EASTERN TULE GROUNDWATER SUSTAINABILITY AGENCY JOINT POWERS AUTHORITY

County of Tulare

City of Porterville

Porterville Irrigation District

Saucelito Irrigation District

Teapot Dome Water District

Vandalia Water District

Terra Bella Irrigation District

Kern-Tulare Water District

Meeting of the ETGSA Executive Committee

Thursday, February 18, 2021
Convenes at 2:00 p.m.

info@easterntulegsa.com
www.easterntulegsa.com

Eric Borba
GSA Chairman

Steve Kisling
GSA Vice-Chairman

Aubrey Mauritson
Legal Counsel

Rogelio Caudillo
General Manager

Zoom Videoconference:
Join Zoom Meeting
https://us02web.zoom.us/j/86231565983
Meeting ID: 862 3156 5983
By Phone:
+1 669 900 9128 US (San Jose)

In accordance with the Governor's Executive Order (N-29-20) and the declared State of Emergency, including social distancing directives as a result of the threat of the COVID-19 virus, committee members and ETGSA staff will be participating in this meeting remotely. There will not be a physical location for this meeting. Members of the public may participate in the meeting in the following ways:

Join Zoom Meeting
https://us02web.zoom.us/j/86231565983

Meeting ID: 862 3156 5983
One tap mobile
+16699009128,,86231565983# US (San Jose)

Dial by your location
+1 669 900 9128 US (San Jose)
Meeting ID: 862 3156 5983
Find your local number: https://us02web.zoom.us/u/kd7VV27UbT

----------AGENDA----------

Action items are listed in **bold.**

1. ROLL CALL

2. PUBLIC COMMENT

At this time, members of the public may comment on any item not appearing on the agenda. Under state law, matters presented under this item cannot be discussed or acted upon by the Committee at this time. For items appearing on the agenda, the public is invited to make comments at the time the item comes up for Committee consideration. Any person addressing the Committee will be limited to a maximum of three (3) minutes or the Chairman's discretion. At all times, please state your name for the record.

3. ANNOUNCEMENTS

4. MINUTES

a. ***ACTION*** **-** Approve the January 21, 2021 Executive Committee Meeting Minutes.

5. POLICY ISSUES

a. Report & Discussion on ETGSA Fees.

6. TULE SUBBASIN ITEMS

a. Discussion on Aquilogic Memorandum response *(committee may provide recommendation to the board).*

7. NEXT MEETING DATE

a. Next Regular Executive Committee Meeting- Thursday, March 18, 2021 at 2pm.

8. ADJOURMENT

A person with a qualifying disability under the Americans with Disabilities Act of 1990 may request the GSA Authority to provide a disability-related modification or accommodation in order to participate in any public meeting of the GSA Authority. Such assistance includes appropriate alternative formats for the agendas and agenda packets used for any public meetings of the GSA. Requests for such assistance and for agendas and agenda packets shall be made in person, by telephone, facsimile, or written correspondence to the GSA Authority Secretary or to the City of Porterville Public Works Department (559) 791-7804, at least 48 hours before a public GSA meeting.

EASTERN TULE GROUNDWATER SUSTAINABILITY AGENCY JOINT POWERS AUTHORITY

Agenda Item #4.a
Exhibit A

MINUTES OF THE EXECUTIVE COMMITTEE HELD JANUARY 21, 2021

At approximately 2:00 p.m. on January 21, 2021, Chairman Borba called to order a meeting of the Board of Directors of the District. Consistent with Executive Order N-29-20 and social distancing directives, the meeting was conducted by teleconference only, with no physical location for the meeting.

Executive Members Present:	Eric Limas	Sean Geivet
	Nick Keller	Eric Borba
	Steve Dalke	John M. Domondon
	Michael Knight	
Executive Members Absent:	Steve Etchegaray	Glen Fowler
	Denise England	

ROLL CALL

General Manager Caudillo called the roll with the following committee members indicating their presence:

Committee member Limas
Committee member Keller
Committee member Geivet
Committee member Domondon
Committee member Dalke
Chairman Borba

PUBLIC COMMENT

Chairman Borba announced the public comment period. No public comment was provided.

ANNOUNCEMENTS

General Manager Caudillo announced a friendly reminder for all those landowners within ETGSA to setup account with Basin Safe.

TO BE APPROVED

MINUTES

Approve the September 17, 2020 Meeting of the ETGSA Executive Committee Minutes

Committee member Keller moved for approval of the September 17, 2020 meeting of the Executive Committee minutes. Committee member Limas seconded. The motion was carried unanimously by way of the following roll call vote:

In Favor:
Committee member Limas
Committee member Keller
Committee member Geivet
Committee member Domondon
Committee member Dalke

Opposed: None.

POLICY ISSUES

Report and update on ETGSA Meetings

General Manager Caudillo provided a summary of meetings since the last Executive Committee meeting. Attached hereto and incorporated by reference as Agenda Item #5a is a copy of his report.

Public comment from Todd Turley.

Report from 4Creeks on ETGSA Accounting and Invoicing

Consulting Engineer De Groot reported on the ETGSA Accounting and Invoicing. Current focus is on Greater Tule Management Area. First step is to get all landowners set up with the Basin Safe online program. A second notice is forthcoming for those landowners that have not yet signed up. Once all the accounts set up, will send out various invoices.

Discussion ensued regarding Tier 2. Discussion ensued regarding fallowed grounds and consumption.

Consulting Engineer De Groot shared with the committee the FAQ section of the ETGSA website. He also shared a sample 2021 invoice schedule.

Public comment from Todd Turley.

Discussion ensued regarding Friant Water Authority's acquisition of right of way for the canal enlargement and how it relates to ETGSA's groundwater accounting.

NEXT MEETING DATE

Next Executive Committee Meeting – Thursday, February 18, 2021 at 2:00 pm

TO BE APPROVED

The next meeting of the Executive Committee is set for February 18, 2021, at 2:00 p.m.

ADJOURNMENT

As there was no further business to come before the Committee, Chairman Borba adjourned the meeting.

Respectfully submitted,

_____

Chairman Eric Borba

TO BE APPROVED

ETGSA Executive Committee Meeting
February 18, 2021

Agenda Item 5. a

Report & Discussion on ETGSA Fees

Staff Report to the ETGSA Executive Committee

Subject: ETGSA Fees

Submitted By: General Manager

Recommended Action: *n/a (report is for informational purposes*)

Executive Summary:

A summary breakdown cost of the three-management area for future assessment and member contribution. For the first half of ETGSA 20-21 Fiscal Year, the member agencies contributed funds towards ETGSA budget as they have in previous years. The second half of the ETGSA 20–21 Fiscal Year will be funded based on the assessment below (see also Exhibit A):

Greater Tule Management Area

- Groundwater Extraction Fee
  - Total Precipitation and Native Sustainable Yield (Buckets 1 & 2) will be allocated to parcels that are assessed.
  - Water rate assessment will fund the Greater Tule Management Area's portion of the approved 2020-2021 budget (50% for the initial year).
  - The first half of the approved 2020-2021 budget was paid by member agency contributions.
  - Assessments will be invoiced once for the 2020-2021 year at $4.92 per acre foot allocated.
  - Parcels that are 2 acres or less will receive a flat assessment of $9.84 (equal to 2-acre ft).

- Penalties
  - **Tier 1:** The Calculated volume of available overdraft water without surface water that is based on the calculated current overdraft in 2019 reduced to 90% then 80% then 30% calculated over 5-year periods between 2020 and 2035. This volume of water is allocated annually to the actively irrigated lands only.
  - **Tier 2:** Penalty Water utilized beyond all water buckets available and any remaining Tier 1 5-year block allocation. Any water used in this bucket is

reduced from the remaining volume available in Bucket 5: Tier 1 Transitional Water for subsequent 5-year blocks.

- Tier 1 & Tier 2 charges will be invoiced quarterly.

Community Management Area

- Management area composed of City of Porterville and unincorporated committees within the ETGSA boundaries.
- Management area will be managed differently from other management areas.
- Policies related to management area are currently a work in progress.

Kern-Tulare Water District Management Area

- Management area composed of Kern-Tulare Water District boundaries.
- Management area will be managed differently from other management areas.
- Policies related to management area are currently a work in progress.

Background: n/a

Fiscal Impact: n/a

Attachments:

- Exhibit A: Notice of the Groundwater Extraction Fee
- Exhibit B: 2021 Water Year Allocations- Greater Tule Management Area

Agenda Item #5.a
Exhibit A

Notice of Groundwater Extraction Fee

During the Eastern Tule Groundwater Sustainability Agency (ETGSA) Board of Directors meeting on August 6, 2020, the board approved sending the water rate study for public review and set a public hearing for October 1, 2020 at 2:00 pm. The Water Rate Study identifies the fee to be paid by property owners within the Greater Tule Management Area of the ETGSA to fund a portion of the Adopted 2020-21 Fiscal Year Budget to implement the Sustainable Groundwater Management Act (SGMA). Below is a summary of the Water Rate Study:

2020-2021 WATER RATE STUDY

		Breakdown of Budget		
Approved 2020-2021 Budget	*Administration / Overhead*	*Professional Services*	*Water Accounting*	*Technical Monitoring*
$1,519,210	*$496,710*	*$550,000*	*$200,000*	*$272,500*
Portion of Budget Paid by Water Rate Assessments (50% for the initial year):				
$759,605	***$248,355***	***$275,000***	***$100,000***	***$136,250***

The Water Rate is calculated using the total amount of the Sustainable Yield water available for 2020-2021, which includes the long term average total precipitation and the calculated native sustainable yield, which sums to 0.96 acre-feet per acre. Applied to the total gross acres of the ETGSA, the volume of water equates to 154,409 acre-feet per year of water. Applying the portion of the budget to this volume of water, the annual water rate is set at $4.92 per acre foot.

	Breakdown of Water Rate Per Acre Foot			
Total Water Rate ($/ac-ft)	*Administration / Overhead*	*Professional Services*	*Water Accounting*	*Technical Monitoring*
$4.92	*$1.61*	*$1.78*	*$0.65*	*$0.88*

The water rate will be applied to the parcels owned within the Greater Tule Management Area of the ETGSA, based on the County Assessor Records. A copy of the study is available on ETGSA's website or may be obtained by contacting the ETGSA office.

A Public Hearing on a groundwater extraction fee will be held via videoconference on October 1, 2020 at 2:00 pm for the ETGSA. Members of the public can attend the public hearing via videoconference at the following link:

us02web.zoom.us/j/89646217669
Call in: +1-669-900-9128
Meeting ID: 896 4621 7669

Written comments can be submitted online at **easterntulegsa.com/groundwaterextractionfee**

For more information on the Eastern Tule GSA and Sustainable Groundwater Management Act please visit: **easterntulegsa.com**

2021 WATER YEAR ALLOCATIONS - GREATER TULE MANAGEMENT AREA

Bucket of Water	October 1, 2020 - September 30, 2021 Water Year Allocation	Notes
1 - Total Precipitation	**0.89** AF/Acre	Average Precipitation for the 29 year period 1991 - 2019.
2 – Native Sustainable Yield	**0.15** AF/Acre	NSY = [Mountain Block Recharge + Tule River/Deer Creek/White River Natural Channel Loss]/Total Tule Subbasin Gross Acres. *(Basin Setting Table 2-4)*
3 - Landowner GW Credits	By Landowner	To be provided by individual landowner by separate agreement with other landowners. Future years may be carry over from Buckets 1 & 2 that were not used.
4 - Landowner SW Credits	By Landowner	To be provided by the Surface Water District or Surface Water Rights Holders. This includes surface water used for recharge, groundwater banking, irrigation demand, or prior credits accrued.
5 - Tier 1 (Transitional)	**3.53** AF/Acre	Total Current 2020 Irrigated Acres: 78,179 Acres
		Total Area of Greater Tule Management Area: 131,697 Acres
		Total 5-year (2015-2019) Average Annual Gross Consumption =240,701 acre-feet / year
		Total Average Gross Overdraft = Total Consumption - NSY - Total Ave. Annual Precip. = 103,455 ac-ft/yr
		90% of Gross Overdraft Available (Remaining 4 years): 92,087 ac-ft/yr (1.18 ac-ft/yr)
		Initial Year (2021) will include three years of annual allocations.
PENALTY WATER AVAILBLE FOR OVERUSE		
Tier 2 (Penalty)		Water used only to balance overuse. The amount used will be deducted from subsequent year transitional water allocations to that landowner.

ETGSA Executive Committee Meeting
February 18, 2021

Agenda Item 6.a

Discussion on Aquilogic Memorandum

Staff Report to the ETGSA Executive Committee

Subject: Tule Subbasin Items

Submitted By: General Manager

Recommended Action: *Committee may provide recommendation to the board.*

Executive Summary:

Aquilogic memorandum suggests that the treatment of subsidence in the ETGSA GSP and certain subsequent work was oversimplified and offered a hypothesis that three-dimensional deformation and propagation of subsidence from west of the ETGSA was impacting the Fraint-Kern Canal.

- Is pumping in ETGSA instigating and leading cause of land displacement?
- Other factors that can be contributed.
- Current groundwater flow model the best tool for predicting future subsidence?

Eastern Tule White Area Growers (ETWAG) asks that the committees review this memo to consider the final recommendations. These recommendations can be summarized as:

- ETGSA and Tule TAC recommend that FWA engage Lawrence Berkley Labs (LBL) independently to get input on whether and how FWA should consider horizontal stress caused by regional land subsidence impacts on the $500M+ canal re-design project.
- LBL and/or Aquilogic are made members of the ETGSA subsidence committee and that committee construct a workplan to evaluate factors that impact subsidence and potential methods to assess such factors. LBL has an existing 3D subsidence model of the region that has been used for PG&E pipelines, the High-Speed Rail project, and other central valley work. It could be relatively inexpensive to update the model to get a second opinion on the technical work underpinning the canal re-design project and the associated $125M ETGSA investment.

The ETGSA Stakeholder Committee met on February 11, 2021 and made the following recommendation to the ETGSA Board of Directors:

- Recommendation for Board to send the Aquilogic Memorandum to Land Subsidence Ad-Hoc Committee for consideration of recommendations.

Background:

Aquilogic gave a presentation to the ETGSA Stakeholder Committee, the ETGSA Executive Committee, and the ETGSA Board in August and September 2020. Aquilogic also presented at the Tule Subbasin Technical Advisory Committee (TAC) on October 21, 2020.

Thomas Harder presented responses to Aquilogic comments at the Tule Subbasin TAC meeting in October and at the ETGSA Board in November.

Fiscal Impact: n/a

Attachments:

- Exhibit A: Aquilogic Subsidence study Response to Comments and Recommendation for FWA Assessments

aquilogic, Inc.
environment ● water ● strategy

Agenda Item #4.a
Exhibit A

245 Fischer Avenue, Suite D-2
Costa Mesa, CA 92626
Tel. +1.714.770.8040
Web: www.aquilogic.com

December 4, 2020

MEMORANDUM

To: Eastern Tule Groundwater Sustainability Agency Board
From: Tom Watson, aquilogic, Inc.
Bob Abrams, aquilogic, Inc.

Subject: Aquilogic Subsidence Study: Response to Comments and Recommendations for FWA Assessments
Tule Subbasin and Friant-Kern Canal Subsidence
Project No.: 038-02A

Aquilogic, Inc. (**aquilogic**) gave presentations to the Eastern Tule Groundwater Sustainability Agency (ETGSA) Stakeholder Committee, the ETGSA Executive Committee, and the ETGSA Board in August and September 2020 regarding our comments on the ETGSA Groundwater Sustainability Plan (GSP).[1] During these presentations, we suggested that the treatment of subsidence in the ETGSA GSP and certain subsequent work was oversimplified and we offered a hypothesis that three-dimensional (3D) deformation and propagation of subsidence from west of the ETGSA was impacting the Friant-Kern Canal (FKC), in addition to locally caused subsidence. Our presentations evolved over time as we continued to receive feedback, learn more, and refine our hypothesis. Our most recent presentation was to the Tule Subbasin Technical Advisory Committee (TAC) on October 21, 2020. In that presentation, we asked three questions, which formed the basis for our analysis:

1. Is pumping in the ETGSA the instigating and leading cause of land displacement (subsidence) at the FKC (MP 90-120)?
2. Are there other factors that can contribute to the observed undesirable results?
3. Is the current groundwater flow model, which is limited to one-dimensional (1D) simulation of subsidence, the best tool for predicting future subsidence?

It should be emphasized that our intention has been to present a hypothesis that we hope will motivate additional subsidence-related work in the Tule Subbasin, and especially regarding the FKC (see below). It was never our intention to suggest that the material we presented represents the final conclusions of an analysis.

[1] Aquilogic (2020). Comments on Tule Subbasin Groundwater Sustainability Plans pertaining to existing and predicted future subsidence. Prepared for Wonderful Orchards by aquilogic. May 27, 2020.

In reviewing the various Thomas Harder & Company (THC) responses to **aquilogic's** hypothesis on the relationship between subregional land subsidence and undesirable results at the FKC, we thought it important to clarify a few salient points and remarks made by THC regarding the hypothesis. We provide this information, like all of our related presentations, with no other intent than a collegial exchange of ideas, and thus have chosen to refrain from responding line by line to the THC presentation materials, many of which we believe reflect a noticeable and unfortunate informational bias against new concepts not specifically included in the current ETGSA GSP or subsidence monitoring plan.

It is important to reemphasize here that, contrary to suggestions by some, the purpose of our study was not to delay or derail ongoing negotiations with the Friant Water Authority (FWA) regarding costs to repair the FKC, nor to somehow hold the ETGSA or white area growers blameless for the undesirable results identified at the FKC. We have always recognized that ETGSA pumping is a contributor to subsidence observed along the FKC, however we continue to maintain that a holistic solution to ongoing subsidence requires recognition and detailed assessment of contributing hydraulic and 3D geomechanical factors both within the Subbasin and far downgradient from the ETGSA.

For brevity, this review is comprised of three parts: (1) Background, (2) Responses to Selected THC Comments, and (3) Conclusions and Recommendations. The discussion herein is based on a recent THC technical memorandum,[2] THC presentations, our reviews of the relevant scientific literature to date, and discussions with third-party experts.

BACKGROUND

As noted, our presentations evolved over time, as did the three motivating questions stated above. The purpose of the **aquilogic** study, which has also evolved, is fourfold:

1. In a hypothesis testing mode, evaluate research conducted by independent experts (i.e., the U.S. Geological Survey [USGS], Jet Propulsion Laboratory [JPL], Lawrence Berkeley Laboratory [LBL], and Virginia Polytechnic Institute and State University [Virginia Tech]) to understand the history and potential future of Tule Subbasin land subsidence, caused by pumping-induced 3D deformation of the subsurface,
2. Better inform the ETGSA, other Tule Subbasin GSAs, FWA, and other stakeholders about the local and regional causes of subsidence related to current and future undesirable results at the FKC and factors for consideration in the design of the FKC fix,
3. Support THC, other Tule Subbasin technical consultants, ETGSA, Subbasin stakeholders, and FWA by providing this information for consideration, and

[2] THC (2020). Responses to Aquilogic comments on land subsidence in the Eastern Tule Groundwater Sustainability Agency area. Technical Memorandum prepared for David De Groot (4 Creeks) by Thomas Harder (Thomas Harder & Co). October 12, 2020.

4. Provide recommendations for an integrated and coordinated subsidence mitigation solution consistent with SGMA.

With the exception of data from various Tule Subbasin GSPs, much of the data we used to develop the hypothesis is from peer-reviewed scientific publications, and not based on our own opinions. As noted in item #1 above, we tested our hypothesis against available scientific literature and existing data and presented our materials to recognized experts at LBL and JPL for their input. This process led to some additional insights and refinements, but most importantly it did not result in overturning the basic concepts we have presented to date. Furthermore, the deeper we look into these issues, the more peer-reviewed scientific material we find that supports our hypothesis. Condensed and simplified, these concepts are:

- The subject of land subsidence in the Tule Subbasin is more complex than currently portrayed in Tule Subbasin GSPs and various THC reports and presentations,
- Geology and aquifer characteristics, along with the distribution and amount of local and more distal pumping to the west of the ETGSA, are likely contributing factors to FKC subsidence,
- The Tule Subbasin is administerial with only one true hydraulic boundary, the eastside foothills of the Sierra Nevada Mountain Range (Sierras), and is hydraulically connected to three neighboring subbasins,
- Aquifers within and directly adjacent to the Tule Subbasin are part of a subregional and hydraulically connected groundwater flow system. Based on USGS and JPL data, deep sustained pumping of groundwater aquifers downgradient from the ETGSA, including areas outside of the Subbasin, have caused significant levels of subsidence Subbasin-wide and at the FKC,
- The USGS has measured historic subsidence in the Subbasin as early as 1926 which, based on recent JPL Interferometric Synthetic Aperture Radar (InSAR) data, appears to have propagated more or less radially in all directions, merging with other subsidence "bowls," and has shifted and deepened over time,
- Pumping-induced subsurface deformation that results in land subsidence is non-uniform, with both vertical and horizontal components (i.e. 3D; east-west, north-south, and vertical),
- 3D deformation caused by subsidence can exert strong horizontal forces over considerable distances, which are capable of causing damage to surface and buried infrastructure (pipelines, rail, canals, etc.) especially at the edges of subsidence bowls and in fine-grained soils along subbasin margins where aquifer materials tend to thin,
- The USGS groundwater flow model (MODFLOW-OWHM), suggested by the California Department of Water Resources (DWR) for use in GSP development, only provides a 1D subsidence solution to a 3D subsurface deformation challenge,
- The MODFLOW Subsidence Package, which is designed for assessing confined aquifers, overestimates vertical compaction in unconfined/semiconfined aquifers, such as those generally found east of Highway 99, and

- 1D subsidence models tend to focus excessive amounts of vertical deformation near a pumped well.[3]

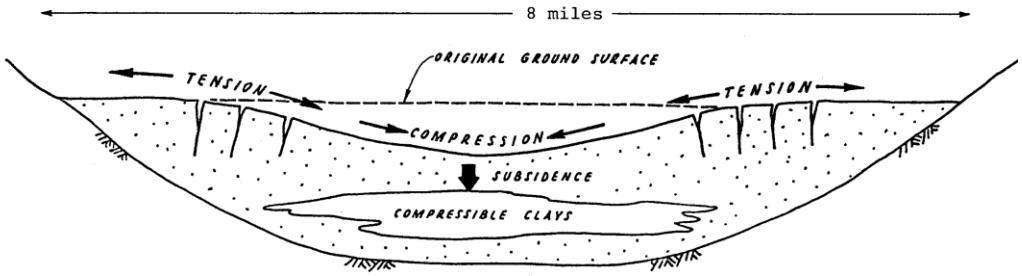
Responses to Selected THC Comments

Before clarifying some of the THC comments and conclusions related to our presentation(s), it should be made clear that we thought the ETGSA GSP had probably checked the boxes to meet the minimum Sustainable Groundwater Management Act (SGMA) requirements of assessing SGMA-identified undesirable results, of which subsidence is one. We also acknowledge that additional data would be helpful to further support what we have proposed to date and have made recommendations to that point in this response. Below, we have provided the THC conclusion in italics followed by our clarifying comment.

- **THC**: *It is not likely that ground tilting from 20 feet of land subsidence in the western Tule Subbasin has contributed substantially to land subsidence beneath the FKC located 20 miles away*. **Response**: While there was no data or analysis provided by THC to substantiate this opinion, the subject land subsidence, as documented historically by USGS benchmark measurements and more recently by JPL InSAR data, extends to well over 10 feet vertically in many areas and covers portions of three adjacent counties and most of Tulare County. These subsidence bowls represent a tremendous volume of earth displacement. Horizontal stresses are known to increase outward from the center of a subsidence bowl and are cumulative, with the highest stresses found at or near the margins of the bowl. These horizontal stresses are exacerbated at subbasin margins where aquifers tend to thin, and most especially if fine-grained materials are present. As illustrated below conceptually for an eight-mile-wide subsidence bowl in Arizona,[4] these stresses lead to ground tilting, horizontal compression in the center of a subsidence bowl, and horizontal tension at the margins of a subsidence bowl, which can lead to earth fissures:

[3] Burbey, T.J. and Helm, D.C. (1999). Modeling three-dimensional deformation in response to pumping of unconsolidated aquifers. Environmental & Engineering Geoscience, Vol. V, No.2, Summer 1999, pp. 199-212.

[4] Viets, V.F., Vaughan, C.K., and Harding, R.C. (1979). Environmental and economic effects of subsidence, LBL-8615, GSRMP-1, UC-66e. Earth Sciences Division, Lawrence Berkeley Laboratory, University of California, 251 p.



(Maximum Subsidence ≃ 5 feet)

Figure III-A-2. Features of a typical subsidence area. (Willcox, Arizona).

During a conversation with the experts at LBL, in which **aquilogic** and THC participated, LBL stated that recent horizontal displacement due to tension along portions of the FKC could differentially exceed at least 1 foot and such forces are known to propagate over long distances. Two recently published scientific papers further support the **aquilogic** hypothesis and illustrate the potential impact of 3D geomechanical stresses.[5,6] These two papers discuss tensional forces near Pixley and the FKC, and note the existence of a subsidence-related tensional surface feature referred to as the Pixley Fissure, which was identified in the late-1960s.[7] Fissures such as the Pixley Fissure are often unreported if on private land and/or become infilled rapidly by standard agricultural land practices or land-leveling, therefore they are generally not permanent features and can escape being noticed. Nevertheless, the Pixley Fissure is hard evidence of the tensional forces that exist at the edges of subsidence bowls impacting the Tule Subbasin. As the primary Tule Subbasin subsidence bowl expands eastward, the region affected by horizontal tension would also be expected to shift eastward, toward the FKC.

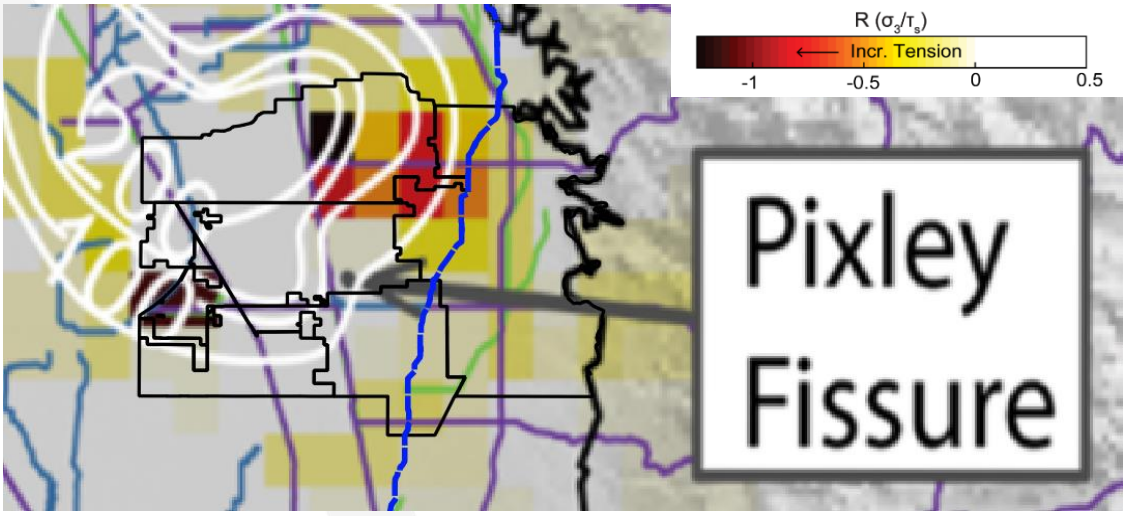
In fact, an analysis of geomechanical stresses in the Tule Subbasin area during the 2007-2010 drought shows tensional forces underlying the FKC. In the figure below,[6] the GSAs comprising the Tule Subbasin are shown as black lines, the blue line is the FKC, the location of the Pixley Fissure is shown, the white contours indicate total volume strain, and the colors indicate tensional forces, with darker colors indicating increasing tension. As shown by the yellow, orange, red, and black colors, strong tensional forces were at work during this

[5] Rucker, M. L., Fergason, K. C., and Smilovsky, D. (2019). The Pixley Fissure revisited—Understanding an old geohazard to safeguard new infrastructure. *In* IAEG/AEG Annual Meeting Proceedings, San Francisco, California, 2018. Cham: Springer, Vol. 5, p. 69–76.

[6] Carlson, G., Shirzaei, M., Ojha, C., and Werth, S. (2020). Subsidence-derived volumetric strain models for mapping extensional fissures and constraining rock mechanical properties in the San Joaquin Valley, California. Journal of Geophysical Research: Solid Earth, 125, e2020JB019980.

[7] Guacci, G. (1979). The Pixley Fissure, San Joaquin Valley, California. *In* Saxensa, S.K. (ed.), Evaluation and Prediction of Subsidence, International Conference on Evaluation and Prediction of Subsidence, held at Casino Hotel, Pensacola Beach, Florida, ASCE Engineering Foundations Conferences, p. 303-319.

period adjacent to and beneath the FKC. There are many factors that contribute to fissuring, but the underlying subsidence-induced stresses appear to be present and could be directly impacting the FKC now or in the near future. There is a risk of fissure formation at and near the FKC.



- **THC:** *Groundwater pumping closer to the Canal will have a greater impact on groundwater levels and, therefore, land subsidence at the Canal*. **Response:** While the logic of this THC statement is sound on its face, it appears to limit its scope to ETGSA-related effects, including some adjacent areas, and does not answer the obvious question, "What effects do downgradient and more distant deep groundwater pumping have on the long-term efficacy and permanence of the currently proposed FKC fix?" We believe further data and model analysis, in addition to what has previously been conducted, is needed to determine the potential impact of more distal pumping-induced subsidence on the FKC. Because MODFLOW's subsidence capability is limited to 1D vertical, **aquilogic** suggests that other modeling codes, such as those used by LBL, be considered for such an analysis. Without this information, and a more holistic (Subbasin-wide) approach, we believe a comprehensive solution for the FKC fix will likely be elusive and could result in the need for additional expensive post-fix repairs or modifications, and could potentially lead to associated future liability to FKC stakeholders in the ETGSA/Subbasin, should subsidence exceed the current MODFLOW estimates.

- **THC:** *Land subsidence occurs from lowering groundwater levels in areas where the subsurface contains thick layers of clay - both conditions are present near the Friant-Kern Canal, particularly south of the Tule River*. **Response**: Please see the responses to the first two bullet items directly above regarding geomechanical forces at the Subbasin/subsidence-bowl margins and MODFLOW. We accept that local pumping-induced dewatering of clay

sequences can lead to subsidence at or near the FKC. However, based on the data **aquilogic** has reviewed and compiled, deep, downgradient pumping (i.e., to the west of the FKC), can also contribute to FKC subsidence. Further, because aquifer materials are known to thin along the eastern margins of the Subbasin where the FKC is located, these areas have a higher potential for the propagation of subsidence-induced horizontal geomechanical forces. The significance of these forces is described in the scientific literature.[6]

- **THC:** *A critical missing element of their presentation is the context of scale-the acknowledgement of the vertical exaggeration shown in their graphics*. **Response:** Please see the response to the first bullet item above. Based on our take-aways from the THC presentations, we assume this comment pertains primarily to the THC unsubstantiated opinion that propagating subsidence and associated horizontal deformation cannot substantially contribute to impacts at the FKC. The suggestion that the scale of the **aquilogic** hypothesis would somehow affect the technical underpinnings of the hypothesis or its merits seems to be a distraction at best when the scientific literature and data are viewed in total. Significantly, the experts at both LBL and JPL did not express any issues or concerns with regard to the physical scale of **aquilogic's** hypothesis and they did not reject its conclusions. Turning to specific examples, the Subbasin geologic cross section we utilized for the purpose of explaining geologic relationships was from Tule Subbasin GSP materials prepared by THC, and the InSAR video **aquilogic** presented was from a report prepared by JPL specifically for DWR on Central Valley subsidence. The THC cross section provided key landmarks (e.g., Highway 43, Highway 99, Highway 65) as well as vertical scales. These features were described during our presentations. For the JPL video, it was apparent that the perspective encompassed a wide swath of the Central Valley. To orient the viewer, we pointed out the relevant geographic landmarks and the maximum scale of the propagating subsidence captured by the JPL InSAR data, which was approximately 37 inches (~3 feet) for the 2007-2010 period. That amount of measured subsidence for this three-year period, which encompasses the width of the Central Valley, should be noteworthy with respect to maintenance and operations and the potential for damage to critical infrastructure like the FKC. **Aquilogic** intended the video to be a demonstration of the concept of how subsidence has, and continues to, propagate over time from a few centralized locations and spread outwards towards more distant areas, including towards the FKC, in addition to locally caused subsidence.

CONCLUSIONS AND RECOMMENDATIONS

In summary, based on our study and THC's work in the Subbasin, we see two separate but complementary elements that require further assessment. Our study assessed and proposed a hypothesis on how subregional 3D subsidence has propagated outward from distant subsidence centers and the relationship of horizontal ground stresses to such subsidence. These issues are

not typically considered in SGMA and the ability to simulate these issues is absent from USGS groundwater flow models, such as MODFLOW, which only assess 1D vertical land subsidence. The THC work to date is focused on SGMA requirements, utilizing MODFLOW to assess groundwater flow and 1D subsidence. Founded on this understanding we recommend the following:

1. The potential for horizontal deformation to impact the FKC is a structural design and planning issue, as such we recommend that the prudent course is to remove it from the SGMA discussion by facilitating a direct conversation between the experts at LBL and the engineers at FWA. Because LBL has the recognized expertise and ability to independently model 3D deformation, there is no need for Subbasin stakeholders to be distracted from current SGMA efforts or spend the time and funds to build a new model to assess these forces. Benefits to this approach include:

    - Segregation of responsibility for assessing potential structural issues of the proposed FKC fix to the FWA and away from the SGMA process.
    - A more thorough analysis to inform the comprehensive fix for the FKC and potentially less future liability for ETGSA, Subbasin stakeholders, and Friant stakeholders.

2. Further refinement of the mechanism governing subsidence propagation is important to the long-term efficacy of proposed SGMA Project Management Actions (PMAs) in the ETGSA/Subbasin and the proposed FKC fix. To address this, we recommend that work be done cooperatively with LBL to conduct focused simulations beyond those previously completed by THC. As part of this effort, the proposed LBL modeling team would consult with the ETGSA to integrate, among other items, all necessary existing well location and construction information, groundwater level data, groundwater pumping data and geospatial data. Benefits to this approach are:

    - It integrates the ideas presented in our hypothesis and relevant SGMA requirements, as well as potential FKC engineering considerations, by providing for more coordinated and sustainable groundwater resource planning.
    - It provides further substantiation of the contributions to existing and future subsidence impacting the FKC, allowing for greater certainty for future conditions, the possibility to bring more parties to the table with regard to cost allocations for the FKC fix and helps stabilize FWA funding concerns related to the project.