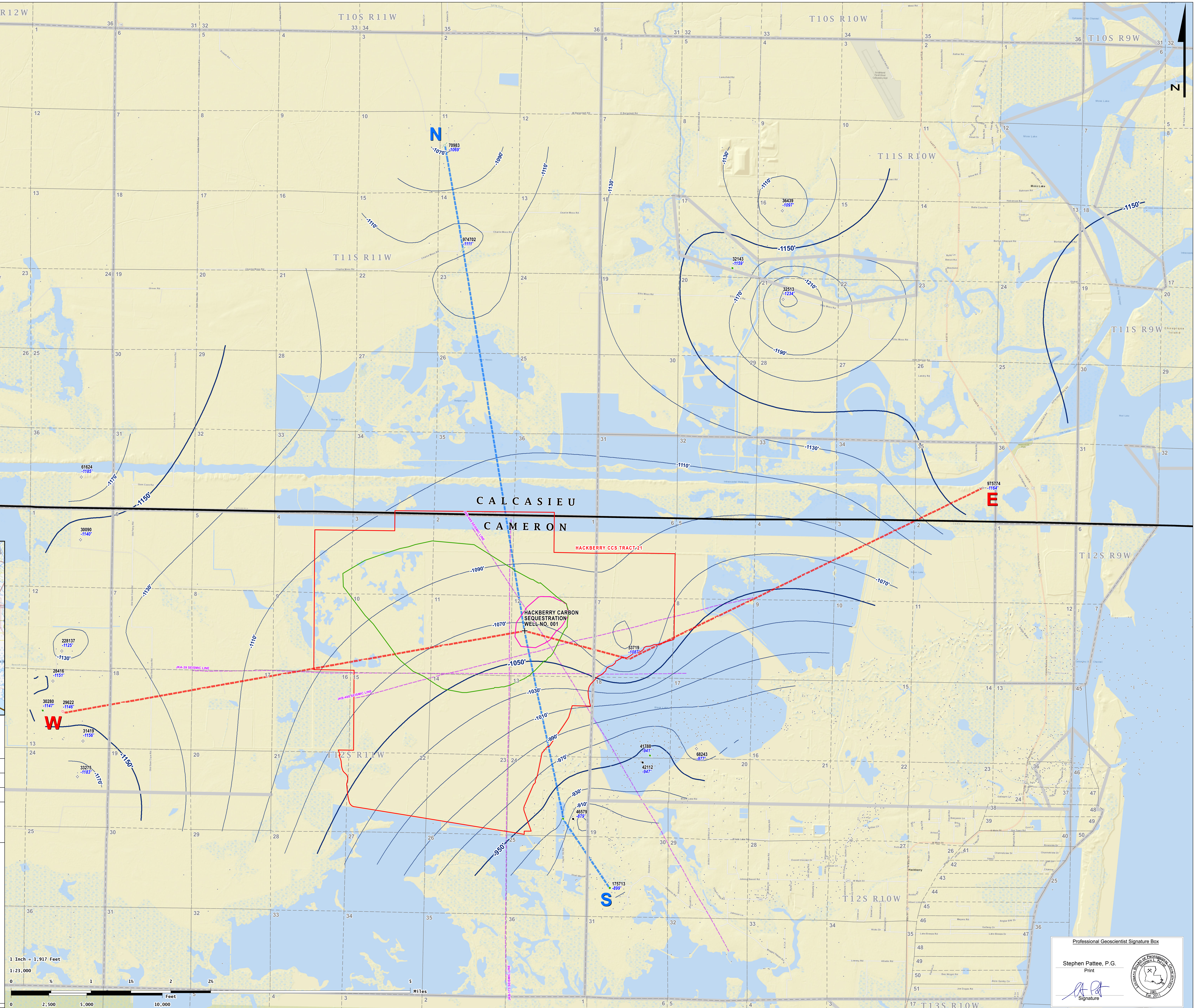

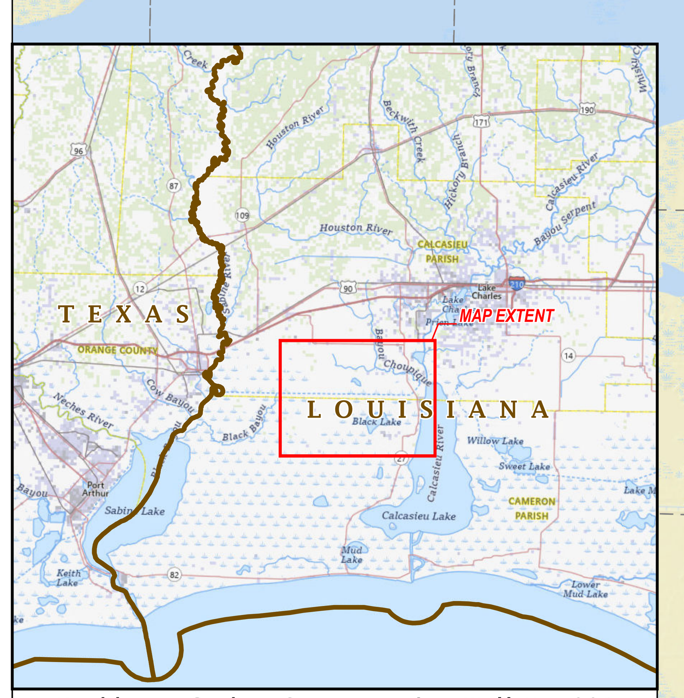

Hackberry Carbon Sequestration Well No. 001

Base USDW Map

Hackberry Carbon Sequestration, LLC

Cameron Parish, LA

Appendix C-1

Drawn by: Steven Larcom	Date: 9/5/2024	Approved by: Steve Pattee

PCS: NAD 1983 Louisiana-South Zone FIPS 1702 (US Ft.)

LONQUIST SEQUESTRATION LLC

Louisiana Registration No. EF 5937

- Hackberry Carbon Sequestration Well No. 001 SHL
- Maximum Plume Extent
- Critical Pressure Front
- Hackberry CCS Tract 21 Permit Boundary
- Sections
- Townships
- Counties
- Seismic Survey Line

Cross-Section Reference Line

- N-S
- W-E

Base USDW Contours

Depth (Subsea Ft.)

- 10 Ft. C.I.
- 50 Ft. C.I.

- Oil & Gas Well SHL [LDNR]

Control Wells: Base USDW (21)

SHL Status - Description (Count) [LDNR]

- 02 - Approval to Construct Injection Well (1)
- 09 - Active-Injection-Produced Salt Water (2)
- 10 - Active-Producing-Oil (1)
- 29 - Dry and Plugged-No Prod. Spec. (10)
- 30 - PA-Gas (1)
- 30 - PA-No Prod. Spec. (2)
- 30 - PA-Oil (4)

Note: Cross-section reference wells are labeled with the SN and the corresponding Base USDW value (Subsea Ft.)

Hackberry Carbon Sequestration Well No. 001 SHL - T12S R11W, Sec. 11 - Cameron Parish, LA

NAD83 (DMS)	NAD83 (DD)	NAD83 LA-S FIP 1702 (US Ft.)
LAT = 30° 1' 51.1708"	LAT = 30.0308808	X = 2,611,585.657'
LONG = -93° 26' 54.318"	LONG = -93.4484218	Y = 562,899.265'

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Stephen Pattee, P.G.
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Signature

LOUISIANA BOARD OF PROFESSIONAL GEOSCIENTISTS
STEPHEN L. PATTEE
1001
Est. 2011

LONQUIST SEQUESTRATION LLC

Hackberry Carbon Sequestration, LLC

Hackberry Carbon Sequestration Well No. 001

N-S USDW Cross Section

Horizontal Scale = 279.3
Vertical Scale = 25.0
Vertical Exaggeration = 11.2x

TOPS AND MARKERS

- 200'_SAND PLJ
- 200'_SAND_BASE PLJ
- 500'_SAND PLJ
- 500'_SAND_BASE PLJ
- 700'_SAND PLJ
- 700'_SAND_BASE PLJ
- USDW PLJ
- PLIOCENE PLJ

UWI
Well Name
Well Number
Operator
WELL - SERIAL_NUMBER
WELL - TD
WELL - ELEV_KB
WELL - STATUS_CODE

CORES | SHOWS | DST/WLT | IP | CASING

SDWL

GAS

OIL

WATER

OTHER

LINER

PERFS

ACTIVE | INACTIVE | OPENHOLE | BRIDGEPLUG | FRACPLUG | PACKER | PROPOSED | SQUEEZED | JUNK

By: Parker Jessee

June 15,2021 2:07 PM

APPENDIX C-2

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Signature

PETRA 6/15/2021 2:07:20 PM (N-S USDW Cross Section.CSP)

LONQUIST SEQUESTRATION LLC

Hackberry Carbon Sequestration, LLC

Hackberry Carbon Sequestration Well No. 001

W-E USDW Cross Section

Horizontal Scale = 354.6
Vertical Scale = 25.0
Vertical Exaggeration = 14.2x

TOPS AND MARKERS

- 200'_SAND PLJ
- 200'_SAND_BASE PLJ
- 500'_SAND PLJ
- 500'_SAND_BASE PLJ
- 700'_SAND PLJ
- 700'_SAND_BASE PLJ
- USDW PLJ
- PLIOCENE PLJ

UWI
Well Name
Well Number
Operator
WELL - SERIAL_NUMBER
WELL - TD
WELL - ELEV_KB
WELL - STATUS_CODE

CORES | SHOWS | DST/WLT | IP | CASING

SDWL

GAS

OIL

WATER

OTHER

LINER

PERFS

ACTIVE | INACTIVE | OPENHOLE | BRIDGEPLUG | FRACPLUG | PACKER | PROPOSED | SQUEEZED | JUNK

By: Parker Jessee

June 15,2021 2:07 PM

APPENDIX C-3

Professional Geoscientist Signature Box

Stephen Pattee, P.G.
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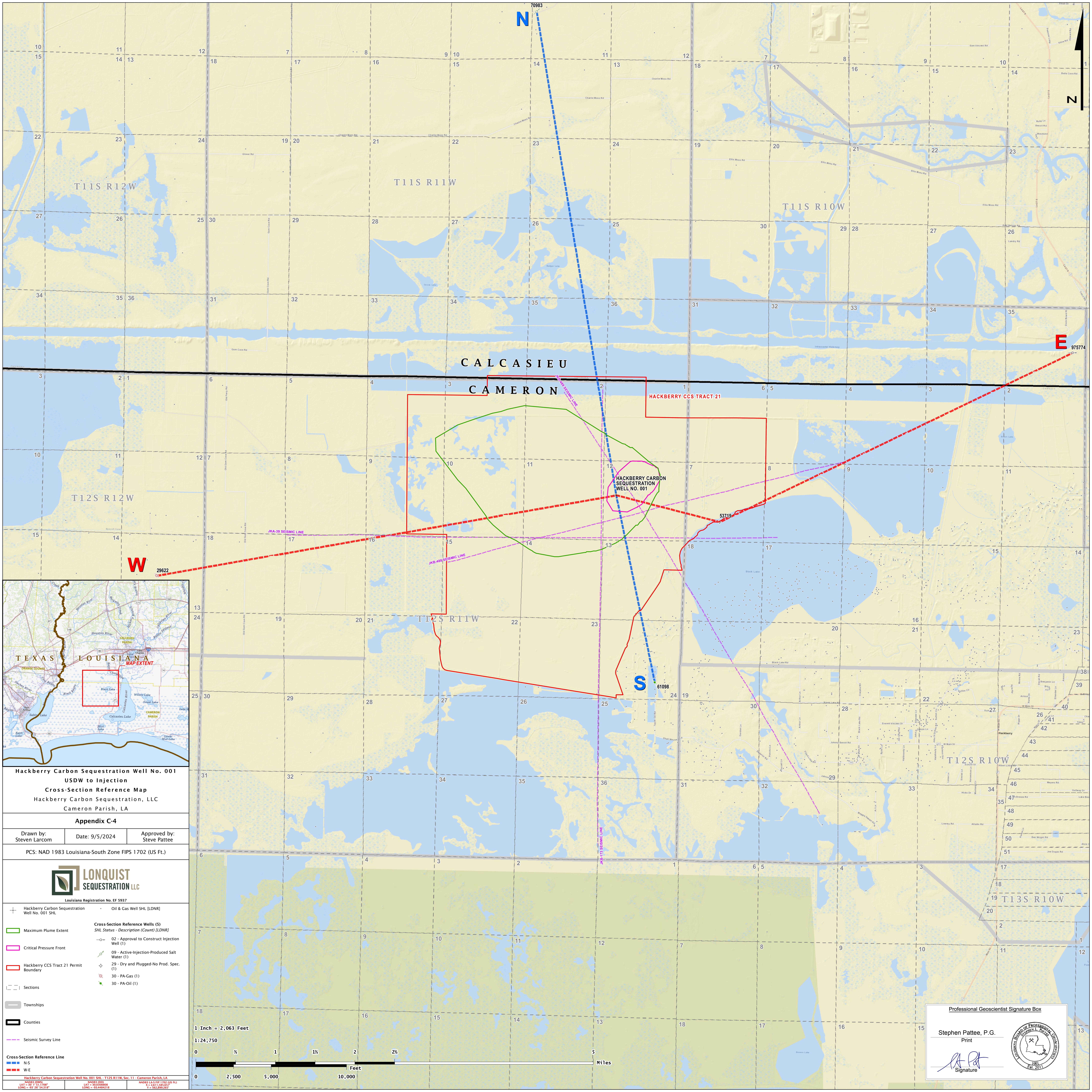
Signature



N
70983
S
61098
W
29622
E
975774
53719
CALCASIEU
CAMERON
HACKBERRY CCS TRACT 21
HACKBERRY CARBON SEQUESTRATION WELL NO. 001
JKA-39 SEISMIC LINE
JKB-485 SEISMIC LINE
T11S R12W
T11S R11W
T11S R10W
T12S R12W
T12S R11W
T12S R10W
T13S R10W
TEXAS
LOUISIANA
MAP EXTENT
Hackberry Carbon Sequestration Well No. 001
USDW to Injection
Cross-Section Reference Map
Hackberry Carbon Sequestration, LLC
Cameron Parish, LA
Appendix C-4
Drawn by: Steven Larcom
Date: 9/5/2024
Approved by: Steve Pattee
PCS: NAD 1983 Louisiana-South Zone FIPS 1702 (US Ft.)
LONQUIST SEQUESTRATION LLC
Louisiana Registration No. EF 5937
Hackberry Carbon Sequestration Well No. 001 SHL
Oil & Gas Well SHL [LDNR]
Maximum Plume Extent
Critical Pressure Front
Hackberry CCS Tract 21 Permit Boundary
Sections
Townships
Counties
Seismic Survey Line
Cross-Section Reference Wells (5)
SHL Status - Description (Count) [LDNR]
02 - Approval to Construct Injection Well (1)
09 - Active-Injection-Produced Salt Water (1)
29 - Dry and Plugged-No Prod. Spec. (1)
30 - PA-Gas (1)
30 - PA-Oil (1)
Cross-Section Reference Line
N-S
W-E
Hackberry Carbon Sequestration Well No. 001 SHL - T12S R11W, Sec. 11 - Cameron Parish, LA
NAD83 (DMS) LAT = 30° 1' 51.1708" LONG = -93° 26' 54.318"
NAD83 (DD) LAT = 30.0308808 LONG = -93.4484218
NAD83 LA-S FIP 1702 (US Ft.) X = 2,611,585.657' Y = 562,899.265'
1 Inch = 2,063 Feet
1:24,750
0 ½ 1 1½ 2 2½ 5 Miles
0 2,500 5,000 10,000 Feet
Professional Geoscientist Signature Box
Stephen Pattee, P.G.
Print
Signature

LONQUIST SEQUESTRATION LLC

Hackberry Carbon Sequestration, LLC

Hackberry Carbon Sequestration Well No. 001

N-S USDW Cross Section

Injection Zone in relation to USDW

Horizontal Scale = 250.4
Vertical Scale = 100.0
Vertical Exaggeration = 2.5x

Well Header Info

UWI
Well Name
Well Number
Operator
Well - Serial Number
Well - TD
Well - Elevation KB
Well - Status Code

Legend

- Formation Tops/Bottoms
- USDW
- Fault
- Confining Zones
- 200' Sand
- 500' Sand
- 700' Sand
- Perforated Intervals
- CO_2 Plume Boundary
- Critical Pressure Boundary

Well Symbols

- Proposed Injection Well
- Dry and Plugged
- Injection Well
- Oil Well - Plugged and Abandoned

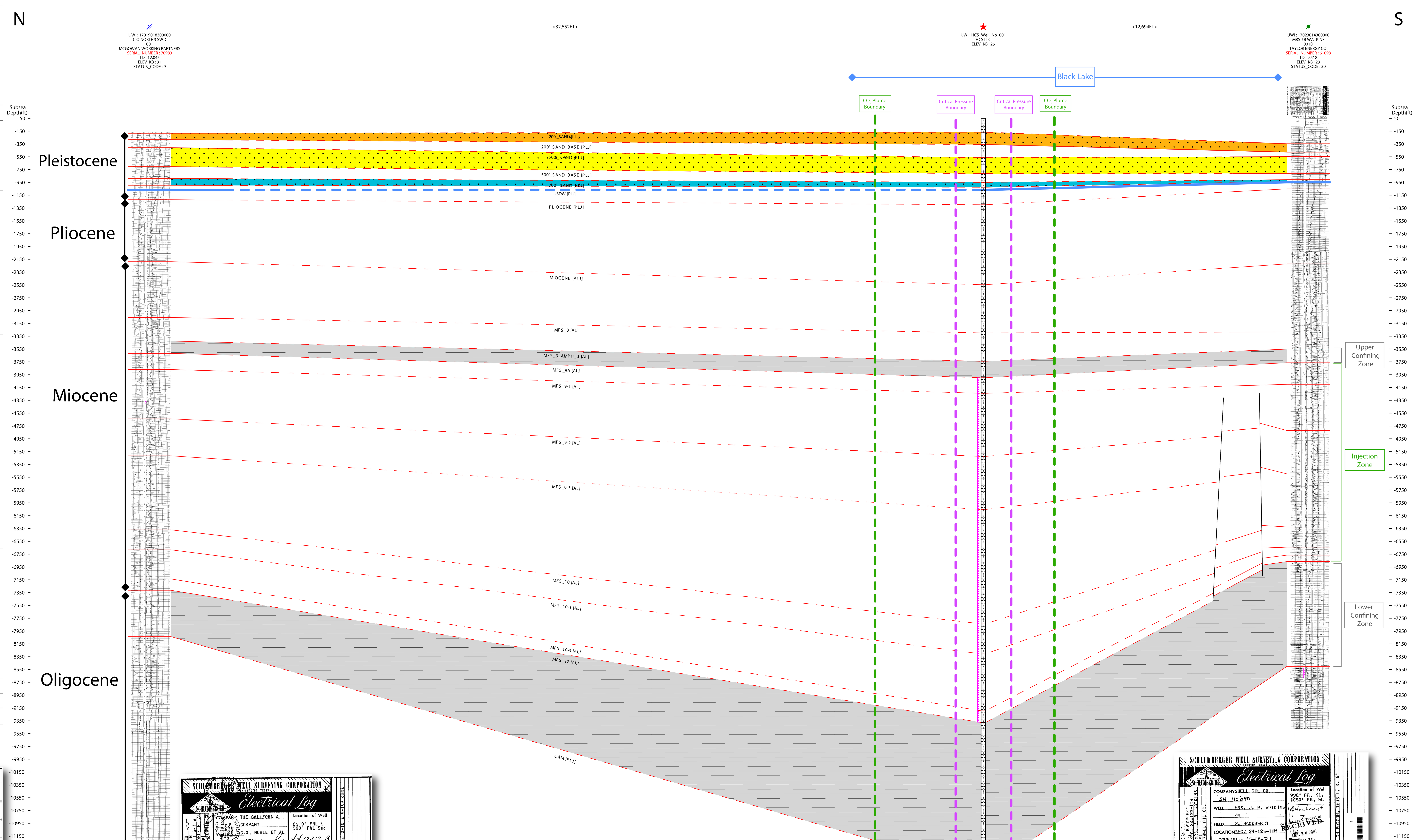
Horizontal Scale

0' 1,250' 2,500'

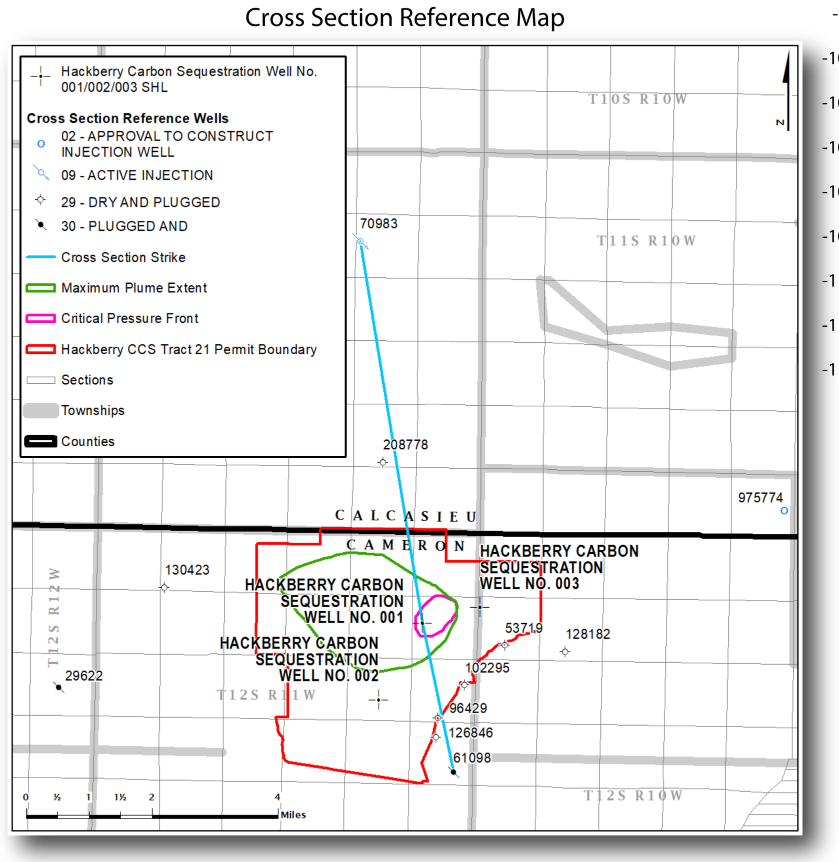
Note: Dashed lines are inferred

By: Parker Jessee

January 29,2025 5:36 PM



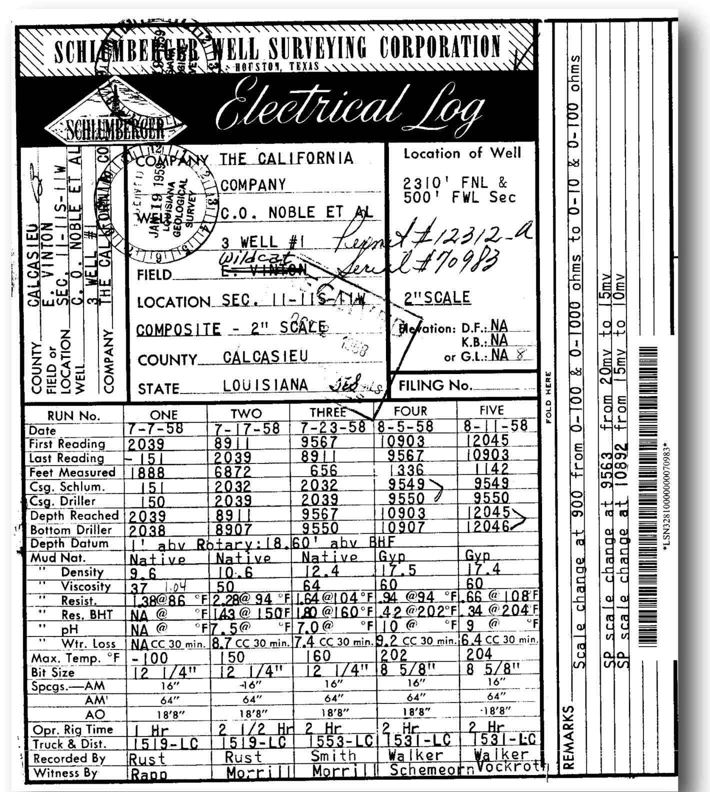
Cross Section Reference Map

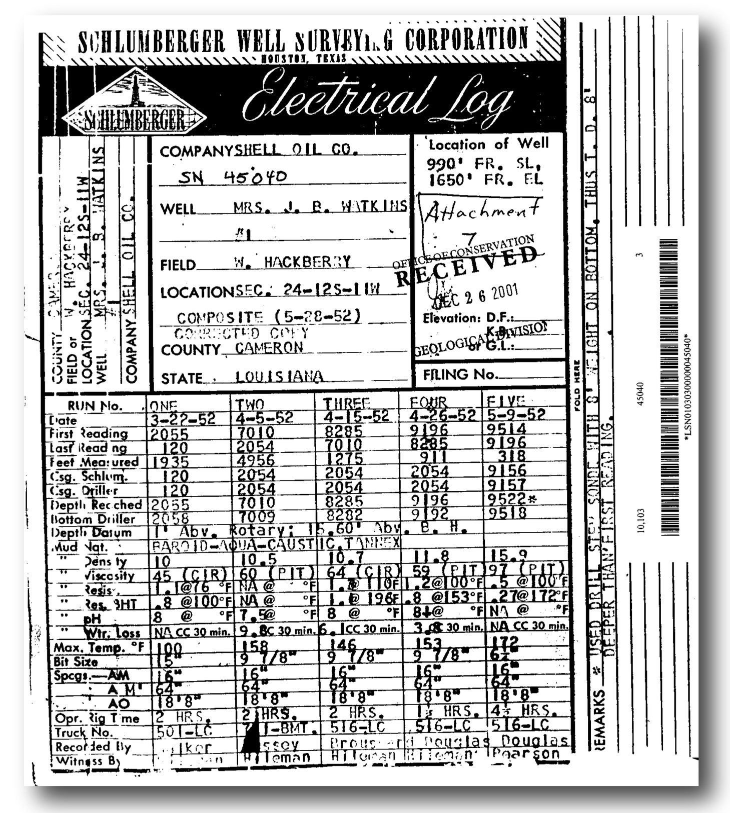


Professional Geoscientist Signature Box

Stephen Pattee, P.G.
Print

Signature
Date: 1/30/2025





LONQUIST SEQUESTRATION LLC

Hackberry Carbon Sequestration, LLC

Hackberry Carbon Sequestration Well No. 001

W-E USDW Cross Section

Injection Zone in relation to USDW

Horizontal Scale = 354.6
Vertical Scale = 100.0
Vertical Exaggeration = 3.5x

Well Header Info

UWI
Well Name
Well Number
Operator
Well - Serial Number
Well - TD
Well - Elevation KB
Well - Status Code

Legend

- Formation Tops/Bottoms
- USDW
- Confining Zones
- 200' Sand
- 500' Sand
- 700' Sand
- Perforated Intervals
- CO_2 Plume Boundary
- Critical Pressure Boundary

Well Symbols

- Proposed Injection Well
- Dry and Plugged
- Injection Well
- Gas Well - Plugged and Abandoned

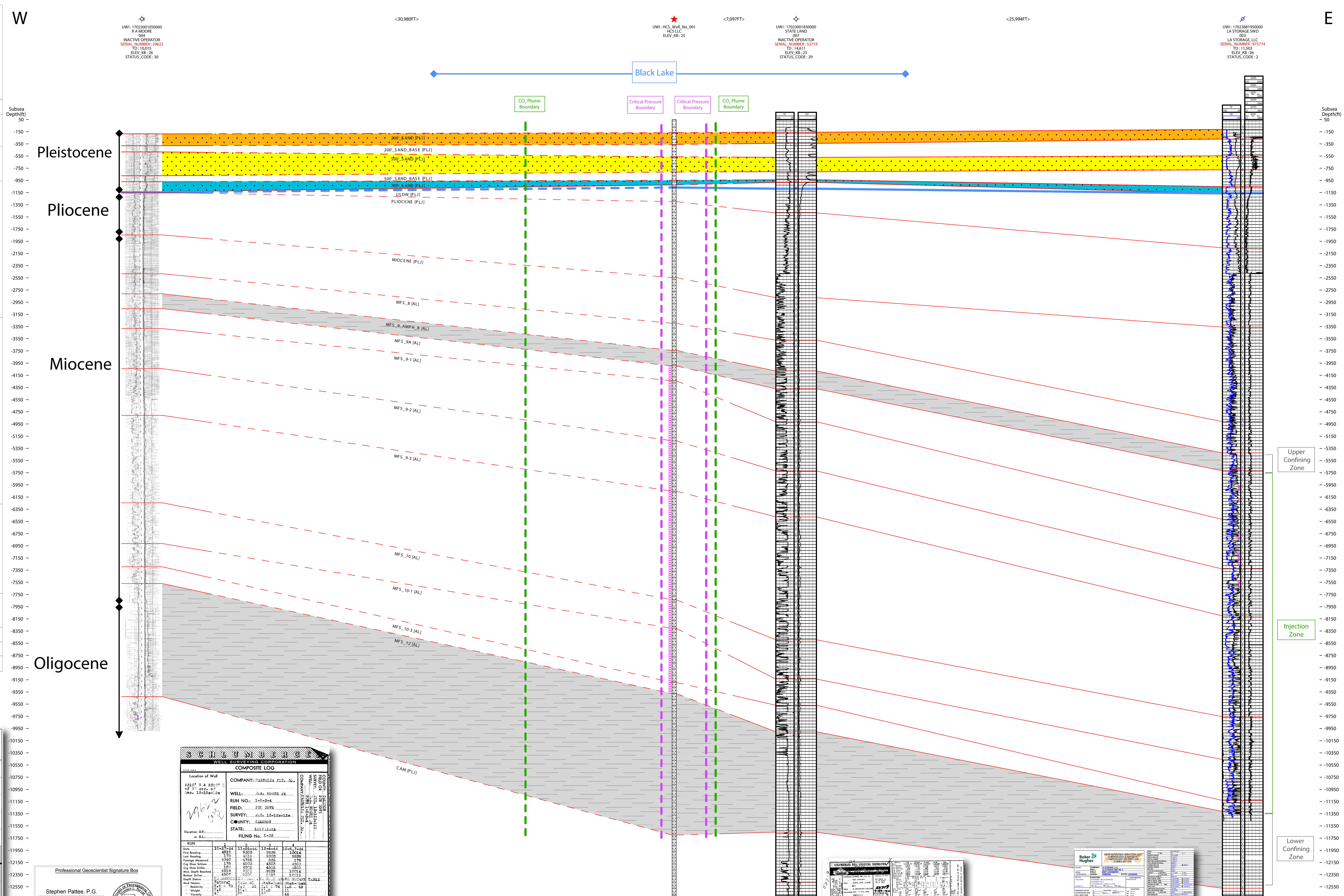
Horizontal Scale

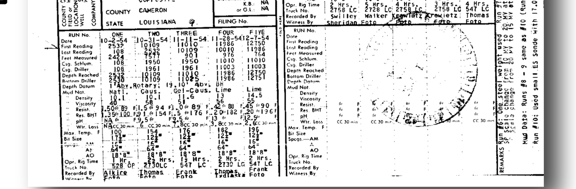
0' 1,775' 3,550'

Note: Dashed lines are inferred

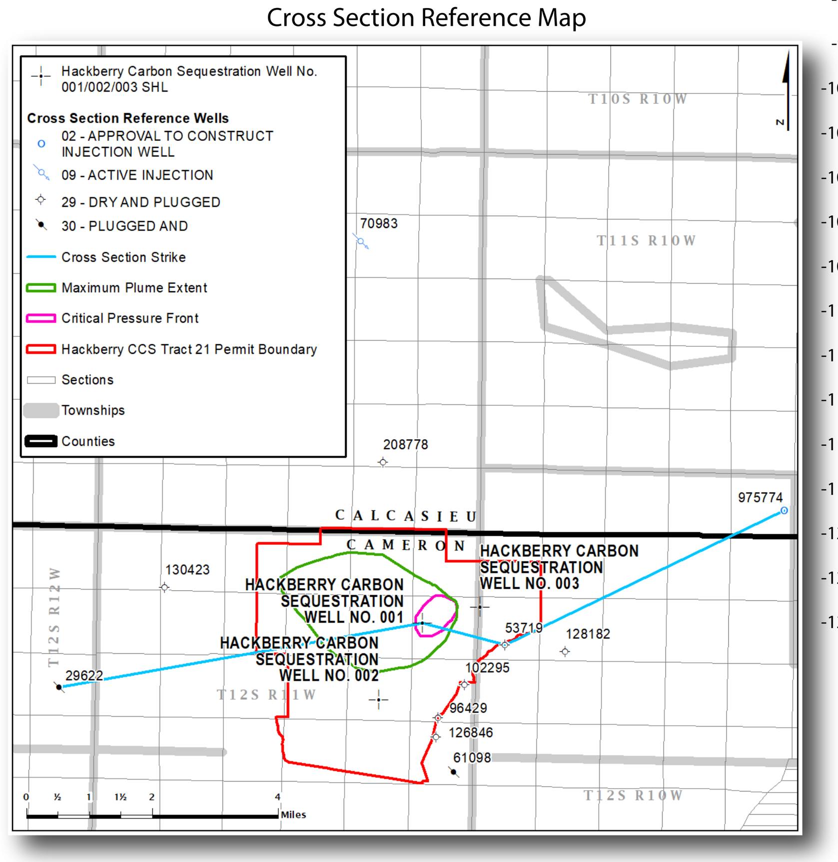
By: Parker Jessee

January 29,2025 5:40 PM





Cross Section Reference Map



Professional Geoscientist Signature Box

Stephen Pattee, P.G.
Print

Signature Date: 1/30/2025

APPENDIX C-7

Analysis of Groundwater Withdrawal Impacts on the Chicot Aquifer Liberty Gas Storage Expansion Project Cameron Parish, Louisiana

Prepared for

Liberty Gas Storage LLC

San Diego, CA

Prepared by

LBG-Guyton Associates
Professional Groundwater and Environmental Engineering Services
11111 Katy Freeway Suite 850
Houston, Texas 77079

February 26, 2009

Table of Contents

Tables

Figures

Analysis of Groundwater Withdrawal Impacts on the Chicot Aquifer
Liberty Gas Storage Expansion
Cameron Parish, Louisiana

Executive Summary

Liberty Gas Storage submitted on July 31, 2008, Water Well Notification Forms for mining water wells to support the development of a natural gas storage cavern for the Liberty Gas Storage Expansion Project (LGSE) located in the west part of the West Hackberry Salt Dome. As shown in the Water Well Notification Forms, two or three water wells will be located in the 500-Foot Sand for a total pumping rate of 2,000 gpm (two wells are anticipated to provide this flow, with the third water well included as a contingency well). In addition, two or three water wells will be located in the 700-Foot Sand with a total pumping rate of 2,000 gpm. This approach, namely splitting the total required project flow between the 500-Foot Sand and 700-Foot Sand, was selected in recognition of concerns related to usage of water from the 500-Foot Sand, noting that water chemistry in the 700-Foot Sand is expected to be unacceptable, however, using water blended from the 500-Foot Sand and 700-Foot Sand should have adequate water chemistry. The pumping is planned to occur over a two or three year period.

This report provides the results of an LGSE study which has been performed to evaluate the impact of LGSE mining water wells on the Chicot aquifer, in particular with regard to salt water intrusion. The study includes the following elements:

- Reviewing previous geological and aquifer studies in the area.
- Mapping the 500-Foot Sand and 700-Foot Sand in the region of the LGSE Project site based on existing well logs.
- Compiling available historical data from existing wells in the area for water analyses, fluid levels, usage and mechanical information.
- Developing a two dimensional flow model, MODFLOW, (a USGS developed program for determining drawdown and water movement due to well pumping) to evaluate impacts of LGSE water well operation on the Chicot aquifer.

A review of existing well logs and local geology were employed to create structure and thickness maps and cross sections for the 500-Foot and 700-Foot Sands. In addition, the intervening geologic formations between the 200-Foot, 500-Foot, and 700-Foot Sands are shown to be layers of clay such that the LGSE Project water wells located in the 700-Foot Sand are not expected to impact either the 500-Foot or 200-Foot Sands.

Available data from wells developed in the 500-Foot Sand, and within the region of the LGSE Project site, shows a large variation in chloride concentrations from well to well. The data also shows that chloride levels in individual wells have not changed with time, which indicates that the water characteristics have been stable over many years of pumping even though fluid levels have varied.

The MODFLOW program was run to determine the impact of the LGSE Project 500-Foot Sand water wells at their permitted flow rate over a 3-year period. The two-dimensional model results showed that limited drawdown would occur in wells screened in the 500-Foot Sand, with the pumping effects less with distance from the LGSE Project wells (e.g., the drawdown of the Hackberry municipal wells is about 12 feet and is not expected to be significant to their operation, as the fluid levels are several hundred feet above the top of the 500-Foot Sand depth). Furthermore, the model results show that the 500-Foot Sand is generally replenished from the north with very small movement of water at the location of the Hackberry municipal wells or from the southern portions of the aquifer.

In conclusion, this study demonstrates that operation of LGSE Project cavern development water wells:

1) is not expected to negatively impact current operation of any existing water wells within the area, including the Hackberry municipal water wells and

2) is not expected to result in significant or detrimental salt water intrusion into the 500-Foot Sand.

Analysis of Groundwater Withdrawal Impacts on the Chicot Aquifer

Liberty Gas Storage Expansion Project
Cameron Parish, Louisiana

Introduction

Liberty Gas Storage LLC (LGS) owns approximately 160 acres on the northwestern corner on the West Hackberry Salt Dome near Hackberry, Louisiana that includes three existing caverns filled with brine. LGS plans to develop a fourth gas storage cavern in addition to the three existing caverns for their natural gas storage facility, the Liberty Gas Storage Expansion (LGSE) project. In order to develop the proposed cavern within the project time frame, an average of 3,000 gallons per minute (gpm), with a maximum of 4,000 gpm of groundwater will be needed for cavern development (leaching) over a period of two to three years. Of this total, approximately half (2,000 gpm maximum) will be obtained from wells completed in the 500-Foot Sand of the Chicot aquifer with the balance from wells completed in the 700-Foot Sand of the Chicot aquifer.

As part of the environmental permitting effort for the LGSE project, LGS has performed this study to demonstrate that groundwater pumping activities should not adversely affect aquifer resources. This report provides the results of this study to address the following concerns:

- Show that the groundwater withdrawal from the proposed production wells should not adversely affect groundwater quality in the 500-Foot Sands.
- Assure that the aquifer has sustainability.
- Insure that the groundwater withdrawals will not adversely affect the pumping rates of other water wells in the area.

Several methods were enlisted to complete this study, as follows.

First, local geology, hydrogeology and aquifer reports, in addition to well logs and tests, were assembled and studied. Then, structure and isopach maps and cross sections were created for both the 500-Foot Sand and 700-Foot Sand. A base map showing the oil, gas and water well locations used in the study is attached as Figure 1. The data were then assembled and a two-dimensional groundwater flow model was developed to address issues regarding groundwater usage by LGSE.

In addition, groundwater quality data were gathered and new water samples collected, analyzed and compared with previous results. In general, the 500-Foot Sand contains water with 1,000 to 1,500 milligrams per liter (mg/l) total dissolved solids (TDS) at the project site, while the water in the 700-Foot Sand is estimated to contain at least 10,000 mg/l TDS at the project site.

Local Geology

Surface and near surface deposits in the project area consist of Holocene-Age sediments comprised of alluvial, bay and marsh deposits that are generally 30 feet thick or less (Whiting, 1980). There are also some thin (less than 5 feet) eolian deposits present in the elevated area above the West Hackberry Salt Dome.

Underlying the Holocene deposits is the Pleistocene age Prairie Formation comprised of alluvial, deltaic marsh and littoral sediments (Whiting, 1980). Based on area well logs, the Prairie Formation extends to a depth of approximately 200 feet below ground level in the project vicinity and is compromised primarily of clay.

Beneath the Prairie Formation is a sequence of Pleistocene deposits that collectively comprise what is known as the Chicot aquifer. Based on the depth of similar deposits in the Lake Charles area, the aquifer is comprised of three sand units referred to as the 200-Foot Sand, 500-Foot Sand and 700-Foot Sand. However, the sand units occur at variable depths throughout southwest Louisiana and their depths are influenced by subsurface structures, such as the West Hackberry Salt Dome.

The 200-Foot Sand and 500-Foot Sand are the primary source of fresh groundwater in southwest Louisiana, including Hackberry. The 700-Foot Sand is utilized as a source of fresh groundwater in areas generally to the north of the Hackberry area.

The Pleistocene deposits that comprise the Chicot aquifer are underlain by Pliocene and Miocene deposits, the lower most of which is the Anahuac marine shale of Miocene age, a relatively impermeable unit that seals the underlying pressurized oil bearing formations from the overlying Miocene sands (Whiting, 1980). The Miocene formations are, in turn, underlain by older sediments that can extend to depths greater than 30,000 feet in the Gulf Coast area.

Chicot Aquifer Characteristics

The Chicot aquifer is composed of unconsolidated silt, sand and minor gravel interbedded with layers of clay and sandy clay deposited by ancestral streams, tidal marshes and/or estuarine environments. The deposits dip and thicken toward the Gulf of Mexico (LDEQ, 2002).

Well logs of oil test holes and water wells were collected for the Hackberry area extending to the west to the LGSE site and beyond. These logs were used to develop structure maps and cross-sections of the 200-Foot, 500-Foot and 700-Foot Sands. A list of the wells logs used in this study, along with their contour map identification, is included in Table 1. Depths are not corrected for elevation and well depth datum, i.e. Kelly Bushing, rig floor, etc. Since almost all wells are located on land or in a marsh or lake vertically within ten feet of sea level, the depths of the sands are plotted as shown on the well logs.

200-Foot Sand

The 200-Foot Sand generally consists of fine to medium sand with coarse grained sand and sometimes gravel at its base in areas where the zone is thickest. This layer generally dips southward at approximately 10 feet per mile. The 200-Foot Sand occurs from approximately 200 to 300 feet below the surface across the LGSE site and is approximately 100 feet thick, as shown on Cross Section A-A' (Figure 2). The thickness of the 200-Foot Sand is less evident in the east, than in the west part of the cross section. Cross Section B-B', shown on Figure 3, also provides information regarding the depth and thickness of the 200-Foot Sand. The LGSE project will not utilize water from the 200-Foot Sand for cavern development or maintenance. Regionally, the 200-Foot Sand supplies water for irrigation, industrial, public supply and domestic purposes. Locally, the 200-Foot Sand provides water to some domestic wells, although many of the rural users in the area obtain groundwater from the Cameron Parish Water Works District 2 or 11.

500-Foot Sand

The 500-Foot Sand is composed of fine to coarse grain sand that normally fines upward and grades to Deltaic deposits (Whiting, 1980). The 500-Foot Sand at the LGSE site occurs in the depth interval from approximately 460 to 610 feet below land surface and is hydraulically separated from the 200-Foot Sand by approximately 70 feet of predominately clay material, which serves as a barrier to groundwater flow migration between the 500-Foot Sand and the 200-Foot Sand.

The position and thickness of the 500-Foot Sand is shown on Cross Section A-A' and Cross Section B-B' on Figures 2 and 3, respectively. The cross sections show that the thickness of the 500-Foot Sand ranges from approximately 130 to 220 feet.

The structure contour map showing the depth to the top of the 500-Foot Sand was developed based on review and evaluation of the well logs and is shown on Figure 4. Also shown are the somewhat irregular shaped 2,000- and 3,000-foot contours of the West Hackberry Salt Dome. These contours illustrate that the Salt Dome itself has influenced the depth to the top of the 500-Foot Sand, i.e. generally shallower over the top of the Salt Dome, and getting deeper, further away. Electric log data showing the depth to the top of the 500-Foot Sand are very limited south of the Hackberry area as very few oil wells have been drilled in that direction.

The well logs were used to develop a sand thickness isopach map for the 500-Foot Sand, as shown on Figure 5. The map shows that the thickness of the 500-Foot Sand varies from 150 to 225 feet in much of the area. At the LGSE site the 500-Foot Sand is approximately 130 feet thick, based on well log LIB-1 shown on Figure 5. The sand thickness, in general, is greater than 150 feet thick between the LGSE site and the Town of Hackberry.

The 500-Foot Sand is a heavily used aquifer in the region, particularly to the north toward Lake Charles, supplying the bulk of the groundwater used for irrigation, public supply and some industrial needs. The 500-Foot Sand also is utilized as a municipal drinking water source for the Cameron Parish Water Works District No. 2 (Town of Hackberry) and Cameron Parish Water Works District No. 11. Combined pumping by these two water providers in the year 2000 averaged approximately 0.83 million gallons per day (mgd) or 576 gpm. In the vicinity of the LGSE site, water in the 500-Foot Sand is moderately hard and contains TDS in the range of 1,000 to 1,500 mg/l. In the Hackberry area and to the east, the water in the 500-Foot Sand contains less TDS, with a range of 600 to 850 mg/l.

700-Foot Sand

The 700-Foot Sand is the deepest of the groundwater bearing sands in the Chicot aquifer. At the LGSE site, the 700-Foot Sand occurs in the depth interval from approximately 820 to 990 feet below land surface and is separated from the 500-Foot Sand by approximately 180 feet of clay that serves as a barrier to groundwater flow between the 700-Foot Sand and the 500-Foot Sand. The depth and thickness of the 700-Foot Sand are shown on cross sections provided on Figures 2 and 3. A structure contour map for the 700-Foot Sand was developed based on the same log data used for the 500-Foot Sand and is presented on Figure 6. As with the 500-Foot Sand, the contour map shows that the depth to the top of the 700-Foot Sand is generally higher over the West Hackberry Salt Dome and generally deeper further away from the Salt Dome, particularly east, towards the Town of Hackberry.

The well log data were used to develop a map showing the sand thickness for the 700-Foot Sand as shown in Figure 7. The data show that the thickness of the 700-Foot Sand ranges from approximately 100 to 175 feet in the area along Cross Section A-A' and that the sand thickness increases in the area northeast of the West Hackberry Salt Dome. Well log data is limited in the area south of the Salt Dome (as few oil wells have been drilled to the south), and wells north of the Salt Dome were not logged that shallow.

The well log for Well LIB-1 located on the LGSE site shows that the 700-Foot Sand has very low resistivity of approximately 2 ohm-meters. It is estimated that the water in the 700-Foot Sand in that area has a TDS of approximately 10,000 to possibly 15,000 mg/l and thus would not be suitable for municipal supply or irrigation. Utilization of water from the 700-Foot Sand is planned to provide up to 2,000 gpm of the supply needed for LGSE cavern development, however the high TDS is expected to require mixing with water from the 500-Foot Sand to achieve acceptable water chemistry. At Oil Test Hole E-38 shown on Figure 2, the resistivity in the 700-Foot Sand ranges from approximately 25 ohm-meters at the top of the sand to approximately 6 ohm-meters at the base of the sand, indicating that the mineralization of the water is increasing with depth. This data supports the general trend of the mineralization of water in the 700-Foot Sand increasing going from north to south in the area.

Groundwater Quality Data

500-Foot Sand

Groundwater production wells have been in use in the Hackberry area for decades and screen either the 200-Foot or 500-Foot Sand. One plugged and abandoned USGS observation well in the area approximately two miles north of Hackberry screened the 700-Foot Sand. Some of the early chemical analysis data for the area in the LDNR files date back to about 1949. Groundwater well information used in this study is listed on Table 2. Data supplied includes DOTD well number, well owner, year completed, depth, screened interval, water levels, etc. Chemical analysis data is provided in Table 3, which shows water quality data for wells that screen the 200-Foot, 500-Foot and 700-Foot Sands.

A map showing the chloride concentration from water wells is included as Figure 8. This data shows that there is some variation in chloride content of the water at different locations within the area, but individual well chloride content varies little over time. The chlorides in the 500-Foot Sand in the Hackberry area and to the east across Calcasieu Lake are lower than in proximity to the LGSE site. Data for Wells -69, -121, -134, -160 and -161 show that chloride levels, in general, have remained consistent through the years. At Wells -160 and -161 the chloride content was reported higher in year 2000 but more recent analysis shows chloride values returning to levels in samples collected prior to 2000. To update existing data, LGSE collected several water well samples in 2008. These samples were analyzed by Sherry Laboratories of Lafayette, an approved LDEQ lab, and are included in this study.

Five of the 500-Foot Sand wells have had chloride content recorded over extended periods of time, one as old as 1963. The chloride content for wells -160, -161, -69, -121 and -134 were plotted on Figure 9 to illustrate groundwater consistency through time. Well -160, owned by the Cameron Parish Water District 2 (Town of Hackberry), has shown a chloride content from 218 to 230 mg/l, except for one sample collected in 2000 as noted previously. Well -161, also operated by the Town of Hackberry, has data dating back to 1981. The data show a small variation in chlorides, but the latest sample collected in May 2008 had concentrations similar to a sample collected from the well in 1981.

Well -69 was owned by Olin Corporation and was used to provide water for cavern development in the 1960s, 1970s, 1980s and the early 1990s. During this period, Well -69 pumped at rates between 800 to 1,000 gpm. The chlorides increased from 500 to 535 mg/l over the past 45 years, indicating only a small change in water quality, even though the well was heavily used over a three decade period.

Of the 35 water wells found in the area, only Wells -66 and -134 have had more than a single water level reported. Well -66 static levels ranged from 36 feet in 1959 to 57 feet in 1983 with a maximum depth of 66 feet recorded in 1979. Since Well -66 is only half a mile away from Well -69, its thirty foot variation is likely explained by the water usage from Well -69 for cavern development and pumping at Well-66 for development of two small storage caverns located near by.

Recorded water levels in Well -134 were higher than levels recorded in Well -66, and water level in Well -134 increased with time. The water level ranged from 50 feet in 1977 up to 40 feet in 2005 with a maximum depth of 51 feet in 1980. This lesser change may have been due to inactivity in the area, as this well was an observation well and not used for groundwater production. Also, it is located to the southeast of the Town of Hackberry, several miles from the Salt Dome and is farther away from the pumping for cavern formation that occurred near Wells -66 and -69.

Wells -134 and -121, both USGS observation wells, also provided water with a consistent chloride content over the 20 years that samples were collected.

In summary, the water chemistry data for wells screening the 500-Foot Sand show little to no change in quality over the past 30 to 45 years. Chloride measurements have remained relatively constant even though groundwater has been pumped continuously in the Hackberry area during this period, in addition to substantial amounts of groundwater that were pumped for storage cavern development immediately east of the LGSE site. The water chemistry in the 500-Foot Sand has also remained consistent to the east across Calcasieu Lake throughout the years.

700-Foot Sand

Chemical analysis is available for only one well, USGS observation Well -122, that screens the 700-Foot Sand. The data on Table 3 show TDS and chloride contents of 702 and 250 mg/l, respectively, in 1979. The last analysis available, which was performed in 1983 shows a chloride content of 230 mg/l. The well screens the interval from 910 to 920 feet and the well's log shows a resistivity of approximately 40 ohm-meters in the depth interval screened. Well -122 has been plugged and abandoned.

Groundwater Flow Model

A groundwater flow model was developed to simulate pumping from the 500-Foot Sand by the LGSE project at the maximum project flowrate (2,000 gpm) over the maximum expected duration (3 years). The two-layer MODFLOW-2000 model (Harbaugh and Others, 2000) was used for this simulation. The model contains 40 rows and 60 columns totaling 2,400 grid cells, which are each one-quarter mile squares. A map showing the model area is included as Figure 10. The objectives of the model were to simulate the water-level drawdowns as the result of pumping at the LGSE project and also to estimate water movement within the aquifer as pumping occurs using MODPATH, a particle tracking post-processing package for MODFLOW (Pollock, 1994).

The model incorporated the aquifer characteristics estimated through the use of physical data obtained from the available geophysical logs, a pumping test at Well -160 and general hydrogeologic data. This section of the report details the development of the model and the results obtained.

Structure

The USGS Digital Elevation Model was used in conjunction with well logs in the Hackberry area to develop top and base elevation maps for the 500-Foot Sand for the modeling software package. Sand thickness shown on Figure 5 were also used as inputs to the model. There are a few areas where the estimated thickness of the 500-Foot Sand exceeded 200 feet, but for the model to be conservative, it was estimated that the maximum sand thickness of the 500-Foot Sand was 200 feet.

Boundary Conditions

The model assumes that there is no vertical flow that would serve as a source of water to the 500-Foot Sand and that there is no flow across the boundaries at the east and west ends of the model grid. This assumption is based on the history of pumping further to the north in the Lake

Charles area, indicating that flow in the area is generally more north-south than in an east-west direction.

A general head boundary (GHB) was incorporated along the north and south ends of the model grid to simulate groundwater flow through those areas. A hydraulic gradient of approximately one-foot per mile was implemented from the south to the north, based on historical water levels in the area dating back to the year 2000. Limited historical water levels were plotted and a potentiometric surface developed that indicated that a GHB water level of approximately 50 feet below sea level would be appropriate to the north of the study area and a water level of approximately 40 feet below mean sea level would be reasonable to estimate conditions at the south edge of the model area. The conductance values assigned to the GHB were based on aquifer characteristics in the area (hydraulic conductivity and aquifer thickness) and assumed that the prescribed head was five miles north of the north model boundary and five miles south of the south model boundary.

Model Parameters and Aquifer Conditions

Transmissivity estimates for the 500-Foot Sand used in the model were developed with the sand layer thickness and aquifer hydraulic conductivity. The hydraulic conductivity of the Chicot aquifer is moderate to high and ranges from approximately 40 to 220 feet per day (USGS, 1988). A pumping test of Well -160 showed a transmissivity of 13,300 feet^2/day for an aquifer thickness at the well of approximately 170 feet. Hydraulic conductivity was calculated by dividing transmissivity by the aquifer thickness, resulting in a value of 78 feet per day. For the model a hydraulic conductivity of 75 feet/day was used, which is within the range reported by the USGS, 1988. The aquifer occurs under artesian conditions, therefore a storage coefficient of 0.0003 was assumed. An illustration showing the estimated transmissivity within the model area is provided as Figure 10.

Model Simulation

A steady state model scenario was simulated using the above described boundary conditions and model parameters without any pumping from the LGSE project. The simulated steady state water levels are similar to the regional groundwater flow that was incorporated into the general head boundaries on the north and south ends of the model.

A model run was performed to simulate the pumping of 1,000 gpm each from the two wells completed in the 500-Foot Sand and located at the LGSE site. The modeling assumed a continuous pumping period of 3 years. The simulation resulted in model outputs which show the estimated drawdown that would occur at the LGSE site and at various distances away from the site, including at the Town of Hackberry (Figure 11). The model showed that the estimated drawdown that would occur at the LGSE site is approximately 24 feet after three years of pumping and that the effects of pumping decrease with distance away from the site. At the Town of Hackberry the estimated water-level decline in wells that screen the 500-Foot Sand range from 11 to 13 feet.

It is worth noting that the MODFLOW model predicted a lower estimated water-level decline at the Town of Hackberry wells, 11 to 13 feet, compared to 17 feet previously reported using the simplified Theis equation. The reason for the difference is that the pumping test data and aquifer thickness data indicate that the 500-Foot Sand transmissivity at the Town of Hackberry and in areas between Hackberry and the LGSE site is higher than previously estimated.

The amount of interference drawdown at the Town of Hackberry resulting from pumping the 500-Foot Sand at the LGSE site is small, and there should not be a significant reduction in the pumping rates of wells in the Hackberry area. The interference drawdown effects from pumping by the LGSE project should not result in the municipal well pumps needing any lowering nor upgrading to continue to provide water at the same rates that they are providing water presently. The static water levels in wells at the Town of Hackberry are approximately 60 feet below land surface and the top of the screened intervals in the wells begin at a depth of approximately 460 to 490 feet, thus there is approximately 400 to 430 feet of available drawdown between the static water level and the top of the screened intervals in the wells.

Particle Tracking

An evaluation of groundwater movement near and at distance from the LGSE project was performed using MODPATH (Pollock, 1994). Particles were forward tracked from eleven different locations, and water movement in each grid block was used to calculate particle movement in the 500-Foot Sand during the three-year pumping period. For this analysis it was assumed that the porosity of the aquifer sands is 20 percent. The results of the particle tracking are shown on Figure 12.

The results of the analysis show very small amounts of groundwater movement in the 500-Foot Sand due to pumping groundwater at a rate of 2,000 gpm at the LGSE site for three years. As expected, the amount of groundwater movement decreases as distance from the LGSE project site increases. MODPATH calculated groundwater movement due to the three years of pumping at locations shown in Figure 12 and the amounts of water movement ranged from 390 feet at Site 2 (approximately ¾ mile east of the LGSE site) to 75 feet at Site 1 (approximately 2.75 miles west of the LGSE site).

The MODPATH data show that rates of groundwater movement resulting from the proposed LGSE pumping from the 500-Foot Sand are very small. This is because the amount of the pumping is very small compared to the total amount of water that is in storage in the aquifer and because the water-level gradient in the aquifer is relatively small. The particle tracking also shows, because of the limited movement of water, that pumping by the project should not induce brackish water intrusion or a change in the quality of water produced by other wells in the area that screen the 500-Foot Sand.

These model results are consistent with empirical data from Well -69 which was pumped extensively in the 1960s, 1970s, 1980s and early 1990s to provide water for the development of caverns at the Strategic Petroleum Reserve and the three existing caverns at the LGSE site. Well -69 screens the 500-Foot Sand and had a reported chloride content of 500 mg/l in 1963. After being pumped for all or parts of four decades, the chlorides were measured at 535 mg/l in March of 2008. During this same period, the chlorides reported at Well -160 (Figure 8), which provides water to the Town of Hackberry, was 218 mg/l in February 1972, 229.7 mg/l in June 2003 and

230 mg/l in May 2008. This is a further indication that the chloride content and overall mineralization of the water in the 500-Foot Sand has remained stable for the past 35 years, which is again consistent with MODPATH results.

Conclusions

Geologic and hydrogeologic data were collected from multiple sources and evaluated, and a two-dimensional groundwater flow model was constructed to analyze potential impacts to the Chicot aquifer due to operation of LGSE groundwater wells screened in the 500-Foot Sand. The results of this evaluation and groundwater flow modeling demonstrate the following:

- Pumping from either the 500-Foot Sand or the 700-Foot Sand by the LGSE project also should not adversely affect groundwater quality in the 200-Foot Sand and 500-Foot Sand, respectively, because of the separation with thick clays between the 700-Foot and 500- and 200-Foot Sands.

- There is no evidence that pumping from the 500-Foot Sand for storage cavern development during the 1960s, 70s, 80s and early 1990s impacted water quality of wells located in the area. Therefore, groundwater pumping for the LGSE project should not adversely affect groundwater chemistry of wells screening the 500-Foot Sand.

- The groundwater flow modeling shows that the aquifer can readily sustain the pumping of 2,000 gpm from the 500-Foot Sand for the period needed for the cavern development.

- The groundwater flow modeling results also show that groundwater pumping for the LGSE project will result in a small interference drawdown (approximately 11 to 13 feet at the Town of Hackberry), therefore pumping rates of wells in the area that screen the 500-Foot Sand should not be significantly impacted. The wells that provide water for public supply or municipal supply should continue to provide water at high rates as needed for normal use and for peak pumping rates such as for fire protection.

- Particle tracking modeling results show that the rates of groundwater movement in the 500-Foot Sand resulting from the proposed LGSE pumping are very small. The particle tracking results also indicate that pumping by the project should not induce brackish water intrusion or a change in the quality of water produced by other wells in the area that screen the 500-Foot Sand.

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Tables

Figures

Table 1. Electric Log Identification Table

Electric Log ID	Louisiana DNR SONRIS Well Number	Company	Well	Total Depth (feet)
LIB-1	54575	Carrl Oil Company	J C Ellender #2	1,902
E-2	29373	Sulphur Company	Gulf Refining Co FEE #1	2,160
E-3	71601	Southwest Enterprises	Benson Vincent ET AL #B1	2,717
E-4	69827	R.J. Coleman	Jasper Little ET AL #1	1,833
E-5	41028	K.B. Knox	Raymond Vincent #2	3,572
E-6	60260	Harry Hurt	Natalie Vincent ET AL #1	5,512
E-7	73228	Woods & Mason	Eugene Hanzen ET AL #2	3,341
E-8	67575	R.J. Coleman	Benson Vincent ET AL #1	3,570
E-9	112805	Lawrence Oil Incorporated	Authur Little ET AL #1	3,515
E-10	89355	The Ballard & Cordell Corporation	Dugas, ET AL #1	3,353
E-12	12540	K.B. Know et al	Luger Duhon #1	3,197
E-13	68425	R.J. Coleman	Ludger Duhon #1	3,451
E-14	--	Gulf Plains Petroleum Company	Eugene Hanzen ET AL #1	3,433
E-16	126845	Pan American Petroleum	Agnes E Lowrey #1	1,595
E-17	54573	Carrl Oil Company	J C Ellender #1	1,550
E-18	126782	Pan American Petroleum	B Lyons Palmer #1	1,630
E-19	128906	Pan American Petroleum	Mammie L Gray #5	1,829
E-20	29407	Freeport Sulphur	JM Vincent Estate #1	2,148
E-21	29654	Freeport Sulphur	JM Vincent Estate #4	2,118
E-22	29561	Freeport Sulphur	William Little Jr #1	2,521
E-23	120308	Brownie Drilling	Floyd Little ET AL #1	2,413
E-24	42624	Standolind Oil	State Land 90	4,970
E-25	42112	Standolind Oil	WH AMPH VU;SL 42 INJ #88	6,074
E-26	68243	Pan American Petroleum	Gulf Land A R/A /B/ 52	5,366
E-27	86594	Layne Louisiana	DOE SPR 11	4,000
E-28	56997	Sutton Joint	Porter Ellender #2	1,705
E-29	124813	Pan American Petroleum	Nason P Elender #1	1,794
E-30	66075	EC Bolton	Lester Lacy #3	3,420
E-31	54439	RJ Coleman	Benson Vincent ET AL #1	2,983
E-32	74240	RD MacDonald	Beulah Duhon Dugas #1	3,150
E-33	65591	RJ Coleman	Vernie H Subwischer #4	3,030
E-34	41788	Standolind	SL 42 #87	6,700
E-35	45574	Standolind Oil	Gulf Land	--
E-36	45040	Shell Oil	Mrs J B Watkins #1	9,518
E-38	50668	Magnolia Petr Company	E Verdine #1	14,394
E-39	53001	Union Sulphur	J B Watkins #57	3,509
E-40	111187	Pan American Petroleum	Gulf Land A R A B 122	4,333
E-41	43397	Standolind Oil	Cameron Parish SCH BD R/A A #30	6,689
E-42	33207	Standolind Oil	Gulf Lands 38	10,395
E-44	64818	The Texas Company	Hackberry #63	8,917

2/13/2009

Table 2. Water Well List with Completions and Usage

Well Number	Well Owner	Year Com-pleted	Aquifer	Well Elevation (feet)	Total Depth of Well (feet)	Screened Interval & Total Screen (feet)	Casing & [Screen] Diameter/s (inches)	Specific Capacity (gpm/ft)	Pumping Rate (gpm)	Static Water Level Depth (feet)	Date	Reported Use of Water
-1a	Sabine Storage & Operations (Olin Mathieson Chemical) Well 2	1934	11205LC	10	409	-- --	-- --	--	--	--	7	Ind
-1b	Sabine Storage & Operations (Olin Mathieson Chemical) Well 4	1947	11205LC	6	470	385-468 83	12, 8 [8]	--	--	--	--	Ind
-2	LA Alligator Wholesalers	2003	11205LC	--	460	440-460 20	6 [6]	3.3	150	48	9/8/2003	Irr
-5	Union Sulphur	1979	11205LC	--	740	-- --	-- --	--	--	--	--	Ind
-7	Grand Lake School	--	11205LC	--	757	-- --	2 --	--	--	2.53	8/21/1943	PS
-31	Union Sulphur	--	11205LC	--	550	-- --	8 --	--	--	--	--	Dom
-35	Colligan	--	11205LC	--	516	-- --	2 [2]	--	--	--	--	Dom
-36	Stromer	1949	11202LC	--	241	-- --	3 [3]	--	--	--	--	Dom
-64	Trident NGL. Inc. (Cities Service Refining)	1957	11205LC	--	504	461-505 44	10, 4 [4]	--	--	--	--	P/A
-66	Targa Midstream Services (Trident NGL. Inc.) (Cities Service Refining)	1957	11205LC	--	503	423-503 80	22, 10 [10]	95.2	2,000	37 35.66 37.1 45.05 39.26 41.49	4/21/57 4/20/1959 4/22/1960 9/5/1961 3/28/1962 3/30/1963	Ind

Table 2. Water Well List with Completions and Usage

Well Number	Well Owner	Year Com- pleted	Aquifer	Well Elevation (feet)	Total Depth of Well (feet)	Screened Interval & Total Screen (feet)	Casing & [Screen] Diameter/s (inches)	Specific Capacity (gpm/ft)	Pumping Rate (gpm)	Static Water Level Depth (feet)	Date	Reported Use of Water
-66	Targa Midstream Services (Con't)									44.9	3/27/1964	
										45.58	3/23/1965	
										47.13	3/22/1966	
										48.47	3/22/1967	
										47.75	3/3/1969	
										62	2/25/1970	
										59.14	2/18/1971	
										61.91	3/9/1977	
										66.45	3/2/1979	
										57.3	3/18/1983	
-69	Sabine Storage & Operations (Olin Mathieson Chemical) Well 5	1959	11205LC	--	480	400-480 80	16,8 [8]	32.9	1,000	46.97	1959	Ind
-91	Hackberry Recreation Dist. Well 1	1963	11205LC	--	419	377-419 42	8,4 [4]	--	50	41.67	7/11/1964	P/A
-121	USGS Observation	1974	11205LC	--	691	-- --	2 --	--	--	58.59	11/4/1974	Obs
-122	USGS Observation	1974	11207LC	--	920	910-920 10	2,2 [2]	--	--	64.79	9/1/1974	P/A
-134	USGS Observation	1977	11205LC	--	710	690-710 20	--	--	--	50.35	1/6/1977	Obs
										49.99	2/23/1977	
										51.47	2/26/1980	
										45.35	3/1/1985	
										41.64	11/21/1989	
										44.1	8/27/1996	
										43.58	8/25/1999	
										40.45	10/24/2005	

Table 2. Water Well List with Completions and Usage

Well Number	Well Owner	Year Com-pleted	Aquifer	Well Elevation (feet)	Total Depth of Well (feet)	Screened Interval & Total Screen (feet)	Casing & [Screen] Diameter/s (inches)	Specific Capacity (gpm/ft)	Pumping Rate (gpm)	Static Water Level Depth (feet)	Date	Reported Use of Water
-141	Targa Midstream Services (Cities Service Oil Company) Well 2	1969	11205LC	--	537	395-537 102	16,8 [8]	41.5	1,012	59	10/24/1969	Ind
-146	Olin Mathieson Chemical Well 6	1977	11202LC	--	300	-- --	-- --	--	--	--	--	P/A
-152	Trident NGL. Inc.	1996	11205LC	--	750	-- --	4 --	--	--	--	--	Ind
-152a	Aker Kvaerner - LNG Well 1	2008	11205LC	--	780	620-760 140	10,6 [6]	2.19	265	57	5/5/2008	Ind
-152b	Aker Kvaerner - LNG Well 2	2008	11205LC	--	800	660-800 140	10,6 [6]	16.4	440	58.48	5/14/2008	Ind
-159	Hackberry Water System Well 1	1971	11205LC	5	530	460-530 70	12,6 [6]	--	--	58.2	11/26/1971	P/A
-160	Cameron Parish Water Works District 2 (Town of Hackberry Well 2)	1972	11205LC	--	563	490-560 70	12,6 [6]	16.5	955	57	2/7/1972	PS
-161	Cameron Parish Water Works District 2 (Town of Hackberry Well 3)	1981	11205LC	--	560	489-560 71	12,6 [6]	--	--	59.8	9/9/1981	PS
-175	Cameron Parish Water Works District 11 Big Lake Well 2A	1983	11205LC	--	710	-- --	10,6 [6]	--	--	57	8/20/1983	PS
-5001Z	Olin Mathieson Chemical Well 3	1946	11205LC	--	476	410.5-474 63.5	12, 8 [8]	--	--	19	1946	P/A

Table 2. Water Well List with Completions and Usage

Well Number	Well Owner	Year Com-pleted	Aquifer	Well Elevation (feet)	Total Depth of Well (feet)	Screened Interval & Total Screen (feet)	Casing & [Screen] Diameter/s (inches)	Specific Capacity (gpm/ft)	Pumping Rate (gpm)	Static Water Level Depth (feet)	Date	Reported Use of Water
-5055Z	Rio Bravo	1981	11205LC	--	470	460-470 10	4 [4]	--	125	62	12/16/1981	P/A
-5145Z	WRT Oil Corporation	1981	11205LC	--	650	630-650 20	4 [4]	--	--	--	--	RS
-5328Z	Amoco Producing Company Gulflan 169	--	11205LC	--	426	-- --	-- --	--	--	--	--	P/A
-5329Z	Amoco Producing Company Gulflan 106	--	11205LC	--	532	-- --	-- --	--	--	--	--	P/A
-5359Z	Amoco Producing Company Gulflan 146	--	11205LC	--	529	-- --	-- --	--	--	--	--	P/A
-5402Z	WRT Oil Corp. Vincent #15	1986	11205LC	--	605	585-605 20	4 [4]	--	--	70	11/26/1986	RS
-5545Z	Amoco Production Co. GulfLan 253	1990	11205LC	--	665	645-665 20	4 [4]	--	--	--	--	P/A
-5683Z	Trident NGL Inc.	1993	11205LC	--	546	526-546 20	4 [4]	--	--	55	10/22/1993	P/A
-5684Z	WRT Energy Corp. Vibcent # 17	1993	11205LC	--	620	600-620 20	4 [4]	--	--	55	10/8/1993	RS
-6127Z	Texas Petroleum Investments (Hilcorp Energy) Well 1	2005	11202LC	--	280	260-280 20	4 [4]	--	40	35	11/10/2005	PS

Table 2. Water Well List with Completions and Usage

Well Number	Well Owner	Year Com-pleted	Aquifer	Well Elevation (feet)	Total Depth of Well (feet)	Screened Interval & Total Screen (feet)	Casing & [Screen] Diameter/s (inches)	Specific Capacity (gpm/ft)	Pumping Rate (gpm)	Static Water Level Depth (feet)	Date	Reported Use of Water
-6181Z	LA Alligator	2007	11205LC	--	645	--	--	--	--	--	--	Irr
-6182Z	LA Alligator	2007	11205LC	--	645	--	--	--	--	--	--	Irr

EXPLANATION:

Aquifer:

11202LC = "200-Foot" Sand of Lake Charles Area
11205LC = "500-Foot" Sand of Lake Charles Area
11207LC = "700-Foot" Sand of Lake Charles Area

Use of Water:
PS = Public Supply
Dom = Domestic
Ind = Industrial
Irr = Irrigation
Obs = Observation
RS = Rig Supply
P/A = Plugged and Abandoned

Water Well records obtained from the Water Resources Section of Louisiana Department of Transportation and Development (LDTD).

Table does not provide data for all wells in area as driller's reports have not been submitted to the LDTD for all wells in the area.

Table 3. Chemical Analyses of Water from Wells

(all constituents reported as milligrams per liter (mg/L) except specific conductance and pH)

DOTD Well Number, Sbreened Interval or Total Depth (feet)	Water Use	Reporting Agency	Sample Date	Iron (Fe)	Manga-nese (Mn)	Cal-cium (Ca)	Magne-sium (Mg)	Sodium (Na)	Bicar-bonate (HCO3)	Sul-fate (SO4)	Chlo-ride (Cl)	Fluo-ride (F)	Nitrate (N)	Dis-solved Solids	Total Hardness (as CaCO3)	Specific Conductance (micromhos/cm)	pH
200-Foot Sand																	
-36	Domestic	USGS	8/9/1949	--	--	--	--	--	--	--	75	--	--	--	--	748	--
241																	
-6127Z	Public Supply	SLI	3/18/08	--	--	--	--	--	--	--	93	--	--	412	--	677	--
280																	
500-Foot Sand																	
-1b	Industrial	--	10/10/1985	0.3	--	32.0	7.1	--	--	--	--	--	--	1,040	84	1,500	8.0
385-468																	
-2	Irrigation	SLI	5/5/08	--	--	--	--	--	--	--	285	--	--	724	--	1,390	--
440-460																	
-5	Industrial	USGS	8/9/1949	--	--	--	--	--	--	--	130	--	--	--	--	841	--
740																	
-7	Public Supply	USGS	12/8/1943	0.6	--	--	--	--	--	2	230	0.8	--	--	63	--	7.7
757			8/24/1948	0.7	--	--	--	--	--	--	200	0.1	--	--	94	1,050	--
-31	Domestic	USGS	6/9/1949	--	--	--	--	--	--	--	130	--	--	--	--	850	--
550																	
-35	Domestic	USGS	8/9/1949	--	--	--	--	--	--	--	220	--	--	--	--	1,130	--
516																	
-64	Plugged	USGS	4/24/1957	0.1	--	--	--	--	--	2.0	400	--	--	1,000	120	--	8.1
461-505	and Abandoned		4/9/1963	--	--	--	--	--	--	--	430	--	--	--	--	1,690	--
-66	Industrial	SLI	3/18/2008	--	--	--	--	--	--	--	415	--	--	862	--	1,700	--
423-503																	
-69	Industrial	USGS	4/9/1963	--	--	--	--	--	--	--	500	--	--	--	--	1,880	--
400-480		ENV	12/7/07	0.441	0.142	36.8	9.7	388.0	341.6	<10	536	--	<1.0	1,402	132	2,062	7.78
		SLI	3/18/2008	--	--	--	--	--	--	--	535	--	--	--	--	2,080	--
-91	Plugged	USGS	5/1/1964	0.07	--	22.7	6.3	240	290	0	260	--	--	+_	83	1,320	7.7
377-419	and Abandoned																
-121	Observation	USGS	9/6/1974	--	--	--	--	--	--	--	210	--	--	--	--	1,070	--

Table 3. Chemical Analyses of Water from Wells

(all constituents reported as milligrams per liter (mg/L) except specific conductance and pH)

DOTD Well Number, Sbreened Interval or Total Depth (feet)	Water Use	Reporting Agency	Sample Date	Iron (Fe)	Manga-nese (Mn)	Cal-cium (Ca)	Magne-sium (Mg)	Sodium (Na)	Bicar-bonate (HCO3)	Sul-fate (SO4)	Chlo-ride (Cl)	Fluo-ride (F)	Nitrate (N)	Dis-solved Solids	Total Hardness (as CaCO3)	Specific Conductance (micromhos/cm)	pH
691		USGS	9/17/1974	--	--	--	--	--	--	--	220	--	--	--	--	1,100	--
		USGS	3/25/1975	--	--	--	--	--	--	--	220	--	--	--	--	1,050	--
		USGS	2/25/1977	--	--	--	--	--	--	--	230	--	--	--	--	1,090	--
		USGS	12/6/1979	--	160	42	10	180		0.8	230	0.1		613	150	1,120	10.5
		USGS	3/6/1981	--	--	--	--	--	--	--	230	--	--	--	150	1,130	--
		USGS	4/13/1982	--	--	--	--	--	--	--	230	--	--	--	150	--	--
		USGS	6/20/1983	--	--	--	--	--	--	--	220	--	--	--	--	--	--
		USGS	8/27/1996	--	--	--	--	--	--	--	220	--	--	--	--	1,130	--
-134 690-710	Observation	USGS	1/19/1977	0.78	--	--	--	--	--	--	320	--	--	--	--	1,450	6.8
		USGS	3/16/1977	--	--	--	--	--	--	--	320	--	--	--	--	1,450	--
		USGS	3/27/1979	--	--	--	--	--	--	--	310	--	--	--	--	1,430	--
		USGS	2/26/1980	0.12	80	19	6.2	270	--	0	310	0.2	--	778	73	1,400	8.2
		USGS	6/29/1983	--	--	--	--	--	--	--	300	--	--	--	--	--	--
		USGS	8/27/1996	--	--	--	--	--	--	--	300	--	--	--	--	1,420	--
-141 395-537	Industrial	USGS	6/13/1996	--	--	--	--	--	--	--	420	--	--	--	--	1,820	--
-152 750	Industrial	USGS	6/13/1996	--	--	--	--	--	--	--	25	--	--	--	--	456	--
-152a 780	Industrial	ANA	5/3/2008	0.288	--	--	--	--	--	ND	16.9	--	--	--	--	437	8.0
-152b 800	Industrial	ANA	5/15/2008	0.204	--	21.5	4.19	64.2	207	ND	23.9	--	--	308	--	447	8.1
-159 460-530	Plugged and Abandoned	USGS	11/5/1981	0.17	0.09	25	6.2	260	--	--	280	0.30	--	711	89	1,280	7.5
-160 490-560	Public Supply	CUL	2/8/1972	0.02	0.03	27.2	9.2	203.4	--	0	218	0.1	--	639	106	1,060	7.05
		LDH	4/17/2000	0.17	0.06			157.7		0	306.4	0.2	0	666	44		7.85
		LDH	6/2/2003	0.07	0.08			212.3		<1	229.7	0.2	0	676	84.4		7.58
		SLI	5/5/2008	--	--	--	--	--	--	--	230	--	--	579	--	1,150	--
-161 489-560	Public Supply	PEL	6/10/1981	0.42	0.08	17.60	9.72	242.65	290.28	00.2	265	--	--	859.87	82	--	8.0
		LDH	4/17/2000	0.10	0.07			220.4		63	286.4	0.2		734	60.1	--	7.82
		LDH	6/2/2003	0.12	0.07			189.7		<1	280.4	0.2		720	78.8	--	7.5
		SLI	5/5/2008	--	--	--	--	--	--	--	255	--	--	683	--	1,270	--

Table 3. Chemical Analyses of Water from Wells

(all constituents reported as milligrams per liter (mg/L) except specific conductance and pH)

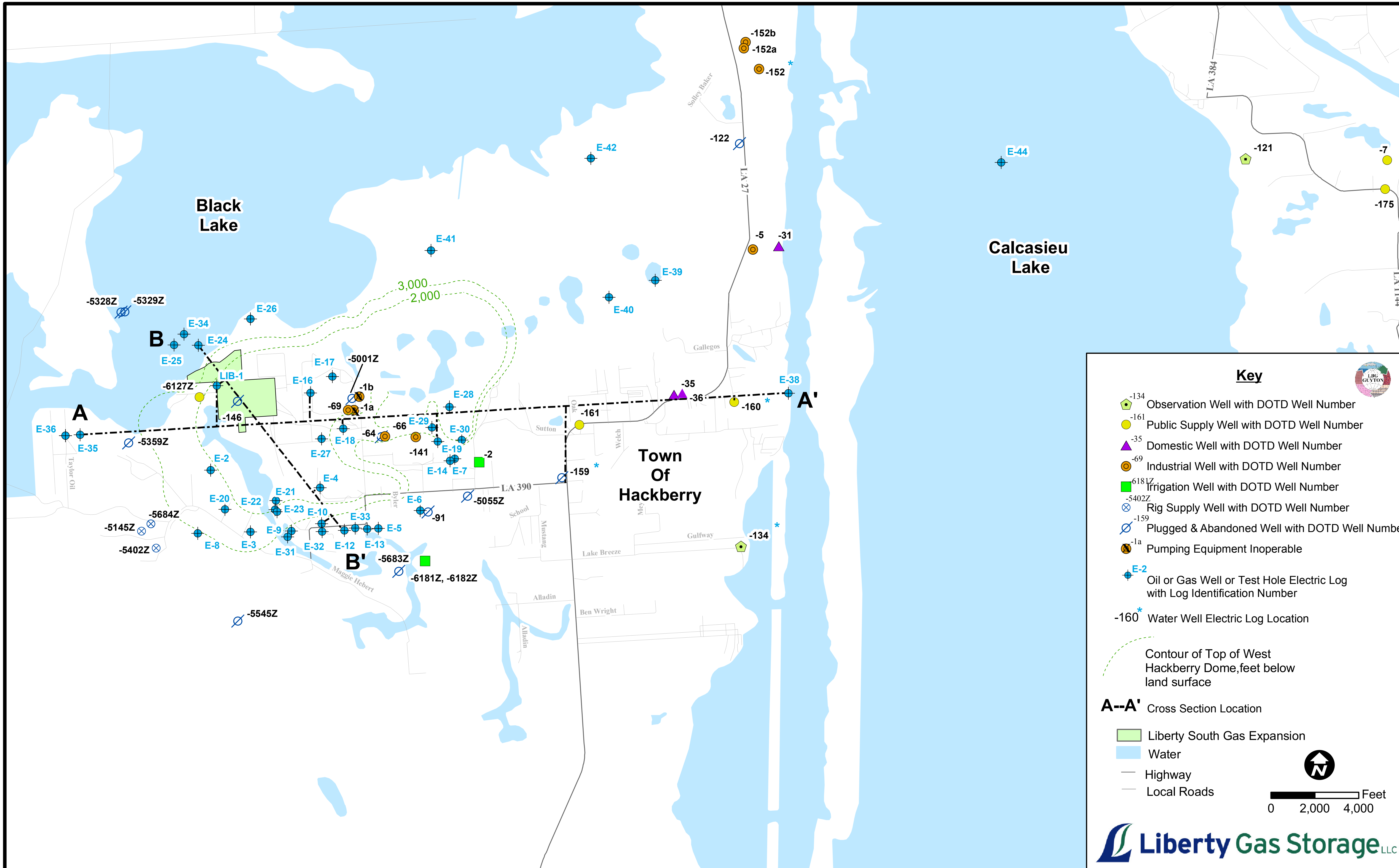
DOTD Well Number, Sbreened Interval or Total Depth (feet)	Water Use	Reporting Agency	Sample Date	Iron (Fe)	Manga-nese (Mn)	Cal-cium (Ca)	Magne-sium (Mg)	Sodium (Na)	Bicar-bonate (HCO3)	Sul-fate (SO4)	Chlo-ride (Cl)	Fluo-ride (F)	Nitrate (N)	Dis-solved Solids	Total Hardness (as CaCO3)	Specific Conductance (micromhos/cm)	pH
-175 710	Public Supply	USGS	6/14/1996	--	--	--	--	--	--	--	180	--	--	--	--	974	--
-6181Z, -6182Z 645, 645 Distribution System	Other (irrigation)	SLI	3/18/2008	--	--	--	--	--	--	--	325	--	--	812	--	1,570	--
700-Foot Sand																	
-122 920	Plugged and Abandoned	USGS	9/1/1974	--	--	--	--	--	--	--	280	--	--	--	--	1,320	--
		USGS	3/18/1975	--	--	--	--	--	--	--	270	--	--	--	--	1,290	--
		USGS	3/16/1977	--	--	--	--	--	--	--	260	--	--	--	--	1,290	--
		USGS	12/4/1979	--	20	6.4	2.9	260	--	10	250	0.3		702	28	1,260	10.9
		USGS	2/26/1981	--	--	--	--	--	--	--	240	--	--	--	30	1,250	--
		USGS	5/4/1982	--	--	--	--	--	--	--	230	--	--	--	--	--	--
		USGS	6/28/1983	--	--	--	--	--	--	--	230	--	--	--	--	--	--

EXPLANATION:

ND= Not Detected

Reporting Agency:

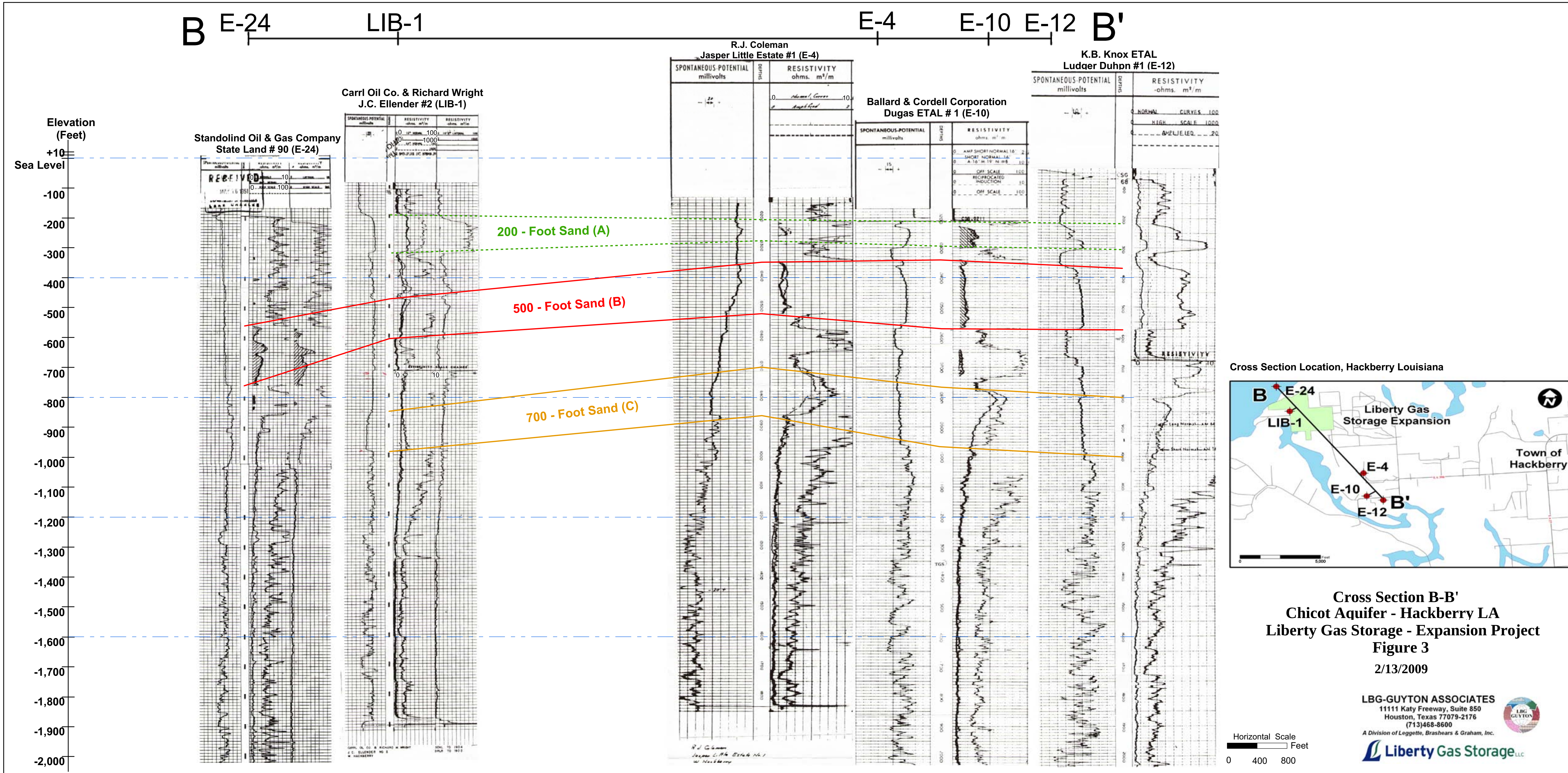
CUL = Curtis Laboratories, Houston, Texas
ENV = Envirodyne Laboratories, Inc. - Houston, Texas.
LDH = Louisiana Department of Health and Hospitals, Lake Charles, Louisiana.
PEL: = Petroleum Laboratories, Inc. - Lafayette, Louisiana.
SLI = Sherry Laboratories, Inc. - Lafayette, Louisiana.
USGS = United States Geological Survey - National Water Information System



Locations of Wells and Test Holes
Chicot Aquifer - Hackberry LA

Figure 1
2/26/2009

A
E-35
LIB-1
E-16
E-18
E-19
HA-159
HA-160
E-38
A'
Standolind Oil & Gas Company
Gulf Land DR AA (E-35)
Carrl Oil Co. & Richard Wright
J.C. Ellender #2 (LIB-1)
Pan American Petroleum Corporation
A. E. Lowery #1 (E-16)
Pan American Petroleum Corporation
B. Lyons Palmer # 1 (E-18)
Pan American Petroleum Corporation
M. L. Gray #5 (E-19)
Cameron Parish Water Works District 10
(Former Hackberry Water Works District #2)
Hackberry Water Well #1 (HA-159)
Hackberry Water Works District #2
Hackberry Water Well #2 (HA-160)
Magnolia Petroleum Company
E. Verdine #1 (E-38)
Elevation
(Feet)
+10
Sea Level
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1,000
-1,100
-1,200
-1,300
-1,400
-1,500
-1,600
-1,700
-1,800
-1,900
-2,000
200 - Foot Sand (A)
Base 200 - Foot Sand (A)
500 - Foot Sand (B)
700 - Foot Sand (C)
Cross Section Location, Hackberry Louisiana
Liberty Gas
Storage Expansion
Town of
Hackberry
Horizontal Scale
Feet
0
800
Cross Section A-A'
Chicot Aquifer - Hackberry LA
Liberty Gas Storage - Expansion Project
Figure 2
2/13/2009
LBG-GUYTON ASSOCIATES
11111 Katy Freeway, Suite 850
Houston, Texas 77079-2176
(713)468-8600
A Division of Leggette, Brashears & Graham, Inc.
Liberty Gas Storage LLC


B
E-24
LIB-1
E-4
E-10
E-12
B'
Elevation
(Feet)
+10
Sea Level
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1,000
-1,100
-1,200
-1,300
-1,400
-1,500
-1,600
-1,700
-1,800
-1,900
-2,000
Standolind Oil & Gas Company
State Land # 90 (E-24)
Carrl Oil Co. & Richard Wright
J.C. Ellender #2 (LIB-1)
R.J. Coleman
Jasper Little Estate #1 (E-4)
Ballard & Cordell Corporation
Dugas ETAL # 1 (E-10)
K.B. Knox ETAL
Ludger Duhon #1 (E-12)
SPONTANEOUS POTENTIAL millivolts
RESISTIVITY ohms. m²/m
200 - Foot Sand (A)
500 - Foot Sand (B)
700 - Foot Sand (C)
Cross Section Location, Hackberry Louisiana
Liberty Gas Storage Expansion
Town of Hackberry
Cross Section B-B'
Chicot Aquifer - Hackberry LA
Liberty Gas Storage - Expansion Project
Figure 3
2/13/2009
Horizontal Scale
Feet
0
400
800
LBG-GUYTON ASSOCIATES
11111 Katy Freeway, Suite 850
Houston, Texas 77079-2176
(713)468-8600
A Division of Leggette, Brashears & Graham, Inc.
Liberty Gas Storage LLC

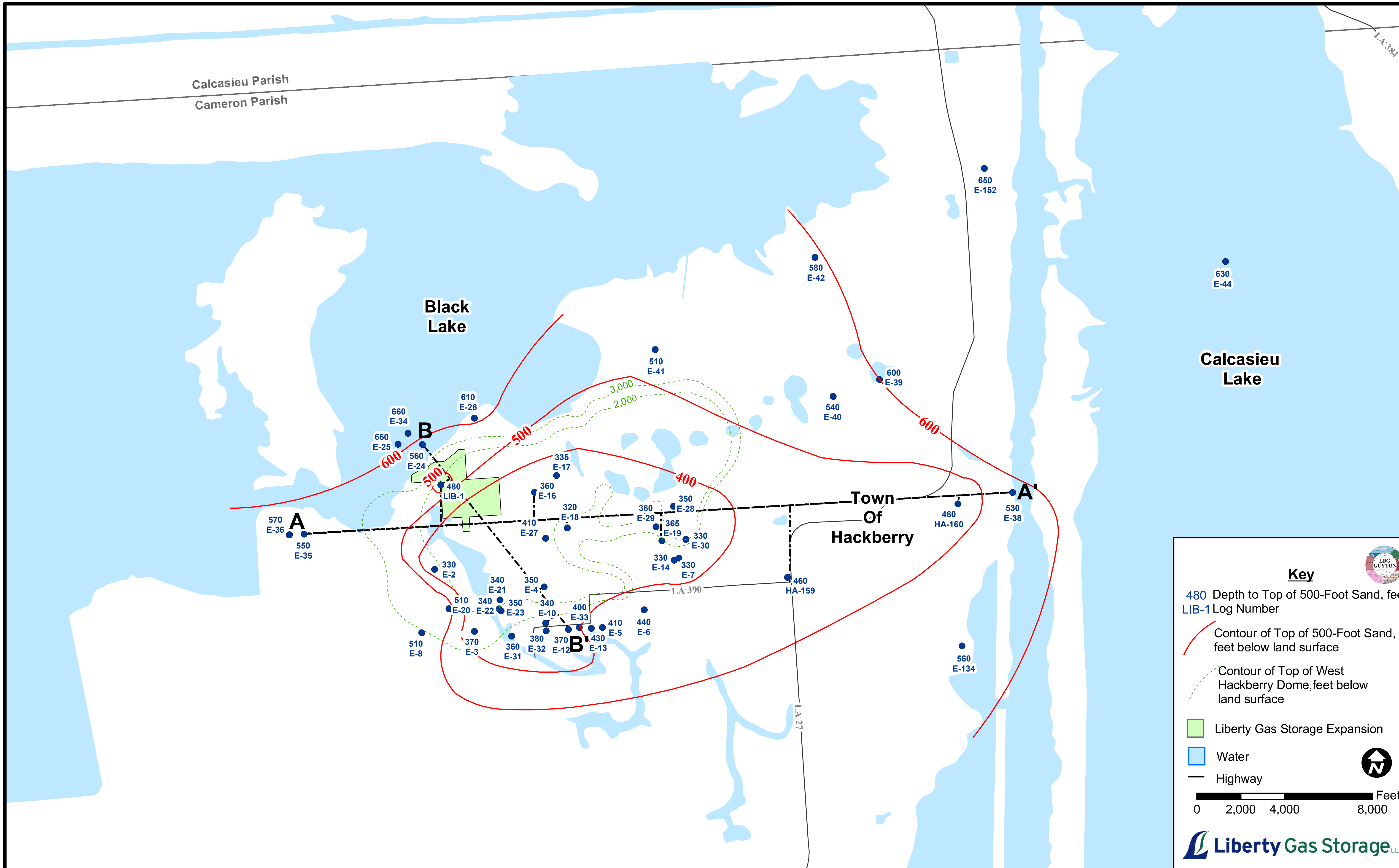
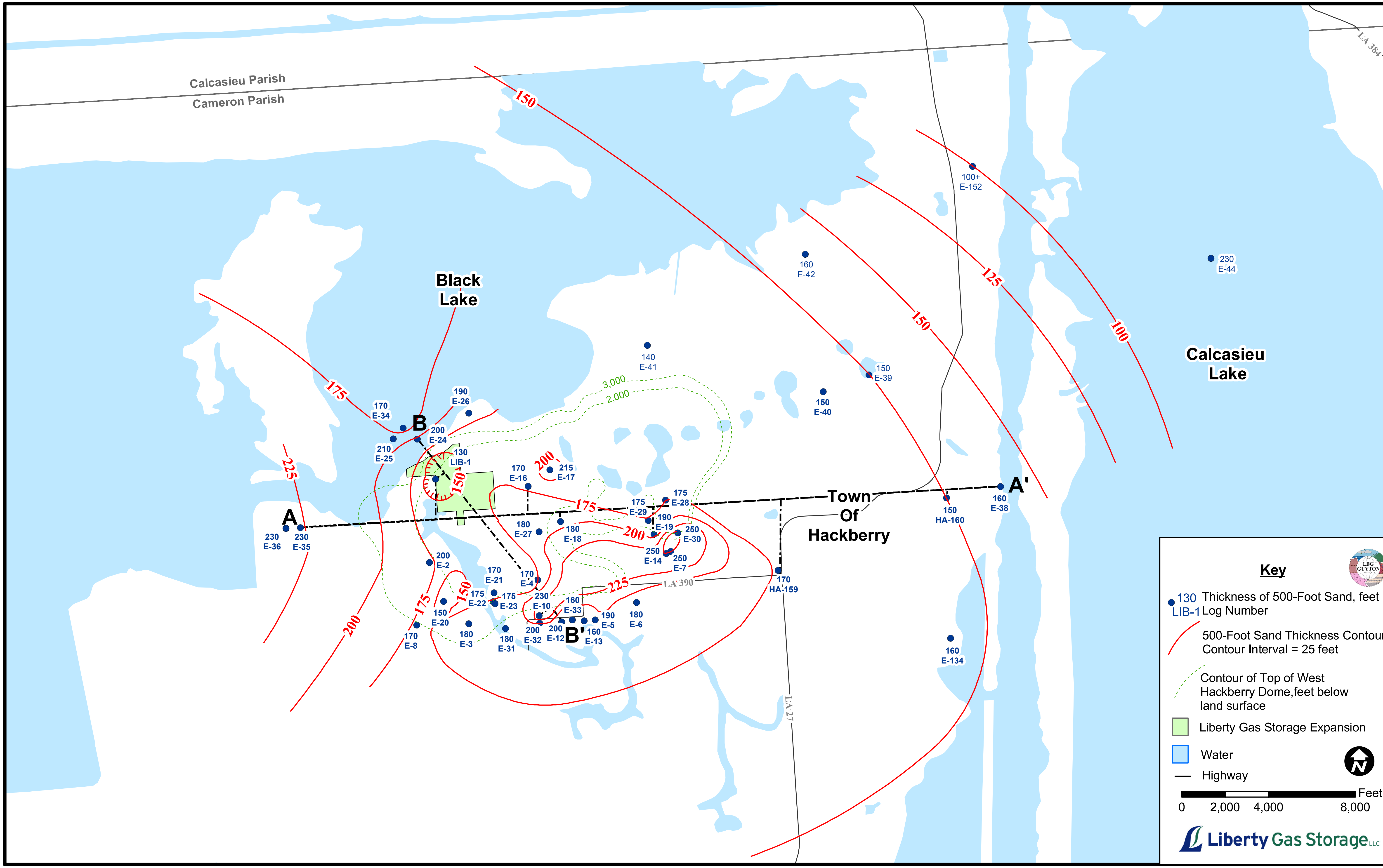


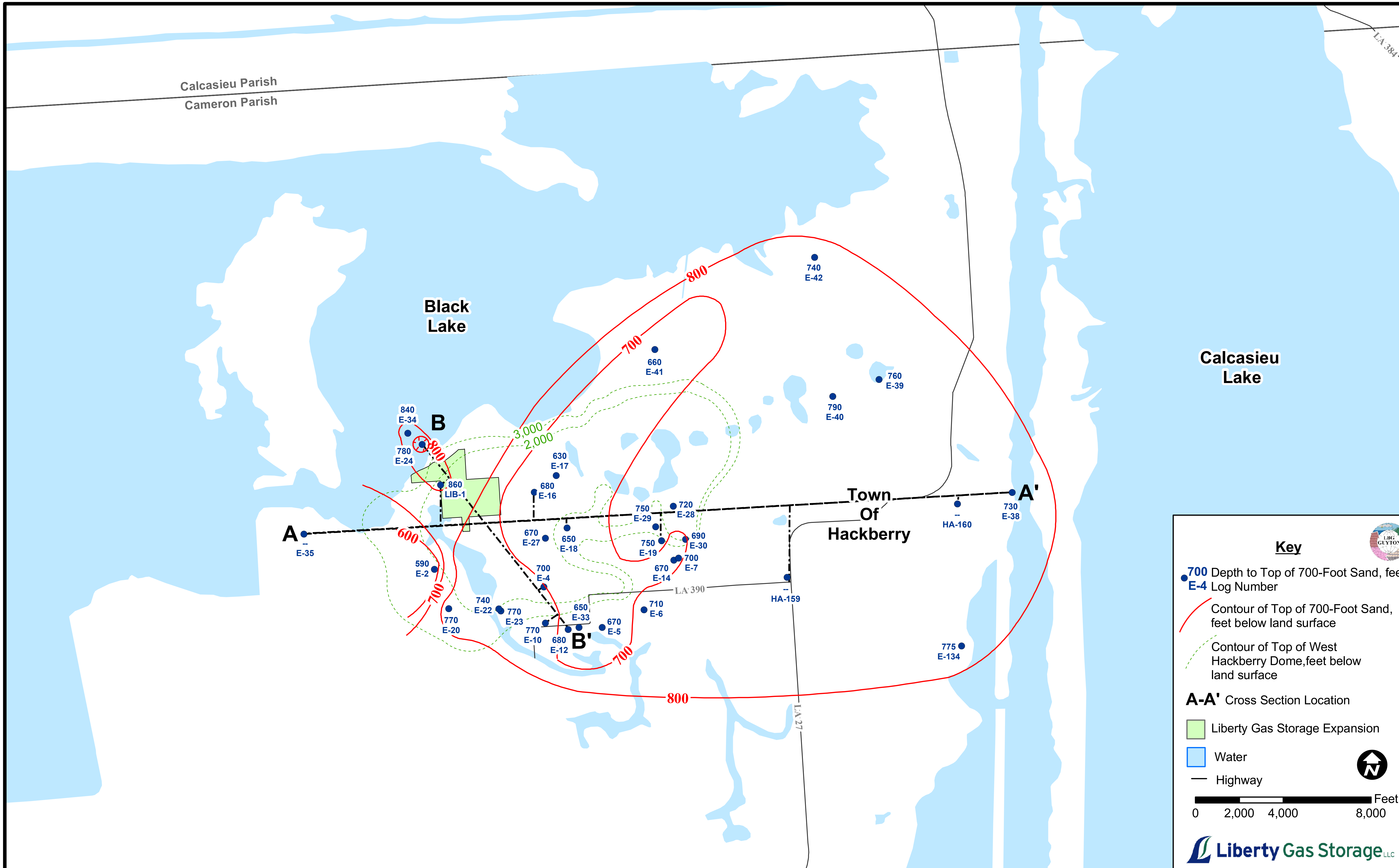
Figure 4
2/13/2009

Structure Contour Map
500-Foot Sand of the Chicot Aquifer - Hackberry LA



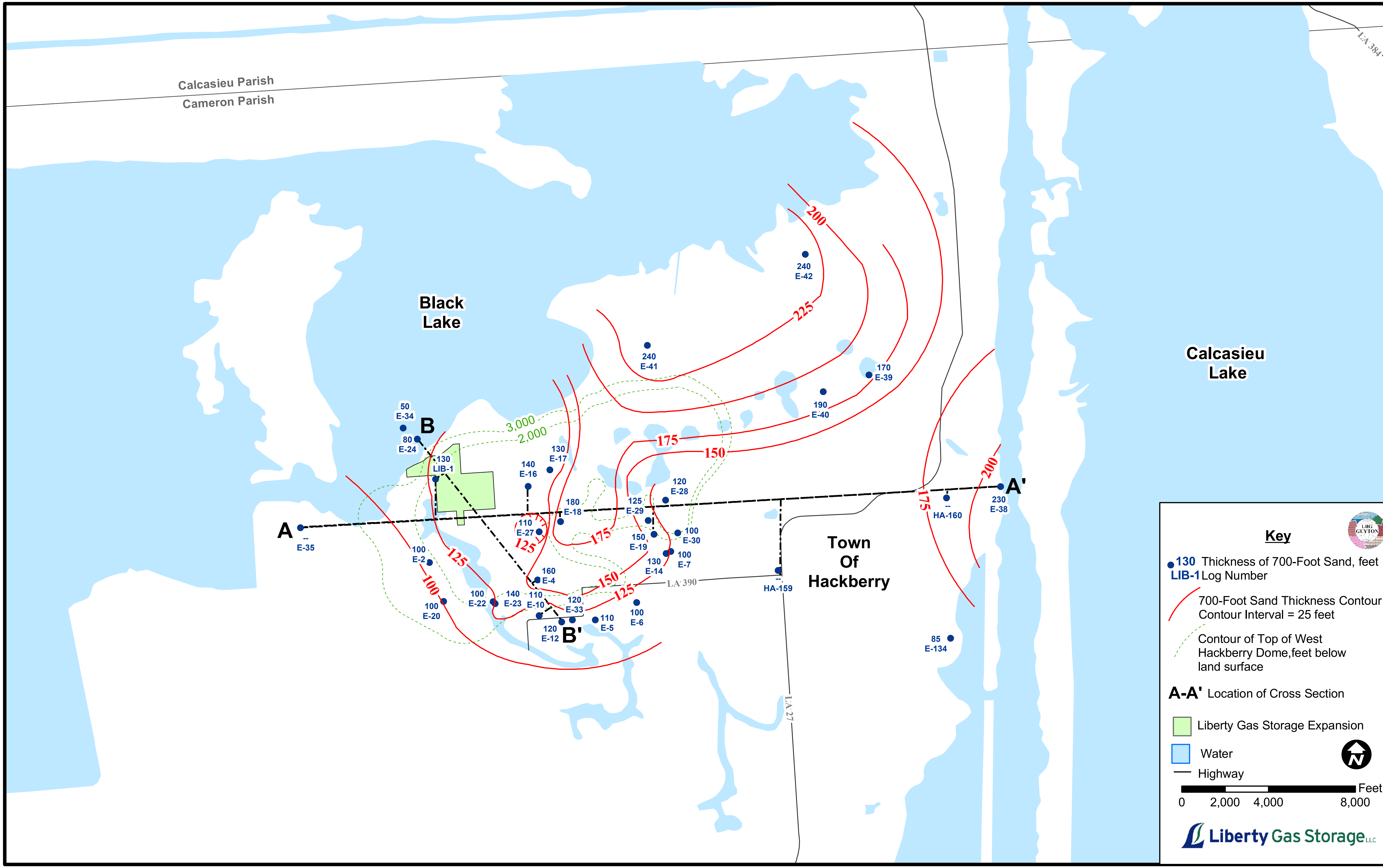
Sand Thickness Isopach
500-Foot Sand of the Chicot Aquifer - Hackberry LA

Figure 5
2/13/2009



Structure Contour Map
700-Foot Sand of the Chicot Aquifer - Hackberry LA

Figure 6
2/13/2009

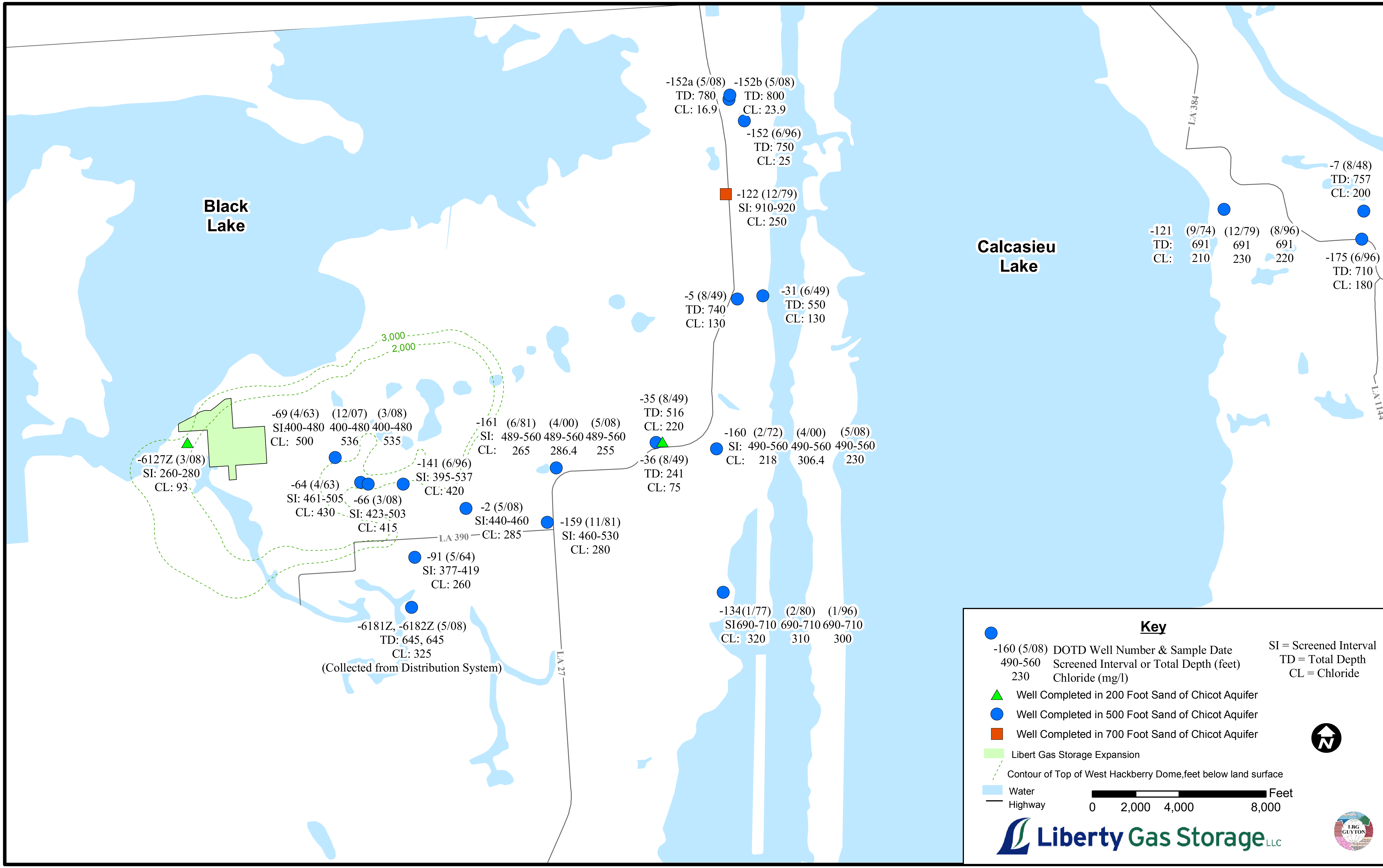


Sand Thickness Isopach

700-Foot Sand of the Chicot Aquifer - Hackberry LA

Figure 7

2/13/2009

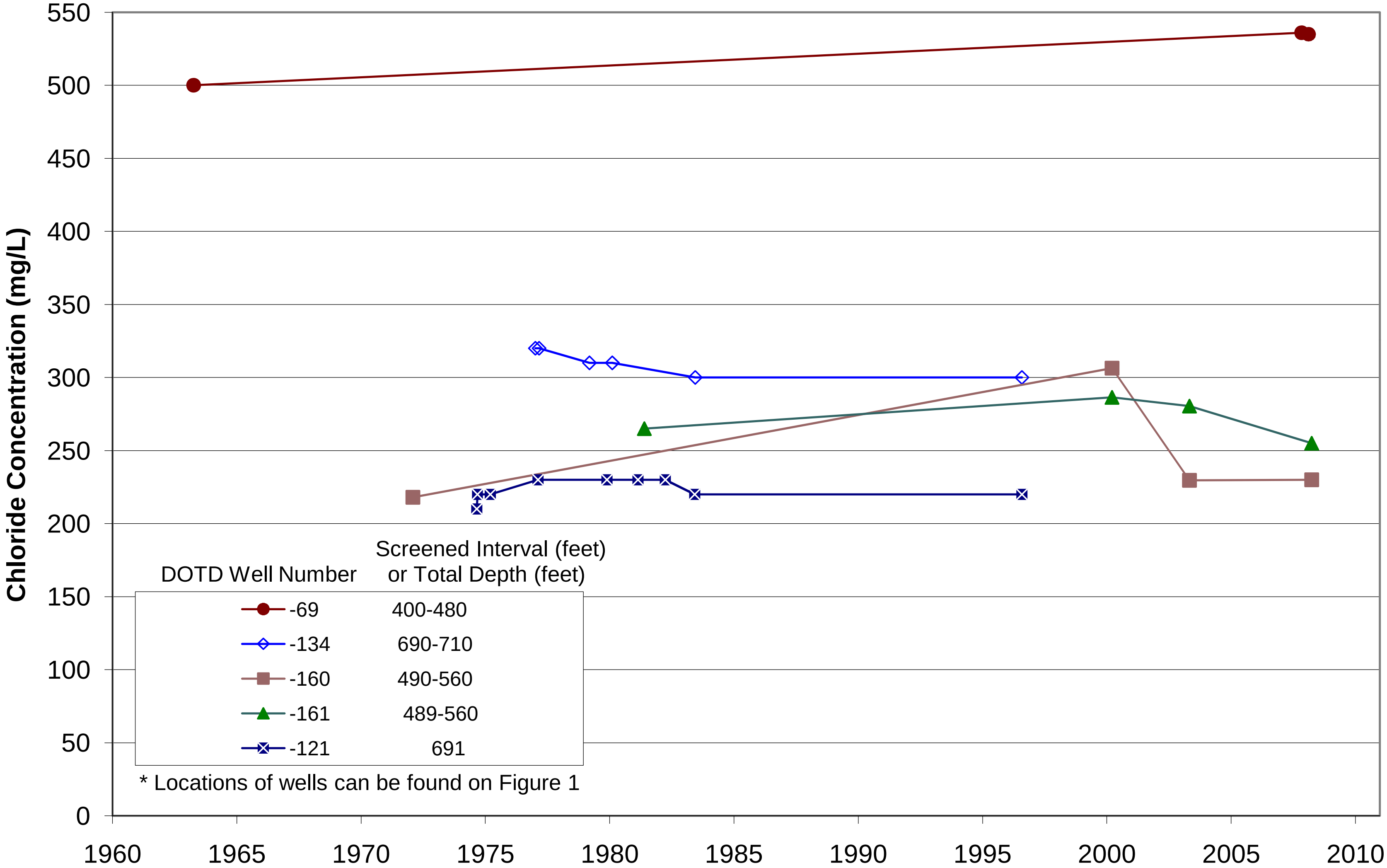


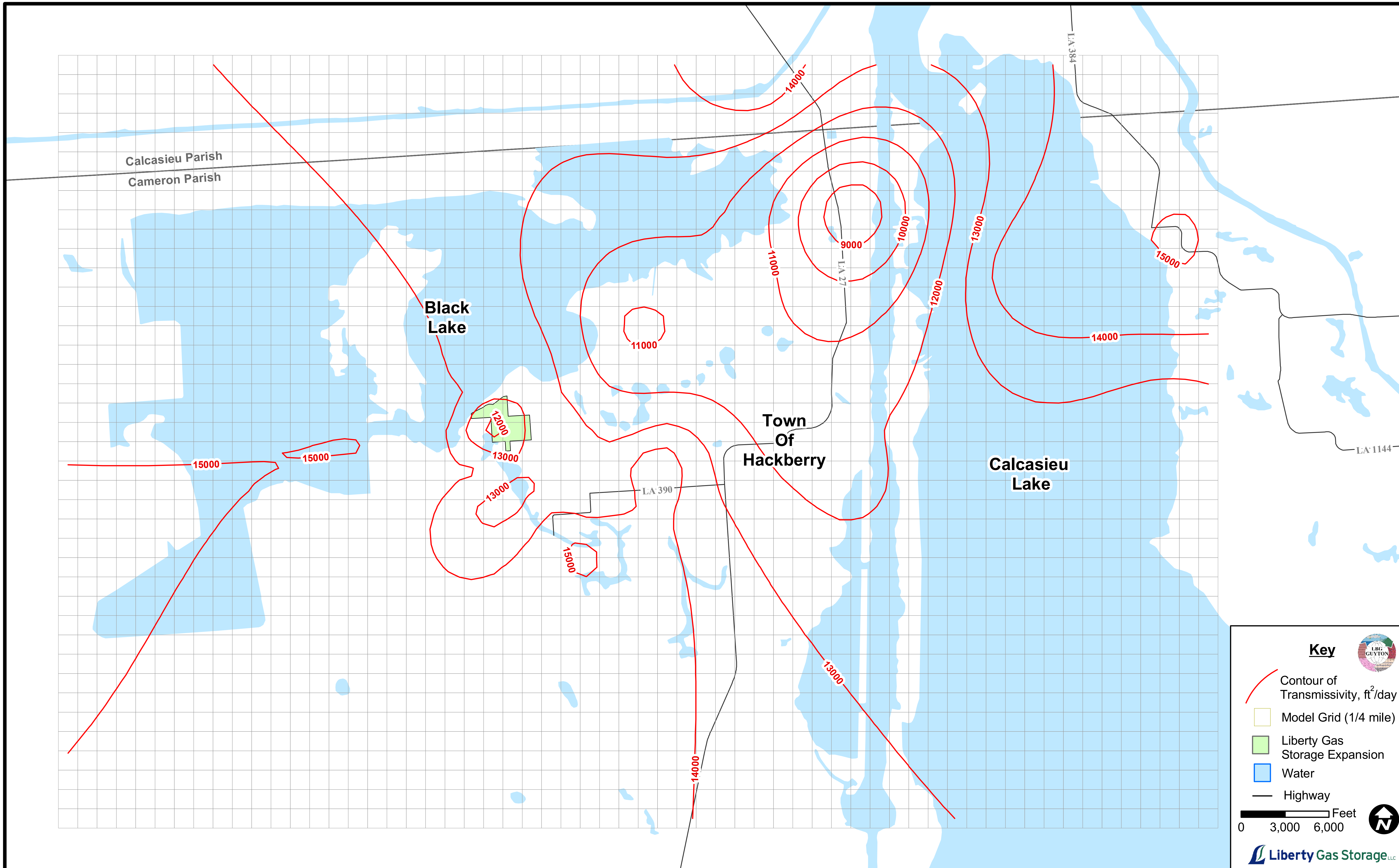
Water Quality Data
Chicot Aquifer - Hackberry LA

Figure 8
2/26/2009

2/26/2009

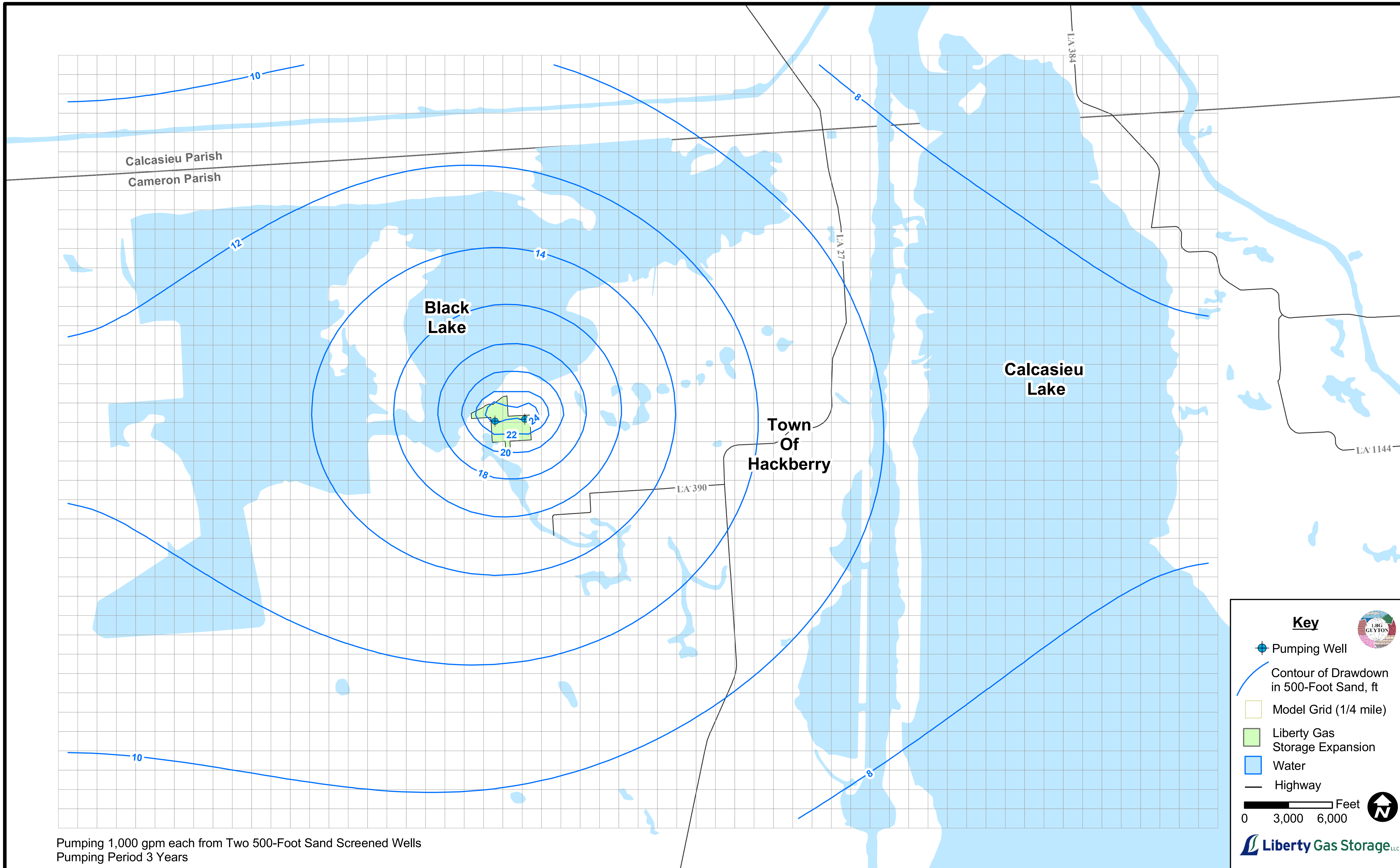
Figure 9. Historical Chloride Concentrations of 500 Foot Sand





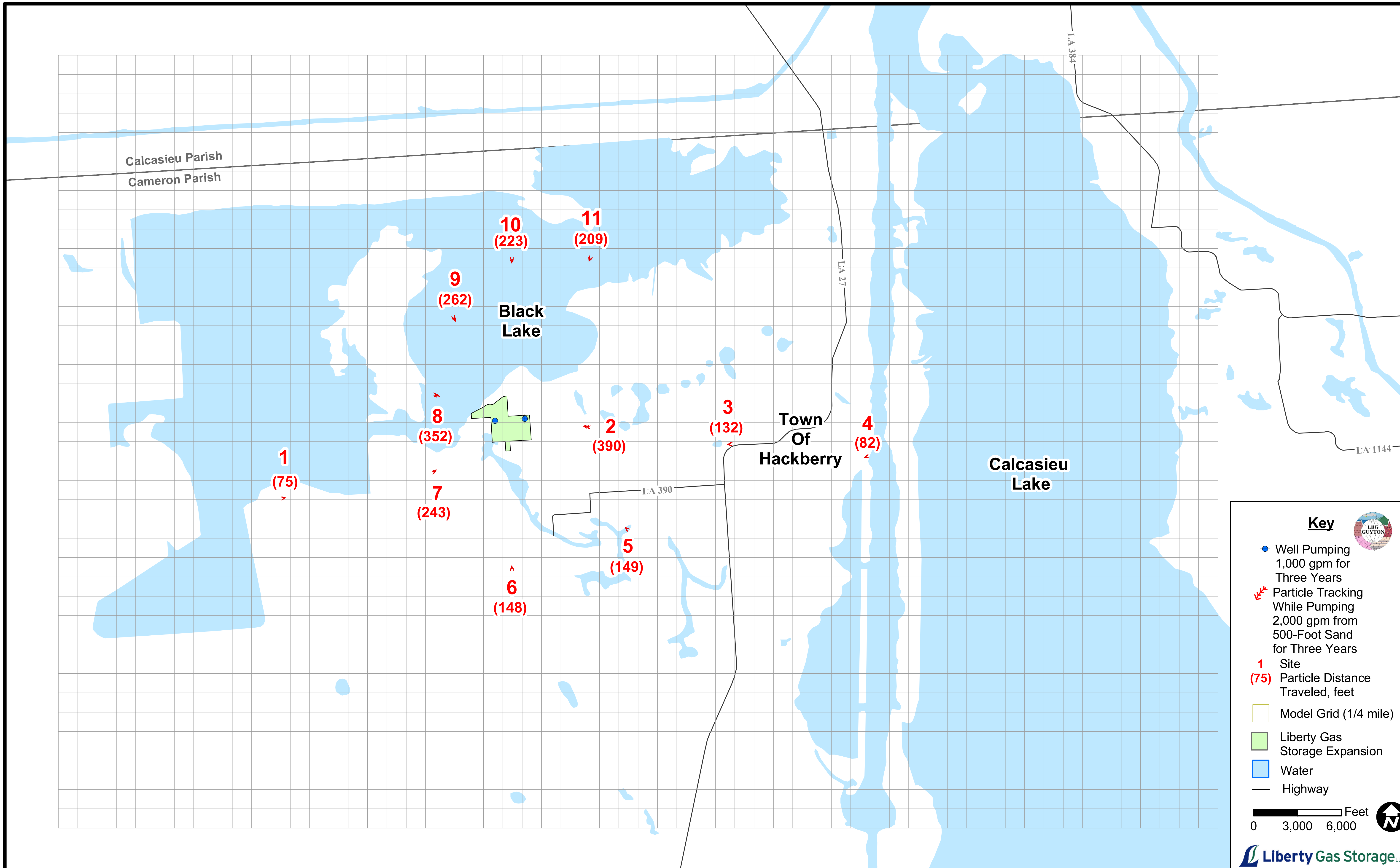
Model Area Transmissivity in the 500-Foot Sand of Chicot Aquifer - Hackberry LA

Figure 10
2/13/2009



Simulated Drawdown for the
500-Foot Sand of Chicot Aquifer - Hackberry LA

Figure 11
2/13/2009



Particle Tracking in the 500-Foot Sand of Chicot Aquifer - Hackberry LA

Figure 12
2/26/2009

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER
COOPERATIVE EXTENSION SERVICE AND THE
LOUISIANA RICE RESEARCH BOARD

WATER-RESOURCES INVESTIGATIONS REPORT 02-4088
Potentiometric Surface--SHEET 1 OF 2
Lovelace, J.K., Fontenot, J.W., and Frederick, C.P., 2002, Louisiana Gound-Water Map No. 14: Potentiometric Surface, January 2001, and Water-Level Changes, June 2000 to January 2001, of the Chicot Aquifer System in Southwestern Louisiana

INTRODUCTION

The Chicot aquifer system is the principal source of fresh ground water in southwestern Louisiana. Figure 1 shows the extent of freshwater in the aquifer system. In 2000, approximately 800 Mgal/d of water were withdrawn from wells in the aquifer system. About 540 Mgal/d were used for rice irrigation (B.P. Sargent, U.S. Geological Survey, written commun., 2001), primarily in Acadia, Jefferson Davis, southern Evangeline, northern Vermilion, and eastern Calcasieu Parishes. Water withdrawals from the aquifer system have lowered the water levels, creating an elongated cone of depression in the potentiometric surface over much of the region (Zack, 1971, p. 7-9 and pl. 2).

Seasonal pumping for rice irrigation, which typically occurs from February through June, causes water-level declines in the Chicot aquifer system in the aforementioned parishes and adjacent areas. During July through January, water levels generally recover after pumping during the rice-growing season. Nyman (1984, p. 8) stated, "Annual water-level fluctuations range from 2 to 3 ft in essentially unpumped areas in parts of Beauregard and Allen Parishes and from 20 to 40 ft near pumping centers for rice irrigation in Jefferson Davis and Acadia Parishes."

Data from a survey of farmers conducted during May 2000, indicated a widespread increase in per-acre application of ground water from the Chicot aquifer system for rice irrigation during the 2000 growing season (B.P. Sargent, U.S. Geological Survey, written commun., 2000). The increased ground-water use presumably was due to the below normal rainfall. Estimates of ground water used for rice irrigation increased from 420 Mgal/d in 1995 (Lovelace and Johnson, 1996, p. 15) to 540 Mgal/d in 2000 (B.P. Sargent, U.S. Geological Survey, written commun., 2001). Zack (1971) indicated that the amount of ground water withdrawn in southwestern Louisiana in any particular year is inversely proportional to the total rainfall during the rice-growing season.

Additional knowledge about ground-water flow and effects of increased withdrawals on water levels in the Chicot aquifer system are needed to assess ground-water-development potential and to protect the resource. To meet this need, the U.S. Geological Survey (USGS), in cooperation with the Louisiana State University Agricultural Center Cooperative Extensive Service and the Louisiana Rice Research Board, established a study to monitor water-level changes in wells completed within the Chicot aquifer system and to evaluate changes in the potentiometric surface (water levels). Results of the study are to be reported periodically; this is the second such report.

This report presents maps and data that describe the potentiometric surface, January 2001, and water-level changes, June 2000 to January 2001, in the massive, upper, and "200-foot" sands of the Chicot aquifer system. Hydrographs of water levels in selected wells completed in the aquifer system are presented. The potentiometric-surface map can be used for determination of ground-water-flow direction, hydraulic gradients, and effects of withdrawals on water levels in the system. Water-level data are on file at the USGS office in Baton Rouge, La.

Description of Study Area

The study area, located in southwestern Louisiana, extends across about 9,000 mi^2 and includes all or parts of Acadia, Allen, Beauregard, Calcasieu, Cameron, Evangeline, Iberia, Jefferson Davis, Lafayette, Rapides, St. Landry, St. Martin, St. Mary, Vermilion, and Vernon Parishes (fig. 1). The climate generally is warm and temperate with high humidity and frequent rain. The average annual temperature is about 20^oC and the average annual rainfall is 55 in. (National Oceanic and Atmospheric Administration, 1995, p. 7, 9). Much of the area is rural, and rice cultivation is the primary agricultural activity. In 1999, 460,000 acres of rice were planted in southwestern Louisiana (Louisiana Cooperative Extension Service, 2000).

Acknowledgments

The authors gratefully acknowledge the assistance and cooperation of numerous public water suppliers and private well owners who allowed water levels to be measured in their wells. The authors thank Eddie Eskew, Keith Fontenot, Howard Cormier, Ron Levy, Jerry Whatley, and Gary Wicke, County Agents of the Louisiana Cooperative Extension Service, who initiated contacts with many of the land owners and farmers whose wells were used in this study. Additionally, the authors thank Z. "Bo" Bolourchi, Chief, Water Resources Programs, Louisiana Department of Transportation and Development, for providing well information that was used to select wells for this study, and Frank R. Glass, Jr. and Dan J. Tomaszewski of the U.S. Geological Survey, for collecting water-level data used for this study.

HYDROGEOLOGY

The Chicot aquifer system underlies most of southwestern Louisiana and parts of the Texas coastal lowlands. The aquifer system is composed of deposits of silt, sand, and gravel interlayered with deposits of clay and sandy clay that dip towards the south and southeast. The sand deposits grade southward from coarse sand and gravel to finer sediments and become increasingly subdivided by clay units. The Chicot aquifer system also thickens eastward, towards the Atchafalaya River area, where it is hydraulically connected to alluvial deposits of the Atchafalaya and Mississippi Rivers (Nyman, 1984, p. 4).

The Chicot aquifer system has been divided into three subregions in Louisiana based on the occurrence of major clay units.

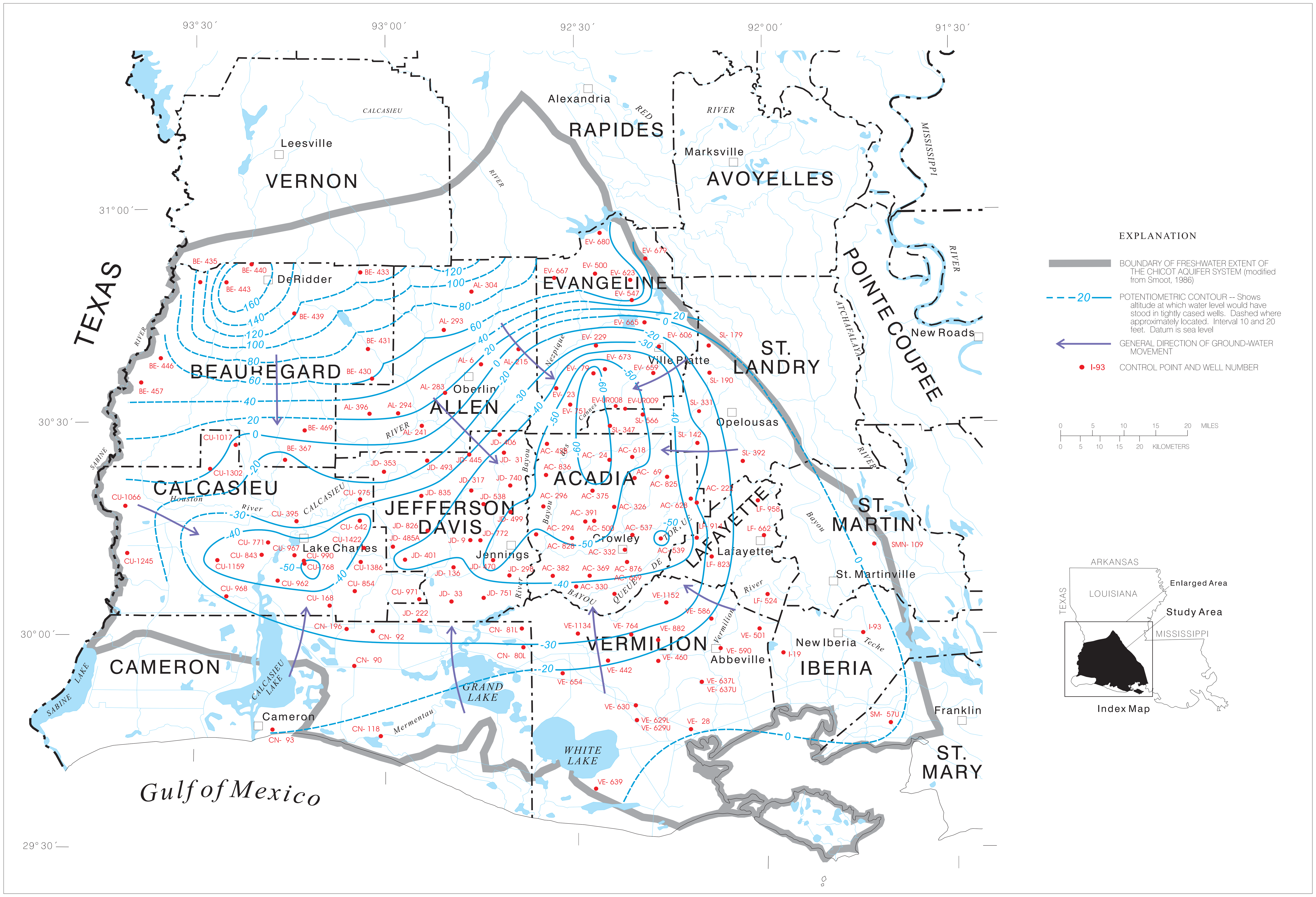


Figure 1. Potentiometric surface of the massive, upper, and "200-foot" sands of the Chicot aquifer system in southwestern Louisiana, January 2001.

In the northern part of the study area, the aquifer system is composed mainly of a single massive sand. The approximate southern boundary of the massive sand extends along the Beauregard-Calcasieu Parish line and across northern Jefferson Davis, Acadia, and Lafayette Parishes. South of the massive sand, from eastern parts of Calcasieu and Cameron Parishes to the Atchafalaya River, the aquifer includes upper and lower sand units (Whitman and Kilburn, 1963, p. 10). In central and western Calcasieu and Cameron Parishes, the Chicot aquifer system includes the "200-," "500-," and "700-foot" sands, named after their depths of occurrence in the Lake Charles area (Jones, 1950, p. 2). The "200-foot" sand is stratigraphically equivalent to, and continuous with, the upper sand. Figure 2 shows a partial hydrogeologic column of aquifers in southwestern Louisiana.

Recharge to the Chicot aquifer system occurs in areas where the aquifer deposits crop out in southern Rapides and Vernon Parishes and in northern Allen, Beauregard, and Evangeline Parishes. In these areas, precipitation infiltrates sandy soil and moves slowly downdip towards areas of concentrated pumping in Acadia, Calcasieu, and Jefferson Davis Parishes and parts of adjacent parishes. Additional recharge is supplied from vertical leakage through overlying and underlying clay confining units, and from alluvial deposits associated with the Atchafalaya River, which are laterally adjacent to the upper sand unit (Nyman, 1990, p. 14).

POTENTIOMETRIC SURFACE

A potentiometric-surface map (fig. 1) was constructed using water-level data (table 1, sheet 2) from wells completed in the massive, upper, and "200-foot" sands of the Chicot aquifer system. Water levels were measured during January 2001; water levels typically rise to their yearly high during January or February (fig. 3). Water levels were measured using steel or electrical tapes marked with 0.01-ft gradations; wells in which water levels were measured were not being pumped at the time the measurements were made.

The highest water level, about 168 ft above sea level, was measured in the outcrop area of the Chicot aquifer system in northwestern Beauregard Parish. Water levels more than 40 ft below sea level were recorded in parts of Acadia, Calcasieu, Evangeline, and Jefferson Davis Parishes. The lowest water levels, more than 60 ft below sea level, extended over an area of about 100 mi^2 in southern Evangeline and northern Acadia Parishes.

Ground water moves through the aquifer system from areas of higher hydraulic head to areas of lower hydraulic head, and the direction of flow is perpendicular to potentiometric contours. During January 2001, flow in the aquifer generally was towards rice-growing areas of Acadia, Jefferson Davis, southern Evangeline, and eastern Calcasieu Parishes. Flow also was towards population and industrial centers in central Calcasieu Parish. In the northern part of the study area, flow in the massive sand generally was towards the south and southeast along the dip of sediments. In the southern part of the study area, flow in the upper sand and the "200-foot" sand was to the north from coastal areas. Along the eastern extent of the aquifer system, flow generally trended westward.

System	Series	Aquifer system	Aquifer: Lake Charles area	Aquifer: Rice-growing area
Quaternary	Pleistocene	Chicot aquifer system	"200-foot" sand of Lake Charles area	Chicot aquifer, upper sand unit
			"500-foot" sand of Lake Charles area "700-foot" sand of Lake Charles area	Chicot aquifer, lower sand unit

Figure 2. Partial hydrogeologic column of aquifers in southwestern Louisiana (modified from Lovelace and Lovelace, 1995, p. 10).

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
acre	4,047	square meter
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
million gallons per day (Mgal/d)	3,785	cubic meter per day

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: $^oF = 1.8(^oC) + 32$.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Louisiana Ground-Water Map No. 14:

Potentiometric Surface of the Chicot Aquifer System in Southwestern Louisiana, January 2001

By

John K. Lovelace, Jared W. Fontenot, and C. Paul Frederick

2002

For additional information, contact:

District Chief
U.S. Geological Survey
3535 S. Sherwood Forest Blvd., Suite 120
Baton Rouge, LA 70816
E-mail: dc_la@usgs.gov
Fax: (225) 389-0706
Telephone: (225) 389-0281

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Fax: (303) 202-4188
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WATER-LEVEL CHANGES

Changes in water levels in the massive, upper, and "200-foot" sands of the Chicot aquifer system from June 2000 to January 2001 are shown in figure 4. Water levels in these sands are typically near their annual low in June and near their annual high in January. The water-level change map was prepared by calculating the difference between water levels at individual wells measured during June 2000 and January 2001, and by comparing the potentiometric-surface maps created from these measurements. Then, lines of equal water-level change were plotted. The water-level changes shown in figure 4 represent the approximate amount of water-level recovery that occurred between the annual low and the annual high water levels in the aquifer prior to the start of seasonal pumping for rice irrigation in 2001.

Water levels generally rose throughout most of the Chicot aquifer system in the study area. Water levels rose more than 5 ft in rice-growing areas of Acadia, Jefferson Davis, southern Evangeline, and eastern Calcasieu Parishes. The largest water-level rise, 30 ft, occurred at well Cu-854 in southeastern Calcasieu Parish. Slight water-level declines, generally less than 1 ft, occurred along the northern and eastern extents of the Chicot aquifer system. These areas correspond to outcrop areas for the Chicot aquifer system, where the aquifer system receives direct recharge from infiltration, and to areas where the aquifer system receives lateral recharge from alluvial deposits associated with the Atchafalaya River. The slight water-level decline in these areas may have been in response to drought conditions that prevailed in southwestern Louisiana during much of 2000. The largest decline, -8 ft, occurred at well JD-835 in northwestern Jefferson Davis Parish and probably was caused by pumping from one or more nearby wells.

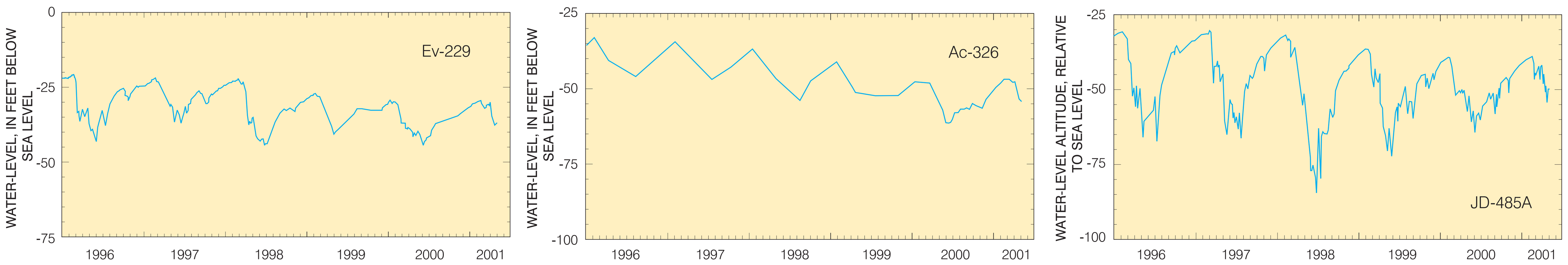

Figure 3. Water levels in the Chicot aquifer system for wells Ev-229 (Evangeline Parish), Ac-326 (Acadia Parish), and JD-485A (Jefferson Davis Parish), 1996-2001.

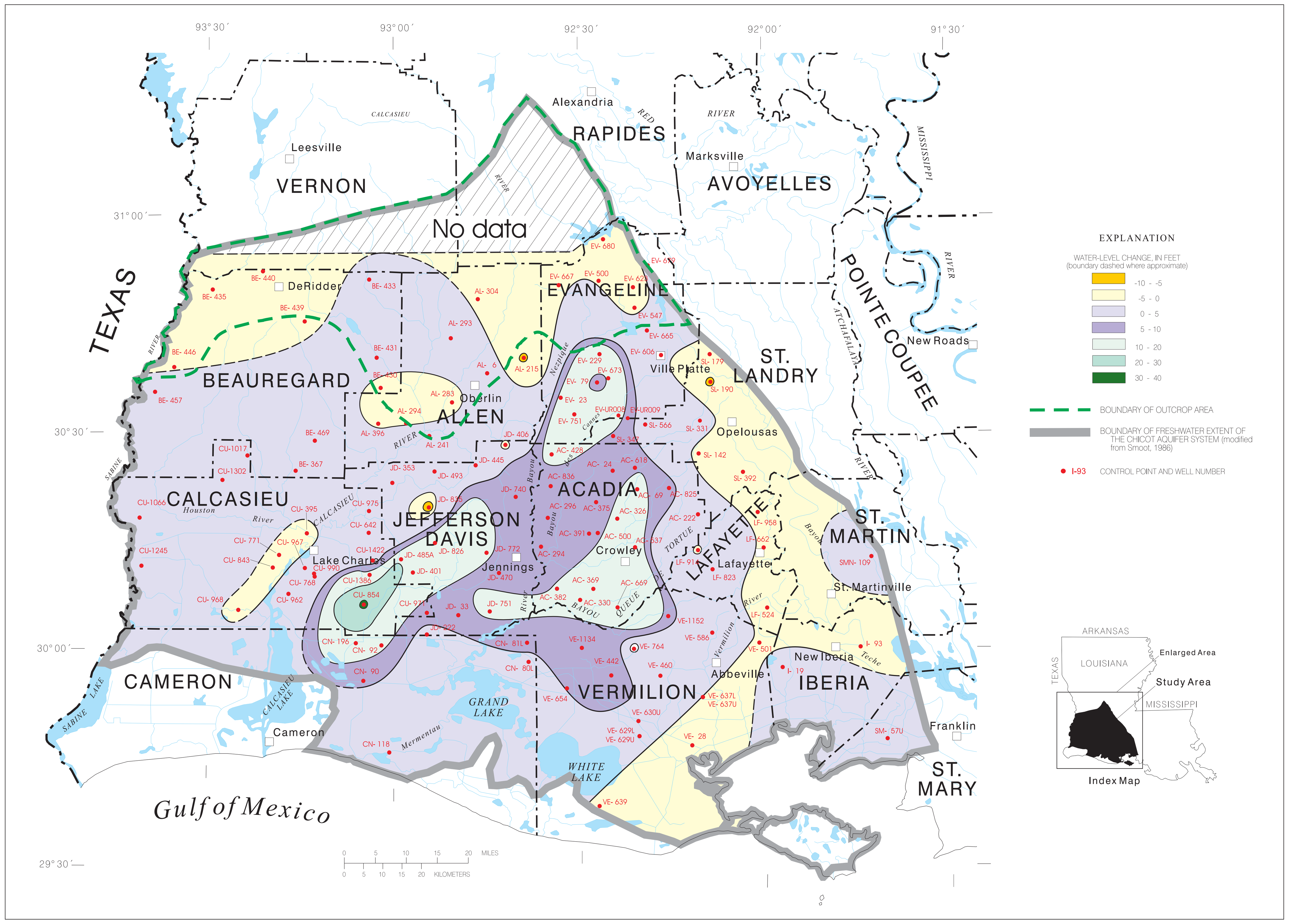

Figure 4. Water-level changes in the massive, upper, and "200-foot" sands of the Chicot aquifer system in southwestern Louisiana, June 2000 to January 2001.

Table 1. *Water-level data used to construct the potentiometric-surface map, January 2001, and water-level change map, June 2000 to January 2001, of the massive, upper, and "200-foot" sands of the Chicot aquifer system*
[Aquifer code: 112CHCT, massive sand; 112CHCTU, upper sand; and 11202LC, "200-foot" sand. --, no data]

Well number	Aquifer code	Altitude of land surface (feet relative to sea level)	Depth of well (feet)	June 2000 water-level measurements: Date	June 2000: Depth to water level (feet below land surface)	June 2000: Altitude of water level (feet relative to sea level)	January 2001 water-level measurements: Date	January 2001: Depth to water level (feet below land surface)	January 2001: Altitude of water level (feet relative to sea level)	Water-level changes, June 2000 to January 2001
Acadia Parish										
Ac- 24	112CHCT	41.00	284.00	6-27	109.18	-68.18	1-25	102.11	-61.11	7.07
Ac- 69	112CHCT	43.00	--	6-1	107.88	-64.88	1-30	90.33	-47.33	17.55
Ac- 222	112CHCTU	36.00	--	6-14	72.48	-36.48	1-30	65.74	-29.74	6.74
Ac- 294	112CHCTU	25.00	260.00	6-14	78.63	-53.63	1-25	73.45	-48.45	5.18
Ac- 296	112CHCTU	31.00	250.00	6-7	89.38	-58.38	1-25	82.71	-51.71	6.67
Ac- 326	112CHCTU	25.80	202.00	6-6	89.98	-64.18	1-30	77.11	-51.31	12.87
Ac- 330	112CHCTU	12.00	280.00	6-14	63.72	-51.72	1-31	51.50	-39.50	12.22
Ac- 332	112CHCTU	20.00	294.00	--	--	--	1-31	65.09	-45.09	--
Ac- 369	112CHCTU	15.00	280.00	6-8	73.07	-58.07	1-26	59.63	-44.63	13.44
Ac- 375	112CHCTU	36.00	315.00	6-27	102.07	-66.07	1-25	94.39	-58.39	7.68
Ac- 382	112CHCTU	11.00	292.00	6-8	65.74	-54.74	1-26	54.09	-43.09	11.65
Ac- 391	112CHCTU	21.00	256.00	6-6	82.11	-61.11	1-25	73.48	-52.48	8.63
Ac- 428	112CHCT	42.00	203.00	6-7	104.78	-62.78	1-09	93.72	-51.72	11.06
Ac- 500	112CHCTU	22.00	248.00	6-6	85.16	-63.16	1-17	76.68	-54.68	8.48
Ac- 500	112CHCTU	22.00	248.00	6-6	85.16	-63.16	1-25	73.89	-51.89	11.27
Ac- 537	112CHCTU	25.00	211.00	6-8	86.26	-61.26	1-17	69.26	-44.26	17.00
Ac- 537	112CHCTU	25.00	211.00	6-8	86.26	-61.26	1-31	68.44	-43.44	17.82
Ac- 539	112CHCTU	31.00	251.00	--	--	--	1-30	82.69	-51.69	--
Ac- 618	112CHCT	40.00	249.00	6-7	106.70	-66.70	1-25	97.03	-57.03	9.67
Ac- 628	112CHCTU	35.00	250.00	--	--	--	1-31	68.58	-33.58	--
Ac- 669	112CHCTU	15.00	176.00	6-20	68.40	-53.40	1-26	52.31	-37.31	16.09
Ac- 825	112CHCT	43.00	265.00	6-8	97.91	-54.91	1-30	91.75	-48.75	6.16
Ac- 828	112CHCTU	21.00	302.00	--	--	--	1-30	72.97	-51.97	--
Ac- 836	112CHCT	37.00	275.00	6-7	97.75	-60.75	1-31	89.44	-52.44	8.31
Ac- 876	112CHCTU	21.00	298.00	--	--	--	1-26	62.23	-41.23	--
Allen Parish										
Al- 6	112CHCT	80.00	--	6-28	67.21	12.79	1-25	66.07	13.93	1.14
Al- 215	112CHCT	70.00	207.00	6-28	78.79	-8.79	1-25	84.08	-14.08	-5.29
Al- 241	112CHCT	42.97	62.00	6-19	34.65	8.32	1-24	32.90	10.07	1.75
Al- 283	112CHCT	62.00	93.00	6-20	40.84	21.16	1-24	41.95	20.05	-1.11
Al- 293	112CHCT	100.00	84.00	6-22	32.92	67.08	1-25	32.50	67.50	0.42
Al- 294	112CHCT	48.00	142.00	6-19	26.27	21.73	1-24	26.32	21.68	-0.05
Al- 304	112CHCT	114.00	104.00	6-23	20.21	93.79	1-25	20.36	93.64	-0.15
Al- 396	112CHCT	57.00	315.00	6-23	32.86	24.14	1-25	33.44	23.56	-0.58
Beauregard Parish										
Be- 367	112CHCT	45.00	455.00	6-27	71.20	-26.20	1-15	69.49	-24.49	1.71
Be- 430	112CHCT	120.00	123.00	6-1	59.68	60.32	1-24	60.82	59.18	-1.14
Be- 431	112CHCT	70.00	84.00	6-1	6.70	63.30	1-24	3.66	66.34	3.04
Be- 433	112CHCT	132.00	82.00	6-1	7.62	124.38	1-24	5.92	126.08	1.70
Be- 435	112CHCT	129.00	124.00	6-1	20.39	108.61	1-15	20.82	108.18	-0.43
Be- 439	112CHCT	169.00	189.00	6-1	48.27	120.73	1-15	48.67	120.33	-0.40
Be- 440	112CHCT	212.00	169.00	6-1	45.07	166.93	1-15	45.70	166.30	-0.63
Be- 443	112CHCT	206.00	164.00	--	--	--	1-31	37.98	168.02	--
Be- 446	112CHCT	83.00	157.00	6-1	26.70	56.30	1-15	26.85	56.15	-0.15
Be- 457	112CHCT	95.00	155.00	6-1	48.25	46.75	1-15	46.57	48.43	1.68
Be- 469	112CHCT	84.00	380.00	6-21	71.37	12.63	1-15	69.42	14.58	1.95
Calcasieu Parish										
Cu- 168	11202LC	7.81	375.00	--	--	--	1-31	45.46	-37.65	--
Cu- 395	11202LC	12.00	200.00	6-27	40.21	-28.21	1-16	40.33	-28.33	-0.12
Cu- 642	11202LC	19.00	287.00	6-1	64.32	-45.32	1-16	62.76	-43.76	1.56
Cu- 768	11202LC	11.53	306.00	6-14	68.83	-57.30	1-16	66.11	-54.58	2.72
Cu- 771	11202LC	17.76	241.00	6-8	63.21	-45.45	1-16	63.81	-46.05	-0.60
Cu- 843	11202LC	12.00	205.00	6-8	56.01	-44.01	1-11	56.18	-44.18	-0.17
Cu- 854	11202LC	20.00	430.00	6-8	83.64	-63.64	1-30	52.82	-32.82	30.82
Cu- 962	11202LC	11.00	287.00	6-21	53.36	-42.36	1-16	52.80	-41.80	0.56
Cu- 967	11202LC	12.00	240.00	6-14	58.95	-46.95	1-16	58.70	-46.70	0.25
Cu- 968	11202LC	10.00	276.00	6-28	40.18	-30.18	1-16	40.33	-30.33	-0.15
Cu- 971	112CHCTU	5.00	500.00	6-13	47.94	-42.94	1-16	42.06	-37.06	5.88
Cu- 975	11202LC	20.00	237.00	6-13	48.65	-28.65	1-16	45.60	-25.60	3.05
Cu- 990	11202LC	14.00	183.00	6-14	65.86	-51.86	1-31	63.83	-49.83	2.03
Cu-1017	112CHCT	72.50	351.00	6-27	75.40	-2.90	2-01	75.05	-2.55	0.35
Cu-1066	11202LC	25.00	255.00	6-28	34.81	-9.81	1-15	33.03	-8.03	1.78
Cu-1159	11202LC	13.00	280.00	--	--	--	1-31	57.84	-44.84	--
Cu-1245	11202LC	11.00	136.00	6-28	16.43	-5.43	1-15	16.04	-5.04	0.39
Cu-1302	11202LC	45.00	180.00	6-27	43.56	1.44	2-01	43.48	1.52	0.08
Cu-1386	11202LC	24.00	325.00	6-9	78.75	-54.75	1-30	62.35	-38.35	16.40
Cu-1422	11202LC	22.00	262.00	6-9	63.06	-41.06	1-30	60.07	-38.07	2.99
Cameron Parish										
Cn- 80L	112CHCTU	4.73	481.00	6-20	39.00	-34.27	1-11	34.41	-29.68	4.59
Cn- 81L	112CHCTU	4.45	478.00	6-20	41.84	-37.39	1-11	36.42	-31.97	5.42
Cn- 90	11202LC	3.19	396.00	6-20	37.48	-34.29	1-30	31.32	-28.13	6.16
Cn- 92	11202LC	5.50	443.00	6-8	49.41	-43.91	1-30	37.62	-32.12	11.79
Cn- 93	112CHCTU	3.76	360.00	6-28	36.77	-33.01	1-30	23.93	-20.17	12.84
Cn- 118	112CHCTU	5.00	638.00	6-28	24.02	-19.02	1-30	23.72	-18.72	0.30
Cn- 196	11202LC	10.00	420.00	6-8	59.31	-49.31	1-31	42.67	-32.67	16.64
Evangeline Parish										
Ev- 23	112CHCT	51.06	360.00	6-1	104.19	-53.13	1-09	92.92	-41.86	11.27
Ev- 79	112CHCT	55.00	250.00	6-1	125.66	-70.66	1-09	119.48	-64.48	6.18
Evangeline Parish--continued										
Ev- 229	112CHCT	65.66	231.00	6-1	109.56	-43.90	1-08	96.42	-30.76	13.14
Ev- 500	112CHCT	117.52	120.00	6-1	50.16	67.36	1-10	50.23	67.29	-0.07
Ev- 547	112CHCT	113.38	80.00	6-1	52.60	60.78	1-10	53.67	59.71	-1.07
Ev- 606	112CHCT	75.00	255.00	6-27	104.84	-29.84	1-23	104.60	-29.60	0.24
Ev- 623	112CHCT	137.20	96.00	6-1	68.86	68.34	1-10	72.10	65.10	-3.24
Ev- 659	112CHCT	60.52	252.00	--	--	--	1-26	104.65	-44.13	--
Ev- 665	112CHCT	59.29	100.00	6-1	71.80	-12.51	1-10	67.34	-8.05	4.46
Ev- 667	112CHCT	122.20	91.50	6-1	48.39	73.81	1-10	48.62	73.58	-0.23
Ev- 673	112CHCT	60.00	247.00	6-1	128.32	-68.32	1-10	117.72	-57.72	10.60
Ev- 679	112CHCT	46.00	70.00	6-1	7.34	38.66	1-10	6.73	39.27	0.61
Ev- 680	112CHCT	120.00	89.00	6-1	56.97	63.03	1-10	57.58	62.42	-0.61
Ev- 751	112CHCT	53.00	275.00	6-1	125.18	-72.18	1-09	110.24	-57.24	14.94
Ev-UR008	112CHCT	56.00	--	6-1	124.22	-68.22	1-09	110.74	-54.74	13.48
Ev-UR009	112CHCT	58.00	--	6-27	117.61	-59.61	1-26	110.18	-52.18	7.43
Iberia Parish										
I- 19	112CHCTU	9.72	460.00	6-9	18.96	-9.24	1-24	17.49	-7.77	1.47
I- 93	112CHCTU	18.53	585.00	6-9	22.14	-3.61	1-11	22.71	-4.18	-0.57
Jefferson Davis Parish										
JD- 9	112CHCTU	24.10	318.00	--	--	--	1-10	71.70	-47.60	--
JD- 31	112CHCT	50.00	250.00	--	--	--	1-31	94.63	-44.63	--
JD- 33	112CHCTU	7.18	350.00	6-7	50.97	-43.79	1-10	43.98	-36.80	6.99
JD- 136	112CHCTU	20.00	274.00	--	--	--	1-30	53.80	-33.80	--
JD- 222	112CHCTU	4.61	300.00	6-7	43.62	-39.01	1-10	39.34	-34.73	4.28
JD- 298	112CHCTU	15.00	297.00	--	--	--	1-30	56.69	-41.69	--
JD- 317	112CHCT	42.27	289.00	--	--	--	1-31	86.22	-43.95	--
JD- 353	112CHCT	25.00	300.00	6-28	41.79	-16.79	1-10	41.06	-16.06	0.73
JD- 401	112CHCTU	14.00	282.00	6-7	72.32	-58.32	1-10	54.73	-40.73	17.59
JD- 406	112CHCT	50.00	450.00	6-22	82.09	-32.09	1-25	82.34	-32.34	-0.25
JD- 445	112CHCT	47.82	262.00	6-16	79.32	-31.50	1-10	78.66	-30.84	0.66
JD- 470	112CHCTU	10.00	325.00	6-7	68.17	-58.17	1-10	62.51	-52.51	5.66
JD- 485A	112CHCTU	21.36	290.00	6-7	80.85	-59.49	1-10	61.14	-39.78	19.71
JD- 493	112CHCT	37.95	220.00	6-6	57.09	-19.14	1-10	56.86	-18.91	0.23
JD- 499	112CHCTU	30.00	250.00	--	--	--	1-31	80.15	-50.15	--
JD- 538	112CHCTU	33.00	245.00	--	--	--	1-31	81.22	-48.22	--
JD- 740	112CHCT	35.00	264.00	6-6	90.04	-55.04	1-09	82.85	-47.85	7.19
JD- 751	112CHCTU	10.00	193.00	6-7	56.56	-46.56	1-10	45.04	-35.04	11.52
JD- 772	112CHCTU	27.00	340.00	6-16	86.38	-59.38	1-10	74.67	-47.67	11.71
JD- 826	112CHCTU	26.00	225.00	6-28	76.27	-50.27	1-27	65.60	-39.60	10.67
JD- 835	112CHCTU	31.00	280.00	6-28	53.94	-22.94	1-10	62.18	-31.18	-8.24
Lafayette Parish										
Lf- 524	112CHCTU	25.00	174.00	6-9	27.25	-2.25	1-24	31.17	-6.17	-3.92
Lf- 662	112CHCTU	40.37	152.00	6-8	51.09	-10.72	1-24	51.98	-11.61	-0.89
Lf- 823	112CHCTU	30.00	363.00	6-9	59.02	-29.02	1-24	57.18	-27.18	1.84
Lf- 914	112CHCTU	30.00	250.00	6-8	68.11	-38.11	1-24	69.58	-39.58	-1.47
Lf- 958	112CHCTU	50.00	115.00	6-8	54.72	-4.72	1-24	55.58	-5.58	-0.86
St. Landry Parish										
SL- 37	112CHCT	60.00	629.00	--	--	--	1-23	97.29	-37.29	--
SL- 142	112CHCT	50.00	235.00	6-7	83.84	-33.84	1-23	85.07	-35.07	-1.23
SL- 179	112CHCT	55.23	94.00	6-5	56.85	-1.62	1-11	57.34	-2.11	-0.49
SL- 190	112CHCT	74.36	175.00	6-6	84.78	-10.42	1-23	91.03	-16.67	-6.25
SL- 331	112CHCT	61.00	282.00	6-6	91.46	-30.46	1-23	88.58	-27.58	2.88
SL- 347	112CHCT	50.00	300.00	6-1	119.18	-69.18	1-11	109.98	-59.98	9.20
SL- 392	112CHCT	46.74	126.00	6-7	55.39	-8.65	1-23	56.86	-10.12	-1.47
SL- 459	112CHCT	51.00	249.00	6-27	117.61	-66.61	1-26	110.18	-59.18	7.43
SL- 566	112CHCT	51.00	250.00	6-7	103.23	-52.23	1-26	101.77	-50.77	1.46
St. Martin Parish										
SMn- 109	112CHCTU	11.34	375.00	6-22	9.74	1.60	1-11	9.47	1.87	0.27
St. Mary Parish										
SM- 57U	112CHCTU	8.72	638.00	6-28	11.02	-2.30	1-11	9.12	-0.40	1.90
Vermilion Parish										
Ve- 28	112CHCTU	6.74	260.00	6-6	7.13	-0.39	1-24	8.86	-2.12	-1.73
Ve- 442	112CHCTU	5.42	281.00	6-6	36.68	-31.26	1-25	28.07	-22.65	8.61
Ve- 460	112CHCTU	9.78	300.00	6-20	29.01	-19.23	1-24	27.72	-17.94	1.29
Ve- 501	112CHCTU	21.62	227.00	6-5	29.51	-7.89	1-24	29.77	-8.15	-0.26
Ve- 586	112CHCTU	15.40	259.00	6-5	34.88	-19.48	1-24	33.98	-18.58	0.90
Ve- 590	112CHCTU	16.00	260.00	--	--	--	1-25	24.65	-8.65	--
Ve- 629L	112CHCTU	1.79	487.00	6-6	10.83	-9.04	1-24	9.59	-7.80	1.24
Ve- 629U	112CHCTU	1.79	457.00	6-6	9.70	-7.91	1-24	9.42	-7.63	0.28
Ve- 630U	112CHCTU	4.75	528.00	6-6	15.66	-10.91	1-24	14.29	-9.54	1.37
Ve- 637L	112CHCTU	4.06	243.00	6-7	14.69	-10.63	1-24	14.51	-10.45	0.18
Ve- 637U	112CHCTU	4.06	198.00	6-7	13.56	-9.50	1-24	14.40	-10.34	-0.84
Ve- 639	112CHCTU	5.84	608.00	6-6	11.30	-5.46	1-24	11.40	-5.56	-0.10
Ve- 654	112CHCTU	9.60	267.00	6-20	33.82	-24.22	1-25	28.51	-18.91	5.31
Ve- 764	112CHCTU	15.00	250.00	6-20	43.84	-28.84	1-25	44.61	-29.61	-0.77
Ve- 882	112CHCTU	10.00	279.00	--	--	--	1-25	31.45	-21.45	--
Ve-1134	112CHCTU	5.00	190.00	6-20	45.55	-40.55	1-25	37.93	-32.93	7.62
Ve-1152	112CHCTU	10.00	235.00	6-20	56.57	-46.57	1-25	47.12	-37.12	9.45

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Louisiana Ground-Water Map No. 14:

Water-Level Changes in the Chicot Aquifer System in Southwestern Louisiana, June 2000 to January 2001

By
John K. Lovelace, Jared W. Fontenot, and C. Paul Frederick

2002