# 1. ADMINSTRATIVE INFORMATION

1.1 SITE BACKGROUND

1.2 GENERAL IDENTIFICATION DATA

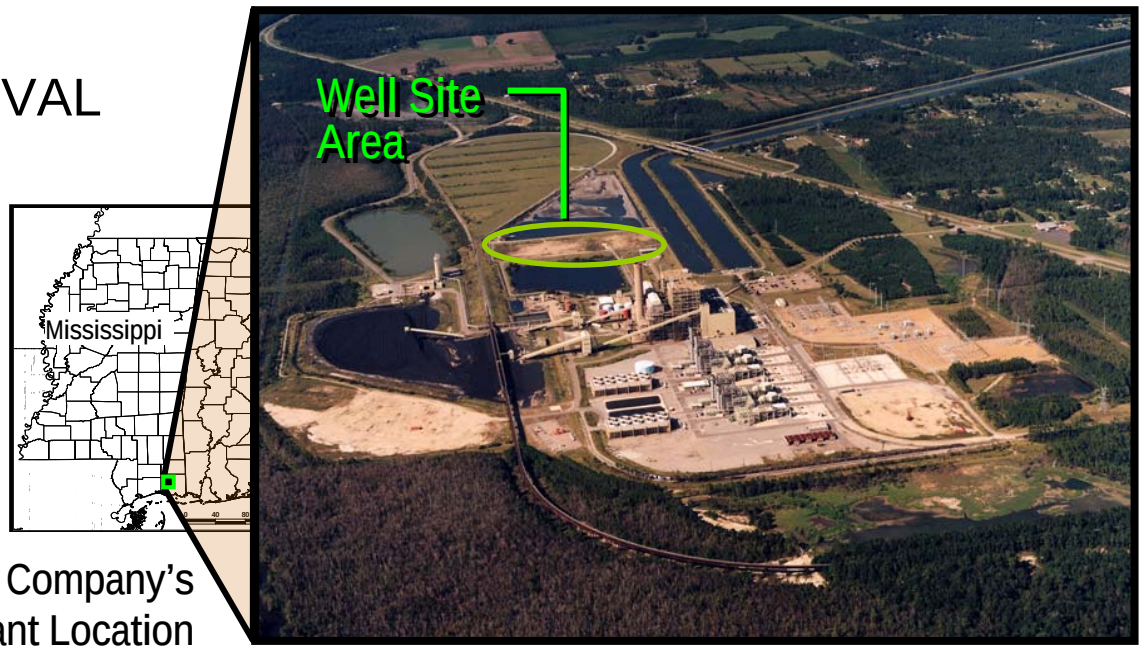
1.3 REGULATORY CLASSIFICATION

1.4 WELL DATA – INJECTION WELL NO. 1

1.5 WELL DATA – OBSERVATION WELL NO. 1

1.6 PROPOSED PERMIT APPROVAL CONDITIONS

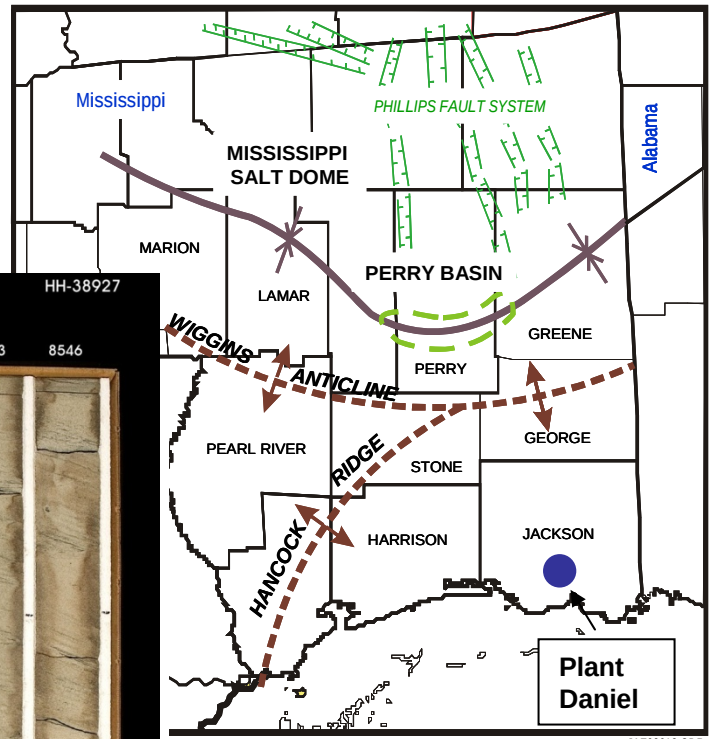
1.7 QUALITY ASSURANCE/ QUALITY CONTROL




Mississippi Power Company's
Victor J. Daniel Power Plant Location

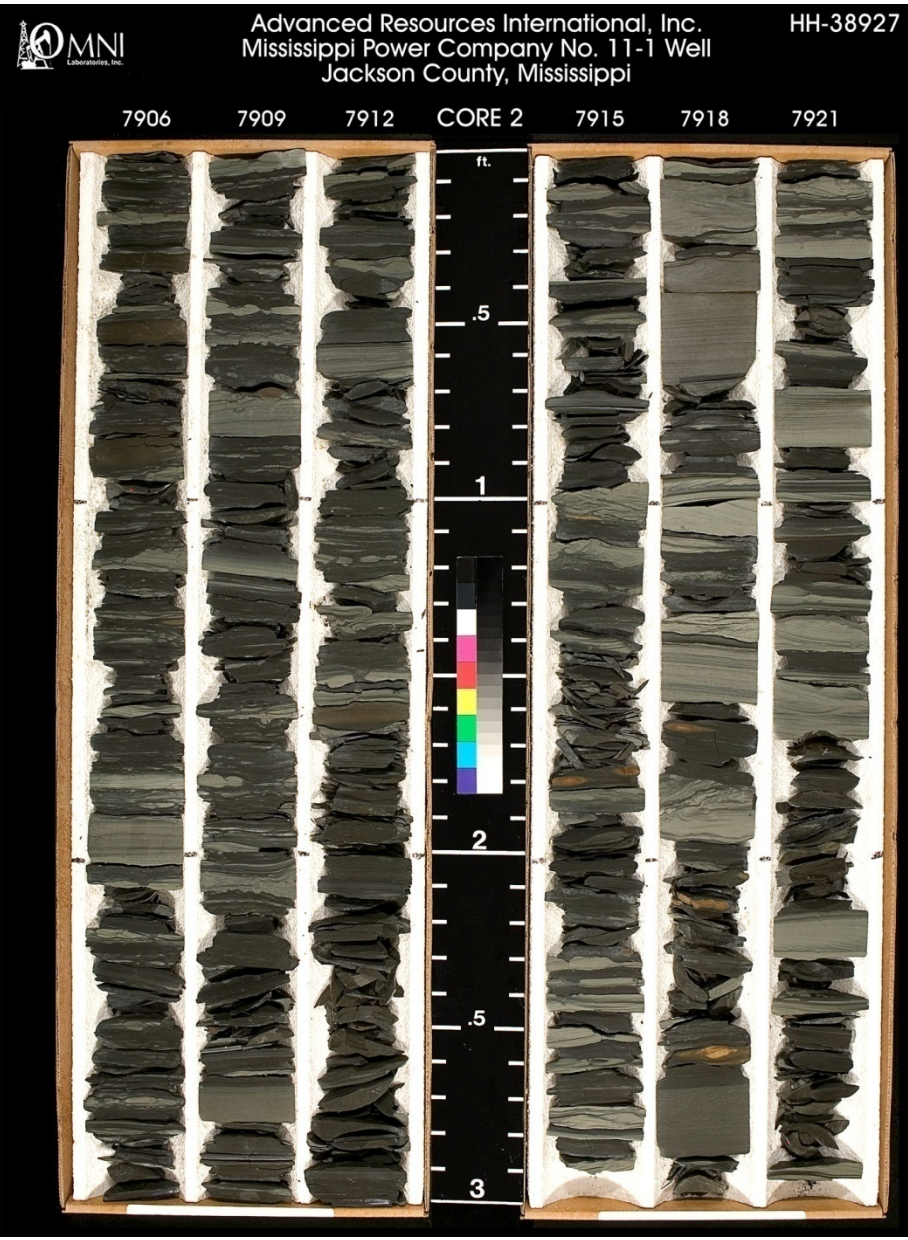
# 2. GEOLOGY




Southeastern Mississippi Subsurface Structure

# Site Characterization - Core Collection & Analysis




# *Tuscaloosa Formation Core Analysis (Massive Sand Reservoir)*

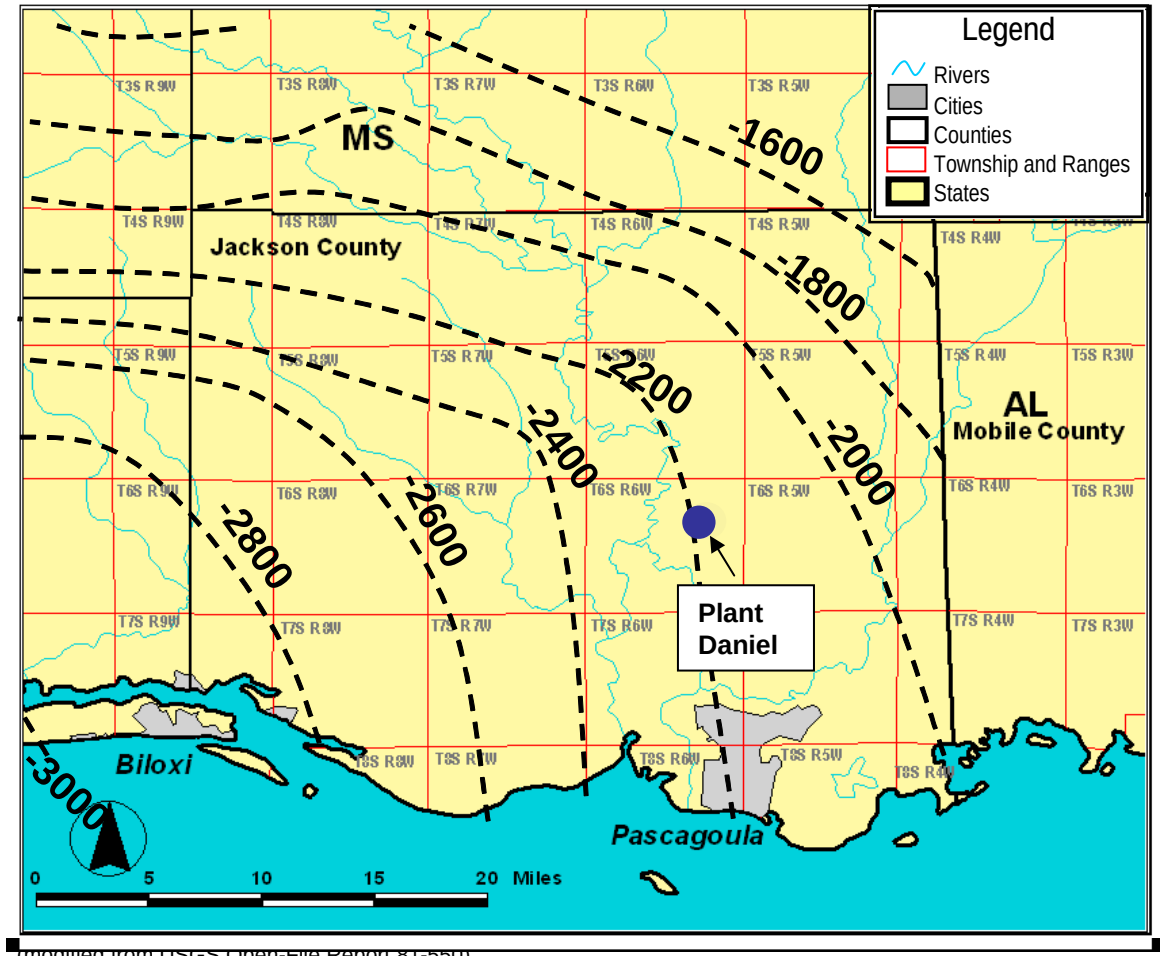
| Core Number | Sample Number | Sample Depth, (ft) | Permeability *millidarcies (mD)* | | Porosity, Percent (%) | | Grain Density, g/cm$^2$ |
|---|---|---|---|---|---|---|---|
| | | | To Air | Klinkenberg | Ambient | 2500 psi | |
| 3 | 3-1 | 8531.45 | 1450.0 | 1380.0 | 22.7 | 22.4 | 2.65 |
| 3 | 3-5 | 8535.50 | 2390.0 | 2300.0 | 24.5 | 24.2 | 2.64 |
| 3 | 3-9 | 8539.50 | 1930.0 | 1850.0 | 24.1 | 23.8 | 2.65 |
| 3 | 3-13 | 8543.45 | 652.0 | 614.0 | 19.7 | 19.4 | 2.67 |
| 3 | 3-17 | 8547.50 | 1460.0 | 1400.0 | 23.8 | 23.5 | 2.65 |
| 3 | 3-21 | 8551.50 | 936.0 | 888.0 | 23.2 | 22.9 | 2.65 |
| 3 | 3-25 | 8555.50 | 848.0 | 804.0 | 22.8 | 22.5 | 2.66 |
| 3 | 3-29 | 8559.50 | 1030.0 | 977.0 | 24.4 | 24.1 | 2.65 |
| 3 | 3-33 | 8563.50 | 641.0 | 603.0 | 23.4 | 23.1 | 2.65 |
| 3 | 3-37 | 8567.50 | 3390.0 | 3280.0 | 25.3 | 25.0 | 2.65 |
| Average values: | | | 1230.0 | 1180.0 | 20.7 | 21.3 | 2.66 |

Quick Look Core Analysis

# Southern Mississippi Hydrogeology

EPA defined “Low Salinity” waters (<10,000 mg/l) are protected and exist at a depth of about 1,600 to 2,800 feet bgs in Jackson County.

The freshwater (<1,000 mg/l) zone (potable) exists in shallower formations at less hen 1,000 feet bgs.




(modified from USGS Open-File Report 81-550)

# Observation Well: Reservoir Characterization

- Mud logging from 6,000 ft to TD
- Nearly 120 feet of whole core collected from three formations:
  - Selma Chalk (30'/27'), Marine Shale (28'/26'), and Massive Sand (60'/58')
- Core analysis with permeability (horizontal and vertical), porosity, grain density, capillary pressure, relative permeability, and mineralogy
- Wire-line logging included:
  - Halliburton's Triple Combo (gamma ray, resistivity, and porosity)
  - RST Cased Hole Neutron Log (baseline for water/gas saturation)
  - Cement Bond Log with 3D Cast V Evaluation
- Vertical Seismic Profiling (VSP):
  - Geologic description & baseline plume monitoring (time-lapse)

# *Injection Well: Reservoir Characterization*

- Wire-line logging included:
  - Schlumberger's Platform Express Log (caliper, gamma ray, resistivity, porosity)
  - Mechanical Properties Log (in-situ stress/fracture gradient)
  - Combinable Magnetic Resonance (porosity/permeability)
  - Elemental Capture Spectroscopy (mineralogy)
  - Cement Bond Log with Cast V Evaluation
- Sidewall coring of the Marine Shale, Massive Sand and Washita-Fredericksburg Formations
- Well injection "pressure transient" test - injection falloff pressure decline
- Reservoir fluid sampling - flow reaction simulation/equilibrium models
- Mechanical Integrity Testing (MIT) - casing, tubular & packer integrity

# 3. RESERVOIR MODELING

3.1 RESERVOIR MODELING OF THE INJECTION ZONE

3.2 MODEL DESCRIPTION

3.3 INJECTION ZONE STRATIGRAPHY AND LITHOLOGY

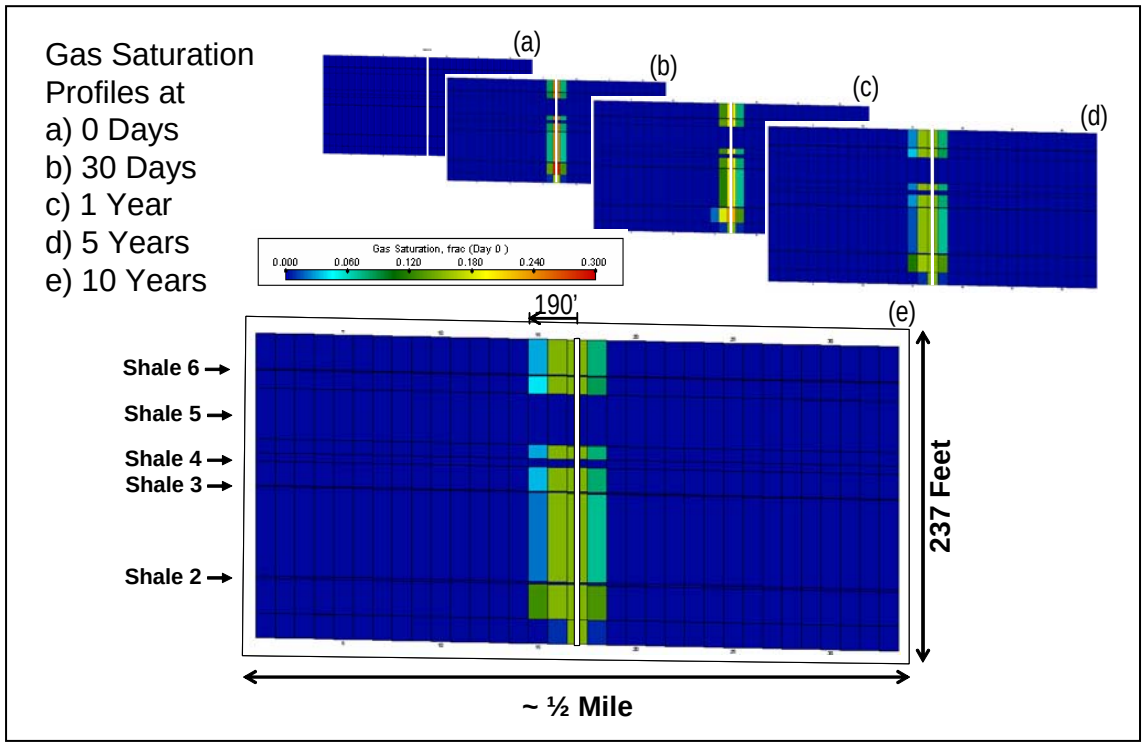
3.4 MODEL INPUTS

3.5 $CO_2$ TRAPPING MECHANISMS

3.6 GEOPHYSICAL SIMULATION RESULTS

3.7 LONG-TERM FATE OF INJECTED $CO_2$

3.8 MODELING SUMMARY




Reservoir Modeling $CO_2$ Injection/Plume (vertical view)

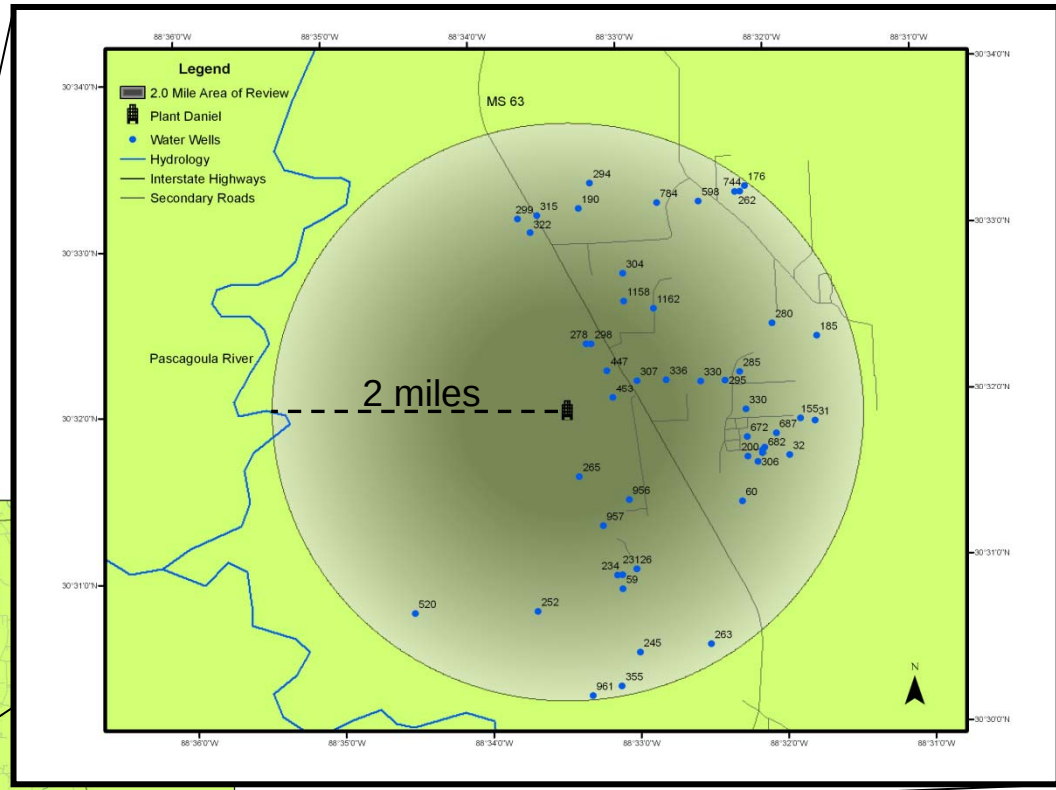
# 4. AREA OF REVIEW

4.1 INTRODUCTION

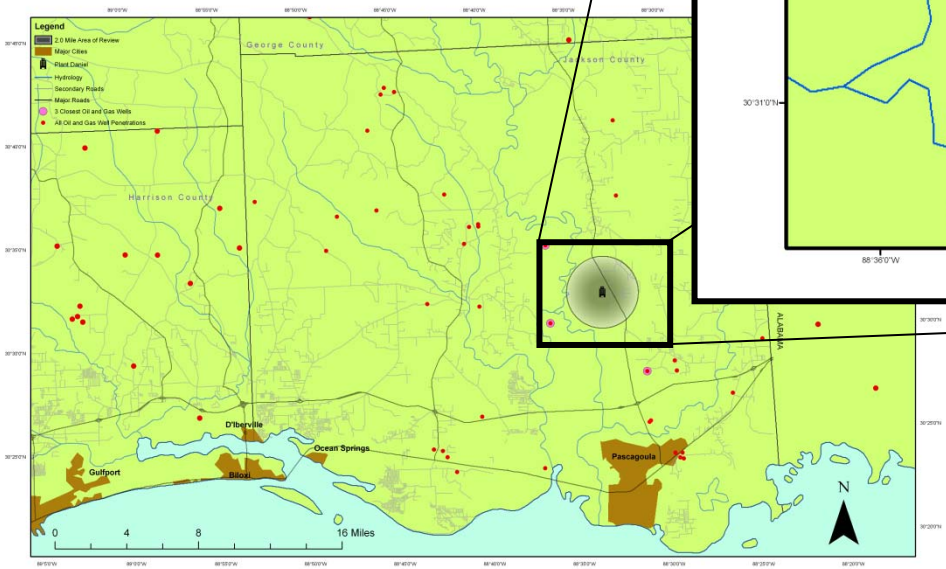
4.2 WATER WELLS

4.3 OIL AND GAS WELLS

4.4 SUMMARY




Depth and Location of Surrounding Water Wells in the Area of Review - open well file review




Location of Oil and Gas Wells Surrounding the Area of Review

# 5. WELL CONSTRUCTION



# 6. MONITORING AND VERIFICATION

6.1 INTRODUCTION

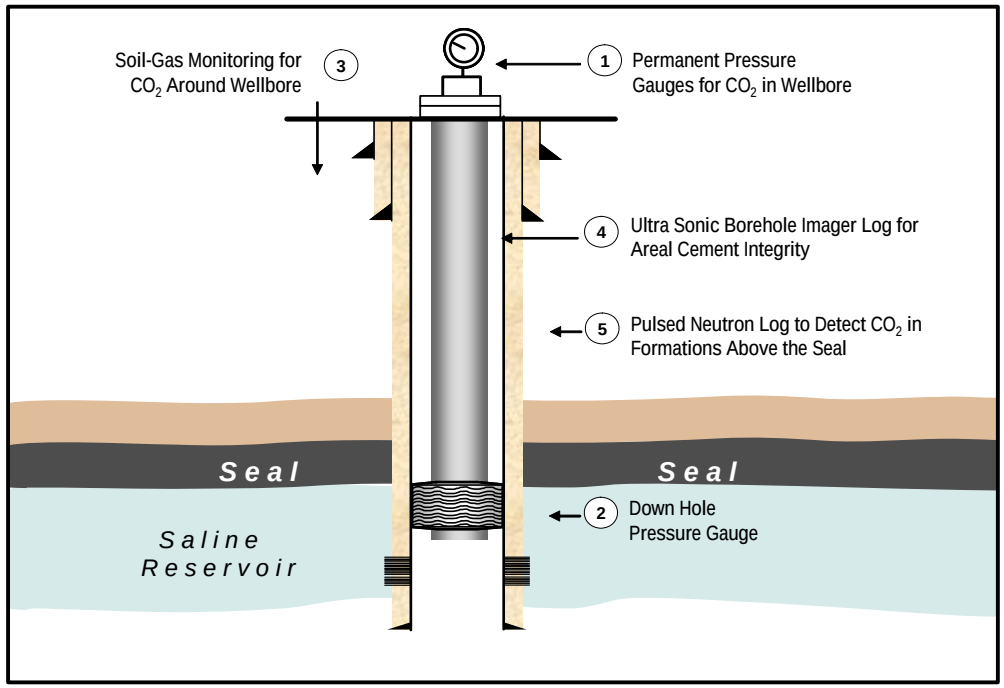
6.2 ASSURING WELL-INTEGRITY

6.3 MONITORING RESERVOIR PRESSURE

6.4 MONITORING $CO_2$ PLUME MOVEMENT

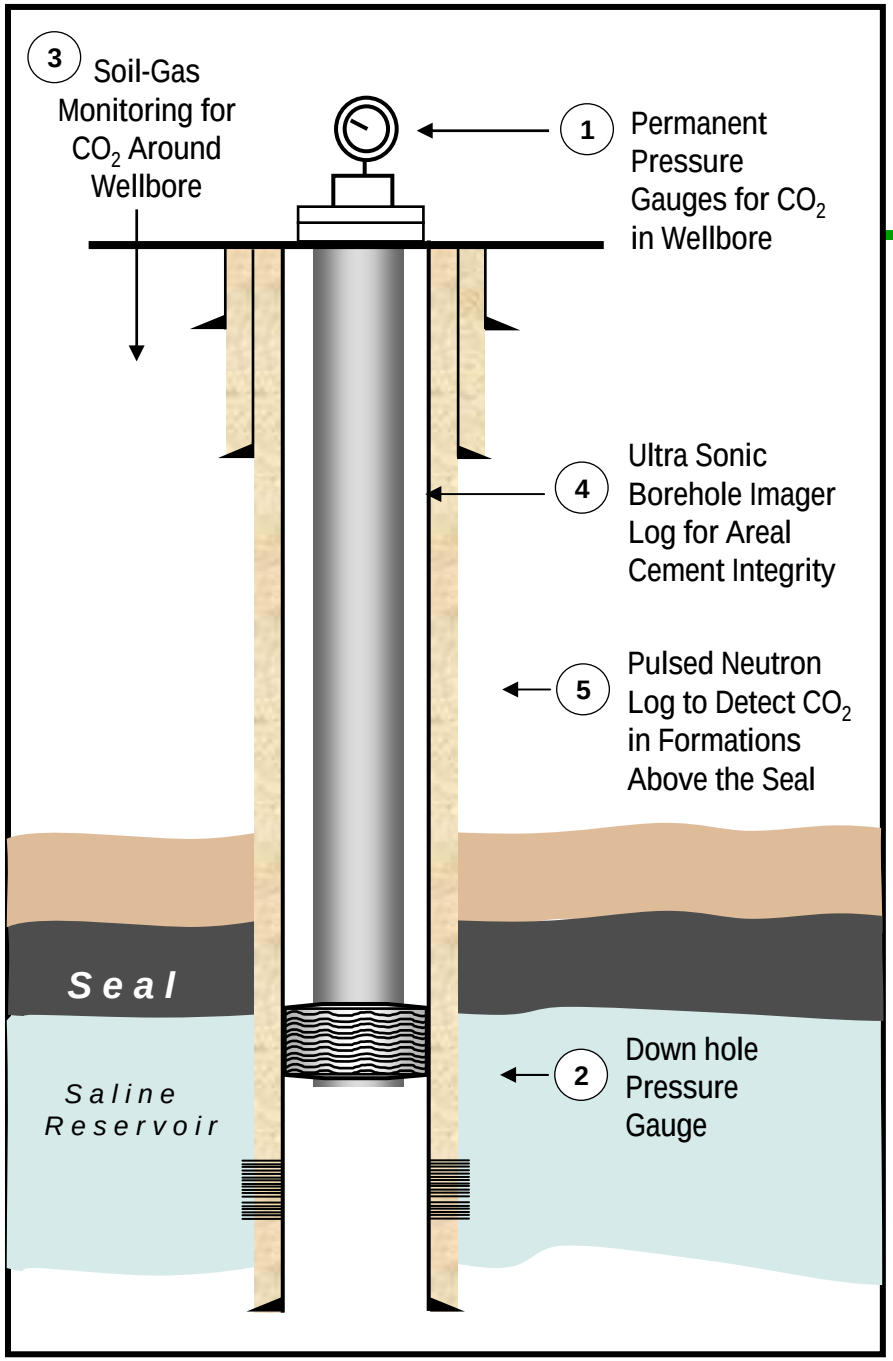
6.5 MONITOR FOR $CO_2$ SURFACE LEAKAGE

6.6 ADDITIONAL RESERVOIR CHARACTERIZATION TOOLS




General Measurement, Monitoring, and Verification Protocols to be Employed at the Mississippi Saline Reservoir Test Site

# Well Integrity and Pressure Monitoring




The project will include a series of MMV activities to assure well integrity:

- To assure well integrity at the surface, we will: (1) install a pressure gauge on the wellhead to measure sustained casing pressure ($CO_2$ leakage in the well); (2) conduct continuous monitoring of annular and down hole pressure; and, (3) conduct near-surface soil gas measurements.
- To assure down-hole well integrity, we will: (4) use an Ultra Sonic Borehole Imager (advanced version of the Cement Bond Log) both after cementing and after $CO_2$ injection; and, (5) run a series of RST Logs to detect $CO_2$ above the reservoir seal.



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# $CO_2$ Monitoring & Verification Protocols

- Soil Flux - Automated real-time LI-COR 8100 soil flux chamber monitoring
- Tracer Injection - PFT's added at the wellhead to tag and track injected $CO_2$ with Praxair Seeper Trace™ monitoring technology
- $CO_2$ Isotopes - Isotopic sampling of $CO_2$ for determination of $^{13}C$ signatures
- Groundwater Sampling - Water quality for pH, salinity, metals, alkalinity, conductivity, and temperature
- Seismic Profiling – VSP baseline and post-injection surveys
- Reservoir Saturation Tools – Reservoir water/gas saturation
- Reservoir Fluid Sampling – Field parameters, major cations/anions, trace metals/minor constituents, dissolved gases, redox indicators, isotopes, organics, etc.

# Permit Approval Conditions

- Maximum injection pressure at the well head of 2,000 psi; well below a conservative fracture gradient estimated at .7772 psi per foot (2,700 psi)
- Daily confirmation of injected $CO_2$ stream; maximum injection rate of 300 gpm; high-purity 99% $CO_2$
- Tubing- positive casing string annulus must maintain a positive differential pressure of at least 100 psig and no more then 200 psig
- Successful mechanical integrity testing including - radioactive tracer test, annulus pressure test, and differential temperature survey
- Static bottom hole pressure fall-off test in the target formation (massive sands of the Tuscaloosa Formation)
- Continuous recording of pressure in the injection well