Kemper County Storage Complex

Proposed Injection Wells MPC 19-2 and MPC 32-1

Mississippi Power Company

Geological Site Characterization

40 CFR 146.82, 40 CFR 146.83

Facility Information

Facility Name: Kemper County Storage Complex

Well Names: MPC 19-2 and MPC 32-1

Facility Contact: Mississippi Power Company

Environmental Affairs

P.O. Box 4079

Gulfport, MS 39502-4079

Well Locations: Kemper County, Mississippi

MPC 19-2:

Latitude: 32.6130560, Longitude: -88.8061110

MPC 32-1:

Latitude: 32.5908015, Longitude: 88.7792582

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List of Acronyms/Abbreviations

AoR	Area of Review
CCUS	Carbon capture, utilization, and storage
CO_2	Carbon dioxide
CMG	Computer Modelling Group
DOE	Department of Energy
ECO_2S	Establishing an Early Carbon Dioxide Storage
EPA	Environmental Protection Agency
ERRP	Emergency and Remedial Response
ft	feet
KCSC	Kemper County Storage Complex
mg/L	milligrams per liter
MMt	Millions of Metric tons
MPC	Mississippi Power Company
PISC	Post-Injection Site Care
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
RCA	Routine Core Analysis
SS	Sub-Sea
Tonnes	Metric tons
TVD	True Vertical Depth
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water

A. Regional Geology, Hydrogeology, and Local Structural Geology [40 CFR 146.82(a)(3)(vi)]

A.1. Physiography of Proposed Kemper County Storage Complex

Mississippi is divided into several physiographic subdivisions, which represent varying topographic profiles induced by differential erosion of geologic bedrock. As a result, the boundaries of these regions generally parallel geologic outcrops [1]. The Kemper County Storage Complex is located within Mississippi's North Central Hills physiographic region (**Figure 1**) which overlies the predominately sandy units of the Eocene-aged Claiborne Group and the Eocene-Paleocene Wilcox Group [2]. The Wilcox Group outcrops along the eastern boundary of the North Central Hills province and is the recharge area for Eocene and Paleocene aquifers.

A.2. Structural Setting of the Kemper County Storage Complex

Kemper County is underlain by over 26,000 ft of sedimentary rock of Cambrian through Tertiary age which nonconformably overlies the Precambrian crystalline basement [3]. Paleozoic strata range in age from Cambrian through Pennsylvanian and were deposited near the southern limit of the Black Warrior Basin, at what is now the buried juncture of the Appalachian and Ouachita tectonic belts in central and southern Kemper County (**Figure 2**) [4] [5].

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[1] Mallory, M. J. (1993). Hydrogeology of the Southeastern Coastal Plain aquifer system in parts of eastern Mississippi and western Alabama (No. 1410-G).

[2] Dockery III, D.T. & D.E. Thompson (2019). Mississippi Environmental Geology, 2nd edition, Mississippi Department of Environmental Quality, Office of Geology, 398 pp.

[3] Hale-Erlich, W. S., & Coleman Jr, J. L. (1993). Ouachita-Appalachian juncture: A Paleozoic transpressional zone in the southeastern USA. *AAPG bulletin*, *77*(4), 552-568.

[4] Thomas, W. A. (1977). Evolution of Appalachian-Ouachita salients and recesses from reentrants and promontories in the continental margin. *American Journal of Science*, *277*(10), 1233-1278.

[5] Thomas, W. A. (1988). The Black Warrior basin, *in*. L. Sloss, ed., Sedimentary cover—North American craton, U.S.: Geological Society of America, The Geology of North America, v. D-2, p. 471-491.

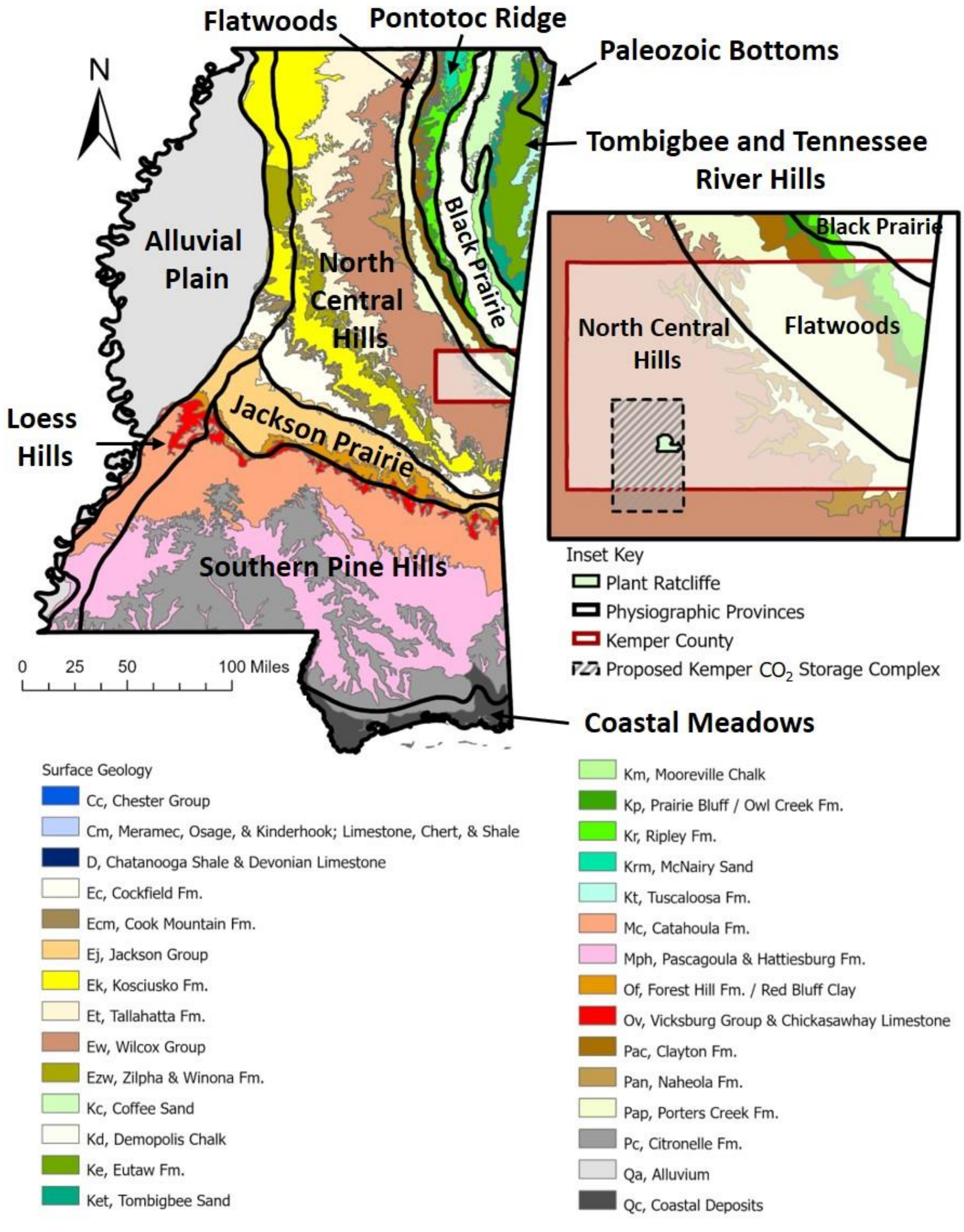

Figure 1. Map of the Surface Geology in Mississippi with Physiographic Regions. Inset map shows the Location of Proposed Kemper County Storage Complex.

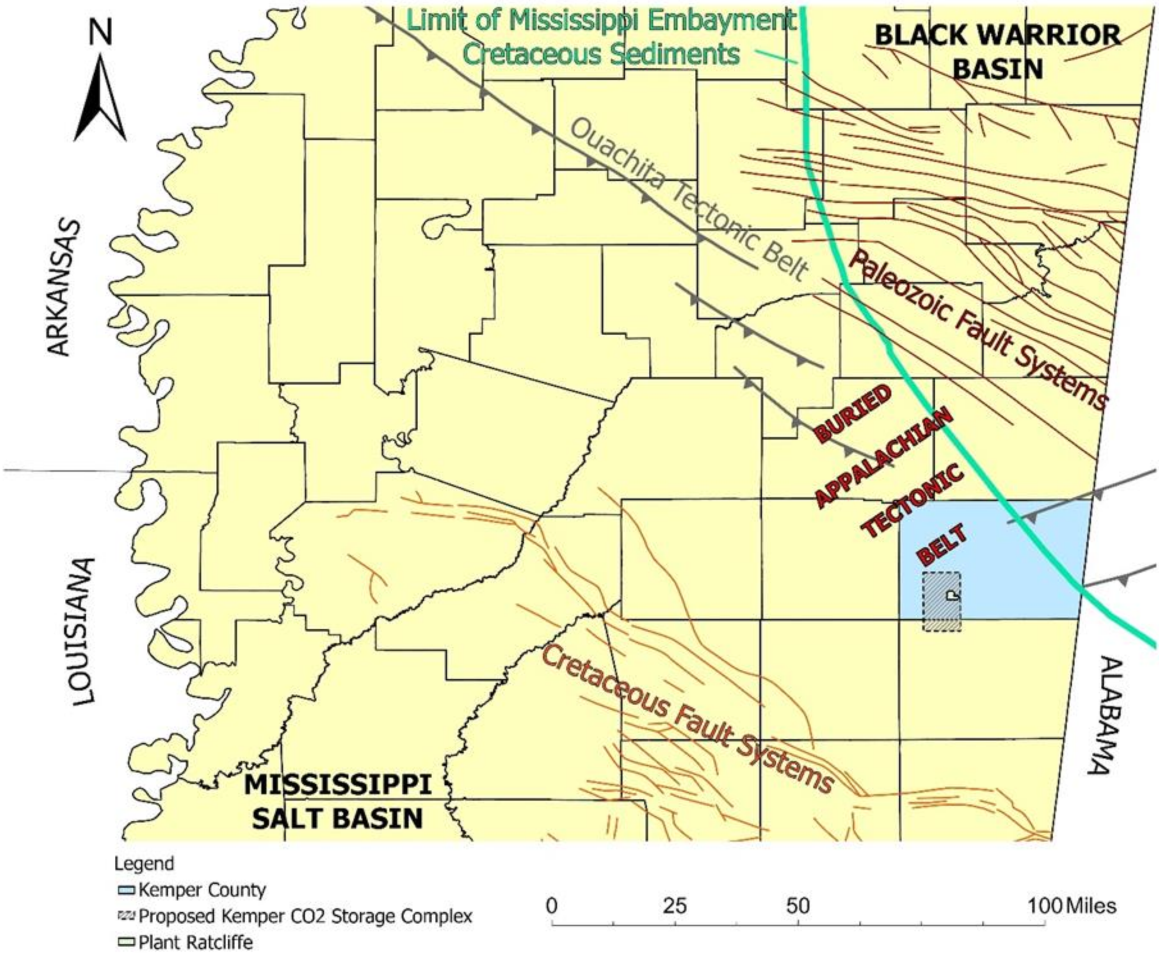

Figure 2. Generalized Structural Setting of Kemper County Storage Complex in Central Mississippi.

Thrust faults associated with the Appalachian and Ouachita orogenies penetrate the Paleozoic section below the injection zone in Kemper County (**Figure 3**). The transition from the Paleozoic to the Mesozoic is recorded in geophysical logs and seismic lines by an erosional surface marking the change in depositional environment from a synorogenic clastic wedge to fluvial deltaic deposits associated with the Gulf Coastal Plain (**Figure 3)** [6]. Above this unconformity the Mesozoic units are unfaulted and of lower structural complexity (**Figure 4**). The Mesozoic-Cenozoic strata were deposited in the Mississippi Embayment, a subsection of the larger Gulf of Mexico Basin, forming a southwest-dipping wedge of sediment. Mesozoic structural features include the Cretaceous Fault System, located approximately 40 miles south of the Storage Complex, marking the closest surface expression of faults to the Kemper County Storage

[6] Thomas, W. A. (1985). The Appalachian-Ouachita connection: Paleozoic orogenic belt at the southern margin of North America. *Annual Review of Earth and Planetary Sciences*, *13*(1), 175-199.

Complex. The limit of the Cretaceous sediments of the Mississippi Embayment in northeast Kemper County corresponds to the surface outcrop of the Upper Cretaceous age Selma Chalk.

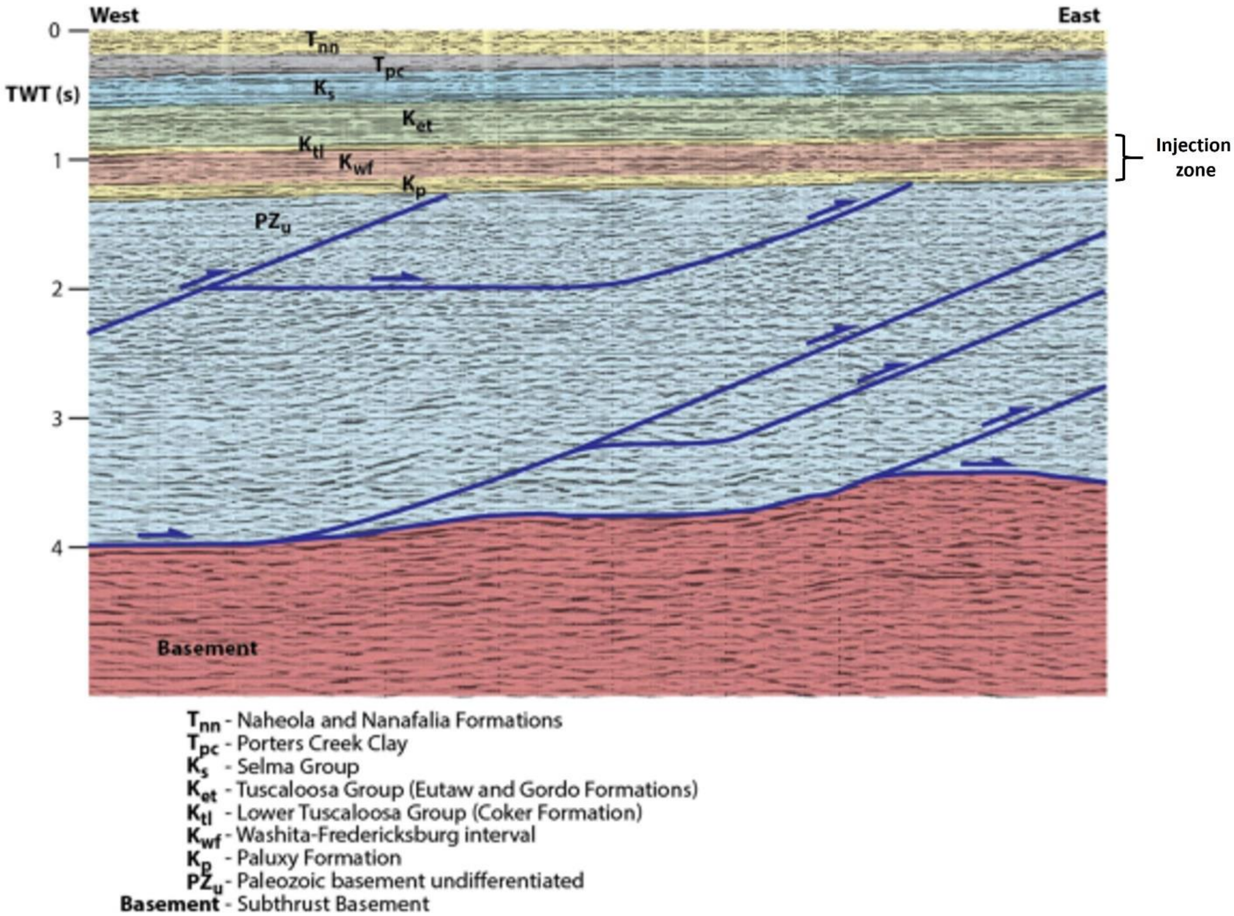

Figure 3. Interpreted Seismic Profile Near the Kemper County Storage Complex, which shows the relationship between Paleozoic strata of the Appalachian-Ouachita Oregen and gently dipping deposits of the Mississippi Embayment. (Seismic formation licensed to the Geological Survey of Alabama by Seismic Exchange, Inc.).

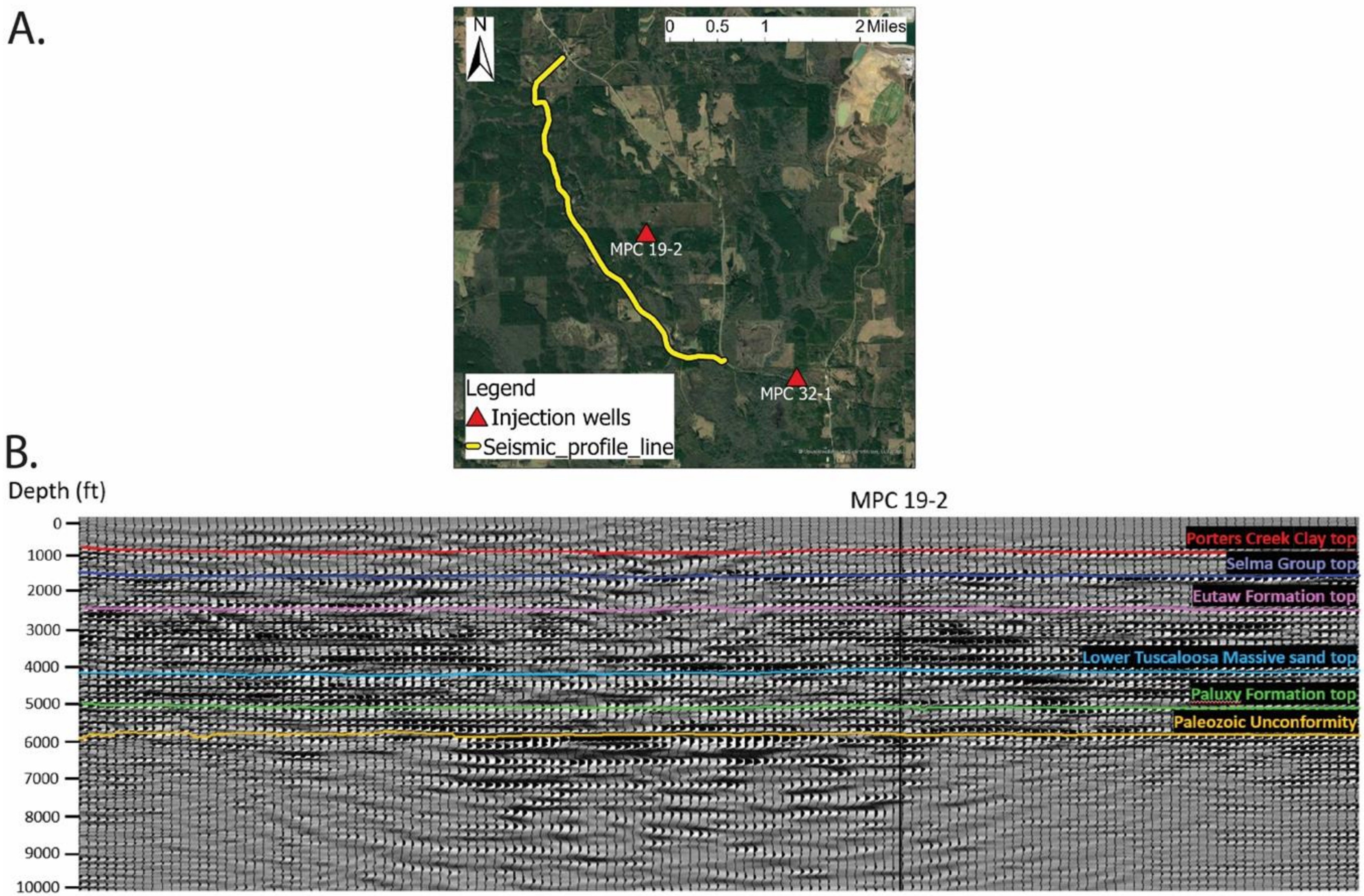

Figure 4. Exodus 2D Seismic Lines 2021 Survey. A: Map view of seismic profile line relative to proposed injection wells. B: Seismic profile with formation tops and approximate location of MPC 19-2.

A.3. Cenozoic and Mesozoic Stratigraphy at the Proposed Kemper County Storage Complex

The thicknesses presented in this section are representative of the six characterization wells (MPC 10-4, MPC 26-5, MPC-34-1, MPC 01-1, MPC 03-1, MPC 19-1) and the Kemper County Storage Complex; see **Section A.2.** for the full description of depths and thicknesses for the target formations.

The shallowest stratigraphic unit at the Kemper County Storage Complex is of Quaternary age (**Table 1**), consisting of Alluvium deposits that serve as the shallowest fresh water bearing aquifer in the county [7]. The underlying Nanafalia Formation of the Wilcox Group consists of 300 ft of sand, clay, and lignite which is underlain by the Nanafalia sand. The sand at the base of the Nanafalia Formation is about 200 ft thick and constitutes the primary USDW that is used for drinking water in Kemper County. This Formation includes fluvial, interfluvial, and wetland deposits [8].

The Nanafalia Formation sharply overlies the Naheola Formation of the Paleogene Midway Group. The Naheola Formation is around 110 ft of interbedded, fluvial-deltaic sandstone and shale that becomes more sand-dominated towards the base of the Formation. The Porters Creek Clay consists of 640 ft of gray claystone that coarsens upwards and becomes sandier towards the top of the section where it contacts the overlying Naheola Formation. The Clayton Formation is composed of 20 ft of arenaceous limestone and calcareous sandstone that marks the base of the Midway Group. These strata form a transgressive unit of sediments that blanketed Mississippi Embayment near the beginning of the Paleogene [9] [8].

The top of the Cretaceous Section in Kemper County is formed by the Selma Chalk. The Selma Chalk is a 900 ft succession of chalk and marl that represents a regionally extensive muddy carbonate ramp. The combination of the Selma Chalk along with the Lower Midway Group Clayton Formation and Porters Creek Clay forms a >1,500 ft aquitard that isolates the freshwater-bearing aquifers in the Tertiary from the Cretaceous aquifers below. The Selma Chalk is underlain

7 Pashin et al. (2020). See Section A.1., footnote #1

8 Mancini, E. A., & Tew, B. H. (1993). Eustasy versus subsidence: Lower Paleocene depositional sequences from southern Alabama, eastern Gulf Coastal Plain. *Geological Society of America Bulletin*, *105*(1), 3-17.

9 Mancini, E. A., Puckett, T. M., & Tew, B. H. (1996). Integrated biostratigraphic and sequence stratigraphic framework for Upper Cretaceous strata of the eastern Gulf Coastal Plain, USA. *Cretaceous Research*, *17*(6), 645-669.

by the Eutaw Formation, which is a transgressive sedimentary package consisting of 360 ft of marginal marine and shelf deposits [9].

Table 1. Cenozoic and Mesozoic Stratigraphic Units at Proposed Kemper County Storage Complex.

System	Series	Stratigraphic Unit	Major Sub-Units	Potential Reservoirs and Confining Units	
Quaternary	Holocene	Alluvium		Shallow Alluvial Aquifers	
Tertiary – Paleogene	Eocene – Lower	Wilcox Group	*Undifferentiated*	Freshwater Aquifer	
Tertiary – Paleogene	Paleocene – Upper	Wilcox Group	Nanafalia Fm.	Freshwater Aquifer	
Tertiary – Paleogene	Paleocene – Upper	Midway Group	Naheola Fm.	Freshwater Aquifer	
Tertiary – Paleogene	Paleocene – Upper	Midway Group	Porters Creek Clay	Aquitard	
Tertiary – Paleogene	Paleocene – Lower	Midway Group	Clayton Fm.	Aquitard	
Cretaceous	Upper	Selma Chalk	Owl Creek / Prairie Bluff Fm.	Aquitard	
Cretaceous	Upper	Selma Chalk	Ripley (McNairy) Fm.	Aquitard	
Cretaceous	Upper	Selma Chalk	Demopolis Fm.	Aquitard	
Cretaceous	Upper	Selma Chalk	Mooreville Fm.	Aquitard	
Cretaceous	Upper	Eutaw Formation	Tombigbee Sand	USDW	
Cretaceous	Upper	Eutaw Formation	McShan Fm.	USDW	
Cretaceous	Upper	Tuscaloosa Group	Upper Tuscaloosa (Gordo Fm.)	USDW?	
Cretaceous	Upper	Tuscaloosa Group	Tuscaloosa Marine Shale	**Confining zone**	
Cretaceous	Upper	Tuscaloosa Group	*Undifferentiated Lower Tuscaloosa Shale*	**Confining zone**	
Cretaceous	Upper	Tuscaloosa Group	Lower Tuscaloosa Massive sand	**Saline Reservoir**	**INJECTION ZONE**
Cretaceous	Lower	Washita-Fredericksburg Interval	Dantzler sand	**Saline Reservoir**	**INJECTION ZONE**
Cretaceous	Lower	Washita-Fredericksburg Interval	*Undifferentiated Upper Shale*	**Confinement Interval**	**INJECTION ZONE**
Cretaceous	Lower	Washita-Fredericksburg Interval	Big Fred sand	**Saline Reservoir**	**INJECTION ZONE**
Cretaceous	Lower	Washita-Fredericksburg Interval	*Undifferentiated Basal Shale*	**Confinement Interval**	**INJECTION ZONE**
Cretaceous	Lower	Paluxy Formation		**Injection Interval**	**INJECTION ZONE**
Cretaceous	Lower	Mooringsport Formation		Limestone Marker	
Paleozoic Undifferentiated		Pennsylvanian Pottsville Fm?		Regional Confining Unit	

The Tuscaloosa Group is divided into the Upper Tuscaloosa, the Tuscaloosa Marine Shale, and the Lower Tuscaloosa [10]. The Upper Tuscaloosa consists of a 280 ft thick coarsening-upwards succession of thickly interbedded sandstone and variegated mudstone. The Tuscaloosa Marine Shale is a 220 - 250 ft thick succession of interbedded shale, siltstone, and fine-grained sandstone that grades upwards from offshore facies to coastal and terrestrial facies in the overlying Upper Tuscaloosa. The Lower Tuscaloosa consists of the undifferentiated shale which makes up the upper 240 - 320 ft of the Formation, and the Lower Tuscaloosa Massive sand. The Lower Tuscaloosa Massive sand member is a 200 - 240 ft interval of very fine- to medium-grained sands. A basal conglomerate forms the lower 30 - 50 ft of the Lower Tuscaloosa Massive sand, and the remainder is dominated by very poorly consolidated sandstone. The sand is interpreted to have formed in a fluvial to coastal setting [10].

The Washita-Fredericksburg Interval is composed of two primary stratigraphic units, the sandstone lithofacies and the mudstone lithofacies. The sandstone lithofacies consists of the Dantzler sand and Big Fred sand members, while the mudstone lithofacies consists of the Upper and Basal Washita-Fredericksburg shale units. The Dantzler sand forms the upper 50 – 120 ft of the Washita-Fredericksburg Interval and is composed of multi-storied sandstone bodies separated by mudstone intervals that are around 10 ft thick [11]. The Upper Washita-Fredericksburg shale is 310 - 400 ft and consists of interbedded sandstone and mudstone layers that is dominantly shaly, with individual mudstone packages typically < 35 ft [11]. The Big Fred sand makes up the central portion of the Washita-Fredericksburg Interval and consists of a 410 - 490 ft thick succession of quartzose sandstone, pebble and cobble conglomerate and red and gray mottled mudstone [12]. Individual sandstone bodies are up to 100 ft thick, and as mudstone decreases upwards in section, single-story sandstone bodies are locally thicker than 60 ft with varying lateral continuity [13]. Like the Upper Washita-Fredericksburg shale, the Basal shale consists mostly of shale with some sandstone interbeds and is around 310 - 400 ft thick. The Washita-

[10] Mancini, E. A., Mink, R. M., Wayne Payton, J., & Bearden, B. L. (1987). Environments of deposition and petroleum geology of Tuscaloosa Group (Upper Cretaceous), South Carlton and Pollard fields, southwestern Alabama. *AAPG Bulletin*, *71*(10), 1128-1142.

[11] Pashin et al. (2020). See Section A.1., footnote #1.

[12] Pashin, J. C., Hills, D. J., Kopaska-Merkel, D. C., & McIntyre, M. R. (2008). Geological Evaluation of the Potential for CO2 Sequestration in Kemper County. *Mississippi: Birmingham, Final Report, Southern Company Research & Environmental Affairs*.

[13] Koperna, G. (2020). *Geologic Framework for the Kemper Storage Complex (Deliverable 6.2. b)* (No. DOE-SSEB-0029465-54). Southern States Energy Board, Peachtree Corners, GA (United States).

Fredericksburg Interval was deposited in a fluvial environment, likely representing interfluvial redbeds [14].

The Paluxy Formation consists of a 530 - 630 ft interval of fine- to medium-grained sandstone, conglomerate, and mudstone that are arranged in thickly bedded packages with cross-bedding structures. Sandstone beds are 10 - 100 ft thick and about 40 ft on average, whereas mudstone interbeds are usually less than 20 ft. The Paluxy Formation sands are interpreted to have been deposited in a fluvial setting similar to the Washita-Fredericksburg Interval [15]. The lowest Mesozoic stratigraphic unit above the Paleozoic unconformity is the Mooringsport Formation, which is a sub horizontal limestone interval that is 30 - 60 ft thick.

A.4. Storage zone

The target storage and confining formations at the Kemper County Storage Complex are in the Lower Cretaceous section of Kemper County, from the top of the Tuscaloosa Marine Shale to the base of the Paluxy Formation (**Table 1**). These identified zones are known to be regionally consistent throughout eastern Mississippi. The Primary confining zone for this Project is the Tuscaloosa Marine Shale and undifferentiated Lower Tuscaloosa shale, which will be referred to as the Tuscaloosa Marine Shale confining zone. Locally, the Tuscaloosa Marine Shale isolates USDW in the Eutaw Formation from saline aquifers in the Lower Tuscaloosa Massive sand and Dantzler sand. The Tuscaloosa Marine Shale is a proven confining unit in Mississippi and Alabama for hydrocarbons in the Lower Tuscaloosa [16] [17] [18]. Below the confining zone is the injection zone, which consists of a series of saline storage zones, confinement intervals, and the injection interval. The Paluxy Formation is the base of the injection zone and serves as the specific injection interval for this Project. The Lower Tuscaloosa Massive sand, Dantzler sand, and Big Fred sand are alternate saline storage reservoirs in the injection zone, while the Upper and Basal Washita-Fredericksburg shales are secondary confinement intervals. The confinement intervals and alternate saline storage reservoirs form a containment system that can buffer the vertical migration of fluids out of the injection interval, with the Tuscaloosa Marine Shale confining zone

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[14] Renken, R. A., Mahon, G. L., & Davis, M. E. (1989). Hydrogeology of clastic Tertiary and Cretaceous regional aquifers and confining units of the southeastern coastal plain aquifer system of the United States (No. 701)

[15] Folaranmi, A. T. (2015). *Geologic characterization of a saline reservoir for carbon sequestration: The Paluxy Formation, Citronelle Dome, Gulf of Mexico Basin, Alabama* (Doctoral dissertation).

[16] Galicki, S. J. (1986). Frontmatter: Mesozoic-Paleozoic Producing Areas of Mississippi and Alabama.

[17] Mancini et al. (1987) See Section B.1.c., footnote #12.

[18] Bebout, D. G., White, C. M., Garrett, C. M., and Hentz, T. F., editors (1992). Atlas of major central and eastern Gulf Coast gas reservoirs: Austin, Texas, Gas Research Institute and Texas Bureau of Economic Geology, 88 p.

providing the ultimate closure for this system. See **Section A.2.** for full dataset of injection and confining zone depths and thicknesses in the project area.

Figure 5 is a composite type-log that shows typical depths and thicknesses of the Tertiary and Cretaceous age formations. The shallow Tertiary formations and the Upper Cretaceous Selma Chalk are represented by the Southern Company #1 water test well, located at Plant Ratcliffe, while the deeper Cretaceous formations below the Selma Chalk are represented by the MPC 19-1 well. At Plant Ratcliffe, the logs are representative of the geology of the Kemper County Storage Complex.

A.5. Hydrogeology

The USDW aquifers within Kemper County reside in both Tertiary- and Upper Cretaceous-age clastic reservoirs. The Tertiary formations include the Middle and Lower Wilcox, the Naheola, and the Nanafalia Formations (**Table 1**). The Middle and Lower Wilcox USDW aquifers have Total Dissolved Solids (TDS) of < 200 milligrams-per-liter (mg/L). The principal drinking water source for Kemper County comes from the Middle and Lower Wilcox Formation. Potable water at Plant Ratcliffe is provided by the Northwest Kemper Water Association which utilizes the Lower Wilcox as its source for drinking water. The Naheola and Nanafalia Formations are shallower than 600 feet in the area around the Storage Complex, and these formations receive meteoric recharge at the surface in northeastern Kemper County. Therefore, all active and potential aquifers of Tertiary age can be expected to be USDWs and must be protected. The Porters Creek Clay and Selma Chalk together serve as an aquitard to separate the freshwater aquifers in the Tertiary from the Upper Cretaceous. The Upper Cretaceous contains the Eutaw-McShan, Gordo and Coker with potential USDW aquifers with TDS concentrations of 1,000 to 20,000 mg/L. The Eutaw-McShan aquifer is the deepest USDW in the Kemper County Storage Complex. Water used for industrial purposes at Plant Ratcliffe (i.e., non-potable) is sourced primarily as reclaimed water from two publicly owned treatment works (POTWs) nearby and is thus not related to USDWs. All reservoirs that qualify as USDWs will be monitored in the region for signs of contamination. The most likely indicators of groundwater impact from CO_2 leakage include: 1) an increase in TDS content if water with higher TDS migrated into overlying USDW and 2) a reduction in pH as CO_2 or carbonated brine results in an increase in dissolved carbonate or bicarbonate. See **Section A.7.** for more on the hydrogeology of the Kemper County Storage Complex.

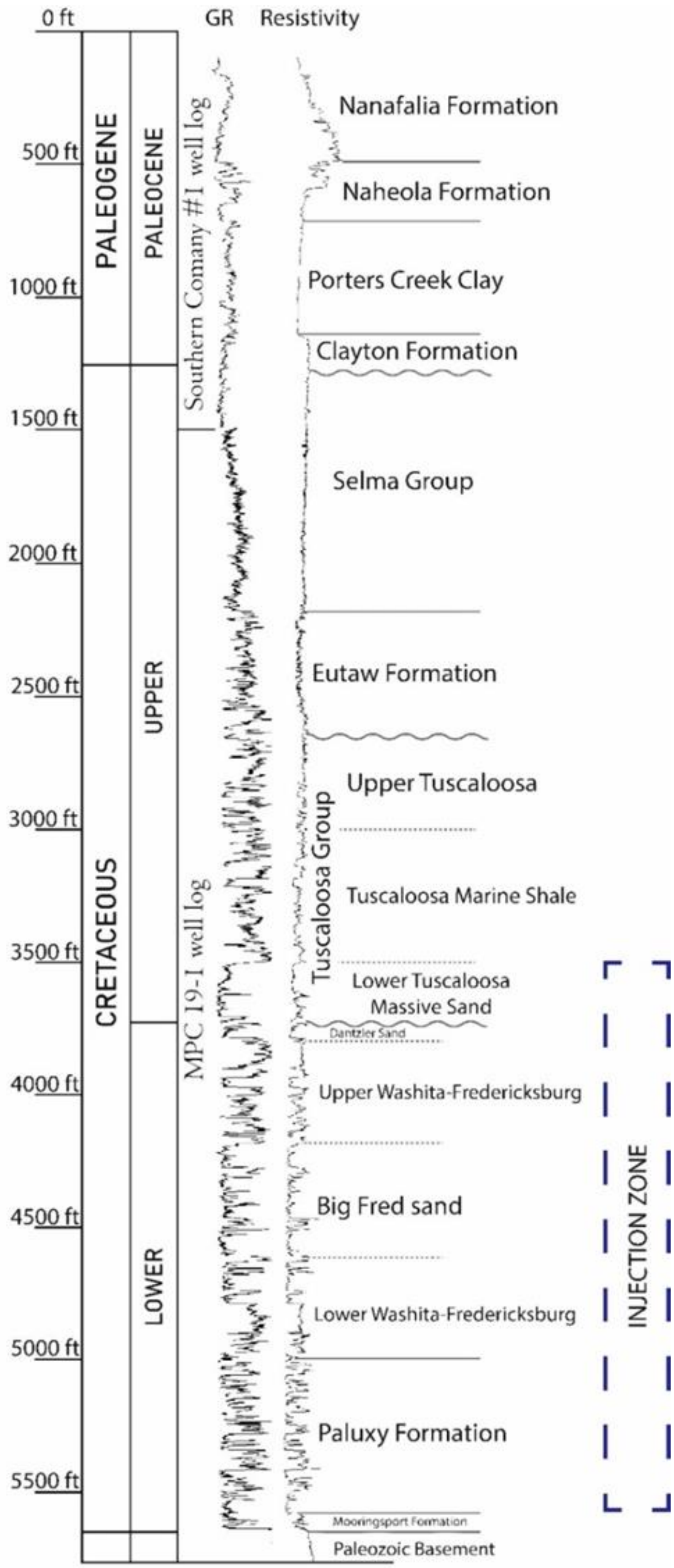

Figure 5. Composite "Type Log" for Mesozoic-Cenozoic Formations at the Proposed Kemper County Storage Complex. GR = Gamma Ray. Each log shows increasing values from left to right.

B. Maps and Cross Sections of the AoR [40 CFR 146.82(a)(2), 146.82(a)(3)(i)]

Figure 6 shows the full Stratigraphic cross section for the six characterization wells. The cross section was generated in Petra™ by selecting formation tops using geophysical logs from the top of section to TD (total depth). Gamma ray values are colored from left to right to relatively distinguish sandstone or limestone units corresponding to low API (beige), from shaly sequences corresponding to higher API (black). The Maximum Flooding Surface in the Tuscaloosa Marine Shale interval serves as the reference datum. Interpretation of the characterization wells shows a uniform stratigraphic package across our interval of interest. No significant changes in formation thickness have been observed through the characterization wells and the primary confining interval shows no sign of diminishing across the project area. The storage interval (Lower Tuscaloosa Massive sand through base of the Paluxy Formation) represents a 2,000 – 2,200 ft thick package over the study area.

Figure 7 is an enhanced cross-section of the characterization wells, showing the primary confining zone (Tuscaloosa Marine Shale) and storage interval (top Lower Tuscaloosa Massive sand through the base of the Paluxy Formation), which includes the Upper and Basal shales of the Washita-Fredericksburg Interval as secondary confinement intervals. Log analysis of the characterization wells indicates that the geology of the proposed storage and confining interval is consistent across the Area of Review. Characterization of the Paluxy Formation has identified four zones as potential CO_2 storage reservoirs. These zones consist of sand bodies that are separated by shale baffles which will control the movement of the CO_2 plume in the subsurface. See the *Area of Review and Corrective Action Plan* for more information about the modelled CO_2 plume.

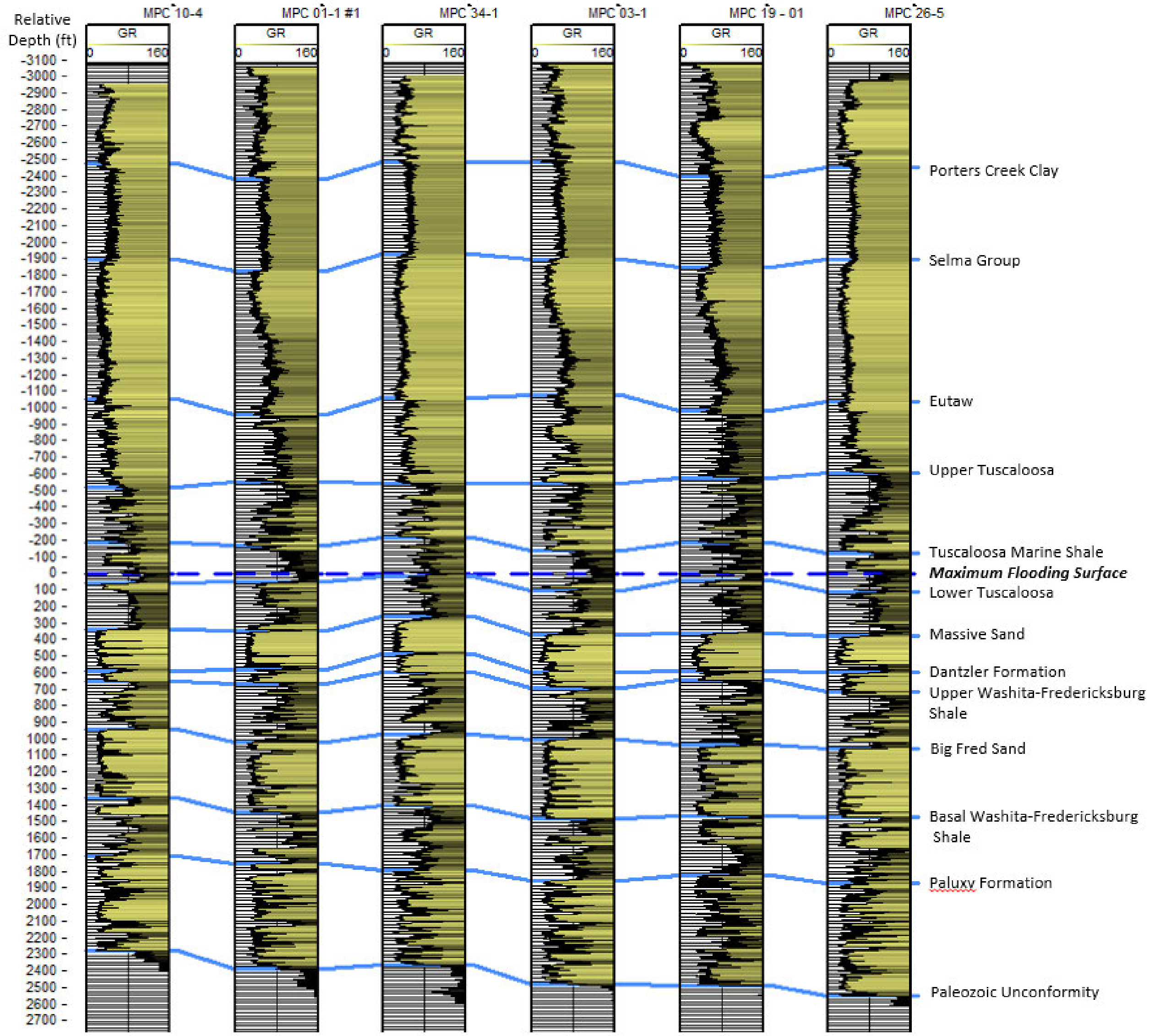

Figure 6. Characterization Wells Full cross-section. The cross-section is flattened on the Maximum Flooding Surface in the Tuscaloosa Marine Shale interval.

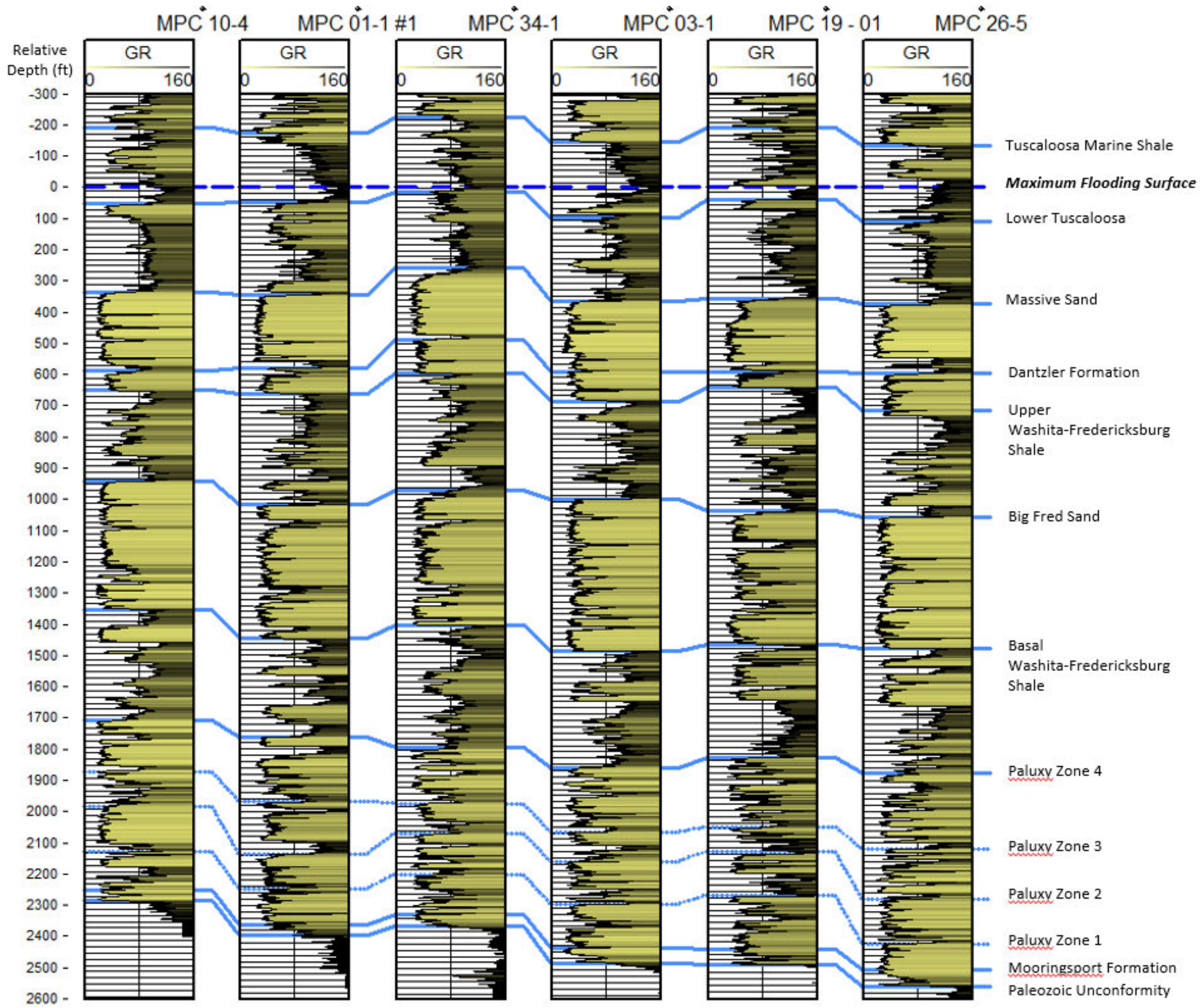

Figure 7. Characterization Well Cross-Section of the Injection Zone. Gamma Ray (API) is in Track 1, and resistivity (Ohm-meter) is in Track 2 for each well. The cross-section is flattened on the Maximum Flooding Surface in the Tuscaloosa Marine Shale interval.

As part of the characterization process, stratigraphic picks were made on the digital well logs using Petra™ geologic interpretation software. These logs were then correlated across the study area resulting in a series of contour and isopach maps to demonstrate the relative structure and thickness of the injection zone, storage interval, and primary and secondary confining zones. All depths are reported in sub-sea feet (SS). **Figure 8** shows the spatial extent of the contour maps, using the characterization wells as a point of reference, marking the approximate location of the injection wells. Each of the confinement intervals and storage zones are laterally continuous across this region and there are no major geologic structures (faults, domes, etc.) in the storage zone that would serve as trapping mechanisms or leakage pathways for stored CO_2 and/or brine to escape toward the ground surface. The red dashed line shown is the official Area of Review

(AoR) that was modelled for the Kemper County Storage Complex. For more information on the spatial extent of the AoR, see the *Area of Review and Corrective Action Plan*.

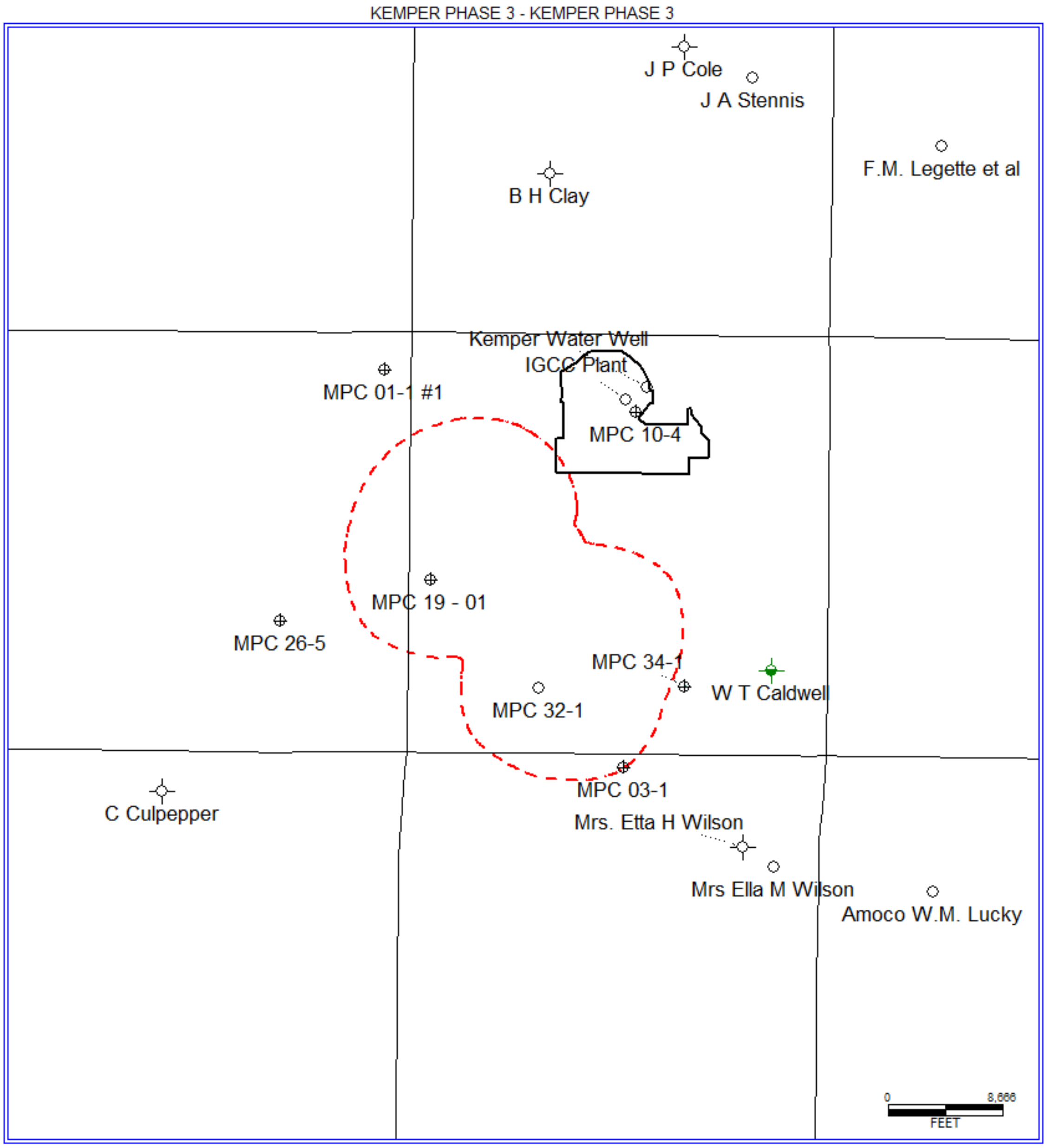

Figure 8. Contour Map Data Limits, including well locations, well names, Plant Ratcliffe outline, and the Area of Review outline (red dashed line).

The elevation of the Tuscaloosa Marine Shale is -2692 to - 2380 ft SS around the characterization wells (**Figure 9)**, and the thickness of the Tuscaloosa Marine Shale ranges from 221 - 245 ft (**Figure 10)**. The Tuscaloosa Marine Shale dips to the southwest at 59.2 ft per mile and thickens towards the south of the characterization wells from 219 – 245 ft.

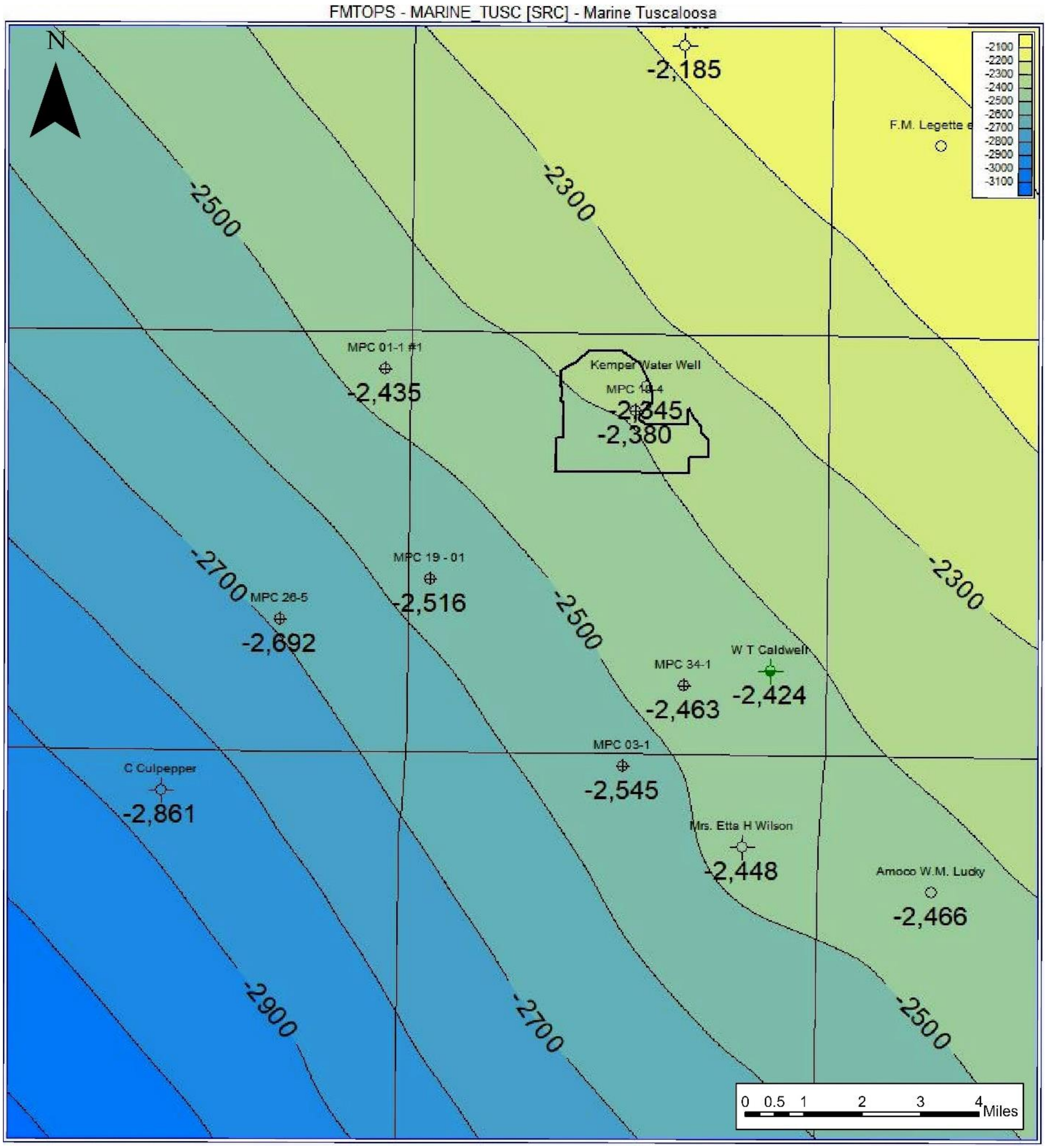

Figure 9. Top of Tuscaloosa Marine Shale Structure Map.

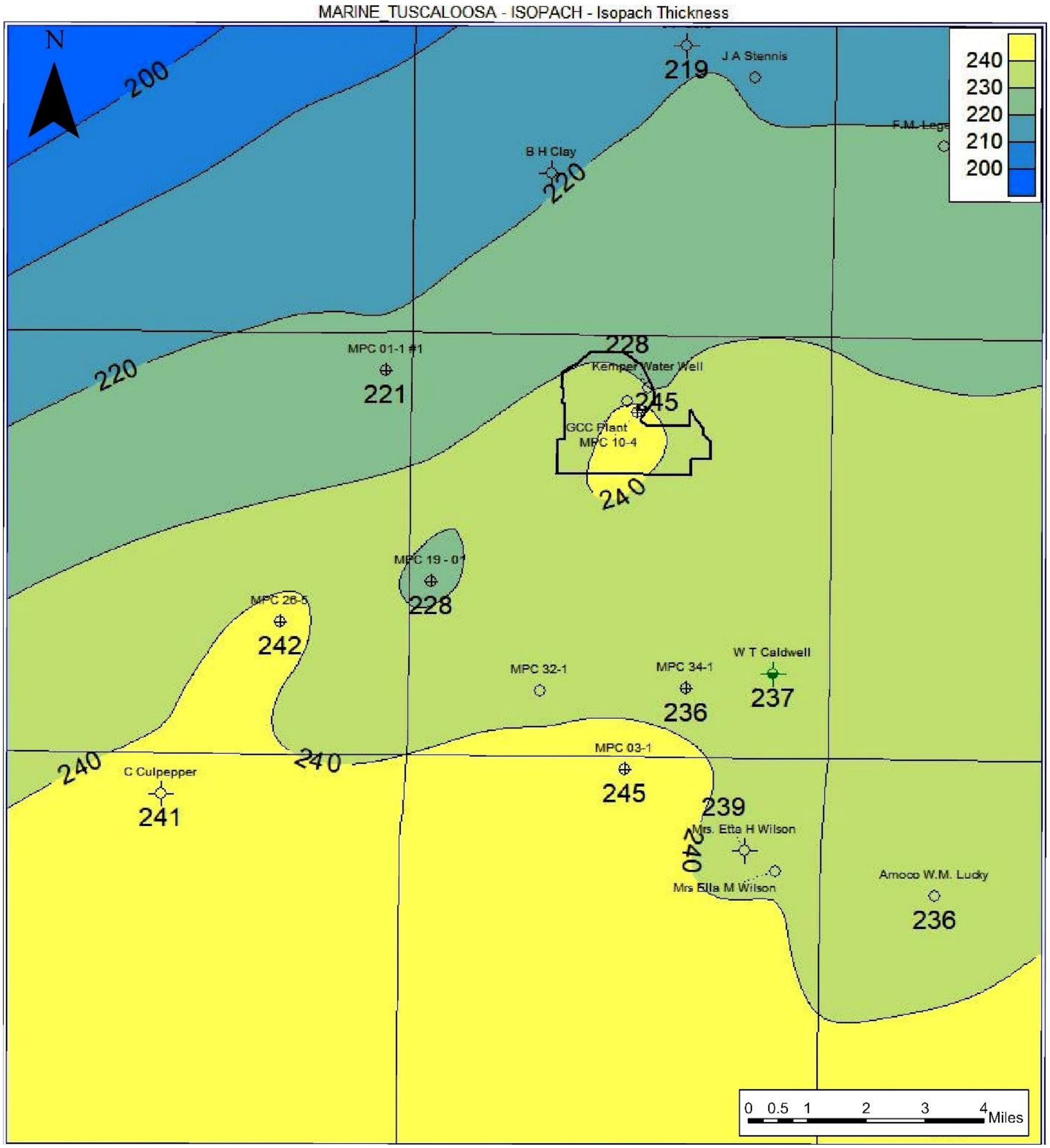

Figure 10. Tuscaloosa Marine Shale Gross Isopach Map.

The elevation of the Lower Tuscaloosa is -2934 to -2625 ft SS around the characterization wells (**Figure 11)**, and the thickness ranges from 245 - 319 ft (**Figure 12)**. The Lower Tuscaloosa dips to the southwest at 54.9 ft per mile and its thickness nonuniformly decreases to the northeast and southwest of the characterization wells. The net shale of the Tuscaloosa Marine Shale and Lower Tuscaloosa shale ranges from 236 – 267 ft in the characterization wells (**Figure 13**).

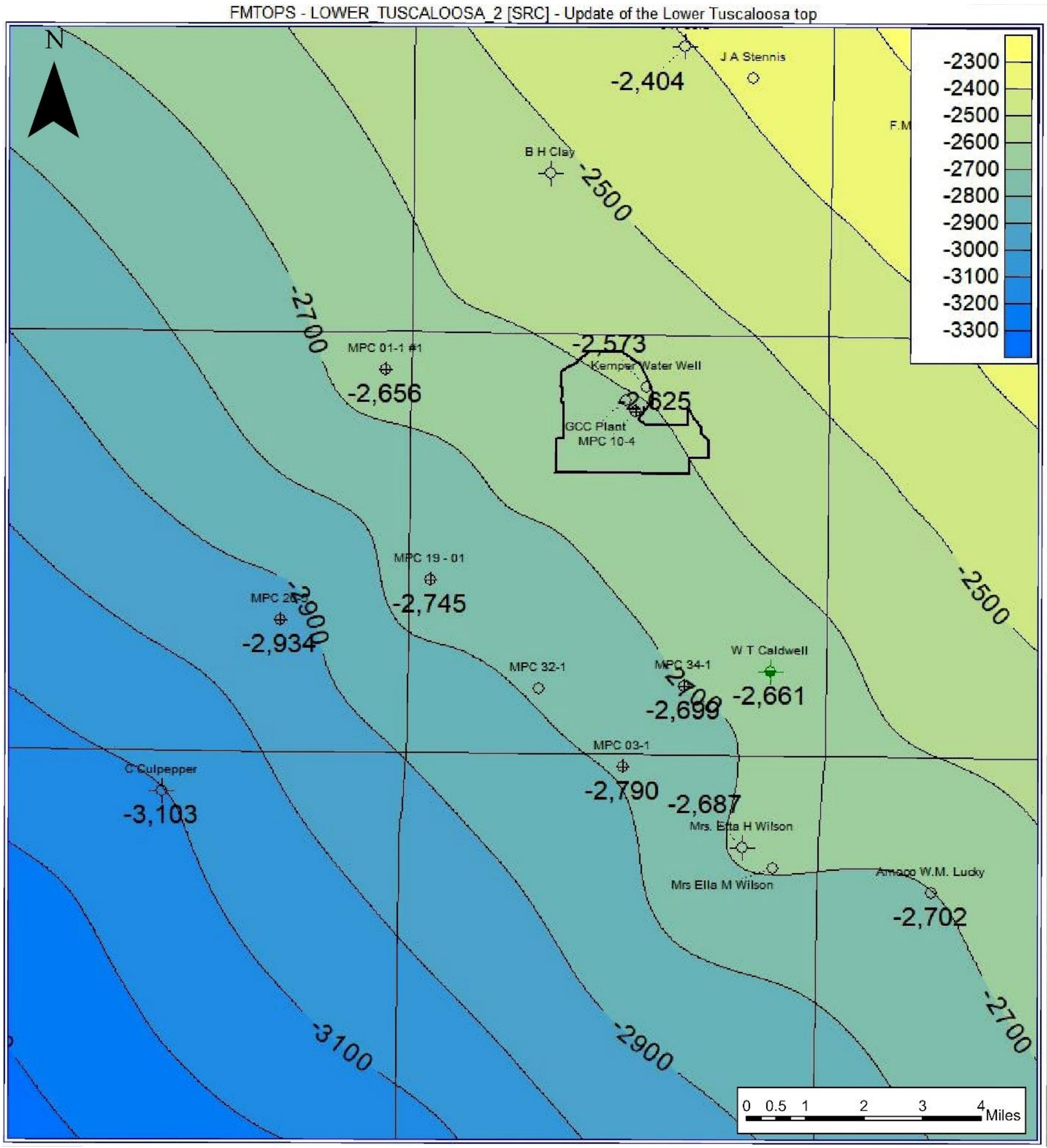

Figure 11. Top of Lower Tuscaloosa shale Structure Map.

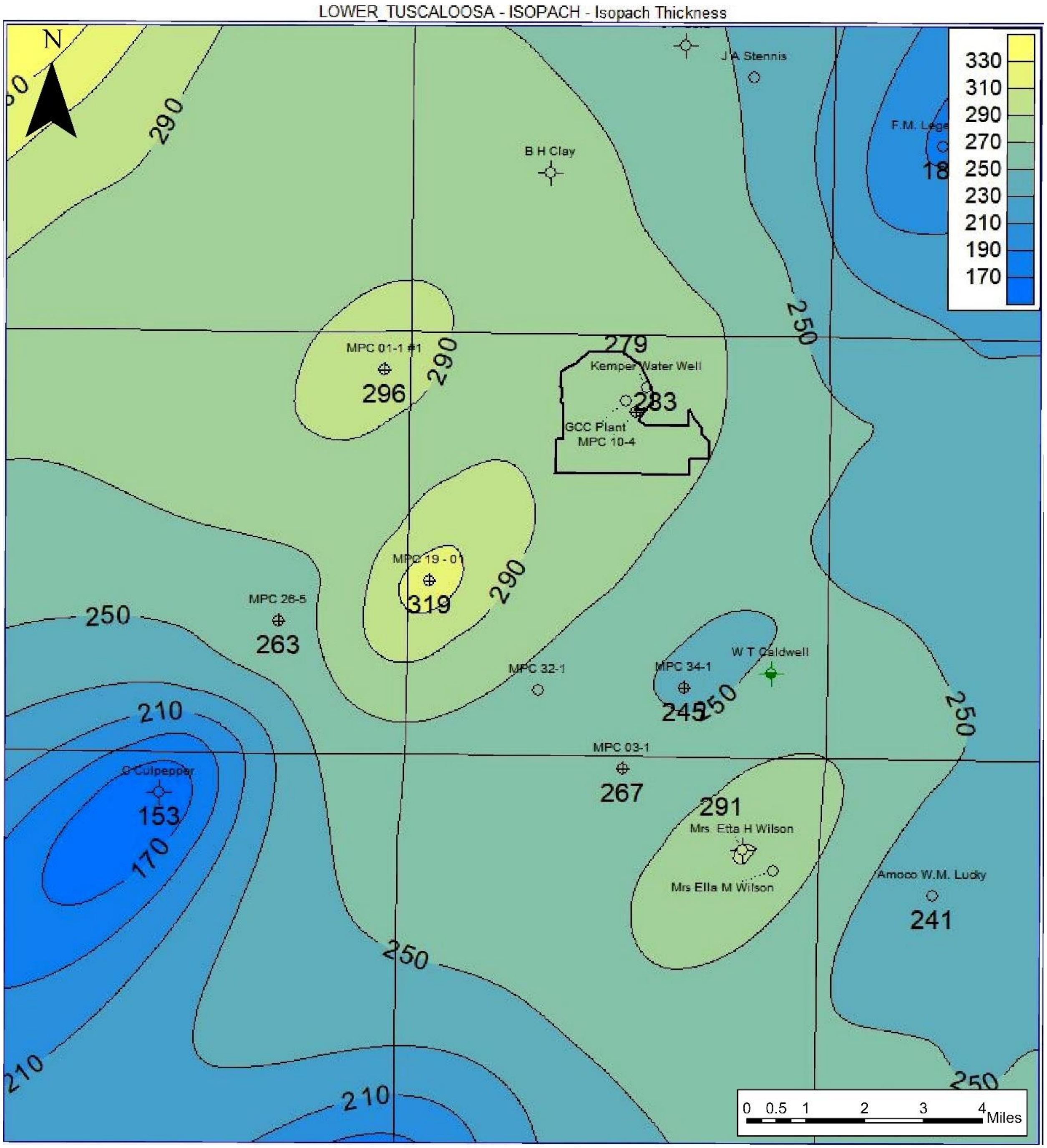

Figure 12. Lower Tuscaloosa Gross Isopach Map.

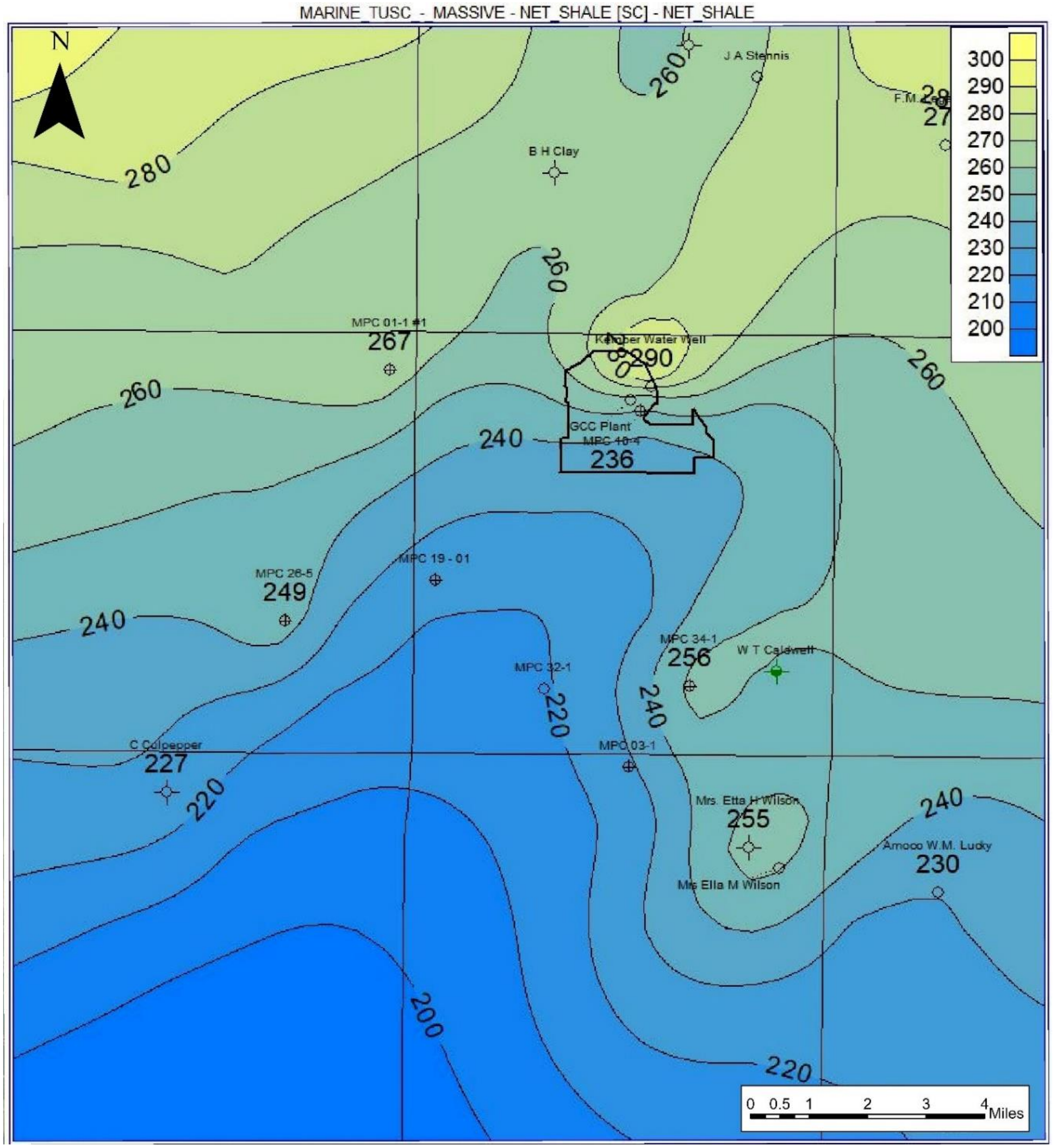

Figure 13. Net shale map (ft) of the interval from the top of the Tuscaloosa Marine Shale to the top of the Lower Tuscaloosa Massive sand.

The depth of the Lower Tuscaloosa Massive sand is - 3197 to - 2909 ft SS around the characterization wells (**Figure 14**), and the thickness ranges from 201 to 232 ft (**Figure 15**). The Lower Tuscaloosa Massive sand dips towards the southwest at 43.2 ft per mile and thickens nonuniformly to the southeast.

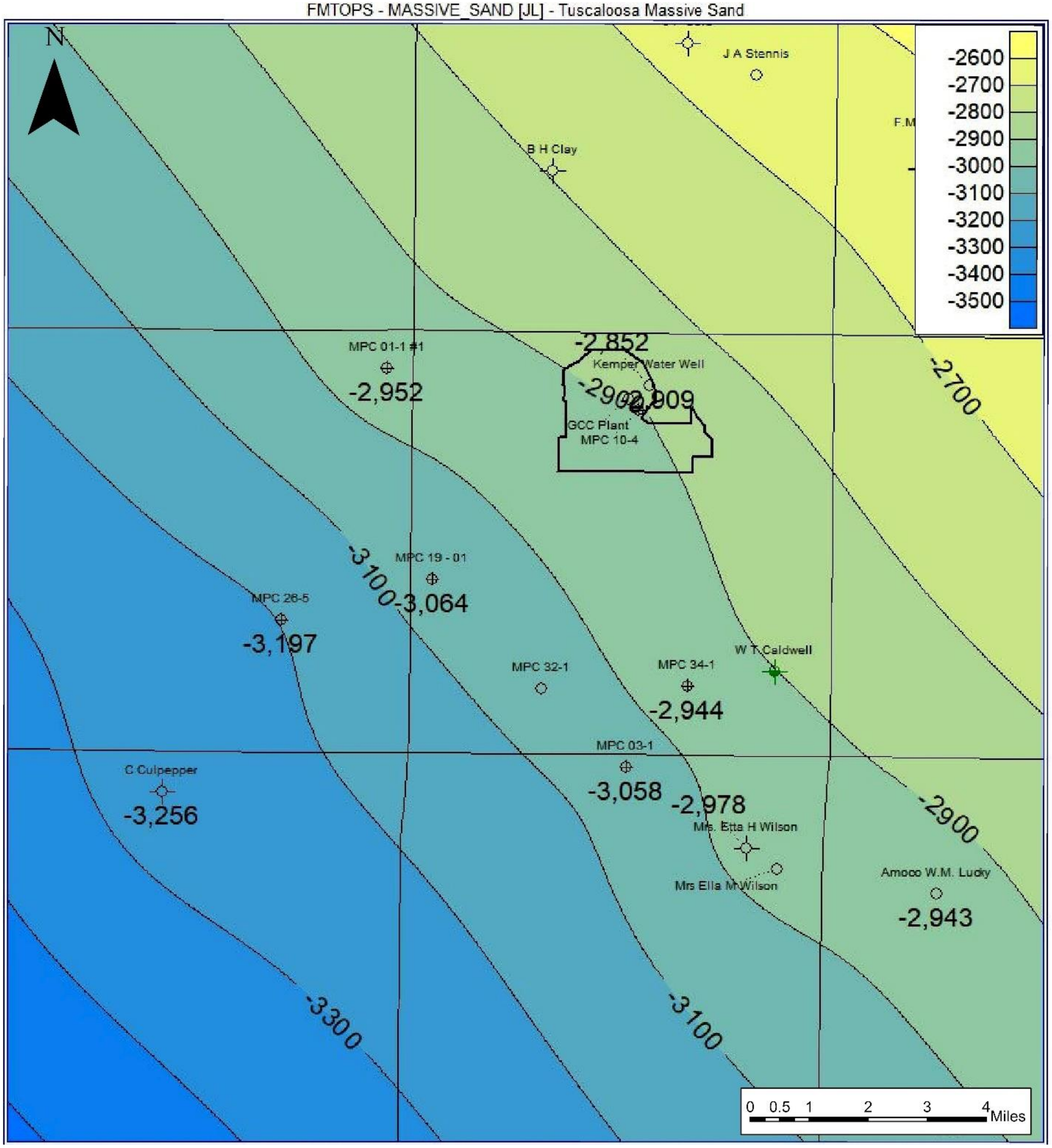

Figure 14. Top of Lower Tuscaloosa Massive sand Structure Map.

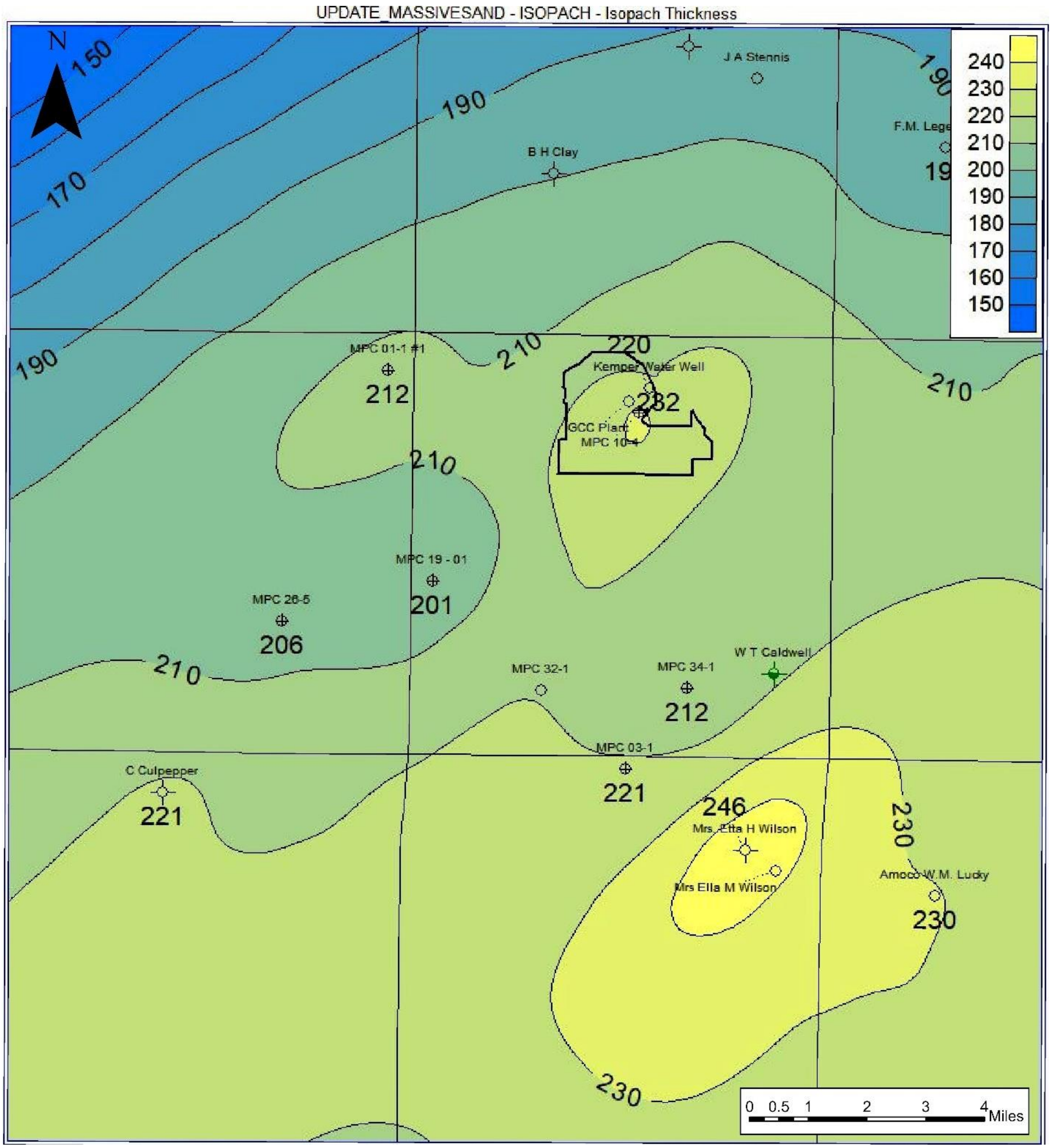

Figure 15. Lower Tuscaloosa Massive sand Gross Isopach Map.

The elevation of the Dantzler sand is -3419 to - 3159 ft SS around the characterization wells (**Figure 16)**, and the thickness ranges from 52 - 119 ft (**Figure 17)**. The Dantzler sand dips to the southwest at 45 ft per mile and its thickness increases to the southwest of the characterization wells from <52 ft to 182 ft.

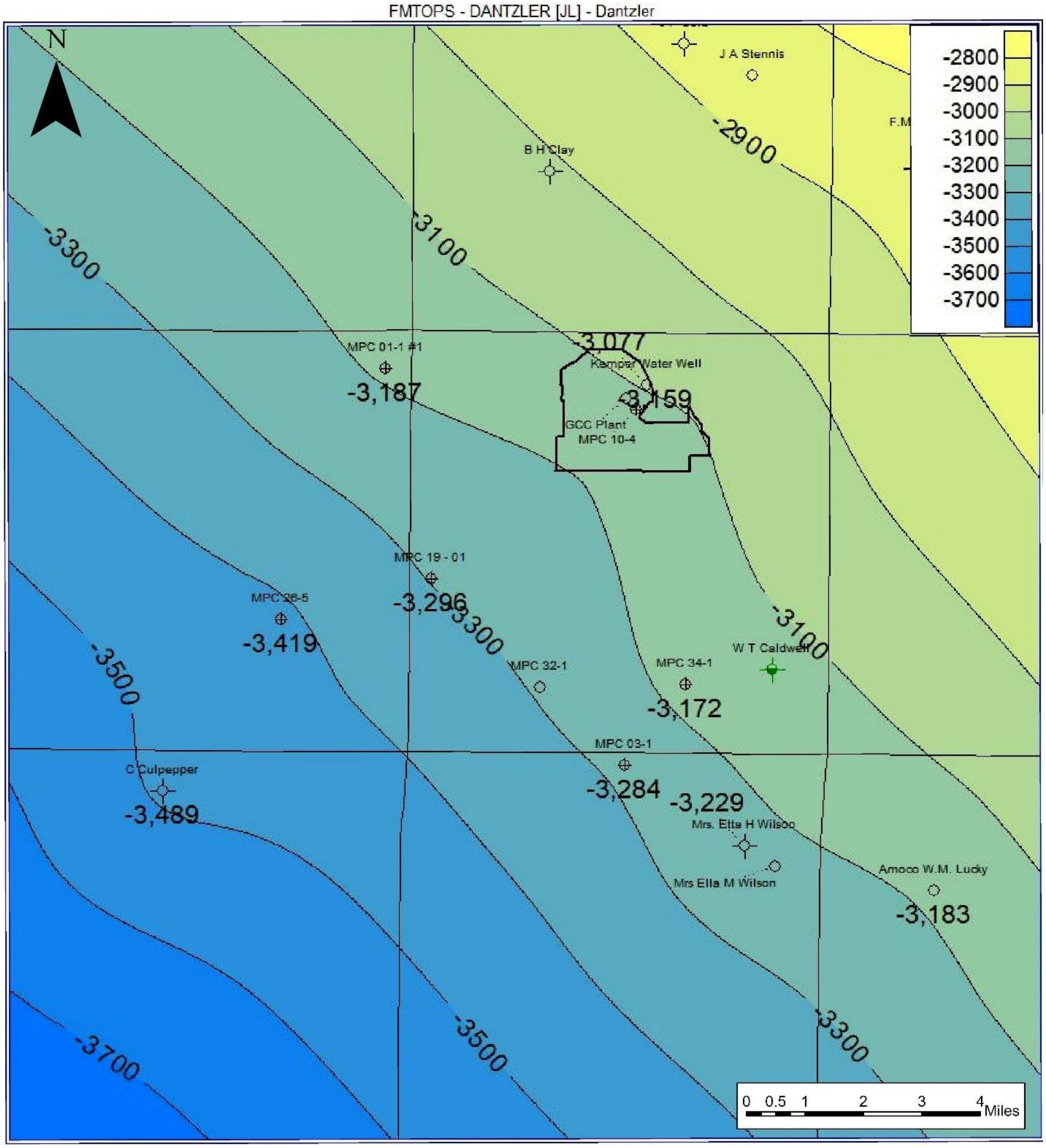

Figure 16. Dantzler sand Structure Map.

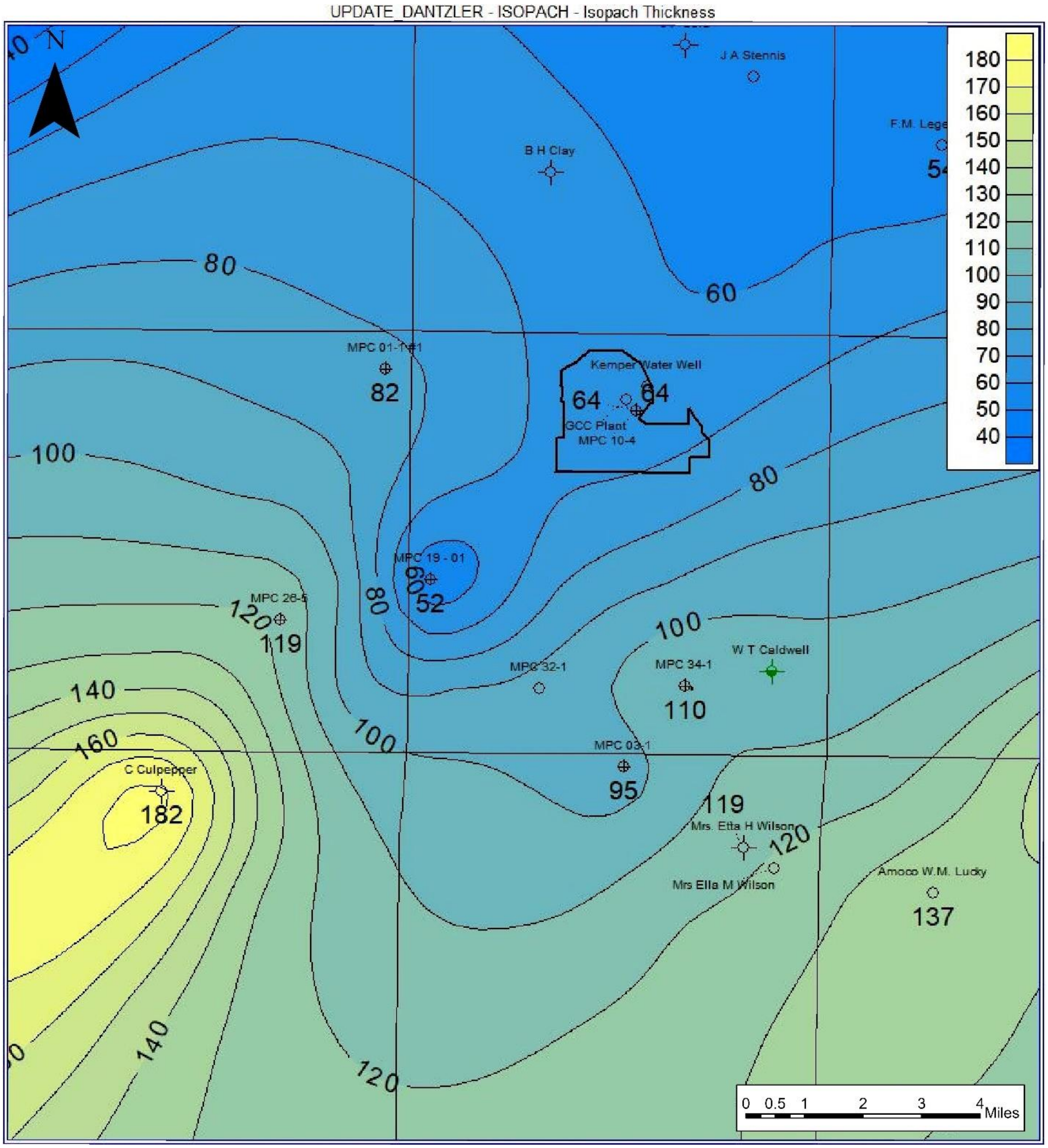

Figure 17. Dantzler sand Gross Isopach Map.

The elevation of the Washita-Fredericksburg Interval is -3538 to - 3223 ft SS around the characterization wells (**Figure 18)**, and the thickness ranges from 289 - 396 ft (**Figure 19)**. The Washita-Fredericksburg Interval dips to the southwest at 53.8 ft per mile and its thickness increases to the northeast.

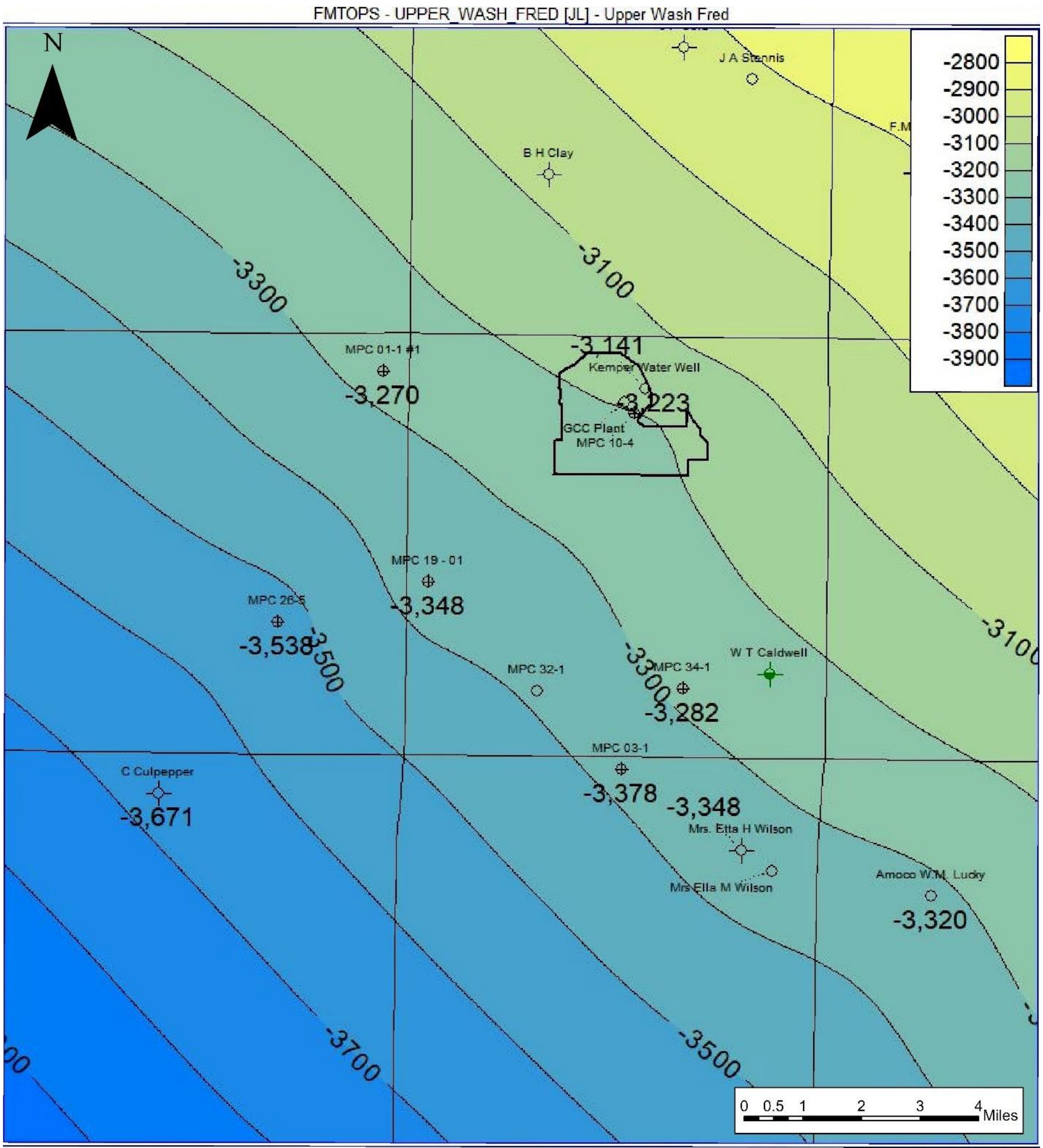

Figure 18. Top of Upper Washita-Fredericksburg Shale Structure Map.

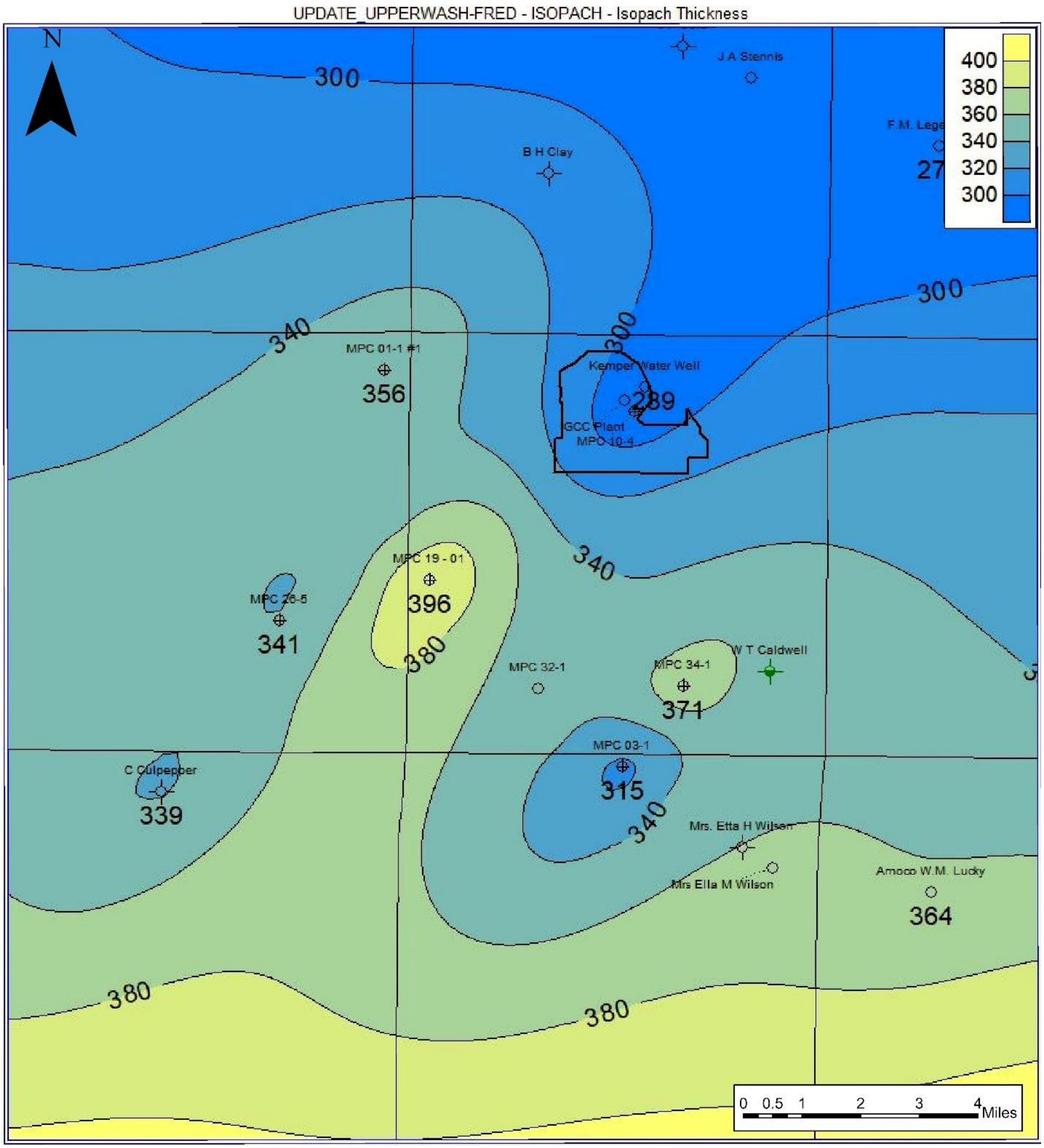

Figure 19. Upper Washita-Fredericksburg Shale Gross Isopach Map.

The elevation of the Big Fred sand is -3879 to - 3512 ft SS around the characterization wells (**Figure 20)**, and the thickness ranges from 412 - 484 ft (**Figure 21)**. The Big Fred sand dips to the southwest at 58.1 ft per mile and its thickness increases to the southwest.

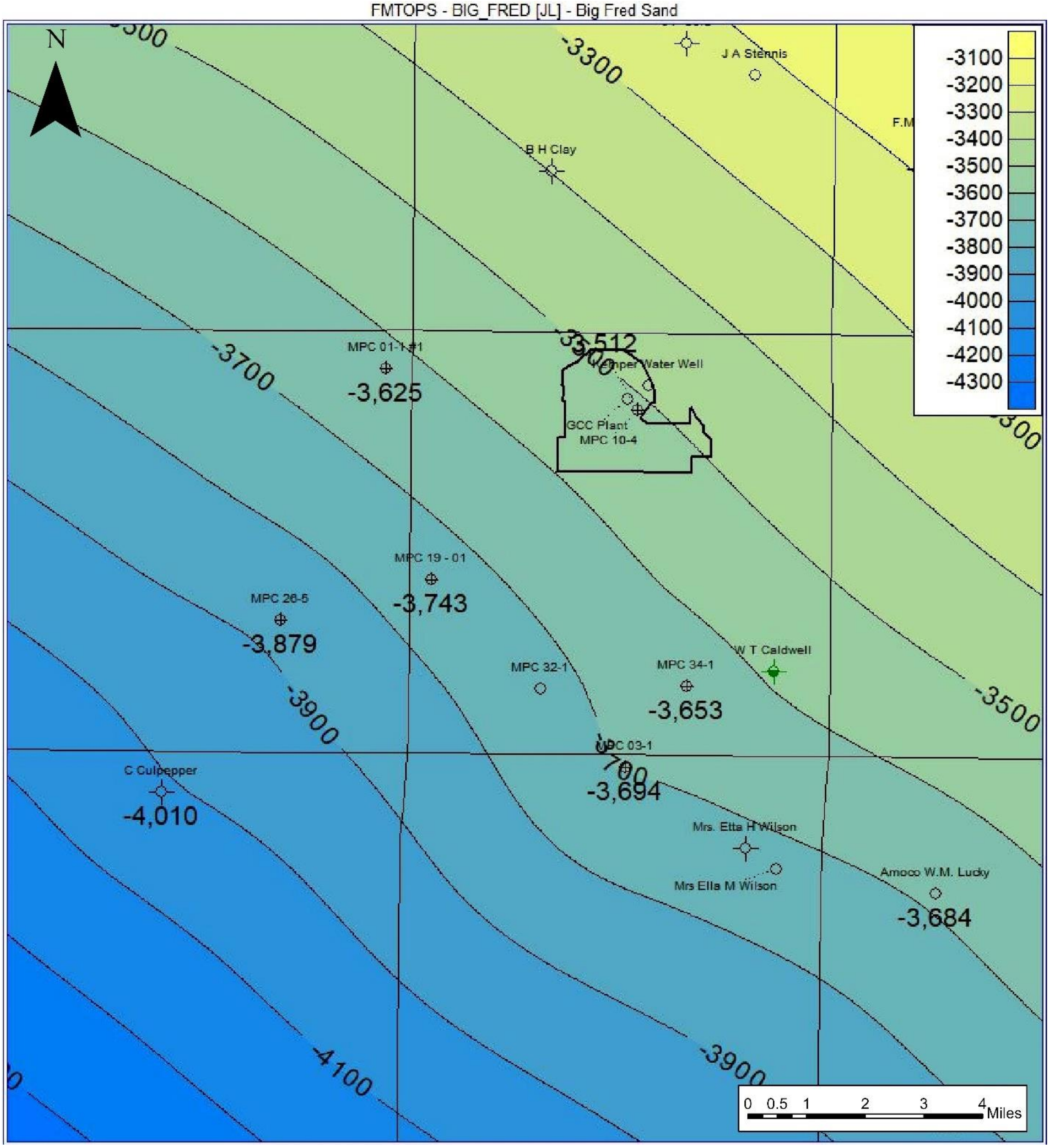

Figure 20. Top of Big Fred sand Structure Map.

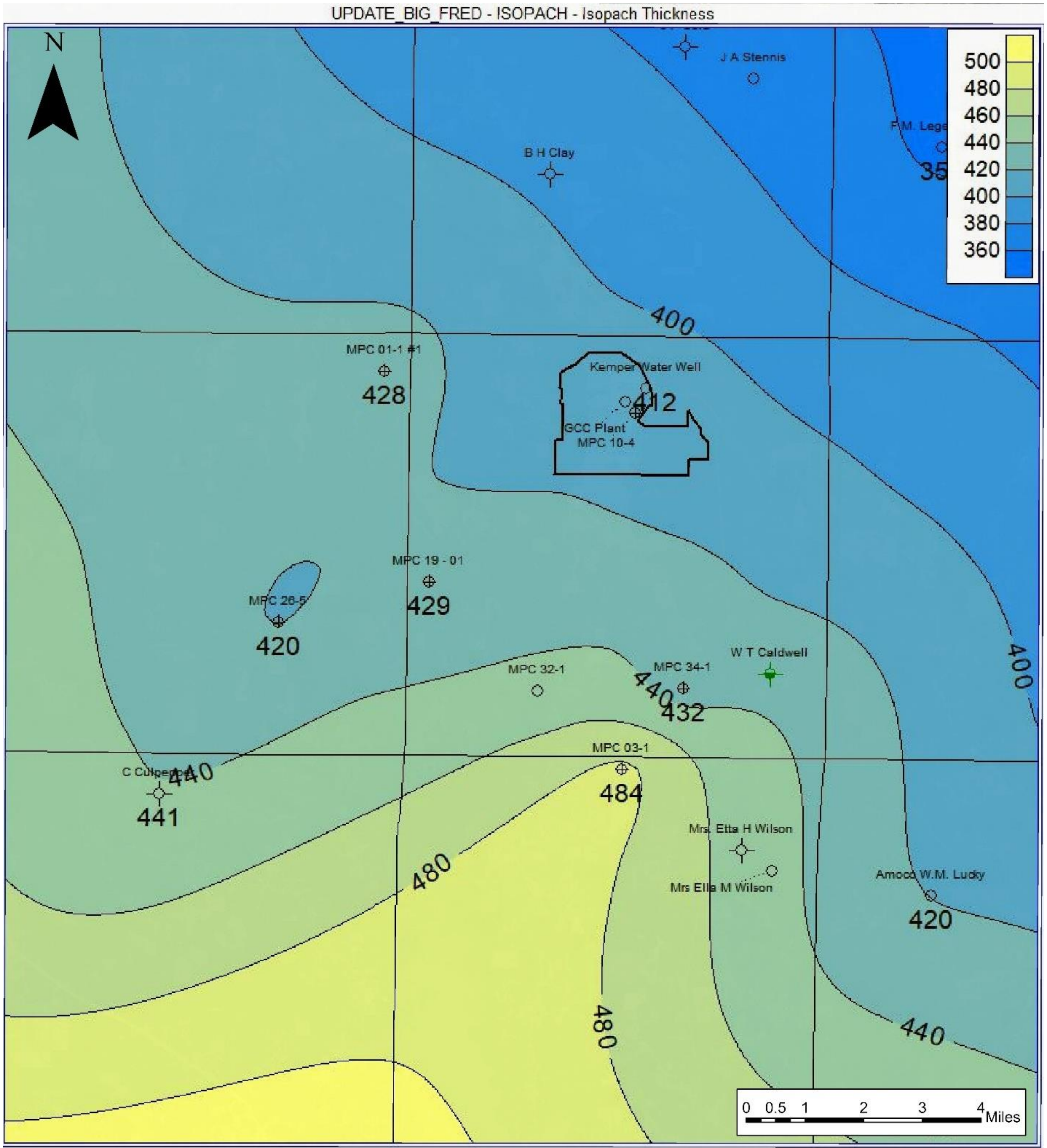

Figure 21. Big Fred Sand Gross Isopach Map.

The elevation of the Basal Washita-Fredericksburg shale is -4299 to - 3924 ft SS around the characterization wells (**Figure 22)**, and the thickness ranges from 314 - 399 ft (**Figure 23)**. The Big Fred sand dips to the southwest at 63.8 ft per mile and its thickness increases to the southwest from 314 to 465 ft.

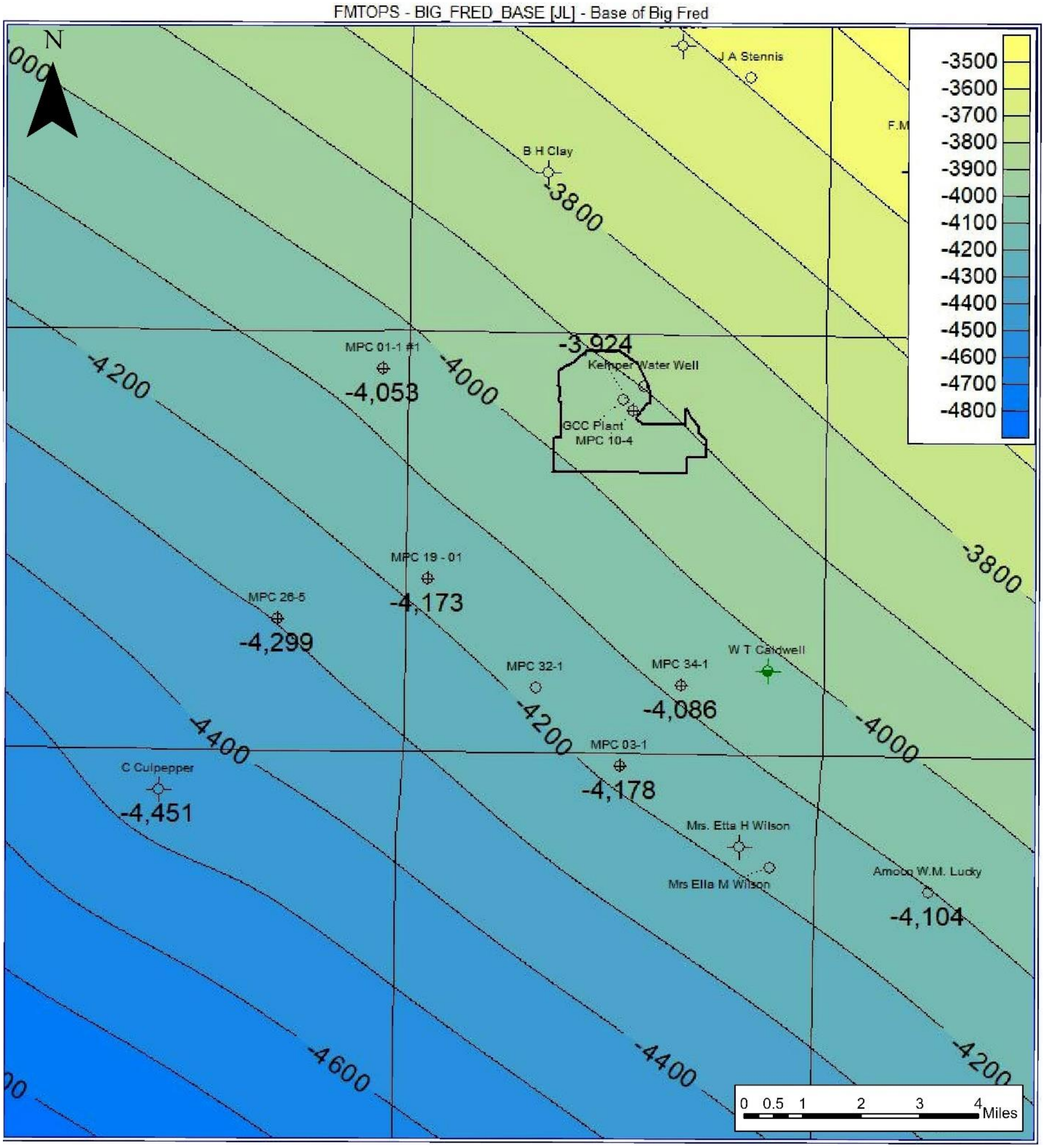

Figure 22. Top of Basal Washita-Fredericksburg shale Structure Map.

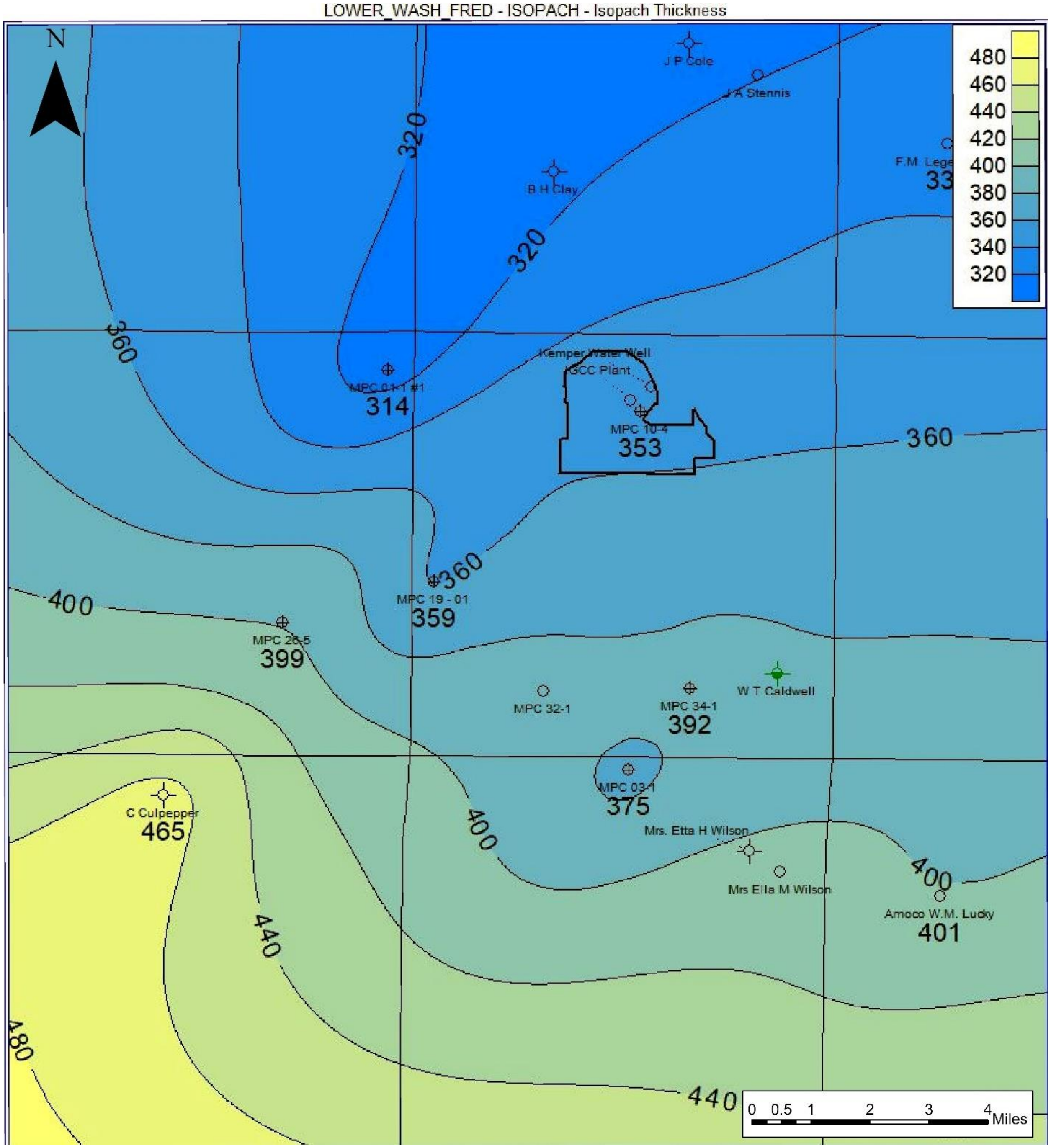

Figure 23. Basal Washita-Fredericksburg Shale Gross Isopach Map.

The elevation of the Paluxy Formation is -4698 to -4277 ft SS around the characterization wells (**Figure 24)**, and the thickness ranges from 534 - 630 ft (**Figure 25)**. The Paluxy Formation dips to the southwest at 72.9 ft per mile and its thickness increases uniformly to the west from 484 to 676 ft. The net sand for the Paluxy Formation ranges from 350 to 496 ft for the characterization wells (**Figure 26**).

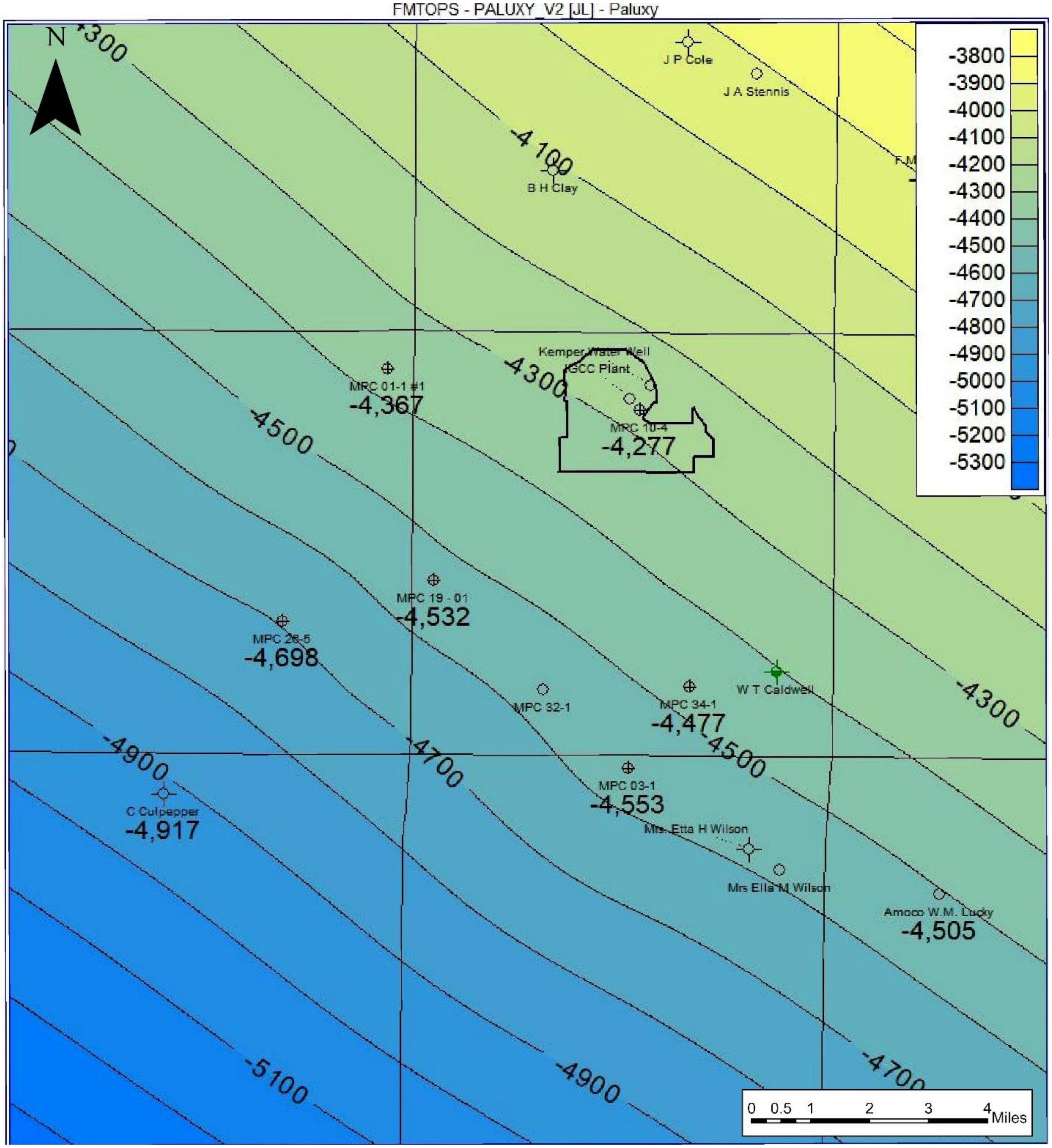

Figure 24. Top of Paluxy Formation Structure Map.

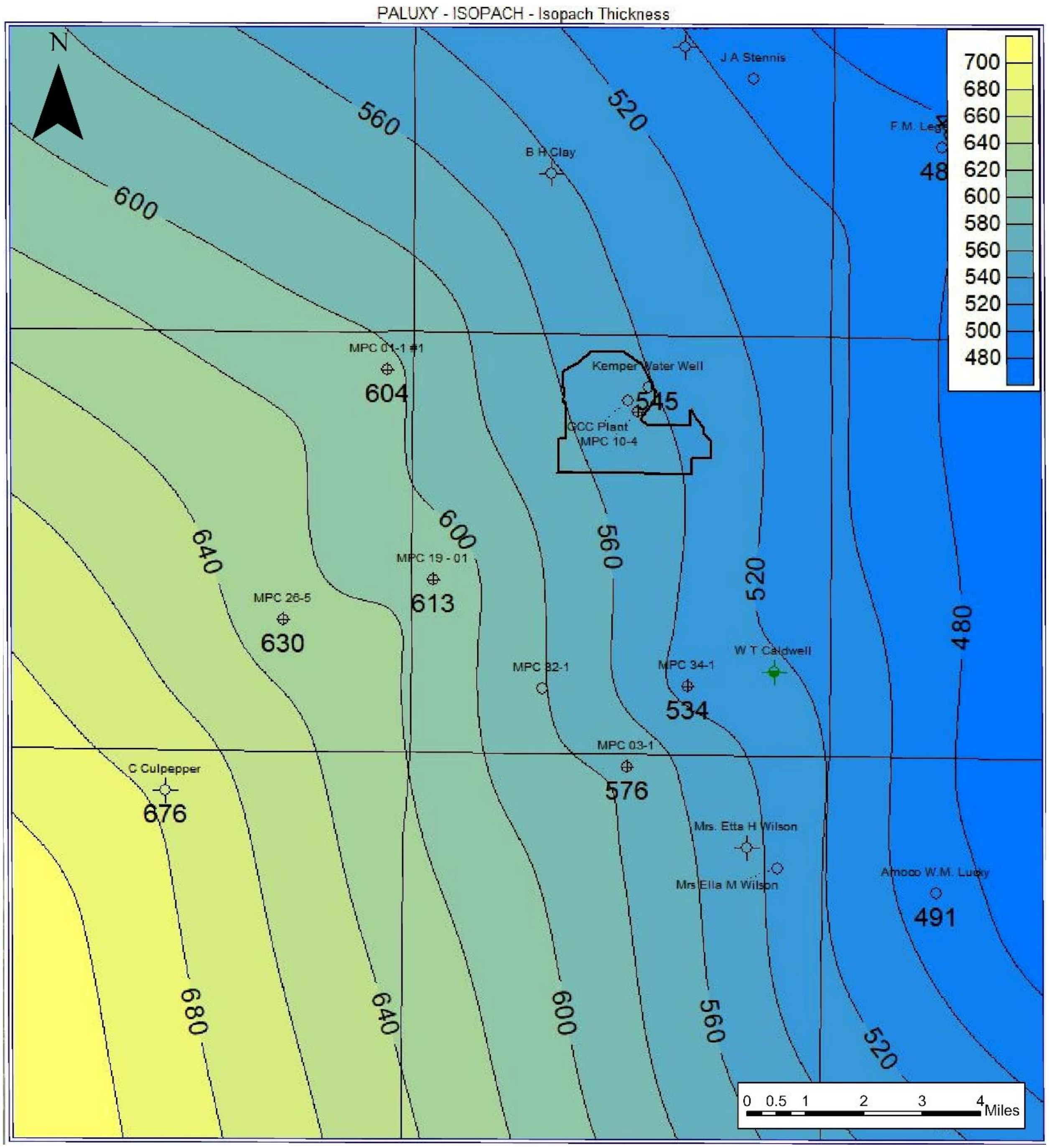

Figure 25. Paluxy Formation Gross Isopach Map.

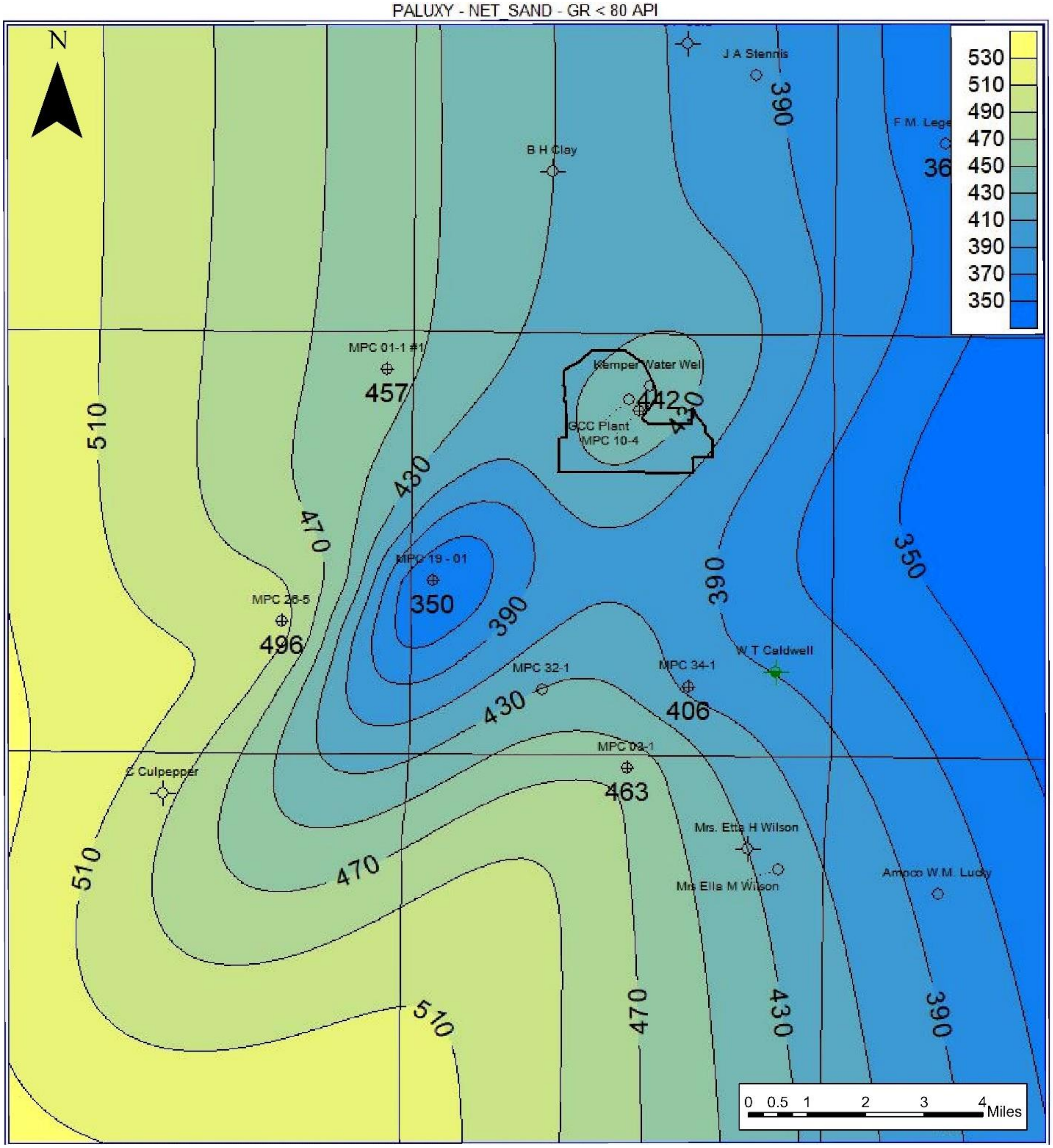

Figure 26. Net Sand Map of the Paluxy Formation.

C. Faults and Fractures [40 CFR 146.82(a)(3)(ii)]

There are no suspected faults and/or fractures that penetrate the injection zone or confining zone in the AoR or Kemper County. Inactive Paleozoic faults are present below the Cretaceous section of Kemper County at the juncture of the buried Ouachita and Appalachian tectonic belts. These thrust faults are absent above the Paleozoic Unconformity, which can be seen in 2-D seismic lines (**Figure 3 and 4**). As evidenced by the 2-D seismic section, the AOR represents a region of low seismic hazard due to the lack of faults and fractures present through the targeted storage interval and surrounding units (see **Section A.6.**). The closest faults that penetrate Cretaceous strata are 40 miles to the south and west of the Kemper County Storage Complex (**Figure 2**). Faulting within these sediments is likely related to either subsidence as the Mississippi embayment and Gulf of Mexico basin continued to deepen or movement associated with salt structures within the basin [19] [20]. The lack of surface faulting north of the Cretaceous Fault Zone, and consequently at the proposed storage site, is partly due to lesser subsidence in the area and the absence of Jurassic-age salt deposition [21].

D. Injection and Confining Zone Details [40 CFR 146.82(a)(3)(iii)]

The injection zone for the Kemper County Storage Complex consists of a series of saline formations in the Cretaceous section of Kemper County, the Paluxy Formation, the Big Fred sand, and the Lower Tuscaloosa Massive sand member of the Lower Tuscaloosa. The target injection interval comprises the sands of the Paluxy Formation at the base of the Lower Cretaceous. The Tuscaloosa Marine Shale serves as the primary confining zone for the Kemper County Storage Complex, while the Upper and Basal Washita-Fredericksburg shale members act as secondary confinement intervals. See **Section A.2.** for depth, thickness, and areal extent of the injection and confining zones in the AoR.

Subsurface geology for the Kemper County Storage Complex was first investigated using data from five characterization wells located in the southwest corner of Kemper County: Mississippi Power Company (MPC) 10-4, MPC 26-5, MPC 34-1, MPC 01-1, MPC 19-1, and MPC 03-1 (**Figure 8**). Each well penetrates the target storage reservoirs and confining zones, and are

[19] Law Engineering Testing Co. (1981). Geologic Evaluation of Gulf Coast Salt Domes: Overall Assessment of the Gulf Interior Region. Office of Nuclear Waste Isolation, Technical Report ONWI-106. 162 p.

[20] Hosman, R. L. (1991). *Regional stratigraphy and subsurface geology of Cenozoic deposits, Gulf Coastal Plain, south-central United States* (No. 91-66). US Geological Survey.

[21] Rosenbalm, A. (2020). Investigating the timing of initial Louann Salt Flow and its relationship with the Gilbertown Fault Zone, Southwest Alabama.

used for subsurface geological characterization, mapping, and numerical modeling [22]. Whole-core was acquired from confining and storage intervals to define the petrophysical properties which are summarized in **Table 2**. The reservoir properties for the storage and confining units were determined from core samples obtained through the characterization wells and were shown to be consistent in nature. This suggests a lateral consistency of necessary reservoir properties across the AoR.

Reservoir characteristics of the injection and confining zones were investigated using core samples, petrographic thin sections, and geophysical logs from the MPC 10-4, MPC 26-5, and MPC 34-1 wells [23]. Routine core analysis (RCA) was used to determine porosity, Klinkenberg permeability, and fluid saturation. Density porosity logs were used to quantify sandstone porosity. Pressure decay permeability analysis was performed on mudrock samples from core and cuttings, and standard petrographic thin section were developed from core samples to determine porosity and mineralogy. This reservoir data was then used to calculate storage capacity of the three saline reservoirs in the injection zone (Lower Tuscaloosa Massive sand, Big Fred sand, and Paluxy Formation sands).

Static Storage capacity was estimated for each interval using the Dept. of Energy (DOE) Volumetric Equation[24]:

$$G_{CO_2} = A_t h_g \Phi_{tot} \rho E_{saline}$$

Where, the storage capacity (G_{CO_2}, expressed in MMt) is the product of the total area (1 square mile), net reservoir thickness (ft), core derived porosity (decimal units), CO_2 density (ρ, expressed as lbs/ft^3) at reservoir pressure and temperature conditions, and a saline storage efficiency factor (E_{saline}, expressed as a decimal unit). Standard saline storage efficiency factors (Goodman et al., 2011) of 7.4%, 14%, and 24% were applied to capacity estimates to reflect the fraction of total pore volume that will be occupied by injected CO_2. These specific saline storage efficiencies are

[22] Koperna et al. (2020). See Section B.1.d., footnote #15

[23] Pashin et al. (2020). See Section A.1., footnote #1

[24] Goodman, A., Hakala, A., Bromhal, G., Deel, D., Rodosta, T., Frailey, S., Small, M., Allen, D., Romanov, V., Fazio, J., Huerta, N., McIntyre, D., Kutchko, B., and Guthrie, G. (2011). U.S. DOE methodology for the development of geologic storage potential for carbon dioxide at the national and regional scale. *International Journal of Greenhouse Gas Control*. Vol. 5, Issue 4, p. 952-965.

used when the area, net reservoir thickness, and core-derived (effective) porosities are known for the storage reservoirs. These efficiency factors are determined from the equation below[24]:

$$E_{saline} = E_A E_L E_g E_d$$

The areal displacement efficiency (E_A) is the fraction of planar area surrounding the injection well that CO_2 can contact which is influenced by geologic reservoir heterogeneity (i.e., reservoir porosity and permeability contrasts) and/or CO_2 mobility. The vertical displacement efficiency (E_L) is the fraction of vertical cross-section or thickness with the volume defined by the area that can be contacted by a CO_2 plume from a single well which is affected by formation dip and CO_2 buoyancy. The vertical displacement efficiency takes into account potential porosity and permeability contrasts between sub-layers in the same geologic unit. The gravity displacement efficiency (E_g) is the fraction of net thickness that is contacted by CO_2 due to the density and mobility difference between CO_2 and in situ water. Lastly, the microscopic displacement efficiency (E_d) is the fraction of CO_2 contacted, water-filled pore volume that can be replaced by CO_2. These efficiency values assume that all in situ fluids are fully displaced by CO_2.

Additionally, Lohr and Hackey (2018) [25] conducted Mercury Injection Capillary Pressure (MICP) analysis on Tuscaloosa Marine Shale core samples to determine CO_2 column height retention, porosity, and Swanson permeability. Oklahoma State University analyzed thin sections to determine composition and fabric of the Tuscaloosa Marine Shale, and porosity of the reservoir and confining units was determined using the Dean Stark Extraction method [26]. Net storage reservoir thicknesses and porosity were also investigated using triple combo well logs [27]. Porosity, permeability, and calculated storage capacity for sandstone and mudstone units are presented in **Tables 3 and 4**, respectively.

[25] Lohr, C. D., & Hackley, P. C. (2018). Using mercury injection pressure analyses to estimate sealing capacity of the Tuscaloosa marine shale in Mississippi, USA: Implications for carbon dioxide sequestration. *International Journal of Greenhouse Gas Control*, *78*, 375-387.

[26] Koperna, G. (2020). *Core Analysis Report (Deliverable 6.1. a)* (No. DOE-SSEB-0029465-60). Southern States Energy Board, Peachtree Corners, GA (United States).

[27] Koperna, G. (2020). *Geophysical Well Log Report (Deliverable 6.2. a)* (No. DOE-SSEB-0029465-61). Southern States Energy Board, Peachtree Corners, GA (United States).

Table 2. Well Core Depths from the Characterization Wells.

MPC 26-5			
Depth Range (ft)	**Cored (ft)**	**Recovered (ft)**	**Intervals Cored**
3,587 - 3,643	56	4	Lower Tuscaloosa Massive sand
3,645 - 3,622	17	10.5	Lower Tuscaloosa Massive sand
4,331 - 4,349	18	4.3	Washita-Fredericksburg Interval Big Fred sand
MPC 34-1			
Depth Range (ft)	**Cored (ft)**	**Recovered (ft)**	**Intervals Cored**
4,850 - 4,867	17	12.5	Washita-Fredericksburg Interval
5,307 - 5,340	33	30	Paluxy Formation
MPC 10-4			
Depth Range (ft)	**Cored (ft)**	**Recovered (ft)**	**Intervals Cored**
3,170 - 3,200	30	26	Tuscaloosa Marine Shale
3,200 - 3,210	10	7	Tuscaloosa Marine Shale
5,038 - 5,068	30	27.5	Paluxy Formation
5,068 - 5,098	30	30	Paluxy Formation
5,098 - 5,135	37	28	Paluxy Formation
MPC 01-1			
Depth Range (ft)	**Cored (ft)**	**Recovered (ft)**	**Intervals Cored**
3,850 – 3,881	31	31	Upper Washita-Fredericksburg shale
MPC 19-1			
Depth Range (ft)	**Cored (ft)**	**Recovered (ft)**	**Intervals Cored**
3,076 – 3,099	23	0	Tuscaloosa Marine Shale
3,099 – 3,125	26	6	Tuscaloosa Marine Shale
4,800 – 4,808	8	5	Basal Washita-Fredericksburg shale
4,808 – 4,832	24	20	Basal Washita-Fredericksburg shale
5,320 – 5,344	24	15	Paluxy Formation
5,344 – 5,369	25	25	Paluxy Formation

Table 3. Tabulation of Mudstone Porosity and Permeability Data Measured from Core.

Mudstone Characteristics			Tuscaloosa Marine Shale	Paluxy Formation
Porosity				
RCA Porosity (%) [28]	**MPC 10-4**		2 – 4	4.2 – 14.7
	MPC 19-1			7.9 and 13.6
MICP Porosity [29]			3.86 – 9.86	
Permeability				
RCA permeability (mD) [28]	**MPC 10-4**		0.54 - 38.1	0.2 - 0.37
	MPC 19-1		3.11 - 13	0.0058 and 0.032
MICP Permeability (mD) [29]			< 0.003	
Pressure decay permeability (nD) [28]	**MPC 26-5**	**Hyperbolic**	194.7	34.4
		Exponential	64.4	23.8
	MPC 10-4	**Hyperbolic**	79.9	
		Exponential	12.4	

[28] Pashin et al. (2020). See Section A.1., footnote #1.

[29] Lohr and Hackey (2018). See Section B.4., footnote #26.

Table 4. Tabulation of Sandstone Porosity, Permeability, and Storage Capacity Estimates.

Sandstone Characteristics		Lower Tuscaloosa Massive sand	Washita-Fredericksburg sand	Paluxy sands
Porosity				
RCA Porosity (%) [37]		28.8	27.4	26.3
RCA Porosity (%) [30]	MPC 10-4			30
	MPC 34-1		> 30.0	
	MPC 19-1			28
Mercury Injection Porosity (%) [30]	MPC 10-4			28.3 – 32.6
Triple Combo Porosity (%) [38]	MPC 26-5	30.0	28.0	28.0
	MPC 34-1	30.0	28.0	27.0
	MPC 10-4	31.0	27.0	28.0
Permeability				
RCA Permeability (mD) [30]	MPC 10-4			1800
	MPC 34-1		600	
Pressure decay permeability MPC 26-5 (nD) [37]	Hyperbolic			34.40
	Exponential			23.80
Capacity				
Storage capacity (Mt/mi^2) [37]	p10	1.82	7.53	4.28
	p50	3.45	14.25	8.10
	p90	5.92	24.43	13.90

[30] Koperna et al. (2020). See Section B.4., footnote #27.

D.1. Tuscaloosa Marine Shale

The Tuscaloosa Marine Shale is a succession of interbedded shale, siltstone, and very fine- to fine-grained sandstone that serves as a regional confining unit in the eastern Gulf of Mexico basin. The Tuscaloosa Marine Shale consists of medium to dark gray mudstone that forms laminae to medium beds. The siltstone and sandstone units are light to medium grey, forming laminae to very thick beds (**Figure 27)** [31]. The basal portion of the Tuscaloosa Marine Shale contains graded bedding of shale, siltstone, and sandstone, and these beds have sharp bases and gradational to sharp tops. Other structures included soft-sediment deformation, current ripple cross laminae, and pinstripe, lenticular, and wavy bedding. The Lower and Upper Tuscaloosa together form a progradational succession of fluvial-deltaic deposits that grade upwards from the offshore facies associated with the Tuscaloosa Marine Shale, to the coastal and terrestrial facies of the Upper Tuscaloosa. The Tuscaloosa Marine Shale is the top-seal for the hydrocarbons sourced in the lower Tuscaloosa Group, which is a major source of petroleum in Mississippi and Alabama [32] [33] [34], making it an adequate confining unit for CO_2 storage [35].

Table 3 details porosity and permeability data for the Tuscaloosa Marine Shale, including RCA and Pressure decay permeability [28], and Mercury Injection Capillary Pressure (MICP) data [29]. Porosity measurements from fresh cuttings and core samples indicate that porosity of the mudrocks is on the order of 2 - 4%, although these values appear to reflect alteration of the mudrock during retrieval and preparation of the samples. Permeability values from RCA in the Tuscaloosa Marine Shale show a wide range of permeability from 0.54 to 38.1 mD. Curves fitted to the pressure decay analysis for wells MPC 25-5 and MPC 10-4 data yielded permeability values of 194.7 and 79.9 nD for the Hyperbolic segment, and 64.4 and 12.4 nD for the Exponential segment, respectively. MICP analysis conducted on core and cuttings from the Tuscaloosa Marine Shale yielded porosity values of 3.86 – 9.86%, and Swanson permeability values less than 0.003 mD. Moreover, it was demonstrated that the Tuscaloosa Marine Shale can retain a CO_2 column height of 100 meters before any CO_2 intrusion, suggesting desirable sealing ability [29].

[31] Koperna et al. (2020). See Section B.1.d., footnote #15.

[32] Galicki (1986). See Section B.1.d., footnote #18.

[33] Mancini et al. (1987). See Section B.1.c., footnote #12.

[34] Bebout et al. (1992). See Section B.1.d., footnote #20

[35] Koperna et al. (2020). See Section B.1.d., footnote #15.

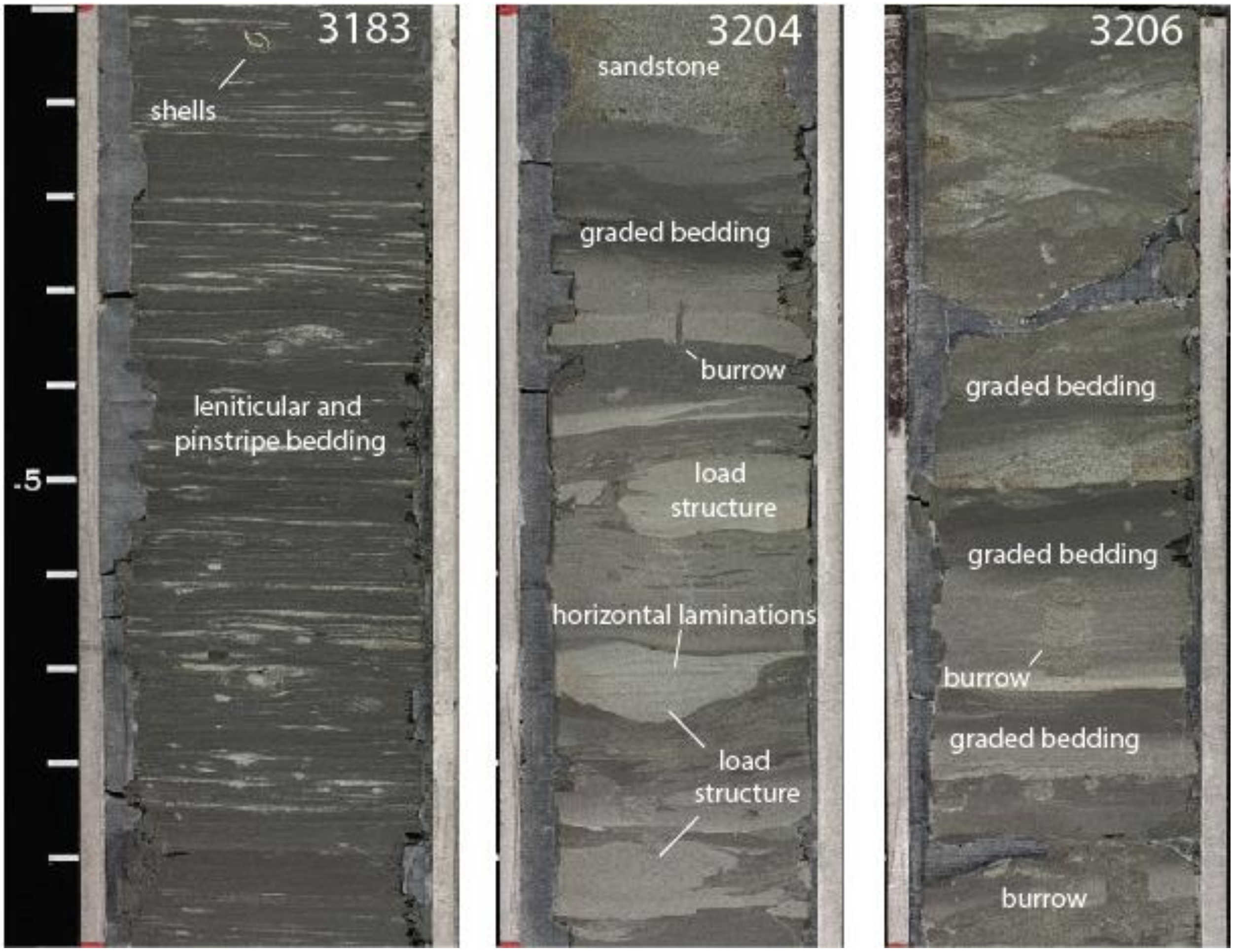

Figure 27. Tuscaloosa Marine Shale Core from MPC 10-4.

D.2. Lower Tuscaloosa

The Lower Tuscaloosa Massive sand marks the top of the injection zone, directly underlying the Tuscaloosa Marine Shale confining zone and is interpreted to have formed in a fluvial to coastal environment [36]. This unit consists of an interval of thickly bedded, very poorly sorted, medium-grained consolidated sandstone while a basal conglomerate forms the lower portion of the Lower Tuscaloosa Massive sand [37]. RCA of the Lower Tuscaloosa Massive sand shows a porosity value of 28.8% [37], while porosity derived from triple combo logs run on the characterization wells yielded porosity values of 30 and 31% [38]. CO_2 storage capacity for the

[36] Mancini et al. (1987). See Section B.1.c., footnote #12.

[37] Pashin et al. (2020). See Section A.1., footnote #1.

[38] Koperna et al. (2020). See Section B.4., footnote #28.

Lower Tuscaloosa Massive sand was calculated at 1.82, 3.45, and 5.92 Mt / mi^2 for estimates of p10, p50, and p90, respectively.

D.3. Upper Washita-Fredericksburg shale

In the upper part of the Washita-Fredericksburg interval, and overlying the Big Fred sand, is a mudstone assemblage that is proposed as one of the secondary confinement intervals for the Paluxy Formation. The interbedded sandstone and mudstone units resemble those of the Paluxy Formation and lower Washita-Fredericksburg interval. Mudstone X-ray diffraction mineralogy of mudstone from well MPC 26-5 in the Washita-Fredericksburg Interval shows 35.3% clay, 63.2% quartz, 1.5% carbonate, with most of the clay being smectite [39]. Correlation of mudstone units in the Washita-Fredericksburg Interval shows that individual mudstone layers have sufficient continuity to contain the migration of injected CO_2 in and around the Kemper energy facility [40]. Several Washita-Fredericksburg Interval sandstone units are known to produce hydrocarbons in Mississippi, demonstrating that relatively thin shale beds within the Washita-Fredericksburg Interval succession can form effective reservoir seals [41] [42]. This red mudstone succession likely represents the abandonment of the fluvial channel facies in the Big Fred sand.

D.4. Big Fred sand

The Big Fred sand makes up the central portion of the Washita-Fredericksburg Interval and consists of a succession of quartzose sandstone, pebble and cobble conglomerate and red and gray mottled mudstone [43]. RCA of the Washita – Fredericksburg Interval sands shows porosity values of 27.4% [39] and 30% [44], while porosity derived from triple combo logs yielded porosity values of 27 and 28% [45]. CO_2 Storage capacity for the Washita-Fredericksburg Interval sands was calculated at 7.53, 14.25, and 24.43 Mt / mi^2 for estimates of p10, p50, and p90, respectively. Grain size decreases upwards in section from conglomeritic sand to fine sand, silt,

[39] Pashin et al. (2020). See Section A.1., footnote #1.

[40] Koperna et al. (2020). See Section B.1.d., footnote #15.

[41] Frascogna, X. M., editor (1957). Mesozoic-Paleozoic producing areas of Mississippi and Alabama: Mississippi Geological Society, v. I, 139 p.

[42] Galicki (1986). See Section B.1.d., footnote #18.

[43] Pashin et al. (2008) See Section B.1.d., footnote #14.

[44] Koperna et al. (2020). See Section B.4., footnote #27.

[45] Kopera et al. (2020). See Section B.4., footnote #28

and mud [46] [43]. The Washita-Fredericksburg Interval is interpreted as fluvial conglomerate and interfluvial redbeds [46] [47].

D.5. Washita-Fredericksburg Basal Shale

The basal shale of the Washita-Fredericksburg Interval contains mudstone with isolated sandy units which act as an overlying seal for CO_2 storage in sands of the Paluxy Formation [48].This gray, silty mudstone has a blocky appearance resulting from inclined fractures, interpreted as blocky peds produced during soil development [49]. The bottom part of the Basal shale contains a network of sandstone-filled cracks, providing evidence for desiccation and sand infiltration through a soil profile. The gray appearance of the infiltrating sand may be a secondary feature resulting from the migration of reducing fluids through the sandstone during its initial burial and diagenesis [48]. This unit is present throughout the east-central Gulf of Mexico Basin, making it a suitable and regionally extensive seal. Renken et al. (1989) [46] and Pashin et al. (2008) [47] suggested that the Washita-Fredericksburg Interval contains fluvial and interfluvial redbeds similar to those in the underlying Paluxy Formation.

D.6. Paluxy Formation

The Paluxy Formation is a succession of sandstone and shale with three major lithofacies: 1) the conglomerate lithofacies, 2) the sandstone lithofacies, and 3) the mudstone lithofacies [48]. The Paluxy Formation sands are composed of thick- to very- thick bedded sandstone packages with regular cross-bedding structures separated by thinner mudstone laminae (**Figure 28 and 29**) [50].The sand is dominantly fine- to medium-grained, while some intraclastic and extraclastic granules and pebbles are locally present along cross-bed foresets [50]. The Paluxy Formation has been interpreted to represent sandy braided fluvial (sandstone and conglomerate) and interfluvial deposits (mudstone) [51].

Sandstone lithologies of the Paluxy Formation are composed of quartz, feldspar, and lithic fragments, and is classified as subarkose and feldspathic litharenite according to the Folk (1980)

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[46] Renken et al. (1989). See Section B.1.d., footnote #16.

[47] Pashin et al. (2008) See Section B.1.d., footnote #14.

[48] Koperna et al. (2020). See Section B.1.d., footnote #15.

[49] Retallack, G. J. (1990). Soils of the Past—An Introduction to Paleopedology: Boston, Unwin– Hyman, 520 p.

[50] Pashin et al. (2020). See Section A.1., footnote #1.

[51] Folaranmi (2015). See Section B.1.d., footnote #17.

classification [52] [53]. Quartz grains are angular to subrounded and slightly elongate to spherical. Quartz content ranges from 65 – 95%, while feldspar and lithic fragments are present in relatively equal proportions in the Paluxy Formation sands. Orthoclase and plagioclase feldspar are both present and commonly partially dissolved or vacuolized and result in secondary porosity. Lithic rock fragments in the Paluxy Formation sand include metamorphic rocks, igneous rocks, and a few grains of oolitic chert. Common accessory minerals include biotite and muscovite, with minor amounts of zircon grains, calcite cement, and kaolinite in pore spaces. Like the Washita-Fredericksburg Interval, the anomalously high-water saturation (100%) in the cores from the clay-rich intervals in the Paluxy Formation was likely due to the shallow burial depths and resulting low thermal maturity and immature clay minerals. The RCA results for the Paluxy Formation sands show an average of 1.8 D permeability and 28% porosity for the MPC 10-4 samples, and porosity derived from triple combo logs run on the three Phase II characterization wells suggests porosity of 27 and 28% in the Paluxy Formation sands [53]. Additionally, Paluxy Formation sand core samples underwent steady-state CO_2/Brine Relative Permeability Measurements at the University of Wyoming and found a porosity and permeability of 30% and 1601 mD, respectively [53]. Scanning electron microscopy of the Paluxy Formation sands thin sections reveal a predominance of quartz, and a porosity of 20 – 25% was determined from BSE images [54]. Other minerals include feldspar, clay (kaolinite, smectite, and illite), and carbonates (calcite, dolomite, and siderite). Clay minerals are present as a coating on other mineral phases or bridges between grains. Cross-sectional slices extracted from 3D X-ray CT images were analyzed and yielded an average porosity of 26% [54]. In reactive transport simulations, the carbonate minerals showed the greatest alterations. Clay and aluminosilicate minerals were altered to a lesser degree. The mineral dissolution resulted in a porosity increase from 25 – 32% [54]. Calcite will dissolve more quickly in regions where brine saturation is higher, while other minerals grains are left mostly unchanged. These reactive phases are anticipated to dissolve along all depths in the Paluxy Formation. Pore network modeling showed an increase in permeability from 1555.4 mD to 8000 mD. Curves fitted to the pressure decay analysis for mudstones in the Paluxy Formation from well MPC 26-5 data yielded permeability values of 34.4 and 23.8 nD for the Hyperbolic and Exponential segment, respectively

[52] Pashin et al. (2020). See Section A.1., footnote #1.

[53] Koperna et al. (2020). See Section B.4., footnote #27.

[54] Beckingham, L., Qin, F., Anjikar, I., & Bensinger, J. (2020). *Evaluation of water-rock-CO2 interactions in the Paluxy formation at the Kemper County Energy Facility (Deliverable 6.3)* (No. DOE-SSEB-0029465-33). Southern States Energy Board, Peachtree Corners, GA (United States).

[55]. Capacity for the Paluxy Formation sands was calculated at 4.28, 8.10, and 13.9 Mt / mi^2 for estimates of p10, p50, and p90, respectively. See **Section A.8.** for how the mineralogy of the Paluxy Formation impacts any geochemical reactions and on the compatibility with the CO_2 stream.

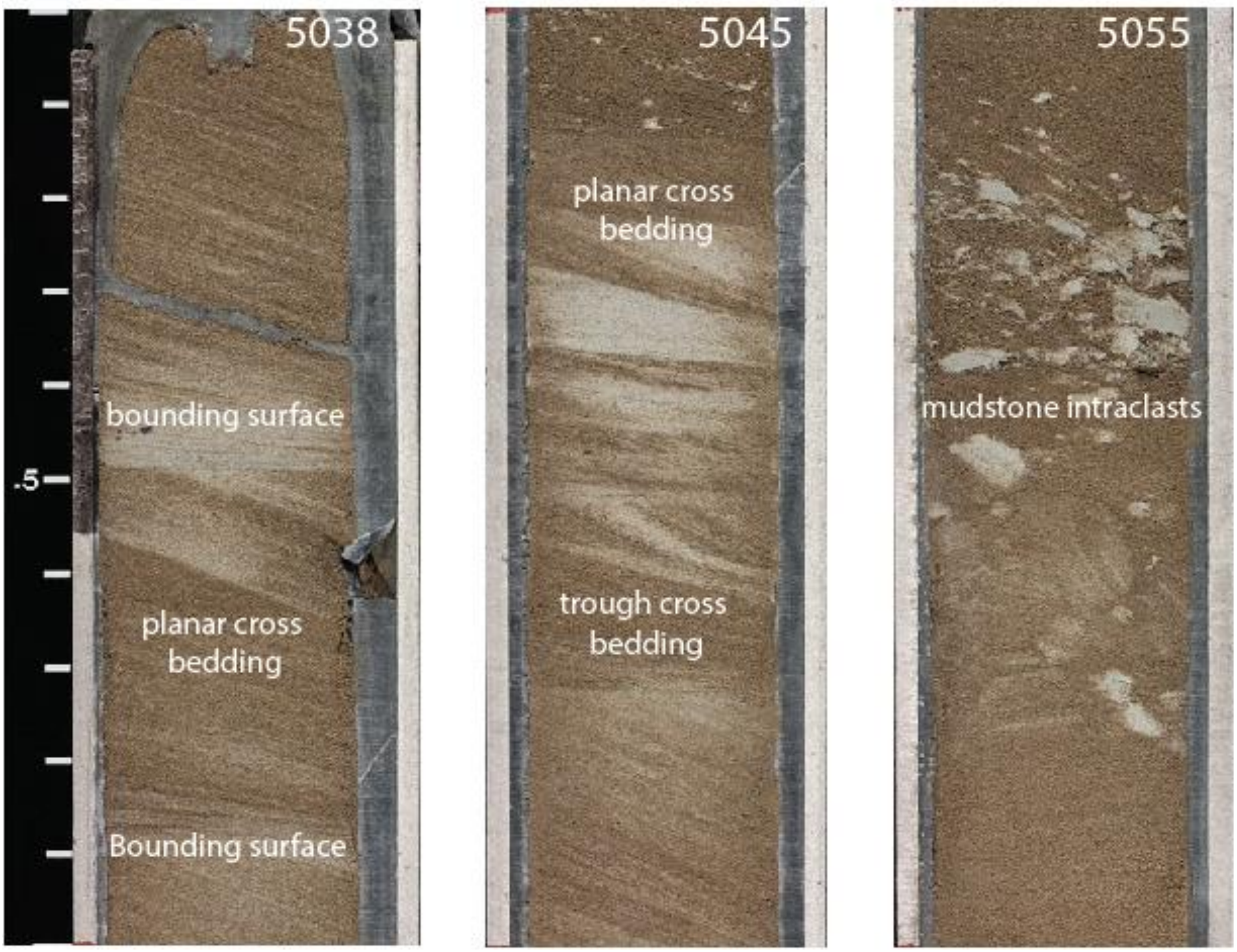

Figure 28. Paluxy Formation Core from Well MPC 10-4.

[55] Pashin et al. (2020). See Section A.1., footnote #1.

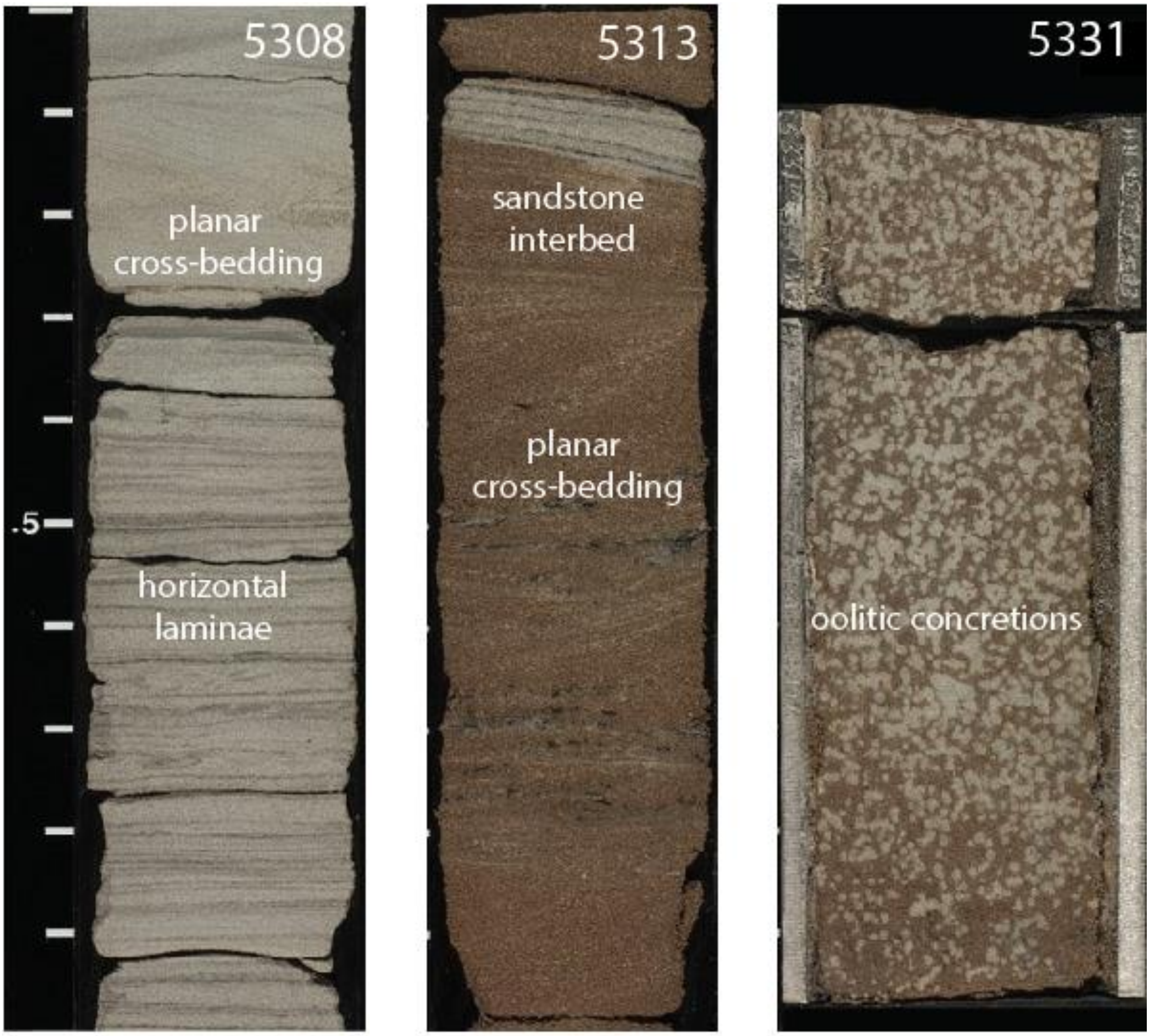

Figure 29. Paluxy Formation Core from Well MPC 34-1.

E. Geomechanical and Petrophysical Information [40 CFR 146.82(a)(3)(iv)]

A One-Dimensional Mechanical Earth Model (1-D MEM) was developed to determine a fracture gradient for geologic formations within the injection zone. The calculated fracture gradient for each formation establishes the maximum allowable injection pressure that prevents fracturing of the reservoir and confining units within the storage zone. The mechanical model was first developed using well MPC 01-1 which contained both geophysical well logs and rock mechanics core test results. Geomechanics tests were conducted on cored intervals of confining unit shale lithologies from the Upper Washita-Fredericksburg shale. Geomechanics test samples were collected from depths that range from 3,857.15 ft to 3,875.45 ft. The data were collected on samples that were cut from whole core using tests that include Multi-Stage Triaxial Compressive Strength, Brazilian Tensile Strength, and Uniaxial Pore Volume Compressibility.

The elastic moduli determined from the core test results are indicated in **Table 5**. The reported Poisson's Ratio were variable while Young's Modulus values are low suggesting that these rocks behave in a ductile rather than brittle fashion. In addition, the Biot Coefficient values are high indicating that these rocks are relatively compliant. The estimated Unconfined Compressive Strength (UCS) ranges from 1,748 psi to 4,331 psi from two samples. The tests indicate variability in the UCS results and overall suggest that the rocks are relatively weak in compression. In addition, the tensile strength of the samples ranges from 23 psi to 150 psi indicating that the shale lithologies are very weak in tension. Although the tested lithologies have lower strength, the elastic moduli and compressive strength test results support that these samples are not brittle and behave in a ductile fashion under stress. Ductile shale lithologies typically provide good seal quality because they inhibit the propagation of fractures due to their ability to self-heal.

Table 5. Elastic Mechanic Properties Determined from the Uniaxial Pore Volume Compressibility Tests.

Depth	Bulk Modulus	Biot Coefficient	Young's Modulus	Poisson's Ratio
3857.15	1.17	0.80	1.01	0.15
3865.65	2.55	0.90	0.89	0.27
3874.80	2.21	0.70	1.27	0.12

After determining the static elastic moduli from core test results, the dynamic elastic moduli were estimated using the dipole sonic and bulk density logs for well MPC 01-1. The dynamic elastic moduli were correlated with core derived static values using correlations for sandstones and shales determined by [56]. The overburden stress gradient was determined to be 0.96 psi/ft using well logs and a pore pressure gradient was determined to be 0.415 – 0.435 psi/ft from well logs and a Modular Formation Dynamic Test (MDT) at well MPC 03-1. In addition, the regional

[56] Morales, R.H. and Marcinew, R.P., 1993, Fracturing of Higher-Permeability Formations: Mechanical Properties Correlations: SPE Annual Technical Conference and Exhibition, Houston, Texas, October 1993, Paper Number SPE 26562-MS.

tectonic stress direction was determined to be a normal faulting regime which was incorporated into the mechanical model. The data were fed into the Poroelastic Horizontal Strain Model which computed the minimum and maximum principal horizontal stresses. The mechanical model for well MPC 01-1 was validated using wellbore breakouts from the caliper log which demonstrated a good correlation. The 1-D MEM was then applied to the rest of the five wells within the AoR that contained geophysical well logs and satisfactorily predicted breakouts which validated the entire model.

The average minimum principal stress for each formation was determined from the mechanical model and represents the pressure required to fracture the formation at depth. The maximum (100%) mean fracture pressure for the Paluxy Formation is 3,384 psi and a mean maximum 100% fracture pressure gradient of 0.65 psi/ft.

F. Seismic History [40 CFR 146.82(a)(3)(v)]

Central Mississippi, and Kemper County in particular, are areas with historically moderately low earthquake risk. Mississippi is part of the Stable Continental Region which comprises most of eastern North America [57]. In this region, most of the earthquakes are low magnitude and occur at irregular intervals. The estimated Peak Ground Acceleration (PGA; expressed as a percentage of the gravity constant, 9.8 m/s^2) for the Kemper County Storage Complex is 6 - 10% g (**Figure 30**), meaning that there is a there is a 2% probability that Kemper County will experience Peak Ground Acceleration of 6% to 10% g due to seismic activity within 50 years. Conversely, there is a 98% probability that PGA of this magnitude would not be achieved within fifty years. Peak Ground Acceleration of 8 to 10% g corresponds to an earthquake intensity of VI to VII on the Modified Mercalli Intensity Scale and magnitude 5 on the Richter Scale [58].

[57] Wheeler, R.L., 2003, Tectonic summaries for web-served earthquake responses, southeastern North America: U.S. Geological Survey Open-File Report 03–343, 27 p.

[58] Bolt, B. (1993). Earthquakes: Revised and Expanded.

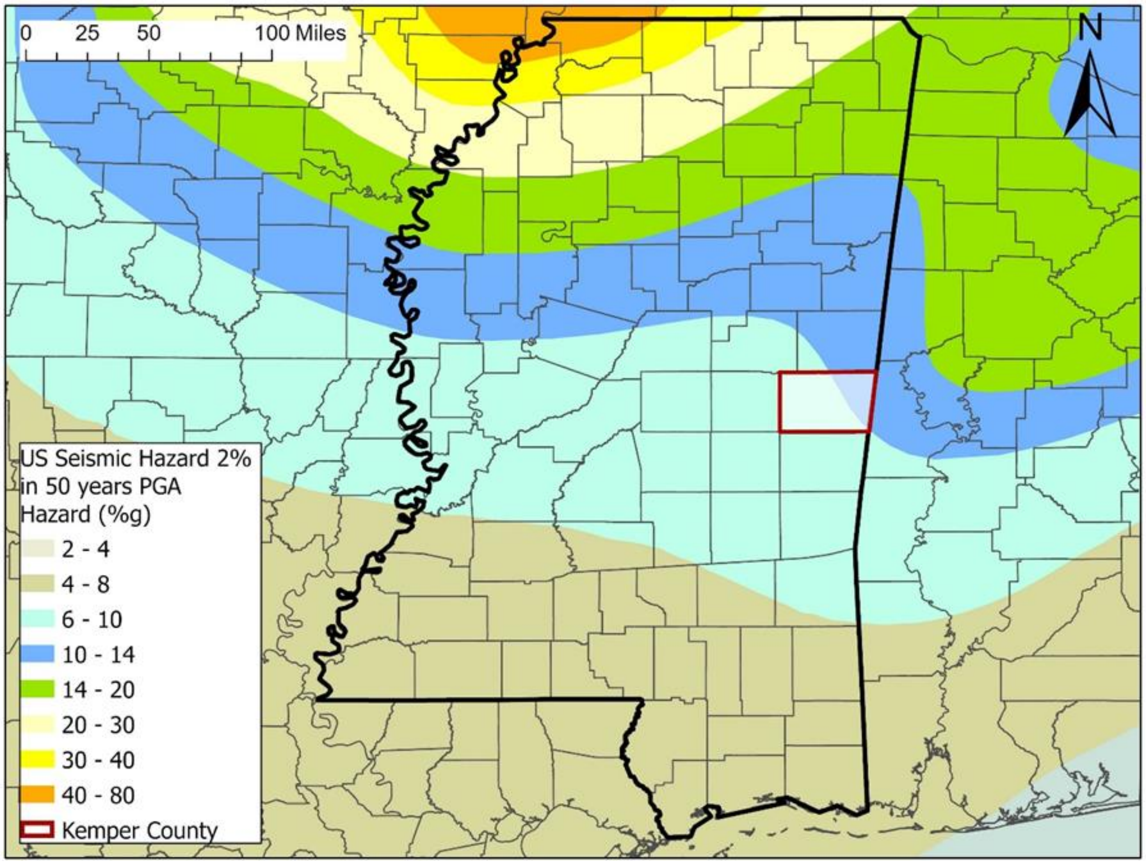

Figure 30. Seismic Hazard Map for Mississippi [59].

The estimated seismic hazard for northern and central Mississippi is elevated due to proximity to the New Madrid seismic zone which encompasses northeastern Arkansas, southwestern Kentucky, southeastern Missouri, and northwestern Tennessee. The southern end of the New Madrid seismic zone is about 40 miles from the northwest corner of Mississippi and approximately 185 miles from the proposed Kemper County Storage Complex. Paleoseismic studies have concluded that during the past 1,200 years, the New Madrid seismic zone has generated earthquakes of magnitude 7 to 8 approximately every 500 years. The New Madrid seismic zone generated a sequence of earthquakes in the winter of 1811 and 1812, which lasted for several months and included three earthquakes of estimated magnitude between 7 and 8 [60]. The current seismic hazard map for Mississippi implies that it would take a reactivation of the New

[59] Petersen, M., Moschetti, M., Powers, P., Mueller, C., Haller, K., Frankel, A., Zeng, Y., Rezaeian, S., Harmsen, S., Boyd, O., Field, N., Chen, R., Rukstales, K., Luco, N., Wheeler, R., Williams, R., and Olsen, A. (2014). Documentation for the 2014 Update of the United States National Seismic Hazard Maps. USGS Open File Report 2014-1091.

[60] Chung, J., Okok, A., & Rogers, J. D. (2021). Geologic impacts and calculated magnitudes of historic earthquakes in the central United States. *Engineering Geology*, *280*, 105923.

Madrid seismic zone of similar magnitude and intensity as the 1811-1812 earthquakes to generate the estimated PGA of 8 to 10 %g in Kemper County.

Figure 31 shows the occurrence of earthquakes throughout Mississippi since 1927. Approximately sixty recorded seismic events in Mississippi since 1927 and only half of which were able to be felt at the surface with the remainder only detectable via instrumentation [61]. The strongest earthquake in Mississippi occurred in 1931 in the Charleston area of Tallahatchie County in northwest Mississippi approximately 120 miles northwest of the proposed Kemper County Storage Complex. The estimated magnitude was 4.7 on the Richter scale and the maximum intensity of VI – VII on the Modified Mercalli Intensity scale (which describes the effects of shaking on the ground and structures) was felt at Charleston [62].

Four earthquakes of low magnitude have been recorded in the vicinity of the proposed Kemper County Storage Complex. In Kemper County, only one earthquake has been recorded near the Mississippi – Alabama state boundary. Three earthquakes were recorded in northern Lauderdale in 2002 and 2012 near the Kemper County line. Details of the four earthquakes are provided in **Table 6**. A larger collection of low magnitude earthquakes were recorded further to the south in Clarke County, MS. These earthquakes may be explained by their proximity to the Gulf Margin Normal Fault Area, which contains normal faults that accommodate extension associated with the massive sediment load deposited on the southern margin of North America [63]. However, there are no observed faults in the Mesozoic-Cenozoic section at the Kemper County Storage Complex [64]. Therefore, no failure of reservoir rock or fault reactivation is expected to occur. Earthquakes in Alabama counties that border Mississippi are shown in **Figure 32**. **Table 7** indicates earthquakes that occurred in Sumner County, Alabama which borders Kemper County, Mississippi.

[61] MDEQ, 2021. Fact Sheet 1: Earthquake Epicenters. Mississippi Department of Environmental Quality.

[62] Bograd, M.B.E (2017). *Earthquakes* in *The Mississippi Encyclopedia,* University Press of Mississippi and online, https://mississippiencyclopedia.org/entries/earthquakes/, Accessed March 2, 2021Bolt, B. A., 1993, Earthquakes, W.H. Freeman, N.Y., 331 pp.

[63] Dart, R. L., & Bograd, M. B. (2011). *Earthquakes in Mississippi and vicinity 1811-2010* (No. 2011-1117, pp. 1-1). US Geological Survey.

[64] Koster, J., & Hills, D. (2018). *Seismic Reflection Interpretation in Support of Project ECO2S, Kemper County, MS (Poster)* (No. DOE-SSEB-0029465-17). Southern States Energy Board, Peachtree Corners, GA (United States).

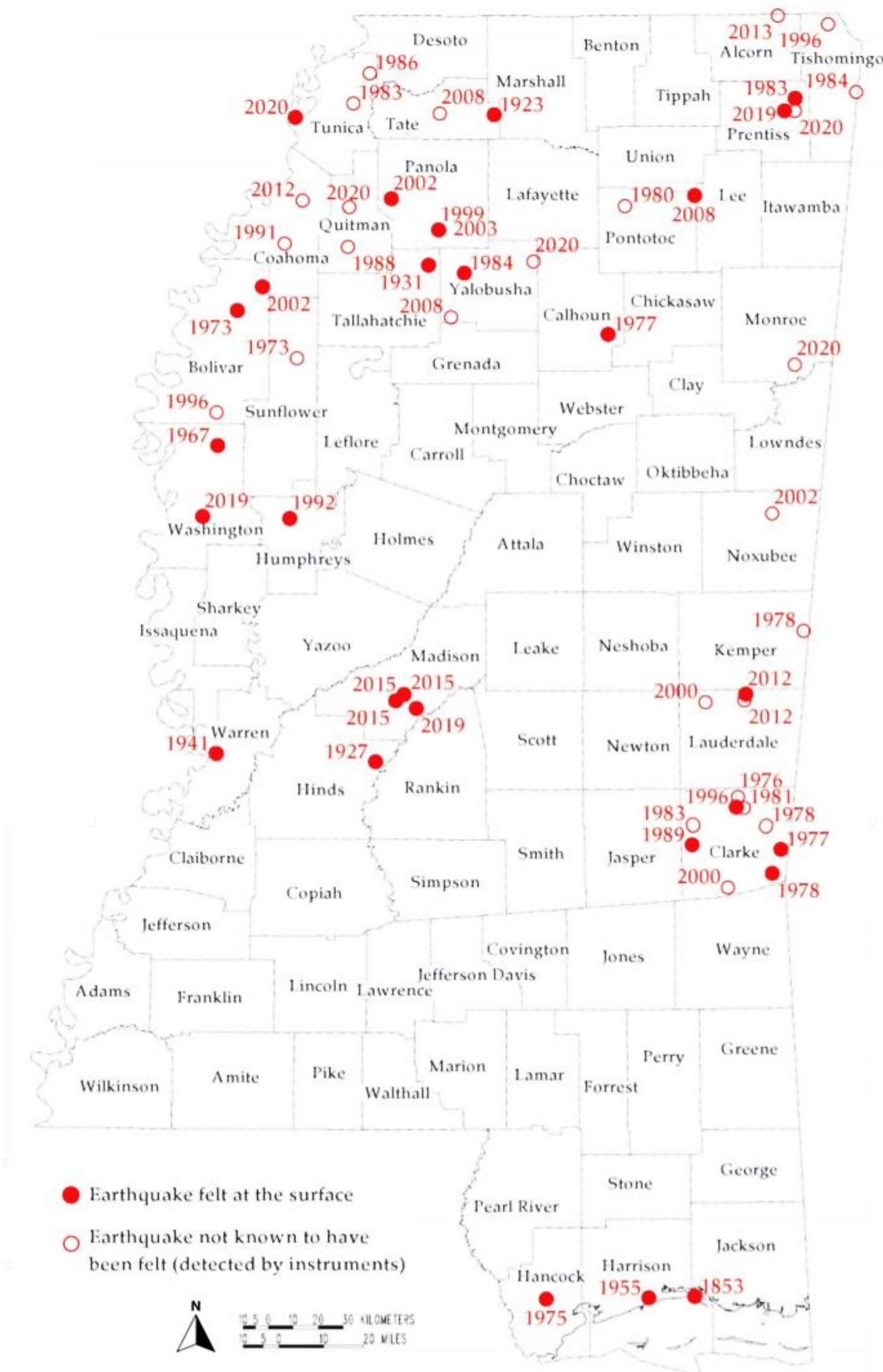

Figure 31. Earthquake Epicenters in Mississippi.

Table 6. Historical Earthquakes Recorded in Kemper County and Vicinity.

Date of Occurrence	Location	Magnitude	Felt at Ground Surface?
January 8, 1978	Kemper County- Alabama Border	3.0	Not Felt
October 10, 2000	Northwest Lauderdale County	2.3	Not Felt
July 27, 2012	Lauderdale County – Meridian Station	2.1	Felt at Surface
July 29, 2012	Lauderdale County – Meridian Station	1.6	Not Felt

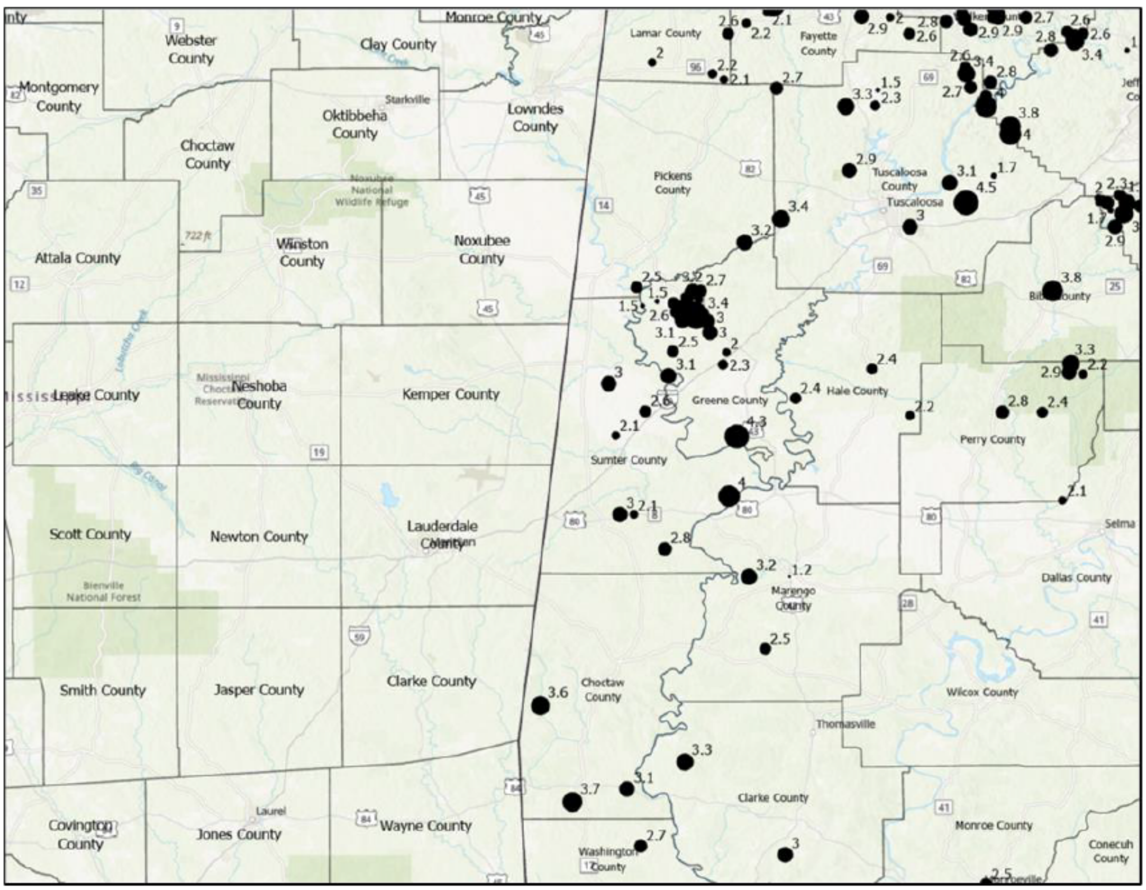

Figure 32. Earthquakes that have Occurred within the Alabama Counties that Border the State of Mississippi.

Table 7. Earthquakes in Sumnter County, Alabama which Borders Kemper County, Mississippi.

Eq_Name	Magnitude (mw)	Depth	Z_Units	Lat	Long	County	Year
1978_Jan_08_SumterCo	3.0	5	km	32.7800	-88.2500	Sumter	1978
1998_May_07_Demopolis	2.8	10	km	32.3700	-88.1100	Sumter	1998
2002_May_21_York	3.0	27.4	km	32.4560	-88.2210	Sumter	2002
2006_Mar_11_Livingston	2.6	30.7	km	32.7120	-88.1590	Sumter	2006
2009_Jul_17_York	2.1	32	km	32.4550	-88.1870	Sumter	2009
2017_Aug_24_Livingston	2.1	0.0	km	32.6520	-88.2320	Sumter	2017

G. Hydrologic and Hydrogeologic Information [40 CFR 146.82(a)(3)(vi), 146.82(a)(5)]

The major aquifers in the central part of Mississippi are part of the southeastern Coastal Plain aquifer system, which developed within the Mississippi Embayment through the Cretaceous – Tertiary periods. The principal aquifers in central Mississippi strike mainly northwest to southeast and dip to the south-southwest, like the target injection zone of the Kemper County Storage Complex. The aquifers consist mostly of clastic sediment including gravel, sand, clay, chalk, and marl deposited by a cyclic rise and fall of sea levels [65].

The eastern central Mississippi aquifer systems described below in descending order are the Wilcox, Eutaw-McShan, Tuscaloosa aquifer system, and the Lower Cretaceous aquifer (**Table 8**). The Eutaw-McShan aquifer is considered a single aquifer, while the Tuscaloosa aquifer system is generally sub-divided and consists of the Gordo and Coker aquifers.

[65] Strom, E. W. (1998). Hydrogeology and simulation of ground-water flow in the Cretaceous-Paleozoic aquifer system in northeastern Mississippi (Vol. 98, No. 4171). US Department of the Interior, US Geological Survey.

Table 8. Geologic Units and Principal Aquifers in Central Mississippi [66].

SYSTEM	SERIES	GROUP	FORMATION	PRINCIPAL AQUIFER	AQUIFER SYSTEM
TERTIARY	EOCENE	WILCOX GROUP	NANAFALIA FORMATION	MIDDLE/LOWER WILCOX AQUIFER SYSTEM	LOWER WILCOX AQUIFER
	PALEOCENE	MIDWAY GROUP	NAHEOLA FORMATION		
			PORTERS CREEK CLAY	AQUITARD	
CRETACEOUS	UPPER	SELMA GROUP	UNDIFFERENTIATED	AQUITARD	
		EUTAW GROUP	EUTAW FORMATION	EUTAW-MCSHAN AQUIFER	
			MCSHAN FORMATION		
		TUSCALOOSA GROUP	GORDO FORMATION	GORDO AQUIFER	TUSCALOOSA AQUIFER SYSTEM
			COKER FORMATION	COKER AQUIFER	
			TUSCALOOSA MARINE SHALE	AQUITARD (PRIMARY CONFINING ZONE)	
			MASSIVE SAND	MASSIVE SAND AQUIFER (SALINE RESERVOIR)	

The Wilcox aquifer is 350 feet thick in Kemper County but is up to 1,000 feet in western Mississippi. The Wilcox crops out in eastern Kemper County and dips towards the axis of the Mississippi embayment. The principal source of recharge is from the outcrop, and groundwater movement is westerly and southwesterly [67]. Groundwater is generally a mixed calcium and sodium bicarbonate salt, with concentrations less than 1,000 mg/L extending up to 70 miles from the outcrop area [67]. Each of the shallow groundwater wells around the Kemper County Storage Complex produces from the Middle or Lower Wilcox (**Figure 33**) for domestic water use and small-scale agriculture.

[66] Pashin et al. (2008) See Section B.1.d., footnote #14.

[67] Taylor, R. E., & Arthur, J. K. (1992). Hydrogeology of the middle Wilcox aquifer system in Mississippi.

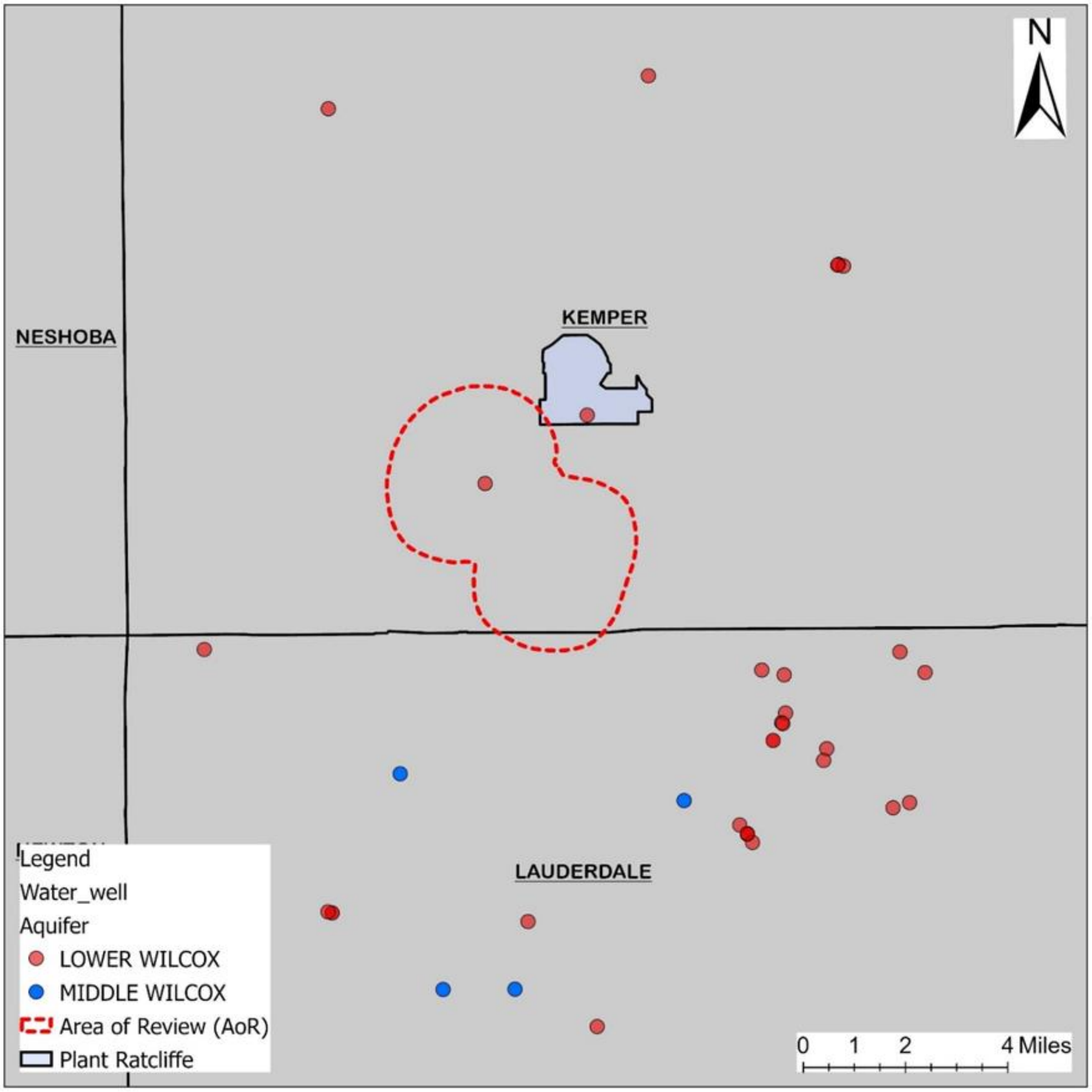

Figure 33. Shallow Groundwater Wells around the Kemper County Storage Complex.

The Porters Creek clay and Selma Chalk together form an aquitard over 1,500 ft thick in Kemper County that isolates the Tertiary Wilcox aquifer from the underlying Cretaceous Eutaw-McShan aquifers. The Porters Creek Clay is a shale interval in the Paleocene Midway group that forms a coarsening-upwards sequence that have been interpreted as regionally extensive marine shelf deposits, being traceable across the Gulf Coast Basin [68]. The Porters Creek Clay consists of thick, massive carbonaceous clay, about 500 – 600 ft thick in Kemper County. In the Mississippi Interior Salt Basin, the Porters Creek Clay acts as a confining unit that retains oil in fractured chalk

[68] Mancini et al. (1996). See Section B.1.c., footnote #11.

reservoirs [69]. The top of the Cretaceous section is capped by the Selma Chalk, which forms an extensive regional seal for oil and gas accumulations from the Eutaw Formation [70] [71] [72]. The Selma is a ~900 ft succession of chalk and marl which represents a regionally extensive muddy carbonate ramp which bordered the Cretaceous sea in the Gulf of Mexico region [73].

The Eutaw-McShan aquifer consists of the hydrologically connected Eutaw and McShan strata. The aquifer crops out in northeastern Mississippi and northwestern Alabama and dips at about 35 to 40 feet per mile towards the axis of the Mississippi embayment in northern areas, and southwestward in southern areas. It is separated from the Wilcox aquifer by the Porters Creek Clay (Midway) Group and the Selma Chalk. Near the Kemper County Storage Complex, the Eutaw Formation is 400 – 550 ft thick and at depths of 1500 – 3000 ft. The Eutaw Formation marks the deepest USDW in Kemper County, with TDS concentrations of 1610 mg/L.

Recharge to the Eutaw-McShan aquifer occurs principally from precipitation but some recharge likely originates as vertical leakage from overlying and underlying aquifers [74] [75]. Discharge occurs to hydrologic lows at the outcrop, to the underlying Gordo Formation, and to wells completed in the aquifer. TDS concentrations increase downdip, exceeding 10,000 mg/L in central Mississippi. Separating the Eutaw-McShan from the underlying Gordo Formation is a clay / silt confining layer that is relatively thin but can locally exceed 175 ft of thickness [76]. This confining unit isolates the two aquifers, although the Eutaw-McShan may be recharged by the Gordo Formation in parts of the down-dip area [76].

The Gordo, Coker, and the Lower Tuscaloosa Massive sand aquifers of the Tuscaloosa Group and the underlying Lower Cretaceous aquifer constitute the regional Tuscaloosa Aquifer system. While the term “Aquifer System” is commonly used to describe the Tuscaloosa, the sand-

[69] Pashin, J. C. (2000). Revitalizing Gilbertown oil field: characterization of fractured chalk and glauconitic sandstone reservoirs in an extensional fault system (Vol. 168). Geological Survey of Alabama.

[70] Frascogna (1957). See Section B.4.c., footnote #42.

[71] Davis & Lambert (1963). See Section B.4.c., footnote #43.

[72] Galicki (1986). See Section B.1.d., footnote #18.

[73] Mancini et al. (1996). See Section B.1.c., footnote #11.

[74] Mallory (1993). See Section B.1.a, footnote #3.

[75] Strom, E. W., & Mallory, M. J. (1995). *Hydrogeology and simulation of ground-water flow in the Eutaw-McShan Aquifer and in the Tuscaloosa aquifer system in northeastern Mississippi* (Vol. 94, No. 4223). US Department of the Interior, US Geological Survey.

[76] Strom (1998). See Section B.7., footnote # 67.

rich aquifer zones are typically confined by relatively impermeable clay horizons that limit vertical communication between the individual aquifers, creating individual aquifers within the system.

The Gordo Formation crops out in the northeastern portion of the State and dips at 35 to 40 feet per mile towards the axis of the Mississippi embayment (westerly to southwesterly). At 350 feet, the thickest part of the aquifer lies in downdip areas to the southwest, thinning to a feather edge in up-dip outcrop areas along the Mississippi-Alabama state line. The Gordo Formation is recharged through precipitation at the outcrop and from the Coker and Eutaw-McShan aquifers. Discharge from the Gordo Formation also occurs to the Coker and Eutaw-McShan aquifers and to wells drilled in the formation [76]. Regional groundwater movement is westerly and southwesterly but has been modified locally near Tupelo and Columbus due to large withdrawals [77]. TDS concentrations increase downdip, with the limit of freshwater (10,000 mg/L) placed in the southern half of Kemper County [76].

The Coker aquifer underlies the Gordo Formation and crops out in the northwestern portion of Alabama. The aquifer dips at 35 to 40 feet per mile towards the southwest. Total sand thickness ranges from 1 foot at the outcrop to about 350 feet in the downdip portions. The Coker is recharged primarily by precipitation on outcrop areas, but leakage between the adjoining Gordo and Lower Tuscaloosa Massive sand Formations may also provide recharge and discharge pathways to and from the aquifer. TDS concentrations increase downdip, exceeding 10,000 mg/L in the southwest corner of Kemper County [78].

The Lower Tuscaloosa Massive sand aquifer underlies and is considered part of the Coker in updip areas, however, confining clay of up to 200 feet in thickness exists in western, downdip portions of the aquifer area, hydraulically isolating the two zones [78]. The Lower Tuscaloosa Massive sand dips at 35 to 40 feet per mile towards the southwest. The aquifer ranges in thickness from its feather edge in eastern, updip regions to more than 350 feet in downdip portions of the Lower Tuscaloosa Massive sand. The aquifer does not crop out at the surface and is recharged only through the overlying, hydrologically connected portions of the Coker aquifer. Discharge occurs to the underlying and overlying strata, and to wells completed in the aquifer. TDS concentrations increase downdip, exceeding 10,000 mg/L near Plant Ratcliffe.

[77] Darden, D. (1984). *Potentiometric map of the Gordo Aquifer in northeastern Mississippi, November and December, 1982* (No. 83-4254).

[78] Strom (1998). See Section B.7., footnote # 67.

The Lower Cretaceous aquifer beneath the Lower Tuscaloosa Massive sand does not crop out in Mississippi. To the north and northeast of Plant Ratcliffe, the aquifer pinches out against Paleozoic rock. To the west, southwest, and south, in the downdip direction, the aquifer contains water with increasing TDS concentrations [78]. The aquifer dips about 35 to 40 feet per mile toward the west and southwest [78]. Well data indicates that total sand thickness within the study area ranges from about 1 foot where it pinches out against Paleozoic rocks in the northeast, to more than 1,000 feet [78], with the sand generally thickening downdip. The Lower Cretaceous aquifer receives recharge from the Lower Tuscaloosa Massive sand aquifer in the up-dip area. The Lower Cretaceous aquifer is confined from the overlying Lower Tuscaloosa Massive sand aquifer by clay and silt.

Within the AoR, groundwater is only utilized from the Wilcox aquifer. A total of 54 groundwater wells are listed within this area and are completed in either the Middle Wilcox or the Lower Wilcox aquifer. Maximum well depth is 480 feet below ground level and none of these wells penetrate the Porters Creek Clay (Midway). The top of the Porters Creek Clay is located more than 4,100 feet above the Paluxy Formation injection interval.

H. Geochemistry [40 CFR 146.82(a)(6)]

H.1. Paluxy Formation Mineralogy (Solid-Phase Geochemistry – Injection Interval)

The mineralogy of the Paluxy Formation was investigated using Petrographic Microscopy and Scanning Electron Microscopy on thin sections cut from whole core in addition to X-Ray Diffractometry of powdered samples. The dominant framework grain composition comprises monocrystalline quartz with the polycrystalline quartz being the second most abundant. Quartz content in the Paluxy Formation ranges from 65 - 95%. Potassium feldspars (e.g., Albite) constitute the next most abundant framework grain and ranges in concentration from 2 - 16%. Potassium feldspars are typically partially dissolved and clay coats on grains reveal remnant feldspars grains that have partially or completely altered to clays.

Lithic fragments have a similar abundance to potassium feldspar and include metamorphic rock fragments such as schist, quartzite, and chert with some igneous rock fragments. Accessory minerals include muscovite, biotite, and siderite. In addition, the Paluxy Formation contains minor amounts of calcite cement and pore-filling matrix clays such as smectite/illite and kaolinite. Paluxy Formation sandstones predominantly plot as subarkose using the Folk (1980) Diagram [79] [80].

Continuum Scale Reactive Transport Modeling was conducted to simulate the geochemical reactions that would occur during CO_2 injection in the Paluxy Formation based on the injection interval mineralogy [81]. The geochemical evolution of the Paluxy Formation sandstones was simulated over a short-term period (170 hours) and a long-term period (7,300 days, or 20 years). Modelling results indicate an initial increase in porosity from 25 to 33% primarily due to calcite dissolution over the short-term period, and a subsequent decrease in porosity to 31% due to quartz reprecipitation over the 20-year long-term period.

Calcite occurs within the Paluxy Formation almost entirely as a pore-space filling cement and does not represent a major or minor framework grain constituent or structural mineralogical component of the injection reservoir. Thus, calcite cement dissolution as a result of CO_2 injection would dissolve pore-space filling cement, thereby increasing porosity. Calcite does not represent a major or minor framework grain, therefore settling of the formation matrix is not expected to occur. On a long timescale (20 years), geochemical simulations indicate the precipitation of quartz due to the super-saturation of aqueous SiO_2 which is expected to form chalcedony, a polymorph of quartz, as the likely precipitating phase. Geochemical simulations suggest that the precipitation of both quartz and calcite will reduce the initial porosity increase from 33 to 31% (a 2% porosity reduction). The modelling results indicate that the mineralogy of the injection zone is compatible with CO_2 and injection will slightly increase reservoir porosity due to minor calcite cement dissolution.

H.2. Tuscaloosa Marine Shale (Solid-Phase Geochemistry – Confining Zone)

XRD analysis and SEM imaging was conducted on samples of the Tuscaloosa Marine Shale to identify the mudstone mineralogy of the primary confining zone [82]. XRD analyses of core samples identified quartz silt and clay (kaolinite, illite, smectite) as the primary mineralogical compositions that make up the mudstone. The range in mineral abundances for the Tuscaloosa Marine Shale include quartz (26 - 60.9%), kaolinite (9.4 - 36%), smectite (0 – 33%), illite/mica (1 - 21.1%), mixed illite/smectite (10.4 – 12.5%), potassium feldspar (1 – 7%), chlorite (0.5 – 2.7%),

[79] Folk (1980). See Section B.4.f., footnote #54.

[80] Pashin et al. (2020). See Section A.1., footnote #1.

[81] Beckingham et al. (2020). See Section B.1.f., footnote #57.

[82] Pashin et al. (2020). See Section A.1., footnote #1.

calcite (0 – 2%), plagioclase (0 – 2%), pyrite (0 – 2%), and anatase (0.6 – 0.9%). Overall, the low abundance of reactive mineralogy (e.g., calcite) indicates that the confining zone is compatible with the CO_2 injectate.

H.3. Pore-fluid Chemistry of the Injection Zone and Shallow USDWs

Fluid sampling analyses establish the geochemistry of pore-fluids by reporting the total dissolved solids (TDS) in addition to measuring the concentration of cations and anions present in the formation brines. Formation pore-fluids were sampled using Core Laboratories™ Positive Displacement Bottom Hole Sampling (PDBHS) Tool from each reservoir within the injection zone at wells, Water Well No. 1, MPC 34-1, and MPC 10-4 (**Figure 8**). In addition, a fluid sample of lowest most USDW was collected from the Eutaw Formation at the Kemper County USDW Characterization Well. Eutaw Formation sample fluids were recovered from the characterization well by airlift pumping through a screened interval of well pipe at the formation depth.

The results of water quality analyses conducted on seven fluid samples recovered from the injection zone and lowest most USDW are indicated in **Table 9**. Within the injection zone, fluid sampling results confirm that saline brines saturate each geologic formation, and the formations are well above the 10,000 mg/L USDW cutoff. Geochemical results show that the pore-fluid brines range in TDS from 18,604 mg/L in the shallowest portion of the injection zone (3,360 ft) to 107,196 mg/L in the deepest portion of the injection zone (5,183 ft). The Eutaw Formation has been identified as the deepest USDW over the project AOR. Sample analysis through this zone has confirmed this with a TDS concentration of 1,610 mg/L.

Table 9. Geochemical Water Quality Results Determined from Fluid Samples Taken by the Positive Displacement Bottom Hole Sample Tool from Four Different Characterization Wells in Kemper County, Mississippi.

Formation	Sample ID	Well Name	Sample Depth (ft.)	Formation Pressure (psi)	Formation Temperature (°F)	TDS (mg/L)	pH
Eutaw	680-204221-1	Kemper County USDW Characterization Well	2,190 - 2,210	Not Reported	Not Reported	1,610	8.70
Lower Tuscaloosa Group	201801592-01	Water Well No. 1	3,360	1,400	100	18,791	7.32
Lower Tuscaloosa Group	201801592-02	Water Well No. 1	3,360	1,400	100	18,604	6.77
Washita-Fredericksburg Interval	201801231-05	MPC 34-1	4,470	1,750	125	80,587	6.14
Washita-Fredericksburg Interval	201801231-06	MPC 34-1	4,470	1,750	125	81,779	4.75
Paluxy	201901859-01	MPC 10-4	5,183	2,180	128	107,196	5.50
Paluxy	201901859-01-01	MPC 10-4	5,183	2,180	128	106,848	5.48

I. Other Information (Including Surface Air and/or Soil Gas Data, if Applicable)

No additional information applicable.

J. Site Suitability [40 CFR 146.83]

The Mesozoic-Cenozoic section around Plant Ratcliffe in Kemper County, MS contains a 1.7-km succession of saline reservoir and sealing strata composing a CO_2 Storage Complex with exceptional reservoir properties and complex depositional architecture. The Injection zone is a ~2000 ft interval located in the Cretaceous section of Kemper County, from the top of the Lower Tuscaloosa Massive sand through to the base of the Paluxy Formation. The Tuscaloosa Marine Shale is the primary confining zone that directly overlies the injection zone and acts as a regional confining unit throughout the Gulf of Mexico Basin that is capable of preventing vertical migration of CO_2 out of the injection zone. The Tuscaloosa Marine Shale is a low-porosity (2 - 4%) low permeability (< 1 mD) unit composed of interbedded dark-gray shale, siltstone, and sandstone that modelling has shown will retain a CO_2 column height of 100m before any intrusion. The Lower Tuscaloosa Massive sand is a saline storage zone that directly underlies the Tuscaloosa Marine Shale and is composed of sandstone and conglomerate. The Washita-Fredericksburg Interval contains interbedded sandstone and mudstone and is divided into two mudstone-dominated confinement intervals (the Upper and Basal Washita-Fredericksburg shales), and one sandstone-dominated saline storage zone (the Big Fred sand) that is situated in the middle of the Washita-Fredericksburg Interval. The prospective injection interval is in the sands of the Cretaceous-aged Paluxy Formation. Paluxy Formation sandstone porosity ranges from 26 – 33% and the permeability was measured at 1.8 D. The storage capacity of the injection interval is estimated at 4.28, 8.10, and 13.90 Mt/mi^2 for storage efficiency factors of 7.4, 14, and 24%, respectively. An injected CO_2 stream will be confined to the Paluxy Formation sands, and the overlying confinement intervals and primary confining zone prevent the vertical migration of the plume into the overlying USDWs within the Eutaw Formation and above. The low abundance of reactive minerals (e.g., calcite) in the primary confining zone and injection interval demonstrate that these zones are compatible with the CO_2 injectate. The lack of faults, wells that penetrate the injection formation, and intensive seismic activity in Kemper County make the presence of secondary pathways for CO_2 plume migration highly unlikely. The Selma Chalk and Porters Creek Clay of the Upper Cretaceous and Tertiary sections act as aquitards to prevent plume migration into the overlying Nanafalia and Naheola Formation aquifers. The regional continuity of the confinement intervals and lack of faults in the Cretaceous section of Kemper County demonstrates that CO_2 plume migration will be confined to the injection zone.