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October 26, 2022

TO: Big Valley Groundwater Advisory Committee (BVAC)
Agenda Date: November 3, 2022

FROM: Maurice L. Anderson, Director MAN FOR

SUBJECT: November 3, 2022, Big Valley Groundwater Advisory Committee (BVAC) Packet

ACTIONS REQUESTED:

- **SUBJECT #1:** Amended and restated memorandum of understanding between the Lassen County Big Valley Groundwater Basin Sustainability Agency and the Modoc County Big Valley Groundwater Basin Sustainability Agency, adopted on August 23, 2022

ACTION REQUESTED:
1. Receive report; and
2. Receive public comment; and
3. Possible direction to staff.

- **SUBJECT #2:** Comments submitted to the Department of Water Resources during public review of the adopted Groundwater Sustainability Plan

ACTION REQUESTED:
1. Receive correspondence; and
2. Receive public comment; and
3. Possible direction to staff.

- **SUBJECT #3:** Potential Sustainable Groundwater Management (SGM) grant application

ACTION REQUESTED:
1. Receive report; and
2. Receive public comment; and
3. Possible direction to staff.

- **SUBJECT #4:** Airborne Electromagnetic (AEM) Survey results

ACTION REQUESTED:
1. Receive report; and
2. Receive public comment; and
3. Possible direction to staff.

- **SUBJECT #5:** University of California Cooperative Extension office report on applicable research and projects

ACTION REQUESTED:

1. Receive report; and
2. Receive public comment; and
3. Possible direction to staff.

- **SUBJECT #6:** LandIQ Mapping Workshop

ACTION REQUESTED:

1. Receive report; and
2. Receive public comment;
3. Possible direction to staff.

SUMMARY:

The attached packet is being provided for the above-mentioned items to be discussed at the November 3, 2022 Big Valley Groundwater Advisory Committee meeting.

The Big Valley Groundwater Basin, California Department of Water Resources (DWR) Basin No. 5-004, is classified as a "medium" priority basin. The basin, spans a land area of about 144 square miles in Modoc and Lassen counties (28 and 72 percent respectively). To comply with the requirements set forth by the 2014 Sustainable Groundwater Management Act (SGMA) (California Water Code, Section 10720 et seq.), both counties have taken on the role of the Groundwater Sustainability Agency (GSA) for the portion of the basin within their jurisdictional boundaries.

The Groundwater Sustainability Plan (GSP) was adopted by both County Boards of Supervisors on December 15, 2021 and submitted to DWR on January 27, 2022. DWR evaluates GSPs within two years of their submittal and will issue a written assessment. If deficiencies are found, the GSAs have 180 days to submit an amended GSP. Three public comments on the adopted GSP have been received. The following subject matters pertain to the next steps associated with the implementation of the GSP.

MLA:clf
Enclosures

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November 3, 2022

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Unapproved Minutes (October 20, 2021)

Big Valley Groundwater Basin Advisory Committee (BVAC)

Unapproved Meeting Minutes

BVAC Members:
Lassen County BVAC – Aaron Albaugh, Board Representative; Gary Bridges, Alt. Board Representative; Kevin Mitchell, Public Representative; Duane Conner, Public Representative
Modoc County BVAC – Geri Byrne, Board Representative; Ned Coe, Alt. Board Representative; Jimmy Nunn, Public Representative; John Ohm, Public Representative

Wednesday, October 20, 2021	5:00 PM	Adin Community Center 605 Highway 299 Adin, CA 96006

BVAC Convene in Special Session.

Present: Committee Members: Byrne, Albaugh, Mitchell, Ohm, and Nunn.
Absent: Committee Members: Conner

Also in attendance: BVAC Secretary Maurice Anderson
BVAC Staff Tiffany Martinez
BVAC Staff Gaylon Norwood
BVAC Recorder Brooke Suarez
Alt. Board Representative Gary Bridges

BVAC Chairman Byrne called the meeting to order at 5:06 p.m. Chairman Byrne read the public comment rules for the meeting.

Flag Salute: Chairman Byrne requested Representative Nunn lead the Pledge of Allegiance.

General Update by Secretary: None

Matters Initiated by Committee Members: Vice-Chairman Albaugh stated it was an arduous task to complete the GSP. He thanked the public and staff for participating in the process.

Correspondence (unrelated to a specific agenda item): None

Approval of Minutes (September 9, 2021) –

A motion was made by Vice-Chairman Albaugh to approve BVAC meeting minutes from October 6, 2021 with a change. The motion was seconded by Representative Nunn. The motion was carried by the following vote:

Aye: 5 – Byrne, Albaugh, Mitchell, Ohm, and Nunn.

Tiffany Martinez facilitated the meeting. The meeting process will be that chapters 1 – 3, then chapters 4 – 6, and then chapters 7 – 12 will be reviewed and after each section the floor will open to public comment.

SUBJECT #1:
Introduction of the Revised Draft Groundwater Sustainability Plan (GSP – *all chapters)*

ACTION REQUESTED:

1. Receive reports from the pertinent ad hoc committees, BVAC Secretary, Staff, and/or Consultant.
2. Receive public comment.
3. Adopt a resolution recommending that the Big Valley Groundwater Sustainability Agencies (GSAs) each conduct a public hearing to consider adoption of a Groundwater Sustainability Plan for the Big Valley Groundwater Basin.

T. Martinez reviewed the schedule.

David Fairman reviewed the changes to chapters 1 – 3. GEI met with ad hoc committee regarding interconnected surface water to incorporate changes. The approach to interconnected surface water and groundwater dependent ecosystems was modified to identify and describe the conditions to these two items. The maps were adjusted to correspond with these changes. The areas of interconnected surface water were narrowed down to 15 feet instead of 20 feet. David Lile provided information to back these changes. He also provided some research to justify using the Fall 2015 groundwater contours as the base line for the 15 feet for groundwater dependent ecosystems. The thought is that the ecosystems need access to water during the growing season and the fall water level is more representative of what levels are available for growth. Spring water levels are used as the base for interconnected surface water because that is the time when the most physical water is available though there is a data gap in regards to interconnected surface water areas.

D. Fairman noted that the cover photo was revised. Text was revised to text regarding the Modoc Watermaster, Exhibit A. Figures 6-10 and 6-12 were changed in regards to rounding consistencies. Clarifications were made to the text regarding the ACWA pipeline, Exhibit B.

T. Martinez highlighted the MOU portion regarding coming to a consensus because of the time line available.

Committee comment: Committee members had verbiage changes. D. Fairman was going to make changes on the "live document" as they were brought up. Discussion was held on interconnected surface water. The ad hoc committee wanted the interconnected surface water portion of the GSP to have a write up that DWR would accept.

Vice-Chairman Albaugh brought up having the GEI contract extended to include the write up for the annual report. T. Martinez stated that the contract with GEI ends with the production of the GSP. D. Fairman responded that GEI can pass data to L. Snell and D. Lile for the first annual report.

Representative Conner subsequently arrived at 5:38 pm.

There were no changes to Chapter 2 but there were verbiage changes to Chapter 3. The committee came back to the interconnected surface water topic and T. Martinez conferred with the committee to change the verbiage in the interconnected surface water section.

Public comment: Julie Parlee stated that there were many grammatical changes that needed to be made. She gave an example of how punctuation could change the meaning of the text in the GSP. She will edit document and return it.

On-line comment: Doreen SmithPower put forth correspondence during the last meeting. She stated that the correspondence was not entered into the record. She requested that the correspondence be found and enter it into the record. Julie noted, regarding section 3.4.1, that there should be an emphasis on the data gap of removing abandoned wells from inventory. At least in Adin, as it is obvious that 18 wells are an undercount of wells to standard. She had mentioned this before.

T. Martinez opened the floor to committee comment on Chapters 4-6.

Committee comment: The committee made verbiage changes. D. Fairman was asked to explain what basin and range were in the GSP. Vice-Chairman Albaugh stated that Figure 4.2 legend is unreadable in the packet. He also wanted Figure 4.2 to be accurate. A discussion was held on the wells that were drilled and the resulting test result tables that were in the GSP. Discussion was once again held on interconnected surface water as it pertains to Chapter 5. Vice-Chairman Albaugh wants Figure 5-17 removed but T. Martinez pointed out that it had been voted on at the last meeting to keep it in. There were no changes to Chapter 6.

Public comment: None

On-line comment: Julie had a comment regarding various wildlife statements throughout the Plan. She stated "Wildlife species go beyond "charismatic megafauna" such as deer and geese. A variety of habitats are required by different species for different functions (foraging, shelter, reproduction) at different times of day and season. Agricultural lands contribute but she believes that CDFW would disagree with the generalized statements implying that agricultural lands are superior to ACWA, sagebrush steppe, riparian, forested habitats outside the groundwater basin, etc, in providing habitat benefits. They all provide the diversity and intersectionality required for the wildlife who live here." She can provide examples of species' life history if needed.

Motion to break:

> **A motion was made by Vice-Chairman Albaugh to take a break. The motion was seconded by Representative Nunn. The motion was carried by the following vote:**
>
> **Aye:** 6 – Byrne, Albaugh, Mitchell, Conner, Ohm, and Nunn.
>
> Break was from 7:00 pm. to 7:15 pm.

T. Martinez opened Chapters 7-12 for committee comment.

Committee comment: The committee had verbiage changes.

Public comment: Julie Parlee felt that Section 9.3.2 was selling itself short. The Allen Camp Dam project should have more information such as all the additional benefits it would create, i.e. jobs. It should also recap all the previous studies and approval processes it has gone through and how government did not come through in following up on the project.

Online comment: Julie had a comment on Section 9.4.2: "Beaver dam analogues are not "commonly used"...yet. But they could be. I also note that a previous mention concerning beaver reintroduction has been removed, which is fine, because they evidently are still within the region enough that they could repopulate if we provided attractive habitat, such as dam analogues. There is also recent genetics research on beavers that they should not be moved long distances as they are genetically distinct by watershed. So we could relocate unwanted beavers off private land to other local locations." Doreen SmithPower had a comment on perennial streams and a definition of a perennial stream. She stated her letter was not submitted into the record. Lastly, she suggested that the GSP maps should be referenced differently.

Vice-Chairman Albaugh asked Ian Espinoza if there were any red flags in the GSP. I. Espinoza stated that as an employee of DWR he is not allowed to comment. He did state that the GSP shows that the committee really shows that they know their basin. He suggested reviewing

letters regarding other GSPs and see if the Big Valley GSP answers the deficiencies in those letters. Vice-Chairman Albaugh also asked Ian Espinoza about the basin boundary. Espinoza answered that there is nothing in the GSP, as its own process, that would trigger a modification to the basin boundary. He was also asked when is the next reranking filing date. Ian Espinoza has heard nothing.
T. Martinez reviewed the timeline if the committee passed the resolution, stating that if passed the tentative meeting date of the GSAs would be December 14, 2021. D. Fairman stated that the GSP will be open for public comment for 30 days and DWR, after receiving the GSP, will have a 75-day public comment period (verified by J. Boyt, DWR, online).

Discussion was held on changes to the Resolution.

Motion to approve resolution BVAC-2021-1:

> **A motion was made by Vice-Chairman Albaugh to approve the resolution with changes. The motion was seconded by Representative Nunn. The motion was carried by the following vote:**
>
> **Aye:** 6 – Byrne, Albaugh, Mitchell, Conner, Ohm, and Nunn.

Public comment: None

Matters Initiated by the General Public (regarding subjects not on the agenda)**:** None

Establish next meeting date: No further meetings, the job of the BVAC committee was to provide a GSP to the GSAs.

Motion to adjourn:

> **A motion was made by Representative Conner to take adjourn. The motion was seconded by Representative Ohm. The motion was carried by the following vote:**
>
> **Aye:** 6 – Byrne, Albaugh, Mitchell, Conner, Ohm, and Nunn.

Subject #1: Amended and Restated MOU

AMENDED AND RESTATED MEMORANDUM OF UNDERSTANDING BETWEEN THE LASSEN COUNTY BIG VALLEY GROUNDWATER BASIN SUSTAINABILITY AGENCY AND THE MODOC COUNTY BIG VALLEY GROUNDWATER BASIN GROUNDWATER SUSTAINABILITY AGENCY

This Amended and Restated Memorandum of Understanding, dated as of _____, 2022 (MOU), is entered into by and between the Lassen County Big Valley Groundwater Basin Groundwater Sustainability Agency and the Modoc County Big Valley Groundwater Basin Groundwater Sustainability Agency for the purpose of advising the Lassen and Modoc groundwater sustainability agencies during the development and implementation of the Groundwater Sustainability Plan (GSP) required under the 2014 Sustainable Groundwater Management Act for the Big Valley Groundwater Basin.

WHEREAS, the Lassen County Big Valley Groundwater Basin Groundwater Sustainability Agency (GSA) and the Modoc County Big Valley Groundwater Basin Groundwater Sustainability Agency entered into a Memorandum of Understanding, approved by the Modoc GSA on May 21, 2019, and approved by the Lassen GSA on June 11, 2019 (Existing Memorandum of Understanding); and

WHEREAS, the primary purpose of the Existing Memorandum of Understanding was to form an advisory committee to advise both GSAs on the development of a Groundwater Sustainability Plan (GSP) for the Big Valley Groundwater Basin; and

WHEREAS, the Big Valley Groundwater Basin Advisory Committee (BVAC) was instrumental in the development of the Big Valley Groundwater Basin GSP, which was approved by both GSAs on December 15, 2021; and

WHEREAS, the GSAs understand and agree that the BVAC can be of continued value to the GSAs and the public to assist in the implementation of said GSP; and

WHEREAS, it is understood that the GSAs and their staff will have to work cooperatively to successfully implement the adopted GSP; and

WHEREAS, this MOU replaces the Existing Memorandum of Understanding in its entirety.

NOW, THEREFORE, the parties hereto agree to amend the Existing Memorandum of Understanding in its entirety as follows:

1. Background

The Sustainable Groundwater Management Act (SGMA or Act) became effective January 1, 2015, and is codified as Part 2.74 of the California Water Code (Section 10720, et seq.). The regulations adopted to enforce the provisions of the Act are found in Section 350, et seq., Division 2, Chapter 1 .5, Subchapter 2 of Title 23 of the California Code of Regulations.

This MOU pertains to the Big Valley Groundwater Basin (BVGB), which was inaccurately designated as a "medium priority" basin by the California Department of Water Resources (DWR). This designation as a medium priority basin requires preparation of a GSP under the Act.

The SGMA was created to ensure groundwater basins throughout the state are managed to reliably meet the needs of all users, while mitigating changes in the quality and quantity of groundwater. The intent of the Act, as described in section 10720.1 of the Water Code, is to:

- Provide for the sustainable management of groundwater basins.
- Enhance local management of groundwater consistent with rights to use or store groundwater.
- Establish minimum standards for sustainable groundwater management.
- Provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater.
- Avoid or minimize subsidence.
- Improve data collection and understanding about groundwater.
- Increase groundwater storage and remove impediments to recharge.
- Manage groundwater basins through the action of local governmental agencies to the greatest extent feasible, while minimizing state intervention to only when necessary to ensure that local agencies manage groundwater in a sustainable manner.
- Provide a more efficient and cost-effective groundwater adjudication process that protects water rights, ensures due process, prevents unnecessary delay, and furthers the objectives of the Act.

The role of the GSA is to create a GSP, and then to implement and enforce that plan. The plan must include measurable objectives that can be used to demonstrate the basin is sustainably managed within twenty (20) years of implementation.

Absent a qualified planning process which produces a GSP, the State Water Resources Control Board (State Board) is authorized to declare that the Basin is out of compliance and, thereby, they will intervene and place the Basin on probation with regard to SGMA.

The Lassen and Modoc County Board of Supervisors have adopted resolutions (17-013 and 2017-09, respectively) declaring themselves to be the Groundwater Sustainability Agency (GSA) for the portion of the Big Valley Groundwater Basin within their respective jurisdictions. No other agency pursued GSA status and, therefore, Lassen and Modoc Counties were awarded

exclusive GSA status by DWR for the portion of the Big Valley Groundwater Basin within their respective jurisdictions.

Lassen and Modoc Counties (as the GSA for the portion of the Basin in their jurisdiction) worked cooperatively and prepared one GSP for the entire Big Valley Groundwater Basin. Said GSP was adopted by both GSAs on December 15, 2021, and subsequently submitted to DWR. In turn, both Counties intend to work cooperatively in the implementation of said GSP.

Lassen County was awarded a grant (Grant Number 46000 12669) to provide funding for the preparation of a GSP for the Big Valley Groundwater Basin. All requirements of said grant have been satisfied.

2. Purpose

The purpose of this MOU is to:

a. Establish the BVAC and its responsibilities.
b. Establish the membership of the BVAC.
c. Describe how meetings of the BVAC will be conducted and how information, findings, conclusions, decisions, etc. of the BVAC will be conveyed to the Lassen County Groundwater Sustainability Agency and to the Modoc County Groundwater Sustainability Agency.
d. Advise both Lassen and Modoc counties (as the respective GSAs for the portion of the groundwater basin in their respective jurisdictions) on the implementation of the GSP. This includes, but is not limited to, making recommendations regarding the annual reports, five-year updates and project implementation detailed in the GSP as required by the SGMA.
e. Provide additional detail regarding the shared responsibility of the two GSAs to implement the adopted GSP.
f. Provide additional direction to staff of the two GSAs on actions necessary to implement the GSP and to comply with SGMA.
g. Describe terms for the sharing of costs necessary to implement the GSP and to meet future requirements of SGMA.

3. Goals of the BVAC are as follows:

a. Work collaboratively and transparently with other members to identify common goals, foster mutual understanding, and develop and implement a GSP that all members and their constituents can live with and support;
b. Develop a common understanding of existing groundwater resources, including groundwater dependent habitats, public trust resources and the current and future needs of all beneficial uses and users in the Big Valley Groundwater Basin, as well as current and future water needs;

c. Solicit and incorporate community and stakeholder interests into committee discussions and emerging committee agreements in order to develop and implement a locally-informed and broadly supported GSP;
d. Consider and integrate science, to the best of its ability and with support from qualified scientific consultants, during GSP development and implementation;
e. Support implementation efforts guided by GSP goals to use, monitor, and manage water resources in a sustainable manner, ensure local control, address current and future local water needs, support the agricultural economy in Adin, Bieber, Nubieber, Lookout, and outlying communities, and support tourism and fish and wildlife habitat in the Basin;
f. Negotiate in good faith to achieve consensus on management of groundwater resources in the Big Valley Groundwater Basin now and into the future;
g. Advise the Lassen and Modoc GSAs on the preparation and implementation of a GSP;
h. Provide a forum for the public to comment during the preparation and implementation of the GSP;
i. Provide recommendations to the Lassen and Modoc GSAs that would result in actions which have as minimal negative impact as possible on the residents of Big Valley Groundwater Basin;
j. Advise the Lassen and Modoc GSAs on the preparation and implementation of a GSP to produce the lowest possible fixed costs to the residents of Big Valley;
k. Ensure local control of the Big Valley Groundwater Basin be maintained by the Lassen and Modoc GSAs; and
l. Advise the GSAs on the implementation of the GSP, as provided in this MOU.

As a standing committee of the Lassen and Modoc GSA's, the BVAC will operate in compliance with the Ralph M. Brown Act (Brown Act). Committee meetings will be noticed and agendas posted according to the Brown Act. All meetings will be open to the public and allow public comment. Speakers will generally be limited to three minutes, but time may be adjusted based upon meeting circumstances. As needed, the Chair may place time limits on public comments to ensure that the committee is reasonably able to address all agenda items during the course of a meeting. The Lassen GSA will announce committee meetings on its website and through its regular communication channels. Recommendations and advice from the committee will be presented to the Lassen and Modoc GSA's through their staff.

4. BVAC Membership Composition

1. One (l) member of the Lassen County Board of Supervisors selected by said Board.
2. One (I) alternate member of the Lassen County Board of Supervisors selected by said Board
3. One (1) member of the Modoc County Board of Supervisors selected by said Board.
4. One (l) alternate member of the Modoc County Board of Supervisors selected by said Board
5. Two (2) public members selected by the Lassen County Board of Supervisors. Said members must either reside or own property within the Lassen County portion of the Big Valley Groundwater Basin.

6. Two (2) public members selected by the Modoc County Board of Supervisors. Said members must either reside or own property within the Modoc County portion of the Big Valley Groundwater Basin.

Member vacancies
If a vacancy occurs, the respective GSA will select a new committee member. Applications or letter of intent for all members of the committee must be kept on file with the respective GSA. An appointing GSA must notify the other GSA in writing if a member of the BVAC has been replaced.

Committee Member Terms

- Committee members shall serve four (4) year terms, starting from the date of their appointment. If any committee member decides, for any reason, to terminate his or her role, he/she will notify GSA staff as soon as possible after making such a determination. Committee members interested in serving beyond four (4) years must re-apply through the GSA's application process.
- The chair and vice-chair will serve a one (1) year term. At the end of the term of a chair or vice-chair, the committee will use its decision-making procedures to nominate and confirm a new chair and vice-chair. Any interested chair or vice chair may be nominated for a second term; however, no chair or vice-chair shall serve more than two (2) consecutive terms.

5. BVAC Roles and Responsibilities
This section describes roles and responsibilities that the Big Valley Advisory Committee Members commit to during development and implementation of the Big Valley Groundwater Basin GSP.

GSAs
The Lassen and Modoc GSAs are the final decision makers in the GSP process. The GSA's will:

- Provide guidance, evaluation and feedback that directs GSA staff and Advisory Committee members to build and implement an effective GSP;
- Work collaboratively with GSA staff, Advisory Committee members, consultants, and constituents;
- Receive, evaluate, and decide on all GSP and SGMA related actions that come in the form of advice and recommendations from the Big Valley Advisory Committee;
- Welcome feedback that pertains to the GSP from all diverse stakeholder interests in the Basin; and
- Serve as a representative for the Basin, making decisions in the best interest of achieving and maintaining long-term groundwater sustainability for all beneficial uses and users in the Basin.

Advisory Committee Members
Members of the Advisory Committee ("members") collectively represent the diversity of beneficial groundwater uses and users in the Big Valley Groundwater Basin. Committee members commit to:

- Serve as strong, effective advocates and educators for the interests of the group (constituency) that they represent;
- Nominate and confirm a committee chair and vice chair every year;
- Arrive at each meeting fully prepared to discuss all agenda items and relevant issues; including, but not limited to, reviewing previous meeting summaries, drafts and final GSP chapters, and other information distributed in advance of each meeting;
- Use an innovative problem-solving approach in which the interests and viewpoints of all members are considered;
- Explore all options to resolve disagreements, including, as needed, one-on-one discussions with GSA staff, or, at Advisory Committee meetings, interest-based caucuses or small group discussions;
- Act as liaisons throughout the GSP development and implementation process to educate, inform and solicit input from the wider local community and interested constituencies;
- Present constituent views on the issues being discussed and commit to engage in civil, respectful, and constructive dialogue with other members, as well as GSA staff, technical team members, and meeting facilitators;
- Ensure accuracy of information dissemination during or outside meetings, and correct false information as needed or appropriate;
- Avoid representing individual viewpoints as those of the committee and respect confidential conversations;
- Work collaboratively to ensure broad constituent understanding and support for any advice and recommendations that the committee shares with the Lassen and Modoc GSA Boards;
- Coordinate with Lassen and Modoc GSA staff regarding recommendations for any additional committee tasks that should be undertaken by the committee, and which items shall be presented to the GSA Boards for its review and approval;
- Operate at all times in compliance with the Brown Act;
- Attend meetings consistently - participation in 75% of the meetings is the minimum expectation. (*Given the volume of information to be considered and discussed, it is essential that members actively participate in committee meetings on a consistent basis. It is understood that professional and personal commitments may at times prevent members from attending committee meetings. In such cases, members shall notify both Lassen and Modoc GSA staff no less than 24 hours in advance to be excused from attending any given committee meeting. As needed, staff will reach out to members who are not actively participating in at least 75% of the meetings to give them the opportunity to explain their absences and reaffirm their interest to participate on the committee, and thus not lose their seat. Members who do not meet the threshold for active participation, and have not expressed an interest to continue*

participating, will be removed from the committee and replaced by the applicable GSA Board from the committee. Alternates selected by the applicable GSA Board may attend in the absence of a committee member, but must alert the Lassen and Modoc GSA staff prior to the meeting.); and

- Recuse him/herself from discussion and voting if he/she has a personal interest or stake in the outcome which constitutes a conflict of interest (as that term is defined by the Political Reform Act and in accordance with Government Code Title 9, Political Reform; Chapter 7, Conflicts of Interest).

Through its public meetings, the committee meetings shall serve as a forum for public dialogue on SGMA and GSP development and implementation. With approval by the Lassen and Modoc GSA's, committee tasks may be established, amended, repealed, or added at any time.

Duly appointed alternates may vote on all matters before the BVAC in the absence of the appointed member. Each alternate shall be informed of the business of the BVAC and the actions they are considering and voting for when acting on behalf of a member.

The following are desired attributes for BVAC members:

a. Have knowledge and experience in water resources management.
b. Represent an agency, organization, tribe, academia, or interest that is under-represented in the region (e.g., disadvantaged communities or unincorporated areas).
c. Have the ability and desire to objectively articulate the perspective of his/her BVAC seat and caucus at a level beyond that of his/her individual interest.
d. Provide recommendations with the best interests of the entire Big Valley region in mind.

6. Appointment

Members of the BVAC shall be appointed by the respective Board of Supervisors acting as the GSA. Members will serve at the pleasure of said Boards and may be terminated at any time without cause. Persons interested in serving on the BVAC shall submit a letter of interest or application to the pertinent Clerk of the Board of Supervisors which includes the following:

a. Current level of SGMA knowledge and experience;
b. Knowledge of groundwater in the Big Valley Groundwater Basin;
c. Their ability to commit to attending meetings of the Advisory Committee; and
d. Demonstrated ability to work collaboratively with others of differing viewpoints and achieve good faith compromise.

7. BVAC Chair and Vice Chair Roles

The BVAC Chair and Vice Chair must be BVAC members. The Chair and Vice Chair will be determined by a majority vote of the BVAC.

Although not required, the following attributes are desirable for the Chair and Vice Chair:

- Chair: prior experience working in the role of a Chair of a committee.
- Vice Chair: attributes and ability to assume Chair role and responsibilities, but not necessarily as much experience as the Chair.
- Chair and Vice Chair should come from different GSAs.
- Familiar with the purpose, structure, and content of meetings.
- Willing and able to attend each BVAC meeting.
- Ability to even-handedly articulate all interests.
- Consensus-builder.

The role of the Chair and Vice Chair will vary between BVAC meetings; however, the Vice Chair's primary role is to take on Chair responsibilities in the absence of the Chair and/or at the discretion of the Chair. General responsibilities for the Chair are as follows:

a. Review BVAC agenda prior to finalization and distribution to stakeholders (one week prior to BVAC meetings);
b. Meet with staff prior to each BVAC meeting to go over the BVAC agenda and presentation(s) so that the BVAC meeting runs smoothly and without interruption;
c. Manage the BVAC agenda, select members to speak in turn, and keep the BVAC on task and on time;
d. Convene each BVAC meeting and initiate introductions;
e. Organize and call on public speakers during appropriate agenda items (if applicable) and determine public comment procedures;
f. Identify when the BVAC has reached an impasse and needs to move forward with formal voting to resolve an issue;
g. Summarize key decisions and action items at the end of each BVAC meeting;
h. Close meetings;
i. Ensure that notes are prepared summarizing discussion, agreements, and decisions;
j. Review and provide comments on BVAC meeting notes.

8. Meetings

Meetings of the BVAC will be conducted as often as is needed during implementation of the GSP. The BVAC may establish a regular meeting schedule or call each meeting as a special meeting in accordance with the Brown Act. Meetings shall be conducted in accordance with the Brown Act, this MOU, SGMA, and any other applicable rules or regulations.

Meetings shall be noticed in accordance with the Brown Act. The Lassen County Department of Planning and Building Services will coordinate Brown Act noticing and any other noticing that is executed. The Lassen County Department of Planning and Building Services will prepare and disseminate packets in advance of all meetings, as applicable. Said Department shall serve as staff to the BVAC, and be the repository of all associated records, with a copy of all records sent to the Modoc County Clerk of the Board.

The Director of the Lassen County Planning and Building Services Department, or his or her designee, shall serve as Secretary of the BVAC and may comment on any item, but does not have a vote. The designated Modoc County GSA groundwater staff member may comment on any item, but does not have a vote.

Legal counsel shall be provided by the Modoc County Counsel.

Staff from either GSA or the BVAC chair or vice chair may request that a meeting be scheduled, in which case the Secretary shall schedule a meeting accordingly. BVAC members may request that the chair or vice chair provide direction to schedule a meeting. In which case, it shall be at the discretion of the chair or vice chair to provide direction to the Secretary to schedule a meeting.
A quorum is required to convene. Formal voting may not occur without a quorum of BVAC members and the BVAC may not take any action, other than to adjourn the meeting to a future date and time; however, presentations and discussion of agenda topics may occur. A quorum shall be defined as having at least four BVAC representatives present.

Meeting Location
All meetings of the Big Valley Groundwater Advisory Committee must be held within the boundary of the Big Valley Groundwater Basin. Lassen GSA staff will work collaboratively with the Chair to determine a location which will encourage the most participation from all stakeholders. Meeting locations shall remain consistent to prevent reduced participation from all stakeholders.

9. Public Comments at BVAC Meetings
BVAC meetings are open to the public, and public comments are welcomed and encouraged. To ensure that members of the public have an adequate chance to provide comments, the BVAC Chair will invite public comments by members of the public in attendance on any agenda item in which the BVAC is deciding or formulating a recommendation. An open public comment period will be offered at the end of BVAC meetings to allow members of the public to speak to non-agenda topics.

If there is substantial public interest or comment on a topic, the BVAC Chair or Vice Chair may implement the following procedures to ensure that such comments are received in a timely manner:

- Members of the public will be asked (but not required) to fill out a speaker card to indicate their name, affiliation, contact, and the specific agenda item they wish to speak to (if applicable).
- Speaker cards will be limited to one per person per agenda item. Participants may submit multiple speaker cards to address multiple agenda items.
- The BVAC Chair or Vice Chair will invite those who submitted speaker cards to address the agenda item prior to calling for a consensus decision and/or vote on that item.

- Speaker cards will generally allow three minutes of public speaking time per speaker.
- However, in the event that there are a large number of public speaker comments, it will be up to the discretion of the BVAC Chair or Vice Chair to reduce the time for each public speaker to ensure that all agenda items are addressed and that the BVAC meeting closes on time.

10. Decision-making Procedures
In order to hold a meeting and conduct its work, a quorum of the Big Valley GSA Advisory Committee must be present.

a. **Consensus as the Fundamental Principle:** The advisory committee shall strive for consensus (agreement among all participants) in all of its decision-making. Working toward consensus is a fundamental principle which will guide group efforts, particularly when crafting any draft or final advisory committee proposals, reports or recommendations for GSA Boards consideration. If the committee is unable to reach consensus, the range of opinions provided, including areas of agreement and disagreement, will be documented in meeting summaries or otherwise communicated in written reports when advisory committee work is shared with the GSA Boards.

b. **Definition of Consensus:** Consensus means all committee members either fully support or can live with a particular decision and believe that their constituents can as well. In reaching consensus, some committee members may strongly endorse a particular proposal, report or recommendation, while others may simply accept it as "workable." Others may only be able to "live with it" as less than desired but still acceptable. Still others may choose to "stand aside" by verbally noting disagreement, yet allowing the group to reach consensus without them, or by abstaining altogether. Any of these actions constitutes consensus.

c. **Types of Decision-Making:**
1. Administrative: Decisions about the daily administrative activities of the Committee, including, but not limited to, meeting logistics, meeting dates and times, agenda revisions and schedules. Administrative designs will typically be put forward to the group by Lassen County Department of Planning and Building Services staff. As needed, staff will consult with the committee. Any administrative decisions by the committee will be made on a simple majority vote of all members present at a meeting. The committee will defer to the decision-making procedures outlined in this section of the MOU in circumstances where it is unclear if a committee decision is administrative in nature, or represents a more substantive GSP/SGMA decision (described below).

2. Groundwater Sustainability Planning/SGMA Advice and Recommendations: Advice and recommendations regarding implementation of the Big Valley GSP, topics and actions mandated by SGMA, and other groundwater related topics that the committee chooses to address related to the Big Valley Groundwater Basin. All GSP/SGMA

advice and recommendation decisions will be made by the decision-making procedures outlined in this section of the MOU.

3. Consensus with Accountability: Consensus seeking efforts recognize that a convened group such as Big Valley Advisory Committee makes recommendations, but is not a formal decision-making body like the Lassen or Modoc GSAs. That said, achieving consensus is the goal, as this allows all stakeholder interests represented on the committee to communicate a unified group perspective to the GSA Boards as it considers public policy decisions and actions which may affect the constituencies that members represent, and the wider community. Using a model of consensus with accountability, all committee members shall commit to two principles:

   - All members are expected to routinely express their thoughts to ensure they have clarity on how their perspectives and those of others may shift over time.
   - All members shall negotiate agreement in a manner that serves their interests as a representative of the community, and offers either neutral impact to others with differing views, or ideally provides benefit to others' with differing views as well as their own.

   Operating by consensus with accountability will encourage multi-interest solutions based on shared member interests. Such solutions are in turn more sustainable and durable as they represent shared agreements rather than majority/minority dynamics. Most consensus building during the course of GSP development and SGMA implementation will be based on verbal dialogue, deliberation and iterative development of group ideas. The Chair may commonly ask, when it appears consensus or near consensus agreement has emerged or is emerging, if any member cannot live with said agreement. For any final decisions, committee members will demonstrate consensus, or lack thereof, in the following manner:

Nay:	I do not support the proposal.
Aye:	I support the proposal.
Stand Aside:	Member verbally notes he/she is willing to stand aside and allow group consensus.
Abstention:	At times, a pending decision may be infeasible for a participant to weigh in on. Member verbally notes he/she abstains. Abstentions do not prevent group consensus.

Any member that stands aside or abstains from a decision is encouraged to explain why his/her choice is being made.

d. **Less than 100% Consensus Decision Making:**
The advisory committee is consensus seeking, but shall not limit itself to strict consensus if 100% agreement among all members cannot be reached after all interests and options have been thoroughly identified, explored and discussed. Less-than-consensus decision-making shall not be undertaken lightly. If the committee cannot come to 100% agreement, it could set aside the particular issue while it continues work on other issues, then revisit the disagreement later in the process. Finally, the committee recognizes that certain deadlines must be met during the collaborative process to ensure completion of all SGMA opportunities and requirements on time.

If, after thoroughly exploring all ideas and options, consensus is absent or otherwise not forthcoming, the committee, with assistance from the GSA staff, will clearly document majority and minority viewpoints. The Chair and Vice-Chair will then work with GSA staff to incorporate all viewpoints into the meeting summary, and, as warranted, prepare a committee report to the GSA Boards. The chair, in coordination with GSA staff, will then present the report to the GSA Boards, ensuring that all majority and minority viewpoints are clearly communicated and accurately represent the outcomes of committee discussions. Any committee member holding minority viewpoints will have the opportunity, if he/she is not comfortable with the process, to present his/her viewpoints directly to the GSA Boards at the time the report is presented. Members wishing to do this will express their interest and minority viewpoints with GSA staff in advance of said GSA Board meetings.

e. **Decision Outcomes**: Advisory committee decisions will be made at appropriate meetings and, in accordance with the Brown Act, will be publicly noticed in advance and shared via the Lassen County GSA's website and SGMA interested parties email list. As described above, all committee proposals, reports and recommendations will reflect the outcomes of collaborative member discussions. All consensus agreements and other negotiated outcomes during GSP development and implementation, as well as discussion outcomes when consensus is not forthcoming, will be documented, as described above, and shared with the GSA Boards.

11. Collaborative Process Agreements and Meeting Ground Rules
Members commit to the following process agreements during discussion, deliberation and attempts to find consensus-based solutions to sustainable groundwater management in the Big Valley Groundwater Basin. Moreover, members also agree to abide by meeting ground rules in order to intentionally and consistently engage each other in civil and constructive dialogue during the collaborative process.

Process Agreements

- Strive to focus on interests versus positions. A focus on interests instead of positions will help reveal the needs, hopes or concerns behind any member's words. By extension, this can help identify shared interests among committee members and, based on those shared interests, multiple options for mutually beneficial agreements.

- Foster mutual understanding and attempt to address the interests and concerns of all participants. For the collaborative process to be successful, all members must seek to understand the interests and concerns of other members, then strive to reach agreements that take all member interests under consideration.
- Inform, educate and seek input from community constituents. To the extent possible, members will share information and solicit input from their constituents, scientific advisors, and others about ongoing committee discussions and potential agreements or recommendations as they emerge.
- View challenges as problems to be solved rather than battles to be won. Challenges will at times arise during discussion of issues. Remember to focus on the challenge versus on each other. Search for multi-interest solutions, rather than win/lose agreements.
- Be creative and innovative problem solvers. Creative thinking and problem solving are essential to success in any collaboration. Get beyond the past, climb out of the perceived "box" and attempt to think about the problem, and potential solutions, in new ways.
- Negotiate in good faith. All members agree to candidly and honestly participate in decision making, to act in good faith in all aspects of this effort, and to communicate their interests in group meetings. Good faith also requires that parties not make commitments for which they cannot or do not intend to honor.
- Consider the long-term view. Taking a long-term view of the planning horizon may help inform collaborative discussions and reduce conflict, and thereby ensure long-term sustainability of groundwater resources.

Ground rules

- Use common conversational courtesy and treat each other with respect. Civil and respectful dialogue tends to foster a constructive, thorough and solutions-oriented environment within multi-stakeholder groups.
- Remember that all ideas and points of view linked to the committee's charge have value. All ideas have value in this setting. Simply listen, you do not have to agree. If you hear something you do not agree with or you think is silly or wrong, please remember that a fundamental purpose of this forum is to encourage diverse ideas.
- Be candid, listen actively and seek to understand others. This promotes genuine dialogue and mutual understanding. Mutual understanding in turn helps parties identify shared interests. Shared interests set the foundation to finding and developing mutually acceptable agreements.
- Be concise and share the air. Keep in mind that time is limited at meetings. Be concise when sharing your perspective so that all members can participate in the discussion and remember, people's time is precious, treat it with respect.
- Avoid editorial comments. At times it will be tempting to try and interpret the intentions or motivations of others. Please avoid this temptation and instead speak to the interests you represent and the motivation behind them.

- Stay focused on the meeting agenda. The committee is a Brown Act compliant body. As such, it is important to stay focused on the posted agenda for any given meeting.
- Welcome levity and humor to the discussions. Work around water can at times be daunting and filled with challenges. Levity and humor are both welcome and helpful at times, as long as it does not come at the expense of others.
- Turn cell phones off or to vibrate. Help the group avoid distractions by turning cell phones to vibrate, not checking email during meetings and, if you must take a call, taking it outside the room.

12. Communications/Media Relations

Members are asked to speak only for themselves or the constituency they represent when asked by external parties, including the media, about the committee's work, unless there has been a formal adoption of a statement, report, or recommendations by the committee. Members will refer media inquiries to GSA staff while also having the freedom to express their own opinions to the media. Members should inform media and external parties that they only speak for themselves and do not represent other members or the committee as a whole. The temptation to discuss someone else's statements or positions should be avoided.

13. Indemnification/Defense

Claims Arising from Acts or Omissions.

No GSA, nor any officer or employee of a GSA, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another GSA under or in connection with this MOU. The GSA's further agree, pursuant to California Government Code section 895.4, that each GSA shall fully indemnify and hold harmless the other GSA and its agents, officers, employees and contractors from and against all claims, damages, losses, judgements, liabilities, expenses, and other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any work delegated to or action taken or omitted to be taken by such GSA under this MOU .

14. Litigation

In the event that any lawsuit or legal action is brought by a third party against either GSA based upon or arising out of the terms of this MOU or the activities hereunder, the Parties shall cooperate in the defense of such lawsuit or legal action. Each GSA shall bear its own legal costs associated with such litigation or legal action.

15. Books and Records

Each GSA will be entitled to receive copies of documents, records, historical data, data compiled through consultants and any and all information related to groundwater within the Big Valley Groundwater Basin developed pursuant to this MOU; provided that nothing in this paragraph shall be construed to operate as a waiver of any right to assert any privilege that might apply to protect the disclosure to information or materials subject to the attorney-client privilege, attorney work product privilege, or other applicable privilege or exception to disclosure.

16. Miscellaneous

a. Term of Agreement. This MOU shall remain in full force and effect until the date upon which all parties to this agreement have executed a document terminating the provisions of this MOU.
b. Termination. This MOU may be terminated by either party without cause upon thirty (30) days' prior written notice to the other party.
c. No Third-Party Beneficiaries. This MOU is not intended and will not be construed to confer a benefit or create any right on any third party, or the power or right to bring an action to implement any of its terms.
d. Amendments. This MOU may be amended only by written instrument duly signed and executed by all parties.
e. Compliance with Law. In performing their respective obligations under this MOU, the Parties shall comply with and conform to all applicable laws, rules, regulations and ordinances.
f. Construction of Agreement. This MOU shall be construed and enforced in accordance with the laws of the United States and the State of California.

17. All notice required by this MOU will be deemed to have been given when made in writing and delivered or mailed to the respective representatives of the Parties at their respective addresses as follows:

For the County of Modoc: Clerk of the Board
204 South Court Street
Alturas, CA 96101

For the County of Lassen:
Lassen County Planning and Building Services
707 Nevada Street, Suite 5
Susanville, CA 96130

18. UC Cooperative Extension Farm Advisor Offices
The assistance provided by the Lassen and Modoc County UC Cooperative Extension Farm Advisor Offices in the development of the GSP and the first GSP Annual Report is recognized and appreciated by the GSAs. The GSAs willingly accept any additional assistance said offices may be able to provide the GSAs in future years undertaking activities necessary to implement the GSP as required by SGMA.

GSA staff from both GSAs are hereby directed to coordinate with the UC Cooperative Extension Farm Advisor Offices for all future GSP implementation and for all activities associated with this MOU.

19. Preservation of Powers

Each GSA shall retain its powers granted through SGMA. In addition, each GSA reserves its rights and its ability to exercise those rights in its sole and absolute discretion, and confirm that nothing contained herein shall:

1. Alter any water right, contract right, or any similar right held by either GSA, landowners or customers, or amend any water delivery practice, course of dealing, or conduct.
2. Limit or interfere with the respective GSA's rights and authorities over their own internal matters, including, but not limited to, legal rights to surface water supplies and assets, groundwater supplies and assets, facilities, operations, water management and water supply matters.
3. Modify or limit either GSA's police powers, land use authorities, well permitting authority, or any other authority.
4. Modify or limit the authority of either County from issuing well permits and making any findings required by local ordinance or state law, regulation, or executive order. Each County will determine the protocol to be followed when issuing well permits within its own jurisdiction.

20. Project Implementation

The BVAC shall make a recommendation regarding any project being considered by either GSA related to implementation of the GSP before the GSA approves said project. If a particular project involves both GSAs, execution of a project implementation agreement will be considered by the GSAs.

21. Annual Reports and Five Year GSP Updates

The SGMA requires that annual reports be submitted to DWR by April 1st of every year following adoption of a GSP. The SGMA also requires that five-year updates be submitted to DWR, in accordance with the adopted regulations.

Annual reports shall be submitted to the BVAC prior to consideration by the GSAs. The BVAC shall make a recommendation to the GSAs regarding the five-year update prior to presentation of said five-year update to the GSAs.

To the greatest degree reasonably possible, the annual report and five-year updates will be prepared by both GSAs' staff working cooperatively with the UC Cooperative Extension Farm Advisors offices, and other partners as necessary. Only if it is determined by the GSAs that this is not reasonably feasible, will a contract for professional services be considered. If a contract for professional services is being considered by either GSA regarding implementation of the GSP or activities required by SGMA, the BVAC shall make a recommendation to the GSA or GSAs prior to execution of any contract.

GSA staff will also investigate grants and other funding mechanisms and report their findings to the GSAs as information becomes available. The BVAC will provide a recommendation to the

GSAs regarding any potential grant application. However, staff from either GSA, may, at its own discretion, present potential grant funding opportunities directly to their GSA, without said grant opportunity first having to be considered by the BVAC, if, in staff's opinion, there is insufficient time for the BVAC to consider said opportunity.

22. Annual GSP Work Plan and Schedule

On a yearly basis, staff from each GSA will work cooperatively on the development of a draft Annual GSP Work Plan and Schedule. Said draft Work Plan and Schedule will be presented to the BVAC for comment prior to consideration by the two GSAs. The draft Work Plan and Schedule shall list the goals and objectives to be achieved by the GSAs within the 12 months following adoption of said Annual Work Plan and Schedule for the development, financing, and implementation of the Big Valley GSP. The Annual GSP Work Plan and Schedule shall include an estimated cost (or estimated cost range) and deadline for completing each goal and objective included in the Annual GSP Work Plan and Schedule.

The Annual GSP Work Plan and Schedule may be amended from time to time by a majority vote of each of the two GSAs to conform with new information and developments related to the Basin and the financing and implementation of the Big Valley GSP.

If possible and available, information regarding the potential availability of grant funds that may be appropriate for the implementation of the Annual GSP Work Plan and Schedule should be presented concurrently to or prior to consideration of the Annual GSP Work Plan and Schedule. If it is determined appropriate to do so, and if the timing of the grant funding allows, the BVAC may comment on the potential availability of grant funds that may be appropriate for the implementation of the Annual GSP Work Plan and Schedule prior to presentation of the Annual GSP Work Plan and schedule to the GSAs. However, staff from either GSA, may, at its own discretion, present potential grant funding opportunities directly to their GSA, without said grant opportunity first having to be considered by the BVAC, if, in staff's opinion, there is insufficient time for the BVAC to consider said opportunity.

23. Annual GSP Implementation Budget

On a yearly basis, as soon as reasonably possible after submittal of the Big Valley GSP Annual Report to the Department of Water Resources (which is due April 1st of each year following adoption of the GSP), the BVAC shall recommend, by a majority vote of its members, an Annual GSP Budget.

At a minimum, the Annual GSP Budget shall include the following:

1. An estimate of staff time needed from each GSA for the upcoming Fiscal Year for implementation of the Big Valley GSP Annual Work Plan and Schedule.

2. A list of goods or services or category of goods and services, necessary for and related to the development, financing, monitoring, and implementation of the Annual GSP Work Plan and Schedule for the upcoming Fiscal Year.

If possible, the Annual GSP Budget should be considered concurrently with the approval of the Annual GSP Work Plan and Schedule.

For the Annual GSP Budget to take effect, said Budget must be approved by each GSA.

Each GSA shall pay for those expenses set forth and approved in the Annual GSP Budget in the proportions set forth below (based on the percentage of the total Groundwater Basin within the jurisdiction of the respective GSA):

- Lassen County Big Valley Groundwater Basin Groundwater Sustainability Agency - 72%
- Modoc County Big Valley Groundwater Basin Groundwater Sustainability Agency – 28 %

The above percentages shall remain in effect until modified by amendment of this MOU or in accordance with other applicable requirements. The GSAs will consider amendment of the above percentages at the time that any Basin Boundary Modification is proposed. Additionally, either GSA may, at any time, request review of said percentages, at which time the BVAC shall provide a report to the GSAs.

In Kind Contributions are appropriate and recognized as satisfactory to meet cost share requirements of a party to the Agreement. Any In Kind contributions to be substituted for monetary reimbursement of GSP implementation costs shall be included in the Annual GSP Work Plan and Schedule and approved in writing as part of the Annual GSP Implementation Budget.

If the GSAs determine, during consideration of the Annual GSP Implementation Budget, that cost sharing is required for any contract or expenditure, cost-sharing allocations for any contract or expenditure shall be agreed to in writing in advance of executing any contracts with consultants, vendors, or other contractors or incurring any expense. Any such contracts shall be drafted in a manner that reflects that consultants, vendors or contractors hired to perform work are working on behalf of both GSAs and shall work with both GSAs on a collective basis. The contracts shall include appropriate indemnity language and insurance provisions agreed to by the GSAs.

Nothing in this MOU shall prevent either GSA from voluntarily incurring its own costs related to GSP development and implementation at that GSAs expense.

24. Lassen-Modoc Big Valley GSAs Group

A Share Point site has been established where a copy of records and data associated with the development and implementation of the GSP is maintained. Said Share Point site is hosted by Lassen County. However, access will be provided to appropriate staff from both GSAs and to the Farm Advisors from both counties. Lassen County will continue to host the Share Point site. A copy of all future records (such as annual reports, five-year updates, etc.) and associated data and records associated with implementation of the GSP will be maintained on said Share Point site.

Signature
The parties here to have executed Amended and Restated Memorandum of Understanding as of the dates shown below.

The effective date of this MOU is the latest signature date affixed to this page. This MOU may be executed in multiple originals or counterparts. A complete original of this MOU shall be maintained in the records of each of the parties.

COUNTY OF LASSEN

By: _____ Date: 8/23/2022
Chairman, Lassen County Board of Supervisors

ATTEST:

By: _____ Date: 8/23/2022
Clerk of the Board

APPROVED AS TO FORM:

_____ Date: 8/4/2022
Lassen County Counsel

COUNTY OF MODOC

By: _____ Date: _____
Chairman, Modoc County Board of Supervisors

ATTEST:

By: _____ Date: _____
Clerk of the Board

APPROVED AS TO FORM:

_____ Date: 8-4-2022
Modoc County Counsel

County of Modoc
Clerk of the Board

Modoc County is a collaborative community where people, families, government, and businesses, live, work, and thrive.

Tiffany Martinez
Clerk of the Board
204 South Court Street
Alturas, CA 96101
Phone: (530) 233-6201
email:
tiffanymartinez@co.modoc.ca.us
website: www.co.modoc.ca.us

August 31, 2022

Gaylon F. Norwood
Deputy Director
707 Nevada Street, Suite 5
Susanville, CA 96130-3912

RE: Big Valley GSP MOU

Mr. Norwood,

Enclosed is the signature page for the Big Valley GSP MOU that was adopted and signed by the Modoc County Board of Supervisors on August 23, 2022.

I have retained the copy sent to Modoc County from Lassen County to have one copy on file in Modoc County with original signatures.

Sincerely,

Tiffany Martinez
Clerk of the Board

RECEIVED

SEP 07 2022

LASSEN COUNTY DEPARTMENT OF
PLANNING AND BUILDING SERVICES

Signature
The parties here to have executed Amended and Restated Memorandum of Understanding as of the dates shown below.

The effective date of this MOU is the latest signature date affixed to this page. This MOU may be executed in multiple originals or counterparts. A complete original of this MOU shall be maintained in the records of each of the parties.

COUNTY OF LASSEN

By: _____ Date: _____
Chairman, Lassen County Board of Supervisors

ATTEST:

By: _____ Date: _____
Clerk of the Board

APPROVED AS TO FORM:

_____ Date: 8/4/2022
Lassen County Counsel

COUNTY OF MODOC

By: Geri Byrne Date: 8-23-2022
Chairman, Modoc County Board of Supervisors

ATTEST:

By: Tiffany L. Martinez Date: 8-23-2022
Clerk of the Board

APPROVED AS TO FORM:

_____ Date: 8-4-2022
Modoc County Counsel

Subject #2: Public Comments on GSP

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STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY GAVIN NEWSOM, GOVERNOR

CENTRAL VALLEY FLOOD PROTECTION BOARD
3310 El Camino Ave., Ste. 170
SACRAMENTO, CA 95821
(916) 574-0609 FAX: (916) 574-0682

April 22, 2022

Paul Gosselin, Deputy Director
Statewide Groundwater Management
California Department of Water Resources
1416 9th Street
Sacramento, CA 95814

Gaylon Norwood, Plan Manager
County of Lassen GSA
707 Nevada St, Ste 5
Susanville, CA 96130

Subject: Comments on Big Valley Basin Groundwater Sustainability Plan

Dear Mr. Gosselin and Mr. Norwood,

Thank you for the opportunity to comment on the Big Valley Basin Groundwater Sustainability Plan (GSP), which is a joint document prepared by two Groundwater Sustainability Agencies (GSAs).[1] The GSP describes how the GSAs will reach long term groundwater sustainability by outlining the need to reduce overdraft conditions and by identifying projects that may replace or supplement groundwater supplies to meet current and future water demands.

The Central Valley Flood Protection Board (Board) is the State's regulatory agency responsible for ensuring appropriate standards are met for the construction, maintenance, and operation of the flood control system that protects life, property, and habitat in California's Central Valley. The Board serves as the State coordinator between the local flood management agencies, and the federal government, with the goal of providing the highest level of flood protection possible to California's Central Valley.

Encroachment Permit

As required by California Code of Regulations, Title 23, Division 1 (Title 23), Section 6, approval by the Board is required for all proposed encroachments within a floodway, on adjacent levees, and within any Regulated Stream identified in Title 23, Table 8.1. Specifically, Board jurisdiction includes the levee section, the waterward area between project levees, a minimum 10-foot-wide strip adjacent to the landward levee toe, the area within 30 feet from the top of bank(s) of Regulated Streams, and inside Board's Designated Floodways. Activities

[1] The Big Valley Basin GSP was prepared by the following GSAs: Lassen County GSA and Modoc County GSA

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outside of these limits which could adversely affect Federal-State flood control facilities, as determined by Board staff, are also under Board's jurisdiction. Permits may also be required for existing unpermitted encroachments or where it is necessary to establish the conditions normally imposed by permitting, including where responsibility for the encroachment has not been clearly established or ownership or uses have been changed.

Some of the proposed projects identified in the GSP are within the Board's jurisdiction, thereby requiring Board approval. These projects include, but are not limited to, the additional stream gages and flow measurement project in the Research and Data Development Category. Please alert Board staff if you would like to schedule a pre-application meeting to discuss any of the projects in detail and/or to determine the documentation required to process an encroachment permit.

Federal permits, including U.S. Army Corps of Engineers (USACE) Section 404 and Section 10 regulatory permits and Section 408 Permission, in conjunction with a Board permit, may be required for the proposed projects. In addition to federal permits, state and local agency permits, certification, or approvals may also be required. State approvals may include, but are not limited to, California Department of Fish and Wildlife's Lake and Streamed Alteration Agreement and Regional Water Quality Control Board's Section 401 Water Quality Certification. The project proponent must obtain these authorizations.

Closing

The Board recognizes the importance of groundwater sustainability in California and commends the GSAs on their effort in planning for a more resilient future. However, the potential risks to public safety, including increased flood risks, need to be considered when developing proposed projects that seek to mitigate for unsustainable groundwater extraction. The Board seeks to establish a collaborative approach with GSAs to better fulfill our regulatory responsibilities in the new paradigm of SGMA. Board staff is available to discuss any project(s) proposed under the GSP as it relates to flood control works.

If you have any questions regarding these comments, please contact Ruth Darling at (916) 574-1417, or via email at Ruth.Darling@cvflood.ca.gov.

Sincerely,

Ruth Darling

Ruth Darling, Program Manager
Flood Planning and Programs Branch

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ec: Gaylon Norwood, Plan Manager
gnorwood@co.lassen.ca.us

Paul Gosselin, Deputy Director
Paul.Gosselin@water.ca.gov

Portal Submission: https://sgma.water.ca.gov/portal/gsp/comments/95

Comments for BV Groundwater Sustainability Plan

APR 23, 2022

Julie Rechtin, Adin, CA

I and several other community members were not on the Advisory Committee but still attended many of the BVAC meetings. Our goals were and are sustainable and diverse ecosystems and communities in this Basin. We believe we contributed more diverse viewpoints which the GAC and SGMAs could have used to make our Plan stronger and more representative of the Basin as a whole. As our comments often were brushed off or labeled as "data gaps," we hope that DWR or the five-year update will consider our concerns more fully.

I won't repeat those comments as they are mostly listed in the comment matrix. But I will supplement or addend due to further information.

My previous comments are listed under Julie Rechtin, Julie Retchin (mis-spelled), and probably 85% of the "Julie" comments. (There is at least one other "Julie" who made comments.)

Sec 3.4.1: Data gap: Adin wells

We community members in Adin see no movement to adequately inventory our wells. We reject the "substandard" characterization of most of our wells which allows them to be discounted or excluded from the well inventory. (One of my previous comments requests a definition of "standard" and the ramifications of having a substandard well; I did not get a satisfactory response.)

Several of us would like to compile a true inventory of *functioning* wells, including characteristics such as well depth, recorded water depths, sanitary seals, water quality (over time, as some become more mineralized as summer progresses each year or through the years,) jet pump vs submersible, etc. We don't believe the current data base of well drilling records fits our needs. We believe this more complete inventory could also be educational for our town as most people are only minimally aware of their well and pump characteristics. We would like to work with Modoc County and the well drillers to inform the well owners about their wells while also providing data for the Groundwater annual reports and 5-year update.

Lookout is just outside the basin boundary, but it also must be affected by lowering water tables. We would like to encourage something similar there.

Sec 5.6 including Fig 5-18: Interconnected surface water

Adin is unusual in that the groundwater levels have stayed quite stable over time and from spring to fall (as shown on the groundwater elevation maps and well 2851.) Three streams flow through Adin: Dry Creek (basically ephemeral,) Butte Creek (intermittent,) and Ash Creek (largest flow and perennial.) The low areas of town definitely are within the (recent history) floodplain of these creeks. (The deletion of Butte Creek from the potentially interconnected surface water in Fig 5-18 needs to be better researched on the ground.) Proximity to the first two creeks predicts a higher and more dependable water table, with some wells still using jet pumps, others shallowly-placed submersibles. There were even artesian wells in the past in Adin.

The Plan emphasizes that groundwater recharge should not deplete surface water streams. However, without this "depletion" from Ash Creek (with probably some Butte Creek contribution,) Adin likely would not have been established in the first place. I also previously have commented on the recharge probably already occurring and additional recharge possible within the Ash Creek Wildlife Area, as well as the GDEs which exist there as a result.

As a side note, although DWR does not include Round Valley in our groundwater basin, most of the residents understand how critical it and its Ash Creek watershed are to our town.

Sec 9.2.2: Line 2924: potential community water supply for the town of Adin.

I don't remember this Adin "replumbing" proposal being mentioned during any Advisory Committee meeting as a potential solution for the slow creep and possible future inadequate recharge of our Adin wells. No community member with whom I have discussed this, wants it. We have a sewer system. We have good water quality in most of our wells. Plumbing this town would be ferociously expensive and there is no need at this point. And we would like to keep it that way. If this is the justification for voluntary metering, residents won't sign up!

Sec 9.4.1: Forest treatments

The annual report (made available on 7 Apr 2022) reiterates Plan statements that recharge occurs quite quickly in this basin. This belief is based on groundwater level correlating with and precipitation through land and stream inflow into the basin. And that recharge allows the groundwater levels to recover from the groundwater pumping which obviously lowers the groundwater levels in much of the basin (difference between spring and fall levels) on an annual basis. This makes BVGB very fortunate, and watershed management critical.

Please see my previous comments on forest treatments, and comment above concerning Ash Creek watershed. I would like to add: The Cove and Stone fires and subsequent salvage/safety-related fuels treatments affected the Ash Creek watershed. (They also affected the Pit River, but with less impact given its much larger watershed.) The Gold Fire affected Ash, Butte, and Willow Creeks. Large areas burned severely, with increased and more intense run-off and resulting sedimentation. Not enough effort has been expended in slowing down the water and silt. Also, parts of the Cove and Stone fires (especially those which were previously plantations) are already converting to the Modoc version of chapparal: manzanita and Ceanothus, with attendant more frequent fire return interval. From a groundwater perspective, we need to look at the impact these fires and immediate treatments had on water quantity and timing, and utilize the recent Postfire Restoration Framework for National Forests in California (Government Technical Report PSW 270, published 2021) to guide these lands into the most achievable optimal future ecosystems.

Other parts of these watersheds have not burned recently...yet. But they will, and they will burn severely due to the longstanding fire deficit coupled with overstory thinning (either selective or removal) without adequate understory treatment, too-thick and brush-filled plantations, etc. Thinning only the overstory actually creates a higher fire risk as well as disturbing the soil/humus that can retain moisture into the dry season. The forest treatments mentioned in this section need to focus on

returning these ecosystems to a more resilient relationship with fire with much more emphasis on prescribed fire using (repeat, variable intensity) broadcast burning.

Thank you for the opportunity to comment.

Julie Rechtin

The Nature Conservancy

Union of Concerned Scientists
Science for a healthy planet and safer world

CIVICWELL
Transforming Local Vision into Action
Formerly Local Government Commission (LGC)

Audubon | CALIFORNIA

CLEAN WATER ACTION | CLEAN WATER FUND

April 23, 2022

Paul Gosselin
Deputy Director, Sustainable Groundwater Management Office
California Department of Water Resources
Sacramento, California
Submitted via SGMA GSP Portal

Re: Comments on the Big Valley Groundwater Sustainability Plan

Dear Deputy Director Gosselin,

On behalf of the above-listed organizations, we appreciate the opportunity to comment on the Groundwater Sustainability Plan (GSP) for the Big Valley Basin. Our organizations are deeply engaged in and committed to the successful implementation of the Sustainable Groundwater Management Act (SGMA) because we understand that groundwater is critical for the resilience of California's water portfolio, particularly in light of climate change. Our review focuses on how well drinking water users, disadvantaged communities, tribes, environment, stakeholder involvement, and climate change were addressed in the GSP.[1] Collectively, these issues are true indicators of sustainability. Because California's water and economy are interconnected, the sustainable management of each basin is of interest to both local communities and the state as a whole.

Under the requirements of SGMA, Groundwater Sustainability Agencies (GSAs) must consider the interests of all beneficial uses and users of groundwater, including domestic well owners, environmental users, surface water users, state and federal government, California Native American tribes, and

[1] Our organizations are non-tribal NGOs that are providing a review of the identification of federally and state recognized tribes (Data source: SGMA Data viewer) or other tribal interests identified within the GSP. We recognize that there are likely tribal interests that we are not able to detect through mapped lands and stated interests in the GSP. The lack of detection of tribal interests in our analysis should not be taken as evidence for a lack of tribal interests in a basin, but rather that our method could not identify tribal interests. We recommended during our review of draft GSPs that the GSA utilize the DWR's "Engagement with Tribal Governments" Guidance Document to comprehensively address these important beneficial users in their GSP.

disadvantaged communities (DACs).[2,3] As stakeholders, we reviewed all the draft and final versions of the 2022 GSPs. We appreciate that some basins have consulted us directly via focus groups, workshops, and working groups. Recognizing that GSPs are complicated and resource intensive to develop, we provided technical and policy relevant feedback on each of the 2022 draft GSPs directly to each GSA with the goal of supporting the improvement of GSPs prior to the submission of the final GSP to the California Department of Water Resources (DWR).

Our organizations evaluated the GSPs based on the following nine criteria:

1. Stakeholder engagement
2. Identification of DACs, domestic wells, and tribes
3. Identification of interconnected surface waters (ISWs)
4. Identification of groundwater dependent ecosystems (GDEs)
5. Incorporation of climate change in the water budget
6. Inclusion of ecosystems in the water budget
7. Consideration of impacts to DACs, drinking water users, and environmental users in the sustainable management criteria (SMC)
8. Identification and reconciliation of data gaps
9. Identification of potential impacts to beneficial users in the Projects and Management Actions

Our reviews did not assess the quality of the data provided in the GSP, but analyzed whether data were provided, what data sources were cited, how information about beneficial users of groundwater were used to develop the plan, and whether or not the GSP included plans to reconcile existing data gaps. In our review of the final GSPs, we have specifically looked to see whether the GSA responded to our comments on the draft GSP and whether corresponding edits were made in the final plan.[4]

Based on our evaluation, we found this plan to be **incomplete,** meaning that we found gaps in how beneficial users were addressed within our nine evaluation criteria. Based on this, we recommend that this plan be found incomplete and the GSA be given up to 180 days to address the missing components.

In general, we found the plan to have deficiencies in the following areas:

- DAC and environmental stakeholder engagement during the GSP development process
- Identification of DACs
- Identification of GDEs
- Identification of ISWs
- Inclusion of native vegetation in the water budget
- Consideration of DACs, drinking water users, and environmental users during the establishment of the sustainable management criteria
- Lack of a drinking water well impact mitigation program
- Representative monitoring well locations relative to key beneficial users

Our specific comments related to the GSP in the Big Valley Basin along with detailed recommendations are provided in **Attachment A.** Please refer to the enclosed list of attachments for additional technical recommendations:

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[2] "The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater" [Water Code 10723.2]

[3] "When evaluating whether a Plan is likely to achieve the sustainability goal for the basin, the Department shall consider the following: [...] (4) Whether the interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected by the use of groundwater in the basin, have been considered." [23 CCR § 355.4(b)(4)]

[4] "When evaluating whether a Plan is likely to achieve the sustainability goal for the basin, the Department shall consider the following: [...] (10) Whether the Agency has adequately responded to comments that raise credible technical or policy issues with the Plan." [23 CCR § 355.4(b)(10)]

Attachment A	GSP Specific Comments
Attachment B	Freshwater species located in the basin
Attachment C	Maps of representative monitoring sites in relation to key beneficial users

The success of SGMA - the sustainable management of groundwater for current and future social, economic, and environmental benefits - depends on the inclusion of *all* beneficial users in the development and implementation of GSPs. The degree to which key beneficial users are included in GSPs is a critical indicator of whether a plan is indeed on the path to sustainability. Sustainably managing our groundwater resources is critical to the long-term resilience of California's communities, economy, and environment.

We appreciate the opportunity to comment and are available to respond to any questions you might have.

Best Regards,

Ngodoo Atume
Water Policy Analyst
Clean Water Action/Clean Water Fund

J. Pablo Ortiz-Partida, Ph.D.
Bilingual Senior Climate and Water Scientist
Union of Concerned Scientists

Samantha Arthur
Working Lands Program Director
Audubon California

Roger Dickinson
Policy Director
CivicWell (formerly Local Government Commission)

E.J. Remson
Senior Project Director, California Water Program
The Nature Conservancy

Melissa M. Rohde
Groundwater Scientist
The Nature Conservancy

Attachment A

Specific Comments on the Big Valley Basin Final Groundwater Sustainability Plan

This attachment contains our findings for nine criteria used for the evaluation of the basin's draft and final GSP. Here, each of the nine criteria are separated into separate sections and contain a short description of our evaluation criteria and observations.

1. Stakeholder engagement
2. Identification of DACs, domestic wells, and tribes
3. Identification of interconnected surface waters (ISWs)
4. Identification of groundwater dependent ecosystems (GDEs)
5. Incorporation of climate change in the water budget
6. Inclusion of ecosystems in the water budget
7. Consideration of impacts to DACs, drinking water users, and environmental users in the sustainable management criteria (SMC)
8. Identification and reconciliation of data gaps
9. Identification of potential impacts to beneficial users in the Project and Management Actions

A table containing the original evaluation questions for each of the nine criteria are also included under the corresponding section. Within the table, there are a range of three possible answers based on how well the GSP satisfactorily answered the question. In the last column to the right of the table, we also indicate whether or not we saw improvements from the draft GSP for the corresponding question in the final GSP.

1. Stakeholder engagement

The SGMA statute requires that the GSP Notice and Communication chapter identify how stakeholders were actively engaged in the SGMA process.[5] Stakeholder engagement is critical for the GSAs to fully understand the specific interests and water demands of all beneficial users, and to support the identification and consideration of beneficial users in the development of sustainable management criteria and selection of projects and management actions. To evaluate this, we used the International Association of Public Participation (IAP2) spectrum of public participation referenced in DWR's "Stakeholder Communication and Engagement" guidance document.[6] To differentiate between engagement processes for various stakeholders, we considered participation activities that fell under the inform, consult, involve, collaborate, or empower categories. A "Yes" score was given to plans where GSAs proactively identified and targeted outreach to stakeholders to invite stakeholder perspectives into the GSP development process, such as through working groups, advisory committees and GSA board seats. While a "Somewhat" score was given to plans where GSAs had public meetings, email notifications list and public comment process. A "No" score was given to plans where the GSAs failed to identify and engage stakeholders.

However, it is important to note here that it is nearly impossible through reading the plans to decipher whether stakeholder voices are being heard and empowered via these processes. To assess actual engagement, local stakeholders would need to be directly consulted to share their feedback, which was not possible for us to assess during our evaluation of the 2022 GSPs. The expectation is that robust stakeholder engagement includes active and targeted outreach to ensure that stakeholder concerns are consistently understood and stakeholder feedback is incorporated in the decision making process. Because our evaluation of stakeholder engagement across the 2022 GSPs is limited to what is presented in the GSP text, it is possible that despite stakeholders being represented on a GSA board or advisory group that stakeholder feedback was not fully considered and incorporated into the GSP. When stakeholders are considered and empowered in the GSP development process, we would expect to see stakeholder interests adequately reflected throughout the plan.

Table 1 provides a list of questions we used to evaluate how stakeholder engagement was documented in the GSP for key stakeholders, such as DACs, tribes, and the environment. The GSP satisfactorily answered three of seven questions for this criteria. While the GSP documents challenges with conducting outreach to DAC stakeholders during the COVID-19 pandemic and lack of resources, recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 1. Questions used to evaluate stakeholder engagement in the GSP.

Does the GSP engage stakeholders?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP document how DAC stakeholders were given opportunities to engage in the GSP development process?		Inform OR consult		No Change
Does the GSP document how tribal stakeholders were given opportunities to engage in the GSP development process?			Involve, collaborate, OR empower	Draft Sufficient
Does the GSP document how environmental stakeholders were given opportunities to engage in the GSP development process?		Inform OR consult		No Change
Does the Stakeholder Communication and Engagement Plan or GSP include outreach to DACs during GSP implementation?		Inform OR consult		No Change

[5] "A communication section of the Plan shall include a requirement that the GSP identify how it encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin." [23 CCR §354.10(d)(3)]

[5] California Department of Water Resources. 2018. Guidance Document for Groundwater Sustainability Plan: Stakeholder Communication and Engagement. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Assistance-and-Engagement/Files/Guidance-Doc-for-GSP---Stakeholder-Communication-and-Engagement.pdf

Does the Stakeholder Communication and Engagement Plan or GSP include outreach to tribes during GSP implementation?			Involve, collaborate, OR empower	**Draft Sufficient**
Does the Stakeholder Communication and Engagement Plan or GSP include outreach to environmental stakeholders during GSP implementation?		Inform OR consult		**No Change**
Does the GSP include a Stakeholder Communication and Engagement Plan?			Included	**Draft Sufficient**

RECOMMENDATIONS

- In the Notice and Communication chapter, describe active and targeted outreach to engage all stakeholders throughout the GSP development and implementation phases. Refer to "Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation" for specific recommendations on how to actively engage stakeholders during all phases of the GSP process. While some of these resources have already been stated in the GSP, we recommend that the GSAs should improve utilization of these resources and documentation of the engagement process.[7]
- Provide documentation on how stakeholder input was incorporated into the GSP development process.
- Utilize DWR's tribal engagement guidance to comprehensively identify, involve, and address all tribes and tribal interests that may be present in the basin.[8]

[7] Collaborating for Success: Stakeholder Engagement for Sustainable Groundwater Management Act Implementation. Available at: https://static1.squarespace.com/static/5e83c5f78f0db40cb837cfb5/t/5f3ca8c136dbe60157dd5664/1597810892937/SGMA_Stakeholder_Engagement_White_Paper.pdf

[8] Engagement with Tribal Governments Guidance Document. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/Guidance-Doc-for-SGM-Engagement-with-Tribal-Govt_ay_19.pdf

2. Identification of DACs, domestic wells, and tribes

The consideration of beneficial uses and users in GSP development is contingent upon adequate identification of *all* beneficial users, including DACs, domestic wells, and tribes.[1,2] Table 2 provides a list of questions we used to evaluate how these beneficial users were identified in the GSP. These elements are critical for the GSA to fully understand the specific interests and water demands of these beneficial users, and to support their consideration in the development of sustainable management criteria and selection of projects and management actions.

In our review of the identification of DACs, domestic wells, and tribes, we found that the GSP did not map DACs in the basin or explicitly state the population of DACs in the basin. The GSP does not explicitly identify the water source for DACs. The GSP states that the entire basin is considered a DAC, however we recommend that the GSP provide a map identifying DAC blocks, tracts, or places.

Table 2 shows the GSP satisfactorily answered three of six questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 2. Questions used to evaluate the identification of DACs, domestic wells, and tribes in the GSP.

Does the GSP identify DACs, domestic wells, and tribes?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP identify each **DAC** by name and location on a map?	Neither mapped NOR identified by name in text	Mapped OR identified by name in text	Mapped AND identified by name in text	**No Change**
Are **tribal lands** identified and mapped in the basin?	Neither mapped NOR identified in text	Mapped OR identified in text	Mapped AND identified in text	**Draft Sufficient**
Does the GSP describe the size of the population in each **DAC**?	Not included	Vaguely mentioned or mapped	Explicitly mentioned or mapped	**No Change**
Does the GSP map minimum well depth, or depth range of **domestic wells**?	Neither mapped NOR depth ranges included	Map OR depth ranges included	Map AND depth ranges included	**Draft Sufficient**
Does the GSP map the density of **domestic wells** in the basin?	Not included		Included	**Draft Sufficient**
Does the GSP identify the water source for **DACs**?	Not identified	Only general reference	Explicit identification	**No Change**

RECOMMENDATIONS

- Provide a map of the locations of DACs within the basin and provide the population of each identified DAC. Identify the sources of drinking water for DAC members, including an estimate of how many people rely on groundwater (e.g., domestic wells, state small water systems, and public water systems).

3. Identification of interconnected surface waters

SGMA requires that the GSP identify ISWs in the basin, including estimates of the quantity and timing of depletions.[9] Table 3 provides a list of questions we used to evaluate how well ISWs were identified in the GSP. The complete analysis of ISWs requires mapping of gaining and losing reaches and assessing the temporal variability in stream depletions to account for the inherent variability within California's Mediterranean climate. Since this relies upon seasonal and multiple water years of data, the GSP should discuss the spatial and temporal gaps in data needed to adequately characterize the interaction between groundwater and surface water within the basin. In the absence of data, the GSP should not exclude any segments with data gaps from the ISW map and instead consider and map them explicitly as potential ISWs until data gaps are reconciled. The absence of evidence is not the evidence of absence.

In our review of the identification of interconnected surface waters, we found that the GSP did not provide supporting information for the ISW analysis. To assess ISWs, the GSP assumes streams to be interconnected where the depth to water is less than 15 feet below ground surface, based on spring 2015 contours. However, it is common practice to utilize deeper thresholds, such as 50 feet below groundwater surface, to indicate a disconnected stream reach.[10,11] Furthermore, using seasonal groundwater elevation data over multiple water year types is an essential component of identifying ISWs. Using depth-to-groundwater contours from one point in time, especially from the height of a historic drought, is not sufficient evidence to state that reaches are not connected to groundwater. In California's Mediterranean climate, groundwater interconnections with surface water can vary seasonally and interannually, and that natural variability needs to be considered when identifying ISWs.

Table 3 shows the GSP satisfactorily answered one of five questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 3. Questions used to evaluate the identification of ISWs in the GSP.

Does the GSP identify interconnected surface water (ISW)?	No	Somewhat	Yes	Draft vs. Final GSP
Are gaining and losing reaches adequately assessed spatially and temporally?		ISW map with single water year data; unclear methods		No Change
Are the conclusions of ISWs consistent with the assessment?	Vague and contradictory with analysis OR No evidence to support conclusion.			No Change
Are all shallow principal aquifers acknowledged in defining ISW?			Acknowledged	Draft Sufficient
Were data gaps identified when mapping ISWs?		Vague description		No Change
In the case of data gaps and uncertainty, were streams mapped and described as potential ISWs in the GSP?		Vague description OR no map		No Change

[9] "Each plan shall provide a description of current and historic groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes [...] (f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information." [23 CCR § 354.16(f)]

[10] Jasechko, S. et al. 2021. Widespread potential loss of streamflow into underlying aquifers across the USA. Nature, 591: 391-395. doi: https://doi.org/10.1038/s41586-021-03311-x

[11] The Nature Conservancy. 2021. ICONS Tool. Available at: https://icons.codefornature.org/

RECOMMENDATIONS

- Use a deeper depth threshold, such as 50 feet, to determine which stream reaches in the basin are potentially interconnected with groundwater.
- Use seasonal data over multiple water year types to capture the variability in environmental conditions inherent in California's climate, when mapping ISWs. We recommend the 10-year pre-SGMA baseline period of 2005 to 2015.
- Provide depth-to-groundwater contour maps using the best practices presented in The Nature Conservancy's "Identifying GDEs under SGMA: Best Practices for using the NC Dataset" to aid in the determination of ISWs.[12] Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a digital elevation model (DEM) to estimate depth-to-groundwater contours across the landscape. This will provide accurate contours of depth-to-groundwater along streams and other land surface depressions where GDEs are commonly found.
- On the map of stream reaches in the basin (Figure 5-18), consider any segments with data gaps as potential ISWs and clearly mark them as such. Reconcile ISW data gaps with specific measures (shallow monitoring wells, stream gauges, and nested/clustered wells) along surface water features in the Monitoring Network section of the GSP.

[12] The Nature Conservancy's "Identifying GDEs under SGMA: Best Practices for using the NC Dataset." Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/TNC_NCdataset_BestPracticesGuide_2019.pdf

4. Identification of groundwater dependent ecosystems

SGMA requires that GDEs be identified in the GSP.[13,14] Table 4 provides a list of questions we used to evaluate how these beneficial users were identified in the GSP. These elements are critical for the GSA to fully understand the specific interests and water demands of these beneficial users, and to support their consideration in the development of sustainable management criteria and selection of projects and management actions.

In our review of the identification of GDEs, we found that the GSP used groundwater data from one point in time (fall 2015) to characterize groundwater conditions supporting the basin's GDEs. We recommend using groundwater data from multiple seasons and water year types to determine the range of depth to groundwater around NC dataset polygons. Using seasonal groundwater elevation data over multiple water year types is an essential component of identifying GDEs and is necessary to capture the variability in groundwater conditions inherent in California's Mediterranean climate.

Furthermore, the GSP does not provide an inventory of the flora or fauna species present in the basin's GDEs, except to present the common plant species and their rooting depths. The GSP does not acknowledge endangered, threatened, or special status species in the basin.

Table 4 shows the GSP satisfactorily answered two of eight questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 4. Questions used to evaluate the identification of GDEs in the GSP.

Does the GSP identify groundwater dependent ecosystems (GDEs)?	No	Somewhat	Yes	Draft vs. Final GSP
Is there an inventory, map, or description of fauna (e.g., birds, fish, amphibian) and flora (e.g., plants) species or habitat types in the basin's GDEs? Please indicate in the notes if threatened and endangered species are identified in the GSP.		Some details lacking on flora, fauna OR threatened or endangered species		No Change
Were GDEs in the basin identified (mapped) and described in the GSP using best available data (e.g., NC dataset, localized VegMap data)?			GDE map included with best available data	Draft Sufficient
Was depth-to-groundwater data from the underlying principal aquifer used to verify the NC dataset?		Incorporated, but unclear spatial or temporal data		No Change
Did the GSP avoid using any of the following criteria when deciding whether or not to remove NC dataset polygons from the final GDE map: 1) presence of surface water, 2) distance from agricultural fields, 3) shallow principal aquifer was not considered main pumping aquifer, 4) groundwater connection only some percentage of the time, 5) other?			Yes	Draft Sufficient
Were multiple water year types (e.g., wet, average, dry) of groundwater level data used to characterize groundwater conditions in the GDEs?	No			No Change
Were depth-to-groundwater measurements under GDEs corrected for land surface elevations?	No			No Change
Were data gaps identified when mapping GDEs?		Data gaps described vaguely		No Change

[13] "Each plan shall provide a description of current and historic groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes [... (g)] Identification of GDEs within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information." [23 CCR § 354.16(g)]

[14] Refer to Attachment B for a list of freshwater species located in the basin.

In the case of data gaps and uncertainty, were potential GDEs mapped and described in the GSP?		No map OR vague description		No Change

RECOMMENDATIONS

- Use depth-to-groundwater data from multiple seasons and water year types (e.g., wet, dry, average, drought) to determine the range of depth to groundwater around NC dataset polygons. We recommend that a baseline period (10 years from 2005 to 2015) be established to characterize groundwater conditions over multiple water year types. Refer to best practices for using local groundwater data to verify whether polygons in the NC Dataset are supported by groundwater in an aquifer.[12]
- Provide depth-to-groundwater contour maps, noting best practices.[12] Specifically, ensure that the first step is contouring groundwater elevations, and then subtracting this layer from land surface elevations from a DEM to estimate depth-to-groundwater contours across the landscape. Map the location of groundwater wells on the contour maps to illustrate monitoring locations in relation to GDEs.
- If insufficient data are available to describe groundwater conditions within or near polygons from the NC dataset, include those polygons as "Potential GDEs" in the GSP until data gaps are reconciled in the monitoring network.
- Include an inventory of the fauna and flora present within the basin's GDEs (see Attachment B of this letter for a list of freshwater species located in the Big Valley Basin). Note any threatened or endangered species.
- For more information on shallow groundwater conditions in the basin, refer to The Nature Conservancy's new tool, "SAGE: Shallow Groundwater Estimation Tool", which uses machine learning and 35 years of satellite data to predict depth to groundwater and determine groundwater level trends for every polygon within the NC Dataset.[15,16]

[15] Webtool available at: https://gde-work.earthengine.app/view/sage

[16] Rohde, M.M., T. Biswas, I.W. Housman, L.S. Campbell, K.R. Klausmeyer, J.K. Howard. 2021. A machine learning approach to predict groundwater levels in California reveals ecosystems at risk. *Frontiers in Earth Science*, doi: 10.3389/feart.2021.784499. Available at: https://www.frontiersin.org/articles/10.3389/feart.2021.784499/full

5. Incorporation of climate change in the water budget

The SGMA statute identifies climate change as a significant threat to groundwater resources and one that must be examined and incorporated in the GSPs. The GSP Regulations require integration of climate change into the projected water budget to ensure that projects and management actions sufficiently account for the range of potential climate futures.[17]

In our review of climate change in the projected water budget, we found that the GSP did incorporate climate change into the projected water budget using DWR change factors for 2070. However, the GSP did not consider multiple climate scenarios (such as the 2070 wet and 2070 extremely dry climate scenarios) in the projected water budget. The GSP would benefit from clearly and transparently incorporating the extremely wet and dry scenarios provided by DWR into projected water budgets or selecting more appropriate extreme scenarios for the basin. While these extreme scenarios may have a lower likelihood of occurring and their consideration is only suggested by DWR, their consequences could be significant and their inclusion can help identify important vulnerabilities in the basin's approach to groundwater management.

Furthermore, the GSP does not calculate a sustainable yield based on the projected water budget with climate change incorporated.

Table 5 shows the GSP satisfactorily answered four of six relevant questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 5. Questions used to evaluate whether the GSP accounted for climate change.

Does the GSP account for climate change in the water budget?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP incorporate climate change into the projected water budget using DWR change factors or other source?			Yes	Draft Sufficient
Does the GSP consider multiple climate scenarios (e.g., the 2070 wet and 2070 extremely dry) scenarios in the projected water budget?	No			No Change
Does the GSP incorporate climate change into precipitation inputs for the projected water budget?			Yes	Draft Sufficient
Does the GSP incorporate climate change into evapotranspiration inputs for the projected water budget?			Yes	Draft Sufficient
Does the GSP incorporate climate change into surface water flow inputs (e.g., imported water, streamflow) for the projected water budget?			Yes	Draft Sufficient
Does the GSP incorporate climate change into sea level inputs for the projected water budget?				Not Applicable
Does the GSP calculate a sustainable yield based on the projected water budget with climate change incorporated?	No			No Change

[17] "Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow." [23 CCR §354.18(e)]

RECOMMENDATIONS

- Integrate climate change, including extreme climate scenarios, into all elements of the projected water budget to form the basis for development of sustainable management criteria and projects and management actions
- Calculate sustainable yield based on the projected water budget with climate change incorporated.
- Incorporate climate change scenarios into projects and management actions.

6. Inclusion of ecosystems in the water budget

Native vegetation and managed wetlands are water use sectors that are required to be included into the water budget.[18,19] Based on our review, we found native vegetation was improperly omitted in the historical, current, and projected water budgets. The Final GSP does not state whether there are managed wetlands present in the basin.

Table 6 shows the GSP did not satisfactorily answer the only relevant question for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 6. Questions used to evaluate whether the GSP accounted for ecosystems in the water budget.

Does the GSP account for ecosystems in the water budget?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP include water demands for **native vegetation** in the historic, current, and projected water budgets?		Vague description		**No Change**
Does the GSP include water demands for **managed wetlands** in the historic, current, and projected water budgets?				**Not Applicable**

RECOMMENDATIONS

- Quantify and present all water use sector demands in the historical, current, and projected water budgets with individual line items for each water use sector, including native vegetation.
- State whether or not there are managed wetlands in the basin. If there are, ensure that their groundwater demands are included as separate line items in the historical, current, and projected water budgets.

[18] "'Water use sector' refers to categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation." [23 CCR §351(al)]

[19] "The water budget shall quantify the following, either through direct measurements or estimates based on data: (3) Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow." [23 CCR §354.18]

7. Consideration of impacts to DACs, drinking water users, and environmental users in the sustainable management criteria?

The consideration of potential impacts on *all* beneficial users of groundwater in the basin are required when defining undesirable results and establishing minimum thresholds.[20,21,22] Table 7 provides a list of questions we used to evaluate the consideration of DACs, drinking water users, and environmental users in the sustainable management criteria of the GSP. Adequate consideration of potential impacts on these beneficial users is contingent upon adequate identification and engagement of the appropriate stakeholders, and is essential for ensuring the GSP integrates existing state policies on the Human Right to Water and the Public Trust Doctrine.[23]

SGMA requires that the sustainable management criteria be consistent with the Human Right to Water policy and avoid significant and unreasonable impacts on drinking water users. The GSP should describe direct and indirect impacts on DACs and drinking water users when defining undesirable results and minimum thresholds for chronic lowering of groundwater levels and degraded water quality.

Disadvantaged Communities (DACs)

The GSP does not provide an analysis of the direct or indirect impacts on DACs when defining undesirable results. In addition, the GSP does not provide an analysis of the impacts of the proposed minimum thresholds nor measurable objectives for the groundwater elevation nor water quality sustainability indicators. This is particularly concerning given the absence of a drinking water well mitigation plan in the GSP.

Drinking Water Users

The GSP does not provide an analysis of the direct or indirect impacts on drinking water users when defining undesirable results. In addition, the GSP does not provide an analysis of the impacts of the proposed minimum thresholds nor measurable objectives for the groundwater elevation nor water quality sustainability indicators. This is particularly concerning given the absence of a drinking water well mitigation plan in the GSP.

SGMA specifically requires that GSPs include "impacts on groundwater dependent ecosystems" and to assess whether surface water depletions caused by groundwater use are having an adverse impact on beneficial users of surface water and groundwater.[24,25,26] The GSP should describe direct and indirect impacts on GDEs and instream habitats within ISWs when defining undesirable results and minimum thresholds for chronic lowering of groundwater levels, degraded water quality, and depletion of interconnected surface water.

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[20] "The description of undesirable results shall include [...] potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results." [23 CCR §354.26(b)(3)]

[21] "The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[22] "The description of minimum thresholds shall include [...] how state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the agency shall explain the nature of and the basis for the difference." [23 CCR §354.28(b)(5)]

[23] "The Department shall consider the state policy regarding the human right to water when implementing these regulations." [23 CCR §350.4(g)]

[24] "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results." [23 CCR §354.28(c)(6)]

[25] "The description of minimum thresholds shall include the following: [...] (4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[26] Water Code §10727.4(l)

Environmental Users

The GSP does not provide an analysis of the direct or indirect impacts on GDEs and environmental beneficial users of surface water when defining undesirable results. In addition, the GSP does not provide an analysis of the impacts of the proposed minimum thresholds nor measurable objectives for the groundwater elevation, water quality, nor depletion of surface water sustainability indicators.

Table 7 shows the GSP satisfactorily answered none of the eleven questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 7. Questions used to evaluate the consideration of DACs, drinking water users, and environmental users in the sustainable management criteria of the GSP.

Does the GSP consider impacts to DACs, drinking water users, and GDEs in the sustainable management criteria?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP analyze direct or indirect impacts on **domestic drinking wells** when defining Undesirable Results?		Mentioned, but not well analyzed		**No Change**
Does the GSP analyze direct and indirect impacts on **DACs** when defining Undesirable Results?	No mention			**No Change**
Does the GSP analyze direct and indirect impacts on **GDEs** when defining Undesirable Results?	No mention			**No Change**
Does the GSP evaluate the cumulative or indirect impacts of proposed groundwater elevation and water quality minimum thresholds on **drinking water users (e.g., domestic wells, municipal water suppliers)**?	No mention			**No Change**
Does the GSP evaluate the cumulative or indirect impacts of proposed groundwater elevation and water quality minimum thresholds on **DACs**?	No mention			**No Change**
Does the GSP evaluate the cumulative or indirect impacts of proposed minimum thresholds for groundwater elevations and ISW on **GDEs or environmental beneficial users of surface water**?	No mention			**No Change**
Does the GSP establish Water Quality minimum thresholds and measurable objectives for the identified constituents/contaminants identified in the plan area?	No			**No Change**
Are Water Quality minimum thresholds based on or within the Maximum Contaminant levels (MCLs)?	No			**No Change**
Does the GSP consider **drinking water users** when establishing water quality and groundwater elevation measurable objectives?	No mention			**No Change**
Does the GSP consider **DACs** when establishing water quality and groundwater elevation measurable objectives?	No mention			**No Change**
Does the GSP consider **GDEs** when establishing ISW and groundwater elevation measurable objectives?	No mention			**No Change**

RECOMMENDATIONS

- Describe direct and indirect impacts on drinking water users and DACs when describing undesirable results and defining minimum thresholds for chronic lowering of groundwater levels. Include information on the impacts during prolonged periods of below average water years.
- Consider and evaluate the impacts of selected minimum thresholds and measurable objectives on drinking water users and DACs within the basin. Further describe the impact of passing the minimum threshold for these users. For example, provide the number of domestic wells that would be fully or partially de-watered at the minimum threshold.
- Consider minimum threshold exceedances during drought years when defining the groundwater level undesirable result across the basin.
- Establish water quality SMC. Set minimum thresholds and measurable objectives for all water quality constituents within the basin that can be impacted and/or exacerbated as a result of groundwater use or groundwater management.
- Describe direct and indirect impacts on drinking water users and DACs when defining undesirable results for degraded water quality.[27] For specific guidance on how to consider these users, refer to "Guide to Protecting Water Quality Under the Sustainable Groundwater Management Act."[28]
- Evaluate the cumulative or indirect impacts of proposed minimum thresholds for degraded water quality on drinking water users and DACs.
- When establishing SMC for the basin, consider that the SGMA statute [Water Code §10727.4(l)] specifically calls out that GSPs shall include "impacts on groundwater dependent ecosystems."
- When defining undesirable results for chronic lowering of groundwater levels, provide specifics on what biological responses (e.g., extent of habitat, growth, recruitment rates) would best characterize a significant and unreasonable impact to GDEs. Undesirable results to environmental users occur when 'significant and unreasonable' effects on beneficial users are caused by one of the sustainability indicators (i.e., chronic lowering of groundwater levels, degraded water quality, or depletion of interconnected surface water). Thus, potential impacts on environmental beneficial uses and users need to be considered when defining undesirable

[27] "Degraded Water Quality [...] collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues." [23 CCR §354.34(c)(4)]

[28] Guide to Protecting Water Quality under the Sustainable Groundwater Management Act https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1559328858/Guide_to_Protecting_Drinking_Water_Quality_Under_the_Sustainable_Groundwater_Management_Act.pdf?1559328858

results in the basin.[29] Defining undesirable results is the crucial first step before the minimum thresholds can be determined.[30]

- When defining undesirable results for depletion of interconnected surface water, include a description of potential impacts on instream habitats within ISWs when minimum thresholds in the basin are reached.[31] The GSP should confirm that minimum thresholds for ISWs avoid adverse impacts on environmental beneficial users of interconnected surface waters as these environmental users could be left unprotected by the GSP. These recommendations apply especially to environmental beneficial users that are already protected under pre-existing state or federal law.[20,32]

- To identify beneficial users in the basin that may be at risk to groundwater level declines, refer to The Nature Conservancy's new tool, "SAGE: Shallow Groundwater Estimation Tool", which uses machine learning and 35 years of satellite data to predict depth to groundwater for each polygon within the NC Dataset.[33,34]

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[29] "The description of undesirable results shall include [...] potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results". [23 CCR §354.26(b)(3)]

[30] The description of minimum thresholds shall include [...] how minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests." [23 CCR §354.28(b)(4)]

[31] "The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results." [23 CCR §354.28(c)(6)]

[32] Rohde MM, Seapy B, Rogers R, Castañeda X, editors. 2019. Critical Species LookBook: A compendium of California's threatened and endangered species for sustainable groundwater management. The Nature Conservancy, San Francisco, California. Available at: https://groundwaterresourcehub.org/public/uploads/pdfs/Critical_Species_LookBook_91819.pdf

[33] Webtool available at: https://igde-work.earthengine.app/view/sage

[34] Rohde, M.M., T. Biswas, I.W. Housman, L.S. Campbell, K.R. Klausmeyer, J.K. Howard. 2021. A machine learning approach to predict groundwater levels in California reveals ecosystems at risk. *Frontiers in Earth Science*, doi: 10.3389/feart.2021.784499. Available at: https://www.frontiersin.org/articles/10.3389/feart.2021.784499/full

8. Identification and reconciliation of data gaps

Adaptive Management is at the core of SGMA. SGMA also requires that impacts to beneficial uses or users of groundwater be monitored.[35] Beneficial users may remain unprotected by the GSP without adequate monitoring. When data gaps are not identified, particularly in shallow aquifers, impacts disproportionately threaten GDEs, aquatic habitats, and shallow domestic well water users. In addition to monitoring wells, biological monitoring is an important component to ensure impacts to GDEs do not occur.[14] Table 8 provides a list of questions we used to evaluate whether the GSP identified data gaps in the monitoring network and made plans to reconcile them. In many cases, GSPs did not provide adequate mapping to clearly convey whether current and proposed monitoring well locations sufficiently monitored groundwater conditions for key beneficial users. For this reason, we created a set of maps (provided in Attachment C) that we included in the draft GSP comment letters to help us evaluate the questions in Table 8.

In our review, we found that the GSP did not identify and reconcile data gaps for some beneficial users in the basin. Table 8 shows the GSP satisfactorily answered none of the four questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 8. Questions used to evaluate whether the GSP identified data gaps and made plans to reconcile them.

Does the GSP identify and reconcile data gaps?	No	Somewhat	Yes	Draft vs. Final GSP
Do the Representative Monitoring Sites (RMS) in the monitoring network adequately represent water quality conditions around **DACs, domestic wells, tribes, and GDEs** (in the case of data gaps, evaluate proposed monitoring sites)?	Not present within DAC, domestic well, tribal areas, NOR GDEs.			**No Change**
Do the Representative Monitoring Sites (RMS) in the monitoring network adequately represent shallow groundwater elevations around **DACs, domestic wells, tribes, and GDEs** (in the case of data gaps, evaluate proposed monitoring sites).		Not adequately cover DAC, domestic well, tribal areas, OR GDEs.		**No Change**
Does the GSP include a plan to identify and fill shallow monitoring well data gaps around **GDEs** and **ISWs** in the monitoring network?	No			**No Change**
Does the GSP include any plans to incorporate **GDE**-related biological monitoring into the monitoring network?	No			**No Change**

RECOMMENDATIONS

- Provide maps that overlay current and proposed monitoring well locations with the locations of DACs, domestic wells, and GDEs to clearly identify monitored areas.
- Increase the number of representative monitoring sites (RMSs) in the shallow aquifer across the basin as needed to map ISWs and adequately monitor all groundwater condition indicators across the basin and at appropriate depths for *all* beneficial users. Prioritize proximity to DACs, domestic wells, GDEs, and ISWs when identifying new RMSs.

[35] "The monitoring network objectives shall be implemented to accomplish the following: [...] (2) Monitor impacts to the beneficial uses or users of groundwater." [23 CCR §354.34(b)(2)]

- Ensure groundwater elevation and water quality RMSs are monitoring groundwater conditions spatially and at the correct depth for *all* beneficial users - especially DACs, domestic wells, and GDEs.
- Describe biological monitoring that can be used to assess the potential for significant and unreasonable impacts to GDEs or ISWs due to groundwater conditions in the basin.
- Prioritize the installation of new wells around beneficial uses most susceptible to groundwater decline by referring to The Nature Conservancy's new tool, "SAGE: Shallow Groundwater Estimation Tool", which uses machine learning and 35 years of satellite data to predict depth to groundwater for each polygon within the NC Dataset.[36,37]

[36] Webtool available at: https://igde-work.earthengine.app/view/sage
[37] Rohde, M.M., T. Biswas, I.W. Housman, L.S. Campbell, K.R. Klausmeyer, J.K. Howard. 2021. A machine learning approach to predict groundwater levels in California reveals ecosystems at risk. *Frontiers in Earth Science*, doi: 10.3389/feart.2021.784499. Available at: https://www.frontiersin.org/articles/10.3389/feart.2021.784499/full

9. Identification of potential impacts to beneficial users in the Project and Management Actions

Project and Management Actions are essential for ensuring the basin stays within or achieves its sustainable yield and avoids undesirable results for *all* beneficial users in the basin. Therefore, it is important that the GSP identifies benefits or impacts of project and management actions to key beneficial users. Table 9 provides a list of questions we used to evaluate whether benefits and potential impacts to beneficial users were identified in the GSP's Project and Management Actions. While not all projects and management actions are applicable to every basin, the GSP should include benefits and evaluate impacts to vulnerable beneficial users in all planned projects and management actions, and include a drinking water well mitigation program to protect drinking water. We assessed whether or not the projects had specific plans (such as a timeline and funding) in place during the GSP planning horizon, or whether it was described as a potential future project.

Table 9 shows the GSP satisfactorily answered three of six questions for this criteria. Recommendations from our Draft GSP comment letter that have not been addressed in the Final GSP are listed below.

Table 9. Questions used to evaluate whether potential impacts to beneficial users were identified in the GSP's Project and Management Actions.

Does the GSP identify potential impacts to beneficial users in the Project and Management Actions?	No	Somewhat	Yes	Draft vs. Final GSP
Does the GSP include any recharge projects with explicit benefits to the **environment?**			Yes	**Draft Sufficient**
Does the GSP include any habitat or stream restoration or invasive species removal projects (e.g., to improve water supply in the basin or **GDE** habitats)?			Yes	**Draft Sufficient**
Does the GSP identify benefits or impacts of identified projects and management actions to key beneficial users such as **GDEs, drinking water users, tribes, DACs?**			Yes	**Draft Sufficient**
Does the GSP include any recharge projects with explicit benefits to **DACs?**	No			**No Change**
Does the GSP include a drinking water well mitigation program to avoid significant and unreasonable loss of **drinking water?**	No			**No Change**
Does the GSP identify potential impacts to water quality from Projects and Management Actions?		Vague description or listed as potential project		**No Change**

RECOMMENDATIONS

- For DACs and domestic well owners, include a drinking water well impact mitigation program to proactively monitor and protect drinking water wells through GSP implementation. Refer to "Framework for a Drinking Water Well Impact Mitigation Program" for specific recommendations on how to implement a drinking water well mitigation program.[38]

[38] Framework for a Drinking Water Well Impact Mitigation Program. Available at: https://static1.squarespace.com/static/5e83c5f78f0db40cb837cfb5/t/5f3ca9389712b732279e5296/1597811008129/Well_Mitigation_English.pdf

- For DACs and domestic well owners, include a discussion of whether potential impacts to water quality from projects and management actions could occur and how the GSAs plan to mitigate such impacts.
- Develop management actions that incorporate climate and water delivery uncertainties to address future water demand and prevent future undesirable results.

Attachment B

Freshwater Species Located in the Big Valley Basin

To assist in identifying the beneficial users of surface water necessary to assess the undesirable result "depletion of interconnected surface waters", Attachment C provides a list of freshwater species located in the Big Valley Basin. To produce the freshwater species list, we used ArcGIS to select features within the California Freshwater Species Database version 2.0.9 within the basin boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[1]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[2] as well as on The Nature Conservancy's science website[3].

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Grus canadensis tabida	Greater Sandhill Crane		Threatened	
Actitis macularius	Spotted Sandpiper			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus occidentalis	Western Grebe			
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		Special Concern	BSSC - Third priority

[1] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710

[2] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS

[3] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species-database

Aythya collaris	Ring-necked Duck			
Aythya marila	Greater Scaup			
Aythya valisineria	Canvasback		Special	
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chlidonias niger	Black Tern		Special Concern	BSSC - Second priority
Chroicocephalus philadelphia	Bonaparte's Gull			
Cistothorus palustris palustris	Marsh Wren			
Cygnus columbianus	Tundra Swan			
Egretta thula	Snowy Egret			
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Gallinula chloropus	Common Moorhen			
Grus canadensis	Sandhill Crane			
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Himantopus mexicanus	Black-necked Stilt			
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Numenius americanus	Long-billed Curlew			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			

Phalaropus tricolor	Wilson's Phalarope			
Plegadis chihi	White-faced Ibis		Watch list	
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
Calasellus californicus	An Isopod		Special	
Cambaridae fam.	Cambaridae fam.			
Cyprididae fam.	Cyprididae fam.			
Hyalella azteca	An Amphipod			
Hyalella spp.	Hyalella spp.			
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Dicamptodon ensatus	California Giant Salamander			ARSSC
Dicamptodon tenebrosus	Pacific Giant Salamander			
Lithobates pipiens	Northern Leopard Frog		Special Concern	ARSSC
Rana boylii	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Taricha granulosa	Rough-skinned Newt			
Taricha rivularis	Red-bellied Newt			ARSSC
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis couchii	Sierra Gartersnake			
Thamnophis sirtalis sirtalis	Common Gartersnake			

Pseudacris regilla	Northern Pacific Chorus Frog			
Thamnophis elegans elegans	Mountain Gartersnake			Not on any status lists
INSECTS & OTHER INVERTS				
Dubiraphia brunnescens	Brownish Dubiraphian Riffle Beetle		Special	
Ablabesmyia spp.	Ablabesmyia spp.			
Acentrella spp.	Acentrella spp.			
Aeshnidae fam.	Aeshnidae fam.			
Ambrysus mormon				Not on any status lists
Ampumixis dispar				Not on any status lists
Anopheles spp.	Anopheles spp.			
Baetidae fam.	Baetidae fam.			
Baetis adonis	A Mayfly			
Baetis spp.	Baetis spp.			
Berosus spp.	Berosus spp.			
Brachycentrus occidentalis				Not on any status lists
Brachycentrus spp.	Brachycentrus spp.			
Caenis spp.	Caenis spp.			
Callibaetis spp.	Callibaetis spp.			
Cenocorixa wileyae				Not on any status lists
Centroptilum spp.	Centroptilum spp.			
Cheumatopsyche spp.	Cheumatopsyche spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Chloroperlidae fam.	Chloroperlidae fam.			
Coenagrionidae fam.	Coenagrionidae fam.			
Corisella spp.	Corisella spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus spp.	Cricotopus spp.			
Diphetor hageni	Hagen's Small Minnow Mayfly			
Dubiraphia spp.	Dubiraphia spp.			
Dytiscidae fam.	Dytiscidae fam.			
Enallagma spp.	Enallagma spp.			
Epeorus spp.	Epeorus spp.			
Ephemerella spp.	Ephemerella spp.			
Ephydridae fam.	Ephydridae fam.			
Fallceon quilleri	A Mayfly			

Glossosoma alascense	A Caddisfly			
Glossosoma spp.	Glossosoma spp.			
Goera archaon	A Caddisfly			
Haliplus spp.	Haliplus spp.			
Heptagenia spp.	Heptagenia spp.			
Heptageniidae fam.	Heptageniidae fam.			
Hesperocorixa laevigata				Not on any status lists
Hesperocorixa spp.	Hesperocorixa spp.			
Hesperoperla pacifica	Golden Stone			
Hetaerina americana	American Rubyspot			
Hexagenia limbata	A Mayfly			
Hydropsyche alternans				Not on any status lists
Hydropsyche spp.	Hydropsyche spp.			
Hydroptila spp.	Hydroptila spp.			
Ischnura spp.	Ischnura spp.			
Isonychia intermedia				Not on any status lists
Isonychia spp.	Isonychia spp.			
Isonychia velma	A Mayfly			
Isoperla spp.	Isoperla spp.			
Laccophilus spp.	Laccophilus spp.			
Lepidostoma spp.	Lepidostoma spp.			
Libellula nodisticta	Hoary Skimmer			
Limnophyes spp.	Limnophyes spp.			
Liodessus obscurellus				Not on any status lists
Malenka spp.	Malenka spp.			
Micropsectra spp.	Micropsectra spp.			
Mideopsis spp.	Mideopsis spp.			
Nectopsyche spp.	Nectopsyche spp.			
Neophylax spp.	Neophylax spp.			
Neotrichia spp.	Neotrichia spp.			
Nixe kennedyi	A Mayfly			
Notonecta spp.	Notonecta spp.			
Ophiogomphus spp.	Ophiogomphus spp.			
Optioservus canus	Pinnacles Optioservus Riffle Beetle		Special	
Optioservus quadrimaculatus				Not on any status lists
Optioservus spp.	Optioservus spp.			
Ordobrevia nubifera				Not on any status lists

Paraleptophlebia spp.	Paraleptophlebia spp.			
Peltodytes callosus				Not on any status lists
Peltodytes spp.	Peltodytes spp.			
Petrophila spp.	Petrophila spp.			
Plathemis lydia	Common Whitetail			
Procladius spp.	Procladius spp.			
Protoptila balmorhea				Not on any status lists
Protoptila spp.	Protoptila spp.			
Psectrocladius spp.	Psectrocladius spp.			
Psephenus falli				Not on any status lists
Pseudochironomus spp.	Pseudochironomus spp.			
Pteronarcys californica	Giant Salmonfly			
Pteronarcys spp.	Pteronarcys spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Rhithrogena spp.	Rhithrogena spp.			
Rhyacophila spp.	Rhyacophila spp.			
Sanfilippodytes spp.	Sanfilippodytes spp.			
Serratella spp.	Serratella spp.			
Sialis spp.	Sialis spp.			
Sigara spp.	Sigara spp.			
Simulium anduzei				Not on any status lists
Simulium spp.	Simulium spp.			
Skwala americana	American Springfly			
Sperchon spp.	Sperchon spp.			
Stictotarsus spp.	Stictotarsus spp.			
Taeniopteryx nivalis	Boreal Willowfly			
Tanypus spp.	Tanypus spp.			
Tanytarsus spp.	Tanytarsus spp.			
Tricorythodes explicatus	A Mayfly			
Tricorythodes spp.	Tricorythodes spp.			
Zaitzevia parvula				Not on any status lists
Zaitzevia spp.	Zaitzevia spp.			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Lontra canadensis canadensis	North American River Otter			Not on any status lists
Neovison vison	American Mink			Not on any status lists

Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Helisoma minus	A Freshwater Snail			E
Anodonta californiensis	California Floater		Special	
Ferrissia spp.	Ferrissia spp.			
Fluminicola turbiniformis	Turban Pebblesnail			V
Gonidea angulata	Western Ridged Mussel		Special	
Gyraulus spp.	Gyraulus spp.			
Hydrobiidae fam.	Hydrobiidae fam.			
Lanx klamathensis	Scale Lanx		Special	E
Lymnaea spp.	Lymnaea spp.			
Lymnaeidae fam.	Lymnaeidae fam.			
Margaritifera falcata	Western Pearlshell		Special	
Menetus opercularis	Button Sprite			CS
Physa spp.	Physa spp.			
Pisidium spp.	Pisidium spp.			
Sphaeriidae fam.	Sphaeriidae fam.			
Sphaerium spp.	Sphaerium spp.			
Valvata spp.	Valvata spp.			
PLANTS				
Carex sheldonii	Sheldon's Sedge		Special	CRPR - 2B.2
Downingia laeta	Great Basin Downingia		Special	CRPR - 2B.2
Ranunculus macounii	Macoun's Buttercup		Special	CRPR - 2B.2
Scutellaria galericulata	Hooded Skullcap		Special	CRPR - 2B.2
Alisma triviale	Northern Water-plantain			
Alopecurus aequalis aequalis	Short-awn Foxtail			
Alopecurus carolinianus	Tufted Foxtail			
Alopecurus geniculatus geniculatus	Meadow Foxtail			
Alopecurus pratensis	NA			
Alopecurus saccatus	Pacific Foxtail			
Arundo donax	NA			
Beckmannia syzigachne	American Sloughgrass			
Bidens cernua	Nodding Beggarticks			

Callitriche heterophylla bolanderi	Large Water-starwort			
Callitriche palustris	Vernal Water-starwort			
Calochortus uniflorus	Shortstem Mariposa Lily		Special	CRPR - 4.2
Carex integra	Smooth-beak Sedge			
Carex lasiocarpa	Slender Sedge		Special	CRPR - 2B.3
Carex nebrascensis	Nebraska Sedge			
Carex pellita	Woolly Sedge			
Damasonium californicum				Not on any status lists
Downingia bacigalupii	Bacigalup's Downingia			
Downingia cuspidata	Toothed Calicoflower			
Downingia elegans	NA			
Downingia insignis	Parti-color Downingia			
Elatine californica	California Waterwort			
Elatine rubella	Southwestern Waterwort			
Eleocharis acicularis acicularis	Least Spikerush			
Eleocharis macrostachya	Creeping Spikerush			
Elodea canadensis	Broad Waterweed			
Epilobium campestre	NA			Not on any status lists
Epilobium hallianum				Not on any status lists
Eryngium alismifolium	Inland Coyote-thistle			
Eryngium aristulatum aristulatum	California Eryngo			
Eryngium articulatum	Jointed Coyote-thistle			
Eryngium mathiasiae	Mathias' Coyote-thistle			
Euthamia occidentalis	Western Fragrant Goldenrod			
Floerkea proserpinacoides	False Mermaidweed			
Glyceria borealis	Small Floating Mannagrass			

Gratiola ebracteata	Bractless Hedge-hyssop			
Gratiola heterosepala	Boggs Lake Hedge-hyssop		Endangered	CRPR - 1B.2
Gratiola neglecta	Clammy Hedge-hyssop			
Juncus uncialis	Inch-high Rush			
Lemna minor	Lesser Duckweed			
Lemna minuta	Least Duckweed			
Limosella acaulis	Southern Mudwort			
Limosella aquatica	Northern Mudwort			
Ludwigia palustris	Marsh Seedbox			
Marsilea vestita vestita	NA			Not on any status lists
Mimulus latidens	Broad-tooth Monkeyflower			
Myosurus apetalus	Bristly Mousetail			
Myosurus minimus	NA			
Navarretia heterandra	Tehama Navarretia			
Navarretia intertexta	Needleleaf Navarretia			
Navarretia leucocephala minima	Least Navarretia			
Perideridia oregana	Oregon Yampah			
Persicaria amphibia				Not on any status lists
Persicaria lapathifolia				Not on any status lists
Persicaria maculosa	NA			Not on any status lists
Phacelia distans	NA			
Phalaris arundinacea	Reed Canarygrass			
Phyla nodiflora	Common Frog-fruit			
Pilularia americana	NA			
Plagiobothrys leptocladus	Alkali Popcorn-flower			
Pogogyne douglasii	NA			
Porterella carnosula	Western Porterella			
Potamogeton foliosus foliosus	Leafy Pondweed			
Potamogeton pusillus pusillus	Slender Pondweed			
Psilocarphus brevissimus brevissimus	Dwarf Woolly-heads			

Psilocarphus oregonus	Oregon Woolly-heads			
Ranunculus aquatilis aquatilis	White Water Buttercup			
Ranunculus aquatilis diffusus				Not on any status lists
Rorippa curvipes	Rocky Mountain Yellowcress			
Rumex salicifolius salicifolius	Willow Dock			
Rumex triangulivalvis				Not on any status lists
Sagittaria cuneata	Wapatum Arrowhead			
Sagittaria latifolia latifolia	Broadleaf Arrowhead			
Salix exigua exigua	Narrowleaf Willow			
Salix exigua hindsiana				Not on any status lists
Salix gooddingii	Goodding's Willow			
Salix laevigata	Polished Willow			
Salix lasiandra lasiandra				Not on any status lists
Salix lutea	Yellow Willow			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Scirpus microcarpus	Small-fruit Bulrush			
Senecio hydrophiloides	Sweet Marsh Ragwort		Special	CRPR - 4.2
Senecio hydrophilus	Great Swamp Ragwort			
Sidalcea oregana oregana	Oregon Checker-mallow			
Spirodela polyrhiza	NA			
Stuckenia pectinata				Not on any status lists
Symphyotrichum frondosum	Alkali Aster			
Typha latifolia	Broadleaf Cattail			
Veronica anagallis-aquatica	NA			
Veronica catenata	NA			Not on any status lists

Attachment C

Maps of representative monitoring sites in relation to key beneficial users

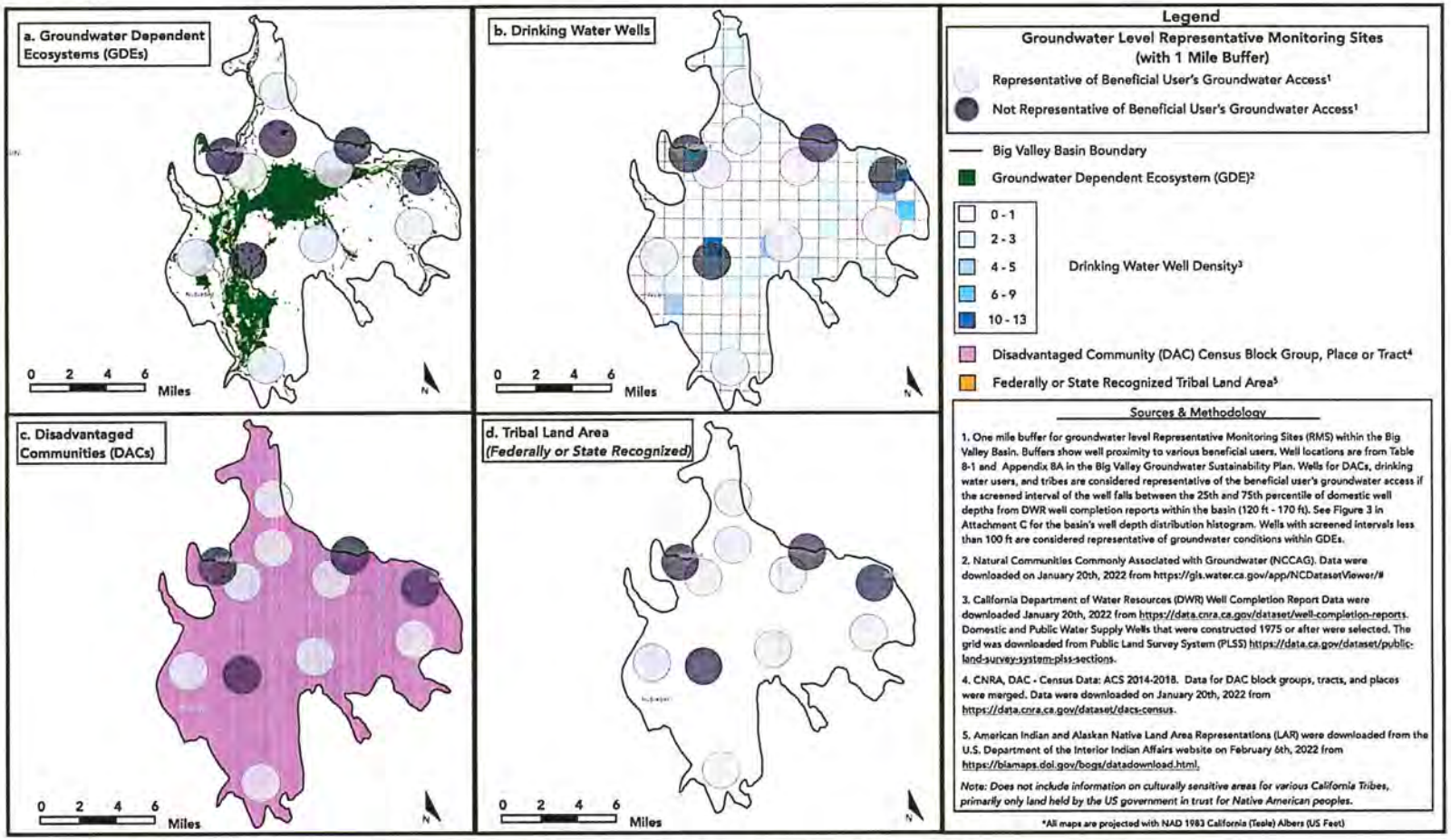


Figure 1. Groundwater elevation representative monitoring sites in relation to key beneficial users: a) Groundwater Dependent Ecosystems (GDEs), b) Drinking Water users, c) Disadvantaged Communities (DACs), and d) Tribes.

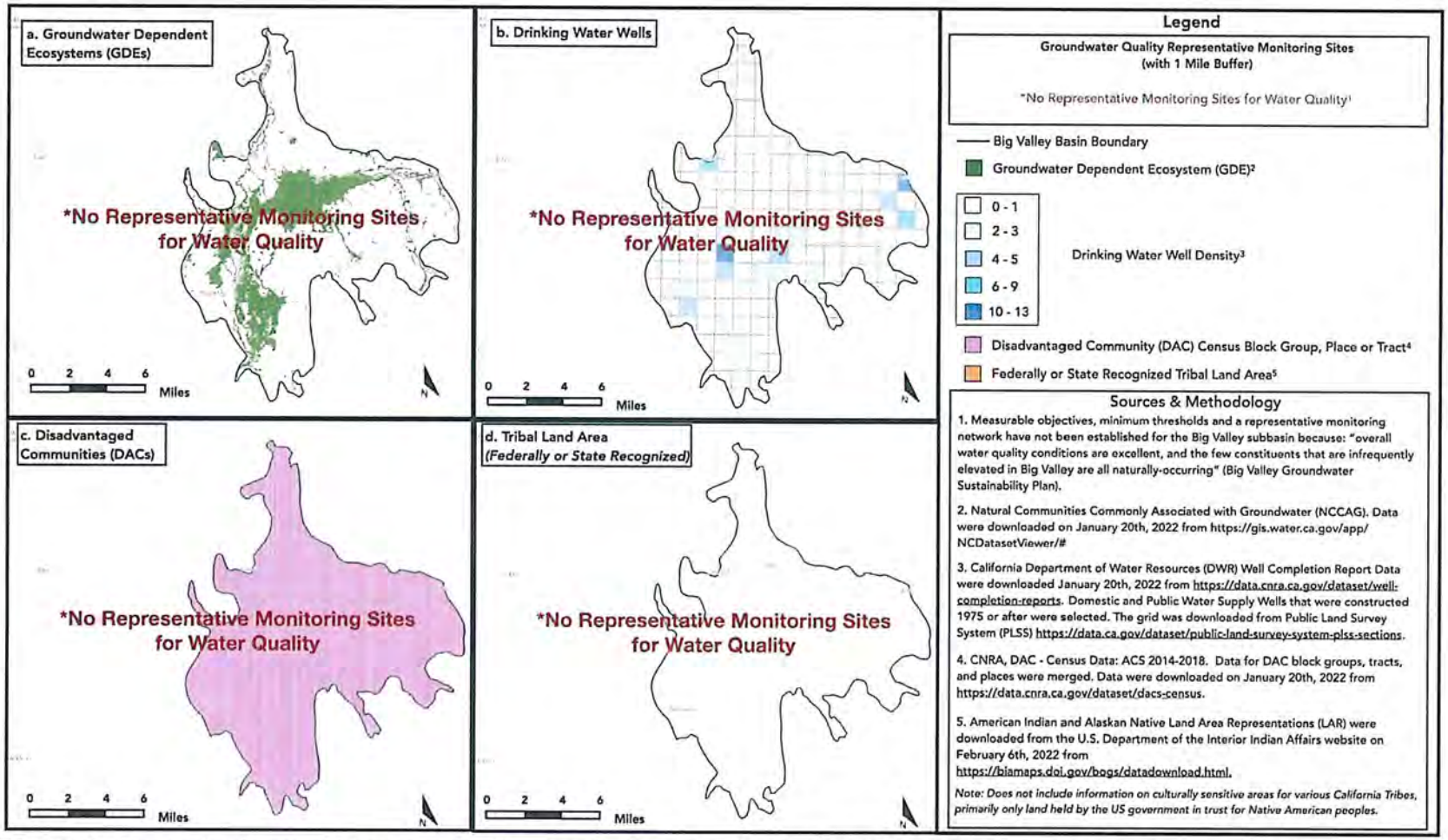


Figure 2. Groundwater quality representative monitoring sites in relation to key beneficial users: a) Groundwater Dependent Ecosystems (GDEs), b) Drinking Water users, c) Disadvantaged Communities (DACs), and d) Tribes.

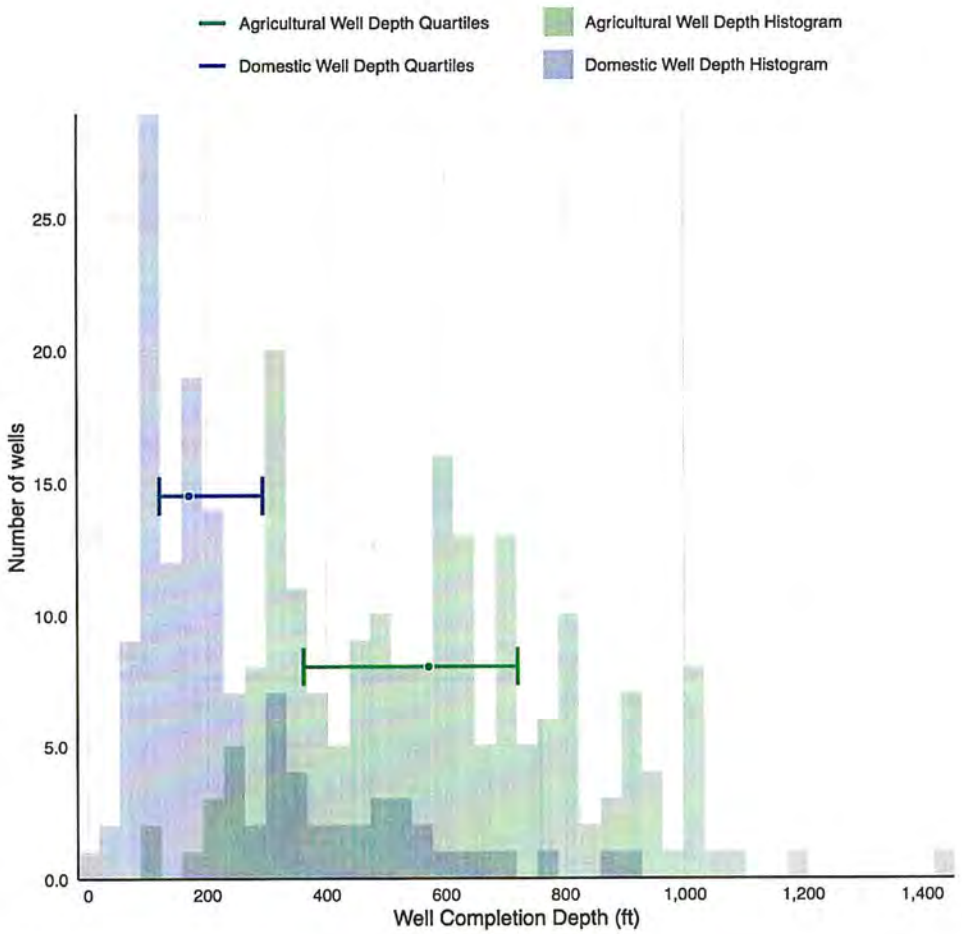
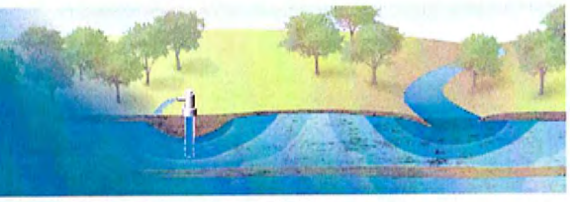


Figure 3. Groundwater well depth histogram for domestic (blue) and agricultural (green) wells. If less than 10 agricultural or domestic wells are present within the basin, the sector histogram is not shown. Data from California Department of Water Resources' Online System for Well Completion Reports (https://data.cnra.ca.gov/dataset/well-completion-reports).

Subject #3: SGMA Implementation Round 2 Grant Application

Sustainable Groundwater Management (SGM)
GRANT PROGRAM



SGM Grant Program SGMA Implementation Proposal Solicitation Package

PROP 68
State of California Parks • Water Bond 2018

California Natural Resources Agency's
Department of Water Resources
-
Division of Regional Assistance

December 2021

FOREWORD

The California Department of Water Resources (DWR) is administering the Sustainable Groundwater Management (SGM) Grant Program Sustainable Groundwater Management Act (SGMA) Implementation funding solicitation using funds authorized by the California Budget Act of 2021 (Stats. 2021, ch. 240, § 80) and the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (Proposition 68). This document is the Proposal Solicitation Package (PSP) for activities/tasks related to SGMA implementation, which includes, but are not limited to:

- Revisions, updates, and/or modifications of a Groundwater Sustainability Plans (GSPs);
- Revisions, updates, and/or modifications of an Alternative to a GSP (Alternative); and/or
- Capital improvement activities as listed within a GSP or Alternative to a GSP.

This document is not a standalone document and the applicant will need to refer to the 2021 SGM Grant Program 2021 Guidelines (2021 Guidelines) for additional information. **Potential applicants are highly encouraged to read the 2021 Guidelines, PSP, and Agreement template prior to deciding to submit an application.** The 2021 Guidelines and the Agreement template can be found at the following link: www.water.ca.gov/sgmgrants.

A glossary of terms used throughout this PSP are available in Appendix B (Definitions) of the 2021 Guidelines.

GRANT PROGRAM WEBSITE AND OTHER USEFUL LINKS

This document, as well as other pertinent information about the SGM Grant Program, can be found at the following link: www.water.ca.gov/sgmgrants.

Other useful links are identified below.

Sustainable Groundwater Management Act (SGMA):
https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=WAT&division=6.&title=&part=2.74.&chapter=&article=

GSP Regulations:
https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I74F39D13C76F497DB40E93C75FC716AA&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)%20

Sustainable Groundwater Management Act (SGMA) Portal:
https://sgma.water.ca.gov/portal/#intro

Disadvantaged Community (DAC) and Economically Distressed Area (EDA) Mapping Tools:
https://water.ca.gov/Work-With-Us/Grants-And-Loans/Mapping-Tools

CalEnviroScreen 3.0:
https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

DWR Grants Review and Tracking System (GRanTS) Application Tool:
https://grants.water.ca.gov

E-MAIL LIST

In addition to the website, DWR will distribute information via e-mail. If you are not already on the SGM Grant Program e-mail list, please use the following link to be added to the list: https://water.ca.gov/Work-With-Us/Grants-And-Loans/Sustainable-Groundwater and click the "Subscribe" button on the right side of the webpage.

CONTACT INFORMATION

For questions about this document, or other technical issues regarding SGM Grant Program, please contact DWR's Division of Regional Assistance at (916) 902-7131 or by e-mail at: SGWP@water.ca.gov.

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Acronyms and Abbreviations Used in This Proposal Solicitation Package

COD	Critically Overdrafted (Basin)
DAC	Disadvantaged Community
DWR	Department of Water Resources
EnvDAC	Environmentally Disadvantaged Community
FAB	Financial Assistance Branch
FE-SWRP	Functionally Equivalent Stormwater Resource Plan
GB	Gigabyte
GIS	Geographic Information System
GRanTS	Grants Review and Tracking System
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IRWM	Integrated Regional Water Management
MHI	Median Household Income
OEHHA	Office of Environmental Health Hazard Assessment
PSP	Proposal Solicitation Package
SB	Senate Bill
SDAC	Severely Disadvantaged Community
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SWRP	Stormwater Resource Plan
TA	Technical Assistance

I. Introduction

DWR is administering the Sustainable Groundwater Management (SGM) Grant Program SGMA Implementation grant solicitations using funds authorized by the California Budget Act of 2021 (Stats. 2021, ch. 240, § 80) (Budget Act of 2021) and Proposition 68 for projects that encourage sustainable management of groundwater resources that support SGMA and/or invest in groundwater recharge projects with surface water, stormwater, recycled water, and other conjunctive use projects. The Budget Act of 2021 can also provide funding for planning activities that support SGMA implementation. The funding will be divided into a minimum of two rounds of grant solicitations. Round 1 will be awarded in 2022 and Round 2 is projected to be awarded in Spring/Summer 2023. Any future grant solicitations will be identified at a later time and is dependent upon future appropriation. This PSP contains specific information regarding the process, eligibility, and required content for grant applications for the grant funds for the grant solicitations. DWR also issued the 2021 Guidelines that will be used to administer the grant solicitation and provide general information regarding program and eligibility requirements.

II. Funding

The Budget Act of 2021 appropriates a total of $180 million in Fiscal Year (FY) 2021/2022 to DWR for SGMA implementation. After administrative costs, $171 million is available for grant awards. Of the $171 million appropriated by the Budget Act of 2021, $152 million shall be directed to projects that benefit Critically Overdrafted (COD) groundwater basins that support implementation of SGMA.

The Budget Act of 2021 also authorizes the Legislature to appropriate a total of $60 million in FY 2022/2023 and $60 million in FY 2023/2024 to DWR for SGMA implementation. After administrative costs, $114 million will be available for grant awards that will be directed to projects that benefit medium and high priority groundwater basins (including COD basins) that support implementation of SGMA. Priority in future funding grant solicitations will be given to applicants in basins that have not previously been awarded SGMA Implementation funding.

Proposition 68 authorizes the Legislature to appropriate a total of $120 million to DWR for drought and groundwater investments to achieve regional sustainability. After the administrative cost and previous funding awards, approximately $71.5 million is available for drought and groundwater investments to achieve regional sustainability through investments in groundwater recharge with surface water, stormwater, recycled water, and other conjunctive use projects, and projects to prevent or clean up contamination of groundwater that serves as a source of drinking water (Public Resources Code § 80146(a)). Of the approximately $71.5 million, a minimum of $15 million is reserved for projects located within and solely supporting a Severely Disadvantaged Community (SDAC).

The $114 million in future General Fund appropriations, the remaining $17 million in FY 2021/2022 General Fund appropriation, and the remaining $71.5 million in Proposition 68 grant funds will be combined together in a single funding round for the medium and high priority basins as outlined above. Any future appropriations will be added to this second funding solicitation. If all of the funds are not awarded, subsequent funding rounds will be conducted later using the same PSP and the 2021 Guidelines. A minimum of $35 million in future appropriations from General Funds, or 30% (whichever is greater), must be used to address the needs, risks, and/or vulnerabilities in Underrepresented Communities identified by the SGM Grant Program Underrepresented Community Technical Assistance Program (TA Program). The Project or Component must be consistent with the findings and conclusions identified in the TA Program and be within a community identified by the TA Program heat maps. The maps can be found on the TA Program website: www.water.ca.gov/sgmgrants

DWR is reserving $2 million of the General Funds for a technical assistance provider with a minimum of $1 million out of the $2 million for technical assistance. All work completed must address the needs, risks, and/or vulnerabilities of Underrepresented Communities as identified by the TA Program and must also be consistent with the TA Program. All work conducted must be reviewed and approved by DWR prior to commencing. Work should be equitably distributed throughout all regions of the State

and will use the TA Program Heat Maps. The technical assistance provider will be encouraged to conduct a minimum of one community meeting in each of the basins that includes a representative of all GSA(s) and/or responsible entity within the basin with community representatives to assist in building strong relationships between community leaders and the entities responsible for implementing SGMA. All findings/conclusions shall be reported to the local GSA(s) and/or responsible entity in a meeting that includes a representative from DWR. The goal of the TA Program is to foster strong working relationships and effective communications between the Underrepresented Communities and their local groundwater sustainability agency responsible for implementing SGMA so that those community's needs, risks, and/or vulnerabilities will be properly identified and addressed in the GSP(s) or Alternative(s) to a GSP.

TABLE A – FUNDING BREAKDOWN[1]

	Total Appropriation (in Millions)	Total Funding Available[2]	Round 1 – COD Basins (Current Solicitation)		Future Solicitations – min of 30% must be for URC's	
			General	Technical Assistance Agreement[3]	General	SDAC*/URC
Prop 68	$120	$71.5	N/A	N/A	$56.5	$15*
2021 Budget Act – General	$120	$114	$112	$2	N/A	N/A
2021 Budget Act – SJV Projects	$60	$57	$40	N/A	$17	N/A
Projected FY 2022/23 Appropriation	$60	$57	N/A	N/A	$39.5	$17.5 (or 30% whichever is greater)
Projected FY 2023/24 Appropriation	$60	$57	N/A	N/A	$39.5	$17.5 (or 30% whichever is greater)

[1]All amounts shown are in Millions of dollars and are approximate and subject to change depending on actual expenditures from previous funding awards.
[2]Amount available after deducting previous Prop 68 funding awards and 5% DWR administration costs.
[3]Agreement to a technical assistance provider for Technical Assistance to Underrepresented Communities.

A. COD Basin SGMA Implementation (Round 1)

SGM Grant Program have identified 21 groundwater basins that are listed as COD Basins, according to the most current DWR Bulletin 118. However, not all 21 COD Basins identified in the most current DWR Bulletin 118 meet the eligibility requirements listed in Section III. DWR anticipates 20 of the COD Basins will meet the eligibility requirements at the time of the Round 1 grant solicitation. If you represent a COD Basin and are unsure of your eligibility status, please contact the SGM Grant Program staff at sgwp@water.ca.gov.

DWR intends to make up to $152 million available for projects in eligible COD basins for tasks and activities that help the basins reach sustainability, whereby the $152 million will be split evenly to provide $7.6 million per eligible COD basin. However, DWR must award a minimum of $40 million of the $57 million granted by the Budget Act of 2021 by September 15, 2022 to COD basins within the San Joaquin Valley (SJV) basin for tasks and activities that include:

- Geophysical investigation(s) of groundwater basins to identify recharge potential (e.g., Aerial Electromagnetic Surveys);
- Early implementation of existing regional flood management plans that incorporate groundwater recharge (e.g., basin recharge using floodwater); or
- Projects that would complement efforts of a local GSP, that provide for floodplain expansion to benefit groundwater recharge or habitat (e.g., basin recharge using peak flows from a river, creek, or stream).

The nine COD basins outside of the SJV basin will have $7.6 million available to award based upon the submitted Spending Plan. That leaves $43.6 million in General Funds for the 11 COD basins within the SJV basin. If DWR receives Spending Plans from these 11 basins that request $40 million or more in SJV projects, then the 11 SJV COD basins will be eligible for the full $7.6 million per SJV COD basin. If DWR receives Spending Plans from these 11 basins that request less than $40 million in SJV projects, then DWR will evenly reduce the amount of funding available to each SJV COD basin according to the shortfall. For example, if DWR receives Spending Plans from the 11 basins requesting only $28 million of the $40 million for SJV projects, then the 11 basins within the SJV basin will be eligible for a maximum of $6.5 million per basin. See calculation below:

Non-SJV COD Basins - $7.6M per non-SJV COD Basin

$7.6M x 9 Basins = $68.4M of the $112M in Gen Fund

SJV COD Basins:
($112M - $68.4M) ÷ 11 = $3.963M

Assuming SJV COD basins apply for $28M in SJV-type funds, the amount per SJV COD Basin equals:

Example:
($43.6M + $28M) ÷ 11 = $6.5M per SJV COD Basin

TABLE B – FUNDING BREAKDOWN FOR ROUND 1 – COD BASINS[1]

Basin Type	# of Basins	Total Funding Available	2021 Budget Act – General	2021 Budget Act – SJV Projects	Min Grant Award per basin	Max Grant Award per basin
SJV COD	11	$83.6	$43.6	$40[2]	$3.963	$7.6
Non-SJV COD	9	$68.4	$68.4	$0	$7.6	$7.6

[1]All amounts shown are in Millions of dollars and must be awarded by September 2022 per the 2021 Budget Act.
[2]Actual amount is dependent on how much SJV COD basins request in their respective Spending Plan.

The Budget Act of 2021 requires all funding agencies to expedite execution of grant agreements in an effort to get the funding out to the eligible applicants as quickly as possible. However, the Budget Act of 2021 also requires funding for the SGMA Implementation to be awarded via a competitive grant process. DWR has determined that $7.6 million is available per COD Basin and that each COD Basin will be required to conduct a self-evaluation of their project list using the scoring criteria outlined in Table 7 to determine which projects are the most competitive within the basin. These self-evaluations shall be submitted as backup documentation to a Spending Plan. Only one Spending Plan will be accepted per COD Basin and the applicant must meet the eligibility requirements listed within the PSP and the 2021 Guidelines.

A template for the Spending Plan and the scoring criteria will be emailed out to each GSA contact once the final 2021 Guidelines and PSP are released to the public. **The Spending Plan must be in the template that is provided. Any other format will not be reviewed and the funding for that COD Basin will be forfeit.** A workshop for the COD Basins only will be provided to review the scoring criteria and Spending Plan template. Each applicant should provide a Spending Plan for a minimum of $10 million for the SGM Grant Program staff to review and rank. The COD Basin applicants **have until noon on February 18, 2022** to submit a Spending Plan to sgwp@water.ca.gov or will forfeit the allotted funding.

Once the Spending Plan is received by the SGM Grant Program staff, the applicant will be contacted to set up an appointment to review the Spending Plan, check the eligibility of the Project(s), and to develop a draft Agreement. The draft Agreement will be reviewed by the Office of General Counsel and the Financial Assistance Branch (FAB) Manager. The Manager of the SGM Grant Program will review their comments and finalize the Agreement to route for signature.

To expedite the Agreement process, it is highly recommended that the applicants within the COD Basins submit their Spending Plans well in advance of February 18, 2022, if possible. The SGM Grant Program staff will be reviewing the Spending Plans in the order in which they were received.

Any remaining available funds not awarded in the Round 1 grant solicitation will be available in future funding rounds.

B. Medium and High Priority Basin SGMA Implementation Funding (Round 2)

The remaining approximately $17 million in Budget Act of 2021 funds (including any unawarded funds in Round 1), the remaining approximately $71.5 million in Proposition 68 funds, and an estimated $114 million in future General Funds will be combined for a competitive grant solicitation(s). If any additional funds are provided to the SGM Grant Program for awards between the posting of the final PSP to the Round 2 grant solicitation, an additional solicitation(s) will be held for additional grant awards. Applicants must be located within a COD basin, medium, or high priority basins. Priority will be given to applicants who have not previously received SGMA Implementation funding. Funds can be used for revisions, updates, and/or modifications to a GSP or Alternative to a GSP and for funding capital improvement projects outlined in those plans. Funding will be awarded in a competitive manner based upon the scoring criteria outlined in Table 7.

A minimum of $35 million, or 30% (whichever is greater), of the General Funds must be used towards projects that serve Underrepresented Communities (URC); of that a minimum of 10% of the grant funds must be used for projects that serve Severely Disadvantaged Communities (SDAC). In addition, a minimum of $15 million of the Proposition 68 funds must be used towards Projects or Components that benefit an SDAC.

Any remaining funds not awarded in this grant solicitation will be available in future funding rounds.

Eligible project types and eligible tasks are described further in Section III.B.

At this time, the minimum and maximum grant award amounts for the Round 2 grant solicitation are:

Minimum Grant Amount – $1 million per basin
Maximum Grant Amount – $20 million per basin

This is subject to change based upon the future appropriations approved by the Legislature.

C. Eligible Costs and Payment

Eligible reimbursable costs are those that were: incurred by the Grantees after the date the 2021 Guidelines and PSP were approved, meet the conditions of the "Eligible Costs" as outlined in Section III., and defined as "reimbursable costs" in Appendix B of the 2021 Guidelines. DWR's standard method of payment is reimbursement in arrears. Funds are disbursed after DWR approves the submittal of the DWR invoice form and required backup documentation by the Grantee. Grantees shall invoice and report on a quarterly basis only, except for the technical assistance provider. Additionally, DWR reserves the right to withdraw awarded funds due to lack of responsiveness on the part of the Grantee in submitting invoices and reporting and associated deliverables.

The Concurrent Drawdown method, in which the Grantee can request reimbursement, will be the only payment method in this solicitation. See the 2021 Guidelines Appendix B for more information on reimbursement methods. Costs associated with the development or management of the GSA and costs associated with the development and submittal of a grant application are not eligible.

III. ELIGIBILITY

Applications for the Grant Solicitation(s) must meet all applicable eligibility criteria to be considered for grant funding as described in the 2021 Guidelines, Section III. Additional eligibility requirements are described below and identified in Question 5 in Table 3 – Grant Application Checklist, of this PSP. A comprehensive eligibility checklist is provided in Table 2 – SGM Grant Program SGMA Implementation Eligibility Checklist, as a reference for applicants.

A. Eligible Applicants

Eligible applicants for the SGMA Implementation are:

- GSAs;
- Member agencies of GSAs;
- An entity that represents a GSA(s) which can include public agencies, non-profit organizations, public utilities, federally recognized Indian Tribes, State Indian Tribes listed on the Native American Heritage Commission's Tribal Consultation list, or mutual water companies; and
- Agencies with an Alternative to a GSP, including those within basins that adjudicated after January 1, 2015 or adjudications that have been filed but the court has not acted on the filing; and
- Entities that have adjudicated with or without a Watermaster or are in the process of adjudicating that do not have a GSP or Alternative to a GSP.

The Round 1 grant solicitation is limited to applicants who meet the criteria listed above and are located within eligible COD basins only.

The Round 2 grant solicitation is limited to the applicants who meet the criteria listed above and are located within medium and high priority basins, including COD basins.

Public utilities and mutual water companies must provide justification that the proposed project has a clear and definite public purpose and shall benefit the customers of the water system and not the investors. All applicants must comply with the eligibility criteria outlined in the 2021 Guidelines.

Entities representing a GSA(s) must have a letter of support from each GSA they represent. All applicants must have a GSP that has been submitted to DWR for review and deemed complete by DWR (posted to the SGMA Portal by DWR) or an Alternative to a GSP. An exemption to this requirement can be provided for those basins whose basin prioritization was changed by DWR and whose GSPs are not due to DWR until 2024/2025. Basins that are adjudicated prior to January 1, 2015 **are not** eligible to apply for or receive grant funding. Go to the SGMA website link provided in the Foreword for additional information on Bulletin 118, Basin Prioritization. If you are uncertain of the eligibility requirements, please contact the SGM Grant Program staff at sgwp@water.ca.gov.

Only one application will be accepted per basin. Applicants who apply on behalf of a GSA(s) are required to obtain and submit a letter of support from each GSA they represent.

Applicants are encouraged to work with the interested parties and other non-member agency(-ies) of the GSA(s) in their basin(s) (e.g., resource conservation districts, nonprofit organizations, Tribes, etc.) that have potential activities, tasks, and/or components that are complimentary to the overall grant application and proposed Project. These activities, tasks, and/or components should be included within the proposed application with the GSA, member agency(-ies) of a GSA, or Alternative to a GSP as the applicant and potential Grantee. The interested parties and/or non-member agency(-ies) would be listed as a cooperating entity. Project proponents would access grant funding through their relationship with the grant applicant, at DWR's discretion. DWR strongly recommends working with all potential interested parties within the basin(s) to ensure successful implementation of the GSP or Alternative to a GSP.

The grant applicant is the agency submitting the application (e.g., GSA) on behalf of the basin(s). The grant applicant is also the same agency that would enter into an agreement with the state should the

application be successful. If there is more than one eligible agency within a basin, an eligible agency may be part of the proposals as a cooperating entity but must identify a single entity that will act as the grant applicant and submit a basin-wide application and receive the grant on behalf of the basin.

Any funds not awarded and still available to DWR to award, and any future funding provided to the SGM Grant Program, will use the 2021 Guidelines and this PSP in a future grant solicitation.

B. Eligible Project Types

Eligible project types for the SGM Grant Program SGMA Implementation – Planning and Projects must be consistent with the purpose of the Budget Act of 2021 and Proposition 68, which include:

- Activities and/or tasks that consist of the development of groundwater recharge projects with surface water, stormwater, recycled water, and other conjunctive use projects;
- Projects that prevent or clean up contamination of groundwater that serve as a source of drinking water (Public Resources Code § 80146(a));
- Projects and programs that support water supply reliability, water conservation, and water use efficiency and water banking, exchange, and reclamation;
- Geophysical investigation(s) of groundwater basins to identify recharge potential; early implementation of existing regional flood management plans that incorporate groundwater recharge; or projects that would complement efforts of a local GSP, that provide for floodplain expansion to benefit groundwater recharge or habitat; and
- Revisions, updates, and/or modifications to a GSP or Alternative to a GSP. The Project or Component must fill known data gaps and address comments received from DWR after its review of a submitted GSP or Alternative to a GSP, if received. If the applicant has not received comments from DWR on their GSP or Alternative to a GSP, the Project or Component must be consistent with SGMA regulations and GSP requirements.

Eligible projects include those activities associated with the planning and implementation of a GSP or Alternative to a GSP and must also be consistent with the goals within the GSP or Alternative to a GSP.

Projects that are in basins determined to be probationary under SGMA by the State Water Board at or after the time of application submittal **are** eligible for this grant program to allow for those applicants to continue working towards sustainability. The project area and service area must be within the most current DWR Bulletin 118 basin that are designated by DWR as medium or high priority basins, including COD basins, by the latest SGMA Basin Prioritization.

The use of the term "project" refers to the activities and/or tasks related to the planning or implementation of a GSP or Alternative to a GSP and can include multiple components and/or tasks. A proposal, or project for purposes of this PSP, refers to all the supporting documentation submitted that details the actions that are proposed for the funding. The application will describe a single proposal/project; however, each application may contain multiple components and tasks that collectively makeup a single proposal/project. See the 2021 Guidelines, Appendix B for further definitions of components and project.

Examples of eligible project activities, tasks, and/or components can include, but are not limited to, the following:

- Filling data gaps in a GSP(s) or Alternative to a GSP
- Project development activities (e.g., feasibility studies, design, permits, environmental documents)
- Long-term planning studies
- Technical and planning assistance for Underrepresented Communities
- Interested party outreach and engagement
- Vulnerability or risk assessments
- Technical assistance for Underrepresented Communities
- Engagement and outreach to Underrepresented Communities
- Evaluation of groundwater management needs

- Impact studies on domestic and de minimis groundwater well users
- Annual reporting for GSPs and Alternative to a GSP
- Identifying and proper destruction of abandoned wells
- Identifying of recharge location(s)
- Soil carbon enhancement and Healthy Soil Initiative activities
- Native Yield studies
- Coordination activities with adjacent GSA(s)
- Instrumentation for monitoring wells (e.g., pressure transducers)
- Pilot or demonstration projects meeting the purpose of SB-170 and Proposition 68
- Installation of meters on groundwater production and agricultural wells
- Installation of monitoring well(s)
- Connection of communities to a municipal water supply (except laterals on private land)
- Groundwater recharge projects with surface water, stormwater, recycled water, and other conjunctive use projects
- Groundwater contaminant remediation or prevention projects for groundwater that serves as a source of drinking water
- Construction, rehabilitation, or expansion of conveyance facilities for groundwater recharge projects
- Wastewater treatment and water recycling facility upgrades for groundwater recharge project sources
- Stormwater and runoff capture projects that support groundwater recharge
- Groundwater recharge facility expansion
- Seawater barrier injection wells
- Groundwater recharge projects that address groundwater dependent ecosystems (GDEs)
- Projects and programs that support water supply reliability, water conservation, water use efficiency and water banking, exchange, and reclamation
- Planning, design, and environmental documentation only as a task of a Project or Component of an overall project (not a standalone task).

Please email the SGM Grant Program staff at sgwp@water.ca.gov if you are not sure about a Project, component, or activity that you may be applying for funding. The SGM Grant Program staff will make appointments with you to review your project(s) in relationship to the eligible activities/tasks and competitiveness of the application as a whole.

Examples of ineligible project activities, tasks, and/or components can include, but are not limited to, the following:

- Gifts of public funds to a private person or entity (e.g., gift certificates and other incentives to attend public meetings, complete surveys, etc.)
- Purchasing of low-flow and/or high-density appliances
- Water markets and trading programs
- Purchases of water supplies
- Rebate programs
- Travel expenses, except mileage to the project location from a pre-approved starting location
- Food and drink
- Per diem expenses
- Federal and state taxes
- Tuition
- Overhead/Indirect/Markup – for Grantees, consultants/contractors, or their subs.

NOTE: Water Code section 10562(b)(7) requires that all projects that include stormwater and dry weather runoff capture be listed in a SWRP or Functionally Equivalent SWRP (FE-SWRP) and the SWRP or FE-SWRP must be incorporated into an adopted Integrated Regional Water Management Plan (IRWM) for the region the project is located. The State Water Board defines stormwater as "the temporary surface water runoff and drainage generated by immediately preceding storms" and defines stormwater and dry weather runoff capture as "to intercept, store, manage, and use stormwater and dry weather runoff, thereby reducing the volume of runoff exiting a site". All proposals using stormwater runoff, dry weather runoff, and potential peak flows should review Water Code section

10562 and the State Water Board's SWRP Guidelines. Applicants should consult their legal counsel regarding this topic.

IV. Solicitation Process and Schedule

The solicitation period is listed in the table below. These dates are estimated and are subject to change. Any change or update to the schedule will be posted on the SGM Grant Program website. Updates may also be sent through email announcements. To be placed on the SGM Grant Program email contact list, please use the link listed in the Foreword.

TABLE 1 – SCHEDULE FOR SGM GRANT PROGRAM SGMA IMPLEMENTATION GRANT SOLICITATION

Milestone or Activity	Tentative Date[1]
SGMA Implementation - Round 1 Schedule	
Final 2021 Guidelines & PSP posted to public	December 17, 2021
COD Basin – Round 1 Grant Solicitation Opens	December 20, 2021
Application Workshop	January 5, 2021
Round 1 Grant Solicitation Closes	February 18, 2022[2]
Final Awards	March/April 2022
Execute Agreements	May 2022
Initial TA Program Ends – Release of Needs, Risks, and/or Vulnerabilities in Underrepresented Communities to public	**July/August 2022**
SGMA Implementation - Round 2 Schedule	
Medium & High Priority - Round 2 Grant Solicitations Opens	September 2022
Public Review of Draft Funding List	April/May 2023
Final Awards	June 2023
Execute Agreements	July/August 2023

[1] Dates are subject to change and will be determined based on number of comments received for the draft document, number of applications received, amount of funds requested, and number of grant awards given. Dates for the TA Program is dependent upon the ability to have public meetings due to COVID-19 mandates by State and/or County.
[2] Applicants are encouraged to submit their Round 1 Spending Plan prior to February 18, 2022 deadline, if possible.

An applicant workshop will be conducted to address questions and to provide general assistance to potential applicants preparing grant applications. Details of the workshop will be provided via the SGM website and email distribution list. In addition to the informational workshop, applicants are encouraged to seek assistance from DWR staff in understanding SGM Grant Program requirements and completing grant applications. Questions can be submitted via the contact information provided in the Foreword on Page 2.

V. APPLICATION INSTRUCTIONS

This section provides instructions for preparing and applying and consists of two subsections: A. What to Submit and B. How to Submit. It is important that applicants follow the Application Instructions to ensure that their application will address all the required elements. Applicants are reminded that once the application has been submitted to DWR, any privacy rights as well as other confidentiality protections afforded by law with respect to the application package, will be waived. Prior to beginning the application, applicants should verify that they meet the Eligibility Criteria outlined in the 2021 Guidelines, Section III.C. and in Table 2 below.

TABLE 2 – SGM GRANT PROGRAM SGMA IMPLEMENTATION ELIGIBILITY CHECKLIST

Criteria Type	Eligibility Criteria	Place to Provide Information	Criteria Met (Yes, No, or NA[1])
Applicant Eligibility	Is the applicant eligible?	Self-Certification Form	
	Agricultural Water Management Compliance Link: https://water.ca.gov/Programs/Water-Use-And-Efficiency (2015 and/or 2020 AWMPs are applicable).	Self-Certification Form	
	California Statewide Groundwater Elevation Monitoring (CASGEM) Compliance Link: https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM. Basin Prioritization information can be found at: https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization	Self-Certification Form	
	Climate Change Compliance	Self-Certification Form	
	Consistency with the Delta Plan	Self-Certification Form	
	Groundwater Management Compliance, SGMA Compliance	Self-Certification Form	
	Open and Transparent Water Data	Self-Certification Form	
	Public Utilities and Mutual Water Companies Compliance	Self-Certification Form	
	SWRP Compliance SB 985 Link: https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swrp/	Self-Certification Form	
	Surface Water Diverter Compliance	Self-Certification Form	
	Sustainable Water Use and Demand Reduction Compliance	Self-Certification Form	
	Urban Water Management Compliance Link: https://water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Urban-Water-Management-Plans. (2015 and/or 2020 UWMPs are applicable).	Self-Certification Form	
	Water Metering Compliance	Self-Certification Form	
Proposal Eligibility	Only one application per basin OR Applicant is acting as the sole GSA over multiple basins	NA	
	Does the proposal include design, construction, operation, mitigation, or maintenance of Delta conveyance facilities?	GRanTS Application	
	Does the proposal include acquisition of water except for projects that will provide fisheries or ecosystem benefits or improvements that are greater than required current applicable environmental mitigation measures or compliance obligations?	GRanTS Application	
	Does the proposal include any share of the costs of remediation recovered from parties responsible for the contamination of a groundwater storage aquifer?	GRanTS Application	
Project Type Eligibility	Is the project eligible?	NA	

[1] NA = not applicable

A. What to Submit

Applicants must submit a complete SGM Grant Program Application during the open filing phase as shown in Table 1 – Schedule for SGM Grant Program SGMA Implementation – Planning and Projects Grant Solicitation.

B. How to Submit

1. Round 1

Applicants should submit a Spending Plan to SGWP@water.ca.gov by February 18, 2022, to obtain funding. The Spending Plan should be completed using the template provided by the assigned DWR Grant Manager. Any Spending Plans outside of the template format will not be reviewed or awarded any funding. The Spending Plan should have copies of the completed scoring criteria as outlined in Table 7 for each project proposed for funding for the basin. Below are the steps an applicant must take to apply for the Round 1 grant solicitation funds.

1. Depending on the COD Basin, the applicants should develop a project review committee that are responsible for completing a self-evaluation for a project using the scoring criteria outlined in Table 7. The project review committee should include a representative for each entity within a GSA, a representative from each GSA within the basin if there are multiple GSAs, a representative from each entity within an, and/or another method where all interested parties have an equal vote.
2. The project review committee can either develop one consensus scoring self-evaluation for each project; complete an independent scoring criterion and then use the average as the final score; have one entity that is not related to the project to conduct an independent review of another entities project and have that one score as the final; or another un-biased review process predetermined by the review committee. The scoring criteria Excel table will be provided by the assigned DWR Grant Manager. This scoring criteria should be used as it is and cannot be edited in any way. Any applications who have edited the scoring criteria will be thrown out and not awarded any grant funds.
3. Once the final score(s) is obtained for each project, the projects should be ranked based upon the scoring criteria and listed highest to lowest.
4. If the project review committee determine that a lower scoring project(s) should be higher on the ranking list due to available funding, accessibility to the site, already completed environmental/permitting/design, then the project review committee must be responsible for fully documenting and justifying why a lower scoring project was included within the Spending Plan versus a higher scoring project.
5. The applicant must provide an adopted resolution that has been adopted by the applicant's governing body designating an authorized representative to submit the application and execute an agreement with the State of California for the SGMA Implementation grant application. Please see Pages 19 – 20 for the example resolution language and additional instructions.
6. Complete the Eligibility Self-Evaluation form located on the SGM Grant Program website at www.water.ca.gov and submit the Eligibility Self-Evaluation form with the Spending Plan. Please see Page 20 for additional instructions. Table 2 below is an example of the eligibility questions included within the Eligibility Self-Evaluation form.
7. Prepare the Spending Plan and include the scoring criteria sheet(s) per recommended project, review notes, and other justification, along with the resolution(s) and Eligibility Self-Evaluation form, and submit the plan to SGWP@water.ca.gov **prior to noon on February 18, 2022**. Any COD Basin that has not submitted a Spending Plan by this date and time has forfeited the funds and they will be moved into the available funding for Round 2.

2. Round 2

Applicants must submit a complete application online using DWR's GRanTS electronic submittal tool, or another electronic submittal tool, please use the link listed in the Foreword or as directed by SGM Grant Program via email and on the SGM Grant Program website. GRanTS can only be accessed with Microsoft Edge and Google Chrome. The name of these grant solicitations in GRanTS is " SGMA Implementation Round #" depending on the grant solicitation in which you are applying. To access the

application, applicants must register and have an account in GRanTS, or another online submittal tool, if they have not already done so. The online application will be available no later than the date specified on the Program website, according to Table 1. If an applicant has questions as to the content or the information requested in the grant solicitation, or questions or problems with GRanTS, please refer to the phone number or email listed in the Foreword.

When uploading an attachment in GRanTS, the following attachment title naming convention must be used: Att#_SGM_AttachmentName_#ofTotal#, where "#ofTotal#" identifies the number of files that make up an attachment, where "#" is the number of a file and "Total#" is the total number of files submitted in the attachment. This naming convention will be repeated in more detail for each Attachment in the following pages.

File size for each attachment submitted via GRanTS is limited to 2 gigabytes (GB). Breaking documents into sections or chapters so that each are less than 2 GB will aid in uploading files. Acceptable file formats are: PDF, MS Word, MS Excel, or MS Project. However, DWR prefers and highly encourages applicants to use PDF files. All portions of the GRanTS application must be received in the open filing phase. Submittals received outside the open filing phase may not be reviewed or considered for funding. The GRanTS system will allow applicants to resubmit any attachments before the close of the open filing phase.

Note: ***The GRanTS, or other application tool, instruction is not for Round 1. All of the instructions listed below is not for Round 1; however, applicants for Round 1 will access certain tables in this section following the instructions listed above on Page 15****. Please provide answers to only the questions listed in Table 3. Do not answer questions that appear on the screen in GRanTS that are not listed below, unless marked with an asterisk (*). Please note that the application and/or review questions outlined in Tables 3 through 7 may be reworded, combined, or separated as the information is transferred into our online application tool (e.g., GRanTS or other application). SGM Grant Program staff may make clarifying or editorial changes to the application following approval. SGM Grant Program staff may also make changes to Tables 3 through 7 depending upon language outlined in future appropriations and legislative requirements.* ***Tables 3 through 7 are subject to change depending on the final preparations of the review questionnaire.*** *No substantive changes will be made to the evaluation criteria and scoring scheme.*

TABLE 3 – GRANT APPLICATION CHECKLIST (NOT FOR ROUND 1)
APPLICANT INFORMATION TAB ***The following information is general and applies to the applicant and the overall proposal.*** *Specific project information should be detailed on separate project component tabs provided in the GRanTS application. Applicants must enter all information listed in the Information Tab of this checklist (Table 3) along with any field marked with an asterisk (*).*
Organization Name: Provide the name of the Agency/Organization responsible for submitting the application. Should the proposal be successful, this Agency/Organization will be the Grantee.
Point of Contact: Please type the First Name, Last Name, Email Address, Phone Number, Division Name, Address, City, State, and Zip of the Point of Contact person. Should the proposal be successful, this person will be the Point of Contact for the Agreement.
Point of Contact Position Title: Provide the title of the Point of Contact person. (Maximum Character Limit: 50)
Proposal Name: Provide the title of the proposal. This title cannot be changed for the life of the grant and **should NOT include the grant solicitation title anywhere**. (Maximum Character Limit: 50)
Proposal Objective: Provide the objective of the proposal. The objective should include the project description, purpose, goals, and targets of the proposed project. The reader should be able to understand what is being proposed (project description), where the project will be located, the purpose/why the project is needed, and how (goals and targets) those needs will be met. (Maximum Character Limit: 2,000)
PROPOSAL BUDGET *For the proposal, the following budget items should be taken from Table 5A or 5B – Grant Proposal Summary Budget*
Other Contribution: Provide the amount of other funds (such as other State grants, Federal grants, etc.) not included in the categories as listed below. If there is no other contribution, enter zero. Other Contribution costs are not considered part of the total project cost.
Local Contribution (Cost Share): Provide the local cost share that will be committed to the Project. If none, enter zero.
Federal Contribution: Enter any Federal funds being used. If none, enter zero.
In-Kind Contribution: **Leave blank** and include all In-Kind Contributions in the Local Contribution above.
Grant Funds Requested: Please provide the amount of total grant funds requested. Amounts must be between $1,000,000 and $20,000,000. The amounts may be edited based upon Legislature approval of future appropriations.
Total Proposal Cost: Provide the total proposal cost, in dollars. This amount must agree with the total proposal cost shown in Attachment 3 Budget Table is the sum of the Local Contribution (Cost Share) and Grant Funds Requested.
GEOGRAPHIC INFORMATION *GRanTS requests latitude and longitude in degrees, minutes, and seconds.* *You may use converters on the web, such as https://www.fcc.gov/media/radio/dms-decimal*
Latitude: Enter the latitude at the location that best represents the Project area. This should be taken from the center of the Project site.
Longitude: Enter the longitude at the location that best represents the Project area. This should be taken from the center of the Project site.
Longitude/Latitude Clarification: Only use if necessary to explain the location. (Maximum Character Limit: 250)
Location: Identify the approximate location that best represents the center of the Project area. Provide cross-streets or the closest main streets for reference. Provide City and County(-ies) the Project is located in for frame of reference. (Maximum Character Limit: 100)
County(-ies): Provide the County(ies) in which the Project is located.
Groundwater Basins: Provide the groundwater basin as listed in the current version of DWR Bulletin 118 (https://water.ca.gov/Programs/Groundwater-Management/Basin-Boundary-Modifications) in which the Project is located. Only one application per basin is allowed.
Hydrologic Regions: Provide the hydrologic region in which the Project is located. For proposals covering multiple hydrologic regions, hold down the control key and select all that apply.
Watershed(s): Provide the name of the watershed(s) the groundwater basin underlies (Maximum Character Limit: 250)

TABLE 3 – GRANT APPLICATION CHECKLIST (NOT FOR ROUND 1)
A map of California watershed can be found at the following link: https://www.conservation.ca.gov/dlrp/grant-programs/watershed/Documents/CALFED_Watershed_Map[1].pdf. If the groundwater basin covers multiple watersheds, you may only provide one "Unique Watershed Number" as listed on the watershed map and should be the one that the majority of the Project is located.
LEGISLATIVE INFORMATION
Enter the State Assembly, State Senate, and U.S. Congressional Districts in which the groundwater basin is located. For proposals covering multiple State Assembly, State Senate, and U.S. Congressional Districts, hold the control key down and select all that apply. Maps of these districts are found at: http://www.legislature.ca.gov/legislators_and_districts/legislators/your_legislator.html.
PROJECTS TAB ***This section contains information about the project contained in the Proposal.*** *Applicants must enter all information listed in the Projects Tab of this Checklist (Table 3) along with any field marked with an asterisk (*).*
PROJECT INFORMATION
Project Name: Provide the title of the Project (Maximum Character Limit: 150) DO NOT include the solicitation name in the Project name (e.g., SGMA Implementation). The Project name will remain the same for the life of the grant and must match identically with all invoices and timesheets that will be provided in invoicing if the Project is selected for funding.
Implementing Organization: This should be GSAs, member agencies of GSAs, an entity that represents a GSA(s) (which can include public agencies, non-profit organizations, public utilities, federally recognized Indian Tribes, State Indian Tribes listed on the Native American Heritage Commission's Tribal Consultation list, or mutual water companies), and agencies with an Alternative to a GSP.
Secondary Implementing Organization: Not applicable to this solicitation
Proposed Start Date: This date includes local cost share and reimbursement; therefore, the Start Date should be after the date the 2021 Guidelines and PSP were approved (approximately December 24, 2021).
Proposed End Date: This is the last date that funds can be reimbursed for the Project; therefore, the End Date should be before June 30, 2025 (end date could be subject to change based upon legislative approval of future appropriations).
Scope of Work: Describe the type(s) of work proposed and task(s) needed to complete work. (Maximum Character Limit: 450)
Project Description: Provide a generalized description of the proposed Project. Provide the need the Project will meet and how the proposed Project will meet the need(s). (Maximum Character Limit: 1,000)
Project Objective: Provide a description of the proposed Project's objectives, the goals and targets needed to meet those objectives, and how the proposed Project will meet those. (Maximum Character Limit: 500)
PROJECT BENEFITS INFORMATION
Benefit Level: Leave blank.
Benefit Type: Leave blank.
Benefit: Leave blank.
Description: Leave blank.
Measurement: Leave blank.
PROJECT BUDGET *The following budget items should be taken from the Grant Proposal Summary Budget*
If only one Project (no components) is being proposed, use the "Copy Budget data from Applicant Info" feature to populate previously entered data. Otherwise, enter individual budget items for each Project component in the same manner as described for the Applicant Information Tab. The sum of the budget items must agree with the total project budget.
GEOGRAPHIC INFORMATION
Enter the geographical information for each individual Project and Project component location (latitude and longitude in degrees, minutes, and seconds).
LEGISLATIVE INFORMATION ***(Note: for each Project component; different from Applicant Information)***
If only one Project is being proposed, use the "Copy Legislative data from Applicant Info" feature to populate previously entered data. Otherwise, enter legislature information for each Project component in the same manner as described for the Applicant Information Tab. For projects covering more than one district, hold the control key down and select all that apply.

TABLE 3 – GRANT APPLICATION CHECKLIST (NOT FOR ROUND 1)
QUESTIONS TAB *The answers to these questions will be used in processing the application and determining eligibility and completeness.*
Q.1. Project Description: Provide a brief abstract of the proposal. This abstract must provide an overview of the proposal including the main issues and priorities addressed in the proposal. (25 words or less)
Q.2. Previous Funding: Has the applicant received prior funding through another grant source? If so, identify the source and amount of funding provided for the Project.
Q.3. Project Representatives: Provide the name and details of the Project Director who is responsible for signing and executing the Agreement for the applicant. This is the authorized person as outlined within the adopted resolution and the title within the adopted resolution must align with the title provided here. Persons that are contractors/consultants or their subs cannot be listed as the Project Director. Other entities included in the GSA can be listed here.
Q.4. Project Manager: Provide the name, title, and contact information of the Project Manager from the applicant agency or organization that will be the day-to-day contact on this application. This person must be an employee of the applicant agency and cannot be contactors/consultants or their subs.
Q.5. Eligibility: Has the applicant met the requirements listed within the 2021 Guidelines and submitted the Eligibility Criteria Self-Certification form? Q.5.1. Is the proposed Project consistent with the goals within the GSP or Alternative to a GSP?
Q.6. Eligibility: To satisfy SB 985 requirements, all stormwater and dry weather capture projects must be listed in a SWRP or approved FE-SWRP that is consistent with the relevant code provisions enacted by SB 985 (Water Code §10562 (b)(7)) as determined by the State Water Board. The SWRP or FE-SWRP must be incorporated within the local Integrated Regional Water Management Plan (IRWMP). The definition of a stormwater and dry weather capture project is provided within Appendix B of the 2021 Guidelines.
Q7. Underrepresented Community Assistance: Will the Project benefit an Underrepresented Community? Q.7.1.: If so, how much of the funds requested will directly benefit the Underrepresented Community? Q.7.2: How much of the funds being requested will benefit an SDAC?
Q.8. Certification: By submitting the application, the applicant and its authorized representative are certifying that: a) The applicant is an eligible entity; b) He/She/They is/are aware that any attachment exceeding the page limit listed in the attachment templates will NOT be reviewed; c) He/She/They is/are aware that, once the proposal is submitted in GRanTS, any privacy rights and other confidentiality protections offered by law with respect to the application package and project location are waived; d) He/She/They is/are aware that, if the proposed Project is chosen for funding, any privacy rights and other confidentiality protections offered by law with respect to any portion of the grant (including the Agreement, all deliverables, all invoices, and backup documentation supporting the invoices, and all reporting requirements outlined within the agreement) are waived; e) He/She/They agrees/agree to the Start and End Dates provided in this application and will complete the project within the dates provided; and f) **He/She/They, and their attorney, has/have read and agrees to all the Terms and Conditions of the Agreement template.**
CLIMATE RISK IN INVESTMENTS TAB *The answers to these questions will be used in surveying Program applicants.*
Q.9. Climate: Does the organization have a primary point of contact for climate change? (Yes/No. If yes, who is it and to what position in the organization does that person report?)
Q.10. Climate: Does the organization have a strategic business plan that considers climate change? (Yes/No. If yes, please submit a copy.)
Q.11. Climate: Has the organization adopted any policies or made any formal public statements about climate change? (Yes/No. If yes, please submit a copy.)
Q.12. Climate: Has the organization conducted a climate change vulnerability assessment? (Yes/No. If yes, please submit a copy.)
Q.13. Climate: How would you describe your organization's capacity to adapt to the impacts of climate change? (Open ended; one to three paragraphs.)

ATTACHMENTS TAB	*Provide the attachments listed below by attaching files to the GRanTS application. When attaching files, please use the naming convention found in Section V.B of this PSP. Requirements for information to be included in these attachments are found in Section V.B.2 of this PSP or in the supplied templates.*
ATTACHMENT #	ATTACHMENT TITLE
Attachment 1	Authorizing Documentation (e.g., adopted resolution using example provided on Page 18)
Attachment 2	Eligibility Criteria Self-Certification Form
Attachment 3	Work Plan **(Applicant MUST use supplied template)**
Attachment 4	Maps, supporting letters, figures, tables, or budget backup documentation (Optional)

ATTACHMENTS TAB INSTRUCTIONS (not for Round 1)

Within the Attachments Tab, applicants are required to submit up to three attachments, as applicable, to complete the SGMA Implementation grant solicitation application. A discussion of each attachment is provided below. Attachments 1 and 2 (Authorizing Documentation and Eligibility Criteria Self-Certification Form) are mandatory and provide backup documentation for the eligibility of an applicant. Attachments 3 (Work Plan) is also mandatory and will be scored during the application review based upon the applicant using the templates provided on the Program website.

ATTACHMENT 1. AUTHORIZING DOCUMENTATION

For the "AttachmentName" in the naming convention of GRanTS, use the following for this attachment:

Att1_SGM_AuthDoc_#of#".

The applicant must provide an adopted resolution that has been adopted by the applicant's governing body designating an authorized representative to submit the application and execute an agreement with the State of California for the SGMA Implementation grant application. An adopted resolution must be provided before DWR can enter into an agreement with the Grantee. If a resolution cannot be adopted prior to the application submittal, a draft can be submitted with a note of when an adopted resolution is expected.

If an entity is acting on behalf of a GSA, then an adopted resolution from the GSA is required authorizing the applicant entity to act in such a role. Furthermore, a resolution is required by the entity acting as applicant stating authorization to work on behalf of the GSA. Therefore, no less than two adopted resolutions are required for the application and grant execution.

The following text box provides an example of the resolution that must be submitted to fulfill this requirement.

RESOLUTION NO. _____

Resolved by the *<Insert Name of Applicant Governing Body>*, that an application be made to the California Department of Water Resources to obtain a grant under the 2021 Sustainable Groundwater Management (SGM) Grant Program SGMA Implementation Round *<insert funding round>*Grant pursuant to the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access For All Act of 2018 (Proposition 68) (Pub. Resource Code, § 80000 et seq.) and the California Budget Act of 2021 (Stats. 2021, ch. 240, § 80) and to enter into an agreement to receive a grant for the: *<Insert Project Name>*. The *<Insert title of Authorized Applicant Official>* of the *<Insert Name of Applicant>*, or designee, is hereby authorized and directed to prepare the necessary data, conduct investigations, file such application, and execute a grant agreement and any future amendments (if required), submit invoices, and submit any reporting requirements with the California Department of Water Resources. Passed and adopted at a meeting of the *<Insert Name of Applicant>* on *<Insert date>*.

Authorized Original Signature:_____
Printed Name:_____
Title:_____
Clerk/Secretary:_____

CERTIFICATION

I do hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the *<Insert Name of Applicant>* held on *<Insert date>*.

Clerk/Secretary:_____

DWR highly recommends you follow this language verbatim to ensure that the resolution is sufficient to execute an agreement, execute future amendments (if required), submit invoices, and submit all reporting requirements. ***Any deviation from this template may result in a delay in executing the Agreement and beginning the Project***.

ATTACHMENT 2. ELIGIBILITY CRITERIA SELF-CERTIFICATION FORM

For the "AttachmentName" in the naming convention of GRanTS, use the following for this attachment:

"Att2_SGM_EligDoc_#of#".

The applicant must use the form located on the Program website (www.water.ca.gov/sgmgrants) and upload the completed form as Attachment 2. Details for the eligibility criteria can be found in Section III.C. of the 2021 Guidelines.

ATTACHMENT 3. WORK PLAN (not for Round 1)

For the "AttachmentName" in the naming convention of GRanTS, use the following for this attachment:

"Att3_SGM_WrkPlan_#of#".

Attachment 3 must contain the Project description, a Scope of Work, one budget summary table, and one schedule table. The budget categories, schedule tasks, and scope of work must align with one another. The Work Plan template should be downloaded from the Program webpage at www.water.ca.gov/sgmgrants.

The Work Plan **MUST NOT EXCEED** the page limits as detailed in Table 4 below. Pages must use a minimum Arial, 10-point type font. Anything greater than the maximum allowed page will not be

reviewed or used in our scoring of the application. Maps, supporting letters, or figures should NOT be included within the Work Plan document and should be uploaded separately. There is no limit to the maps, supporting letters, figures, or tables. Please refer to the template for specific details that should be included. An outline and general description are provided in the table below. **Any changes made to the Word template will not be reviewed or scored by DWR technical staff.**

TABLE 4 – WORK PLAN TEMPLATE OUTLINE

Section Title	Section Description	Maximum Page Limit
GENERAL PROJECT DESCRIPTION	Provide a narrative description of the proposed Project (or component), a brief description of the groundwater basin from the GSP, and a description of communities served by the Project. Describe how the Project (or component) will help to meet or meet the sustainability goal(s) outlined in the GSP or Alternative to a GSP. Provide the goal(s) and target(s) using quantifiable benefits only (e.g., acre-feet per year (AFY) captured, AFY recharged, etc.). Other benefits can be discussed but will not increase your score.	4 PAGES PER COMPONENT
SCOPE OF WORK AND DELIVERABLES	Descriptions of the anticipated tasks necessary to complete the proposal. Tasks should be organized by the budget categories, as indicated in the template. Each task identified in the proposal must have a minimum of one deliverable. Deliverables should be actual work products that can be submitted to DWR.	2 PAGES PER COMPONENT
BUDGET	In the table provided in the template, provide the estimated costs for each budget category. If the Project has components, the budget summary is an estimate per component only. This is a summary budget only. If desired, backup documentation for the cost estimates can be provided in a separate document along with the maps, figures, or tables. Local Cost Share (aka. Matching Funds) are not required. However, additional points will be provided for those who provide Local Cost Share at a minimum of 5% of the total project cost.	2
SCHEDULE	In the table provided in the template, provide a schedule for each budget category showing the sequence and timing of each of the tasks and subtasks, depending on how the tasks and subtasks are outlined in the Work Plan's Scope of Work and Deliverables and Budget table.	2

Use Table 5: Proposal Summary Budget Table (Table 5A, No Components) or Component Summary Budget (Table 5B, Multiple Components). Costs must be broken down consistent with how tasks are presented in the Scope of Work section of the Work Plan. For example, if the Scope of Work describes projects at the task and subtask level, the budget must also present costs at the task and subtask level.

NOTE: the maximum grant administration budget cannot exceed 10% and the maximum construction administration budget cannot exceed 15% of the requested grant funds. Grantees shall invoice and report on a quarterly basis only. The technical assistance provider may invoice and report on a monthly basis.

Grant Proposal Summary Budget

If there are no components to the proposal, Table 5A should be used.

TABLE 5A – GRANT PROPOSAL SUMMARY BUDGET (NO COMPONENTS)

GRANT PROPOSAL TITLE: _____

Budget Categories [1]	(a) Requested Grant Amount	(b) Local Cost Share: Non-State Fund Source[2]	(c) Total Cost	(d) % Local Cost Share (Col (b))/(Col (c))
(a) Grant Administration	$0	$0	$0	
(b) Planning / Design / Environmental	$0	$0	$0	
(c) Construction / Implementation	$0	$0	$0	
(d) Monitoring / Assessment	$0	$0	$0	
(e) Interested Parties Outreach / Public Education	$0	$0	$0	
Grand Total *Sum rows (a) through (e) for each column*	**$0**	**$0**	**$0**	**0%**

[1] Only these Budget Categories shall be used. Tasks can be added for more detail. **If any Budget Category is edited, the budget will not be scored.**

[2] List sources of funding: *Use as much space as required here. If reporting Local Cost Share, Local Cost Share is calculated based on the total project cost (grant amount plus match), **not** the grant amount. Local Cost Share will not be included in the Agreement, if awarded, and will only be used as a tool for scoring the grant application.*

If there are components, Table 5B should be used.

TABLE 5B – GRANT PROPOSAL SUMMARY BUDGET (MULTIPLE COMPONENTS)

GRANT PROPOSAL TITLE: _____

Budget Categories [1]	(a) Requested Grant Amount	(b) Local Cost Share: Non-State Fund Source[2]	(c) Total Cost	(d) % Local Cost Share (Col (b)/ Col (c))
Component 1 Grant Administration	$0	$0	$0	
Component 2: Title	$0	$0	$0	
Component 3: Title	$0	$0	$0	
Component n: Title	$0	$0	$0	
Grand Total *Sum rows (1) through (n) for each column*	**$0**	**$0**	**$0**	**%**

[1] These components are shown here for example purpose only. Actual number of components may vary.

[2] List sources of funding: *Use as much space as required. Local Cost Share is calculated based on the total project cost (grant amount plus match), **not** the grant amount. Local Cost Share will not be included in the Agreement, if awarded, and will only be used as a tool for scoring the grant application.*

Grant Proposal Summary Schedule

The schedule should show the sequence and timing of each of the tasks and subtasks, depending on how the tasks and subtasks are outlined in the Scope of Work and Budget table. Please use Table 6A for applications without components and Table 6B for applications with multiple components.

The proposal dates within the proposal must start and end at the following dates:

Start Date – Reimbursable grant funds begin after the date the 2021 Guidelines and PSP are approved (anticipated for December 17, 2021).

Work Completion Date – All work, including final invoicing and reporting and retention invoice, must be completed on or before June 30, 2025. Actual end date may be edited based upon future appropriations and legislature approvals.

The dates within the Schedule cannot be before the Start Date listed above or after the Work Completion Date. The Work Completion Date is the date that all deliverables and invoices are submitted to DWR and approved by the DWR Grant Manager. The Work Completion Date IS NOT the construction end date. Absolutely no work will be reimbursed or reported as local cost share after the Work Completion Date.

TABLE 6A – GRANT PROPOSAL SCHEDULE (NO COMPONENTS)

GRANT PROPOSAL TITLE: _____

Categories	Start Date (Earliest Start Date)	End Date (Latest End Date)
(a) Grant Agreement Administration		
Task n. xx		
(b) Planning / Design / Environmental		
Task n. xx		
(c) Construction / Implementation		
Task n. xx		
(d) Monitoring / Assessment		
Task n. xx		
(e) Interested parties Outreach / Public Education		
Task n. xx		

TABLE 6B – GRANT PROPOSAL SCHEDULE (MULTIPLE COMPONENTS)

GRANT PROPOSAL TITLE: _____
COMPONENT TITLE: _____

Categories	Start Date	End Date
Component 1: Grant Agreement Administration	Earliest Start Date	Latest End Date
(a) Grant Agreement Administration		
Task 1. xx		
Task n. xx		
Component 2: Title	Earliest Start Date	Latest End Date
(a) Component Administration		
Task 1. xx		
Task n. xx		
(b) Planning / Design / Environmental		
Task 1. xx		
Task n. xx		
(c) Construction / Implementation		
Task 1. xx		
Task n. xx		
(d) Monitoring / Assessment		

Categories	Start Date	End Date
Task 1. xx		
Task n. xx		
(e) Stakeholder Outreach / Public Education		
Task 1. xx		
Task n. xx		
Component n: Title	Earliest Start Date	Latest End Date
(a) Component Administration		
Task 1. xx		
Task n. xx		
(b) Planning / Design / Environmental		
Task 1. xx		
Task n. xx		
(c) Construction / Implementation		
Task 1. xx		
Task n. xx		
(d) Monitoring / Assessment		
Task 1. xx		
Task n. xx		
(e) Interested parties Outreach / Public Education		
Task 1. xx		
Task n. xx		

VI. Application Review

All applications will first be screened for eligibility and completeness in accordance with Section VI of the 2021 Guidelines and Section III of this PSP. The information provided by applicants in GRanTS, as well as Attachments 1 through 3 of the application, will be used in determining eligibility and completeness. The final dates for all proposals for both Round 1 and Round 2 will be provided in the grant solicitation announcement and posted on the SGM Grant Program website (www.water.ca.gov/sgmgrants).

A. Round 1

All complete and eligible applications will require a self-evaluation be submitted with the application package. Applicants will self-evaluate their application based on the evaluation questions presented below in Table 7 – Application Evaluation Criteria. Eligible applicants should submit their self-evaluation form and spending plan to sgwp@water.ca.gov no later than **noon on February 18, 2022**. SGM Grant Program staff will meet with each eligible applicant to review their spending plan and self-evaluation forms to determine the final project list for award.

B. Round 2

All complete and eligible applications will be evaluated, scored, and ranked based on the evaluation questions presented below in Table 7 – Application Evaluation Criteria. Please note that the application and/or review questions outlined in Table 7 – Application Evaluation Criteria may be reworded, combined, or separated as the information is transferred into our online application tool (e.g., GRanTS or other application). SGM Grant Program staff may make clarifying or editorial changes to the application following PSP approval. Table 7 is subject to change depending on the final preparations of the review questionnaire and various application templates. No substantive changes will be made to the evaluation criteria and scoring scheme.

For proposals with multiple components, the evaluation will be repeated for each component. The score for a proposal with multiple components will be determined by summing each individual component's total score, dividing that summation by the number of components for the Component Average Score, and then rounding up or down to the nearest whole number (Final Score). See Table 7 for an example of the scoring criteria.

DWR staff may recommend reducing individual grant amounts from the requested amount. However, such reductions will be considered only if technical reviewers have indicated that the budget is too high for the task(s)/component(s) described or some tasks/components are determined to be ineligible for the grant program or are not necessary for project completion. A reduction would also be weighed against whether the reduced funding would impede project implementation or if the proposed budget is determined inconsistent with similar projects. A reduction in requested grant funds can also occur when a greater number of well-qualified projects are requesting grant funds greater than the funding available.

If multiple applications are received within a single basin, DWR will contact the applicants and request that a consolidated application for the basin be submitted before the close of the open filing period, if feasible. If identified after the close of the solicitation, DWR will work with the multiple applicants to consolidate, if awarded.

VII. Award Process

Funding will be allocated to proposals consistent with minimum and maximum award amounts, using the proposal score, professional judgement, and available funding. DWR's funding recommendation may vary from grant funding requests.

Following funding awards DWR will execute an Agreement with the Grantee. Agreements are not executed until signed by both the authorized representative of the Grantee and DWR. The Grantees

have approximately six months to obtain an executed Agreement after the grant award notification letter is sent by DWR. The exact date for Agreement execution will be outlined in the grant award notification letter. DWR reserves the right to withdraw an award due to lack of responsiveness on the part of the applicant.

Please note that the review questions outlined in Table 7 may be reworded, combined, or separated. SGM Grant Program staff may make clarifying or editorial changes to the scoring criteria following approval. SGM Grant Program staff may also make changes to Table 7 depending upon language outlined in future appropriations and legislative requirements. ***Table 7 is subject to change depending on the final preparations of the review questionnaire.*** *No substantive changes will be made to the evaluation criteria and scoring scheme.*

TABLE 7 – APPLICATION EVALUATION CRITERIA

Section Name	Q#	Questions	Possible Points	Scoring Guidance
General	1	Was a description of the proposed Project or Component provided? Did it explain why this Project or Component was chosen over all others identified in the Plan in terms of benefits provided, communities served, measurable objectives, minimum thresholds, plan implementation timeline, and feasibility? If you feel a question component does not apply to your proposed project, please explain why it is not applicable. (Example "Measurable objective not applicable because project is planning only".) • *No funds will be awarded without clear justification for the proposed tasks/subtasks.*	4	• 4 – Fully addressed • 3 – Mostly addressed, with minor details not included or unclear • 2 – Mostly addressed, with significant details missing or unclear • 1 – Marginally addressed • 0 – Not addressed
General Implementation Only	2-Imp	Does the Project or Component provide a description of quantifiable benefits? Was an explanation of the benefits that are expected to be realized from the Project or Component provided, along with how those benefits will be evaluated and quantified? • *To obtain full points, 3 or more quantifiable benefits must be identified and fully supported with backup documentation.*	4	• 4- At least three quantifiable benefits with explanations and supporting documents. • 3 – Two quantifiable benefits with explanations and supporting documents. • 2 - Two quantifiable benefits lacking explanations and supporting documents. • 1 - One quantifiable benefit with explanations and supporting documents. 0 – Benefits provided but are not explained or quantified.
General Planning Only	2-Plan	Does the Project Description describe a well-coordinated proposal including a GSP(s) that encompasses the entire basin or describes why a portion of the basin is not covered in the proposal? Does it describe how well the multiple GSA(s) surrounding and within the basin are working together?	4	• 4 – Fully addressed • 3 – Mostly addressed, with minor details not included or unclear • 2 – Mostly addressed, with significant details missing or unclear • 1 – Marginally addressed • 0 – Not addressed
General	3	Does the Project or Component fully describe their plan for outreaching and engaging interested parties (e.g., residents, local leaders, non-profit representing Underrepresented Communities, etc.) located within Underrepresented Communities? Does the outreach and engagement include interested parties during all phases of the Project or Component (e.g., planning, design, and implementation)? Can interested parties provide input and be involved in the decision-making processes? • *To obtain full points, a minimum of three comment letters are required from the Underrepresented Communities.*	3	• 3 – Interested parties included on decision-making committees and fully engaged/involved in all aspects of the Project or Component • 2 – Interested parties engaged/involved, but not included on decision-making committees • 1 – Marginally addressed • 0 – Not addressed
General	4	Was there a regional and Project map(s) depicting the site location, current conditions, and benefitting areas? • *The information should be clear and easy to read. If not, the point will not be given.*	2	• 2 – Provided and all necessary information provided • 1 – Provided but missing some information • 0 – Not provided

General	5	Does the project benefit an Underrepresented Community (-ies)? Was there a map(s) depicting the Underrepresented Community (-ies) that the project will benefit? Does the project benefit an SDAC? Was there a map(s) depicting the SDAC(s) that the project will benefit? Please provide the amount of funding that will benefit both the Underrepresented Community and SDAC. • *No points will be given if a map(s) is not provided.*	3	• 3- Project benefits an SDAC(s) • 2- Project benefits Underrepresented Community • 1 – Project partially benefits either • 0 – Project does not benefit either
General	6	Will the Project or Component positively impact issues associated with small water systems or private shallow domestic wells (e.g., groundwater contamination vulnerability, drawdown, etc.)? Was justification such as domestic well census results, water system maps, service area maps, etc. provided? Does the Project or Component help address the needs of the State Water Board's SAFER Program?	3	• 3 – Fully addressed • 2 – Mostly addressed, with minor details not included or unclear • 1 – Marginally addressed • 0 – Not addressed
General	7	How does the proposed Project or Component address the Human Right to Water (AB 685 Section 106.3)? How will the Project or Component support the established policy of the State that every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes?	4	• 4 – Fully addressed • 3 – Mostly addressed, with minor details not included or unclear • 2 – Mostly addressed, with significant details missing or unclear • 1 – Marginally addressed • 0 – Not addressed
Scope of Work	8	Did the proposal provide a description of the tasks/subtasks that will be completed as part of this grant Project? • *No funds will be awarded without clear justification for the proposed tasks/subtasks.*	3	• 3 – Fully addressed • 2 – Mostly addressed • 1 – Marginally addressed • 0 – Not addressed
Budget	9	Is a budget summary table provided? Is the budget reasonable for the project? Is the budget table tasks/subtasks provided in the scope of work coincide with the tasks/subtasks in the budget and schedule tables? Is local cost share included (minimum of 5%)? Local cost share may include costs expended on projects before grant agreement date. • *Local cost share is not required but necessary to obtain full points.*	3	• 3 – Local cost share is provided, and budget is consistent and feasible • 2 – Budget is consistent and feasible • 1 – Budget is consistent but not feasible • 0 – Not consistent and feasible
Schedule	10	Is the tasks/subtask in the schedule table consistent with those listed in the budget table and within the description in the application? Is the schedule feasible?	1	• 1 – Consistent and feasible • 0 – Not consistent and feasible
		Total Range of Possible Points	0-30	
		(a) Average of Questions 1 – 8 for Multiple Component Applications		
		(b) Total Score for Questions 9 and 10		
		Total Points Overall Project:		
		TOTAL FUNDING RECOMMENDED:		$

Subject #4: Airborne Electromagnetic (AEM) Survey Results

THE CALIFORNIA DEPARTMENT OF WATER RESOURCES' STATEWIDE AIRBORNE ELECTROMAGNETIC SURVEY PROJECT

DATA REPORT FOR SURVEY AREA 2
TULELAKE, BIG VALLEY, AND FALL RIVER VALLEY

RAMBOLL

Eclogite Consulting

GEI Consultants

SKYTEM

RAS
REALtime Aquifer Services

HydroGeophysics Group
AARHUS UNIVERSITY

Sinton HELICOPTERS

CALIFORNIA AIRBORNE ELECTROMAGNETIC SURVEYS

TULELAKE, BIG VALLEY, AND FALL RIVER VALLEY

Project name	California Airborne Electromagnetic Surveys for the Scott River Valley, Shasta Valley, and Butte Valley
Project no.	1690021880, Work Order 2
Recipient	California Department of Water Resources – Sustainable Groundwater Management Office
Document type	Report
Version	1
Date	October 11, 2022
Prepared by	Ahmad-Ali Behroozmand, Chris Petersen, Julián Consoli, Ian Gottschalk, Kaylee Glenney, Max Halkjaer, Paul Thorn, Peter Thomsen
Checked by	Timothy K. Parker
Approved by	Timothy K. Parker, Max Halkjaer
Description	This is a data report describing the acquisition, processing, inversion and lithology transform for the AEM survey conducted in Tulelake, Big Valley, and Fall River Valley Groundwater Basins. In addition, the report provides a description of the well data collected along the planned flight lines and the projects data management system.

Timothy K. Parker, PG

10/18/2022
Date

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LIST OF ABBREVIATIONS AND ACRONYMS

ACT	Accumulated Coarse Thickness
AEM	Airborne Electromagnetic
CF	Clay Fraction
DMS	Data Management System
DOI	Depth of Investigation
DWR	Department of Water Resources
EC	Electrical Conductivity
EM	Electromagnetic
GAMA	Groundwater Ambient Monitoring and Assessment
GIS	Geographic Information System
GPS	Global Positioning System
GSP	Groundwater Sustainability Plan
km	Kilometer
L	Liter
m	Meter
mg	Milligrams
OSWCR	Online System for Well Completion Reports
PLSS	Public Land Survey System
QA	Quality Assurance
QC	Quality Control
SGMA	Sustainable Groundwater Management Act
SR	State Route
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TEM	Time-domain (or Transient) Electromagnetics
USCS	Unified Soils Classification System

ACKNOWLEDGEMENTS

DWR would like to acknowledge the AEM Survey project partners, including the Groundwater Sustainability Agencies (GSAs) for Tulelake, Big Valley, and Fall River Valley, California Geologic Survey, California Department of Fish and Wildlife, California Department of Food and Agriculture, California State Water Resources Control Board, and United States Geologic Survey. This project was funded through the California Drought, Water, Parks, Climate, Coastal Protection and Outdoor for all Fund (Senate Bill 5, Proposition 68).

PROJECT TEAM

The project team for the AEM Survey covering the Scott River Valley, Shasta Valley, and Butte Valley includes:

Ramboll – responsible for coordination of the contractors, onsite geophysicist during data acquisition, data processing and inversion, lithology model, initial hydrostratigraphic model, reporting and quality control of deliverables.

GEI – collected and compiled well data into the data management system and assisted in report preparation.

SkyTEM – coordinated the AEM surveys field operation, providing the AEM equipment and leading the field work.

Sinton Helicopters – provide helicopter, pilots, AEM instrumentation and flew the AEM survey.

AECOM – assisted DWR with outreach to the local GSA's and authorities, plan the location of the flight lines, assisting with the initial collection of well data from the GSA's.

Eclogite – digitized well lithology and geophysical logs.

RealTime Aquifer Services – provided additional geophysical logs in digital format.

Aarhus University, Denmark – assisted with the lithology model and the initial hydrostratigraphic model.

AEM DATA REPORT AND USE DISCLAIMER

This Data Report was prepared by the Project Team for the California Department of Water Resources (DWR). DWR makes no warranties, representations or guarantees, either expressed or implied, as to the accuracy, completeness, correctness, or timeliness of the information provided in this report or related datasets that are accessible through the California Open Data Portal, nor accepts or assumes any liability arising from use of the AEM data or reports. Neither the Department nor any of the sources of the information utilized by the contractor to develop the report and datasets shall be responsible for any errors or omissions, or for the use or results obtained from the use of this information. Classifications and boundaries shown in this report are graphical representations only, and do not establish legal rights or define legal boundaries. A Groundwater Sustainability Agency is not required to use the AEM report and underlying data, and their use does not guarantee the adequacy of a Groundwater Sustainability Plan that relies on such data.

0. EXECUTIVE SUMMARY

Regional airborne geophysical surveys are being conducted by the California Department of Water Resources (DWR) and its contractors in all of the state's high- and medium-priority groundwater basins to collect data on the geometry and geologic properties of the underlying aquifer systems that provide groundwater to local communities (Figure 0-1). The focus of this report is the Tulelake, Big Valley, and Fall River Valley geophysical survey (Figure 0-1). The regional geophysical surveys, which use the airborne electromagnetics (AEM) technique, have been compared to an MRI to see beneath the ground surface. The AEM data and products from the surveys are being provided to assist local water managers and the state as they implement the Sustainable Groundwater Management Act (SGMA) to manage groundwater for long term sustainability. The AEM surveys are funded by voter-approved Proposition 68. All data from the surveys are being made available to the public online.

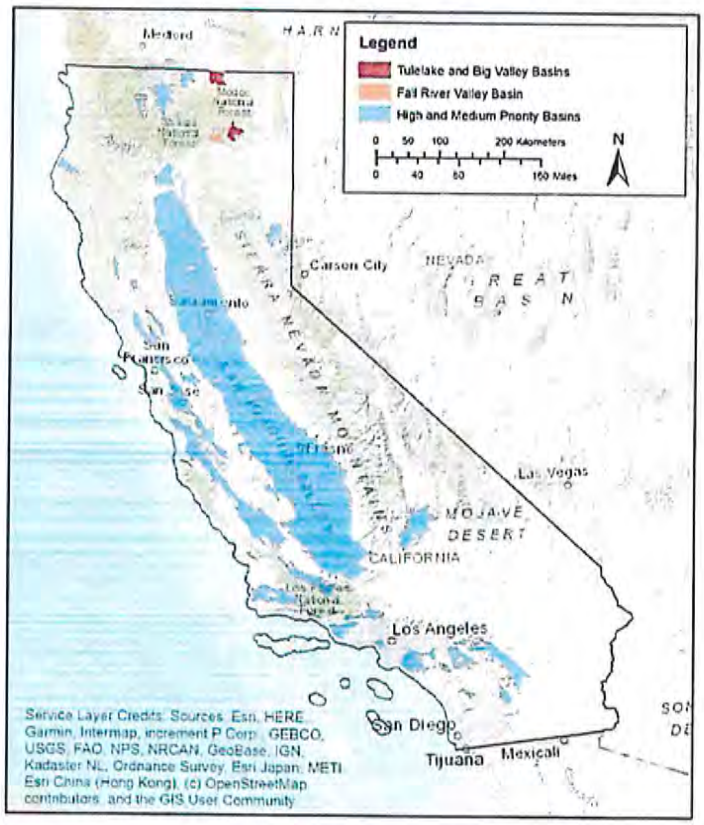


Figure 0-1 SGMA high and medium priority groundwater basins in California. The Tulelake and Big Valley Groundwater Basins which are a medium priority, are shown in red and the Fall River Valley Groundwater Basin, a low priority basin, is shown in orange.

The AEM survey technique utilizes a helicopter flying approximately 80 kilometers per hour (50 miles per hour). The geophysical equipment is mounted on a large hexagonal frame and suspended below the helicopter about 30 meters (100 feet) above the ground surface (Figure 0-2) The AEM equipment sends a pulsating, weak electromagnetic signal into the ground and measures the response, which provides an electrical resistivity profile of the earth's geological layers and structures down to depths of as much as 300 meters (1,000 feet). Aquifer systems generally consist of (1) aquifers typically composed of sands and gravels that have high resistivities, and (2) aquitards composed of silt and clays that have low resistivities. The resistivity profiles aid in mapping the overall aquifer systems' dimensions and extent. The AEM survey data are analyzed in detail, correlated with data from nearby wells, and typically modeled to produce maps of the subsurface resistivity, lithology, and an initial hydrostratigraphic model. In this project, the landscape is dominated by volcanic rocks, which have high resistivities and present challenges when modeling the lithology and hydrostratigraphy.

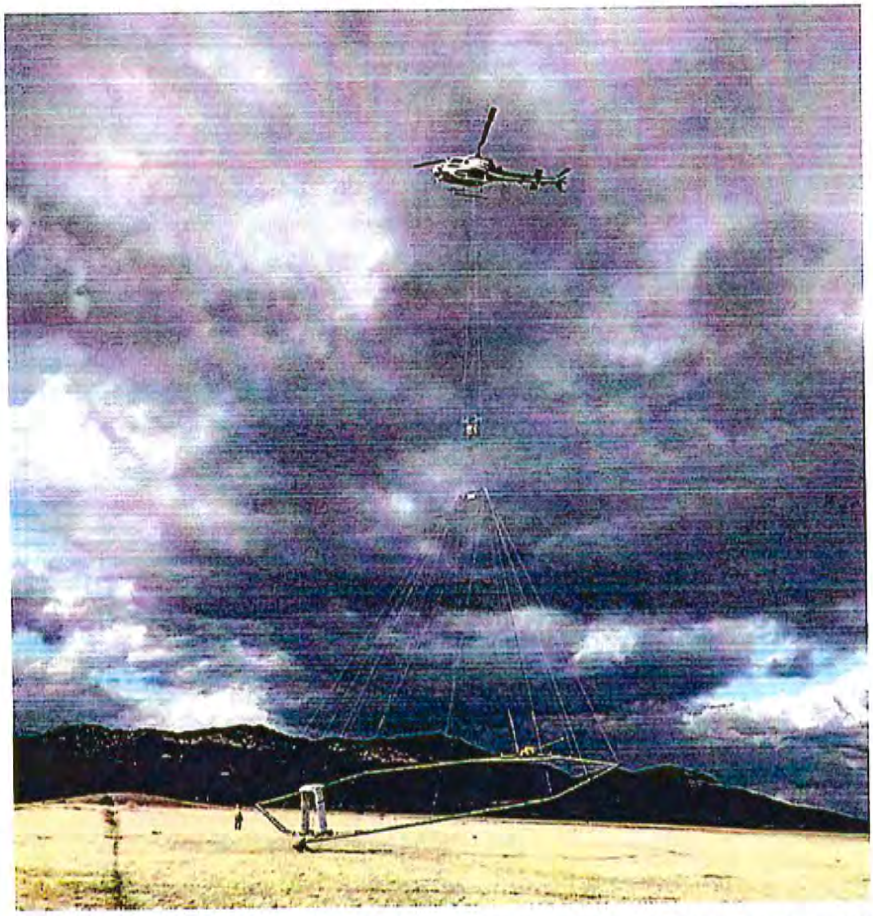


Figure 0-2 Helicopter raising the hexagonal SkyTEM system to start collecting AEM data during the survey.

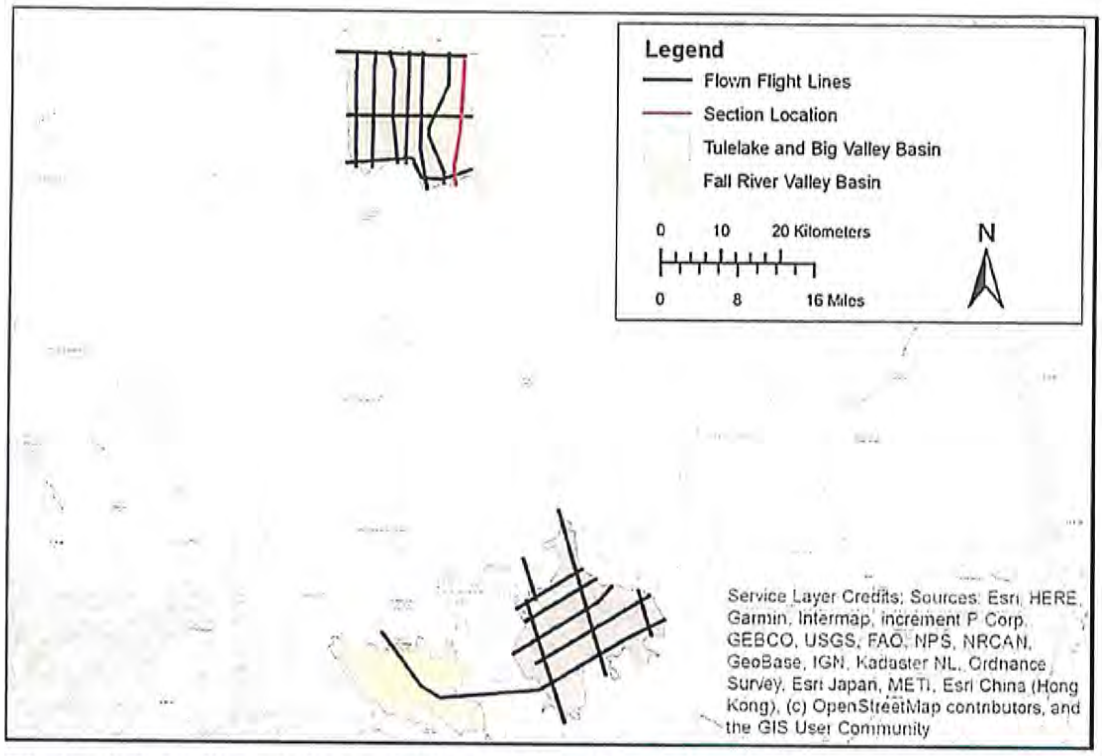


Figure 0-3 Outline of the Tulelake, Big Valley, and Fall River Valley and the flight lines showing where the AEM survey was flown. The red line shows the location of the vertical profile shown in Figure 0-4.

Tulelake, Big Valley, and Fall River Valley AEM Survey

The Tulelake, Big Valley, and Fall River Valley survey was conducted from November 7th to 12th, 2021 totaling 436.0 linear kilometers (270.9 miles). Prior to the survey, public outreach was conducted to provide information about the survey to local residents, media and law enforcement agencies. Both during and after AEM data acquisition, measures were taken to ensure acceptable data quality. This included daily AEM system tests, evaluation of the unprocessed AEM data, and conducting repeat AEM lines to ensure the reproducibility of the collected data.

Well lithology and borehole geophysical logs located along the AEM flight lines were compiled to provide additional data to support and ground-truth the surveys, with the objective of obtaining two high-quality lithology logs in each of the Public Land Survey System one-mile square sections that the flight lines cross. High-quality lithology logs are defined as having a verified location accuracy of less than 50 meters (164 feet), at least 30 meters (98 feet) deep and have an average description interval of less than 30

meters (98 feet). In total, there were 88 high-quality lithology logs and 7 borehole geophysical logs compiled. Groundwater levels and water quality data (as total dissolved solids [TDS]), both of which can affect the subsurface resistivity, were also compiled.

The AEM data were then processed to filter out potential noise in the data and, if necessary, remove the data where interference is too great to effectively filter. Potential sources for noise in the data include electric power transmission lines, railroads, pipelines, and any significant metallic objects. After AEM data processing, resistivity models were produced that in general, provide profiles indicative of coarse-grained (sands and gravels) and fine-grained (silts and clays), represented by higher and lower resistivities, respectively. Three types of models were produced: a smooth resistivity model, showing the gradual resistivity transition with depth, a sharp resistivity model, where subsurface boundaries are inferred from the AEM data, and a few-layer model, which was used for uncertainty calculations. Figure 0-4 shows a vertical resistivity section with the sharp model (top section).

The resistivity and coarse fraction data were combined to produce an initial hydrostratigraphic model for the basin, designating areas or layers of the subsurface having similar hydrogeologic properties. This was done utilizing a clustering algorithm, where the relationship between resistivity and coarse fraction were divided into groups with similar properties. As resistivity and coarse fraction is inherently related to the earth's hydrogeological properties, each group of datapoints represents an individual hydrostratigraphic unit. Based upon the observed relationship between resistivity and the coarse fraction observed in the sediments, a lithology model and an initial hydrostratigraphic model was produced for Tulelake. Figure 0-4 shows a vertical section with the coarse fraction model (second section down) and the initial hydrostratigraphic model (third section). However, for Big Valley, there was no observable relationship between resistivity from the AEM survey and the coarse and fine sediments identified in the lithological descriptions from wells close to the flight lines. Thus, it was not possible to produce a lithologic model or initial hydrostratigraphic model for Big Valley.

The resistivity and lithology profiles will be useful for local groundwater management agencies to refine hydrogeologic conceptual models and groundwater flow models and may also assist in the identification of recharge areas and interconnected surface water.

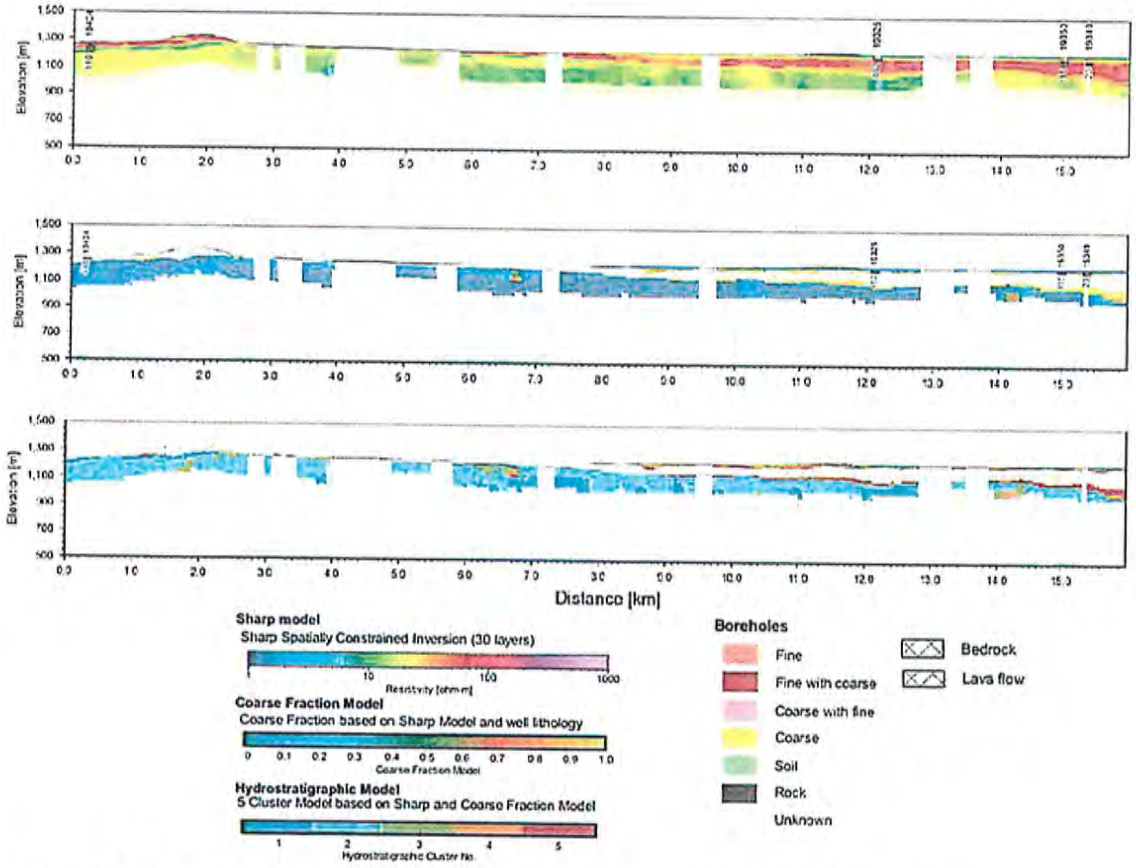


Figure 0-4 Vertical resistivity section series from a AEM flight line in Tulelake. The top section shows the sharp 30-layer resistivity model, the second section shows the coarse fraction model, and the third section shows the initial hydrostratigraphic model. The lava flow, as identified as the area with higher resistivity, is shown on the coarse fraction model and the initial hydrostratigraphic model. The location of the section is shown on Figure 0-3.

1. INTRODUCTION

The California Department of Water Resources (DWR) is currently conducting airborne electromagnetic (AEM) surveys in California's high- and medium-priority groundwater basins. The data from the surveys will assist local water managers as they implement their respective GSPs to comply with the Sustainable Groundwater Management Act (SGMA) to sustainably manage groundwater.

An electromagnetic survey is a geophysical technique conducted from the land surface or the air that measures the electrical properties of the earth's subsurface materials. AEM is an airborne electromagnetic technique that includes a large hexagonal frame containing the geophysical equipment suspended by cable beneath a helicopter about 100 feet above the ground surface along a defined flight path. During the survey, the system sends a weak pulsating electromagnetic signal that penetrates up to approximately 300 meters (1,000 feet) into the earth. The returning signal pulse is picked up by receivers in the frame. The data collected provides a measurement of the electrical resistivity of the different geological strata, providing information on the distribution of coarse-grained and fined-grained materials in the subsurface, as well as groundwater salinity.

This report presents information on the AEM survey conducted in the Tulelake, Big Valley, and Fall River Valley groundwater basins, located in northeastern California (Figure 1-1). Tulelake is a medium priority subbasin of the Klamath River Valley Basin. Big Valley is also designated as a medium priority basin by the state. The Fall River Valley is designated as a low-priority groundwater basin. A limited portion of Fall River Valley was surveyed because it is adjacent to a medium-priority basin (Big Valley) and there is state and federal agency interest in the basin's hydrogeology. This report provides documentation on the data collection, processing, and analysis, including the methods used, results, uncertainty, and quality control.

1.1 Overview of the California State-wide AEM Survey

The DWR has a long history of data collection, monitoring, and reporting to support characterizing California's groundwater basins. *California's Groundwater*, DWR Bulletin 118, Update 2020 (DWR 2020) is the State's official publication on the occurrence and nature of groundwater in California. The publication defines the groundwater basin boundaries and features current knowledge of groundwater resources including information on the location, characteristics, use, management status, and conditions for each of the State's 10 hydrologic regions. With the passage of SGMA in 2014, there is an increased need for local agencies, state agencies and the public to better understand groundwater basin characteristics in order to make informed management decisions to achieve sustainability in the next two decades.

The objective of the Proposition 68 funded AEM survey program is to support the State's continued effort to improve groundwater basin characterization and to provide groundwater sustainability agencies (GSAs) and interested parties with a regional and statewide dataset, which GSAs can utilize as one way to support the technical requirements of DWR's Groundwater Sustainability Plan (GSP) Regulations and SGMA. The data collection effort will provide essential information about subsurface hydrogeologic characteristics of groundwater basins. This will reduce uncertainty and could improve the potential for successful implementation of GSPs and groundwater recharge projects. The focus of the AEM surveys is on all of California's high- and medium-priority groundwater basins (Figure 1-1) where data collection is feasible, as these are the groundwater basins that are required to develop GSPs and achieve long-term sustainability within 20 years under SGMA.

1.1.1 DWR AEM Survey Flight Line Planning

DWR conducts the AEM survey flight line planning with input from local, state and federal agencies. The flight line plan is then transmitted by DWR to Ramboll for execution. The AEM survey flight lines are developed with the goal of collecting high-quality data that is beneficial to local, state, and federal agencies by supporting basin characterization and the implementation of SGMA. The steps to developing the survey flight lines are described below.

Step 1: With input from DWR's Regional Office staff, an approximate 2-mile by 8-mile grid was first oriented to capture large-scale hydrogeologic features within the surveyed area. Large-scale hydrogeologic features that were considered included aquifer structures, geologic bedding and buried feature orientations, faults, and presence of brackish to saline groundwater.

Step 2: Due to a combination of safety considerations and the potential for noise in the collected data, flight lines were modified to avoid or minimize the interaction with the following:

- Urban areas
- Structures containing people or confined livestock
- Oil and gas well fields
- Highways
- Transmission lines
- Railroads
- Pipelines
- Vineyards (most vines are supported by metal posts)

Step 3: Flight lines were modified to incorporate important areas identified by GSAs and state and federal agencies.

Step 4: The flight lines were finally modified to be co-located with existing high-quality lithology and borehole geophysical data gathered from public databases or provided from the GSAs.

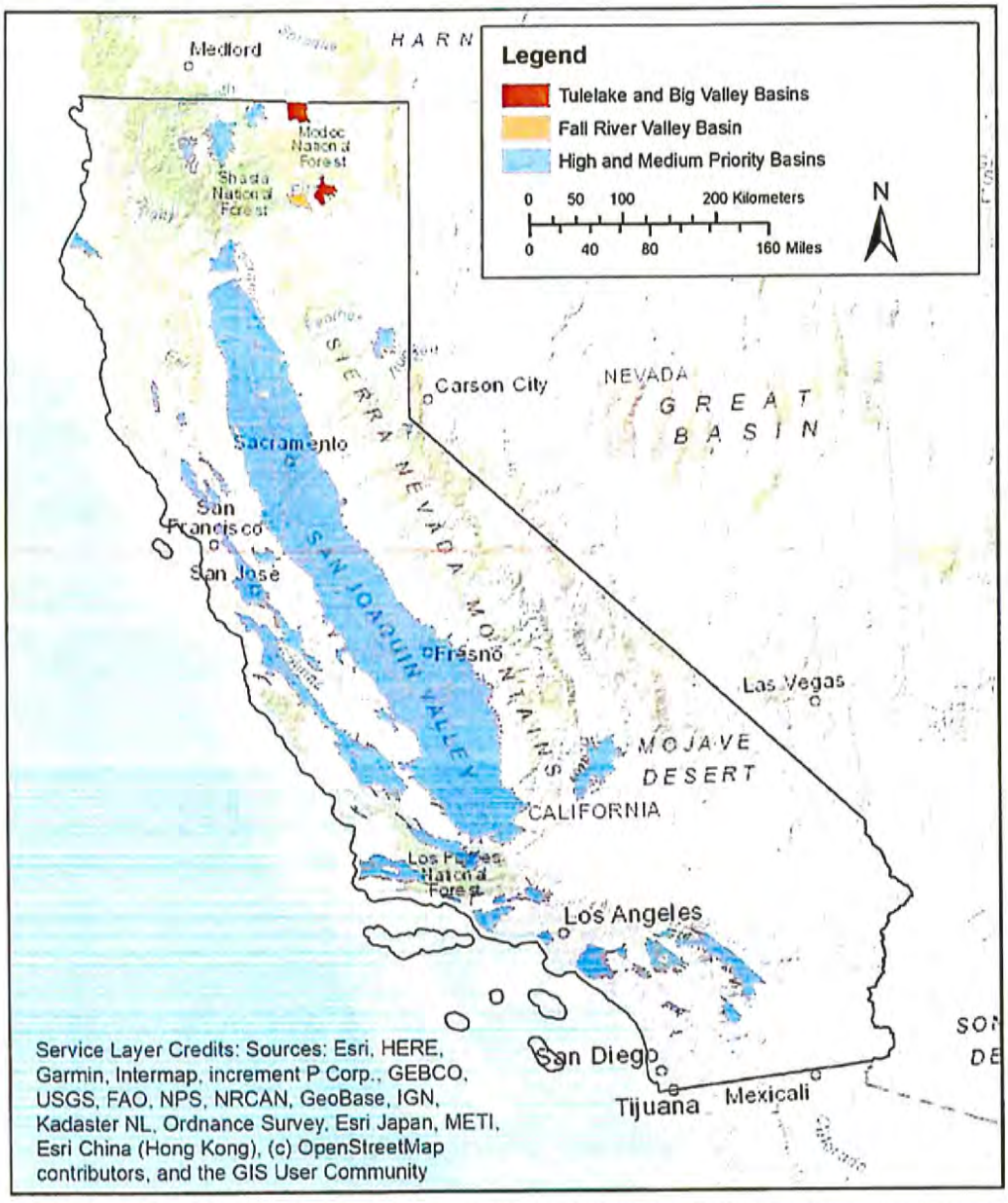


Figure 1-1 SGMA high and medium priority basins in California. The Tulelake and Big Valley Groundwater Basins which are a medium priority, are shown in red and the Fall River Valley Groundwater Basin, a low priority basin, is shown in orange.

Step 5: The flight lines were transmitted to the consultant team, where they are further examined by SkyTEM and Ramboll to adjust for potential infrastructure interference and safety considerations.

All flight line planning was conducted using ArcGIS, and publicly available data were utilized when available.

1.1.2 Statewide AEM Survey Planning and Coordination

Coordination and engagement with a wide range of organizations helps to ensure that the end use of the high-value AEM data are optimized to support sustainable groundwater management activities, in addition to providing benefits to a range of state, federal, and Tribal government hydrogeologic and geologic related projects. For each priority groundwater basin to be surveyed, DWR coordinates and engages with local, state, federal agencies, and Tribal governments (where present) to develop the survey design to meet a broad number of objectives. DWR also provides ongoing coordination, communication and public outreach throughout the process to support the AEM project logistics and to ensure the community is informed of the activities, as outlined below.

Local Coordination

DWR coordinates with local GSAs within each groundwater basin planned for an AEM survey to identify important areas within their basin where they want to ensure that AEM data is collected. For many GSAs, these include areas of known data gaps, areas being considered for groundwater recharge or other projects, or areas critical to GSP implementation.

Local Data Request

DWR also requests that the local basin GSAs share high-quality, digitized lithology or borehole geophysical logs (that are not currently available in state databases) with DWR to support the AEM data interpretation. Integration of existing lithology and borehole geophysical logs supports and reduces the uncertainty in the interpretation of the AEM data and is incorporated into the groundwater basin flight line planning process (described in Section 3.1)

State and Federal Agency Coordination

DWR is collaborating and coordinating with state and federal agencies listed below that may benefit from the AEM data to support other state and federal interests, such as fault and seismic hazard mapping, canal and aqueduct maintenance, land subsidence, managed aquifer recharge, and groundwater modeling. DWR solicits input on flight line planning, requests area maps and descriptions, and provides updates on the AEM survey program status and schedule.

State Agencies

- California Department of Fish and Wildlife
- California Department of Food and Agriculture
- California Department of Water Resources
- California Geological Survey
- State Water Resources Control Board

Federal Agencies
- United States Bureau of Reclamation
- United States Geological Survey

Tribal Government Engagement
DWR elected not to survey Tribal Trust Lands (as defined by the United States Bureau of Indian Affairs) unless the Tribe within the surveyed basin indicates that data collection and publication is acceptable.

DWR engages with Tribes within the surveyed basin through meetings and letters to Tribal leaders with information about the AEM project and an invitation to elect to join the surveys. DWR will only survey Tribal Trust Lands (as defined by the United States Bureau of Indian Affairs) if the specific Tribe(s) within the basin to be surveyed indicates that data collection and publication is acceptable. Notifications of surveys are provided in lieu of invitations if data collection over the Tribal Trust Land is not possible due to technical limitations. Technical limitations can be caused by the proximity of a potential survey area to urban areas, buildings, or electromagnetic noise sources, like infrastructure and other metallic features.

The AEM Survey Schedule webpage (https://gis.water.ca.gov/app/AEM-schedule) provides a map showing the AEM survey progress and locations of federally recognized Tribal Trust Lands and the surveyed basins.

1.1.3 AEM Survey Public Outreach

Prior to initiating the surveys within a groundwater basin, DWR conducts outreach to the public to provide an overview of the project and to notify interested parties of the upcoming work. Conducting outreach is a priority for DWR to ensure that the public is comfortable with the low-flying helicopter and is aware of the importance of the project. DWR's public outreach plan in each survey area includes the following activities:

- Posting a social media announcement on DWR's LinkedIn and Twitter pages and sharing with local GSAs to be re-posted on their social media websites.
- Providing a press release to local media outlets to be shared with their subscribers; interviews were also conducted by DWR staff when requested.
- Sending notification letters (in English and Spanish) via United States Postal Services to parcel owners within a 500-meter buffer beneath the planned flight path.

These public outreach activities were conducted within one month prior to the start of the AEM survey in the Tulelake, Big Valley, and Fall River Valley.

Ramboll, SkyTEM, and Sinton Helicopters conducted outreach to county law enforcement to notify them of the AEM surveys and to provide background information about the project. Prior to the surveying the following sheriff's offices were contacted via mail and telephone:

- Siskiyou County Sheriff
- Modoc County Sheriff
- Shasta County Sheriff
- Lassen County Sheriff

1.2 Tulelake, Big Valley, and Fall River Valley AEM Survey

For the Tulelake, Big Valley, and Fall River Valley survey, shown on Figure 1-2, a total of 436.0 linear kilometers (270.9 miles) was flown and data were acquired between November 6 to November 13. During the survey, the acquired AEM survey data were downloaded from the AEM instrumentation, initially checked for quality, and uploaded daily to a secure server for storage and subsequent analysis.

Parallel to the collection and processing of the AEM data, well information along the flight lines was gathered and compiled in a project data management system. The well data collected includes lithology, borehole geophysical logs, water level measurements and water quality (TDS) measurements. The processed and inverted AEM resistivity data was then analyzed in combination with the well data, providing information on how resistivity relates to lithology. This report provides a summary and documentation of the listed tasks, including the methods used, results, uncertainty, and quality control.

1.3 Basin Geology

This report has a focus on the AEM data collected in the Tulelake, Big Valley, and Fall River Valley. However, the basin's hydrogeology determines the resistivity distribution in the subsurface; therefore, a very basic hydrogeological description of the Tulelake, Big Valley, and Fall River Valley is provided as general background information in this section. For more information, please see the descriptions in Bulletin 118 (https://water.ca.gov/programs/groundwater-management/bulletin-118) as well as the GSP submitted for the basin (https://sgma.water.ca.gov/portal/gsp/status).

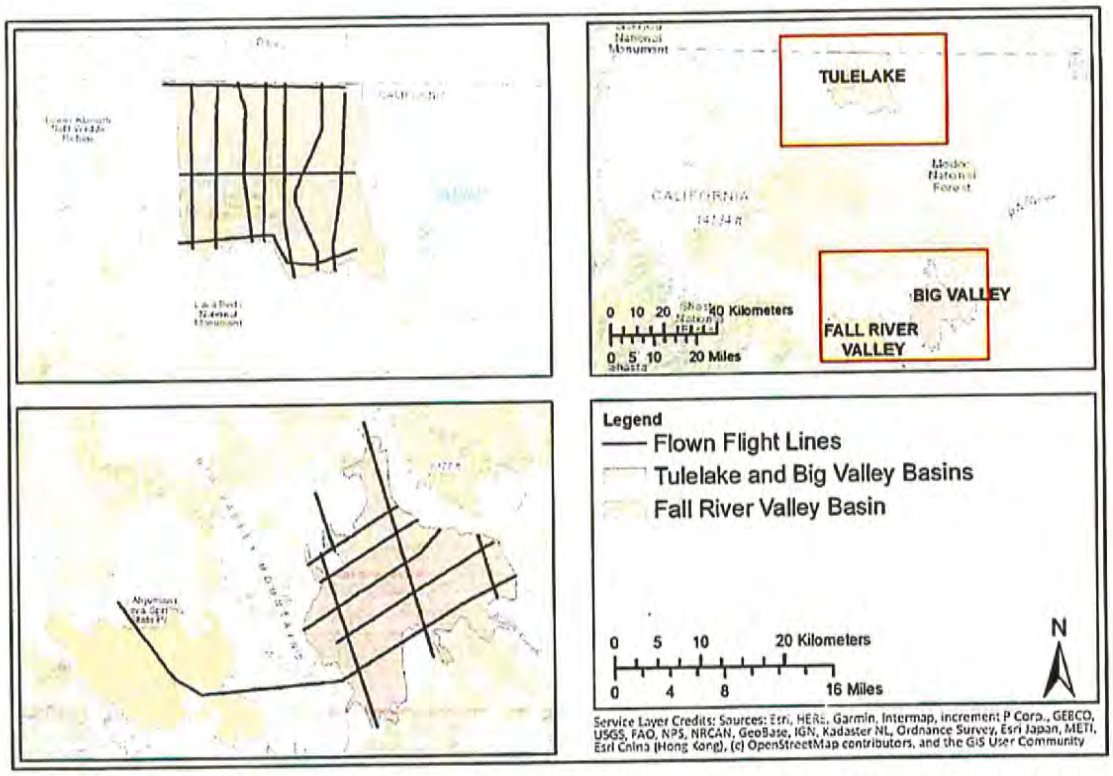


Figure 1-2 Map showing the flight lines flown in the Tulelake, Big Valley, and Fall River Valley. Tulelake and Big Valley basins are shown in brown, while Fall River Valley Basin is shown in yellow.

The study area's geology is dominated by volcanics, with Holocene to Quaternary volcanic flow rocks found to the north, and Tertiary volcanic rock flows and pyroclastics found to the south (CGS 2010). The three groundwater basins in the study area are the medium priority Tule Lake Groundwater Subbasin and Big Valley Groundwater Basin, and the low priority Fall River Valley Groundwater Basin.

The Tule Lake Groundwater Subbasin makes up the southern portion of the Upper Klamath Groundwater Basin and is bounded by the California-Oregon border to the north, faulted Holocene to Quaternary volcanic flow rocks to the south and east, and Tertiary volcanic flow rocks to the west (CGS 2010). The primary water bearing formations of the subbasin include Tertiary to Quaternary Lake deposits and volcanics (DWR, 2003).

The Big Valley Groundwater Basin is a broad flat plain consisting of a series of depressed fault blocks surrounded by tilted fault block ridges. The basin is bounded to the north and south by Pleistocene and Pliocene basalt and Tertiary pyroclastic rocks of the Turner Creek Formation, to the west by Tertiary rocks of the Big Valley Mountain

volcanic series, and to the east by the Turner Creek Formation. The primary water-bearing formations in Big Valley are Holocene sedimentary deposits, Pliocene and Pleistocene lava flows, and the Plio-Pleistocene Bieber Formation (DWR, 2003).

The Fall River Valley Groundwater Basin is located west of Big Valley and is bounded on the east by Tertiary basalt of the Big Valley Mountains, and on the west by Pleistocene basalt and Pliocene andesite of Soldier and Saddle Mountains. The primary water-bearing formations are Holocene sedimentary deposits, Holocene lava flows, Pleistocene lake and near-shore deposits, and Pleistocene to Pliocene volcanic rocks (DWR, 2003).

Not only does the regional geology control the resistivity distribution of the subsurface, but it also affects the inversion and other modeling processes. The location and unique nature of the geology surveyed in this project, specifically the preponderance and high resistivity of the volcanic rock flows, have presented a challenge to conduct the lithology transform and develop the hydrostratigraphic model using the methodology applied to alluvial basins.

1.4 Report Contents and Appendices

The data report for the Tulelake, Big Valley, and Fall River Valley survey is divided up into a main body and 11 appendices. The purpose of the main report is to provide a general overview of the activities conducted and a basic description of the methodology and results. The main report is divided into six sections. The first section includes an introduction to the California statewide AEM survey and the specific survey for the Tulelake, Big Valley, and Fall River Valley. Section 2 gives a brief description of the Tulelake, Big Valley, and Fall River Valley geography and hydrogeology. Section 3 provides a description of the data collection, including the acquisition of the AEM data as well as the gathering of well data along the planned flight lines. Section 4 presents the AEM processing and inversion methods, results, and uncertainty.

The report appendices provide detailed technical documentation of all the activities conducted including survey methodology, results and quality control measures undertaken before, during, and upon completion of the AEM surveys, and include:

- Appendix 1 - Detailed description and presentation of the well data gathered along the planned flight lines, a description of the data management system, and the quality control checks of the collected well data included in the data management system.
- Appendix 2 - Technical details on the acquisition and quality control of the AEM data.
- Appendix 3 - Technical details of the processing and inversion of the AEM data, including methodology, results, uncertainty and quality control.
- Appendix 4 - Technical details of lithology model.

- Appendix 5 – Technical details of the development of the initial hydrostratigraphic model.
- Appendix 6 – Profile atlas containing the smooth resistivity model and the total magnetic intensity.
- Appendix 7 – Profile atlas containing the 30-layer sharp inversion model, the 4-layer model and the resistivity uncertainty analysis.
- Appendix 8 – Profile atlas showing the lithology model results and lithology model uncertainty.
- Appendix 9 – Profile atlas showing the initial hydrostratigraphic model results and cluster model uncertainty index.
- Appendix 10 - Resistivity maps, broken out for specific elevation intervals and as depth intervals.
- Appendix 11 - Description of the deliverables.

2. HYDROGEOLOGIC DATA ACQUISITION AND COMPILATION

Lithologic data, resistivity logs, water level measurements, and water quality (TDS) measurements from wells were assembled for the Tulelake, Big Valley, and Fall River Valley groundwater basins. The data were compiled along the planned flight lines before they were flown. This data was then quality control checked and assembled into a data management system (DMS) for this project. This section provides a brief description of the results for the collection of the well data. A detailed description of the data compilation process and results is presented in Appendix 1.

2.1 Well Lithology Logs

For this project, the contractual objective was to obtain a minimum of two "best available" lithology logs from available well completion reports for each Public Land Survey System (PLSS) one-mile square section the flight lines cross. Best available lithology logs are defined as logs which can be accurately located within 50 meters (165 feet), and that contain high quality lithologic descriptions based on the detail in both the description and discretization. A lithology log is considered high quality if the log's descriptions extend more than 30 meters (100 feet) below ground surface, descriptions are understandable, and the average description interval is less than 30 meters (100 feet) (i.e., there are at least one lithologic description for every 30 meters on average); otherwise, it is considered a low-quality lithology log.

In total, the planned flight lines cross 258 PLSS sections, as shown on Figure 2-1. There are a total of 88 high-quality lithology logs distributed across 64 PLSS sections that the flight lines cross. There are 21 sections that contain two or more high-quality lithology logs, 43 sections that contain only one high-quality log, and 194 sections that contain no high-quality logs. In total, there are 33 sections that contain only low-quality logs and 161 sections that do not contain any lithology logs. Of the 88 high-quality lithology logs, seven were digitally available from the Online System for Well Completion Reports (OSWCR) database, five were provided by GEI Consultants, and 76 were digitized for this project (as described in Appendix 1).

The well lithology log data were added to the project DMS. The lithologic descriptions in the DMS were then standardized with regards to their different descriptors to conform with the Unified Soils Classification System (USCS). They were then simplified into three basic textures: fine, coarse and rock. The data entered into the DMS was quality control checked with regards to the well placement, transcription, and other well construction information such as well screen interval. All wells digitized by the project team were quality control checked. A random control check of 10% of the wells provided by local agencies and from the OSWCR database was then conducted.

2.2 Borehole Geophysical Logs

For this project, high quality electrical resistivity logs were compiled from well locations from the CalGEM database that are within the PLSS sections in which the flight lines cross. High quality electrical resistivity logs are defined as being located with an accuracy of 50 meters (165 feet), with measurements over the interval of 0 to 300 meters (1,000 feet) below ground surface, and that have a hard copy log image of sufficient quality to be digitized. However, logs that were more than 40-years old or within an oil field were not included due to the changing hydrological conditions in the basin over time (potential changes in water levels and groundwater salinity), and the metal infrastructure within oil fields that interfere with the AEM survey signal. In the study area, there were no resistivity logs in the CalGEM database within the sections which met the criteria.

Geophysical logs were also compiled for the DMS by RealTime Aquifer Services (RAS), local agencies, and GEI Consultants (GEI). RAS provided two geophysical logs located within PLSS sections crossed by a flight line, and GEI provided five geophysical logs.

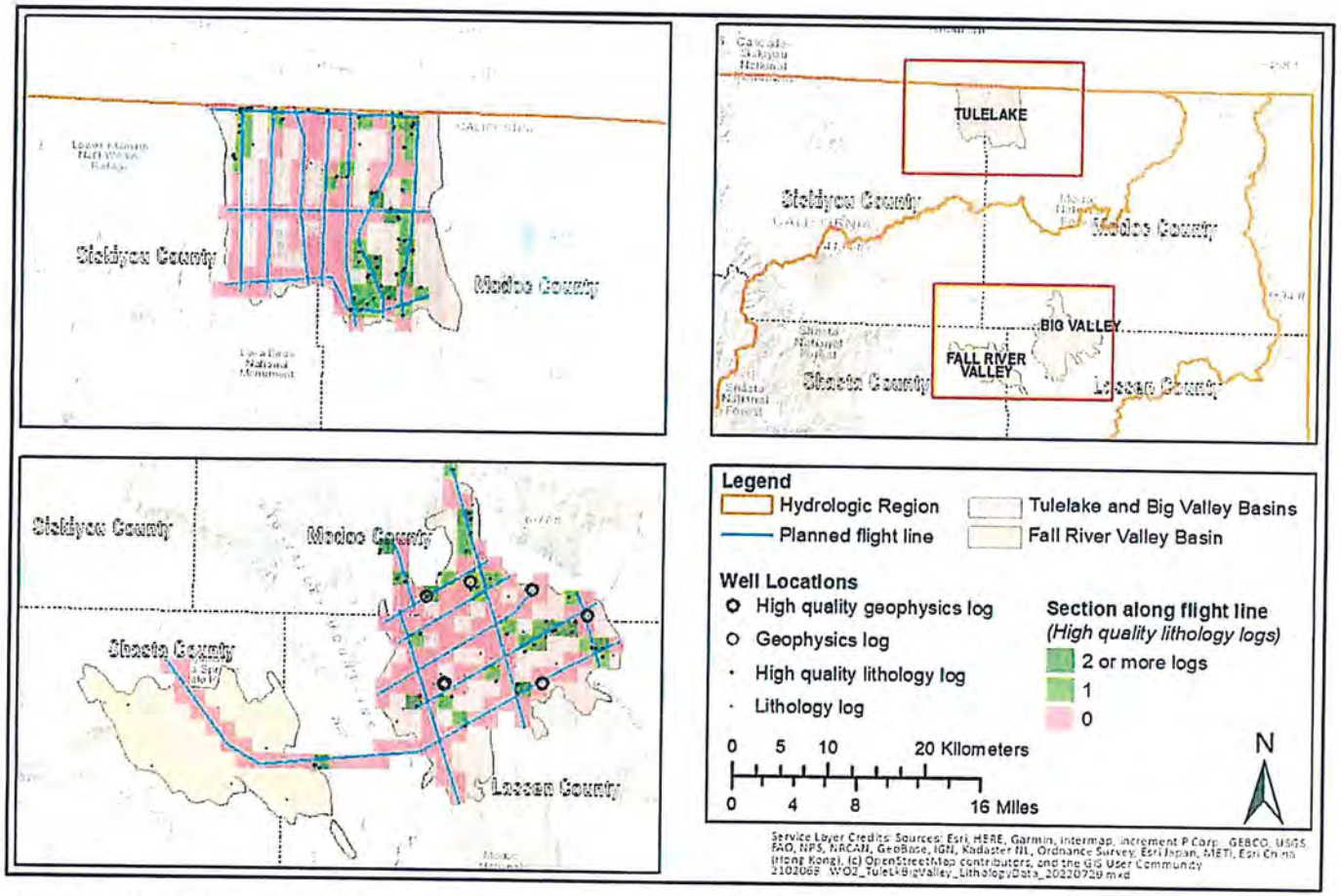


Figure 2-1 Location of well lithology and borehole geophysical logs within the study area used in the AEM survey. The map shows the flight lines in blue and the wells within the PLSS sections that the flight lines cross. The sections with two or more high-quality lithology logs are shown in dark green, sections with one high-quality log in light green, and sections with no high-quality logs as light red.

2.3 Groundwater Occurrence

Information on the depth to groundwater is important in the interpretation of geophysical data because the electrical resistivity of subsurface lithologies differs between unsaturated and saturated conditions. Understanding the depth to groundwater supports the AEM data inversion process. Figure 2-2 shows depths to groundwater for select wells in the study area. For more detailed information on groundwater occurrence see the GSP for the basin.

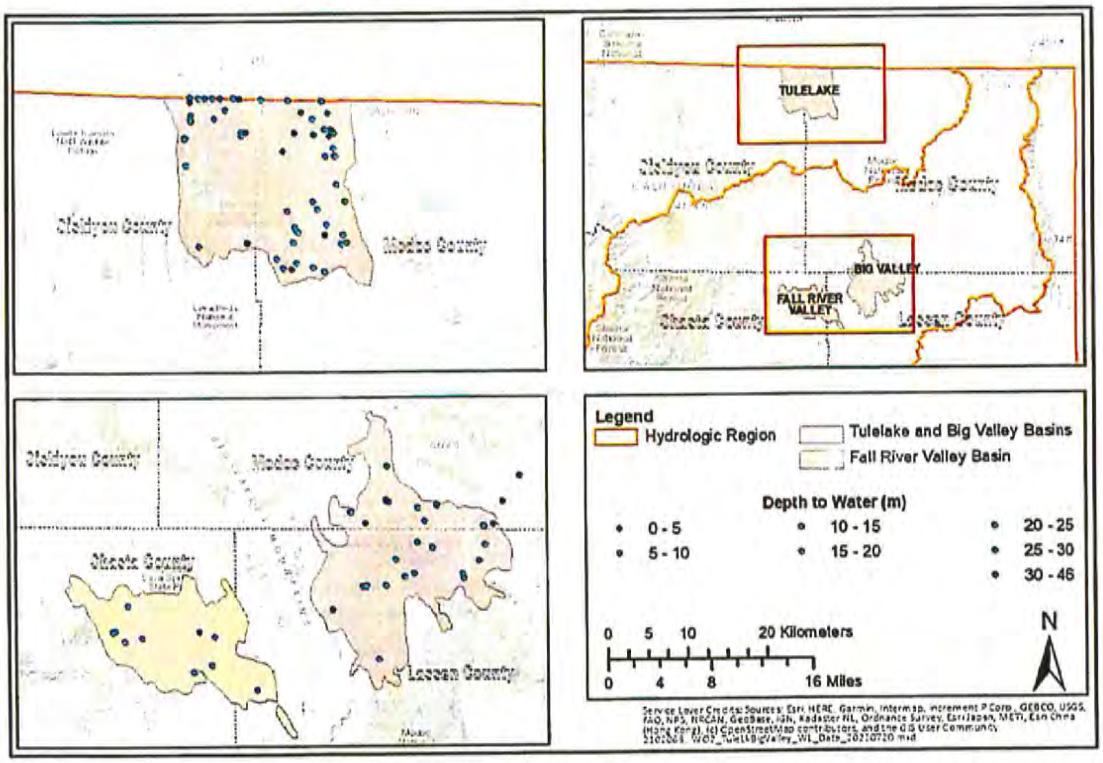


Figure 2-2 Map showing the depths to groundwater in the study area for select wells between 2019 and 2021. Shallow depths to water (< 5 m) are shown in blue, depths to water between 15 and 20 m are in blue-green, and depths to water between 30 and 46 m are in green.

2.4 Total Dissolved Solids in Groundwater

Groundwater quality is important to geophysical interpretation because electrical conductivity varies depending on the dissolved constituents in groundwater. These can vary by depth, aquifer, and geographic location within a groundwater basin. A measure of the amount of dissolved constituents in groundwater is recorded in total dissolved solids (TDS) concentrations. In addition to TDS measurements, electrical conductivity (EC) is often measured directly. TDS and EC vary proportionally to one another. Both measurements were assembled from the State Water Resources Control Board's (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) system. The GAMA system is the most comprehensive, readily available, and reliable water quality dataset. It includes data collected from various federal, state, and local programs. This dataset is being updated by the state as new water quality data is reported to the state for compliance monitoring.

Figure 2-3 shows available water quality data throughout the study area. There were a minimal number of wells with only EC measurements, therefore only TDS was plotted in the figure. TDS values within the study area range from less than 250 milligrams per Liter (mg/L) 1,698 mg/L.

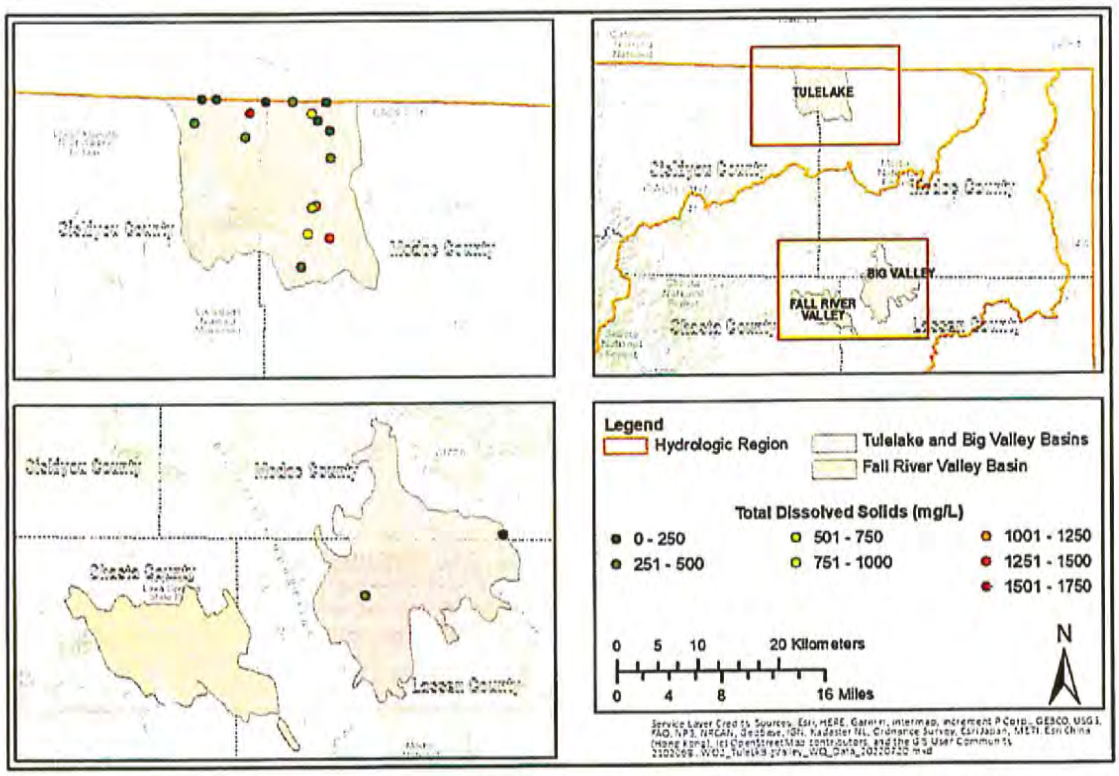


Figure 2-3 Map showing the groundwater quality (TDS) in the study area between 2005 and 2015. Lower levels of TDS (0-750 mg/L) are shown in green, moderate levels (751-1250 mg/L) are in yellow/orange, and higher levels (1251-1750 mg/L) are in red.

3. AIRBORNE ELECTROMAGNETICS SURVEY

3.1 Basin AEM Survey Methodology, Objectives and Flight Line Planning

This section introduces the methodology used for the AEM data acquisition, describes survey objectives, and discusses procedures taken for flight planning.

3.1.1 AEM Survey Methodology

The AEM survey method being used is a time-domain or transient electromagnetic method, known as TEM. The TEM methods are based on the principle of inducing electrical currents into the subsurface and receiving Earth's response over a short period of time. The TEM-instrumentation consists of a transmitter loop, a receiver coil, electronic instrumentations, and several auxiliary devices.

During each transient measurement, direct current is initiated through the transmitter loop. After a short time, the current is abruptly turned off. This abrupt turn-off induces electrical currents (called eddy currents) in the subsurface, which in return, generates secondary magnetic fields that decay with time. The decaying magnetic fields are measured using the receiver coil as a voltage timeseries, also referred to as a sounding. An optimization algorithm, called inversion, is then applied to the processed data to yield estimates of the subsurface resistivity structure, called resistivity models.

The TEM system can be deployed on the ground surface for stationary measurements or carried on moving platforms such as sleds, boats or, in the case of AEM, carried by a helicopter or airplane. Figure 3-1 provides an image of the actual AEM system, operated by SkyTEM Surveys, and the helicopter, owned by Sinton Helicopters, that were used in the DWR AEM statewide surveys.

An example of a single sounding of AEM data and a corresponding resistivity model of the subsurface is shown in Figure 3-2. During the inversion, the entire AEM dataset is inverted together and the resistivity model for each sounding is constrained. This is done by introducing a dependency in between models for neighboring soundings, as discussed in Section 4.2 and Appendix 3.

More information on the physical principles of the TEM method can be found in Ward and Hohmann (1988), Schamper et al. (2013), and in Appendix 2. A detailed description of the SkyTEM/AEM system used in this survey can be found in Section 3.2.1 and Appendix 2.

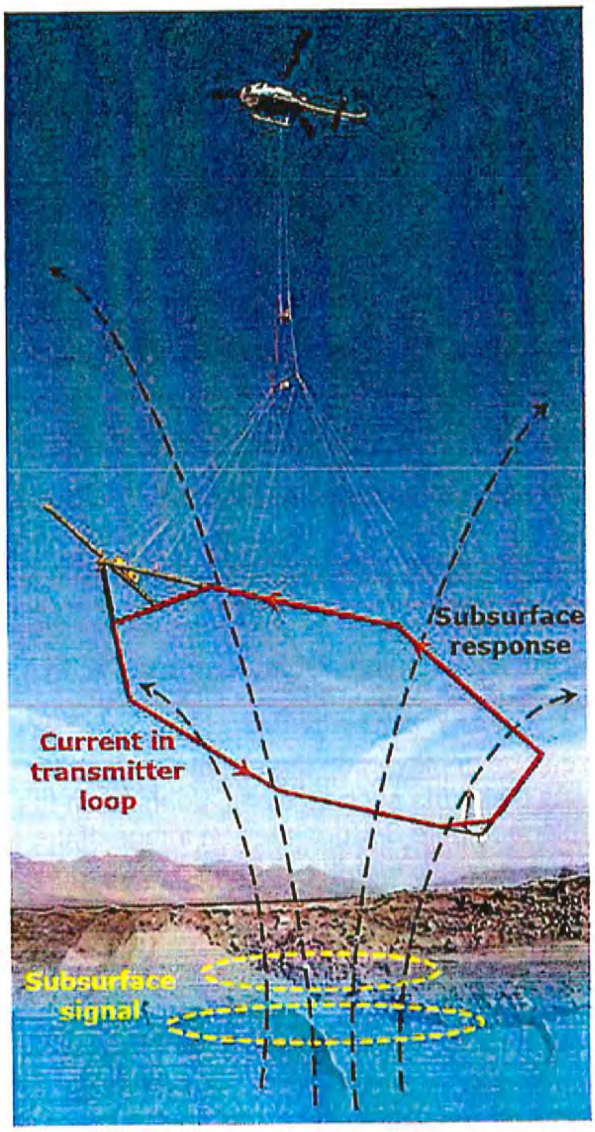


Figure 3-1 AEM Survey Schematic including the transmitter loop (current in red), subsurface signal (in yellow), and subsurface response (in dashed black lines) which is picked up by the system receiver. Note: the illustration does not depict primary magnetic fields.

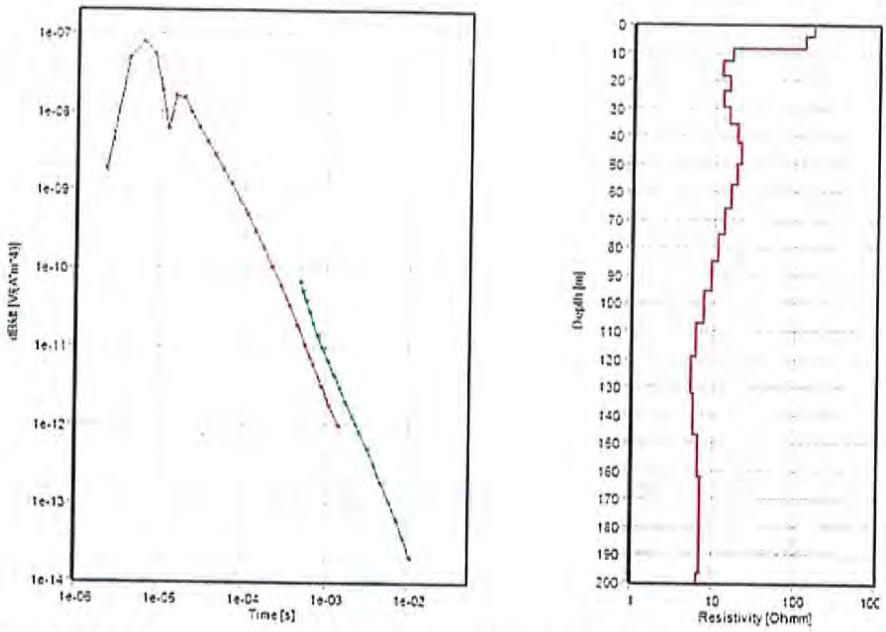


Figure 3-2 Example of a single sounding of acquired AEM data (change in magnetic field as a function of time) shown on the left-hand side, and a corresponding resistivity model showing the modeled resistivity from the ground surface to a depth of 200 meters (650 feet).

3.1.2 AEM Survey Flight Line Planning

The flight lines for the AEM survey were initially prepared by DWR, as discussed in Section 1.1.2, and provided to Ramboll for execution. Ramboll, SkyTEM and Sinton Helicopters conducted a review of the planned flight lines using aerial photos from Google Earth and aeronautical charts to identify possible safety considerations in relation to:

- Built up areas that would need to be avoided
- Trees and forested areas that the pilot either would need to navigate around or climb in altitude while flying over
- Towers, power lines, and other infrastructure that the pilot either would need to navigate around or climb in altitude while flying over
- Major roads that the pilot would need to navigate around
- Restricted air space
- Restricted areas due to endangered species

A proposed flight line plan was then prepared incorporating the safety review of the DWR flight lines and landing zone bases (small airports) that were identified for survey logistics, equipment checks and data downloads, and fueling. The safety

considerations and proposed flight line plan were presented to DWR for final review, and subsequently approved for execution.

Figure 3-3 shows a map of the planned flight lines along with the land use within Tulelake, Big Valley, and Fall River Valley. At times during flight line execution, Sinton Helicopters had to diverge slightly from the planned flight due to visual observations of potential safety hazards, such as the presence of people, livestock or other safety hazards (shown in Figure 3-5).

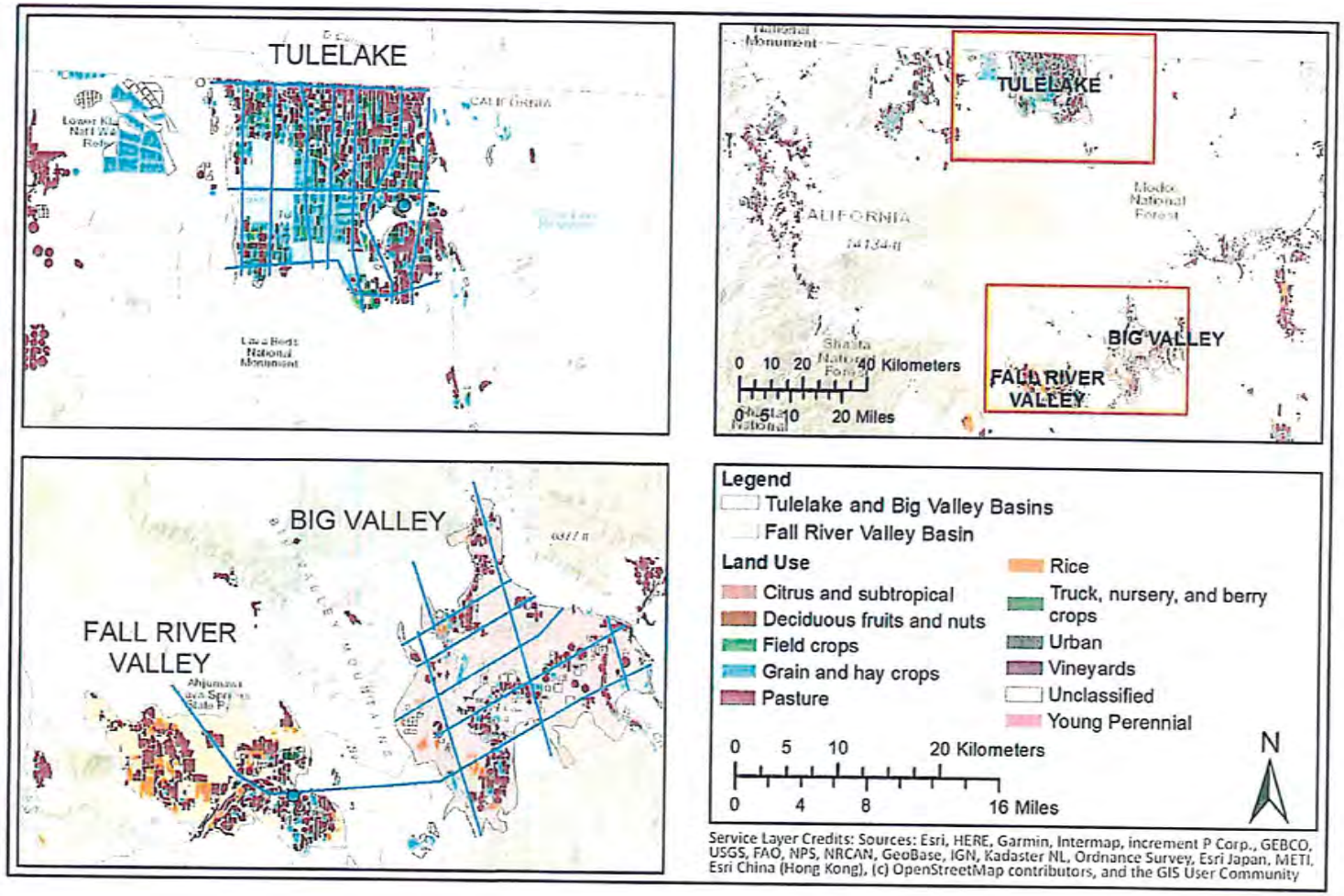


Figure 3-3 Map of planned flight lines, landing zones and land use. Planned flight lines are shown in dark blue and landing zones as cyan circles. Urban areas are shown in grey, vineyards are in purple, and the remaining areas are other types of crops.

3.2 Basin AEM Survey

3.2.1 Basin AEM Survey Equipment and Instrumentation

The helicopter-borne SkyTEM304M time-domain electromagnetic system was used during this survey. Throughout this report, the terms SkyTEM, SkyTEM304M, and AEM system are used synonymously to indicate the geophysical survey equipment.

The AEM system is carried as a sling load, suspended 30 m (98 ft) beneath the helicopter and flown 30-50 m (98-164 ft) above the land surface (Figure 3-4) while flying at a groundspeed of 80-100 kph (50–62 mph). The system is designed for hydrogeological, environmental, and mineral investigations. The SkyTEM304M system has a transmitter loop area of 342 m^2 (3,681 ft^2) contained within a hexagonal frame suspended beneath the helicopter.

In addition to acquiring electromagnetic data, which provides information about the resistivity structure of the subsurface, the system also collects magnetic data, which are primarily used for mapping magnetic anomalies, fractures, and faults. Auxiliary data are also recorded and include GPS data for positional accuracy, inclinometer for the pitch and roll of the system, laser altimeter data for elevation, and video for a record of the ground surface along the flight path. A more comprehensive description of the TEM methodology can be found in Appendix 2.

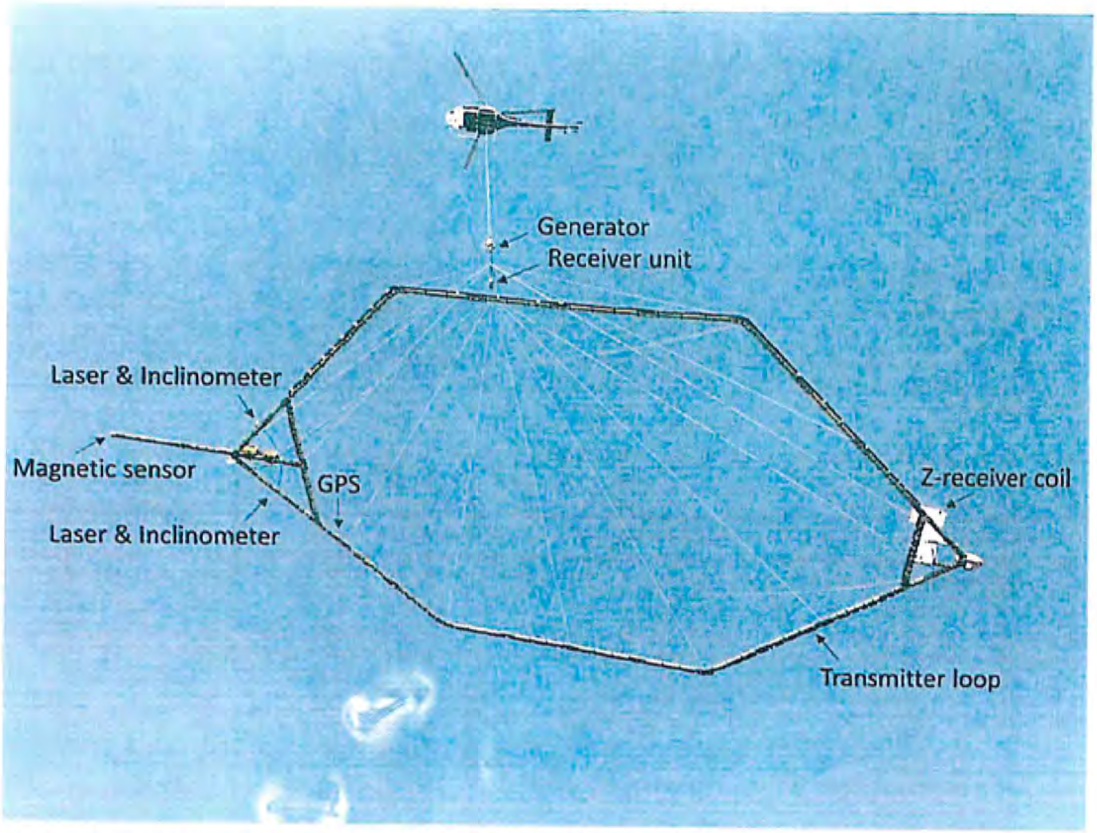


Figure 3-4 AEM equipment and instrumentation configuration. The picture shows the helicopter towing the hexagonal transmitter loop. The front of the loop contains the GPS, laser, inclinometer, and magnetic sensor. At the back of the loop is the Z-receiver coil. Suspended between the transmitter loop and the helicopter are the generator and receiver unit.

3.2.2 Landing Zones

Tulelake Municipal Airport (November 6th to 10th) and a private ranch in Pittville were used as the landing zone bases throughout the survey (see Figure 3-5).

3.2.3 Basin AEM Survey Data Acquisition

The AEM survey was carried out between November 7th to 12th, 2021. A total of 436.0 line-km (270.9 line-miles) of data were acquired.

Before, during and after the acquisition of the AEM data, several measures were taken to ensure that the AEM system functioned properly, and that the quality of the acquired data was acceptable. During the initial on-site SkyTEM system set-up phase, very high-altitude tests, waveform, configuration settings and null positions were checked in

collaboration with SkyTEM to ensure that the configuration and specifications were performing as agreed upon in the contract.

During the survey, SkyTEM provided daily updates, including a map of daily production, high altitude test, raw electromagnetic, magnetic, and reference line data (see Appendix 2), which was quality control checked daily by Ramboll. The quality of the data evaluated daily during the Tulelake, Big Valley, and Fall River Valley AEM survey was found to be acceptable.

Figure 3-5 shows the actual flown flight lines compared with the planned flight lines. In general, it was not necessary to deviate significantly from the planned flight lines in the Tulelake, Big Valley, and Fall River Valley. Figure 3-6 provides three photos of the AEM array during data acquisition in the Tulelake, Big Valley, and Fall River Valley survey.

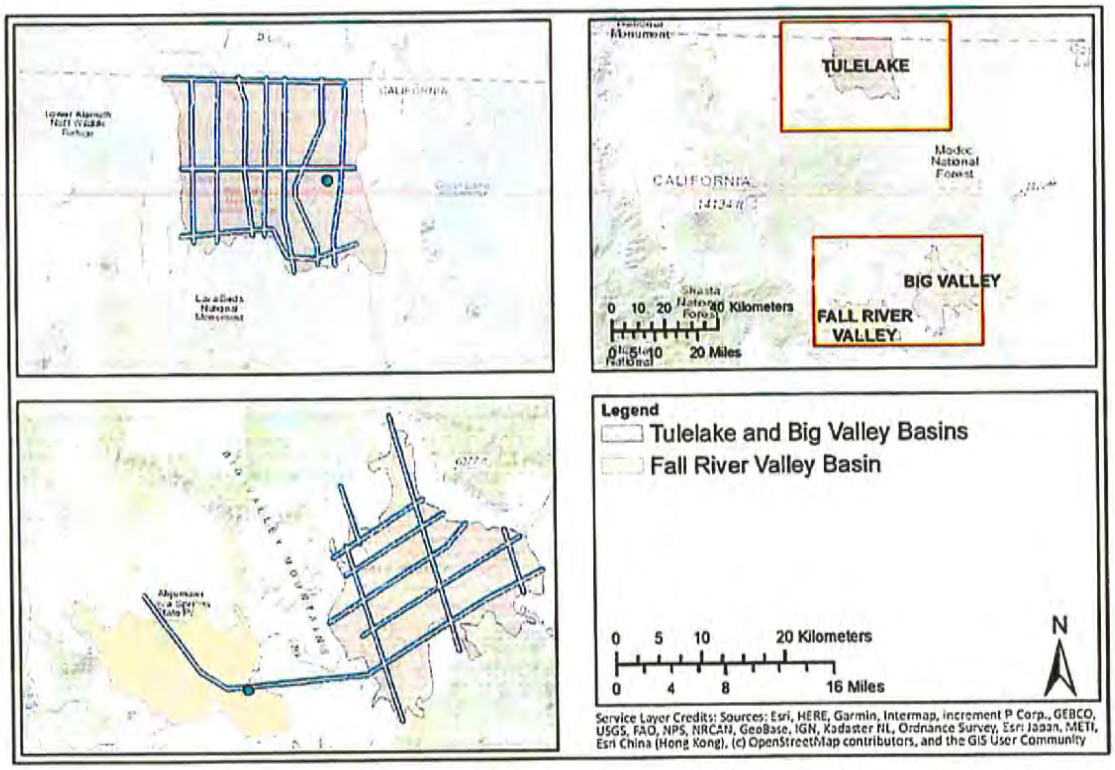


Figure 3-5 Map showing the planned and flown flight lines in the Tulelake, Big Valley, and Fall River Valley Area. The planned flight lines are shown as the thicker dark blue lines and the actual flown lines are shown as thin white lines on top of the blue lines. The light blue dots show the location of the landing zone bases for the flights conducted in the area.

Figure 3-6 Photos of the AEM flights in the Tulelake, Big Valley, and Fall River Valley Area. The top photo shows the AEM system resting at a private ranch in Pittville. The bottom left shows the system during landing and the bottom right shows the helicopter towing the array during the survey.

3.2.4 Reference Lines

Reference lines are flight lines that are repeated, with the purpose to compare the initial and repeated flight line results to ensure the reproducibility of the AEM system during the survey to validate instrument performance, to identify any potential drift and to document the stability of the data processing and inversion algorithms. One or more reference lines were flown during each production day during the November 7th-10th survey, which resulted in a total of five reference lines in two locations ranging from ~ 550 m to ~ 1,000 m (1,800-3,280 ft) in length.

The results of the reference lines demonstrate that the AEM system was not affected by drift or instrumentation issues. It also showed that the processing and inversion schemes were consistent. These results demonstrate that the data is highly repeatable. More information and the results of the reference lines can be found in Appendix 2.

4. AEM DATA PROCESSING, INVERSION, AND RESULTS

The AEM dataset acquired during the survey is a set of voltage time series, and the measured response resulting from the electromagnetic pulses produced by the AEM transmitter loop. To obtain quantitative information on the subsurface resistivity from the raw AEM data, the data must go through the steps of processing and inversion. Processing refers to actions that prepare the data for inversion, including the removal of noisy or coupled data, and the application of averaging filters to the data. Inversion refers to the numerical optimization algorithm that will find the subsurface resistivity distribution that agrees with the AEM data. Filters are applied to obtain usable, noise-free data and optimize lateral resolution. Here, we present an overview of the processing and inversion, as well as a selection of the resulting resistivity models. A more thorough review of the processing and inversion is presented in Appendix 3, and the full set of resistivity models resulting from the processing and inversion steps are shown in Appendix 6.

4.1 AEM Data Processing and Inversion

After the raw (electromagnetic & auxiliary) data were checked for quality, it was imported into the Aarhus Workbench software to be prepared for data processing and inversion, which comprised the following steps:

1. Process auxiliary data (e.g., GPS, height)
2. Process AEM data automatically and manually
3. Run inversion on AEM data
4. Calculate the depth of investigation from AEM data
5. Run uncertainty analysis on AEM data

4.1.1 Data Processing

The first data to be processed are the auxiliary data, including pitch and roll (tilt) data, transmitter height data, and GPS data. The tilt and transmitter height data affect the raw AEM measurement and must be accounted for during the inversion, while the GPS data are needed to relate each measurement with its correct geographic position. Each type of auxiliary data was quality control checked before being used in the inversion. To relate the resistivity models to the topography of the landscape, a terrain elevation was assigned to each electromagnetic sounding using a digital elevation model (DEM). For more information about these steps see Appendix 3.

Next, the raw AEM data (voltage timeseries) were processed to prepare for inversion. The AEM system continuously makes electromagnetic measurements, which results in approximately 25-35 measurements per kilometer along each flight line. The AEM data processing comprises an automatic and a manual component. The automatic processing requires selection of appropriate filters and other parameters. After automatic processing, the data are manually reviewed for noise, as well as interference from infrastructure, such as powerlines or pipes. The distance of AEM data locations to human-made structures was considered, and portions of the dataset were selectively

removed. The AEM data processing is an iterative process, which requires revisiting the data after each step, and again after provisional inversion results are visualized. Detailed information about the voltage timeseries data processing steps and settings are provided in Appendix 3.

4.1.2 Inversion

Once the auxiliary and AEM data were processed, they were used to produce resistivity models through inversion. The inversion is an iterative optimization, where the resistivity model at each location where AEM data were acquired (i.e., each sounding) along each flight line, is used to calculate synthetic AEM data. These synthetic AEM data are compared to the processed AEM data acquired during the survey. The misfit between the observed and synthetic data is used as a criterion to update the resistivity model, and the process is repeated. While minimizing the data misfit, the employed inversion scheme enables applying vertical constraints (i.e., between the resistivity values of adjacent layers) and spatial constraints (i.e., along and between flight lines), to allow the migration of information to nearby AEM data. Once the synthetic AEM data match the acquired AEM data within a specified tolerance, the resistivity model is considered final.

All AEM data were inverted simultaneously using the spatially constrained inversion (SCI) approach (Viezzoli et al., 2008), which accounts for all model parameters, AEM data and spatial constraints. The inversion algorithm requires user input on specific values, including the depth discretization of the resistivity model (i.e., the estimate of the subsurface resistivity structure), the initial estimate of resistivity values, and horizontal and vertical constraints. Each value is selected based on the AEM system setup, depth interval of interest, and background geologic information of the study area; multiple inversions may be run on the same dataset to find the optimal values for these input values. Typically, two to three inversions are run for each dataset to 1) finalize the processing of the data and 2) obtain final input values for the inversion. The system setup information (AEM equipment metrics) is used during the inversion when calculating the synthetic AEM data. Detailed information of the inversion approach can be found in Auken et al. (2015) and Appendix 3.

4.1.2.1 Inversion Schemes

Using the SCI approach with a different setup, the AEM data can be inverted to result in different types of resistivity-depth models. The following inversion schemes were used in this study:

- Smooth inversion: in this scheme, a large number of layers (20-30) are used in the model, where each layer thickness is larger than that of the layer above it. Each layer thickness remains fixed during iterations of the inversion, but the resistivity value of each layer is allowed to vary. Using spatial constraints, resistivity values are restricted to stay within a factor of neighboring resistivity values, resulting in smoothly varying resistivity-depth models.

- Few-layer inversion: in this scheme, a small number of layers (typically 3-6) are used in the model; both the resistivity and thickness of each layer are allowed to vary during the inversion. The few-layer inversion can represent sharp boundaries in the subsurface, unlike the smooth inversion. The few-layer inversion is used in this project for the uncertainty analysis since the uncertainty in the thickness and depth of each layer can be analyzed (unlike in the smooth and sharp inversions).
- Sharp inversion: Like the smooth inversion, the sharp inversion uses a large number of layers. Like the few-layer inversion, the sharp inversion is favorable when expecting sharp layer boundaries. However, unlike the smooth inversion, the sharp inversion is designed to support both gradual and abrupt changes in resistivity values (Vignoli et al., 2015). Furthermore, the sharp inversion overcomes the limitation in the few-layer inversion of setting a small, constant number of layers in the inversion over a large survey area, where conditions are likely to change spatially.

For detailed description of the three inversion schemes, see Appendix 3.

4.1.2.2 Depth of Investigation

The resistivity models resulting from each inversion were used to calculate the depth of investigation (DOI). The DOI is dependent upon the geology, water quality and data quality: areas with thick conductive clays and saline water will typically have a shallower DOI than sands and fresh water. The DOI gives an indication of the depth to which a resistivity-depth model can be considered reliable, and below which there is an elevated uncertainty. Since the AEM method is a diffusive method, it is not possible to define an exact DOI, below which there is no information on the resistivity structure. Thus, resistivity information below the DOI still may be useful, but interpretation of resistivity values below the DOI is cautioned. In this study, the DOI was calculated using sensitivity information output from the inversion, following the approach presented by Christiansen et al. (2012). More information about the DOI can be found in Appendix 3. The resulting DOI varies spatially throughout the survey area but is typically 170 – 320 m (560 – 1,050 ft).

4.1.2.3 Inversion Uncertainty Analysis

The acquired AEM data are affected by environmental noise, both natural and anthropogenic, which is presented as the standard deviation or error bars on the data. This uncertainty in the raw AEM data will propagate during the inversion to the estimated resistivity values, and in the case of the few-layer inversion, to the layer thickness; each of these values will also have an associated standard deviation.

For the employed inversion approaches, the model parameter uncertainties are estimated based on the *a posteriori* model covariance matrix and presented as normalized standard deviation factors (STDFs). The STDFs are classified in different intervals, ranging from very well determined parameters (low STDFs) to undetermined parameters (high STDFs). For details about the calculation of the model parameter

uncertainties and how to read the uncertainty sections, see Appendix 3. The uncertainty analysis sections for the few-layer model, corresponding with the resistivity sections, are presented in Appendix 3, Section 8.3. The uncertainty analyses for the smooth and sharp models are provided as tables and databases described in Appendix 11.

4.2 Selected Results

The modelled AEM data represent resistivities along the flown flight lines that can be presented as vertical sections or as plan-view maps. In this section, selected representative results of each are illustrated. The entire set of vertical sections of resistivity models are presented in Appendix 6 and Appendix 7, where Appendix 6 shows the smooth inversion results, while Appendix 7 displays the sharp inversion results and the few-layer inversion results with associated uncertainty analysis. The vertical sections are placed along all the flown lines as sheets with a section length of up to 17 km, where a 1 km overlap is included when a flight line is longer than 17 km.

The entire set of plan-view resistivity maps are shown in Appendix 10, where the resistivity values are depth-averaged and presented as horizontal slices in either elevation intervals or depth intervals of 20 m (66 ft).

A color scale was developed to illustrate the resistivity models as vertical sections and plan-view maps. On each resistivity color scale, cool colors (blues, greens) represent lower resistivity values, while warm colors (reds, purples) represent higher resistivity values. For the resistivity models in this survey, an interval of 1-1,000 ohm-m was used to illustrate structural variations across the study area. The color scale is shown in Figure 4-1 through Figure 4-3.

4.2.1 Vertical Resistivity Sections

In this section, four vertical model-sections (Figure 4-1 to Figure 4-3) across the surveyed area are provided to illustrate the geographical variations with a focus on how the generated resistivity models compare to well lithology logs and water levels. Detailed geologic structures (folding and possible faulting) are evident along the sections. In addition, an example of model uncertainties calculated for a specific flight section is illustrated in Figure 4-4.

4.2.1.1 Section 700700, Distance Interval 0-16 km

Figure 4-1 shows a 16-km-long section, located along the eastern edge of Tulelake Groundwater Basin, shows a continuous resistive layer, thinning but not fully disappearing between 3 and 6 km along the section, overlying a more conductive region. The high-resistivity layer correlates with the intervals classified as "rock" (brown color) observed in the boreholes projected on the section.

4.2.1.2 Section 570100, Distance Interval 0-14 km

The 14-km-long section shown in Figure 4-2 is in the south of Tulelake Groundwater Basin, within Lava Beds National Monument. The section displays a region of exceptionally high resistivity (light purple) dipping south and overlying a more conductive layer (yellow); between 2 and 4 km along the section, two distinct conductive layers are evident (1,200 m and 1,100 m above sea level).

4.2.1.3 Section 110100, Distance Interval 0-16

Figure 4-3 shows a 16-km-long section in Big Valley Groundwater Basin, featuring a prominent conductive (blue) layer rising and falling in elevation between 4 and 8 km along the section. A sequence of alternating resistive and conductive layers (orange and green colors, respectively) follows the dipping angle of this conductive layer until 11 km along the section, at which point the layers begin rising in elevation.

4.2.1.4 Section 700700, Distance Interval 0-16 km

Figure 4-4 displays model uncertainties along the same profile displayed in Figure 4-1. The top panel shows the vertical 4-layer resistivity model section used for sensitivity analysis of the model parameters. Uncertainty analysis of the resistivity values is shown on panel 2. Uncertainty analysis of the thickness of layers 1, 2 and 3 is shown on panel 3, while the uncertainty analysis of the depth to the bottom of layers 1, 2 and 3 is shown on panel 4.

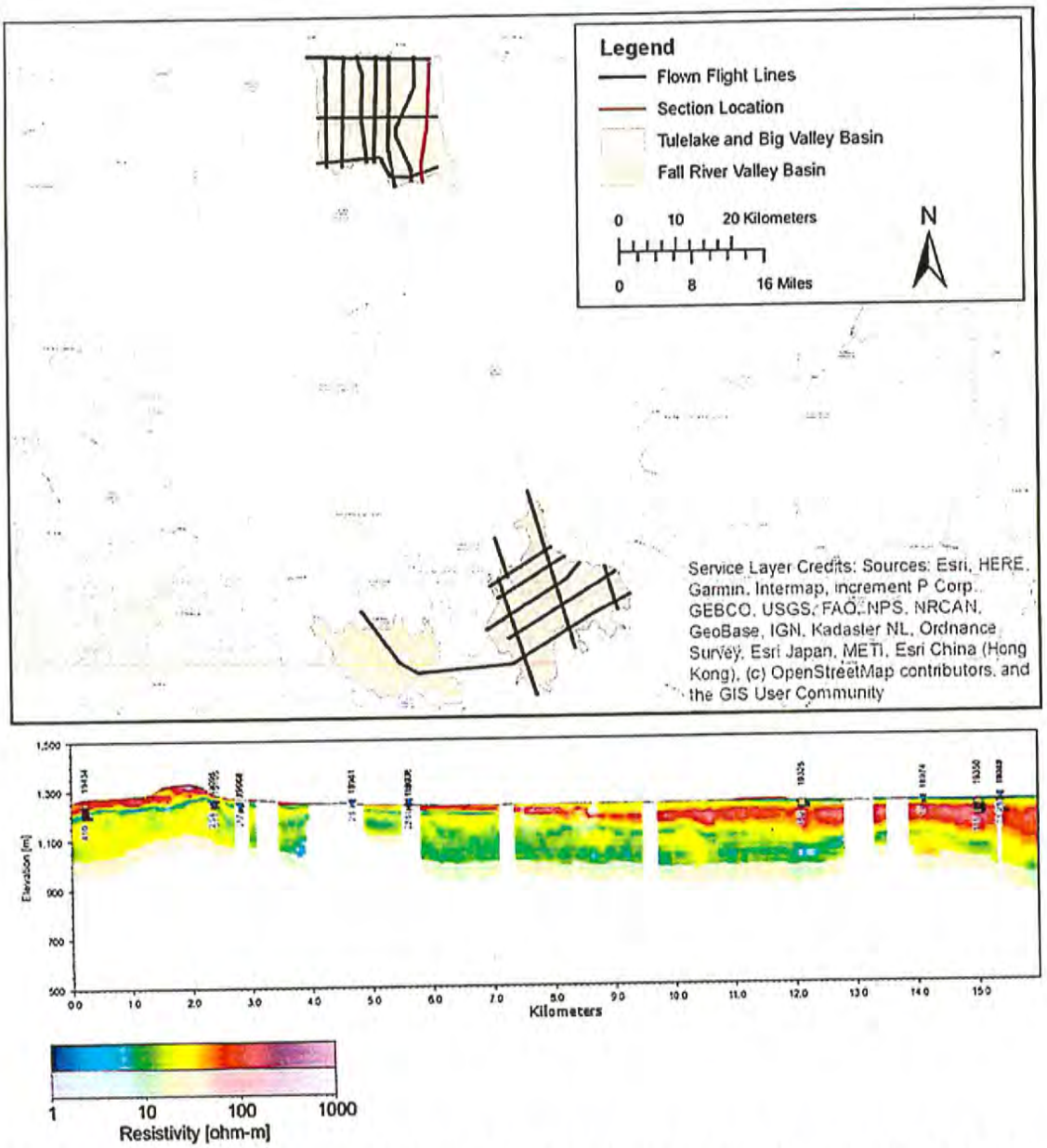


Figure 4-1 Resistivity along Section 700700 between 0 and 16 km in the Tulelake basin. The location of the section is shown in red in the top panel, while vertical resistivity section, from north to south, is shown in the bottom panel. Lithology data (colored rectangles) and water level measurements (blue triangles) measured from nearby boreholes are projected onto the section, with the well IDs shown above and the projection distance shown below the borehole.

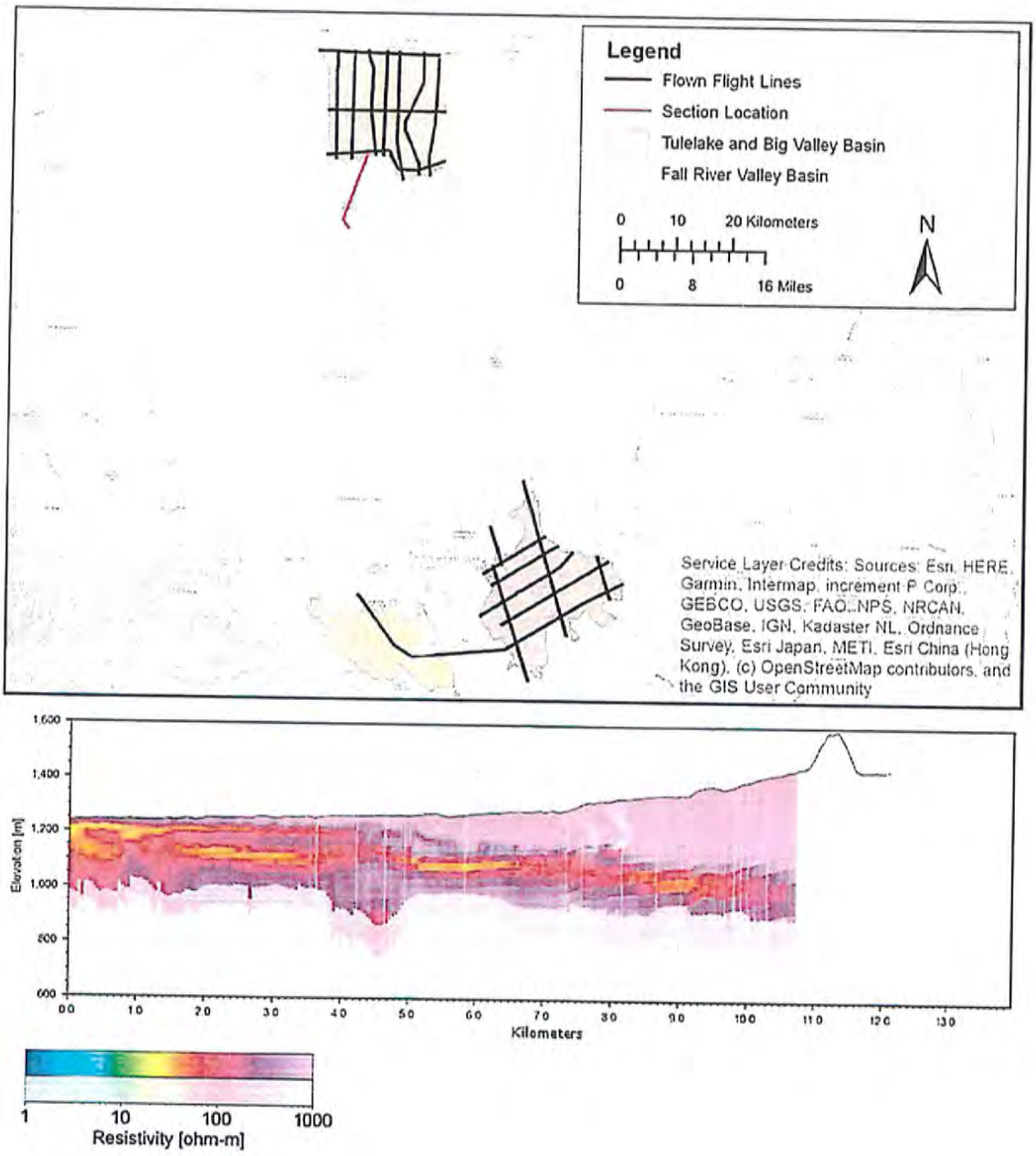


Figure 4-2 Resistivity along Section 570100, between 0 and 14 km in the region between Tulelake and Big Valley basins. The location of the section is shown in red in the top panel, while the vertical resistivity section, from north to south, is shown in the bottom panel.

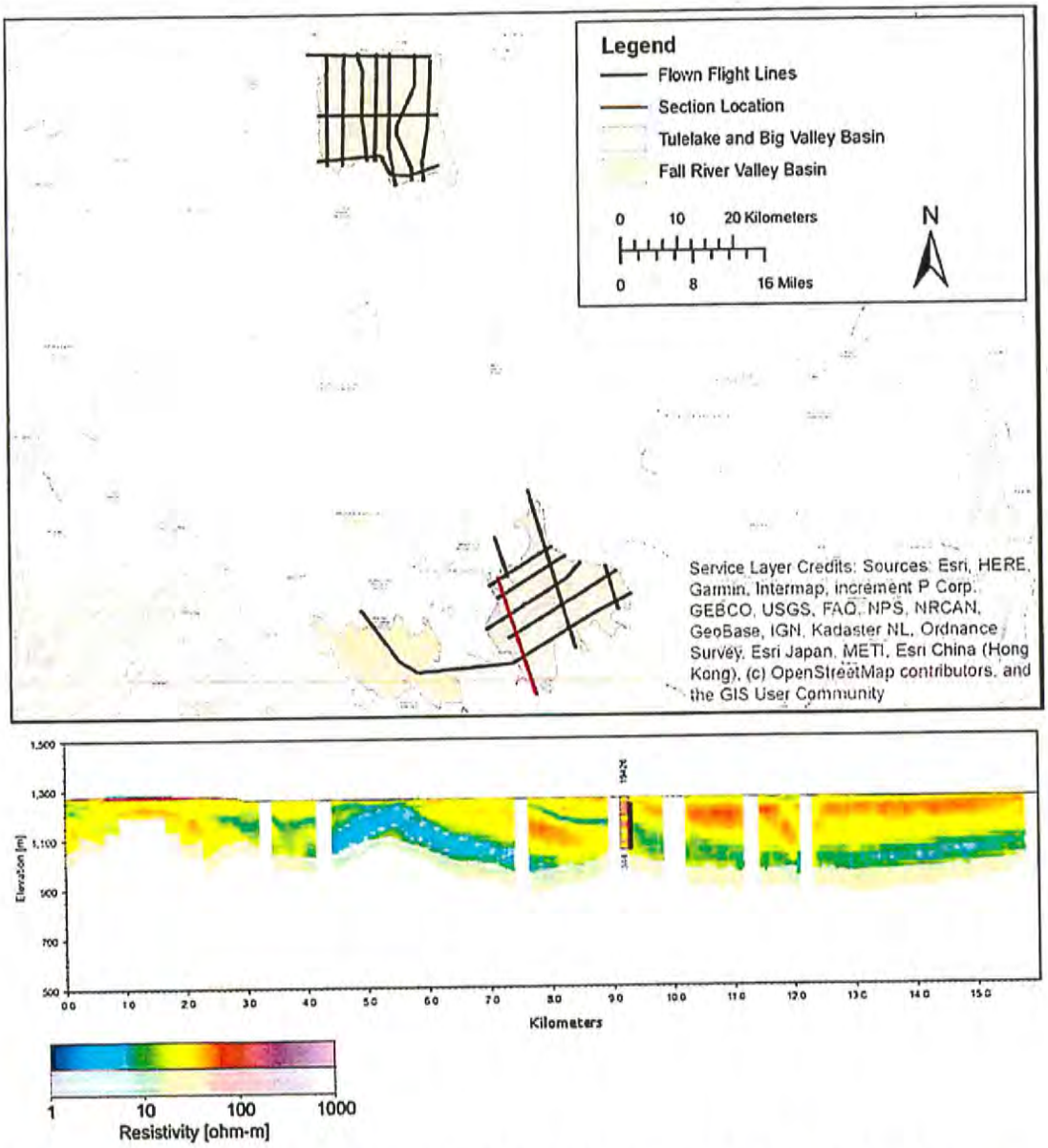


Figure 4-3 Resistivity along Section 110100 between 0 and 16 km in the Big Valley basin. The location of the section is shown in red in the top panel, while the vertical resistivity section, from north to south, is shown in the bottom panel. Lithology data (colored rectangle) measured from a nearby borehole are projected onto the section, with the well ID shown above and the projection distance shown below the borehole.

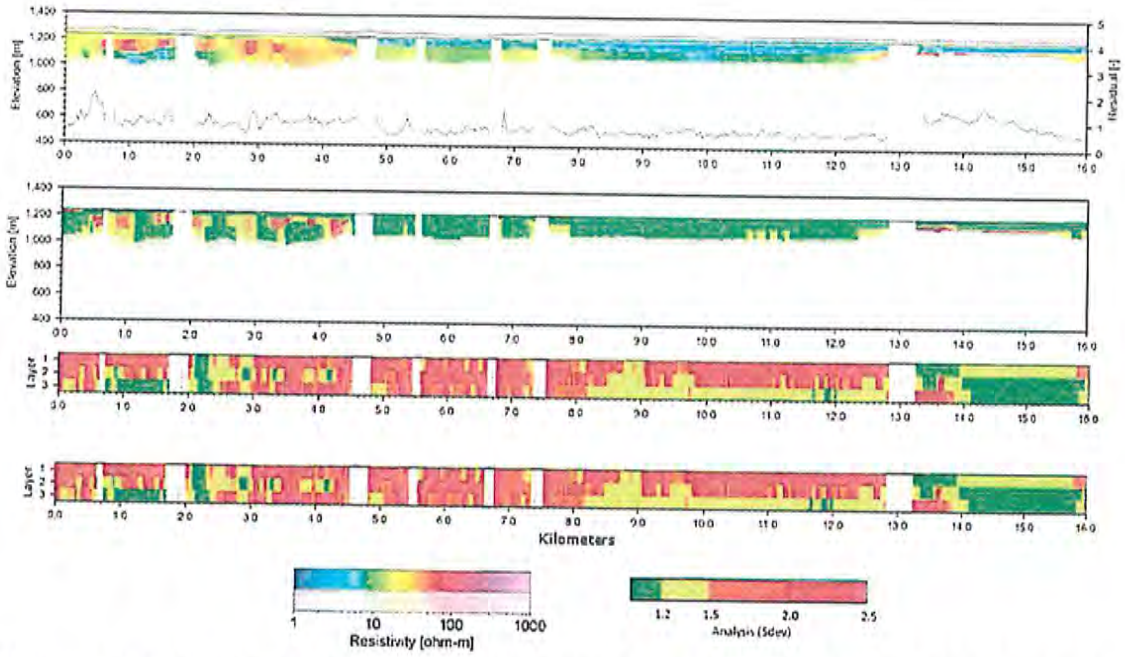


Figure 4-4 Example of illustration of the model uncertainties along 16 km of line 700700. The top panel shows the vertical 4-layer resistivity model section used for sensitivity analysis of the model parameters. Uncertainty analysis of the resistivity values is shown on panel 2. Uncertainty analysis of the thickness of layers 1, 2 and 3 is shown on panel 3, while the uncertainty analysis of the depth to the bottom of layers 1, 2 and 3 is shown on panel 4.

4.2.2 Mean Resistivity Plan-View Maps

Mean resistivity plan-view maps of horizontal slices along the flight lines are displayed at different depth and elevation intervals; these maps illustrate detailed structures and provide insight into variations across the surveyed area at each interval. Three representative maps of mean resistivities at different depth and elevation intervals are provided in Figure 4-5 through Figure 4-7. More information on how each interval's mean resistivity is calculated can be found in Appendix 3.

Figure 4-5 illustrates the mean resistivity in the depth interval 20-40 m (65-130 ft) below ground surface. At this depth interval, a large portion of western Tulelake has a relatively low resistivity (blues), while Big Valley has a more complex distribution of resistivity values.

Figure 4-6 shows the mean resistivity in the elevation interval 980-1,000 m (3,215-3,281 ft) above mean sea level (amsl). At this high elevation, resistivity values from

only the edges of Tulelake and Big Valley are present, while the very high resistivity values (purples) in the area between the two basins can be seen.

Figure 4-7 shows the mean resistivity in the elevation interval 1,040 m-1,060 m (3,412-3,478 ft) amsl. At this elevation, the gradation in Tulelake from lower to higher resitivity (blues to purples) can be seen clearly moving from north to south.

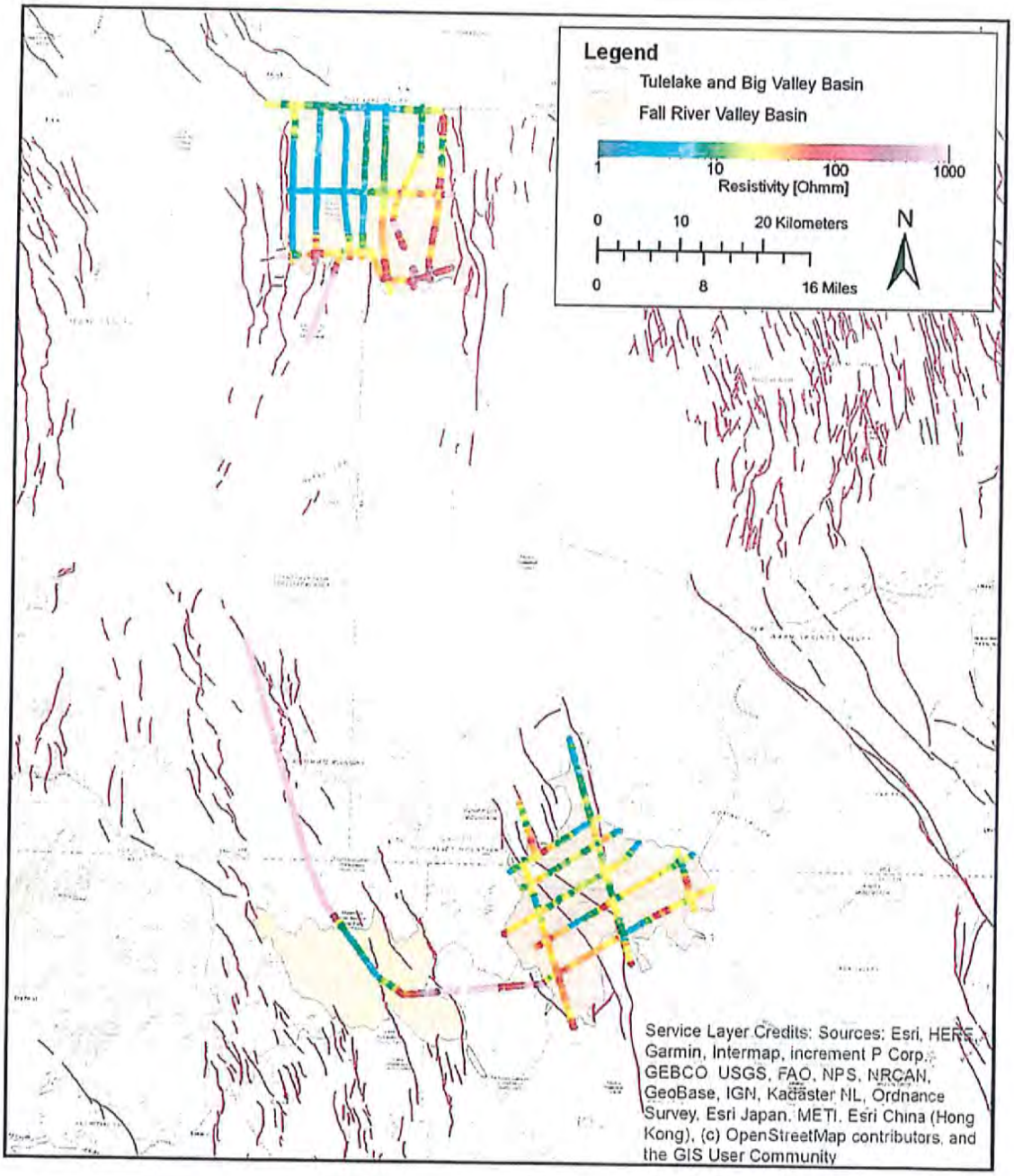


Figure 4-5 Mean resistivity plan-view map in the depth interval 20-40 m (66-131 ft) below land surface. The colors represent the resistivity, with blue colors representing the lower resistivities, below 10 ohm-m, the yellow and green colors representing the moderate resistivities, between 10 and 50 ohm-m, and the orange and red colors representing the higher resistivities, over 50 ohm-m.

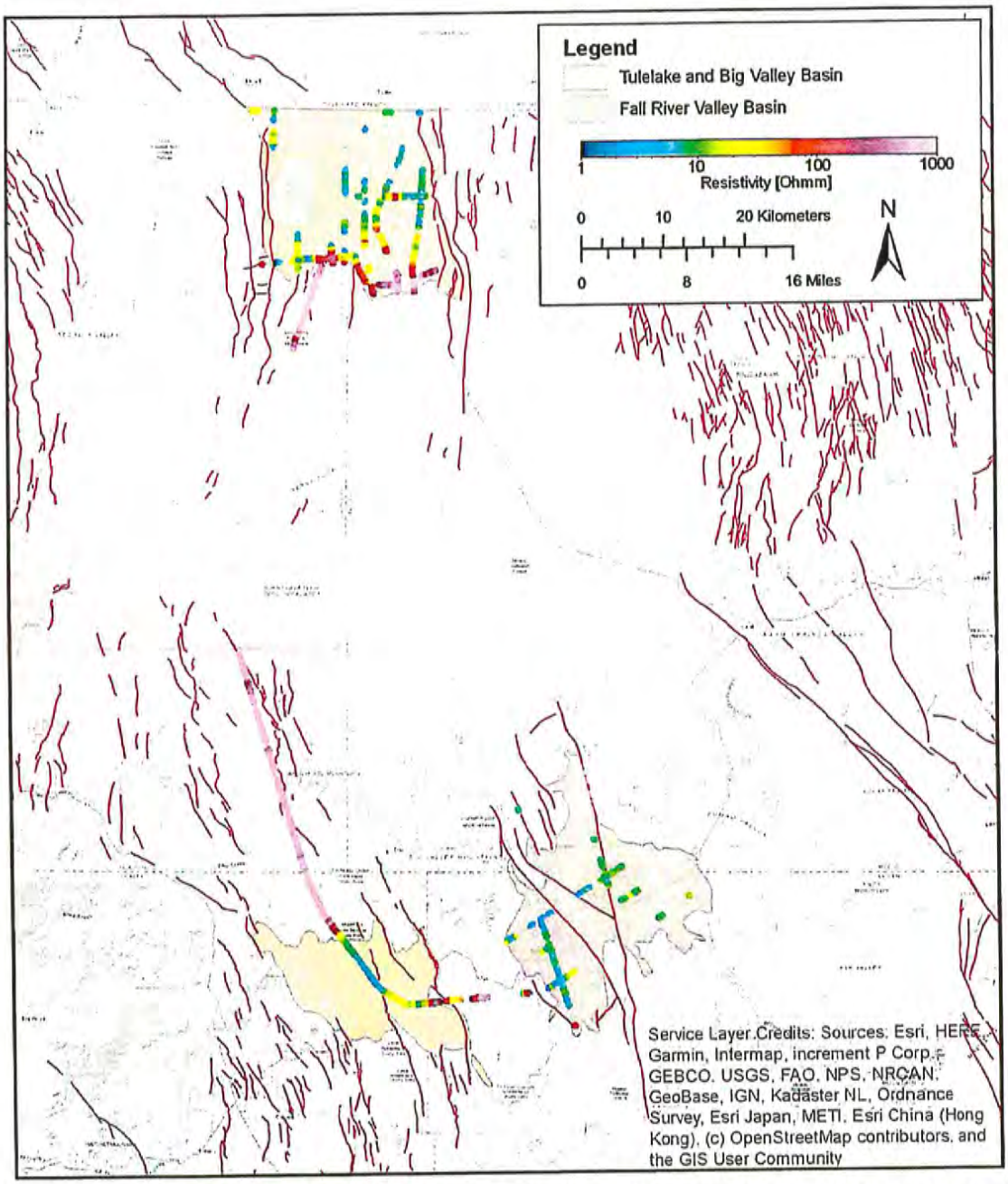


Figure 4-6 Mean resistivity plan-view map in the elevation interval 980-1,000 m (3,215-3,281 ft) amsl. The colors represent the resistivity, with blue colors representing the lower resistivities, below 10 ohm-m, the yellow and green colors representing the moderate resistivities, between 10 and 50 ohm-m, and the orange and red colors representing the higher resistivities, over 50 ohm-m.

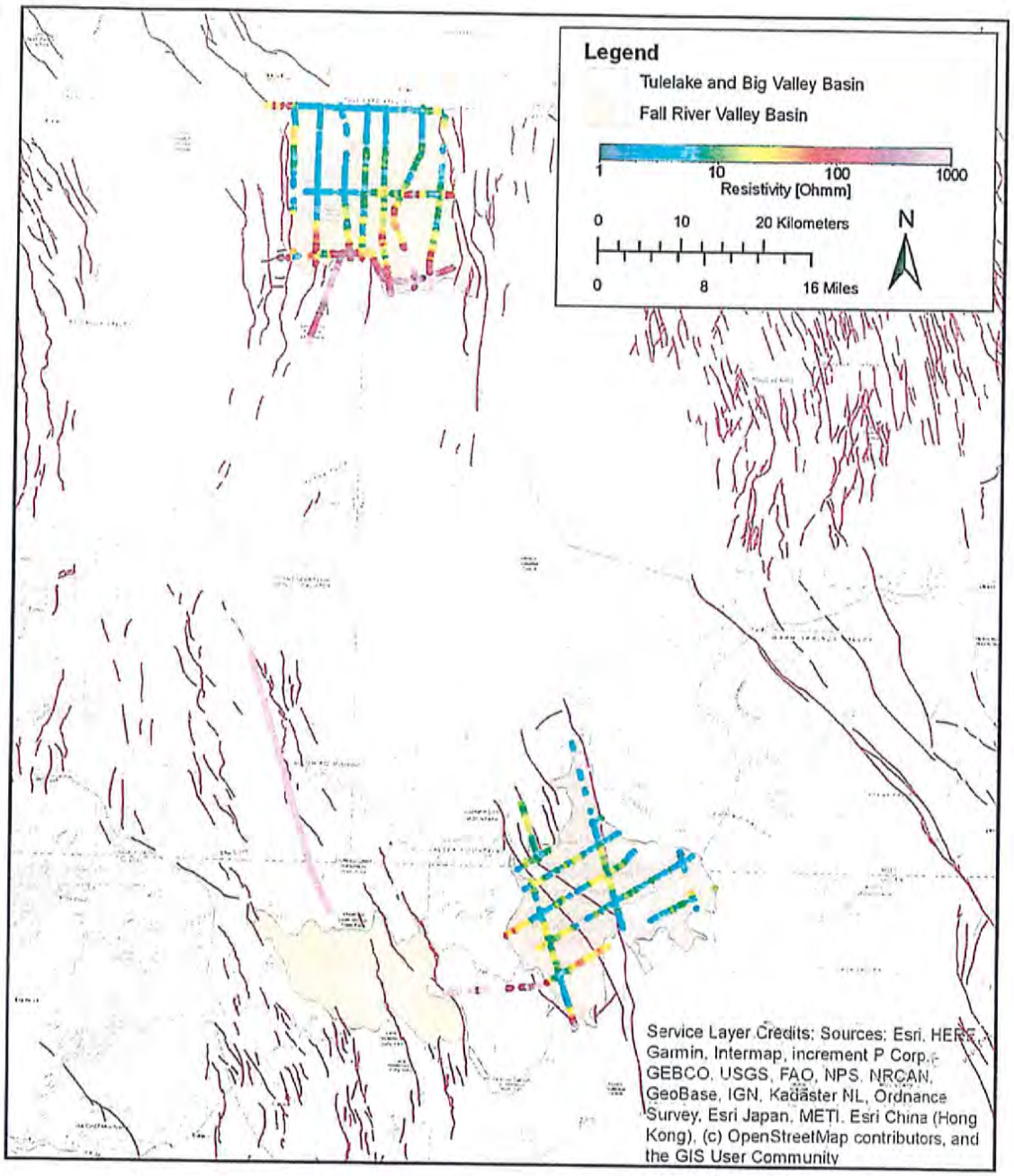


Figure 4-7 Mean resistivity plan-view map in the elevation interval 1,040 m to 1,060 m (3,412-3,478 ft) amsl. The colors represent the resistivity, with blue colors representing the lower resistivities, below 10 ohm-m, the yellow and green colors representing the moderate resistivities, between 10 and 50 ohm-m, and the orange and red colors representing the higher resistivities, over 50 ohm-m.

5. LITHOLOGY MODEL

Lithology Transform and Interpretation Disclaimer
This report provides a resistivity-to-lithology transform and applies it to interpret the AEM resistivity data for lithology. The lithology transform and interpretation are based on available existing supporting data and are designed for informational purposes only. These resources are not intended for regulatory purposes as part of the Sustainable Groundwater Management Act. The Department of Water Resources makes no warranties, representations or guarantees, either expressed or implied, as to the accuracy, completeness, correctness, or timeliness of the information that is presented in the lithology transform and lithology interpretations provided in this report, nor accepts or assumes any liability arising from use of this report or underlying data.

5.1 Introduction

The resistivity values estimated using the AEM method provide value for groundwater management because of the relationship between electrical resistivity and subsurface properties of interest. This includes the degree of saturation, groundwater salinity, and lithology. Generally, resistivity will decrease with an increase in fine sediment, salinity, and saturation. The relationship between resistivity values, lithology, and salinity can be seen in Figure 5-1, where the resistivity range corresponding to gravel and sand is higher than that of glacial tills and higher still than that of clays. Similarly, saltwater has a much lower resistivity than does freshwater. Consolidated rocks such as granite will typically have very high resistivities. Shales, on the other hand, can take on a wide range of resistivity values.

The wide range of resistivity values spanned by each bar in Figure 5-1 (most spanning over an order of magnitude) underscores the variable and site-specific nature of the relationship between resistivity and earth materials. Locally variable conditions can cause coarse sediments to have higher resistivity in some areas than in others, and mixtures of sediments (e.g., glacial till) result in resistivity values between those of coarse and fine.

The sharp resistivity model from the data processing and inversion (Section 4.1.2.1) was used for developing the resistivity-to-lithology transform, since the model prefers to keep resistivity values relatively consistent but can also accommodate lateral and horizontal variations. The sharp inversion model has 30 layers, with the first layer thickness of 2 m (7 ft), with layer thickness gradually increasing with depth to 600 meters (1,970 ft). However, the lower boundary in the resistivity-to-lithology transform was set as the first layer boundary above the DOI (Section 4.1.2.2).

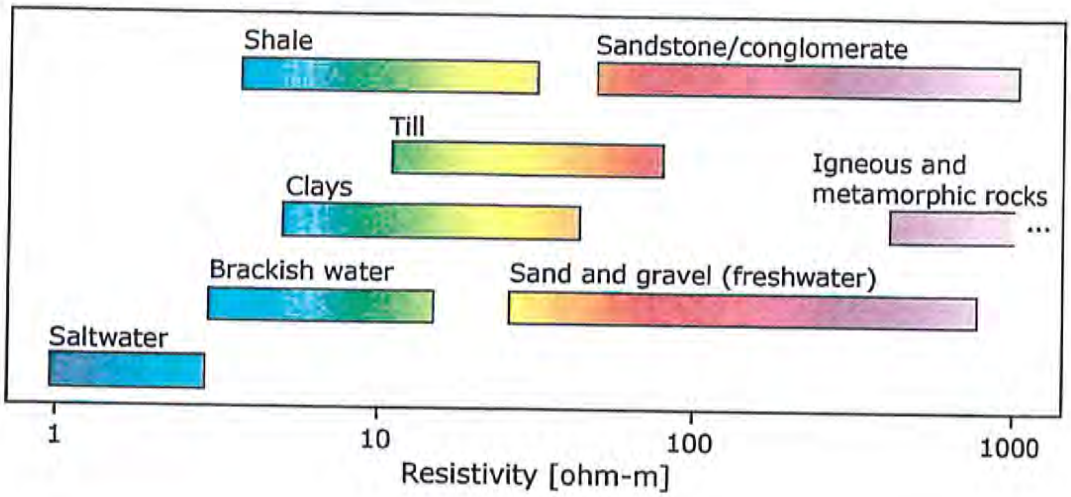


Figure 5-1 Typical relationship between resistivity, lithology, and salinity (after Palacky, 1987).

Establishing a transform to predict lithology from resistivity is a challenging task, because (1) in addition to lithology, the resistivity measurement also depends on other subsurface properties (water saturation and water quality), (2) the relationship between resistivity and lithology varies spatially and 3) the transform does not apply to certain geologic variations, such as consolidated rocks. One or more of these conditions are typically found across groundwater basins in California and therefore a successful transform should address these dependencies.

The Accumulated Clay Thickness method is specifically developed for translating resistivity models in large AEM datasets—such as those acquired in this project—into models of the fractional thickness of clay sediment (Christiansen et al. 2014, Foged et al. 2014). The resulting clay fraction models can be used to better understand the spatial distribution of coarse and fine sediment, and can be an integral data component to support the development of a hydrostratigraphic or groundwater flow model. In the following text, we focus on coarse sediments, and thus ACT refers to Accumulated Coarse Thickness, which is the complement of Accumulated Clay Thickness.

To predict the lithology using the resistivity models resulting from the AEM surveys in the Tulelake and Big Valley basins, a 3D grid of translator functions was applied. The ACT method has the advantageous property that the resistivity-lithology relationship is not represented by just one "global" translator function. Rather, the translator function in the grid can vary spatially, calibrated from nearby well lithology data, allowing the resistivity-to-lithology to implicitly account for changes in resistivity due to changes in salinity and saturation, as well as to regional variability in the resistivity-lithology relationship.

This section provides a summary of the methods and results of the resistivity-to-lithology transform. A detailed description of the theory, methods and results from the lithology transform are presented in Appendix 4. The resistivity-to-lithology transform results and uncertainty for each line is shown on the profiles presented in Appendix 8.

5.2 Resistivity-to-Lithology Transform Methodology

The resistivity-to-lithology transform used in the Tulelake and Big Valley Groundwater Basins follows a modified workflow based on a methodology specifically developed for large AEM datasets (see Foged et al., 2014), using the Aarhus Workbench Hydro Structural Modeling module. The resistivity models produced from inversion (Section 4) are used along with well completion report lithology log data (Section 2) to optimize a set of translator functions, each of which can map the resistivity of a depth interval (ACT layer) to the amount of coarse material, quantified as the coarse fraction (CF) within the same layer.

The workflow used to develop the lithology models is followed for each basin separately, allowing for adaptation of the conditions addressed in the previous section. The process is as follows:

1. Prepare the data needed for lithologic modeling and evaluate whether the employed methodology is appropriate for the given basin.
2. If the methodology is appropriate, establish the resistivity-to-lithology transform.
3. If the methodology is deemed not to be appropriate, implement a manually defined resistivity-lithology transform.
4. Evaluate the transform results.

First, a preliminary evaluation of the resistivity-lithology relationship in each basin was conducted. This involves a geologic assessment to obtain a general understanding of the different geologic units and to restrict further analysis to regions where the transform modeling is valid. Specific cases that can affect resistivity measurements beyond the lithology are discussed in Section 5.4 and the approaches to remove those regions from the analysis or handle the conditions were addressed.

Texture descriptions from lithology logs within 800 m (2,625 ft) of the flown flight lines were used in the analysis. The resistivity data were projected to the actual well log location and both the AEM resistivity models and lithology logs were re-discretized to common transform layers. The texture description from each depth interval from each lithology log was aggregated into either "fine" or "coarse", where fine corresponds to a CF of 0, and coarse corresponds to a CF of 1. Fine materials were considered to include clay and silt sediments (lower permeability), while coarse materials were considered to include sand and gravel (higher permeability). As an intermediary step, the lithology log descriptions were first simplified to four texture categories: fine, fine with coarse, coarse with fine, and coarse.

The next steps before deciding if the transform modeling approach is valid for the actual basin was to evaluate the correlation between lithology and resistivity for each basin. This was done by analyzing the histograms of resistivity for each lithologic unit. If a correlation was found, initial ACT settings was established. The grid of translator functions was set with a lateral spacing of 10,000 m (32,808 ft) and a vertical spacing corresponding to the thickness of the ACT model. In addition, the lower boundary in the resistivity-to-lithology transform was set as the first layer boundary above DOI (Section 4.1.2.2). Initially, the lateral spacing between grid nodes was set at 10,000 m (32,808 ft) to accommodate the relatively sparse lateral coverage of the AEM data (3 km). In principle, the final applied node distance depends on the actual extent of the AEM datasets and can therefore vary from the 10,000 m.

After establishing the initial ACT settings, the volume of available lithology data within the 3D grid was analyzed to assess whether sufficient data exist for transform modeling. If so, the ACT numerical optimization was performed, and the results were evaluated and visualized.

If no correlation was found between lithology and resistivity for a basin or if the volume of available lithology data was found insufficient, selected well data was compared manually with nearby resistivity models to determine a relationship between resistivity and lithology. In this case, the translator function parameters were manually determined, and a uniform translator function was applied throughout the 3D grid. Finally, if a relationship could not be determined, it was decided that transforming resistivity to lithology is not applicable since additional or refined well data is required.

During the resistivity-to-lithology transform, each translator function in the grid is optimized using nearby resistivity models from the survey area and the simplified texture description from nearby lithology logs. Each translator function has the form of the function in Figure 5-2. Nearby resistivity values are input into each translator function to predict the CF. Predicted CF values are compared to the simplified texture values from nearby lithology logs, and the translator function is adjusted, through an automated process, to minimize the difference between the CF in the lithology logs and the predicted CF from the translator function. The translator function provides a lower resistivity limit m_{lower}, where all layers with a resistivity lower than this limit will contain only fine sediments, and an upper resistivity limit, m_{upper}, where-all layers with a resistivity higher than this limit will contain no fine sediments.

Along each of the flight lines in this project, simplified texture descriptions from nearby lithology logs were compared to the sharp resistivity model.

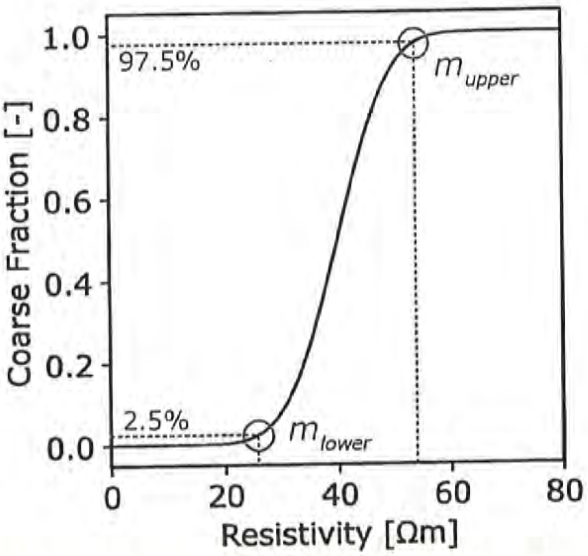


Figure 5-2 An example of a single fraction translator function (after Foged et al., 2014) in the 3D grid. The coarse fraction (CF) ranges from 0 (minimal coarse material) to 1 (coarse dominated). The value m_{lower} represents the lower value where all resistivities below this value represent layers containing only clay, and m_{upper} represents the upper value, where all resistivities higher than this value represent layers containing no clay. In this example, the lower limit is at 25 ohm-m and the upper limit is at 55 ohm-m.

The final step is to calculate the coarse fraction model uncertainty. The uncertainty is based on the uncertainty of the AEM model resistivity related to the transfer function for the specific layer. In other words, the range in resistivity is used for calculating a range in coarse fraction from the specific translator function. This is then converted to a standard deviation factor for the coarse fraction, typically between 1.0 and 1.3, where 1.0 is the most certain with uncertainty increasing as the standard deviation factor increases.

5.3 Transform Results

Figure 5-3 contains a selected profile along a flight line in the Tulelake Groundwater Basin, which shows the lithology model resulting from the resistivity-to-lithology transform. The lithology models for all flown sections are presented in Appendix 8.

The initial results from the lithology model illustrate the viability in utilizing this approach applied to AEM data in the Tulelake area. The model in general has a good correlation between coarse fraction and resistivity values. Since the survey is at reconnaissance level with a wide flight line spacing, the results of the resistivity-to-lithology transform can only be applied directly along the flight lines; variations where no AEM data were acquired are unknown.

In the Big Valley Groundwater Basin, no clear correlation was found between lithology, as described in available well logs, and resistivity. Thus, no resistivity-to-lithology transform was possible. A manual approach was attempted to evaluate the resistivity-to-lithology relationship between specific well lithology data and resistivity model. This was done by including well lithology logs that are within 100 m from a AEM sounding—only three high-quality lithology logs in the project database were within this maximum distance. Based on an evaluation of resistivity models and the three nearby lithology logs, there is no clear evidence that fine material has a lower resistivity than coarse material. Thus, it is not possible to differentiate between coarse and fine materials in the resistivity data. For this reason, the ACT method was not found applicable to establish a translation from resistivity to lithology. The volcanic setting in and around Big Valley and the low density of lithology information near AEM data create a challenging environment for establishing a resistivity-to-lithology transform.

To better understand the relationship between resistivity and the basin lithology, future work is recommended to include:

- Examination of original lithology descriptions from well logs to see if certain lithology types (that may be grouped together in the same classification) show a relationship with resistivity.
- Compare borehole geophysical resistivity logs with nearby lithology logs (including those more than 800 meters (1/2 mile) from flight lines). Borehole resistivity data have a higher vertical resolution that does not diminish with depth, providing more data points that could be used for a lithology transform in Big Valley.
- Further develop the geologic understanding of the basin to map locations where the ACT approach is and is not valid. This will allow for a better zoning for the lithology transform.

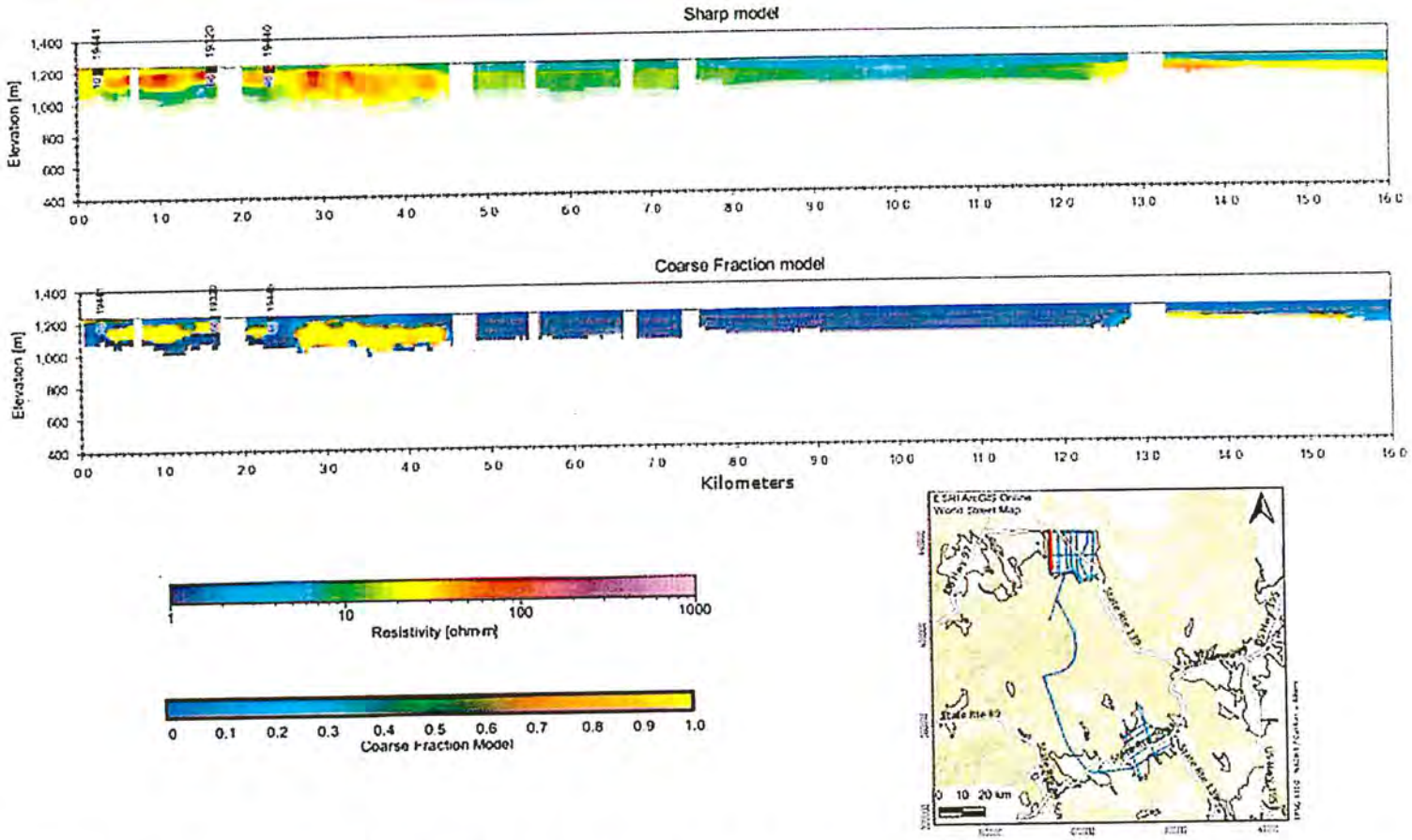


Figure 5-3 Lithology model resulting from the resistivity-to-lithology transform along Profile 700100. The yellow colors show the sediments/materials with high coarse content (scale value 1.0) transitioning to the dark blue colors showing sediments with the highest clay content (scale value 0.0).

5.4 Specific Cases

Specific cases that can affect resistivity measurements beyond the lithology include, but are not limited to, the degree of sediment saturation, presence of saline water, and the degree of consolidation (rock). These specific cases are discussed below.

5.4.1 Saturated and Unsaturated Sediments

Resistivity is not only influenced by the lithology but also by the water quality and degree of saturation in the subsurface. Unsaturated sediments tend to have a higher resistivity than saturated sediment. This difference in the rock physics relationship between saturated and unsaturated zones can be taken into consideration in the translator function, where a separate translator function is produced for the unsaturated and saturated zone. Separating the unsaturated and saturated zones requires information on the elevation of the water table at the location of each well used in the transform; these data are primarily obtained through water level measurements in unconfined aquifers. In some cases, it is determined that an insufficient density of water level data is available to reliably estimate the water table elevation across the survey area to separate the saturated from the unsaturated sediments in the resistivity-to-lithology transform. However, even without sufficient information on the water table elevation, through use of the 3D grid of translator functions, the resistivity-to-lithology transform is still able to implicitly account for spatial variation in the depth to saturated sediments.

Figure 5-4 shows a schematic of the grid of translator functions above and below the water table. The colored bars, representing the resistivity models produced from AEM data, have warmer colors (higher resistivity) above the water table, shown as a blue line, than below the water table. The nodes of the grid of translator functions, shown as black dots, are separated laterally and vertically by the thickness of each ACT model cell. It is noted that, while the translator function nodes are shown on top of the resistivity model cells in this two-dimensional schematic, the nodes of the applied translator grid in 3D did not necessarily intersect a cell in the resistivity model. A translator function (with the shape of the curve in Figure 5-2) is fit to the borehole lithology and resistivity data within each depth interval. Because each translator function is fit separately, a different transform can result above and below the water table.

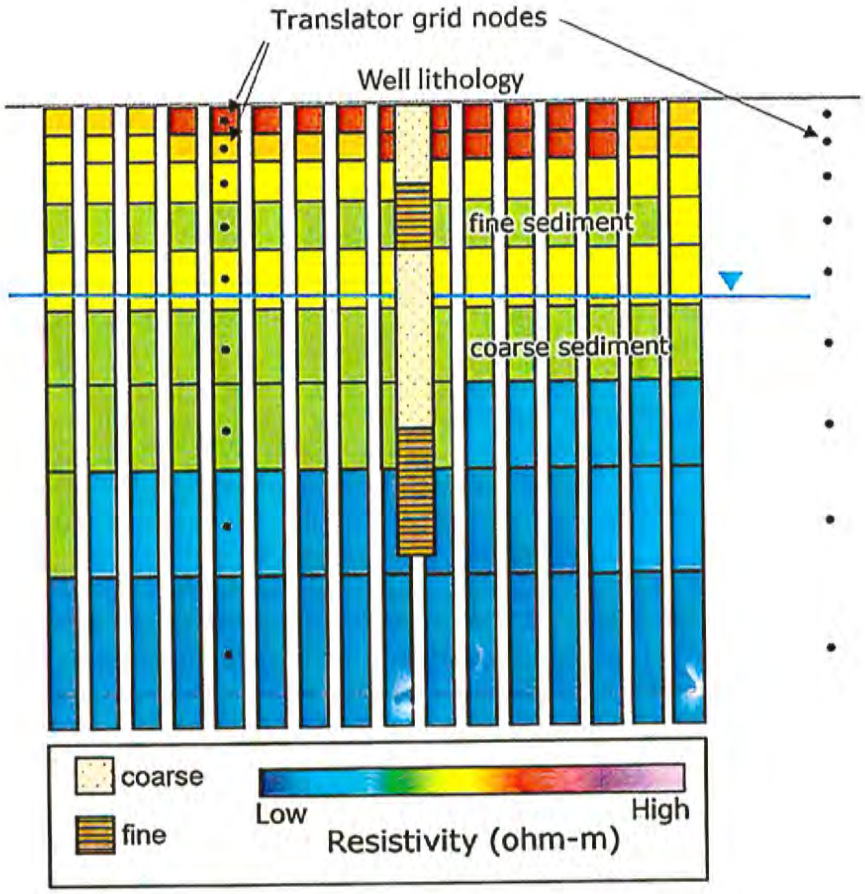


Figure 5-4 Schematic demonstrating the ability of the resistivity-to-lithology transform to implicitly account for the change from unsaturated to saturated sediments. The well shows the simplified lithology from log descriptions.

In the case of Figure 5-4, even if the depth to the water table is unknown, the translator functions above the water table will be fit to the generally higher resistivity values, while those below the water table will be fit to the lower resistivity values. While the transform can accommodate a small to moderate groundwater gradient in the boundary between unsaturated and saturated sediment, it should be noted that because the grid of translator functions has a large lateral spacing, a steep gradient is expected to cause some smearing in the lithology model resulting from the resistivity-to-lithology transform.

5.4.2 Saline Water

Groundwater salinity can also influence the observed resistivity in the saturated zone. Groundwater with higher TDS values will have lower resistivity. As with the transition from unsaturated to saturated zones, the resistivity-to-lithology transform can implicitly

account for variations in salinity, assuming (1) the salinity does not change rapidly over a short lateral distance, (2) the salinity is not very high, and (3) the salinity of the coarser sediment is similar or lower than that of the fine sediment. If the salinity varies rapidly over a short distance, smearing will occur in the translator function in a similar way as when the water table gradient is steep. Once the salinity becomes high (about 3,000 mg/L), differences in the resistivity between coarse and fine materials are damped. Finally, if the salinity of the coarse sediment is higher than that of the fine sediment, the translator function will fail, since the function (Figure 5-2) assumes that coarser sediment is more resistive than finer sediment. Coarse sediment may contain more saline water than fine sediment, for example, in areas affected by seawater intrusion, since the water saturating coarse sediments (aquifer) is more readily displaced by intruding seawater than the water saturating fine sediments (aquitard).

To circumvent potential challenges to the resistivity-to-lithology transform in areas of elevated salinity, one of two approaches is applied: (1) the resistivity-to-lithology transform can either be divided into different zones (e.g., a freshwater zone and a brackish zone) with each zone evaluated for whether the resistivity-to-lithology transform should be applied, or (2) the brackish zone is removed from the analysis.

In the areas near the flight lines in this project, the measured TDS was determined not to have a significant influence on the observed resistivity value.

5.4.3 Consolidated Rocks

Consolidated rocks (e.g., bedrock) have different hydraulic properties than unconsolidated sediment, often forming a hydraulic barrier within a groundwater basin. The resistivity-to-lithology transform applied in this project was developed for unconsolidated sediments: the translator function considers a spectrum of fine to coarse sediment.

Since many igneous and metamorphic rocks tend to have a high resistivity (Figure 5-1), the resistivity-to-lithology transform will interpret these rocks as coarse sediment (a high CF value). Given their high resistivity, these rocks can often be distinguished from unconsolidated materials in the resistivity models. On the other hand, consolidated sedimentary rocks, including shales and sandstones, take on a wide range of resistivity values that may be similar to those of unconsolidated sediment. The transform will interpret these rocks as either fine or coarse sediment, depending on their resistivity values in comparison to those of nearby unconsolidated sediment.

When analyzing the lithology model resulting from the resistivity-to-lithology transform, it is important to first remove any areas corresponding to consolidated rocks.

6. INITIAL HYDROSTRATIGRAPHIC MODEL

6.1 Introduction

The data acquired during an AEM survey can provide valuable information for developing or refining a hydrostratigraphic model of the surveyed area. However, due to the large amounts of data acquired during a typical AEM survey, including this project, manually interpreting the hydrostratigraphic units corresponding to the resistivity or lithology model can be labor intensive.

Here, an automated approach was applied to produce a model consisting of zones of similar properties from a resistivity model and a lithology model. This model could be used to help develop a better understanding of the regional hydrostratigraphy, or as the basis for a numerical groundwater flow model. The approach uses a clustering algorithm, which classifies a set of data points into a predefined number of groups with similar properties. It is a widely used approach for pattern recognition, image processing and analysis of large datasets where grouping is required. Since resistivity is related to the hydrogeologic properties of interest, the clustering approach relies on the assumption that groups defined from resistivity and borehole lithology data also have similar hydrogeologic properties.

There are other approaches, not pursued here, that can provide an automated conversion of AEM data into an interpreted hydrostratigraphic model. These include, for example, the use of multipoint statistics (Gulbrandsen et al, 2021) or the Octree algorithm for 3D voxel modeling (Jorgensen et al, 2013). It is not within the scope of this project to provide a critical review of the different methodologies that can be applied in the interpretation of AEM data to a hydrostratigraphic model. Rather, the clustering approach used here is presented as an example of an approach that could be used, illustrating the value of AEM data as input to a 3D hydrostratigraphic model. The clustering approach used for this project was chosen for the following reasons:

(1) It provides an automated grouping providing a representation of the hydrostratigraphy
(2) The grouping is data driven, reproducible, and is geographically and depth independent
(3) The process requires only the measured resistivity and lithology log data

This section provides a description of the clustering methodology and the resulting hydrostratigraphic model in the Tulelake Groundwater Basin. As explained in section 6.3, it was not possible to do a resistivity to coarse fraction transform for the Big Valley Groundwater Basin and thus it is not possible to construct an initial hydrostratigraphic model based upon the AEM resistivity data in Big Valley.

6.2 Methodology

The clustering modeling methodology, developed by Marker et al. (2015), consists of an algorithm that pairs a lithology model, outlined in Section 5, with a resistivity model to produce a defined number of groups, each of which consists of similar resistivity and lithology values. The resistivity value for each cell in the sharp resistivity model is paired with the corresponding lithology model CF value across the entire basin. The result is a set of resistivity-CF pairs that can be visualized as a scatter plot. To aggregate the groups of similar resistivity-lithology value pairs, a clustering algorithm is applied to the pairs, with a predetermined user-defined number of groups, or clusters. The resultant groups then represent points with similar resistivity and lithology and are thus presumed to have similar hydrogeological properties.

At first glance, combining the CF values with the resistivity values that produced said CF values may seem circular. However, as described in Section 5, the lithology data used in the resistivity-to-lithology transform is simplified as either coarse or fine. This simplification is necessary for the computation-intensive numerical calculations in the transform. However, details in the lithology information are lost in the process, resulting in some details contained within the resistivity model being muted or absent in the lithology model. By adding the resistivity information back into the clustering process, these details can be captured in the resultant initial hydrostratigraphic model.

The process of developing the initial hydrostratigraphic model begins with determining the number of groups, or clusters, to be identified. Determining the number of groups requires an understanding of the depositional environment(s) of the groundwater basin, including the basin's geological complexity as well as other parameters which could influence resistivity, such as changes in water quality (both horizonal and vertical) and the depth to saturated sediment. If the basin hydrogeology changes significantly across the survey area, the application of the clustering algorithm can be divided into multiple zones.

Once the number of clusters for each cluster model has been determined, each resistivity-CF pair from the resistivity model and corresponding lithology model are entered into the clustering algorithm, which iteratively works to identify the best partitions between groups. The results of the clustering algorithm in Tulelake Groundwater Basin survey are shown as a scatterplot in Figure 6-1. The CF value for each resistivity-CF pair is shown along the x-axis, while resistivity value is shown on the y-axis. Each point is colored according to the group it was placed in. Cluster 1, represented by 41% of all the clustered datapoints, contains the lowest resistivities and lowest CF. This cluster represents the units with the highest amount of clay materials in the initial hydrostratigraphic model. Each following group has a sequentially higher CF and resistivity. A more detailed description of the clustering process is presented in Appendix 5.

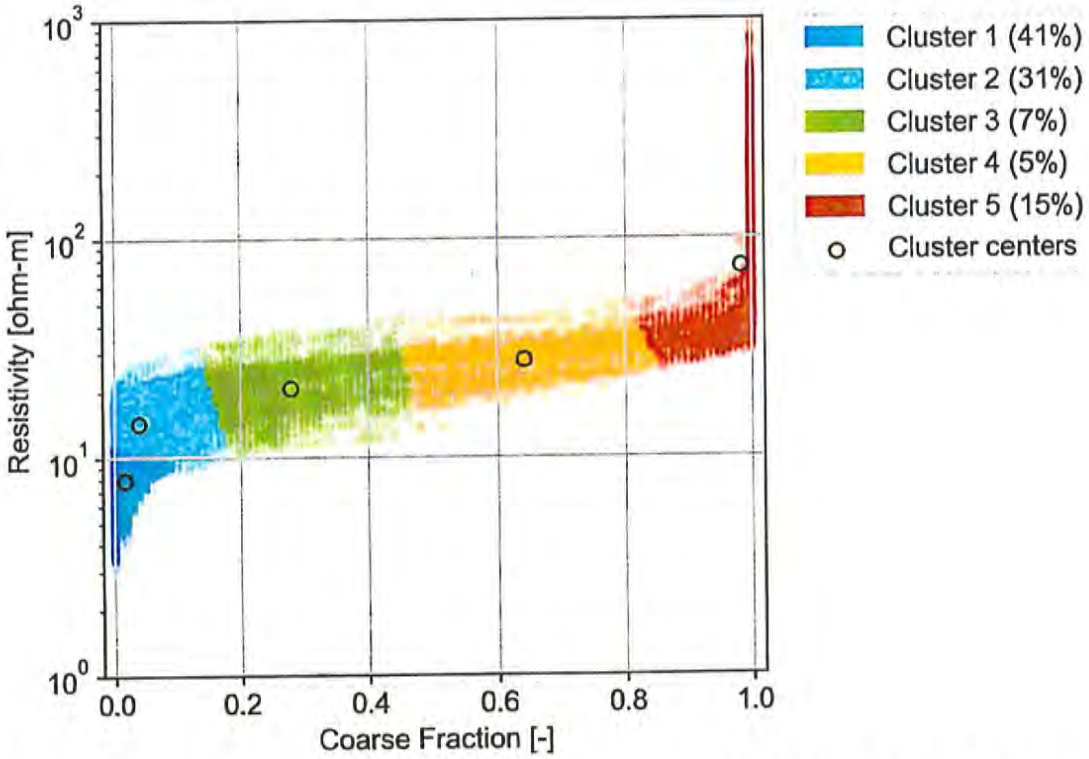


Figure 6-1 The results of the clustering algorithm applied to the data in the Tulelake survey. Percentages in the legend indicate the ratio of resistivity-CF pairs included in the respective group. Note that there is overlap of points within the cluster model.

6.3 Clustering Algorithm Implementation

The first step in the cluster modeling process for the Tulelake Groundwater Basin was to determine whether the area should be divided into separate regions due to changes in the hydrostratigraphy. This included the consideration of whether the unsaturated zone should be clustered separately from the saturated zone. In this case, the depth to the water table ranges from near surface to a maximum of 35 meters (115 feet) below ground surface in Tulelake (see Figure 2-2). Since the depth to the water table was less than 35 meters, it was determined that the unsaturated and saturated zone should not be separated for the clustering process.

Groundwater salinity was also evaluated. Available TDS measurements show a relatively small range in salinity around the flight lines in the Tulelake and Big Valley survey. In Tulelake, the maximum TDS measured was 1,750 mg/L in a single well, with only 2 other wells containing TDS values between 750 and 1,500 mg/L (see Figure 2-3). Therefore, it was determined that salinity did not have a significant influence on resistivity and subsequently did not affect the cluster modeling process.

Five groups were chosen for the clustering algorithm to identify from the resistivity-CF pairs. This decision was based on the observed hydrogeology of the basin, where the different groups could accommodate the different hydrogeology, including coarse layers both in and above the saturated zone, mixed units, silty fines, clayey fines and the bedrock along the sides of the basin. The choice of five groups was used a starting point producing an initial hydrostratigraphic model, which was subsequently evaluated as to whether a new iteration with more or fewer cluster groups was needed.

6.4 Results

The five different cluster groups representing the initial hydrostratigraphic model layers were plotted as profiles along all the flight lines where AEM data was acquired. The initial hydrostratigraphic model was evaluated for how well the chosen five-group model represents the hydrostratigraphy and whether a different number of clusters was needed. A profile showing the result of the initial hydrostratigraphic model is shown on Figure 6-2. Evaluation of the profile lines suggests that the clustering resulted in reasonable, continuous layers and the layering correlated well with the basin's geological features. Thus, it was determined that a second iteration with a different number of clusters was not needed. Profiles of all the initial hydrostratigraphic models are shown on the data sheets in Appendix 9.

The uncertainty for the clustering model is presented as an index showing how close the data point is to an adjoining cluster boundary. The basis of the uncertainty index is that the closer a specific point is to another cluster boundary, the greater the chance is that that specific point may have hydrostratigraphic properties closer to the neighbor cluster, and the lower the numeric value. Thus, points that have an uncertainty index of over 0.5 are closer to the cluster center than the neighboring cluster and have a high certainty of belonging in that cluster. However, points with an uncertainty index of under 0.2 will be near the neighboring cluster and thus have much higher uncertainty whether that specific point belongs in its own cluster or the neighboring cluster. An example of the results showing the uncertainty index is shown on Figure 6-2, and the uncertainty index for all the clustering results are shown on the profiles on the data sheets in Appendix 9.

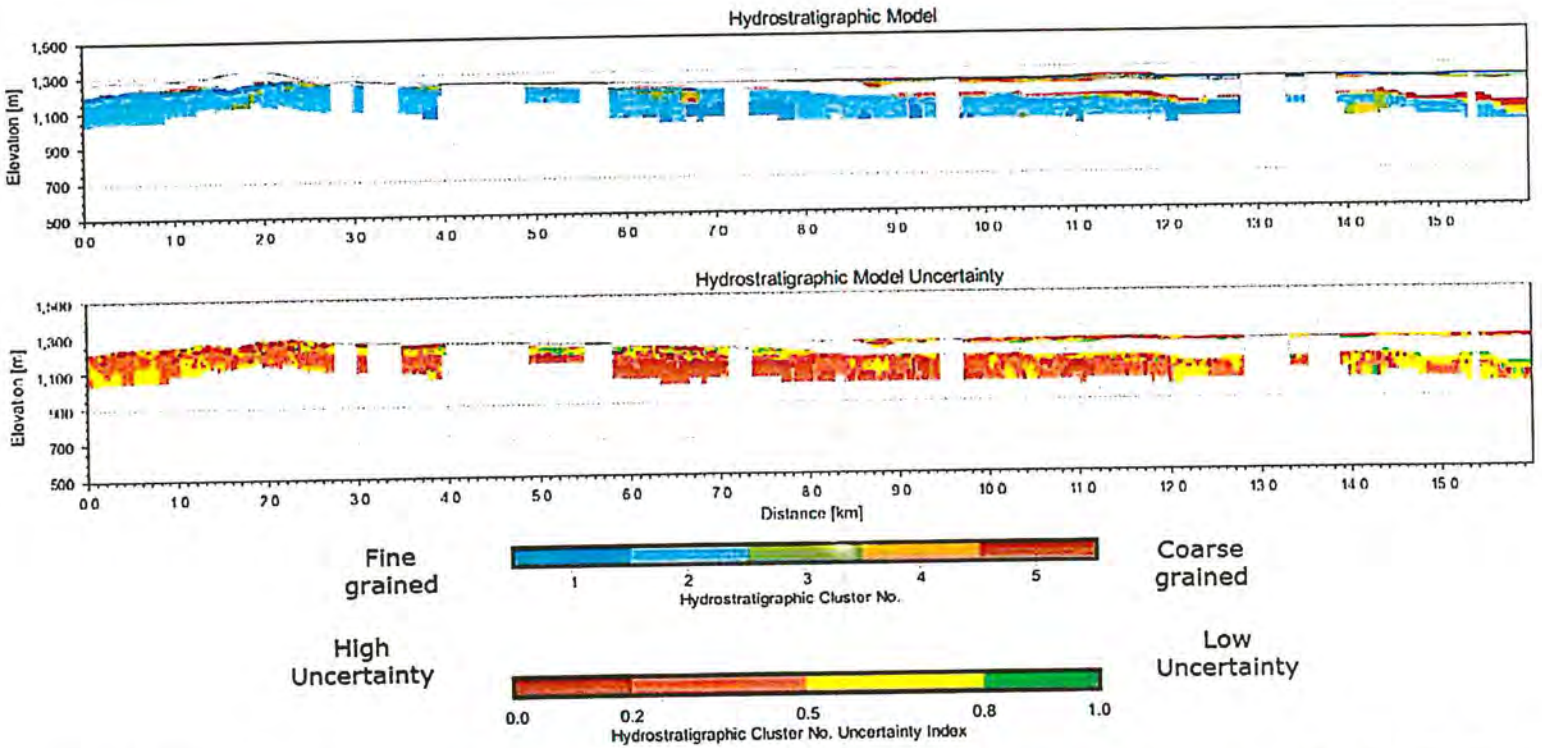


Figure 6-2 Initial hydrostratigraphic model shown along Section 700700. The top bar shows the distribution of the different groups along the section and the bottom bar shows the associated uncertainty, where the red colors represent the areas of the model with highest uncertainty, and the green color represents the lowest uncertainty. The location of the section is shown on Figure 4-1.

6.5 Perspectives on the Initial Hydrostratigraphic Model

The cluster modeling process provides the opportunity to handle a large amount of AEM data produced from an AEM survey in order to construct an initial hydrostratigraphic model. The model is generated solely on a statistical analysis of the gathered data and its relationship with observed coarse versus fine materials and is completely independent from external biases that affect where model boundaries are drawn. As a result, the hydrostratigraphic model resulting from the clustering approach is reproducible.

The main limitation for the use of the clustering model to develop an initial hydrostratigraphic model is the wide spacing of the AEM flight lines. Ideally, the AEM line spacing should be close together, allowing for a 3D AEM model to be developed. With a line spacing in a 2 x 8-mile grid, the spacing is too large to extrapolate the data to the area between the grid lines. Thus, the results of the initial hydrostratigraphic model are only representative along the line where AEM data has been collected. A closer line spacing, on the order of 250 m, will allow for the data to be interpolated between the lines into a 3D model grid, providing the possibility for a direct input into a numerical flow model.

The development of the hydrostratigraphic model is an iterative process. For the purpose of this project, only one iteration was conducted and thus, the result is considered to be an initial hydrostratigraphic model. More iterations could be conducted and compared with the known hydrostratigraphy of the basin to provide more realizations. In addition, in the process outlined by Marker et al. (2015), cluster models with varying number of clusters can be evaluated in the flow model calibration process. In this case, the flow model could be used as input to help define the necessary number of clusters in the hydrostratigraphic model when used as input to a numerical flow model. This is an opportunity that could be realized with further infill along the flight lines where AEM data is interpreted.

7. REFERENCES

Auken, E., A.V. Christiansen, C. Kirkegaard, G. Fiandaca, C. Schamper, A.A. Behroozmand, et al. 2015. An overview of a highly versatile forward and stable inverse algorithm for airborne, ground-based and borehole electromagnetic and electric data. Explor. Geophys. 46:223–235. doi: 10.1071/EG13097

California Geological Survey (CGS). 2010. Geologic Map of California. Scale 1:750,000.

DWR. 2020. California's Groundwater – Bulletin 118 – Update 2020.

Gulbrandsen, M., Rasmussen, T. and Jensen, N., 2021. Indian Wells Valley – The Multiple Point Statistics Method. The Groundwater Architecture Project (GAP): Utilizing advanced geophysical and computational methods for the development of hydrogeolgic conceptual models. https://mapwater.stanford.edu/.

Schamper C., Pedersen, J., Auken, E., Christiansen, A., Vittecoq, B., Deparis, J., Jaouen, T., Lacquement, F., Nehlig, P., Perrin, J. and Reninger, P. (2013). Airborne Transient EM Methods and Their Applications for Coastal Groundwater Investigations. In: Wetzelhuetter C. (eds) Groundwater in the Coastal Zones of Asia-Pacific. Coastal Research Library, vol 7. Springer, Dordrecht.

Viezzoli, A., Christiansen, A. V., Auken, E., and Sørensen, K. I., 2008, Quasi-3D modeling of airborne TEM data by spatially constrained inversion: Geophysics, 73, F105–F113. doi:10.1190/1.2895521

Vignoli, G., Fiandaca, G., Christiansen, A. V., Kirkegaard, C., and Auken, E., 2015, Sharp Spatially Constrained Inversion with applications to transient electromagnetic data: Geophysical Prospecting, 63, pp 243-255. doi: 10.1111/1365-2478.12185

Ward SH, Hohmann GW (1988) Electromagnetic theory for geophysical applications. Electromagnetic Methods in Applied Geophysics, vol. 1, (ed MN Nabighian), pp 131–311, SEG publication.

Subject #6: University of California Cooperative Extension Report

TECHNICAL MEMORANDUM

DATE: October 26, 2022

Project No.: 1030-80-22-01
SENT VIA: EMAIL

TO: Tiffany Martinez, Clerk of the Board/Assistant County Administrative Officer for the County of Modoc

FROM: Garrett Rapp, PE
Carolina Sanchez, PE

REVIEWED BY: Polly Boissevain, PE, RCE #36164

SUBJECT: Draft Water Availability Analysis for a Water Rights Application Workplan

BACKGROUND AND OBJECTIVES

The County of Modoc (County) and the County of Lassen are the two Groundwater Sustainability Agencies (GSAs) overlying the Big Valley Groundwater Basin (Basin). Figure 1 shows the location of the Basin, the watershed tributary to the Basin, and the boundaries of Modoc and Lassen Counties.

The Groundwater Sustainability Plan (GSP) for the Basin was completed in December 2021 and includes recommendations for projects and management actions (PMAs) to achieve long-term sustainability of the Basin. One of the PMAs involves investigating and implementing groundwater recharge projects through agricultural managed aquifer recharge (AgMAR). There are several challenges in implementing AgMAR in the Basin, including:

1. There is a limited understanding of the impacts of AgMAR on the types of crops grown in the Basin, such as irrigated pasture and hay fields
2. There is a limited understanding on the existing water rights in the Basin
3. There is a limited understanding of the volume of water available for AgMAR
4. The potential surface water diversion period may be impacted by the cold winters that cause the ground to freeze

To address the crop-specific questions, the County is working with the University of California Cooperative Extension, Modoc County (UCCE), to research crop responses to AgMAR. The research is ongoing, and the next steps include the implementation of AgMAR at a small scale. In order to implement any type of AgMAR project, the County (or AgMAR project implementer) will require a water rights diversion permit from the State Water Resources Control Board (State Board).

Water rights permits can either be standard or temporary. Standard permits require a rigorous water availability analysis (WAA) to demonstrate that a proposed diversion does not encroach upon senior water rights holders or impair environmental or other flow requirements. Temporary permits require a simpler

WAA than a standard permit and may be valid for either 180 days or 5 years. The State Board expects a temporary permit to serve as a foundation for the eventual application for a standard permit. Thus, before applying for a standard permit, the County will apply for a 180-day temporary permit to continue exploring methods and locations to implement AgMAR.

The application for a temporary water rights permit requires a WAA; however, the State Board does not provide clear directions on how to perform it. On May 6, 2022, the County, West Yost, and UCCE staff met with the State Board staff responsible for reviewing all water rights permit applications related to groundwater storage (i.e., diversions for groundwater recharge projects). During this meeting, State Board staff explained that there is no specific scope that can be followed to ensure the approval of a water rights permit application and provided a general framework of the types of data and analyses that can be used to conduct a WAA.

The next step for the County is to determine the scope of the technical demonstrations that need to be performed to complete the WAA for a temporary water rights permit application to perform the pilot AgMAR project. The technical scope is dependent on a variety of factors, including: 1) the complexity and number of existing water rights permits within and downstream of the Basin, 2) the availability of surface water data within and downstream of the Basin, 3) the timing of the proposed diversions for AgMAR, 4) potential impacts to the Sacramento-San Joaquin delta (Delta), and 4) other factors that may be introduced by the State Board during the application process.

This technical memorandum describes the proposed technical scope to complete a WAA, including the portion of the scope that has been completed thus far.

WAA SCOPE OF WORK

The following are the key tasks necessary to perform the proposed scope of services, each further described below:

- Task 1 – Coordination with the State Board, California Department of Fish and Wildlife, and Other Agencies
- Task 2 – Collect and Evaluate Data
- Task 3 – Conduct WAA
- Task 4 – Document the WAA
- Task 5 – Evaluate Applicability of Temporary Transfers

Task 1 – Coordinate with the State Board, California Department of Fish and Wildlife, and Other Agencies

The objective of this task is to obtain buy-in from the State Board and other relevant agencies on the WAA. This includes, but is not limited to:

- Coordinating with the State Board continuously through the development of the WAA to obtain input on the methods and analyses being used. The State can provide important input on (1) the aptness of the WAA analyses, (2) the required documentation for submitting the WAA to the State, and (3) other general input.
- Consulting with the California Department of Fish and Wildlife (CDFW) once the WAA is completed to discuss the project and how the proposed diversion will be protective of fish

and wildlife. A temporary permit application requires a consultation with CDFW prior to its submittal.

- Consulting with the USBR to ensure the WAA is responsive to its Shasta Dam operations and permit.

In addition to the May 6, 2022 meeting with State Board staff, West Yost and the County have met with State Board staff regularly through the development of the technical scope of work for the WAA to ensure that the data collection, research, and recommendations were in line with the State Board's expectations. A total of three meetings were conducted. Agendas for these meetings are included as Attachment A. A summary of the outcomes of each meeting is below.

- August 5, 2022 meeting:
  - The State Board staff provided resources summarizing the difference between the types of water rights permit applications (180-day temporary permit, 5-year temporary permit, etc.).[1]
  - The State Board staff recommended applying for a 180-day temporary permit using the WAA for streamlined recharge permitting (streamlined WAA).[2] The streamlined WAA requires an application of a "90th Percentile/20 Percent method" (90/20 method) to define daily limits on diversion. The 90/20 method is described in Task 3.
  - The State Board staff emphasized that the information supporting a temporary permit application should be consistent with the information that would be used in a future standard permit application. For example, if the temporary permit is conducted as part of the streamlined recharge permitting process, the standard permit should as well.
  - The State Board staff did not provide a specific method to address the time-step discrepancies between the 90/20 method, which relies on daily estimates, and water rights permits, which specify monthly limits.
  - The State Board staff restated that there is no specific scope that can be followed to ensure the approval of a water rights permit application.
- August 22, 2022 meeting:
  - The State Board staff underlined their concerns of the impacts this project may have on Shasta Dam operations.
  - The State Board staff agreed to put more thought into their concerns with Shasta Dam to provide direction on how to address their concerns.
  - The State Board staff recommended that West Yost reach out to the United States Bureau of Reclamation (USBR) to obtain their feedback on reconciling Shasta Dam water rights in the WAA.
  - The State Board staff mentioned a bill (Senate Bill No. 1205)[3] that may result in the standardization of WAA. The bill was signed by the Governor and filed with Secretary of

[1] State Board Water Rights Fiscal Year 2021-2022 Fee Schedule Summary

[2] Water Availability Analysis for Streamline Recharge Permitting

[3] Senate Bill No. 1205

State on September 16, 2022. As of this meeting, there was no timeline associated with the implementation of the bill.

- October 3, 2022 meeting:
  - The State Board staff shared the operations manual for Shasta Dam.
  - The meeting attendees discussed and agreed on a general process of what the permit conditions may entail, which can be translated into the steps that need to be addressed in the WAA. These steps included:
    - Identifying if flow at the proposed point of diversion (POD) meets the flow thresholds established with the 90/20 method and is protective of Shasta Dam water rights and operations
    - Identifying if the Delta is in "excess" per Term 91[4]
    - Identifying if flows in the Sacramento River, downstream of Shasta Dam and upstream of the Delta, are sufficient to meet water rights requirements along the Sacramento River
    - Diverting water per the WAA and permit conditions
  - The State Board staff clarified that a separate department leads the petitions for water transfers. The State Board staff provided resources to better understand the requirements for and potential challenges involved in temporary water transfers.
  - The State Board staff offered to review the proposed technical scope for the WAA.

Additional meetings will be required to complete the WAA. Additionally, the County will need to meet with the CDFW and USBR. These coordination meetings have and will continue to guide the scope of the subsequent tasks.

Task 2 – Collect and Evaluate Data

The objective of this task is to ensure that all data required to for the WAA is collected and analyzed. As described herein, much of the available data has already been collected and processed for use in the WAA.

The following data were collected to characterize the surface water and permitted points of diversion in the study area:

- Surface water flow data. Historical and current surface water flow data was collected and reviewed. Table 1 summarizes the gages within the Big Valley watershed, the data collector, watershed area, and period of record. Figure 1 shows the locations of these gages.
- Water rights data. Two sets of water rights data were collected and reviewed:

[4] Term 91 has been included in permits and licenses, granted after 1965, for diversion and use of water in the Delta watershed. Term 91 requires that those holding such permits and licenses cease diverting water when the State Water Resources Control Board's Division of Water Rights (Division) gives notice that water is not available for use under those permits and licenses. This occurs at times when the State Water Project and Central Valley Project are releasing previously stored water to meet water quality and flow requirements in the Delta and the Delta is termed to be in "balanced conditions," generally during the summer and fall. The Division will also give notice when Term 91 is no longer in effect (i.e., when the Delta is in "excess conditions"). (State Board website accessed on October 3, 2022).

- Water rights data and point of diversion locations from eWRIMS. Figure 2 shows the location of all points of diversion downstream of the Basin to Shasta Dam and upstream of the Basin to the Warner Mountains that are in the eWRIMS database. This does not include the pre-1914 water rights that have not been geolocated.
- Water rights data from a recent WAA to support an application for a water rights permit downstream of the Pit River. A permit applicant (Downstream Applicant) recently developed a tool that includes all water rights upstream of Freeport, near Sacramento, which includes the Pit River watershed. This tool, herein referred to as the Face Value (FV) Tool, includes all water rights information (water right type, effective date, status, face value, etc.) from the Sacramento Delta to the Warner Mountains. The tool was developed in May 2022 and thus is missing the water rights information for any new water rights approved/applied for since May 2022.

- Information and data on the operations of Shasta Dam. During the August 22, 2022 meeting with the State Board, State Board staff recommended meeting with the USBR to determine the analysis necessary to demonstrate that any new diversions upstream of Shasta Dam do not encroach upon the diversion rights of Shasta Dam. West Yost staff met with USBR staff on September 13, 2022 to discuss the recommendations and available data for this analysis. USBR staff indicated that the following two conditions generally indicate that any new diversions upstream of Shasta Dam do not encroach upon the diversion rights of Shasta Dam:
  - Water levels behind Shasta Dam are higher than the conservation water level. The USBR operates Shasta Dam for water storage, flood management, and hydropower. The operations of the dam vary based on antecedent conditions, predicted inflows, and required outflows, and does not operate based on rigid thresholds. USBR staff recommended using the historical operation data to characterize conditions when water levels behind the dam are higher than the conservation water level. Data on historical operations beginning in 1995 are found on the Army Corps of Engineers' website.[5]
  - The Delta is in "excess." The USBR publishes monthly reports characterizing the daily coordinated operations between the Central Valley Project and the State Water Project.[6] These reports indicate whether the Delta is in "balance" or "excess."
- Basin water budget and other GSP data. The Basin water budget was obtained to identify the method use to estimate surface water flow inputs and output to the Basin. Initially, the intent was to utilize this data in the WAA, however the data was on an annual time-step and this did not meet the needs of the WAA. In addition to the water budget information, GIS files of the basin boundary, surface water gages, etc. were collected.
- Technical Information for Preparing Water Transfer Proposals. The DWR developed a white paper[7] with information on preparing proposals for water rights transfers. This white paper

[5] SPK WCDS - California Plots (army.mil)

[6] Water Accounting Reports (usbr.gov)

[7] Technical Information for Preparing Water Transfer Proposals (Water Transfer White Paper) Information for Parties Preparing Proposals for Water Transfers Requiring Department of Water Resources or Bureau of Reclamation Approval (DWR, 2019)

was downloaded and reviewed for the County to consider transfers as a potential alternative to obtaining a temporary permit.

Table 1. Surface Water Gages within the Big Valley Subbasin Watershed

Gage Name	Gage Number	Data Collector	Watershed Area (acres)	Period of Record
Ash C A Adin CA	11350500	USGS	165,120	Aug 1904 to Sep 1982
Ash C A Ash Valley CA	11349500	USGS	87,040	Oct 1928 to Sep 1931
Willow Creek Nr Adin CA	11351000	USGS	40,320	Apr 1930 to Sep 1931
Widow Valley C Nr Lookout CA	11351500	USGS	17,728	Apr 1930 to Sep 1931
Pit R Nr Lookout CA	11349000	USGS	1,014,400	Apr 1929 to Sep 1980
Pit R Nr Canby CA	11348500	USGS	915,840	Oct 1929 to Present
Muck Valley PP nr Bieber CA	n/a	Private	1,584,000	Jan 2010 to Present
Pit R Nr County Rd (a)	n/a	Private	1,014,400	Sep 2022 to Present

(a) This gage was recently installed by the County with support from DWR. The data will become available online in the near future.

Additional data may be required based on future coordination with the State Board, CDFW, and others.

Task 3 – Conduct WAA

Task 3 involves an evaluation of the data collected in Task 2 pursuant to the streamlined WAA process. The streamlined WAA presents two methods for demonstrating water availability for a diversion permit application:

- The 90/20 method, which relies on historical data at local surface water gages to derive a conservative threshold for the volume of divertible water. By using the surface water gage data, the 90/20 method assumes that upstream diversions and water rights are reflected in the flow at the gage.
- Demonstrating the imminent threat of flood conditions in the source waters and the need for flood control actions to identify water available for diversions.

Since a flood control agency does not operate in the region of the proposed diversions, the method of demonstrating flood conditions is not applicable. Therefore, the 90/20 method is appropriate for demonstrating water availability. The following describes the four steps of the 90/20 method.

1. *Gage selection.* An appropriate stream gage must be selected to estimate the 90th percentile flows at or near the project's proposed POD. Ideally, the gage would be operated by the United States Geological Survey (USGS) and have a record of at least 30 years. The State Board provides recommendations for alternative solutions if no appropriate gage exists, including using data from multiple gages.
2. *90th percentile diversion threshold.* The 90th percentile diversion threshold must be calculated for each day over the proposed diversion period (December 1 through March 31). When using paired gages, the 90th percentile flows must be prorated to the POD based on the relative drainage areas and precipitation over the drainage areas using the following formula:

$$Q_{POD} = Q_{gage} * \left(\frac{DA_{POD}}{DA_{gage}}\right) * \left(\frac{P_{POD}}{P_{gage}}\right)$$

Where:

- Q_{POD} = 90th percentile flow at the POD;
- Q_{gage} = 90th percentile flow calculated for the gage;
- DA_{POD} = drainage area at the POD;
- DA_{gage} = drainage area at gage;
- P_{POD} = average annual precipitation at the POD; and
- P_{gage} = average annual precipitation at the gage.

3. *Downstream demand.* The streamlined WAA states that "[s]enior demands and environmental flows along the source water body's downstream flow path need to be compiled and compared against the 90th percentile flow at the POD to verify that the 90th percentile is a high enough flow rate to ensure downstream demands are satisfied... Projects located within the Sacramento-San Joaquin Watershed may calculate demands along a flow path that ends at the Legal Delta and accept terms related to the Delta, including a term based on the Net Delta Outflow Index to ensure demands on the Delta are satisfied."
4. *Diversion threshold and downstream demand comparison.* The calculated downstream demands should be compared to the 90th percentile flow at the POD(s). The streamlined WAA states that "If the needs of downstream diverters and the environment exceed the chosen diversion thresholds, then further analysis or a higher threshold will be needed to demonstrate that instream beneficial uses and senior water rights are protected."

In addition to establishing the 90th percentile (or greater) threshold for diversion, the total daily diversion cannot exceed 20 percent of the total estimated daily flow at the POD.

The streamlined WAA process is parallel to the potential permit conditions discussed at the October 3, 2022 coordination meeting with the State Board staff. The process consists of:

- Identifying if flow at the study area meets the flow thresholds established with the 90/20 method and is protective of Shasta Dam water rights and operations
- Identifying if the Delta is in "excess" per Term 91[8]
- Identifying if flows in the Sacramento River, downstream of Shasta Dam and upstream of the Delta, are sufficient to meet water rights requirements along the Sacramento River
- Diverting water per the WAA and permit conditions

[8] Term 91 has been included in permits and licenses, granted after 1965, for diversion and use of water in the Delta watershed. Term 91 requires that those holding such permits and licenses cease diverting water when the State Water Resources Control Board's Division of Water Rights (Division) gives notice that water is not available for use under those permits and licenses. This occurs at times when the State Water Project and Central Valley Project are releasing previously stored water to meet water quality and flow requirements in the Delta and the Delta is termed to be in "balanced conditions," generally during the summer and fall. The Division will also give notice when Term 91 is no longer in effect (i.e., when the Delta is in "excess conditions"). (State Board website accessed on October 3, 2022).

Tasks 3.1 through 3.4 discuss the application of the four steps of the streamlined WAA to the Big Valley Basin and how the potential permit conditions are addressed.

Task 3.1 Select Appropriate Gage(s) for the WAA

The objective of this task is to select the correct local gage to perform the WAA. Table 1 and Figure 1 summarize the stream gages proximate to the watershed. Based on the locations and period of record, West Yost proposes to use a combination of the two USGS gages along the Pit River (Pit R Nr Lookout CA and Pit R Nr Canby CA) to apply the 90/20 method. The "Pit R Nr Lookout CA" gage (Lookout gage) is closer to the Basin than the "Pit R Nr Canby CA" gage (Canby gage), but the Canby gage has a more complete period of record. The daily streamflow measurements for these gages over the concurrent period of record[9] are highly correlated (r-squared = 0.96), and there are few additional inputs or diversions from the Pit River between the two gages (see Figures 1 and 2). Therefore, using both gages to define the 90th percentile flow at the Lookout gage would be appropriate.

Task 3.2 Estimate the 90th Percentile Diversion Threshold

The objective of this task is to estimate the 90th percentile diversion threshold per the streamlined WAA. The threshold was estimated for the Lookout and Canby gages. Figure 3a shows the 90th percentile daily flows at the Canby gage based on its entire period of record, and the daily flows at the Canby gage for Water Year (WY) 2018 during the WAA period of December 1 through March 31. Table 2 summarizes the statistics of the 90th percentile daily flows at the Lookout and Canby gages by each month over the WAA period.

Table 2. 90th Percentile Flows at Lookout and Canby Gages

Gage Name	Month	90th Percentile Daily Flow Statistic (cfs)			
		Minimum	Maximum	Mean	Median
Pit R Nr Lookout CA	December	181	728	342	305
	January	340	1,270	656	583
	February	553	1,460	900	858
	March	866	1,530	1,152	1,120
Pit R Nr Canby CA	December	194	711	394	351
	January	228	3,180	1,668	2,174
	February	778	3,284	1,299	1,234
	March	589	1,830	1,110	1,087

Task 3.3 Evaluate Downstream Demands

The objective of this task is to identify all downstream demands and evaluate how they may be impacted by the proposed diversion. The streamlined WAA suggests collecting and reviewing water rights data using eWRIMS tools to determine downstream water demands. Based on initial discussions with the State Board staff, water rights information downstream of Shasta Dam did not seem to be applicable to a WAA for a

[9] The Canby and Lookout gages have concurrent daily streamflow measurements for about 32 percent of their 51-year concurrent period of record.

temporary permit. Thus, West Yost's original intent was to collect and review all water rights data upstream of the Basin and along the downstream trace of the Pit River to Shasta Dam. Figure 2 shows the locations of the points of diversions downstream of the Basin to Shasta Dam and upstream of the Basin to the Warner Mountains. However, the State Board later emphasized the need to include Shasta Dam operations in the WAA (see Task 1).

A challenge to the data collected from eWRIMS is that no digital documentation of pre-1914 rights exists other than Supplemental Statements of Diversion and Use and limited location information. Analyzing Supplemental Statements of Diversion and Use would require digitizing information from PDFs to a usable format like Excel. Additional challenges include interpreting the diverse conditions of water rights permits, which can define storage rights, rights to divert water for non-consumptive use, or may include multiple PODs. The State Board recommended that West Yost contact the Downstream Applicant to obtain their FV tool to leverage for our water rights analysis.

The FV tool includes a comprehensive summary of water rights from Freeport, near Sacramento, to Goose Lake, on the border of Oregon and California, on a monthly time-step.[10] Figure 4 shows the area covered by the FV tool. The FV tool also estimates water availability at key locations based on the unimpaired flow data from DWR's *Estimates of Natural and Unimpaired Flows for the Central Valley of California: Water Years 1922-2014*,[11] which is available on a monthly time-step. This analysis is referred to as the FV analysis. The FV analysis is conducted at discrete points of interest for the Downstream Applicant: Red Bluff, Wilkins Slough, and Freeport (see Figure 4).

The FV Tool was adapted to meet the needs of this WAA. The original FV Tool excludes water rights permits for applications that were submitted after the Downstream Applicant's priority date of September 30, 1977 (junior water rights). The FV tool was adjusted to include these junior water rights, which are dated through January 2021. Applications submitted after January 2021 will need to be added at a later time.

The adjusted FV analysis suggests the following:

- There is no flow available at the Red Bluff point between December and March of each year.
- There is water available in 23 out of 93 years at the Wilkin Slough point. On average, about 21,000 acre-ft of water is available between December and March of each year.
- There is water available in 22 out of 93 years at the Freeport point. On average, about 68,000 acre-ft of water is available between December and March of each year.
- The Red Bluff point is the critical point to define water availability since the adjusted FV analysis indicates there is no available flow. This suggests that if a WAA analysis can demonstrate that water is available to this point, water is available to meet other water rights downstream of the Red Bluff point.

As mentioned in the Downstream Applicant's WAA, the FV analysis is a conservative evaluation of water availability, as it assumes the face value diversions and storage of all existing water rights directly downstream, upstream, and/or tributary to the flow path of the proposed diversion location. Additionally,

[10] The analysis assumes that the monthly demand is equal to the maximum rate that can be diverted each day per the permit terms, as such, the sum of the monthly diversions is sometimes larger than the FV of the permit.

[11] Estimates of Natural and Unimpaired Flows for the Central Valley of California: Water Years 1922-2014

the FV tool is based on a monthly time-step, which may underestimate water available during high-flow events that last hours/days. Thus, it is recommended to conduct this analysis on a daily time-step. Task 3.4 describes how the daily analysis can be performed. It may not be necessary for the analysis to go further downstream than the Red Bluff point.

As described earlier, one of the State Board staff's main concerns is how the WAA will address the water rights permit and operations at Shasta Dam. As such, the first step in continuing the WAA analysis is to correlate the gaged data within the Study Area to Shasta Dam Operations as described by and with additional input from the USBR. This task will include preparing a time-history and distribution curve of outflow from Shasta Dam, analyzing if there is a relationship between outflow from Shasta Dam to flows on the Pit River as measured at the Canby gage, and determining what conditions at the gage ensure that Shasta Dam is not impacted, such that diversions may occur. These conditions will be integrated into the 90/20 analysis to determine when diversions would be possible such that flows are above the 90th percentile and ensure the protection of the water right and operations at Shasta Dam. Figure 3b is a concept graphic of how the Shasta Dam operations will be considered in the analysis, building on the 90th percentile daily flows and WY 2018 daily flows at the Canby gage shown in Figure 3a: the daily flow and 90th percentile at the gage will be plotted along with the timing of Shasta Delta outflow in "Excess" per Term 91. The days when the flow at the gage is both above the 90th percentile and during the timing of Shasta Delta outflow in "Excess" per Term 91 represent times when water is available.

Task 3.4 Compare the Diversion Threshold to Downstream Demands

The objective of this task is to determine whether flows in the Sacramento River, downstream of Shasta Dam and upstream of the Delta, are sufficient to meet water rights requirements along the Sacramento River. The recommended method to perform this is by converting the monthly face values of water rights permits downstream of Shasta Dam in the FV tool to daily values. These values can then be used to identify the minimum daily flow required to protect these water rights. Comparing the minimum daily flow to actual flow data at a gage downstream of Shasta Dam based on the analysis performed in Task 3.3, a correlation can be developed to identify the months/years where both the FV Tool and the analysis from Task 3.3 suggest there is sufficient water to divert.

The FV analysis assumed that the monthly demand is equal to the maximum rate that can be diverted each day per the permit terms, thus it would be reasonable to assume the same amount of diversion each day to convert the monthly values into daily values. These assumptions and methods should be discussed with the State Board staff for input. Figure 3c is a concept graphic of how downstream water rights may be included in the analysis: the same information from Figure 3b will be plotted along with the period of sufficient flow for water rights downstream of the POD. The days when the flow at the gage is (1) above the 90th percentile, (2) during the time when Shasta Dam storage is above the conservation storage and Delta outflow is in "Excess" per Term 91, and (3) during a period when flow is sufficient to meet downstream demands represent times when water is available. Figure 3d is a concept graphic of the water availability determination by day, the total daily flow is broken down as follows:

- Volume of water allocated to satisfy senior downstream water rights.
- Volume of water required to meet instream flow requirements (to be determined in coordination with the CDFW).
    - To assist an understanding of the potential instream flow requirements, the State Board provided information on a policy that establishes instream flow requirements for major stream locations across California, including in the Pit River at the Muck Valley Dam

downstream of the Basin.[12] The flow requirement in the Pit River at the Muck Valley Dam downstream of the Basin from November to March ranges from 216 cfs in February to 255 cfs in December. The 90th percentile daily flows at the Canby and Lookout gages exceed the instream flow requirements at the Muck Valley Dam over 95 percent of the time.

  - The hypothetical example shown in Figure 3d assumes that the water required for senior downstream water rights and instream flows is less than the 90th percentile daily flow volume. If "the needs of downstream diverters and the environment exceed the chosen diversion thresholds" (see step 4 of the streamlined WAA), then the threshold would have to be increased above the 90th percentile daily flow based on further analysis.

- Unallocated volume under the 90th percentile
- Divertible water, which is the lesser of:
  - Total daily flow minus the 90th percentile flow for that day, or
  - 20 percent of the total daily flow.
- Volume of water greater than the 20 percent threshold

Task 4 – Document the WAA

The objective of this task is to document the WAA for review by the State Board. The WAA documentation will include:

- Summary of the County's objectives and background information on the Basin.
- Summary of feedback obtained by the State Board staff throughout the process and how the feedback was addressed in the WAA.
- Detailed description of methodology used to address each step in the streamlined WAA and the State Board staff's comments.
- Detailed charts and graphics explaining the analysis performed for each step in the streamlined WAA.
- Conclusion of the water availability, including (1) average, minimum and maximum annual volume of water available; and (2) frequency of water availability.
- Backup documentation of the analysis performed for each step in the streamlined WAA.

Task 5 – Evaluate Applicability of Temporary Transfers

The objective of this task is to determine the applicability of obtaining a temporary water rights transfer as an alternative to obtaining a temporary permit. This would provide the County with flexibility to temporarily divert water.

[12] Pit River at the Muck Valley Dam Instream Flow Requirements

The DWR developed a white paper[13] with information on preparing proposals for water rights transfers. The DWR white paper outlines a set of criteria for eligible transfers. Eligible transfers include transfers based on cropland idling and crop shifting, which may be an applicable transfer for the County. Under this type of transfer, only certain crops are allowed for transfers, including alfalfa (limited to the Sacramento Valley floor and north of the American River), rice, wild rice, Sudan grass, etc. Crops not allowed for transfer include alfalfa in the delta region, pastures, orchards, mixed and miscellaneous grasses, etc. The types of crops for the Basin include native pasture, grass hay, alfalfa hay, wild rice, and rangeland. Based on this, there is a potential to temporarily transfer water rights for idled lands of alfalfa and wild rice.

There is some uncertainty around the applicability of this alternative to meet the County's objectives and the level of effort to move forward with a transfer application. As such, this task includes:

- Coordinating with the DWR to obtain guidance and input on the transfer process
- Conducting research to identify lands currently growing the types of crops eligible for transfer that hold water rights with the Basin
- Working with the growers from the lands identified to determine any plans for fallowing/idling the lands

SUMMARY OF NEXT STEPS TO COMPLETE THE WAA AND ADDITONAL CONSIDERATIONS

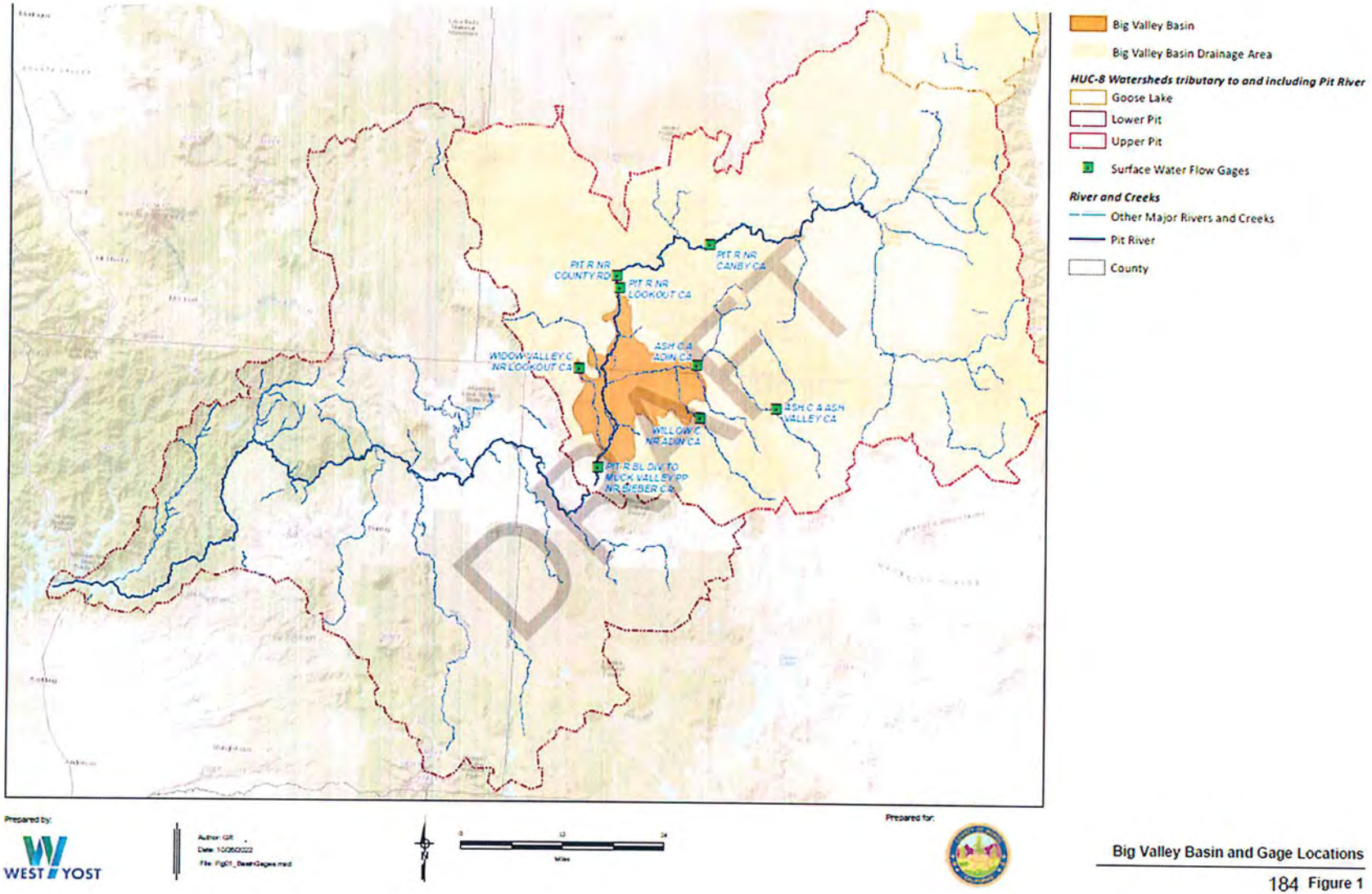
The WAA scope of work described herein includes a description of work that has already been completed, the specific steps required to complete the WAA, by task, include:

- Task 1 – Coordination with the State Board, California Department of Fish and Wildlife, and Other Agencies. Although the County has been in communication with the State since May 2022, additional meetings will be required to complete the WAA. Additionally, the County will need to meet with the CDFW and USBR. These coordination meetings have and will continue to guide the scope of the subsequent tasks.
- Task 2 – Collect and Evaluate Data. At this time, it appears all relevant data to conduct the WAA has been collected and reviewed. However, additional data may be required based on future coordination with the State Board, California Department of Fish and Wildlife (CDFW) and others
- Task 3 – Conduct WAA. Tasks 3.1 and 3.2 have been completed. Tasks 3.3 and 3.4 will be required to finalize the WAA.
- Task 4 – Document the WAA. This TM partly documents the WAA, specifically the data collected thus far, and the analysis performed for Tasks 3.1 and 3.2 The documentation will need to be expanded to document the final WAA once Tasks 3.3 and 3.4 are completed.
- Task 5 – Evaluate Applicability of Temporary Transfers. This task has yet to be initiated.

The work completed thus far has emphasized the complexity of the water rights application process and the potential risks involved due to the location of the Basin and proposed diversion upstream of Shasta

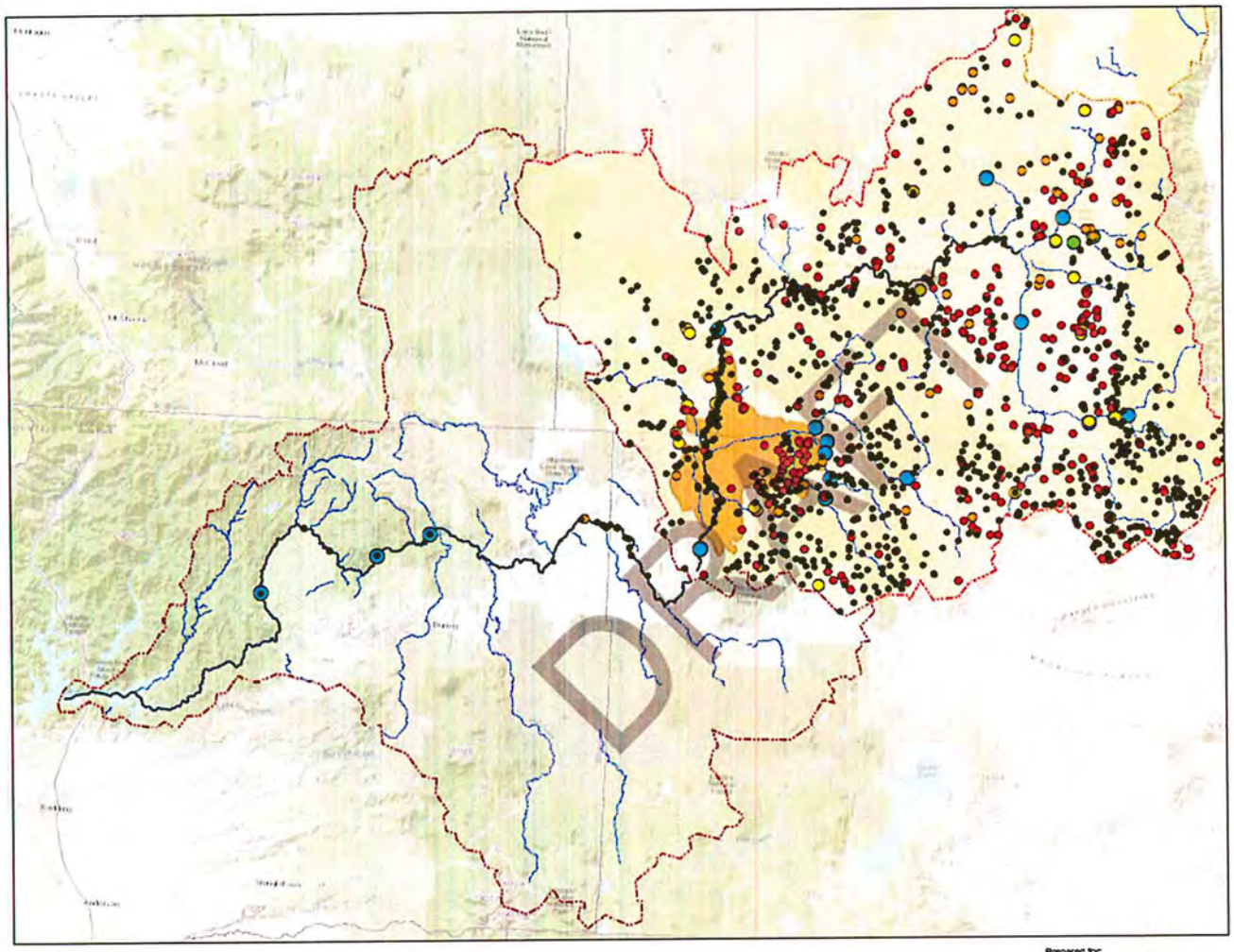
[13] Technical Information for Preparing Water Transfer Proposals (Water Transfer White Paper) Information for Parties Preparing Proposals for Water Transfers Requiring Department of Water Resources or Bureau of Reclamation Approval (DWR, 2019)

Dam, the Delta, and myriad downstream senior water rights. Because of this complexity, West Yost recommends acquiring legal advice to guide the County in the process to develop the WAA and the temporary permit application or to assist with a temporary water rights transfer if that becomes the preferred option.



Big Valley Basin and Gage Locations

184 Figure 1



Points of Diversion

Symbolized by Permit Face Value in acre-ft

- 0 - 0.5
- >0.5 - 100
- >100 - 1,000
- >1,000 - 5,000
- >5,000 - 10,000
- >10,000

Big Valley Basin

Big Valley Basin Drainage Area

HUC-8 Watersheds tributary to and including Pit River

Goose Lake

Lower Pit

Upper Pit

River and Creeks

Other Major Rivers and Creeks

Pit River

County

Note:
The location and face value information of the points of diversion shown herein is from eWRIMS. eWRIMS has no digital documentation on the locations of pre-1914 rights. As such, these permits are not included herein.

Prepared by:

WEST YOST

Author: GR
Date: 10/28/2022
File: Fig02_PODs.mxd

Prepared for:

Relevant Points of Diversion Upstream of Shasta Dam

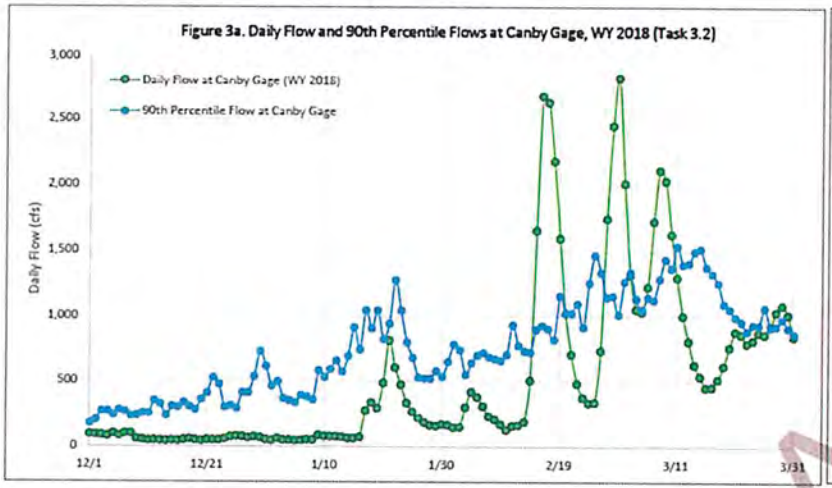


Figure 3a. Daily Flow and 90th Percentile Flows at Canby Gage, WY 2018 (Task 3.2)
Daily Flow at Canby Gage (WY 2018)
90th Percentile Flow at Canby Gage
Daily Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
12/1
12/21
1/10
1/30
2/19
3/11
3/31

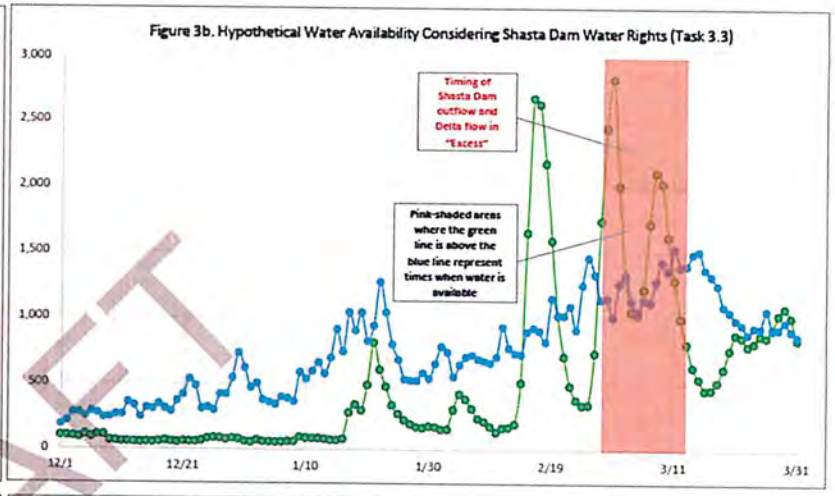


Figure 3b. Hypothetical Water Availability Considering Shasta Dam Water Rights (Task 3.3)
Timing of Shasta Dam outflow and Delta flow in "Excess"
Pink-shaded areas where the green line is above the blue line represent times when water is available
3,000
2,500
2,000
1,500
1,000
500
0
12/1
12/21
1/10
1/30
2/19
3/11
3/31

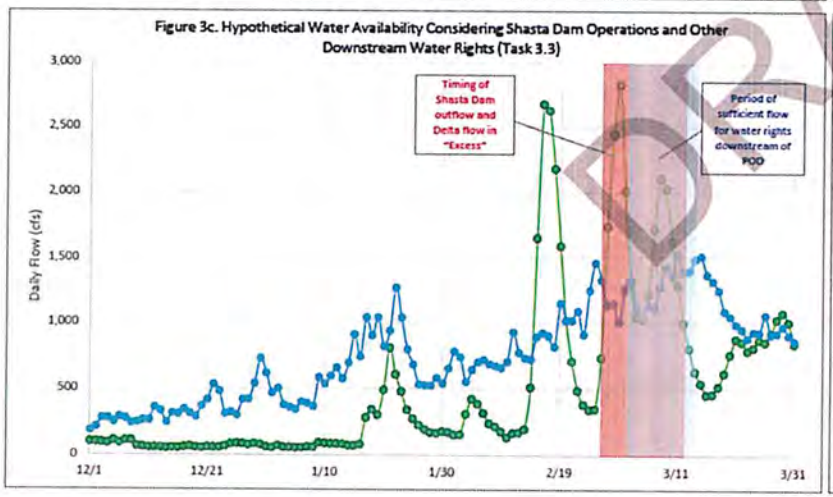


Figure 3c. Hypothetical Water Availability Considering Shasta Dam Operations and Other Downstream Water Rights (Task 3.3)
Timing of Shasta Dam outflow and Delta flow in "Excess"
Period of sufficient flow for water rights downstream of POD
Daily Flow (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
12/1
12/21
1/10
1/30
2/19
3/11
3/31

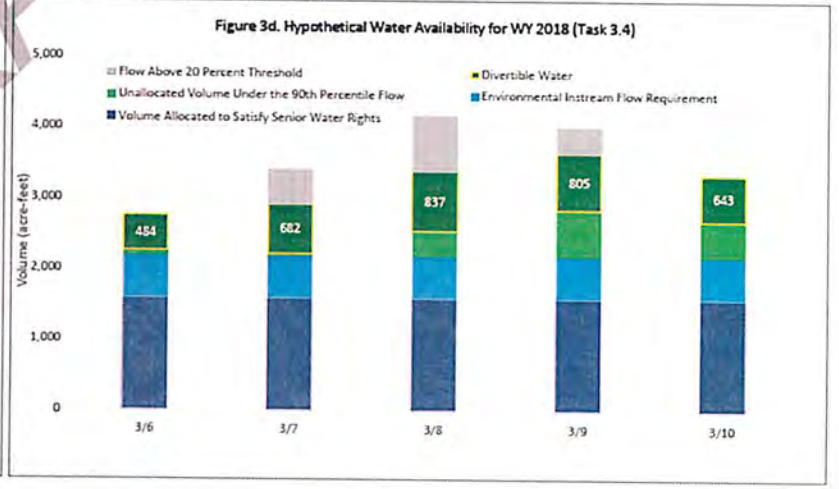


Figure 3d. Hypothetical Water Availability for WY 2018 (Task 3.4)
Flow Above 20 Percent Threshold
Unallocated Volume Under the 90th Percentile Flow
Volume Allocated to Satisfy Senior Water Rights
Divertible Water
Environmental Instream Flow Requirement
Volume (acre-feet)
5,000
4,000
3,000
2,000
1,000
0
484
682
837
805
643
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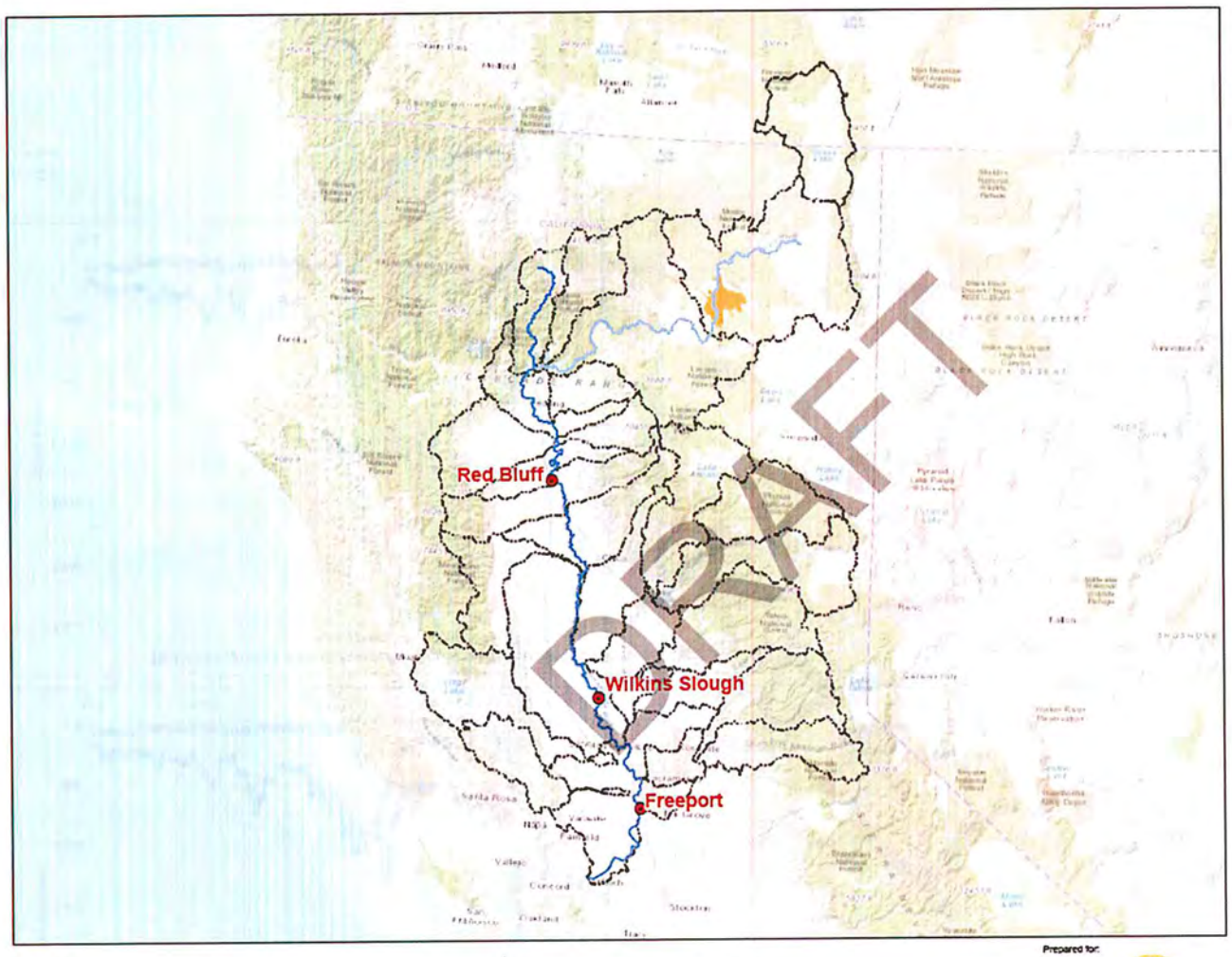

Point of Interest

HUC-8 Watersheds included in WAA

Big Valley Basin

Sacramento River

Pit River

Prepared by:

WEST YOST

Author: GR

Date: 10/26/2022

File: Fig04_FVtool.mxd

Prepared for:

Sacramento River Watershed Domain for Downstream Applicant WAA

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Subject #6: LandIQ Mapping Workshop