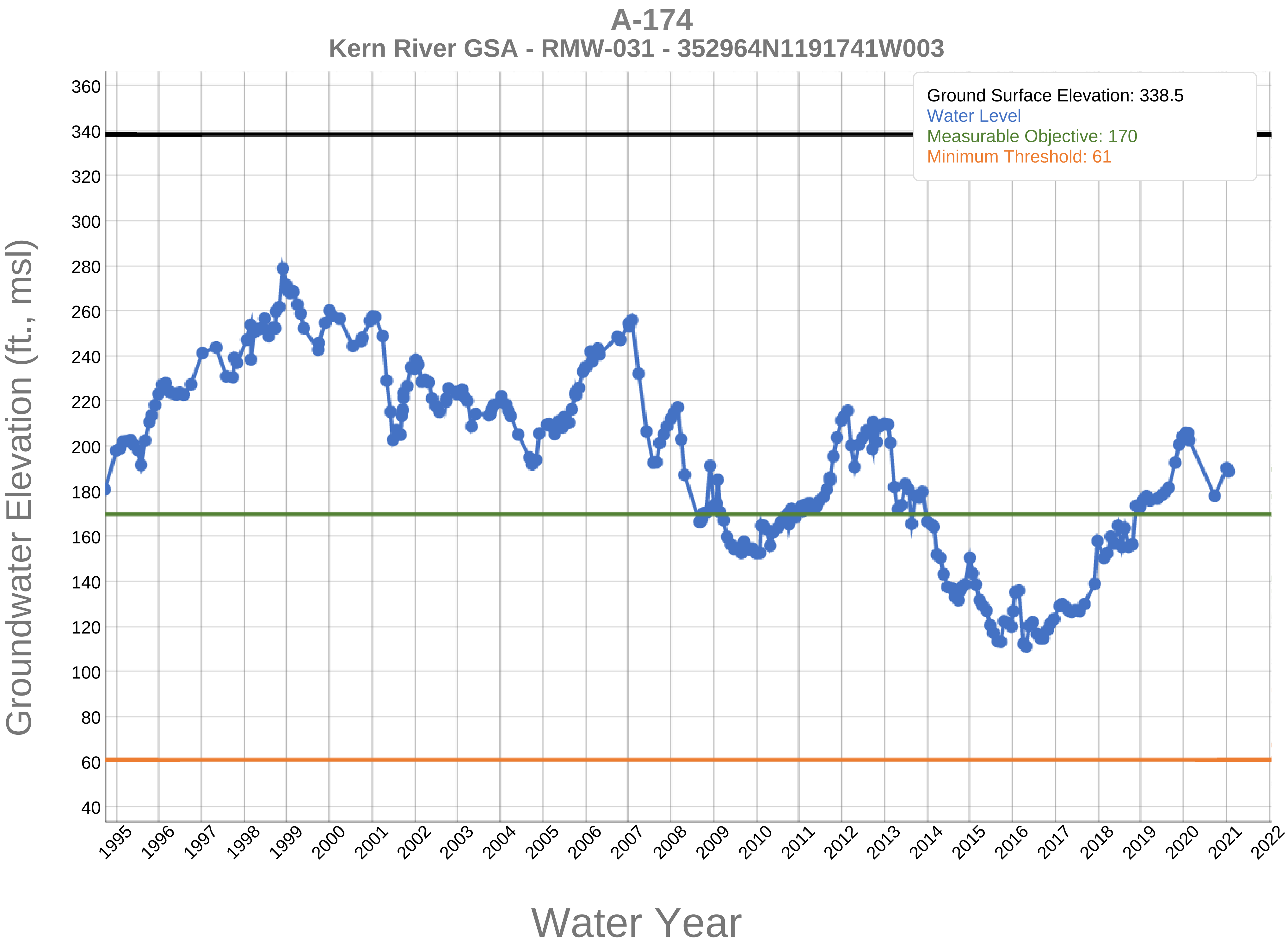
Kern River GSA - RMW-029 - 353247N1191870W001



A-173

Kern River GSA - RMW-030 - 353328N1189409W001




A-174
Kern River GSA - RMW-031 - 352964N1191741W003
Ground Surface Elevation: 338.5
Water Level
Measurable Objective: 170
Minimum Threshold: 61
Groundwater Elevation (ft., msl)
360
340
320
300
280
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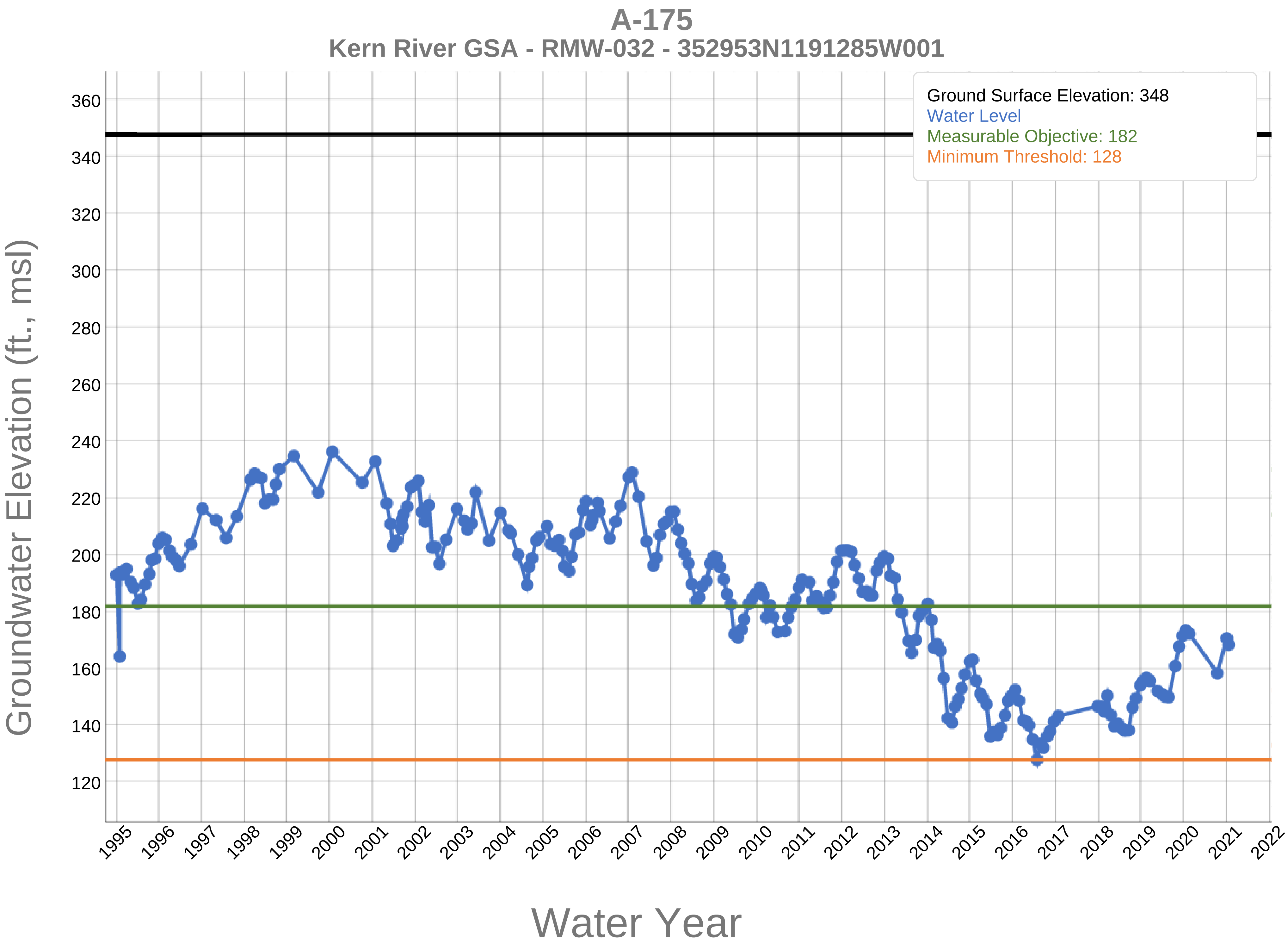
Water Year



A-175
Kern River GSA - RMW-032 - 352953N1191285W001
Ground Surface Elevation: 348
Water Level
Measurable Objective: 182
Minimum Threshold: 128
Groundwater Elevation (ft., msl)
360
340
320
300
280
260
240
220
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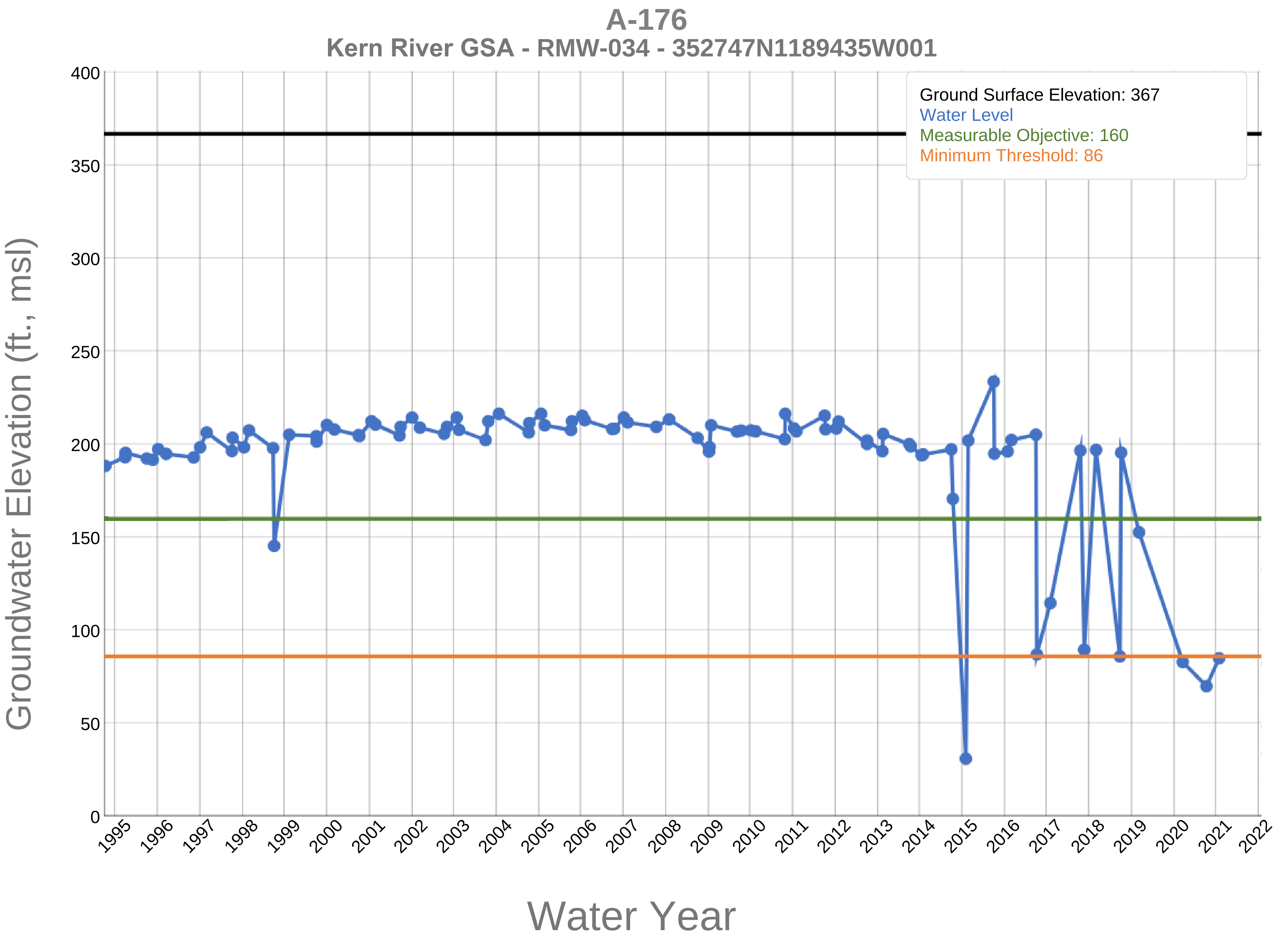
Water Year


A-176
Kern River GSA - RMW-034 - 352747N1189435W001
Ground Surface Elevation: 367
Water Level
Measurable Objective: 160
Minimum Threshold: 86
Groundwater Elevation (ft., msl)
Water Year
0
50
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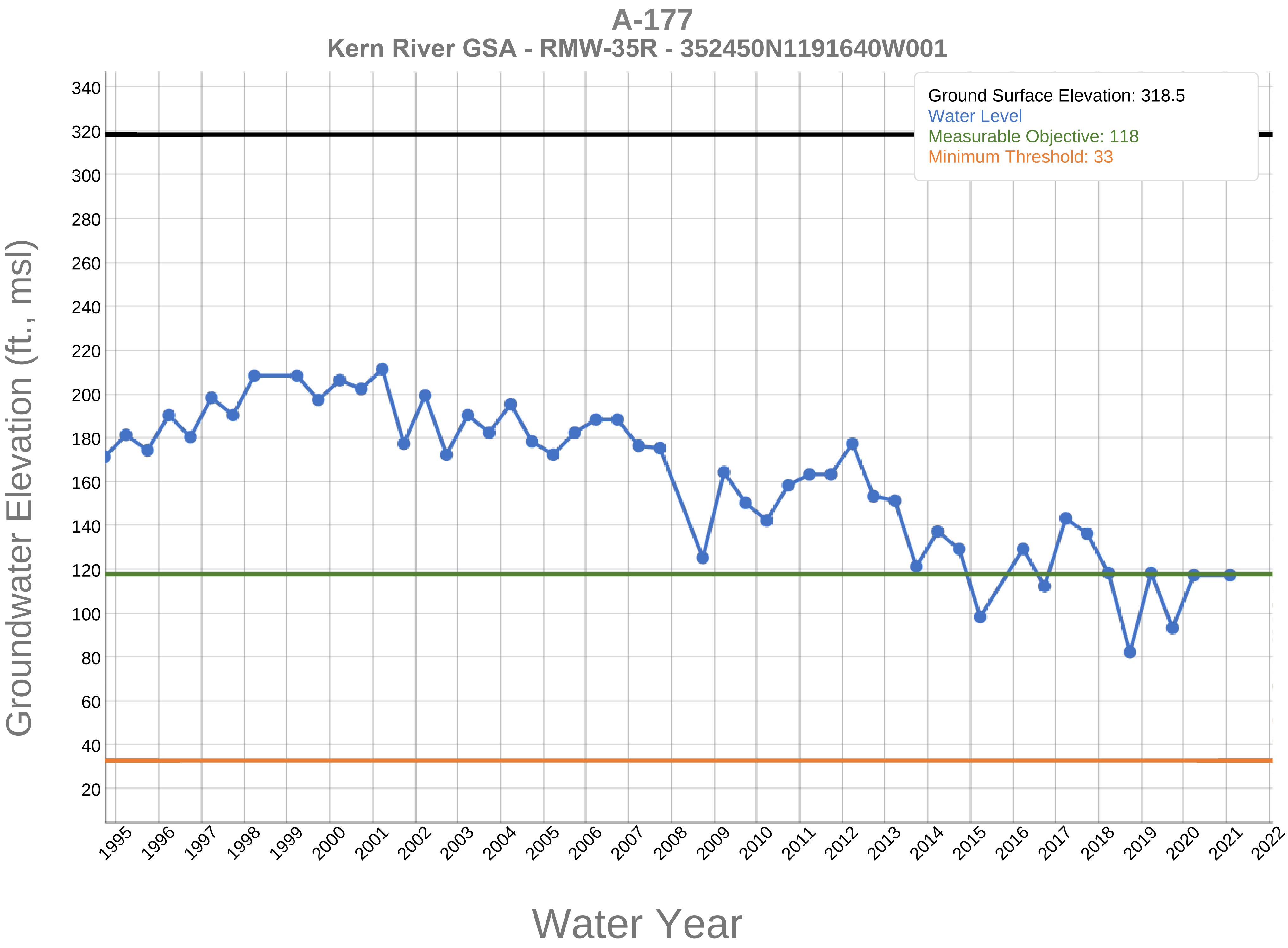
A-177
Kern River GSA - RMW-35R - 352450N1191640W001
Ground Surface Elevation: 318.5
Water Level
Measurable Objective: 118
Minimum Threshold: 33
Groundwater Elevation (ft., msl)
Water Year
340
320
300
280
260
240
220
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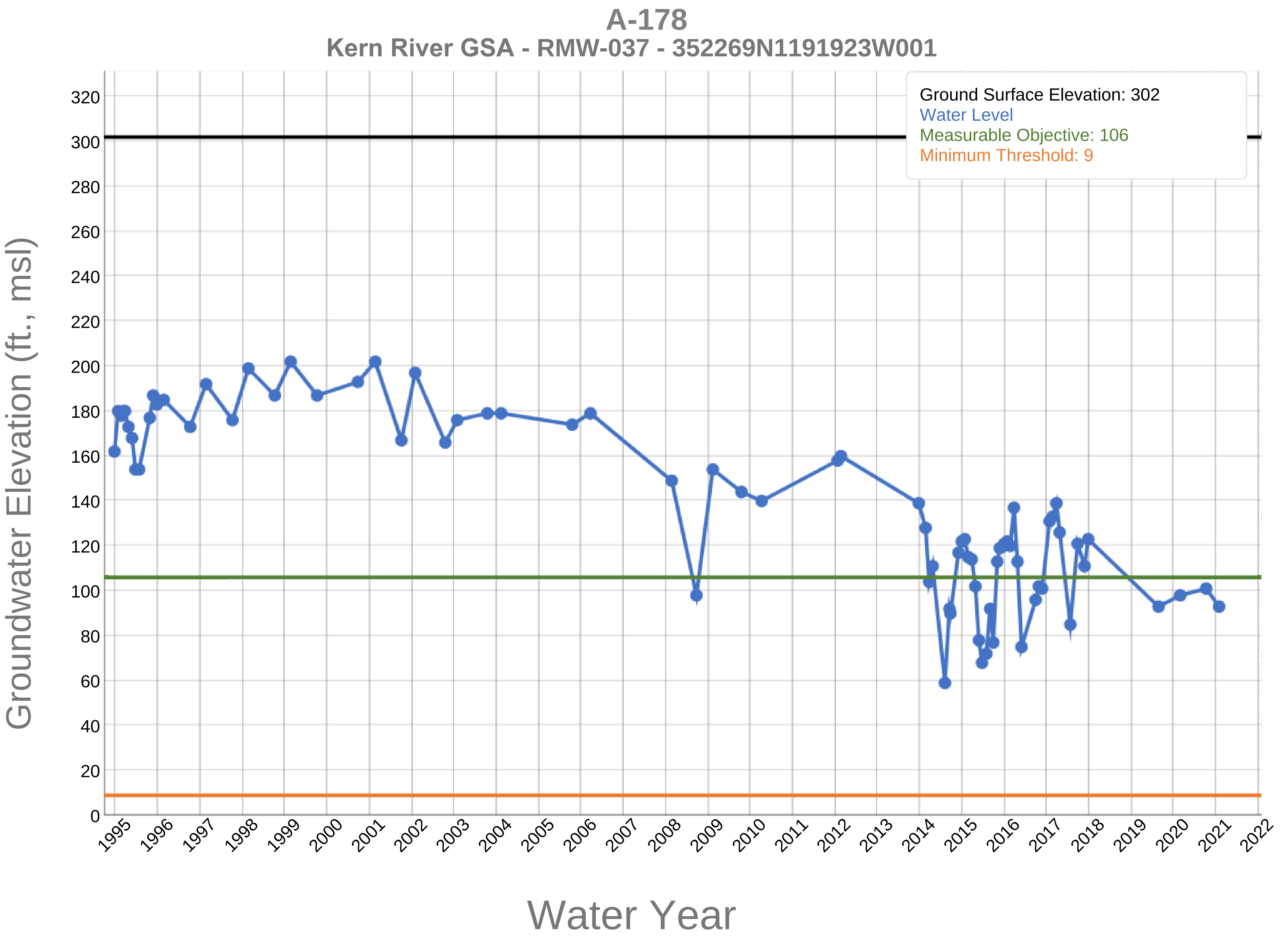
A-178
Kern River GSA - RMW-037 - 352269N1191923W001
Ground Surface Elevation: 302
Water Level
Measurable Objective: 106
Minimum Threshold: 9
Groundwater Elevation (ft., msl)
0
20
40
60
80
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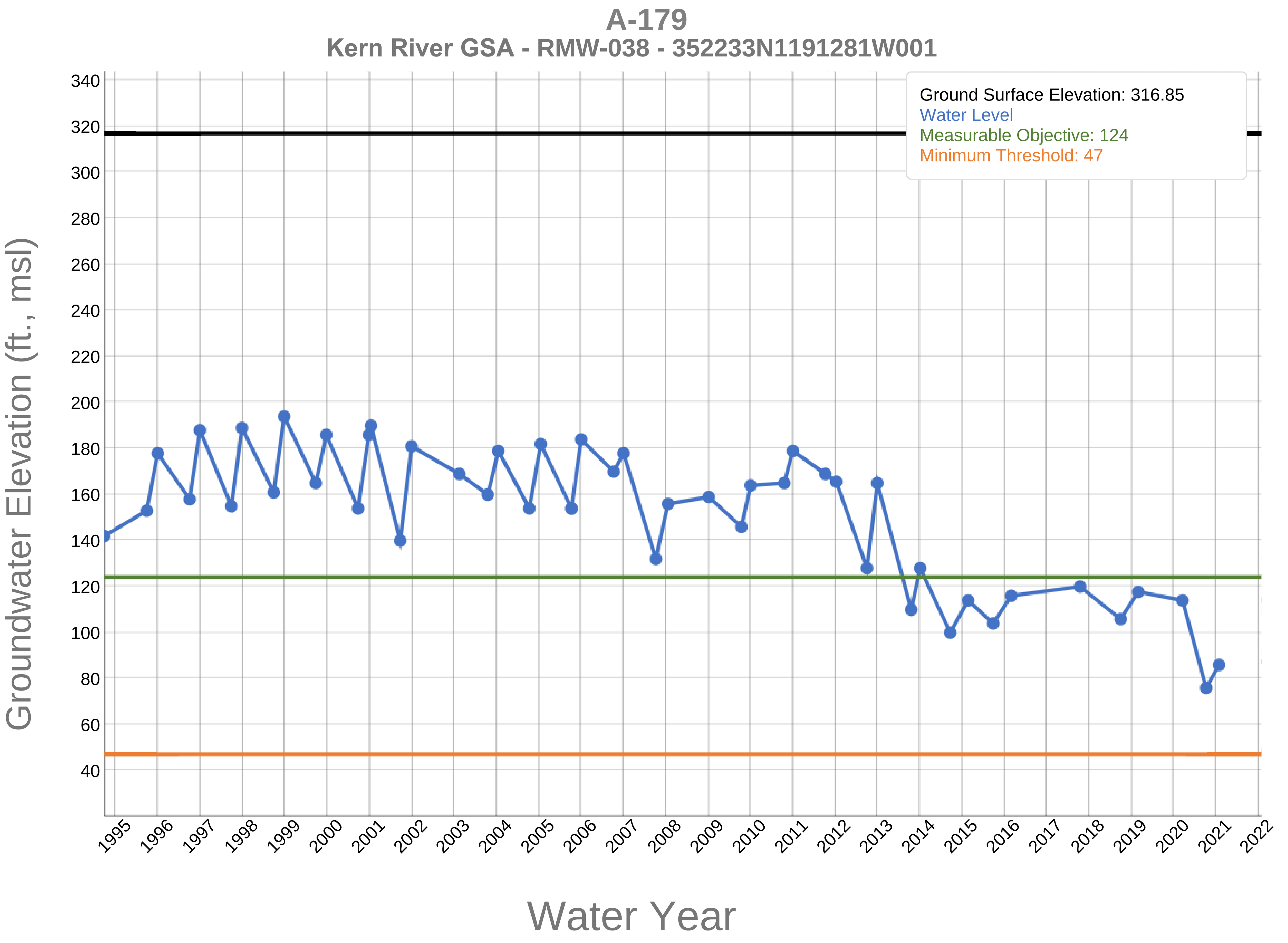
Water Year



A-179
Kern River GSA - RMW-038 - 352233N1191281W001
Ground Surface Elevation: 316.85
Water Level
Measurable Objective: 124
Minimum Threshold: 47
Groundwater Elevation (ft., msl)
Water Year
340
320
300
280
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240
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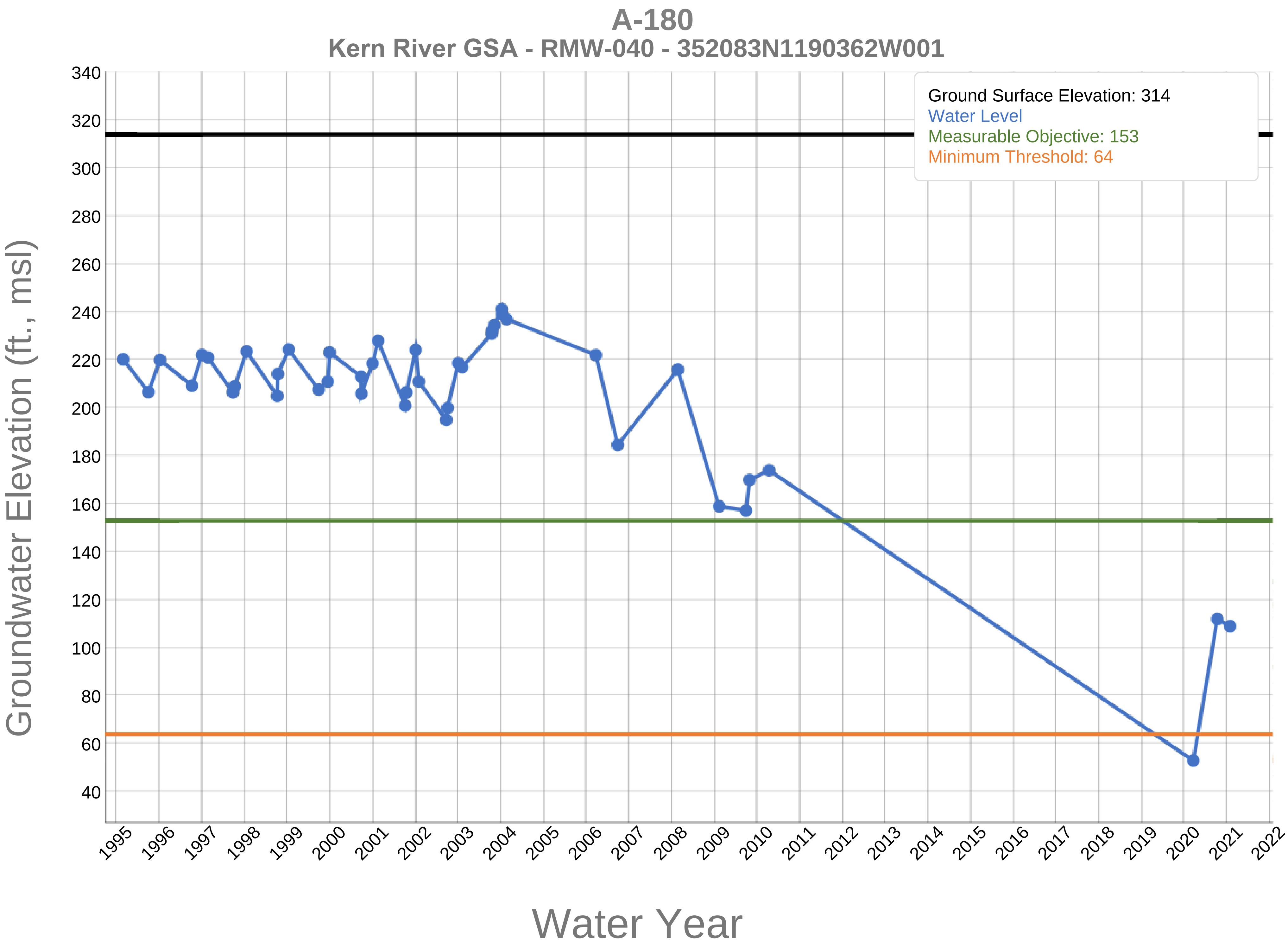

A-180
Kern River GSA - RMW-040 - 352083N1190362W001
Ground Surface Elevation: 314
Water Level
Measurable Objective: 153
Minimum Threshold: 64
Groundwater Elevation (ft., msl)
340
320
300
280
260
240
220
200
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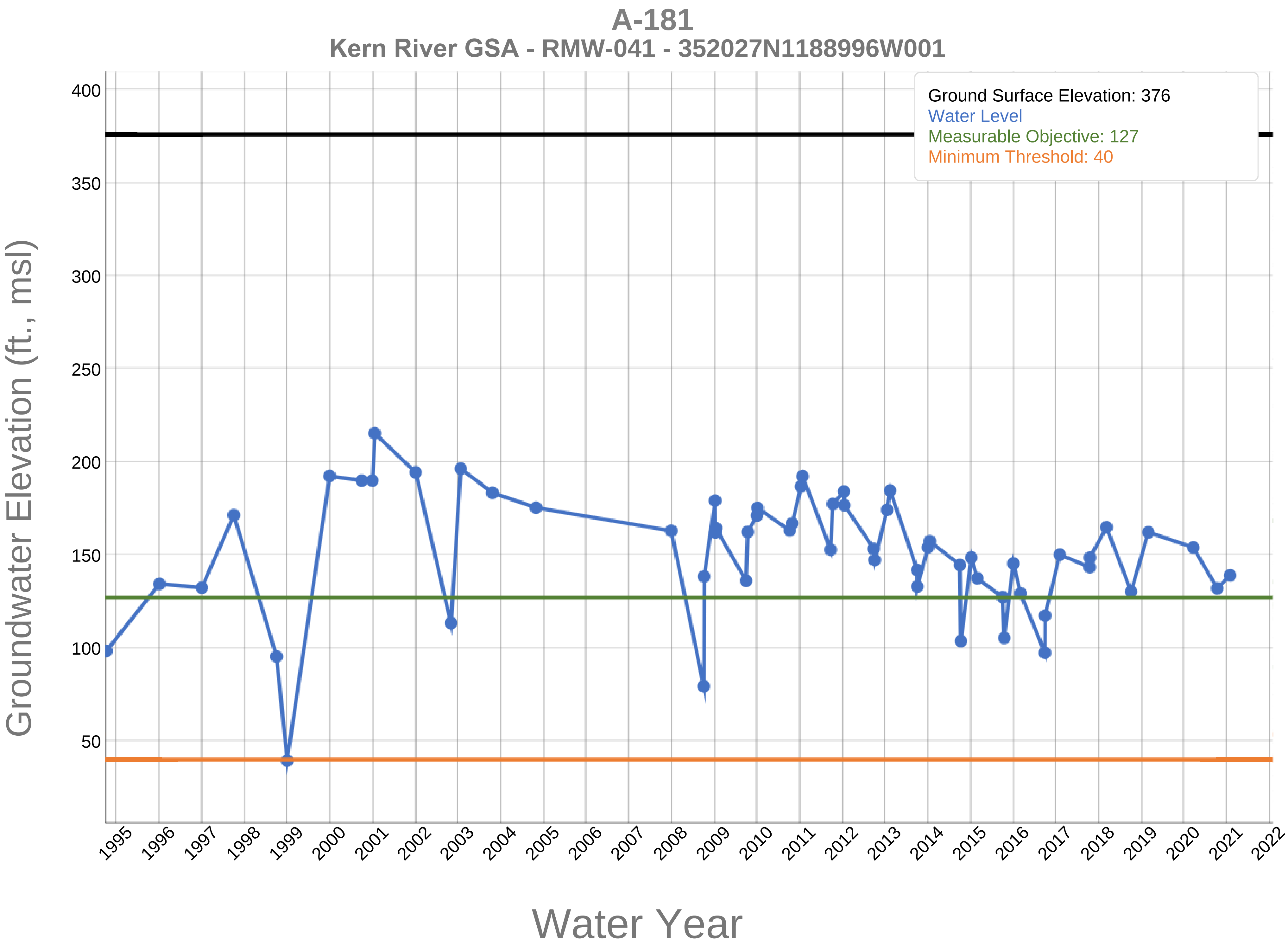
Water Year



A-181
Kern River GSA - RMW-041 - 352027N1188996W001
Ground Surface Elevation: 376
Water Level
Measurable Objective: 127
Minimum Threshold: 40
Groundwater Elevation (ft., msl)
400
350
300
250
200
150
100
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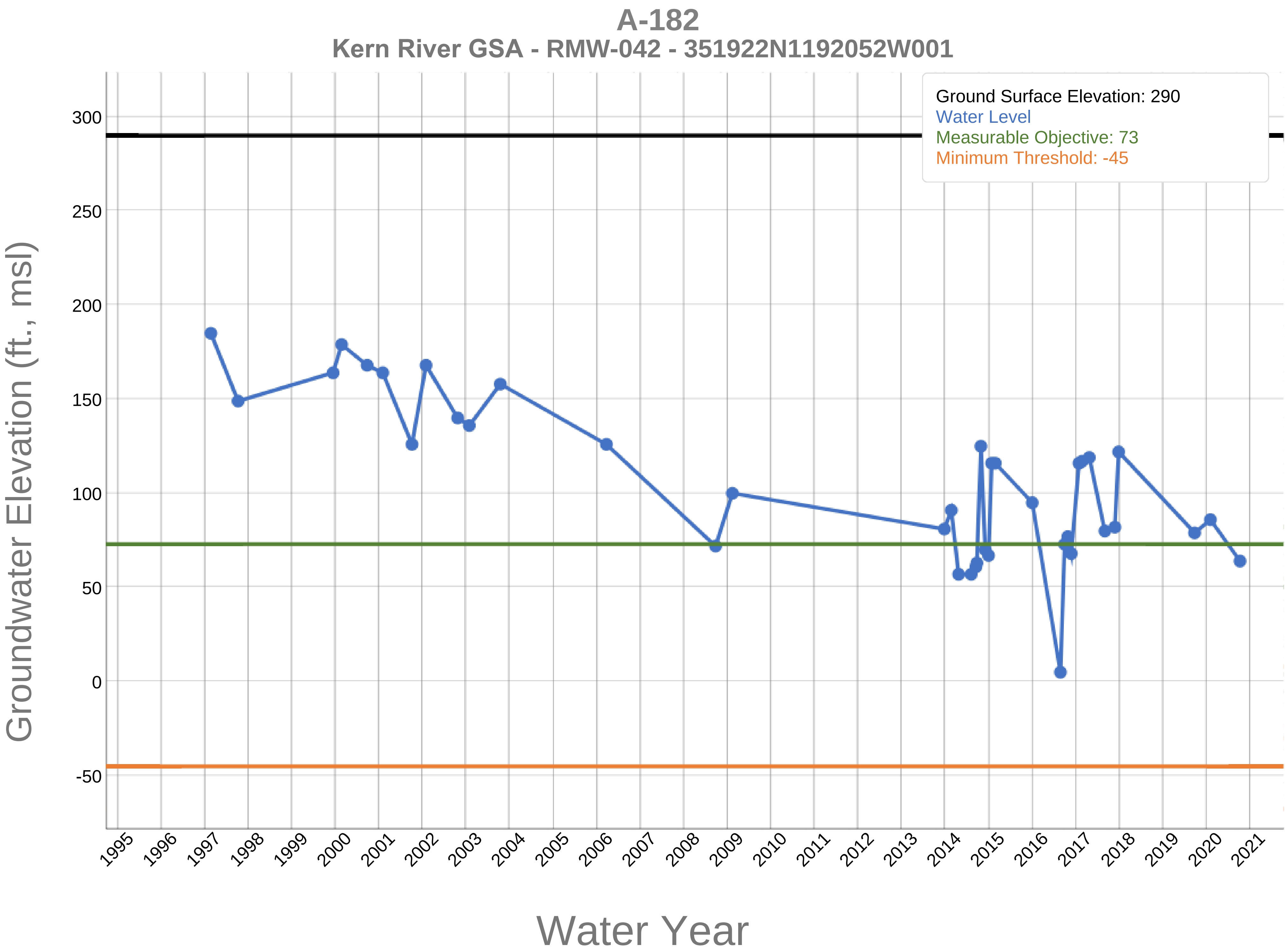
Water Year


A-182
Kern River GSA - RMW-042 - 351922N1192052W001
Ground Surface Elevation: 290
Water Level
Measurable Objective: 73
Minimum Threshold: -45
Groundwater Elevation (ft., msl)
300
250
200
150
100
50
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-50
1995
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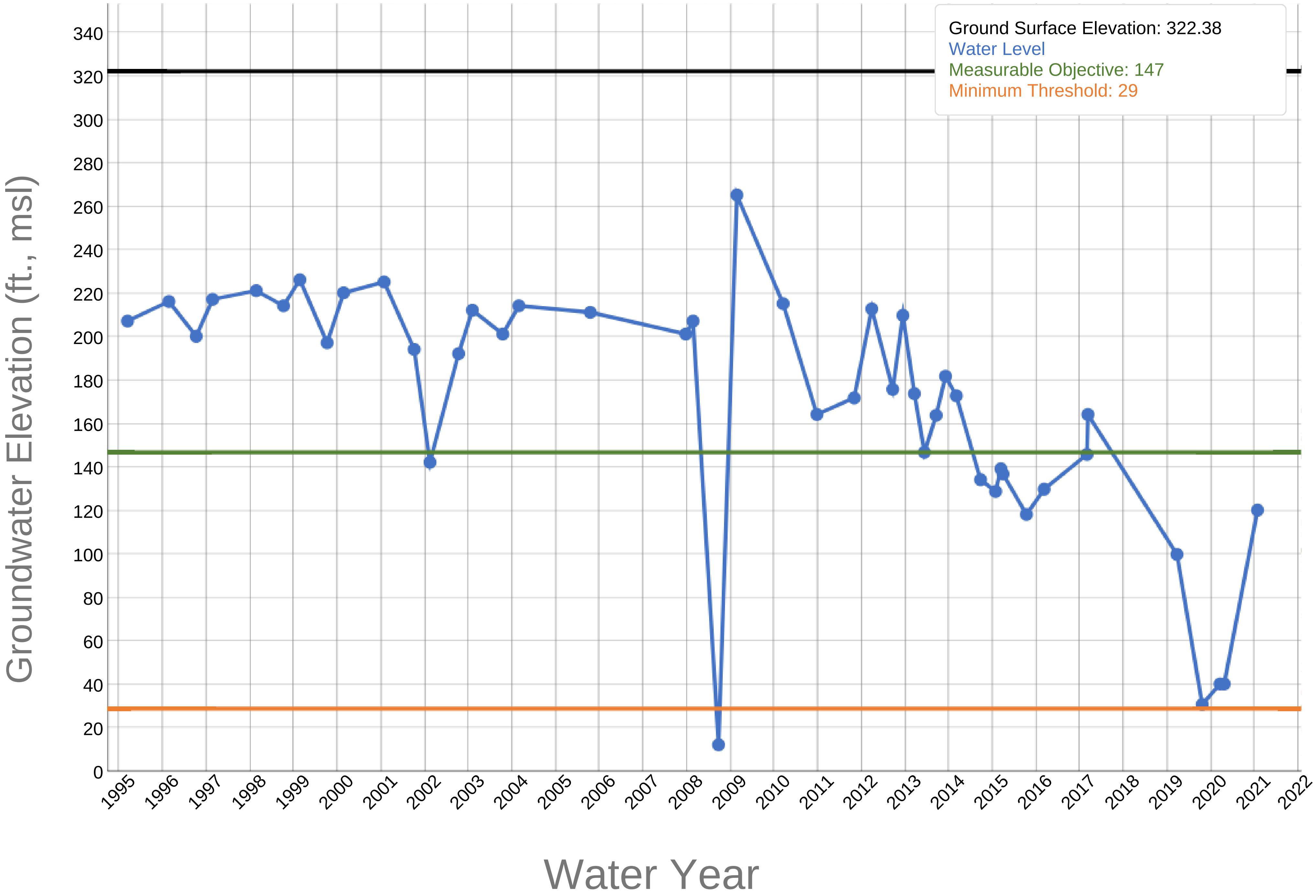
Water Year

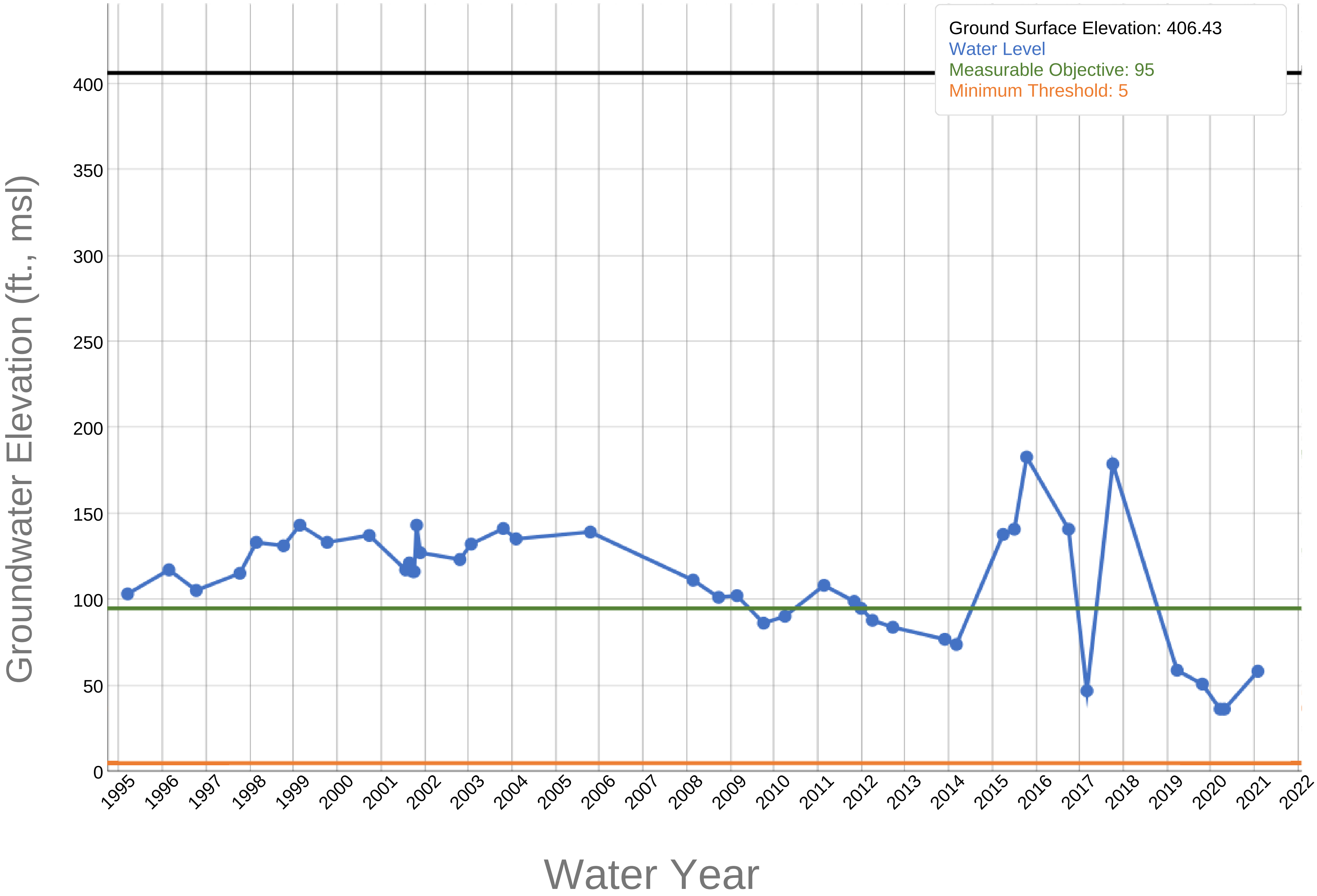
A-183

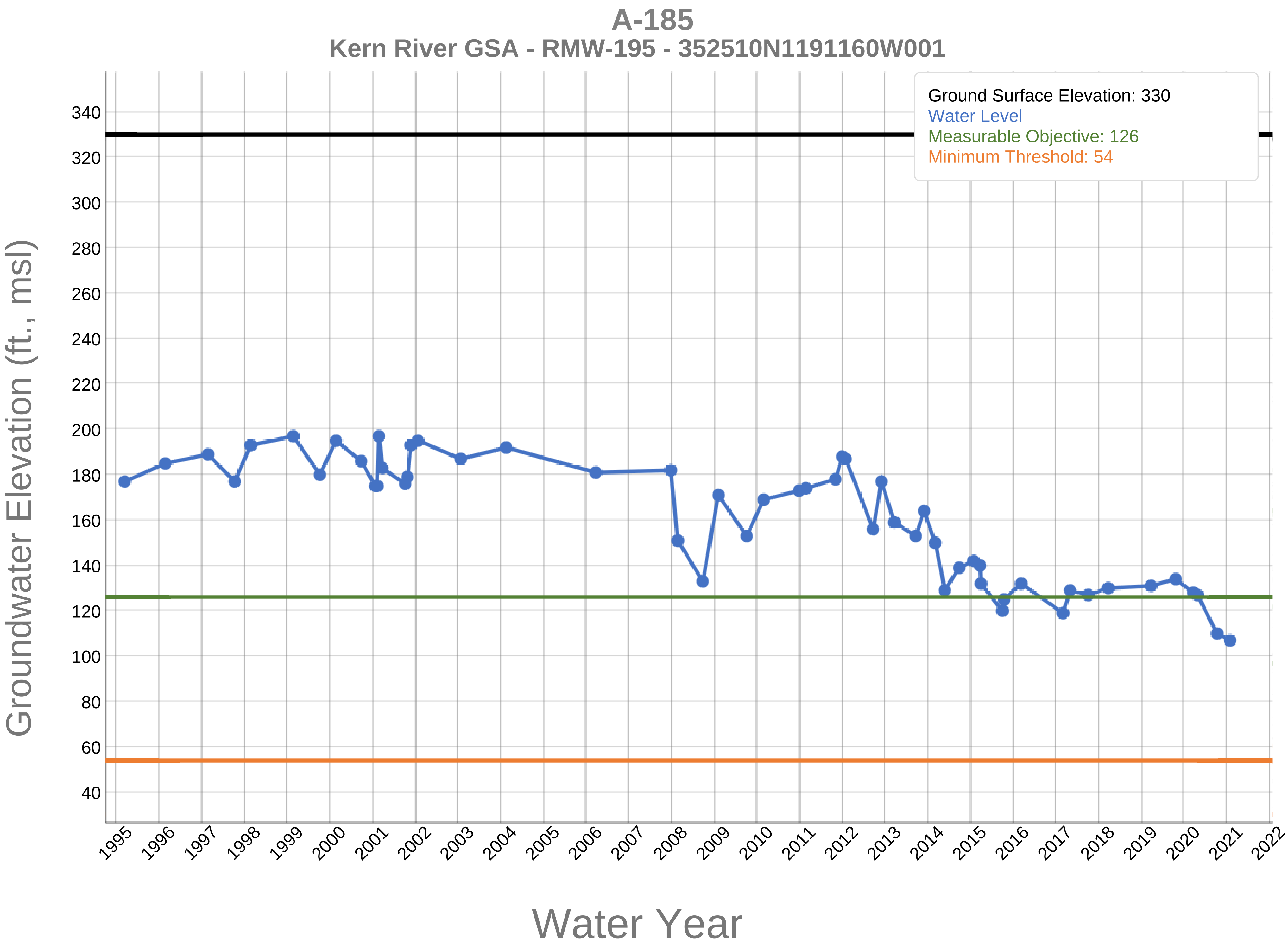
Kern River GSA - RMW-192 - 352220N1190000W001



A-184

Kern River GSA - RMW-193 - 352080N1188710W001





A-185
Kern River GSA - RMW-195 - 352510N1191160W001
Ground Surface Elevation: 330
Water Level
Measurable Objective: 126
Minimum Threshold: 54
Groundwater Elevation (ft., msl)
340
320
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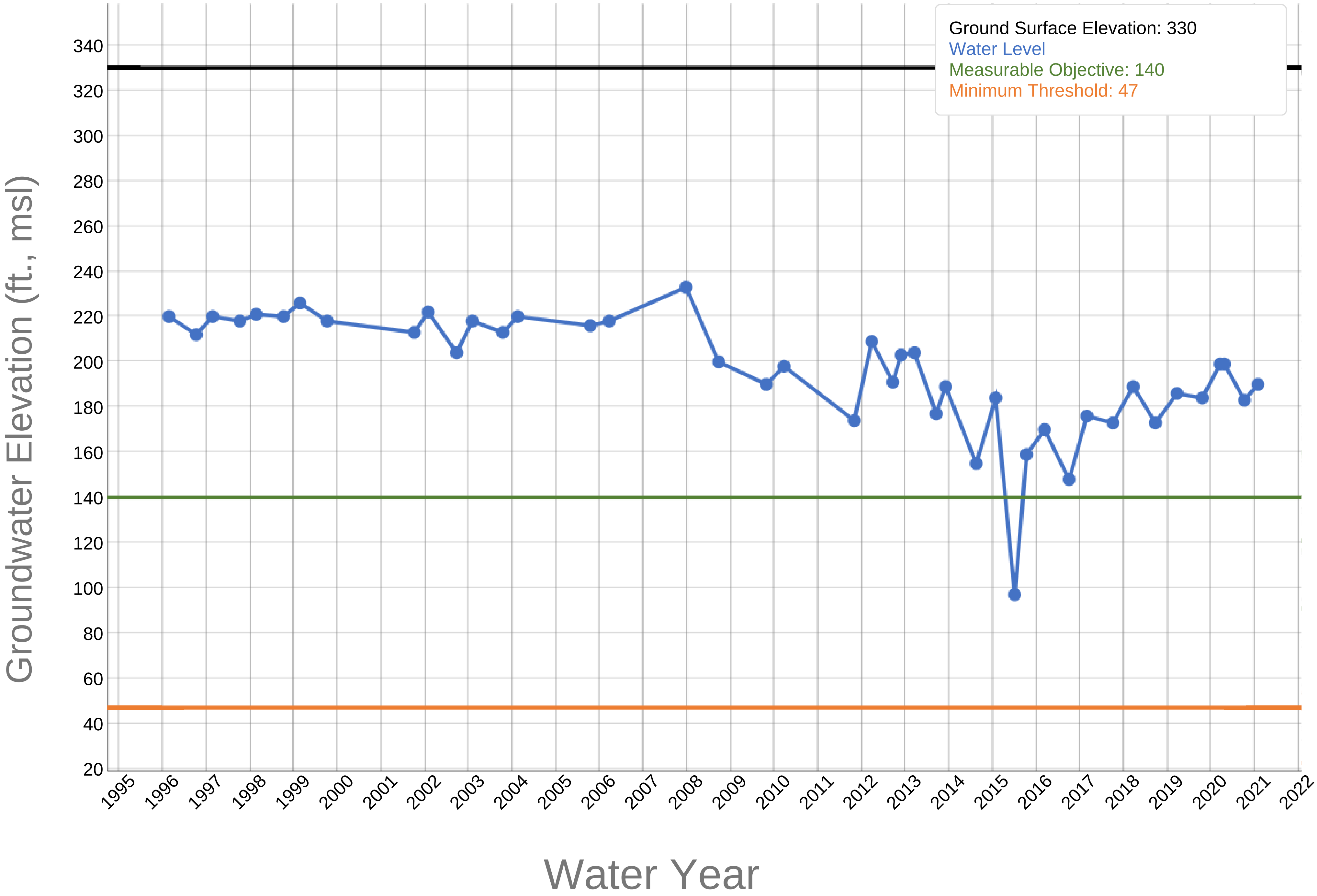
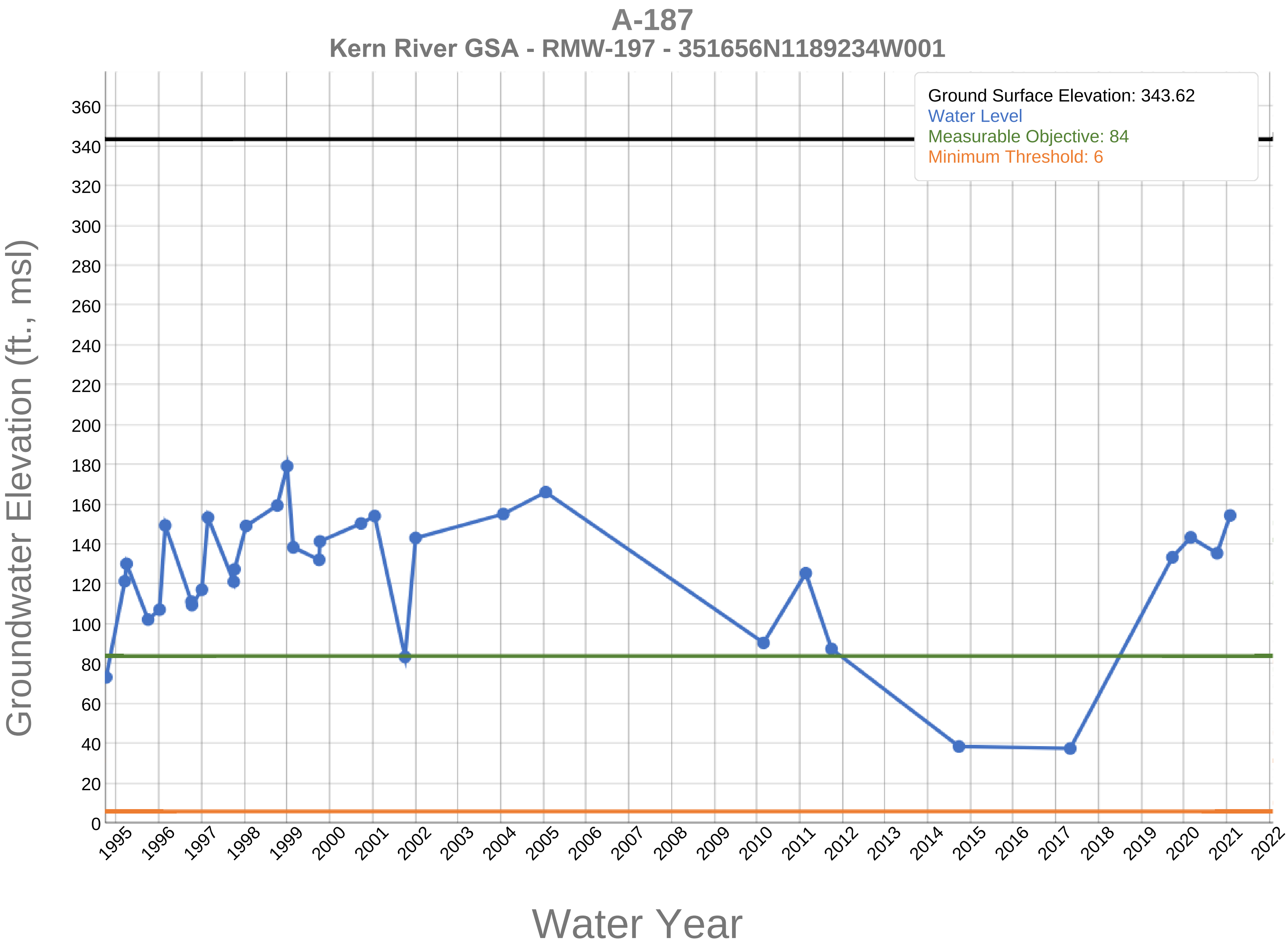
Water Year

A-186

Kern River GSA - RMW-196 - 352410N1190280W001




A-187
Kern River GSA - RMW-197 - 351656N1189234W001
Ground Surface Elevation: 343.62
Water Level
Measurable Objective: 84
Minimum Threshold: 6
Groundwater Elevation (ft., msl)
Water Year
0
20
40
60
80
100
120
140
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180
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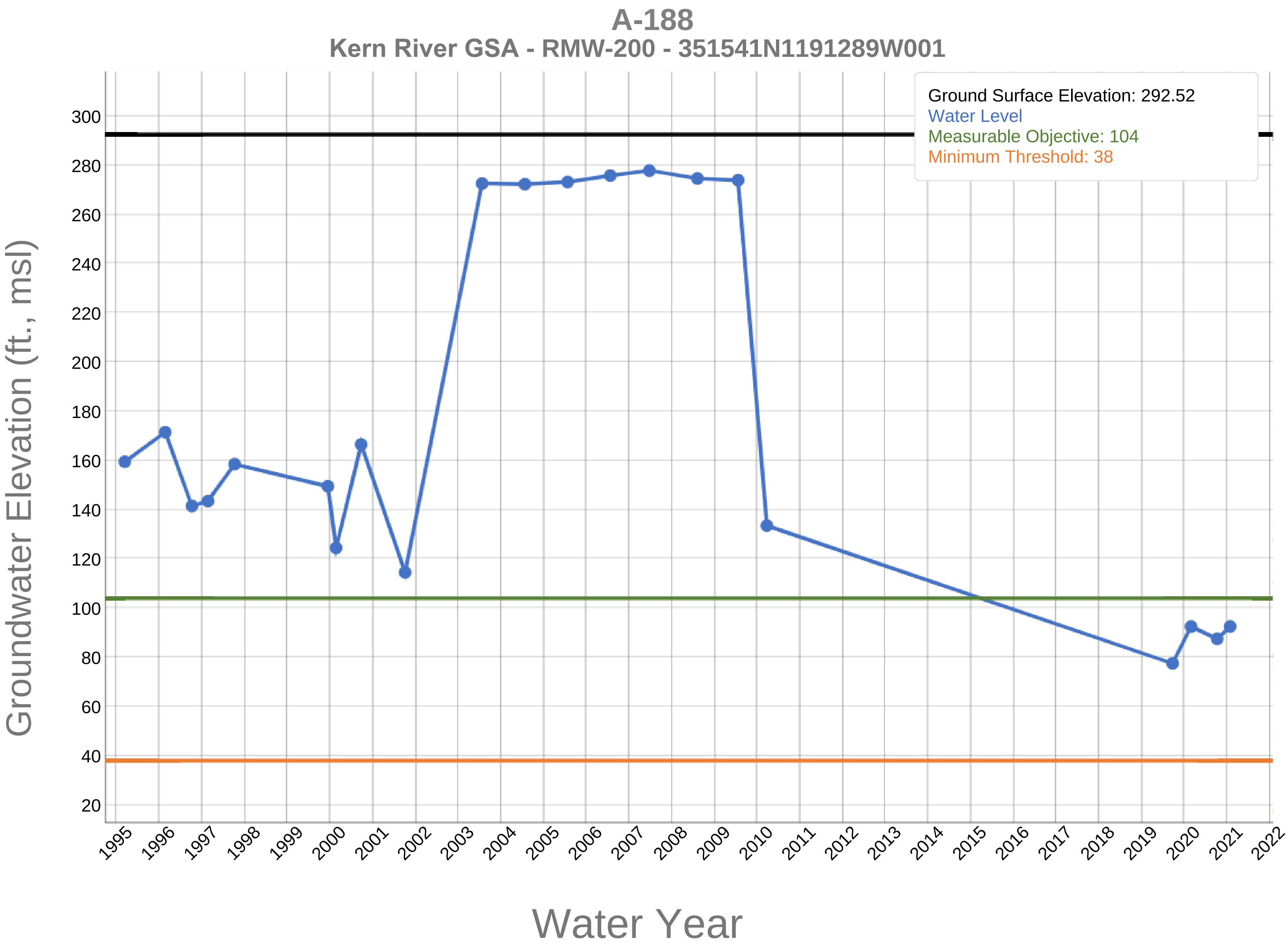
A-188
Kern River GSA - RMW-200 - 351541N1191289W001
Ground Surface Elevation: 292.52
Water Level
Measurable Objective: 104
Minimum Threshold: 38
Groundwater Elevation (ft., msl)
300
280
260
240
220
200
180
160
140
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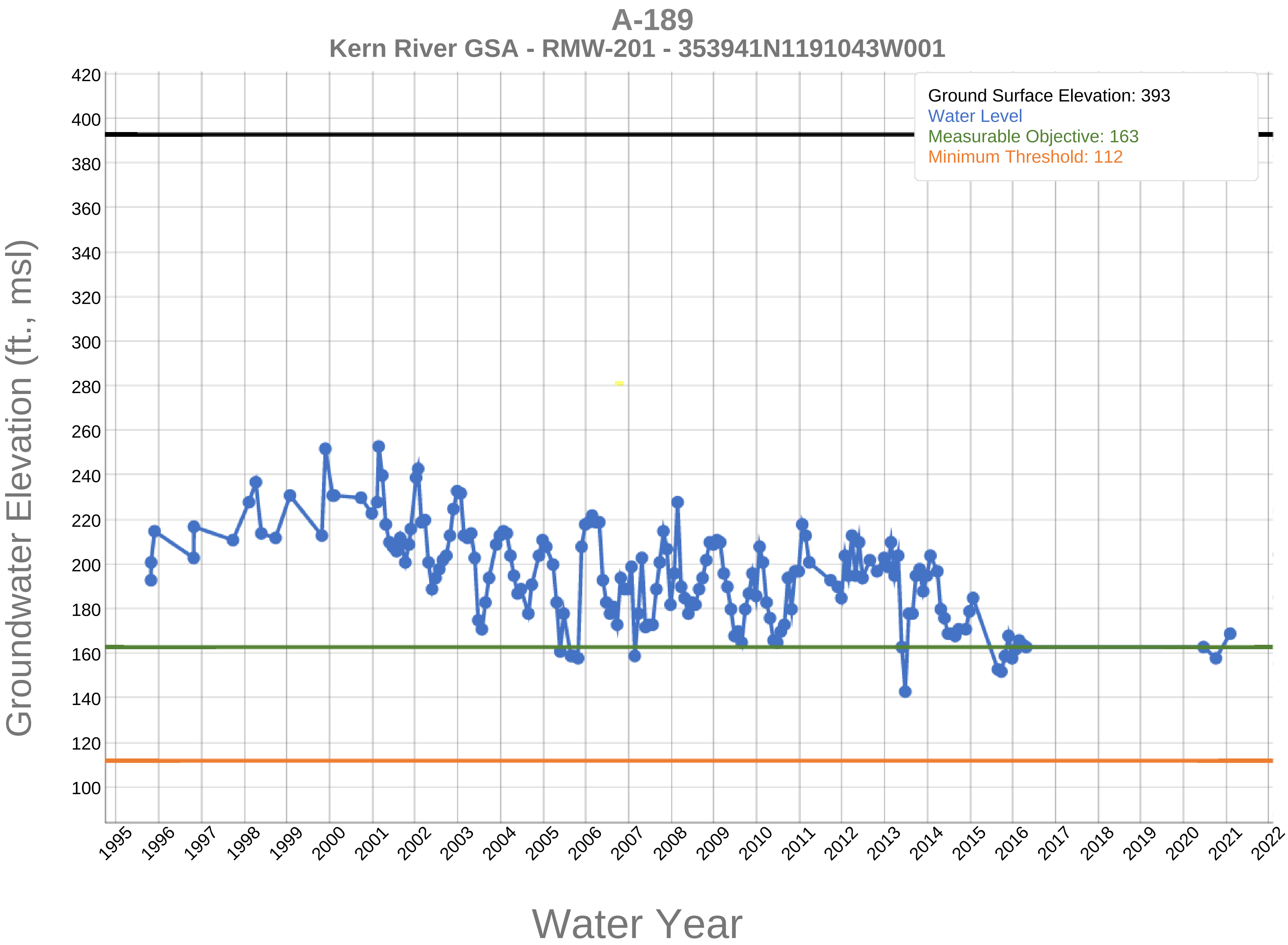
Water Year



A-189
Kern River GSA - RMW-201 - 353941N1191043W001
Ground Surface Elevation: 393
Water Level
Measurable Objective: 163
Minimum Threshold: 112
Groundwater Elevation (ft., msl)
420
400
380
360
340
320
300
280
260
240
220
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180
160
140
120
100
1995
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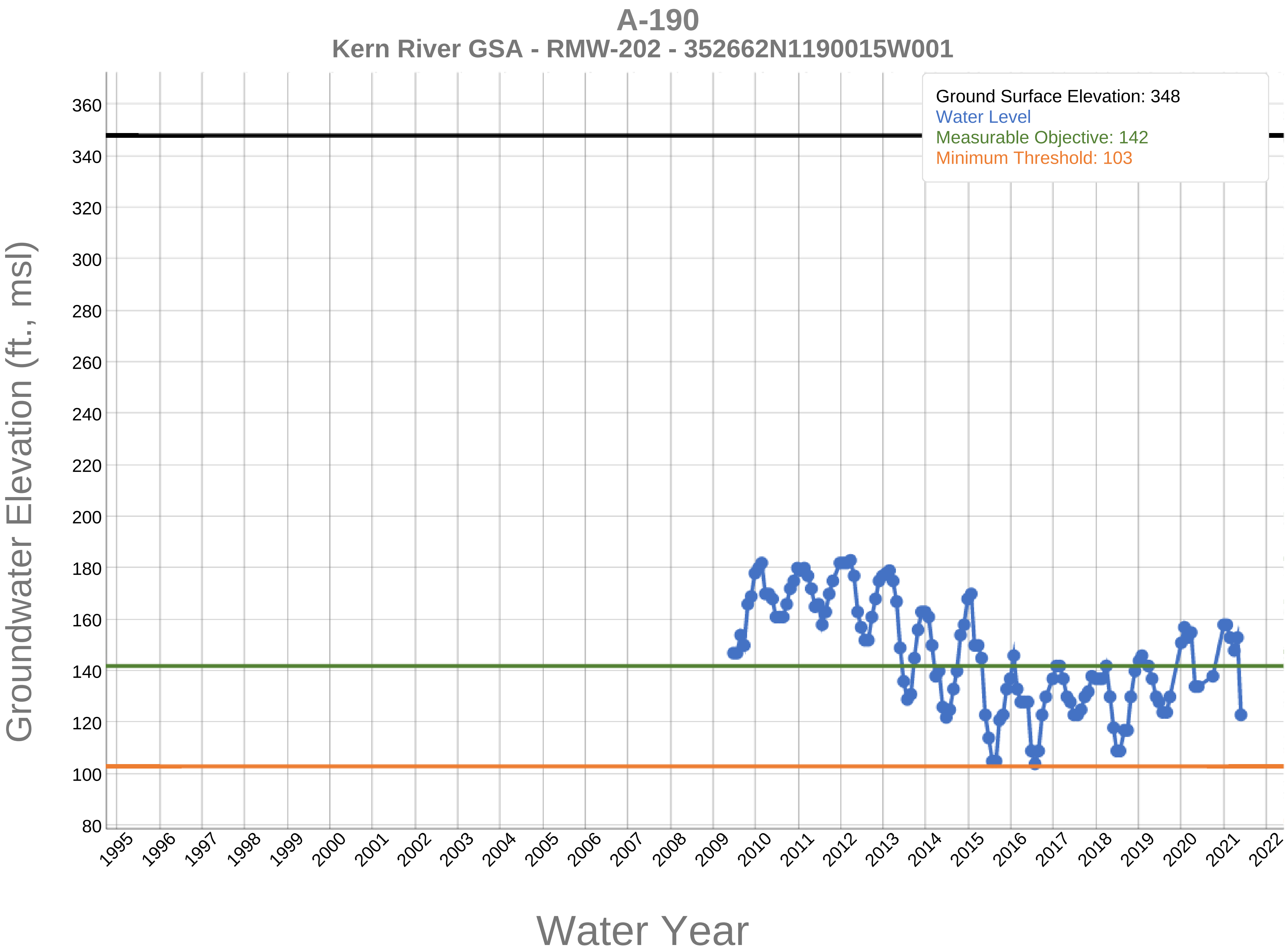
Water Year


A-190
Kern River GSA - RMW-202 - 352662N1190015W001
Ground Surface Elevation: 348
Water Level
Measurable Objective: 142
Minimum Threshold: 103
Groundwater Elevation (ft., msl)
Water Year
360
340
320
300
280
260
240
220
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140
120
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1995
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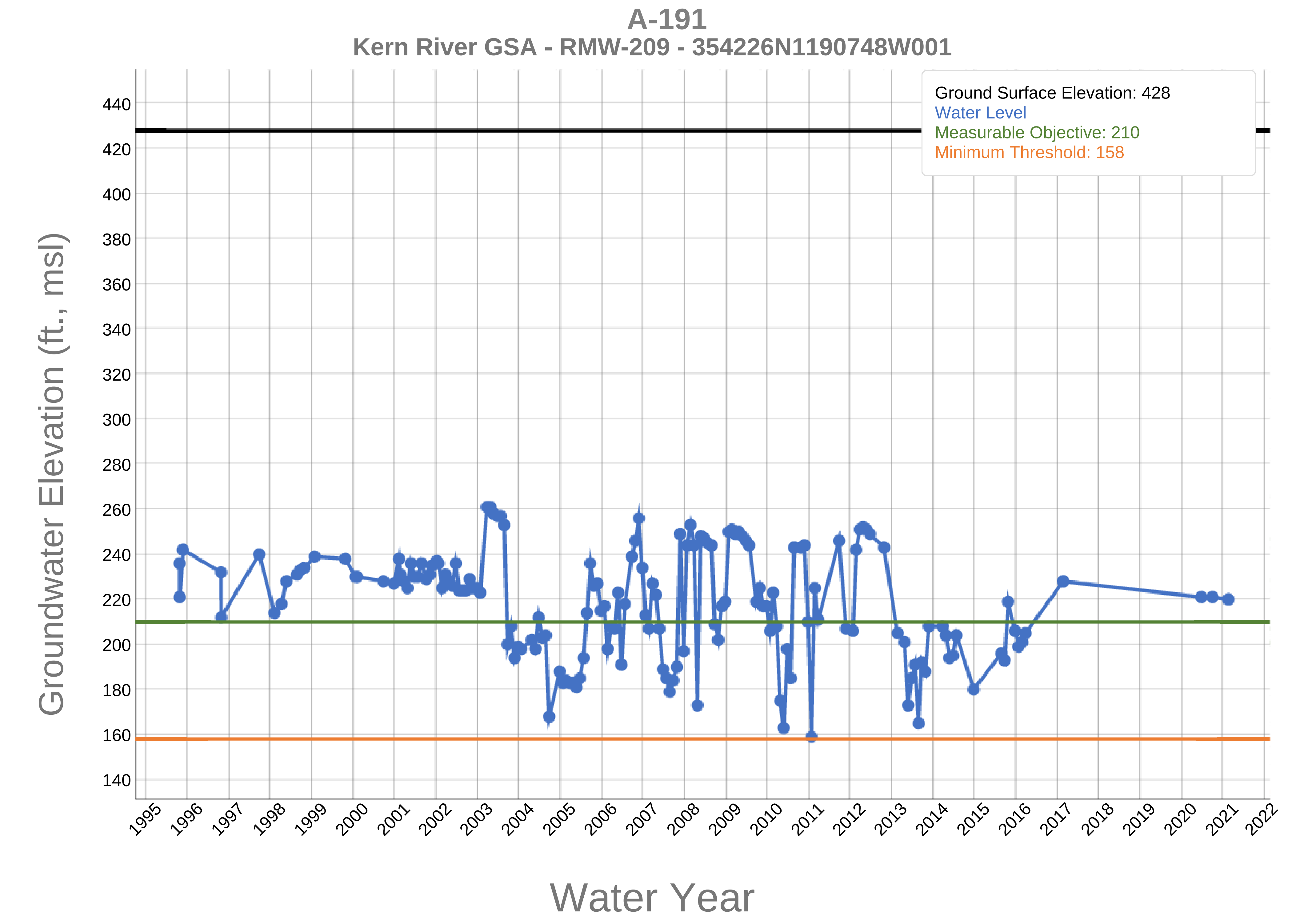

A-191
Kern River GSA - RMW-209 - 354226N1190748W001
Ground Surface Elevation: 428
Water Level
Measurable Objective: 210
Minimum Threshold: 158
Groundwater Elevation (ft., msl)
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
1995
1996
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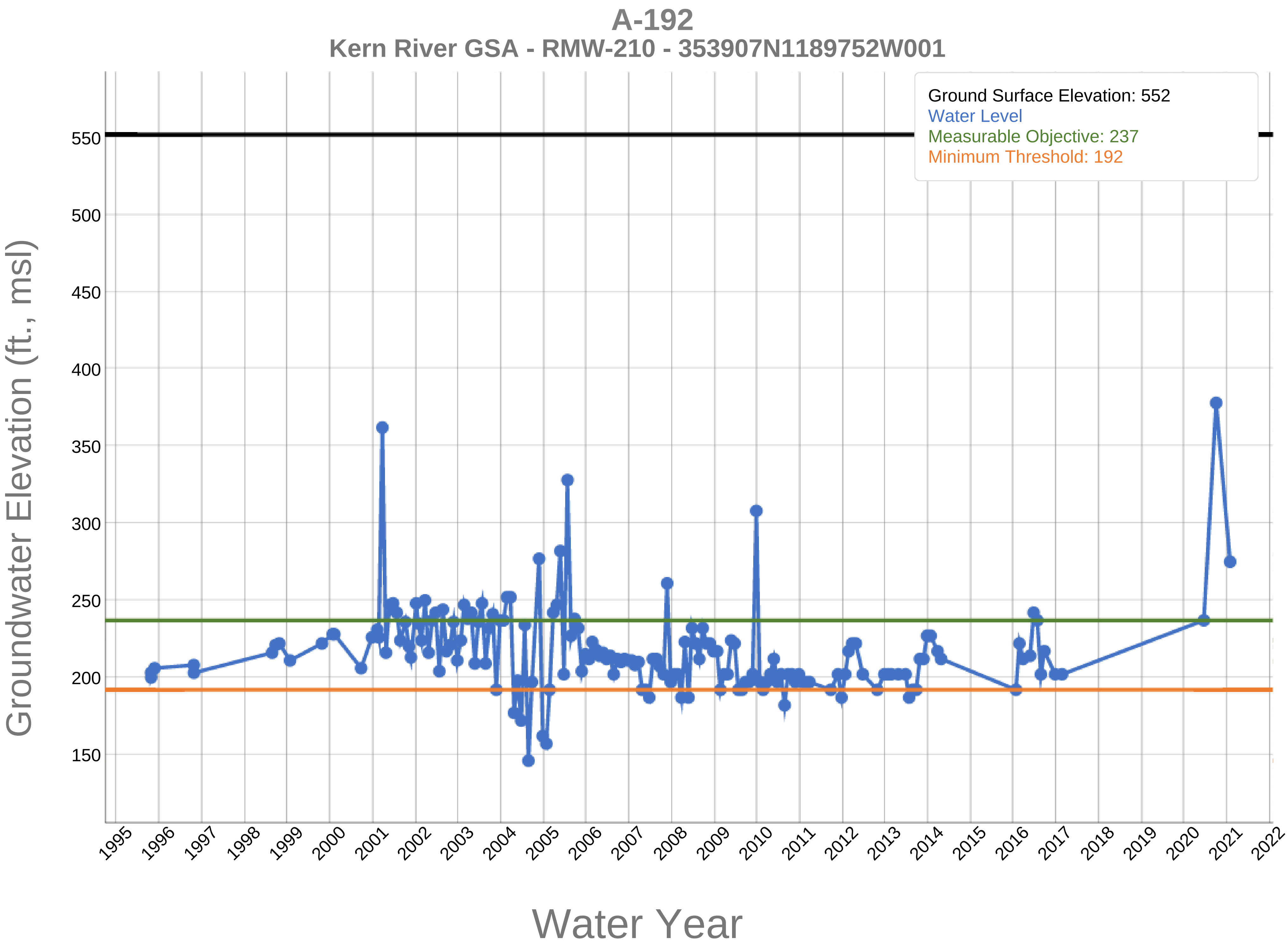
Water Year


A-192
Kern River GSA - RMW-210 - 353907N1189752W001
Ground Surface Elevation: 552
Water Level
Measurable Objective: 237
Minimum Threshold: 192
Groundwater Elevation (ft., msl)
550
500
450
400
350
300
250
200
150
1995
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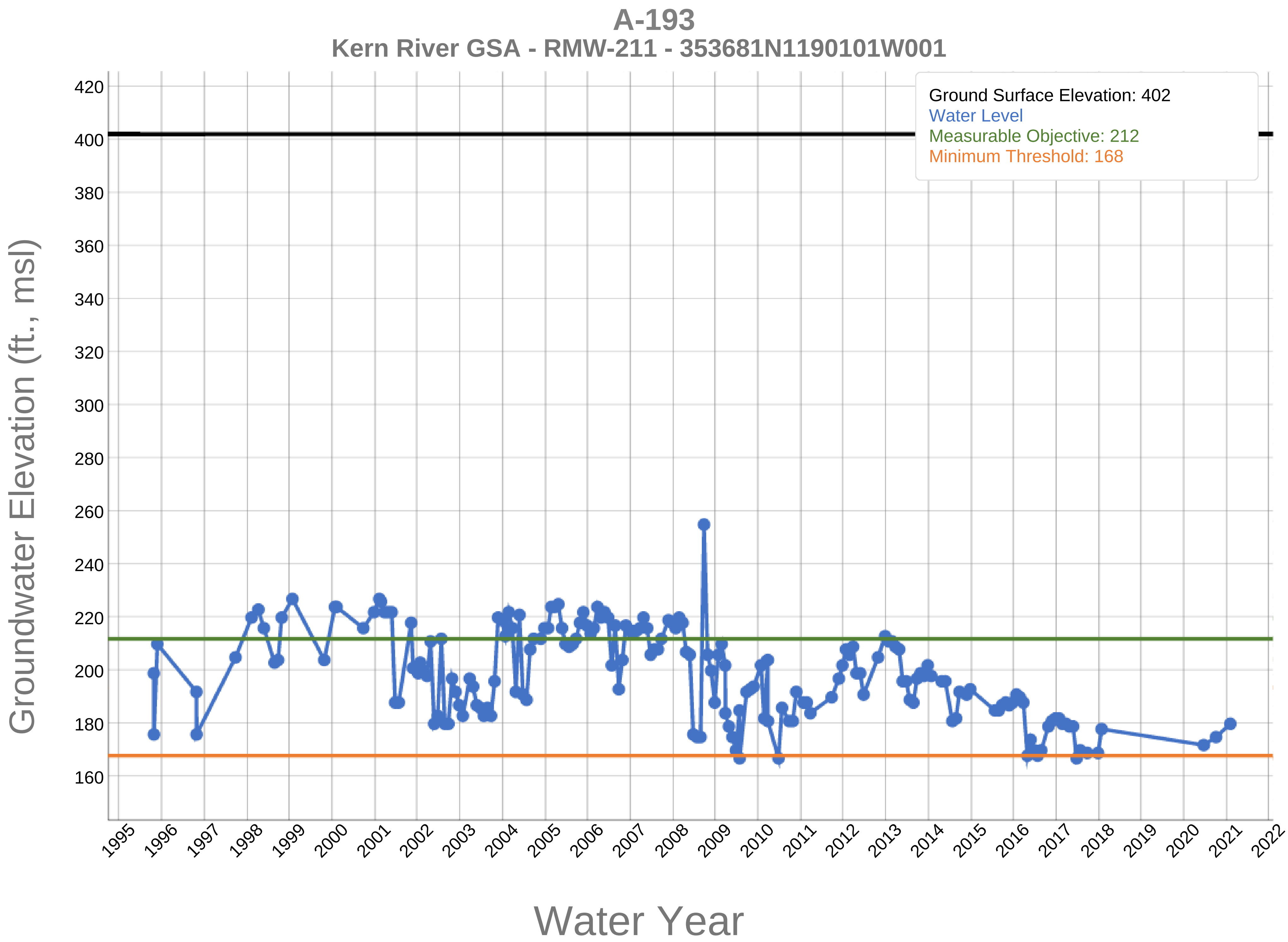
2022
Water Year


A-193
Kern River GSA - RMW-211 - 353681N1190101W001
Ground Surface Elevation: 402
Water Level
Measurable Objective: 212
Minimum Threshold: 168
Groundwater Elevation (ft., msl)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
1995
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1997
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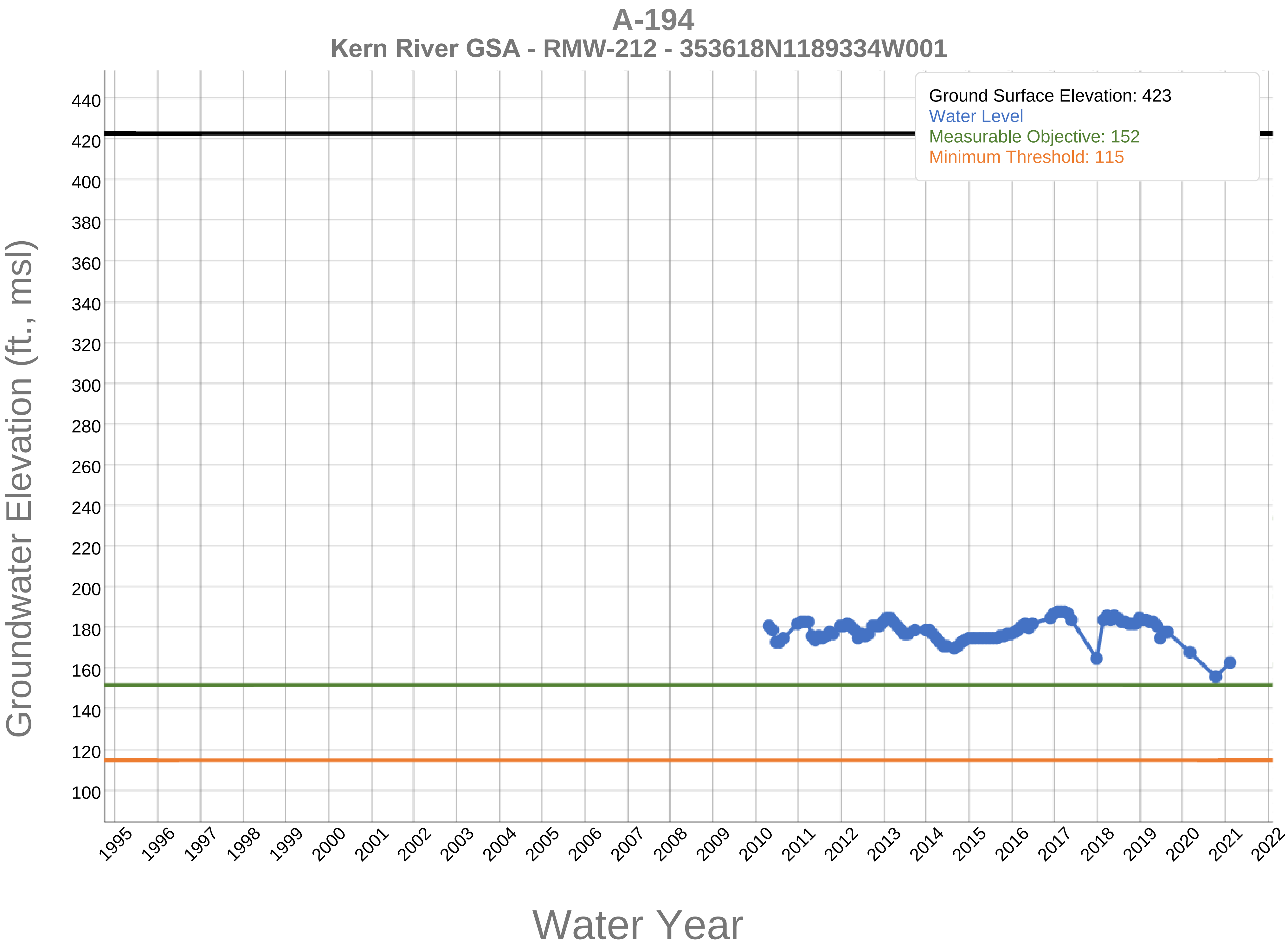
Water Year


A-194
Kern River GSA - RMW-212 - 353618N1189334W001
Ground Surface Elevation: 423
Water Level
Measurable Objective: 152
Minimum Threshold: 115
Groundwater Elevation (ft., msl)
440
420
400
380
360
340
320
300
280
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220
200
180
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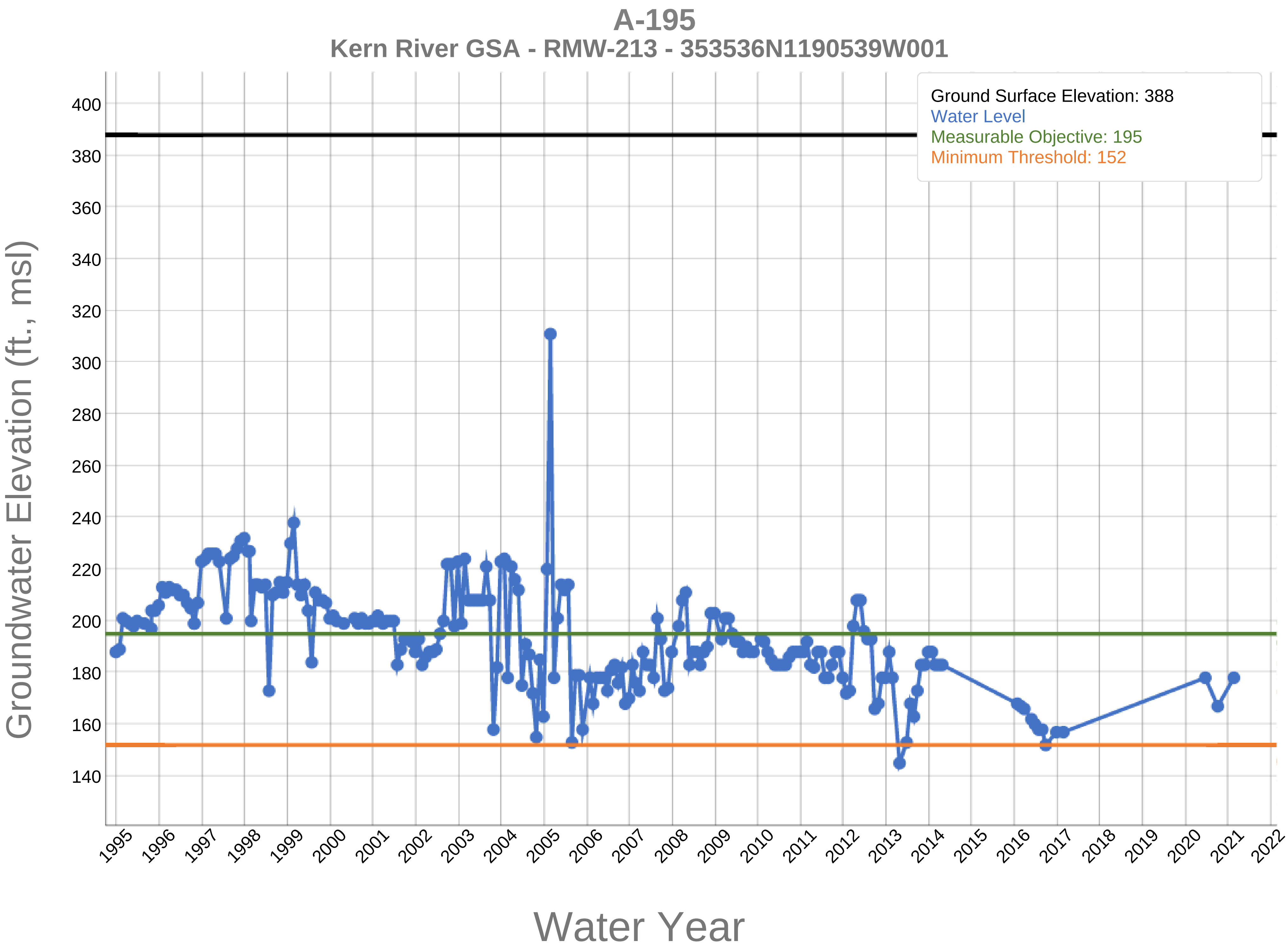
Water Year



A-195
Kern River GSA - RMW-213 - 353536N1190539W001
Ground Surface Elevation: 388
Water Level
Measurable Objective: 195
Minimum Threshold: 152
Groundwater Elevation (ft., msl)
Water Year
400
380
360
340
320
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280
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180
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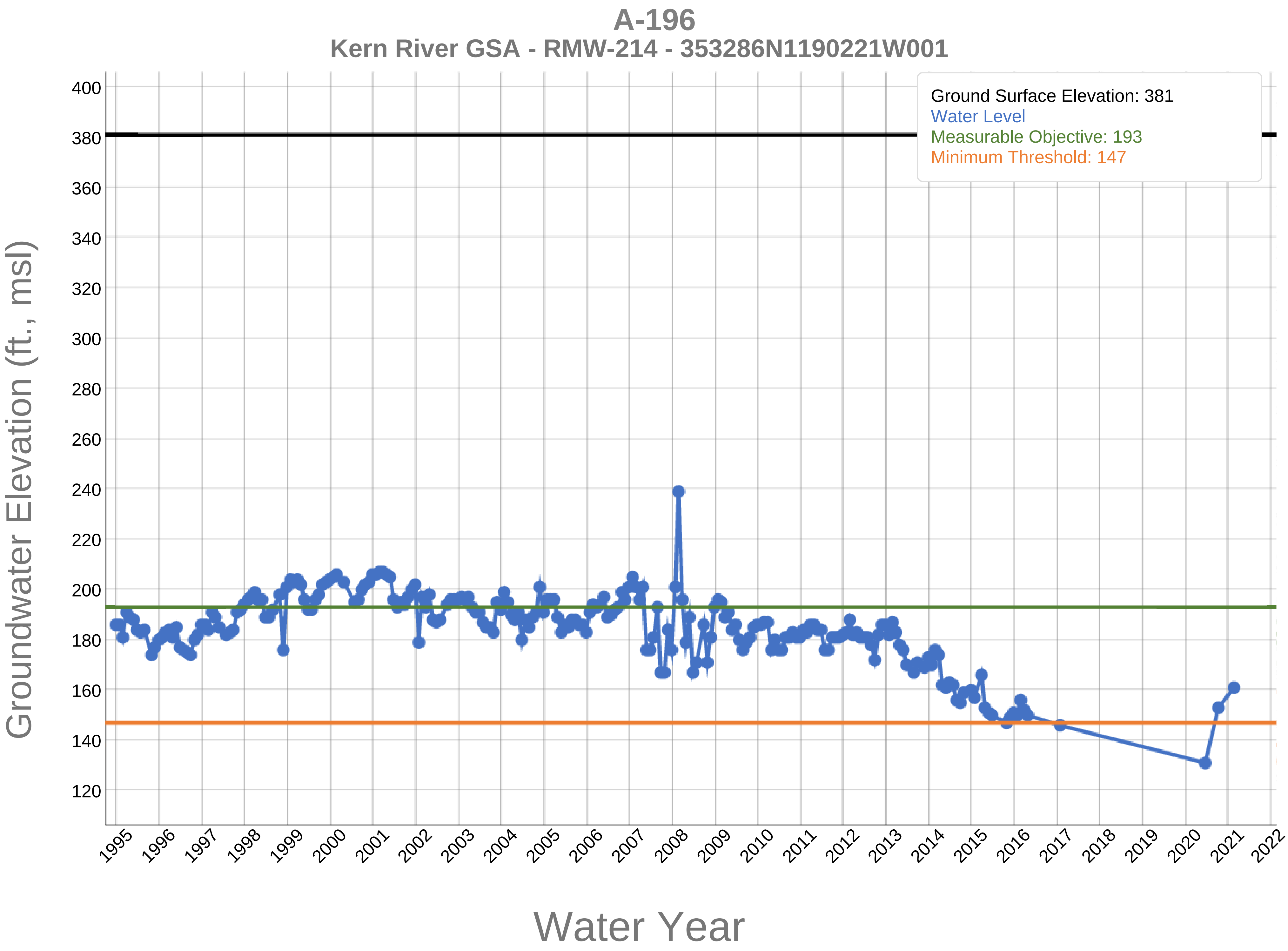

A-196
Kern River GSA - RMW-214 - 353286N1190221W001
Ground Surface Elevation: 381
Water Level
Measurable Objective: 193
Minimum Threshold: 147
Groundwater Elevation (ft., msl)
Water Year
400
380
360
340
320
300
280
260
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1995
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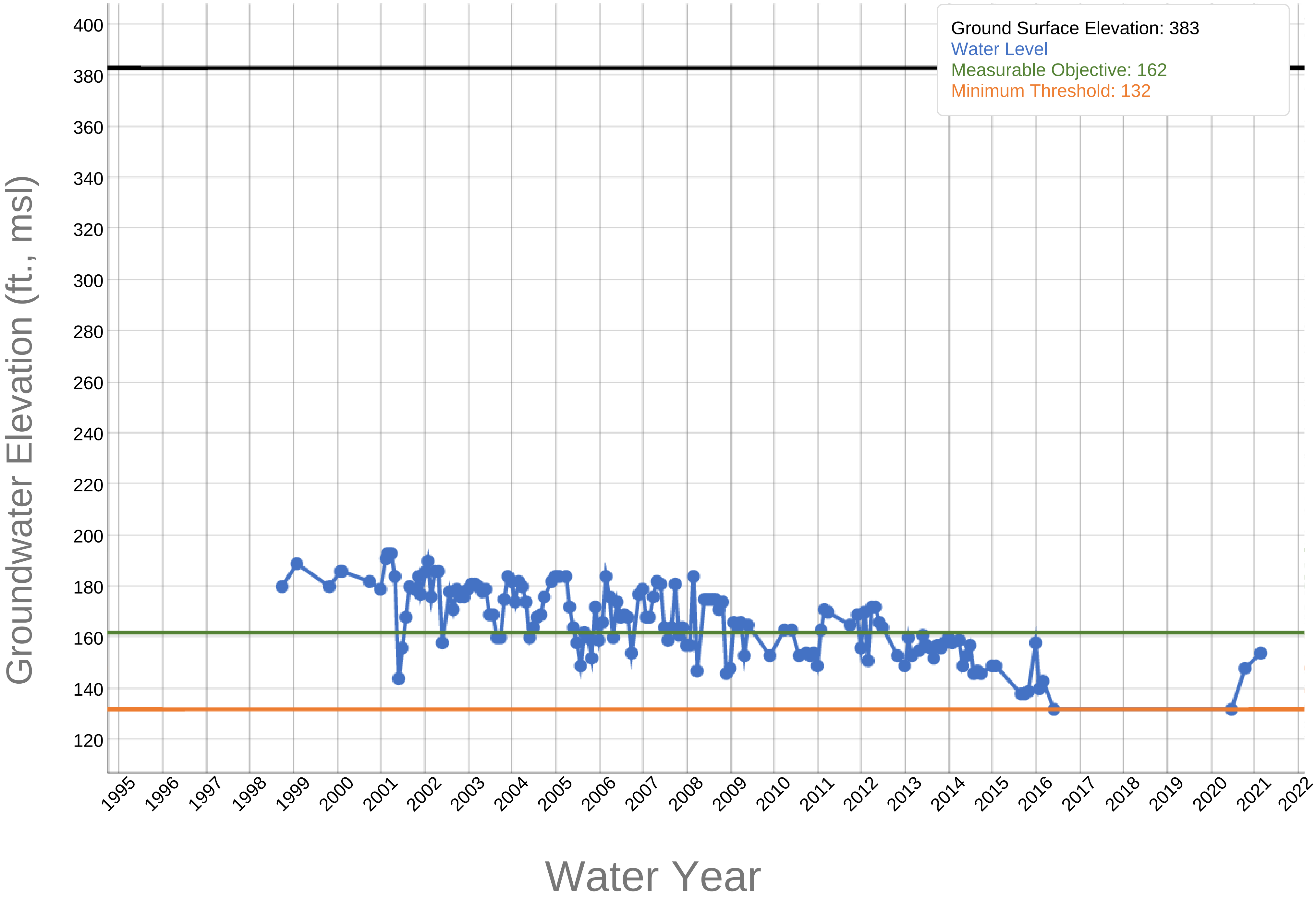
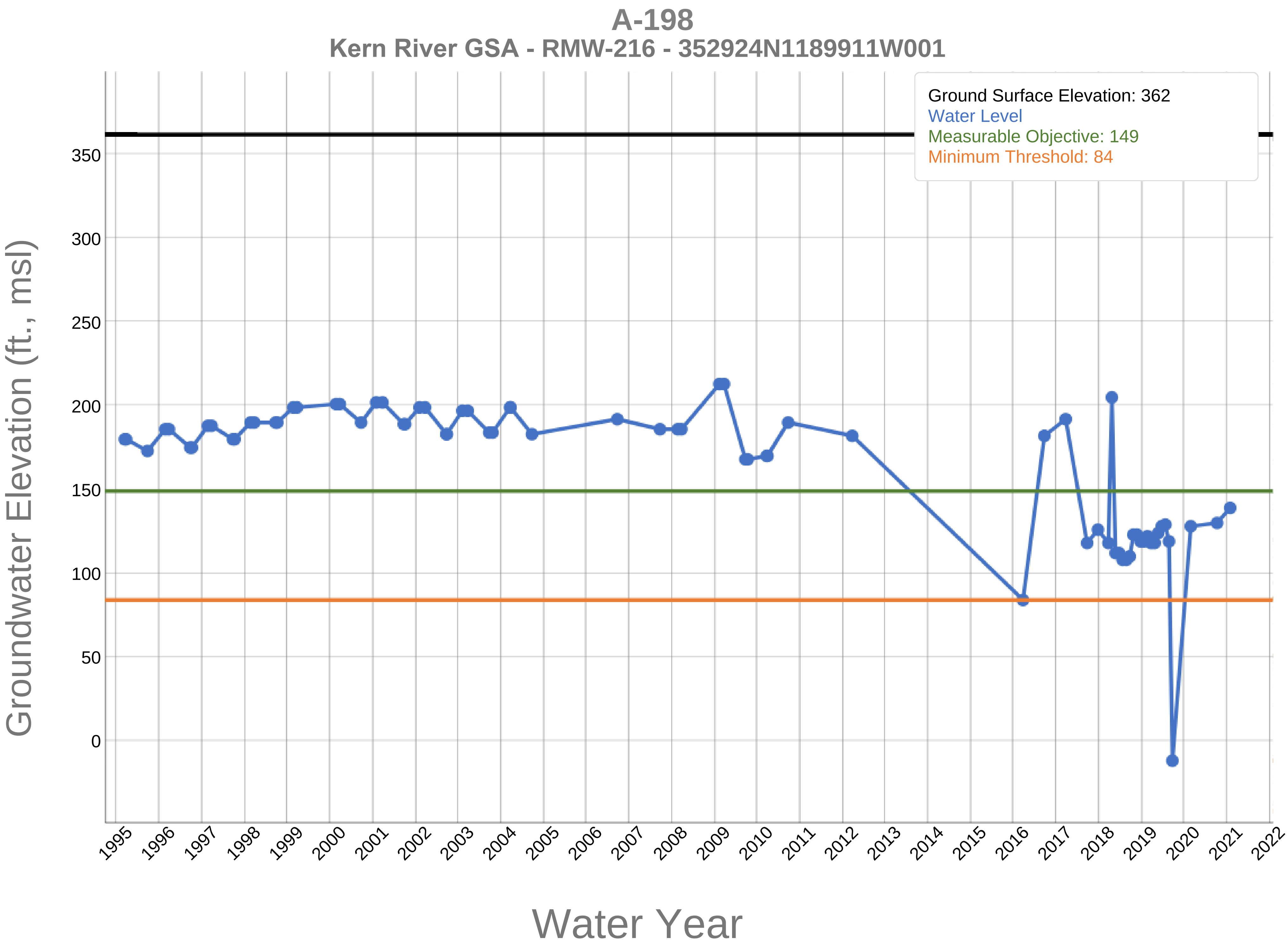
A-197

Kern River GSA - RMW-215 - 353325N1190016W001




A-198
Kern River GSA - RMW-216 - 352924N1189911W001
Ground Surface Elevation: 362
Water Level
Measurable Objective: 149
Minimum Threshold: 84
Groundwater Elevation (ft., msl)
350
300
250
200
150
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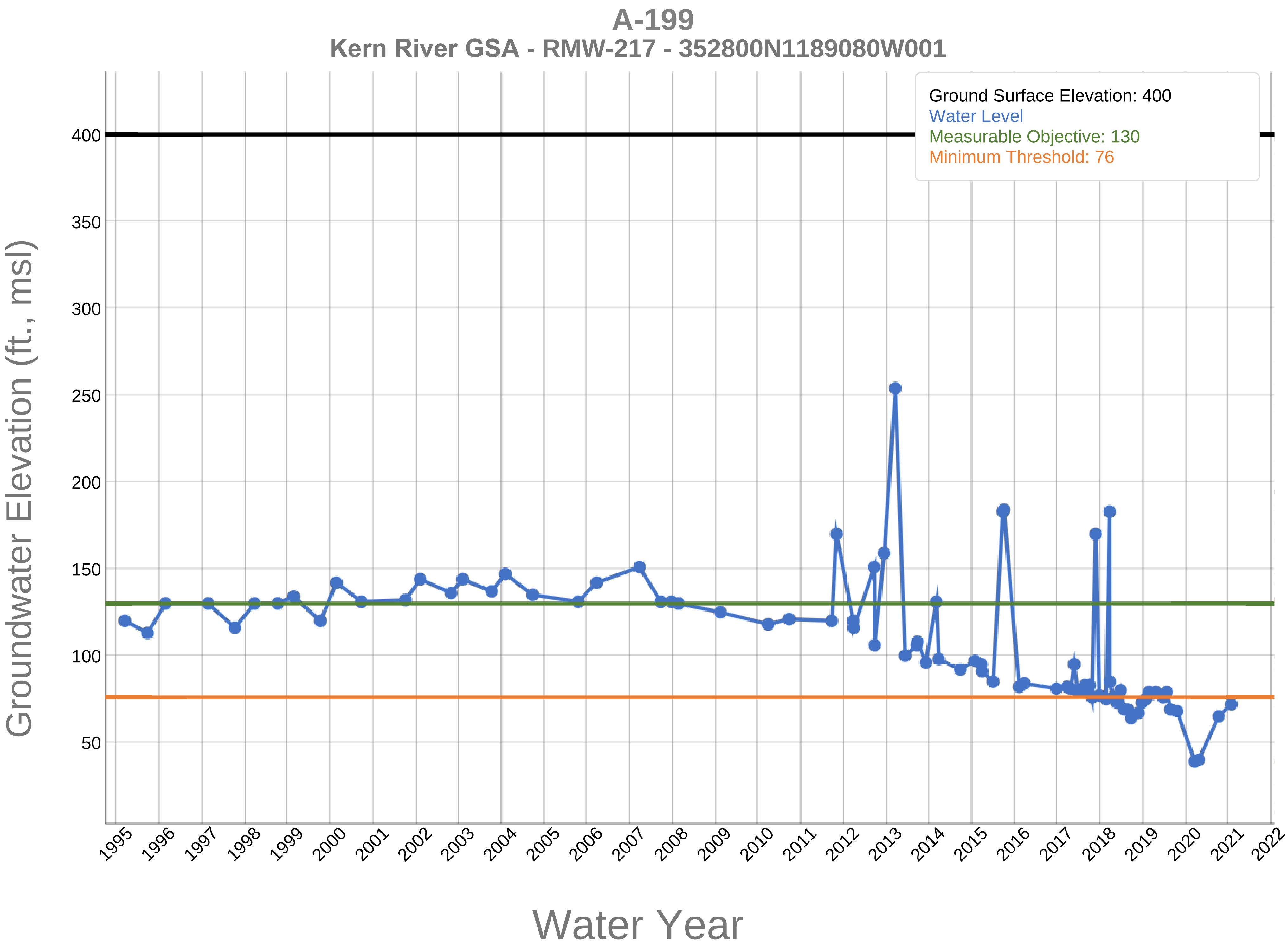
Water Year


A-199
Kern River GSA - RMW-217 - 352800N1189080W001
Ground Surface Elevation: 400
Water Level
Measurable Objective: 130
Minimum Threshold: 76
Groundwater Elevation (ft., msl)
400
350
300
250
200
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1995
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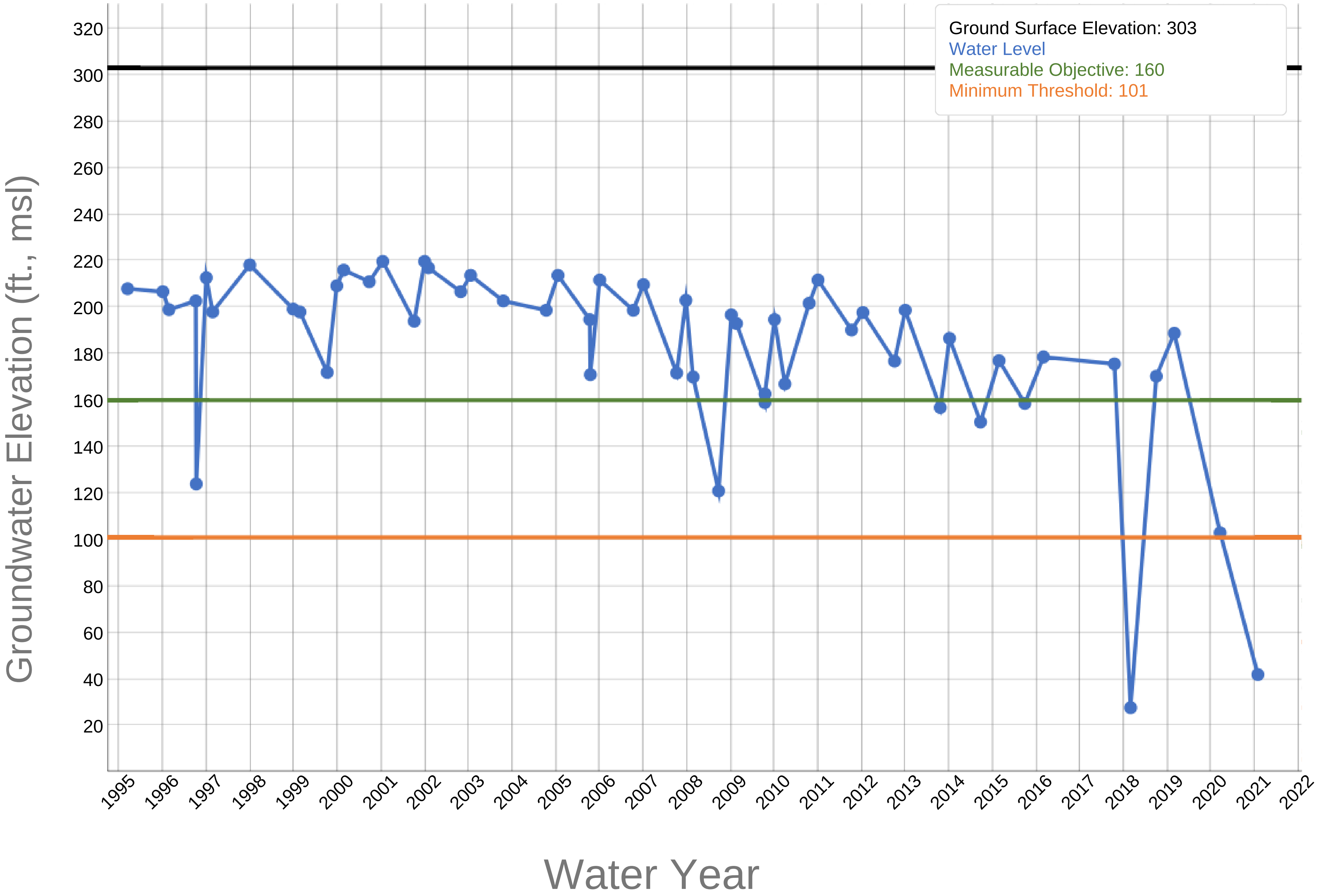
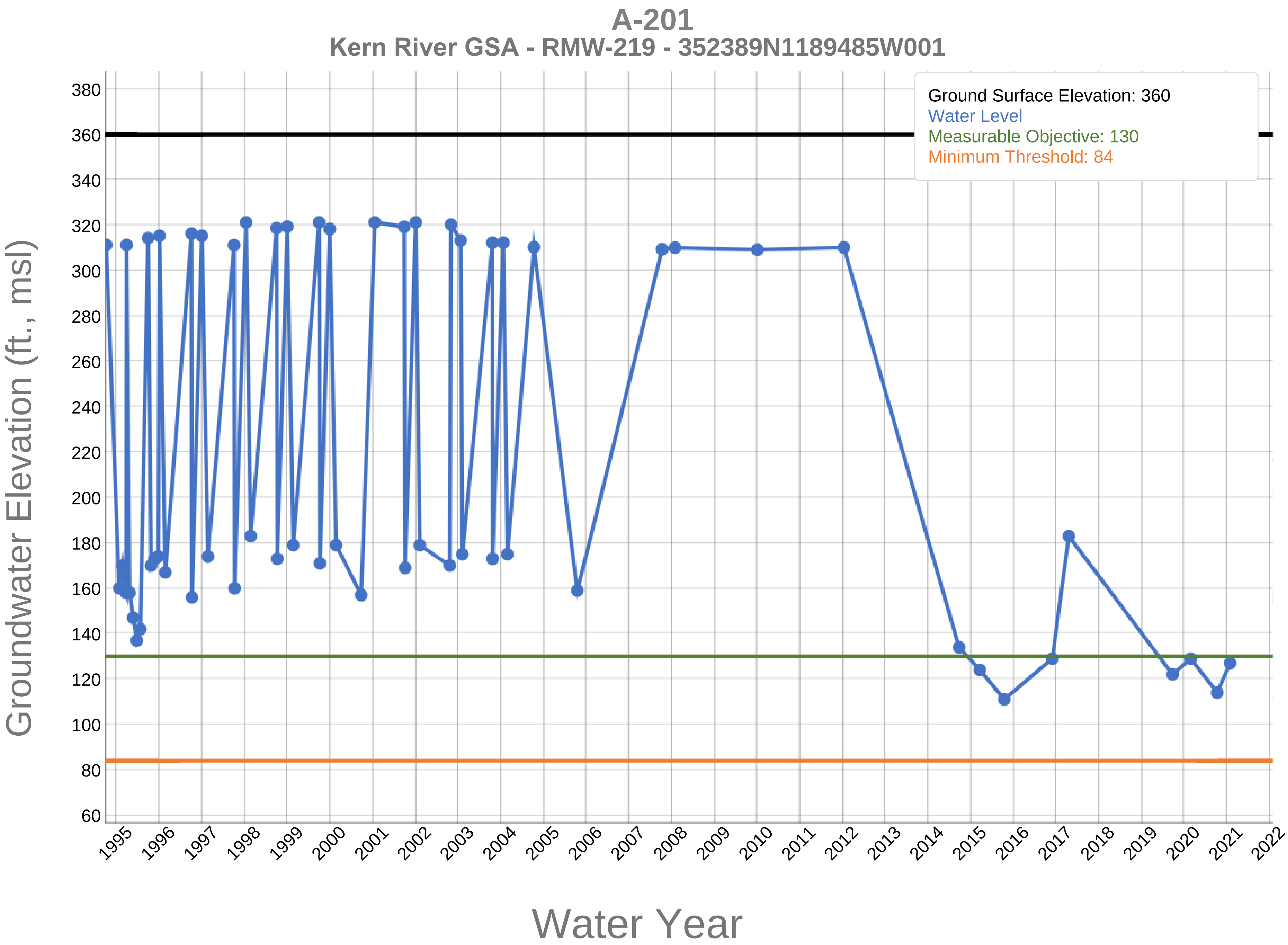
Water Year

A-200

Kern River GSA - RMW-218 - 351867N1190820W001




A-201
Kern River GSA - RMW-219 - 352389N1189485W001
Ground Surface Elevation: 360
Water Level
Measurable Objective: 130
Minimum Threshold: 84
Groundwater Elevation (ft., msl)
Water Year
380
360
340
320
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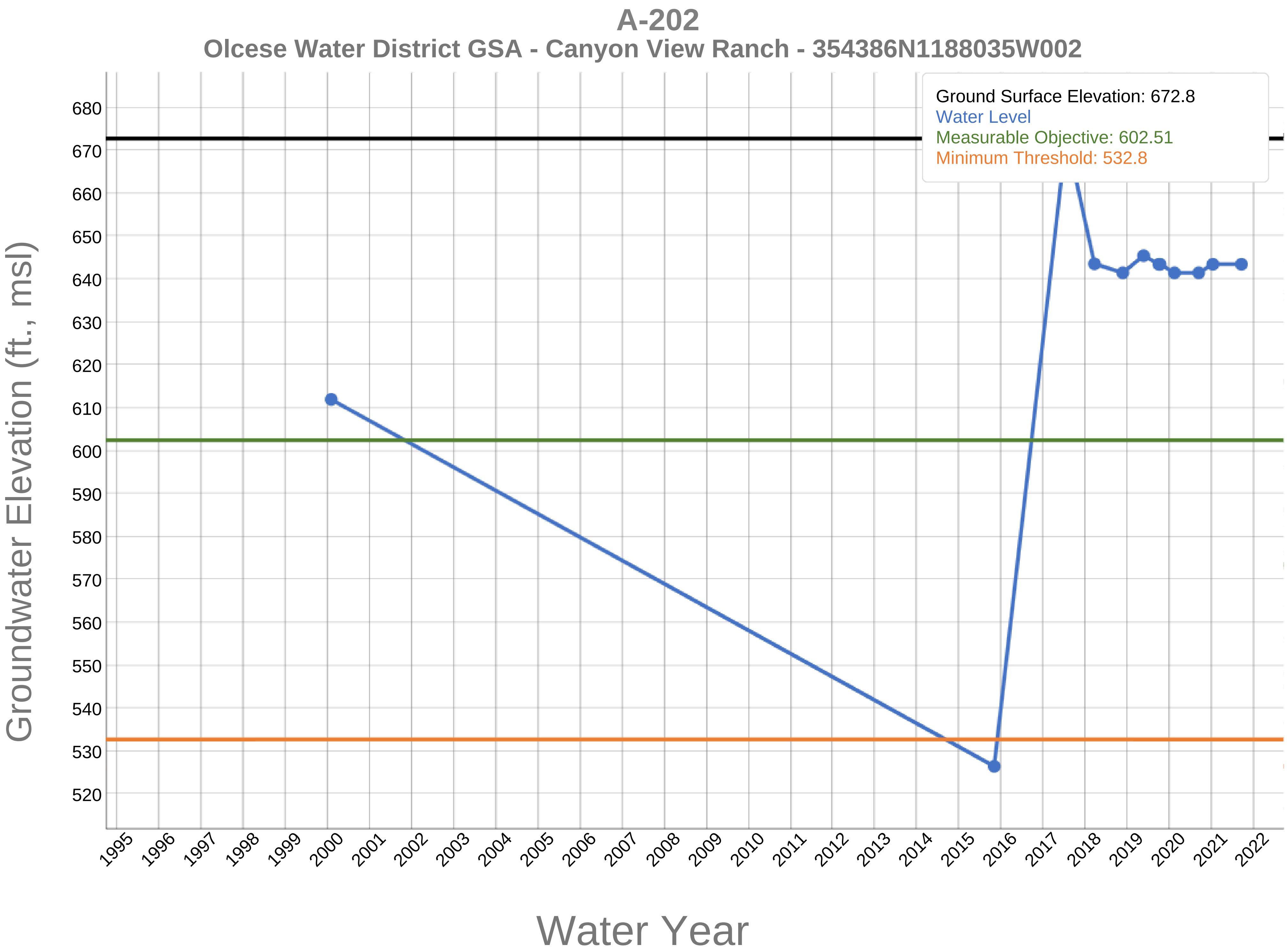
A-202
Olcese Water District GSA - Canyon View Ranch - 354386N1188035W002
Ground Surface Elevation: 672.8
Water Level
Measurable Objective: 602.51
Minimum Threshold: 532.8
Groundwater Elevation (ft., msl)
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
1995
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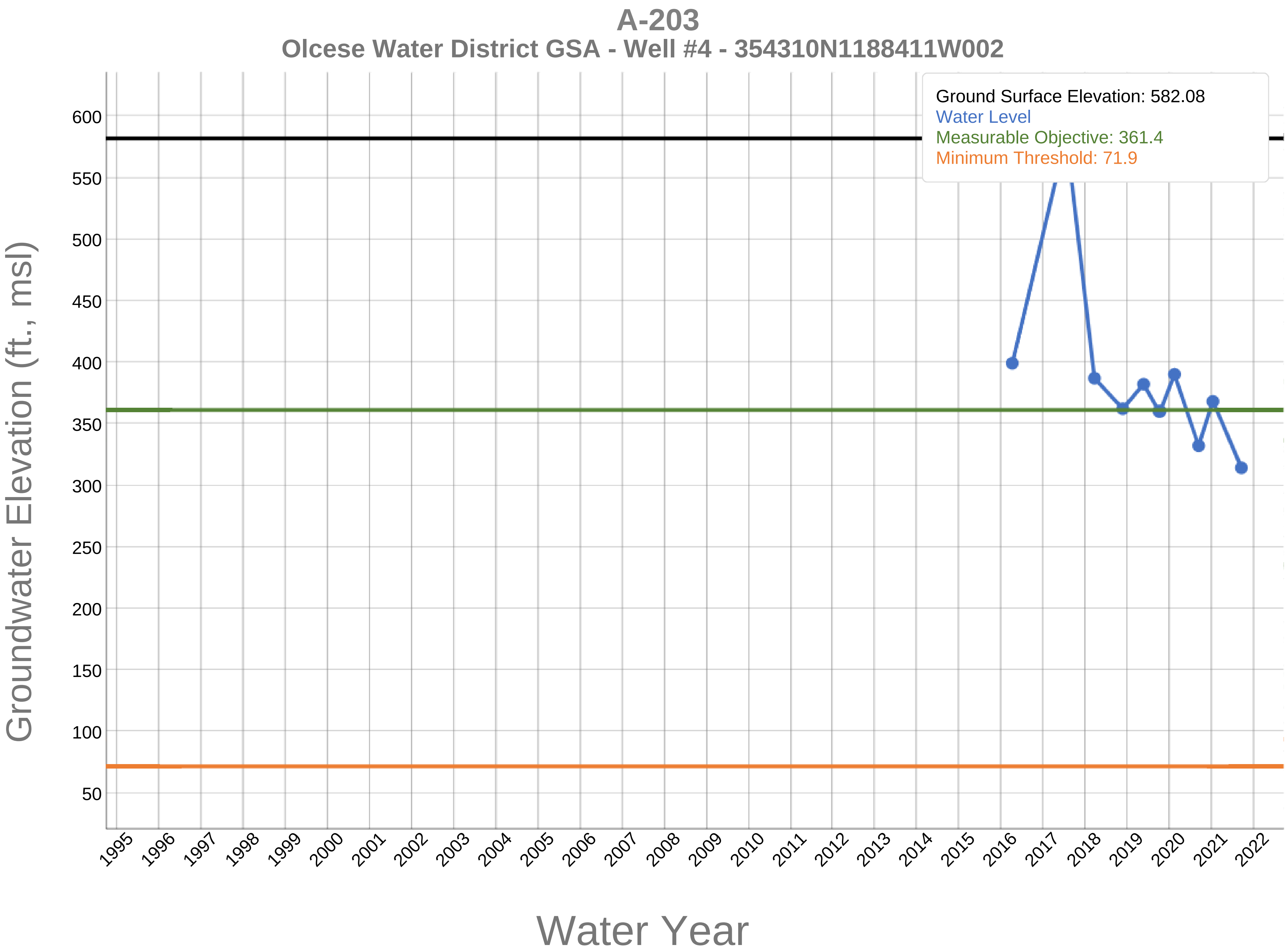
Water Year


A-203
Olcese Water District GSA - Well #4 - 354310N1188411W002
Ground Surface Elevation: 582.08
Water Level
Measurable Objective: 361.4
Minimum Threshold: 71.9
Groundwater Elevation (ft., msl)
Water Year
600
550
500
450
400
350
300
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200
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TODD GROUNDWATER