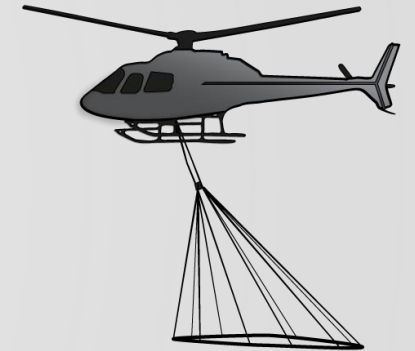


# DWR's Statewide Airborne Electromagnetic (AEM) Surveys

Public Webinar Meeting, June 8<sup>th</sup>, 2021



# Agenda Overview



- Introduction to AEM method & data use
- Safety & other AEM surveys
- Survey implementation & outreach plan
- DWR's request for relevant existing data
- Public question & answer (~20 minutes)

# How to Ask Questions

## Webinar Participants

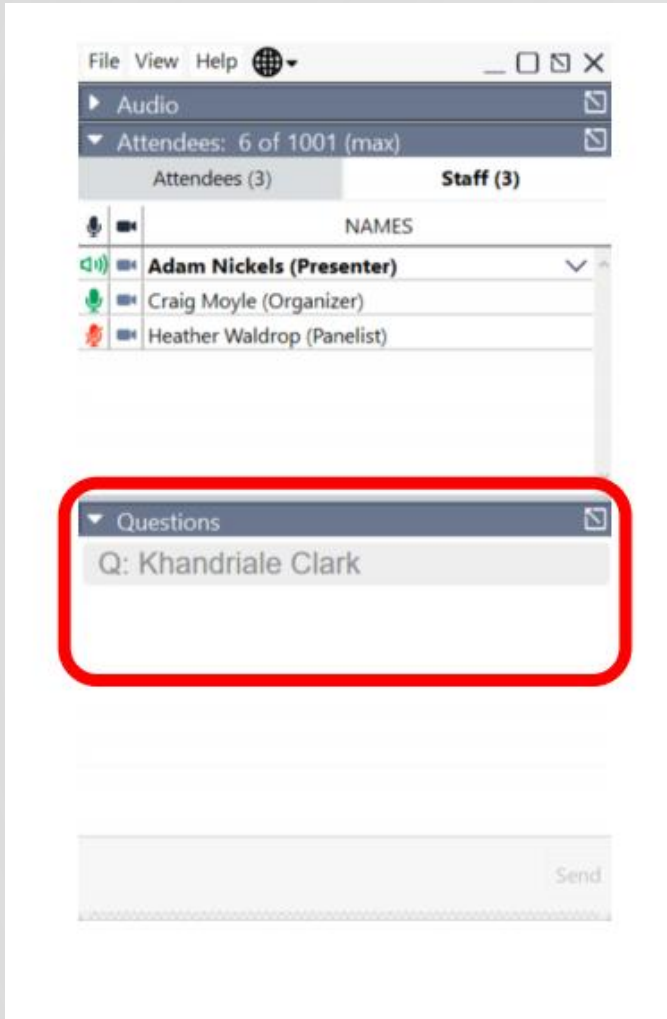
- Open “Questions” tab in the GoTo Webinar dashboard
- Type in your request or your questions and send to “Organizers & Panelists.”
- When your questions is next, we will read your question aloud for the presenter to answer

## Conference Call-Only Participants

- Send an email to the following address: [AEM@water.ca.gov](mailto:AEM@water.ca.gov)
- We will post your emailed question in the “Questions” tab in the GoTo Webinar dashboard to be read aloud to the presenter to answer

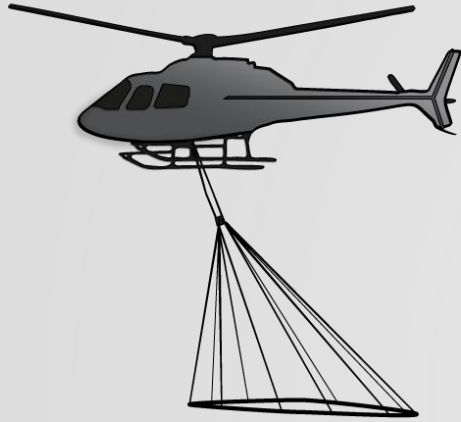
Visit the project website for more information:

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





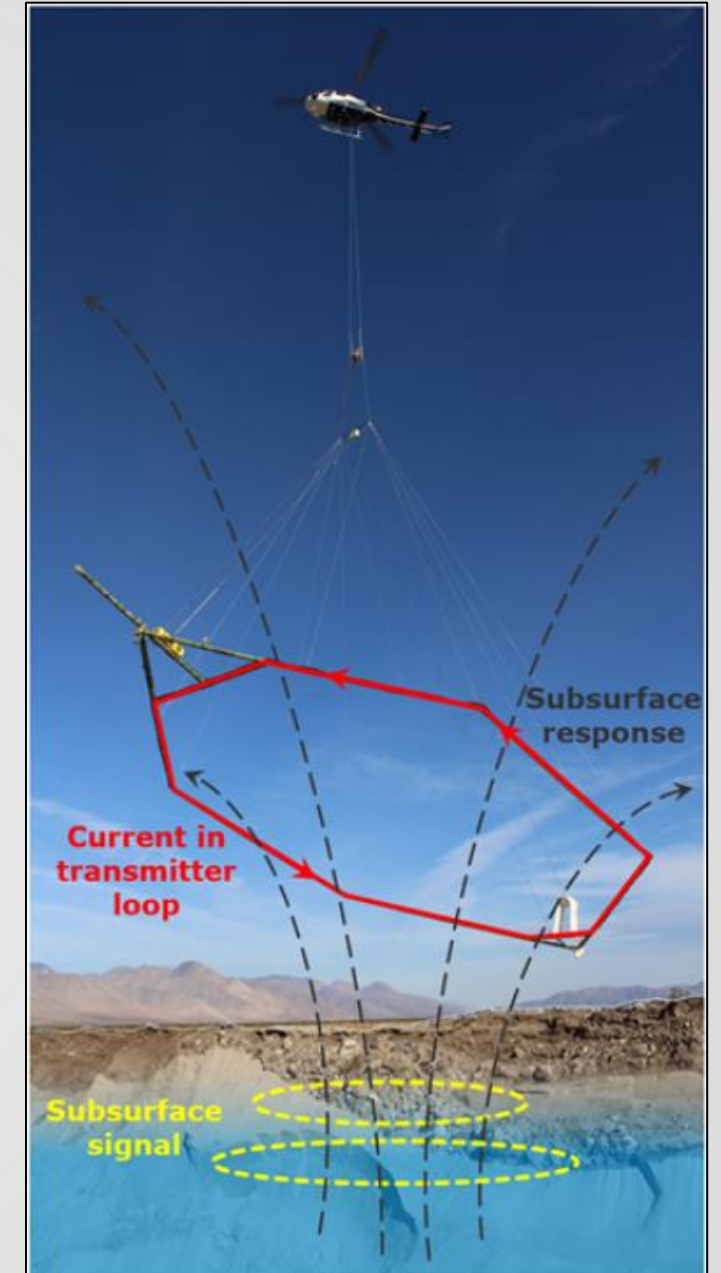
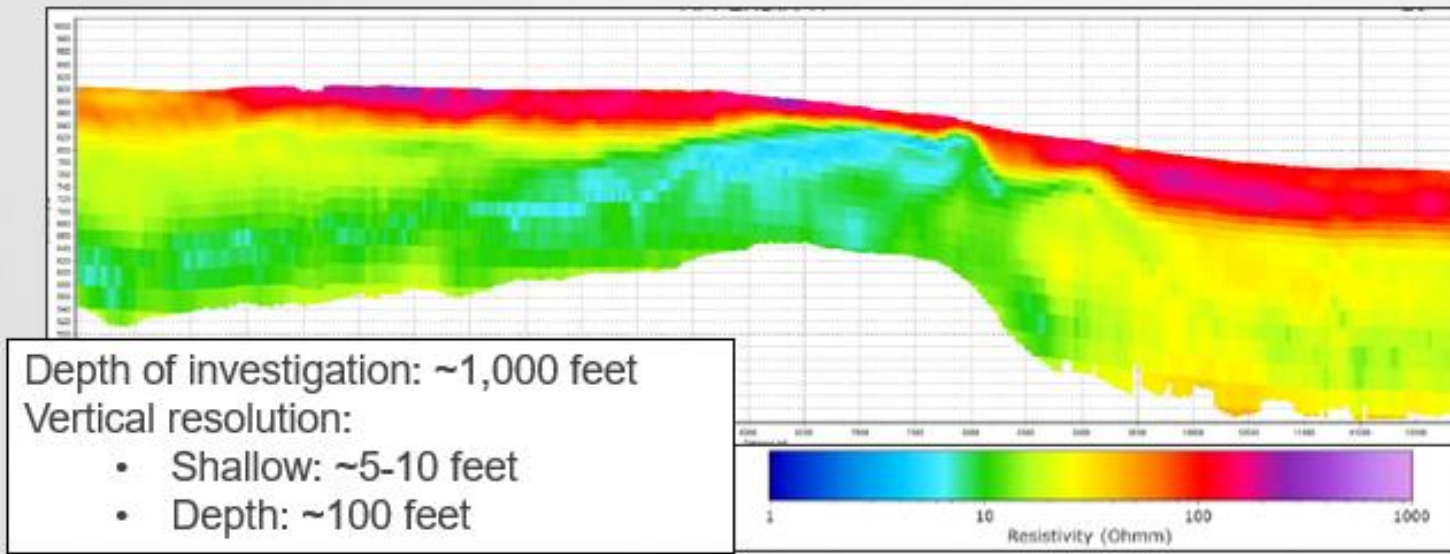
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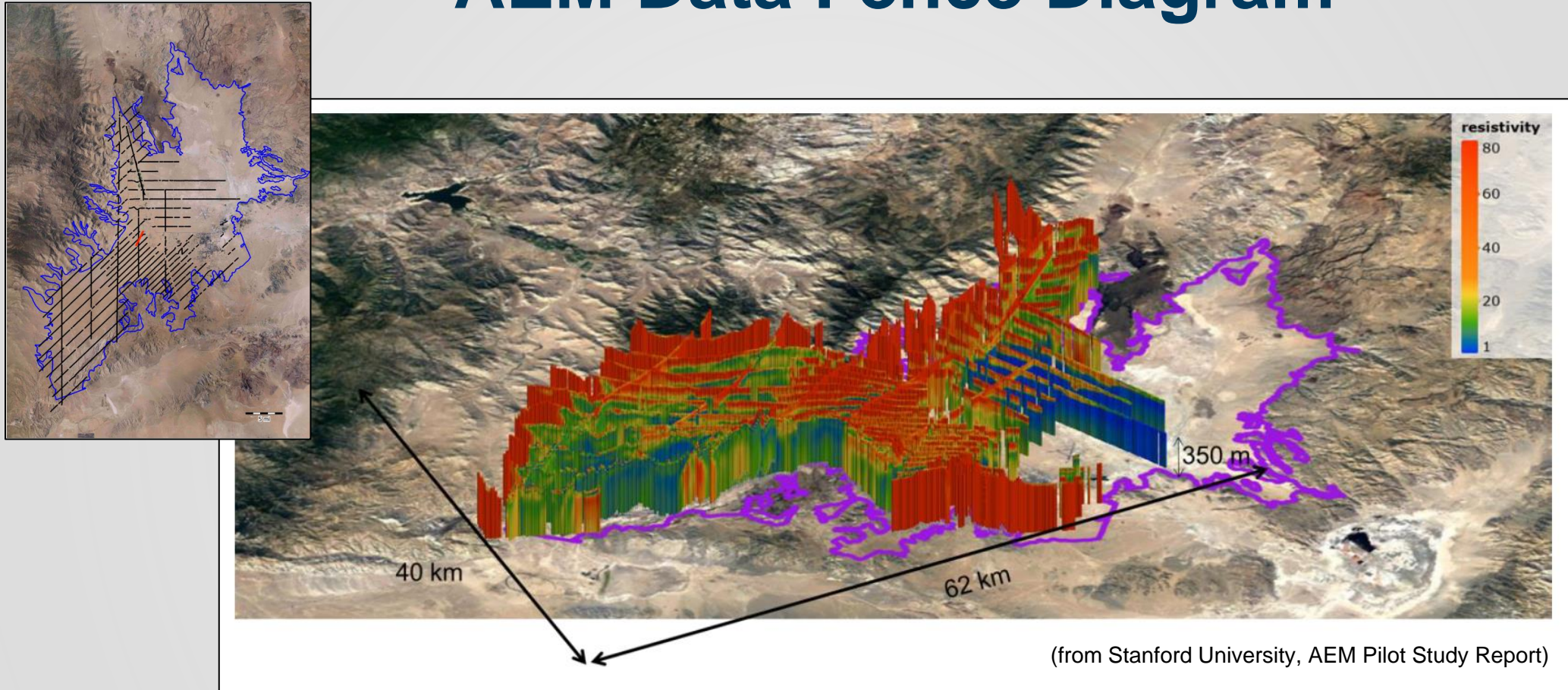
# Airborne Electromagnetic (AEM) Method

- Geophysical method with equipment towed beneath helicopter.
- Signal bounces off layers in the subsurface and measures the electromagnetic (EM) response of subsurface materials.
- Create a 2-dimensional image of EM properties (shown as electrical resistivity or conductivity).





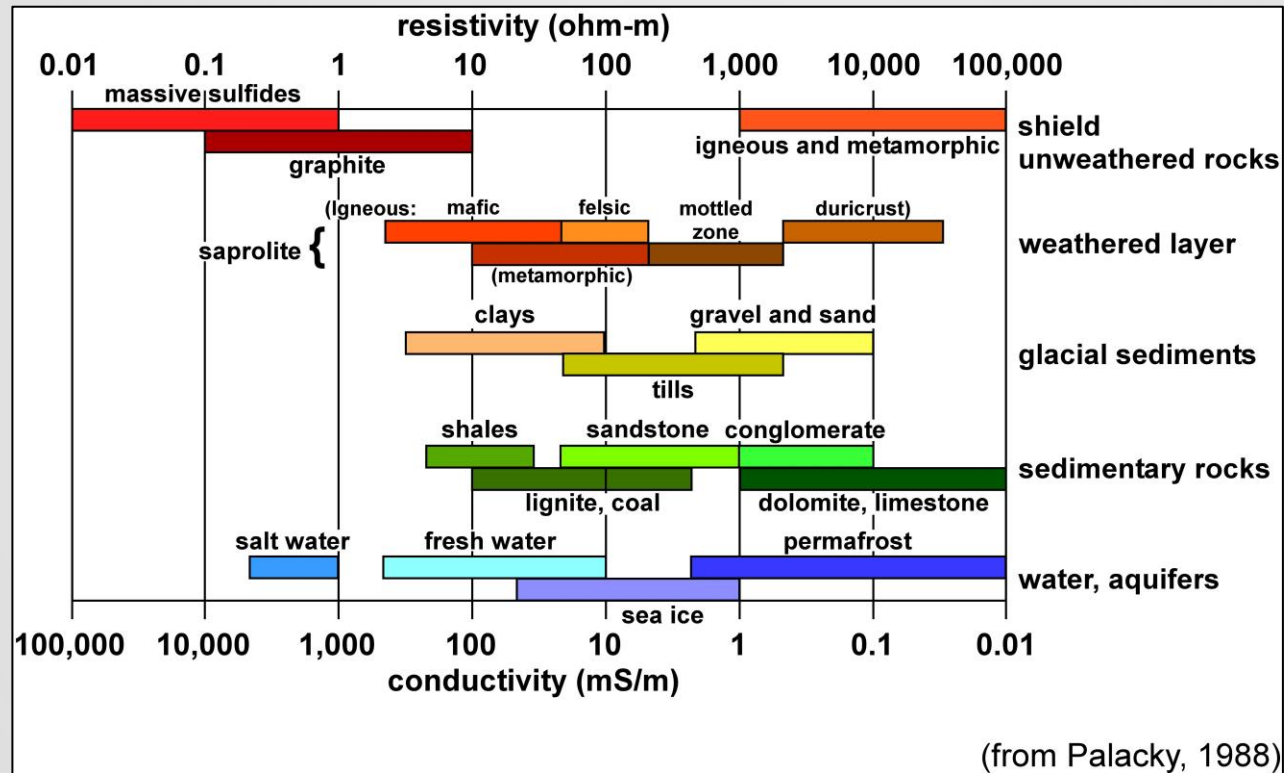
# AEM Data Fence Diagram



AEM data collected in a grid used to create a 3-dimensional fence diagram

# AEM Data Interpretation

Electromagnetic properties are related to material properties

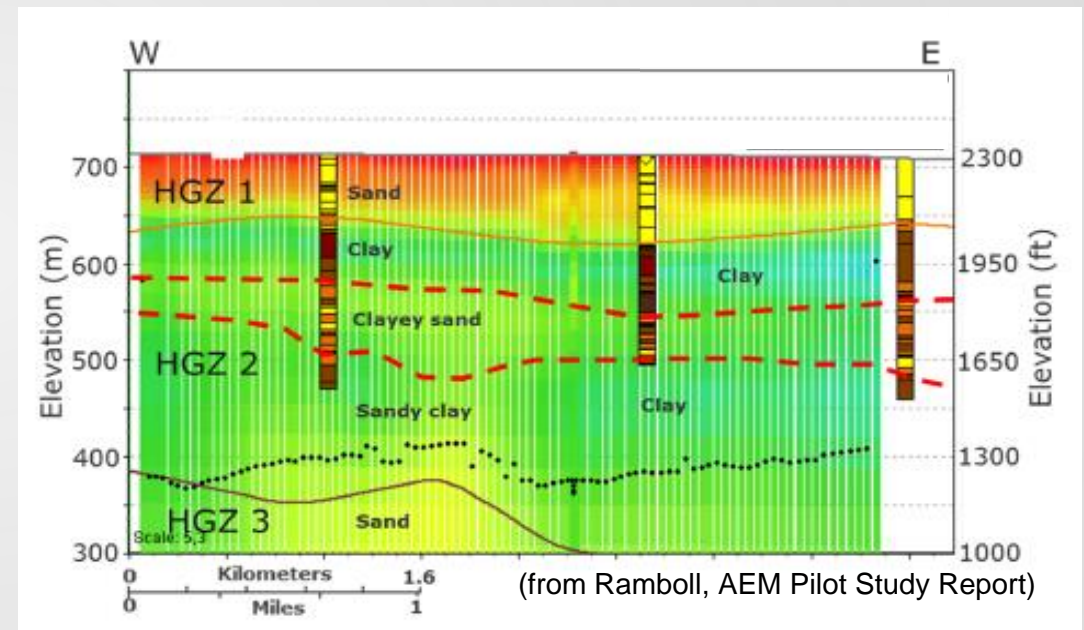
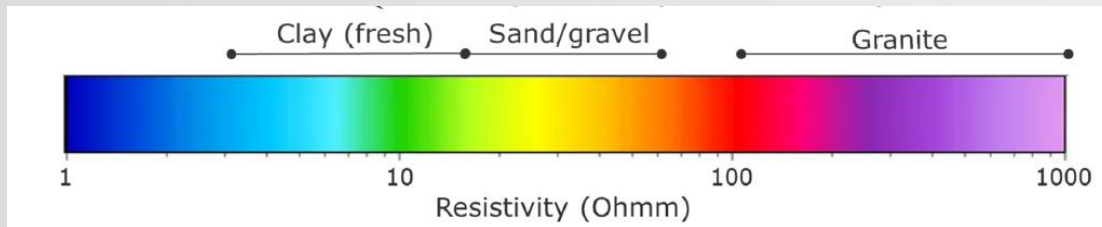


# AEM Data Interpretation

Define site specific resistivity to lithology relationship using *existing data*

## Types of existing data:

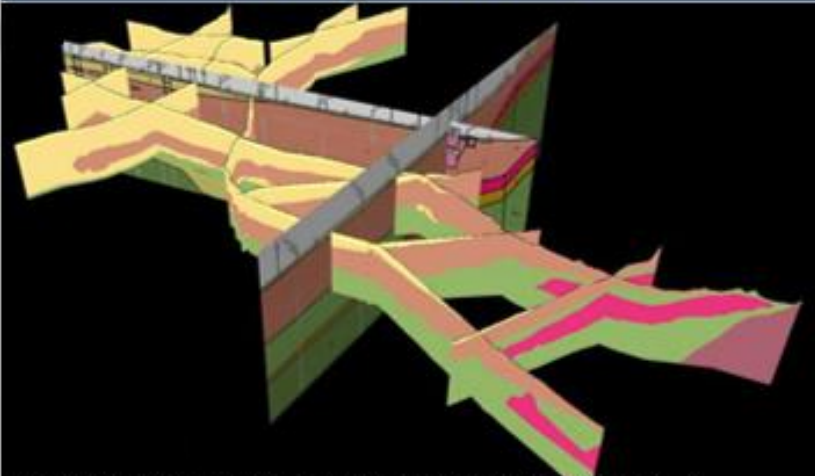
- Lithology logs
- Geophysical data
- Groundwater quality (TDS)
- Groundwater levels





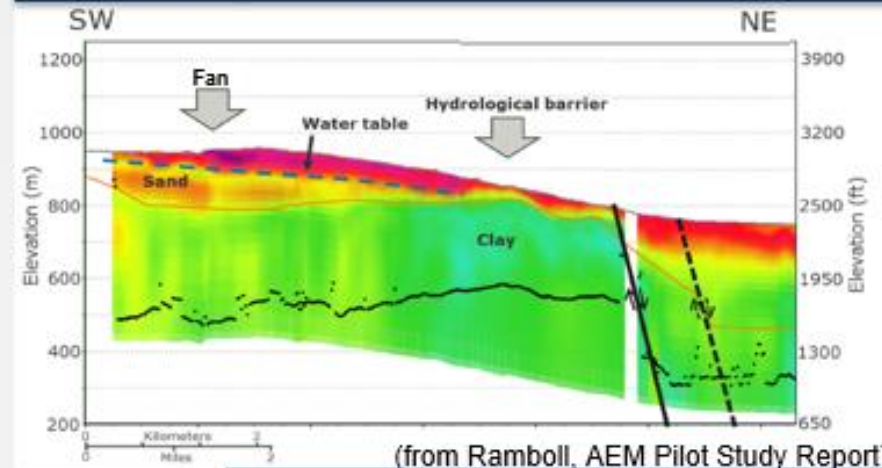
# How can AEM data be used?

## Groundwater or hydrogeologic conceptual model



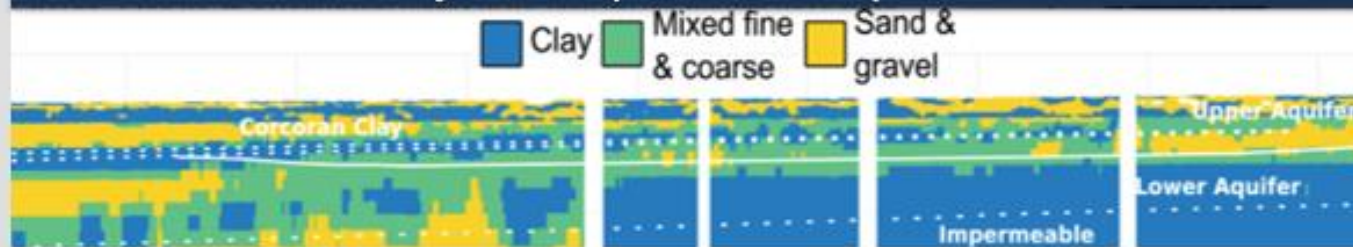
(from Aqua Geo Frameworks, AEM Pilot Study Report)

## Recharge areas or additional studies



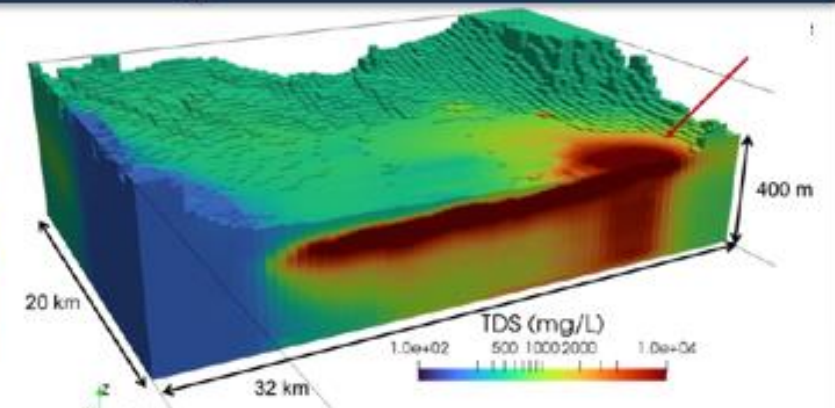
(from Ramboll, AEM Pilot Study Report)

## Clays susceptible to compaction



(from Knight et al., 2018)

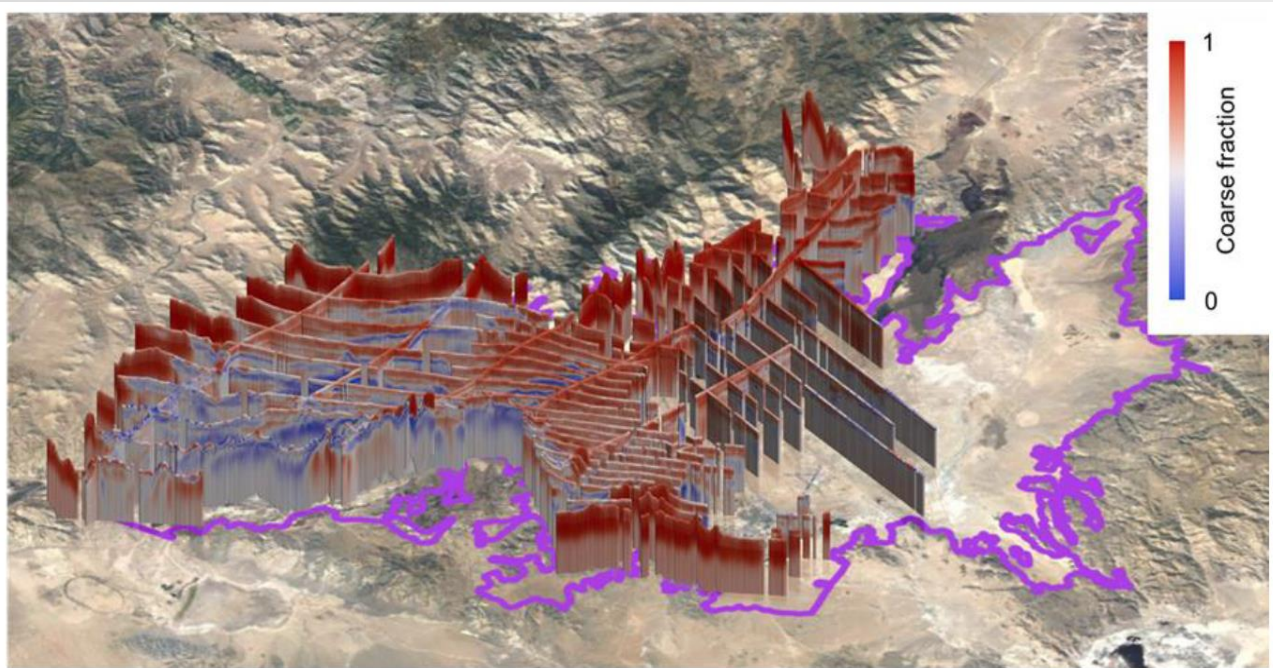
## High total dissolved solids



(from Stanford University, AEM Pilot Study Report)

# Data uncertainty

## Coarse Fraction Probabilities



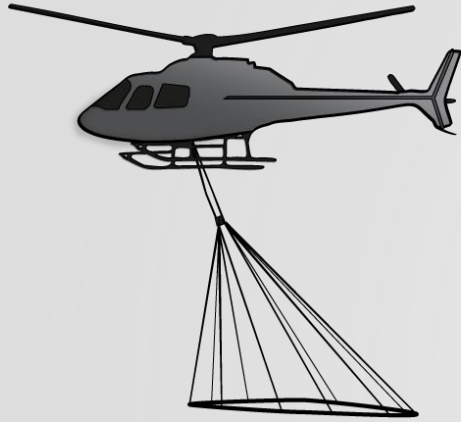
(from Stanford University, AEM Pilot Study Report)

Uncertainty can be reduced with the incorporation of high-quality existing (or new) data.

### Types of existing data:

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

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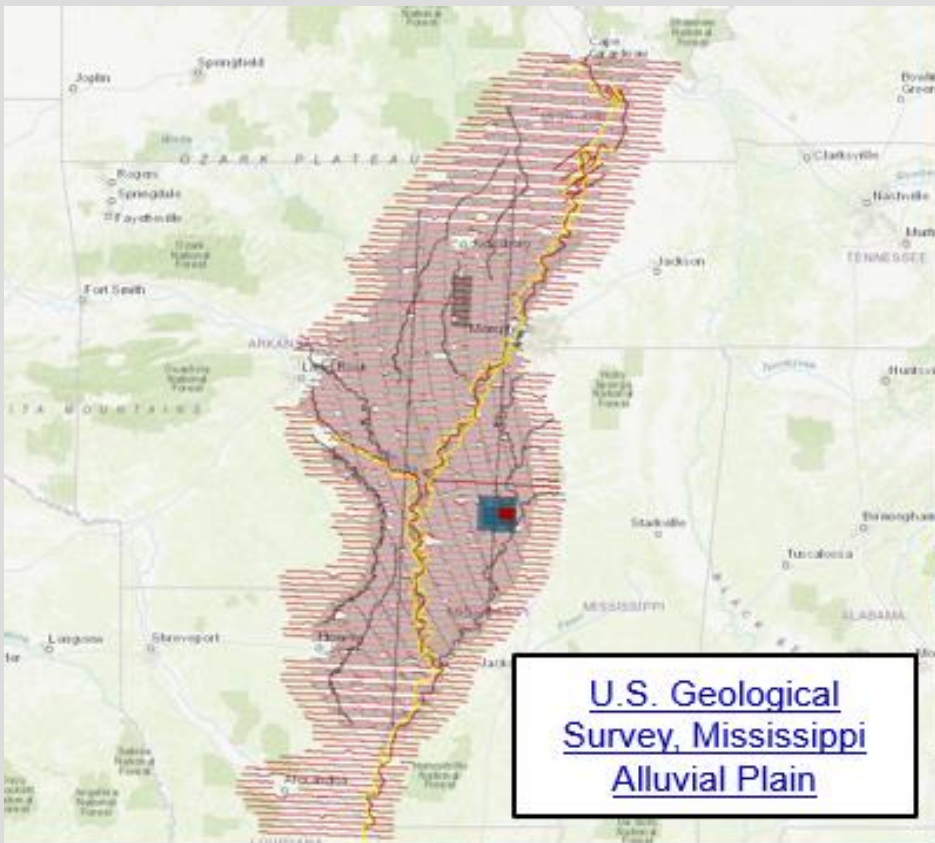


# Safety

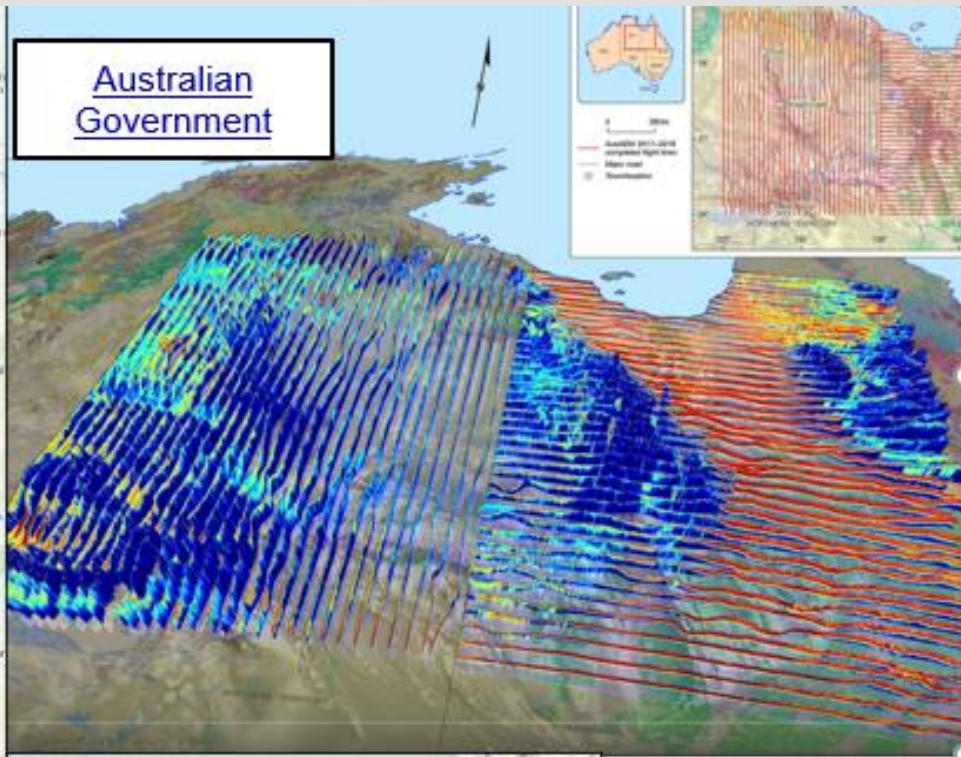
- Helicopter flies at 200 feet above ground; AEM equipment carried at 100 feet above ground.
- Noise generated is less than operating a lawn mower.
- Professional, experienced, and licensed pilots that follow all regulations.
- Surveys not conducted over:
  - Urban areas
  - Buildings
  - Confined livestock
  - Military bases
  - FAA no-fly zones



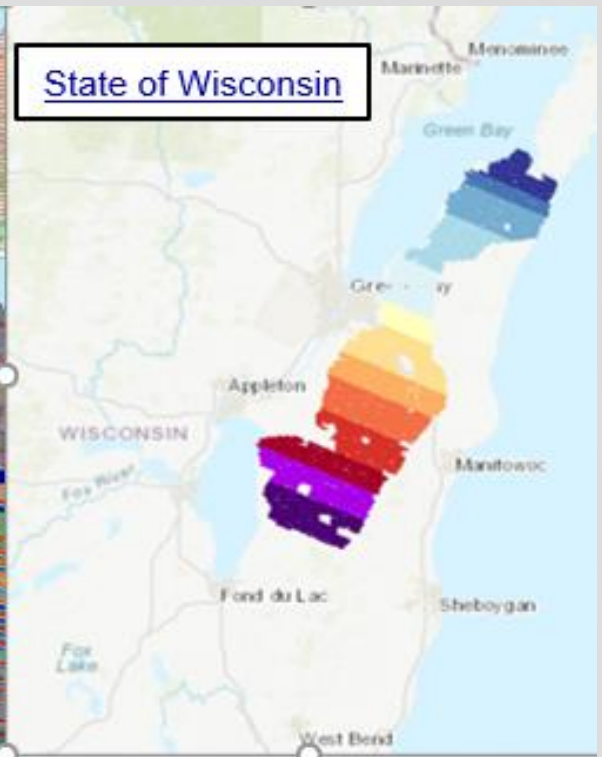




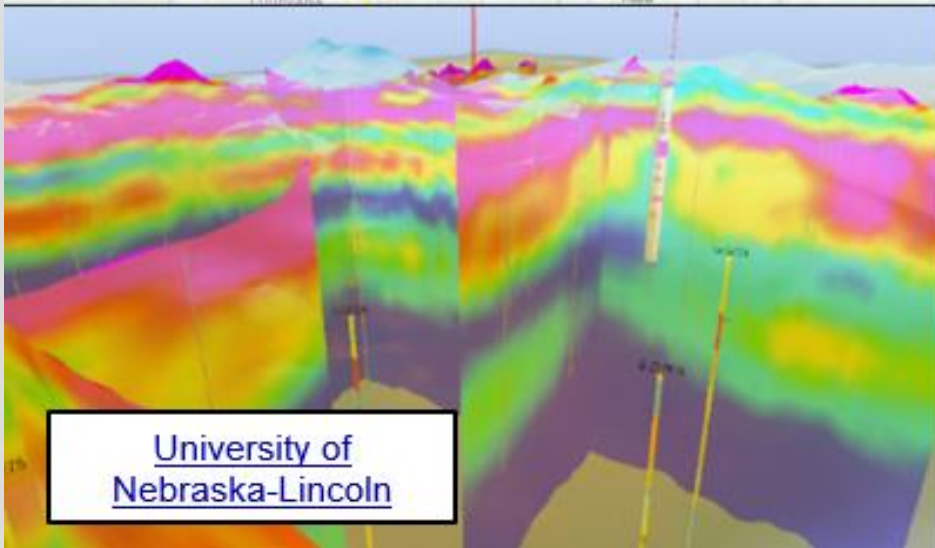
U.S. Geological Survey, Mississippi Alluvial Plain



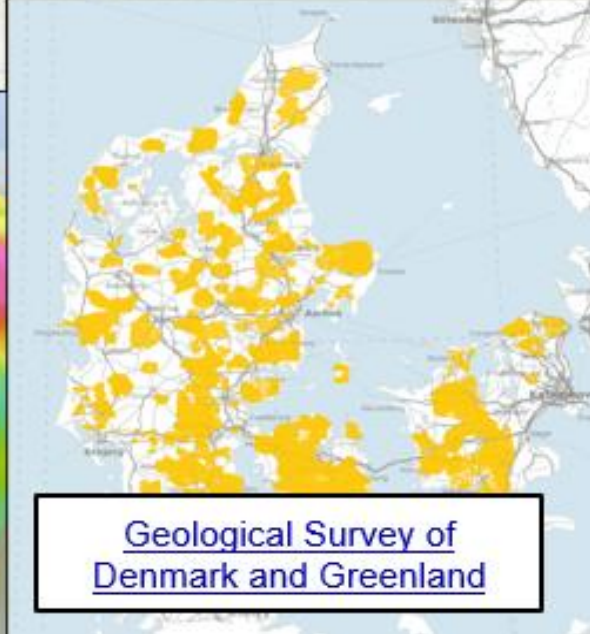
Australian Government



State of Wisconsin



University of Nebraska-Lincoln

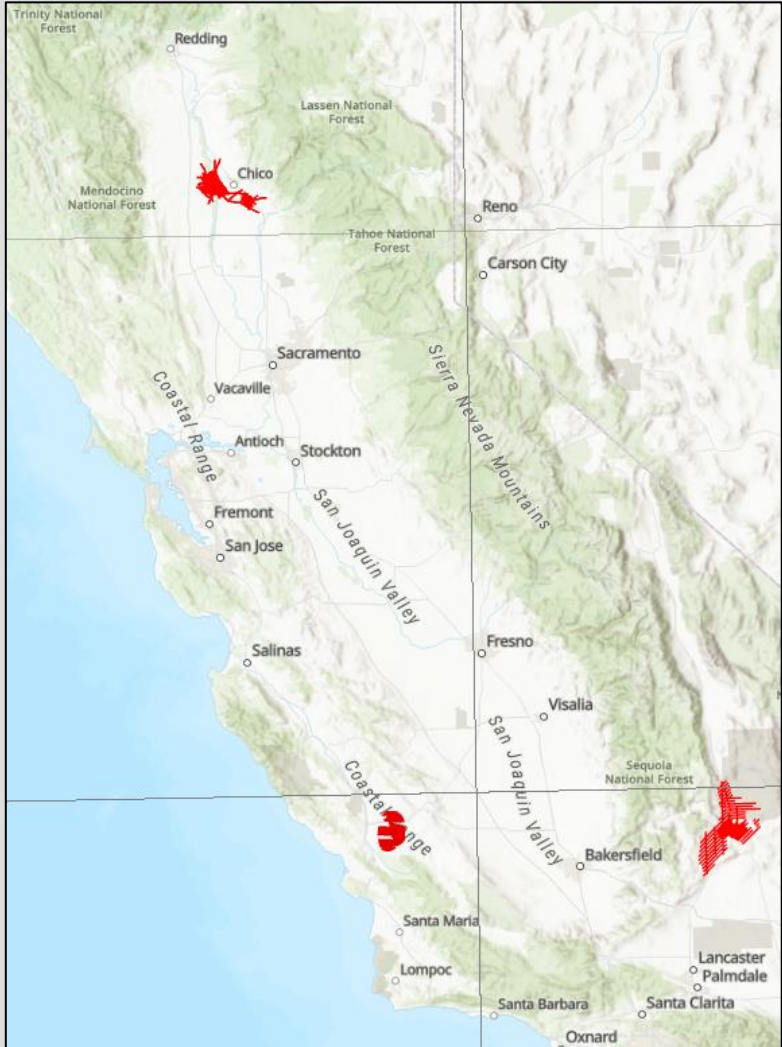


Geological Survey of Denmark and Greenland

# National and International AEM Surveys



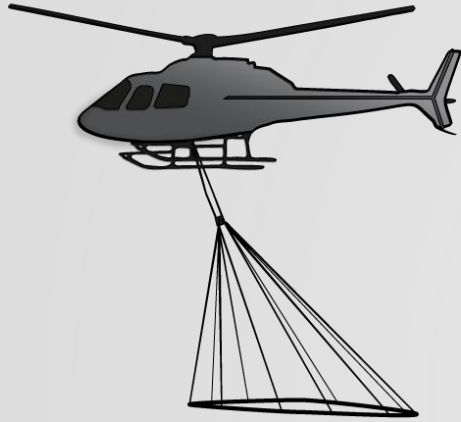
# AEM Pilot Studies in California



- Pilot studies conducted from 2018-2020.
- Purpose to show successful AEM data collection in California and provide recommendations.
- Led by Stanford University with participants from academic and private sectors, and local and state water agencies.
- Reports and data: [California Natural Resources Agency Open Data Portal](#).
- Pilot study website: [The Stanford Groundwater Architecture Project \(GAP\)](#)
- Funded by grants from DWR, the Ministry of Denmark, and three local agencies (Butte County, Indian Wells Valley Water District, and San Luis Obispo County - Paso Robles).



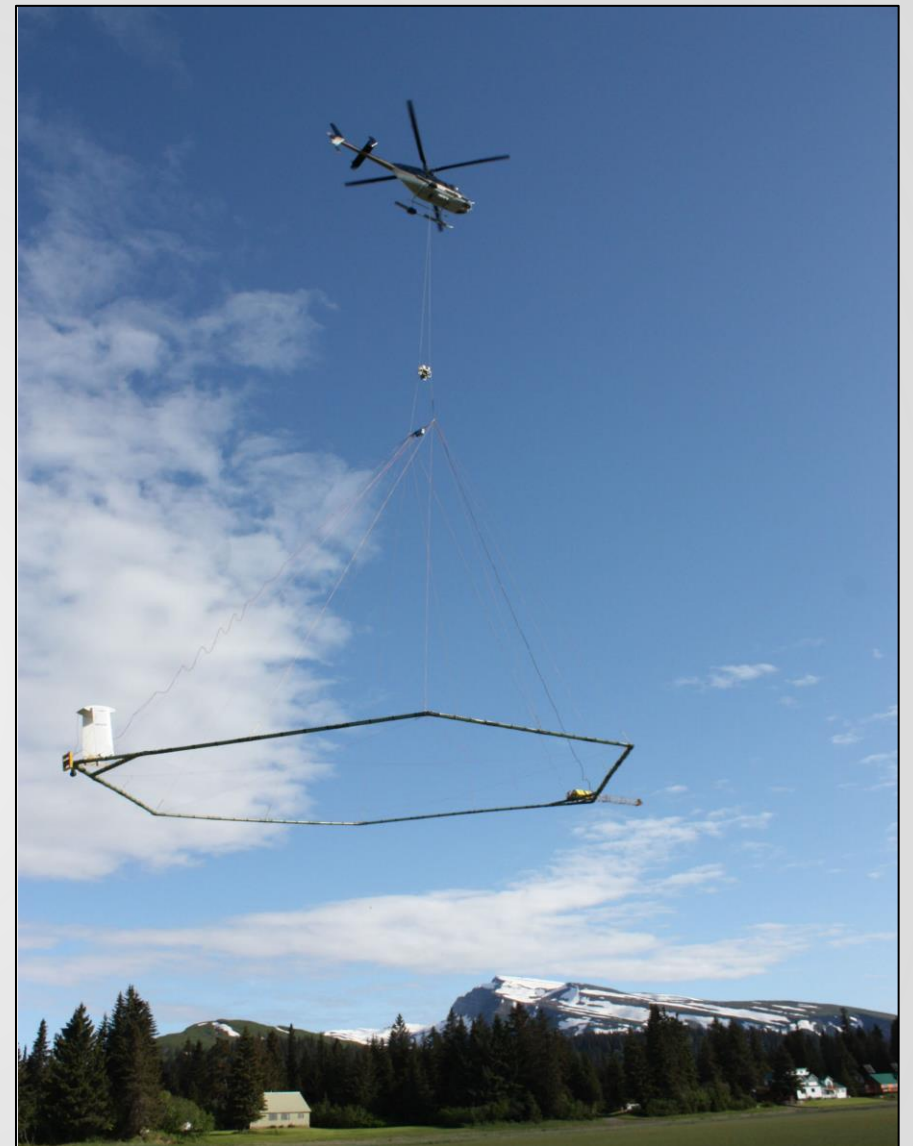
# Agenda Overview



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# Statewide AEM Surveys: Project Implementation

- Funded through Proposition 68 and the General Fund.
- Conducted in all high- and medium-priority basins, where data collection is feasible.
- Surveys begin summer 2021 & continue over next several years.
- DWR contracting with Ramboll, SkyTEM, Sinton Helicopters, Aarhus University, GEI, AECOM, and Stantec.



# Survey Flight Lines

Example Coarse Grid: ~ 2 by 8 mile spacing

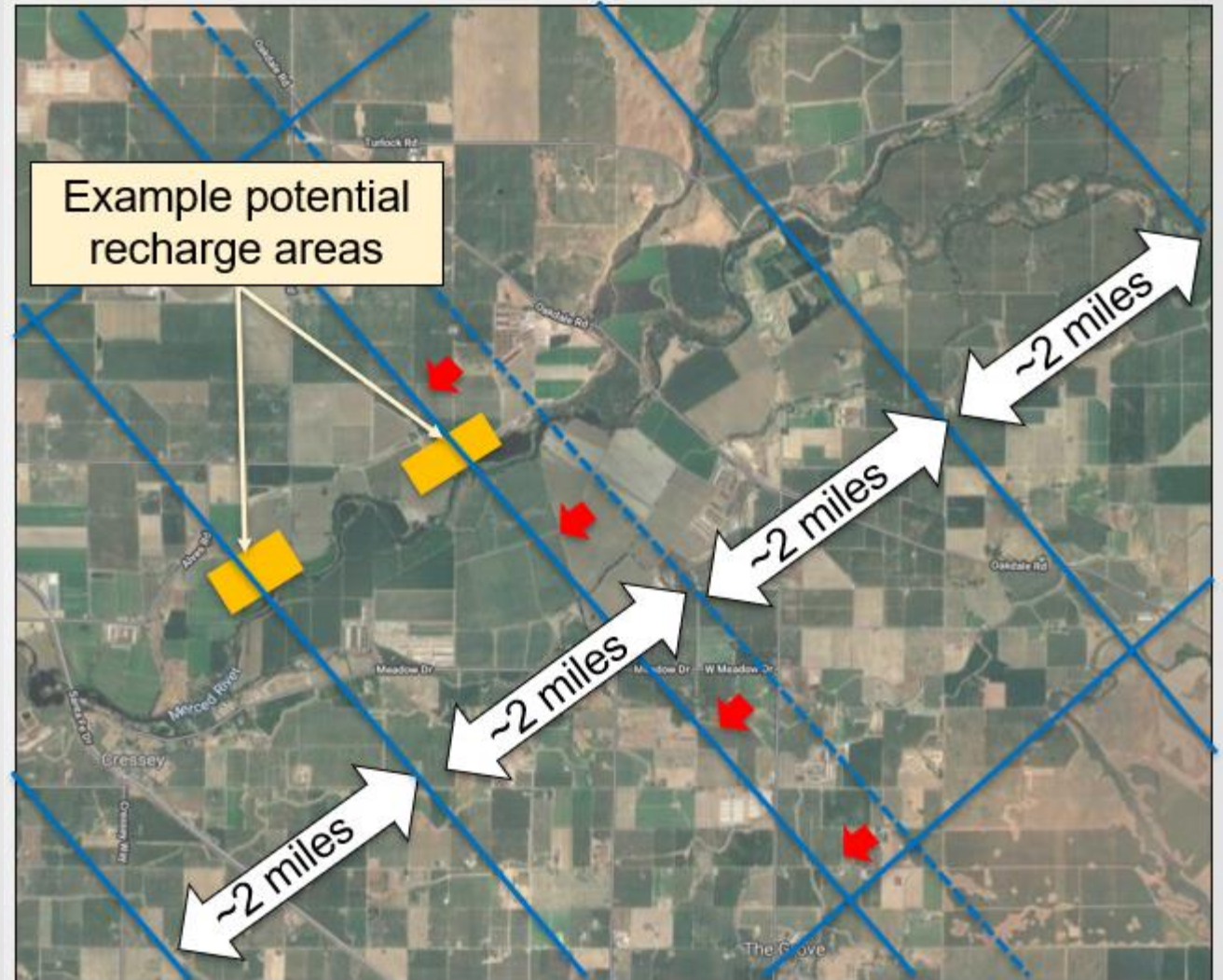
- Data collected in coarse grid of approx. 2 by 8 mi spacing.
  - Improves understanding of local and regional aquifer structure.
  - Identify areas for additional investigations.
- Grid oriented to capture major geologic features.
- Survey lines will avoid noise sources and data won't be collected over restricted areas.





# Survey Flight Lines: Locations of Important Areas

- Survey lines edited given input from GSAs and state and federal agencies to cover important areas:
  - Areas with known data gaps
  - Areas considered for groundwater recharge projects
  - Areas critical to successful SGMA implementation
- Grid density will not be changed, but survey lines will be shifted to cover important areas.

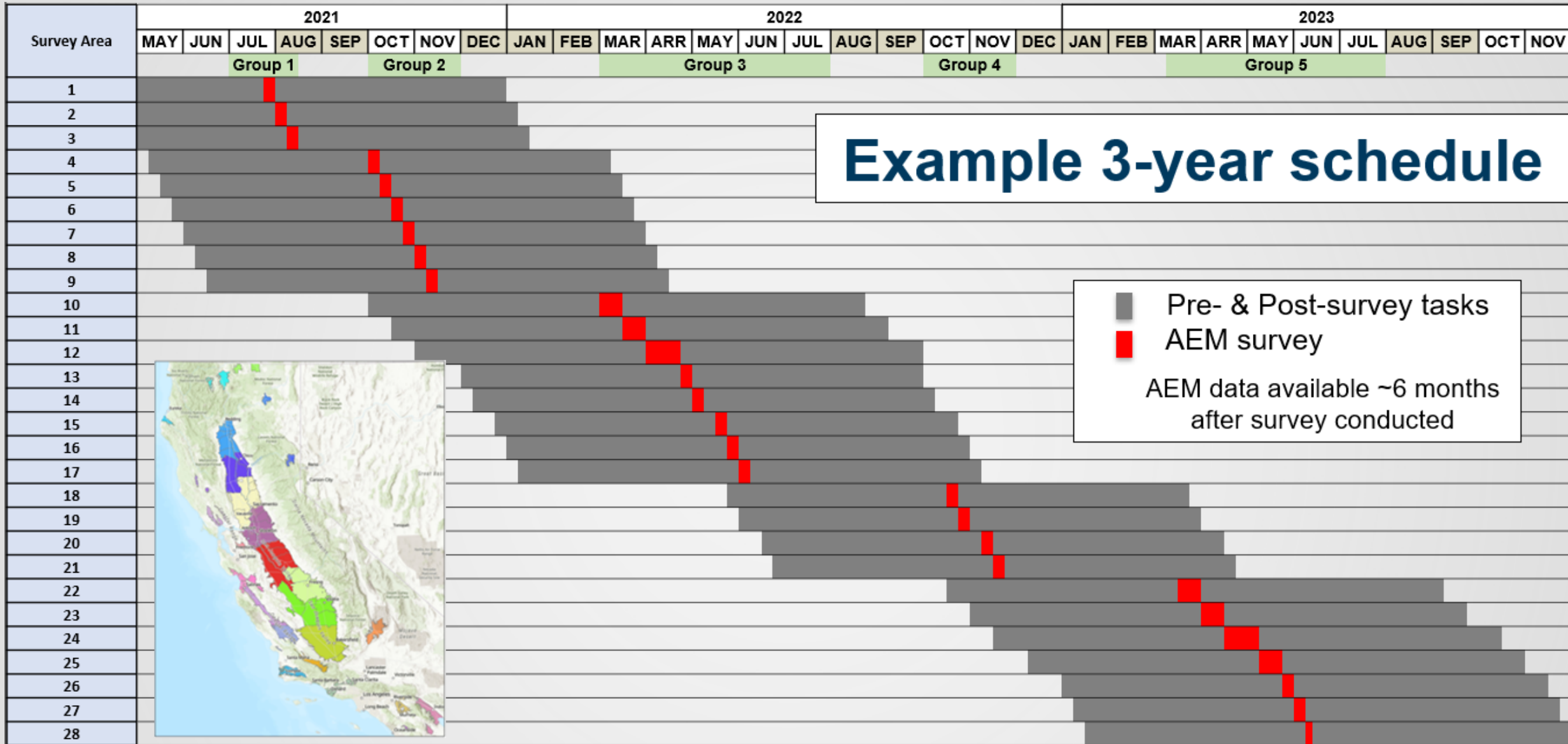


# Survey Areas



- High- and medium-priority basins grouped into ~30 survey areas.
- Each survey area contains between 1 and 8 basins.
- Data collected in all survey areas over next 3 years.

# Example 3-year schedule



**Example 3-year schedule**

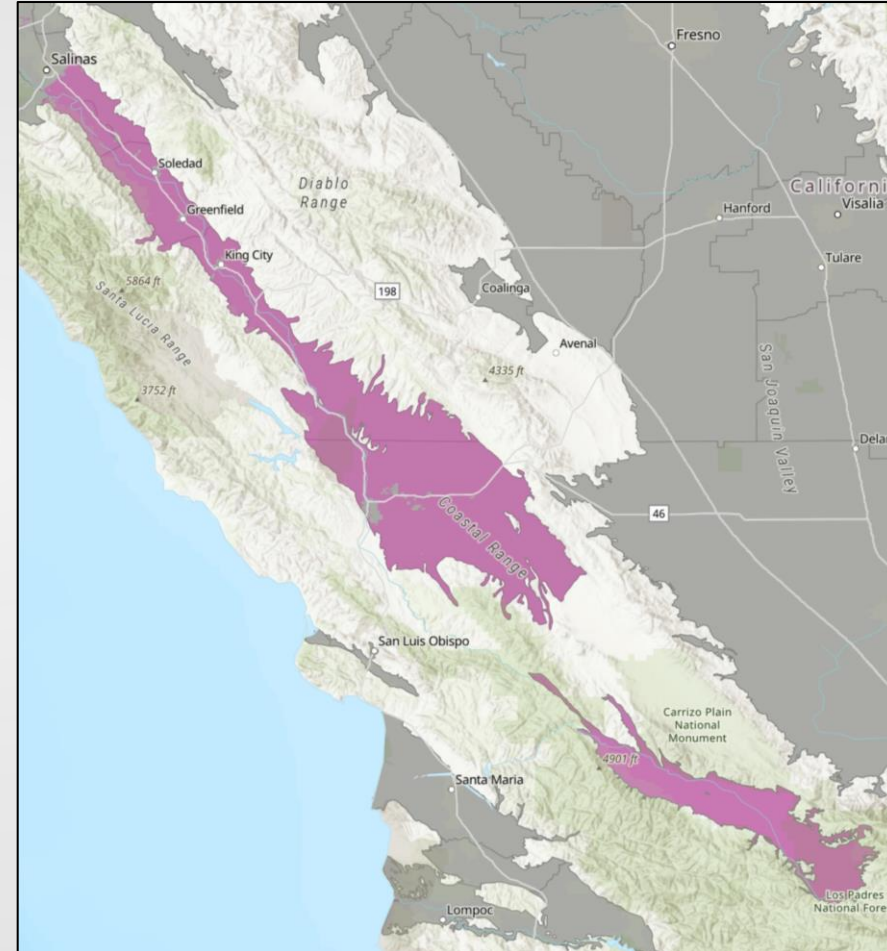
Pre- & Post-survey tasks  
 AEM survey  
 AEM data available ~6 months after survey conducted

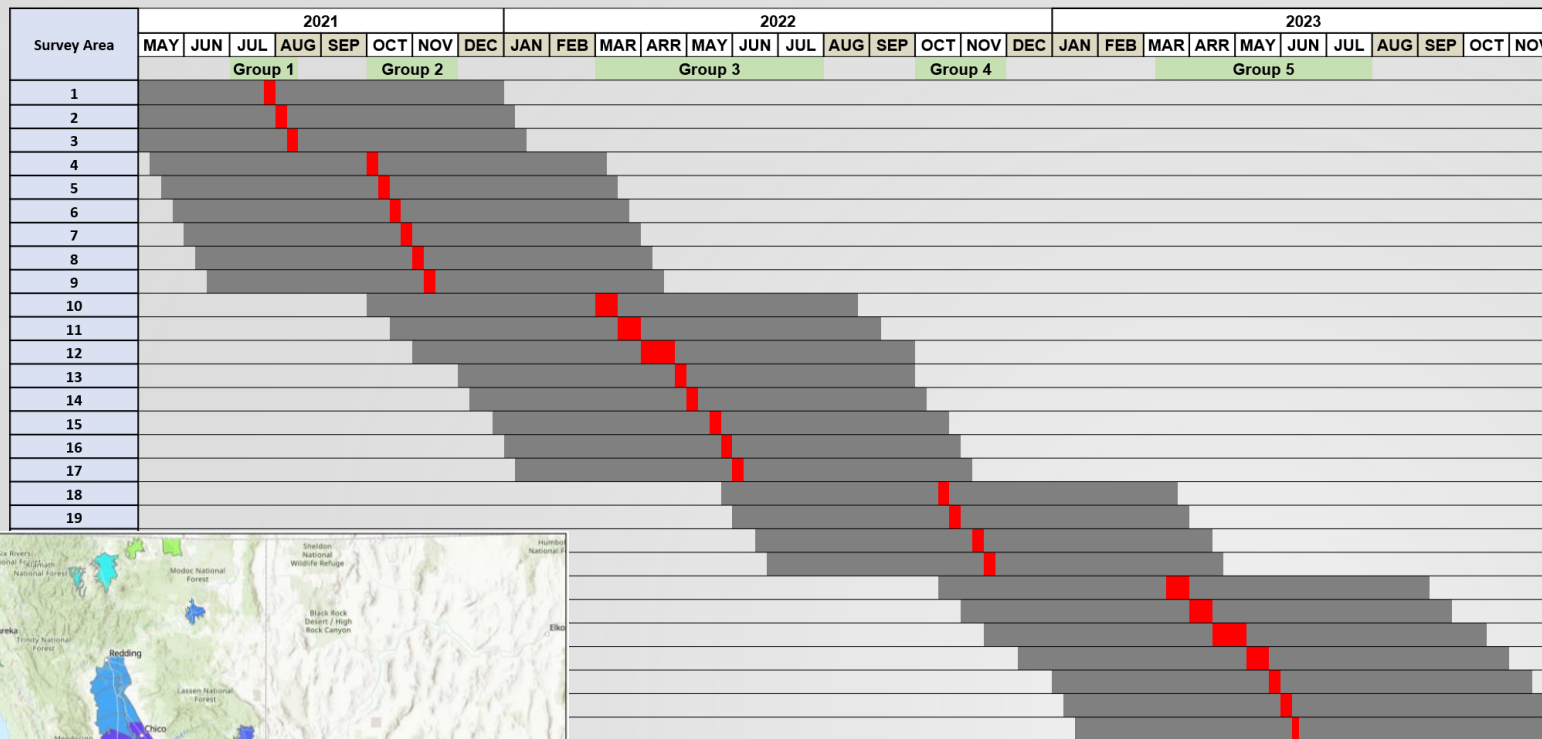




# Survey Group 1

- Salinas Valley (from town of Salinas) down to Paso Robles and Cuyama.
- Surveys starting in July through August.
- Survey lines developed in coordination with the GSAs and state and federal agencies.





# Schedule Development

- Each Survey Group will include both Central Valley basins and surrounding Northern, Southern & Coastal basins.

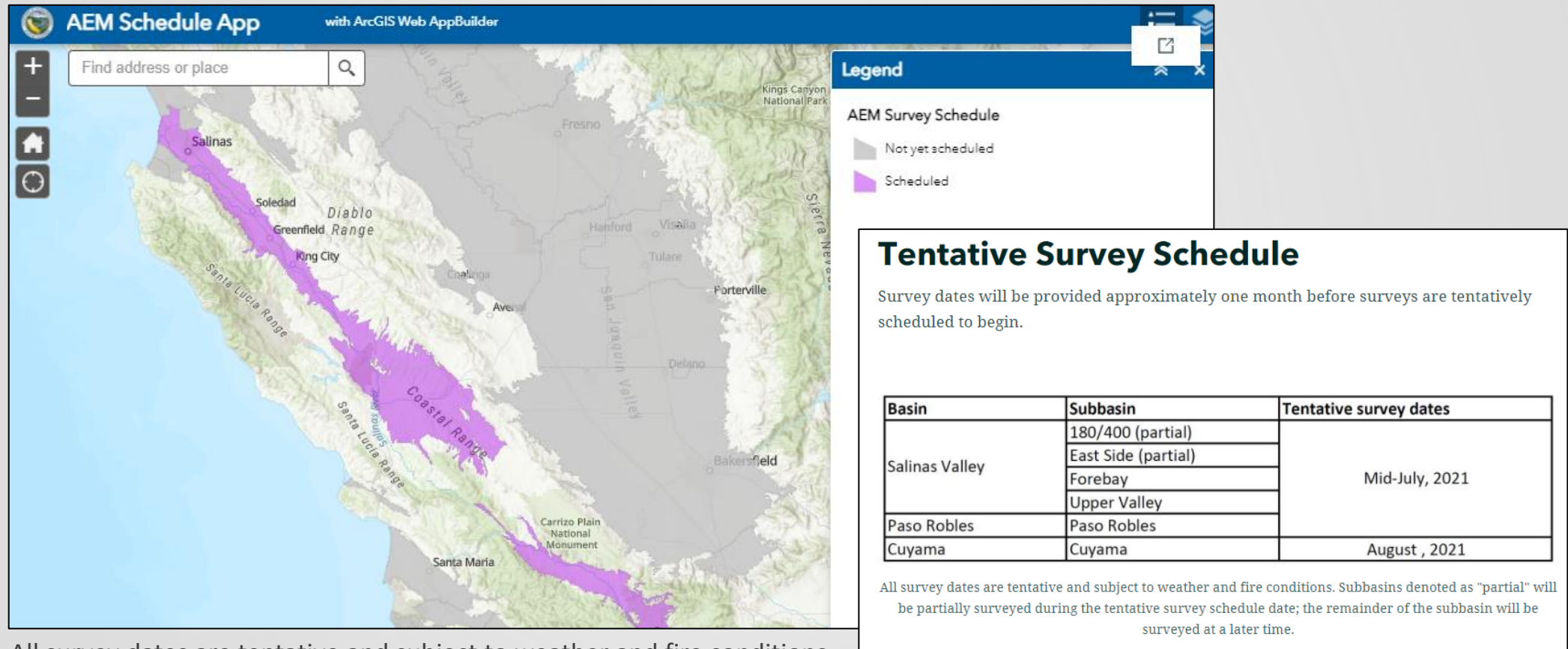
- Inside the Central Valley, surveys planned to start in the south.
- Surrounding basins will be prioritized by amount of digitized existing data and disadvantaged communities.
- Schedule will also consider weather, local permits & regulations, and Tribes.



# Survey Schedule

## [AEM Survey Schedule Storymap](#)

(accessed from the AEM Webpage, Schedule tab).



All survey dates are tentative and subject to weather and fire conditions.



# Data Availability

All datasets and reports made available on CNRA Open Data Portal.

- Unprocessed, processed, and interpreted AEM data
- Supporting data (lithology and geophysical logs)

The screenshot shows a web browser window displaying the dataset page for "Airborne electromagnetic (AEM) Pilot Studies" on the data.ca.gov portal. The browser's address bar shows the URL "data.ca.gov/dataset/airborne-electromagnetic-aem-pilot-studies". The page features a navigation menu with categories like DATASETS, ORGANIZATIONS, TOPICS, STATE PORTALS, DOCUMENTATION, CALDATA, CA STATE GEOPORTAL, and ABOUT. The breadcrumb trail indicates the path: Home / Organizations / California Department of Water Resources / Airborne electromagnetic (AEM) Pilot Studies. On the left, there is a sidebar for the dataset, showing the title "Airborne electromagnetic (AEM) Pilot Studies", a "Followers" count of 0, and the organization "Department of Water Resources, State of California" with its logo. The main content area has tabs for "Dataset", "Topics", "Activity Stream", and "Showcases". The dataset title is "Airborne electromagnetic (AEM) Pilot Studies". The description states: "Airborne electromagnetic (AEM) geophysical data were collected in California as a part of AEM pilot studies. The purpose of the AEM pilot studies was to inform the development of the Department of Water Resources' (DWR's) statewide AEM survey project. The AEM pilot studies were conducted in three areas: Butte and Glenn Counties, San Luis Obispo County, and Indian Wells Valley. The AEM surveys were conducted from 2018 through 2020 and were led by Stanford University with participants from the academic and private sectors, and local and state water agencies. All data used, collected, or created as a part of the AEM pilot studies are provided here." A detailed paragraph follows, mentioning funding from DWR, the Ministry of Denmark, and three local agencies, and listing pilot study participants such as Stanford University, Aarhus University, Aqua Geo Frameworks, Ramboll, I-GIS, SkyTEM, University of California Davis, California State University Sacramento, California State University Chico, Parker Groundwater, the Danish Water Technology Alliance, the Danish Environmental Protection Agency, Glenn County Department of Water Resource Conservation, Butte County Department of Water Conservation, Indian Wells Valley Water District, and San Luis Obispo County. Below this, a section titled "Data and Resources" features a PDF icon and the title "AEM Pilot Study Recommendation Report" with a sub-description: "Pilot study participant recommendations for future AEM surveys conducted in...". An "Explore" button is located at the bottom right of the page.

# Data Use & Tools

Goal to provide tools and guidance on AEM data use and integration into groundwater & hydrogeologic conceptual models.

The screenshot displays the website for the California Department of Water Resources. At the top left is the department's logo and name. A navigation bar contains icons and labels for 'Water Basics', 'What We Do', 'Programs', 'Work with Us', 'News', 'Library', and 'Search'. The main heading is 'Data and Tools'. Below it, a paragraph explains the need for data access under the Sustainable Groundwater Management Act (SGMA). A featured article titled 'Data Tools and Reports Fact Sheet' is highlighted with a light blue background. A secondary navigation bar includes 'Data', 'Mapping', 'Modeling', 'Climate Change', 'Maps', and 'Reports'. A dropdown menu is open under 'Data', showing 'Prop 68' and 'Water Year Type'. On the right side, there is a 'Data and Tools' sidebar with a link to 'Airborne Electromagnetic (AEM) Surveys' and a 'Contact Us' section with email addresses for general and regional inquiries, and a list of basin points of contact.

CALIFORNIA DEPARTMENT OF  
**WATER RESOURCES**

Water Basics What We Do Programs Work with Us News Library Search

## Data and Tools

We have a long history of data collection, monitoring, and reporting. With the passage of the [Sustainable Groundwater Management Act \(SGMA\)](#), there is an increased need for local and state agencies and the public to easily access water data in order to make informed management decisions.

**Data Tools and Reports Fact Sheet** | (Publish Date: Apr 26, 2018)  
Quick reference guide to data, tools and guidance that help Groundwater Sustainability Agencies (GSAs) develop Groundwater Sustainability Plans (GSPs), and implement the requirements of the Sustainable Groundwater Management Act (SGMA).

[Data](#) [Mapping](#) [Modeling](#) [Climate Change](#) [Maps](#) [Reports](#)

[Prop 68](#) [Water Year Type](#)

**Data and Tools**

- [Airborne Electromagnetic \(AEM\) Surveys](#)

### Contact Us

General Inquiries:  
[sgmps@water.ca.gov](mailto:sgmps@water.ca.gov)

Regional Inquiries:  
[sgmp\\_rc@water.ca.gov](mailto:sgmp_rc@water.ca.gov)

Basin Points of Contact:  
[Northern Region](#)  
[North Central Region](#)  
[South Central Region](#)  
[Southern Region](#)

# Project Outreach

Outreach prior to surveys in each survey area

- GSAs:
  - Pre-survey meetings with survey area GSA representatives
  - Important area maps
  - Request GSA support (details to be provided during pre-survey meeting)
- Public:
  - Mailers to residents beneath flight path and newspaper articles or radio ads in local media outlets
  - DWR to coordinate with GSAs on sharing outreach materials with stakeholders
- Tribes:
  - Share how AEM data can support groundwater management
  - Get input on schedule development





## Airborne Electromagnetic (AEM) Surveys



Flyover of a helicopter performing an Airborne Electromagnetic Survey.

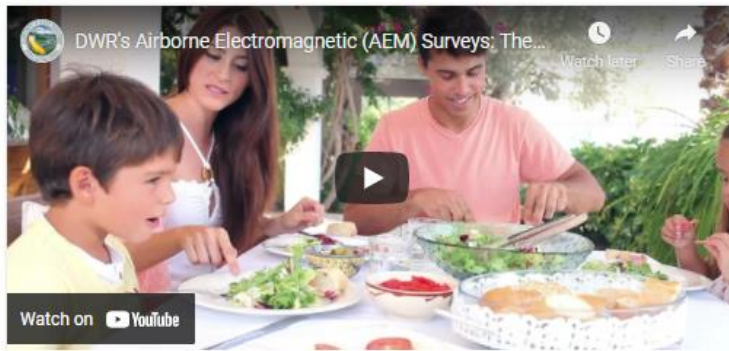
The Department of Water Resources is conducting airborne electromagnetic (AEM) surveys in California's high- and medium-priority groundwater basins, where data collection is feasible, to assist local water managers as they implement the Sustainable Groundwater Management Act (SGMA) to manage groundwater for long term sustainability.


The AEM project provides state and federal agencies, groundwater sustainability agencies (GSAs), stakeholders, and the public with basin-specific and cross-basin geophysical data, tools, and analyses.

The surveys are funded by voter-approved Proposition 68, Senate Bill 5, and from the general fund. More information can be found in the AEM Proposition 68 Fact Sheet.

During an AEM survey, a helicopter tows electronic equipment that sends signals into the ground which bounce back. The process has been compared to taking an MRI of the ground's subsurface. The data collected is used to create continuous images that are interpreted for underground geology.

The resulting information will provide a standardized, statewide dataset that improves the understanding of aquifer structures. It can also help with the development or refinement of hydrogeologic conceptual models and can help identify areas for recharging groundwater.



Watch on  YouTube

Vídeo en Español

### Contact Information

**General Inquiries**  
AEM@water.ca.gov

**Northern Region**  
Pat Vellines  
Patricia.Vellines@water.ca.gov

**North Central Region**  
Chelsea Spier  
Chelsea.Spier@water.ca.gov

**South Central Region**  
Amanda Peisch-Derby  
Amanda.Peisch@water.ca.gov

**Southern Region**  
Tim Ross  
Timothy.Ross@water.ca.gov

**DWR Headquarters**  
AEM Project Manager  
Katherine Dlubac  
Katherine.Dlubac@water.ca.gov

### Tags

Data Groundwater Manageme ...

# Outreach Materials

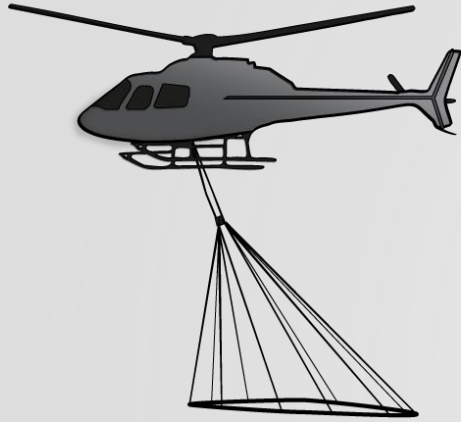
- AEM website  
<https://water.ca.gov/Programs/SGMA/AEM>
- Prop 68 Fact Sheet
- Existing Data Fact Sheet
- Survey schedule & map
- 2-minute AEM video (*New!*)
- Frequently Asked Questions (*New!*)
- Presentation slide deck
- Newspaper article
- Radio advertisement
- Social media announcements
- Survey notification letter

# Project Coordination

- State & Federal Agency AEM Working Groups
  - Provide input on multi-benefit projects, important area maps, and share existing data.
- Technical advisory committee
  - Provide recommendations on defined issues areas for program's continued development.
  - ~10 invited members: international, federal, state, local & academic practitioners and experts.



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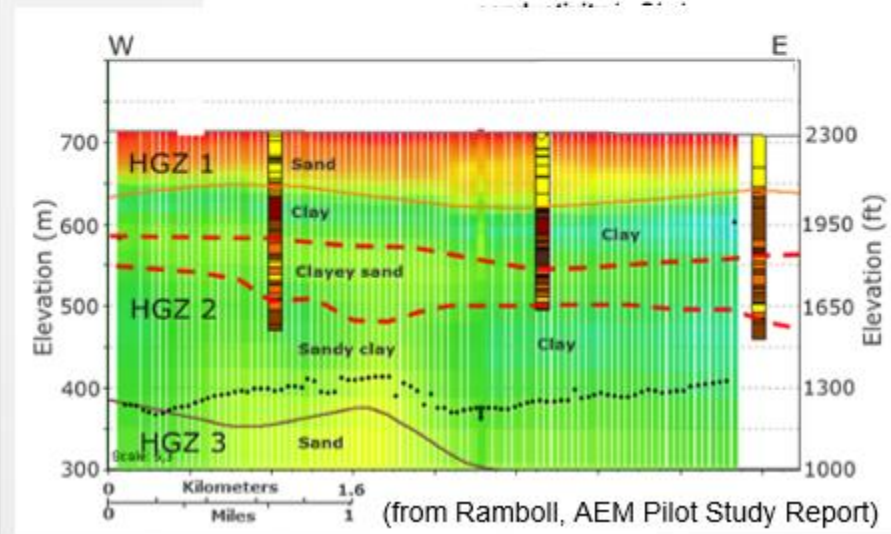
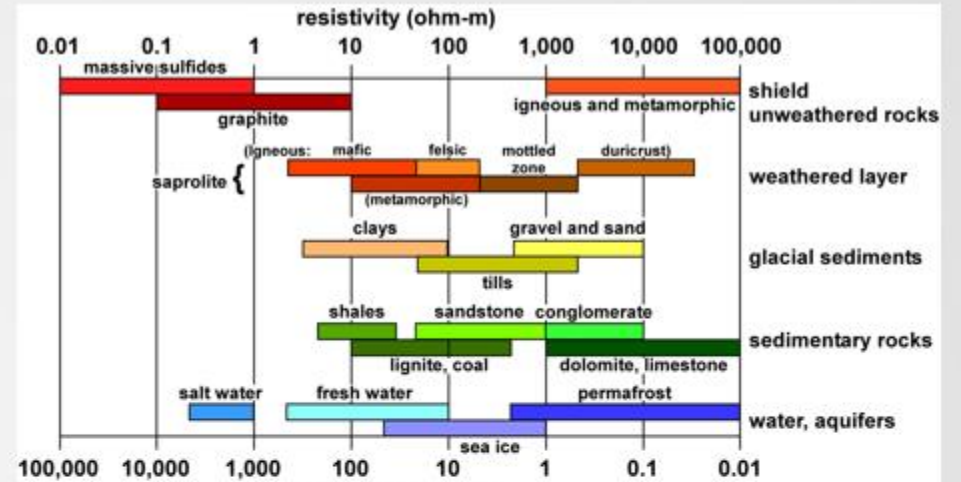
# Relevant existing data: Why and what

## Why:

- Existing data supports the reliable interpretation of AEM data
- Define relationship between geophysical properties and aquifer properties

## What:

- Lithology and geophysical logs
- Digitized (not just scanned pdfs)
- High-quality
  - Good lithologic descriptions
  - Accurate locations



(from Palacky, 1988)

## **Relevant existing data: typical compilation process**

1. Gather data from OSWCR, CalGEM, etc.
2. Sort for high quality logs
3. Determine accurate location of wells
4. Digitize data

***GSA's may have already completed this work while developing GSPs.***

# DWR requests relevant existing data

- Type of existing data requested:
  - Lithology logs
    - Digitized logs
    - Accurate locations of wells
    - List of high-quality wells
  - Geophysical data
    - Any and all geophysical logging and surface data (does not need to be digitized)
- Amount & location: Any and all existing data across basin
- **No additional work requested from GSAs**



# Data Submittal

More information and data submittal instructions provided in the [Existing Data Fact Sheet](#) available on the AEM website, from the GSAs tab.



## California's Statewide Airborne Electromagnetic (AEM) Surveys

### Existing Data Fact Sheet

*California Department of Water Resources  
Sustainable Groundwater Management Program  
April 2021*

#### Project overview

DWR will conduct airborne electromagnetic (AEM) surveys in California using funds available through Proposition 68. The AEM method is a geophysical method where data are collected from instruments towed beneath a helicopter. AEM data can be interpreted for continuous images of large-scale aquifer structure and provide a standardized, statewide dataset that supports the implementation of SGMA.

DWR will conduct surveys in all High and Medium Priority basins and data will be collected in a coarse grid. DWR will define flight lines and orient them to ensure data are collected over important areas (e.g. areas with known data gaps, adjacent to critical infrastructure, or where GSAs are considering recharge).

#### Why existing data are needed

Existing data support and ensure reliable processing and interpretation of AEM data. The locations of existing data should be incorporated into flight line planning so that the AEM survey lines are oriented close to the location of the existing data. The following types of existing data are needed to support the AEM surveys:

- Lithology logs
- Geophysical data (surface and logging)

#### Request for existing data

DWR will obtain existing data that are readily available through statewide data management systems

# Data Submittal

More information and data submittal instructions provided in the [Existing Data Fact Sheet](#) available on the AEM website, from the GSAs tab.

## 1. [Existing Data POC form](#)



## Point of Contact (POC) form

Please fill out this Point of Contact (POC) form to identify the person who will provide DWR with existing data in support of California's Statewide airborne electromagnetic (AEM) surveys.

After filling this form, the POC will receive a registration link for the SendFiles transfer application (<https://sendfiles.aecom.com/>) within a business day.

If you are having trouble with this form or submitting your data, please contact the DWR AEM team at [AEM@water.ca.gov](mailto:AEM@water.ca.gov)

This cover sheet takes approximately 2 minutes to complete.

\* Required

### POC and sub-basin information

1. First name of Point of Contact (POC) \*

# Data Submittal

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1. [Existing Data POC form](#)
2. Submit data via AECOM's [Send Files web service](#) (follow instructions on Fact Sheet)

## Send Files

Home My Messages/Files Sign Out

**AECOM**

**PLEASE READ BEFORE USING:** A security update now requires all recipients to be registered to receive shared files.  
[Click here to view more details](#)

Easily transfer large files to others by entering the email address of the recipient(s), and then selecting the files you wish to transfer. An email will be sent to each recipient, with a link to download each file. This site is to be used by AECOM employees, clients, and other companies and individuals working with AECOM, to transfer business related information only.

Recipient email address(es): (\*)

Please enter your name: (\*)  
Katherine Dlubac

Your email address:  
katherine.dlubac@water.ca.gov

Subject:

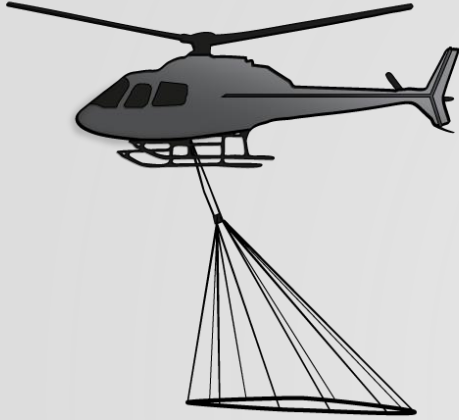
**Sending to multiple recipients:**  
Separate email addresses with a semicolon when sending to multiple recipients:  
**Example:**  
user@domain.com;  
user1@domain1.com

**Paste Addresses from Outlook:**  
John Doe  
<john.doe@gmail.com>;  
Smith, Tom  
<Tom.Smith@aecom.com>;  
Sally White  
<sallywhite@yahoo.com>

**Sending multiple files:**  
Click the "Select File(s)" button. Select multiple files by holding down the Ctrl or Shift keys.



# Agenda Overview



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# How to Ask Questions

## Webinar Participants

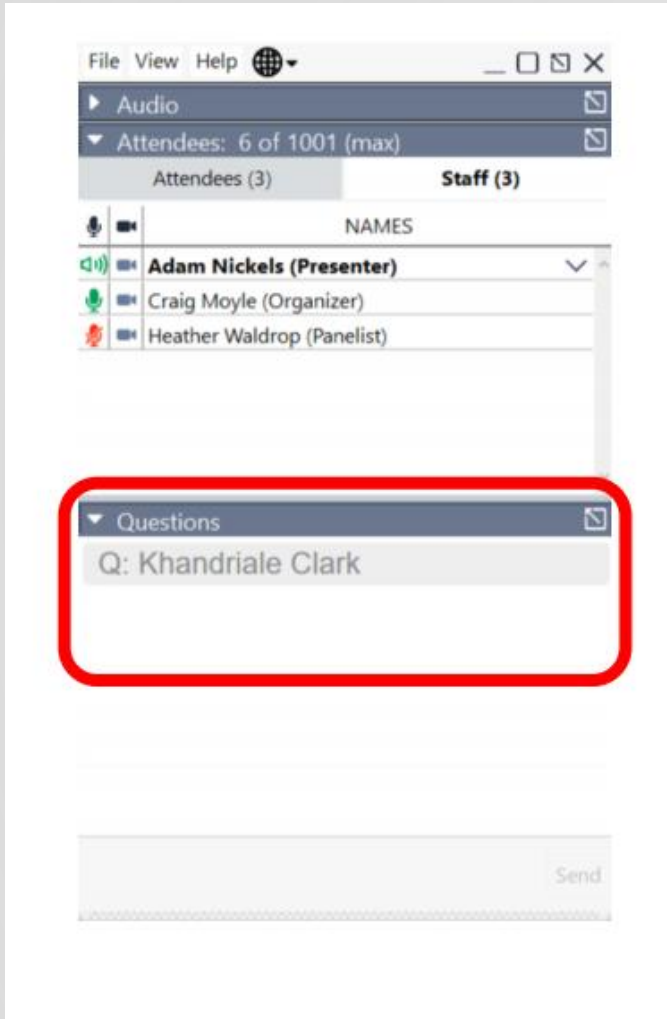
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Visit the project website for more information:

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





CALIFORNIA DEPARTMENT OF WATER RESOURCES  
SUSTAINABLE GROUNDWATER  
MANAGEMENT OFFICE



# Thank you!

Statewide AEM survey website:

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

General inquiries:

[AEM@water.ca.gov](mailto:AEM@water.ca.gov)

