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# Appendix A

# Deep Aquifers Definition, Final Extents Descriptions, and Delineations Using AEM and Other Data

# INTRODUCTION

The Deep Aquifers' extent was developed through a 2-phase process. The first phase of the Deep Aquifers Study (Study) focused on developing a conceptual definition of the Deep Aquifers and conducting a preliminary investigation based on existing data. This provided the foundation for a Phase 1 extent, interim management recommendations, and Study-focused data collection.

The second phase included conducting and integrating field studies, including AEM surveys, aquifer tests, and isotope analysis. With the additional data, the Deep Aquifers' lateral extent was finalized, which provided the basis for the water budget, analysis of current conditions, management guidance, and monitoring recommendations. This appendix summarizes the conceptual definition and the data, methods, and results of the lateral extent delineation. It describes the process of developing the definition, the Phase 1 extent, and the Phase 2 final extent by applying the Study-generated AEM data.

# DEEP AQUIFERS DEFINITION

Previous studies have addressed the Deep Aquifers presence; however, there has been no unifying definition of the Deep Aquifers. Previously applied definitions have included:

- **Thorup, 1976:** The Deep Zone along the coast lies above the Miocene Marine Shale and is Pliocene in age. The top of the Deep Aquifer is the top of the Paso Robles Formation. This aquifer is.
- **Harding ESE, 2001:** The Deep Aquifer refers to the aquifer(s) contained in the middle or lower portions of the Paso Robles Formation and include what have been called the 800-foot, 900-foot, 1,000-foot, and 1,500-foot Aquifers.
- **Feeney/Rosenberg, 2003:** The current use of the term "deep aquifer" essentially aggregates all sediments below the 400-foot aquifer without respect to geology. Data available strongly suggest a multiple aquifer system.
- **MCWRA, 2017:** "Deep Aquifers" will be used to refer to the water-bearing zones in the 180/400 Foot Aquifer Subbasin underlying the Pressure 400-Foot Aquifer.

## Study Definition for Delineation of the Deep Aquifers

For this Study, Montgomery & Associates developed a draft definition of the Deep Aquifers and presented it to the GTAC on February 3, 2022. GTAC discussions and recommendations reflected the complexity of the Deep Aquifers and the complexity of putting a definition on an aquifer system with limited data. The GTAC provided considerations that helped guide the definition and focus the Study, ultimately leading to the final extent.

The agreed upon definition of the Deep Aquifers are that they are water-bearing sediments that:

- Are below a relatively continuous aquitard, or area of higher clay content, that is often encountered between approximately 500 feet and 900 feet below land surface within the Salinas Valley Basin and potentially shallower where uplifted. The relatively continuous high-clay aquitard, or 400/Deep Aquitard, must be below the identified 400-Foot Aquifer, or its stratigraphic equivalent.
- Are in the Paso Robles Formation, Purisima Formation, and/or Santa Margarita Sandstone.

The definition focuses primarily on the presence of an aquitard—or zone with higher incidence of clay—that separates the 400-Foot Aquifer from the Deep Aquifers and is in specific geologic formations. The emphasis on an aquitard, or area of higher aquitard clay contents, reflects the idea that mapping these distinct aquifers requires they be separated from an overlying aquifer by some physical, definable feature. Generally, aquifers are separated by aquitards. This definition is supported by existing data that suggest near the coast, the Deep Aquifers are below a significant amount of clay that occurs below the 400-Foot Aquifer or its stratigraphic equivalent even if not called the 400-Foot Aquifer. This clay has provided protection from vertical migration of seawater to date, and separates the Deep and 400-Foot Aquifers into distinct productive zones.

It is important to distinguish a single continuous clay body/area—called 400/Deep Aquitard—that separates the Deep Aquifers from the 400-Foot Aquifer. Other distinct clay bodies that may occur in the subsurface at similar depths as the 400/Deep Aquitard are not considered the 400/Deep Aquitard; rather they are considered discontinuous and potentially overlying adjacent aquifers materials. They are not overlying the Deep Aquifers. The continuous 400/Deep Aquitard is encountered in the Paso Robles Formation.

The zone in which to encounter the 400/Deep Aquitard has been defined as generally occurring between 500 feet and 900 feet below land surface. This is based on the dipping trough structure of the Salinas Valley Basin and to be more accommodating of the heterogenous sediments in the subsurface. Where structural features impact the depth of formations, the depth to the 400/Deep Aquitard may be impacted and occur at shallower depths. Therefore, maintaining integrity with the continuity of the 400/Deep Aquitard and the established hydrostratigraphy of the Basin focused the data analysis in structurally deformed areas.

Another way to distinguish the 400/Deep Aquitard is the presence of porcelaneous chert within drill cuttings, which is indictive of source material from older sedimentary, sources and of the Paso Robles Formation. Other depositional/alluvial features in the subsurface may not have this clast type, may be considered sourced from other materials, and are therefore considered a different depositional feature or sediment adjacent to the Deep Aquifers and 400/Deep Aquitard.

The geologic formations are important because the 400/Deep Aquitard is encountered in one of the most dominant formations in the Salinas Valley, the Paso Robles Formation, to which previous investigators have linked to the Deep Aquifers. The Purisima Formation is generally either adjacent to or beneath the Paso Robles Formation, does not crop out in the Salinas Valley, and is only encountered at depth. Therefore, any wells completed in the Purisima Formation are assumed to be exclusively in the Deep Aquifers. The Santa Margarita Sandstone is not a consistent geologic layer within the Salinas Valley Basin, however, is included in the Basin conceptual hydrostratigraphy. It is considered to lie below the Purisima Formation, and subsequently wells completed in the Santa Margarita Sandstone are also assumed to be in the Deep Aquifers where the continuous 400/Deep Aquitard is encountered.

This definition is also intended to be comparable to previous definitions of the Deep Aquifers, such as those listed at the beginning of this section, and also includes a set of optional secondary characteristics to account for uncertainty and subsurface complexity when evaluating whether a well is in the Deep Aquifers. The characteristics are electrical resistivity, screen interval depth and extent, similar lithology and/or borehole geophysics to established nearby Deep Aquifers wells, differences in water quality from overlying and adjacent aquifers, and differences in groundwater levels from the overlying 400-Foot (or equivalent) Aquifer.

The optional secondary characteristics are necessary because of the subsurface complexity. The sediments which comprise the subsurface materials and productive aquifers are a mix of sands, gravels, clays, and silts throughout most of the geologic formations where the Deep Aquifers are encountered. These geologic formations record the basin's historical relationship with advancing and retreating seas, the continual tectonic and erosive forces acting on the Gabilan and Sierra de Salians Ranges, and the continued evolution of the Salinas River resulting in subsurface complexity. The secondary criteria help address this complexity and uncertainty frequently encountered in the subsurface. Figure A-1 shows a flowchart developed for this definition and was used throughout the Study to reanalyze existing and Study-generated data.

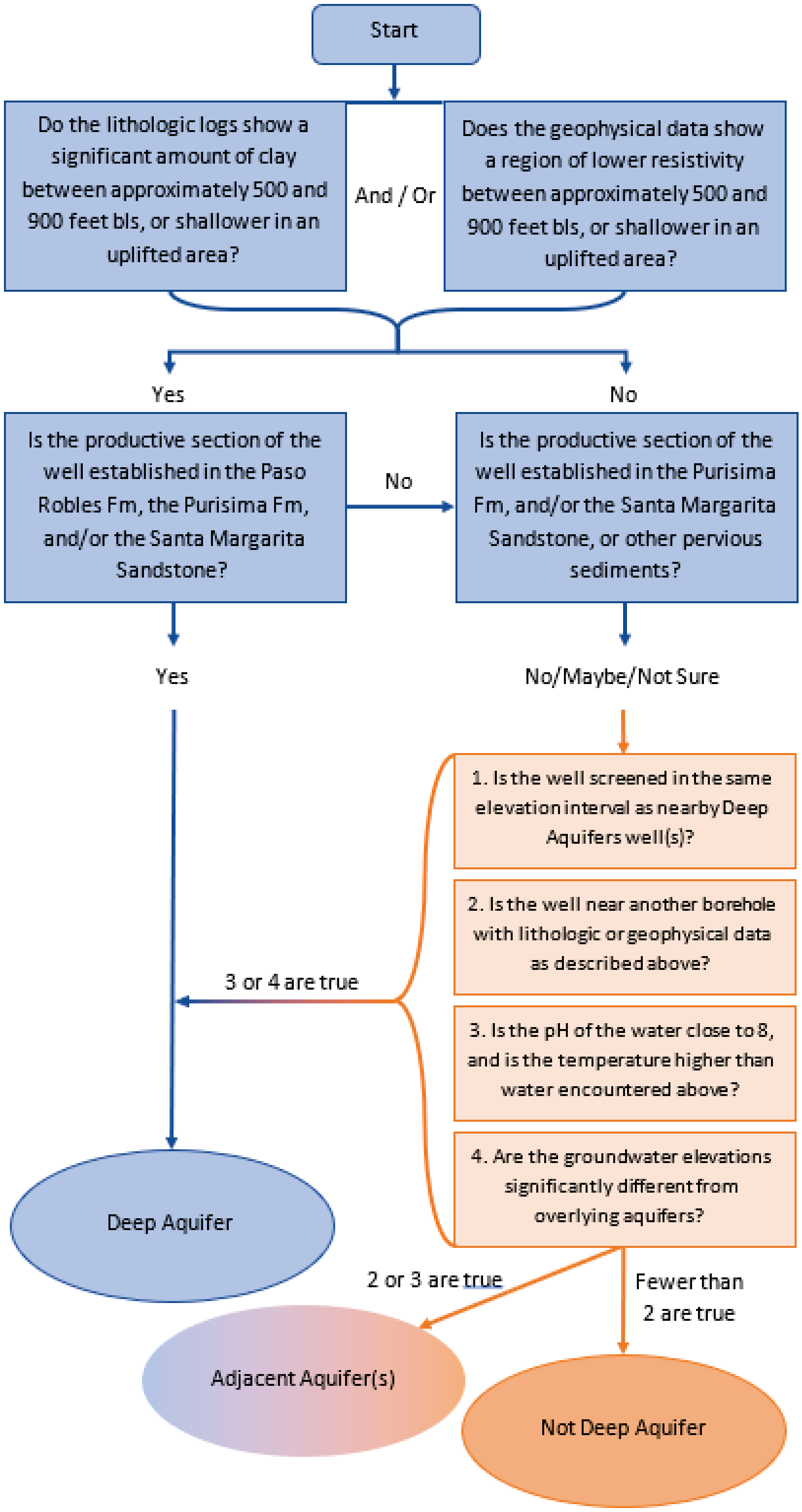


Figure A-1. Deep Aquifers Definition Flow Chart

## DATA

This Study delineated the Deep Aquifers extent by integrating all available data, including well completion reports (WCRs) of 133 deep wells, basin structure from previous geologic reports, 91 e-logs, 2 previous AEM surveys, and an additional 300.3 line-km (186.6 line-miles) of AEM surveys collected specifically for this Study. In addition, 3 monitoring wells were drilled prior to the conclusion of the Study that confirmed the stratigraphy in their respective locations. All data—described in greater detail here—were integrated to produce the refined Phase 2 final extent presented.

### Well Completion Reports

WCRs are records of boreholes that include key information such as driller-observed lithology, screen intervals, and date of well installation. Some WCRs were more detailed than others with more frequent lithologic descriptions, e-logs, and other construction or water level details. All California WCRs are publicly available, with redacted information, through the Online System for Well Completion Reports (OSCWR) database. The Monterey County Health Department, Monterey County Water Resource Agency, and private entities also have WCRs available if WCRs cannot be located through the State site due to varying naming conventions. This Study procured WCRs from all these sources.

### Geophysical Data

The 2 types of geophysical data primarily available for use in this Study were AEM resistivity data and borehole resistivity data. Both types of data send electrical pulses into the subsurface and receive signals back. The received signal helps differentiate subsurface materials and high TDS water. For this Study, most of the resistivity data were interpreted to be indicative of varying sediment type, as most of the Study was conducted far from seawater-intruded areas. The lower resistivity values roughly correspond to finer sediments such as clays and silts, whereas the higher resistivity values roughly correspond to coarser sediments such as sands and gravels. The highest resistivity values were in places of known bedrock such as the Gabilan Range and Sierra de Salinas.

M&A partnered with Ramboll to conduct an additional AEM surveys for the Study, and synthesize these data with previous AEM surveys conducted by DWR. Borehole geophysical logs were collected from various well owners, organized, and included in the AEM analyses for improved AEM validation.

### E-logs/Borehole geophysical logs

E-logs and borehole geophysical logs are important for refining the WCR analysis. The lithology reported in the WCRs is typically from drilling notes and may not be the most accurate representation of the subsurface materials because the cuttings have longer travel times to the surface as the borehole advances. Borehole geophysical tools, such as electrical resistivity loggers, can take *in-situ* measurements and record refined subsurface signals that are then interpreted for more accurate borehole logs. Although some WCRs have e-logs attached, the majority of e-logs for this study were requested from Monterey County Health Department and various stakeholders. Monterey County Health Department shared 254 PDF files of wells, which were organized, reviewed, and matched to wells in the database. M&A and Ramboll incorporated 92 e-logs into the database for Deep Aquifers analysis, and Ramboll used them to verify the AEM subsurface resistivity data.

### AEM Data

AEM data is a measure of resistivity of materials in the subsurface, both solid and liquid. Lower resistivity materials—which have higher electrical conductance—are clays and/or higher total dissolved solids (TDS) water. Higher resistivity materials—which have lower electrical conductance—are sands and gravels and/or lower TDS water. AEM data are collected over broad areas and are therefore useful for filling in the gaps between known points such as wells. This study focused on reviewing and analyzing the lower resistivities at the target depth, as these were easily correlated to higher clay contents.

There have been 3 AEM surveys in the Salinas Basin prior to the Deep Aquifers AEM survey, but only 2 were used for the analysis here as the 2019 survey was a repeat and extension of the 2017 survey. The surveys also collected lithologic logs, geophysical logs, water level information, and water quality information to refine the relationship between resistivity and lithology.

### DWR Surveys

The State of California has conducted AEM surveys across California's major groundwater basins in support of SGMA implementation. The first of these surveys, DWR Survey Area 1, was conducted in 2020 in the Salinas Valley and Paso Robles Basins using the SkyTEM 312 system. The average depth of investigation with this survey/these data is approximately 150 to 400 meters (492-1,312 feet). This survey is shown on Figure A-2 as pink lines.

The second of these surveys, DWR Survey Area 8, was conducted in 2022, focused on the coastal areas of the Salinas Valley Basin, and included some flightlines in Monterey Bay. Several of these flightlines repeat the same lines as the coastal lines described below. The average depth of investigation with this survey/these data is approximately 150-400 meters (492-1,312 feet). This survey is shown on Figure A-2 as purple lines.

### Coastal Surveys

Marina Coast Water District conducted 2 coastal surveys, one in 2017 and one in 2019, to estimate the seawater intrusion extent. The AEM system used in the 2019 survey is the SkyTEM 312 system, which is the same as used in the DWR Statewide AEM Surveys. As the 2019 survey was a repeat and extension of the 2017 survey, only the 2019 data are incorporated into the analysis for this study. The average depth of investigation with these data is approximately 150 to 400 meters (492-1,312 feet) because it used the same tool as the DWR statewide surveys. The areas of seawater intrusion impacted the depth of investigation as high saline/high TDS water interfere with the signal, resulting in shallower depths of investigation. This survey is shown on Figure A-2 as black lines.

### Deep Aquifers AEM Study

The AEM survey conducted for the Deep Aquifers Study employed a customized tool to extend the depth of investigation to identify and locate the 400/Deep Aquitard in the subsurface. Additionally, the survey flightlines for this study were selected to fill in the gaps from the DWR surveys, provide a more complete picture of the subsurface at the greater depth, and interrogate areas where questions on the extents were most pertinent. Depth of investigation ranges from 350 to 400 meters (1150-1310 feet) in coastal areas, to up to 600 meters (1970 feet) in inland areas. This survey is shown on Figure A-2 as blue lines.

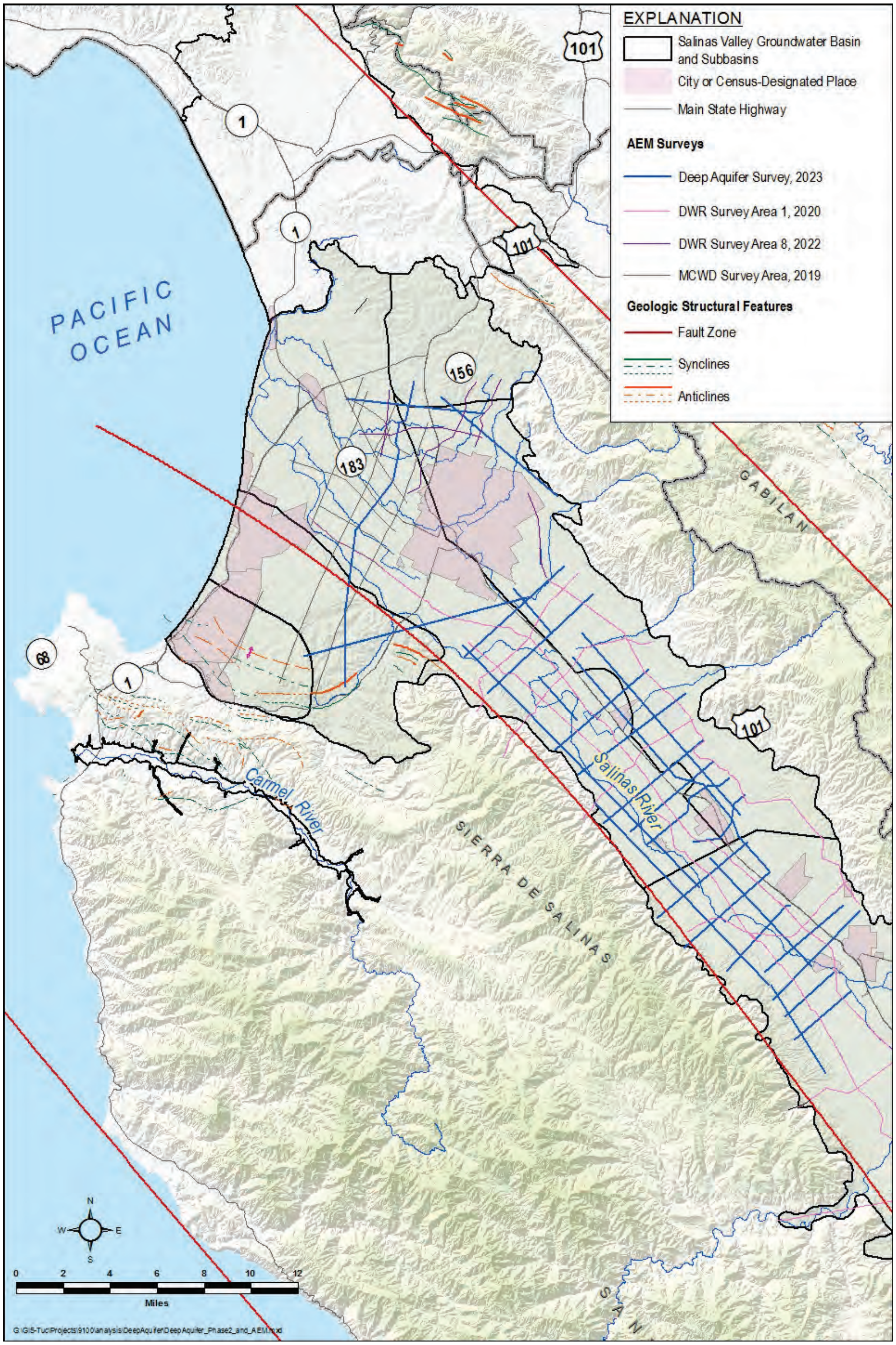


Figure A-2. AEM Survey Lines

## Previously Prepared Reports

Previous reports on the Deep Aquifers or specific well investigations helped limit the extent of the Deep Aquifers. Several of these reports focused on the installation of a Deep Aquifers well, providing detailed information about the lithologic and water quality setting with which to compare it to other boreholes. Previous published investigations of the Deep Aquifers are listed in Table A-1.

Table A-1. Previous Investigations of the Deep Aquifers

| Date | Author | Title |
|---|---|---|
| 1970 | Greene, USGS | Geology of Southern Monterey Bay and its Relationship to the Ground Water Basin and Salt Water Intrusion |
| 1976 | Thorup, R.R. | Report on Castroville Irrigation Project Deep Test Hole and Freshwater Bearing Strata Below the Pressure 400-Foot Aquifer, Salinas Valley, CA |
| 1976-1983 | Thorup, R.R. | Hydrogeological Report on the Deep Aquifer, Salinas Valley, Monterey County, CA (draft report) |
| 2001 | Harding ESE | Hydrogeologic Investigation of Salinas Valley Basin in the Vicinity of Fort Ord and Marina Salinas Valley, California - Final Report |
| 2002 | Hanson, R.T., *et al.* | Geohydrology of a Deep-aquifer System Monitoring-well Site at Marina, Monterey County, California |
| 2003 | Feeney, M.B., and L.I. Rosenberg, | Deep Aquifer Investigation - Hydrogeologic Data Inventory, Review, Interpretation, and Implications. |
| 2005 | MACTEC Engineering | Final report; Installation of Deep Aquifer Monitoring Wells – DMW-2; Marina Coast Water District; Marina, California |
| 2009 | HydroMetrics WRI | Seaside Groundwater Basin Modeling and Protective Groundwater Elevations |
| 2015 | Brown & Caldwell | State of the Salinas River Groundwater Basin - Hydrology Report |
| 2017 | MCWRA | Recommendations to Address the Expansion of Seawater Intrusion in the Salinas Valley Groundwater Basin; Special Reports Series 17-01 |
| 2018 | MCWRA | Deep Aquifers Roundtable Meeting; March 9, 2018, slide presentation |
| 2020 | MCWRA | Recommendations to Address the Expansion of Seawater Intrusion in the Salinas Valley Groundwater Basin: 2020 Update; Special Reports Series 20-01 |

## MCWRA Deep Wells Designations

Many of the wells within the basin have been designated as Deep Aquifers wells by Monterey County Water Resources Agency (MCWRA). These designations provided the basis for a preliminary initial extent, shown on Figure A-3. These well designations provide anchor points of known aquitard/Deep Aquifers locations and screened intervals of known Deep Aquifers water production. These wells were used as comparison points for nearby deep wells' subsurface lithology and screened intervals.

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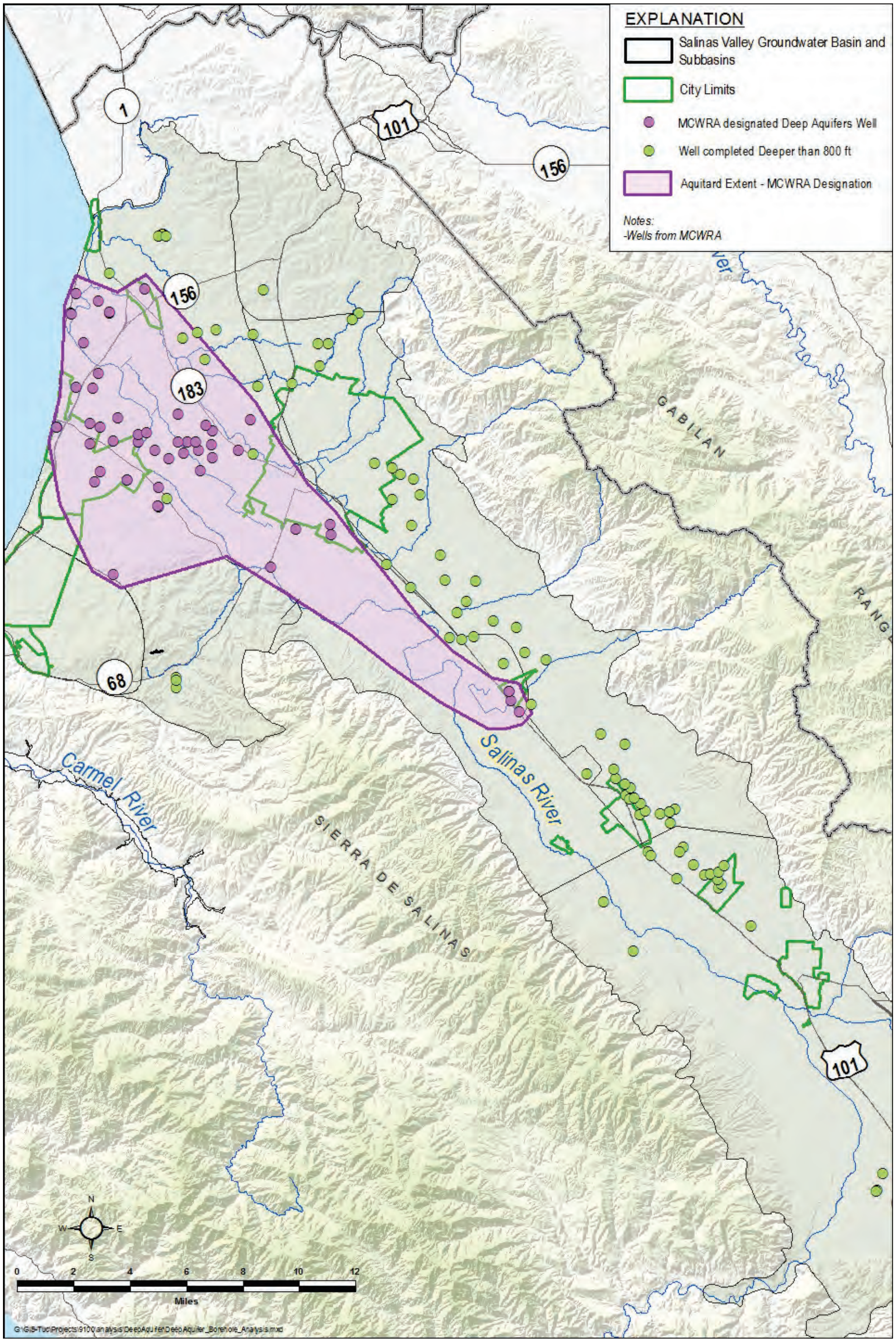



Figure A-3. MCWRA Designated Wells (purple) and Respective Preliminary Deep Aquifers Extent

### Basin Structure

The basin structure used for this analysis was first developed by the USGS in the *Two-Dimensional and Three-Dimensional Digital Flow Models of the Salinas Valley Ground-Water Basin, California* report, and focuses on the bottom of the usable portion of the basin with respect to groundwater resources (Durbin, 1978). The USGS report discusses the fact that the depth to the basement rocks is likely deeper than the modeled basin bottom, however due to compaction and water quality, deeper sediments and sedimentary rocks may not be productive or useful for the basin without additional treatment. The basin structure delineated by the USGS is shown on Figure A-4. The model structure reflects the northwest dipping, asymmetrical trough shape of the Salinas Basin. The portions of the basin structure closer to the Gabilan range are more likely to be in contact with the crystalline rocks of the Gabilan Range, thereby representing the actual bottom of the basin. The portions of the basin closer to the Sierra de Salinas are less likely to be in contact with the crystalline basement, and subsequently represent the usable basin thickness.

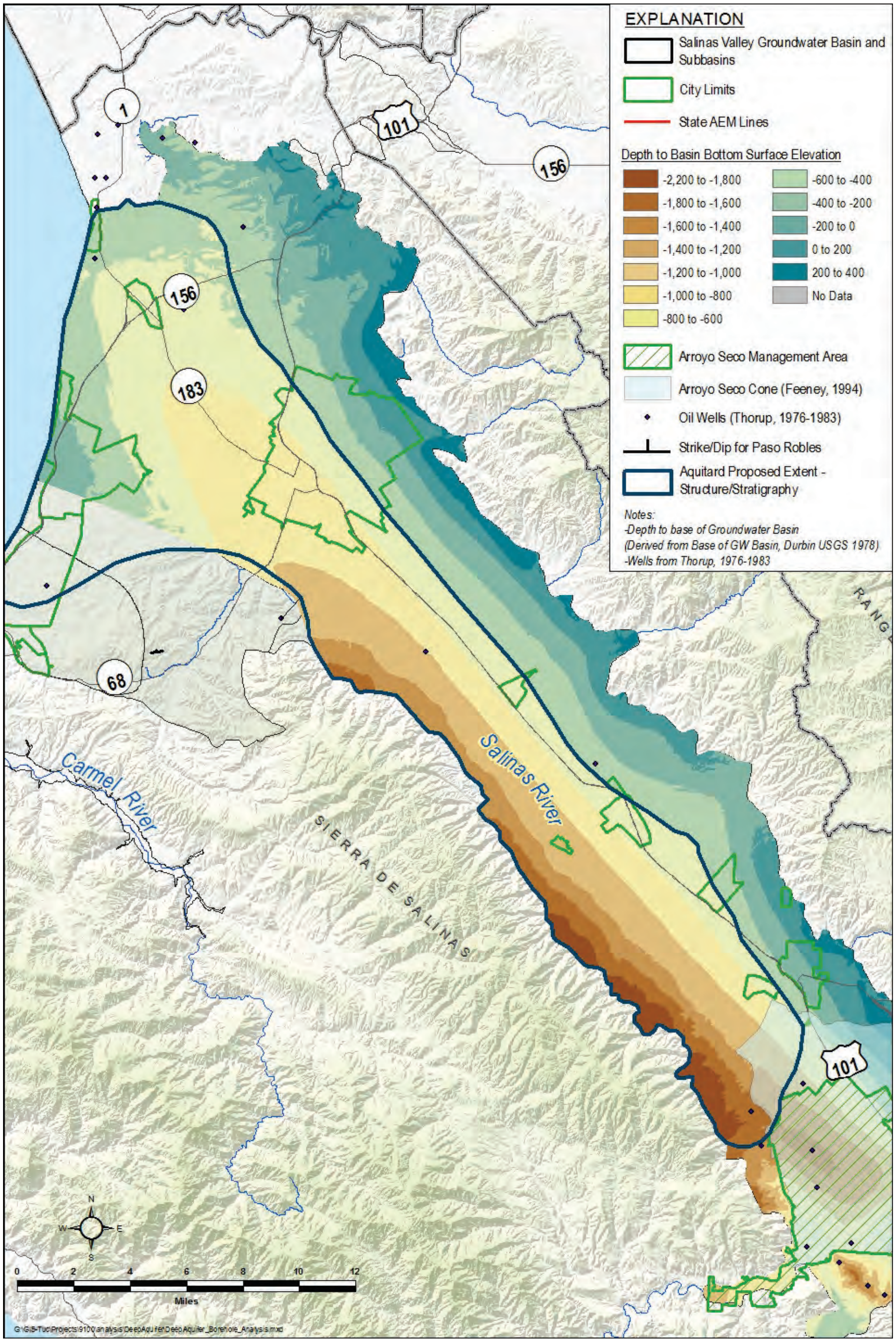



Figure A-4. Basin Structure Extent with USGS Model Contours

#### Paso Robles Formation Extent

The extent of the Paso Robles Formation in the subsurface was first described in the *Hydrogeological Report on the Deep Aquifer, Salinas Valley*, with additional supporting plates prepared in 1983 (Thorup, 1976; Thorup, 1983). This was one of the earliest investigations to characterize the Deep Aquifers in the Salinas Basin. The report assessed oil exploration wells, deep wells, geophysical data, and geological maps to determine the extent of the Paso Robles Formation; which was assumed to constitute the Basin's deeper productive zones. The extent of the Paso Robles Formation in the subsurface as described in this report is shown on Figure A-5.

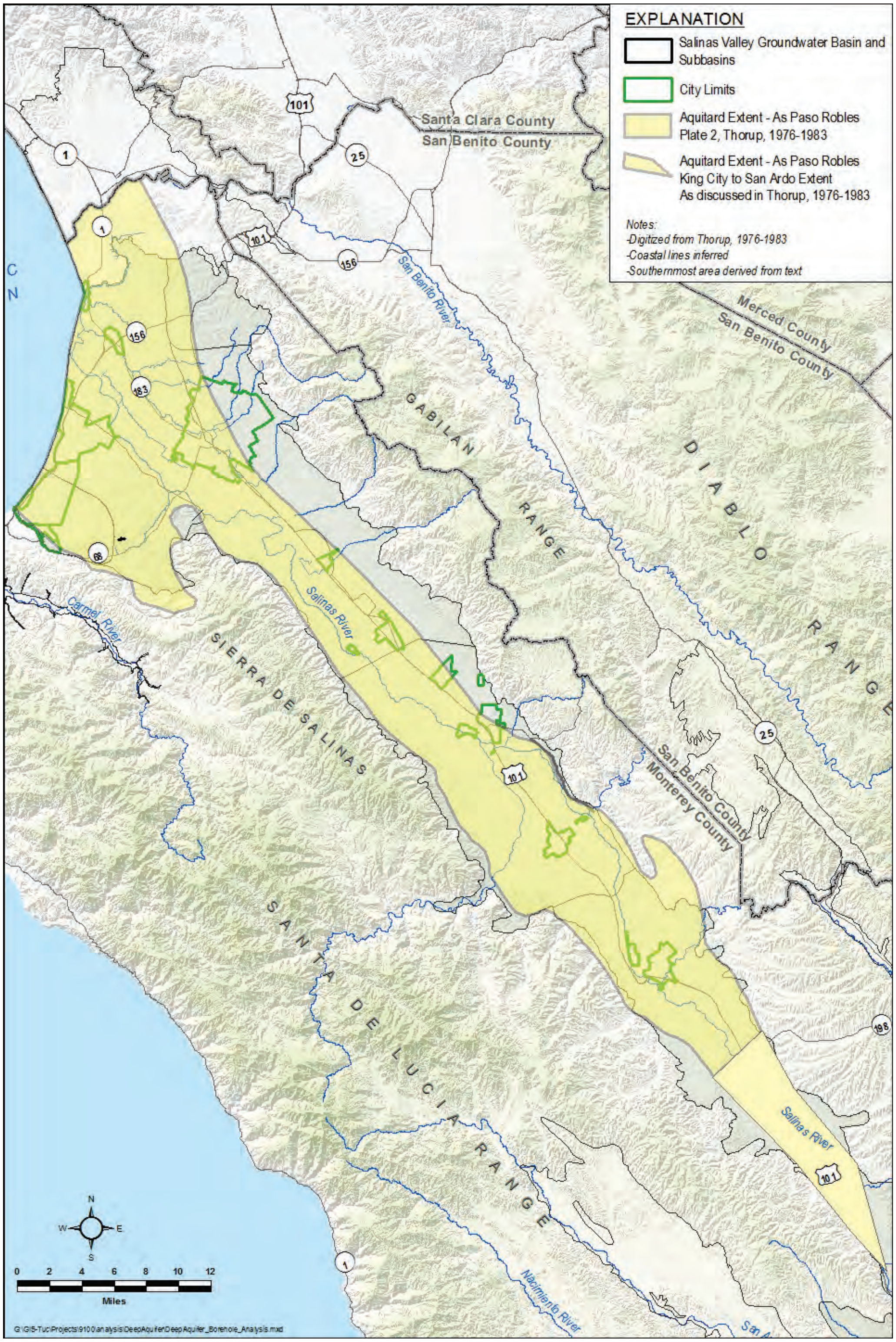



Figure A-5. Extent of Paso Robles Formation as Described by Thorup (1976), Appended at Coast

# METHODS

The Deep Aquifers' extents are primarily delineated by identifying and locating the 400/Deep Aquitard, as guided by the Deep Aquifers definition. The methods for locating the Deep Aquifers extents were iterative as new data became available throughout the Study.

## Delineating Lateral Extent – Phase 1

Phase 1 focused on analyzing and integrating all pre-existing data within the framework of the Deep Aquifers definition. Pre-existing data included WCRs, e-logs, previously published data, and previous AEM surveys.

### Well Completion Reports

WCRs were the first set of data M&A reviewed to assess the extent of 400/Deep Aquitard and the Deep Aquifers. M&A evaluated the WCRs to identify where there was a higher incidence of clay or fine-grained material in the subsurface at the target depth of approximately 500 to 900 feet below land surface (ft bls). The higher incidence of clay through this target interval is referred to as the 400/Deep Aquitard throughout this memo.

M&A looked at all wells drilled to 800 feet or greater, based on historical practices and assumptions that the shallowest incidence of the Deep Aquifers was the 800-Foot Aquifer. All WCRs for these wells were compiled and reviewed for aquitard thickness using two methods. Method 1 summed the thicknesses of all clay units from 500 to 700 feet below ground surface (bgs). This is based on local expert recommendations, as well as the traditional definition of the 400-Foot Aquifer occurring primarily between 270 and 470 feet bgs. Method 2 expanded on Method 1 by summing the thicknesses of all clay units from 450 to 900 feet bgs. The aquitard thickness of MCWRA-designated Deep Wells were compared with the aquitard presence and thickness in other deep wells to establish a firm understanding of the aquitard thickness in MCWRA-designated Deep wells and apply it to the other deep wells. Upon comparison, the primary observation was that while the clay incidence separating the Deep Aquifers from overlying aquifers was present, the thickness was variable from well to well. These two initial analyses and review of MCWRA-designated Deep Aquifers wells necessitated a more thorough and standardized approach to evaluating WCRs for clay content and intervals, which is described below.

*Standardized/Thorough WCR Review for 400/Deep Aquitard*

Each WCR was analyzed using the following steps, and recorded in an excel table for future use:

1. Review WCR and note all intervals of clay, or clay/fines-dominant intervals, starting at 450 ft bgs, and continuing to the full drill depth of the borehole. Skip coarse intervals, or non clay-dominant intervals.
2. Review WCR and note screen interval(s).
3. Make note of other sediment characteristics such as color, presence of fossils and shells, or other notable characteristics encountered in the subsurface.
4. Note where the well is located.

This was completed for 131 WCRs, and Figure A-6 shows an example of this analysis.

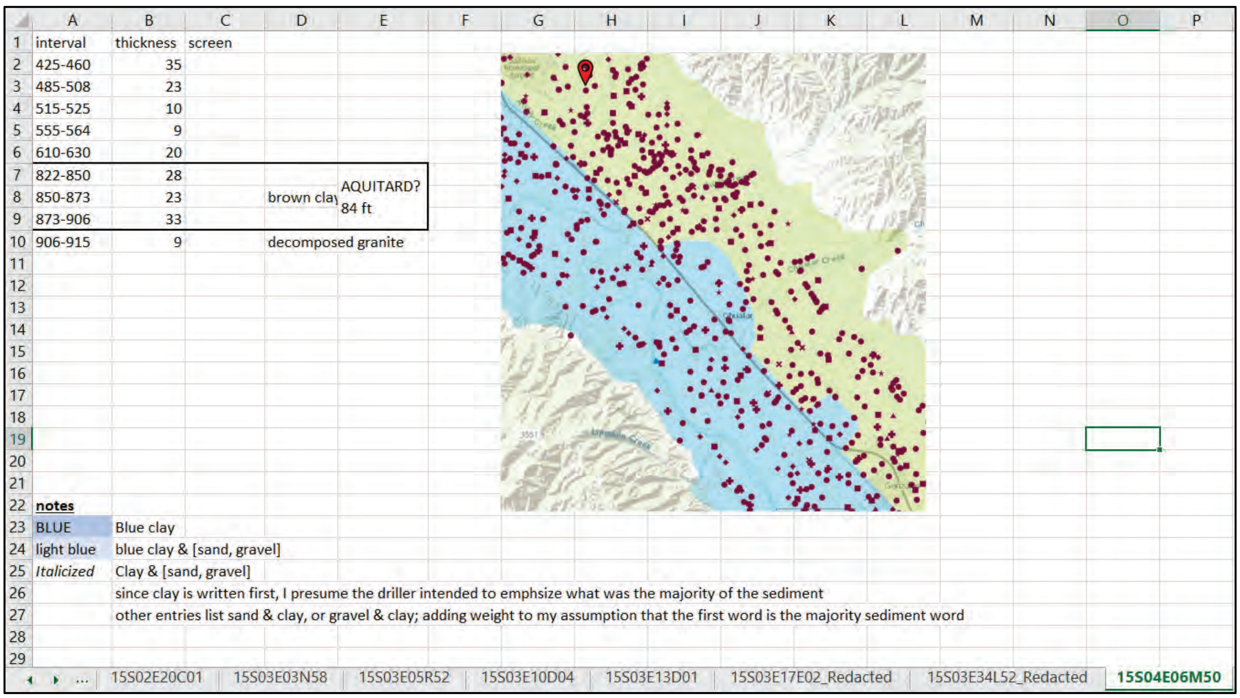



Figure A-6. Example of Standardized WCR Evaluation

This task highlighted certain challenges, including:

- Inconsistent nomenclature
- Poor quality of scanned WCR PDFs
- Difficulty interpreting and correlating inconsistent intervals (e.g., many 5-feet intervals versus a few 50-feet intervals)
- Difficulty interpreting handwritten logs
- Lengthy logs as a result of greater borehole depths

Linguistic Interpretation Over time, various drillers with various levels of expertise and knowledge have drilled and installed hundreds of wells in the Salinas Valley Basin. They each bring these varying levels of expertise and knowledge to their work, which is reflected in their logs. Language choice and interpretation is an important component of evaluating these logs.

The goal in evaluating a borehole for clay content was to identify where there was more clay or fine-grained material in the subsurface. This is a direct result of many local experts describing the aquitard that separates the 400-Foot Aquifer from the Deep Aquifers as less of a competent, continuous, notable single layer of clay, and more of an interval where there is a higher occurrence of clay that effectively acts as a confining unit over the productive zones of the Deep Aquifers. Cautious review of language in the drillers' logs was necessary to derive useful information about the subsurface, and the 400/Deep Aquitard. Table A-2 and Table A-3 provide a list of words and phrases used to identify clay-rich intervals, along with the rationale used to support the note. The phrases selected are non-exhaustive of every notation in every WCR. However, these selections are provided here to demonstrate the bulk of phrases found, as well as the over-arching line of reasoning to delineate sediment intervals from WCRs.

Table A-2. Phrases Used to Determine Clay-rich or Fines-dominant Intervals from Drillers' Logs

| Phrase | Reasoning |
|---|---|
| Clay | "Clay" is a clear indication of sediments encountered. |
| Silt | "Silt" is a clear indication of low permeability sediments encountered. |
| Silty Clay | "Silty" is the modifier to "clay," and both sediments are in the "fines" category, which are low-permeability. |
| Sandy/Gravelly Clay | "Sandy"/ "Gravelly" is the modifier to "clay," whereby "clay" is the dominant sediment, and "Sand" / "Gravel" is the lesser sediment. These intervals were considered ~50% clay/fines. |
| Clay and …<br>Clay/<br>Clay with … | Notes that started with "Clay" were considered to be predominantly clay, earning the primary spot in the notation. |
| Shale | Shale is sedimentary rock formed from consolidated clay/fines, and considered low-permeability. |
| Sandy Clay & Shale | A double mention of clay-based sediments is considered fines/clay-dominant. |
| Shale and … | Notes that started with "Shale" were considered to be predominantly shale/clay/fines, earning the primary spot in the notation. |
| Clay with sand streaks | Notes that started with "Clay" were considered to be predominantly clay, earning the primary spot in the notation. |
| Gravel Streaked Clay/ Sand Streaked Clay | "Gravel Streaked"/ "Sand Streaked" are modifiers to "clay." "Clay" is the dominant sediment, and "Gravel" / "Sand" is the lesser sediment, streaking the clay. These intervals were considered ~50% clay/fines. |

Note: Much of this interpretation is based on relating the phrases to USCS soils-classification flowcharts. Logs that specifically called out clay percentages were strongly considered. Soils with clay percentages at 50% or greater were considered a clay, in the same line of reasoning as the USCS soil classification determination.

Table A-3. Phrases Used to Determine Non Clay-rich or Fines-dominant Intervals from Drillers' Logs

| Phrase | Reasoning |
|---|---|
| Sandy Clay & Gravel | Clay is not the dominant sediment with the presence of a “Sandy” modifier and inclusion of “gravel” |
| Sand/Gravel & Clay | Notes that started with “Sand” or “Gravel” were considered to be predominantly sand, earning the primary spot in the notation. |
| Clayey Sand/Gravel | “Clayey” is the modifier to “Sand”/”Gravel,” whereby “Sand”/”Gravel” are the dominant sediment, and “Clay” is the lesser sediment. These intervals were considered <50% clay/fines. |
| … “with clay”/”with clay lenses”/”with clay streaks” | Clay is not the dominant sediment. Clay exists only as smaller pieces of the whole. |
| Clay Streaked Sand/Gravel | “Clay Streaked” is the modifier to “Sand” or “Gravel.” “Sand” or “Gravel” are the dominant sediments, and “Clay” is the lesser sediment, streaking the sand or gravel. |

This analysis also allowed each well to be assigned a level of confidence that the aquitard as present. Due to the amount of clay in the subsurface, the main confidences were “Yes” and “Maybe” for a primary aquitard that separates the 400-Foot Aquifer from the Deep Aquifers. These categorizations were used for building proposed aquitard extents based on different constraining conditions, as shown on Figure A-7.

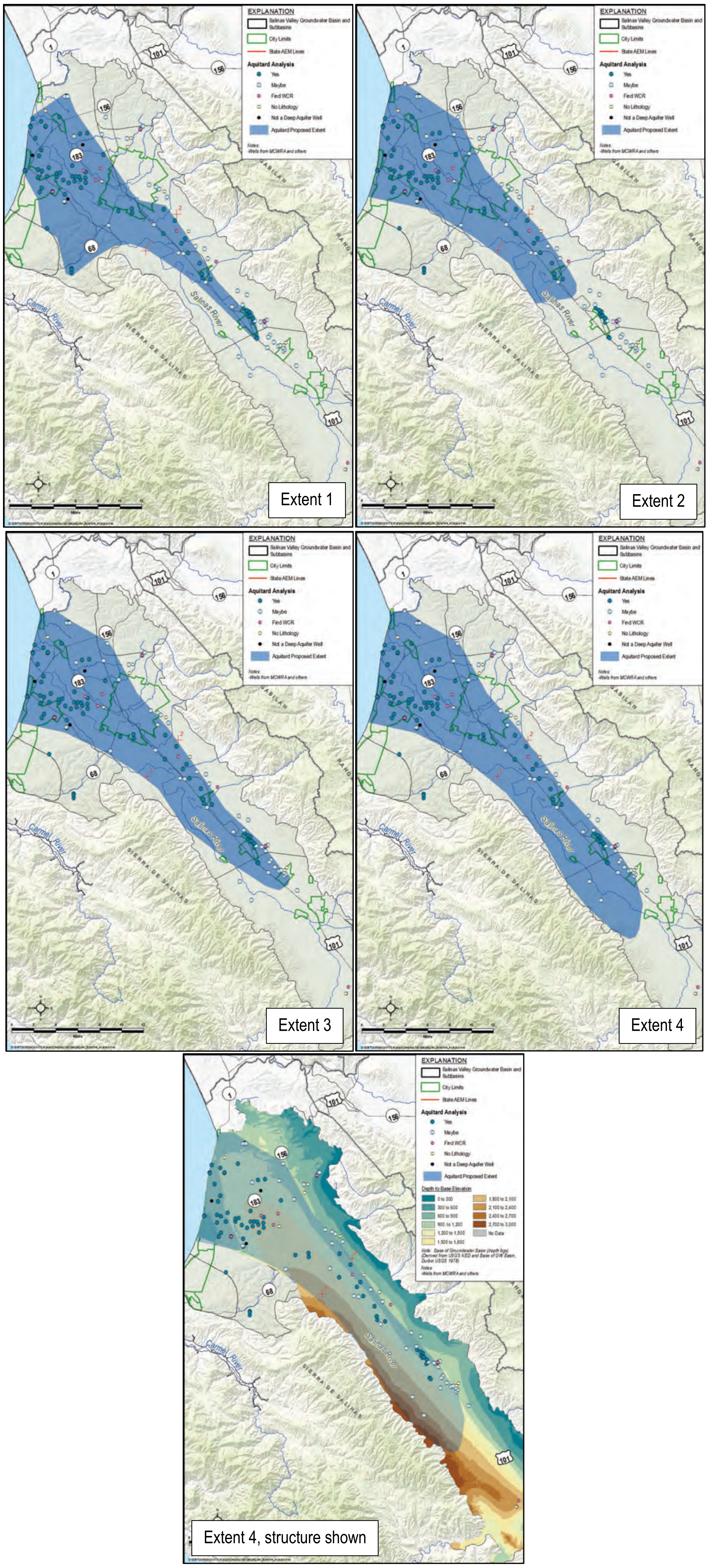



Figure A-7. Proposed 400/Deep Aquitard Extents Based on WCR Analysis and Visualization Analysis/Confidence Assessment

Extent 1 is the smallest extent, fitted as closely as possible to the wells that were categorized with "Yes" aquitard confidence.

Extent 2 is a relatively small extent that includes most of the "Yes" aquitard confidence wells (except near Gonzales), a closeness with the Sierra de Salinas, and excludes the SBWMFO-5/Hoffman well in the Monterey Subbasin. The SBWMFO-5/Hoffman well was excluded because the stratigraphic relationship between the Former Fort Ord highlands, where the well is located, and the lowlands of the main Salinas Basin where the 400-Foot/Deep Aquitard is unclear.

Extent 3 is similar to Extent 2, but includes the wells near Gonzales.

Extent 4 is the largest extent. It includes the wells with "Yes" aquitard confidence and incorporates more structural understanding of the basin. The basin structure used to estimate Extent 4 is from the Durbin basin model from 1978, which is shown on Figure A-7.

Of the proposed extents based on the WCR analysis, extents 2 & 3 from Figure A-7 seemed most probable to move forward with based on integrating existing data and historical reports, as well as conversations with local experts.

*Lith Log Analysis Use – Simplified Lithology*

After analyzing the WCRs for clay and fines-rich intervals, these intervals were tabulated to facilitate construction of a geologic model, using Leapfrog Geo software (Leapfrog Geo). The Leapfrog model was constructed with the borehole information and provides a better visualization of the clay/fines in the subsurface by borehole. The intervals were split into the following 3 simplified intervals for visualization:

- "Clay" (Dark Blue)
- "Clay and" (Light Blue)
- "Not Clay" (White)

These simplified designations for the intervals were selected to broaden the visual scope of the subsurface, and focus on the important components noted in the WCRs. Several boreholes had many intervals of each type. Additionally, boreholes very close to one another could look very different due to a combination of subsurface sediment variability over short distance and variable driller descriptions, resulting in lithologic variability over short distances, similar to the boreholes in the example on Figure A-8.

Figure A-8. Example Leapfrog Borehole Displays for Closely Spaced Wells 15S/02E-04A03 and 5S/02E-04A04

Each borehole was visually inspected in the Leapfrog model to determine the 400/Deep Aquitard presence and interval. This visual inspection was coupled with a comparison to other relevant data to establish the presence of the aquitard. In each borehole, the largest cluster of clay intervals were compared to the well's screened interval and the largest cluster of clay intervals in nearby known Deep Aquifer or other deep to establish the 400/Deep Aquitard depth.

Well screen intervals were an important component of aquitard analysis as a secondary check on site-specific conditions. Drillers, or other water resources professionals who helped design the well, presumably have a conceptual understanding of the subsurface conditions and adjust the well construction to maximize productivity from specific intervals. Due to the nature of the interbedded and complex sedimentation of the Salinas Valley Basin, the screen interval provided a secondary check on aquitard presence and location.

*Development of the 400/Deep Aquitard using Lithology logs*

Once the lithologic visualization was complete, the interval that was determined to be the aquitard was recorded, and the analysis simplified the boreholes into the following 3 categories, shown on Figure A-9:

- Not Aquitard (White)
- Aquitard (Dark Gray)
- Deep Aquifer (White)

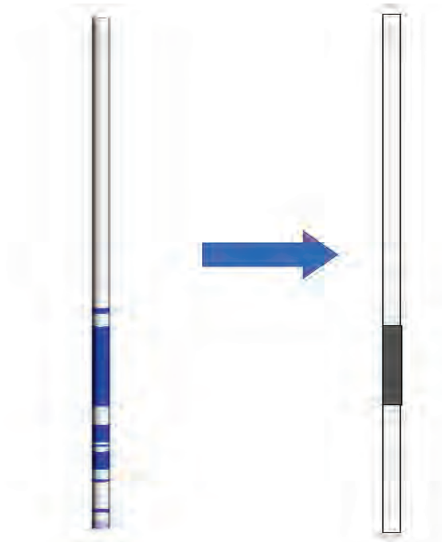


Figure A-9. Example of How Borehole Lithology at Well 15S/04E-21E52 is Converted to Aquitard Delineation

From this simplification and subsequent review in the Leapfrog platform, aquitard surfaces (top/bottom) were generated to create a volumetric representation of the aquitard. This volume was then compared to the reported screened intervals of wells for a more complete view of the aquitard and wells relationships, as shown on Figure A-10.

This visualization helped review the relationship between the 400/Deep Aquitard and well screens based on geography. The wells closest to the coast primarily had screened intervals below the aquitard. Inland wells had screened intervals that spanned the aquitard. This is shown on Figure A-10, with the aquitard represented by transparent purple and the well screens represented by yellow. On this figure, the coast is to the left, and the inland regions are to the right.

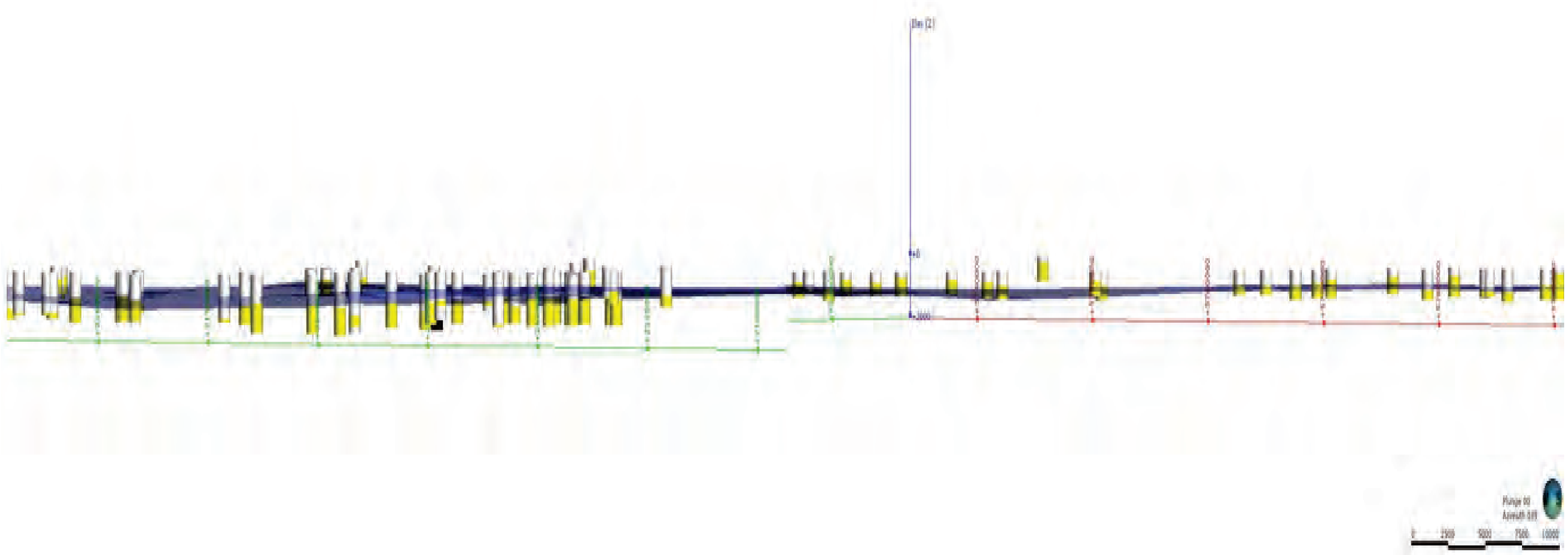


Figure A-10. Extent 2 400/Deep Aquitard and Screen Intervals Comparison

*Final WCR Extent*

The final WCR lithologic log analysis resulted in the Phase 1, or preliminary Deep Aquifers extent shown on Figure A-11. This extent was based on reviewing WCR Extents 2 and 3 against previously published reports and the DWR AEM flightlines to better refine the preliminary extent. The preliminary extent is primarily based on WCR Extent 3, but is refined further from looking more closely at key wells.

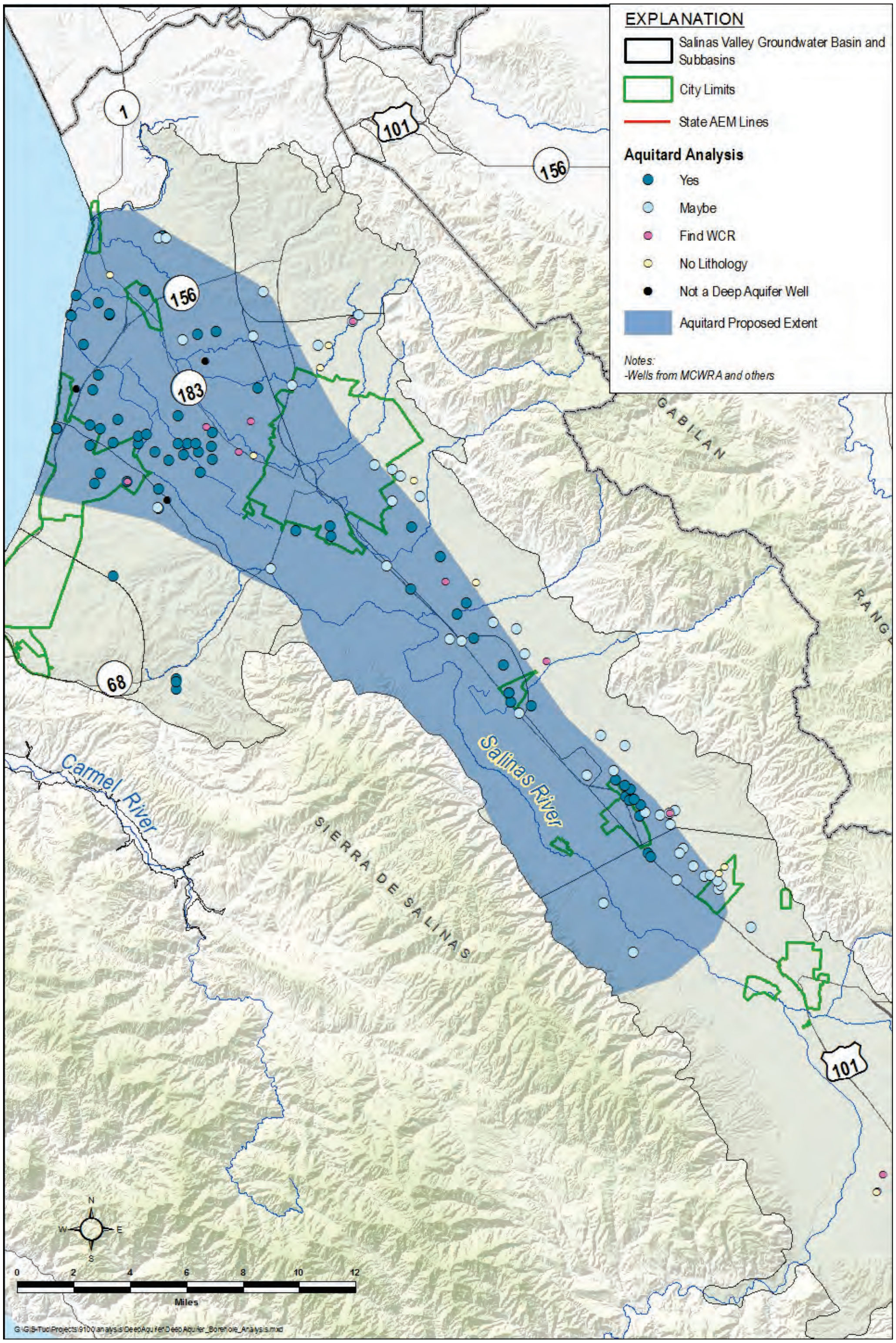



Figure A-11. WCR Based Deep Aquifers Extent from Lithologic Log Analysis

### Geophysical Data

*E-logs/Borehole geophysical Logs*

The Phase 1 analyses reviewed e-logs to try and identify a signature resistivity pattern that indicates the 400/Deep Aquitard. Formations can sometimes be quickly and easily identified through unique borehole resistivity shapes when the electrical pulse encounters a sharp change, or specific facies change. Similar to the WCR analyses, the e-log analysis did not identify or locate a specific or unique resistivity signature to denote the 400/Deep Aquitard. Rather, the higher incidence of clay in the subsurface was reflected in segments of lower resistivity, often below 25 ohm-meters, in the profile of the borehole in the vicinity of the higher clays delineating the 400-Foot Aquifer from the Deep Aquifers.

The primary use of the e-logs during the Study was for ground truthing the AEM resistivity profiles. Ramboll incorporated the e-logs into the AEM inversion process for the Study's AEM survey, as explained in more detail in Appendix 2 of the Deep Aquifers Study Report.

*AEM Data*

Phase 1 analyses incorporated AEM data from 2020 DWR Survey Area 1 and 2019 MCWD surveys. Generally, electrically resistive zones may indicate aquifers, and electrically conductive zones may indicate aquitards and/or high TDS waters. The Phase 1 analysis focused on identifying and locating the continuous 400/Deep Aquitard using the lower resistivity data in the subsurface, and correlating as much additional data as possible to verify sediment types.

The MCWD survey was conducted in the coastal area, and largely focused on the presence saltwater intrusion with high density line placement and a different inversion process. The inversion process from this survey masked some lithologic differences between higher resistivity units and made formation identification challenging. However the flightline density was useful for reviewing continuity of resistivities through geologically challenging areas.

Several of the longitudinal flightlines from DWR Survey Area 1 showed the presence of a lower resistivity unit at the depth of investigation, which coincided with the base of the 400-Foot Aquifer. This supported the location of the 400/Deep Aquitard identified in the WCR analysis and feedback from other experts in the Basin. AEM results from an example flight line are shown on Figure A-12. The hotter colors correspond with the 180-Foot and 400-Foot aquifers. The cooler colors, particularly the green color adjacent to the depth of investigation, corresponds with the 400/Deep Aquitard.

A few of the cross-Basin flightlines from DWR Survey Area 1 showed the presence of a lower resistivity unit in a sloping, wedge coming off the Gabilan Range, seen on Figure A-14 and

Figure A-15. These sloping, lower resistivity units are alluvial fans, and are characteristic of the sedimentary deposits from the Gabilan Range on the east side of the Basin, exemplified on Figure A-13.

These alluvial fan deposits are distinct from the relatively continuous 400/Deep Aquitard encountered in the main body of the Salinas Valley Basin because they are derived from different source material and have different depositional features.

The edge of the alluvial fans are therefore indicative of the extent of the 400/Deep Aquitard.

Two DWR Survey Area 1 cross-Basin flightlines were used to delineate the extent of the alluvial fans originating from the Gabilan Range. These fans are shown in the blue hues (lowest resistivities) on Figure A-14 and Figure A-15.

MONTGOMERY
& ASSOCIATES

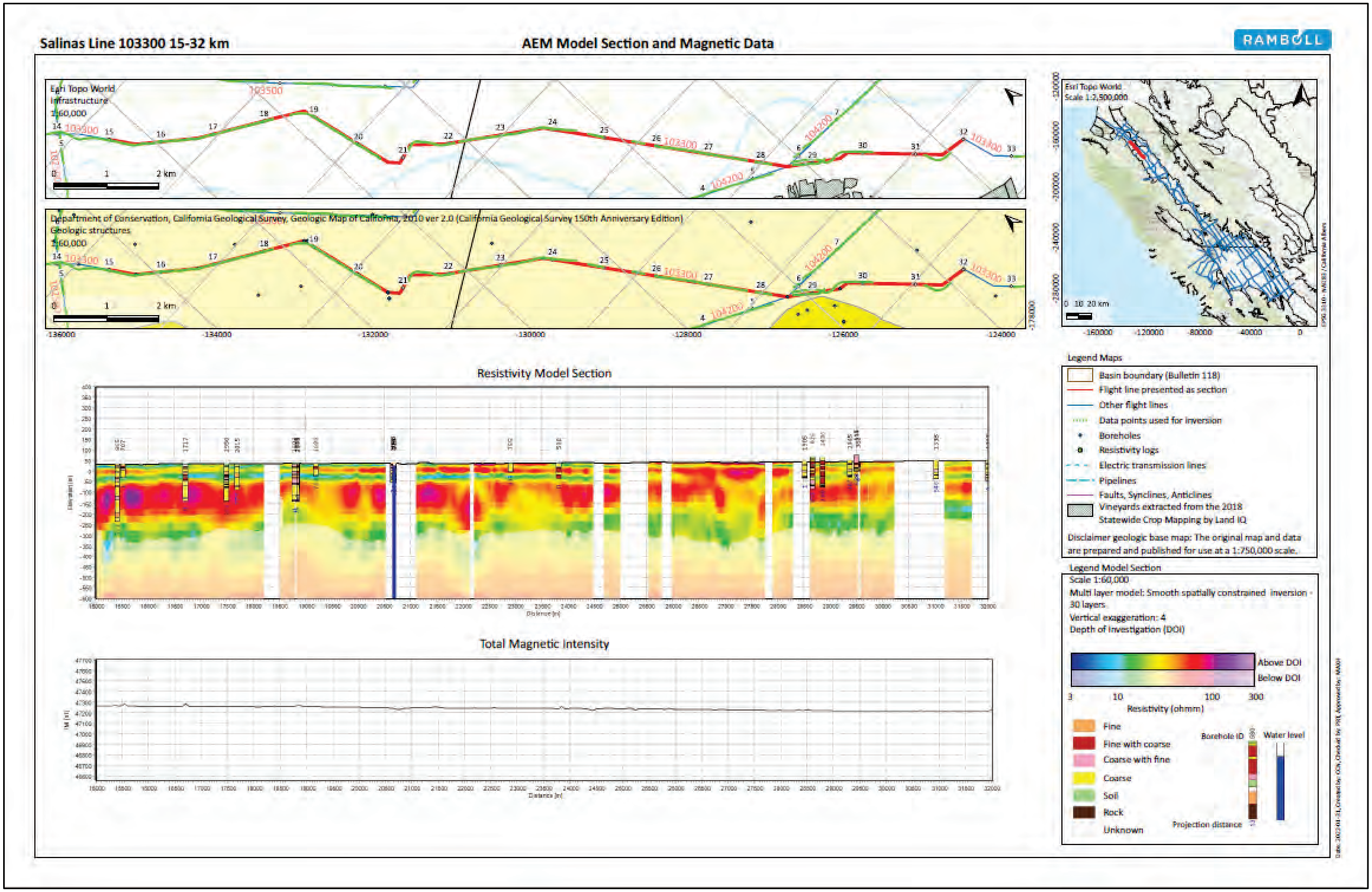



Figure A-12. DWR Survey Area 1, Line 103300, 15-32km Section Showing Lower Resistivities (interpreted as 400/Deep Aquitard) (DWR, 2022)

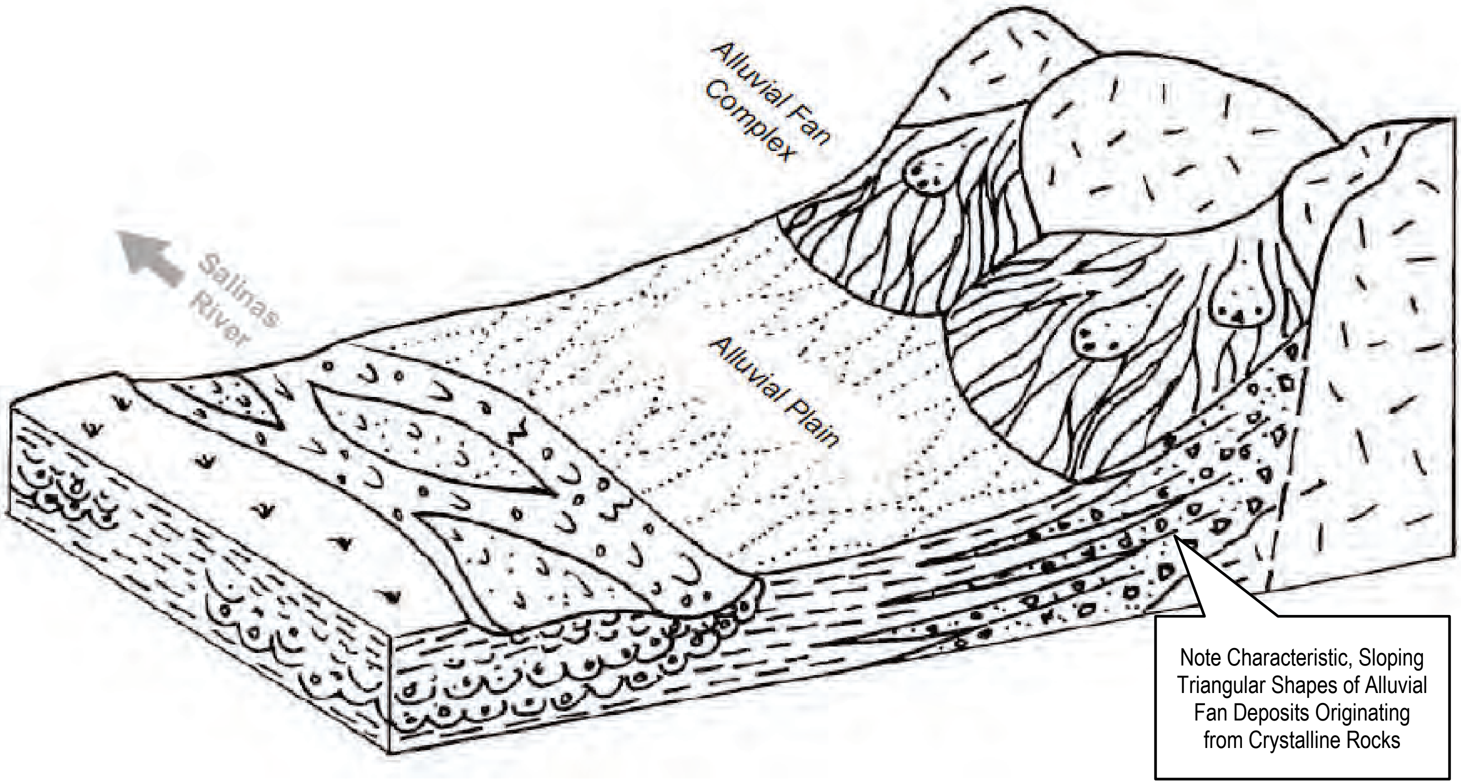



Figure A-13. Cartoon Diagram of Alluvial Fan Complex and Relationship with Salinas Valley Basin Sediments (Kennedy/Jenks, 2004)

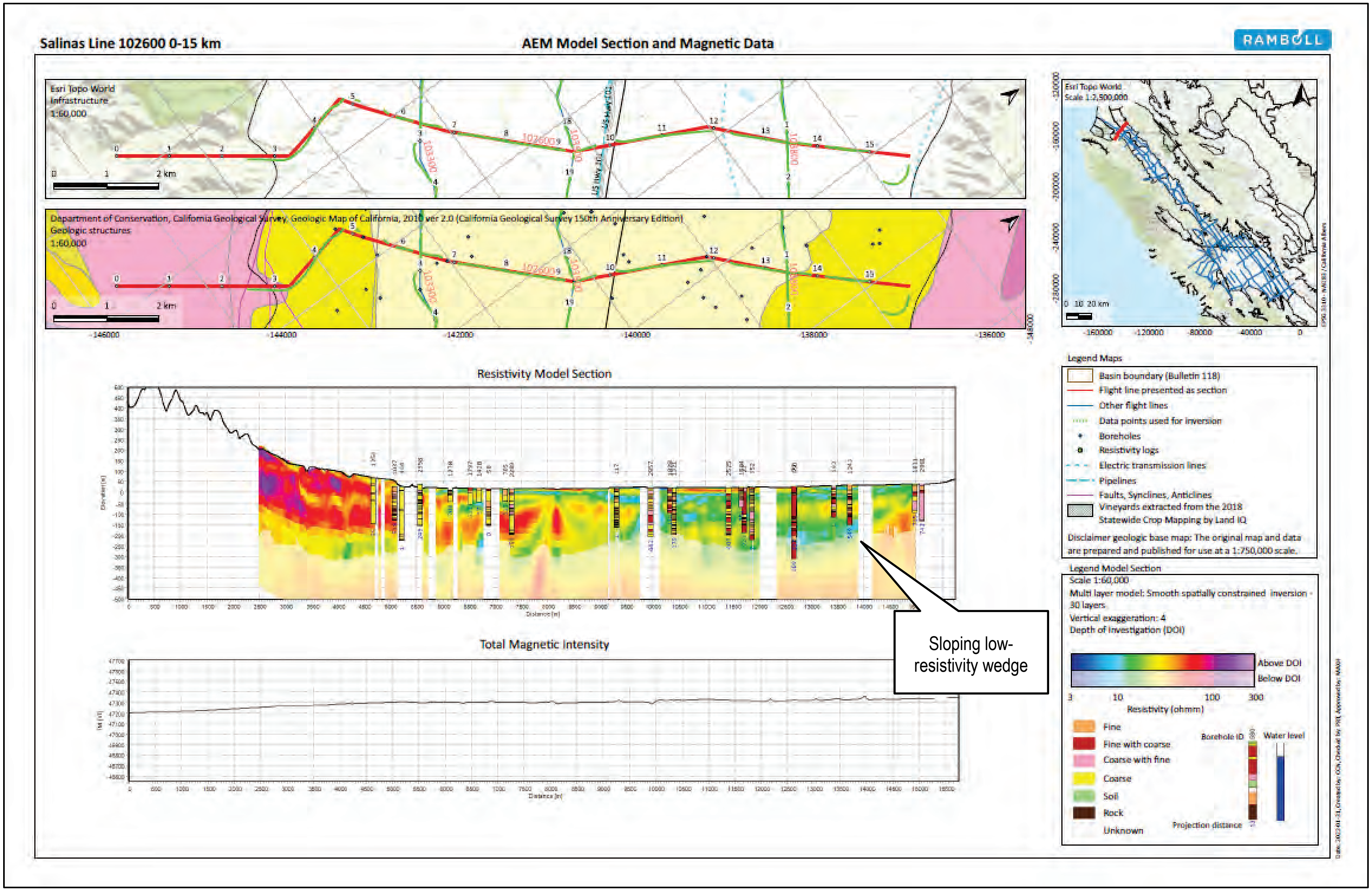



Figure A-14. DWR Survey Area 1, Line 102600, 0-15km Section Showing Lower Resistivities (Blue Hues Interpreted as Alluvial Fans) (DWR, 2022)

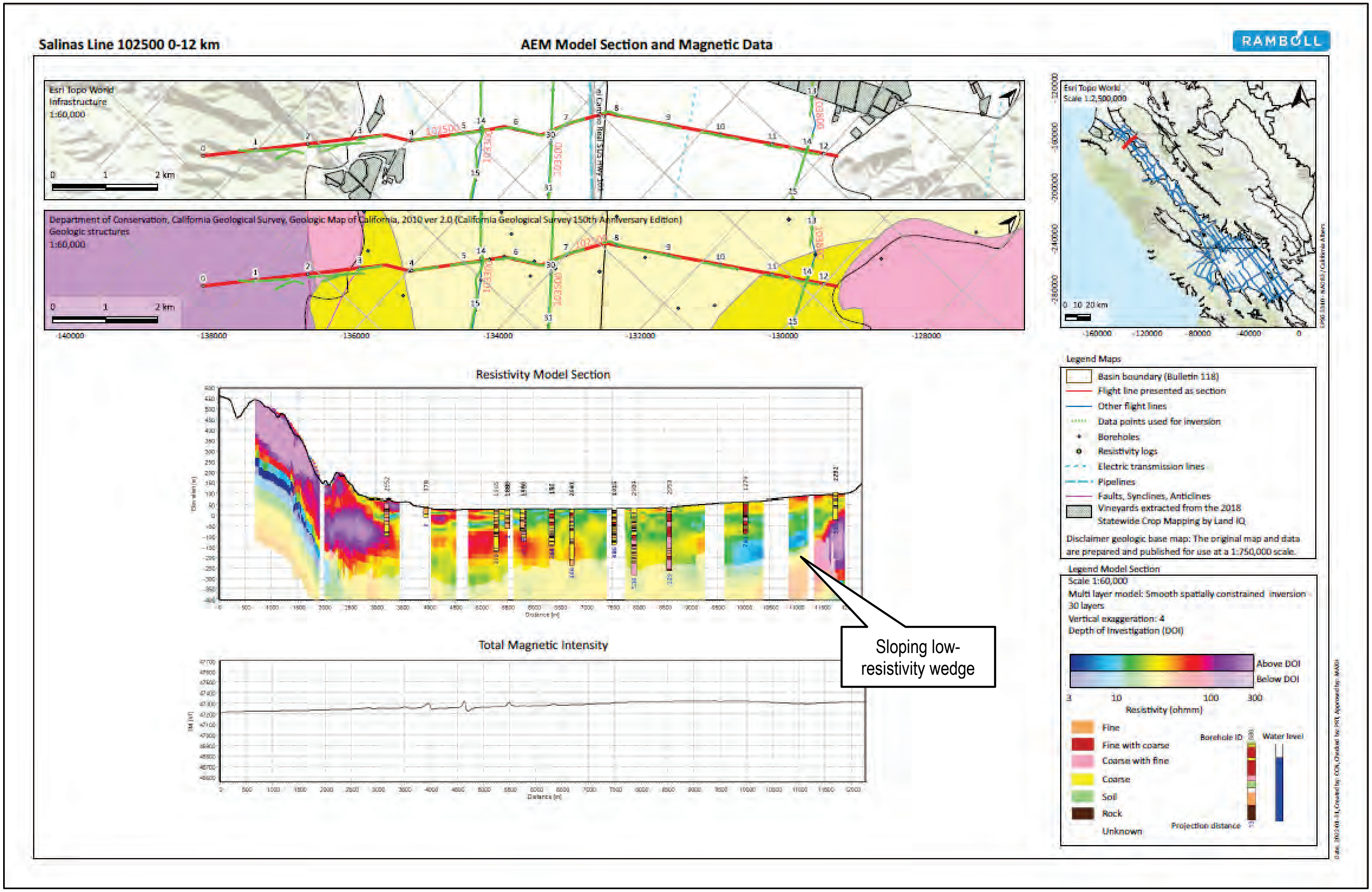



Figure A-15. DWR Survey Area 1, Line 102500, 0-12km Section Showing Lower Resistivities (Blue Hues Interpreted as Alluvial Fans) (DWR, 2022)

### Previously Published Reports and Other Data

*Basin Structure (USGS, 1978)*

The USGS-developed Basin structure shown on Figure A-4 further limited the extent of the Deep Aquifers. Based on lithology reported in the WCRs, as well as Deep Wells designated by MCWRA where the 400/Deep Aquitard was easily discernable, 600 feet below land surface was selected as the upper threshold for the extent of the Deep Aquifers; any portion of the basin shallower than 600 feet below land surface was not considered to contain the Deep Aquifers, whereas any portion of the basin deeper than 600 feet below land surface was considered to contain the Deep Aquifers. All areas where the USGS-developed Basin structure was less than 600 feet deep were eliminated as potential Deep Aquifer locations.

*Paso Robles Extent (Thorup, 1976-1983)*

The 400/Deep Aquitard is found in the lower Paso Robles Formation. Plate 2 of the *Hydrogeological Report on the Deep Aquifer, Salinas Valley* report outlined the Paso Robles Formation, with notable exclusions near the coast (Thorup, 1976; Thorup, 1983). For this study, the coastal segments were interpolated by incorporating other known geological features such as the Ord Terrace Fault, Laguna Seca Anticline, and the Elkhorn Slough clay-filled paleochannel. The extent of the Paso Robles Formation reported by Thorup is shown on Figure A-5.

For the Phase 1 analysis, the Paso Robles Formation was generally honored throughout the preliminary extent delineation with the exception of the region near the City of Salinas based on a few key WCRs.

### Other Data

*Alluvial Fans Additional Discussion*

The alluvial fans were excluded from the extent based on not only the resistivity profiles, but also because they are a different depositional environment than the sediments that constitute the Deep Aquifers and the overlying 400/Deep Aquitard.

The alluvial fans are primarily derived from the Gabilan Range and are composed of decomposed granite. Chemical weathering of decomposed granite can result in potassium-rich clays. Therefore, the abundance of clays in the subsurface in the alluvial fan-dominated regions is expected. The lowest resistivity areas (less than or equal to 10-ohm-m) were considered the extents of the alluvial fans.

The sediments of the main Salinas Basin are derived from a variety of rock sources, including older sedimentary rocks such as the Monterey Shale. The Salinas Valley Basin sediments, including the Paso Robles Formation, contain porcelaneous chert, which is not encountered in the alluvial fan deposits. Therefore, the alluvial fans are considered a separate and discontinuous deposit in the Basin.

#### Integration/Synthesis of existing data and Phase 1 extent

The synthesis of all publicly available AEM surveys, borehole geophysical data, previously published reports, well completion reports, numerical model reports, and first-hand experience resulted in a comprehensive initial view of the Deep Aquifers' extent. The specific data-supported extents were overlapped on a single map and compared to one another to look for concurrence of extents and places where some data were stronger than other data (Figure A-16).

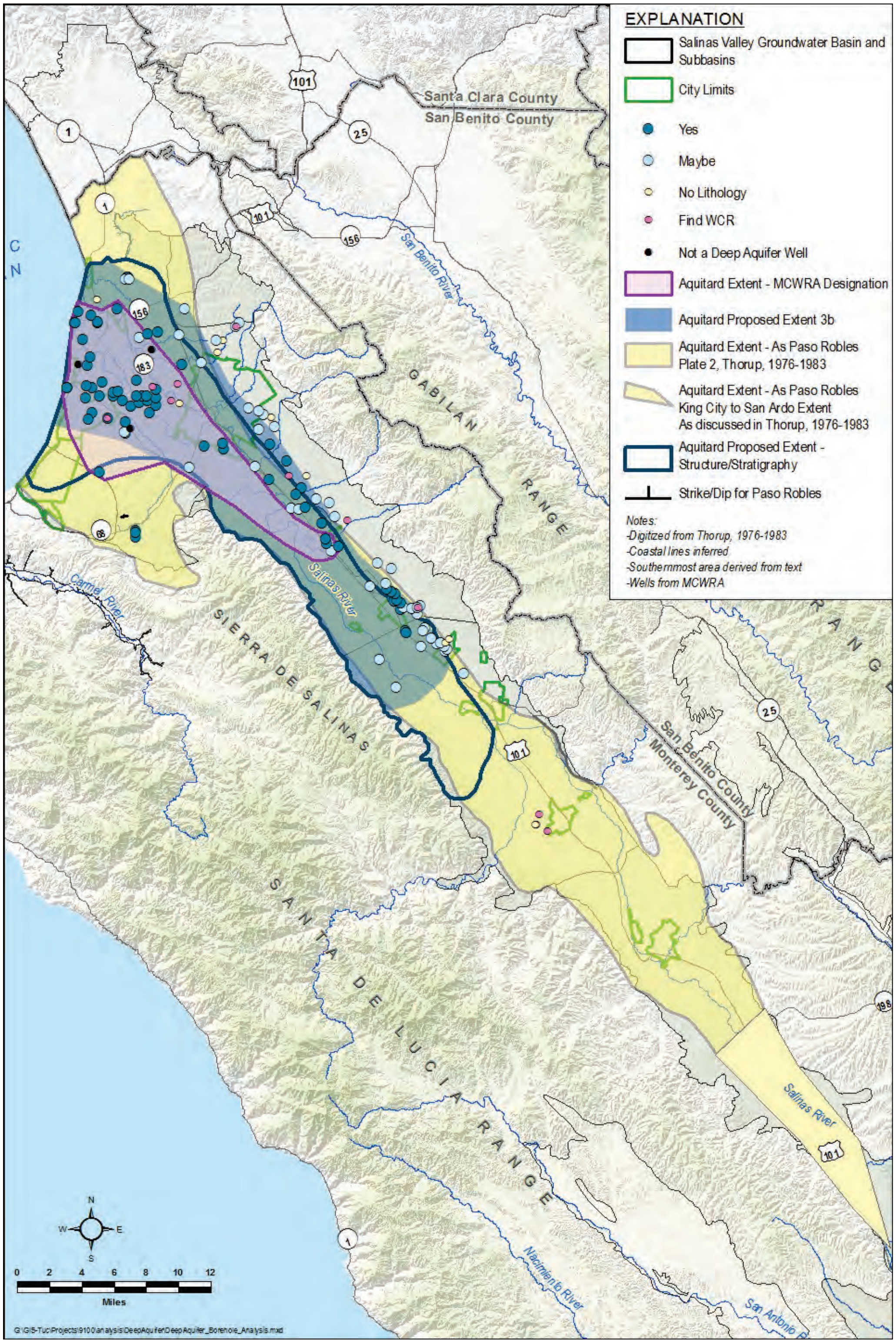



Figure A-16. Overlapping of Various Data-Based Deep Aquifers Extents

Results of this synthesis are summarized below:

- **Gabilan Range Bajada/East Boundary:** The structurally based boundary, the Paso Robles extents, WCRs, and the DWR Survey Area 1 AEM data all agreed well through the Gabilan Bajada.
- **Arroyo Seco Cone/Southern Boundary:** Two wells and 3 DWR Survey Area 1 AEM flightlines concurred to delineate the southern boundary near the City of Soledad. While some data suggested the Deep Aquifers' boundary could be farther south, the concurrence of AEM data and well logs defined this southern boundary near Soledad.
- **Sierra de Salinas/West Boundary:** The structurally based boundary, the Paso Robles extents, and the DWR Survey Area 1 AEM data all concurred to mark the boundary at the Basin boundary.
- **South Coastal Boundary/South Marina :** This boundary exists in the Seaside Basin near Highway 68. Previously published cross sections, mapped structural deformities, coastal AEM flightlines, and 1 MCWRA Deep Aquifers well all suggested the extent of the Deep Aquifers is in the Former Fort Ord area. Many of the available data focused on the geology rather than stratigraphy of this area, and the 400/Deep Aquitard was not as easily identified. This Study exercised caution in conflating geology with hydrostratigraphy and delineated the boundary based on the most overlapping data as possible.
- **Monterey Bay Shoreline/Coastal Boundary:** The Deep Aquifers definition is terminated at the coastline as all data are focused on land.
- **Elkhorn Slough and North Salinas Boundary/North Boundary:** The structurally based boundary, the Paso Robles extents, and WCRs data all suggested the Deep Aquifers extend up to Basin Boundary at Elkhorn Slough.

This synthesis resulted in a Phase 1, or Preliminary extent of the Deep Aquifers, shown on Figure A-17.

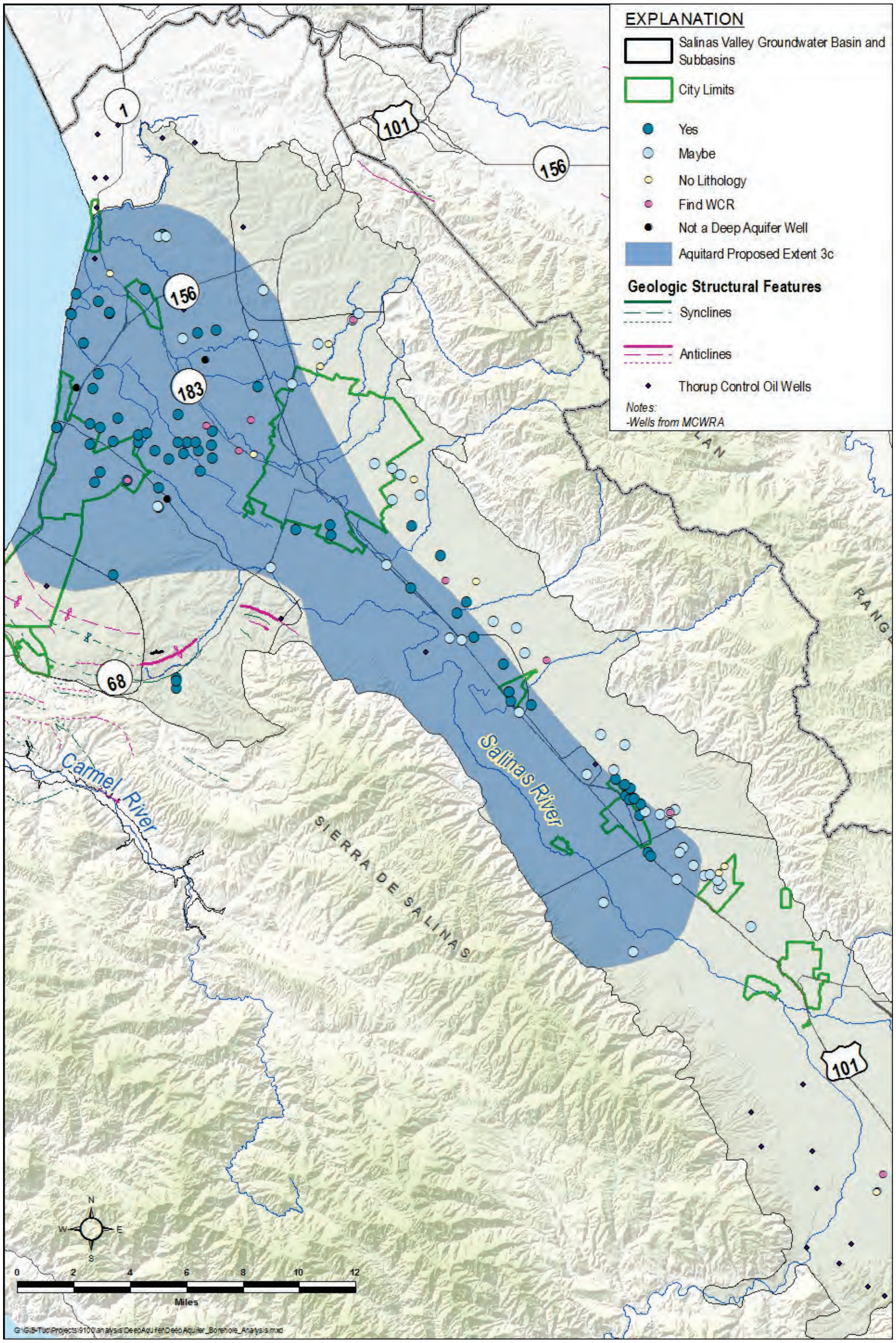



Figure A-17. Phase 1, Preliminary Deep Aquifers Extent

## Delineating Lateral Extent – Phase 2

Phase 2 integrated AEM, aquifer tests, water chemistry, and isotopic data into the Phase 1 analysis and extent. These data were used to refine the existing extent. These data were not categorized into individual extents like the data-driven extents shown in Phase 1 analysis. They were instead compared to the boundaries of the Phase 1 extent and used to address specific points where the improved data showed the need to move the extent.

### Deep Aquifers AEM Study

The most pivotal data gathered and applied/used during Phase 2 analysis was from the AEM survey conducted for the Deep Aquifers Study. This survey employed a customized tool to extend the depth of investigation to identify and locate the 400/Deep Aquitard in the subsurface. Additionally, the survey flightlines for this study were selected to fill in the gaps from the DWR surveys, provide a more complete picture of the subsurface at the greater depth, interrogate areas where questions on the extents were most pertinent. Depth of investigation ranges from 350 to 400m (1,150-1,310 feet) in coastal areas, to up to 600m (1970 feet) in inland areas.

The deeper depth of investigation of 350-400m (1,150-1,310 feet) in coastal areas, to up to 600m (1970 ft) in inland areas, compared to approximately 150-400 m (492-1,312 feet), revealed both the 400/Deep Aquitard as well as other key sediments in the subsurface.

### Other Supporting Data

Aquifer tests, water chemistry, and isotopic data were used to support the AEM-refined boundaries through Phase 2. These data were primarily used to try to understand recharge and transmission of water to and within the Deep Aquifers, but also supported the delineated extents in key wells.

## RESULTS - DEEP AQUIFERS EXTENT

The synthesis of all data from both phases of the Study resulted in the final extent shown on Figure A-18, described in the sections below, and available in the main body of the Deep Aquifers report. Importantly the Deep Aquifers extent is limited to the defined Salinas Valley Groundwater Basin for management purposes. This is similar to how the geologic formations of the Deep Aquifers are treated as they extend north of the Salinas Valley into the Pajaro Basin and Santa Cruz area.

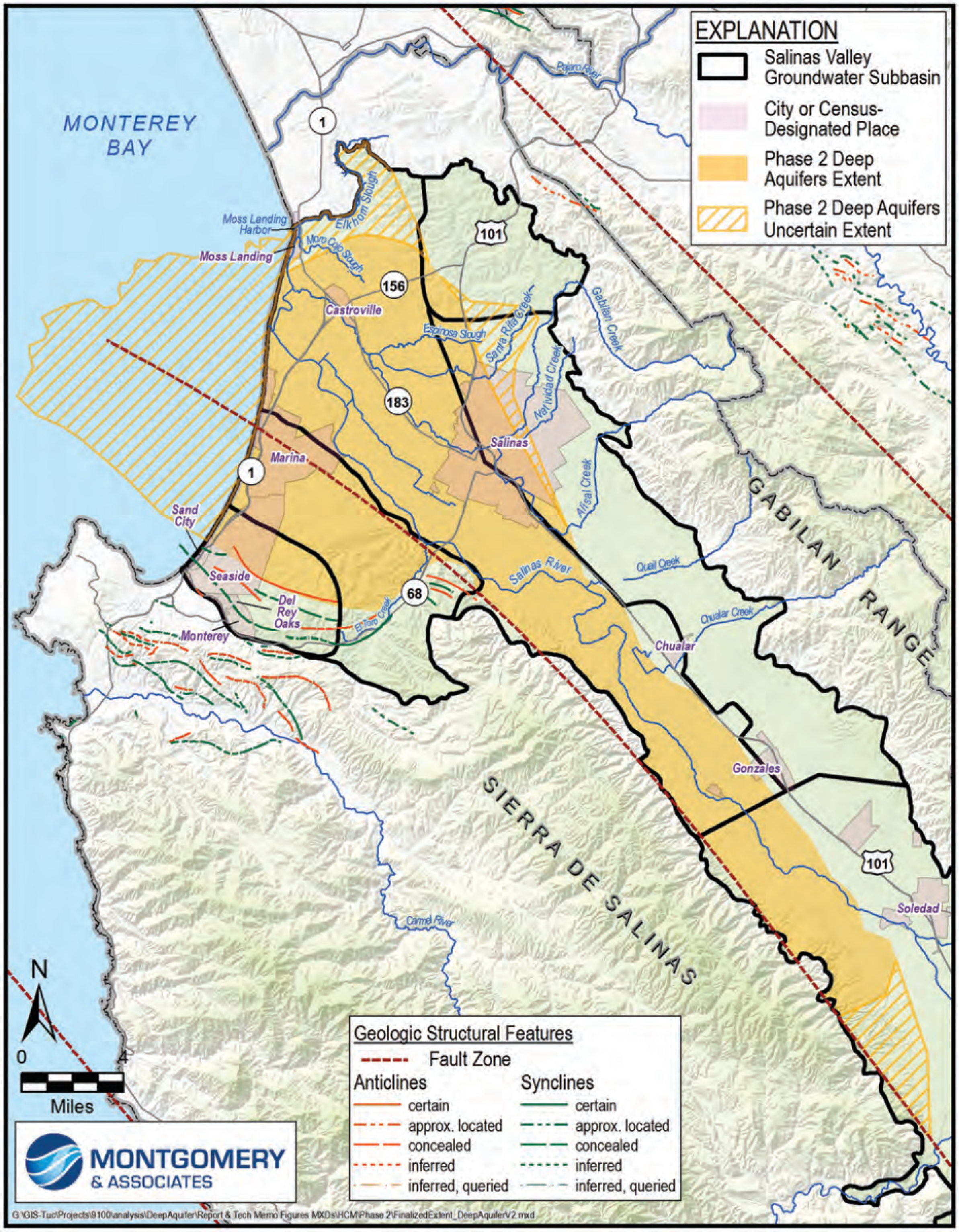



Figure A-18. Deep Aquifers Final Extent

**Physical Lateral Boundaries**

The Deep Aquifers are bounded by the following physical features:

*The Monterey Bay shoreline*

The Deep Aquifers' northern boundary is defined by the Monterey Bay shoreline. The controlling data that determined/focused this boundary are primarily a lack of data beneath the Monterey Bay and lack of offshore groundwater management authority. The geologic formations that form the Deep Aquifers outcrop in Monterey Canyon under the Monterey Bay, as shown on Figure A-19 (Wagner *et al*., 2002). The portion of these geologic formations that exist under the Monterey Bay and crop out in Monterey Canyon are considered an "uncertain" lateral extent.

The Deep Aquifers likely extend under Monterey Bay, and there are no hydrogeologic barriers limiting groundwater flow across the coastal boundary. However, there are no wells or subsurface data to provide lithologic insight into the sediments beneath the Bay, much less collect aquifer water samples. All Deep Aquifers' extraction occurs on land, and all known data are on land.

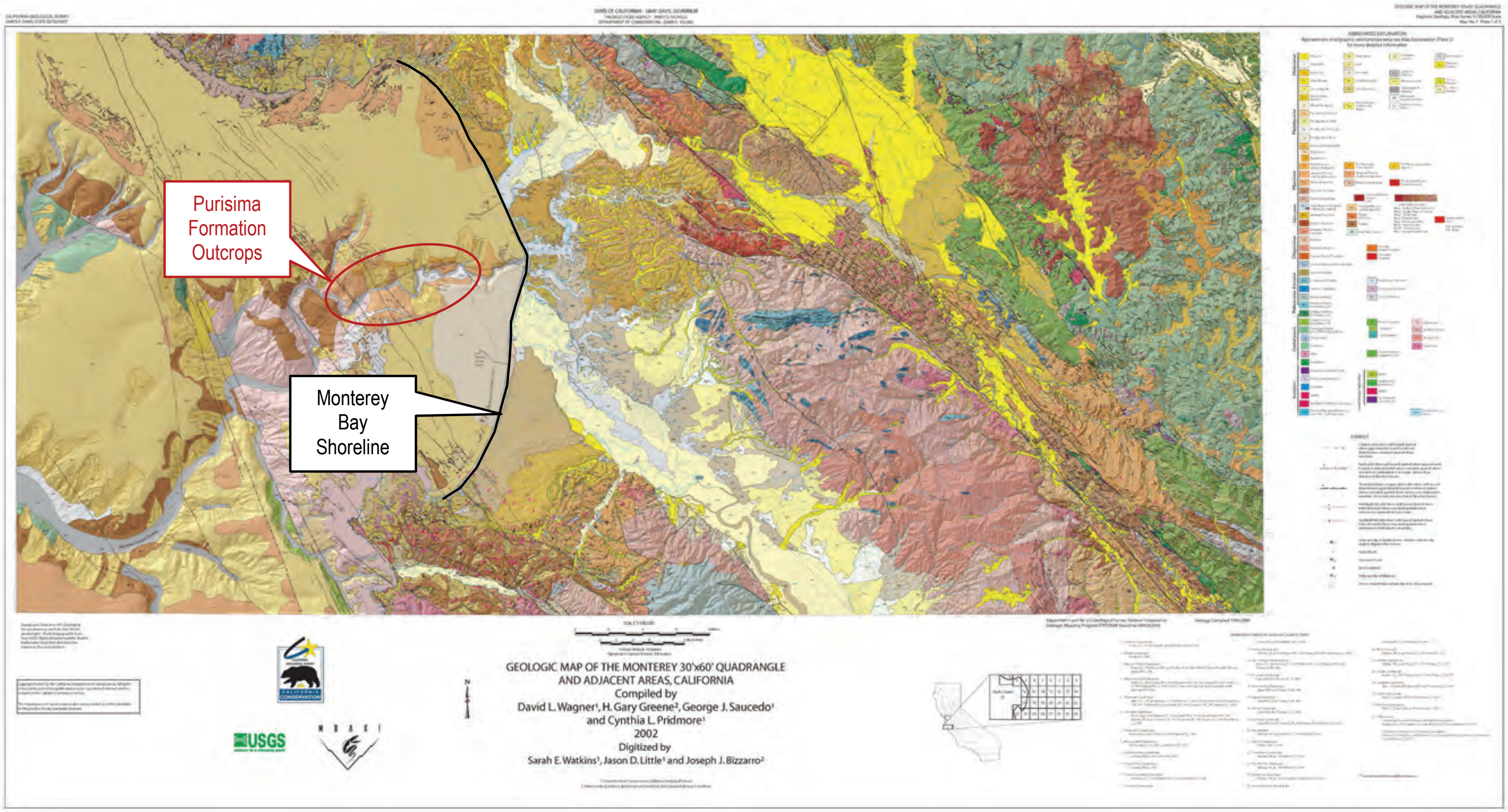



Figure A-19. Map of Monterey Bay Region Geology with Monterey Bay Shoreline Outlined in Black and Outcrops of Deep Aquifers Geologic Formations Circled in Red (Wagner *et al*., 2002)

*Elkhorn Slough & North of City of Salinas*

The northern boundary of the Deep Aquifers is generally south of the current course of Elkhorn Slough; corresponding to a paleo-drainage of the Salinas River (DWR, 2003). Elkhorn Slough is a buried and clay-filled paleo-drainage that is at least 400 feet deep, and represents a discontinuity in the 400/Deep Aquitard shown on Figure A-20. Figure A-20 shows the Paso Robles Formation terminating somewhere before Elkhorn Slough, on the left of the cross-section. This implies the 400/Deep Aquitard contained within the Paso Robles Formation also terminates. (Durbin *et al.*, 1978; Fugro West, 1995). The Purisima Formation does continue to the north, ultimately cropping out near Santa Cruz (Feeney and Rosenberg, 2003; Fugro West, 1995). However, the clays commonly found in the Paso Robles Formation that define the continuous 400/Deep Aquitard do not.

The controlling data that determined this boundary are published cross-sections (Feeney, Rosenberg, 2003; Greene, 1977; Garrison *et al.*, 1990; Fugro West, 1995), AEM surveys (DWR, 2023; MCWD, 2019), and local deep wells (13S/02E-19Q03, 13S/02E-15M03). Well 13S/02E-19Q03 is further highlighted on Figure A-20 with a blue rectangle positioned near the Purisima Formation contact where the geophysical log indicated a thick section of low-resistivity material, generally interpreted as clay-abundance as discussed above. The 400/Deep Aquitard can be assumed to be present here, however its continuity is uncertain moving northward (rightward on the figure).

The extent of the continuous 400/Deep Aquitard found within the Paso Robles Formation is unclear in this particular region due to the abundance of clay in the subsurface from several sources as seen on Figure A-21 through Figure A-23. These AEM profiles show an abundance of blue hues in the subsurface, which are low resistivity and indicate strong clay presence throughout all depths of the profile. The various clay sources makes it difficult to discern whether any clay horizon is part of the continuous aquitard. Therefore, it is difficult to demarcate where the extent of the Deep Aquifers may be through this area.

The best data available to draw this boundary were the previously published reports and maps through the area . The USGS claims the Paso Robles Formation pinches out near Moss Landing (Greene, 1977), and the *Deep Aquifer Investigation* shows the Paso Robles Formation beginning to thin northward from Moss Landing (Feeney and Rosenberg, 2003). Therefore, this boundary was set closer to wells that show a clear aquitard, and the remainder of the area in the Salinas Valley Basin is considered uncertain.

Inland from the coast, the Deep Aquifers boundary generally follows the previously mapped structural boundary, the mapped Paso Robles Formation boundary, and one well near Prunedale. The AEM data were intermittent in the area between Prunedale and the City of Salinas due to interference from infrastructure.

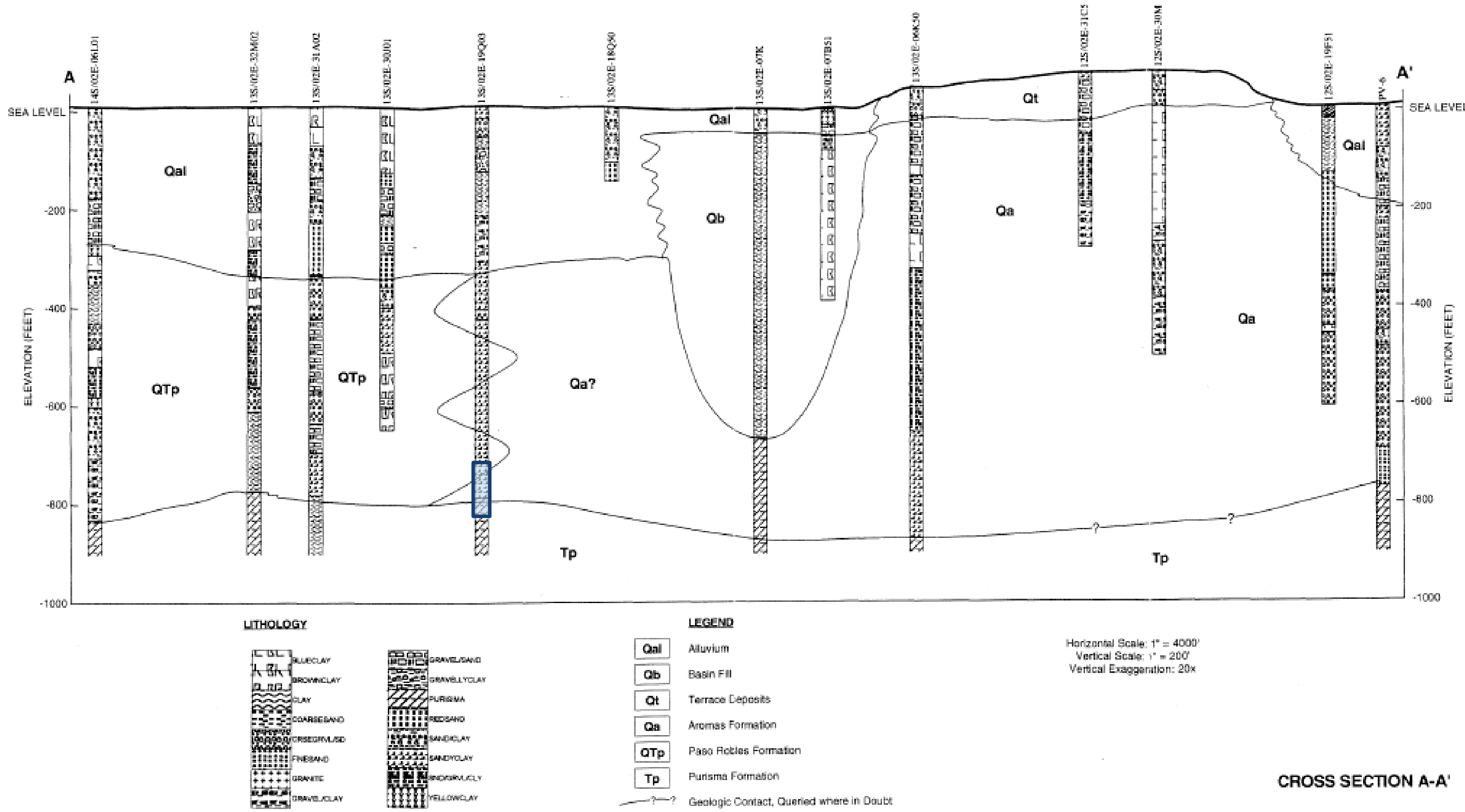



Figure A-20. Coastal Cross-section A-A' Showing Clay-filled Elkhorn Slough and Low-Resistivity Zone in Key Well (Fugro West, 1995)

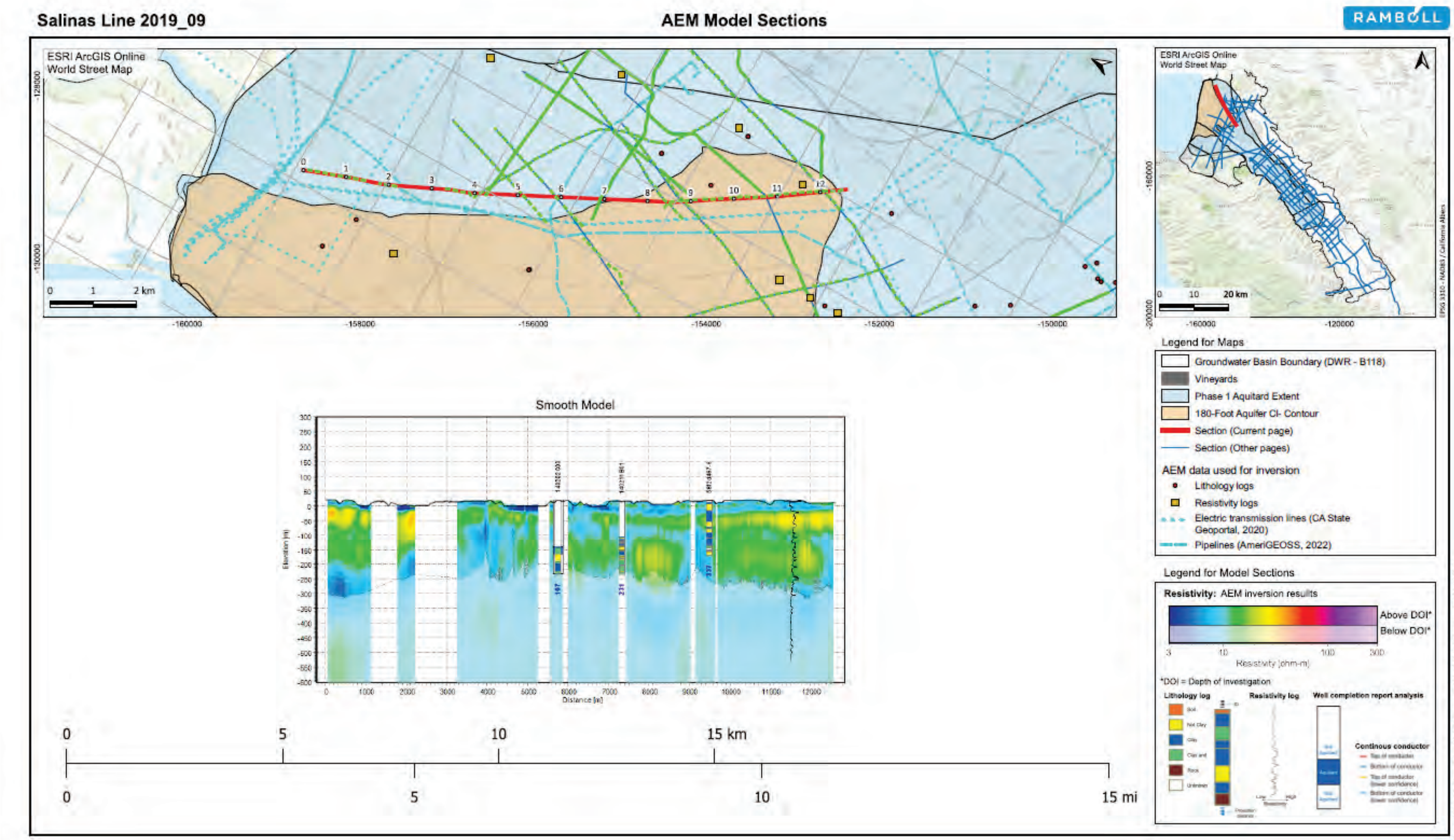



Figure A-21. MCWD AEM Survey, 2019, with Elkhorn Slough Toward Left of Section

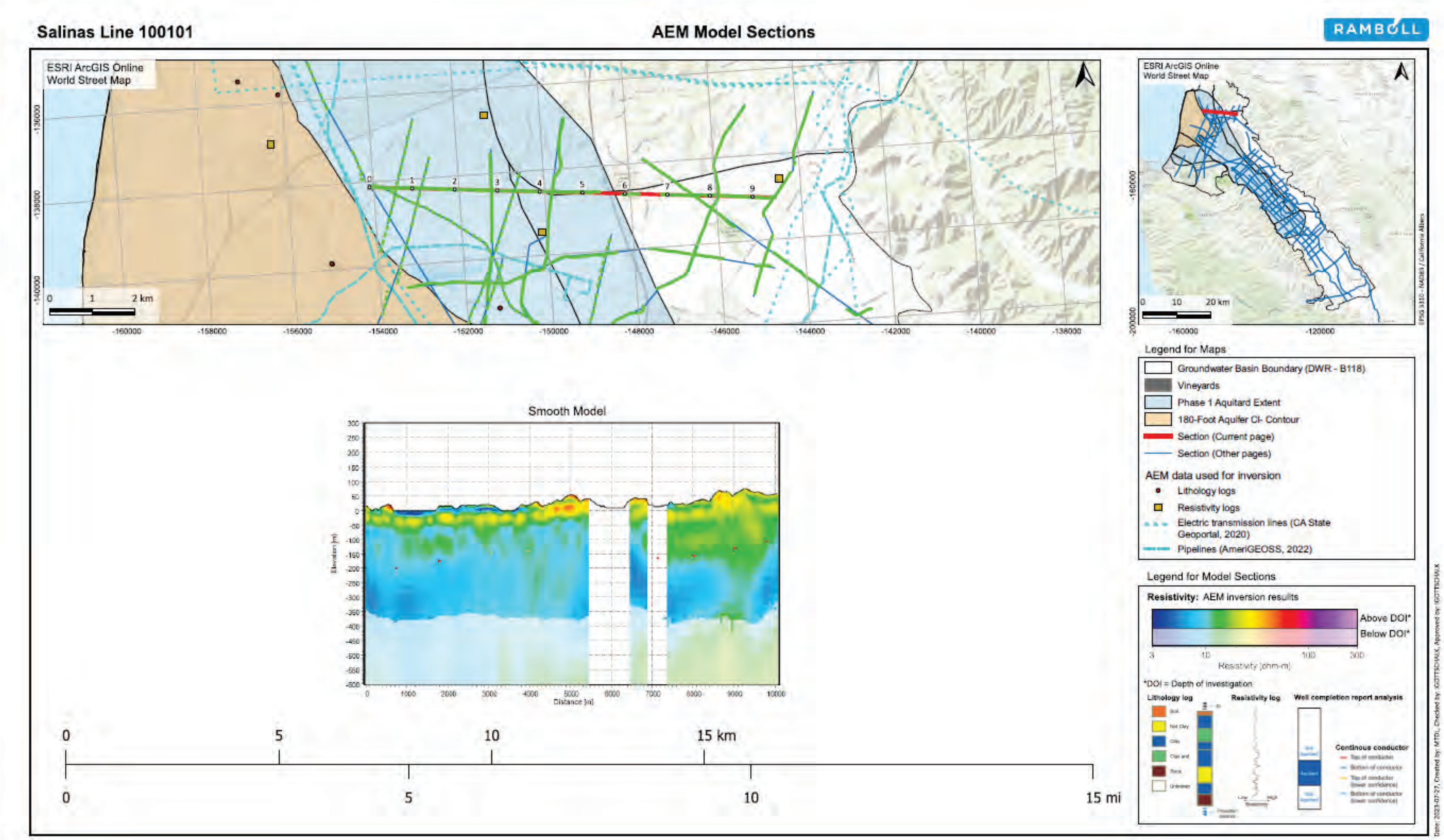



Figure A-22. Deep Aquifers Study Survey Line 100101, 2023

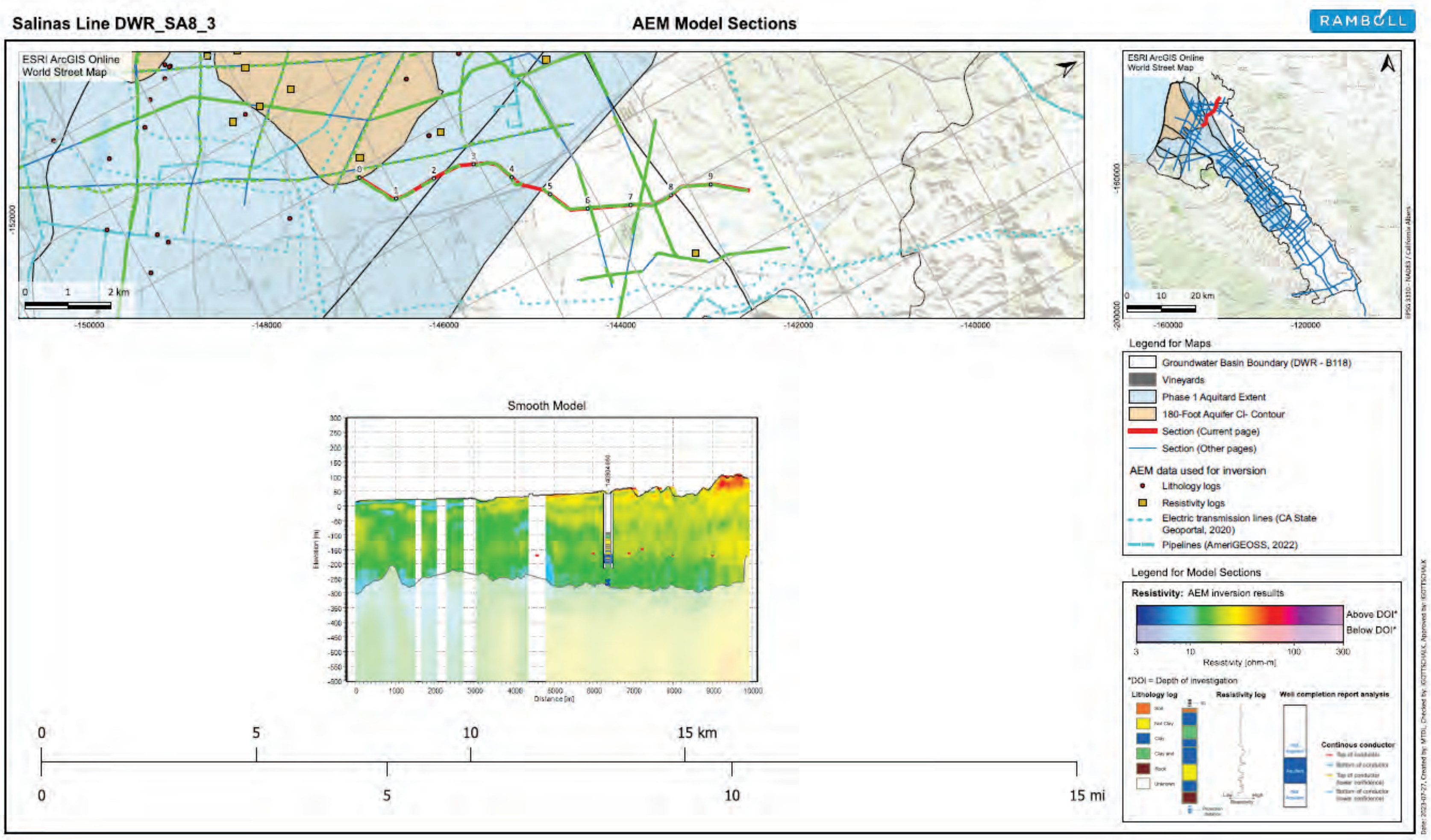


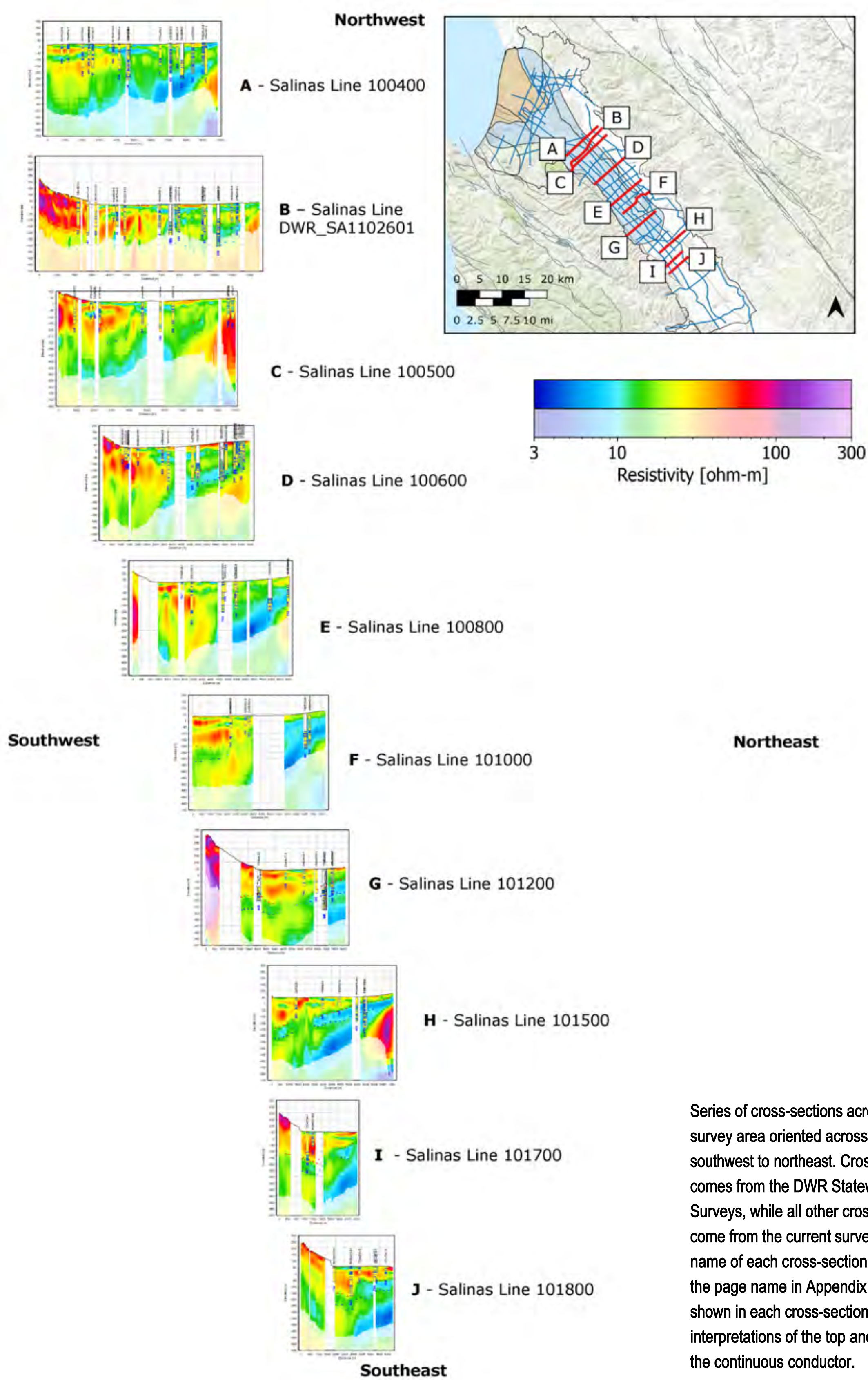

Figure A-23. DWR Survey Area 8, 2022

*The Gabilan Range Bajada*

The Deep Aquifers' northeast boundary is defined by the extent of the alluvial fan complex, or bajada, along the Gabilan Range. Multiple alluvial fans have developed along this mountain front, and they represent a discontinuity in the 400/Deep Aquitard that defines the presence of the Deep Aquifers. Although these fans are represented by an abundance of clay in the subsurface, they are not of the same source, and overlie different sediments from the Deep Aquifers. This bajada constitutes an adjacent aquifer system.

The controlling data that determined this boundary are primarily the AEM surveys (DWR, 2020; Deep Aquifer Study, 2023). Several wells were analyzed in the Phase 1 portion of the study, and combined with the USGS's Basin Bottom model (Durbin 1978) and the extent of the Paso Robles Formation mapped in the *Hydrogeological Report on the Deep Aquifer, Salinas Valley* (Thorup 1976) to estimate the Deep Aquifers' presence. Subsequent to the Phase 1 portion of this study, DWR's AEM Survey Area 1 and this study's AEM Survey revealed the fans were larger and extended further into the Salinas Valley than previously understood. An example of this is shown on Figure A-24. These fan sediments, shown as blue areas on the Figure A-24 cross-sections, comprise eroded Gabilan Range rocks, and do not contain clasts or sediments typical of the Deep Aquifers.

Therefore, the extent of the alluvial fans as determined by the AEM surveys is the eastward lateral limit of the 400/Deep Aquitard, and subsequently, the Deep Aquifers.




Series of cross-sections across the survey area oriented across the basin southwest to northeast. Cross-section B comes from the DWR Statewide AEM Surveys, while all other cross-sections come from the current survey. The name of each cross-section refers to the page name in Appendix 3. The dots shown in each cross-section are the interpretations of the top and bottom of the continuous conductor.

Figure A-24. Cross-Basin AEM Profiles from DWR Survey Area 1 and Deep Aquifers Study (Ramboll, Deep Aquifers Study Appendix B)

*The Arroyo Seco Cone and Forebay/Upper Valley Basement Rock Rise*

The Deep Aquifers' southern boundary is defined by the Arroyo Seco Cone and the basement rock rise near the boundary of the Forebay and Upper Valley Subbasins. This is an area where the continuity of 400/Deep Aquitard is interrupted or impacted by the alluvial fans from both the Arroyo Seco River and Reliz Creek, as well as by fans from the Gabilan Range. Additionally, the basement rocks rise to form the Gabilan High, which contributes to a discontinuity in the 400/Deep Aquitard from increased erosion of the Paso Robles Formation.

The controlling data that determined this boundary are the AEM surveys (DWR, 2020; Deep Aquifer Study, 2023) and previously published reports and cross-sections (Feeney, 1994; Durham 1974; Brown & Caldwell, 2015). The AEM surveys revealed a unique relationship between the Salinas Valley sediments, which include the Paso Robles Formation, and both the Arroyo Seco Cone and alluvial fans from the Gabilan Range as discussed previously. Where resistivity data exist, they confirm the presence of deeply buried Paso Robles formation, overlain by different sediments and deposition from the Arroyo Seco Cone. The 400/Deep Aquitard is circled in a black dashed line on Figure A-25, and is shown to have these coarse, overlying, Arroyo Seco Cone sediments. Moving southward in the Basin, sediments from Reliz Creek and the Gabilan Range alluvial fans, shown circled with black dashed lines on Figure A-26, begin coalescing. Where these alluvial sediments are deposited coincides with structural changes in the basement rock. Structural changes begin occurring as the Basin progresses southward toward King City, shown on Figure A-27 through Figure A-29. Figure A-28 demonstrates a rise in the basement with the crystalline granite increasing in elevation and having less sedimentary rocks overlying them, benchmarked with the black line and arrow (Durham, 1974). Figure A-29 demonstrates the same with a decrease in deeper wells as the cross section moves south, or right (Brown & Caldwell, 2015). The lack of deeper wells is because the crystalline rocks generally do not produce water.

Published reports and cross sections map this structural shallowing southward, as well as minor outcrops of Paso Robles Formation in the foothills of the Sierra de Salinas, broken up by the presence of the Reliz Fault Zone. Combining the published reports and cross sections with the AEM data, the southernmost extent of the Deep Aquifers is delineated at the AEM cross sections with the clearest view and indication of continuous 400/Deep Aquitard in the subsurface. There are additional indications that the continuous 400/Deep Aquitard extends even further south, however these data are sparse and intermittent, and therefore classified into an uncertain region of the extent. The Deep Aquifers neither extend into the Upper Valley Subbasin, nor past the structural rise.

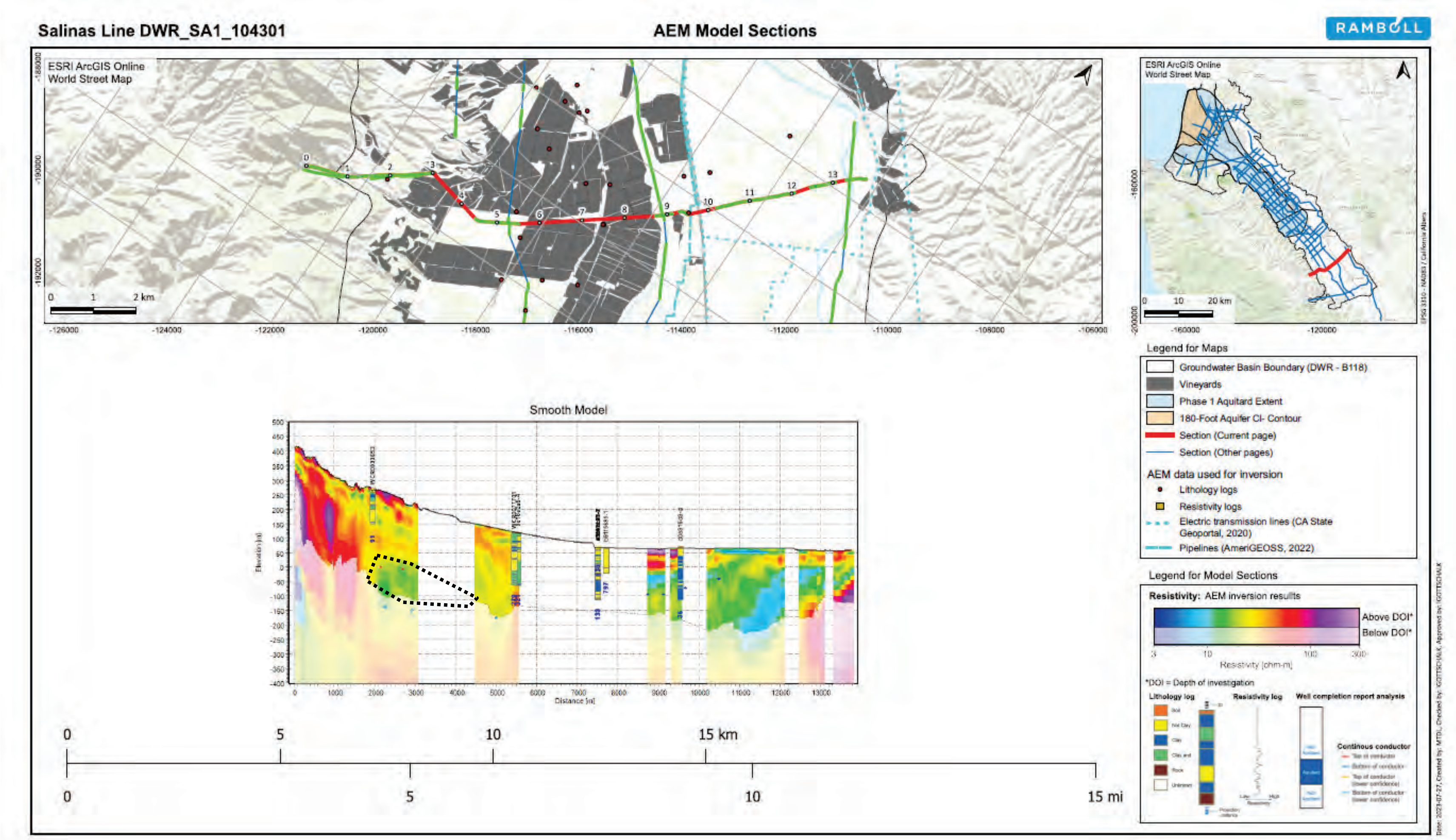



Figure A-25. Deep Aquifers Study AEM Profiles Showing the Continuous 400/Deep Aquitard under the Arroyo Seco Cone

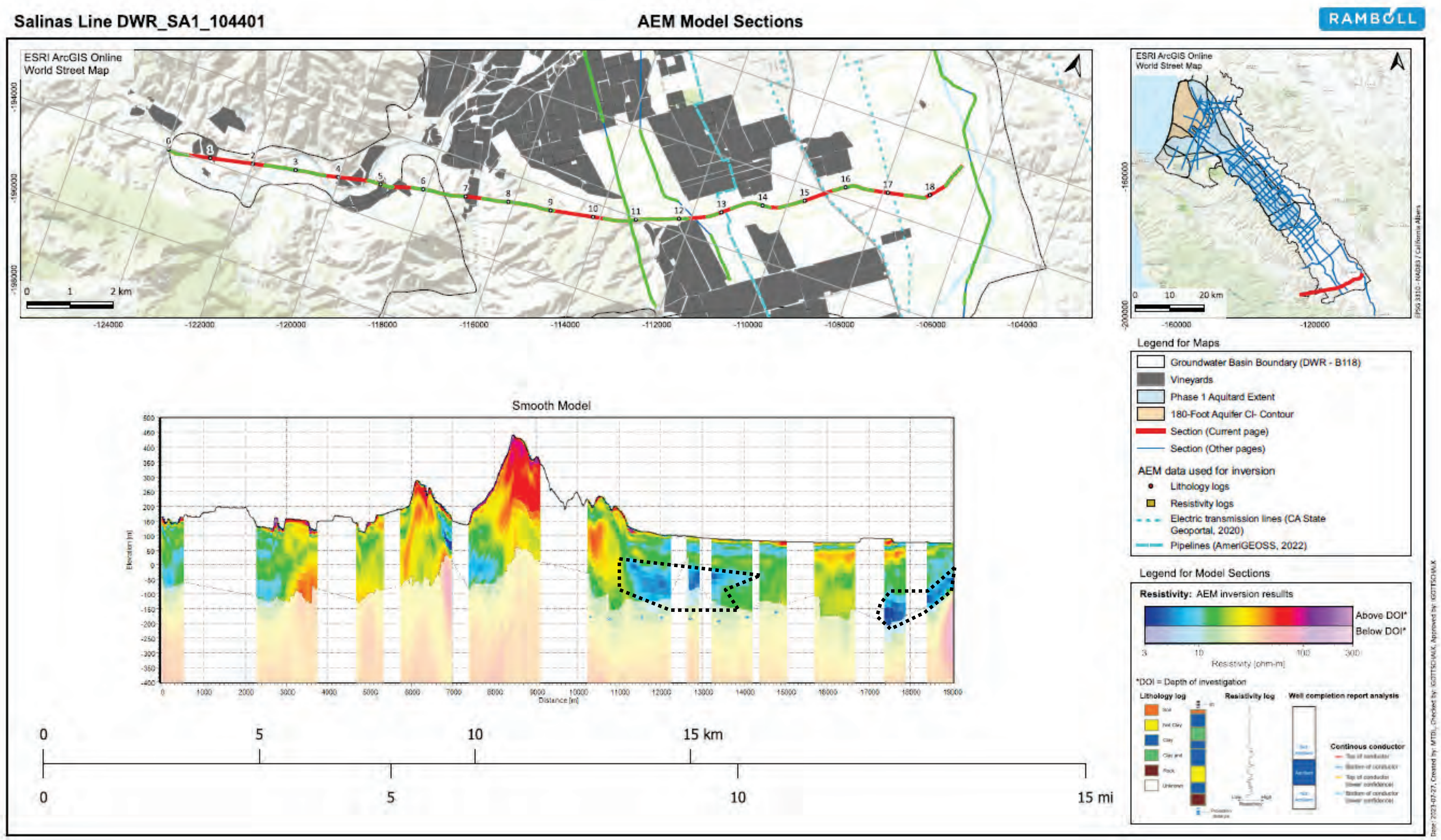



Figure A-26. Coalescing Alluvial Fans on the South Side of the Arooyo Seco Cone, Shown in DWR 2020 AEM Survey

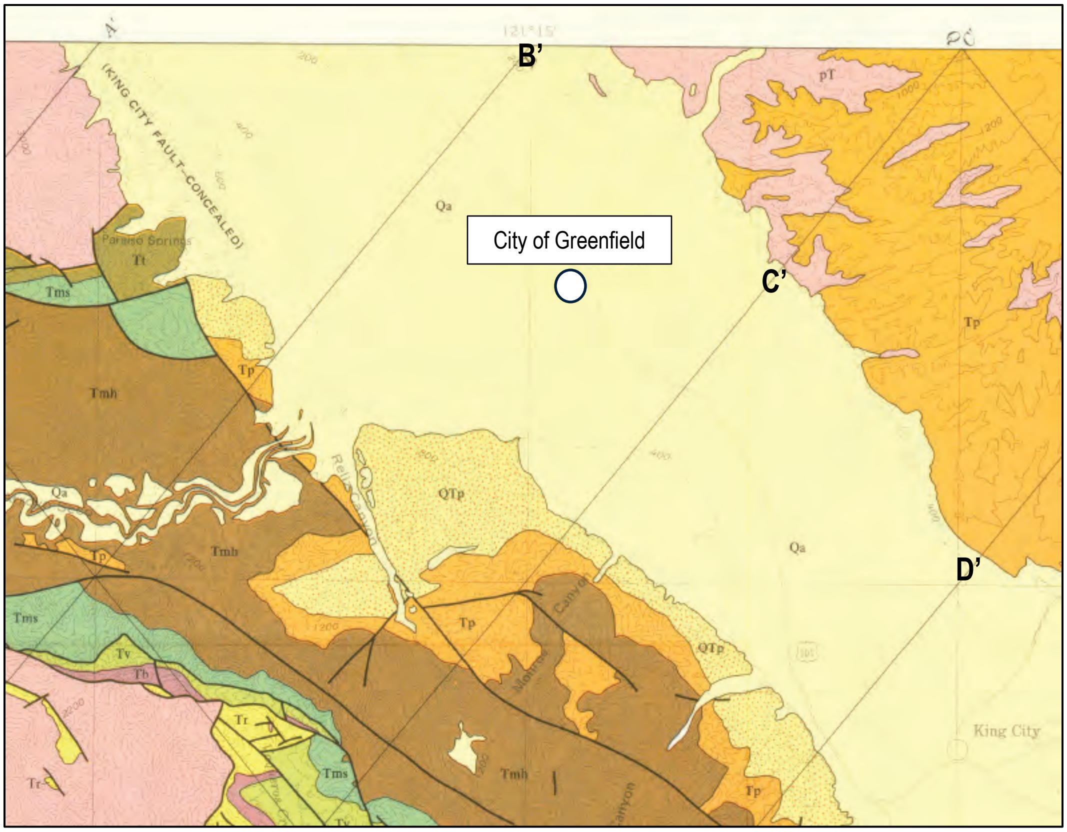



Figure A-27. Durham, 1974, Geologic Map with Selected Cross Sections to Demonstrate Gabilan High and Shallowing of Paso Robles Fm Moving South through the Valley

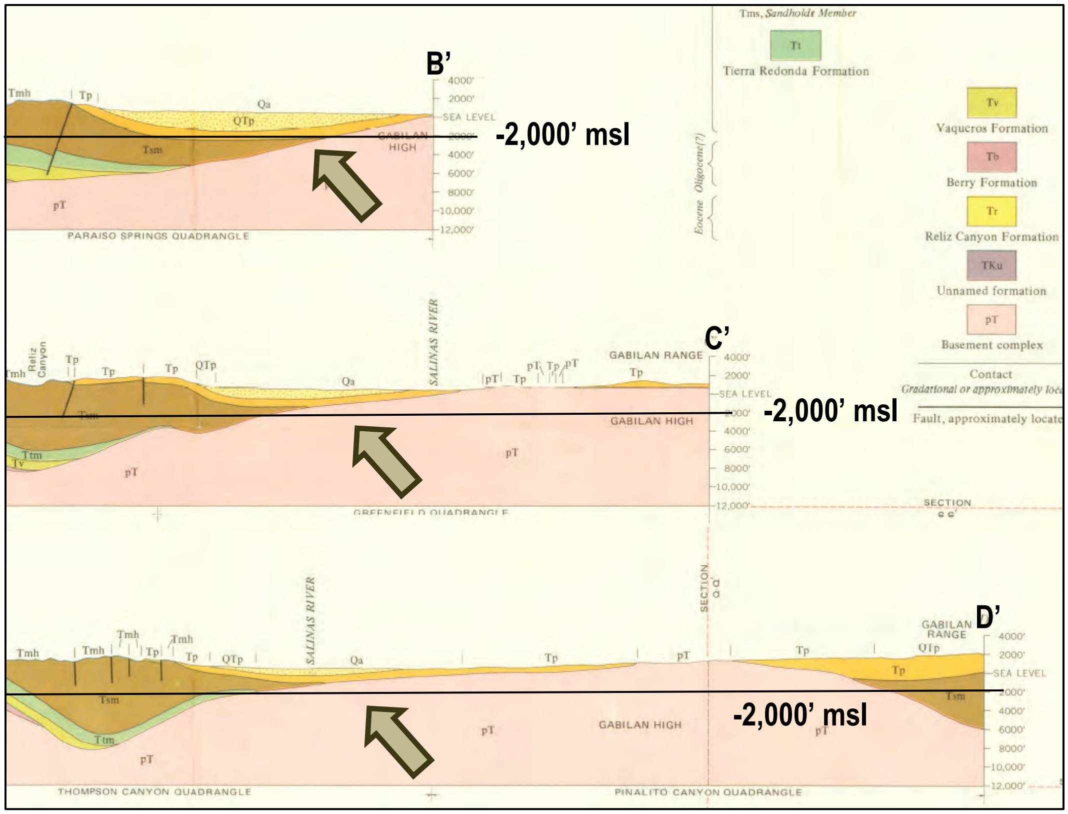



Figure A-28. Selected Cross Sections to Demonstrate Gabilan High and Shallowing of Paso Robles Formation (QTp) Moving South through the Valley (Durham, 1974)

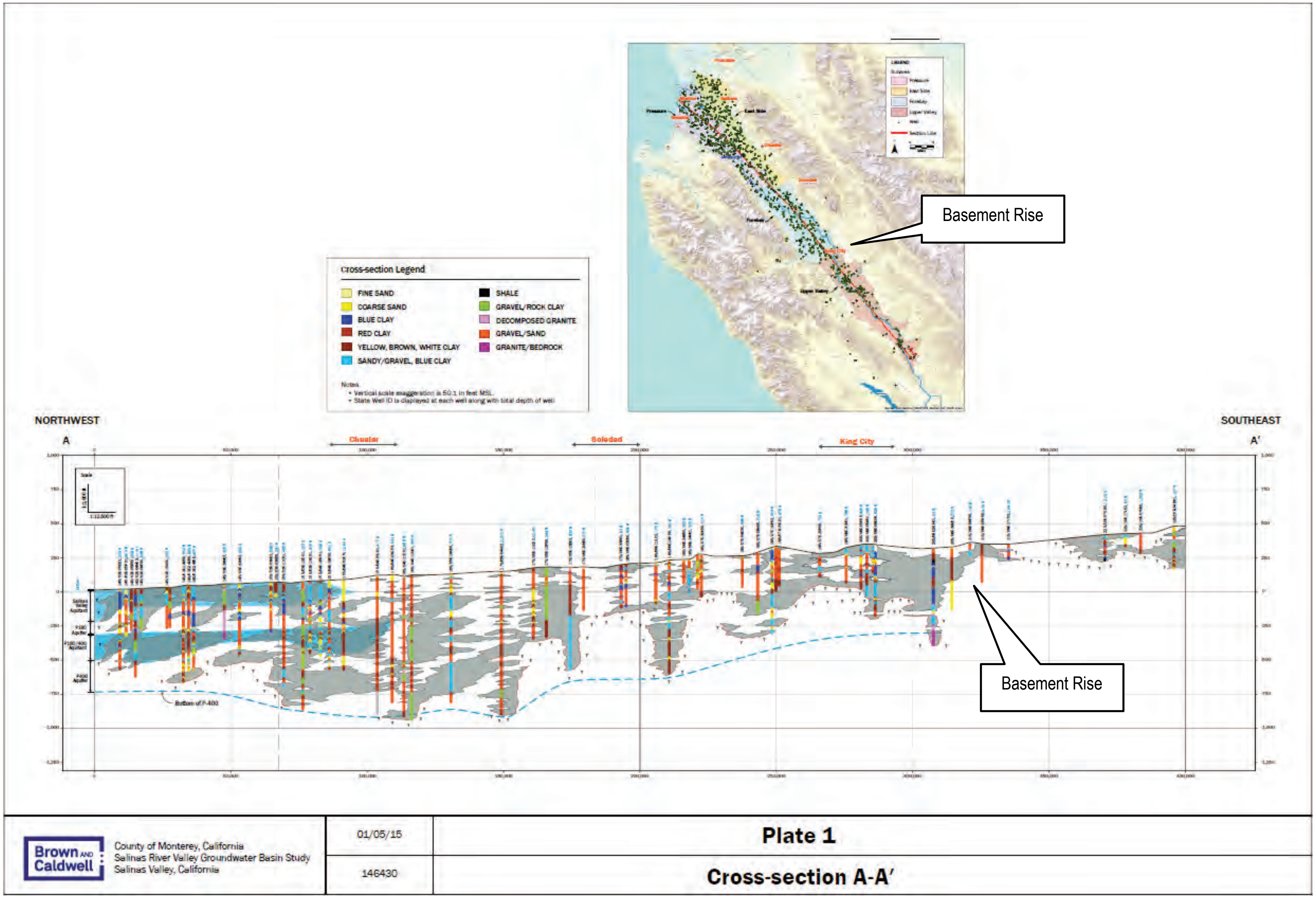



Figure A-29. Down Valley Cross Section by Brown and Caldwell Showing Structural Rise near King City

*The Sierra de Salinas/Reliz Fault*

The inland southwest boundary is defined by the presence of the Reliz Fault that displaces the Basin and corresponds to the contact between the Quaternary deposits and the low-permeability granitic and metamorphic basement rock of the Sierra de Salinas. This geologic contact creates a groundwater flow barrier and the southwestern hydrogeologic boundary of the Basin, as well as the Deep Aquifers. The controlling data that determined/focused this boundary are primarily the AEM surveys (DWR, 2020; Deep Aquifer Study, 2023).

An example AEM flight line showing the effect of the Reliz Fault is shown on Figure A-30. On this figure, the Reliz Fault zone lies between the 2 vertical dashed lines. A vertical displacement juxtaposing high resistivity features (shown as reds and purples) and lower resistivity features (shown as greens and blues) is evident in the fault zone. The red and purple features represent crystalline rocks of the Sierra de Salinas, and the adjacent green sediments between 250 and 400 meters bgs represent the 400/Deep Aquitard. The Salinas Valley Sediments, including the Paso Robles Formation, do not extend laterally across this displacement, and as such the displacement from the fault represents a discontinuity. Therefore, the Reliz Fault, as mapped by the California Geologic Survey, is the western lateral extent against the Sierra de Salinas.

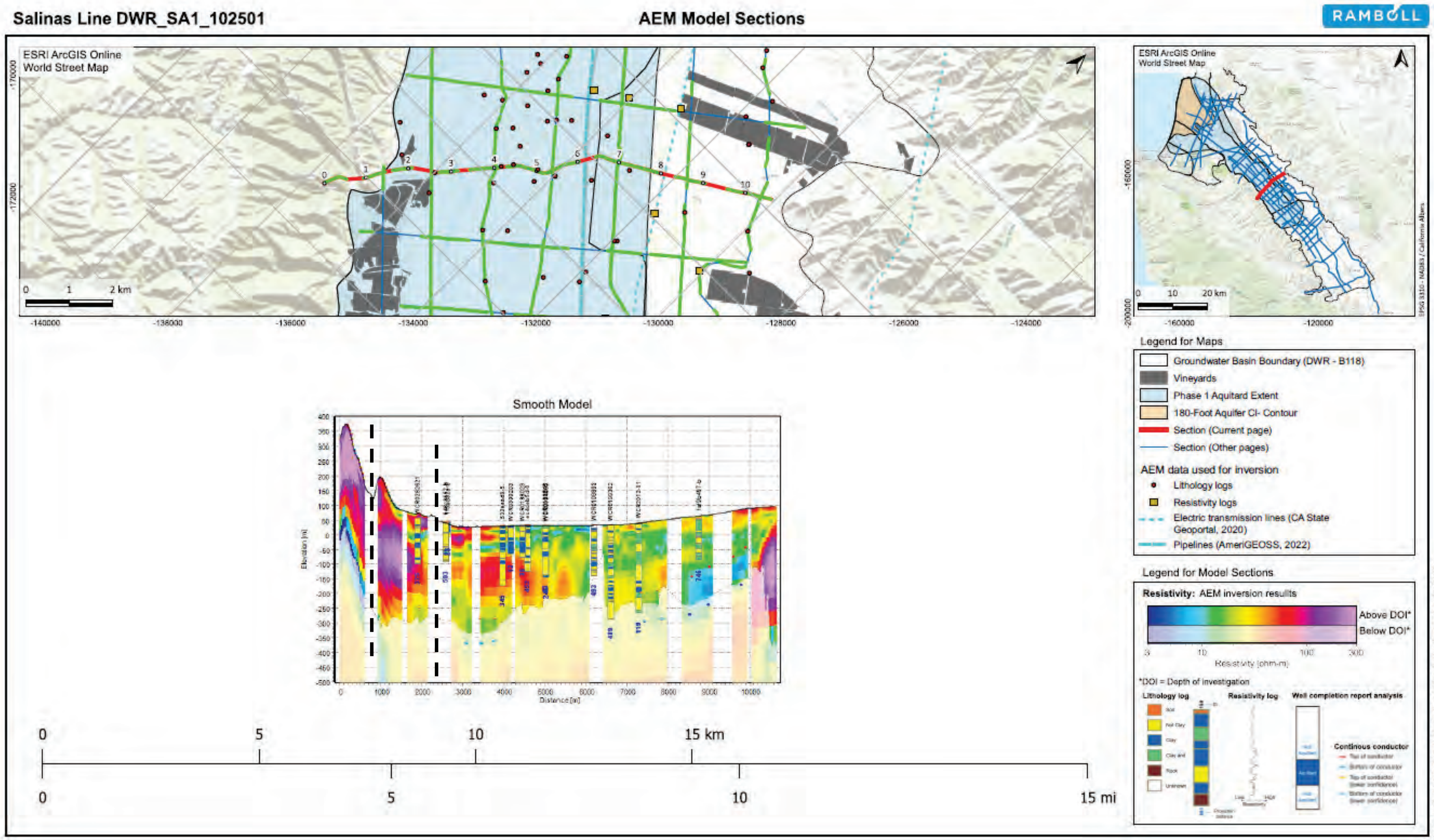



Figure A-30. AEM Profile Showing Reliz Fault Displacement on Left

*South Coastal/Laguna Seca Anticline Axis*

The coastal southwest boundary is defined by the Laguna Seca Anticline axis, which was formed during a period of structural uplift and deformation. The Anticline axis generally follows a semi-parallel orientation as Highway 68, traversing through the Seaside Basin and turning northward near the Toro Park region. The north-dipping arm is seen clearly in AEM data, and the 400/Deep Aquitard sediments are readily discernable from the Anticline into the main Salinas Basin. The Reliz Fault bisects the north-dipping arm, but does not act as a barrier to flow, as established by equipotential lines for the principal aquifers described in both the Monterey and 180/400-Foot Aquifer Subbasins' GSPs.

The controlling data that determined this boundary are the AEM surveys (MCWD, 2019, DWR, 2022, and Deep Aquifer Study, 2023), previously published reports and cross-sections (Feeney and Rosenberg, 2003; Hanson, 2002; Yates, 2005; HydroMetrics WRI, 2009; Feeney, 2007; Feeney, 2010; MacTec, 2005; Harding ESE, 2001), and wells with known screen intervals. The anticlinal structure is depicted in the modified A-A' cross section from the Deep Aquifer Investigation (Feeney and Rosenberg, 2003), modified in the *Seaside Groundwater Basin Watermaster Seawater Sentinel Wells Project, Summary of Operations* report (Feeny, 2007), and shown on Figure A-31. This figure shows how the Paso Robles Formation occurs continuously from the Reliz Fault over the anticline, terminating at the Ord-Terrace Fault. Geologic maps, cross-sections, and descriptions were helpful to begin the analysis; additional geophysical data refined the hydrogeological relationships with the regional geology.

The AEM surveys display a low-resistivity zone that follows the anticlinal structure (Figure A-32). This low resistivity zone is outlined with a black dashed line, and does not necessarily correspond with the geologic contacts shown on Figure A-31. The outlined low resistivity zone on Figure A-32 appears to be continuous with the low-resistivity 400/Deep aquitard in the Monterey and 180/400-Foot Aquifer subbasins. The low resistivity zone in these AEM surveys suggests a continuous aquitard from the Monterey subbasin up the north arm of the Laguna Seca anticline. Furthermore, the depth of this low-resistivity zone is supported by the locations of known wells' screened intervals.

The screened intervals for wells installed for the Seaside Basin are shown as grey horizontal bands on Figure A-32, and were helpful to correlate the subsurface geology with the subsurface hydrogeology. Overlaying these wells' screen intervals with the AEM data shows that many of these wells are screened below the continuous, low-resistivity aquitard within the Paso Robles Formation, and only a few screened above the aquitard. Notably, there are no wells screened within the aquitard, suggesting the aquitard is avoided when installing wells. Additionally, the Seaside model developed by HydroMetrics WRI in 2009 made note of historical observations of a thick, clay-rich zone within the Paso Robles Formation, and subsequently discretized it within the model.

The continuous low-resistivity zone shown on the AEM data and unscreened by most wells defines a continuation of the400/Deep Aquitard. This low resistivity zone does not necessarily terminate at the crest of the Laguna Seca Anticline, however it does change dip direction across the crest of the anticline. It is unclear from the AEM data if the deep aquifers sediments, shown in red on Figure A-32 extend south of the anticline crest. Therefore, to find a reasonable lateral extent with the structure, stratigraphy, and hydrostratigraphy all acting in concert, the axis of the Laguna Seca Anticline was selected as the southern coastal lateral extent of the Deep Aquifers.

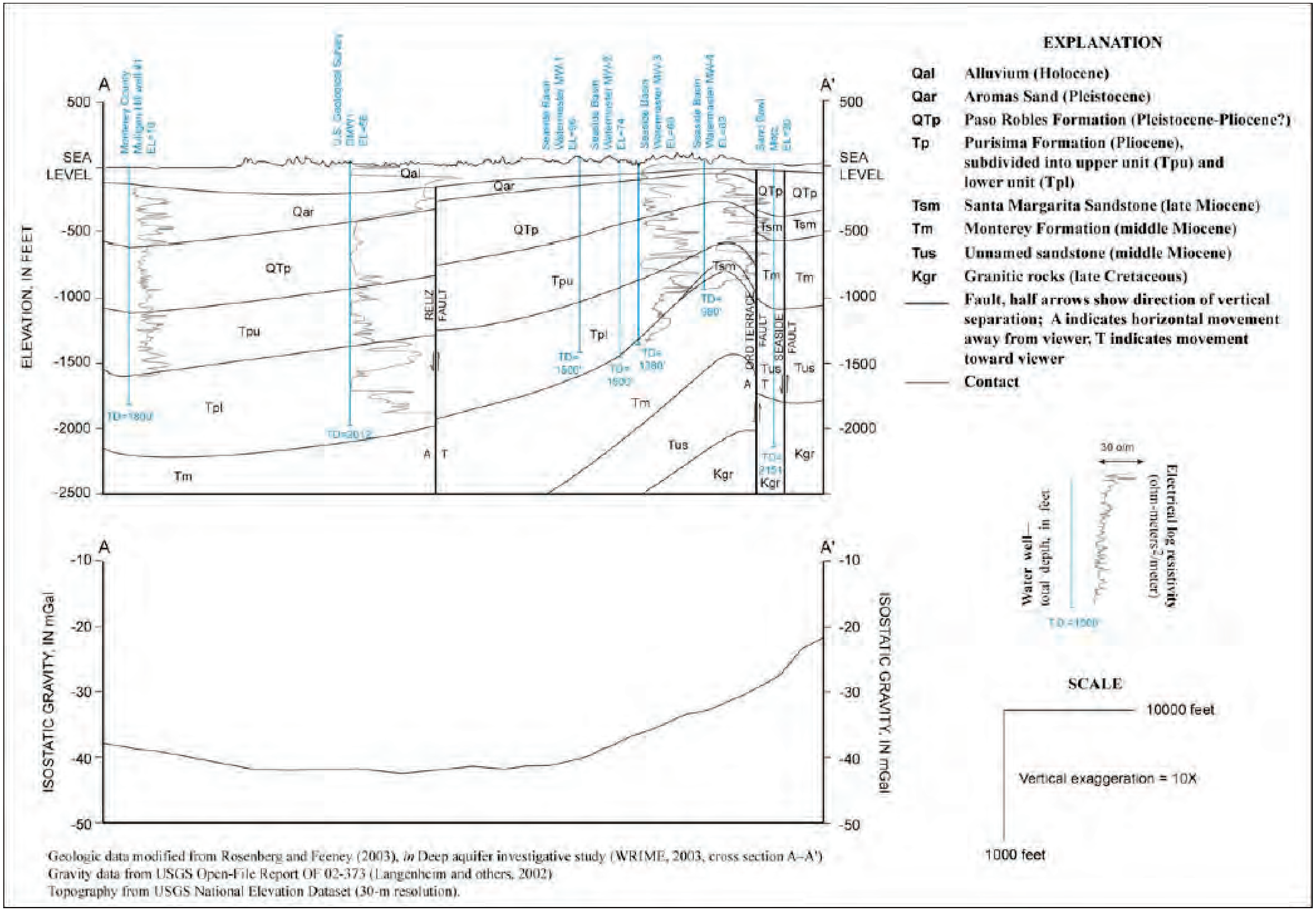



Figure A-31. Modified Feeney and Rosenberg, 2003 Cross Section A-A', Modified by Feeney, 2007

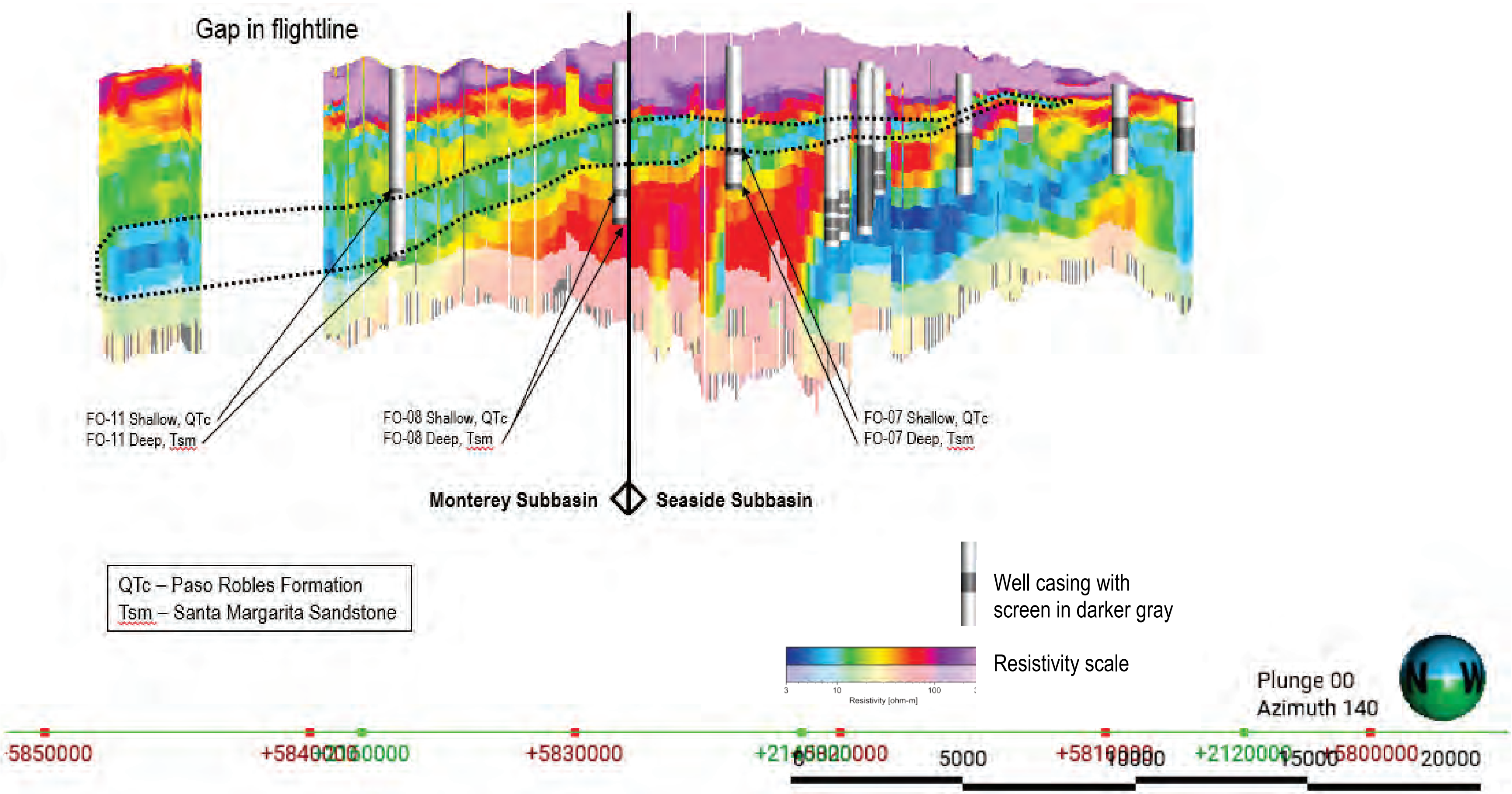



Figure A-32. 2022 DWR Coastal AEM survey Highighting the Hydrostratigraphy that Separates Sediment Types within the Paso Robles Formation

## SUMMARY

The Deep Aquifers' extent is delineated by the extent of the continuous 400/Deep Aquitard as identified through a variety of data, including AEM surveys, WCRs, borehole e-logs, previously published reports and cross sections, and professional experience in the Basin. Through the synthesis of all data available for each area, the extent was determined based on multiple lines of evidence using overlapping or confirming data as much as possible. In certain areas, some data are weighed more heavily than others based on availability of data, overlapping/confirming data, completeness of data, and reliability of data. Much of the synthesis was built on existing knowledge. There are still areas of uncertainty, which are shown on Figure A-18. However, the areas of certainty delineated through this analysis have shifted the historical conceptual understanding of the Deep Aquifers' presence in the Basin. The data presented here are the best available data at the time of publication of this report.

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