Main Issue in Montgomery County Water Controversy: Does Montgomery County have a Groundwater Problem?

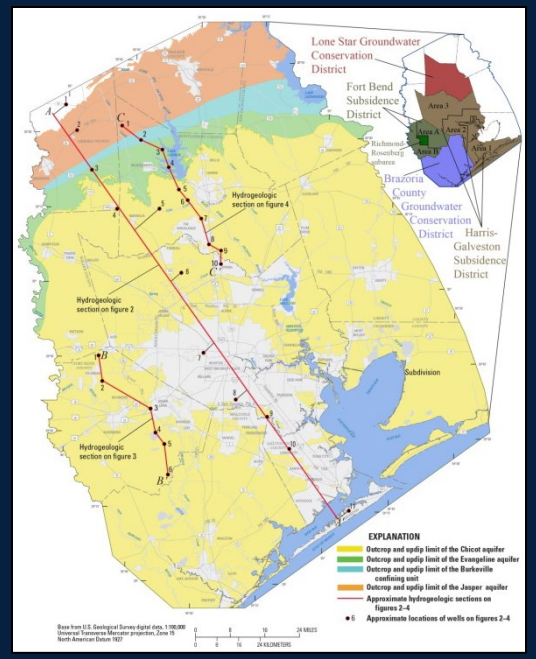
- Answer: Yes. The exact same problems Harris, Galveston, and Fort Bend counties have been trying to solve since 1975.
- Two different problems caused by over-pumping the aquifers:
  - Water supply problems – Increased pumping costs, decreased well reliability, and in some cases water well failures.
  - Subsidence and fault movement – Increases the risk of flooding; damages infrastructure.

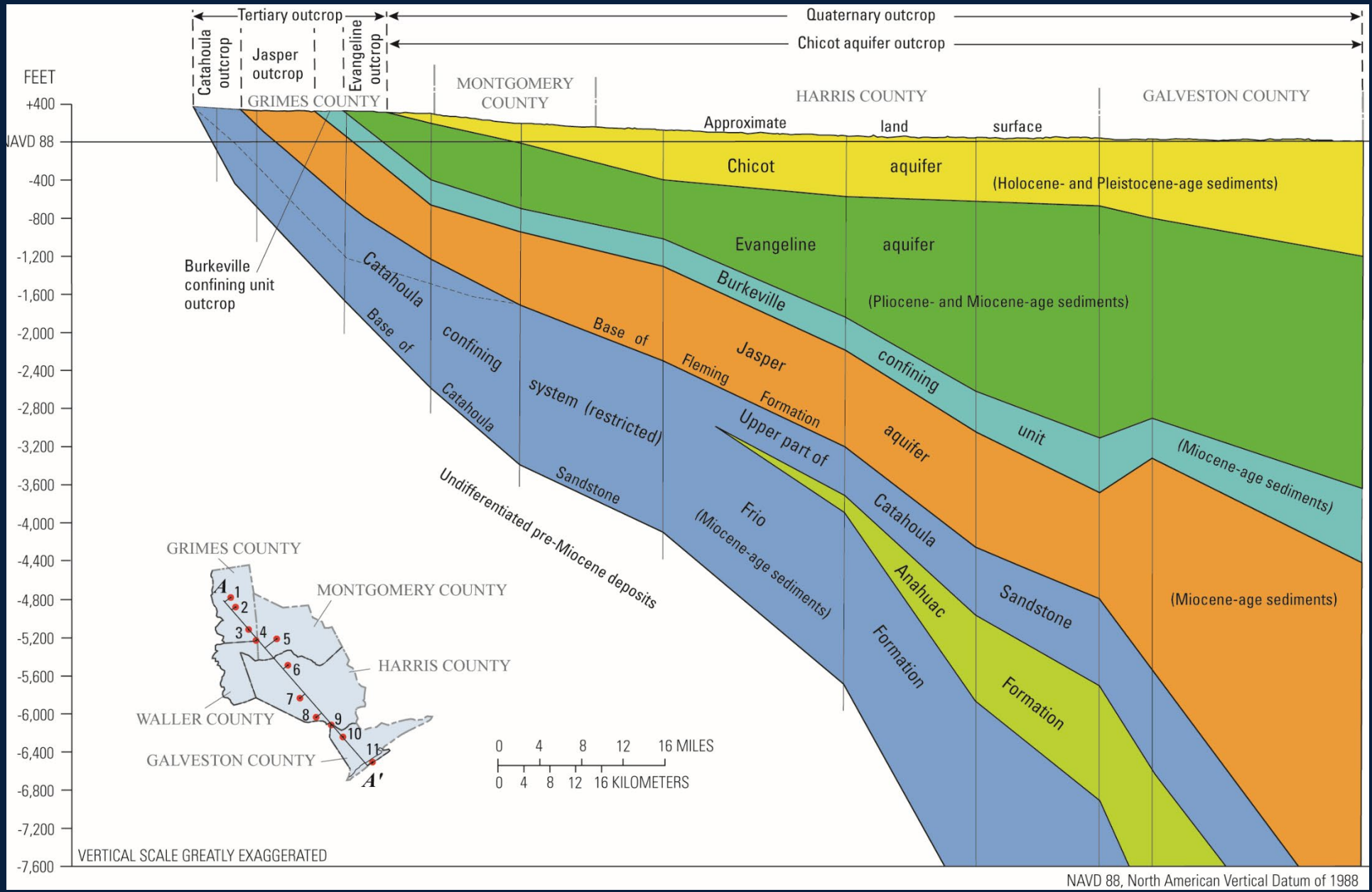
- Answer: No. Don't necessarily agree that there are problems (or at least not yet):
  - Water supply – Pressure declines will actually cause more recharge.
  - The Jasper has not and will not experience subsidence.*
  - Harris County's pumpage has been causing the subsidence in Montgomery County.*
  - Respecting people's right to pump groundwater trumps any problems that may result.

*See Feb 2021 HARC Report on LSGCD Phase 1 Subsidence Investigation

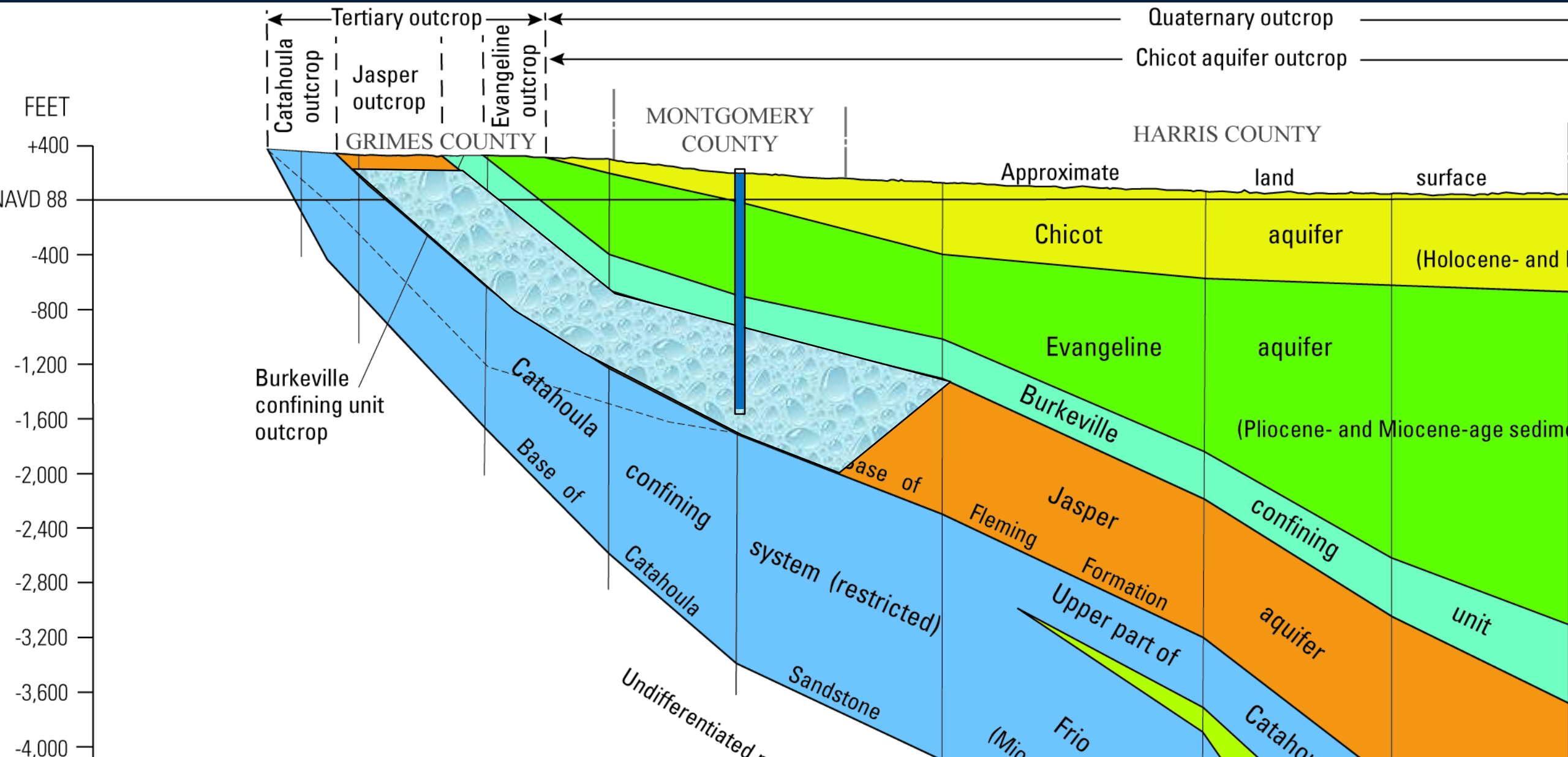
Hydrogeology of the Gulf Coast Aquifers and Historical Data Showing Water-Level Response to Past Over-Pumpage of Groundwater

Hydrogeology of the Gulf Coast Aquifer System

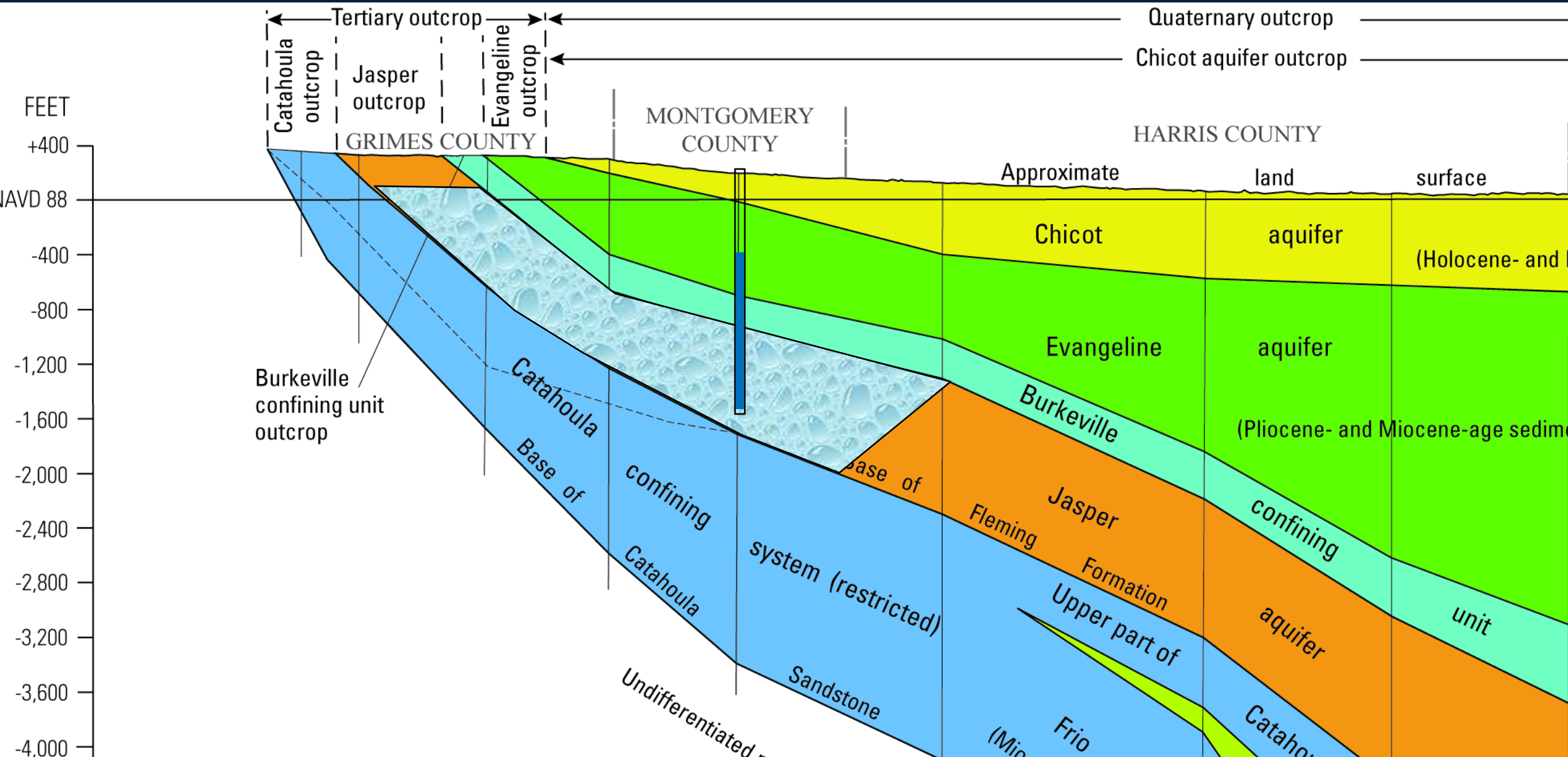




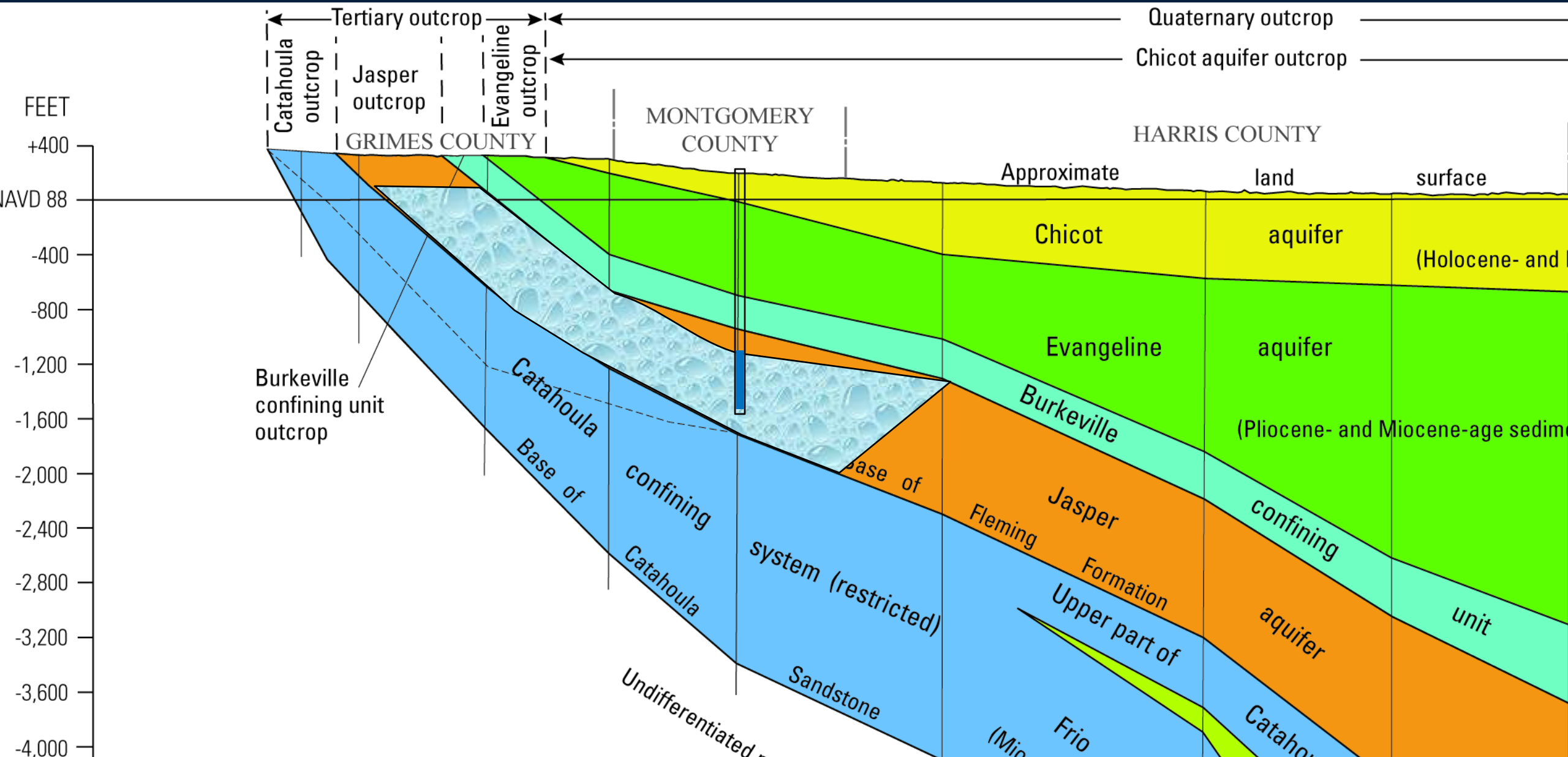
How Montgomery County water wells work



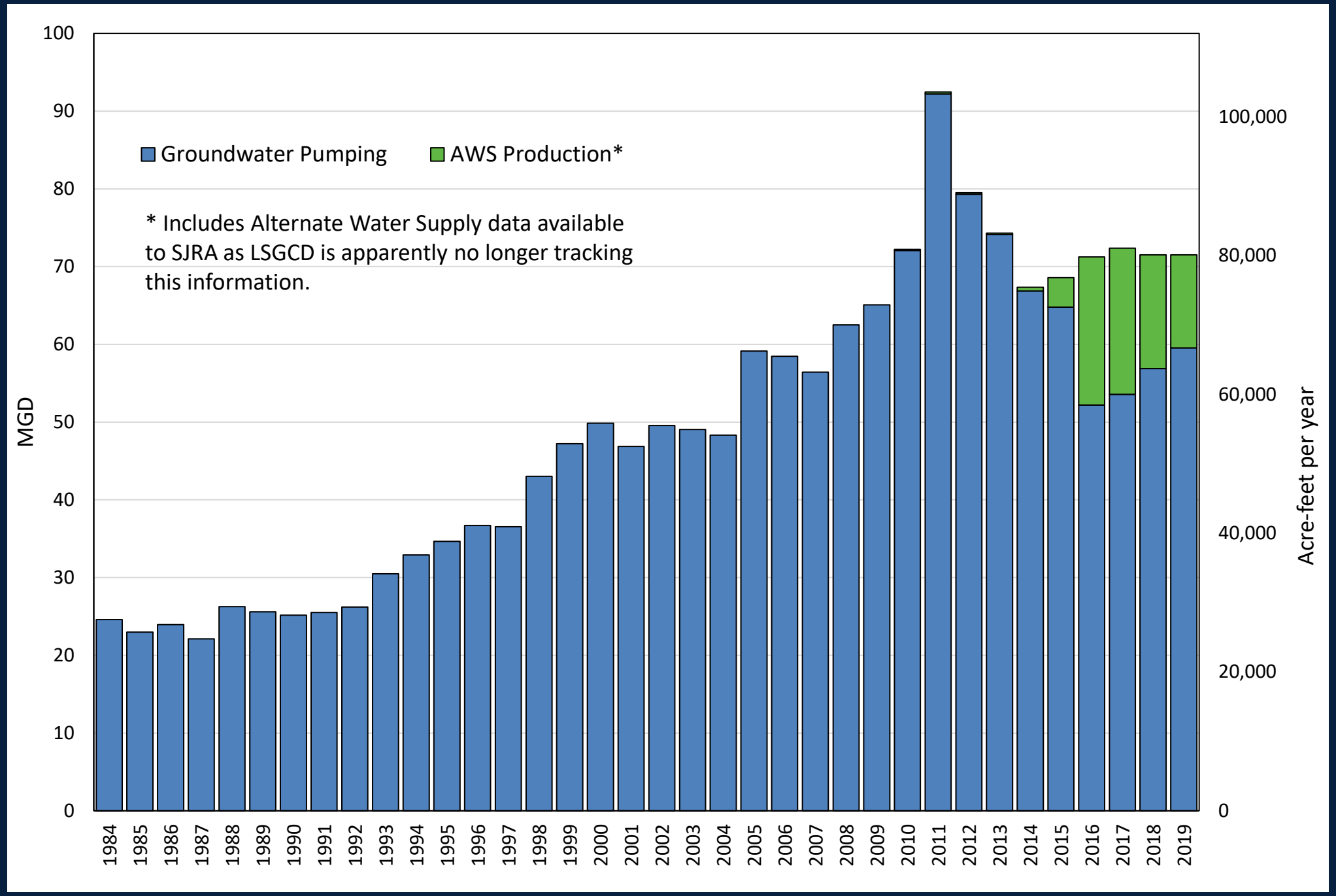
How Montgomery County water wells work



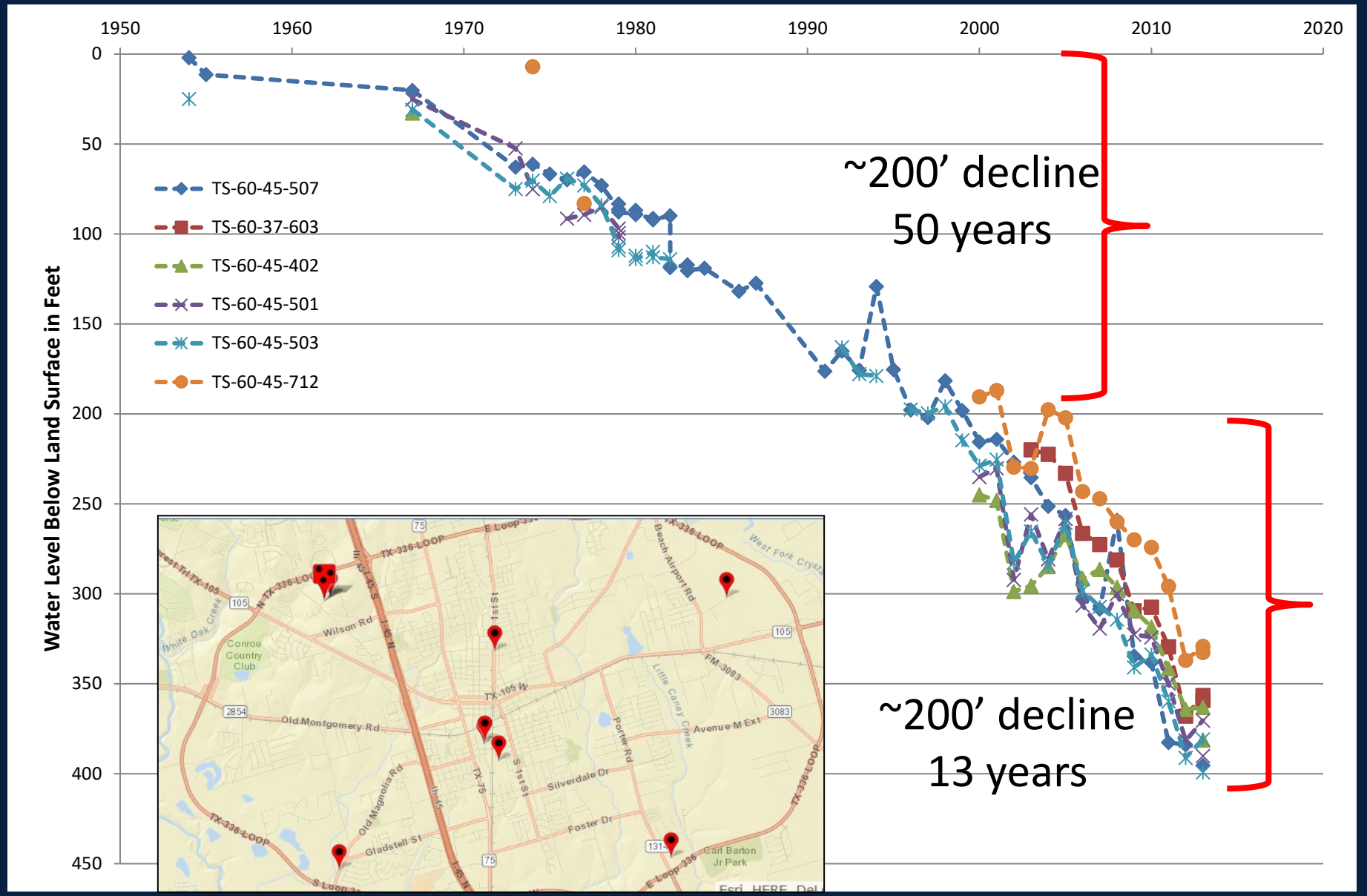
How Montgomery County water wells work



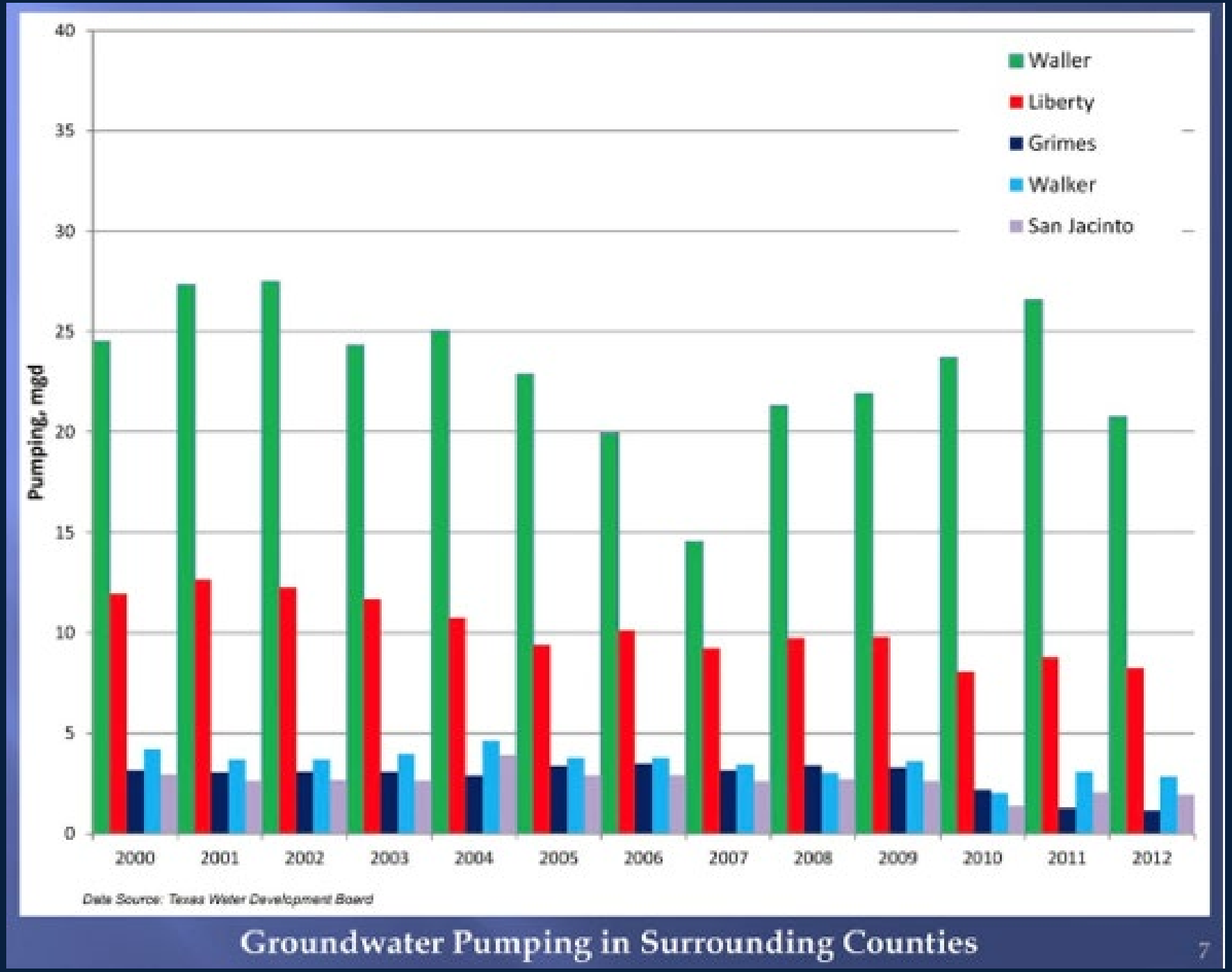
Montgomery County Historical Water Demand – Groundwater and Alternate Water Supply



Conroe-Area Jasper Aquifer Historical Groundwater Levels

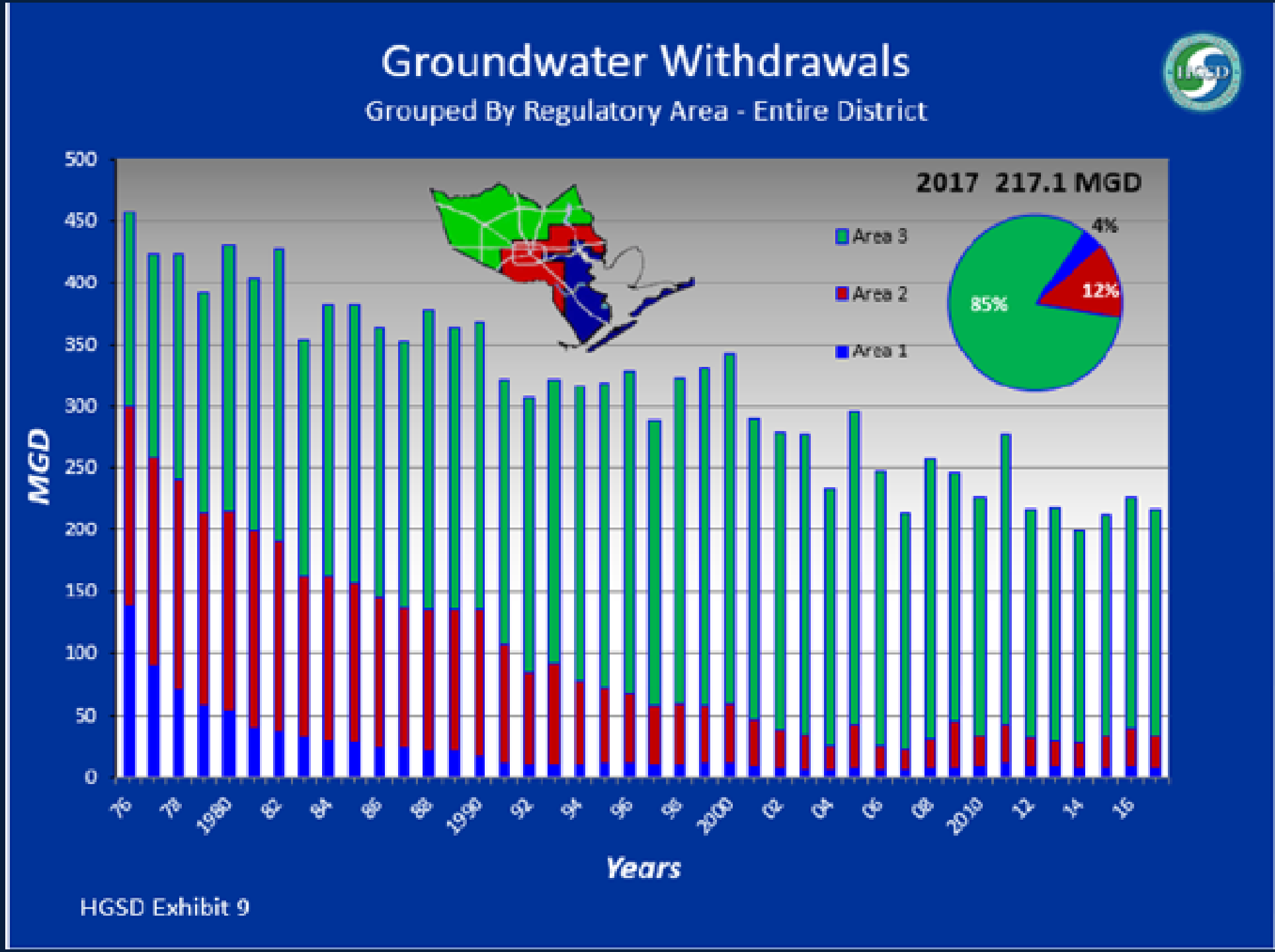


Surrounding County Historical Groundwater Pumpage



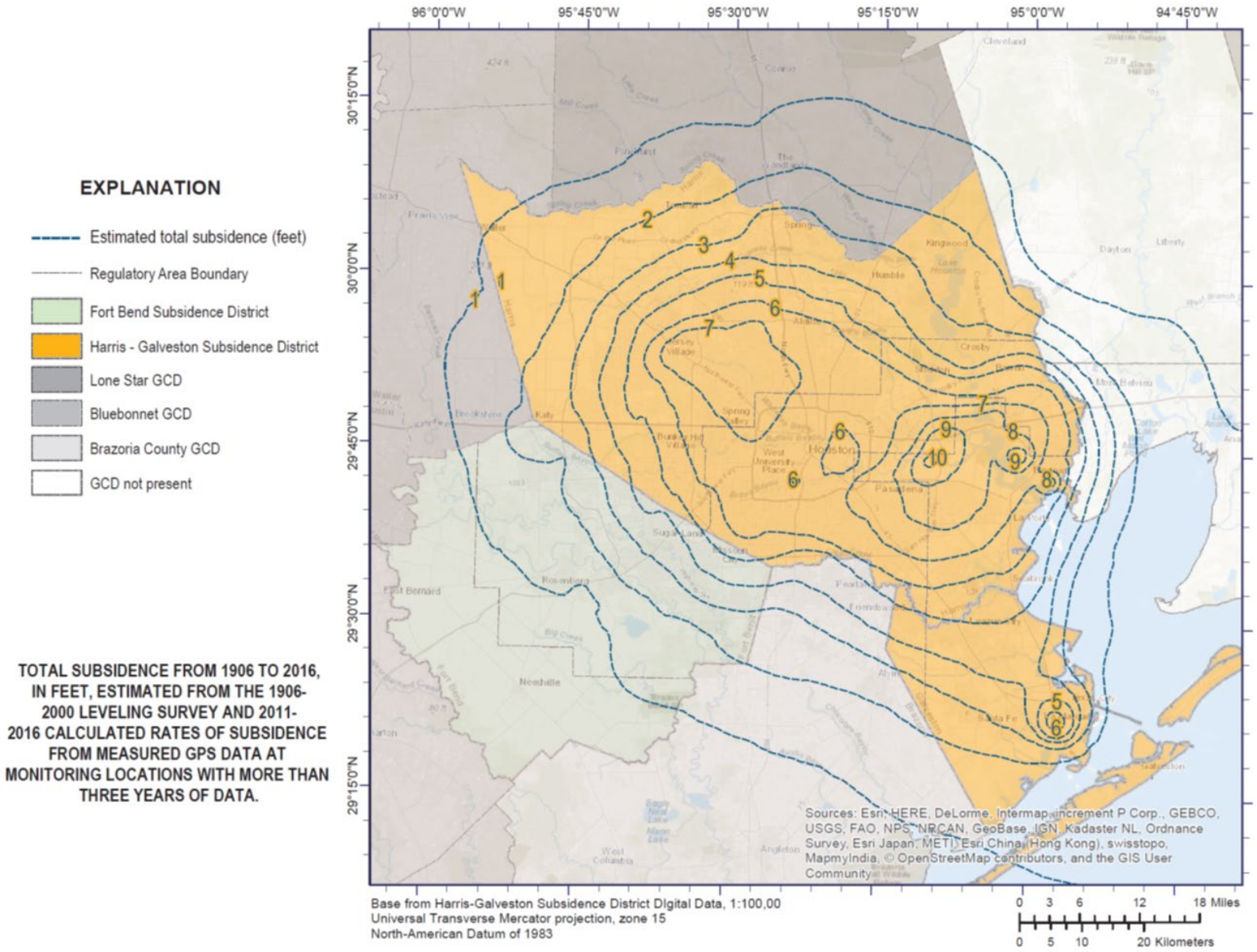
Groundwater Pumping in Surrounding Counties

Harris-Galveston County Historical Groundwater Pumpage



Historical Data Showing Subsidence Response to Over-Pumpage of Groundwater

Estimated Total Subsidence 1906-2016



- Total subsidence over the period of development has been estimated based on traditional benchmark surveying from 1906-2000 and the calculated subsidence rates from measured GPS vertical movement data from sites active in 2016 with more than three years of vertical movement data.
- The largest magnitude of historical subsidence has occurred in the ship channel area of Eastern Harris County.

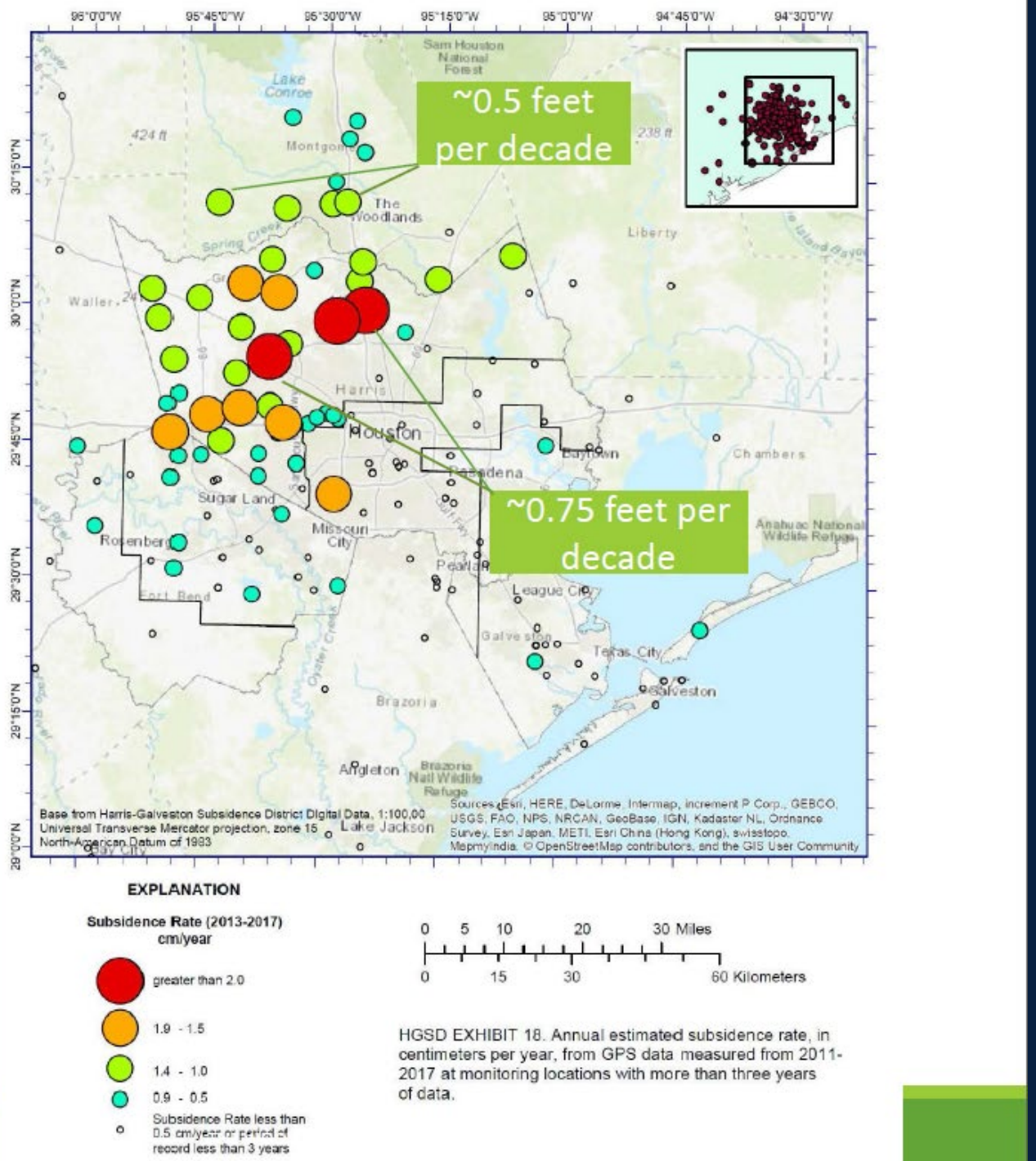
HARRIS-GALVESTON SUBSIDENCE DISTRICT

Annual Subsidence Rate 2013-2017

The highest subsidence rates observed today in the region are located in Southern Montgomery County, Northern and Western Harris County, North-eastern Fort Bend County.

The City of Houston in cooperation with the Regional Water Authorities are currently undertaking the largest water infrastructure project in the US to supply alternative water to these areas.

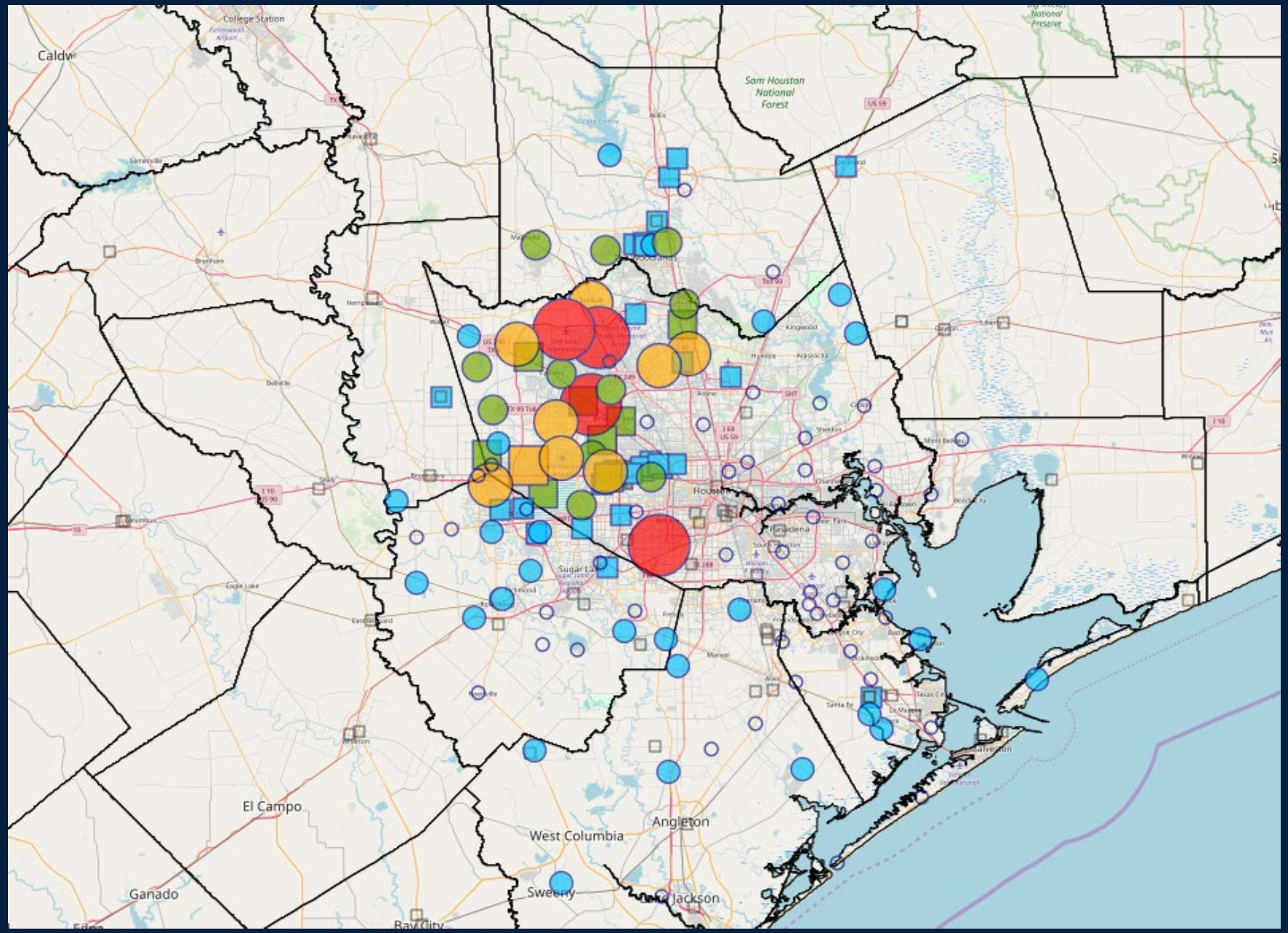
Subsidence has generally ceased in areas where conversion has been completed and groundwater use has been reduced.



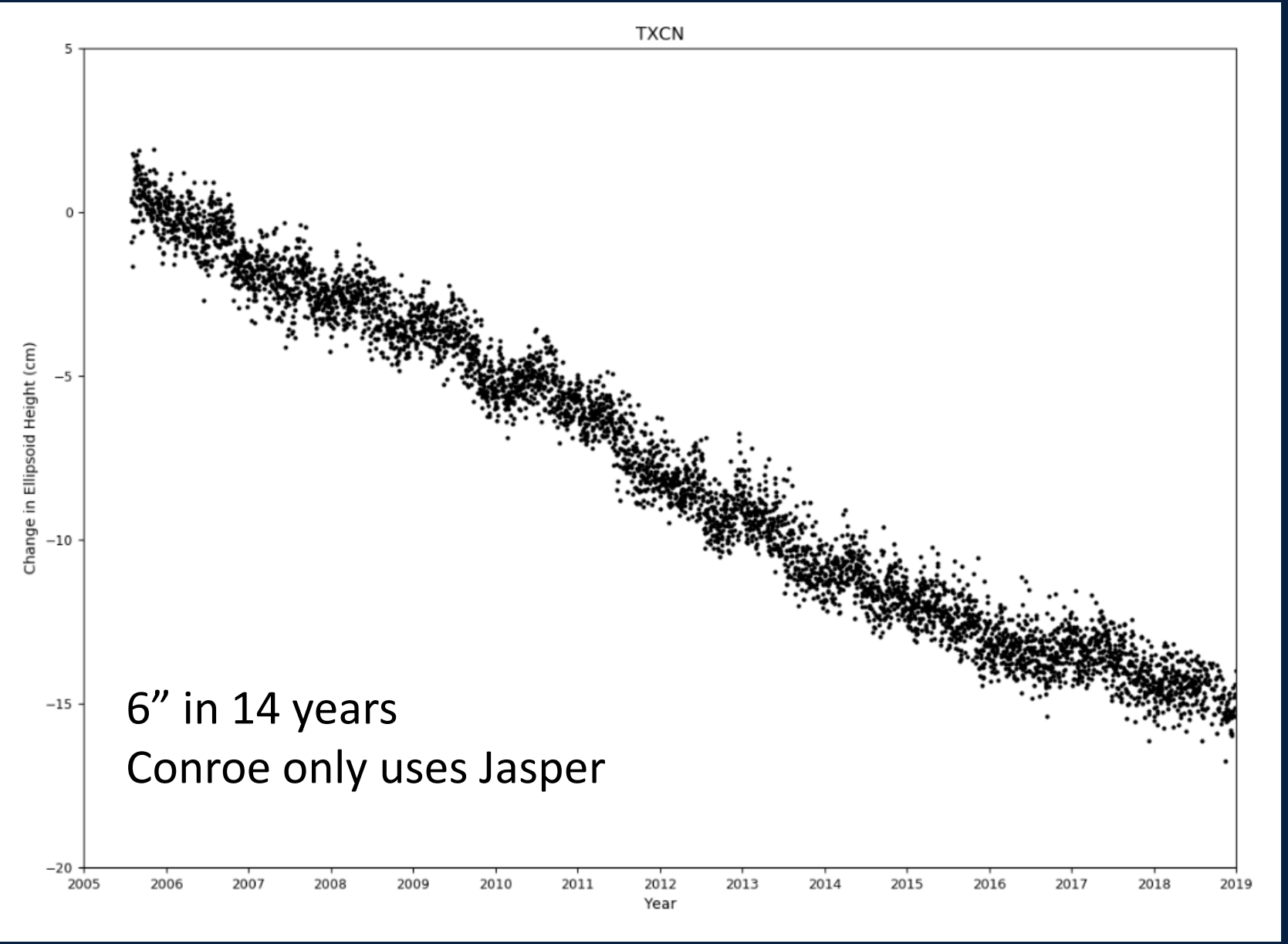
HGSD EXHIBIT 18. Annual estimated subsidence rate, in centimeters per year, from GPS data measured from 2011-2017 at monitoring locations with more than three years of data.

x 7.50 in

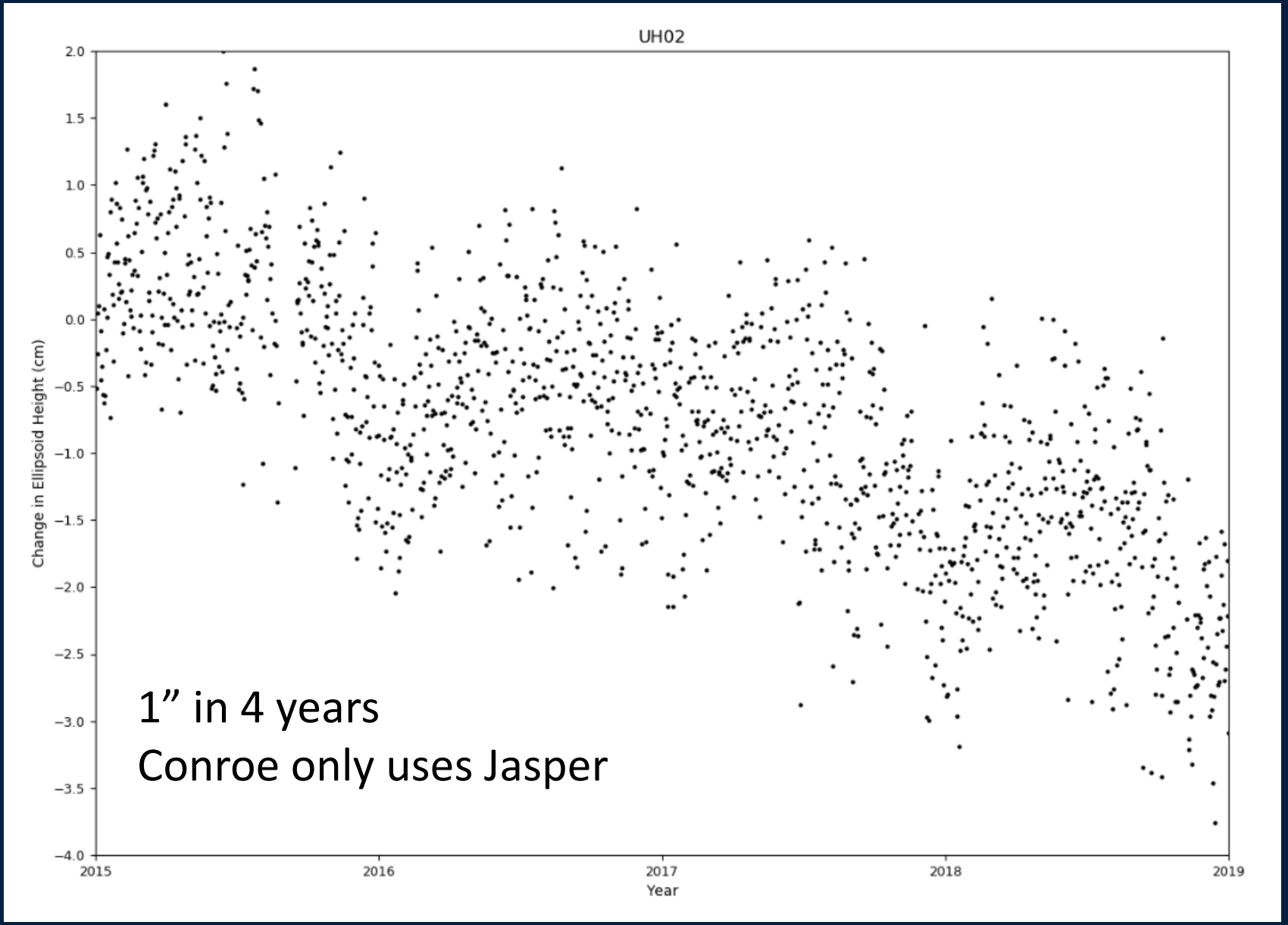
Subsidence Measuring Sites



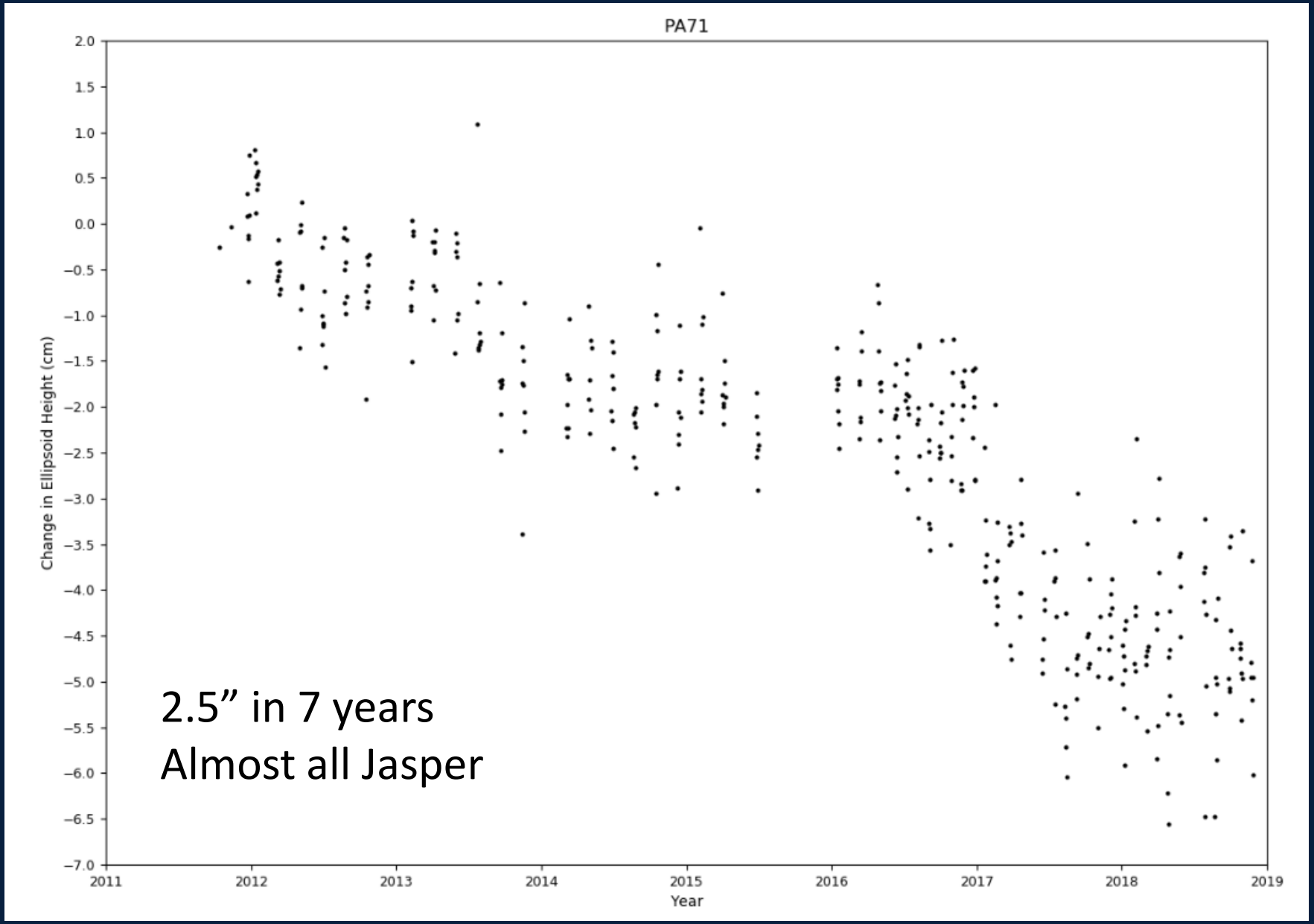
TXDOT CORS Site at Conroe Airport



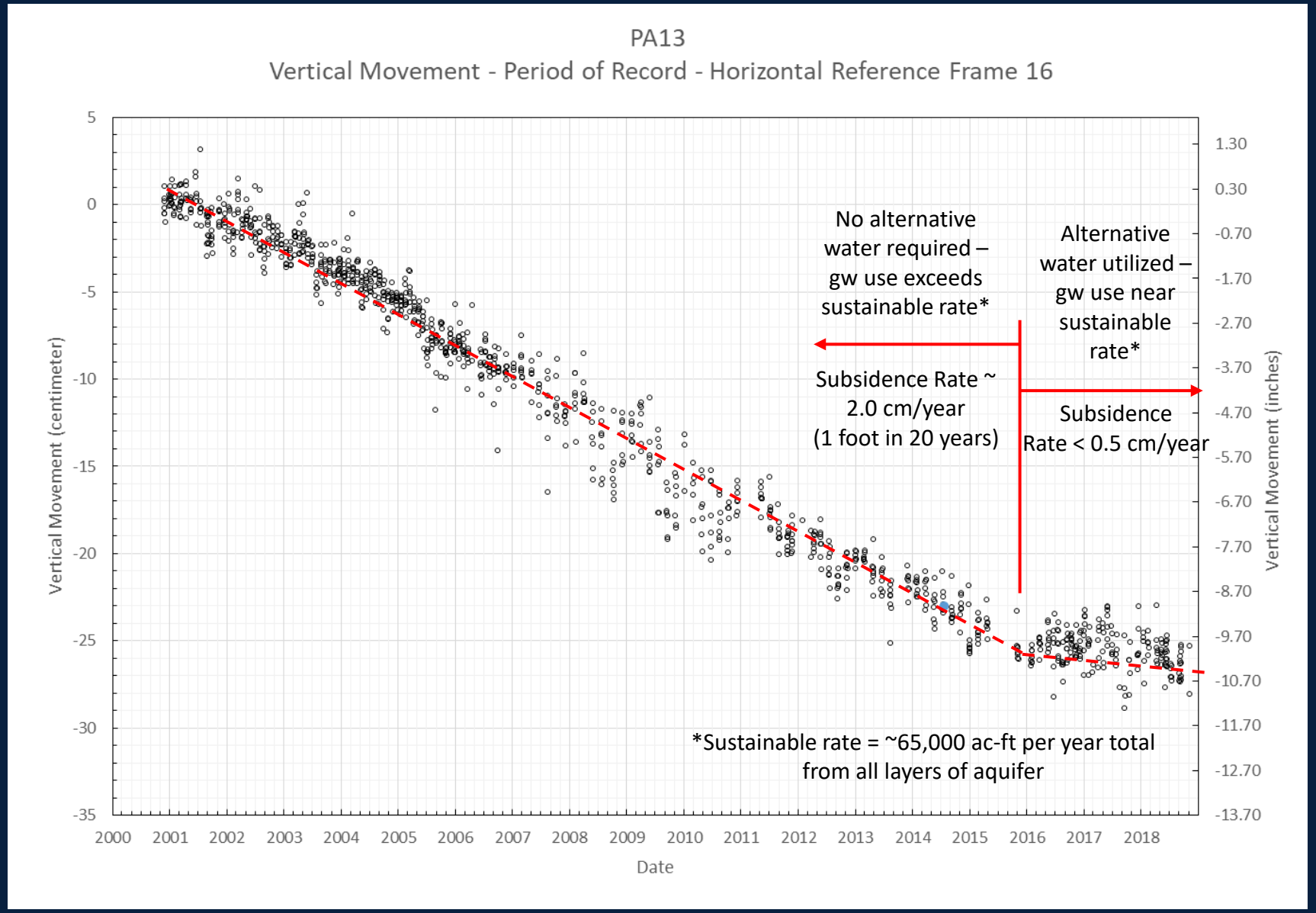
U of H Site in Conroe



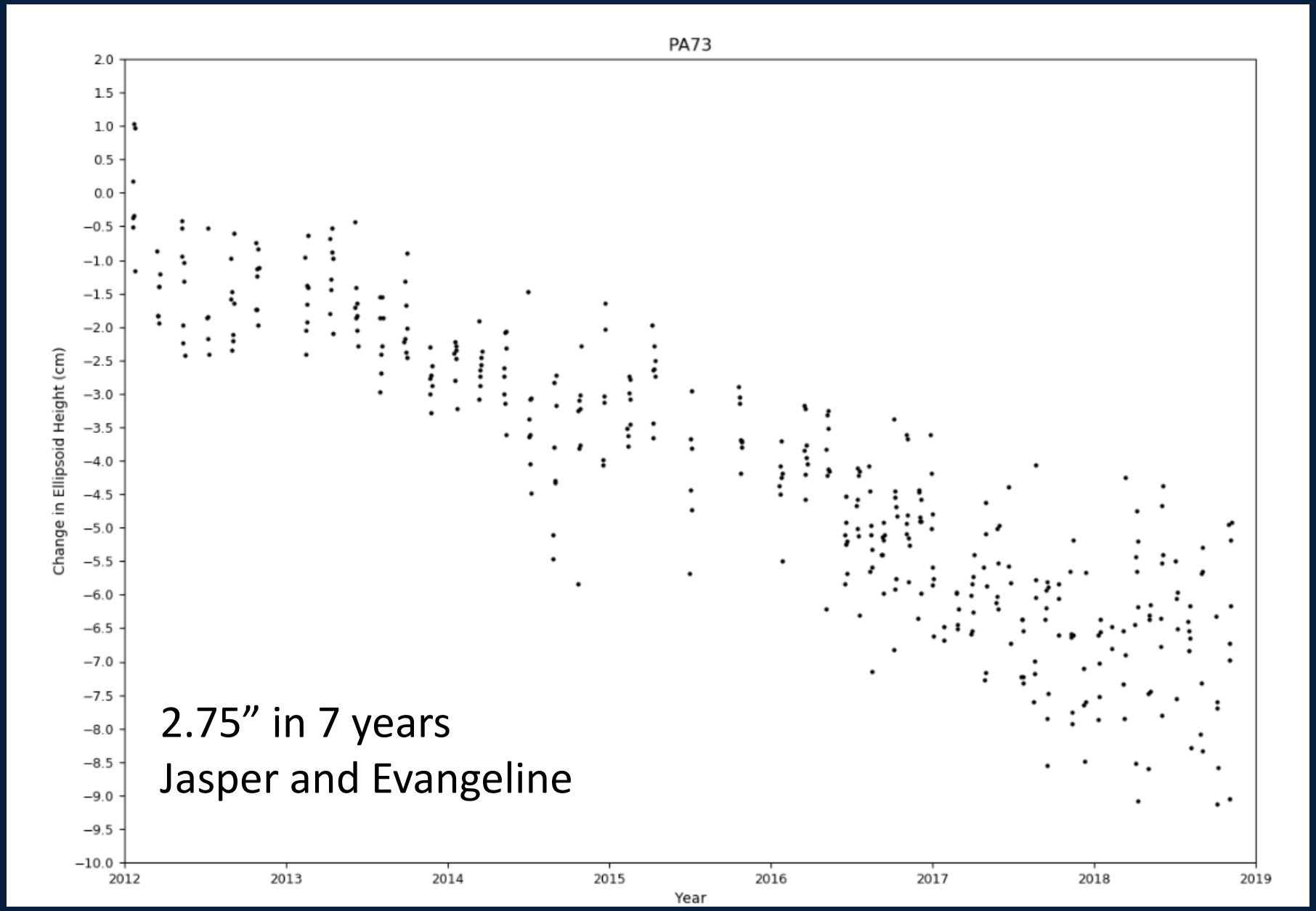
HGSD PAM 71 Site at Lake Conroe



HGSD PAM 13 Site in The Woodlands



HGSD PAM 73 Site in Magnolia



Recent Studies Confirming that Subsidence is Connected to Water-Level Declines, including in the Jasper

- October 2021 U of H Report on Land Subsidence and Aquifer Compaction in Montgomery County
- August 2015 SMU Report on Mapping of Ground Deformation using MT InSAR
- May 2018 HGSD Report on Jasper Aquifer
- May 2018 U of H Report on Subsidence in Greater Houston Region
- June 2019 SMU Report on Subsidence and Fault Movement in Montgomery County

October 2021 U of H Report on Land Subsidence and Aquifer Compaction in Montgomery County

- *"According to this study, land subsidence in Montgomery County since the mid-2000s is primarily contributed by sediment compaction in the Evangeline and Jasper aquifers; . . ."* (p. 1)

- *". . . The compaction of [the] Jasper aquifer contributes approximately one-third of the land subsidence since the mid-2000s; . . . "* (p. 1)

Land subsidence and aquifer compaction in Montgomery County, Texas, U.S.: 2000–2020 (springer.com)

August 2015 SMU Report on Subsidence Mapping

- *"The primary source of the land surface subsidence in the Houston area is attributed to the long-term withdrawal of subsurface fluids."* (pp. 298)

- *". . . most of the subsidence zones generally agree with the ground-water withdrawal contours."* (p. 296)

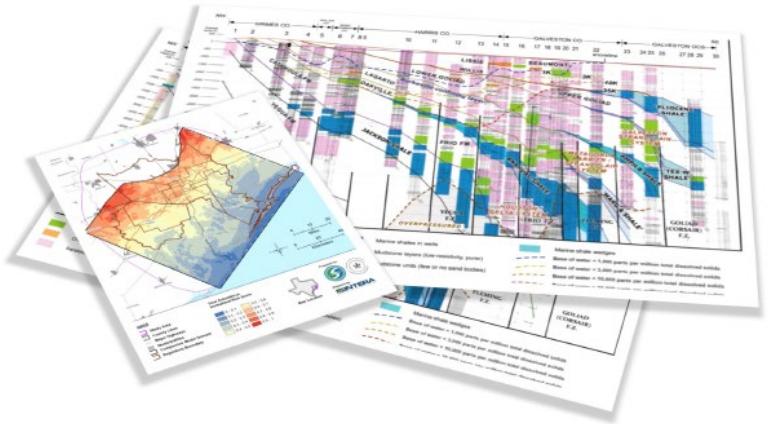
- *"The maximum subsidence centers transferred from [Jersey Village] during [the] 1990s to Spring in Harris County and The Woodlands in Montgomery County after 1998, where a generally steady subsidence rate of 30 mm/yr has been observed during the whole timespan."*

- *"Subsurface fluid extraction has activated surface faults throughout the [Houston-Galveston region] during the past several decades." "Our InSAR results have demonstrated that ground subsidence due to excessive ground water withdrawals has exacerbated the faults in [the Houston-Galveston region].* (p. 302)

May 2018 HGSD Report on Jasper Subsidence

Investigation of the Brackish Groundwater Resources in the Gulf Coast Aquifer and the Determination of Potential Subsidence Risk Due to Resource Development

EXECUTIVE SUMMARY



HARRIS-GALVESTON SUBSIDENCE DISTRICT
FORT BEND SUBSIDENCE DISTRICT
AUGUST
2018

The results of this study confirm the potential for compaction in the Jasper aquifer and subsidence to occur from brackish groundwater development particularly in up-dip areas near where the Jasper is being used for freshwater supply.

Montgomery County is this area

May 2018 U of H Report on Subsidence (2006-2016)

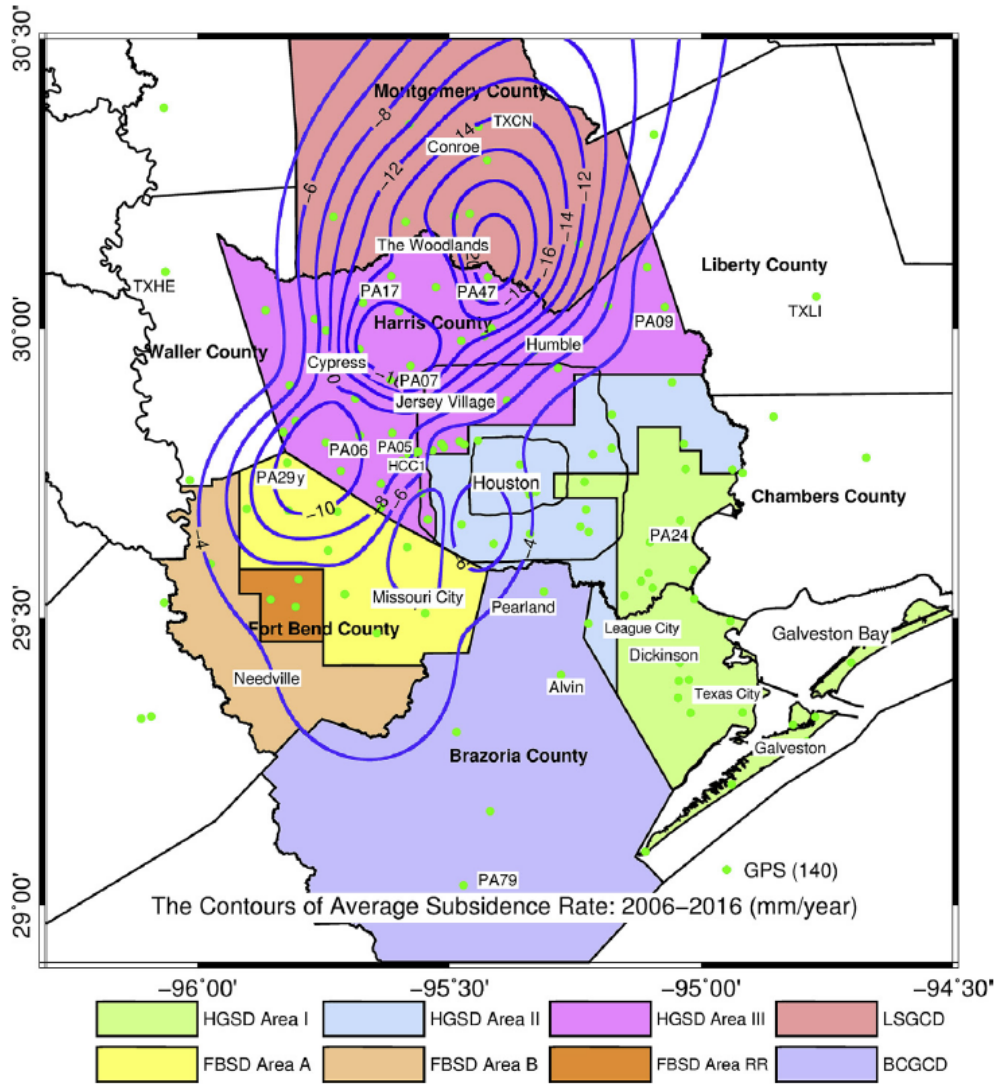


Fig. 8. Contour maps showing the average subsidence rate (mm/year) during the period from 2006 to 2016. The contour map was derived from the subsidence rates at 140 permanent GPS sites (>3 years). The colored areas indicate the current groundwater regulatory zones administered by the Harris–Galveston Subsidence District (HGSD), the Fort Bend Subsidence District (FBSD), the Lone Star Groundwater Conservation District (LSGCD) and the Brazoria County Groundwater Conservation District (BCGCD).

June 2019 SMU Report on Subsidence & Faults

- *"The newly discovered fault activation appears to be related to excessive groundwater exploitation from the Jasper aquifer in Montgomery County. The continuous mining of groundwater from the Jasper aquifer formed new water-level decline cones over Montgomery County, corroborating the intensity of new fractures."* (p. 1)

- *". . . the potential risks of active faults are still high, with potential to cost millions of dollars in property and infrastructure."* (p. 3)

- *"Hundreds of paved roads and homes in the Houston area are being offset by faults and require frequent maintenance."* (p. 1)

- *"Damage to a swimming pool at the Conroe Aquatics Center, which is located on the InSAR-mapped fault line, was reported early in 2018, indicating the activation of Conroe Fault."* (p. 12)

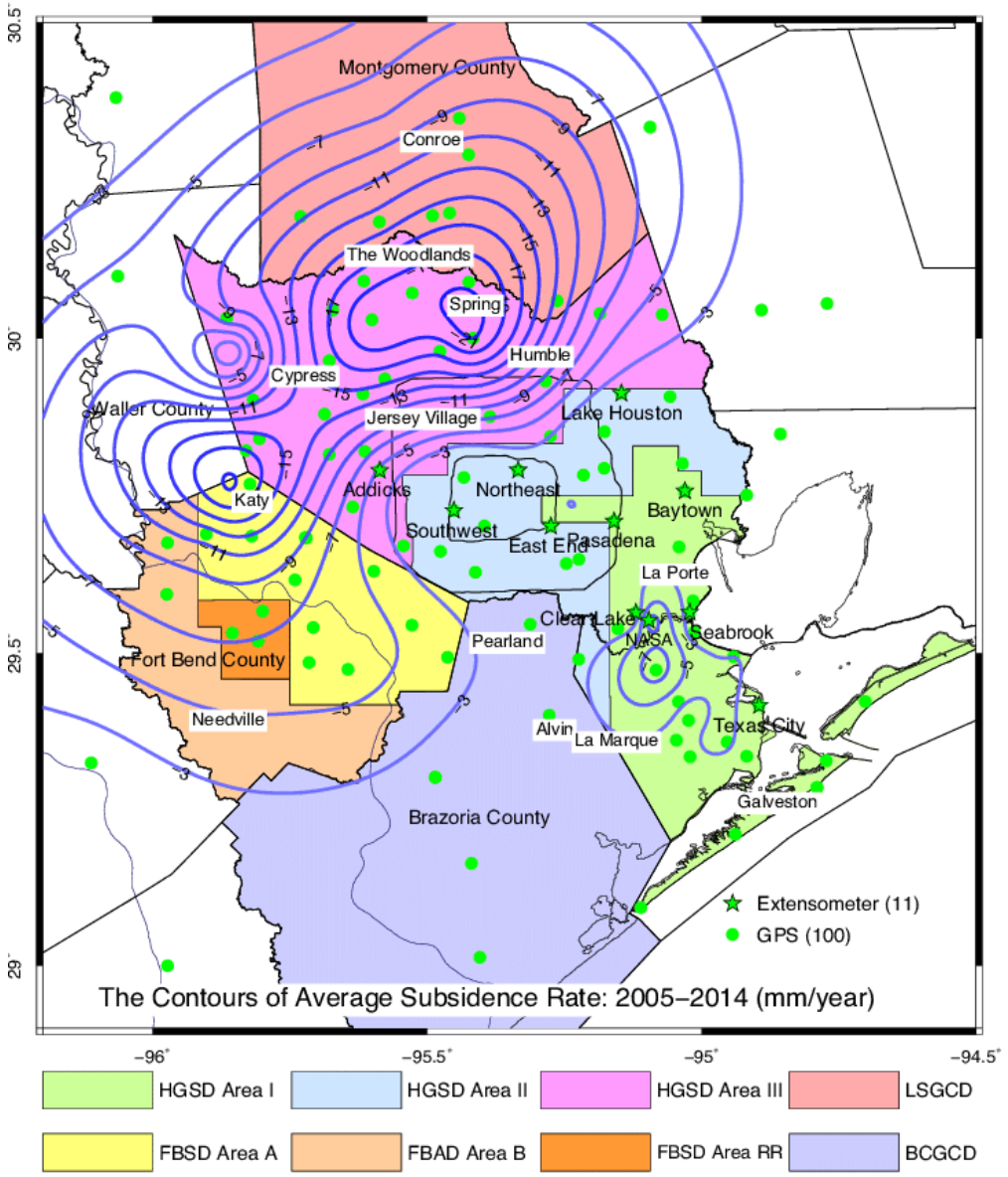


Figure 3, Wang, G.

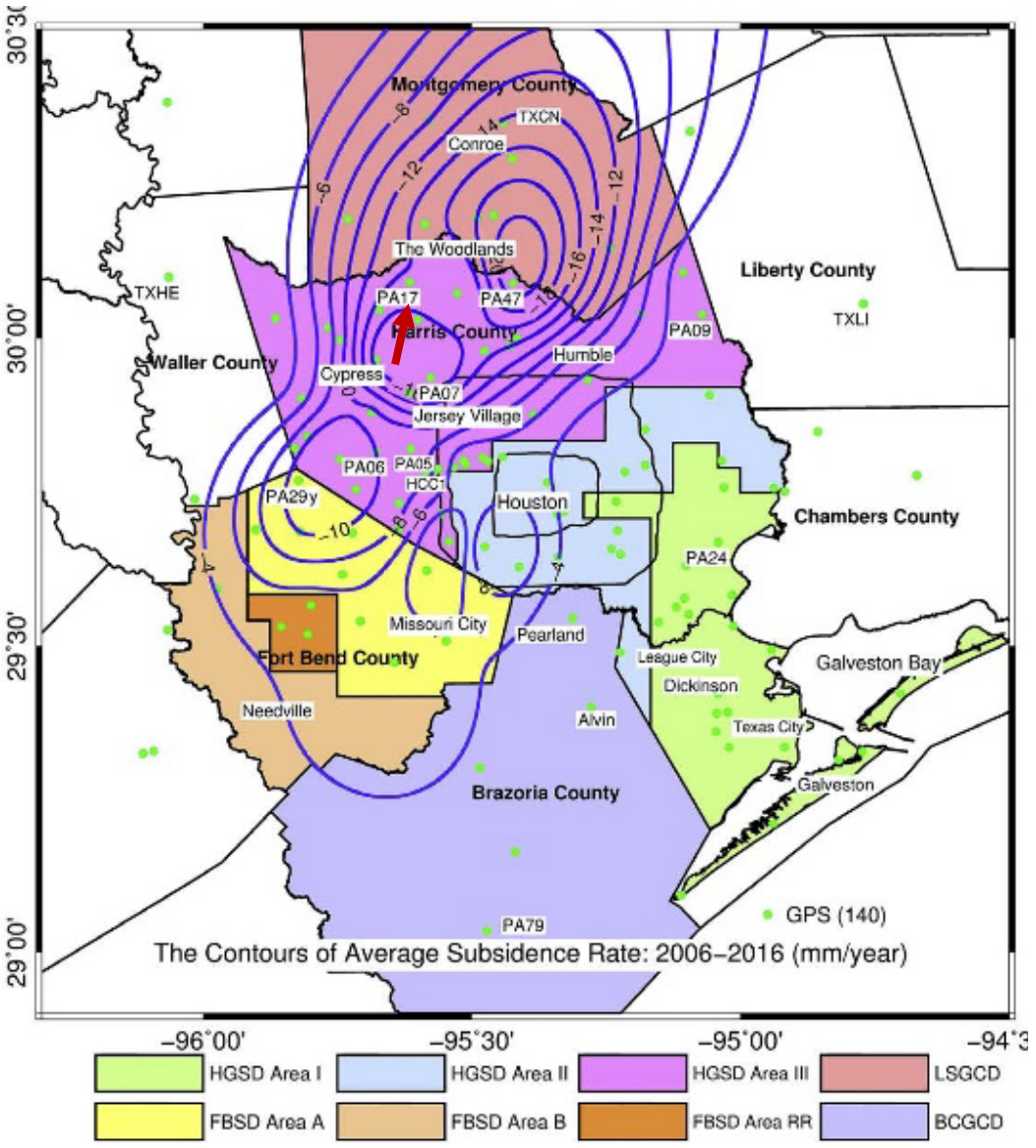


Figure 8, Kearns, T.J.

Reference Citations:

Kearns, T.J., Wang, G., Turco, M., Welch, J., Tsibanos, V., & Lui, H, (2018). Houston16: A stable geodetic reference frame for subsidence and faulting study in the Houston metropolitan area, Texas. *U.S., Geodesy and Geodynamics* , https://doi.org/10.1016/j.geog.2018.05.005.

Wang, G., Welch, J., Kearns, T.J., Yang, L. & Serna, Jr., J.(2015). Introduction to GPS geodetic infrastructure for land subsidence monitoring in Houston, Texas, USA. *Proceedings of International Association of Hydrological Sciences*, 372, 297-303. http://doi.org/10.5194/piahs-372-297-2015

Independent Scientific Review of the Current Groundwater Controversy by the Houston Advanced Research Center (February 2021)

Key Findings by HARC Regarding Claim that Jasper Aquifer Doesn't Subside

- "The Phase 1 (Thornhill) Report describes the Jasper Aquifer as being 1,000 times less susceptible to subsidence than the Chicot Aquifer based on simulations using the HAGM. This statement is misleading."
- "The current state of the science on the Jasper Aquifer is that it is likely susceptible to compaction."

Key Findings by HARC Regarding Claim that Subsidence in Mont Co is Caused by Harris Co

- “It is misleading to suggest that Harris County is responsible for 80-90% of subsidence in Montgomery County.”
- “Based on water-level data, the area’s downdip in Harris County may be affected by updip groundwater use in Montgomery County.”

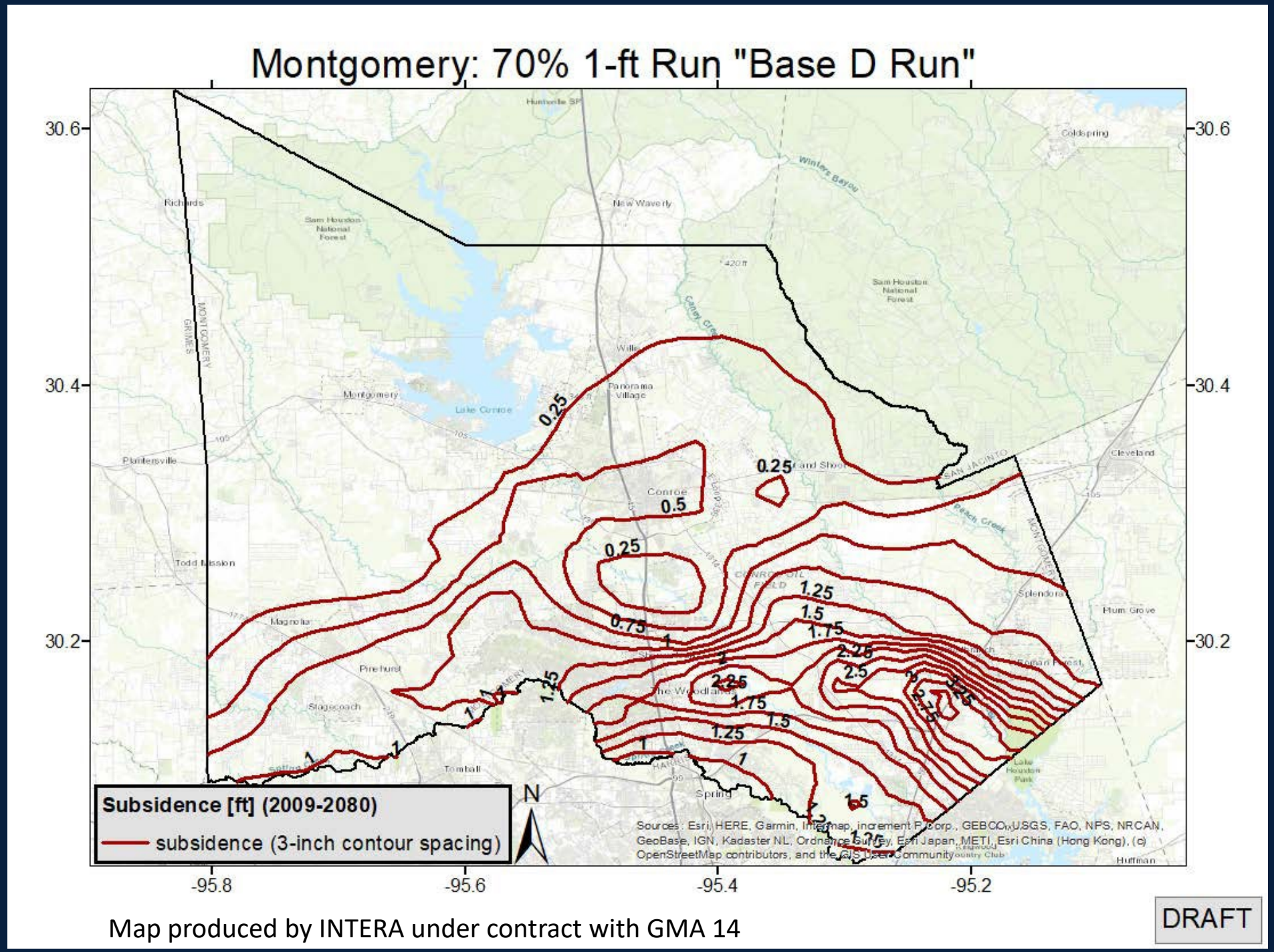
Key Findings by HARC Regarding Consequences of Subsidence

- “Consequences of subsidence in the greater Houston-Galveston region include: a reduced capacity for aquifer storage, submerged lands, increased frequency and severity of flooding, collapsed water well casings, disruption of irrigation ditches, damage to foundations of commercial and residential real estate, and damage to public infrastructure such as roads and bridges.”

Desired Future Conditions Under Consideration for Montgomery County

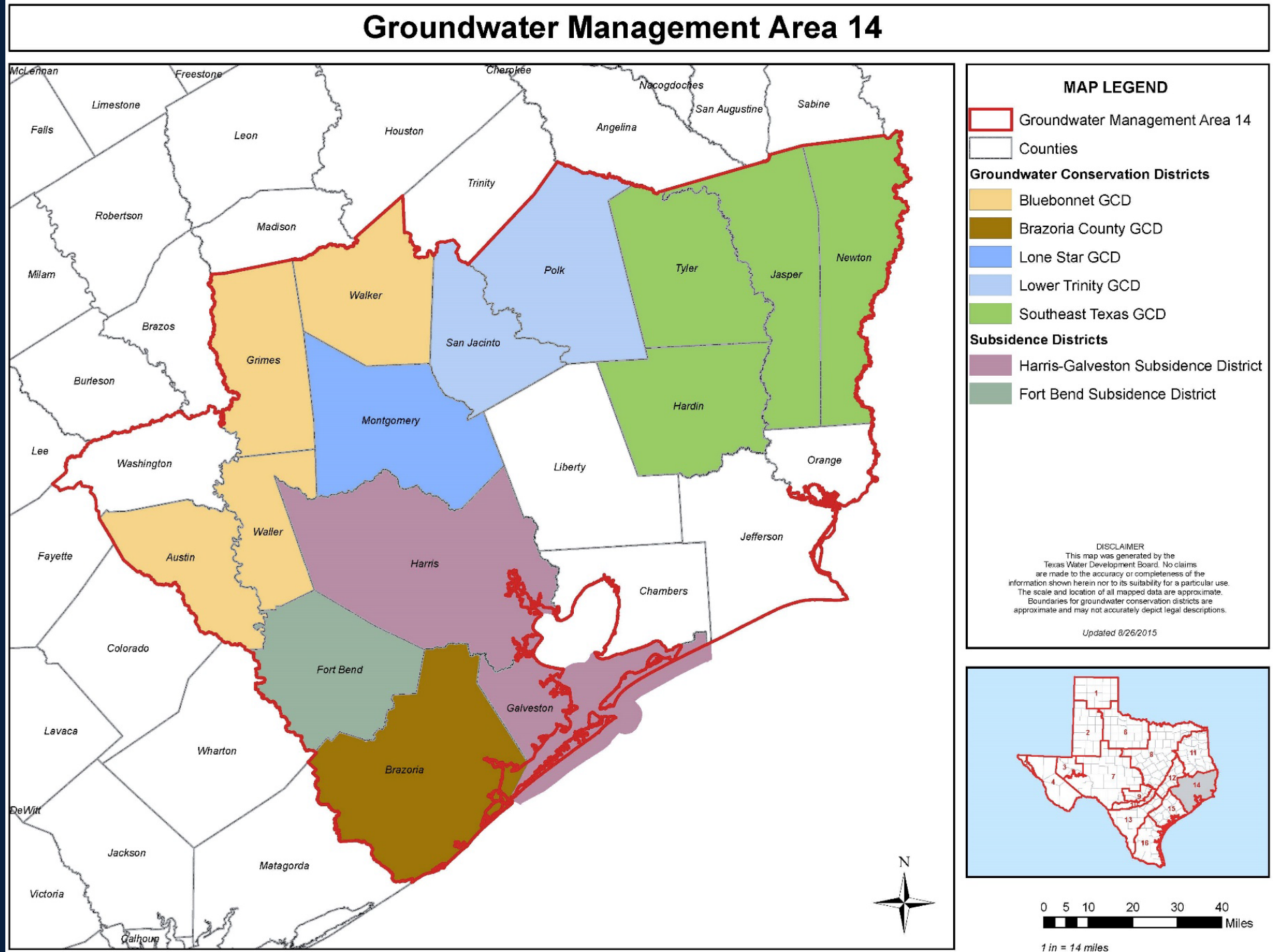
Is this amount of additional subsidence acceptable?

Note: The model under-predicts and is being updated to fix this problem!



Map produced by INTERA under contract with GMA 14

Groundwater Management Planning



Desired Future Conditions

"quantitative description, adopted in accordance with Section 36.108, of the desired condition of groundwater resources in a management area at one or more specified future times."

Ref: Texas Water Code, Chapter 36

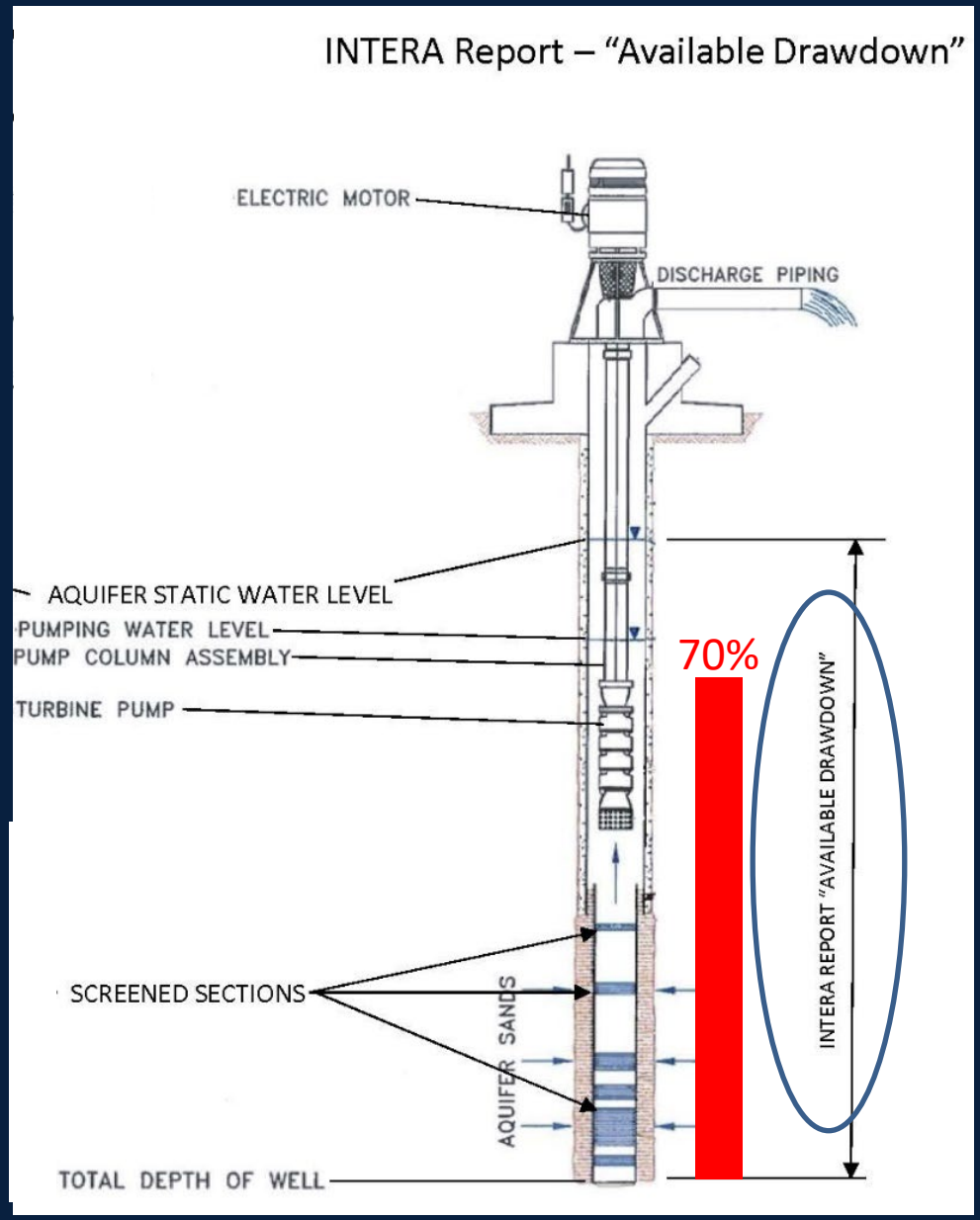
Desired Future Conditions

"must provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging and prevention of waste of groundwater and control of subsidence in the management area."

Ref: Texas Water Code, Chapter 36

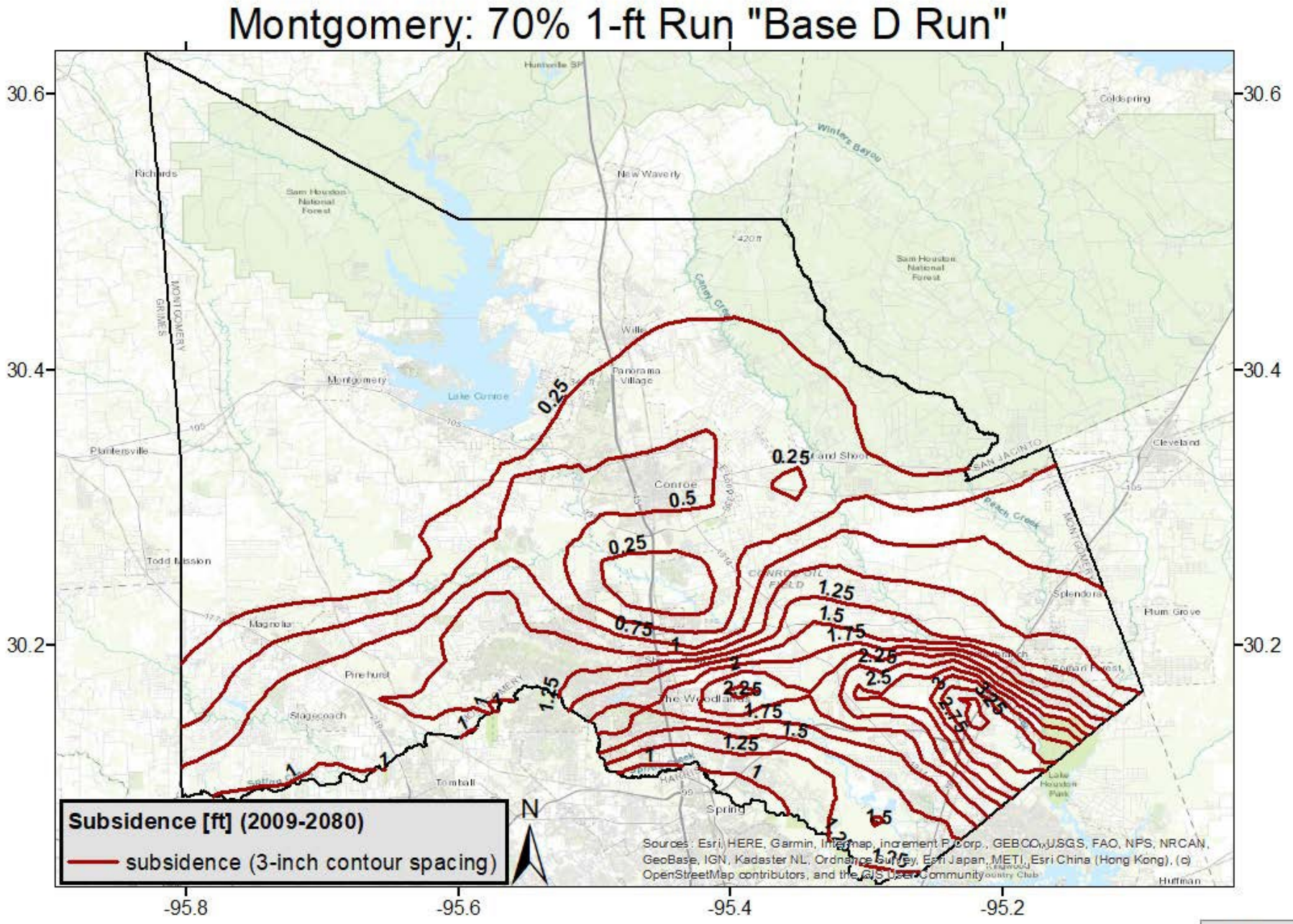
DFC Scenarios Being Considered by GMA 14

1. "High" scenario - 70% remaining available drawdown or 1 foot additional subsidence (average) using Run D pumpage — ~115,000 ac-ft per yr
2. "Medium" scenario - 70% remaining available drawdown or 1 foot additional subsidence (average) using 2016 pumpage — ~97,000 ac-ft per yr
3. "Low" scenario - 80% remaining available drawdown or 1 foot additional subsidence (average) using 2016 pumpage — ~61,000 ac-ft per yr



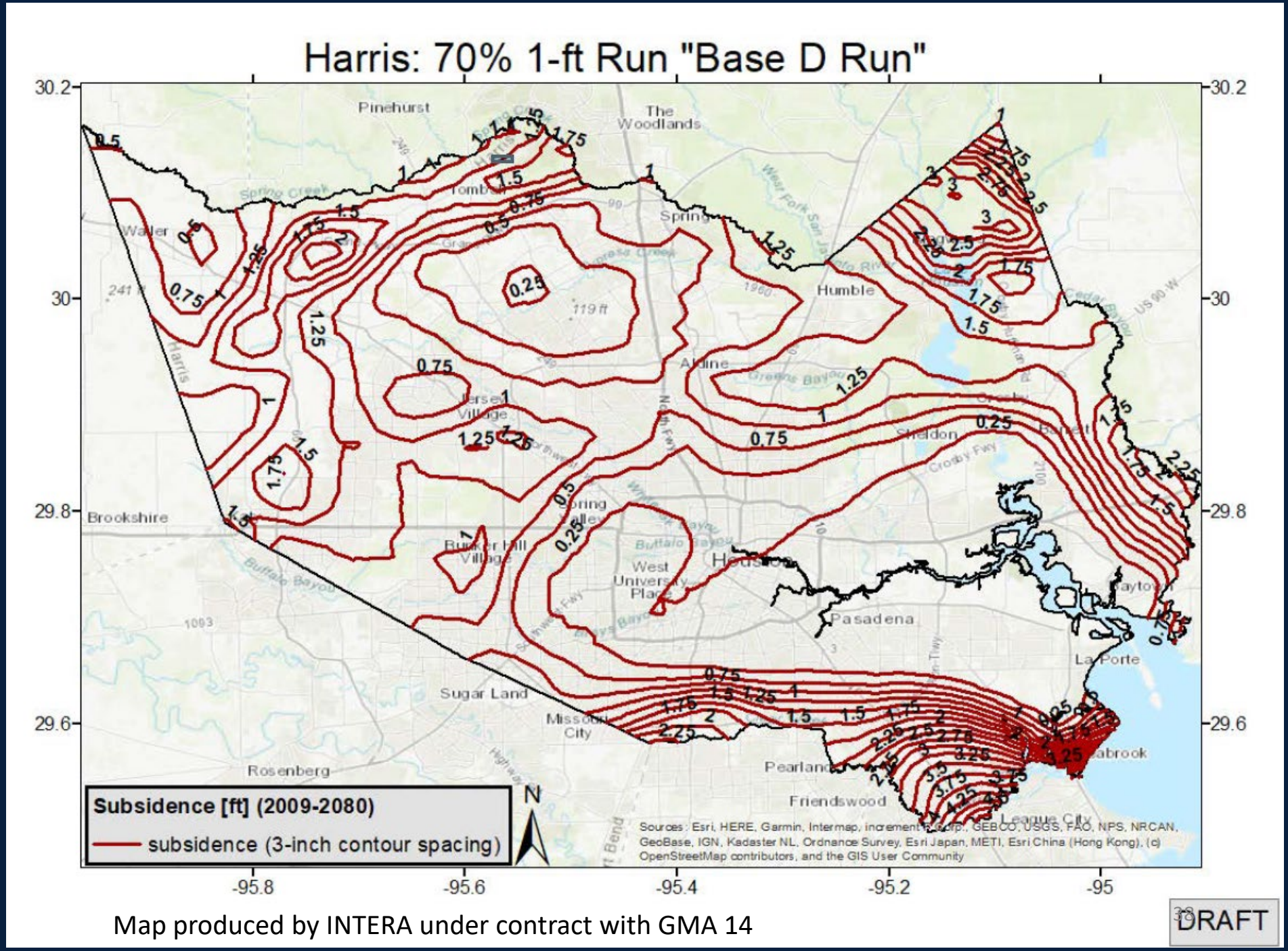
Results of "High" Scenario with 115,000+ afpy Groundwater Pumpage

Note: The model under-predicts subsidence in the north and is being updated to fix this problem!



Map produced by INTERA under contract with GMA 14

Results of "High" Scenario in Harris County

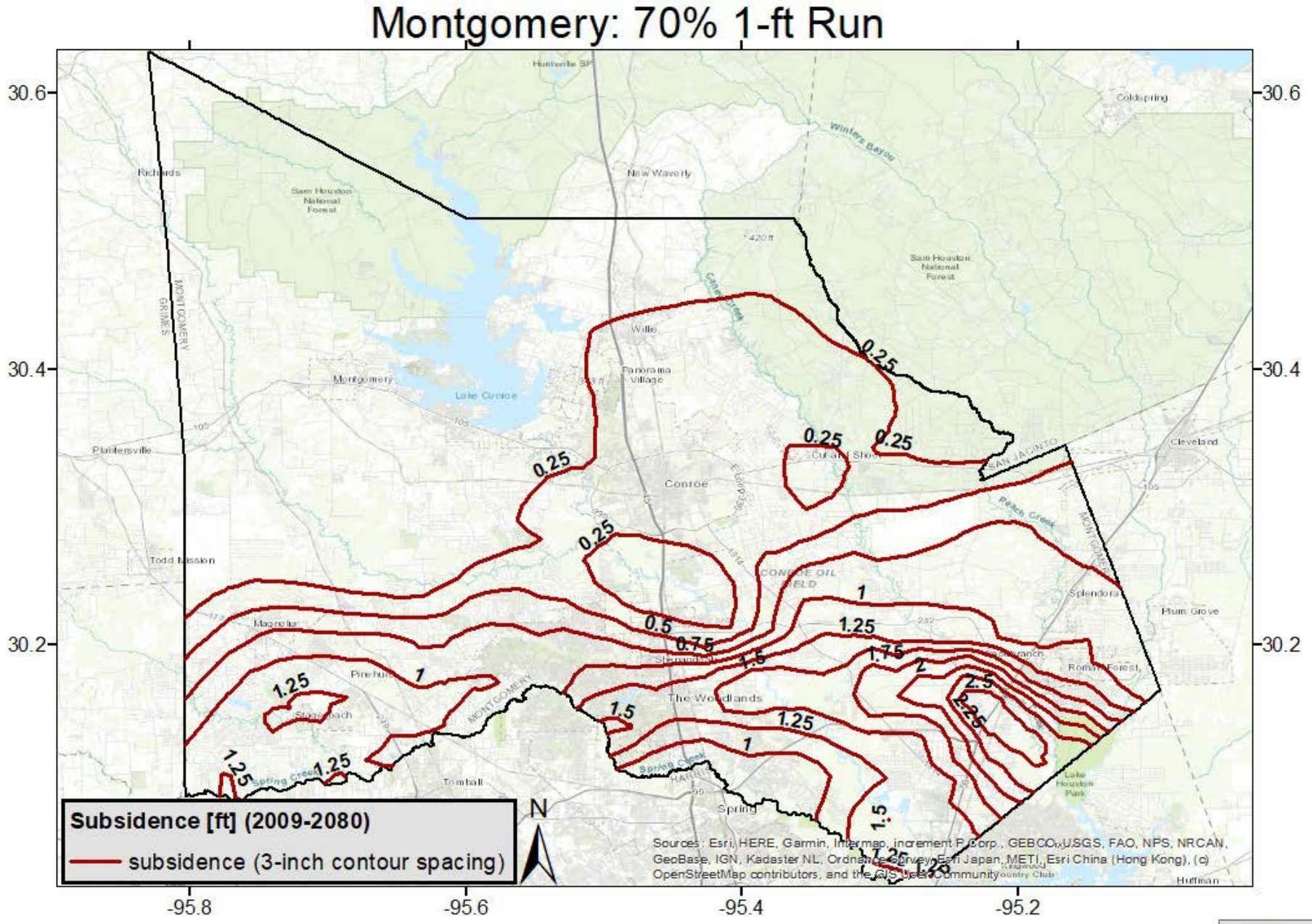


Map produced by INTERA under contract with GMA 14

DRAFT

Results of "Medium" Scenario with 97,000+ afpy Groundwater Pumpage

Note: The model under-predicts subsidence in the north and is being updated to fix this problem!



Map produced by INTERA under contract with GMA 14

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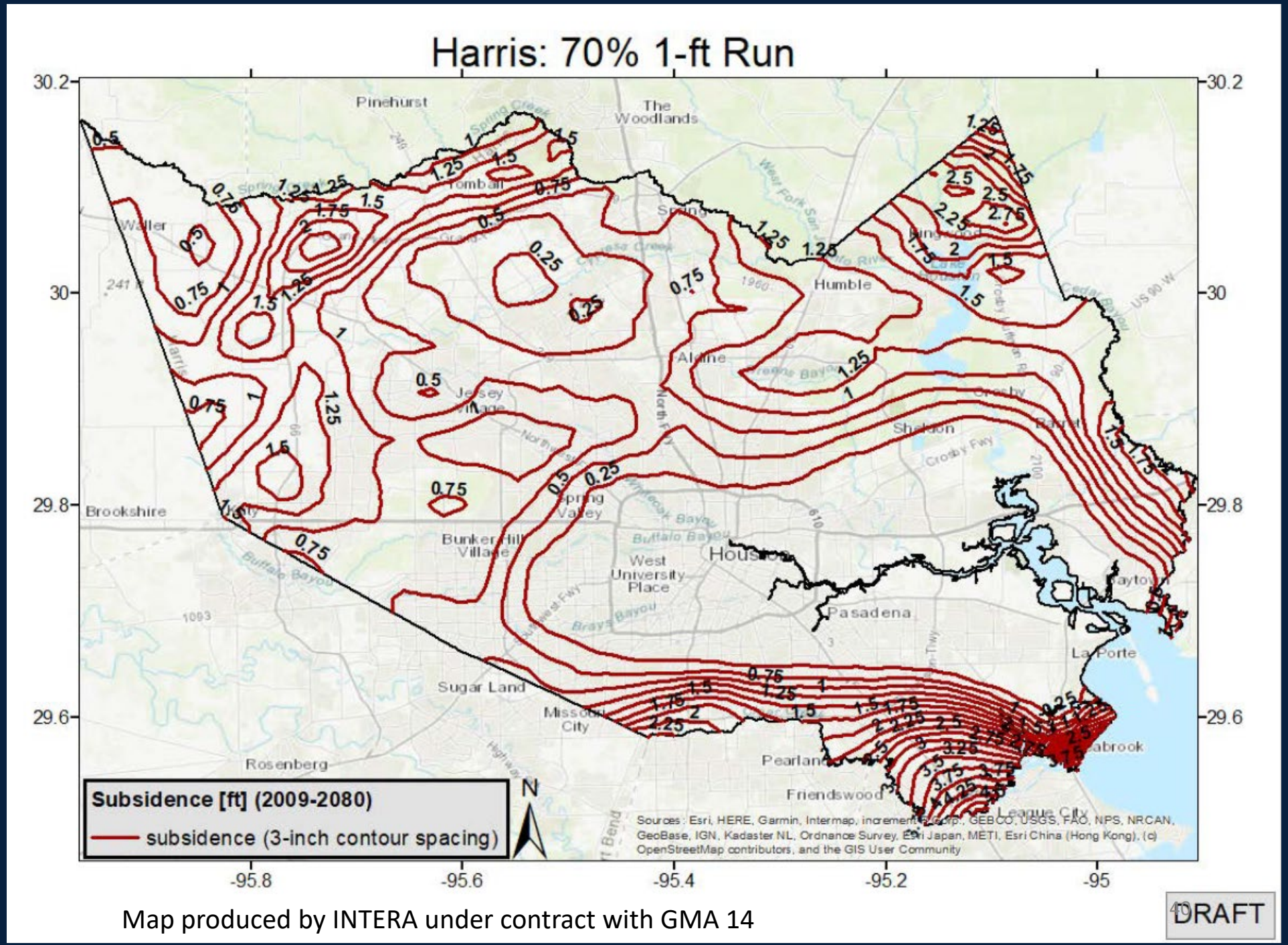
Results of "Medium" Scenario in Harris County



Map produced by INTERA under contract with GMA 14

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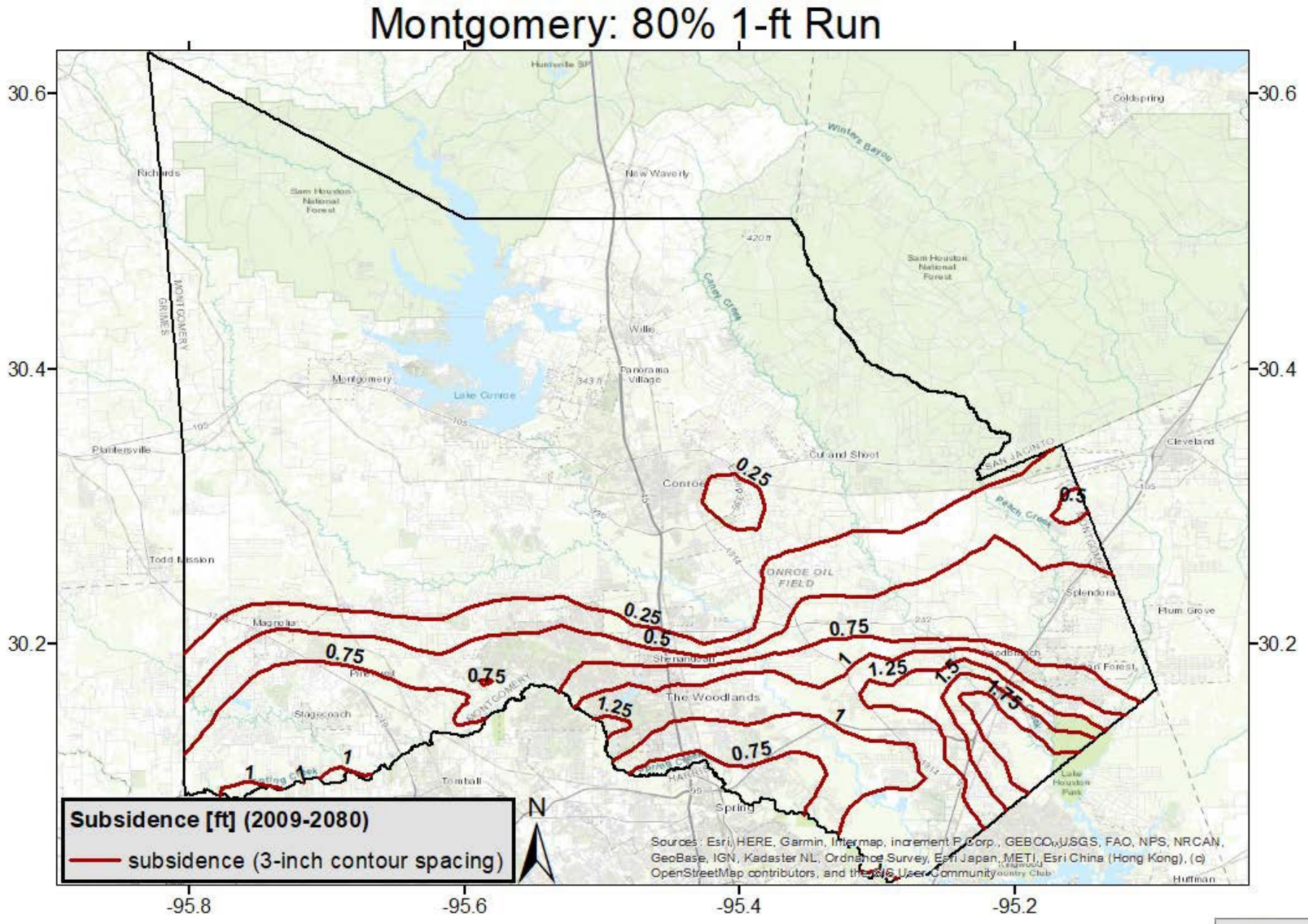
Results of "Low" Scenario with 61,000+ afpy Groundwater Pumpage

Note: The model under-predicts subsidence in the north and is being updated to fix this problem!



Map produced by INTERA under contract with GMA 14

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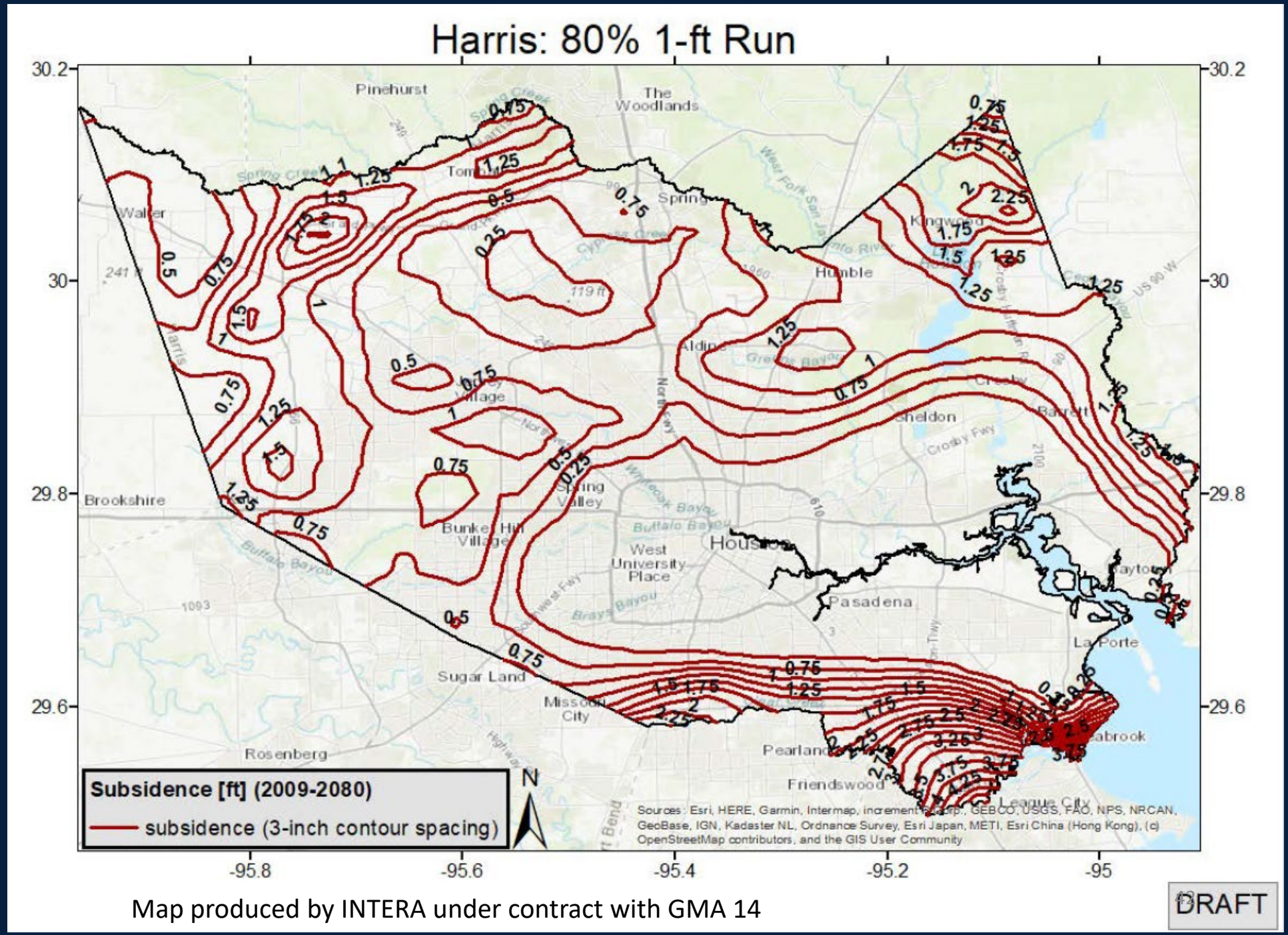
Results of "Low" Scenario in Harris County



Map produced by INTERA under contract with GMA 14

Projected Montgomery County Water Demand

2021 Regional Water Plan
Water Demand Projections by County for 2020-2070 in Acre-Feet

Total Water Demand for MONTGOMERY County

County	Category	2020	2030	2040	2050	2060	2070
MONTGOMERY	IRRIGATION	5,642	5,642	5,642	5,642	5,642	5,642
MONTGOMERY	LIVESTOCK	537	537	537	537	537	537
MONTGOMERY	MANUFACTURING	2,135	2,413	2,413	2,413	2,413	2,413
MONTGOMERY	MINING	1,453	1,363	1,077	921	806	728
MONTGOMERY	MUNICIPAL	101,024	125,960	152,557	184,295	224,165	272,018
MONTGOMERY	STEAM ELECTRIC POWER	4,845	4,845	4,845	4,845	4,845	4,845
MONTGOMERY County Total		**115,636**	**140,760**	**167,071**	**198,653**	**238,408**	**286,183**

Source: Texas Water Development Board, Region H Planning Group

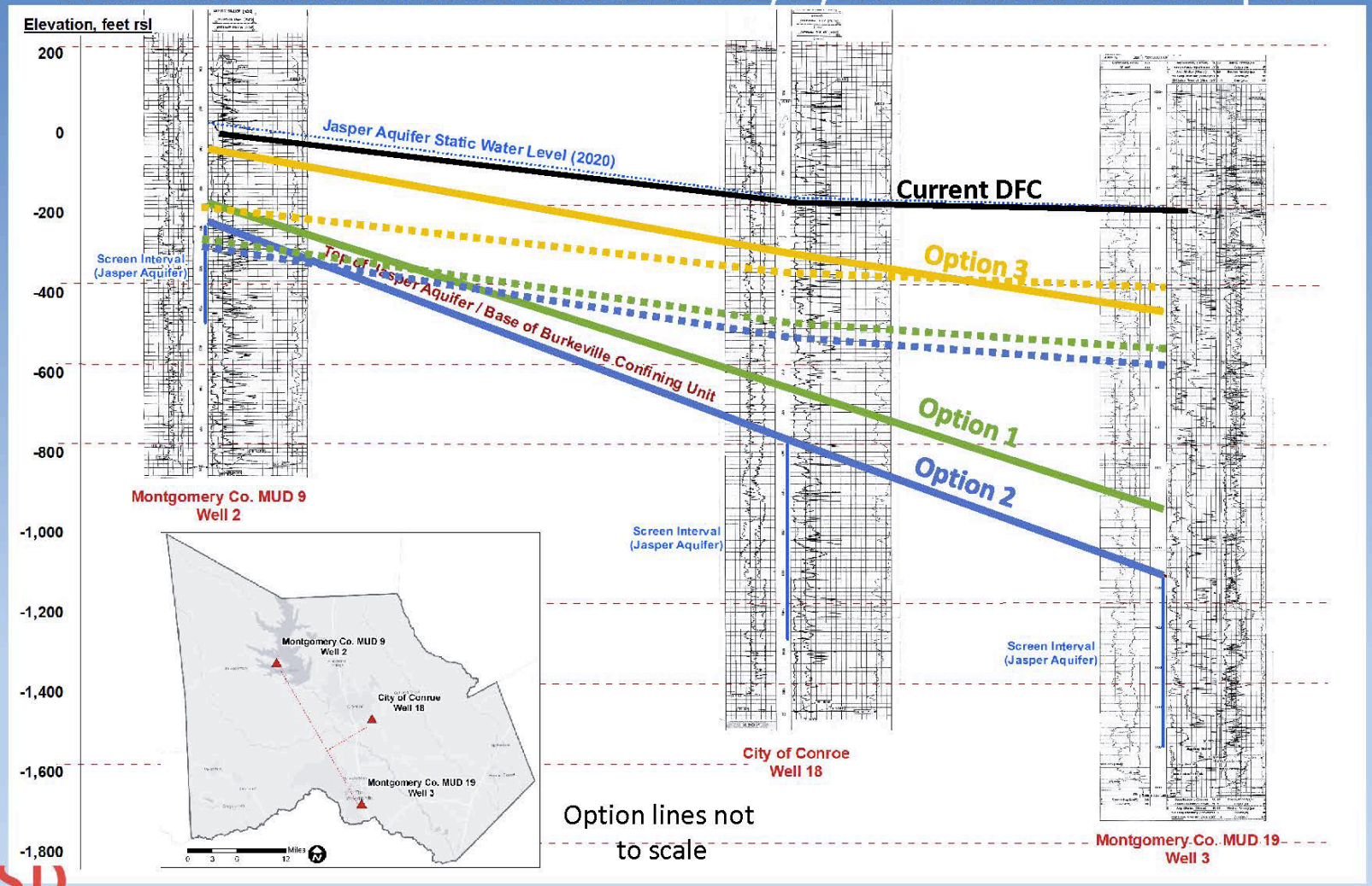
DFC's Requested by Lone Star GCD

- Option 3 = Similar to GMA 14's Run D; ~250' of drawdown in Jasper
- Option 2 = ~900' of drawdown in Jasper
- Option 1 = ~700' of drawdown in Jasper

* No consideration of subsidence!

RESULTS – LSGCD Jasper

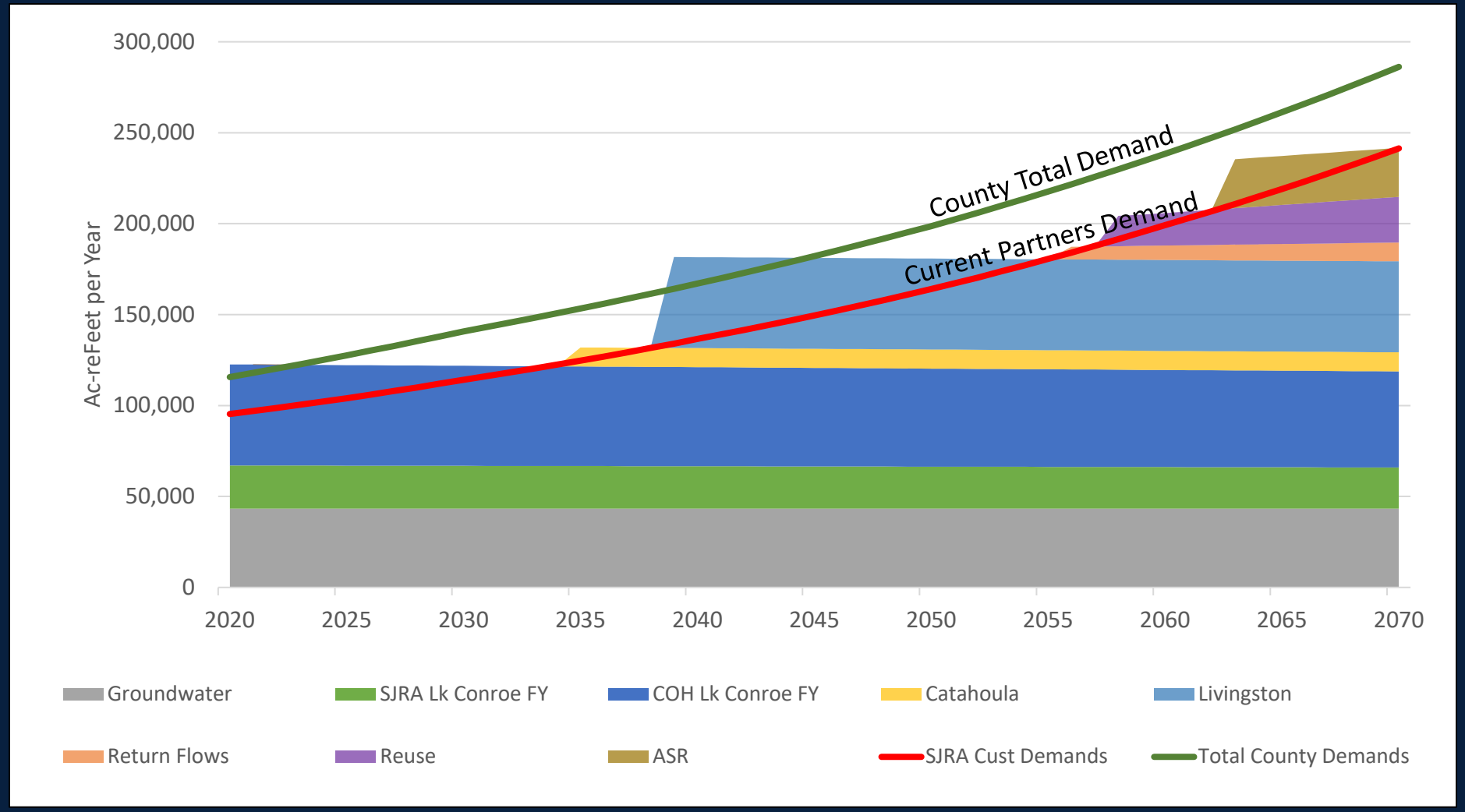
Dotted lines illustrate simulated water level on 12/31/2080 associated with each option



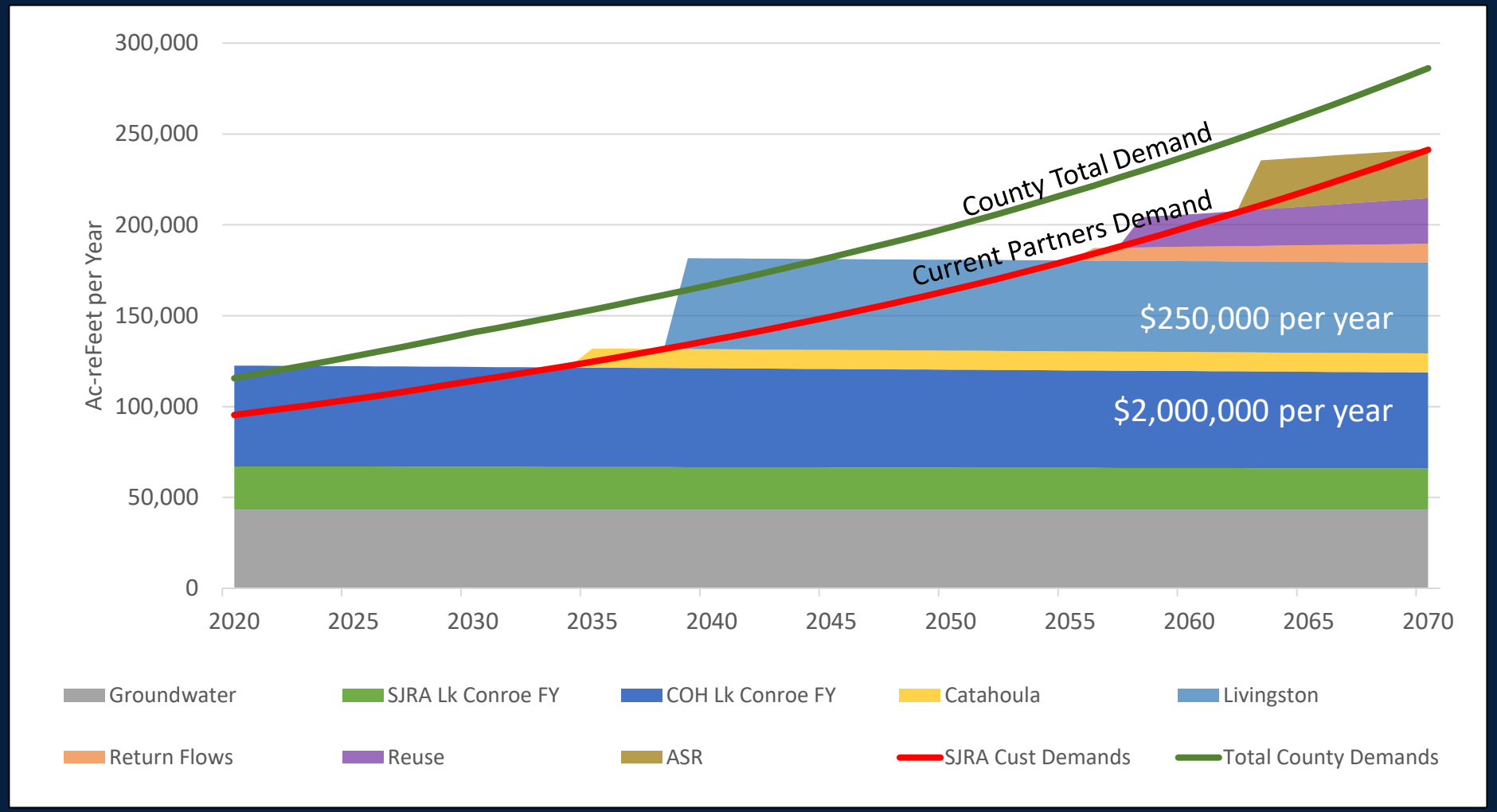
Long-Term Water Planning and Importance of Regional Partnerships

(Potential consequences of LSGCD failing to properly manage aquifers)

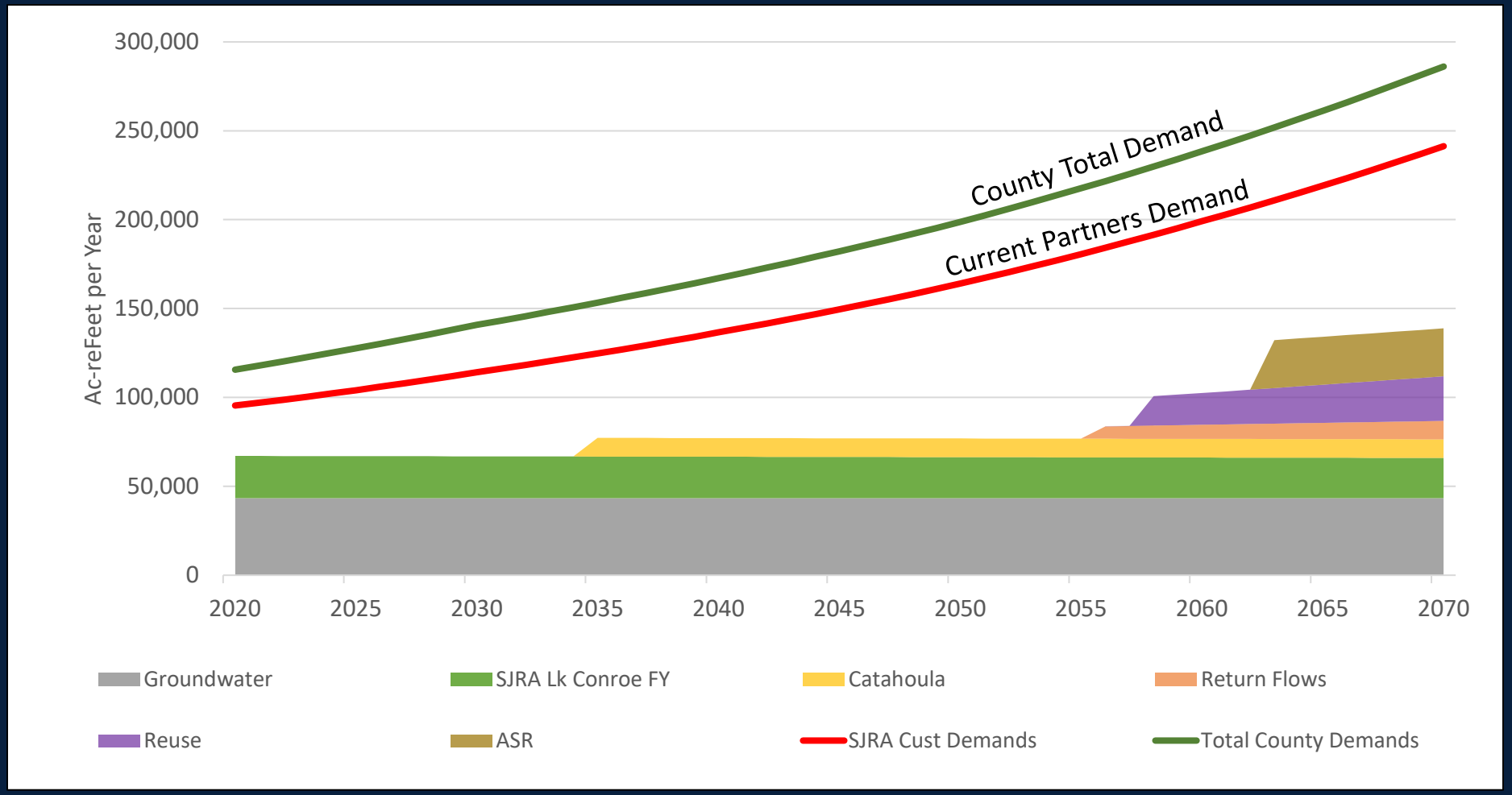
Water Supply Strategies Needed to Meet Future Montgomery County Demand



Water Supply Strategies Needed to Meet Future Montgomery County Demand



Montgomery County Water Supply SHORTAGE without Reserved Supplies



San Jacinto River Authority

Questions and Discussion

Reference Slides for GMA 14 DFC Issue

DFCs Being *Considered* by GMA 14

DFC

Base Well File	Drawdown Scenario	Subsidence Scenario	Fraction Drawdown Remaining	Average Additional Subsidence_feet	Maximum Additional Subsidence_feet*	Model Input Pumping_afy**	Chicot Drawdown_feet	Evangeline Drawdown_feet	Jasper Drawdown_feet
2016DFCs	70	1.0	0.68	-0.55	-3.3	97,012	39.0	20.7	185.1
2016DFCs	80	1.0	0.80	-0.35	-2.22	61,537	26.9	-4.8	71.1
RunD	70	1.0	0.68	-0.61	-4.05	115,673	40.4	41.1	320.2

Modeled Subsidence Results

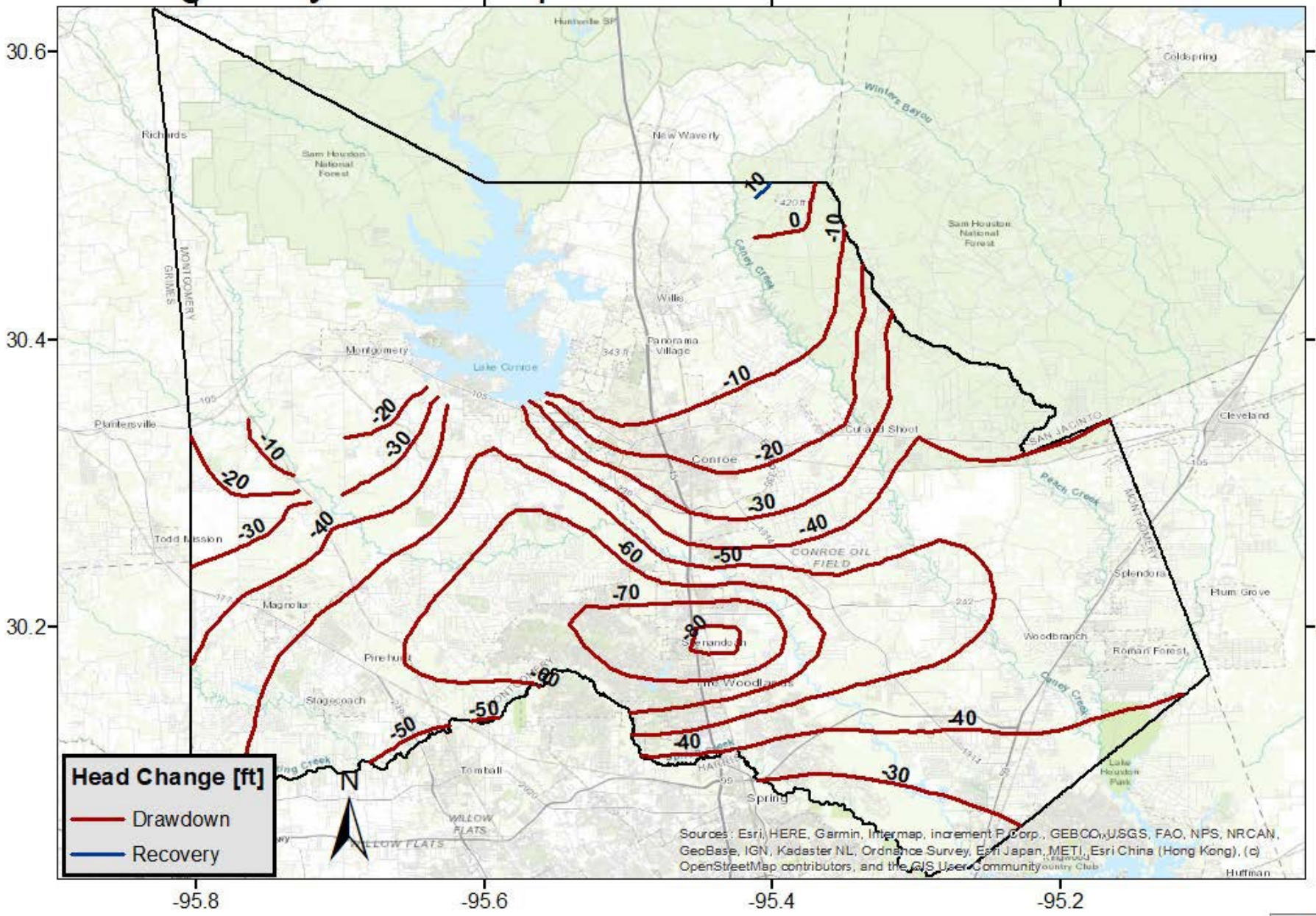
Modeled Drawdown Results

*Maximum Additional Subsidence is located in one cell of model (one cell of model = 1 square mile; Montgomery County = 1,077 sq. miles)

**Current total groundwater withdrawals permitted by LSGCD = 98,089 afpy

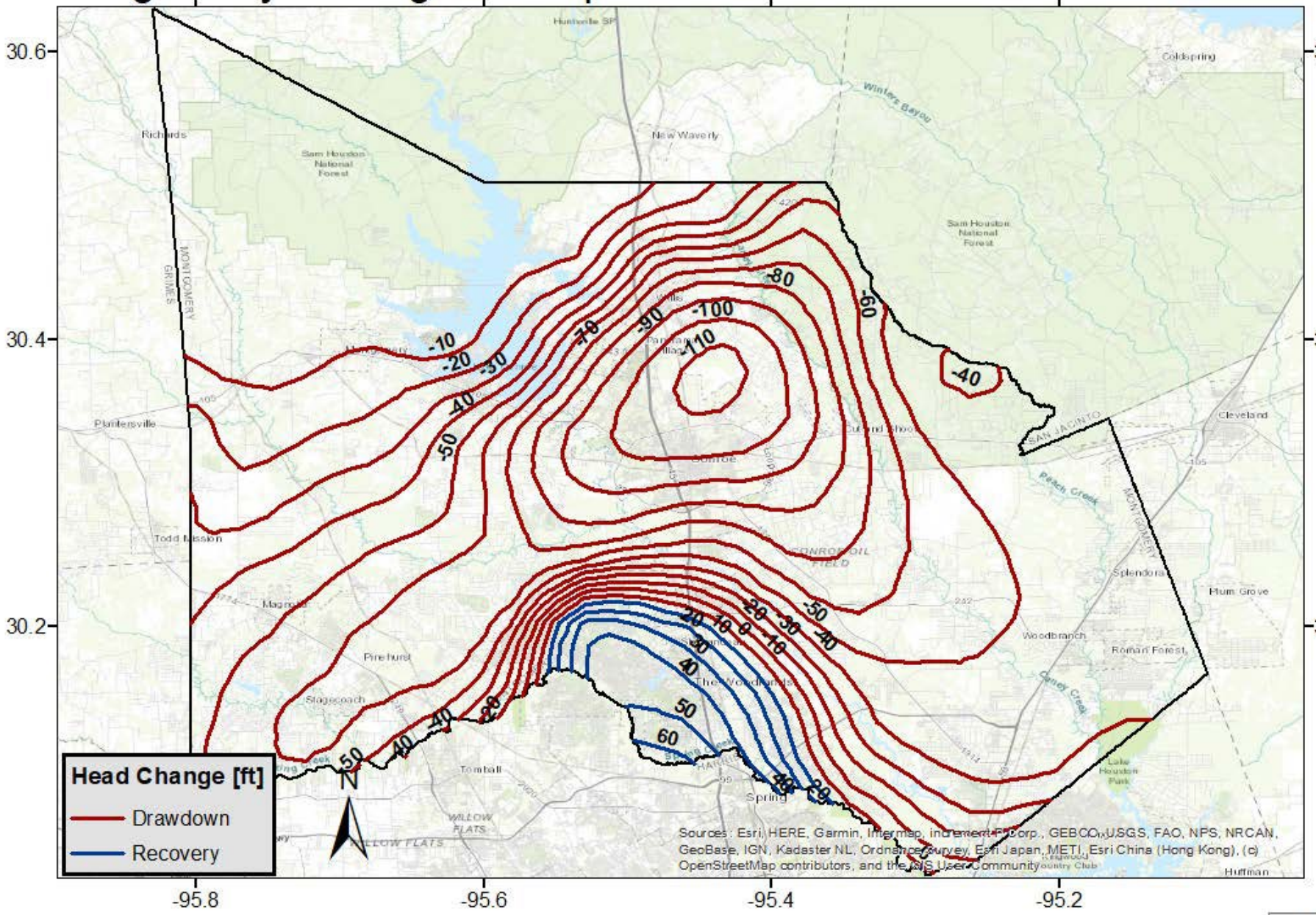
70% remaining drawdown available +
1 foot average additional subsidence
“Run D” base pumpage

Montgomery: Chicot Aquifer - 70% 1-ft Run "Run D Base"



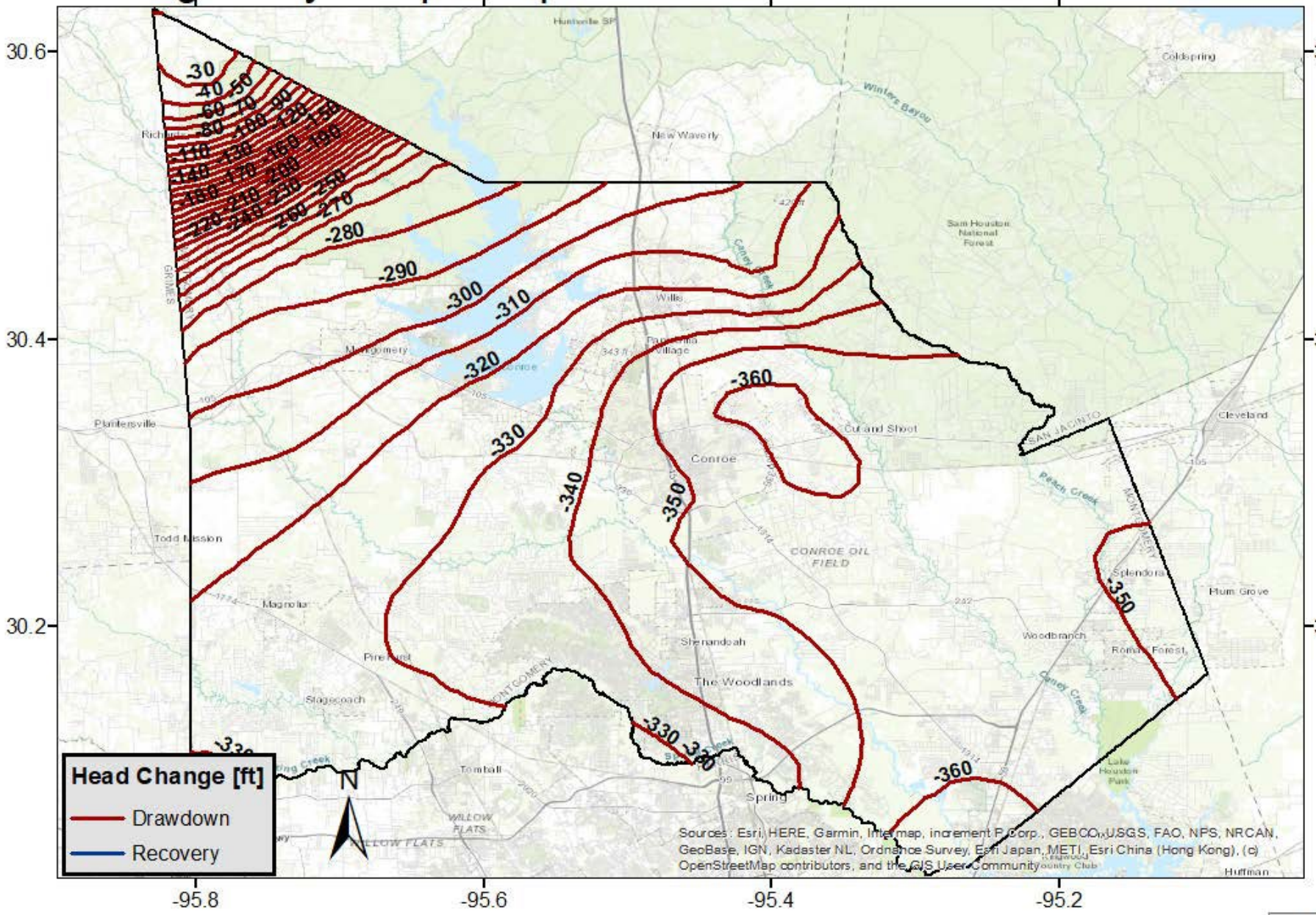
DRAFT

Montgomery: Evangeline Aquifer - 70% 1-ft Run "Run D Base"



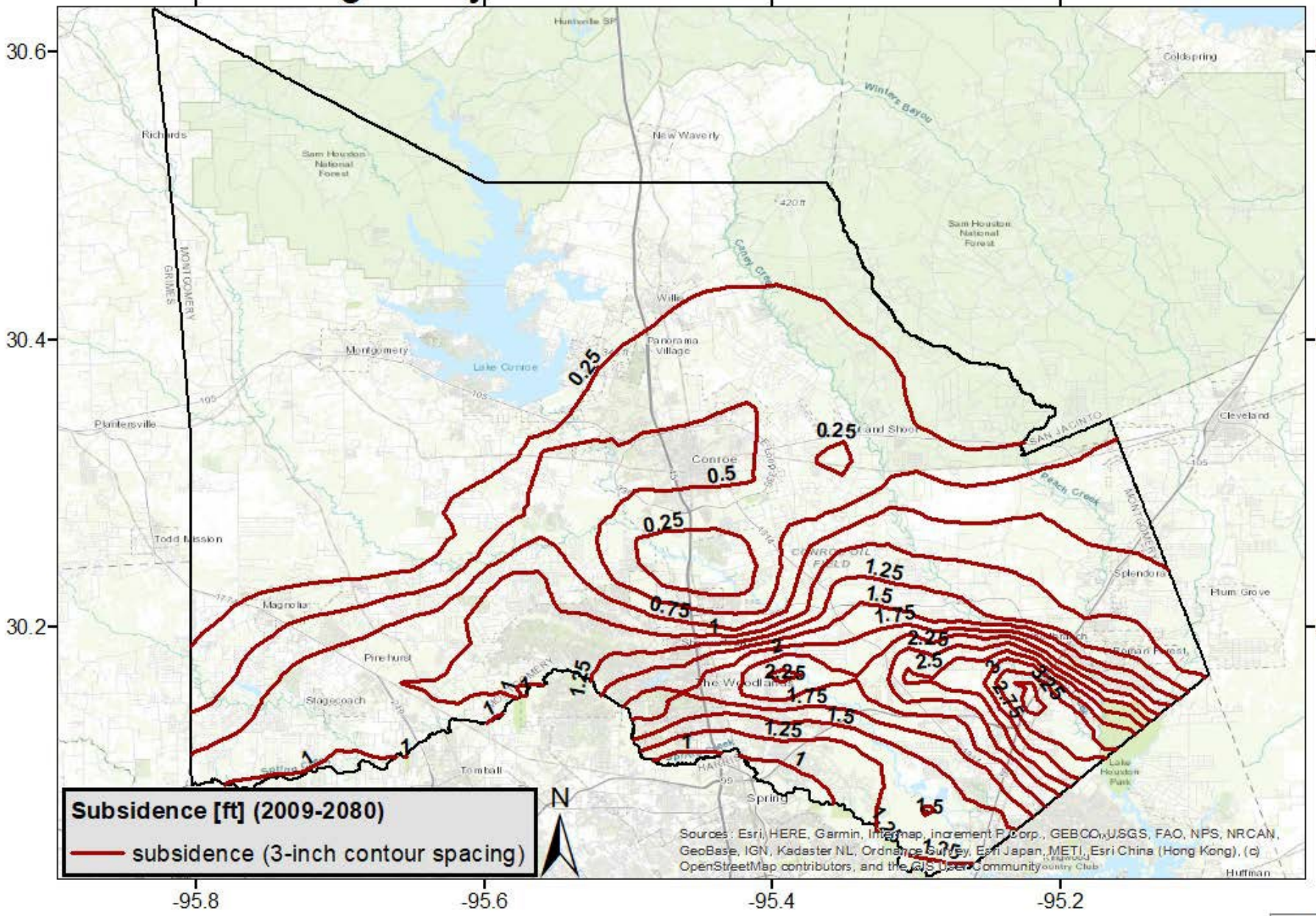
DRAFT

Montgomery: Jasper Aquifer - 70% 1-ft Run "Run D Base"



DRAFT

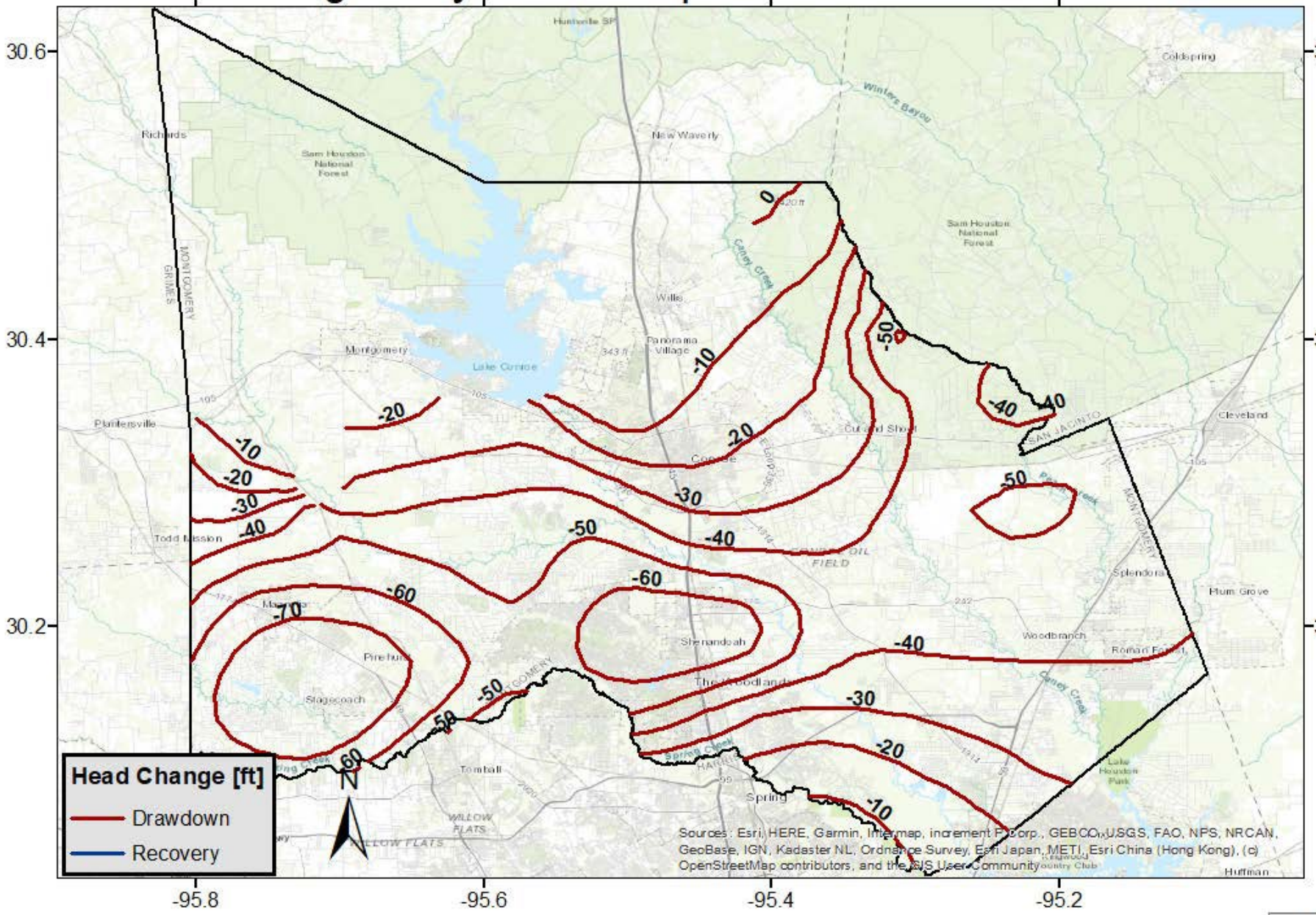
Montgomery: 70% 1-ft Run "Base D Run"



DRAFT

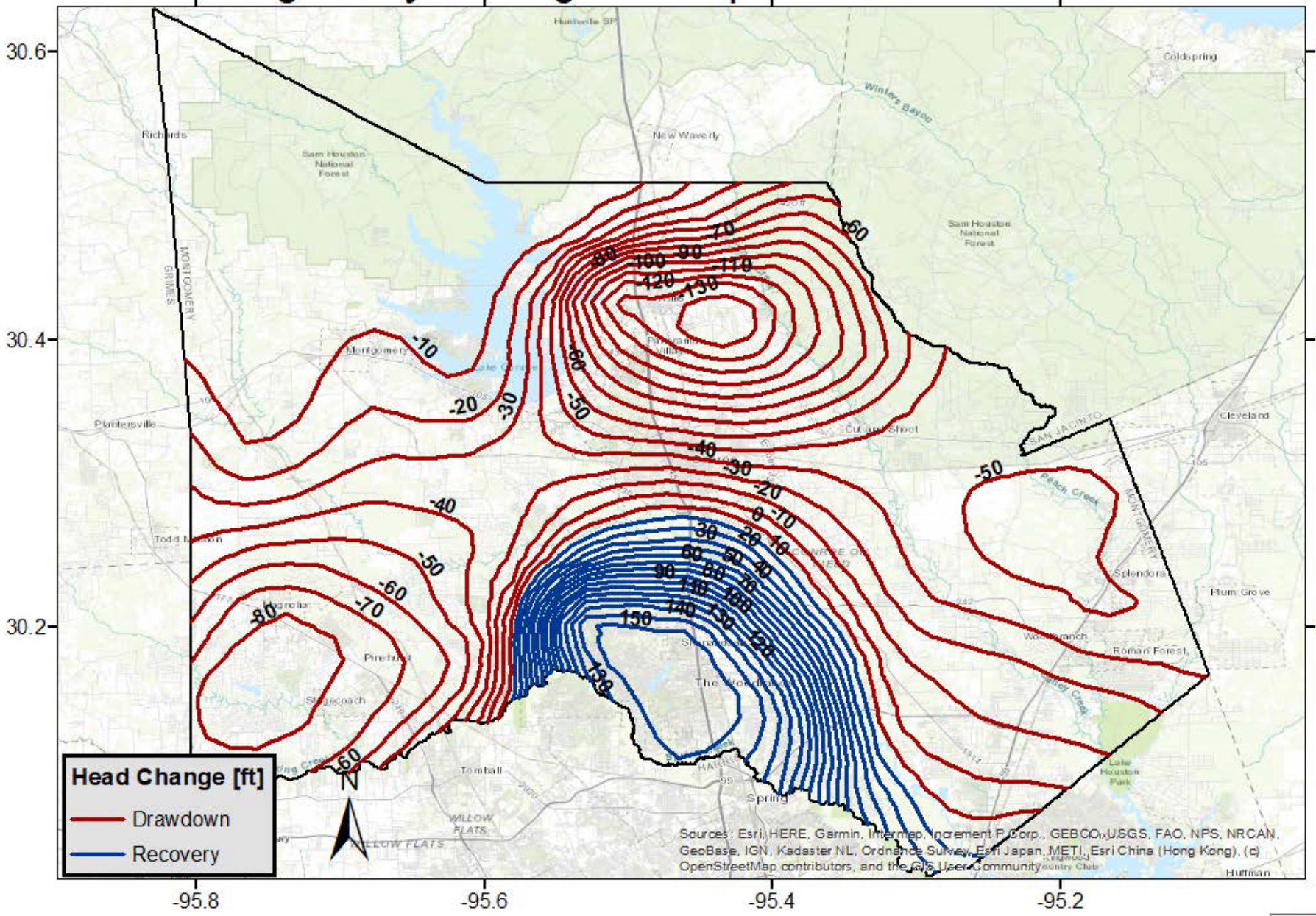
70% remaining drawdown available +
1 foot average additional subsidence
2016 base pumpage

Montgomery: Chicot Aquifer - 70% 1-ft Run



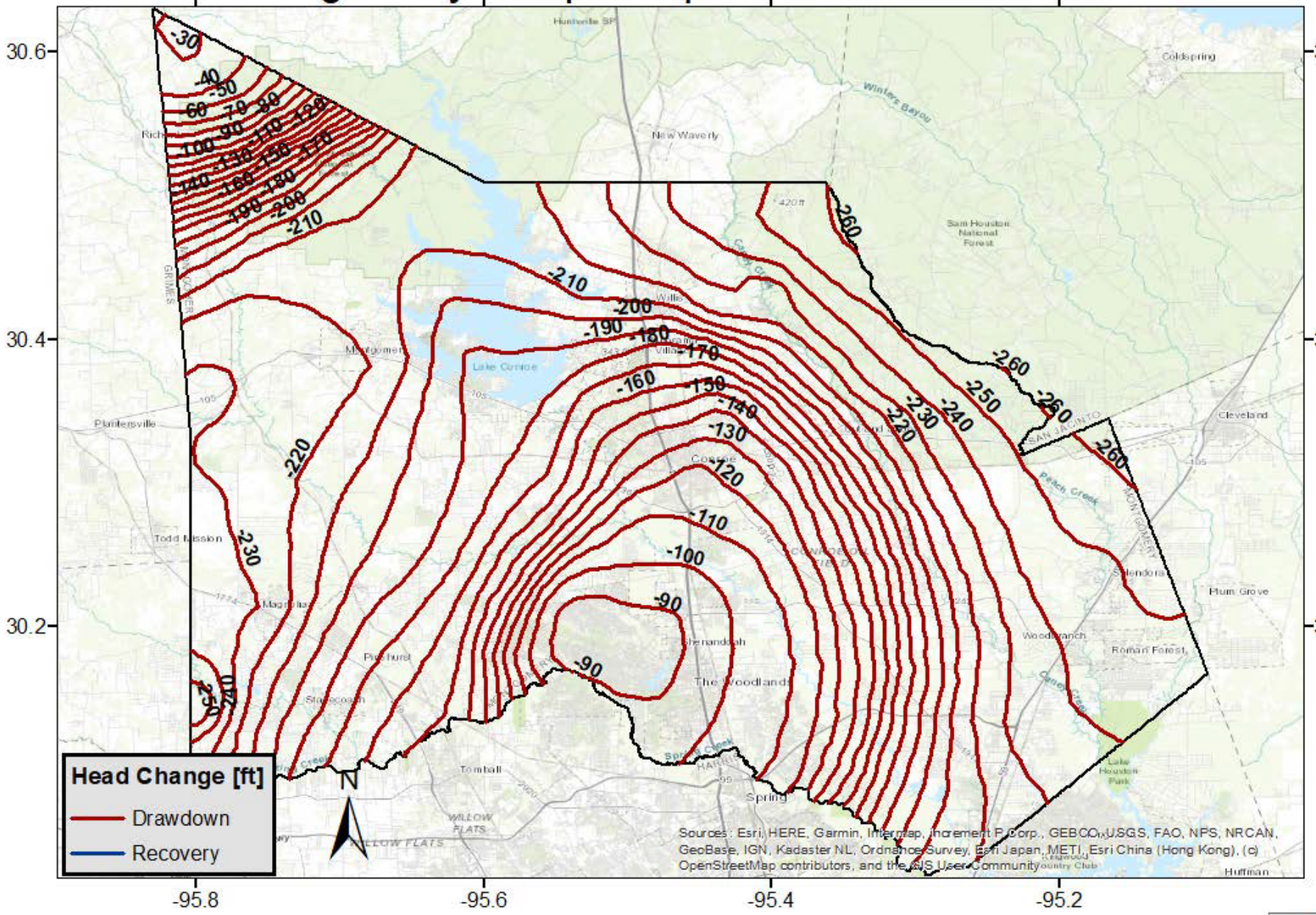
DRAFT

Montgomery: Evangeline Aquifer - 70% 1-ft Run



DRAFT

Montgomery: Jasper Aquifer - 70% 1-ft Run



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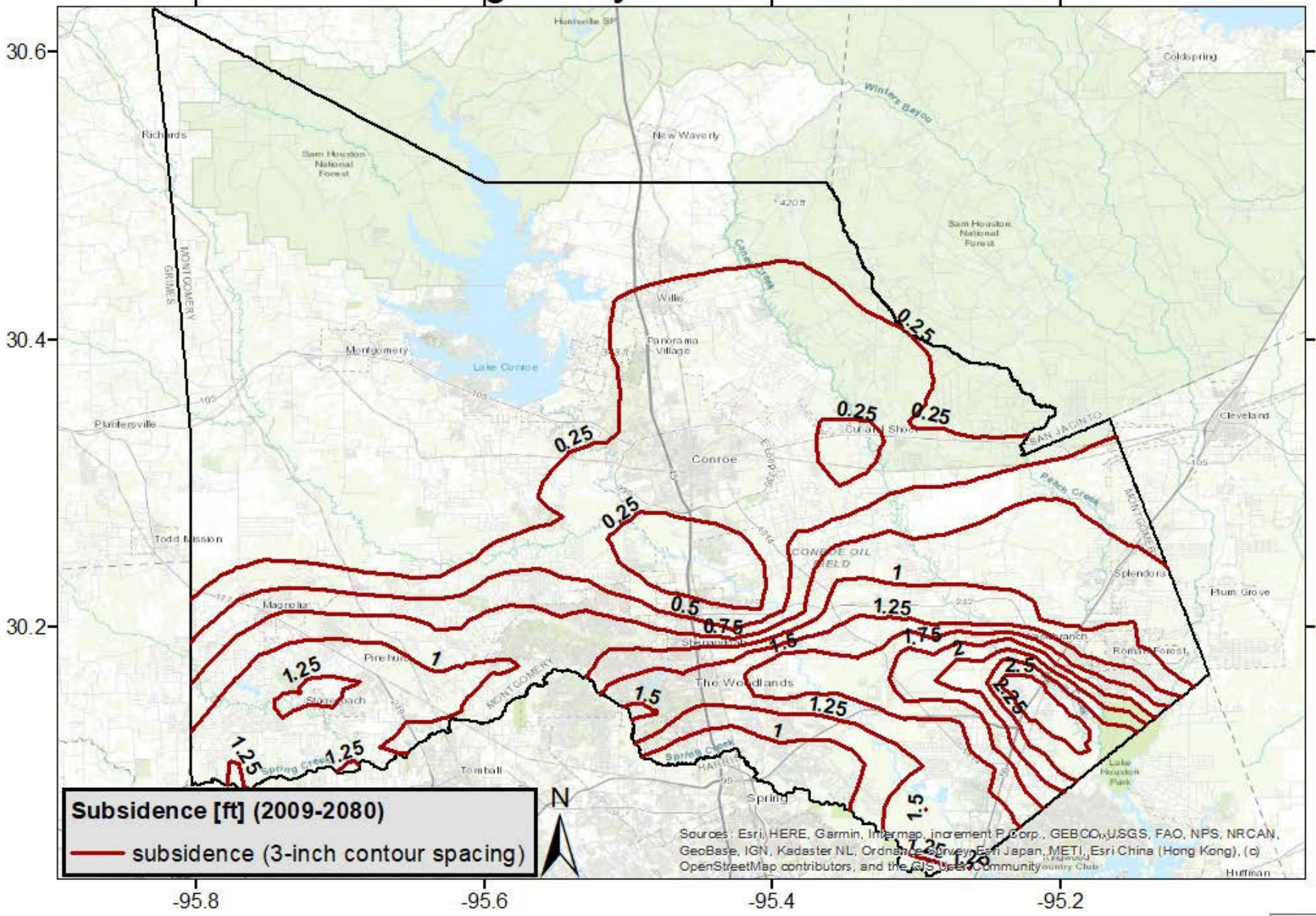
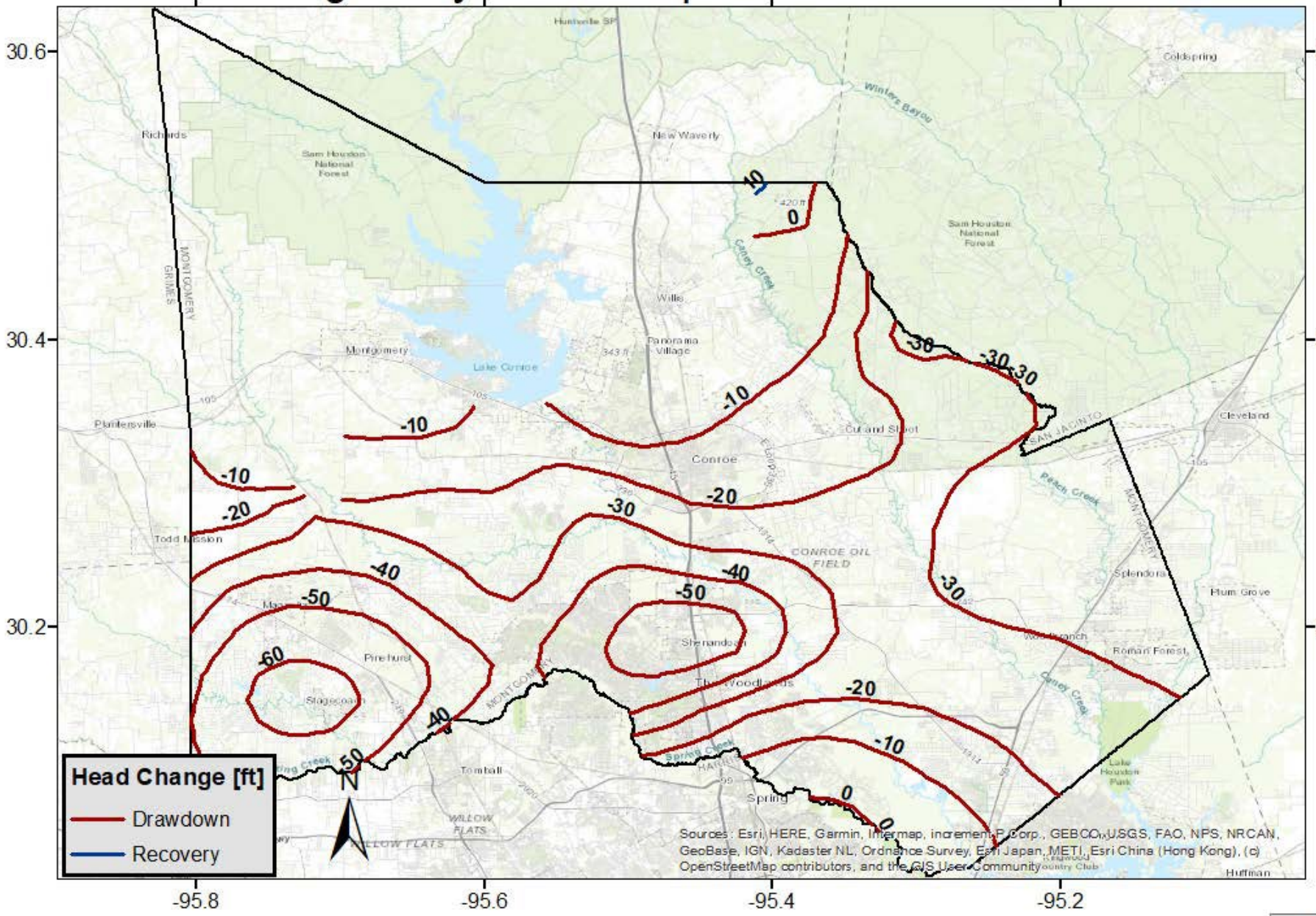
Montgomery: 70% 1-ft Run



DRAFT

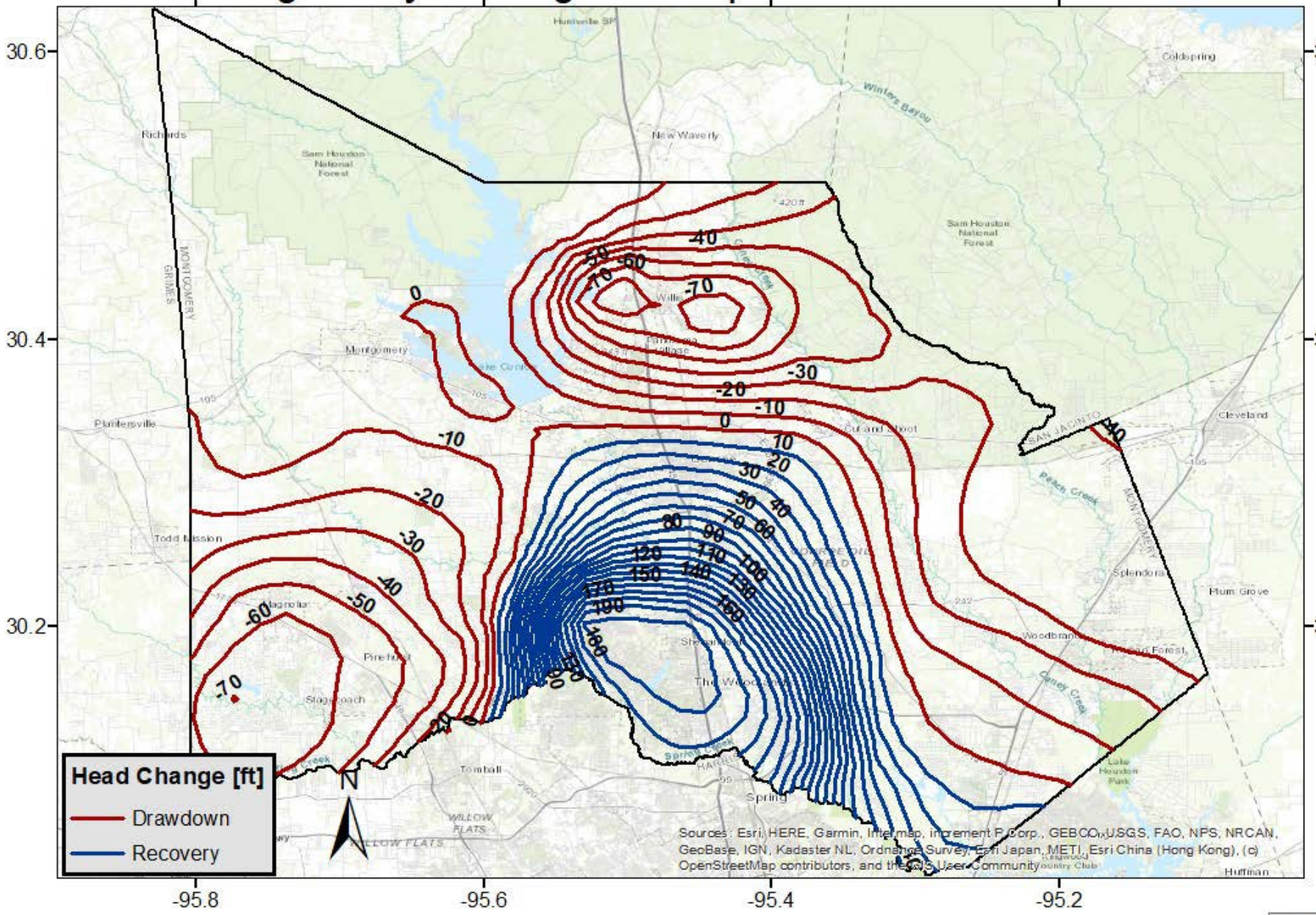
80% remaining drawdown available +
1 foot average additional subsidence
2016 base pumpage

Montgomery: Chicot Aquifer - 80% 1-ft Run



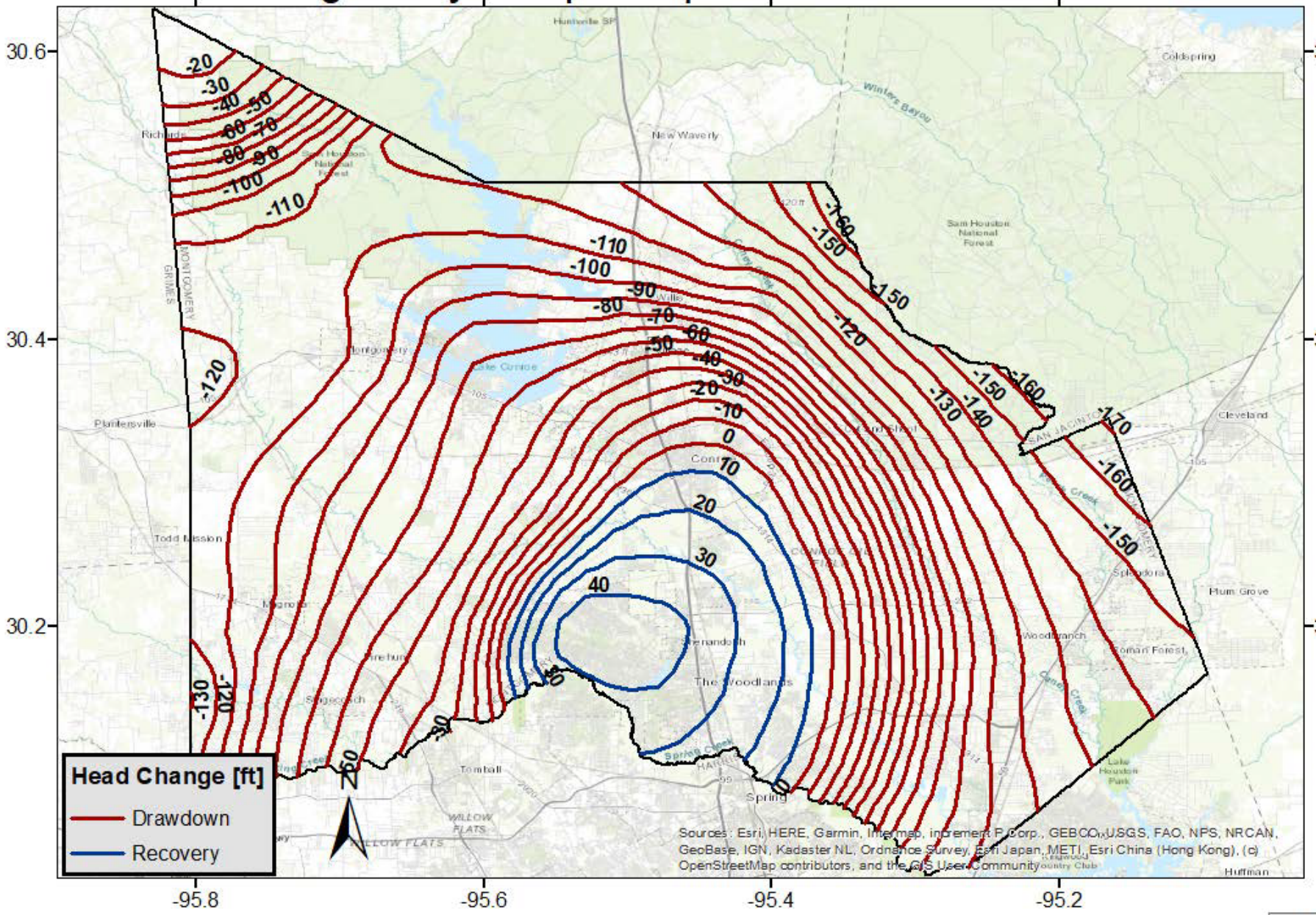
DRAFT

Montgomery: Evangeline Aquifer - 80% 1-ft Run

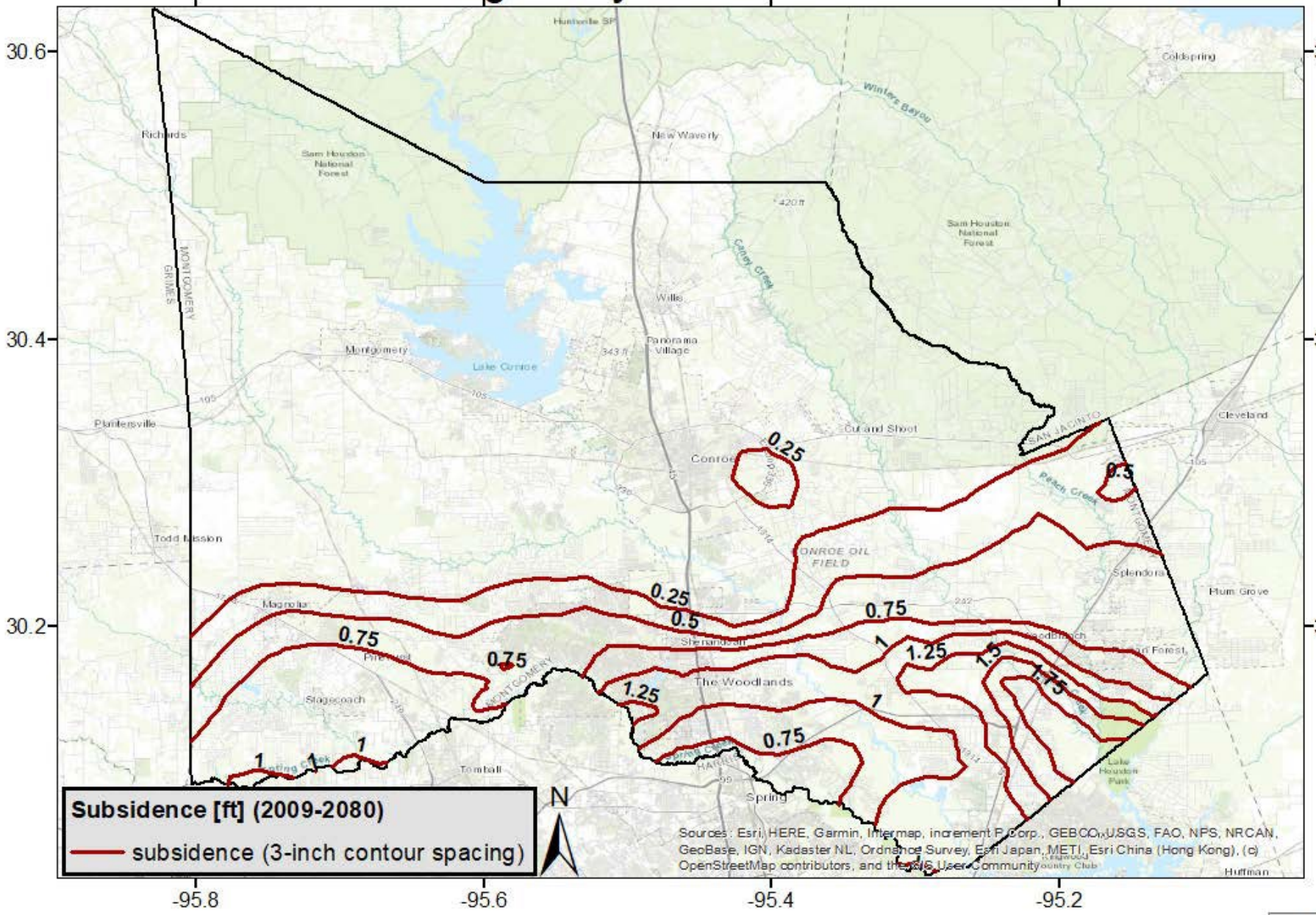


DRAFT

Montgomery: Jasper Aquifer - 80% 1-ft Run



Montgomery: 80% 1-ft Run



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Catahoula Aquifer Issue

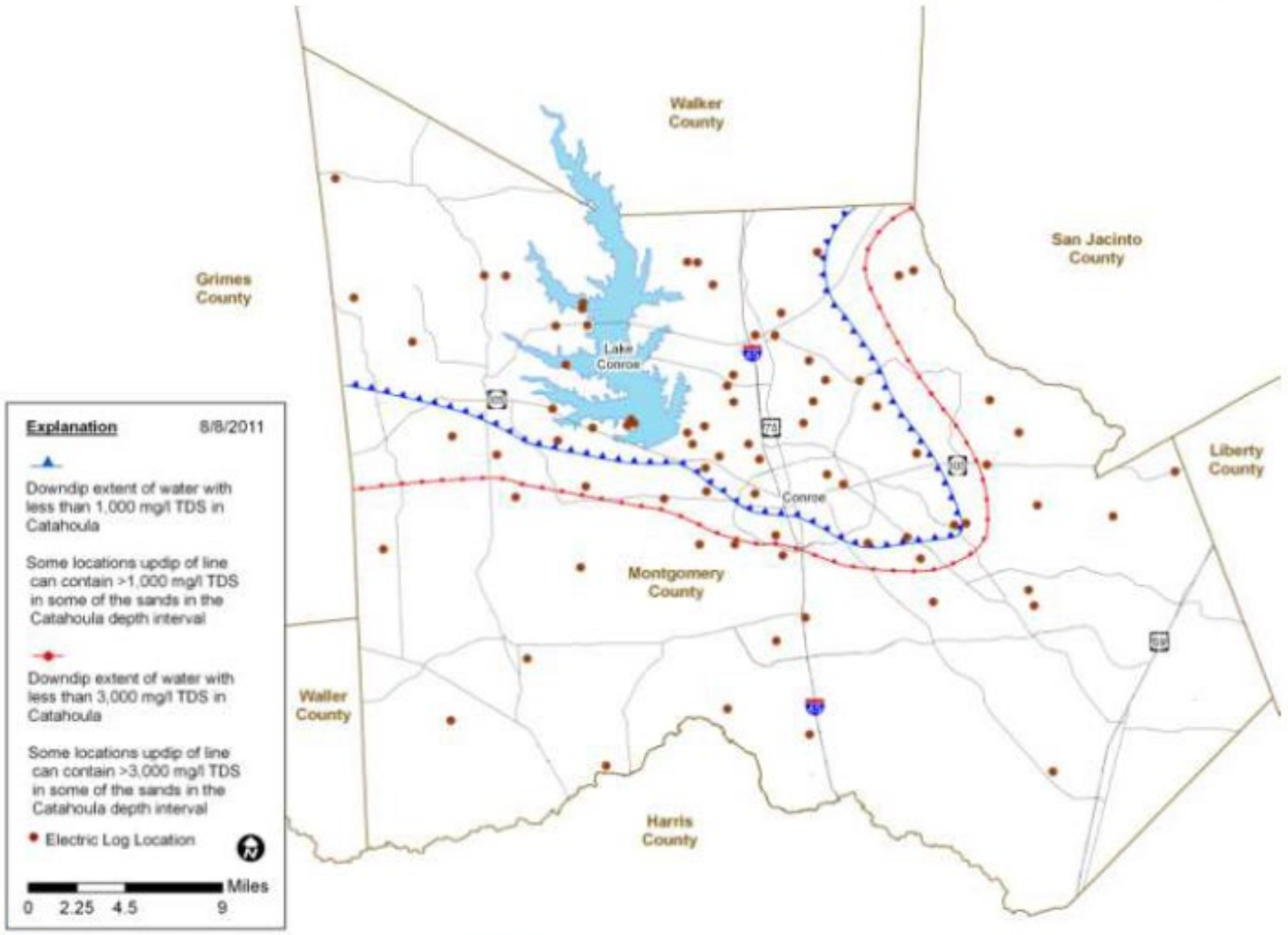
Key Points

- The Catahoula is a deeper aquifer underlying the aquifers primarily used in our area for water supply.

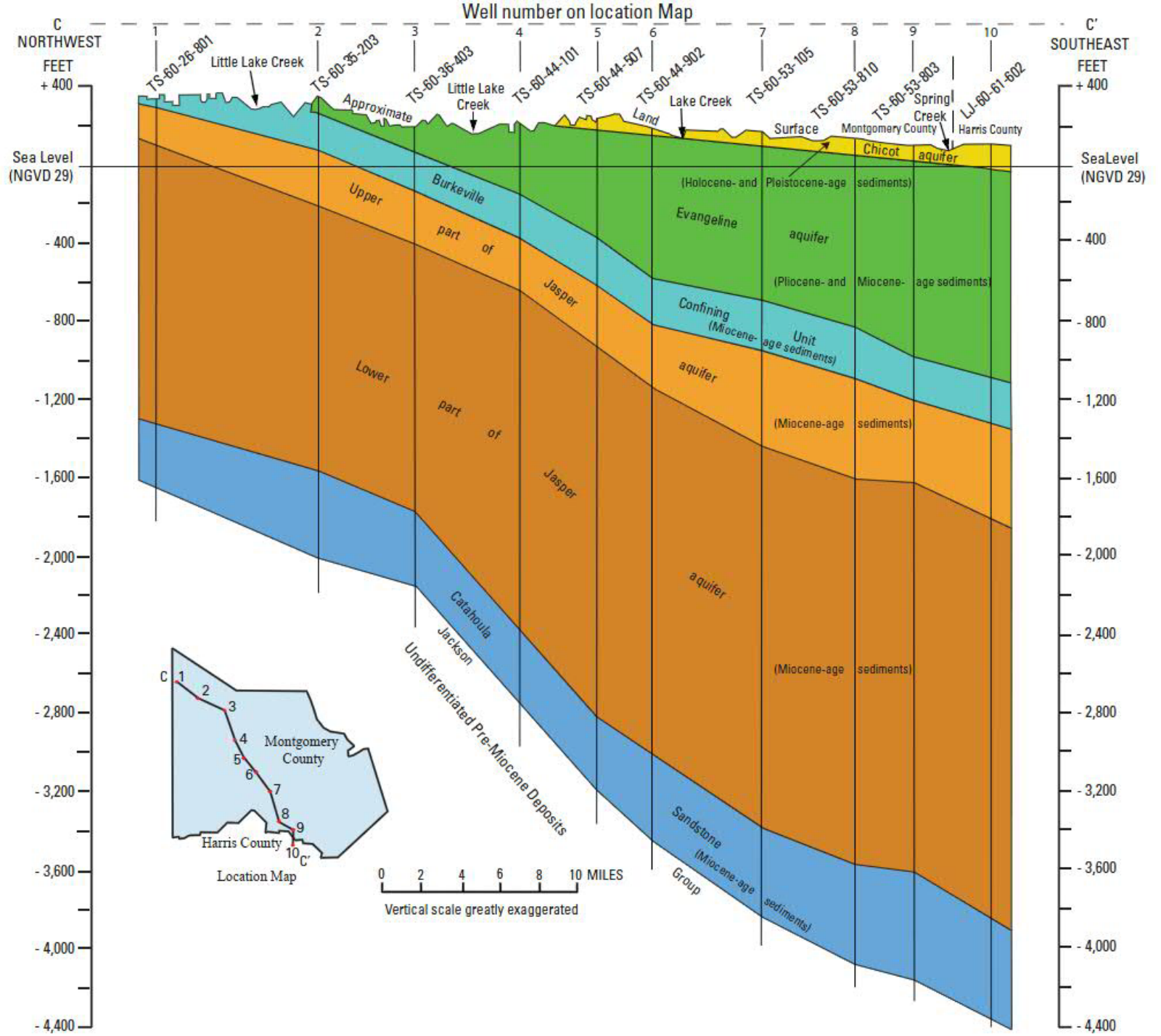
- The majority of the Catahoula is brackish or saline. The only portion of the Catahoula that contains fresh water suitable for drinking without treatment is in the northwest portion of Montgomery County – basically north of SH 105 and west of I-45.

- Utilities are now beginning to utilize the Catahoula, and additional data is being developed regarding how much fresh water it can reliably produce.

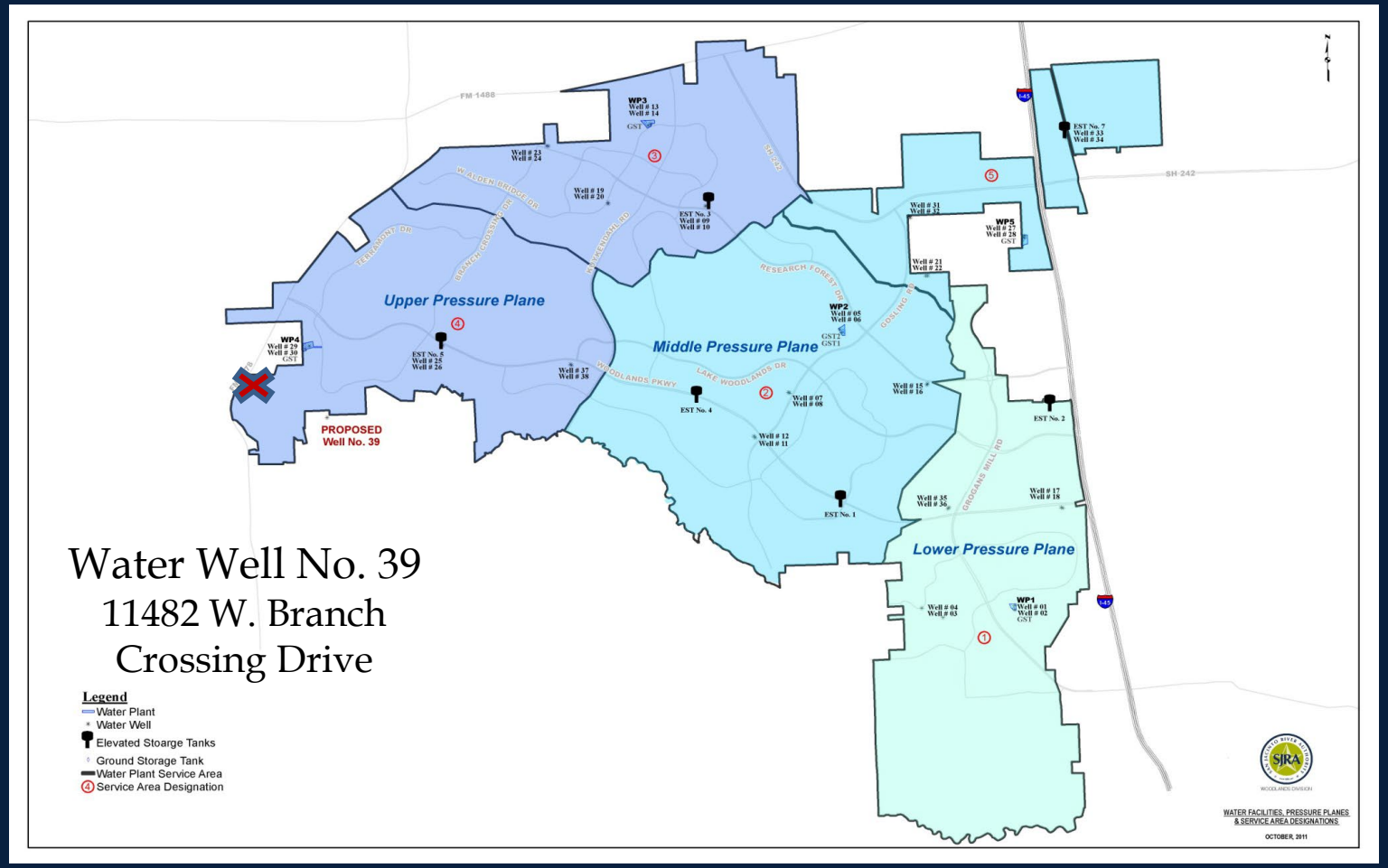
Down-Dip Extent of Freshwater and Slightly Saline Sands Based on Analysis of Geophysical Logs



Preliminary Results Associated with Work in Progress


Well number on location Map
C
NORTHWEST
FEET
+ 400
Sea Level
(NGVD 29)
- 400
- 800
- 1,200
- 1,600
- 2,000
- 2,400
- 2,800
- 3,200
- 3,600
- 4,000
- 4,400
C'
SOUTHEAST
FEET
+ 400
SeaLevel
(NGVD 29)
- 400
- 800
- 1,200
- 1,600
- 2,000
- 2,400
- 2,800
- 3,200
- 3,600
- 4,000
- 4,400
1
2
3
4
5
6
7
8
9
10
TS-60-26-801
Little Lake Creek
TS-60-35-203
TS-60-36-403
Little Lake Creek
TS-60-44-101
TS-60-44-507
TS-60-44-902
Lake Creek
TS-60-53-105
TS-60-53-810
TS-60-53-803
Spring Creek
LJ-60-61-602
Harris County
Montgomery County
Approximate Land Surface
Chicot aquifer
(Holocene- and Pleistocene-age sediments)
Evangeline aquifer
(Pliocene- and Miocene- age sediments)
Upper part of Jasper aquifer
Burkeville Confining Unit
(Miocene-age sediments)
Lower part of Jasper aquifer
(Miocene-age sediments)
Catahoula Sandstone
(Miocene-age sediments)
Jackson Group
Undifferentiated Pre-Miocene Deposits
C
C'
Montgomery County
Harris County
Location Map
0 2 4 6 8 10 MILES
Vertical scale greatly exaggerated

SJRA Well 39


Upper Pressure Plane
Middle Pressure Plane
Lower Pressure Plane
PROPOSED
Well No. 39
Water Well No. 39
11482 W. Branch
Crossing Drive
Legend
Water Plant
Water Well
Elevated Stoarge Tanks
Ground Storage Tank
Water Plant Service Area
Service Area Designation
WATER FACILITIES, PRESSURE PLANES
& SERVICE AREA DESIGNATIONS
OCTOBER, 2011

Well 39 Participants

- SJRA
  - Project management and coordination
- Weisinger Incorporated
  - Constructed well
  - Conducted water sampling and analysis (Envirodyne)
- LBG-Guyton Associates
  - Provided basic construction phase services
  - Reviewed test hole geophysical logs
  - Recommended sands from which to sample
  - Reviewed/interpreted results received to date
- USGS
  - Reviewed test hole geophysical logs
  - Conducted water sampling
  - Conducting water analysis
  - Reviewing/interpreting results
- Thornhill Group, Inc. – third party funded
  - Reviewed plan
  - Observed process/procedures
  - Conducted sampling
  - Reviewed results received to date

Test Hole Boring

Chicot Aquifer

Evangeline Aquifer

Burkeville Confining Unit

Jasper Aquifer

Catahoula Aquifer

Catahoula Aquifer
Base (3900′ depth)

Natural Ground

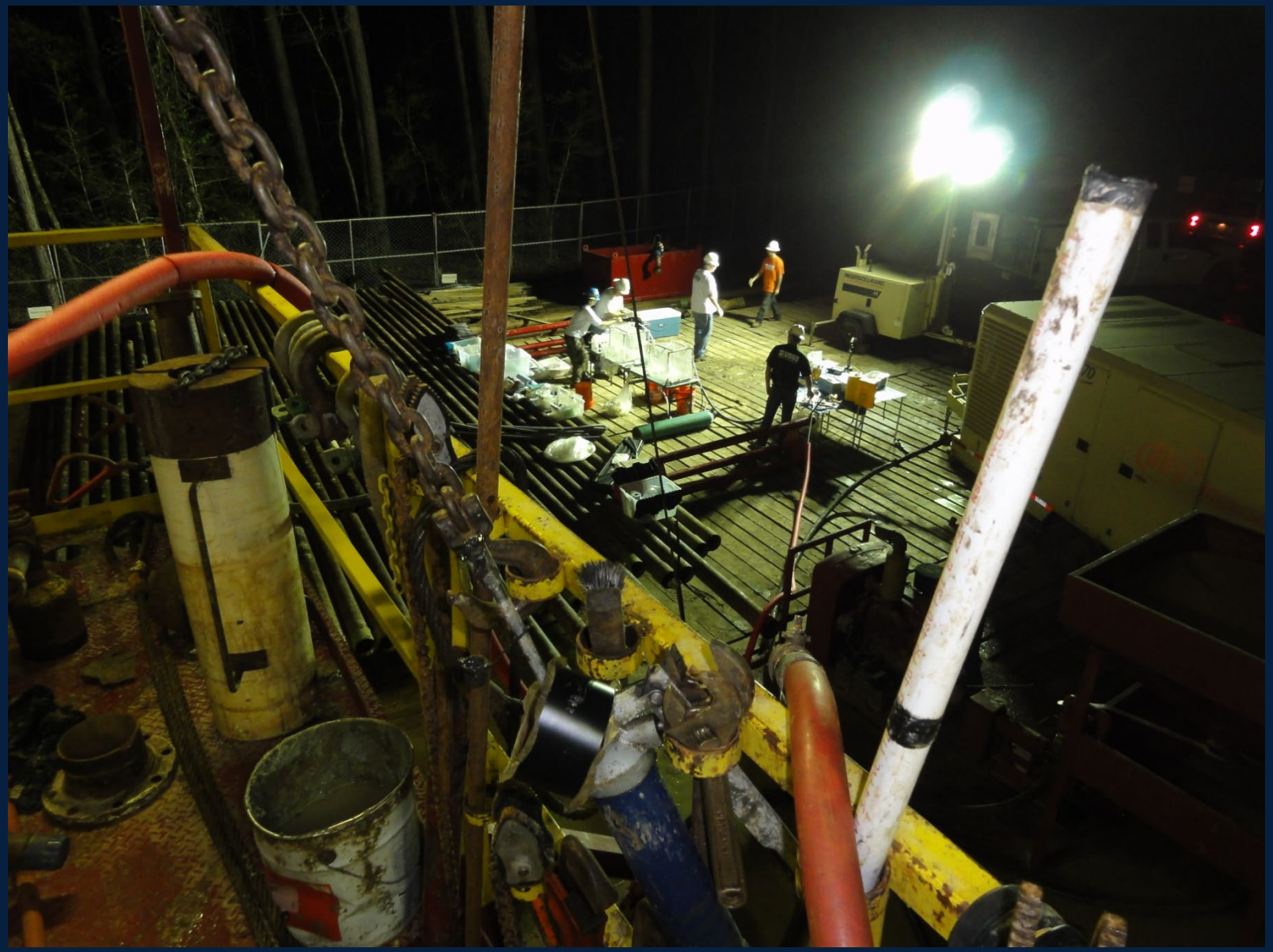
Upper Catahoula Sands
Sampled (2270′ – 2300′ depth)

Lower Catahoula Sands
Sampled (3555′ to 3595′ depth)

Bottom of Boring (4006′ depth)

Test Well Drilling Equipment

USGS Water Sampling Operations
Upper Catahoula Sands (2,270’ – 2,300’)



Field Measurement of 61,499 uS/cm or about 41,000 mg/l TDS from Lower Catahoula Sands (3,555’ – 3,595’)

USGS Field Participation

Well 39 Sample Results

- Lower Catahoula Sands - 3555’ to 3595’ depth
  - Water Temperature 115 – 120° F
  - Significant Methane in water
  - TDS 41,204 mg/l (limit* = 500 mg/l)
  - Chloride 25,000 mg/l (limit* = 250 mg/l)
  - Iron 12.1 mg/l (limit* = 0.3 mg/l)
  - Aluminum 6.080 mg/l (limit* = 0.05 to 0.2 mg/l)
  - Manganese 1.43 mg/l (limit* = 0.05 mg/l)

- Upper Catahoula Sands - 2270’ to 2300’ depth
  - Water Temperature 105° F
  - Methane in water
  - TDS 2,590 mg/l (limit* = 500 mg/l)
  - Chloride 1,060 mg/l (limit* = 250 mg/l
  - Iron 1.53 mg/l (limit* = 0.3 mg/l)
  - Aluminum 0.937 mg/l (limit* = 0.05 to 0.2 mg/l)
  - Manganese 0.102 mg/l (limit* = 0.05 mg/l)

*Secondary Standards

Conroe/Quadvest Lawsuit Issue

Key Points

- Conroe City Council voted in August 2016 to refuse to pay the GRP rate increase proposed by SJRA and unanimously approved by the GRP Review Committee (of which Conroe is a member). Magnolia joined them.

- Conroe's refusal to pay forced SJRA to file suit to enforce the contracts. SJRA is obligated by its bond covenants to enforce the GRP contracts (which are declared under state law to be valid and incontestable).

- In summer 2020, Quadvest and Woodland Oaks (both private, for-profit utilities) entirely stopped paying the approved rates resulting in additional contract enforcement litigation.

Key Points

- Since their initial breach of contract, Conroe and Magnolia have continued to pay the 2016 rates and Quadvest and Woodland Oaks have continued to not pay at all even though the other 76 utilities have paid the full rates.

- The other 76 utilities have been forced to pay higher rates due to nonpayment by Conroe, Magnolia, Quadvest, and Woodland Oaks and due to litigation costs.

Amount in Arrears by Breaching Parties

Actual thru August 2022

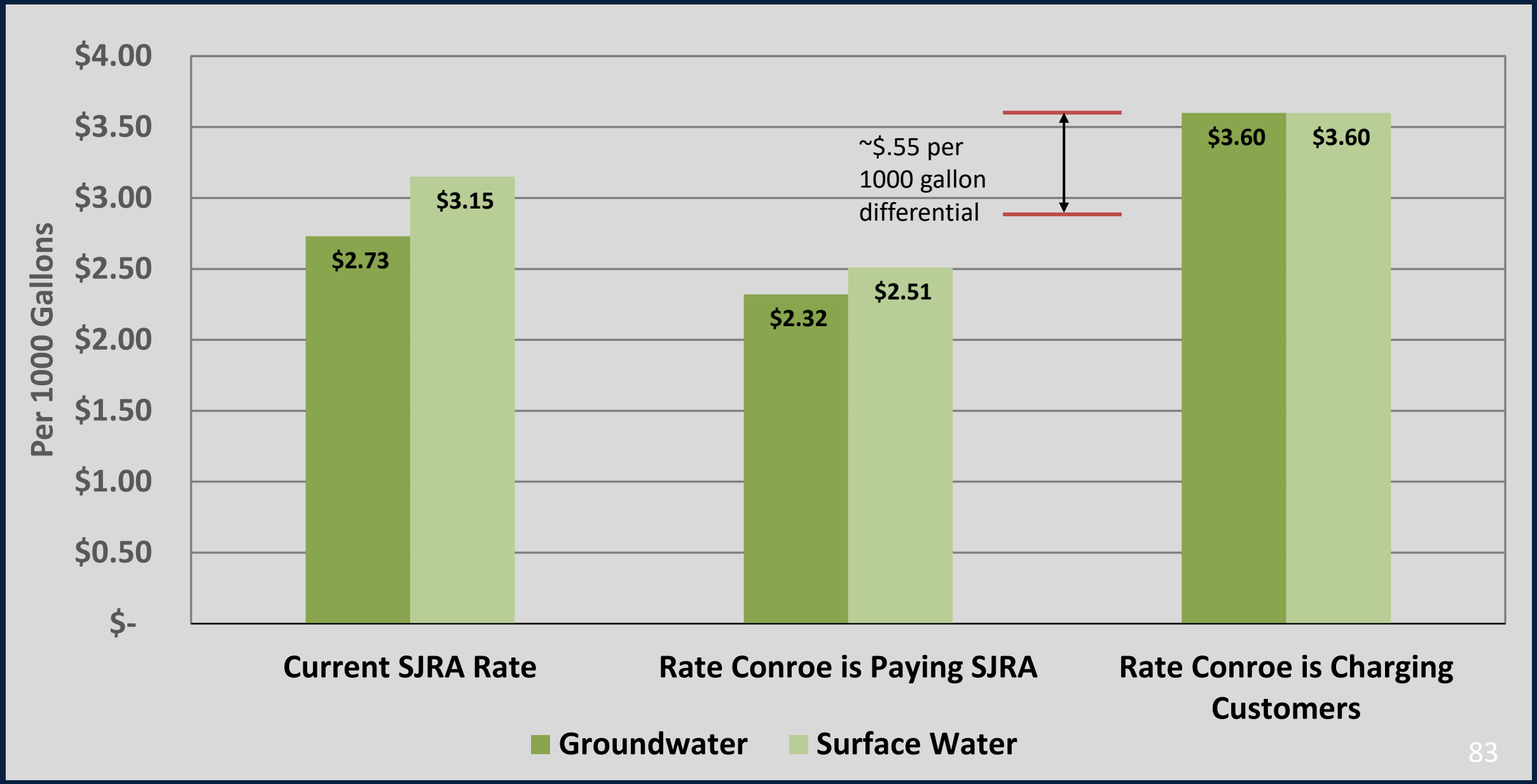
City of Conroe. $14,780,209.81

City of Magnolia . . . . . $ 708,940.91

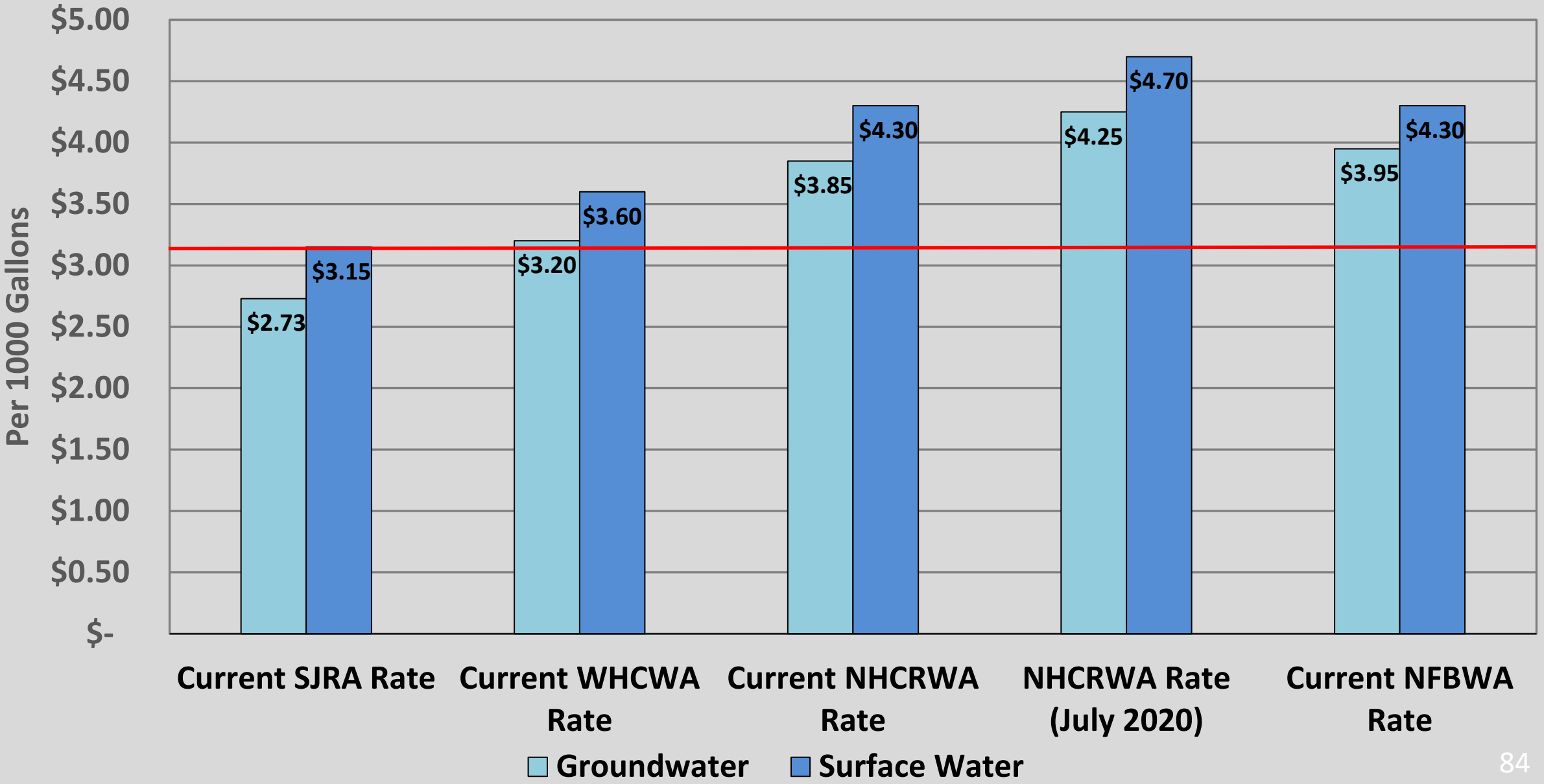
Quadvest, LP $10,208,138.35

Woodland Oaks Utility . . . $ 925,569.08

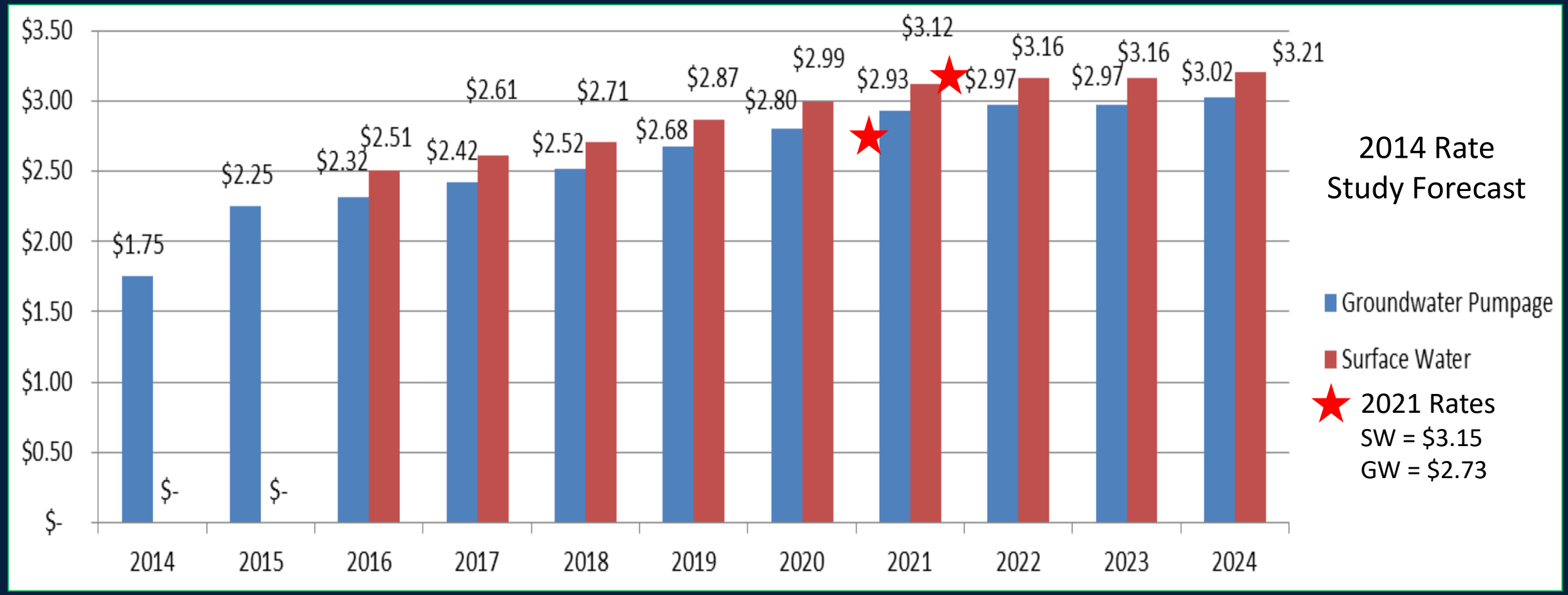
What Conroe is Charging Their Customers vs. What They Are Paying SJRA (2022)



SJRA's Rates Are Lower Than Similar Programs in the Region (2022)

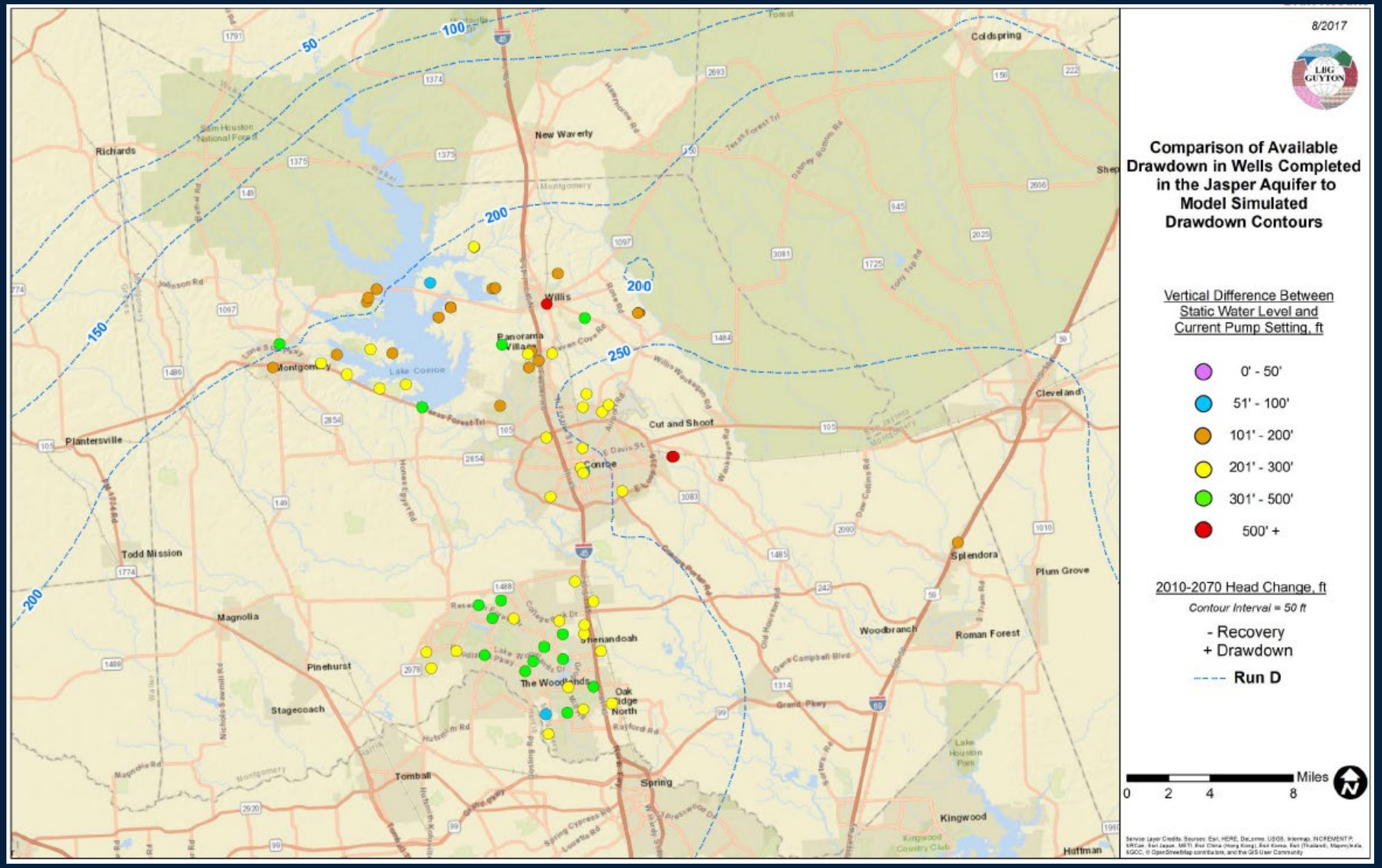


SJRA Provided 10-year Projections of Rates and Has Stayed Very Close to Projections

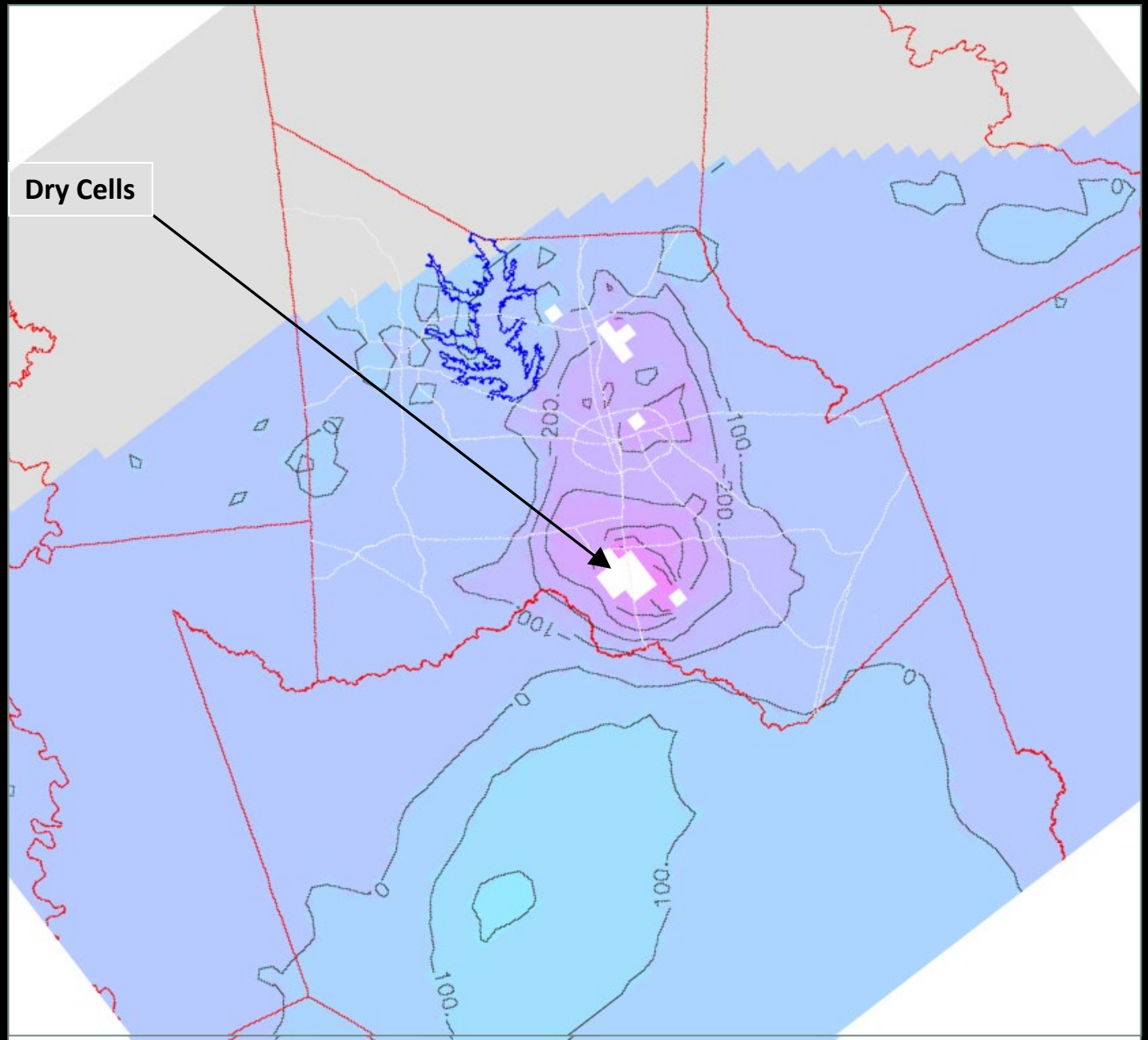


Historical Slides

LSGCD 2017 “Run D” Proposal Results in Additional Groundwater Decline



Drawdown for Evangeline: 10-Year Steps, 2000 to 2050



Drawdown for Jasper: 10-Year Steps, 2000 to 2050