2. What (What is the interest of the stakeholder? How will the stakeholder be affected? What are the stakeholders' needs?)
3. Who (Who is the right messenger for the information)
4. How (How should the information be delivered? What are the best methods?)
5. When (What is the appropriate timing for the messages?)
6. Engagement and Knowledge Transfer (How do we create two-way communications?))

Table 5 illustrates some of these ideas.

Table 5. Communications Planning Questions

Who	Interest	Messenger	Delivery	Timing	Knowledge Transfer
• Impacted • Partner • Provider • Regulator	• How will decision affect? • What will stakeholder need?	• Who is a trusted information Source? • How do we ID and Partner	• What are the best delivery methods?	• When should we conduct outreach?	• What do the stakeholders know that we need to know?

4.4. GSA Boards

Due to the multiple subbasin GSAs, specific focus is needed on communications to keep them informed, provide consistent updates and information that the Boards can use in their own outreach, and support their decision making. Primary objectives for communications with the subbasin GSA Boards are to ensure:

- Consistent understanding of the requirements for a GSP and/or GSP coordination
- On-going access to current information
- Timely notice of any significant developments or decision points that may require changes to policies and/or require some other board action
- Confidence that the GSP(s) will be accepted by the GSA's stakeholders

Key communications activities involving the Board include;

1. Providing short and digestible pieces of information to ensure each Board member can quickly articulate to his/her constituents on key matters and remain sufficiently informed so that no decision points are surprises.
2. Provide user-friendly informational materials to be used with public audiences, and will support the Board with their own constituent outreach.
3. Utilize regular Board communications for routine updates and reserve specific Board agenda items for highly significant discussion items.

4.5. Primary Audiences

There are several core stakeholder groups that will require ongoing communications and tailored messaging throughout the planning process. They are:

- Agriculture
- Disadvantaged Communities
- Municipals

Other stakeholders requiring special consideration include:

- Industrial Users/ Business
- Regulators (State and Federal)
- Potential Partners
- Environmental Organizations
- Federal Agencies

While all of the stakeholder types are important to engage for development of a GSP, the first three will be most affected by any changes that might be proposed as a result of the *GSP(s)*.

The following provides an outline of key messages and activities in support of each of the audience types.

4.2.1. Agricultural

Messages about the GSP(s) development should feature the overall desirability of a sustainable management approach how the plan will contribute to management certainty and protect against regulatory oversight.

In thinking about irrigation users it is also important to remember that one size does not fit all.

4.2.2. Disadvantaged Communities

Messages developed for this sector should be tailored and specific to the community. This type of outreach is often best served by use of surrogates and trusted messengers. As identified in the SA, these messages should be aligned with activities of the IRWM, especially given the high, current dependence of many on unsustainable water sources. Messages about ways to access the increased availability of resources due to grant incentives should also be considered.

A specific outreach method to consider relates to the predominance of cells phones within the communities. According to the Pew Research Center, "over 50 percent of low-income households own a smartphone. Smartphone penetration in this demographic creates substantial opportunities for utilities to reach disadvantaged communities with software solutions like customer self-service platforms and targeted digital communications."[12]

4.2.3. Municipals

[12] Secondary Source: Water Smart. https://www.watersmart.com/rethinking-disadvantaged-community-engagement/ (accessed June 1, 2017)

Some care will be needed to address tensions related to the relative percentages of use by Municipal agencies and what constitutes highest and best beneficial uses within an agricultural region. A promising interaction with this community would involve collaboration on messaging to achieve mutually beneficial goals.

Some thought it might be possible for the municipal agencies to provide in-kind support to the GSP development process through support for project websites and mailing lists, production of meeting notices, assistance to the planning process from in-house public information professionals and offering access to physical meeting spaces.

Municipals may need assistance in making the case for the need to think at a Basin scale rather than more local terms.

4.2.4. Business and Industry Interests

Business and industry interests seek assurances about the availability of water for operations and the viability of the farming industry in the region. Messages for these audiences should focus on how the GSP(s) development will contribute to sustainability and how these audiences can participate in discussion specific to their interests.

4.2.5. Regional/Statewide Interests and Regulators

Some degree of uncertainty remains in the overall legal, legislative and regulatory environment as it relates to SGMA implementation.

It is in the interest of the subbasin stakeholders to engage state and federal agencies and regulators throughout the process. These parties may have resources to assist the subbasin and a cooperative attitude will build good will in the event that adjustments are needed to achieve SGMA compliance.

4.2.6. Potential Agency Partners

A variety of collaborations to achieve GSP(s) development goals may be possible. The GSAs should consider the potential for collaboration with non-GSA members and inter-basin (adjacent subbasin) partners, as part of plan deliberations.

4.2.7. GSP Coordinators Planning Forum

A planning forum for subbasin GSP coordinators should be established to further inform a coordination strategy. This forum would include agency representatives as well as the consultant teams and be used for the sole purpose of coordination and mutual support. It is anticipated that this body might meet on a quarterly or as needed basis. This forum would also provide a central point of contact for adjacent subbasin coordinators.

4.2.8. Environmental Community

As noted in the SA, this community will be interested in a GSP features. The focus of messaging for this group being on how the GSP(s) development will contribute to a sustainable regional water portfolio. Special effort should be made to identify specific topics of interest. For example, as part of GSP development, a list of groundwater dependent species may be created, or impacts to wetlands may be identified. These types of lists would highlight where input from the environmental community might be needed.

4.2.9. Federal Government

Federal representatives interviewed for the assessment asked to be kept informed of subbasin SGMA activities. These agencies have a direct interest in surface water integration as well as SGMA activities that could impact wetlands restoration efforts or groundwater dependent ecosystems and species.

RISK MANAGEMENT

Risk management is the identification, assessment, and prioritization of risks (defined as *the effect of uncertainty on achieving objectives*) followed by coordinated, efficient and economical strategies and actions to minimize, monitor, and control the probability and/or impact of negative events. Strategies and actions may also be used to avert risk by leveraging strengths and opportunities.

Risks can come from uncertainty in economic factors, threats from project failures (at any phase), regulatory and legal uncertainties, natural causes and disasters (drought, flood, etc.), as well as dissention from adversaries, or events of uncertain or unpredictable circumstances. Several risk management standards have been developed. This analysis utilizes those from the Project Management Institute.

Table 6 outlines standardized risk categories and translates them to outreach risks.

Table 6. Risk Factors

RISK CATEGORY	Outreach RISK FACTORS
Technical, quality, or performance	• Realistic performance goals, scope and objectives
Project management	• Quality of outreach design • Outreach deployment and change management • Appropriate allocation of time and resources • Adequate support for Outreach in project management plans
Organizational / Internal	• Executive Sponsorship • Proper prioritization of efforts • Conflicts with other functions • Distribution of workload between organizational and consultant teams
Historical	• Past experiences with similar projects • Organizational relations with stakeholders • Policy and data adequacy • Media and stakeholder fatigue*
External	• Legal and regulatory environment • Changing priorities • Risks related to political dynamics

5.1. Technical, quality, or performance

The subbasin is fortunate to have a high level of water knowledge and skilled personnel available to assist with GSP planning. In general, stakeholder expectations for outreach and performance goals, scope and objectives are attainable. The larger concern in this category is properly communicating the scope of the GSP(s) development and the need for extensive coordination and outreach among a number of parties. Communication of SGMA requirements for outreach as a planning requirement should be an ongoing consideration and appears to be underestimated in emphasis.

5.2. Project management

A number of positive project management factors are present for the GSP(s) development outreach. Project managers view outreach as an important planning element. The outreach design is based on best management practices and industry standards. It is not overly complicated and with technical services support from DWR and other sources, sufficient resources should be available to properly execute it. Procedures and practices are already in place that can be leveraged to achieve communication goals.

The primary concern in this category relates to GSP coordination. This type of outreach will require additional assessment as the individual GSAs will determine their own protocols for representation.

5.3. Organizational / Internal

Conflicts with other GSA member functions and/or conflicts with outreach activities by efforts that include the same stakeholders (e.g. Irrigated Lands, IRWM, and CV-Salts) should be monitored.

One additional consideration will be the distribution of workload between GSA, organizational and consultant teams. Clear roles and responsibilities must be defined and continuous interaction in place to ensure successful execution.

The GSP(s) development process will also need identified, high level spokespersons or champions. These individuals should be able to discuss subbasin planning with the media, in discussions with regulators and potentially at professional conferences.

5.4. External

The legal and regulatory environment of the GSP(s) development process is complex and evolving. Ongoing issues with surface water deliveries and changing agricultural market conditions are outside of the control of the parties. It will be important for mechanisms to be in place that allow for relatively rapid responses to changing conditions.

5.5. Historical

The primary stakeholders in this process generally view interactions and meetings as productive. There is a history of cooperation and a willingness to work together to save costs and achieve better outcomes.

TACTICAL APPROACHES

Following are specific tactical approaches that may be utilized to deliver the activities, messages, and recommendations of the previous chapters. These approaches are based on best communication practices and grounded in the public participation philosophy of the International Association for Public Participation, Public Participation Spectrum as illustrated in **Table 7**.

The Spectrum represents a philosophy that outreach should match the desired level of input from both the stakeholder and the organizational entity.

Table 7. IAP2 Public Participation Spectrum

IAP2 Public Participation Spectrum

Developed by the International Association for Public Participation

INCREASING LEVEL OF PUBLIC IMPACT →

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
Public Participation Goal:	To provide the public with balanced and objective information to assist them in understanding the problems, alternatives and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public issues and concerns are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision-making in the hands of the public.
Promise to the Public:	We will keep You informed.	We will keep you informed, listen to and acknowledge concerns and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and issues are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.
Example Tools:	● Fact sheets ● Web Sites ● Open houses	● Public comment ● Focus groups ● Surveys ● Public meetings	● Workshops ● Deliberate polling	● Citizen Advisory Committees ● Consensus-building ● Participatory decision-making	● Citizen juries ● Ballots ● Delegated decisions

Based on the assessment findings for the GSP(s) development, most stakeholders would simply like to be INFORMED unless there is a potential for significant changes that may include that stakeholder. Tactics for this group will include fact sheets, websites, open houses, briefings, and informational items placed in publications they already read.

The next largest group of stakeholders, primarily groundwater pumpers and disadvantaged communities, wish to be CONSULTED. This group will have access to all the materials prepared as part of the informational phase. In addition they should be invited to provide comments on written materials and planning concepts and participate in focused workshops and/or briefings. They should also be invited to attend larger public meetings.

The development of some GSP features may require a higher degree of INVOLVEMENT. This would focus on engagement of a subset of stakeholders that may experience significant impacts associated with SGMA.

COLLABORATION opportunities have also been identified; however, they are of a different character than defined in the Spectrum. Collaboration in this GSP(s) development process will focus on working with partners that have mutual goals to achieve those goals together. This will more resemble a partnership than a public engagement activity.

6.1. Communications Coordination.

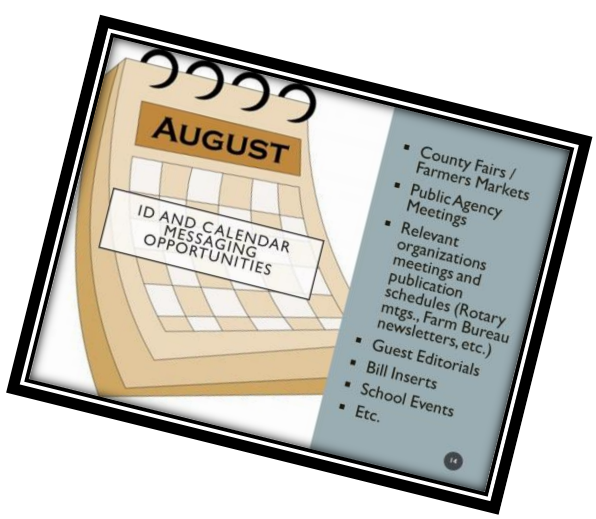
Each GSA is required to perform legally mandated outreach activities and the GSP submission guidelines require a minimum level of engagement.

The subbasin GSAs should coordinate outreach activities even if there is a decision to move forward with multiple GSPs. In addition to efficiency and cost savings (the GSAs can share resources) this strategy will allow for consistency in messaging and reduce confusion for stakeholders that may not know what GSA jurisdiction they are in, and/or are in multiple GSA jurisdictions. Following are suggested options for communications coordination.

1. Website
2. Meeting calendar
3. Branded informational Flyers, Templates, PowerPoint Presentations, etc.
4. Periodic newsletter
5. GSP related mailing lists
6. Descriptions of interested parties
7. Issues and interest statements for legally mandatory interested parties
8. Public workshops
9. Message calendar
10. Press releases and guest editorials
11. Speakers Bureau
12. Existing group venues
13. Outreach documentation

6.2. Tactics

6.2.1. Website



As part of the communications plan development, a list of website concepts and draft website content was prepared. The following describes the proposed approach:

a. Centralized – Establish a centralized website for the entire subbasin.
b. Individual GSAs – Posting of material to a website is part of the SGMA requirements. Those GSAs with their own webpages can link to and from the centralized site if they wish to provide their own customized information. For those GSAs without their own website, courtesy pages would be provided as an added feature of the main site. The courtesy pages would all use a single template with the same information to facilitate easy management and updates. Individual GSAs choosing to take advantage of the courtesy pages would be responsible for ensuring that information is current. The page should include a "Last Updated" box to indicate the timeliness of the information.
c. **Basic features** – A basic website framework has already been developed along with introductory information that has prepopulated each page. **Figure 10** illustrates the basic content of the site and includes:
    1. Background information
    2. Information about getting involved, including meeting information
    3. A separate link for Spanish Language materials
    4. Frequently asked questions
    5. Links to GSAs
    6. Contact information

Should a GSA decide to not participate in the Central website, a similar structure could be utilized.

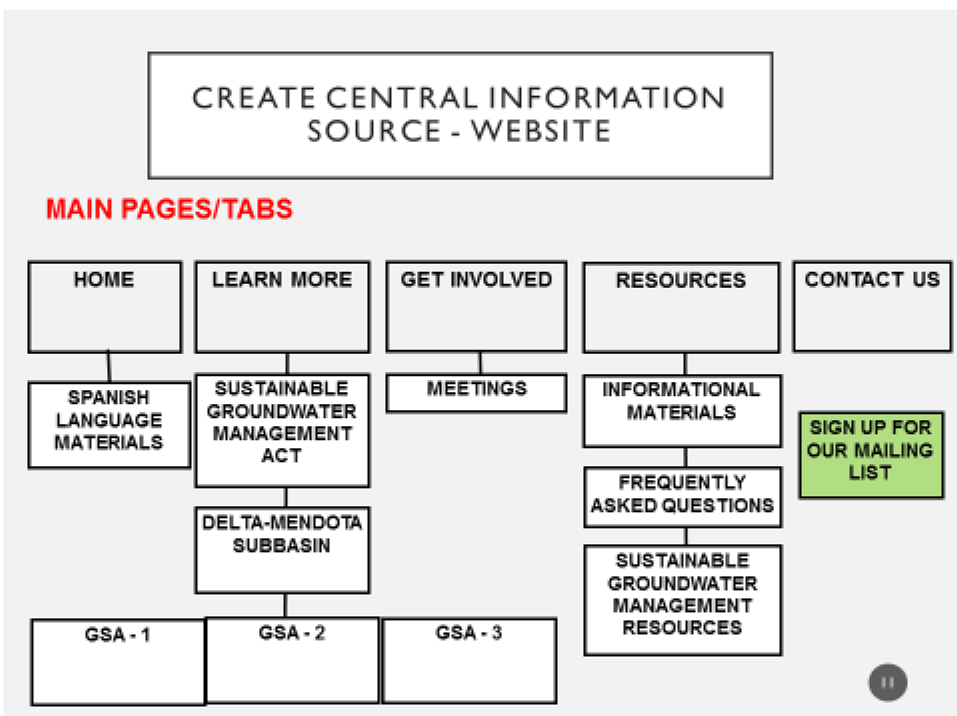


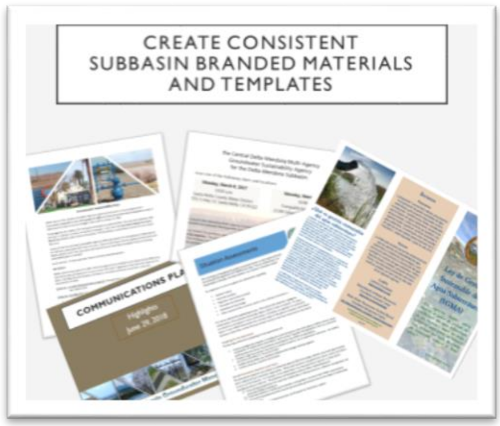
Figure 10. Website Structure

6.2.2. Meeting Calendar

A shared meeting calendar will provide a one-stop shop for stakeholders and assist in preventing meeting conflicts while creating more potential for shared activities. This calendar should include current and scheduled meetings and workshops as well as serve as the repository for agendas and meeting notes, along with copies of meeting materials and presentation.

An integrated project calendar should also be developed that links planning project milestones with communications milestones.

6.2.3. Branded Informational Flyers, Templates, PowerPoint Presentations, etc.



Subbasin level materials should have a single look and feel to create on-going consistency and visual recognition by stakeholders. Use of templates, shared presentations and flyers will create efficiencies and reinforce messaging. This communications plan incorporates some of this type of branding.

6.2.4. Periodic Newsletter

The need for regular communications cannot be overstated. One option is production of a periodic newsletter. Given the relatively short GSP(s) development process timeframe and the GSP development requirements for periodic outreach to identified stakeholders, a quarterly schedule would be realistic and achieve compliance with SGMA requirements for periodic updates to stakeholders. The newsletter should be designed so that individual GSAs can add tailored information if they choose to. For Portable Document Format (PDF) versions of the newsletter, a GSA could add a simple one or two page insert and the edition could be used as a handout or mailer. For a professional looking, email version of the newsletter, we recommend free or low cost services such as Mail Chimp or Constant Comment, which can be integrated with mailing lists.

Adding GSA specific information to an email newsletter can be done with web-links in the email to the very same PDF page prepared for the hardcopy mailer. An alternative is emailing the entire newsletter PDF as an attachment (although this format is less likely to be read than the mailer services).

6.2.5. GSP related mailing lists

Each GSA is required to develop notification lists. A central list may be utilized for GSP(s) related notifications.

6.2.6. Descriptions of Interested Parties

Each GSA is required to develop descriptions of interested parties. These lists should be updated and merged for use in the GSP(s) submittal(s). These can also be provided as background information on the website as part of constructing an administrative record. The SA in Chapter 4 provides an initial start for this documentation.

6.2.7. Issues and Interest Statements for Legally Mandatory Interested Parties

A GSP submission must include a statement of interests for listed stakeholders. As suggested earlier, this can also be included on the website.

6.2.8. Coordinated Public Workshops

SGMA requires a series of public hearings and some public workshops. Such workshops should be coordinated with other subbasin entities.

During the GSA formation process the County of Merced and a forming GSA body conducted a joint workshop to explain more about SGMA and the proposed GSA formation. Distribution of meeting flyers and notices was done concurrently, and DWR attended the event to answer questions. The GSP development process will offer similar opportunities, not only within the subbasin, but with adjacent subbasins.

6.2.9. Message Calendar

Basic messages should be associated with the planning schedule and each stage of GSP(s) development and serve as the theme for the communications materials being generated. For example, during the GSA formation period there was a need to communicate the basics of SGMA and groundwater management. During the GSP(s) initiation phase messages should focus on the basics of groundwater sustainability and the current state of the subbasin. As the GSP(s) begins to take form the specifics of the GSP(s) and what it means for each stakeholder would be the focus.

6.2.10. Press Releases and Guest Editorials

At some point in the GSP development and implementation process, it is likely that stakeholders will be asked to make changes and/or financially support a sustainability effort. It will be more productive for the GSAs and their GSP collaboration partners to frame discussions about these changes than to have others, perhaps with less knowledge, do so on their behalf. For that reason there is a need for press releases and/or guest editorials to offer the media and stakeholders accurate information offered in the context of SGMA. This type of outreach should be closely coordinated as consistency in messages is critical to stakeholder acceptance.

6.2.11. Speakers Bureau

Efforts should be made to conduct outreach at events and meetings that already occur (e.g. Farm Bureau meetings, Rotary Club, etc.). A list of knowledgeable presenters should be developed in the event an organization or other entity would like a presentation. Speakers Bureau engagements should be recorded on the planning project meeting calendar.

6.2.12. Existing Group Venues

Fully leverage the activities of existing groups.

- Maintain a roster of existing groups and typical meeting schedules with a nexus to GSP(s) development. Add the dates to the messaging calendar.
- The list of audiences, messages and existing groups should be referenced when there is a need to deploy information.
- Conduct informal outreach with the leaders of such groups to determine the best way to interact.
- Determine what communications channels these groups are using and equally leverage these, for example by placement of articles in newsletters.

6.2.13. Outreach Documentation

A central point of contact should be identified on the website and an outreach statistics inventory should be established that identifies dates, times, audiences and attendance. This information will be also be useful in conducting follow up with stakeholders as well as documenting outreach as part of GSP submittal guidelines.

6.3. Procedural and Legally Mandated Outreach

A discussion of SGMA outreach requirements was provided in Chapter 1 and a full list of requirements is contained in Appendix 1. One major feature of the requirements is a submission to DWR of the opportunities that interested parties will be given to participate in the GSP deliberations. The Situation Assessment provides an initial description that can be added to with additional outreach.

Following are the Required Interested Parties for the purpose of mandated outreach:

Table 9 provides a list of the mandated outreach and the timeframe in which is required.

Table 8. Mandated Outreach

Timeframe	Item
Prior to initiating plan development	1. Statement of how interested parties may contact the Agency and participate in development and implementation of the plan submitted to DWR.

Timeframe	Item
	2. Web posting of same information.
Prior to plan development	1. Must establish and maintain an interested persons list. 2. Must prepare a written statement describing the manner in which interested parties may participate in GSP development and implementation. Statement must be provided to: a. Legislative body of any city and/or county within the geographic area of the plan b. Public Utilities Commission if the geographic area includes a regulated public water system regulated by that Commission c. DWR d. Interested parties (see Section 10927) e. The public
Prior to and with GSP submission	1. Statements of issues and interests of beneficial users of basin groundwater, including types of parties representing the interests and consultation process 2. Lists of public meetings 3. Inventory of comments and summary of responses 4. Communication section in plan that includes: • Agency decision making process • ID of public engagement opportunities and response process • Description of process for inclusion • Method for public information related to progress in implementing the plan (status, projects, actions)
90 days prior to GSP Adoption Hearing	1. Prior to Public Hearing for adoption or amendment of the GSP, the GSP entities must notify cities and/or counties of geographic area 90 days in advance.
90 days or less prior to GSP Adoption Hearing	2. Prior to Public Hearing for adoption or amendment of the GSP, the GSP entities must: a. Consider and review comments b. Conduct consultation within 30 days of receipt with cities or counties so requesting
GSP Adoption or Amendment	1. GSP must be adopted or amended at Public Hearing.
60 days after plan submission	1. 60-day comment period for plans under submission to DWR. Comments will be used to evaluate the submission.
Prior to adoption of fees	1. Public meeting required prior to adoption of, or increase to fees. Oral or written presentations may be made as part of the meeting. 2. Public notice shall include: a. Time and place of meeting b. General explanation of matter to be considered

Timeframe	Item
	c. Statement of availability for data required to initiate or amend such fees d. Public posting on Agency Website and provision by mail to interested parties of supporting data (at least 20 days in advance) 3. Mailing lists for interested parties are valid for 1 year from date of request and may be renewed by written request of the parties on or before April 1 of each year. 4. Includes procedural requirements per Government Code, Section 6066.
Prior to conducting a fee adoption hearing.	1. Must publish notices in a newspaper of general circulation as prescribed. 2. Publication shall be once a week for two successive weeks. Two publications in a newspaper published once a week or oftener, with at least five days intervening between the respective publication dates not counting such publication dates, are sufficient. 3. The period of notice begins the first day of publication and terminates at the end of the fourteenth day, (which includes the first day.)

6.4. Items for Future Consideration

This GSP(s) Coms Plan outlines an outreach effort based on project and stakeholder needs and preferences. This document has been prepared as a working draft living document and should be updated as new information and the GSP(s) development process needs are developed.

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MEASUREMENTS & EVALUATION

A guiding principle for evaluation and measurement of the Coms Plan's success is to provide regular, unbiased reporting of progress toward achieving goals. Success may be evaluated in several ways, including process measures, outcome measures, and an annual evaluation of accomplishments. Optional evaluation measures are described below.

As part of each outreach effort debrief the following process and outcome measures will be discussed and recorded in a check sheet. The check sheets will be prepared with the goal of continuous improvement rather than criticisms.

7.2. Process Measures

Process measures track progress toward meeting the goals of the Coms Plan. These include:

- Level of attendance at outreach meetings
- Shared understanding of the overarching aims, activities, and opportunities presented by different planning approaches and project activities
- Productive dialogue among participants at meetings and events
- Sense of authentic engagement; people understand why they have been asked to participate, and feel that they can contribute meaningfully
- Timely and accurate public reporting of planning milestones
- Feedback from Coordinating Body and GSA members, regulators, stakeholders, and interested parties about the quality and availability of information materials
- Level of stakeholder interest in the GSP(s) development process information

7.3. Outcome Measures

Outcome measures track the level of success of the Coms Plan in meeting its overall goals. Some outcome measures considered for the GSP(s) development process include the following:

- Consistent participation by key stakeholders and interested parties in essential activities. Participants should have no difficulty locating the meetings, and should be informed as to when and where they will be held.
- Response from meeting participants that the engagement methods provided for a fair and balanced exchange of information.
- Feedback from interested parties that they understand how their input is used, where to track data, and what results to expect.
- The project receives quality media coverage that is accurate, complete and fair.

7.4. Mid-cycle Evaluation of Accomplishments

A mid-cycle evaluation provides an opportunity to examine the current effectiveness of the Coms Plan and provides a chance to reevaluate strategies to meet the GSP(s) development process objectives. The evaluation tasks may include:

- Preparation of an executive-level summary detailing high-level initiatives and accomplishments of the previous cycle. This evaluation should also include positive news, best practices, goals and objectives, notable changes, timelines, and priorities.
- Identifying gaps and areas for improvement.
- Highlighting how gaps and areas for improvement in the cycle has been addressed.
- Outlining process and outcome measures and their current results.

ROLES AND RESPONSIBILITIES

The GSP(s) development Coms Plan outlines numerous strategies, activities and tactics. While none are highly complex, there is a requirement for coordination and clarity regarding who will be responsible for executing the tasks.

After the planning team evaluates the timelines and priorities for each of the communications activities a recommended next step is completion of a Responsible, Accountable, Consulted, and Informed (RACI) Chart. This Chart, as displayed in **Table 10**, outlines key tasks and the assignment of roles and responsibilities for accomplishing them.

Table 9. Sample RACI Chart

Activity TYPE	SPECIFIC PRODUCT	RESPONSIBLE	ACCOUNTABLE	CONSULTED	INFORMED
Internal Staff Communications, information materials for/briefings	Draft	Person A	Person E	Person I	
	Final Draft	Person A	Person E	Person I	Project Team
List Serves, mailing lists	Customer Contacts	Person B - Person A	Person E	Person I	Project Team
	Concurrent jurisdictions	Lisa Beutler/MWH	Person G	Person I	Project Team
	Other - identified stakeholders	Person A	Person G	Person I	Project Team
Web Content and Maintenance	Draft Content and Content Refresh	Lisa Beutler/MWH/	Person G	Person H	Project Team
	Site Administration	Person A	Person G	Person H	
General public Intro Packets, Fact Sheets and Brochures	Draft	Person D	Person E	Person I- Subject Matter Experts	Person J
	Revised Draft	Person D	Person E	Person I- Subject Matter Experts	Person J
	Final Draft	Person D	Person E	Person I- Subject Matter Experts	Project Team
Newsletter Content	Draft	Lisa Beutler/MWH	Person E	Person I- Subject Matter Experts	Person J
	Revised Draft	Person D	Person E	Person I- Subject Matter Experts	Person J
	Final Draft	Person D	Person E	Person I- Subject Matter Experts	Project Team

Responsible
Those who do the work to achieve the task. There is at least one person with a role of *responsible*, although others can be delegated to assist in the work required.

Accountable (also approver or final approving authority)
This is the person ultimately answerable for the correct and thorough completion of the deliverable or task, and the one who delegates the work to those responsible. <u>There **may only** be only one *accountable*</u> specified for each task or deliverable.

Consulted
Those whose opinions are sought, typically subject matter experts were people that are impacted by the activity; and with whom there is two-way communication.

Informed
Those who are kept up-to-date on progress, typically on the launch and completion of the task or deliverable. This is one way communication.

Role distinction
There is a distinction between a role and the individual assigned the task. Role is a descriptor of an associated set of tasks that could be performed by just one or many people.

In the case of the RACI Chart, the team may list as many people as is logical except for the Accountable role.

Scope of Work
Completion of the RACI Chart will also support development of any future scopes of work for consultant provided communication and outreach services.

LIST OF APPENDICES

Appendix 1. Public Outreach Requirements under SGMA

GSP Regulations

CODE	PUBLIC OUTREACH REQUIREMENT
§ 353.6. Initial Notification (a) Each Agency shall notify the Department, in writing, prior to initiating development of a Plan. The notification shall provide general information about the Agency's process for developing the Plan, including the manner in which interested parties may contact the Agency and participate in the development and implementation of the Plan. The Agency shall make the information publicly available by posting relevant information on the Agency's website.	1. Statement of how interested parties may contact the Agency and participate in development and implementation of the plan submitted to DWR. 2. Web posting of same information. **Timing**: *Prior to initiating development of a plan.*
§ 353.8. Comments (a) Any person may provide comments to the Department regarding a proposed or adopted Plan. (b) Pursuant to Water Code Section 10733.4, the Department shall establish a comment period of no less than 60 days for an adopted Plan that has been accepted by the Department for evaluation pursuant to Section 355.2. (c) In addition to the comment period required by Water Code Section 10733.4, the Department shall accept comments on an Agency's decision to develop a Plan as described in Section 353.6, including comments on elements of a proposed Plan under consideration by the Agency.	1. 60-day comment period for plans under submission to DWR. Comments will be used to evaluate the submission. 2. Parties may also comment on a GSA's (or GSAs') statements submitted under section 353.6 **Timing**: For GSP Submittal - *60 days after submission to DWR*
§ 354.10. Notice and Communication Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following: (a) A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties. (b) A list of public meetings at which the Plan was discussed or considered by the Agency. (c) Comments regarding the Plan received by the Agency and a summary of any responses by the Agency. (d) A communication section of the Plan that includes the following: (1) An explanation of the Agency's decision-making process. (2) Identification of opportunities for public engagement and a discussion of how public input and response will be used.	5. Statements of issues and interests of beneficial users of basin groundwater, including types of parties representing the interests and consultation process 6. Lists of public meetings 7. Inventory of comments and summary of responses 8. Communication section in plan that includes: • Agency decision making process • ID of public engagement opportunities and response process • Description of process for inclusion • Method for public information related to progress in implementing the plan (status, projects, actions) **Timing**: For GSP Submittal – *with plan* For GSP Development – *continuous. [Note: activities should be included*

Appendix 1

CODE	PUBLIC OUTREACH REQUIREMENT
(3) A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin. (4) The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	*in the project schedule and information posted on web.]*
§ 355.2. (c) Department Review of Adopted Plan (c) The Department (DWR) shall establish a period of no less than 60 days to receive public comments on the adopted Plan, as described in Section 353.8.	1. 60 day public review period for public comment on submitted plan. **Timing**: After GSP Submittal to DWR – *60 days*
§ 355.4. & 355.10 Criteria for Plan Evaluation The basin shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act. The Department shall evaluate an adopted Plan for compliance with this requirement as follows: (b) (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. … (10) Whether the Agency has adequately responded to comments that raise credible technical or policy issues with the Plan.	1. Required public outreach and stakeholder information is submitted, including statement of issues and interests of beneficial users. 2. Public and stakeholder comments and questions adequately addressed during planning process. **Timing**: For GSP Submittal – *with plan* For resubmittal related to corrective action *– with submittal*

California Water Code

CODE	PUBLIC OUTREACH REQUIREMENT
10720. This part shall be known, and may be cited, as the "Sustainable Groundwater Management Act." **10720.3** (a) This part applies to all groundwater basins in the state. … (c) The federal government or any federally recognized Indian tribe, appreciating the shared interest in assuring the sustainability of groundwater resources, may voluntarily agree to participate in the preparation or administration of a groundwater sustainability plan or groundwater management plan under this part through a joint powers authority or other agreement with local agencies in the basin. A participating tribe shall be eligible to participate fully in planning, financing, and management under this part, including eligibility for grants and technical assistance, if any exercise of regulatory authority, enforcement, or imposition and collection of fees is pursuant to	1. Tribes and the federal government may voluntarily participate in GSA governance and GSP development. **Timing**: *Prior to initiating development of a plan.*

Appendix 1

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the tribe's independent authority and not pursuant to authority granted to a groundwater sustainability agency under this part.	
CHAPTER 4. Establishing Groundwater Sustainability Agencies [10723 - 10724]	
10723. a) Except as provided in subdivision (c), any local agency or combination of local agencies overlying a groundwater basin may decide to become a groundwater sustainability agency for that basin. (b) Before deciding to become a groundwater sustainability agency, and after publication of notice pursuant to Section 6066 of the Government Code, the local agency or agencies shall hold a public hearing in the county or counties overlying the basin.	1. Must hold public hearing in the county or counties overlying the basin, prior to becoming a GSA **Timing**: *Prior to becoming a GSA.*
10723.2 The groundwater sustainability agency shall consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans. These interests include, but are not limited to, all of the following: (a) Holders of overlying groundwater rights, including: (1) Agricultural users. (2) Domestic well owners. (b) Municipal well operators. (c) Public water systems. (d) Local land use planning agencies. (e) Environmental users of groundwater. (f) Surface water users, if there is a hydrologic connection between surface and groundwater bodies. (g) The federal government, including, but not limited to, the military and managers of federal lands. (h) California Native American tribes. (i) Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems. (j) Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency.	1. Must consider interest of all beneficial uses and users of groundwater. 2. Includes specific stakeholders as listed. **Timing**: *During development of a GSP.*
10723.4. The groundwater sustainability agency shall establish and maintain a list of persons interested in receiving notices regarding plan preparation, meeting announcements, and availability of draft plans, maps, and other relevant documents. Any person may request, in writing, to be placed on the list of interested persons.	3. Must establish and maintain an interested persons list. 4. Any person may ask to be added to the list **Timing**: *On forming a GSA.*
10723.8. (a) Within 30 days of deciding to become or form a groundwater sustainability agency, the local agency or combination of local agencies shall inform the department of its decision and its intent to undertake sustainable groundwater management. The	1. Creates notification requirements that include: a. A list of interested parties b. An explanation of how interests will be considered

CODE	PUBLIC OUTREACH REQUIREMENT
notification shall include the following information, as applicable: … (4) A list of interested parties developed pursuant to Section 10723.2 and an explanation of how their interests will be considered in the development and operation of the groundwater sustainability agency and the development and implementation of the agency's sustainability plan.	**Timing**: *On forming a GSA & with submittal of GSP*
10727.8 (a) Prior to initiating the development of a groundwater sustainability plan, the groundwater sustainability agency shall make available to the public and the department a written statement describing the manner in which interested parties may participate in the development and implementation of the groundwater sustainability plan. The groundwater sustainability agency shall provide the written statement to the legislative body of any city, county, or city and county located within the geographic area to be covered by the plan. The groundwater sustainability agency may appoint and consult with an advisory committee consisting of interested parties for the purposes of developing and implementing a groundwater sustainability plan. The groundwater sustainability agency shall encourage the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin prior to and during the development and implementation of the groundwater sustainability plan. If the geographic area to be covered by the plan includes a public water system regulated by the Public Utilities Commission, the groundwater sustainability agency shall provide the written statement to the commission. (b) For purposes of this section, interested parties include entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of a groundwater basin managed by the groundwater sustainability agency.	2. Agencies preparing a GSP must prepare a written statement describing the manner in which interested parties may participate in its development and implementation. 3. Statement must be provided to: a. Legislative body of any city and/or county within the geographic area of the plan b. Public Utilities Commission if the geographic area includes a regulated public water system regulated by that Commission c. DWR d. Interested parties (see Section 10927) e. The public 4. GSP entities may form an advisory committee for the GSP preparation and implementation. 5. The GSP entities are to encourage active involvement of diverse social, cultural and economic elements of the affected populations. **Timing**: *On initiating GSP*
10728.4 Public Notice of Proposed Adoption, GSP Adoption Pubic Hearing A groundwater sustainability agency may adopt or amend a groundwater sustainability plan after a public hearing, held at least 90 days after providing notice to a city or county within the area of the proposed plan or amendment. The groundwater sustainability agency shall review and consider comments from any city or county that receives notice pursuant to this section and shall consult with a city or county that requests consultation within 30 days of receipt of the notice. Nothing in this section is intended to	3. GSP must be adopted or amended at Public Hearing. 4. Prior to Public Hearing for adoption or amendment of the GSP, the GSP entities must: a. Notify cities and/or counties of geographic area 90 days in advance. b. Consider and review comments

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preclude an agency and a city or county from otherwise consulting or commenting regarding the adoption or amendment of a plan.	c. Conduct consultation within 30 days of receipt with cities or counties so requesting
10730 Fees. (a) A groundwater sustainability agency may impose fees, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activity, to fund the costs of a groundwater sustainability program, including, but not limited to, preparation, adoption, and amendment of a groundwater sustainability plan, and investigations, inspections, compliance assistance, enforcement, and program administration, including a prudent reserve. A groundwater sustainability agency shall not impose a fee pursuant to this subdivision on a de minimis extractor unless the agency has regulated the users pursuant to this part. (b) (1) Prior to imposing or increasing a fee, a groundwater sustainability agency shall hold at least one public meeting, at which oral or written presentations may be made as part of the meeting. (2) Notice of the time and place of the meeting shall include a general explanation of the matter to be considered and a statement that the data required by this section is available. The notice shall be provided by publication pursuant to Section 6066 of the Government Code, by posting notice on the Internet Web site of the groundwater sustainability agency, and by mail to any interested party who files a written request with the agency for mailed notice of the meeting on new or increased fees. A written request for mailed notices shall be valid for one year from the date that the request is made and may be renewed by making a written request on or before April 1 of each year. (3) At least 20 days prior to the meeting, the groundwater sustainability agency shall make available to the public data upon which the proposed fee is based. (c) Any action by a groundwater sustainability agency to impose or increase a fee shall be taken only by ordinance or resolution. (d) (1) As an alternative method for the collection of fees imposed pursuant to this section, a groundwater sustainability agency may adopt a resolution requesting collection of the fees in the same manner as ordinary municipal ad valorem taxes. (2) A resolution described in paragraph (1) shall be adopted and furnished to the county auditor-controller and board of supervisors on or before August 1 of each year that the alternative collection of the fees is being requested. The resolution shall include a list of parcels and the amount to be collected for each parcel. (e) The power granted by this section is in addition to any powers a groundwater sustainability agency has under any other law.	Related to GSAs 5. Public meeting required prior to adoption of, or increase to fees. Oral or written presentations may be made as part of the meeting. 6. Public notice shall include: a. Time and place of meeting b. General explanation of matter to be considered c. Statement of availability for data required to initiate or amend such fees d. Public posting on Agency Website and provision by mail to interested parties of supporting data (at least 20 days in advance) 7. Mailing lists for interested parties are valid for 1 year from date of request and may be renewed by written request of the parties on or before April 1 of each year. 8. Includes procedural requirements per Government Code, Section 6066. **Timing**: *Prior to adopting fees.*

California Government Code

CODE	PUBLIC OUTREACH REQUIREMENT
6060 Whenever any law provides that publication of notice shall be made pursuant to a designated section of this article, such notice shall be published in a newspaper of general circulation for the period prescribed, the number of times, and in the manner provided in that section. As used in this article, "notice" includes official advertising, resolutions, orders, or other matter of any nature whatsoever that are required by law to be published in a newspaper of general circulation. **6066** Publication of notice pursuant to this section shall be once a week for two successive weeks. Two publications in a newspaper published once a week or oftener, with at least five days intervening between the respective publication dates not counting such publication dates, are sufficient. The period of notice commences upon the first day of publication and terminates at the end of the fourteenth day, including therein the first day.	4. Must publish notices in a newspaper of general circulation as prescribed. 5. Publication shall be once a week for two successive weeks. Two publications in a newspaper published once a week or oftener, with at least five days intervening between the respective publication dates not counting such publication dates, are sufficient. 6. The period of notice begins the first day of publication and terminates at the end of the fourteenth day, (which includes the first day.) **Timing**: *Prior to adopting fees*

Appendix 2. Communications Governance

Given the relatively large number of stakeholders, a recommendation for coordinated efforts, and the legal requirements for outreach[13] some form of communications governance is recommended.

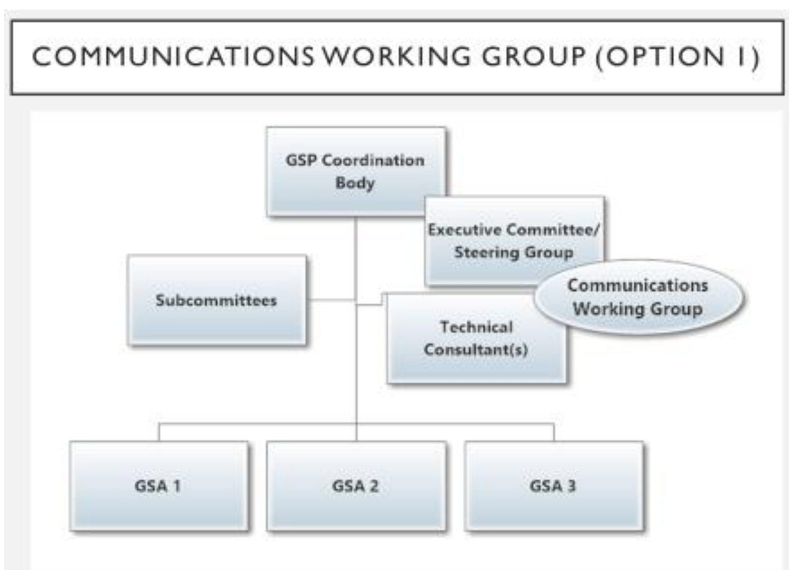
Execution of communications activities can be accomplished by an individual or multiple individuals, and/or include or be solely managed by project consultants. The actual form of the governance is less important than a clear understanding of the roles and responsibilities of those responsible for ensuring required communication. Also essential is a clear chain of command that ensures the elected representatives of GSAs are able to retain communications leadership and guidance.

A driving consideration for establishing a communications governance structure is the level of effort associated with required activities and the fact that communications are highly time dependent. That means that communications activities should be occurring that may happen outside of regularly scheduled GSA meetings. In this case delegation with guidance to a communications team is efficient and effective.

Several governance options for consideration are offered below.

Communications Option 1

Communications Option 1 is based on an overall GSP(s) development structure that includes a GSA member based leadership function that is guiding the Technical Consultants. A communications working group which might include staff, consultants and GSA elected officials, or some combination of those roles could be formed to serve as a communications working group that would ultimately report to the larger GSP coordinating body.



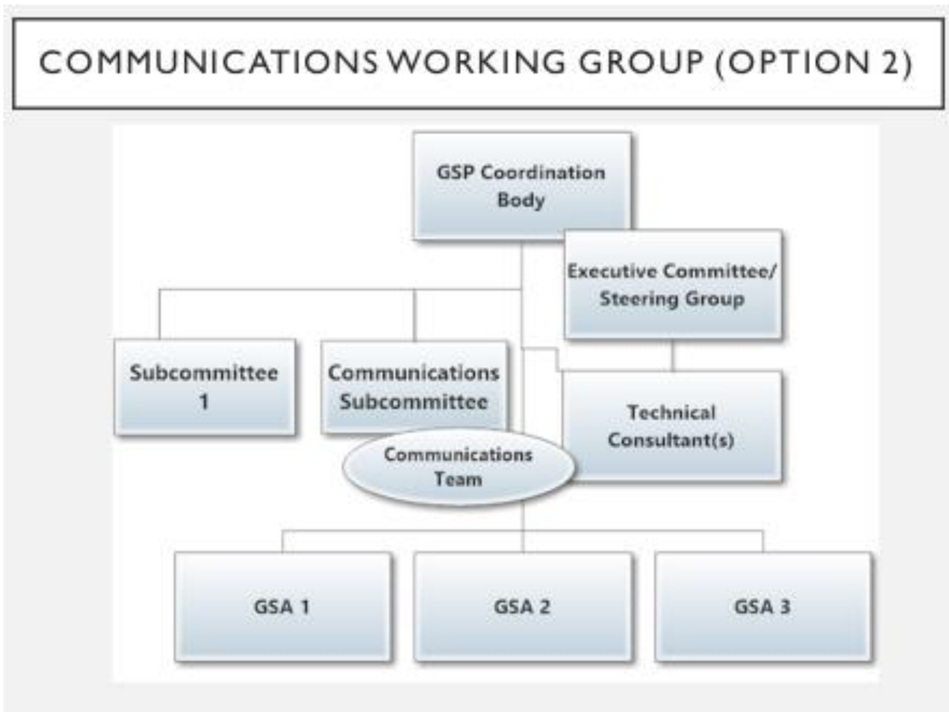
Communications Governance Option 1

Communications Option 2

[13] See Appendix 1

Appendix 1

Communications Option 1 is based on an overall GSP(s) development structure that includes a GSA member based subcommittee guiding the Technical Consultants. A communications working group which might include staff, consultants and GSA elected officials, or some combination of those roles could be formed to serve as a communications team that is affiliated with a subcommittee and would ultimately report to the larger GSP coordinating body



Communications Governance Option 2

Appendix H. Comments Received

California Poultry FEDERATION

4640 Spyres Way, Suite 4 | Modesto, CA 95356 | Phone: (209) 576-6355 | Fax: (209) 576-6119 | www.cpif.org

VIA E-MAIL (contactus@sjrecwa.net)

December 12, 2019

Members of the San Joaquin River
Exchange Contractors GSP Group
c/o San Joaquin River Exchange
Contractors Water Authority
541 H Street
Box 2115
Los Banos, California 93635

Re: SJREC Group GSP

Dear Members of the San Joaquin River Exchange Contractors GSP Group:

The California Poultry Federation ("CPF") appreciates the opportunity to comment on the draft Groundwater Sustainability Plan (the "GSP") for the San Joaquin River Exchange Contractors ("SJREC") GSP Group. CPF is the trade association for California's diverse and dynamic poultry industry. Our members include growers, hatchers, breeders, and processors that work with chickens, turkeys, ducks, game birds, and squab. Water is essential for all of them—both for nutrition and for maintaining sanitary conditions. CPF therefore supports effective measures to assure reliable water supplies.

In this regard, CPF commends the draft GSP for emphasizing projects to increase recharge and utilize surface waters. Such measures—which are essential for maintaining an economically viable groundwater source for all beneficial users—should be the top priority for each SJREC GSP Member Groundwater Sustainability Agency ("GSA"). We encourage all the Member GSAs to continue identifying and implementing projects that increase water supplies. In addition, we recommend the adoption of incentives such as additional extraction rights to build support for augmentation from private parties.

One other point deserves mention. It is essential that the public have meaningful opportunities to participate in the implementation of the GSP, which means that there must be sufficient time to review drafts, evaluate supporting information, and submit written comments. But it was difficult here to ascertain when the draft GSP became available and when written comments were due. Member GSAs should employ electronic mail to give interested persons timely notice of developments in the Delta-Mendota Subbasin such as document availability and deadlines for participation. And they should utilize one central clearinghouse available through the Internet for disseminating documents and for receiving written comments.

Please contact me if you need any further information about these comments.

Very truly yours,

Bill Mattos

Bill Mattos
President

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

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December 9, 2019

Via Mail and Electronic Mail

Chris White
Executive Director
San Joaquin River Exchange Contractors Water Authority GSP
541 H Street
Post Office Box 2115
Los Banos, California 93635

Email: cwhite@sjrecwa.net.

Subject: Comments on the San Joaquin River Exchange Contractors Water Authority Groundwater Sustainability Plan

Dear Mr. White:

The California Department of Fish and Wildlife (Department) Central Region is providing comments on the San Joaquin River Exchange Contractors (SJREC) Water Authority Draft Groundwater Sustainability Plan (GSP) prepared by San Joaquin River Exchange Contractors Water Authority Groundwater Sustainability Agency (GSA) pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of Groundwater Sustainability Plans under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

- Groundwater Sustainability Plans shall identify and consider impacts to groundwater dependent ecosystems (GDEs) pursuant to 23 California Code of Regulations (CCR) § 354.16(g) and Water Code § 10727.4(l);
- Groundwater Sustainability Agencies shall consider all beneficial uses and users of groundwater, including environmental users of groundwater pursuant to Water Code §10723.2 (e); and Groundwater Sustainability Plans shall identify and

consider potential effects on all beneficial uses and users of groundwater pursuant to 23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3);

- Groundwater Sustainability Plans shall establish sustainable management criteria (SMC) that avoid undesirable results within 20 years of the applicable statutory deadline, including depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water pursuant to 23 CCR § 354.22 *et seq.* and Water Code §§ 10721(x)(6) and 10727.2(b) and describe monitoring networks that can identify adverse impacts to beneficial uses of interconnected surface waters pursuant to 23 CCR § 354.34(c)(6)(D); and

- Groundwater Sustainability Plans shall account for groundwater extraction for all Water Use Sectors including managed wetlands, managed recharge, and native vegetation pursuant to 23 CCR §§ 351(al) and 354.18(b)(3).

Accordingly, the Department values SGMA groundwater planning that carefully considers and protects groundwater dependent ecosystems and fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.

COMMENT OVERVIEW

The Department supports ecosystem preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science.

The Department recommends that the GSP provide additional information and analysis that considers all environmental beneficial uses and users of groundwater in its sustainability management criteria and better characterize or consider surface water-groundwater connectivity. In addition, the Department is providing additional comments and recommendations below.

GSP COMMENTS AND RECOMMENDATIONS

1. **Comment #1 Plan Area**. Section 2.0 Plan Area and Basin Setting. Subsection 2.1.1 Description of Jurisdictional Areas and Other Features, Subsection 2.1.4 Additional GSP Elements (pages 27 to 28 and Figure 3).

   This section mentions Department-owned lands within the Delta-Mendota Subbasin. There are four small parcels on Los Banos Wildlife Area and two additional parcels on Mud Slough Unit of the Los Banos Wildlife Area that are within the GSP area. None of these parcels have any wells present.

a. *Issue*: Pursuant to 23 CCR § 354.8 (a)(3), GSPs are to identify "Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land)." The GSP states, "the California Department of Fish and Wildlife own[s] and operate[s] lands [including] California Protected Areas and Wildlife Areas" (page 27), but the GSP does not specify which lands fall within the GSP area.

b. *Recommendation*: The Department recommends identifying the specific Department-owned and -managed lands in the GSP narrative as identified above. The Department further recommends the label in the Explanation Key be changed from "State Wildlife Areas" to "California Department of Fish and Wildlife".

2. **Comment #2 Environmental Beneficial Users of Groundwater.** Section 2.1 Description of the Plan Area. Subsection 2.1.5 Notice and Communication (page 49).

   The GSP lists environmental beneficial uses and users of groundwater in the basin but does not describe these users or their relationship to groundwater.

   a. *Issue:* Pursuant to 23 CCR § 354.10(a), GSPs are to include in the Notice and Communication Section a "description of the beneficial uses and users of groundwater in the basin." The GSP identifies environmental uses among beneficial users and specifies GDEs and managed duck clubs as types of beneficial users (pages 46 and 49) but does not describe how environmental uses and users benefit from or rely on groundwater.

   b. *Recommendations:* The Department recommends elaborating on environmental beneficial uses and users of groundwater in the Notice and Communication Section by identifying specific beneficial users (see Appendix B, Table CC-7, page B133) and including a detailed description on how these users, such as GDEs and the species therein, may rely on groundwater and may be impacted by SMC pursuant to 23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3). The Critical Species LookBook (TNC 2019) is a resource to help identify threatened and endangered species in any basin subject to SGMA and to help understand species relationships to groundwater. The LookBook also offers narrative on species and habitat groundwater dependence that can be a model for describing environmental beneficial uses and users of groundwater in the GSP.

3. **Comment #3 Subsidence.** Chapter 2.0 Plan Area and Basin Setting. Section 2.2 Basin Setting (starting page 52). Proposed SMC for subsidence within the Plan area do not correspond with current or proposed groundwater extraction practices for the lower confined aquifer.

a. *Issues:*

i. CDWR has classified the Delta-Mendota Subbasin as a 'Critically Overdrafted' subbasin due to subsidence issues. The GSP acknowledges that land subsidence is a current issue within the Delta-Mendota Subbasin and that historically, up to 16 feet of subsidence has been reported in areas within its southern portion. While the GSP acknowledges the presence of subsidence within the basin, it also repeatedly indicates that the causes of subsidence originate outside of the GSP area due to excessive groundwater extraction practices within the lower confined aquifer system by neighboring entities (page 104). The GSP indicates that most of the wells within the GSP area are completed above the Corcoran Clay within the unconfined aquifer; however, the GSP also notes that there are some production wells within the GSP area completed below the Corcoran Clay where a majority of subsidence within the San Joaquin Valley occurs. The GSP proposes SMC for the subsidence sustainability indicator, including a Measurable Objective for inelastic land subsidence of less than 0.005 ft/year and a Minimum Threshold of "that which doesn't reduce [SJREC's] conveyance capacity without appropriate mitigation" (page 104). In other words, the GSP has no tolerance for subsidence without mitigation.

ii. Based on the current and historic data sets for subsidence (NASA JPL InSAR and SJV CDWR), the SJREC GSA is experiencing subsidence due to groundwater extraction practices. The GSP acknowledges subsidence in the GSP area, but indicates a majority of land subsidence is attributed to the extraction of water in aquifers beneath the Corcoran Clay outside of plan area; however, the SJREC has wells completed in the lower confined aquifer and extracts water from the lower confined aquifer. The GSP approach to manage subsidence moving forward is to limit groundwater extractions to 0.25 acre-foot (AF)/acre (page 97). This proposed approach is more than double the amount of the maximum extraction (0.10 AF/acre) observed from historic, current, and projected water budgets. Presumably, the potential doubling of water extractions from the lower aquifer would compound existing over-draft conditions and contribute to continued subsidence. The GSP indicates that overdraft in the lower aquifer has the potential to instantly trigger inelastic land subsidence (page 97). The lower aquifer sustainable yield must be managed annually and, more importantly, site-specifically to ensure significant and/or unreasonable land subsidence does not result from the overdraft. As previously stated, the Delta-Mendota Subbasin is characterized by CDWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the basin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (CDWR "Critically Overdrafted"). Increasing the amount of allowable water to be extracted from the lower aquifer does not promote sustainability nor demonstrate a likelihood of achieving Measurable Objectives, and instead reflects the conditions that merited the subbasin's Critically Overdrafted status.

iii. The GSP repeatedly indicates that the upper aquifer is stable and that subsidence within the upper aquifer is unlikely to occur. Within the Appendix I (KSDA Report), the report provides a description of the geologic materials encountered at depth and provides a number of geologic cross sections depicting the hydrogeologic framework beneath the GSP area. Within these cross sections, the GSP identifies a number of confining layers (A and C clay layers) above the Corcoran Clay. The GSP describes these clays as acting as semi-confining layers; and in one location (Management Area G), the GSP indicates that based on pumping test data, the aquifer is more than likely confined. These clay layers act as confining beds and restrict the movement of groundwater.

The lowering of groundwater levels within the upper aquifer provides the potential to create groundwater-level-induced stresses which can promote subsidence. Nearby records for an Extensometer station (Yearout) located in the Farmers Water District (east of the SJREC) indicates total compaction between the years of 1999 to 2017 at approximately 0.30 ft. Additional historic extensometer data for the Yearout Extensometer station is provided by the USGS online database *(https://www.usgs.gov/centers/ca-water-ls/science/extensometers-and-compaction?qt-science_center_objects=0#qt-science_center_objects).* These records indicate that between the years of 1966 and 1983, approximately 0.30 feet of compaction in the upper aquifer was recorded. When pumping induces groundwater level drop below critical head, preconsolidation stresses are surpassed and compaction of fine-grained materials occur, resulting in subsidence. The GSP describes groundwater levels within the upper aquifer currently as being stable; however, compaction within the upper aquifer is a realistic potential for the GSP area and should be considered in future planning.

b. *Recommendation:* The Department recommends that the SJREC re-evaluate its threshold for allowable groundwater extraction practices within the lower confined aquifer to mitigate subsidence-related undesirable results.

4. **Comment #4. Interconnected Surface Waters.** Section 2.2 Basin Setting. Subsection 2.2.2 Current and Historical Groundwater Conditions (page 53).

The GSP does not explicitly identify interconnected surface waters within the GSP area or estimate depletions from those systems.

a. *Issue:* Pursuant to 23 CCR § 354.16(f), a GSP shall identify "interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems" within the Groundwater Sustainability Plan's 'Groundwater Conditions' section. The GSP does not explicitly meet this requirement, despite the likely presence of interconnected surface water reaches along the San Joaquin River. The GSP cites Figure 52 in Appendix I as showing potential locations of interconnectivity and suggests that the Groundwater Sustainability Agencies will continue to monitor groundwater levels near the San Joaquin River and expand the understanding of shallow groundwater (page 106). However, the GSP does not identify interconnected surface waters as a data gap (page 112), despite its intent to expand understanding of shallow groundwater and despite the Delta-Mendota Subbasin Common Chapter demonstrating significant unknowns for San Joaquin River Interconnectivity (Appendix B, page B128-129). Finally, SMC for interconnected surface waters are non-specific for each management area, and instead refer to vague, unquantified narrative metrics that do not meet GSP regulatory requirements (see Comment #6).

b. *Recommendations:* The Department recommends that the GSA identify interconnected surface waters in the Plan area in Section 2.2.2; characterize the relationship between groundwater and interconnected surface waters; identify the estimated quantity and timing of streamflow depletions in the subbasin attributable to groundwater pumping; and develop quantifiable SMC for interconnected surface waters accordingly. If this information is not available, the Department recommends identifying an expeditious and specific path to expanding the shallow groundwater monitoring system to gather the necessary data (see Comment #7).

5. **Comment #5 Groundwater Dependent Ecosystems.** Section 2.0 Plan Area and Basin Setting. Subsection 2.1.4 Additional GSP Elements (page 46, Figures 8 and 9).

The GDE identification section, pursuant to 23 CCR § 354.16 (g), is based on limited information to identify ecosystems that may depend on groundwater.

a. *Issue*: The GSP does not provide a narrative on the methodology used to screen and remove potential GDEs from the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset, even though Figures 8 and 9 suggest that potential NCCAG GDEs were removed from the dataset for specific reasons (pages 46-48). Also, the GDE maps provided in Figures 8 and 9 are difficult to decipher (pages 46-48). Presumably the GDEs included in the GSP correspond with Appendix B GDE maps on pages B130-B132, which identify basin-wide GDEs. If this is the case, the GDE maps provided in the GSP reflect an initial assessment of GDEs that may be further refined (Appendix B page B142), as none of the GDEs have been field verified (page

46). The GDE section also includes a list of potential groundwater dependent vegetation, citing that none of the species are threatened or endangered, but it does not identify species that may rely on this groundwater dependent vegetation (see Appendix B starting page B133 for a list of potential Freshwater Species). Finally, the GSP offers that in the event the GSA notices impacts to GDEs, "an in-depth review to mitigate those impacts will be initiated" (page 46). The GSP, however, offers no details as to how impacts to GDEs will be 'noticed,' nor what those impacts might look like.

b. *Recommendations:* The Department recommends that the GSP consider the following for information gathering related to GDEs:

   i. The Department recommends refining the identification of GDEs through field verification, improving readability of GDE maps, identifying groundwater dependent fish and wildlife species in the basin, and identifying and implementing appropriate monitoring approaches to track environmental beneficial users over time capable of capturing early signs of adverse impacts to GDEs (e.g., stressed phreatophyte vegetation or increased surface water temperatures [see Comment #2]) to encourage actionable responses to observed impacts to GDEs.

   ii. Additionally, the Department recognizes that NCCAG (Klausmeyer et al. 2018) provided by California Department of Water Resources (CDWR) is a good starting reference for GDEs; however, the Department recommends the GSP include additional resources for evaluating GDE locations. The Department recommends consulting other references, including but not limited to the following tools and other resources: the California Department of Fish and Wildlife (CDFW) Vegetation Classification and Mapping Program (VegCAMP) (CDFW 2019A); the CDFW California Natural Diversity Database (CNDDB) (2019B); the California Native Plant Society (CNPS) Manual of California Vegetation (CNPS 2019A); the CNPS California Protected Areas Database (CNPS 2019B); the U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (2018); the USFWS online mapping tool for listed species critical habitat (2019); the U.S. Forest Service CALVEG ecological grouping classification and assessment system (2019); and other publications by Klausmeyer et al. (2019), Rohde et al. (2018), The Nature Conservancy (TNC) (2014, 2019), Naumburg et al. (2005), and Witham et al. (2014).

6. **Comment #6 Sustainable Management Criteria.** Section 3.0 Sustainable Management Criteria (starting on page 96).

SMC demonstrate limited consideration of undesirable results for environmental beneficial uses and users of groundwater, interconnected surface water SMC fail to meet GSP regulatory standards, and SMC do not reflect a 'Critically Overdrafted' Basin status.

a. *Issues:*

i. SMC do not discuss potential impacts to environmental beneficial users of groundwater and may risk significant and unreasonable impacts to GDEs. There are no analyses on effects of undesirable results to environmental beneficial uses and users of groundwater pursuant to 23 CCR § 354.26(b)(3). For example, for chronic lowering of groundwater levels, the proposed measurable objective is to "manage to avoid shallow groundwater while maintaining groundwater levels above the minimum threshold" (page 97). While it is not clear what 'avoid shallow groundwater' means, in theory minimizing shallow groundwater depletions will benefit environmental beneficial uses and users of groundwater. However, the GSP does not provide this explanation via an analysis of effects of Undesirable Results (UR) on beneficial uses nor does the GSP offer an actionable basis for how SMC will be designed and implemented to mitigate these potential adverse effects.

ii. Interconnected Surface Water (ISW) SMC are confusing and inconsistent. In the Executive Summary, the GSP does not propose to develop Measurable Objectives (MO) and Interim Milestones for ISW (page v), but later suggests that MO for ISW will equate to Minimum Thresholds (MT) (page 98) and depletions of surface water attributable to groundwater pumping will be managed through well siting and screening requirements for wells in close proximity to the San Joaquin River (page 106). ISW SMC for each management area (starting page 131) either dismiss the likelihood of interconnected surface waters and do not provide SMC for ISW, or; cite plans to work with SJREC to sustainably manage ISW and refer to Subsections 3.2.6, 3.3.6, and 3.4.6 for more details. These sections identify ISW MOs, MTs, and URs) respectively. However, each section fails to provide quantified, specific, and justified SMC that meet SMC criteria pursuant to 23 CCR §§ 354.20(b)(2), 354.26(b), 354.28(b), 354.28(c)(6), 354.30(a-c):

1. [Subsection 3.2.6] ISW MOs are set as the same as MTs; interim milestones are to "collect and analyze additional data to ensure Undesirable Result for depleted surface water does not occur" (page 98). Effectively, no quantifiable interim milestones are provided and there is no room for operational flexibility when MOs equal MTs.

2. [Subsection 3.3.6] ISW MTs are described as "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" (page 106). The GSP also says the MTs established shall support the location, quantity, and timing of potential depletions. Despite this narrative on MTs, no quantified MTs are established for ISW in the GSP area. Instead, the GSP claims that a management technique for the siting and screening of new wells near the San Joaquin River will ensure that significant and unreasonable depletions of ISW are avoided, and this management technique will avoid impacts to GDEs and other beneficial uses and users of surface water (page 106). No hydrogeologic analysis is provided to substantiate this statement, and this management technique offers nothing to manage existing wells, nor does the management technique appear in the Project and Management Actions section (starting page 113). Finally, the GSP vaguely states, "Depletions of interconnected surface water will be monitored and managed consistent with the other sustainability indicators and the more restrictive management will be implemented to ensure this plan area is absent of any undesirable results" (page 106). There is no evident consistency between the monitoring and management of other sustainability indicators and ISW; and, because no specific MTs are established for ISW, resultantly, there are also no quantified MOs (see Comment #6.ii.1 above).

3. [Subsection 3.4.6] ISW URs are described as "significant and unreasonable depletion of interconnected surface water [occurring] when groundwater extraction from the SJREC GSP Group decreases streamflow to a significant and unreasonable level for beneficial users in a stretch of the San Joaquin River that was historically losing (seeping from the river)" (page 109). This UR description does not identify specific criteria based on a quantitative description of MT exceedances that cause significant and unreasonable effects [23 CCR § 354.26(b)(2)], nor does the description identify potential effects on beneficial uses and users in the basin [23 CCR § 354.26(b)(3)], in part because no quantified MTs are established. Inexplicably, this UR is also only applied to 'historically losing' streams, even though both losing streams and gaining streams can be interconnected with groundwater. Not only does the GSP *not* thoroughly identify ISW and depletions (see Comment #4), it also does not establish quantifiable ISW SMC that meet GSP regulatory standards and that reflect a firm grasp on local surface water-groundwater interactions.

iii. The Delta-Mendota Subbasin is designated as 'Critically Overdrafted,' but in contrast to its designated Critically Overdrafted status, the GSP generally touts a sustainable groundwater management legacy and occasionally suggests that local adverse impacts are attributable to neighboring Groundwater Sustainability Agencies and basins (pages iv, v, 6, 40, 46, and 97). The GSP establishes MTs that are a 25% increase in depth to water beyond pre-established trigger elevations that represent three-year water level trends extrapolated to an additional drought year beyond the observed historic low (page 100, Table 39). Similar to ISW SMC, no interim milestones are provided for groundwater levels (page 100). No figures are provided to communicate clearly the relationship between historic groundwater elevation, triggers, and MTs for representative monitoring wells. Based on the narrative and table provided, these groundwater level MT suggest that groundwater elevations at representative wells can continue to decrease for the next 20 years, dropping further from historically low drought groundwater elevations, without witnessing undesirable results. However, based on subsidence alone, it appears that undesirable results are already occurring; and, given the semi- and unconfined nature of the upper aquifer, adverse impacts to shallow groundwater supporting GDEs are feasible under declining groundwater conditions. Therefore, the GSP's MTs that allow for continued groundwater table decline, mirroring the historical trends that led to the subbasin's Critically Overdrafted status, are unlikely to protect against URs. Conceptually, there is a disconnect between the subbasin's 'Critically Overdrafted' designation and sustainable management criteria the allow for continued groundwater level decline.

b. *Recommendations:* The Department recommends that the GSA reevaluate SMC with the following suggestions:

   i. Clarify how species and habitat groundwater needs were considered in the identification of SMC and identify specific potential adverse impacts on environmental beneficial users of groundwater and causal relationships with groundwater pumping (e.g., terrestrial GDE stress/loss, increased instream temperatures, etc.).

   ii. Identify ISW and establish quantifiable ISW SMC (see Comment #6).

   iii. Revise SMC to reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades. Provide context for SMC using figures that show historic water elevations in comparison to MTs and MOs.

7. **Comment #7 Monitoring Network.** Section 3.5 Monitoring Network (Figure 22). The number and distribution of shallow groundwater monitoring wells in the GSP area and along the San Joaquin River are insufficient for analysis of shallow groundwater trends and groundwater-surface water interconnectivity.

a. *Issue:* Existing shallow groundwater monitoring wells are insufficient to characterize shallow groundwater and surface water-groundwater interactions along the course of the main waterway (i.e., San Joaquin River) in the GSP area or to monitor impacts to environmental beneficial uses and users of shallow groundwater and interconnected surface waters [23 CCR § 354.34(2)]. The GSP provides a table in Appendix B: Estimated Quantity of Gains/Depletions for Interconnected Stream Reaches, San Joaquin River (Table CC-6); this table indicates the presence of data gaps and the need for additional data to clarify the interconnected surface water relationship within the GSP area along the San Joaquin River. Additionally, few representative monitoring wells capture shallow groundwater trends and few are located along interconnected surface waters throughout the GSP area. Therefore, there is limited data on shallow groundwater level trends as they relate to environmental users of groundwater. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, which are impacted disproportionately by shallow groundwater trends.

b. *Recommendation*: The Department recommends installing additional shallow groundwater monitoring wells near potential GDEs in the basin and along interconnected surface waters, potentially pairing multiple-completion wells with streamflow gages for improved understanding of surface water-groundwater interconnectivity.

OTHER COMMENTS: Implementation of Future Project Actions Related to SGMA

SGMA exempts the preparation and adoption of GSPs from the California Environmental Quality Act (CEQA) (WC §10728.6); however, SGMA specifically states that implementation of project actions taken pursuant to SGMA are not exempt from CEQA (WC §10728.6). The Department is California's Trustee Agency for fish and wildlife resources and holds those resources in trust by statute for all the people of the State (Fish & G. Code, §§ 711.7, subd. (a) & 1802; Pub. Resources Code, § 21070; CEQA Guidelines § 15386, subd. (a)). The Department, in its trustee capacity, has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of those species (*Id.*, § 1802). Similarly, for purposes of CEQA, the Department is charged by law to provide, as available, biological expertise during public agency environmental review efforts, focusing specifically on projects and related activities that have the potential to adversely affect fish and wildlife resources.

The Department is also a Responsible Agency under CEQA (Pub. Resources Code, § 21069; CEQA Guidelines, § 15381), and the Department expects that it may need to exercise regulatory authority as provided by the Fish and Game Code for implementation of projects related to the GSP that are also subject to CEQA. These projects may be subject to the Department's lake and streambed alteration regulatory authority (i.e., Fish & G. Code, § 1600 *et seq.*). Notification pursuant to Fish and Game Code § 1602 is warranted if a project will (a) substantially divert or obstruct the natural flow of any river, stream, or lake; (b) substantially change or use any material from the bed, bank, or channel of any river, stream, or lake (including the removal of riparian vegetation); and/or (c) deposit debris, waste or other materials that could pass into any river, stream, or lake. Likewise, to the extent that implementation of any project may result in "take" as defined by State law of any species protected under the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 *et seq.*), related authorization as provided by the Fish and Game Code will be required. The Department is required to comply with CEQA in its issuance of a Lake or Streambed Alteration Agreement or an Incidental Take Permit.

The implementation of SGMA does not alter or determine surface or groundwater rights (WC §10720.5). It is the intent of SGMA to respect overlying and other proprietary rights to groundwater, consistent with section 1200 of the Water Code (Section 1(b)(4) of AB 1739). The capture of unallocated stream flows to artificially recharge groundwater aquifers are subject to appropriation and approval by the State Water Resources Control Board (SWRCB) pursuant to Water Code § 1200 et seq. The Department, as Trustee Agency, is consulted by SWRCB during the water rights process to provide terms and conditions designed to protect fish and wildlife prior to appropriation of the State's water resources. Certain fish and wildlife are reliant upon aquatic and riparian ecosystems, which in turn are reliant upon adequate flows of water. The Department therefore has a material interest in assuring that adequate water flows within streams for the protection, maintenance and proper stewardship of those resources. The Department provides, as available, biological expertise to review and comment on environmental documents and impacts arising from project activities.

CONCLUSION

In conclusion, the GSP needs to address all SGMA statutes and regulations, and the Department recommends that the GSA seriously consider fish and wildlife beneficial uses and interconnected surface waters. The Department recommends that the GSA consider the above comments before the GSP is submitted to CDWR. The Department appreciates the opportunity to provide comments on the GSP. If you have any further questions, please contact Dr. Andrew Gordus, staff toxicologist, at Andy.Gordus@wildlife.ca.gov or (559) 243-4014 extension 239.

Sincerely,

Julie A. Vance
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Enclosures (Literature Cited)

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Appendix I. Hydrogeologic Conceptual Model and Groundwater Conditions for the San Joaquin River Exchange Contractors Service Area GSP

HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE SAN JOAQUIN RIVER EXCHANGE CONTRACTORS SERVICE AREA GSP

prepared for
San Joaquin River Exchange
Contractors GSA
Los Banos, California

by
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Groundwater Quality Consultants
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June 2019

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June 14, 2019

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San Joaquin River Exchange
  Contractors GSA
P. O. Box 2115
Los Banos, CA 93635

Re: Service Area GSP

Dear Chris:

Submitted herewith is our report on groundwater conditions in the SJREC Service Area GSP. We appreciate the cooperation of SJREC and CCID in providing data for this report.

Sincerely Yours,

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HYDROGEOLOGIC CONCEPTUAL MODEL AND GROUNDWATER CONDITIONS FOR THE SAN JOAQUIN RIVER EXCHANGE CONTRACTORS SERVICE AREA GSP

INTRODUCTION

This report is intended to satisfy Sections 354.14 (Hydrologic Conceptual Model) and Section 354.16 (Groundwater Conditions) of a Groundwater Sustainability Plan (GSP) for the San Joaquin River Exchange Contractors (SJREC) Water Authority service area. The service area has previously been divided into ten management sub-areas. Management Sub-areas A, B, C, D, E, F, G, and K are in the Central California Irrigation District (CCID). These sub-areas extend from north to south from near Crows Landing to Mendota. Sub-area I is the Firebaugh Canal Water District, Sub-area H is the San Luis Canal Co. service area, and Sub-area J is the Columbia Canal Co. service area. Also covered by this report are a number of white areas in Merced County, Madera County, and Fresno County that generally adjoin the SJRECWA service area.

SURFICIAL CHARACTERISTICS OF BASIN

Topography

Figure 1 shows topographic conditions in the basin. Overall, the land west of the San Joaquin River generally slopes to the northeast towards the San Joaquin River. The land in the Columbia Canal Co. service area slopes to the southwest, also toward the river. Major streams that pass through the area are the San Joaquin River, Los Banos Creek, San Luis Creek, and Orestimba Creek.

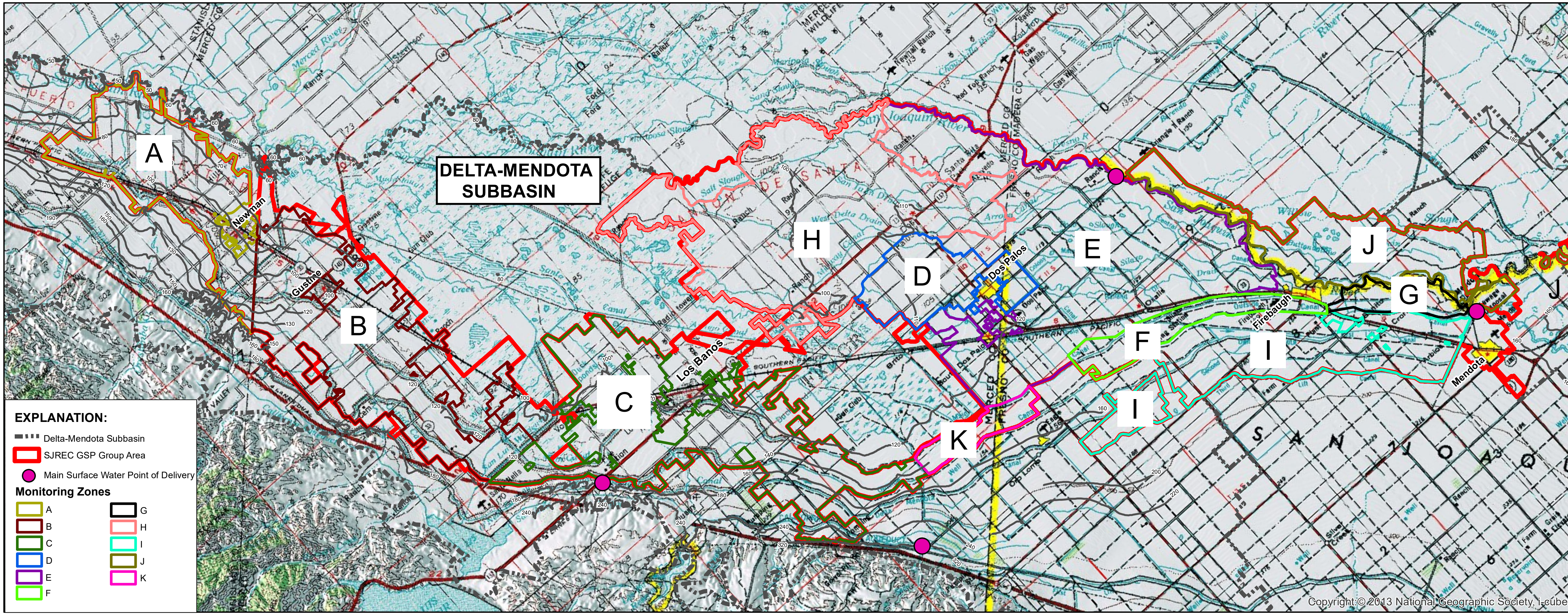

FIGURE 1 - TOPOGRAPHIC MAP OF SJREC GSP GROUP

Land surface elevations range from about 160 to 250 feet above mean sea level near the west edge of Sub-areas B and C to about 55 feet above mean sea level near the San Joaquin River and the north end of Sub-area A.

Surficial Geology

Hotchkiss and Balding (1971, Plate 1) mapped the surficial geology of the Tracy-Dos Palos Area, which includes the north part of the SJREC service area. Figure 2 shows the part of their map that covers lands in the service area. Much of the surficial deposits were mapped as flood basin deposits. These are unconsolidated clay, silt, sand, and gravel deposits on the floodplain of the San Joaquin River. Alluvial deposits are present along the southwest edge of the area, primarily along the Orestimba Creek, San Luis Creek, Los Banos Creek, and Ortigalita Creek alluvial fans. These are unconsolidated clay, silt, sand, and gravel.

Mitten, LeBlanc, and Bertoldi (1970) mapped the geomorphic features of the Madera area, which includes Sub-area J. Surficial materials in most of this sub-area (the Columbia Canal Co. service area) were mapped as flood basin deposits. However, in the east part of the area the surficial deposits were mapped as the younger alluvium.

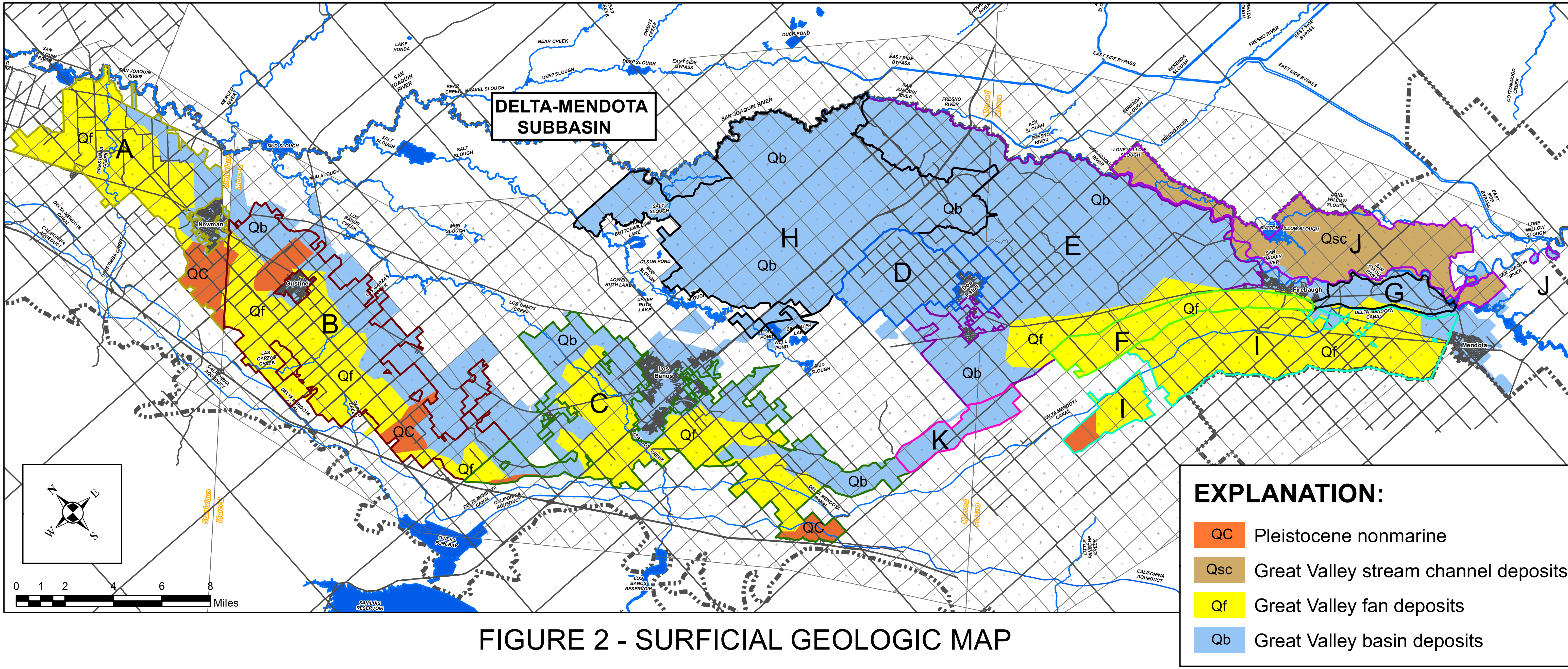

FIGURE 2 - SURFICIAL GEOLOGIC MAP

Topsoils

Harradine, et al (1956) mapped topsoils in the Mendota area, which extends southeasterly from the Merced County-Madera County line to south of Tranquillity. Soils in the northwest part (Red Top area) were mapped as "Soils of the Valley Basin". These include the Merced, Temple, Rossi, and Traver soils series. The Merced, Tempe, and Rossi soils are fine textured and poorly drained, whereas the Traver soils are coarse textured. Soils farther to the southwest, including near Dos Palos, west of Firebaugh, and west of Mendota were mapped as "Soils of the Valley Basin". These include the Williams, Oxalis, Lethen, and Levis soil series. These soils are fine-textured with moderate to strong amounts of alkali and usually have high amounts of gypsum. Most of the rest of the topsoils, except for alluvial fans of the major westside streams, were classified as "Soils of the Recent Alluvial Fans and River Flood Plains". These include Panoche, Panhill, and Columbia Soils. The Panoche and Panhill soils have a wide range of texture and calcareous profiles. The Columbia soils occupy the recent floodplain along or near the San Joaquin River and are more permeable than the other two soils.

Ulrich and Stromberg (1962) provided a soil survey for the Madera Area, which includes Sub-area J. Topsoils of the Traver-Chino Association are predominant in this sub-area, except near the San

Joaquin River, north of Mendota, where soils of the Columbia-Temple Association are predominant. The Traver soils are medium to coarse textured. They have slightly more clay in the subsoil than in the surface soil and are generally strongly affected by salts and alkali. The Chino soils have slightly more clay in a moderately calcareous subsoil. Concentrations of salts and alkali vary from slight to strong. Soils of the Columbia-Temple Association have imperfect to poor natural drainage. The Columbia soils are non-calcareous and coarse textured. The Temple soils are farther from the river and have a medium to fine texture, and a strongly calcareous subsoil. In many places they are slightly saline.

Figure 3 shows the major types of topsoils in the SJREC GSP Group Area. For the part of the area on the west side of the San Joaquin River, U.S. Soils Conservation Service reports on soils in the Newman, Los Banos, and Mendota areas were used. For Subarea J, the report on soils in the Madera area was used.

For this evaluation, KDSA grouped the soil textures into three groups: Coarse-grained (generally sand or loamy sand, clay or silty clay, and intermediate (i.e. sandy clay). This map indicates that the coarsest topsoils are either to the east near the San Joaquin River, or to the west along alluvial fans such as along Los Banos Creek. The finest grained topsoils were

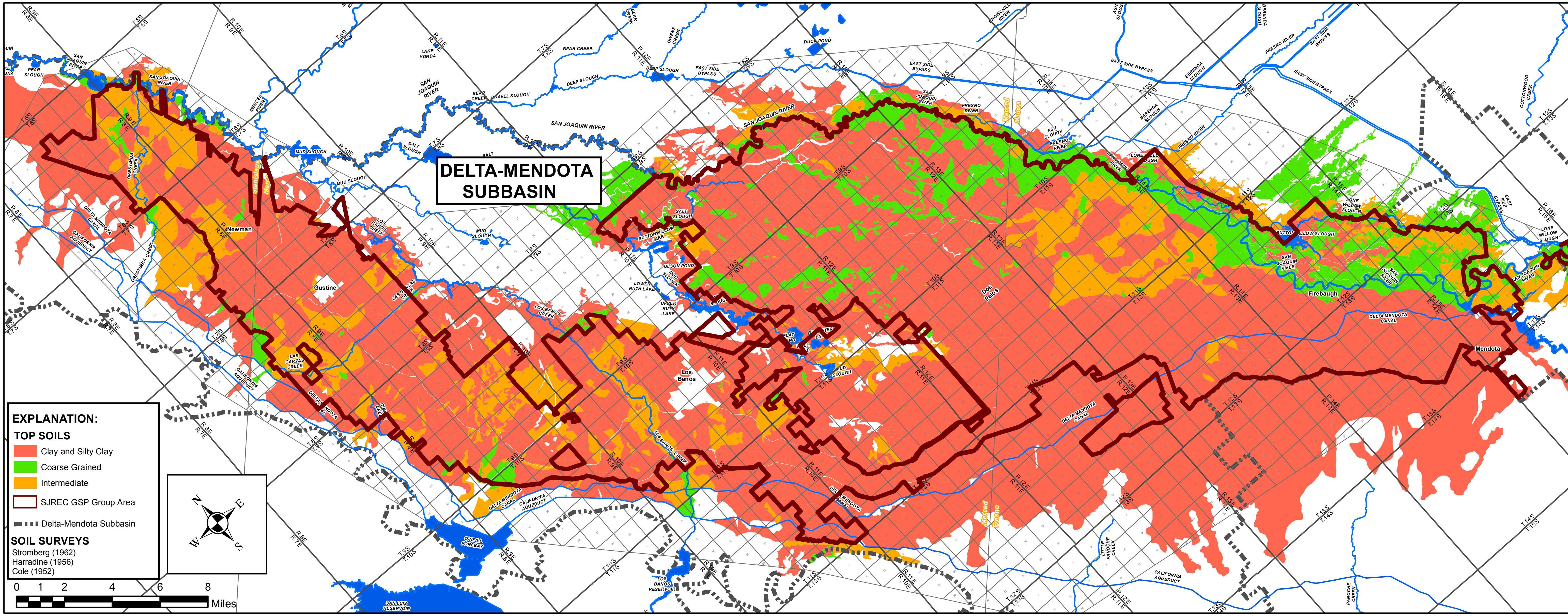

FIGURE 3 - TOPSOILS

along much of the rest of the area, except Stanislaus County, where intermediate materials are more extensive.

Surface Water Bodies

Figure 4 shows the location of surface water bodies in the SJREC GSP Group Area. Major streams on the west side are Orestimba Creek, San Luis Creek, Los Banos Creek, and Garzas Creek. Dams have been built in San Luis Creek and Los Banos Creek. Los Banos Creek joins the San Joaquin River near or north of the north boundary of the San Luis National Wildlife Refuge (NWR). The San Joaquin River passes through the area, and divides Madera County from Fresno County. Major reservoirs are the San Luis Reservoir and O'Neill Forebay and Los Banos Creek Detention Reservoir. Major canals in the area include the California Aqueduct, the Delta-Mendota Canal (DMC), Arroyo Canal, and the CCID's Main, Outside, and Poso Canals. The San Luis Drain, located east of Los Banos, was designed to carry subsurface drainage flows, which formerly were discharged to the Kesterson Reservoir. The main canals in the Columbia Canal Co. service area are the Columbia Canal, the Ridge Ditch, and Lone Willow Slough. The Mendota Pool extends both east along the San Joaquin River and south along the Fresno Slough. The Chowchilla Bypass extends to the north from the river upstream of the pool.

Figure 4 also shows locations of a number of regulating res-

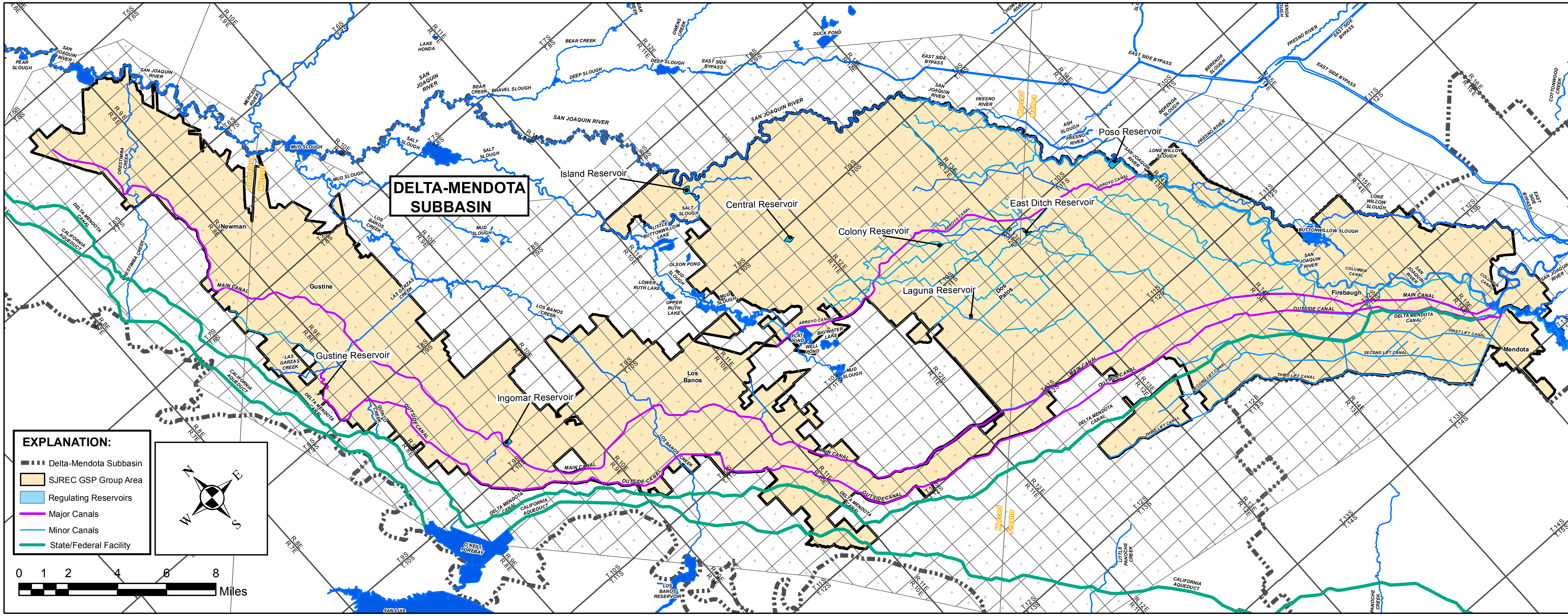

FIGURE 4 - SURFACE WATER BODIES

ervoirs in the SJREC GSP Group Area.

SUBSURFACE GEOLOGIC CONDITIONS

Hotchkiss and Balding (1971) described the geology, hydrology, and water quality of the Tracy-Dos Palos Area, which includes the north part of the SJREC GSP Group Area that is west of the San Joaquin River. Davis and Poland (1957) described groundwater conditions in the Mendota-Huron Area, which includes the rest of the area west of the San Joaquin River and south of Dos Palos. Mitten, LeBlanc, and Bertoldi (1970) described these features in the Madera area, which includes Sub-area J. In addition, Kenneth D. Schmidt & Associates (KDSA, 1997a) provided a report for the CCID on groundwater conditions in the area between Mendota and Crows Landing. KDSA (1997b) provided another report focusing on groundwater flows in the SJREC service area. These reports provide significant information on subsurface geologic conditions that was used in this report.

Regional Geologic and Structural Setting

The SJREC GSP Group Area is within the San Joaquin Valley, which is a topographic and structural trough bounded on the east by the Sierra Nevada fault block and on the west by the folded and faulted Coast Ranges. Both mountain blocks have contributed to marine and continental deposits in the Valley. In the west-central part of the valley, more than 12,000 feet of sediments are present. Groundwater is present in alluvial deposits that dip slightly toward the trough of the valley (the San Joaquin River), from both the west and east sides.

Lateral Basin Boundaries

Figure 1 shows the boundaries of the relevant parts of the Delta-Mendota Sub-basin and the SJREC GSP Group Area. The SJREC GSP Group boundaries include the north end of the CCID service area on the north side, the San Joaquin River and the east edge of the Columbia Canal Co. service area on the east side. The west and south edges of the CCID service area comprise the west and south boundaries.

Definable Bottom of the Basin

Figure 5 shows the definable bottom of the basin beneath the SJREC GSP Group Area. Historically, the U.S. Geological Survey (Page, 1973) used an electrical conductivity of 3,000 micromhos per centimeter at 25°C to delineate the regional base of the fresh groundwater in the San Joaquin Valley. The underlying groundwater is termed "connate water" and is of higher salinity. Page indicated that the base of the fresh groundwater ranged from about 600 to 1,200 feet deep in most of the SJREC GSA service area. As part of this

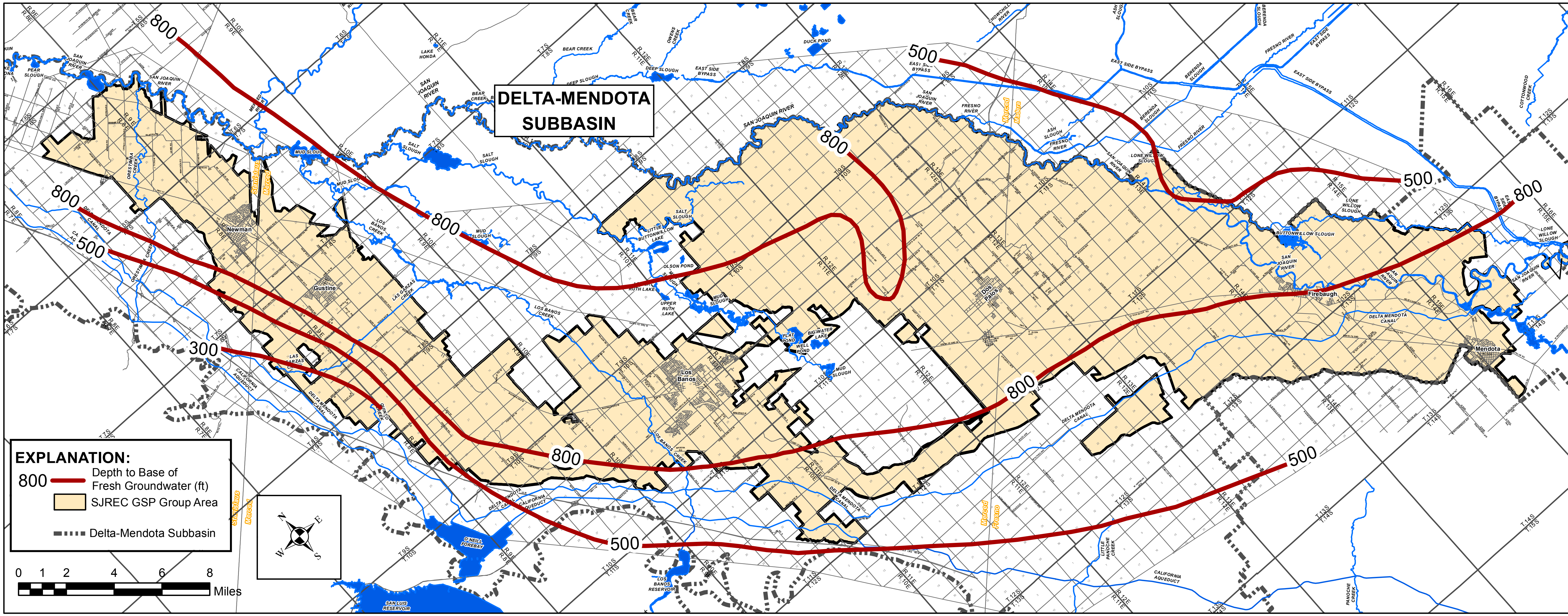

FIGURE 5 - DEFINABLE BOTTOM OF BASIN

evaluation, electric logs for a number of deep holes were obtained from the California Division of Oil, Gas, & Geothermal Resources and interpreted, to determine in more detail the bottom of the basin.

Sub-area A

The bottom of the basin ranges from about 800 to 1,160 feet deep in the area between Crows Landing and Newman, and deepens to the south. The under-lying deposits are either predominantly clay or contain brackish groundwater.

Sub-area B

The bottom of the basin ranges from less than 500 to about 800 feet deep in the area between Newman and Santa Nella. The shallowest bottom is generally to the west near I-5.

Sub-area C

The bottom of the basin between Santa Nella and the boundary between T11S and 12S ranges from about 550 to 800 feet deep and generally is deeper to the east.

Sub-area D

The bottom of the basin near Dos Palos ranges from about 750 to 970 feet deep and is deeper to the southeast.

Sub-area E

The bottom of the basin in the area generally between Dos Palos and Firebaugh ranges from about 650 to 1,000 feet deep, and is generally deepest in the area northeast and southeast of Dos Palos.

Sub-area F

The bottom of the basin ranges from less than 500 to about 800 feet deep in this sub-area. The shallowest bottom is near Firebaugh and the northwest corner of the sub-area.

Sub-area G

The bottom of the basin ranges from 600 to 700 feet deep in the CCID Headgate area, between Firebaugh and Mendota on the west side of the San Joaquin River.

Sub-area H

The bottom of the basin in the San Luis Canal Co. service area ranges from about 750 to 1,040 feet deep and generally is the deepest to the northeast.

Sub-area I

For the area in the FCWD service area, the bottom of the basin ranges from about 700 feet near Firebaugh and Mendota to about 730 feet near the southwest edge of the sub-area.

Sub-area J

The bottom of the basin in the Columbia Canal Co, service area ranges from about 680 feet deep near Mendota to about 1,150 feet deep near the north end of the sub-area. The bottom of the basin generally exceeds 1,000 feet in depth north of Firebaugh.

Sub-area K

The bottom of the basin ranges from about 700 to 800 feet deep in this sub-area.

Formation Names

Hotchkiss and Balding (1971) divided the unconsolidated deposits in the Tracy-Dos Palos area (west of the San Joaquin River) into flood basin deposits (normally less than 50 feet thick), Quaternary alluvium (usually less than 200 feet thick), and the Tulare Formation (up to almost 1,000 feet thick). The Tulare Formation has an upper, thinner section which is above the Corcoran Clay, and a thicker, lower section below the clay. The Corcoran Clay is a regional confining bed, which divides the groundwater into an upper aquifer and lower aquifer. Deposits in most of the west part of the SJREC GSP Group Area are generally tan in color and are termed the Diablo Range deposits. Deposits to the east are brown, gray, or white in color and are termed the Sierra deposits. These deposits are shown on a number of subsurface geologic cross sections that are presented later in this report.

Mitten, LeBlanc, and Bertoldi (1970) divided the unconsolidated deposits in the Madera Area (east of the San Joaquin River) into the younger alluvium (normally less than about 50 feet thick), the Quaternary older alluvium less than 1,000 feet thick, and the Tertiary Quaternary continental deposits (1,000 to 2,000 feet thick). The Corcoran Clay is present beneath Subarea J, and the predominant deposits in this sub-area are generally termed the Sierra deposits.

Confining Beds

There are two confining beds that are important beneath part of the SJREC GSP Group Area. These are the A-Clay and Corcoran Clay (also termed the E-Clay by Croft, 1969). The extent of the A-Clay has only been mapped in the part of the SJREC GSA near Mendota. Figure 6 shows the depth to the top of and the extent of the A-Clay near Mendota, taken from KDSA (2013). This clay is located primarily in a relatively narrow band along the valley trough. The A-Clay is important, as it acts to enable shallow groundwater to develop in the overlying deposits, and also acts as a confining bed for groundwater in this underlying strata. The top of the A-Clay is usually less than 80 feet deep. Groundwater above the A-clay can be in direct hydraulic communication with streamflow

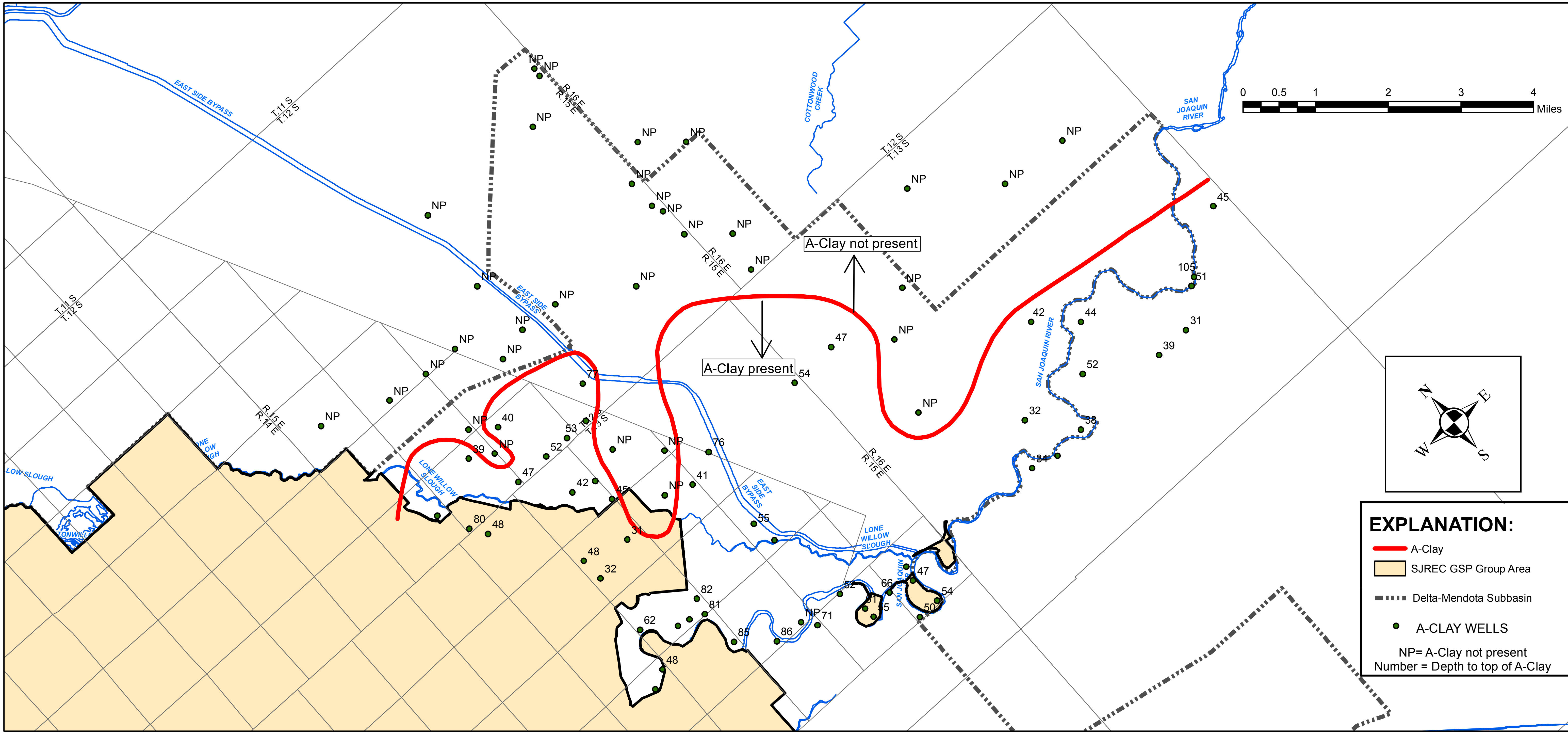

FIGURE 6 - EXTENT AND DEPTH TO TOP OF A-CLAY

in the San Joaquin River. In the area along the west side of the Fresno Slough branch of the Mendota Pool, the Mendota Pool Group (MPG) operates a series of shallow water supply wells tapping strata above the A-Clay.

The Corcoran Clay is indicated to be the most important confining bed in the Delta-Mendota Sub-basin. Figure 7 shows the depth to the top of the Corcoran Clay, which was mapped by KDSA (1997a). Historically, this clay has been used to divide the groundwater system in the San Joaquin Valley into an upper aquifer (above the clay) and lower aquifer (below the clay). The Corcoran Clay underlies most of the SJREC GSP Group Area, except for a small area along the west boundary of the CCID. The Corcoran Clay has been deformed since its deposition. The top of the clay is shallowest (about 50 feet deep) near Santa Nella. North of Fresno County, the top of the clay is deepest near Newman, Gustine, and Los Banos, where the depth exceeds 250 feet. The depth to the top of the Corcoran Clay is commonly about 200 feet near the San Joaquin River in the area north of Fresno County. The top of the clay deepens to the south in the SJREC GSP Group Area, and ranges from about 400 to 450 feet deep near Mendota. In most of the Fresno County, the top of the clay is generally deeper to the south and west.

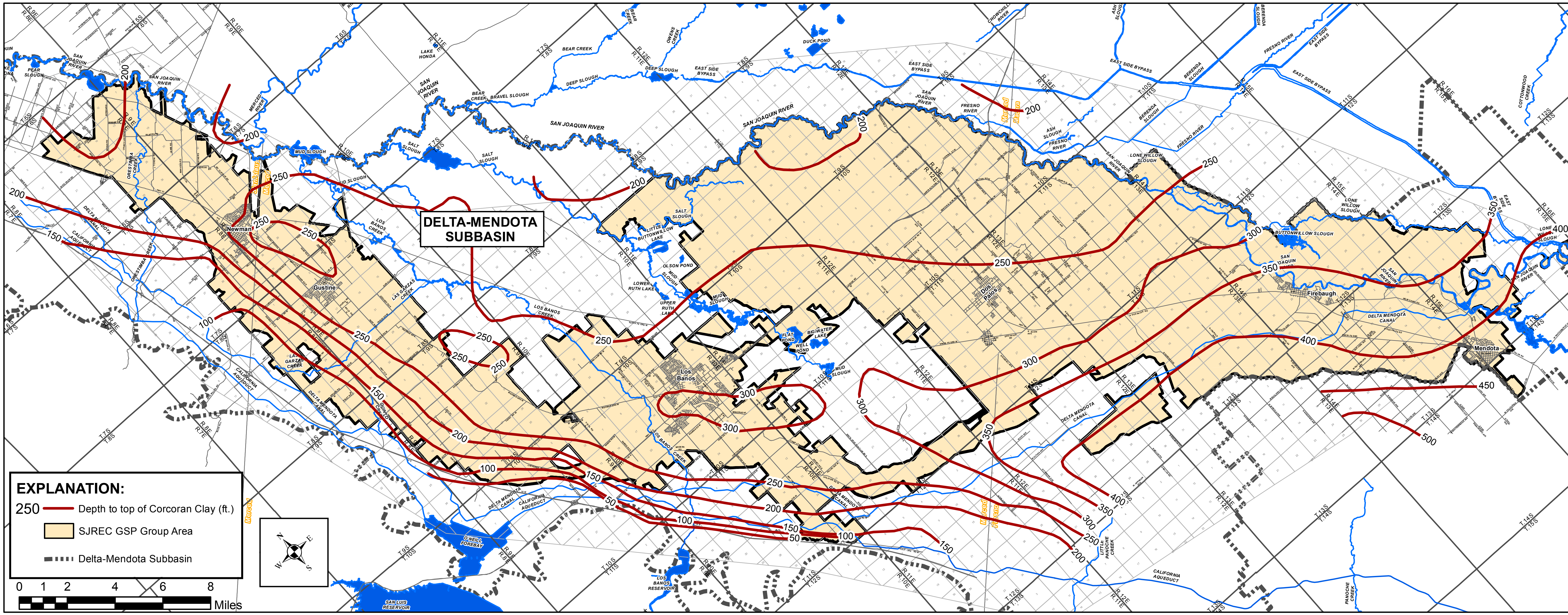

FIGURE 7 - DEPTH TO TOP OF CORCORAN CLAY

The depth to the top of the Corcoran Clay in the Red Top-El Nido area was shown in Figure 8 of KDSA (2013). The top of the Corcoran Clay is shallowest in the northeast part of that area and deepest to the south. The depth ranges from about 160 feet near Chamberlain Road and Combs Road, to more than 300 feet near Avenue 10 and Road 6.

Figure 8 shows the thickness of the Corcoran Clay in the SJREC GSP Group Area. The clay is less than 20 feet thick in the area northwest of Newman, and over 80 feet thick northeast of Newman. The clay averages about 60 feet thick near Mendota and much of the San Joaquin River. The Corcoran Clay is thickest in two areas. The clay is more than 120 feet thick northwest of Volta and south of Dos Palos near the Delta-Mendota Canal.

Subsurface Geologic Cross Sections

Figure 9 shows the locations of subsurface geologic cross sections that are discussed in this report. Some of these sections were reproduced or modified from previous U.S. Geological Survey studies. Regional Cross Sections A-A′, C-C′, D-D′, and E-E′ are from Hotchkiss and Balding (1971), and Cross Section B-B′ is from Miller, Green, and Davis (1971). KDSA (1997a) developed a number of local cross sections. Two of these (F-F′ and G-G′) were in one of the major areas of past pumping into the DMC near

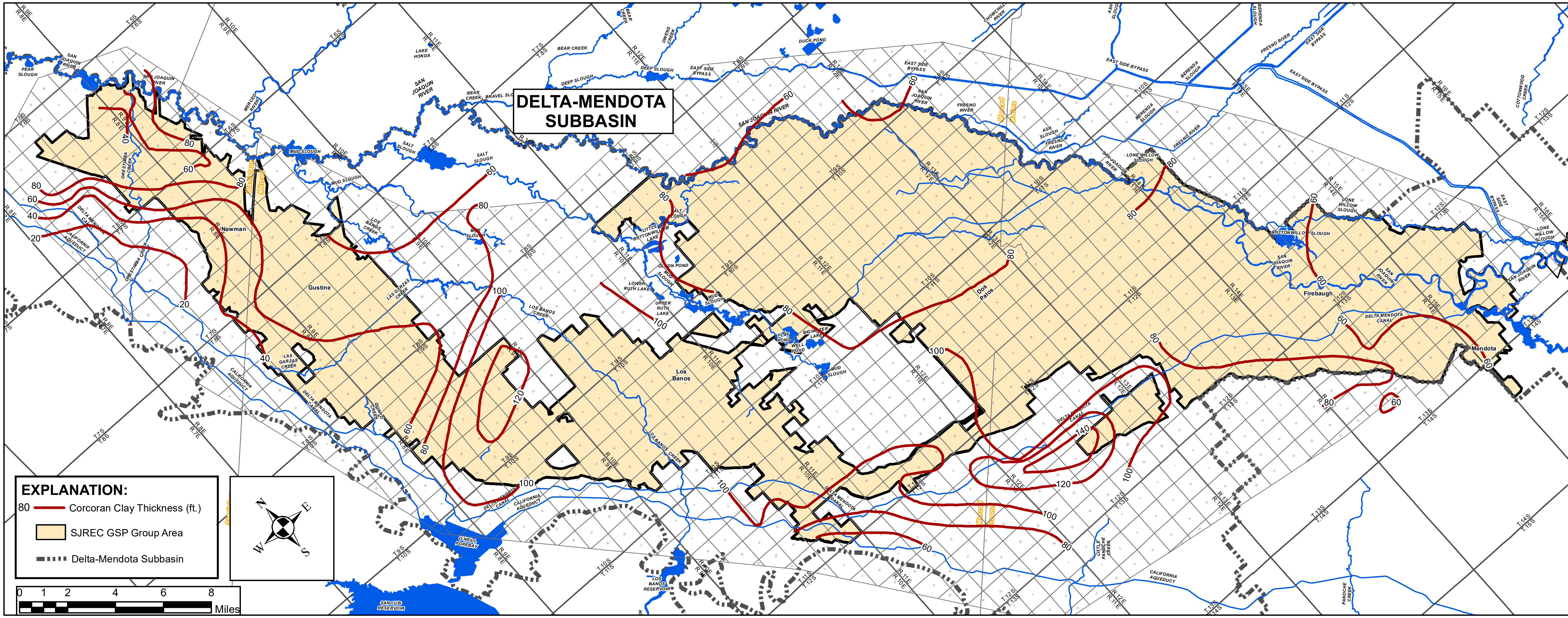

FIGURE 8 - CONTOURS OF THICKNESS OF THE CORCORAN CLAY

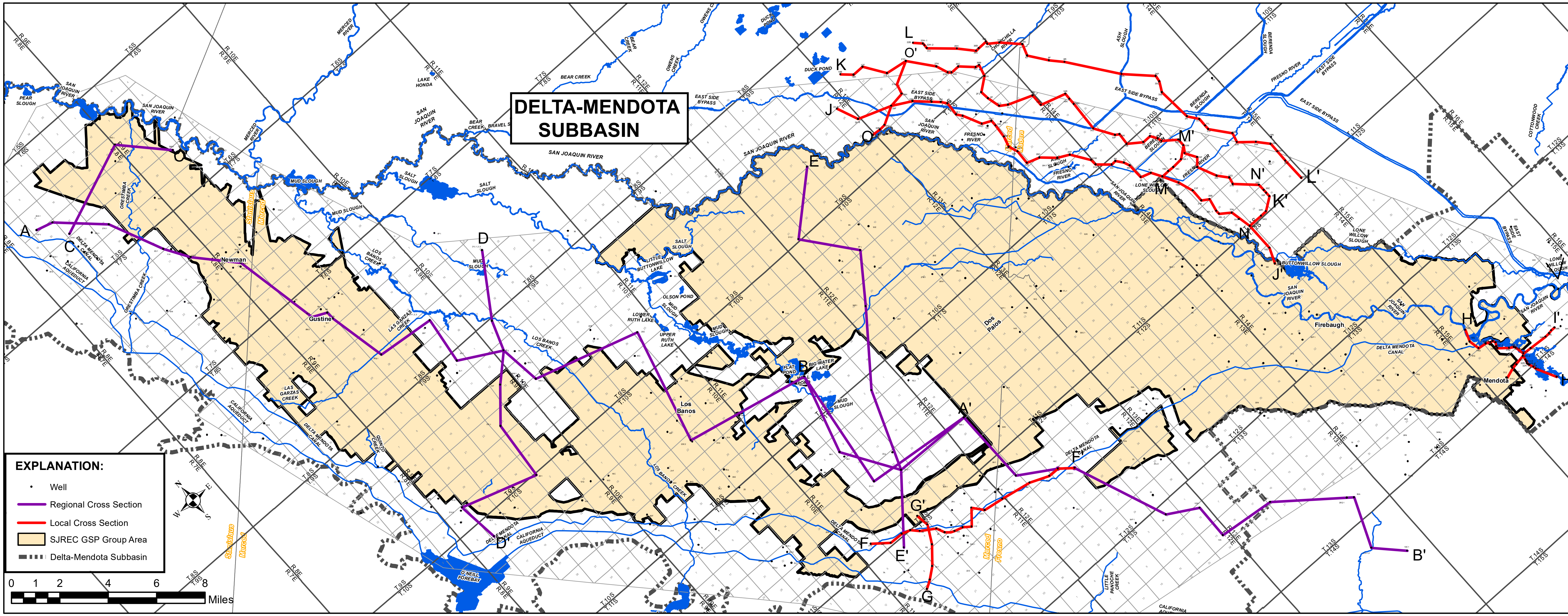

FIGURE 9 - LOCATION OF SUBSURFACE GEOLOGIC CROSS SECTIONS

Russell Avenue, and two others (H-H′ and I-I′) were in the Mendota Pool area. In addition to these sections, a number of other local cross sections were previously developed by KDSA as part of cooperative studies between the CCID and the Cities of Los Banos, Gustine, and Newman. As part of the Sack Dam-Red Top area subsidence evaluation, KDSA (2013) developed a number of local subsurface geologic cross sections in that area which is east of and adjacent to Sub-area E. Some or parts of these are used in this report. References to reports on these evaluations are provided at the end of this report.

Regional

Cross Section A-A' (Figure 10) extends from near Crows Landing, through Newman, Gustine, and Los Banos, to a point southwest of Dos Palos. This cross section extends along the length of the northern and central parts of the CCID. An average of about 100 feet of alluvial deposits are present above the Tulare Formation along this section. The Tulare Formation comprises the Coast Range derived deposits in both the upper and lower aquifers. The vertical extent of the Corcoran Clay and the base of the Tulare Formation are shown. In general, the Corcoran Clay and the base of the Tulare Formation are deeper to the south along this section. The base of the lower aquifer ranges from

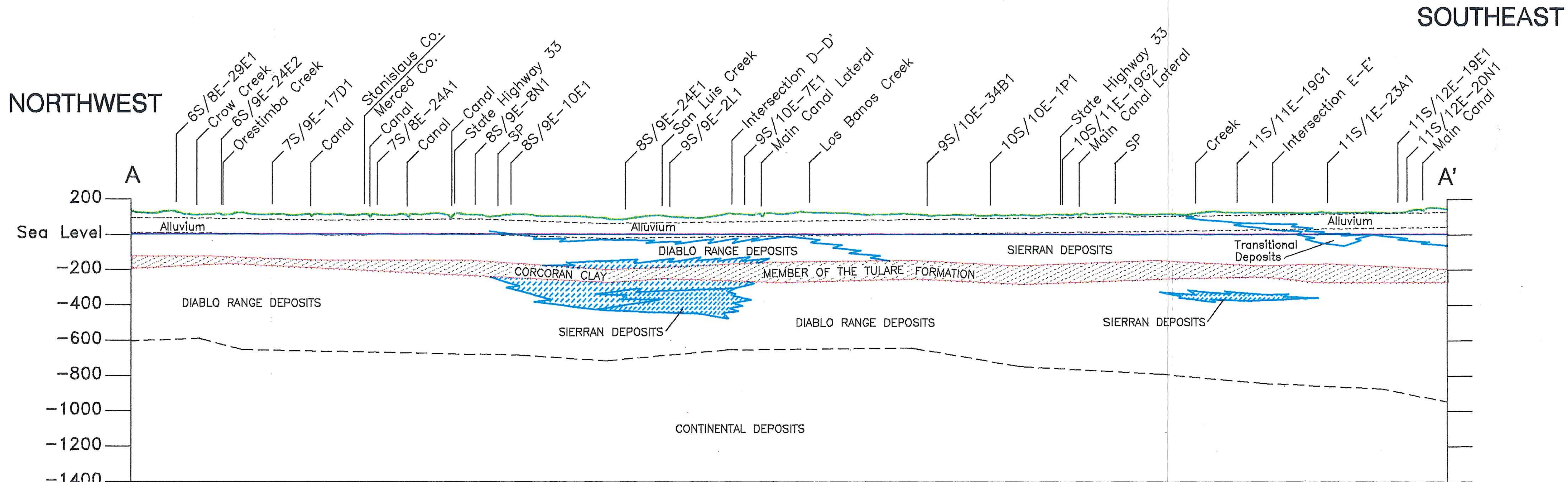

FIGURE 10-REGIONAL SUBSURFACE GEOLOGIC CROSS SECTION A-A'

5 0 5 10 15 20 25 MILES

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about 700 feet deep near the north end of this section to about 900 to 1,000 feet deep near the south end. The base of the lower aquifer generally corresponds to the base of permeable fresh water-producing deposits in this area. In general, groundwater in the deposits below the Tulare Formation in this area has total dissolved solids concentrations exceeding 2,000 mg/l, and has historically been considered unusable.

Cross Section B-B' (Figure 11) extends from east of Los Banos south to near the southwest corner of the study area, south-southwest of Mendota. This section is based primarily on electric logs, which are shown on the section. The Corcoran Clay clearly deepens to the south along this section. The base of the Tulare Formation (the base of the lower aquifer in this area) ranges from about 900 to 1,000 feet deep near the north end of the section to almost 1,600 feet deep south-southwest of Mendota.

Cross Section C-C' (Figure 12) extends from west to east through Crows Landing. The top of the Corcoran Clay averages about 200 feet thick and the clay dips to the east along this section. The Tulare Formation (also termed the Diablo or Coast Range deposits) is about 600 feet thick. Less than 70 feet of alluvial or flood basin deposits are above the Tulare Formation along this section. Some water supply wells tap both the shallow

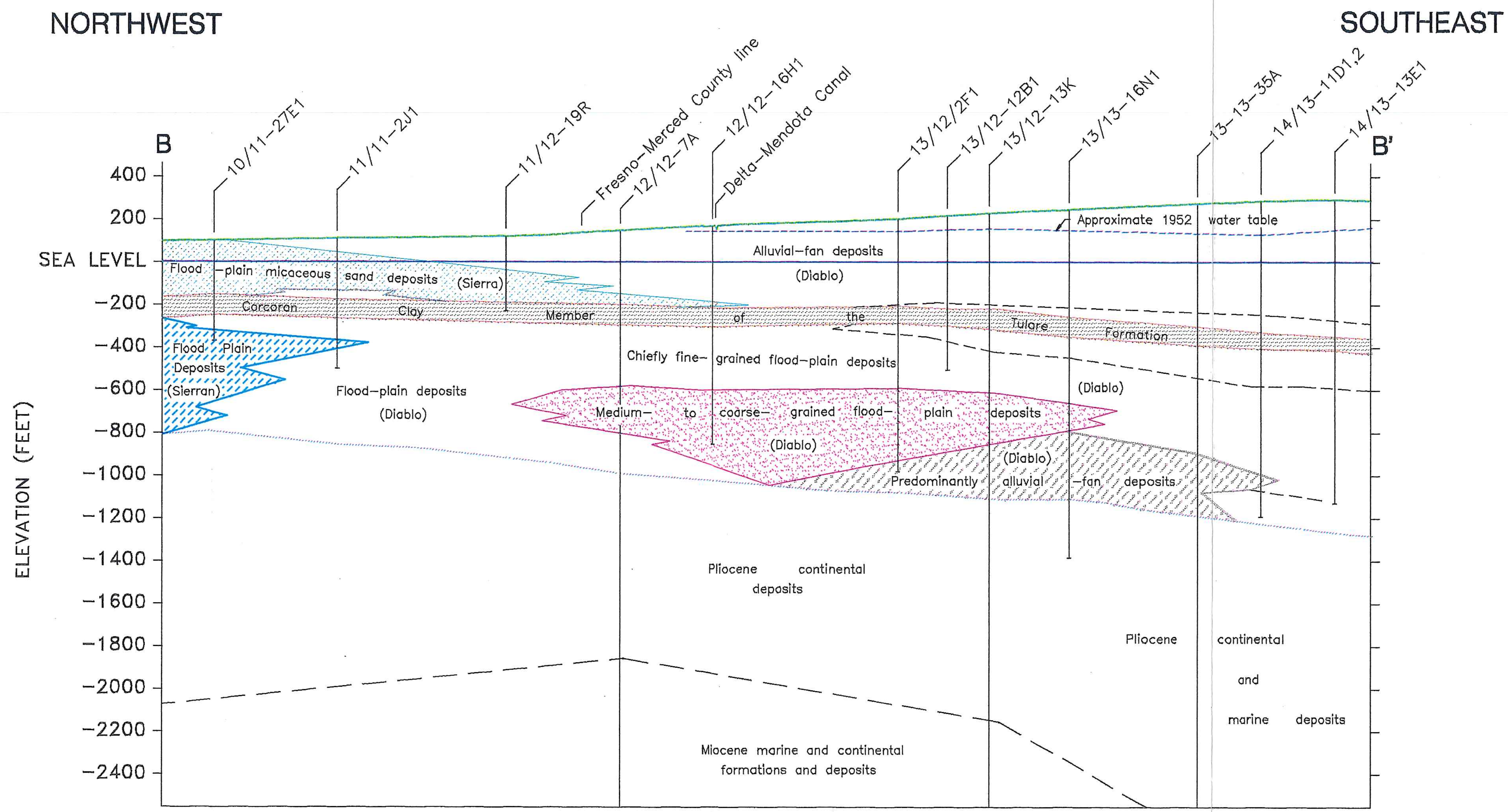

FIGURE 11-REGIONAL SUBSURFACE GEOLOGIC CROSS SECTION B-B'

2 1 0 2 4 6 8 10 MILES

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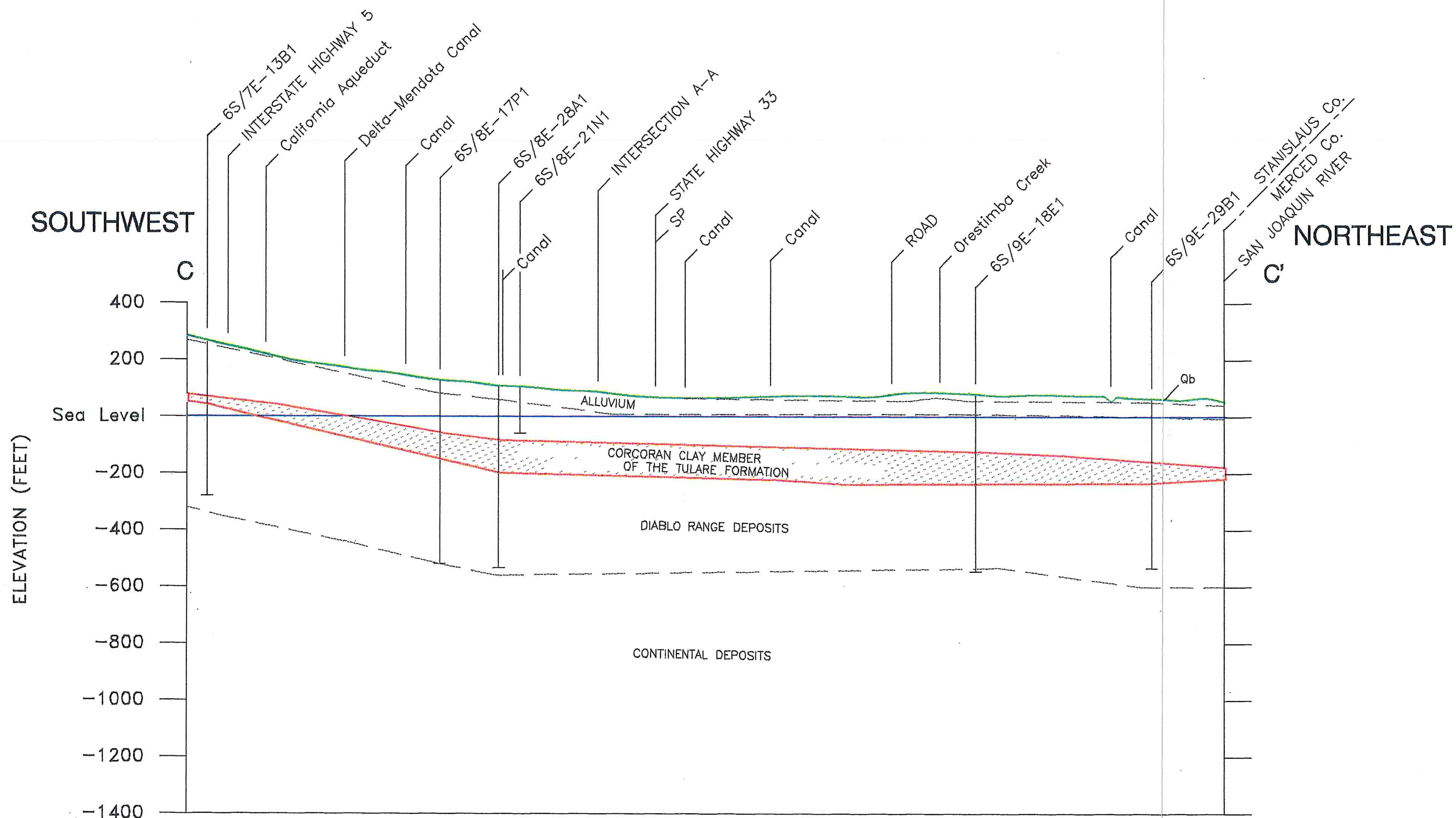
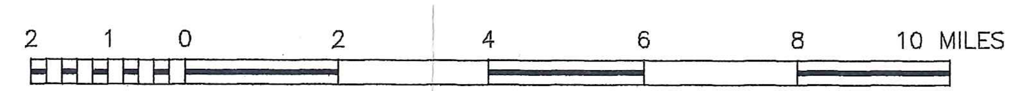


FIGURE 12-REGIONAL SUBSURFACE GEOLOGIC CROSS SECTION C-C'



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deposits and the Tulare Formation.

Cross Section D-D' (Figure 13) extends from near the O'Neill Forebay on the southwest to the northeast to a point east-southeast of Gustine. The Corcoran Clay crops out at the land surface and the top of the clay is about 200 feet deep to the east near the San Joaquin River along this section. The Tulare Formation (Diablo Range deposits) is about 600 feet thick along this section. Beneath most of the area along this section east of the Main Canal, coarse-grained deposits derived from the Sierra Nevada are present below the Corcoran Clay. Beneath the east half of the section, the Sierran deposits are present both above and below the Corcoran Clay. The Sierran deposits generally thicken to the east, toward the San Joaquin River. These deposits were formed when the depositional axis of the valley (the valley trough) was much farther west than at present.

Cross Section E-E' (Figure 14) extends from the southwest to the northeast, between Los Banos and Dos Palos. This section clearly illustrates the dip of the Corcoran Clay, from very shallow depth near Interstate 5, to near maximum depth near the Santa Fe Grade. The deposits of the Tulare Formation and the Sierran deposits are also thickest near or southwest of the Santa Fe Grade. Sierran deposits are present both above and below

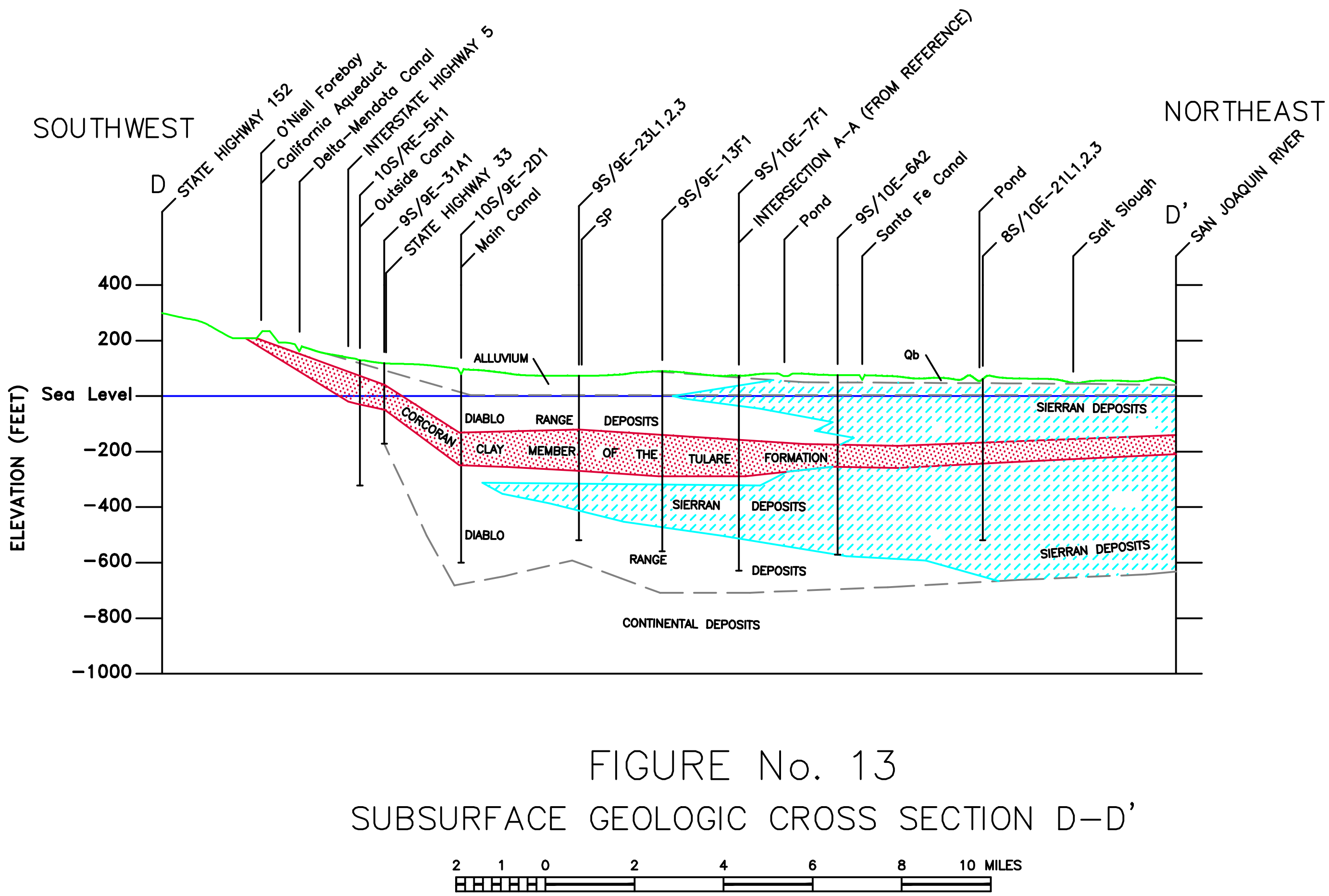

FIGURE No. 13

SUBSURFACE GEOLOGIC CROSS SECTION D-D'

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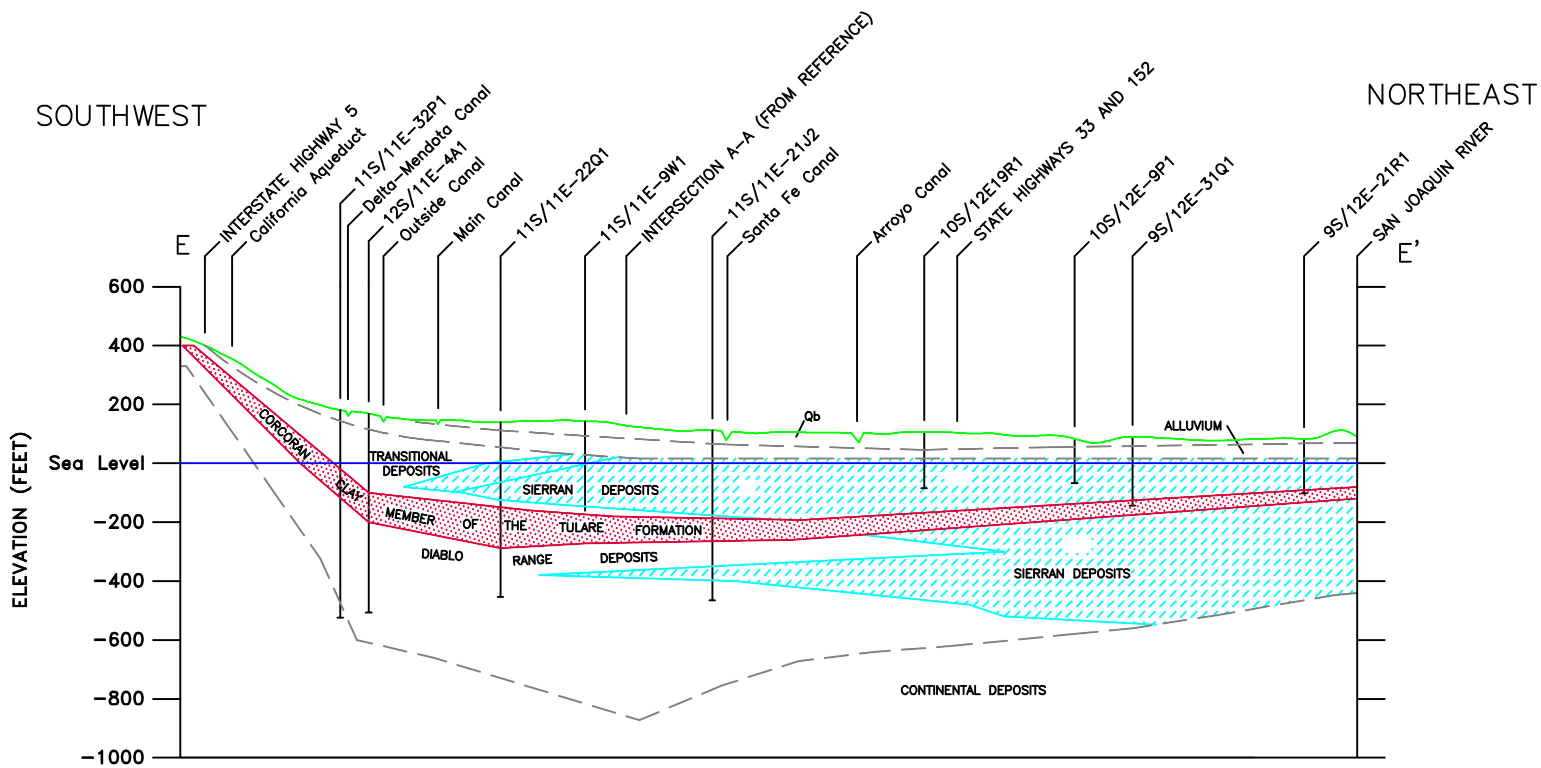

FIGURE No. 14

SUBSURFACE GEOLOGIC CROSS SECTION E–E'

2 1 0 2 4 6 8 10 MILES

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the Corcoran Clay beneath most of this section, except west of the Outside Canal. These deposits are thickest to the east near the San Joaquin River.

DMC Pumping Area

Concerns have been expressed about the impacts of pumping from a concentrated group of wells into the Delta-Mendota Canal. Thus KDSA developed two cross sections in this area. Cross Section F-F' (Figure 15) extends from a point about one mile northeast of the Dos Amigos Pumping Plant along the Delta-Mendota Canal to the east-southeast, to near Russell Avenue. The Corcoran Clay generally deepens to the southeast along this section. Although the Corcoran Clay is less than 50 feet thick along part of the section, it is usually about 80 to 100 feet thick. The perforated intervals of a number of water supply wells are shown along this section. Many of the supply wells are perforated exclusively in the lower aquifer and sealed opposite the upper aquifer, and generally range in depth from about 600 to 1,000 feet. The deeper supply wells are generally to the southeast near Russell Avenue.

Cross Section G-G' (Figure 16) extends from near Eagle Field Road and I-5 to the northeast to near the Outside Canal. Wells along this section range from about 300 to 900 feet in depth.

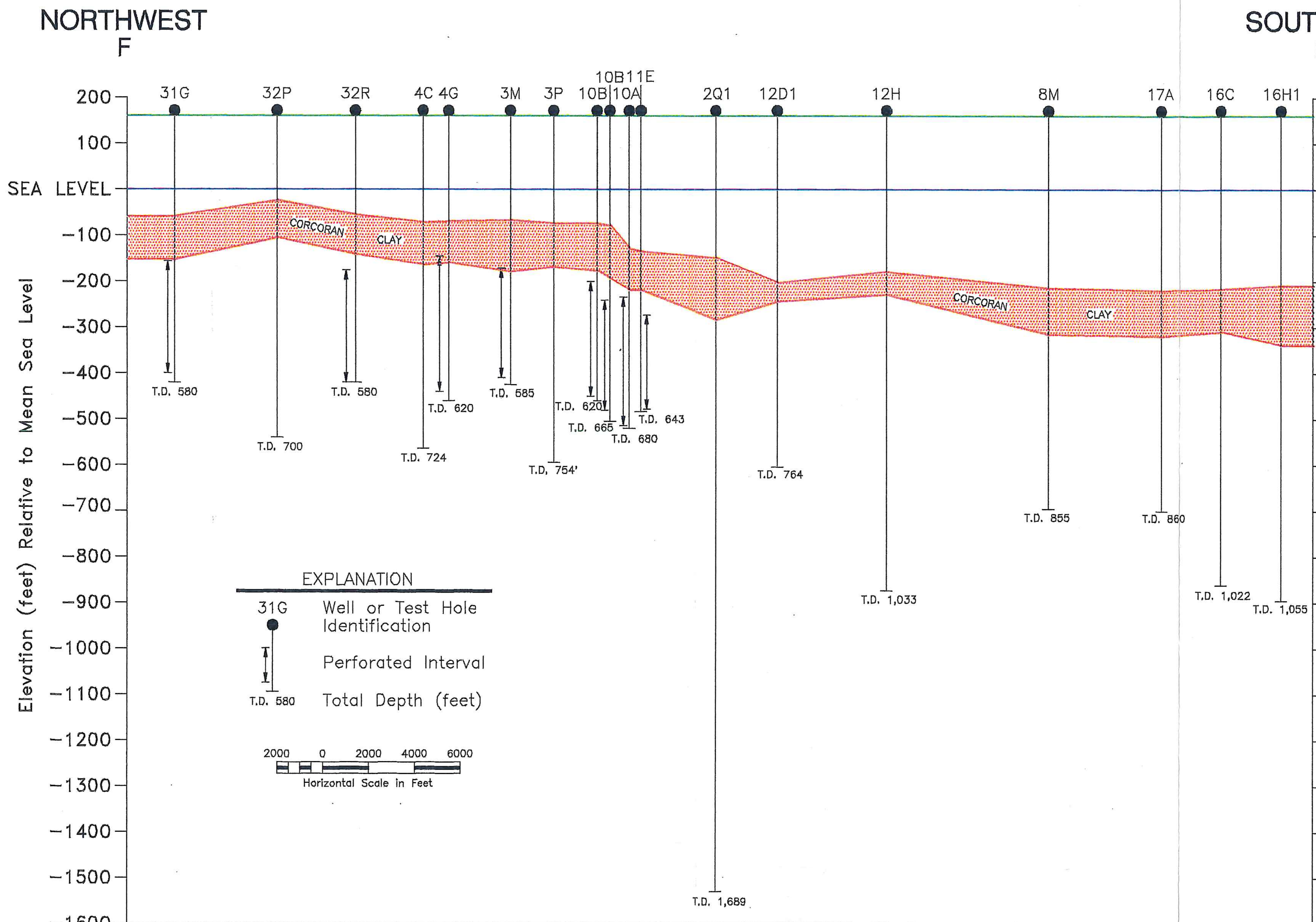

FIGURE 15-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION F-F'

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DMC PUMPING AREA

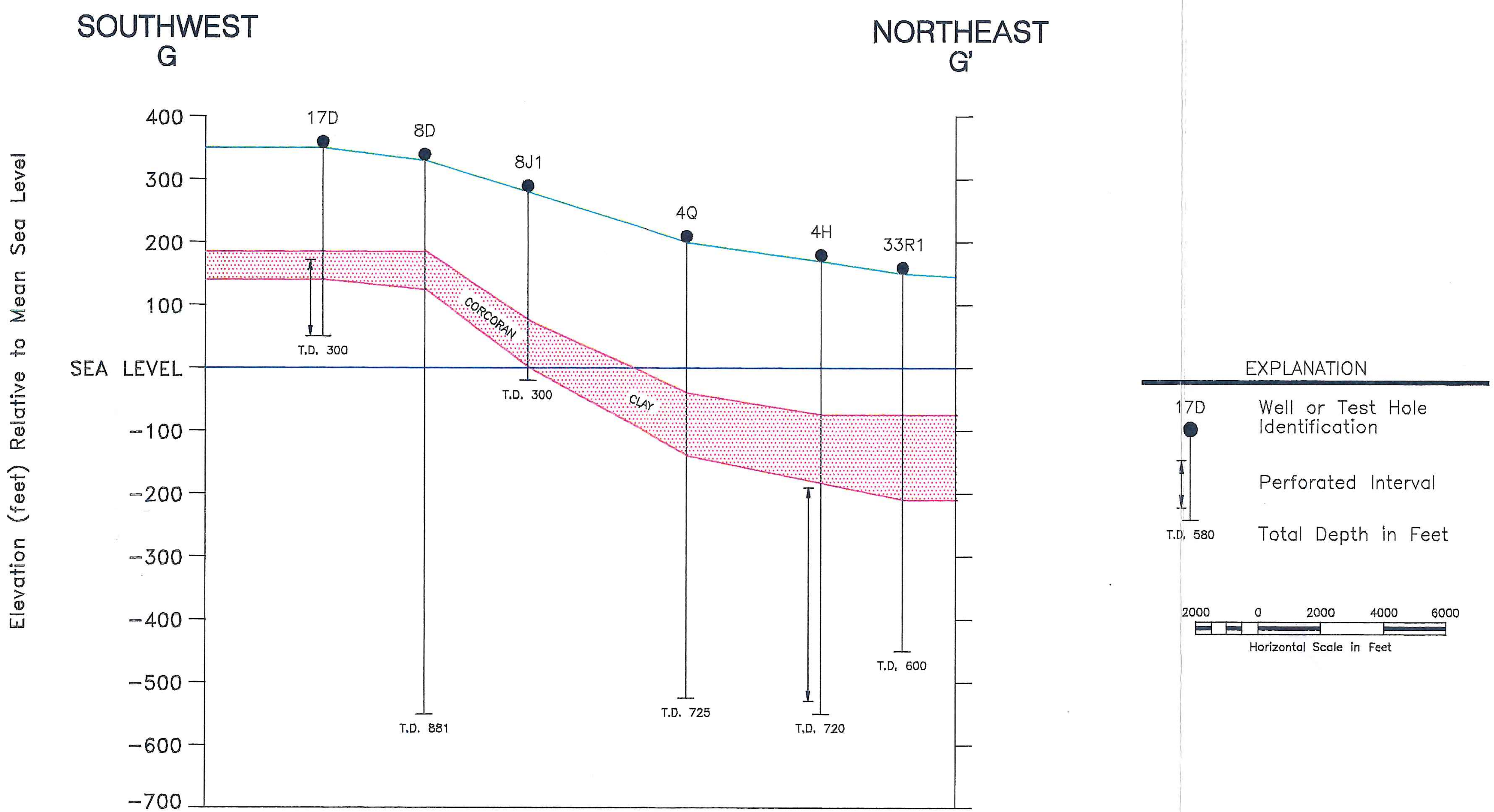

FIGURE 16-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION G-G'

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DMC PUMPING AREA

This section clearly illustrates the dip and thickening of the Corcoran Clay to the northeast in this area. The top of the clay is about 180 feet deep near the southwest end of the section and over 220 feet deep near the northeast end. The clay thickens significantly, from about 40 feet to the southwest to 130 feet to the northeast.

Mendota Pool Area

The Mendota Pool Area has been another area of a large amount of pumping from a dense network of wells. KDSA (1997) developed two local subsurface geologic sections in this area. Section H-H' (Figure 17) extends from north of the Mendota Dam, south along the Mendota Pool to near Whites Bridge Road. Electric logs are not available for most wells along this section, and thus the section is based primarily on drillers logs. Experience indicates that fine-grained flood-basin deposits are locally more than 100 feet thick in some places in the Mendota-Tranquillity area. Regional maps of another locally important confining bed (the A-clay), which is part of the flood-basin deposits, are available only for the area south of Mendota. Normally this clay is present only near the trough of the valley. The A-clay has been important historically in this area, because much of the land east of the Fresno Slough has been in a U.S. Bureau of Reclamation contract area, where water-supply wells aren't permitted to tap

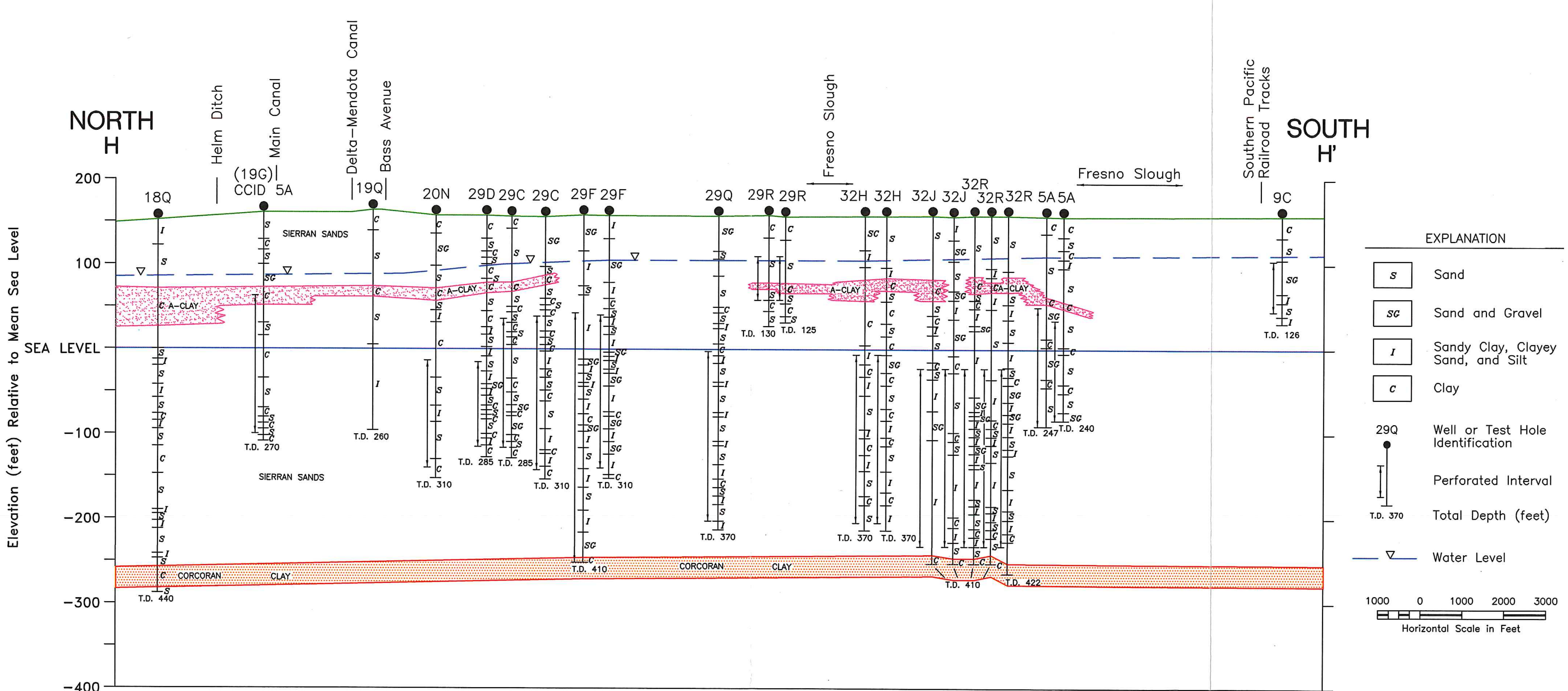

FIGURE 17-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION H-H'

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groundwater above the A-clay. The A-clay is continuous beneath much of this section. The two locations where this clay is not shown may be due to a lack of identification of the clay on the drillers logs. The top of the clay is commonly about 80 feet deep along this section. The A-clay is normally from about 10 to 30 feet thick, however beneath the north end of the section the thickness appears to increase substantially. The top of the Corcoran Clay is about 400 to 420 feet deep along this section. Only one test well was drilled deep enough along this section to apparently reach the bottom of this clay. This section shows some shallow wells in two areas where pumping of groundwater above the A-clay was commenced in the 1990's (Etchengoinberry Ranch and Five Star Ranch). Although not specifically indicated on this map, coarse-grained Sierran deposits predominate between the A-clay and Corcoran Clay, and historically comprised the major aquifer tapped by wells in the Mendota area. Higher salinity groundwater is present below the Corcoran Clay in most of this area. Some Sierran sands are also present above the A-clay and below the Corcoran Clay.

Cross Section I-I' (Figure 18) extends from near the Mendota Airport to the east, through the Mendota Pool, to a point about one-half mile west of San Mateo Avenue. In contrast to the pre-

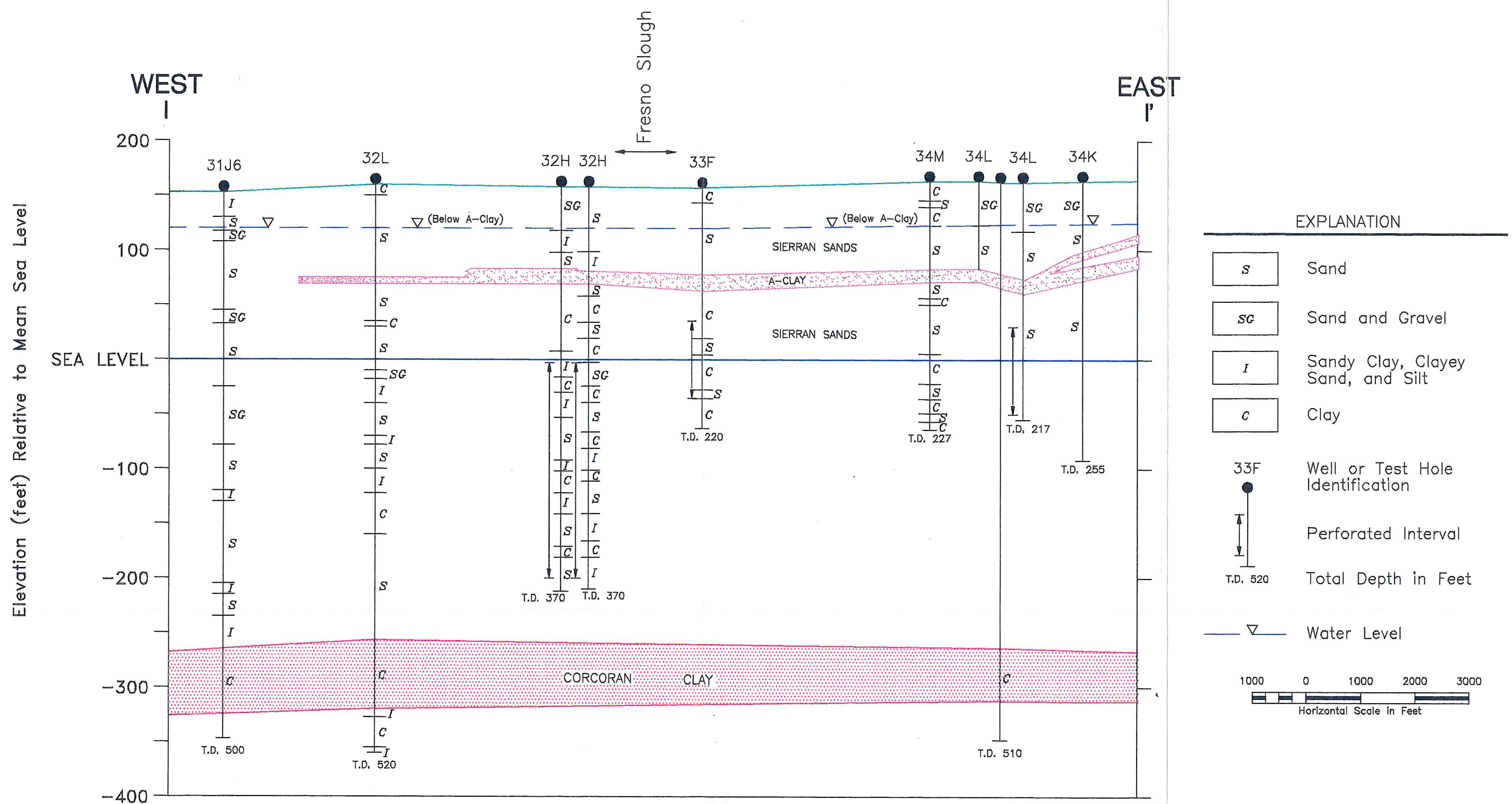

FIGURE 18-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION I-I'

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MENDOTA POOL AREA

vious section, electric logs and/or geologic logs are available for most of the wells along this section. Numerous monitor wells have been drilled at the Spreckels Sugar Co. factory in this area, to tap strata above or below the A-clay. Geologic and electric logs for these wells and geologic logs for several deep soil borings provide substantial information on the location of the A-clay in this area. The A-clay has been identified along much of this section, particularly in the area east of the Fresno Slough. The top of this clay ranges from about 60 to 90 feet deep. Near the east edge of the section, the A-clay bifurcates into two layers, which is a common trend. Three wells or test wells along this section penetrated the Corcoran Clay. The top of the clay is about 420 feet deep along this section, and the clay is about 50 to 60 feet thick.

Sack Dam-Red Top Area

As part of a subsidence evaluation in the Sack Dam-Red Top Area, KDSA developed six local subsurface geologic cross sections, and some or parts of these are reproduced herein. Three of the cross sections (J-J', K-K', and L-L') are oriented from the north-northwest to the south-southeast. The other three cross sections (M-M', N-N', and O-O') are oriented from the west-southwest to the east-northeast.

Cross Section J-J′ (Figure 19) extends from near Roosevelt Road, west of Indiana Road to the southeast to near Avenue 10 and Road 6. The part of this section north of Avenue 22 is generally near the Eastside Bypass. The section is generally parallel to the San Joaquin River and an average of about a mile and a half northeast of the river. The Corcoran Clay thickens to the northwest and southeast along this section. The thickness ranges from about 35 feet between Avenues 17 and 18 to about 100 feet near the north end of the section. The top of the clay is about 210 feet deep near the north end and about 305 feet deep near the south end. Fine to intermediate textured deposits are prevalent above the Corcoran Clay along much of the section, except near Jefferson Road near Avenue 17, and south of Avenue 11½. Coarse-grained strata below the water level and above the Corcoran Clay are generally uncommon along this section, except near the south end. Some thick, extensive clay layers are present below the Corcoran Clay along this section, including one below a depth of about 800 to 850 feet. North of Washington Road, such layers are predominant. Another such layer is present beneath the part of this section south of Avenue 16½ at an average depth of about 600 to 650 feet. In terms of land subsidence, both the Corcoran Clay and deeper clays are important because of their aggregate thickness. Coarse-grained strata

FIGURE 19-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION J-J'

are common along the part of this section south of Washington Road, below the Corcoran Clay and above a depth of about 550 to 650 feet.

Cross Section K-K′ (Figure 20) extends from Chamberlain Road west of Lone Tree Road on the north to near Avenue 12 and Road 7 on the south. This section is an average of about a mile and a half northeast of Cross Section A-A′. The Corcoran Clay ranges from about 60 feet thick to about 100 feet thick along the section. The top of the Corcoran Clay is about 180 feet deep at the north end of the section and 290 feet deep near the south end. Coarse-grained strata below the water level and above the Corcoran Clay are more common south of Jefferson Road than along Cross Section A-A′. These coarse-grained strata are usually present along the part of the section south of Avenue 17½. Within the uppermost 50 feet, sands are common between Avenues 17 and 18, between Avenues 14 and 15, and south of Avenue 13. A relatively thick extensive clay layer is indicated to be present beneath a depth of about 800 to 850 feet along this section. Fine-grained deposits are predominant below the Corcoran Clay along the part of the section north of Jefferson Road. Intermediate textured deposits (such as sandy clay) are predominant below the Corcoran Clay along much of rest of the section.

FIGURE 20-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION K-K'

Coarse-grained strata in the lower aquifer are primarily above a depth of about 600 650 feet along this section.

Cross Section L-L′ (Figure 21) extends from near Roosevelt Road west of Flanagan Road to the south near Avenue 12 and Road 9. The part of this section south of Avenue 20 is generally near the Eastside Bypass, and the section is an average of about two miles northeast of Section B-B′. The Corcoran Clay ranges from about 50 to 80 feet thick and thickness to the north and south along this section. The top of this clay ranges from about 170 feet deep near the north end to about 270 feet deep near the south end of the section. Fine-grained of intermediate textured deposits above the Corcoran Clay are predominant along the parts of the section west of Highway 59 and between Avenues 16 and 18. Clay strata are predominant both above and below the Corcoran clay along much of the part of the section north of Avenue 19. Clay or intermediate textured deposits are predominant in the lower aquifer along much of the section. Sand strata in the lower aquifer are usually present above a depth of about 650 feet.

Cross Section M-M′ (Figure 22) extends from near Avenue 16 and the realigned Fresno River to the east-northeast to near Avenue 17½ and Road 9. The Corcoran Clay ranges from about 40 to 60 feet thick along the section. The top of the Corcoran Clay

FIGURE 21-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION L-L'

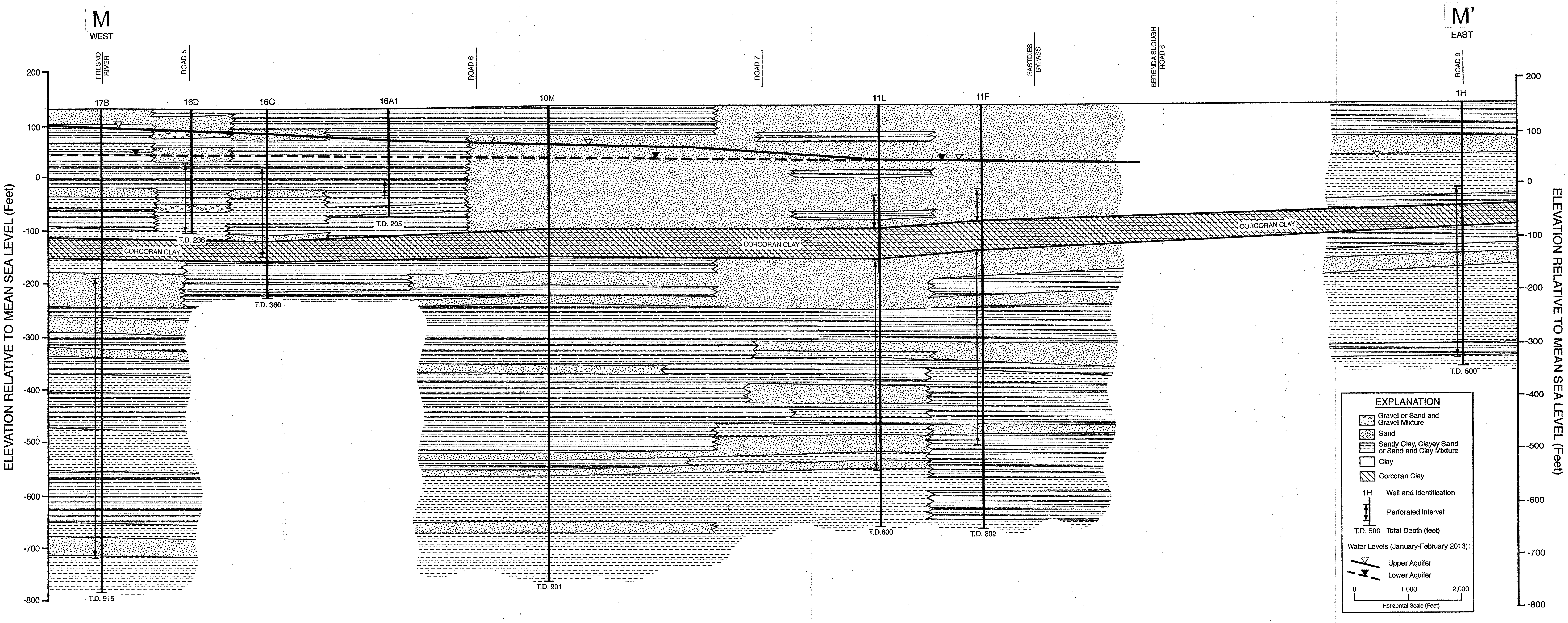


FIGURE 22-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION M-M’

ranges from about 240 feet deep near the west end of the section to 195 feet deep near the east end. Sand strata are predominant above the Corcoran Clay between Roads 6 and 8 along the section. A substantial thickness of intermediate textured or clay deposits are present above the Corcoran Clay in the parts of the section west of road 6 and east of Road 8. Clay and intermediate textured deposits are predominant below the Corcoran clay along the section. Some sand strata are usually present in the lower aquifer above a depth from about 800 feet along the section, where logs for deep wells or test holes are available. The thickest sands in the lower aquifer are generally within about 100 feet of the base of the Corcoran Clay.

Cross Section N-N′ (Figure 23) extends from near Avenue 12 and Road 6 to the northeast to near Avenue 14 and Road 9. The Corcoran Clay ranges from about 40 feet thick near the east end of the section to almost 70 feet thick near the west end. Sand is predominant in the upper aquifer along this section between Roads 6½ and 8. Productive sands are also present in the upper aquifer between Roads 8 and 9 along this section. Clay and intermediate textured deposits are predominant in the lower aquifer along this section, particularly below a depth of about 550 feet. Water producing sand or gravel are common in the lower aquifer within about 150 feet of the base of the Corcoran Clay.

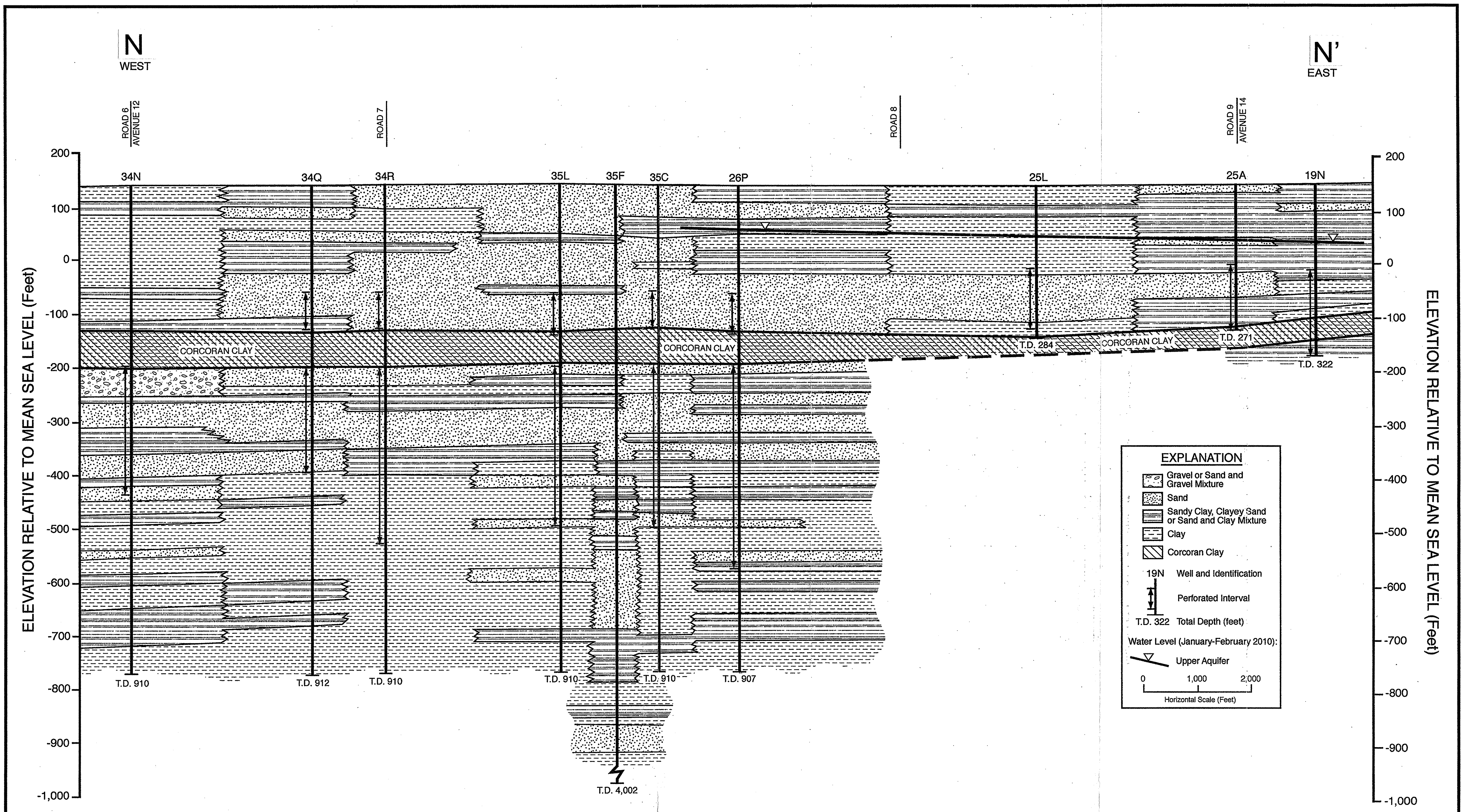


FIGURE 23-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION N-N'

Cross Section O-O′ (Figure 24) extends from near Indiana Road and the San Joaquin River to the northeast near Roosevelt Road, west of Flanagan Road. The Corcoran clay generally thickens to the northeast along this section, from about 55 feet to 85 feet. The top of this clay is about 200 feet deep near the southwest end and about 160 feet deep near the northeast end. Clay layers are predominant both above and below the Corcoran Clay along the part of the section east of Newhall Road. More sand layers are present both above and below the Corcoran Clay along the part of the section west of Newhall Road. Most of the sand layers are indicated to be above a depth of about 600 feet along this section.

GROUNDWATER USE AND WELL DATA

Primary Uses of Each Aquifer

The primary use of the upper and lower aquifers is irrigation and public supply. Secondary uses of these aquifers are for private domestic and industrial.

Depths of Water Supply Wells

Figure 7 is a good indication of the maximum depths of most supply wells in the SJREC GSA, as they tap strata above the Corcoran Clay. The depths of most upper aquifer supply wells generally range from about 100 to 300 feet, although some near the DMC

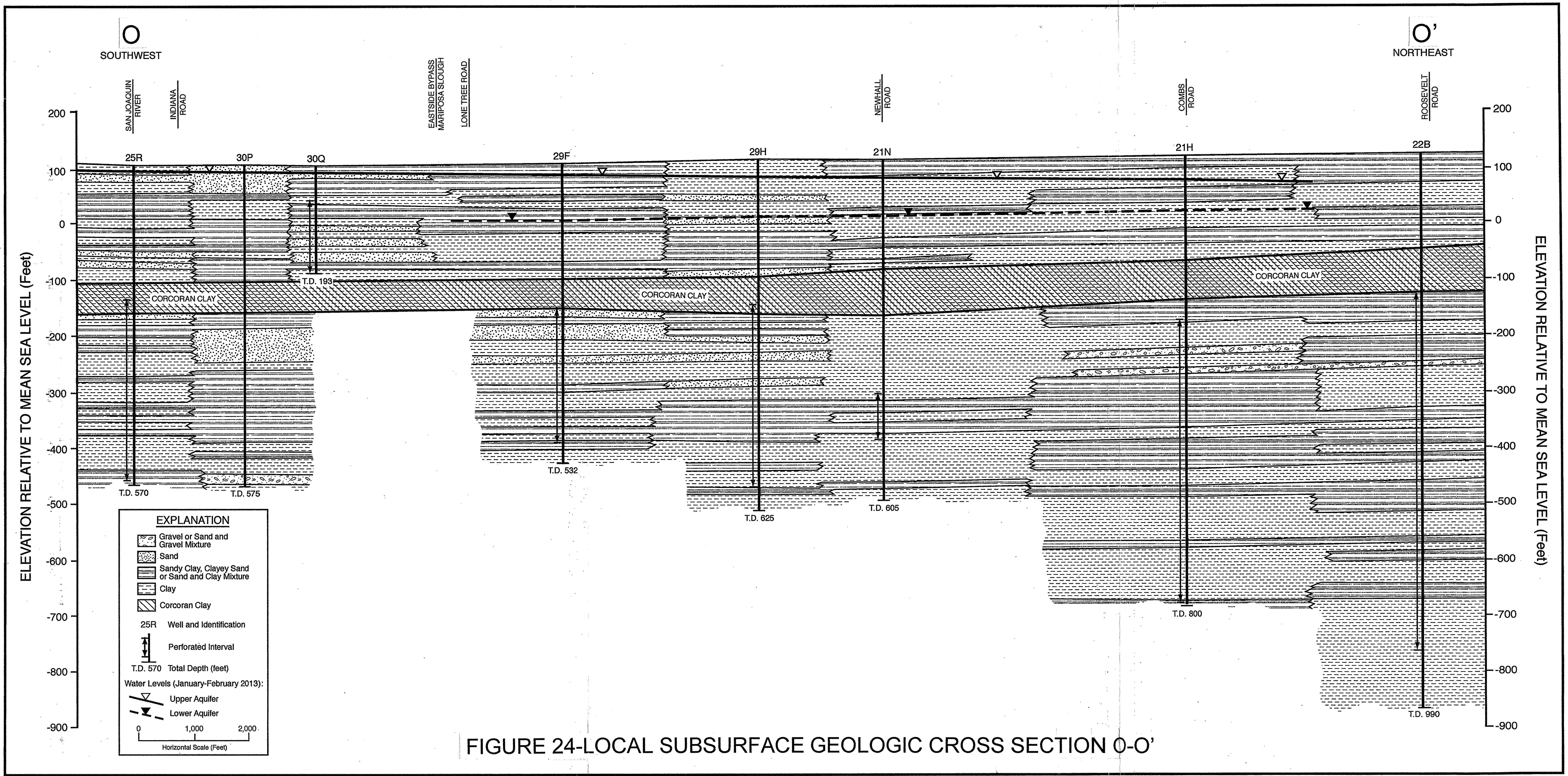


FIGURE 24-LOCAL SUBSURFACE GEOLOGIC CROSS SECTION 0-O'

in the south part of the area are more than 400 feet deep. As for maximum depths of wells tapping the lower aquifer, Figure 5 is relevant. Thus the maximum depths of these wells range from about 500 to 800 feet (the bottom of the basin). There are few water supply wells that are more than 600 feet in depth in the SJREC GSP Group Area.

WATER LEVELS

Water-level Elevations and Direction of Groundwater Flow

Above the A-Clay Near Mendota

In the SJREC GSP Group Area, the only place where water-level maps are available for above the A-clay is near Mendota. Figure 25 shows water-level elevations and the direction of groundwater flow above the A-clay for December 2012-January 2013, modified from the 2012 MPG pumping program report by Luhdorff & Scalmanini and KDSA (2013). Historical maps indicate that a recharge ridge has been present beneath the San Joaquin River and the easterly branch of the Mendota Pool. Groundwater from the north side of this ridge has moved northward and into Madera County. There is no known pumpage from wells tapping strata above the A-clay north of the San Joaquin River. The water levels above the A-clay are important because they are shallower then water levels in strata

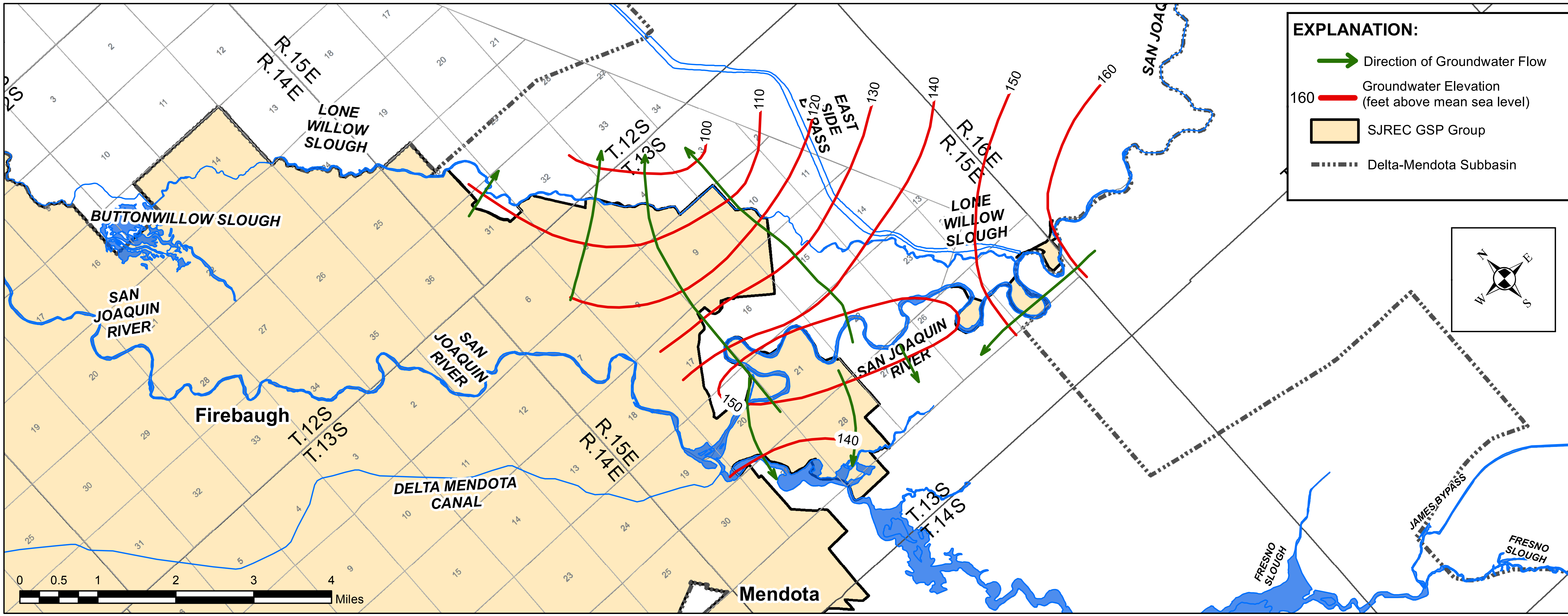


FIGURE 25- WATER-LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW ABOVE THE A-CLAY (DECEMBER 2012- JANUARY 2013)

beneath this clay. These shallower water levels limit the amount of storage space for recharging and storing groundwater in areas underlain by the A-clay.

Water-level hydrographs for shallow observation wells near the river in the area east of San Mateo Road indicate a significant response to streamflow in the river. During streamflow, water levels in strata above the A-clay rise, and during periods of no streamflow they fall. Because water is normally present in the Mendota Pool, water levels in shallow wells have been more stable in this reach, compared to farther east. In general, water levels in wells tapping strata above the A-clay have been relatively stable over the long-term, rising during and following periods of streamflow in the San Joaquin River, and falling during the intervening periods.

Upper Aquifer

Figure 26 shows water-level elevations and the direction of groundwater flow for the upper aquifer for February 2015. The coverage for this map has been expanded to the east in the Red Top-El Nido Area, because of concerns about land subsidence in that area. Overall, the directions of groundwater flow in February 2015 were similar to those shown on the previous map for Spring 1986 and 2006, which were representative of periods of

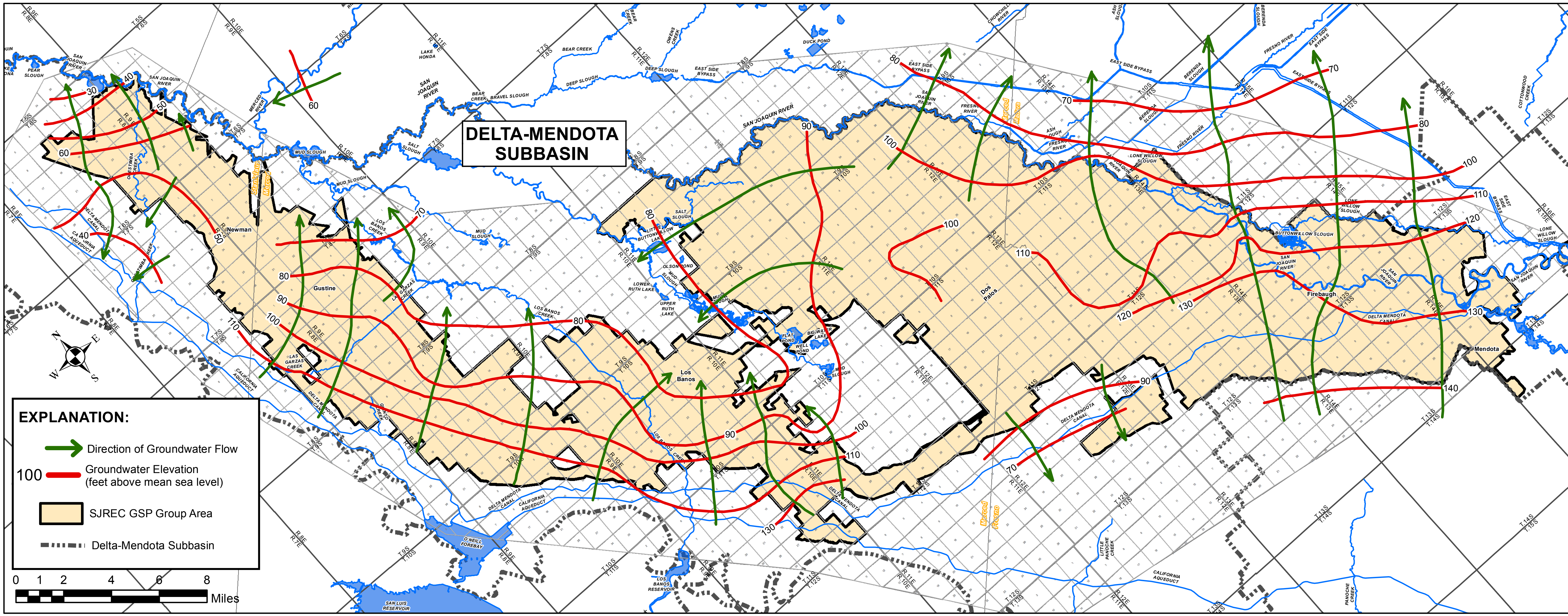


FIGURE 26 - WATER LEVEL ELEVATIONS AND DIRECTION OF GROUNDWATER FLOW FOR UPPER AQUIFER (SPRING 2015)

abundant surface water supplies in most of the area. In 1986 and Spring 2006 there was a groundwater divide east of Dos Palos. South of Highway 152, groundwater was flowing northeast and into Madera County. North of Highway 152, groundwater was moving northerly and toward the San Joaquin River from both sides of the river. Water levels in Spring 2013 are generally representative of a dry period. South of Chamberlain Road, groundwater in the upper aquifer was flowing into Madera and Merced Counties. North of this road, groundwater was generally flowing toward the San Joaquin River from both sides of the river.

Lower Aquifer

In most parts of the SJREC service area, few wells tap strata only below the Corcoran Clay. However, there are a number of wells that tap strata both above and below the Corcoran Clay, particularly in the area west of Newman and near Monitoring Zone J. These wells are termed composite wells. Water levels in these wells generally are significantly lower than those in nearby wells that tap only the upper aquifer. The water levels in these composite wells normally are similar to water levels in wells that tap strata only below the Corcoran Clay, such as in the Panoche and Westlands Water Districts. For this reason, water-level measurements for selected composite wells have been used, in addition to measurements for wells tapping only the lower aquifer, to prepare water-level elevation maps for the lower aquifer. Because of recent concerns about land subsidence in the Red Top-El Nido area, significantly improved water-level maps are available east of the Exchange Contractors service area in this area for Spring 2015.

The Fall 1981 water-level elevation and direction of groundwater flow maps prepared by KDSA (1997) for the lower aquifer indicated a number of features which weren't previously well known. First, a groundwater divide was present in the area between Mendota and a point near the San Joaquin River northeast of Los Banos. The divide extended through Sub-area E. Groundwater northeast of this divide was moving to the northeast and into the Madera area. Southwest of this divide, groundwater was moving southwest and out of the CCID toward the Panoche Water District. The groundwater flow directions in Fall 1981 were primarily toward pumping depressions due to pumping of groundwater from below the Corcoran Clay in the Madera area, and in the Panoche Water District and the Westlands Water District. There has been little pumping of water from the lower aquifer in Sub-areas E and G, due to high salinity. Beneath and adjacent to the groundwater divide, there has been significant downward flow of groundwater from the upper aquifer through the Corcoran Clay. This has provided a significant source of recharge to groundwater in the lower aquifer. Northwest of the Stanislaus-Merced County line, groundwater in the lower aquifer was indicated to flow upward into the upper aquifer. This was the only known part of the SJREC service area where there was upward flow of groundwater from the lower to the upper aquifer.

Figure 27 shows water-level elevations and directions of groundwater flow for the lower aquifer in part of the SJREC GSP Group Area in Spring 2015. This map was also extended into the Red Top area because of concerns about land subsidence. The most extensive coverage was for the Westlands W.D. and in the Red Top area. In the Red Top area, water-level elevations ranged from 14 to 28 feet above mean sea level, and the direction of groundwater flow was to the northeast. In the Westlands W.D. area, water-level elevations ranged from 20 feet to 50 feet below mean sea level and the direction of groundwater flow was to the south. In the Panoche W.D., water-level elevations ranged from about 10 to 20 feet below mean sea level and the direction of groundwater flow was to the southwest. North and west of Newman, water-level elevations ranged from about 40 to 50 feet above mean sea level. The direction of groundwater flow was primarily to the east. Groundwater flow directions were the same as in Fall 1981 and Spring 1993. That is, groundwater flowed away from the divide toward pumping depressions in the Madera Area and in the Panoche

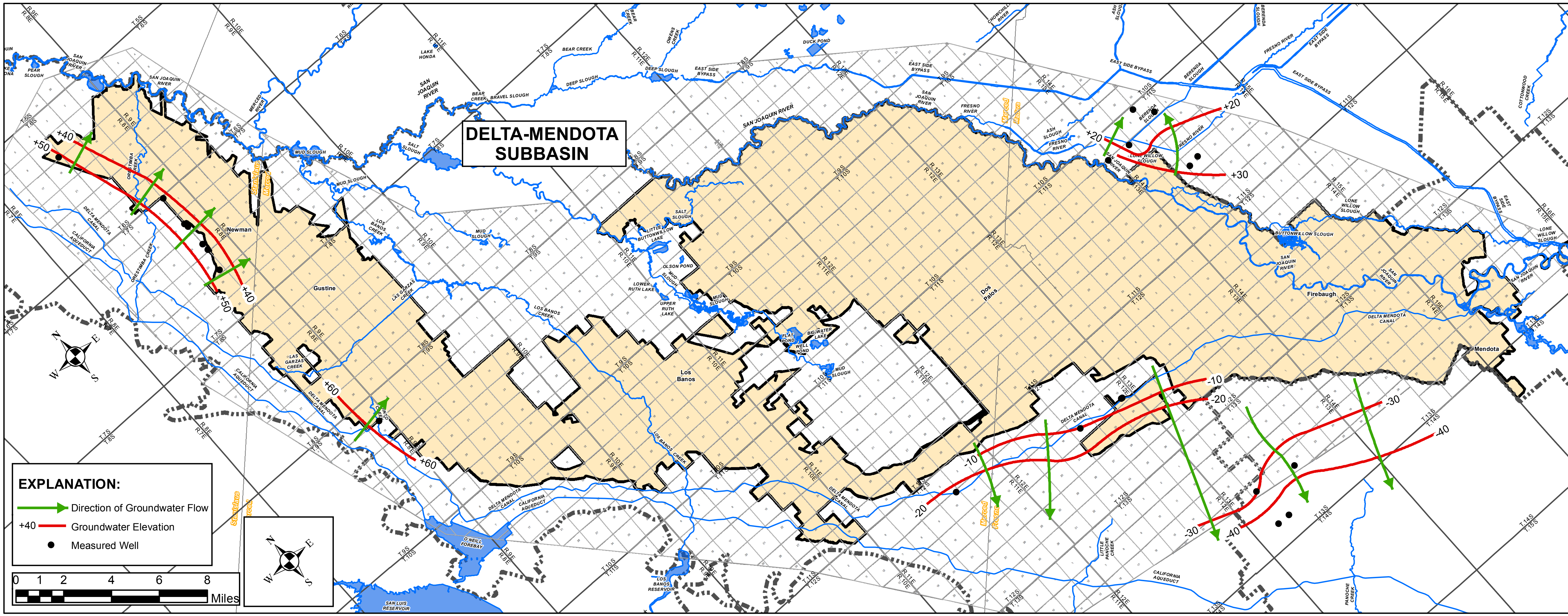


FIGURE 27 - WATER-LEVEL ELEVATIONS AND DIRECTIONS OF GROUNDWATER FLOW FOR LOWER AQUIFER (SPRING 2015)

and Westlands Water Districts. In general, water-level elevations in the lower aquifer in the Westlands Water District were significantly lower in Spring 2015 than in Fall 1981.

Water-Level Trends

KDSA (2014) provided updated water-level hydrographs for the SJREC service are a through early 2013. As part of the present evaluation, a number of these previously prepared water-level hydrographs were updated through early 2017.

Figure 28 shows the locations of wells with updated water-level hydrographs, which are provided in Appendix A of this report. An effort was undertaken to determine the depths and perforated intervals for many of the wells with hydrographs. Such information, where available, is provided on the hydrographs. Measurements for shallow wells (i.e., from about 10 to 20 feet deep) were purposely excluded from this evaluation, so that water-level changes in the water-producing deposits that are tapped by water supply wells could be evaluated. In order to evaluate the long-term water-level changes, a period of average hydrologic conditions is normally used. The period 1962-89 was considered representative for the 1997 evaluation. Subsequently, the period 1962 to 2005 was evaluated by KDSA (2008). For the KDSA 2014 report, the period 1962-2013 was evaluated. The water-level hydrograph evalua-

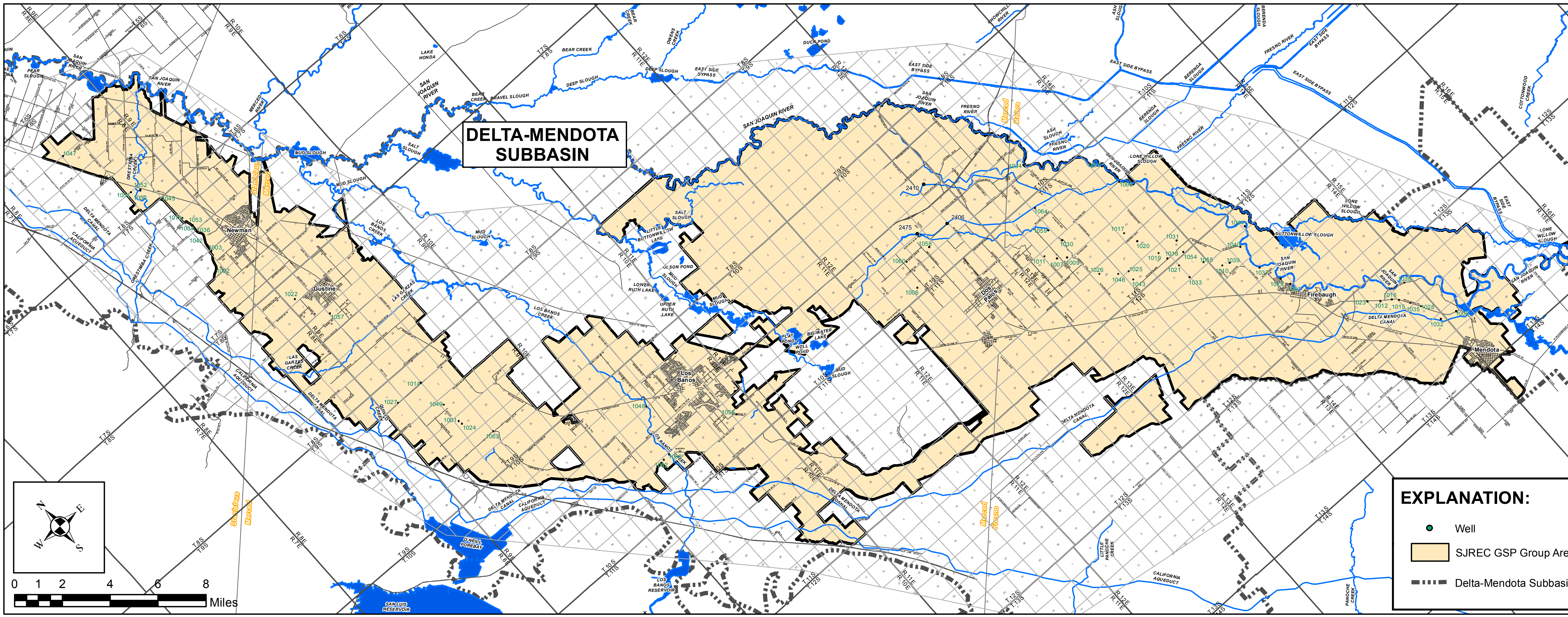


FIGURE 28 - LOCATIONS OF WELLS WITH LONG-TERM WATER LEVEL HYDROGRAPHS

tion for the SJREC service area was divided into the sub-areas which had previously been delineated. Most of the water-level hydrographs extend back to at least 1970, and many extend back to at least 1960. In interpreting trends in the hydrographs, individual measurements were not given as much weight as the preponderance of measurements for a particular well. This helps to eliminate errors and other factors that produce atypical results. The cited trends are considered applicable to most of the wells in each sub-area evaluated, however, they don't apply to every single well. The perforated intervals or total depths of the measured wells and an available map showing the depth to the top of and thickness of the Corcoran Clay (KDSA, 1997b) were used to divide the water-level measurements into the upper aquifer (above this clay) and the lower aquifer (below this clay). A number of measured wells tap both aquifers, and are termed composite wells. Water-level hydrographs for composite wells are more difficult to interpret, compared to those for other wells. Thus most of the interpretation of water-level trends was based on measurements for wells that are known to tap either the upper or lower aquifer.

Water-level fluctuations in confined aquifers are generally much greater than those in unconfined aquifers. Based on water-level depths and fluctuations shown on the hydrographs, the lower aquifer appears to be confined throughout the study area. Although the upper aquifer is generally considered to be unconfined over much of the study area, there is confinement in some locations. One example is near the San Joaquin River at Mendota, where fine-grained flood-basin deposits (the A-clay) are present at shallow depth. In this area, groundwater in deposits between about 100 and 250 feet in depth is normally confined, whereas the top of the Corcoran Clay is about 450 feet deep, or well below these deposits. The confinement in the upper aquifer is generally most pronounced near the trough of the valley, where shallow confining layers are present and groundwater levels are shallow.

Sub-Area A

This is the northernmost sub-area in the Exchange Contractors service area, comprising the Crows Landing-Newman area. Water-level hydrographs for 28 wells with construction records indicated no long-term change in water level in this sub-area through 1995. About 80 percent of these wells tapped strata only above the Corcoran Clay. Hydrographs for 12 wells with construction records indicated long-term water-level rises prior to about 1989. About two-thirds of these wells tapped strata below the Corcoran Clay.

Water-level hydrographs in this sub-area were updated through Spring 2019. An example of a hydrograph for an upper aquifer well (T6S/R8E-22A1) is provided in Figure 29. This is for CCID Well No. 2, or SGMA Well 1002. Since the mid 1960's, depth to water in this well has usually ranged from about 25 to 55 feet. The water level fell during the 1987-93 drought, and then recovered by the late 1990's. During 2012-16, the water level fell to more than 80 feet deep. However, by early Summer 2019, the water level had recovered to 47 feet deep. The overall long-term trend after the late 1980's has been one of relatively stable water levels in both aquifers in this sub-area. There was little indication of the previous rising water levels for wells tapping the lower aquifer.

Sub-Area B

This area primarily comprises the Gustine area and lands farther south. The Gustine Drainage District formerly operated a number of drainage wells to lower shallow water levels in this sub-area. However, most of these are inactive due to numerous tile drainage systems that have been installed to control shallow groundwater. Water-level hydrographs for 25 wells with construction records that were evaluated in 1997 indicated no long-term change in water level. About 85 percent of these wells tapped strata above the Corcoran Clay. Hydrographs for 11 wells with construction records indicated long-term rises (prior to about 1989). About two-thirds of these wells tapped strata above the Corcoran Clay.

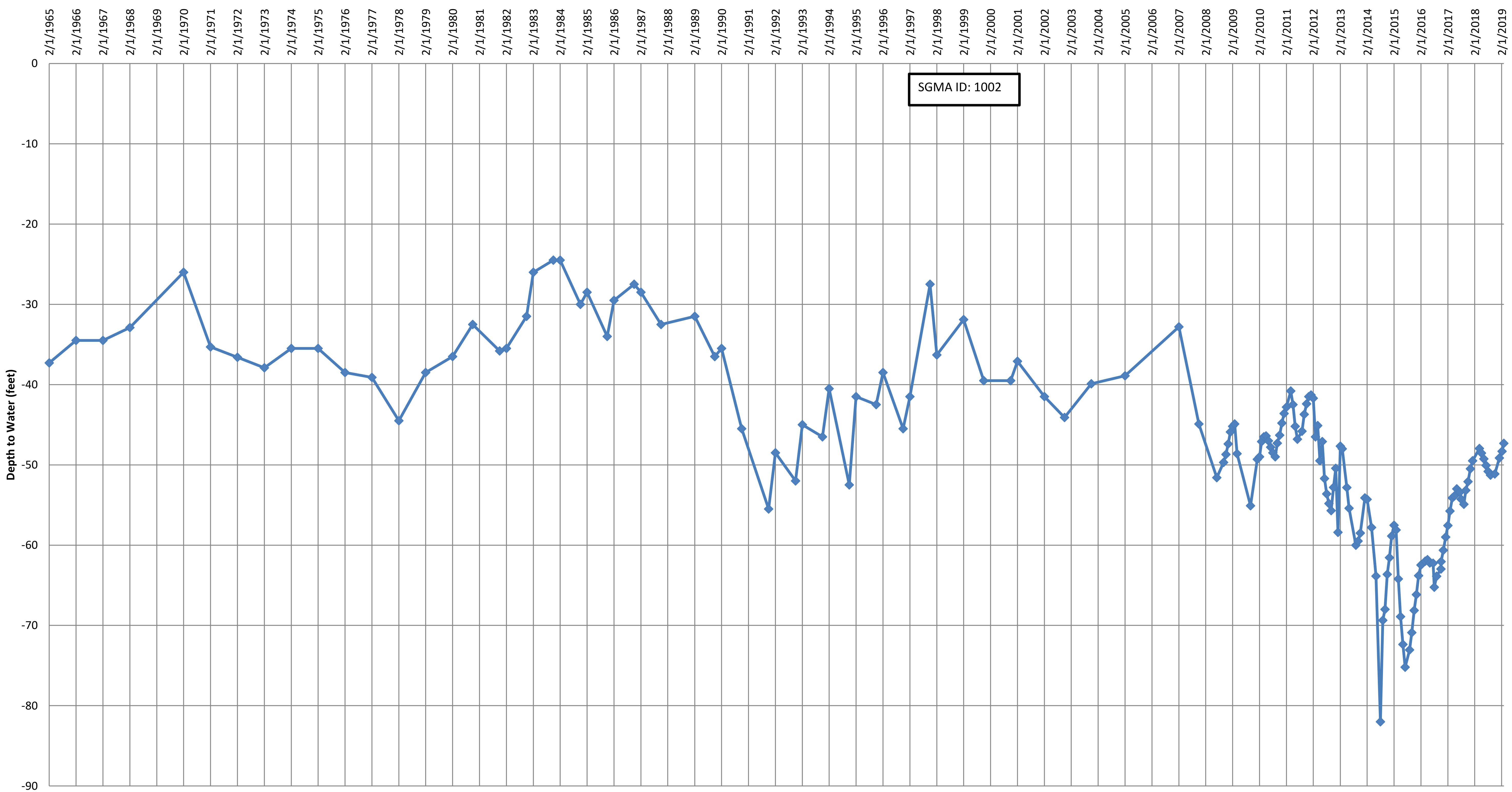


FIGURE 29 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA A

Hydrographs for two wells with construction records indicated long-term declines, and both of these wells tapped strata above the Corcoran Clay.

As part of the KDSA (2008) evaluation, water-level hydrographs for 19 wells in this sub-area were updated through 2006. Essentially the same trends were indicated as for the previous evaluation. Water levels in eight of these wells became so shallow during the 1990's, that they couldn't rise any further and began flowing. Most of these wells were in the area east of Gustine, and this situation was apparently exacerbated by the abandonment of the former drainage wells. Figure 30 is considered a representative water-level hydrograph for this sub-area. Well T9S/R9E-5R1 is CCID Well No. 14, or SGMA Well 1014. From 1965 to 2011, water levels were relatively stable. During 2012-16, water levels temporarily fell to the deepest levels of record (up to 35 feet deep). However, by Spring 2019, the water level had recovered to less than 8 feet deep.

Sub-Area C

This area includes the Volta-Los Banos area and lands to the south. Most wells in this area tap the upper aquifer, due to either limited water production capacity or poor quality groundwater in the lower aquifer. The CCID has one well in the Los Banos area that taps groundwater below the Corcoran Clay. This

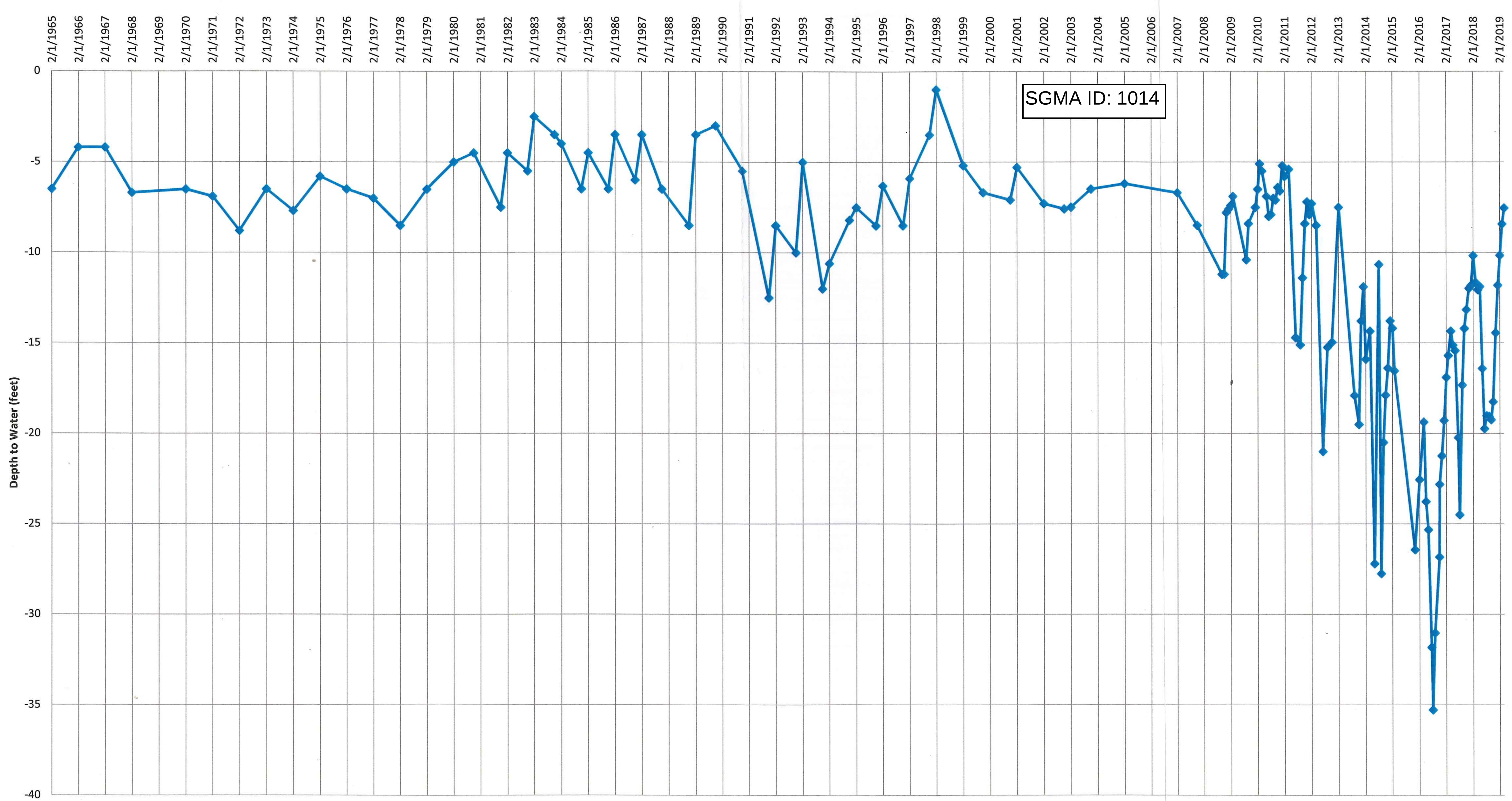


FIGURE 30- REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA B

well was installed to enable additional pumpage and not influence existing supply wells in the vicinity. Water-level hydrographs for 15 wells with construction records evaluated in 1997 indicated long-term water-levels rises (prior to about 1989). About 70 percent of these wells tapped strata above the Corcoran Clay. Hydrographs for nine wells with construction records indicated no long-term change. Almost all of these wells tapped strata above the Corcoran Clay.

As part of the KDSA (2008) evaluation, water-level hydrographs for 15 wells in this sub-area were updated through the mid-2000's. There was less evidence of rising water levels compared to the previous evaluation, and more evidence of stable water levels through the mid-2000's. Figure 31 is an updated water-level hydrograph for Well T11S/R10E-24N1 or CCID Well No. 8A (SGMA Well 1008), which is considered representative for this sub-area. Over the long-term, water levels have been relatively constant, rising during wet periods and falling during dry periods (1989-94, 2008-09, and 2013-16). Prior to 2008, the deepest water level was less than 40 feet deep. During 2008-10 the water levels temporarily fell to more than 50 feet deep and then fully recovered by Spring 2011. During 2013-16, the water level temporarily fell to more than 65 feet deep. However, by Summer 2017, the water level had recovered to a depth of 30 feet. Several ap-

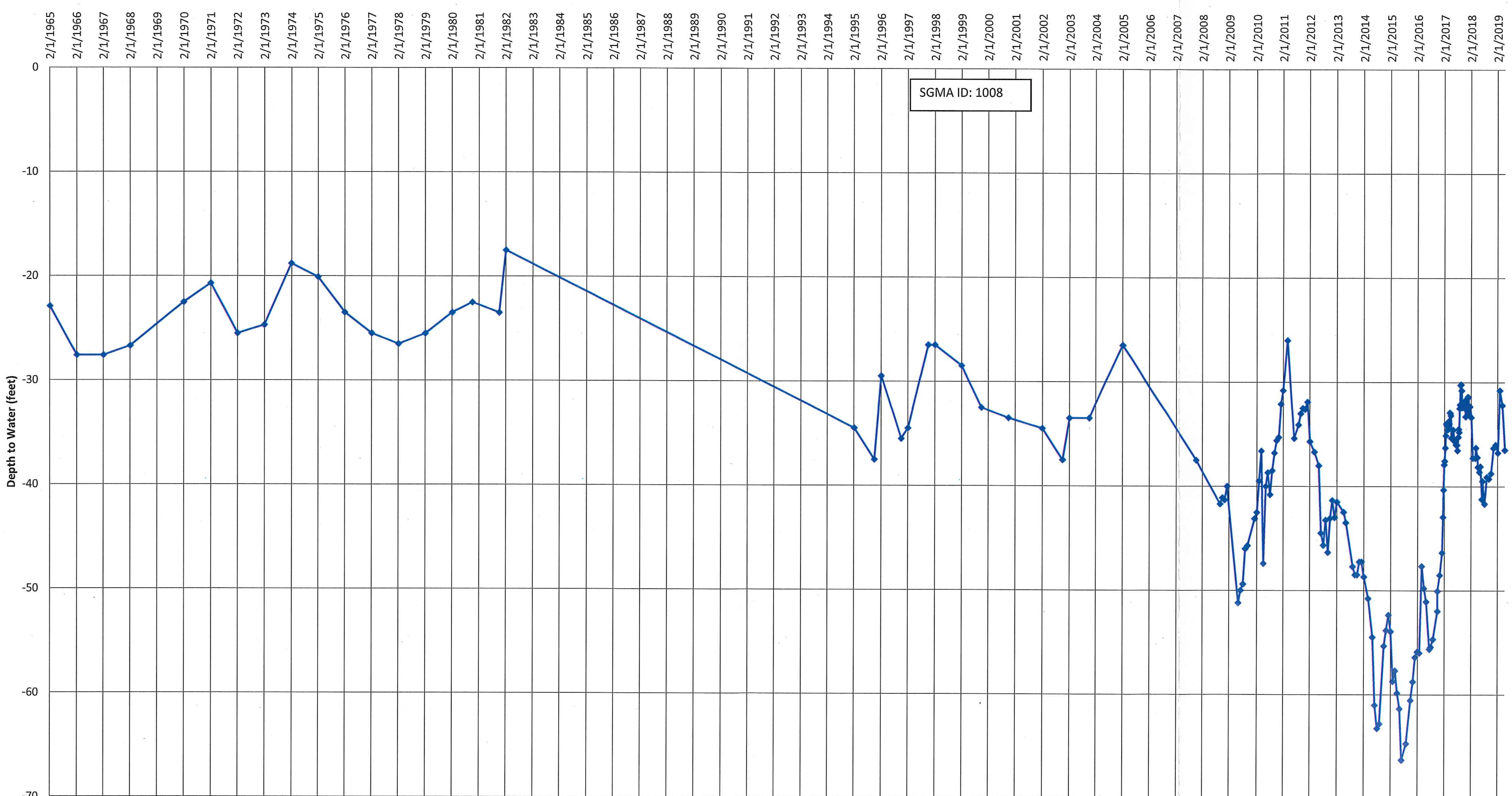


FIGURE 31 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA C

parently composite wells in the area south of Los Banos had rising water levels prior to the early 1980's, and declining water levels thereafter. These trends appear to be for the lower aquifer, and may be due to pumping of lower aquifer wells in the Panoche Water District. Although water levels in some wells in the sub-area temporarily declined during the 1976-77, and 1987-93, and 2013-16 droughts, they have been relatively stable over the long term.

Sub-Areas D & E

These sub-areas include the area in and around Dos Palos. All of the hydrographs originally prepared for these sub-areas are for wells that tap strata above the Corcoran Clay. Groundwater below the Corcoran Clay is indicated to be of poor quality in much of this area, and has seldom been used for water supply. For the 1997 evaluation, water-level hydrographs for 14 wells with construction records indicated no long-term change in water level through 1995. Hydrographs for four wells with construction records indicated long-term rising water levels through 1995.

As part of the KDSA (2008) evaluation, water-level hydrographs for 28 wells were updated through the mid-2000's. Two of those wells appear to tap the lower aquifer. The overall trend was one of constant water levels in both aquifers, and water-level rises were no longer apparent.

Figure 32 is an updated water-level hydrograph for CCID Well No. 6 or SGMA Well No. 1006, which is considered representative of Sub-area D. Overall water levels have been stable, and have temporarily fallen during droughts (1976, 2009, and 2014-16). In summer 2017, the water level was about 20 feet deep. However, by Spring 2019, the water level had recovered to a depth of less than five feet. Figure 33 is an updated water-level hydrograph for CCID Well No. 11 or SGMA Well 1011, which is considered representative for Sub-area E. Prior to 2013, no overall long-term water-level change was indicated. There was a temporary water-level decline in 1994, but the water level quickly recovered. Prior to 2013, the deepest water level was about 17 feet deep. During 2013-16 the water level temporarily fell to more than 27 feet deep. However, by Spring 2019 the water level had recovered to about 8 feet deep.

Sub-Areas F, I, & K

Sub-area I comprises the Firebaugh Canal Water District and Sub-area F is an adjacent part of the CCID known as the Camp 13 Drainage District. Sub-area K is another similar area. These areas have subsurface drainage problems, and tile drains are extensive. Because of their proximity, overall similarity, and general lack of groundwater pumping, these three sub-areas were combined for evaluation. Water-level hydrographs for six wells

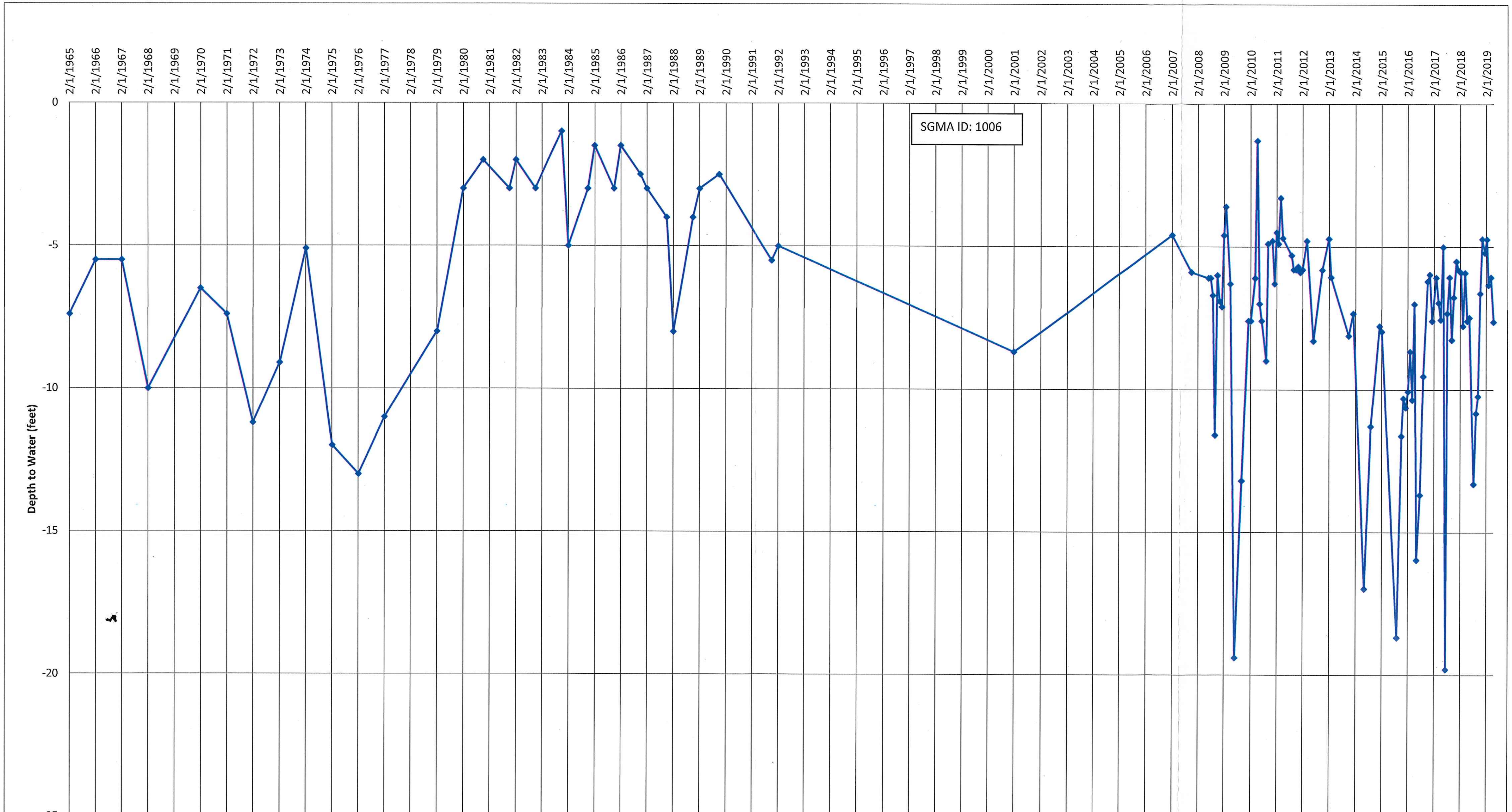


FIGURE 32 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA D

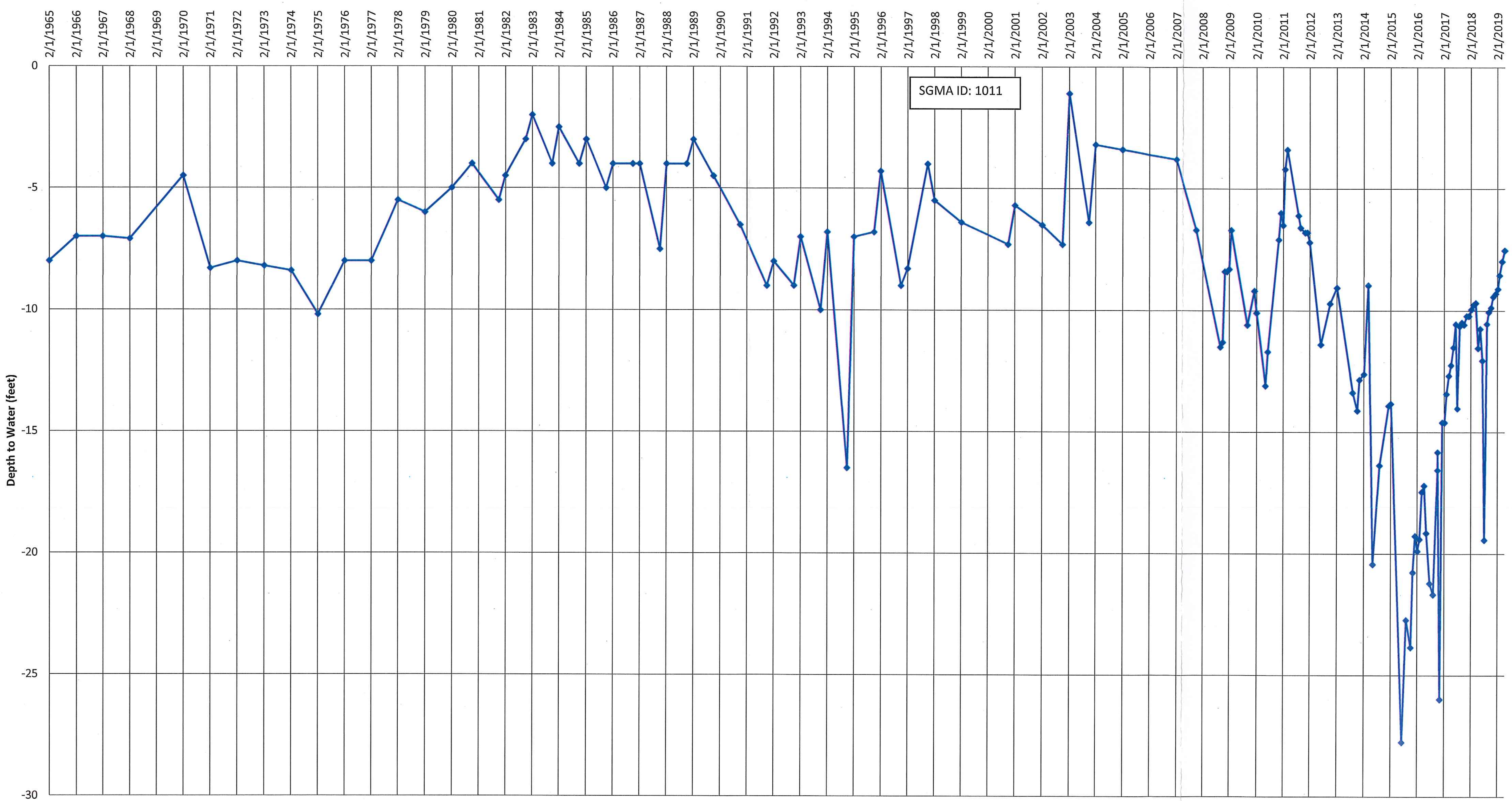


FIGURE 33 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA E

with construction records were available for the 1997 evaluation, and all showed long-term rises. The majority of these wells tapped strata above the Corcoran Clay.

Depth to water prior to 2014 was usually between about five and 20 feet. During the recent drought, the water-level fell to more than 75 feet, then recovered. Figure 34 is considered a representation of a hydrograph for an upper aquifer well near the sub-area.

Sub-Area G

This sub-area is generally west of the San Joaquin River and between Mendota and Firebaugh. All of the hydrographs prepared for this area are for wells that tap strata above the Corcoran Clay. Groundwater below the Corcoran Clay is indicated to be of poor quality in most of this area. Water-level hydrographs for about three-fourths of the wells evaluated in 1997 showed long-term rises, whereas the remainder showed no long-term change in water level (prior to about 1989). However, a pronounced trend was that in the early 1990's, water levels in a number of wells were either near the deepest or the deepest of record. For the KDSA (2008) evaluation, water-level hydrographs for 10 wells were updated through the mid-2000's. There was little or no evidence of water-level rises after 1989, and overall there was a stability in water levels. The A-clay (a shallow confining bed) in part of this sub-area confines groundwater in the upper aquifer.

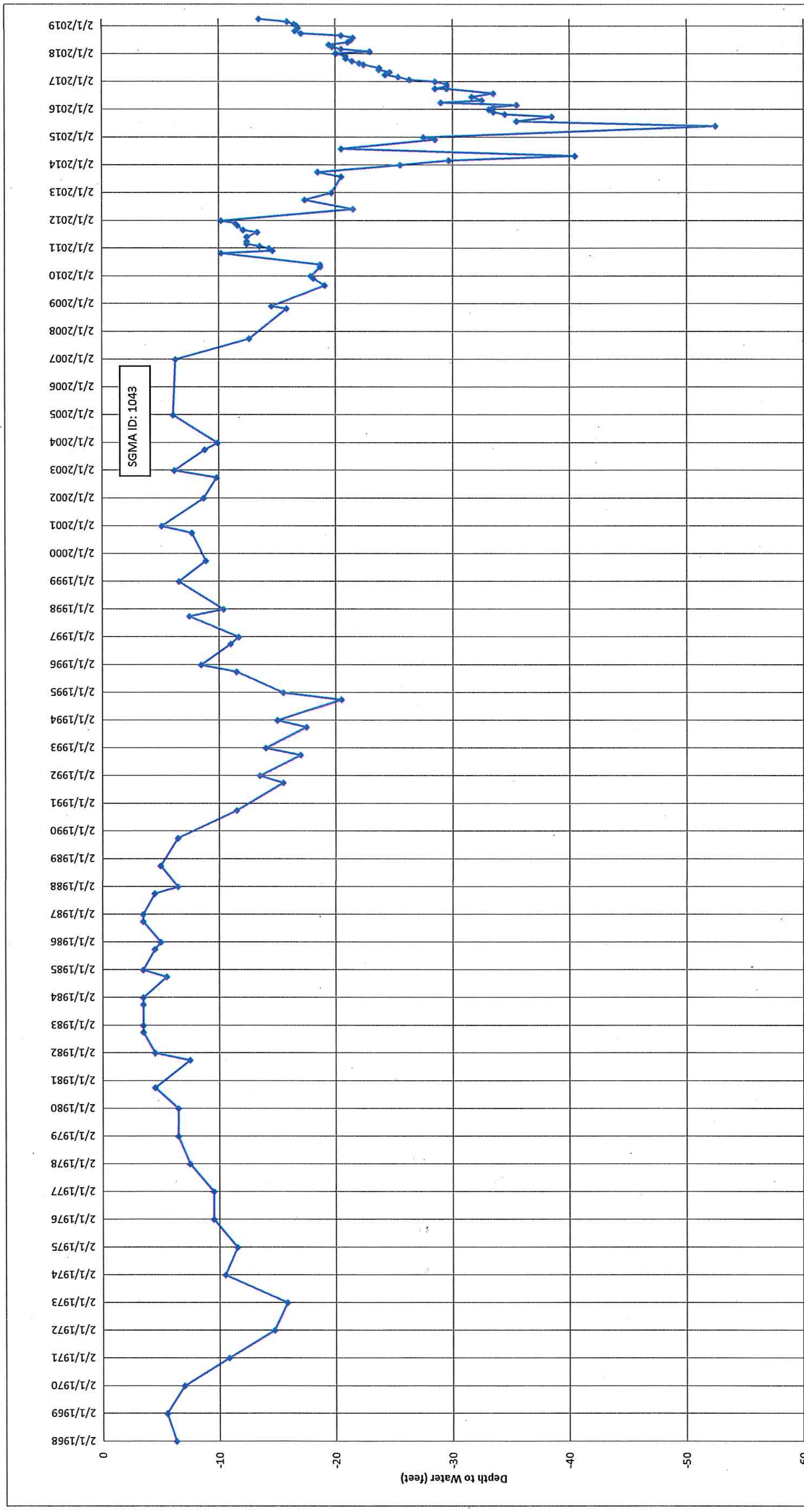


FIGURE 34 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREAS F, I, & K

There were significant water-level declines during drought periods, such as 1987 to 1993, in many wells. Figure 35 is an updated water-level hydrograph for Well CCID Well No. 5A, or SGMA 1005, which is considered representative for this sub-area. The water level in this well temporarily fell to about 55 feet deep during the 1993-94 drought, and then recovered by early 1999. During 2013-16, the water level again temporarily fell, and was about 55 feet deep in Summer 2015. However, by Spring 2019, the water level had recovered to a depth of about 18 feet. Over the long-term, water levels in this subarea were relatively stable prior to 1991. However, water levels after 1990 were deeper by an average of about 20 to 25 feet. Part of this is attributed to pumping by the Mendota Pool Group and other private wells in the Headgate Area, starting in the early 1990's.

Sub-Area H

This sub-area comprises the San Luis Canal Company (SLCC) service area. Water-level trends in this area weren't evaluated by KDSA (1997). Almost all wells in this area tap the upper aquifer. As part of the KDSA (2008) evaluation, water-level hydrographs were prepared by CCID for 17 wells, which records extending from 1959 to the mid-2000's. These hydrographs showed relatively constant water levels during this period. Water levels in some wells temporarily declined during the 1987-93 drought, but subsequently recovered. Updated water-level hydrographs by the

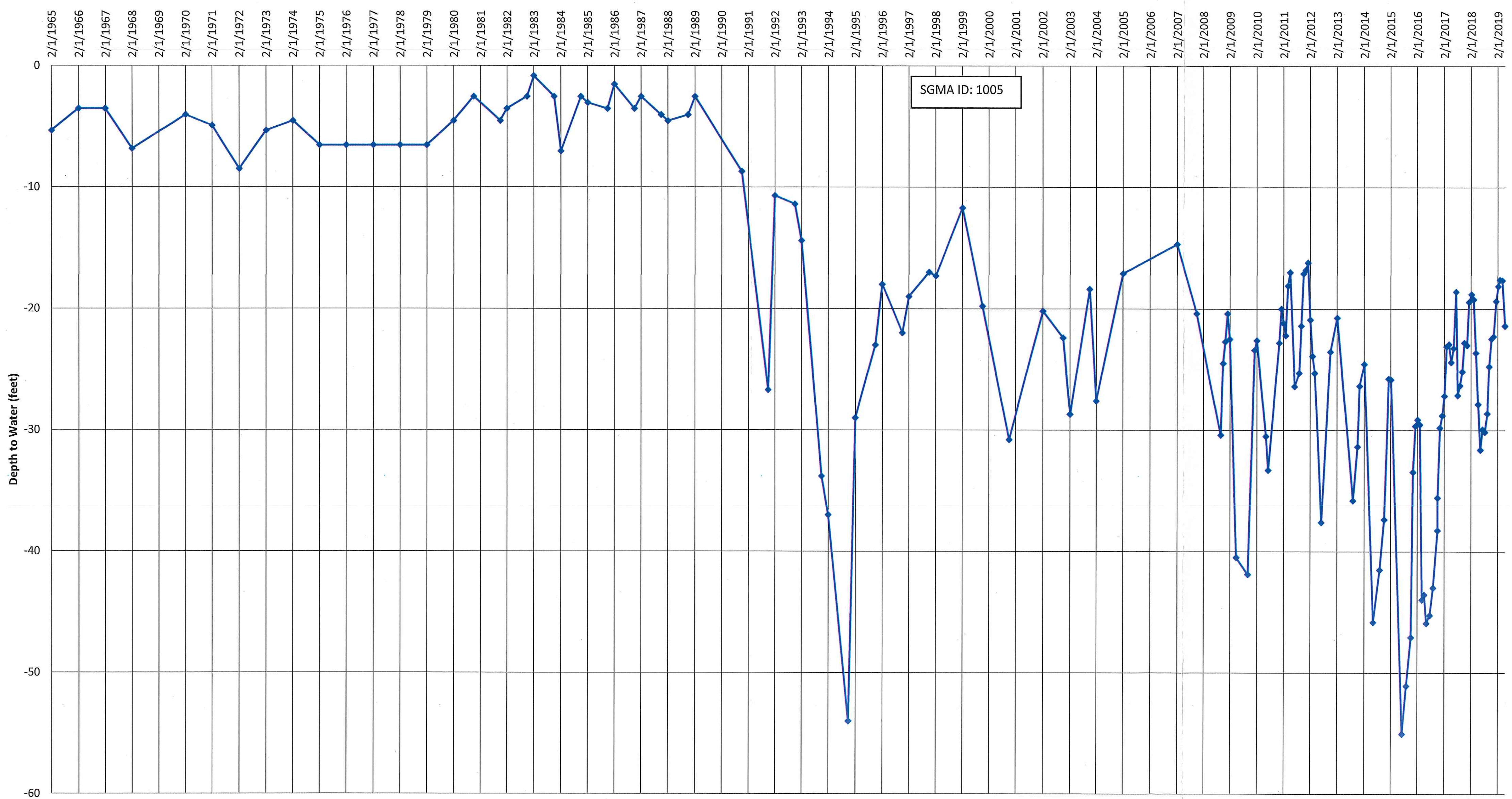


FIGURE 35 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA G

SLCC show no indication of groundwater overdraft in this area. Figure 36 is an updated water-level hydrograph for Well T9S/R12E-32N1 or SGMA Well 2759, which is considered representative for this sub-area. The water level in this well temporarily fell to a depth of about 32 feet during the 1976-77 drought, then quickly recovered. The water level in this well temporarily fell during 2006 and 2008 to between 20 and 23 feet deep, and then recovered. Water levels in this well have been stable over the long term through early 2013.

Sub-Area J

This sub-area comprises the Columbia Canal Co. service area. Irrigation wells in this area primarily tap the upper aquifer, although some deeper wells also tap the upper part of the lower aquifer. Water-level trends in this sub-area were also not evaluated by KDSA (1997). As part of the KDSA (2008) evaluation, water-level hydrographs, extending from the early 1950's to the mid-2000's were prepared for ten wells. Water-level hydrographs, extending from the late 1970's or 1980 to the mid-2000's, were also prepared for 19 other wells. Most of the hydrographs extending back to the 1950's showed water-level declines. Water levels in a number of these wells declined significantly during

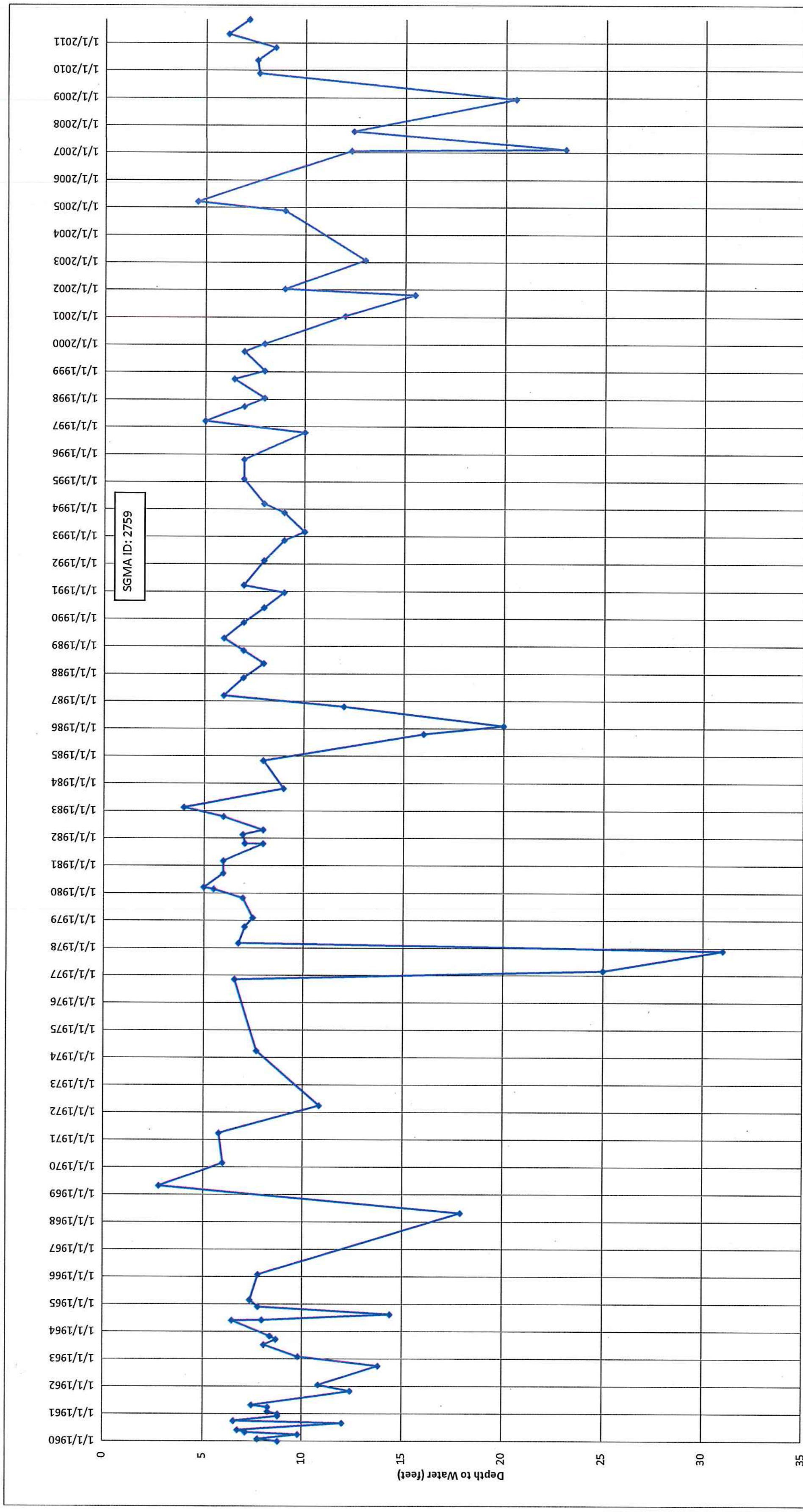


FIGURE 36 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA H

the 1970's and during the 1987-93 drought, but then subsequently partially recovered. Water-level hydrographs for wells that extended from the late 1970's or 1980 appeared to indicate more stable water levels, however many indicated slight water-level declines, particularly after about 1989. This was believed to be partly due to increased pumping in areas east of the Columbia Canal Co. service area, and some was due to MPG pumping near the San Joaquin River.

Figure 37 is a water-level hydrograph for SGMA Well 3199, which is considered representative for this sub-area. The water level in this well was relatively stable from 1980 to 1990. The water level temporarily declined during the 1991-94 drought, during 2002-2003, and during 2014-15. The water levels in this well averaged about five feet lower after 1990 and through 2008. The water level hadn't fully recovered by Spring 2017. Overall, the water level fell about seven feet between Spring 2008 and Spring 2017, or an average of about 0.8 foot per year. In summary, slightly declining water levels have been the predominant trend in Sub-area J, and part of these declines are due to pumping in adjoining areas outside of the sub-area. CCC has completed their canal lining conservation projects, which have substantially reduced pumpage in their service area since 2017.

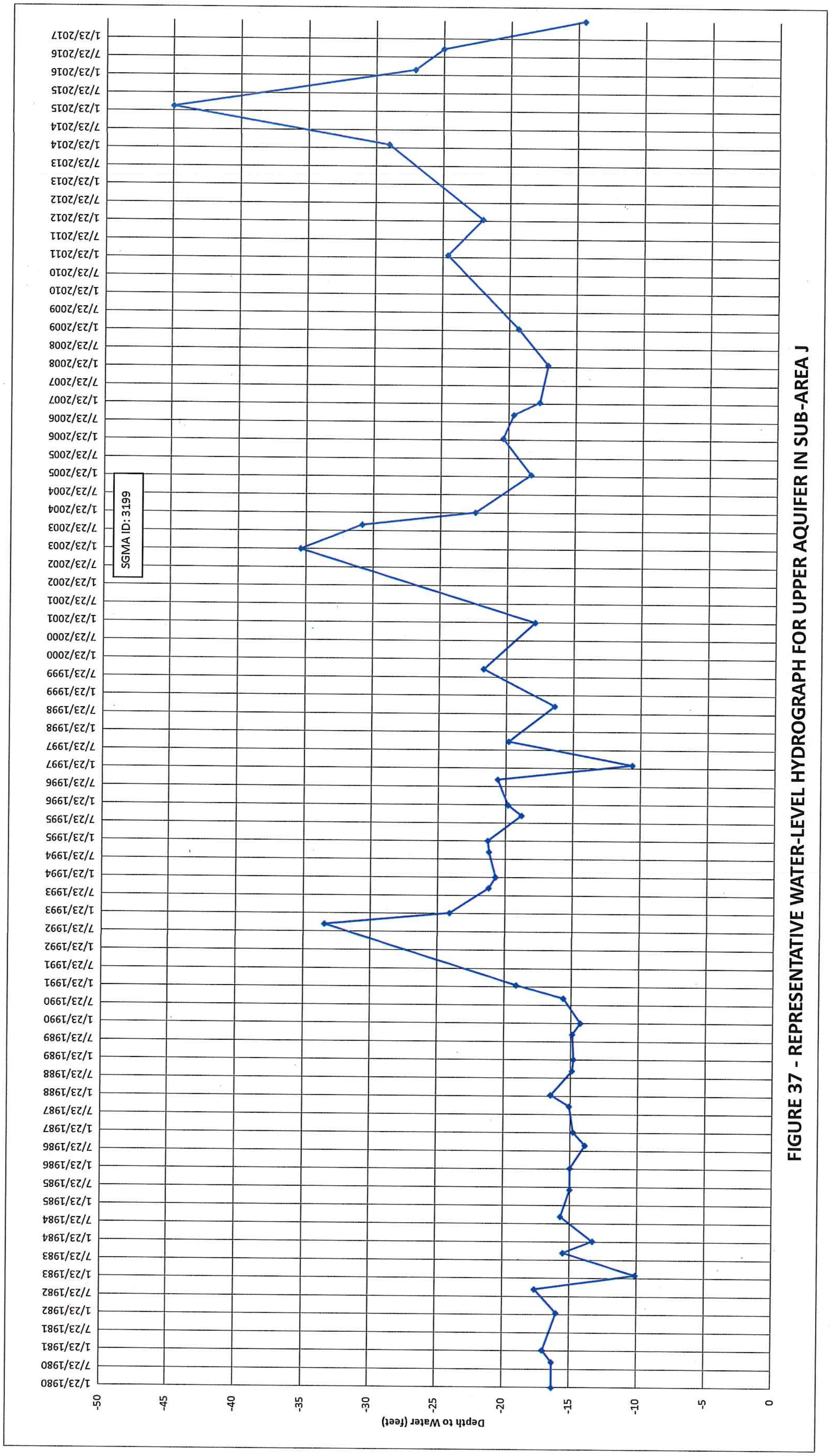


FIGURE 37 - REPRESENTATIVE WATER-LEVEL HYDROGRAPH FOR UPPER AQUIFER IN SUB-AREA J

Vertical Head Differences

Vertical head gradients between the upper and lower aquifers can be determined by dividing the difference in water level or hydraulic heads between the aquifers by the thickness of the Corcoran Clay. To determine vertical head differences, water-level elevation maps for the upper and lower aquifers were compared and the differences contoured. Such maps were prepared for Fall 1986 and Spring 1992 and showed similar results. Figure 6 of KDSA (1997b) showed head difference contours for Spring 1992. Water levels in strata below the Corcoran Clay were lower than those in strata above the Corcoran Clay throughout the area, except for a small area northeast of Newman. Head differences ranged from about 20 feet near Newman and the east edge of the north part of the Grassland Water District, north of Highway 152, to about 140 feet near the southwest edge of Area I and in the Hamburg Farms area. The head difference was about 40 feet south of Gustine, near Dos Palos, and in Area J. The head difference was about 80 feet southwest of Los Banos and near the boundary between Areas F and I. Thus overall, the head difference increased toward the southwest in the GSA.

Beneath almost all of the SJREC GSP Area there has been downward flow of groundwater through the Corcoran Clay. Vertical head differences have apparently been relatively the same during wet periods and droughts, except in some local areas, such as the Mendota Pool and Hamburg Farms areas. These head differences can be used along with the map showing the thickness of the Corcoran Clay to determine the vertical head gradients between the upper and lower aquifers in the service areas.

SOURCES OF GROUNDWATER RECHARGE

Figure 38 shows potential recharge areas, excluding groundwater flows, in the area. The major sources of recharge to groundwater above the A-Clay are seepage of water from the San Joaquin River and Mendota Pool, and deep percolation from irrigated lands. The major sources of recharge to the upper aquifer are lateral groundwater inflow, seepage from streamflow, seepage from conveyance facilities, deep percolation from irrigated areas not underlain by the A-clay, and downward flow of groundwater through the A-Clay. Lateral groundwater flows are shown on the previous water-level maps. In the area north of Washington Road, there is also recharge from upward flow through the Corcoran Clay. The major sources of recharge to the lower aquifer are downward flow through the Corcoran Clay and lateral ground water inflow.

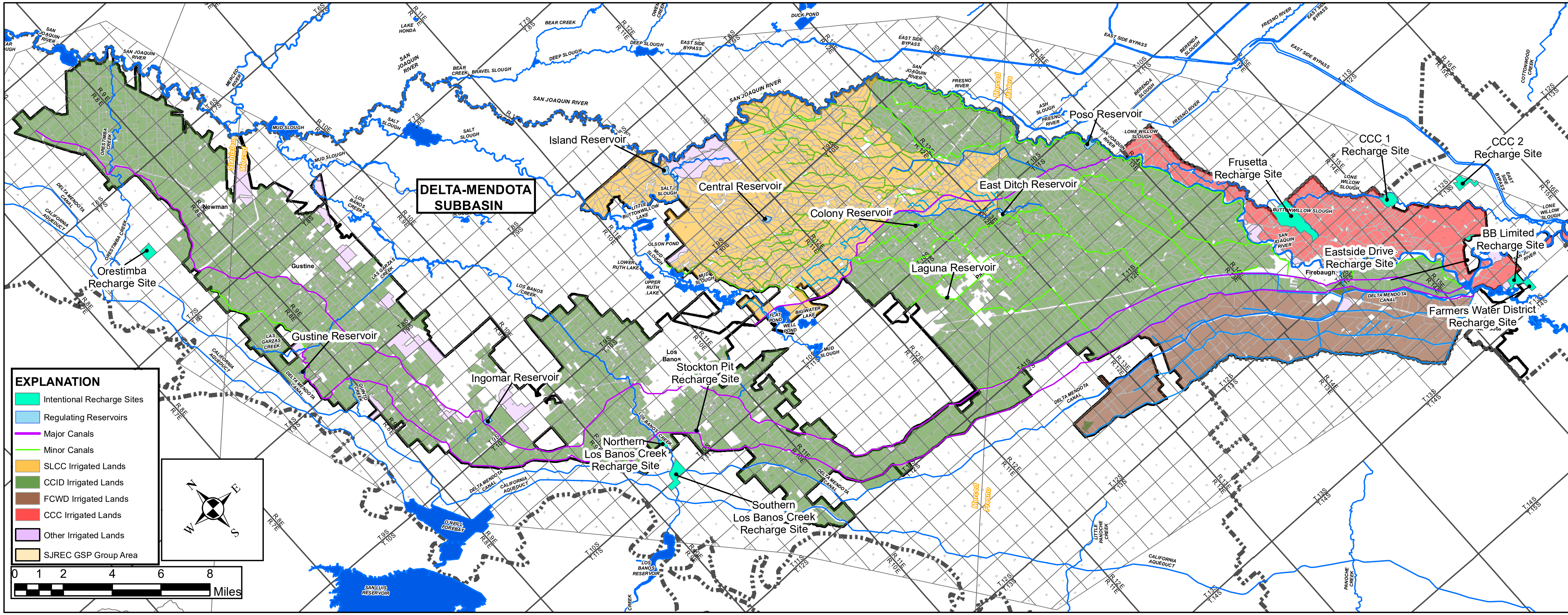


FIGURE 38 - POTENTIAL GROUNDWATER RECHARGE AREAS

Intentional recharge sites are shown in Figure 37. Included are Los Banos Creek sites, the Stockton Pit, the Orestimba Creek site, Columbia Canal Co. 1 and 2 sites, the Frusetta site, the B&B Ltd site, and the Farmers Water District site.

SOURCES OF GROUNDWATER DISCHARGE

Figure 39 shows locations of potential sources of discharge. Locations of active supply wells and drainage wells in and near the SJREC GSA are shown. For groundwater above the A-Clay, the major sources of discharge are pumpage (only in the Mendota area), downward flow of groundwater through the A-Clay, lateral groundwater outflow, flow to tile drainage systems, and direct evaporation. The major sources of groundwater discharge for the upper aquifer are well pumping, lateral groundwater outflow, and downward flow of groundwater through the Corcoran Clay. The major sources of discharge for the lower aquifer are well pumpage and lateral groundwater outflow.

AQUIFER CHARACTERISTICS

Specific capacities and aquifer transmissivities for the Exchange Contractors service area were discussed in detail by KDSA (1997a). Figure 25 of KDSA (1997a) showed specific capacities for a number of wells, as of the mid-1990's. Figure 12 of the

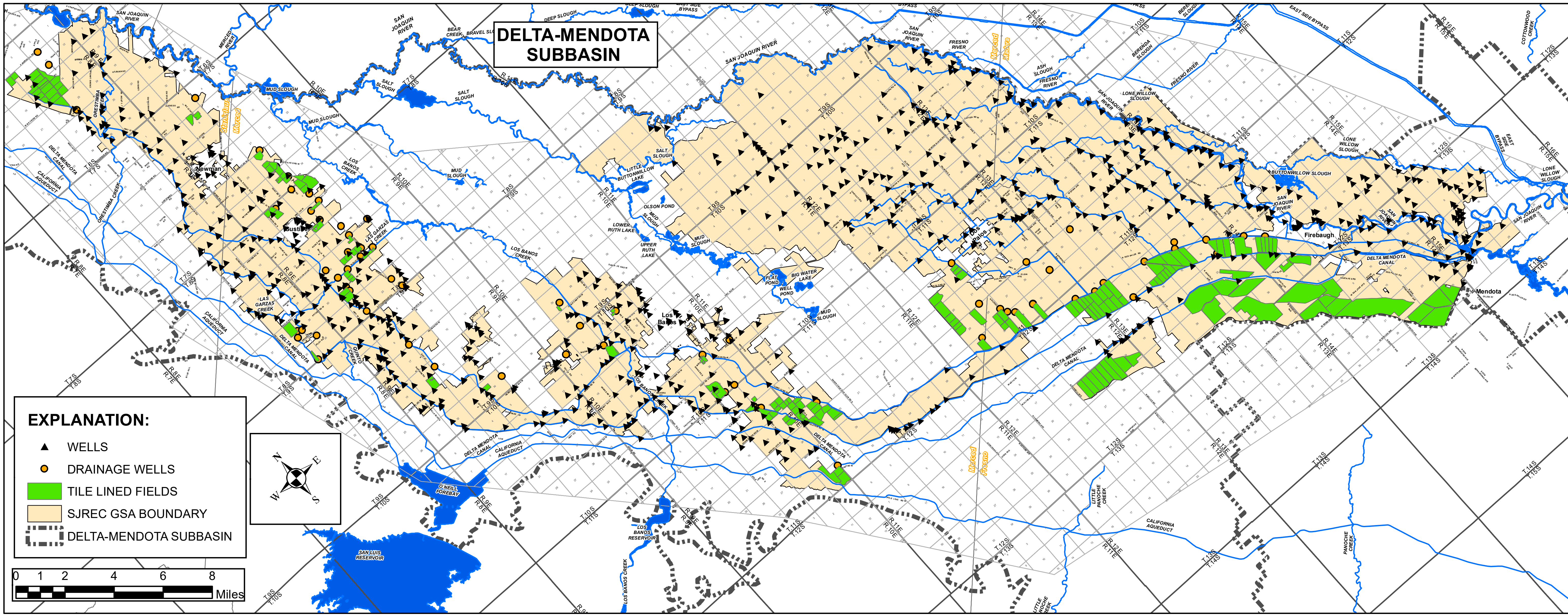


FIGURE 39 - POTENTIAL GROUNDWATER DISCHARGE AREAS

KDSA (2008) report was an updated map of specific capacities for CCID and other wells in the service area. In general, the same pattern was evident as from the previous map. Figure 40 of this report is an updated specific capacity map for 2012, and the same general patterns are evident. Almost all of these values are for wells tapping the upper aquifer, except for the area west of Crows Landing and Newman, where many tests are for composite wells. The highest specific capacities are in the south part of Sub-area B, and in Sub-areas C, G, and J. Highly permeable Sierran sands are tapped by most large-capacity water supply wells in Sub-areas G and J. High permeable deposits are also present in the Santa Nella-Volta-Los Banos area. Along the west side of the study area, higher specific capacities were common for wells located within major alluvial fans (i.e. San Luis Creek, Los Banos Creek, and Orestimba Creek.

Table 1 shows the range in specific capacities and the average specific capacity in each township and range in the SJREC GSP Group Area. Specific capacities of wells ranged from as low as 10 gpm per foot of drawdown to as high as over 170 gpm per foot. The average specific capacity of supply wells in the SJREC GSP Group Area for which records are available is about 70 gpm per foot.

Aquifer Tests Prior to 1996

The results of aquifer tests that were available in or near

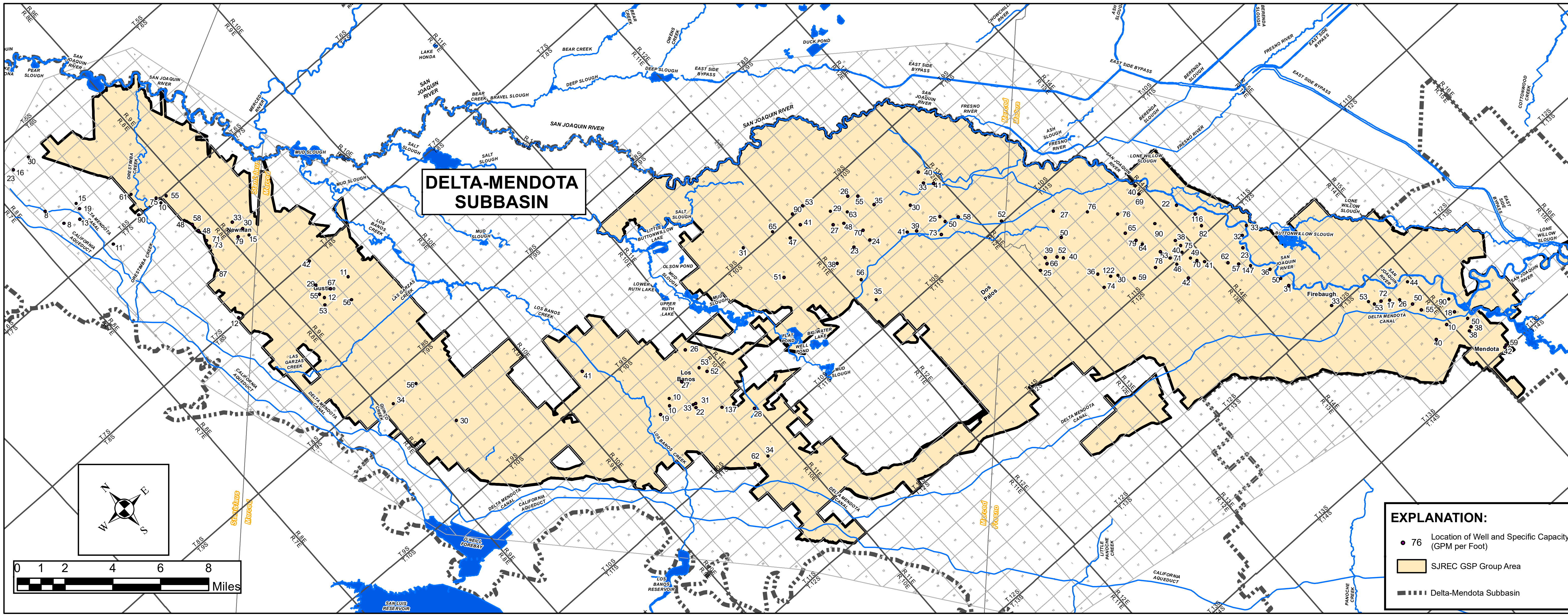


FIGURE 40 - DISTRIBUTION OF SPECIFIC CAPACITIES (2012)

TABLE 1- SPECIFIC CAPACITIES

Township/Range	Specific Capacity (gpm/ft) Range	Average
T6S/R8E	61-90	75
T7S/R8E	48-87	64
T9S/R9E	30-56	40
T10S/R10E	10-176	55
T10S/R11E	-	77
T11S/R10E	34-137	84
T11S/R11E	138-171	155
T11S/R12E	58-108	83
T9S/R13E	-	68
T10S/R13E	78-103	90
T11S/R13E	25-122	63
T12S/R13E	41-79	54
T11S/R14E	22-130	87
T12S/R14E	23-147	59
T13S/R14E	10-77	42
T13S/R15E	18-160	100
City of Gustine	12-67	41
Gustine Drainage District	11-56	41
City of Los Banos	10-53	32
City of Newman	15-79	46

the SJREC Area prior to 1996 are summarized in Table 2. Seven aquifer tests had been conducted for wells tapping the upper aquifer. One of these tested wells was between Gustine and Santa Nella. Four wells that were tested near Mendota tapped strata between the C-Clay and the Corcoran Clay. The C-clay is a local confining bed between the A-clay and Corcoran Clay. Leaky aquifer tests were conducted at two sites near Mendota, which allowed determination of the vertical hydraulic conductivity of the A-clay and the storage coefficient for strata confined below the A-clay. Two other aquifer tests were conducted near Mendota on shallow wells tapping unconfined strata above the A-clay (Luhdorff & Scalmanini, 1993).

Transmissivities of strata above the A-clay near Mendota ranged from 140,000 to 280,000 per foot and averaged 210,000 gpd per foot (Luhdorff & Scalmanini, 1993). These values are for highly permeable Sierran sands. Transmissivities of strata below the A-clay and above the Corcoran Clay near Mendota ranged from about 60,000 to 260,000 gpd per foot, and averaged 120,000 gpd per foot.

The two leaky aquifer tests near Mendota both indicated a vertical hydraulic conductivity of the A-clay of 0.024 gpd per square foot. Storage coefficients for strata below the A-clay and above the Corcoran Clay ranged from $7x10^{-4}$ to $1x10^{-3}$. Prior

TABLE 2-RESULTS OF AQUIFER TESTS PRIOR TO 1996

Well No.	Date	Perforated IntervaL (feet)	Pumping Rate (gpm)	Static Level (feet)	Pumping Level (feet)	Drawdown (feet)	Specific Capacity (gpd/ft)	Transmissivity (gpd/ft)
T9S/R9E-5R1	10/67	-	-	-	-	-	58.6	83,000
T13S/R14E-24M	12/88-1/89	112-244	2,210	28.9	84.1	55.2	39	260,000
T13S/R15E-29D	4/93	50-100	630	36.0	56.4	20.4	30.9	-
T13S/R15E-29F	4/93	50-80	297	34.0	53.1	19.1	19.1	139,000
T13S/R15E-30B	9/90	180-290	770	71.3	91.9	20.6	37.5	88,000
	3/90	170-290	1,025	61.2	81.8	20.6	49.8	108,000
T13S/R15E-32M	11/88	140-260	530	37.9	46.9	9.0	59	59,000
T13S/R15E-34J1	4/81	120-216	2,000	-	-	-	-	77,000
T14S/R15E-9B	4/93	50-100	627	-	-	-	-	283,000

Results for 5R1 from Hotchkiss and Balding (1971). Results from 24M1, 30B, and 32M from files of Kenneth D. Schmidt and Associates. Results for 29D, 29F, and from Luhdorff & Scalmanini (1993) to the KDSA (1997b) evaluation, no aquifer tests were known to have been conducted to determine the vertical hydraulic conductivity of the Corcoran Clay in or near the SJREC GSA.

Results of 1996-97 Aquifer Tests

Because of the lack of previous aquifer tests in large parts of the Exchange Contractors service area, an extensive aquifer testing program was undertaken in late 1996 and early 1997. Fifteen aquifer tests were conducted between October 17, 1996 and February 6, 1997. Eleven of the pumped wells from these tests were CCID wells, and the remainder were private irrigation wells. Most of these wells were selected to provide data along the western and eastern edges of the service area, for use in groundwater inflow and outflow calculations. In general, 24-hour pumping periods were used, and several other wells in the vicinity were used as observation wells, where possible. In addition to these tests, a one-week long Leaky Aquifer Test was done in January 1997 on a well tapping strata below the Corcoran Clay. Details and graphical plots for these tests were provided by KDSA (1997b).

Twenty-four Hour Tests

The primary purpose of these tests was to provide actual transmissivity values in specific areas and to provide better conversion factors between specific capacities and aquifer transmissivities for use in other areas. In many cases observation wells either didn't tap exactly the same strata as the pumped well, or were too distant to have a drawdown useful for determing aquifer transmissivity. The corrected recovery measurements for the pumped well itself usually provide the most reliable determinations of aquifer transmissivity.

Table 3 summarizes the results of these tests. Nine of these tested wells only tapped the upper aquifer, and six others were composite wells that tapped both aquifers. Specific capacities of the tested wells ranged from 17 to 271 gpm per foot. Aquifer transmissivities ranged from about 32,000 to 500,000 gpd per foot. Transmissivities at three test sites ranged from about 400,000 to 500,000 per foot. One of these was for CCID Well No. 23A, or SGMA Well 1023, which taps highly permeable Sierran sands northwest of Mendota. The two others were CCID Wells No. 3 (SGMA Well 1003) and 51 (SGMA Well 1051), which are composite wells in the Crows Landing-Newman area. Transmissivities ranged from 37,000 to 59,000 gpd per foot at four sites: CCID Wells No. 5A (SGMA Well 1005) and 44 (SGMA Well 1044), north of Mendota, Well T12S/R15E-32B (SGMA Well 2988), a composite well east of Firebaugh, and Well T11S/R14E-19L (SGMA Well 2313), northwest of Firebaugh.

TABLE 3-RESULTS OF 1996-97 AQUIFER TESTS

Well No.	SGMA I.D.	Date	Perforated Interval feet)	Specific Capacity (feet)	Transmissivity (gpd/ft) Drawdown	Transmissivity (gpd/ft) Recovery
CCID 5A	1005	10/17/96	100-260	23	65,000	54,000
CCID 23A	1023	10/21/96	90-180	140	500,000	446,000
CCID 44	1044	10/23/96	100-280	26	75,000	58,000
CCID 41	1041	10/28/96	86-236	30	-	78,000
CCID 8A	1008	11/4/96	75-220	95	-	168,000
CCID 27A	1027	11/4/96	160-280	28	79,000	69,000
CCID 2	1002	11/6/96	90-337	55	193,000	143,000
CCID 3*	1003	11/6/96	85-355	271	400,000	-
CCID 13*	1013	12/4/96	100-415	50	192,000	172,000
CCID 45	1045	12/11/96	120-270	48	207,000	-
CCID 51	1051	12/11/96	87-477	44	388,000	440,000
T12S/R15E-32B*	-	12/17/96	210-510	17	42,000	32,000
T13S/R15E-3N*	-	1/8/97	190-430	30	97,000	77,000
T12S/R15E-10K*	-	1/30/97	210-534	54	135,000	112,000
T11S/R14E-19L	-	2/6/97	160-320	19	43,000	32,000

*Composite Well

A conversion factor of 1,500 that has been commonly used for unconfined aquifers in the San Joaquin Valley to multiply times the specific capacity to estimate transmissivity. For confined aquifers, a factor of 2,000 has been commonly used. Comparison of the specific capacity and transmissivity values for the 24-hour aquifer tests indicated a range in values from about 1,800 to 4,700, and an average of 2,850 for this factor. This higher value than commonly used is probably partly due to low to moderate well efficiencies. The effect of a lower well efficiency is to make the specific capacity smaller relative to the transmissivity (thus making the conversion factor larger). The commonly used conversion factors for unconfined aquifers were developed by the U.S. Geological Survey based on data for wells in the eastern part of the valley, many of which were open-bottomed wells at that time. Such wells have no gravel pack and often have no perforations, and are highly efficient. Gravel packed wells normally have a lower efficiency than the open-bottomed wells, due to head losses associated with the gravel and perforations. Using the average specific capacity in the SJREC GSP Group Area of about 70 gpm per foot, the average transmissivity would be about 200,000 gpd per foot. This value reflects two major factors. First is the high lateral hydraulic conductivity of the Sierran sands in the east part of the area. Second, many of the wells pump tested, particularly along the west part of the area north of Los Banos, were intentionally drilled in more favorable areas (located in major alluvial fans). These factors must be carefully evaluated when utilizing transmissivity values to determine groundwater flows in other parts of the area.

Leaky Aquifer Test

A one-week long Leaky Aquifer Test was conducted during January 13-20, 1997, along the Delta-Mendota Canal in the Hamburg Farms area. The main purposes of the Leaky Aquifer Test were to determine the transmissivity of the lower aquifer and the vertical hydraulic conductivity of the Corcoran Clay. The test site was located between Hamburg and Bennett Roads, southwest of Dos Palos about two miles northwest of the Fresno-County-Merced County line. This area was selected because drillers logs and electric logs are available for many test holes and wells in this area, and almost all wells were sealed opposite the Corcoran Clay. Also, numerous wells of relatively similar depth and perforated interval are located in relatively close proximity. The Corcoran Clay is indicated to be about 110 feet thick in this area. The DMC pumpers wells in this area pump water from below the Corcoran Clay. Except for the test, there was no significant pumpage from wells in this vicinity during Winter 1996-97. Because of this, January 1997 was an ideal time to conduct a Leaky Aquifer Test.

The pumped well was perforated from 360 to 680 feet in depth. Three nearby supply wells were used as observation wells during the test. These wells were perforated opposite similar intervals as the pumped well. A total of 34,056,400 gallons was pumped during the test and the average pumping rate was 3,406 gpm.

Theis (log-log) drawdown plots for the closest observation wells indicated no deviation from the type curve (no leakage) during the test. Based on drawdown measurements for this test, a transmissivity of 160,000 gpd per foot and storage coefficient of 0.001 were indicated to be the best values. The vertical hydraulic conductivity of the Corcoran Clay was indicated to be less than 0.001 gpd per square foot. Corrected recovery plots for these wells indicated an average transmissivity of about 140,000 gpd per foot.

The relatively low value for the vertical hydraulic conductivity of the Corcoran Clay indicated at this test site is not believed to be typical of the entire SJREC GSP Group Area for two reasons. First the clay is much thicker and more well developed at the test site than in most other parts of the area. Secondly, there were no known composite wells in the vicinity of the test site. In some parts of the area where groundwater is pumped from the lower aquifer, composite wells are present that tap both the upper and lower aquifers. Where annular seals are not present opposite the Corcoran Clay, such wells effectively allow more movement of groundwater through the Corcoran Clay.

Specific Yields

Some of the best estimates of specific yield in the SJREC GSA were provided by Davis, et al (1959) in U.S. Geological Survey Water-Supply Paper 1469. Four geographic areas considered in that report are covered by the GSP area. The northernmost part (in T7S and T8S) are in the Tracy-Patterson area, generally in Stanislaus County. The southern part is in Group I of the Mendota/Huron Area. Much of the area in Merced County is in Group 1 and 2 of the Los Banos Area. The remaining part of the GSP area (Management Area J) is primarily in the San Joaquin River area of Madera County. Specific yields were provided by Davis, et al (1959) for three depth intervals (10 to 50 feet, 50 to 100 feet, and 100 to 200 feet) and for the combined intervals. Considering the depth to the top of the Corcoran Clay, the specific yields for the combined intervals are reasonable to use to evaluate unconfined groundwater in the SJREC GSA.

A combined average specific yield of 13.5 percent was indicated for the part of the GSP in T7S and T8S. The average specific yield in Group 1 of the Los Banos Area (the western part) was 10.5 percent and in Group 2 of the Los Banos area (the eastern part) was 12.0 percent. The average combined specific yield in Group I of the Mendota-Huron area (Fresno County) was 9 percent. This was the lowest average specific yield in the GSP, and is primarily due to finer grained Coast Range deposits in this part of the GSP. Lastly the average specific yield in the Madera County part of the GSP was 14.7 percent, the highest of all values for the GSP. This reflects the predominance of Sierran sands in the subsurface of this part of the SJREC GSP Area.

Table 4 shows specific yields by management subarea. Values ranged from 9 percent in Subarea I to 14.7 percent in Sub-area J. The other values for the rest of the sub-areas range from 10.5 percent in Subarea C to 13.3 percent in Sub-areas A, B, and G.

CHANGES IN GROUNDWATER IN STORAGE

The most accurate method to estimate changes in groundwater storage is to evaluate water-level trends and specific yields for the upper aquifer (above the Corcoran Clay). Specific yields were discussed in the previous section of this report. The hydrologic base period used for this evaluation is 2003-12. The water-level trends for this period that were evaluated were for Spring 2004 and Spring 2013. The acreages of the monitoring zones are as follows:

Monitoring Zone	Acres	Monitoring Zone	Acres
A	20,227	G	3,734
B	33,486	H	47,336
C	34,508	I	23,794
D	10,392	J	17,062
E	54,633	K	3,578
F	6,740		

TABLE 4- SPECIFIC YIELDS FOR UPPER AQUIFER IN MONITORING ZONES OF SJREC GSA

Sub-Area	Specific Yield (percent)
A	13.3
B	13.3
C	10.5
D	12.2
E	12.2
F	11.5
G	13.3
H	12.2
I	9.0
J	14.7
K	11.0

Specific yields were derived from data presented in U.S. Geological Survey Water-Supply Paper 1469 by Davis et al (1959)

Water-level hydrographs covering this base period have been prepared for a number of CCID wells in monitoring zones A, B, D, E and G and were presented in the 2017 CCID pumping program report by KDSA (2018). In Area A, records were available for six wells, in Area B records were available for three wells, in Area D records were available for 15 wells, and in Area G records were available for eight wells. In the remaining areas, representative water-level hydrographs presented earlier in this report were used.

Based on this information, the following average water-level changes occurred between Spring 2003 and Spring 2013.

Monitoring Zone	Water-Level Change (ft/yr)	Monitoring Zone	Water-Level Change (ft/yr)
A	-0.6	G	-0.3
B	-0.1	H	0
C	-0.8	I	0
D	-0.7	J	-0.5
E	-0.7	K	-0.6
F	0		

Following are the average annual groundwater storage changes by monitoring zone between Spring 2003 and Spring 2013.

Monitoring Zone	Change in Storage (AF/yr)	Monitoring Zone	Change in Storage (AF/yr)
A	-1,600	G	-150
B	-450	H	0
C	-3,050	I	0
D	-850	J	-1,300
E	-4,600	K	0
F	0		

The combined average decrease in storage, or the groundwater overdraft, between Spring 2003 and Spring 2013 was 11,950 acre-feet per year. The period selected (2003-12) was to comply with the DWR SGMA requirement to use a recent base period for the water budget. It should be noted that this period was slightly below average in terms of average surface water supplies to the CVP Contractors west of the SJREC GSA. Overall, the small storage decreases indicate little overdraft in the service area. Figure 41 shows the average annual changes in storage in the monitoring zones for 2003-12.

LAND SURFACE SUBSIDENCE

The land surface can irreversibly subside when water levels in confined aquifers decline and interbedded fine-grained confining beds are compacted. Subsidence begins when the water surface in the aquifer falls below a certain threshold level. The rate of subsidence depends on how far water levels fall below that level, how long they remain there, and the characteristics of the sediments. Grain size is the most important sediment characteristic (Meade, 1968). Observations in the San Joaquin Valley indicate that subsidence began when water levels dropped more than about 100 feet below the earliest measured levels. Subsidence due to pumping from above the Corcoran Clay has been demonstrated to be reversible at two Mendota area compaction recorders. That is, compaction occurs during seasonal pumping periods, and then the

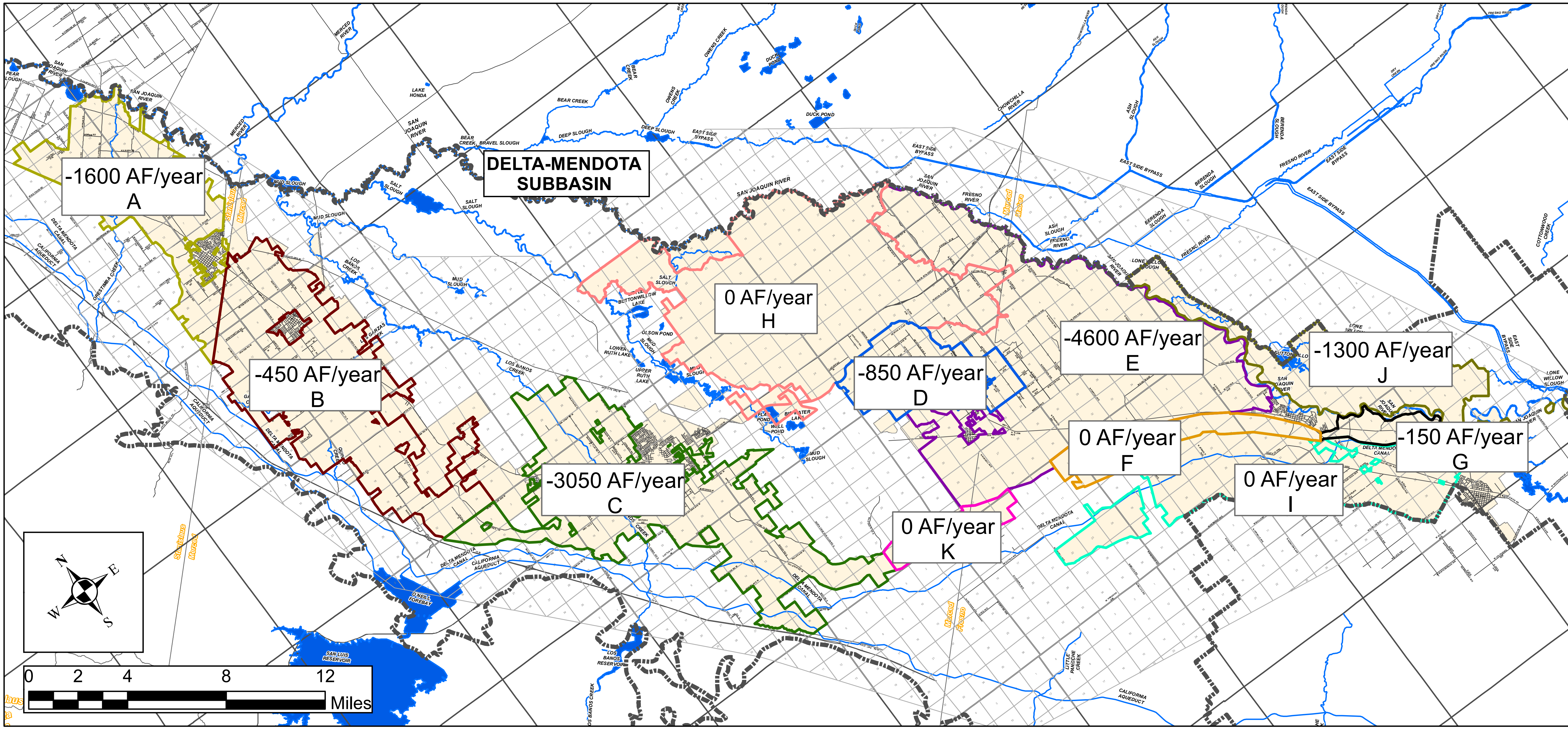


FIGURE 41 - AVERAGE ANNUAL CHANGE IN GROUNDWATER STORAGE FOR UPPER AQUIFER FROM 2003-2012

land surface rebounds during subsequent non-pumping periods. Subsidence was measured extensively in the part of the SJREC GSA south of Los Banos by the U.S. Geological Survey for many decades. The total land subsidence between 1926 and 1972 (taken from U.S. Geological Survey Professional Paper 437-I by Ireland, Poland, and Riley, 1984) ranged from one to 12 feet in the part of the GSA south of Los Banos.

From 1972 until about 2010, much less information was available on land subsidence than for the previous decades. This was because once water from the San Luis Canal (California Aqueduct) became available, it was thought that the subsequent decrease in pumpage would essentially eliminate overdraft and land subsidence. However, by the drought of the early 1990's, it had become apparent that subsidence was continuing. Some information has been available for the settling of some canals and other features. The Delta-Mendota Canal and CCID Outside Canal have required extensive repairs due to subsidence, and the repair or replacements of Mendota Dam and Sack Dam are being considered. Figure 42 shows present land subsidence monitoring sites in the area, including compaction recorders and GPS sites, DMC land surface points, and SJRRP land surface points. Figure 43 shows land subsidence along the CCID Outside Canal from 1960 to 2017 between the head of the Canal near Mendota Dam to Highway 152. The total subsidence was about four feet near the head of the canal, near and north of Nees Avenue, and near the county line.

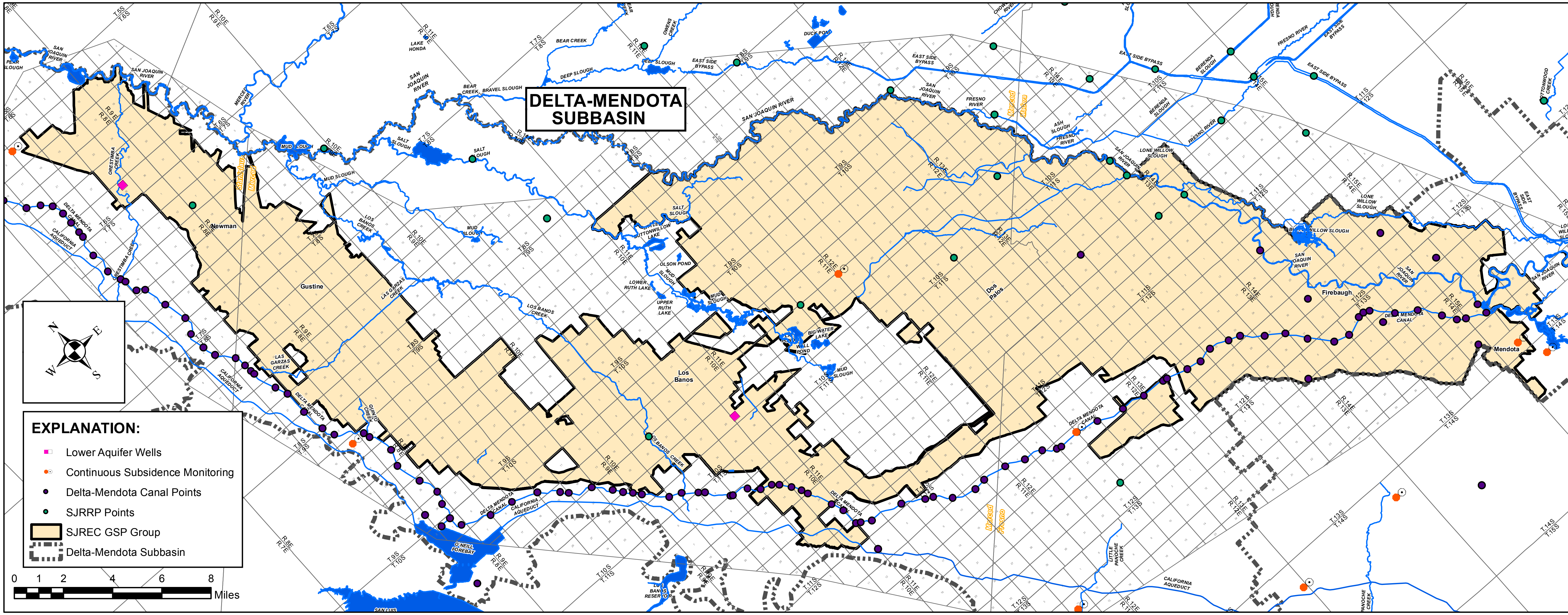


FIGURE 42 - SUBSIDENCE MONITORING POINTS

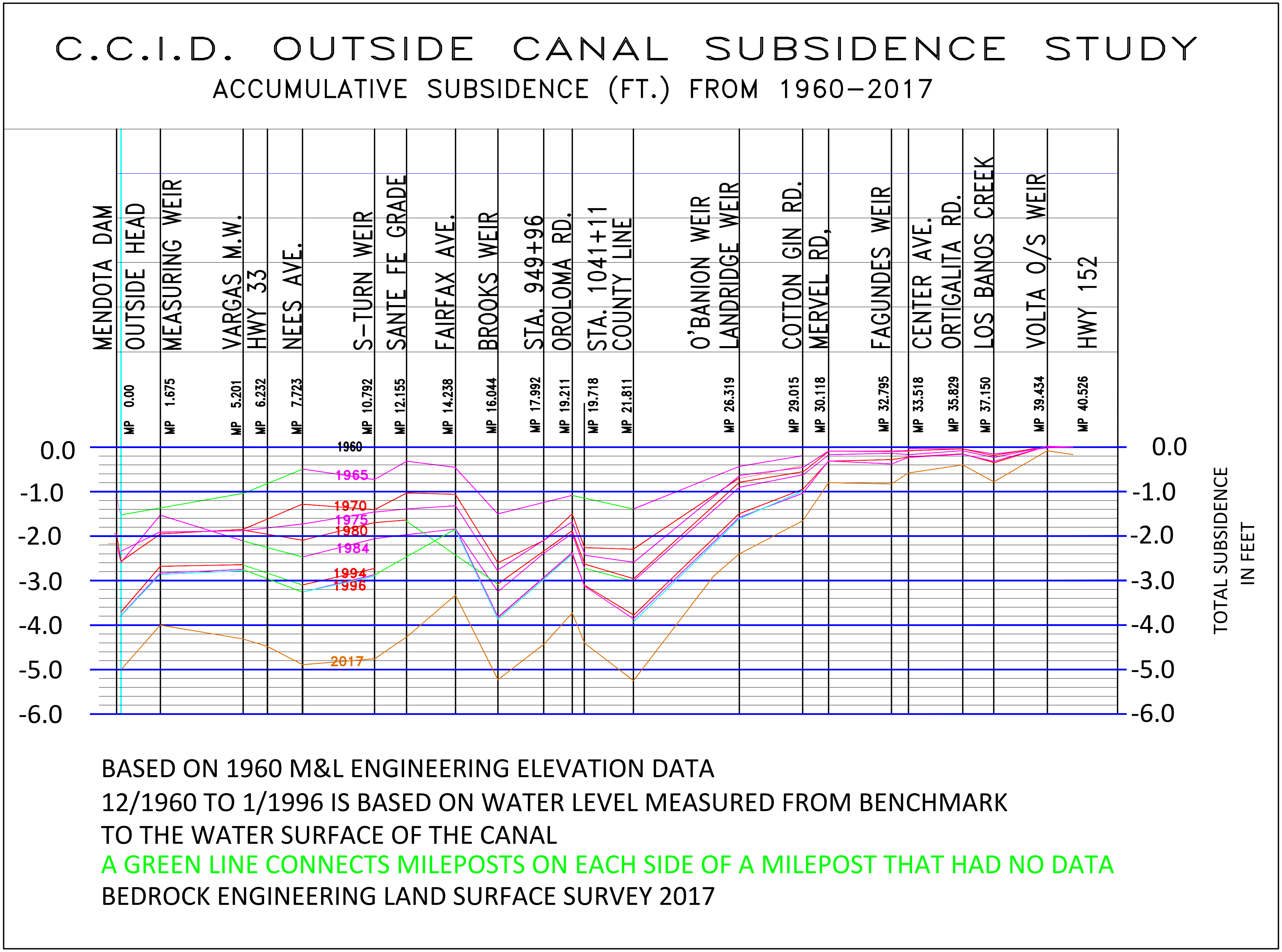
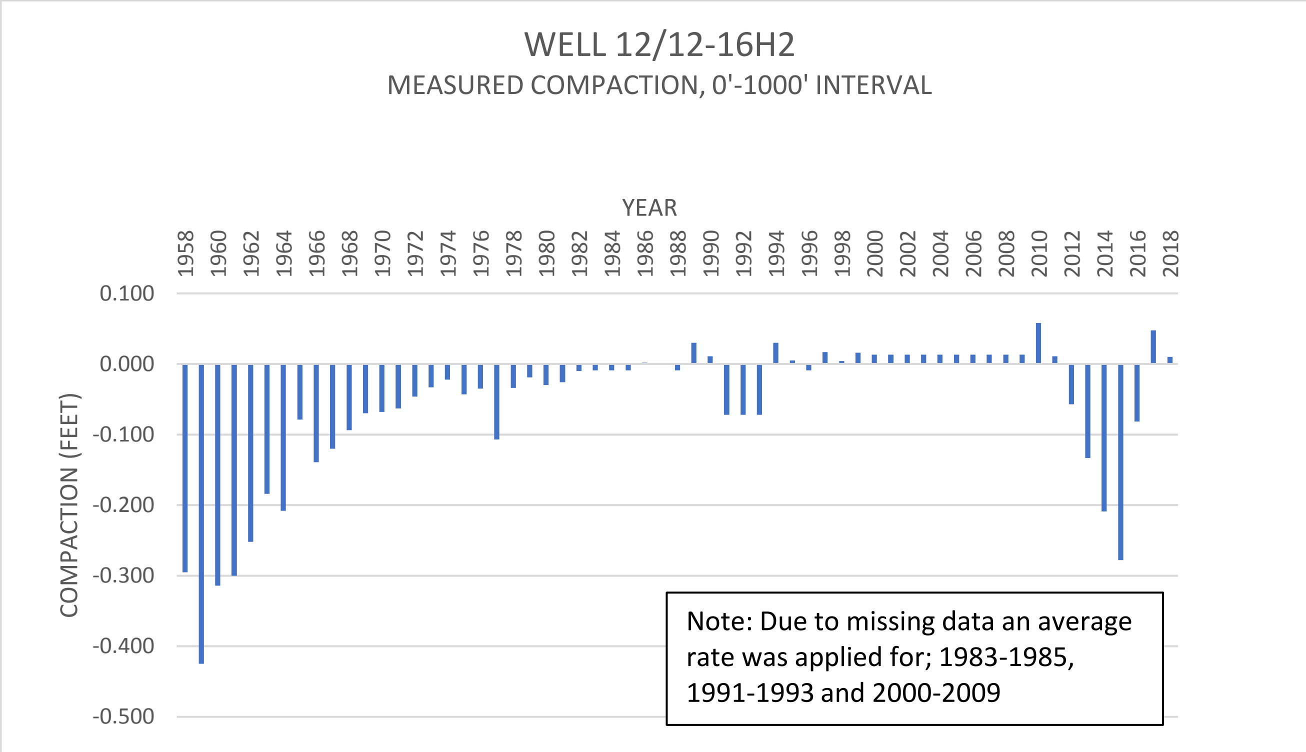


FIGURE 43 - BENCHMARK ELEVATIONS ALONG OUTSIDE CANAL (1960-2017)

There have been adequate water-level declines to cause subsidence in the Crows Landing-Newman area. The partial submergence of Anderson Road Bridge over the Main Canal indicates that there has been at least a foot of subsidence just south of Orestimba Creek. A number of recorders were installed in the San Joaquin Valley several decades ago, to allow the rates and amounts of compaction of strata at different depth intervals to be evaluated. One of these recorders (Russell Avenue or Ora Loma) is in the area (T12S/R12E-16H or SGMA ID's 10255, 10256, and 10257). Annual rates of compaction of the deposits between the ground surface and 1,000 feet near Russell Avenue and the DMC are shown on Figure 44. Since 1975, compaction and subsidence rates were relatively low, except during drought periods (1976-77, 1990-93, and 2012-15). Compaction rates declined after deliveries from the San Luis Canal/California Aqueduct began in 1968 and pumpage from outside the SJREC GSP Group was subsequently reduced. Near Russell Avenue, 93 percent of the measured compaction during 1958-82 was in strata below the top of the Corcoran Clay. Water-level hydrographs are shown for well 16H5 (perforated from 670 and 712 feet) and 16H6 (perforated from 770 and 909 feet). Figure 44 indicates that water levels do not need to be drawn down below historic lows, for compaction to resume. Data for 1987-92 are incomplete, because by this time, much of the subsidence and compaction monitoring had been discontinued. The compaction in the depth interval above the Corcoran Clay has not been monitored at this recorder since 1982.


WELL 12/12-16H2
MEASURED COMPACTION, 0'-1000' INTERVAL
YEAR
COMPACTION (FEET)
0.100
0.000
-0.100
-0.200
-0.300
-0.400
-0.500
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Note: Due to missing data an average rate was applied for; 1983-1985, 1991-1993 and 2000-2009

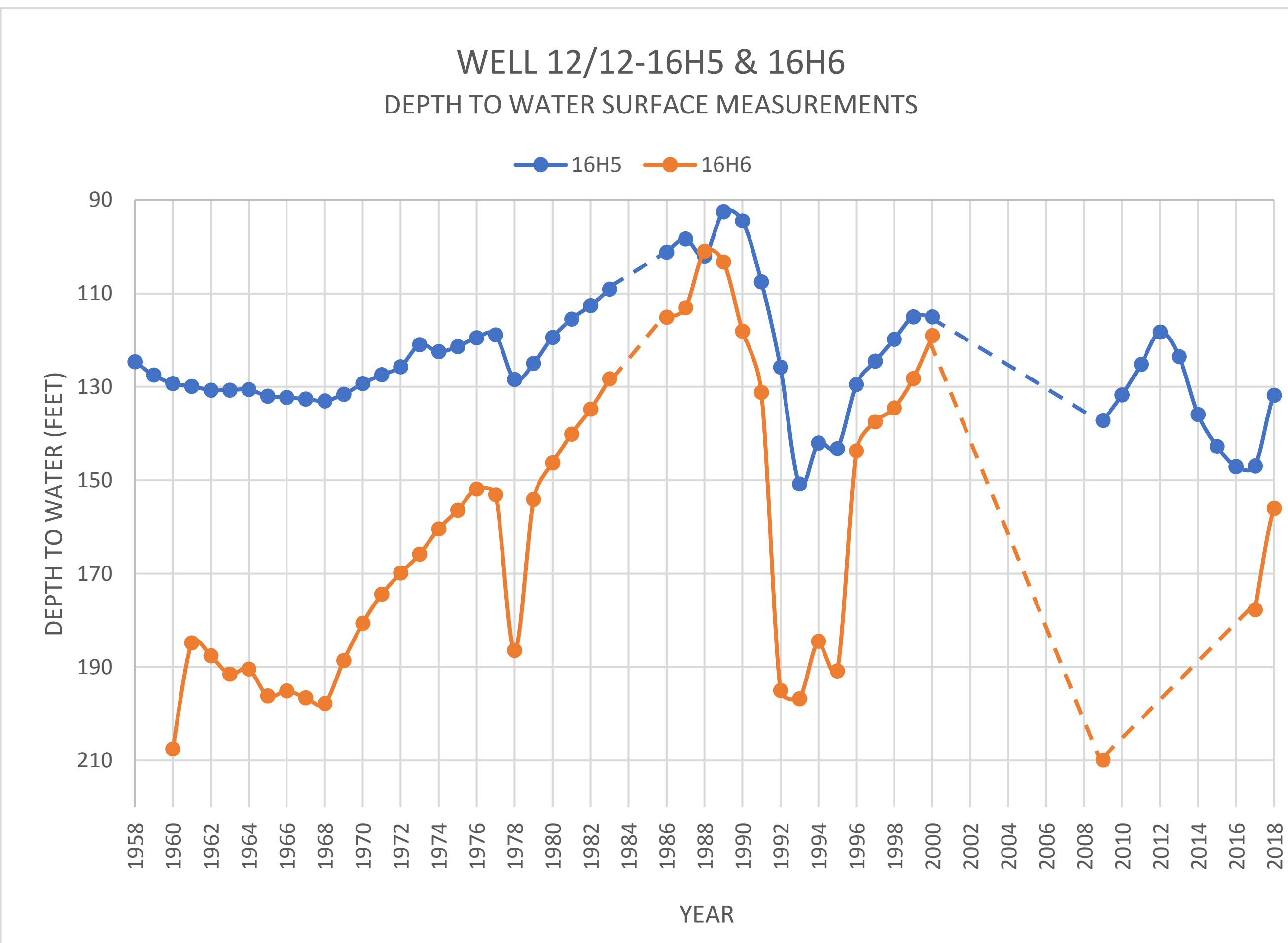

WELL 12/12-16H5 & 16H6
DEPTH TO WATER SURFACE MEASUREMENTS
16H5
16H6
DEPTH TO WATER (FEET)
90
110
130
150
170
190
210
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
YEAR

Figure 45 shows land subsidence along the Delta Mendota Canal between the head of the canal and Check 21 (Mile Post 116.48). The greatest subsidence (about 0.5 to 0.6 feet) was near Check 6, between Checks 7 and 11, near Check 14, and between Checks 17 and 19.

Highway 152 Transect

Periodic surveys of land surface elevations have been done along Highway 152. Figure 46 shows land surface subsidence along this section between 1972 and 2017. The maximum subsidence (about 9.1 feet) occurred near the Eastside Bypass. In the area west of Turner Island Road, most of the subsidence apparently occurred after 1988. In contrast, along the east part of the transect, significant subsidence occurred before 1988. This is because irrigation wells tapping the lower aquifer were generally installed earlier in this area.

Sack Dam-Red Top Area

The Sack Dam-Red Top Area was near the north edge of historical land subsidence studies in the San Joaquin Valley by the U.S. Geological Survey. More recent subsidence monitoring has been undertaken in parts of the valley during the past eight years, due to the reoccurrence of land subsidence.

A number of land surface elevation surveys have been done in this area since 2008. Data for 2008 and 2010 were used to prepare a contour map (Figure 47). Land subsidence during this period

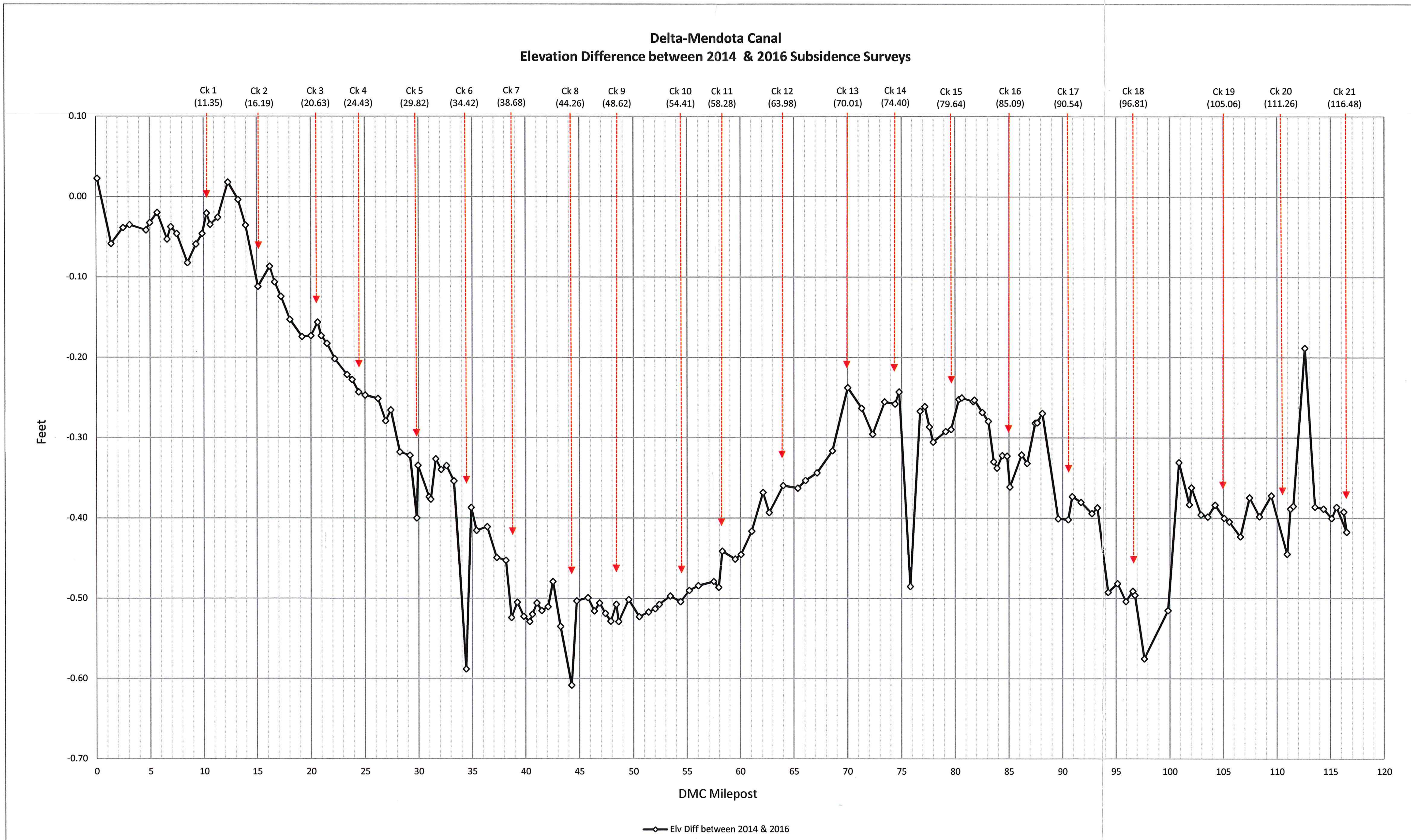
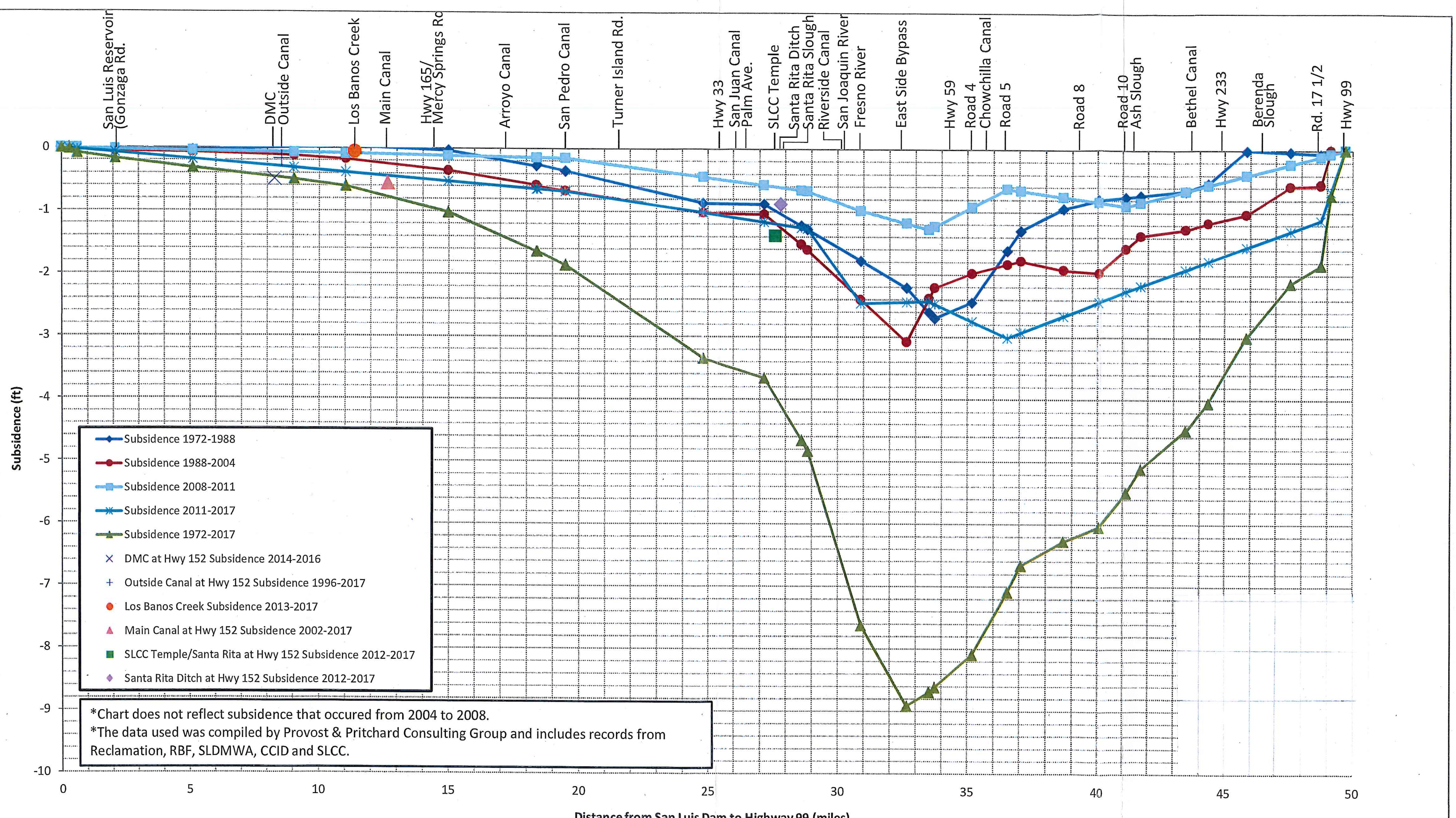
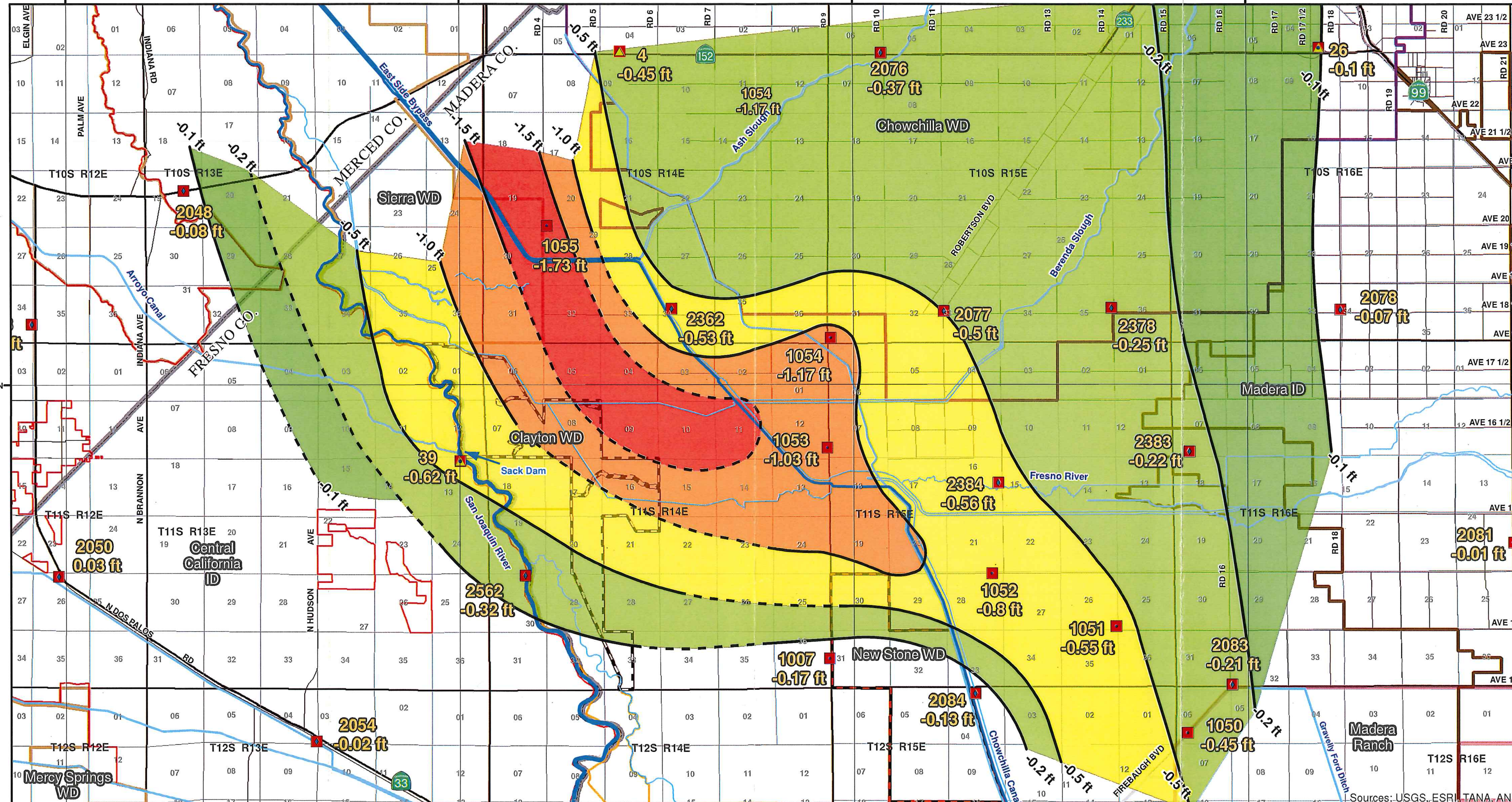


FIGURE 45-LAND SUBSIDENCE ALONG DELTA-MENDOTA CANAL (2014-16)



Source:
Elevation change computed from report geodetic surveys along Highway 152 from Caltrans, edtied by Bureau of Reclamation.

FIGURE 46- HISTORICAL LAND SUBSIDENCE ALONG HIGHWAY 152 TRANSECT



0 4,500 9,000 Feet

PROVOST & PRITCHARD CONSULTING GROUP — EST. 1968 — An Employee Owned Company

In Association with Kenneth D. Schmidt & Associates

Legend

- County
- Township/Range
- Major Canal / Slough / River

Elevation Change (Feet)

- -0.1 to -0.2
- -0.2 to -0.5
- -0.5 to -1.0
- -1.0 to -1.5
- -1.5

*Points Surveyed 06-29-2010
Labeled By Change In Elevation (ft) Since 2008

- AT Point
- Primary Control Pt
- Primary/AT Point
- Secondary Control Pt

FIGURE 47-LAND SUBSIDENCE IN RED TOP-EL NIDO AREA (2008-10)

2008 to 2010 Change in Elevation of Ground Surface from TO19 Preliminary Subsidence Map

*Data from RBF Consulting Co.
Map for California Flood Safe July 13, 2010

Date: August 27, 2012

exceeded 1.5 feet along a northwest-southeast trending area passing through the north end of the Triangle T Ranch (north of Avenue 16), and extending to the northwest (including Vlot Farms). Land subsidence exceeded 1.0 foot during 2008-10 southwest of the Eastside Bypass, between Avenues 14 and 21. Land subsidence west of the San Joaquin River was indicated to usually be less than half a foot, except near Sack Dam (0.62 foot). Land subsidence during this period exceeded half a foot over a fairly large area east of the river, extending south to Avenue 12 and north to past Highway 152. Much of the greatest subsidence was in the western part of the Chowchilla W.D., west of the Madera I.D., and in other undistricted areas east of the San Joaquin River. Surface water supplies in these areas have been limited, particularly during drought periods, and thus groundwater has been heavily used.

An agreement was developed between the landowners east of the San Joaquin River and the CCID and SLCC (west of the river) to undertake a program to decrease subsidence in the Sack Dam-Red Top area. Measures undertaken include:

1. Provision of surface water to part of the area, to reduce lower aquifer pumpage.

2. Constructing new shallow wells to tap groundwater above the Corcoran Clay. Pumping of this water isn't prone to subsidence.
3. Implementation of intentional recharge projects to recharge the upper aquifer and make its yield more sustainable.
4. Avoiding constructing new deep wells tapping the lower aquifer, and not pumping existing lower aquifer wells, to the extent possible.

Recent land subsidence surveys indicate that the program has been highly successful.

Figure 48 shows land subsidence in and near the SJREC GSP Group Area for December 2013-2017. This map indicates that subsidence exceeded about 0.5 foot during this period in a large area. This area extended to within about five miles of Merced on the north, to near Chowchilla and Madera on the east, to near San Joaquin on the south, and to near Dos Palos and Firebaugh on the southwest. Subsidence rates ranging from about 1.5 feet were primarily in the Sack Dam-Red Top area and to the southeast.

GROUNDWATER QUALITY

The chemical quality of the groundwater along the west part of the GSP area is influenced by the chemical quality of west-

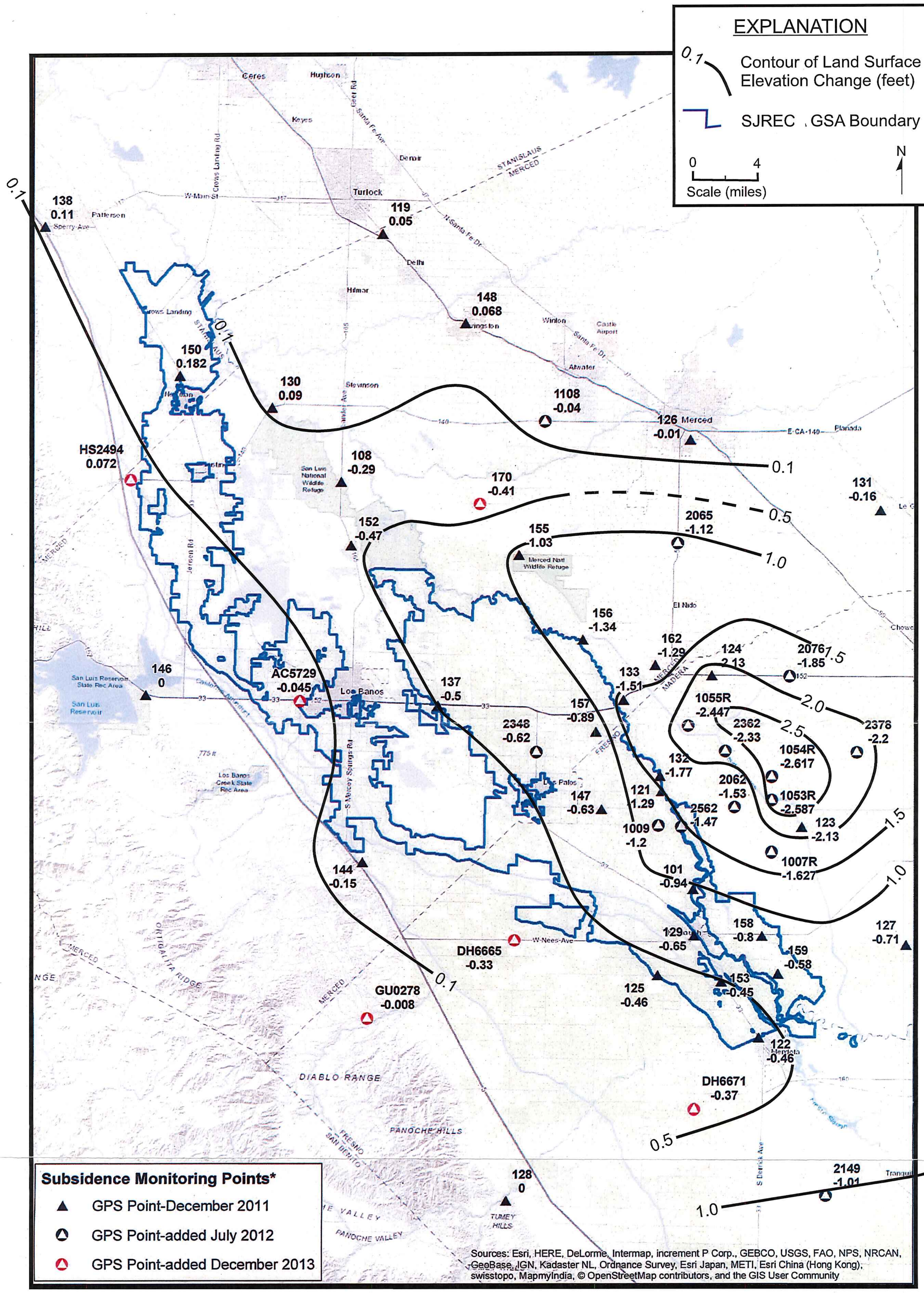


FIGURE 48- CHANGE IN GROUND SURFACE ELEVATIONS (FEET) FOR 12/13-12/17

side streams. Davis (1961) showed that the chemical quality of water for the west-side streams can be closely correlated with the geologic units in their respective drainage basins. Streams that drain basins that are chiefly underlain by sedimentary rocks of Cretaceous age and by the Franciscan Formation generally contain a high proportion of bicarbonate. The water from west-side streams in much of the area north of Los Banos is mostly bicarbonate in character. Streams that drain basins that are underlain by Tertiary marine formations contain a high proportion of sulfate and/or chloride. The dominant cations in most of the west side streams are calcium and sodium. Where serpentinized rocks are exposed, the streamflows have high magnesium concentrations. The quality of the groundwater along parts of the east edge of the GSP area is influenced by seepage from the San Joaquin River and the Eastside Bypass. This water is of low salinity and bicarbonate is the major anion. Because DMC water has been used for irrigation for many decades, the quality of this water has influenced groundwater quality in the upper aquifer throughout the service area. The DMC water has a much higher salinity than that of the San Joaquin River, and irrigation with the DMC water has contributed to an increased salinity of groundwater in the upper aquifer.

Upper Aquifer

Hotchkiss and Balding (1971) compared the quality of groundwater in the upper aquifer to that of streams in the Tracy-Dos Palos area. They indicated that the bicarbonate-type groundwater bodies were recharged by the streams that had the largest drainage basins, namely, Del Puerto, Orestimba, San Luis, and Los Banos Creeks. The TDS concentrations in groundwater of the bicarbonate type often ranged from about 400 to 600 mg/l, and increased in the downgradient direction, from west to east, in the late 1960's.

The concentrations of TDS ranged from about 1,200 mg/l to the west to around 700 mg/l towards the San Joaquin River in the late 1960's. There are areas of sulfate-type groundwater in the central and southern parts of the Tracy-Dos Palos area. Sulfur springs are present on Crow and Orestimba Creeks, indicative of sulfate-bearing deposits in the watershed that are probably responsible for the type of groundwater in the area.

There is chloride-type groundwater in parts of the Grassland Water District, east of Gustine and around Dos Palos. Sodium chloride type groundwater extends from near Mendota northward to Dos Palos. TDS concentrations in the chloride-type groundwater in the Grassland Water District ranged from 500 to around 13,000 mg/l in the 1960's.

There are transitional types of water (bicarbonate-sulfate and sulfate-bicarbonate) such as near Gustine, and these represent mixtures of water from various sources. In the vicinity of Los Banos, most of the transitional type groundwater is sulfate-chloride and bicarbonate-sulfate, but near the San Joaquin River it is chloride-bicarbonate in type. The TDS concentrations in the transitional type groundwater ranged from about 400 to 4,200 mg/l in the 1960's.

Good quality groundwater is present in the upper aquifer near Mendota and to the east, where recharge from the San Joaquin River, Eastside Bypass, and Mendota Pool are significant.

Electrical Conductivity

KDSA (1997b), as part of studies for the CCID, mapped electrical conductivities and boron concentrations in the upper aquifer, based on analyses for the 1990's. Figure 29 of KDSA (1997) showed electrical conductivities for the upper aquifer, which is reproduced herein as Figure 49. Groundwater with electrical conductivities of less than 1,200 micromhos per centimeter at 20°C was present in areas recharged by the larger westside streams, from Los Banos Creek to near Crows Landing. Relatively low electrical conductivities were also found along the east side

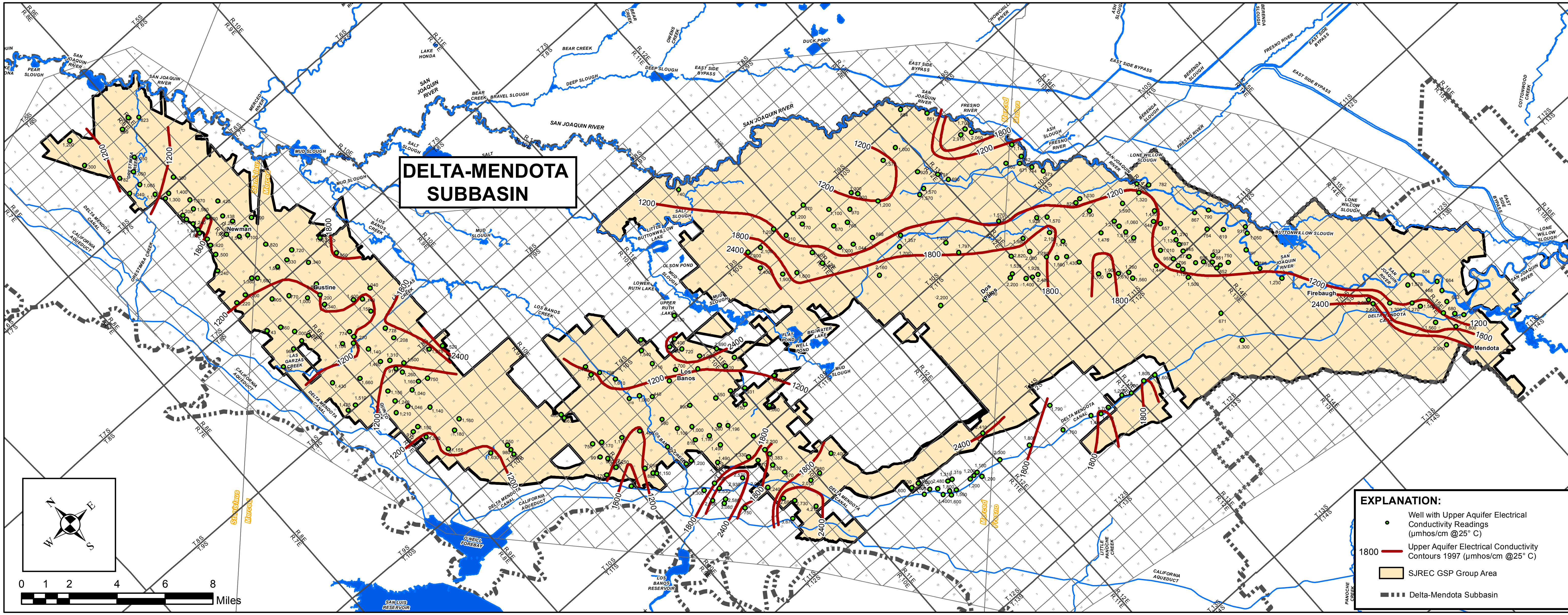


FIGURE 49 - ELECTRICAL CONDUCTIVITIES FOR WELLS TAPPING THE UPPER AQUIFER (1997)

of the area near the San Joaquin River, from south of Highway 152 to near Mendota.

An exception to the pattern of low groundwater salinity to the east, was an area of high electrical conductivity in the center of T10S/R13E. A zone of relatively shallow brackish water is indicated by interpretation of many electric logs in this area. The area of brackish water appears to underlie a large part of the San Luis Canal Co. area, and virtually all water supply wells in this area are completed above a depth of about 250 feet, above the brackish water zone.

Electrical conductivities greater than 1,800 micromhos were in 1) areas recharged by creeks south of Los Banos Creek, 2) an area of poor quality groundwater southwest of Mendota, 3) at the downslope ends of westside alluvial fans in T8S/R9E and T9S/R9E, and 4) in an area northeast of Los Banos. These are believed to have been due to historical evaporation of shallow groundwater in those areas.

Intermediate electrical conductivities (1,200 to 1,800 micromhos) were associated with the smaller westside drainages and in an area adjacent to the area of low electrical conductivity groundwater near the San Joaquin River.

As part of the KDSA (2008, Figure 19) evaluation, an updated map was prepared to show the distribution of electrical conductivity in the upper aquifer for the mid-2000's in parts of the Exchange Contractors service area where recent data were available. In the KDSA (1997b) report, electrical conductivity contours for 1,200, 1,800, and 2,400 micromhos were shown for the 1990's. These same contours are shown for the mid-2000's, where data were available. Substantial data were available for the area between Dos Palos and Mendota, in the Crows Landing and Newman areas, and in the Los Banos area. Overall, these contours were generally similar to those for the 1990's.

A substantial amount of information on electrical conductivities of well water is available for the New Columbia Ranch in Sub-area J. Electrical conductivities exceeded 1,200 micromhos per centimeter in water from several wells in an area primarily north of the extension of Avenue 5 and Avenue 8. These moderate to high electrical conductivities were present in a southeasterly trending lobe east of the Buttonwillow Slough. Water from four wells in this area had electrical conductivities ranging from 1,710 to 1,860 micromhos in 2001. Another localized area of high salinity was indicated to the southeast. The lowest electrical conductivities (less than 600 micromhos) near the Eastside Bypass (Chowchilla Canal Bypass). Seepage from the Bypass is indicated to be an important source of recharge in Sub-area J.

The electrical conductivities for well water increased substantially to the southwest in the Sub-area H. The highest electrical conductivities were in water from three wells and ranged from 2,073 to 2,351 micromhos in July 2004. A localized area of high electrical conductivity (exceeding 1,200 micromhos) was present north of Hutchins Road and west of San Juan Road. The lowest electrical conductivities (less than 900 micromhos) were near the Santa Rita Slough and in the area south of Roosbury Road, and in a localized area north of Highway 152 and west of San Juan Road.

The electrical conductivity map for the area south of Sub-area H was generally consistent with that for the mid-1990's (Figure 29 of KDSA, 1997). However, a noticeable trend was for a number of the mid-2000's contours to be slightly northeast or downgradient of the contours for the mid-1990's. In the Mendota-Firebaugh area, the mid-2000's contours for 1,200, 1,800, and 2,400 micromhos averaged about a half mile east of those for the mid-1990's. This was consistent with observations from groundwater monitoring near Mendota, and with observations in the western part of Sub-area J, where TDS concentrations and electrical conductivities have increased during the past decade. The northeasterly migration of high salinity groundwater in the upper aquifer was due to the increased northeasterly water-level slope, which has been caused by decreased pumpage and subsurface irrigation drainage from the San Luis Unit of the CVP and by water-level declines in western Madera County, particularly in irrigated areas without surface water supplies.

Figure 50 is an updated electrical conductivity map for part of the SJREC GSA for 2012. A substantial amount of additional data has become available in the Sack Dam-Red Top area. In that area, electrical conductivities were usually much lower for groundwater in the lower aquifer than in the upper aquifer. Also, electrical conductivities of groundwater in the upper aquifer generally decreased to the northeast. South of Avenue 18-1/2, electrical conductivities for the upper aquifer exceeded 4,000 micromhos to the southwest, nearby the San Joaquin River.
The lowest electrical conductivities in this area (less than 500 micomhos) were to the east near the Eastside Bypass. In parts of the SJREC GSA where data were available, the same trends were generally present as in the mid 2000's.

KDSA (2006) reported on a more detailed evaluation of groundwater quality for the upper aquifer in Sub-areas F and I. Figure 6 of KDSA (2006) showed electrical conductivity of water from wells tapping the upper aquifer in the 1990's. This figure is reproduced in this report as Figure 51. Electrical conductivity of groundwater in the upper aquifer changed laterally over relatively short distances near Firebaugh. Values increased from 1,500 to 6,000 micromhos over a distance of about a mile. This area was upgradient of the San Joaquin River. Northeasterly

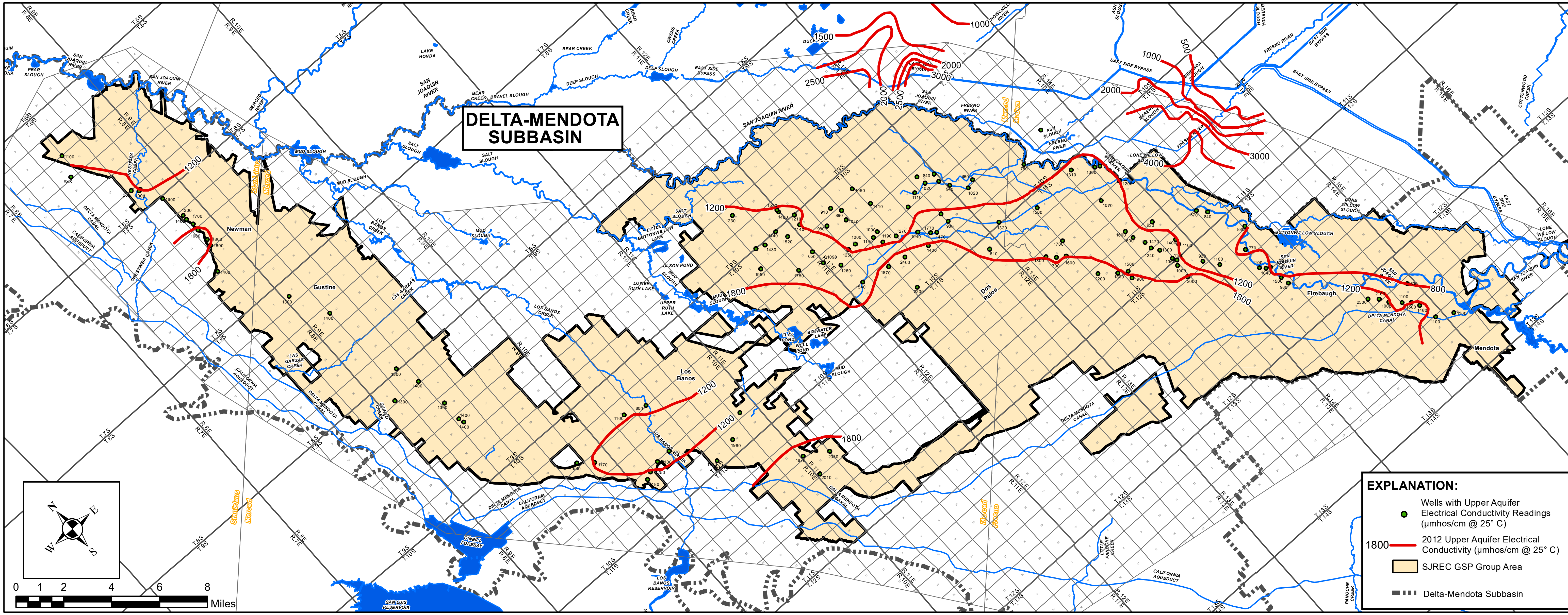


FIGURE 50 - ELECTRICAL CONDUCTIVITIES FOR WELLS TAPPING THE UPPER AQUIFER IN 2012

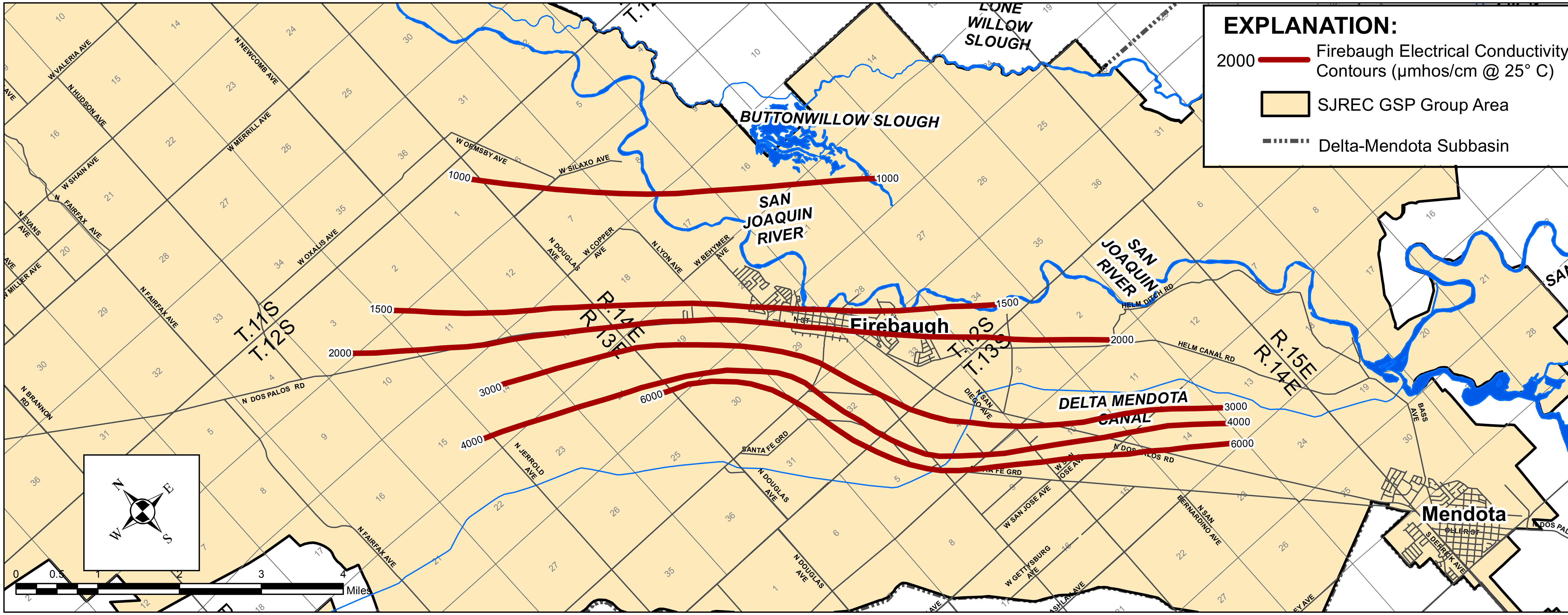


FIGURE 51- ELECTRICAL CONDUCTIVITY OF WATER FROM WELLS TAPPING UPER AQUIFER IN FIREBAUGH AREA IN THE 1990's

movement of high TDS groundwater in the upper aquifer has been occurring in this area for decades, due to decreased pumpage and irrigation drainage in the San Luis Unit of the CVP and by lowered water levels in western Madera County. A groundwater pumping and transfer program is being developed in the area northwest of Firebaugh by the Exchange Contractors to intercept the poor quality groundwater and beneficially use it through mixing with better quality surface water.

Time Trends. The CCID prepared updated hydrographs for District pumpage and electrical conductivity for four parts of the District. For CCID wells in the Mendota-Firebaugh area, electrical conductivities have generally increased since 1959. Rates of increase in electrical conductivity have generally been greater during periods of heavy pumping, compared to periods of little pumpage. More high salinity groundwater inflow from west of the wells appears to be induced during periods of heavy pumping, and there is more downward leakage of shallow high TDS groundwater. For the area between Firebaugh and Dos Palos, a similar pattern has been evident since 1959. For the Los Banos area, historical data for the CCID wells are limited, but no large changes in electrical conductivity are indicated. For the Gustine-Newman area, electrical conductivities in water from several wells, have increased since 1968, but the increases appears to be less than in the Firebaugh-Mendota area. Part of these increases is likely due to downward flow of poor quality shallow groundwater, particularly when water levels are significantly lowered in the underlying strata.

Boron

KDSA (1997b, Figure 30) also mapped boron in wells tapping the upper aquifer in the 1990's. Along the east part of the Exchange Contractors service area and south of Highway 152, boron concentrations were usually less than 0.5 mg/l. This is consistent with groundwater recharge in these areas from east side streams, which contain low boron concentrations. The lowest boron concentrations (less than 0.1 mg/l) in the upper aquifer were in T10S and T11S.

The distribution of boron concentrations in groundwater recharged by westside streams is more complex. The lowest boron concentrations in the groundwater to the west were associated with recharge from the larger westside streams, such as Orestimba, Los Banos, Garzas, and Quinto Creeks. Groundwater in some parts of this area contained more than 2.5 mg/l of boron. The second was in parts of T8S/R9E and T9S/R9E, northeast of Los Banos. These high concentrations were probably due to historic evaporation of shallow groundwater at the downslope end of the alluvial fan. Shallow groundwater southwest of Mendota also contained high boron concentrations. This is in the area where high salinity groundwater has been present for many decades.

As part of the KDSA (2008) evaluation, boron analyses of well water for 2004-05 were obtained and plotted. These values generally agreed well with the values for the 1990's. In general, higher boron concentrations in the mid-1990's corresponded to higher electric conductivities, as in the 1990's.

Lower Aquifer

The chemical quality of the groundwater in the lower aquifer in the much of the service area is less well known that of the upper aquifer, due to the overall small number of wells tapping the lower aquifer. In general, for the area north of Los Banos, in much of the western part of the rest of the CCID, and in the Red Top-El Nido area, TDS concentrations in groundwater below the Corcoran Clay are less than those in groundwater above the Corcoran Clay. However, experience in Dos Palos, the SLCC service area, Firebaugh, and Mendota indicates that higher TDS groundwater is present below the Corcoran Clay in those areas. High concentrations of hydrogen sulfide, iron, and manganese are present in the lower aquifer in some areas, particularly where reducing conditions are present.

Groundwater Quality Degradation

There are generally four types of groundwater quality problems that are important in the SJREC GSP. The first type comprise naturally occurring chemical constituents. Some of the most important in the SJREC GSP are nitrate, arsenic, hexavalent chromium, selenium, total dissolved solids (TDS), sulfate, chloride, and boron. Iron, manganese, and hydrogen sulfide concentrations are also important in some deeper groundwater under reduced conditions. For some of the deeper groundwater, high pH's and sodium adsorption ratios are a problem for irrigation use.

Most of these constituents are important in terms of developing new public supply wells to meet the Title 22 standards for public water supplies. The way those are normally handled is by conducting test well or pilot hole programs, whereby vertical trends in groundwater quality are determined. In this manner, either good quality groundwater is found and tapped by a suitable designed well, or the groundwater may be treated for specific constituents, if necessary. The SGMA program doesn't need to be directly involved with such programs. However, the data obtained are usually in the public record and can be periodically accessed and reviewed. Guidelines for the development of individual private domestic wells or irrigation wells in problem areas could be developed from this information.

The second type is termed a plume or point source contamination problem. Plumes by definition are usually long and narrow. Many of these fall under the jurisdiction of the Regional Water Quality Control Board. Numerous sites have Waste Discharge Requirements that are periodically updated. These are all in the public record and can be accessed through Regional Board websites and their offices in Sacramento and Fresno. It is recommended that the SGMA process not be directly involved in this process. If desired, the SJREC GSA could provide input to the Regional Board through the normal public process.

The third type is associated with nonpoint sources. The most important of these would be crop irrigation, including the use of fertilizers, soil amendments, water treatment chemicals, and increases in groundwater salinity due to concentration of salts by evapotranspiration. The Regional Board has an Irrigated Lands program. There is no reason for the SGMA process to directly get involved with that program, unless measures are proposed that would affect the SGMA program.

The fourth type is termed hydrogeologic modification. The most important one of these is the northeasterly migration of poor quality groundwater in the Dos Palos-Mendota area. The poor quality groundwater has been present in the upper aquifer, some distance west of the San Joaquin River. Northeasterly movement of this water has largely resulted from subsurface drainage and decreased pumpage in the CVP area west of the river and development of a large depression cone in Madera County east of the San Joaquin River. Historically, prior to large-scale pumping of groundwater, this poor quality groundwater would have been moved towards the San Joaquin River, and either discharged into the river or have been consumed by evapotranspiration of phreatophytes. This type of groundwater quality problem appears to be under the purview of the SGMA process.

Sustainable Management Criteria For Degraded Groundwater Quality

There are areas of relatively high salinity groundwater in the upper aquifer above the Corcoran Clay that extend from near Tranquillity to the south to near Red Top on the north. Much of this shallow groundwater is beneath agricultural drainage problem areas, where shallow groundwater has required the installation of subsurface tile drains. Much of the saltiest groundwater is indicated to be above the A-clay, a local confining bed that averages about 70 feet in depth. Evidence indicates that tile drains have intercepted most of this shallow groundwater. However, moderate to high salinity groundwater extends from below a depth of about 70 feet to near the top of the Corcoran Clay, except to the east near the San Joaquin River. This water can be pumped and mixed with canal water for beneficial use.

KDSA (2006) reported on a detailed evaluation of groundwater quality for the upper aquifer in Management Sub-areas F and I. Figure 6 of KDSA (2006) showed electrical conductivity of water from wells tapping the upper aquifer in the 1990's. That figure is reproduced in this report as Figure 51. Electrical conductivity of groundwater in the upper aquifer changed laterally over relatively short distances near Firebaugh. Values increased to the southwest from 1,500 to 6,000 micromhos over a distance of about a mile. This area was indicated to be upgradient of the San Joaquin River.

Northeasterly movement of high TDS groundwater in the upper aquifer has been occurring in this area for decades. A groundwater pumping and transfer program (GP/WT) was developed in the area southwest of Firebaugh by the Exchange Contractors to intercept the poor quality groundwater and beneficially use it through mixing with better quality surface water. The FCWD manages this program.

It has been proposed to eventually pump as much as 20,000 acre-feet per year from 20 interceptor wells located between Mendota and Fairfax Avenue. These wells are to be located between the CCID Main Canal and the DMC. The pumping was proposed to largely occur during eight months of the year. The top of the Corcoran Clay is at an average depth of about 350 feet in this area. Two pilot wells (Snyder and Del Rey) were installed and pumped for an extended period to obtain information for an environmental assessment study. Presently, there are seven wells in the program. Water samples are collected from the pumped wells on an annual basis for determination of electrical conductivity and boron. Downgradient wells that are monitored include CCID wells in the Poso Well Field.

The objective of the GP/WT project is to intercept as much of the moderate to high salinity groundwater that is moving to the northeast in the area above the Corcoran Clay as is feasible. Groundwater quality monitoring has been conducted for both the pumped wells and a number of CCID wells to the northeast. These results would be reviewed and evaluated about every three years.

INTERCONNECTED SURFACE AND GROUNDWATER SYSTEMS IN THE SJREC GSA

There are several areas in the SJREC GSA where the shallow groundwater is indicated to be in direct hydraulic continuity with streamflow. The only place where this situation is known to occur is along some reaches of the San Joaquin River. For many decades there were few shallow observation wells or monitor wells near the river in or near the SJREC GSA. Some of the only ones were north of the river at the New Columbia Ranch and near the former County of Fresno Mendota Landfill. Once the San Joaquin River Restoration Project became operative, a number of shallow monitor wells were installed for Reclamation along the river between Gravelly Ford and Stevinson.

Besides this information, another factor to be considered is the direction of groundwater flow in the upper aquifer. Where water-level elevation maps indicate flow towards the river from both sides, this is also usually an indication of a direct hydraulic communication, at least along reaches where the river is flowing. Upper aquifer water-level elevation maps for the area south of Highway 152 do not indicate flow toward the river from the east. Only general water-level elevation maps are available for the upper aquifer east of the river and north of Highway 152. However it appears that there is direct hydraulic communication between streamflow in the river for the reach north of Sub-area H. Water-level elevation maps for the upper aquifer are available south of the Merced River near Stevinson, and a westerly direction of flow toward the San Joaquin River is indicated. The same situation pertains farther north, in the west parts of the Turlock and Modesto Irrigation Districts.

Available data indicate that in some river reaches this direct hydraulic communication is present all or most of the time. An example is beneath the east branch of the Mendota Pool. In contrast, along other reaches, the direct hydraulic communication is only present during and following significant flows in the river. An example of this is east of the Mendota Pool, during periods when the river hasn't flowed continuously for many years.

KDSA evaluated water-level hydrographs for SJR Restoration Program shallow monitor wells near the river, and compared these to nearby river channel elevations (usually determined within 100 to 200 feet of the wells). Reclamation has identified six river reaches between the head of the Chowchilla Bypass and Hills Ferry Road. Reach 2B is located between the Chowchilla Bifurcation Structure and Mendota Dam. Water-level measurements for shallow monitor wells near the river indicate that for the part of this reach east of San Mateo Road, the shallow groundwater is in hydraulic connection with the river streamflow only near or slightly following periods of streamflow in this reach. At those times, groundwater levels near the river are above the river channel. In contrast, during periods of no streamflow, groundwater levels are below the stream channel, and no hydraulic connection exists. The part of the reach west of San Mateo Road coincides with the easterly or San Joaquin river branch of the Mendota Pool. Along this part of the reach, there is a hydraulic connection between the shallow groundwater and the water in the Mendota Pool. Shallow groundwater levels in this part of the reach are generally above the channel or bottom of the pool.

Reach 3 extends from Mendota Dam to Sack Dam. There is generally always streamflow along this reach, as the SLCC obtaining DMC water released from Mendota Dam that flows into the Sack Dam in a low flow channel. Water-level records were compared to the stream channel elevations at 14 sites along the reach. Groundwater levels were always above the nearby river channel, and thus the shallow groundwater was in hydraulic connection with streamflow in the river.

Reach 4A extends from Sack Dam to the Sand Slough Bypass. Water-level records and stream channel elevations at six locations along this reach were examined. Records indicate that within about two miles downstream of Sack Dam, groundwater levels are normally above the nearby channel elevation. Thus along this part of the reach, the shallow groundwater may be in hydraulic connection with flow in the river. Records at sites more than two miles downstream of Sack Dam to about a mile and a half downstream of the Highway 152 crossing of the river indicate shallow groundwater levels below the channel elevation. There is normally no streamflow in the river along this part of the reach, except for river releases or flood flows. Thus in this part of the reach, there is no hydraulic connection between shallow groundwater and flow in the river, except during periods of streamflow. For the third part of the reach, extending downstream to the Sand Slough Bypass, shallow groundwater levels are above the nearly channel elevation, and the shallow groundwater is in hydraulic connection with streamflow.

Reach 4B extends from the Sand Slough Control Structure downstream to the Mariposa Bypass. Records for seven sites along this reach were examined. At all of these sites, the shallow groundwater was above the nearby channel elevation, and thus the shallow groundwater was in hydraulic connection with flow in the river.

No shallow water-level records were available for Reach 4B2, which extends from the Mariposa Bypass to the Eastside Bypass.

Reach 5 extends from the Eastside Bypass to Hills Ferry Road. Records were examined for two sites near Fremont Ford. Shallow groundwater levels were above the nearly channel elevations. Thus the shallow groundwater was in hydraulic communication with streamflow in the river.

Figure 52 shows locations of interconnected groundwater and surface water bodies in or adjacent to the SJREC GSP, based on the foregoing information. The only relevant surface water body is the San Joaquin River.

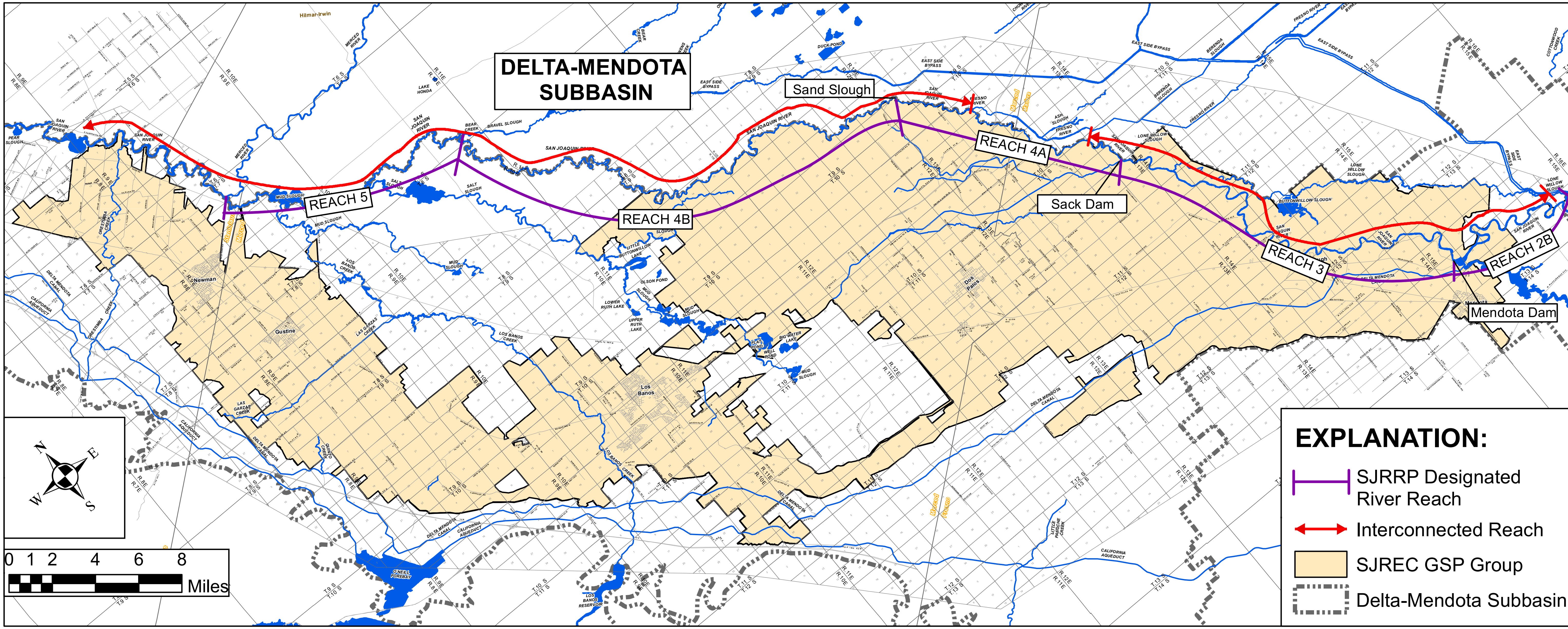


FIGURE 52 - INTERCONNECTED GROUNDWATER AND SURFACE WATER

KNOWN GROUNDWATER CONTAMINATION SITES

Figure 53 shows known contamination sites that were taken from the Regional Water Quality Control Board Geotracker website. Included are leaking underground storage tank (LUST) cleanup sites where groundwater was locally contaminated, and one Department of Toxic Substances Control (DTSC) cleanup site north of Los Banos. Other cleanup sites are for landfills or other types of sources that have affected groundwater. Overall, the groundwater contamination within these sites is indicated to be localized, and only in the shallow groundwater.

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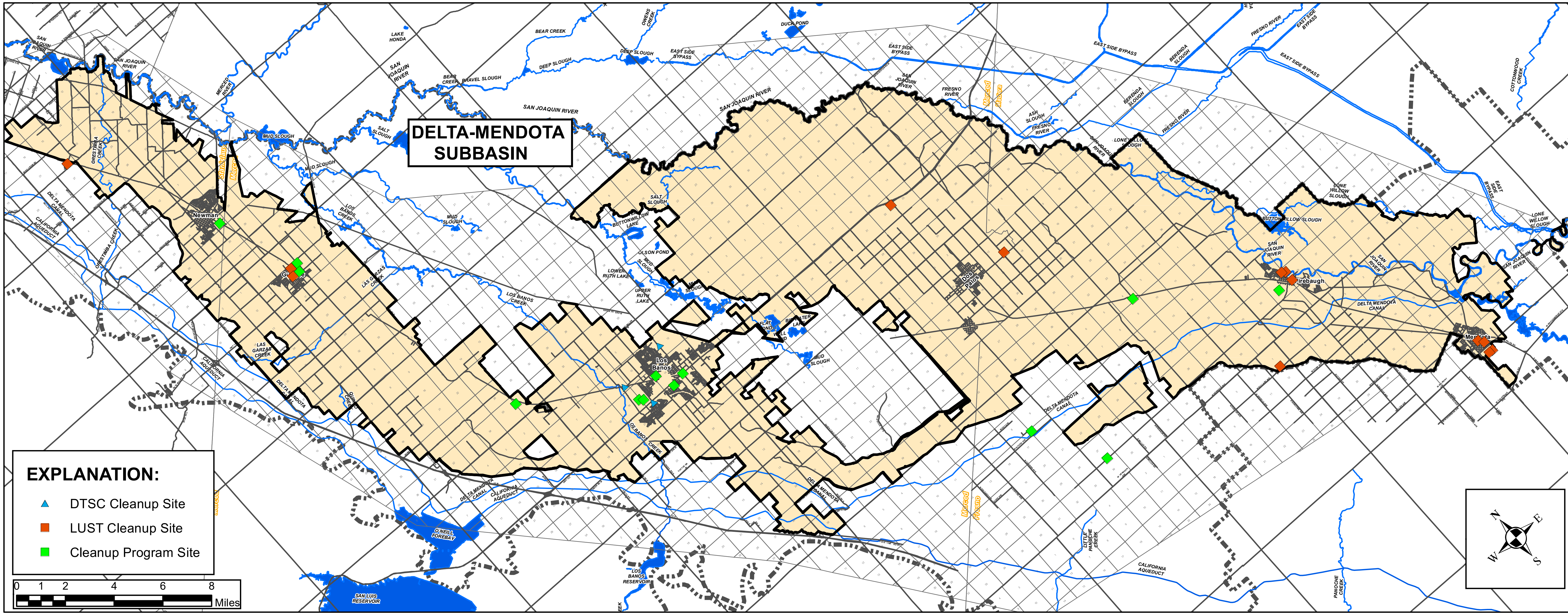

FIGURE 53 - KNOWN GROUNDWATER CONTAMINATION SITES

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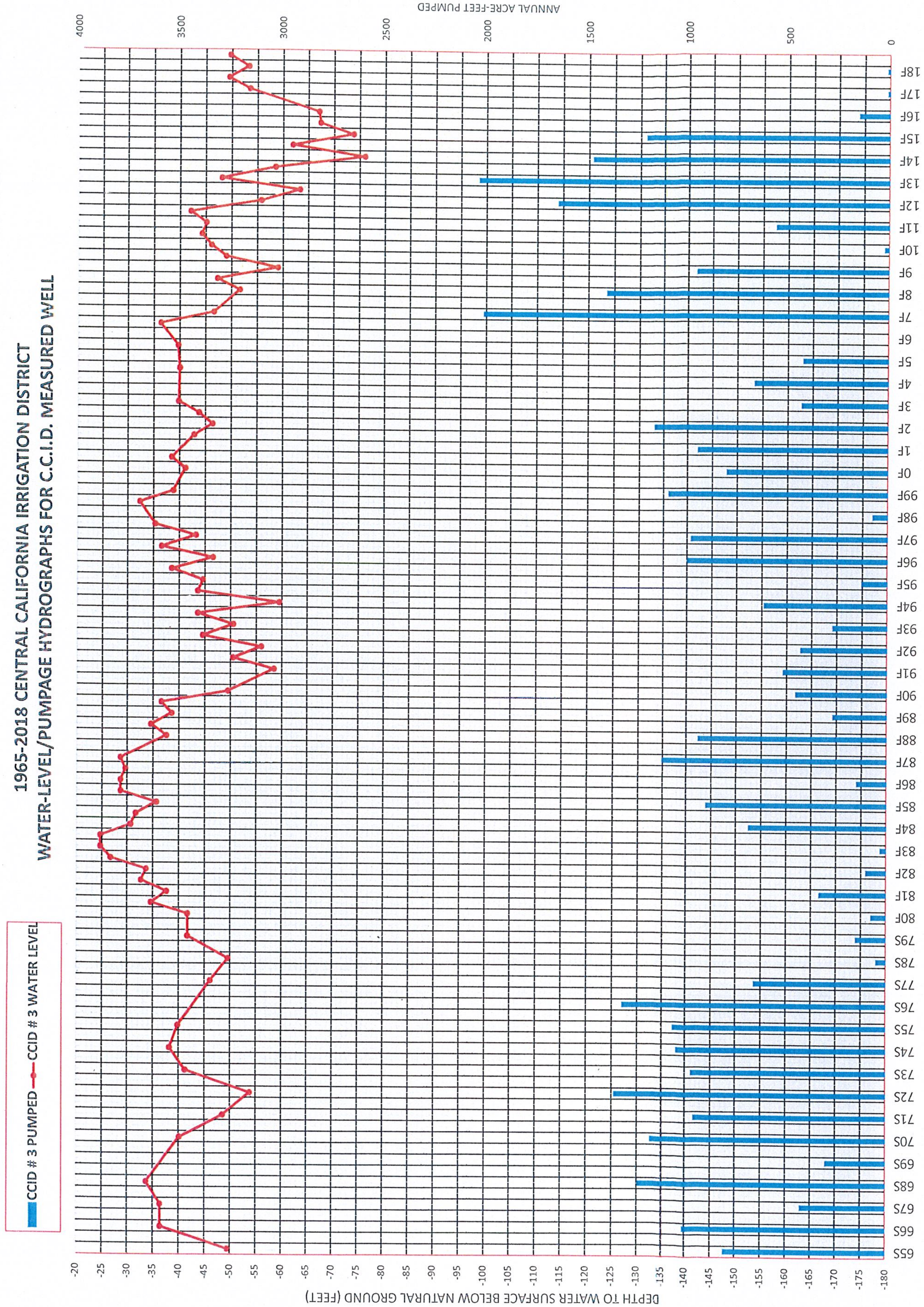
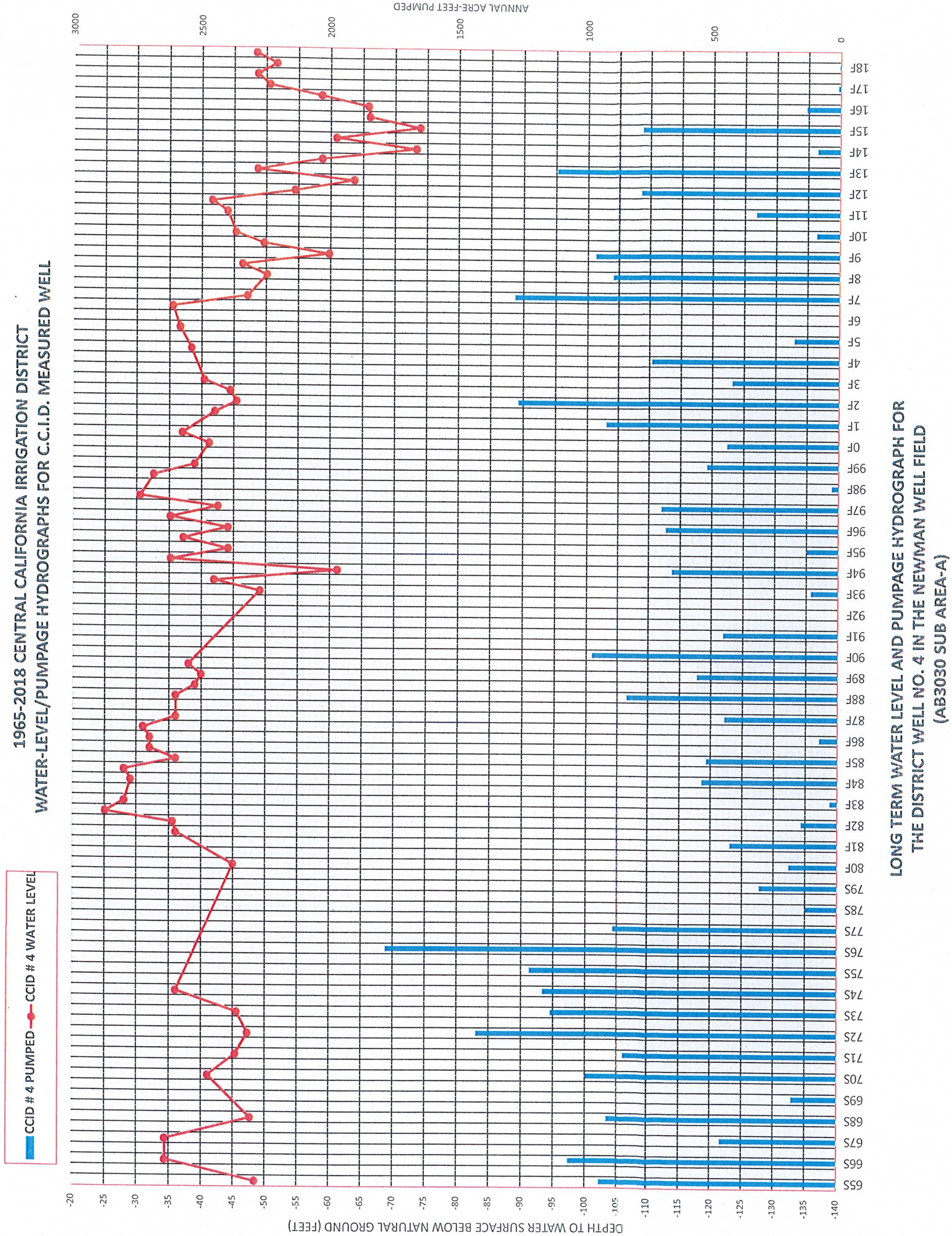
APPENDIX A

WATER-LEVEL HYDROGRAPHS

1965-2018 CENTRAL CALIFORNIA IRRIGATION DISTRICT
WATER-LEVEL/PUMPAGE HYDROGRAPHS FOR C.C.I.D. MEASURED WELL



LONG TERM WATER LEVEL AND PUMPAGE HYDROGRAPH FOR THE DISTRICT WELL NO. 3 IN THE NEWMAN WELL FIELD (AB3030 SUB AREA-A)


1965-2018 CENTRAL CALIFORNIA IRRIGATION DISTRICT
WATER-LEVEL/PUMPAGE HYDROGRAPHS FOR C.C.I.D. MEASURED WELL
CCID # 4 PUMPED
CCID # 4 WATER LEVEL
ANNUAL ACRE-FEET PUMPED
DEPTH TO WATER SURFACE BELOW NATURAL GROUND (FEET)
LONG TERM WATER LEVEL AND PUMPAGE HYDROGRAPH FOR
THE DISTRICT WELL NO. 4 IN THE NEWMAN WELL FIELD
(AB3030 SUB AREA-A)