Kinney County GCD Board Meeting

Bill Hutchison

April 10, 2024

Topics

- Data availability and use
- Geologic update progress report

Topics

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- Geologic update progress report

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- Geologic update progress report

Data Availability and Use

- USGS Site link (Las Moras Spring data):

https://waterdata.usgs.gov/monitoring-location/08456310/#parameterCode=00065&period=P7D&showMedian=false

- TWDB (Quad 807 precipitation and evaporation data):

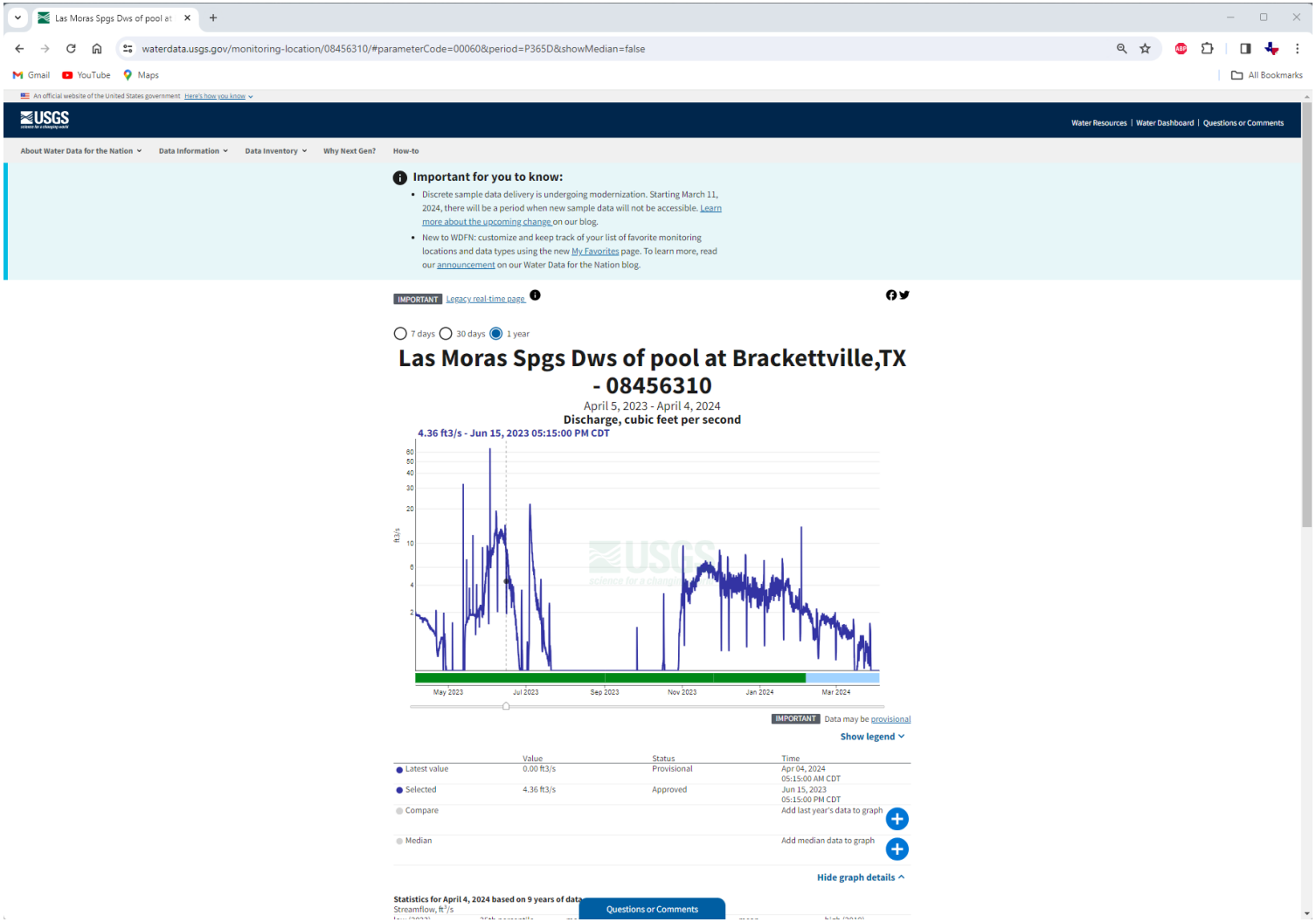
https://waterdatafortexas.org/lake-evaporation-rainfall

- Google Drive data:

https://drive.google.com/drive/folders/1mpyv5T2_CcDl5CLMDIFeYOwvpPLudW2H?usp=drive_link

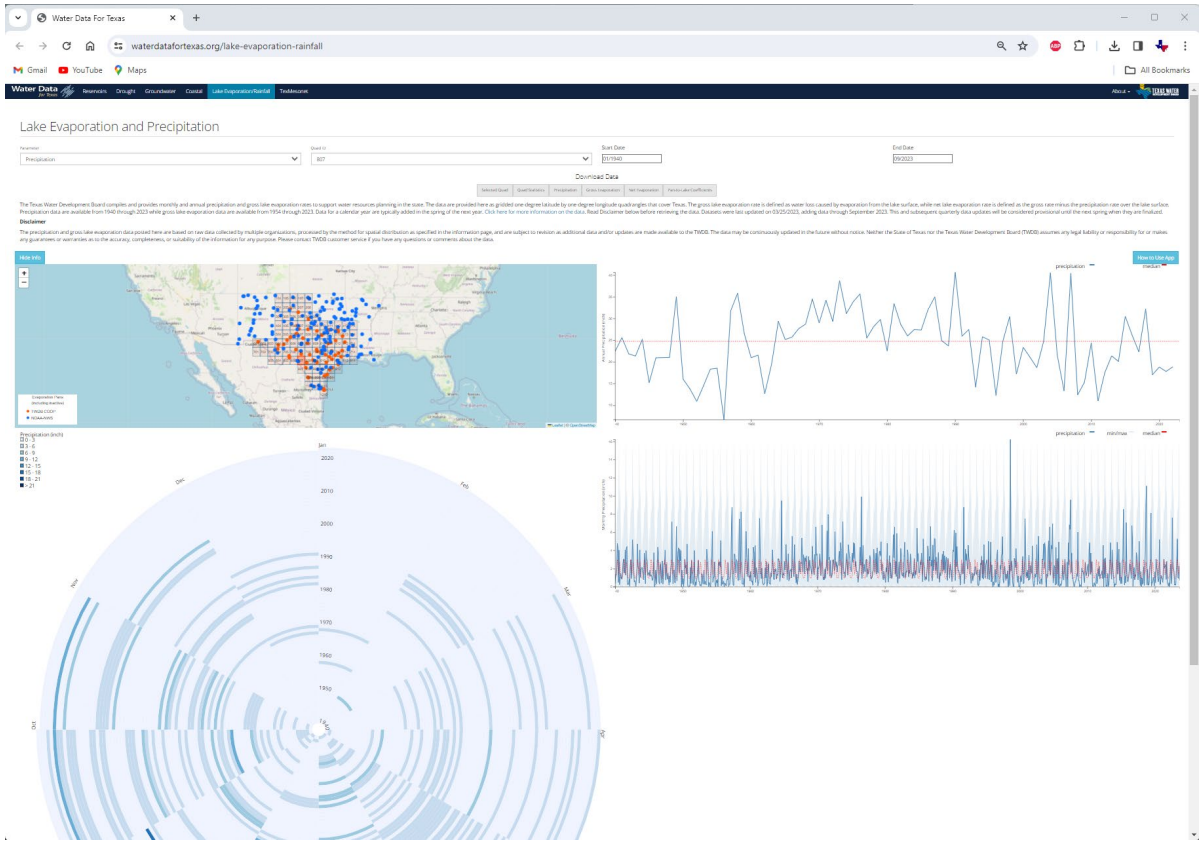
- Precipitation, pumping, spring flow graphs
- Precipitation vs recharge relationships

USGS Data


Las Moras Spgs Dws of pool at
waterdata.usgs.gov/monitoring-location/08456310/#parameterCode=00060&period=P365D&showMedian=false
Gmail
YouTube
Maps
All Bookmarks
An official website of the United States government Here's how you know
USGS
Water Resources | Water Dashboard | Questions or Comments
About Water Data for the Nation
Data Information
Data Inventory
Why Next Gen?
How-to
Important for you to know:
Discrete sample data delivery is undergoing modernization. Starting March 11, 2024, there will be a period when new sample data will not be accessible. Learn more about the upcoming change on our blog.
New to WDFN: customize and keep track of your list of favorite monitoring locations and data types using the new My Favorites page. To learn more, read our announcement on our Water Data for the Nation blog.
IMPORTANT Legacy real-time page
7 days
30 days
1 year
Las Moras Spgs Dws of pool at Brackettville,TX - 08456310
April 5, 2023 - April 4, 2024
Discharge, cubic feet per second
4.36 ft3/s - Jun 15, 2023 05:15:00 PM CDT
ft3/s
60
50
40
30
20
10
8
6
4
2
May 2023
Jul 2023
Sep 2023
Nov 2023
Jan 2024
Mar 2024
IMPORTANT Data may be provisional
Show legend
Value
Status
Time
Latest value
0.00 ft3/s
Provisional
Apr 04, 2024 05:15:00 AM CDT
Selected
4.36 ft3/s
Approved
Jun 15, 2023 05:15:00 PM CDT
Compare
Add last year's data to graph
Median
Add median data to graph
Hide graph details
Statistics for April 4, 2024 based on 9 years of data
Streamflow, ft3/s
Questions or Comments

TWDB Data

- Quad 807
  - Precipitation since 1940 (monthly)
  - Evaporation since 1954 (monthly)



Google Drive Files

- All draft technical memoranda (TMs) associated with model development
- All associated data, processing codes, and references documented in each TM

June 11, 2023

Kinney County Groundwater Model Technical Memoranda

Technical Memorandum (TM) Number	Pages	Subject	Version 1 Completion Date	Most Recent Version and Completion Date	Notes
23-01	14	Model Grid and Unstructured Discretized Input File (DISU)	3/23/2023		Grid numbering and cell geographic attributes (old model row and column, top and bottom elevations, county, GMA, watershed, faults, model edges).
23-02	5	Simulation Name File, Time Discretization, Model Name, and Solver (mfsim.nam, TDIS, NAM, and IMS)	3/23/2023		Quarterly stress period (3 months each).
23-03	3	Initial Conditions (IC6)	3/23/2023		Set initial conditions to land surface for initial run. Will add steady state output as initial conditions after intitial run.
23-04	3	Output Control (OC6)	3/23/2023		Saves head and cell by cell flows for each stress period
23-05	28	Node Property Flow (NPF6)	3/27/2023		Initial values based on assumption of preferential flow paths due to karst
23-06	10	Storage (STO6)	3/27/2023		Initial values are based on contstant storativity and specific yield for each layer
23-07	13	Time-Variant Specified Head (CHD6)	3/29/2023		Initial = Layer specific. Need to add geographic areas for each layer
23-08		Well (WEL6)			4 instances (Ag, Non Ag Non Exempt, Municipal, Exempt)
23-09	14	Springs (DRN6)	4/28/2023		3 instances (Las Moras and other seep/spring areas in Edwards, alluvial gaining stream)
23-10	20	Recharge (RCH6)	4/18/2023	v2: 4/18/2023	6 instances based on recharge zone. V2: Included map of recharge zones
23-11		Evapotranspiration (EVT6)			Hold for now (using net recharge initially)
23-12	68	Calibration Data	4/17/2023		TWDB groundwater levels, KCGCD groundwater levels (EcoKai and Goebel), Las Moras Spring
23-13		Initial Model Run			To verify that all input files are working and plan for initial calibration steps. Includes post-processor documentation.
23-14		Calibration Results			Summary of Calibration. Each TM will be updated as appropriate with details
23-15		Initital Predictive Simulations			Pumping and recharge sensitivity to scope alternative management simulations
23-16	34	Simulation Thresholds	6/11/2023		Precipitation and spring flow data analysis to pick thresholds for management simulations

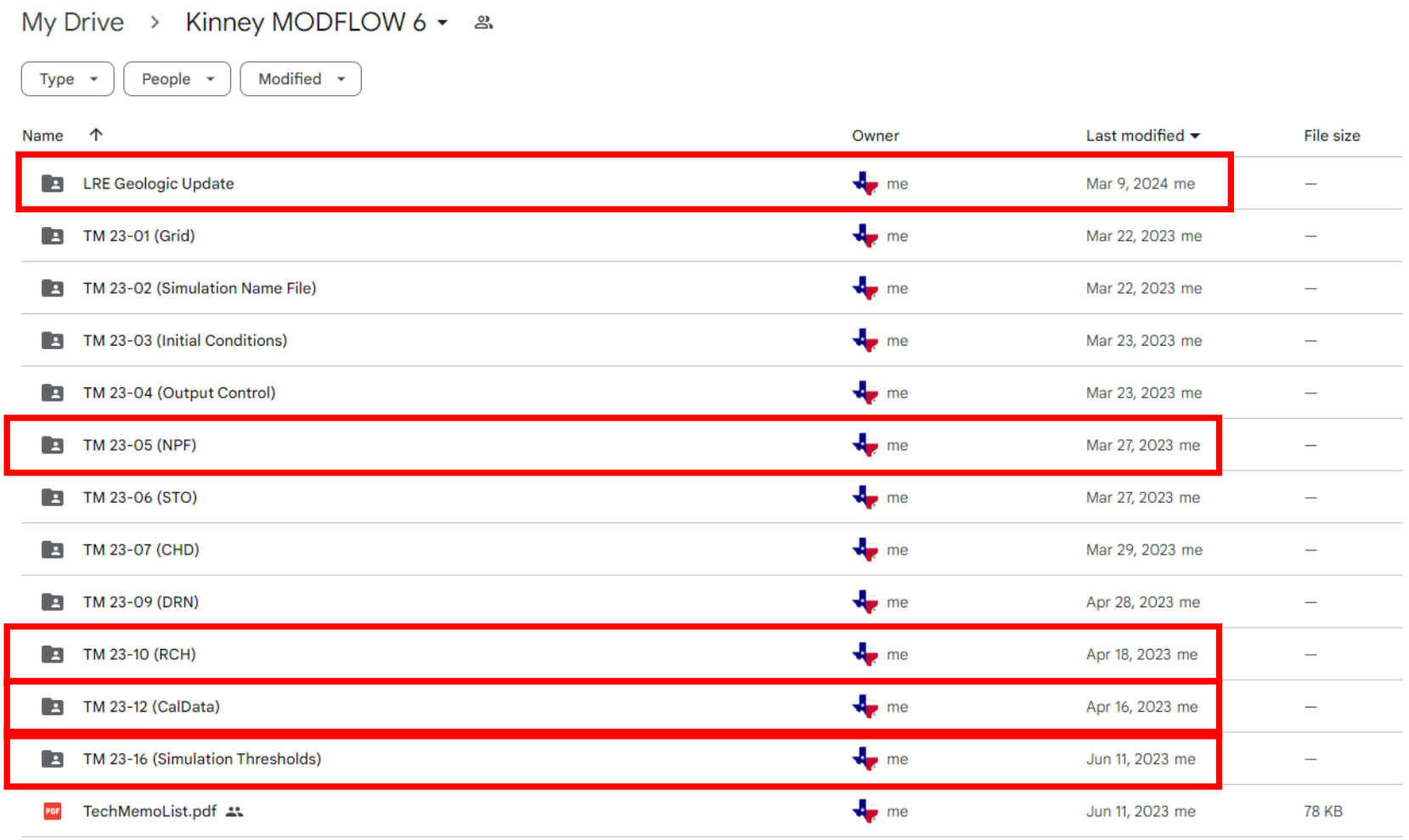
Google Drive Subfolders

My Drive > Kinney MODFLOW 6

Type | People | Modified

Name	Owner	Last modified	File size
LRE Geologic Update	me	Mar 9, 2024 me	—
TM 23-01 (Grid)	me	Mar 22, 2023 me	—
TM 23-02 (Simulation Name File)	me	Mar 22, 2023 me	—
TM 23-03 (Initial Conditions)	me	Mar 23, 2023 me	—
TM 23-04 (Output Control)	me	Mar 23, 2023 me	—
TM 23-05 (NPF)	me	Mar 27, 2023 me	—
TM 23-06 (STO)	me	Mar 27, 2023 me	—
TM 23-07 (CHD)	me	Mar 29, 2023 me	—
TM 23-09 (DRN)	me	Apr 28, 2023 me	—
TM 23-10 (RCH)	me	Apr 18, 2023 me	—
TM 23-12 (CalData)	me	Apr 16, 2023 me	—
TM 23-16 (Simulation Thresholds)	me	Jun 11, 2023 me	—
TechMemoList.pdf	me	Jun 11, 2023 me	78 KB

Google Drive Subfolders



Precipitation and Las Moras Spring Flow

- TM 23-16 (June 11, 2023)
- Statistical analysis of monthly precipitation and daily spring flow (1940 to 2022)
- Outlines basis for future predicative simulations related to pumping reductions based on alternative spring flow thresholds
- Some of these data have been recently updated (2023) to complete analyses to address recent questions and issues (not on Google Drive yet)
- Link:

https://drive.google.com/drive/folders/1yXQ_WK4lZOt4891K7Oan7Ozbuamq-Jgu?usp=drive_link

Groundwater Level Data

- TM 23-12 (April 17, 2023)
- Link:

https://drive.google.com/drive/folders/14McLbGjAh_Lmbi83jXceByl2UPm0qqBx?usp=drive_link

Name	Owner	Last modified	File size
KCGCD Data	me	Apr 16, 2023 me	—
LasMorasData	me	Apr 16, 2023 me	—
TWDB Data	me	Apr 16, 2023 me	—
TechMemo23-12(CalData).pdf	me	Apr 16, 2023 me	5.5 MB

KCGCD Groundwater Level Data

- EcoKai Transducer
  - All raw and processed data as documented in TM
- Goebel
  - Historic data collected by Dr. Joe Goebel (2009 to 2012)
- Combined
  - Combined EcoKai and Goebel

Las Moras Data

- Same raw data as TM 23-16
- Processing focused on data for model calibration
- Used in subsequent slides
- TM Link:

https://drive.google.com/drive/folders/1UNDwJiWj80qmsfL-dqEnDKMd7g1it5vC?usp=drive_link

TWDB Data

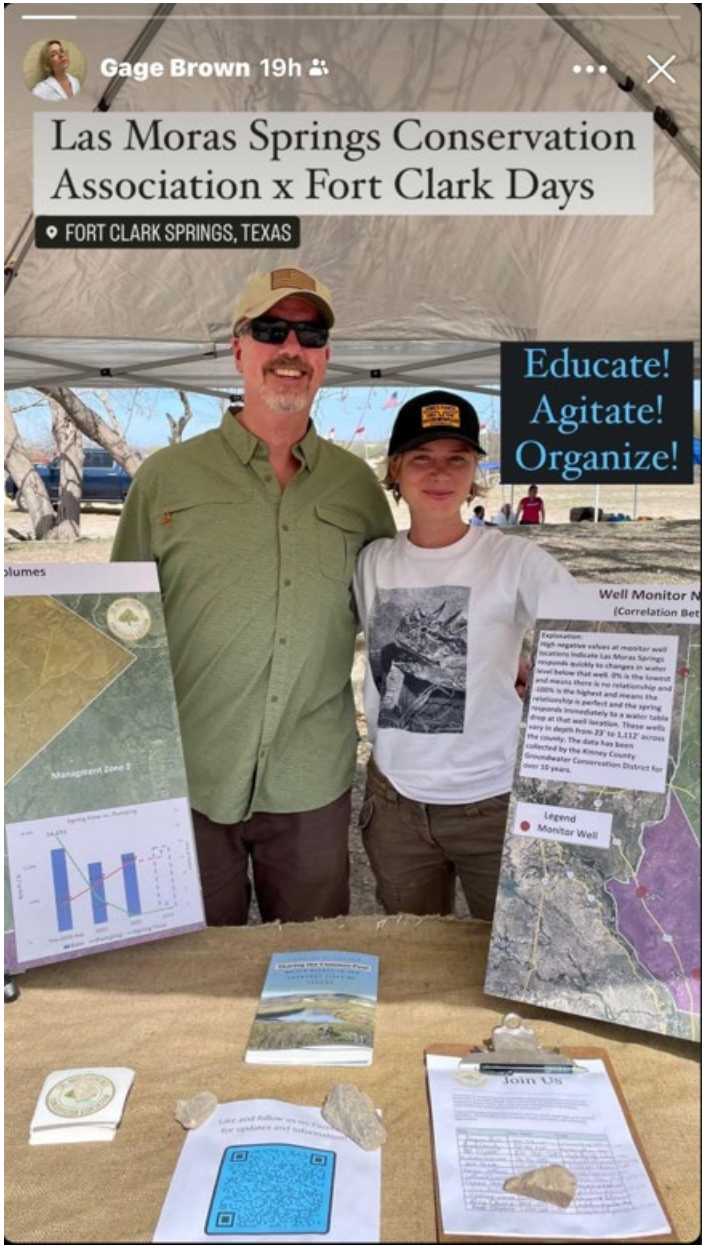
- Raw data for Kinney and surrounding counties from TWDB database
- Processed data for use in model calibration

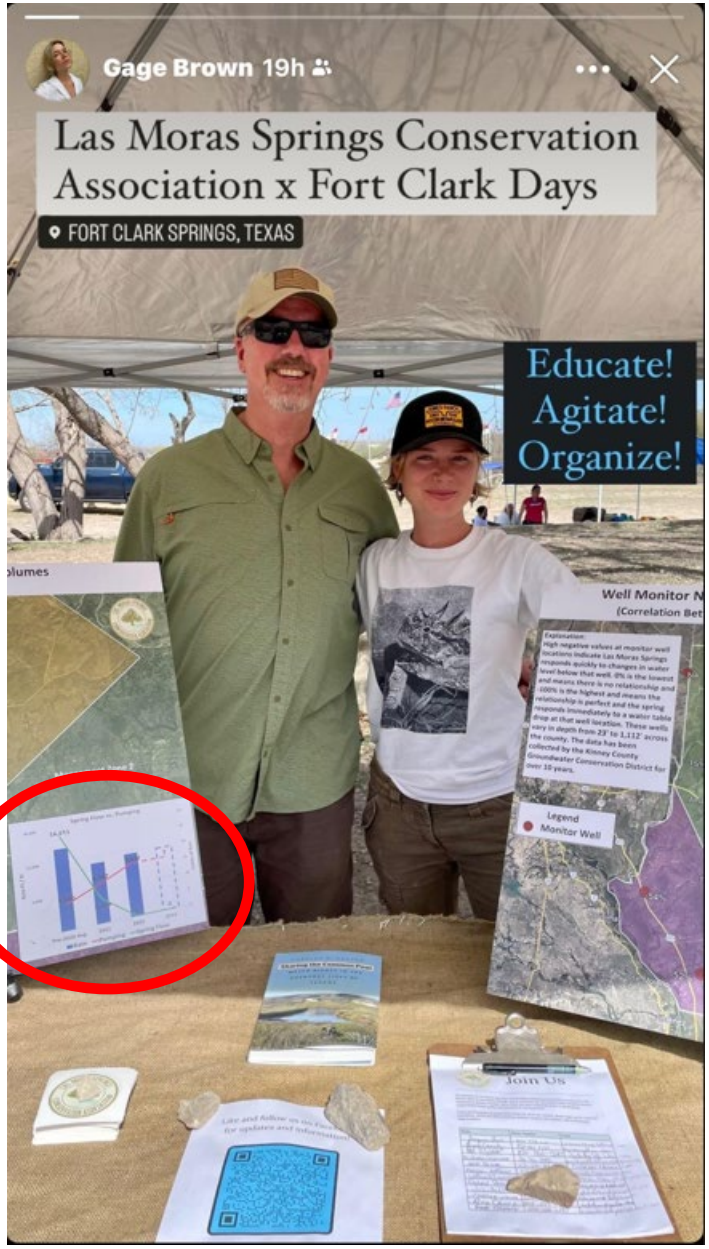
Recharge Estimates

- TM 23-10 (version 2) (April 18, 2023)
- Initial estimates of recharge for model
- Expected to be adjusted during calibration

Topics

- Data availability and use
- Geologic update progress report


Gage Brown 19h
Las Moras Springs Conservation Association x Fort Clark Days
FORT CLARK SPRINGS, TEXAS
Educate!
Agitate!
Organize!
Management Zone 2
Legend
Monitor Well
John Us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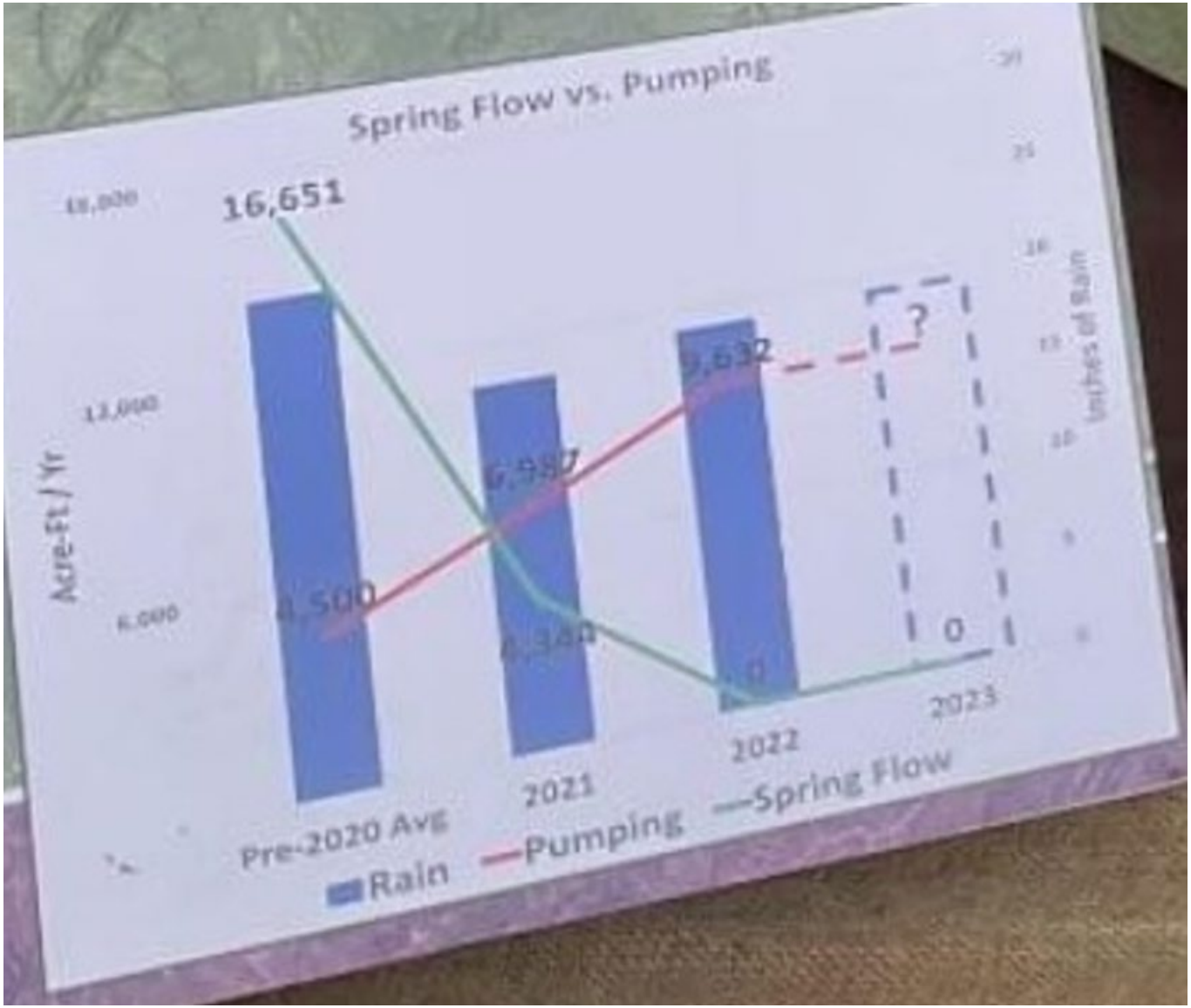
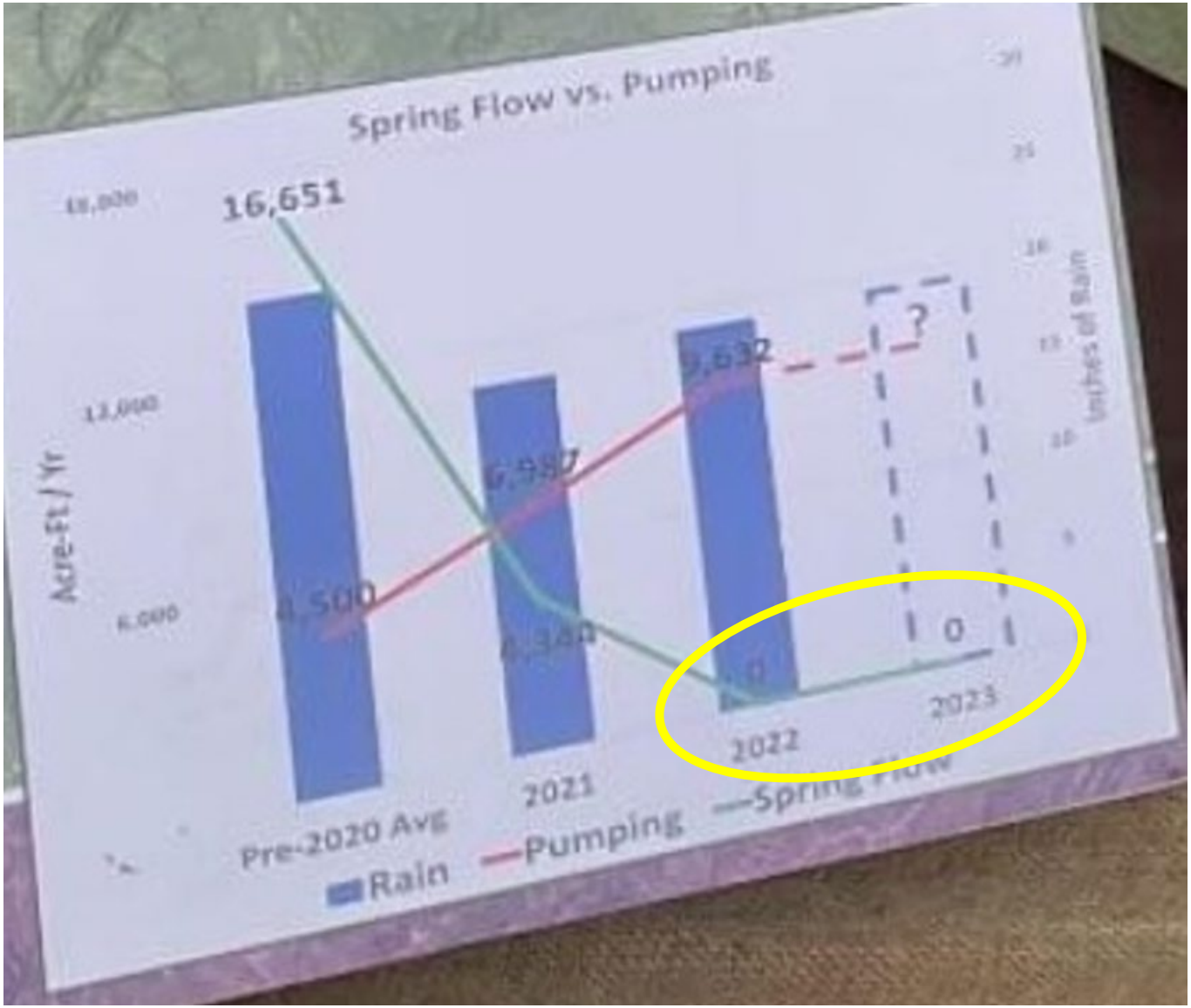
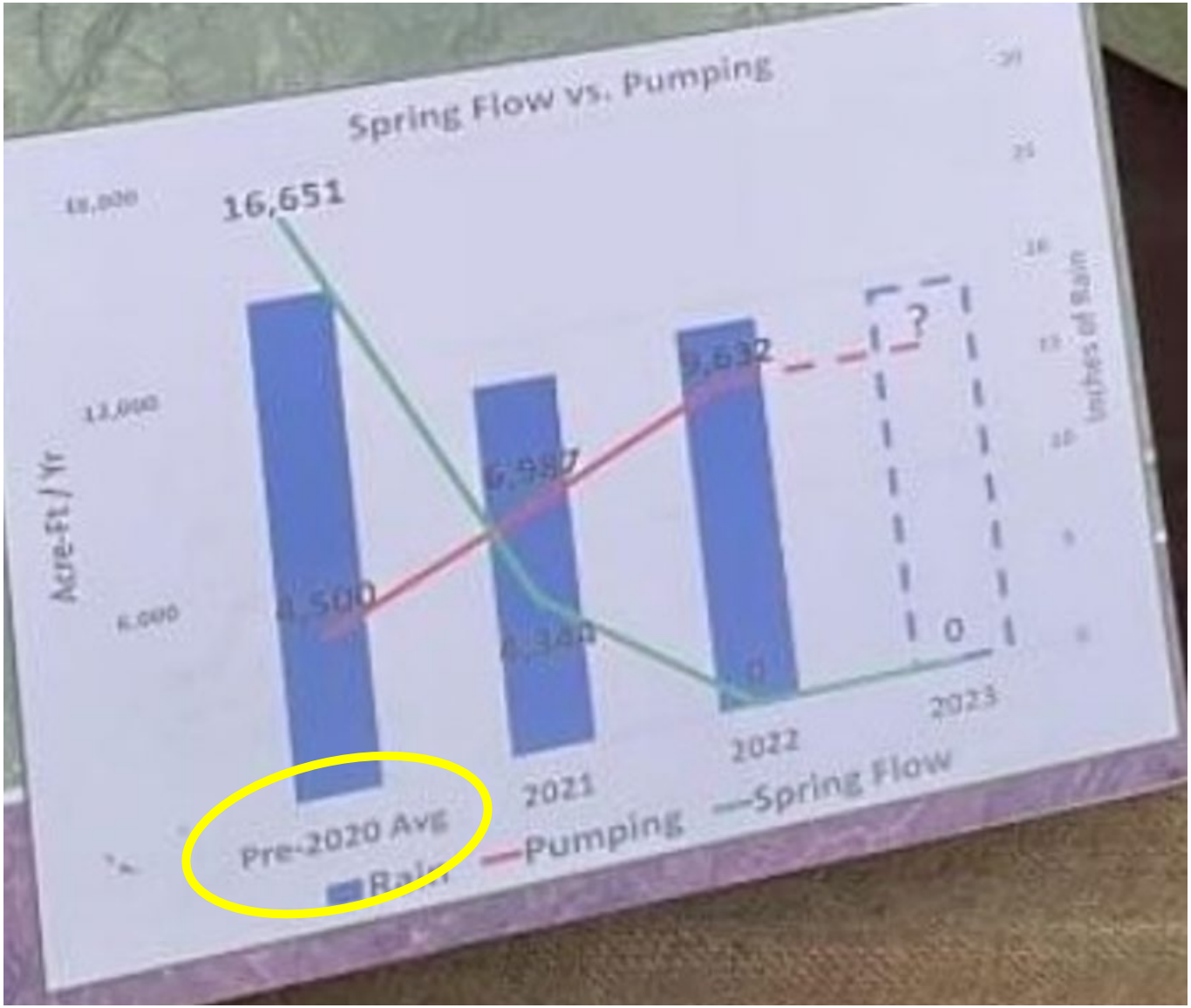
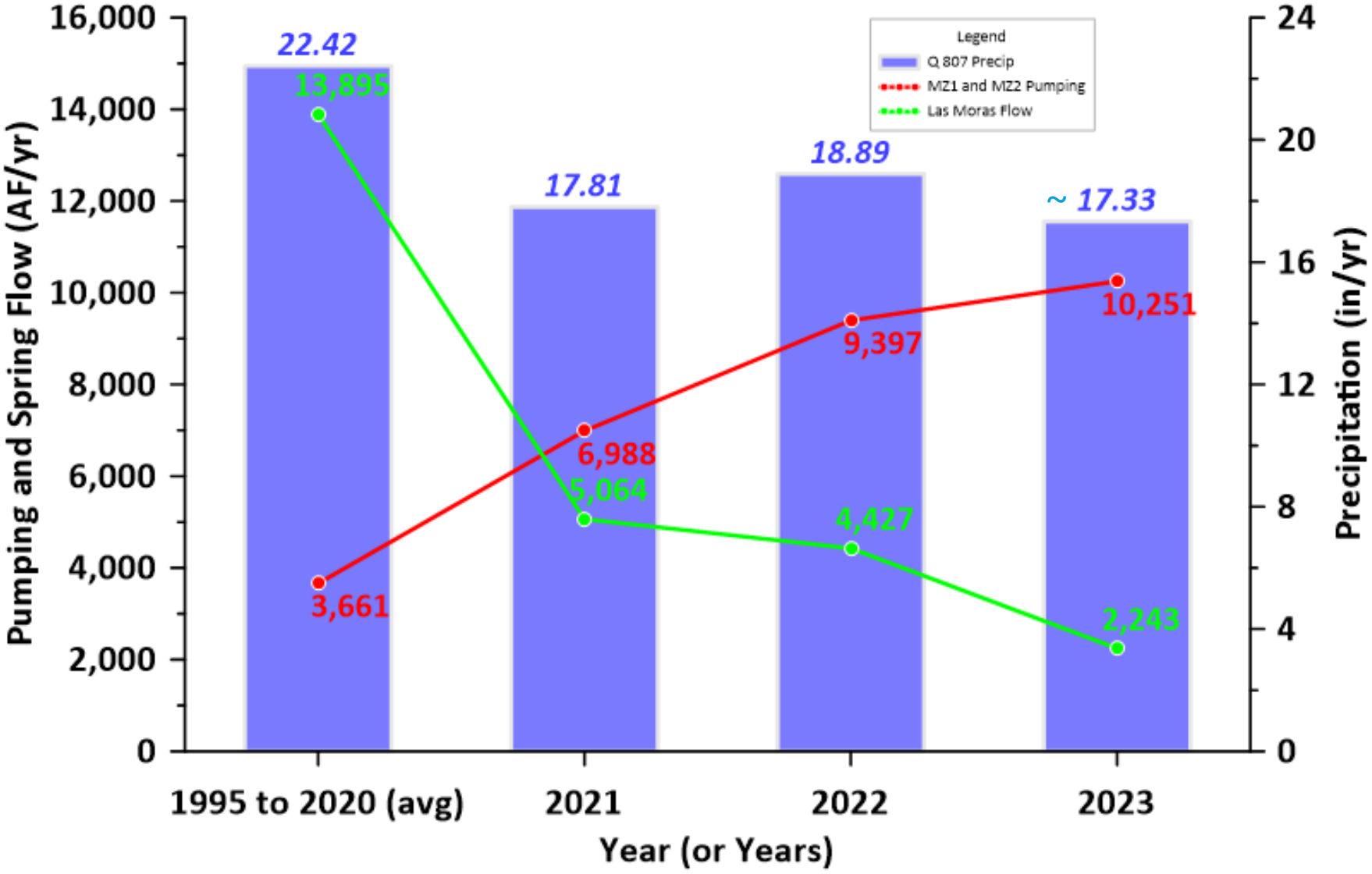

Spring Flow vs. Pumping
16,651
Acre-Ft / Yr
Inches of Rain
18,000
12,000
6,000
9,632
6,987
8,500
4,340
0
?
0
Pre-2020 Ave
2021
2022
2023
Rain
Pumping
Spring Flow


Spring Flow vs. Pumping
16,651
Acre-Ft / Yr
Inches of Rain
2,632
?
0
2022
2023
2021
Pre-2020 Ave
Rain
Pumping
Spring Flow


Spring Flow vs. Pumping
16,651
Acre-Ft / Yr
Inches of Rain
2021
2022
2023
Pre-2020 Ave
Rain
Pumping
Spring Flow

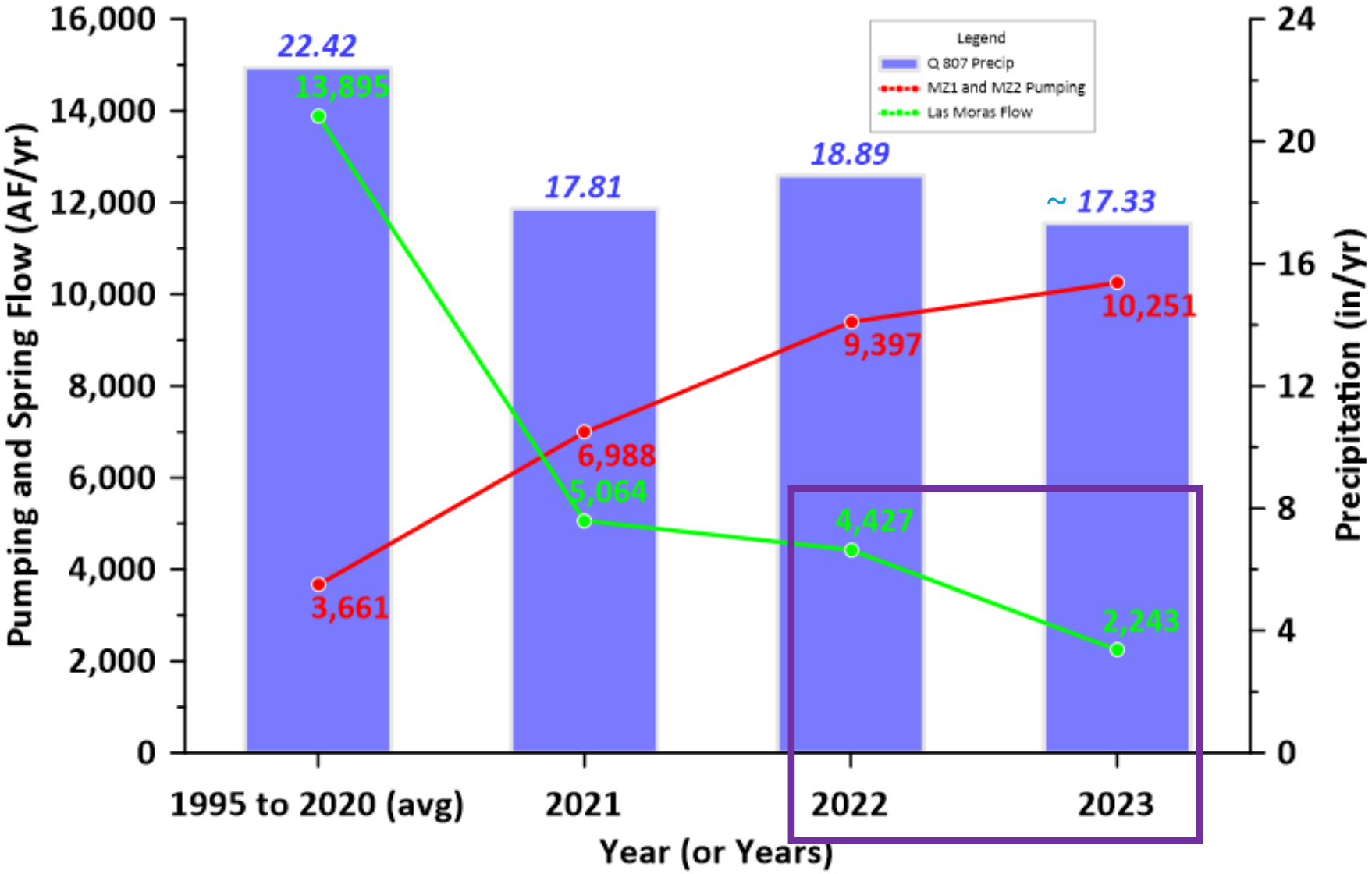
Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow



Notes: Quad 807 precip quarters Jan to Sept 2023 = 15.33 in, Oct to Dec 2023 estimate = 2 in (data available in mid-April 2024)

2023 pumping data preliminary

Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow



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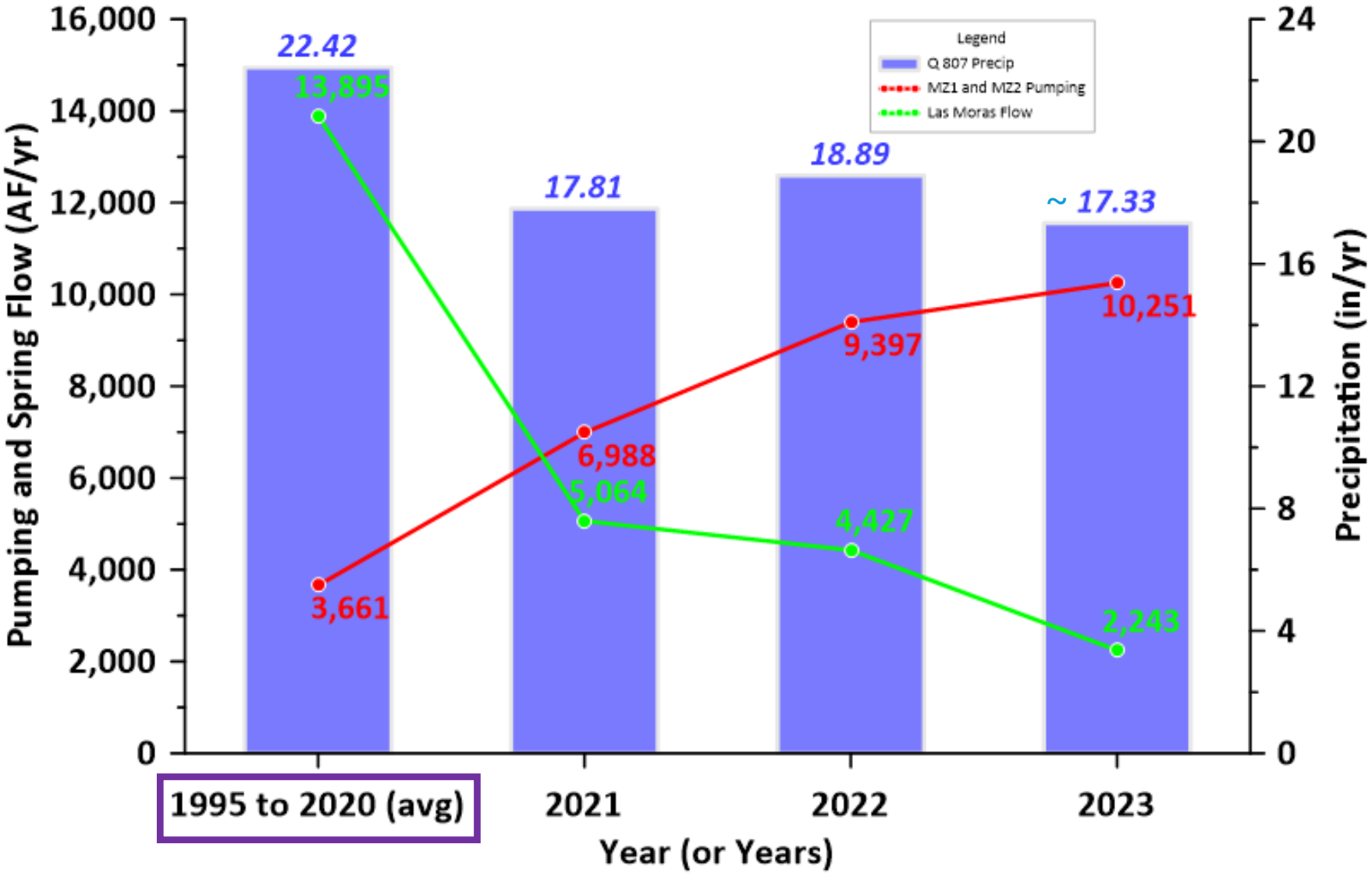
Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow



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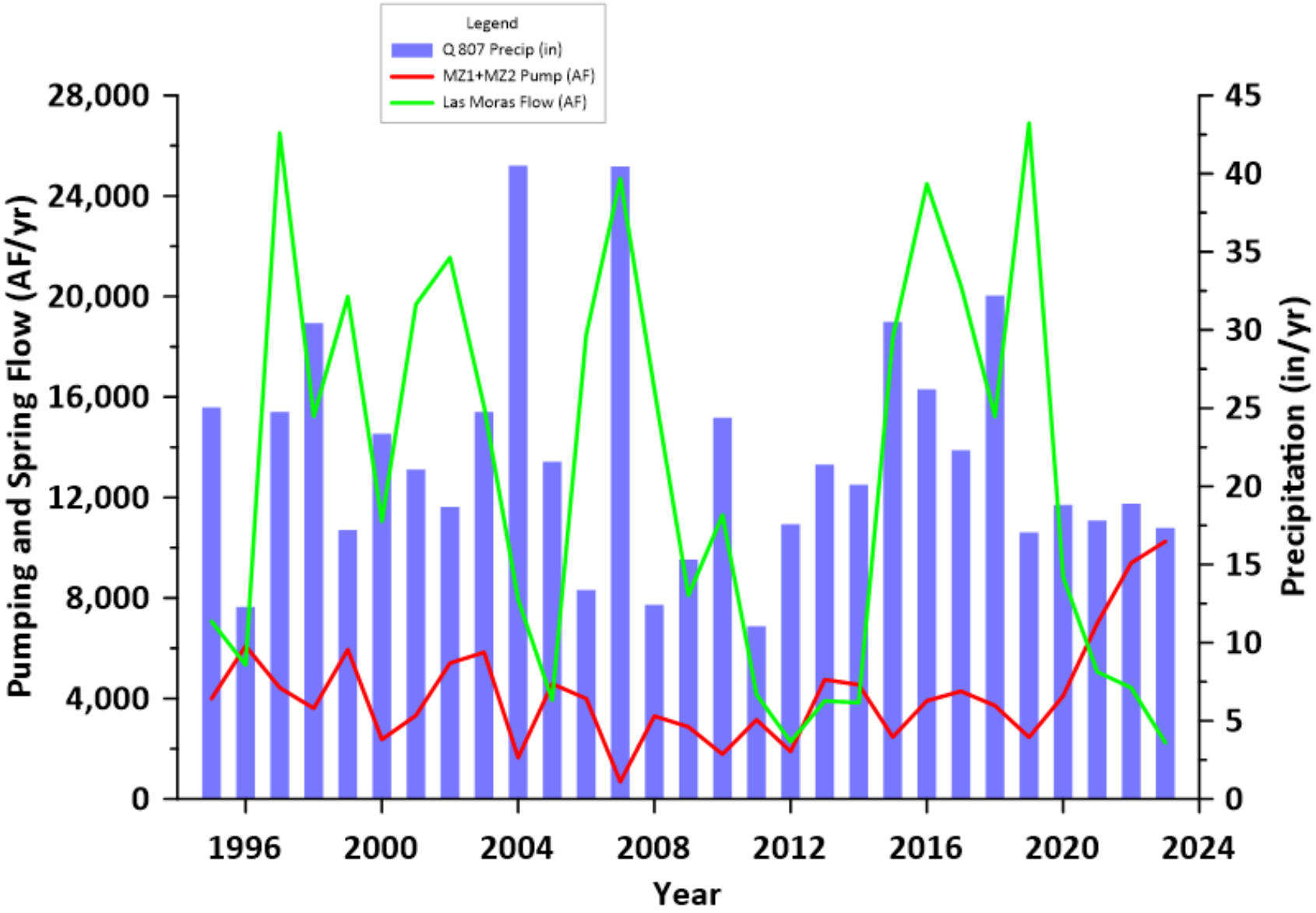
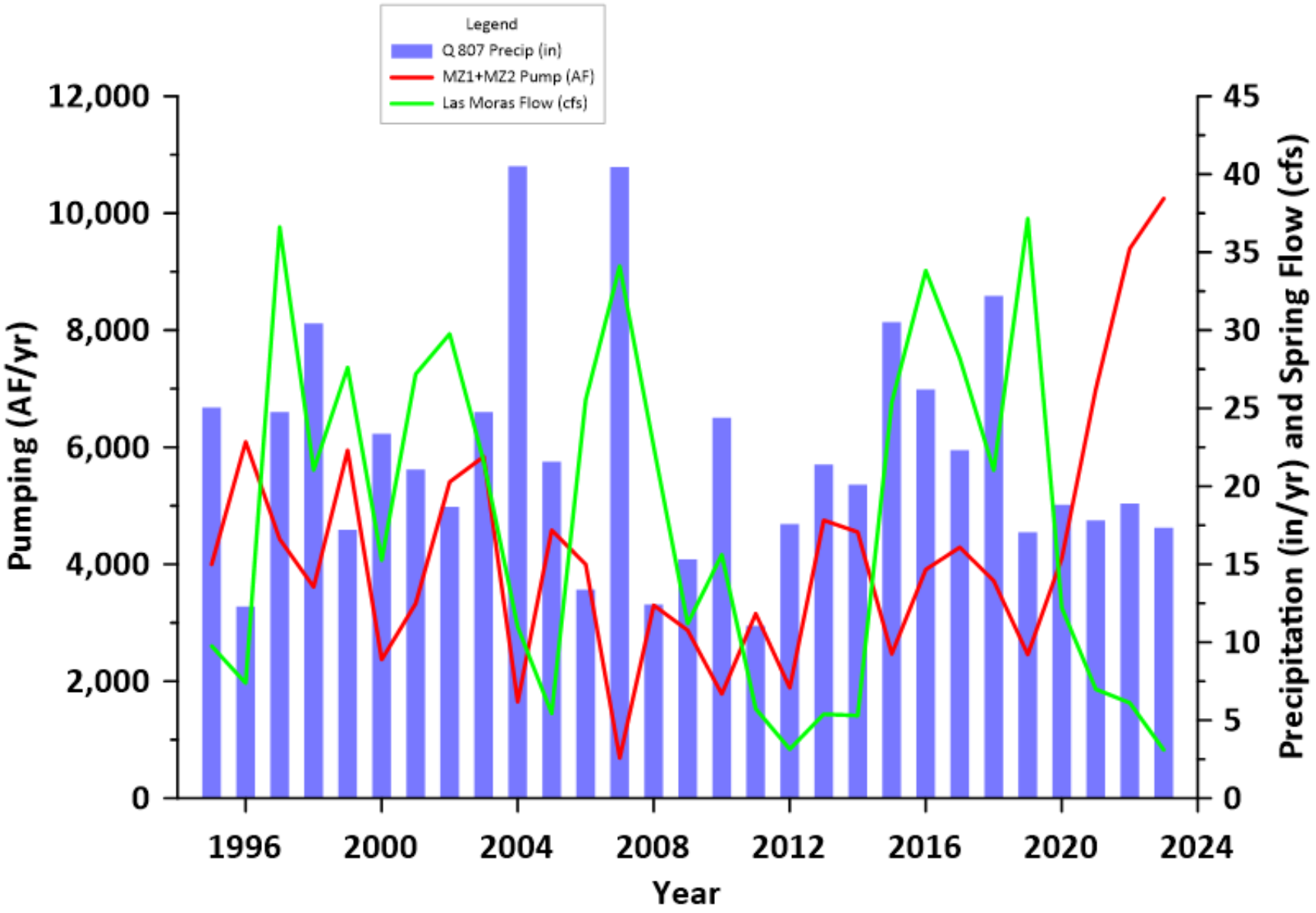
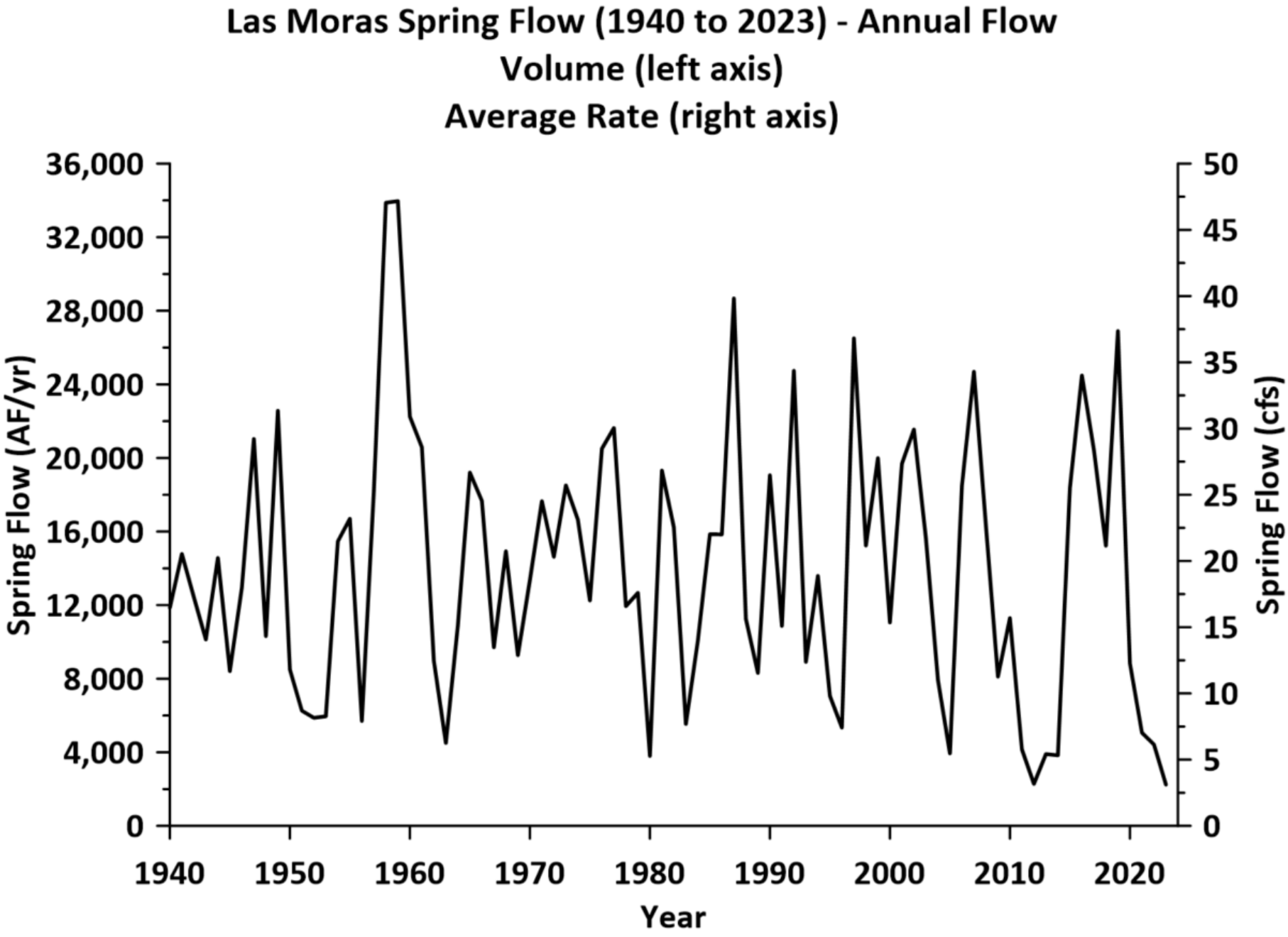
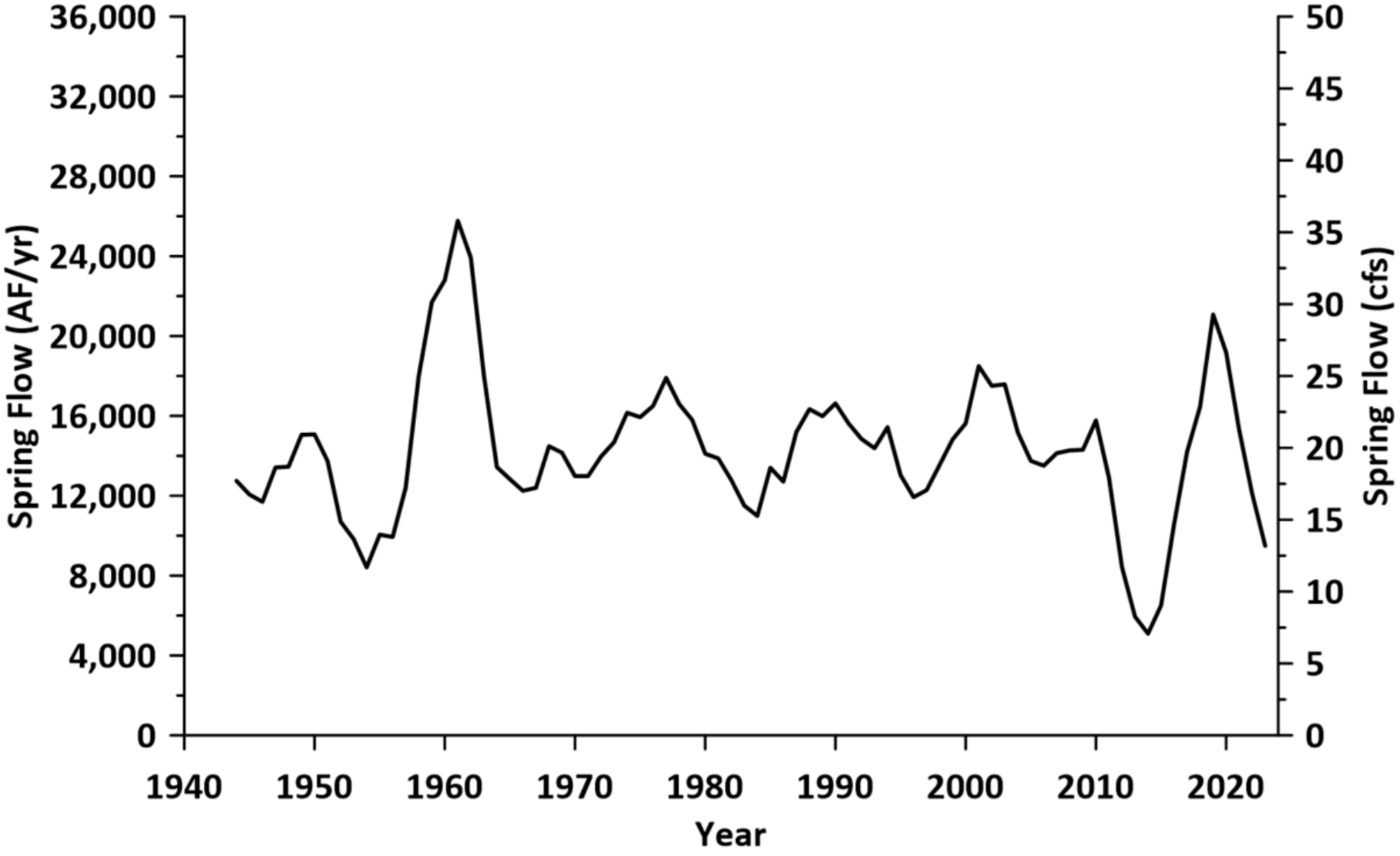
2023 pumping data preliminary

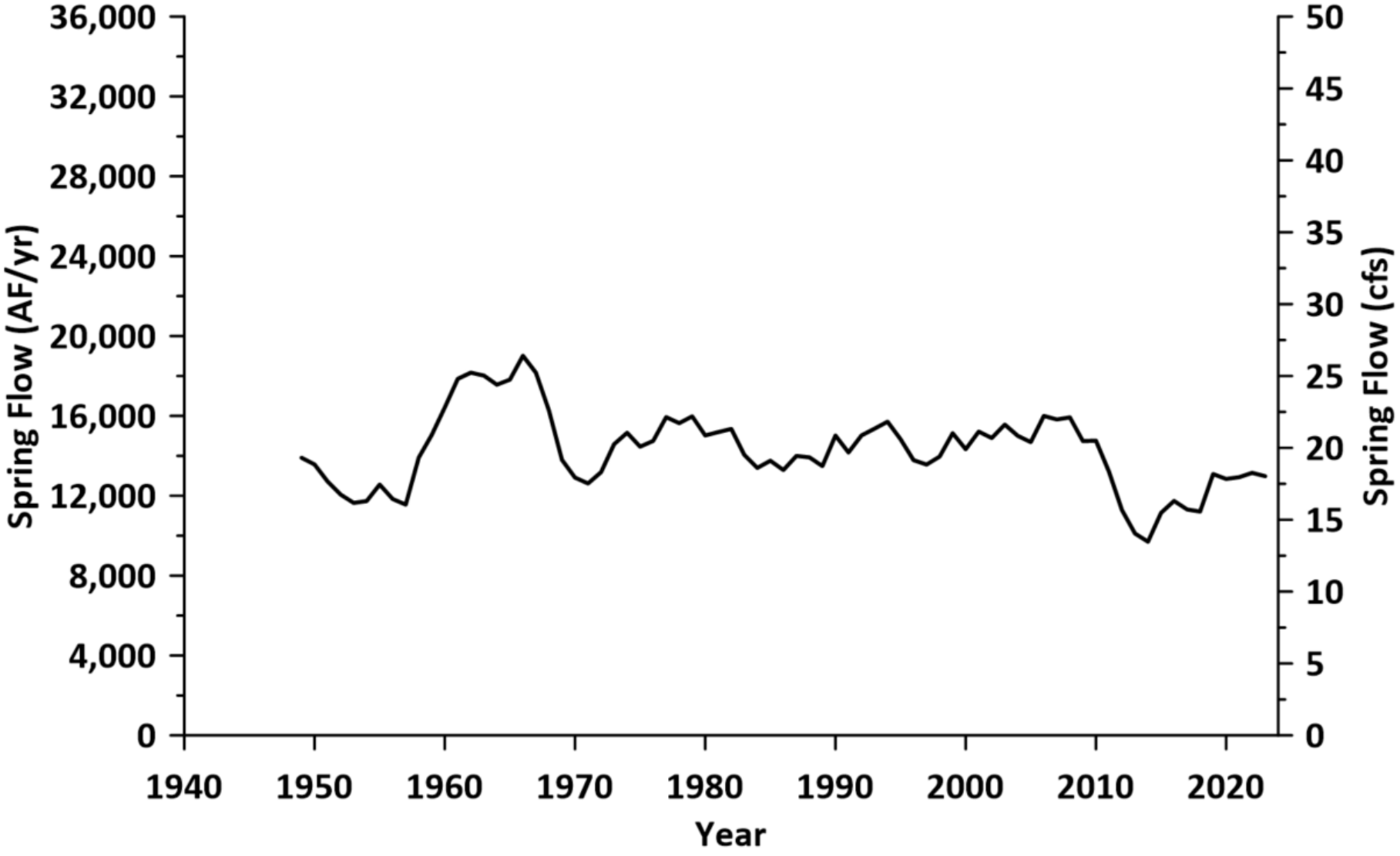
Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow




Quad 807 Precipitation, MZ 1 and 2 Pumping, Las Moras Spring Flow
Legend
Q 807 Precip (in)
MZ1+MZ2 Pump (AF)
Las Moras Flow (cfs)
Pumping (AF/yr)
Precipitation (in/yr) and Spring Flow (cfs)
Year
12,000
10,000
8,000
6,000
4,000
2,000
0
45
40
35
30
25
20
15
10
5
0
1996
2000
2004
2008
2012
2016
2020
2024


Las Moras Spring Flow (1940 to 2023) - Annual Flow
Volume (left axis)
Average Rate (right axis)
Spring Flow (AF/yr)
36,000
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
Spring Flow (cfs)
50
45
40
35
30
25
20
15
10
5
0
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year


Las Moras Spring Flow (1940 to 2023) - 5-Year Running Average
Volume (left axis)
Average Rate (right axis)
Spring Flow (AF/yr)
36,000
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
Spring Flow (cfs)
50
45
40
35
30
25
20
15
10
5
0
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year


Las Moras Spring Flow (1940 to 2023) - 10-Year Running Average
Volume (left axis)
Average Rate (right axis)
Spring Flow (AF/yr)
36,000
32,000
28,000
24,000
20,000
16,000
12,000
8,000
4,000
0
Spring Flow (cfs)
50
45
40
35
30
25
20
15
10
5
0
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

Recharge

- Rainfall
  - Evaporation
  - Runoff
  - Infiltration
- Bennett and Sayre (1962):
  - The principal source of recharge is the direct infiltration of rainfall.
  - The landscape is deeply dissected, and solutional openings and fissures are abundant, particularly on the slopes and in the beds of streams.
  - Recharge is dependent on the amount and intensity of rainfall events during induvial storms. Much of the water from heavier rainstorms enters the ground directly or via stream channels.

TM 23-10 version 2 (April 8, 2023)

- Relied on Bennett and Sayre (1962) estimates
  - 1.4 in/yr for West Nueces and Nueces River (average from 1940 to 1950 via stream discharge data)
  - Acknowledged limitations and noted that estimate is an indication of the “correct order of magnitude”
- TM 23-10 documents the initial attempt at spatial and temporal distribution for model input
  - To be adjusted during calibration

Recharge Zones

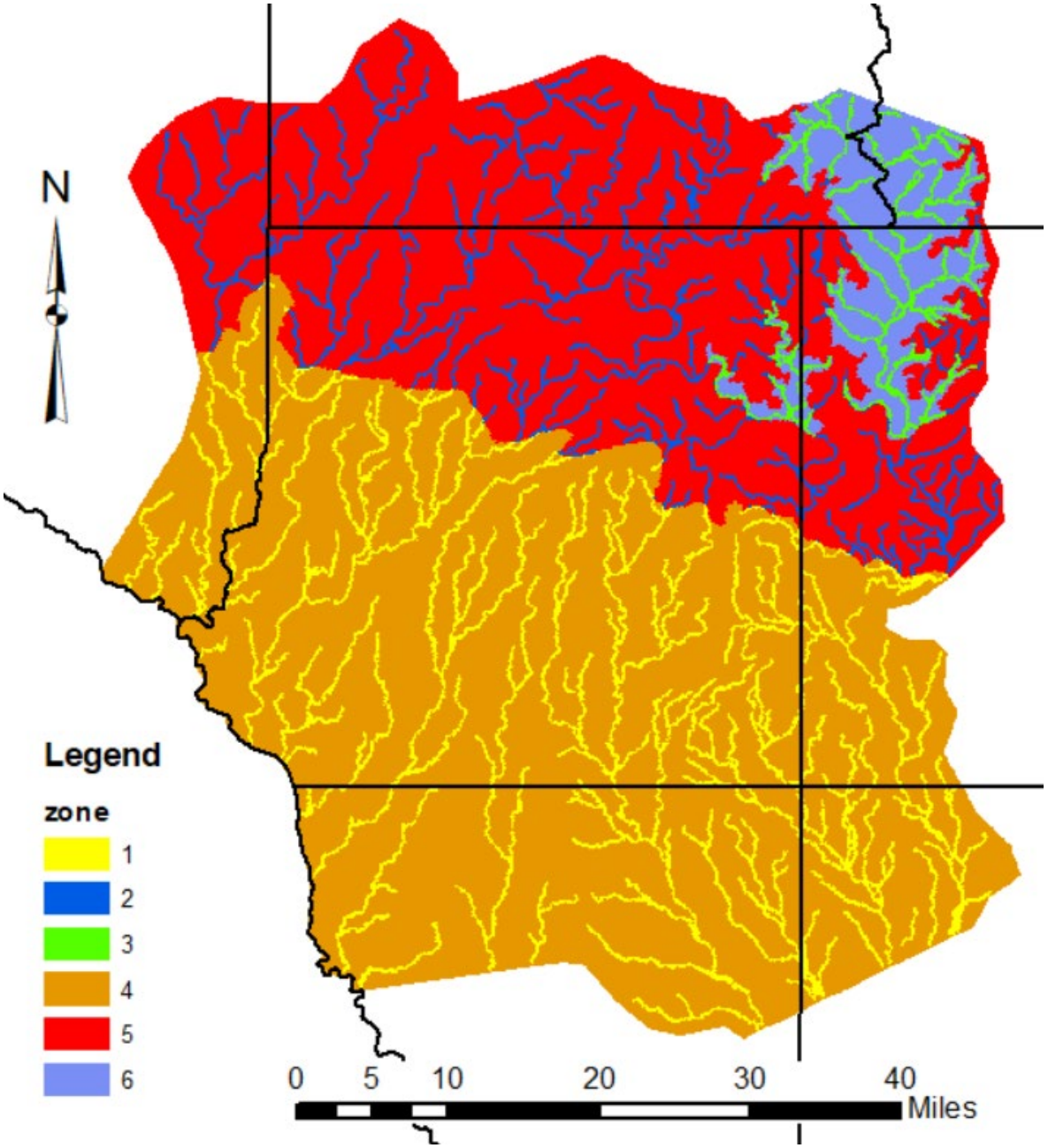
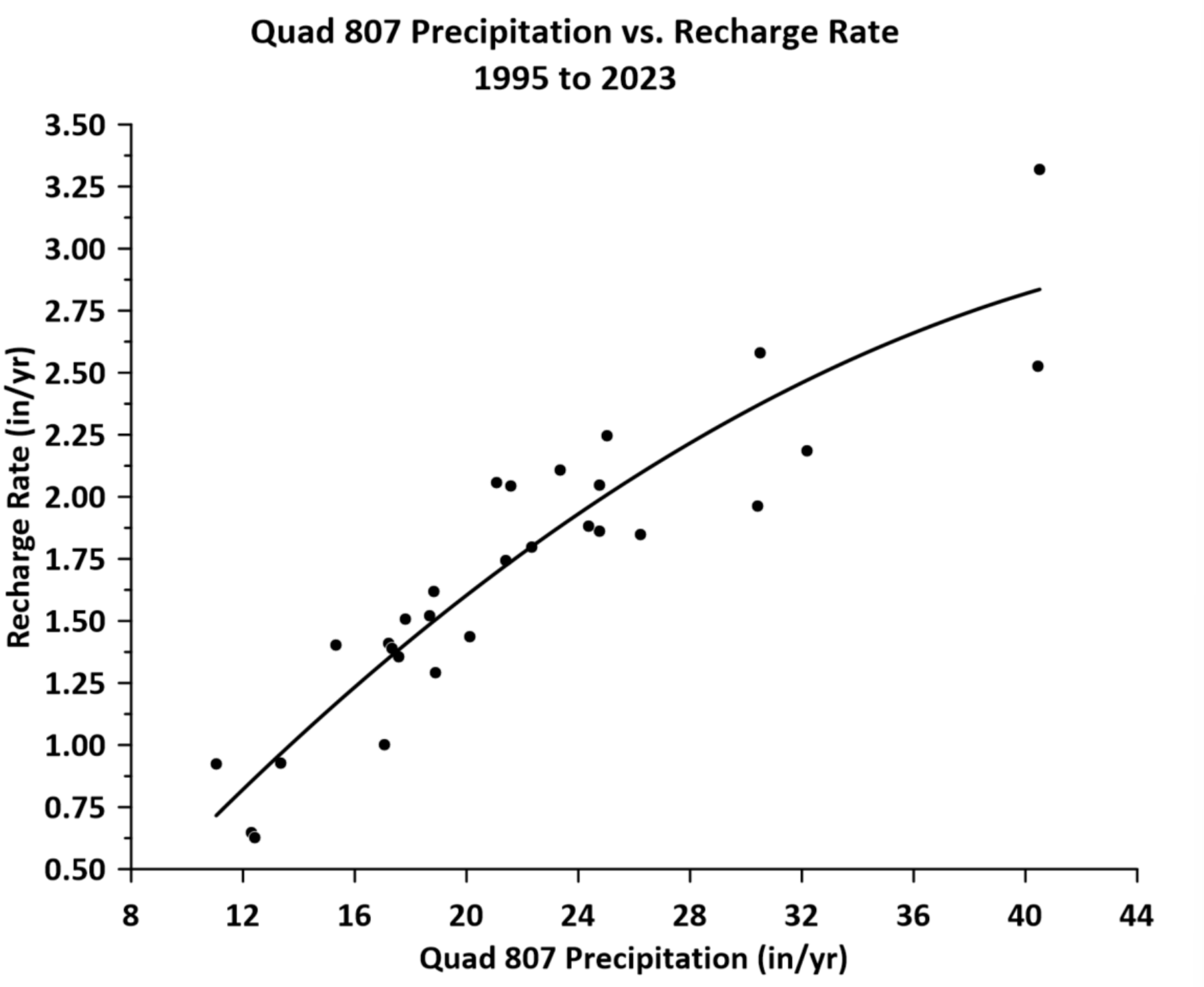
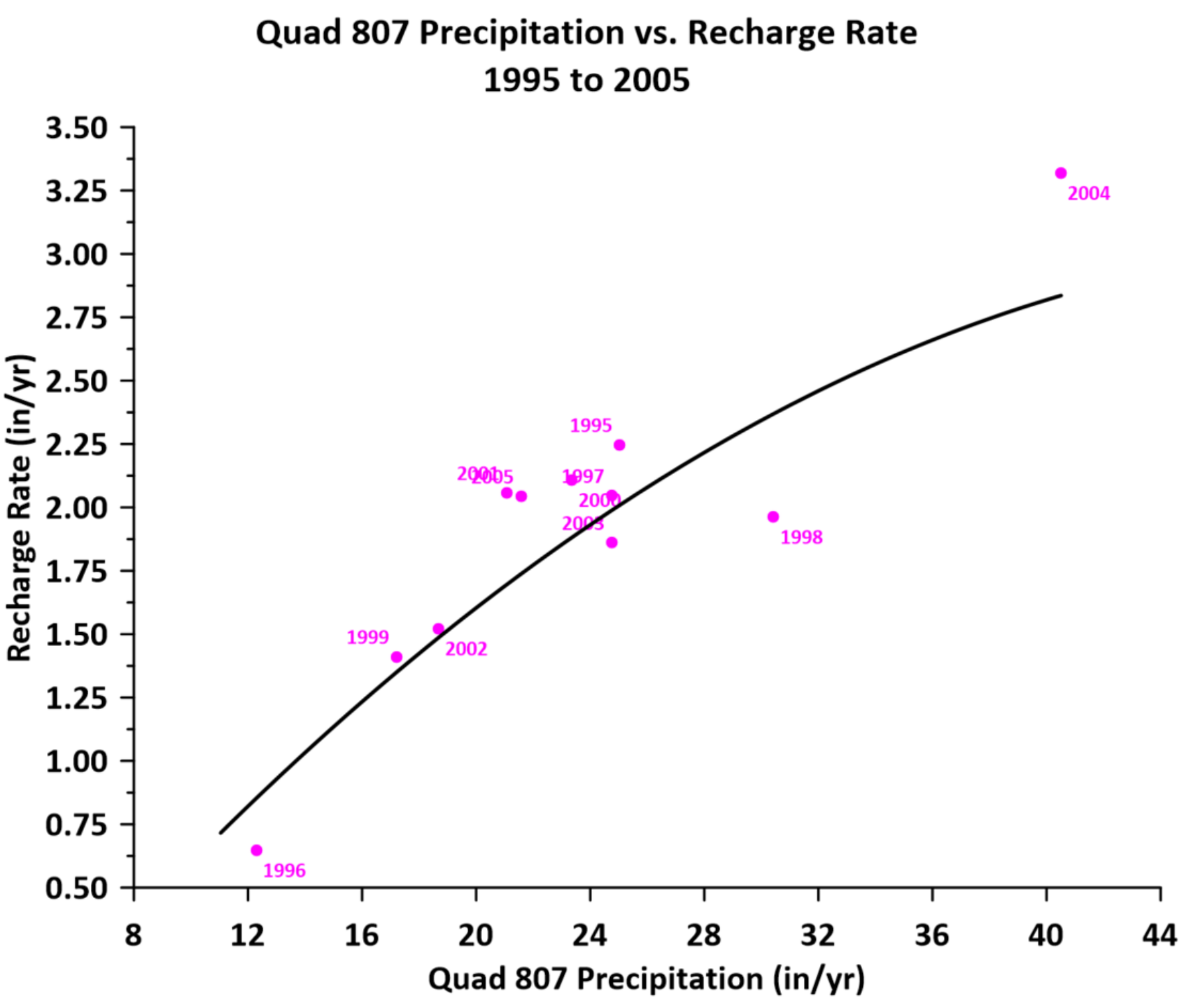
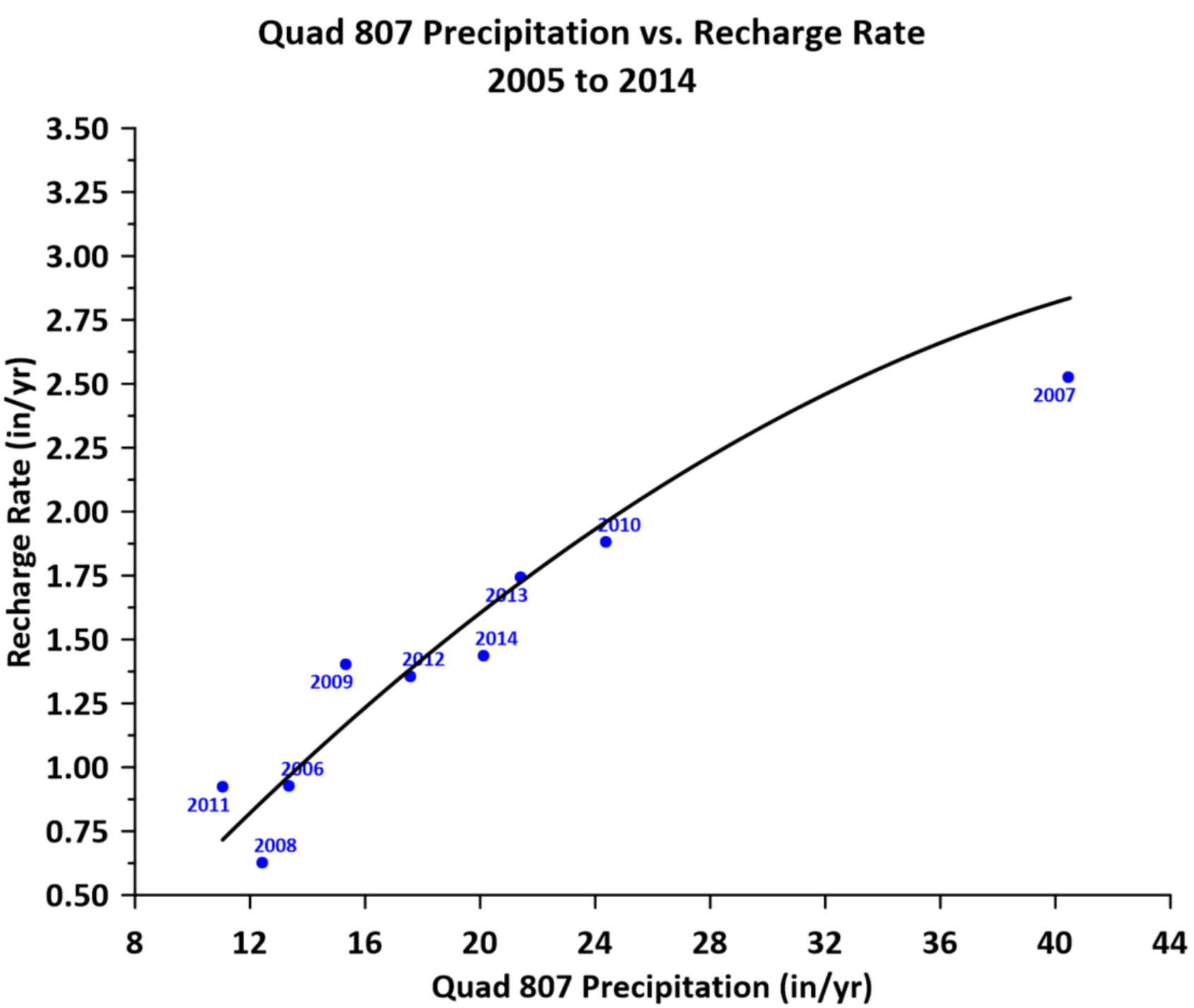
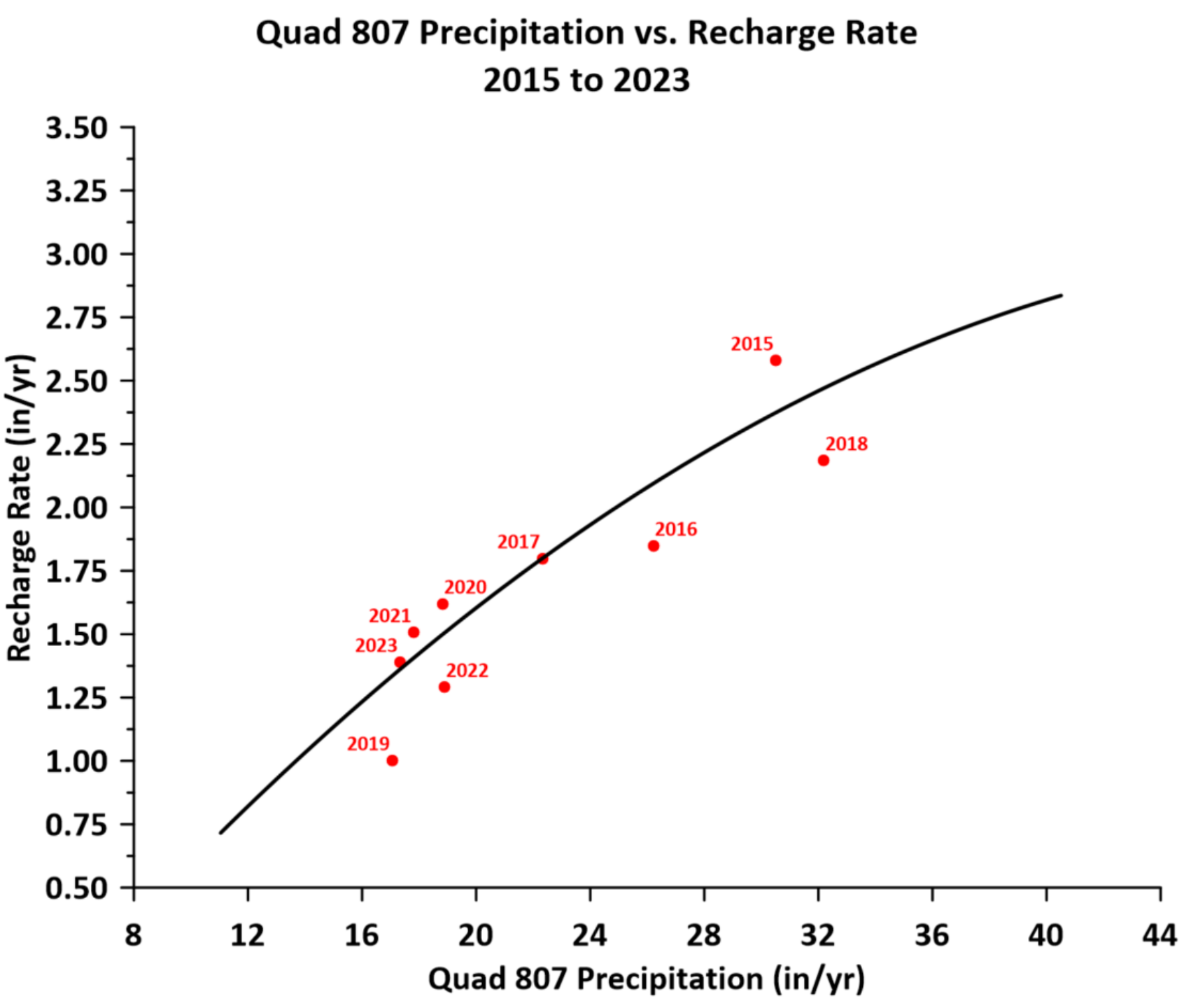


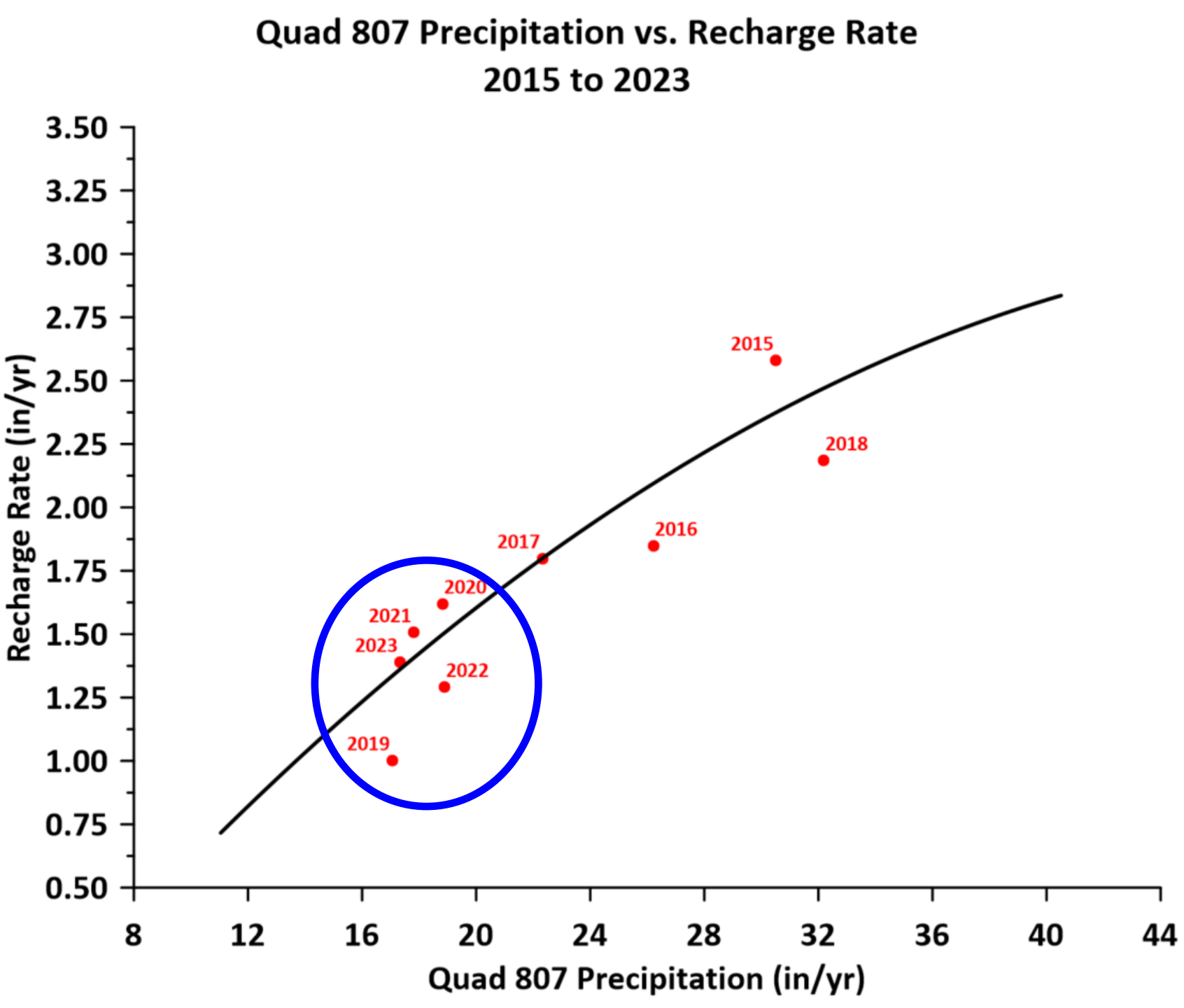
Figure 8 of TM 23-10 (April 8, 2023)


Quad 807 Precipitation vs. Recharge Rate
1995 to 2023
Recharge Rate (in/yr)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
8
12
16
20
24
28
32
36
40
44
Quad 807 Precipitation (in/yr)


Quad 807 Precipitation vs. Recharge Rate
1995 to 2005
Recharge Rate (in/yr)
Quad 807 Precipitation (in/yr)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
8
12
16
20
24
28
32
36
40
44
2004
1995
2001
2005
1997
2000
2003
1998
1999
2002
1996


Quad 807 Precipitation vs. Recharge Rate
2005 to 2014
Recharge Rate (in/yr)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
8
12
16
20
24
28
32
36
40
44
Quad 807 Precipitation (in/yr)
2007
2010
2013
2014
2012
2009
2006
2011
2008


Quad 807 Precipitation vs. Recharge Rate
2015 to 2023
Recharge Rate (in/yr)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
8
12
16
20
24
28
32
36
40
44
Quad 807 Precipitation (in/yr)
2015
2018
2016
2017
2020
2021
2023
2022
2019


Quad 807 Precipitation vs. Recharge Rate
2015 to 2023
Recharge Rate (in/yr)
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
8
12
16
20
24
28
32
36
40
44
Quad 807 Precipitation (in/yr)
2015
2018
2016
2017
2020
2021
2023
2022
2019

What do Data Tell Us?

- Variation in rainfall explains most of the variation in spring flow
  - Groundwater pumping has some effect on spring flow
- Low rainfall/recharge conditions since 2019 (5 years and counting)
  - Other historic drought periods included interceding wet years
    - Highlights importance of wet years to “fill the aquifer”
  - Comparing current conditions to averages ignores the dynamics of “fill and drain” conceptual model
- Presentation on September 28, 2023 (slide 92):
  - If current pumping (about 6,000 to 10,000 AF/yr) was reduced to about 4,000 to 5,000 AF/yr, spring flow would increase between 1 to 8 cfs
  - Suggestions that elimination of pumping would result in “normal” or “average” spring flow during an extended drought are not supported by data

Topics

- Data availability and use
- Geologic update progress report

Why Update the Geologic Structure of the Model?

- Model development in 2023
  - 13 TMs completed and uploaded to Google Drive
  - Used geologic framework of 2010 TWDB model (TM 23-01)
    - Limitations due to MODFLOW-2005 code
  - Relied on URS (2004) faults (TM 23-05)
- Issues in mid-2023
  - Pumping
  - Geologic structure?
  - Faults?
- While pumping issues were being resolved, recommended updating the geologic structure of the model
  - Improvements with new geophysical data
  - Remove limitations associated with 2010 effort (i.e. MODFLOW 6 code allows for a more accurate representation of geologic structure)

Geology Update Progress Report

- Work to update geologic framework of model was authorized during KCGCD Board meeting of November 8, 2023
- Two phases:
  - Phase 1 (completed February 29, 2024):
    - Geophysical log interpretation
    - Preliminary maps
  - Phase 2 (scheduled completion in May 2024):
    - Geologic data (fault lines, structure, igneous intrusions, facies changes, karst development)
    - 3D geologic map
    - Update model grid

Phase 1 Letter Report (Available on Google Drive Site)

https://drive.google.com/drive/folders/1oIm1rgYUEdddx3hDfZRu4LvxSaO6vr2y?usp=drive_link

Attached Deliverables

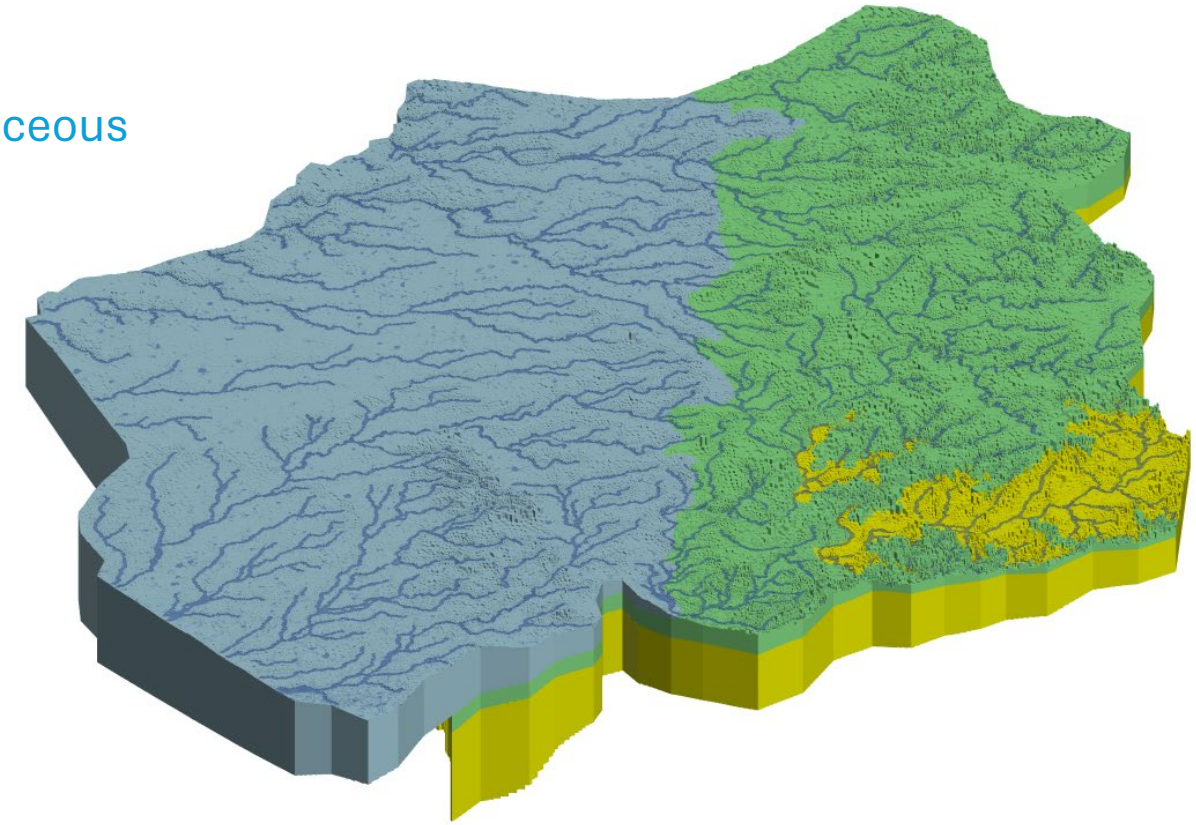
Included as attachments to this document.

a. Table 1. Stratigraphic Well Control (Excel Copy)
b. Supporting GIS data in GAM projection (stratigraphic picks, 10-M DEM, GAT surface geology and faults)
c. Geophysical logs listed in Table 1
d. (5) Annotated Type Logs

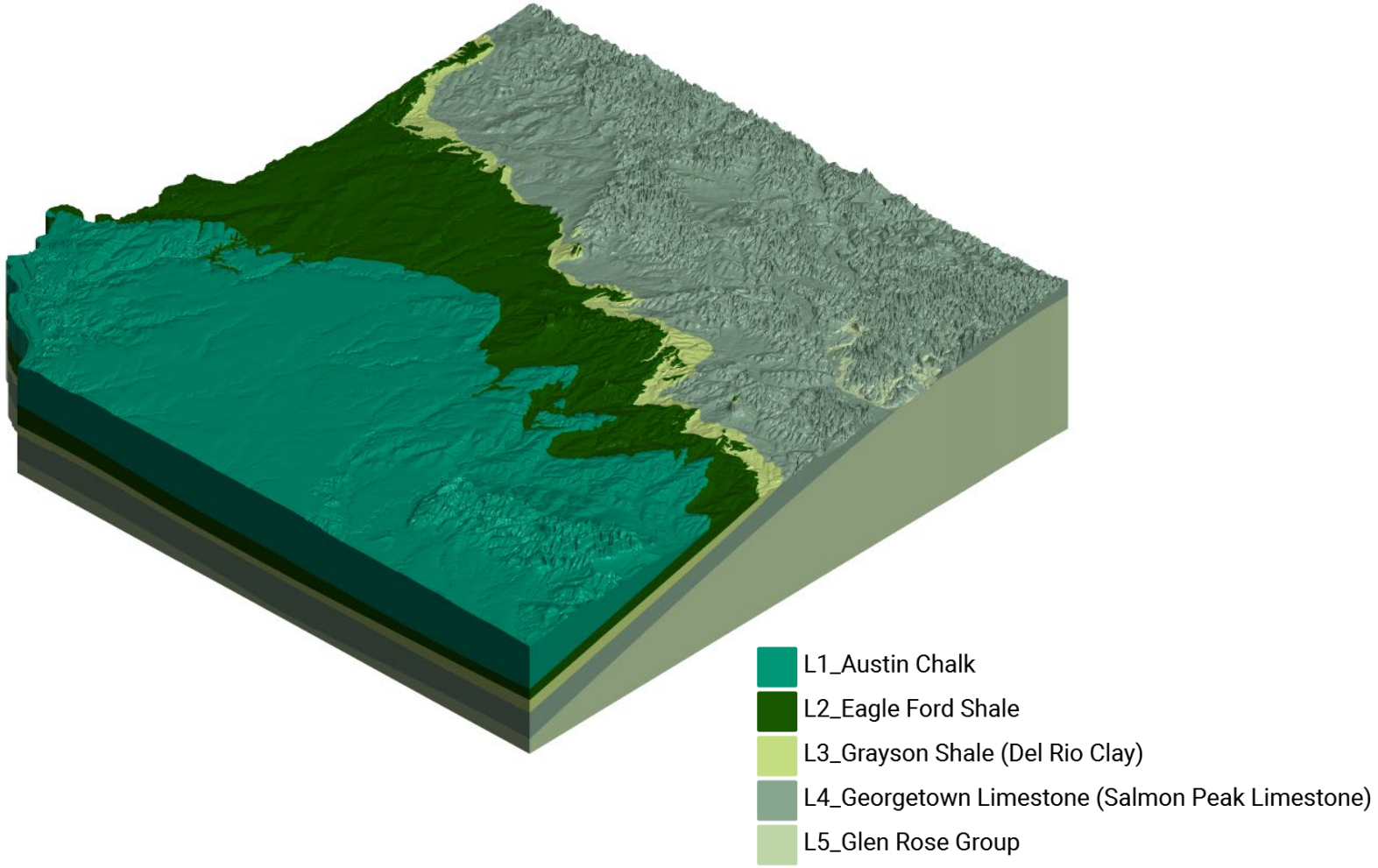
Current Geologic Framework (from 2010 TWDB Model)

Layers

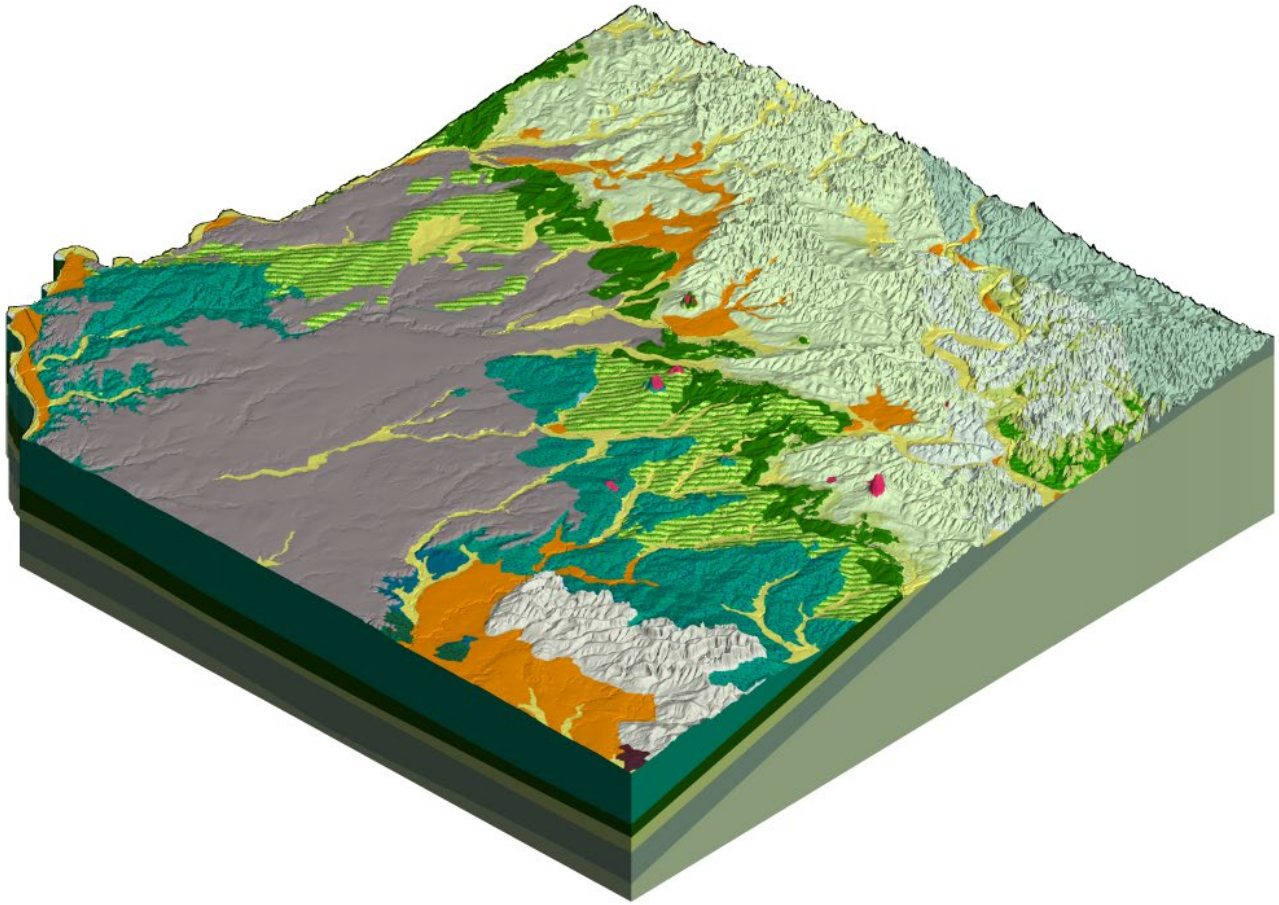
1. Alluvium
2. Upper Cretaceous
3. Edwards
4. Trinity



Preliminary Updated Geologic Model (Alluvium not included)



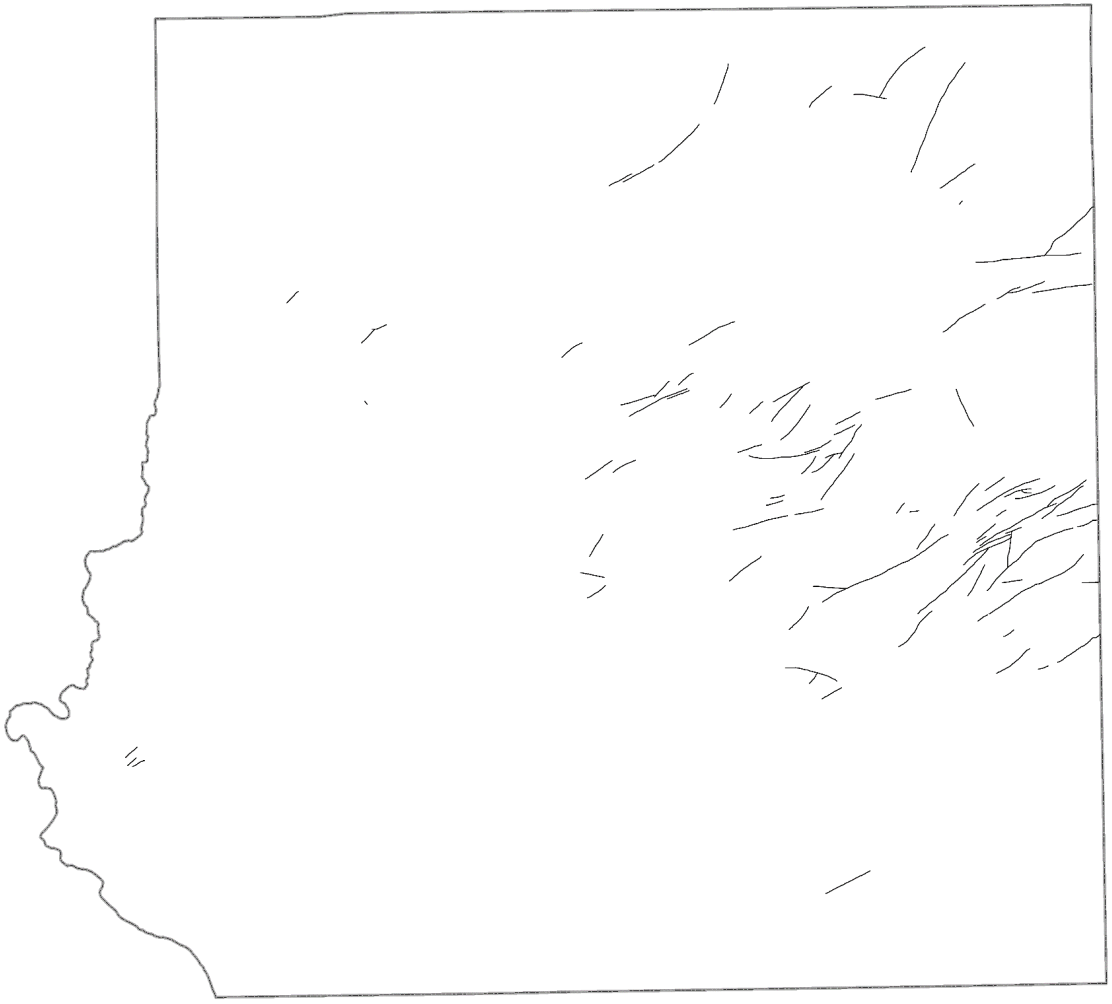
Preliminary Updated Geologic Model with Surface Geology (GAT)



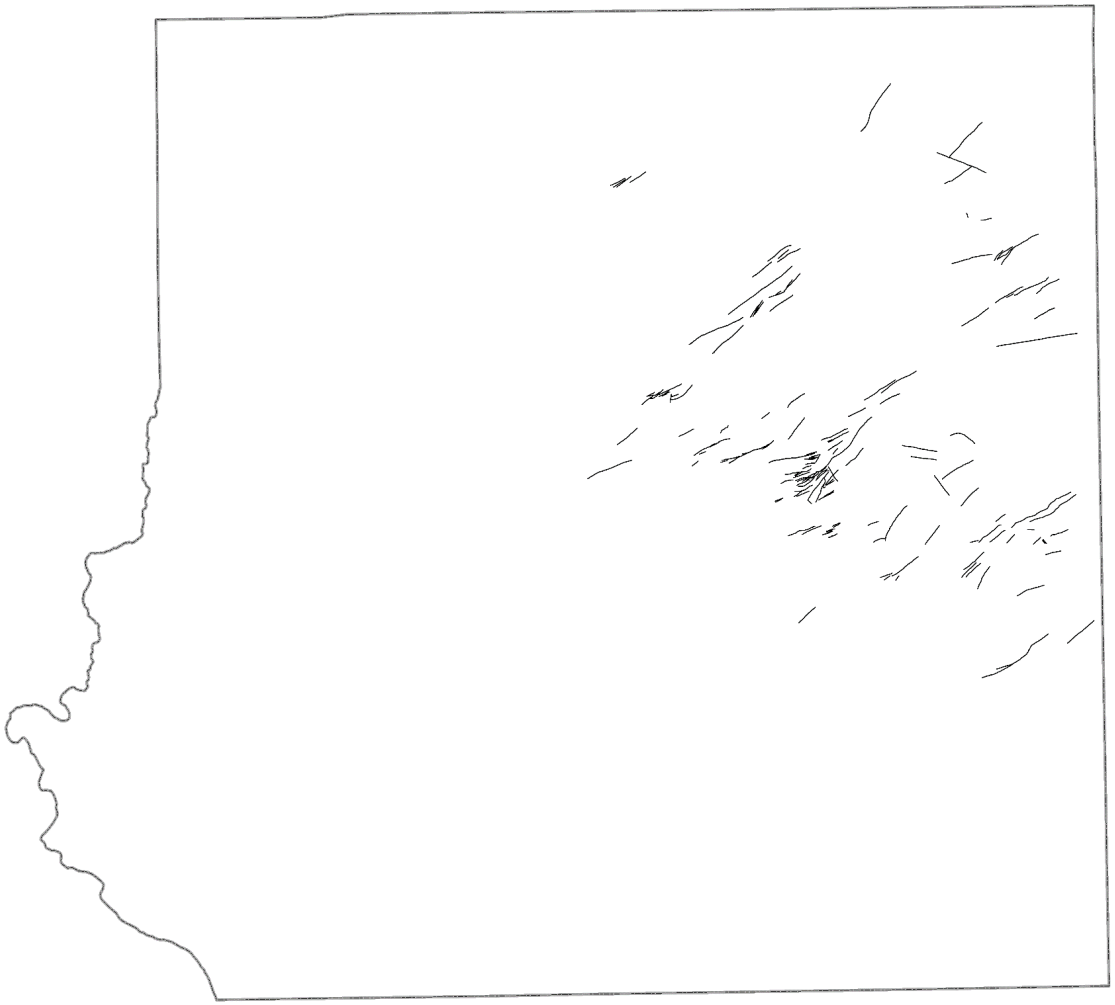
Faulting Sources

- Geologic Atlas of Texas (GAT)
- Moore, 2010. Geologic Map of the Edwards Aquifer and Related Rocks in Northeastern Kinney and Southernmost Edwards Counties, South-Central Texas, USGS Scientific Investigations Map 3105.
- URS Study (2004)

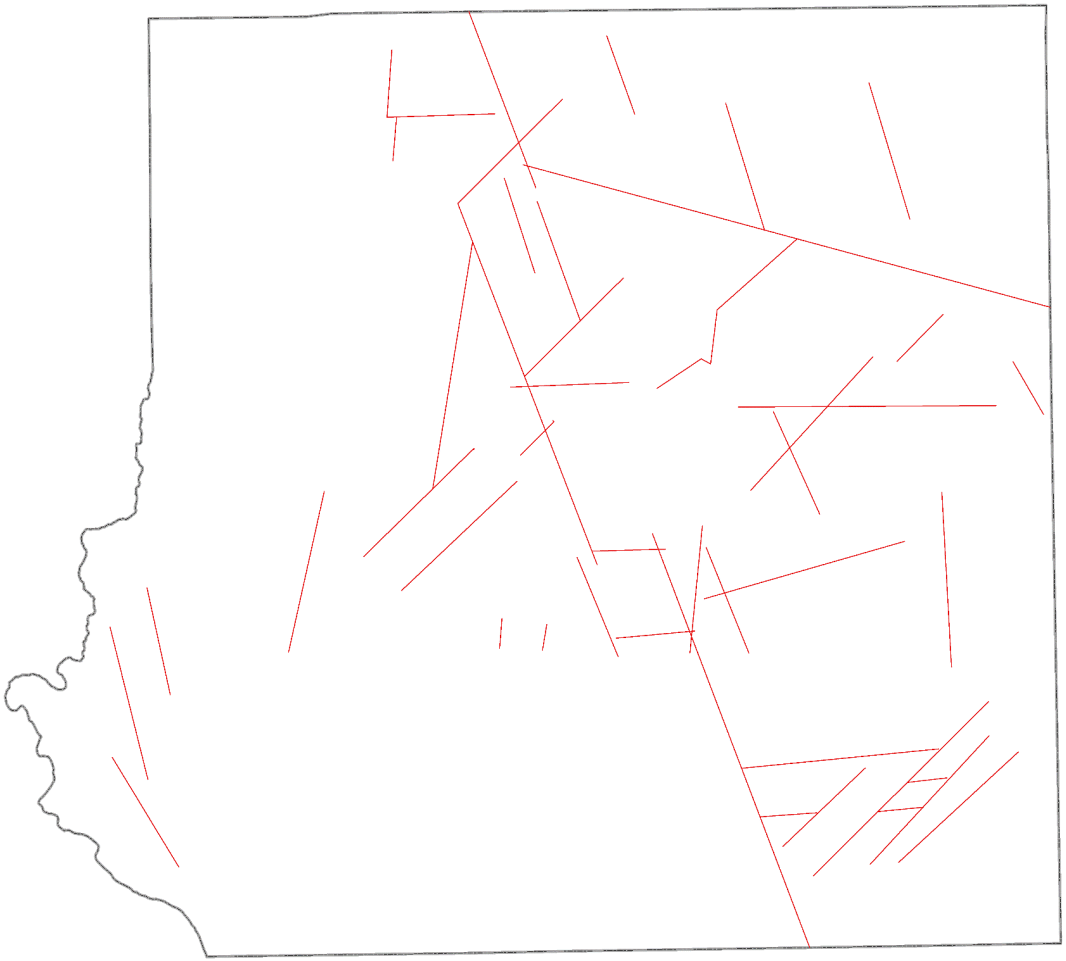
GAT Faults



Moore (2010) Faults



URS (2004) Faults



Observations

- GAT and Moore (2010) faulting are generally consistent
  - Moore (2010) has more detail in important area for the model
- URS (2004) does not appear to be consistent with GAT or Moore (2004)
  - Contributor to 2023 model calibration issues?
- Work is continuing as part of Phase 2
  - Scheduled for completion in May 2024