

API #: 15-129-21782-0000

Nadel and Gussman

Horizon #1-6

SE/SW/NE Section 6, T32S R42W

Morton County, Kansas

15-129-21782-00-00

2310 FSL 1800 FEL

T. Michael Dodge

RECEIVED
KANSAS CORPORATION COMMISSION

JAN 22 2008

CONSERVATION DIVISION
WICHITA, KS

MIKE DODGE- Consulting Geologist
1632 Maiden Grass Dr., Loveland, CO 80537
(970)-663-7035
Cell (620)-621-1519

6-32-42W

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SUMMARY AND CONCLUSIONS

Nadel and Gussman L.L.C.'s Horizon #1-6 was drilled to a Total Depth of 5210' (5196' Loggers TD) as a Wildcat (Greenwood Field development well shallow), with the Wabaunsee, Topeka, Lansing, and Morrow considered the primary objectives. The well was spudded on 4/25/06, and drilling was completed on 5/3/06.

Gas and Sample evaluation began at 2500', with unlagged samples caught by the Drilling Crews from 2500' to TD (One Dry Cut sent to KGS).

Wm. Gruenerwald & Assoc.'s Taylor #1 (approx. ½ mile S) was used for correlation.

Wabaunsee

The Wabaunsee was topped at 2742' (+805), 11' high to correlation. Three thin porosities at the top of the Wabaunsee (2753-58' - 22u gas increase, 2762-64' - No gas increase, and 2777-82' - 22u gas increase) were developed in grainy to granular, fossiliferous Limestone (some fine to medium grained Sandstone noted in samples), with no sample shows observed. Logs indicate the top and bottom intervals to be porous, but 50-56% Sw's, with low gas increase make me believe the intervals have very low pressure, and may be depleted.

Intervals at 2970-75' (20u gas increase) and 2986-94' (20u gas increase) in grainy to fine sucrosic, silty to sandy, trace fine oolitic (moldic in part) are developed. Logs indicate the upper interval to be wet (86% Sw) and the lower interval (appears to be top of Elmont) has a questionably low Sw (27-18%) - most likely due to oomoldic nature.

From 3052-57' (20u gas increase) and 3080-84' (25u gas increase), samples show micro to very fine crystalline, grainy, fossiliferous, silty Limestone. Logs calculate Sw's of 43-40%.

Topeka

The Topeka was topped at 3147' (+400), 10' high to correlation. Three thin well developed porosities are developed at the top (3148-52' - 6u gas increase and 60% Sw, 3160-66' - No gas increase and 72-80% Sw, and 3172-82' - 28u gas increase and 48-62% Sw). The lower of these intervals shows some productive potential in granular, silty to sandy, slightly fossiliferous Limestone (some pinpoint and fine vugs noted), though much associated water is likely.

From 3282-95' (Lecompton) gas increased 49u in grainy, fossiliferous, trace dolomitic Limestone. Logs show some productive potential from 3282-86' (Sw-30%) and 3292-95' (Sw- 48%).

Lansing

The Lansing Formation was topped at 3512', 3509' Logs (+38), 10' high to correlation. Total Gas increased 104u from 3512-18'. Poor Samples at the top made it hard to evaluate this interval, but it appears to be grainy to micro sucrosic to granular, silty to sandy Limestone, with minor Silt and silty very fine grained Sandstone noted. Similar lithology was observed at 3525-34', with a 30u gas increase. Logs show potential gas here with Sw's of 26-37%.

Three thin intervals in the Lansing from 3721-25' (92u gas increase, 14% Porosity with no crossover, poor MicroLog, and Sw of 65%), 3727-30' (67u gas increase, 18% Porosity with no crossover, Good MicroLog, and Sw of 15%), and 3735-40' (89u gas increase, 14+% Porosity with crossover, good MicroLog, and 18% Sw) show some productive potential, though the lack of Porosity crossover is troubling. Poor Sample representation, but the intervals appear to be very fine to micro crystalline, fossiliferous, silty Limestone, with some pelletoidal to trace distorted fine oolitic.

Weak gas increases were noted from 3802-04' (25u in grainy to granular, fossiliferous to sandy Limestone, 14% Porosity, Sw-50%) and 3890-3900' (10u in sucrosic, silty to sandy, slightly fossiliferous Limestone, 19.5% Porosity, Sw- 75%).

Morrow

The Morrow Formation was topped at 4614', 4608' Logs (-1061), 12' high to correlation.

No significant shows were observed in the Morrow. The only Sand seen in the Upper Morrow was from 4630-36' (4633-38' Logs), and appears tight and Limy on Logs. The Morrow 'F' was topped at 4916' (-1369), 17' high to correlation. Samples indicate tight limy Sand (very fine to fine grained, glauconitic, with Limestone and fossil fragments associated), argillaceous, silty Limestone, and interbedded dark, silty Shale. No gas increases or sample/Log shows were observed.

The Morrow 'G' was topped at 5028' (-1481), 7' high to correlation. Very fine to medium grained Sandstone was observed from 5028-51'. The Sand was very firm to friable, slightly calcareous with secondary Quartz overgrowth, and glauconitic, with minor white clay filling and Pyrite noted. No gas increases or sample were observed, and Logs indicate the interval to be wet.

The Keyes Sandstone was topped at 5076' (-1529), 23' high to correlation. Sands from 5077-94' and 5112-27' were fine to very coarse grained, non to slightly calcareous with secondary Quartz overgrowth common, and slightly glauconitic. Minor white lightgreen clay filling and inter granular Pyrite were noted. No shows were observed, with Logs showing the interval to be porous (9-14%), tight (ratty MicroLog) and wet (45-70% Sw). No Gas increases or sample shows were observed.

The Chester was topped at 5128' (-1581), 14' high to correlation. From 1528' to TD, a sequence of multi colored Shale (variegated in part) and chalky, silty-sandy Limestone was observed.

As of 5/3/06, 5.5" casing was scheduled to be run to 4000/4100' to further evaluate the upper gas intervals penetrated in this well.

If you have any questions concerning this well, or I can be of any further help in any way, feel free to call me any time. Thank you.

Mike Dodge
1632 Maiden Grass Drive
Loveland, CO 80537
Home: (970)-663-7035 Cell: (620)-621-1519

WELL RESUME

Operator: Nadel and Gussman L.L.C.

Well Name: Horizon #1-6 **API #:** 15-129-21782-0000

Field: Greenwood (Shallow), Wildcat (Deep).

Location: 2310' FNL & 1800' FEL SE/SW/NE Section 6, T32S R42W

County: Morton **State:** Kansas

Spud Date: 4/25/06 **Drilling Completed:** 5/3/06

Elevations: GL- 3536'
KB- 3547'

Total Depth: Driller's TD- 5210'
Logger's TD- 5196'

Contractor: Murfin Drilling, Rig #22

Pumps: #1 EMSCO DB-550 6" x 15"
#2 EMSCO D-375 6" x 14"

Wellsite Geologist: Mike Dodge **Company Geologist:** Charlie Harding

Mud Logging Equipment: MBC Well Logging w/ 6v Continuous Sampling Total Gas Detector, 6v Single Column Gas Chromatograph. Start Gas Detection at 2500'. Unlagged Samples were Caught by the Drilling Crews from 2500'-TD (One Dry Cut Sent to KGS).

Tool Pusher: Kelly Wilson **Company Man:** John May

Mud Company: Champion Drilling Fluids, Inc. **Mud Engineer:** Tom Bradford

Type Drilling Mud: Chemical/LSND.

Hole Sizes: 12 1/4" 0-1474'; 7 7/8" 1474'-TD.

Casing: 8 5/8" New 24# set at 1470'.

Cores: None.

DST's: None.

Electric Logs By: HLS **Logging Engineer:** E. Shibalov, A. Marioza

Type Logs Ran: HRI/SP/GR from TD to Surface Casing.
SDL/DSN/MLL/CAL/GR from TD to 2700'

Bottom Hole Formation: Chester

Well Status: Running 5.5" Casing to 4000/4100'.

DAILY CHRONOLOGY

<u>Date</u>	<u>7am Depth</u>	<u>24 Hr. Ftg.</u>	<u>Activity Previous 24 Hours</u>
4/26	1025	1025	Rig Up, Mix Mud, Drill Rat & Mouse Holes, Dig Ditches, Spud at 5:45pm 4/25/06, Drill (12 ³ / ₄), Rig Service, Survey.
4/27	1474	449	Drill (8 ¹ / ₄), Circulate, Drop Survey & TOH, Run & Cement 8 5/8" Casing, WOC, TIH, Drill Cement.
4/28	2295	821	Drill Cement & Plug (660' Cement), Drill (15 ¹ / ₄), Rig Service, Survey.
4/29	3005	710	Drill (22 ³ / ₄), Rig Service, Survey.
4/30	3610	605	Drill (23 ¹ / ₄), Rig Service.
5/1	4170	560	Drill (23 ¹ / ₄), Rig Service.
5/2	4660	490	Drill (22 ³ / ₄), Rig Service, Survey.
5/3	5210	550	Rig Service, Drill (23 ¹ / ₄), Reach TD @ 6:45am, Circulate.
5/4	5210	0	Circulate, Short Trip, Circulate & WO Logging Truck, Drop Survey and Strap Out for Logs, Log with HLS.

BIT RECORD

<u>#</u>	<u>Size</u>	<u>Make</u>	<u>Type</u>	<u>Depth In</u>	<u>Depth Out</u>	<u>Footage</u>	<u>Hours</u>
1	12¼"	HTC	GT C03	0	1474	1474	21
2	7 7/8"	HTC	GX 22S	1474	5210	3736	139 ¾

DIRECTIONAL SURVEYS

655'- ½°

1474'- Miss Run

1794'- ½°

2838'- ¼°

4207'- ½°

5210'- 2°

FORMATION E-LOG TOPS AND CORRELATION

Nadel & Gussman Horizon #1-6 SW/NE Sec. 6, T32S R42W Morton Co., KS KB- 3547'				Wm. Gruenerwald & Assoc. Taylor #1 C/SW/SE Sec. 6, T32S R42W Morton Co., KS KB- 3552'			
Formation	KB- 3547'	+/-	Prognosis	+/-			
Wabunsee	2742 (+805)	+5	2747 (+800)	+11	2758 (+794)		
Topeka	3147 (+400)	+10	3157 (+390)	+10	3162 (+390)		
Heebner	3356 (+191)	-14	3341 (+206)	-4	3357 (+195)		
Lansing	3509 (+38)	+10	3519 (+28)	+10	3524 (+28)		
Marmaton	4102 (-555)	+20	4122 (-575)	+21	4128 (-576)		
Cherokee	4226 (-679)	+16	4242 (-695)	+21	4252 (-700)		
Atoka	4465 (-918)	+17	4482 (-935)	+20	4490 (-938)		
Morrow	4608 (-1061)	+9	4617 (-1070)	+12	4625 (-1073)		
Upper Morrow SS	-----	-----	4797 (-1250)	-----	-----		
Morrow 'F' SS	4916 (-1369)	+11	4927 (-1380)	+17	4938 (-1386)		
Morrow 'G' SS	5028 (-1481)	-11	5017 (-1470)	+7	5040 (-1488)		
Keyes SS	5076 (-1529)	+6	5082 (-1535)	+23	5104 (-1552)		
Chester	5128 (-1581)	-6	5122 (-1575)	+14	5147 (-1595)		

MUD RECORD

<u>Date</u>	<u>Depth</u>	<u>WT</u>	<u>FV</u>	<u>PV</u>	<u>YP</u>	<u>GS</u>	<u>WL</u>	<u>Cl</u>	<u>pH</u>	<u>LCM</u>	<u>Pm</u>	<u>Pl/Mf</u>	<u>Cl</u>	<u>Ca</u>	<u>Sol/Wtr</u>	<u>Cost</u>
4/26	1450	10.1	33	7	13	11/16	----	----	8.5	5#	----	.1/.35	1800	800	9.8/90.2	\$3072
4/27	1474	----- Drilling with Water -----														
4/28	2690	8.6	34	4	8	2/6	-----	3/32	9.0	4#	----	.1/.8	1200	480	3.2/96.8	5876
4/29	3120	9.0	35	7	7	5/10	-----	3/32	9.0	3#	----	0/.8	1000	80	4.8/95.2	7648
4/30	3750	8.9	40	7	10	7/14	18.4	2/32	8.5	4#	----	0/.9	1100	80	4.2/95.8	8679
5/1	4230	9.1	43	9	19	7/24	16.8	2/32	8.5	3#	----	0/.9	1000	40	5.2/94.8	10,110
5/2	4880	9.0	44	11	18	7/20	15.2	2/32	8.0	4#	----	0/.7	800	40	4.8/95.2	12,732

4812

SHOW EVALUATION

Log Depths	Electric Logs	Samples		
INTERVAL	Rt	POROSITY	Sw	MLL
	Density	Neutron		
WABAUNSEE				
2753-2758	12	12%	10.5	50%
2762-2764	13	4%	10%	75%
2777-2782	2.3	24%	20%	56%
2970-2975	1.5	21.5%	18%	86%
2986-2994	20	17-21%	10-19%	27-18%
3052-3057	16	13%	8%	43%
3080-3084	16	10%	13%	40%
TOPEKA				
3148-3152	3.5	17.5%	14.5%	60%
3160-3166	3.2	12-16%	10.5-12.5	72-80%
3172-3182	3.2	27-18%	19-14%	48-62%
LECOMPTON				
3282-3286	9	22%	18%	30%
3286-3292	6	12%	9%	70%
3292-3295	6	17%	14%	48%
LANSING				
3511-3516	7.5	24%	11%	37%
3525-3530	45	12%	9%	26%
3530-3534	40	8.5%	6%	41%
3721-3725	4	14%	14%	65%
3727-3730	45	18%	18%	15%
3735-3740	50	15.5%	13%	18%

GAS INCR EVALUATION
(over Bkgd)

Possible Low

Pressure Gas or Depleted.

Wet

Prob. Water/ Minimal Gas

Probably Wet.

6u

None

28u

Minimal Gas

49u

Poss. Gas

104u

30u

Poss. Wet Gas

92u

67u

89u

SHOW EVALUATION (Cont.)							
Log Depths INTERVAL	Rt	Electric Logs POROSITY	Sw	MLL	Samples LITHOLOGY	GAS INCR (over Bkqd)	EVALUATION
		Density	Neutron				
LANSING (Cont.)							
3802-3804	6.5	16%	12%	50%	Yes	LS: vf-mic xln, gmy-gran. foss, sdy ip, No S	25u Thin- Wet
3890-3900	1.5	20%	19%	75%	Yes	LS: suc., silty-sdy, sl foss, No Show.	10u Wet
MORROW- 'G' SANDSTONE							
5028-5051	5	16%	13%	55%	Yes	SS: v frm-frt, vf-m gr. mod str, sl calc / sec Qtz, glau, wh cly fld ip, tr Pyr, No Shows.	None Wet
KEYES SANDSTONE							
5077-5094	12-17	10-16%	8-13%	45-70%	Ratty	SS: frt-lse-v frm. f-vc gr. non-sl calc / sec Qtz, glau ip, chky wh cly fld ip, tr Pyr, No Shows.	None Tigh/Wet

[illegible][illegible]

SAMPLE DESCRIPTIONS

Unlagged Samples were caught by the Drilling Crews from 2500' to TD (One Dry Cut sent to KGS). Samples are lagged in these descriptions. Formation Tops are Sample Tops.

2490-2510 SHALE (70%) red, redbrown, trace green, soft, subplaty to irregular, non calcareous to slightly calcareous to dolomitic, silty in part, anhydritic in part, trace medium to dark gray, gray green, subplaty, calcareous, silty in part. **LIMESTONE** (20%) white, trace brown, friable to firm, predominantly very fine crystalline, micro to crypto crystalline in part, slightly chalky, dolomitic in part, grainy to granular in part, silty to sandy in part, trace fossiliferous, trace orange translucent Chert, very poor to poor to no visible inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut. **DOLOMITE** (10%) white, light brown, friable, grainy to fine sucrosic.

2510-2530 SHALE (70%) as above. **LIMESTONE** (30%) as above. **DOLOMITE** (Trace).

2530-2555 SHALE (50%) predominantly red, redbrown, green, brown, as above. Occasional medium gray, green gray, soft, subplaty to irregular, calcareous to slightly calcareous, slightly silty in part, trace micro Pyrite. **LIMESTONE** (50%) white, occasionally tan, light brown, light gray, very fine to fine to micro crystalline, chalky in part, sandy in part, occasionally slightly dolomitic, trace fossiliferous, very poor to poor to no visible inter crystalline porosity, occasional moderate to bright yellow mineral fluorescence, no stain odor or cut.

2555-2570 LIMESTONE (50%) white, light to medium gray, occasionally tan, brown, friable to firm, micro to very fine crystalline, slightly chalky in part, silty to sandy in part, fossiliferous, occasionally slightly argillaceous, trace translucent lightgray Chert, very poor to poor to no visible mineral fluorescence, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) as above, trace dark gray, slightly carbonaceous.

2570-2590 SHALE (80%) red, redbrown, occasionally green, brown, medium gray, soft, subplaty to blocky to irregular, non calcareous to slightly dolomitic, silty in part, anhydritic in part. **LIMESTONE** (20%) as above, occasional fine crystalline, granular, fossiliferous in part, sandy in part.

2590-2625 LIMESTONE (50%) white, occasionally light to medium gray, friable to firm, very fine to micro crystalline, chalky in part, grainy to granular in part, fossiliferous in part, silty in part, occasionally slightly argillaceous, trace translucent Chert and micro Pyrite, very poor to no visible to poor inter crystalline porosity, yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) as above.

2625-2640 LIMESTONE (50%) light to medium gray, white, brown, as above, predominantly micro crystalline, becoming very silty to sandy in part, fossiliferous in part, occasional fossil fragments, argillaceous in part. **SHALE** (50%) as above, occasional brown sandy with fossil fragments.

2640-2660 LIMESTONE (70%) light to medium gray, salt and pepper, trace white, brown, friable to firm, very fine to micro crystalline, very silty to sandy with Silt and silty very fine grained Sandstone stringers, occasionally slightly fossiliferous with trace scattered broken fine oolites, trace to occasional orange translucent lightgray milky Chert, no visible to very poor to poor inter crystalline porosity, trace to occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) medium gray, occasionally dark gray, soft to firm, subplaty to blocky, calcareous, silty, fossiliferous in part, trace carbonaceous.

2660-2690 LIMESTONE (70%) as above, increase argillaceous with occasional darkgray black Shale stringers and partings, fossiliferous in part. **SHALE** (30%) medium to dark gray, black, firm, subplaty to blocky, calcareous, slightly silty, fossiliferous, slightly carbonaceous, trace micro Pyrite and mica.

2690-2705 LIMESTONE (70%) light to medium gray, occasionally white, brown, soft to friable to firm, micro crystalline, slightly chalky in part, silty to sandy, fossiliferous, argillaceous in part, trace to occasional translucent orange Chert, very poor to no visible inter crystalline porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) as above, predominantly medium gray.

2705-2720 LIMESTONE (60%) as above, predominantly silty and argillaceous, fossiliferous in part. **SHALE** (40%) medium to dark gray, soft to firm, subplaty to blocky, calcareous, silty, fossiliferous in part, micro micaceous in part, trace carbonaceous material.

2720-2735 SHALE (60%) as above, fossiliferous in part, trace plant remains, subchalky in part. **LIMESTONE** (40%) light to medium gray, white, brown, firm, micro to very fine crystalline, chalky in part, fossiliferous, silty to sandy in part, argillaceous in part, trace mica and carbonaceous material, no visible to very poor inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut.

2735-2750 LIMESTONE (70%) light to medium gray, tan, brown, white, firm to slightly friable, micro crystalline, silty, fossiliferous, argillaceous in part, no visible to very poor porosity, occasional yellow mineral fluorescence. **SHALE** (30%) medium to dark gray, trace black, as above.

WABAUNSEE 2751' (+796)

2750-2770 LIMESTONE (80%) white, cream, light tan, trace pink, yellow, firm to slightly friable, very fine to micro to fine crystalline, slightly chalky, grainy, granular in part with red Shale filling, fossiliferous in part with trace broken fine oolites, very poor to poor to no visible inter crystalline porosity, moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (20%) redbrown, maroon, medium to dark gray, calcareous, silty, trace fossiliferous, trace carbonaceous material.

2770-2785 LIMESTONE (60%) as above, occasionally redbrown orange, sandy grading to fine to medium grained Sandstone in part, predominantly granular fine crystalline, chalky in part, trace medium to dark gray argillaceous, occasional very poor to poor inter granular porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) as above, silty to sandy in part.

2785-2795 SHALE (60%) redbrown, red, brown, medium gray, soft to slightly firm, calcareous, silty. **LIMESTONE** (40%) light to medium gray, white, light brown, as above, predominantly chalky, grainy to granular in part, fossiliferous, silty, sandy in part.

2795-2810 LIMESTONE (60%) light gray, tan, white, cream, trace redbrown, pink, firm to friable, micro to very fine to fine crystalline, chalky in part, sandy in part, fossiliferous in part, occasionally poorly developed distorted .5 to 1 mm oolitic with micritic to very fine crystalline matrix, argillaceous in part, no visible to very poor to poor inter crystalline and inter oolitic porosity, occasional moderate to dull yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) redbrown, trace medium to dark gray, green.

2810-2835 SHALE (70%) redbrown, red, trace medium to dark gray, soft to firm, blocky to subplaty, calcareous, slightly silty. **LIMESTONE** (30%) as above.

2835-2850 SHALE (50%) as above. **LIMESTONE** (50%) white, light gray, tan, firm, micro to very fine to fine to crypto crystalline, slightly chalky, fossiliferous, silty to sandy in part, occasional redbrown Shale partings, argillaceous in part, no visible to very poor to poor inter crystalline porosity, yellow mineral fluorescence, no stain odor or cut.

2850-2870 LIMESTONE (70%) white, light gray, tan, brown, firm, micro to very fine to crypto crystalline, predominantly dense, slightly chalky, fossiliferous, silty in part, trace sandy, no visible to very poor to poor inter crystalline porosity, yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) redbrown, medium to dark gray, trace black carbonaceous.

2870-2890 SHALE (60%) redbrown, firm to soft, blocky, calcareous, silty to sandy. **LIMESTONE** (40%) as above, very fossiliferous in part.

2890-2910 LIMESTONE (70%) light to medium gray, tan, brown, white, firm, micro to very fine to fine to crypto crystalline, predominantly dense, fossiliferous in part, silty in part, trace sandy, argillaceous in part, trace translucent lightgray Chert, very poor to no visible porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) as above with medium to dark gray, firm, fossiliferous in part.

2910-2950 LIMESTONE (70%) white, tan, light gray, trace light brown, firm to slightly friable, micro to very fine to crypto crystalline, slightly chalky, predominantly dense, fossiliferous, silty in part, trace sandy, occasionally slightly argillaceous, trace Chert and crystalline Calcite, no visible to very poor inter crystalline porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) redbrown, occasional medium to dark gray, trace green gray.

2950-2970 LIMESTONE (70%) white, light gray, cream, tan, firm to slightly friable, slightly chalky, predominantly dense, grainy to fine sucrosic in part, trace granular, fossiliferous, silty to sandy in part, very poor to no visible to poor inter crystalline porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) as above.

2970-2990 LIMESTONE (60%) as above, trace pink, redbrown, trace .5 mm oolitic with micritic to very fine crystalline matrix, becoming moldic in part, trace lightgray Chert, poor visible inter oolitic porosity, occasional moderate to dull yellow mineral fluorescence. **SHALE** (40%) redbrown, medium gray, silty in part, fossiliferous in part.

2990-3010 LIMESTONE (80%) as above with tan, light gray, white, firm, crypto to micro crystalline, dense, slightly chalky in part, grainy in part, silty in part, trace fossiliferous, no visible porosity. **SHALE** (20%) as above.

3010-3030 LIMESTONE (70%) tan, brown, light to medium gray, white, as above, predominantly dense crypto crystalline, occasionally micro to very fine crystalline, slightly to moderately fossiliferous, silty in part, argillaceous in part, rare Chert, no visible to very poor inter crystalline porosity, dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) redbrown, medium to dark gray, silty in part, fossiliferous in part.

3030-3050 LIMESTONE (70%) tan, light to medium gray, light brown, white, firm, crypto to micro crystalline, predominantly dense, chalky in part, fossiliferous in part, silty in part, argillaceous in part, trace granular, trace brown gray translucent Chert, no visible to very poor porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) medium to dark gray, redbrown, black, calcareous, fossiliferous in part, silty in part, carbonaceous in part.

3050-3090 LIMESTONE (60%) white, light brown, tan, light to medium gray, firm to slightly friable, micro to very fine to crypto crystalline, slightly chalky in part, grainy in part, fossiliferous, silty in part, occasionally argillaceous, trace gray tan milky Chert, very poor to no visible to poor inter crystalline porosity, occasional moderate to dull yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) redbrown, medium to dark gray, black, firm to friable to soft, blocky to subplaty, calcareous, silty in part, fossiliferous in part, carbonaceous in part.

3090-3110 SHALE (50%) as above. **LIMESTONE** (50%) as above, grainy to sucrosic to granular in part.

3110-3135 SHALE (60%) redbrown, medium to dark gray, green gray, green, black, soft to firm, calcareous, silty to sandy in part, trace fossiliferous, trace carbonaceous. **LIMESTONE** (40%) cream, white, light to medium gray, tan, firm, micro to very fine to crypto crystalline, chalky in part, fossiliferous in part, very silty in part, occasionally slightly argillaceous, trace lightgray translucent Chert, no visible to very poor to poor inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut.

3135-3145 SHALE (80%) redbrown, red, occasionally medium to dark gray, black. **LIMESTONE** (20%).

3145-3170 LIMESTONE (50%) white, friable, very fine to micro crystalline, chalky, grainy to micro sucrosic, silty to sandy, slightly fossiliferous, trace milky lightgray Chert, very poor to poor to no visible inter crystalline porosity, dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) redbrown, medium to dark gray, trace black.

TOPEKA 3162' (+385)

3170-3190 LIMESTONE (70%) white, light gray, light brown, friable to firm, very fine to micro to fine to crypto crystalline, chalky in part, granular in part, silty to sandy in part, trace to slightly fossiliferous, trace translucent milky Chert, occasional pinpoint to fine vugs, very poor to poor to no visible to fair inter crystalline and vugular porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) as above.

3190-3205 LIMESTONE (80%) as above, predominantly granular very fine to fine to micro crystalline, fossiliferous, trace to occasional lightgray milky Chert, rare vugs. **SHALE** (20%) redbrown, medium to dark gray, trace black.

3205-3230 SHALE (60%) redbrown, green gray, medium gray, firm to soft, blocky to subplaty, calcareous, silty in part. **LIMESTONE** (40%) white, cream, tan, light gray, pink, brown, predominantly dense micro to crypto crystalline, very silty in part, fossiliferous in part, argillaceous in part.

3230-3250 SHALE (50%) as above, occasionally medium gray very silty, limy in part. **LIMESTONE** (50%) white, light gray, tan, brown, trace pink, green, medium gray, firm to friable, micro to crypto to very fine crystalline, slightly chalky in part, silty in part, fossiliferous in part, argillaceous in part, no visible to very poor inter crystalline porosity, trace dull yellow mineral fluorescence, no stain odor or cut.

3250-3270 LIMESTONE (50%) light to medium gray, tan, white, brown, firm, micro to crypto to very fine crystalline, slightly chalky, argillaceous in part, silty in part, fossiliferous in part, trace Chert and crystalline Calcite, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) redbrown, brown, medium to dark gray, trace green gray, silty in part, trace fossiliferous.

3270-3280 LIMESTONE (50%) predominantly grainy very fine to micro crystalline, fossiliferous, trace brown micro sucrosic dolomitic, trace to occasional crystalline Calcite. **SHALE** (50%).

3280-3305 LIMESTONE (60%) white, light gray, cream, tan, trace green, micro to very fine to crypto crystalline, slightly chalky, grainy, slightly fossiliferous, silty in part, trace dolomitic, trace translucent lightgray milky Chert, very poor to no visible to poor inter crystalline porosity, dull to moderate yellow mineral fluorescence. **SHALE** (40%) redbrown, brown, occasionally medium gray, green gray, calcareous in part, silty in part, micro micaceous in part.

3305-3330 LIMESTONE (60%) cream, white, light gray, light brown, tan, firm to friable, micro to very fine to crypto crystalline, slightly chalky, grainy to granular in part, fossiliferous, silty in part, trace sandy, occasional Chert, very poor to no visible to poor inter crystalline porosity. **SHALE** (40%) as above.

3330-3355 LIMESTONE (90%) light to medium gray, brown, mottled, firm to slightly friable, micro to very fine to crypto crystalline, slightly chalky, grainy in part, fossiliferous, silty in part, slightly argillaceous in part, trace milky Chert, no visible to very poor porosity, trace to occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (10%) medium to dark gray, redbrown, calcareous, fossiliferous in part.

HEEBNER 3360' (+187)

3355-3375 LIMESTONE (90%) light to medium gray, white, lower brown, firm to slightly friable, micro to very fine crystalline, slightly chalky, grainy, silty, fossiliferous, argillaceous in part, trace milky lightgray brown Chert, no visible to very poor inter crystalline porosity. **SHALE** (10%) medium to dark gray, black, carbonaceous, calcareous, micro micaceous in part.

3375-3395 LIMESTONE (90%) light gray, light brown, cream, white, firm, micro to very fine to crypto crystalline, grainy, chalky in part, fossiliferous in part, silty in part, argillaceous in part, trace Chert and Pyrite, no visible to very poor inter crystalline porosity, occasional dull to moderate yellow mineral fluorescence, no stain odor or cut. **SHALE** (10%) dark to medium gray, black, redbrown, carbonaceous in part.

3395-3415 LIMESTONE (70%) as above, very silty grading to Siltstone in part. **SHALE** (30%) medium to dark gray, redbrown, black, green gray, fossiliferous in part, micro micaceous in part, carbonaceous in part, trace micro Pyrite.

3415-3430 LIMESTONE (60%) white, light to medium gray, trace green, firm to friable, micro to very fine to crypto crystalline, slightly chalky, silty to sandy with Silt stringers, trace fossiliferous, argillaceous in part, trace translucent Chert, no visible to very poor inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) redbrown, red, medium to dark gray, black, firm, calcareous, carbonaceous in part, slightly silty in part.

3430-3450 SHALE (60%) medium to dark gray, redbrown, soft to firm, subplaty to splintery to blocky, calcareous, slightly silty, fossiliferous in part, trace to occasionally carbonaceous material. **LIMESTONE** (40%) light to medium gray, white, friable to firm, micro crystalline, silty, argillaceous, fossiliferous in part, no visible to very poor porosity, trace to occasional yellow mineral fluorescence.

3450-3470 LIMESTONE (70%) white, cream, light gray, light brown, friable to firm, micro to crypto to very fine crystalline, chalky, grainy in part, fossiliferous in part, silty in part, occasional orange milky tan Chert, no visible porosity, occasional dull yellow mineral fluorescence. **SHALE** (30%) as above.

3470-3490 SHALE (60%) redbrown, medium to dark gray, soft to firm, subplaty to blocky to splintery, calcareous, slightly silty, trace plant remains and carbonaceous material, trace fossiliferous, trace Pyrite, earthy to smooth. **LIMESTONE** (40%) white, cream, light to medium gray, fossiliferous in part, silty in part, argillaceous in part.

3490-3510 LIMESTONE (70%) white, cream, occasionally light gray, light brown, firm to slightly friable, micro to very fine crystalline, chalky, grainy in part, trace micro sucrosic to granular, fossiliferous in part, trace Chert, very poor to no visible inter crystalline porosity, dull to moderate yellow mineral fluorescence. **SHALE** (30%) medium to dark gray, black, occasionally redbrown, gray green, calcareous, carbonaceous in part, silty in part.

LANSING 3512' (+35)

3510-3545 LIMESTONE (60%) white, cream, light gray, firm to friable, very fine to micro crystalline, slightly chalky in part, silty to sandy, grading to Silt and silty very fine grained Sandstone in part, trace fossiliferous, trace green minerals and Pyrite, no visible to very poor porosity, occasional dull yellow mineral fluorescence. **SANDSTONE** (20%) light gray, white, friable to firm, silty very fine grained, subangular to subround, moderately well sorted, slightly to moderately calcareous, no visible porosity, No stain odor fluorescence or cut. **SHALE** (20%) as above, trace black carbonaceous.

3545-3560 LIMESTONE (90%) tan, light gray, white, firm to slightly friable, very fine to micro crystalline, very silty to sandy, slightly argillaceous in part, trace fossiliferous, trace Pyrite, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence, no stain odor or cut. **SHALE** (10%) as above.

3560-3575 LIMESTONE (60%) as above, fossiliferous in part, argillaceous in part. **SHALE** (40%) redbrown, green, medium to dark gray, maroon, firm, blocky to subplaty, calcareous, slightly silty, trace fossiliferous, trace carbonaceous, trace Pyrite.

3575-3590 SHALE (60%) medium to dark gray, occasional redbrown, blocky, silty to sandy, micaceous, occasionally slightly fossiliferous, trace Pyrite. **LIMESTONE** (40%) light to medium gray, white, firm to friable, very fine to micro crystalline, silty to sandy, fossiliferous in part, argillaceous in part, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence.

3590-3610 SHALE (50%) as above, very silty to sandy with Silt stringers, occasionally Pyrite, carbonaceous in part. **LIMESTONE** (50%) light to medium gray, tan, gray brown, white, micro to very fine crystalline, silty to sandy with Silt stringers, fossiliferous, argillaceous, trace Chert and Pyrite, no visible to very poor porosity, trace yellow mineral fluorescence, no stain odor or cut.

3610-3650 SHALE (60%) medium gray, redbrown, dark gray, firm to soft, subplaty to blocky to splintery, calcareous, silty in part, trace sandy, trace fossiliferous, trace carbonaceous material, trace Pyrite, earthy to slightly gritty. **LIMESTONE** (40%) cream, light to medium gray, white, trace brown, firm, micro to very fine to crypto crystalline, silty in part, argillaceous in part, fossiliferous in part, trace milky translucent Chert, trace Pyrite, no visible to very poor porosity, occasional yellow mineral fluorescence, no stain odor or cut.

3650-3670 SHALE (60%) as above, trace black, carbonaceous. **LIMESTONE** (40%) white, light to medium gray, trace cream, tan, light brown, firm, micro to crypto to very fine crystalline, chalky in part, fossiliferous in part, argillaceous in part, trace translucent tan Chert, no visible porosity, trace yellow mineral fluorescence.

3670-3690 LIMESTONE (50%) white, tan, occasionally light gray, light to medium brown, firm, predominantly dense crypto to micro crystalline, very fine crystalline in part, chalky in part, fossiliferous in part, trace milky translucent Chert, no visible porosity, yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) medium to dark gray, redbrown, subplaty to blocky to irregular, calcareous, silty in part, fossiliferous in part, trace carbonaceous.

3690-3710 LIMESTONE (70%) tan, light brown, white, light to medium gray, as above, predominantly crypto crystalline, occasionally micro to very fine crystalline, silty to sandy in part. **SHALE** (30%) as above.

3710-3730 LIMESTONE (70%) cream, white, light brown, firm to slightly friable, micro to very fine crystalline, chalky, fossiliferous, silty in part, occasional milky Chert, no visible to very poor to poor inter crystalline porosity, occasional dull to moderate yellow mineral fluorescence,

no stain odor or cut. **SHALE** (30%) dark to medium gray, black, redbrown, firm to soft, subplaty to blocky, calcareous, slightly to very carbonaceous, silty in part, occasional plant remains, occasional Pyrite.

3730-3745 LIMESTONE (60%) as above with light to medium gray, white, silty, fossiliferous, argillaceous in part, trace medium gray pelletoidal, rare scattered distorted fine oolites, trace Chert and Pyrite, no visible to very poor porosity, occasional dull yellow mineral fluorescence. **SHALE** (40%) medium to dark gray, silty to sandy, very calcareous, occasional carbonaceous material, trace to occasional very carbonaceous.

3745-3770 SHALE (50%) medium gray, occasionally dark gray, firm, blocky to subplaty, calcareous, silty to sandy, occasionally carbonaceous material, trace fossiliferous, trace to occasional Pyrite. **LIMESTONE** (50%) light to medium gray, white, trace brown, mottled in part, firm, micro to very fine crystalline, predominantly silty and argillaceous, fossiliferous, occasional medium to dark gray pelletoidal, trace Pyrite and translucent milky lightgray Chert, no visible porosity, occasional yellow mineral fluorescence.

3770-3790 LIMESTONE (60%) as above, predominantly very fine crystalline, fossiliferous, silty to sandy in part, argillaceous in part, trace pelletoidal. **SHALE** (40%) as above, occasional micro Pyrite, micaceous in part.

3790-3810 LIMESTONE (70%) white, cream, light brown, trace medium gray, friable to firm, very fine to micro crystalline, chalky in part, grainy to granular in part, fossiliferous, rare sandy with green minerals, trace Chert and Pyrite, very poor to no visible to poor inter crystalline porosity, trace dull yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) dark to medium gray, black, firm, subplaty, calcareous, carbonaceous in part, silty in part, occasional disseminated and micro Pyrite.

3810-3830 LIMESTONE (70%) cream, white, light brown, trace brown, light to medium gray, firm, micro to crypto crystalline, slightly chalky, predominantly dense, slightly grainy in part, slightly fossiliferous, occasional milky Chert, no visible porosity. **SHALE** (30%) dark to medium gray, black, redbrown, as above.

3830-3850 LIMESTONE (60%) as above, occasionally micro to very fine crystalline, moderately fossiliferous, silty and argillaceous in part, occasional milky lightgray cream Chert, no visible to very poor porosity, trace dull yellow mineral fluorescence, no stain odor or cut.

SHALE (40%) dark to medium gray, gray brown, soft to friable to firm, blocky to irregular, calcareous, silty, carbonaceous with plant remains, fossiliferous in part, slightly micaceous, trace to occasional Pyrite.

3850-3890 LIMESTONE (70%) light to medium gray, occasionally tan, white, cream, brown, firm to very firm, micro to crypto to very fine crystalline, argillaceous, fossiliferous, silty in part, trace Pyrite and Chert, no visible to very poor inter crystalline porosity, trace yellow green mineral fluorescence. **SHALE** (30%) as above.

3890-3910 LIMESTONE (70%) cream, white, light gray, light brown, friable to firm, micro to crypto to very fine crystalline, chalky in part, sucrosic in part, slightly fossiliferous, occasionally silty to sandy with trace Silt and very fine grained Sandstone stringers, trace green minerals, trace to occasional milky Chert, very poor to no visible to poor inter crystalline and inter granular porosity, occasional dull to moderate to bright yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) medium to dark gray, redbrown, silty, occasional carbonaceous material and plant remains, occasional micro Pyrite.

3910-3930 LIMESTONE (60%) light to medium gray, cream, white, as above, becoming argillaceous very silty to sandy in part, trace Chert and Pyrite, no visible to very poor porosity, trace mineral fluorescence. **SHALE** (40%) as above, limy and very silty in part.

3930-3950 SHALE (50%) medium to dark gray, friable to firm, blocky, calcareous, silty to sandy, carbonaceous in part with occasional plant remains and carbonaceous material, trace black very carbonaceous, micaceous, trace to occasional micro Pyrite, fossiliferous in part.

LIMESTONE (50%) light to medium gray, occasionally cream, white, tan, predominantly friable to firm, very fine to micro crystalline, argillaceous, silty to sandy, occasional dense micro to crypto crystalline, fossiliferous in part, trace Pyrite, occasional moderate yellow mineral fluorescence, no stain odor or cut.

3950-3970 SHALE (50%) medium gray, gray brown, soft to firm, blocky, limy, silty to sandy, slightly carbonaceous, micaceous in part, trace Pyrite. **LIMESTONE** (50%) light to medium gray, friable to firm, very fine to micro crystalline, slightly chalky, argillaceous, silty to sandy, trace fossiliferous, occasional carbonaceous material, trace Pyrite, no visible porosity, trace to occasional yellow mineral fluorescence, rare weak residual yellow cut.

3970-3990 LIMESTONE (70%) white, light brown, light gray, friable, very fine to fine to micro crystalline, granular, slightly chalky in part, fossiliferous in part, trace pelletoidal, silty to sandy in part, argillaceous in part, trace Chert and Pyrite, no visible to very poor inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) as above.

3990-4010 LIMESTONE (70%) light gray, white, tan, firm, micro to crypto to very fine crystalline, slightly chalky, grainy in part, trace granular, slightly fossiliferous, slightly argillaceous in part, occasional crystalline Calcite, trace Chert and Pyrite, no visible to very poor porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (30%) medium to dark gray, redbrown, green.

4010-4050 LIMESTONE (60%) light to medium gray, white, tan, brown, firm to slightly friable, micro to very fine to crypto crystalline, grainy to very fine sucrosic in part, slightly fossiliferous in part, silty in part, slightly argillaceous in part, trace to occasional milky lightgray translucent Chert, trace crystalline Calcite and Pyrite, no visible to very poor inter crystalline porosity, occasional yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) redbrown, medium to dark gray, brown, black, firm to friable to soft, blocky to subplaty, calcareous, silty in part, carbonaceous in part with occasional plant remains, trace fossiliferous, trace Pyrite, earthy to smooth to slightly gritty.

4050-4090 SHALE (50%) redbrown, medium to dark gray, green gray, firm, blocky to subplaty to splintery, calcareous in part, slightly silty in part, trace to occasional plant remains, trace fossiliferous, trace Pyrite. **LIMESTONE** (50%) tan, cream, white, light brown, light gray, firm, micro to crypto to very fine crystalline, slightly chalky in part, occasionally slightly grainy, trace granular, fossiliferous, occasionally slightly silty, occasionally slightly argillaceous, trace crystalline Calcite and milky translucent Chert, no visible to very poor porosity, occasional yellow mineral fluorescence.

4090-4110 LIMESTONE (60%) light gray, tan, brown, white, micro to crypto to very fine crystalline, slightly chalky, grainy in part, predominantly silty, slightly fossiliferous, slightly argillaceous in part. **SHALE** (40%) dark to medium gray, redbrown, black, green, firm, blocky to subplaty to splintery, calcareous, carbonaceous in part, slightly silty, trace fossiliferous, trace micro Pyrite.

MARMATON 4110' (-563)

4110-4130 LIMESTONE (80%) tan, light brown, off white, friable to firm, micro to crypto crystalline, slightly chalky, grainy in part, fossiliferous, trace translucent Chert, no visible porosity, trace dull yellow mineral fluorescence, no stain odor or cut. **SHALE** (20%) dark gray, black, carbonaceous, occasionally redbrown, green.

4130-4150 LIMESTONE (50%) tan, cream, white, light brown, firm, micro to crypto to very fine crystalline, chalky in part, fossiliferous in part, silty in part, occasionally slightly argillaceous, trace crystalline Calcite and lightgray translucent Chert, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence, no stain odor or cut. **SHALE** (50%) dark gray, black, occasionally medium gray, redbrown, soft to firm, subplaty to blocky to platy, calcareous, carbonaceous, slightly silty, fossiliferous in part, occasional plant remains, micaceous in part, trace Pyrite.

4150-4190 SHALE (50%) dark gray, black, medium gray, redbrown, predominantly silty and carbonaceous with occasional plant remains, micaceous in part, trace fossiliferous, trace Pyrite. **LIMESTONE** (50%) white, tan, light brown, light gray, firm to slightly friable, very fine to micro to crypto crystalline, fossiliferous, silty in part, occasional milky lightgray lightbrown translucent Chert, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence, no stain odor or cut.

4190-4210 SHALE (60%) dark gray, black, medium gray, redbrown, firm, blocky to subplaty to platy to splintery, calcareous to slightly calcareous, carbonaceous in part, silty in part, fossiliferous in part, trace to occasional disseminated and micro Pyrite. **LIMESTONE** (40%) as above.

4210-4230 LIMESTONE (60%) white, light to medium gray, tan, light brown, firm to slightly friable, micro to very fine to crypto crystalline, slightly chalky in part, fossiliferous, silty in part, slightly argillaceous in part, trace to occasional translucent brown milky lightgray Chert, trace Pyrite and crystalline Calcite, no visible to very poor inter crystalline porosity, trace yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) as above.

CHEROKEE 4230' (-683)

4230-4250 SHALE (50%) dark gray, black, occasionally medium gray, gray brown, redbrown, firm, blocky to subplaty, calcareous, carbonaceous, silty in part, fossiliferous in part, micaceous in part, trace Pyrite. **LIMESTONE** (50%) as above.

4250-4270 SHALE (60%) dark gray, black, firm to very firm, blocky to subplaty, calcareous, carbonaceous, silty, trace sandy, fossiliferous in part, micro micaceous in part, trace to occasional micro Pyrite. **LIMESTONE** (40%) light to medium gray, brown, white, predominantly micro to crypto crystalline, dense, argillaceous, fossiliferous with shell fragments, silty in part, no visible porosity, trace yellow mineral fluorescence.

4270-4290 LIMESTONE (50%) light gray, tan, occasionally white, light brown, firm to slightly friable, micro to very fine to crypto crystalline, fossiliferous, silty in part, trace sandy with green minerals, argillaceous in part, trace translucent milky Chert, trace Pyrite and crystalline Calcite, no visible to very poor inter crystalline porosity, trace to occasional dull yellow mineral fluorescence. **SHALE** (50%) as above, medium gray in part.

4290-4310 SHALE (60%) black, dark to medium gray, firm to very firm, blocky to subplaty, calcareous, carbonaceous, silty, micro micaceous, trace to occasional micro Pyrite, fossiliferous in part. **LIMESTONE** (40%) as above, very argillaceous and silty in part.

4310-4330 LIMESTONE (60%) cream, white, light gray, light brown, firm, micro to crypto to very fine crystalline, slightly chalky, silty to sandy, slightly fossiliferous in part, argillaceous in part, trace Chert and crystalline Calcite, no visible to very poor inter crystalline porosity, trace to occasional dull yellow mineral fluorescence, no stain odor or cut. **SHALE** (40%) as above.

4330-4350 LIMESTONE (60%) light to medium gray, white, tan, brown, firm, becoming predominantly micro to crypto crystalline, dense in part, occasionally silty, trace sandy, slightly fossiliferous in part, argillaceous in part, trace to occasional brown translucent gray Chert, no visible porosity, occasional dull yellow mineral fluorescence. **SHALE** (40%) dark to medium gray, black, gray green, carbonaceous in part, slightly silty in part, trace fossiliferous, trace Pyrite.

4350-4370 SHALE (50%) dark to medium gray, black, redbrown, brown, firm to slightly soft to very firm, subplaty to blocky to splintery to irregular, calcareous, carbonaceous in part, slightly silty in part, trace sandy with green minerals, fossiliferous in part, trace to occasional Pyrite. **LIMESTONE** (50%) light to medium gray, light to medium to dark brown, white, tan, as above, sandy very fine crystalline in part, occasional Chert, trace Pyrite, no visible to very poor porosity.

4370-4410 LIMESTONE (50%) light to medium gray, cream, white, light to medium brown, micro to crypto to very fine crystalline, fossiliferous in part, silty in part, trace sandy, occasionally slightly argillaceous, trace to occasional brown tan milky translucent Chert (fossiliferous in part), trace Pyrite, no visible to very poor porosity, trace dull yellow mineral fluorescence. **SHALE** (50%) as above.

4410-4430 SHALE (50%) dark gray, black, medium gray, occasionally redbrown, green gray, firm, subplaty to blocky to splintery, calcareous, carbonaceous, silty in part, trace sandy, trace fossiliferous, trace micro Pyrite. **LIMESTONE** (50%) as above.

4430-4450 SHALE (50%) as above. LIMESTONE (50%) light to medium to dark gray, tan, brown, white, mottled in part, firm to very firm to slightly friable, micro to very fine to crypto crystalline, argillaceous in part, silty in part, fossiliferous in part, trace to occasional micro Pyrite, trace Chert, no visible to very poor porosity, rare yellow mineral fluorescence.

4450-4470 LIMESTONE (60%) as above. SHALE (40%) dark to medium gray, occasional black, firm to very firm, blocky to subplaty to irregular, calcareous, carbonaceous in part, slightly silty in part, trace sandy, trace fossiliferous, trace Pyrite, smooth to earthy to slightly gritty.

ATOKA 4473' (-926)

4470-4510 LIMESTONE (80%) tan, light to medium gray, white, mottled in part, very firm to firm, crypto crystalline, dense, slightly chalky, slightly grainy in part, slightly fossiliferous, no visible porosity, rare yellow mineral fluorescence, no stain odor or cut. SHALE (20%) as above.

4510-4530 LIMESTONE (60%) as above, occasionally light to medium to dark brown, silty in part, fossiliferous in part. SHALE (60%) dark to medium gray, black, firm to soft to very firm, subplaty to blocky, calcareous, silty in part, carbonaceous in part, micro micaceous in part, trace fossiliferous, trace Pyrite.

4530-4550 SHALE (50%) as above, slightly to very carbonaceous, occasional disseminated and micro Pyrite. LIMESTONE (50%) light to dark gray, light to dark brown, white, tan, mottled in part, firm to very firm, micro to crypto to very fine crystalline, fossiliferous, silty in part, argillaceous in part, trace to occasional Pyrite, no visible porosity, rare yellow mineral fluorescence.

4550-4570 SHALE (60%) black, firm, subplaty to splintery, calcareous to slightly calcareous, carbonaceous, micro micaceous in part, fossiliferous in part, trace to occasional micro Pyrite. LIMESTONE (40%) as above, predominantly mottled light to medium gray, argillaceous, trace crystalline Calcite.

4570-4610 SHALE (70%) as above, slightly silty in part. **LIMESTONE** (30%) light to medium to dark gray, brown, white, firm to very firm, micro to crypto to very fine crystalline, silty in part, trace sandy, fossiliferous in part, argillaceous in part.

MORROW 4614' (-1067)

4610-4630 SHALE (50%) dark to medium gray, black as above with occasional light to medium gray, soft, subplaty to irregular, slightly silty, micaceous, trace micro Pyrite, subchalky to slightly gritty. **LIMESTONE** (50%) light to medium gray, white, brown, firm, micro to crypto crystalline, slightly chalky, silty, trace sandy with rare fine to medium Quartz sand grains, argillaceous, slightly fossiliferous in part, no visible porosity, trace yellow mineral fluorescence.

4630-4650 SHALE (60%) tan, medium to dark to light gray, green gray, soft to firm, subplaty to irregular to platy, calcareous in part, slightly silty, carbonaceous in part, occasional micro Pyrite. **LIMESTONE** (20%) as above. **SANDSTONE** (20%) light gray, white, light brown, hard to slightly friable, fine to coarse grained, angular to subround, poor sorted, slightly calcareous with secondary Quartz, occasional white light green clay filled, trace micro Pyrite, no visible porosity, No stain odor fluorescence or cut.

4650-4670 SHALE (60%) as above, predominantly light gray, green gray, occasional black carbonaceous, occasional to abundant Pyrite. **LIMESTONE** (30%) white, light to medium brown, cream, light to medium gray, friable to very firm, micro to very fine to crypto crystalline, silty to sandy with trace Silt stringers, fossiliferous in part, trace to occasional to abundant Pyrite, argillaceous in part, no visible porosity, trace to occasional yellow mineral fluorescence, no stain odor or cut. **SANDSTONE** (10%) as above, very fine to fine grained in part, friable in part, trace yellow mineral fluorescence, no stain odor or cut.

4670-4710 SHALE (70%) dark to medium to light gray, black, green gray, trace brown, dark green, olive, firm to soft, blocky to irregular to platy to splintery, non to slightly to moderately calcareous, silty in part, carbonaceous in part, occasional Pyrite. **LIMESTONE** (30%) light to medium to dark brown, light to medium gray, white, firm, micro to crypto to fine crystalline, fossiliferous in part, silty to sandy in part with occasional fine to coarse Quartz grains, trace Pyrite, no visible porosity, occasional yellow mineral fluorescence.

4710-4740 SHALE (80%) dark gray, black, medium to light gray, green, brown, soft, platy to subplaty to splintery, slightly to moderately calcareous, carbonaceous in part, slightly silty in part, micro micaceous in part, occasional plant remains, trace to occasional micro Pyrite. **LIMESTONE** (20%) white, light to medium gray, light to medium brown, very fine to micro to crypto crystalline, chalky in part, fossiliferous in part, trace to very sandy, argillaceous in part.

4740-4770 SHALE (90%) dark gray, occasionally medium to light gray, green, green gray, tan, soft, platy to splintery, slightly to trace calcareous, micro micaceous, slightly silty in part with trace Silt and silty very fine grained Sandstone stringers, occasional plant remains, trace to occasional micro Pyrite. **LIMESTONE** (10%) as above.

4770-4785 SHALE (100%) predominantly dark gray, black, medium gray, soft, platy to splintery, slightly to trace calcareous, as above, occasional medium to light gray, soft, blocky to subplaty, non calcareous, silty with medium gray Silt stringers, trace glauconite, trace plant remains and Pyrite, rare brown crypto crystalline Limestone.

4785-4800 SHALE (90%) dark to medium gray, soft to slightly firm, platy to splintery to subplaty, becoming calcareous, slightly silty in part, micro micaceous in part, trace micro Pyrite and plant remains. **LIMESTONE** (10%) tan, brown, light to medium gray, white, firm, micro to crypto to very fine to fine crystalline, chalky in part, sandy in part, fossiliferous in part.

4800-4830 SHALE (100%) dark gray, black, trace to occasionally light to medium gray, green gray, soft to slightly firm, platy to splintery, calcareous, micro micaceous, trace Pyrite. **LIMESTONE** (Trace) brown, white, very fine to fine crystalline, sandy, fossiliferous, occasional Shale fragments, trace Pyrite.

4830-4850 SHALE (100%) as above, becoming slightly to non calcareous, trace very fine to fine grained Sandstone stringers, occasional disseminated and micro Pyrite. **SANDSTONE** (Trace) light gray, brown, white, loose to firm, fine to medium Quartz grains with Limestone and fossil fragments, angular to rounded, poor sorted, calcareous, argillaceous in part, No stain odor fluorescence or cut.

4850-4860 SHALE (80%) dark gray, as above. **LIMESTONE** (20%) cream, light brown, white, firm to slightly friable, predominantly fossil fragments with very fine to medium grained Quartz sand grains, white clay filled in part, chalky in part, trace Pyrite, no visible porosity, trace to occasional yellow mineral fluorescence, no stain odor or cut.

4860-4880 SHALE (90%) dark gray, black, soft, platy to splintery, calcareous, micaceous in part with occasional medium gray, firm, blocky, calcareous, very silty, trace sandy, trace to occasional plant remains and Pyrite. **LIMESTONE** (10%) as above.

4880-4900 SHALE (100%) dark gray, black, medium gray, soft to slightly firm, platy to splintery to subplaty, calcareous, micro micaceous, slightly silty, trace to occasional plant remains and Pyrite. Trace **SHALE** green, light gray, non calcareous, subchalky.

4900-4915 SHALE (100%) as above. **LIMESTONE** (Trace) brown, light to dark gray, white, fossiliferous, argillaceous, sandy in part.

MORROW 'F' 4917' (-1370)

4915-4930 SHALE (60%) dark gray, black, medium gray, as above, calcareous, very silty in part. **SHALE** (20%) green, light gray, soft, irregular, non calcareous, occasional plant remains and Pyrite, slightly silty in part, trace glauconite, subchalky. **SANDSTONE** (20%) light gray, translucent, white, brown, friable to firm, moderately well sorted very fine to fine sand matrix with scattered fine to coarse Quartz grains, occasional Limestone and fossil fragments, Calcite cement, occasional secondary Quartz, glauconitic, trace Pyrite, no visible porosity, No stain odor fluorescence or cut.

4930-4950 SHALE (60%) as above. **SANDSTONE** (40%) light to medium to dark gray, brown, white, predominantly friable very fine to fine grained, occasional fine to coarse Quartz grains with Limestone and fossil fragments, glauconitic, occasional secondary Quartz, white clay filled in part, trace Pyrite, no visible porosity, No stain odor fluorescence or cut.

4950-4970 SHALE (60%) dark gray, black, medium gray, calcareous, slightly silty in part, occasional light gray, green, soft to firm, blocky, calcareous. **LIMESTONE** (30%) dark to medium to light gray, very firm to firm, crypto to micro crystalline, slightly chalky in part, silty in part, argillaceous in part, trace sandy, no visible porosity, rare yellow mineral fluorescence. **SANDSTONE** (10%) as above.

4970-4975 SHALE (50%) as above. **SANDSTONE** (50%) medium to light gray, friable, very fine to fine grained, calcareous, glauconitic, white clay filled in part, trace Pyrite, no visible to very poor porosity, No stain odor fluorescence or cut.

4975-4990 SHALE (70%) dark to medium gray, calcareous, silty to sandy in part, micro micaceous, trace glauconite. **SANDSTONE** (20%) as above. **LIMESTONE** (10%) light to medium brown, medium to dark gray, micro to very fine to crypto crystalline, sandy in part, dense and argillaceous in part.

4990-5015 SANDSTONE (50%) light to medium to dark gray, white, firm to very firm, fine to very fine grained, angular to subround, moderately sorted, calcareous, secondary Quartz, glauconitic, trace to occasional micro Pyrite, trace red Shale grains, no visible to very poor porosity, No stain odor fluorescence or cut. **SHALE** (50%) dark gray, black, firm to soft, subplaty to platy to splintery to irregular, non to slightly to moderately calcareous, silty to sandy in part, trace to occasional Pyrite, smooth to earthy to gritty.

5015-5035 SANDSTONE (60%) light gray, very firm to friable, very fine to medium grained, subangular to subround, moderately sorted, slightly calcareous, occasional secondary Quartz, glauconitic, white clay filled in part, trace micro Pyrite, no visible porosity, No stain odor fluorescence or cut. **SHALE** (40%) as above.

5035-5045 SHALE (50%) dark gray, soft to firm, platy to splintery, non to slightly calcareous, micro micaceous in part, trace Pyrite, smooth to earthy. **SANDSTONE** (50%) as above, becoming limy in part.

5045-5060 SHALE (60%) as above. **SANDSTONE** (40%) light gray, white, medium gray, friable to very firm, very fine to coarse grained, angular to subround, poor sorted, Calcite and Silica cement with secondary Quartz, glauconitic, occasional Limestone fragments, argillaceous in part, trace Pyrite, no visible to very poor inter granular porosity, No stain odor fluorescence or cut.

5060-5075 SHALE (80%) dark gray, occasional medium gray, trace green, firm to soft, platy to splintery, calcareous in part, micro micaceous, trace micro Pyrite. **SANDSTONE** (20%) as above, occasional Limestone fragments, chalky white clay filled in part, very argillaceous in part. **LIMESTONE** (Trace) tan, light gray, crypto crystalline, slightly chalky.

5075-5090 SHALE (60%) as above. **SANDSTONE** (40%) light gray, friable to loose to very firm, fine to very coarse grained, angular to subround, poor sorted, Calcite cement with secondary Quartz, glauconitic, chalky white clay filled in part, limy in part, occasional red Shale fragments, no visible to very poor porosity, trace yellow mineral fluorescence, no stain odor or cut.

5090-5100 SANDSTONE (70%) as above, occasional yellow orange Quartz grains, non to slightly calcareous with secondary Quartz, occasional glauconite, No stain odor fluorescence or cut. **SHALE** (30%) dark gray, black, brown.

5100-5115 SHALE (60%) dark gray, black, non to slightly to moderately calcareous, occasionally Pyrite, trace to occasional plant remains. **SANDSTONE** (40%) as above, friable to loose to very firm very fine to very coarse grained, glauconitic in part, trace Pyrite, no visible to very poor porosity, No stain odor fluorescence or cut.

5115-5130 SANDSTONE (60%) loose to very firm fine to very coarse grained, slightly calcareous, secondary Quartz, glauconitic, chalky white clay filled in part, trace Pyrite. **SHALE** (40%) as above.

CHESTER 5128' (-1581)

5130-5140 LIMESTONE (40%) white, light green, occasionally light gray, friable to firm, very fine to micro crystalline, slightly chalky, silty to sandy, trace Pyrite, no visible porosity, No stain odor fluorescence or cut. **SHALE** (40%) dark to medium gray, black as above with redbrown, maroon, green, light to medium gray, purple, trace variegated, soft to firm, blocky to irregular, slightly to non calcareous, chalky, trace Pyrite. **SANDSTONE** (20%) as above.

5140-5170 SHALE (50%) redbrown, orange, occasionally maroon, purple, light to medium gray, green, as above, silty in part, trace sandy. **LIMESTONE** (30%) redbrown, tan, white, green, light to medium gray, pink, lavender, friable to soft to firm, micro to very fine crystalline, slightly chalky, silty to sandy in part, argillaceous in part, trace Pyrite. **SANDSTONE** (20%) light gray, translucent, white, loose to friable to firm, fine to very coarse Quartz grains, secondary Quartz.

5170-5185 SHALE (40%) as above. **LIMESTONE** (30%) redbrown, brown, pink, white, green, chalky, silty to sandy. **SANDSTONE** (30%) as above.

5185-5195 SHALE (40%) dark gray, black with redbrown, green, medium to light gray, maroon, purple, slightly calcareous, subchalky to earthy to subwaxy. LIMESTONE (40%) redbrown, green, brown, white, pink, maroon, friable to firm, micro to very fine to crypto crystalline, chalky, silty to sandy in part. SANDSTONE (20%) as above.

5195-5210 SHALE (40%) as above. LIMESTONE (40%) predominantly white, light gray, occasionally redbrown, pink, green, brown, friable to firm, very fine to micro crystalline, slightly chalky, silty to sandy. SANDSTONE (10%) as above.