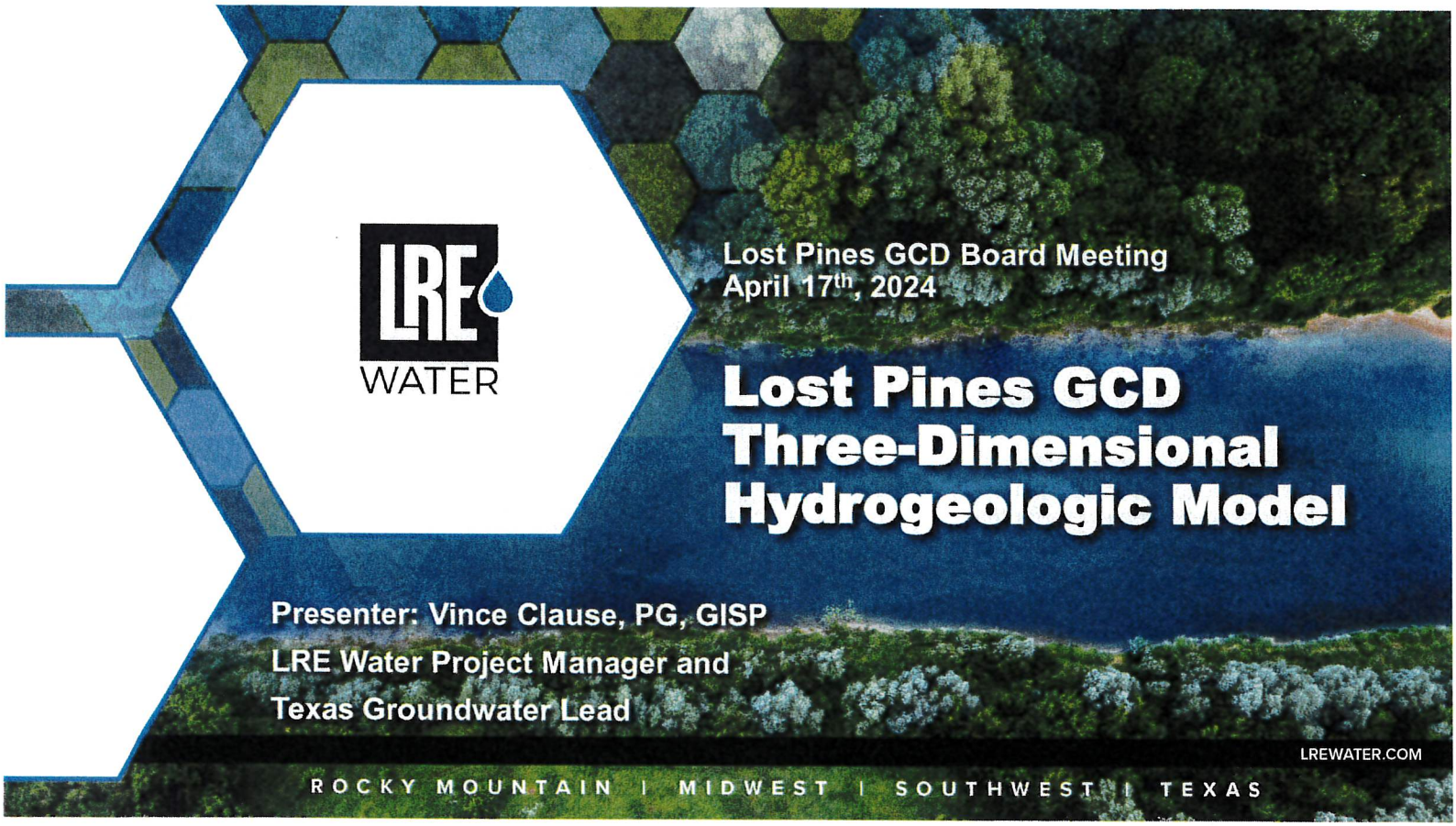

LRE WATER
Lost Pines GCD Board Meeting
April 17th, 2024
Lost Pines GCD
Three-Dimensional
Hydrogeologic Model
Presenter: Vince Clause, PG, GISP
LRE Water Project Manager and
Texas Groundwater Lead
LREWATER.COM
ROCKY MOUNTAIN | MIDWEST | SOUTHWEST | TEXAS

Project Background

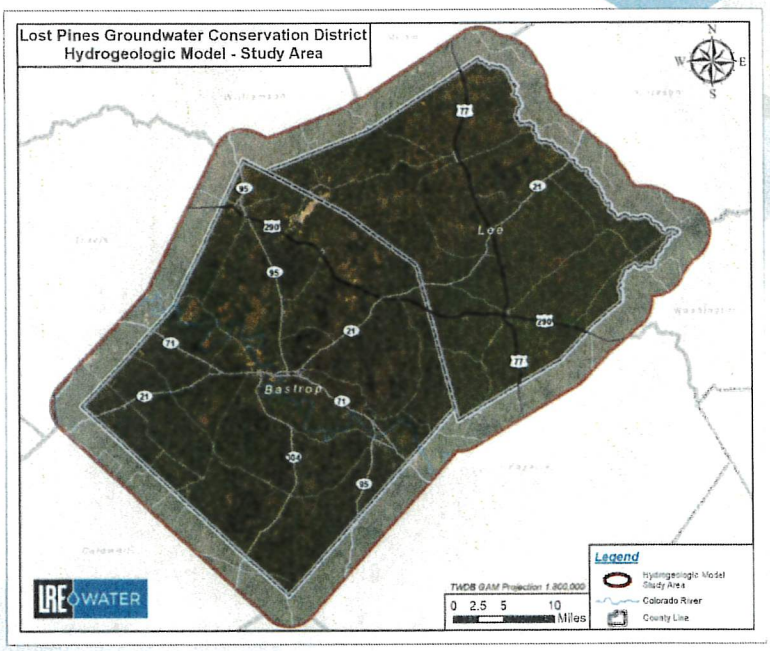
Aims to integrate, build upon and ultimately enhance existing regional datasets with new hydrogeologic data.

Specifically, this work:

- Included a detailed stratigraphic analysis
- Uses innovative 3D modeling techniques to better define the hydrogeologic framework for the LPGCD.

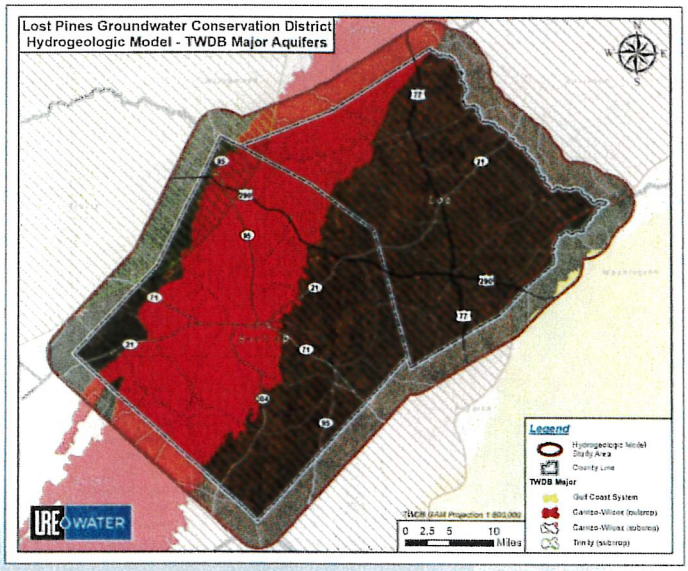
Study Area: Bastrop and Lee counties

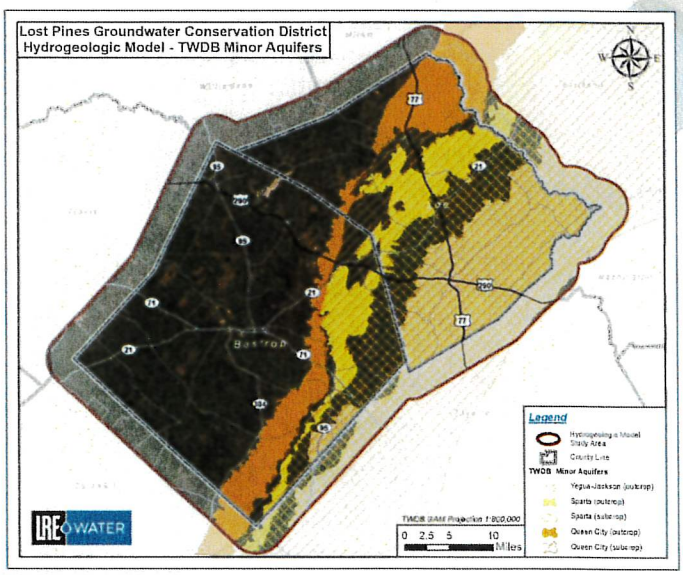
- 3-Mile Buffer into surrounding counties



LRE WATER

Study Area
TWDB Major And Minor Aquifers

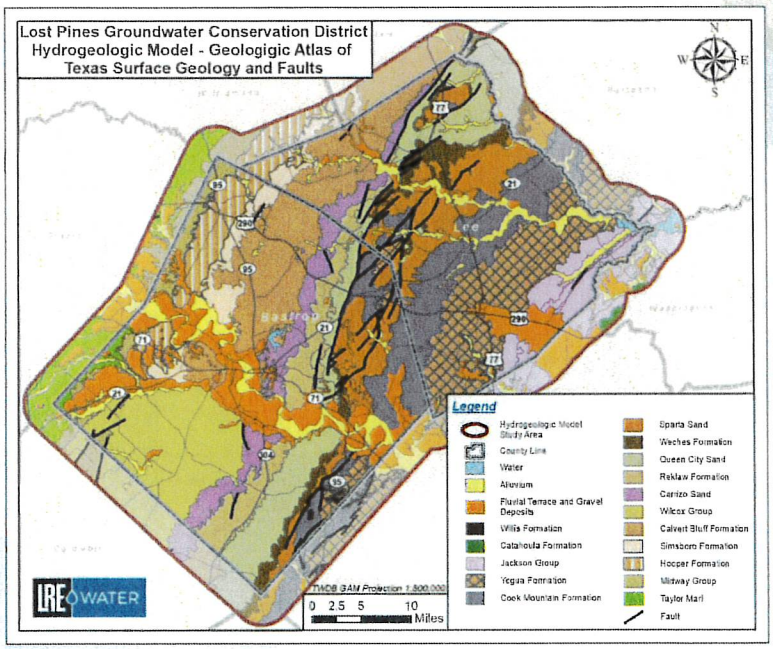




LRE WATER

Study Area
Hydrogeology

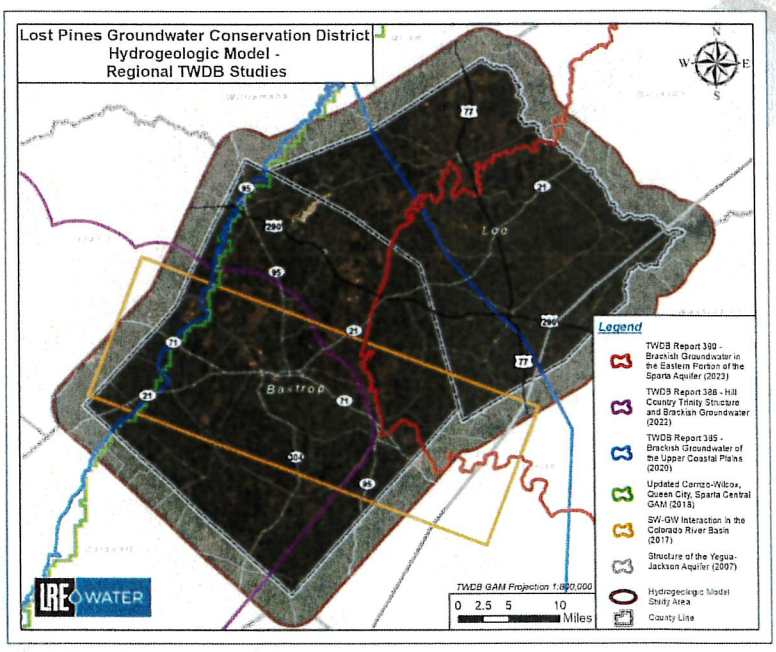
Period	Series / Epoch	Group	Geologic Unit	Lithology Type	Hydrogeologic Unit
Quaternary	Holocene to Pleistocene		Alluvium	River gravels, sands, clays and terrace deposits	Alluvial System
Tertiary	Pliocene (?)		Willis Formation	Fine to medium sand	Gulf Coast
	Miocene		Catahoula	Tuffaceous sand and sandstone interbedded with clay, silt and tuff	
	Eocene	Jackson	Manning Wellborn Caddell	Clay, Silt, volcanic ash, tuffaceous sand and shale and bentonic clay	Yegua-Jackson
			Yegua	Medium to fine sand, silt, clay, gypsum, some lignite	
		Claiborne	Cook Mountain	Clay and small amounts of sand, sandstone, limestone, glauconite, gypsum	Aquitard
			Sparta Sand	Fine to medium sand with some clay	Sparta
			Weches	Iron-bearing glauconitic clay and sand	Aquitard
			Queen City	Massive to thin-bedded fine to medium sand, clay and some conglomerate	Queen City
			Reklaw	Glauconitic sand and silt in lower section, clay, and thin sandstone beds in the upper	Aquitard
		Wilcox	Carrizo	Fine to cross-bedded sand and some thin beds of sandstone and clay	Carrizo-Wilcox
			Calvert Bluff	Interbedded lignitic and carbonaceous sandstone and shales	
			Simsboro Sand	Massive, fine- to medium-grained, well-sorted sandstone	
			Hooper	Interbedded lignitic and carbonaceous sandstone and shale	
	Paleocene	Midway		Clay, silt, glauconitic sand, and thin beds of limestone and sandstone	Aquitard
Cretaceous	Gulf	Navarro	Taylor Marl	Clay and silt, some sandstone	



Literature Review

Lots of great research, but something is missing...

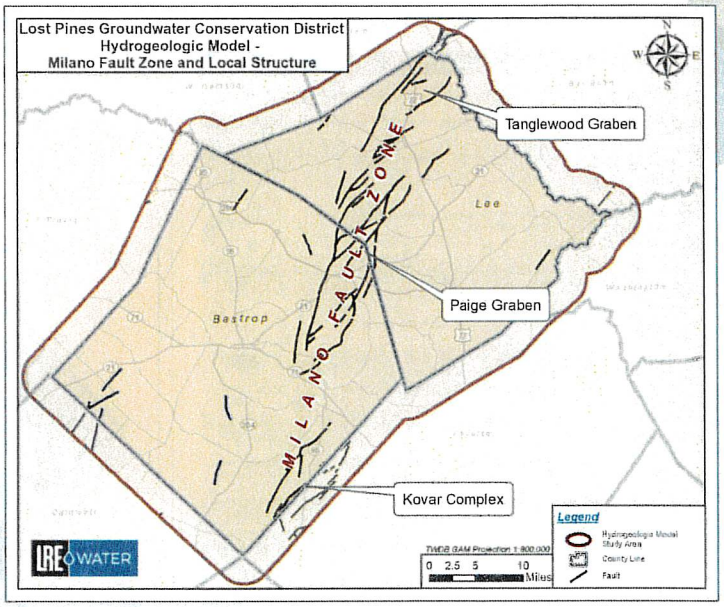
Report	Summary	Source
Ground-Water Resources of Bastrop County, Texas	General overview of the groundwater resources of Bastrop County, Texas	Follett (1970)
Ground-Water Resources of Lee County, Texas	General overview of the groundwater resources of Lee County, Texas	Thompson (1968)
The Wilcox Group and Carrizo Sand (Paleogene) in East-Central Texas: Depositional Systems and Deep-Basin Lignite	Evaluation of the Wilcox Group and Carrizo Sand depositional systems and lignite seams.	Ayers and Lewis (1985)
Groundwater Availability in the Carrizo-Wilcox Aquifer in Central Texas – Numerical Simulations of 200 through 2050 Withdrawal Projections	Developed a numerical model to assess possible hydrologic effects of groundwater withdrawal scenarios.	Dutton (1999)
Transmissivity, Hydraulic Conductivity, and Storativity of the Carrizo-Wilcox Aquifer in Texas	Developed a aquifer test / hydraulic property database for the Carrizo-Wilcox Aquifer.	Mace and others (2000)
Groundwater Availability Model for the Central Part of the Carrizo-Wilcox Aquifer in Texas	Documentation report for the Central Carrizo-Wilcox Aquifer GAM	Dutton and others (2003)
Structure of the Yegua-Jackson Aquifer of the Texas Gulf Coastal Plain	Documents the structure, lithology and depositional framework for the Yegua-Jackson Aquifer	Knox and others (2007)
Groundwater availability model for the Yegua-Jackson Aquifer	Documents the development of the Yegua-Jackson Groundwater Availability Model	Deeds and others (2010)
Brackish groundwater in aquifers of the Upper Coastal Plains, Central Texas	Regional review of Brackish Groundwater potential within the Carrizo-Wilcox Aquifer (Bastrop)	Meyer and others (2020)
Brackish groundwater in the eastern portion of the Sparta Aquifer	Regional review of Brackish Groundwater potential within the East Texas Sparta Aquifer (Lee)	Laughlin and others (2023)
Groundwater availability models for the Queen City and Sparta aquifers	Documentation report for the development of the Queen City and Sparta Aquifers GAM.	Kelley and others (2024)
Groundwater availability model for the central portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers	Documentation report for the development of the updated Sparta, Queen City and Carrizo-Wilcox Aquifers GAM.	Young and others (2018)
GMA 12 update to the groundwater availability model for the central portion of the Sparta, Queen City, and Carrizo-Wilcox aquifers	Documentation for updates related to the updated Sparta, Queen City and Carrizo-Wilcox Aquifers GAM.	Young and others (2020)
The Milano Fault System, Central Texas: Structure and Implications for the Simsboro Aquifer	Review of the Milano Fault Zone and identified boundary conditions to flow in the Carrizo-Wilcox Aquifer system.	Ewing and Young (2018)



Detailed Stratigraphic Framework

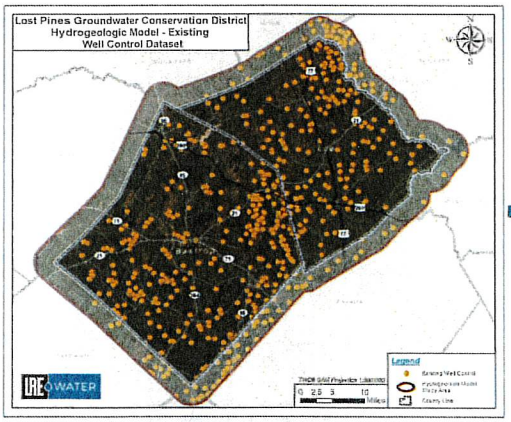
Key Objectives

- Resolve data inconsistencies
- Better define the Milano Fault Zone
- Increase confidence in groundwater analysis
- Develop geologic framework for LPGCD groundwater flow model

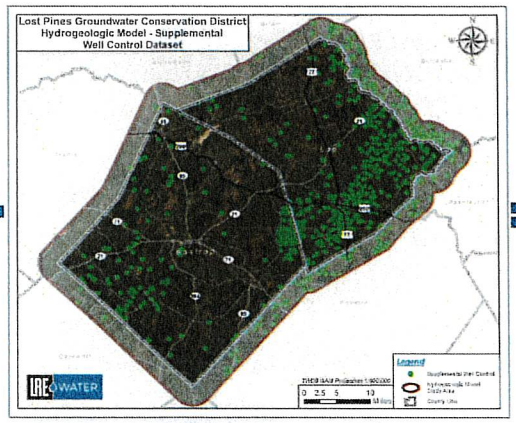


LPGCD Stratigraphic Well Control

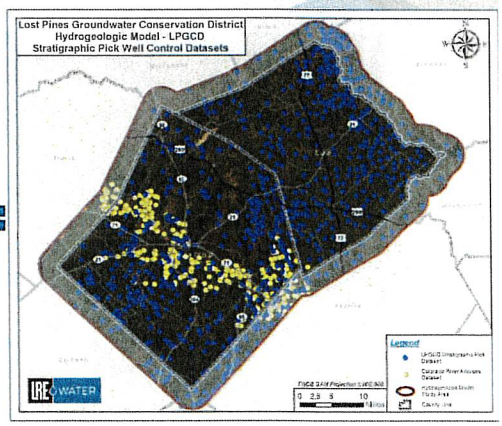
793 Geophysical Logs (+alluvium control)



*Not every well was reviewed from this dataset. Wells that were reviewed are flagged as "LRE Reviewed" (373) others as "Not Reviewed" (238).

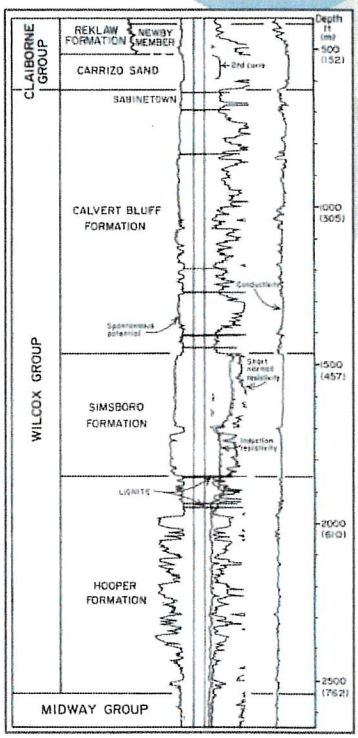


*Only a subset of these wells were included within the LPGCD Stratigraphic Well Control Dataset and are flagged as "LRE Acquired" (182).



Stratigraphic Well Control

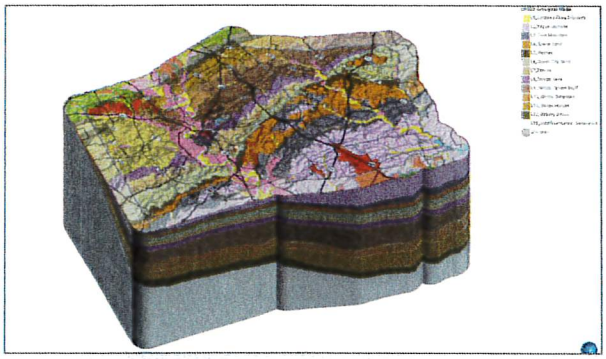
	Bastrop		Lee		Buffer Zone		Total		
	Existing Control	New Total	Existing Control	New Total	Existing Control	New Total	Existing Control	New Total	% Increase
Colorado R. Alluvium	376	-	N/A	-	84	-	460	460	0%
Cook Mountain	1	1	4	15	6	6	11	22	100%
Sparta	12	12	21	33	22	25	55	70	27%
Weches	21	8	27	42	21	13	69	63	(-8.7%)
Queen City Sand	20	22	12	57	19	32	51	111	117%
Reklaw	77	80	52	149	31	56	160	285	78%
Carrizo Sand	92	96	69	157	39	64	200	317	59%
Calvert Bluff	103	114	26	187	39	61	168	347	106%
Simsboro Sand	107	139	84	199	56	86	247	424	72%
Hooper	117	180	86	221	62	94	265	495	87%
Midway Group	212	277	42	215	52	89	306	581	90%



Geophysical "Type Log" for the Carrizo-Wilcox Aquifer (Ayers and Lewis, 1985).

Hydrogeologic Model Framework

- Developed as a 13-layer system



	GAM Model Layers			Hydrogeologic Model Layers	
Yegua-Jackson GAM	Catahoula	Layer 1	X	Inconsequential to Hydrogeologic Model Development.	
	Upper Jackson	Layer 2	X	Layer 2	Yegua - Jackson
	Lower Jackson	Layer 3	→		
	Upper Yegua	Layer 4	→		
	Lower Yegua	Layer 5	→		
Carrizo-Wilcox, Queen City, Sparta GAM	Colorado River Alluvium	Layer 1	→	Layer 1	Colorado River Alluvium
	Shallow Flow Zone	Layer 2	X	Inconsequential to Hydrogeologic Model Development.	
	Represented as Overlying Formation		X	Layer 3	Cook Mountain
	Sparta Aquifer	Layer 3	→	Layer 4	Sparta Aquifer
	Weches Formation	Layer 4	→	Layer 5	Weches Formation
	Queen City Aquifer	Layer 5	→	Layer 6	Queen City Aquifer
	Reklaw Formation	Layer 6	→	Layer 7	Reklaw Formation
	Carrizo Aquifer	Layer 7	→	Layer 8	Carrizo Aquifer
	Calvert Bluff Formation	Layer 8	→	Layer 9	Calvert Bluff Formation
	Simsboro Formation	Layer 9	→	Layer 10	Simsboro Formation
	Hooper Formation	Layer 10	→	Layer 11	Hooper Formation
	Represented as the base of Layer 8.		X	Layer 12	Midway Group
	Inconsequential to GAM Model Development.		X	Layer 13	Undifferentiated Cretaceous

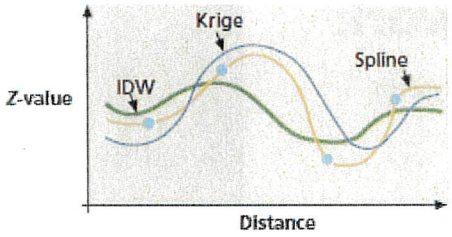
Hydrogeologic Model Variance Analysis

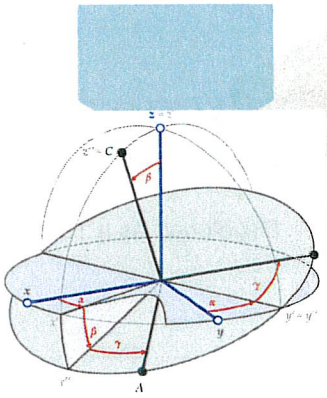
Model Variance is the difference between modeled surfaces and stratigraphic well control.

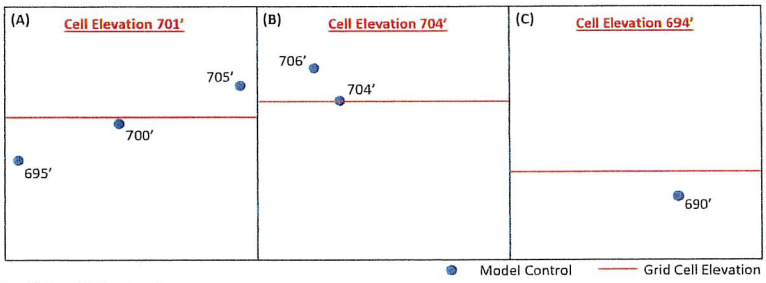
Variance is introduced through

- The representation of complex geology in a somewhat simplified manner
  - e.g. faults, folds, missing/repeat beds
- Interpolation along the X,Y, and Z axis.
- Model interpolation techniques and grid cell resolution effect.

LPGCD Model Variance ~ 10 Feet.

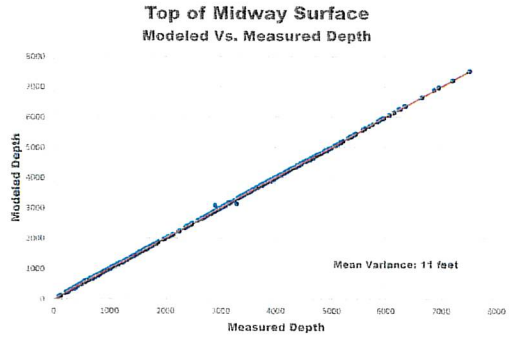


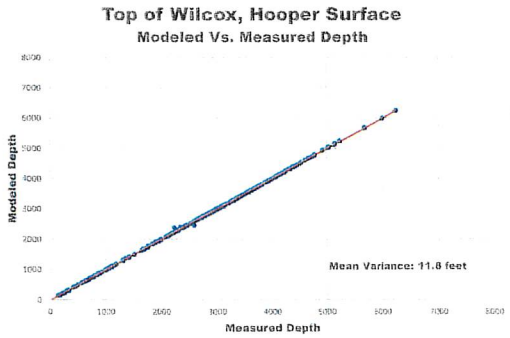


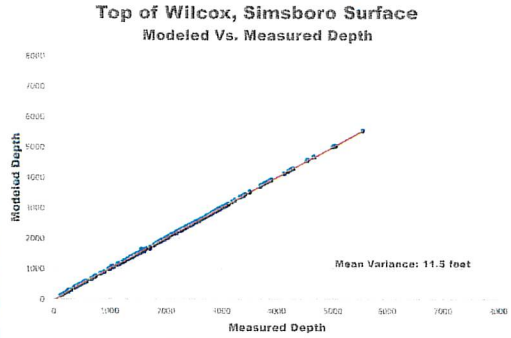


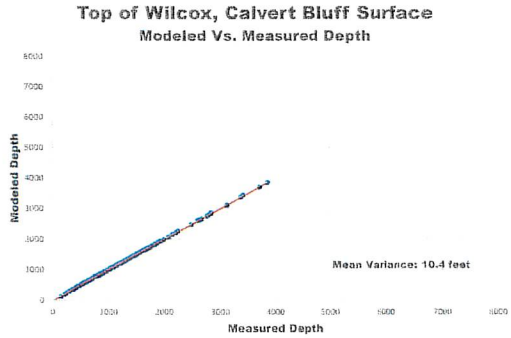
Demonstration of model grid cell resolution effect.

VARIANCE RESULTS



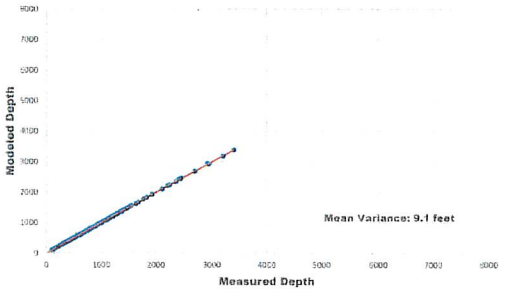




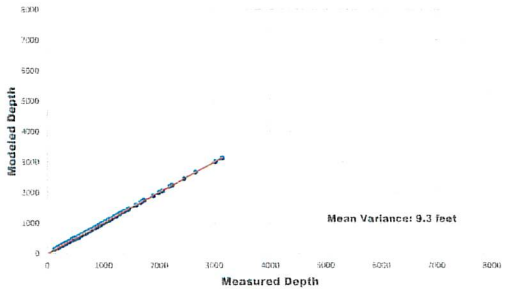


VARIANCE RESULTS

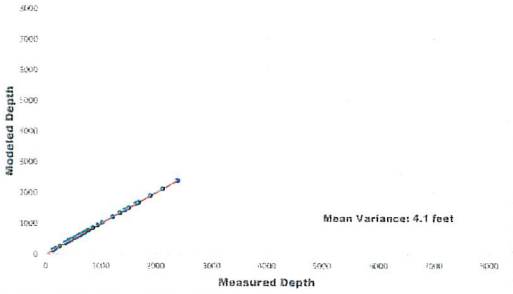
Top of Carrizo Sands Surface
Modeled Vs. Measured Depth



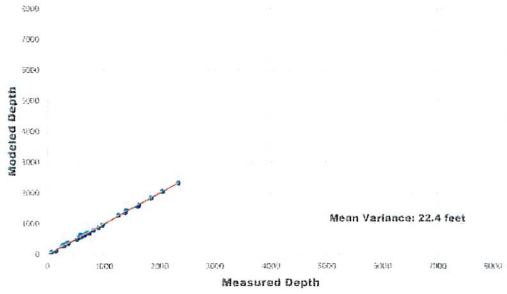
Top of Reklaw Surface
Modeled Vs. Measured Depth



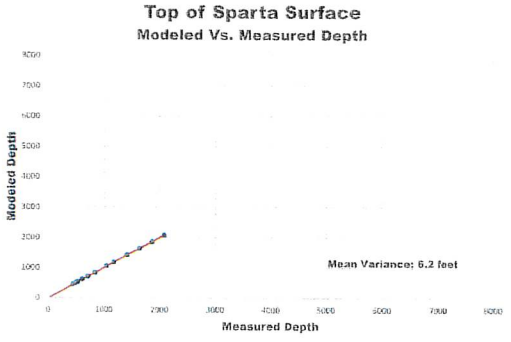
Top of Queen City Surface
Modeled Vs. Measured Depth

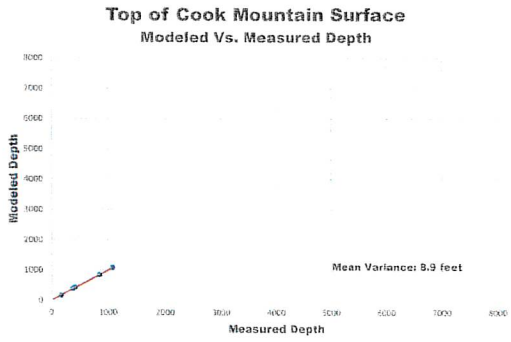


Top of Weches Surface
Modeled Vs. Measured Depth



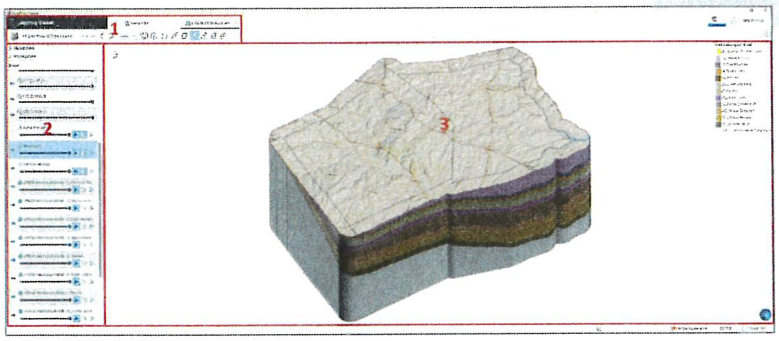
VARIANCE RESULTS (CONT.)





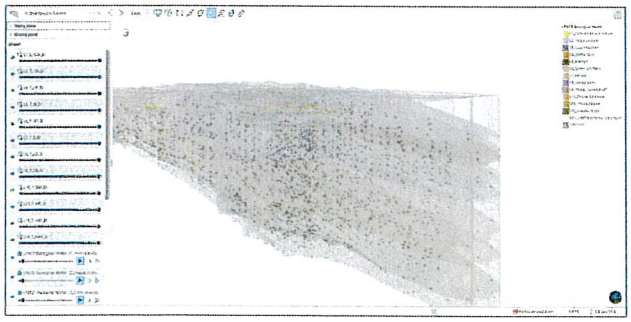
LPGCD 3D HYDROGEOLOGIC MODEL

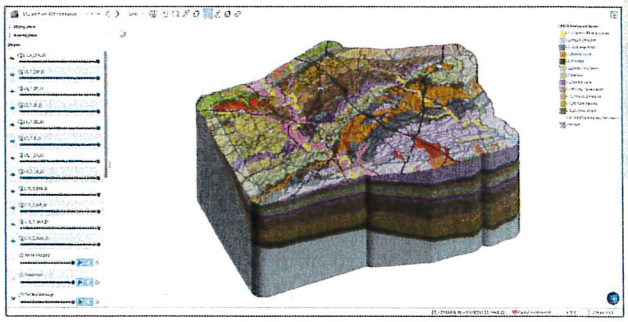
- Interactive workspace – Provided to the LPGCD as Leapfrog viewer file
  - Freeware Software
  - 16 pre-defined model scenes

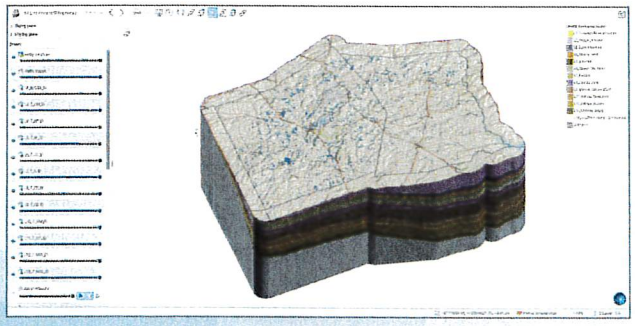


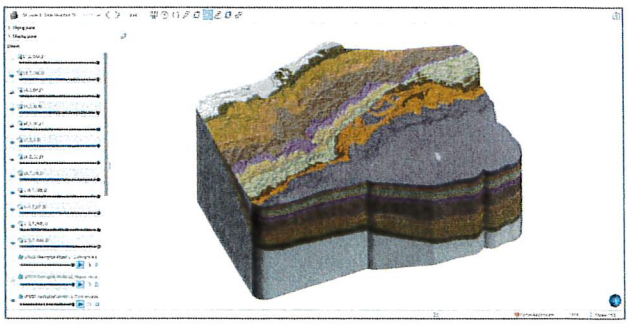
LPGCD 3D Hydrogeologic Model

Scene 1 - 4



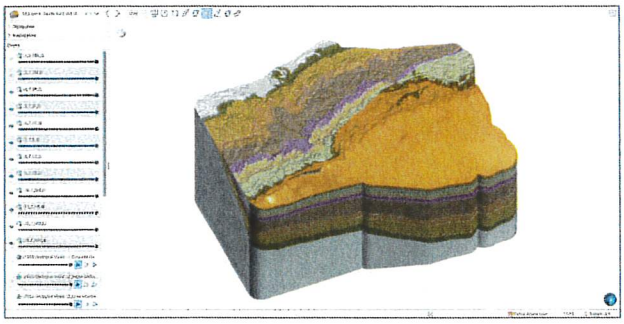


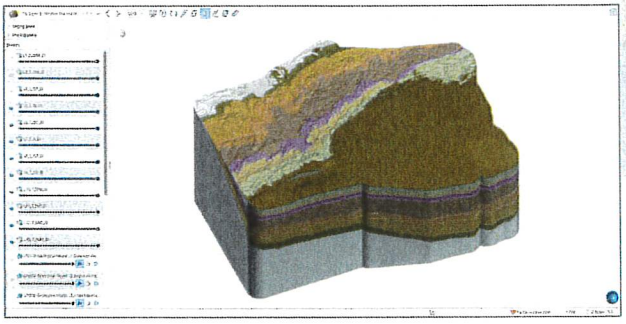


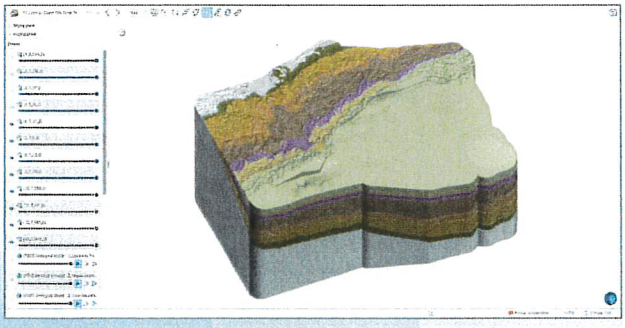


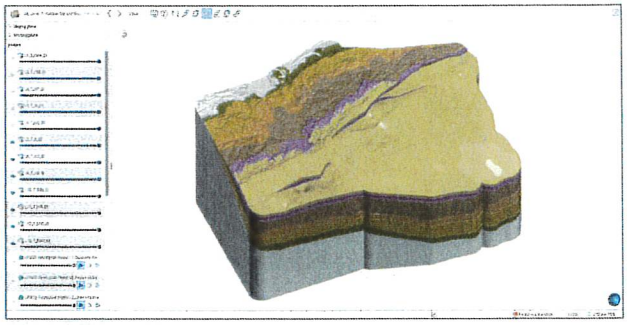
LPGCD 3D Hydrogeologic Model

Scene 5 - 8



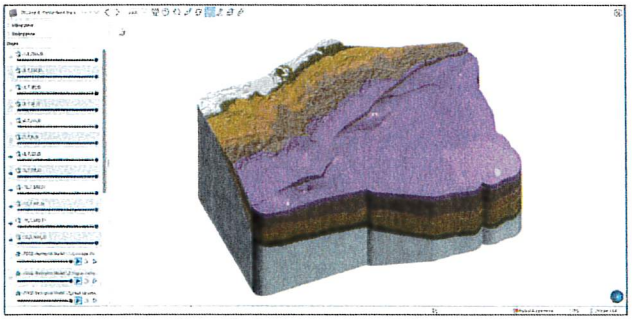


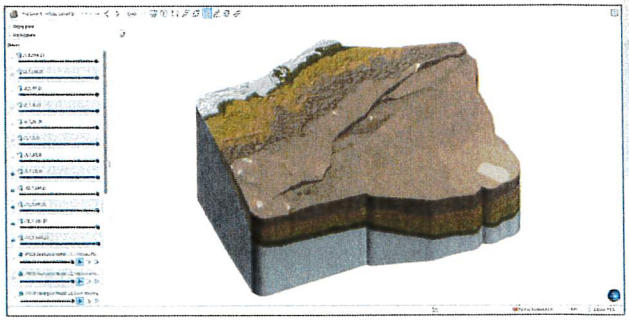


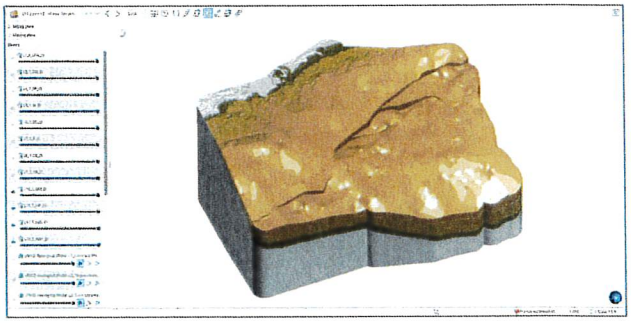


LPGCD 3D Hydrogeologic Model

Scene 9 - 12

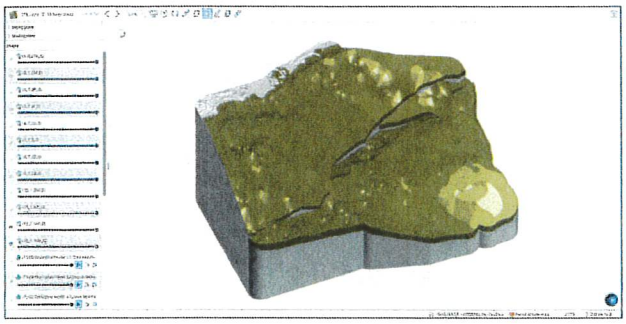


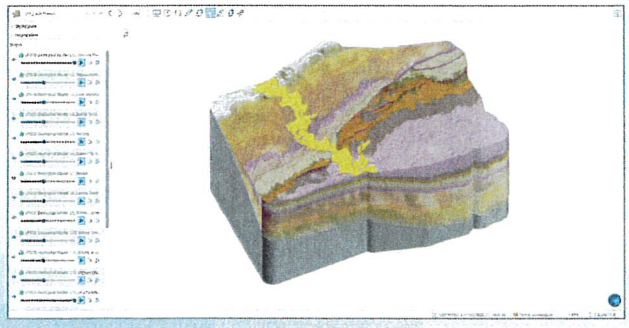


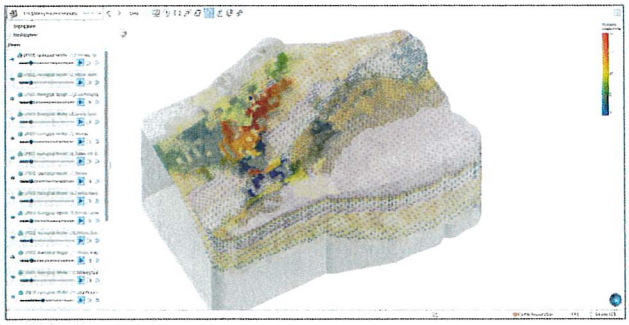


LPGCD 3D Hydrogeologic Model

Scene 13 - 16







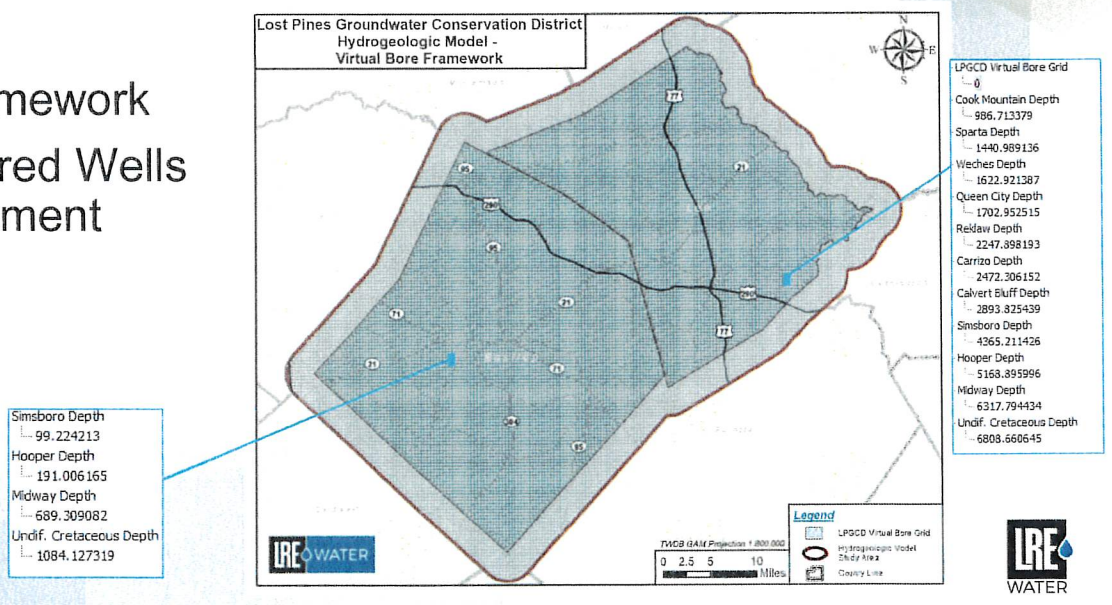
LPGCD 3D Hydrogeologic Model

Demo

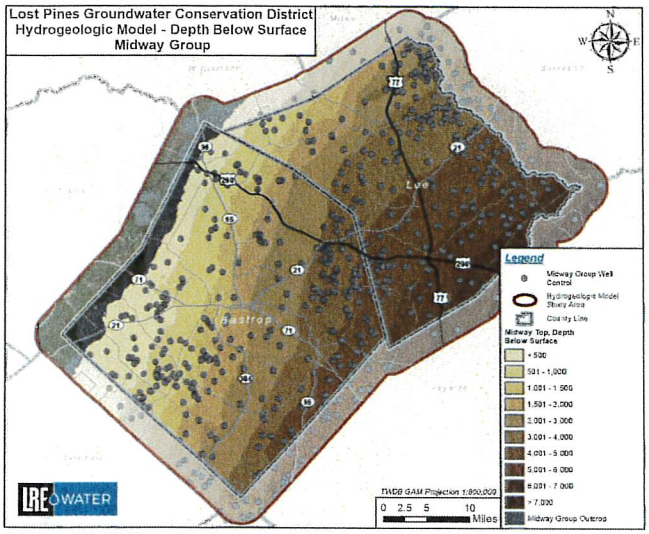
LPGCD 3D Hydrogeologic Model

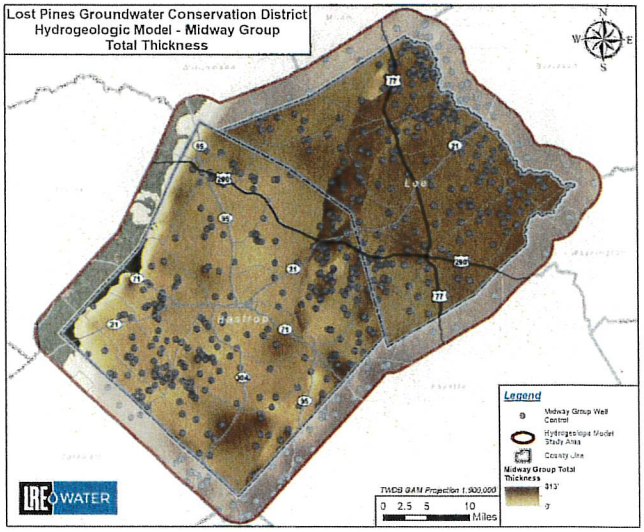
Supplemental Deliverables

- GIS Datasets
- Virtual Bore Framework
- LPGCD Registered Wells – Aquifer Assignment



LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Midway Group





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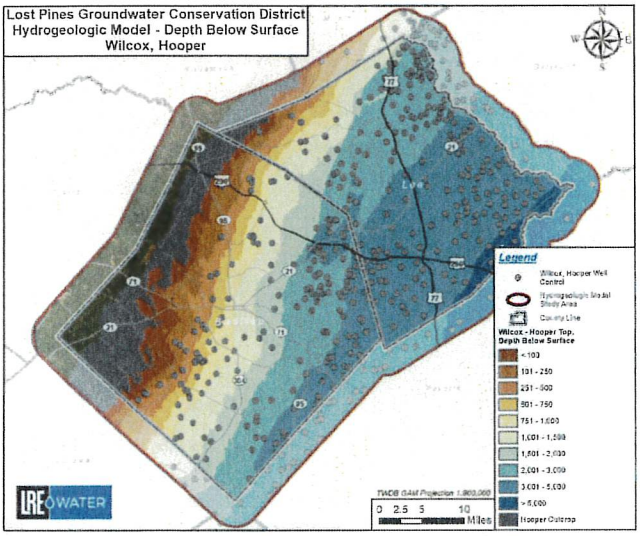
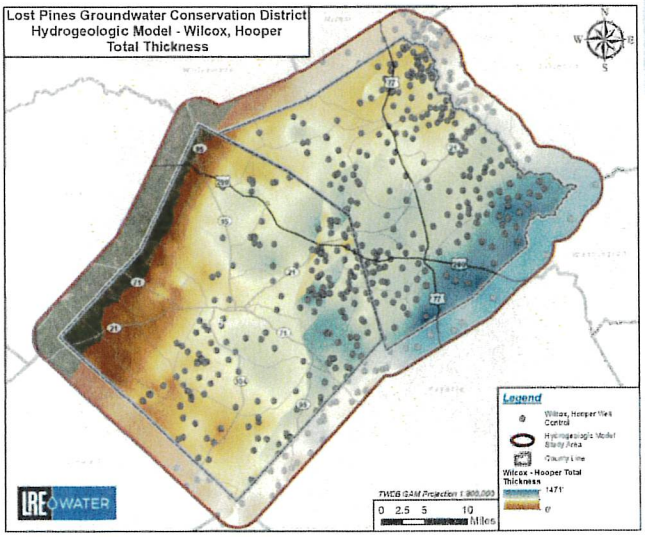
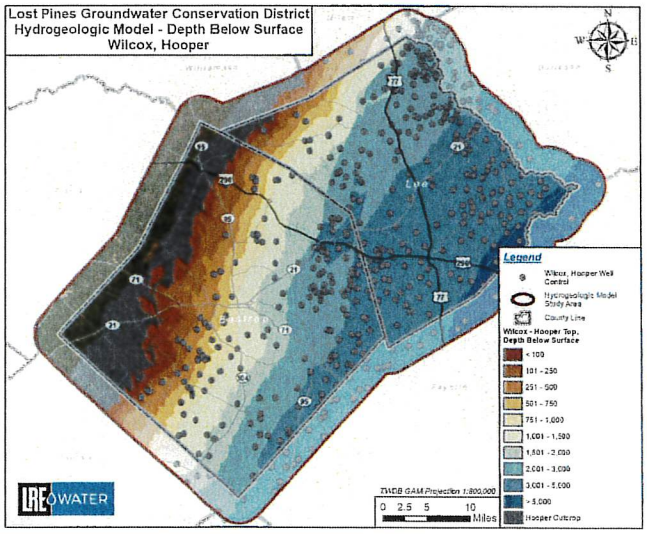
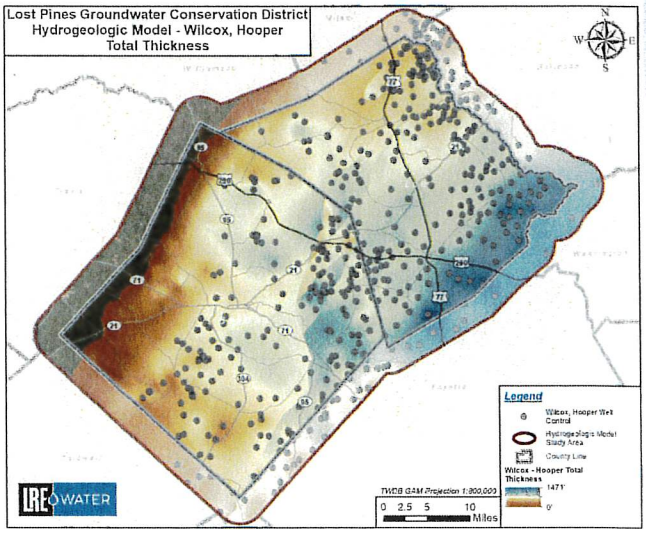
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Wilcox, Hooper



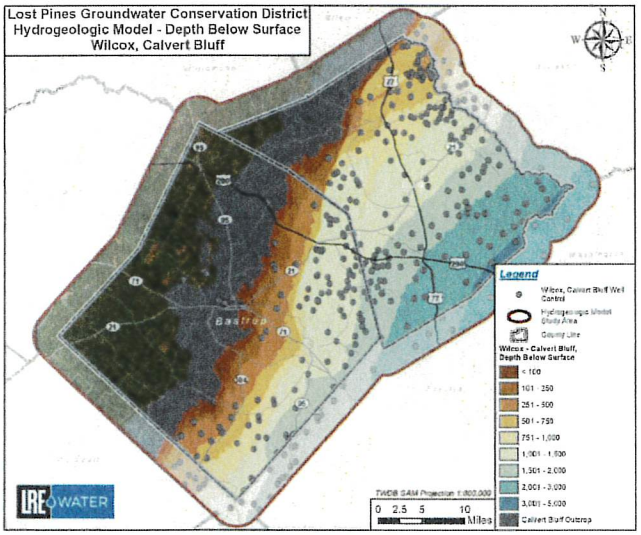


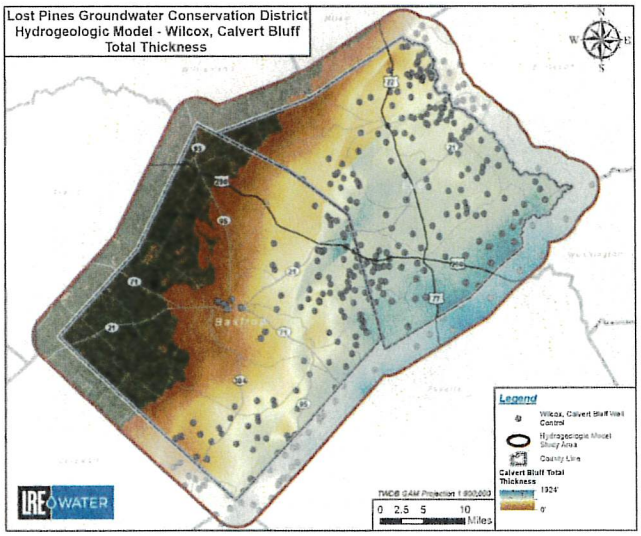
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Wilcox, Simsboro



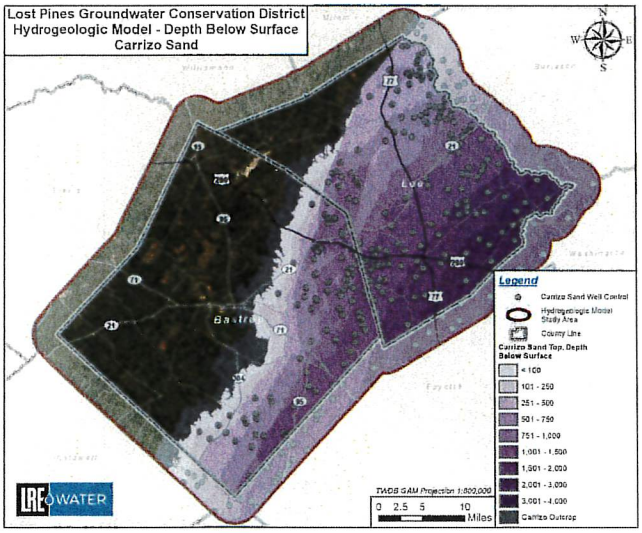


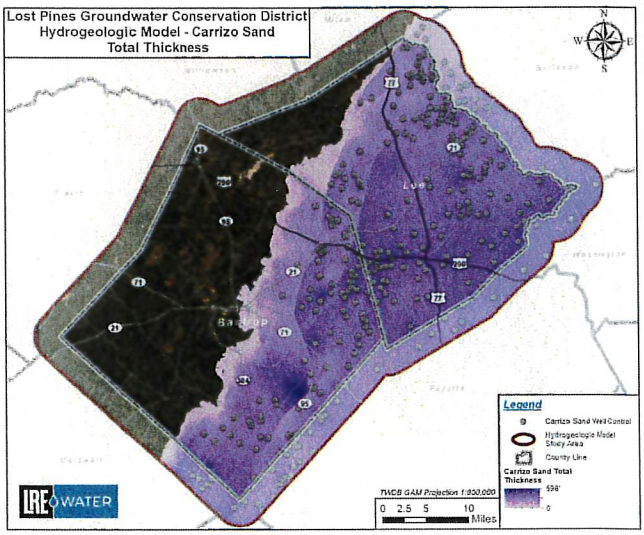
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Wilcox, Calvert Bluff



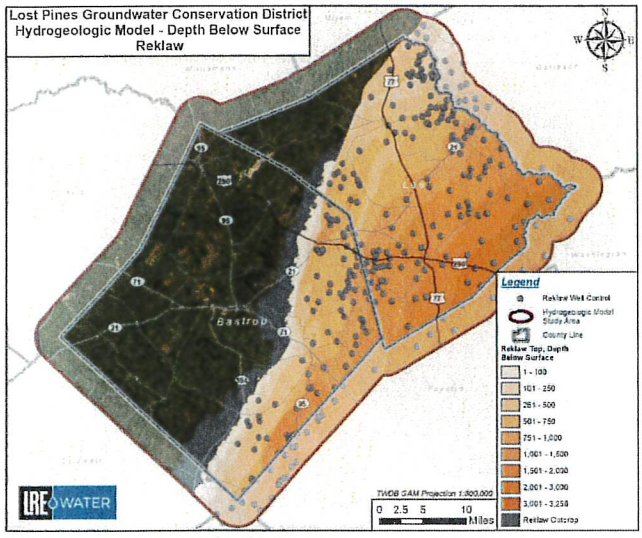


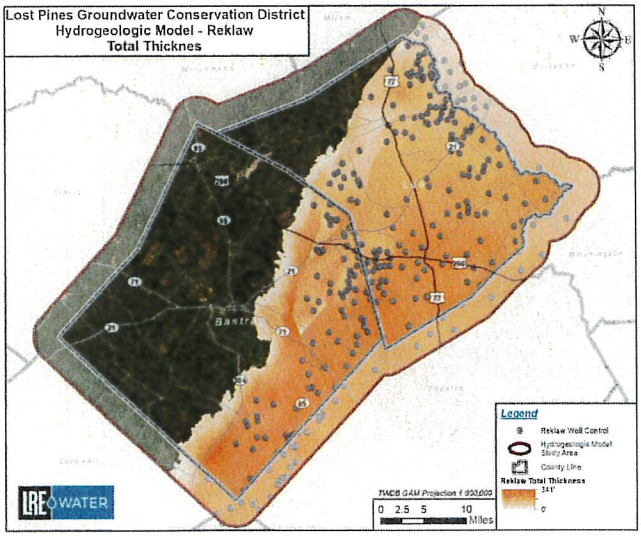
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Carrizo Sand



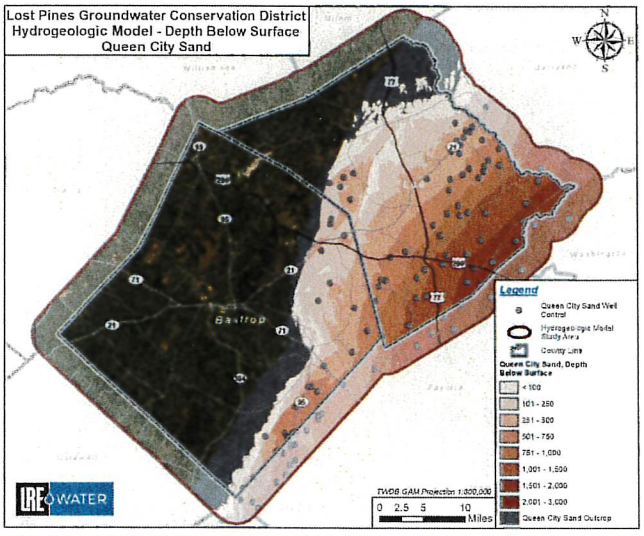


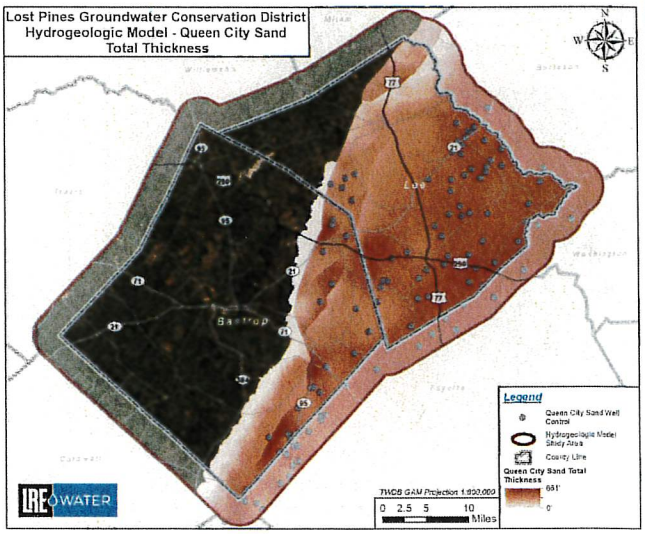
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Reklaw



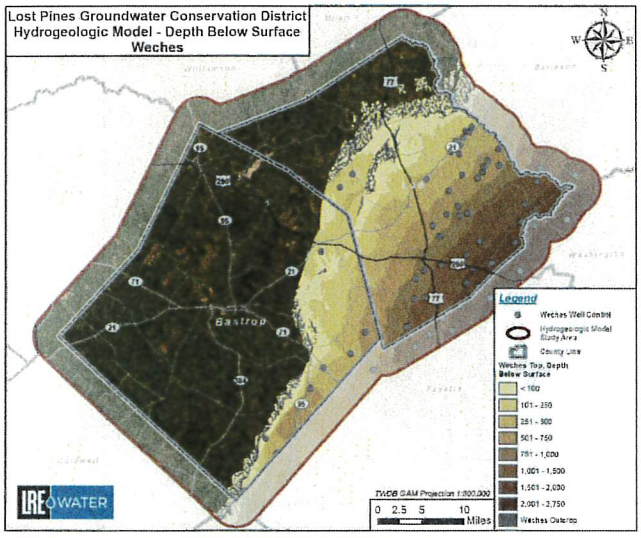


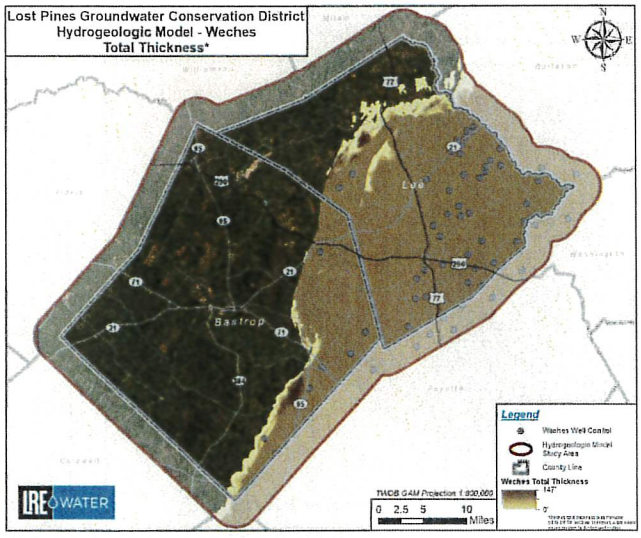
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Queen City Sand





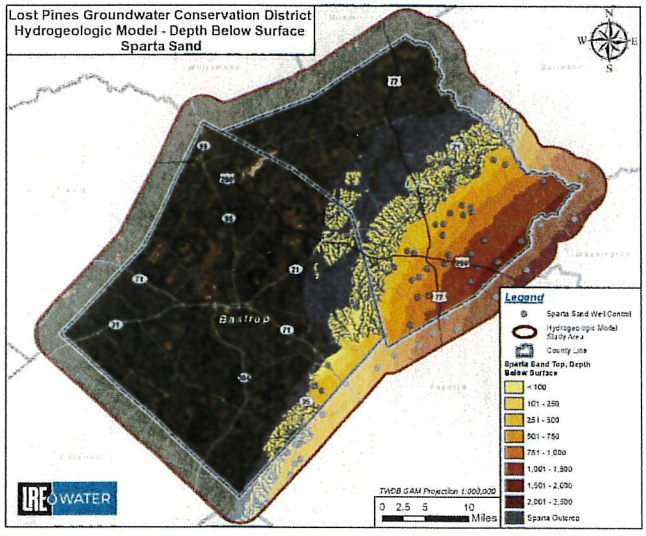
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Weches

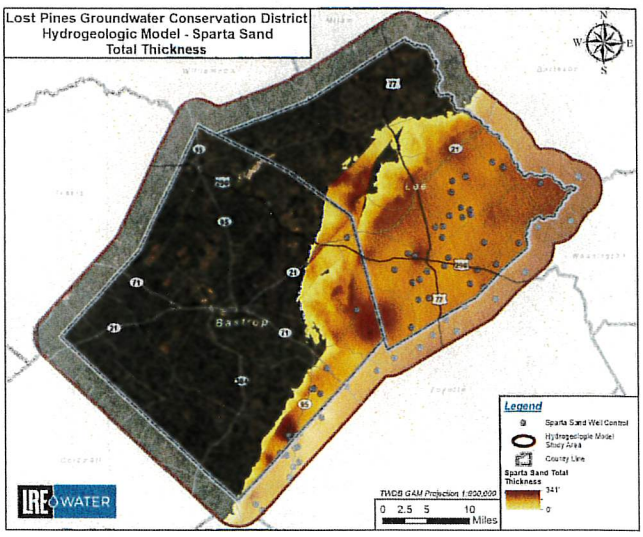




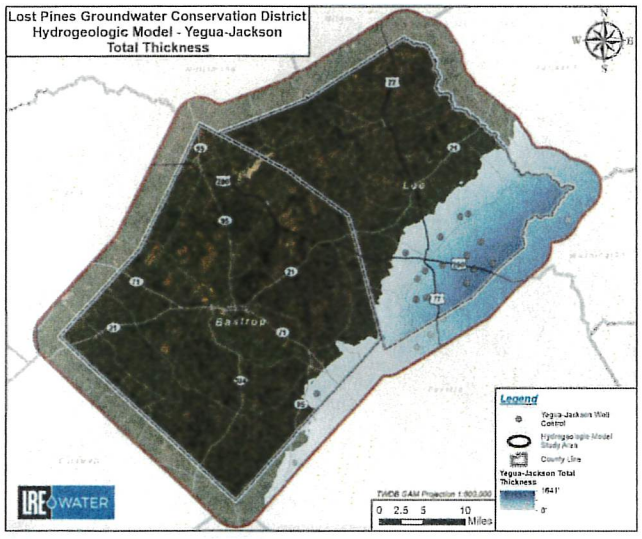
*Uniform subcrop thickness assigned as a model workaround.

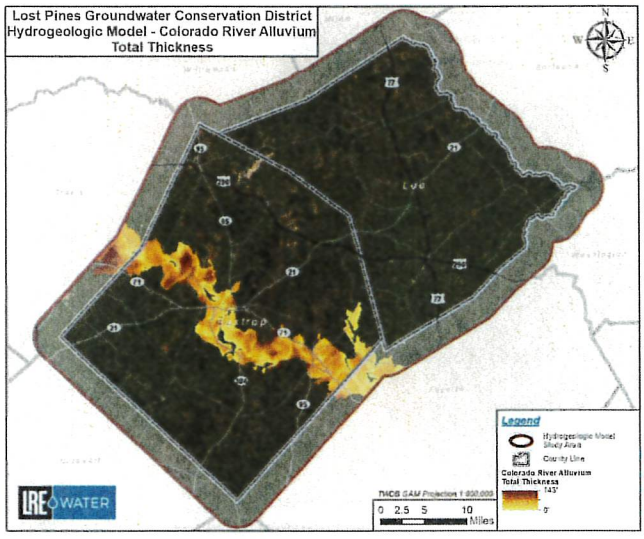
LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Sparta Sand





LPGCD 3D Hydrogeologic Model
Stratigraphic Surface Exports – Sparta and Colorado River Alluvium Thickness





CONCLUSIONS AND RECOMMENDATIONS

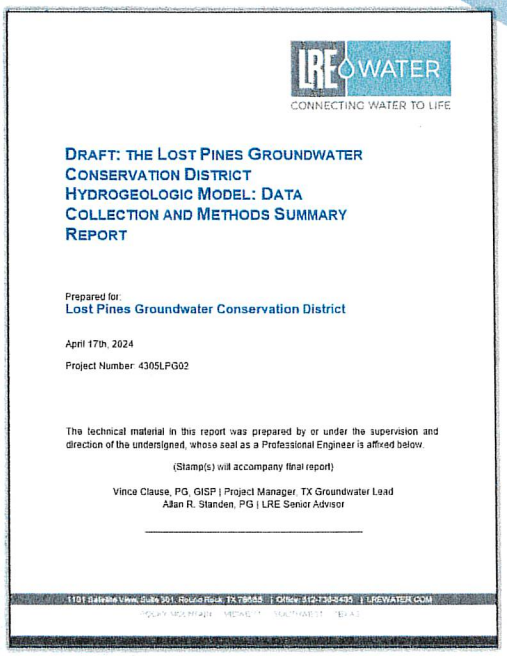
Future aquifer pump test should be carefully considered and evaluated around faults.

Annual updates to account for new data and enhance local discernment.

Review the "Not Reviewed" well dataset.

Review local areas with higher variance/ identify areas for improvement.

Develop a local groundwater flow model using the geologic data developed through this work.



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CONNECTING WATER TO LIFE

DRAFT: THE LOST PINES GROUNDWATER CONSERVATION DISTRICT HYDROGEOLOGIC MODEL: DATA COLLECTION AND METHODS SUMMARY REPORT

Prepared for:
Lost Pines Groundwater Conservation District

April 17th, 2024

Project Number: 4305LPG02

The technical material in this report was prepared by or under the supervision and direction of the undersigned, whose seal as a Professional Engineer is affixed below.

(Stamp(s) will accompany final report)

Vince Clause, PG, GISP | Project Manager, TX Groundwater Lead
Allan R. Standen, PG | LRE Senior Advisor

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Questions?

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