Permit Application Narrative
for
Roulette Oil & Gas Co, LLC
Clara #20 Well
37-105-21374-00-00
Clara Twp, Potter County, PA

Prepared by
Cary P. Kuminecz PG (NY & PA)
StratResources Geologic Consulting, PLLC

8/9/2022

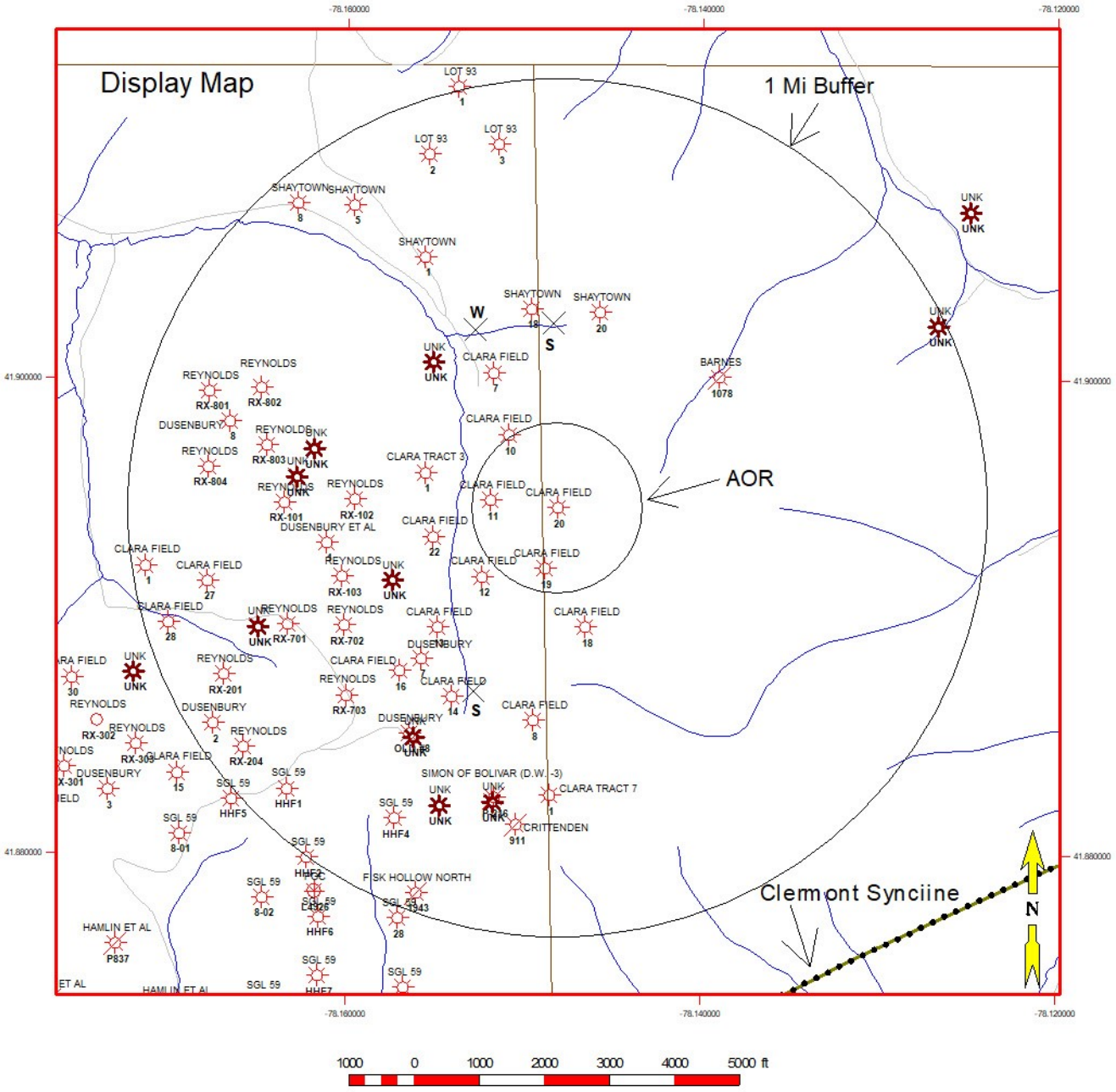
Project Description: Roulette Oil & Gas Co., LLC (ROGC) requests approval for a permit from the Pennsylvania Department of Environmental Protection (PADEP) to convert a production well, the Clara #20 (API No. 37-105-21374-00-00) to a Class II-D Underground Injection Control well. The Environmental Protection Agency (EPA) awarded an Underground Injection Control (UIC) permit to ROGC, effective January 14, 2022 (Permit PAS2D050BPOT). Produced formation brine water will be injected into the Cooper 5-0, Sheffield 3-1 and Kane 3-0 sandstone reservoirs. The brine intended for disposal comes from approximately 60 shallow conventional oil and gas wells on the lease and another approximately 50 shallow conventional oil and gas wells on ROGC operated leases in the general area.

Well Location: The Clara Field #20 well is located in Clara Township of Potter County, Pennsylvania within the Potato-Oswago Creeks watershed within the larger Ohio River watershed. The map coordinates for the well are 41.894586 latitude and –78.148143 longitude. The Clara Field #20 is a vertical well with a total depth of 2,310 feet and located within the USGS Shinglehouse 7.5 Minute Quadrangle Map. The nearest municipality to the well is Millport, located approximately 2.5 miles northeast of the well location. The display map for this location is shown in Figure 1.

Roulette Oil & Gas Co., LLC (ROGC) used a fixed radius method of one-quarter mile for determining the Area of Review (AOR). No streams, water wells, or springs exist within the AOR. There are no hazardous waste facilities within the AOR, but within the AOR are found three gas wells, including the Clara Field #20, the proposed Class II-D well. Also found are proposed monitor wells Clara Field #11 (37-105-21136-00-00) and Clara Field #19. (37-05-21359).

Geologic Setting: The Clara #20 well (is located within the Deep Valleys Section of the Appalachian Plateaus Physiographic Province, which was formed by fluvial erosion and periglacial mass wasting (Sevon, W.D., 2018)). The Deep Valleys Section is characterized by deep, angular valleys of moderate to high relief. The bedrock on which the well sits is at the approximate boundary of the Mississippian-Devonian Huntley Mountain Formation (MDhm) composed primarily of gray, fine-grained sandstones and siltstones with minor amounts of red mudstones and the underlying Mississippian-Devonian Shenango-Owayo Formation (MDso), composed of gray shales and siltstones along with yellowish-gray, fine-grained sandstones (retrieved from https://www.gis.dcnr.state.pa.us/pageode/).

The Clara Field #20 well begins at the surface in undifferentiated Mississippian-Upper Devonian rocks and reaches a total depth of 2,310’ (Driller TD) in Upper Devonian Elk Group strata. A portion of the Pennsylvania DCNR’s stratigraphic, schematic cross-section illustrates the gross stratigraphy of this area of the Appalachian basin (Figure 2).



Well Symbols

Well Status

- A GAS
- A OIL
- D&A
- D&A_G
- GAS
- LOC

w
X Water Well

s
X Spring

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
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GEOLOGIST
PG002142-G

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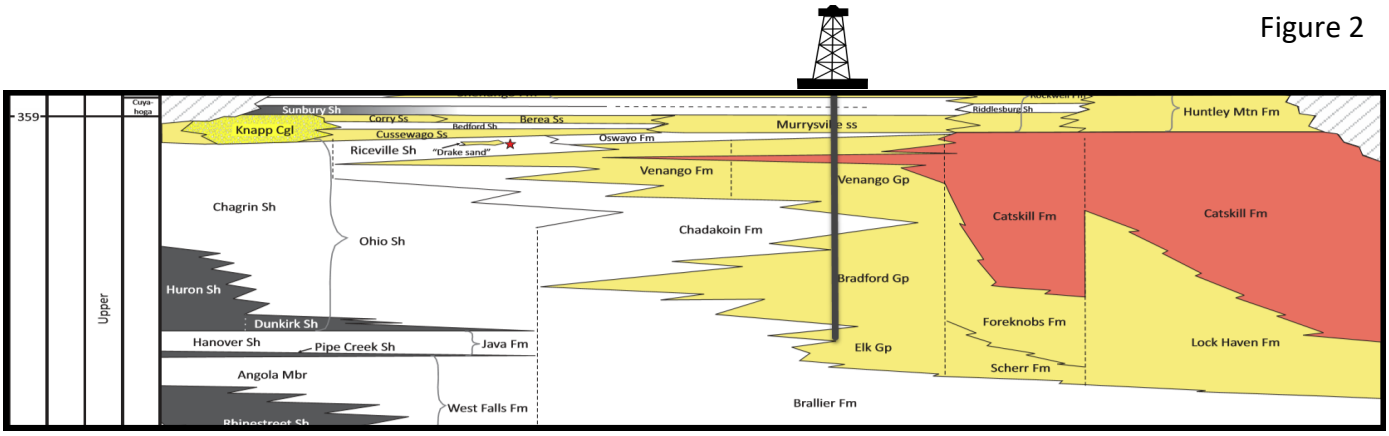
Clara 20 Conversion to Class II-D UIC Well
AOR & 1 Mile Buffer
Clara Twp
Potter County, PA

Author:		Date:
C.P. Kuminecz		August 9, 2022

Figure 1

Approximate location of the Clara Field #20

Figure 2



One problem in identifying and tracing reservoir trends from area to area is the existence of multiple names for the same reservoir given by industry operators and geologists over the years. Because of this, subsurface Upper Devonian formation names are informal in Pennsylvania and nomenclature for the same reservoirs varies from area to area and from operator to operator. This UIC Class II-D application, its well logs, cross-sections and maps will apply the Bradford Group nomenclature used by StratResources Geologic Consulting, PLLC (SRGC) as listed in the stratigraphic nomenclature table below (Table 1), along with approximate industry equivalents. Most of these zones, also known as sequences and sequence sets, were penetrated by the Clara Field #20 wellbore. Correlations were made by tying-in to SRGC's own regional cross-section grid. The proposed injection zones for the Clara #20, from youngest to oldest, are the Cooper 5-0 (CPR5-0), Sheffield 3-1 (SHF3-1), and Kane 3-0 (KANE3-0) and are highlighted in Table 1.

Stratigraphy: The Bradford Group in this area of the northern Appalachian basin is characterized by repeating intervals of relatively tight sandstones and grey shale. Depositional environments range from down slope turbidites to near shore deltas, beaches, bars, stream channels, and incised valleys with estuaries and their associated environments. The repeated sand-shale intervals were formed from constantly shifting shorelines due to repeated changes in relative sealevel during the Upper Devonian. Most of the preserved reservoirs and their overlying marine shales were deposited during sealevel lowstands and during early sealevel transgressions. Reservoir quality varies considerably in these sandstones. Fifty (50) zones, or vertical sequences, within the Bradford Group were deposited between falls in relative sealevel. These have been identified and correlated across portions of northern Pennsylvania.

West	Bradford Group NY &PA Oil Region Names		East
Approximate Industry Terms	***SRGC Sequence Terms***	***SRGC Sequence Set***	***Approximate Industry Terms***
Base of Pink Rock, Warren 1st	WRRN1-0	Warren	Base of Pink Rock, Warren 1st
Warren 2nd	WRRN2-0		Warren 2nd
	WRRN3-0		
	WRRN4-0		
	WRRN5-0		
	WRRN6-0		
	WRRN6-1		
	WRRN6-2		
	WRRN6-3		
Queen, Glade	WRRN7-0		Speechley Stray, Bradford 1st
	SPCH1-0	Speechley	
	SPCH2-0		Bradford 1st, Glade
Clarendon, Balltown	SPCH3-0		Bradford 1st
	SPCH4-0		Watsonville
	SPCH5-0		Watsonville, Kinzua
	SPCH6-0		Clarendon
	SPCH7-0		Dewdrop
Cherry Grove, Tiona	TION1-0	Tiona	Cherry Grove
	TION2-0		Chipmunk
	TION3-0		
	TION4-0		
	TION5-0		
Cooper	CPR1-0	Cooper	Chipmunk Bradford 2nd, Cooper, Penny
	CPR2-0		
	CPR3-0		
	CPR4-0		
	CPR5-0		
Klondike	SHF1-0	Sheffield	Bradford 2nd Harrisburg Run, Deerlick, Richburg
	SHF2-0		
	SHF3-0		
	SHF3-1		
	SHF4-0		
Not usually present or penetrated	BDFD1-0	Bradford	
	BDFD2-0		
	BDFD3-0		Bradford 3rd Richburg
	KANE1-0	Kane	
	KANE2-0		
	KANE2-1		
	KANE3-0		
	KANE4-0		
	KANE5-0		Lewis Run, W&P
	ELK1-0	Elk	Waugh & Porter, Kane, Haskill
	ELK2-0		
	ELK3-0		
	ELK3-1		
	ELK4-0		
	ELK5-0		
	ESTR1-0	Elk Stray	Sartwell
	ESTR2-0		
	ESTR3-0		Haskill
	HSKL1-0	Haskill (Elk Group)	

Note: *Locally, additional industry terms may be used. Also, industry terms shown in this chart have approximate top and bottom boundaries. The actual stratigraphic boundaries of industry terms and their equivalence with SRGC terminology will vary with operators and location.*

Denotes Injection Zones

Table 1

Geologic Structure within the 1 mile Buffer: The AOR and one-mile buffer around the Clara #20 well are situated in a flank position to the Smethport Anticline and Clermont Syncline. The axis of the Clermont Syncline is located approximately 1,500 feet southeast of the one-mile buffer and 8,300 feet southeast of the Clara #20 well. The axis of the Smethport Anticline , at the Onondaga Limestone level, is located approximately 10,500 feet northwest of the 1 mile Buffer (or 17,300 feet northwest of the Clara #20 well) according to Faill (2011). However, a structure contour map on a thin shale (known to StratResources as the T-12 Structure Marker) located at the top of the Speechley sandstone interval shows that at this level of the shallow Upper Devonian the axis of the Smethport Anticline has migrated to a position approximately 1,500 feet northwest of the one-mile buffer. The Clermont Syncline shows no such shifting in this area above the Onondaga Limestone (See Figure 3). Therefore, the only geologic structural elements that affect the Upper Devonian Bradford Group within the one-mile buffer are the flank areas of these two folds. The structural and stratigraphic geologic cross-sections also highlight these zones in Figures 4 and 5, respectively. These cross-sections can be expanded to see the detail. Tabletop-sized paper copies are available in the hard copy Appendix of this application. Digital versions are found within the digital application.

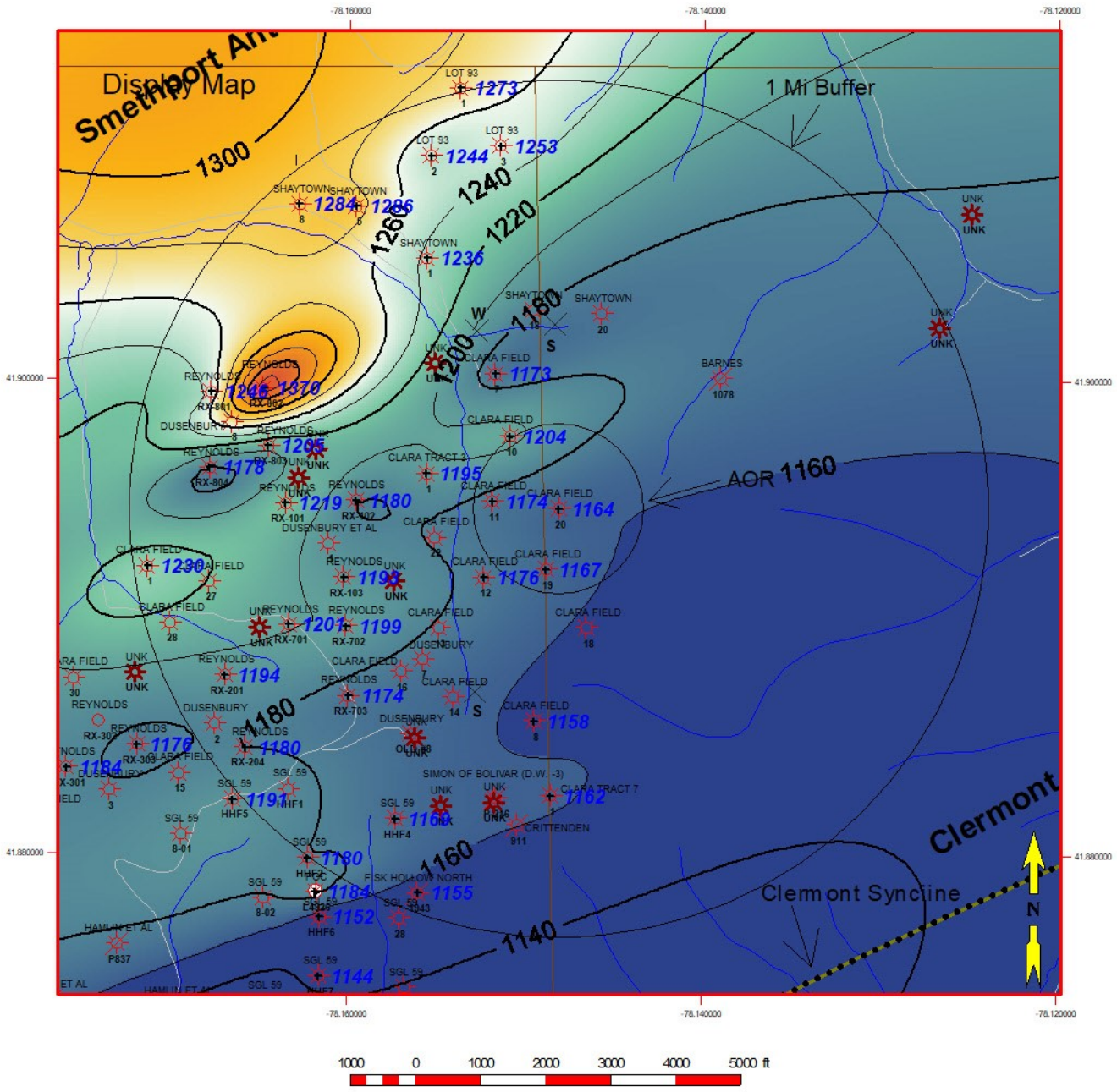
The nearest inferred fault to the Clara Field #20 well, trends SW to NE and is located approximately 12,000' southeast of the Clara Field #20 well (Faill, 2011), but this inferred fault is associated with much deeper Cambrian and Lower Ordovician Rocks (Wagner, 1976).

Estimated Depths to Deeper Horizons (Salina Group and Basement): The top of the Salina Group is estimated to be at a depth of 6,788 feet below the ground elevation at the Clara #20 well. Since the Clara #20 reached a total depth of 2,310 feet, then the top of the Salina Group is located 4,478 feet below the total depth of the Clara #20. The Potter Development Co. Matteson #122 well, located on the Hebron Anticline 3.2 miles southeast of the Clara #20, was used to make this estimate. The top of the Salina Group in the Matteson #122 is at 5,303 feet. The well reached a total depth of 5,561 feet in Salina salt.

The depth to the top of the crystalline basement from the surface elevation of the Clara Field #20 well is approximately 3,600 meters or 11,811 feet (TVD) below sealevel, which is 14,116 feet below the ground level elevation of 2,305 feet based on the PA-DCNR Open File Report (Gold et al, 2004). Therefore, the distance from the total depth of the Clara #20 well (2,310 feet) to the basement is approximately 14,116 feet minus 2,310 feet for a calculated distance of 11,806 feet.

Deepest Fresh Water Zone and Top Injection Zone: The deepest USDW zone reported by the driller of the Clara #20 was at 340' with a fresh water flow of 0.5". Surface casing was set and cemented at 501' or 161' deeper than the fresh water zone. Cement returns were noted at the surface and confirmed by calculation. There is no available chemical analysis of the water from this USDW zone and it is now behind pipe, though nearby formation waters were chemically analyzed and provided to the EPA as a part of their application process. Section D of this application contains that analysis.

There are three proposed injection zones in this well. They are the sandstone reservoirs within the Cooper 5-0 (CPR5-0) sequence penetrated from 1486' - 1502'; the Sheffield 3-1 (SHF3-1) sequence penetrated from 1594' - 1617'; and the Kane 3-0 (KANE3-0) sequence, penetrated from 1823-1833.' The top of the uppermost injection zone (Cooper 5-0) occurs at 1,486 feet measured depth. Therefore, the thickness of the interval from the USDW to the topmost injection zone is 1,146 feet.



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W
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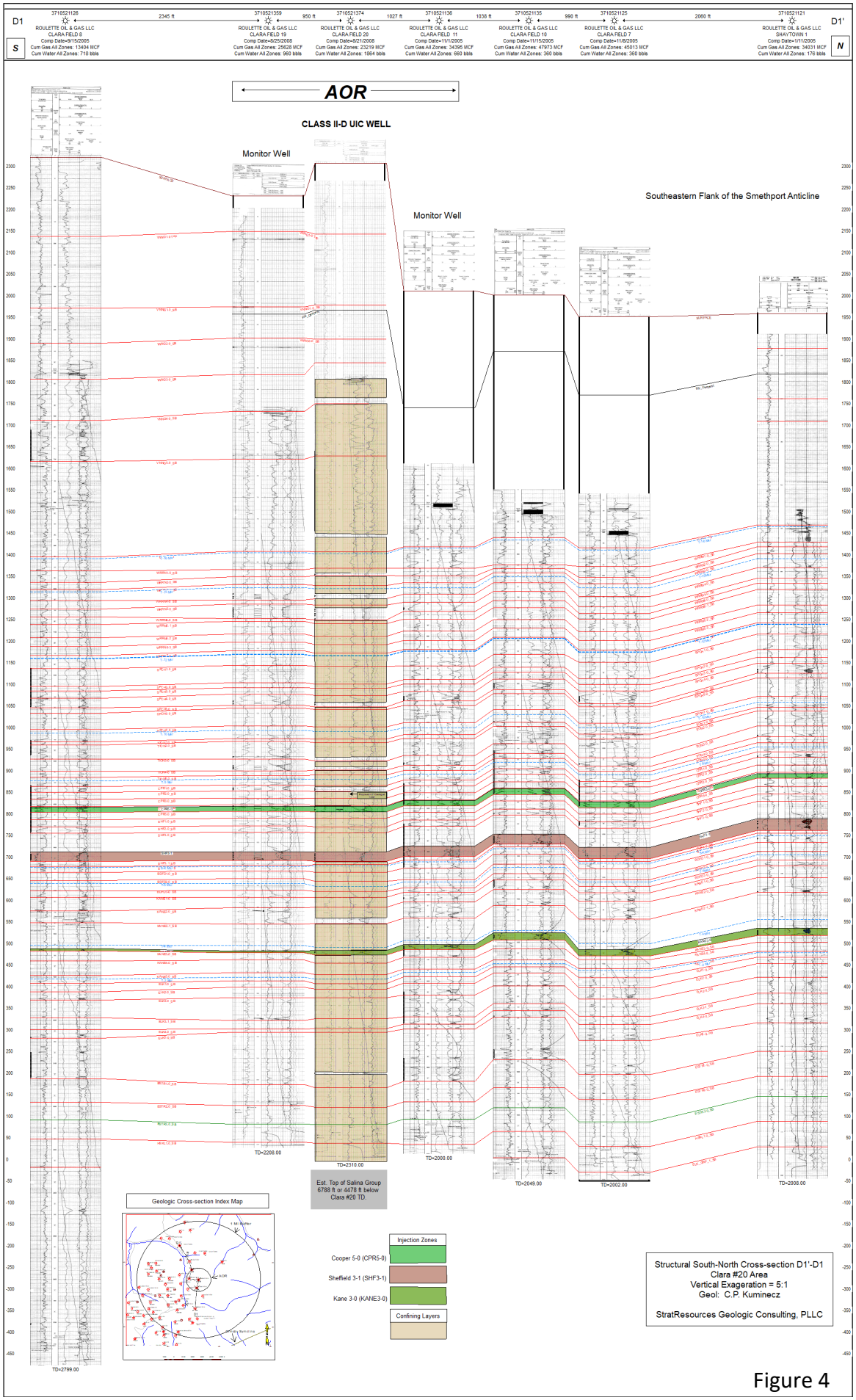
Clara 20 Conversion to Class II-D UIC Well
T-12 Marker Structure Contour Map
Clara Twp
Potter County, PA

Author:	C.I. = 20'	Date:
C.P. Kuminecz		August 9, 2022

Figure 3


D1
D1'
S
N
3710521126
ROULETTE OIL & GAS LLC
CLARA FIELD 8
Comp Date=9/15/2005
Cum Gas All Zones: 13404 MCF
Cum Water All Zones: 718 bbls
2345 ft
3710521359
ROULETTE OIL & GAS LLC
CLARA FIELD 19
Comp Date=8/25/2006
Cum Gas All Zones: 25626 MCF
Cum Water All Zones: 960 bbls
950 ft
3710521374
ROULETTE OIL & GAS LLC
CLARA FIELD 20
Comp Date=8/21/2006
Cum Gas All Zones: 23219 MCF
Cum Water All Zones: 1864 bbls
1027 ft
3710521136
ROULETTE OIL & GAS LLC
CLARA FIELD 11
Comp Date=11/1/2005
Cum Gas All Zones: 34395 MCF
Cum Water All Zones: 660 bbls
1038 ft
3710521135
ROULETTE OIL & GAS LLC
CLARA FIELD 10
Comp Date=11/15/2005
Cum Gas All Zones: 47973 MCF
Cum Water All Zones: 360 bbls
990 ft
3710521125
ROULETTE OIL & GAS LLC
CLARA FIELD 7
Comp Date=11/8/2005
Cum Gas All Zones: 45013 MCF
Cum Water All Zones: 360 bbls
2060 ft
3710521121
ROULETTE OIL & GAS LLC
SHAYTOWN 1
Comp Date=1/11/2005
Cum Gas All Zones: 34031 MCF
Cum Water All Zones: 176 bbls
AOR
CLASS II-D UIC WELL
Monitor Well
Monitor Well
Southeastern Flank of the Smethport Anticline
TD=2799.00
TD=2208.00
TD=2310.00
TD=2000.00
TD=2049.00
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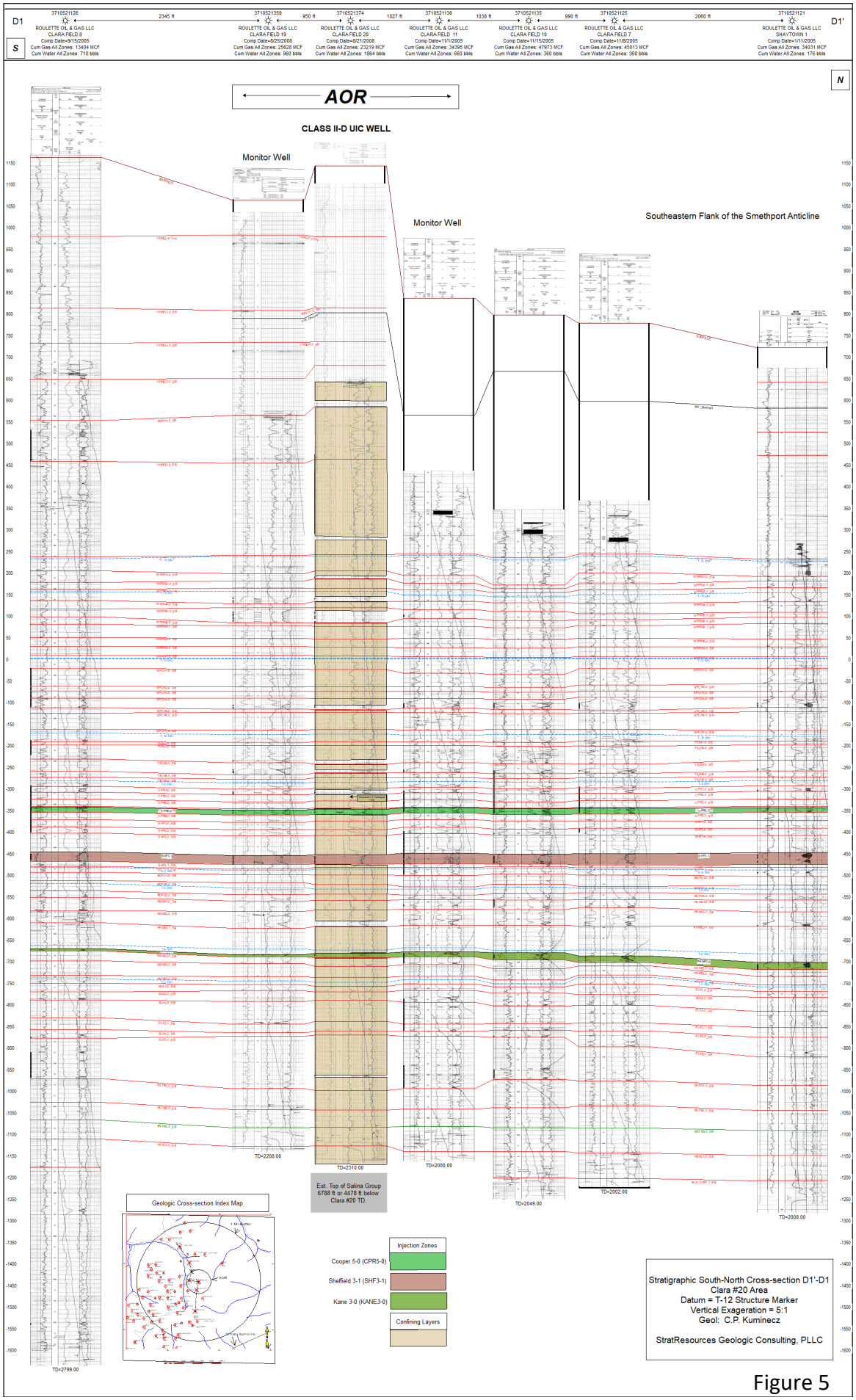
Geologic Cross-section Index Map
Injection Zones
Cooper 5-0 (CPR5-0)
Sheffield 3-1 (SHF3-1)
Kane 3-0 (KANE3-0)
Confining Layers
Structural South-North Cross-section D1'-D1
Clara #20 Area
Vertical Exageration = 5:1
Geol: C.P. Kuminecz
StratResources Geologic Consulting, PLLC

Figure 4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Confining Layers
Stratigraphic South-North Cross-section D1'-D1
Clara #20 Area
Datum = T-12 Structure Marker
Vertical Exageration = 5:1
Geol: C.P. Kuminecz
StratResources Geologic Consulting, PLLC

Figure 5

Potential for Induced Seismicity: The potential for induced seismicity due to formation brine injection into this well is deemed extremely low. Induced seismicity can occur during injection of high volumes of water under high pressure during hydraulic fracturing operations and/or water disposal. The volumes of water planned for injection in the Clara #20 are small (5-500 BWPD with an expected average of 20 BWPD) and a maximum injection pressure less than 974 psi (see the EPA Application (Section D) for the determination of these values). There has been no measureable seismic activity recorded in Potter County, based on the map of Pennsylvania Earthquake Epicenters (Faill, 2004; Nyblade & Homman, 2017). The most significant induced seismic event in Pennsylvania related to the oil & gas industry was correlated to fluids introduced into fractures by Hilcorp Energy Company while fracking a pair of Utica Shale wells in Lawrence County in 2016. It was determined there was a good correlation between the fracking operations and the seismic activity which never exceeded a magnitude of 2.3 on the Richter Scale. These wells were fractured at depths only 2,500-3,000 feet above the crystalline basement (Waechter, 2021), whereas the Clara #20 has already been fractured without any measureable seismic activity reported and the distance from the total depth of the Clara #20 well to the crystalline basement is estimated to be 11,806 feet, which makes movement of shallow, low pressure, injected formation fluids downward through the Salina Group and to the fractured crystalline basement below, *extremely* unlikely.

Injection & Confining Zone Depths: The confining zone for the three proposed injection zones are interspersed and overlain by numerous unnamed shale beds (defined as intervals with Gamma Ray values greater than 140 API units) and tight sandstone/siltstone beds with bulk density values greater than 2.52 g/cc occurring within the Bradford and Venango Groups. These confining intervals having a total thickness of 985 feet between the depths of 1446' and base of the surface casing at 501'. Several individual shale beds within this interval are more than 20' thick.

Additional confining intervals between the top of the uppermost injection zone between 1,502 feet and 1,833 feet ***within*** the injection interval also exist. Finally, the lower confining zone is within the shales below 1,833 feet to the well's total depth of 2,310 feet. Only one thin sand stringer with porosity, from 2,106 to 2,109 feet, is found in the lower confining zone. The remaining beds are shale. Table 2 summarizes the confining zone intervals. The confining intervals in the Clara #20 are highlighted in tan color on the geologic cross-sections (Figures 4 and 5).

Zone	Purpose	Top (MD)	Base (MD)	Thickness (ft)
Upper Confining Zone (Mainly Tight SH & SS)-to be behind cemented 4.5" casing at 1460'. 1460-1486'	Confining	501'	1486'	985
CPR5-0 Sandstone	Injection	1486'	1502'	16
SHF3-1 Sandstone	Injection	1594'	1617'	23
KANE3-0 Sandstone	Injection	1823'	1833'	10
Lower Confining Zone	Confining	1833'	2310'	477

Table 2

References Cited:

Faill, 2004. *Earthquake catalog and epicenter map of Pennsylvania*, Pennsylvania Geological Survey, 4th sur., Map 69.

Faill, 2011. *Folds Map of Pennsylvania.* PA Geological Survey, 4th sur., Open File Report OFGG, 11-01.0.

Gold et al, 2004. *Basement depth and related geospatial database for Pennsylvania*. PA Geological Survey, 4th sur., Open File Report, OFGG 0.5.01.0.

Nyblade & Homman, 2017. *Seismicity in Pennsylvania and the Pennsylvania State Seismic Network* (PASEIS), PA DCNR, presentation to the Geophysical Society of Pittsburgh.

Sevon, W.D., 2018. Physiographic provinces of Pennsylvania, Map 13, PA DCNR, 2p.

Wachter, D., 2017 (updated 2021), "DEP moves to prevent more fracking-induced quakes". *New Castle News*, retrieved from https://www.sharonherald.com/news/local_news/dep-moves-to-prevent-more-fracking-induced-quakes/article_15e4ad3c-d17a-5e1c-8f21-2292f2d8b8f0.html.

Wagner, 1976. *Growth faults in Cambrian and lower Ordovician rocks of western Pennsylvania*. AAPG Bulletin, v60, 3, pp.414-427.