# Red River GCD Board Meeting

October 24, 2019

*Discussion of DFC factors for GMA 8*

# GMA 8 - WSP Team Approach to Presenting Information on Nine Factors

## (Texas Water Code Subsections 36.108(d)(1-9))

- Factor presentations – Three GMA 8 Meetings (November 2019, February 2020, and May 2020)
- Focused discussion on factors during each meeting
- Factor presentation content to be reflective of explanatory report content
- Re-visit factor discussions as needed when various GAM runs, or DFC statements considered

# GMA 8 Schedule to Discuss Nine Factors

| November 2019 | | |
|---|---|---|
| Environmental Impacts | Subsidence Impacts | Hydrological Conditions |
| **February 2020** | | |
| Aquifer Uses or Conditions | Supply Needs & Management Strategies | Private Property Rights |
| **May 2020** | | |
| Socioeconomic Impacts | DFC Feasibility | Other Relevant Information |

# Three factors to be discussed at Nov 22 GMA 8 meeting

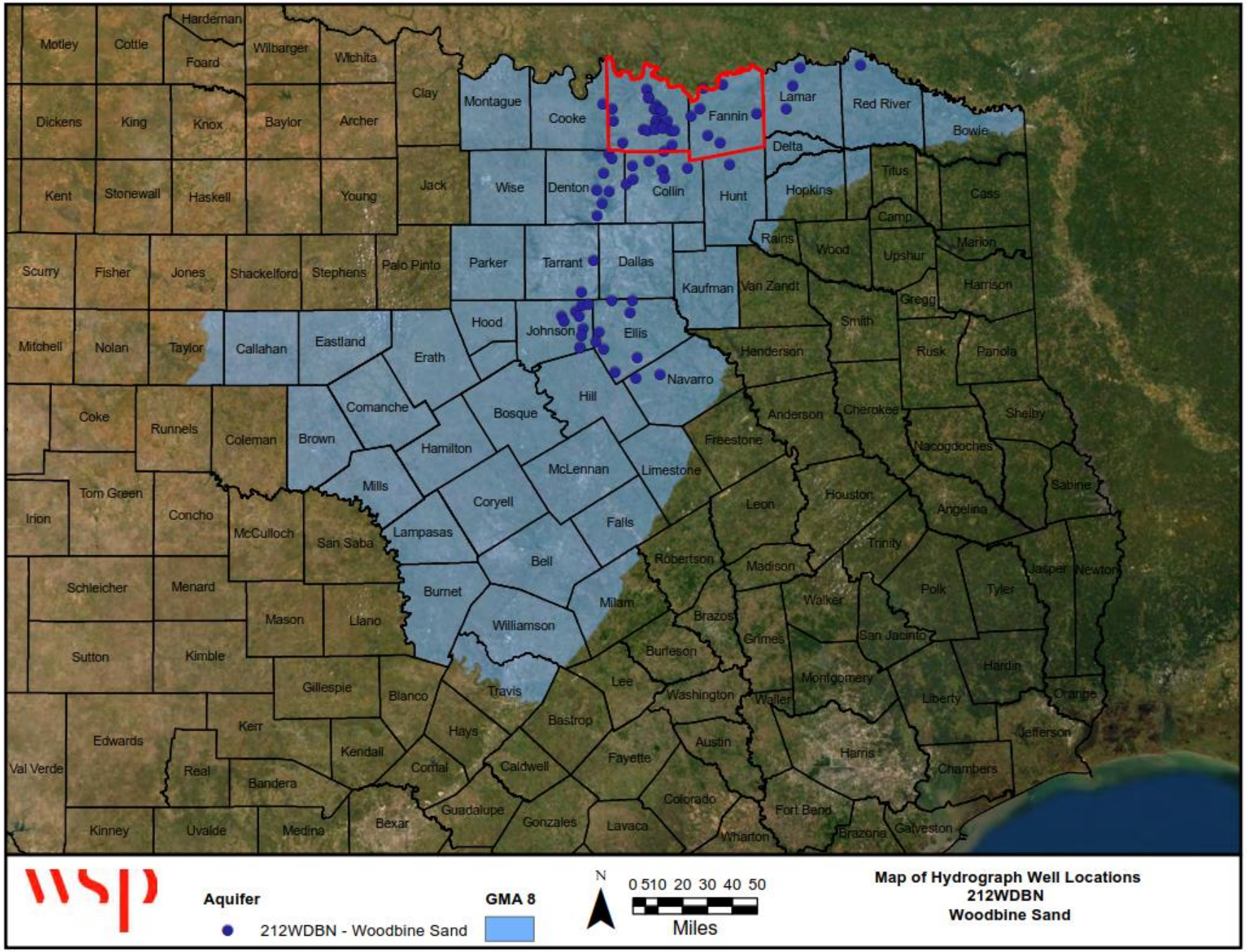
1. Hydrological Conditions
2. Subsidence
3. Environmental Impacts

# Hydrological Conditions Summary: Water Level Data

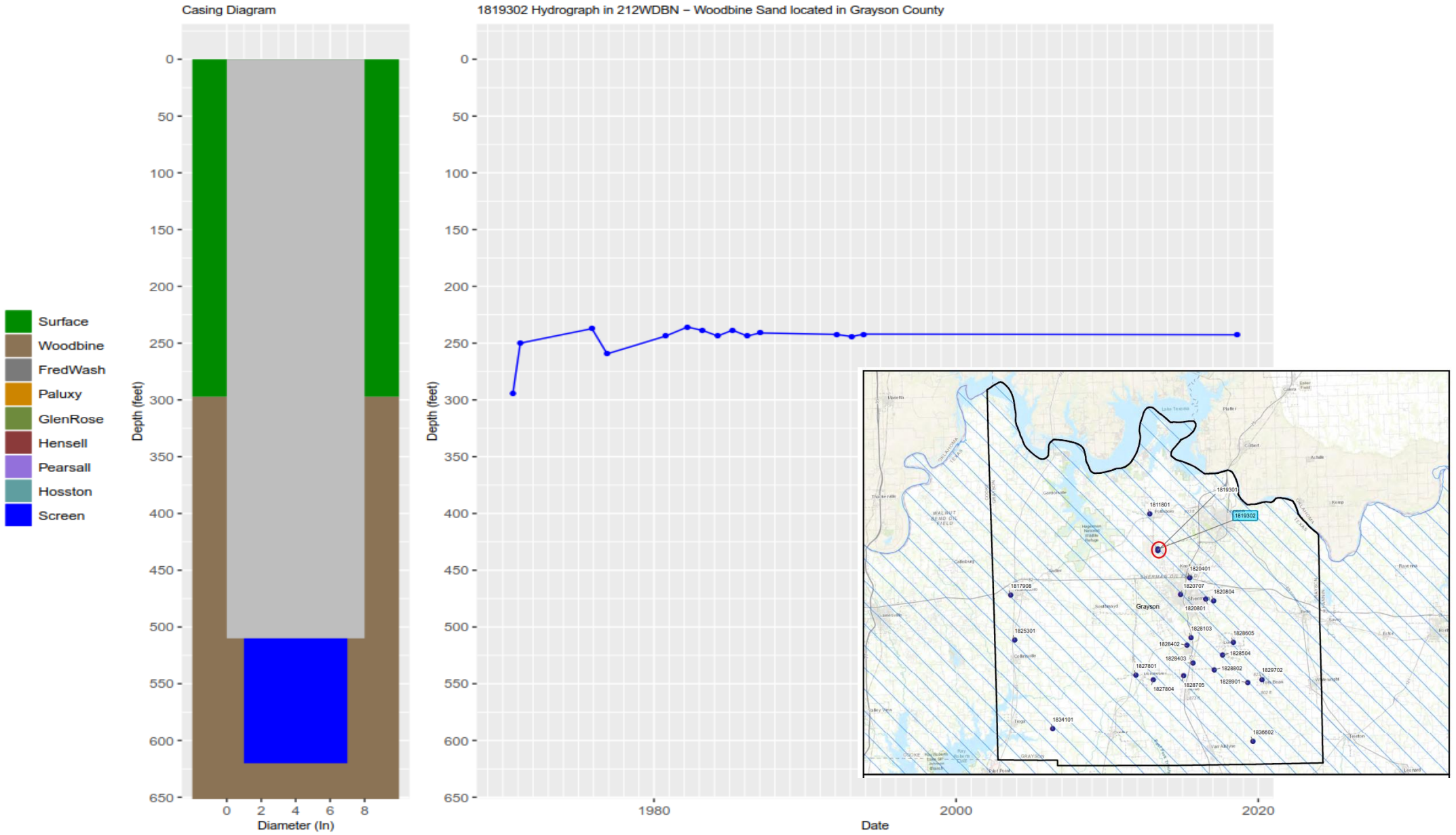
- TWDB GWDB water level data
- Define relevant **TWDB** aquifer codes
- Count measurements and throw out null values.
  - *Wells with less than 3 measurements; and*
  - *Wells that do not have a measurement since 2000*
- Selection criteria reduced well locations with water levels from 8,461 to 627 wells used for mapping/hydrographs

# WOODBINE AQUIFER WELLS WITH HYDROGRAPHS





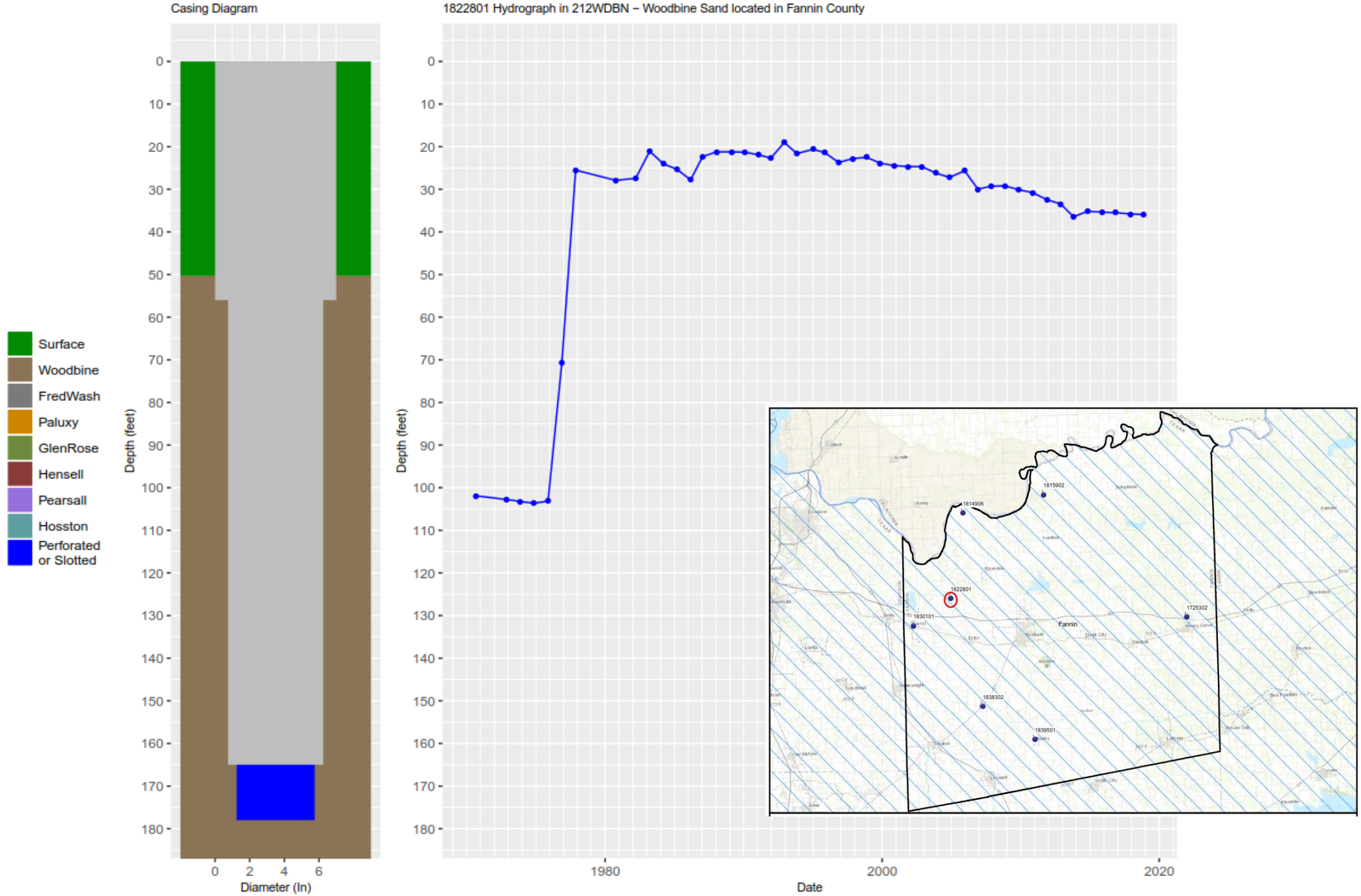
# WOODBINE AQUIFER HYDROGRAPH




The Aquifer layers shown in the casing diagram were developed using the NTWGAM. In certain cases, assumptions used to develop the NTWGAM can cause well casing and screen intervals to not align well with modeled aquifer layers.

# WOODBINE AQUIFER HYDROGRAPH






The Aquifer layers shown in the casing diagram were developed using the NTWGAM. In certain cases, assumptions used to develop the NTWGAM can cause well casing and screen intervals to not align well with modeled aquifer layers.

# TWDB Subsidence Tool- What Is It?

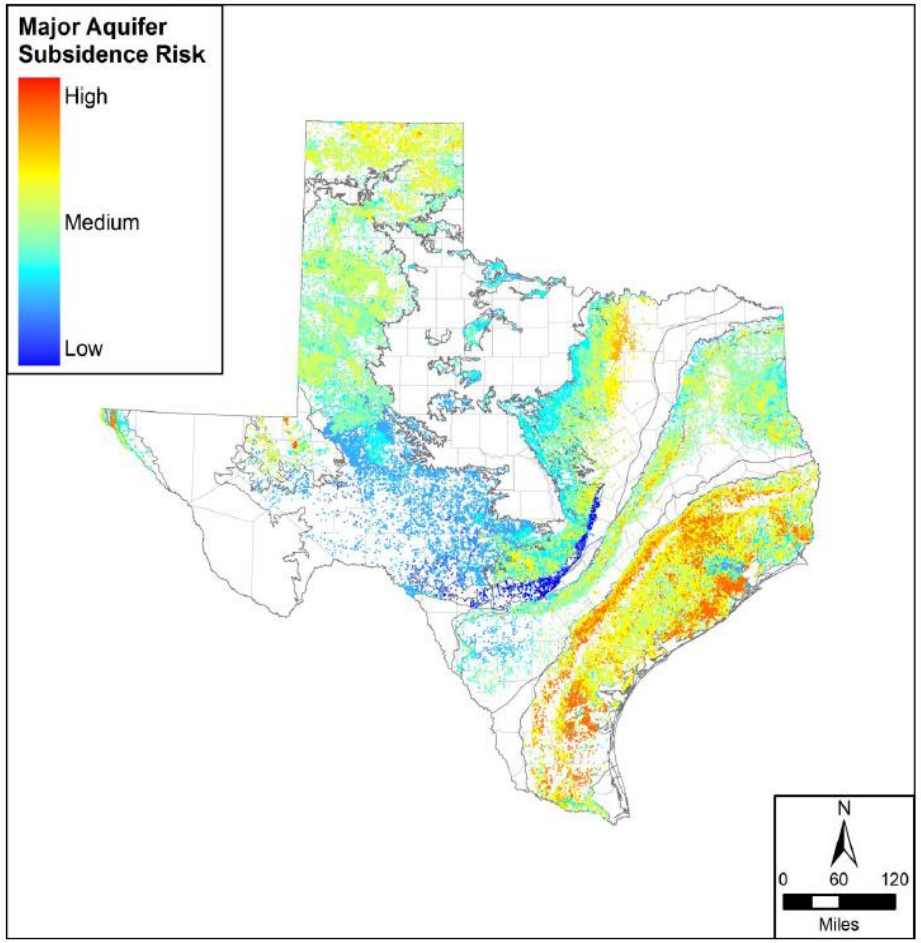
- Developed in 2017
- Helps GCDs identify risk subsidence due to groundwater pumping
- Capable in identifying risk subsidence in all major/minor aquifers in Texas

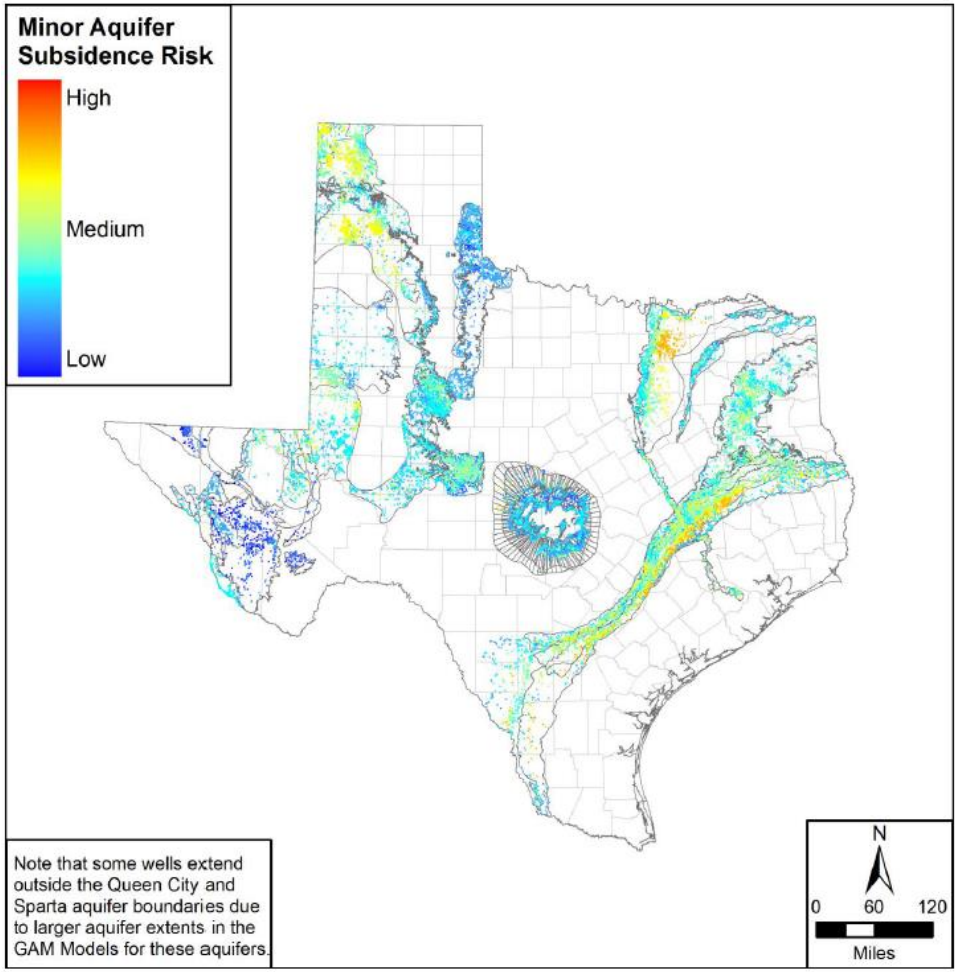
# Subsidence

- How Is Subsidence Estimated?
  - *Saturated thickness and extent of clay*
  - *Clay compressibility*
  - *Aquifer lithology*
  - *Pre-consolidation characterization*
  - *Predicted DFC water level decline*

# Visualizing the Subsidence Risk

- 340,000 wells statewide
- “High Risk” include Yegua Jackson and Gulf Coast
- “Low Risk” include igneous and Edwards aquifers
- *The only common characteristic shared by all “High Risk” aquifers is that they all have unconsolidated clastic aquifers*

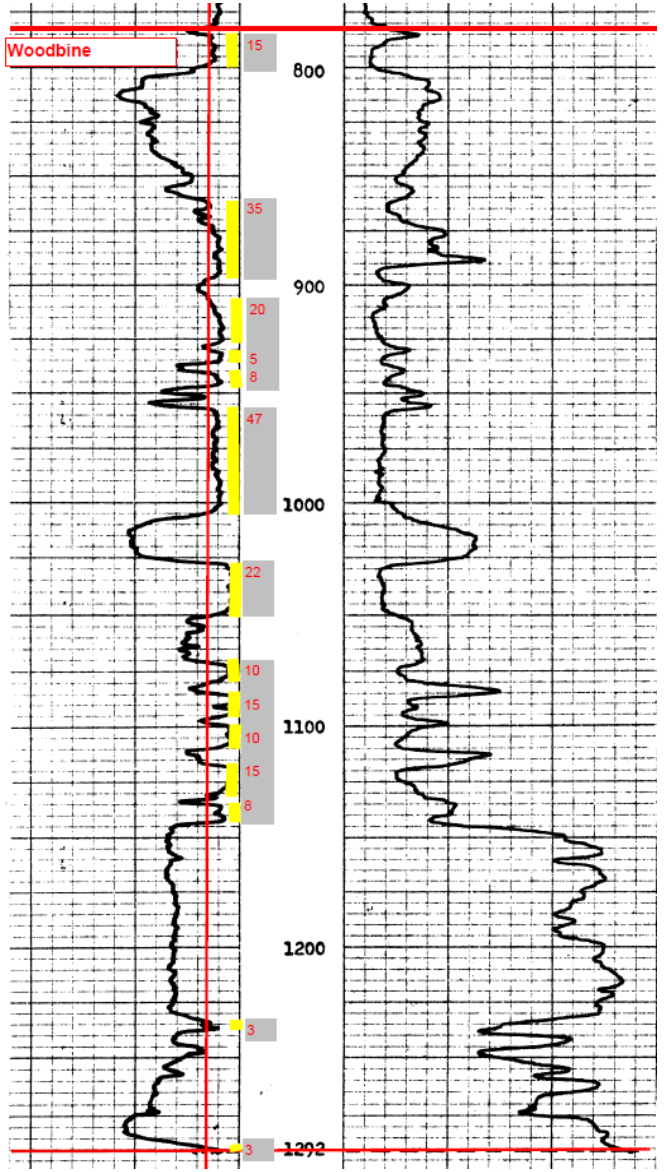


# The Localized Evaluation Process

1. Identify the downdip area
2. Find 2-3 TWBD or GCD wells that meet available data criteria
3. Analyze logs to determine aquifer thickness and clay thickness
4. Calculate the risk using the tool

**City of Randolph 18-38-302**
**Clay thickness = 216 feet**



# Subsidence Calculations

| | |
|---|---|
| **Aquifer** | **Woodbine** |
| **Report Generated by** | A. Feigenbaum |
| **Report Date** | 9/5/2010 |
| **Well Name** | City of Randolph #18-38-302 |
| **Water Levels to Use for Predictions** | Base and Future |

| **Location and Water Level Based User Input** | **User Input Values** | **Units** |
|---|---|---|
| Land Surface (feet MSL) | 668 | feet |
| Aquifer Top (feet MSL) | -582 | feet |
| Aquifer Thickness | 510 | feet |
| Clay Thickness within Aquifer | 216 | feet |
| Groundwater Temperature | 33 | Degrees Celsius |
| Groundwater Total Dissolved Solids (TDS) | 741 | mg/l |
| Predevelopment Water Level (feet MSL) | 368 | feet |
| Current Water Level (feet MSL) | 180 | feet |
| Unsaturated Thickness | 180 | feet |
| Preconsolidation (deepest) Water Level (feet MSL) | 132 | feet |
| Base Water Level (feet MSL) | 183 | feet |
| Future Water Level (feet MSL) | -64 | feet |
| Beginning Year for Subsidence Evaluation | 2010 | year |
| Ending Year for Subsidence Evaluation | 2070 | year |

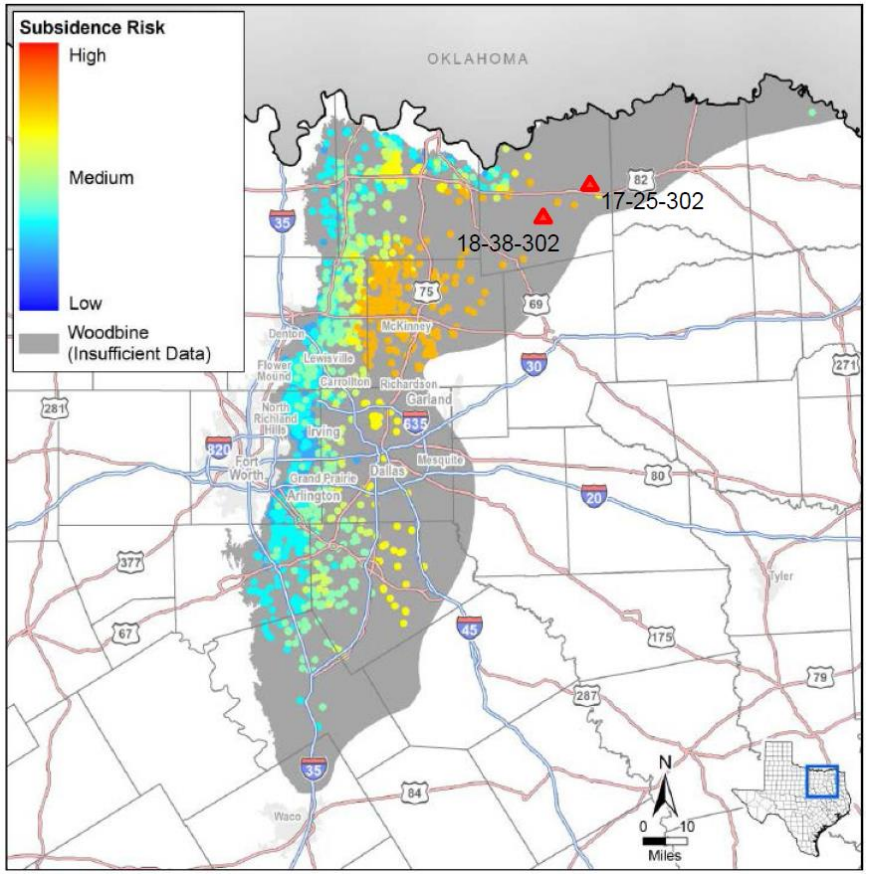
# Subsidence Risk Results

Note that this sheet estimates subsidence as described in *Identification of the Vulnerability of the Major and Minor Aquifers of Texas to Subsidence with Regard to Groundwater Pumping* (TWDB Contract Number 1648302062). Estimates provided by this tool are approximate and actual subsidence may vary significantly from the estimates provided by this tool. In addition, time delay of subsidence is not included in the calculation.

| **Aquifer Subsidence Calculations based on overall aquifer information and user supplied input values** | | **Units** |
|---|---|---|
| Water Level Trend | -4.11 | ft/year; negative for decline |
| Predominant Aquifer Lithology | Consolidated Clastic | Description |
| Aquifer Storage Coefficient | 1E-04 | Dimensionless |
| Aquifer Porosity | 25 | Percent |
| Predominant Aquifer Clay Type | Hard Clay | Type |
| Aquifer Clay Porosity | 50 | Percent |
| Minimum Aquifer Compressibility | 8.96E-05 | $psi^{-1}$ |
| Maximum Aquifer Compressibility | 1.38E-04 | $psi^{-1}$ |
| Minimum Clay Compressibility | 4.76E-04 | $psi^{-1}$ |
| Maximum Clay Compressibility | 8.96E-04 | $psi^{-1}$ |
| Minimum Elastic Specific Storage ($S_{ske}$) | 4.56E-07 | $ft^{-1}$ |
| Maximum Elastic Specific Storage ($S_{ske}$) | 8.26E-07 | $ft^{-1}$ |
| Minimum Inelastic Specific Storage ($S_{skv}$) | 4.56E-05 | $ft^{-1}$ |
| Maximum Inelastic Specific Storage ($S_{skv}$) | 8.26E-05 | $ft^{-1}$ |
| **Total Weighted Risk for Well 0 (low risk) to 10 (high risk)** | **6.41** | |

# Evaluation: Red River GCD

| Well Owner | State Well ID | Aquifer Thickness (feet) | Clay Thickness (feet) | **Subsidence Risk Score** | Minimum Subsidence (feet) | Maximum Subsidence (feet) |
|---|---|---|---|---|---|---|
| City of Honey Grove | 17-25-302 | 410 | 254 | **5.63** | 0.17 | 0.31 |
| City of Randolph | 18-38-302 | 510 | 216 | **6.41** | 0.65 | 1.17 |

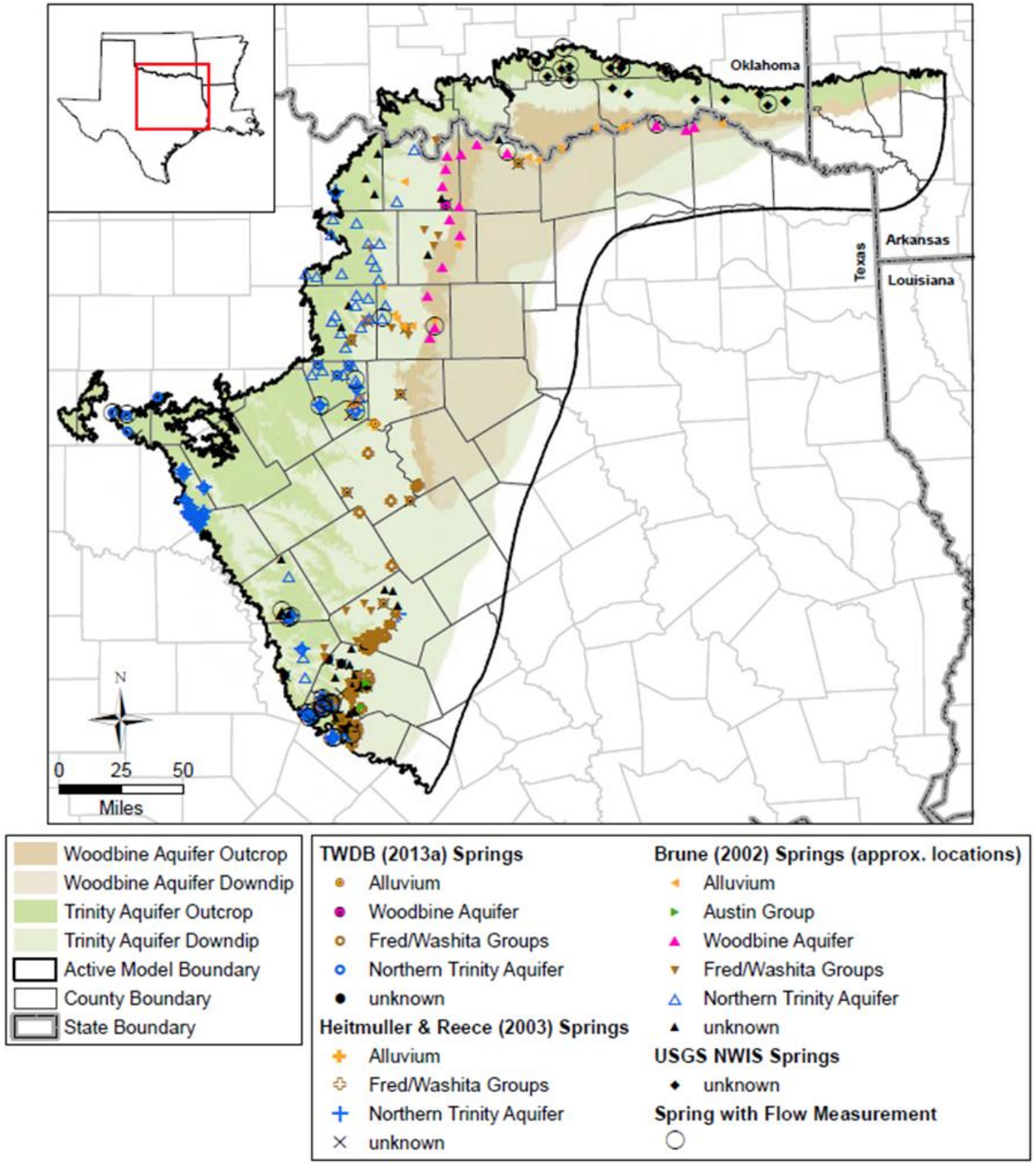


# Red River GCD Results

- Woodbine Aquifer has a subsidence risk score of 4.5
- The 2 wells used in our study have risk scores from 5.63 to 6.41
  - *These are downdip wells characteristic of worst case scenario*
- Clay thicknesses range from 216-254 feet
- Aquifer thicknesses range from 410-510 feet

Conclusion: The calculated risk values align reasonably well with the subsidence report, indicative of a medium subsidence risk.

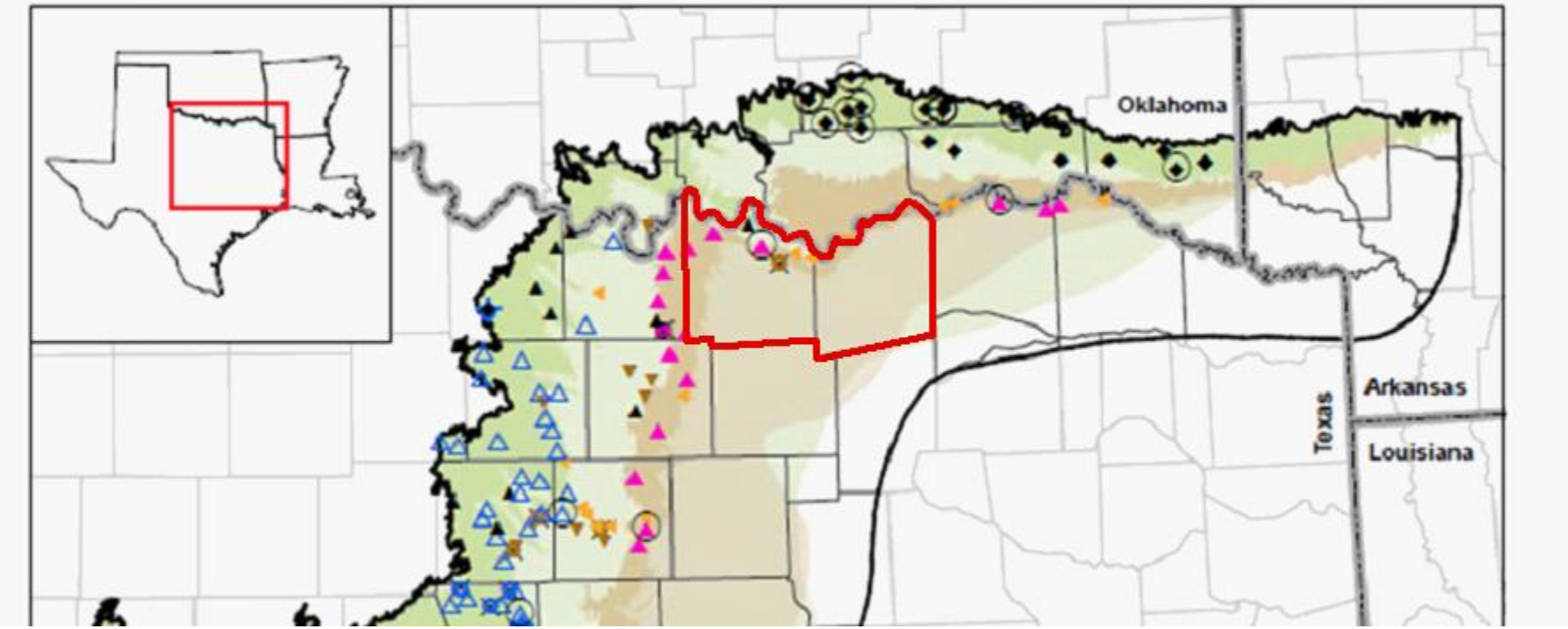
# Environmental Impacts: Spring Locations



# Environmental Impacts: Spring Discharge and Streamflow

- Southern portion of GMA 8 has the greatest density of springs.
- Most are in the Washita/Fredericksburg, which includes Edwards BFZ.
- Many located in far western extent of GMA 8.
- Springs flow when the water level elevation of the aquifer is higher than the spring elevation.
- Water level declines reduce spring flow.

# Environmental Impacts: Spring Locations




- Woodbine Aquifer Outcrop
- Woodbine Aquifer Downdip
- Trinity Aquifer Outcrop
- Trinity Aquifer Downdip
- Active Model Boundary
- County Boundary
- State Boundary

**TWDB (2013a) Springs**
- Alluvium
- Woodbine Aquifer
- Fred/Washita Groups
- Northern Trinity Aquifer
- unknown

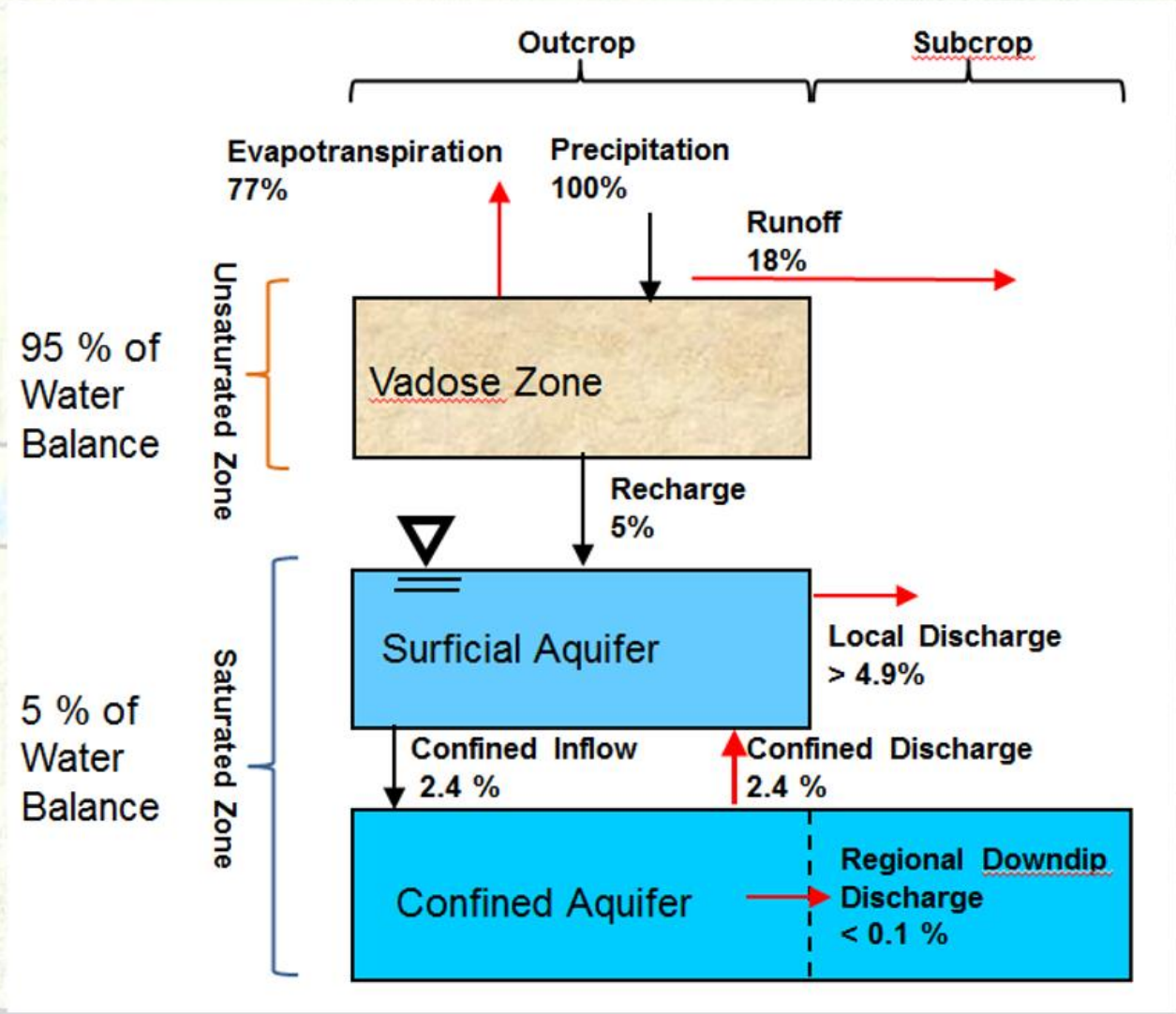
**Heitmuller & Reece (2003) Springs**
- Alluvium
- Fred/Washita Groups
- Northern Trinity Aquifer
- unknown

**Brune (2002) Springs (approx. locations)**
- Alluvium
- Austin Group
- Woodbine Aquifer
- Fred/Washita Groups
- Northern Trinity Aquifer
- unknown

**USGS NWIS Springs**
- unknown

**Spring with Flow Measurement**

# Conceptual Total Water Balance

# Environmental Impacts Summary

- Includes impacts to spring flow and to surface water-groundwater interaction.
- Water budgets from Run 10 in existing ER indicate reduced spring flows and baseflows where DFCs include drawdowns in aquifer outcrop areas.
- Examples of water budgets include:
  - *Fannin Woodbine because the water budget has ephemeral and perennial flows; and*
  - *Grayson Woodbine because the water budget has ephemeral flows.*

# Environmental Impacts:
# ER Run 10 Water Budget Examples

| NTGCD Run 10 - Fannin County - Woodbine Aquifer | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Lateral Flow | -6,947 | -6,922 | -6,846 | -6,795 | -6,716 | -6,469 | -6,470 |
| Leakage (Above) | -313 | -273 | -239 | -210 | -186 | -157 | -145 |
| Leakage (Below) | -893 | -860 | -830 | -798 | -759 | -702 | -662 |
| Recharge | 28,791 | 28,791 | 28,791 | 28,791 | 28,791 | 23,974 | 28,791 |
| Perennial | -10,849 | -10,735 | -10,595 | -10,474 | -10,366 | -9,727 | -10,073 |
| Ephemeral | -6,625 | -6,477 | -6,336 | -6,213 | -6,103 | -5,837 | -5,835 |
| Evapotransipration | -2,321 | -2,313 | -2,303 | -2,295 | -2,288 | -2,249 | -2,270 |
| Springs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reservoir | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| Wells | -4,924 | -4,924 | -4,924 | -4,924 | -4,924 | -4,924 | -4,924 |
| Flowing | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage | 3,995 | 3,625 | 3,196 | 2,831 | 2,464 | 6,003 | 1,500 |
| Total | 0 | 0 | 0 | 0 | 0 | -1 | -1 |

12% Decline

| NTGCD Run 10 - Grayson County - Woodbine Aquifer | | | | | | | |
|---|---|---|---|---|---|---|---|
| Component | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 |
| Lateral Flow | 402 | 158 | 87 | 51 | -1 | -57 | -106 |
| Leakage (Above) | 300 | 438 | 521 | 580 | 625 | 667 | 692 |
| Leakage (Below) | -1,505 | -1,445 | -1,440 | -1,433 | -1,420 | -1,403 | -1,389 |
| Recharge | 34,912 | 34,912 | 34,912 | 34,912 | 34,912 | 24,960 | 34,912 |
| Perennial | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ephemeral | -29,943 | -29,238 | -28,559 | -27,985 | -27,492 | -25,954 | -26,218 |
| Evapotransipration | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Springs | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reservoir | -1,629 | -1,605 | -1,587 | -1,573 | -1,562 | -1,543 | -1,537 |
| Wells | -7,526 | -7,526 | -7,526 | -7,526 | -7,526 | -7,526 | -7,526 |
| Flowing | -882 | -865 | -852 | -842 | -835 | -821 | -817 |
| Storage | 5,891 | 5,190 | 4,462 | 3,832 | 3,314 | 11,690 | 2,002 |
| Total | 19 | 18 | 17 | 16 | 14 | 13 | 12 |

12.5% Decline

# Thank you!

wsp.com

# Subsidence: Using the Tool

- Tool requires a geophysical log, adequate water level data, water quality data, and the DFC
- The log is used to determine aquifer top, bottom, thickness, and clay thickness in the *aquifer*, not in the portion of the aquifer, and not from surface to TD
- Ideally, a predevelopment water level, a 2010 water level, and a current water level is available
- Current GCD or TWDB observation wells are the best candidates.

# WSP Team Approach to Preparing the Explanatory Report
## (Texas Water Code Section 36.108(d-3))

- Use GMA 8 second round of DFC joint planning ER as starting point
- Update ER discussion and appendices as needed
- WSP Team presents and reviews 1st ER draft – August 2020
- GMA 8 considers ER approval – November 2020

# Key Factors Impacting Subsidence

1. Clay layer distribution, thickness, & compressibility
2. Amount and timing of water level changes
3. Lowest historical water level

# Agenda Item 9

- Update and possible action regarding the process for the development of Desired Future Conditions (DFCs).
  - *Presentation, discussion and possible action on development of Desired Future Conditions and Modeled Available Groundwater numbers for submission to Groundwater Management Area 8 for the current joint planning cycle*