CHINO BASIN WATERMASTER

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NOTICE OF MEETING

Ground-Level Monitoring Committee

10:00 am – Thursday, March 7, 2024

Held via Zoom Meeting:
https://us06web.zoom.us/j/84420896016?pwd=kt4orgfFqEy26lAvN66qBrFWnrXKg0.1
You can also dial in using your phone:
Join by Phone: 1 669 444 9171 | **Meeting ID:** 844 2089 6016 | **Passcode:** 780409

AGENDA

1. Responses to Comments: *1D Model Simulation of Subsidence in Northwest MZ-1—Subsidence Management Alternative #1*
2. Draft Technical Memorandum: *Proposed Locations and Data for Construction and Calibration of Additional 1D Models*
3. Draft Technical Memorandum: *Recommended Scope of Work and Budget for the Ground Level Monitoring Program for Fiscal Year 2024/25*

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TECHNICAL MEMORANDUM

DATE: February 23, 2024

Project No.: 941-80-23-25 B.2

TO: Ground-Level Monitoring Committee

CC: Edgar Tellez-Foster, *Interim General Manager of the Chino Basin Watermaster*

FROM: West Yost Associates, *Watermaster Engineer*

REVIEWED BY: Andy Malone, PG

SUBJECT: *1D Model Simulation of Subsidence in Northwest MZ-1—Subsidence Management Alternative #1 (FINAL)*

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BACKGROUND AND OBJECTIVES

The Chino Basin Watermaster's Subsidence Management Plan (SMP)[1] identified several "Areas of Subsidence Concern" across the western portion of Chino Basin where the future occurrence of land subsidence and ground fissuring is a concern. The SMP states that if data from existing monitoring efforts in the "Areas of Subsidence Concern" indicate the potential for adverse impacts due to subsidence, Watermaster will revise the SMP to avoid those adverse impacts.

Figure 1 is a map of the so-called Northwest MZ-1 Area of Subsidence Concern (Northwest MZ-1). Watermaster has monitored vertical ground motion in Northwest MZ-1 via InSAR[2] dating back to 1992. Land subsidence in Northwest MZ-1 was first identified as a concern in 2006 in the MZ-1 Summary Report.[3] Of particular concern is that the subsidence across the San Jose Fault in Northwest MZ-1 has occurred in a pattern of concentrated differential subsidence—the same pattern of differential subsidence that occurred in the Managed Area during the time of ground fissuring. Ground fissuring is the main subsidence-related threat to infrastructure.

The issue of differential subsidence and the potential for ground fissuring in Northwest MZ-1 has been discussed at prior meetings of the Ground Level Monitoring Committee (GLMC), and the subsidence has been documented and described as a concern in Watermaster's State of the Basin Reports, the annual reports of the GLMC, and in the Initial Hydrologic Conceptual Model for Northwest MZ-1.[4] Watermaster increased monitoring efforts in Northwest MZ-1 beginning in 2012 to include ground-elevation surveys and electronic distance measurements (EDM) to monitor ground motion and the potential for fissuring.

In 2015, the Watermaster's Engineer developed the *Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area* (Work Plan).[5] The Work Plan is characterized as an ongoing Watermaster effort and includes a description of a multi-year scope of work, a cost estimate, and an implementation schedule. The Work Plan was included in the SMP as Appendix B. Implementation of the Work Plan began in July 2015. On an annual basis, the GLMC analyzes the data and information generated by the implementation of the Work Plan. The results and interpretations generated from the analysis are documented in the annual reports of the GLMC and used to prepare recommendations for future activities.

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[1] Wildermuth Environmental, Inc. 2015. Chino Basin Subsidence Management Plan. Prepared for the Chino Basin Watermaster. July 23, 2015.

[2] Interferometric Synthetic Aperture Radar (InSAR) is a remote sensing technique that is used to monitor vertical ground motion over time.

[3] Wildermuth Environmental, Inc. 2006. MZ-1 Summary Report. Prepared for the MZ-1 Technical Committee. February 2006.

[4] Wildermuth Environmental, Inc. 2017. Initial Hydrologic Conceptual Model and Monitoring and Testing Program for the Northwest MZ-1 Area. Prepared for the Chino Basin Watermaster. December 2017.

[5] Wildermuth Environmental, Inc. 2015. Work Plan to Develop a Subsidence-Management Plan for Northwest MZ-1. Prepared for the Chino Basin Watermaster. July 23, 2015.

The objective of the *Subsidence Management Plan for Northwest MZ-1* is to provide guidance for the Watermaster and the Parties for how to manage hydraulic heads in Northwest MZ-1 (potentially through the management of pumping, recharge, the use of managed storage, and/or the design and implementation of Storage and Recovery Programs) so that the future occurrence of subsidence is minimized or abated in this area. The development of the *Subsidence Management Plan for Northwest MZ-1* will also include the evaluation of the minimum recharge quantity of supplemental water in MZ-1 as called for in Section 8.4 of the Peace II Agreement.[6]

The Work Plan included tasks to construct, calibrate, and use one-dimensional aquifer-system compaction models in Northwest MZ-1 (1D Models) to:

- Assist in understanding the mechanisms behind the ongoing subsidence in Northwest MZ-1
- Assist in the development of the *Subsidence Management Plan for Northwest MZ-1*.

The Work Plan envisioned the use of the 1D Models to update the Watermaster's three-dimensional groundwater-flow model so it could simulate aquifer-system compaction and then be used to develop the *Subsidence Management Plan for Northwest MZ-1*. However, with input from the GLMC, the Watermaster Engineer subsequently recommended to use the 1D Models directly to develop the *Subsidence Management Plan for Northwest MZ-1*.

In 2021 and 2022, the Watermaster Engineer constructed and calibrated the 1D Models and published a technical memorandum to document the results.[7] Figure 1 shows the locations of the two 1D Models at the PX and MVWD-28 sites in Northwest MZ-1. Figures 2 and 3 are diagrams that depict a profile view of each 1D Model including: the data used to construct the 1D Models (borehole lithology and geophysics) and the vertical discretization of the 1D Model grid cells into "sand" and "clay" layers.

The next step is to use the 1D Models to project the future rates and magnitudes of land subsidence in Northwest MZ-1 under various "Subsidence Management Alternatives." The first Subsidence Management Alternative (SMA-1) represents the recent plans of the Chino Basin Parties for groundwater management (*e.g.,* pumping, recharge, use of managed storage, etc.) over a defined planning horizon. SMA-1 was reviewed by the GLMC before it was simulated with the 1D Models.

This memorandum describes the results, conclusions, and recommendations from the 1D Model simulations of SMA-1.

The need to develop additional Subsidence Management Alternatives and run 1D Model simulations will be based on the 1D Model results and interpretations described herein. Each new Subsidence Management Alternative will be reviewed by the GLMC before model simulations are conducted.

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[6] See Section 8.4 of the *Final_Peace_II_Documents.pdf (cbwm.org)*

[7] West Yost Associates. 2022. *Construction and Calibration of One-Dimensional Compaction Models in the Northwest MZ-1 Area of the Chino Basin*. Prepared for the Chino Basin Watermaster. December 2022.

TECHNICAL APPROACH AND METHODS

This section describes the technical approach and methods that were employed to develop and run SMA-1 with the 1D Models to support the ongoing effort to develop a *Subsidence Management Plan for Northwest MZ-1*:

1. **Develop SMA-1 with review and input from the GLMC**. SMA-1 represents the most recently reported plans of the Chino Basin parties for pumping, recharge, and the use of managed storage over the defined planning horizon (2018-2050). The GLMC reviewed and provided input on SMA-1 before it was used in this effort.
2. **Simulate the hydrologic response of the Chino Basin to SMA-1 by aquifer layer**. The existing numerical groundwater-flow model of the Chino Basin (referred to as the Chino Valley Model [CVM]) is used to simulate the hydrologic response of the Chino Basin to SMA-1. The CVM is a five-layer model, so it predicts the hydraulic heads in each model layer under the projected pumping and recharge stresses over the planning horizon.
3. **Simulate the aquifer-system compaction that is predicted to occur in Northwest MZ-1 under SMA-1**. The hydraulic heads of SMA-1, as simulated by the CVM in each model layer, are used as input data for the 1D Models. The output of the 1D Models represents the vertical aquifer-system compaction (and hence, the resulting land subsidence) that is predicted to occur in Northwest MZ-1 under SMA-1. The output is described in terms of the rates, duration, and magnitude of vertical deformation of the aquifer sediments that is predicted to occur at the 1D Model locations over the planning horizon, by CVM layer.
4. **Evaluate model results and develop recommendations***.* The Watermaster Engineer and the GLMC evaluate the projected hydraulic heads versus the projected compaction as simulated by the 1D Models, and then can make one or more of the following recommendations:
    a. Recommend "acceptable thresholds" for projected land subsidence that will avoid or mitigate Material Physical Injury (MPI).
    b. Recommend "subsidence management strategies" for Northwest MZ-1. These recommended strategies may come in the form of:
        i. Recommended operating ranges for hydraulic heads by aquifer layer.
        ii. Recommended groundwater management practices, such as pumping, recharge, the use of local storage, and/or the design and implementation of Storage and Recovery programs. Such recommendations can include guidance for the locations and depth intervals for pumping and recharge.
    c. Recommend the minimum recharge quantity of supplemental water in MZ-1.
    d. Recommend additional work, such as: filling data gaps and/or collecting additional hydrogeologic information; developing additional SMAs; performing CVM and 1D Model simulations of the additional SMAs; and making revised recommendations based on the model results (*i.e.,* 4.a. through 4.c. above). Any additional SMAs will be reviewed by the GLMC before taking the next step to simulate the SMA with the CVM and the 1D Models.

5. **Repeat methods to develop the *Subsidence Management Plan for Northwest MZ-1*.** The methods above are repeated until enough information has been generated to develop the *Subsidence Management Plan for Northwest MZ-1*.

SUBSIDENCE MANAGEMENT ALTERNATIVE #1

SMA-1 is equivalent to the planning scenario that was simulated to support the 2020 Safe Yield Recalculation (2020 SYR)[8] using the 2020 CVM. The 2020 SYR was intended to represent and simulate the Parties' projected pumping, recharge, and use of storage through 2050. This scenario spanned from fiscal year (FY) 2018 through 2050 and included the cultural conditions (e.g., land use, water supply plans) that were assumed based on the best-available planning data at the time of the 2020 SYR.[9] An advantage of using 2020 SYR as the planning scenario for SMA-1 is that the CVM modeling is complete and the simulated hydraulic heads by model layer are readily available for use as input data for the 1D Models.

The remainder of this section describes the pumping and recharge assumptions of 2020 SYR (*i.e.,* SMA-1) and the CVM output, which is the simulated hydrologic response of the aquifer system to SMA-1.

Pumping Projections

The projected pumping and use of managed storage was based on planning data collected from the Parties. The Parties provided projections of monthly groundwater pumping and other water supplies, the use of current and projected wells including a prioritization of use, and the future use of their local storage accounts. These projections were used to develop monthly pumping projections by well in the Chino Basin for 2018-2050.

Table 1 shows the projected pumping by well for the three Appropriative Pool parties with wells near Northwest MZ-1 for 2018-2050: Monte Vista Water District (MVWD), City of Pomona (Pomona), and Golden State Water Company (GSWC). Projected pumping of the three parties reaches 18,650 afy in FY 2040 and stays constant through FY 2050.

Managed Recharge Projections

Recharge components in the Chino Basin primarily include (i) subsurface inflow from adjacent groundwater basins and bedrock, (ii) deep infiltration of precipitation and applied water, (iii) streambed infiltration, and (iv) managed aquifer recharge. Managed aquifer recharge includes the recharge of stormwater, recycled water, and imported water in the Chino Basin via spreading basins or Aquifer Storage and Recovery (ASR) wells.

Table 2 shows the projected managed aquifer recharge at the recharge basins located within or directly upgradient of Northwest MZ-1. Projected stormwater recharge was based on the CVM's surface-water model simulations, which included planned improvements developed during and after the 2013 Recharge Master Plan Update that were assumed to be operational in FY 2023. Projected recycled water recharge at spreading basins were estimates provided by the Inland Empire Utilities Agency (IEUA). Projected imported

[8] West Yost Associates. 2020. *2020 Safe Yield Recalculation*. Prepared for the Chino Basin Watermaster. May 2020.

[9] Refer to Section 7.3 of the 2020 SYR report for more detail on the pumping and recharge projections.

water recharge were estimates based on the requirement to satisfy a portion of the Parties' replenishment obligations when aggregate production exceeds aggregate production rights. Projected managed aquifer recharge in Northwest MZ-1 reaches about 7,000 afy in FY 2040 and stays constant through FY 2050.

Hydrologic Response of the Aquifer System to SMA-1

SMA-1 was simulated for the 2020 SYR from FY 2018 through 2050. Figures 4, 5, and 6 are maps of the Chino Basin that illustrate the changes in hydraulic heads from FY 2018 to FY 2050 in CVM Layers 1, 3, and 5, respectively:

- Figure 4 shows that heads in Layer 1 are projected to decline by up to 25 feet across Northwest MZ-1. Layer 1 represents the shallow, unconfined aquifer in the western portion Chino Basin. At the 1D Model locations, heads in Layer 1 are projected to decline by about 13 to 15 feet.
- Figure 5 shows that heads in Layer 3 are projected to increase by up to 5 feet in the western portion of Northwest MZ-1 and decrease by up to 30 feet in the eastern portion of Northwest MZ-1. Layer 3 represents the intermediate, semi-confined aquifer in the western portion Chino Basin. At the 1D Model locations, heads in Layer 3 are projected to decline by about 5 feet near PX and decline by about 10 feet near MVWD 28.
- Figure 6 shows that heads in Layer 5 are projected to increase across most of Northwest MZ-1. Layer 5 represents the deep, confined aquifer in the western portion Chino Basin. At the 1D Model locations, heads are projected to increase by about 25 feet near PX and increase by about 40 feet near MVWD 28.

Figures 7 and 8 are time-series charts of projected hydraulic heads in CVM model layers 1, 3, and 5 under SMA-1 at the PX and MVWD 28 locations, respectively. The charts span the projection period for SMA-1 (2018-2050), but also show the historical simulation period (1930-2017) to illustrate the lead up to projection period.[10] Note the following changes in hydraulic heads over the historical and projection periods from 1930 to 2050:

- From 1930-1977, heads declined gradually and persistently in Northwest MZ 1 by about 190 feet. Head declines in Layer 5 lagged the head declines in Layers 1 and 3 because there were very few pumping wells with screens across Layer 5 during these times.
- From 1978-2018, heads in Layers 1 and 3 stabilized or increased slightly in response to: implementation of the Judgment which restricted pumping; the wet periods in the late 1970s, early 1980s, and 1990s which enhanced recharge; and the availability of imported water from the State Water Project. However, heads continued to decline in Layer 5 due to the construction of additional deep wells in Northwest MZ-1 with screens across Layer 5 and the associated increases in groundwater extraction from Layer 5.

[10] For the historical period, heads were estimated for the construction and calibration of the 1D Models. For 1930-1977, heads were estimated based on the measured groundwater elevations at wells in the vicinity of the 1D Models. For 1977-2018, heads were estimated from CVM output data at the 1D Model locations by model layer.

- From 2018-2050 in SMA-1, heads in Layers 1 and 3 at the PX and MVWD-28 locations are projected to decline at a gradual rate starting in 2019 with total declines of up to 17 ft by 2050. These projected declines in heads are generally due to a projected increase in pumping from 2018 through 2050 across the Chino Basin.
- From 2018-2050 in SMA-1, heads in Layer 5 at the PX and MVWD-28 locations increase immediately and significantly at the start of the projection. This immediate increase in heads is due to less projected pumping at several wells in Northwest MZ-1 that are screened across Layer 5. However, by 2030, heads begin to gradually decline through 2050, but remain above their initial 2019 heads.

Projected Aquifer-System Compaction and Land Subsidence under SMA-1

The changes in hydraulic heads under SMA-1 by CVM layer were simulated with the 1D Models to project the potential future aquifer-system compaction (*i.e.,* land subsidence) in Northwest MZ-1 from FY 2018 through 2050. For the historical period from FY 1930 through 2017, aquifer-system compaction was simulated during the calibration of the 1D Models.[7] This section describes the results and interpretations of the 1D Model simulations:

- Figures 9 and 10 are time-series charts of the simulated hydraulic heads versus aquifer system compaction by CVM model layer at the PX and MVWD 28 locations, respectively. The charts span the historical simulation period (1930-2017) and the projection period for SMA-1 (2018-2050) to depict the long-term progression of historical and projected aquifer-system compaction. The aquifer-system compaction for CVM layers 2 and 4 (relatively thin aquitard layers) was added to layers 3 and 5, respectively, since layers 2 and 4 are adjacent to and mechanically respond to the head changes in layers 3 and 5.
- Figures 11 and 12 are time-series charts of the simulated hydraulic heads versus aquifer system compaction by CVM model layer at the PX and MVWD 28 locations, respectively, for the projection period for SMA-1 only (2018-2050). These charts provide finer detail of the projected aquifer-system compaction.

The following observations and interpretations are made from inspection of these figures that depict the 1D Model simulation results in Northwest MZ-1:

- From 1930-1977, aquifer-system compaction occurred at its highest rates in response to the persistent declines in heads. Total compaction by 1977 was about six (6) feet at PX and about three (3) feet at MVWD-28. Compaction was greatest in Layers 1, 2, and 3 because shallow pumping dominated during this period.
- From 1978-2017, the rates of aquifer-system compaction in Layers 1, 2, and 3 slowed because of the stabilization of heads after 1978, but delayed drainage of the aquitards in these layers continued. The rates of compaction during this period were highest in Layers 4 and 5 due to the continued declines in heads in Layer 5 caused by increased pumping from Layers 3 and 5. Total compaction from 1930 to 2017 was about nine (9) feet at PX and about 5.5 feet at MVWD-28.

- From 2018-2050 under SMA-1, aquifer system compaction is projected to continue to occur at relatively slow but constant rates. Total compaction during 2018-2050 is projected to be 0.86 ft at PX (about 0.03 ft/yr) and 0.75 ft at MVWD-28 (about 0.02 ft/yr). The highest rates of compaction are projected to occur in Layer 5, even though heads in Layer 5 are projected increase under SMA-1. The persistence of aquifer-system compaction during the projection period is due to the delayed drainage of the aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with the historical head declines that occurred in the coarse-grained aquifer sediments.

Conclusions and Recommendations

The main conclusions and recommendations from this investigation are:

- Under SMA-1, the 1D Model simulations indicate that aquifer-system compaction, and its resulting land subsidence, will continue in Northwest MZ-1 at gradual, constant rates of about 0.02 to 0.03 ft/yr through at least 2050. These rates of projected compaction through 2050 are consistent with the observed current rates of land subsidence in Northwest MZ-1.

- These constant rates of aquifer-system compaction in Northwest MZ-1 are projected to occur even though heads in Layer 5 are assumed to increase by 30-60 ft in SMA-1. This indicates that the compaction is due to the delayed drainage of aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with head declines that occurred historically within the coarse-grained aquifer sediments.

- The highest rates of compaction are occurring below Layer 1—particularly within in Layers 4 and 5 where hydraulic heads are the lowest. These rates of compaction are projected to continue to occur through 2050.

- Pursuant to the SMP, these persistent rates of compaction should be slowed to tolerable levels or completed abated, if possible. The only way to slow or completely abate the compaction is to increase heads and maintain them at higher elevations—particularly within Layers 3 and 5, where heads are lowest and the rates of compaction are highest.

- The Watermaster should establish a "Northwest MZ-1 Guidance Level" of **630 ft-amsl** for hydraulic heads in Layers 3 and 5 at the PX location. Figure 13 displays this Guidance Level, which approximates the current and projected heads in Layer 1 where the current and projected rates of compaction are the lowest. The Guidance Level is an aspirational Watermaster recommendation that, if achieved, would likely slow the rates of compaction and subsidence to more tolerable levels over time.

- Compliance with the Guidance Level should be measured at the PX-2/3 piezometer. Figure 2 shows that the PX-2/3 piezometer is screened across the uppermost portion of Layer 5 at the PX location, and hence, is generally representative of heads in Layers 3 and 5.

- The methods to achieve the Guidance Level have not yet been developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated. The methods to achieve the Guidance Level could include but are not limited to: voluntary modification of pumping patterns; in-lieu recharge; wet-water recharge via spreading and/or injection; or a combination of methods. These methods could necessitate: voluntary modification of water-supply plans of the purveyors in the Chino Basin; modification of Watermaster practices for recharge and replenishment; and/or the implementation of regional-scale storage or conjunctive-use programs. The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed.

- Additional SMAs should be developed and evaluated with the 1D Models to generate the necessary information to establish a Guidance Level in the *Subsidence Management Plan for Northwest MZ-1*. The additional SMAs could be developed during Watermaster's upcoming groundwater modeling efforts associated with the *2025 Safe Yield Reevaluation* and the development of the *Storage and Recovery Master Plan*. The GLMC should participate in the scenario building exercises associated with these Watermaster efforts to develop the SMAs, so that the scenarios include various methods to achieve the Guidance Level. Then, the 1D Models should be used to evaluate the potential future subsidence in Northwest MZ-1 under the SMAs. These model results and evaluations will support the establishment of a Guidance Level in the *Subsidence Management Plan for Northwest MZ-1*. It should be noted that future monitoring and analyses always hold the potential for changes to the Guidance Level, consistent with the adaptive management approach called for in the Chino Basin Subsidence Management Plan.

Table 1. Projected Pumping at Wells in Northwest MZ-1 for Subsidence Management Alternative #1

Well Name	Well Owner	Well Layers	Historical Pumping FY 2010-18 (afy)	Annual Projected Pumping by Fiscal Year[1] (af)																					
				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2	Pomona	1	1,362	0	1,190	1,190	1,190	1,200	1,200	1,200	1,200	1,200	1,210	1,210	1,210	1,210	1,220	1,210	1,220	1,220	1,220	1,220	1,220	1,220	1,220
5B	Pomona	1,3	725	500	850	850	850	850	850	850	850	850	860	860	860	860	860	860	860	860	870	860	860	860	870
6	Pomona	1,3	101	640	900	890	900	900	900	900	900	900	910	910	910	910	910	910	910	910	920	910	910	910	920
10	Pomona	1,3	1,258	1,130	1,000	990	1,000	1,000	1,000	1,000	1,000	1,000	1,010	1,010	1,010	1,010	1,010	1,010	1,010	1,020	1,020	1,020	1,020	1,020	1,020
15	Pomona	1	355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Pomona	1	353	550	850	850	850	850	850	850	850	850	860	860	860	860	860	860	860	860	870	860	860	860	870
17	Pomona	1,3	235	420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Pomona	1	649	340	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
23	Pomona	1,3	864	410	900	890	900	900	900	900	900	900	910	910	910	910	910	910	910	910	920	910	910	910	920
25	Pomona	1,3	1,541	1,540	1,090	1,090	1,100	1,100	1,100	1,100	1,100	1,100	1,110	1,110	1,110	1,110	1,110	1,110	1,120	1,120	1,120	1,120	1,120	1,120	1,120
26	Pomona	1,3	569	270	500	500	500	500	500	500	500	500	500	500	500	500	510	510	510	510	510	510	510	510	510
27	Pomona	1,3	525	1,250	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
29	Pomona	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Pomona	1,3	1,296	1,490	1,190	1,190	1,190	1,200	1,200	1,200	1,200	1,200	1,210	1,210	1,210	1,210	1,220	1,210	1,220	1,220	1,220	1,220	1,220	1,220	1,220
35	Pomona	1,3	7	0	500	500	500	500	500	500	500	500	500	500	500	500	510	510	510	510	510	510	510	510	510
36	Pomona	1,3	1,007	730	800	800	800	800	800	800	800	800	810	810	810	810	810	810	810	810	810	810	810	810	810
Margarita #1	GSWC	1	447	530	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370	370
4	MVWD	1	247	290	190	190	180	180	180	180	180	180	180	180	180	190	190	190	190	190	190	190	190	190	190
5	MVWD	1,3	1,084	1,020	660	650	650	640	640	640	640	640	640	650	650	650	650	650	650	660	660	660	660	660	670
10	MVWD	1,3	165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	MVWD	1,3,5	1,997	2,480	800	790	790	780	780	770	780	780	780	780	790	790	790	790	800	800	800	800	800	810	810
26	MVWD	1,3,5	1,789	1,330	890	880	880	870	870	860	870	870	870	880	880	880	890	890	890	890	900	900	900	900	910
27	MVWD	1,3,5	384	370	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
28	MVWD	1,3,5	2,129	1,540	870	860	860	850	850	840	840	850	850	850	860	860	860	860	870	870	870	870	880	880	880
30	MVWD	1,3,5	182	330	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
31	MVWD	1,3,5	967	370	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
32	MVWD	1,3,5	495	310	100	100	90	90	80	80	80	80	90	90	90	100	100	100	110	110	110	110	120	120	120
33	MVWD	1,3,5	659	0	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
34	MVWD	1,3,5	244	0	940	930	920	920	920	910	910	920	920	920	920	930	930	930	940	940	940	940	950	950	950
Subtotal from Layers 1 and 3			*12,790*	*11,110*	*12,590*	*12,550*	*12,580*	*12,590*	*12,590*	*12,590*	*12,590*	*12,590*	*12,700*	*12,710*	*12,710*	*12,720*	*12,760*	*12,740*	*12,770*	*12,790*	*12,830*	*12,790*	*12,790*	*12,790*	*12,840*
Subtotal from Layers 1, 3, and 5			*8,845*	*6,730*	*5,680*	*5,620*	*5,560*	*5,530*	*5,500*	*5,440*	*5,460*	*5,500*	*5,530*	*5,540*	*5,560*	*5,620*	*5,630*	*5,630*	*5,710*	*5,710*	*5,720*	*5,720*	*5,790*	*5,800*	*5,810*
Total			**21,635**	**17,840**	**18,270**	**18,170**	**18,140**	**18,120**	**18,090**	**18,030**	**18,050**	**18,090**	**18,230**	**18,250**	**18,270**	**18,340**	**18,390**	**18,370**	**18,480**	**18,500**	**18,550**	**18,510**	**18,580**	**18,590**	**18,650**

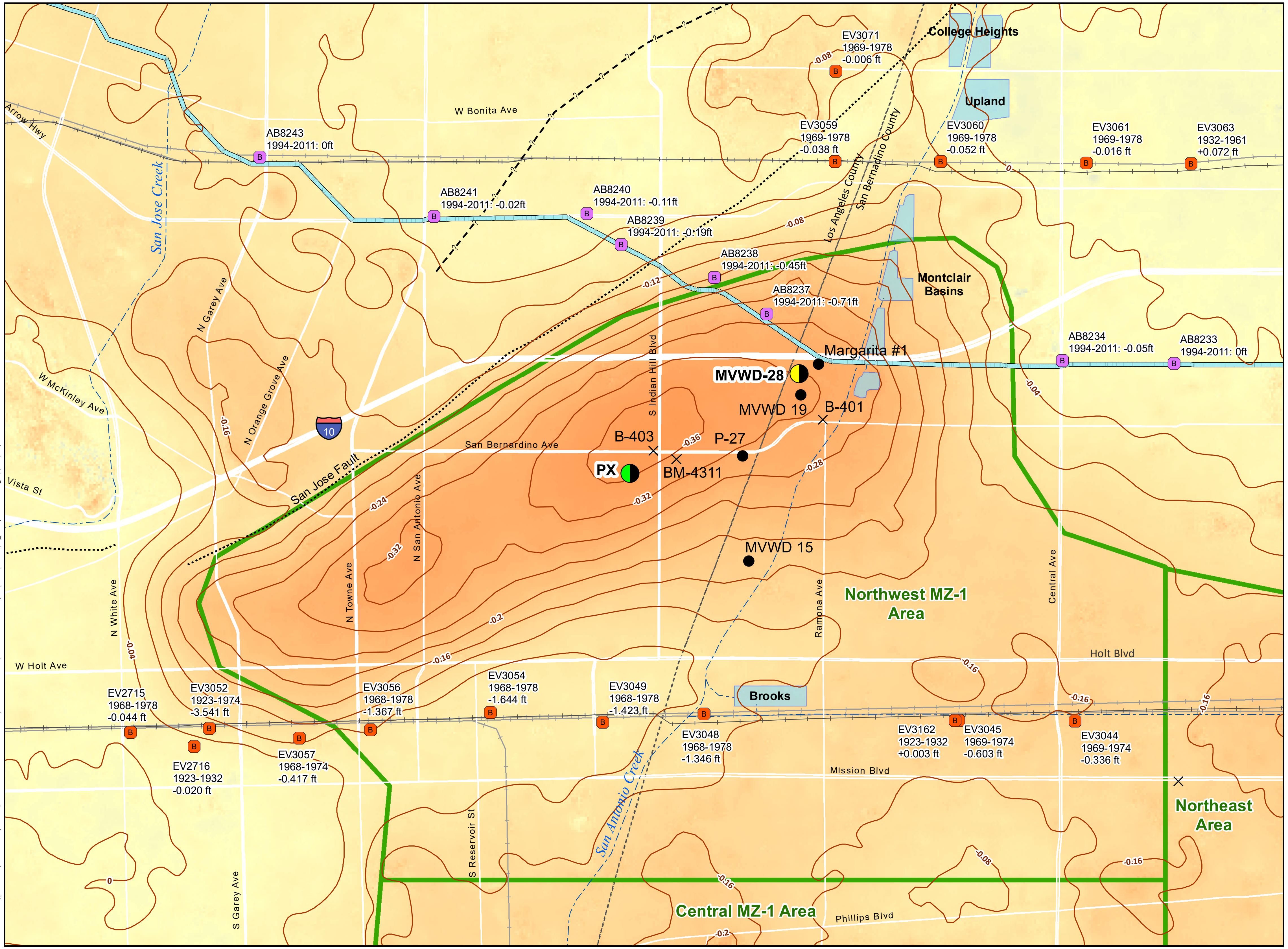
[1] Annual pumping is constant after FY 2040.

Table 2. Projected Managed Recharge Near Northwest MZ-1 for the Baseline Management Alternative

Managed Recharge Type	Historical Recharge FY 2010-18 (afy)	Annual Projected Recharge Volume Near Northwest MZ-1 by Fiscal Year[1,2] (af)																						
		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
Stormwater	1,528	2,520	2,500	2,520	2,620	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,590	2,610	2,610	2,610	2,580	2,600
Recycled Water	1,177	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650	1,650
Imported Water	6,748	0	0	0	0	0	0	0	0	10	150	350	510	320	760	1,200	1,630	2,060	2,380	2,690	3,010	3,330	3,550	2,810
Total	**9,453**	**4,170**	**4,150**	**4,170**	**4,270**	**4,260**	**4,240**	**4,260**	**4,260**	**4,270**	**4,390**	**4,610**	**4,770**	**4,580**	**5,000**	**5,460**	**5,890**	**6,320**	**6,620**	**6,950**	**7,270**	**7,590**	**7,780**	**7,060**

[1] Tabulated recharge includes recharge in College Heights Basins, Upland Basin, Montclair Basins, Brooks Basin, and MVWD ASR wells. No imported water recharge is projected to occur via ASR wells.

[2] Annual managed recharge is constant from FY 2041 through FY 2050.



1D Model Locations

- MVWD-28
- PX

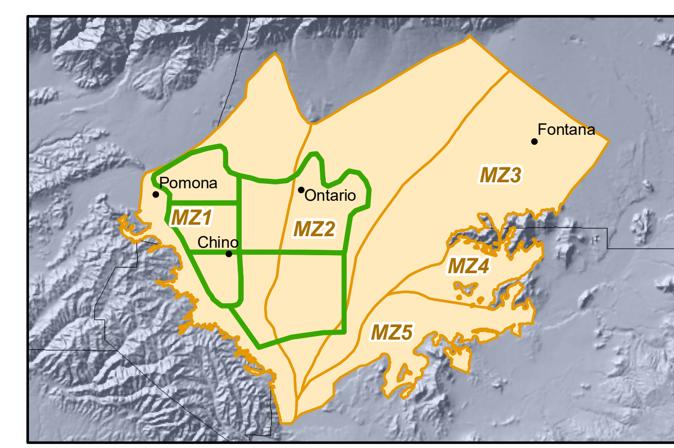
Land Subsidence Features

+0.55 ft / 0 ft / -0.55 ft — Relative Change in Land Surface Elevation as Estimated by InSAR *(March 2011 to March 2022)*

- Contours of Relative Change in Land Surface Elevation as Estimated by InSAR *(March 2011 to March 2022)*
- Benchmark used for 1D Model Calibration
- NGS Benchmarks
- MWD Benchmarks

Other Features

- Well with Historical Measured Heads
- Recharge Basin
- Areas of Subsidence Concern
- Fault (dotted where concealed; queried where uncertain)
- MWD Upper Feeder
- Railroads



0 1 2 Miles
0 2 4 Km

Prepared by:
WEST YOST
Water. Engineered.

Draft

Figure 1

Locations of PX and MVWD-28 1D Models and Historical Elevation Surveys at Benchmarks

Chino Basin Watermaster
Ground-Level Monitoring Committee
Subsidence Management Plan for Northwest MZ-1

Figure 2. PX Site: CVM Layers, Borehole Lithology, 1D Model Cells, and Resistivity Log

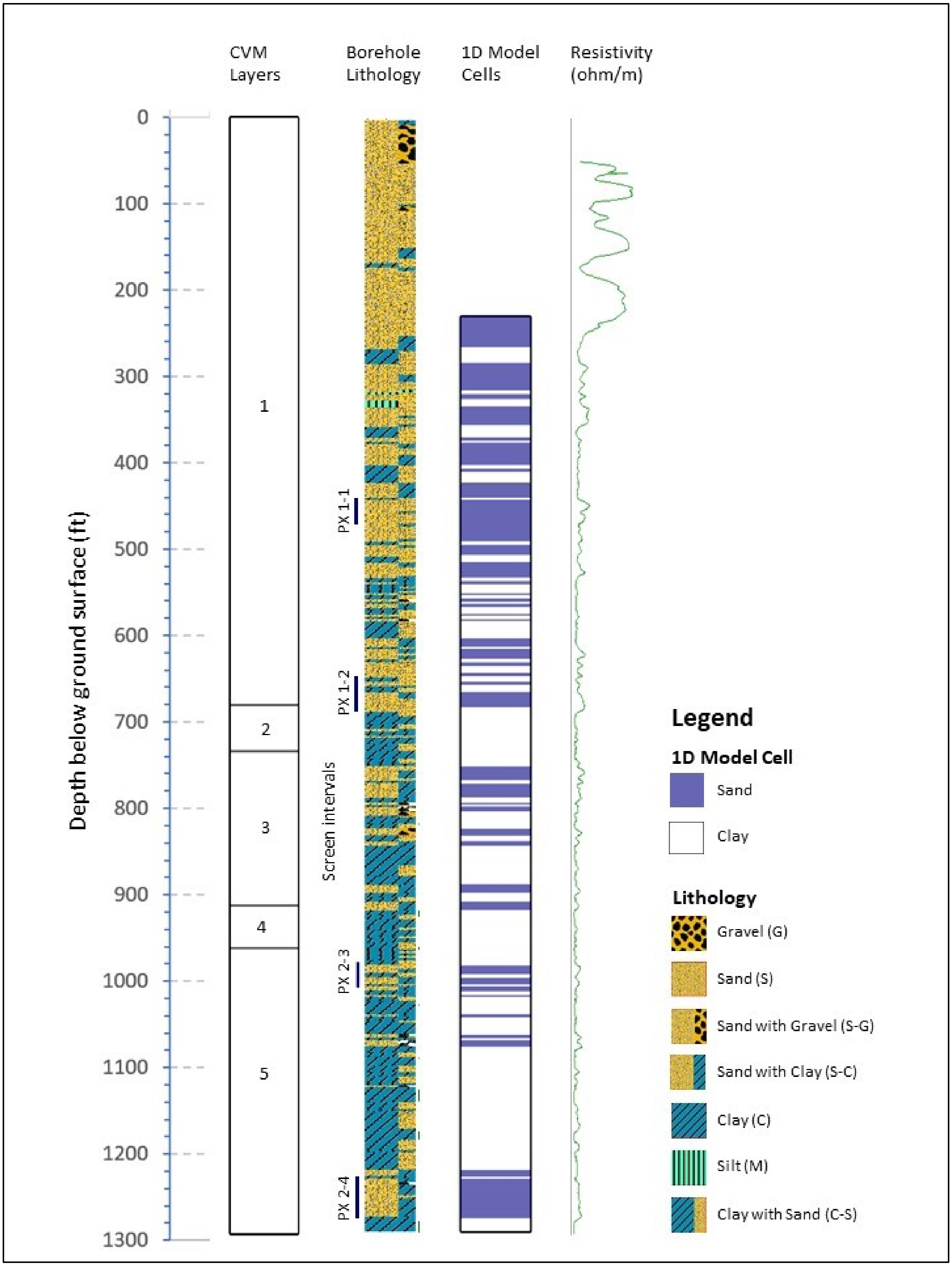
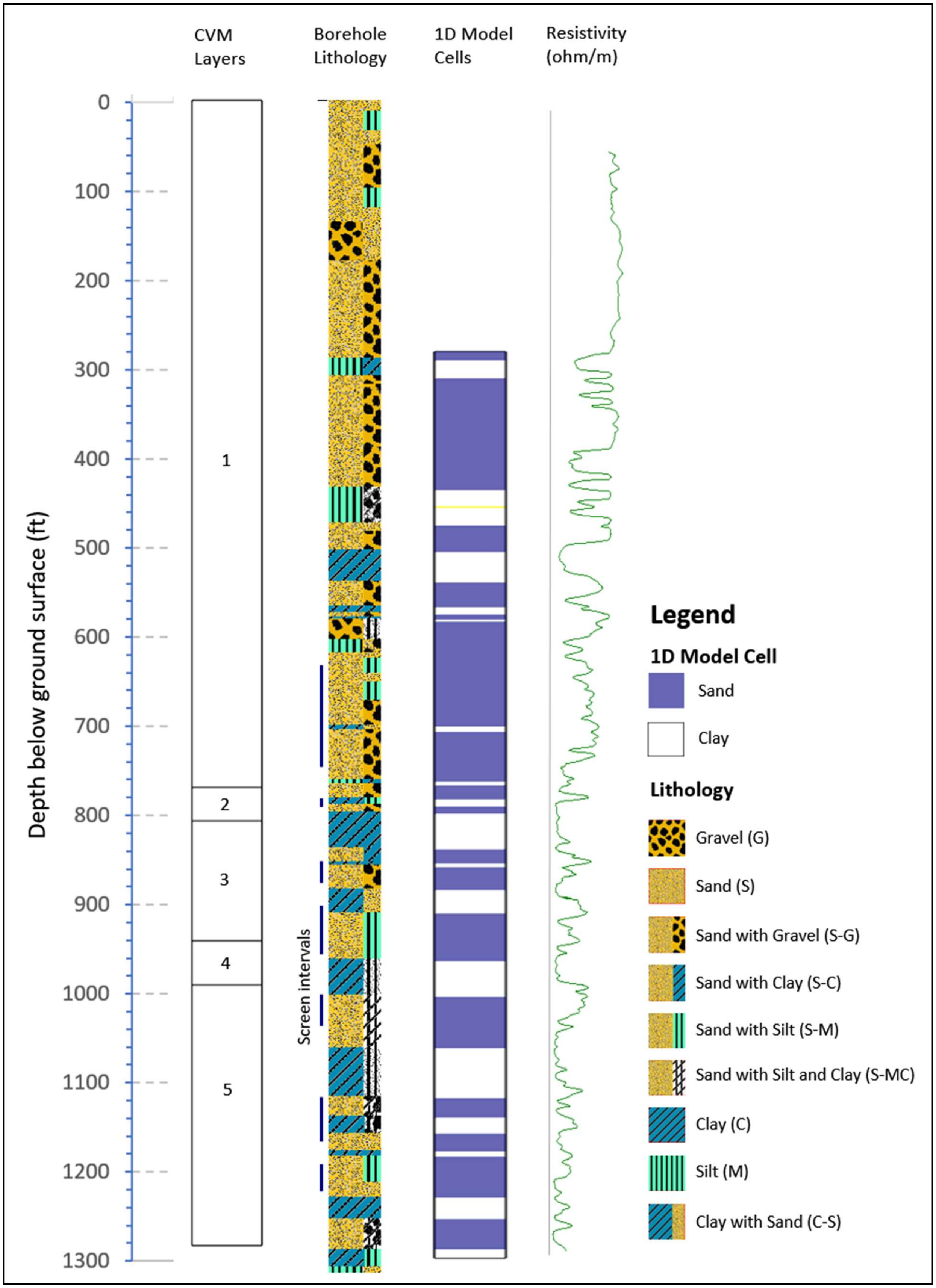
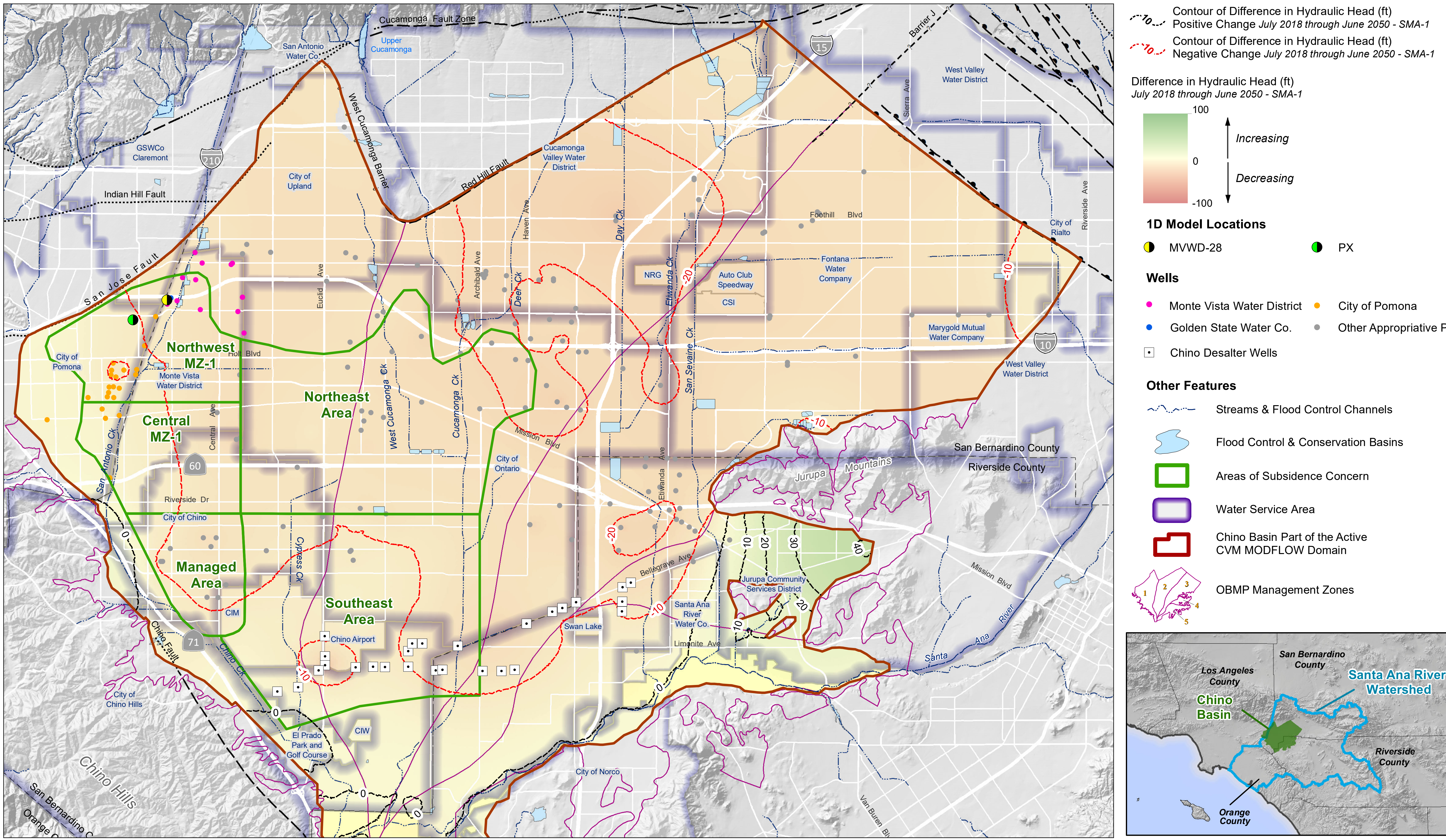


Figure 3. MVWD-28 Site: CVM Layers, Borehole Lithology, 1D Model Cells, and Resistivity Log





Prepared by:

WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 2 SYR_2050-2018_L1.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

Evaluation of Land Subsidence in Northwest MZ-1 under SMA-1

CHINO BASIN WATERMASTER

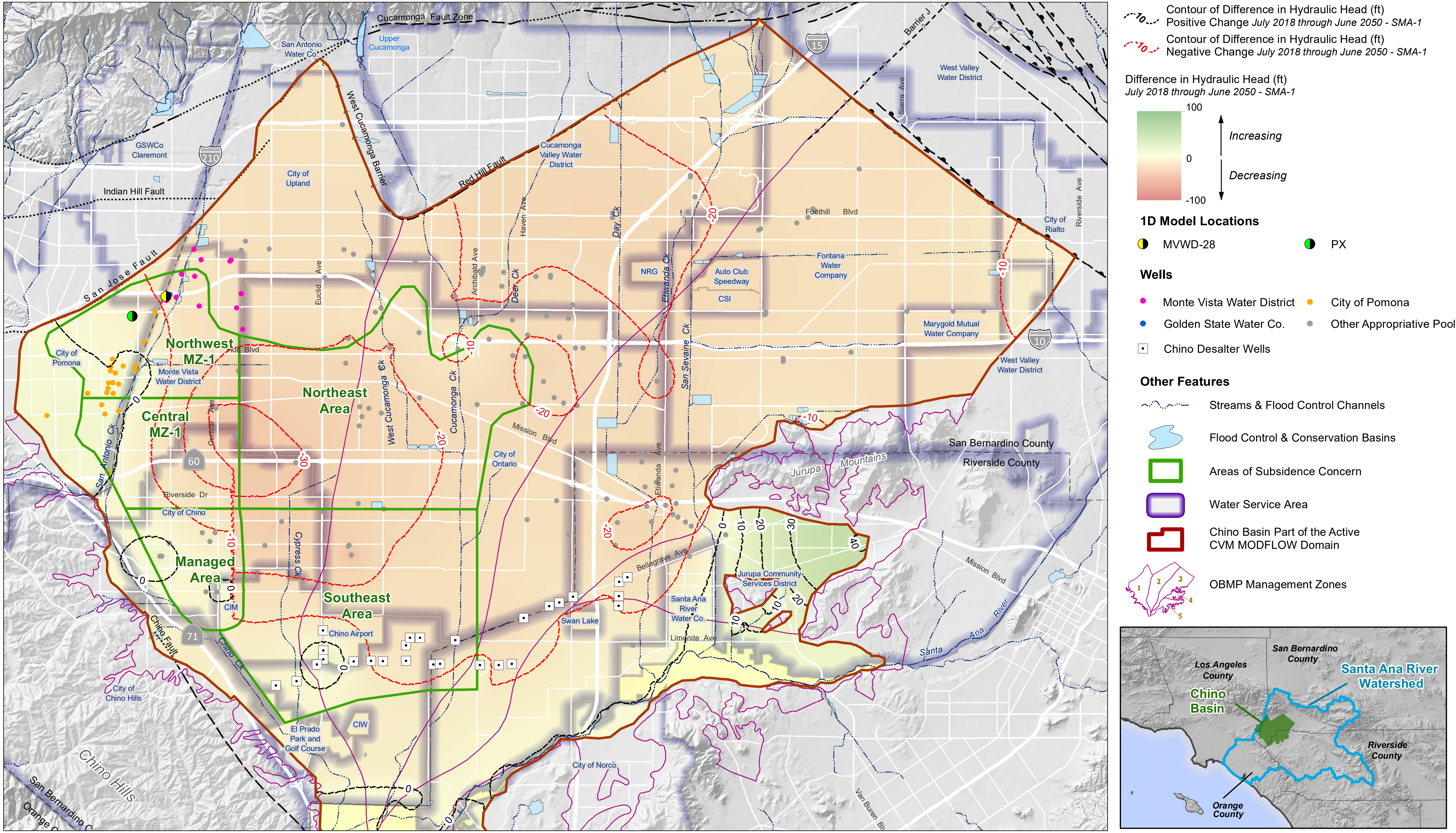
Projected Difference in Hydraulic Head for Layer 1

Subsidence Management Alternative #1

July 2018 through June 2050

Draft

Figure 4



Prepared by:

WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 3 SYR_2050-2018_L3.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

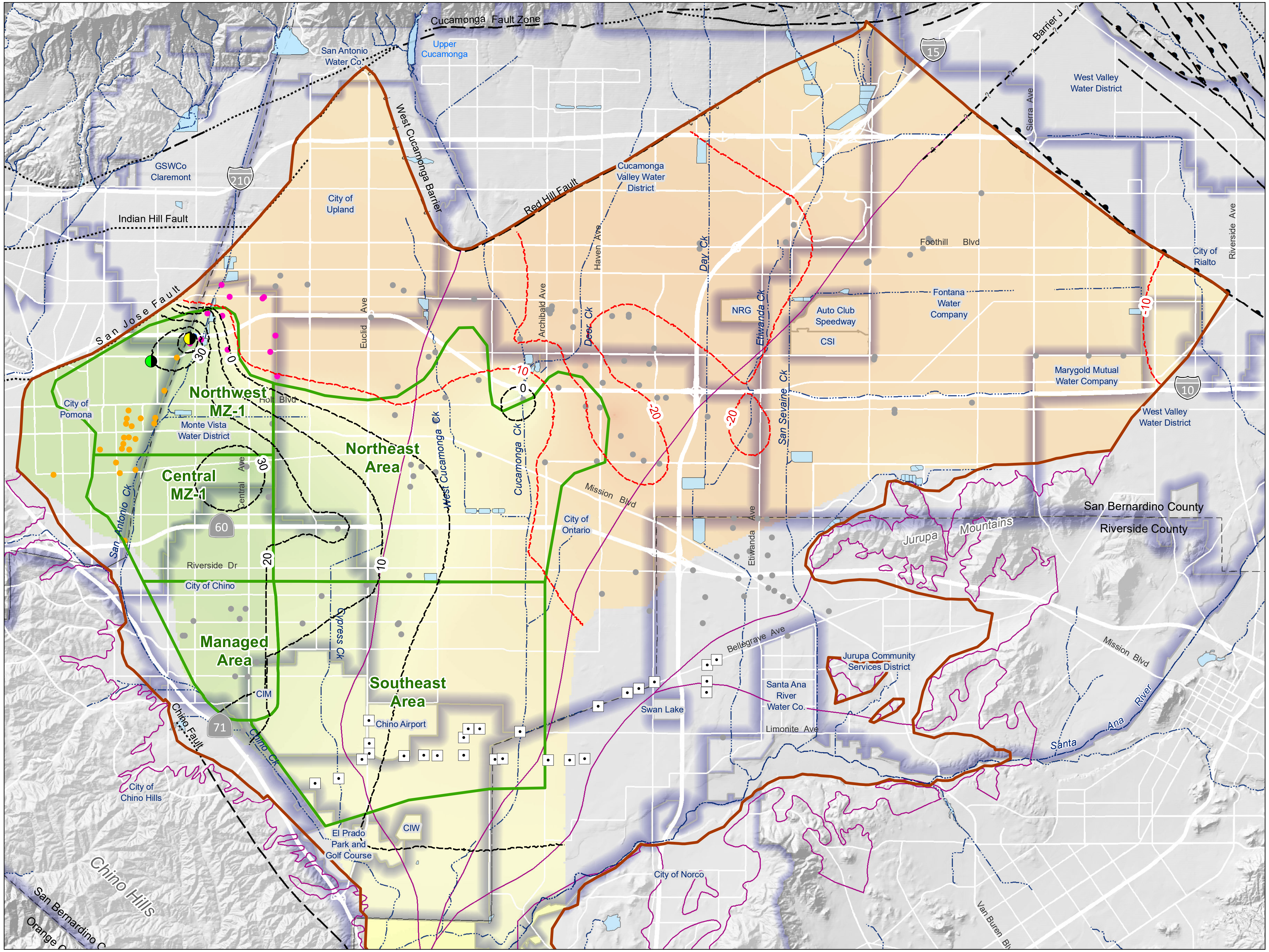
Evaluation of Land Subsidence in Northwest MZ-1 under the SMA-1

CHINO BASIN WATERMASTER — Partners in Basin Management

Projected Difference in Hydraulic Head for Layer 3
Subsidence Management Alternative #1
July 2018 through June 2050

Draft

Figure 5



Contour of Difference in Hydraulic Head (ft)
Positive Change *July 2018 through June 2050 - SMA-1*

Contour of Difference in Hydraulic Head (ft)
Negative Change *July 2018 through June 2050 - SMA-1*

Difference in Hydraulic Head (ft)
July 2018 through June 2050 - SMA-1

100 — *Increasing*
0
-100 — *Decreasing*

1D Model Locations

MVWD-28
PX

Wells

Monte Vista Water District
City of Pomona
Golden State Water Co.
Other Appropriative Pool
Chino Desalter Wells

Other Features

Streams & Flood Control Channels
Flood Control & Conservation Basins
Areas of Subsidence Concern
Water Service Area
Chino Basin Part of the Active CVM MODFLOW Domain
OBMP Management Zones

Prepared by:

WEST YOST

Author: GR
Date: 2/21/2023
File: Figure 4 SYR_2050-2018_L5.mxd

0 1 2 3 4 5 Miles
0 2 4 6 8 Km

Prepared for:

Evaluation of Land Subsidence in Northwest MZ-1 under SMA-1

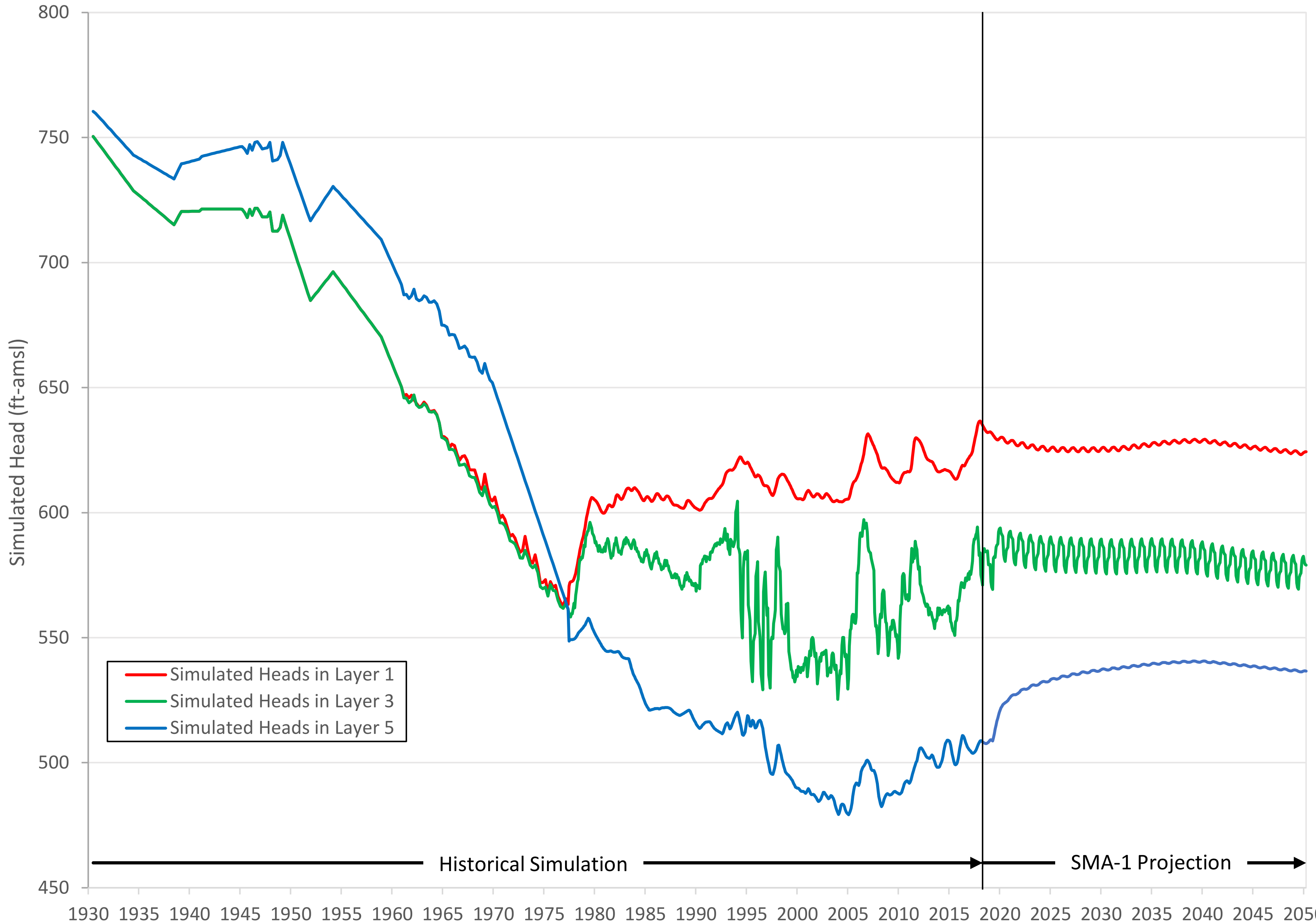
CHINO BASIN WATERMASTER
Partners in Basin Management

Projected Difference in Hydraulic Head for Layer 5
Subsidence Management Alternative #1
July 2018 through June 2050

Draft

Figure 6

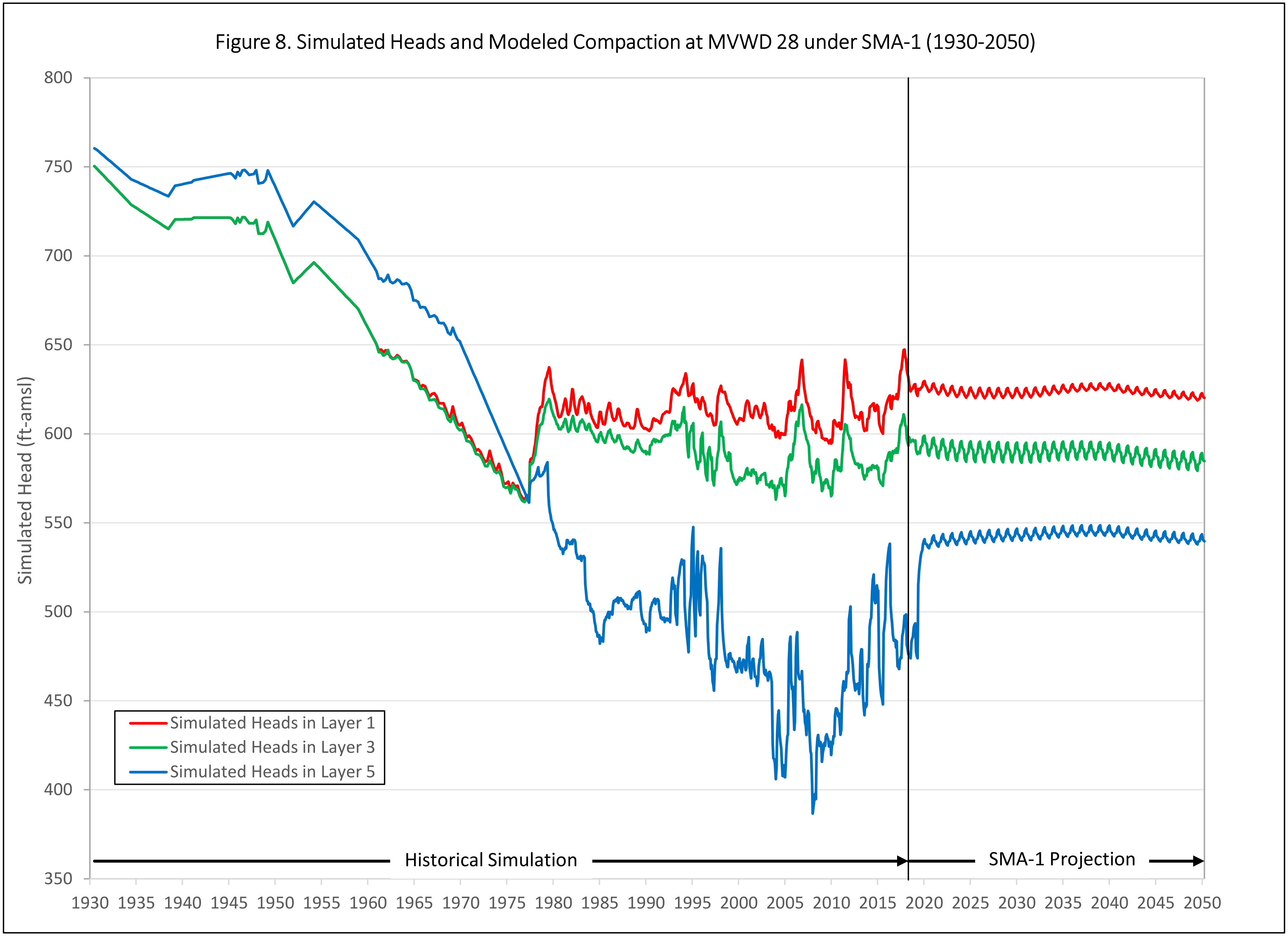
Figure 7. Simulated Heads at the PX Site under SMA-1 (1930-2050)



WEST YOST

941-80-23-25

Ground-Level Monitoring Committee
Subsidence Management Alternative #1
Last Revised: 08-30-2023



WEST YOST

941-80-23-25

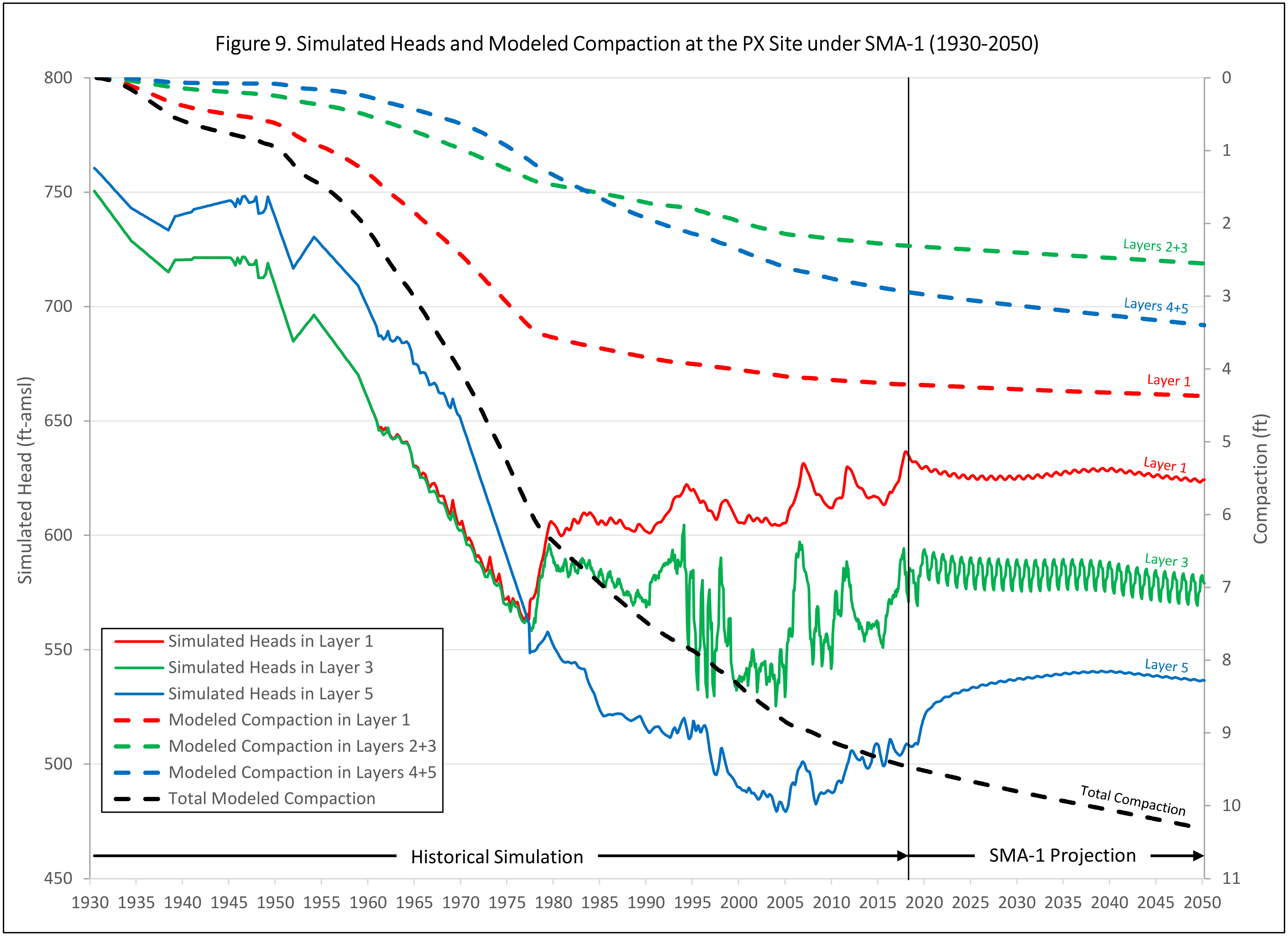
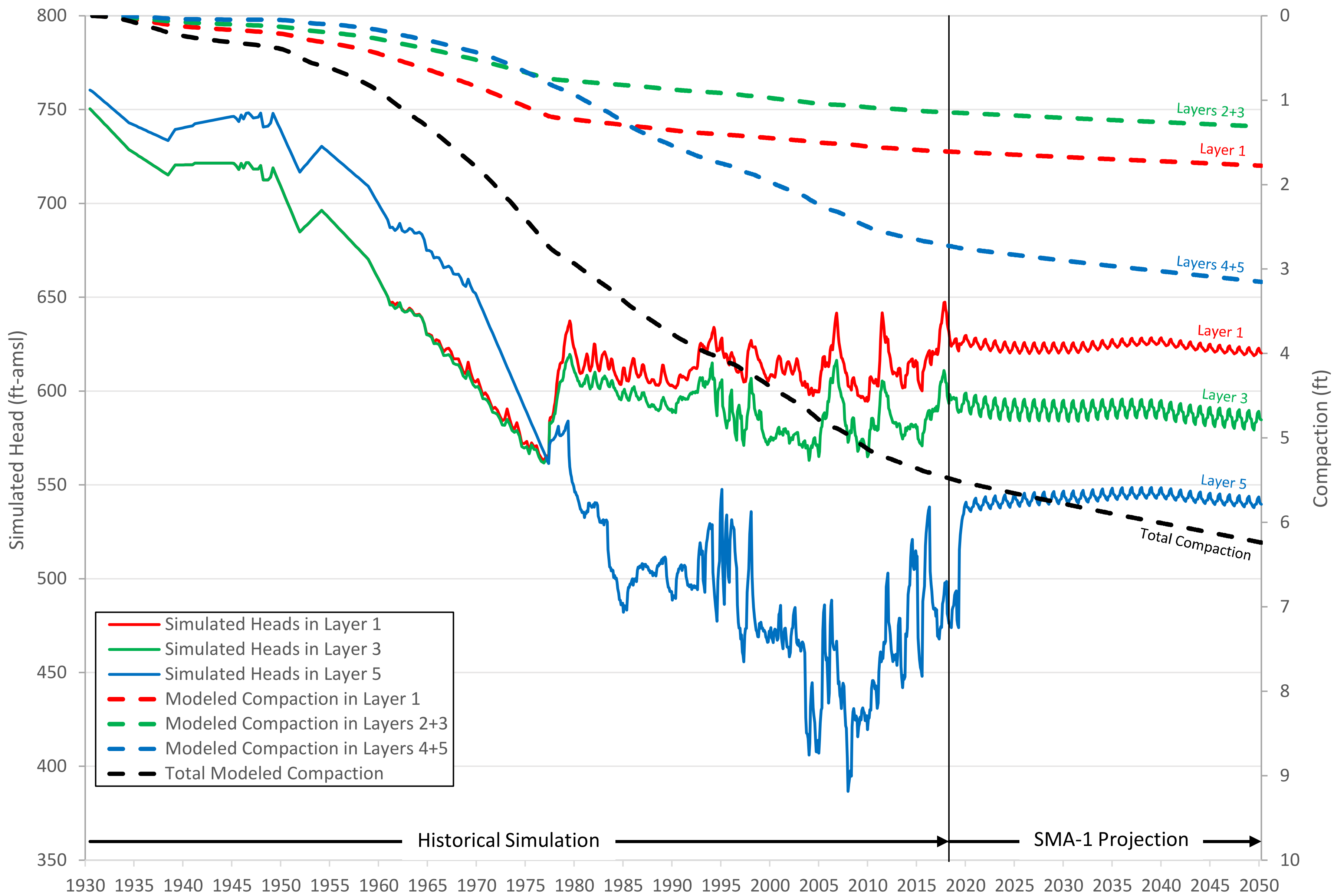


Figure 9. Simulated Heads and Modeled Compaction at the PX Site under SMA-1 (1930-2050)
Simulated Head (ft-amsl)
Compaction (ft)
800
750
700
650
600
550
500
450
0
1
2
3
4
5
6
7
8
9
10
11
1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050
Layers 2+3
Layers 4+5
Layer 1
Layer 1
Layer 3
Layer 5
Total Compaction
Simulated Heads in Layer 1
Simulated Heads in Layer 3
Simulated Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction
Historical Simulation
SMA-1 Projection

Figure 10. Simulated Heads and Modeled Compaction at MVWD 28 under SMA-1 (1930-2050)



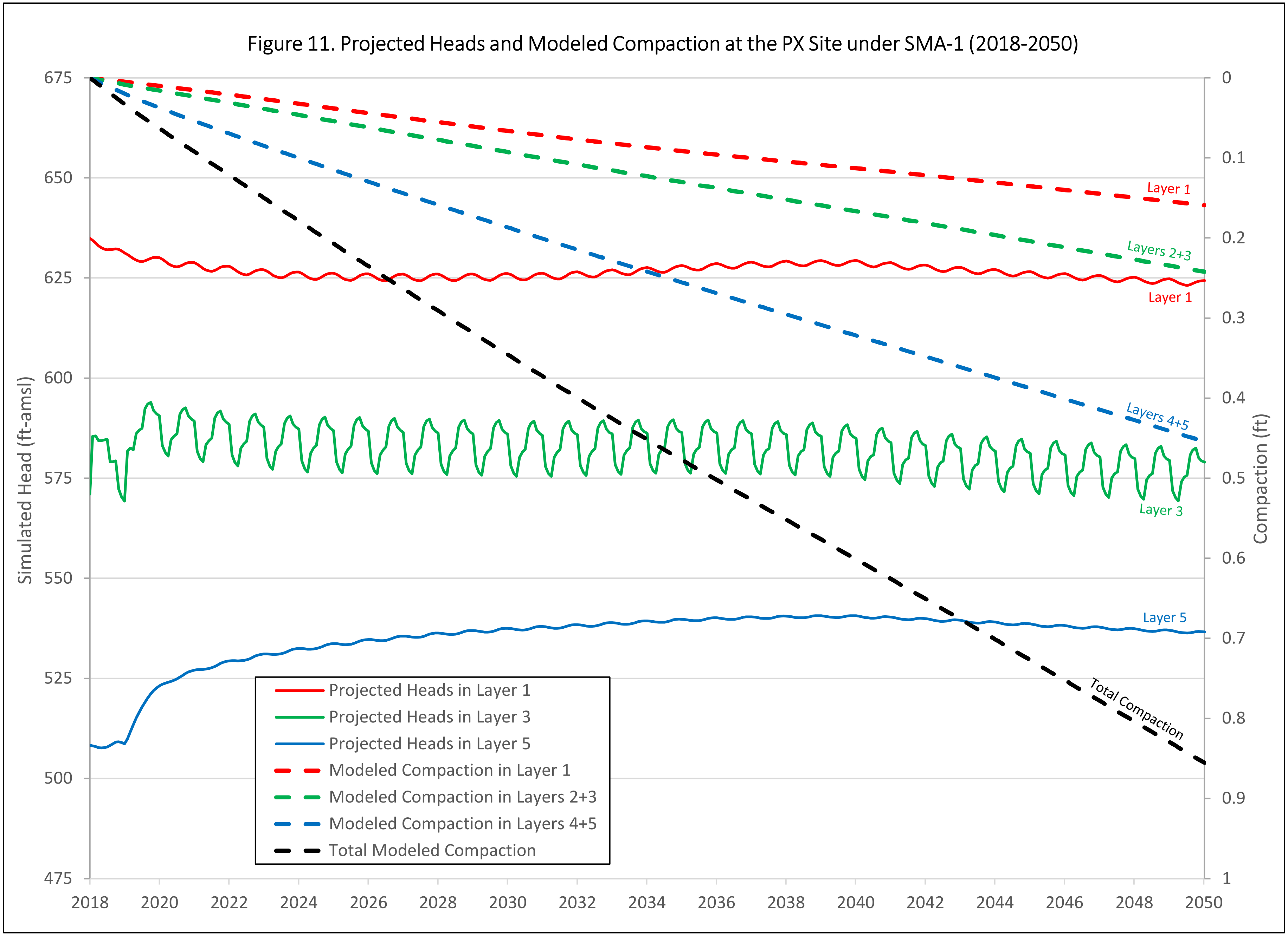


Figure 11. Projected Heads and Modeled Compaction at the PX Site under SMA-1 (2018-2050)
Simulated Head (ft-amsl)
Compaction (ft)
675
650
625
600
575
550
525
500
475
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Layer 1
Layers 2+3
Layer 1
Layers 4+5
Layer 3
Layer 5
Total Compaction
Projected Heads in Layer 1
Projected Heads in Layer 3
Projected Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction

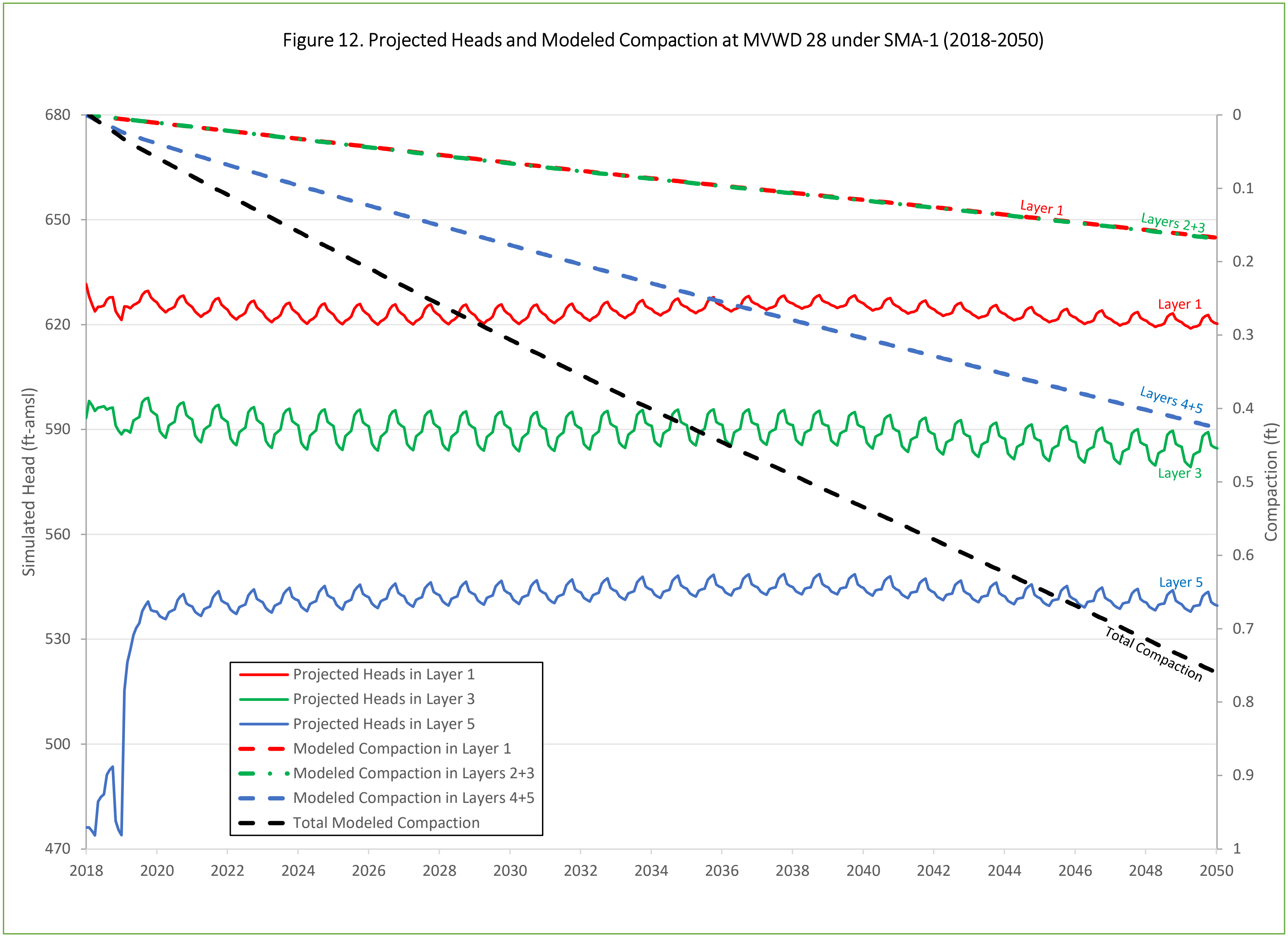
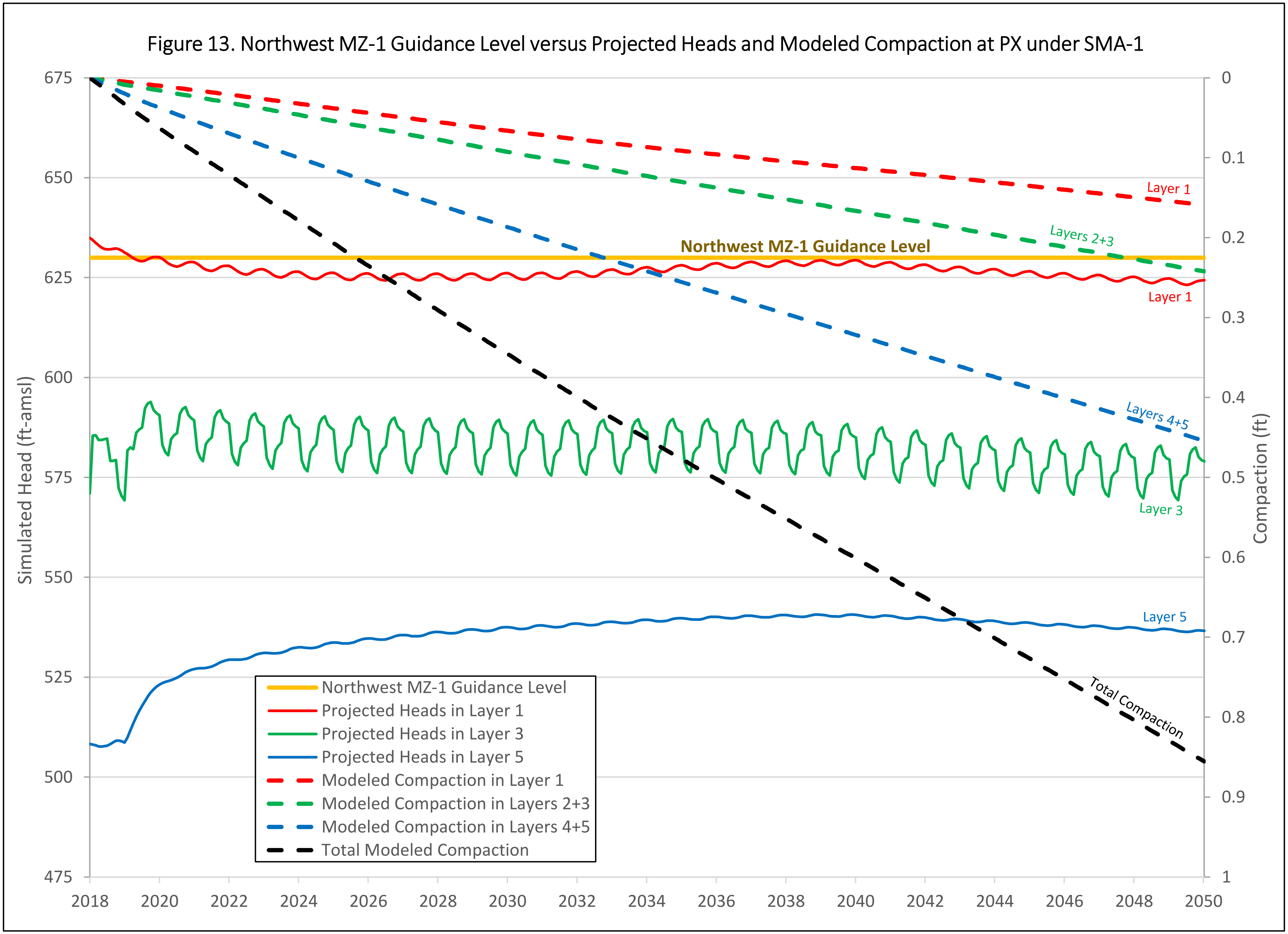


Figure 12. Projected Heads and Modeled Compaction at MVWD 28 under SMA-1 (2018-2050)
Simulated Head (ft-amsl)
Compaction (ft)
680
650
620
590
560
530
500
470
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046
2048
2050
Layer 1
Layers 2+3
Layer 1
Layers 4+5
Layer 3
Layer 5
Total Compaction
Projected Heads in Layer 1
Projected Heads in Layer 3
Projected Heads in Layer 5
Modeled Compaction in Layer 1
Modeled Compaction in Layers 2+3
Modeled Compaction in Layers 4+5
Total Modeled Compaction



WEST YOST

941-80-23-25

STATE OF CALIFORNIA/WSP USA (RICHARD REES, PG, CHG)

Comment 1 – Guidance Level

We note that the preliminary proposed "Guidance Level" for the area is very conservative, with proposed hydraulic pressure heads in Layers 3 and 5 that have not been observed since the mid-1960s to early 1970s. The TM states that the "The methods to achieve the Guidance Level have not yet been developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated. Hence, the Guidance Level proposed herein should be considered 'preliminary' until such work is performed." Consider adding that it is unknown if it is practical to achieve the Guidance Level.

Response:

The Conclusions and Recommendation section has been revised. The second to last bullet now includes the sentence:

"The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed."

Comment 2 – Figure 5

Figure 5 – contours of the negative differences in hydraulic heads south-southeast of the Central MZ-1 are odd, with the negative 10-foot and negative 20-foot contours overlapping. Please verify that this is correctly contoured.

Response:

The figure is correctly contoured. The overlapping and terminal contours are an artifact of the Riley Barrier, which is a groundwater barrier within the deep aquifer system that causes abrupt offsets in hydraulic head.

MONTE VISTA WATER DISTRICT (JUSTIN SCOTT-COE)

Comment 1 – General Comment

In general, the District recommends additional analysis before the recommendation of "preliminary" guidance levels to Chino Basin Watermaster (Watermaster). The District recommends removing the recommendation to Watermaster prior to assessing the guidance level further versus a No Action alternative and establishing on-the-ground monitoring at the extensometer. Understanding how guidance levels will affect wellfield operations, water levels, and projected subsidence should come ahead of the release of guidance levels or recommendations to establish guidance levels.

Response:

The preliminary "Guidance Level" is the Watermaster Engineer's best current estimate for depth-specific hydraulic heads in Northwest MZ-1 to reduce or abate the future occurrence of subsidence.

The TM has been revised to recognize that: "The methods to achieve the Guidance Level have not yet been explored and developed, nor has the effectiveness of these methods to comply with the Guidance Level been simulated and evaluated….The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed."

We encourage the parties to begin to explore potential methods to achieve the Guidance Level during the 2025 Safe Yield Reevaluation and the development of the Storage and Recover Master Plan.

In the meantime, the monitoring program in Northwest MZ-1 is planned to proceed and the additional data collected (e.g., hydraulic heads, ground motion, etc.) can be used in the future to verify and/or improve the 1D Models and refine the Guidance Level.

Comment 2 – Pg 4 "However, the GLMC subsequently recommended to..."

As expressed by the District in prior correspondence and agreed to by Watermaster, the GLMC serves as a gathering of stakeholder representatives for the provision of advice to Watermaster. The GLMC has neither decision-making authority nor ability to make recommendations or take any other formal action. Therefore, the District requests that this language be revised to avoid the suggestion that this recommendation represents the collective perspective of GLMC.

Response:

The text has been modified to read:

"However, with input from the GLMC, the Watermaster Engineer subsequently recommended to use the 1D Models directly to develop the *Subsidence Management Plan for Northwest MZ-1*."

Comment 3 – Pg 5 Develop SMA-1 with review and input from the GLMC; Pg 6 Pumping Projections; Table 1

In correspondence dated April 7, 2023, the District provided projected pumping requirements as part of its participation in the GLMC's review of Subsidence Management Alternative 1 (SMA-1). These projected pumping requirements included projected pumping of 2,100 acre-feet per year (AFY) of City of Chino Hills production rights consistent with the agencies' wholesale water supply agreement, current practice, and future plans. In total, the SMA-1 appears to include ~2,250 AFY less production than the District's projections (8,600 AFY as reflected in the District's correspondence vs. 6,350 AFY as reflected in Table 1 for 2023). Please revise the TM's language to reflect the receipt of the District's input, and consider updating Table 1 and SMA-1 to reflect the District's actual pumping projections.

Response:

SMA-1 is equivalent to the planning scenario that was simulated to support the 2020 Safe Yield Recalculation (2020 SYR) using the 2020 CVM. The 2020 SYR was intended to represent and simulate the Parties' projected pumping, recharge, and use of storage through 2050. This scenario spanned from fiscal year (FY) 2018 through 2050 and included the cultural conditions (e.g., land use, water supply plans) that were assumed based on the best-available planning data at the time of the 2020 SYR. We understand that pumping projections in SMA-1 are not the current pumping projections of the parties. However, the advantage of using 2020 SYR as the planning scenario for SMA-1 is that the CVM modeling is complete and the simulated hydraulic heads by model layer are readily available for use as input data for the 1D Models.

Updated pumping projections (as well as other planning information, such as managed recharge and use of managed storage) will be used to develop and simulate subsequent SMAs using updated versions of the CVM and the 1D Models. Such modeling exercises can be conducted in concert with the 2025 Safe Yield Reevaluation and the development of the Storage and Recovery Master Plan.

Comment 4 – Pg 5 Evaluate model results and develop recommendations

The District continues to be concerned about the lack of physical evidence and means of verification of the conceptual model. The model has projected 7 to 9 feet of subsidence over the historical period as a result of lowering of water levels from 1930 through 1978. Since this period, water levels have stabilized and are projected to recover, while the model continues to project compaction from delayed depressurization. The current projections are dependent upon the model estimates of the timing of this depressurization from 50+ years ago, which are related to the thickness/uniformity/parameterization of the clay units in the model. Lack of observational data increases the uncertainty in the modeling projections.

Extensometer data could provide some measurement/monitoring of current conditions but, so far, has not been successful in Northwest MZ-1. The District recommends developing this baseline data prior to making recommendations solely based on the 1-D Modeling.

Response:

Although the new extensometers at the PX facility are not yet providing reliable data, an extensive database of historical data in Northwest MZ-1 were used to construct and calibrate the 1D Models, including: detailed borehole lithology data at the PX and MVWD-28 wells, hydraulic heads at wells (1930-present), InSAR estimates of vertical ground motion (1992-present), and ground-level surveys (1923-present).

It will always be the case that historical data (i.e., head data or vertical ground motion data) will be limited, and these limited data create some degree of uncertainty in the model simulations. That said, based on the results of the 1D Model calibration and the sensitivity analysis, the Watermaster Engineer and the majority of the technical consultants on the GLMC stated that the 1D Models are sufficiently calibrated to provide a useful tool for evaluating potential future subsidence under future planning scenarios. The GLMC consultant for MVWD concurred verbally at the December 13, 2022 GLMC meeting.

Comment 5 – Pg 5 Evaluate model results and develop recommendations

The District recommends a more comprehensive evaluation of the guidance level prior to making recommendations. Understanding the difference between the alternative management actions is key to understanding if the proposed guidance will be effective. The District recommends running an alternative with the guidance levels in place to show the difference between the “No Action” and guidance level alternative.

Response:

We agree that additional SMAs should be developed, simulated with the CVM and 1D Models, and evaluated to refine the “preliminary” Guidance Level. As a start, such modeling exercises can be conducted in concert with the 2025 Safe Yield Reevaluation and the development of the Storage and Recovery Master Plan.

Comment 6 – Pg 7 Hydrologic Response of the Aquifer System to SMA-1; Tables 1 and 2

Is it possible to include groundwater levels, groundwater pumping, and recharge information to understand the difference between projected conditions and current conditions? A brief discussion on recent operations and how they have affected conditions in Northwest MZ-1 will aid discussion of model updates in the next round of modeling.

Response:

Tables 1 and 2 contain a column that describes historical pumping and recharge (average for 2010-2018) to compare against remaining columns in the tables that describe the projected pumping and recharge (2019-2040). This was done to “understand the difference between projected conditions and current conditions.”

We agree that subsequent SMAs and updates to the 1D Models should leverage new information on recent operations (pumping and recharge).

Comment 7 – Pg 9 Bullet 2 Conclusions and Recommendations

Does this lack of sensitivity to increases in head indicate that additional increases in Layer 5 will also be relatively insensitive? (e.g. modeled subsidence will not change significantly by implementing preliminary guidance levels?

Response:

This observation in the 1D Model results does not necessarily indicate that the compaction in Layer 5 is insensitive to changes in head. Additional model runs are necessary to determine such sensitivity. What this observation does indicate is that the compaction is due to the delayed drainage of aquitard layers, where pore pressures in the clay-rich sediments are continuing to equilibrate with head declines that occurred historically within the coarse-grained aquifer sediments. A subsequent SMA should be developed and simulated with the CVM and the 1D Models that purposefully increases heads in Layer 5 to estimate the effectiveness of the SMA to slow or stop the delayed drainage of the aquitards.

Comment 8 – Pg 9 Bullet 5 Conclusions and Recommendations

The District recommends removing the discussion of preliminary guidance at this time. As mentioned above, several critical steps have not been taken. The District recommends 1) establishing baseline monitoring at the extensometer to understand if current modeled compaction is consistent with measurement data from Northwest MZ-1; and 2) conducting analyses to understand if the 1-D Model projects the guidance to be effective relative to a "No action" alternative. The preliminary guidance lacks analysis of the costs and benefits of action vs. no action. Qualitative statements regarding vertical gradients between the aquifer layers in the area are not sufficient to establish guidance levels which have significant operational requirements and cost to achieve.

Response:

The Guidance Level proposed in the TM is both "preliminary" and provides "guidance" to the parties to direct future analysis, which is consistent with the objectives of the Chino Basin Subsidence Management Plan. The Guidance Level carries no regulatory effect. The preliminary Guidance Level is intended to assist the parties in planning for and making initial management decisions, not obligate them to any specific course of action.

Regarding the District's recommendations:

1. The 1D Model calibrations utilized an extensive historical dataset of vertical ground motion to establish the ability of the 1D Models to simulation aquifer-system compaction and land subsidence. For example, the 1D Models sufficiently matched the historical InSAR estimates of vertical ground motion from 1990-2018.
2. We agree that additional analyses are necessary to evaluate various subsidence management strategies, their effectiveness at slowing or stopping the land subsidence, and their practicality of implementation. Specifically, subsequent SMAs should be developed and simulated with the CVM and the 1D Models that purposefully increases heads in Layer 5 to estimate the effectiveness of the SMA to slow or stop the delayed drainage of the aquitards. In addition, the costs and practicality of such SMAs will need to be evaluated before any Guidance Level is

finalized in the Chino Basin Subsidence Management Plan. This section of the TM has been revised to add the sentence: "The practicality and costs of implementing these methods have not been determined. Hence, the Guidance Level proposed herein should be considered "preliminary" until such work is performed."

Comment 9 – Pg 9 Bullet 6 Conclusions and Recommendations

Future efforts need to be accompanied by monitoring at the extensometer and via other methods to assess the underlying conceptual model. Is delayed depressurization actually occurring and at levels projected by the 1-D Model given the absence of physical evidence?

Response:

There is sufficient physical evidence demonstrating delayed drainage of aquitards, consistent with the 1D Model results. Specifically, there is a long history of monitoring of groundwater levels and vertical ground motion by InSAR (1992-present) and ground-level/GPS surveys (1923-present)—all of which indicate gradual and persistent land subsidence in Northwest MZ-1 due to delayed drainage of aquitards. These monitoring efforts, including annual evaluation of the monitoring data, are ongoing and planned for the future.

The 1D Models are simulating the delayed drainage of aquitards at rates consistent with the recent monitoring data.

Comment 10 – Pg 9 Bullet 7 Conclusions and Recommendations

The District recommends removing this bullet point from this report, which focuses on the 1-D Model. If modeling and analysis (contour maps, vertical distribution, particle tracking, etc.) of existing contamination has been conducted, it should be documented more fully, perhaps in a stand-alone report or in future work. Absent presentation of supporting data, it is out of place here.

Response:

The bullet has been removed from the TM.

Comment 11 – Pg 10 Bullet 8 Conclusions and Recommendations

The analysis contemplated in this bullet point needs to be conducted prior to releasing a "preliminary" guidance level.

Response:

See response to Comment 1.

Comment 12 – Pg 10 Bullet 10 Conclusions and Recommendations

Ongoing monitoring data at the extensometer should also be mentioned here. In the last sentence, the District recommends removing mention of "finalization." These analyses are necessary to draft "preliminary" guidance levels, in addition to better understanding current conditions with monitoring.

Response:

The word "finalize" has been changed to "establish" in this bullet. A sentence was added to the end of this bullet: "It should be noted that future monitoring and analyses always hold the potential for changes to the Guidance Level, consistent with the adaptive management approach called for in the Chino Basin Subsidence Management Plan."

Comment 13 – Figures 2 and 3

How does the simplification of the logs into clay and sand units in the 1-D Model affect the delayed depressurization the model is showing? Does the conceptualization of the clay units exaggerate the delayed depressurization? The distribution of the clay is quite different between the two locations (see differences between MVWD-28 and PX locations), and the presence of interbedded sand should tend to decrease the likelihood of delayed depressurization/compaction.

Response:

Numerical models are always a simplification of the natural world. However, model calibration is designed to quantify the ability of a model to simulate historical monitoring data. These 1D Models have been sufficiently calibrated to historical measurements of vertical ground motion. Therefore, we do not believe the 1D Models are "exaggerating" aquitard compaction.

The underlying geology is different between the two 1D Model locations, which in part, accounts for the differing degrees of aquitard compaction as simulated by the 1D Models and land subsidence as shown by the monitoring data.

Comment 14 – Figures 11 and 12

Layers 1 and Layer 4 and 5 modeled compaction are very similar between the two sites (MVWD-28 and PX), with Layer 2+3 compaction accounting for most of the difference in the projected compaction. In the lithology logs in Figures 2 and 3, the PX site has significantly more clay relative to the MVWD-28 site in Layers 1 and Layer 4 and 5. What explains the lack of difference in projected compaction in these layers between the sites given how different the lithology is between the two sites?

Response:

This observation has not been investigated in detail. During 1D Model calibration, there was a significant difference between total simulated compaction from 1930-2018 at the PX (about 9 ft) compared to total simulated compaction at MVWD-28 (about 6 ft).

The observation that projected compaction from 2019-2040 is similar between the two 1D Models, suggests that the delayed drainage and compaction of aquitards is occurring preferentially in various thicker aquitards at each location. However, no analyses have been performed to verify this hypothesis. This is a potential subject of future study and possible incorporation into the 1D Models and/or Guidance Level.

Comment 15 – Figures 13

We recommend removing this figure until additional analysis is conducted as discussed in comments regarding Conclusions and Recommendation?

Response:

This figure should remain to illustrate the "preliminary" Guidance Level.

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TECHNICAL MEMORANDUM

DATE: February 28, 2024 Project No.: 941-80-23-25 B.2

TO: Ground-Level Monitoring Committee

CC: Edgar Tellez-Foster, *Interim General Manager of the Chino Basin Watermaster*

FROM: West Yost Associates, *Watermaster Engineer*

REVIEWED BY: Andy Malone, PG

SUBJECT: *Proposed Locations and Data for Construction/Calibration of Additional 1D Models (DRAFT)*

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INTRODUCTION

This technical memorandum proposes locations and specific data to be used in the construction and calibration of three (3) one-dimensional compaction models (1D Models) across the western portion of Chino Basin. The 1D Models will be computer-simulation tools that will assist the Chino Basin Watermaster (Watermaster) in its efforts to avoid the adverse impacts associated with land subsidence.

Background

Material Physical Injury (MPI) is a term defined in the Peace Agreement[1] and is a key consideration for the Watermaster in the management of groundwater in the Chino Basin. MPI is defined as:

> *"…material injury that is attributable to the Recharge, Transfer, storage and recovery, management, movement or Production of water, or implementation of the OBMP, including, but not limited to, degradation of water quality, liquefaction, land subsidence, increases in pump lift (lower water levels) and adverse impacts associated with rising groundwater. Material Physical Injury does not include "economic injury" that results from other than physical causes. Once fully mitigated, physical injury shall no longer be considered to be material."*

For any proposed activity listed above (*i.e.,* Recharge, Transfer, storage and recovery, management, movement or Production of water, or implementation of the OBMP), the Watermaster is required to evaluate the potential for the proposed activity to cause MPI. If the evaluation indicates the potential to cause MPI, the activity cannot be approved by the Watermaster unless the MPI is fully mitigated.

Regarding land subsidence specifically, the Peace Agreement recognizes subsidence as a form of MPI that can be caused by aquifer-system compaction. Pursuant to the Peace Agreement, the Watermaster has developed an adaptive Subsidence Management Plan (Subsidence MP).[2] The objective of the Subsidence MP is to provide guidance for pumping and/or recharge strategies that will minimize or abate the future occurrence of land subsidence within the Chino Basin.

Areas of Subsidence Concern

The Subsidence MP identifies several "Areas of Subsidence Concern" across the western portion of Chino Basin where the future occurrence of land subsidence and ground fissuring is a concern. Figure 1 is a map that shows the location of these areas, which were identified based on the following observations:

- The underlying hydrogeologic conditions, particularly the numerous fine-grained sediment layers within the aquifer system (aquitards), are conducive to aquifer-system compaction and associated land subsidence.
- Land subsidence is occurring in these areas or has occurred in the past.

[1] Section 1.1 (y) of the Peace Agreement.

[2] Chino Basin Watermaster. 2015. Chino Basin Subsidence Management Plan. July 23, 2015.

- Historical declines in groundwater levels in these areas since the early- to mid-1900s were extreme (>150 feet) and could still be causing the current land subsidence due to delayed drainage of aquitards.
- Conditions that are conducive to ground fissuring are present, such as geologic faults that act as groundwater barriers which lead to differential subsidence.
- Increases in groundwater pumping (and associated declines in hydraulic heads) are occurring or are planned to occur within or near these areas.

When Watermaster evaluates the potential for subsidence-related MPI, it performs such evaluations within these Areas of Subsidence Concern.

One-Dimensional Compaction Models

The aquitard-drainage model describes how head decline in a coarse-grained aquifer causes the gradual drainage of pore water from the clay interbeds within aquifers and the confining layers separating them, resulting in compression and/or permanent compaction of the clay interbeds. A 1D compaction model can simulate this process of aquitard drainage and compression/compaction. In a 1D compaction model, the time-series of head in the coarser-grained aquifer sediments is assumed to be known, either from physical measurements or groundwater model simulations. The 1D model then solves for the gradual drainage of the clay layers and calculates the resulting compression/compaction. Since 1D models simulate one location in a groundwater basin through the entire thickness of the aquifer system, they can be constructed at high depth resolution, which gives them the ability to simulate both compaction in multilayered aquifer systems and the residual compaction of thicker clay layers within the aquifers.

The Subsidence MP calls for the use of computer-simulation modeling to assist in subsidence management efforts and future updates to the Subsidence MP. To date, two 1D Models have been constructed and calibrated in Northwest MZ-1. Figure 2 shows the location of these two 1D Models and the Watermaster's current ground-level monitoring network:

- **MVWD-28**. This 1D Model was constructed and calibrated in Northwest MZ-1 in 2017.[3] The model was constructed using the borehole lithology and geophysical data from Monte Vista Water District (MVWD) Well 28. It was calibrated using piezometric data and model estimates for historical heads and InSAR estimates of vertical ground motion. The model was prepared for the following reasons: to help understand the history of land subsidence in Northwest MZ-1; to help understand the mechanisms behind the subsidence; and to evaluate the potential for aquifer-system compaction within Northwest MZ-1 under future planning scenarios of pumping and recharge.

[3] Wildermuth Environmental, Inc. 2017. *Task 3 and Task 4 of the Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area: Development and Evaluation of Baseline and Initial Subsidence-Management Alternatives*. Prepared for Ground-Level Monitoring Committee, Chino Basin Watermaster. December 13, 2017.

- **PX**. This 1D Model was constructed and calibrated in Northwest MZ-1 in 2022.[4] The model was constructed using the borehole lithology and geophysical data from the deep borehole at the Pomona Extensometer (PX). It was calibrated using piezometric data and model estimates for historical heads and ground-level survey data and InSAR estimates of vertical ground motion. The model was prepared for the following reasons: to help understand the history of land subsidence in Northwest MZ-1; to help understand the mechanisms behind the subsidence; and to evaluate the potential for aquifer-system compaction within Northwest MZ-1 under future planning scenarios of pumping and recharge.

Figure 2 also shows where land subsidence has been occurring over the last decade. One of the acute areas of subsidence has been within in Northwest MZ-1. The Watermaster, with input from the Ground-Level Monitoring Committee (GLMC), is currently developing a *Subsidence Management Plan for Northwest MZ-1*. The objective of this plan is to provide guidance for the Watermaster and the Parties for how to manage hydraulic heads in Northwest MZ-1 (potentially through the management of pumping, recharge, the use of managed storage, and/or the design and implementation of Storage and Recovery Programs) so that the future occurrence of subsidence is minimized or abated in this area. The 1D Models at MVWD-28 and PX are being used in this effort to evaluate various subsidence management strategies for Northwest MZ-1.

Objectives

In 2023, with input from the GLMC, the Watermaster Board approved a scope of work to construct and calibrate three additional 1D Models across other Areas of Subsidence Concern for the following purposes:

- Evaluate for subsidence-related MPI during the upcoming re-evaluation of the Safe Yield in 2025 (as well as other future MPI evaluations as they arise).
- Support the evaluate for the minimum recharge quantity of supplemental water in MZ-1 as required in Section 8.4 of the Peace II Agreement.[5]
- Inform future updates to the Subsidence MP.

The objectives of this TM are to: (i) describe the proposed locations for the three additional 1D Models and (ii) describe the data that should be used to construct and calibrate the new 1D Models.

Proposed Locations and Data

This section describes the proposed locations and specific data to be used in the construction and calibration of the three new 1D Models in the western portion of Chino Basin.

Figure 2 shows the proposed locations for the three new 1D Models and the two existing 1D Models. The three new 1D Models are proposed for the Northeast Area (City of Ontario), the Southeast Area (western

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[4] West Yost, Inc. 2022. *Construction and Calibration of One-Dimensional Compaction Models in the Northwest MZ-1 Area of the Chino Basin*. Prepared for Ground-Level Monitoring Committee, Chino Basin Watermaster. November 22, 2022.

[5] See Section 8.4 of the *Final_Peace_II_Documents.pdf (cbwm.org)*

portion of the Chino Basin Desalter Authority well field), and the Managed Area (Ayala Park Extensometer). These locations were selected based on the following:

1. Land subsidence is currently occurring in these areas or has occurred in the past.
2. Land subsidence could occur in these areas in the future due to plans for increased pumping and the potential for lowering of groundwater levels.
3. The locations are generally representative of their associated Area of Subsidence Concern. This is evidence by the spatial and temporal history of land subsidence in these Areas of Subsidence Concern as measured by InSAR since the 1990s. In other words, the spatial and temporal trends in historical subsidence occurred in generally consistent patterns across each Area of Subsidence Concern.
4. There is sufficient data available at each location to construct and calibrate 1D Models.

The construction of a 1D Model utilizes deep borehole information on the grain size and texture of aquifer-system sediments—the aquifer system must be discretized into vertical units of: (i) “aquifer layers” composed mainly of gravels and sands and (ii) “aquitard layers” composed mainly of silts and clays. The types of deep borehole information to develop this discretization are descriptions of borehole sediments and borehole resistivity logs.

The calibration of a 1D Model utilizes: (i) historical estimates of depth-specific heads from measurements at nearby wells and/or groundwater modeling results and (ii) historical data on the vertical ground motion that occurred in response to the changes in groundwater levels. To enable the simulation of the delayed drainage and compaction of thicker clay layers, the start of the historical simulation period during 1D Model calibration should be prior to any major declines in groundwater levels.

The remainder of this section describes the data that is proposed to be used to construct and calibrate the three new 1D Models.

Ontario Well 33

Figure 2 the proposed location for the Ontario-33 1D Model within the central portion of the Northeast Area at the location of City of Ontario Well 33. This location was chosen because gradual and persistent land subsidence has occurred across this area since at least 1992, totaling over one foot at this location.

Figure 3 shows the lithologic and borehole resistivity data from Ontario Well 33 which will be used to construct the 1D Model along with the depth intervals of the five layers of the Chino Valley Model (CVM). The lithologic and resistivity data cover the depth interval from 0 to about 1,200 feet below ground surface (ft-bgs). These data are sufficient to construct a 1D Model that will be capable of simulating aquifer-system compaction across the thickness of the Chino Basin aquifer system at this location.

Figure 4 shows the time-series data that will be used during calibration of the Ontario-33 1D Model. These data include:

- *Hydraulic Head*. These data will be derived from: (i) historical measurements of groundwater elevation at several nearby wells and (ii) estimates of hydraulic head by CVM model layer that were derived from the 2020 CVM calibration.

- *Vertical Ground Motion*. These data will mainly come from InSAR estimates of vertical ground motion at the Ontario-33 location from 1992-2022.

CCX

Figure 2 shows the proposed location for the CCX 1D Model within the Southeast Area at the location of Chino Creek Extensometer (CCX). This location was chosen because of its proximity to the western portion of the Chino Basin Desalter Authority (CDA) well field, where increased CDA pumping is imminent.

Figure 5 shows the lithologic and borehole resistivity data from the deep borehole at the CCX which will be used to construct the 1D Model along with the depth intervals of the five layers of the CVM. The lithologic and resistivity data cover the depth interval from 0 to about 635 ft-bgs. These data are sufficient to construct a 1D Model that will be capable of simulating aquifer-system compaction across the thickness of the Chino Basin aquifer system at this location.

Figure 6 shows the time-series data that will be used during calibration of the CCX 1D Model. These data include:

- *Hydraulic Head*. These data will be derived from: (i) historical measurements of groundwater elevation at several nearby wells and (ii) estimates of hydraulic head by CVM model layer that were derived from the 2020 CVM calibration.
- *Vertical Ground Motion*. These data will come from: (i) InSAR estimates of vertical ground motion at the CCX location from 1992-2022; (ii) CCX extensometer data; and (iii) traditional leveling surveys at nearby benchmarks.

Ayala Park

Figure 2 shows the proposed location for the Ayala Park 1D Model within the Managed Area. This location was chosen because: the area experience over two feet of land subsidence in the late-1980s and early 1990s; the land subsidence was accompanied by ground fissuring and damage to overlying infrastructure; and the Managed Area is the primary focus of the Subsidence MP.

Figure 7 shows the lithologic and borehole resistivity data from the deep borehole at the Ayala Park Extensometer which will be used to construct the 1D Model along with the depth intervals of the five layers of the CVM. The lithologic and resistivity data cover the depth interval from 0 to about 1,400 ft-bgs. These data are sufficient to construct a 1D Model that will be capable of simulating aquifer-system compaction across the thickness of the Chino Basin aquifer system at this location.

Figure 8 shows the time-series data that will be used during calibration of the Ayala Park 1D Model. These data include:

- *Hydraulic Head*. These data will be derived from: (i) historical measurements of groundwater elevation at several nearby wells and (ii) estimates of hydraulic head by CVM model layer that were derived from the 2020 CVM calibration.
- *Vertical Ground Motion*. These data will come from: (i) InSAR estimates of vertical ground motion at the Ayala Park Extensometer location from 1992-2022; (ii) Ayala Park extensometer data; and (iii) traditional leveling surveys at nearby benchmarks.

PROPOSED METHODS FOR CONSTRUCTION AND CALIBRATION

This section describes:

- Background information on the modeling tools used to estimate head changes and aquifer system deformation.
- The technical methods that are planned to be applied to construct and calibrate the proposed 1D.

Proposed Model Codes

The United States Geological Survey (USGS) has developed a wide range of computer models to simulate saturated and unsaturated subsurface flow, solute transport, and chemical reactions in groundwater systems. The most widely used of these models is MODFLOW, which simulates three-dimensional (3D) groundwater flow using the finite-difference method. Although it was conceived solely as a groundwater flow model in 1984 and released in 1988 (McDonald et al., 1988), the MODFLOW modular structure has provided a robust framework for the integration of additional simulation capabilities that build on and enhance its original scope. The family of MODFLOW-related models now includes capabilities for simulating coupled groundwater/surface water systems and solute transport.

MODFLOW-NWT (Niswonger et al., 2011) was chosen for this project because: 1) it has extensive publicly available documentation, 2) it has sustained rigorous USGS and academic peer review, 3) it has a long history of development and use, 4) it is widely used around the world in public and private sectors, 5) it can easily operate with additional simulation tools published by others, and 6) it has been used by the Watermaster in the Chino Valley Model (CVM) for the latest Safe Yield Recalculation (WEI, 2020).

The Interbed Storage Package (Leake and others, 1991) of MODFLOW-NWT was chosen to simulate the aquifer-system deformation that is caused by elastic and/or inelastic deformation of the fine-grained interbeds in an aquifer-system due to changes in the effective stress on the soil skeleton because of changing groundwater levels.

Steps to Construct and Calibrate 1D Compaction Models

In summary, the major steps to construct and calibrate a 1D Model are:

1. Construct the 1D Model using the Interbed Storage Package (Leake and others, 1991) of MODFLOW-NWT. The model is a vertical stack of cells that represent the aquifer system at the 1D Model location. The thicknesses of the 1D Model cells (1 ft) is chosen to ensure that the delayed drainage of the aquitards can be adequately simulated. The model cells are categorized into either "Sand" for coarse-grained sediments or "Clay" for fine-grained sediments based on borehole lithologic and resistivity data. Initial aquifer (Sand) and aquitard (Clay) properties are assigned to the 1D Model cells based on past groundwater-flow modeling calibrations in the Chino Basin, past 1D Model calibrations in the Chino Basin, and literature review.

2. Prepare the monthly time-series of historical heads by CVM layer to serve as input data for the 1D Model "sand" cells over the calibration period of 1930-1922. The time-series of heads is based on based on the measured groundwater elevations at wells in the vicinity of the 1D

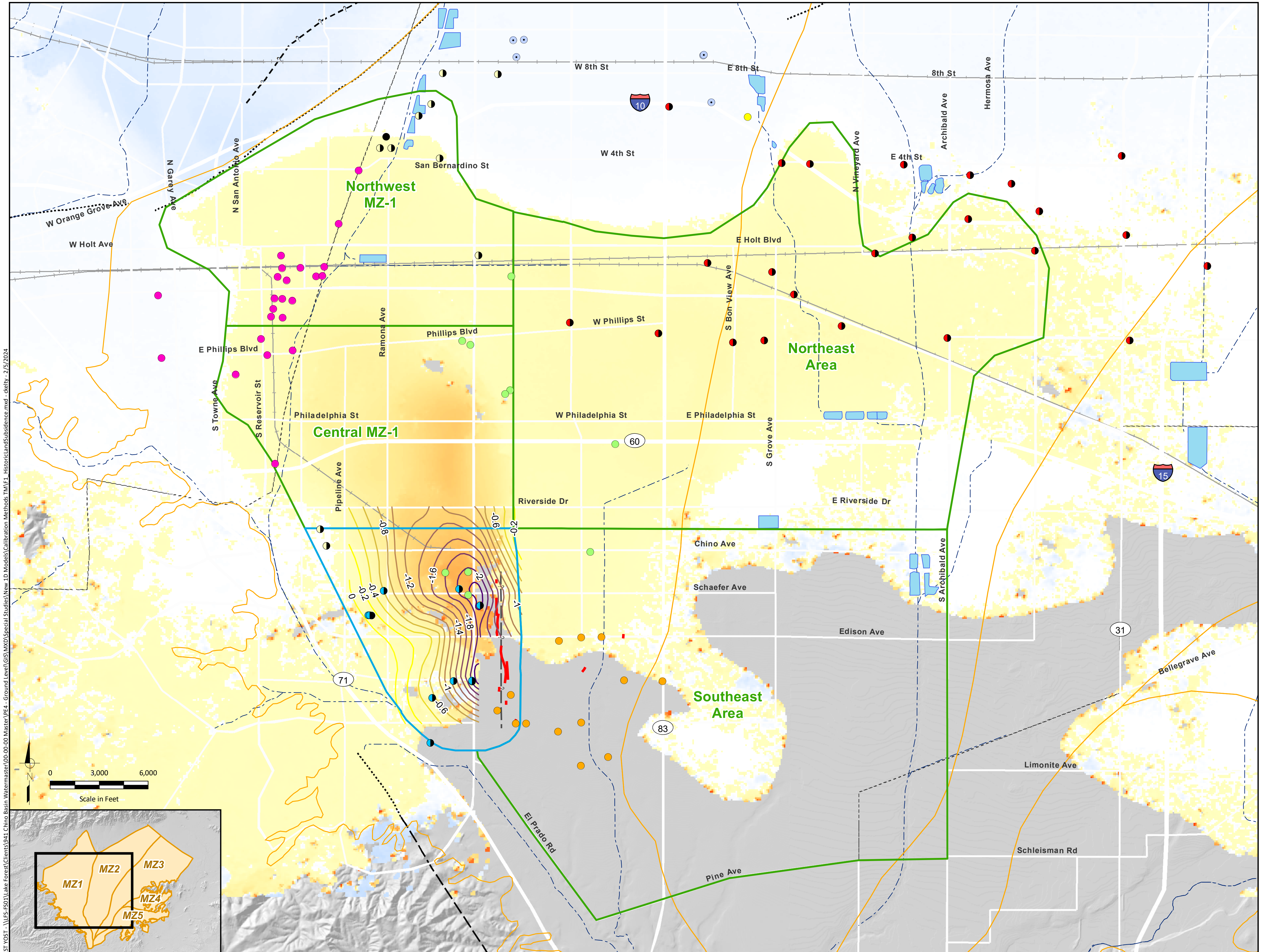
Model, CVM model results for heads by model layer, and professional judgment. The heads are assigned as prescribed heads to the corresponding Sand cells in the 1D Model.

3. Run and calibrate the 1D Models over the historical period of 1930-2022 by adjusting the aquifer and aquitard properties. The 1D Model simulations compute a time series of vertical aquifer-system deformation in each 1D Model cell. During calibration, the aquitard properties are adjusted manually to best match historical observations of land subsidence versus the model-simulated aggregate compaction of the aquifer system. The sum of the calculated vertical deformation in all 1D Model cells are assumed to represent the vertical ground motion at the land surface.

Recommendations and Next Steps

The GLMC should review this memorandum and come prepared to discuss at the next GLMC meeting scheduled for March 7, 2024 at 10am at Watermaster offices. Written comments and recommendations from the GLMC are due to Andy Malone (amalone@westyost.com) and Edgar Tellez-Foster (etellezfoster@cbwm.org) by April 5, 2024.

After receiving and addressing the feedback from the GLMC, West Yost will proceed with the construction and calibration of the three new 1D Models. The results of these efforts will be documented in a draft TM for review and comment by the GLMC.



Subsidence Areas

- Managed Area
- Areas of Subsidence Concern

Contours of Relative Change in Land Surface Elevation as Estimated by Leveling Surveys 1987 to 1999

- 0.0 ft
- -2.2 ft

Relative Change in Land Surface Elevation as Measured by InSAR Oct-1993 to Dec-1995

- + 1 ft
- 0
- - 1 ft
- InSAR absent or incoherent

Active Pumping Wells by Owner: 1987 to 1999

- CA Institution for Men
- City of Chino
- City of Chino Hills
- City of Ontario
- City of Pomona
- City of Upland
- Golden State WC
- Monte Vista WD
- San Antonia WC

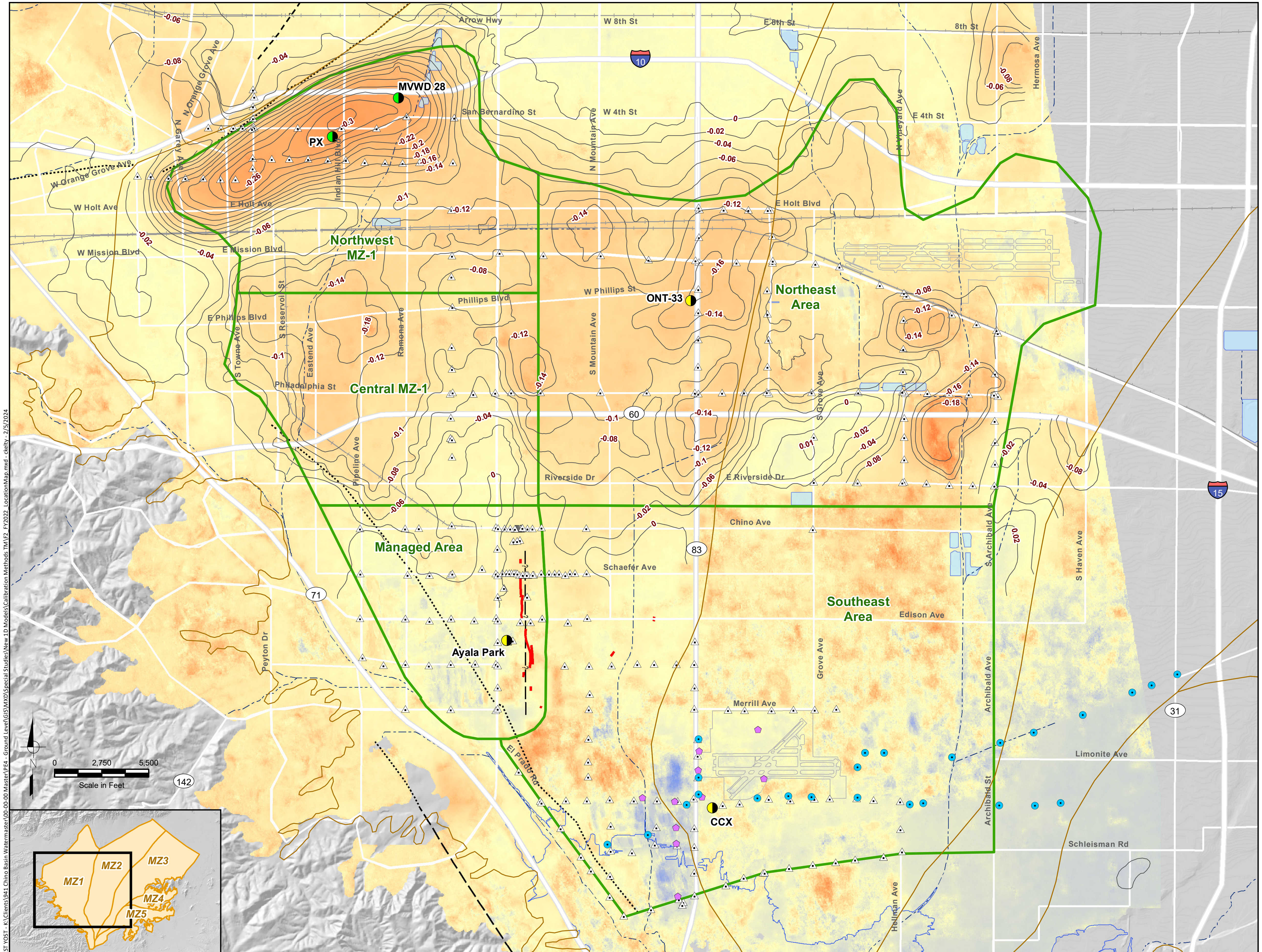
Other Features

- Flood Control and Conservation Basins
- Fault (solid where accurately located; dashed where approximate or inferred; dotted where concealed)
- Historic Ground Fissures

WEST YOST

Chino Basin Watermaster
Construction/Calibration of Additional 1D Compation Models

Figure 1
Areas of Subsidence Concern in the Chino Basin



WEST YOST - K:\Clients\941 Chino Basin Watermaster\00-00-00 Master\PE4 - Ground Level\GIS\MXD\Special Studies\New 1D Models\Calibration Methods TM\F2_FY2022_LocationMap.mxd - ckelty - 2/5/2024

1D Compaction Model Locations

- Existing
- New

Relative Change in Land Surface Altitude as Estimated by InSAR (March 2011 to March 2022)

- + 0.55 ft
- 0 ft
- -0.20
- -0.55 ft
- InSAR absent or incoherent

Other Features

- Areas of Subsidence Concern
- Chino Desalter Authority Well
- SB County Proposed Extraction Well
- Ground-Level Survey Benchmark
- Ground Fissures
- Approximate Location of the Riley Barrier

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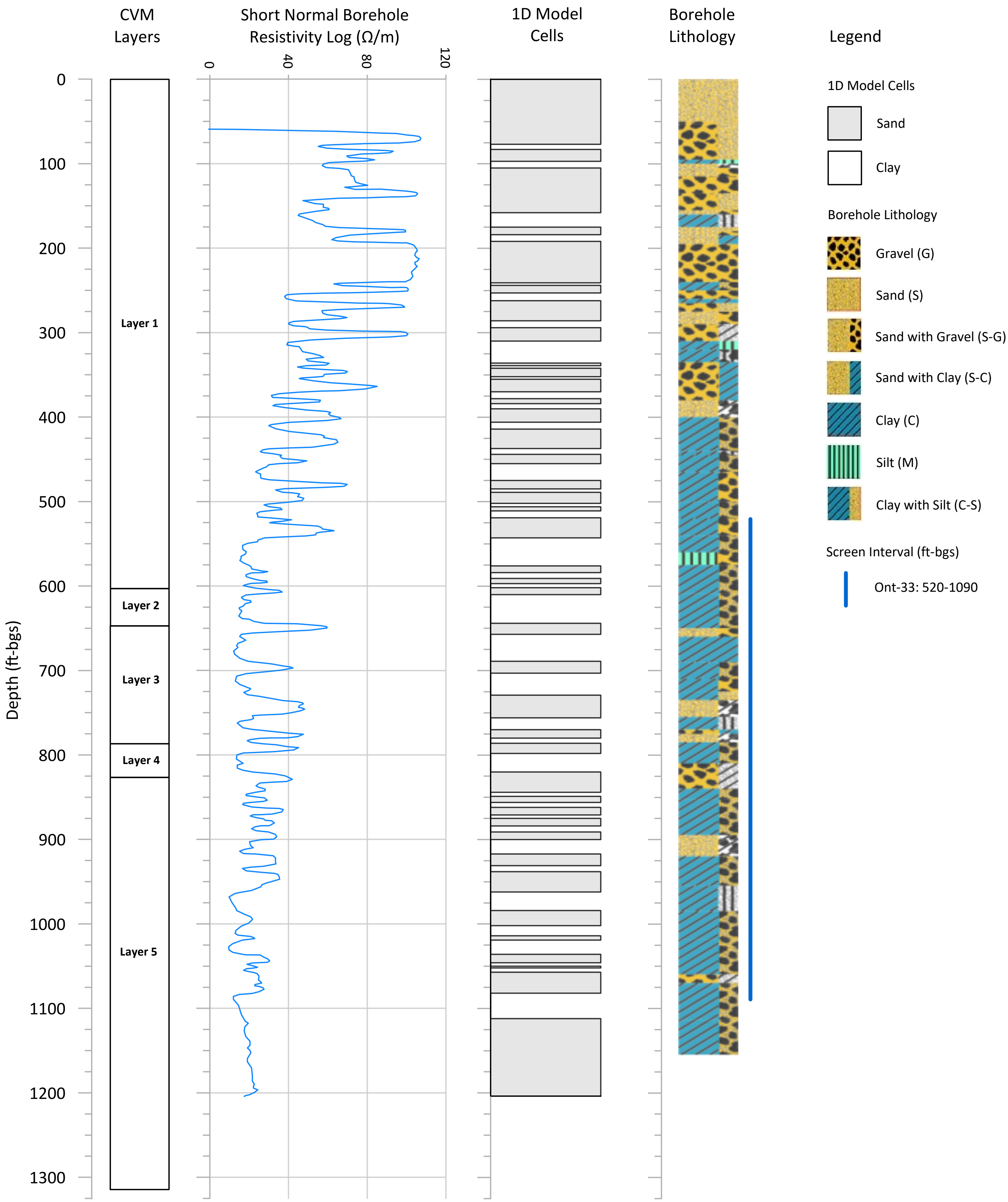
Chino Basin Watermaster

Construction/Calibration of Additional 1D Compation Models

Figure 2

Locations of One-Dimensional Compaction Models



File: Figure3_Ont33_Logs.grf; Date: 2/26/2024; Author: CK

Prepared by:

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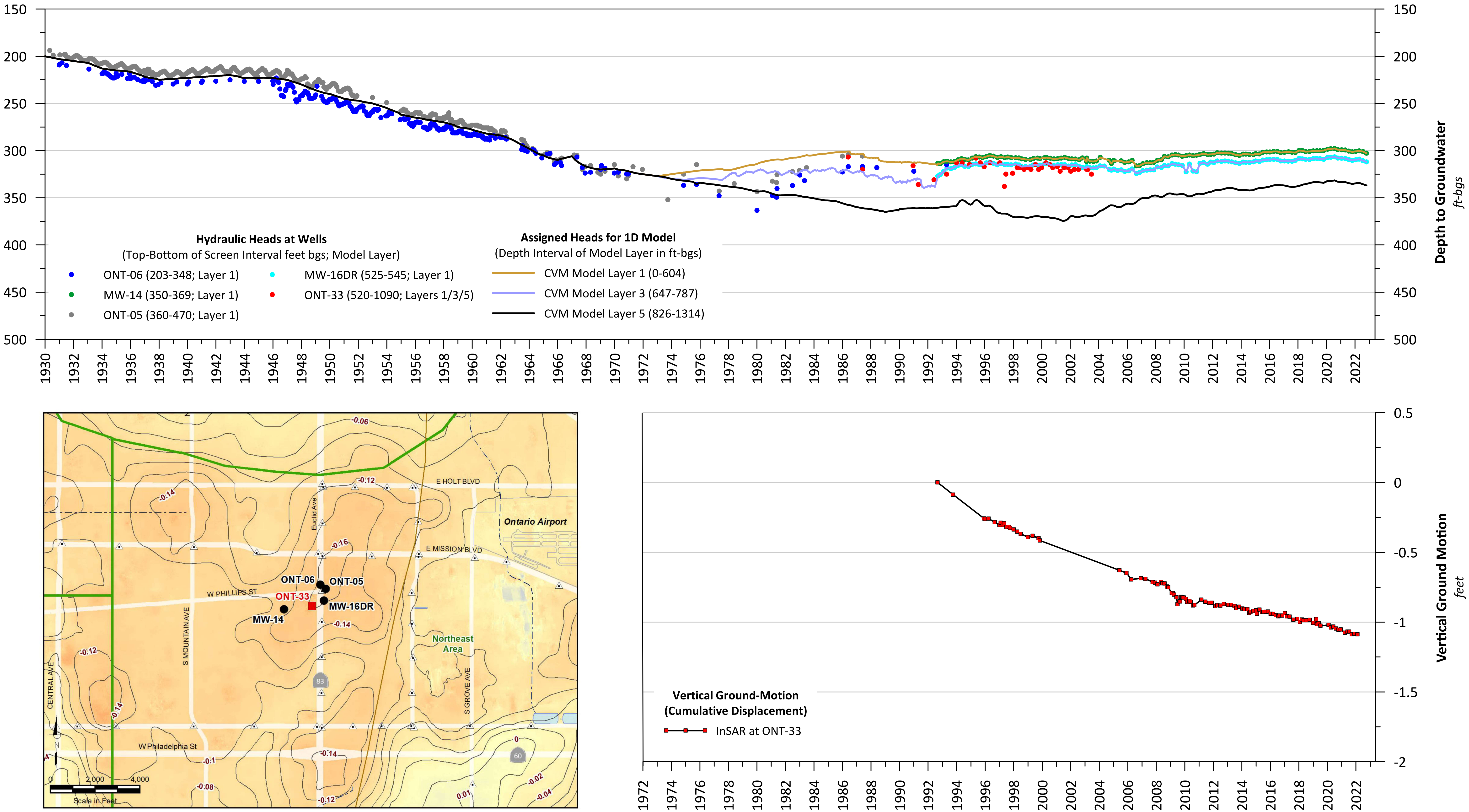
Water. Engineered.

Prepared for:

Chino Basin Watermaster
Construction/Calibration of
Additional 1D Compaction Models

Structure of 1D Model
Ontario Well 33

Figure 3



InSAR from March 2011 to March 2022 (see Figure 2)

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File: Figure4_Ont33.grf
Date: 2/26/2024
Author: CK

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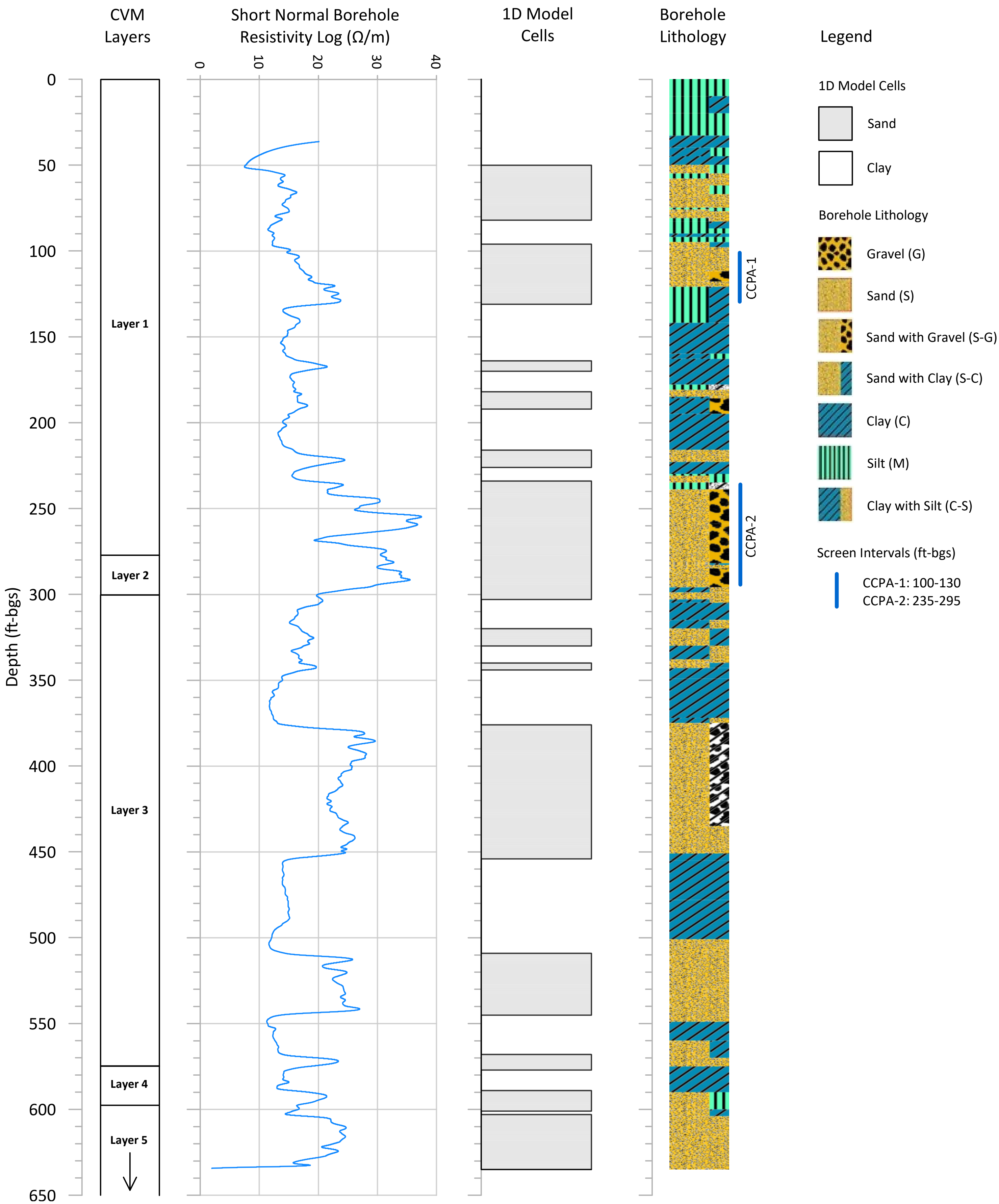
Chino Basin Watermaster
Construction/Calibration of Additional
1D Compaction Models

Historical Data for Calibration of the 1D Model
Ontario Well 33

Figure 4



File: Figure5_CCX_Logs.grf; Date: 2/26/2024; Author: CK

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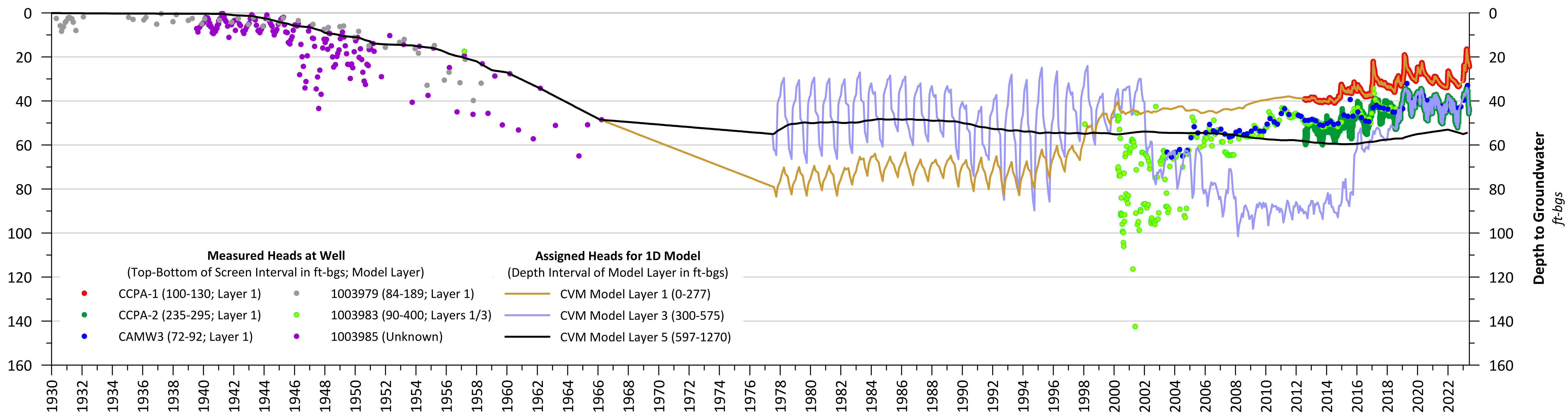
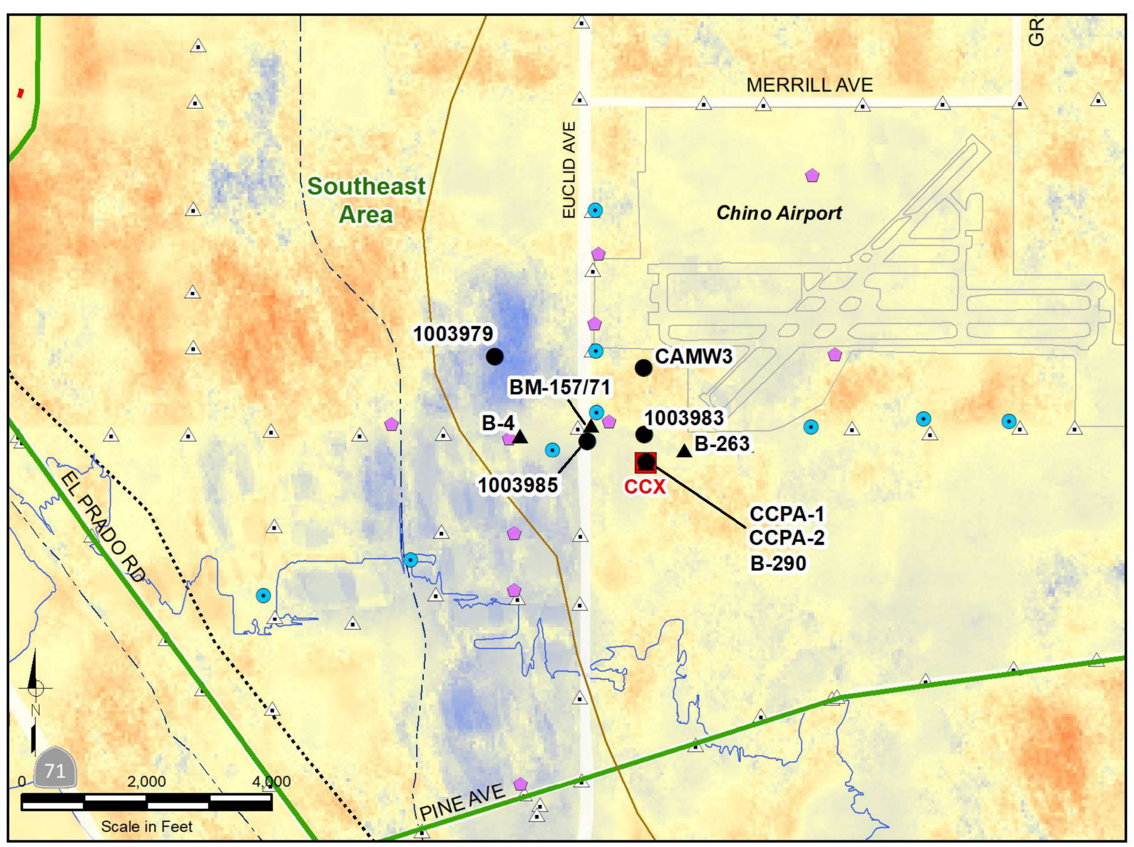
Chino Basin Watermaster
Construction/Calibration of
Additional 1D Compaction Models

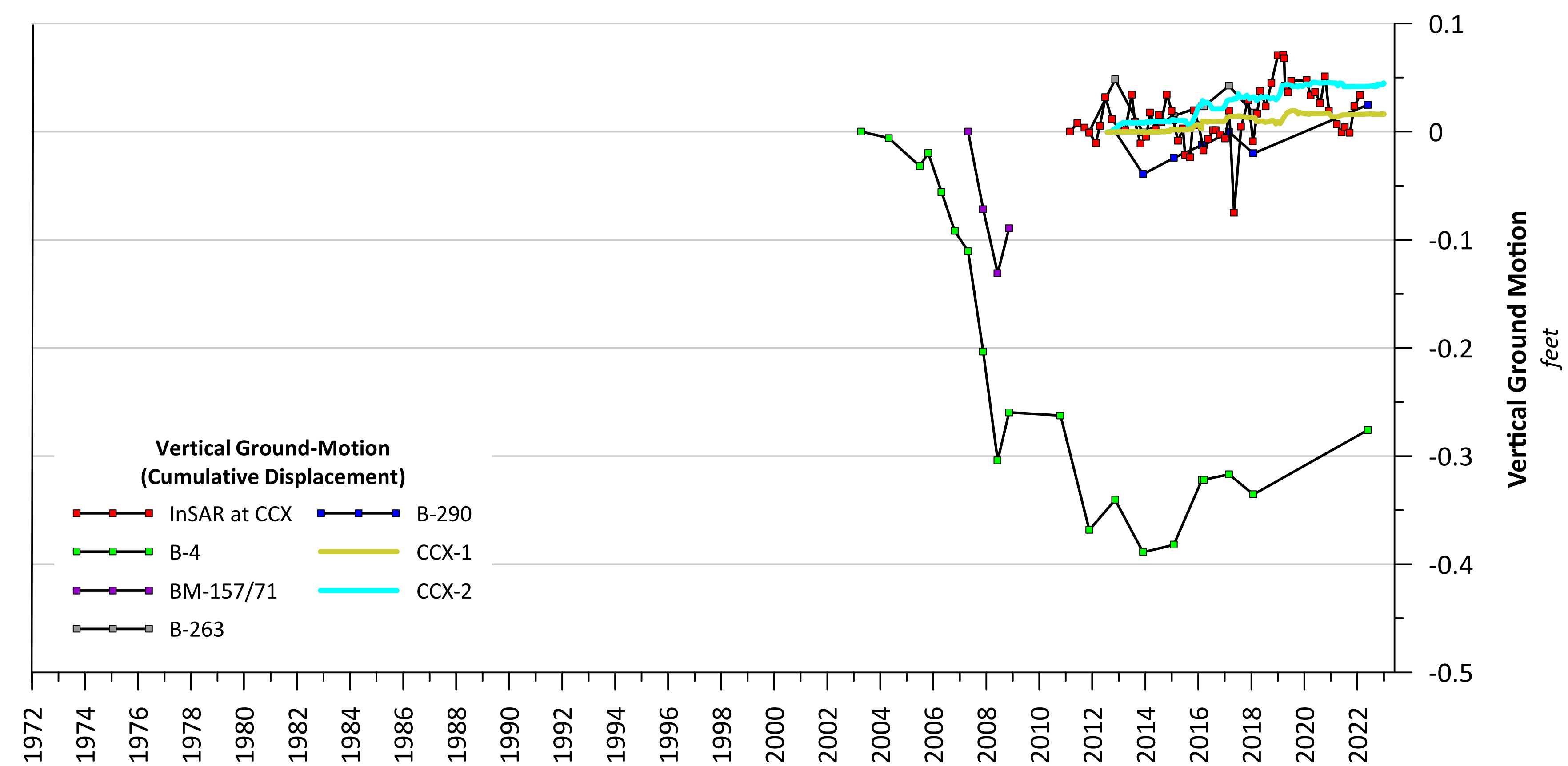
Structure of 1D Model
CCX

Figure 5





InSAR from March 2011 to March 2022 (see Figure 2)



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File: Figure6_CCX.grf
Date: 2/26/2024
Author: CK

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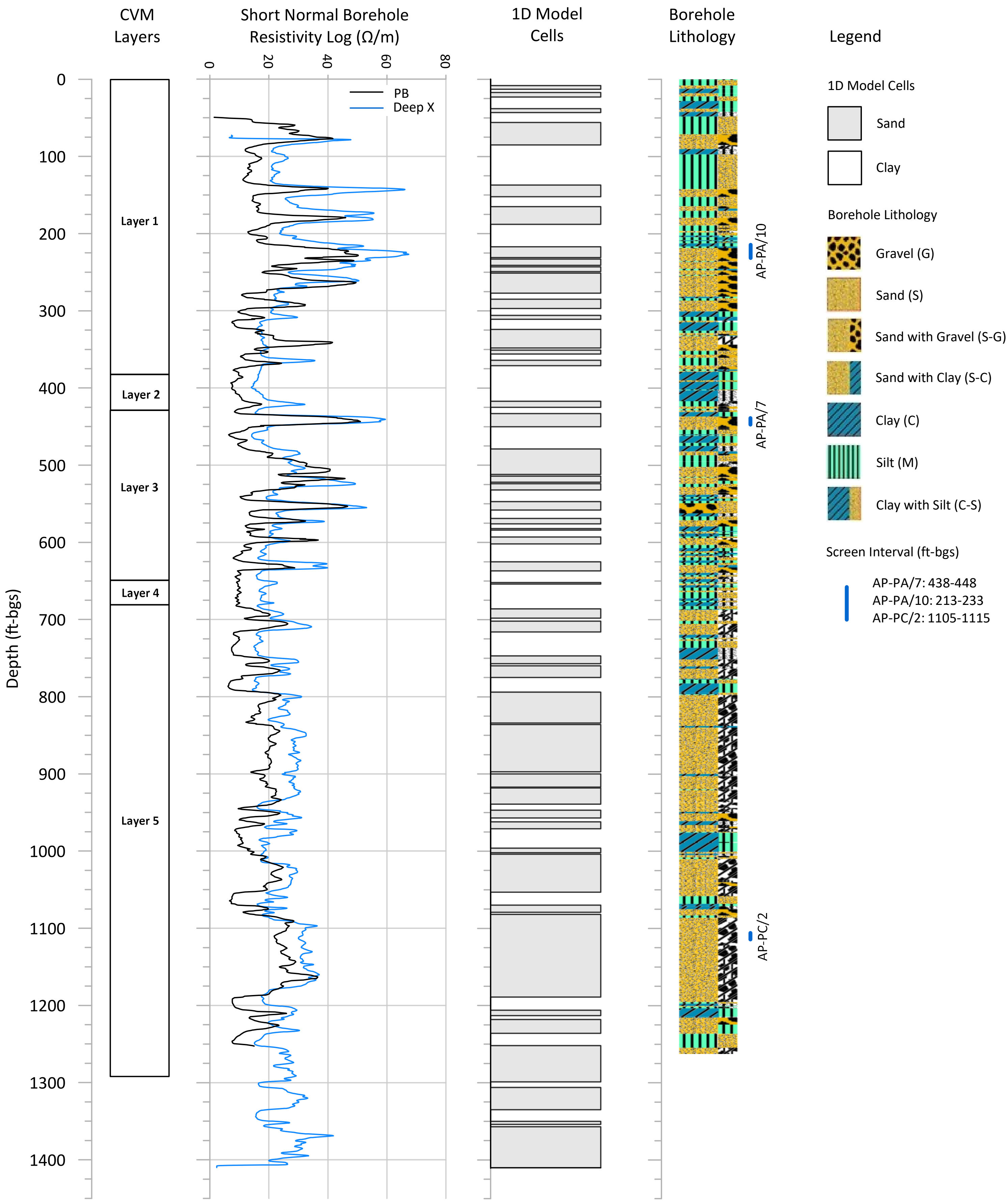
Construction/Calibration of Additional
1D Compaction Models

Historical Data for Calibration of the 1D Model
CCX

Figure 6



File: Figure7_Ayala_Logs.grf; Date: 2/26/2024; Author: CK

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WEST YOST Water. Engineered.

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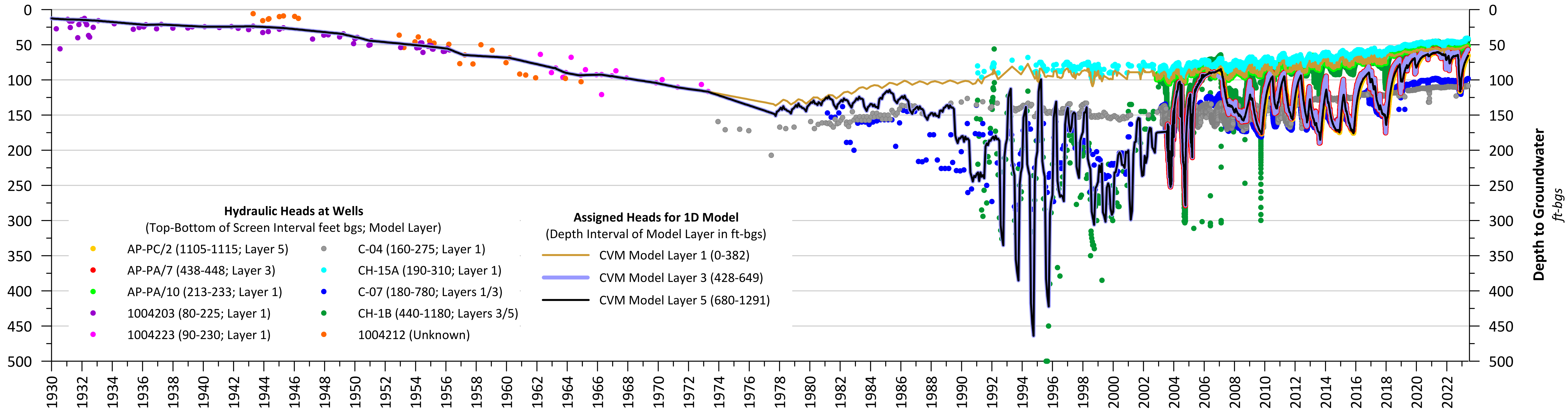
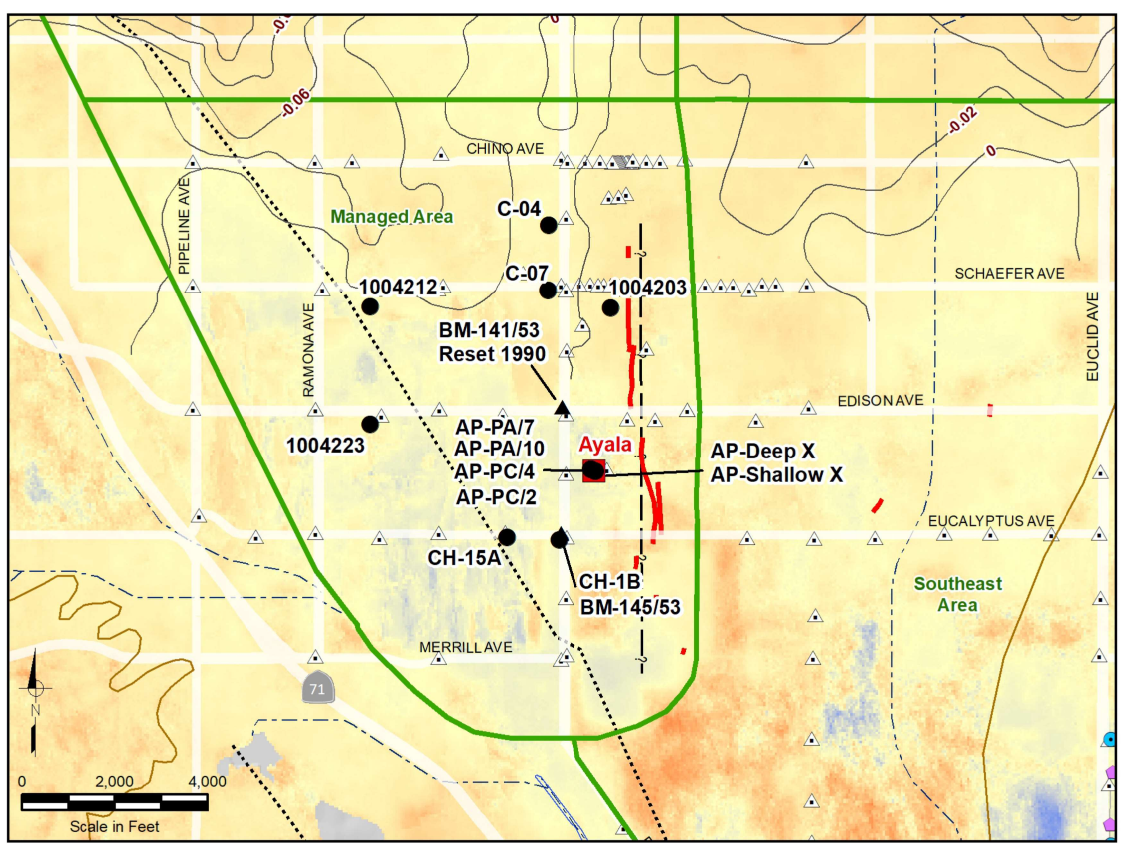
Chino Basin Watermaster
Construction/Calibration of
Additional 1D Compaction Models

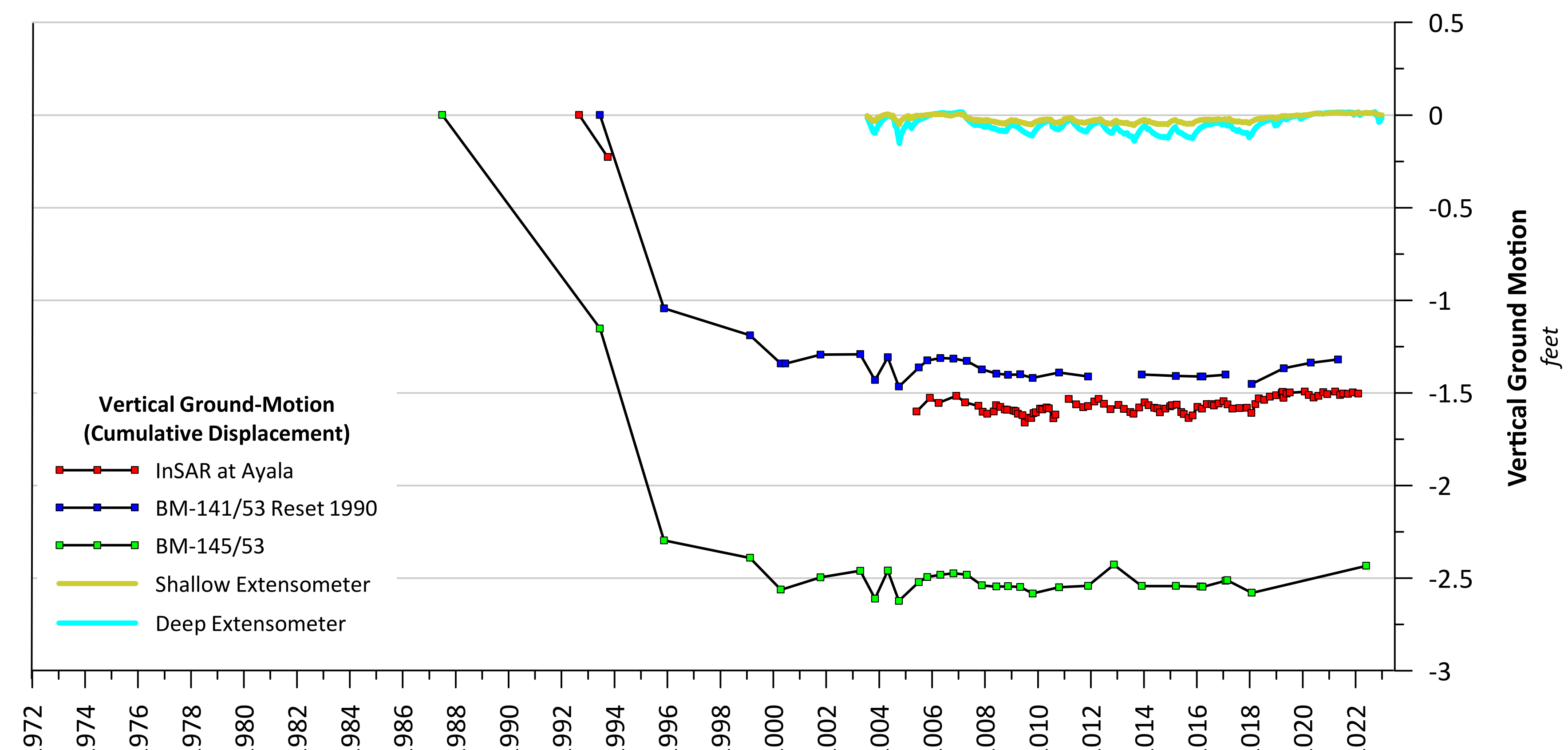
Structure of 1D Model
Ayala Park

Figure 7





InSAR from March 2011 to March 2022 (see Figure 2)



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File: Figure8_Ayala.grf
Date: 2/26/2024
Author: CK

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Chino Basin Watermaster
Construction/Calibration of Additional
1D Compaction Models

Historical Data for Calibration of the 1D Model
Ayala Park
Figure 8

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DRAFT TECHNICAL MEMORANDUM

DATE:	February 23, 2024	Project No.: 941-80-22-26
TO:	Ground-Level Monitoring Committee	
FROM:	West Yost Associates	
REVIEWED BY:	Andy Malone, PG	
SUBJECT:	Recommended Scope of Work and Budget for the Ground-Level Monitoring Program for Fiscal Year 2024/25 **(DRAFT)**	

BACKGROUND AND PURPOSE

Pursuant to the Optimum Basin Management Program Implementation Plan and the Peace Agreement, the Chino Basin Watermaster (Watermaster) implements a Subsidence Management Plan (SMP) for the Chino Basin to minimize or stop the occurrence of land subsidence and ground fissuring. The Court approved the SMP and ordered its implementation in November 2007 (2007 SMP). The 2007 SMP was updated in 2015 (2015 SMP) and can be downloaded from the Watermaster website. The SMP outlines a program of monitoring, data analysis, and annual reporting. A key element of the SMP is its adaptive nature—Watermaster can adjust the SMP as warranted by the data.

The Watermaster Engineer, with the guidance of the Ground-Level Monitoring Committee (GLMC), prepares annual reports which include: the results of the monitoring program; interpretations of the data; recommendations for the Ground-Level Monitoring Program (GLMP) for the following fiscal year (FY); and recommendations for adjustments to the SMP, if any.

This Technical Memorandum (TM) describes the Watermaster Engineer's recommended activities for the GLMP for FY 2024/25 in the form of a proposed scope of services and budget.

Members of the GLMC are asked to:

- Review this TM prior to March 7, 2024.
- Attend a meeting of the GLMC at 10:00 am on March 7, 2024 to discuss the proposed scope of services and budget for FY 2024/25.
- Submit comments and suggested revisions on the proposed scope of services and budget for FY 2024/25 to the Watermaster by April 4, 2024.

A final scope of services and budget that addresses the comments and suggested revisions of the GLMC will be included in the Watermaster's proposed budget for FY 2024/25. The final scope of services, budget, and schedule for FY 2024/25 will be included in Section 4 of the *2023/24 Annual Report for the GLMP*.

RECOMMENDED SCOPE OF SERVICES AND BUDGET – FY 2024/25

A proposed scope of services for the GLMP for FY 2024/25 is shown in Table 1 as a line-item cost estimate. The proposed scope of services is summarized below.

Task 1. Setup and Maintenance of the Monitoring Network

The Chino Basin extensometer facilities are key monitoring facilities for the GLMP. They require regular and as-needed maintenance and calibration to remain in good working order and to ensure the recording of accurate measurements.

Task 1.1. Maintain Extensometer Facilities

This subtask includes performing monthly visits to the Ayala Park, Chino Creek, and Pomona extensometer (PX) facilities to ensure functionality and calibration of the monitoring equipment and data loggers. Two staff members are required for these visits due to safety concerns.

Non-routine efforts to be performed during FY 2024/25 under this subtask include:

- Monthly adjustments to the PX extensometers to improve the accuracy of the measurements of aquifer-system deformation.
- Purchase and install two metal covers for Ayala Park PA vault and PX 2 vault.
- Construct French drains around the PA vault to convey surface-water runoff away from the vault.

Task 1.2. Annual Lease Fees for the Chino Creek Extensometer Site

The County of San Bernardino (County) owns the land the Chino Creek extensometer facility is located on. As such, the Watermaster entered into a lease agreement with the County in 2012 and pays the County and annual rental payment of $1,596.

Task 2. Aquifer-System Monitoring and Testing

This task involves the collection, compilation, and checking of hydraulic head and aquifer-system deformation data from the Ayala Park, Chino Creek, and PX extensometer facilities.

Task 2.1. Conduct Quarterly Monitoring at Extensometer Facilities

This subtask involves the routine quarterly collection, processing, and checking of data from the three extensometer facilities in the Chino Basin. Quarterly data collection is necessary to ensure that the monitoring equipment is in good working order and to minimize the risk of losing data because of equipment malfunction. For this subtask, the complete extensometer and piezometer records from the Ayala Park, Chino Creek, and PX facilities are loaded to HydroDaVE^{SM} (Hydrologic Database and Visual Explanations), the annual report figures are updated, and all the new data are checked for accuracy. If the data indicated malfunctioning equipment or inaccurate measurements, then any necessary adjustments to the monitoring equipment are made. Two staff members are required for these visits due to safety concerns.

Task 3. Basin-Wide Ground-Level Monitoring Program (InSAR)

This task involves the annual collection and analysis of Synthetic Aperture Radar (SAR) scenes to estimate the vertical ground motion across the western portion of Chino Basin from March 2024 to March 2025.[1]

In this subtask, five SAR scenes that are acquired by the TerraSAR-X satellite from March 2024 to March 2025 are purchased from the German Aerospace Center. West Yost will use the SAR scenes to prepare 12 interferograms (InSAR) that describe the incremental and cumulative vertical ground motion that occurred from March 2024 to March 2025 and since 2011. The associated costs to task, acquire, purchase, and process the InSAR data is as follows:

- Task TerraSAR-X for five SAR acquisitions for the western Chino Basin ($1,000)
- Purchase TerraSAR-X data ($10,000)
- Prepare and check InSAR results, including the interferograms and GIS-generated rasters ($62,000)

In addition, West Yost purchased and maintains the GAMMA software that is necessary to process the SAR data and prepare the InSAR estimates of vertical ground motion. The one-time initial cost for the software was $44,000. Since the Watermaster is the only West Yost client that utilizes InSAR services, the Watermaster is paying for the GAMMA software over a three-year period ($11,000 in FY 2023/24, $22,000 in FY 2024/25, and $11,000 in FY 2025/26). The annual maintenance cost is $6,600. Therefore, in FY 2024/25 the Watermaster's costs for the GAMMA software is: $22,000 + $6,600 = $28,000.

Task 4. Perform Ground-Level Surveys

This task involves conducting elevation surveys at benchmark monuments across defined areas of western Chino Basin to estimate the vertical ground motion that occurred since the prior survey. Figure 1 shows the location of the benchmark monuments surveyed across the western Chino Basin. Electronic distance measurements (EDM surveys) are also performed periodically between monuments to estimate horizontal ground motion in areas where ground fissuring due to differential land subsidence is a concern. Table 2 documents the areas surveyed over the last six years as part of the GLMP.

[1] West Yost is now performing this task internally instead of subcontracting the work, as was done in the past. This was made possible by West Yost hiring the InSAR subconsultant directly and purchasing/maintaining the necessary hardware and software.

Table 2. History of Ground-Level Surveys

Ground-Level Survey Area	Ground-Level Survey Completed (Y/N)?						
	2018	2019	2020	2021	2022	2023	2024[b]
Managed Area	Y	N	N	N	N	N	Y
Fissure Zone Area[a]	Y	N	N	N	N	N	N
Central Area	N	N	N	N	N	N	N
Northwest Area	Y	Y	Y	Y	Y	Y	Y
San Jose Fault Zone Area[a]	Y	Y	Y	Y	Y	N	N
Southeast Area	Y	N	N	N	Y	N	N
Northeast Area	Y	Y	Y	N	N	N	N

(a) Denotes EDM survey area (measurements of horizontal strain).
(b) The 2024 ground-level surveys are scheduled to begin in March 2024.

The ground-level surveys recommended for FY 2024/25 include the following:

Task 4.1. Conduct Spring-2025 Elevation surveys in Northwest MZ-1

In this subtask, the surveyor conducts elevation and EDM surveys at the established benchmarks in Northwest MZ-1 in Spring 2025. The elevation survey will begin at the Pomona Extensometer Facility and includes benchmarks across Northwest MZ-1. The elevation survey will be referenced to the Ayala Park elevation datum at the Ayala Park Extensometer via a GPS survey performed at both Ayala Park and the Pomona Extensometers.

The vertical elevation survey is recommended in Spring 2025 because of the recent subsidence that has occurred in Northwest MZ-1 and because the survey will support the development of a subsidence management plan in Northwest MZ-1. The EDM survey is ***not*** *recommended to be performed across the San Jose fault zone because past surveys (2013-2021) have demonstrated that the horizontal strain measured between benchmark pairs appears to behave elastically. The EDM surveys should be conducted less frequently than annual (e.g., once every five years).*

Ground-Level Surveys Not Recommended for Spring 2025

Ground-level surveys are **not** recommended for Spring 2025 in the other Areas of Subsidence Concern (*i.e.,* Managed, Central, Southeast, and Northeast Areas). This recommendation is justified because:

- InSAR is proving to be an accurate, more efficient, higher-resolution method to monitor vertical ground motion across the western Chino Basin.
- Hydraulic heads and vertical ground motion in some of these areas are stable or increasing.

Ground-level surveys should be conducted in these areas less frequently than annual (*e.g.,* once every five years).

Task 4.5. Replace Destroyed Benchmarks (if needed)

In this subtask, the surveyor replaces benchmark monuments that have been destroyed since the last survey, if any.

Task 4.6. Process, Check, and Update Database

In this subtask, the Watermaster Engineer receives and catalogs the survey results provided by the surveyor, prepares the data for display as a GIS layer, and performs checks against InSAR and extensometer data for reasonableness and accuracy.

Task 5. Data Analysis and Reporting

Task 5.1. Prepare Draft 2023/24 Annual Report for the Ground-Level Monitoring Program

Prepare the text, tables, and figures for a draft *2023/24 Annual Report for the GLMP* and submit the report to the GLMC by September 20, 2024 for review and comment.

Task 5.2. Prepare Final 2023/24 Annual Report for the Ground-Level Monitoring Program

Update the text, tables, and figures based on the comments received from the GLMC and prepare a final *2023/24 Annual Report for the GLMP* by November 1, 2024. Responses to GLMC comments will be included as an appendix to the final report. The report will be included in the agenda packet for the November 2024 Watermaster meetings for approval.

Task 5.3. Compile and Analyze Data from the 2024/25 Ground-Level Monitoring Program

In this subtask, monitoring data generated from the GLMP during 2024/25 is checked, mapped, charted, and analyzed as the first step in the preparation of the subsequent annual report. Some of the maps, charts, and tables are shared with the GLMC at its meetings in early 2025 during the development of a recommended scope of services and budget for FY 2025/26.

Task 5.4. Conduct Whispering Lakes Subsidence Investigation of the Northeast Area

In the Northeast Area, the long-term and short-term InSAR estimates indicate that persistent downward ground motion has occurred in a concentrated area south of the Ontario International Airport between Vineyard Avenue and Archibald Avenue in the vicinity of Whispering Lakes Golf Course. The western edge of this subsiding area exhibits a steep subsidence gradient or "differential subsidence."

In FY 2021/22, the Watermaster Engineer conducted a Reconnaissance-Level Investigation that included the review and analysis of readily-available borehole and lithologic data, historical air photos, pumping and recharge data, hydraulic head data, and InSAR estimates of vertical ground motion. Figures and charts were prepared and analyzed to derive interpretations and recommendations for future investigations and monitoring. The investigation and recommendations were included in the FY 2021/22 Annual Report of the GLMC. Plausible mechanisms for this subsidence feature include pumping-induced aquitard drainage and shallow soil consolidation associated with historical land uses. The investigation identified data gaps in available site-specific hydrogeologic data.

Potential next steps presented to the GLMC at its December 13, 2022 meeting included:

- Aquifer-system monitoring (*e.g.,* collecting existing hydrogeologic data; installing transducers at wells in the study area; constructing an aquifer-system monitoring facility within the subsidence feature)

- Further investigation of the historical land use practices in the vicinity of the Whispering Lakes Golf Course (e.g., agricultural disturbance and augmentation of soils; historical sewage disposal and spreading of solids; golf course construction and maintenance activities)
- Perform field studies of shallow soil consolidation (i.e., develop a dataset of site-specific shallow soil compaction that could be compared to the rates of subsidence estimated by InSAR).

The GLMC has recommended a stepwise, process-of-elimination approach to identify the subsidence mechanism(s). The GLMC approved a $10,000 budget for FY 2023/24 to implement the recommendations derived from the Reconnaissance-Level Investigation. This budget is being used to collect and evaluate existing data (e.g., hydrogeologic data, well information, reports, historical land use data) and install transducers at nearby pumping wells. The results of these efforts will be documented in the GLMC Annual Report for 2023/24 along with recommendations for follow-on work.

The GLMC should consider dedicating contingency budget for FY 2024/25 ($10,000) to continue the implementation of the recommendations derived Reconnaissance-Level Investigation and future recommendations based on results of work performed in 2023/24.

Task 6. Develop a Subsidence-Management Plan for Northwest MZ-1

The 2007 SMP called for ongoing monitoring and data analysis of the Managed Area; including annual reporting and adjustments to the SMP, as warranted by the data. The 2007 SMP also called for expanded monitoring of the aquifer-system and land subsidence in other areas of subsidence and ground fissuring concern. Figure 1 shows the location of these so-called Areas of Subsidence Concern: Central MZ-1, Northwest MZ-1, Northeast Area, and Southeast Area. The expanded monitoring efforts outside of the Managed Area are consistent with the requirements of OBMP Program Element 1 and its implementation plan contained in the Peace Agreement.[2]

The 2007 SMP stated that if data from existing monitoring efforts in the Areas of Subsidence Concern indicate the potential for adverse impacts due to subsidence, the Watermaster would revise the SMP to avoid those adverse impacts. The 2014 Annual Report of the GLMC recommended that the 2007 SMP be updated to better describe the Watermaster's land subsidence efforts and obligations, including areas outside of MZ-1. As such, the update included a name change to the 2015 Chino Basin Subsidence Management Plan (2015 SMP) and a recommendation to develop a subsidence management plan for Northwest MZ 1.

The Watermaster had been monitoring vertical ground motion in Northwest MZ-1 via InSAR during the development of the 2007 SMP. Land subsidence in Northwest MZ-1 was first identified as a concern in 2006 in the MZ-1 Summary Report and again in 2007 in the 2007 SMP. Of particular concern was the occurrence of concentrated differential subsidence across the San Jose Fault in Northwest MZ-1—the same pattern of differential subsidence that occurred in the Managed Area during the time of ground fissuring. Ground fissuring is the main subsidence-related threat to infrastructure. The issue of differential subsidence, and the potential for ground fissuring in Northwest MZ-1, has been discussed at prior GLMC meetings, and the subsidence has been documented and described as a concern in the Watermaster's State of the Basin Reports, the annual reports of the GLMC, and in the *Initial Hydrologic*

[2] http://www.cbwm.org/docs/legaldocs/Peace_Agreement.pdf.

Conceptual Model and Monitoring and Testing Program for the Northwest MZ-1 Area (WEI, 2017). The Watermaster increased monitoring efforts in Northwest MZ-1 beginning in FY 2012/13 to include ground elevation surveys and electronic distance measurements (EDM) to monitor ground motion and the potential for fissuring.

In 2015, the Watermaster's Engineer developed the *Work Plan to Develop a Subsidence Management Plan for the Northwest MZ-1 Area* (Work Plan; WEI 2015b).[3] The Work Plan is characterized as an ongoing Watermaster effort and includes a description of a multi-year scope-of-work, a cost estimate, and an implementation schedule. The Work Plan was included in the 2015 SMP as Appendix B. Implementation of the Work Plan began in July 2015. On an annual basis, the GLMC analyzes the data and information generated by the implementation of the Work Plan. The results and interpretations generated from the analysis are documented in the annual report for the GLMP and used to prepare recommendations for future activities.

Progress to Implement Work Plan through FY 2023/24

The progress that has been made to implement the Work Plan through FY 2023/24 is described below:

- An initial hydrogeologic conceptual model of the Northwest MZ-1 Area was developed, and a report was published in 2017.[4] This report described the hydrogeology of the area, speculated on the causes of the observed land subsidence, and included a recommended monitoring program.

- A preliminary one-dimensional (1D) compaction model, based on hydrogeologic information from the MVWD-28 well site, was constructed, calibrated and used to explore the future occurrence of subsidence in Northwest MZ-1 under various basin-operation scenarios of groundwater production and artificial recharge and to identify potential subsidence mitigation strategies. A report[5] was published to document the results and interpretations of the modeling, which were: ***the deep aquifer system is most susceptible to future compaction and associated land subsidence, and hence, heads will need to increase in the deep aquifer system to minimize or abate future subsidence in Northwest MZ-1***. The report also included a recommendation to construct the Pomona Extensometer.

- The initial monitoring program was implemented to closely track groundwater-levels, groundwater production, recharge, and ground motion across Northwest MZ-1. This monitoring program included the construction of the Pomona Extensometer to measure and record depth-specific heads and aquifer-system deformation. Implementation of the monitoring program is ongoing.

- A new 1D model was constructed and calibrated using the hydrogeologic information collected at the Pomona Extensometer. The 1D model at MVWD-28 was also updated and recalibrated using current information. The objectives of this exercise were to: (i) describe the subsidence mechanisms and the pre-consolidation head by aquifer-system layer in Northwest MZ-1 and (ii)

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[3] Work Plan to Develop a Subsidence-Management Plan for Northwest MZ-1
[4] https://www.cbwm.org/docs/engdocs/GLMC/nwmz1/Final_NWMZ1_Task1_Report.pdf
[5] https://www.cbwm.org/docs/engdocs/GLMC/nwmz1/20171220%20Final%20NWMZ1%20Task3-4%20Tech%20Memo.pdf

develop modeling tools that can be used to explore the future occurrence of subsidence in Northwest MZ-1 under various basin-operation scenarios of groundwater production and artificial recharge and to identify potential subsidence mitigation strategies. This work was reviewed by the GLMC, and additional model calibration refinements and sensitivity analyses were performed based on GLMC input. In November 2022, the Watermaster Engineer published a final report[6] on the 1D Model calibrations and sensitivity analyses (with review by the GLMC) and deemed the 1D Models sufficient to simulation future land subsidence under prospective plans for pumping and recharge.

- In 2023, the Watermaster Engineer, with review and input from the GLMC, developed an initial "Subsidence Management Alternative" for Northwest MZ-1 called SMA-1. SMA-1 is equivalent to the planning scenario that was simulated with the 2020 Chino Valley Model (CVM) to support the 2020 Safe Yield Recalculation (2020 SYR). The 2020 SYR was intended to represent and simulate the Parties' projected pumping, recharge, and use of storage through 2050. The results of the 2020 SYR (*i.e.,* projected hydraulic heads by CVM layer) were used as input data for the 1D Model simulations to predict the potential future occurrence of subsidence through 2050. In September 2023, the Watermaster Engineer published a draft TM titled *1D Model Simulation of Subsidence in Northwest MZ-1—Subsidence Management Alternative #1*. The Watermaster's recommendations from this work were the following:

    a. Establish a preliminary "Northwest MZ-1 Guidance Level" of 630 ft-amsl for hydraulic heads in Layers 3 and 5 at the PX location. The preliminary Guidance Level is an aspirational Watermaster recommendation that, if achieved, would likely slow or stop aquitard compaction and land subsidence in Northwest MZ-1.

    b. Compliance with the Guidance Level should be measured at the PX-2/3 piezometer, which is generally representative of heads in Layers 3 and 5.

    c. The methods to achieve the Guidance Level could include but are not limited to: voluntary modification of pumping patterns; in-lieu recharge; wet-water recharge via spreading and/or injection; or a combination of methods. These methods might necessitate: voluntary modification of water-supply plans of the purveyors in the Chino Basin; modification of Watermaster practices for recharge and replenishment; and/or the implementation of regional-scale storage or conjunctive-use programs.

    d. Additional SMAs should be developed and evaluated with the 1D Models to generate the necessary information to finalize the Guidance Level and the *Subsidence Management Plan for Northwest MZ-1*. The additional SMAs could be developed during Watermaster's groundwater modeling efforts associated with the 2025 Safe Yield Reevaluation and the development of the Storage and Recovery Master Plan. The GLMC should participate in the scenario building exercises associated with these Watermaster efforts to develop the SMAs, so that the scenarios include various methods to achieve the Guidance Level. Then, the 1D Models should be used to evaluate the potential future subsidence in Northwest MZ-1 under the SMAs. These model results and evaluations will support the establishment

[6] https://www.cbwm.org/docs/engdocs/GLMC/nwmz1/TM%20-%20941%20-%201D%20Model%20-%20Final.pdf

of a Guidance Level in the *Subsidence Management Plan for Northwest MZ-1*. It should be noted that future monitoring and analyses always hold the potential for revisions to the Guidance Level, consistent with the adaptive management approach called for in the Chino Basin Subsidence Management Plan.

Based on the expected progress through FY 2023/24, the following work is recommended for FY 2024/25 to develop the *Subsidence Management Plan for Northwest MZ-1*:

Task 6.1. Aquifer-System Monitoring

The established monitoring program of piezometric levels and pumping at wells in Northwest MZ-1 will continue through various techniques, including: (i) SCADA-based monitoring by the Monte Vista Water District; (ii) monitoring of piezometric levels via sonar[7]; (iii) monitoring of piezometric levels via pressure transducers at City of Pomona production wells; and (iv) manual measurements of piezometric levels. These data, along with data collected from the PX in Task 2.1, will improve the understanding of the hydrogeology in Northwest MZ-1, will be used to develop the *Subsidence Management Plan for Northwest MZ-1*, and in the future, will be used to adapt the Chino Basin Subsidence Management Plan, as appropriate.

In this subtask, all data is collected, compiled, checked, and analyzed every three months. Charts and data graphics of pumping, piezometric levels, and aquifer-system deformation will be updated to support the data collection and analysis. The PX extensometer data is charted and analyzed monthly in the ongoing effort to improve the reliability and accuracy of the extensometers.

Task 6.5. Provide Advice in the Development of the 2025 SYR Scenarios

The ongoing 2025 SYR involves the development of multiple projection scenarios of future hydrology, pumping, managed recharge, and use of managed storage in the Chino Basin. These projection scenarios will be simulated with an updated CVM. The CVM results will be evaluated for MPI and then used to evaluate the current Safe Yield of the Chino Basin. The evaluation of MPI associated with land subsidence will be performed using the 1D Models in Northwest MZ-1 and in other Areas of Subsidence Concern (see Task 7 below). In FY 2024/25, the GLMC can provide the Watermaster with valuable advice on the following:

- The development of the 2025 SYR scenarios to ensure a plausible range of future conditions are simulated.
- Interpretation of the 1D Model results re: potential subsidence-related MPI associated with the Safe Yield estimates.
- How the model results can be used to evaluate the minimum recharge quantity of supplemental water in MZ-1 as required by the Peace II Agreement.

[7] The use of sonar technology to measure piezometric levels in wells in currently being used in Monte Vista Water District wells 28 and 31.

Providing GLMC advice should be conducted in conjunction with the 2025 SYR and can be discussed at regularly scheduled GLMC meetings at no additional cost.[8]

Task 7. Construct and Calibrate Additional 1D Models Across Western Chino Basin

As describe above in Task 6, the Watermaster has constructed, calibrated, and used 1D Models at the PX and MVWD-28 locations to evaluate the potential future subsidence in Northwest MZ-1 through 2040. The Watermaster used the information derived from the 1D Models to develop a preliminary "Guidance Level" to avoid future subsidence in Northwest MZ-1.

In Task 7, three additional 1D Models are constructed and calibrated across other Areas of Subsidence Concern in western Chino Basin, so that Watermaster can use all of the 1D Models during the 2025 SYR process to:

- Evaluate for subsidence-related MPI during the 2025 SYR.
- Refine the preliminary "Guidance Level" in Northwest MZ-1 and the Managed Area.
- Evaluate for the minimum recharge quantity of supplemental water in MZ-1 as required by the Peace II Agreement.

In FY 2023/24, the three additional 1D Models are being constructed and calibrated in the following areas: Northeast Area (at Ontario Well 33 location), in the Southeast Area near the CDA well field (at the CCX location), and in the Managed Area (at the Ayala Park Extensometer location).

The deliverables of this task are the following:

- A draft TM to describe the background/objectives of the task and the methods that will be used to complete the task. The methods include a description of the proposed locations for the additional 1D Models and the data that will be used to construct and calibrate the models.
- A draft TM that summarizes the construction and calibration of the additional 1D Models.

This task was budgeted and scheduled for completion in FY 2023/24, but the final work will likely spill over into FY 2024/25. If necessary, unspent budget from FY 2023/24 will be carried over to FY 2024/25 to complete this task. ***No additional budget in FY 2024/25 is necessary to complete this task***.

Task 8. Meetings and Administration

Task 8.1. Prepare for and Conduct Four Meetings of the Ground-Level Monitoring Committee

This subtask includes preparing for and conducting four meetings of the GLMC:

- August 2024 – Review and discuss GLMP for FY 2024/25. Review and discuss the draft TM on Task 7 – *Construction/Calibration of Additional 1D Models*.

[8] This is because most of these discussions will be occurring in the 2025 SYR peer review process with the same technical consultants that participate on the GLMC.

- September 2023 – Review the draft 2023/24 Annual Report for the GLMP
- March 2025 – Review the draft recommended scope and budget for FY 2025/26
- April 2025 – Review the final recommended scope and budget for FY 2025/26 (if needed)

Task 8.2. Prepare for and Conduct One As-Requested Ad-Hoc Meeting

This subtask includes preparing for and conducting one ad-hoc meeting of the GLMC, as requested by the GLMC or Watermaster staff.

Task 8.3. Perform Monthly Project Management

This subtask includes monthly project administration and management, including staffing, financial and schedule reporting to Watermaster and subcontractor coordination.

Task 8.4. Prepare a Recommended Scope and Budget for the GLMC for FY 2025/26

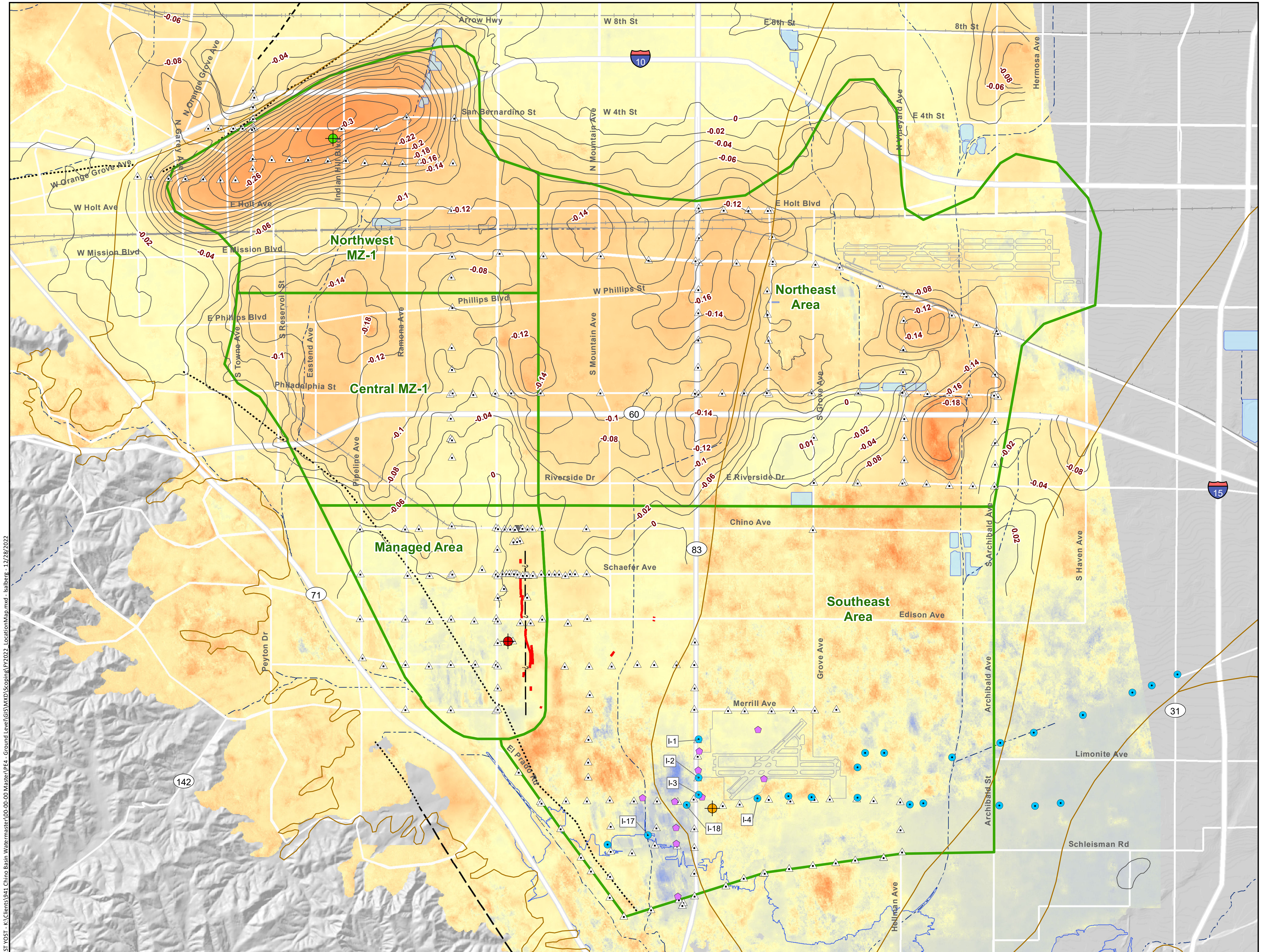
This subtask includes preparing a draft and final recommended scope of services and budget for FY 2025/26 for the GLMP to support the Watermaster's budgeting process.

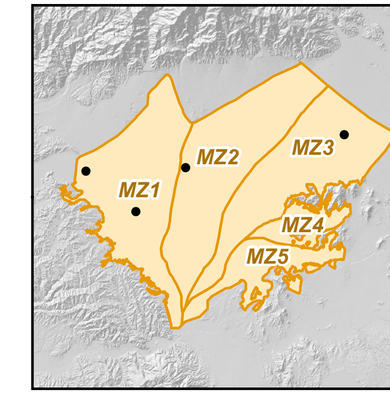
Table 1. Work Breakdown Structure and Cost Estimates for the Ground-Level Monitoring Program: FY 2024/25

Task Description	Notes	Labor (days)		Other Direct Costs						Totals			
		Person Days	Total	Travel	New Equip.	Equip. Rental	Outside Pro	Misc.	Total	Totals by Task	Recommended Budget *2024/25*	Approved Budget *2023/24*	Net Change *from 2023/24*
											a	*b*	*a - b*
Task 1. Setup and Maintenance of the Monitoring Network			**$40,221**						**$8,018**	**$48,239**	**$48,239**	**$47,789**	**$450**
1.1 Maintain Extensometer Facilities													
1.1.1 Routine maintenance of Ayala Park, Chino Creek, and Pomona extensometer facilities		21	$29,437	$649	$250	$350			$1,249	$30,685	$30,685	$33,707	-$3,022
1.1.2 Replacement/repair of equipment at extensometer facilities		6	$10,784	$173	$2,500		$2,500		$5,173	$15,957	$15,957	$12,485	$3,472
1.2 Annual Lease Fees for the Chino Creek extensometer facility		0	$0					$1,596	$1,596	$1,596	$1,596	$1,596	$0
Task 2. MZ-1: Aquifer-System Monitoring and Testing			**$32,724**						**$784**	**$33,508**	**$33,508**	**$31,456**	**$2,052**
2.1 Conduct Quarterly Monitoring at Extensometers Facilities													
2.1.1 Download data from the Ayala Park Extensometer facility		4	$5,436	$332		$40			$372	$5,808	$5,808	$3,032	$2,776
2.1.2 Download data from the Chino Creek Extensometer facility		4	$5,436			$40			$40	$5,476	$5,476	$2,700	$2,776
2.1.3 Download data from Pomona Extensometer facility		4	$5,436	$332		$40			$372	$5,808	$5,808	$10,492	-$4,684
2.1.4 Process, check, and upload data to database		10	$16,416						$0	$16,416	$16,416	$15,232	$1,184
Task 3. Basin Wide Ground-Level Monitoring Program (InSAR)			**$64,880**						**$39,600**	**$104,480**	**$104,480**	**$96,560**	**$7,920**
3.1 Satellite tasking and data selection with AirBus for 2024/25		0.5	$1,144					$1,000	$1,000	$2,144	$2,144		
3.2 Assess SAR baselines for 2024/25 and select/purchase TerraSAR-X frames from Airbus		0.5	$1,144					$10,000	$10,000	$11,144	$11,144	$96,560	$7,920
3.3 Prepare and check interferograms for 2024/25		28	$62,592						$0	$62,592	$62,592		
3.4 GAMMA software for InSAR processing (initial purchase + annual maintenance)		0	$0					$28,600	$28,600	$28,600	$28,600		
Task 4. Perform Ground-Level Surveys			**$7,144**						**$38,600**	**$45,744**	**$45,744**	**$84,280**	**-$38,536**
4.1 Conduct Spring-2024 Elevation surveys in Northwest MZ-1		0.5	$1,288				$28,600		$28,600	$29,888	$29,888	$28,360	$1,528
4.2 Conduct Spring-2024 Elevation Survey in the Northeast Area		0	$0				$53,416		$0	$0	$0	$0	$0
4.3 Conduct Spring-2024 Elevation Survey in the Southeast Area		0	$0				$56,584		$0	$0	$0	$0	$0
4.4 Conduct Spring-2024 Elevation and EDM Surveys in the Managed Area/Fissure Zone		0	$0				$46,800		$0	$0	$0	$31,248	-$31,248
4.5 Replace Destroyed Benchmarks (if needed)		0	$0				$10,000		$10,000	$10,000	$10,000	$19,280	-$9,280
4.6 Process, Check, and Update Database		3	$5,856						$0	$5,856	$5,856	$5,392	$464
Task 5. Data Analysis and Reporting			**$87,084**						**$0**	**$87,084**	**$87,084**	**$85,412**	**$1,672**
5.1 Prepare Draft 2023/24 Annual Report of the Ground-Level Monitoring Committee		19	$36,744						$0	$36,744	$36,744	$36,136	$608
5.2 Prepare Final 2023/24 Annual Report of the Ground-Level Monitoring Committee		8.5	$16,820						$0	$16,820	$16,820	$15,732	$1,088
5.3 Compile and Analyze Data from the 2024/25 Ground-Level Monitoring Program		14	$23,520						$0	$23,520	$23,520	$23,544	-$24
5.4 Continue Whispering Lakes Subsidence Investigation		0	$10,000						$0	$10,000	$10,000	$10,000	$0
Task 6. Develop a Subsidence-Management Plan for Northwest MZ-1			**$16,656**						**$0**	**$16,656**	**$16,656**	**$15,536**	**$1,120**
6.1 Aquifer-System Monitoring													
6.1.1 Collect pumping and piezometric data from agencies every three months; check and upload data to HDX		6	$8,448						$0	$8,448	$8,448	$10,560	-$2,112
6.1.2 Prepare and analyze charts and data graphics of pumping and recharge (Northwest MZ-1), piezometric levels, and aquifer-system deformation from PX		5	$8,208						$0	$8,208	$8,208	$4,976	$3,232
Task 7. Construct and Calibrate Additional 1D Models Across Western Chino Basin			**$0**						**$0**	**$0**	**$0**	**$192,511**	**-$192,511**
7.1 Prepare a draft TM summarizing the background, objectives, and methods; distribute to the GLMC		0	$0						$0	$0	$0	$12,760	-$12,760
7.2 Prepare for and conduct a GLMC meeting to receive feedback and comments on the draft TM		0	$0						$0	$0	$0	$5,110	-$5,110
7.3 Verify and/or recalibrate the 1D Model at Ayala Park Extensometer location		0	$0						$0	$0	$0	$22,736	-$22,736
7.4 Construct two additional 1D Models in the Southeast Area and Northeast Area		0	$0						$0	$0	$0	$62,368	-$62,368
7.5 Calibrate new 1D Models to derive properties of aquifers/aquitards and estimate the pre-consolidation stress(es)		0	$0						$0	$0	$0	$45,472	-$45,472
7.6 Prepare a draft TM summarizing the construction/calibration of additional 1D Models; distribute to the GLMC		0	$0						$0	$0	$0	$37,024	-$37,024
7.7 Prepare for and conduct a GLMC meeting to receive feedback and comments on the draft TM		0	$0						$0	$0	$0	$5,110	-$5,110
7.8 Incorporate the GLMC comments and prepare a final technical memorandum		0	$0						$0	$0	$0	$1,932	-$1,932
Task 8. Meetings and Administration			**$57,562**						**$375**	**$57,937**	**$57,937**	**$59,228**	**-$1,292**
8.1 Prepare for and Conduct Four Meetings of the Ground-Level Monitoring Committee	a	14	$31,744	$291					$291	$32,035	$32,035	$32,636	-$602
8.2 Prepare for and Conduct One As-Requested Ad-Hoc Meeting	a	3	$6,792	$84					$84	$6,876	$6,876	$5,470	$1,406
8.3 Perform Monthly Project Management		3	$7,728						$0	$7,728	$7,728	$11,592	-$3,864
8.4 Prepare a Recommended Scope and Budget for the GLMC for FY 2023/24		5.25	$11,298						$0	$11,298	$11,298	$9,530	$1,768
Totals			**$306,271**						**$87,376**		**$393,647**	**$612,772**	**-$219,125**

Notes:

a Assumes in-person meetings.





N

0 1 2
Miles

Relative Change in Land Surface Altitude as Estimated by InSAR (March 2011 to March 2022)

+ 0.55 ft
0 ft
-0.20
-0.55 ft

InSAR absent or incoherent

- Areas of Subsidence Concern
- Pomona Extensometer Facility
- Chino Creek Extensometer Facility
- Ayala Park Extensometer Facility
- Chino Desalter Authority Well
- SB County Proposed Extraction Well
- Ground-Level Survey Benchmark
- Ground Fissures
- Approximate Location of the Riley Barrier

Chino Basin Watermaster
WEST YOST

Figure 1

Ground-Level Monitoring Program Fiscal Year 2022/23

Chino Basin Watermaster
Ground-Level Monitoring Committee