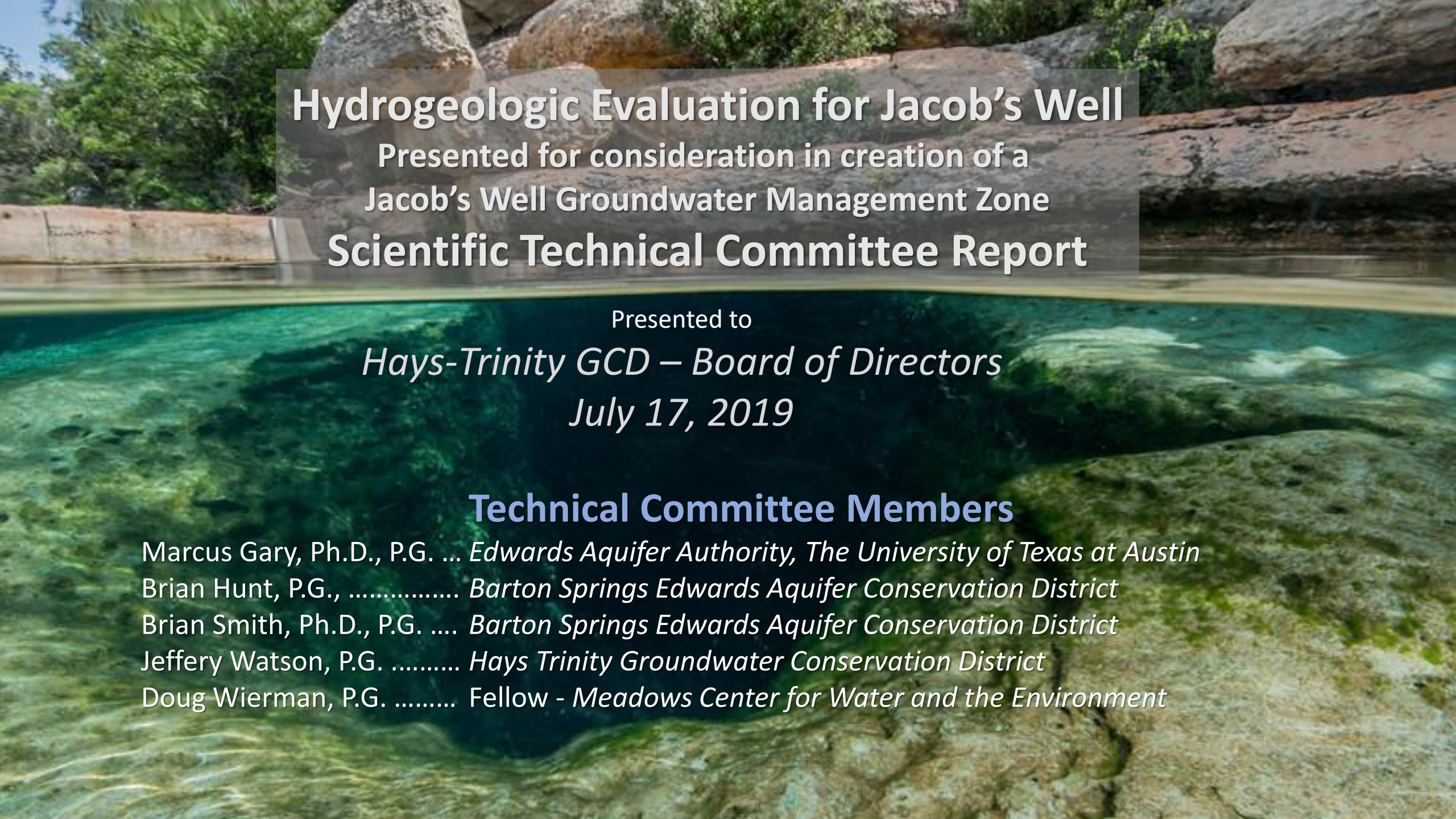

Hydrogeologic Evaluation for Jacob's Well

Presented for consideration in creation of a Jacob's Well Groundwater Management Zone

Scientific Technical Committee Report

Presented to

Hays-Trinity GCD – Board of Directors

July 17, 2019

Technical Committee Members

Marcus Gary, Ph.D., P.G. … *Edwards Aquifer Authority, The University of Texas at Austin*

Brian Hunt, P.G., …… *Barton Springs Edwards Aquifer Conservation District*

Brian Smith, Ph.D., P.G. …. *Barton Springs Edwards Aquifer Conservation District*

Jeffery Watson, P.G. ……. *Hays Trinity Groundwater Conservation District*

Doug Wierman, P.G. …… Fellow - *Meadows Center for Water and the Environment*

Charge of the Scientific Technical Committee

1. Define the spatial extent (springshed) of the JWGMZ based on hydrogeologic observations, data, and related information.
2. Work with Stakeholder Group to update drought indicators and identify flow rate triggers for the JWGMZ.
3. Evaluation of pumping volume (permitted and exempt) within the JWGMZ.
4. Conduct a hydrologic analysis of the water budget to determine cumulative effects of pumping on springflow at Jacob's Well, particularly during drought conditions.
5. Develop a set of possible strategies to minimize negative anthropogenic influences on Jacob's Well springflow.
6. Identify any gaps in data and determine what future studies would improve the GCD's ability to manage groundwater resources in the JWGMZ.

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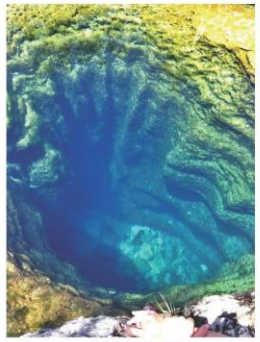
MEMORANDUM

To: HTGCD Board Members, JWGMZ Stakeholders, JWGMZ Technical Team
From: Robin Rather
Date: July 15, 2019
Re: Facilitator's Report: Jacob's Well Spring Flow Stakeholder Task Force--Final Recommendations

Executive Summary

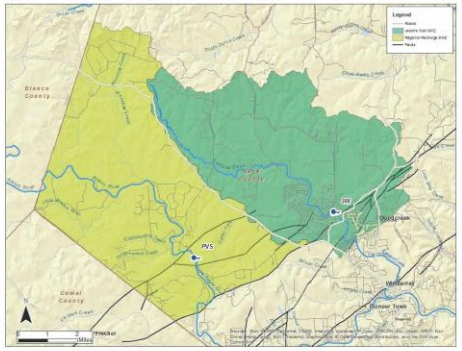


Thirty-five volunteer members of the Hays Trinity Groundwater Conservation District (HTGCD) "Spring Flow" Task Force were asked to review technical and scientific data and to identify best practices to ensure perennial spring flow at Jacob's Well and Cypress Creek. The Task Force came to 100% consensus on all but one of seven recommendations, and that one recommendation had all but two members in consensus. This memo contains a summary of the Task Force's work.

The first three recommendations are the most immediate and the most impactful in the short term:

1. We recommend the immediate establishment of one groundwater management zone shown in dark green in the map at right (the Jacob's Well Groundwater Management Zone, or JWGMZ). We also ask that the establishment of second zone be considered shown in yellow below (Regional Recharge Zone).

   For more detailed maps and technical specifics please refer to the Technical Report written by the JWGMZ Technical team (forthcoming.)



2. Using Jacob's Well Spring as a trigger for permitted

Evaluation for the Development of a Jacob's Well Groundwater Management Zone Hays County, Texas

Technical Report prepared for the Hays Trinity Groundwater Conservation District, Hays County, Texas

Report: 2019-05
July 2019

The Meadows Center
for Water and the Environment
Texas State University

Authors:

Marcus O. Gary, Ph.D., P.G.
Edwards Aquifer Authority, The University of Texas at Austin

Brian B. Hunt, P.G.
Barton Springs/Edwards Aquifer Conservation District

Brian A. Smith, Ph.D., P.G.
Barton Springs/Edwards Aquifer Conservation District

Jeffery A. Watson, P.G.
Hays Trinity Groundwater Conservation District

Douglas A. Wierman, P.G.
Fellow , The Meadows Center for Water and the Environment, Texas State University

MEMBER **THE TEXAS STATE UNIVERSITY SYSTEM**

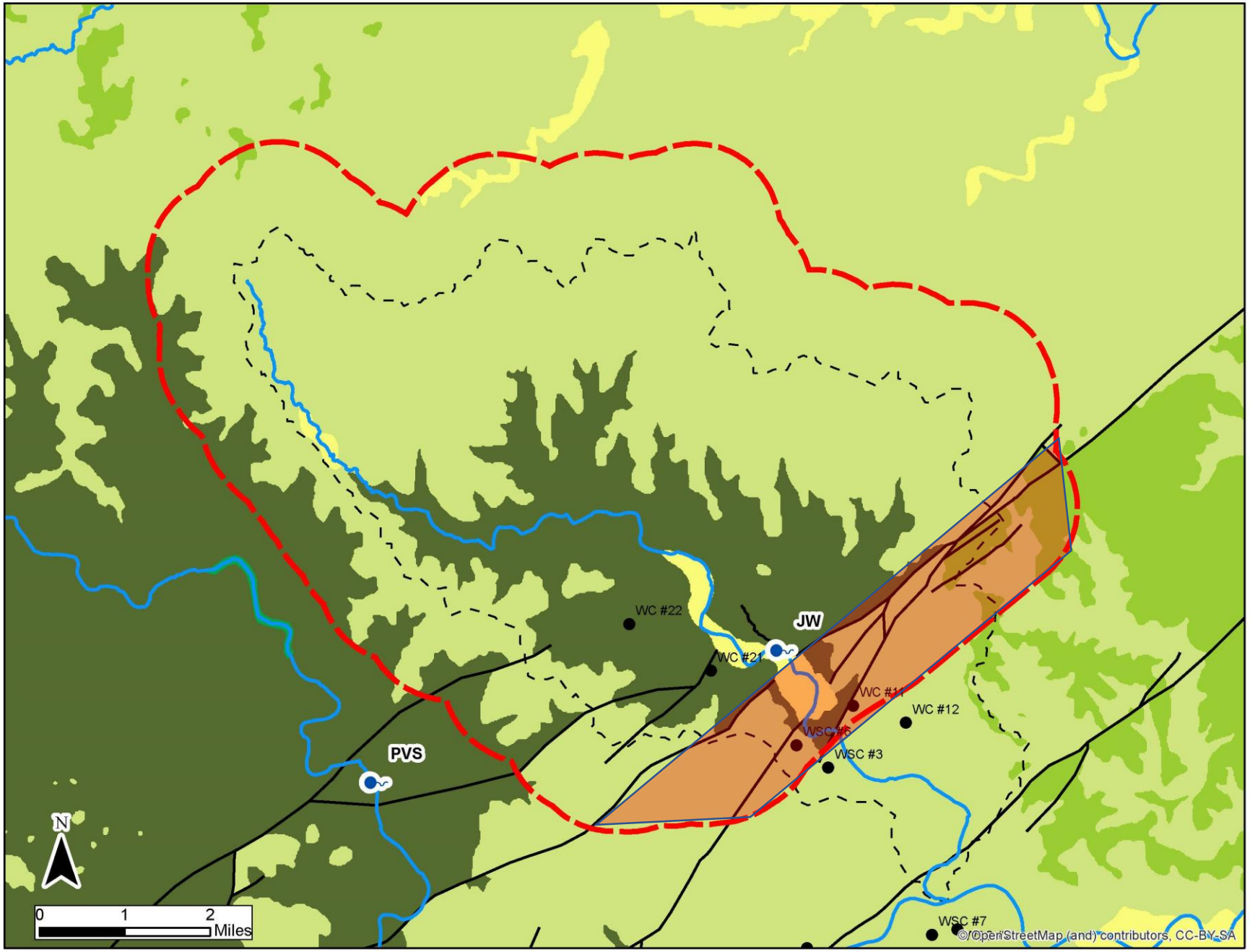
Datasets used in evaluation for this process.

1. Hydrogeologic setting
2. Geologic structure
3. Recharge area for JW
4. Well pumping data
5. Spring flow data
6. Groundwater level data

Suggested JWGMZ Area v 1.0

(presented December 6, 2018)

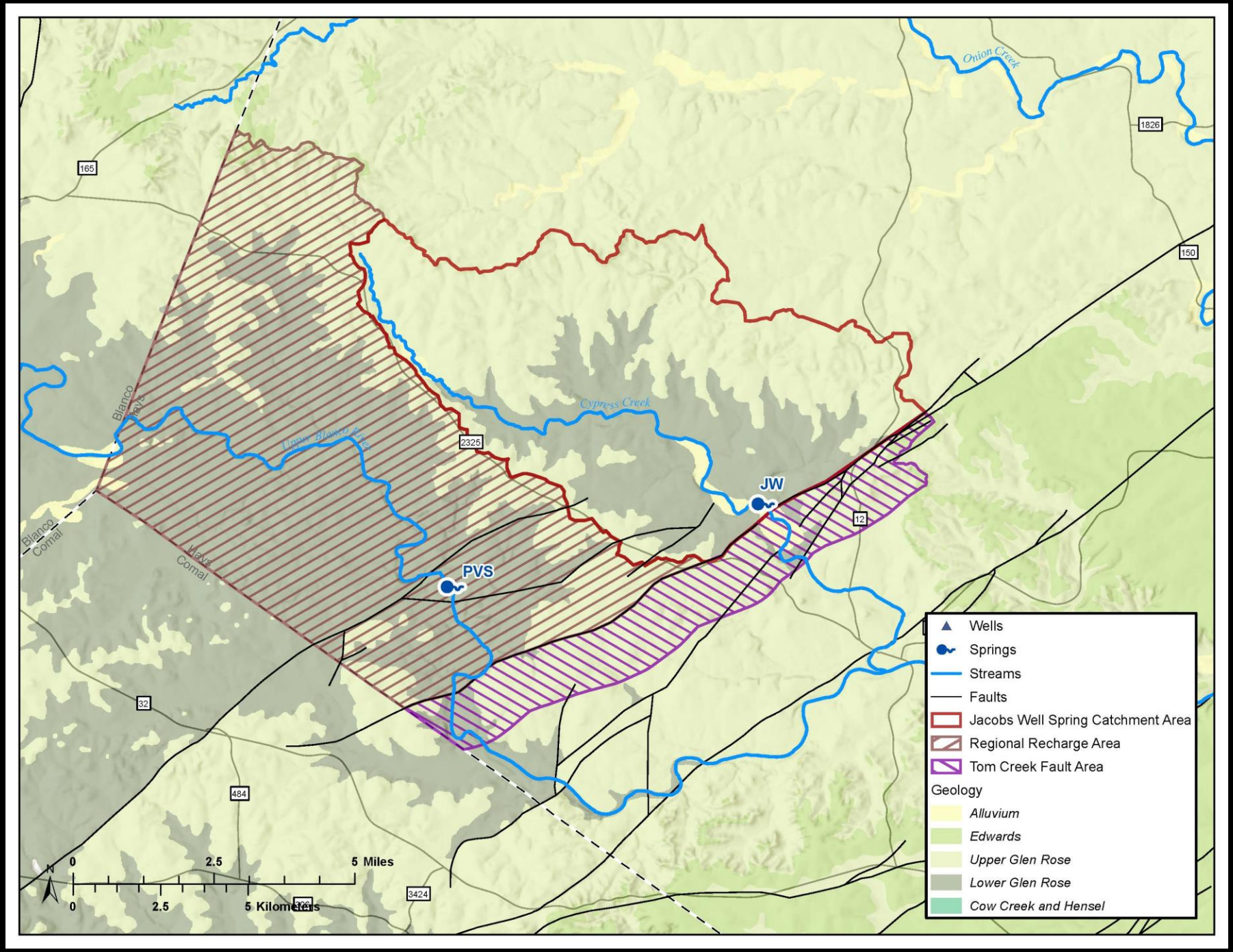
- 1-mile buffer around Dry Cypress Creek watershed upstream of Tom Creek Fault Zone.
- Includes Fault Zone – wells in this area respond similarly to wells in upstream watershed.



JWS Areas of Hydrogeologic Influence

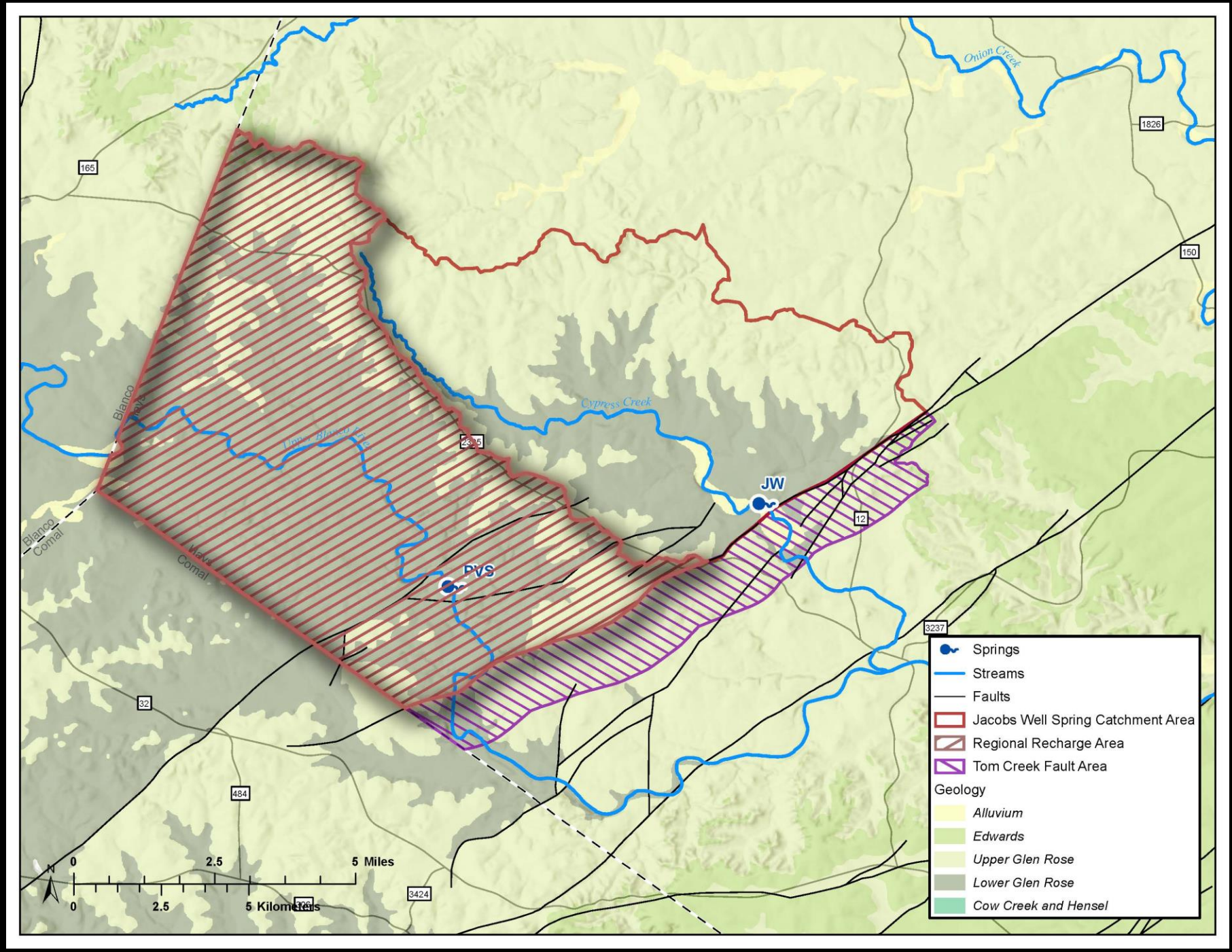
- Three separate areas that each influence flow at Jacob's Well are identified.

1. Jacob's Well catchment area (springshed)
2. Tom Creek Fault area.
3. Regional recharge area.



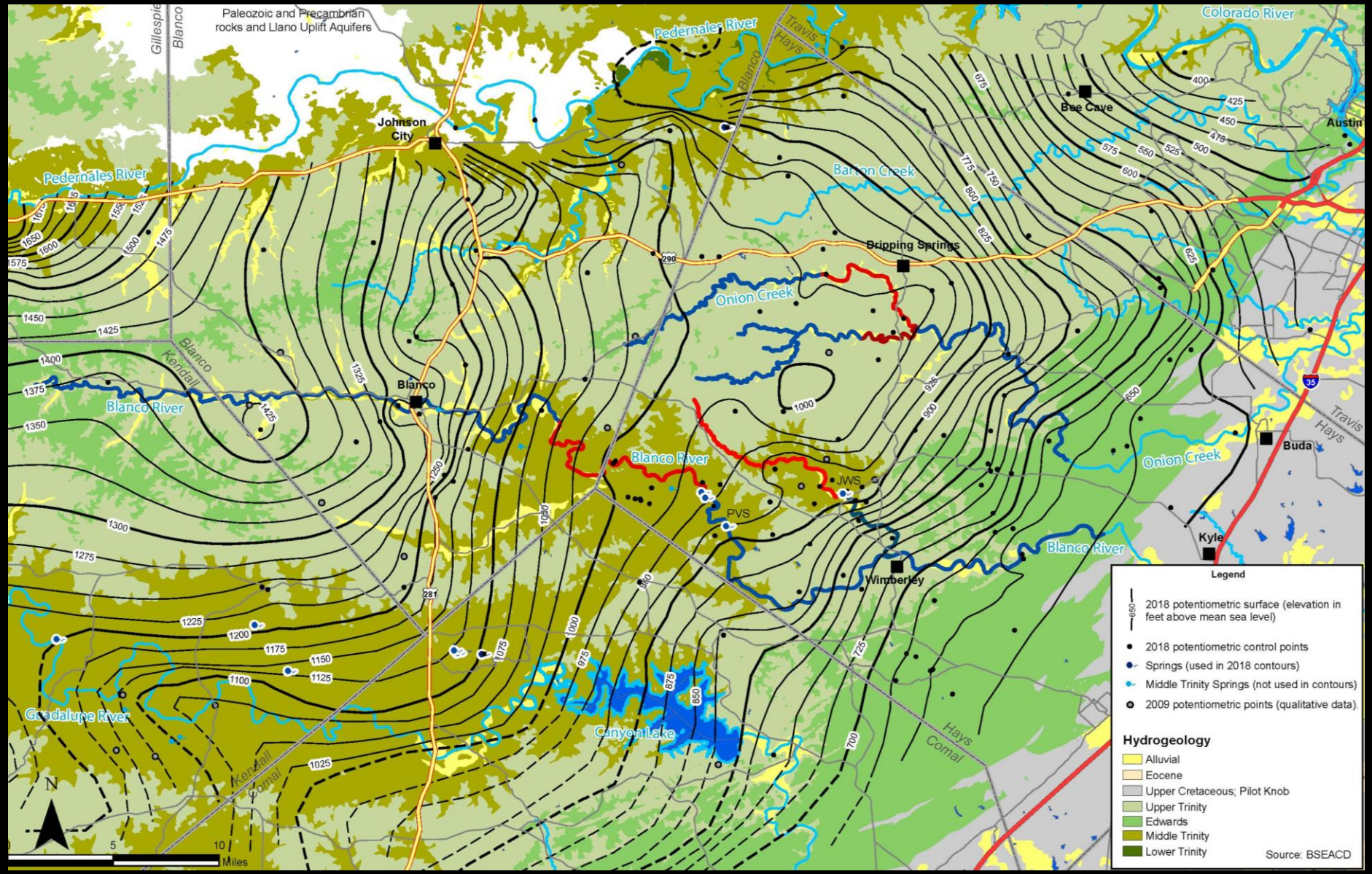
JW Regional Recharge Area

- Bounded by Hays County line to the west, Region K-L boundary to the north, Dry Cypress Creek to the east, and Tom Creek Fault to the south.
- Regional GW flow into the JWS springshed area.
- Includes PVS and Blanco Rv springs.



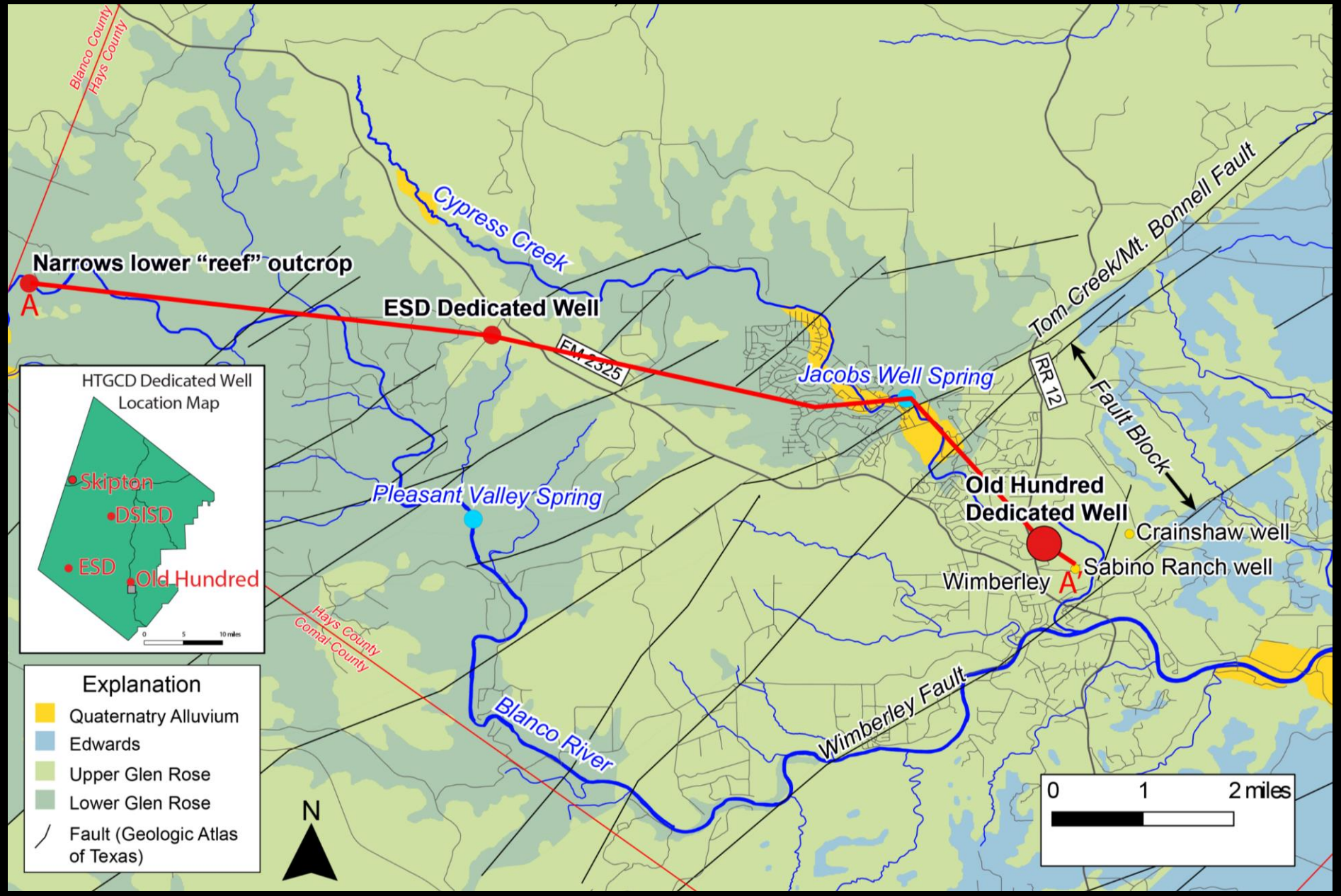
Regional Groundwater Surface

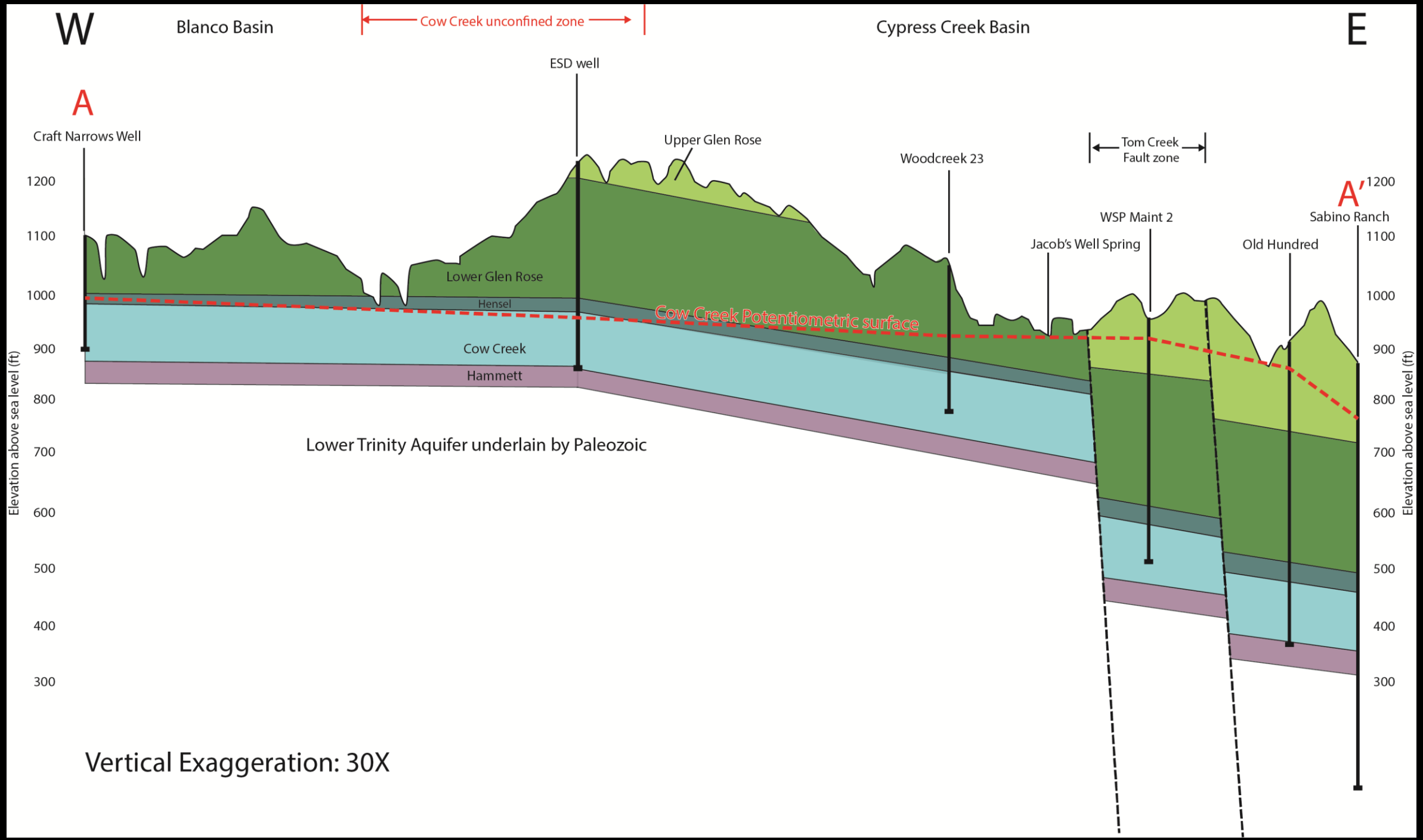
- Water levels in the Middle Trinity aquifer in this portion of the Hill Country are generally from the west to east.
- The water level surface tends to “flatten out” in areas where extensive karst exists, such as JWS



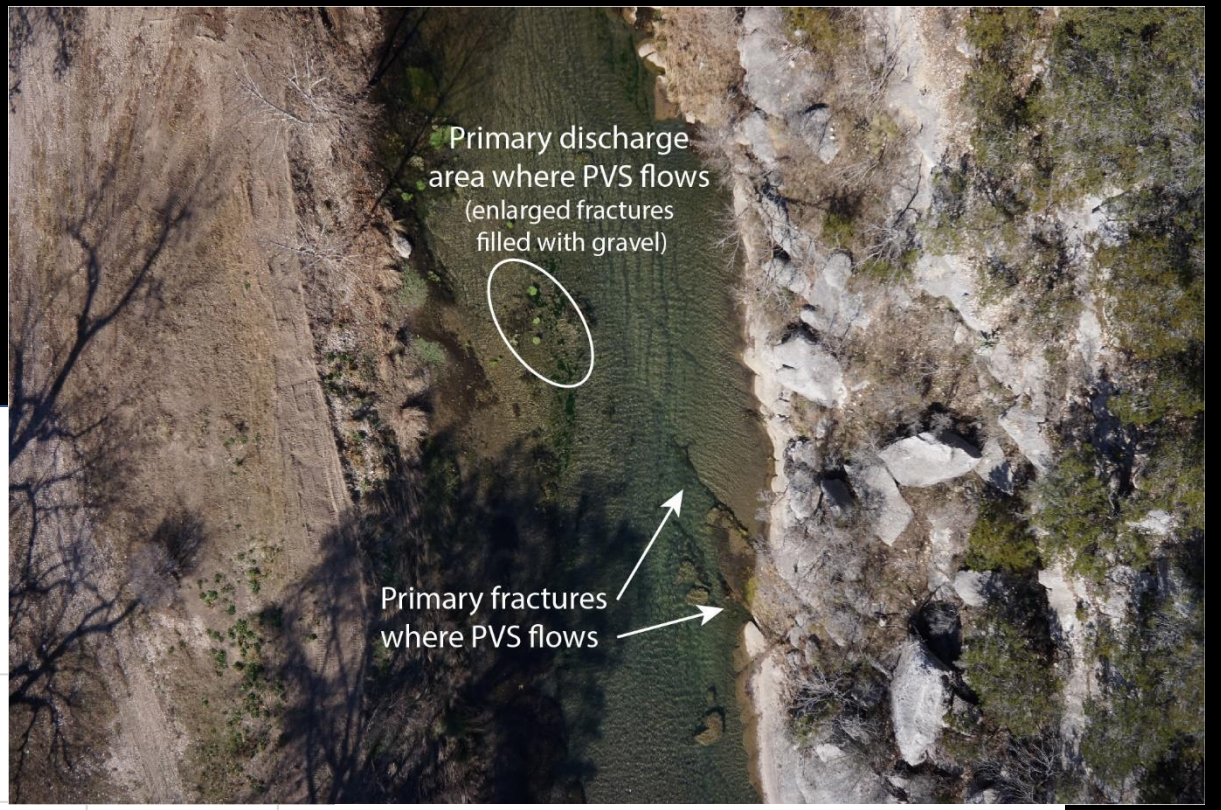
Regional cross-section

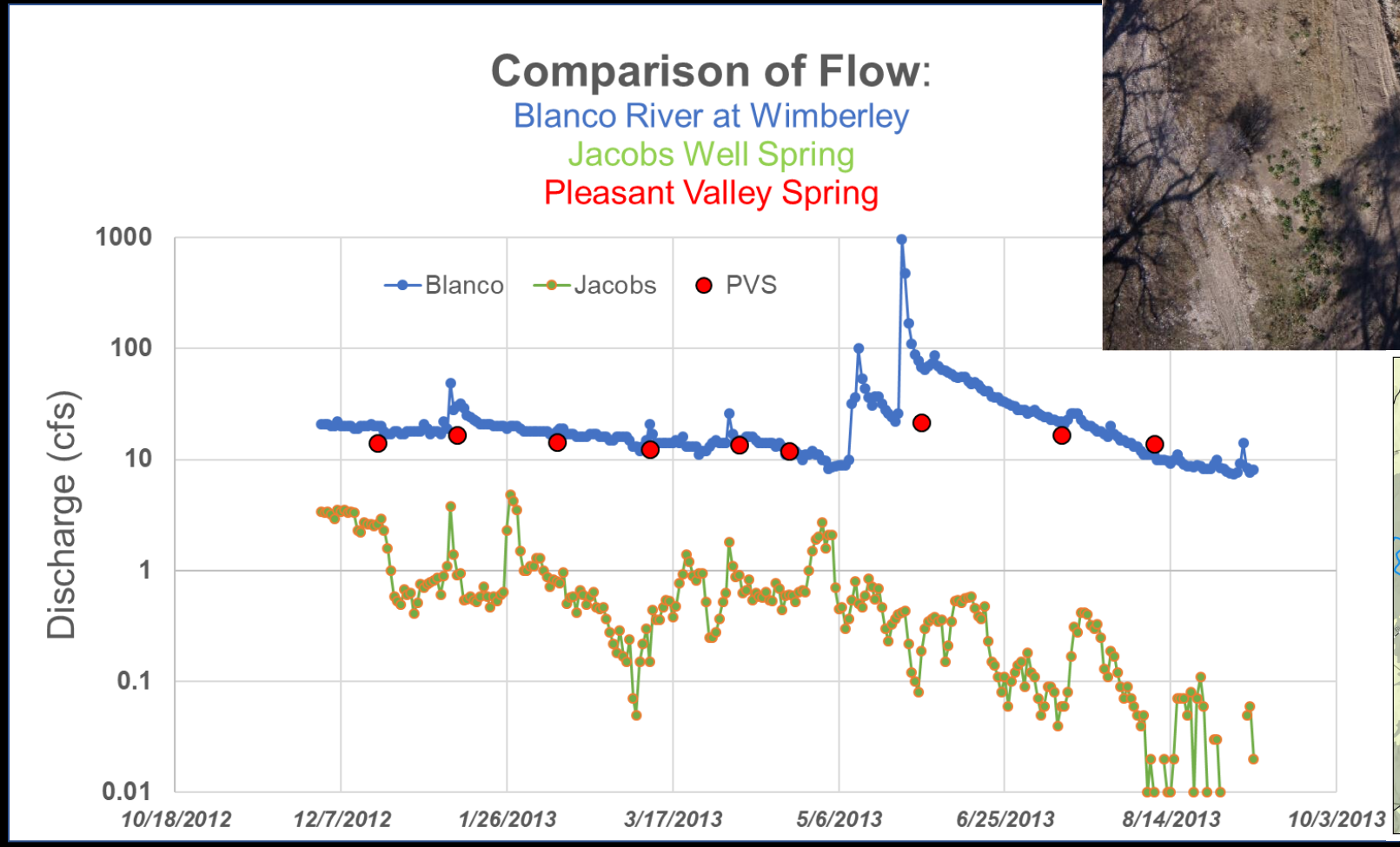
- The HTGCD produced a regional cross-section through JWS running from west to east from the Hays Co. line through the Wimberley area.

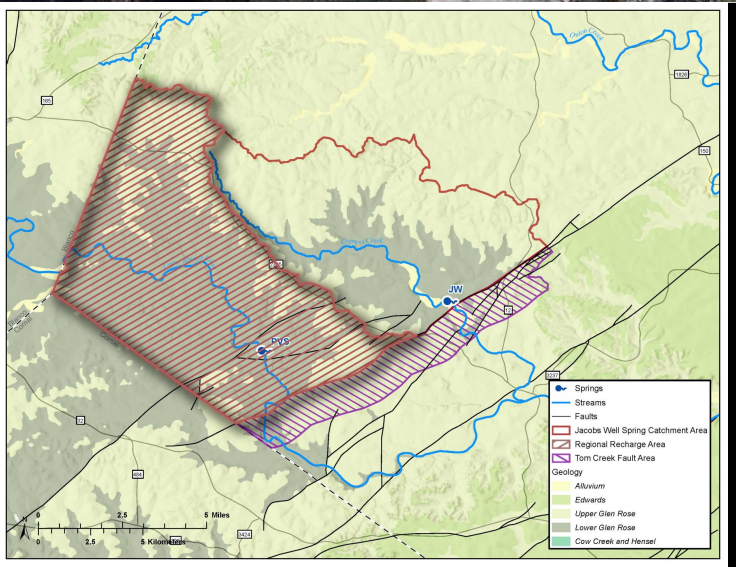



W
Blanco Basin
Cow Creek unconfined zone
Cypress Creek Basin
E
A
A′
ESD well
Craft Narrows Well
Upper Glen Rose
Woodcreek 23
Tom Creek
Fault zone
WSP Maint 2
Jacob's Well Spring
Old Hundred
Sabino Ranch
Lower Glen Rose
Hensel
Cow Creek Potentiometric surface
Cow Creek
Hammett
Lower Trinity Aquifer underlain by Paleozoic
Elevation above sea level (ft)
1200
1100
1000
900
800
700
600
500
400
300
Vertical Exaggeration: 30X

Pleasant Valley Spring (PVS) is a single spring that provides all the flow to the Blanco River in Wimberley under drought conditions.

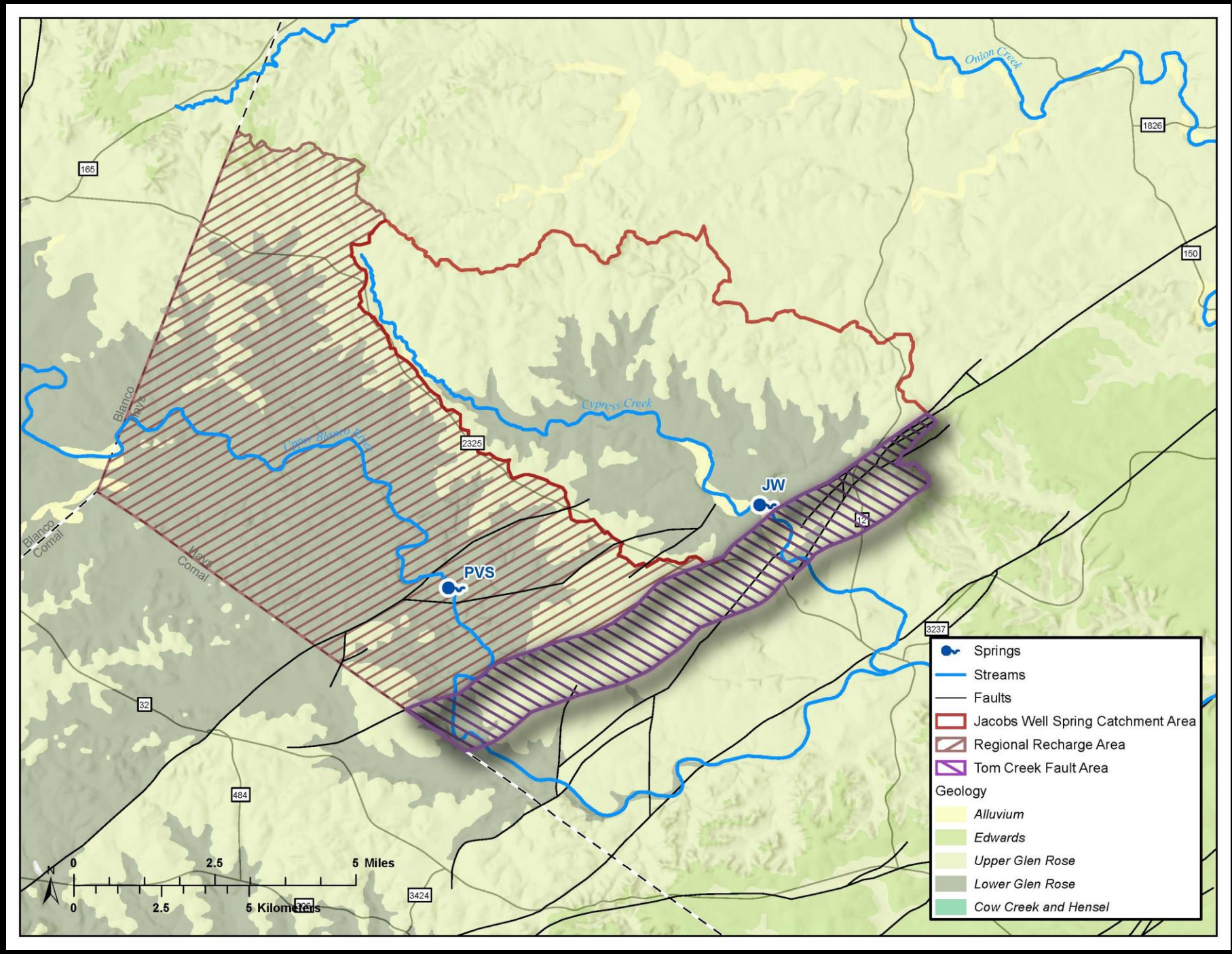


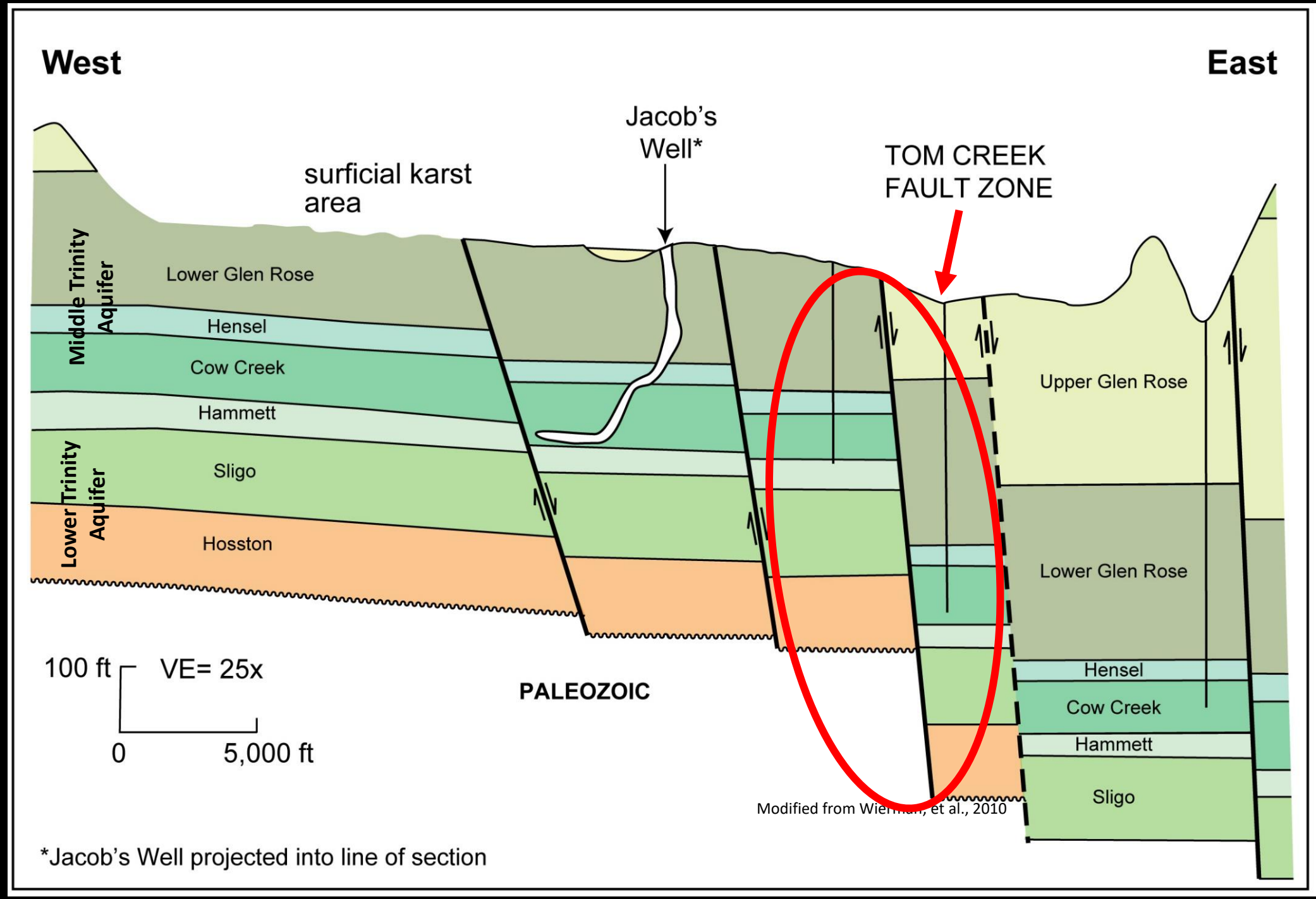




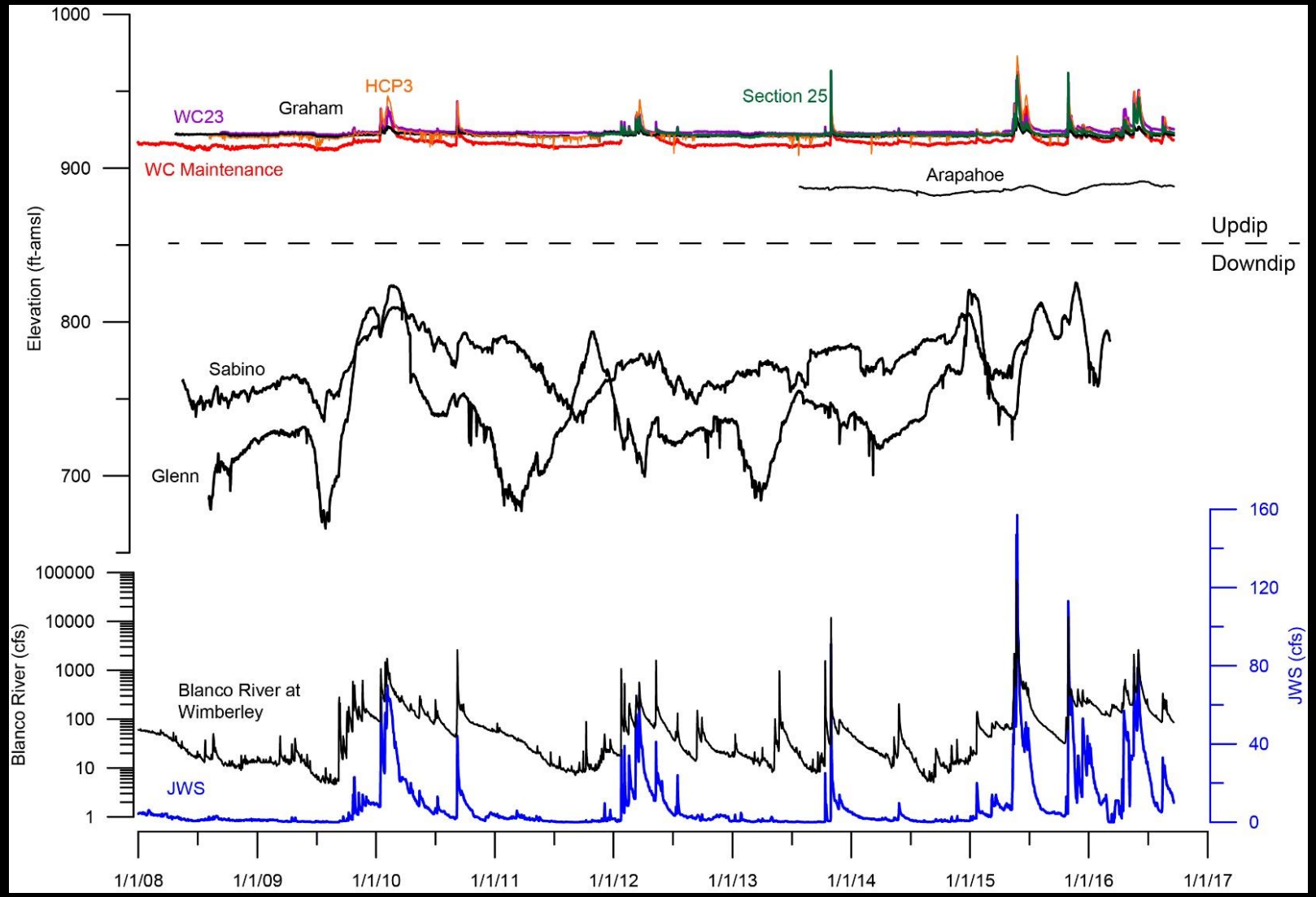
Tom Creek Fault Zone Area

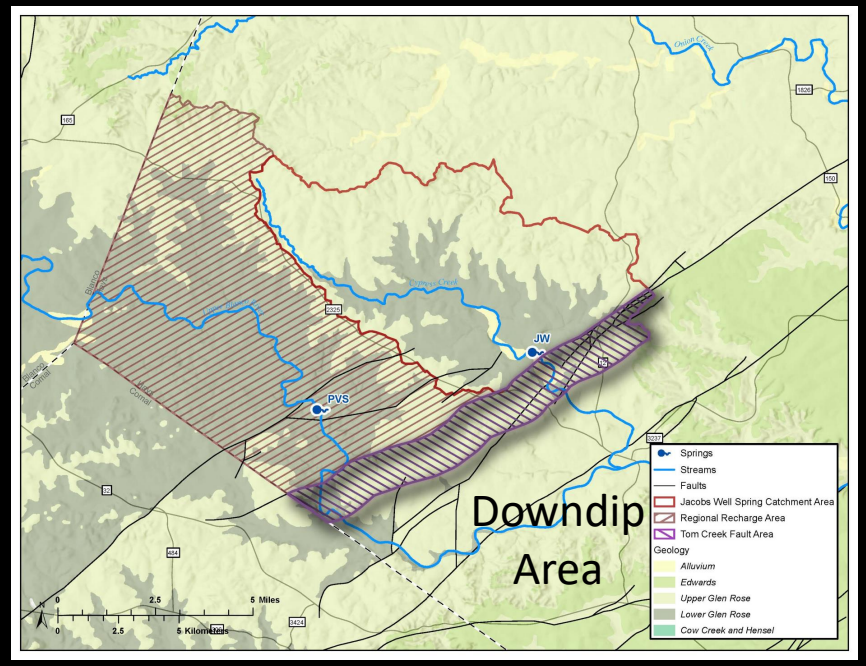
- Bounded by Regional Recharge Area and JW Catchment to the west.
- Reflects a 1-mile wide fault zone southeast from the Tom Creek Fault as mapped by the BEG.




West
East
Jacob's Well*
surficial karst area
TOM CREEK FAULT ZONE
Middle Trinity Aquifer
Lower Trinity Aquifer
Lower Glen Rose
Hensel
Cow Creek
Hammett
Sligo
Hosston
Upper Glen Rose
Lower Glen Rose
Hensel
Cow Creek
Hammett
Sligo
100 ft
VE= 25x
0
5,000 ft
PALEOZOIC
Modified from Wierman, et al., 2010
*Jacob's Well projected into line of section

Wells located in the Tom Creek Fault Area and the Jacob's Well Spring Catchment Area (updip) respond differently than wells to the southeast (downdip) where the Middle Trinity aquifer is deeper in the subsurface





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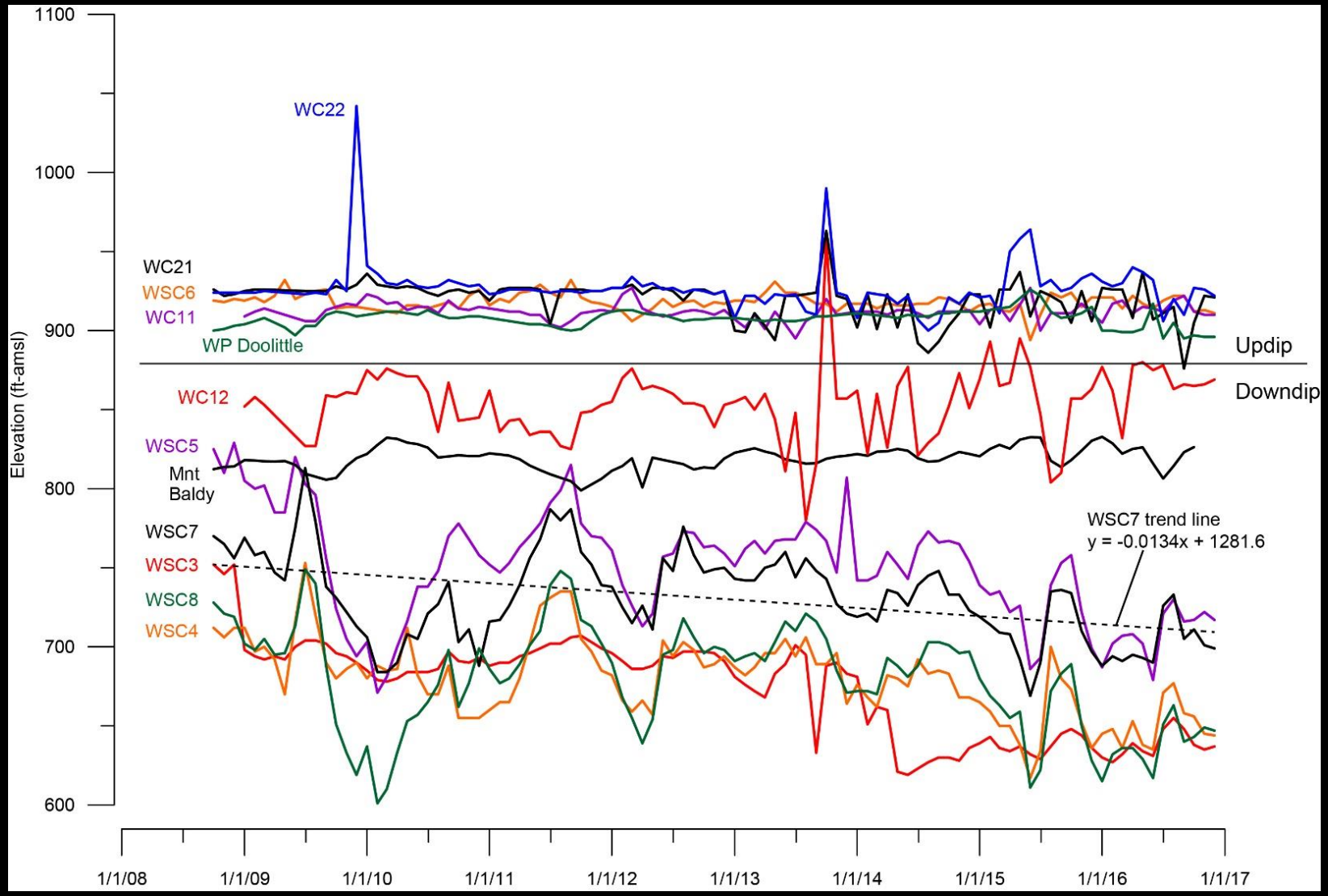
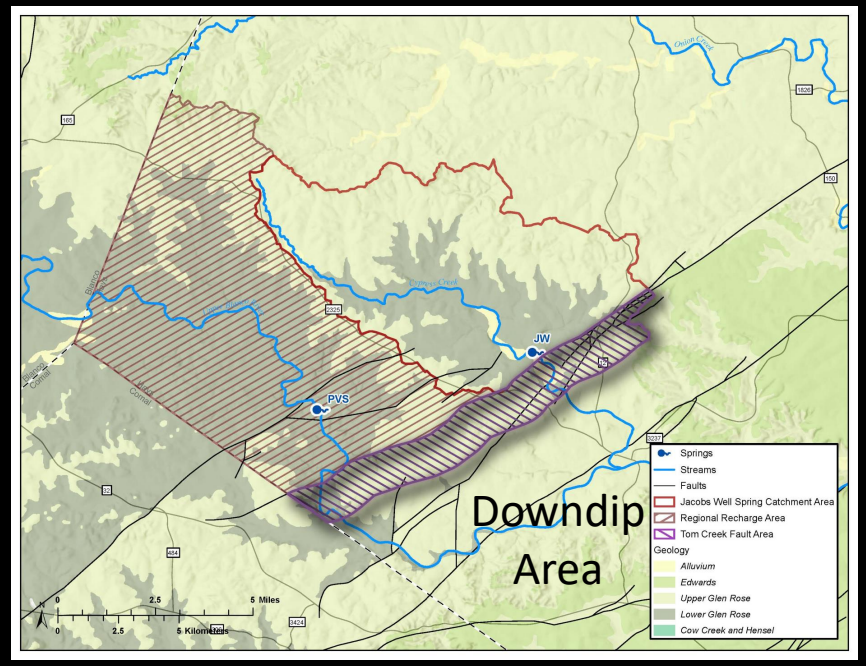
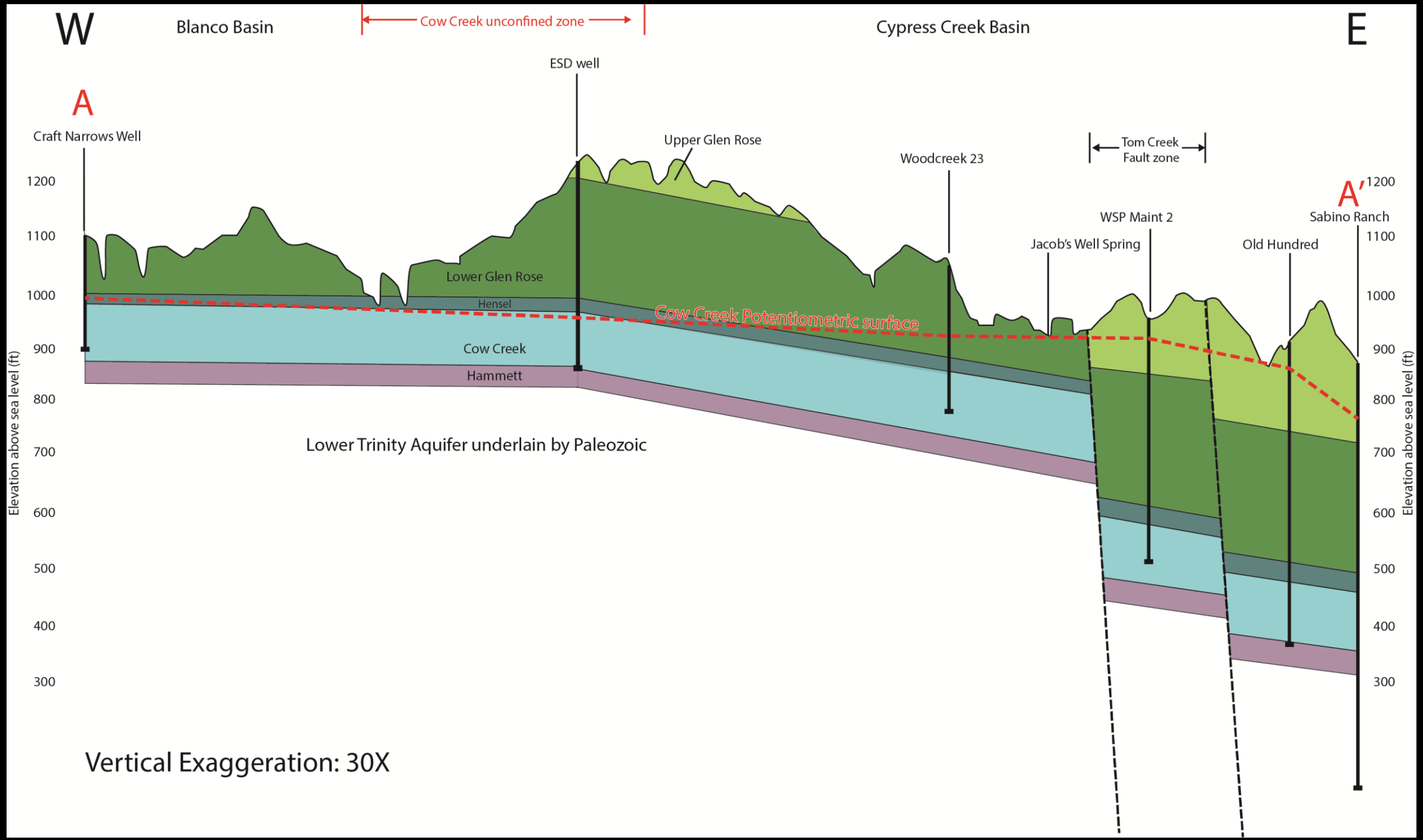
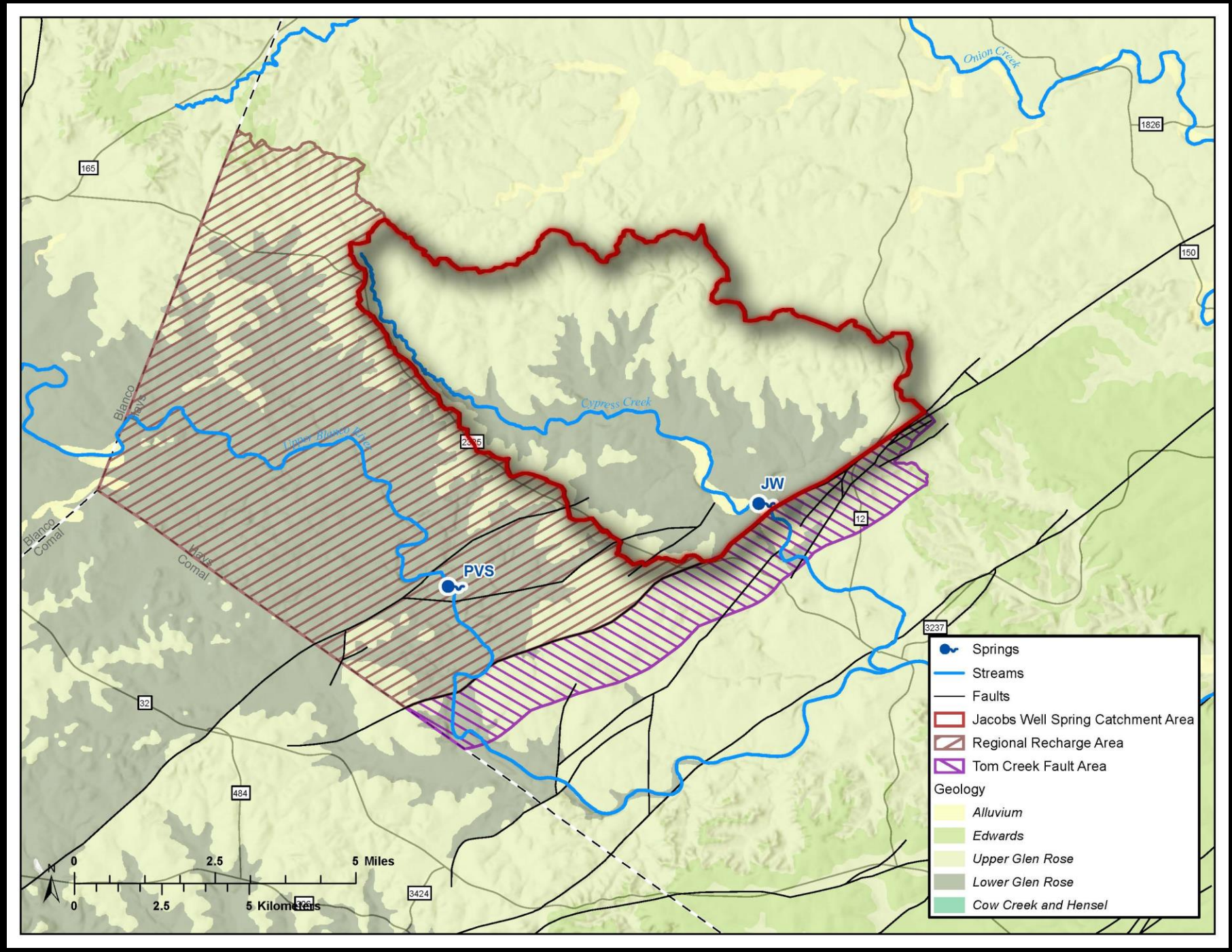




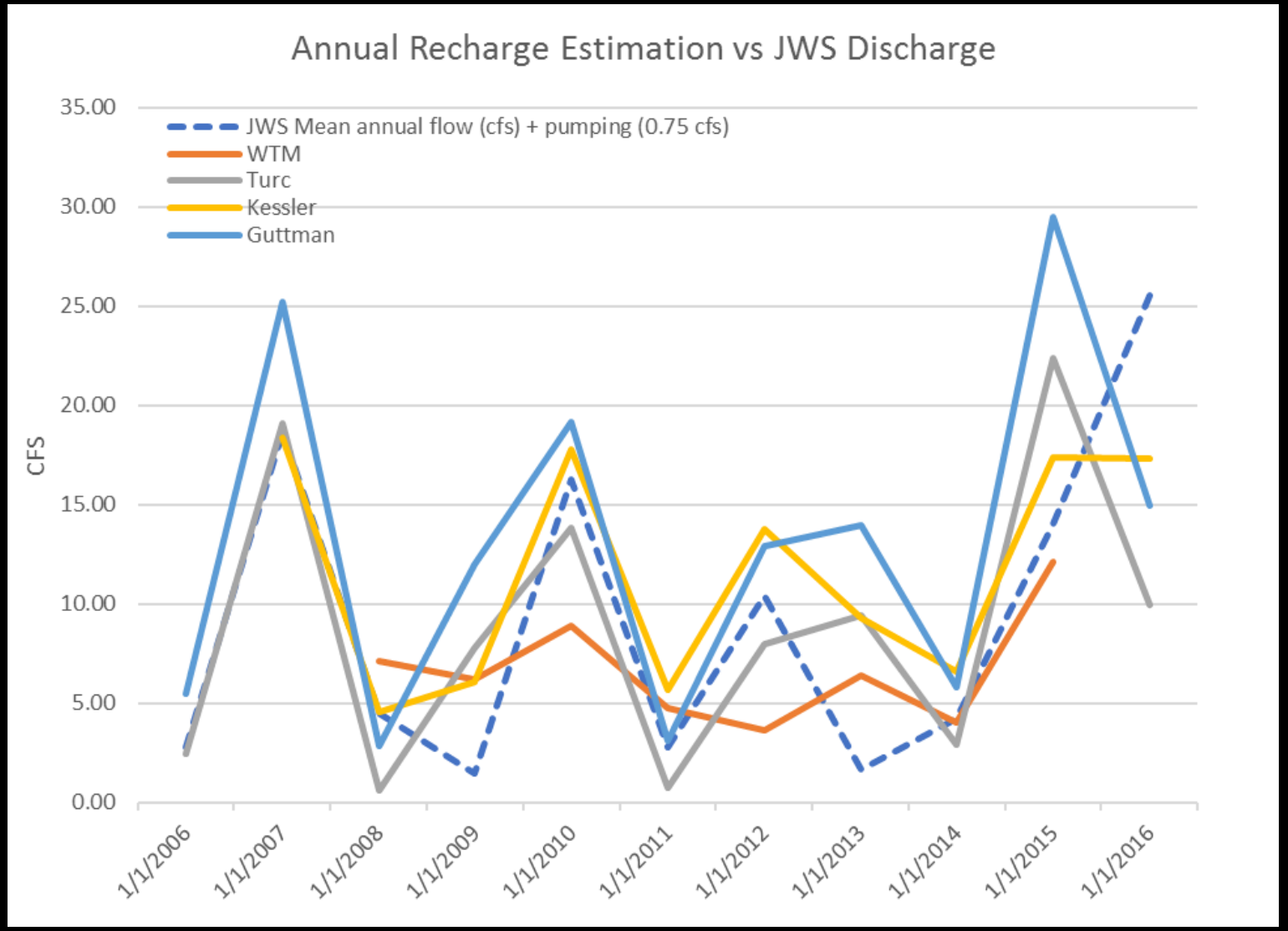

W
Blanco Basin
Cow Creek unconfined zone
Cypress Creek Basin
E
A
A′
ESD well
Craft Narrows Well
Upper Glen Rose
Woodcreek 23
Tom Creek
Fault zone
WSP Maint 2
Jacob's Well Spring
Old Hundred
Sabino Ranch
Lower Glen Rose
Hensel
Cow Creek Potentiometric surface
Cow Creek
Hammett
Lower Trinity Aquifer underlain by Paleozoic
Elevation above sea level (ft)
1200
1100
1000
900
800
700
600
500
400
300
Vertical Exaggeration: 30X

Jacob's Well Spring Catchment Area

- Represents the primary recharge area for JW.
- Water levels in the Middle Trinity aquifer are directly tied to spring flow.
- Cave passages feeding JW developed in this area.



Multiple recharge analyses were conducted to evaluate area of greatest influence to spring flow

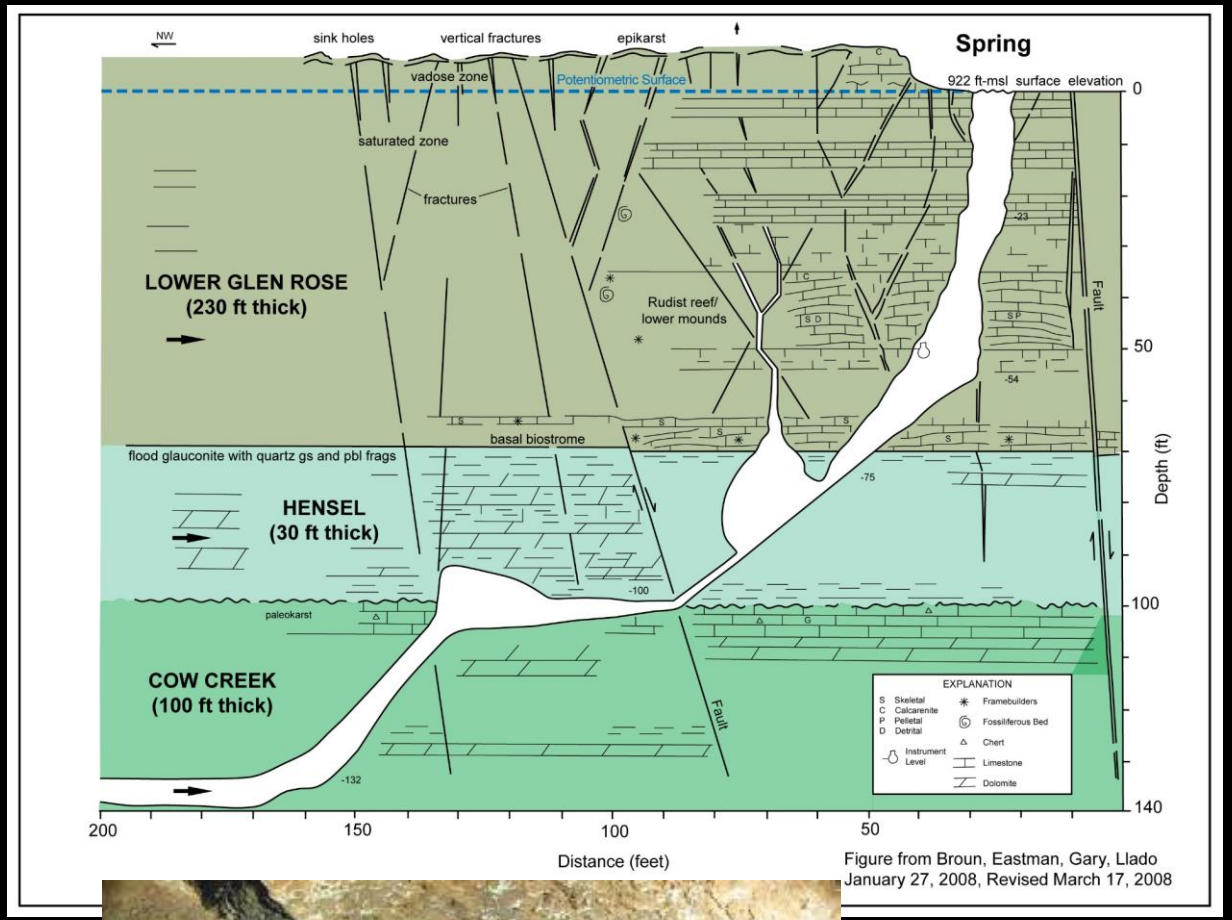


Springshed is estimated by integrating hydrologic data with methods published by Lanini et al., 2016 and Bonacci and Andric, 2015.

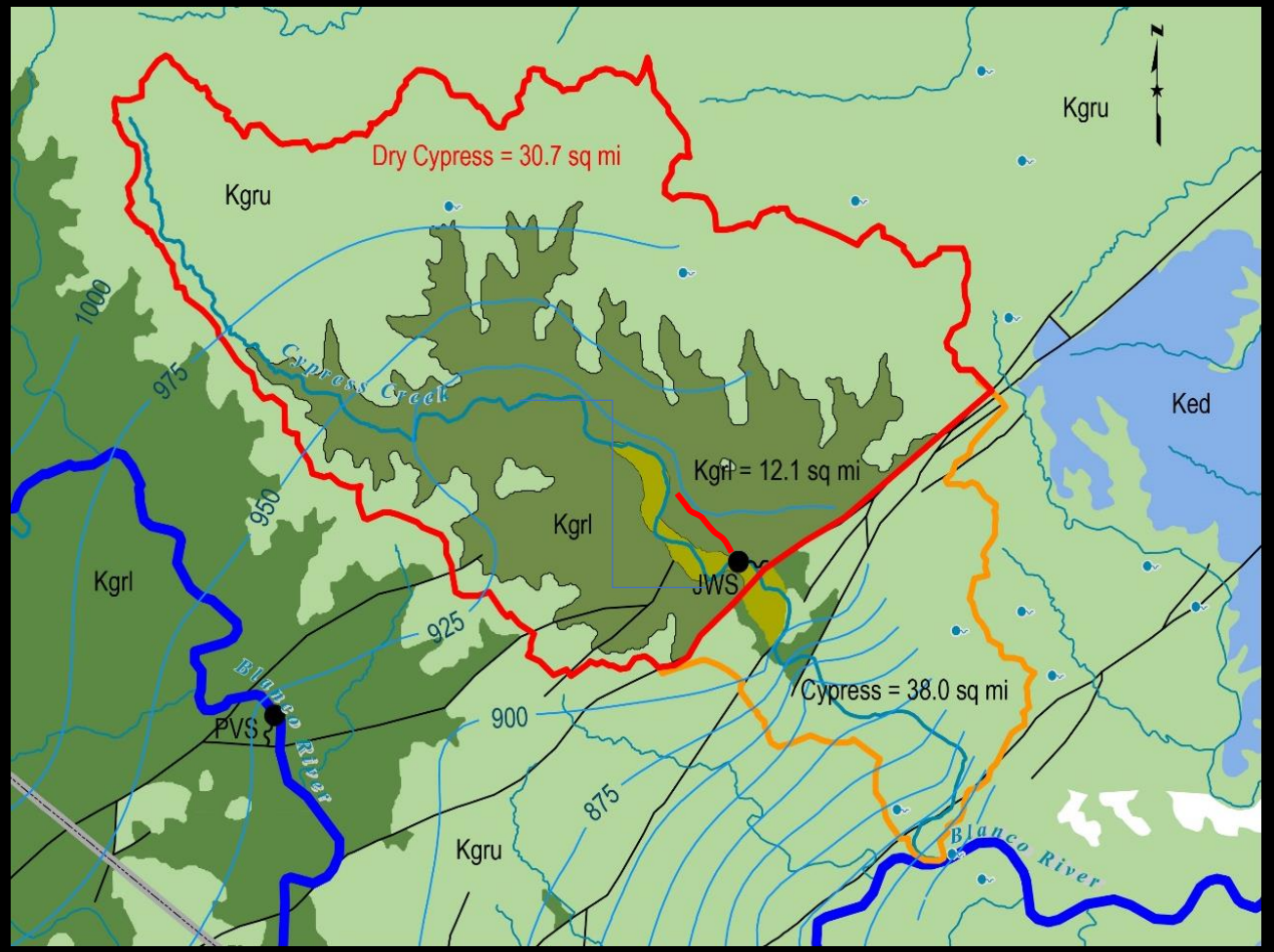
Springshed of Dry Cypress Creek (~31 mi2, or less) is sufficient for all recharge estimates.

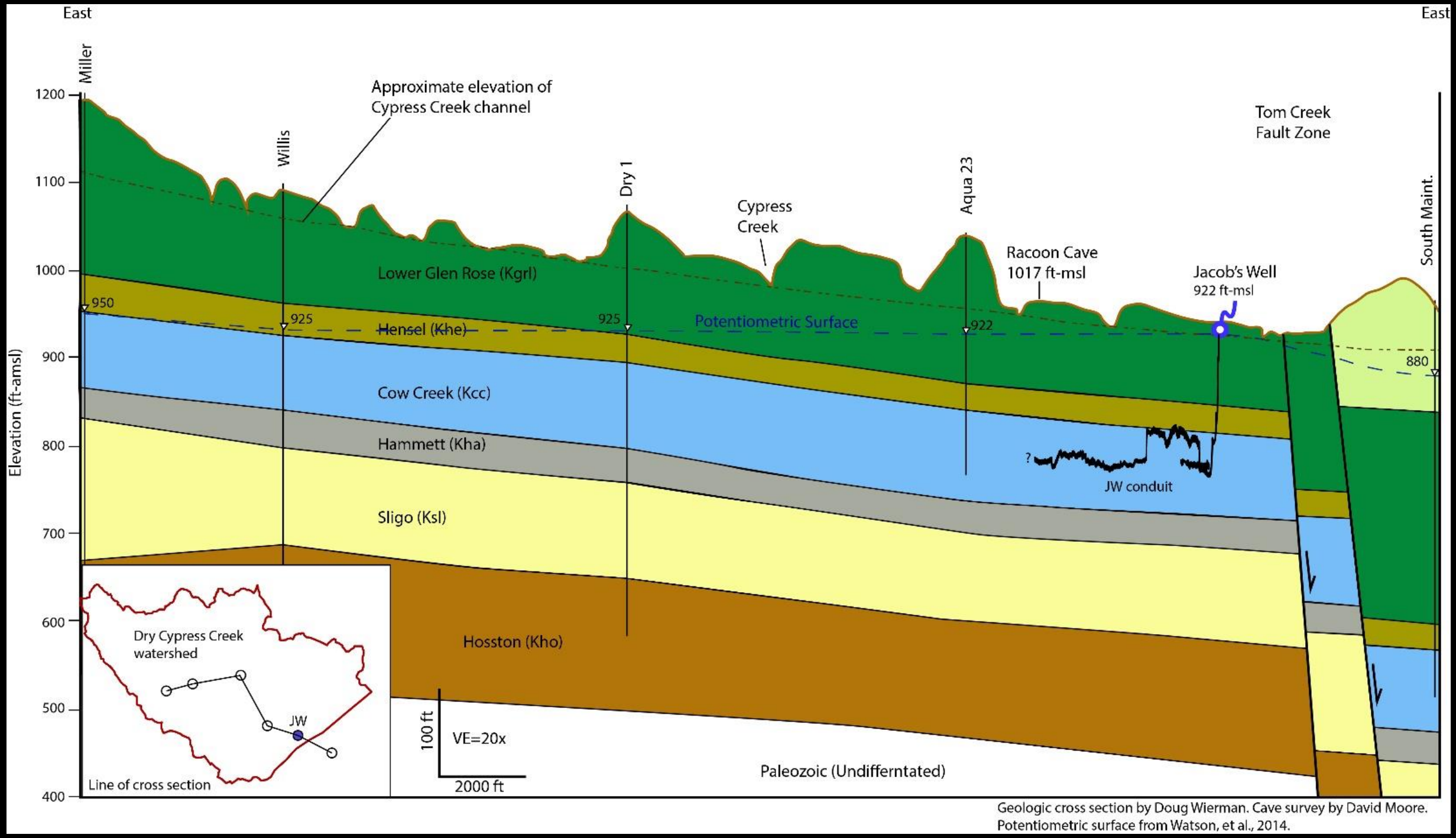
Estimated average annual effective recharge is about 30% of rainfall.

Hunt et. al, in prep



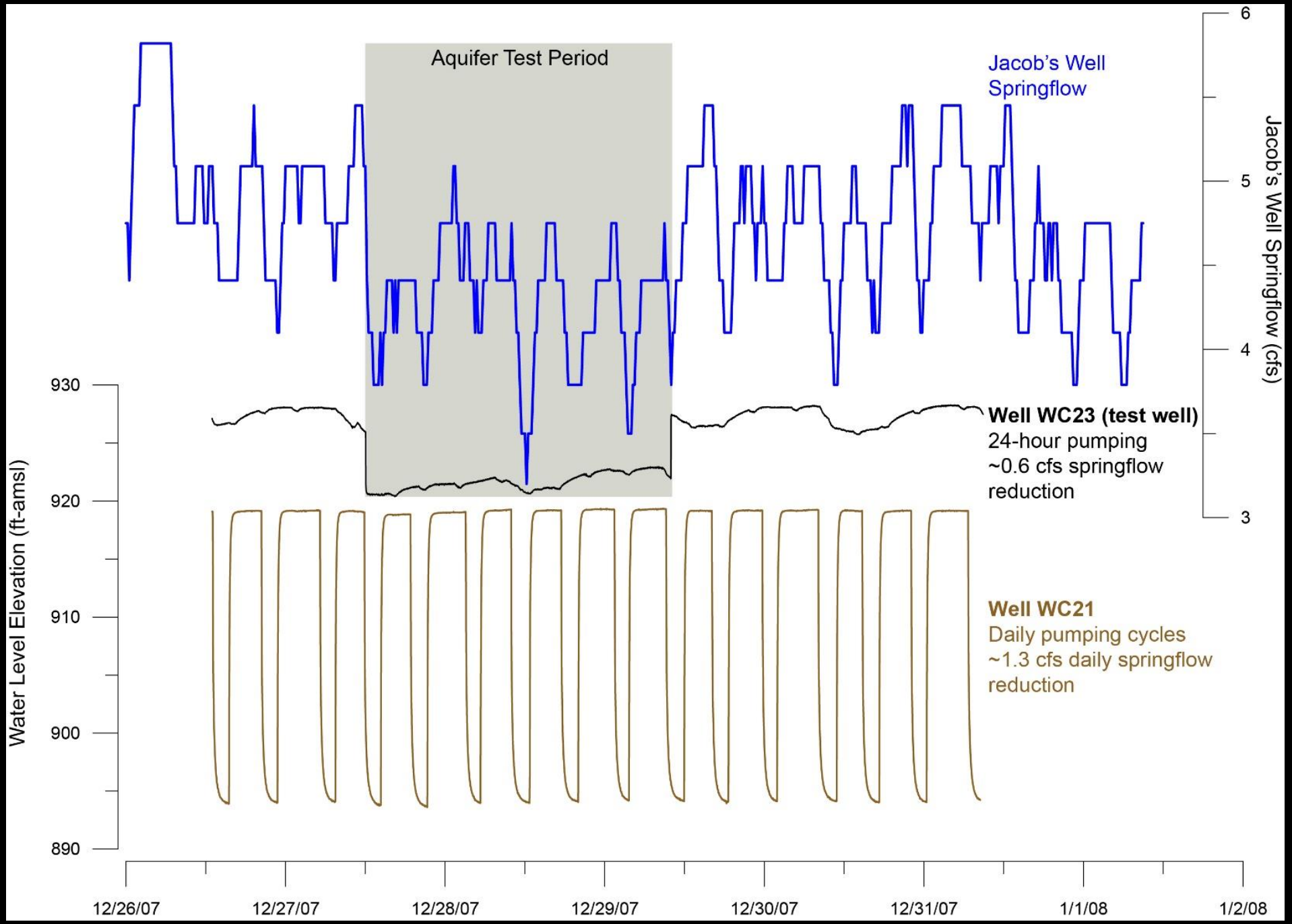
Jacob's Well Spring emerges from the underwater cave system that has developed along fractures in the limestone running from the spring to the northwest.





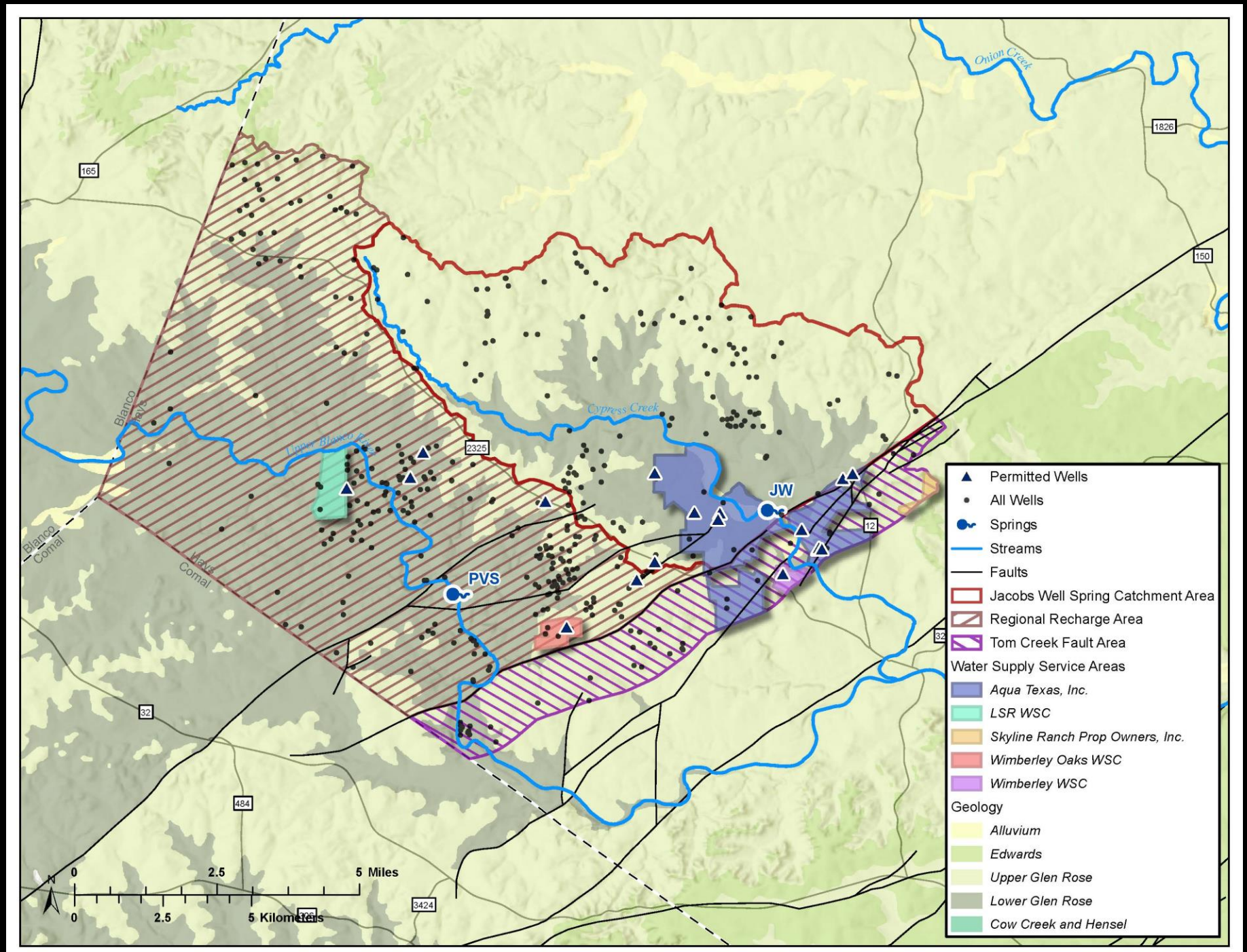
Geologic cross section by Doug Wierman. Cave survey by David Moore.
Potentiometric surface from Watson, et al., 2014.

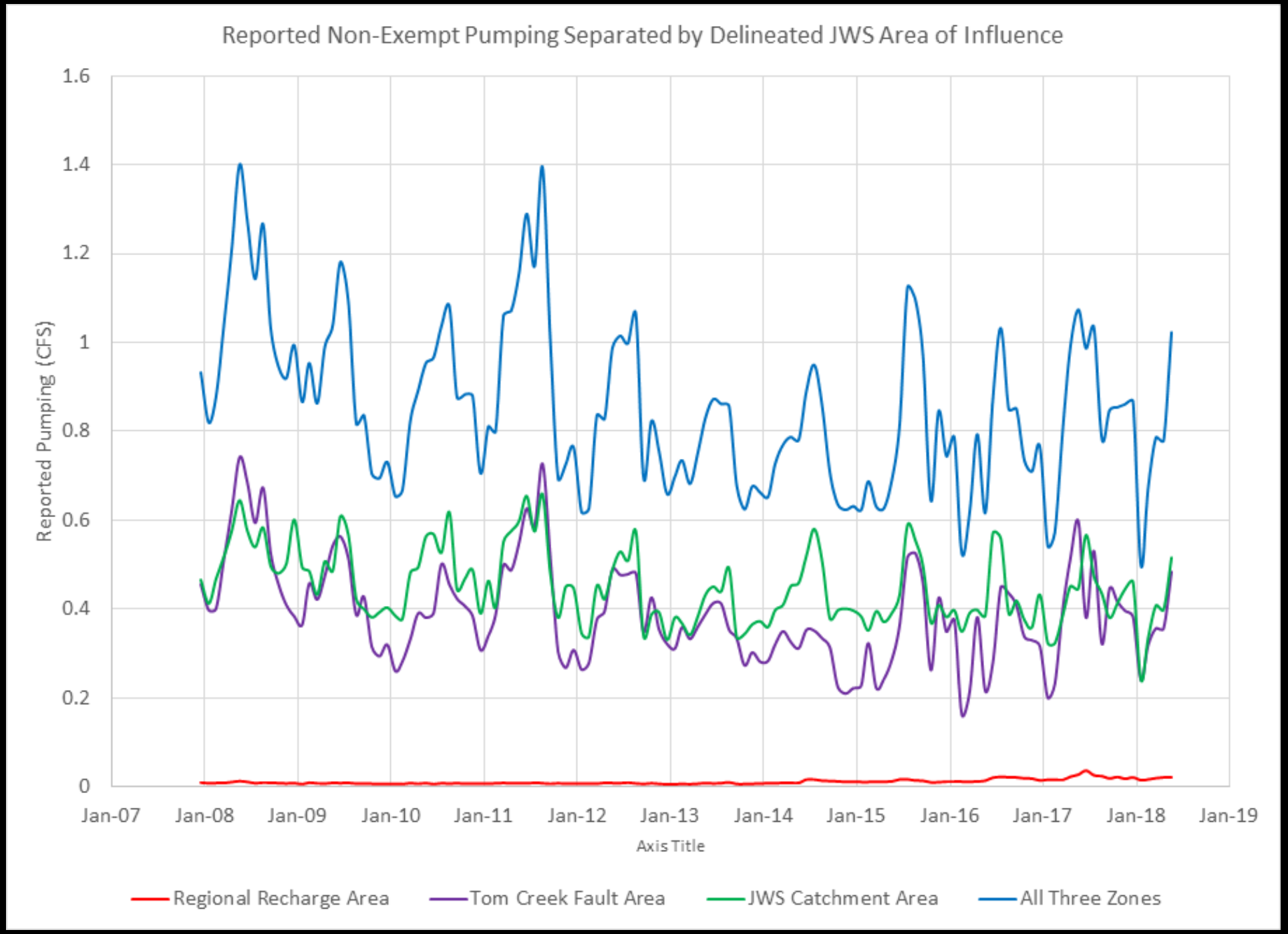
Observed effects of pumping on spring flow



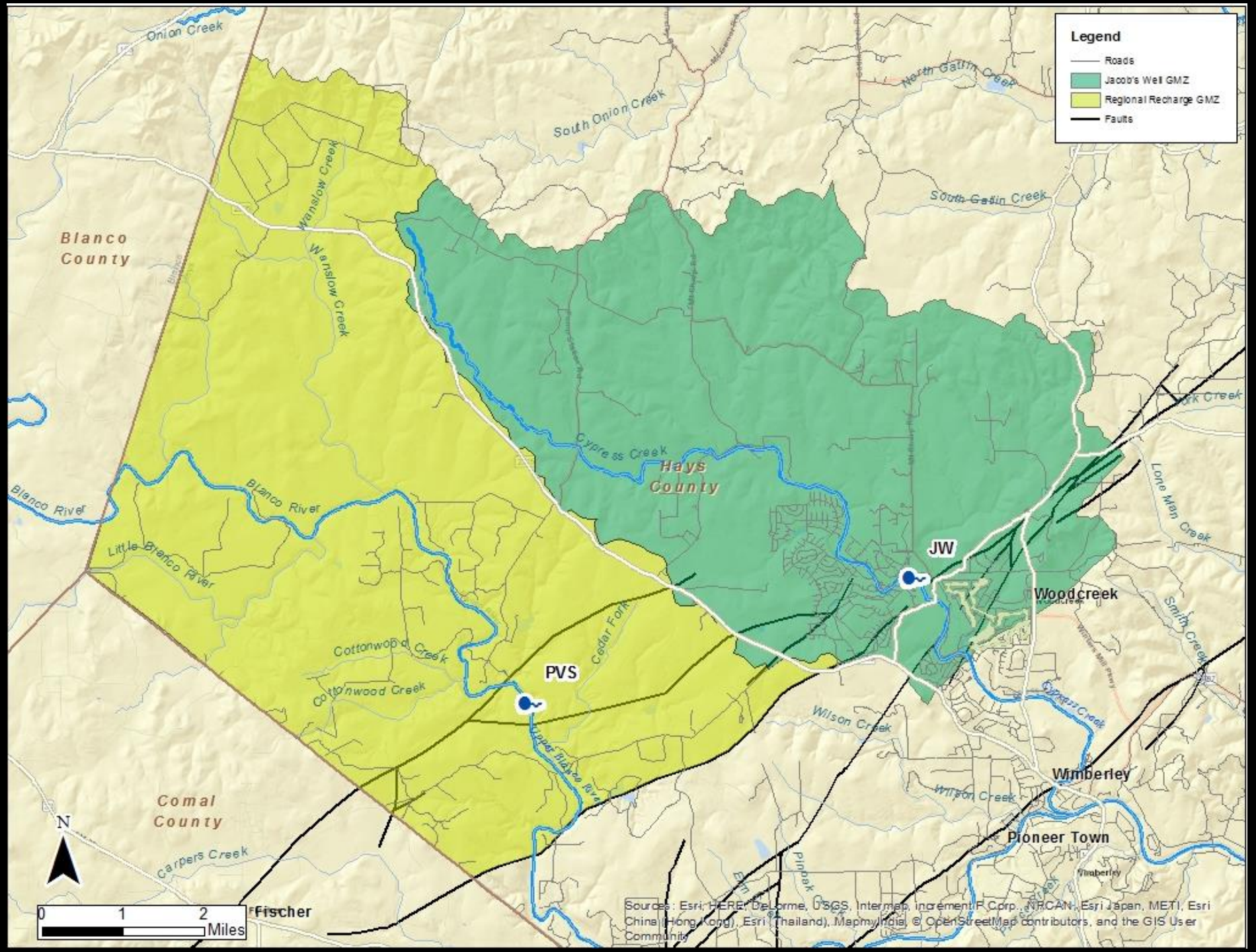
JWS Areas of Hydrogeologic Influence

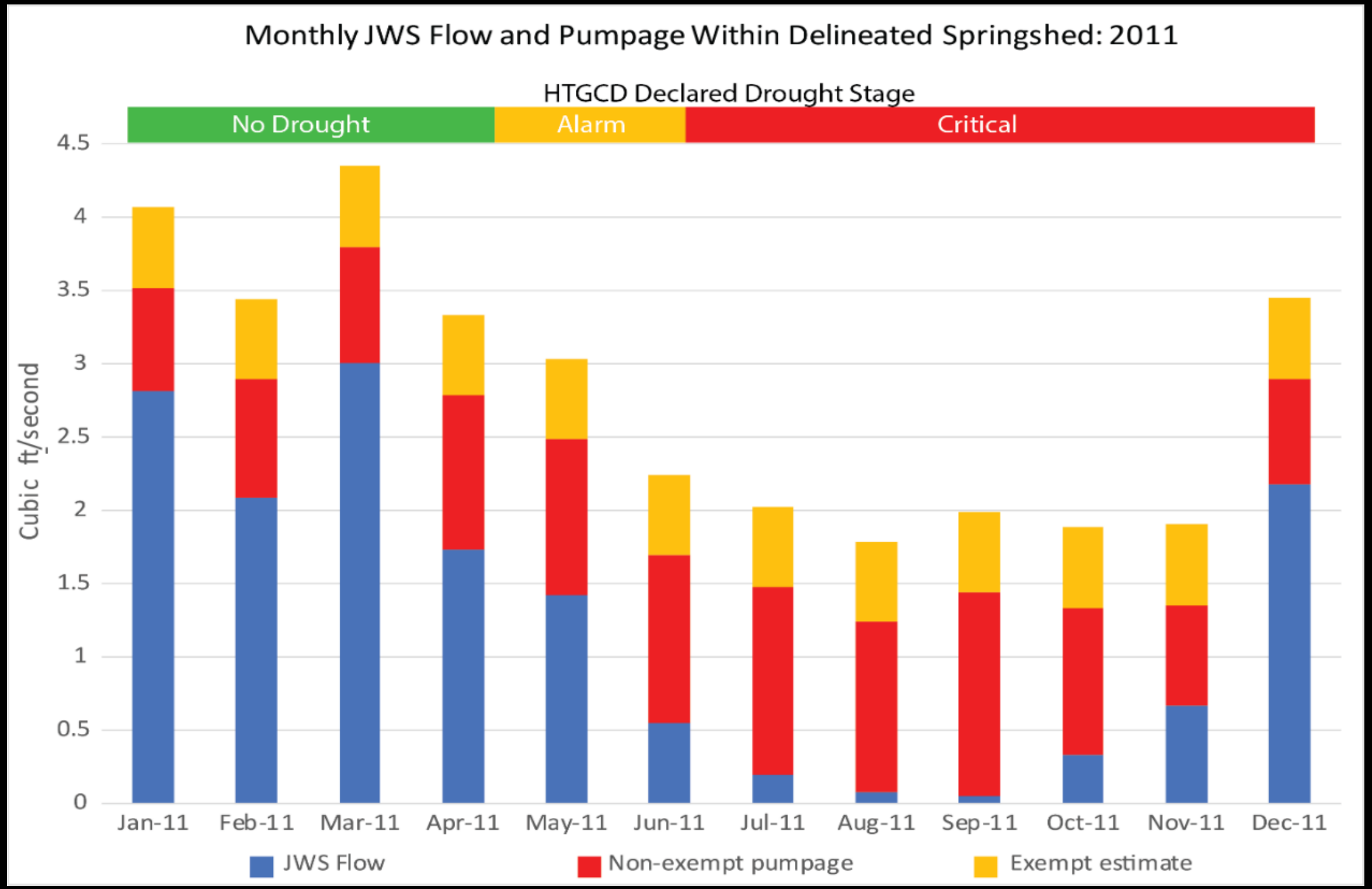
- Permitted wells shown as large triangles
- Exempt wells registered in HTGCD database shown as small dots.
- CCN areas shown as colored polygons.

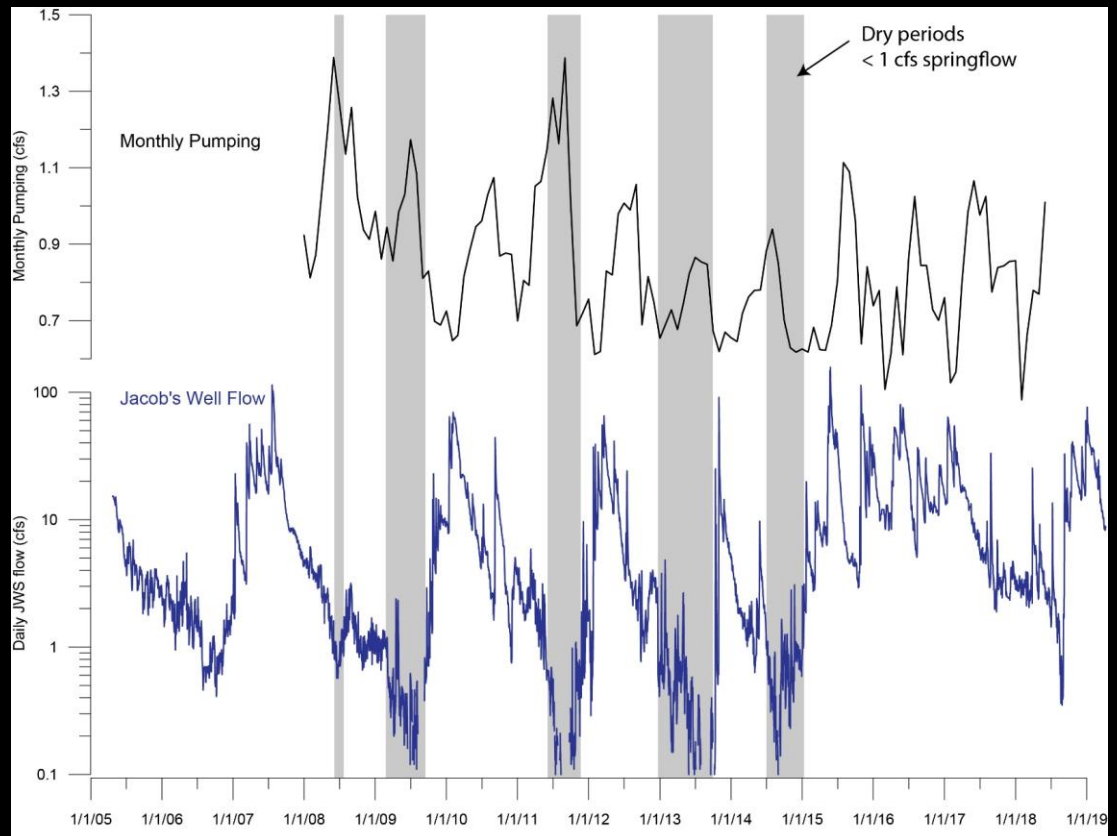


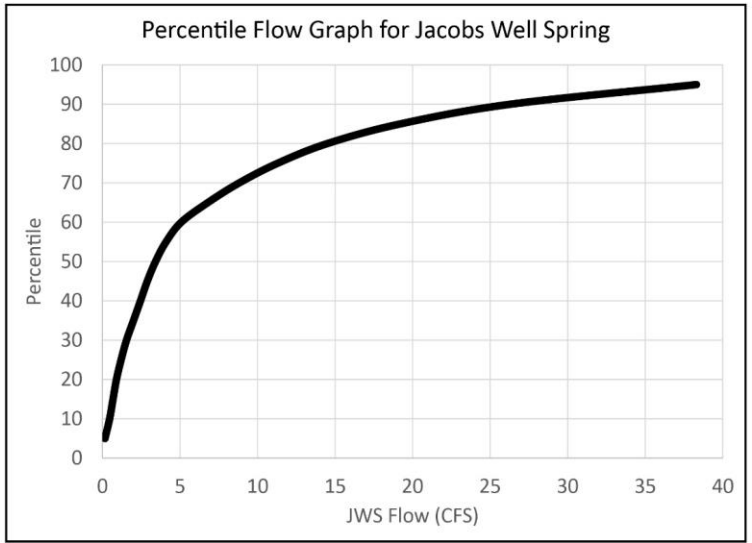

Reported Non-Exempt Pumping Separated by Delineated JWS Area of Influence
Reported Pumping (CFS)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Axis Title
Regional Recharge Area
Tom Creek Fault Area
JWS Catchment Area
All Three Zones

Two suggested areas for potential GMZs

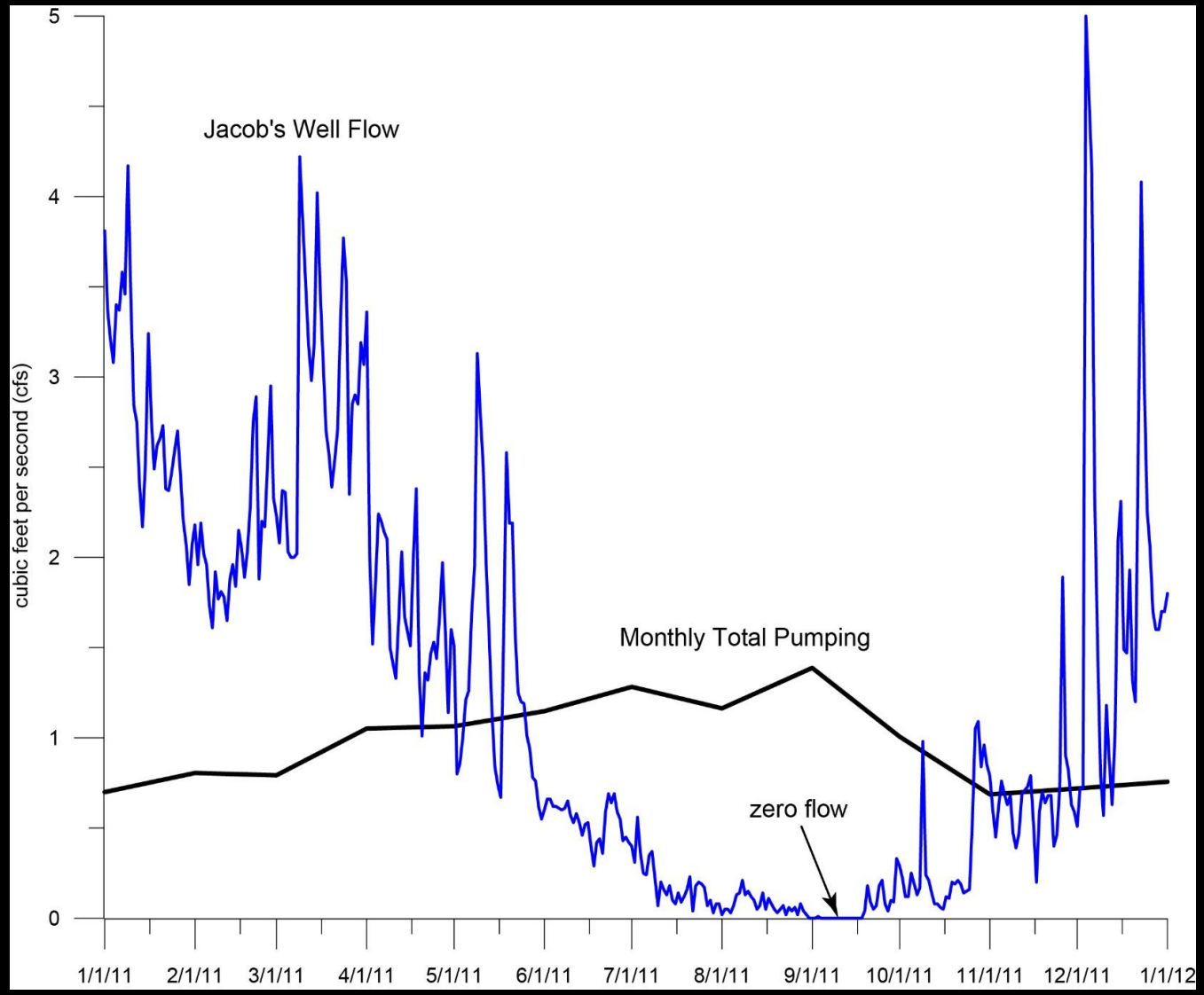



Monthly JWS Flow and Pumpage Within Delineated Springshed: 2011
HTGCD Declared Drought Stage
No Drought
Alarm
Critical
Cubic ft/second
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan-11
Feb-11
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
JWS Flow
Non-exempt pumpage
Exempt estimate

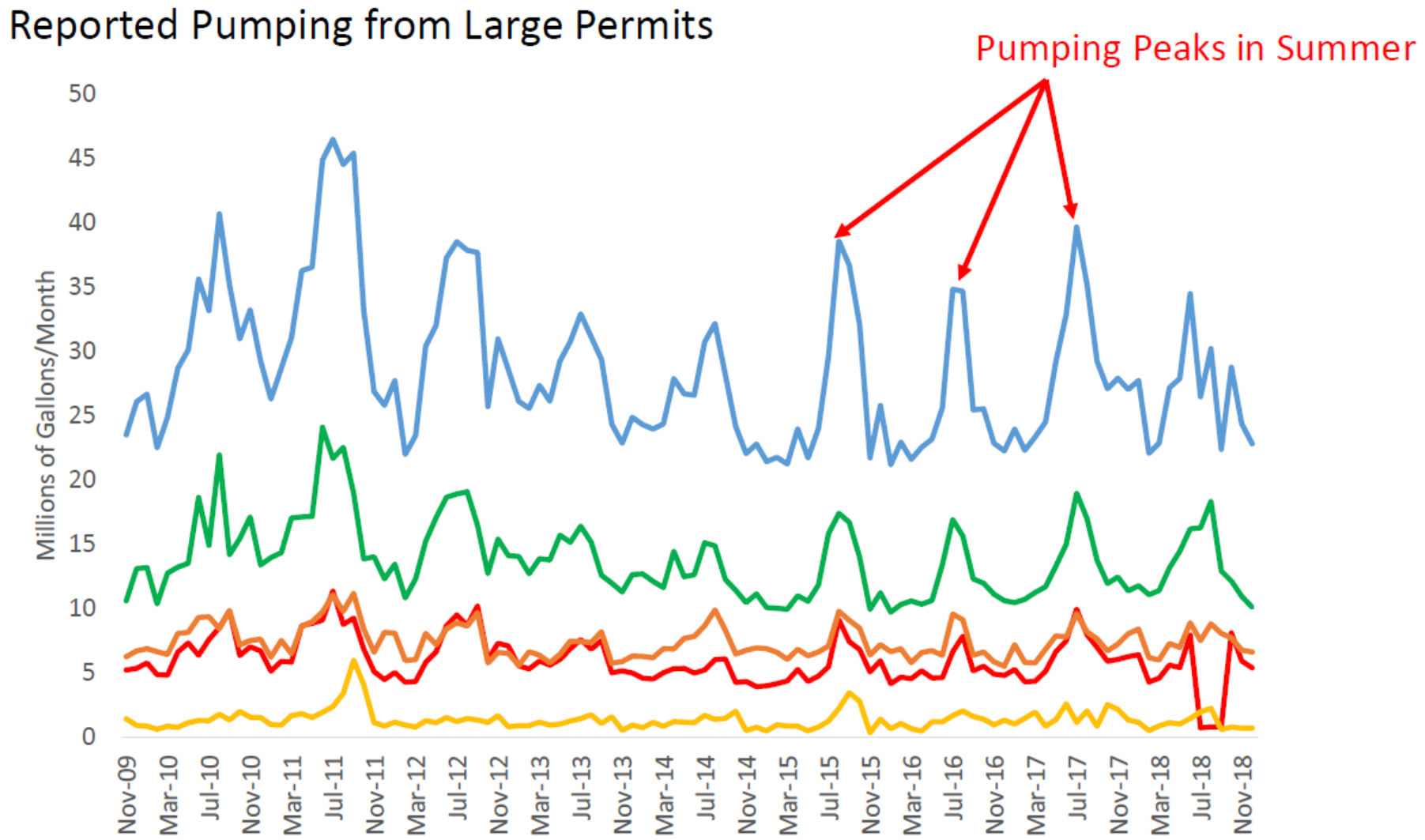




Percentile Analysis	
Percent	Flow (CFS)
95	38.3
90	26.3
85	19.2
80	14.5
75	11.3
70	8.8
65	6.78
60	5.1
55	4.1
50	3.4
45	2.9
40	2.5
35	2.0
30	1.6
25	1.2
20	0.9
15	0.7
10	0.5
5	0.2

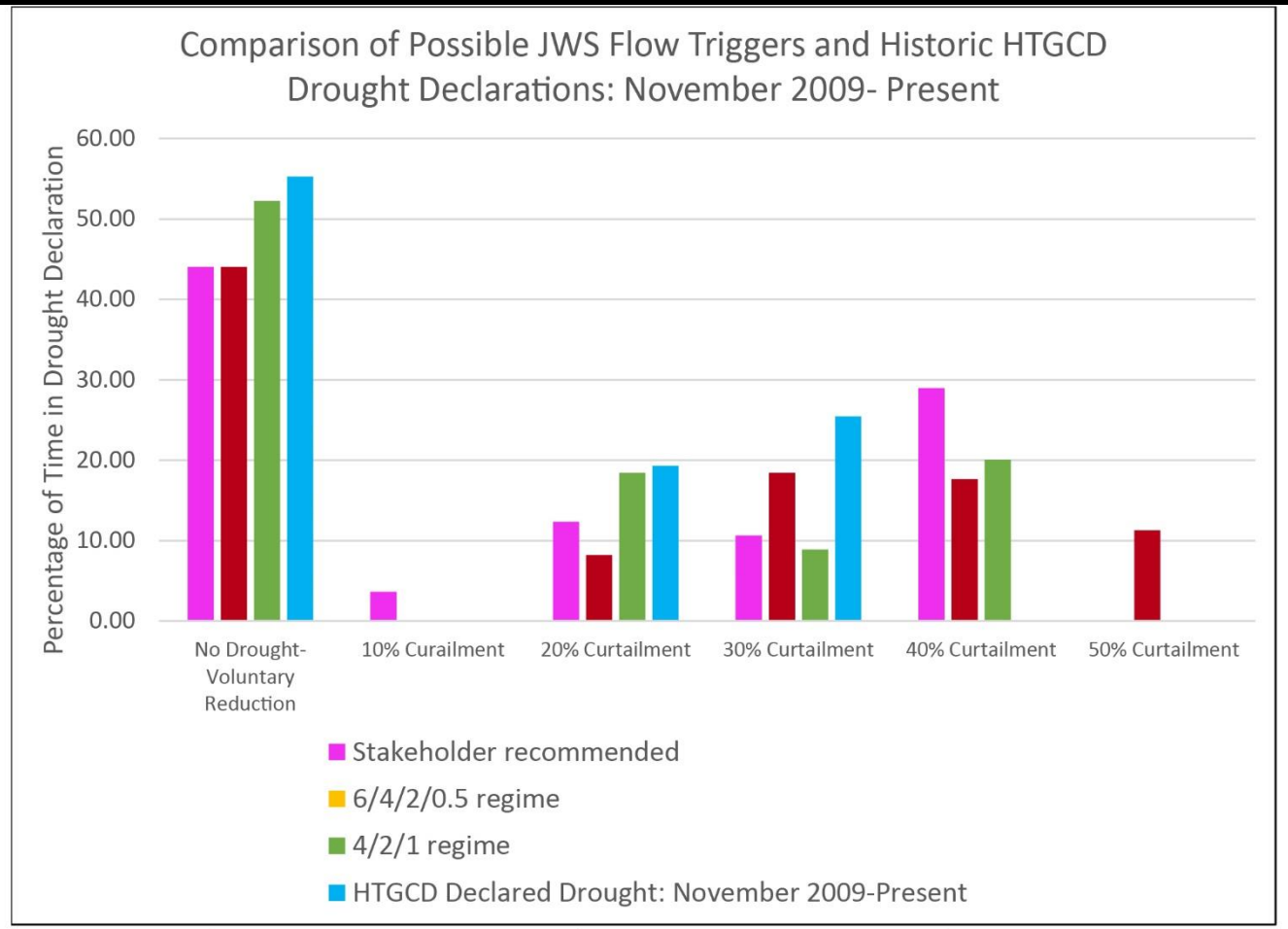


Pumping Trends: 2009-2018

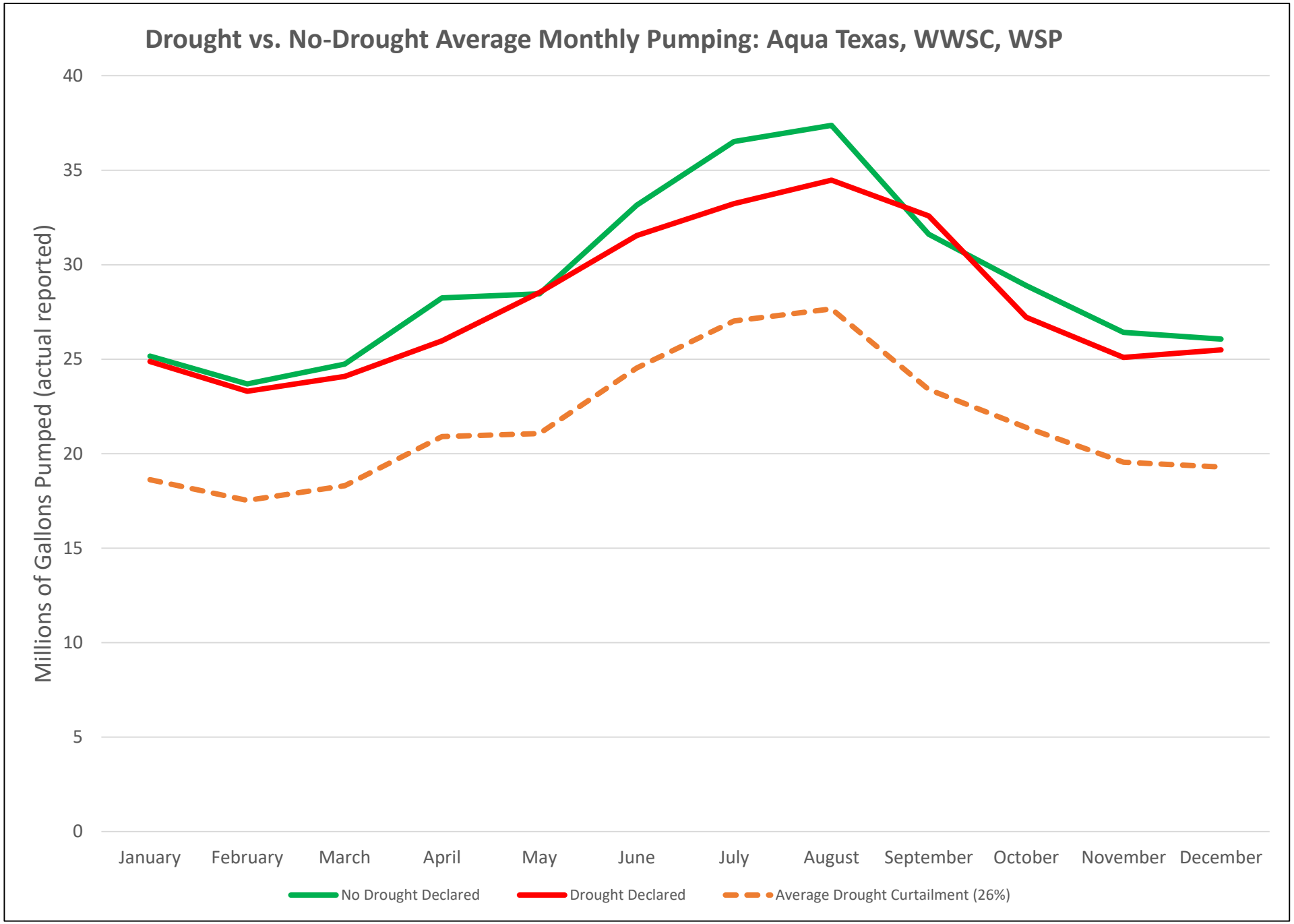


The Stakeholder Task Force recommended the following drought trigger levels for permitted pumping reductions based on a flow index directly from Jacob's Well.

6 cfs – 10% reduction
5 cfs – 20% reduction
3 cfs – 30% reduction
2 cfs – 40% reduction



Curtailment Regimes (JWS Flow Values in Cubic-Feet/second)			
Recommended	6/4/2/0.5 Regime	4/2/1 Regime	Curtailment Percentage
-	-	-	0%
6	-	-	10%
5	6	4	20%
3	4	2	30%
2	2	1	40%
-	0.5	-	50%


Drought vs. No-Drought Average Monthly Pumping: Aqua Texas, WWSC, WSP
Millions of Gallons Pumped (actual reported)
40
35
30
25
20
15
10
5
0
January
February
March
April
May
June
July
August
September
October
November
December
No Drought Declared
Drought Declared
Average Drought Curtailment (26%)

Demand Reduction Tools for Maintaining Sustainable Base Flow at Jacob's Well Spring

Strategy	Description
Drought curtailments	Implementation of a simple, representative drought declaration methodology using Jacob's Well as one of the triggers.
Education	Effective communication to the public related to water resources, drought, and conservation efforts the public can take.
Conservation	Measures and actions taken to reduce the use of water. These could include watering schedules.
Permit reductions and restrictions	Right-sizing and placing ceilings on permitted pumping during non-drought periods.
Infrastructure and efficiency	Reduce line loss and fix other water infrastructure problems that may waste groundwater.

Alternative Water Supply Tools for Maintaining Sustainable Base Flow at Jacob's Well Spring

Strategy	Description
Conjunctive use	Use of surface water and groundwater sources
Aquifer storage and recovery (ASR)	Injection of surface or other water supplies into the Lower Trinity Aquifer for withdrawal during drought periods.
Lower Trinity	Development of the Lower Trinity Aquifer to (1) temporarily or permanently replace pumping from the Middle Trinity and (2) use as a sole-source for future permitted pumping.
Rainwater	Promotion of the use of rainwater for commercial and domestic uses.
Alternative Water Supplies	Importing water from more distant sources.
Temporary interconnections and pipelines	These could alleviate pumping in certain areas.

collective strength
RESEARCH
PLANNING
SUSTAINABILITY

MEMORANDUM

To: HTGCD Board Members, JWGMZ Stakeholders, JWGMZ Technical Team
From: Robin Rather
Date: July 15, 2019
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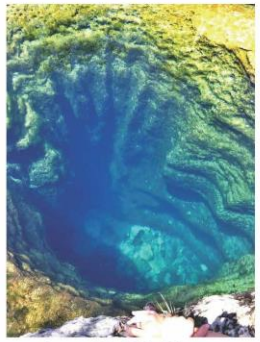
Executive Summary

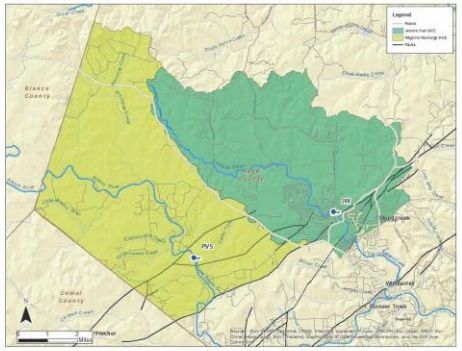


Thirty-five volunteer members of the Hays Trinity Groundwater Conservation District (HTGCD) "Spring Flow" Task Force were asked to review technical and scientific data and to identify best practices to ensure perennial spring flow at Jacob's Well and Cypress Creek. The Task Force came to 100% consensus on all but one of seven recommendations, and that one recommendation had all but two members in consensus. This memo contains a summary of the Task Force's work.

The first three recommendations are the most immediate and the most impactful in the short term:

1. We recommend the immediate establishment of one groundwater management zone shown in dark green in the map at right (the Jacob's Well Groundwater Management Zone, or JWGMZ). We also ask that the establishment of second zone be considered shown in yellow below (Regional Recharge Zone).

   For more detailed maps and technical specifics please refer to the Technical Report written by the JWGMZ Technical team (forthcoming.)



2. Using Jacob's Well Spring as a trigger for permitted

Evaluation for the Development of a Jacob's Well Groundwater Management Zone Hays County, Texas

Technical Report prepared for the Hays Trinity Groundwater Conservation District, Hays County, Texas

Report: 2019-05
July 2019

The Meadows Center
for Water and the Environment
Texas State University

Authors:

Marcus O. Gary, Ph.D., P.G.
Edwards Aquifer Authority, The University of Texas at Austin

Brian B. Hunt, P.G.
Barton Springs/Edwards Aquifer Conservation District

Brian A. Smith, Ph.D., P.G.
Barton Springs/Edwards Aquifer Conservation District

Jeffery A. Watson, P.G.
Hays Trinity Groundwater Conservation District

Douglas A. Wierman, P.G.
Fellow , The Meadows Center for Water and the Environment, Texas State University

MEMBER **THE TEXAS STATE UNIVERSITY SYSTEM**