ILLINOIS EPA INVESTIGATION OF THE THERMOGENIC NATURAL GAS RELEASE INTO THE MAHOMET AQUIFER FROM THE MANLOVE NATURAL GAS STORAGE FIELD

MAHOMET AQUIFER TASK FORCE

JUNE 18, 2018

Rick Cobb, P.G., Deputy Division Manager,
Division of Public Water Suppies

BACKGROUND

- McCord #2 ("MC2"), was injecting natural gas into the Manlove Natural Gas Storage Field at a depth of 4,000 feet below land surface into the Mt. Simon Aquifer into the Mahomet Dome structure
- A release was reported to have occurred December 19, 2016
- Bubbling was observed at the land surface near MC2

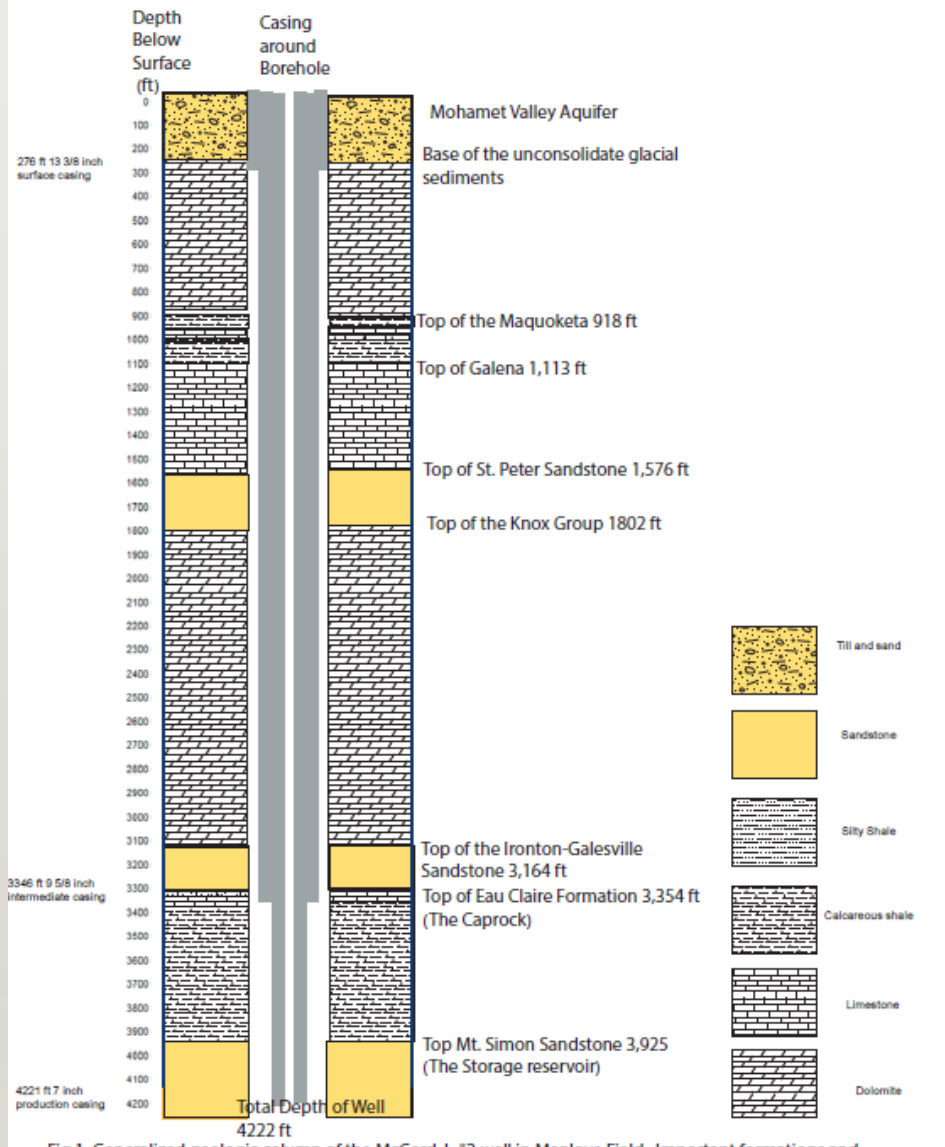
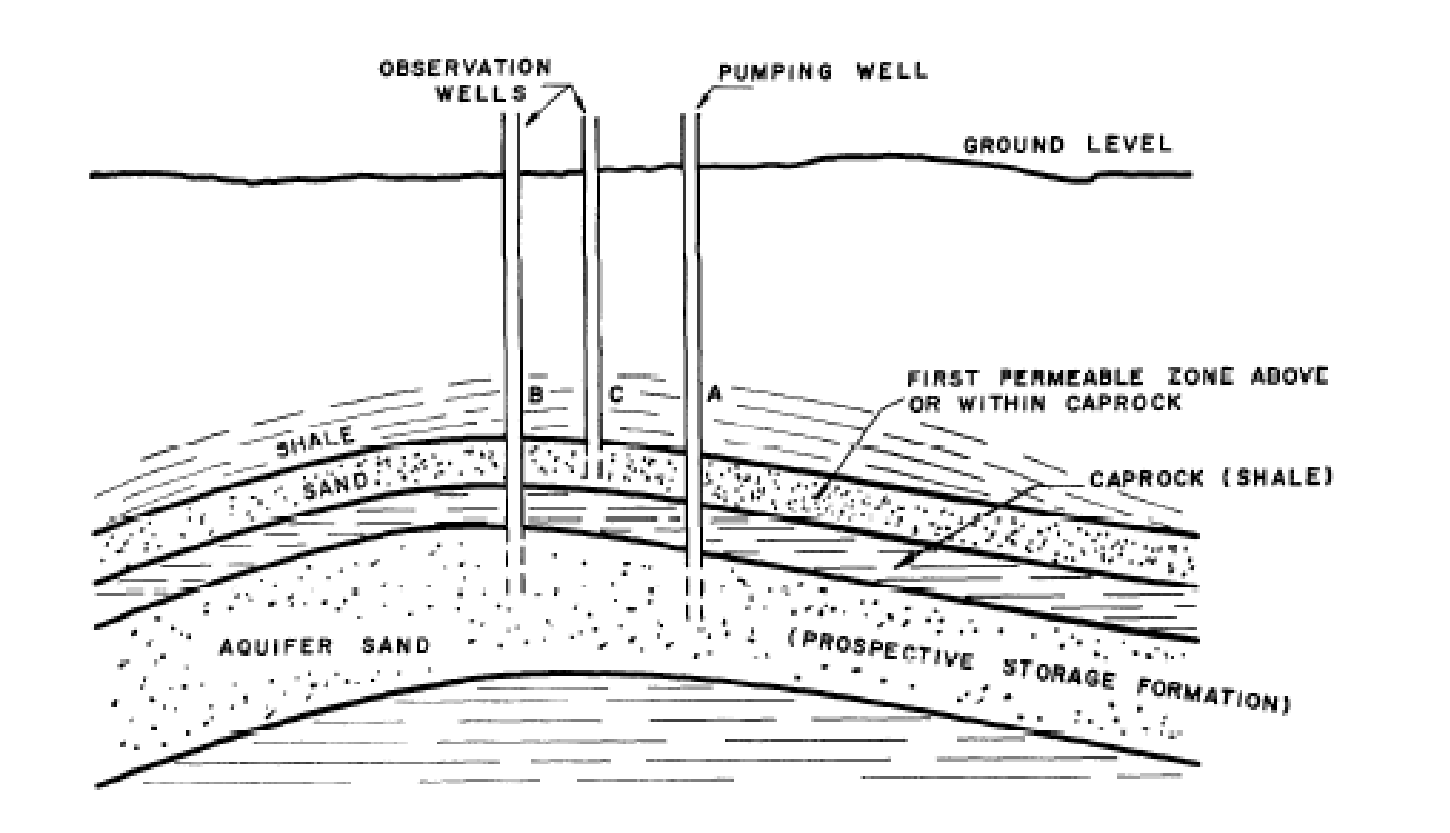
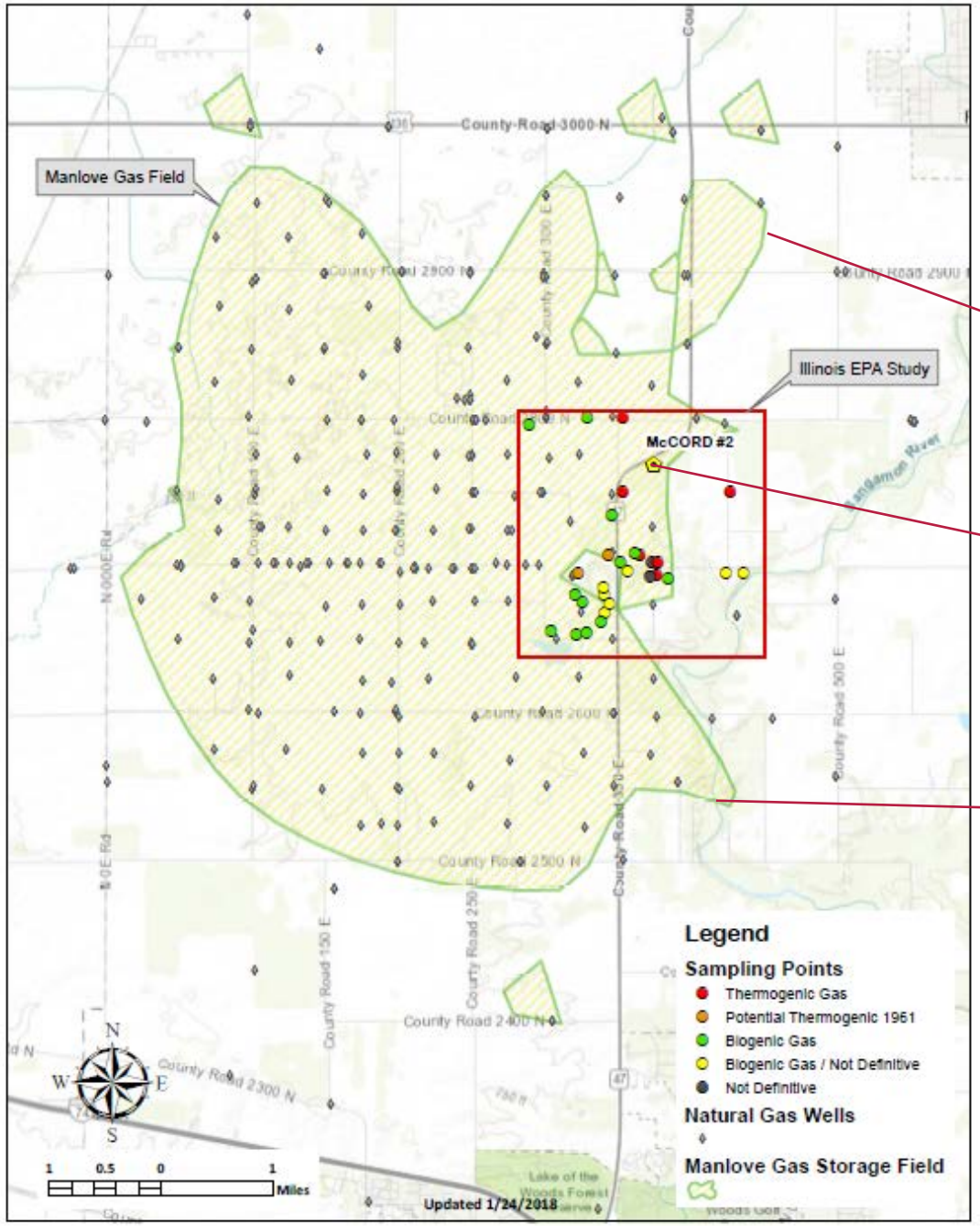


Fig 1. Generalized geologic column of the McCord, L #2 well in Manlove Field. Important formations and casing are also shown. The natural gas is stored in the upper portion of the Mt. Simon Sandstone.

CONCEPTUAL DIAGRAM OF GAS STORAGE IN THE MT. SIMON RESERVOIR

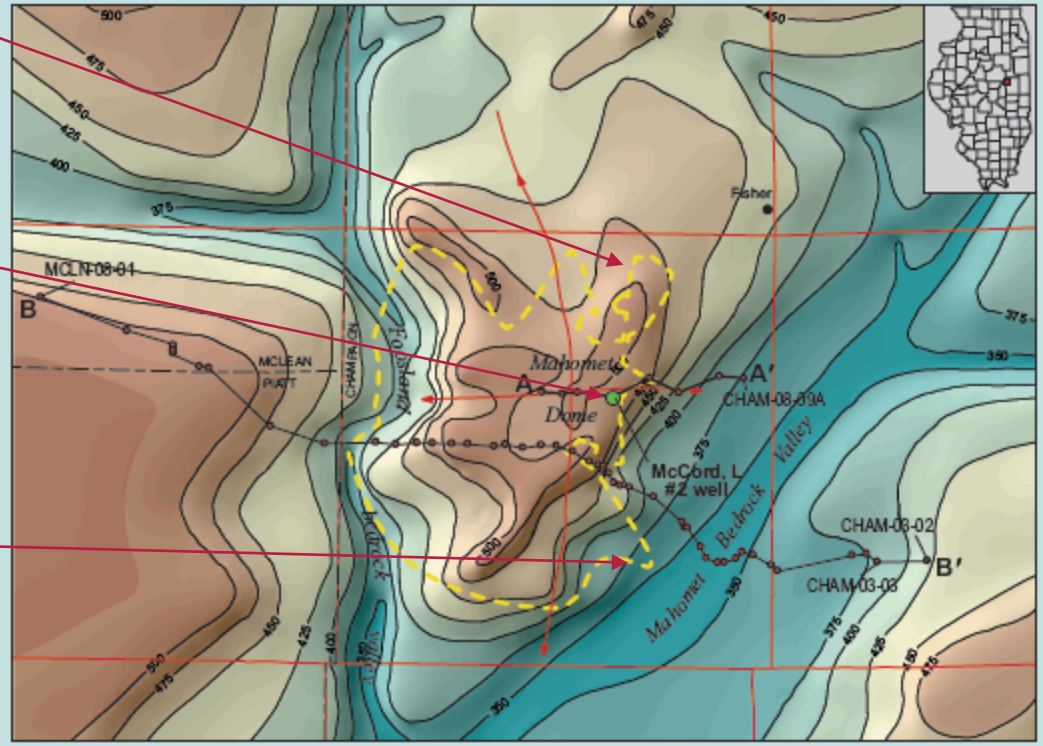


MANLOVE GAS STORAGE FIELD WITH GAS STORAGE WELLS



Geologic Cross Sections of Quaternary Deposits Across the Manlove Gas Storage Field Area, Champaign County, Illinois

Andrew J. Stumpf



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Illinois State Geological Survey
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BACKGROUND ON NATURAL GAS – THERMOGENIC *VS.* BIOGENIC

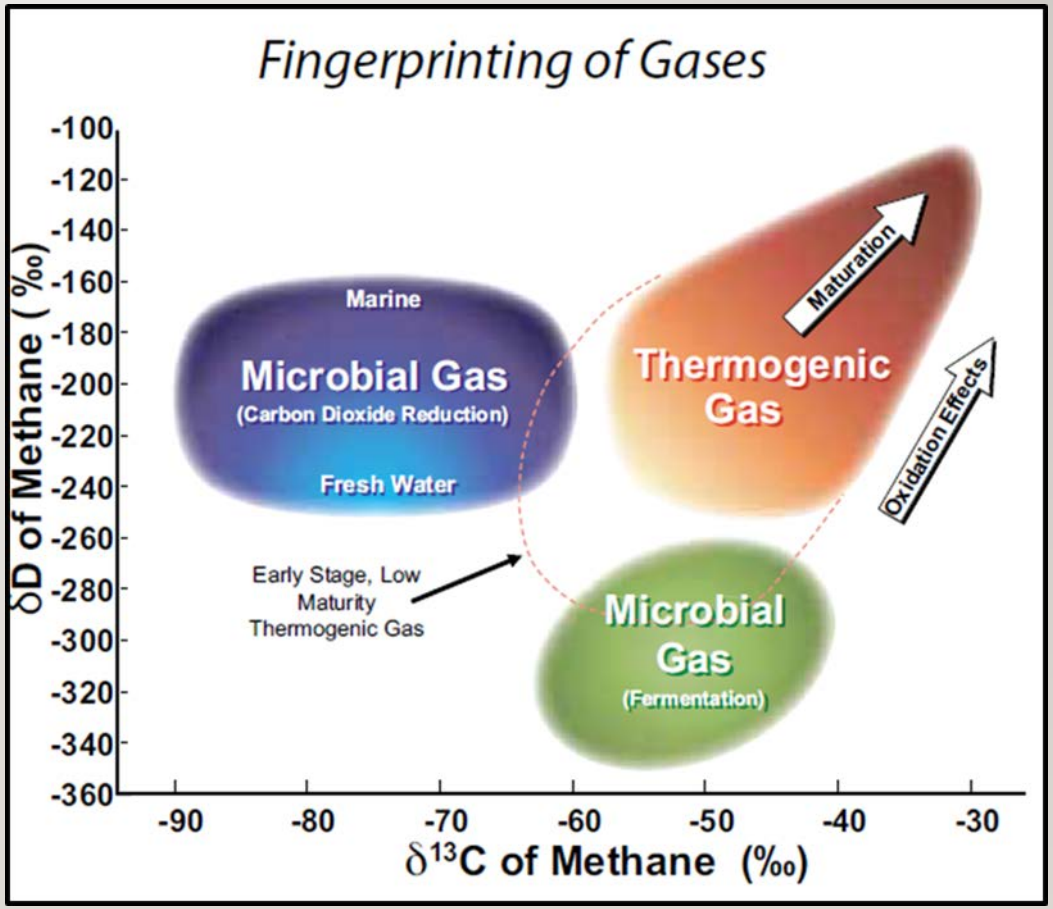
Biogenic

Methanogenesis is the formation of methane by microbes known as methanogens.

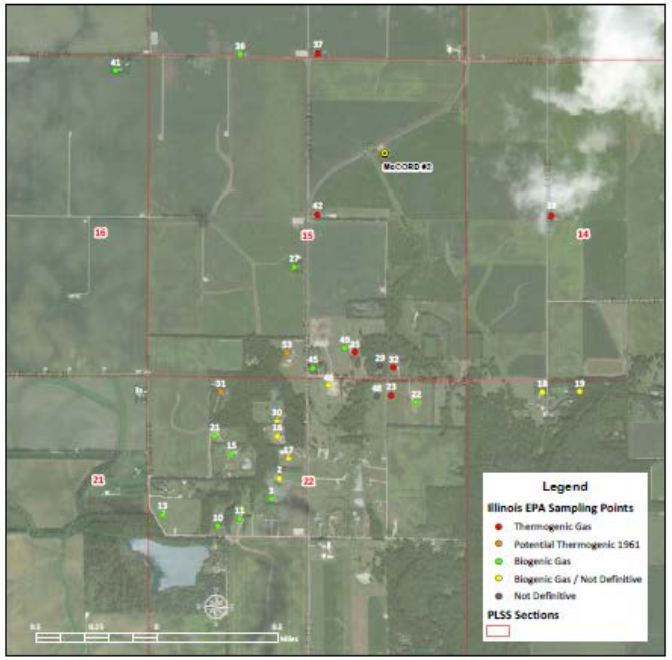
Thermogenic

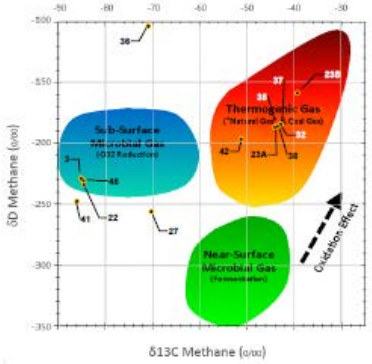
Methane CH_4 (also referred to as C1), thermogenic gas can also contain heavier chain hydrocarbons such as: ethane ("C_2H_6"); propane ("C_3H_8"); iso-butane ("C_4H_{10}"); n-butane ("C_4H_{10}"); and iso-pentane ("C_5H_{12}").

FINGERPRINTING OF GASES



McCORD #2 WITH ILLINOIS EPA SAMPLING DATA IN THE VICINITY OF MAHOMET, IL

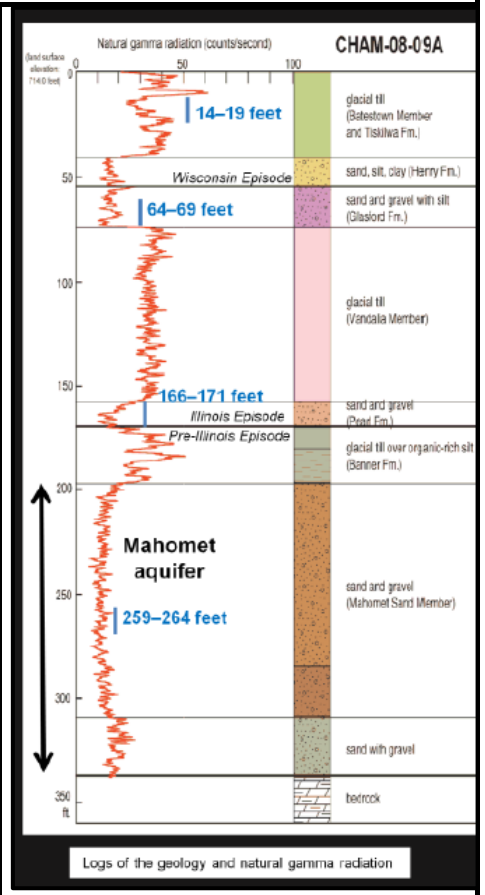




ID	TAX PAYER	ADDRESS
2	[redacted]	2681 COUNTY ROAD 350 E
5	[redacted]	2659 COUNTY ROAD 350 E
10	[redacted]	316 COUNTY ROAD 2650 N
11	[redacted]	326 COUNTY ROAD 2650 N
15	[redacted]	302 COUNTY ROAD 2650 N
15	[redacted]	8 COUNTY ROAD 300 E
16	[redacted]	2678 COUNTY ROAD 350 E
17	[redacted]	2675 COUNTY ROAD 350 E
18	[redacted]	2667 COUNTY ROAD 425 E
19	[redacted]	2688 COUNTY ROAD 425 E
21	[redacted]	2678 COUNTY ROAD 300 E
22	[redacted]	379 COUNTY ROAD 2700 N
23	[redacted]	373 COUNTY ROAD 2700 N
27	[redacted]	275 P COUNTY ROAD 350 E
29	[redacted]	370 COUNTY ROAD 2700 N
30	[redacted]	2685 COUNTY ROAD 350 E
31	[redacted]	2668A COUNTY ROAD 300 E
32	[redacted]	372 COUNTY ROAD 2700 N
35	[redacted]	362 COUNTY ROAD 2700 N
36	[redacted]	PO BOX 713
37	[redacted]	352 COUNTY ROAD 2800 N
38	[redacted]	2759 COUNTY ROAD 425 E
41	[redacted]	251 COUNTY ROAD 2800 N
42	[redacted]	275 P COUNTY ROAD 350 E
45	[redacted]	PO BOX 217
46	[redacted]	2522 COUNTY ROAD 450 E
48	[redacted]	369 COUNTY ROAD 2700 N
49	[redacted]	368 COUNTY ROAD 2700 N
53	[redacted]	2797 COUNTY ROAD 350 E

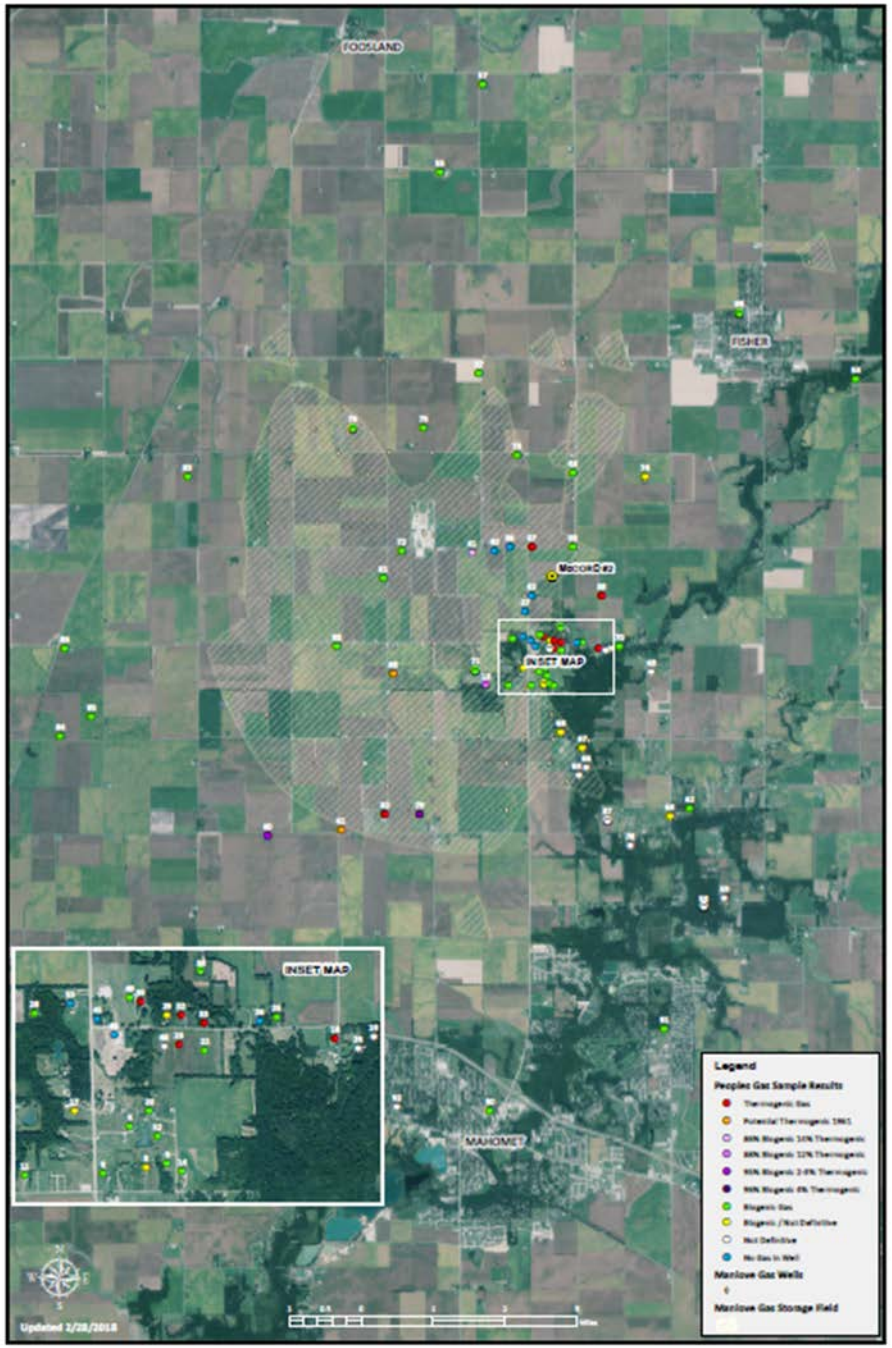
Hydrogeology of the Private Wells Contaminated with Thermogenic Gas

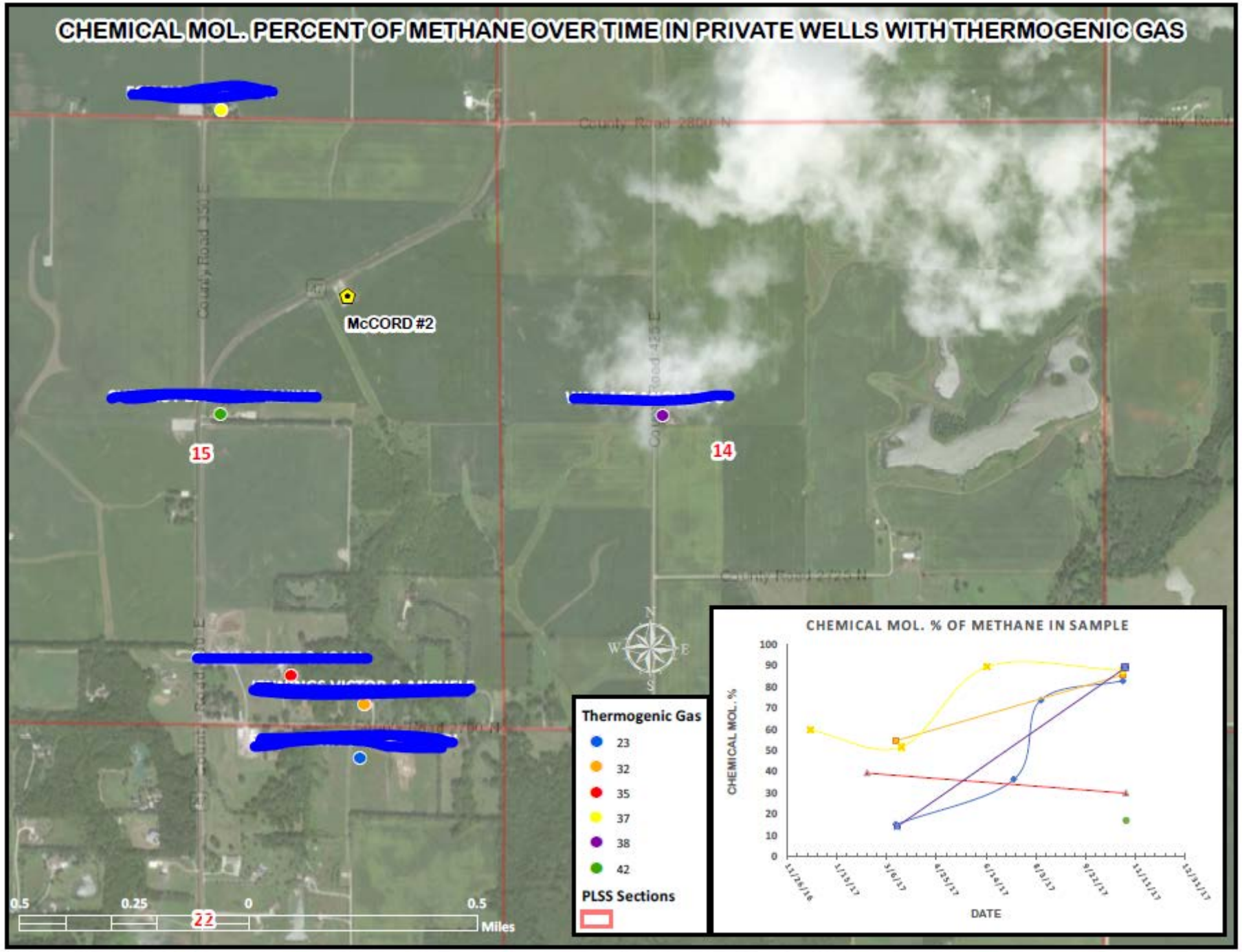
Well ID	Well Depth	Hydrostratigraphic Unit	Geologic Unit
23	150		Ashmore/Pearl
32	61	Wisconsin/Upper Glasford	Ashmore/Pearl
35	???	???	
37	220	Mahomet	
38	106 or 120	Upper Glasford	



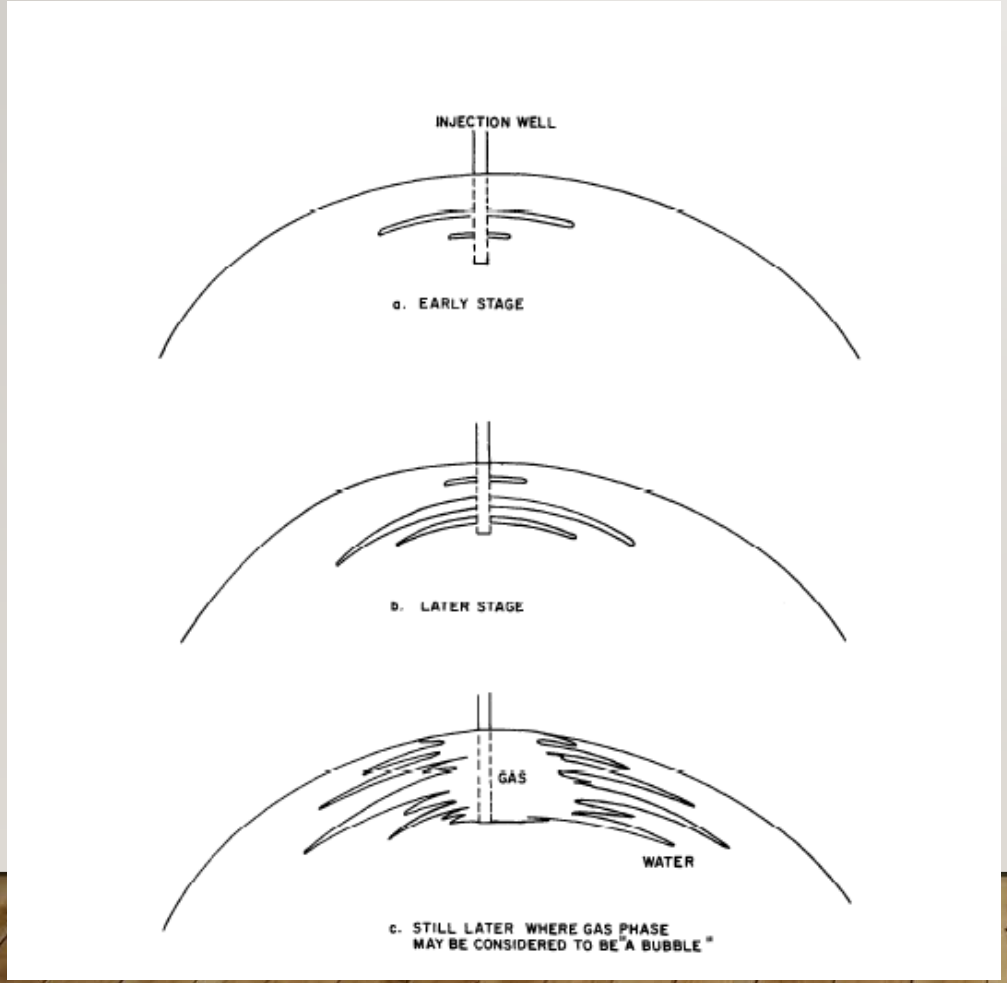
Logs of the geology and natural gamma radiation

McCORD #2 WITH RESULTS FROM PEOPLES GAS SAMPLING EVENTS TO DATE




CHEMICAL MOL. PERCENT OF METHANE OVER TIME IN PRIVATE WELLS WITH THERMOGENIC GAS
County Road 2800 N
County Road 150 E
County Road 425 E
McCORD #2
15
14
22
Thermogenic Gas
23
32
35
37
38
42
PLSS Sections
0.5
0.25
0
0.5
Miles
CHEMICAL MOL. % OF METHANE IN SAMPLE
CHEMICAL MOL. %
100
90
80
70
60
50
40
30
20
10
0
11/28/16
1/13/17
3/6/17
4/25/17
6/14/17
8/3/17
9/22/17
11/11/17
12/31/17
DATE

MOVEMENT OF THE NATURAL GAS RELEASE



1. FREE PHASE GAS FLOW

- Moved upward vertically from the point of release in the bedrock (550' below land surface)
- Spreads out laterally in a radial pattern
- Moving faster than the velocity groundwater through permeable geologic materials(i.e. sand and gravel, sand) and possibly well casing annular seals
- Stops at impermeable zones (i.e. clay rich glacial materials)
- Movement of the bubble stabilizes and starts going into dissolved phase

MOVEMENT OF THE NATURAL GAS RELEASE CONTINED

2. DISSOLVED PHASE OF THERMOGENIC GAS MOVEMENT

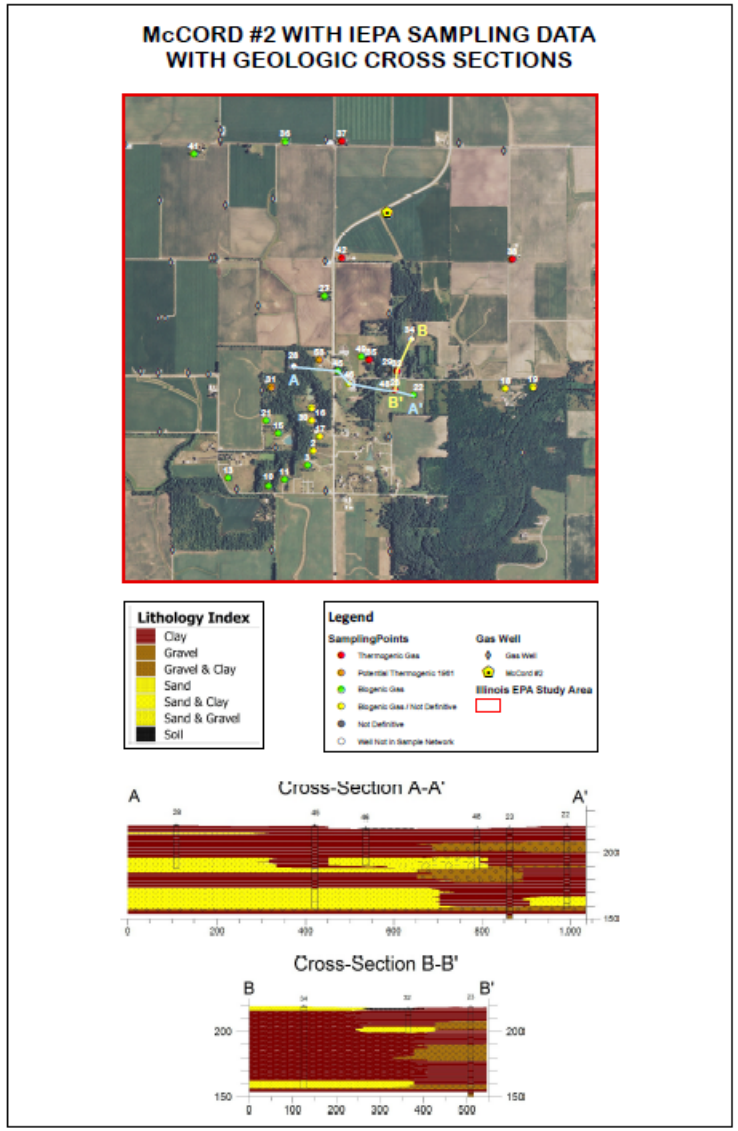
- After the free-phase gas bubble stabilizes
- The thermogenic gas starts going into a dissolved phase
- Moves down gradient at the velocity of groundwater

REMOVING THE THERMOGENIC NATURAL GAS FROM THE AQUIFER

- Delineate where the remaining gas bubble(s) are trapped
- Install relief wells and flare off the gas
- Thus, we need a conceptual geologic model to start the process of finding where the thermogenic gas bubble may be trapped

Table 5. Estimated Hydraulic Conductivity of Typical Geologic Materials, in ft/year (Source: Berg et al., 1984)

Dense limestone/dolomite	10^{-5} to 10^{-8}
Till (>25% clay)	10^{-3} to 10^{-5}
Till (<25% clay)	10^{-2} to 10^{-4}
Loess	10^{-3} to 10^{-1}
Sandstone	$>10^{-1}$
Limestone	$>10^{-1}$
Silty sand	10^{-2} to 10
Clean sand and gravel	10



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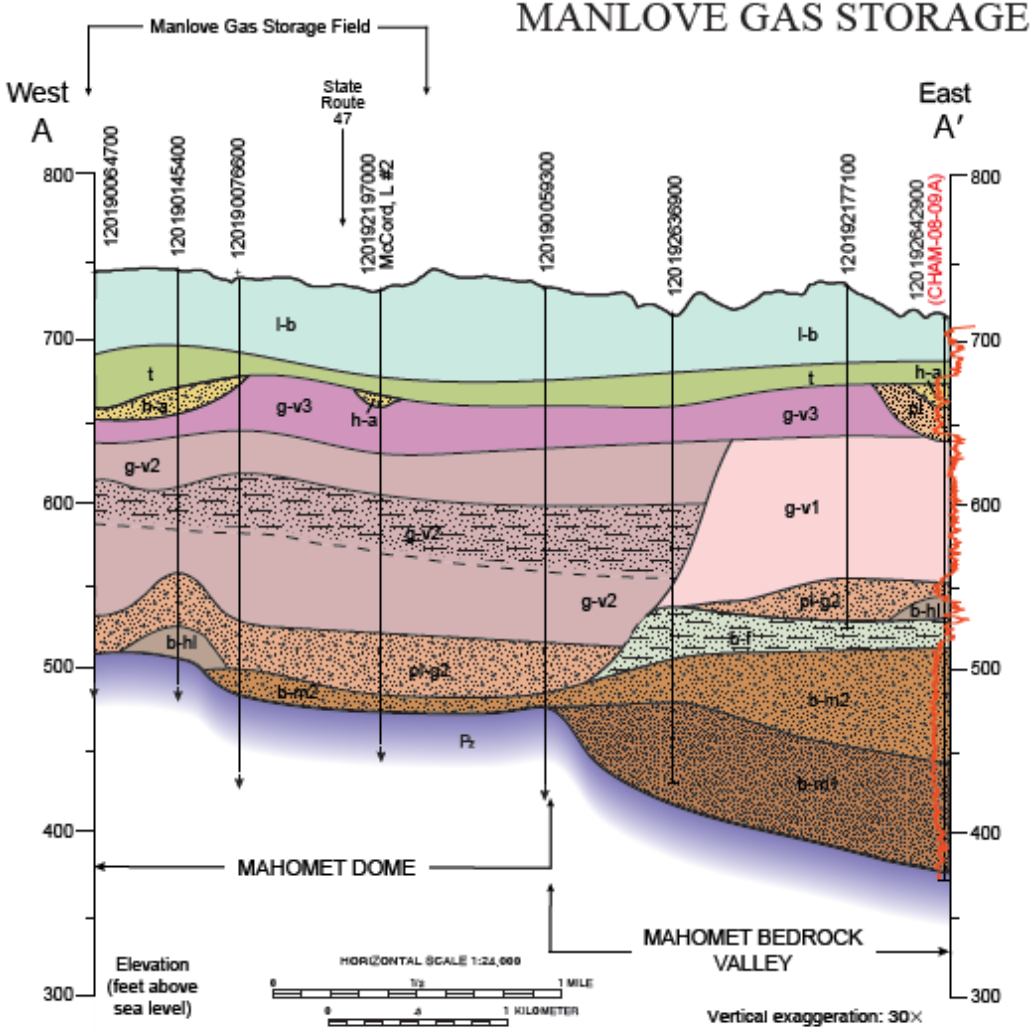
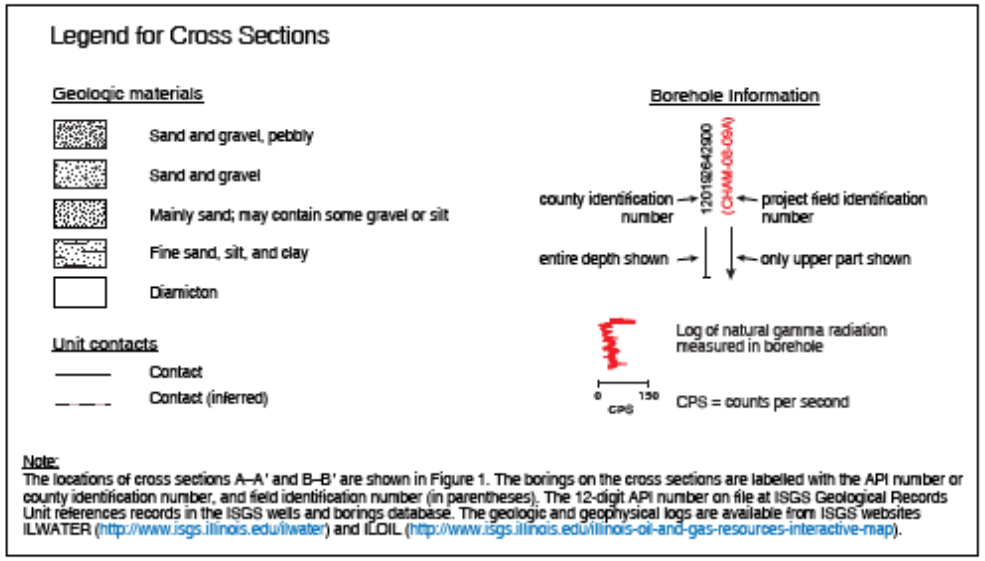
GEOLOGIC CROSS SECTIONS OF QUATERNARY DEPOSITS ACROSS THE MANLOVE GAS STORAGE FIELD AREA, CHAMPAIGN COUNTY, ILLINOIS

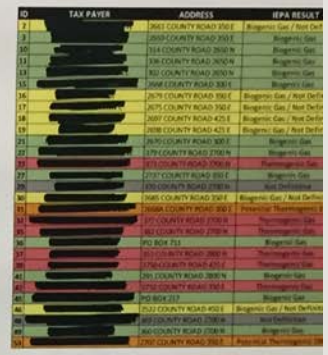
Andrew J. Stumpf





Suggested citation:
Stumpf, A.J., 2018, Geologic cross sections of Quaternary deposits across the Manlove gas storage field area, Champaign County, Illinois: Illinois State Geological Survey, Special Report 6, 7 p.; 2 plates.

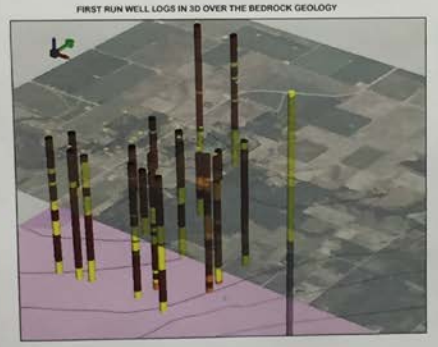
McCORD #2 WITH SAMPLING DATA AND BEDROCK SURFACE GEOLOGY SHOWING WELL LOG DATA USED FOR 3D VISUALIZATION



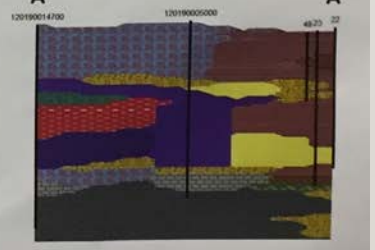
ID	TAX PAYER	ADDRESS	IEPA RESULT
2	[redacted]	2661 COUNTY ROAD 350 E	Biogenic Gas / Not Def
3	[redacted]	2655 COUNTY ROAD 350 E	Biogenic Gas
10	[redacted]	314 COUNTY ROAD 2650 N	Biogenic Gas
11	[redacted]	336 COUNTY ROAD 2650 N	Biogenic Gas
13	[redacted]	832 COUNTY ROAD 2650 N	Biogenic Gas
15	[redacted]	2668 COUNTY ROAD 300 E	Biogenic Gas
16	[redacted]	2679 COUNTY ROAD 350 E	Biogenic Gas / Not Defi
17	[redacted]	2675 COUNTY ROAD 350 E	Biogenic Gas / Not Defi
18	[redacted]	2697 COUNTY ROAD 425 E	Biogenic Gas / Not Defi
19	[redacted]	2698 COUNTY ROAD 425 E	Biogenic Gas / Not Defi
21	[redacted]	2670 COUNTY ROAD 300 E	Biogenic Gas
22	[redacted]	179 COUNTY ROAD 2700 N	Biogenic Gas
23	[redacted]	175 COUNTY ROAD 2700 N	Thermogenic Gas
27	[redacted]	2737 COUNTY ROAD 350 E	Biogenic Gas
30	[redacted]	2850 COUNTY ROAD 2700 N	Not Definitive
32	[redacted]	2685 COUNTY ROAD 350 E	Biogenic Gas / Not Defini
33	[redacted]	2668A COUNTY ROAD 300 E	Potential Thermogenic G
34	[redacted]	271 COUNTY ROAD 2700 N	Thermogenic Gas
35	[redacted]	452 COUNTY ROAD 2700 N	Thermogenic Gas
36	[redacted]	PO BOX 713	Biogenic Gas
37	[redacted]	2110 US RUTE ROAD 2800 N	Thermogenic Gas
38	[redacted]	2754 COUNTY ROAD 425 E	Thermogenic Gas
42	[redacted]	291 COUNTY ROAD 2800 N	Biogenic Gas
43	[redacted]	2752 COUNTY ROAD 350 E	Thermogenic Gas
45	[redacted]	PO BOX 217	Biogenic Gas
46	[redacted]	2522 COUNTY ROAD 450 E	Biogenic Gas / Not Definitive
48	[redacted]	467 COUNTY ROAD 2700 N	Not Definitive
49	[redacted]	460 COUNTY ROAD 2700 N	Biogenic Gas
54	[redacted]	2797 COUNTY ROAD 350 E	Potential Thermogenic G

GIS LEGEND

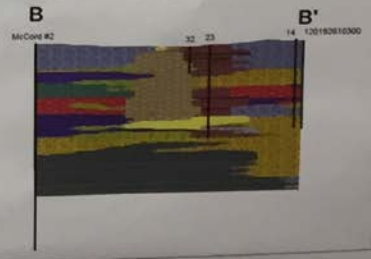
FIRST RUN WELL LOGS IN 3D OVER THE BEDROCK GEOLOGY



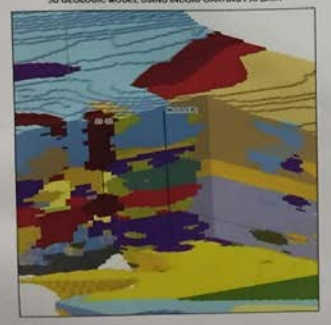
Cross-Section A-A'



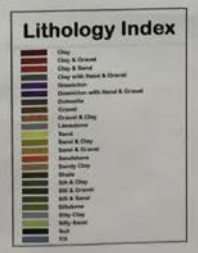
Cross-Section B-B'



3D GEOLOGIC MODEL USING INCORPORATING PRI DATA



Lithology Index



SOURCE INFORMATION

[illegible]

NEXT STEPS

We don't have all the answers

More detailed hydrogeologic characterization may be required

Negotiation with the RP and AGO