SGW-63743
Revision 1

PREDICTED IMPACT OF FUTURE WATER-LEVEL DECLINES ON GROUNDWATER WELL LONGEVITY WITHIN THE CENTRAL PLATEAU, HANFORD SITE

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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P.O. Box 1600
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APPROVED
By Sarah Harrison at 3:59 pm, Jan 20, 2021

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Executive Summary

The water table beneath the Central Plateau of the Hanford Site has declined following cessation of most wastewater discharges to the ground. An evaluation was performed to predict the rates of water-level decline and identify groundwater monitoring wells that are likely to become sample dry. This evaluation used water levels measured in monitoring wells and a numerical groundwater flow model to predict water levels in 520 wells across the Central Plateau from 2020 through 2030. Seventy-four wells are predicted to become sample dry during that period, although 10 of those wells are not currently in active use.

It is expected that the information from this evaluation will be used by project scientists and managers to assess the impact of the loss of these wells on monitoring well networks and to make recommendations to substitute other nearby wells if available, or install replacement wells.

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Terms

P2R	Plateau to River
P&T	pump and treat
SALDS	State-Approved Land Disposal Site

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1 Introduction

The Hanford Site is located in south-central Washington State. From 1943 through the 1980s, the Hanford Site was used to produce plutonium for national defense. During this period, large volumes of wastewater were disposed to the ground via ponds, cribs, and trenches, which increased the water-table elevation. When production operations ceased, the volume of effluent released to the ground declined substantially, and the water-table elevation began to decline.

The U.S. Department of Energy is currently monitoring and remediating Hanford Site groundwater. The declining water table is causing some groundwater monitoring wells screened in the upper portion of the aquifer to have too little water to produce groundwater samples, hereinafter referred to as being "sample dry." This is a particular problem in the 200 East and 200 West Areas of the Hanford Site (known as the Central Plateau), and the surrounding "outer area" (Figure 1). The 200 West pump and treat (P&T) system also has impacted the water table, particularly near extraction and injection wells. Many wells in the Central Plateau have become sample dry during the past 20 years. As water levels continue to decline, additional wells will become sample dry, adversely impacting groundwater monitoring well networks.

The purpose of this report is to evaluate groundwater monitoring wells on the Central Plateau and estimate which of them are likely to go dry between 2020 and 2030. It is expected that this information will be used by project scientists and managers to assess the impact of the loss of these wells on monitoring well networks and to make recommendations to substitute other nearby wells if available, or install replacement wells.

A previous version of this report was released in 2019 (SGW-63743, Rev. 0). The following improvements have been made in this revised evaluation:

- Elevations of screened and perforated intervals have been checked more rigorously and documented in ECF-HANFORD-20-0070, *Open Interval Elevations for Central Plateau Groundwater Monitoring Wells*.
- Projections now use the Plateau to River (P2R) Groundwater Model (CP-57037, *Model Package Report: Plateau to River Groundwater Model, Version 8.3*, Rev. 2) instead of the Central Plateau Groundwater Model (CP-47631, *Model Package Report: Central Plateau Groundwater Model, Version 8.4.5*, Rev. 4).
- The P2R Model incorporated the planned increase in groundwater P&T extraction and injection rates.

A total of 520 Central Plateau wells were evaluated for this report. Appendix A contains well location maps. Most of these wells were being used in 2020 for one or more of the following programs:

- Seven *Resource Conservation and Recovery Act of 1976* units in the 200 West Area and 13 units in the 200 East Area
- Four groundwater operable units under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
- Two additional waste disposal units (State-Approved Land Disposal Site [SALDS] and Solid Waste Landfill)
- Wells monitored under the *Atomic Energy Act of 1954*
- Sitewide water-level monitoring network

P&T extraction and injection wells are evaluated through a separate remedial optimization process.

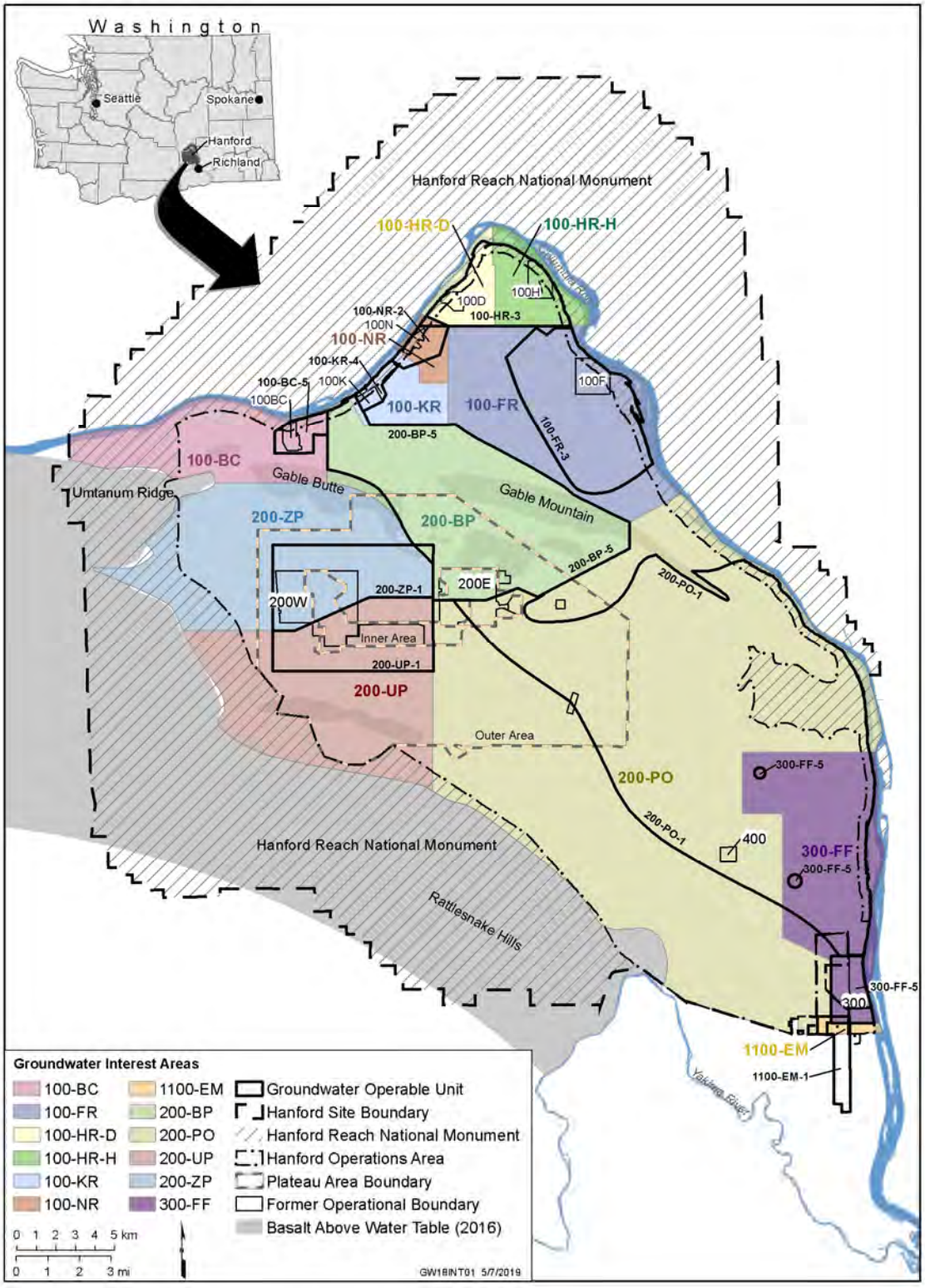

Figure 1. Regions of the Hanford Site

2 Methodology

This chapter describes how groundwater modeling was used to evaluate which Central Plateau monitoring wells are predicted to go dry between 2020 and 2030.

2.1 Groundwater Model

The Central Plateau Groundwater Model (CP-47631, Rev. 4) was the principal computational tool used to design and evaluate the performance of the 200-ZP-1 and 200-UP-1 groundwater remedies until 2019, when it was replaced by the P2R Model (CP-57037, Rev. 2). Groundwater modeling for this evaluation was conducted using the P2R Model.

The P2R Model (CP-57037, Rev. 2) simulated future operating conditions with increased groundwater extraction and injection facilitated by the addition of 10 proposed extraction wells. The locations and planned flow rates of the 200 West Area extraction and injection wells are included in Appendix A of ECF-HANFORD-20-0049, *Description of Groundwater Calculations to Support Performance Assessment for the Calendar Year 2019 (CY 2019) 200 Areas Pump-and-Treat Report*.

The updated P2R Model described in ECF-HANFORD-20-0049 was used for evaluations and future predictions of the 200 West P&T system in DOE/RL-2019-68, *Calendar Year 2019 Annual Summary Report for Pump and Treat Operations in the Hanford Central Plateau Operable Units.* Groundwater modeling results are used in this evaluation to predict water levels across the Central Plateau from 2020 through 2030.

The P2R Model (CP-57037, Rev. 2) is the principal computational tool used to evaluate the performance of the 200 West P&T system. The P2R Model is calibrated to match historical water-level measurements. In general, simulated water levels correspond with measured water levels throughout the area. However, the accuracy of the simulated groundwater elevations is influenced by the structural accuracy of the P2R Model (i.e., how well the model represents actual hydrologic conditions), the accuracy of the water-level data used for calibration, and the magnitude and distribution of validation/calibration residuals between the measured and simulated water levels. To improve accuracy of the predicted water-level decline, predicted water levels for each individual monitoring well were adjusted by an average residual between measured and simulated historical water levels.

Because of model layering and representation of the geology in the P2R Model (CP-57037, Rev. 2), some of the model cells are simulated as unsaturated (dry) and the model was unable to provide simulated water levels for the following wells: 299-E26-77, 699-46-91, 699-50-59, 699-53-47B, 699-53-48A, 699-54-48, and 699-54-49. Water-level projections for those wells were calculated using a simple linear trend. Water levels cannot currently be measured in well 299-W19-23 because of access restrictions, so the water level was estimated based on data from nearby wells.

2.2 Well Screen Elevations

Wells constructed on the Hanford Site since the mid-1980s are typically constructed with a screen to allow groundwater from the aquifer to enter the well. Older wells were previously constructed with perforated casing instead of well screens. The screened or perforated portion of the well connected to the aquifer is referred to as the “open interval.” ECF-HANFORD-20-0070 documents open interval elevations for 611 wells and piezometers in the 200 Areas and the surrounding 600 Area. Dry well predictions were not evaluated for about 90 of those wells because they have no recent water-level data.

To allow for drawdown during pumping, a certain amount of water must be present in a well to extract a sample. When the static water level has declined below this critical level, the well is deemed "sample dry." Sampling is usually feasible if a well has more than 0.9 m (3 ft) of water above the bottom of the open interval. Wells that are sample dry may still be used for water-level monitoring as long as the water level remains above the bottom of the open interval.

2.3 Water-Level Data

Water-level data used in this evaluation were manual measurements made between 2015 and March 2020 and retrieved from the Hanford Environmental Information System database.

For many wells in the 200 East Area and for some in the 200 West Area, the water-level elevations have been corrected for borehole deviation error (Chapter 4 of SGW-54165, *Evaluation of the Unconfined Aquifer Hydraulic Gradient Beneath the 200 East Area, Hanford Site*). Deviation of a borehole from vertical can introduce errors in water-level measurements because the measured depth to water may be larger than the true vertical depth to water. This error results in water-level elevations that are lower than the true elevations. Borehole path surveys using a gyroscope have been conducted in selected wells to correct for well bore deviation error.

2.4 Uncertainty

Estimates of when wells will go dry are subject to various uncertainties (Table 1), including the following:

- Elevation of open interval:
  - The quality of the documentation of well screen depths or perforated intervals varies. Records of well construction or maintenance before the 1980s often lack detail and measurements are approximate.
  - Differences in measurement point elevations create another source of uncertainty. Construction depths are measured from approximate land surface at the time of drilling. After wells are constructed, an approximate "land surface" elevation is either surveyed (brass cap in well pad) or calculated (top of casing minus casing stickup).
  - Water levels in some wells are corrected for borehole deviation from vertical, but construction depths are not. While it would be possible to correct construction information for borehole deviation in those wells with gyroscope surveys, it was deemed unnecessary. Most of the errors are within the range of errors from other sources of uncertainty.
- Well efficiency:
  - This evaluation assumes that wells are sample dry if the water level is <0.9 m (3 ft) above the bottom of the open interval. However, many wells continue to produce enough water for groundwater sampling with lower water levels. Other wells do not recharge readily and require more water.
- Changing hydraulic conditions:
  - Through remedial process optimization, the number, location, and pumping rates of extraction and injection wells change over time in response to remedial action objectives and contaminant distribution.

  - Changes in response to atmospheric barometric pressure.
  - Pressure responses to changes in Columbia River stage have been observed in the 200 East Area. Changes in effluent disposal to the Treated Effluent Disposal Facility (east of the 200 East Area) and SALDS (north of the 200 West Area) also impact water levels.

- Model uncertainty:
  - The structural accuracy of the P2R Model (CP-57037, Rev. 2) (i.e., how well the model represents actual physical conditions)
  - The accuracy of the water-level data used for calibration
  - The magnitude and distribution of validation/calibration residuals
  - Simulated future pumping rates for the 200 West P&T system extraction and injections wells
  - Simulated future releases at SALDS and the Treated Effluent Disposal Facility

Table 1. Types of Uncertainty in Predictions

Category	Source of Uncertainty	Approximate Magnitude
Elevation of open interval	Errors in measurement at the time of drilling.	0.1 to 0.3 m (0.3 to 1 ft)
	Difference in elevation of land surface during drilling and based on surveyed information from the completed well.	Up to 0.5 m (1.6 ft)
	Deviation of borehole from vertical.	Up to 1 m (3 ft); more commonly <0.1 m (<0.3 ft)
Well efficiency	Some wells can continue to be sampled with very little water, while others require longer water columns; depends on hydraulic conductivity, well efficiency, and pump type.	Approximately 1 m (approximately 3 ft)
Hydraulic conditions	Changes in number, location, and pumping rate in extraction and injection wells.	Several meters near extraction or injection wells in the 200 West Area
	Aquifer response to other hydraulic changes such as barometric effects, river stage, or natural recharge.	Typically <0.5 m (<1.6 ft)
Model uncertainty	See text.	Unquantified

3 Results

Seventy-four Central Plateau wells are predicted to be sample dry between 2020 and 2030. Table 2 lists how the wells are currently used and which of them were previously predicted to go dry as documented in SGW-63743, Rev. 0. The number of dry wells in this evaluation was greater than predicted in Rev. 0 (34), primarily because of planned increases in groundwater extraction in the 200 West Area. Several wells that were predicted to go sample dry in Rev. 0 of this document are no longer predicted to go dry (Table 3). Figures 2 through 12 are maps of the simulated water table and the monitoring wells predicted to become sample dry in 2020 through 2030.

Appendix B provides graphs of current and predicted water levels in all wells evaluated in this report, compared to the elevations of their open intervals.

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Table 2. Projected Water-Level Elevations (m NAVD88) for Wells Predicted to be Sample Dry by 2030

Well Name	Well Use[a]	Elev. Bottom of Open Interval[b]	Water-Level Elev.	Water-Level Date	Predicted (Simulated Adjusted) Water-Level Elevations by Year											Comments
					2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
299-E13-10	WL	121.3	121.72	3/31/2019	121.65	121.62	121.59	121.57	121.54	121.51	121.49	121.46	121.44	121.42	121.40	Predicted sample dry before 2019 by Rev. 0.
299-E13-14	AEA-PO, CERCLA-PO, CERCLA-UP, WL	121.5	121.76	4/23/2019	121.68	121.65	121.62	121.60	121.57	121.54	121.52	121.49	121.47	121.45	121.43	Predicted sample dry before 2019 in Rev. 0. Sampled with a bailer in 2019; failed sample attempt in 2020.
299-E17-19	AEA-PO, CERCLA-PO, RCRA-A36B	120.6	121.37	1/21/2020	121.37	121.34	121.31	121.28	121.26	121.23	121.21	121.18	121.16	121.14	121.12	Not predicted sample dry in Rev. 0. Open interval bottom estimate revised (higher). Successfully sampled in 2020.
299-E17-20	AEA-PO	120.8	121.56	1/21/2020	121.56	121.53	121.50	121.48	121.45	121.42	121.40	121.37	121.35	121.33	121.31	Predicted sample dry before 2022 in Rev. 0.
299-E17-9	AEA-PO	120.7	121.64	4/19/2019	121.59	121.55	121.53	121.50	121.47	121.44	121.42	121.40	121.37	121.35	121.33	Predicted sample dry before 2020 in Rev. 0.
299-E24-4	AEA-PO	122.1	121.63	4/19/2019	121.58	121.55	121.52	121.49	121.46	121.44	121.41	121.39	121.37	121.34	121.32	Not predicted sample dry in Rev. 0; open interval bottom estimate revised (higher). It is likely the well has blank casings below perforations.
299-E25-29P	AEA-PO, CERCLA-PO	120.8	121.78	7/31/2019	121.68	121.65	121.62	121.59	121.56	121.53	121.51	121.48	121.46	121.44	121.42	Predicted sample dry before 2019 in Rev. 0. Successfully sampled (pumped) in July 2019.
299-E25-41	AEA-PO, CERCLA-PO, GW Blinds, RCRA-AAX	120.5	121.61	9/20/2019	121.58	121.55	121.52	121.50	121.47	121.44	121.42	121.39	121.37	121.35	121.33	Predicted sample dry by 2024 in Rev. 0.
299-E26-10	AEA-BP, CERCLA-BP, RCRA-LERF-WL, WL	120.7	121.57	2/19/2020	121.62	121.59	121.56	121.53	121.50	121.48	121.45	121.43	121.41	121.38	121.37	Predicted sample dry by 2021 in Rev. 0.
299-E33-13	None	120.7	121.68	7/28/2017	121.62	121.59	121.56	121.53	121.51	121.48	121.46	121.43	121.41	121.39	121.37	Not predicted sample dry in Rev. 0; open interval bottom estimate revised (higher) based on measured depth.
299-E33-14	AEA-BP, WL	120.7	121.58	2/28/2020	121.60	121.57	121.54	121.52	121.49	121.46	121.44	121.42	121.40	121.37	121.36	Predicted sample dry in 2027 in Rev. 0; open interval bottom estimate revised (higher). Unsuccessful sampling attempt in 2019 and 2020; no water to surface.
299-E33-1A	AEA-BP	120.6	121.73	10/8/2017	121.67	121.64	121.62	121.59	121.56	121.54	121.52	121.49	121.47	121.45	121.43	Not evaluated in Rev. 0.
299-E33-26	None	120.6	121.33	7/21/2017	121.27	121.24	121.21	121.18	121.16	121.13	121.11	121.09	121.07	121.05	121.03	Predicted sample dry before 2019 in Rev. 0.
299-E33-7	None	120.8	121.66	3/31/2019	121.61	121.58	121.55	121.53	121.50	121.48	121.45	121.43	121.41	121.39	121.37	Predicted sample dry before 2019 in Rev. 0.
299-E34-9	AEA-BP, CERCLA-BP, CERCLA-BP-RA, RCRA-LL2, AEA-LL2, WL	120.7	121.56	2/20/2020	121.60	121.57	121.54	121.52	121.49	121.46	121.44	121.42	121.39	121.37	121.35	Predicted sample dry by 2021 in Rev. 0.
299-W10-23	AEA-ZP, WL	127.2	130.78	3/16/2020	130.46	129.73	129.41	129.11	128.86	128.64	128.44	128.28	128.13	128.00	127.87	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W10-24	AEA-ZP, RCRA-T, WL	127.3	130.36	3/16/2020	130.03	129.01	128.61	128.28	128.00	127.77	127.57	127.39	127.24	127.10	126.97	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W10-26	AEA-ZP, RCRA-TX-TY, WL	127.8	129.45	2/19/2020	128.95	128.02	127.70	127.33	127.04	126.80	126.59	126.41	126.25	126.11	125.97	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W10-27	AEA-ZP, CERCLA-ZP, RCRA-TX-TY, WL	126.9	129.53	2/18/2020	129.07	128.13	127.79	127.43	127.14	126.90	126.69	126.51	126.35	126.21	126.07	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.

Table 2. Projected Water-Level Elevations (m NAVD88) for Wells Predicted to be Sample Dry by 2030

Well Name	Well Use[a]	Elev. Bottom of Open Interval[b]	Water-Level Elev.	Water-Level Date	Predicted (Simulated Adjusted) Water-Level Elevations by Year											Comments
					2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
299-W11-13	CERCLA-ZP, WL	125.2	129.99	4/5/2019	127.57	125.46	124.66	124.15	123.77	123.46	123.21	123.00	122.81	122.65	122.50	Not predicted sample dry in Rev. 0. Open interval bottom estimate revised (higher) based on measured depth.
299-W11-33Q	AEA-ZP, CERCLA-ZP, WL	126.5	130.86	9/27/2018	128.86	127.02	126.20	125.74	125.38	125.10	124.87	124.67	124.49	124.34	124.20	Not evaluated in Rev. 0.
299-W11-39	AEA-ZP, RCRA-T, WL	126.5	130.15	3/16/2020	129.81	128.63	128.19	127.84	127.55	127.31	127.11	126.93	126.77	126.63	126.50	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W11-40	AEA-ZP, RCRA-T, WL	126.4	129.88	3/16/2020	129.50	128.14	127.66	127.29	126.99	126.74	126.52	126.34	126.18	126.04	125.90	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W11-41	AEA-ZP, RCRA-T, WL	126.9	129.74	3/16/2020	129.31	127.93	127.44	127.06	126.76	126.50	126.29	126.10	125.94	125.79	125.65	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W11-42	AEA-ZP, RCRA-T, WL	127.3	130.16	3/16/2020	129.77	128.43	127.96	127.60	127.30	127.06	126.85	126.66	126.50	126.36	126.23	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W13-2P	CERCLA-ZP	122.5	126.64	11/19/2019	125.83	125.14	122.77	121.69	121.03	120.59	120.27	120.03	119.81	119.64	119.50	Not predicted sample dry in Rev. 0; open interval bottom estimate revised (higher) based on measured depth.
299-W14-13	AEA-ZP, CERCLA-ZP, DOH, DOH-Co, RCRA-TX-TY, WL	127.6	128.06	2/20/2020	127.42	126.32	125.91	125.51	125.19	124.93	124.71	124.52	124.36	124.21	124.07	Predicted sample dry by 2028 in Rev. 0; change in projected impact of P&T on water table.
299-W14-14	AEA-ZP, CERCLA-ZP, RCRA-TX-TY, WL	127.8	129.07	2/20/2020	128.50	127.49	127.12	126.72	126.42	126.16	125.94	125.76	125.60	125.45	125.32	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W14-15	AEA-ZP, RCRA-TX-TY, WL	127.0	128.75	2/20/2020	127.99	126.94	126.54	126.14	125.83	125.57	125.35	125.16	125.00	124.85	124.71	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W14-16	AEA-ZP, CERCLA-ZP, WL	126.8	128.76	11/17/2019	127.83	126.30	125.69	125.23	124.88	124.60	124.36	124.16	123.98	123.83	123.68	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W14-17	AEA-ZP,WL	126.8	129.10	4/1/2019	127.72	126.28	125.67	125.21	124.86	124.58	124.34	124.14	123.97	123.81	123.67	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W14-18	AEA-ZP, RCRA-TX-TY, WL	127.1	128.69	2/19/2020	128.18	127.06	126.64	126.25	125.94	125.68	125.46	125.27	125.11	124.96	124.82	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W14-19	AEA-ZP, RCRA-TX-TY, WL	126.1	129.12	2/20/2020	128.53	127.56	127.21	126.82	126.52	126.26	126.05	125.87	125.71	125.57	125.43	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W15-2	None	135.1	136.71	3/8/2017	136.11	136.32	136.48	136.35	136.20	136.05	135.91	135.78	135.66	135.55	135.44	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W15-763	AEA-ZP, CERCLA-ZP, WL	126.9	130.68	11/15/2019	129.82	129.15	128.96	128.62	128.35	128.13	127.93	127.76	127.62	127.48	127.35	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W15-765	AEA-ZP, CERCLA-ZP, RCRA-TX-TY	126.8	129.92	2/19/2020	129.54	129.18	129.11	128.81	128.56	128.34	128.15	127.99	127.84	127.71	127.58	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W19-101	AEA-UP, CERCLA-UP, WL	123.5	127.40	12/6/2019	127.23	126.85	125.74	125.19	124.81	124.54	124.32	124.14	123.98	123.84	123.71	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W19-12	AEA-UP, CERCLA-UP, WL	129.5	131.72	10/9/2019	131.39	131.25	131.01	130.70	130.45	130.24	130.06	129.89	129.75	129.62	129.50	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W19-131	CERCLA-UP, WL	124.0	128.17	3/3/2020	127.90	127.52	126.37	125.81	125.44	125.17	124.95	124.77	124.61	124.47	124.35	Not evaluated in Rev. 0.

Table 2. Projected Water-Level Elevations (m NAVD88) for Wells Predicted to be Sample Dry by 2030

Well Name	Well Use[a]	Elev. Bottom of Open Interval[b]	Water-Level Elev.	Water-Level Date	Predicted (Simulated Adjusted) Water-Level Elevations by Year											Comments
					2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
299-W19-18	WL	129.7	130.89	3/28/2018	130.02	129.69	129.03	128.61	128.29	128.05	127.85	127.68	127.52	127.39	127.27	Not predicted sample dry in Rev. 0; open interval bottom estimate revised (higher) based on measured depth.
299-W19-35	WL	130.6	131.00	3/19/2015	127.43	127.04	125.91	125.35	124.97	124.70	124.48	124.30	124.14	124.00	123.87	Known to be dry.
299-W19-36	AEA-UP, CERCLA-UP, CERCLA-ZP, WL	126.6	128.36	2/11/2020	128.05	127.67	126.76	126.26	125.92	125.66	125.44	125.26	125.10	124.96	124.83	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W19-43	AEA-UP, CERCLA-UP, WL	125.2	127.03	2/28/2020	126.75	126.38	125.43	124.93	124.58	124.31	124.10	123.92	123.76	123.62	123.49	Not predicted sample dry in Rev. 0; change in projected impact of P&T on water table.
299-W22-10	AEA-UP, CERCLA-UP	130.9	131.68	6/4/2019	131.47	131.36	131.18	130.96	130.77	130.59	130.43	130.29	130.15	130.03	129.92	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth.
299-W22-45	None	131.9	132.53	1/22/2016	131.70	131.59	131.43	131.21	131.01	130.84	130.68	130.53	130.40	130.28	130.16	Not evaluated in Rev. 0.
299-W23-15	None	132.0	133.04	1/22/2016	132.28	132.19	132.07	131.88	131.70	131.54	131.39	131.25	131.12	131.00	130.88	Not evaluated in Rev. 0.
299-W6-11	AEA-ZP, CERCLA-ZP, WAC-SALDS, WL	131.8	132.21	3/19/2018	131.62	131.75	131.48	131.25	131.03	130.84	130.67	130.52	130.39	130.28	130.16	Predicted sample dry before 2019 in Rev. 0. Unsuccessful sampling attempt in January 2020.
299-W6-12	CERCLA-ZP, WAC-SALDS, WL	132.8	133.25	3/19/2018	132.52	133.24	133.20	133.03	132.85	132.69	132.53	132.39	132.27	132.16	132.05	Predicted sample dry before 2019 in Rev. 0. Unsuccessful sampling attempt in January 2020.
299-W7-4	WL	134.0	134.56	3/16/2020	134.46	135.31	135.50	135.40	135.26	135.12	134.98	134.85	134.73	134.63	134.52	Predicted to recover temporarily.
299-W8-1	WAC-SALDS, WL	136.1	136.15	3/16/2020	136.15	137.67	138.19	138.20	138.15	138.06	137.96	137.86	137.76	137.67	137.58	Predicted to recover.
699-23-34A	WL	121.4	121.49	3/31/2019	121.43	121.40	121.37	121.34	121.31	121.29	121.26	121.24	121.21	121.19	121.17	Predicted sample dry before 2019 in Rev. 0. Successful water level in 2019.
699-24-34A	None	121.2	121.57	4/11/2016	121.44	121.41	121.38	121.35	121.32	121.29	121.27	121.24	121.22	121.20	121.17	Not evaluated in Rev. 0.
699-24-34B	None	121.2	121.57	4/11/2016	121.44	121.41	121.38	121.35	121.32	121.30	121.27	121.24	121.22	121.20	121.18	Not evaluated in Rev. 0.
699-24-34C	WL	121.6	121.48	3/31/2019	121.43	121.40	121.37	121.34	121.31	121.28	121.26	121.23	121.21	121.19	121.16	Predicted sample dry by 2024 in Rev. 0. Measured water-levels are below documented bottom of screen.
699-24-35	WAC-SWL,WL	121.1	121.48	10/4/2019	121.45	121.42	121.39	121.36	121.33	121.30	121.28	121.25	121.23	121.20	121.18	Predicted sample dry before 2019 in Rev. 0.
699-25-34C	WL	121.1	121.49	3/31/2019	121.43	121.40	121.37	121.34	121.32	121.29	121.26	121.24	121.21	121.19	121.17	Predicted sample dry before 2019 in Rev. 0.
699-32-43	AEA-PO, CERCLA-PO, WL	121.0	121.53	1/20/2020	121.53	121.50	121.47	121.44	121.41	121.38	121.36	121.33	121.31	121.29	121.26	Not predicted sample dry in Rev. 0; open interval bottom revised (higher); blank casing below perforations.
699-32-70B	AEA-UP, CERCLA-UP, WL	128.9	130.42	4/11/2019	130.29	130.14	129.94	129.72	129.53	129.36	129.20	129.06	128.94	128.83	128.72	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth.
699-32-72B	WL	129.7	130.59	3/28/2019	130.46	130.31	130.12	129.90	129.71	129.54	129.38	129.24	129.12	129.00	128.89	Predicted sample dry by 2020 in Rev. 0.
699-32-77	None	134.3	134.62	3/13/2015	133.74	133.65	133.57	133.43	133.29	133.15	133.01	132.88	132.76	132.65	132.54	Not evaluated in Rev. 0.
699-34-41B	AEA-PO, CERCLA-PO, WL	120.8	121.59	3/31/2019	121.53	121.50	121.47	121.44	121.41	121.39	121.36	121.34	121.31	121.29	121.27	Predicted dry before 2019 in Rev. 0.
699-34-42	AEA-PO, CERCLA-PO	121.5	121.62	1/2/2019	121.54	121.51	121.48	121.45	121.42	121.39	121.37	121.34	121.32	121.30	121.28	Predicted sample dry before 2019 in Rev. 0. Successfully sampled in January 2019.
699-35-66A	AEA-UP, CERCLA-UP, CERCLA-ZP, CERCLA-ERDF, WL	128.0	128.81	3/4/2020	128.89	128.66	128.42	128.17	127.96	127.78	127.62	127.49	127.37	127.26	127.16	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth.

Table 2. Projected Water-Level Elevations (m NAVD88) for Wells Predicted to be Sample Dry by 2030

Well Name	Well Use[a]	Elev. Bottom of Open Interval[b]	Water-Level Elev.	Water-Level Date	Predicted (Simulated Adjusted) Water-Level Elevations by Year											Comments
					2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
699-36-70A	AEA-UP, CERCLA-UP, CERCLA-ZP, CERCLA-ERDF, DOH, DOH-Co, WL	127.5	129.52	3/5/2020	129.49	129.25	128.80	128.43	128.16	127.94	127.76	127.59	127.46	127.33	127.21	Predicted sample dry by 2028 in Rev. 0.
699-38-65	AEA-UP, CERCLA-UP, CERCLA-ZP, WL	126.2	128.45	2/18/2020	128.40	128.06	127.87	127.64	127.43	127.25	127.09	126.96	126.84	126.74	126.66	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth.
699-38-68A	AEA-UP, CERCLA-UP, CERCLA-ZP, WL	127.5	129.08	2/5/2020	128.93	128.63	128.09	127.62	127.29	127.04	126.84	126.68	126.53	126.41	126.29	Predicted sample dry before 2019 in Rev. 0.
699-43-41E	None	123.5	123.43	3/19/2017	123.27	123.22	123.19	123.16	123.14	123.12	123.10	123.07	123.06	123.04	123.02	Predicted sample dry before 2019 in Rev. 0.
699-45-42	AEA-BP, CERCLA-BP, CERCLA-PO, WL	121.8	122.90	1/23/2020	122.86	122.82	122.79	122.76	122.74	122.72	122.70	122.68	122.66	122.64	122.62	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth; blank casing below perforations.
699-45-69A	CERCLA-ZP, WL	125.5	126.97	4/16/2019	126.51	125.54	124.93	124.50	124.19	123.97	123.81	123.69	123.59	123.51	123.45	Predicted sample dry by 2019 in Rev. 0; sampled with bailer in 2019.
699-48-77A	SALDS	135.0	134.86	7/28/2017	134.51	136.11	136.46	136.43	136.35	136.25	136.12	136.00	135.92	135.84	135.74	Known dry but predicted to recover temporarily.
699-48-77D	AEA-ZP, WAC-SALDS, WL	134.2	134.31	12/14/2018	134.14	135.52	135.87	135.86	135.79	135.70	135.57	135.44	135.37	135.31	135.21	Predicted to recover.
699-50-30	WL	119.2	119.17	4/2/2019	119.11	119.08	119.06	119.04	119.02	119.00	118.98	118.96	118.94	118.92	118.91	Not predicted sample dry in Rev. 0; open interval bottom revised (higher) based on measured depth.
699-50-59	AEA-BP, CERCLA-BP, WL	120.8	121.66	4/17/2019	121.63	121.60	121.57	121.55	121.52	121.50	121.47	121.45	121.42	121.40	121.37	Predicted sample dry by 2019 in Rev. 0.
699-61-62	CERCLA-BP, WL	121.3	121.56	2/13/2020	121.65	121.63	121.61	121.59	121.58	121.56	121.54	121.53	121.51	121.50	121.49	Predicted sample dry before 2019 in Rev. 0. Blank casing below perforations.

Reference: NAVD88, *North American Vertical Datum of 1988*.

Notes: Yellow shading indicates sample dry (<0.9 m [3 ft] of water above bottom of open interval).

Orange shading indicates the predicted water level is below the bottom of the open interval.

a. Scheduled for sampling or water-level measurements in 2020.

b. Bottom of screened or perforated interval (ECF-HANFORD-20-0070, *Open Interval Elevations for Central Plateau Groundwater Monitoring Wells*).

AEA = *Atomic Energy Act of 1954*
BP = 200-BP groundwater interest area or 200-BP-5 Groundwater Operable Unit
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOH = Department of Health
ERDF = Environmental Restoration Disposal Facility
GW = groundwater
LERF = Liquid Effluent Retention Facility
P&T = pump and treat
LL2 = Low-Level Burial Grounds Waste Management Area 2
PO = 200-PO groundwater interest area or 200-PO-1 Groundwater Operable Unit
RCRA = *Resource Conservation and Recovery Act of 1976*
SALDS = State-Approved Land Disposal Site
SWL = solid waste landfill
T, TX-TY = Waste Management Areas T and TX-TY
WAC = *Washington Administrative Code*
WL = water level
UP = 200-UP groundwater interest area or 200-UP-1 Groundwater Operable Unit
ZP = 200-ZP groundwater interest area or 200-ZP-1 Groundwater Operable Unit

Table 3. Wells Predicted Sample Dry in Rev. 0 and not in Rev. 1

Well Name	Groundwater Interest Area	Well Use	Notes
299-E13-12	200-PO	AEA-PO	Predicted sample dry by 2027 in Rev. 0; projected decline less in Rev. 1.
299-E27-13	200-BP	200-BP-5, RCRA-C, AEA-BP	Predicted sample dry by 2027 in Rev. 0; projected decline less in Rev. 1.
299-E33-16	200-BP	200-BP-5	Predicted sample dry by 2019 in Rev. 0, but the screen elevation was incorrect.
299-E33-267	200-BP	None	Predicted sample dry by 2027 in Rev. 0; open interval bottom revised (lower).
299-E33-42	200-BP	AEA-BP,CERCLA-BP, RCRA-BBXBY, WL	Predicted sample dry by 2027 in Rev. 0; projected decline less in Rev. 1.
299-E34-12	200-BP	AEA-BP, CERCLA-BP, RCRA-B63, RCRA-LL2, AEA-LL2	Predicted sample dry by 2025 in Rev. 0; projected decline less in Rev. 1.
299-E34-2	200-BP	200-BP-5, RCRA-LL2, AEA-BP	Predicted sample dry by 2028 in Rev. 0; open interval bottom revised (lower).

AEA = *Atomic Energy Act of 1954*
BP = 200-BP groundwater interest area or 200-BP-5 Groundwater Operable Unit
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
LL2 = Low-Level Burial Grounds Waste Management Area 2
PO = 200-PO groundwater interest area or 200-PO-1 Groundwater Operable Unit
RCRA = *Resource Conservation and Recovery Act of 1976*
WL = water level

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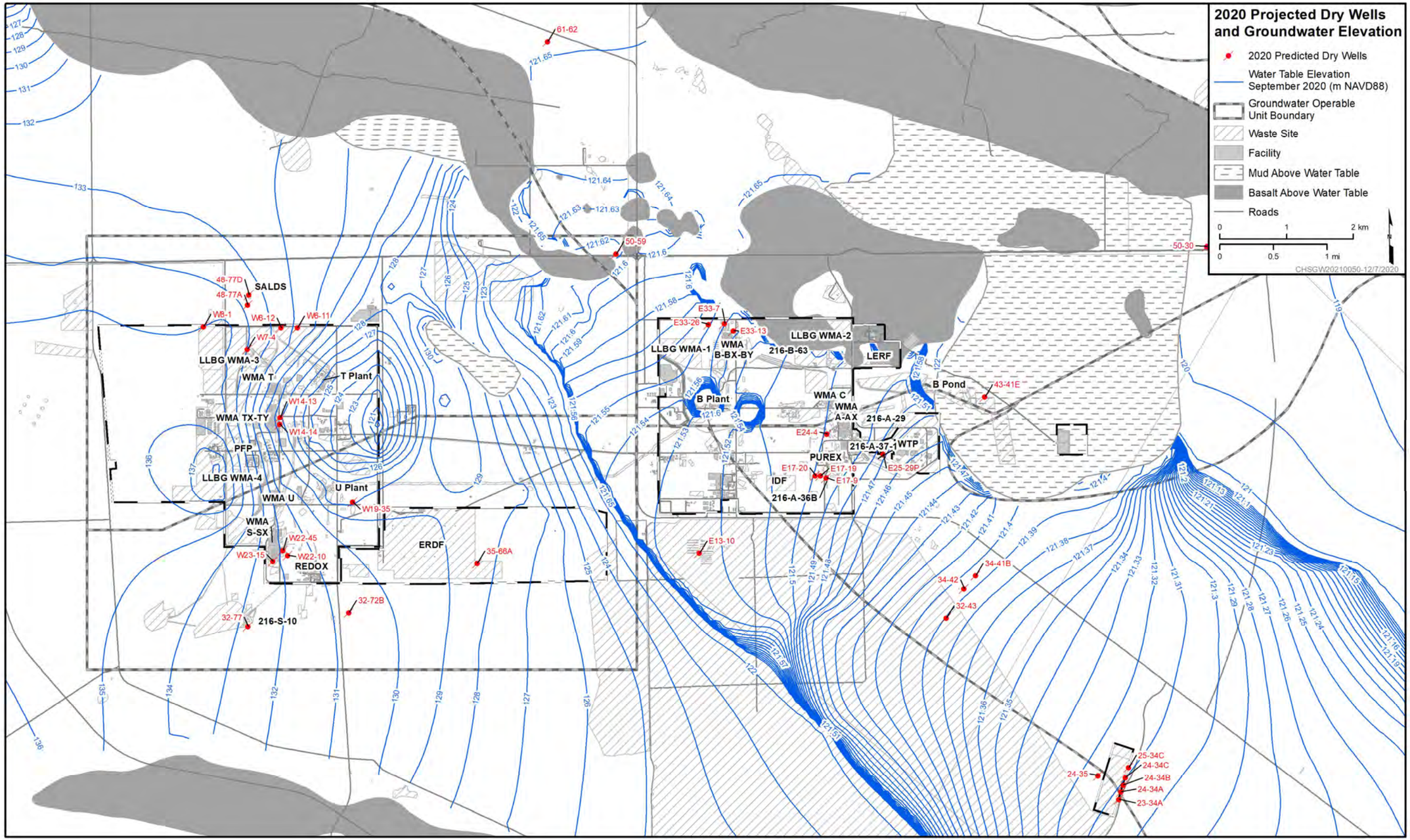

Figure 2. Predicted Water Table and Sample Dry Wells in 2020

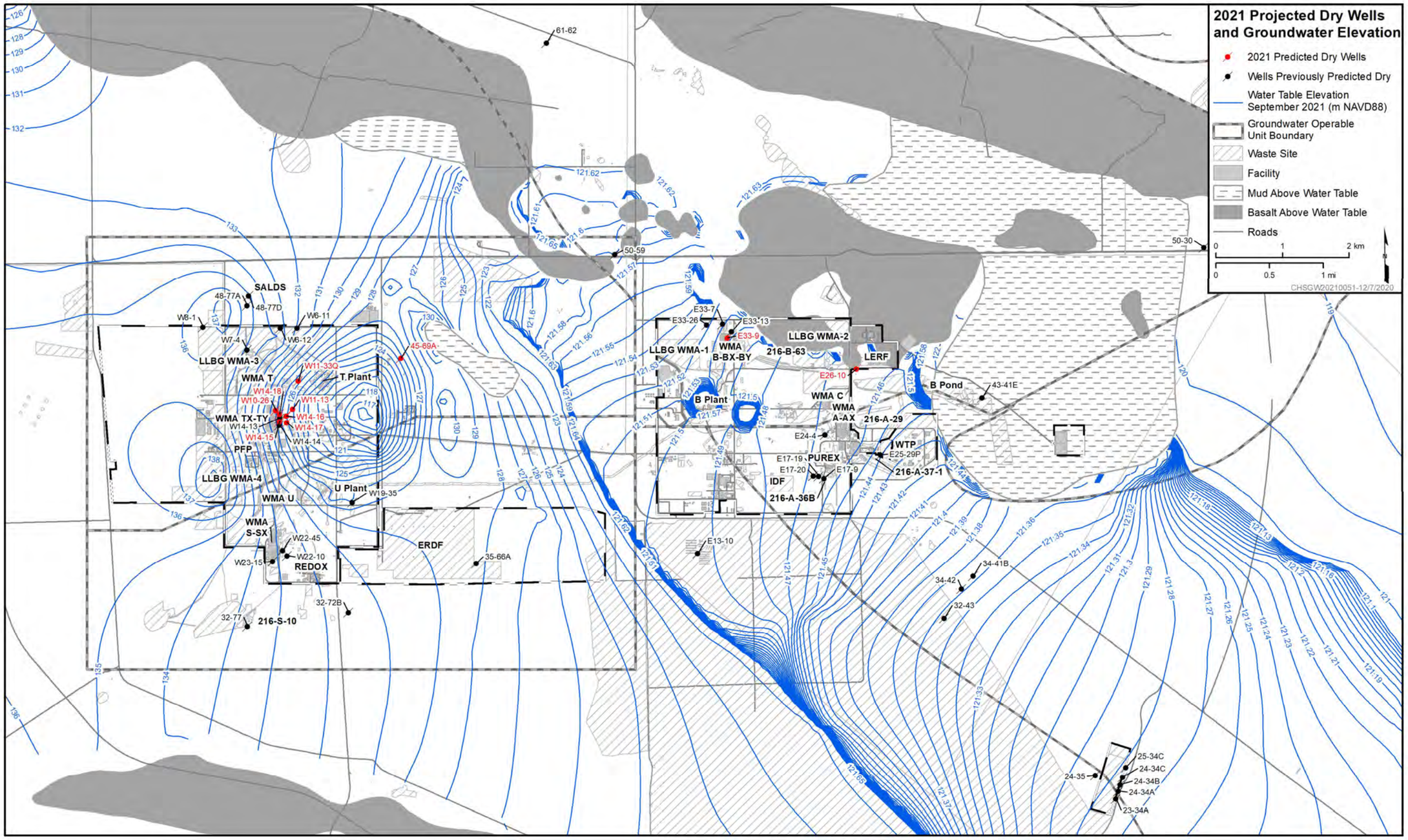

Figure 3. Predicted Water Table and Sample Dry Wells in 2021

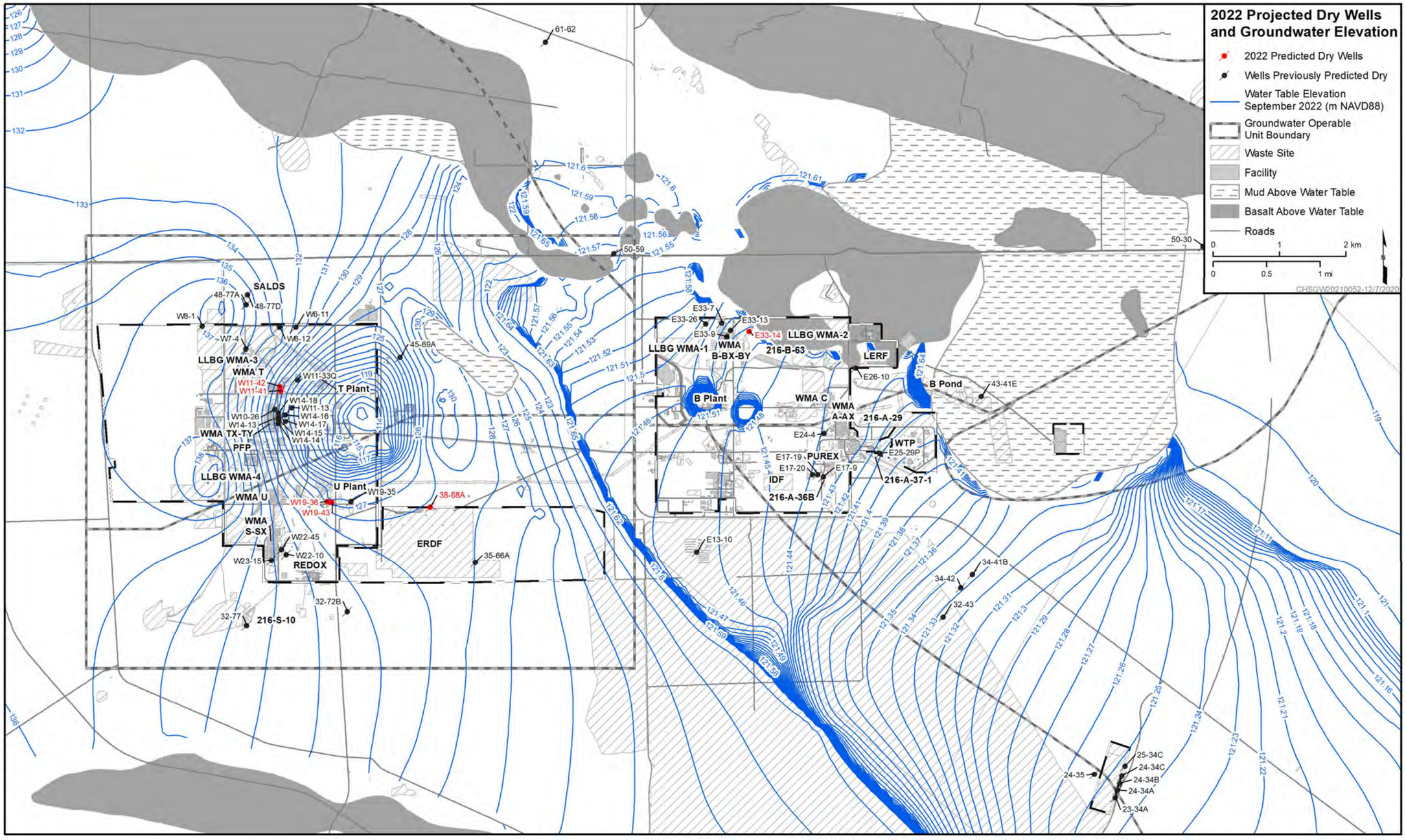

Figure 4. Predicted Water Table and Sample Dry Wells in 2022

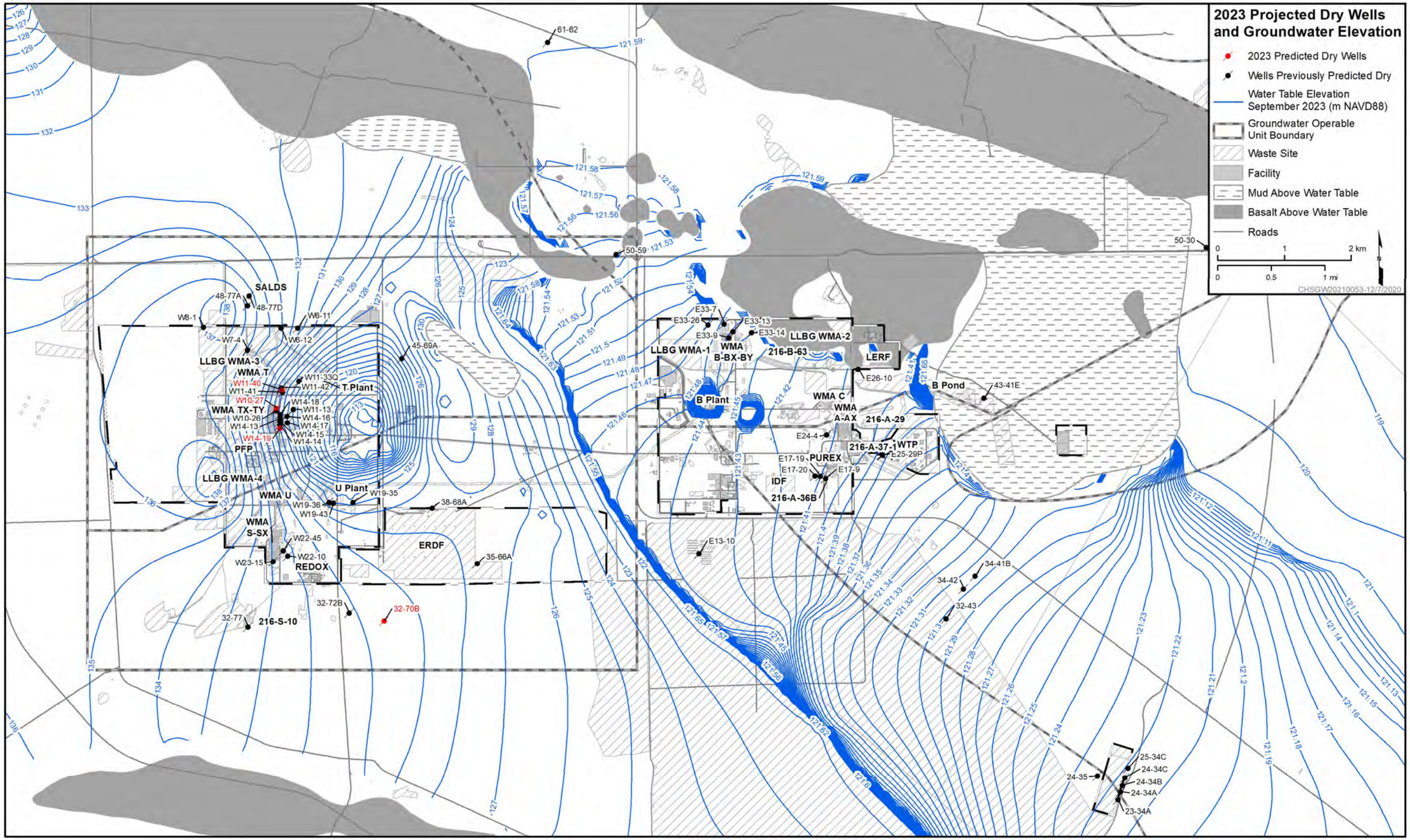

Figure 5. Predicted Water Table and Sample Dry Wells in 2023

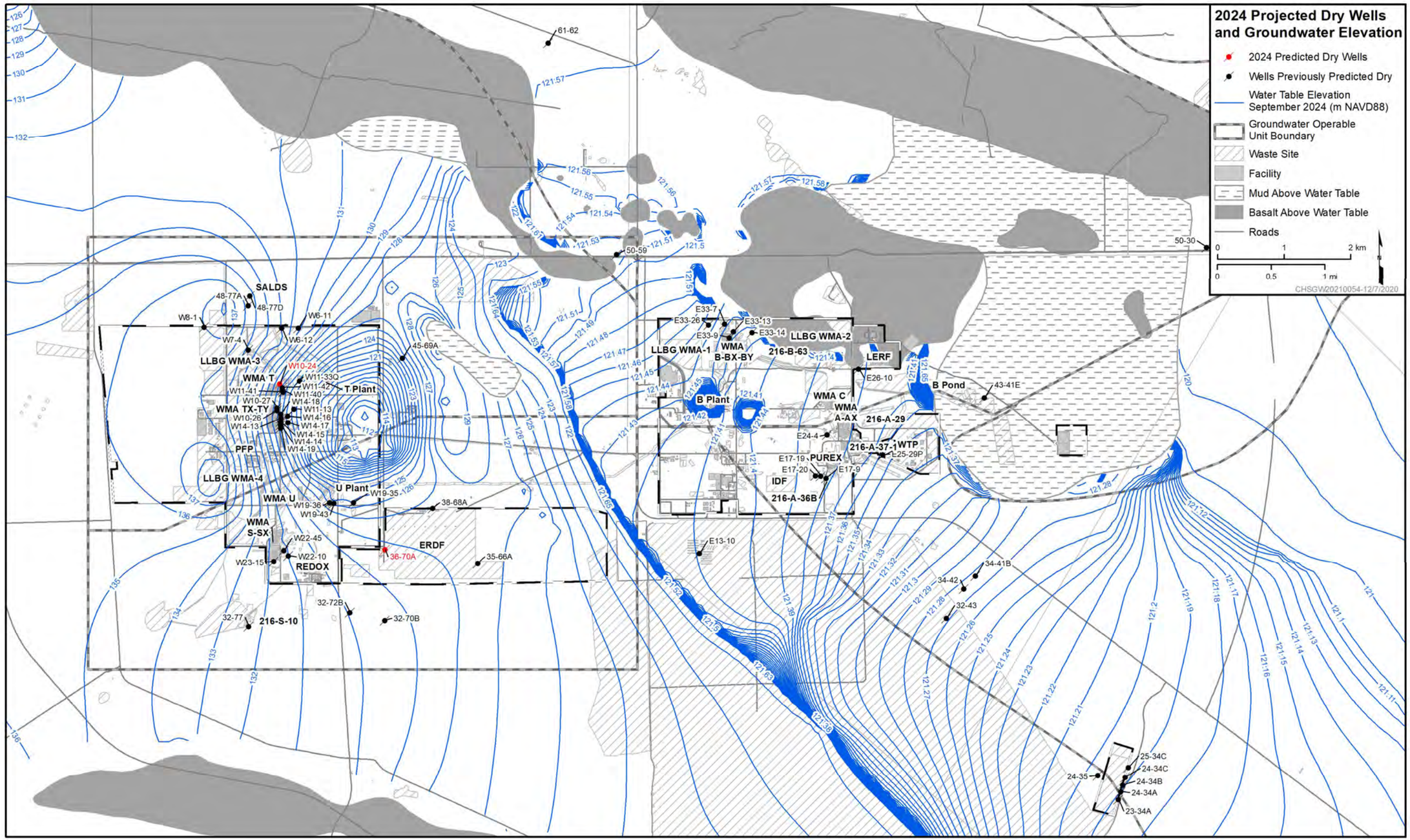

Figure 6. Predicted Water Table and Sample Dry Wells in 2024

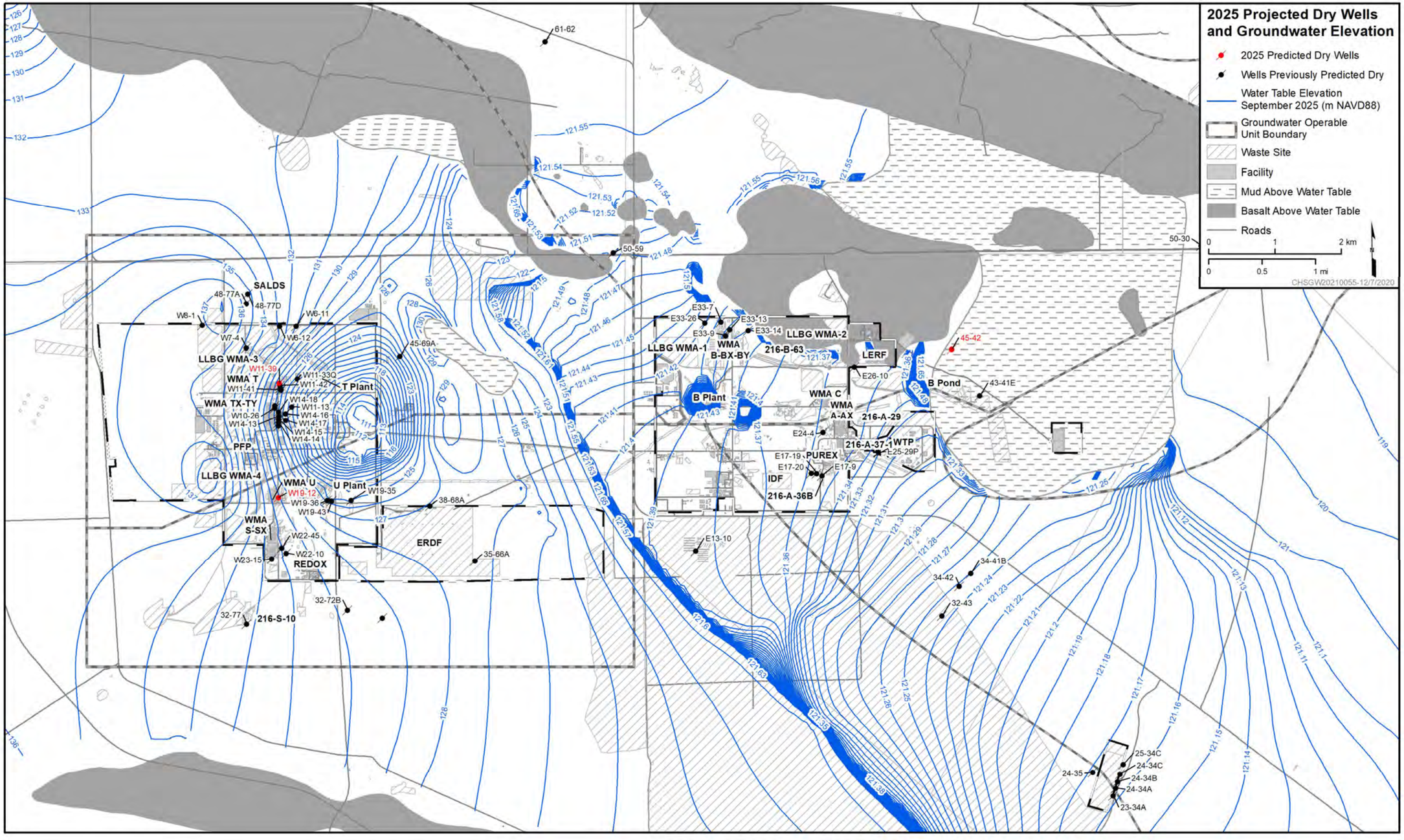

Figure 7. Predicted Water Table and Sample Dry Wells in 2025

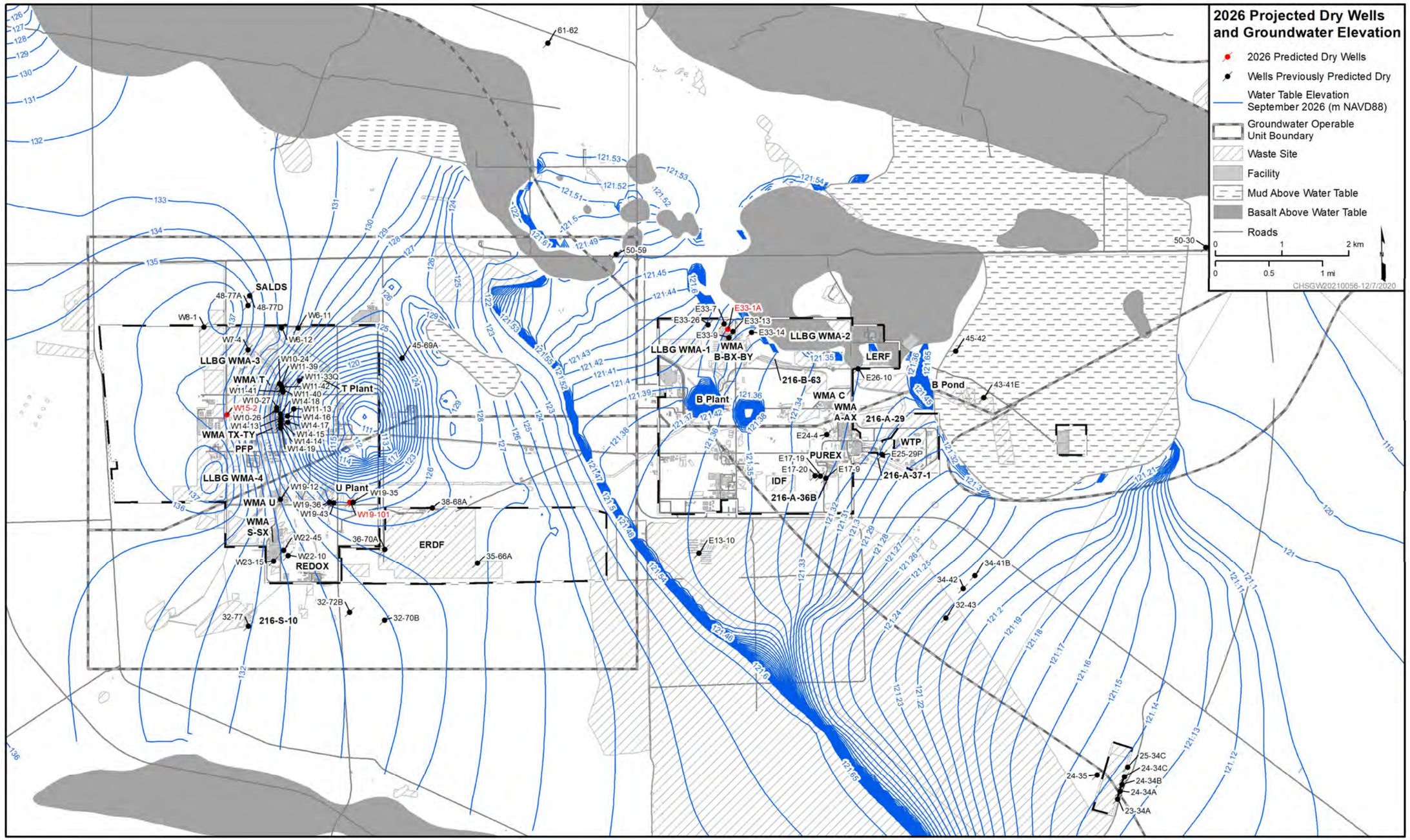

Figure 8. Predicted Water Table and Sample Dry Wells in 2026

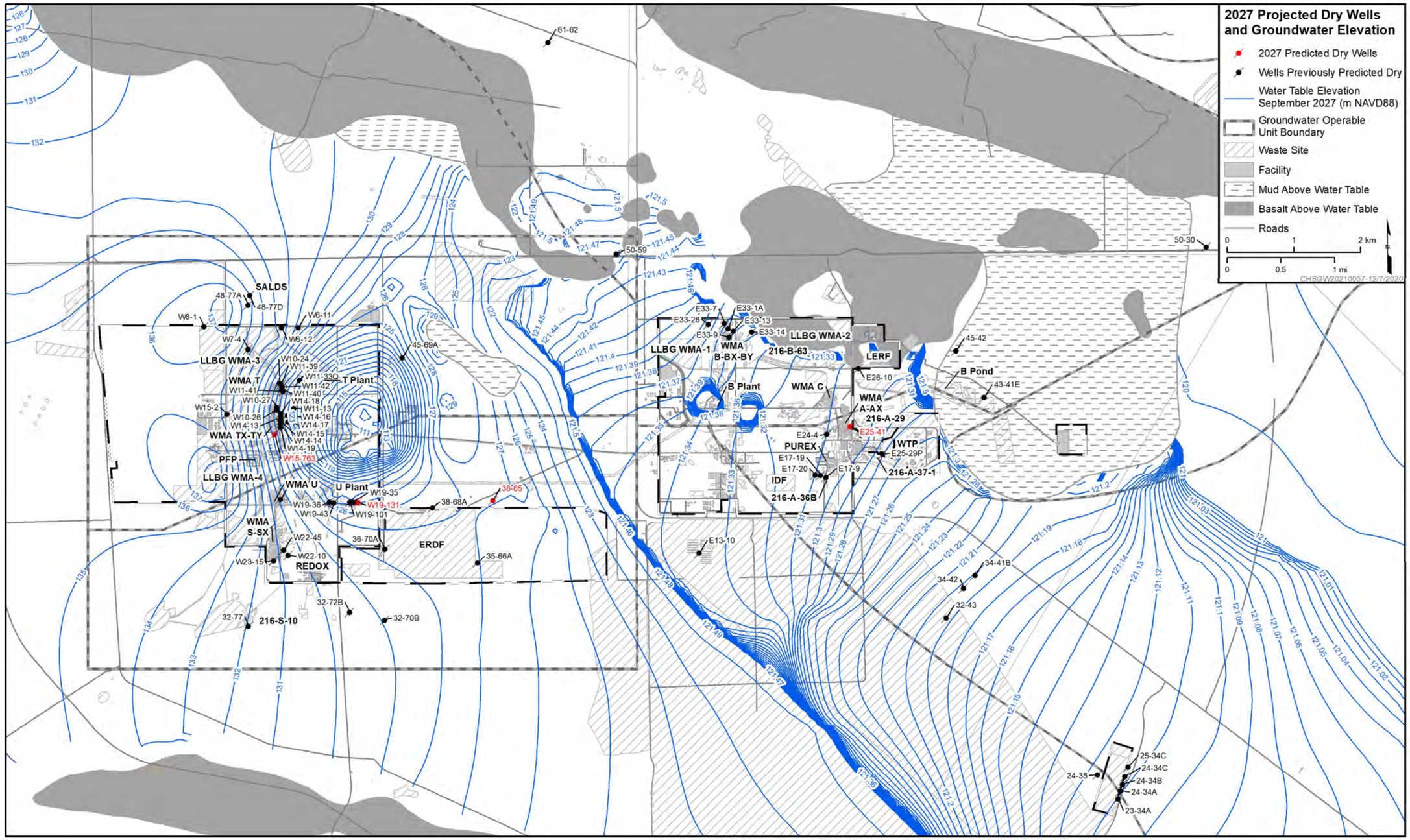

Figure 9. Predicted Water Table and Sample Dry Wells in 2027

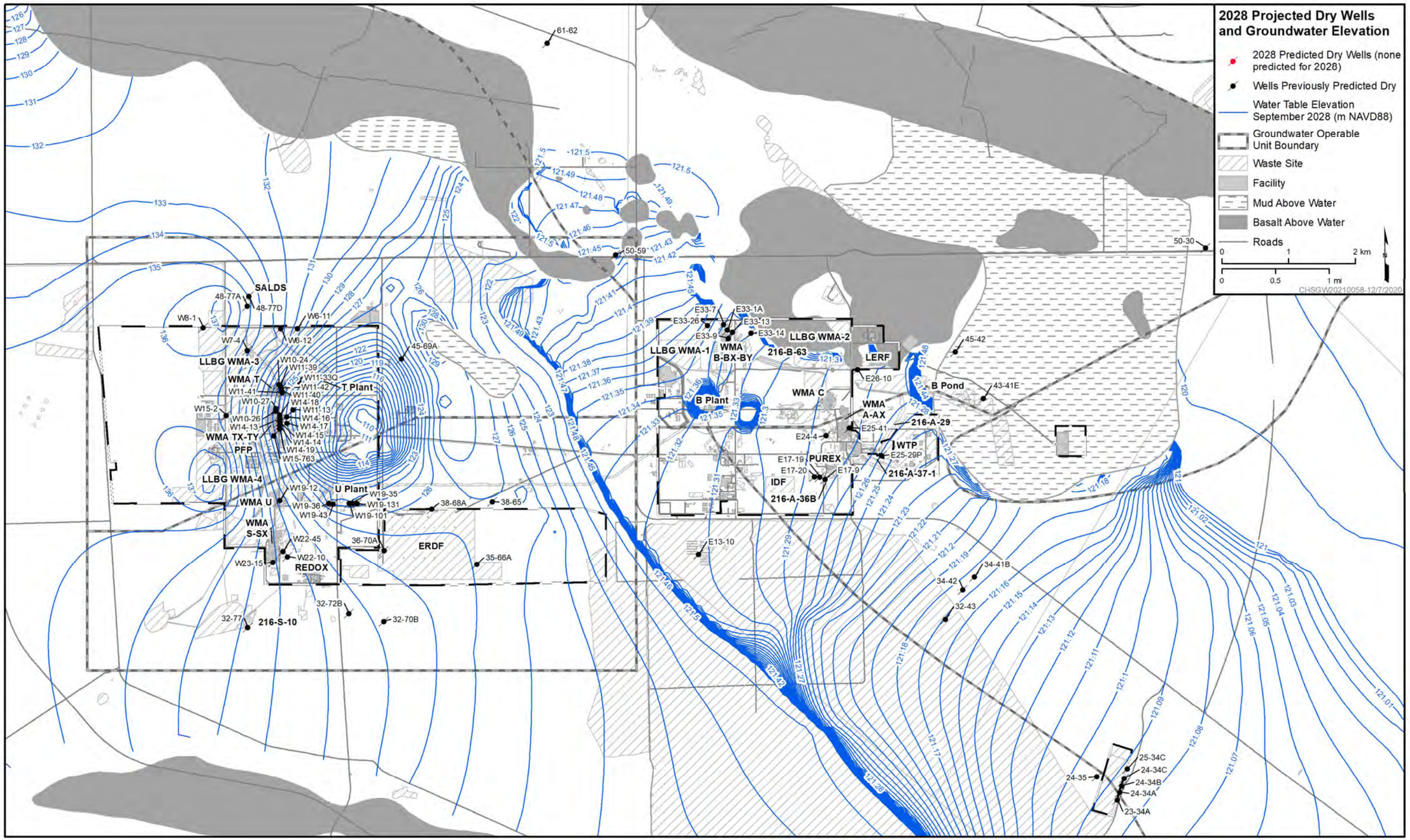

Figure 10. Predicted Water Table and Sample Dry Wells in 2028

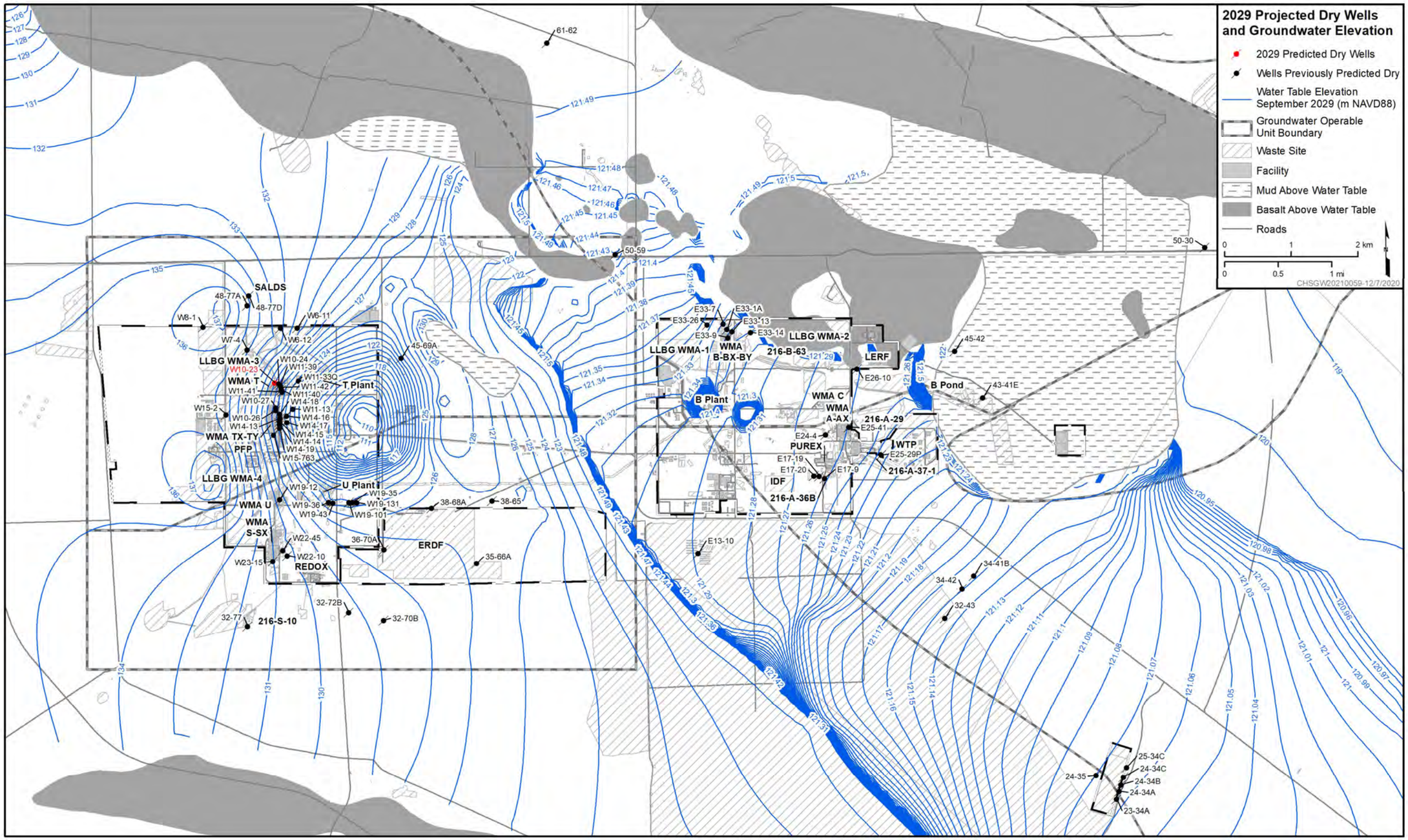

Figure 11. Predicted Water Table and Sample Dry Wells in 2029

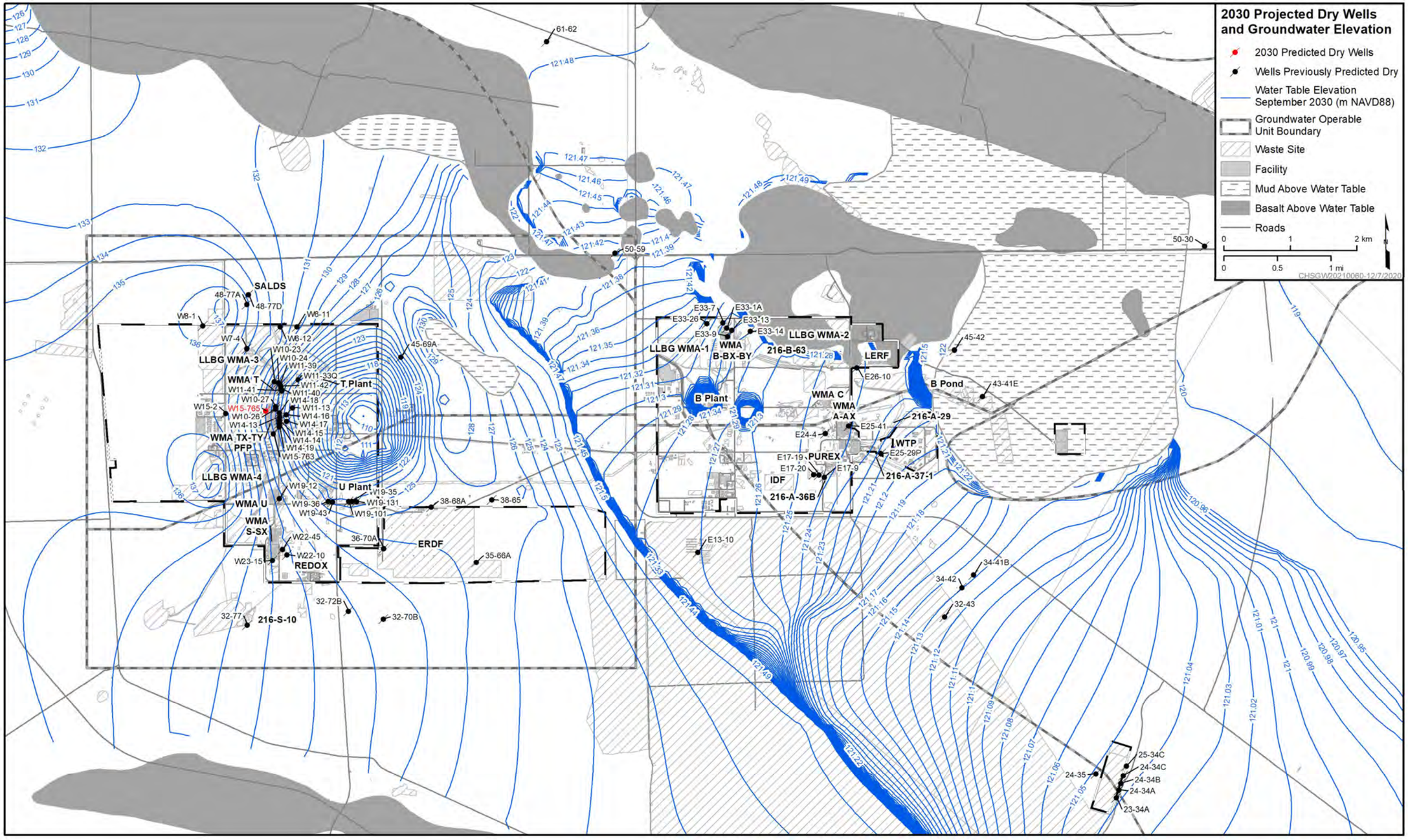

Figure 12. Predicted Water Table and Sample Dry Wells in 2030

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Appendix A

Well Location Maps

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Contents

Figures

Table

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A1 Well Location Maps

Figures A-1 through A-9 are detailed well location maps for the 520 wells evaluated in this document, along with the predicted 2030 water table.

A number of wells along the northern border of the 200 West Area, dry for many years, were evaluated to see if the wells might be sampled again after a predicted increase in the water table. Locations of those wells are shown in Figure A-6. Table A-1 compares the estimated 2030 water-table elevation to the screen bottom elevations. None of the wells are likely to be useful for sampling in the future.

Table A-1. Estimated Water Column for Wells on the Northern Boundary of the 200 West Area

Well Name	Elev. Screen Bottom (m NAVD88)	Estimated Water Table Elevation (m NAVD88)*	Estimated Water Column in 2030 (m)
299-W6-7	135.1	129.5	Dry
299-W7-1	136.3	136.8	0.5 (sample dry)
299-W7-11	137.0	136.2	Dry
299-W7-12	136.6	137.0	0.4 (sample dry)
299-W7-2	138.6	135.5	Dry
299-W7-5	136.0	134.5	Dry
299-W7-6	137.4	133.5	Dry
299-W7-7	136.5	134.0	Dry
299-W7-8	136.4	133.0	Dry
299-W7-9	137.7	137.5	Dry

Reference: NAVD88, *North American Vertical Datum of 1988*.

*Estimated from Figure A-6.

A2 Reference

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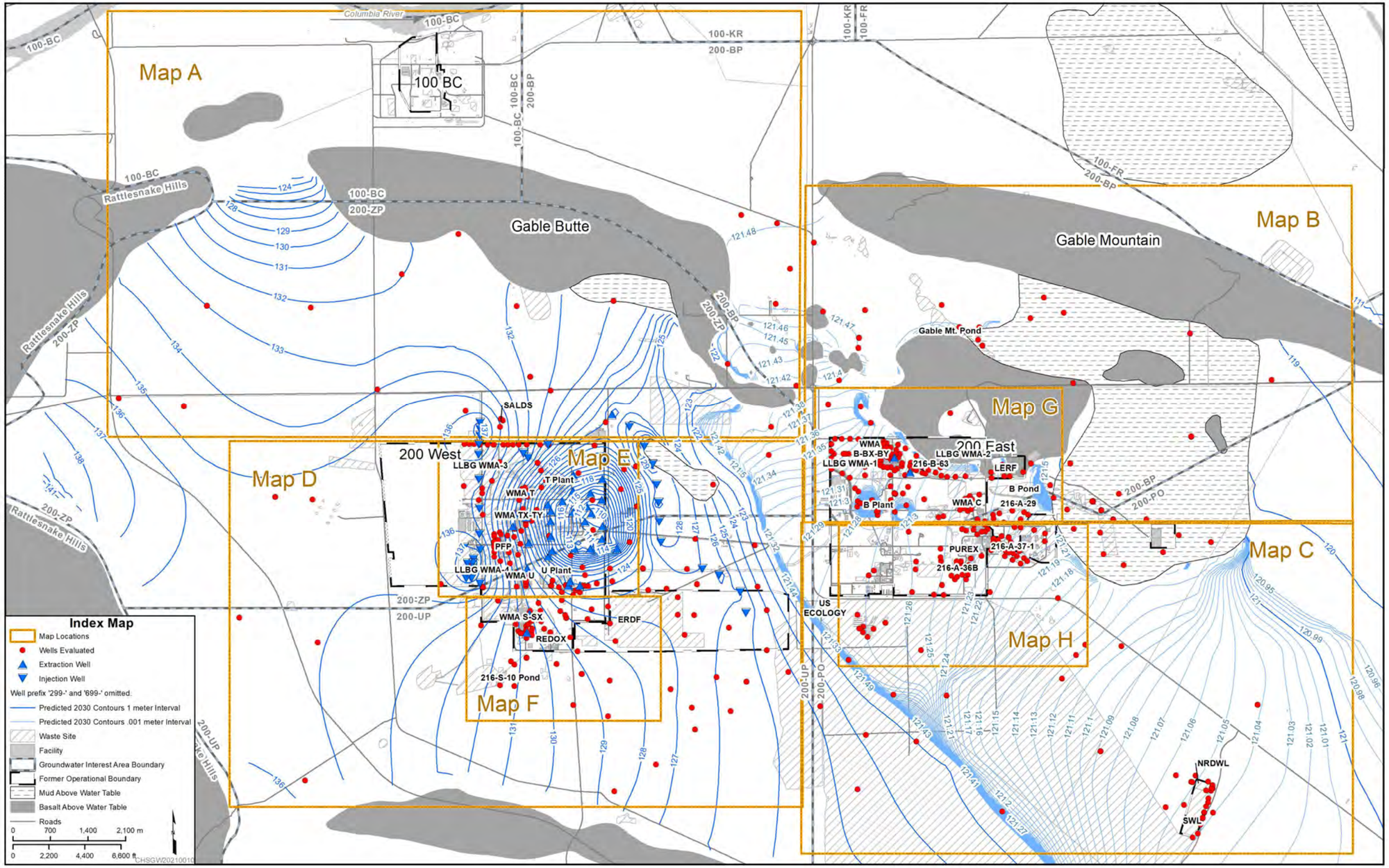

Figure A-1. Index Map and Predicted 2030 Water Table

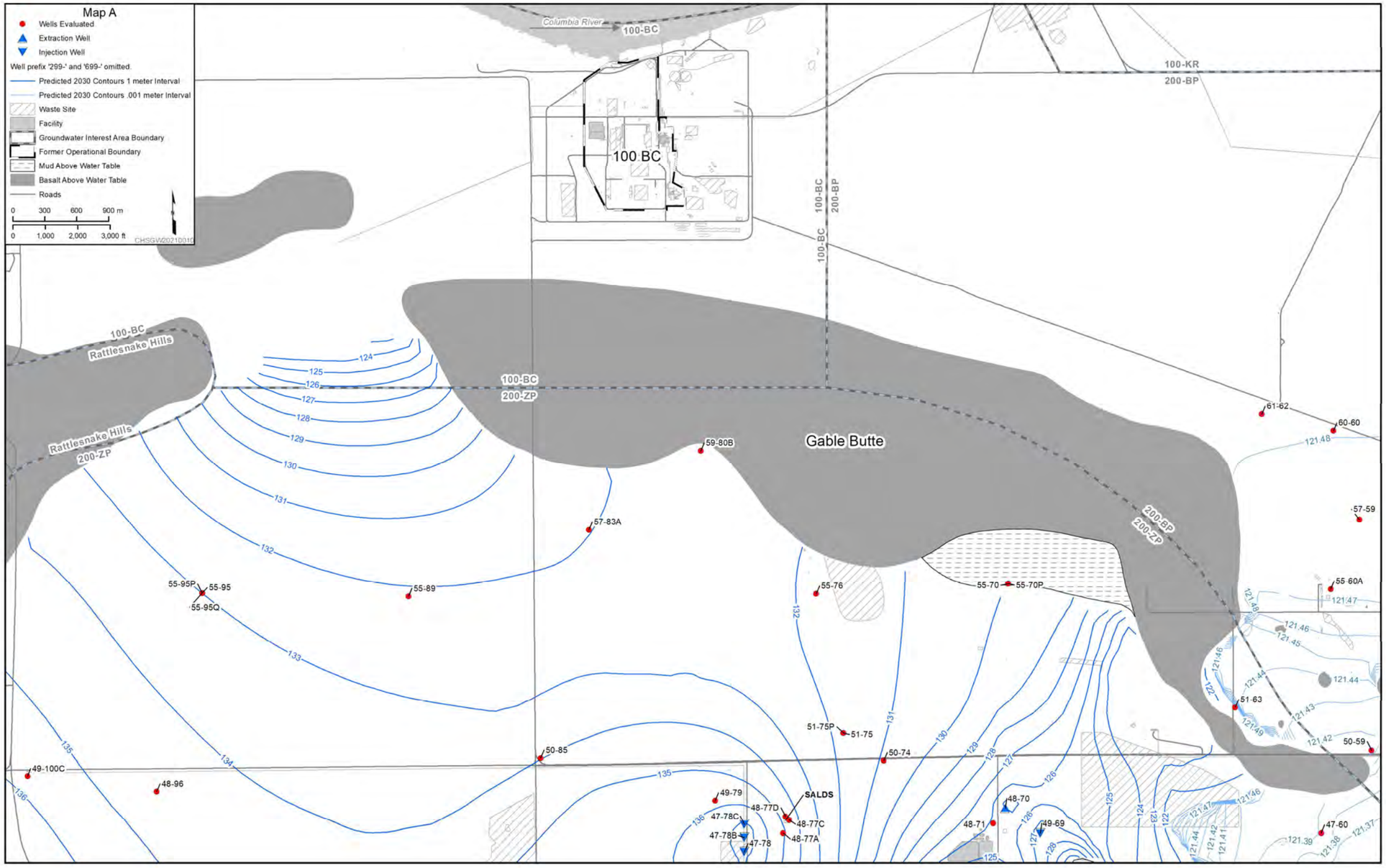

Figure A-2. Map A: Well Locations and Predicted 2030 Water Table for the Region North of the 200 West Area

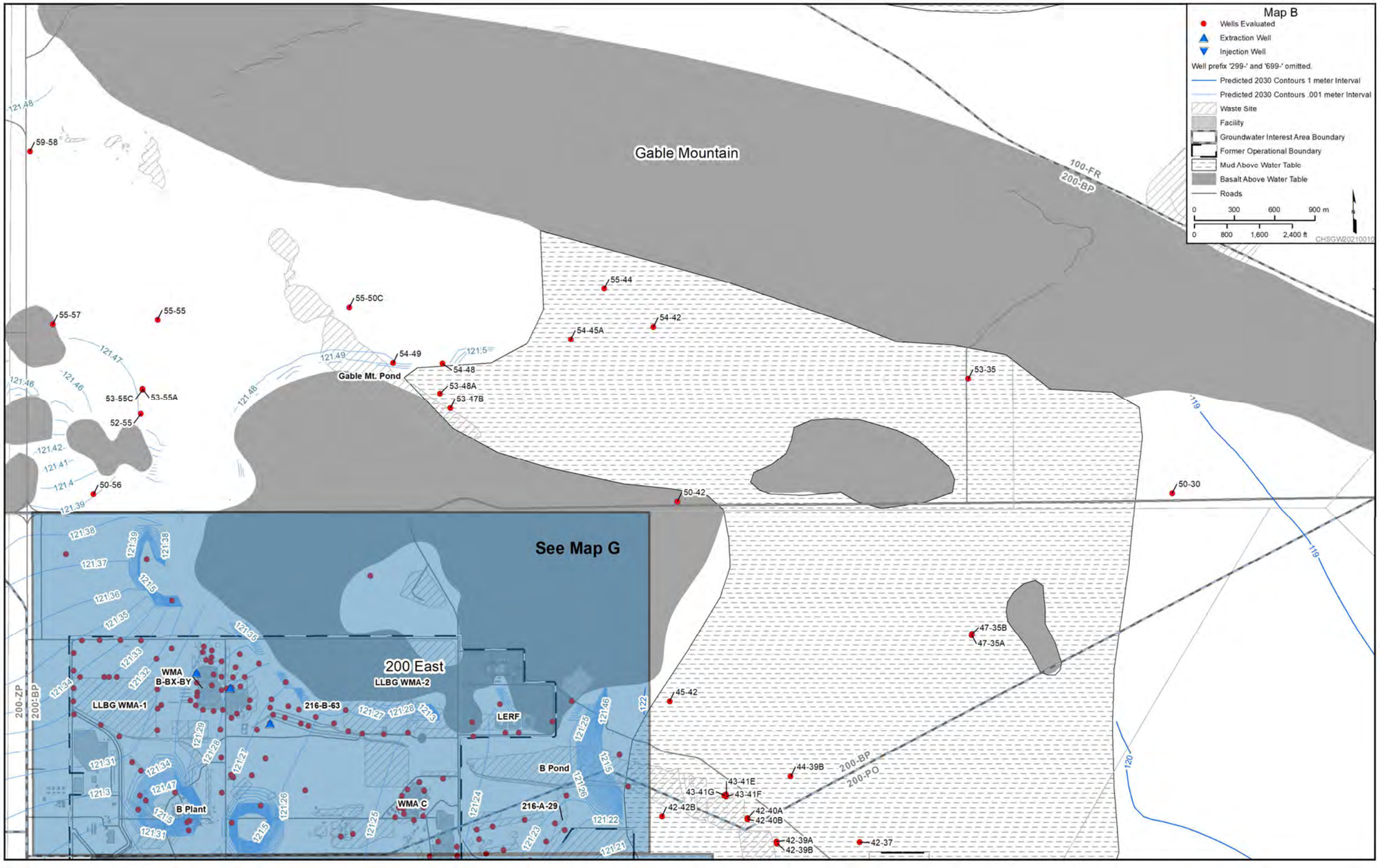

Figure A-3. Map B: Well Locations and Predicted 2030 Water Table for the Region East and North of the 200 East Area

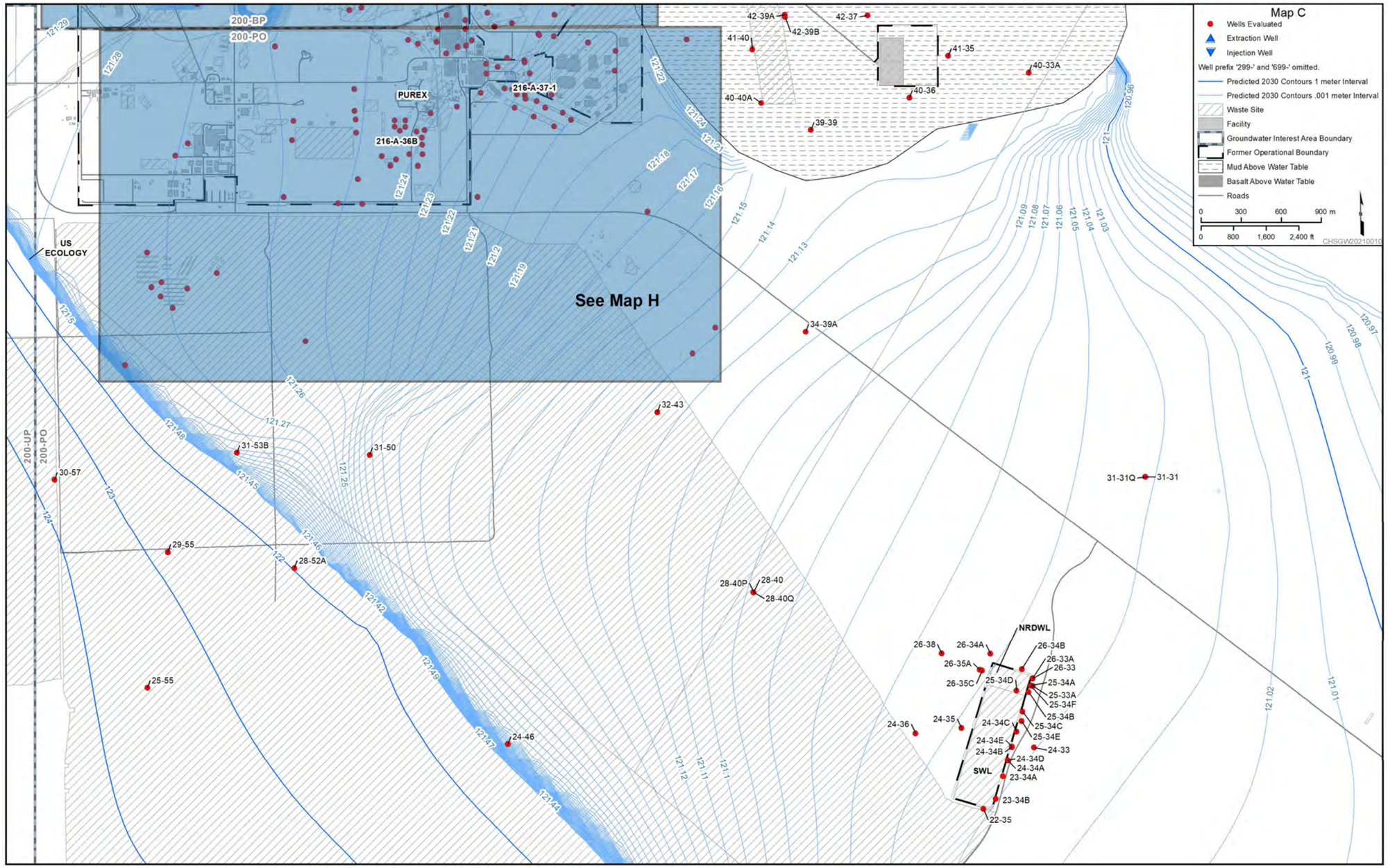

Figure A-4. Map C: Well Locations and Predicted 2030 Water Table for the Region Southeast of the 200 East Area

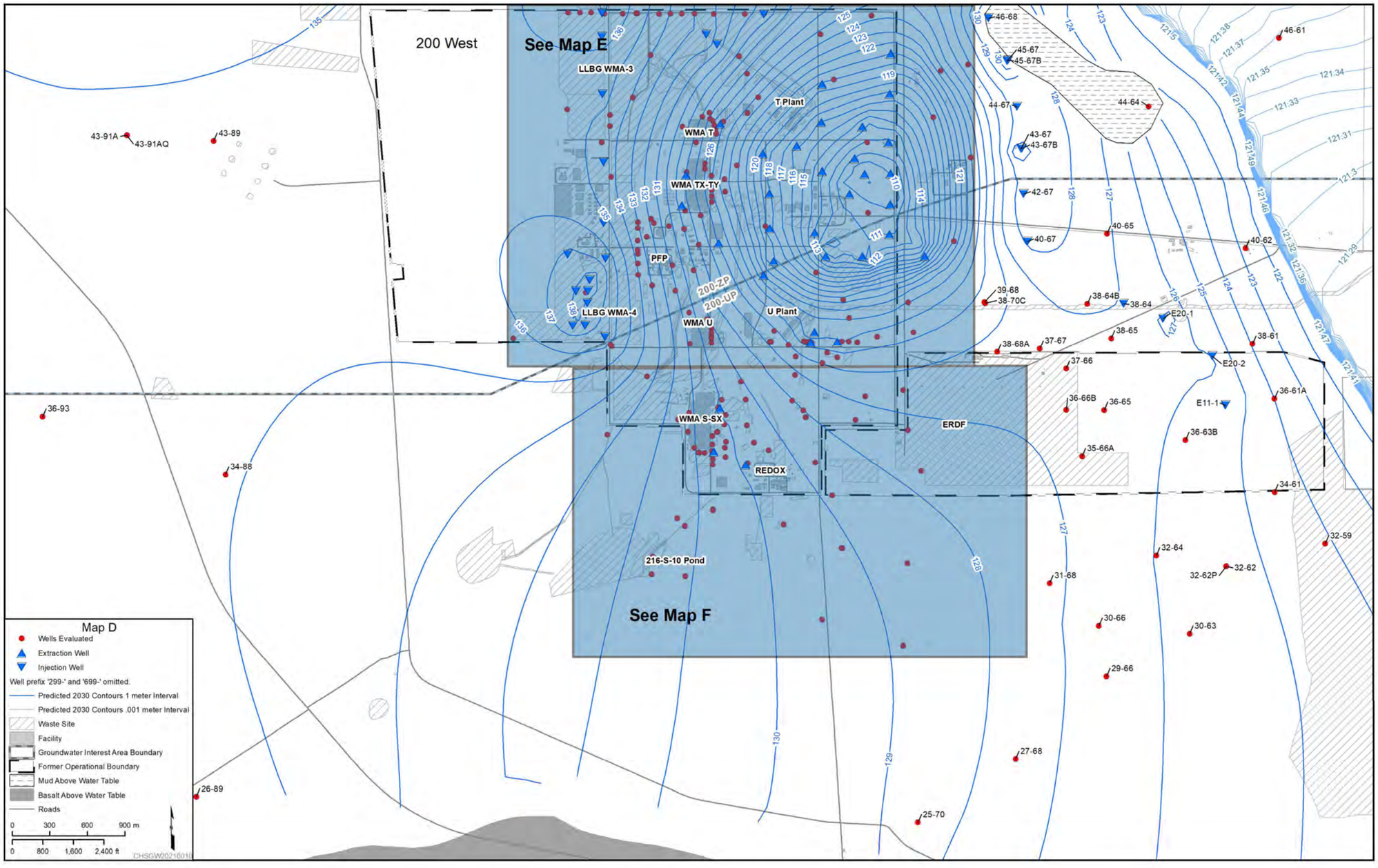

Figure A-5. Map D: Well Locations and Predicted 2030 Water Table for the Region Surrounding the 200 West Area

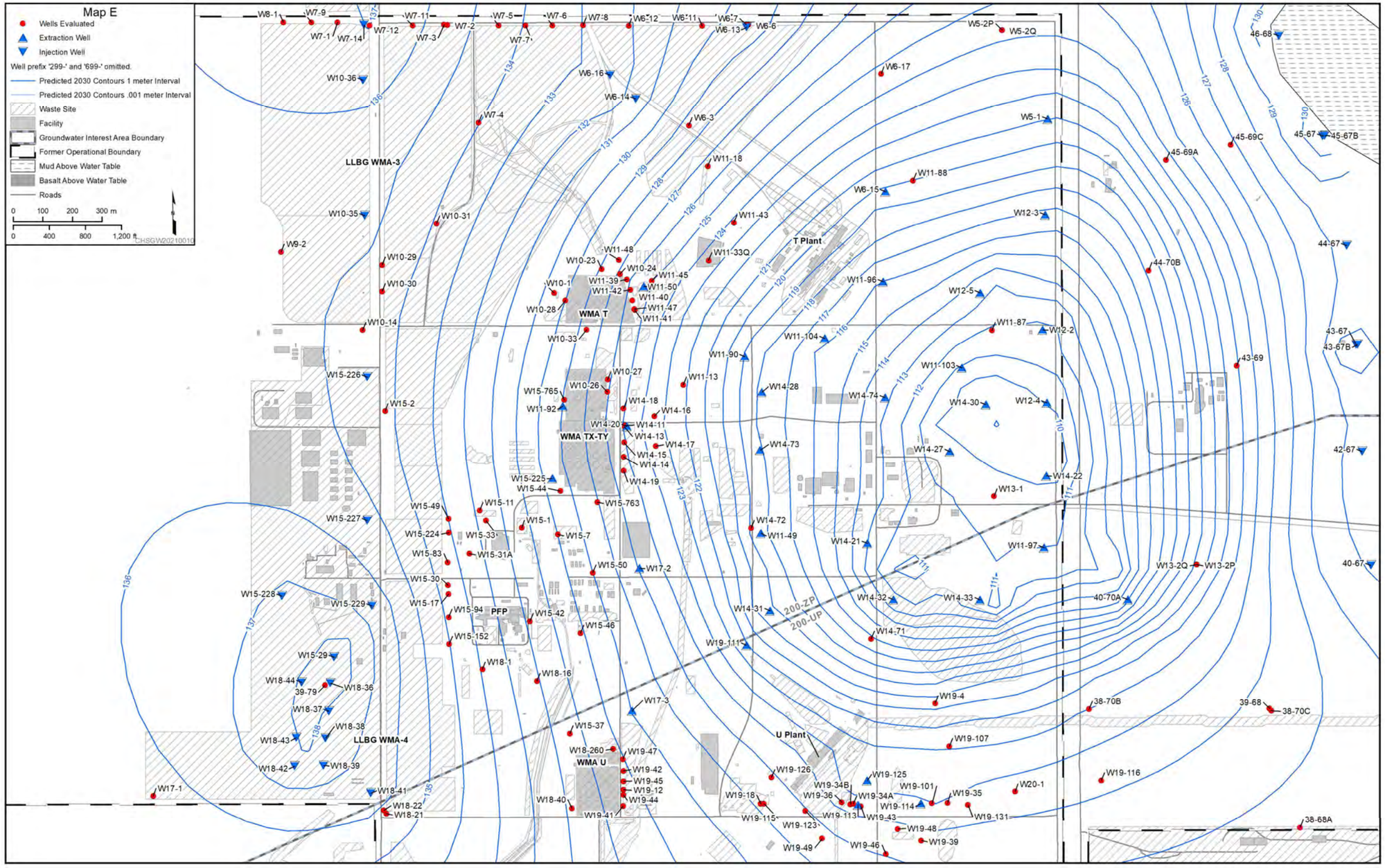

Figure A-6. Map E: Well Locations and Predicted 2030 Water Table for the Main 200 West Area

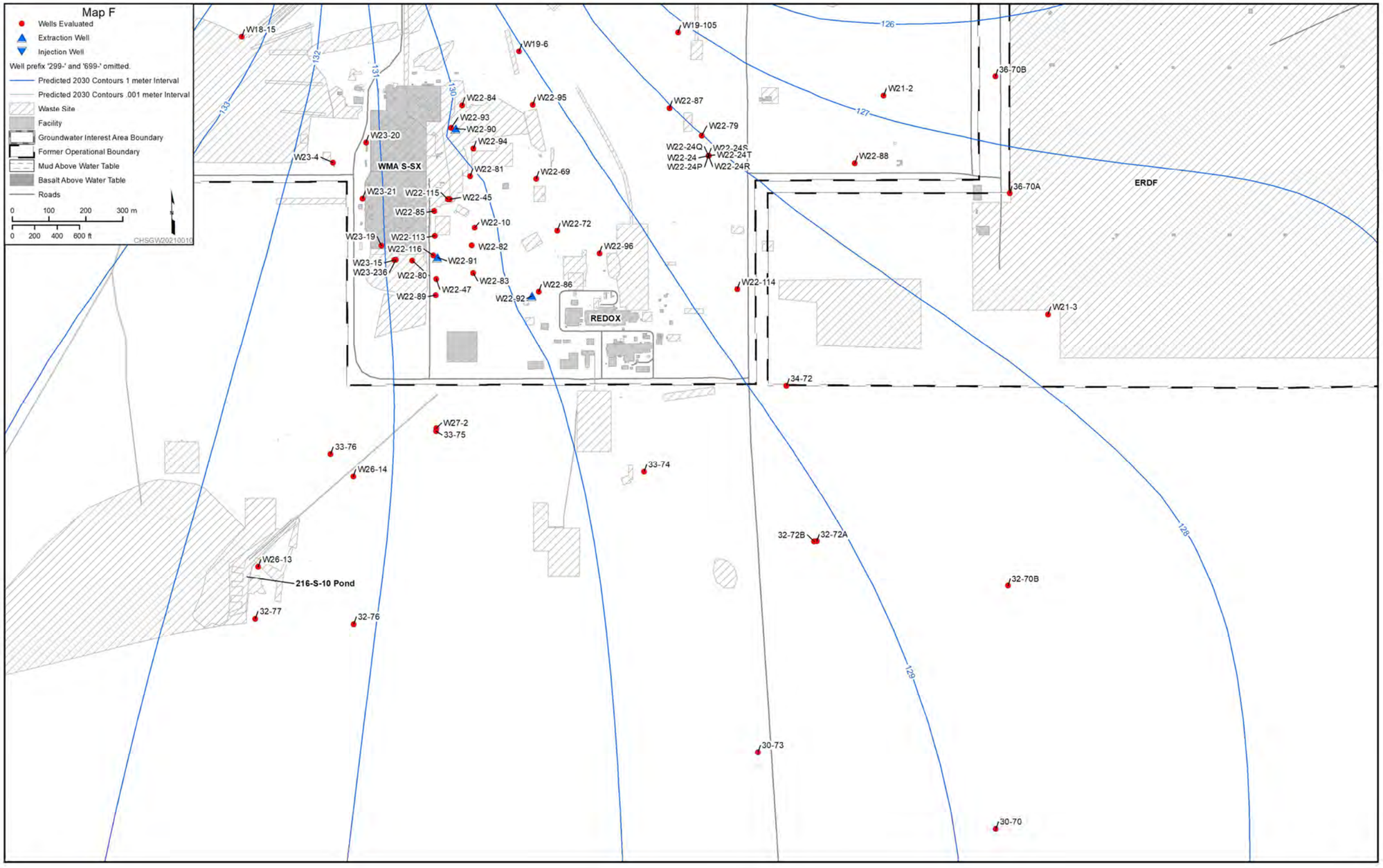

Figure A-7. Map F: Well Locations and Predicted 2030 Water Table for the Southern 200 West Area

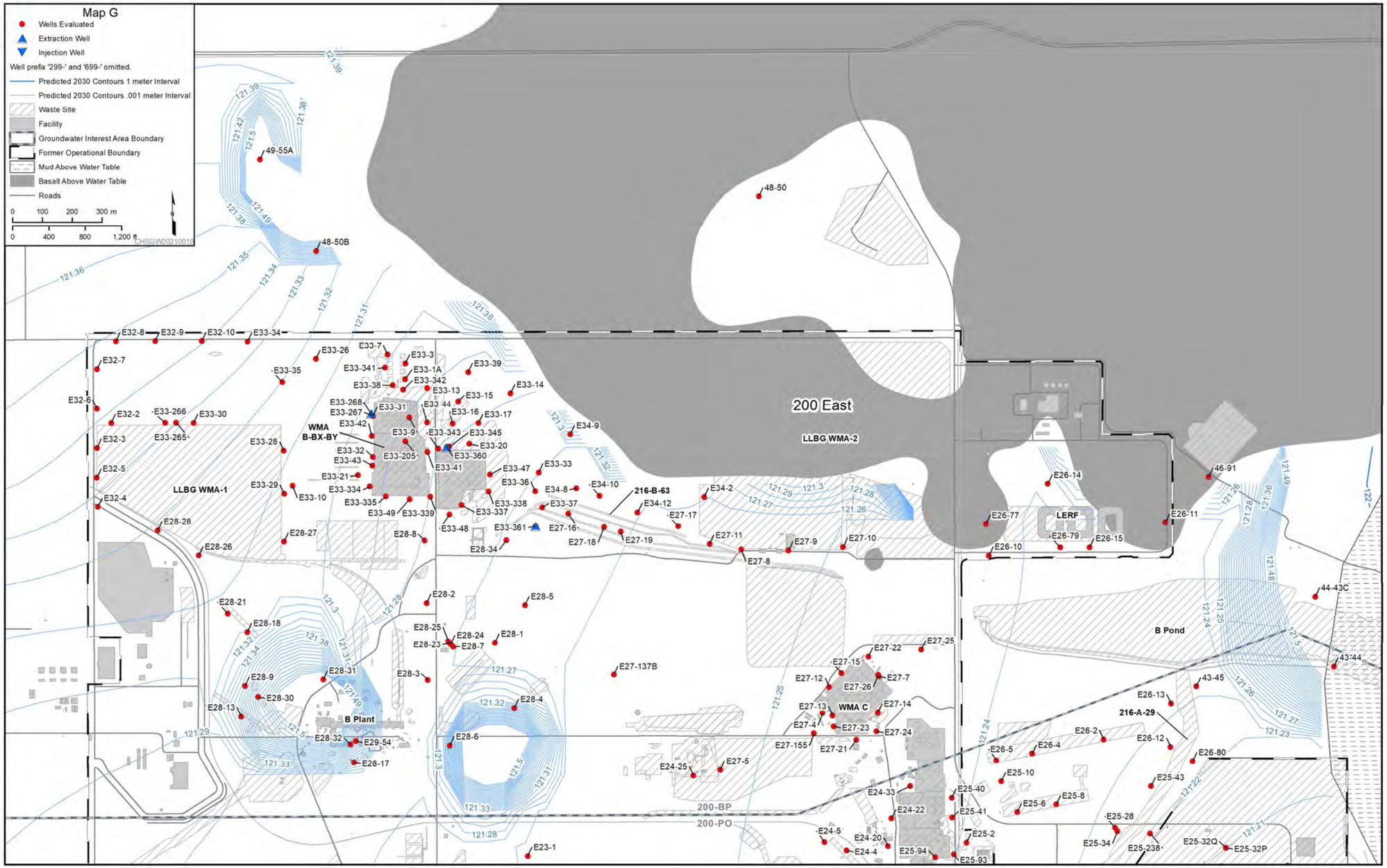

Figure A-8. Map G: Well Locations and Predicted 2030 Water Table for the Northern 200 East Area

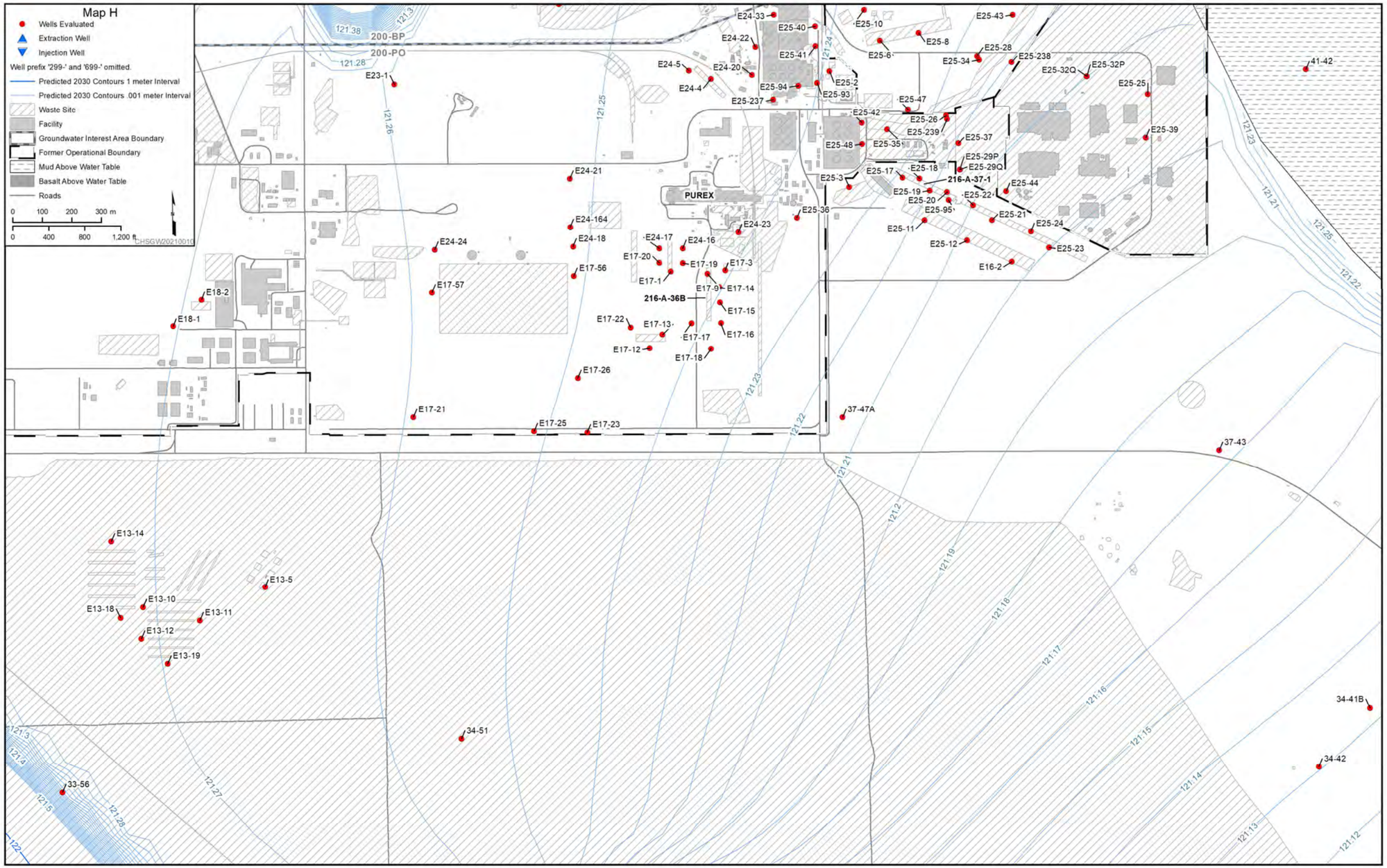

Figure A-9. Map H: Well Locations and Predicted 2030 Water Table for the Southern 200 East Area

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Appendix B

Water-Level Graphs

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Contents

Figures

B1 Water-Level Graphs

This appendix includes water-level graphs for the 520 wells evaluated (Figures B-1 through B-58). The graphs are arranged in alpha-numeric order and contain the following features:

- Measured water levels – elevations based on manual measurements
- Simulated water levels – Chapter 2 of main text
- Simulated adjusted water levels – simulations adjusted to match measured water levels
- Screen bottom – elevation of bottom of open interval (ECF-HANFORD-20-0070, *Open Interval Elevations for Central Plateau Groundwater Monitoring Wells*)
- Sample dry – screen bottom elevation plus 0.9 m (3 ft)
- Predicted – simulated water levels for 2020 through 2030

Five graphs make it appear that measured water levels were below the bottom of the open interval. The reasons for those conditions are as follows:

- Well 299-E24-4: The well has blank casing beneath the perforated interval, so the measurement may represent stagnant water in the blank casing.
- Well 699-24-34C: There are discrepancies in the well documents, and the open interval may be about 1 m (3 ft) deeper than shown on the as-built diagram.
- Well 699-43-41E: There are discrepancies in the well documents, and the measured depth suggests the well is 0.2 m deeper than the well construction diagram indicates.
- Well 699-48-77A: The last measured water levels were likely within the well cap below the screen.
- Well 699-50-30: The plug depth may be slightly deeper than records indicate.

B2 Reference

ECF-HANFORD-20-0070, 2020, *Open Interval Elevations for Central Plateau Groundwater Monitoring Wells*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/AR-04499

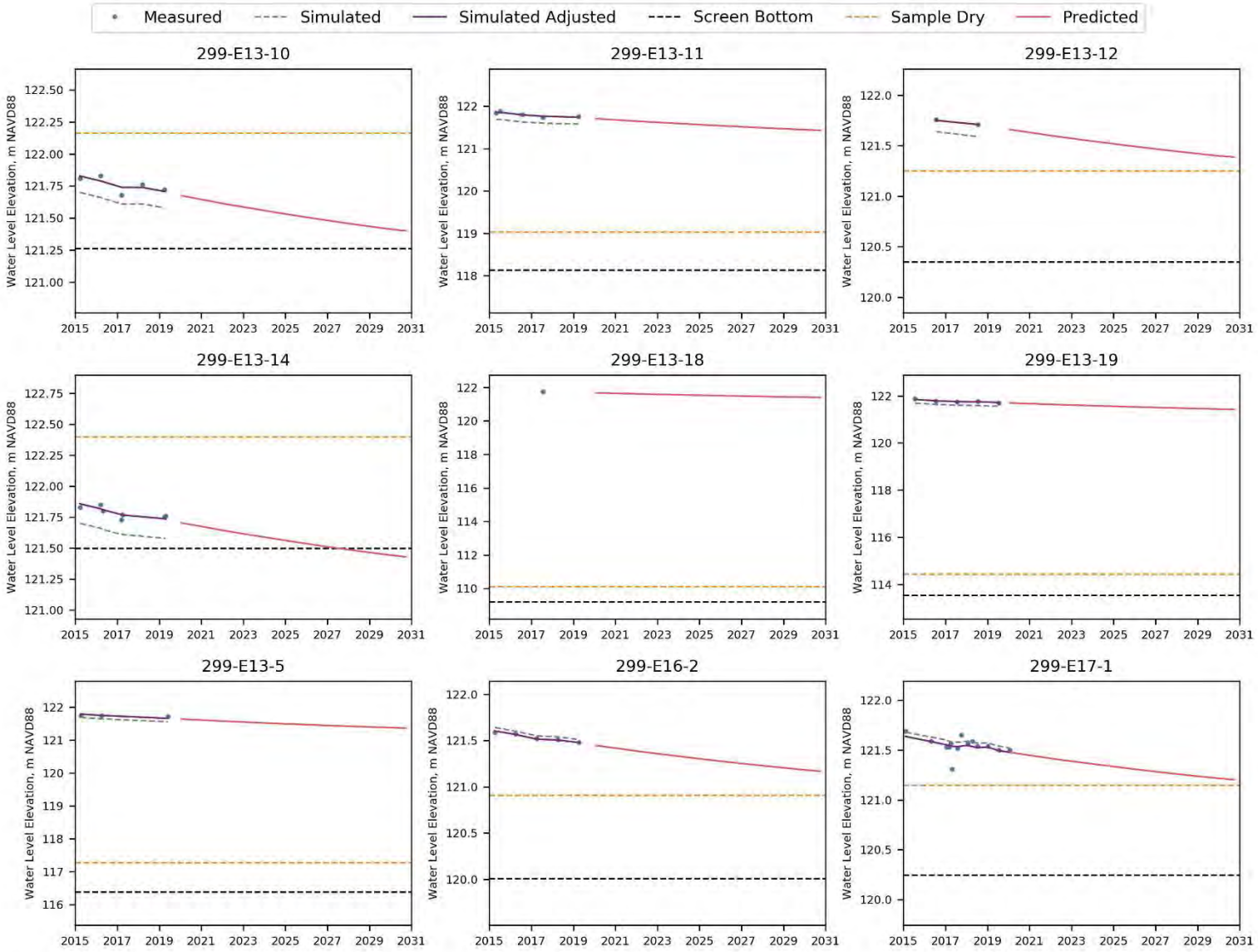

Figure B-1. Water-Level Graphs for Wells 299-E13-10 Through 299-E17-1

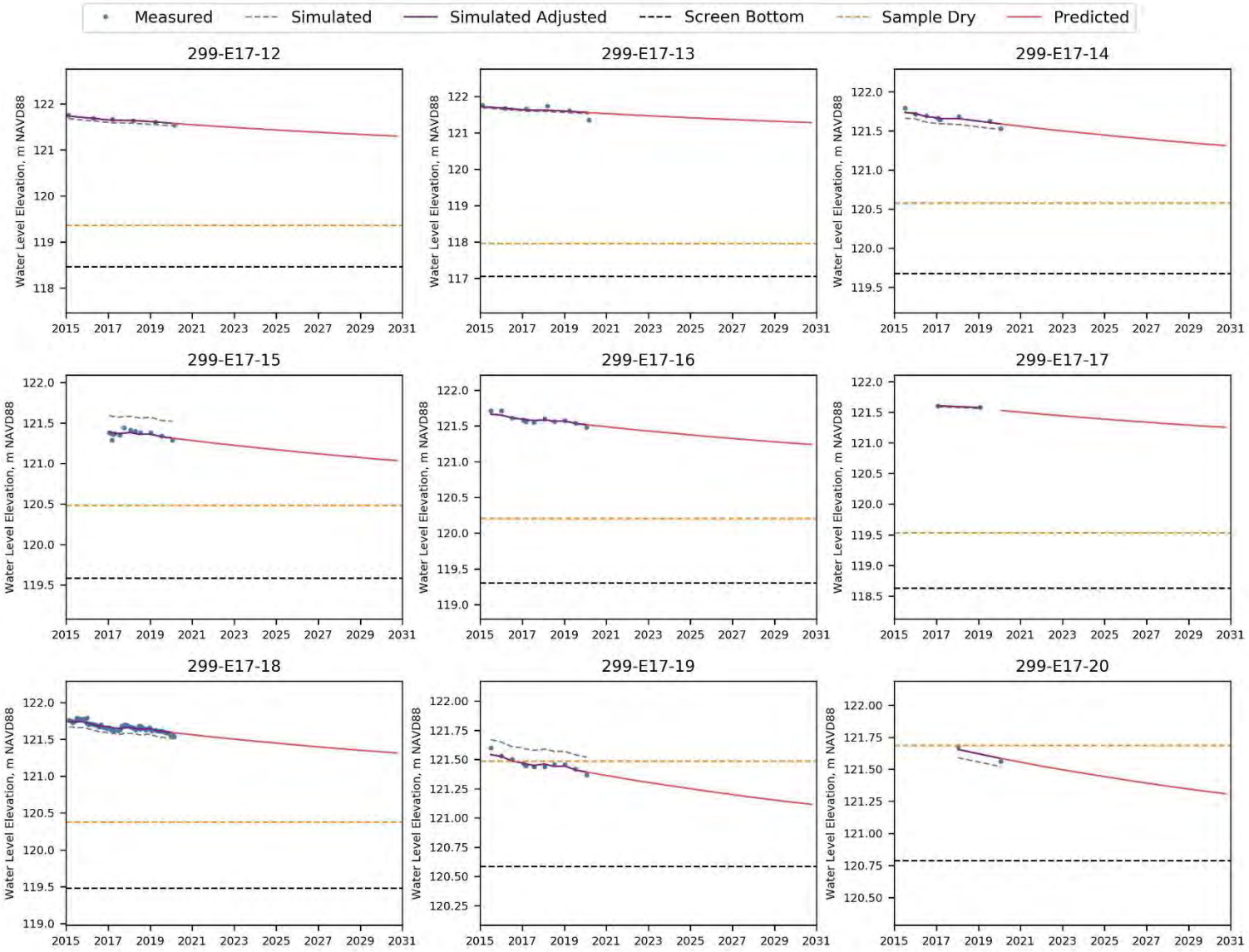

Figure B-2. Water-Level Graphs for Wells 299-E17-12 Through 299-E17-20

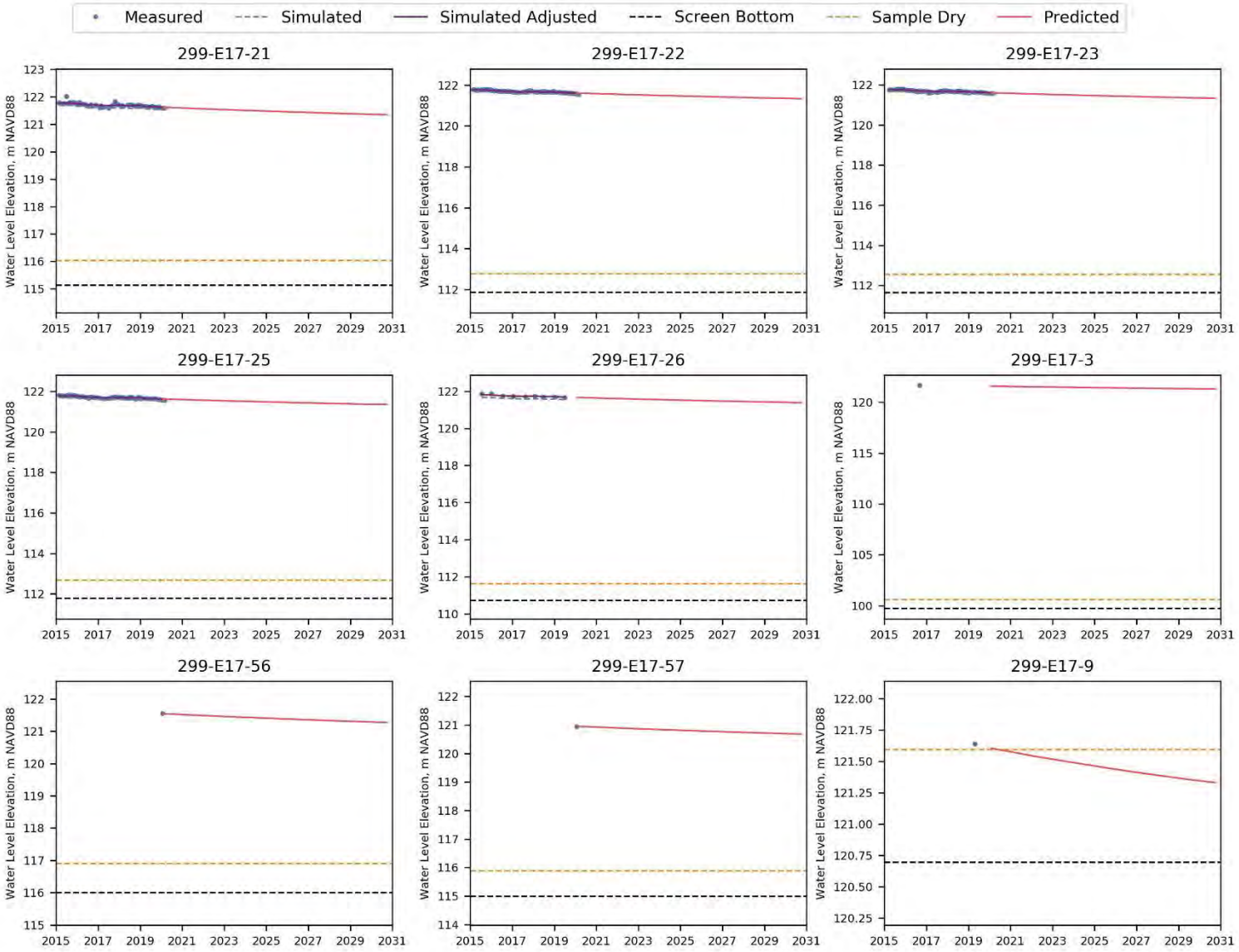

Figure B-3. Water-Level Graphs for Wells 299-E17-21 Through 299-E17-9

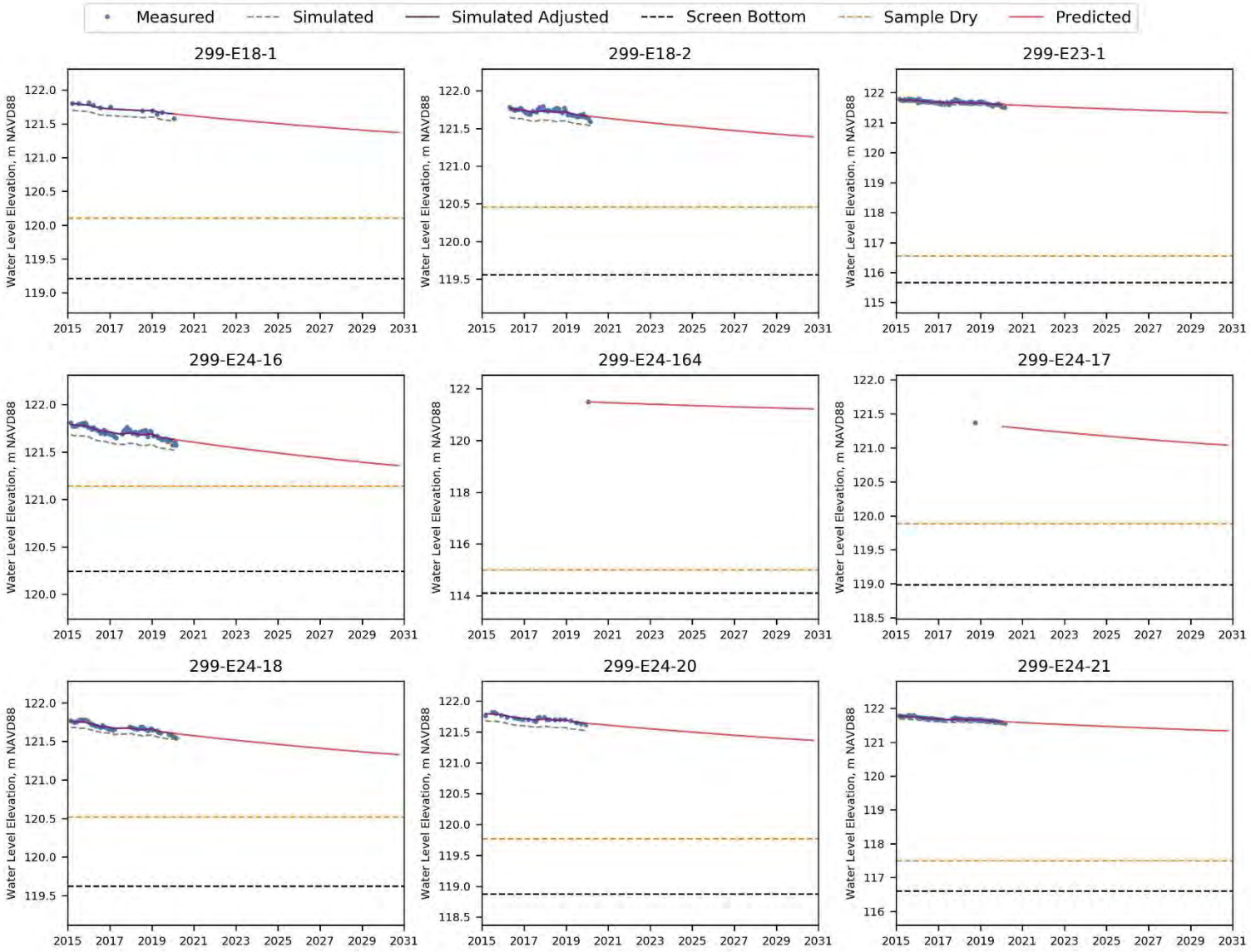

Figure B-4. Water-Level Graphs for Wells 299-E18-1 Through 299-E24-21

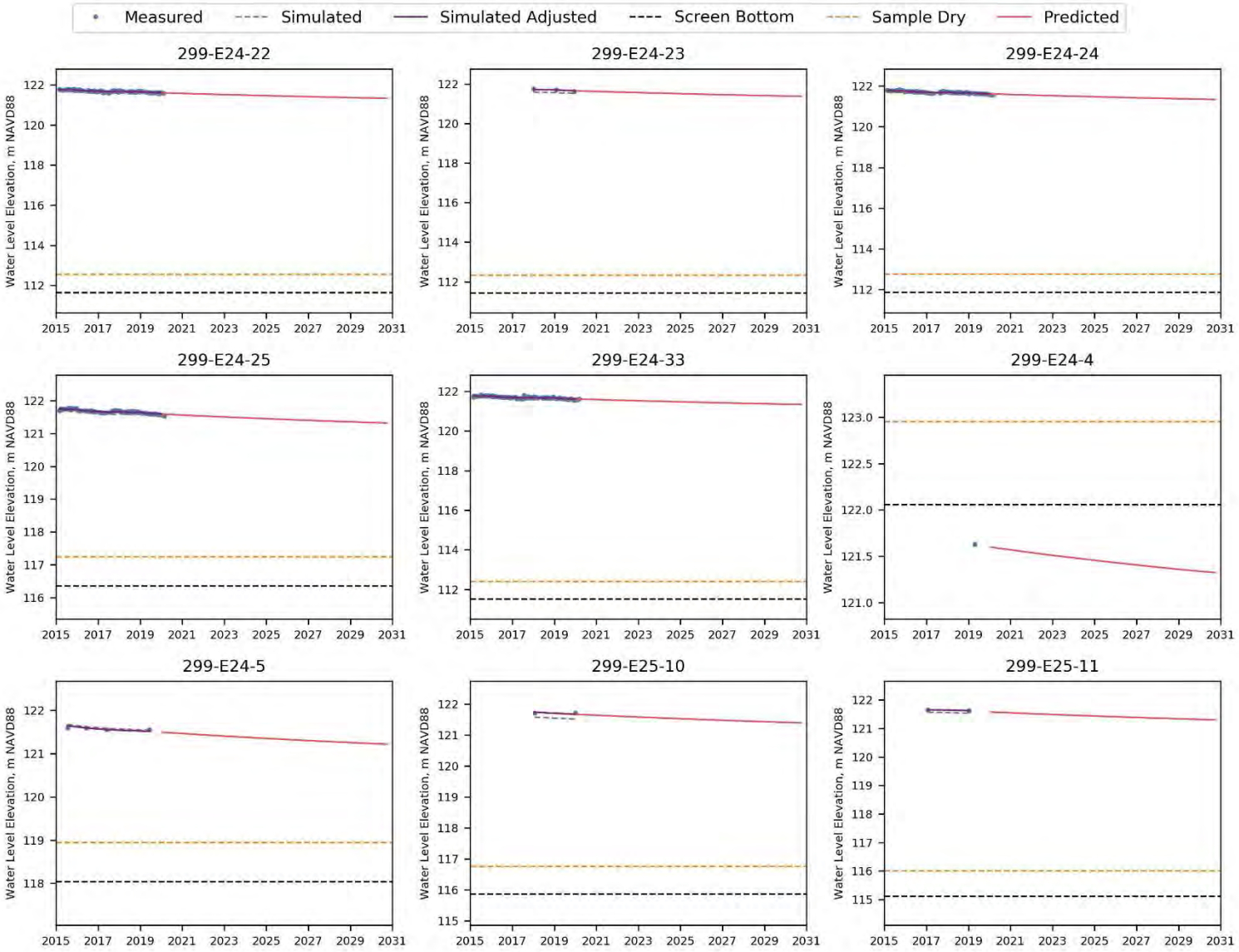

Figure B-5. Water-Level Graphs for Wells 299-E24-22 Through 299-E25-11

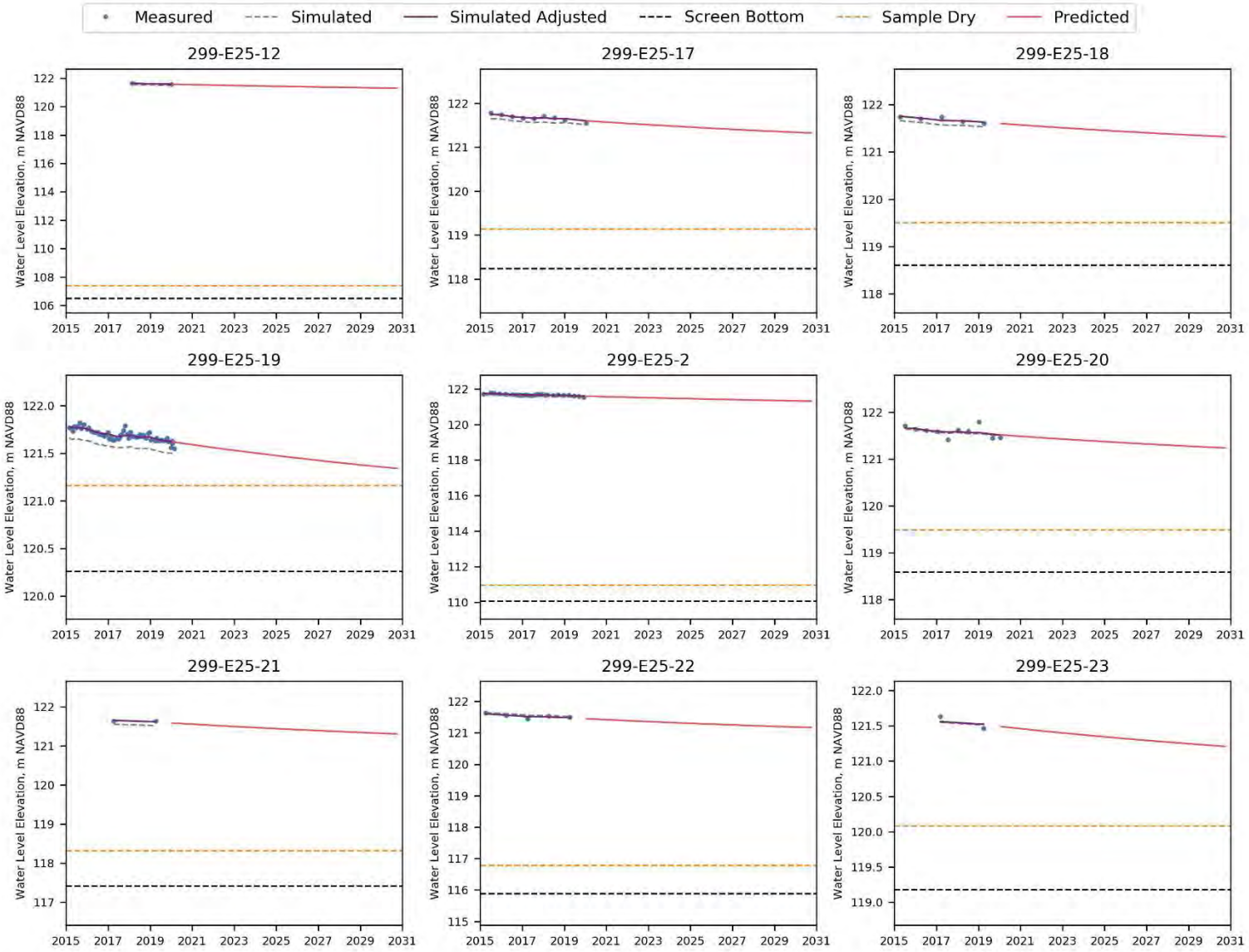

Figure B-6. Water-Level Graphs for Wells 299-E25-12 Through 299-E25-23

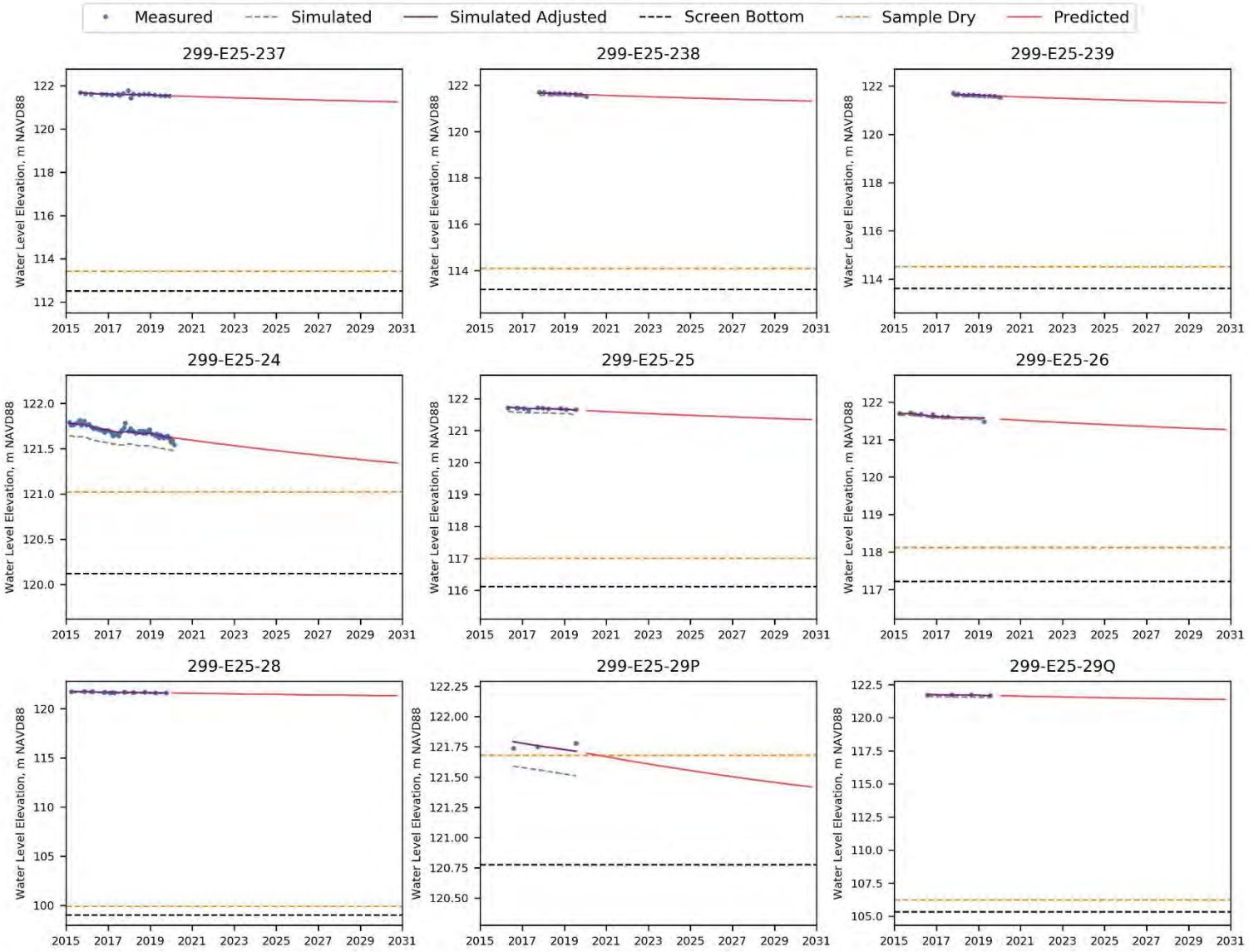

Figure B-7. Water-Level Graphs for Wells 299-E25-237 Through 299-E25-29Q

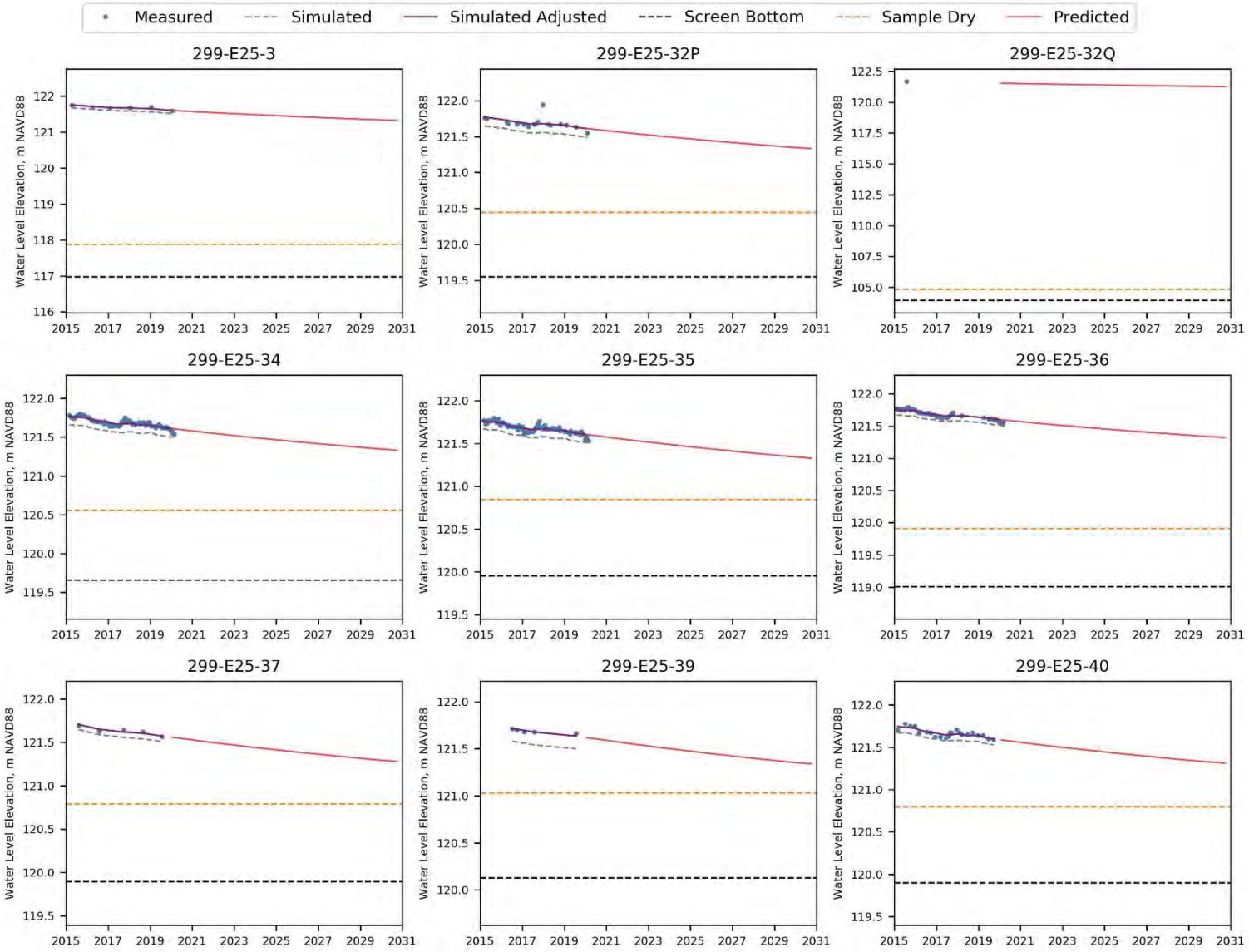

Figure B-8. Water-Level Graphs for Wells 299-E25-3 Through 299-E25-40

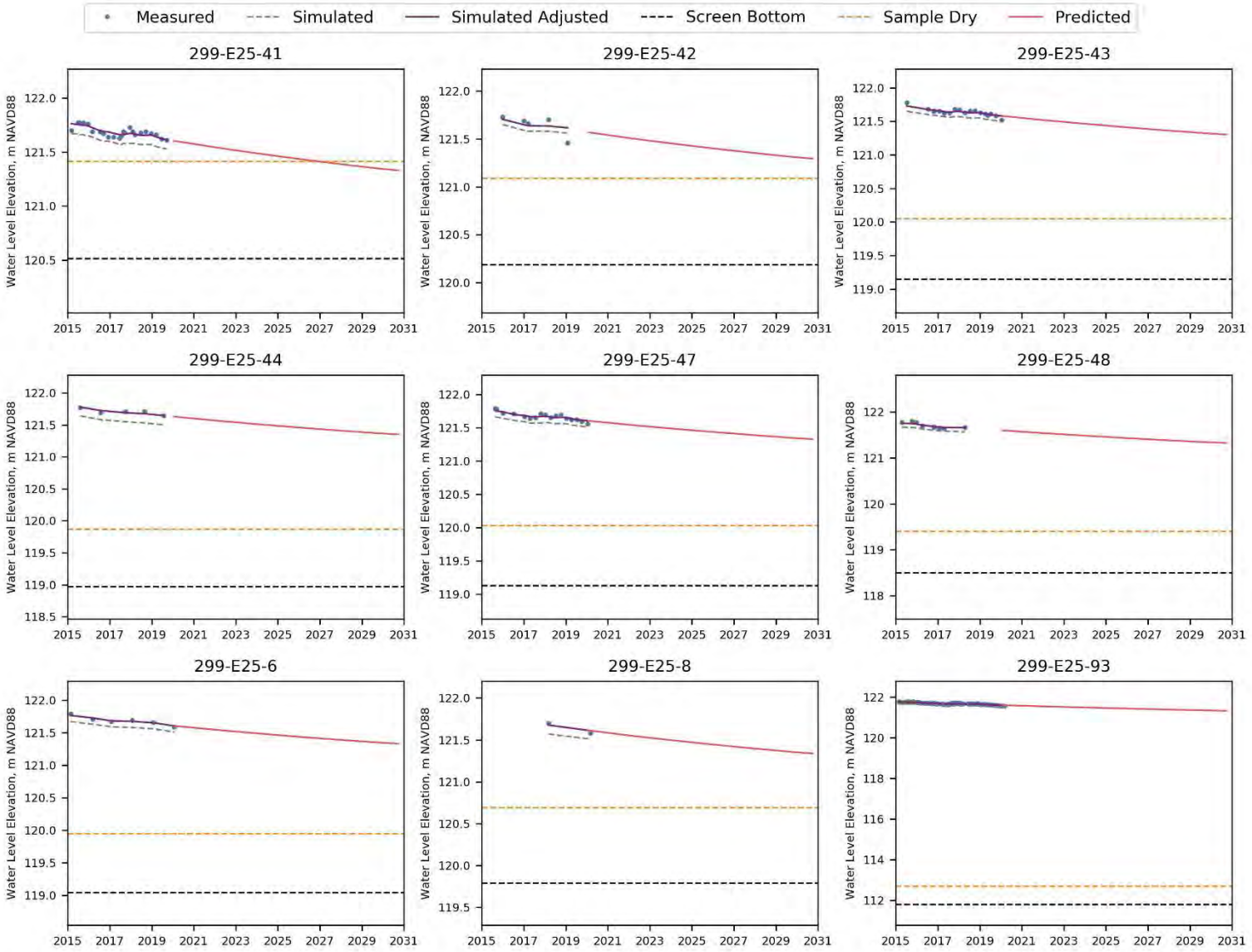

Figure B-9. Water-Level Graphs for Wells 299-E25-41 Through 299-E25-93

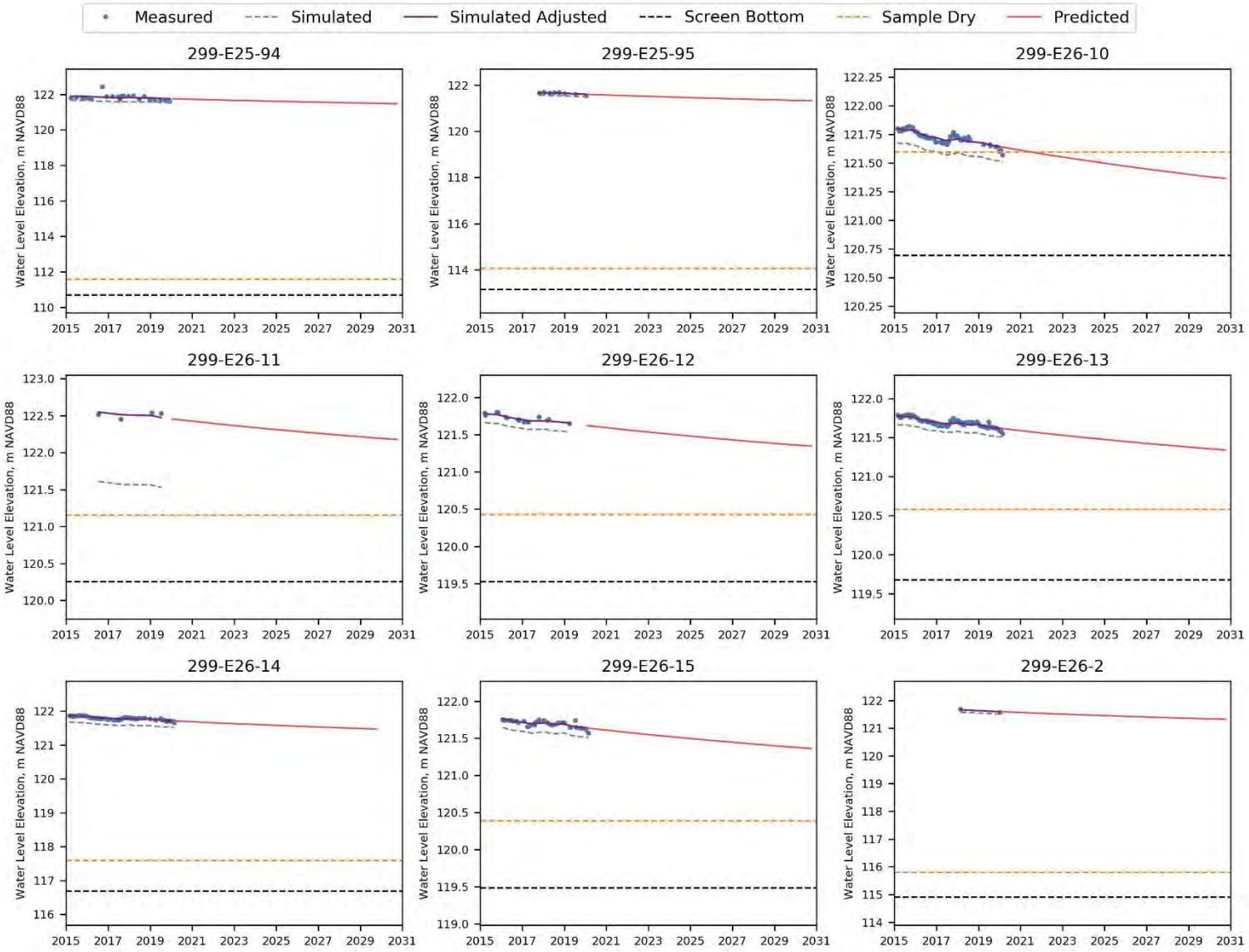

Figure B-10. Water-Level Graphs for Wells 299-E25-94 Through 299-E26-2

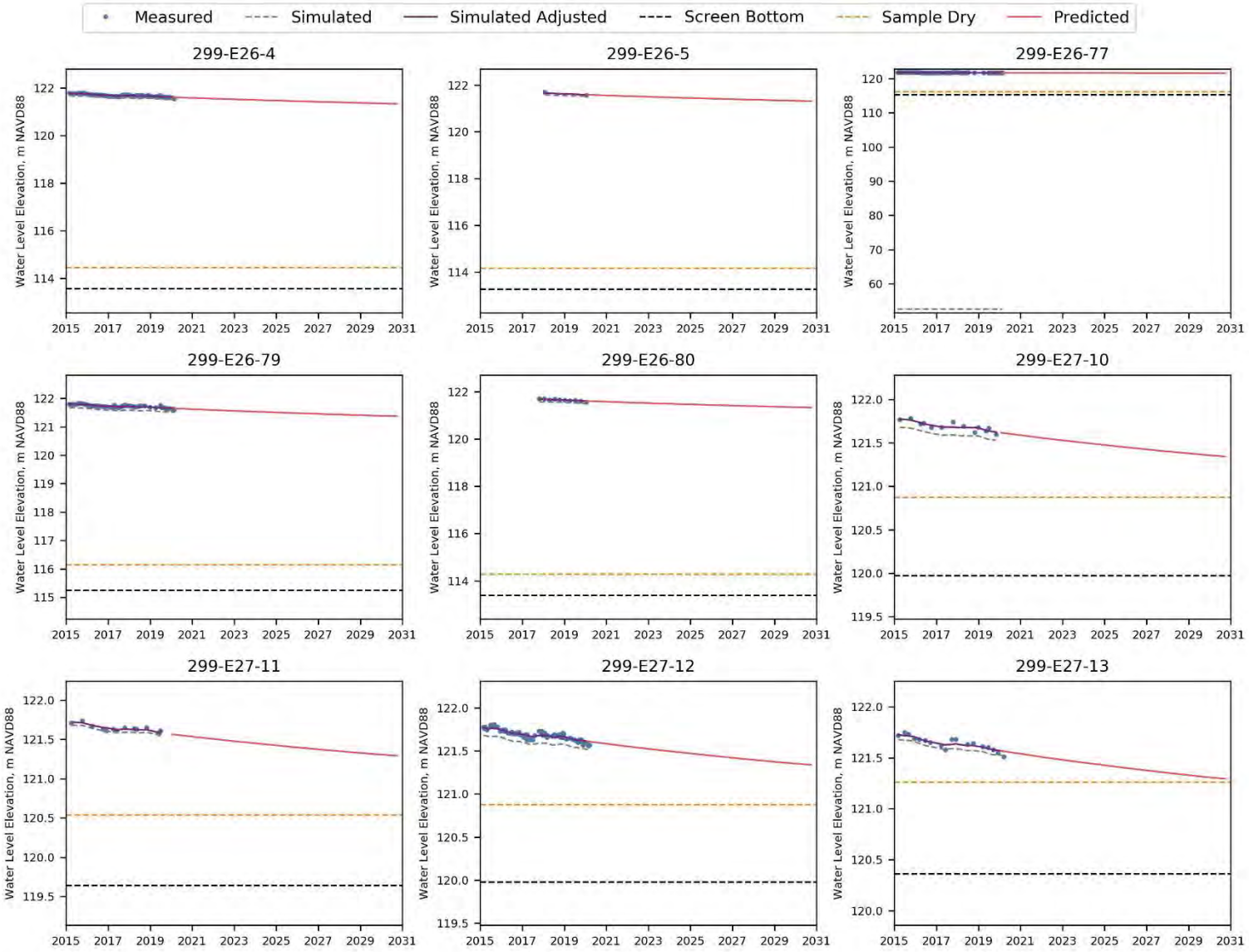

Figure B-11. Water-Level Graphs for Wells 299-E26-4 Through 299-E27-13

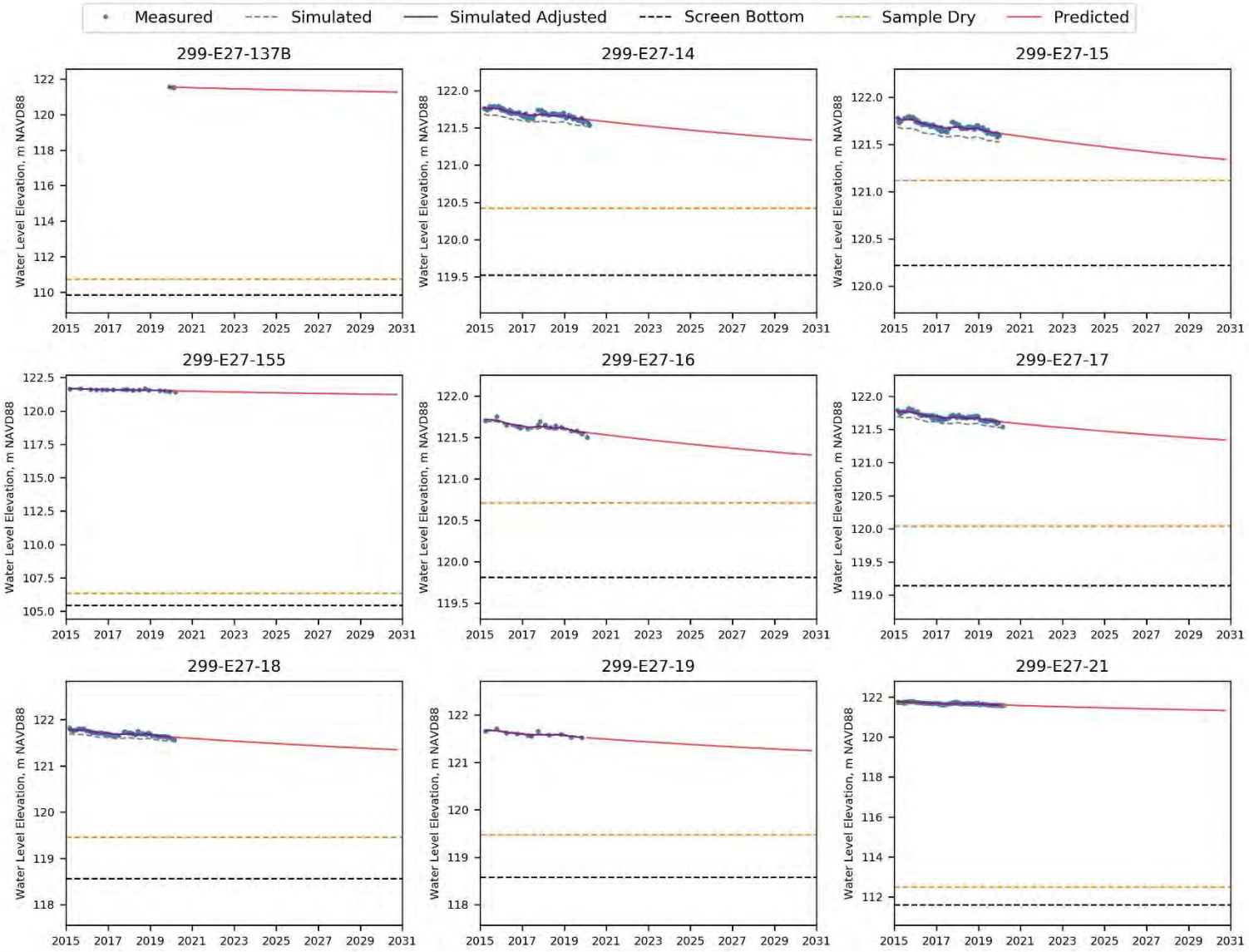

Figure B-12. Water-Level Graphs for Wells 299-E27-137B Through 299-E27-21

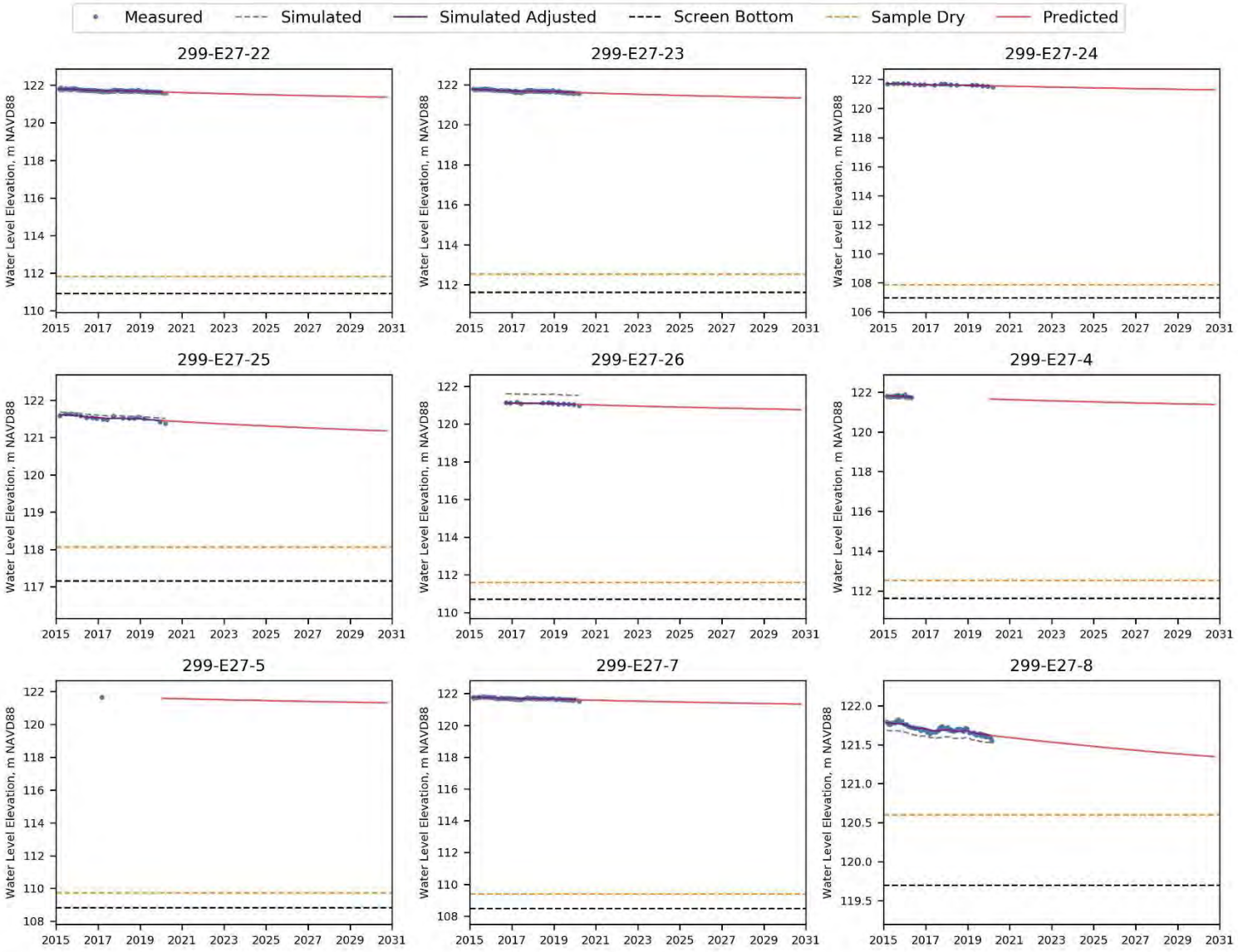

Figure B-13. Water-Level Graphs for Wells 299-E27-22 Through 299-E27-8

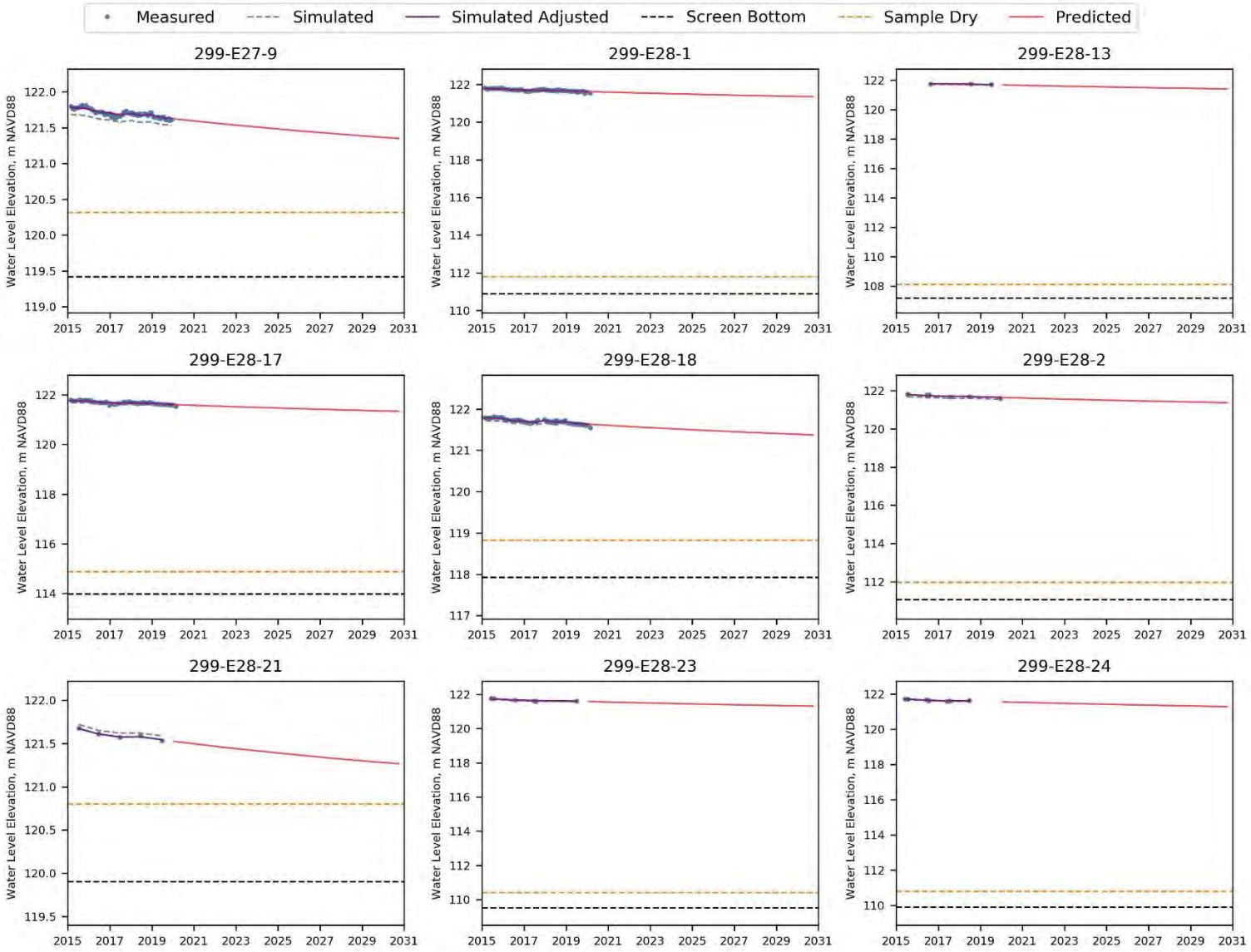

Figure B-14. Water-Level Graphs for Wells 299-E27-9 Through 299-E28-24

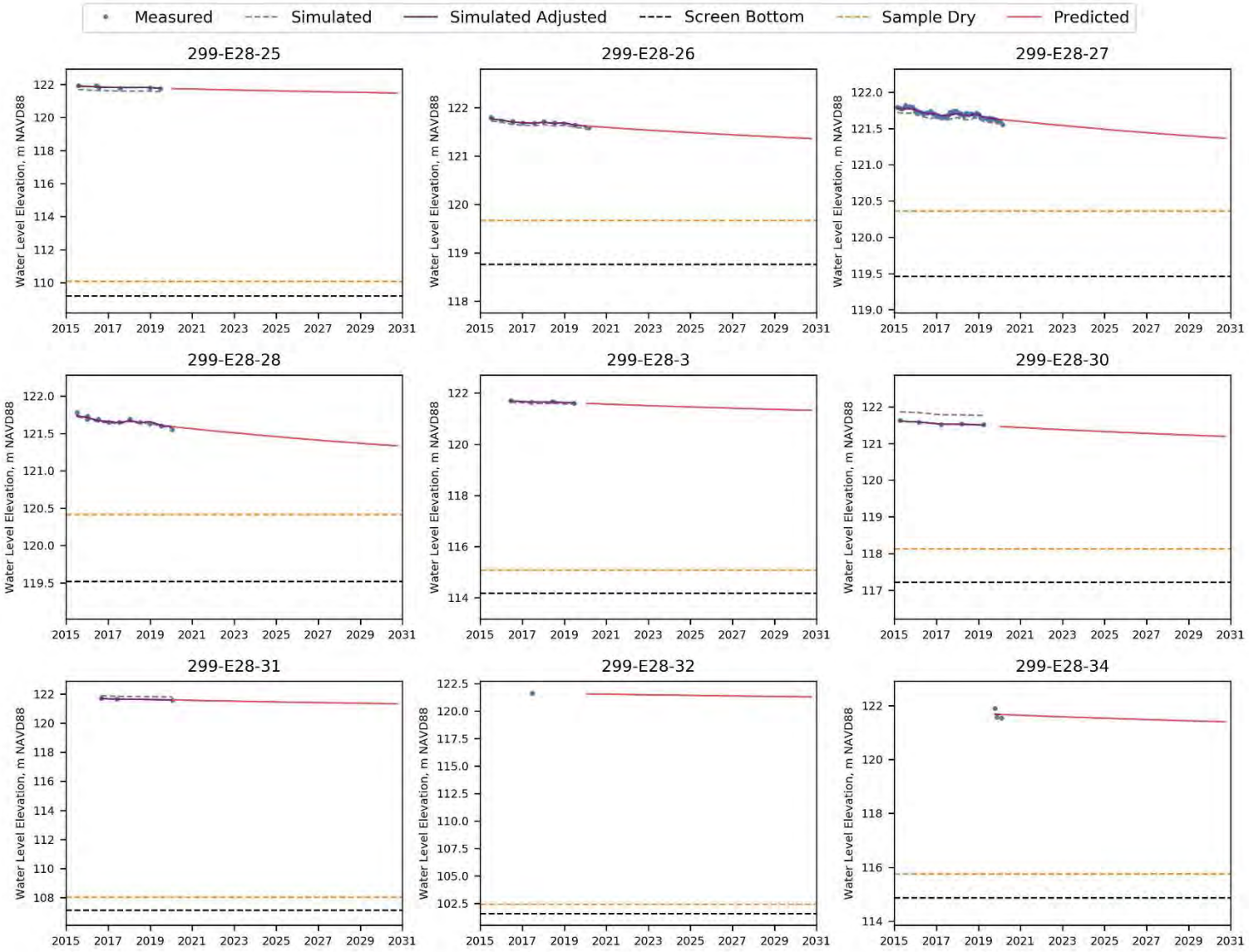

Figure B-15. Water-Level Graphs for Wells 299-E28-25 Through 299-E28-34

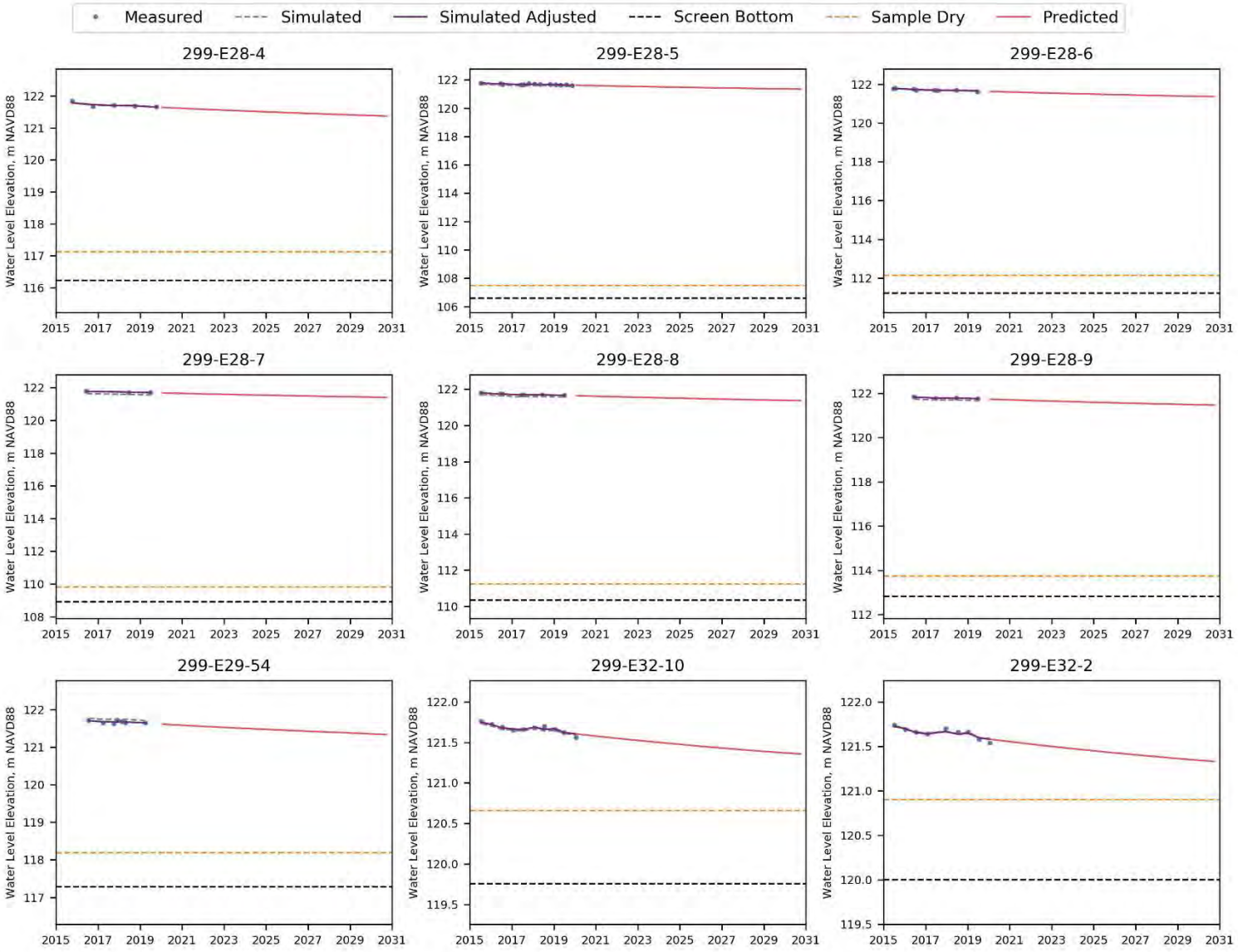

Figure B-16. Water-Level Graphs for Wells 299-E28-4 Through 299-E32-2

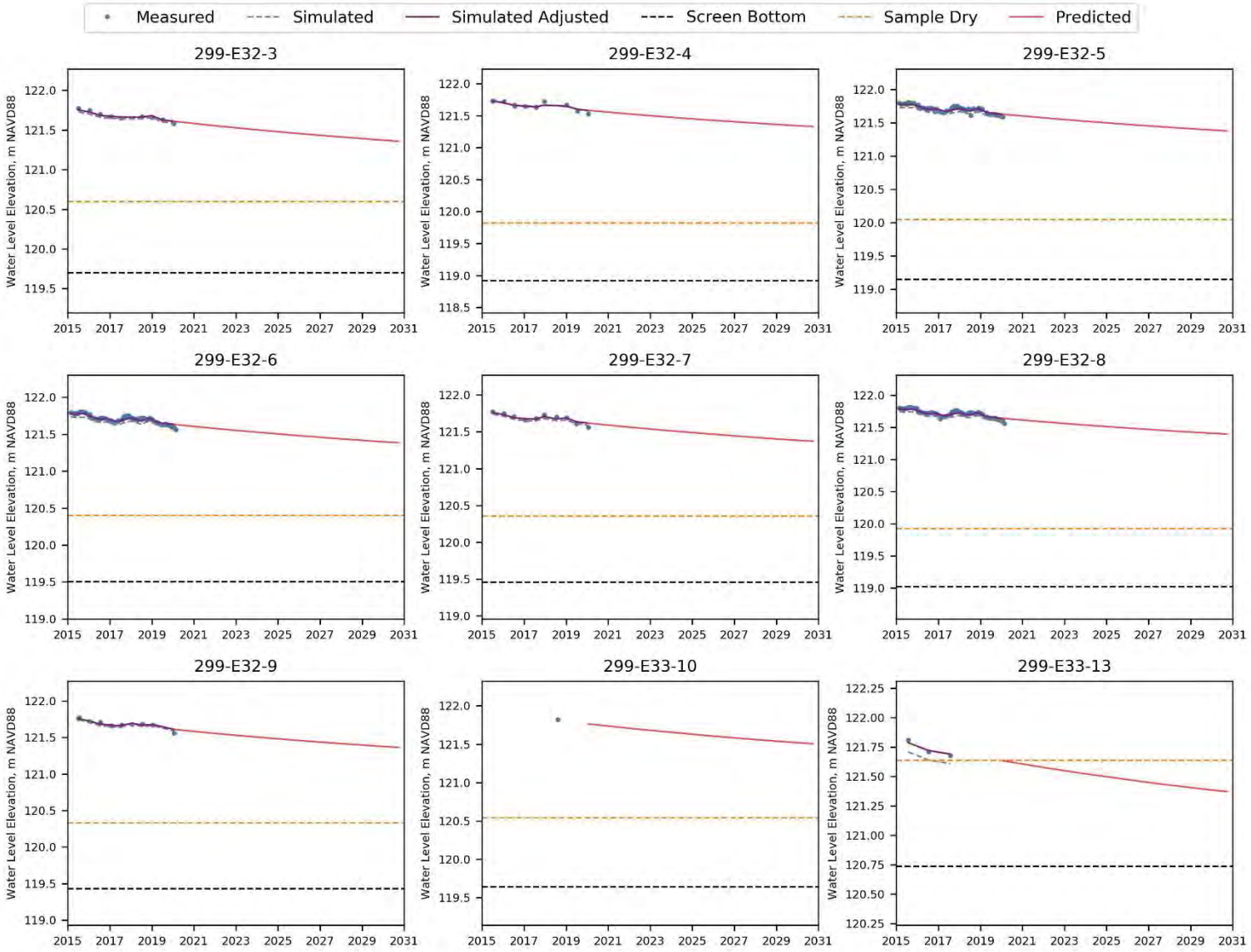

Figure B-17. Water-Level Graphs for Wells 299-E32-3 Through 299-E33-13

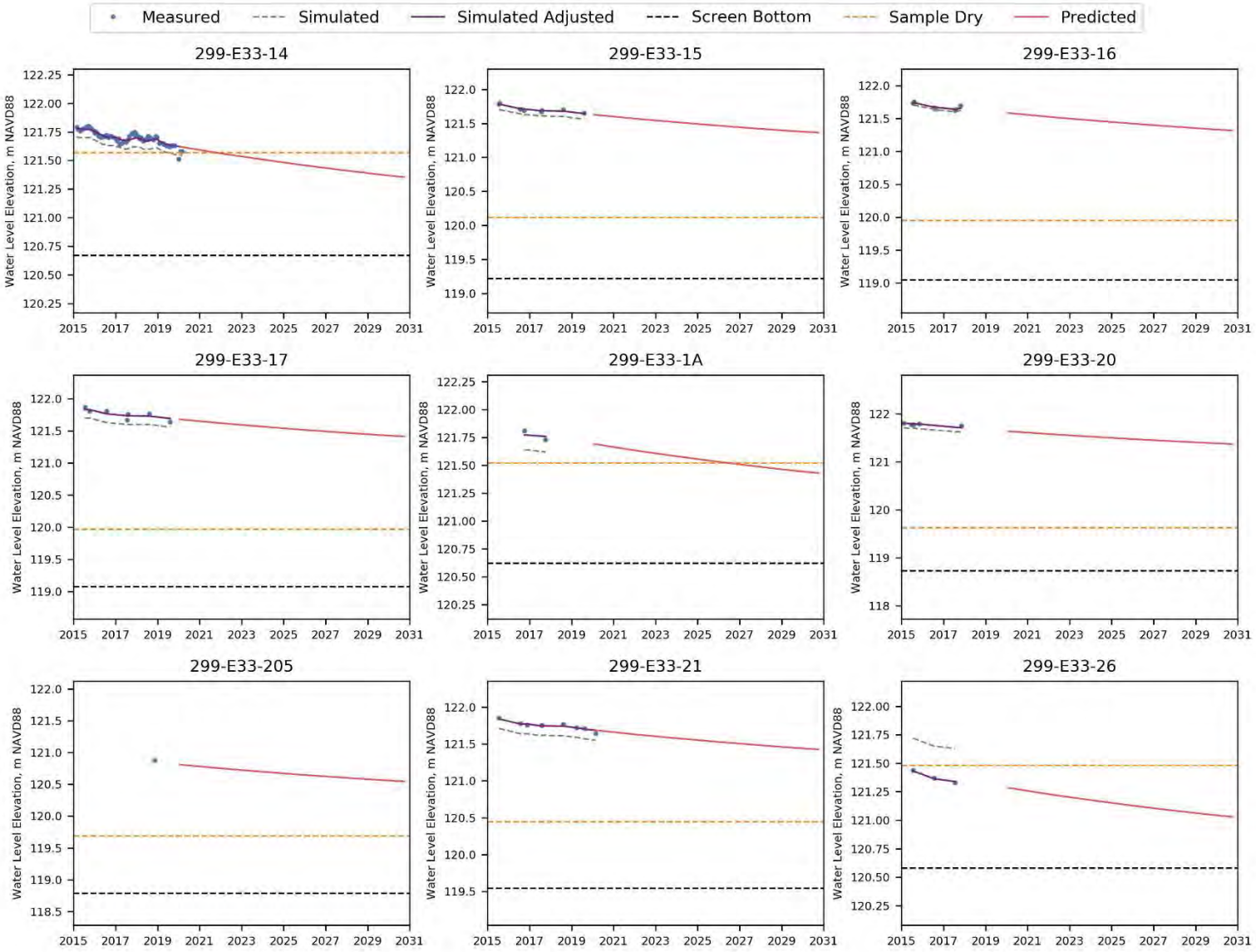

Figure B-18. Water-Level Graphs for Wells 299-E33-14 Through 299-E33-26

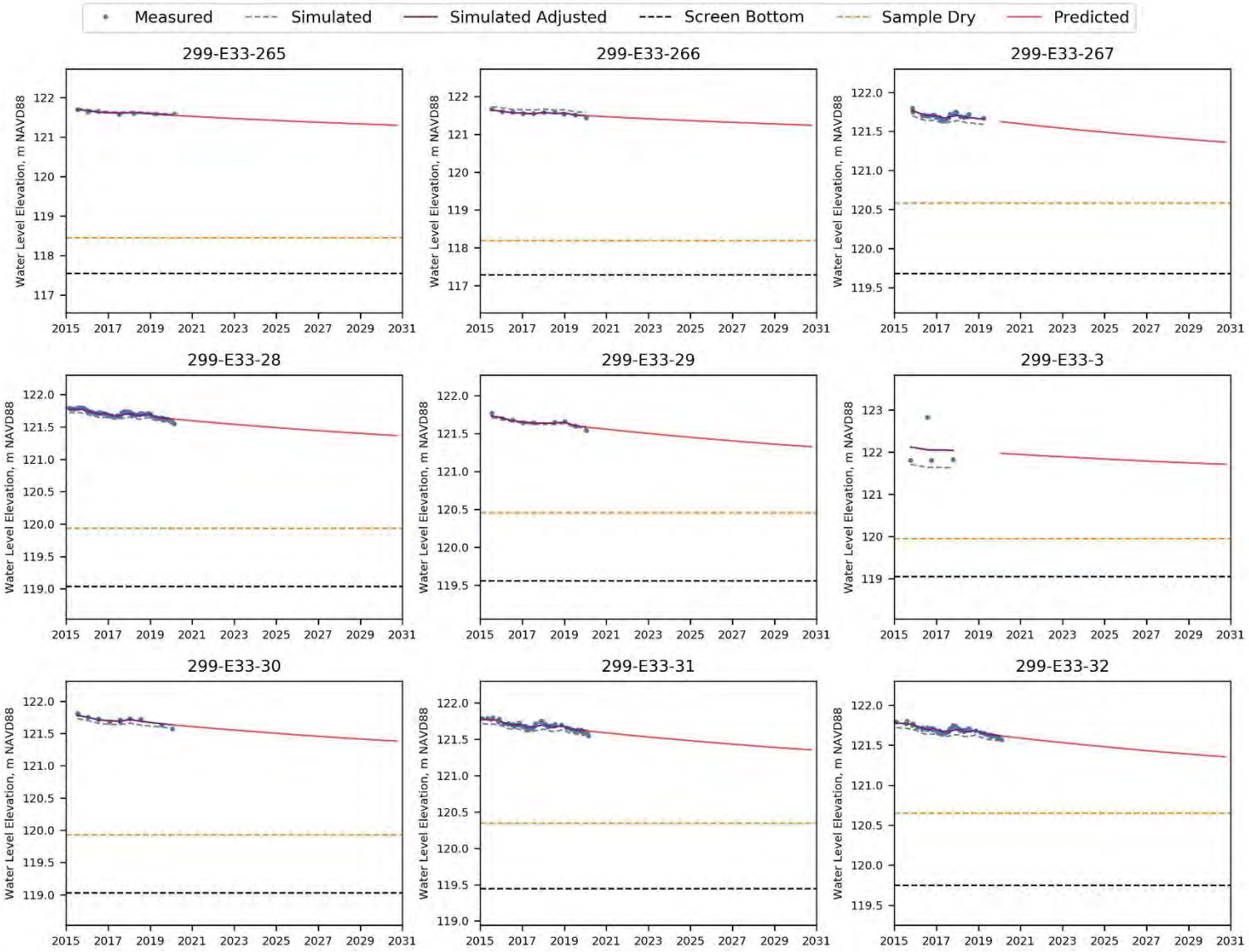

Figure B-19. Water-Level Graphs for Wells 299-E33-265 Through 299-E33-32

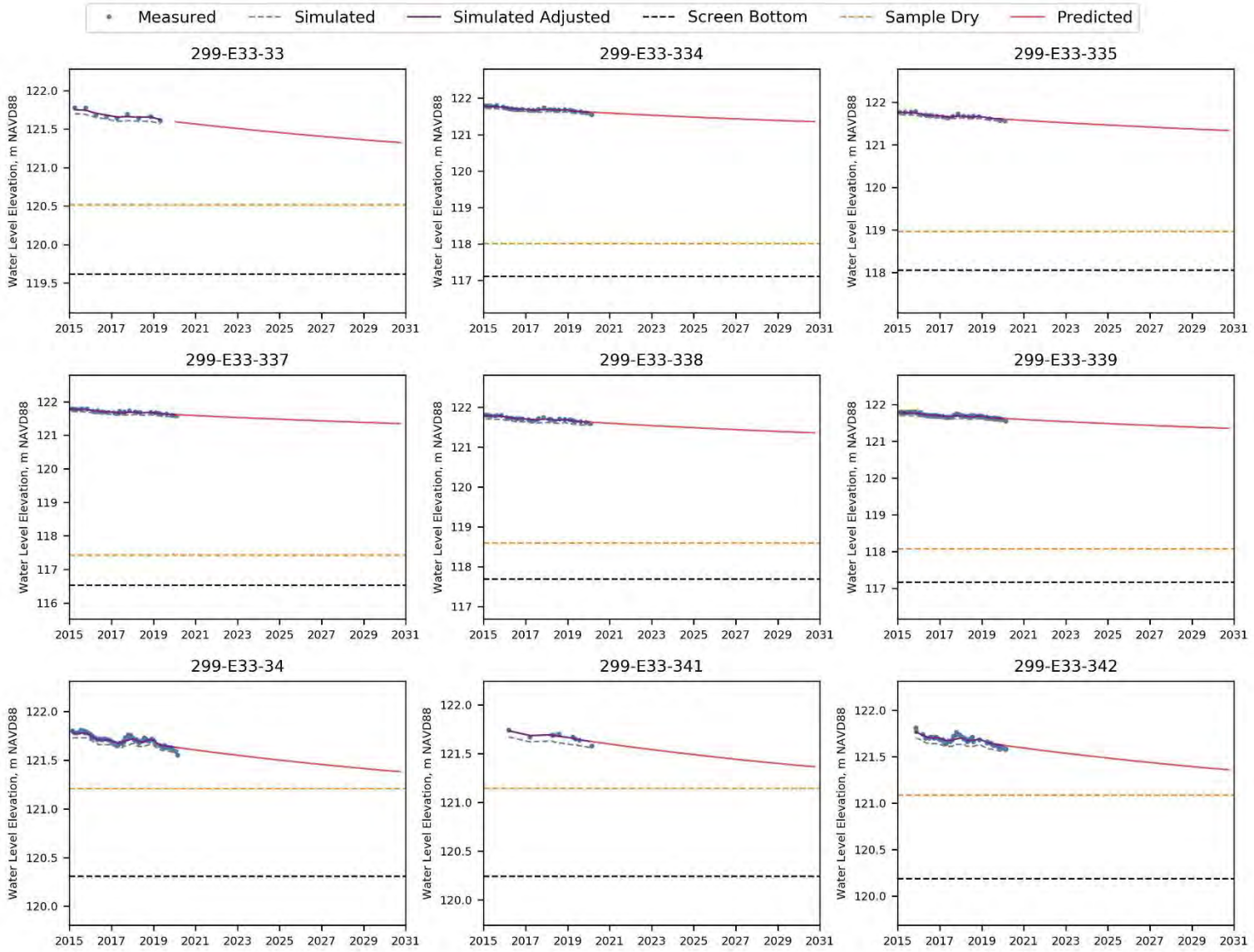

Figure B-20. Water-Level Graphs for Wells 299-E33-33 Through 299-E33-342

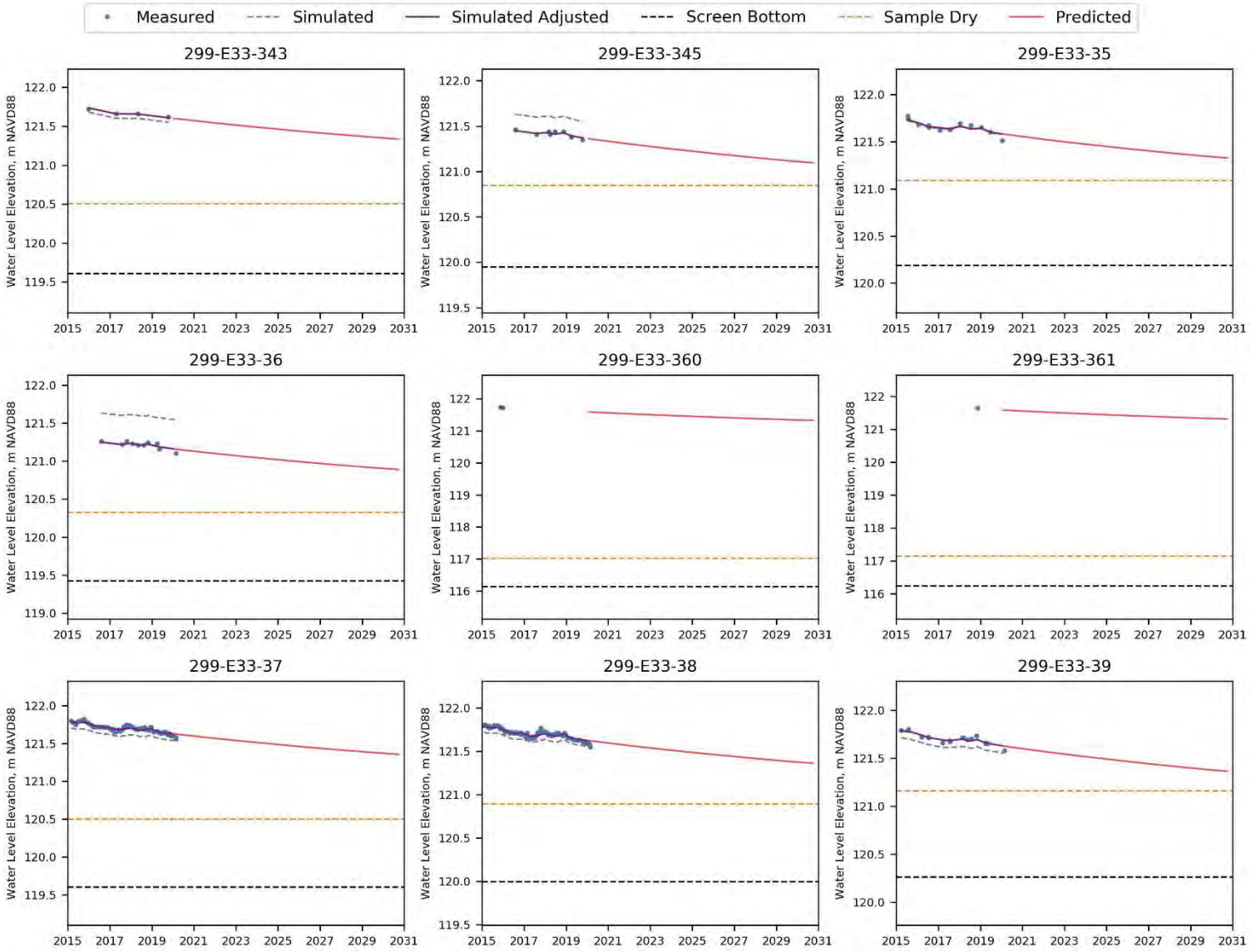

Figure B-21. Water-Level Graphs for Wells 299-E33-343 Through 299-E33-39

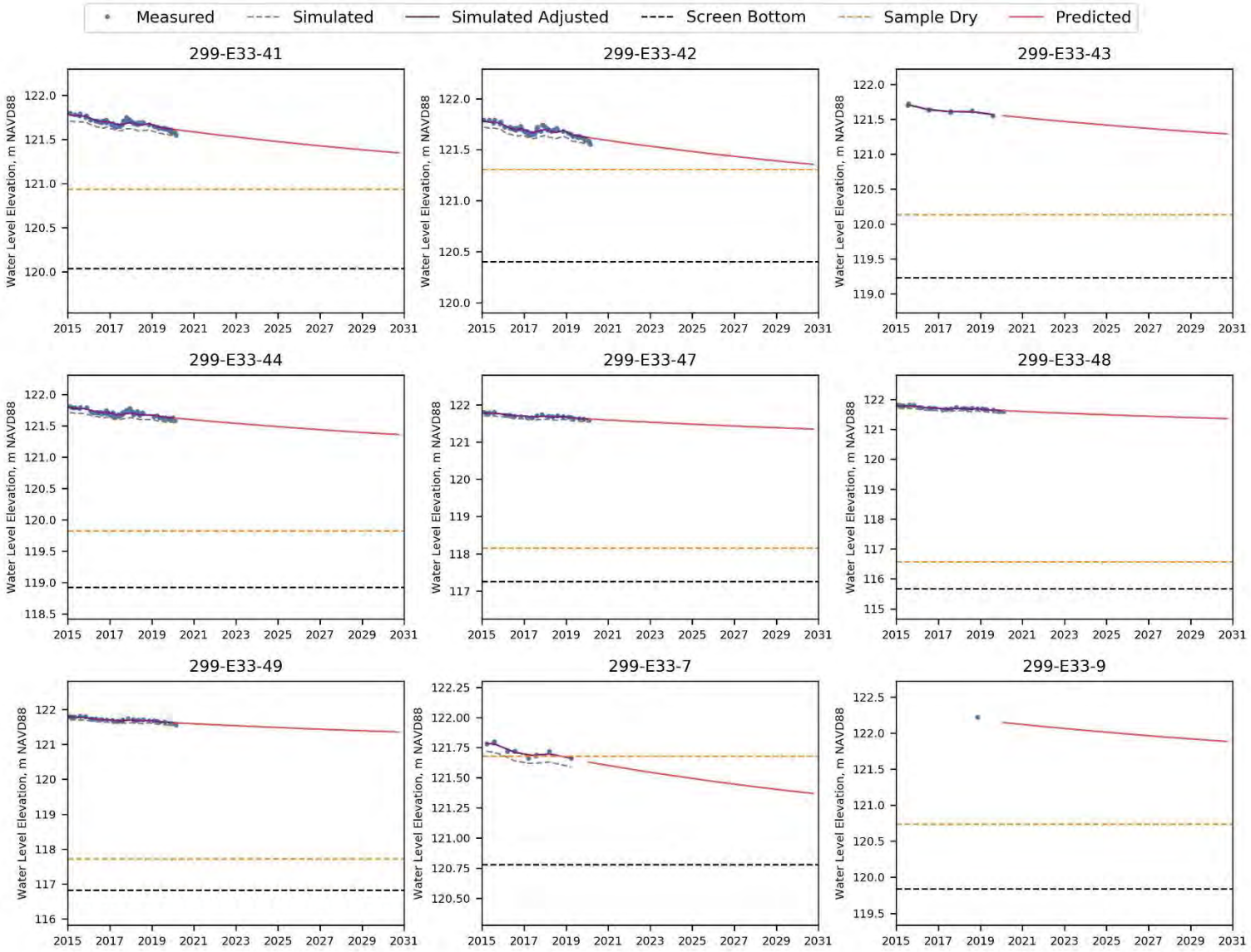

Figure B-22. Water-Level Graphs for Wells 299-E33-41 Through 299-E33-9

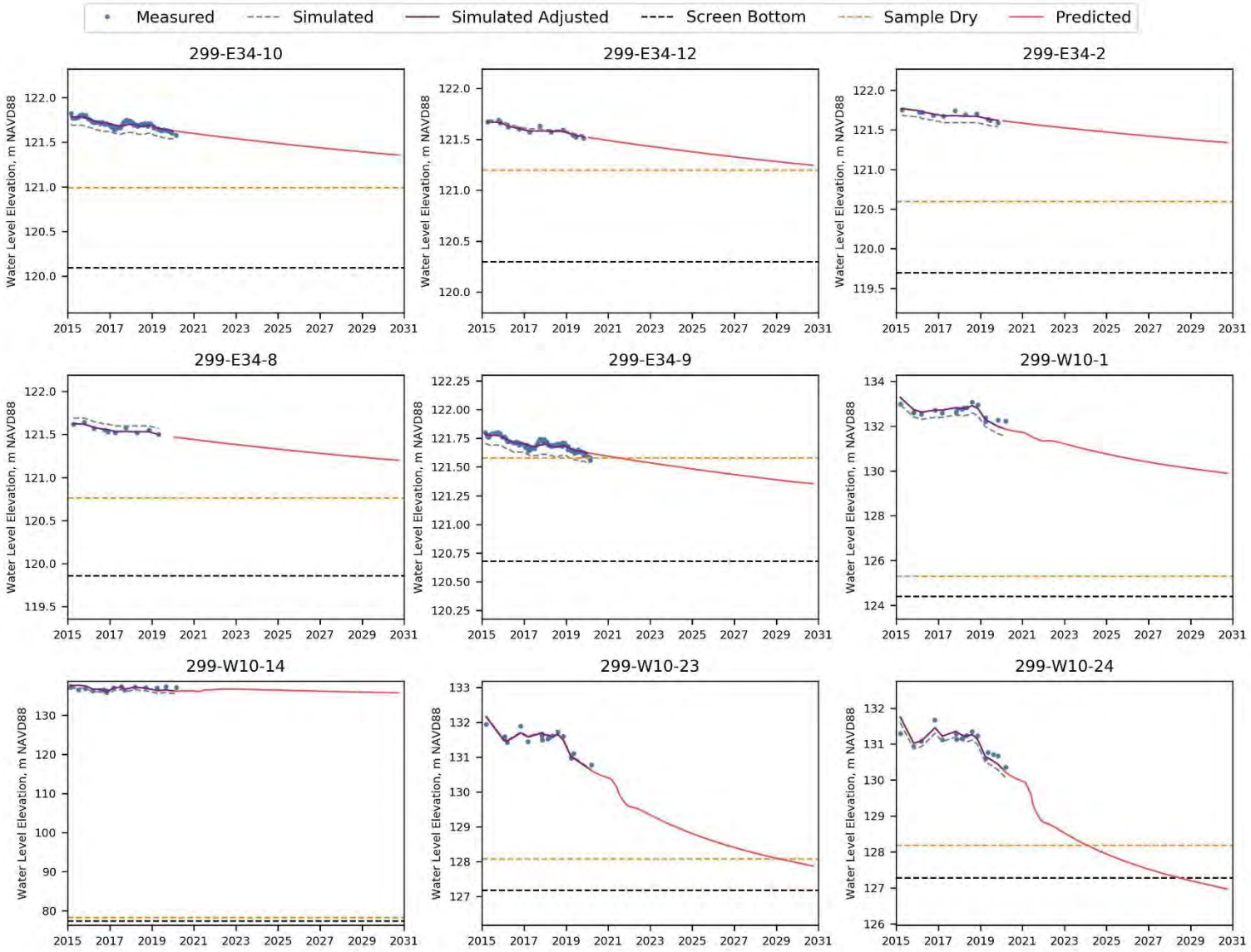

Figure B-23. Water-Level Graphs for Wells 299-E34-10 Through 299-W10-24

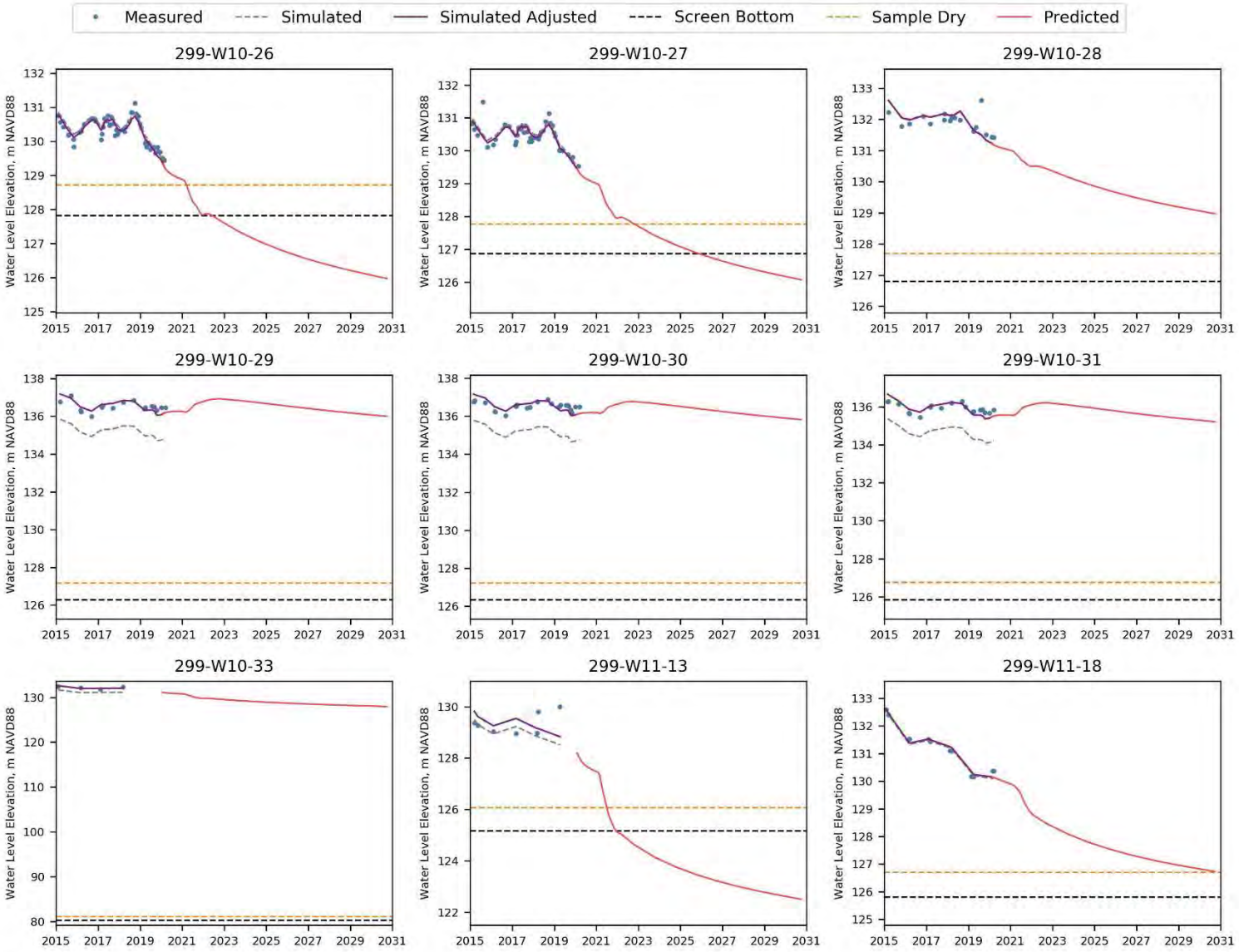

Figure B-24. Water-Level Graphs for Wells 299-W10-26 Through 299-W11-18

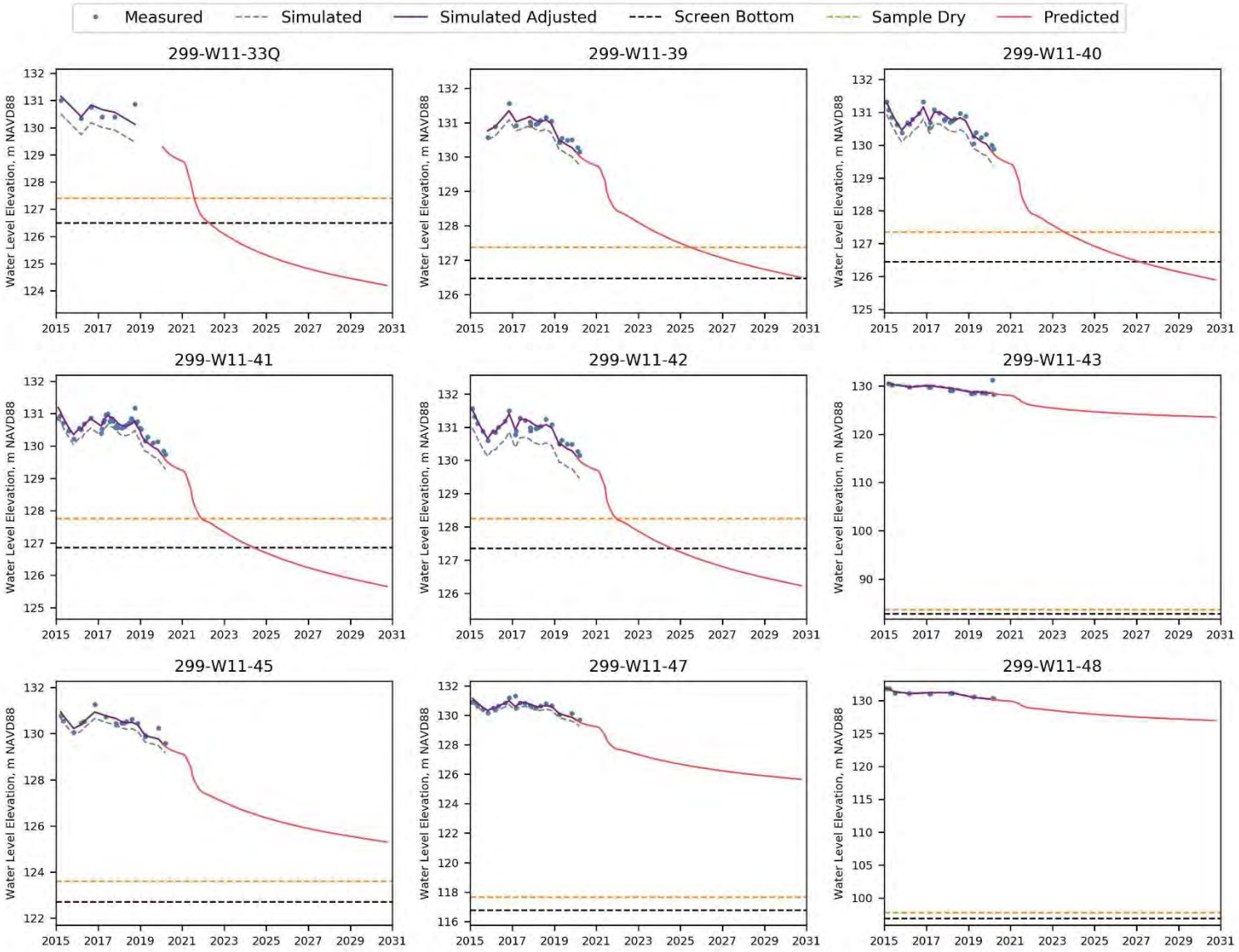

Figure B-25. Water-Level Graphs for Wells 299-W11-33Q Through 299-W11-48

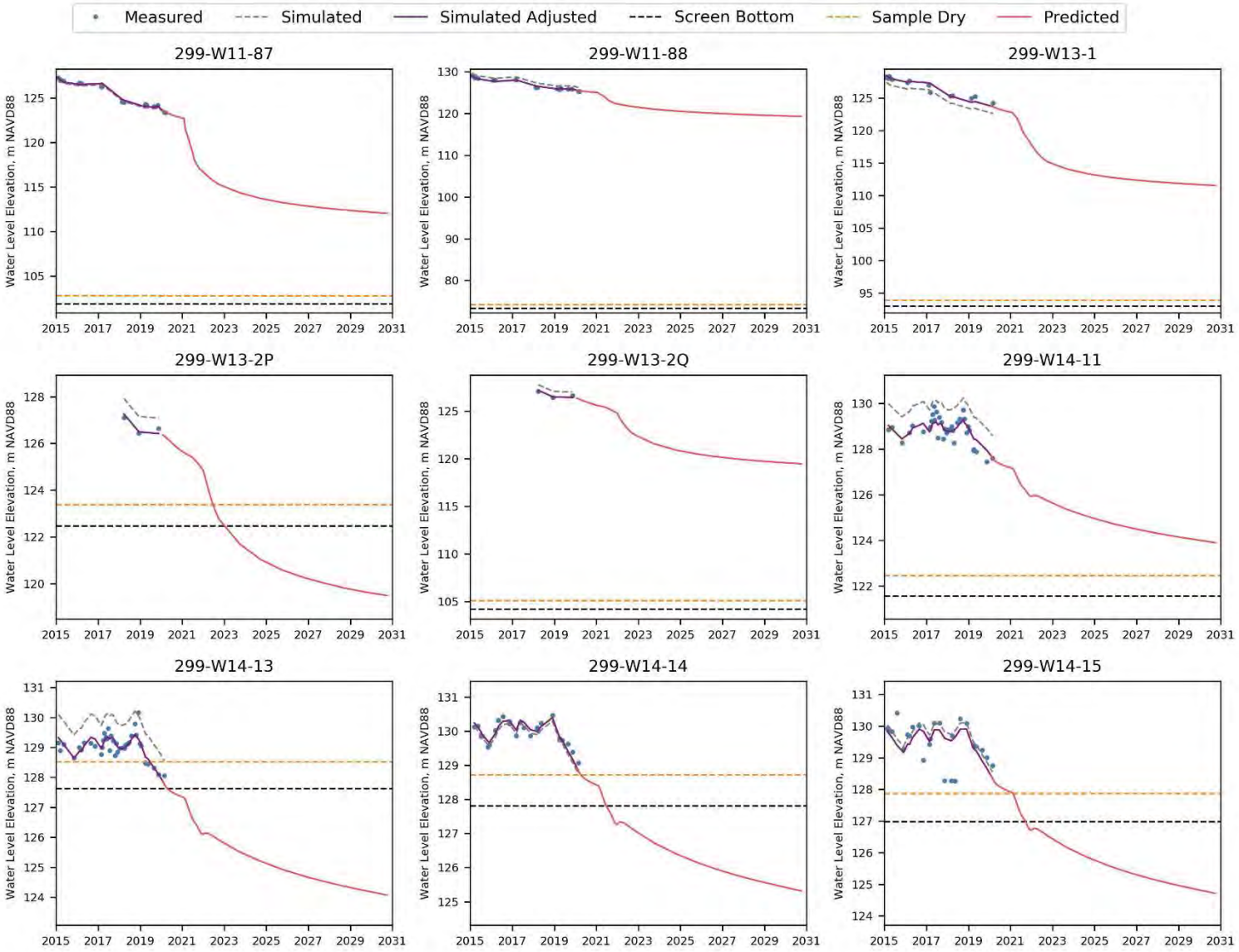

Figure B-26. Water-Level Graphs for Wells 299-W11-87 Through 299-W14-15

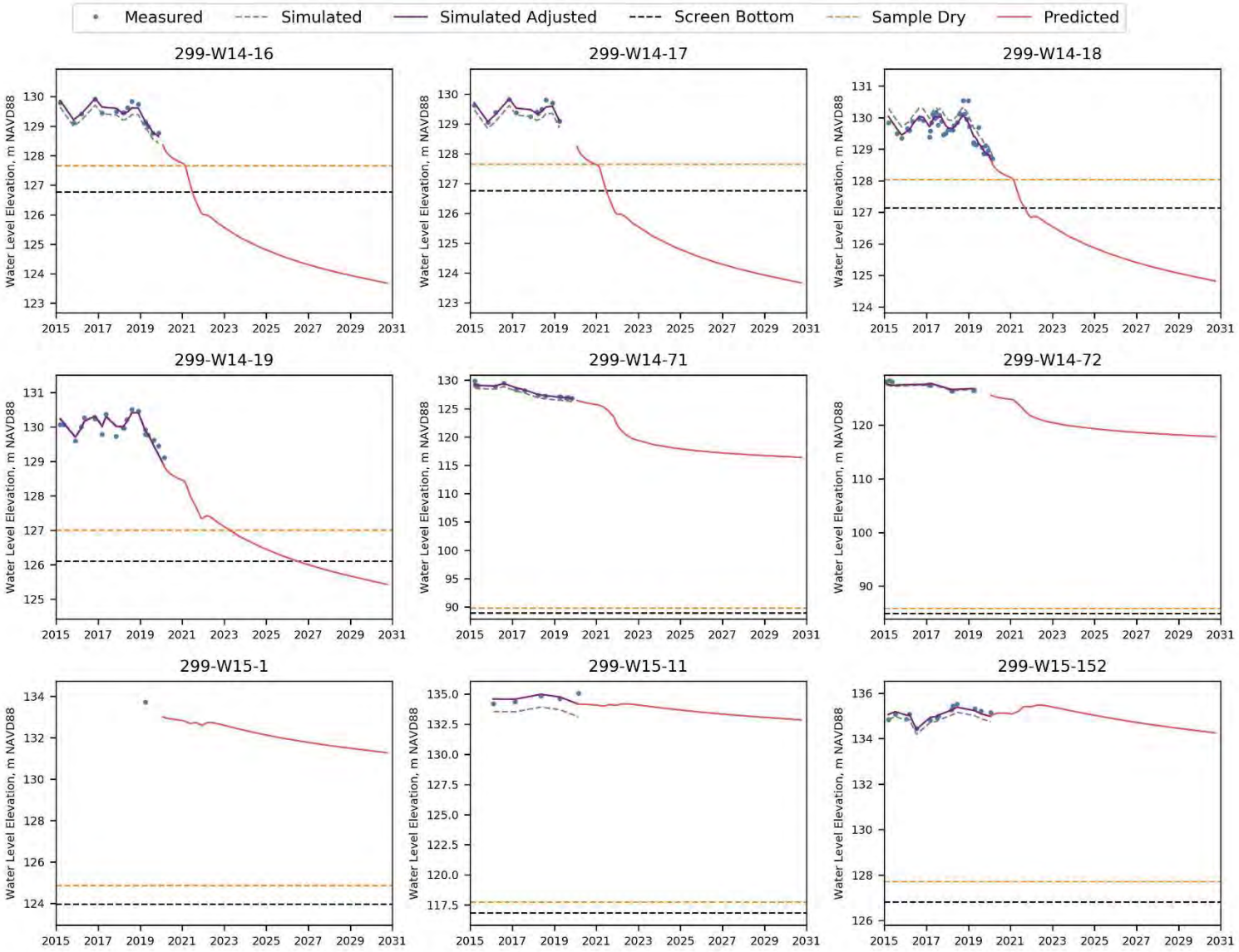

Figure B-27. Water-Level Graphs for Wells 299-W14-16 Through 299-W15-152

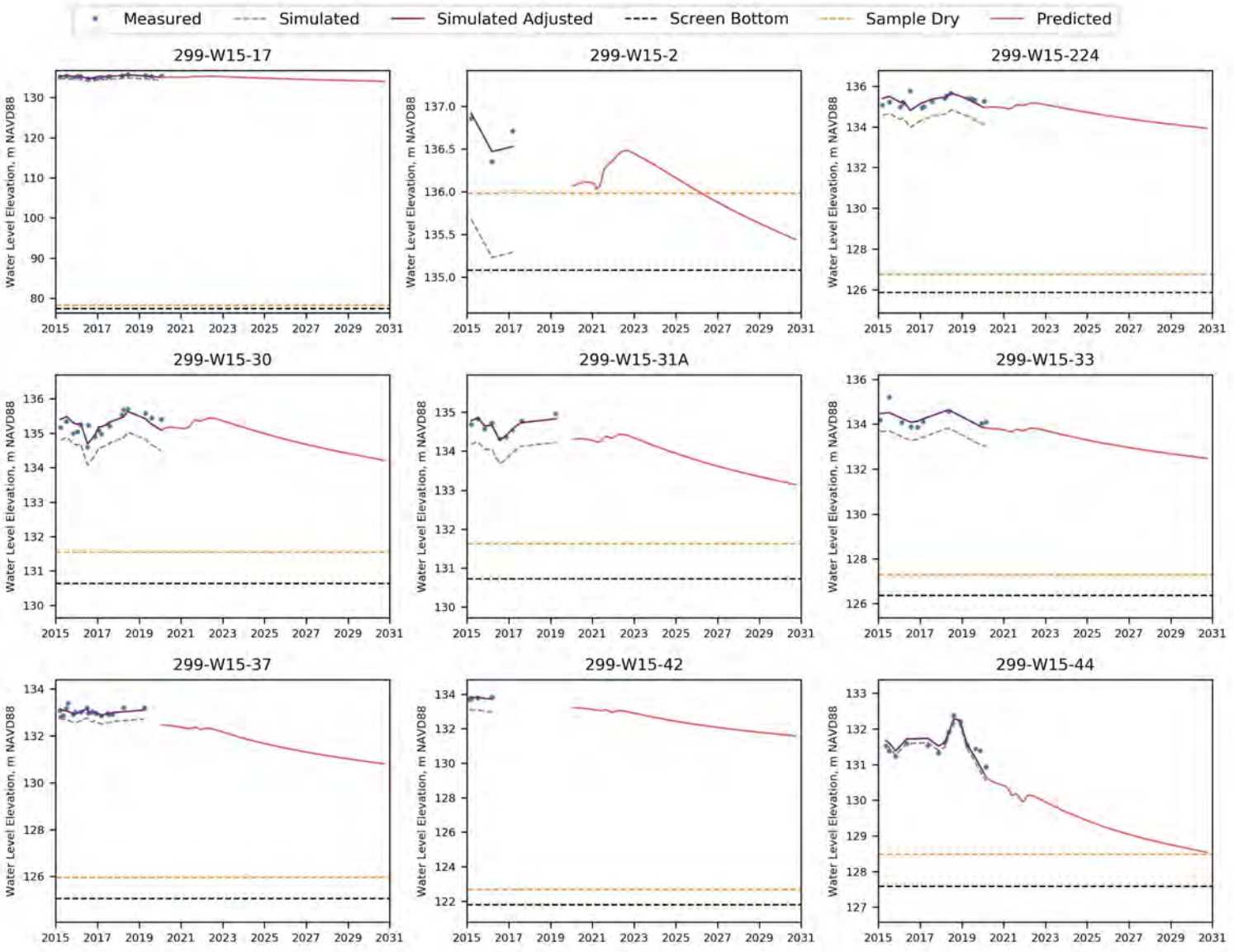

Figure B-28. Water-Level Graphs for Wells 299-W15-17 Through 299-W15-44

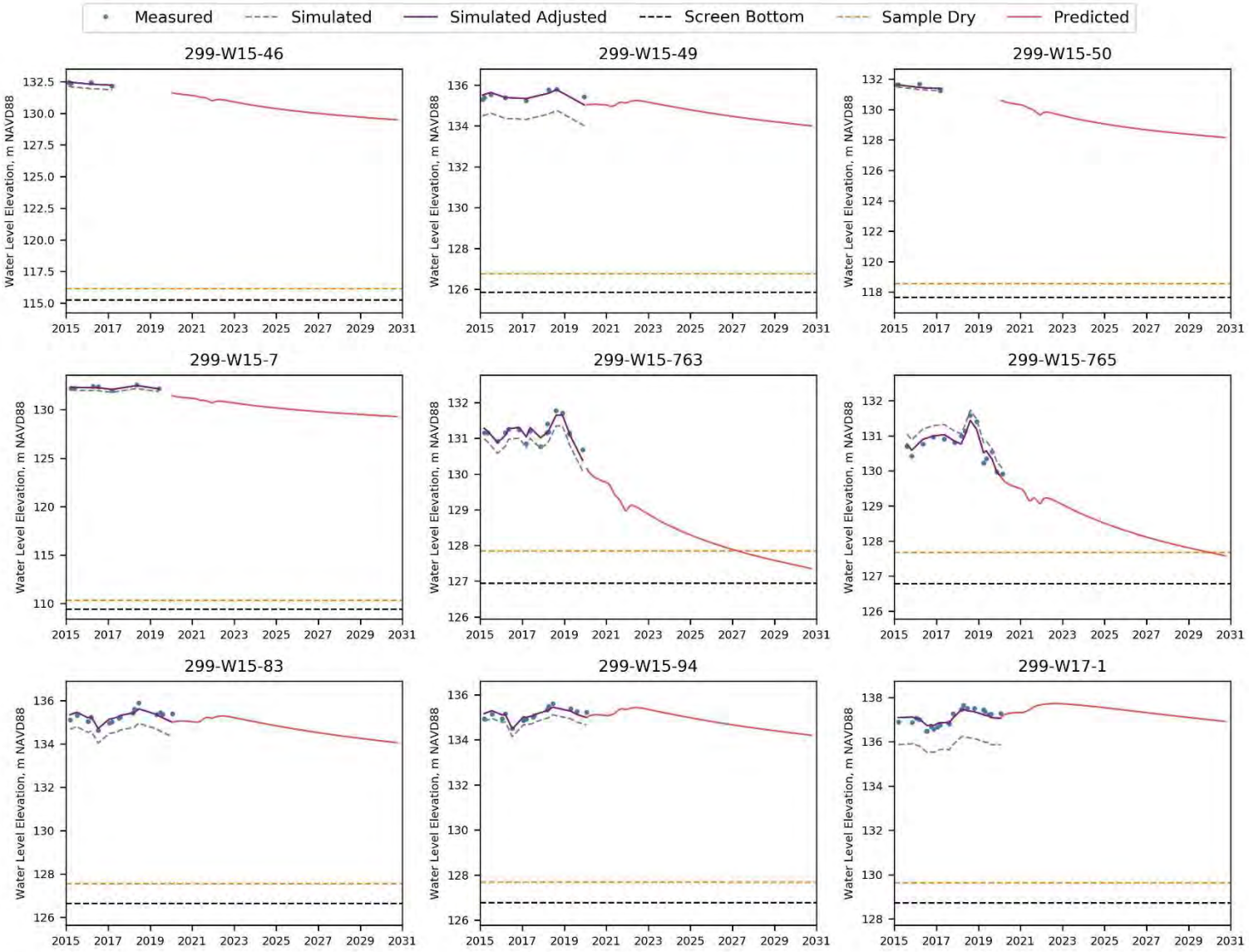

Figure B-29. Water-Level Graphs for Wells 299-W15-46 Through 299-W17-1

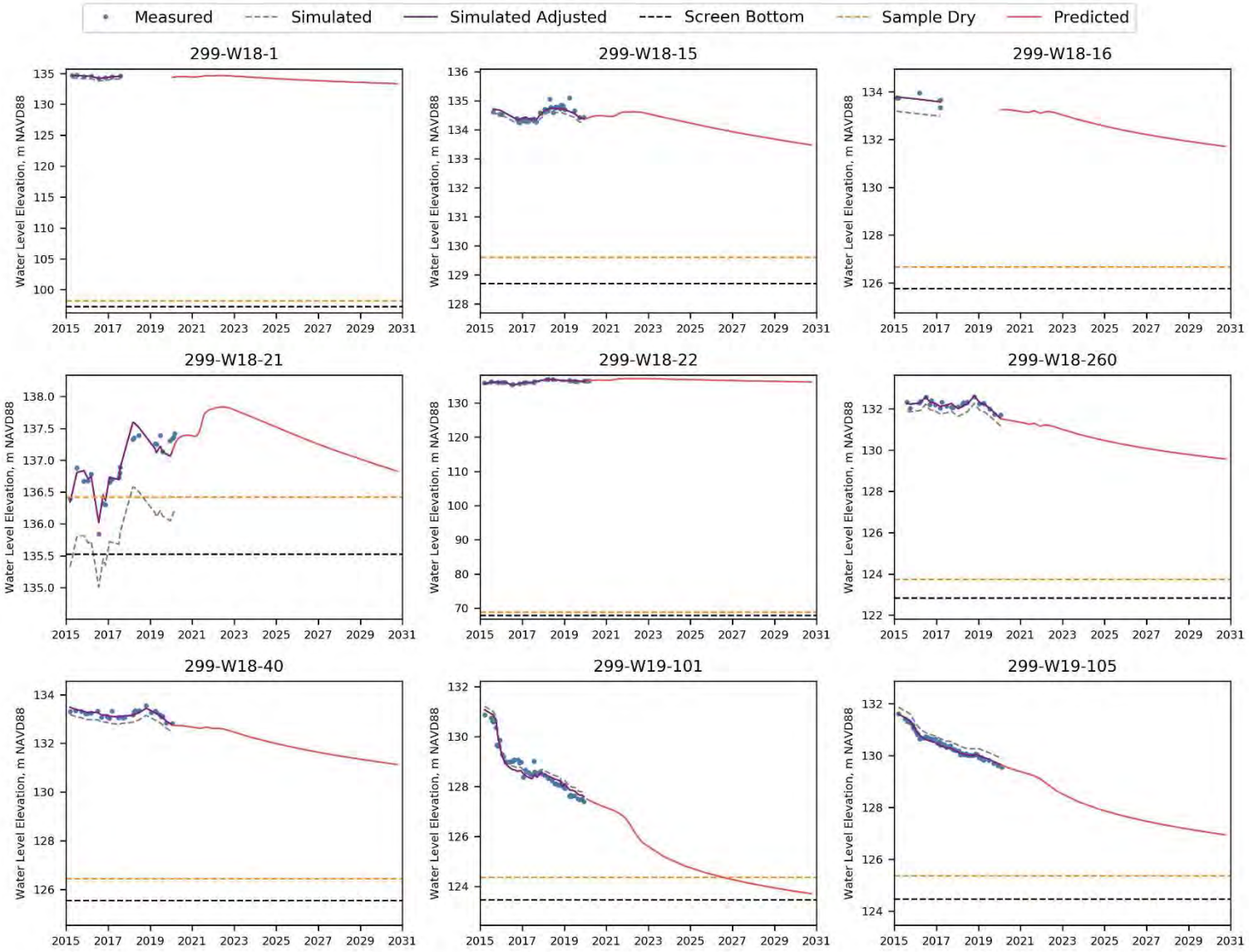

Figure B-30. Water-Level Graphs for Wells 299-W18-1 Through 299-W19-105

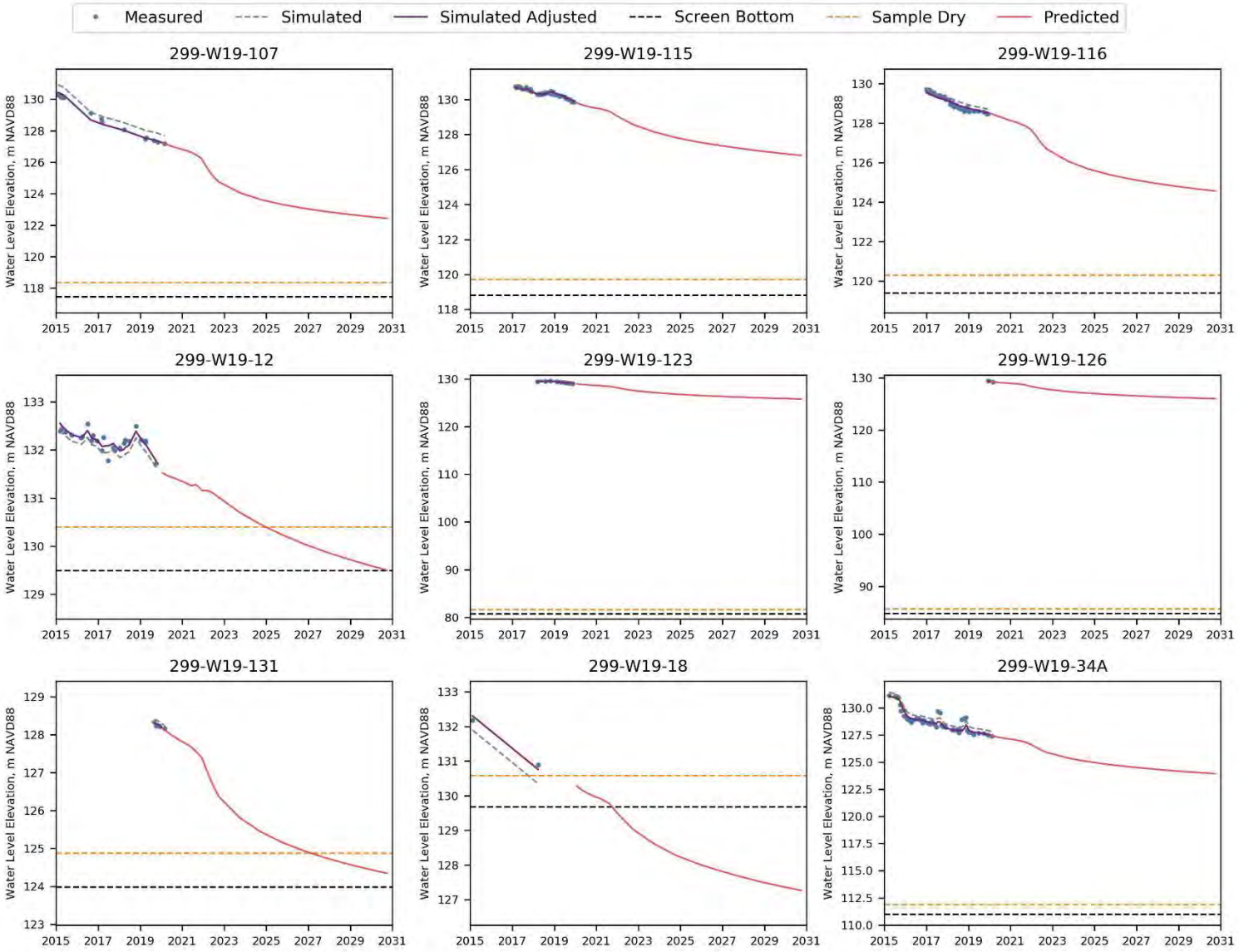

Figure B-31. Water-Level Graphs for Wells 299-W19-107 Through 299-W19-34A

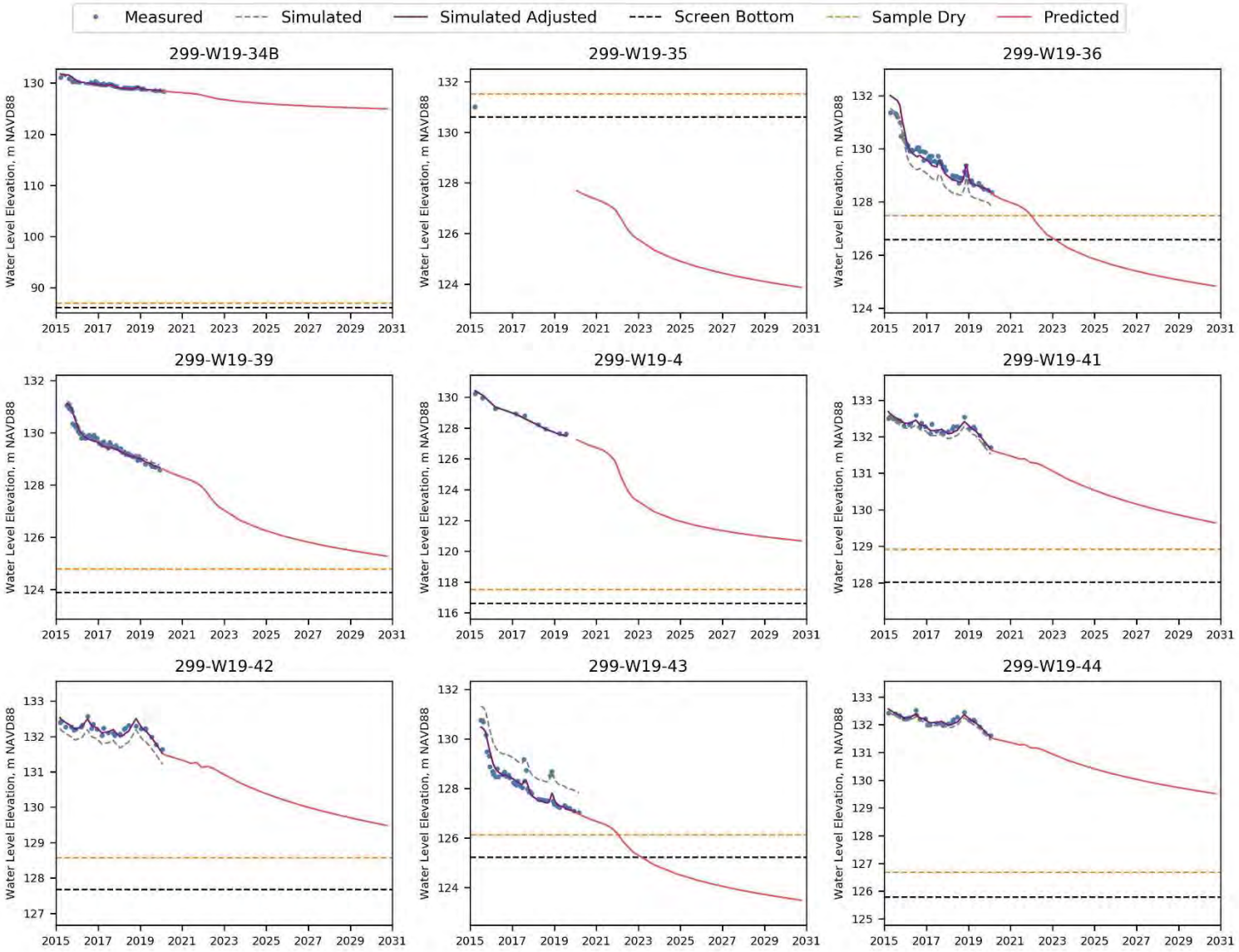

Figure B-32. Water-Level Graphs for Wells 299-W19-34B Through 299-W19-44

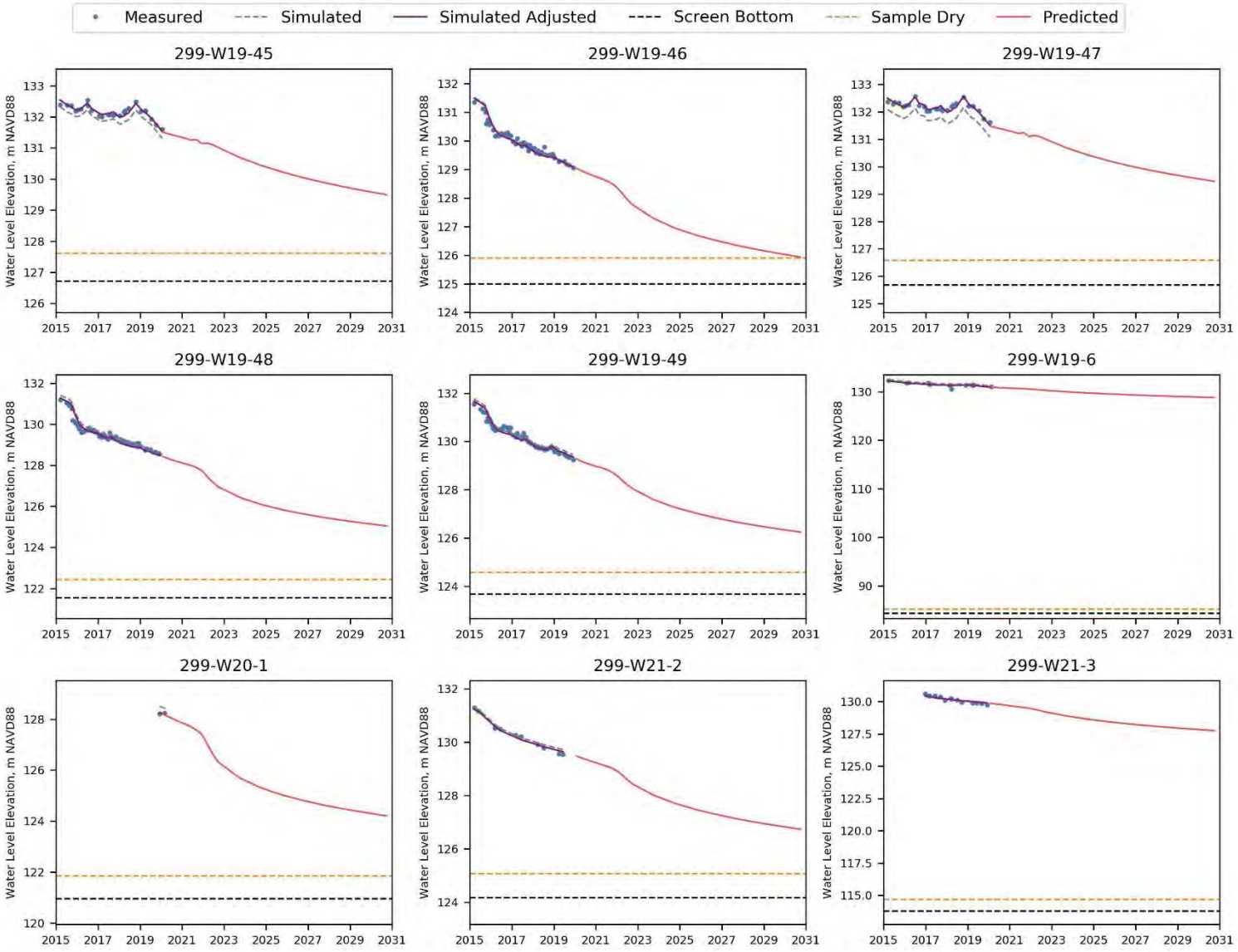

Figure B-33. Water-Level Graphs for Wells 299-W19-45 Through 299-W21-3

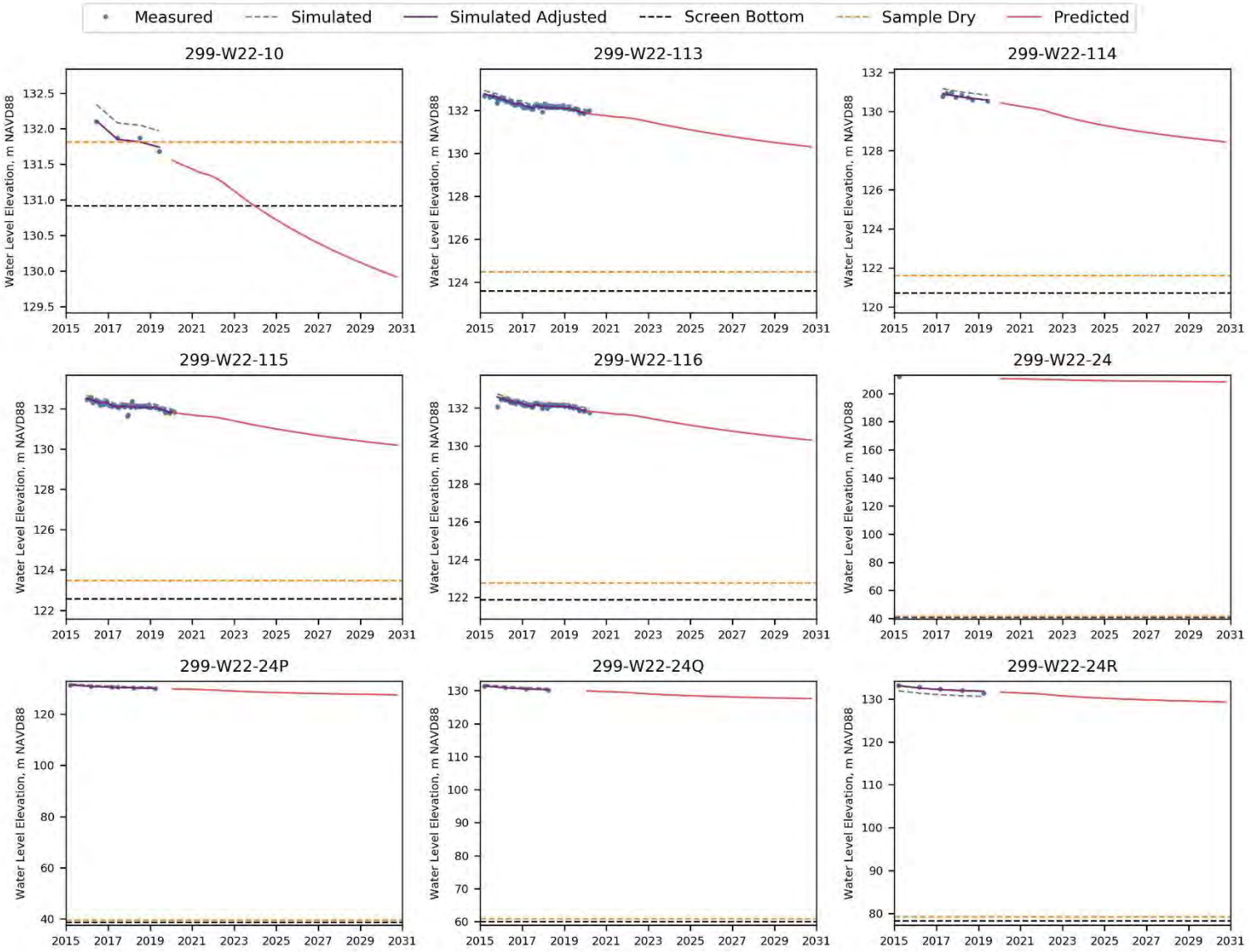

Figure B-34. Water-Level Graphs for Wells 299-W22-10 Through 299-W22-24R

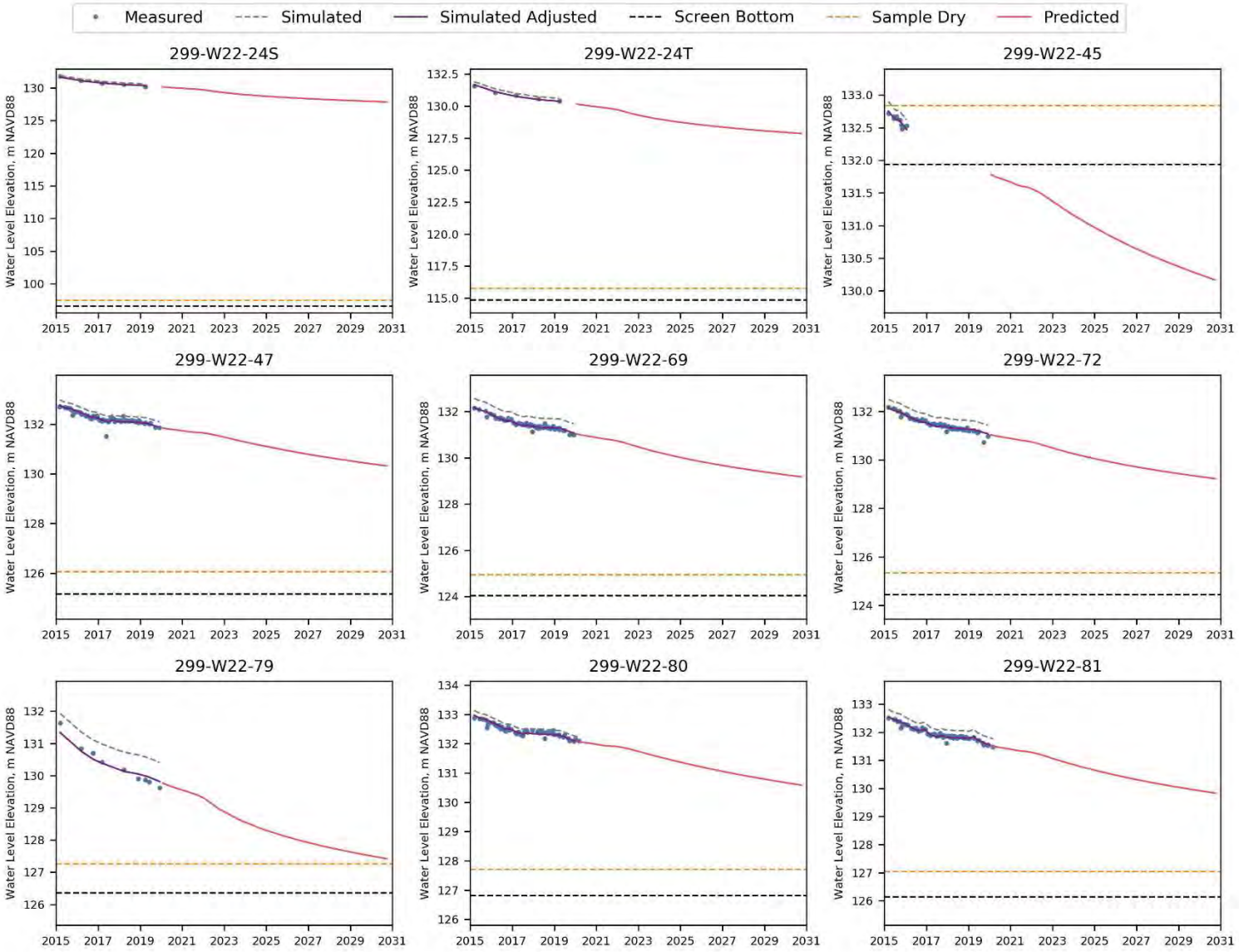

Figure B-35. Water-Level Graphs for Wells 299-W22-24S Through 299-W22-81

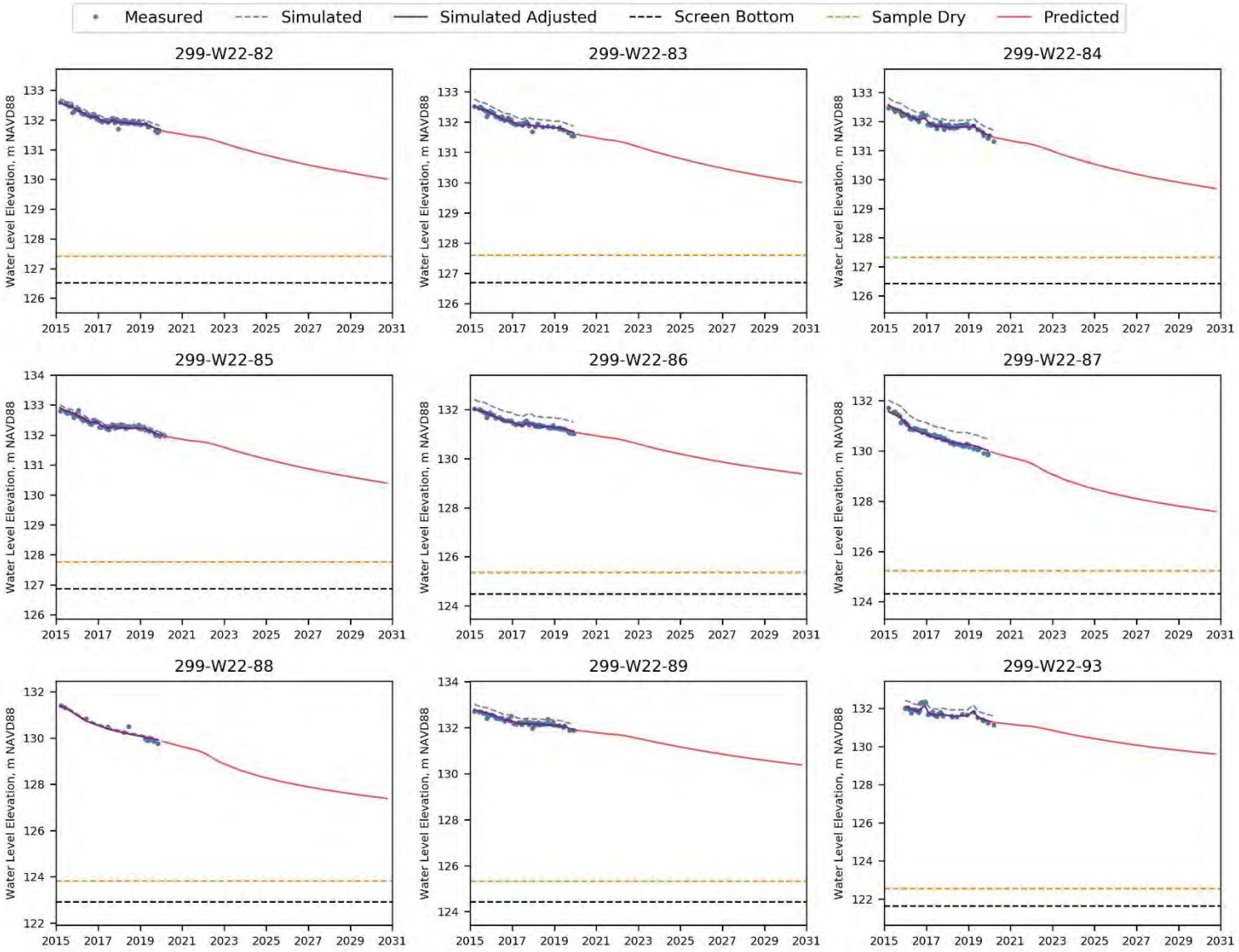

Figure B-36. Water-Level Graphs for Wells 299-W22-82 Through 299-W22-93

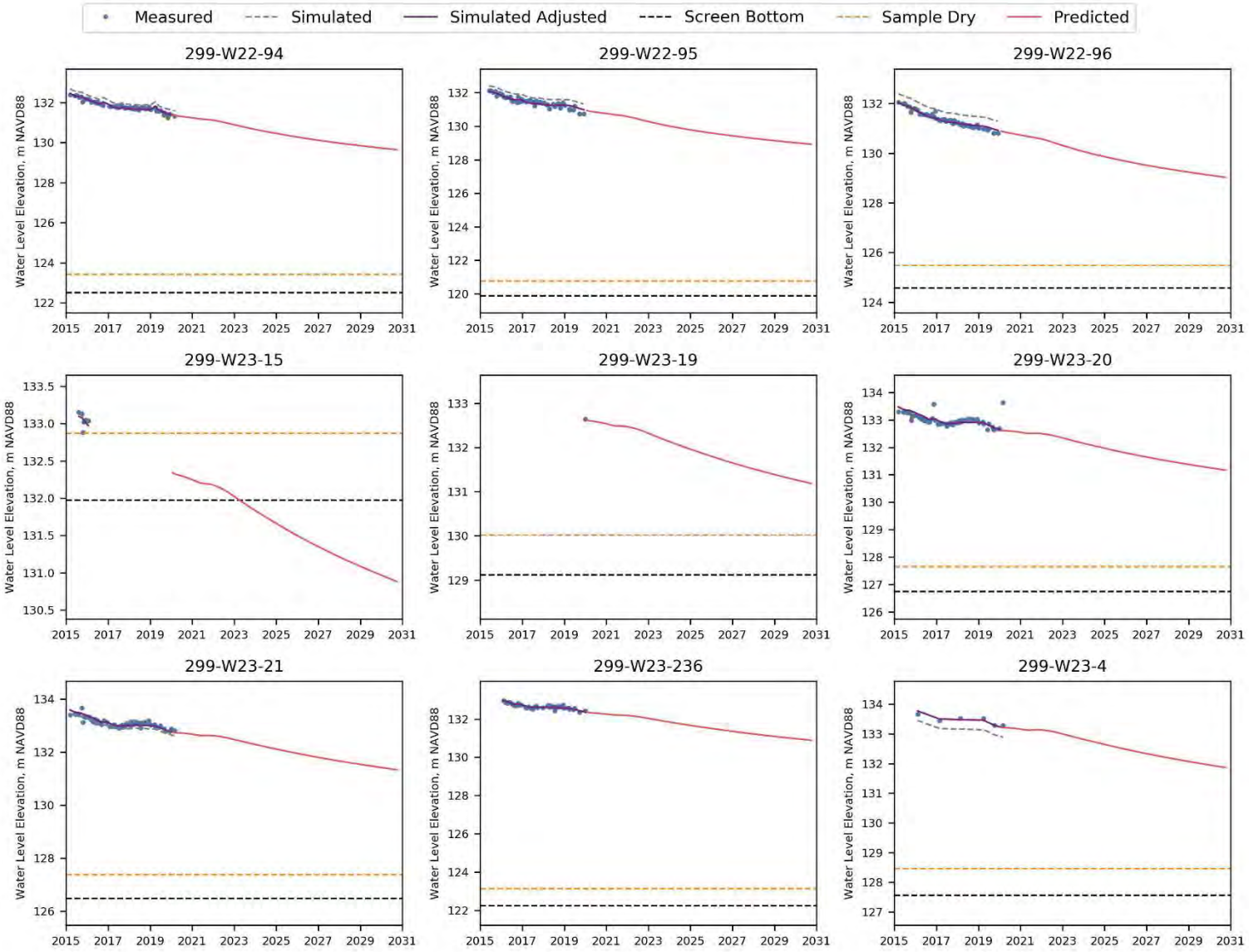

Figure B-37. Water-Level Graphs for Wells 299-W22-94 Through 299-W23-4

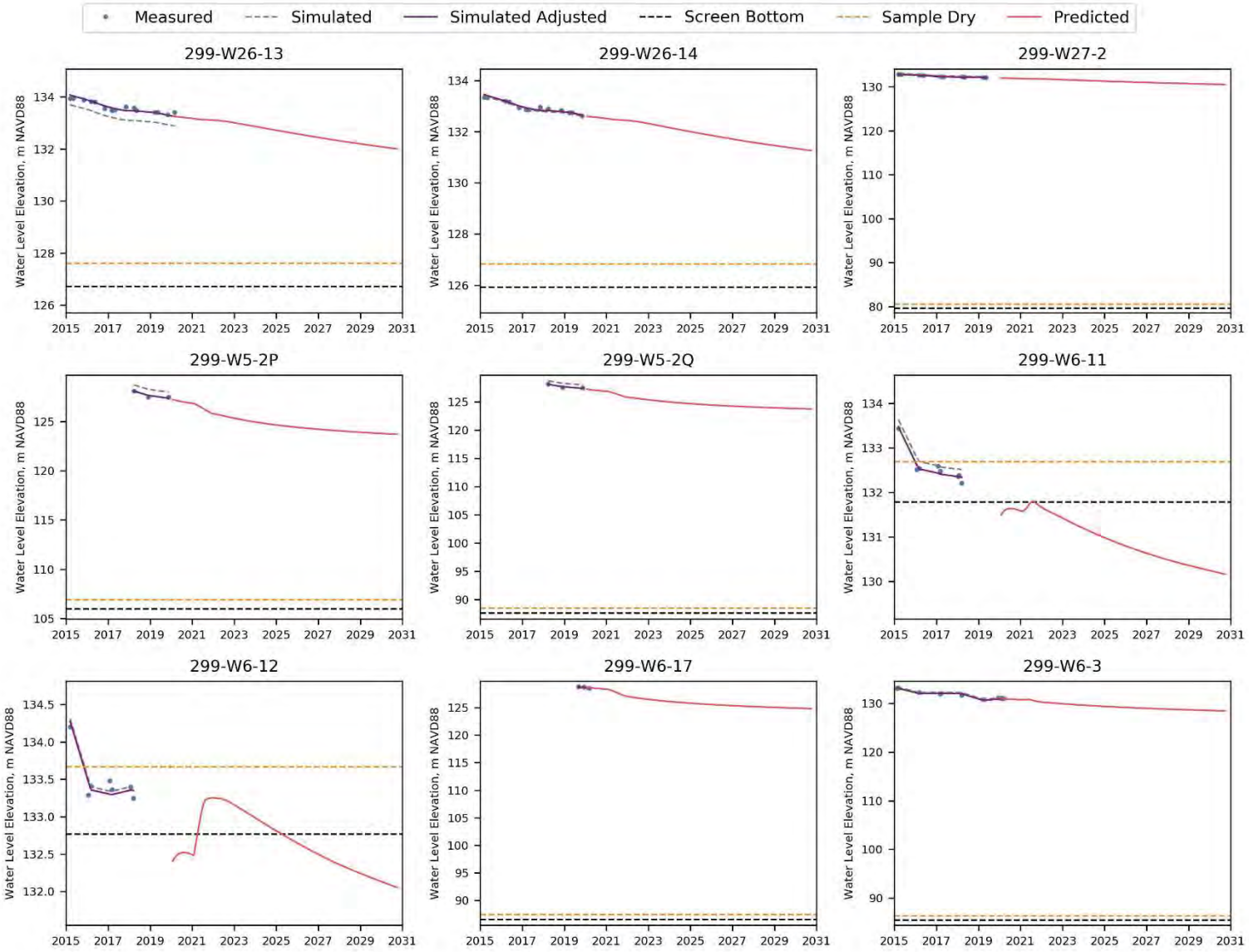

Figure B-38. Water-Level Graphs for Wells 299-W26-13 Through 299-W6-3

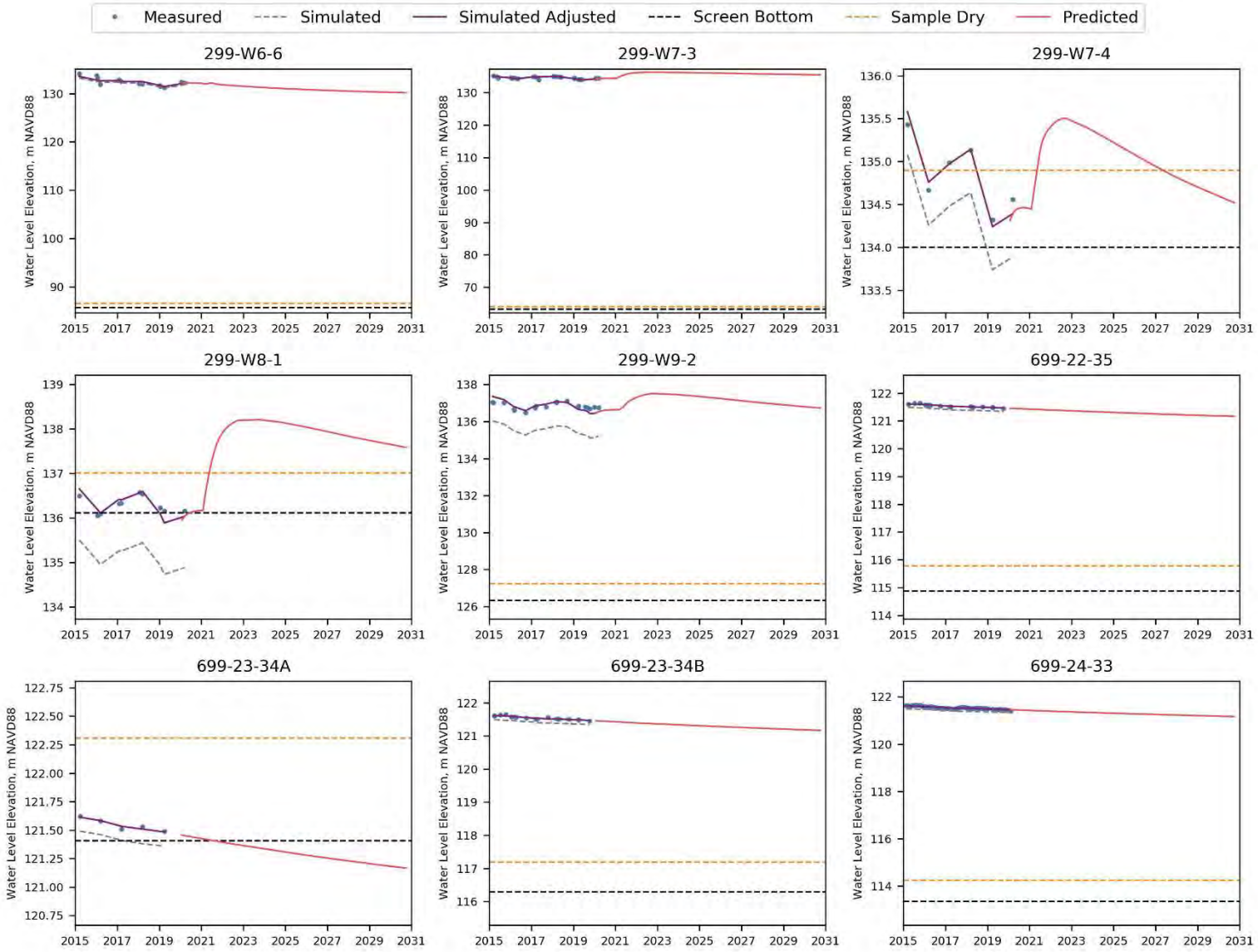

Figure B-39. Water-Level Graphs for Wells 299-W6-6 Through 699-24-33

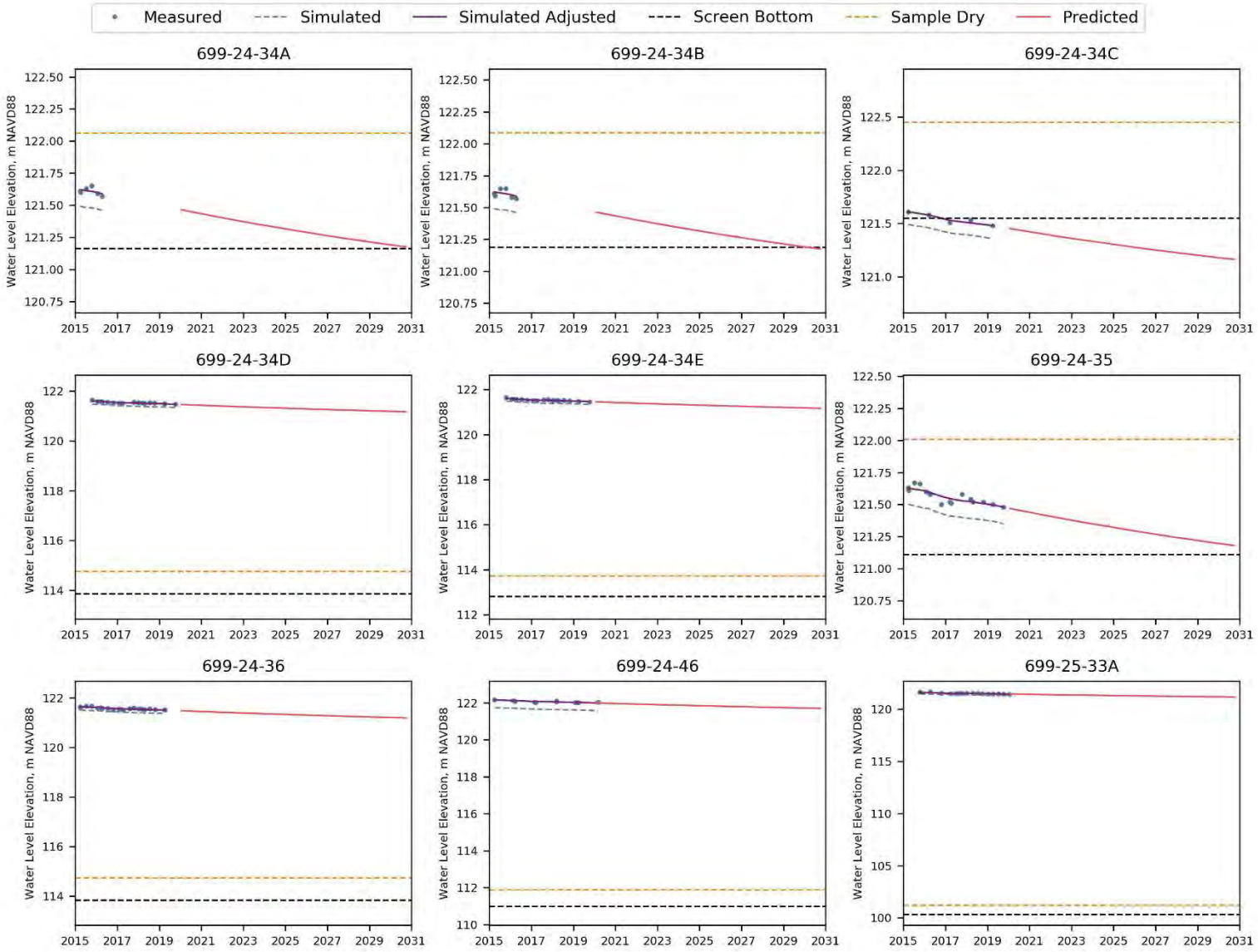

Figure B-40. Water-Level Graphs for Wells 699-24-34A Through 699-25-33A

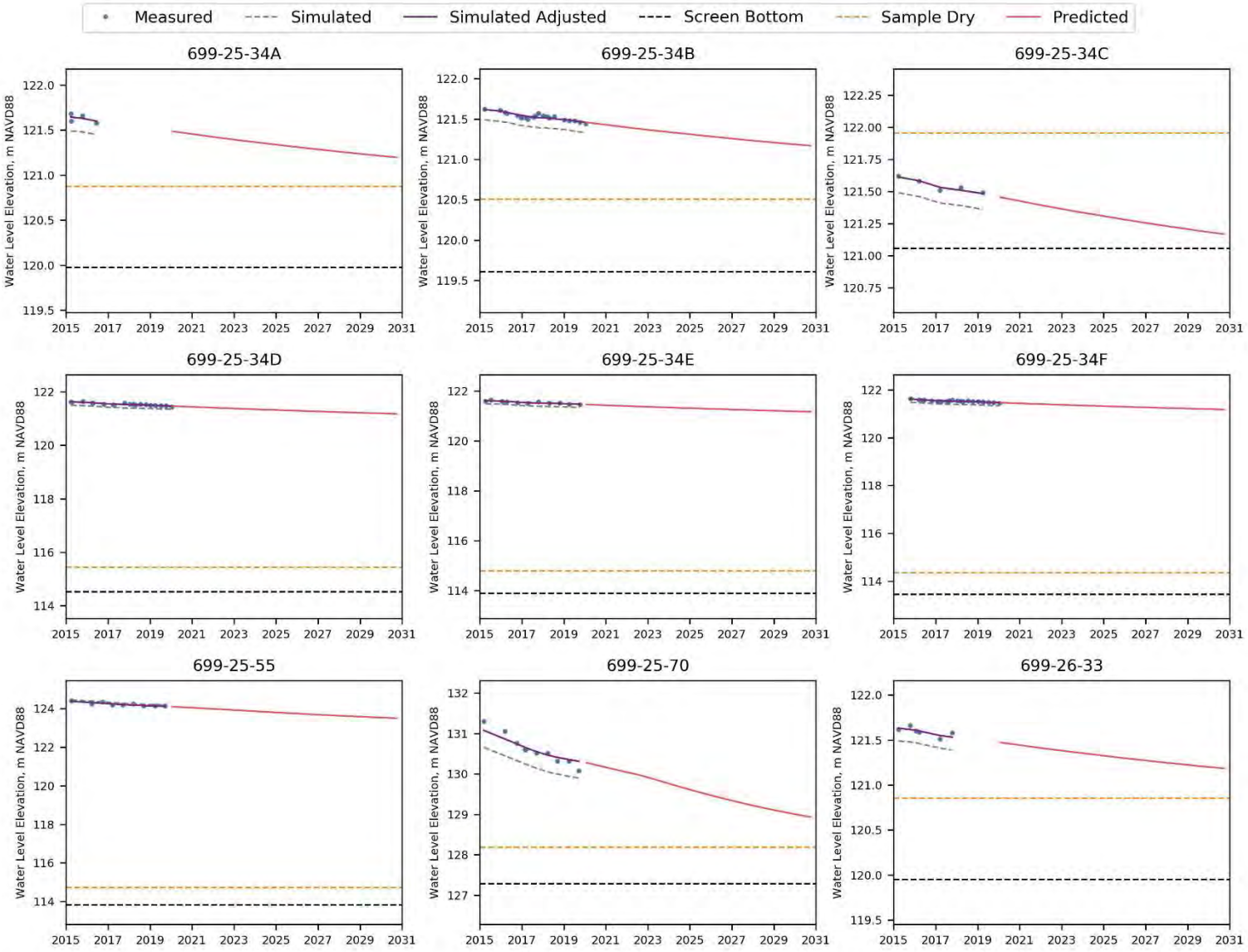

Figure B-41. Water-Level Graphs for Wells 699-25-34A Through 699-26-33

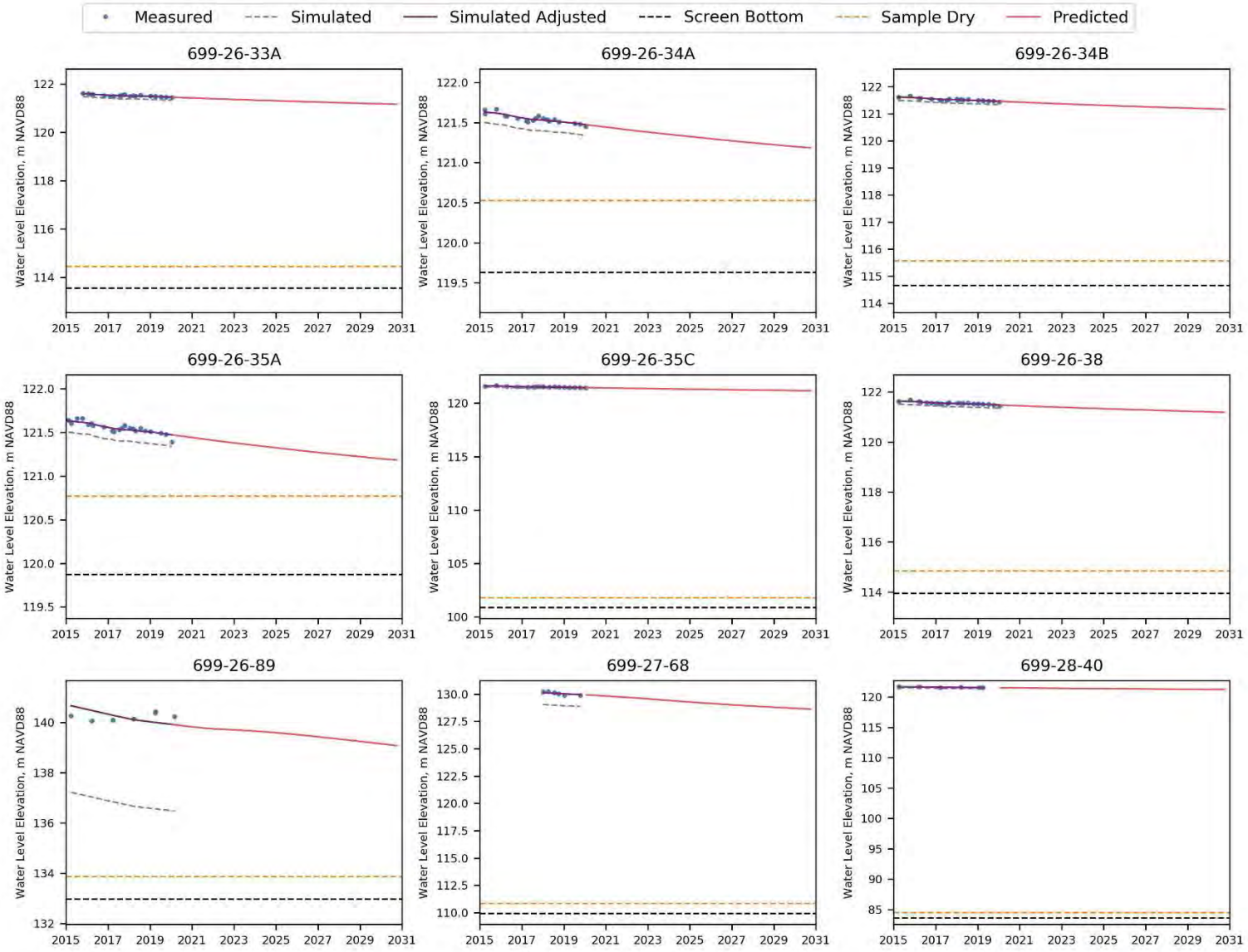

Figure B-42. Water-Level Graphs for Wells 699-26-33A Through 699-28-40

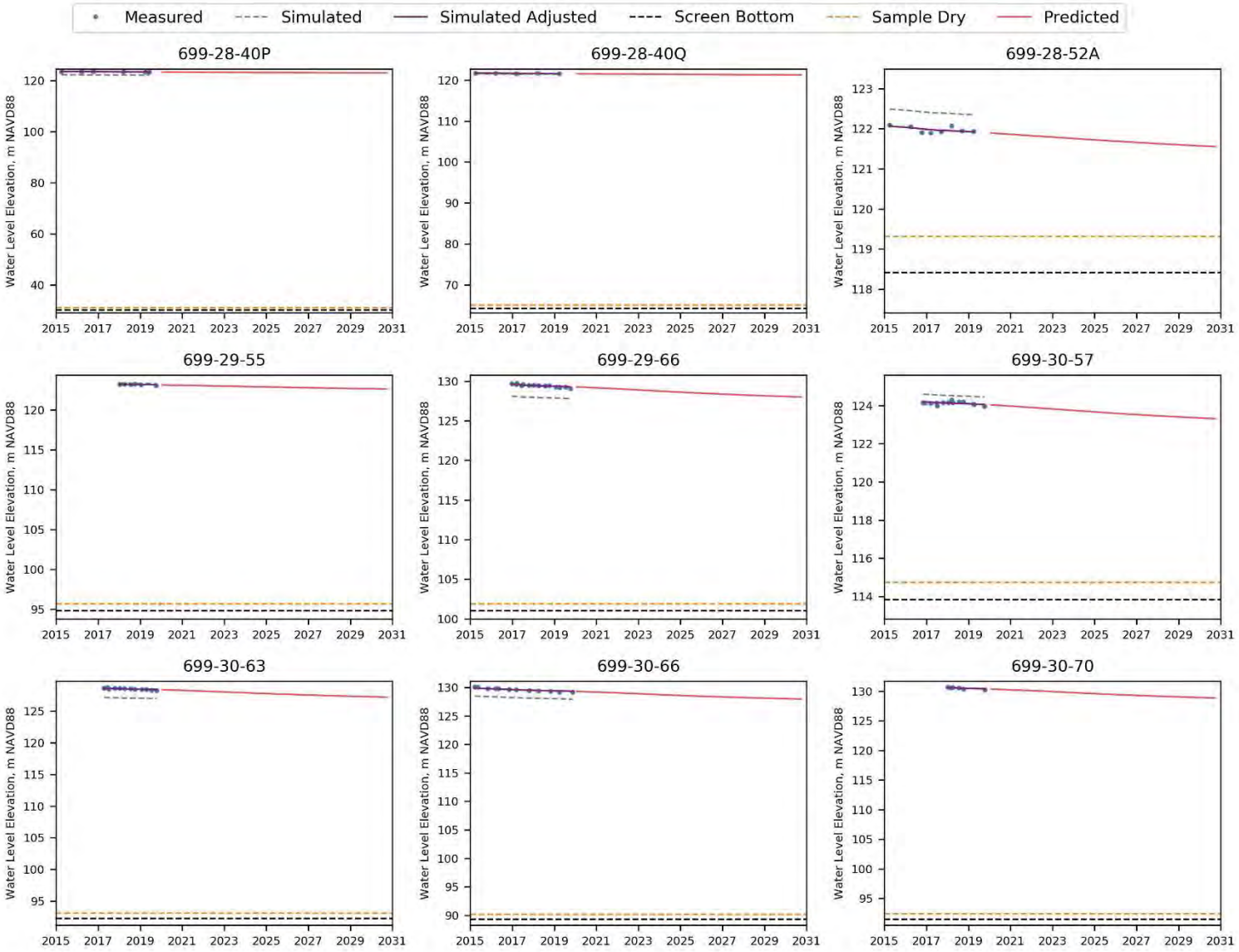

Figure B-43. Water-Level Graphs for Wells 699-28-40P Through 699-30-70

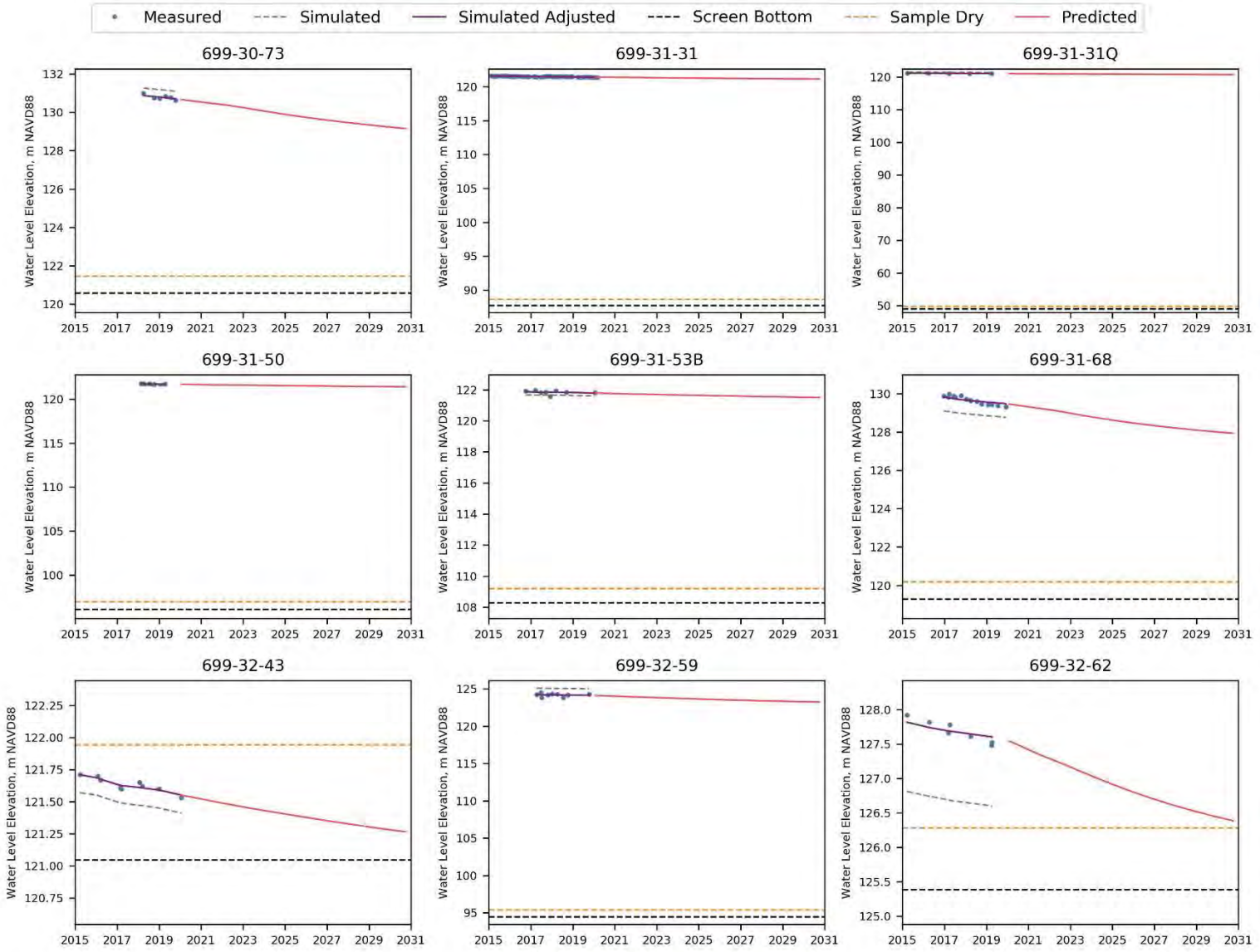

Figure B-44. Water-Level Graphs for Wells 699-30-73 Through 699-32-62

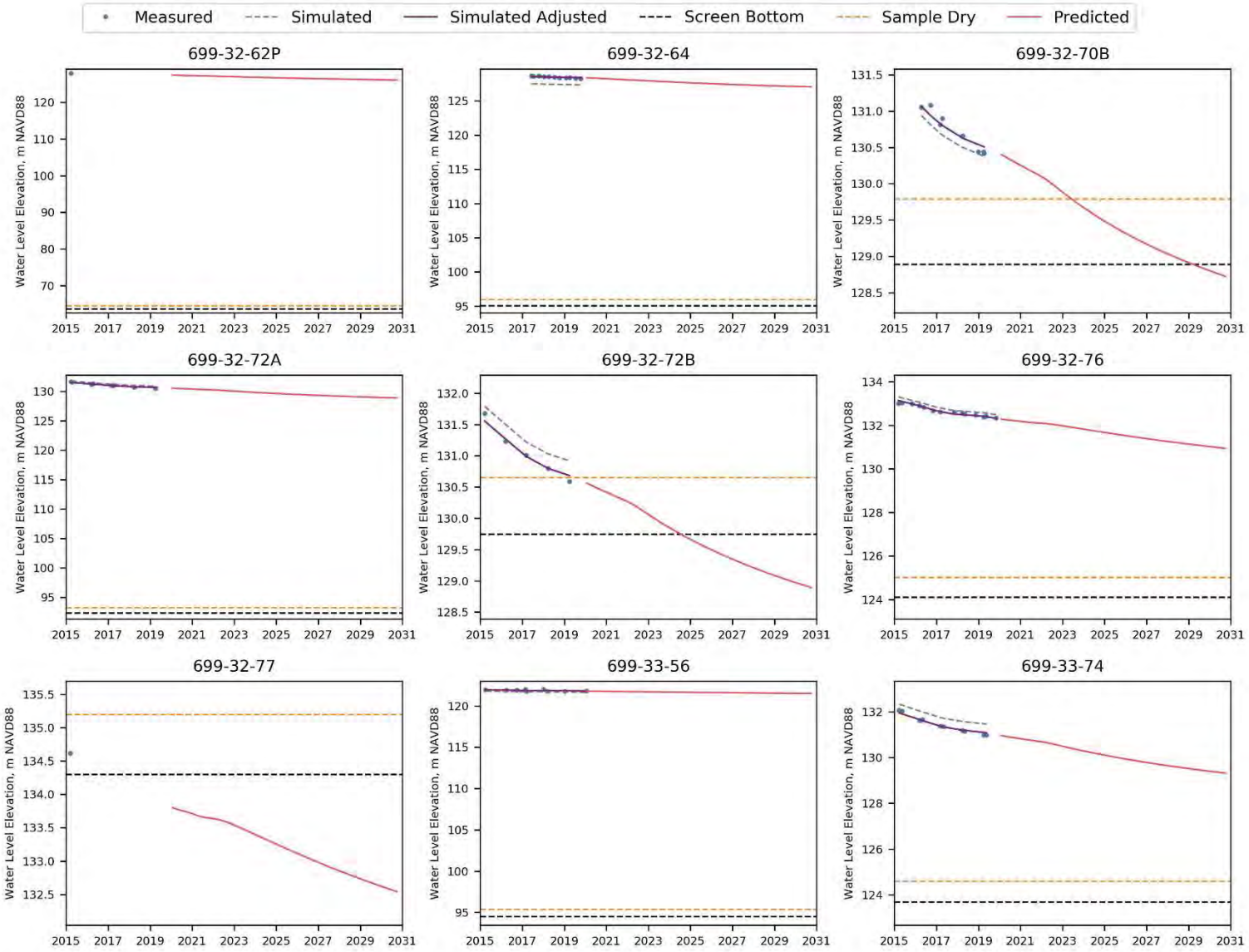

Figure B-45. Water-Level Graphs for Wells 699-32-62P Through 699-33-74

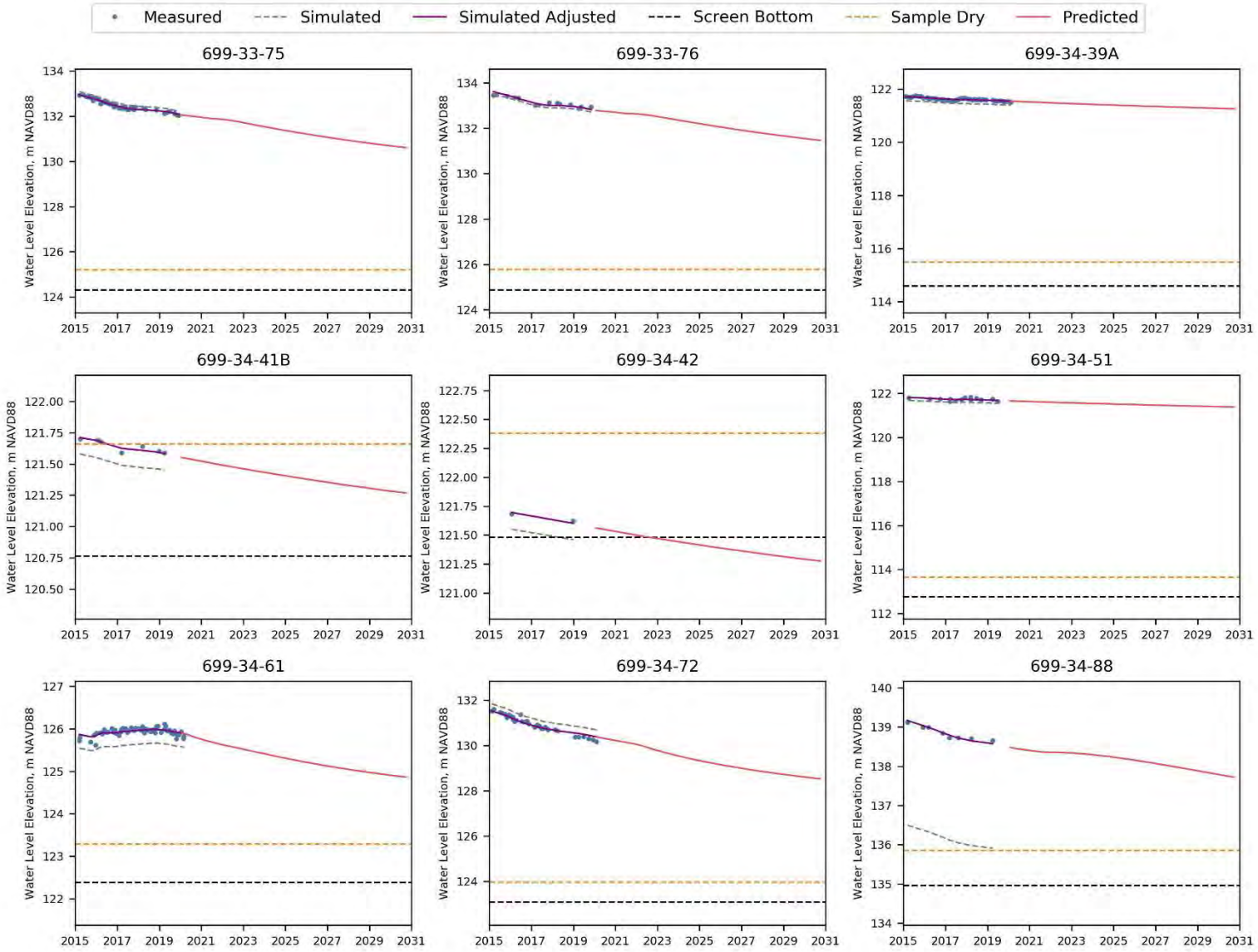

Figure B-46. Water-Level Graphs for Wells 699-33-75 Through 699-34-88

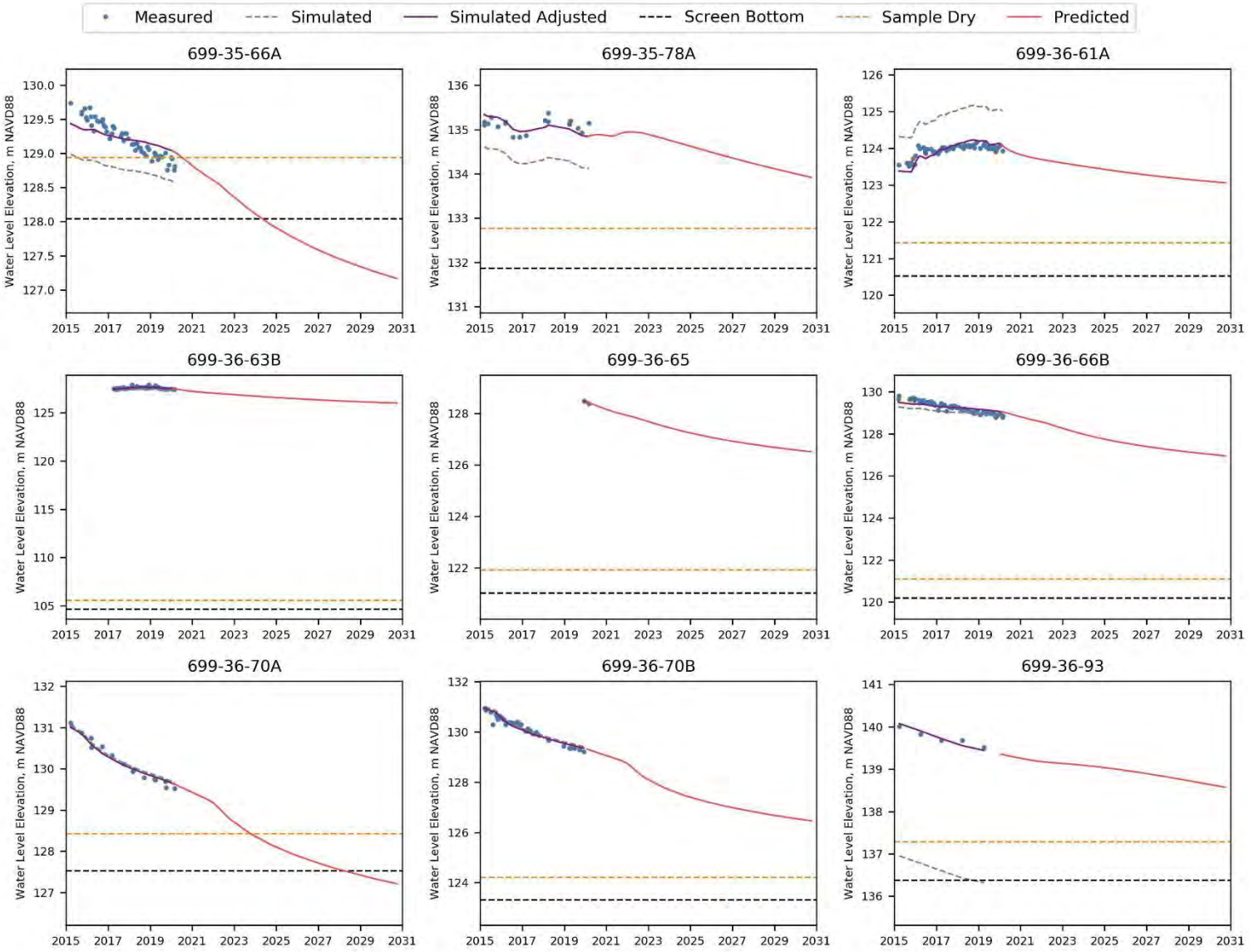

Figure B-47. Water-Level Graphs for Wells 699-35-66A Through 699-36-93

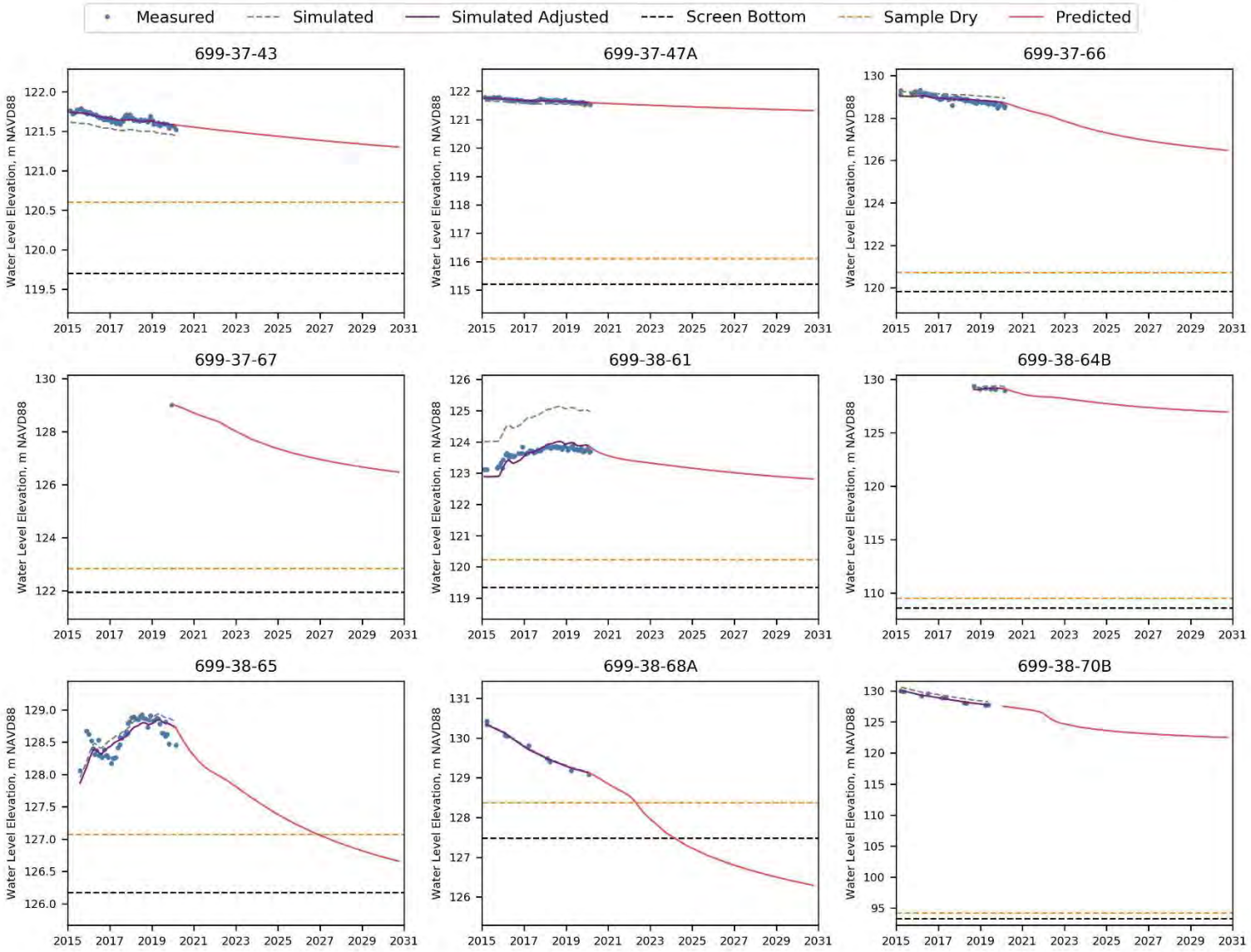

Figure B-48. Water-Level Graphs for Wells 699-37-43 Through 699-38-70B

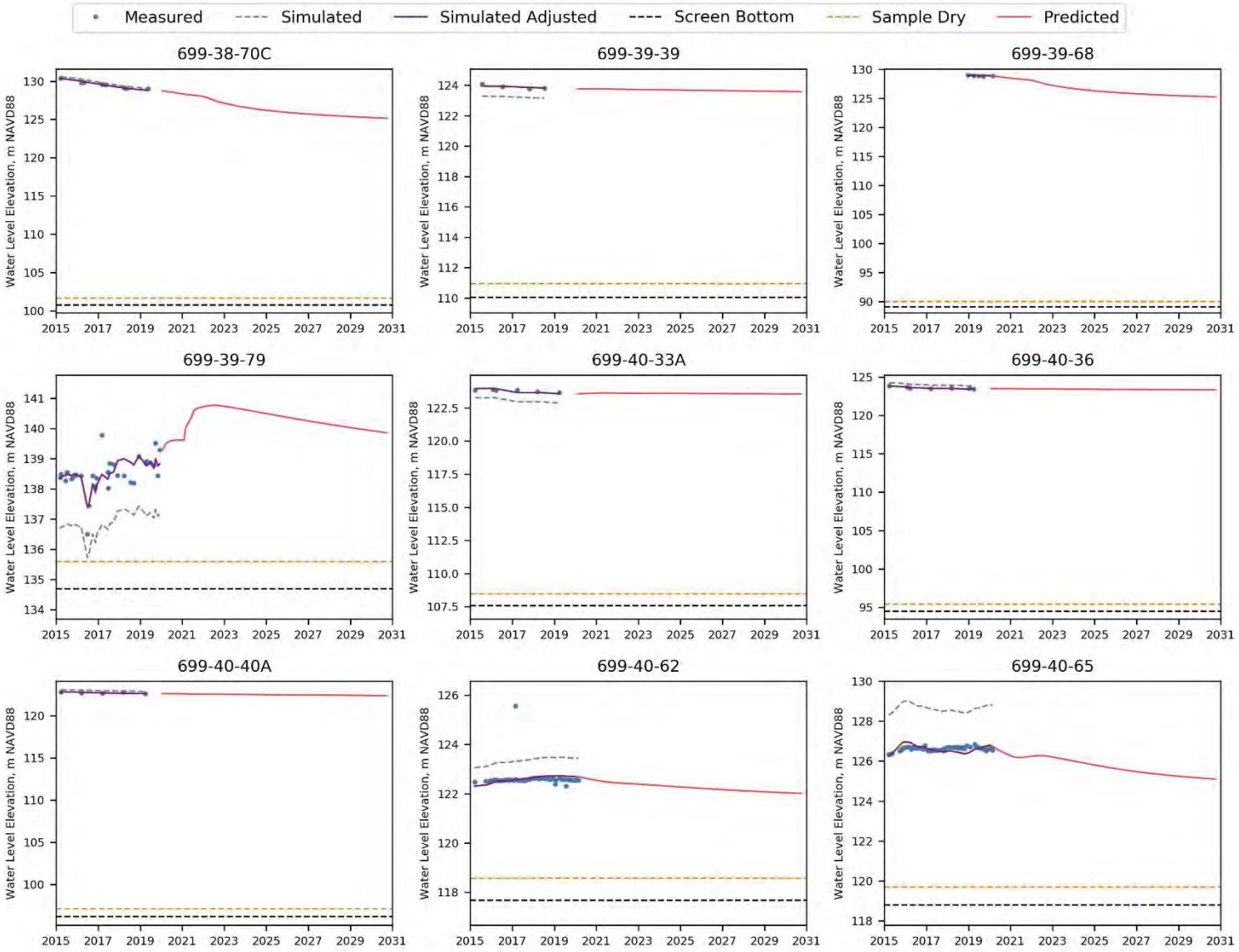

Figure B-49. Water-Level Graphs for Wells 699-38-70C Through 699-40-65

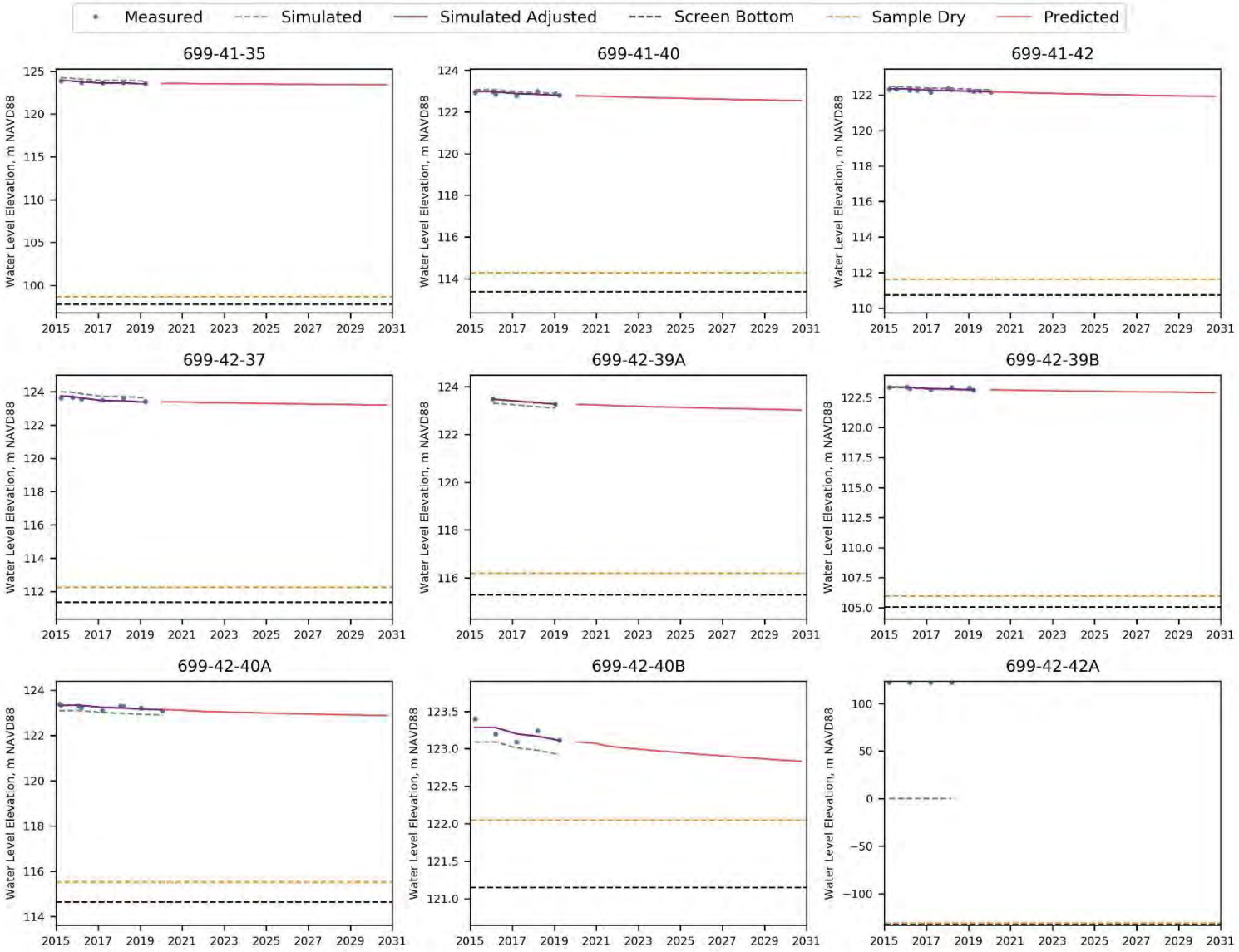

Figure B-50. Water-Level Graphs for Wells 699-41-35 Through 699-42-42A

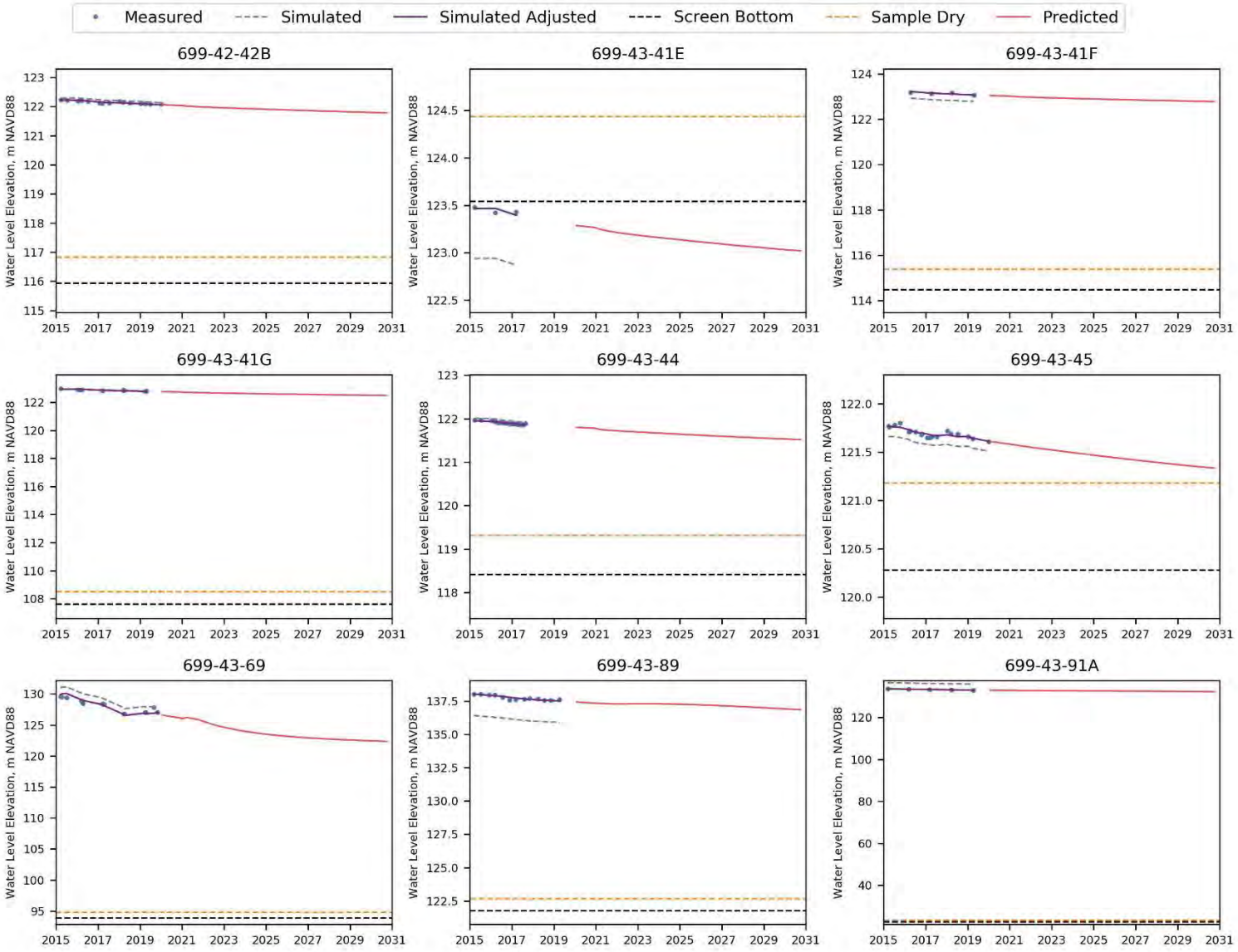

Figure B-51. Water-Level Graphs for Wells 699-42-42B Through 699-43-91A

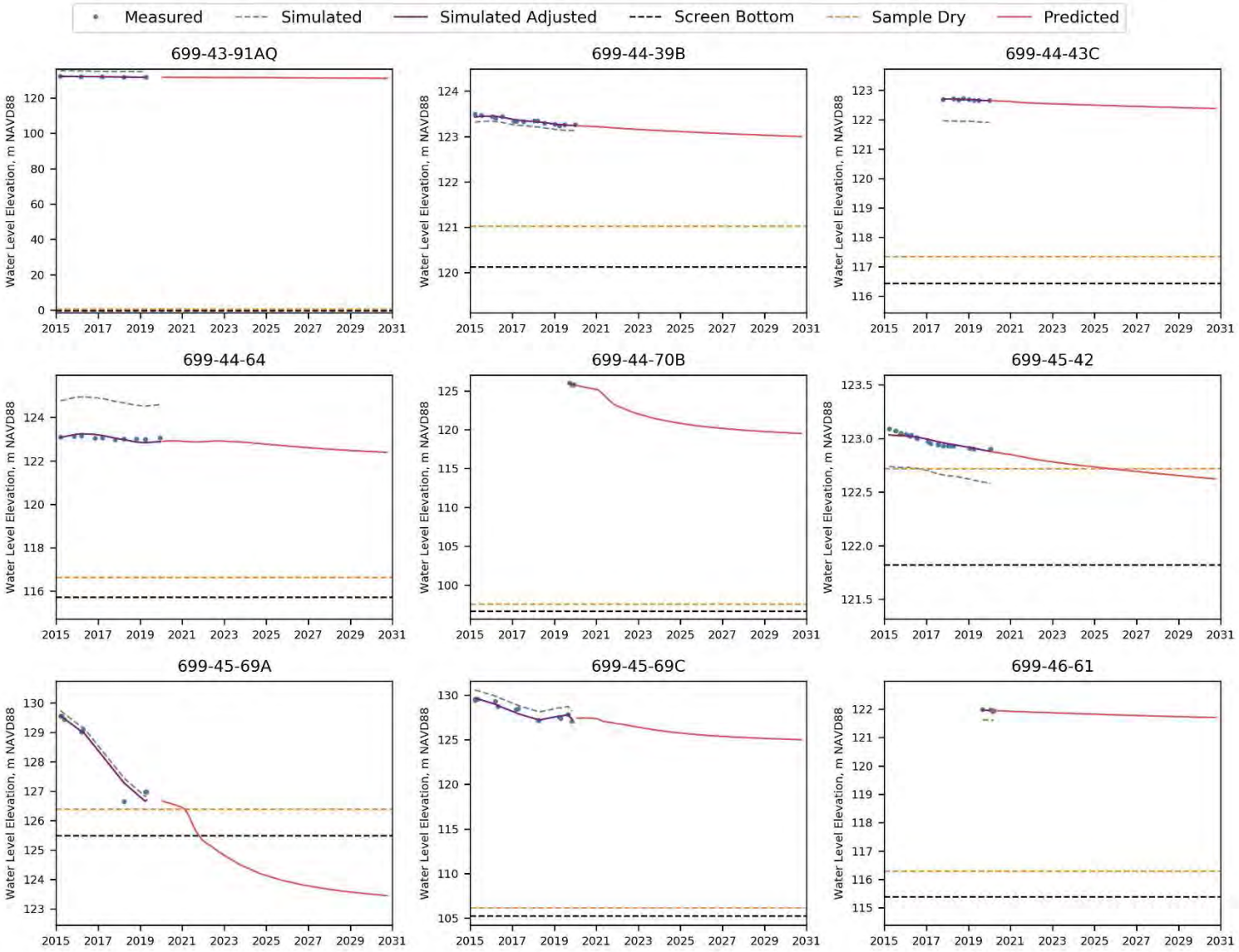

Figure B-52. Water-Level Graphs for Wells 699-43-91AQ Through 699-46-61

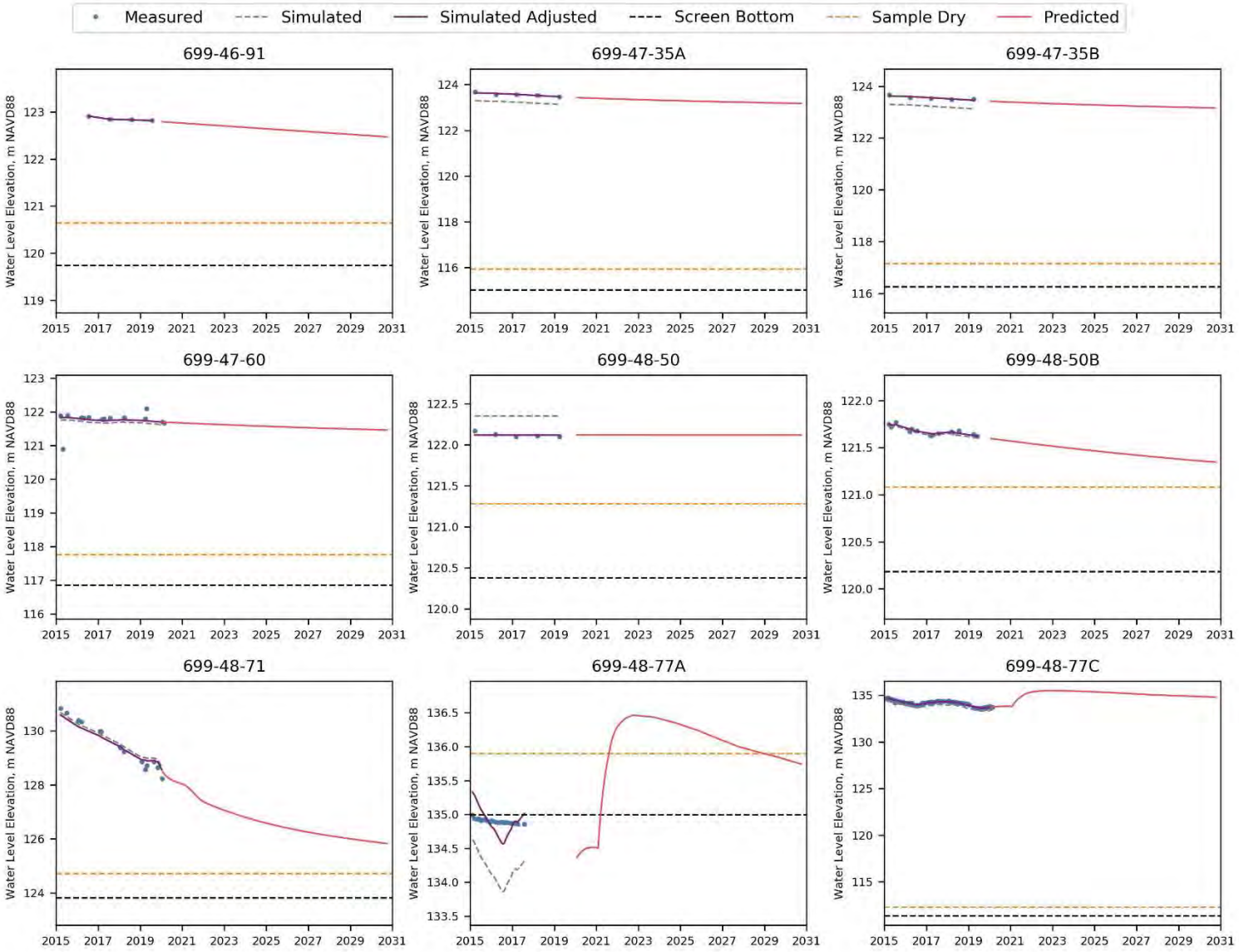

Figure B-53. Water-Level Graphs for Wells 699-46-91 Through 699-48-77C

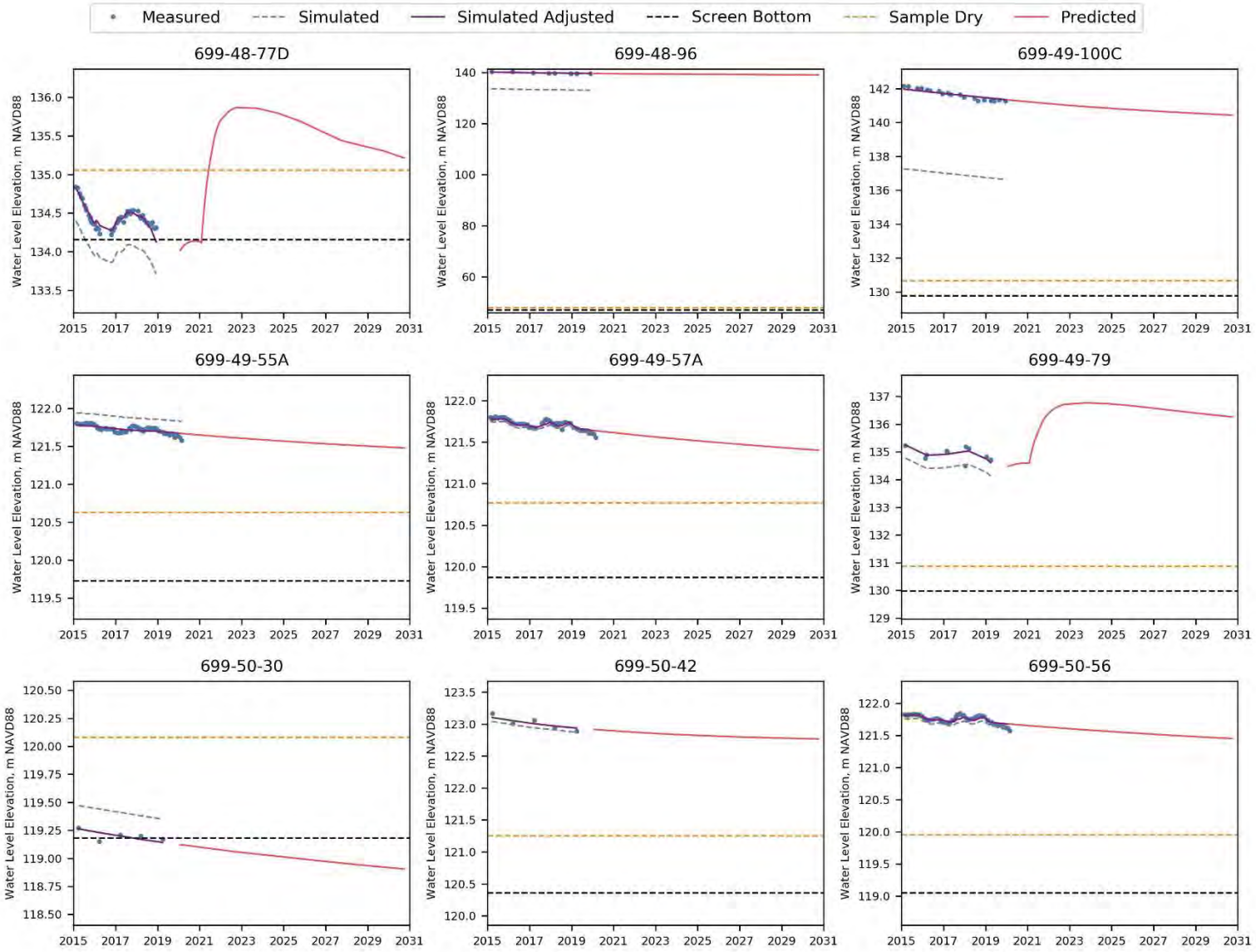

Figure B-54. Water-Level Graphs for Wells 699-48-77D Through 699-50-56

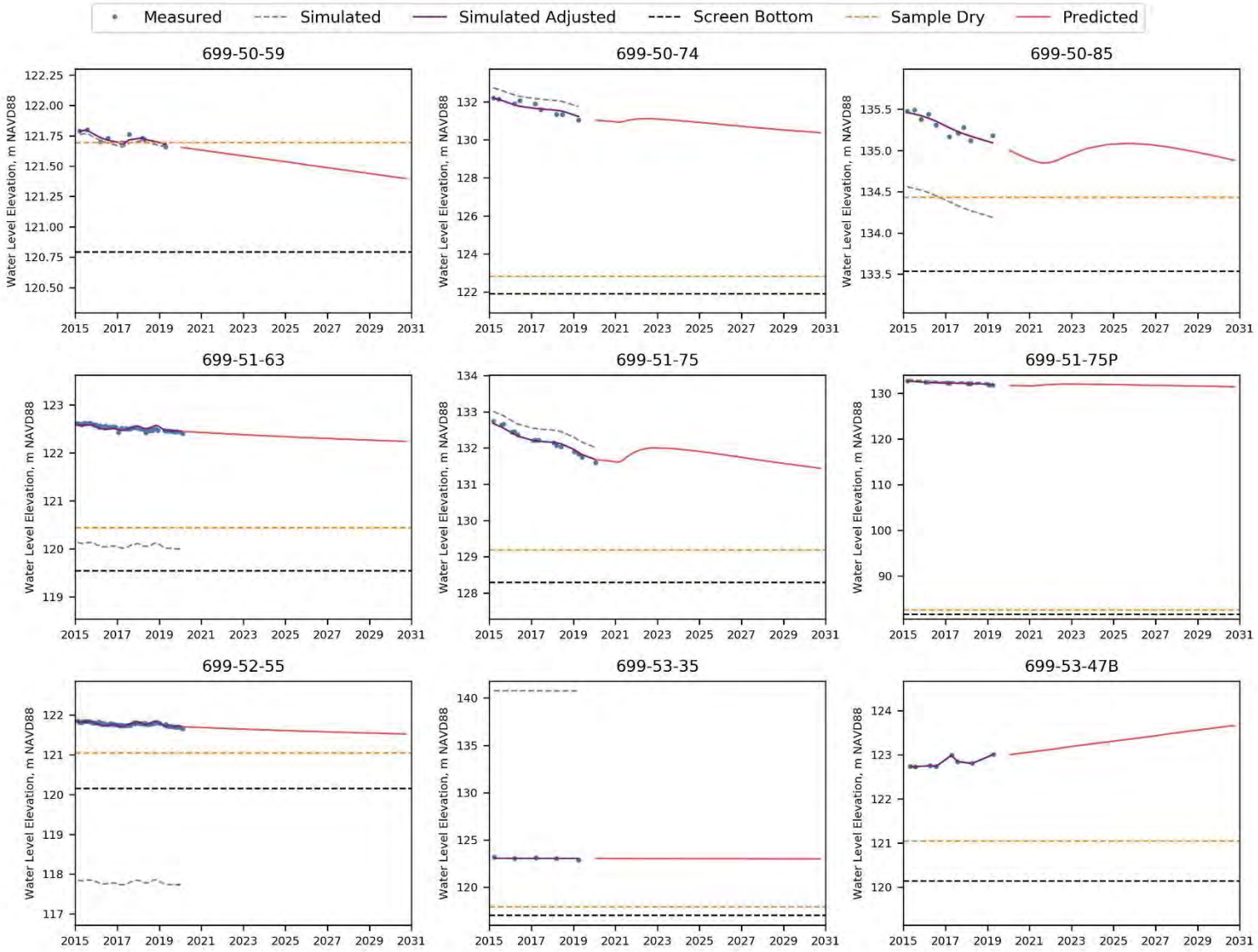

Figure B-55. Water-Level Graphs for Wells 699-50-59 Through 699-53-47B

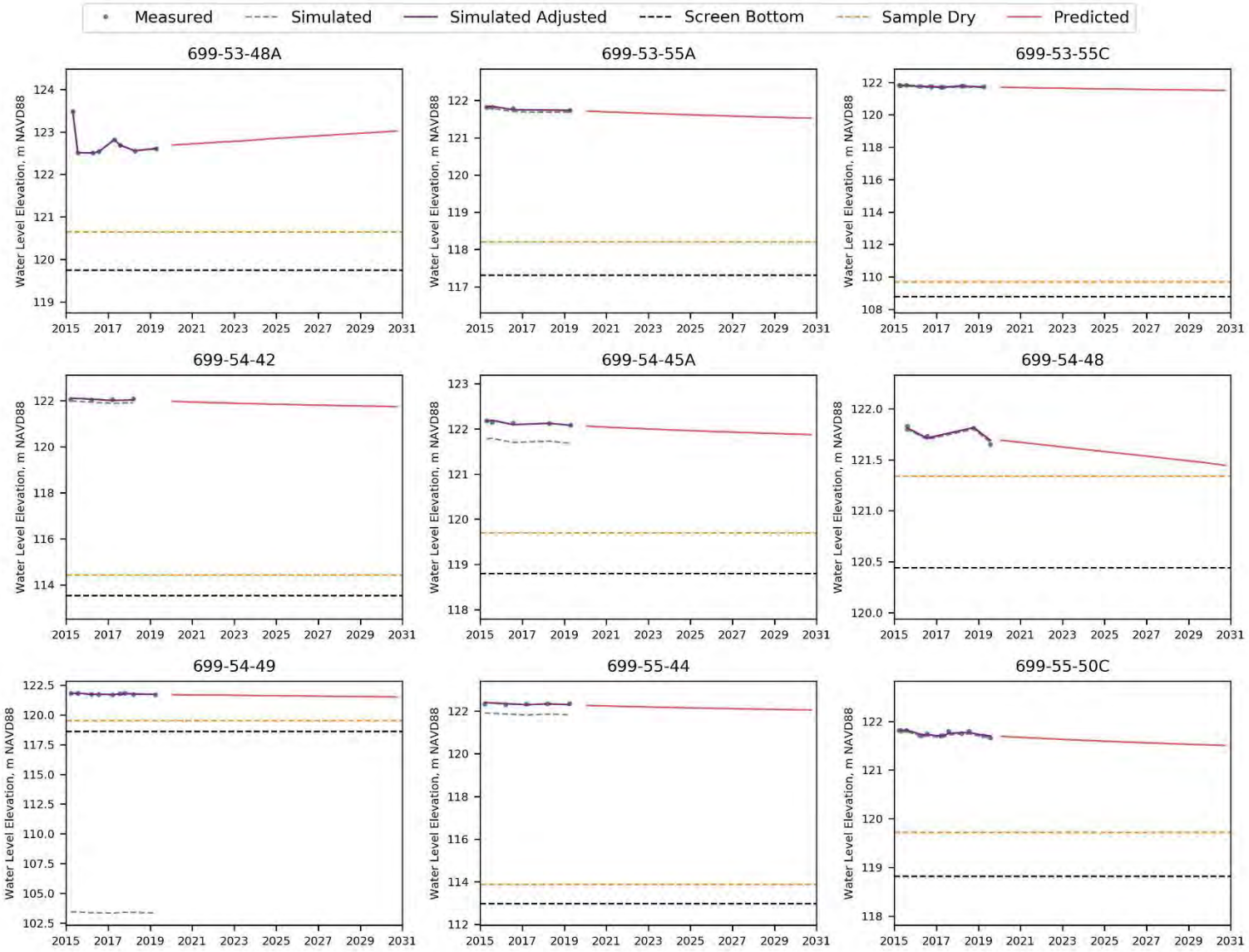

Figure B-56. Water-Level Graphs for Wells 699-53-48A Through 699-55-50C

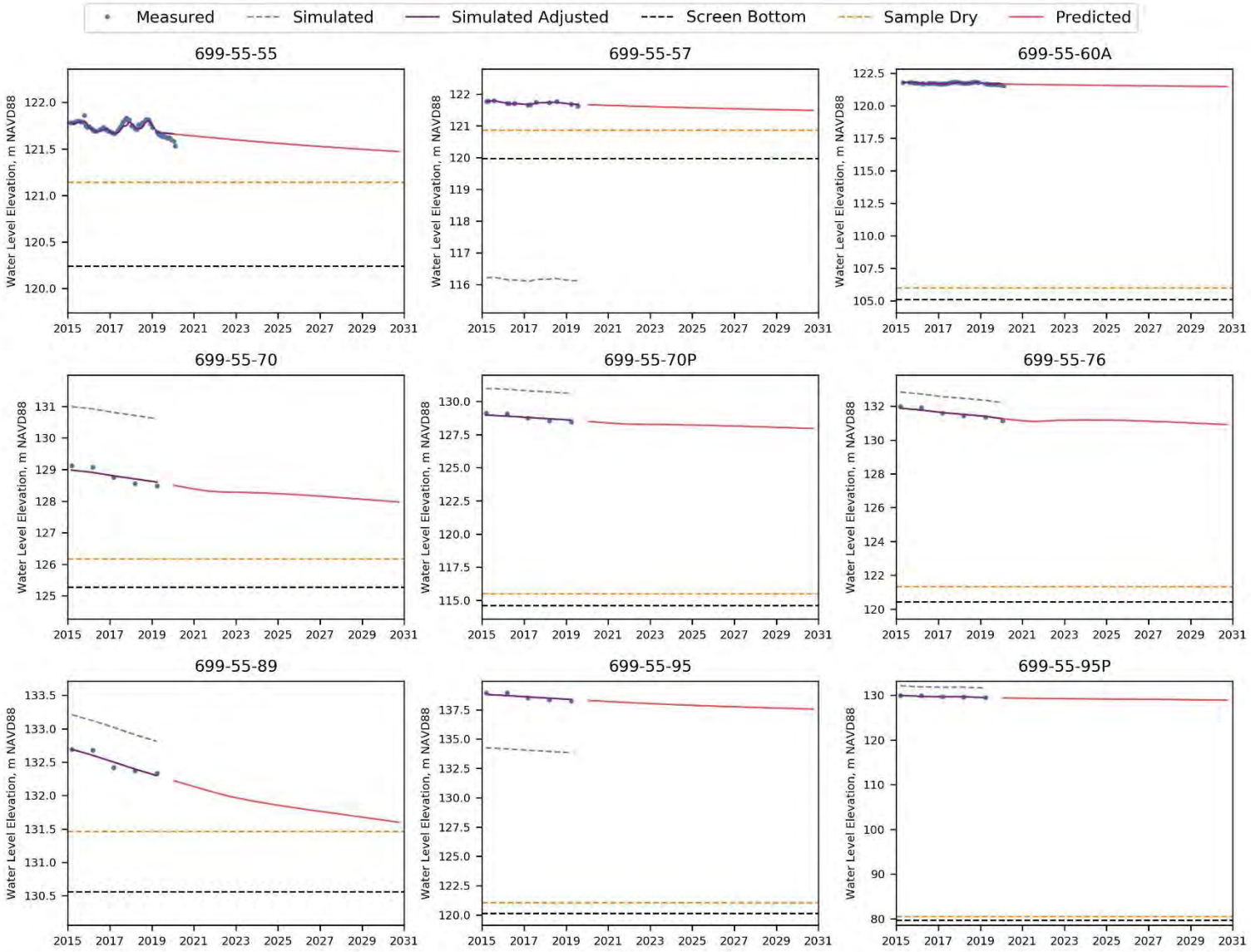

Figure B-57. Water-Level Graphs for Wells 699-55-55 Through 699-55-95P

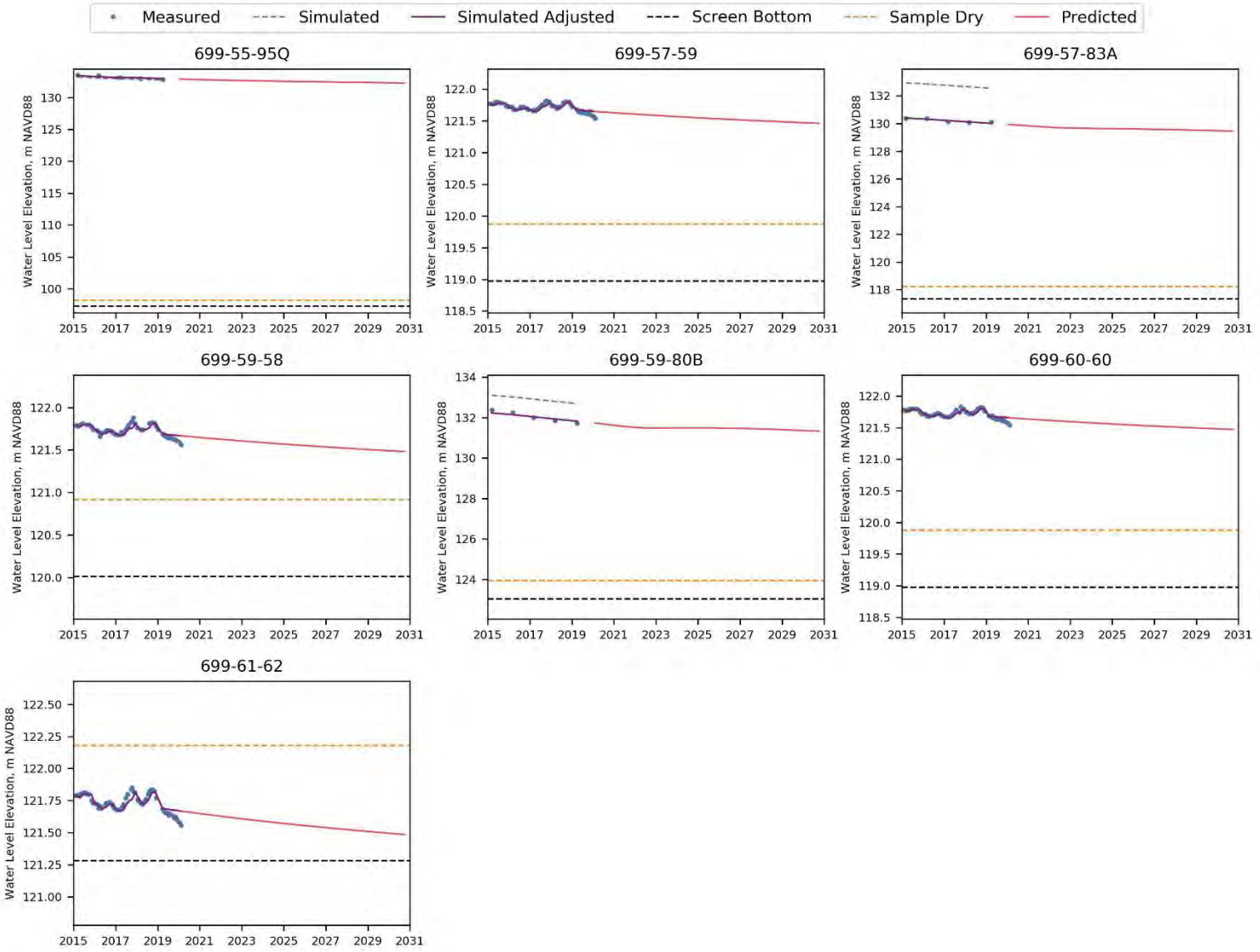

Figure B-58. Water-Level Graphs for Wells 699-55-95Q Through 699-61-62

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