

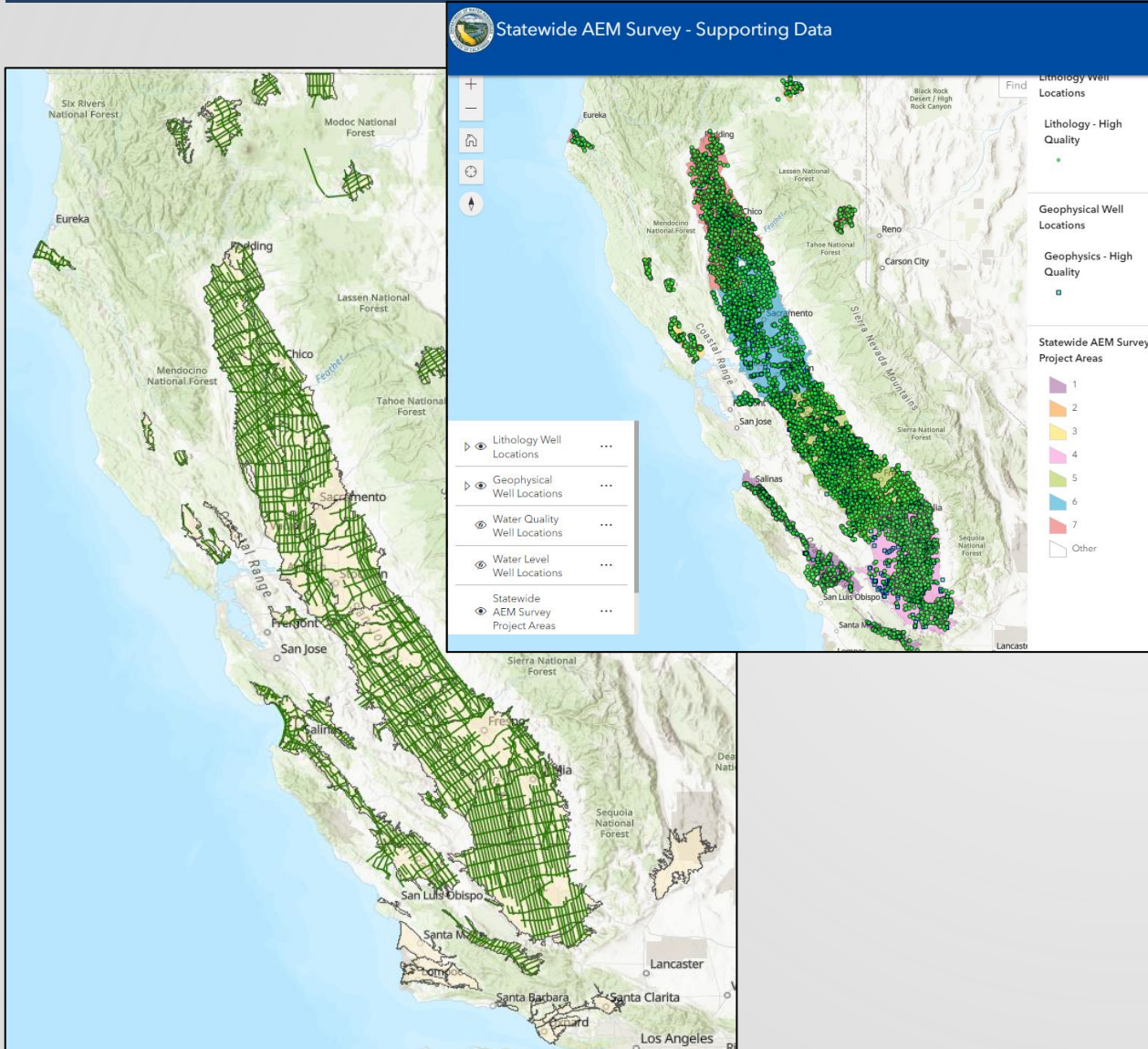
DWR's Basin Characterization Program and Airborne Electromagnetic (AEM) Survey Results and Tools

Steven Springhorn – SGMA Technical Assistance Manager

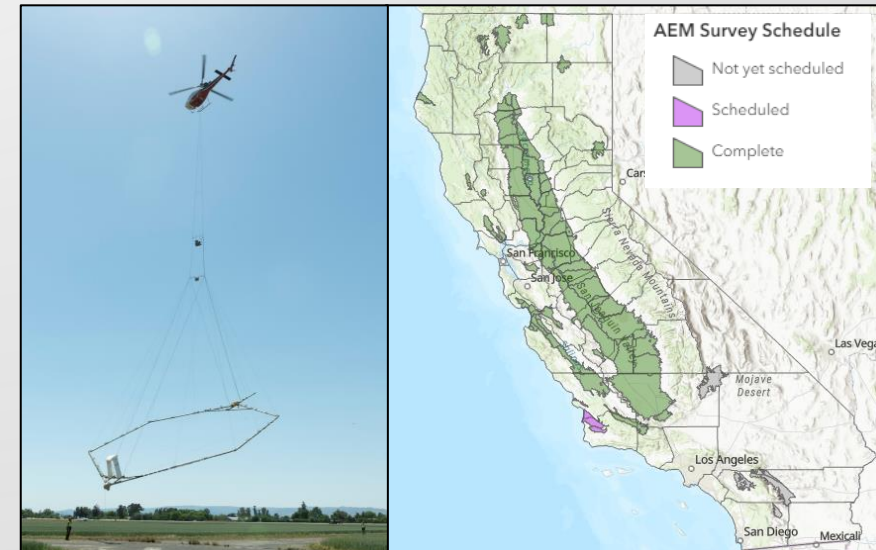
Katherine Dlubac – Statewide AEM Project Manager



Statewide AEM Survey Project Status

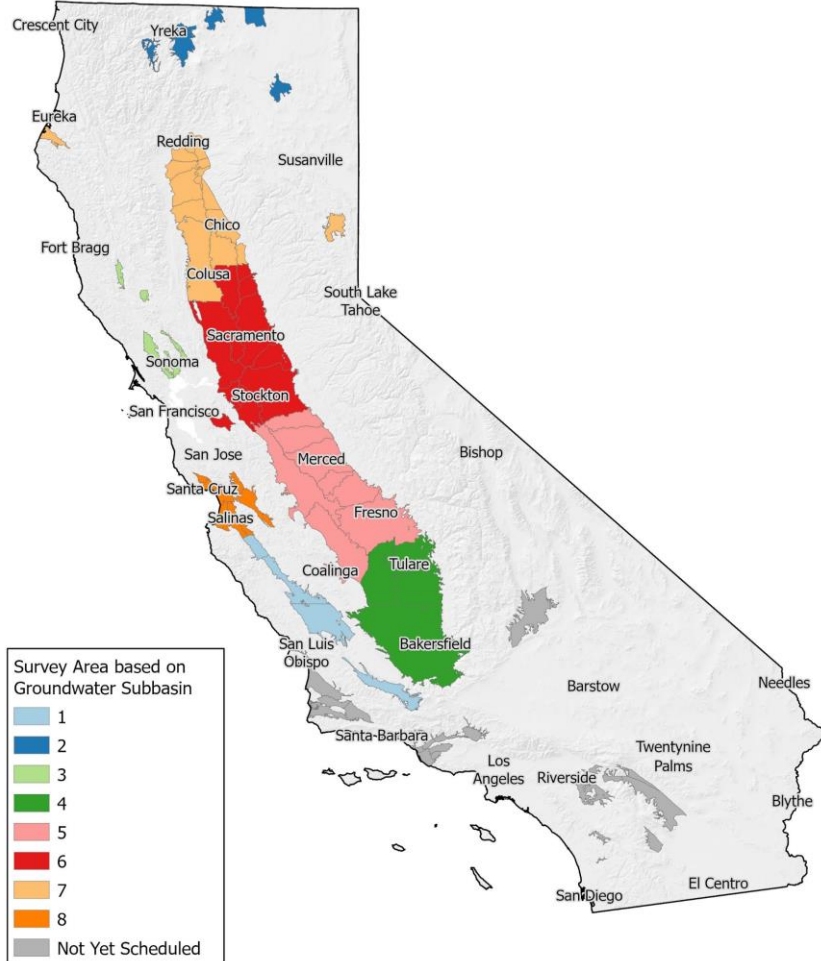


- Surveys 95% complete.
- 15,000 line-miles of AEM data collected.
- 78 groundwater subbasins surveyed.
- 14 final Data Reports published.
- 13,000 high-quality, digitized lithology logs
- 1,200 high-quality digitized e-logs



AEM Survey & Data Release Schedule

AEM Survey Area Key

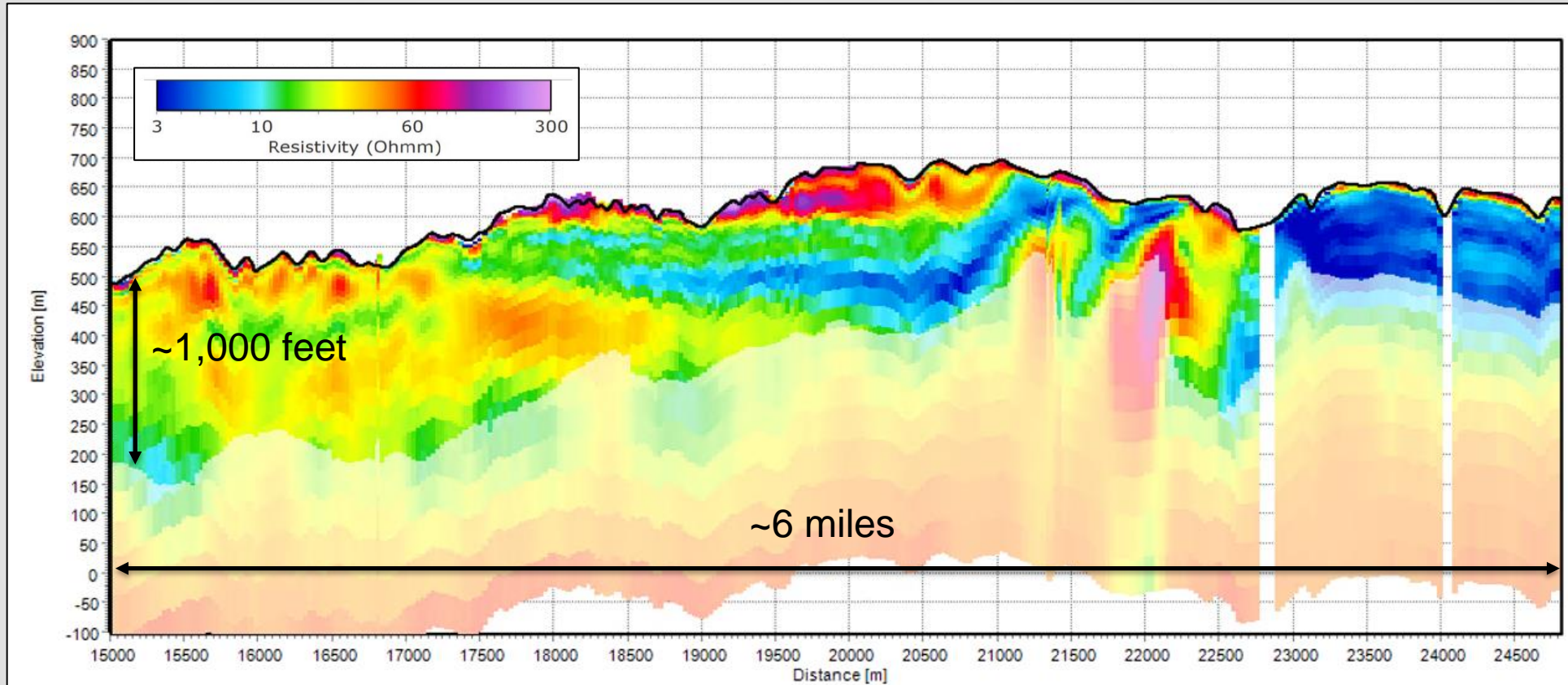
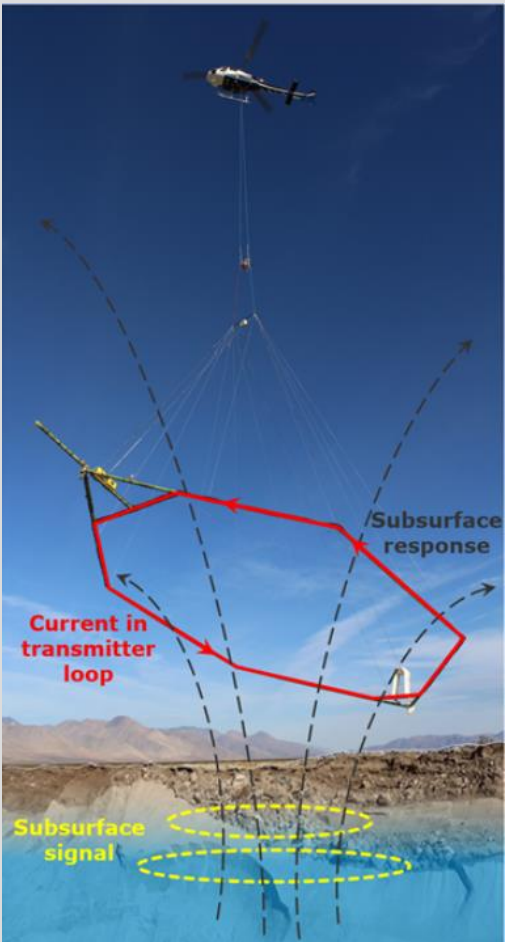


For a complete list of groundwater subbasins surveyed in each survey area, please visit:
<https://water.ca.gov/Programs/Groundwater-Management/Data-and-Tools/AEM> and click on AEM Survey Schedule.

Survey Area	Survey Area Description	Survey Date	Data Availability Status
1	Salinas Valley & Cuyama	August 2021	Complete dataset
2	Northern Basins	November 2021	Complete dataset
3	Northern SF Bay, Ukiah, Big Valley	November 2021	Complete dataset
4	Southern San Joaquin	December 2021 & March 2022	Complete dataset
5	Central San Joaquin	March 2022	Complete dataset
6	Northern San Joaquin & Southern Sacramento	April 2022	Complete dataset
7	Northern Sacramento, Eel River, Sierra	May 2022	Complete dataset
8	Monterey Bay Area	November 2022	AEM only & Supporting Data
9	San Luis Obispo & Santa Barbara County Areas	October 2023	None
10	Salton Sea & Eastern Sierra Areas	November 2023	None

AEM Method and Resistivity Profile

Send signals into earth and measure the EM response



Less Resistive: fine grain-dominated materials or high TDS
More Resistive: coarse grain-dominated materials

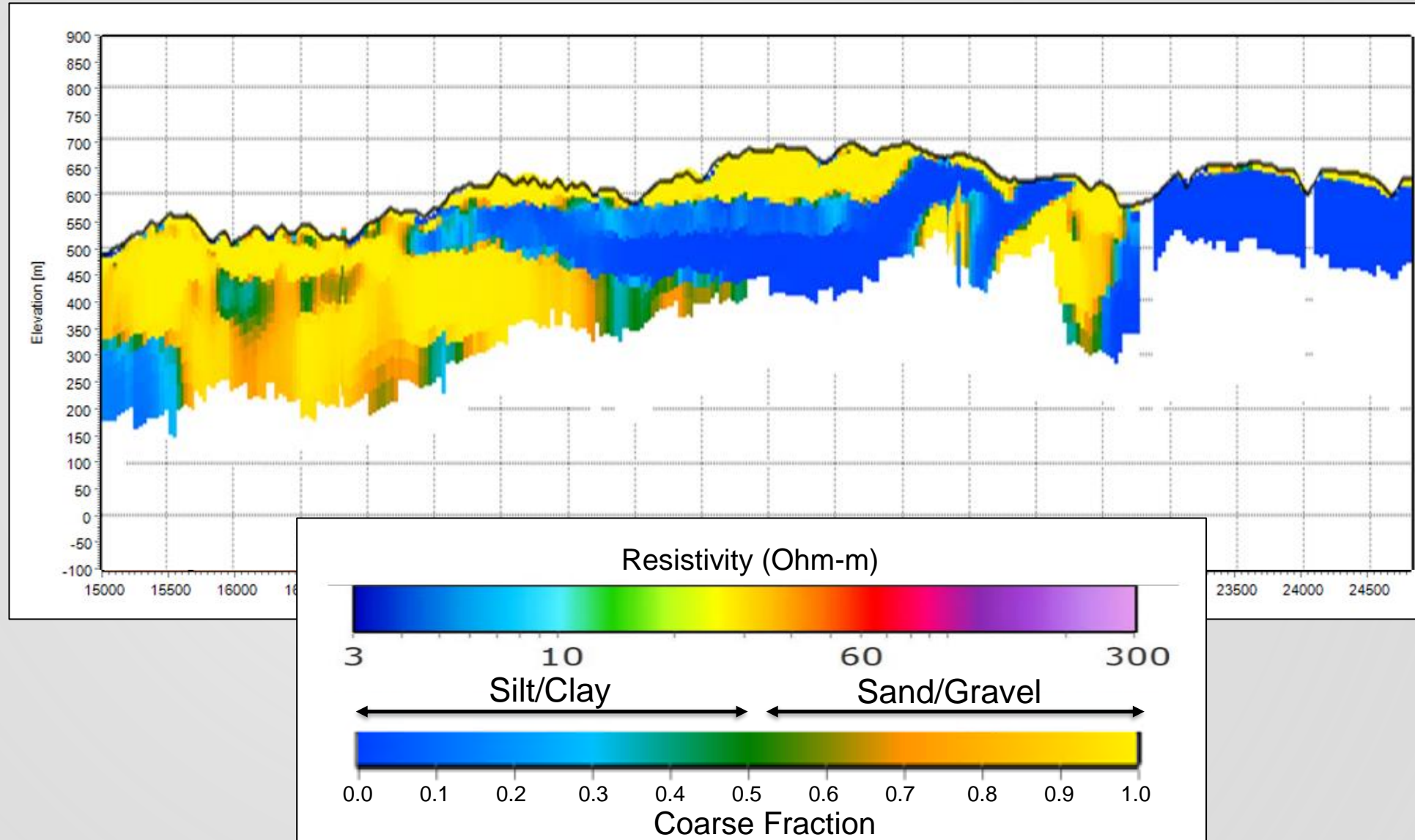
Depth of investigation: ~1,000 feet
Vertical resolution:
Shallow: ~10 feet
Deep: ~100 feet

AEM Interpretation for Lithology/Texture

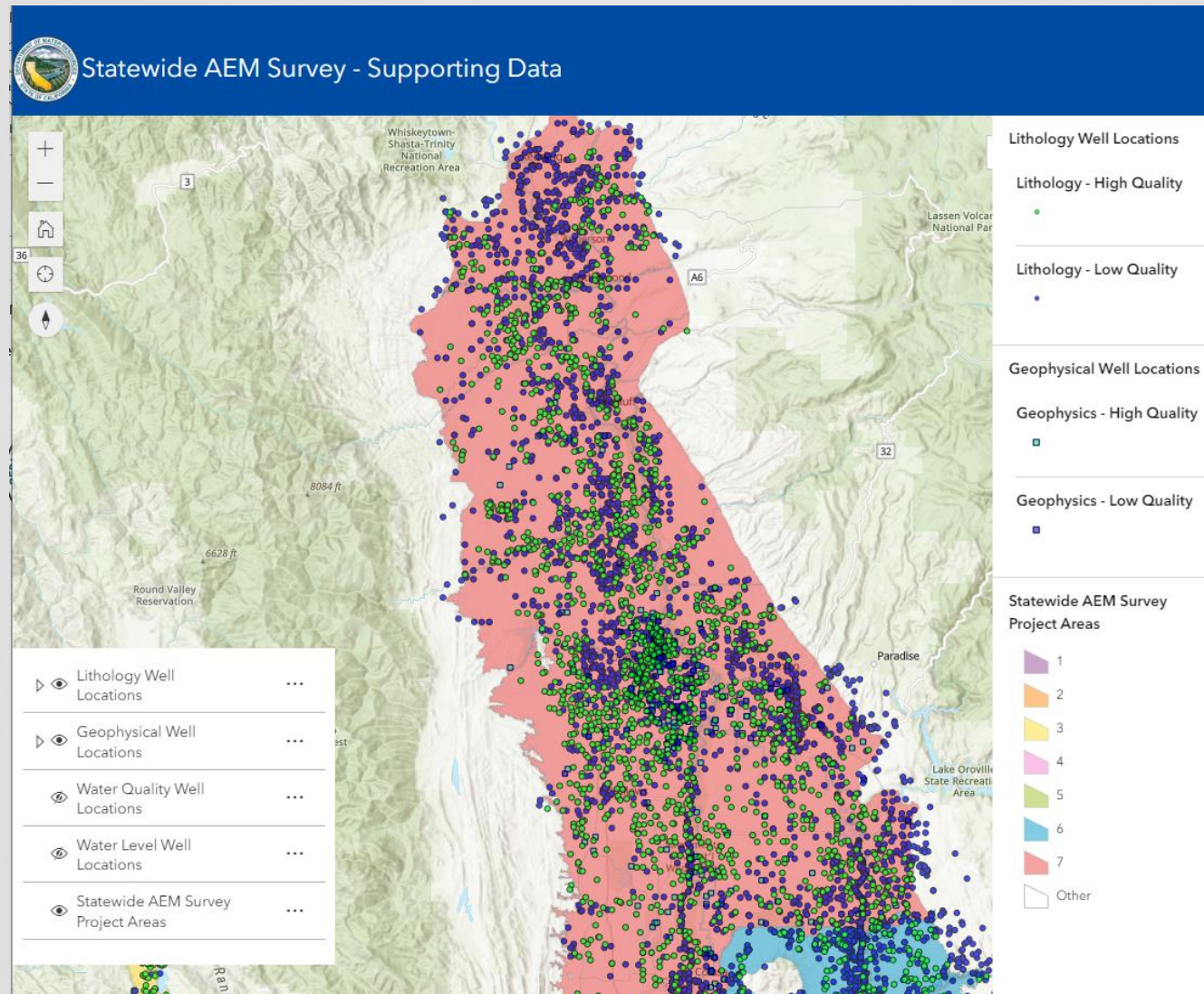
AEM data interpreted from resistivity to lithology using *supporting data*

Existing supporting data:

- Lithology logs
- Geophysical data
- Groundwater quality (TDS)
- Groundwater levels




Digitized Supporting Data



<https://experience.arcgis.com/experience/a6d250e7ef5846e283053430848213ce>

Data Report and Dataset Publication



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DWR Airborne Electromagnetic (AEM) Surveys Data

5 Followers

Statewide AEM Surveys Project Overview

The Department of Water Resources' (DWR's) Statewide Airborne Electromagnetic (AEM) Surveys Project is funded through California's Proposition 68 and the General Fund. The goal of the project is to improve the understanding of groundwater aquifer structure to support the state and local goal of sustainable groundwater management and the implementation of the Sustainable Groundwater Management Act (SGMA).


During an AEM survey, a helicopter tows electronic equipment that sends signals into the ground which bounce back. The data collected are used to create continuous images showing the distribution of electrical resistivity values of the subsurface materials that can be interpreted for lithologic properties. The resulting information will provide a standardized, statewide dataset that improves the understanding of large-scale aquifer structures and supports the development or refinement of hydrogeologic conceptual models and can help identify areas for recharging groundwater.

DWR is collecting AEM data in all of California's high- and medium-priority groundwater basins, where data collection is feasible. Data are collected in a coarsely spaced grid, with a line spacing of approximately 2-miles by 8-miles. AEM data collection started in 2021 and will continue over the next several years. Visit the AEM Survey Schedule Webpage to get up-to-date information on the survey schedule: <https://gis.water.ca.gov/app/AEM-schedule>

Additional information about the Statewide AEM Surveys can be found at the project website: <https://water.ca.gov/Programs/SGMA/AEM>

Datasets published on a rolling basis.
Typical between 3 to 12 months after surveys complete

Organization



California Department of Water Resources
DWR manages California's water resources, systems, and infrastructure, including the State Water Project (SWP), in a responsible, sustainable way. [read more](#)


Social

Twitter

Facebook

Dataset Topics Activity Stream Showcases


Data and Resources



Read Me - DWR Disclaimer

DWR's dataset and Data Report use disclaimer.


Preview Download



Survey Area Map

Map showing Survey Areas


Preview Download



AEM Flight Line Map

Map showing the AEM survey flight lines where data have been collected to date.


Preview Go to resource



AEM Data Viewers

Overview of Tools The Voxel Data Viewer, AEM Profile Viewer, and AEM Data Viewer are innovative...


Preview



Supporting Data Map

Supporting Data An important part of the AEM data processing, inversion, and interpretation is...


Preview Go to resource



Electrical Resistivity Depth Slices and Shallow Subsurface Average Maps

This zipped shapefile provides maps showing electrical resistivity (ohm-meters) depth slices and...


More Info Download



Texture Interpretation (Coarse Fraction) Depth Slices and Shallow ...

This shapefile represents texture data interpretations (as coarse fraction) provided as depth...


More Info Download



Survey Area 1 - Salinas Valley Data Report

Data Report for the Salinas Valley portion of Survey Area 1. File updated on 5/31/2022.


Preview Download



Survey Area 1 - Salinas Valley Data Report Appendices

Appendices for the Salinas Valley Data Report. File updated on 5/31/2022.

More Info Download



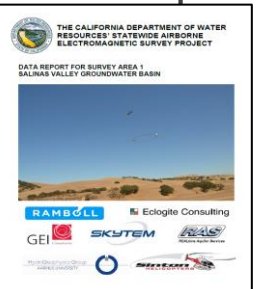
Survey Area 1 - Salinas Valley Fact Sheet

This two-page fact sheet provides a high level overview of the activities completed and data...

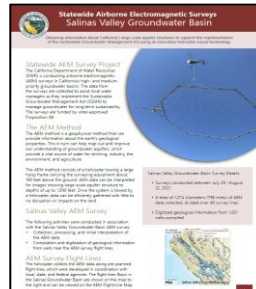
Preview Download

Survey Area Data Package

Data Report



Fact Sheet



AEM Data

ZIP

01_Raw Data

02_Database

03_Sections_and_Thematic_Maps

04_XYZ_Ascii

Readme

Readme_DWR_Disclaimer

Supporting Data

ZIP

AEM_WELL_INFO_csv_WO1_20220

AEM_WELL_LITHOLOGY_csv_WO1

AEM_WELL_WATER_LEVEL_csv_WO1

AEM_WELL_WATER_QUALITY_csv_WO1

Geophysics_WO1_20211213


ReadMe


Readme_DWR_Disclaimer


WO1_Salinas_Cinema_WCRe

<https://data.cnra.ca.gov/dataset/aem>


Data Report and Dataset Publication


 **Survey Area 7 - Flown Survey Lines - PROVISIONAL** 🔥
Provisional flown flight lines for Survey Area 7 (Colusa, Butte, Wyandotte Creek, Vina, Los...


 **Survey Area 7 - Data Report - North Sacramento Valley**
Data Report for Survey Area 7 (North Sacramento Valley - Colusa, Butte, Wyandotte Creek, Vina,...

 **Survey Area 7 - Data Report Appendices (North Sacramento Valley - ...**
Appendices to the Data Report for Survey Area 7 (North Sacramento Valley - Colusa, Butte,...


 **Survey Area 7 - Data Report - Redding Area**
Data Report for Survey Area 7 (Redding Area - South Battle Creek, Bowman, Anderson, Enterprise,...


 **Survey Area 7 - Data Report Appendices (Redding Area)**
Appendices to the Data Report for Survey Area 7 (Redding Area - South Battle Creek, Bowman,...


 **Survey Area 7 - Data Report - Sierra Valley**
Data Report for Survey Area 7 (Sierra Valley groundwater subbasin). File updated on 8/7/2023


 **Survey Area 7 - Data Report Appendices - Sierra Valley**
Appendices to the Data Report for Survey Area 7 (Sierra Valley groundwater subbasin). File...


 **Survey Area 7 - Data Report - Eel River Valley**
Data Report for Survey Area 7 (Eel River Valley Groundwater Basin). File updated on 9/20/2023

 **Survey Area 7 - Data Report Appendices - Eel River Valley**
Appendices to the Data Report for Survey Area 7 (Eel River Valley Groundwater Basin). File...

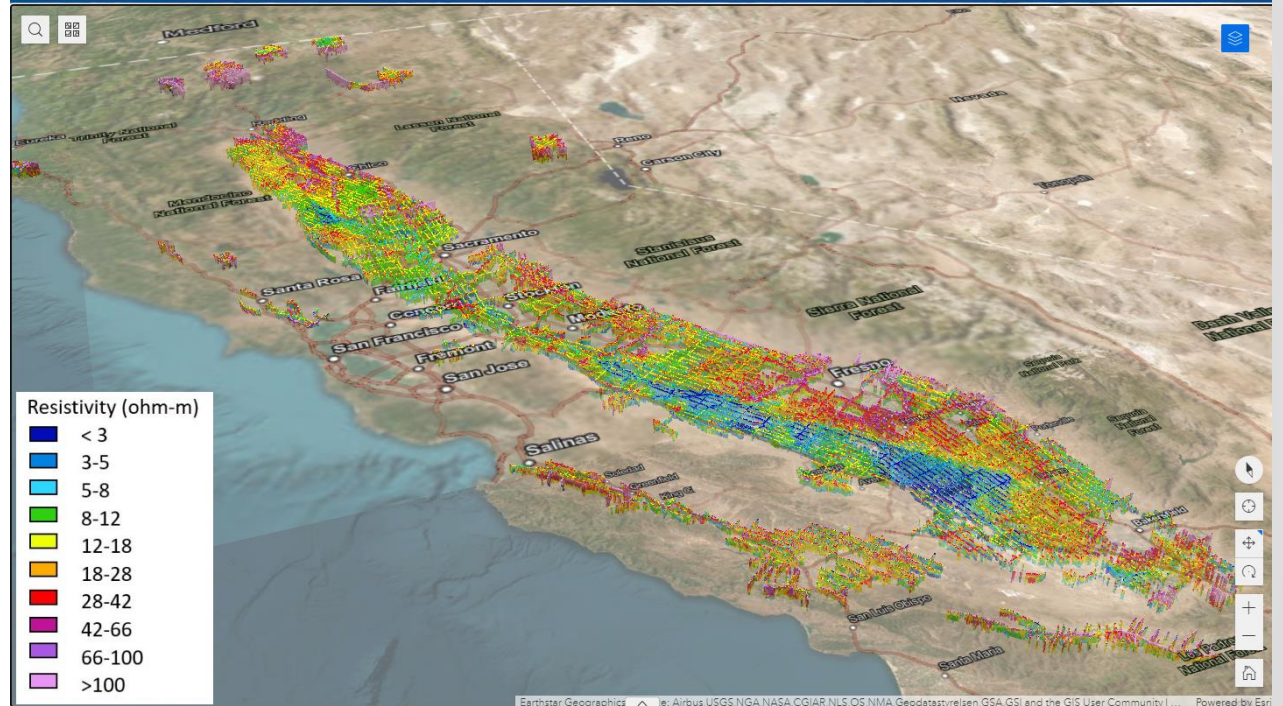
 **Survey Area 7 - Raw AEM Data** 🔥
Raw AEM data and auxiliary data for Survey Area 7.

 **Survey Area 7 - AEM Data - PROVISIONAL**
AEM data package containing a provisional AEM data acquisition parameters, raw, inverted, and...



 **Survey Area 7 - Supporting Data**
Package of compiled data used to support the AEM data interpretation, including digitized well...

 **Survey Area 7 - Esri Scene Layer Package - Resistivity** 🔥
This file contains the electrical resistivity data where each point represents the vertical...


 **AEM Electrical Resistivity Data**



 More Info  Download

 More Info  Download

 More Info  Download

 More Info  Download

ESRI Scene Layer Package
allows data to be readily imported
into ArcPro as Point Clouds with
no depth exaggeration.

Data Visualization Tools



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DWR Airborne Electromagnetic (AEM) Surveys Data

7 Followers

AEM Data Viewers

DWR has developed AEM Data Viewers to provide a quick and easy way to visualize the AEM electrical resistivity data and the AEM data interpretations (as texture) in a three-dimensional space. The most recent data available are shown, which may be the provisional data for some areas that are not yet finalized. The Data Viewers can be accessed by direct link, below, or from the Data Viewer Landing Page: <https://data.cnra.ca.gov/dataset/aem/resource/29c4478d-fc34-44ab-a373-7d484afa38e8>

AEM 3D Viewer (Beta) (computer only): <https://dwr.maps.arcgis.com/apps/instant/3dviewer/index.html?appid=f781b14f42ab45e5b72f32cf07af899c>

AEM Profile Viewer: <https://dwr.maps.arcgis.com/apps/instant/attachmentviewer/index.html?appid=65f0aa6db8124aeda54e1f33c5dfe66c>

AEM Depth Slice and Shallow Subsurface Average Maps

As a part of DWR's upcoming Basin Characterization Program, DWR will be publishing a series of maps and tools to support advanced data analyses. The first of these maps have now been published and provide analyses of the Statewide AEM Survey data to support the identification of potential recharge areas. The maps are located on the SGMA Data Viewer (under the Hydrogeologic Conceptual Model tab) and show the AEM electrical resistivity and AEM-derived texture data as the following:

- Shallow Subsurface Average: Maps showing the average electrical resistivity and AEM-derived texture in the shallow subsurface (the top approximately 50 feet below ground surface). These maps support identification of potential recharge areas, where the top 50 feet is dominated by high resistivity or coarse-grained materials.
- Depth Slices: Depth slice automations showing changes in electrical resistivity and AEM-derived texture with depth. These maps aid in delineating the geometry of large-scale features (for example, incised valley fills).

Shapefiles for the formatted AEM electrical resistivity data and AEM derived texture data as depth slices and the shallow subsurface average can be downloaded here:

Electrical Resistivity Depth Slices and Shallow Subsurface Average Maps: <https://data.cnra.ca.gov/dataset/aem/resource/7d115ac3-d7b8-47fa-ab8b-a078b2525bbe>

Texture Interpretation (Coarse Fraction) Depth Slices and Shallow Subsurface Average Maps: <https://data.cnra.ca.gov/dataset/aem/resource/0952506a-1ad8-4c04-9372-ded45148e6a6>

SGMA Data Viewer (Hydrogeologic Conceptual Model tab) - Depth Slices and Shallow Subsurface Average Maps: <https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#hcm>

Data Visualization Tools



Open Data Organizations Topics Training

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Home / Organizations / California Department of ... / DWR Airborne ... / **AEM Data Viewers**

AEM Data Viewers

Overview of Tools

The AEM 3D Viewer and AEM Profile Viewer are innovative tools that allows GSAs and stakeholders to view AEM datasets online. The GIS-based tools allow datasets can be viewed in a three-dimensional space and allows the user to interact with the data by zooming in and viewing the data from various angles. The tools are accessible from a web browser on a desktop, tablet, or mobile phone and does not require data to be downloaded or the use of specialized software.

AEM Electrical Resistivity

AEM electrical resistivity data shows the distribution of electrical resistivity values within the aquifer, where electrical resistivity describes a material's ability to resist the flow of electrical current. Generally, materials with higher electrical resistivity values correspond to coarse-grain dominated materials, like sands and gravels. Lower resistivity values correspond to fine-grain dominated materials, like silts and clays, or materials saturated with fluids that have a high concentration of dissolved salts or seawater.

AEM Texture Data

AEM electrical resistivity data are interpreted for sediment texture, described as coarse fraction. The interpretation is supported by incorporating geophysical logs data into the transform. (AEM Texture Data to be added to the AEM 3D Viewer soon!)

AEM 3D Viewer (Beta)

The AEM 3D Viewer shows AEM electrical resistivity values displayed as voxels. The voxel space can be navigated using the navigation widget created using the slice widget.

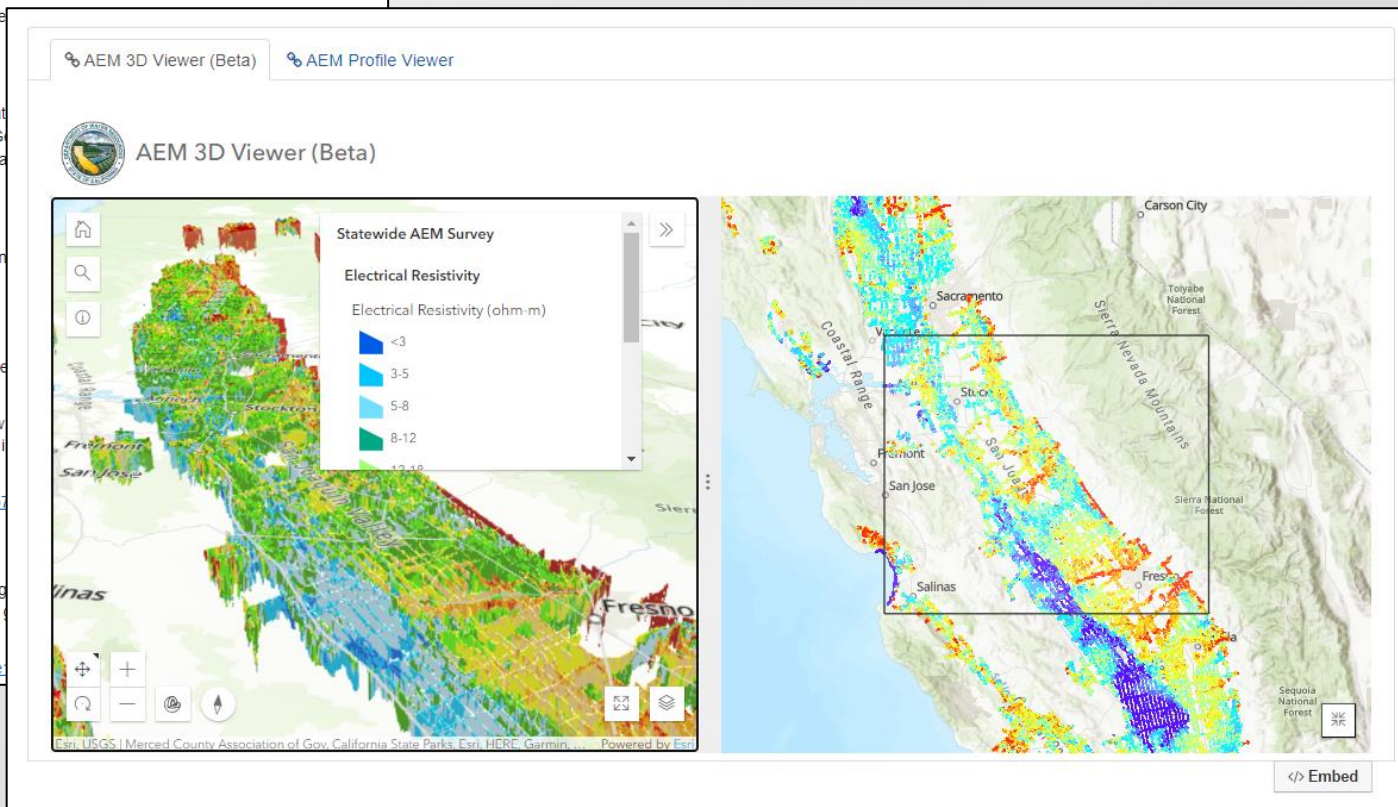
The map insert in the right pane shows the average electrical resistivity values in the shallow subsurface (0-17 m). Zoom into the map to show high-quality lithology and geophysical logs. Click on the survey line segments to show pop-ups of segment profile images. Click on the profile image to view the profile image in a new window.

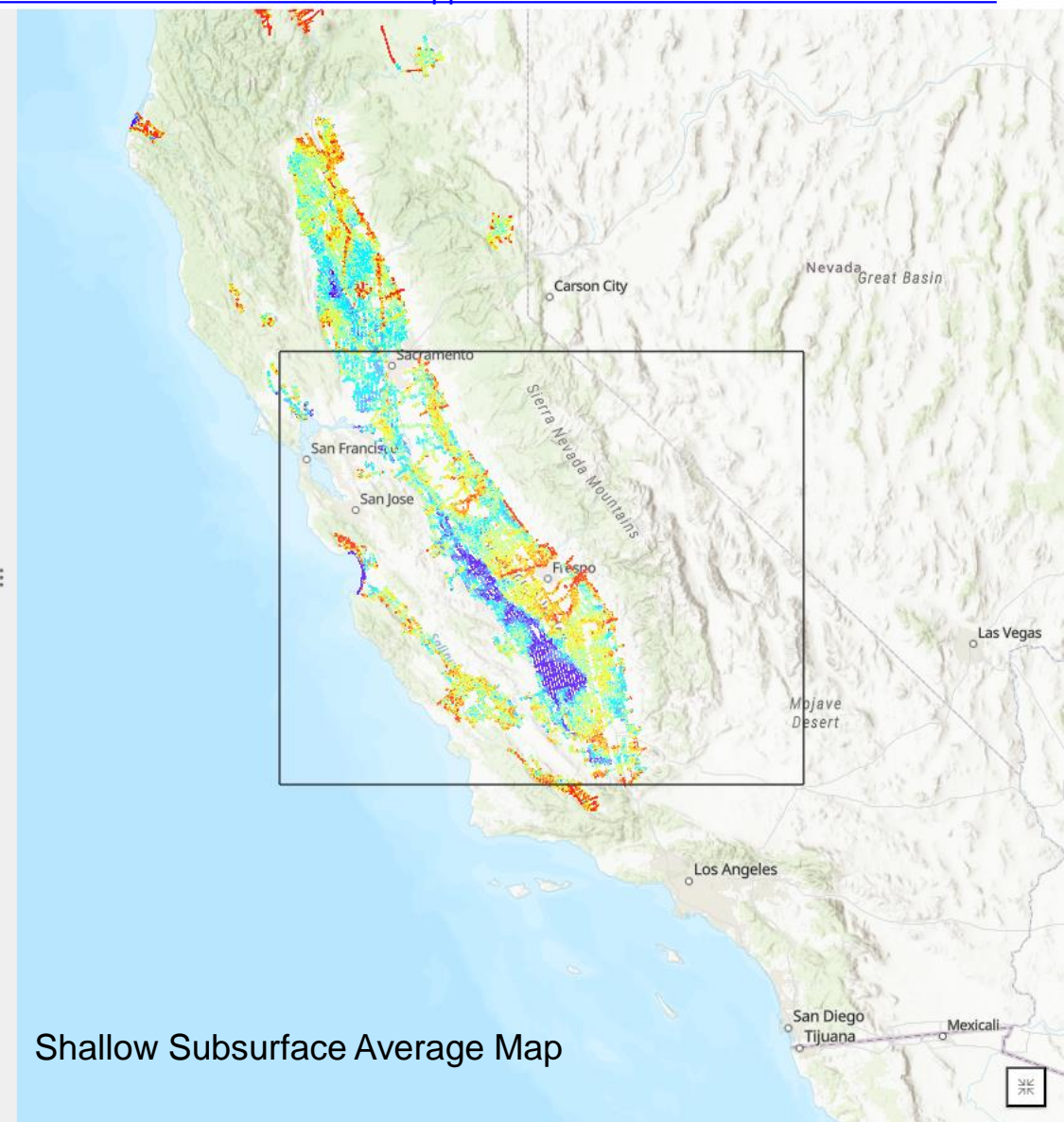
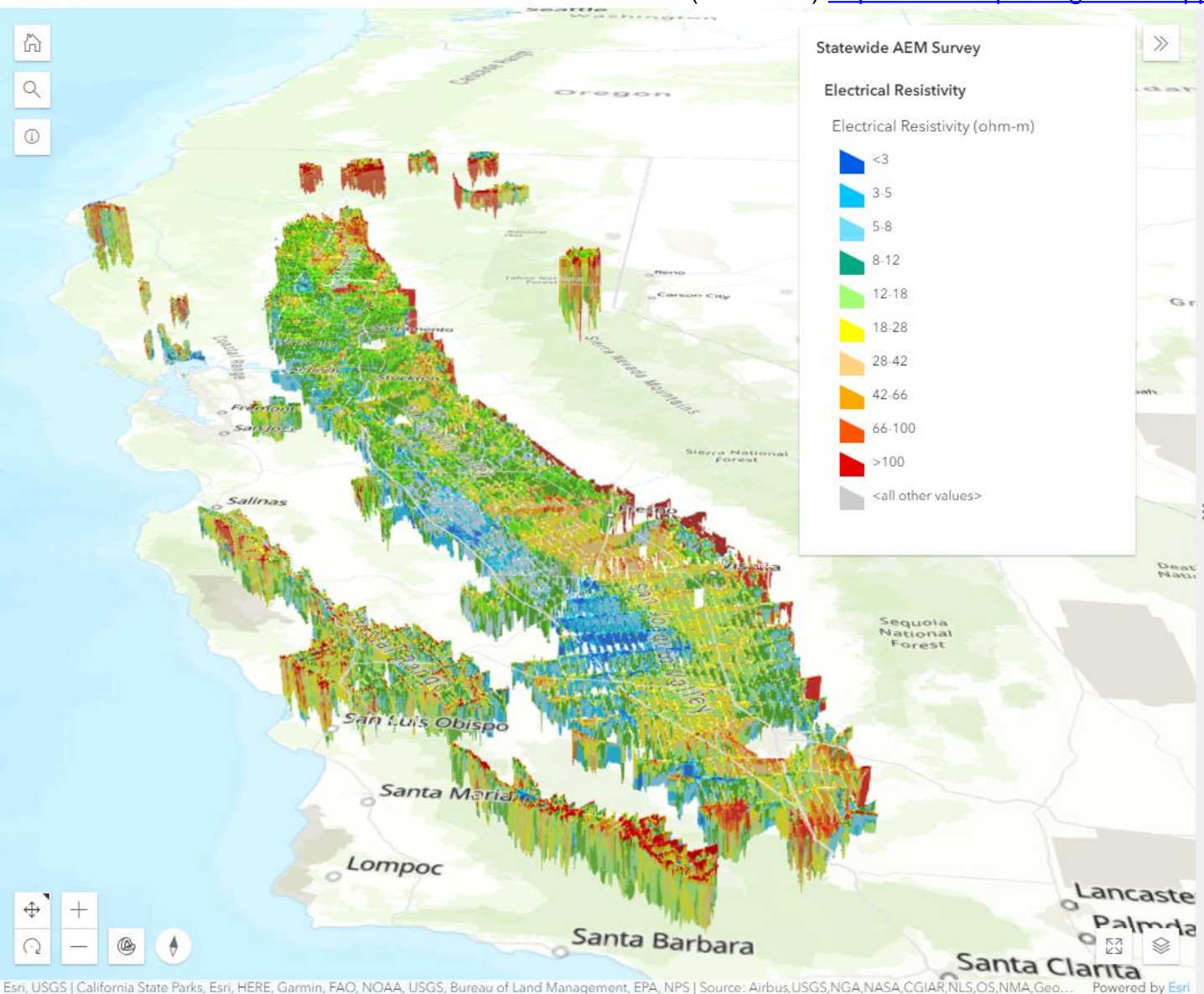
Link to full screen AEM 3D Viewer (computer only): <https://dwr.maps.arcgis.com/apps/insant/3dviewer/index.html?appid=f781b14f42ab45e5b7>

AEM Profile Viewer

The AEM Profile Viewer allows the user to click on profile line segments and show the electrical resistivity profile images in the panel on the right. The profile images show electrical resistivity values in the shallow subsurface (0-17 m), the location of survey line segments, and locations of high-quality lithology and geophysical logs. Click on the profile images to show the profile images.

Link to full screen AEM Profile Viewer: <https://dwr.maps.arcgis.com/apps/insant/attachmentviewer/index.html?appid=65f0aa6db8124aeda54e>

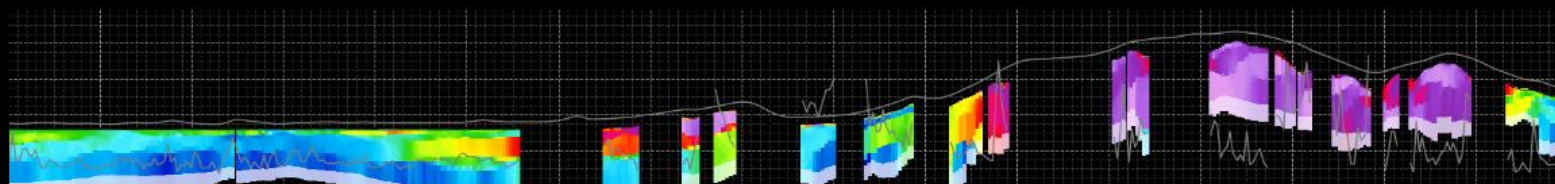
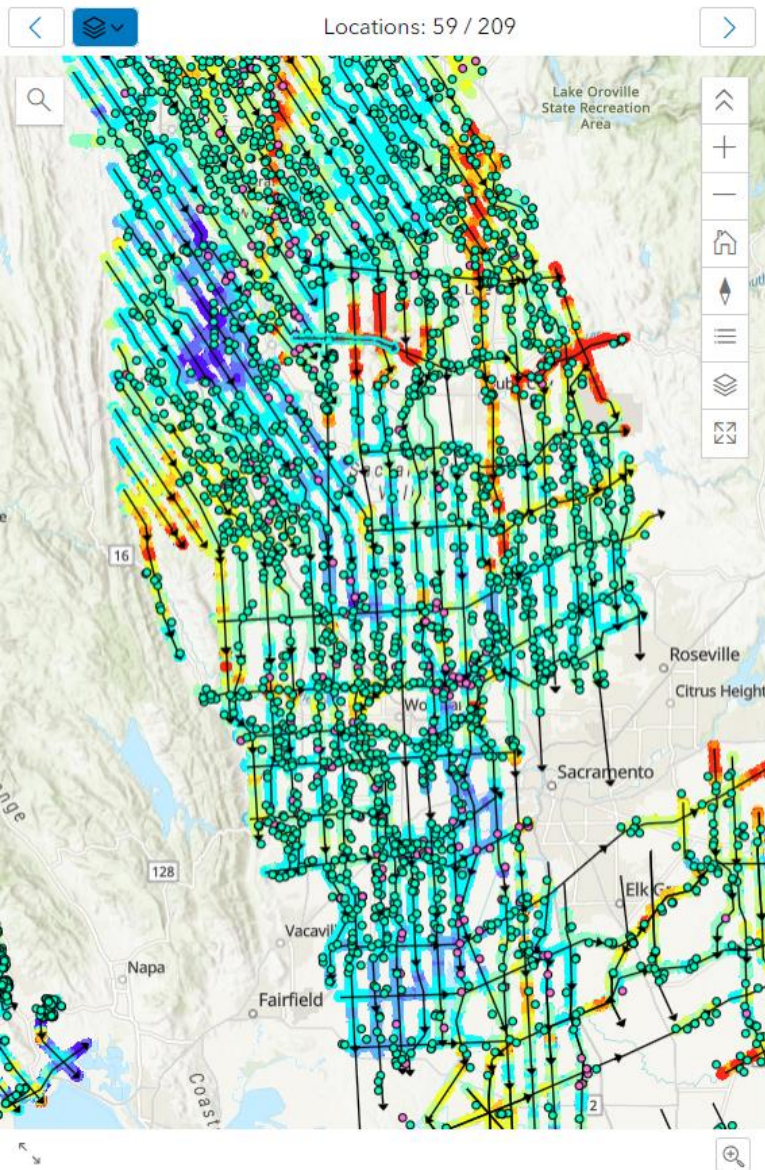




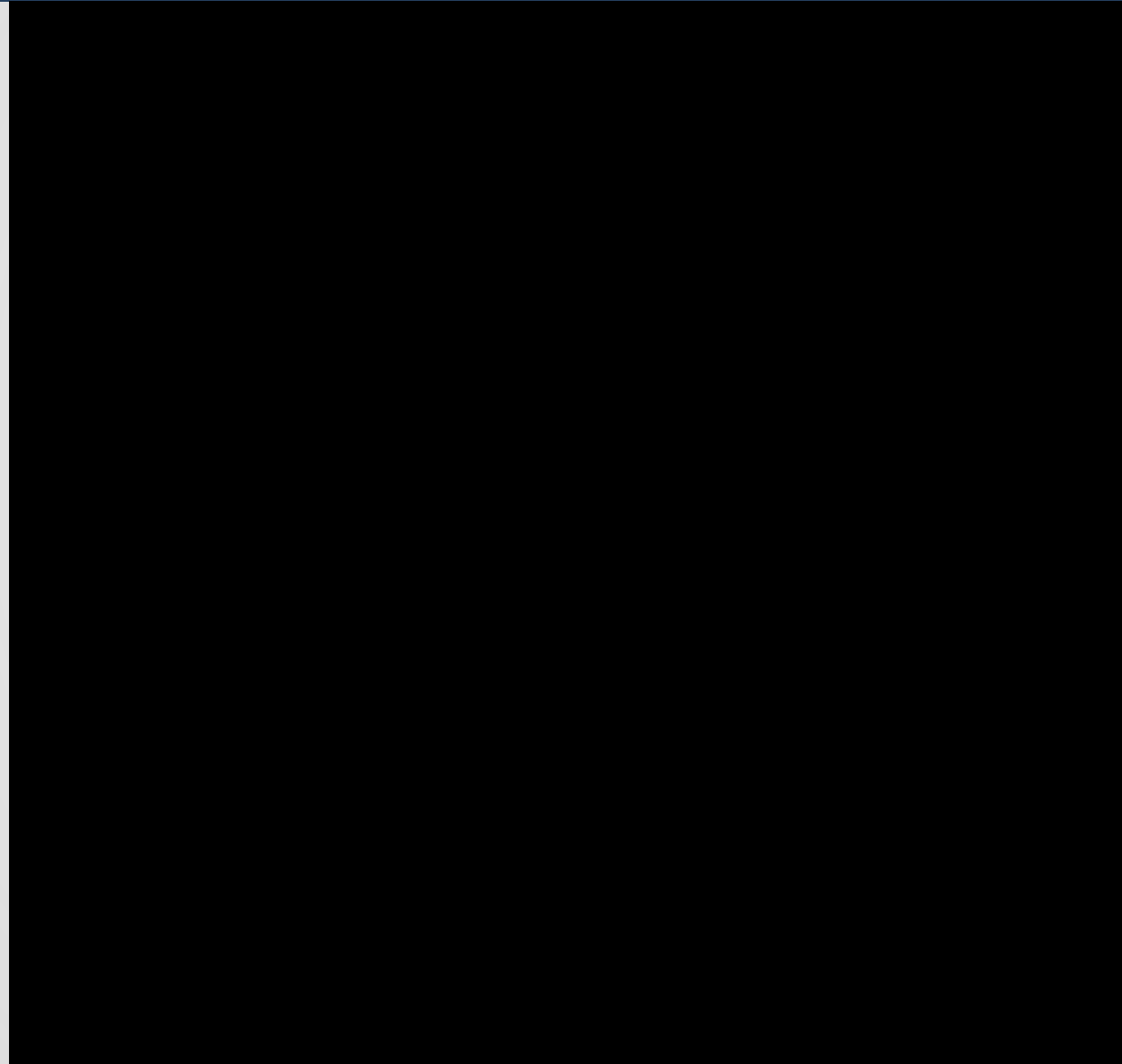
AEM data are processed as ESRI Voxel datasets. 3D Voxel dataset can be viewed from various angles and the Slicer widget allows the user to view data profiles and depth slices. The insert map shows the shallow subsurface average. Zooming in shows locations of high-quality lithology and e-logs and flight line segments. Profile images are shown in popups for flight line segments.



AEM Profile Viewer 1

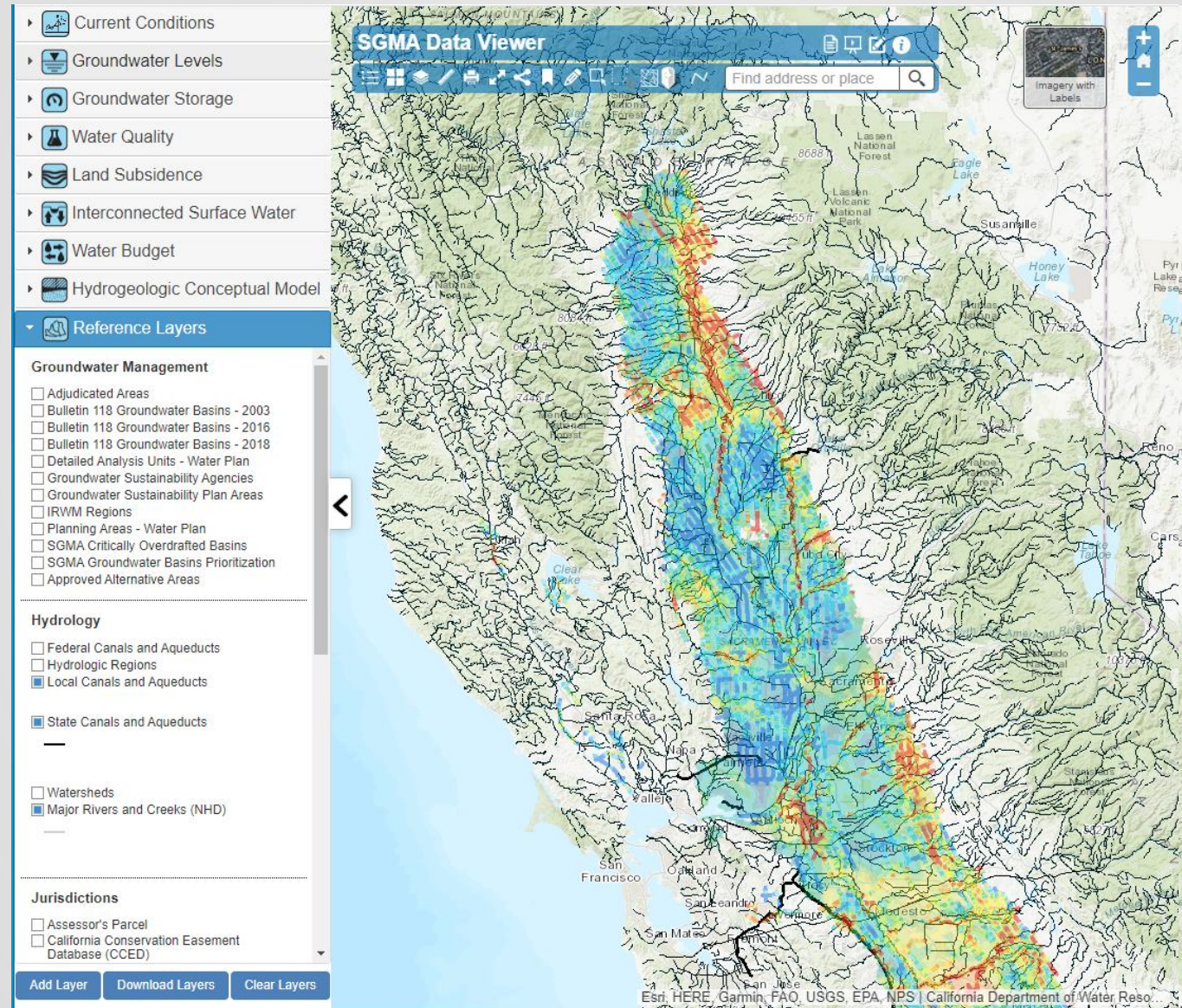


SGMA Data Viewer: AEM Texture Depth Slices



<https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer>

SGMA Data Viewer: AEM Texture Shallow Subsurface Average




Potential Managed
Aquifer Recharge
Locations

SGMA Data Viewer: AEM Texture Depth Slices


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Data and Resources




Read Me - DWR Disclaimer
DWR's dataset and Data Report use disclaimer.

[Preview](#) [Download](#)




Survey Area Map 🔥
Map showing Survey Areas

[Preview](#) [Download](#)




AEM Flight Line Map 🔥
Map showing the AEM survey flight lines where data have been collected to date.

[Preview](#) [Go to resource](#)




AEM Data Viewers
Overview of Tools The AEM 3D Viewer and AEM Profile Viewer are innovative tools that allows GSAs...

[Preview](#)




Supporting Data Map 🔥
Supporting Data An important part of the AEM data processing, inversion, and interpretation is...

[Preview](#) [Go to resource](#)



Electrical Resistivity Depth Slices and Shallow Subsurface Average Maps 🔥
This zipped shapefile provides maps showing electrical resistivity (ohm-meters) depth slices and...

[More Info](#) [Download](#)



Texture Interpretation (Coarse Fraction) Depth Slices and Shallow ... 🔥
This shapefile represents texture data interpretations (as coarse fraction) provided as depth...

[More Info](#) [Download](#)

California's Groundwater Connected Activities

Requirements

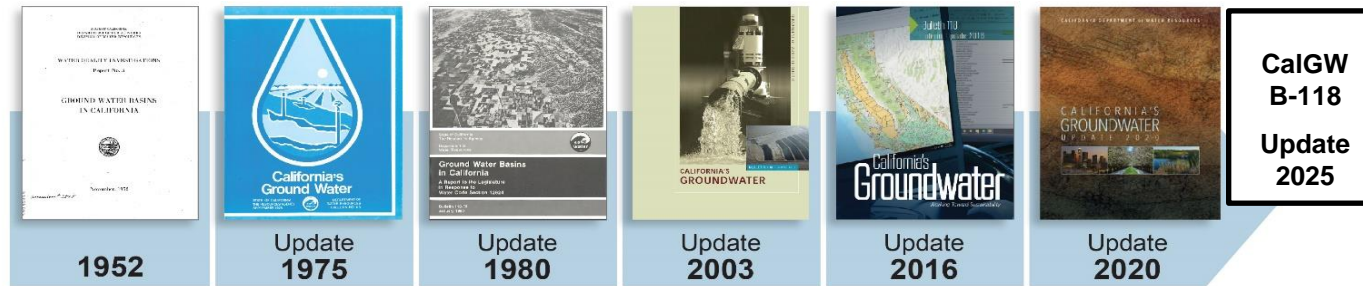
CA Water Code

10720.1, 10729, 10920,
12924

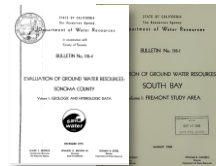
Focus - SGMA Basins
Water Resilience Portfolio,
Water Supply Strategy,
Drought/Flood

DWR is Required to Publish B-118, Characterize Groundwater Basins, and Provide Assistance

California's Groundwater (Bulletin 118) (Archive & Vision)



DWR's Basin Characterization (Analysis)



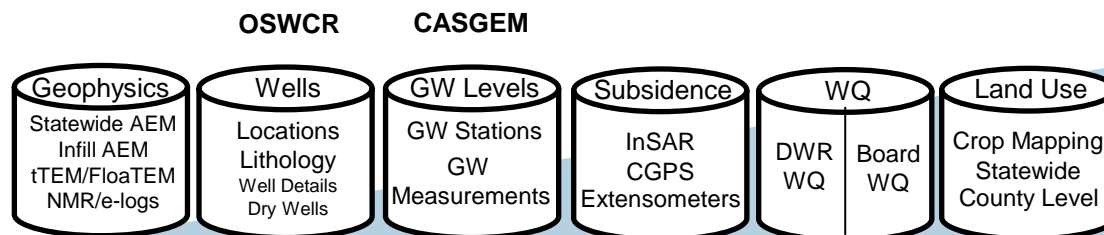
Statewide AEM
Surveys

Regional
&
Subbasin
Reports

Texture
Modeling
&
HydroStrat
Analysis

Local and Regional Basin Characterization

DWR's Data Collection and Stewardship (Access)



New Groundwater
Monitoring
Funding

Public

CalGW
Live

- Data Type
- Address
- Basin
- HR
- Statewide

Audience

SGMA
Data
Viewer

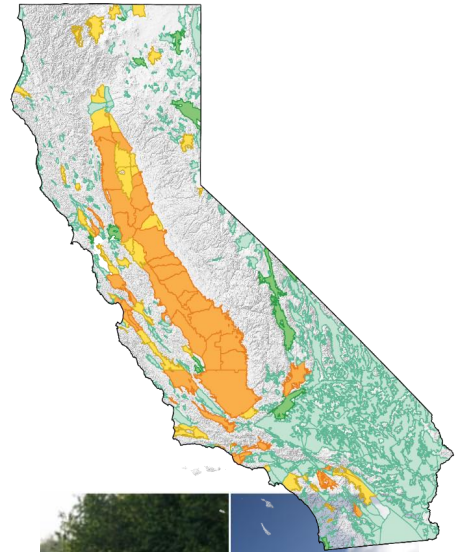
CalGW
Subbasin
Reports

2D/3D
Data
Viewer

Technical

Open
Data

C2VSim
&
Local
Models



DWR's Basin Characterization Program

DWR is required to provide assistance, characterize groundwater basins, and update California's Groundwater (Bulletin 118).

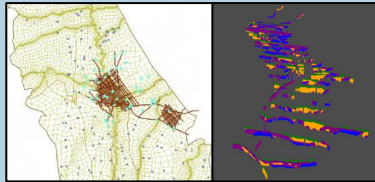
SGMA, Recharge, & GW Applications

- Primary Aquifers
- Extent of Clays
- Recharge Sites
- SW/GW Interaction
- Subsidence Potential
- Base of Fresh Water
- Vulnerable Domestic Wells
- Salinity Mapping

Continued Data Collection



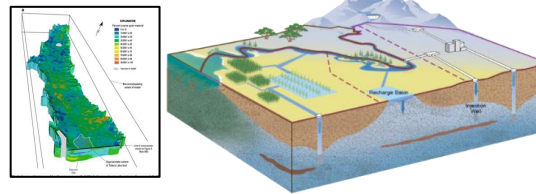
Integrated Analysis of All Subsurface Data



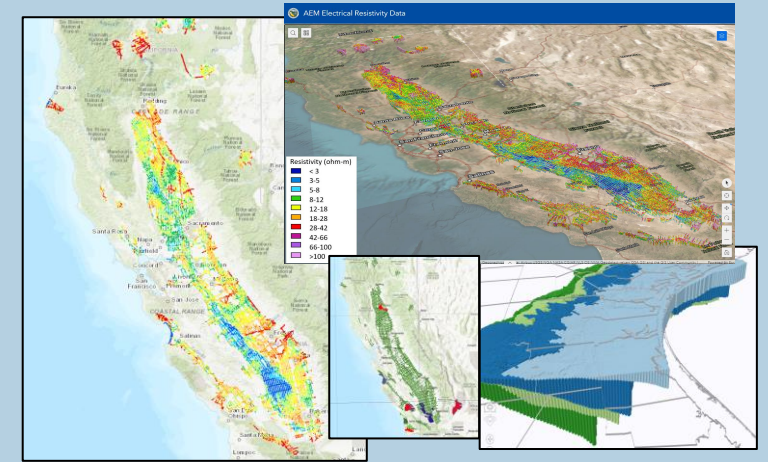
Community of Practice

- Public
- Academia Private Sector
- Local, State, & Federal Agencies
- Basin Characterization workgroup

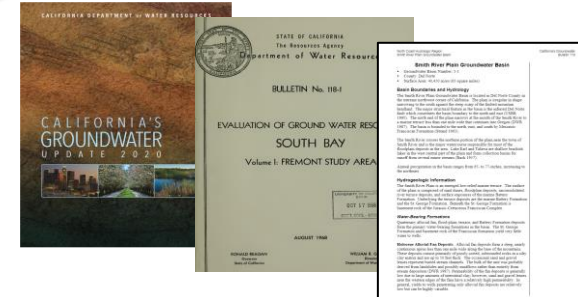
Statewide Texture Model & Hydrostratigraphic Model



Data Access & Visualization



Data Archive *California's Groundwater*



Continued Data Collection (& Compilation)

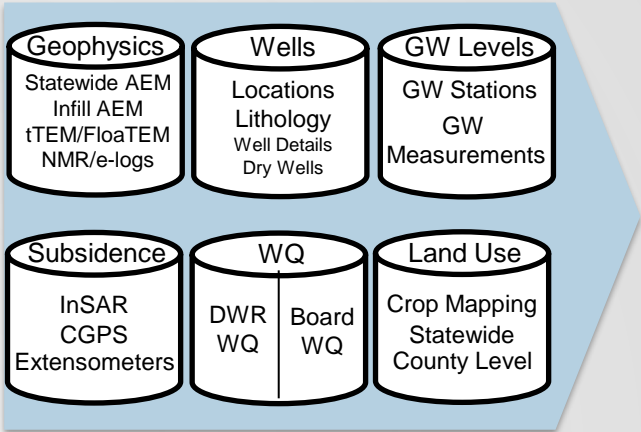
Statewide AEM Surveys
Characterize large-scale aquifer properties

SGMA Implementation Pilot Studies
Address SGMA implementation initiatives at local scale

Compilation & Digitization of Existing Data

GSP/Alt/Adj Hydrogeologic Conceptual Models

Reconnaissance grid



Pilot Study 1: Groundwater Recharge



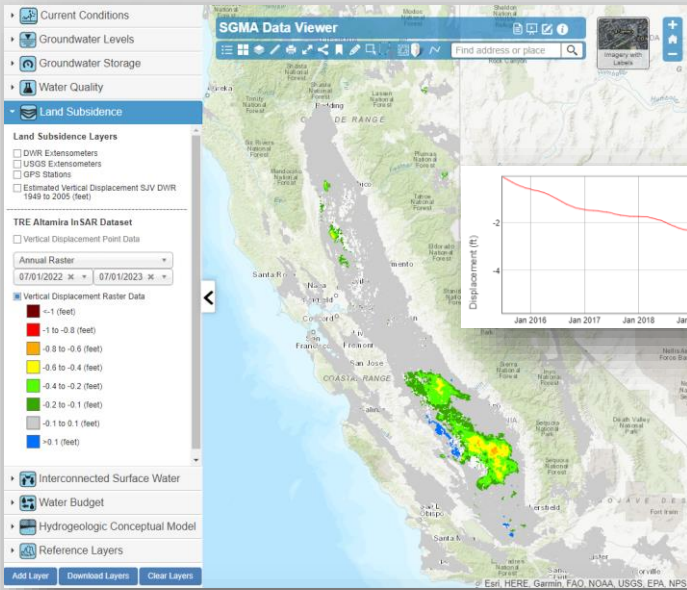
Pilot Study 2: SW/GW Interaction



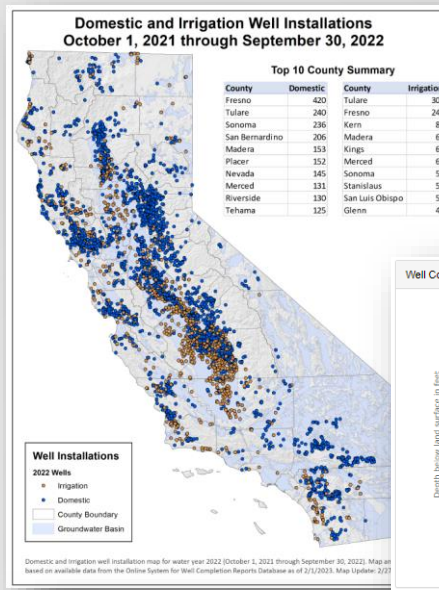
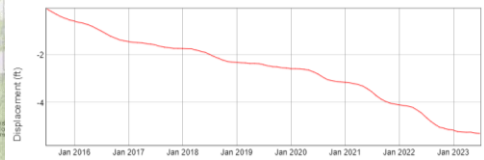
Pilot Study 3: DACs/Domestic Wells/Subsidence



Data Publication



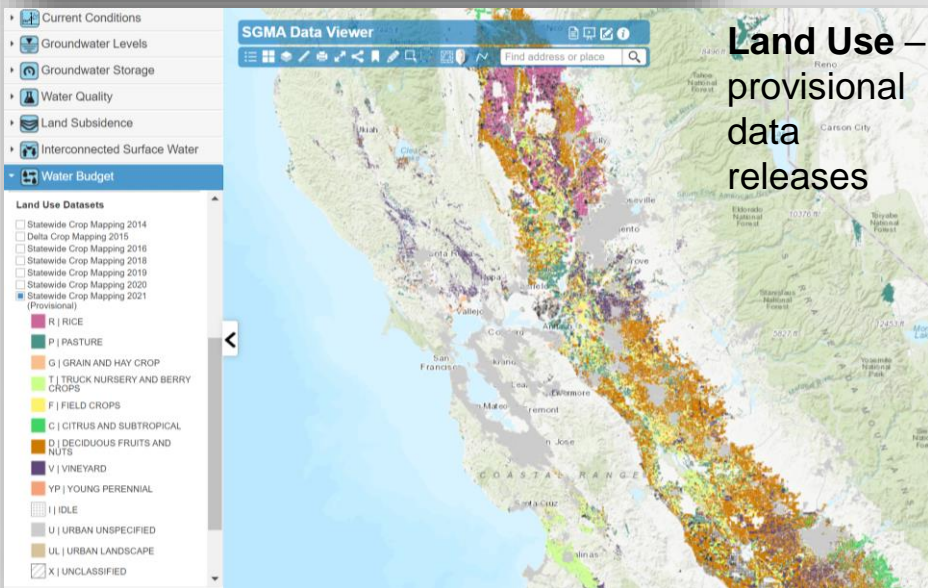
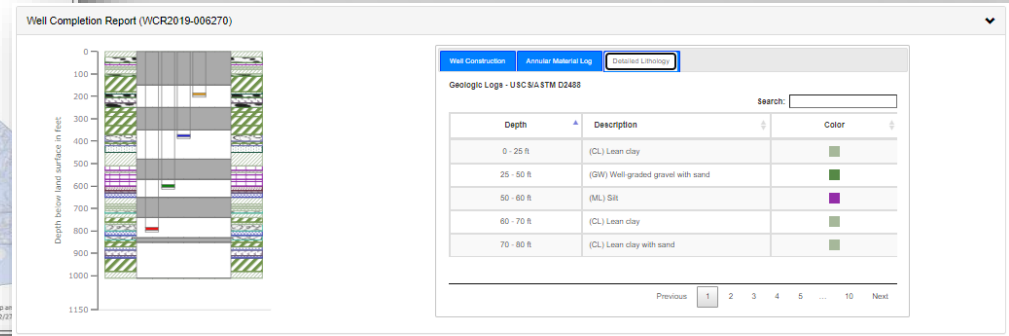
Subsidence – quarterly updates



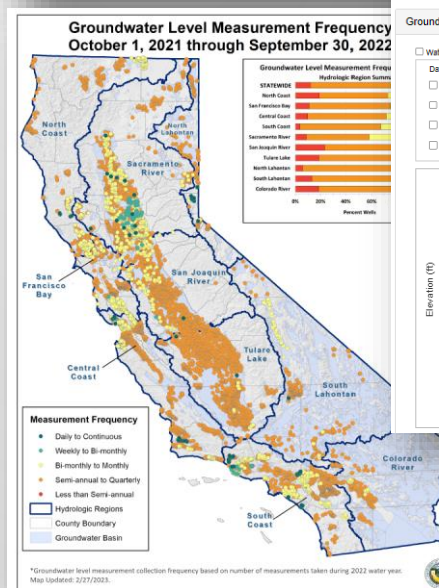
Well Completion Reports – Connection to GWL data

Data made available on

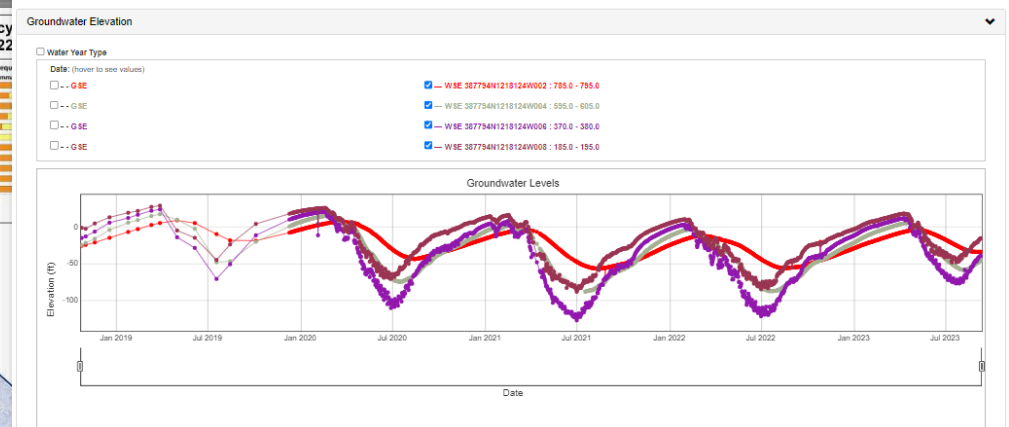
- [CNRA Open Data Portal](#)
- [SGMA Data Viewer](#)
- Dedicated Viewers



Land Use – provisional data releases



Groundwater Levels –
increased monitoring
frequency



SGMA Data Viewer Improvements

AEM Surveys

- Current Conditions
- Groundwater Levels
- Groundwater Storage
- Water Quality
- Land Subsidence
- Interconnected Surface Water
- Water Budget
- Hydrogeologic Conceptual Model**
 - ☐ Fault Classification (State)
 - ☐ Faults (Regional)
 - ☐ Faults (Local)
 - ☐ Fault Classification (Local)

Statewide Airborne Electromagnetic Surveys

- ☐ AEM Flight Lines
- ☒ Average Electrical Resistivity, Depth Interval: 0-17 m

Electrical Resistivity (ohm-m)

1-3
3-5
5-8
8-12
12-18
18-28
28-42
42-66
66-100
>100

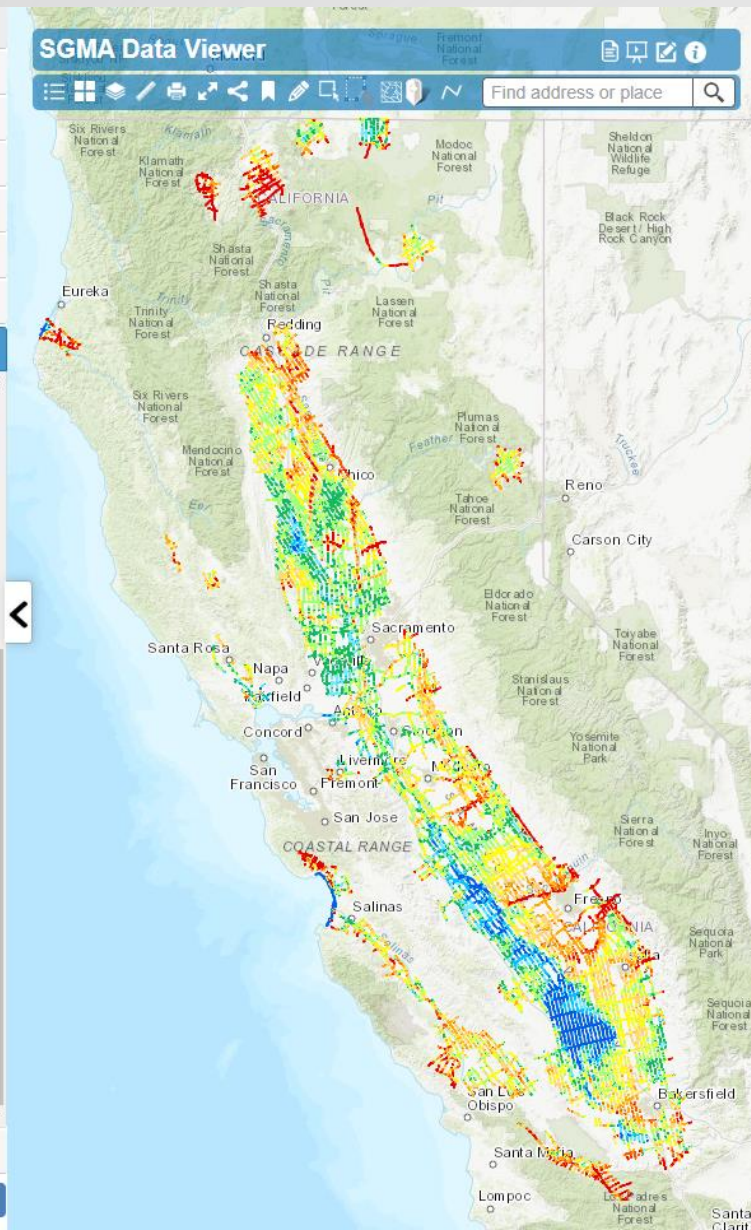
☐ Electrical Resistivity, Depth Slices

Texture Data

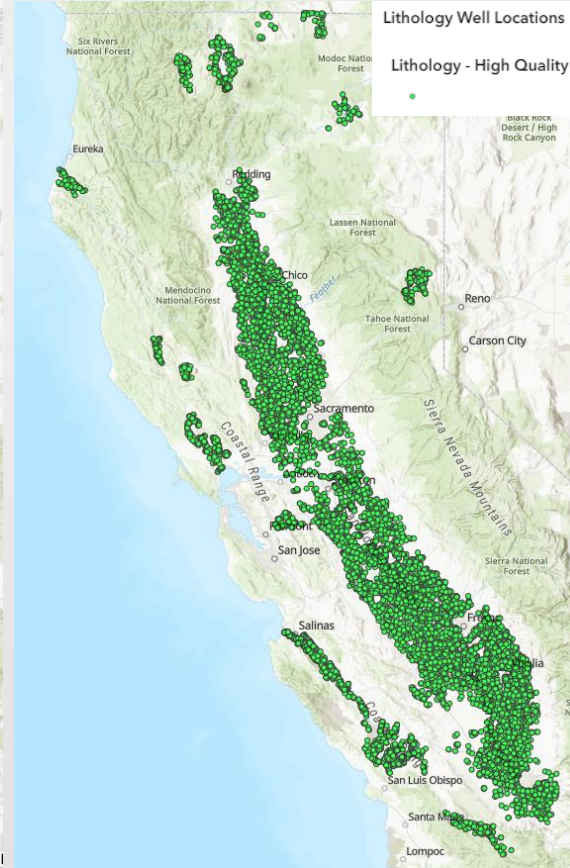
- ☐ DWR AEM Surveys, Depth Interval: 0-15 m
- ☐ DWR AEM Surveys, Depth Slices
- ☐ USGS CVHM2

Reference Layers

Add Layer Download Layers Clear Layers



- Dataset and links to data viewers available on Open Data Portal at: <https://data.cnra.ca.gov/dataset/aem>
- Supporting data from AEM surveys and other efforts
 - Import of digitized well log data to Online System of Well Completion Reports (OSWCR) - ongoing



Data and Resources

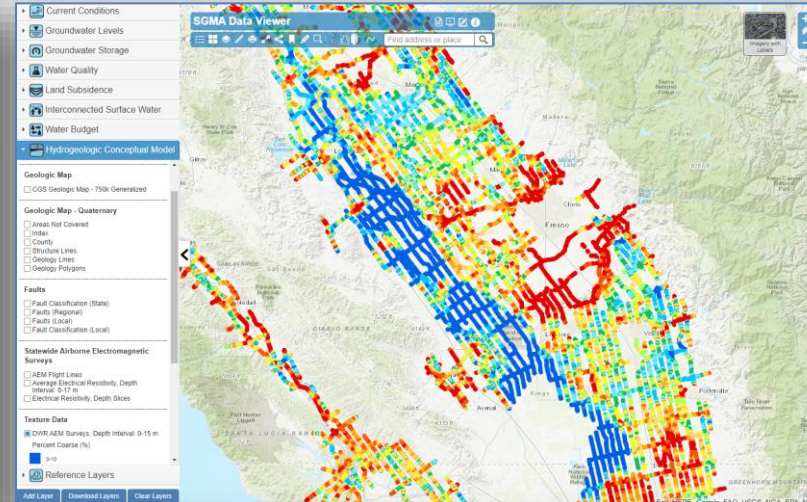
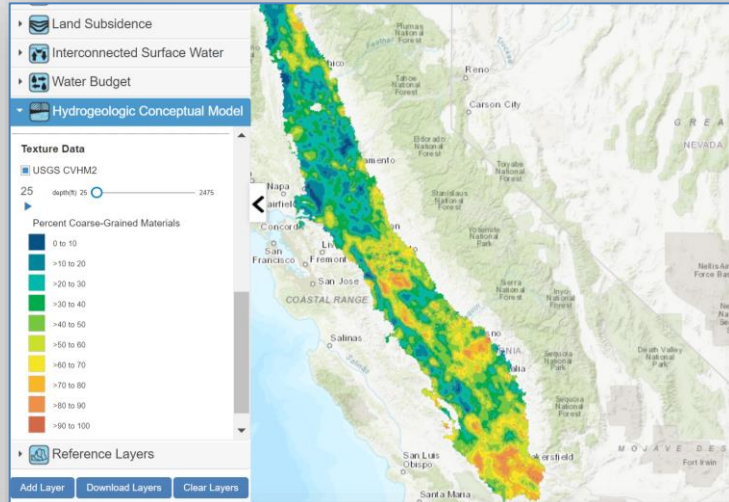
- Well Completion Reports** 🔥
This Well Completion Report dataset represents an index of records from the California Department...
- Well Numbers** 🔥
Table of state and local well numbers that are stored in OSWCR
- Geologic Logs - Free Form** 🔥
OSWCR provides three different methods to enter lithologic information. The "Free Form" method...
- Geologic Logs - Quick Pick** 🔥
OSWCR provides three different methods to enter lithologic information. The "Quick Pick" method...
- Geologic Logs - USCS/ASTM D2488** 🔥
OSWCR provides three different methods to enter lithologic information. The "USCS/ASTM D2488"...
- Geologic Logs - Generalized Lithology and Texture Classification (Under ...)**
This table provides generalized lithology descriptions and texture classifications that have been...
- Casing Data**
Casing data that have been entered into OSWCR including the weld type, casing material type, and...
- Annular Material Log**
Annular fill data that have been entered into OSWCR including the Fill Type and Fill Type Details.
- Borehole Information**
Diameter of the boreholes and the depth range over which that diameter applies

Texture Models

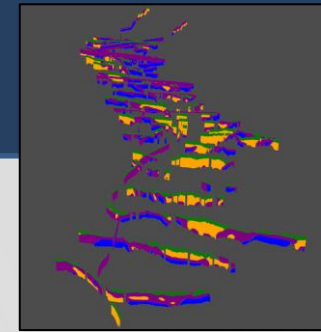
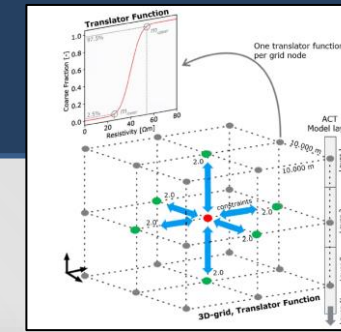
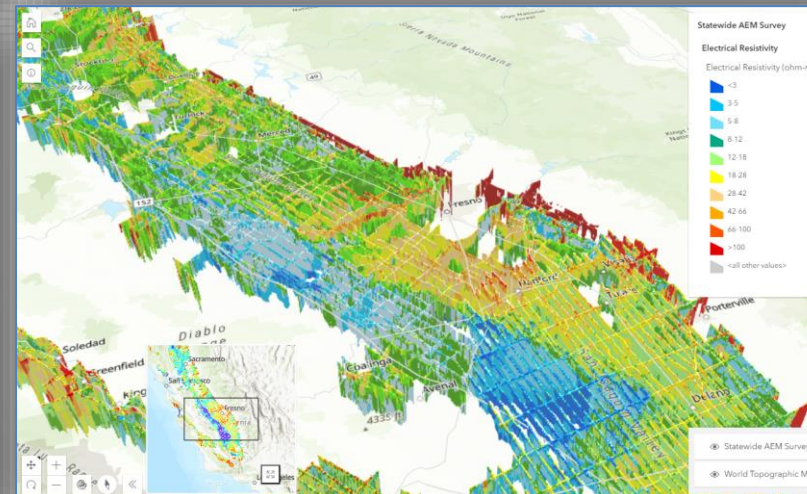
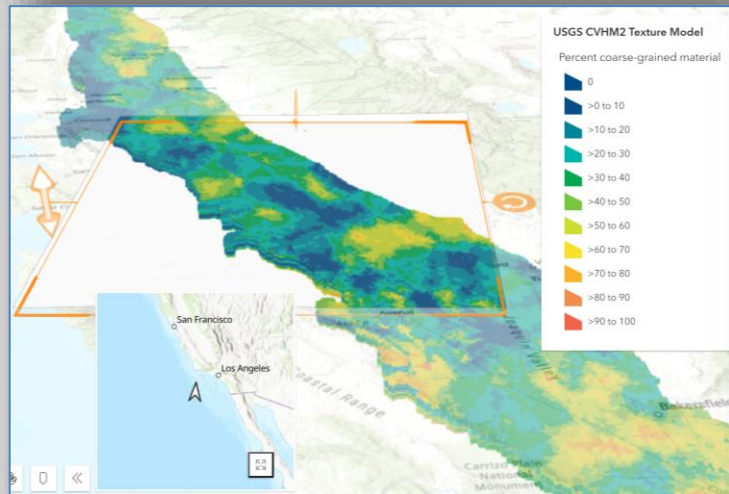
USGS CVHM2 Texture Data

AEM Resistivity and Texture Data

Depth Slice Views



3D Voxel Views



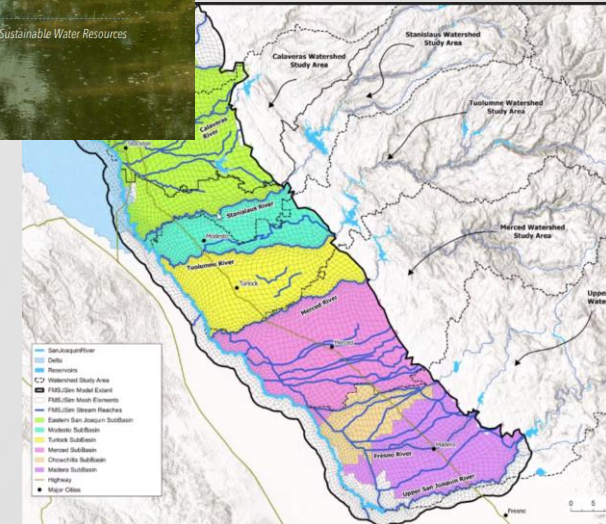
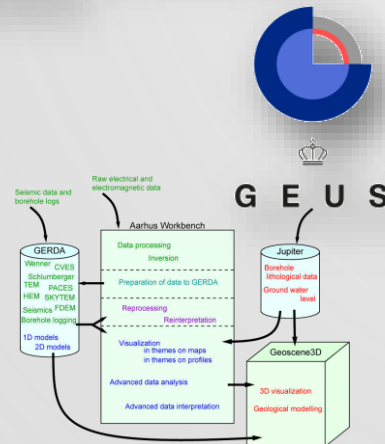
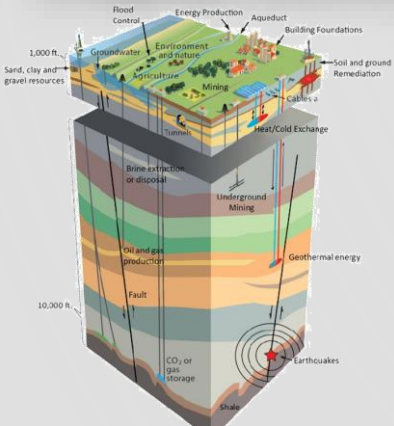
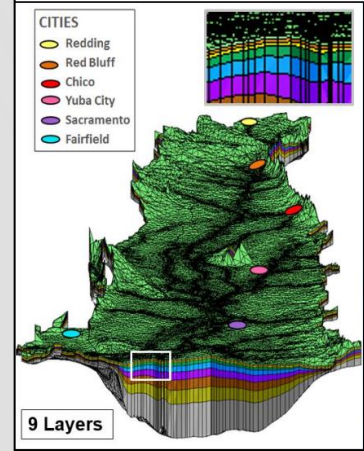
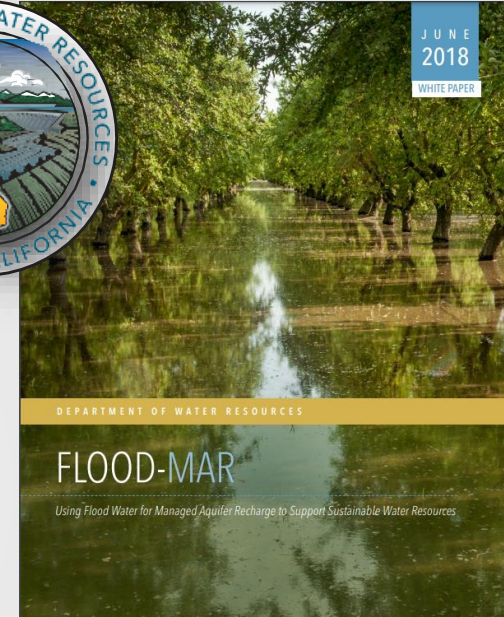
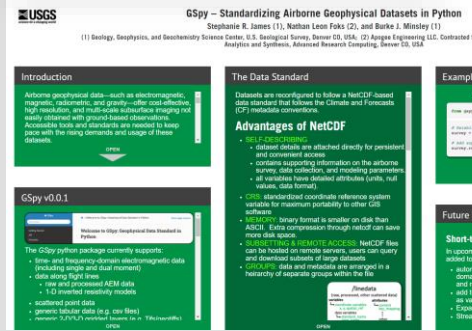
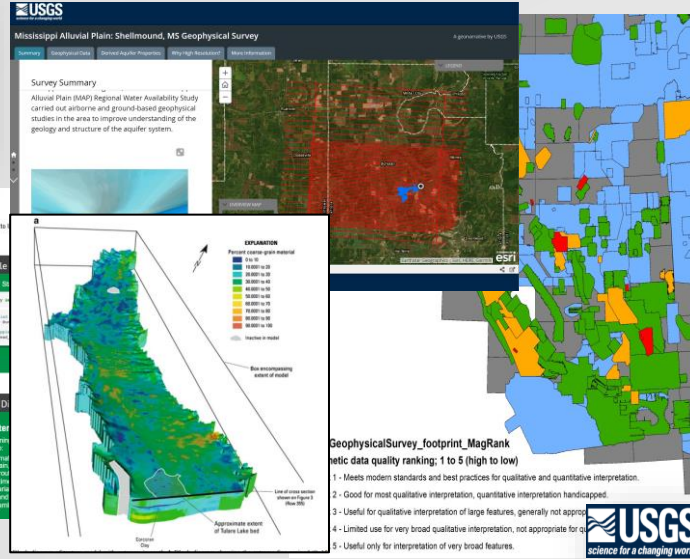
Goal: Development of stewardship, standards, and tools for integration of ALL subsurface data into interpretation

- Lithology logs
- Geophysical logs
- AEM
- InSAR
- Ground-based geophysics
- Water levels
- Water quality

2D/3D Texture Model Tool
Includes Aquifer Parameters

Hydrostratigraphic
Model Tool

Additional Basin Characterization-Related Efforts



Basin Characterization (Tentative) Timeline

Local Scale



Basin Characterization Pilot Studies

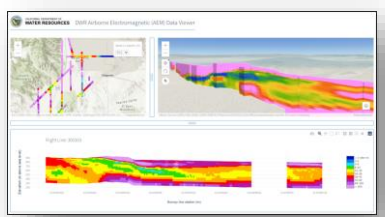
Continued Technical Engagement



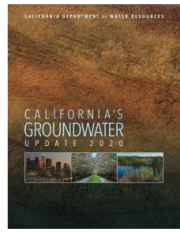
AEM Recon Grid



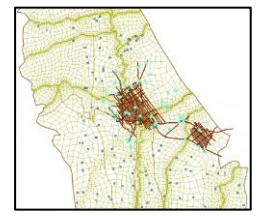
Advanced Data Viewer



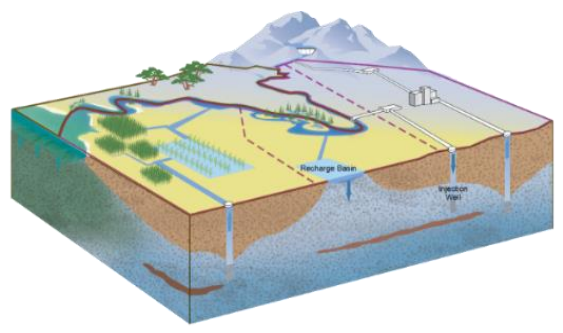
California's Groundwater Update 2025



Analysis Tools Publicly Available



Statewide Texture and Hydrostratigraphic Model



Statewide Scale

Basin Characterization Workgroup

Federal and State
Partners

Academia and
Research
Agencies

Community and
Environmental
Partners

Groundwater
Sustainability
Agencies and
Local Partners

USGS and CA Geological Survey

Existing DWR Recharge and Modeling
Workgroups

DWR and Consultant Team



Questions?

Statewide AEM survey website: <https://water.ca.gov/Programs/SGMA/AEM>

General project email: SGMPS@water.ca.gov



Basin
Characterization
Program Survey



Scan the QR code to
vote or go to
[https://forms.office.com/
g/6haELLuu2e](https://forms.office.com/g/6haELLuu2e)