



Integrated Water Availability Assessment of the Chicot Aquifer System, Southwestern Louisiana

Wade H. Kress

Lower Mississippi-Gulf Water
Science Center

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Connection to Regional Water Availability Studies


USGS
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CLAS Regional Groundwater Availability Study


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USGS is undertaking a 5-year study to assess groundwater availability for the aquifers proximal to the Gulf of Mexico from the Texas-Mexico border through the panhandle of Florida, known as the Coastal Lowlands Aquifer System (CLAS). This study is one of several within the Regional Groundwater Availability Studies of the [USGS Water Availability and Use Science Program](#). Groundwater from this aquifer system is used mainly for municipal, agricultural, and industrial supply. Land subsidence related to groundwater pumping is of concern within this study area; therefore, subsidence will be a main focus of this investigation. The study will focus on quantifying the status of groundwater availability and the trends of availability within the CLAS. Impacts from both climatic and anthropogenic changes to the hydrology will be assessed through use of a numerical model designed within an uncertainty analysis framework. This project will culminate with useful tools, publications, and data summarizing estimates, captured within an uncertainty framework, of past, current and future groundwater availability within the CLAS.



Click on map for larger image



<https://www2.usgs.gov/water/lowermississippigulf/lmgweb/clas/index.html>

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Mississippi Alluvial Plain (MAP) Regional Water Availability Study

Home News*new Status Water Budget Geophysics Support System Products Partners Staff Study Area Maps*new

The **Mississippi Alluvial Plain (MAP)** has become one of the most important agricultural regions in the US, and it relies heavily on a groundwater system that is poorly understood and shows signs of substantial change. The heavy use of the available groundwater resources has resulted in significant groundwater-level declines and reductions in base flow in streams within the MAP. These impacts are limiting well production and threatening future water-availability for the region. Over 9 billion gallons per day of groundwater are withdrawn for irrigation, supporting agricultural production. Agricultural interests in the region are aware to the economic and environmental costs that may come from declining water supplies but lack the basic resource description and analytical tools necessary for effective decision making at a regional scale. Technical specialists working in various Federal and State agencies and universities have worked individually and in partnership over many years to address aspects of particular water issues in the MAP, but no single agency or group has had the resources to support a broad-based and comprehensive scientific effort.

Accurate and ongoing assessments of water availability in the MAP region are critically important for making well-informed management decisions about resource allocation and sustainability, establishing best practices for water use, and dealing with predicted additional changes to the regional water cycle over the next 50-100 years. The goal of the MAP water use and availability project is to improve estimates of water availability for the present, past, and future in the MAP region, to aid water resource managers in making decisions that can help to sustain key agricultural and industrial practices

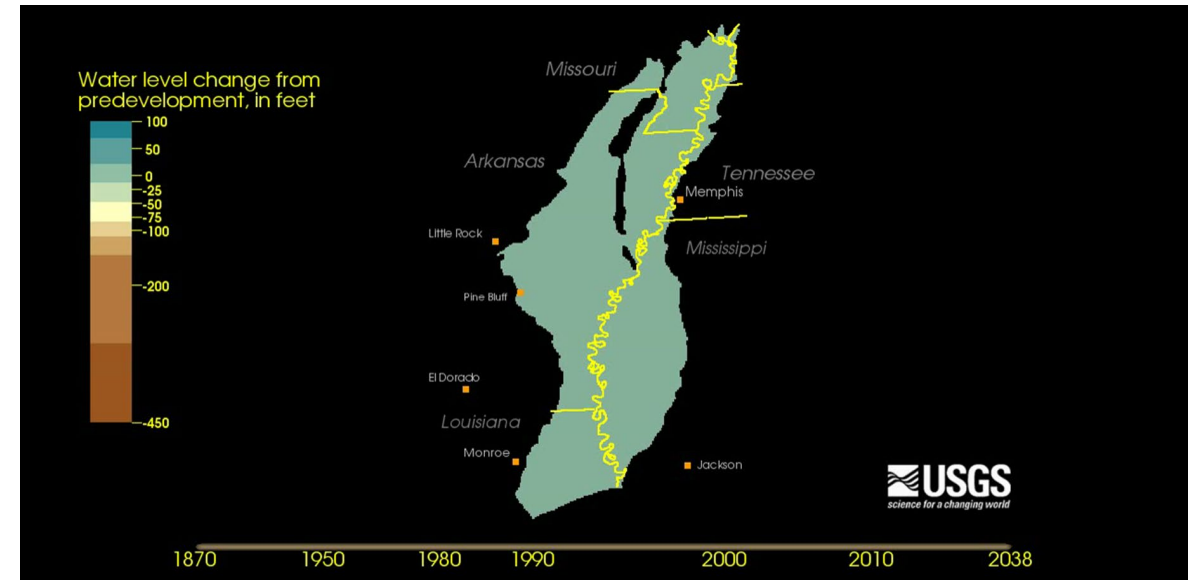
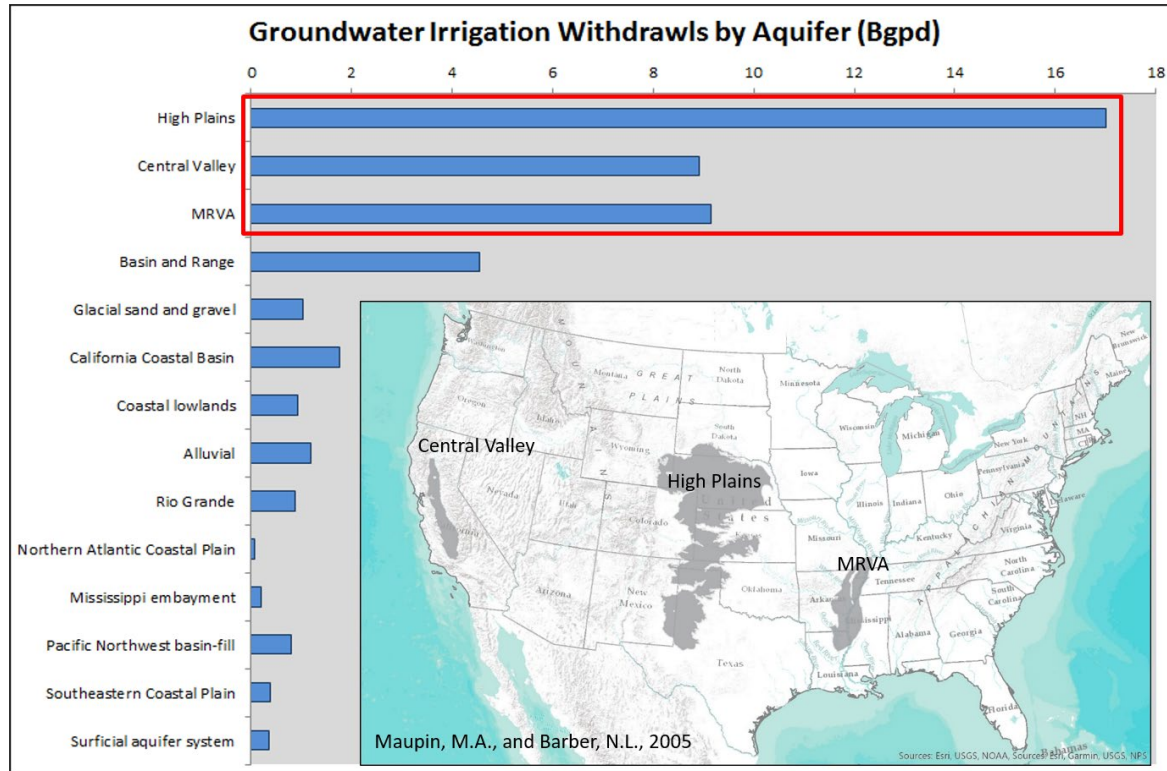
The U.S. Geological Survey (USGS) [Water Availability and Use Science Program \(WAUSP\)](#) is supporting a regional groundwater availability study of the Mississippi Alluvial Plain (MAP) to provide stakeholders and managers information and tools to better understand and manage groundwater



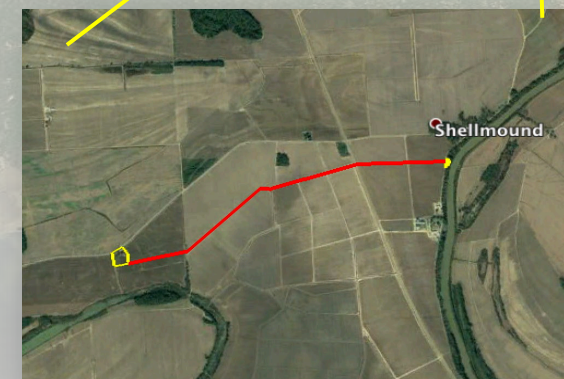
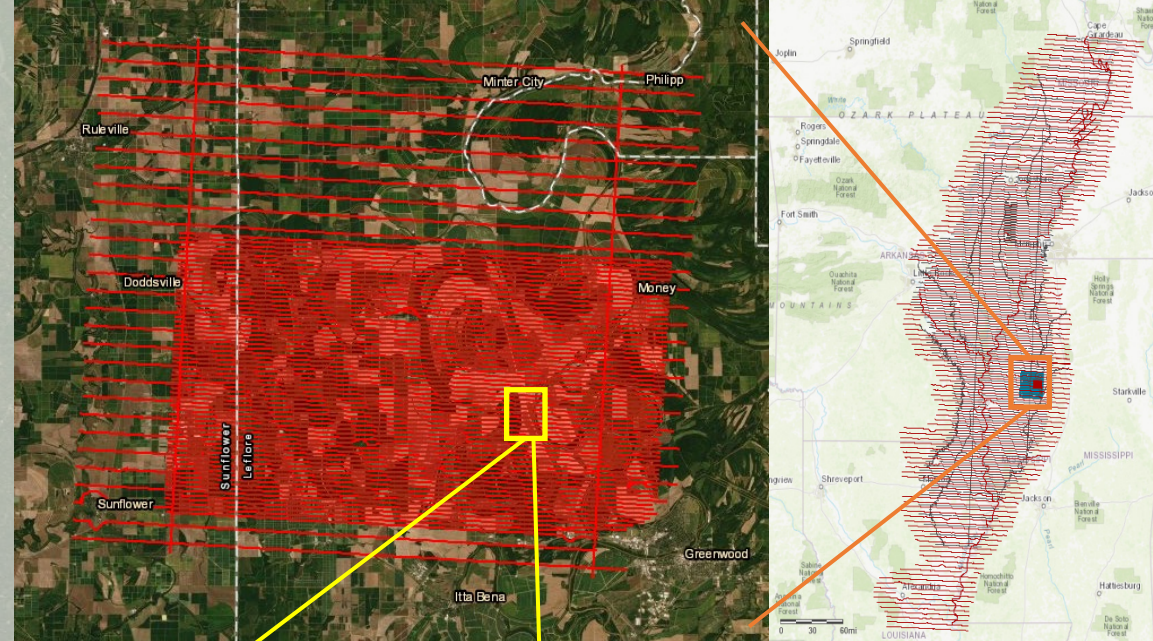
The Mississippi Alluvial Plain

<https://www2.usgs.gov/water/lowermississippigulf/map/>

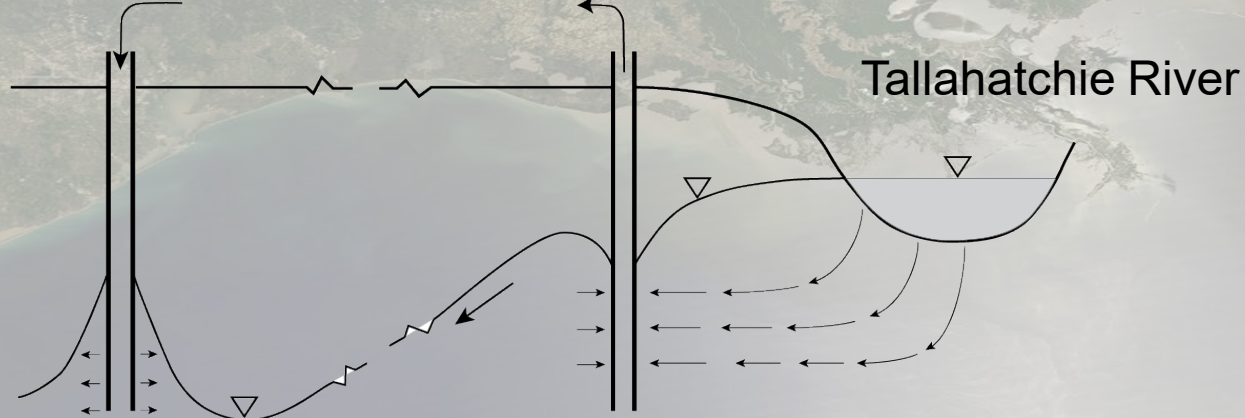
Mississippi Alluvial Plain



Bank filtration, transfer, and injection: Mapping aquifer structure to inform aquifer recharge pilot project installation



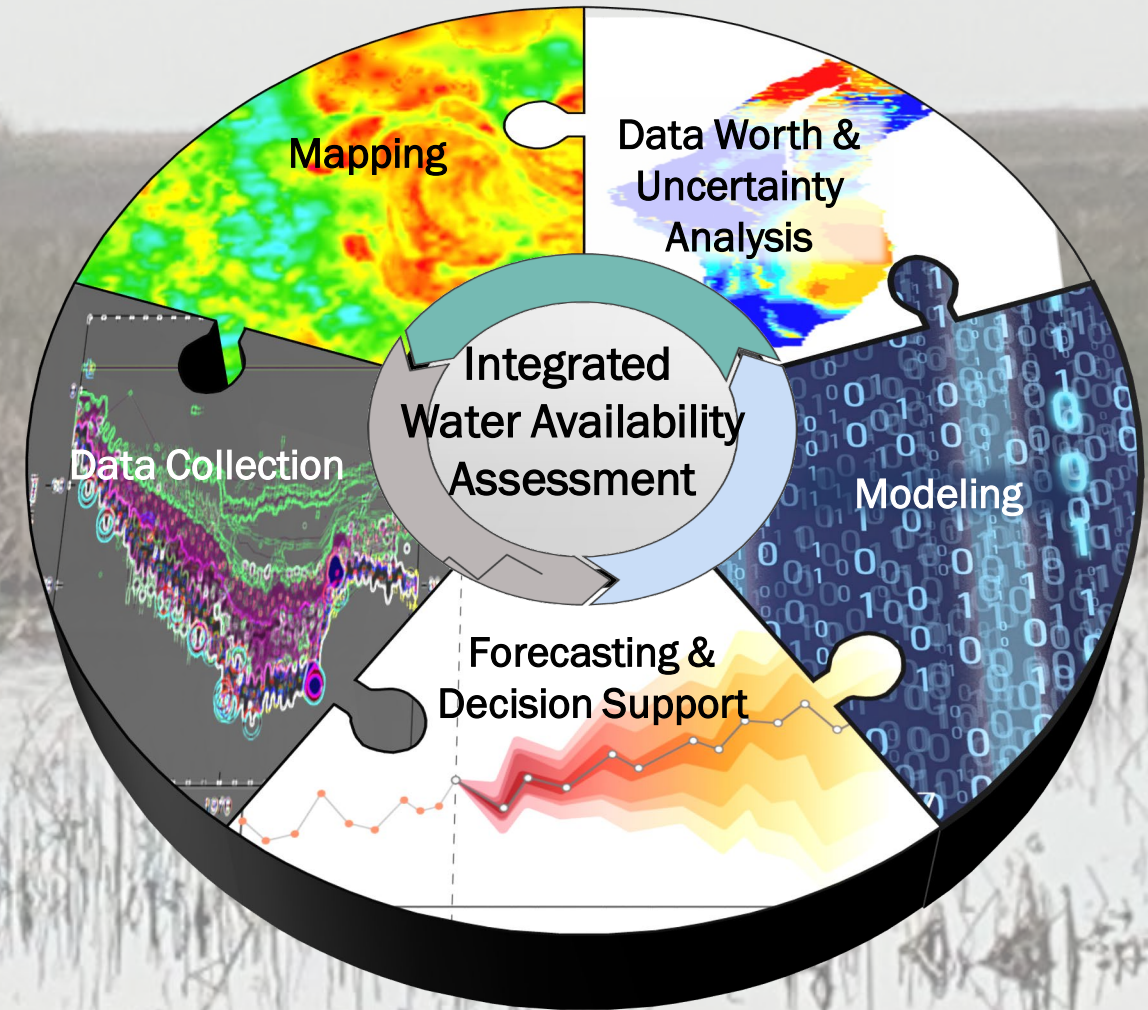
1 extraction, 2 injection wells
1.8 mile transfer



PI for the Transfer and injection
project: Dr. Andy O'Reilly, USDA-ARS
National Sedimentation Laboratory
andrew.oreilly@usda.gov

Chicot Aquifer Study

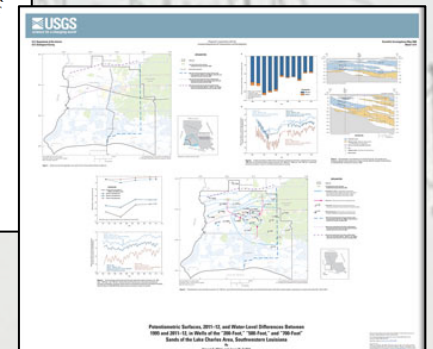
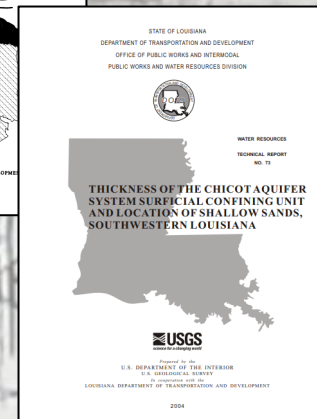
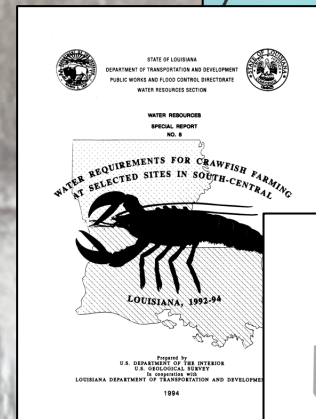
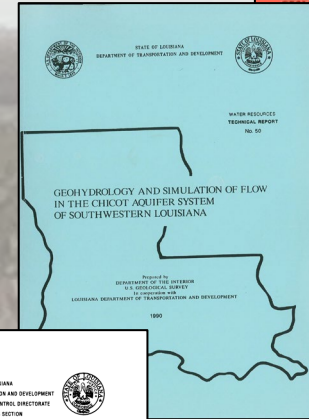
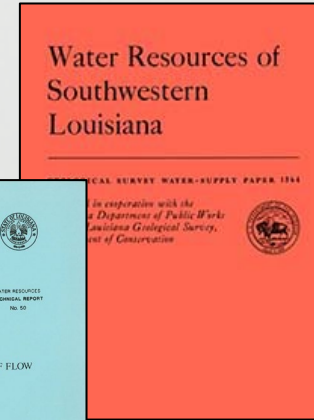
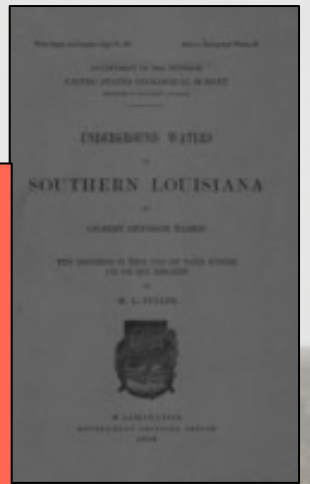
- Compile data all available data
- Develop an integrated suite of models for decision support
 - Groundwater levels and use
 - Water Quality
 - Hydrogeologic Framework
- Evaluate Status and trends
- Provide products for informed decision making



Chicot Aquifer System

Builds on previous studies

- Harris and Fuller, 1904
- Jones and others, 1956
- Nyman and others, 1990
- Sargent, 2004
- White and Griffith, 2020

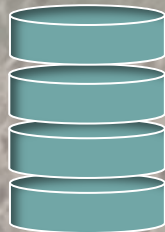




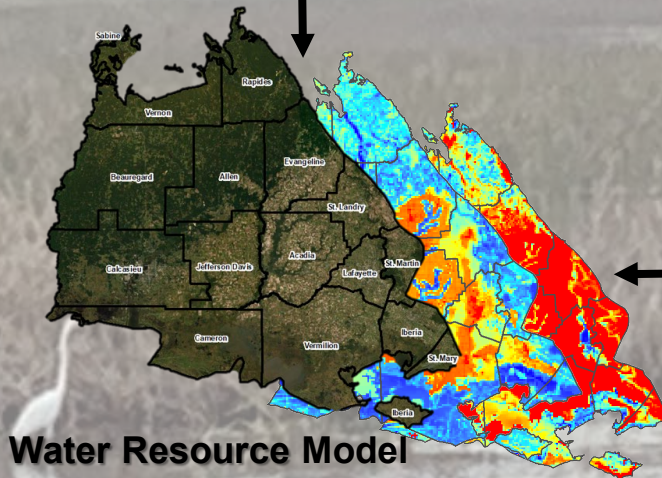
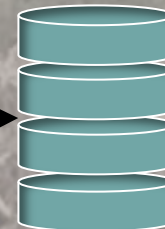
Stakeholder Support



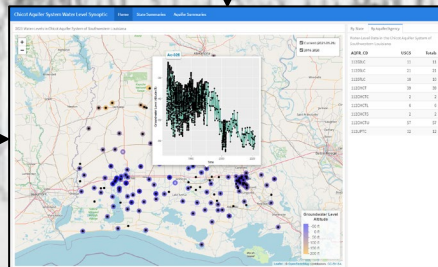
Water Budget Model



Hydrogeologic Model



Water Resource Model



Data Services



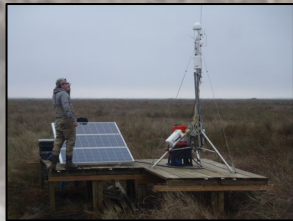
GW Age



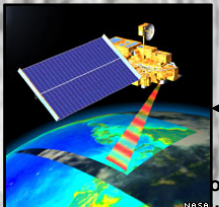
WU Monitoring



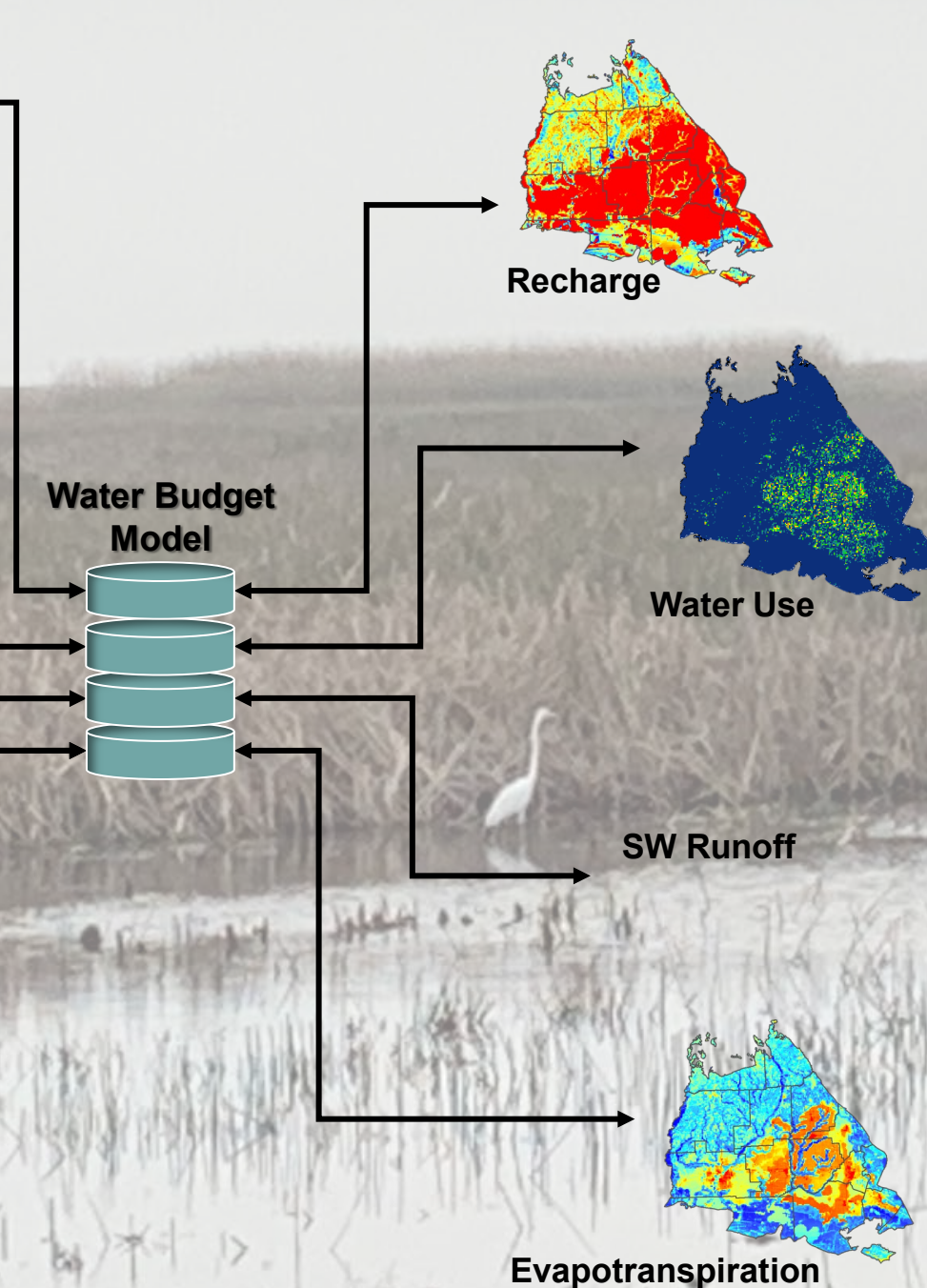
SW Monitoring



ET Monitoring



Remote Sensing



• Water Budget

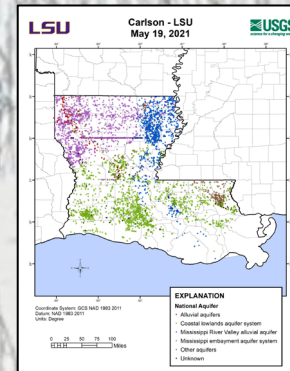
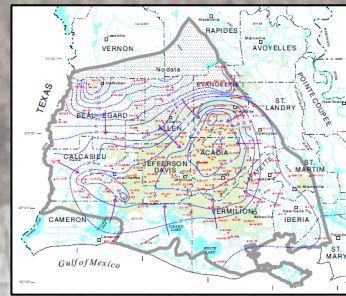
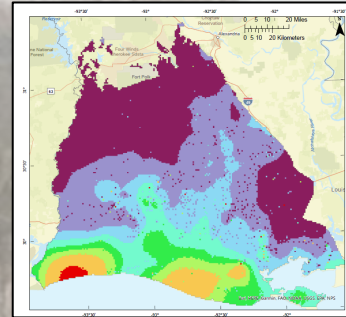
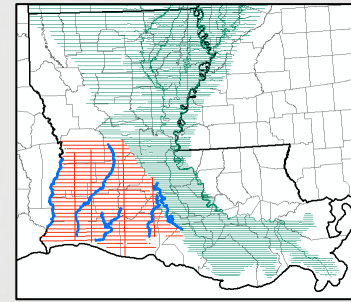
• Data

- Water Use
- ET
- Stream gaging
- Remote sensing

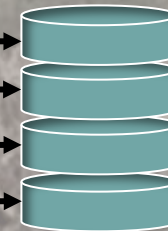
• Models

- Water budgets
 - EWB - national scale
 - SWB - local scale
- Water Use
 - AIWUM
 - Industrial WU model

- Geophysical Mapping
 - Xcalibur Multiphysics
 - LSU – Dr. Frank Tsai
- Salinity Mapping
 - LaDNR - SONRIS
 - LaDEQ
- Groundwater Levels
 - DOTD
- Aquifer Properties
 - DNR
 - DOTD
 - LSU – Dr. Doug Carlson



Hydrogeologic Model



Geophysical Mapping



Salinity Mapping



Groundwater Mapping



GROUNDWATER LEVELS

Collecting groundwater level data, publishing updates, and developing tools



Total LaDNR Wells

216,901

Step 1: Pre-Processed to Geographic area

20,759 Wells Remaining

Step 2: Scripts review metadata and data errors

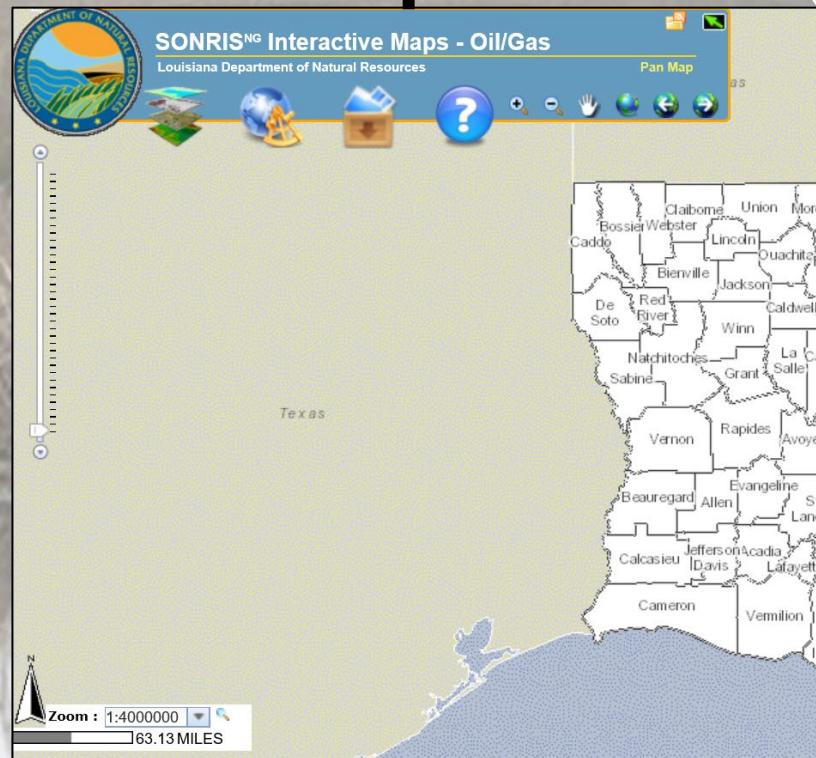
13,946 Wells Removed

Step 3: Hydrographic and Statistical Analysis

Processed 6701 Wells

Publication 6587 wells

Groundwater
Model Input



Quality Assurance of Water Level Records from Wells in the Chicot Aquifer System in southwestern Louisiana from the Louisiana Department of Natural Resources' Strategic Online Natural Resources Information System (SONRIS)

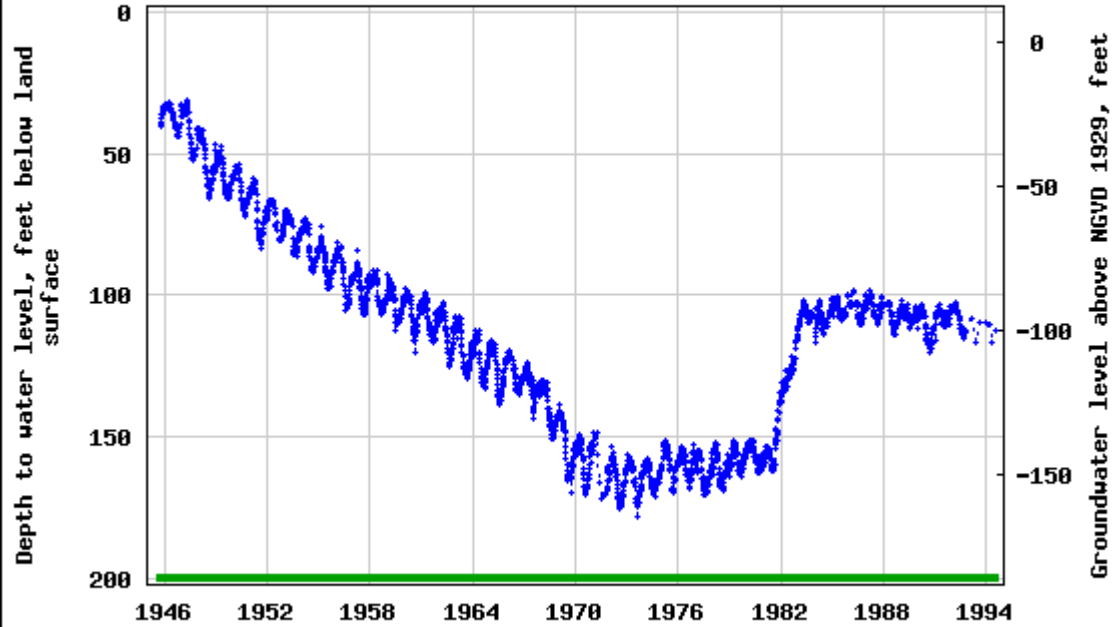
Citation
Bussell, A.M., Asquith, W.H., W.H. Seaton, R.C., 2021, Quality Assurance of Water Level Records from Wells in the Chicot Aquifer System in southwestern Louisiana from the Louisiana Department of Natural Resources' Strategic Online Natural Resources Information System (SONRIS). U.S. Geological Survey data release. <https://doi.org/10.5066/9753J915>

Summary
The Louisiana Department of Natural Resources' (LaDNR) Strategic Online Natural Resources Information System (SONRIS) is a repository for recent (1930s-present) well information that includes date of completion, well construction, geology, and water level. Well information is provided by the well drillers during the permitting process and is updated regularly by LaDNR. This data set consists of well records that were drilled into or through the Chicot aquifer and associated aquifer units (200-foot Sand of Lake Charles Area, 500-foot Sand of Lake Charles Area, 700-foot Sand of Lake Charles Area, Chicot Aquifer System Surficial Confining Unit, Chicot Aquifer, Lower, Chicot Aquifer, Middle, Chicot Aquifer, Shallow Sand, Chicot Aquifer, Upper, Upland Terrace Aquifer, Upland Terrace Aquifer Surficial Confining Unit) in an approximate 15 parish area in southwestern Louisiana as reported by the well drillers. Records that meet specific threshold criteria were identified and statistical analysis done to ensure that the well was open to the Chicot Aquifer System (Asquith and others, 2020). Records that did not meet the specific criteria were identified and noted in the 100-142 - LaDNR SONRIS Dataset. Water levels from wells meeting all criteria were placed into a final dataset to be used in groundwater modeling efforts for the Chicot aquifer. Each original record can be found in the SONRIS data base by searching for the local well number. The LaDNR site can be accessed at the following URL: <http://sonris.com/>

Child Items (3)
Final Dataset
Original Dataset
Statistical Analysis

Map >
Spatial Services
ScienceBase WMS : <https://www.sciencebase.gov/catalog/>
Communities
USGS Lower Mississippi-Gulf Water Science Center #
Associated Items
% Associate an Item
Tags
Categories : Data Release - In Progress
Provenance
Audit History
Created : by stf5-app on Fri Sep 18 11:45:58 MDT 2020
Updated : by abussell@dnr.gov

USGS 301115093191501 Cu-445

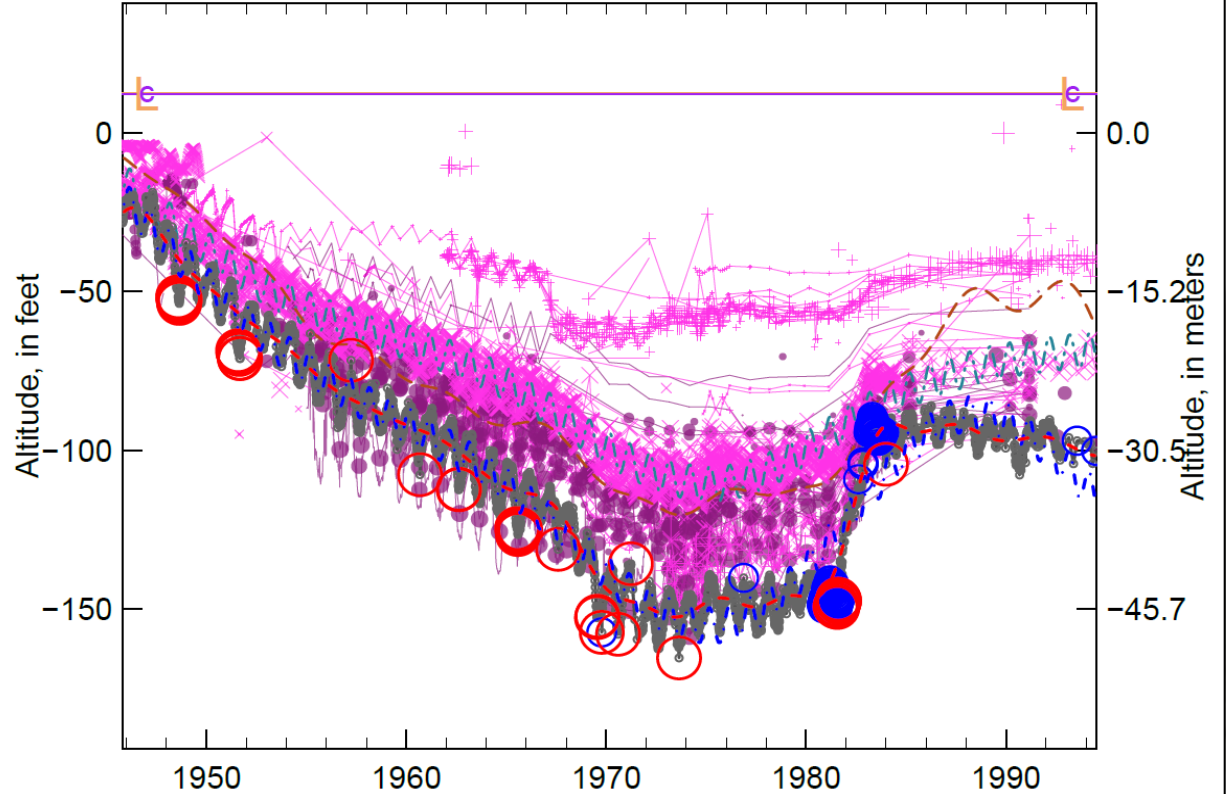


— Period of approved data

```
# GAM_RES_VA      -- Site GAM absolute residual value, in feet
# GAM_OUTLIER    -- Logical whether the residual is an outlier
# SVM_RES_VA     -- Site SVM absolute residual value, in feet
# SVM_OUTLIER    -- Logical whether the residual is an outlier
# GAMandSVM      -- Logical are both GAM and SVM estimates outliers
# RES_MEAN       -- Mean of GAM_RES_VA and SVM_RES_VA with na.rm=TRUE, in feet
```

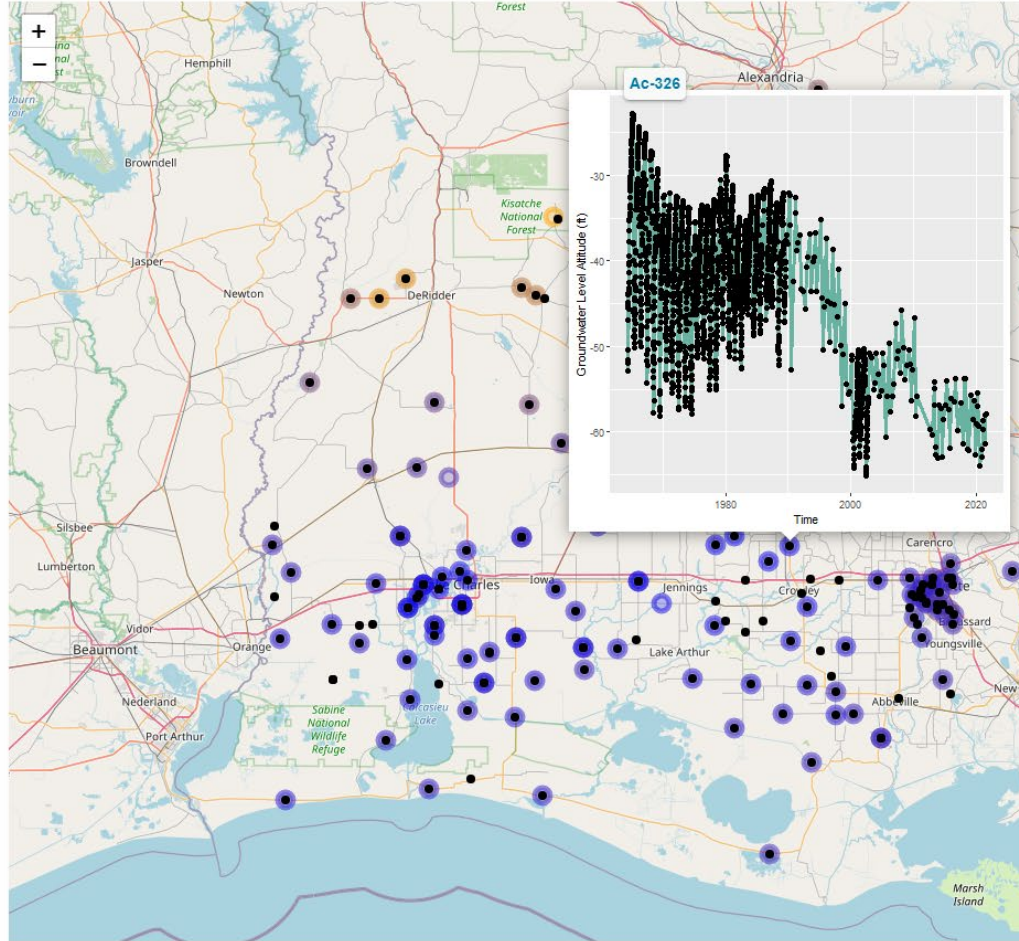
SITE_BADGE	STATION_NM	DEC_LAT_VA	DEC_LONG_VA	ALT_VA	ALT_DATUM_CD	LEV_DT	LEV_VA	LEV_ALT_VA	GAM_RES_VA	GAM_OUTLIER	SVM_RES_VA	SVM_OUTLIER	GAMandSVM	RES_MEAN		
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-03		91.4	-78.98	12.09	TRUE	1.85	FALSE	FALSE	6.97
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-05		91.38	-78.96	12	TRUE	1.85	FALSE	FALSE	6.92
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-10		91.38	-78.96	11.71	TRUE	1.9	FALSE	FALSE	6.81
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-15		91.18	-78.76	11.59	TRUE	1.75	FALSE	FALSE	6.67
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-20		90.98	-78.56	11.44	TRUE	1.6	FALSE	FALSE	6.52
USGS:301115093191001	Cu-446	30.18770697	-93.3195996	-93.3195996	12.42	NGVD29	1983-10-25		90.86	-78.44	11.18	TRUE	1.52	FALSE	FALSE	6.35

USGS:301115093191501



Water-Level Synoptic: January/February

2021 Water-Levels in Chicot Aquifer System of Southwestern Louisiana



By State **By Aquifer/Agency**

Water-Level Data in the Chicot Aquifer System of Southwestern Louisiana

AQFR_CD	USGS	Totals
11202LC	11	11
11205LC	21	21
11207LC	10	10
112CHCT	39	39

112CHCTU 11207LC 11205LC 11202LC 112CHCTS 112CHCTL 112CHCT 112CHCTC 112UPTC

SITE_NO	STATION_NM	STATE_CD	COUNTY_CD	WLEV_COUNT	2016	2017	2018	2019	2020	2021	AQFR_CD	ALT_VA	CURRENT	LEV_VA	LEV_ALT_VA	LEV_AGE_CD
293845092264901	Ve-639	22	113	22	3	3	4	5	5	2	112CHCTU	5.84	2021-06-10 14:49:00	9.78	-3.94	P
293845092264901	Ve-639	22	113	22	3	3	4	5	5	2	112CHCTU	5.84	2021-07-13 18:37:00	10.20	-4.36	P
294615093004201	Cn-118	22	023	19	4	3	4	4	2	2	112CHCTU	5.00	2021-05-13 19:16:00	28.48	-23.48	P
294615093004201	Cn-118	22	023	19	4	3	4	4	2	2	112CHCTU	5.00	2021-07-21 17:41:00	28.39	-23.39	P
294749091402301	SM-57U	22	101	21	3	3	4	4	3	4	112CHCTU	8.72	2021-02-02 00:36:00	8.66	0.06	P
294749091402301	SM-57U	22	101	21	3	3	4	4	3	4	112CHCTU	8.72	2021-04-20 18:31:00	7.43	1.29	P
294749091402301	SM-57U	22	101	21	3	3	4	4	3	4	112CHCTU	8.72	2021-06-14 17:38:00	7.05	1.67	P
294749091402301	SM-57U	22	101	21	3	3	4	4	3	4	112CHCTU	8.72	2021-07-12 16:12:00	7.19	1.53	P
294749091402302	SM-57L	22	101	1					1		112CHCTU	8.72				
294825093112801	Cn-139	22	023	1	1						112CHCTU	5.00				
295031092203202	Ve-630U	22	113	23	3	4	4	5	4	3	112CHCTU	4.75	2021-01-27 20:10:00	13.90	-9.15	P
295031092203202	Ve-630U	22	113	23	3	4	4	5	4	3	112CHCTU	4.75	2021-06-10 13:36:00	12.62	-7.87	P
295031092203202	Ve-630U	22	113	23	3	4	4	5	4	3	112CHCTU	4.75	2021-07-13 19:12:00	13.42	-8.67	P
295345092100702	Ve-637U	22	113	22	4	3	4	4	4	3	112CHCTU	4.06	2021-01-28 19:10:00	12.49	-8.43	P
295345092100702	Ve-637U	22	113	22	4	3	4	4	4	3	112CHCTU	4.06	2021-06-10 16:16:00	11.45	-7.39	P
295345092100702	Ve-637U	22	113	22	4	3	4	4	4	3	112CHCTU	4.06	2021-07-13 19:34:00	11.72	-7.66	P
295345092100703	Ve-637L	22	113	8	2	1				3	112CHCTU	4.06	2021-01-28 19:14:00	12.59	-8.53	P
295345092100703	Ve-637L	22	113	8	2	1				3	112CHCTU	4.06	2021-06-10 16:23:00	11.54	-7.48	P
295345092100703	Ve-637L	22	113	8	2	1				3	112CHCTU	4.06	2021-07-13 19:31:00	11.82	-7.76	P
295504092320101	Ve-654	22	113	3					1	2	112CHCTU	9.60	2021-01-28 16:30:00	29.74	-20.14	P
295504092320101	Ve-654	22	113	3					1	2	112CHCTU	9.60	2021-07-13 16:25:00	28.98	-19.38	P
295645092165501	Ve-460	22	113	3					2	1	112CHCTU	9.78	2021-01-27 19:55:00	40.04	-30.26	P



Picture of Xcalibur Multiphysics Tempest fixed-wing airborne electromagnetic system. Picture provided by Xcalibur Multiphysics

Xcalibur
MULTIPHYSICS

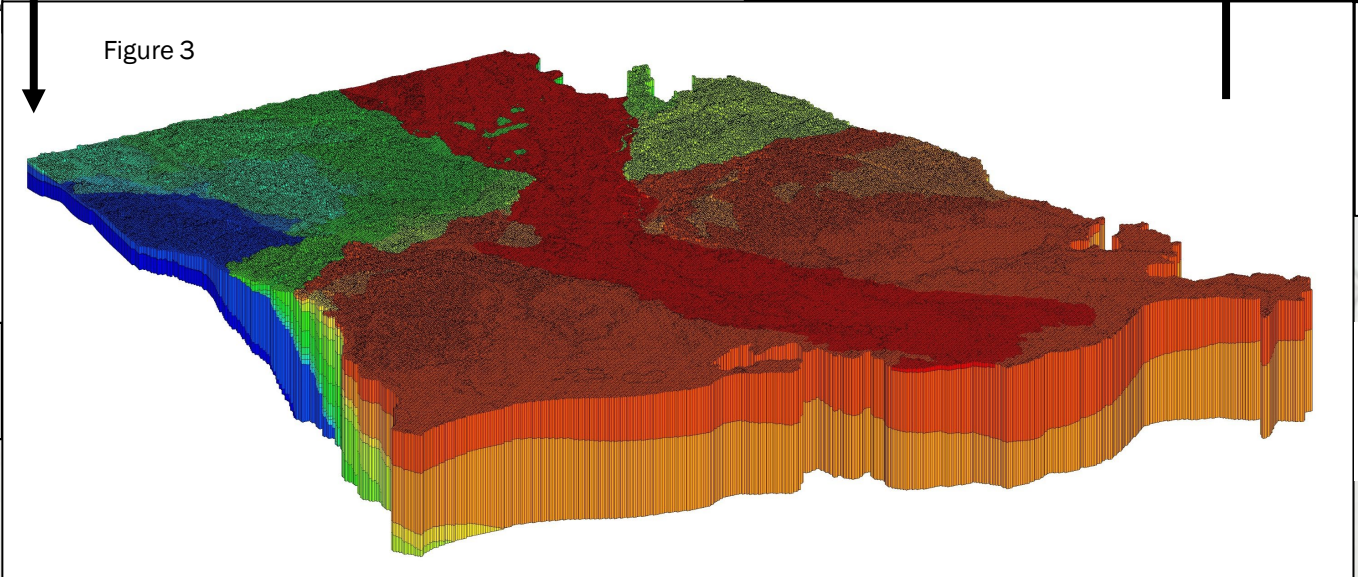
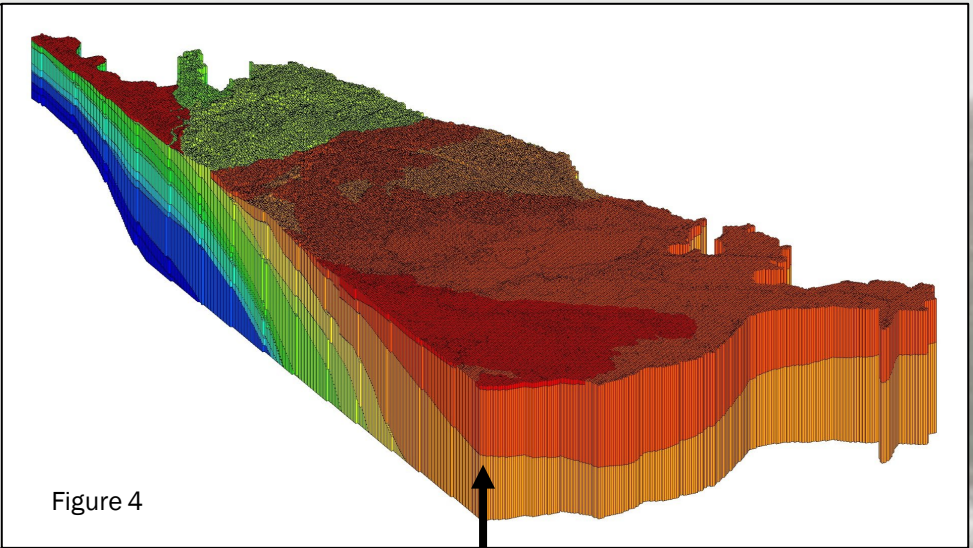
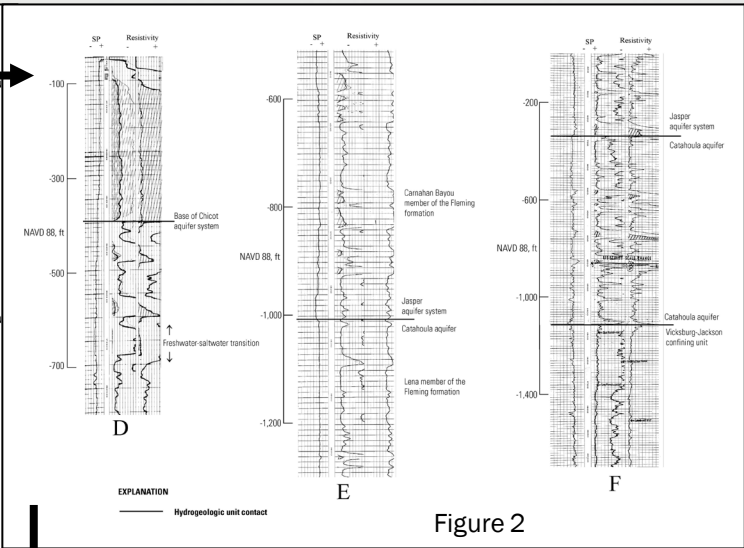
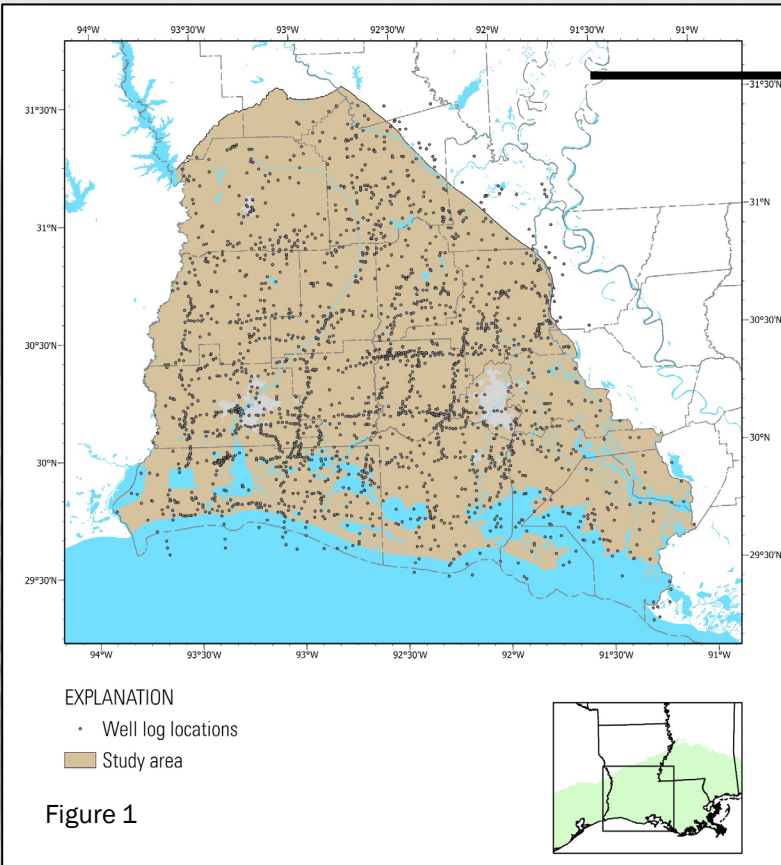


Picture of Xcalibur Multiphysics Resolve helicopter frequency-domain airborne electromagnetic. Picture taken by J.R. Rigby, USGS.

Xcalibur
MULTIPHYSICS

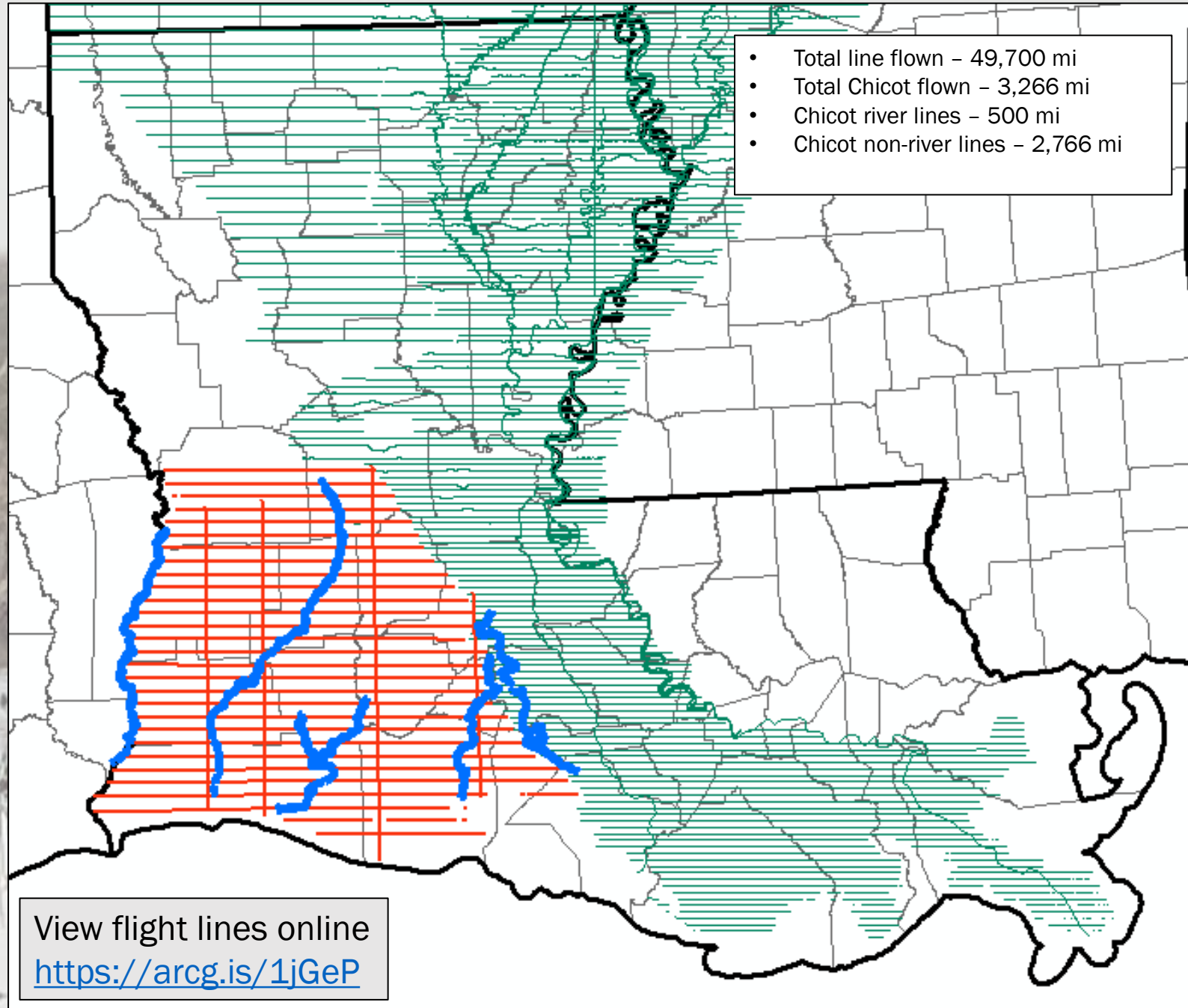
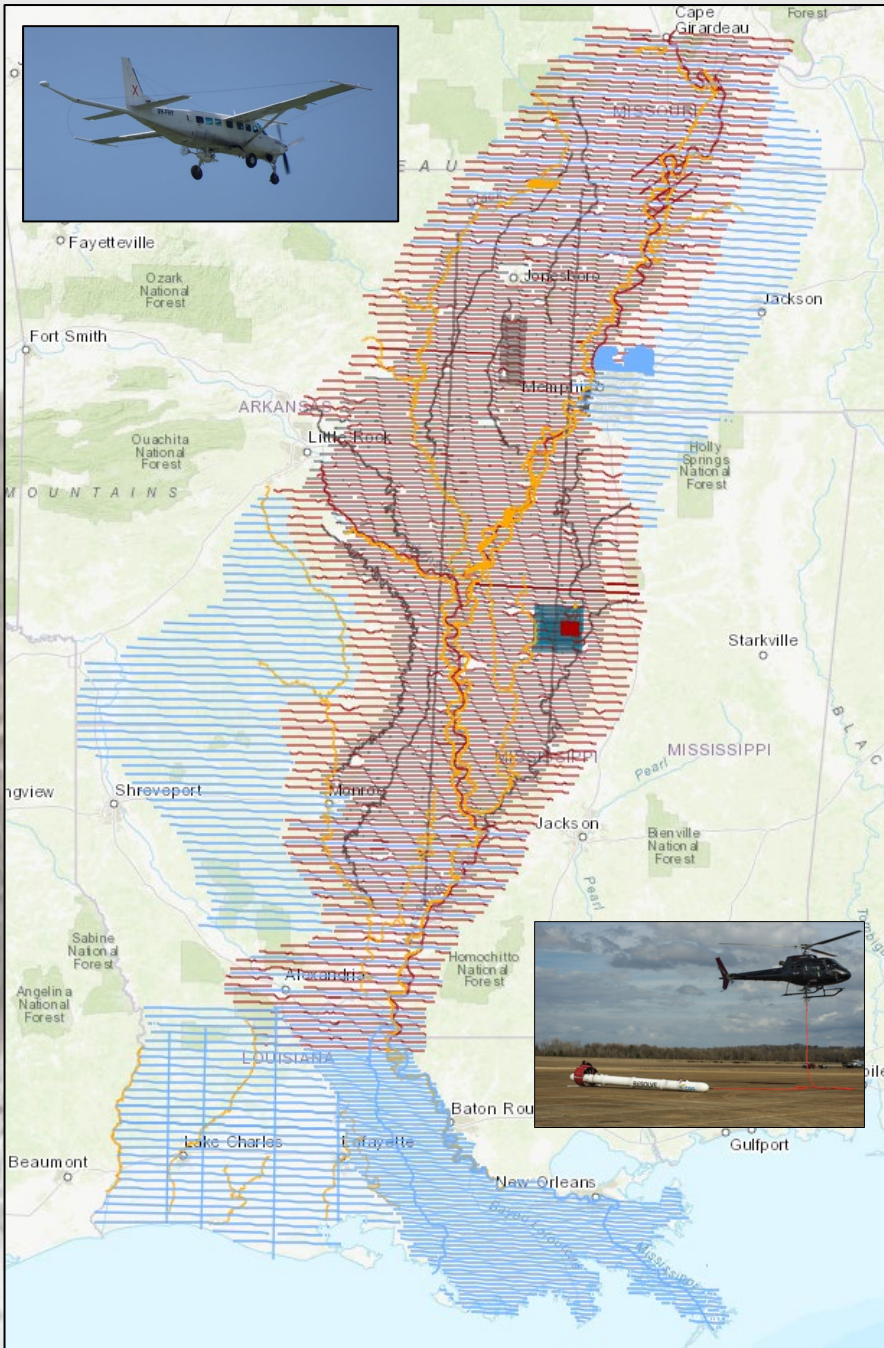
Geophysical Mapping

Stratigraphic Model

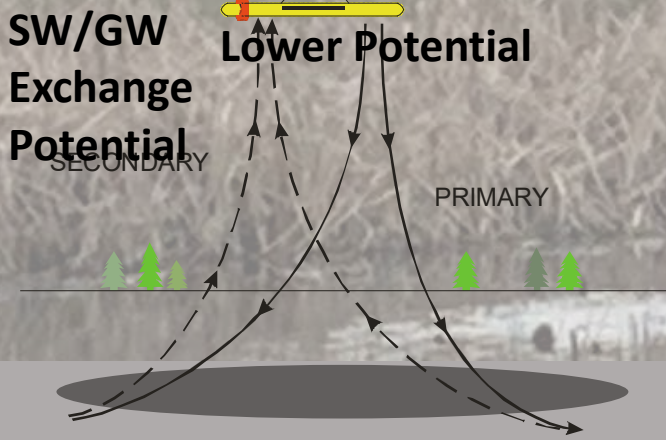


Figures 3-4. 3D geologic model developed by Dr. Frank Tsai, LSU using from Teeple and others (2021) <https://doi.org/10.5066/P9PEFY11>

Figures 1-2. Geophysical logs interpreted to support the hydrogeologic framework of southwest LA. Figure provided by Max Lindaman, USGS



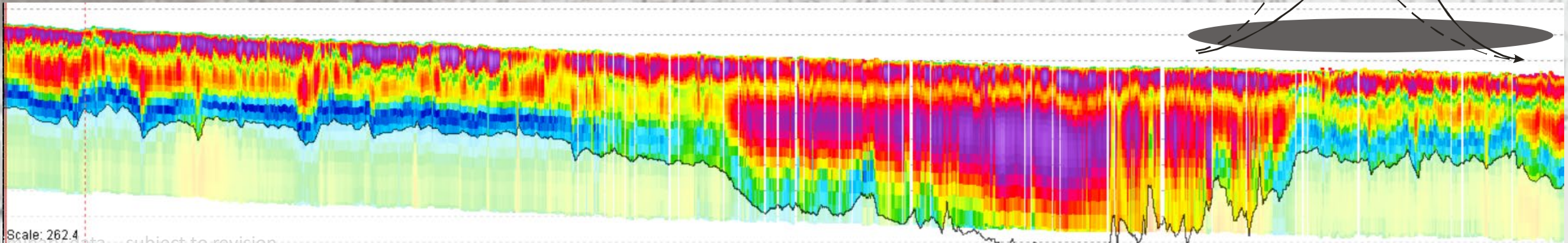
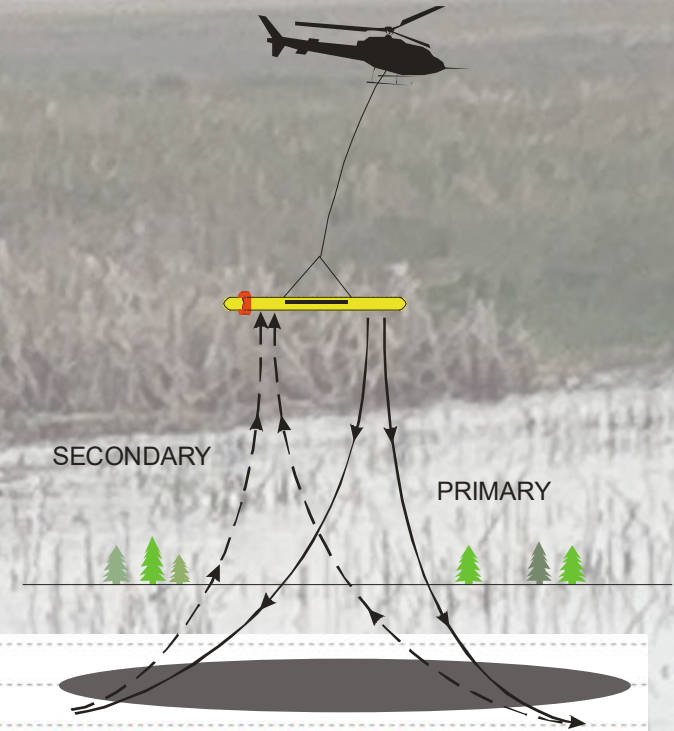
Slide courtesy of Dr. Burke Minsley,
USGS Research Geophysicist



Resistivity (ohm*m) Low (1) High (1,000)

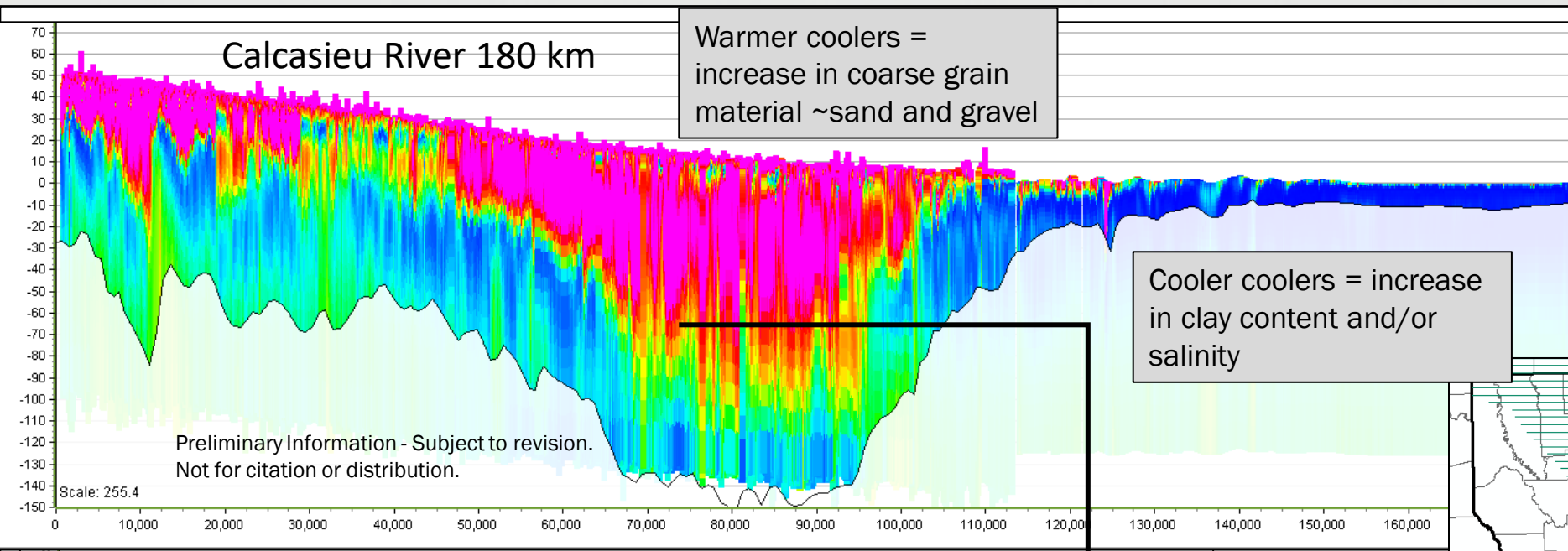


Grain Size Fine Coarse
Sed. Type Clay Sand/Gravel
SW/GW Exchange Potential Lower Potential Higher Potential

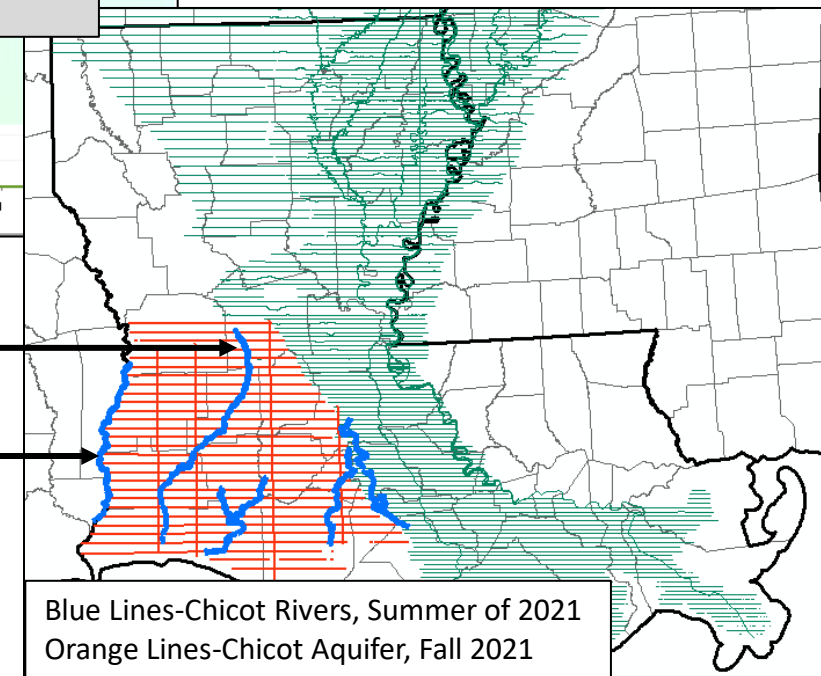
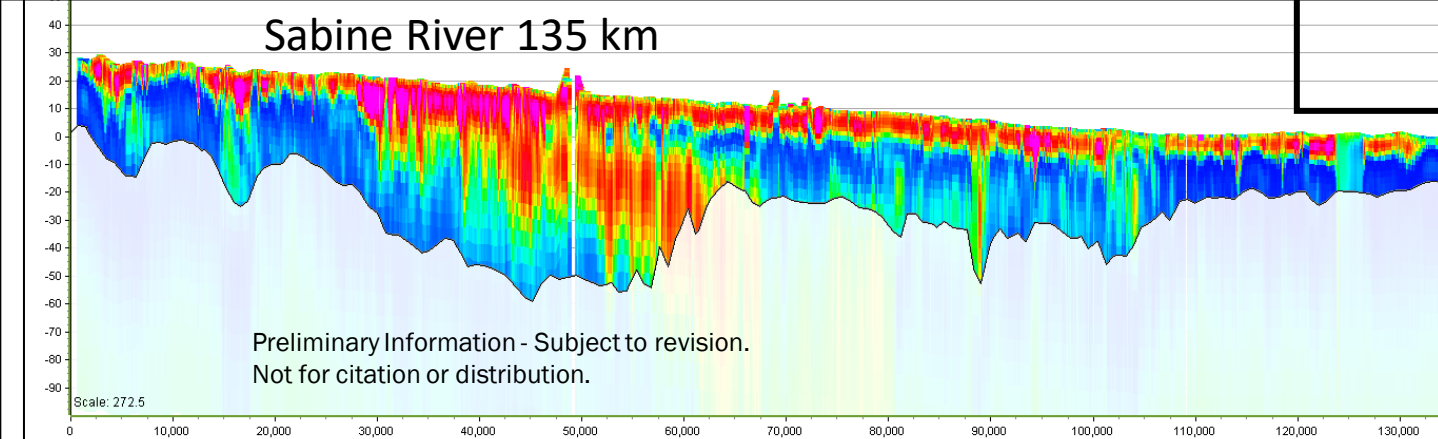


Scale: 262.4
Preliminary data - subject to revision

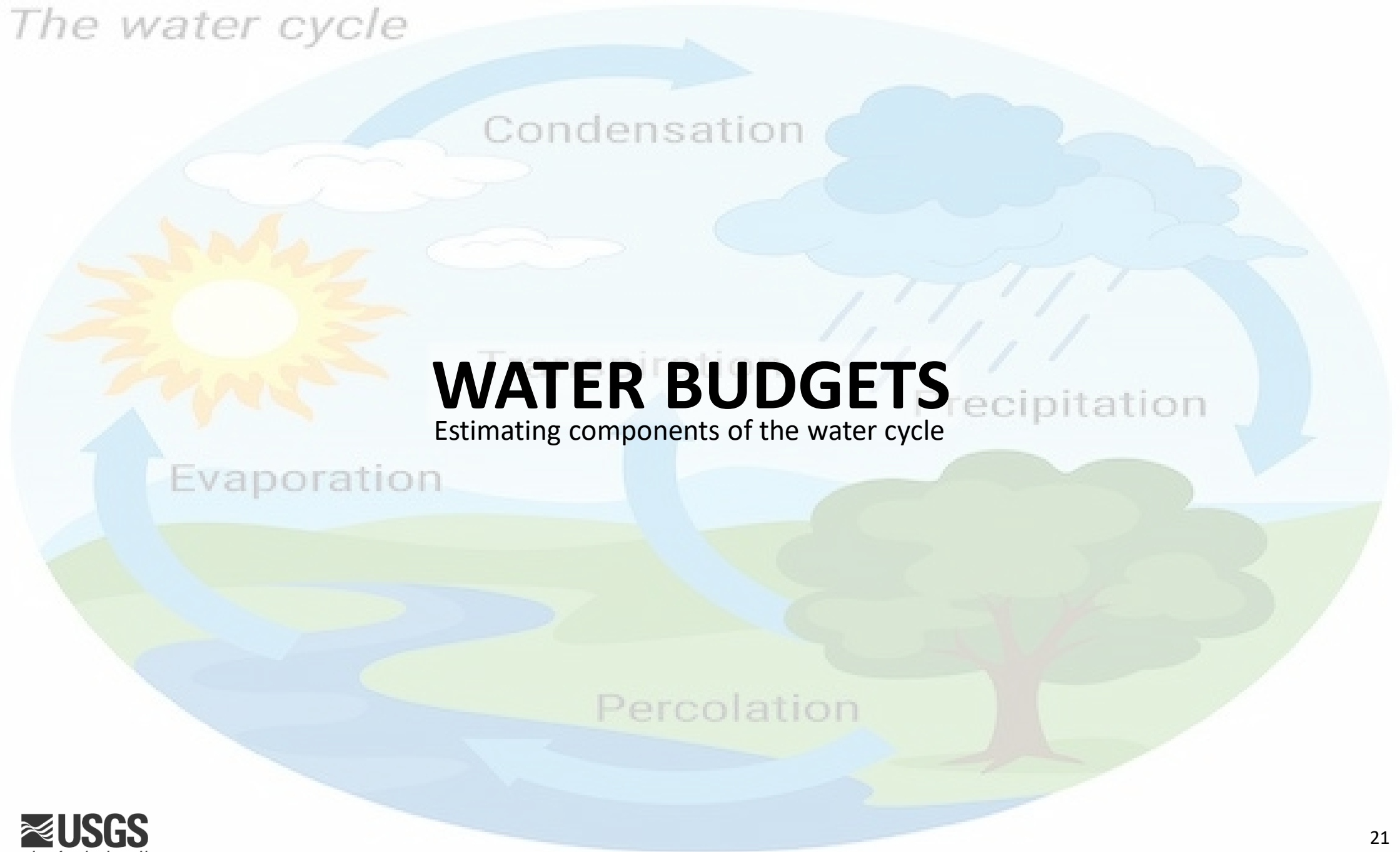
Chicot Aquifer AEM Surveys



- Improve our understanding of GW/SW interactions
- Data collected in the MAP show that rivers are a significant source of recharge to the aquifer



The water cycle



WATER BUDGETS

Estimating components of the water cycle

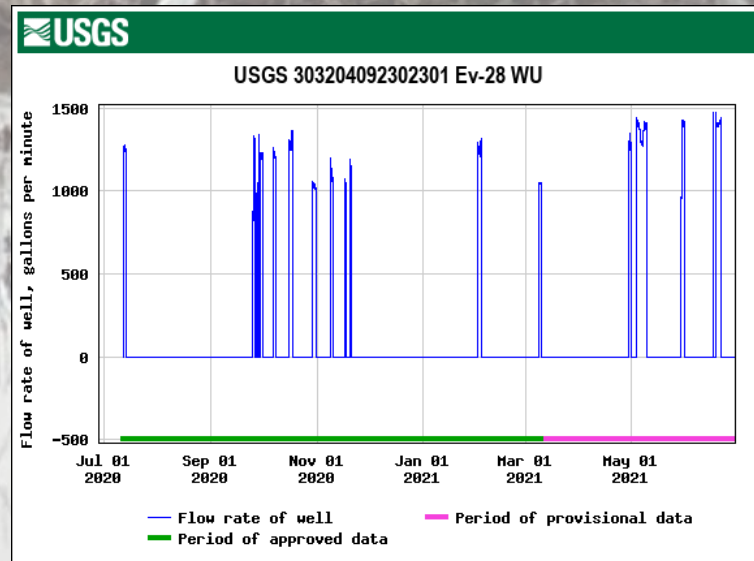
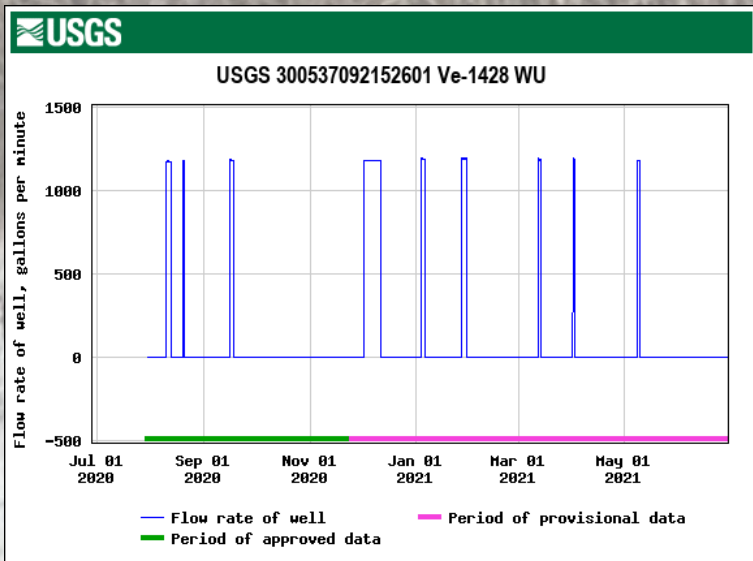
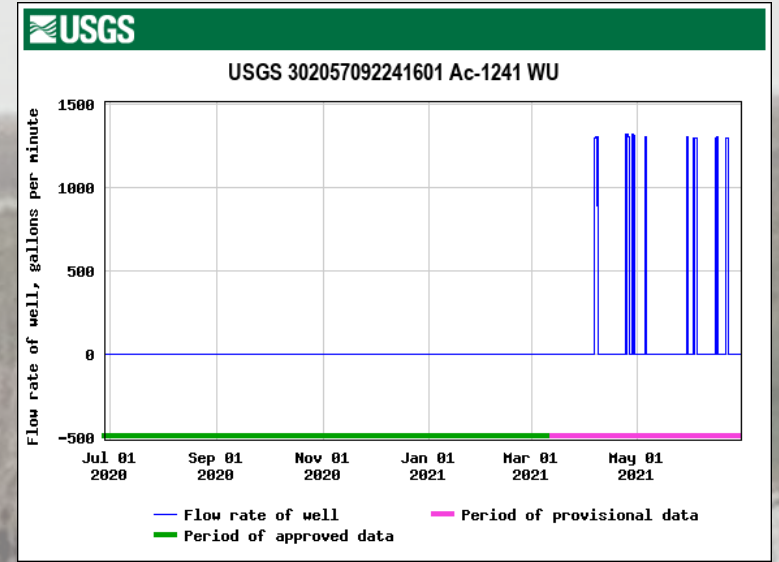
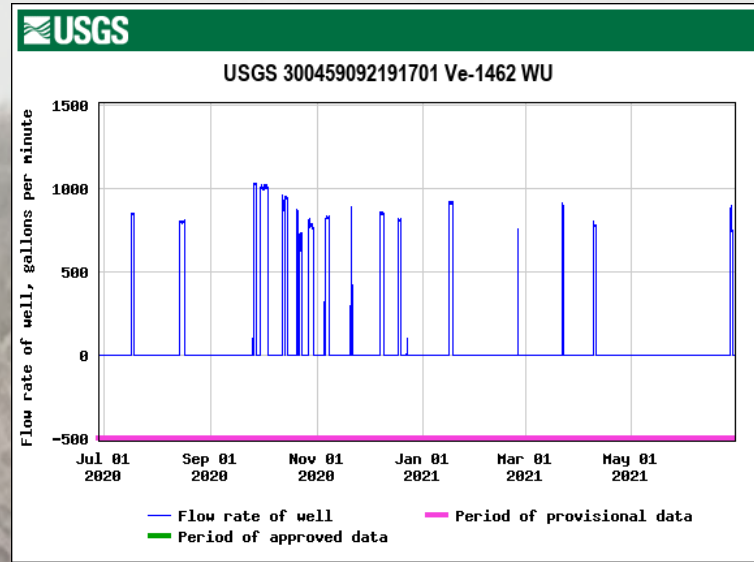
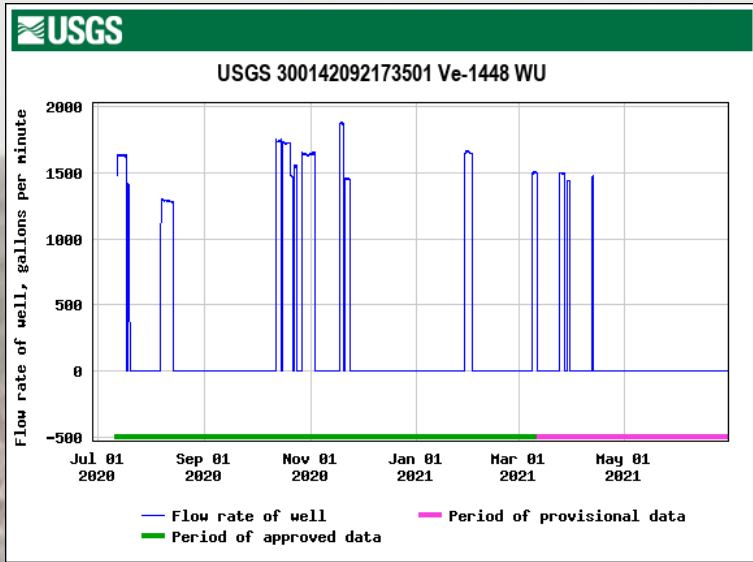


Aquaculture and Irrigation Water Use



Chicot Aquifer System

Water-Use Monitoring Network



waterdata.usgs.gov/nwis/current/?type=customized&sort_key_2=site_no&PARAMeter_cds=STATION_NM, DATETIME,00058&group_key=state_cd

USGS Home
Contact USGS
Search USGS

National Water Information System: Web Interface

USGS Water Resources (District Access) Basin Categories: Current Conditions Geographic Area: United States GO

Click to hide News Bulletins

- Introducing The Next Generation of USGS Water Data for the Nation
- Full News 13
- June 29, 2021 - we are experiencing an outage on some realtime data sites. We are actively investigating it now. A follow up message will be posted when resolved.

Current Conditions for USA -- 91 site(s) found

PROVISIONAL DATA SUBJECT TO REVISION

--- Predefined displays --- Group table by Select sites by number or name
Current Custom Display State go show sites on a map

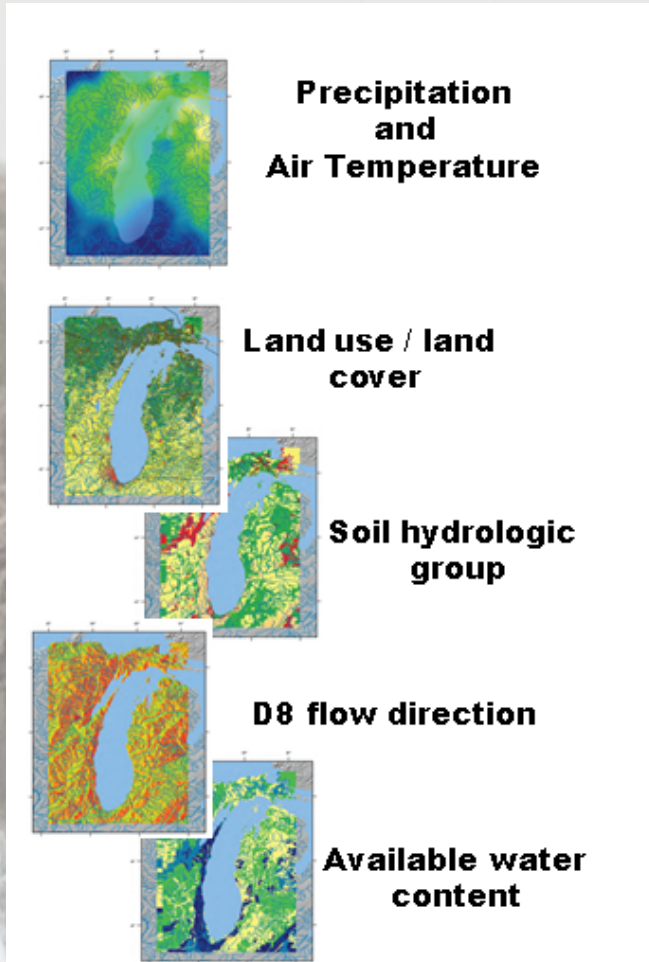
Customize table to display other current-condition parameters

Station Number	Station name	Date/Time	Flow rate of well, gal/min
----------------	--------------	-----------	----------------------------

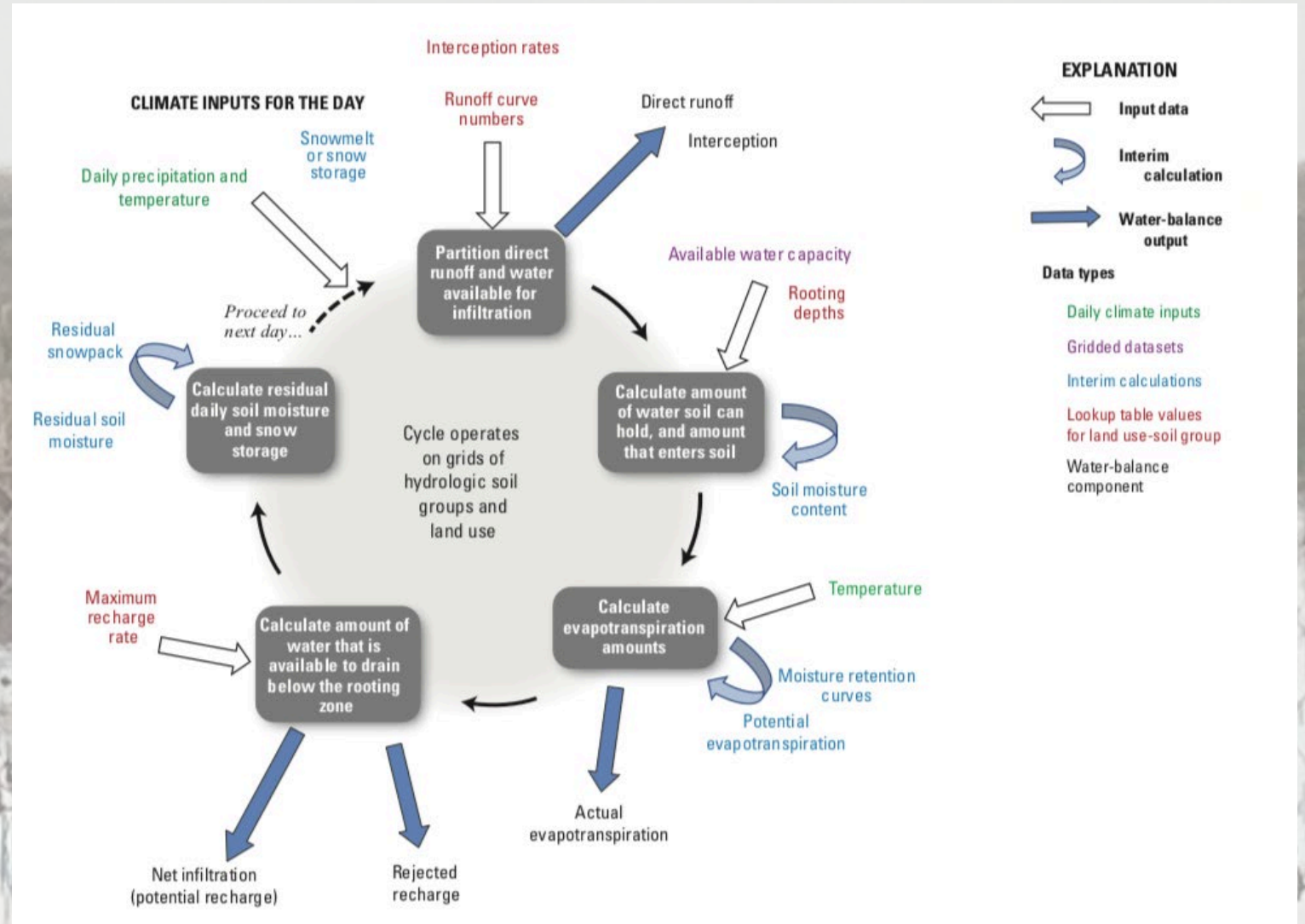
https://waterdata.usgs.gov/nwis/current/?type=customized&sort_key_2=site_no&PARAMeter_cds=STATION_NM, DATETIME,00058&group_key=state_cd

Soil Water Balance Model

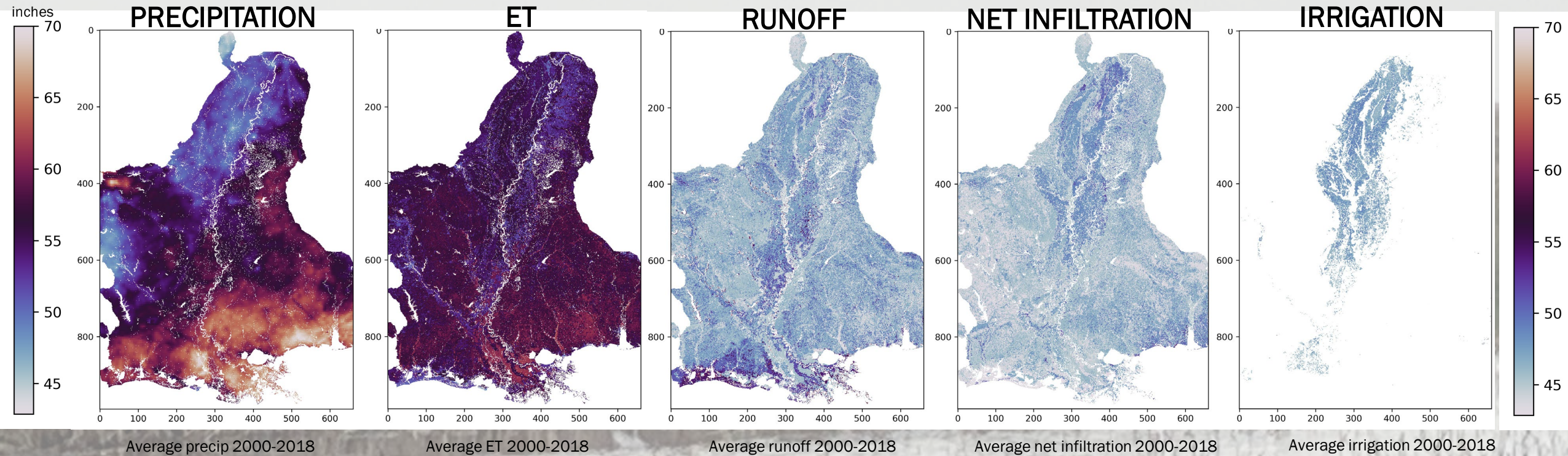
A modified Thornthwaite-Mather model for estimating groundwater recharge



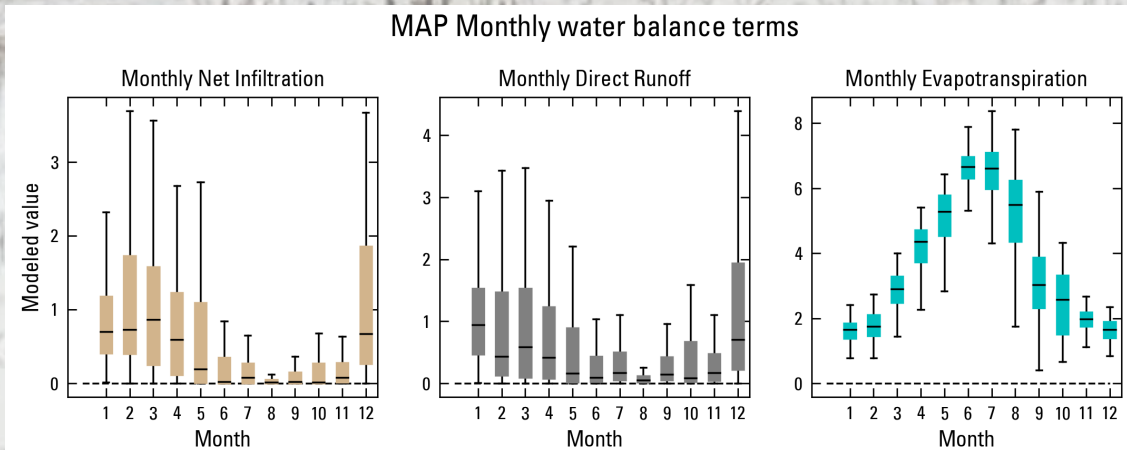
Data requirements for the soil-water-balance model.



Soil Water Balance model



Preliminary information-Subject to revision.
Not for citation or distribution.



WATER QUALITY

Measuring and modeling water quality constituents



Water Quality Samples for the Nation

To view additional data-quality attributes, output the results using these options: one result per row, expanded attributes. Additional precautions are [here](#).

USGS 303550092252401 Ev-5500Z

Available data for this site Water-Quality: Field/Lab samples

Evangeline Parish, Louisiana
 Hydrologic Unit Code 08080201
 Latitude 30°35'50", Longitude 92°25'24" NAD83
 Land-surface elevation 57 feet above NGVD29
 The depth of the well is 43 feet below land surface.
 This well is completed in the Coastal lowlands aquifer system (S100CSLLWD) national aquifer.
 This well is completed in the Chicot Aquifer, Shallow Sand (112CHCTS) local aquifer.

Output formats

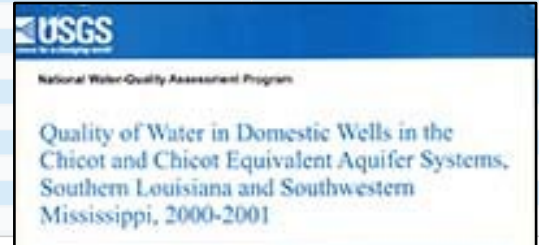
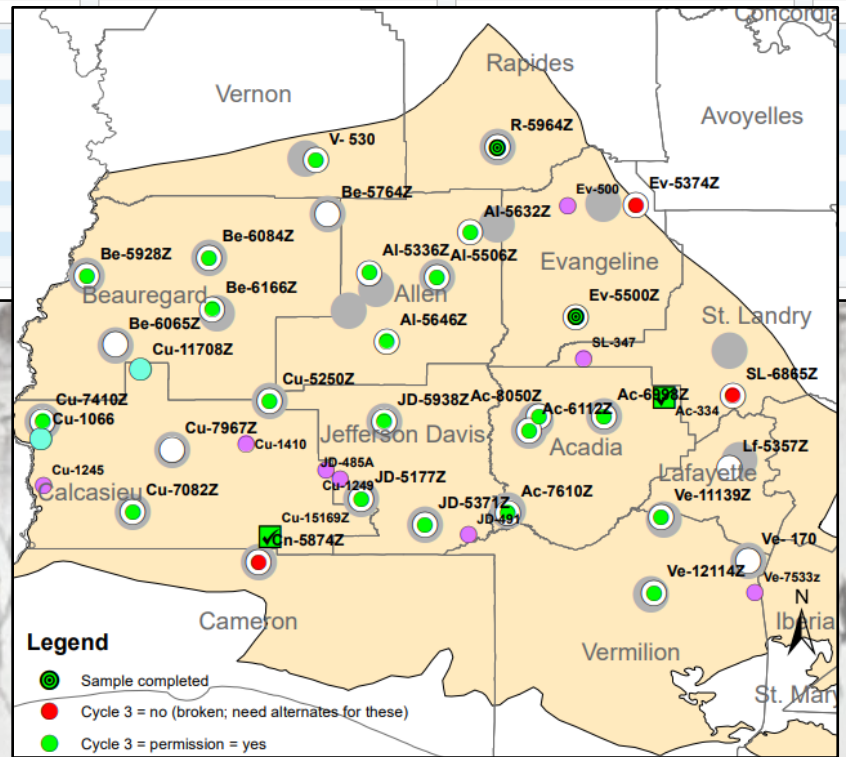
Parameter Group Period of Record table
Inventory of available water-quality data for printing
Inventory of water-quality data with retrieval
Tab-separated data, one result per row
Tab-separated data one sample per row with remark codes combined with values
Tab-separated data one sample per row with tab-delimiter for remark codes
Reselect output format

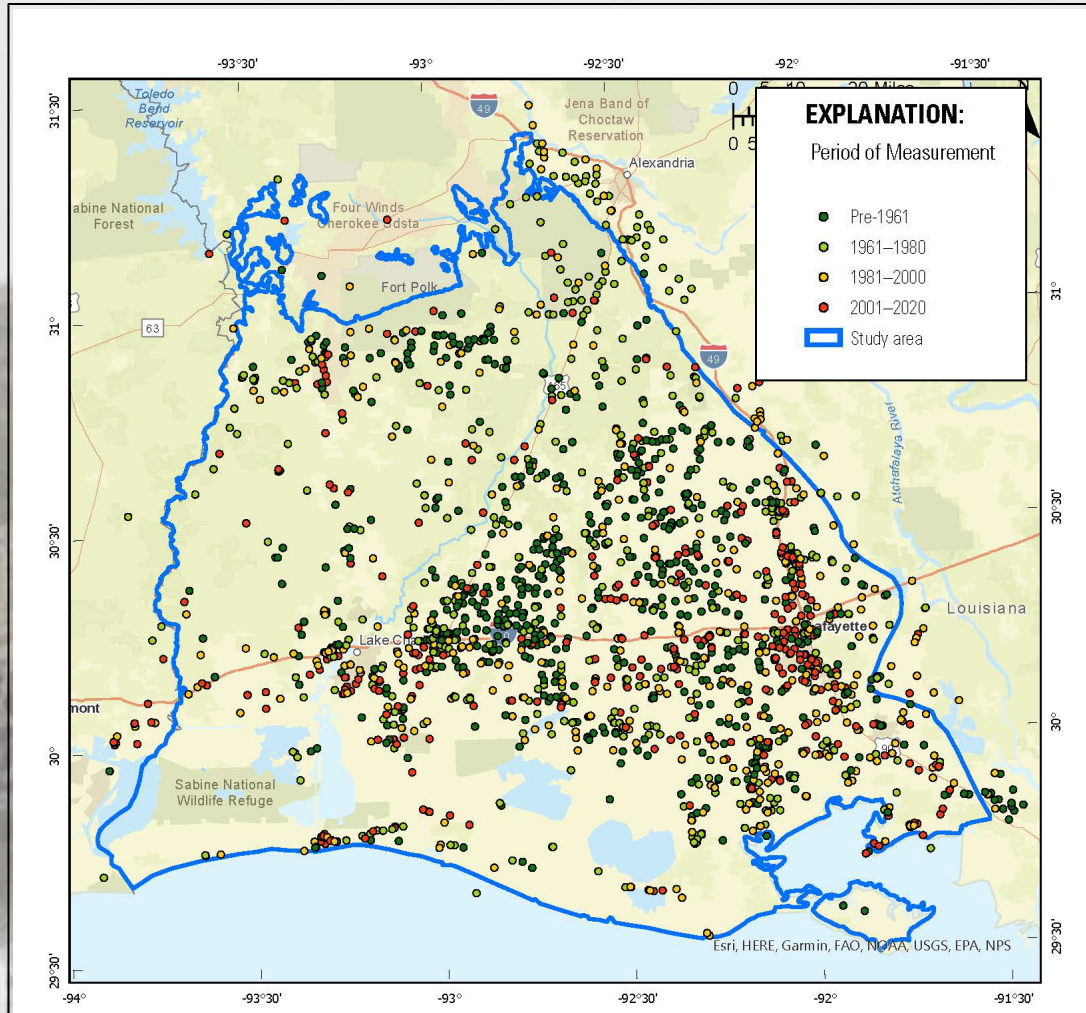
Sample Medium Code	Agency Collecting Sample, Code	Specific conductance, water uS/cm @ 25 degC (00095)	Chloride, water, filtrd, mg/L (00940)
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Fresh Water Complete Analysis

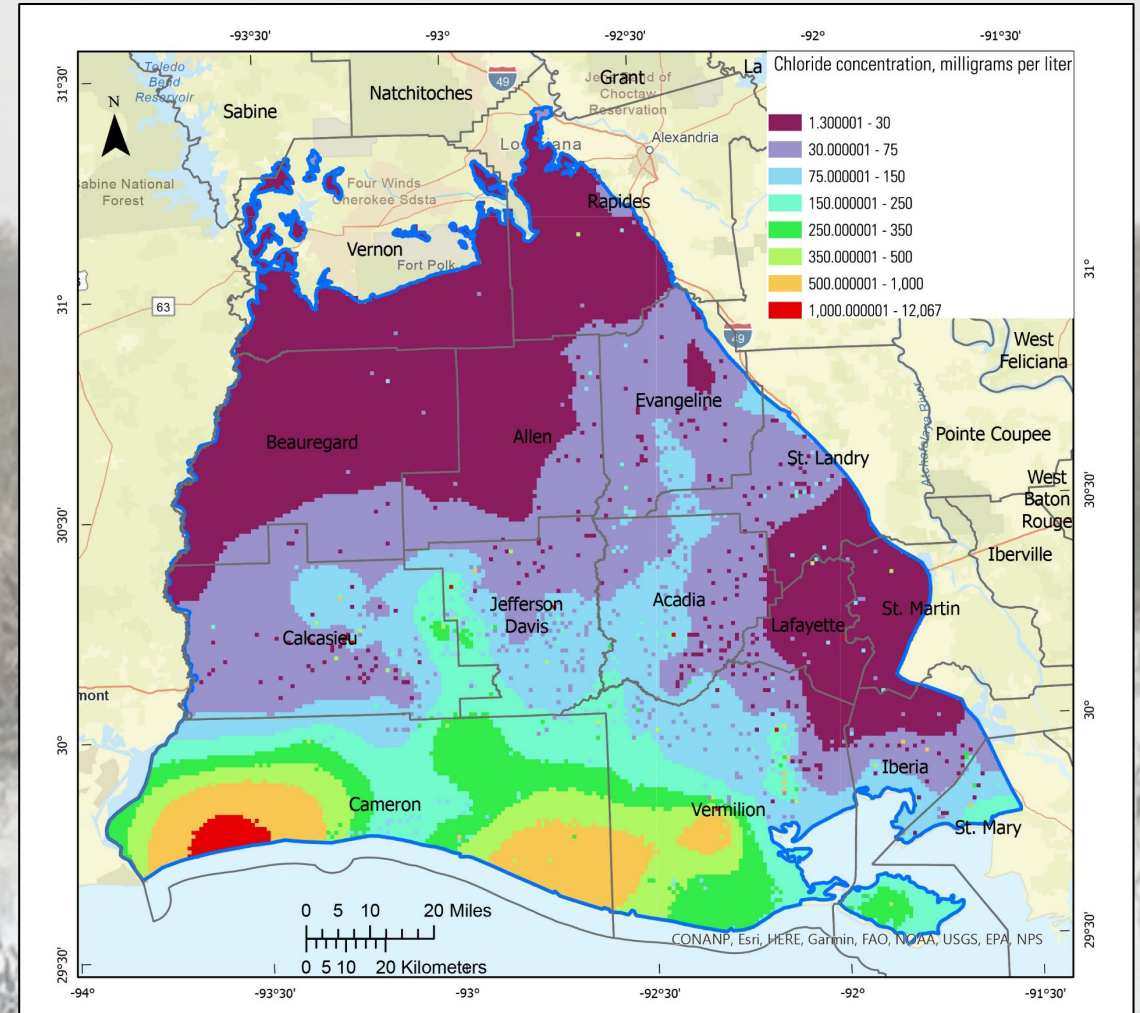
lots
 Sampled by: Rod Howard
 2/18/04 @ 1300
 pH: 7.65*

Parameters - units	Results
pH - s.u.	8.01
Turbidity - NTU	1.31
Color - Apparent	15.00
Langelier's Saturation Index	+0.03
Calcium Carbonate - mg/l	<0.01
Calcium Bicarbonate - mg/l	187.72
Magnesium Carbonate - mg/l	<0.01
Magnesium Bicarbonate - mg/l	60.90
Sodium Carbonate - mg/l	<0.01
Sodium Bicarbonate - mg/l	54.64
Sodium Sulfate - mg/l	<0.01
Sodium Chloride - mg/l	80.42
Nitrogen As Nitrate - mg/l	<0.01
Silica As Silicon Dioxide - mg/l	33.50
Manganese - mg/l	0.12
Chloride - mg/l	48.80
Iron - mg/l	0.64
Carbonate - mg/l	<0.01
Bicarbonate - mg/l	231.80
Sulfate - mg/l	<1
Calcium - mg/l	46.35
Magnesium - mg/l	10.15
Sodium - mg/l	46.58
Fluoride - mg/l	0.15
Total Dissolved Solids- mg/l	418.09
Total Hardness Calcium Carbonate- mg/l	157.51
P Alkalinity As Calcium Carbonate- mg/l	<0.01
MO Alkalinity As Calcium Carbonate- mg/l	190.00
Acidity as Calcium Carbonate - mg/l	<0.01





Locations and time period of measurement for wells used in geostatistical estimation of chloride concentration in the upper, undifferentiated, shallow, confining unit, and “200-foot” sands aquifers- preliminary subject to revision



Geostatistical estimation of chloride concentration in the upper, undifferentiated, shallow, confining unit, and “200-foot” sands aquifer – preliminary subject to revision

Trends

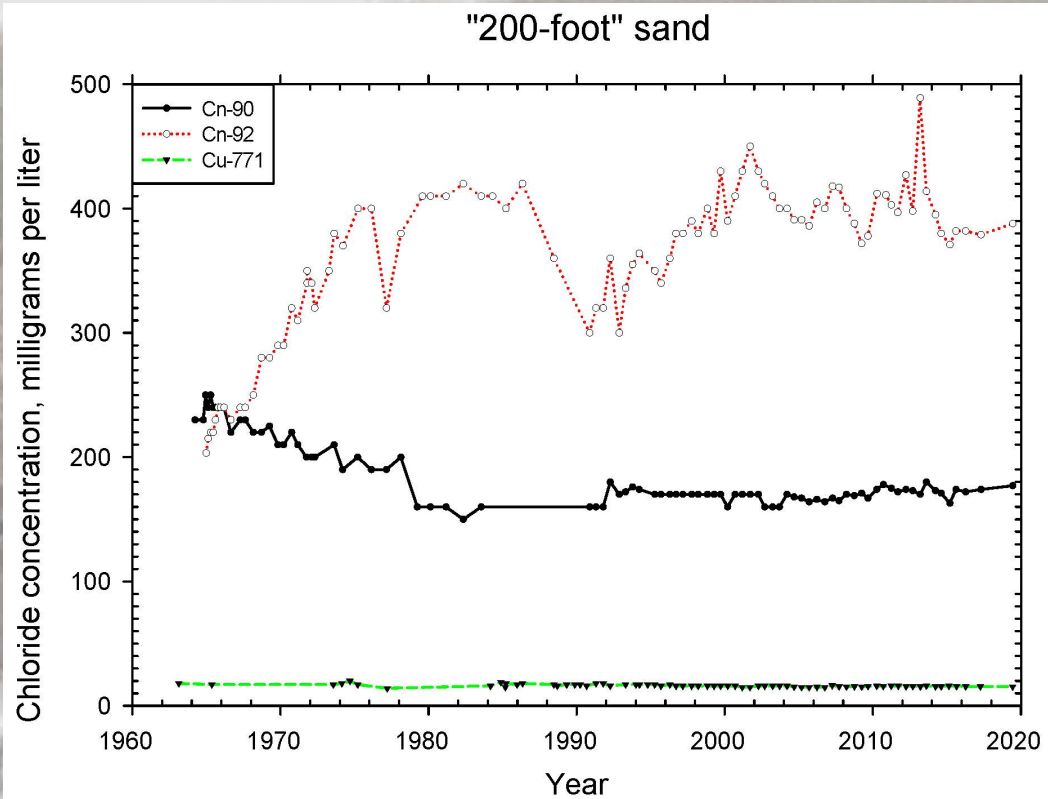


Fig. 20a Chloride time series graphs at wells with greater than 50 years of record, "200-foot" sand (see figures 19a–b for well locations)

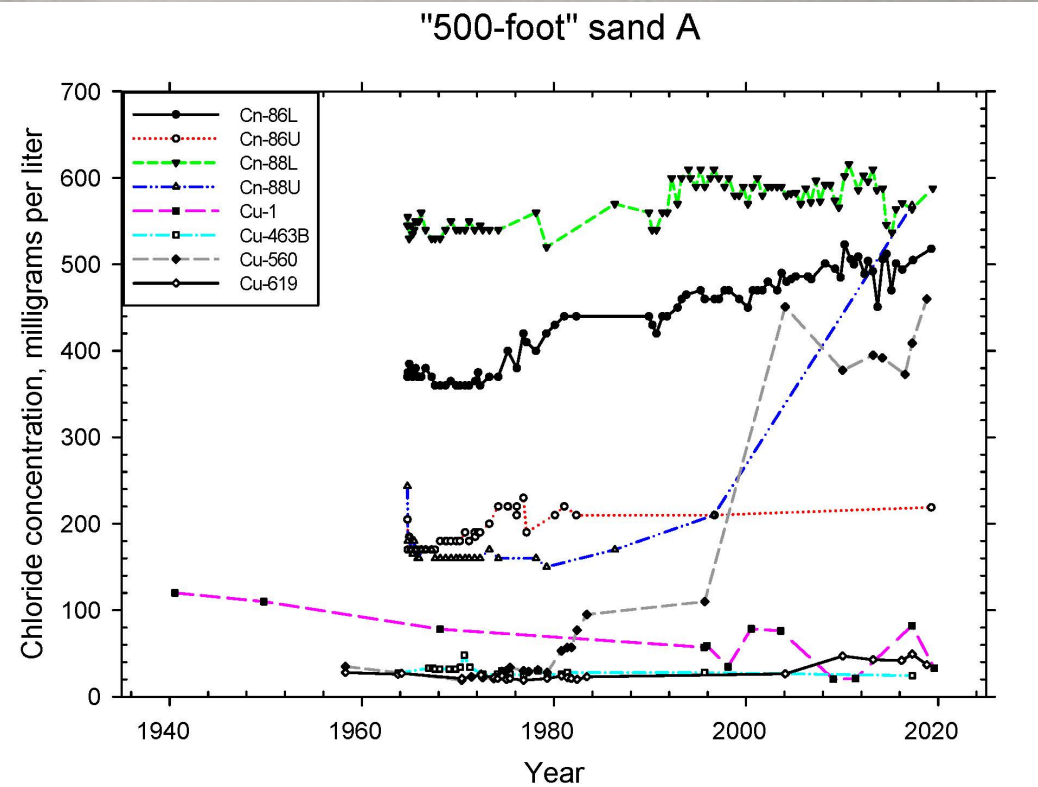
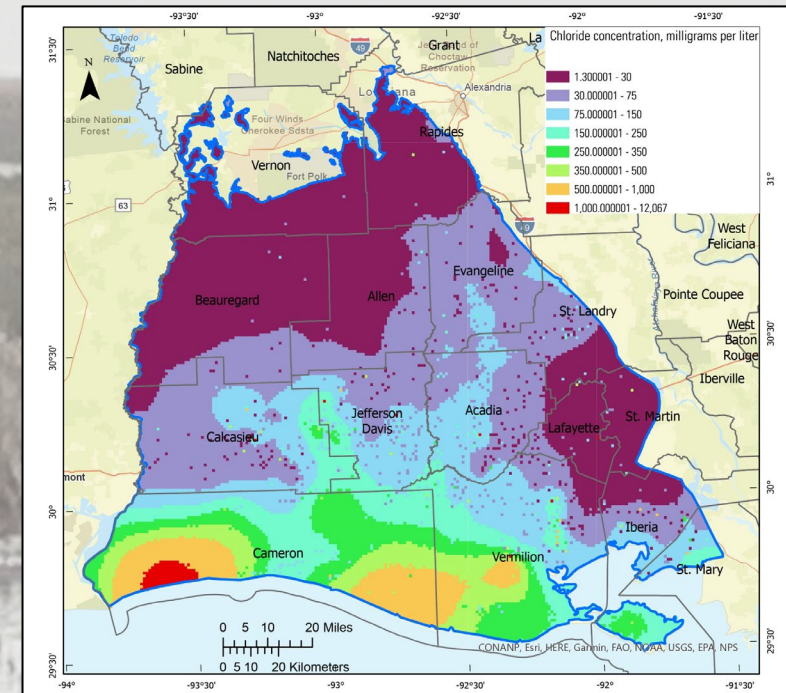
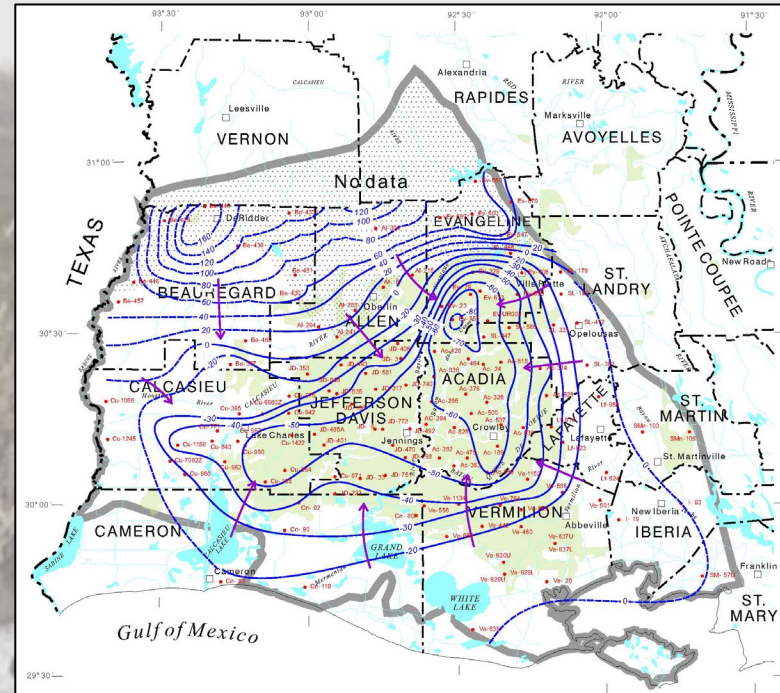
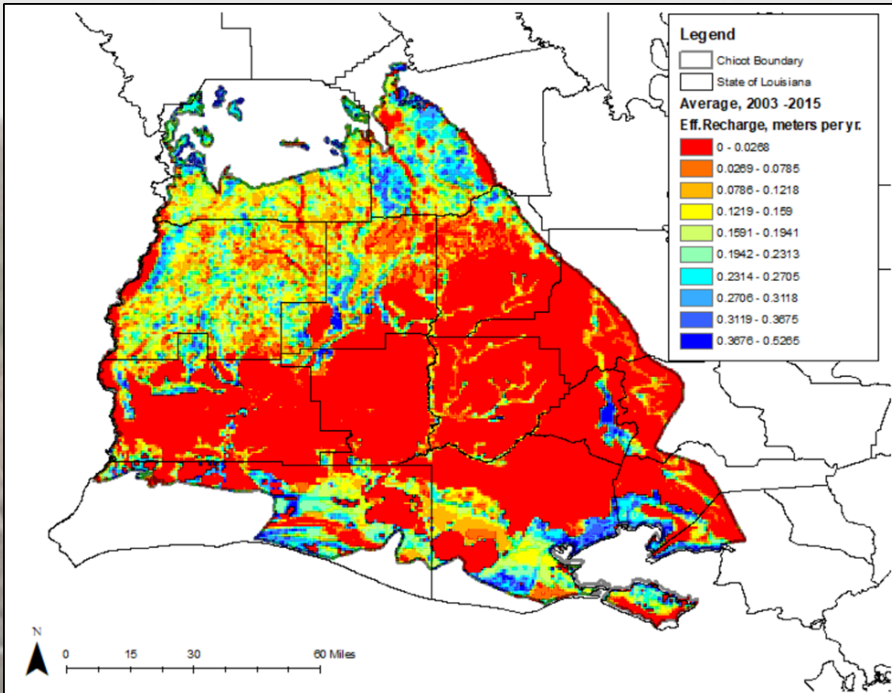


Fig. 20b Chloride time series graphs at wells with greater than 50 years of record, "500-foot" sand aquifer (see figures 19a–b for well locations)

Informed Decision Making



Average Effective Recharge

Reitz, M., and Sanford, W.E., 2019, Modern monthly effective recharge maps for the conterminous U.S., 2003-2015: U.S. Geological Survey data release, <https://doi.org/10.5066/P9NRVAQ5>.

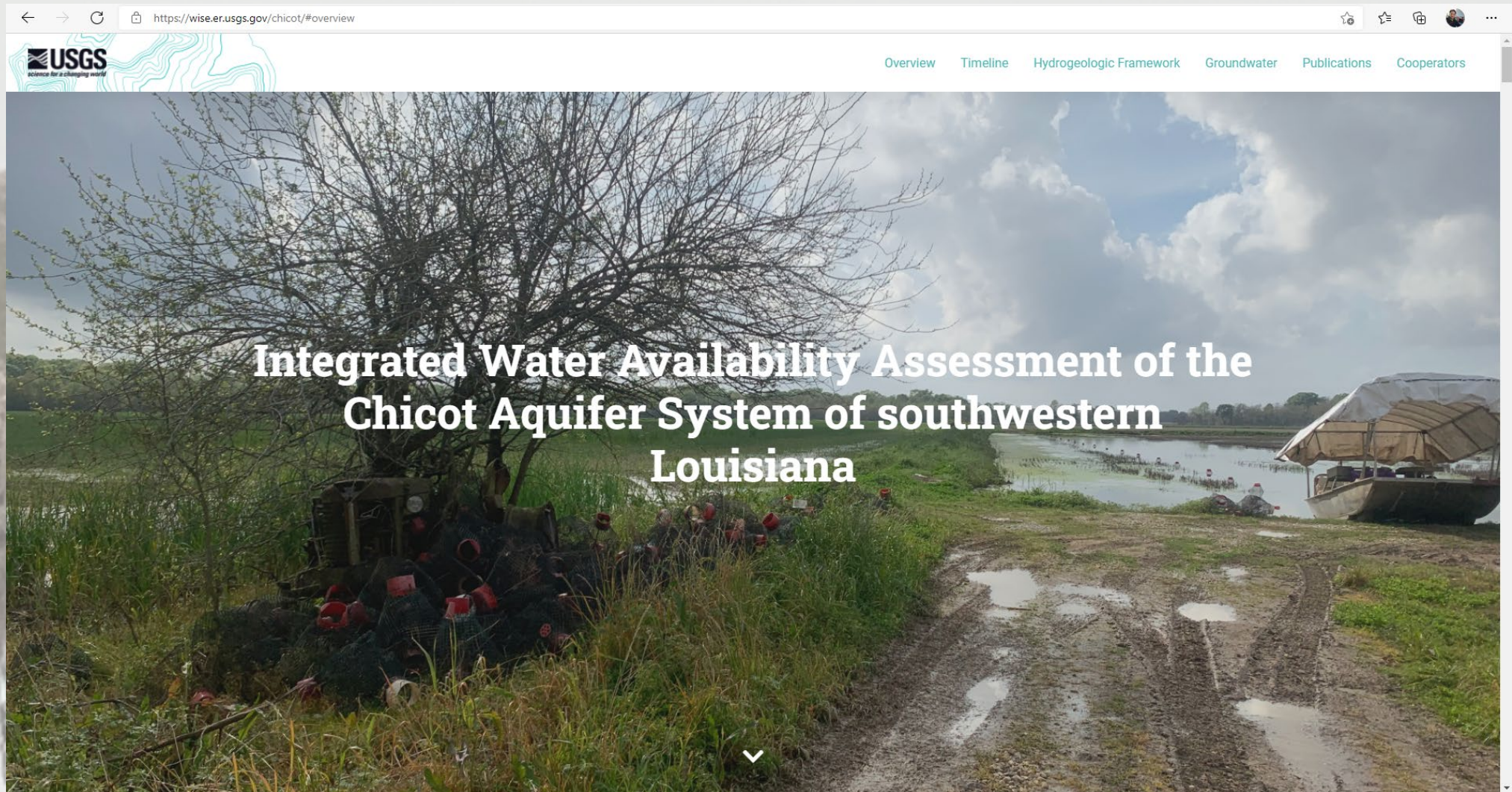
Potentiometric surface

Lovelace and others (2004) Potentiometric surface of the massive, upper, and "200-foot" sands of the Chicot aquifer system in southwestern Louisiana, June 2002.

Chloride Concentration

Geostatistical estimation of chloride concentration in the upper, undifferentiated, shallow, confining unit, and "200-foot" sands aquifer – preliminary subject to revision

Chicot Website



Questions?