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November 1, 2019

Tom Luster
California Coastal Commission
45 Fremont Street #2000
San Francisco, California 94105

RE: Independent Hydrogeological Review of Recent Data and Studies Related to California American Water's Proposed Monterey Regional Water Supply Project
Weiss Job No. 466-2148

Dear Mr. Luster:

This draft report documents Weiss Associates (Weiss's) independent hydrogeological review of data and studies related to California American Water's (Cal-Am) proposed Monterey Regional Water Supply Project (MRWSP). The MRWSP is expected to extract predominately seawater pumped from a planned well field near the Monterey Bay shoreline in the City of Marina California.

This review addresses recent questions raised by the California Coastal Commission (Commission) regarding the likely or potential effects of Cal-Am's proposed seawater extraction on local and regional groundwater resources.

The specific study questions the Commission requested technical opinions from Weiss to address are:

1. What were the effects of potential and actual changes in hydraulic gradient since January 2017, and what is the potential for these changes to affect potential seawater intrusion to, and capture of fresh water from, aquifers tapped by the well field?
2. What is the potential for the well field to adversely affect or capture previously unidentified volumes of fresh water? and
3. What are the possible project modifications to avoid or reduce the potential effects?

BACKGROUND

A Final Environmental Impact Report/Environmental Impact Statement (EIR/EIS) was published on March 29, 2018. It includes comments on the Draft EIR/EIS and responses to those comments, which were extensive regarding potential impacts of the MRWSP on local fresh groundwater resources. These occur primarily in the two uppermost important aquifers at the MRWSP: the Dune Sand Aquifer, and the 180-Foot/180-Foot Equivalent Aquifer.[1] After publication, further

[1] As used in this report, the term "180-Foot" Aquifer includes both the 180-Foot and 180-Foot Equivalent Aquifers.

comments were submitted and responded to on the potential fresh groundwater impacts, with differing scientific opinions, leading to the Commission's request for an independent review in support of their decision process, as to whether or not the project should receive Commission approval.

As documented in the Final EIR/EIS and more recent monitoring reports, a Test Slant Well (TSW) was constructed at the MRWSP site to determine hydrogeologic conditions and gather data to estimate potential freshwater capture by the full-scale project. Weiss reviewed hydrogeological reports and data from initial pumping of the TSW at 2,000 gallons per minute (gpm) and produced an independent hydrogeological review report dated September 29, 2015. This review focused on a permit violation after 2 months of initial testing of the TSW where water quality limit thresholds had been exceeded in a groundwater monitoring event. Among other things, Weiss's review concluded that based on available information, a groundwater model developed for the MRWSP was over-estimating the potential effects of the TSW, and that full scale testing "would not be expected to cause any measurable effects on the nearest agricultural well, located approximately 5,000 feet inland from the TSW, or on wells farther inland." This led to long-term testing of the TSW, which was pumped nearly continuously at 2,000 gpm for 22 months, from May 2, 2016 through February 28, 2018.

In the winter of 2016/2017, during the long-term TSW test, heavier than average rainfall resulted in a seaward steepening of the groundwater gradient in an area approximately 2,000 to 6,000 feet inland from the pumping well. This led to comments that the Final EIR/EIS may not have accounted for this change and potential additional post-2017 changes due to increased rainfall, and differences of scientific opinion on what those changes might be.

SUMMARY OF FINDINGS

Weiss's findings with respect to the Commission's study questions are addressed in detail in this report and summarized as follows:

1. A steepening of the hydraulic gradient seaward in the Dune Sand Aquifer in 2017 will likely result in a limited to negligible effect on seawater intrusion, and likely result in an increase in the fresh water percentage (FWP) of the well field flow due to capture of fresh water from the aquifers tapped by the well field. The gradient change appears to result from local and regional aquifer recharge due to increased rainfall in the 2016-2017 and 2018-2019 rain years. This is significant to the evaluation of the FWP percentages resulting from the MRWSP since there are significant data gaps with respect to groundwater flow paths in the Dune Sand Aquifer and the transfer of fresh water (total dissolved solids [TDS] <3,000 milligrams per liter [mg/L]) from the Dune Sand Aquifer to the 180-Foot Aquifer. Therefore, to be able to rely on Cal-Am's model results to accurately predict FWP, Weiss recommends additional data collection to address these data gaps, development of a consensus conceptual site model (CSM) and modifications of the model assumptions based on the CSM, and then calibration of the model to match the effects of these recent rainfall events.

2. The well field capture analysis presented in the project's Final EIR/EIS appears to be flawed as it does not account for potential freshwater capture beyond the identified capture zone of the well field due to seaward gradients. If such capture is greater than what is already accounted for, it will decrease the ocean water percentage (OWP) in

water extracted by the well field. The uncertainty in the range of OWP depends on how the hydrogeology of the Dune Sand Aquifer and underlying Fort Ord Salinas Valley Aquitard (FO-SVA) is interpreted and modeled. It could be reduced through adjustments to the groundwater model and applying it in non-superposition mode to more accurately reflect the site hydrogeology and implications of the TSW pumping results.

3. Potential project impacts on groundwater quantity and quality can be reduced by extending the planned well field intakes seaward by reducing the angle of slant of the wells or by using horizontal wells to shorten the seawater flow path to the well field intakes, thereby increasing the OWP and decreasing the size of the landward capture zone

DOCUMENT REVIEW

Weiss reviewed the following documents, which describe elements of the CSM for the hydrogeology of the MRWSP vicinity, and potential hydrogeologic impacts of the slant well field during pumping:

1. *Operable Unit 2 Fourth Quarter 2017 through Third Quarter 2018 Groundwater Monitoring and Treatment System Report, Former Fort Ord, California*, prepared for the United States Army Corps of Engineers, on behalf of the United States Department of the Army, by Ahtna Environmental, Inc. (August 2, 2019)
2. *Monterey Peninsula Water Supply Project (MPWSP) Hydrogeologic Investigation Technical Memorandum (TM1) Summary of Results - Exploratory Boreholes*, and Appendix A1 – Borehole Lithologic Logs, by Geoscience (July 8, 2014)
3. *Preliminary Findings of AEM Study*, presented at City of Marina City Council meeting August 7, 2017 by R. Knight (June 16, 2017)
4. *MPWSP – HWG Hydrogeologic Investigation Technical Report* by the Hydrogeologic Working Group (November 6, 2017)
5. Memorandum responding to comments on HWG Investigation Technical Report, From: The Hydrogeologic Working Group, To: Those considering comments on the HWG Final Report (January 4, 2018)
6. *Interpretation of Hydrostratigraphy and Water Quality from AEM Data Collected in the Northern Salinas Valley, CA* by Ian Gottschalk, Rosemary Knight, Stanford University, Stanford, CA Ted Asch, Jared Abraham, Jim Cannia, Aqua Geo Frameworks, Mitchell, NE, prepared for the Marina Coast Water District (15 March 2018)
7. *Final Environmental Impact Report/Environmental Impact Statement* by ESA, Prepared for California Public Utilities Commission and Monterey Bay National Marine Sanctuary (March 28, 2018)*:*
    a. *Chapter 4.4 (Groundwater resources);*
    b. *Chapter 8.2 (Master Responses 5-12);*
    c. *Chapters 8.5.1, 8.5.2 (Comment letters of City of Marina and MCWD and Responses to Comments)*

d. *Appendix E1, Lawrence Berkeley National Laboratories Peer Review;*

e. Appendix E2, North Marina Groundwater Model Review, Revision, and Implementation for Slant Well Pumping Scenarios; and

f. Appendix E3, HWG Hydrogeologic Investigation Technical Report.

8. *Technical Appendices to MCWD/City of Marina submittals to CPUC with technical appendices/attachments*, by MCWD, Knight, Aqua-Geo Frameworks (AGF), and Hopkins Groundwater (April 19, 2018)
9. *Integrated Coastal Groundwater Monitoring Program*, by M. Feeney and M. Zidar for Monterey County Water Resource Agency (May, 2018)
10. *Final EIR/EIS – Appendix J: Memorandum regarding Responses to Comments Received after Publication of MPWSP Final EIR/EIS*, File No. A. 12-04-019 Cal-Am MPWSP FEIR/EIS (September 12, 2018)
11. *MPWSP Test Slant Well Long Term Pumping Monitoring Report No. 64, 17-August-19 – 4-September-19* (September 10, 2019)

INDEPENDENT HYDROGEOLOGICAL REVIEW

This technical review addresses three study questions raised by the Commission which are indented here as corresponding Tasks and corollary questions. These Tasks and corollary questions are shown below in bold text, as worded by the Commission, followed by the results of the review. When referenced in the text, reviewed documents and figures that are excerpted from these references are indicated by a bold superscripted number ([##]) that corresponds to the numbered list of reviewed documents as referenced in the Document Review section above. The figures excerpted from reviewed documents have been renumbered for this document, using red figure numbers in the lower right corner of each page. The numbering system from the document of origin has also been maintained so the reader can examine it from its original context, if desired. Some of the figures have been annotated for clarification (e.g., generally identified in red but additional colors are used in annotation as noted in the figures and/or text).

The hydrogeology of the MRWSP is described in the Final EIR/EIS[7a] and Appendix E3[7f] of the EIR/EIS. If the reader is unfamiliar with the MRWSP, it is recommended to refer to these documents for background and context for the following discussion.

Task 1– Change in Hydrologic Gradient.

1. **Data adequacy: Recent data suggest that the hydraulic gradient in the 180-Foot Aquifer may have shifted from the landward direction that existed during the pump test to a seaward direction. The Final EIR/EIS evaluated the effects of this potential shift to some degree, but did not include data collected after December 2017. Do the more recent data indicate that the hydraulic gradient has shifted to a flat or seaward gradient?**

2. **Analysis – Effects of a shift in the hydraulic gradient:**

   a) If the recent data indicate that the hydraulic gradient has shifted from its previous landward direction to a flat or seaward direction, do the analyses provided as part of the project's Final EIR/EIS adequately describe the expected effects of this shift on

how the proposed project would affect the rate or volume of seawater intrusion into the aquifer or on how much fresh water (using both definitions below) the wells would extract?

b) **Do the more recent data (including the AEM study) support or contradict the Final EIR/EIS conclusions that the proposed project would not increase the rate of seawater intrusion, including under conditions of a shifted hydraulic gradient?**

c) **If the review determines that the project would exacerbate seawater intrusion, do the available data allow for an estimate of how much of an increase in the intrusion rate would occur due to the proposed project?**

Task 1-1. Data Adequacy

The TSW monitoring well clusters MW-1 and MW-3 through MW-9 (Figure 1)[7a] provide continuous water level data recorded from April 2015 through September 2019 (Figures 2 through 9),[11] including periods when the TSW was pumping at 2,000 gpm. Monitoring well clusters MW-3, MW-4, and MW-7 (Figures 3, 4, and 7), located at distances of approximately 700, 2,100, and 5,500 feet inland of the TSW screened interval, provide data that best depict the gradient over time for the Dune Sand Aquifer (shallow or "S" wells), 180-Foot Aquifer (medium or "M" wells), and the 400-Foot Aquifer (deep or "D" wells) in the near-project area. Inspection of these hydrographs show the effects of TSW pumping, and annual cycles reflecting winter recharge and summer pumping for irrigation. Comparison of peak-to-peak and trough-to-trough elements of the hydrographs shows longer-term trends and that changes in water level trends and therefore gradients occurred mainly prior to December 2017. After that date through September 2019, average water levels generally leveled off and did not trend up or down. This indicates that after 2017, there was no significant shift in average groundwater gradient.

To illustrate changes in groundwater gradients over time between well clusters MW-3, MW-4, and MW-7, the hydrographs of MW-4S, MW-4M, MW-7S, and MW-7M have been overlain in shades of blue and green on the MW-3 hydrographs (Figure 10) to allow comparison of water levels between these wells. The groundwater gradient between the wells over time can be calculated by selecting two of the "S" or "M" hydrographs and dividing the difference in feet between their water levels at any point in time by the distance in feet between the two wells.

Throughout the April 2015 to September 2019 monitoring period, the groundwater gradients from MW-3M to MW-4M to MW-7M (180-Foot Aquifer) have been consistently landward, at values ranging from 0.0004 to 0.004, regardless of whether or not the TSW was pumping. The magnitude of the upper end of this range is higher than the 0.0004, 0.0007, and 0.0011 landward gradients used by the 2016 North Marina Ground Water Model (NMGVM)[2016] to generate groundwater capture maps for the Dune Sand and 180-Foot Aquifers.[7e] Indeed, the average landward gradient between these wells is approximately 0.002, nearly double the steepest gradient that was modeled. The result of this difference is that had the well field been pumping from 2015 to 2019, the average capture zone in the 180-Foot Aquifer would be smaller than the smallest of the suite of capture zones depicted in the output from NMGVM.[2016]

In the Dune Sand Aquifer between MW-3S to MW-4S, gradients have ranged from flat to 0.0011 landward when the TSW was not pumping, to up to 0.0012 seaward when it was pumping. Between MW-4S and MW-7S (with one exception) the gradient has been consistently seaward at values ranging up to 0.001 during non-TSW pumping conditions, and from 0.0003 to 0.0012 during

TSW pumping. The exception occurred during a brief period in February-March 2016 when the gradient was flat to slightly landward (0 to 0.00015) between the two wells. Leaving out this exception, the change in gradient during 2017 between MW-4S and MW-7S can best be described as a four-fold steepening of the seaward gradient from 0.0003 to 0.0012 in the Dune Sand Aquifer. The significance of these gradients, in comparison to the modeled 0.0004, 0.0007, and 0.0011 landward gradients, is discussed below in response to question 2a). While it is likely that increased rainfall beginning in 2017 after a several-year dry period is driving these gradient changes, we do not know for certain if they are transient or permanent. The discussion below applies to either case.

Task 1-2. Analysis

2a). If the recent data indicate that the hydraulic gradient has shifted from its previous landward direction to a flat or seaward direction, do the analyses provided as part of the project's Final EIR/EIS adequately describe the expected effects of this shift on how the proposed project would affect the rate or volume of seawater intrusion into the aquifer or on how much fresh water (using both definitions below) the wells would extract?

While the Final EIR/EIS does not provide an analysis that specifically describes either a steeper landward gradient than what was assumed in the model, as is the case with the 180-Foot Aquifer, or a seaward gradient as is the case with the Dune Sand Aquifer, the methodology in the Final EIR/EIS can be applied to describe the expected effects of the shifts that did occur.

Regarding the extraction of fresh water by the wells, the 500 mg/L of TDS used to define fresh water in the Final EIR/EIS is the most conservative definition to use (of the two possible definitions for fresh water) for the purpose of calculating how much fresh water the wells would extract. The Final EIR/EIS**(Appendix H of 7f)** specifies that the OWP is defined as:

$$OWP = 100 \times (C_{pw} - 500)/(C_s - 500)$$

Where C_{pw} = Salinity (TDS in mg/L) concentration from project wells

C_s = Salinity (TDS in mg/L) concentration of ocean water [best estimate is 33,500 mg/L]

500 = Assumed Fresh Water TDS in mg/L

Therefore, if the project wells were pumping 100 percent water with 500 mg/L TDS, the OWP is 0 percent (the extracted water would be 100 percent fresh). If the project wells were pumping 100 percent water with a higher TDS, for example 3,000 mg/L, the OWP would be higher, 7.6 percent (92.4 percent fresh). If the equation was changed to assume that fresh water is defined as 3,000 mg/L instead of 500 mg/L, it would take the form of

$$OWP = 100 \times (C_{pw} - 3000)/(C_s - 3000)$$

and wells pumping 100 percent water with 3,000 mg/L TDS would have an OWP at 0 percent. This example illustrates that the higher the TDS in what is defined as fresh water, the higher OWP in the extracted water will be; or in other words, less fresh water is captured.

The effects of the changes in gradient on seawater intrusion and volume of fresh water extraction is different for the 180-Foot Aquifer and the Dune Sand Aquifer; these are therefore described separately.

180-Foot Aquifer

In the 180-Foot Aquifer, the changes in the gradient in the project area observed since 2017 are within or exceed the range used to model groundwater capture with NMGWM.[2016] To the extent that they are within the range of gradients modeled, the project's Final EIR/EIS adequately describes these gradients and calculates their effects. To the extent the gradients exceed that range, the project's Final EIR/EIS anticipates the expected effects, based on its recognition that a steeper landward gradient will result in a smaller capture area. Where the gradient is consistently landward as is the case with the 180-Foot Aquifer, seawater intrusion due to the well field pumping only occurs within the capture zone of the wells, as described in the Final EIR/EIS. Sea water intrusion beyond the capture zone is not affected, as any steepening of the landward gradient beyond the capture zone will be offset by the longer flow path inland for the sea water to take as the flow lines are deflected towards the capture zone.

As mentioned in Task 1-1, to the extent that the changes in gradient exceed the maximum modeled gradient of 0.0011, the capture zone will become smaller than the smallest capture zone calculated in the Final EIS/EIR. This will reduce the volume of "fresh" water extraction in the first few years of well field operation, as the smaller capture zone will contain a smaller volume of "fresh" water (actually brackish in this area) to be replaced by sea water as pumping continues. But longer term volumes of fresh water will also likely be reduced, as discussed below.

To determine how much fresh water the well field would extract both short- and long-term, the Final EIR/EIS estimated the OWP in the water extracted using an analytic method as well as a method based on the NMGWM.[2016] **(Appendix H of 7f)** The methodology "…was calibrated using test slant well data from April 2015 to October 2016." The source of the fresh water contribution in these methods came from: (1) initial fresh water within the well field capture area that would be pulled in and replaced by ocean water in the first few years of pumping, and (2) estimates of groundwater recharge from rainfall within the capture area of the well field itself. As stated in the analysis, "…groundwater recharge is the only ongoing source of low TDS [i.e., fresh] water that contributes to the capture volume."**(Appendix H of 7f)** The results of the analytical OWP methodology estimated that long-term equilibrium OWP would range between 96 to 99 percent."**[7a]** This range of estimates was developed for landward gradients of 0.0004 to 0.0011, yielding the 96 and 99 percent OWP, respectively. Therefore, using the same assumptions as in the OWP calculations but substituting the much steeper landward gradient of 0.002 should result in a long-term equilibrium OWP well over 99 percent.

Dune Sand Aquifer

For the Dune Sand Aquifer, determining the effects of the 2017 change in gradient from 0.0003 to 0.0012 seaward is less straightforward, mainly because the Final EIR/EIS assumes only a landward gradient. It does not recognize any seaward gradient in its analysis of the Dune Sand Aquifer OWP, drawdown due to pumping, and groundwater capture. In brief, all else being equal, the seaward gradient will result in a reduction of the rate and volume of seawater intrusion, a larger capture area, smaller OWP, and greater volume of fresh water extracted by the wells than was modeled and described in the Final EIR/EIS. To clarify the reasons for this, and to assist in an understanding of the OWP in water pumped from the well field and the well field's potential to capture fresh water, and to serve as a basis for answering the remaining study questions, a discussion of the CSM for the Dune Sand Aquifer and underlying aquitard around and inland from the MW-7 well cluster (hereafter referred to simply as MW-7 to include MW-7S, MW-7M, and MW-7D) is presented below.

Conceptual Site Models (CSM) of the Dune Sand Aquifer Inland from MW-7

The geologic data serving as the foundation for the CSM is provided in the Final EIR/EIS.[7f] A map showing well and geologic cross-section locations (Figure 11), and the cross-sections themselves (Figures 12 through 16), provide a comprehensive view of the MRWSP vicinity. The "Illustration of Aquifer Zones" (Figure 17) shows a more generalized view, in a north-south cross-section just inland from the shore, looking landward at the MRWSP vicinity. The location of the MRWSP well field is indicated on Figure 17 by the arrow labeled "CEMEX". Not visible on the cross-section portion of Figure 17 because it is inland from the line of section is the FO-SVA. Its projection to ground surface is depicted by the irregular purple dashed line. Where present, the FO-SVA is stratigraphically between the Sand Dune Aquifer and the 180-Foot/180-Foot Equivalent Aquifer. A map view of the outline of the FO-SVA is shown on Figure 11.

Inland from the proposed MRWSP well field, it is debated in the Final EIR/EIS,[7a, 7b] comments on the Final EIR/EIS,[7c, 8] and responses,[7c, 8, 10] as to whether or not the FO-SVA at and/or east of MW-7 is discontinuous or continuous. This is mainly due to the lack of data in that area; Figure 11 shows no boreholes or wells in the 2-square-mile area bordered by MW-7, 14S/02E-18C01, 14S/2E-18H, MW-5, G-06, 14S/02E-20B1-3, 14S/02E-21N01, MCWD-6 and MCWD-12.

For purposes of this discussion, the CSM will be identified as CSM-1 where the FO-SVA is discontinuous, and CSM-2 where it is continuous. This CSM-1/CSM-2 terminology is unique to this review, and is not used in any of the reviewed documents.

CSM-1

While not illustrated specifically, CSM-1 is described extensively in the Final EIS/EIR[7a, 7b, 7c, 7e, 7f, and 10] and shown on Figure 18 which was developed for this report by annotating Geologic Cross Section 1A-1A' (Figure 12). Key features of CSM-1 are:

- East of MW-7, the FO-SVA is discontinuous and there are two hydrostratigraphic units above it: the Dune Sand Aquifer, and above that, the "perched/mounded" aquifer. The FO-SVA is shown as being continuous south of MW-7 on Geologic Cross Section 3-3' (Figure 15), and south of MW-5 on Geologic Cross Section 4-4' (Figure 16); however, in between these areas, it is considered discontinuous as shown on all cross-sections that include MW-7 (Figures 12, 13, and 16). As stated in Section 4.4-8 of the Final EIR/EIS,[7a] "The Perched A Aquifer appears to be hydraulically connected with a shallow aquifer local to the Monterey Peninsula Landfill area (referred to as the "-2- Foot" Aquifer) and the Dune Sand Aquifer near CEMEX area (HWG, 2017; see Appendix E3, TM2). The Dune Sand Aquifer is at a lower elevation and not hydraulically connected to the inland perched, mounded aquifers, namely the shallow, local 35-Foot Aquifer at the Monterey Peninsula Landfill and the "A" Aquifer in the Fort Ord Area (approximately 1.5 miles inland). The "A" Aquifer near Fort Ord is at a higher elevation than the Salinas Valley A-Aquifer and is perched on the Fort Ord-Salinas Valley Aquitard."
- CSM-1 considers the groundwater elevations in the "perched/mounded" aquifer (Figures 19 and 20) as separate from the Dune Sand Aquifer (Figures 21 and 22), so the two aquifers are contoured separately. Water from the "perched/mounded" aquifer presumably flows laterally across the perching horizon, then down as if descending stair steps to the lower level Sand Dune Aquifer and/or 180-Foot

Aquifer (Figure 18). As stated in the Final EIR/EIS in Section 8.5 (page 733),[(7c)] "The shallow perched/mounded aquifer is of limited extent, which results in the water from that aquifer flowing over the edge of the underlying clay layer (similar to a waterfall) into the deeper Dune Sand Aquifer and equivalents, or the 180-Foot Aquifer, depending of the hydrostratigraphy at the particular location. This effect is the same as described in the *Protective Groundwater Flows* section above *[this refers to the EIR/EIS and is not included here]*. However, this occurs about 1.5 miles inland of the coast and, therefore, would not be affected by the proposed MPWSP pumping."

- As stated in the Final EIR/EIS in Section 8.5 (page 734), the "Dunes Sand Aquifer (MW-1S, MW-3S, MW-4S, MW-7S, MW-8S, and MW-9S)" does not include the perched aquifer screened by MW-5, and that "Proper contouring using corresponding groundwater elevation data would result in accurate contours that show groundwater in the Dune Sand Aquifer flowing inland from the Monterey Bay."
- The clay layer at MW-7 separating the Dune Sand Aquifer and 180-Foot Aquifer is of limited extent, such that water held up by it at a higher elevation flows laterally until it encounters the edges of the clay layer, or gaps in it, then flows vertically down into the 180-Foot Aquifer as depicted on Figure 18.
- The higher water level at MW-7S and seaward gradient towards MW-4S is a local anomaly that does not reflect the larger picture of the Dune Sand Aquifer, which has an overall gradient landward ranging from 0.0004 to 0.0011. As stated in Appendix E3 of the Final EIR/EIS, "Groundwater flow directions in the Dune Sand Aquifer are complex due to the influence of ocean and river heads; however, Dune Sand Aquifer groundwater flow is indicated to be inland across the CEMEX site".[(7f)]
- Most of the fresh water recharge replenishing the Dune Sand Aquifer migrates to the underlying 180-Foot Aquifer beyond the range of well field capture, and is not susceptible to being drawn into the pumping wells.

As stated in Appendix E2 of the Final EIR,[(7e)] (page 9):

> "The SVA and FO-SVA are composed of clay layers that, where present, reportedly confine underlying aquifers (for example, the 180-FT Aquifer). The SVA underlies most of the northern Salinas Valley floor deposits and the FO-SVA is present beneath most of the former Fort Ord Area. The available information indicates that the FO-SVA thins towards the coast and is absent beneath the younger dune sand deposits; at the CEMEX site, borehole logs for the younger dune sand deposits [MW-1, MW-3, and MW-4, Figures 12 and 13] confirm this clay layer is absent, however thin clay layers are reported in borehole logs further inland [MW-7, Figures 12 and 13] indicating transition zones can exist between the aquitards and where they are absent near the coast. The transition zones provide variable hydraulic connections between the
>
> overlying shallow aquifers and deeper aquifers …." "These aquitards and transition zones are collectively represented by Model Layer 3, and their water transmitting properties are variable throughout the NMGWM area."

And, in another portion of the Final EIR/EIS:

> "Understanding the hydrogeologic characteristics of the Dune Sand Aquifer, there are two important considerations. First, wells from the Dune Sand Aquifer (and equivalents) cannot be contoured with wells from the shallow perched/mounded aquifers to develop contour maps because these are two distinct and hydraulically disconnected aquifers. Second, the primary "connection" between the two, distinct water-bearing zones is that the areal extent of the shallow perched/mounded aquifers, including the A Aquifer underlying Fort Ord, is limited, which results in perched/ mounded water flowing over the edge of the perching clay layer (similar to a waterfall) into the underlying Dune Sand Aquifer (and equivalents) or 180-FTE Aquifer. The edge of the perched clay layer occurs about 1.5 miles inland of the ocean shoreline. Please see response to the comment letter MCWD-HGC and EIR/EIS Appendix E3, Section 2.4.5.2 [page 28 of the Monterey Peninsula Water Supply Project – HWG Hydrogeologic Investigation Technical Report], for additional clarification regarding the hydrogeologic connection of the Dune Sand Aquifer, the 180-FTE Aquifer, and the shallow perched/mounded aquifer."

Much of the contradiction between CSM-1 and CSM-2 (the latter to be discussed following the modeling section below) has resulted from water level data at MW-7S and the lack of nearby wells screened above and below the base of the Dune Sand Aquifer. While CSM-1 considers MW-7S as part of the Dune Sand Aquifer, it also needs to explain the seaward gradient between MW-7S and MW-4S. While not explicitly stated in the Final EIS/EIR, it appears that in the MW-7 location, the Final EIR/EIS assumes that the Dune Sand Aquifer is "perched, mounded" by a clay layer that separates the Dune Sand Aquifer from the underlying 180-Foot Aquifer localized at MW-7S. Figure 13 shows that this clay layer is approximately 4 feet thick, and is at an elevation -48 to -52 feet relative to the North American Vertical Datum of 1988 (NAVD88). It is absent at MW-4S, located approximately 3,400 feet closer to the coast. Evidence that this clay layer provides hydraulic separation as well as physical separation of the Dune Sand and 180-Foot Aquifers comes from comparing water levels between MW-7S, screened in the Dune Sand Aquifer, and MW-7M, screened in the 180-Foot Aquifer. Water levels in MW-7S range from a minimum of 3.5 to 6 feet higher than in MW-7M in the winter, and a maximum of 11 to 13 feet higher in the summer (Figure 10). In comparison, water level differences between the two aquifers are progressively less in the MW-4 and MW-3 well clusters, seaward from the MW-7 well cluster, and where the clay layer is absent. Levels in MW-4S range from a minimum of 2.5 to 3 feet higher than in MW-4M in the winter, and a maximum of 6 feet higher in the summer. Water levels in MW-3S range from a minimum of 1 foot higher than in MW-3M in the winter, and a maximum of 1.5 feet higher in the summer (Figure 10).

Further evidence of hydraulic separation between the Dune Sand and 180-Foot Aquifers at the MW-7 comes from water level trends at MW-7S relative to MW-7M. MW-7S rose approximately 6 feet between October 2015 and June 2017, from approximately 4 feet NAVD88 (1-foot above mean sea level [MSL] which is at 3 feet NAVD88) to 9 feet NAVD88, presumably in response to above-average rainfall following a period of drought. During this time, the water level in MW-7M remained at or below MSL (3 feet NAVD88) (Figure 7).

In summary, despite the landward gradient assumed for the Dune Sand Aquifer in the Final EIR/RIS, the higher water levels at MW-7S, which is screened in the Dune Sand Aquifer, imply a seaward gradient between MW-7S and MW-4S. The only way to retain both landward and seaward gradients in the Dune Sand Aquifer in CSM-1 is to assume that MW-7S is an isolated case, and the clay layer responsible for its higher level is localized and not connected to the FO-SVA, which itself is assumed to be discontinuous or absent up to 1 mile inland from MW-7.

Modeling

Despite CSM-1's assumption that there are multiple aquifers above the FO-SVA east of MW-7, in using the NMGWM^{2016} groundwater model to develop predictions of groundwater capture and OWP from the MRWSP well field, a single layer (Layer 2) was used to simulate both the "perched/mounded" aquifer and the Dune Sand Aquifer. As stated in the Final EIR/EIS, "It is important to note that the NMGWM^{2016} considers the Dune Sand Aquifer, the Salinas Valley A Aquifer, and the -2-Foot Aquifer, plus the hydraulically disconnected perched, mounded aquifers at the Monterey Peninsula Landfill and the Fort Ord "A" Aquifer (occurring 1.5 miles inland) as one connected aquifer. However, this is not the actual hydrogeologic condition and therefore, there would be no impacts on the perched, mounded aquifers because they are above the Dune Sands Aquifer."[7a] This is important in understanding how the Dune Sand Aquifer and FO-SVA were modeled, and how the advantages and limitations of the modeling approach impact the predictions of groundwater capture and OWP at the MRWSP well field.

NMGWM^{2016} assigns Layer 2 to the Dune Sand Aquifer and other aquifers, including the perched aquifer; it assigns the FO-SVA to Layer 3. Relevant features of the model are excerpted from Appendix E3 of the Final EIS/EIR[7e] to show model cross-section locations (Figure 23); cross sections A-A', B-B', and E-E' (Figures 24, 25, and 26); and the horizontal and vertical hydraulic conductivities of model layers 2 and 3 (Figures 27 and 28) with annotations to show key MRWSP monitoring well locations. An enlarged portion of cross section A-A' is annotated to illustrate conceptual features relevant to this discussion (Figure 29). Key features of the modeling of CSM-1 include:

- The horizontal hydraulic conductivity (HK) assigned to the Dune Sand Aquifer inland of the well field, represented by model Layer 2, Zones 16 and 20 (Figures 27 and 29), is 2 and 4 feet per day (ft/day), respectively, which is very low for dune sand. These model values are at the bottom end of the range in values from other sources (Figure 27) of up to 250 ft/day for Zone 16 and 400 ft/day for Zone 20. Indeed, all of the surrounding Zones in Layer 2 are assigned HK values of 1 to 3 orders of magnitude higher than Zones 16 and 20.

- The FO-SVA inland of the well field, represented by model Layer 3, Zones 18 and 21 (Figures 28 and 29), is modeled as being on the order of 1 to 2 feet thick but continuous, in contrast to CSM-1 which considers the FO-SVA to be discontinuous.

- The vertical hydraulic conductivity (VK) assigned to the FO-SVA in Zones 18 and 21 (Figures 28 and 29) is 0.0000005 and 0.0005 ft/day. This indicates that the FO-SVA is considered essentially impermeable in Zone 18, such that ground-water flow above it in the Dune Sand Aquifer (Zone 16 of the model; Figure 29) will be predominantly horizontal. In Zone 21, which includes MW-7, the vertical groundwater gradient across the FO-SVA is on the order of 1 to 10, given modeled thickness of the FO-SVA of 1 to 2 feet at that location, in contrast to the far lower horizontal gradient within the overlying Zone 20 (Dune Sand Aquifer), measured in the range of up to 0.0012. The result of this is that movement of groundwater out of Zone 21 is approximately 2 orders of magnitude greater vertically downward than in the horizontal direction (Figure 29).

This modeling approach results in groundwater mounding inland from MW-7S, such that the model-generated water levels at MW-5S (the well considered to tap a separate perched aquifer above the Dune Sand Aquifer) are in good agreement with actual levels. As stated in Section 8.5 of the Final EIR/EIS (7c) (page 739):

> "Figure 4.2 in Appendix E2 shows the water level at MW-5S calculated by the NMGWM^{2015} (approximately 0 feet above mean sea level), is greatly improved following the update to the (approximately 29 feet, which is much closer to the measured value of 35 feet)."

However, the limits to NMGWM^{2016} reliability for modeling the Dune Sand Aquifer are noted in Section 8.2 of the Final EIR/EIS(7c) (page 80):

> "… model calculated water levels at all monitoring wells located in Model Layer 2 cannot effectively evaluate model reliability for the single zone that represents the Dune Sand Aquifer (the Dune Sand Aquifer is represented by one of the 16 parameter zones in Model Layer 2)."

It therefore appears that this modeling approach used a single layer, continuous FO-SVA or transition zone layer, and unrealistically low hydraulic conductivity assumptions for the Dune Sand Aquifer to simulate multiple layers and a discontinuous FO-SVA, all of which are inconsistent with CSM-1 described here and in the Final EIR/EIS.

The limitations of this approach become apparent in the superposition application of the NMGWM^{2016}(7e) to simulate drawdown and groundwater capture in the Dune Sand Aquifer. The superposition application is described in Appendix E2 of the Final EIR/EIS (page 52):(7e)

> "The initial water levels in superposition are specified zero everywhere in the NMGWM$_{2016}$, and therefore the model does not account for regional background gradients. These regional gradients significantly influence groundwater-flow paths from the ocean to the pumping slant wells, and therefore are important to consider when calculating capture zone boundaries. For the steady-state modeling analysis, we superimposed the measured regional background gradient calculated from Fall 2015 maps that show contours of equal groundwater elevations. We first calculated the regional gradient across the CEMEX site from the contour maps, and then approximately reproduced the gradient in the NMGWM$_{2016}$ by assigning external water levels to the eastern-most general-head boundaries. **Table 5.3** compares the observed and model-calculated gradients, and shows that the average measured gradient (0.0010) is reasonably close to the model-calculated gradient (0.0007)."

Table 5.3
Comparison between calculated gradients at the CEMEX site

Model Layer	Measured Water Level Gradient	Model-Calculated Gradient
2	0.0004	0.0009
4	0.0020	0.0007
6	0.0009	0.0005
Average	**0.0010**	**0.0007**

Of key importance is the methodology for the calculation of regional gradients. It is unclear how the regional gradient was derived for model Layer 2 (Dune Sand Aquifer) from the Fall 2015 groundwater elevation map (Figure 21) in Appendix E2 of the Final EIR/EIS. Figure 21 shows the 2-, 3-, and 4-foot groundwater elevation contours bending in a "U" shape open to the east, with the limbs of the "U" nearly perpendicular to two key hydrogeologic features: the coastline and the margin of the FO-SVA.

This approach denies a simpler interpretation between MW-9S and MW-8S and between MW-7S and MW-4S that the gradient is seaward in those areas. In the Dune Sand Aquifer, the only time between April 2015 and September 2019 where the gradient between MW-4S and MW-7S was landward was during a 2- or 3-week period in February-March of 2016 (Figure 10). At all other times the gradient between these two wells was seaward. It is interesting that groundwater elevations from this period (the only period to show a true landward gradient between MW-4S and MW-7S and not representative of typical conditions) were used in one of only two groundwater elevation maps for the Dune Sand Aquifer provided in the Final EIS/EIR (Figure 28).

Another limitation of the superposition approach for Layer 2 is that initial water levels are set at zero, equal to sea level. As shown in annotated model cross sections A-A', B-B', and E-E' (Figures 30, 31, and 32), this places the bottom of Layer 2 above sea level, above the initial head setting for the model, indicating it would be unsaturated. The estimated areas where this condition occurs is shown on Figure 33. However, superposition analysis results show physical inconsistencies, such as cones of depression that includes these unsaturated areas (Figures 34 and 35), and drawdown of 2 feet in well MW-5S (Figure 34), which is presumably screened in a perched aquifer zone hydraulically separate from the Dune Sand Aquifer. The only way these results could have been achieved with the superposition approach is that some modification to model layers must have taken place that was not documented, along the lines of lowering the riverbed in the example superposition analysis provided in Appendix E2 of the Final EIR/EIS (Attachment 1).[(7e)] The effects of such modification are not documented and cannot be evaluated.

For these reasons, the accuracy of the Dune Sand Aquifer response to well field pumping modeled by the superposition application of NMGWM^{2016} is questionable, and therefore superposition mode is not appropriate for calculating the expected effects of differences in the groundwater gradient on how the proposed project would affect the rate or volume of seawater intrusion into the aquifer or on how much fresh water the wells would extract. However, the NMGWM^{2016} can be used in non-superposition mode to calculate these effects, as discussed below.

<u>CSM-2</u>

CSM-2 applies to the Fort Ord area, south of the MRWSP; whether or not it also applies to the area inland of MW-7 in the MRWSP project area is debated, as mentioned previously. CSM-2 assumes that the FO-SVA is continuous (Figure 36) and that recharge from rainfall enters the Dune Sand Aquifer and flows primarily horizontally above the FO-SVA. On the west seaward side, when this horizontal flow reaches the edges of the FO-SVA, it "waterfalls" downward to the underlying 180-Foot Aquifer, recharging it. And if pumping is occurring near the coast as is proposed at the MRWSP well field, a portion of this fresh water is more likely to be captured than if the fresh water is percolating down to the 180-Foot Aquifer further inland, as is the case with CSM-1.

Commenters on the Final EIR/EIS[(7c, 8)] have contoured the groundwater elevations in the Dune Sand Aquifer in accordance with CSM-2 (Figures 37 through 40). This contouring is consistent with the seaward gradient exhibited between MW-7S and MW-4S, and in one case, even shows the landward gradient between MW-3S and MW-4S (Figure 40). In these interpretations, given that the hydraulic head is lower in the 180-Foot Aquifer than in the Dune Sand Aquifer, downward flow at MW-4 is consistent with the presence of a groundwater sink in the Dune Sand Aquifer at MW-4S. This is acknowledged in the Final EIR/EIS in Section 8.5.2.2 (page 732):**(7c)** "The lower water level at MW-4S relative to 3S and 7S indicates that the movement of fresh water from the Dune Sand Aquifer to the 180-Foot Aquifer is occurring in that area, approximately 2,100 feet inland of the MPWSP slant wells."

Section 8.5 of the Final EIR/EIS (page 759) **(7c)** disputes the interpretation in Figure 40:

> "Therefore, the contouring map provided as Figure 5 in the EKI comment letter is in error because it included the groundwater elevation in MW-5S(P), which is now understood to represent the water level in the perched/mounded aquifer (35-Foot Aquifer in the landfill area and the A-Aquifer near Fort Ord) and not the Dune Sand Aquifer represented by the shallow completions of the MPWSP monitoring wells. Using well MW-5S(P) results in an erroneous seaward (west) gradient. Furthermore, the groundwater contour maps developed by EKI shows groundwater elevation contours where there is no groundwater data to support them."

This illustrates one of the fundamental differences between CSM-1 and CSM-2.

<u>Modeling</u>

As mentioned previously, in non-superposition mode, NMGWM[2016] fairly and accurately models water levels in the Dune Sand Aquifer. While not provided in the Final EIS/EIR modeling, in Section 8.5.2 (page 345),**(7b)** one of the commenters performed model runs and generated groundwater elevation maps of the Dune Sand Aquifer as contoured by the model for both non-pumping and well field pumping conditions at 24.1 million gallons per day (MGD) (Figure 41). As seen in the non-pumping condition scenario, groundwater elevations decrease from 0 to -1 feet inland from the CEMEX site to the same groundwater sink in the Dune Sand Aquifer that is depicted on Figure 40; groundwater flow east of this area is seaward, consistent with CSM-2.

This model run also illustrates an apparent inaccuracy of the model – that MSL for the modeling is set to 0. This is a problem because relative to NAVD-88, MSL is approximately +3 in the MRWSP vicinity (+2.97 in Monterey, +2.87 at Moss Landing, and +3.03 at Pillar Point).[2] Setting the model MSL to +3 will increase the seaside gradient to the well field and result in higher OWP and a smaller area of pumping influence inland than what has been calculated or modeled, all else being equal. This principle is recognized in Section 4.4 of the Final EIR/EIS:**(7a)**

> "The Dune Sand Aquifer response from MPWSP pumping, with current sea level conditions and 0 percent return water, would extend a maximum of about 3 miles inland from the CEMEX site (Figure 4.4-14). Under sea level conditions after 63 years [1.5 feet higher], the area of influence would be reduced in size by about a mile."

MSL appears as 0 instead of +3 in several places in the Final EIR/EIS, such as the hydrographs (Figures 2 through 10) and cross-sections (Figures 12 through 16). However, this discrepancy would not affect the superposition modeling, which appears to be valid for the 180-Foot Aquifer.

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[2] As calculated from the datums portion of www.tidesandcurrents.noaa.gov

<u>Conclusion of the Response to the Task 1-2a. Question</u>

The available data are inadequate to determine which CSM is the most accurate and therefore a definitive answer to the question in Task 1-2a. is not available until a consensus CSM is reached. Several boreholes and/or monitoring well clusters are needed in the 2-square-mile area east of MW-7, which lacks a single data point, to achieve this. Available modeling in this area is flawed for representing both CSM-1 and CSM-2. However, the information provided in the Final EIR/EIS and reviewer comments can be applied to estimate the expected effects, of differences in the groundwater gradient, on how the proposed project would affect the rate or volume of seawater intrusion into the aquifer, and on how much fresh water the wells would extract. This is applied to answering the subsequent questions posed in Tasks 1-2b through Task 3, below.

2b). Do the more recent data (including the AEM study) support or contradict the Final EIR/EIS conclusions that the proposed project would not increase the rate of seawater intrusion, including under conditions of a shifted hydraulic gradient?

The recent data and studies, including the AEM study,[(6)] do not demonstrate a significant new understanding of the distribution of fresh water not already identified in the Final EIR/EIS. Water levels in the MPSWP monitoring wells have increased from 1 to 5 feet in the Dune Sand/180-/400-Foot Aquifer since 2017, in response to above-average rainfall, not a significant change, and likely to be reversed with the inevitable onset of drier weather.

To the extent that water levels have increased, in particular the greatest increase (approximately 5 feet) for the Dune Sand Aquifer at MW-7S, there is a steepening of the seaward gradient and a slight increase in fresh water flowing seaward from the MW-7S area. This would tend to push the seawater intrusion front seaward from what was assumed in the Final EIR/EIS. In addition, the steeper gradient in the 180-Foot Aquifer will decrease the size of the groundwater capture area where seawater replaces fresh water due to pumping.

2c). If the review determines that the project would exacerbate seawater intrusion, do the available data allow for an estimate of how much of an increase in the intrusion rate would occur due to the proposed project?

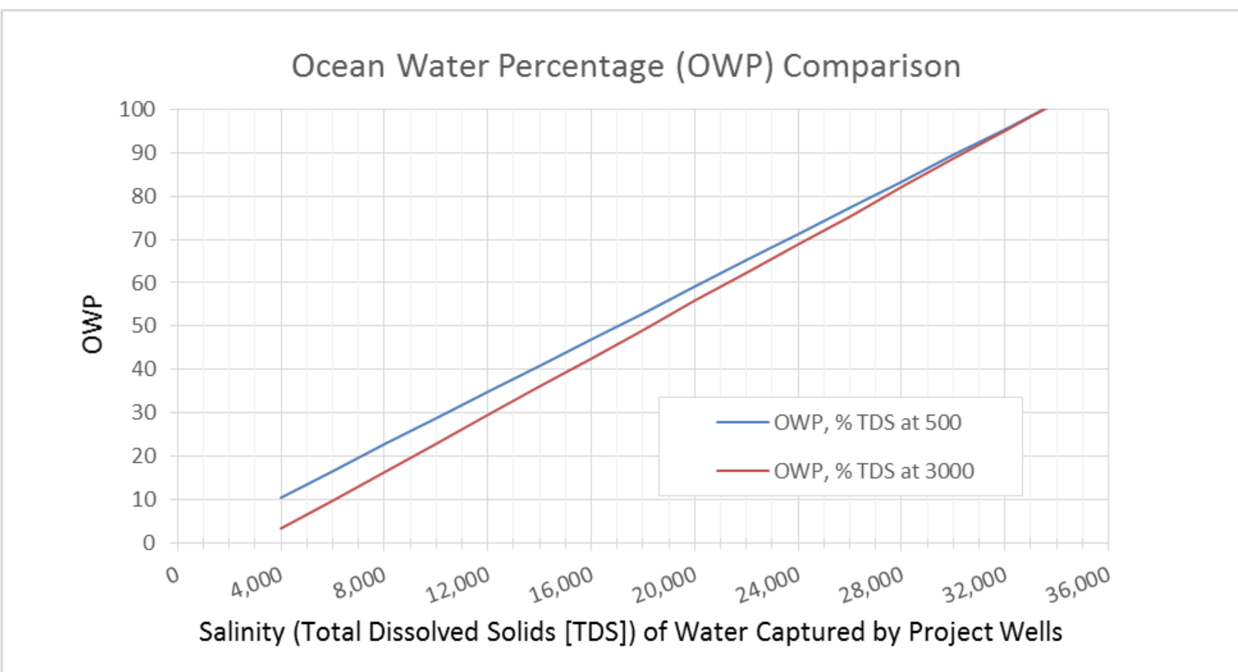
As described above, this review determines that the project would not exacerbate seawater intrusion, as defined in the Final EIR/EIS, where seawater replacement of fresh water within the well capture zone is not considered seawater intrusion since all of the introduced sea water is captured by the well field.

<u>Task 2 – Effects of intake well extractions on fresh water</u>.

1. **<u>Data Adequacy</u>: There have been several claims that the proposed project would extract greater volumes of fresh water from area aquifers than was identified in the Final EIR/EIS – for example, from the Dune Sands Aquifer or from other areas within the aquifers that were identified by an Aerial Electromagnetic ("AEM") survey and associated analyses as having greater volumes of fresh water than had been detected previously. Two key concerns about data adequacy are:**
   - **<u>Extent of "fresh" water:</u> A significant component of this issue area is that the there are two definitions of "fresh" water being applied to the groundwater affected by the proposed project. One is based on the secondary drinking water standard of**

500 mg/L TDS or less and the other is based on the groundwater basin's definition of "potential" drinking water of 3,000 mg/L TDS or less. The Final EIR/EIS used the 500 mg/L standard to determine that water extracted by the wells would be about 7% fresh water. Using the 3,000 mg/L standard, the amount of fresh water extracted would presumably be somewhat greater, as was concluded by the AEM study. Are there sufficient data to determine the extent and volume of fresh water that would be extracted under either definition – i.e., can the expected fresh water withdrawals be characterized under both the 500 mg/L TDS definition and the 3,000 mg/L TDS definition?

The answers would be "yes" and "no" depending on how the different definitions of the drinking water standard are applied. The Final EIR/EIS describes multiple methods of determining the OWP which all give similar results, including groundwater modeling for the test well pumping.[5, page 6] As described previously in the response to Task 1, Question 2a, the higher the TDS in the aquifer compared to what is defined as fresh water, the higher the OWP in the water extracted at the well field will be; in other words, less fresh water is captured. The assumption in the Final EIR/EIS that fresh water contains less than 500 mg/L, TDS accounts for the extent and volume for fresh water withdrawn under the 3,000 mg/L TDS definition. But if the 3,000 mg/L TDS definition of fresh water is used as a baseline, OWP will be lower than for the 500 mg/L TDS definition for a given salinity of water drawn into the wells. This is illustrated on the following chart, which plots increasing salinity of water drawn into the well field versus the OWP. If water drawn into the wells has relatively low salinity, i.e., TDS of 4,000 mg/L, the OWP difference between the 3,000 and 500 mg/L standards is on the order of 7.5 percent, and decreases as the salinity of water drawn into the well field increases, until at 26,000 mg/L TDS in the well field intake water, the OWP difference between the two standards is less than 2 percent.



Given that the OWP during TSW testing rose above 90 percent long-term, and reflects the high end of the TDS range, the decrease in OWP calculated by assuming a fresh water standard of 3,000 mg/L instead of 500 mg/L is on the order of 1 to 2 percent.

- **<u>Adequate data to characterize fresh water</u>: During Cal-Am's test well pump test, specific conductivity data were collected from within the test well at a single location. Samples from this location were intended to represent a mix of water from the Dune Sands Aquifer and the 180-Foot Aquifer. However, the test well extracted water from two separate aquifers – the Dune Sands Aquifer and the 180-Foot Aquifer – with each aquifer having different TDS concentrations. Do the data collected from this sampling location allow for an accurate representation of the amount of fresh water extracted from the test well (under both definitions of fresh water) and are they suitable to use for modeling the expected amount of fresh water that would be extracted by the full proposed project? If the data are not sufficient, what additional data are needed to allow for an accurate representation?**

Specific conductivity is not a precise measurement of TDS, which is being used by the project as an estimator for FWP/OWP. The ratio of TSD to specific conductivity varies with water type and generally is about 0.55 for fresh water and 0.7 for sea water. Therefore, a ratio of 0.7 for the TSW water is appropriate as an estimation of TDS at the TSW. Because the Dune Sand Aquifer and 180-Foot Aquifer have essentially the same hydraulic heads and TDS, a single specific conductivity sample is a reasonable estimator of the TDS in both aquifers at the TSW location. However, the single point specific conductivity data collected at the TSW are not an appropriate indicator of the TDS in each aquifer landward of MW-3 mainly due to uncertainty in the transition from the area of MW-3 seaward, where the Dune Sand and 180-Foot Aquifers behave as a single aquifer, and to the area of MW-7 landward, where they appear to hydraulically separate. Thus, the interpretations of the TSW specific conductivity data cannot be performed out of context, ignoring the data and hydrogeologic conditions at monitoring wells inland. Due to lack of consensus on the CSM inland from MW-7S and questionable modeling approach to the Dune Sand Aquifer and FO-SVA in this area, an accurate representation cannot be made. Additional data from borings and/or wells should be obtained from inland of MW-7S, and between MW-7S and MW-4S, to determine whether CSM-1 or CSM-2 applies. The NMGWM^{2016} should be revised accordingly and run in non-superposition mode to determine just how much aquifer water (fresh or otherwise) will be captured by the well field from the Dune Sand Aquifer and 180-Foot Aquifer.

With regard to the data limitations stated above and a broader project context of the question, Weiss reviewed modeling results for OWP included in the Final EIR/EIS which gives a range of results, including the analytical approach that was described in the response to the Task 1-2a) question for the 180-Foot Aquifer. The results of the different methods of determining OWP are summarized in a memorandum addressing comments on the Hydrogeologic Working Group (HWG) analysis:**(Table 1 from 5)**

Table 1. Summary of OWP Analyses

Source	One Month OWP	One Year OWP	Two Year OWP	Long-Term OWP	Method
2015 DEIR	-	89-92	93-96	93-96	Variable Density Solute Transport Model
MCWD/ GeoHydros	69	89	90	90	Model Water Balance
TSW Field Data	85	92-95	90-92	-	Field Data
HWG Analytical	78-79	88-93	93-97	96+	Analytical Mixing Model
HWG Numerical	82	93	93-94	94	Variable Density Solute Transport Model
Overall Range	69-85	89-95	90-96	90-96+	Various

The low end of this range in values is from an analysis performed by GeoHydros, using water budgets from a model run of the NMGWM,[2016] as described in Section 8.5 of the Final EIR/EIS (page 358)**[(7c)]** and summarized in Table 3 from the GeoHydros report:

Table 3. Evolution of source water for the proposed extractions as defined by water budget reports exported from five timesteps of the calibrated and DD1-44/56 scenarios of the 2016 NMGWM.

Days after Start	Ocean	DSA	SVA	180-ft	400-ft	900-ft	*Total*	Total GW
30	69.1%	22.3%	4.2%	3.5%	0.6%	0.3%	*100%*	30.9%
365	89.0%	3.6%	0.1%	4.9%	1.6%	0.8%	*100%*	11.0%
730	89.7%	2.4%	0.0%	5.2%	1.8%	0.8%	*100%*	10.3%
3,650	90.0%	1.9%	0.0%	5.3%	1.9%	0.9%	*100%*	10.0%
11,680	90.0%	1.8%	0.0%	5.3%	1.9%	0.9%	*100%*	9.9%

The agreement between these approaches, which include the TSW field data, support the use of measurements from the combined Sand Dune Aquifer/180-Foot Aquifer for estimating purposes. The range in OWP from calculations, and OWP derived from field data, for one or more years after start of pumping, is from 89 to 95 percent. Even if all of the fresh water was coming from one or the other aquifers and the other aquifer was 100 percent ocean water, the OWP for the "fresh" aquifer could not be less than an estimated 78 to 90 percent.

The field data from the TSW test can also be used directly to assume that the OWP measured/calculated for the TSW pumping rate will increase for any greater pumping rate, by using the principle of superposition (also known as well interference) described in most hydrogeology texts and handbooks.[3] This principle states that in an aquifer of infinite extent, the drawdown at a given point influenced by multiple wells pumping together is the sum of the individual drawdowns created at that point by each well pumping alone. This principle is acknowledged in Section 4.4 of the Final (page 106):**[(7a)]**

> "When cones of depression from two or more pumping wells overlap, it causes what is referred to as well interference. Interference between pumping wells can create a combined drawdown effect where groundwater levels are lower than would be expected

[3] For example, Roscoe Moss, 1990, *Handbook of Ground Water Development*.

> from the individual pumping wells. Typically, the combined drawdown of two or more wells is equal to the sum of the drawdowns caused by each well individually."

In applying this principle to wells pumping at the shoreline, the inland area can be considered for practical purposes to be the area where the cone of depression expands and at any given point water levels decrease over time, whereas in the seaward area a constant water level is maintained. Therefore, increasing pumping at the coast will create additive effects inland, expanding the cone of depression. Because the water level decrease associated with additional expansion of the cone of depression inland is on top of an already decreased water level, the groundwater gradients from inland towards the pumping wells will increase at a slower rate in response to increased pumping relative to the gradients on the ocean side, which increase to a greater extent because sea level is not affected by pumping. This greater increase in the gradients on the ocean side in response to greater pumping will act to increase the OWP as pumping rates increase. Thus, all else being equal, the values in the "Summary of OWP Analyses" table above can be considered as <u>minimums</u> for any project that produces more than the TSW flow at the TSW location.

With the caveat that more data is needed and the NMGWM[2016] needs to be revised to reflect that additional data and rerun to obtain defensible results, an additional method can be used to approximate the OWP, extrapolating from the TSW testing results, where the OWP ranged from 94 to 96 percent over the 22 months of pumping. Since the test reflects real-world conditions, including a seaward gradient between MW-7S and MW-4S in the Dune Sand Aquifer, and regardless of whether or not CSM-1 or CSM-2 is correct, it serves as a basis for estimating the additional contribution of fresh water under a CSM-2 scenario, or the CSM-1 scenario as modeled by NMGVM.[2016] The bottom half of Figure 41 shows the cone of depression in the Dune Sand Aquifer during pumping at 24.1 MGD at the well field, according to NMGWM[2016] scenario DD1-44/56, as created by GeoHydros in a comment in Section 8.5.2 of the Final EIR/EIS (page 375).**[(7b)]**

Additionally, Weiss performed a simplified flow net analysis using the contours generated to estimate the additional area over which fresh water would be captured by pumping (Figure 42) beyond the capture zones estimated for the Final EIR/EIS. This assumed area is approximately 7 square miles. Assuming annual average groundwater recharge of 5 inches per year (0.42 feet/year), as was done for the Final EIR/EIS OWP analytical estimates,**[(Appendix H of 7f)]** this results in a potential annual average capture volume of 1,900 acre-feet per year. Assuming a worst-case scenario where the well field was pumping at 15.5 MGD (equal to 17,360 acre-feet per year), and assuming an OWP from within the original capture zone of 96 percent from the Final EIR/EIS calculations, the additional captured volume equates to 1,900/17,330, or 11 percent. Subtracting this from the OWP of 96 percent provides an overall OWP of 85 percent.

However, this result is likely to be an underestimate of the true OWP, because it denies any flow of groundwater from the Dune Sand Aquifer to the 180-Foot Aquifer inland of the capture zone (approximately 2,000 to 4,000 feet inland of the pumping wells) defined by the Final EIR/EIS. The NMGVM[2016] (Figure 42) can also be used to generate a best-case scenario by estimating the horizontal flow towards the pumping wells through Layer 2, parameter Zone 20 (Figure 29). This layer has a hydraulic conductivity of 4 ft/day (Figure 27) in Zone 20. Given a conservatively high maximum seaward gradient of 0.0035, a length of Zone 20 of 4 miles perpendicular to the path of flow shown on Figure 42, porosity of 0.25, and a saturated thickness of 50 feet, the model can be estimated to produce a flow towards the pumping wells of only 30 acre-feet per year. This is because, as previously discussed, as modeled, most of the flow from Layer 2 is vertically downward to the 180-Foot Aquifer. This value is too small to have any effect on the original 96 to 99 percent estimated range in OWP calculated in the Final EIR/EIS and is likely to be unrealistically low.

The actual capture of fresh water is likely to be somewhere between the worst- and best-case extremes, and as stated previously, can only be determined by obtaining more data for the Dune Sand Aquifer and FO-SVA in the 2 square miles inland of MW-7, and in the area between MW-4 and MW-7.

For reasons already stated, it appears that the superposition method of applying NMGVM^{2016} to estimate drawdowns in wells inland from the well field is problematic, and appears to over-estimate them, as well as the size of the cones of depression. This would also have the effect of underestimating OWP. The combined effect of: (1) the model setting MSL at 0 instead of +3, which would increase OWP; (2) the results of extrapolating the TSW results to higher flows; (3) OWP estimates based on TSW results already take into account a seaward gradient in the Dune Sand Aquifer; and (4) the likely very low increase in OWP from capturing a portion of the Dune Sand Aquifer recharge indicates that the changes in gradient would not likely result in an OWP outside of the range of 90 to 99 percent derived from the different methods described above. A worst-case scenario estimates the OWP at 85 percent. However, due to the lack of consensus on the CSM inland from MW-7S and questionable modeling approach for the Dune Sand Aquifer and FO-SVA in this area, this is only a range of estimates. Additional data from borings and/or wells should be obtained from inland of MW-7S to determine whether CSM-1 or CSM-2 applies. The NMGWM^{2016} should be revised accordingly and run in non-superposition mode to determine an accurate representation of the amount of fresh water extracted from the test well (under both definitions of fresh water).

2. **<u>Analysis – Effects of recent monitoring data and modeling to determine the extent and volume of fresh water extraction</u>: If the above-reference data and studies are adequate to determine the extent and volume of fresh water extraction, do the recent data and studies, including the AEM study, show that freshwater extractions would result in greater adverse effects to the area aquifers than were identified in the Final EIR/EIS? Additionally, would the project extract fresh water from the Dune Sands Aquifer so as to interfere with recharge or to increase seawater intrusion into that aquifer?**

The recent data and studies, including the AEM study,**(6)** do not demonstrate a significant new understanding of the distribution of fresh water not already identified in the Final EIR/EIS. Water levels in the MRWSP monitoring wells have increased from 1 to 5 feet in the Dune Sand Aquifer and 180/400-Foot Aquifers since 2017, in response to above-average rainfall, not a significant change, and likely to be reversed with the inevitable onset of drier weather.

To the extent that water levels have increased, in particular the greatest increase (approximately 5 feet) for the Dune Sand Aquifer at MW-7S, there is a steepening of the seaward gradient and a slight increase in fresh water flowing seaward from the MW-7S area. Some portion of this additional fresh water will likely be extracted by the project well field.

Several of the predictions of the capture area and drawdowns inland from the well field made using the NMGWM^{2016} do not accord with the TSW results:

- The cones of depression appear to be too large, particularly in the Dune Sand Aquifer;
- Drawdown in the MW-S and MW-M wells does not stabilize until 2 to 3 years after the beginning of pumping in contrast to the stabilization of water levels within 2 months that occurred in the TSW pumping and the statement in the Final EIR/EIS that, "The development of the capture volume occurs much more rapidly

than the establishment of a steady-state salinity within the capture volume. While the boundaries of the capture volume evolve fairly quickly to a steady-state configuration (**over a period of a few months**)[*emphasis added*], the salinity within the capture volume takes several years to evolve to steady-state conditions";**(Appendix H in 7a)** and

- Predicted drawdowns are much greater than those estimated by extrapolating the TSW results.

Regarding the last point, using a conservative application of the principle of super-position/image wells described previously, pumping from the well field at 24.1 MGD compared to the TSW pumping of 2,000 gpm (2.88 MGD) should produce a maximum increase in drawdown of 24.1/2.88, or 8.37 times the drawdown seen at any given well in the TSW pumping. Thus, the drawdown observed at MW-4S of 0.3 feet, and at MW-4M of 0.2 feet, should increase to 2.5 and 1.7 feet respectively. However, the values from using the NMGWM^{2016} are 6.5 and 6 feet, respectively. And the drawdown values for MW-7S, which had zero drawdown in the TSW pumping, are not modeled correctly. As stated in the Final EIR, Appendix E2, pages 24-25:

> "The drawdown and drawdown recovery determined from measured water levels during and after cessation of test slant well pumping are plotted with the corresponding model-calculated drawdown in Figure 4.6. Additionally, the model-calculated drawdown from the NMGWM2015 and from a smaller focus area model developed by others (the CEMEX model) 7S is plotted in Figure 4.6." and, "Specifically, Figure 4.6 shows that drawdown **was not observed in MW-7S** [*emphasis added*]".

Zero drawdown from the TSW at MW-7S x multiplied by 8.37 for the 24.1 MGD scenario is zero. This compares to a drawdown of 3.5 feet calculated by the model. This indicates that the model over-predicts drawdowns from the well field pumping. All else being equal, this would result in an over-prediction of fresh water capture and an under-prediction of OWP. For a definitive analysis, more data is needed east of MW-7S and NMGWM^{2016} needs to be revised, as mentioned previously.

<u>Task 3 – Possible project modifications to avoid or reduce potential effects</u>: Various parties have proposed modifying two project components – the well intake locations and the proposed project's monitoring requirements – to avoid or reduce effects on fresh water and to better detect and respond to possible effects on nearby aquifers.

1. **<u>Data adequacy and analysis regarding well intake locations</u>: The monitoring data collected during the test well pump tests were based on the screened sections of the well being located landward of the shoreline. If the above reviews conclude that the project will affect fresh water in the aquifers at levels beyond those identified in the Final EIR/EIS, and considering factors such as vertical and horizontal conductivity at the proposed well field location and the extent of the aquifers offshore, are there sufficient data to determine how much less fresh water would be extracted if the screened portions of the wells were sited entirely seaward of the shoreline – i.e., if the wells were drilled to lengths that placed their screened sections entirely beneath the floor of Monterey Bay? If so, would the amount of fresh water extracted be within the projections provided in the Final EIR/EIS?**

As mentioned in the response to Task 2.1, there are inadequacies in the data and studies preventing an accurate representation of adverse effects, and potential interference with fresh water recharge, potential outcomes can be approximated. The limitations to these approximations and to a more accurate representation are described below.

The answer to this question depends on filling two data gaps: (1) the lack of hydrogeologic data east of MW-7S as described previously, and (2) the absence of any data seaward of the present TSW. At a minimum, the landward data gap should be addressed and NMGWM^{2016} modified to incorporate the new data. A new test well should be drilled to address the seaward data gap, or at least a test boring, to establish geologic conditions beyond the TSW extent. About all that can be said is that *if* the geology encountered by the TSW continues seaward, less fresh water would be extracted.

2. Data adequacy and analysis regarding monitoring: Several parties have developed a monitoring plan meant to detect and respond to the intake wells' effects on the area aquifers. Based on the above reviews, is the proposed monitoring plan adequate to detect the project's known or expected effects on fresh water withdrawals from the aquifers and on the rate of seawater intrusion? If not, what additional monitoring measures would be needed to detect these effects?

The monitoring plan[9] proposed is marginally adequate to detect the project's known or expected effects on fresh water withdrawals from the aquifers and the rate of seawater intrusion. Continuous monitoring of water levels and electrical conductivity in the well clusters in the proposed well field, each cluster with wells screened in the Dune Sand Aquifer and the 180/400-Foot Aquifer, will be able to track the position of the saltwater/freshwater interface, regardless of how fresh water is defined.

Installing two additional monitoring well clusters inland of MW-7 would assist in determining the continuity of the FO-SVA in that area where currently there is no data. This would assist in modifying the NMGWM^{2016} to better predict groundwater capture areas in the Dune Sand Aquifer and the 180-Foot Aquifer, as well as OWP captured by the pumping well field.

RECOMMENDATION

To obtain a more accurate and definitive groundwater capture zone and OWP estimates due to proposed pumping from the MRWSP well field, it is recommended that additional hydrogeologic data be obtained from the 2 square-mile area east of MW-7S so that a single CSM can be accepted to represent that area. In addition, the area west of MW-7, between MW-4 and MW-7, should be investigated to determine potential aquitards contiguous with those at MW-7, and vertical groundwater gradients between the Dune Sand Aquifer and 180-Foot Aquifer. The new data should be incorporated into NMGWM,^{2016} which should be modified as follows:

- Change the thickness of the FO-SVA (Layer 3) inland from MW-7, and configure so that the top and bottom of Layer 3 approximates the configuration depicted in the geologic cross-section, such that the top resembles a "stair-step" surface;
- Potentially divide Layer 2 into two or more layers;
- Increase the HK of the Dune Sand Aquifer (Layer 2) in parameter Zones 16 and 20, currently modeled with HK of 2 and 4 ft/day, respectively, to values in the range of 50 to 200 ft/day, more akin to the actual HK for dune sand, and in the middle of the range in values from other sources (Figure 27); and

- Modify HK and VK as appropriate in Layers 2, 3, and 4 of the model in the vicinity of the well field, such that drawdowns in more distant wells, particularly MW-4 and MW-7, are in accord with those estimated from a conservative extrapolation of the TSW drawdown data.

Along with these changes, the model should be run in non-superposition mode in a range of scenarios, and flow lines plotted to illustrate the revised capture pattern. Mass balance information should be obtained for those portions of the model affected by groundwater flow to the well field, and from the Dune Sand Aquifer to the 180-Foot Aquifer, and used to calculate new fresh water capture and OWP estimates.

CLOSING

Weiss Associates' work at the California-American Water test slant well site and vicinity was conducted under my supervision. To the best of my knowledge, the data contained herein are true and accurate, based on what can be reasonably understood as a result of this project while satisfying the scope of work prescribed by the client for this project. The data, findings, recommendations, specifications, and/or professional opinions were prepared solely for the use of the California Marine Sanctuary Foundation and the California Coastal Commission in accordance with generally accepted professional engineering and geologic practice. Weiss makes no other warranty, either expressed or implied, and is not responsible for the interpretation by others of the contents herein

Sincerely,
Weiss Associates

William A. McIlvride

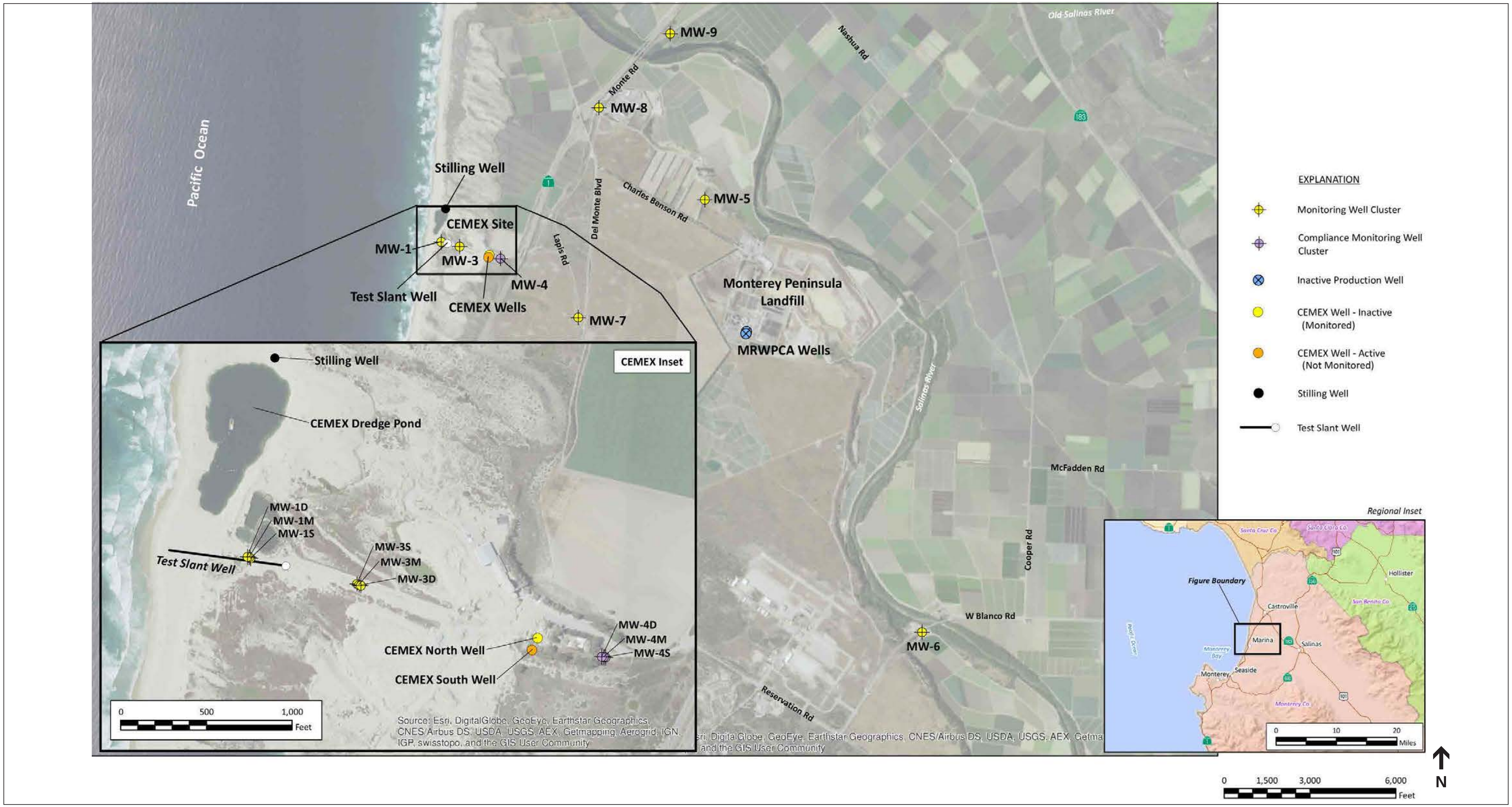
William A. McIlvride, PG, CEG, CHG
Senior Project Hydrogeologist

Attachment A – Figures

J:\California Marine Sanctuary Foundation\2019\Report\CMSF EIR Review Tech Memo_Final.docx

ATTACHMENT A

FIGURES



SOURCE: GeoScience, 2016

Monterey Peninsula Water Supply Project . 205335.01

Figure 4.4-9
Slant Well and Monitoring Well Locations

Figure 1

Groundwater Elevation in MPWSP MW-1

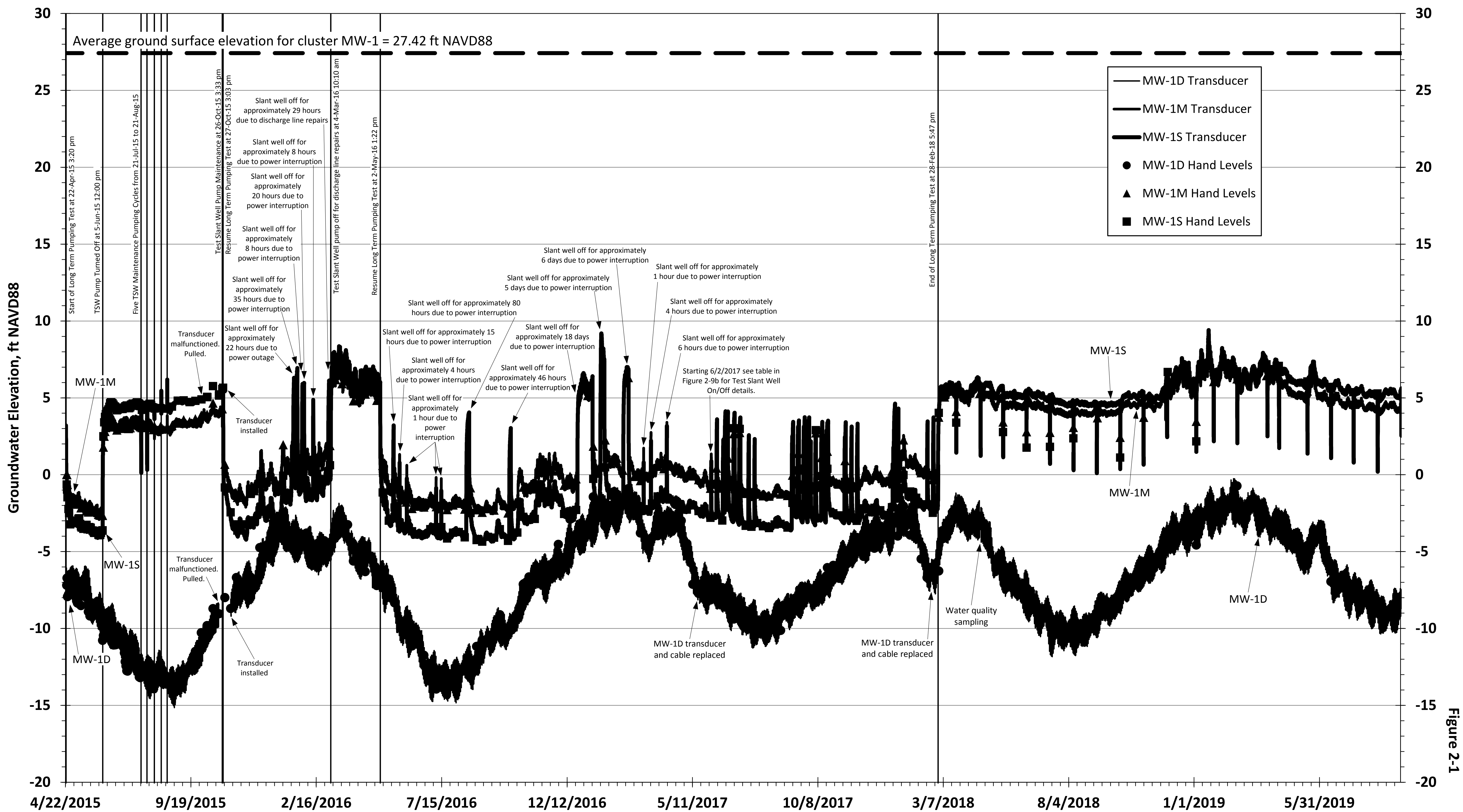


Figure 2

Groundwater Elevation in MPWSP MW-3

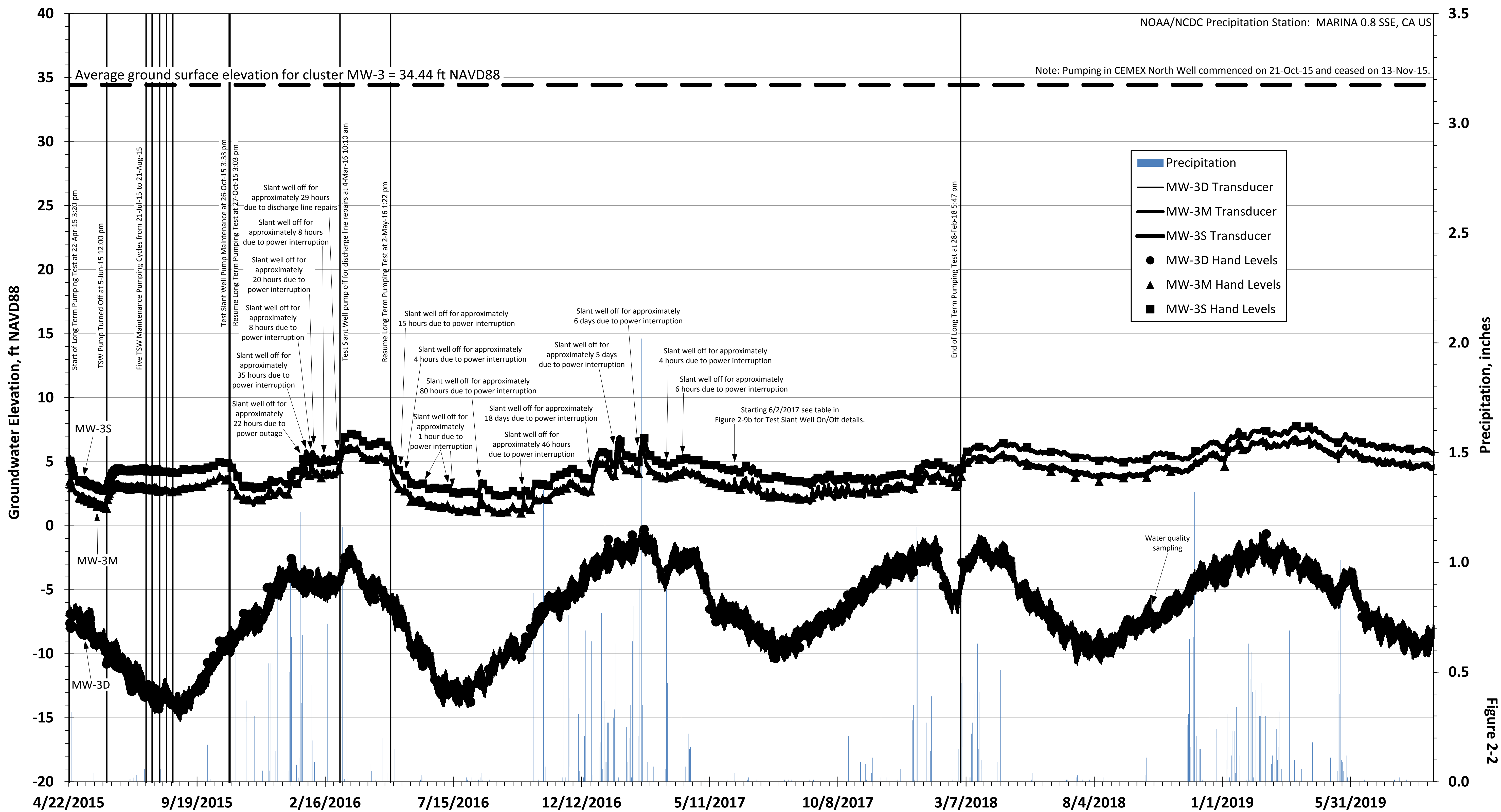


Figure 2-2

Figure 3

Groundwater Elevation in MPWSP MW-4

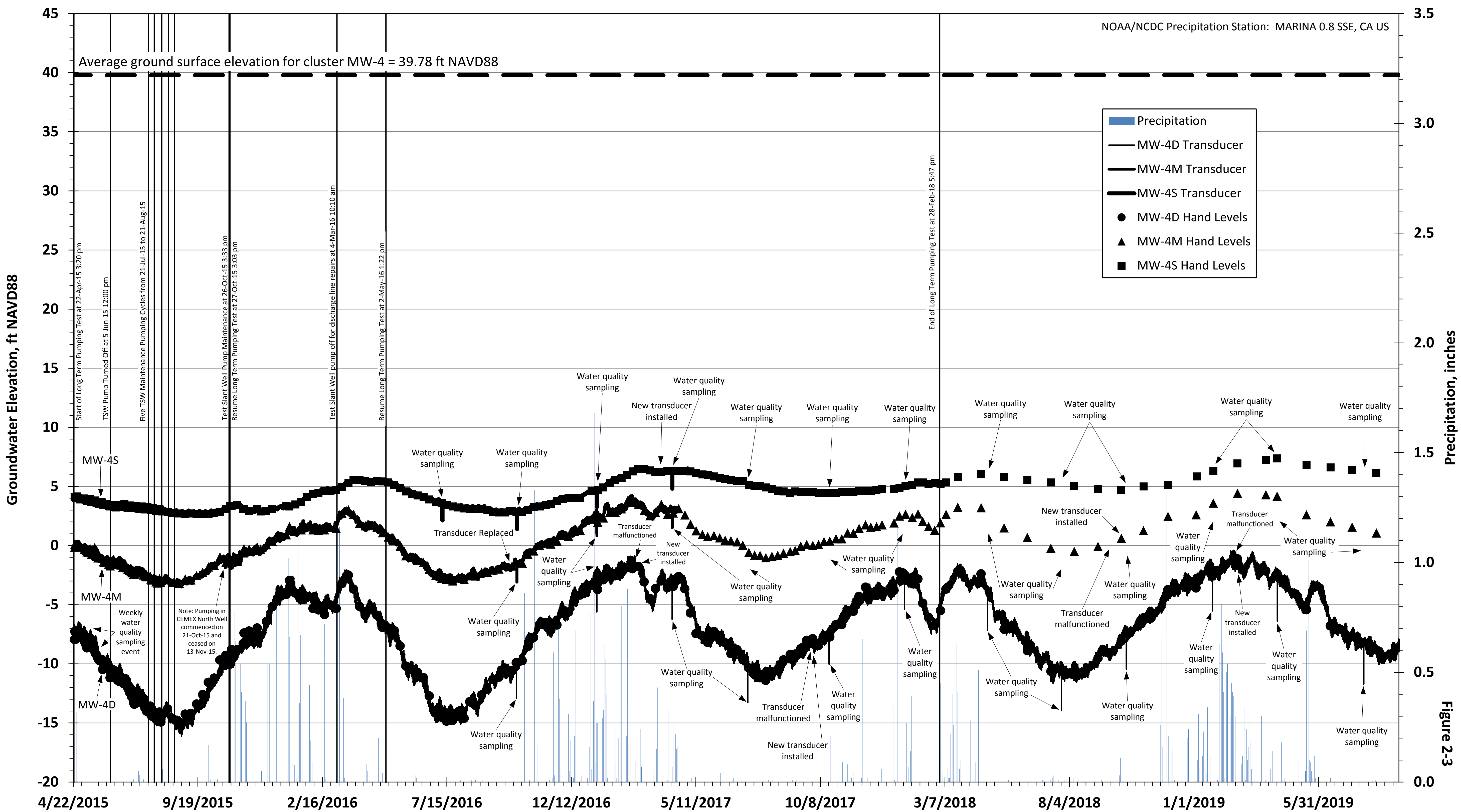


Figure 4

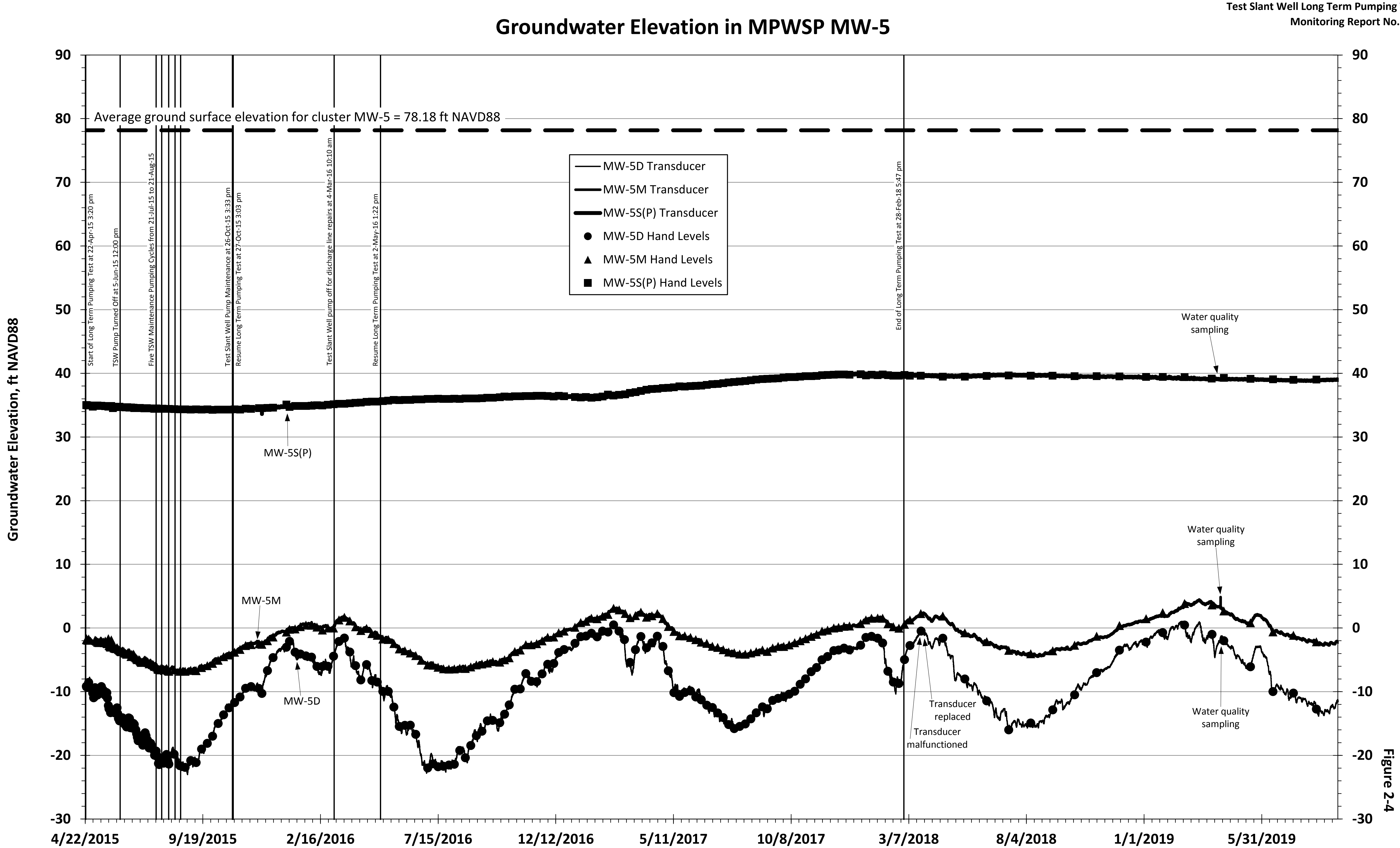

Groundwater Elevation in MPWSP MW-5
Groundwater Elevation, ft NAVD88
Average ground surface elevation for cluster MW-5 = 78.18 ft NAVD88
MW-5D Transducer
MW-5M Transducer
MW-5S(P) Transducer
MW-5D Hand Levels
MW-5M Hand Levels
MW-5S(P) Hand Levels
Start of Long Term Pumping Test at 22-Apr-15 3:20 pm
TSW Pump Turned Off at 5-Jun-15 12:00 pm
Five TSW Maintenance Pumping Cycles from 21-Jul-15 to 21-Aug-15
Test Slant Well Pump Maintenance at 26-Oct-15 3:33 pm
Resume Long Term Pumping Test at 27-Oct-15 3:03 pm
Test Slant Well pump off for discharge line repairs at 4-Mar-16 10:10 am
Resume Long Term Pumping Test at 2-May-16 1:22 pm
End of Long Term Pumping Test at 28-Feb-18 5:47 pm
MW-5S(P)
MW-5M
MW-5D
Water quality sampling
Water quality sampling
Water quality sampling
Transducer replaced
Transducer malfunctioned
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
4/22/2015
9/19/2015
2/16/2016
7/15/2016
12/12/2016
5/11/2017
10/8/2017
3/7/2018
8/4/2018
1/1/2019
5/31/2019
Figure 2-4

Figure 5

Groundwater Elevation in MPWSP MW-6

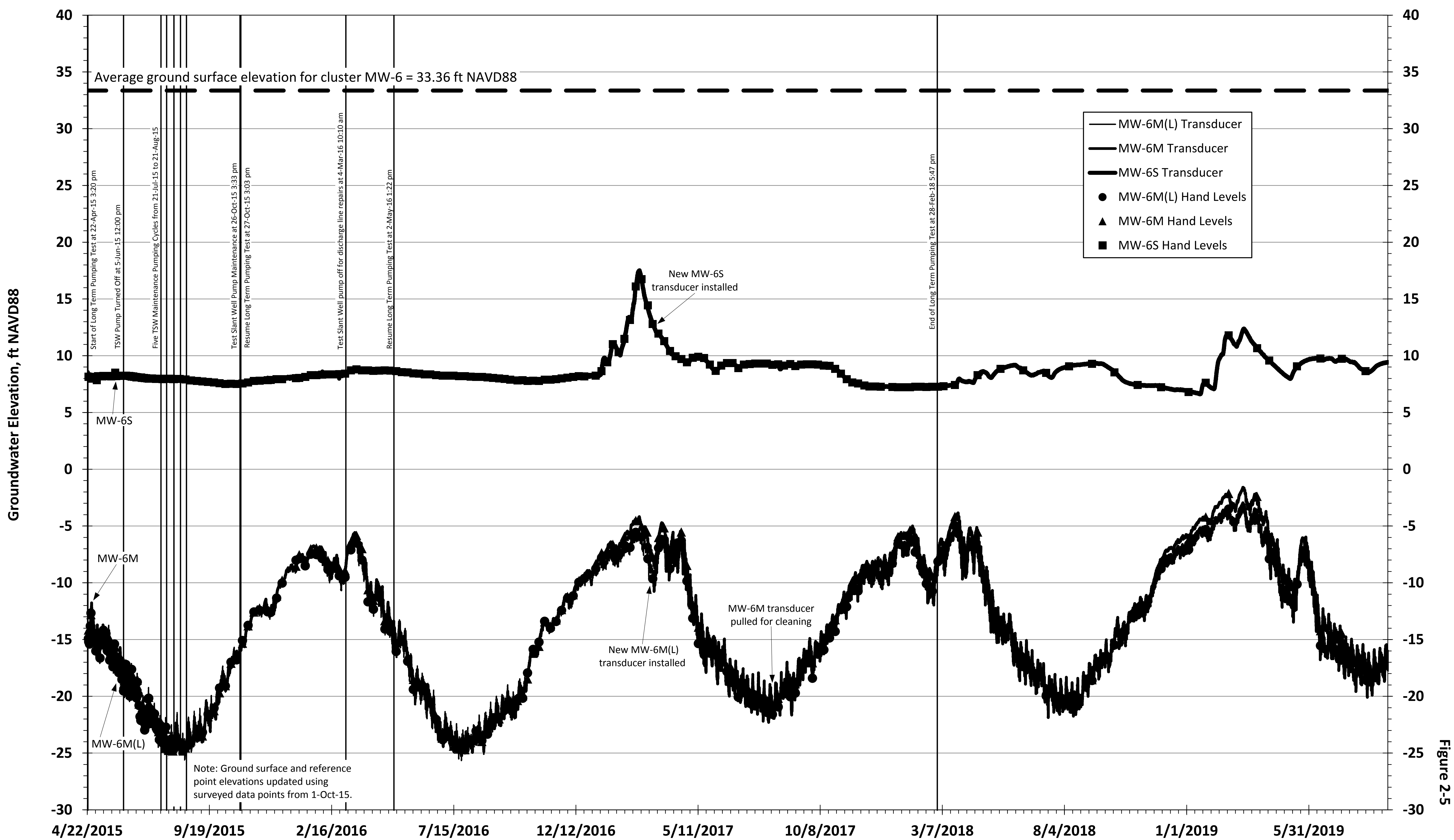
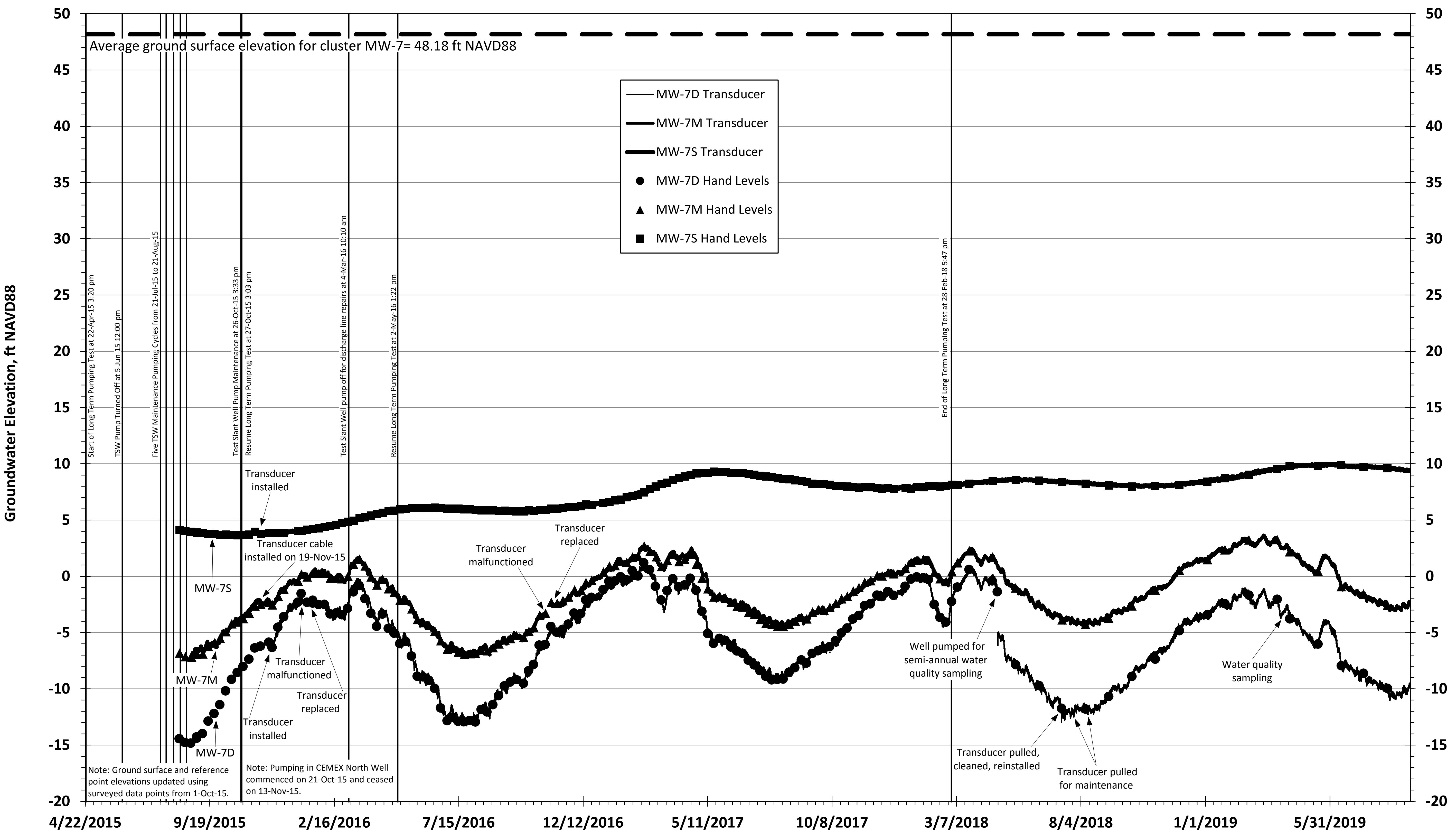
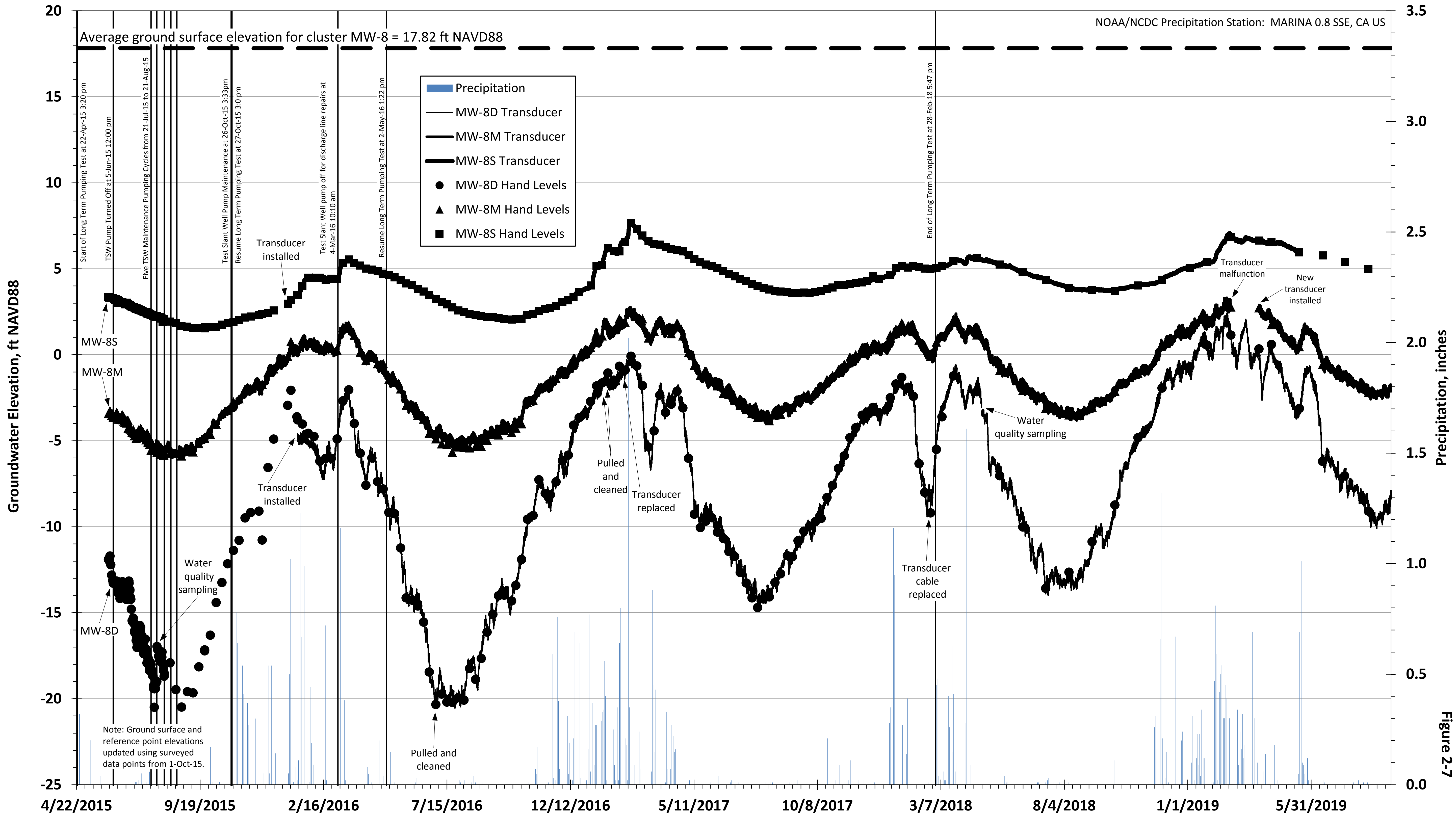


Figure 6

Groundwater Elevation in MPWSP MW-7



Groundwater Elevation in MPWSP MW-8



Groundwater Elevation in MPWSP MW-9

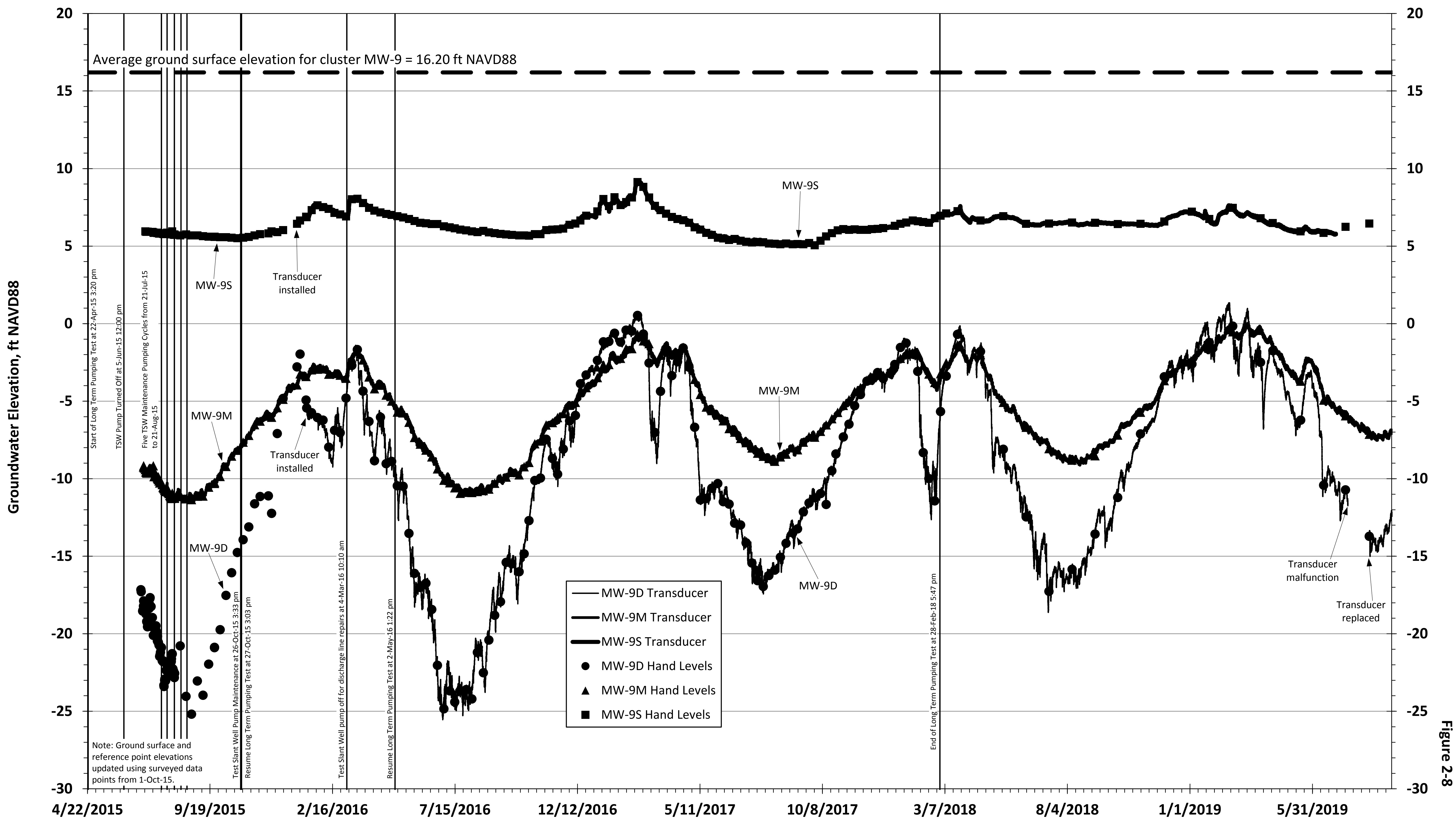


Figure 9

Groundwater Elevation in MPWSP MW-3

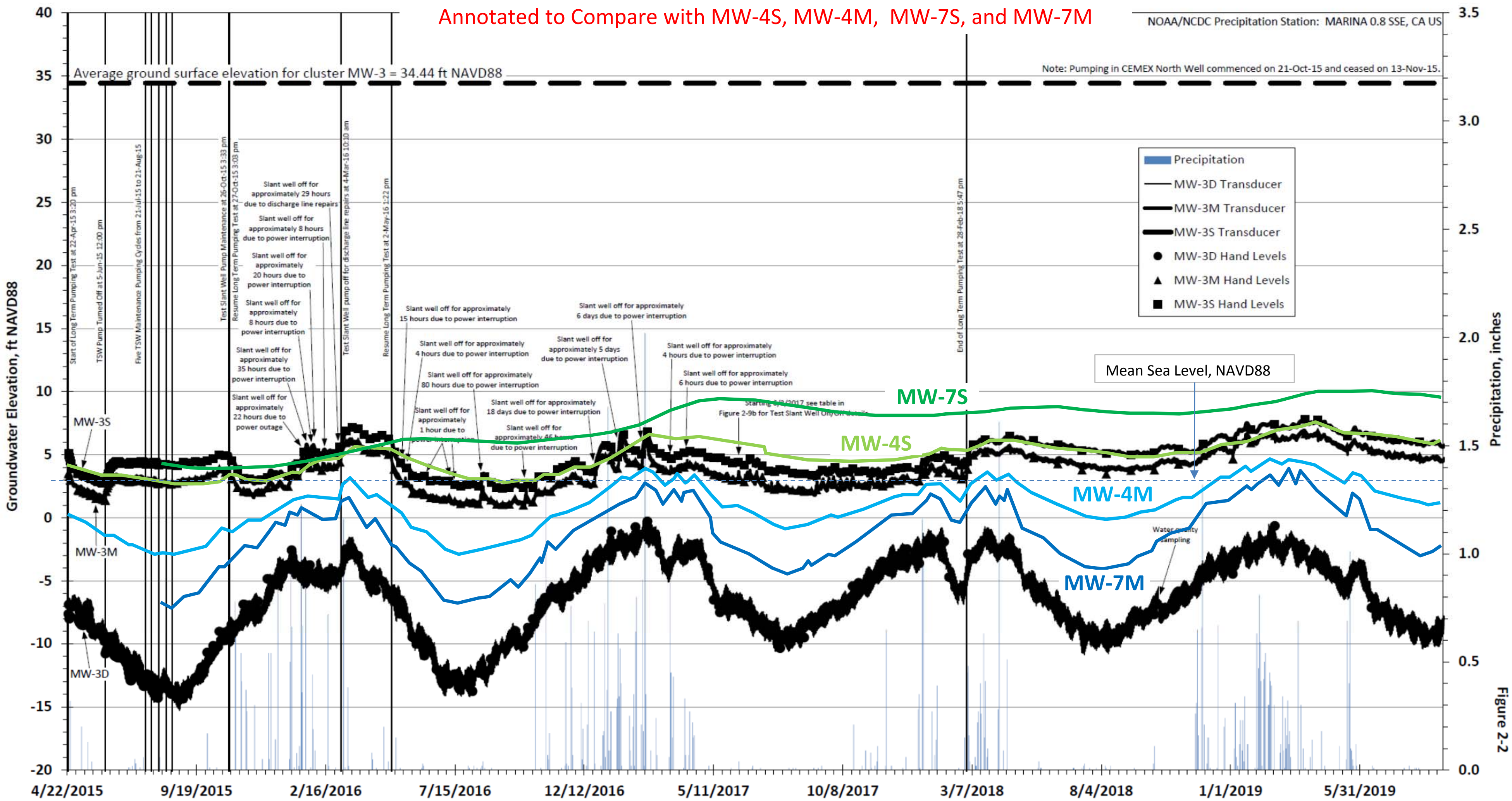
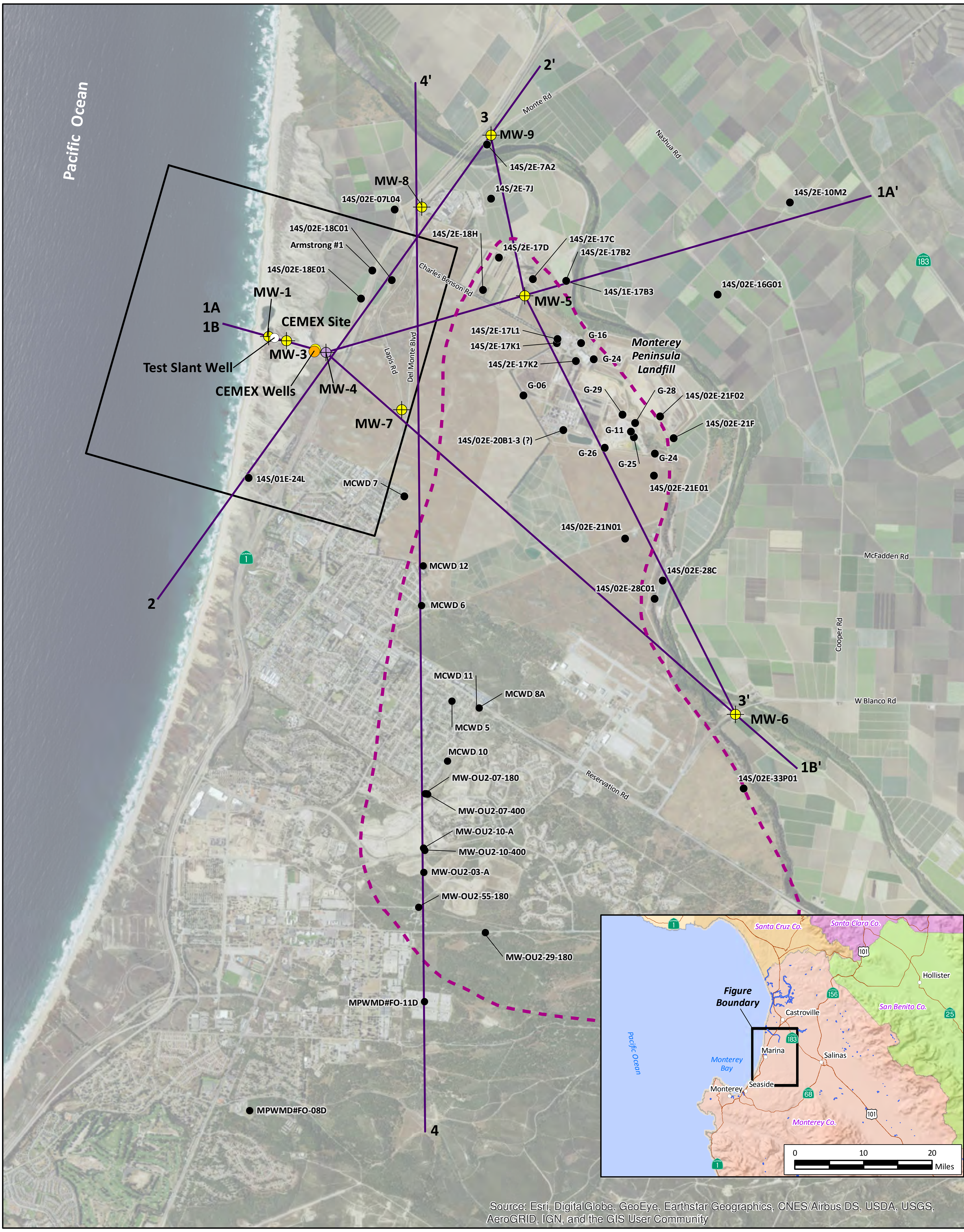


Figure 10

CALIFORNIA AMERICAN WATER

MONTEREY PENINSULA WATER SUPPLY PROJECT
MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE



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EXPLANATION

- CEMEX Model Boundary
- 1 — 1' Cross-Section Location
- Fort Ord Salinas Valley Aquitard (FO-SVA) (GEOSCIENCE, 2016)
- Monitoring Well Cluster
- Compliance Monitoring Well Cluster
- CEMEX Well - Inactive (Monitored)
- CEMEX Well - Active (Not Monitored)
- Test Slant Well
- Other Well Used in Cross-Sections

REGIONAL LOCATION MAP SHOWING WELL AND CROSS-SECTION LOCATIONS

NORTH

0 3,500 7,000 Feet

8-Feb-17

Prepared by: DB. Map Projection: State Plane 1983, Zone IV.

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Figure 2

Figure 11

X:\Projects\MONTEREY AREA DESAL STUDIES\01a) Test Slant Well Project\01) Monitoring Wells\4) TM Monitoring Well Completion\03) Final TM Feb_17\Figures

Figure 12

CALIFORNIA AMERICAN WATER
MONTEREY PENINSULA WATER SUPPLY PROJECT - MONITORING WELL COMPLETION REORT AND CEMEX MODEL UPDATE
GEOLOGIC CROSS-SECTION 1B-1B'
1B W-NW
1B' E-SE
CEMEX Site
Dune Complex - Highland Area
Salinas Valley
Salinas River
Elevation, ft NAVD88
MW-1
Test Slant Well
MW-3
CEMEX Well South
CEMEX Well North
MW-4
Cross-Section 2-2'
Highway 1
MW-7
Del Monte Blvd.
MCWD 7
14S/2E-21N1
14S/2E-28C1
W. Blanco Rd.
MW-6
Cross-Section 3-3'
14S/2E-33P1
Pacific Ocean
Deltaic Deposits (Qf?)
Qd
Older Dune Sand (Qod)
Terrace Deposits (Qt)
Flood Plain Deposits (Qfl)
FO-SVA
SVA
Perched "A" Aquifer
Valley Fill (Qo)
180-Foot Equivalent Aquifer
180-Foot Aquifer
180/400-Foot Aquitard
400-Foot Aquifer
CEMEX North Well Screen Interval
CEMEX South Well Screen Interval
Aromas Sand (?) (Qar)
Paso Robles Formation (QT)
Explanation
Holocene
Qfl
Qd
Pleistocene
Qo
Qt
Qod
Qf
Qar
Pliocene
QT
SVA Clay Layer
Clay Layer
Geologic Contact (approximate)
Wells
MPWSP Monitoring Well Screened Interval
Screened Interval from DWR Well Log
Well Lithology
Conductivity Induction Log Deep (CILD) [mmho/m]
Groundwater Elevation, ft NAVD88 10-Sep-2015)
Shallow Completion
Middle Completion
Deep Completion
34,500 Water Quality (TDS) Measurement, mg/L (February, March, April, and August 2015)
Horizontal Approximate Scale Feet
Vertical Approximate Scale Feet
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Figure 4

Figure 13

CALIFORNIA AMERICAN WATER
MONTEREY PENINSULA WATER SUPPLY PROJECT - MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE
GEOLOGIC CROSS-SECTION 2-2'
2 S-SW
2' N-NE
Salinas Valley
Elevation, ft NAVD88
Pacific Ocean
Deltaic Deposits (Qf?)
Qd
Older Dune Sand (Qod)
Basin Deposits (Qb)
Flood Plain Deposits (Qfl)
Perched "A" Aquifer
Salinas Valley Aquitard
SVA
Terrace Deposits (Qt)
180-Foot Equivalent Aquifer
180-Foot Aquifer
180/400-Foot Aquitard
400-Foot Aquifer
Aromas Sand (?) (Qar)
Paso Robles Formation (QT)
14S/01E-24L
MW-4
Cross-Section 1B-1B'
Cross-Section 1A-1A'
Highway 1
14S/02E-18E1
14S/02E-18C01
Del Monte Blvd.
14S/02E-7L4
MW-8
Salinas River
14S/02E-7A2
MW-9
Screen interval for 14S/02E-18E01 from 636-804 ft NAVD88
11,900
17,900
27,500
1,260
24,000
583
3,204
29,000
366
Explanation
Holocene
Pleistocene
Pliocene
Qfl
Qb
Qd
Qo
Qt
Qod
Qf
Qar
QT
SVA Clay Layer
Clay Layer
Silt Layer
Geologic Contact (approximate)
Wells
MPWSP Monitoring Well Screened Interval
Screened Interval from DWR Well Log
Well Lithology
Conductivity Induction Log Deep (CILD) [mmho/m]
Groundwater Elevation, ft NAVD88 (10-Sep-15)
Shallow Completion
Middle Completion
Deep Completion
Water Quality (TDS) Measurement, mg/L (March, May, and June 2015)
Horizontal Approximate Scale Feet
Vertical Approximate Scale Feet
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Figure 5

Figure 14

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MONTEREY PENINSULA WATER SUPPLY PROJECT - MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE

GEOLOGIC CROSS-SECTION 3-3'

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Figure 6

X:\Projects\MONTEREY AREA DESAL STUDIES\01a) Test Slant Well Project\01) Monitoring Wells\4) TM Monitoring Well Completion\03) Final TM Feb_17\Figures

Figure 15


CALIFORNIA AMERICAN WATER
MONTEREY PENINSULA WATER SUPPLY PROJECT - MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE
GEOLOGIC CROSS-SECTION 4-4'
4 S
4' N
Salinas Valley
Elevation, ft NAVD88
Older Dune Sand (?) (Qod)
"A" Aquifer
Terrace Deposits (?) (Qt)
Paso Robles Formation (?) (Tpr)
Older Dune Sand (Qod)
FO-SVA
Terrace Deposits (Qt)
Upper 180-Foot Aquifer (HLA?)
Lower 180-Foot Aquifer (HLA?)
180/400-Foot Aquitard
Aroma Sand (?) (Qar)
180-Foot Equivalent Aquifer
400-Foot Equivalent Aquifer
Aroma Sand (?) (Qar)
Flood Plain Deposits (Qfl)
Perched "A" Aquifer?
SVA
180-Foot Aquifer
Explanation
Holocene
Pleistocene
Pliocene
Qfl
Qb
Qd
Qo
Qt
Qod
Qf
Qar
Qp
SVA Clay Layer
Clay Layer
Silt Layer
Geologic Contact (approximate)
Well Lithology
Conductivity Induction Log Deep (CILD) [mmho/m]
Wells
MPWSP Monitoring Well Screened Interval
Screened Interval from DWR Well Log
Groundwater Elevation, ft NAVD88
Shallow Completion (Fall-2015)
Middle Completion (Fall-2015)
Deep Completion (Fall-2015)
Inferred Fall 2015 Water Levels from Contour Maps and Well Data.
34,500 Water Quality (TDS) Measurement, mg/L (May, June, and August 2015)
Horizontal Approximate Scale Feet
Vertical Approximate Scale Feet
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Figure 7
8-Feb-17
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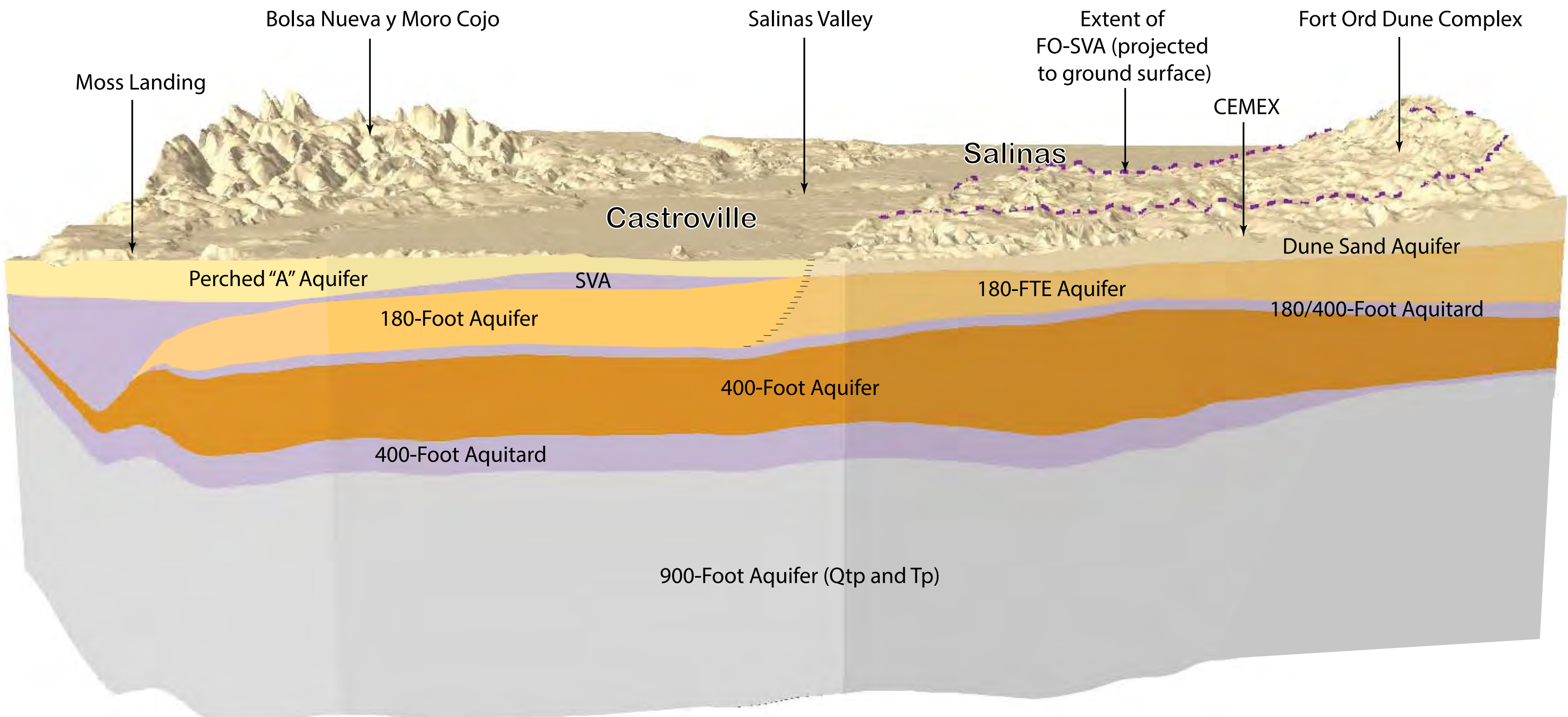
Figure 16



Note: 10x Vertical Exaggeration

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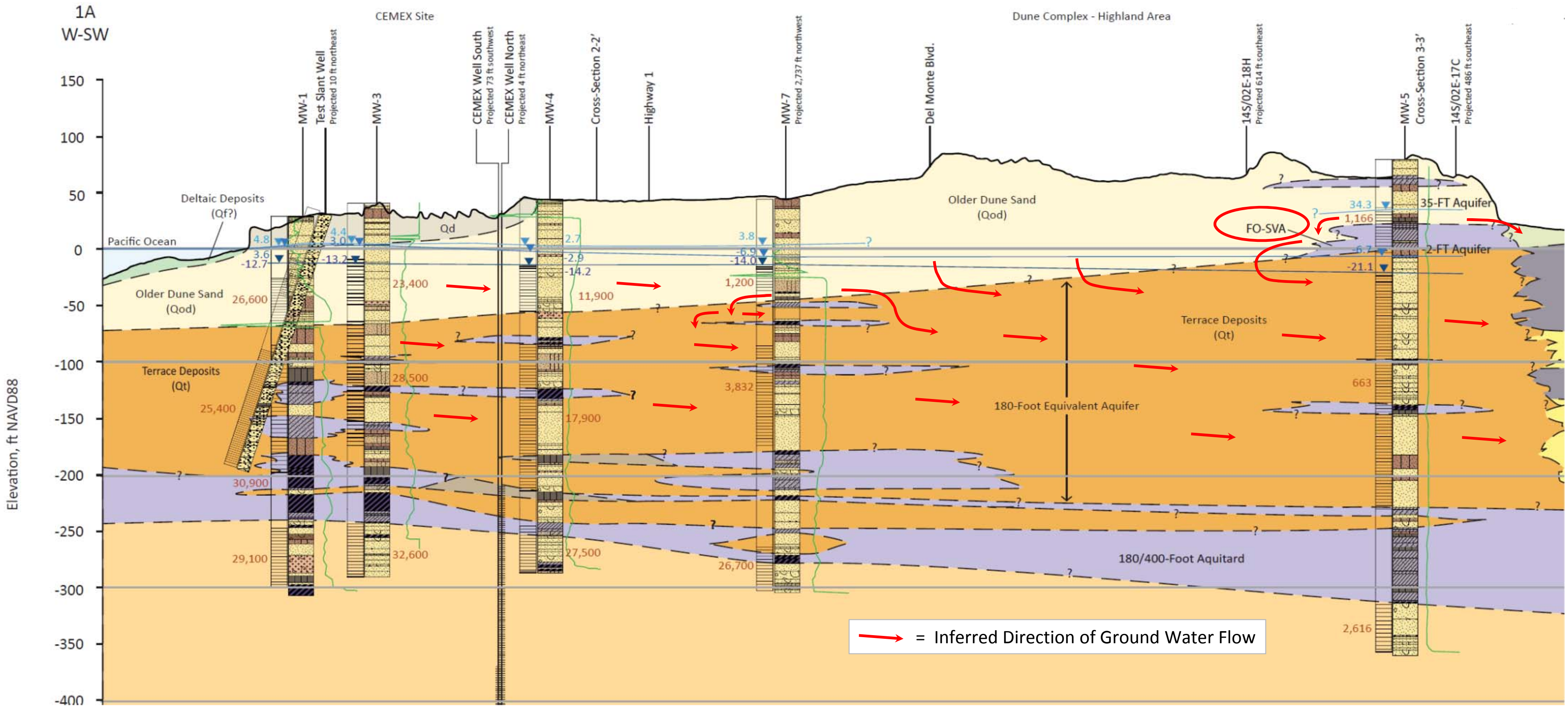
ILLUSTRATION OF AQUIFER ZONES

Figure 8

Figure 17

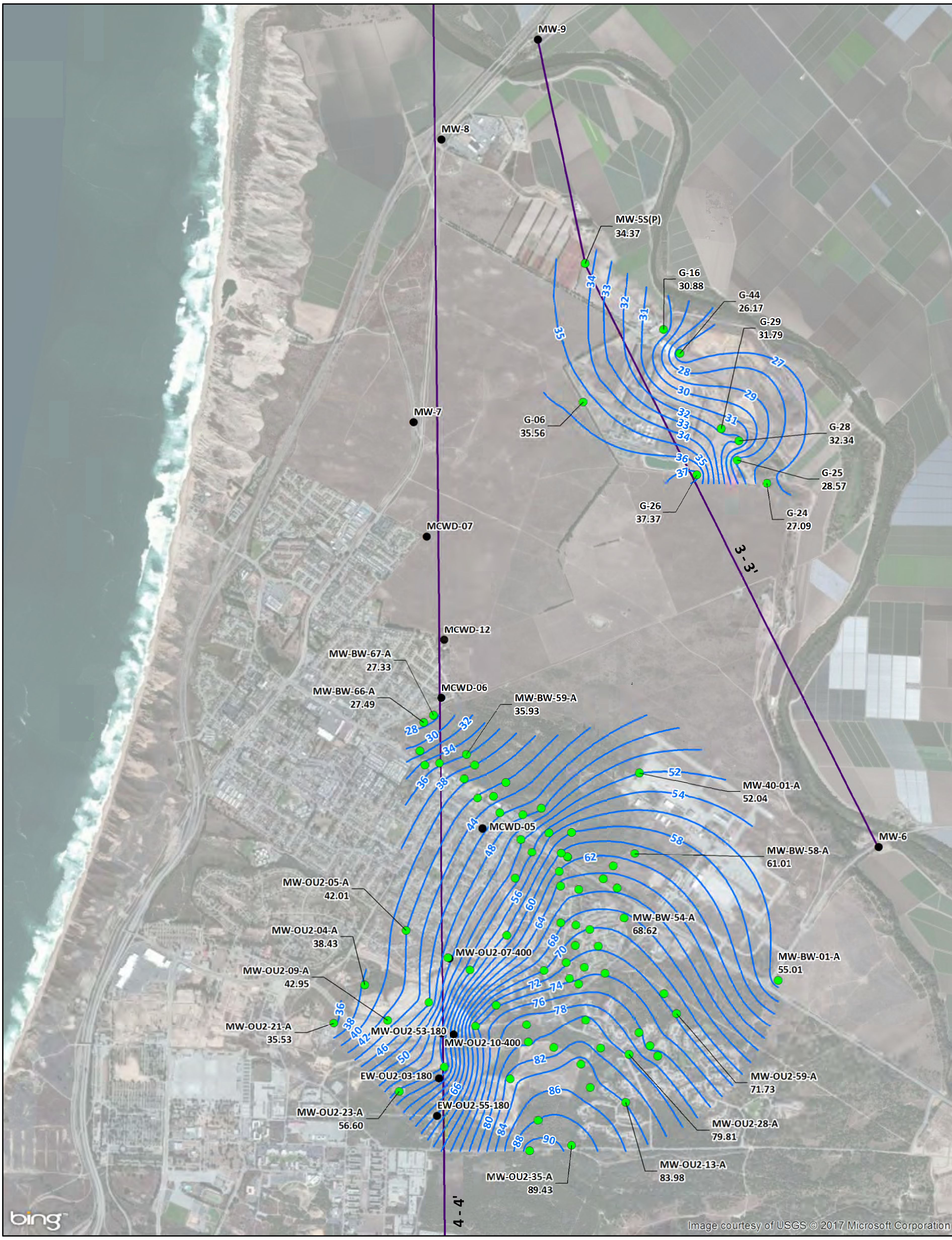
CALIFORNIA AMERICAN WATER

Conceptual Site Model (CSM-1) - Discontinuous Fort Ord Salinas Valley Aquitard (FO-SVA)



Excerpted from Figure 3, Geologic Cross Section 1A-1A', *Monterey Peninsula Water Supply Project - Monitoring Well Completion Report and Cemex Model Update* , Final EIR Appendix E3, annotations in red

Figure 18



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- Monitoring Well (used for contours)
- Other Well (not used for contours)
- 50 Groundwater Elevation (ft, NAVD88)
- Cross-Section Location

GROUNDWATER ELEVATIONS - "PERCHED/MOUNDED AQUIFER" (USING FORT ORD "A" AQUIFER WELLS, MRWMD 35-FOOT AQUIFER WELLS, AND MPWSP MW-5S(P)) FALL 2015

Note: Not all wells in the Fort Ord Area are labeled due to high density of wells.

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Prepared by: DB. Map Projection: State Plane 1983, Zone IV.

NORTH

0 2,000 4,000 Feet

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Figure 9

Figure 19

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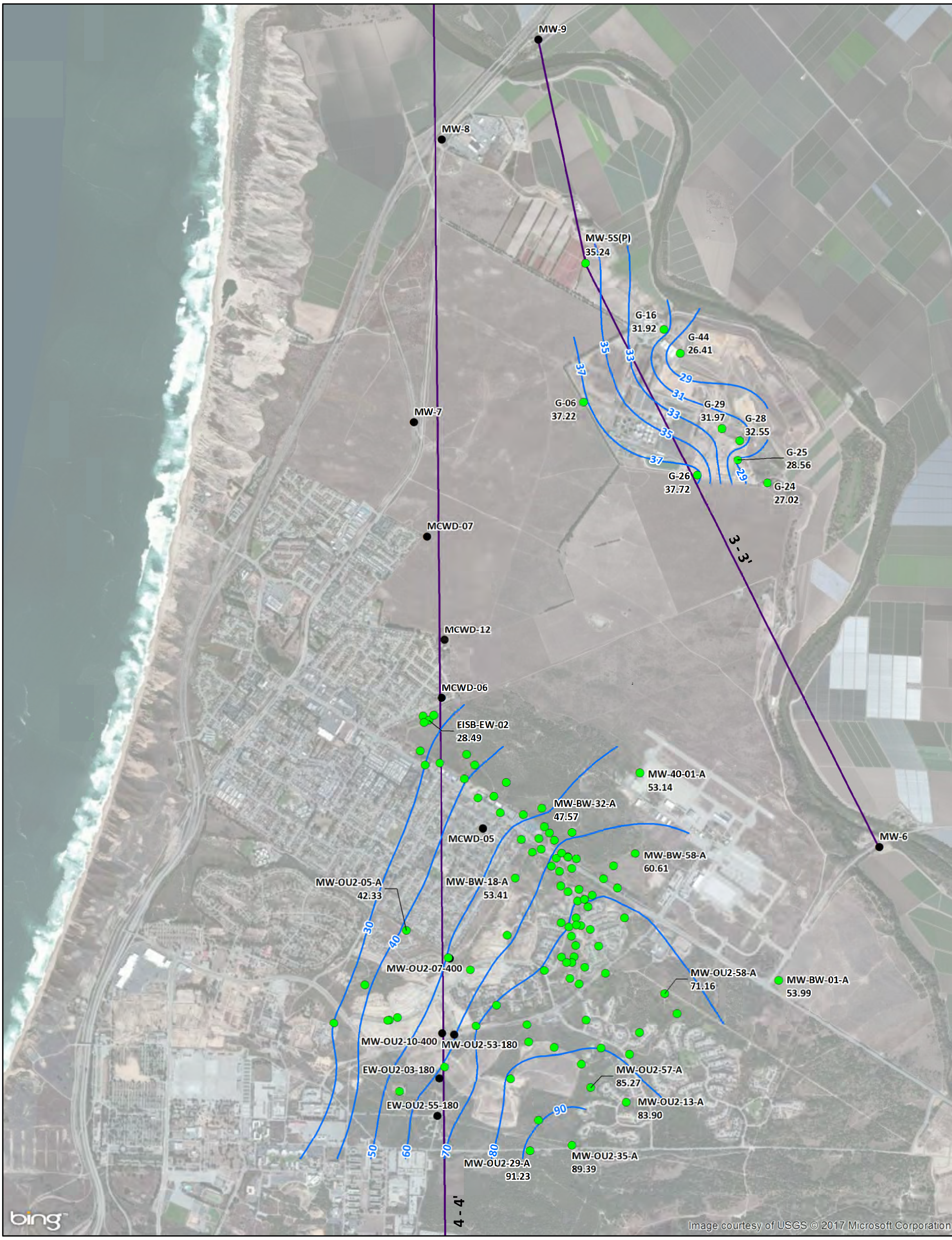
MONTEREY PENINSULA WATER SUPPLY PROJECT
MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE



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- Monitoring Well (used for contours)
- Other Well (not used for contours)
- 50 Groundwater Elevation (ft, NAVD88)
- Cross-Section Location

GROUNDWATER ELEVATIONS - "PERCHED/MOUNDED AQUIFER" (USING FORT ORD "A" AQUIFER WELLS, MRWMD 35-FOOT AQUIFER WELLS, AND MPWSP MW-5S(P)) SPRING 2016

Note: Not all wells in the Fort Ord Area are labeled due to high density of wells.

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Prepared by: DB. Map Projection: State Plane 1983, Zone IV.

NORTH

0 2,000 4,000 Feet

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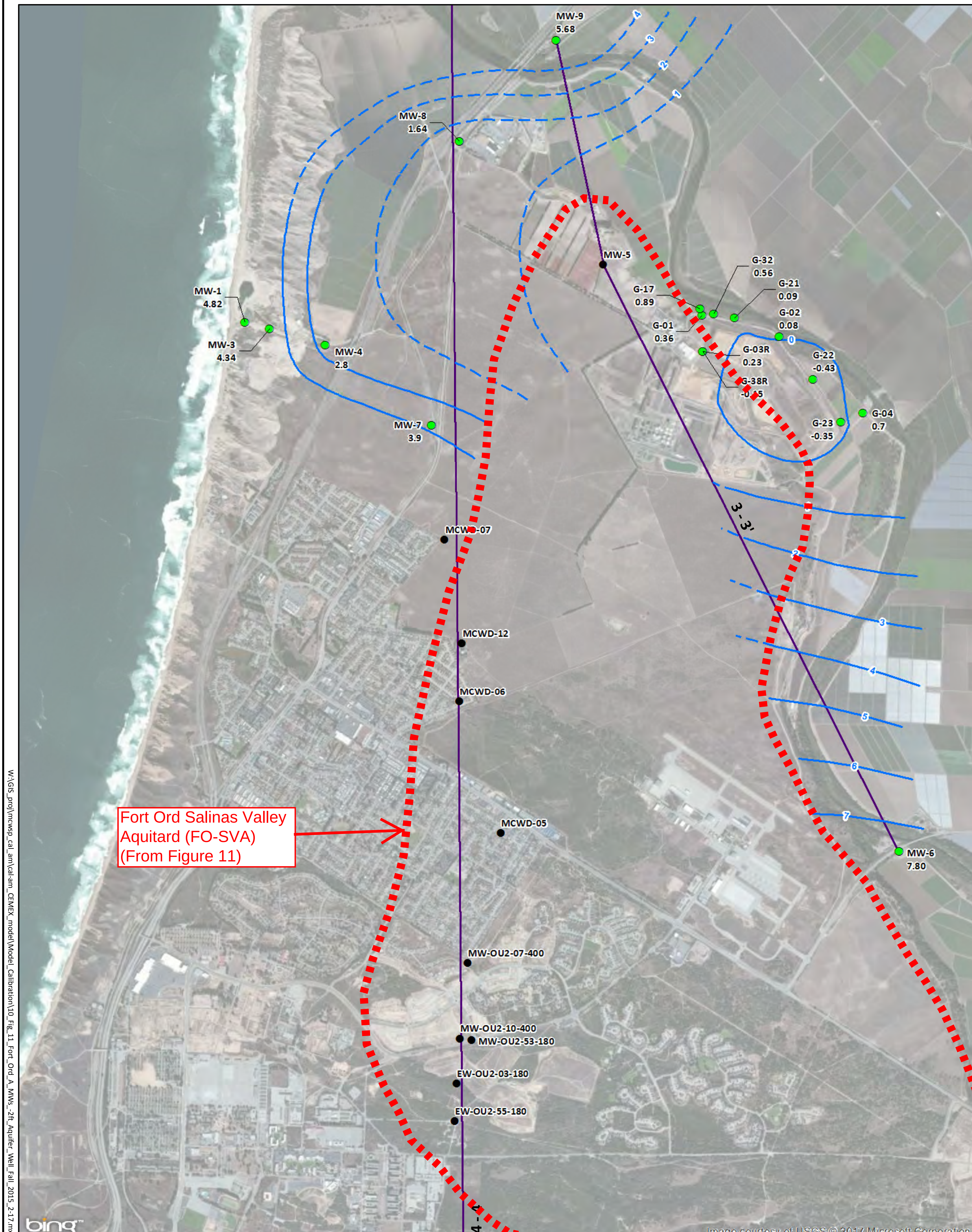
Figure 10

Figure 20

CALIFORNIA AMERICAN WATER

MONTEREY PENINSULA WATER SUPPLY PROJECT
MONITORING WELL COMPLETION REPORT AND CEMEX MODEL UPDATE



- Monitoring Well (used for contours)
- Other Well (not used for contours)
- Groundwater Elevation (ft, NAVD88) Dashed where inferred
- Cross-Section Location

GROUNDWATER ELEVATIONS - "DUNE SAND AQUIFER" (USING MRWMD -2-FOOT AQUIFER WELLS AND MPWSP SHALLOW COMPLETIONS) FALL 2015

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Prepared by: DB. Map Projection: State Plane 1983, Zone IV.

NORTH

0 2,000 4,000 Feet

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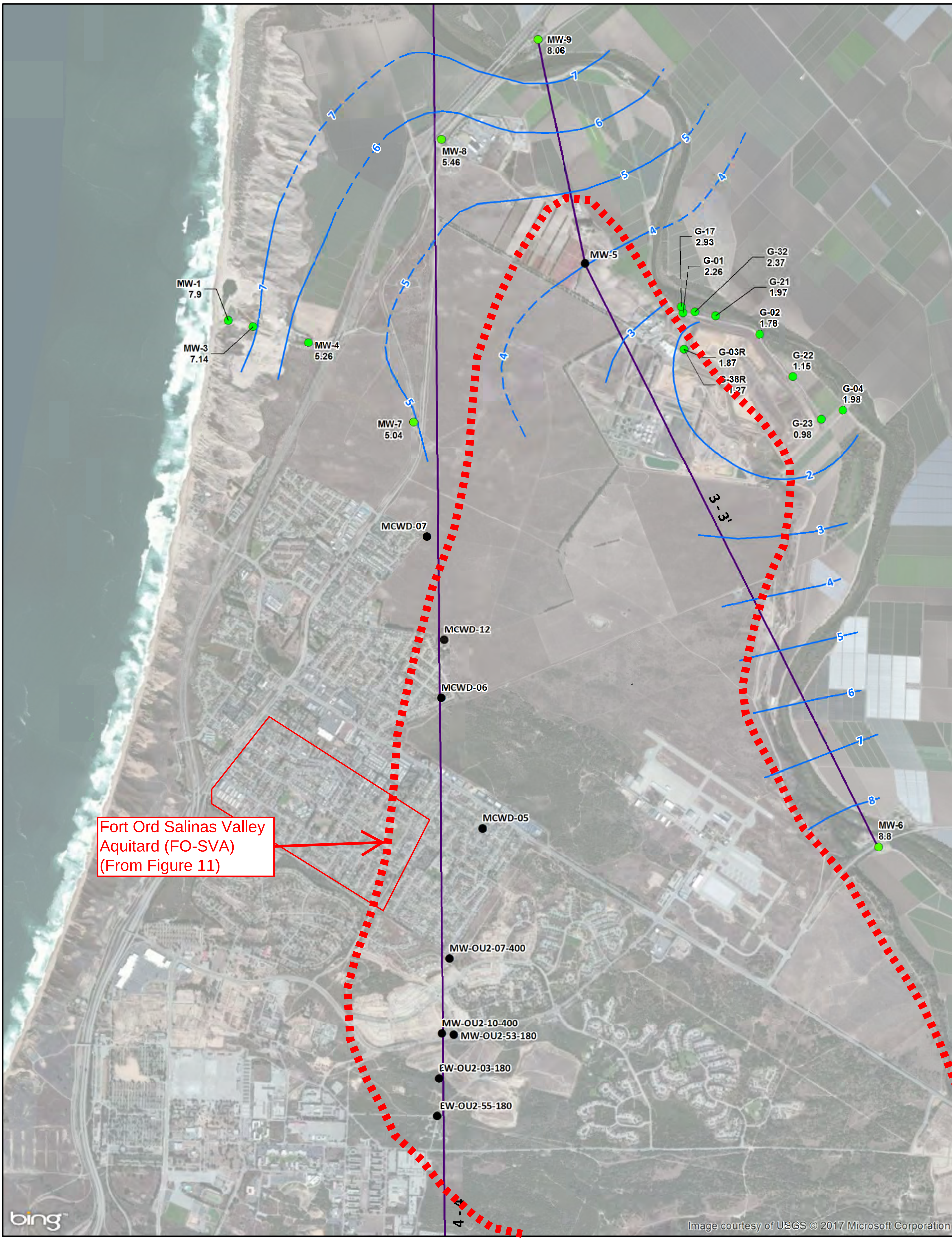
Figure 11

Figure 21



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- Monitoring Well (used for contours)
- Other Well (not used for contours)
- Groundwater Elevation (ft, NAVD88) Dashed where inferred
- Cross-Section Location

GROUNDWATER ELEVATIONS - "DUNE SAND AQUIFER" (USING MRWMD -2-FOOT AQUIFER WELLS AND MPWSP SHALLOW COMPLETIONS) SPRING 2016

8-Feb-17

Prepared by: DB. Map Projection: State Plane 1983, Zone IV.

NORTH

0 2,000 4,000 Feet

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Tel: (909) 451-6650 Fax: (909) 451-6638
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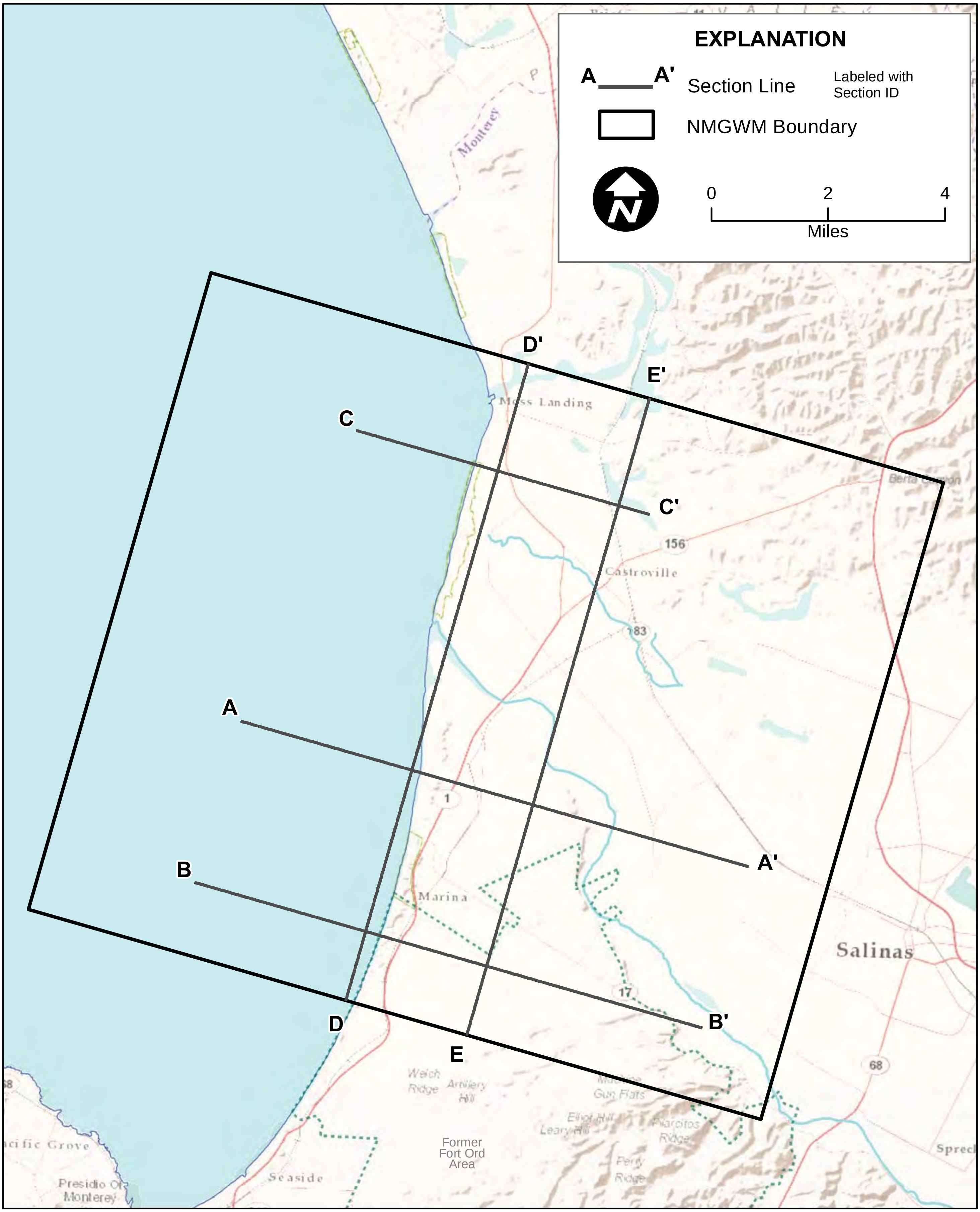
Figure 12

Figure 22



HYDROFOCUS INC. Solutions for Land and Water Resources

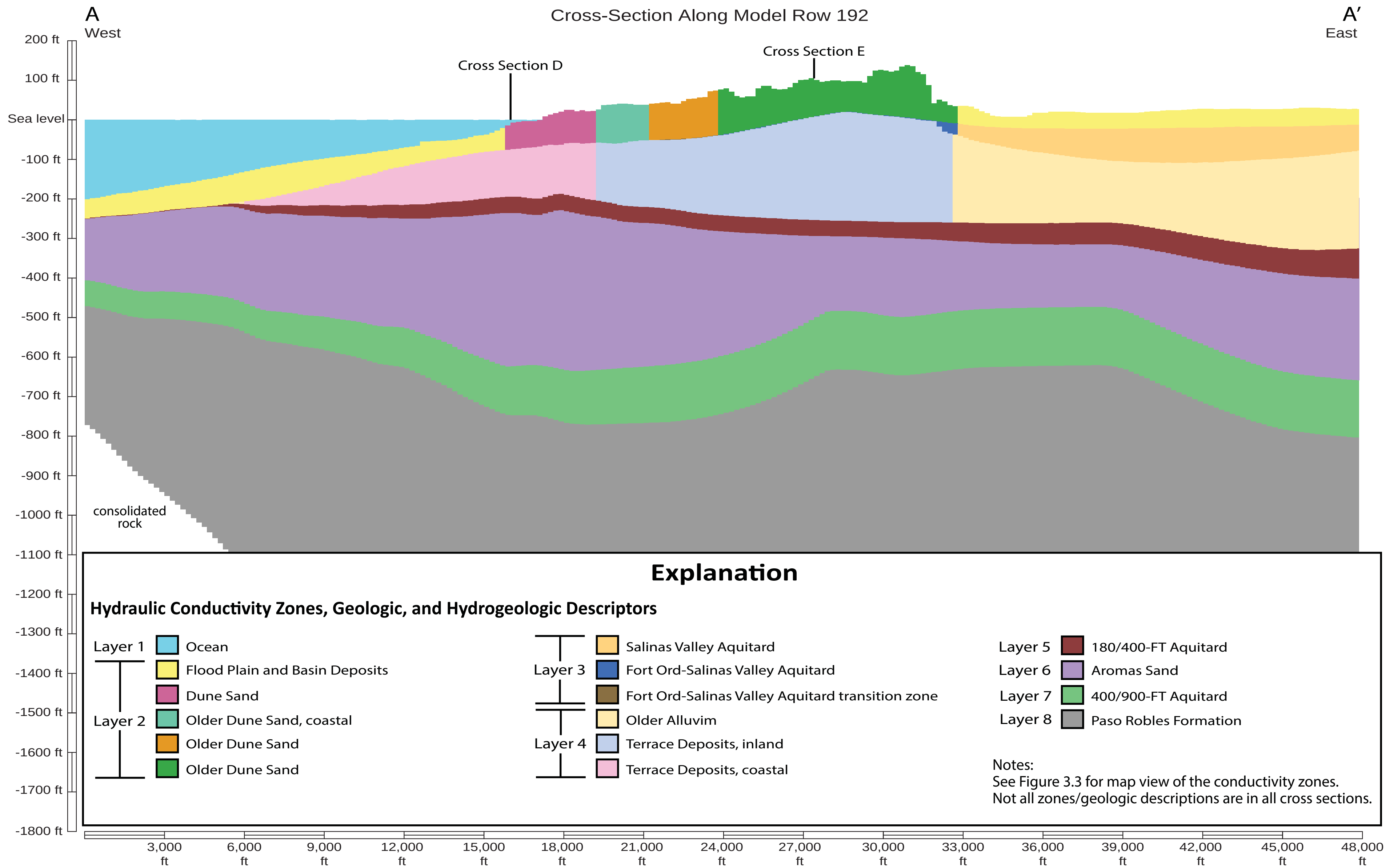
NMGWM[2016] section lines.

Figure 3.2a

PROJECT: 5073

DATE: 8/12/2016

Figure 23



HYDROFOCUS INC.
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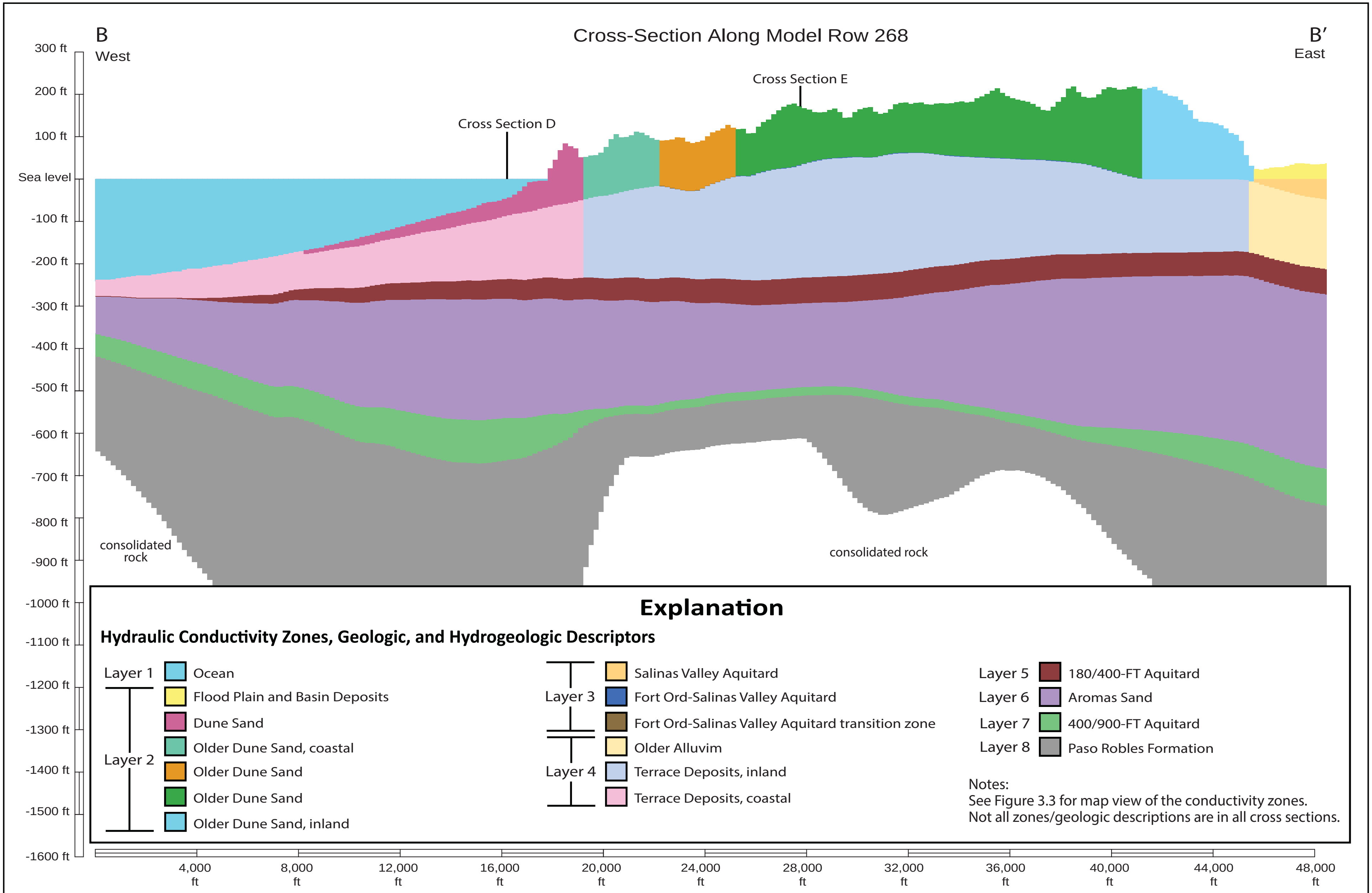
Section A-A’, NMGWM[2016].

Figure 3.2b

PROJECT: 5073

DATE: 11/8/2016

Figure 24



HYDROFOCUS INC.
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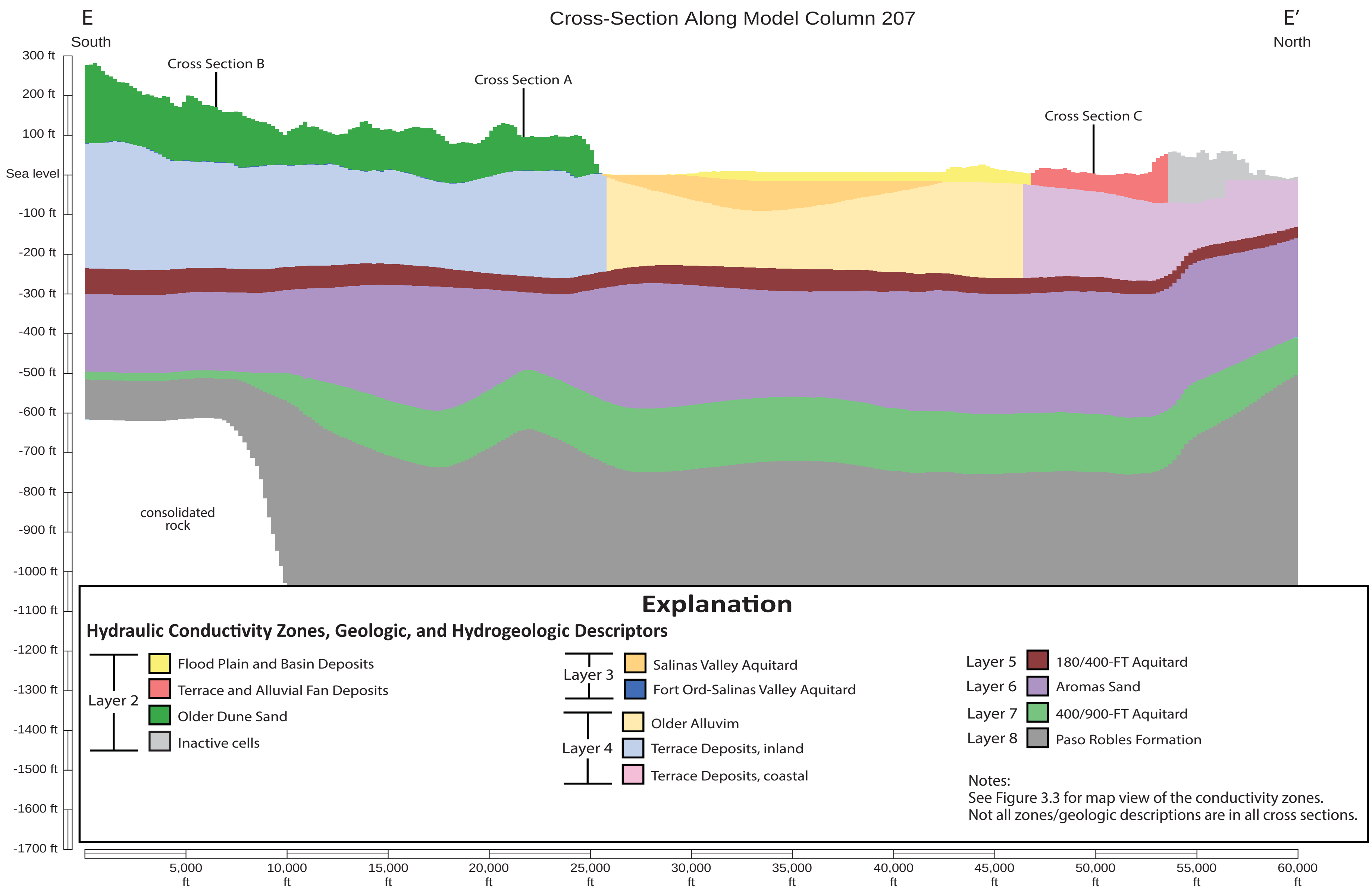
Section B-B', NMGWM2016.

Figure 3.2c

PROJECT: 5073

DATE: 11/21/2016

Figure 25



HYDROFOCUS INC.
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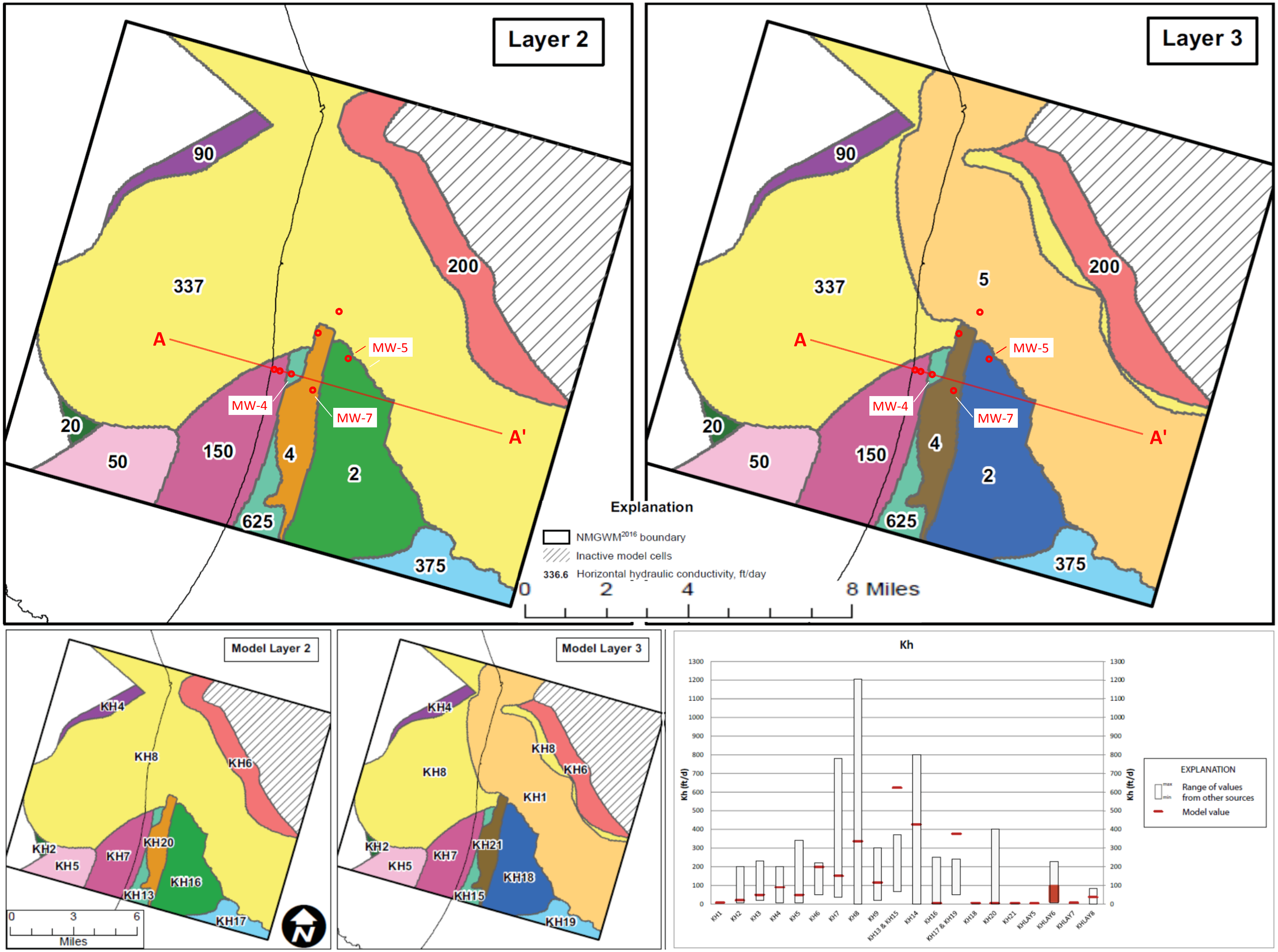
Section E-E', NMGWM[2016].

Figure 3.2f

PROJECT: 5073

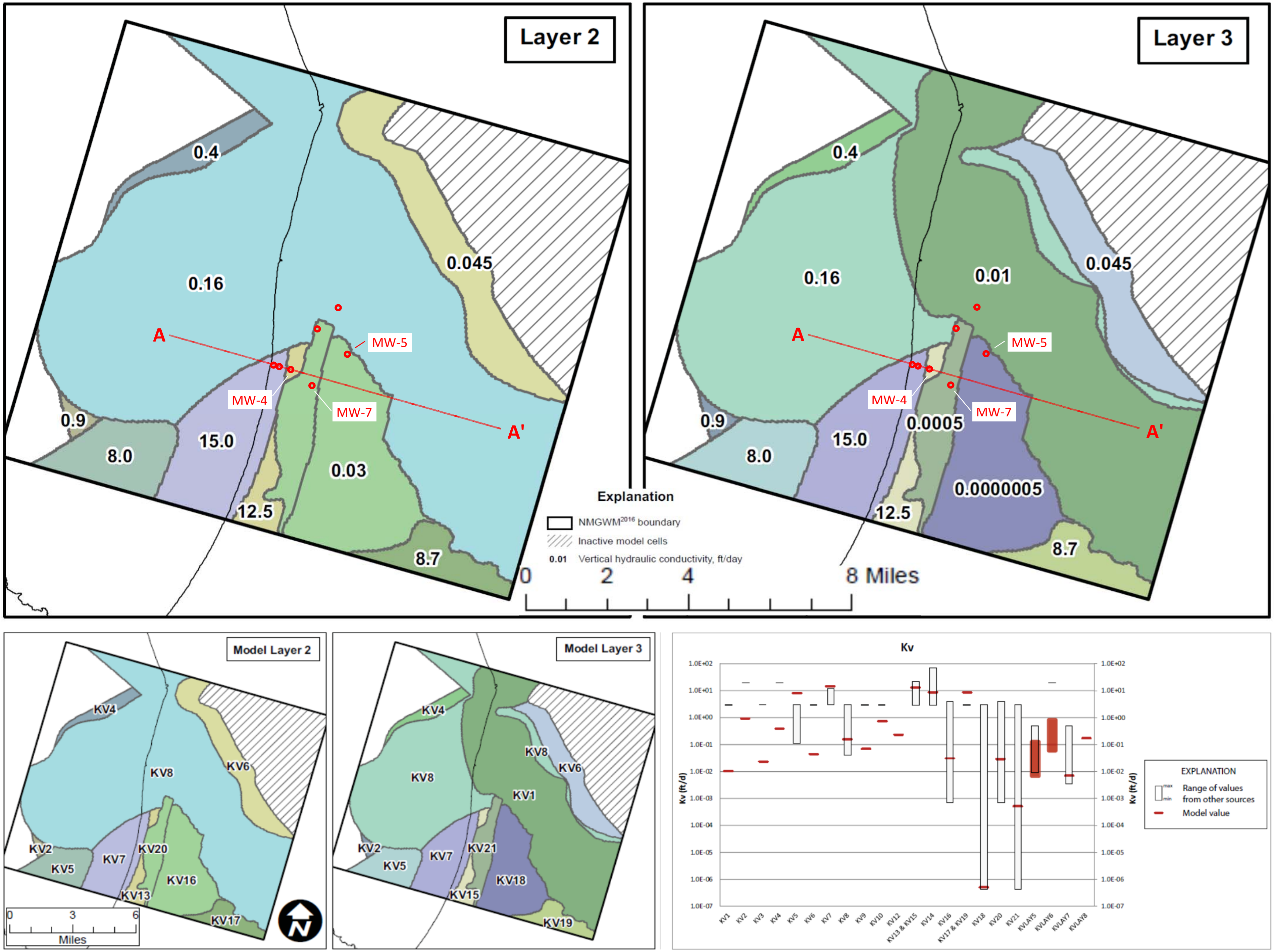
DATE: 11/21/2016

Figure 26



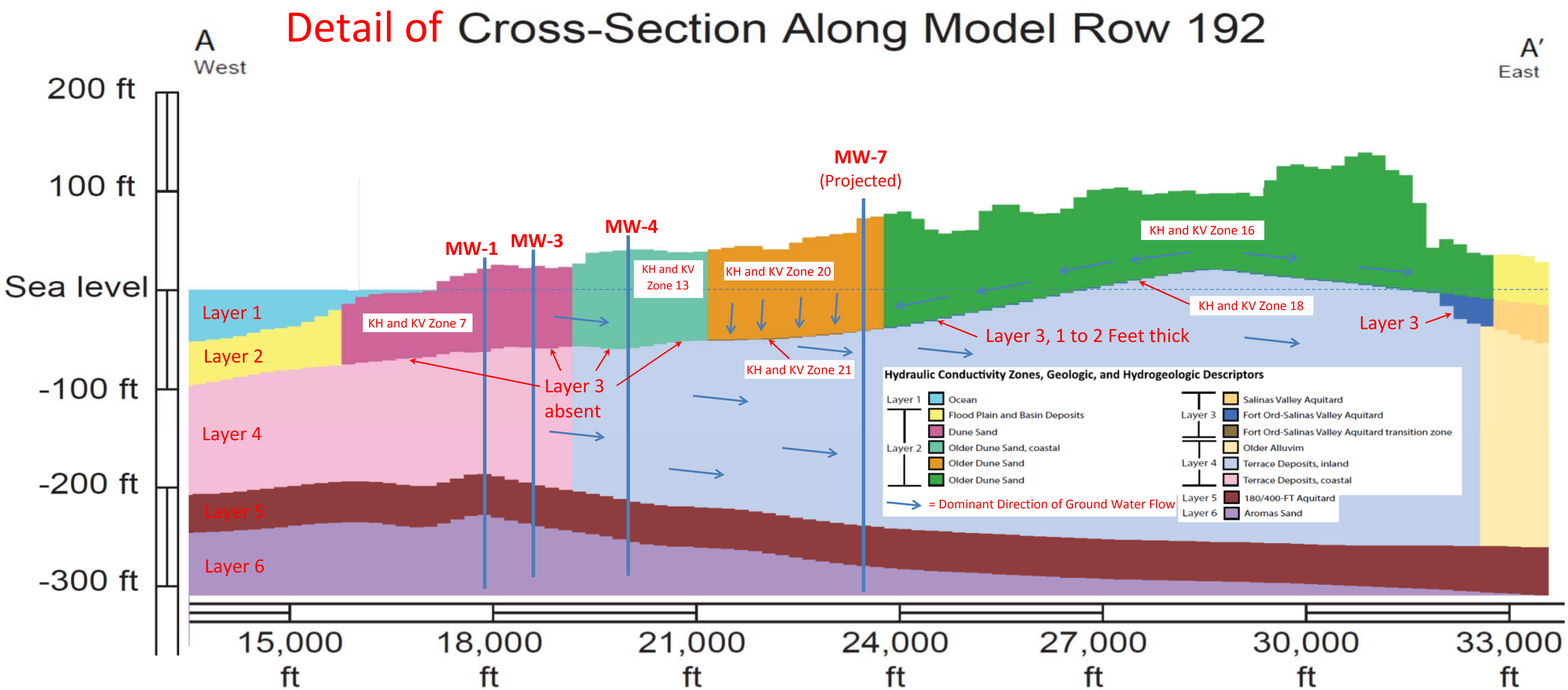
Horizontal Hydraulic Conductivity (KH) Parameter Zones and Values, Model Layers 2 and 3, NMGWM[2016], Excerpted from Figures 3.3a and 3.4a, *Final Environmental Impact Report/Environmental Impact Statement Appendix E2*, March 28, 2018. Red lines and text are added based on other figures in Appendix E2

Figure 27



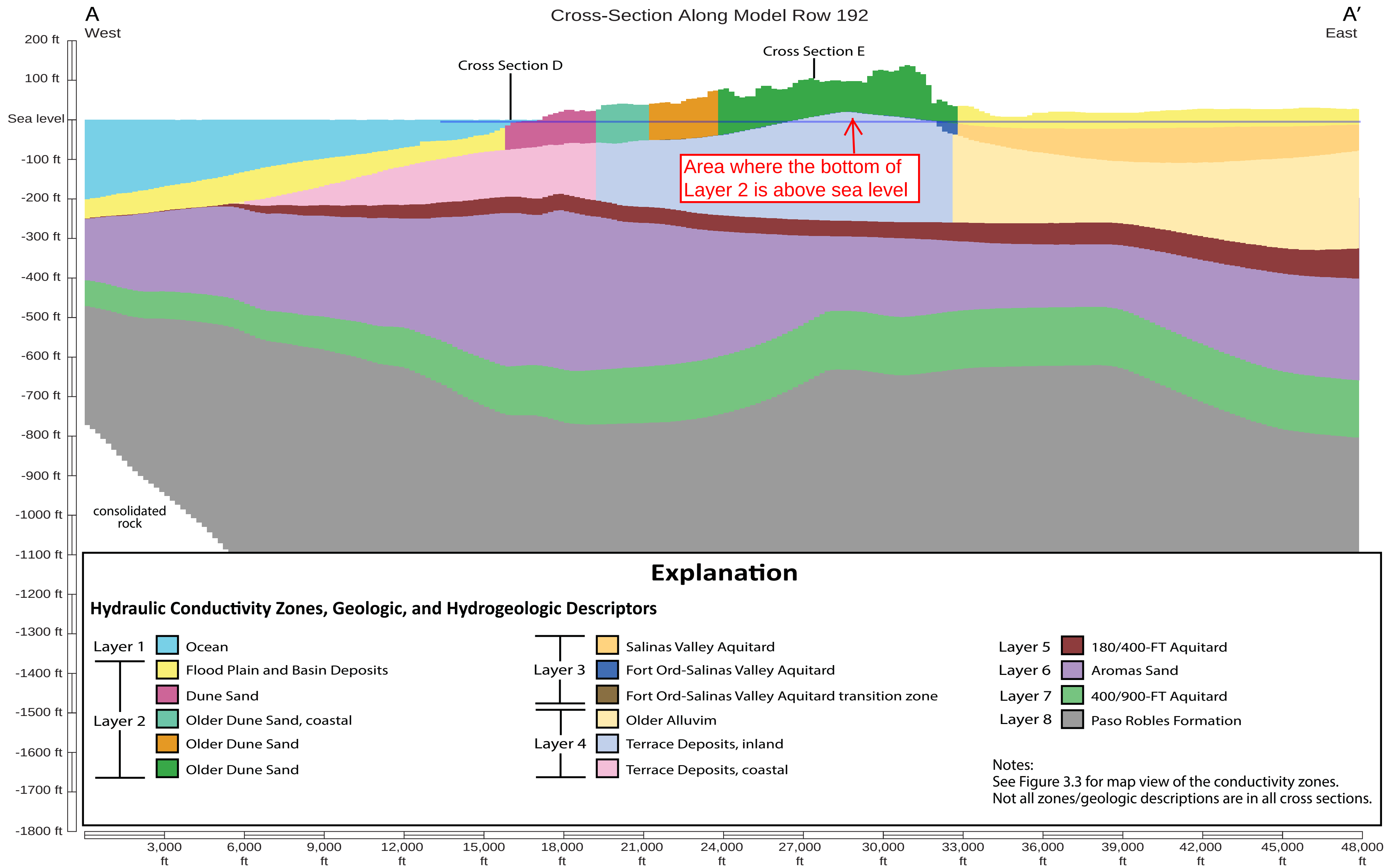
Vertical Hydraulic Conductivity (KV) Parameter Zones and Values, Model Layers 2 and 3, NMGWM2016, Excerpted from Figures 3.3b and 3.4b, *Final Environmental Impact Report/Environmental Impact Statement Appendix E2* , March 28, 2018. Red lines and text are added based on other figures in Appendix E2

Figure 28



Hydraulic Conductivity Zones, Model Cross Section A-A', NMGWM[2016], excerpted from Figure 3.2b, *Final Environmental Impact Report/Environmental Impact Statement Appendix E2* , March 28, 2018. Well and Layer notations are added based on other figures in Appendix E2

Figure 29



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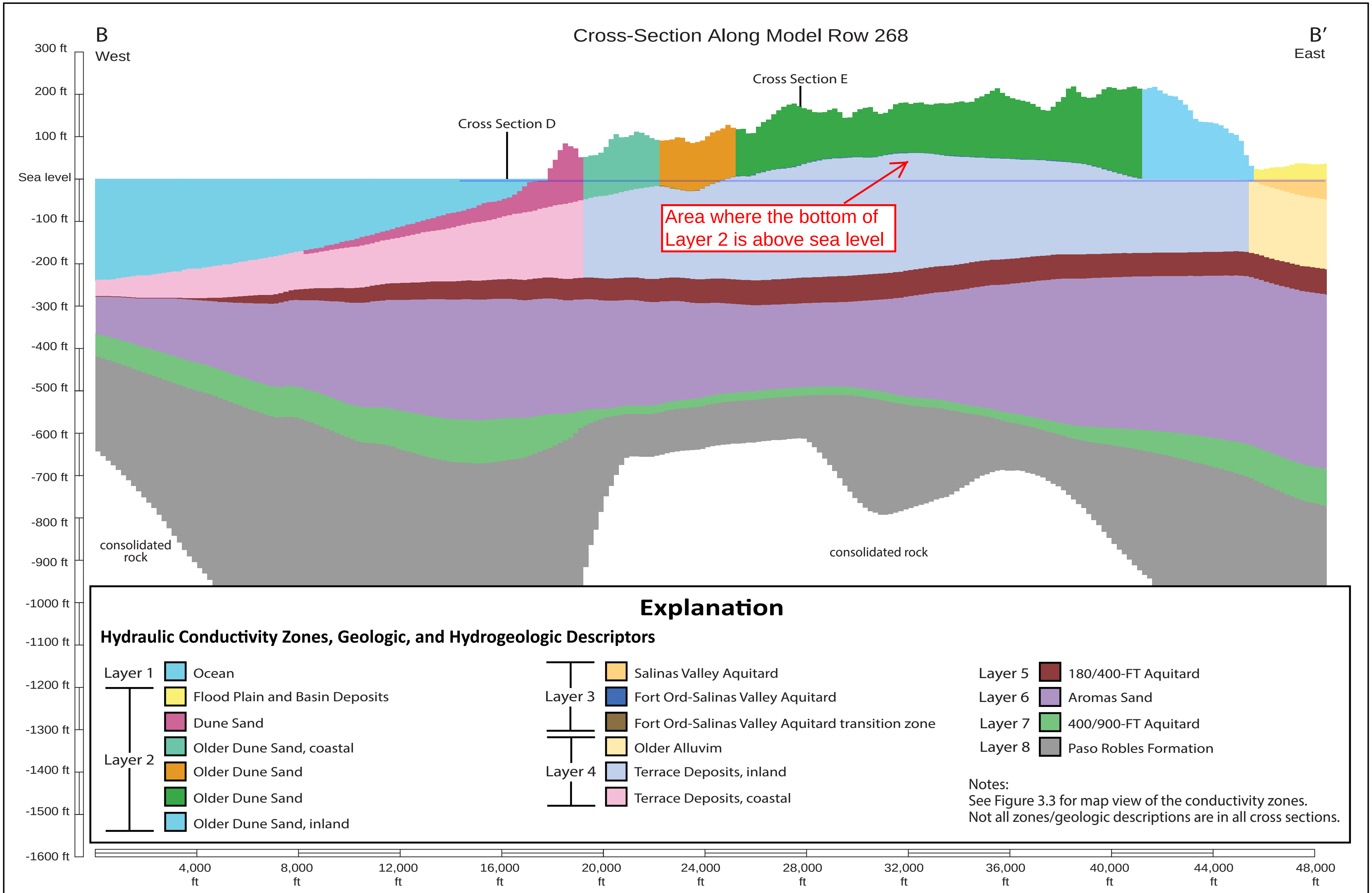
Section A-A′, NMGWM2016, Layer 2 Elevation Issue

Figure 3.2b

PROJECT: 5073

DATE: 11/8/2016

Figure 30



HYDROFOCUS INC.
Solutions for Land and Water Resources

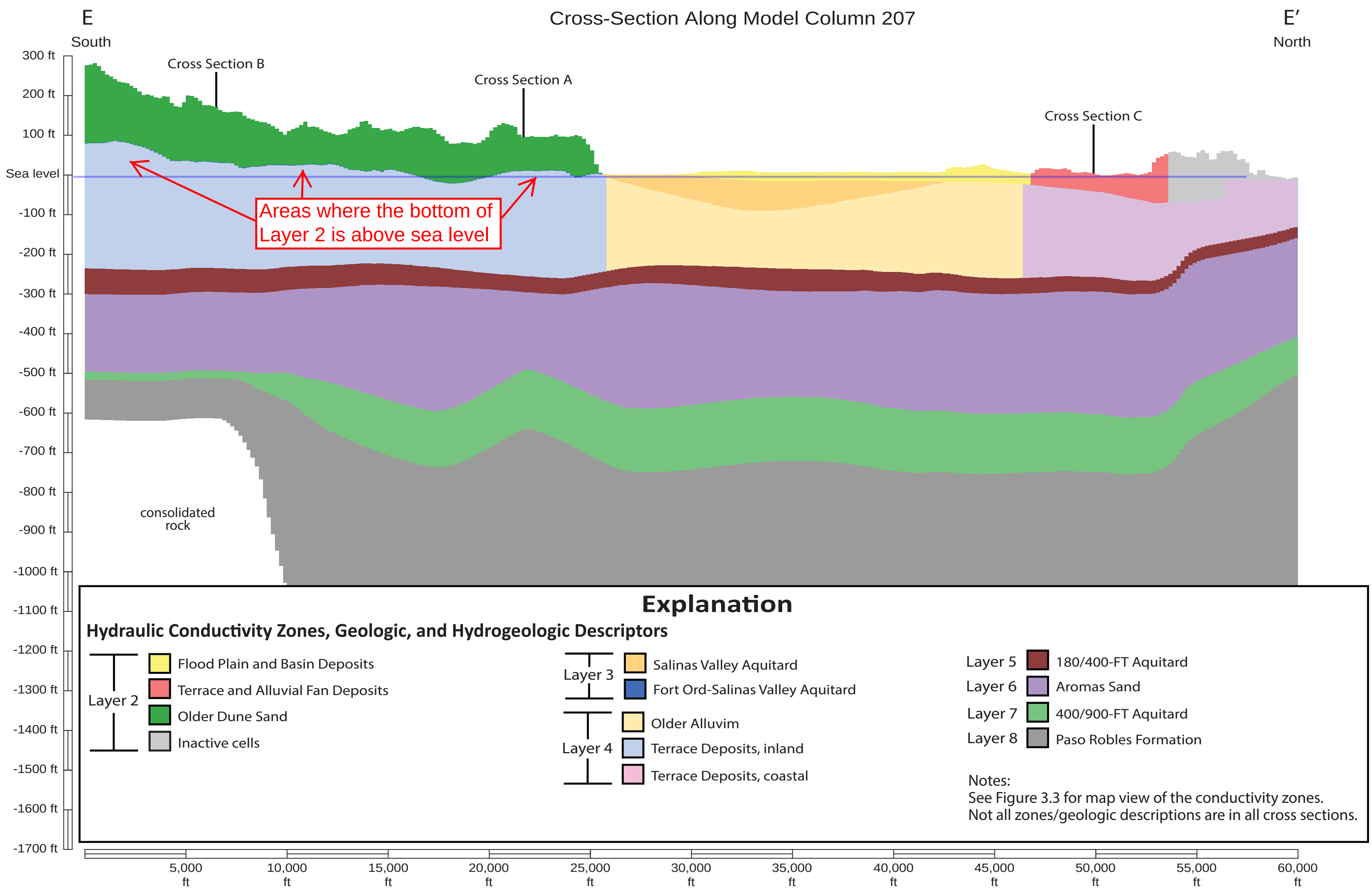
Section B-B', NMGWM^{2016}. Layer 2 Elevation Issue

Figure 3.2c

PROJECT: 5073

DATE: 11/21/2016

Figure 31



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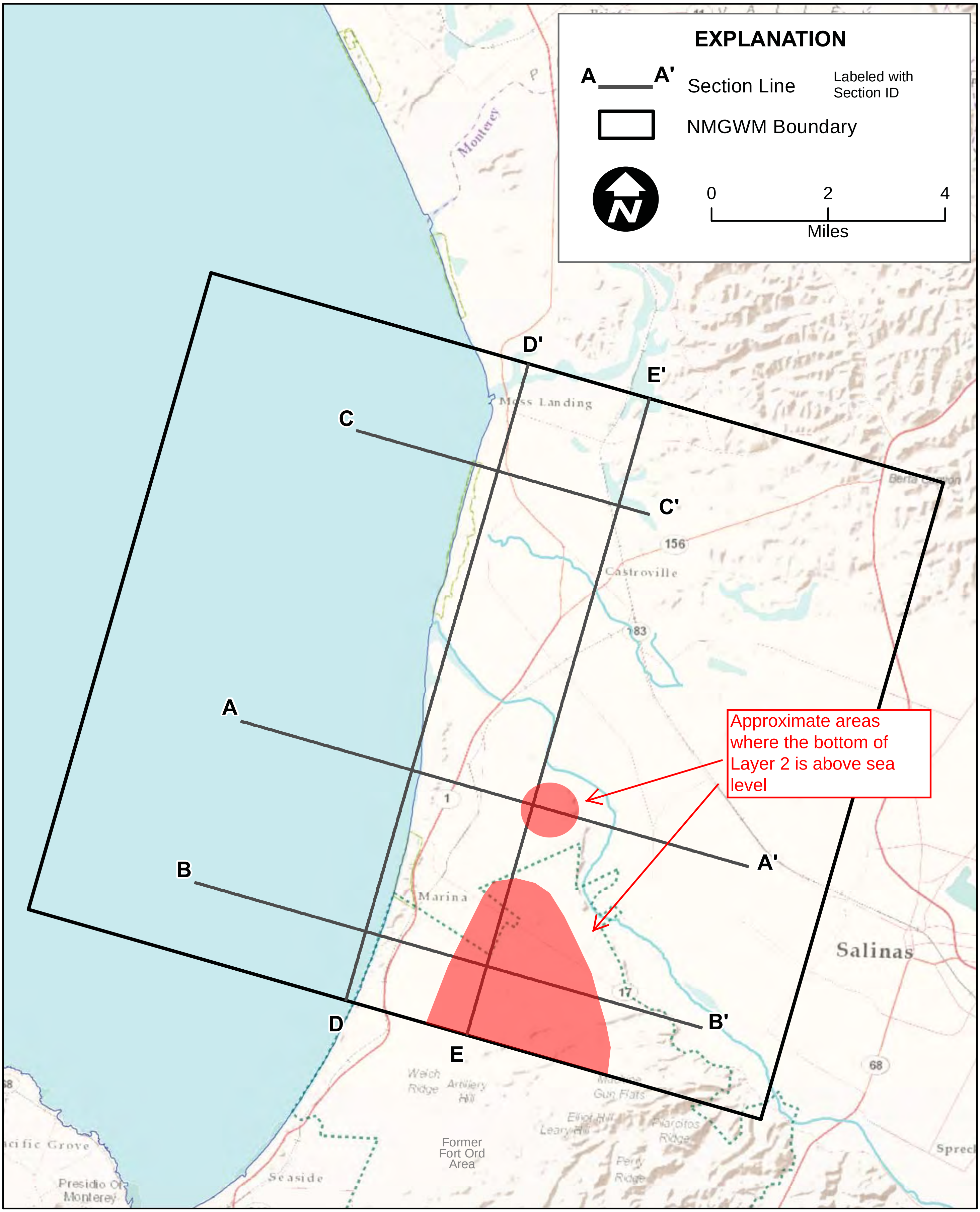
Section E-E', NMGWM[2016] Layer 2 Elevation Issue

Figure 3.2f

PROJECT: 5073

DATE: 11/21/2016

Figure 32



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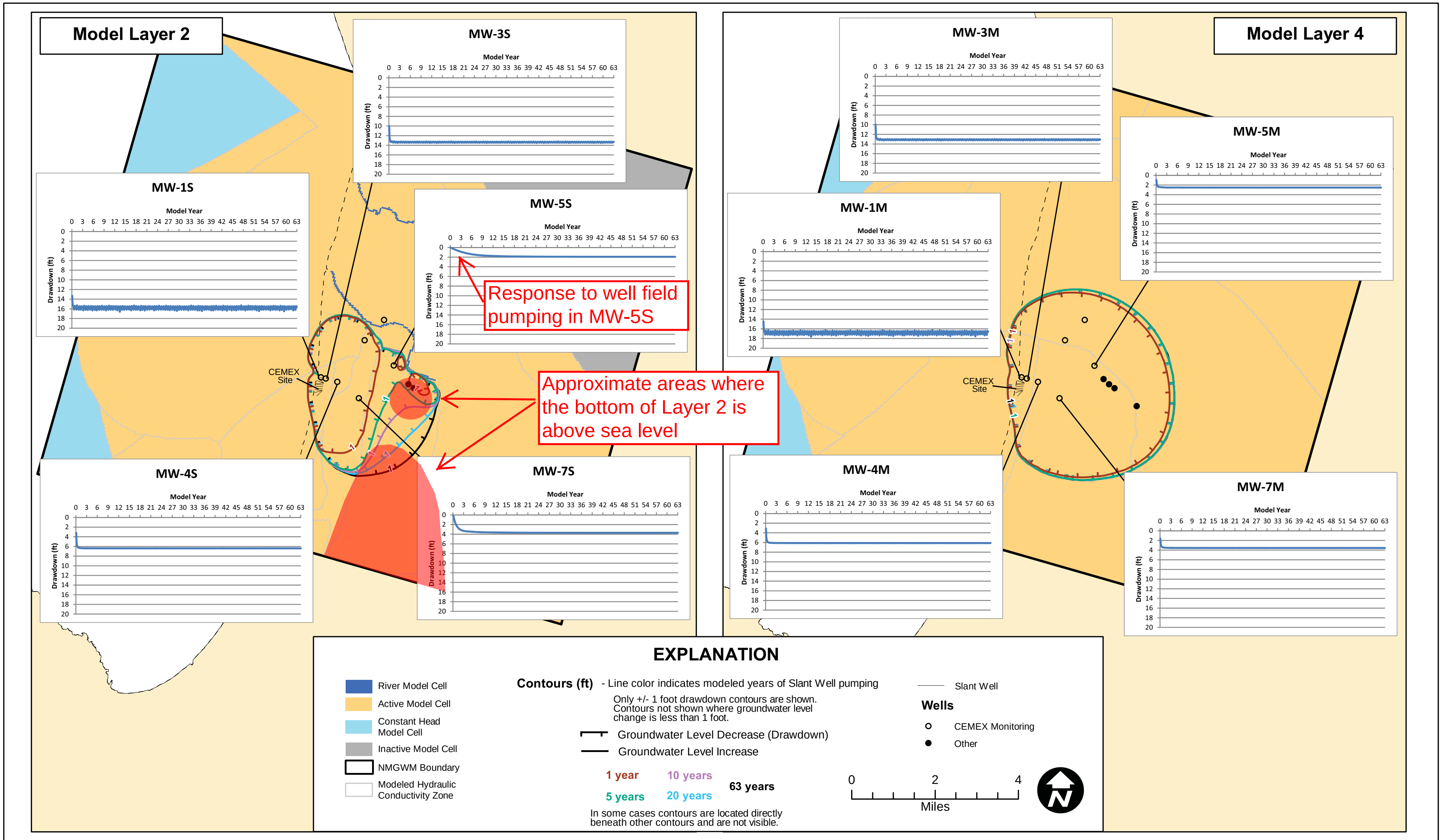
NMGWM[2016] section lines.
Layer 2 Elevation Issue

Figure 3.2a

PROJECT: 5073

DATE: 8/12/2016

Figure 33



HYDROFOCUS INC. Solutions for Land and Water Resources

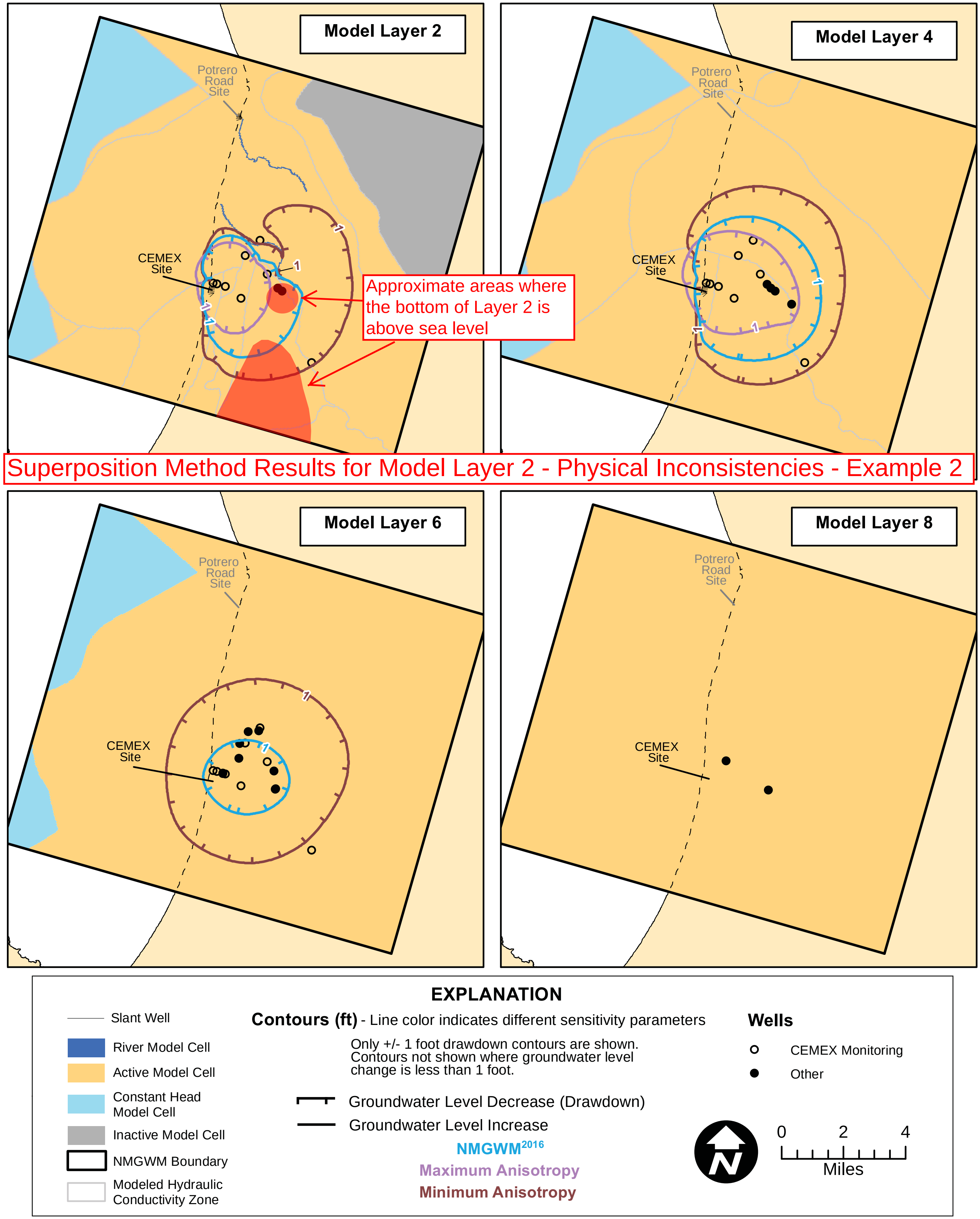
Annual NMGWM[2016] calculated drawdown from slant well pumping (24.1 MGD), 44/56 Layer 2/Layer 4 distribution, 2012 sea level, with no return water, CEMEX site.

Figure 5.3

PROJECT: 5073 | DATE: 7/11/2017

Superposition Method Results for Model Layer 2 - Physical Inconsistencies - Example 1

Figure 34



HYDROFOCUS INC
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Sensitivity of calculated drawdown to hydraulic conductivity after 63 years of slant well pumping (24.1 MGD), 44/56 Layer 2/Layer 4 distribution, 2012 sea level with no return water, CEMEX site.

Figure 6.2

PROJECT: 5073

DATE: 8/30/2016

Figure 35

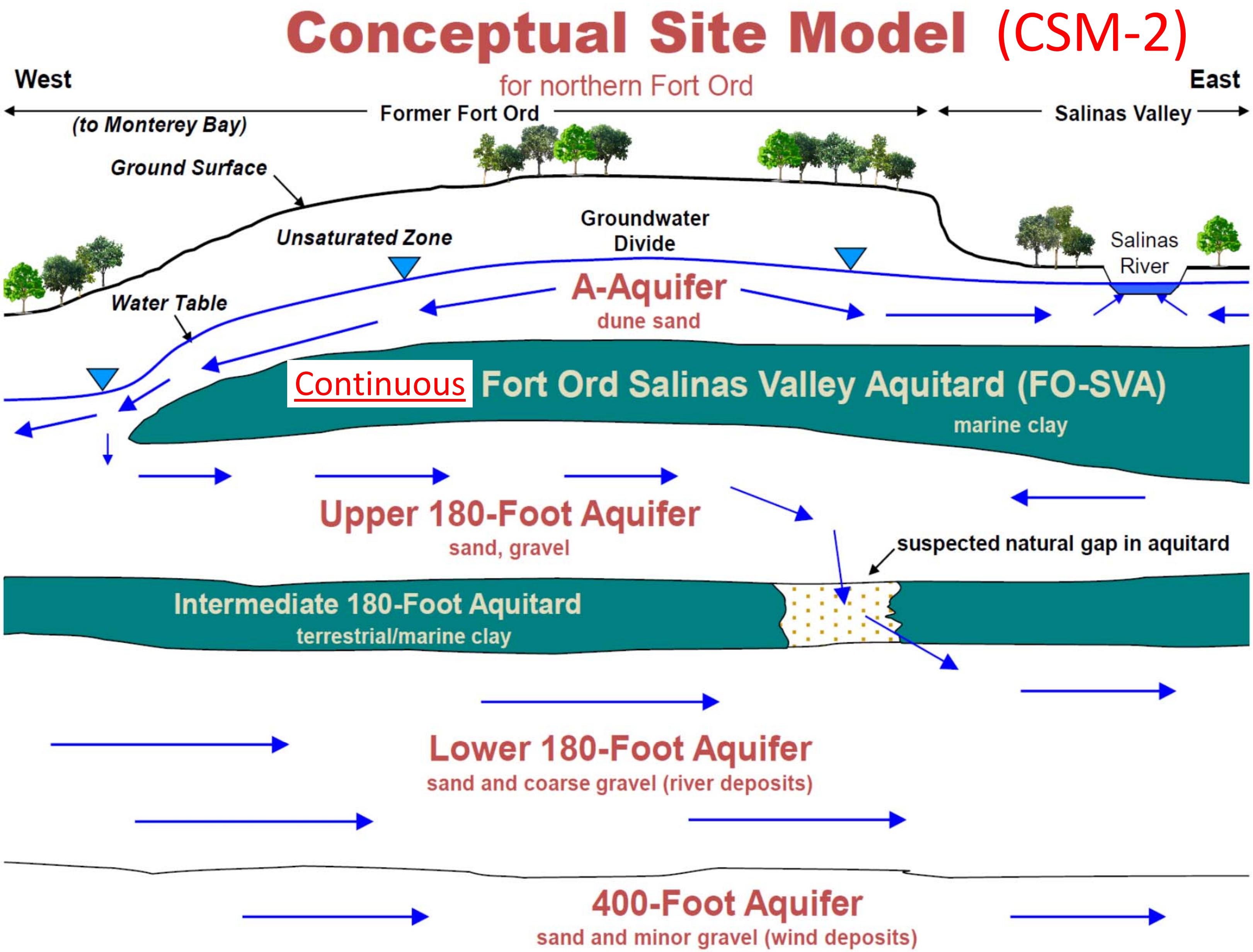


Figure 1: The Conceptual Site Model (Figure 1 at the left) describes groundwater conditions beneath former Fort Ord. Four aquifers are underlying former Fort Ord: A-Aquifer, Upper 180-Foot Aquifer, Lower 180-Foot Aquifer, and the 400-Foot Aquifer. Aquitards bound the A-, Upper 180-Foot Aquifer, Lower 180-Foot Aquifer, and 400-Foot Aquifers.

Groundwater flow in the A-Aquifer splits at a groundwater divide and goes toward the Salinas River and Monterey Bay, and enters the Upper 180-Foot Aquifer at the western edge of the FO-SVA. Groundwater may also be entering the Lower 180-Foot Aquifer through a suspected natural gap in the Intermediate 180-Foot aquitard.

Excerpted from Page 1 of http://docs.fortordcleanup.com/ar_pdfs/factsheets/03-09/; annotations in red

Figure 36

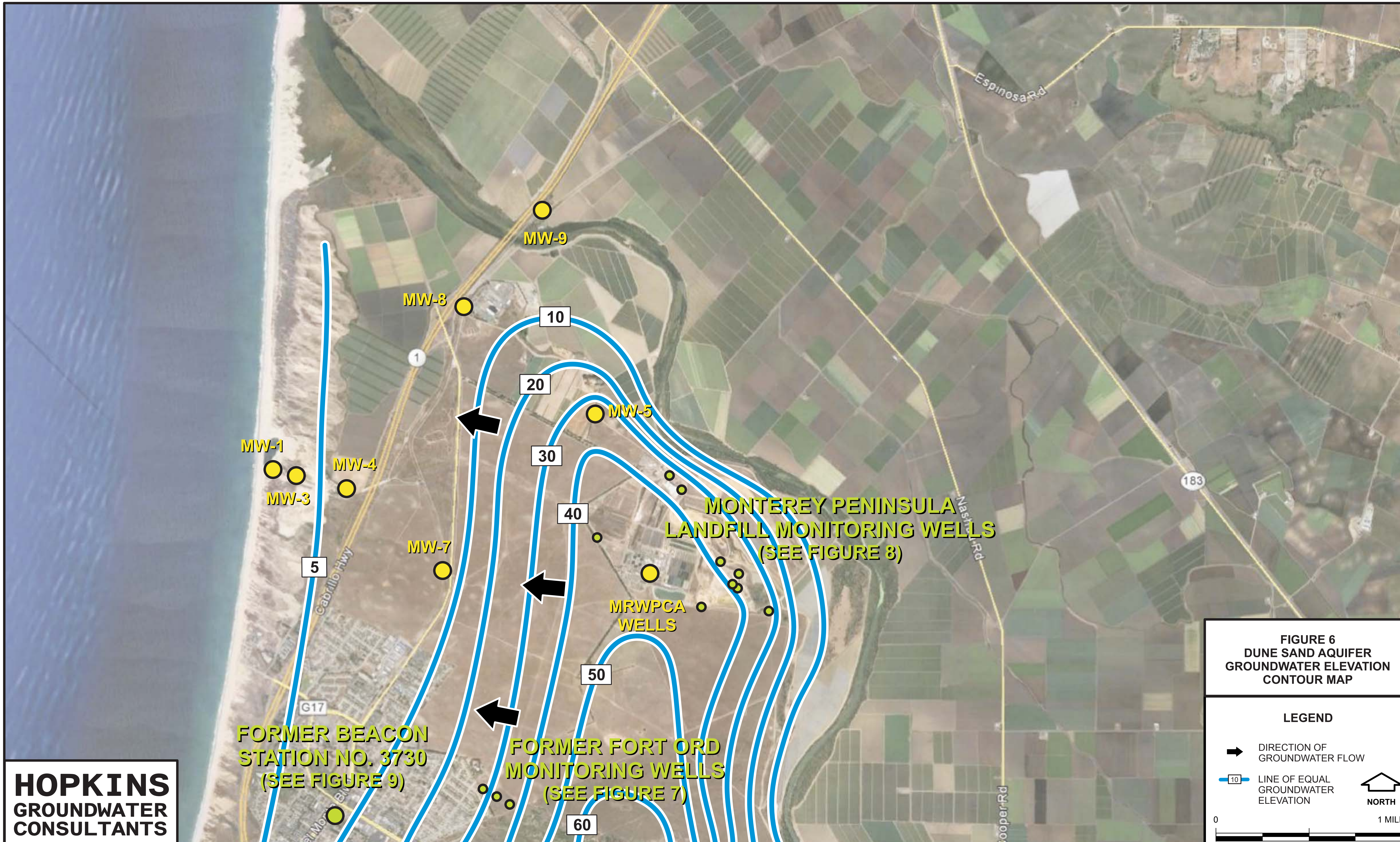
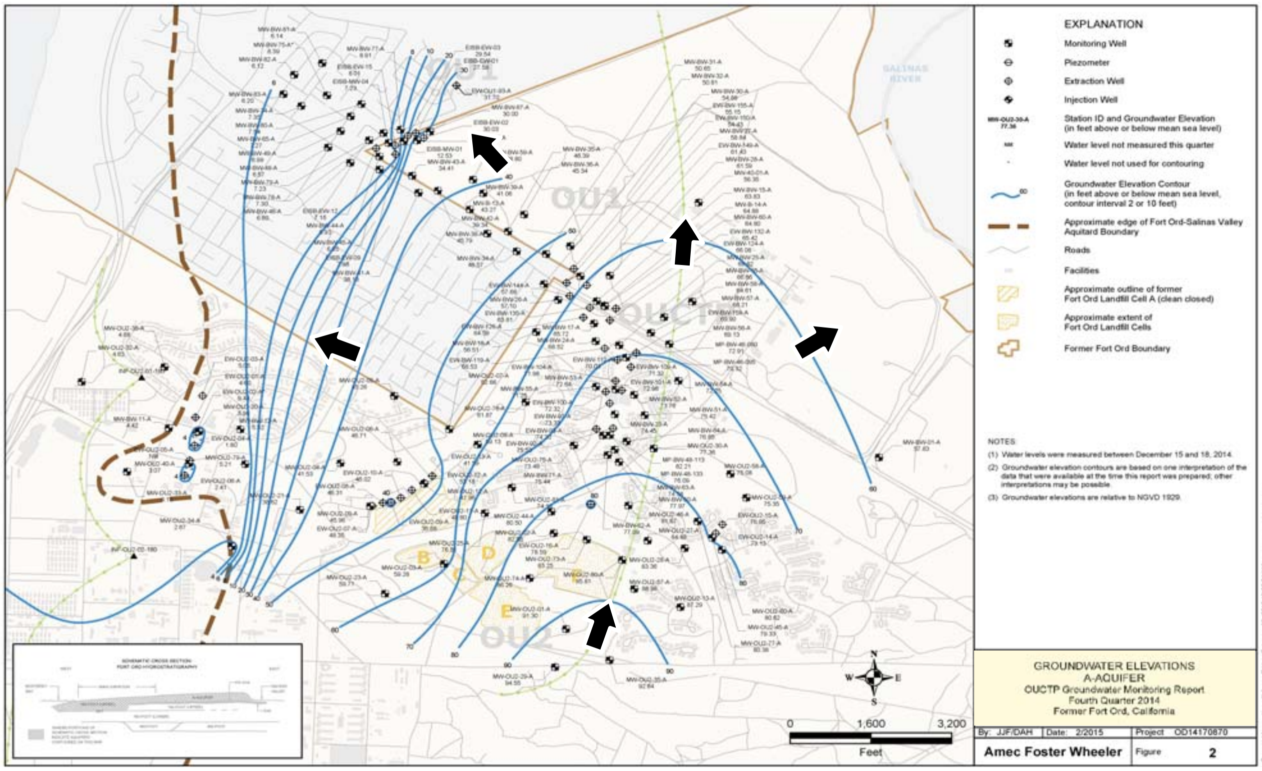
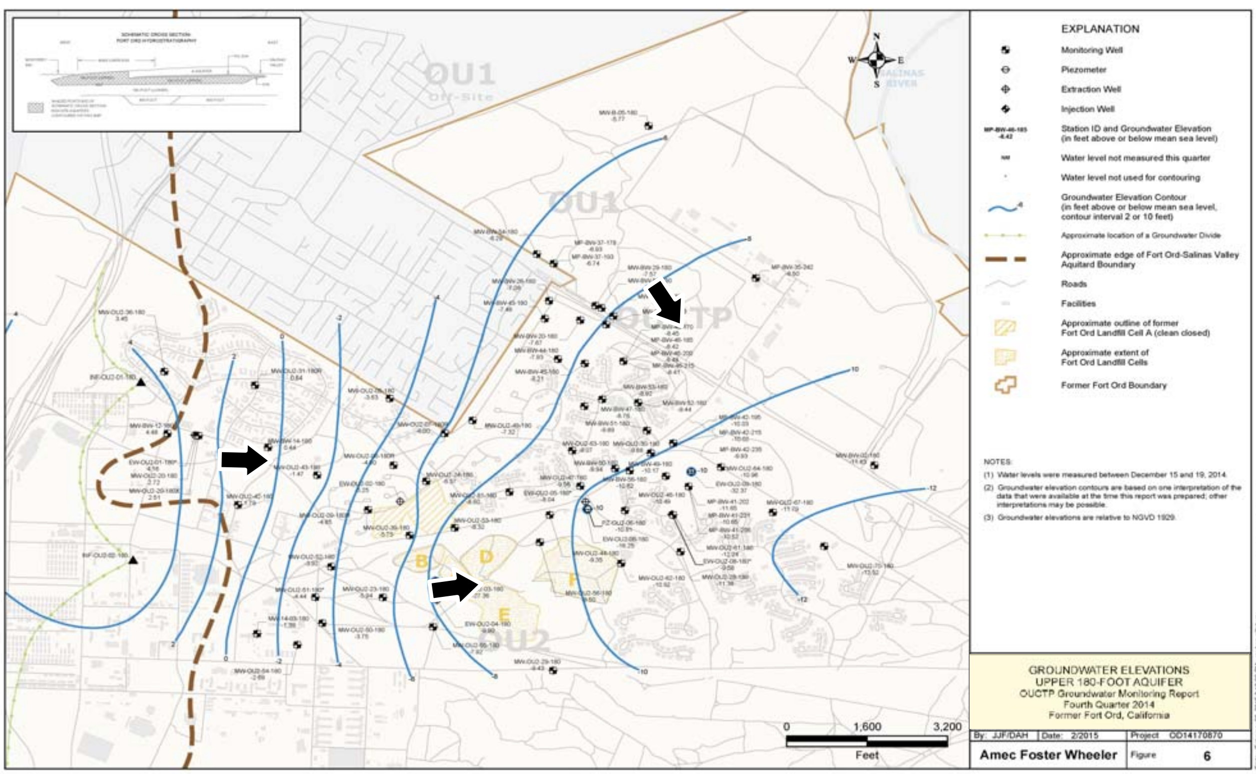

MW-9
MW-8
10
1
20
MW-5
MW-1
MW-4
MW-3
30
40
MONTEREY PENINSULA
LANDFILL MONITORING WELLS
(SEE FIGURE 8)
MW-7
5
Cabrillo Hwy
MRWPCA
WELLS
50
G17
FORMER BEACON
STATION NO. 3730
(SEE FIGURE 9)
FORMER FORT ORD
MONITORING WELLS
(SEE FIGURE 7)
60
Espinosa Rd
Nashua Rd
Cooper Rd
183
HOPKINS
GROUNDWATER
CONSULTANTS
FIGURE 6
DUNE SAND AQUIFER
GROUNDWATER ELEVATION
CONTOUR MAP
LEGEND
DIRECTION OF
GROUNDWATER FLOW
10
LINE OF EQUAL
GROUNDWATER
ELEVATION
NORTH
0
1 MILE

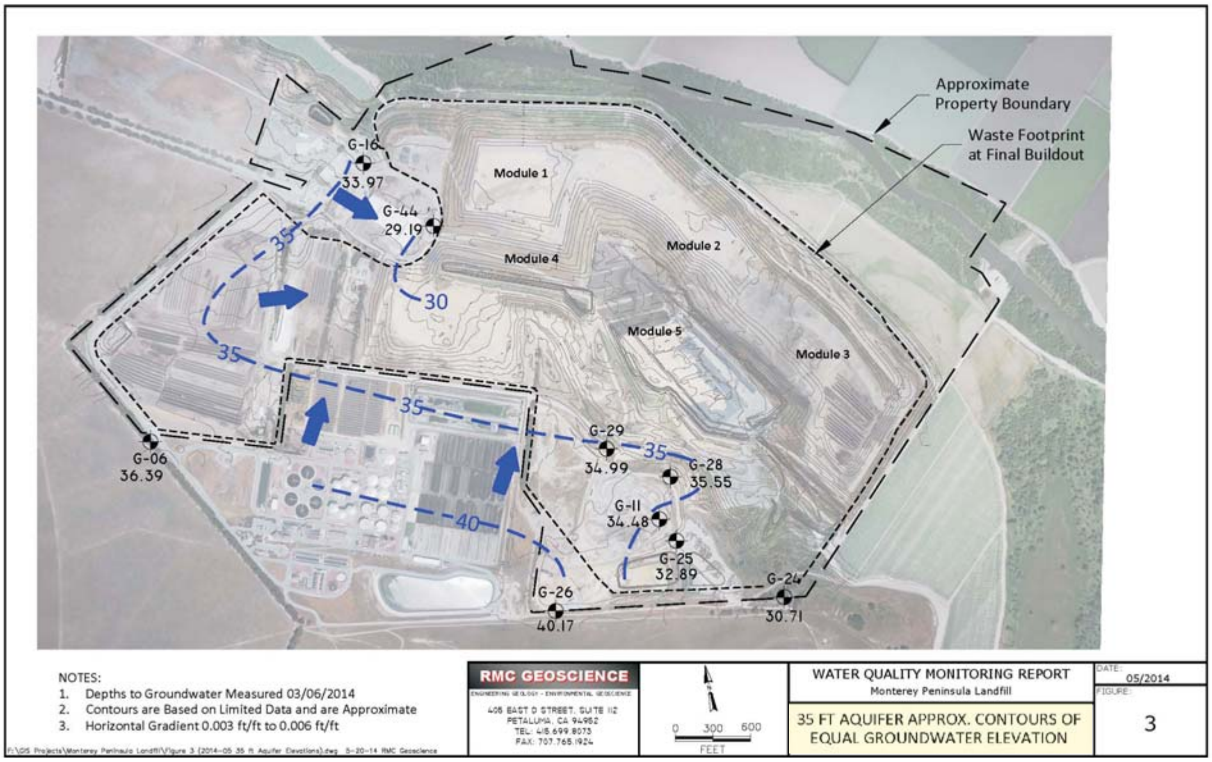
Figure 37

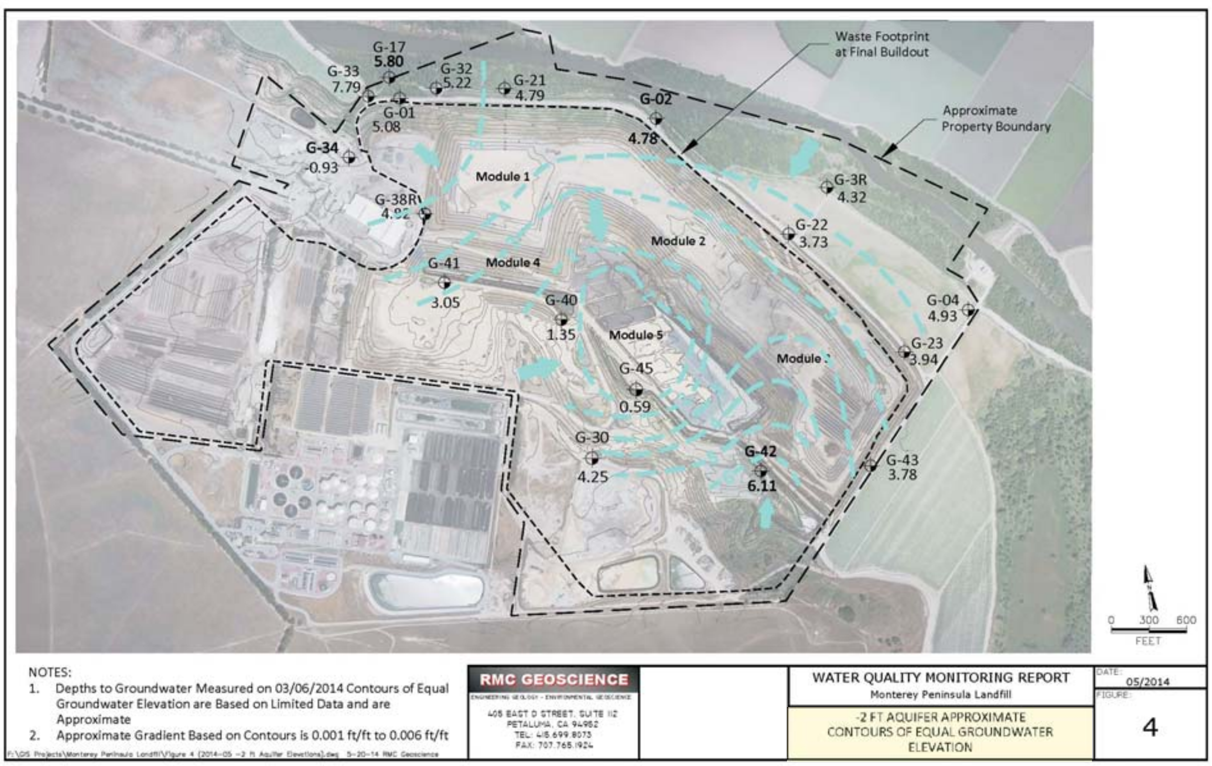




HOPKINS GROUNDWATER CONSULTANTS

FIGURE 7
FORT ORD CLEANUP SITE
GROUNDWATER ELEVATION DATA





HOPKINS GROUNDWATER CONSULTANTS

FIGURE 8
MONTEREY PENINSULA LANDFILL
GROUNDWATER ELEVATION DATA

Figure 39

Legend

- MCWD's Service Area
- DWR Groundwater Basin
- Armstrong Ranch
- Groundwater Divide
- Edge of Fort Ord-Salinas Valley Aquitard
- Groundwater Elevation Contour (2' Interval)
- Groundwater Elevation Contour (10' Interval)
- Cal Am Monitoring Well
- Fort Ord Monitoring Well

Well Labeling

MW-5S — Well ID
35 — Groundwater Elevation (ft MSL)

Abbreviations

Cal Am = California American Water		MCWD = Marina Coast Water District	
DWR = Department of Water Resources		mg/L = milligram per liter	
ft MSL = feet mean sea level		TDS = total dissolved solids	

Notes

1. All locations are approximate.
2. Groundwater levels obtained from Reference 2 are measured in May 2016. Groundwater levels at Fort Ord are measured during June 2016 (Ahta, 2016. Final Operable Unit Carbon Tetrachloride Plume Second Quarter 2016 Groundwater Monitoring Report, Former Fort Ord, California, dated 29 August 2016). All groundwater levels are approximate.
3. Groundwater levels have been correlated for density, where TDS > 10,000 mg/L (see Reference 3).
4. Groundwater elevation contour dashed where approximate.

Sources

1. Aerial photograph provided by ESRI's ArcGIS Online, obtained 21 February 2017.
2. Cal Am Monterey Peninsula Water Supply Project Test Slant Well Long Term Pumping—Monitoring Report No. 55, released 24-May-2016.
3. Guo & Langevin, 2002. User's Guide to SEAWAT, U.S. Geological Survey Techniques of Water Resources Investigations 6-A7, released 2002.

Erler & Kalinowski, Inc.

Groundwater Elevations
Dune Sand Aquifer

Marina Coast Water District
Marina, CA
February 2017
EKI B60094.01
Figure 5

Path: X:\B60094\Maps\2017\02\Fig5_GWE_DuneSandAquifer.mxd

Figure 40

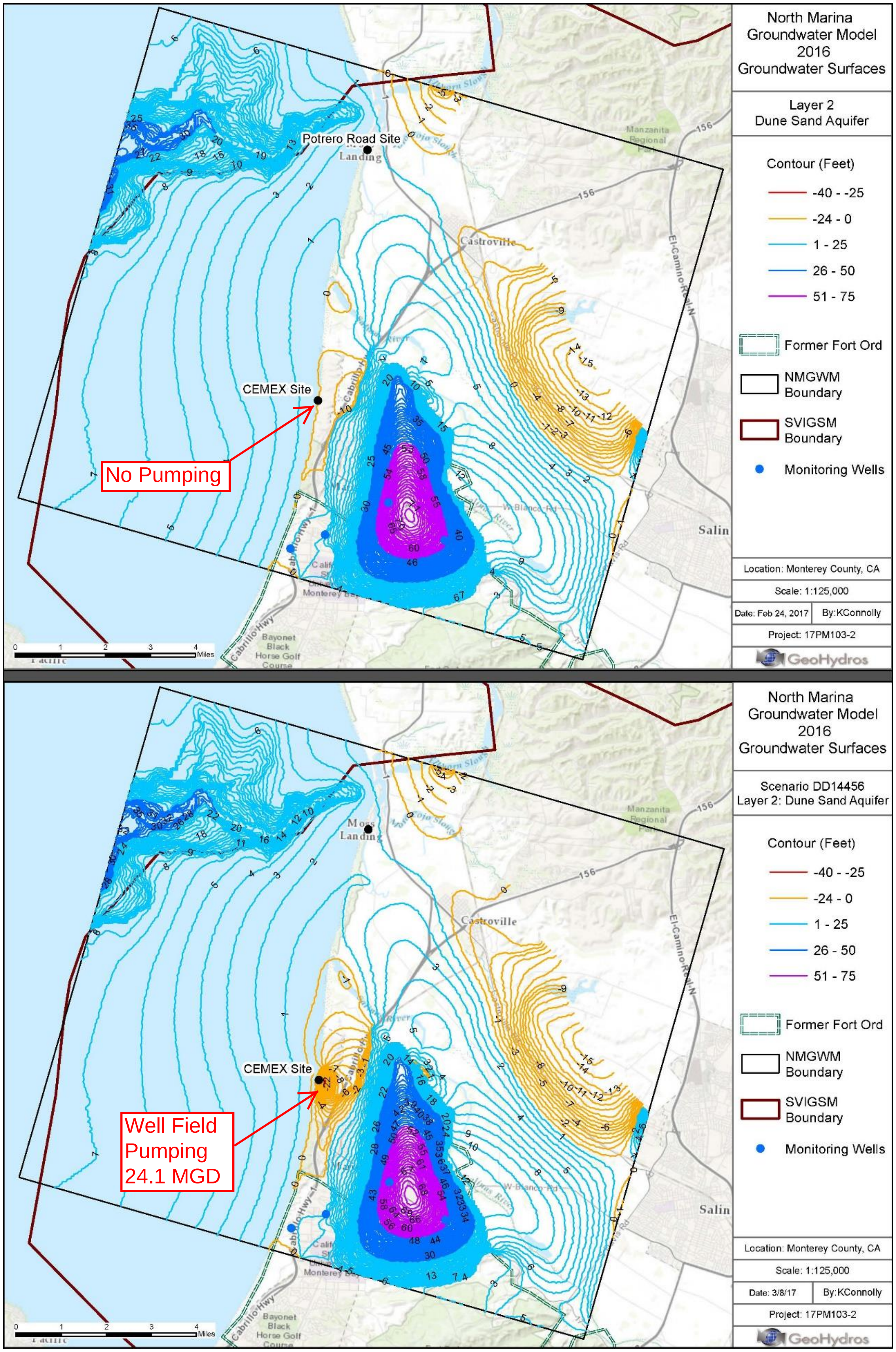
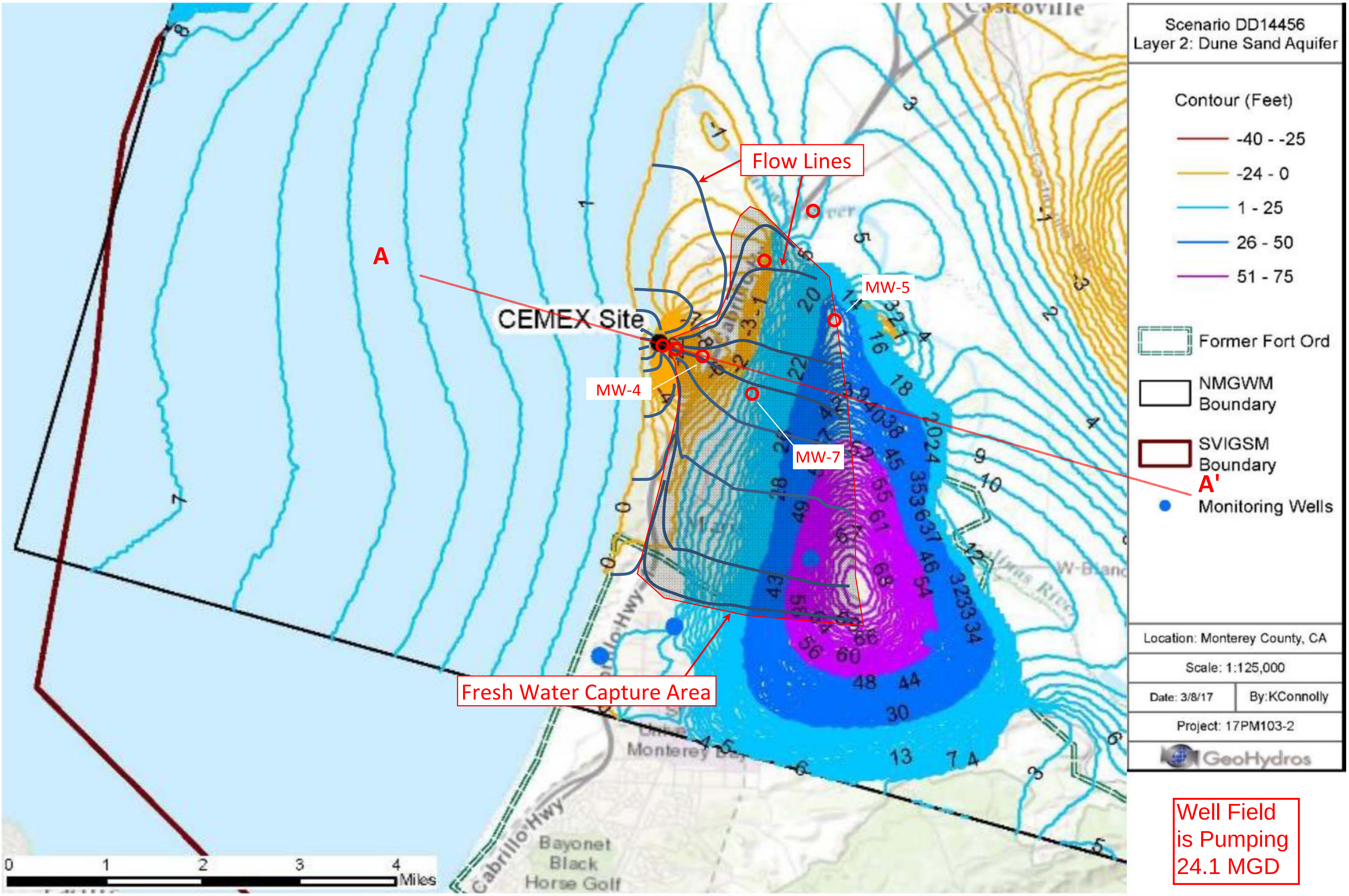


Figure 14. Simulated water table surface in the Dune Sand Aquifer (Layer 2) as portrayed by the calibrated version (top) and Scenario DD1-44/56 (bottom) showing mounding due to recharge in the Dune Sand Aquifer and equivalent fresh water heads assigned as constant values in the ocean resulting in a large eastward gradient across the model.

Figure 41



Well Field is Pumping 24.1 MGD

Figure 14. Simulated water table surface in the Dune Sand Aquifer (Layer 2) as portrayed by the calibrated version (top) and Scenario DD1-44/56 (bottom) showing mounding due to recharge in the Dune Sand Aquifer and equivalent fresh water heads assigned as constant values in the ocean resulting in a large eastward gradient across the model.

With Flow Net and Additional Fresh Water Capture Area (grey shading)

Figure 42