Appendix 3-A

DMS Summary

Introduction

The Tehama County Flood Control and Water Conservation District retained LSCE to provide a Data Management System (DMS). The DMS is a SGMA requirement as well as good business practice. The DMS is an asset, that like a physical asset should be maintained to properly perform. The DMS was created to manage data related to monitoring, analysis, and reporting on groundwater conditions and related information and meet the requirements of the GSP Regulations, including § 352.4, § 352.6, and § 354.4. GSP Regulations state that "Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin."

The Tehama County DMS has five key attributes:

1) Flexibility for importing data from various software platforms and systems,
2) Sufficient capacity to store existing (qualified) historical data and additional future data,
3) Ability to export data to numerous software formats (i.e., ESRI, Tableau),
4) Capability to grow and evolve as part of a larger DMS in the future, and
5) Capability to provide an interactive graphical platform.

This DMS incorporates both the database (data stored within related digital tables) for data storage accompanied by an interface to manipulate, query, and manage that data. Web components can be coupled with this system to allow for online viewing of data in the form of maps and graphs. The DMS has functionality to enable importing of data from and exporting data to other commercially available software programs for data visualization or to an enterprise level database for multi-user needs or both. This DMS consists of a Microsoft database, and visualization is possible with an ESRI webhosted map and webhosted Tableau graphics. The Tehama County DMS User Manual provides additional information about the DMS structure, data import and export procedures, quality control processes, and data analysis queries.

Data Types and GSP Indicators

Public agencies collect and maintain data applicable to GSP development and implementation, including DWR, United States Geological Survey (USGS), State Water Resources Control Board (SWRCB) comprising data from GeoTracker, GAMA, and Division of Drinking Water (DDW), NASA Jet Propulsion Laboratory (JPL), and National Oceanic and Atmospheric Administration (NOAA). The Tehama County Flood Control and Conservation District also conducts groundwater monitoring. These monitoring programs and available data are continually evolving to expand and merge to create a more useful and powerful network of information. Data collection methods and sources will likely change in the future.

The DMS contains a variety of data types, including well location and construction details, groundwater level and quality, land subsidence elevation, stream flow, and septic and well permits. The table below identifies the five applicable sustainability indicators and data maintained in the DMS for monitoring each.

Table 1. Sustainability Indicators and Applicable Monitoring Data

Sustainability Indicator	Ground-water Levels	Ground-water Quality	InSAR Subsidence	Stream Stage and Flow
Chronic Lowering of Groundwater Levels	✓			
Reduction of Groundwater Storage	✓			
Degraded Water Quality		✓		
Land Subsidence			✓	
Depletion of Interconnected Surface Water	✓			✓

DMS Database Structure

The database has a similar structure to common datasets developed by the USGS, SWRCB, and DWR. All data in the DMS are identified by data source. Each site or station is uniquely identified by a Site ID depending on the data source the Site ID could be the State Well Number (SWN), Station ID, or site-specific name. To ensure user flexibility, the DMS was designed using the Microsoft Access 2007-2016 software platform and the *.accdb* database format. The figure below illustrates different relationships that exist in the database. There are three main tables, several smaller tables, and many "lookup tables." The three main tables are:
T_Well = well information
T_WL = water level information related to wells
T_WQ = water level information related to wells

While the Tehama County Flood Control and Conservation District GSA values transparency, several components of the DMS contain confidential information and such information will not be made publicly available. Well owner and contact information, certain well construction information and permit information will be treated in a confidential manner. Other types of information may also be considered confidential and access to such information will be restricted accordingly. Content of the DMS (structure, data, queries, and relationships between tables) is expected to evolve over time to increase the utility and functionality of the DMS.

Table Relationships, part one of two

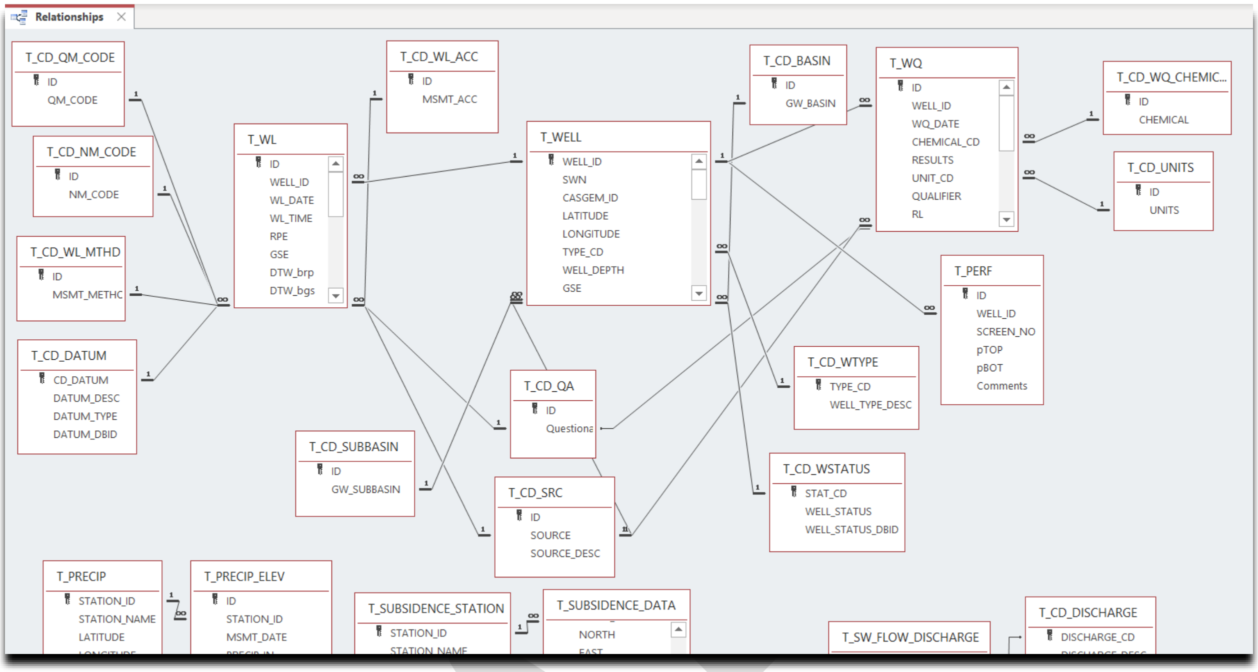
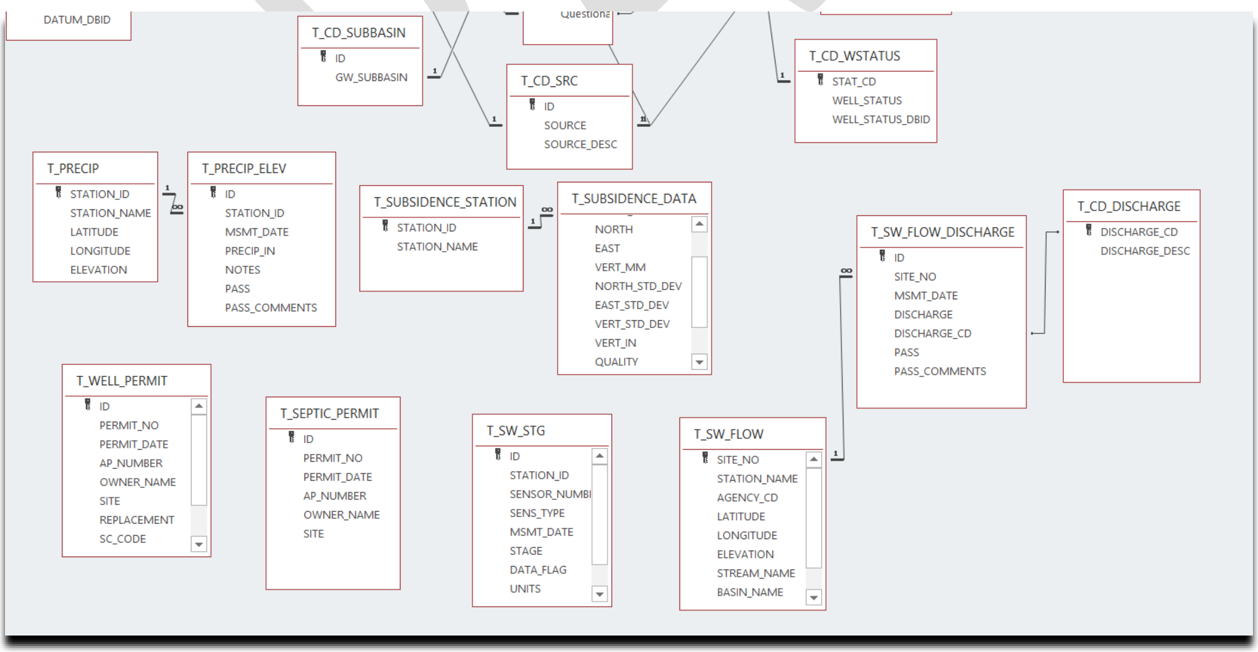


Table Relationships, part two of two



Database Schema and Data Fields

Proper creation of tables and table relationships, also known as schema, will avoid errors in query results and improve database efficiency. All tables in the DMS have a unique primary key (a special key (field) used to uniquely identify records) that serves as the common link between tables. The primary key maintains structural integrity of the relational database, prohibits duplicate entries in a field that requires unique information, and it is a useful field for linking tables with a defined relationship. Tables may also have foreign keys (a key or field used to establish a relationship between two tables) to help association with other tables and their fields. The process of creating proper table construction and relationship definitions makes inconsistent data more obvious and helps with quality control. All tables are normalized to at least the 3rd normal form. Normalization is a database design technique, to modify existing tables and their schema to minimize data redundancy and dependency.

Data standardization is important to avoid mixing definitions, units or other references that make data non-equivalent. Examples include elevation data that is referenced by a datum. There are generally two different vertical datums commonly used in reporting elevations: NGVD29 and NAVD88. NGVD29 is the older vertical datum that is referenced on USGS Quadrangles, and in California it is basically equivalent to mean sea level. Equating the NAVD88 datum to the NGVD29 datum varies by location. The datum in this DMS is all NAVD88. Water quality parameters are also standardized for example nitrate as nitrogen versus nitrate as nitrate, and should have consistent concentration units (e.g., mg/l, ug/l).

Use of List of Values tables. These can help in data standardization and keep track of the allowable values for each table filed (column). These can be referenced by other data tables. For example, T_LOV_WQ_AN which contains list of analytes. These are "lookup tables."

T_LOV_WQ_AN		
T_WQ_AN_DBID	WQ_AN_CD	AN_DESC
2	Cl	Chloride mg/L
3	EC	Electrical Conductivity umhos/cm
4	Perc	Perchlorate ug/L
1	TDS	Total Dissolved Solids mg/L

The well site is uniquely identified by a "Well ID", usually corresponding to the DWR-assigned State Well Number (SWN), USGS Site ID, or local Source Name. It is important to ensure this field is unique as State Well Numbers are not the unique identification that they were intended to be.

Quality Assurance and Quality Control

The DMS users should follow quality assurance and quality control processes to identify inconsistencies with data and common problems that occur through data entry. The most important component of quality control in the DMS is the preparation and review of data before entry in the DMS. These data are technical and should be scrutinized for inconsistencies and completely described before data entry. Tools have been established in the DMS for troubleshooting and error checking. Automatic reports (described in the user manual) have been constructed for presenting data in graphical and tabular format. These reports can be reviewed by a technical person with a conceptual understanding of the data to identify any questionable data or functional problems of the DMS (should they arise).

Additional quality assurance and quality control queries have been established to identify conflicting or inconsistent records or information (e.g., inconsistent units of measure for a water quality parameter, multiple reference point elevations for a well or groundwater pumping during water level collection). Despite efforts to minimize inaccurate data in the DMS inaccurate data does exists and is corrected on an ongoing basis.

It is important to remove redundancy in data. This can occur when two sources of information provide identical or similar data for the same well. The well records with redundant data need to be identified and flagged. Then the duplicated data (water level/quality entry) need to be examined and appropriate steps taken to remove the redundancy. One well ID should be used for each physical well. Nested wells (multiple wells within the same casing) should be uniquely identified.

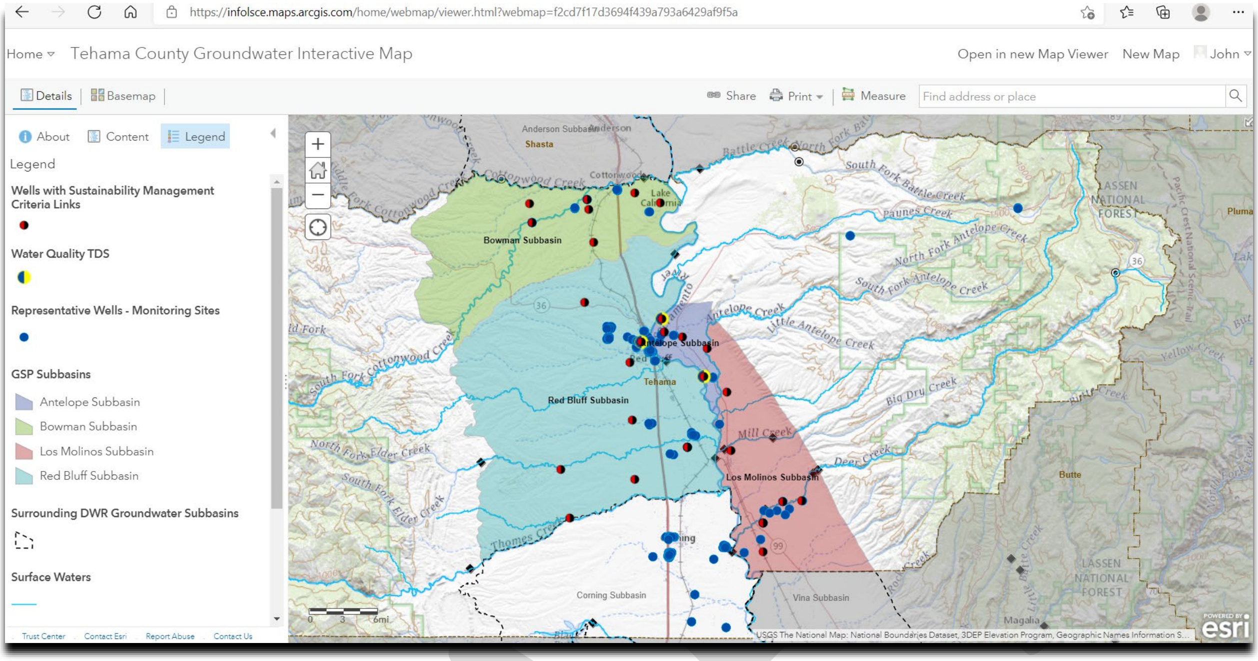
Groundwater level data may contain measuring point discrepancies and/or changes over time. These differences may arise when a well gets modified, re-surveyed or the measuring point changes. There might also be errors in the reference point elevations, in which case the reporting agency should be notified to resolve the error. Other differences in reference point elevations should be considered when making interpretations of water level changes and should, therefore, be rectified. Differences in elevation datum (between the older NGVD29 and more recent NAVD88) should be carefully observed and considered in order to interpret groundwater elevations. Lastly, significant subsidence over time may make the reference point elevation no longer representative.

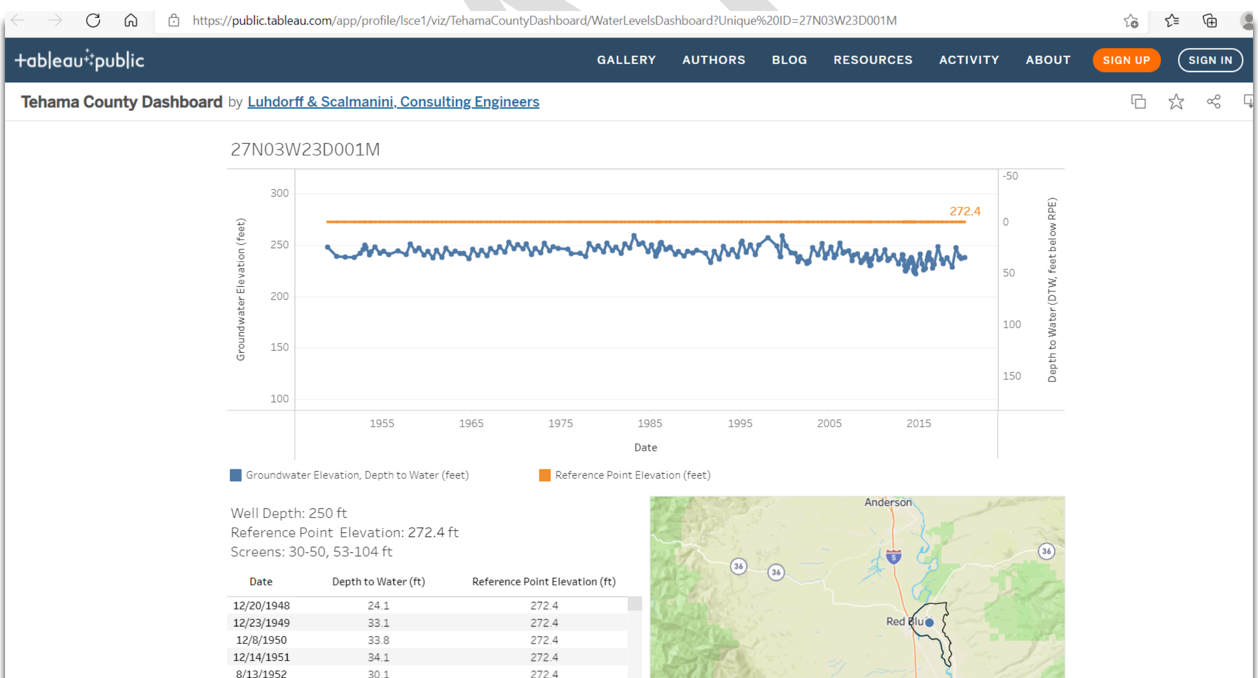
Numeric entries, such as *Depth to Water* field and *water quality value fields* should contain only numeric values. No text, spacing, or punctuation is allowed in numeric data. Data in fields should be consistent and logical. The use of numerical flags, like 999 or -9999 should be avoided as a separate field can perform this function. Also, these comment type numbers can bias mathematical functions, like mean or median. The correct data type and field standards for each table in the DMS are maintained in an Excel spreadsheet and are listed below.

Online Visualization

The data within the database is also presented in front-end software, an interactive ESRI web interface, and graphically in Tableau. Both programs allow users to view and interact with data from a DMS without specific knowledge of DMS software and structure. Below is a figure illustrating an example of an interactive web map in which, after clicking on a site location, site information is presented such as groundwater levels or water sample results for Total Dissolved Solids.

Interactive ESRI Map and Tableau Graph Examples





Reporting

DWR Submittals

Data submittals to DWR, as part of regular reporting, will include data contained in the DMS and be contained in forms (Excel files) provided by DWR through the SGMA Portal[1]. The DMS has the capability to conduct queries for extracting the appropriate reporting data in a format compatible for submittal in accordance with DWR reporting requirements.

Annual CASGEM Reporting

After the submittal of the GSP, the Subbasin will no longer need to update the CASGEM site with data and will instead report groundwater level monitoring data for Representative Monitoring Sites through uploads to the SGMA Monitoring Network Module[2].

GSP Annual Report

GSP Regulation §356.2 requires GSAs to submit GSP annual reports covering the previous water year (October 1 to September 30) every April 1 after submitting the GSP. GSP Regulations require that GSP annual reports include the following content:

- Executive Summary and location map §356.2(a).
- Groundwater elevation data, including groundwater contours and hydrographs for each principal aquifer §356.2(b).
- Total water use including groundwater extraction (general location and volume) for the preceding water year and surface water supply used or available for use (including the volume and sources) for the preceding water year §356.2(b).
- Change in groundwater storage for each principal aquifer §356.2(b).
- A graph illustrating cumulative change in groundwater storage, water year type, annual change in groundwater storage §356.2(b).
- Progress on Plan Implementation including achieving interim milestones, and implementation of projects and management actions §356.2(c).

There is no required template for GSP annual reports, although DWR provides a spreadsheet-based template, that it refers to as an elements guide, intended to accompany each annual report and provide a cross-reference between the content required by the GSP Regulations and the location of the required content in that annual report. Additionally, DWR has released spreadsheet-based templates to use for submitting and uploading data on groundwater extraction, groundwater extraction methods, surface water supply, and total water use required as part of GSP annual reports.

[1] https://sgma.water.ca.gov/portal/
[2] https://sgma.water.ca.gov/SgmaWell/

GSP Five-Year Report

SGMA and the GSP Regulations require GSAs in medium-priority and high-priority basins to conduct a periodic review and assessment of GSPs at least every five years and whenever a GSP is amended. The Five-Year Report will be due by April 1 of every fifth year starting in 2027. The Five-Year Report includes a more comprehensive evaluation compared to the annual report and it will include elements of the annual reports, GSP implementation progress, and progress toward meeting the Subbasin sustainability goal. DWR has not yet released any guidance documents related to the preparation of the GSP Five-Year Report. The content of the Five-Year Report will follow any forthcoming guidance documentation or template provided by DWR.

Appendix 3-B

MOs and MTs for Groundwater Levels

Appendix 3B

Groundwater Level Hydrographs, Measurable Objectives (MO) and Minimum Thresholds (MT) of Groundwater Level Sustainability Indicator Wells

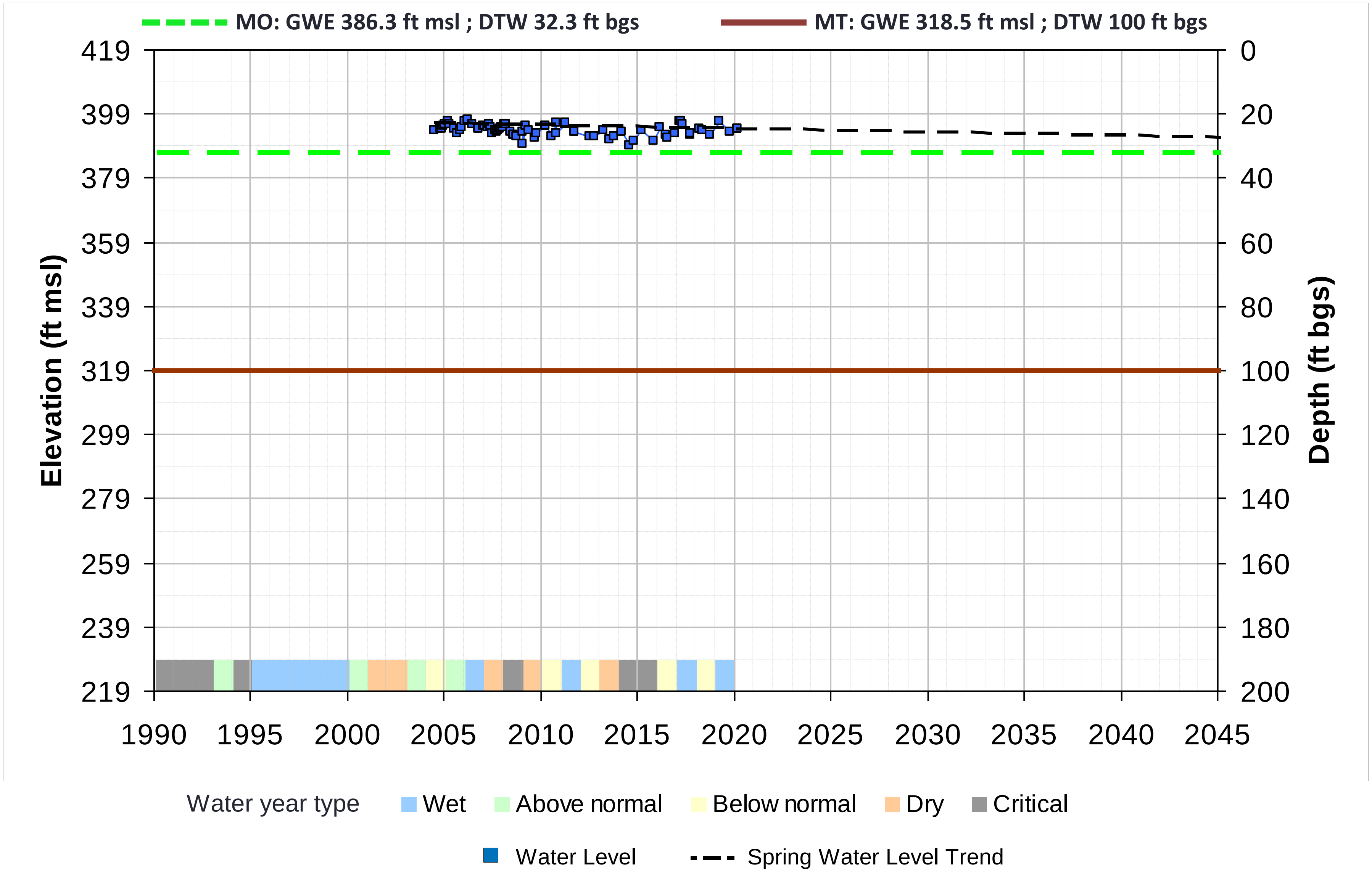
Bowman Subbasin

Bow-1 SWN: 29N03W18M001M

MO = Spring 2042 DTW + 5 ft

Well Depth (ft): 234; Screens (ft bgs): N/A

Aquifer: Upper; Well Type: Irrigation

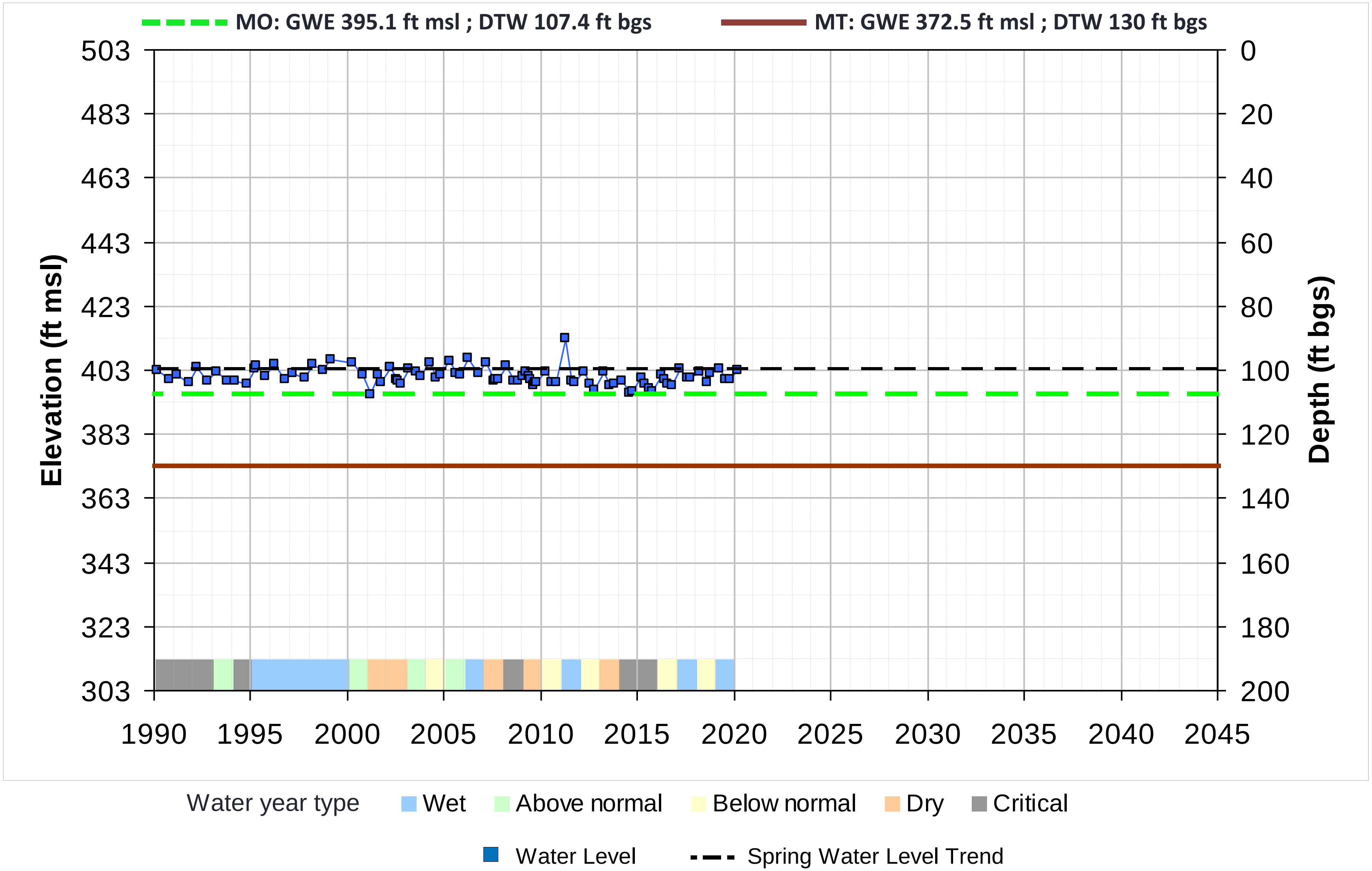


Bow-2 SWN: 29N04W28D001M

Well Depth (ft): 134; Screens (ft bgs): 114 - 134

MO = Spring 2015 DTW + 5 ft

Aquifer: Upper; Well Type: Domestic

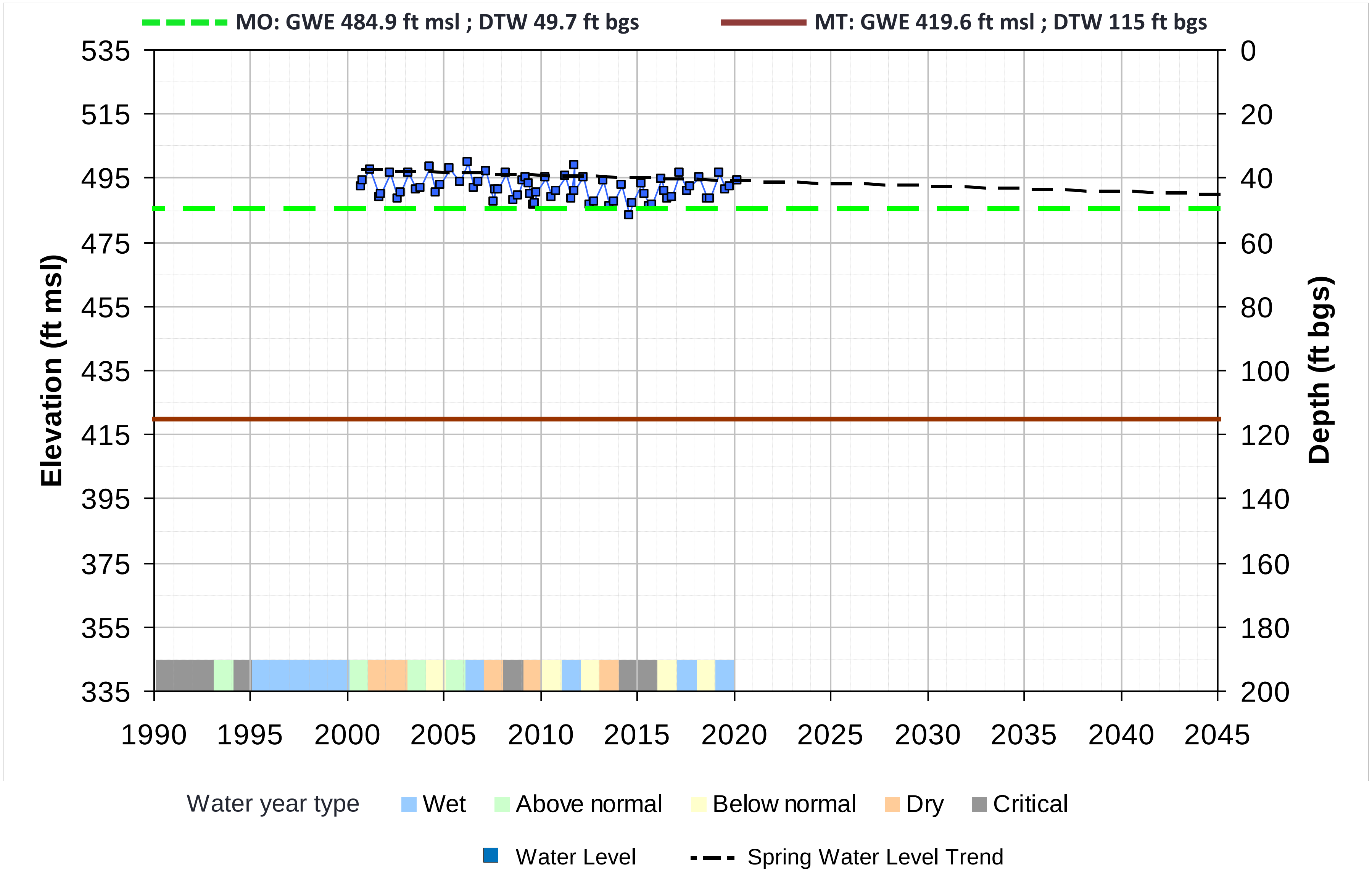


Bow-3 SWN: 29N05W33A004M

MO = Spring 2042 DTW + 5 ft

Well Depth (ft): 210; Screens (ft bgs): 110 - 210

Aquifer: Upper; Well Type: Monitoring

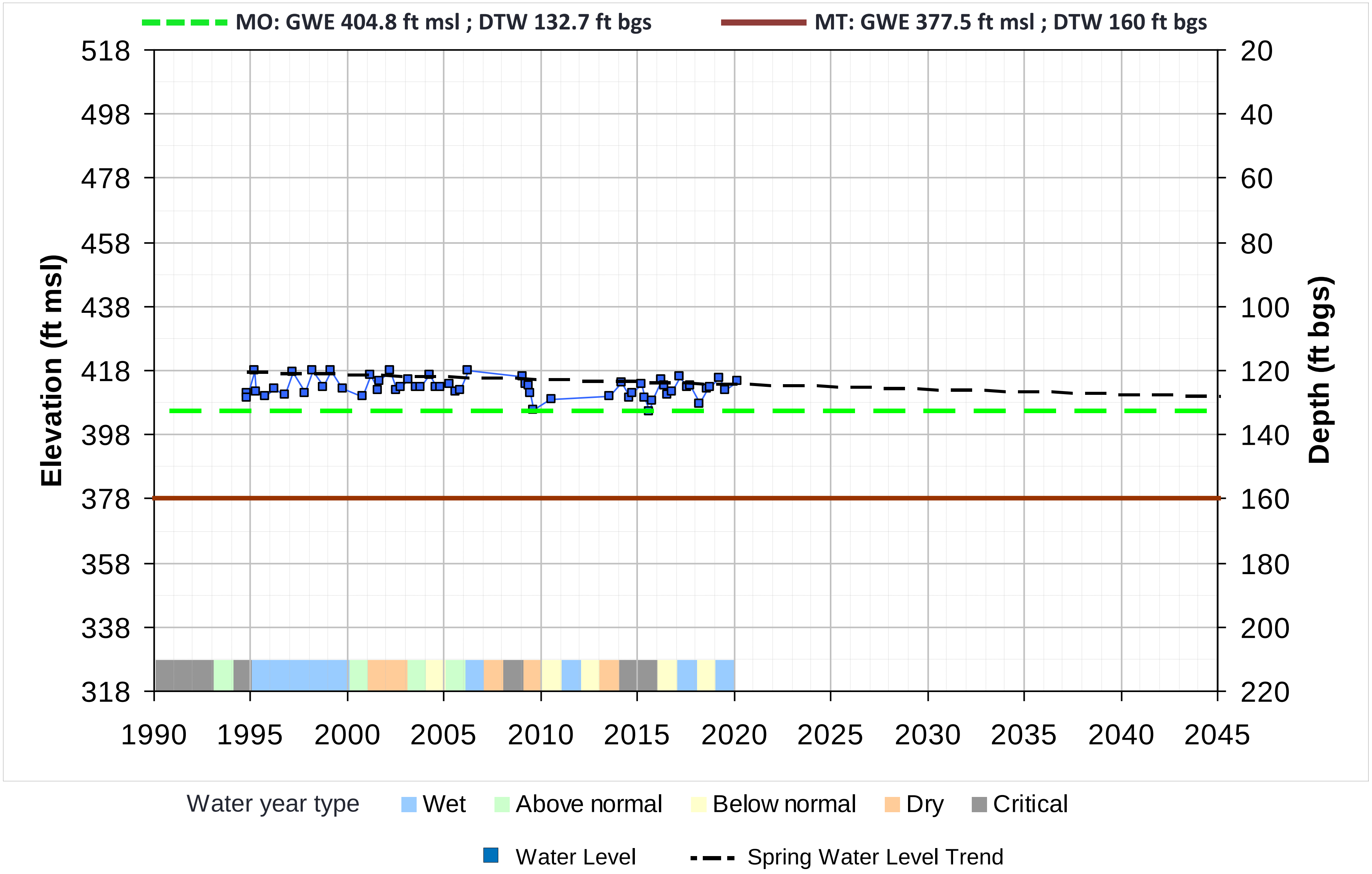


Bow-4 SWN: 28N04W04P001M

MO = Spring 2042 DTW + 5 ft

Well Depth (ft): 270; Screens (ft bgs): 200 - 270

Aquifer: Upper; Well Type: Domestic

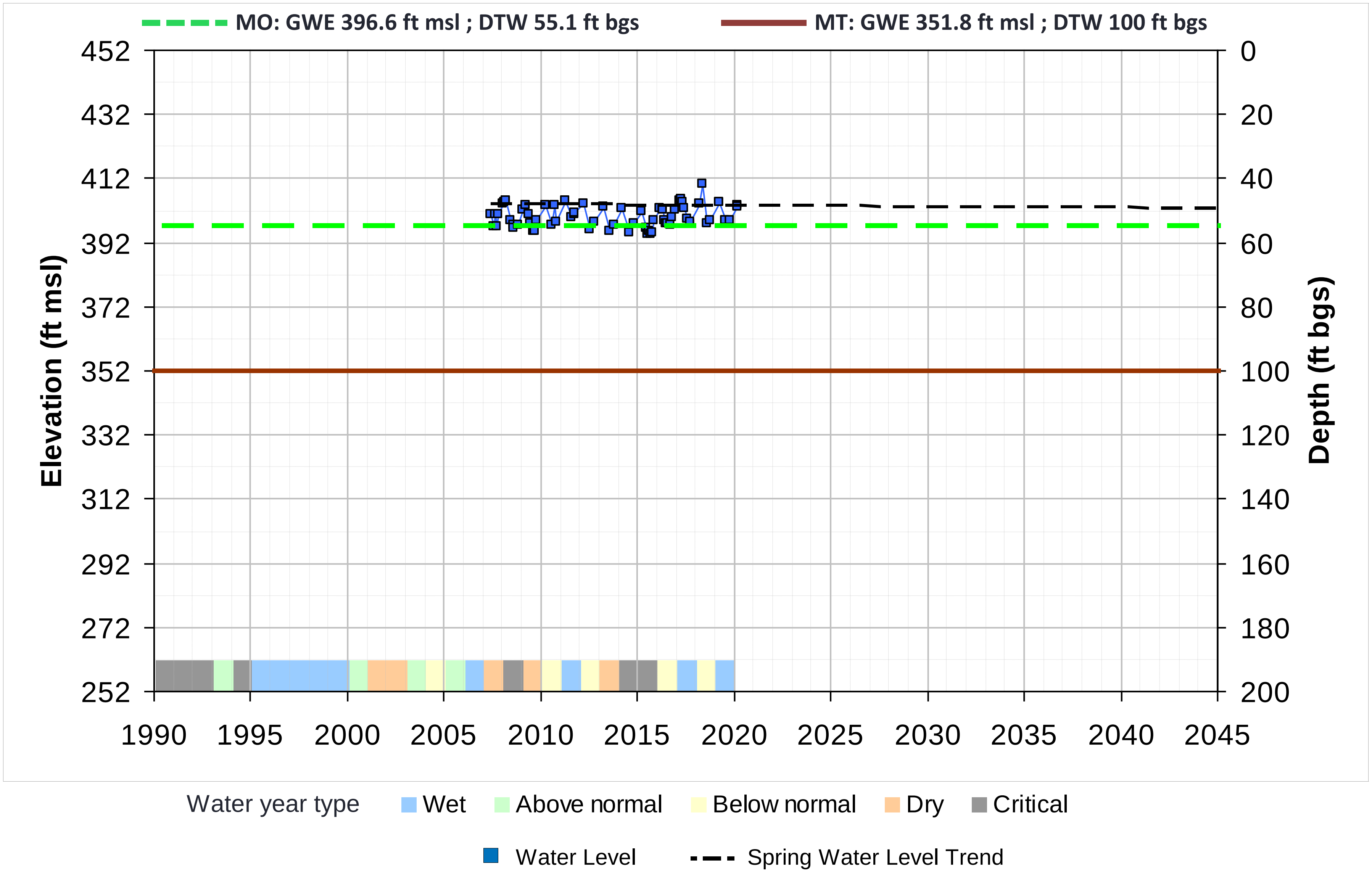


Bow-1 (Lower) SWN: 29N04W20A002M

Well Depth (ft): 451; Screens (ft bgs): 360 - 430

MO = Spring 2042 DTW + 5 ft

Aquifer: Lower; Well Type: Monitoring

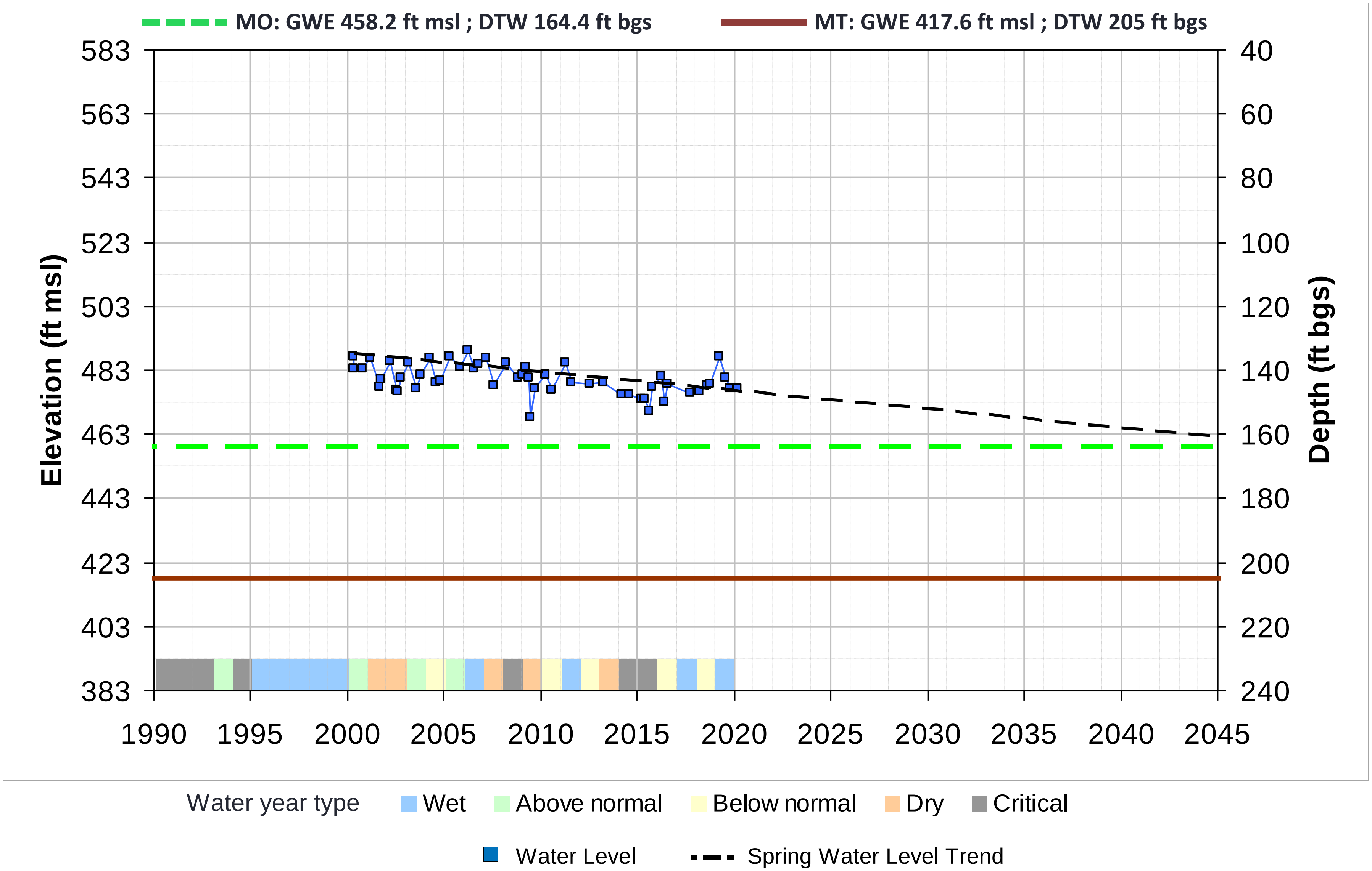


Bow-2 (Lower) SWN: 29N05W21H001M

MO = Spring 2042 DTW + 5 ft

Well Depth (ft): 280; Screens (ft bgs): 250 - 280

Aquifer: Lower; Well Type: Domestic

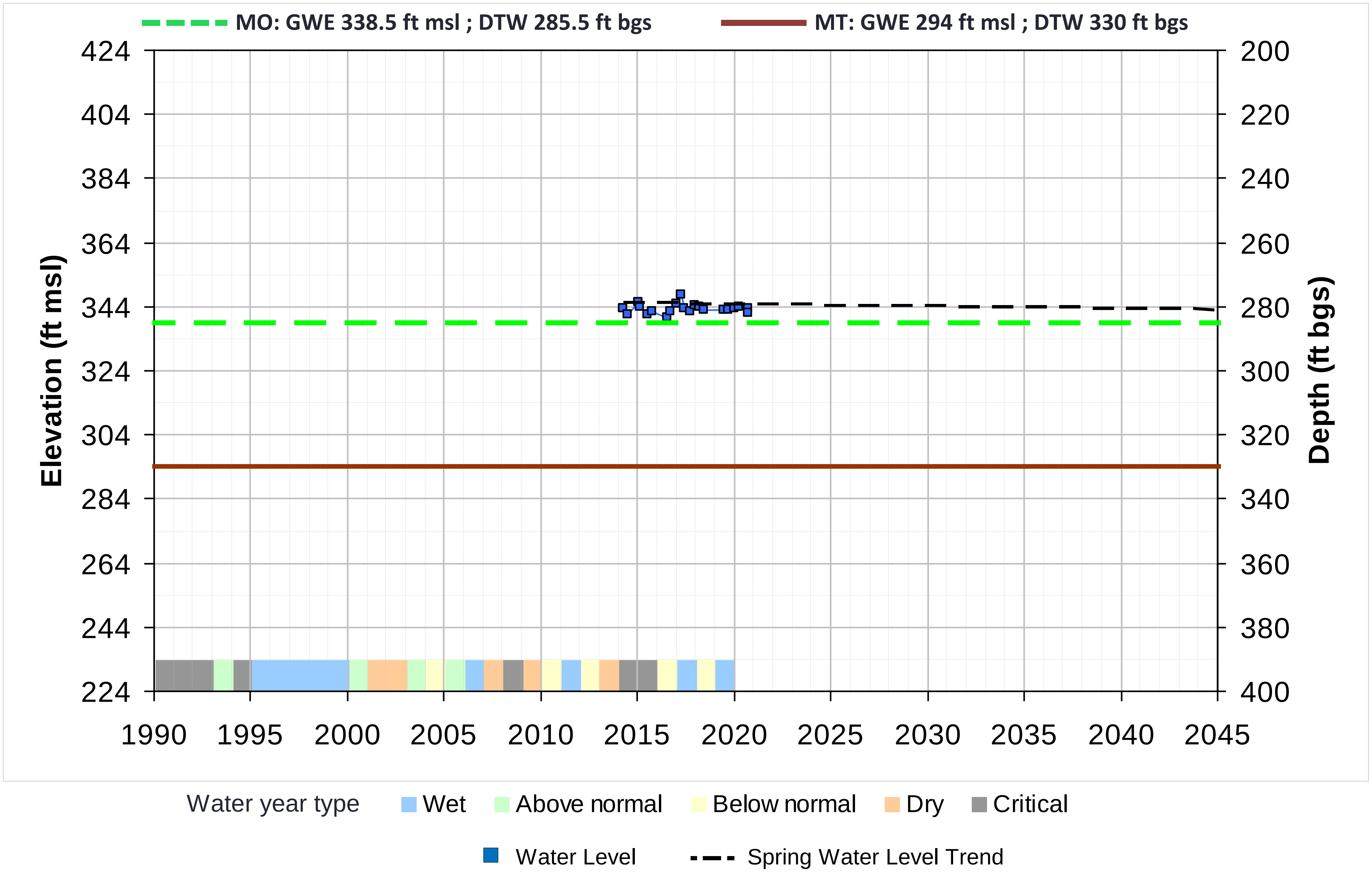


Rio Alto 6   SWN: Rio Alto Well 6

Well Depth (ft): 760; Screens (ft bgs): 390 - 750

MO = Spring 2042 DTW + 5 ft

Aquifer: Lower; Well Type: Municipal



Appendix 3-C

InSAR Subsidence Time Series Graphics

Bowman Subbasin

Sustainable Groundwater
Management Act

Groundwater Sustainability Plan Appendix 3-C InSAR Subsidence Timeseries Data - Draft

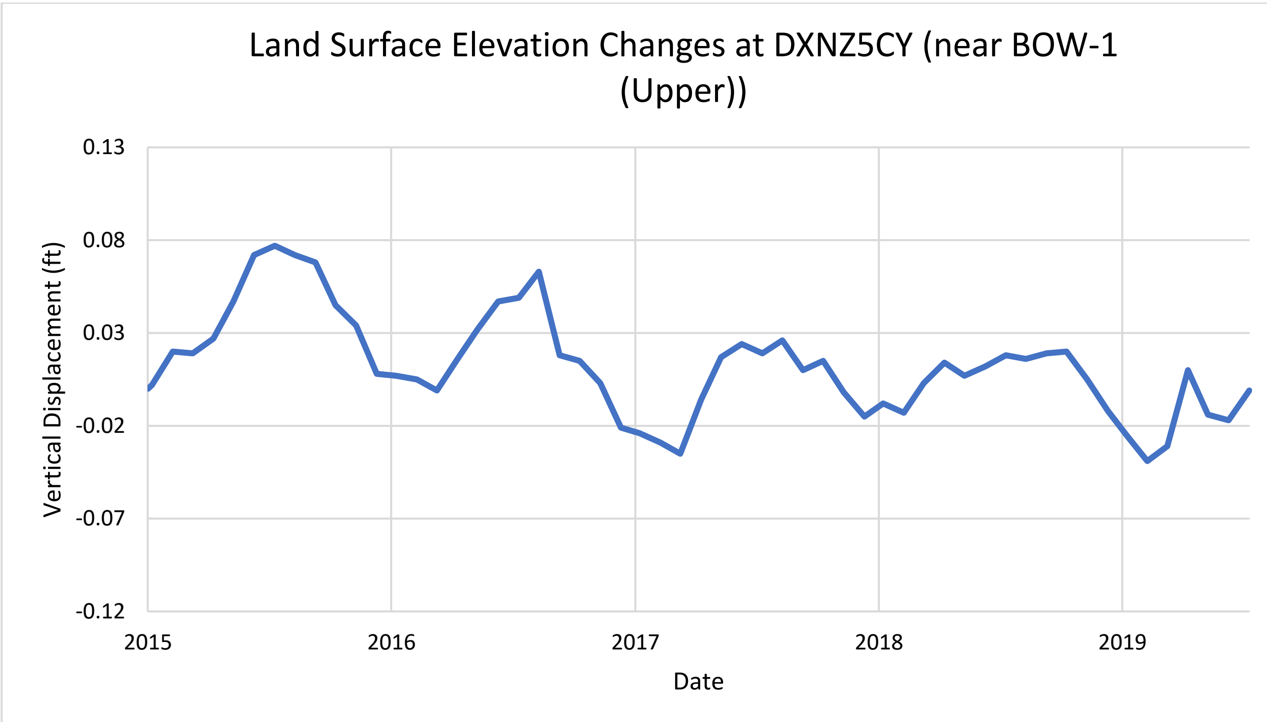
September 2021

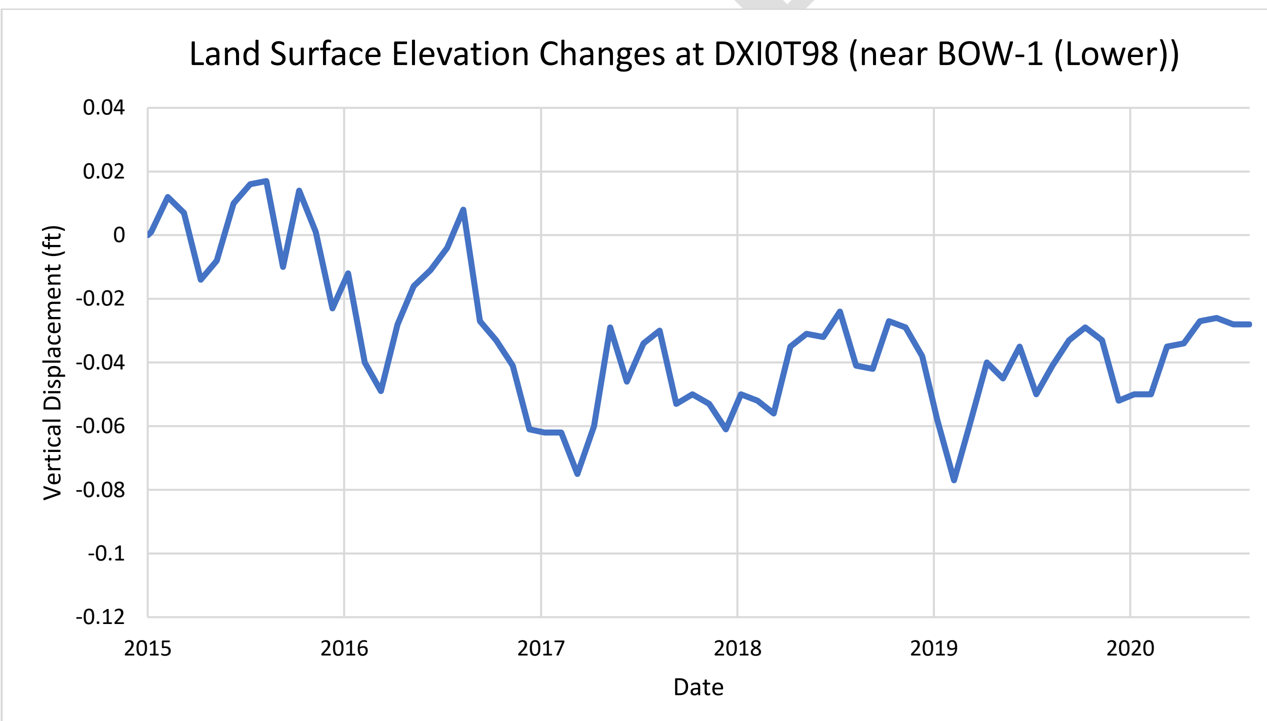
Prepared For:

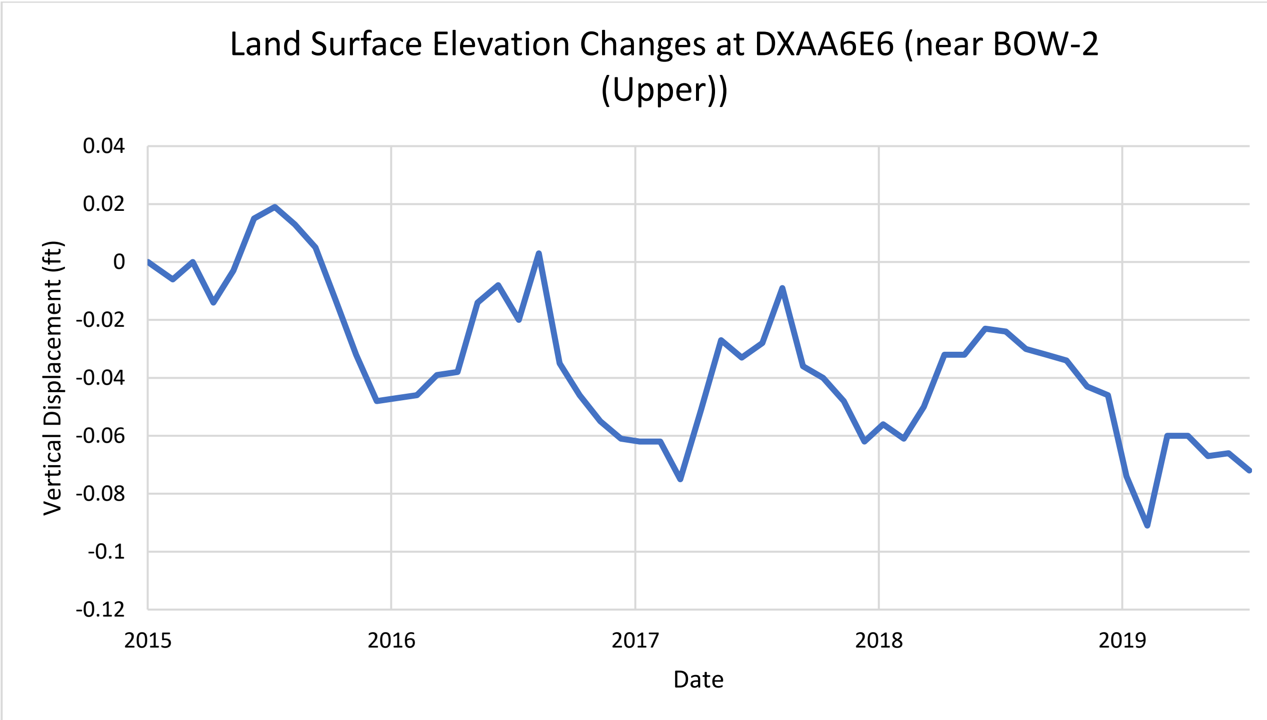
Tehama County Flood Control and Water Conservation District

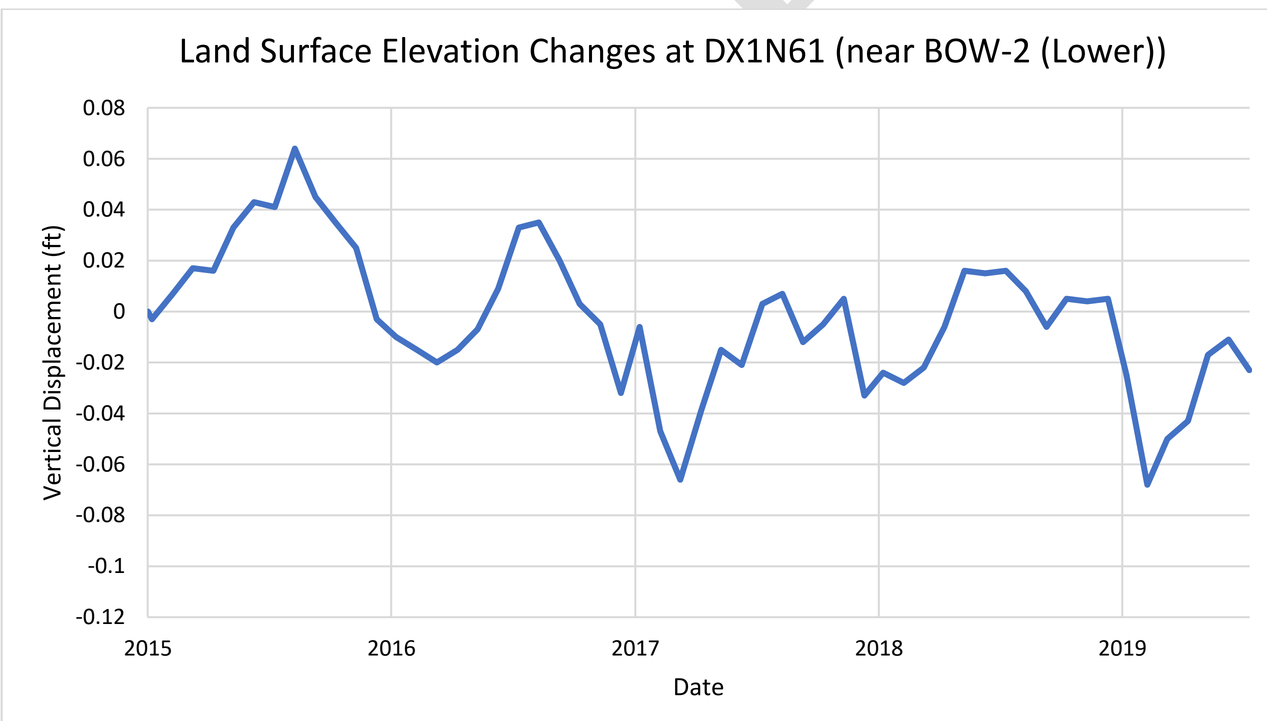
Prepared By:

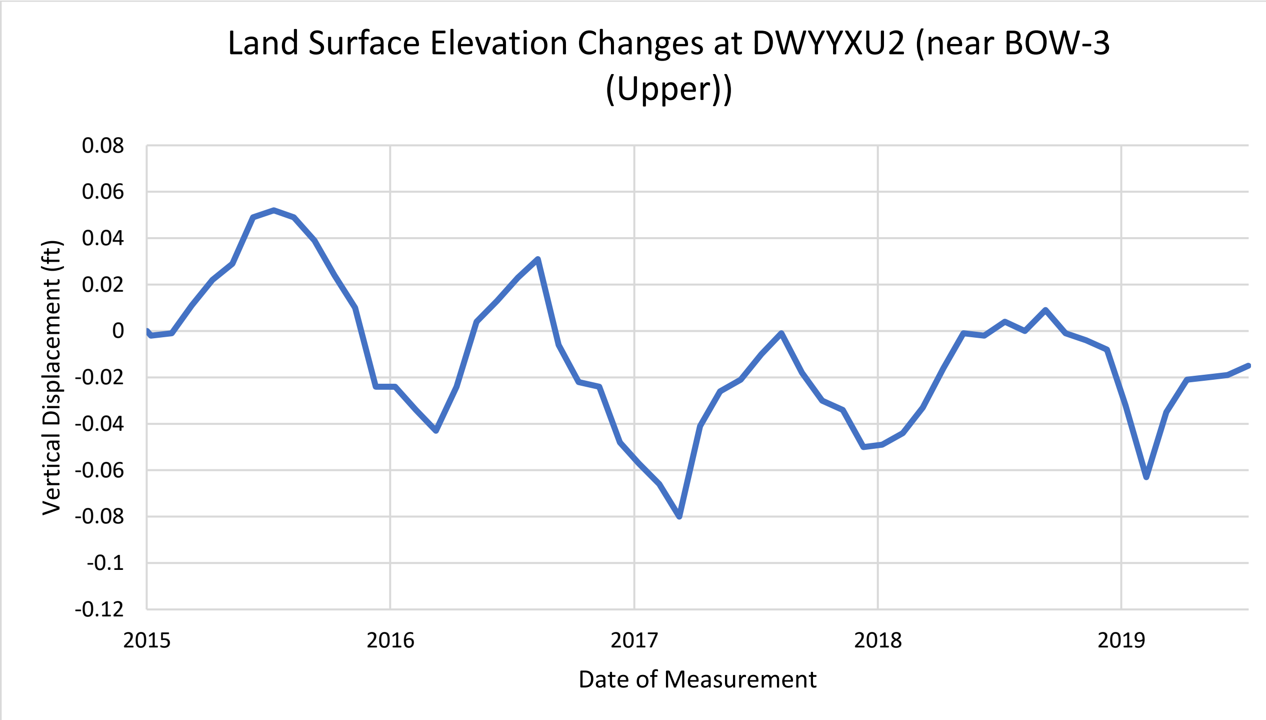
Luhdorff & Scalmanini, Consulting Engineers

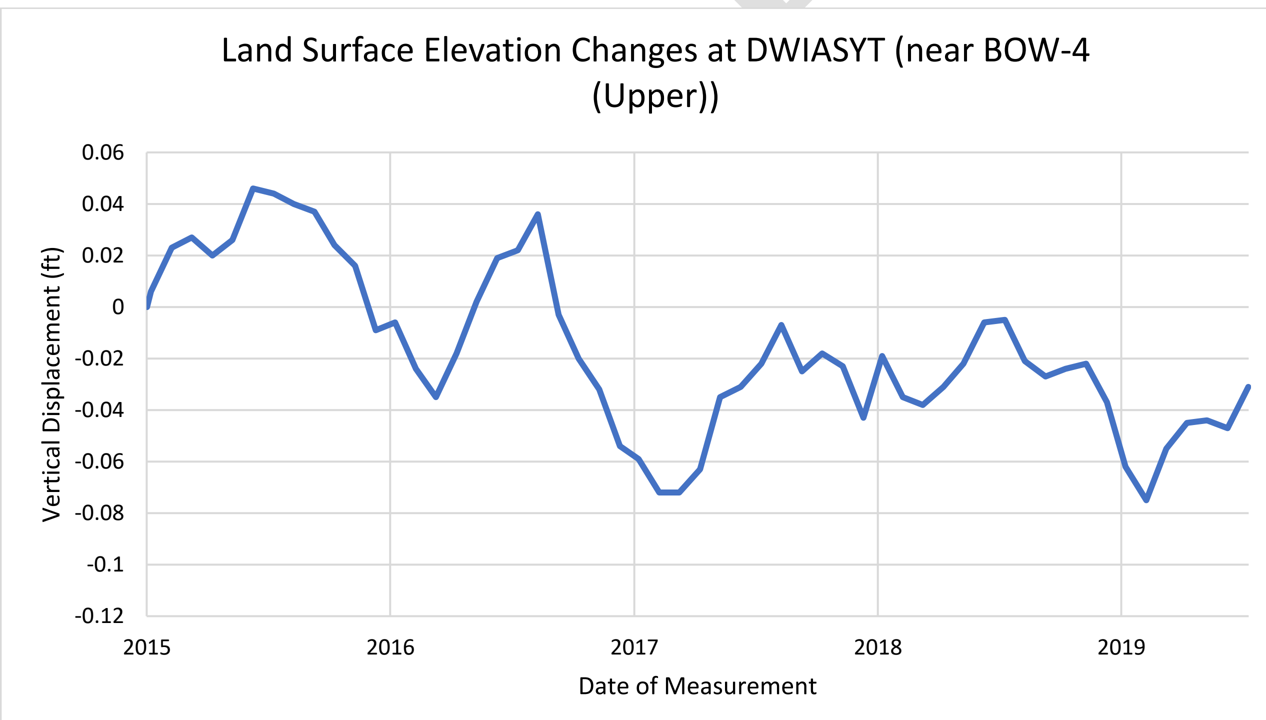

Land Surface Elevation Changes at DXNZ5CY (near BOW-1 (Upper))
0.13
0.08
0.03
-0.02
-0.07
-0.12
Vertical Displacement (ft)
2015
2016
2017
2018
2019
Date


Land Surface Elevation Changes at DXI0T98 (near BOW-1 (Lower))
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
Vertical Displacement (ft)
2015
2016
2017
2018
2019
2020
Date


Land Surface Elevation Changes at DXAA6E6 (near BOW-2 (Upper))
Vertical Displacement (ft)
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
2015
2016
2017
2018
2019
Date


Land Surface Elevation Changes at DX1N61 (near BOW-2 (Lower))
Vertical Displacement (ft)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
2015
2016
2017
2018
2019
Date


Land Surface Elevation Changes at DWYYXU2 (near BOW-3 (Upper))
Vertical Displacement (ft)
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
2015
2016
2017
2018
2019
Date of Measurement


Land Surface Elevation Changes at DWIASYT (near BOW-4 (Upper))
Vertical Displacement (ft)
0.06
0.04
0.02
0
-0.02
-0.04
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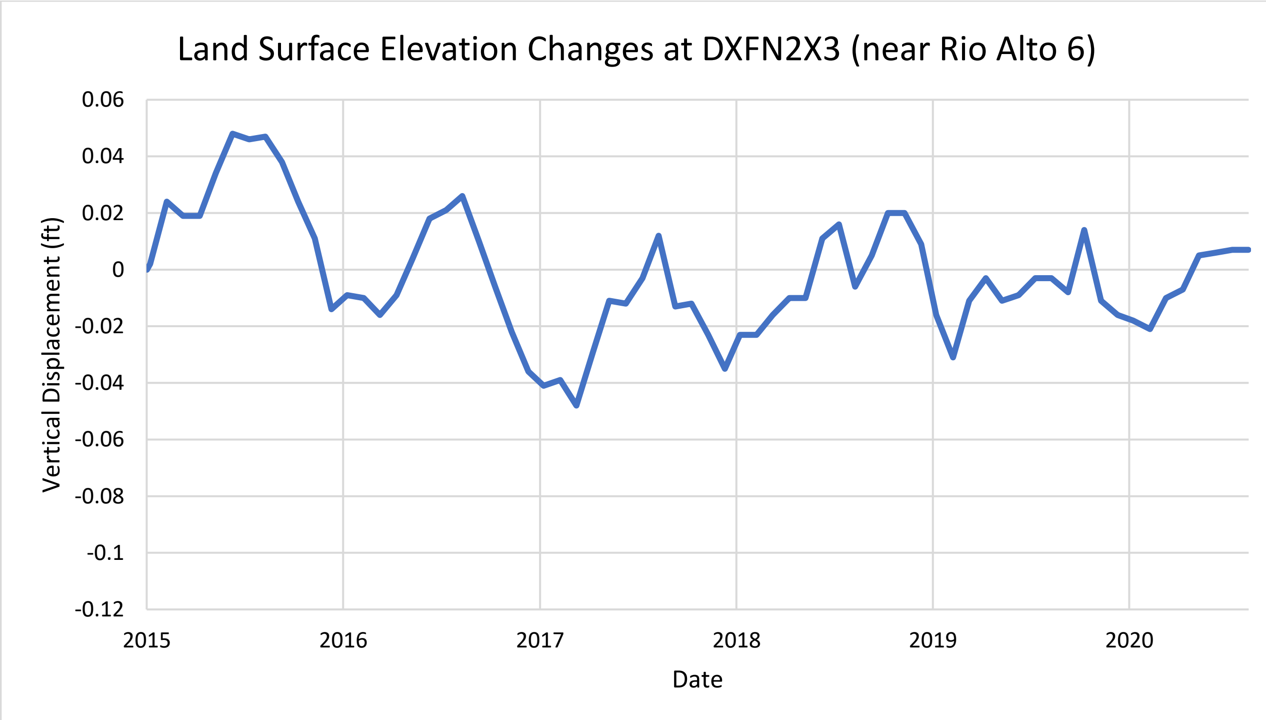
2016
2017
2018
2019
Date of Measurement


Land Surface Elevation Changes at DXFN2X3 (near Rio Alto 6)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
-0.1
-0.12
Vertical Displacement (ft)
2015
2016
2017
2018
2019
2020
Date

Appendix 3-D

Baseline Water Quality Sampling Documentation

Bowman Subbasin

Sustainable Groundwater Management Act

Groundwater Sustainability Plan Appendix 3-D Water Quality Sampling Results - Draft

September 2021

Prepared For:

Tehama County Flood Control and Water Conservation District

Prepared By:

Luhdorff & Scalmanini, Consulting Engineers

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LIST OF TABLES

1 WATER QUALITY SAMPLING

1.1 Summary

This appendix outlines the methodology and results of a Tehama County FCWCD examination of groundwater quality within the Bowman Subbasin in Tehama County, California. Groundwater samples were collected from three wells in the Bowman Subbasin and analyzed for TDS. TDS results were below the California recommended secondary MCL (500 mg/L) in all samples.

1.2 Introduction

Recent groundwater quality data has been identified as a data gap within the Bowman Subbasin. To fill this data gap, water quality samples were collected from wells within the Subbasin. These data support the development and implementation of the Bowman Subbasin GSP to comply with SGMA and achieve sustainable groundwater management by 2042.

The sampled wells are part of the representative monitoring network for groundwater quality for management under the GSP. The primary purpose of testing these samples is to provide a baseline for water quality within the Subbasin for comparison with future repeated sampling events, which are necessary to track temporal trends in groundwater quality. These data will be used to calculate interim milestones to reach MOs at each well over the projected period.

1.3 Methods

On August 19, August 27, and September 13, 2021, three wells were sampled for groundwater quality. All wells are part of a groundwater elevation network monitored by the Tehama County FCWCD/DWR for the Subbasin's California Statewide Groundwater Elevation Monitoring (CASGEM) Program. Field sampling was conducted by LSCE coordinated with both DWR and Tehama County FCWCD. Sampled wells consisted of agricultural wells, domestic wells, and monitoring wells. To ensure the samples are representative of the water quality, a large volume of water was purged from agricultural and domestic wells prior to sampling and samples were collected at the closest point of distribution from the well. Standard purge volume of three well casings were targeted however, flow meters were not installed on all wells. Wells without flow meters were purged for a time calculated using the pump rate listed on the well completion report to achieve three casing volumes. For monitor wells, passive Hydrasleeve samplers were installed and allowed to equilibrate in the well for a minimum of one week. Samples were collected in laboratory supplied plastic bottles and placed on ice before delivery to Basic Labs in Chico, CA. Samples were analyzed for TDS by method SM 2540C. To ensure the validity of laboratory results, sample duplicates were collected from 10% of wells and analyzed by Basic Labs.

Groundwater quality data were compared to published California Code of Regulations, Title 22, Secondary Drinking Water Standards.

Prior to sampling, property owners were contacted to secure permission for LSCE to access and sample the wells. Some owners were unable to be contacted to secure access agreements. LSCE will continue to attempt to reach property owners where samples could not be collected and, if access is denied, identify a suitable replacement well for future WQ sampling events.

1.4 Results and Conclusion

Samples collected from the RMS wells had TDS detections ranging from 134 mg/L in sample Bow-1 to 161 in sample Bow-4 (**Table 1**). All the collected samples are below the California Recommended Secondary MCL for TDS (**Table 1**).

Lab results indicate that there are no widespread water quality concerns relating to TDS within the Subbasin. These samples represent a baseline condition for the start of the GSP implementation period and will be used to compare future results to evaluate if water quality is changing over the GSP implementation period.

Table 1. Bowman Water Quality Sampling Results

Well Name	State Well Number (SWN)	Date Sampled	TDS (mg/L)	Secondary Maximum Contaminant Levels	
				Recommended (TDS mg/L)	Upper Secondary MCL (TDS mg/L)
Bow-1	29N03W18M001M	08/19/2021	134	500	1,000
Bow-2[1]	29N04W28D001M	TBD	TBD	500	1,000
Bow-3[2]	29N05W33A004M	09/13/2021	TBD	500	1,000
Bow-4	28N04W04P001M	08/19/2021	161	500	1,000

1. Access has yet to be secured
2. Awaiting laboratory results