ENLARGED VIEW

SCALE IN FEET 0 1500

LEGEND

- ROAD
- WATER
- B — — — B' CROSS SECTION LOCATION
- MUNICIPAL BOUNDARY LINES
- AREA OF RETSOF & STERLING SALT MINES
- ×14498 DATA POINT LOCATION WITH UNIT D THICKNESS AND API IDENTIFICATION
- SALT MINE SHAFT

0 1/2 1 2 MILES

0 1/2 1 2 KILOMETERS

0 3000 FEET

NORTH

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 1
DATA LOCATION MAP

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

Revised PLATE 1 – DATA LOCATION MAP

AGE	SERIES	GROUP	FORMATION	MEMBER OR INFORMAL ROCK UNIT	DESCRIPTION
PLEISTOCENE	WISCONSONIAN			GLACIAL OVERBURDEN	PREDOMINANTLY GLACIAL TILL OR GLACIOLACUSTRINE CLAYS AND SILTS
UPPER DEVONIAN	SENECAN	WEST FALLS		HATCH SHALE	SHALE; INTERLAYERED GRAY AND BROWNISH BLACK; NON-CALCAREOUS TO CARBONACEOUS; WITH OCCASIONAL ARGILLACEOUS LIMESTONE BANDS AND CONCRETIONARY LAYERS; RARE FOSSILS; MILD PETROLIFEROUS ODOR; FISSILE
				RHINESTREET SHALE	SHALE; INTERLAYED GRAY AND BROWNISH BLACK; PREDOMINANTLY BROWNISH BLACK AND HIGHLY FISSILE TOWARD BASE; NON-CALCAREOUS; CARBONACEOUS; VERY RARE FOSSILS; RARE PYRITE; RARE SEPTARIA; PETROLIFEROUS ODOR
		SONYEA		CASHAQUA SHALE	SHALE; OLIVE GRAY, DARK GRAY, AND BROWNISH BLACK; SLIGHTLY CALCAREOUS TO NON-CALCAREOUS; RARE TO OCCASIONAL FOSSILS INCLUDE STYLIOLINIDS, GONIATITE CEPHALOPODS, SMALL BRACHIOPODS AND PELECYPODS; RARE CARBONIZED PLANT DEBRIS AND PYRITIZED BURROW CASTS; HIGHLY FISSILE
				PULTENEY SHALE	SHALE; INTERBEDDED DARK GRAY AND BROWNISH BLACK, WITH BEDDING THICKNESS AVERAGING 0.5 FEET; NON-CALCAREOUS; BROWNISH BLACK BEDS ARE CARBONACEOUS AND HAVE PETROLIFEROUS ODOR; VERY RARE FOSSILS
				MIDDLESEX SHALE	SHALE; BROWNISH BLACK, RARELY DARK GRAY; CARBONACEOUS; OCCASIONAL PYRITE; ABUNDANT STYLIOLINIDS AND CONODONTS; OCCASIONAL THIN LAYERS OF COALIFIED MATERIAL AND CARBONIZED PLANT FRAGMENTS; RARE CALCAREOUS CONCRETIONS
		GENESEE		WEST RIVER SHALE	SHALE; DARK GRAY, OCCASIONALLY INTERBEDDED WITH BROWNISH BLACK; DARK GRAY INTERVALS ARE CALCAREOUS, WITH OCCASIONAL STYLIOLINIDS, BRACHIOPODS AND PELECYPODS, AND FREQUENT PYRITE BURROW CASTS; BROWNISH BLACK BEDS ARE CARBONACEOUS, NON-CALCAREOUS, WITH RARE PYRITE AND A PETROLIFEROUS ODOR; UNIT CONTAINS OCCASIONAL CALCAREOUS CONCRETIONS AND SEPTARIA
				GENUNDEWA LST	LIMESTONE; DARK GRAY TO OLIVE BLACK; NODULAR; ABUNDANT STYLIOLINIDS AND RARE BRACHIOPODS; NODULES RARELY SEPTARIAN
				PENN YAN SHALE	SHALE; INTERBEDDED DARK GRAY AND BROWNISH BLACK; CALCAREOUS TO SLIGHTLY CALCAREOUS; WITH FREQUENT, CALCAREOUS CONCRETIONS AND THIN, BIOTURBATED, ARGILLACEOUS LIMESTONE BANDS; FOSSILIFEROUS, WITH ABUNDANT STYLIOLINIDS, AND OCCASIONAL BRACHIOPODS AND PELECYPODS; MODERATELY PYRITIC
				GENESEO SHALE	SHALE; BLACK TO BROWNISH BLACK; CARBONACEOUS; SLIGHTLY CALCAREOUS TOWARD BASE OF UNIT; FREQUENT PYRITE AS LAMINAE AND NODULES; MIDDLE THIRD OF UNIT COMMONLY CHARACTERIZED BY FREQUENT FOSSIL HASH LAYERS OF STYLIOLINIDS AND BRACHIOPODS, AND BY THIN ARGILLACEOUS LIMESTONE BEDS; MILD PETROLIFEROUS ODOR THROUGHOUT UNIT; FISSILE; "LEICESTER PYRITE" LAG AT BASE OF UNIT
				WINDOM SHALE	SHALE; DARK GRAY; NON-CALCAREOUS TO SLIGHTLY CALCAREOUS; FREQUENT THIN FOSSIL HASH LAYERS CHARACTERIZED BY AMBOCOELLID BRACHIOPODS, RUGOSE CORALS, BRYOZOANS, CRINOIDS, AND TRILOBITES; PYRITE AS BURROW CASTS AND FOSSIL REPLACEMENT; RARE CALCAREOUS CONCRETIONS; BASE OF UNIT AT BOTTOM OF 0.2 FOOT INTERVAL CONTAINING GRAYISH BLACK, SUBANGULAR PHOSPHATE PEBBLES ("LITTLE BEARDS CREEK PHOSPHALE BED")
		HAMILTON	MOSCOW	KASHONG SHALE	SHALE; DARK GRAY; NON-CALCAREOUS TO CALCAREOUS; SCATTERED AND OCCASIONAL FOSSILS INCLUDE CRINOIDS, BRYOZOANS, AND SPIRIFERID BRACHIOPODS, WITH A NOTICEABLE ABSENCE OF AMBOCOELLIDS; BIOTURBATED AND BURROWED; LOWER HALF OF UNIT COMMONLY CONTAINS FREQUENT FOSSIL HASH BEDS; PYRITE AS BURROW CASTS AND FOSSIL REPLACEMENT; VERY FOSSILIFEROUS IN LOWER 5 FEET
				TICHENOR LST	LIMESTONE; DARK GRAY; NODULAR TO MASSIVE; VERY FOSSILIFEROUS, WITH CRINOIDS, TABULATE AND RUGOSE CORALS, BRACHIOPODS AND BRYOZOANS; INTENSELY CHURNED BY BURROWING
				JAYCOX SHALE	SHALE; DARK GRAY; SLIGHTLY CALCAREOUS TO CALCAREOUS; ABUNDANTLY FOSSILIFEROUS; WITH PYRITE ABUNDANT IN UPPER 1 FOOT
				WANAKAH SHALE	SHALE; DARK GRAY; SLIGHTLY TO NON-CALCAREOUS; WITH OCCASIONAL THIN, BIOTURBATED, ARGILLACEOUS LIMESTONES; FOSSILIFEROUS, WITH ABUNDANT AMBOCOELLID BRACHIOPODS, BRYOZOANS, CRINOIDS, TRILOBITES, STYLIOLINIDS, AND RARE RUGOSE CORAL TOWARD BASE; MODERATELY PYRITIC; MILD PETROLIFEROUS ODOR
			LUDLOWVILLE	LEDYARD SHALE	SHALE; DARK GRAY TO OLIVE BLACK; SLIGHTLY CALCAREOUS; FOSSILIFEROUS, WITH ABUNDANT STYLIOLINIDS; OTHER SCATTERED AND OCCASIONAL FOSSILS INCLUDE AMBOCOELLID BRACHIOPODS, BRYOZOANS, TRILOBITES, CRINOIDS, AND NAUTILOIDS; RARE CARBONIZED PLANT MATERIAL; MODERATELY PYRITIC; MILD PETROLIFEROUS ODOR
				CENTERFIELD LST	LIMESTONE; GRAY; NODULAR TO MASSIVE; FINE TO MEDIUM CRYSTALLINE; FOSSILIFEROUS; GRADES UPWARD AND DOWNWARD TO LESS FOSSILIFEROUS CALCAREOUS SHALE; ABUNDANT FOSSILS INCLUDE RUGOSE AND TABULATE CORALS, BRACHIOPODS, CRINOIDS, BRYOZOANS AND TRILOBITES; BIOTURBATED AND BURROWED; RARE PYRITE
			SKANEATELES	LEVANNA	SHALE; DARK GRAY, BROWNISH BLACK, AND OLIVE BLACK; CALCAREOUS; RARE FOSSILS, EXCEPT FOR STYLIOLINIDS, AND SMALL BRACHIOPODS AND PELECYPODS; MIDDLE THIRD OF UNIT CHARACTERIZED BY ARGILLACEOUS LIMESTONE INTERVALS UP TO 5 FEET THICK; MODERATE PETROLIFEROUS ODOR, BECOMING STRONGER TOWARD BASE OF UNIT WITH A CONCOMITANT INCREASE IN BROWNISH BLACK SHALE INTERVALS
				STAFFORD LST	LIMESTONE; DARK GRAY TO BROWNISH BLACK; MASSIVE; FOSSILIFEROUS, COMMONLY WITH BRACHIOPODS, TRILOBITES, CEPHALOPODS, STYLIOLINIDS AND RARE CORAL; STYLOLITIC; PETROLIFEROUS ODOR; UNIT ABSENT IN HOLES #9443 AND #9457
			MARCELLUS SUBGROUP — OATKA CREEK		SHALE; BLACK; CARBONACEOUS; NON-CALCAREOUS, SLIGHTLY CALCAREOUS IN LOWER PART OF UNIT; HIGHLY PYRITIC; SPARSELY FOSSILIFEROUS, WITH STYLIOLINIDS, AND RARE BRACHIOPODS AND PELECYPODS; OCCASIONAL SEPTARIAN NODULES AND CARBONATE CONCRETIONS; BASE OF UNIT IS BENEATH BROWNISH BLACK STYLIOLINID GRAINSTONE (CHERRY VALLEY LIMESTONE) WHICH RARELY CONTAINS BRACHIOPODS AND PELECYPODS, AND OCCASIONALLY DISPLAYS CONVOLUTE LAMINATIONS; HIGHLY FRACTURED; STRONG PETROLIFEROUS ODOR
			— UNION SPRINGS	BAKOVEN	
				SENECA TIOGA B.	SHALE; BROWNISH BLACK TO DARK GRAY; CARBONACEOUS; SLIGHTLY CALCAREOUS; EXTREMELY ABUNDANT STYLIOLINIDS; OCCASIONAL STYLIOLINID GRAINSTONES; PETROLIFEROUS ODOR
			ONONDAGA	MOOREHOUSE	GENERAL DESCRIPTION: LIMESTONE; OLIVE GRAY, BROWNISH GRAY, DARK GRAY, AND BROWNISH BLACK; MASSIVE; FINE TO MEDIUM CRYSTALLINE; ABUNDANT CHERT; VERY FOSSILIFEROUS; WITH BRACHIOPODS, CRINOIDS, BRYOZOANS, RUGOSE AND TABULATE CORALS; STYLOLITIC; RARE PYRITE; PETROLIFEROUS ODOR. ONONDAGA MEMBER DIFFERENTIATION BASED UPON THE FOLLOWING CHARACTERISTICS: SENECA : LIES ABOVE (AND INCLUDES) THE TIOGA B BENTONITE IN ALL CORES; UPPER FOUR FEET OF THE SENECA OFTEN CONTAINS A 1 TO 2 FOOT THICK BLACK SHALE INTERVAL; CHERTY (~15%) MOOREHOUSE : SIMILAR TO SENECA, BUT MORE CHERTY (~25%); CHERT NODULES OCCASIONALLY PALE BROWN NEDROW : DARKER (BROWNISH BLACK), MORE ARGILLACEOUS AND LESS CHERTY (~5%) THAN OTHER MEMBERS; FOSSILS ARE VERY RARE; SHARP AND IRREGULAR BASE BENEATH DISTINCTIVE, BURROWED, OLIVE GREEN MUDSTONE HORIZON MARKED BY ABUNDANT SMALL, BLUE GREEN FLECKS EDGECLIFF : EXTREMELY CHERTY (25–75%); CHERT NODULES CHARACTERIZED BY INTERNAL, WHITE CALCITE VEINLETS
				NEDROW	
				EDGECLIFF	
				AKRON	DOLOMITE; YELLOWISH BROWN TO BROWNISH GRAY; FINE CRYSTALLINE; LAMINATED; VERY STRONG PETROLIFEROUS ODOR. NOTE – COBLESKILL LIMESTONE IS PRESENT ABOVE THE AKRON DOLOMITE AT SOME CORE LOCATIONS. THE COBLESKILL IS DESCRIBED AS FOLLOWS: GRAY AND BROWNISH GRAY; INTERLAMINATED; FINE CRYSTALLINE; RARE BRACHIOPODS; NO PETROLIFEROUS ODOR
				UNIT H	DOLOMITE; GRAY TO OLIVE GRAY; SILTSTONE; MASSIVE TO LAMINATED; TYPICALLY WITH BLACK, BIOTURBATION MOTTLING; OCCASIONAL SANDY LENSES, RIP-UP CLASTS AND INTRACLASTS; NO PETROLIFEROUS ODOR
					DOLOMITE AND DOLOMITIC SHALE; BROWNISH GRAY, GRAY AND DUSKY YELLOWISH BROWN; FINE CRYSTALLINE; MASSIVE TO LAMINATED; VUGGY; OCCASIONAL HORIZONS OF RIP-UP CLASTS AND INTRACLASTS; CONTAINS BLEBS AND MASSES OF GYPSUM, SPHALERITE, CHERT, ANHYDRITE, AND ELEMENTAL SULFUR; ANHYDRITE RARELY BEDDED; COMMONLY HAS VERY STRONG PETROLIFEROUS ODOR AND OIL SHOWS
			CAMILLUS	UNIT G	SHALE; OLIVE GRAY, OLIVE BLACK, AND GRAY; TYPICALLY MASSIVE DUE TO EXTENSIVE FLUID MIGRATION AND ANHYDRITE FORMATION; ANHYDRITE COMMON AS STRINGERS AND NODULES; OCCASIONALLY CONTAINS BROWNISH GRAY DOLOMITE BEDS WITH GYPSUM-HEALED FRACTURES
			SYRACUSE	UNIT F	DOLOMITE; BROWNISH GRAY AND DUSKY YELLOWISH BROWN; INTERLAYERED WITH THINNER, GRAY SHALES; FINE CRYSTALLINE; MASSIVE TO THIN BEDDED; CONTAINS STROMATOLITES; DESSICATION FEATURES, GYPSUM BLEBS, AND ANHYDRITE NODULES AND STRINGERS ARE COMMON; PETROLIFEROUS ODOR; SHALE INTERVALS ARE MASSIVE DUE TO EXTENSIVE FLUID MIGRATION AND ANHYDRITE FORMATION
				UNIT E	DOLOMITE; BROWNISH GRAY AND DUSKY YELLOWISH BROWN; INTERBEDDED WITH THIN GREENISH GRAY SHALES; FINE CRYSTALLINE; MASSIVE TO THIN BEDDED; CONTAINS STROMATOLITES, DESSICATION FEATURES, AND GYPSUM BLEBS; LOWER FIFTH OF UNIT OCCASIONALLY CONTAINS HALITE STREAKS AND INCLUSIONS; DOLOMITE BEDS FREQUENTLY HAVE A PETROLIFEROUS ODOR; SHALE BANDS TYPICALLY CONTAIN ANHYDRITE NODULES AND STRINGERS, AND ARE MASSIVE DUE TO EXTENSIVE FLUID MIGRATION AND ANHYDRITE FORMATION; UPPER FIFTH OF UNIT IS TYPICALLY SHALE
				UNIT D	INTERBEDDED DOLOMITE, SHALE AND HALITE; DOLOMITE IS DARK YELLOWISH BROWN, GYPSIFEROUS, AND OCCASIONALLY CROSS-BEDDED; SHALE IS GREENISH GRAY, OCCASIONALLY DOLOMITIC, WITH FREQUENT FLUID ESCAPE STRUCTURES; BOTH DOLOMITE AND SHALE CONTAIN BLEBS, BANDS AND INCLUSIONS OF HALITE AND ANHYDRITE; HALITE BEDS ARE WHITE TO GRAY, CLEAR, VERY COARSELY CRYSTALLINE, AND PRIMARILY DIVIDED INTO 2 PROMINENT HORIZONS, D-1 AND D-2.
			VERNON	UNIT C	SHALE; GREENISH GRAY WITH OCCASIONAL DARK RED MOTTLING; TYPICALLY MASSIVE AND STRUCTURELESS; WITH ABUNDANT STREAKS, STRINGERS, AND VEINS OF REDDISH ORANGE HALITE; OCCASIONALLY CONGLOMERATIC, WITH ANHYDRITE PEBBLES AND CLAYSTONE CLASTS AND RIP-UPS; RARE SANDSTONE BEDS AVERAGING 0.5 FEET IN THICKNESS; SMALL, MICACEOUS HEMATITE CRYSTALS COMMONLY ASSOCIATED WITH HALITE; CONTAINS RARE INTERVALS OF BROWN, GYPSIFEROUS DOLOMITE WITH ANHYDRITE NODULES AND HALITE INCLUSIONS
				UNIT B	INTERBEDDED HALITE, SHALE AND DOLOMITE; HALITE BEDS ARE DARK GRAY TO WHITE, CLEAR, COARSELY CRYSTALLINE, AND TYPICALLY SEPARATED BY GRAYISH OLIVE, BRECCIATED SHALE; DOLOMITE INTERBEDS OCCUR BETWEEN THE B-5 AND THE B-6 SALT HORIZONS, ARE TYPICALLY BROWN, WITH OCCASIONAL ANHYDRITE CLASTS, HALITE STREAKS, BEDS, AND INCLUSIONS, AND ARE OFTEN CONTORTED AND BRECCIATED ADJACENT TO THE HALITE BEDS; SHALE INTERBEDS OCCUR BETWEEN THE REMAINING SALT HORIZONS AND ARE GREENISH GRAY TO GRAYISH OLIVE, OCCASIONALLY BRECCIATED AND CONTORTED, AND CONTAIN ANHYDRITE AND INCLUSIONS.
				UNIT A	SHALE; OLIVE GRAY, OLIVE GREEN, AND BROWNISH GRAY; LAMINATED, TO MASSIVE; COMMONLY STRUCTURELESS AND CONTORTED DUE TO EXTENSIVE FLUID MIGRATION; CONTAINS OCCASIONAL STREAKS OF REDDISH ORANGE HALITE, AS WELL AS ANHYDRITE NODULES, AND RIP-UP CLASTS

NATURAL GAMMA LOG

0.0 GR(GAPI) 200.00

DEPTH (FEET)

0, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1750, 1800, 1850, 1900

TIOGA B

MID-BERTIE MARKER, OR "HP" MARKER OF RICKARD (1969)

D2

D1

CB MARKER OF RICKARD (19___)

B6

B5

B4

B3

B2

B1

PLATE 2 – 9455 COLUMN

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 2

REPRESENTATIVE GEOLOGIC COLUMN AND ASSOCIATED NATURAL GAMMA LOG API WELL #21575 (AKZO CORE HOLE #9455)

logged February 1995

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES IN LIVINGSTON COUNTY, NEW YORK

PLATE 3 – SECTION A

NOTE:
FORMATIONAL CONTACTS BETWEEN DATA LOCATIONS (I.E.; CORE HOLES, OIL AND GAS WELLS, AND MINE SHAFTS) FOLLOW THE STRUCTURE DEPICTED IN PLATE 12, STRUCTURAL CONTOUR MAP OF THE TOP OF THE TIOGA "B" BENTONITE.

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 3

GEOLOGIC CROSS SECTION A-A'

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

NORTH
B

SOUTH
B'

20575 — ROUTE 5/20 — LAKE RD. — 17392 — CROSS SECTION C–C' — LITTLE CONESUS CREEK — HENTY RD. — 17336 — PAPER MILL RD. — RAILROAD — CONESUS CREEK — ROUTE 52 — LIMA RD. — ROUTE 20A — GENESEE EXPRESSWAY — RESERVOIR RD. — ROUTE 28 — 10920 — ROUTE 32 — WARNER RD. — 21574 — CROSS SECTION D–D' — JONES BRIDGE RD. — ROUTE 45 — MILL GULLY RD. — 21576 — CROSS SECTION A–A' — LOGAN RD. — ADAMSON RD.

UNCONSOLIDATED SEDIMENTS

SKANEATELES FORMATION
MARCELLUS SUBGROUP
ONONDAGA FORMATION
BERTIE GROUP
CAMILLUS (UNIT G)
SYRACUSE UNIT F
SYRACUSE UNIT E
SYRACUSE UNIT D
VERNON UNIT C
VERNON UNIT B
VERNON UNIT A
LOCKPORT DOLOSTONE

STAFFORD LS
TIOGA "B" BENTONITE

GENUNDEWA LS
TICHENOR LS
CENTERFIELD
D2–SALT
D1–SALT

WEST FALLS GROUP
SONYEA GROUP
GENESEE GROUP
MOSCOW FORMATION
LUDLOWVILLE FORMATION

ELEVATION (FEET RELATIVE TO MEAN SEA LEVEL)

500
0
–500
–1000

ENLARGED VIEW

VERNON UNIT C
B6–SALT
B5–SALT
B4–SALT
B3–SALT
B2–SALT
B1–SALT
VERNON UNIT A
VERNON UNIT B

400
200
0
VERTICAL (EXAGGERATION 15X)
HORIZONTAL
0
3000
6000
SCALE IN FEET

NOTE:
FORMATIONAL CONTACTS BETWEEN DATA LOCATIONS (I.E.; CORE HOLES, OIL AND GAS WELLS, AND MINE SHAFTS) FOLLOW THE STRUCTURE DEPICTED IN PLATE 12, STRUCTURAL CONTOUR MAP OF THE TOP OF THE TIOGA "B" BENTONITE.

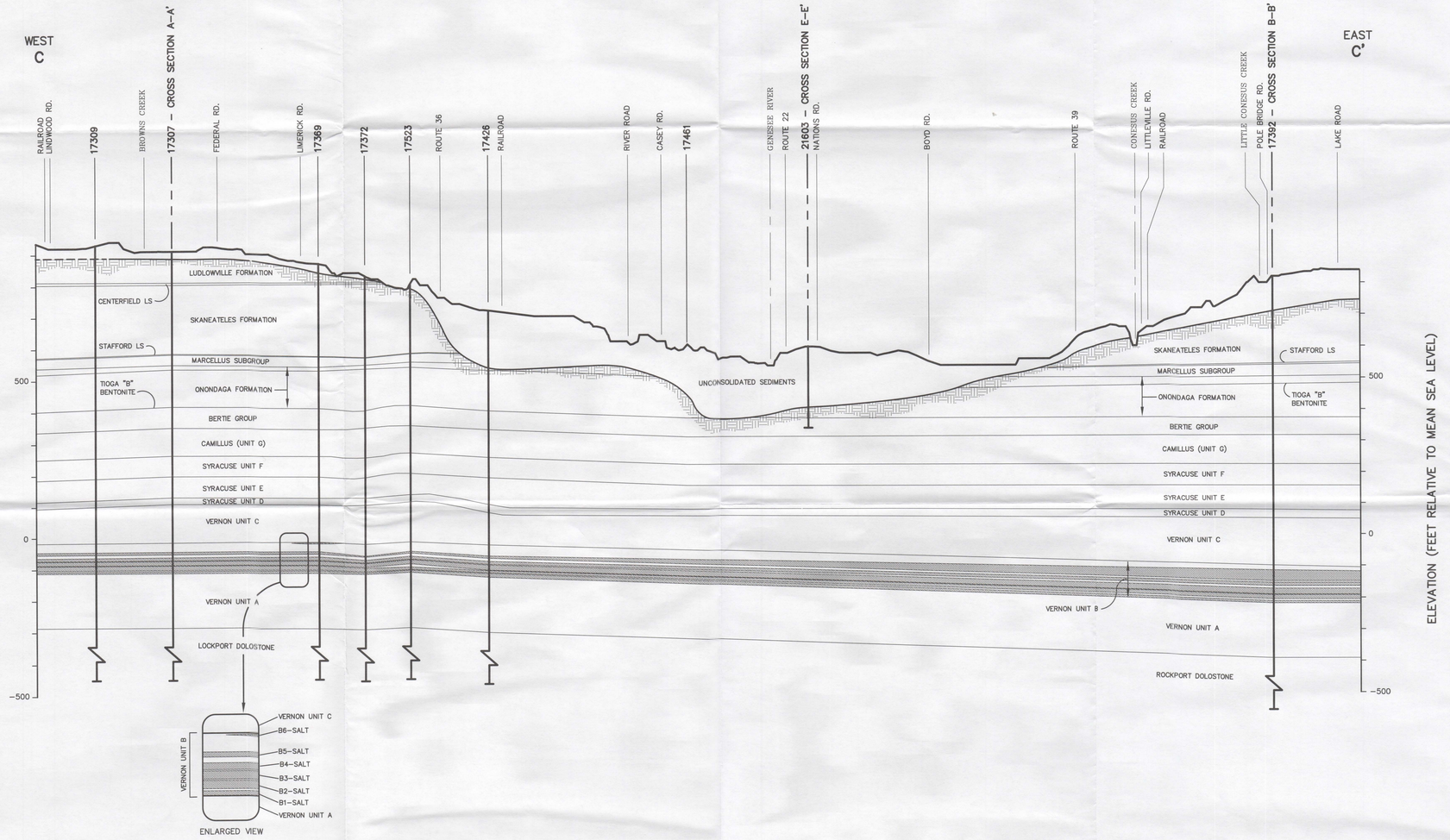
New York State Museum
Map and Chart # 45

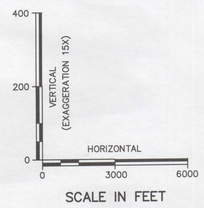
ALPHA GEOSCIENCE

PLATE 4

GEOLOGIC CROSS SECTION B-B'

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK





NOTE:
FORMATIONAL CONTACTS BETWEEN DATA LOCATIONS (I.E.; CORE HOLES, OIL AND GAS WELLS, AND MINE SHAFTS) FOLLOW THE STRUCTURE DEPICTED IN PLATE 12, STRUCTURAL CONTOUR MAP OF THE TOP OF THE TIOGA "B" BENTONITE.

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 5

GEOLOGIC CROSS SECTION C-C'

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

WEST
D

EAST
D'

CROSS SECTION E–E'

CROSS SECTION A–A'

CROSS SECTION B–B'

COUNTY LINE RD.
13841
14380
19633
15592 ROUTE 4
19416
INTERSECTION PERRY RD. & UPPER MORRIS RD.
19413 ROUTE 36 RAILROAD WHEELOCK RD.
RIVER RD.
DUTCH CORNERS RD.
GENESEE RIVER
GENESEE EXPRESSWAY
21572 GROSSETT RD.
JONES BRIDGE RD.
FALL BROOK
21574 GROVELAND RD.
WARNER RD.
ROUTE 28/48 04188
BEACH RD.
CONESUS LAKE
ROUTE 6
SOUTH GULLY
BACKAS RD.
ROUTE 15
04053

ELEVATION (FEET ABOVE MEAN SEA LEVEL)

1000
500
0
–500
–1000

UNCONSOLIDATED SEDIMENTS
WEST FALLS GROUP
SONYEA GROUP
GENESEE GROUP
GENUNDEWA LS
MOSCOW FORMATION
TICHENOR LS
LUDLOWVILLE FORMATION
CENTERFIELD LS
SKANEATELES FORMATION
STAFFORD LS
MARCELLUS SUBGROUP
ONONDAGA FORMATION
TIOGA "B" BENTONITE
BERTIE GROUP
CAMILLUS (UNIT G)
SYRACUSE UNIT F
SYRACUSE UNIT E
SYRACUSE UNIT D
VERNON UNIT C
VERNON UNIT B
VERNON UNIT A
LOCKPORT DOLOSTONE

ELEVATION (FEET ABOVE MEAN SEA LEVEL)

1000
500
0
–500
–1000

SYRACUSE UNIT E
SYRACUSE UNIT D
D2–SALT
D1–SALT
VERNON UNIT C
ENLARGED VIEW

VERNON UNIT C
B6–SALT
VERNON UNIT B
B5–SALT
B4–SALT
B3–SALT
B2–SALT
B1–SALT
VERNON UNIT A
ENLARGED VIEW

400
200
0
VERTICAL (EXAGGERATION 15X)
HORIZONTAL
0
3000
6000
SCALE IN FEET

NOTE:
FORMATIONAL CONTACTS BETWEEN DATA LOCATIONS (I.E.; CORE HOLES, OIL AND GAS WELLS, AND MINE SHAFTS) FOLLOW THE STRUCTURE DEPICTED IN PLATE 12, STRUCTURAL CONTOUR MAP OF THE TOP OF THE TIOGA "B" BENTONITE.

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 6

GEOLOGIC CROSS SECTION D-D'

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

NORTH
E

SOUTH
E'

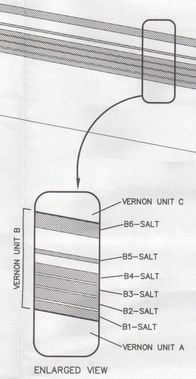
ROUTE 22
21603 – CROSS SECTION C–C'
OXBOW LANE
05061
JAYCOX CREEK
GENESEE RIVER
ROUTE 63
GENESEE RIVER
AIRPORT
13898
GENESEE RIVER
21508
DEWEY HILL RD
CROSS SECTION A–A'
JONES BRIDGE ROAD
CROSS SECTION D–D'
PERRY RD. (BEND IN SECTION)
OXBOW
MEANDER
GENESEE RIVER
GENESEE RIVER (BEND IN SECTION)
STATE ROUTE 408
BEND IN SECTION
KESHEQUA CREEK
G & W RAILROAD
21569
GENESEE EXPRESSWAY
RAILROAD

ELEVATION (FEET RELATIVE TO MEAN SEA LEVEL)

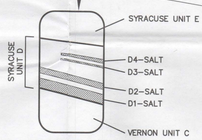
500
0
−500
−1000

UNCONSOLIDATED SEDIMENTS
ONONDAGA FORMATION
BERTIE GROUP
CAMILLUS (UNIT G)
SYRACUSE UNIT F
SYRACUSE UNIT E
SYRACUSE UNIT D
VERNON UNIT C
VERNON UNIT A
LOCKPORT DOLOSTONE

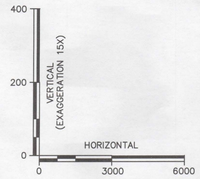
UNCONSOLIDATED SEDIMENTS
TIOGIA "B" BENTONITE
ONONDAGA FORMATION
BERTIE GROUP
CAMILLUS (UNIT G)
SYRACUSE UNIT F
SYRACUSE UNIT E
SYRACUSE UNIT D
VERNON UNIT B
VERNON UNIT C
VERNON UNIT A
LOCKPORT DOLOSTONE



ENLARGED VIEW



ENLARGED VIEW



SCALE IN FEET

NOTE:
FORMATIONAL CONTACTS BETWEEN DATA LOCATIONS (I.E.; CORE HOLES, OIL AND GAS WELLS, AND MINE SHAFTS) FOLLOW THE STRUCTURE DEPICTED IN PLATE 12, STRUCTURAL CONTOUR MAP OF THE TOP OF THE TIOGA "B" BENTONITE.

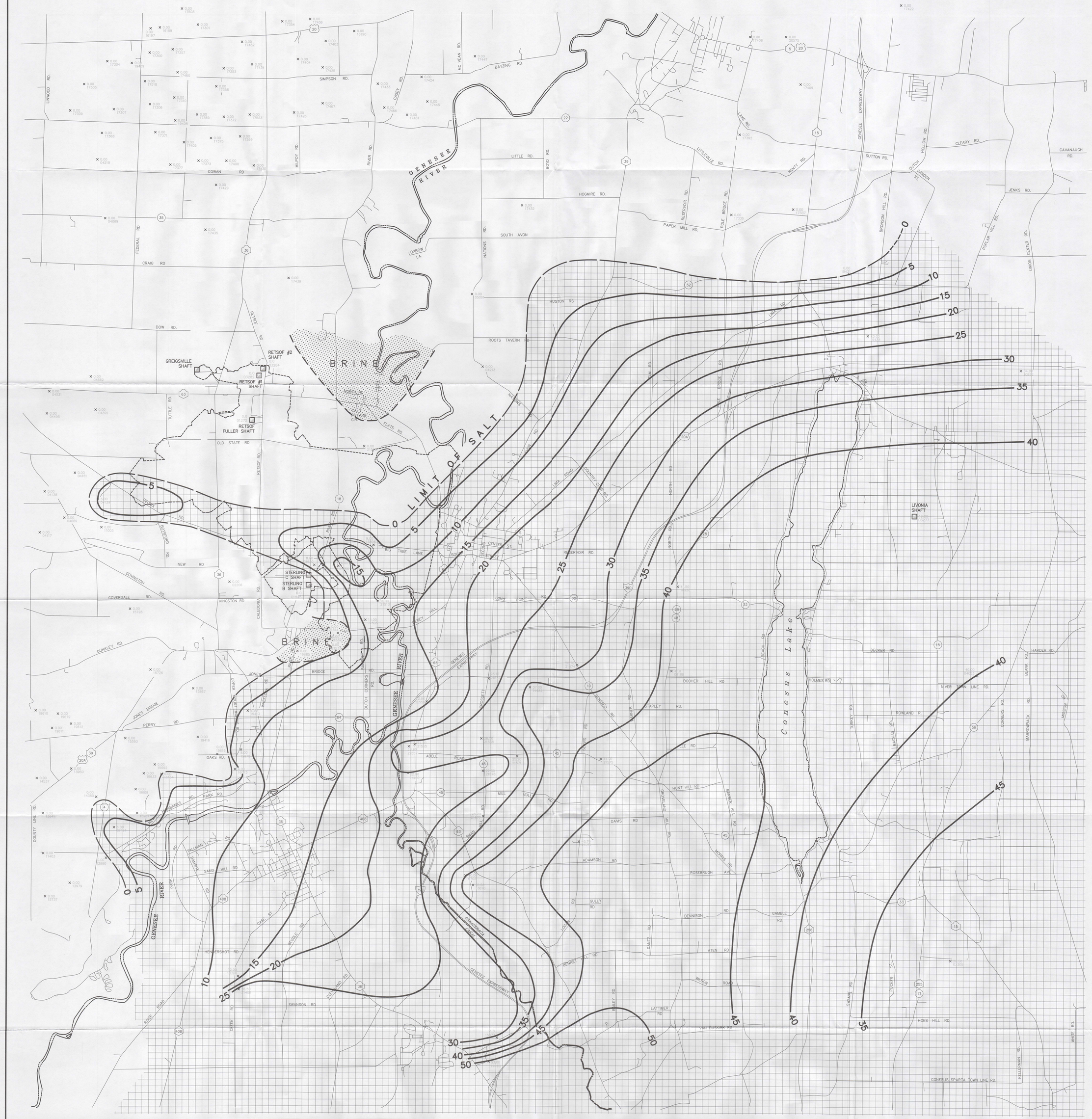
New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 7

GEOLOGIC CROSS SECTION E-E'

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK


GENESEE RIVER
BRINE
BRINE
LIMIT OF SALT
0
5
10
15
20
25
30
35
40
45
50
RETSOF #2 SHAFT
RETSOF #1 SHAFT
RETSOF FULLER SHAFT
GREIGSVILLE SHAFT
STERLING C SHAFT
STERLING B SHAFT
LIVONIA SHAFT
Conesus Lake
SIMPSON RD.
BATZING RD.
LITTLE RD.
HOGMIRE RD.
SOUTH AVON
CRAIG RD
COWAN RD
DOW RD.
ROOTS TAVERN RD.
HUSTON RD
PAPER MILL RD.
SUTTON RD.
CLEARY RD.
CAVANAUGH RD.
JENKS RD.
OLD STATE RD
NEW RD
COVERDALE RD.
KINGSTON RD
DUNKLEY RD.
JONES BRIDGE
PERRY RD
OAKS RD.
PARK RD.
SAND HILL RD
HENDERSHOT RD
SWANSON RD.
ABELE ROAD
DAVIS RD
ADAMSON RD
ROSEBRUGH AVE
DENNISON RD
GAMBLE RD.
ATEN RD
LATTIMER RD.
VAN BUSKIRK RD
HUNT HILL RD.
MILL GULLY RD
BOOHER HILL RD
STAPLEY RD.
LEE RD
DECKER RD.
HOLMES RD.
RIVER TOWN LINE RD.
ROWLAND R.
HOES HILL RD.
CONESUS SPARTA TOWN LINE RD.
RESERVOIR RD.
LONG POINT RD
BIG TREE LANE
SECOND CENTER ST
GENESEE EXPRESSWAY
CANANDAIGUA FEEDER CANAL
LIMA ROAD
COUNTRY CLUB RD
LINWOOD RD.
FEDERAL RD
TUTTLE RD.
RETSOF RD.
BOTSFORD RD.
COVINGTON RD.
CALEDONIA RD.
COUNTY LINE RD.
BIXBY ROAD
CREEK RD.
MC VEAN RD.
CASEY RD.
MILPOY RD.
RIVER RD.
BOYD RD.
NATIONS RD.
OXBOW LA.
JAKE RD.
UTTLEVILLE RD.
HENTY RD.
RESERVOIR RD.
POLE BRIDGE RD.
BRONSON HILL RD.
DUTCH HOLLOW RD
GARDEN ST.
POPLAR HILL RD.
UNION CENTER RD.
0 1/2 1 2 MILES
0 1/2 1 2 KILOMETERS
0 3000 FEET
NORTH
LEGEND
ROAD
WATER
OUTLINE OF RETSOF & STERLING SALT MINES
40 SALT THICKNESS CONTOUR (FEET)
DATA POINT LOCATION WITH API IDENTIFICATION AND TOTAL UNIT D SALT THICKNESS
BRINE
SALT
SALT MINE SHAFT
New York State Museum
Map and Chart # 45
ALPHA GEOSCIENCE
PLATE 8
TOTAL SALT THICKNESS MAP
UNIT D, SYRACUSE FORMATION
STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK
Revised PLATE 8 – TOTAL SALT D.DWG

0 1/2 1 2 MILES

0 1/2 1 2 KILOMETERS

0 3000 FEET

NORTH

LEGEND

ROAD
WATER
40 UNIT D ISOPACH
OUTLINE OF RETSOF & STERLING SALT MINES
47.50 21406 DATA POINT LOCATION WITH UNIT D THICKNESS AND API IDENTIFICATION
SALT MINE SHAFT
LIMIT OF SALT
BRINE

New York State Museum
Map and Chart # 45

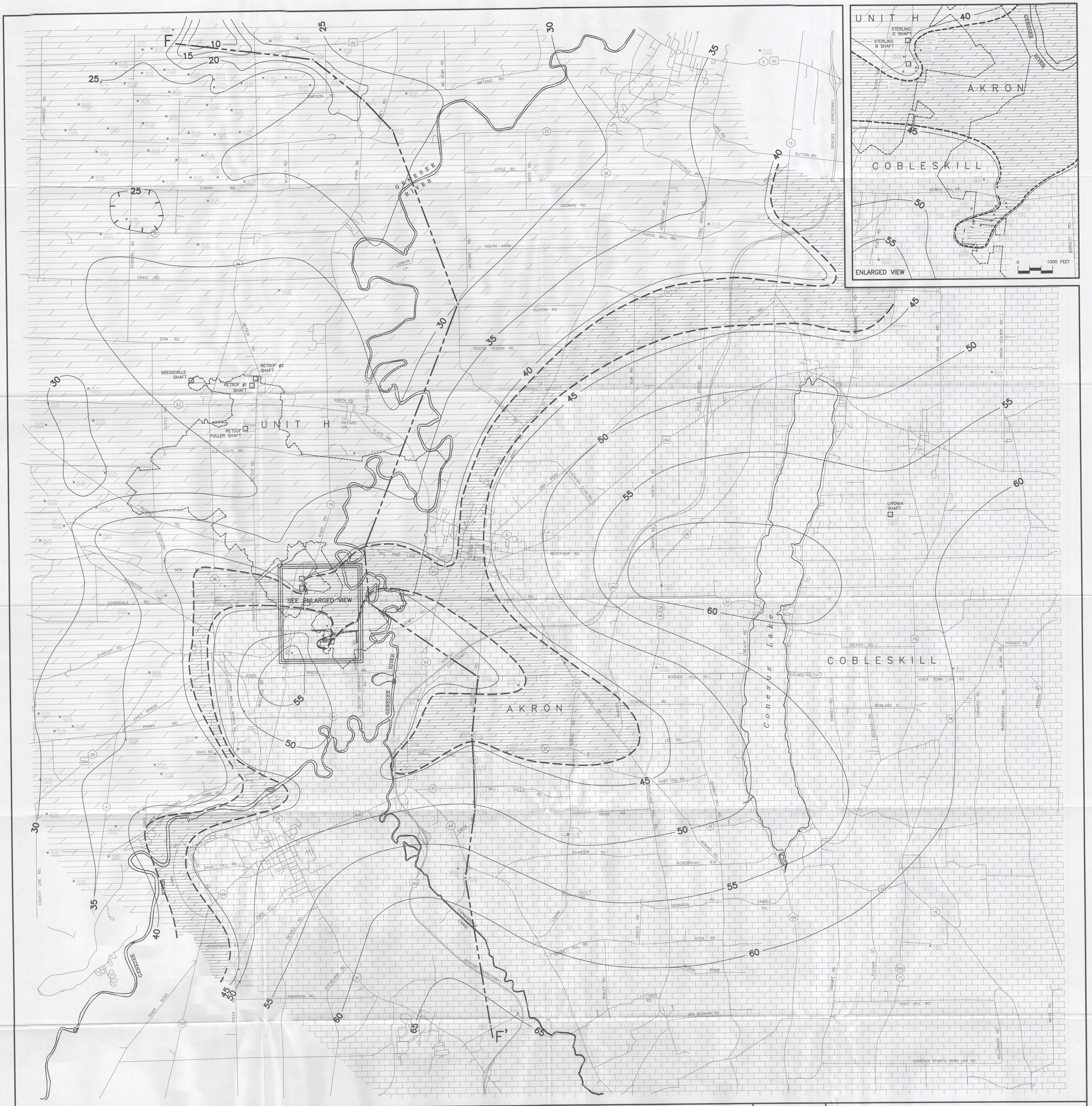
ALPHA GEOSCIENCE

PLATE 9

ISOPACH MAP OF UNIT D SYRACUSE FORMATION

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

Revised PLATE 9 – UNIT D ISOPACH.dwg



0 1/2 1 2 MILES

0 1/2 1 2 KILOMETERS

0 3000 FEET

NORTH

LEGEND

- ROAD
- SALT MINE SHAFT
- WATER
- 55 — RELATIVE ELEVATION CONTOUR OF TOP OF BERTIE GROUP (FEET ABOVE MID–BERTIE "HP" MARKER)
- DATA POINT LOCATION WITH API IDENTIFICATION, AND TOP OF BERTIE GROUP RELATIVE ELEVATION (FEET ABOVE MID–BERTIE "HP" MARKER)
- OUTLINE OF RETSOF & STERLING SALT MINES
- F — — — F' SECTION LINE FOR UPPER BERTIE GROUP CORRELATION CHART (FIGURE 6)
- UNIT H PALEO–OUTCROP
- AKRON PALEO–OUTCROP
- COBLESKILL PALEO–OUTCROP

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 10

PRE-ONONDAGA PALEOGEOLOGIC AND PALEORELIEF MAP

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES IN LIVINGSTON COUNTY, NEW YORK

Revised PLATE 10 – PALEO GEO RELIEF.dwg

HC10–BLP
680.25

21513

21508

SHALE

GENESEO SHALE

PENN YAN SHALE

WEST RIVER SHALE

MIDDLESEX SHALE

RHINESTREET SHALE

ST. MARY'S CEM.

SUBSTATION

LONG POINT ROAD

FALL BROOK

DEWEY HILL

LANDFILL

HC4–BR
1012.34

FALL BROOK FALLS

SEE ENLARGED VIEW

WINDOM

HC1–BMSD
766.89

GENESEE RIVER

GENESEE EXPRESSWAY

GAGING STATION

JONES BRIDGE ROAD

HC2–BLP
596.84

HC2–BG
678.41

HC2–BPY
625.35

21559

21564

21574

21572

14482

HC5–BH
1038.15

DUTCH CORNERS ROAD

CROSSETT ROAD

GENESEO ROAD

WARNER ROAD

STAPLEY ROAD

CASHAQUA SHALE

HATCH SHALE

21573

21558

21557

21555

HC3–BMS
709.28

HC7–BH
1020.70

SERVIS ROAD

EAST GROVELAND ROAD

ABELE ROAD

21571

21575

21578

EAST GROVELAND ROAD

LAKEVILLE ROAD

14100

HC8–BH
988.14

HAMPTON CORNERS

MILL GULLY ROAD

SWAN HILL ROAD

21577

DAVIS ROAD

GROVELAND HILL ROAD

MIDDLESEX SHALE

WEST RIVER SHALE

REST AREA

HC6–BMS
635.16

21576

CASHAQUA SHALE

RHINESTREET SHALE

HATCH SHALE

ADAMSON ROAD

LOGAN ROAD

GULLY ROAD

6702

13870

BUCK RUN CREEK

CANASERAGA CREEK

KESHEQUA CREEK

CANAL

GENESEE EXPRESSWAY

HC9–BH
895.73

HC9–BR
830.57

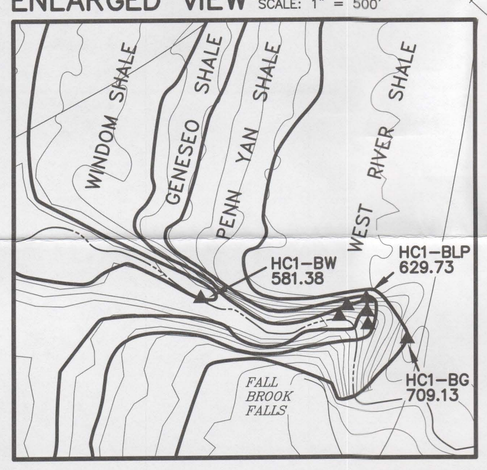
TURNER ROAD

DANTZ ROAD

BENNET HILL ROAD

?

ENLARGED VIEW SCALE: 1" = 500'



0 1/2 1 MILE

0 1/2 1 KILOMETER

0 1200 FEET

NORTH

LEGEND

~~	PROJECTED OUTCROP, NOT ADJUSTED FOR OVERBURDEN / SUBCROP.
● 21577	HAMPTON CORNERS CORE HOLES (1994–1995 SERIES)
x 13870	OIL AND GAS WELL, OR OTHER EXPLORATORY BORING WITH API IDENTIFICATION (ISCO BORING HAS NO API ID.)
▲ HC10–BLP 680.25	SURVEYED LITHOLOGIC CONTACT AT BEDROCK OUTCROP HAMPTON CORNERS MAP AREA 10–BASE OF LEICESTER PYRITE, SUBSCRIPT = ELEVATION IN FEET ABOVE MEAN SEA LEVEL.

–BMSD	BASE OF MIDDLESEX RELATIVE TO LOCAL DATUM
–BW	BASE OF WINDOM
–BG	BASE OF GENUNDEWA LIMESTONE
–BPY	BASE OF PENN YAN
–BMS	BASE OF MIDDLESEX
–BR	BASE OF RHINESTREET
–BH	BASE OF HATCH

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 11

BEDROCK GEOLOGIC MAP

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

New York State Museum
Map and Chart # 45

ALPHA GEOSCIENCE

PLATE 12

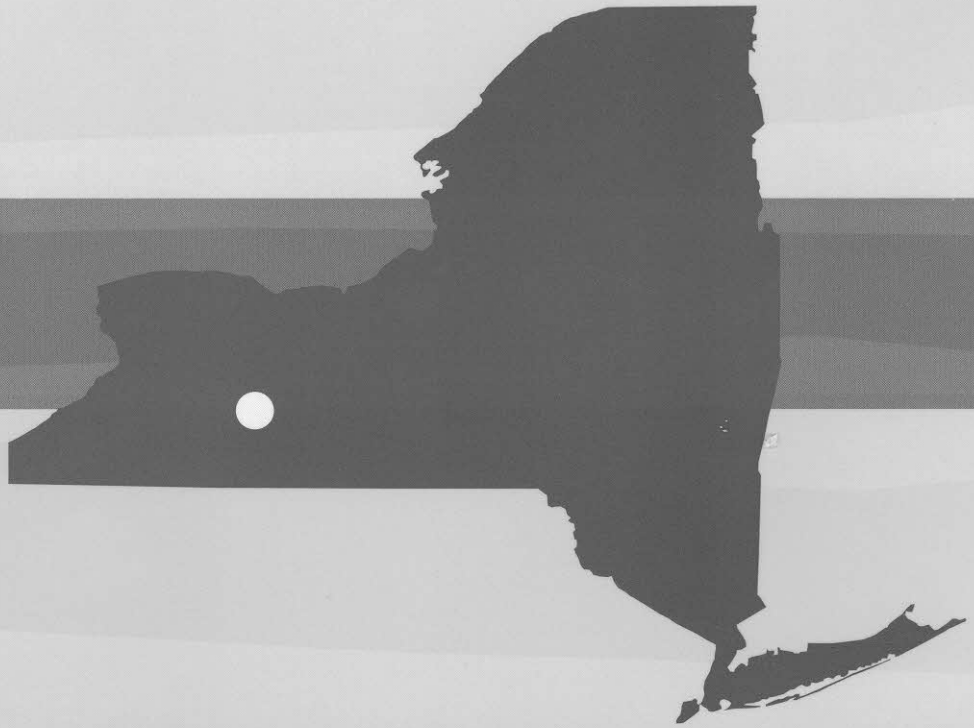
TOP OF TIOGA "B" BENTONITE STRUCTURAL CONTOUR MAP

STRATIGRAPHY OF THE DEVONIAN AND UPPER SILURIAN
IN THE VICINITY OF THE RETSOF, STERLING, AND HAMPTON CORNERS MINES
IN LIVINGSTON COUNTY, NEW YORK

Revised PLATE 12 – TOP TIOGA BENTONITE.dwg

Stratigraphy of the Devonian and Upper Silurian in the Vicinity of the Retsof, Sterling and Hampton Corners Mines in Livingston County, New York

by
Samuel W. Gowan
Steven M. Trader
Maureen E. Piel
Lawrence D. Milliken



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2006

Stratigraphy of the Devonian and Upper Silurian in the Vicinity of the Retsof, Sterling and Hampton Corners Mines in Livingston County, New York

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New York State Museum
Map and Chart Series No. 45
2006

The University of the State of New York
The State Education Department
Albany, New York 12230

Published 2006

Printed in the United States of America

Copies may be ordered from:
Publication Sales
3140 CEC
New York State Museum
Albany, New York 12230
Phone: (518) 402-5344
FAX: (518) 474-2033
Web address: http://www.nysm.nysed.gov/publications/index.html

Library of Congress Catalog Card Number: 2005933119

ISBN: 1-55557-231-6
ISSN: 0097-3793

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INTRODUCTION

A substantial quantity of geologic data was generated in the salt mining district in Livingston County, New York, following the collapse and subsequent flooding of the Retsof and Sterling salt mines in 1994. Most of the data were collected while investigating conditions in the area of the collapse and later while developing a new mine, which is currently being operated by American Rock Salt Company in the area southeast of the flooded Retsof Mine. This publication presents the bedrock stratigraphy and structural conditions derived from the assimilation of those recent data into a preexisting database for a 277-square-mile area of Livingston County that extends from the Wyoming County line on the west to Livonia on the east, and generally lies between Avon and Sonyea on the north and south, respectively (Figure 1). The stratigraphic analysis was focused specifically on the formations extending from the basal unit of the Upper Silurian Vernon Formation up to the base of the West Falls Group of the Upper Devonian.

The targeted geologic interval within the area has been of interest since the late nineteenth century when salt mining was initiated in the Genesee Valley. The stratigraphy associated with several mine shafts and brine wells, which were installed in the Genesee Valley salt mining district starting in 1885 and ending in the early twentieth century, was described by several individuals who were commissioned to assess the salt mining industry in New York State (Bishop, 1886; Luther, 1898; New

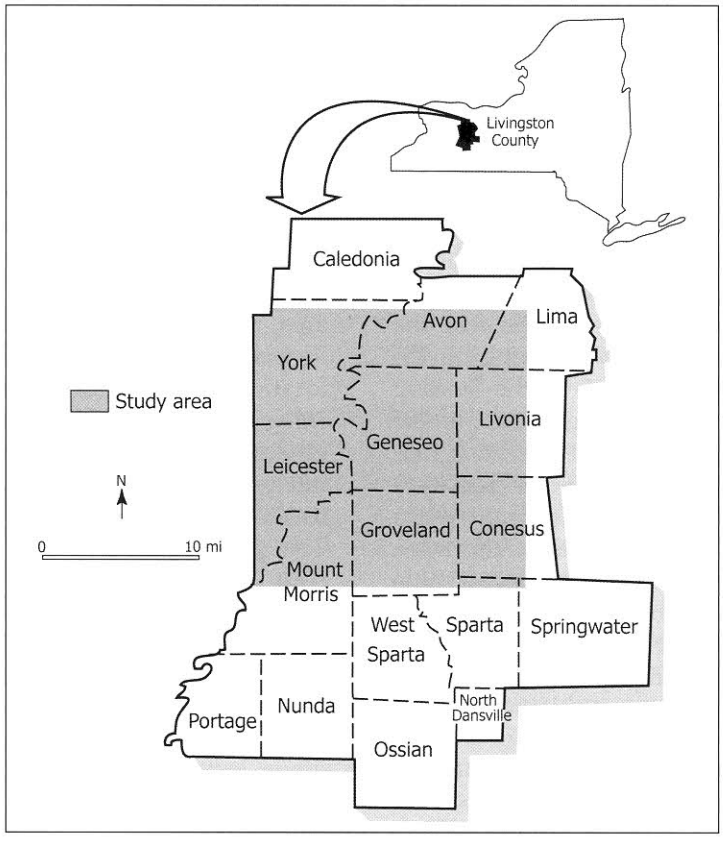


Figure 1: Area of Study

York State Geological Survey, 1938; Werner, 1917). Subsequent publications from the latter half of the twentieth century were focused on correlating the relationship of the units in the Genesee Valley with a much broader area. Rickard (1969, 1989) correlated the Upper Silurian and Lower through Middle Devonian for a broad region that included southern New York, northern Pennsylvania, and eastern Ohio. Rickard's correlation was accomplished from geophysical logs and lithologic data from widely spaced oil and gas wells along with a few scattered mine shafts. Kirchgasser et al. (1994) subsequently described the stratigraphic relationships of the Upper Devonian in the Genesee Valley area with the corresponding strata throughout central and western New York. The stratigraphy by Kirchgasser et al. (1994) was based on a synthesis of several published investigations that had relied principally on rock exposures and scattered borehole data.

Numerous investigations were being conducted for the Retsof, Sterling, and American Rock Salt Company mines during the latter half of the twentieth century. These unpublished reports provide an extensive database of detailed stratigraphic information for the area immediately around the mines. Several of these reports, such as those by Langill and Associates (1981, 1986A, 1990), addressed groundwater inflow to the Barbara ("B") Shaft in the Sterling Mine. The groundwater inflow to the "B" Shaft was of great concern to Akzo Nobel Salt Inc. (owner of the Retsof and Sterling mines), and its predecessor, International Salt Company (ISCO), due to the destabilizing effects that the inflow-related salt dissolution was having on the "B" Shaft and adjacent "C" Shaft in the Sterling Mine. The "C" Shaft was an integral part of the ventilation and escape route for the operating Retsof Mine. Additional subsurface geologic data were generated by International Salt Company while installing power to remote sections of the mine (Eyermann, 1979), investigating resources for mine expansion (Szyprowski, 1967), and attempting to locate an alleged abandoned "A" Shaft (Langill and Associates 1986B). The stratigraphy and drill hole locations for much of this mine-related work were summarized in a report addressing the proposed use of the Retsof and Sterling mines as an incinerator ash storage facility (Dunn, 1992).

The present study builds on the previous work by incorporating detailed, recently acquired, subsurface information from the salt mining district of Livingston County, into the existing stratigraphic models. The new information includes continuous bedrock core data collected for the interval from the top of Unit A of the Vernon Formation up through the near-surface Upper Devonian shale formation from 12 holes in the area between Conesus Lake and the Genesee River. These core holes were logged with a suite of geophysical tools that included natural gamma-ray. These core and geophysical log data are available in Open File Report No. 6X782. The gamma-ray logs provided a mechanism for correlating the new data with geophysical logs and lithologic descriptions from oil and gas wells and the numerous investigations conducted around the Retsof Mine. These investigations had been performed to address operational issues during the life of the mine and to evaluate conditions related to the collapse and flooding of the mine in 1994. The locations for all of the 184 wells, borings, core holes, and shafts are shown on Plate 1. Many of these data points were drilled subsequent to the work by Rickard.

The continuous core data were the key elements in the present study. The cores with the natural gamma-ray logs provide a better understanding of the lithologic character, at least within the study area, for the units correlated across the region by Rickard. The higher spatial density of core hole locations and associated drill cuttings, geophysical logs, and surface outcrop data also provide greater local insight into the character of some interesting geologic features such as the contact between the Onondaga Formation and Bertie Group, the nature of the lateral limits of salt in Unit D of the Syracuse Formation, the lithologic character of Unit C of the Vernon Formation, and the physical appearance of an apparent décollement within Unit B of the Vernon.

STRATIGRAPHY

The geologic units encountered in the rock cores within the study area are represented on Figure 2. The most complete geologic section was encountered at core hole 9455 (API #21575), which was continuously cored starting at the top of rock within the middle of the Hatch Formation of the West Falls Group and extending for a total depth of 1,976.3 feet, where it finished 22.9 feet below the top of Unit A of the Vernon Formation. The natural gamma-ray log signature for core hole 9455 is displayed on Plate 2 along with a generalized geologic log description representing the lithologies derived from all of the core holes in the study area. A detailed log description from the actual core from hole 9455 is provided in Appendix A. The distribution of the geologic units was correlated throughout the region from natural gamma-ray logs, as illustrated on five cross sections (Plates 3-7).

SALINA GROUP

The lithologic units of the Vernon Formation of the Upper Silurian Salina Group represent the base of the section that was available for this investigation. The cores in the Hampton Corners area were cut into the top of Unit A of the Vernon Formation below the last salt of Unit B.

Vernon Formation

Rickard (1969) segregated the Vernon Formation into the members identified in ascending order (Figure 2 and Plate 2) as A, B, and C. The contact between Units A and B was designated by Rickard (1969) as the base of the B1 salt bed, the lowest salt bed in Unit B. Unit A ranges from approximately 162 feet thick in the northwest corner of the study area to 197 feet thick in the southeast corner, based on the gamma-ray logs within the study area and on Rickard (1969). Only the upper portion of Unit A was penetrated by the core holes in the Hampton Corners area. The lithologies encountered in the upper 22 feet of Unit A core consisted of gray to green, massive to laminated shale with occasional, contorted bedding or brecciated zones. Thin beds (less than two feet thick) of salt were present at some locations, and streaks of salt and zones of anhydrite nodules were encountered in most of the cores.

Unit B

Unit B, as defined by Rickard (1969), is the main salt-bearing zone of the Vernon Formation and is comprised of six major salt beds, numbered B-1 through B-6 in ascending order (Plate 2). The top of Unit B was defined in western New York as being the top of the B-6 salt, which is known locally as the Retsof Salt Bed (Rickard, 1969) since it was the principal layer being mined at the Retsof and Sterling mines. The selection of the B-6 salt as the top of Unit B is different from the "cb" marker, which is an evaporite/dolostone bed farther up in the section that is relied upon in Ohio as the upper contact (Rickard, 1969). The B-6 contact is apparently more consistent with historical correlation completed in neighboring Pennsylvania and Ontario.

The salt in layers B-1 through B-6 is generally dark gray to white and translucent with shale blebs and shale fragments commonly embedded in the salt. The salt is coarse to very coarse crystalline, and the beds are highly variable in thickness with salt bed B-6 tending to be the thickest, though B-2, B-3, and B-4 were often as thick.

The lower salt beds (B-1 through B-5) are separated by intervals of greenish-gray to olive-black shale that contain numerous fractures filled with reddish-brown halite. Anhydrite is also common. The shale interval thickness generally ranges between one and five feet with an average of approximately two feet in the cores. The shales are laminated, though laminae are often broken or disrupted by fluid-escape structures. The shale to salt contacts are sharp, but they are also often broken or brecciated. Angular fragments of the shale are occasionally visible within upper portions of the salt beds. A thin, unnamed salt bed was often encountered above B-4, and the shale layer overlying that unnamed salt varies between laminated, massive, and occasionally brecciated.

The interval between salt beds B-5 and B-6 is much thicker and has a more variable lithology

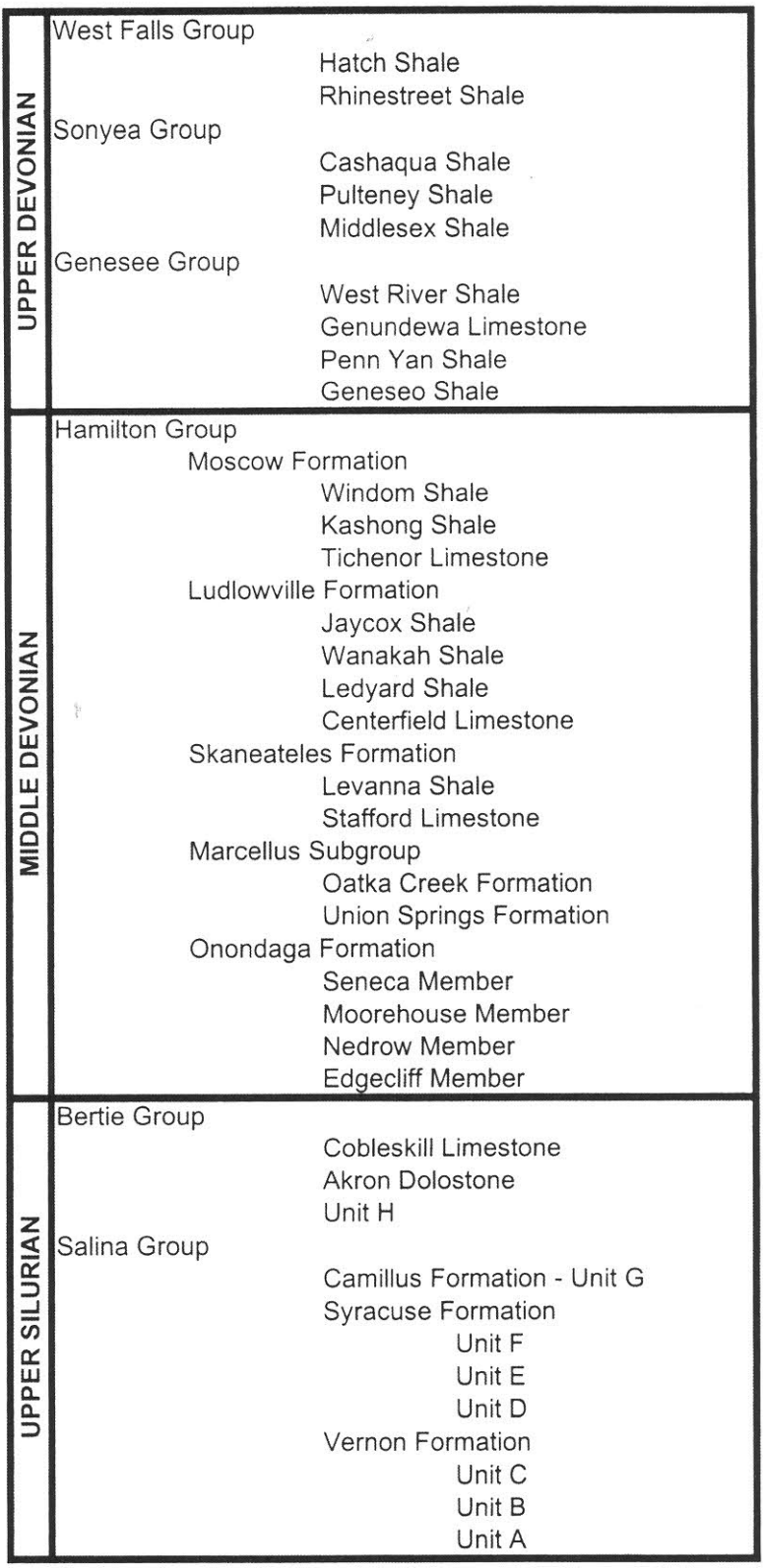
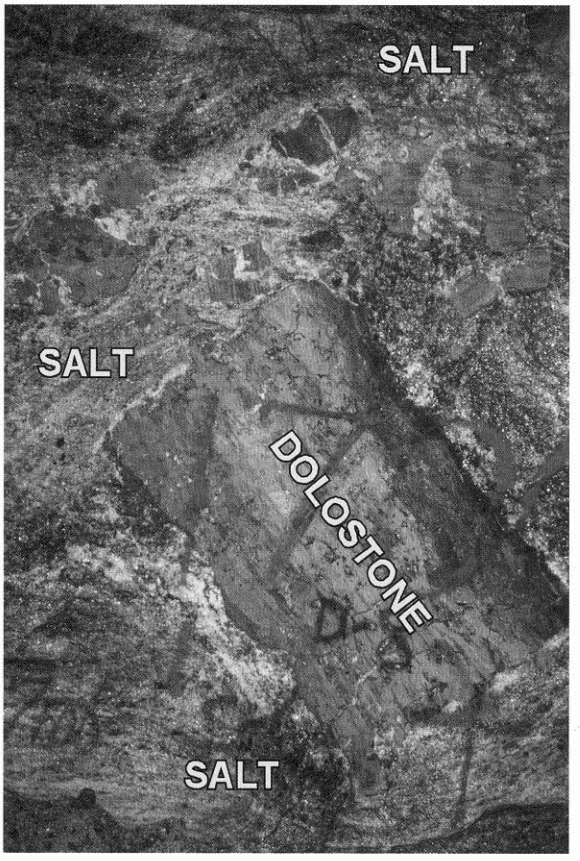


Figure 2: Stratigraphic Column

Photograph 1: Rotated blocks of dolostone and shale at top of B2 salt bed in core from Hampton Corners hole 9456 (API #21576). Note near-vertical laminae within dolostone interval below 1,806.6 feet.



Photograph 2: Retsof Mine wall in exploratory decline (ramp) to the lower salt beds (B-5 down through B-1) near the Fuller Shaft. Note breakage and rotation of shale and dolostone blocks, and apparent flowage of salt.

than the other interlayers. The unit consists of brownish-gray to brown dolostone interlayered with greenish-gray shale and commonly contains anhydrite as thin beds and nodules. Salt is also common as a filling in fractures, as lenses, and as beds at some locations. The dolostone layers are often laminated, but massive bedding and bedding disrupted by fracturing or fluid-escape structures are also common. Dolostone usually is the first rock unit encountered below the B-6 salt. In the cores, this dolostone is often severely fractured and brecciated, exhibiting blocks of dolostone rotated up into the salt such that the laminae are dipping at steep to near-vertical angles (Photograph 1).

The brecciated and rotated nature of the dolostone blocks seen in the Hampton Corners cores appears to correspond with large-scale breakage and rotation of shale and dolostone blocks and apparent flowage of salt that were observed by the authors in an exploratory slope tunneled from the B-6 salt to the lower salt levels (B-1 through B-5) near the Retsof Mine's Fuller Shaft (Photograph 2). The massive, angular rock fragments embedded within the B-2 salt at the slope (which was tunneled in the 1960s) are described in detail by Jacoby (1969).

The salt flowage structures, as well as the rotated blocks of shale and dolomite within the salts, are interpreted in this publication as being drag-induced features associated with a décollement through the Vernon and Syracuse salts. The décollement apparently formed during the Appalachian Orogeny when compressional forces caused the Upper Devonian formations to slide to

Photograph 3: Red and green shale of the Vernon Unit C formation in core from Hampton Corners hole 9456 (API #21576). Note reddish-orange halite lenses, streaks, and fracture-fill.

Photograph 4: Roof of Retsof Mine where the B-6 salt had fallen away, revealing a polygonal network of reddish-orange salt-filled fractures.

the north-northwest by slippage along the salt horizons of the Salina Group (Engelder and Geiser, 1980; Murphy, 1981; Prucha, 1968). The bedrock units above the salt moved laterally, distances of perhaps thousands of feet, along the décollement (Engelder and Engelder, 1977). The lateral motion of the bedrock sliding at the salt levels likely resulted in the flow and drag-induced structures seen in the Hampton Corners rock cores and in the exploratory slope of the Retsof Mine.

Unit C

Unit C is generally a massive, greenish-gray shale with zones of dark red mottling (Photograph 3), which make up about 20 percent of the section. The appearance of dark red mottling in the Vernon Unit C shales in the Hampton Corners cores is consistent with the description provided by Luther (1894) for that horizon in the Livonia Salt & Mining Company shaft (API # 03277). Veins, streaks, and vertical fractures filled with reddish-orange halite are common throughout Unit C (Photograph 3). Conglomeratic zones of apparent rip-up clasts, clay clasts, or anhydrite pebbles occur occasionally and are often associated with fluid-escape structures. The contact with the underlying B-6 salt bed varies from sharp to brecciated, and vertical fractures filled with reddish-orange halite are common in the Vernon Unit C shale above the salt. Photograph 4 shows the underside of the shale where the B-6 salt had fallen away from the roof in the Retsof Mine.

Two regionally persistent, yellowish-brown, shaly dolostones occur in Unit C. Both appear as

low radioactivity zones in an otherwise higher gamma signature on the geophysical log. The upper dolostone is thin and lies roughly 40 feet beneath the top of Unit C, and the thicker, lower dolostone is roughly 40 feet above the B-6 salt (Plate 2). The lower dolostone appears to correspond to the "cb" marker that Rickard (1969) identified as an isochronous dolostone marker bed that can be correlated throughout Pennsylvania and New York. The "cb" horizon also appears as an evaporite bed in Michigan and Ohio. Anhydrite and halite appear as laminae, as lenses, and as a filling in fractures in the "cb" dolostone within the study area.

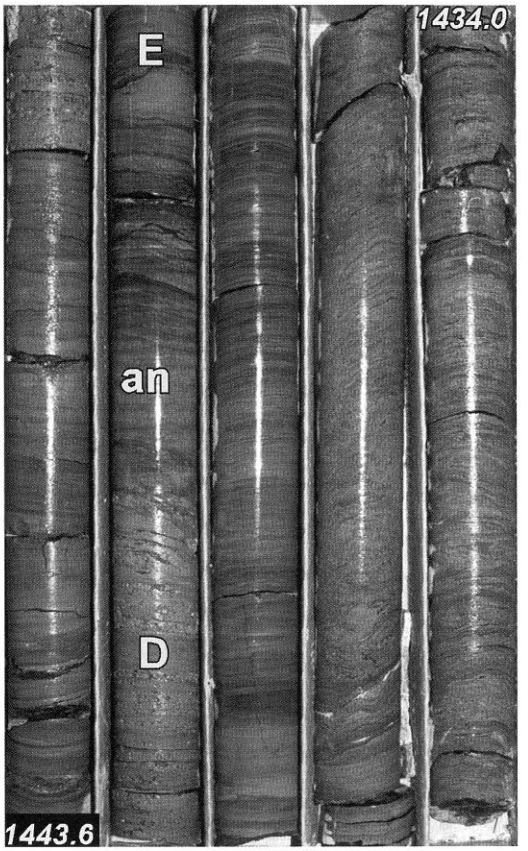
Syracuse Formation

Unit D

The Syracuse Formation consists of Units D, E, and F within the study area. The basal Unit D is distinguished from the other two units by the presence throughout most of the study area of two salt layers, which are locally known as the D-1 and D-2 salts. The salt in both of the Unit D salt beds is white to gray, clear and coarse crystalline. The intervening portion consists of interbedded, yellowish-brown dolostone and gray shale with bands of anhydrite, salt inclusions, salt-filled fractures, and fluid-escape structures.

The Syracuse D salts were the horizons mined by the Livonia Salt & Mining Company, based on the geologic log for the Livonia Shaft (API #03277). Luther (1894) had erroneously interpreted that the horizons mined at Livonia were the B salts that were being mined at all of the other salt mines in the region at the time. The bulk of the mine shafts and salt wells completed prior to the Livonia Shaft were sunk west of the main axis of the Genesee Valley, where the Syracuse Unit D salts were absent. The existence of any substantial salt beds in the region other than the Vernon B salts was simply not known in the late 1800s.

The interval of Unit D above the salt-bearing horizon is primarily an interlayered gray to black shale capped by yellowish-brown dolostone. The Unit D-capping dolostone has abundant salt inclusions which differentiate it from the overlying dolostone of Unit E (Photograph 5). This dolostone bed has a uniquely pitted, vuggy appearance in the cores. The top of Unit D was defined in the core as



Photograph 5: Pitted dolostone at top of Unit D, and basal anhydrite (**an**) of Unit E in core from Hampton Corners hole 9456 (API #21576).

the base of a persistent 0.4- to 1.2-foot interval of shaly, bluish-white to bluish-gray anhydrite that separated the non-salt-bearing dolostone of Unit E from the underlying units (Photograph 5). This anhydrite was apparently also observed by Luther (1894), who described it as a bluish-gray "marlyte" at the Livonia Shaft.

Livingston County lies at the northwestern limit of the Unit D salt beds; however, Unit D itself can be traced throughout the area (Gowan and Trader, 2000). By correlating gamma-ray log signatures for ISCO hole 8601 (API # 19685 on all plates) and Akzo hole 9443 (API # 21539 on all plates) it was determined that distinctive gamma-ray log signatures indicate the presence or absence of salt. Brine was encountered at hole 8601 while drilling

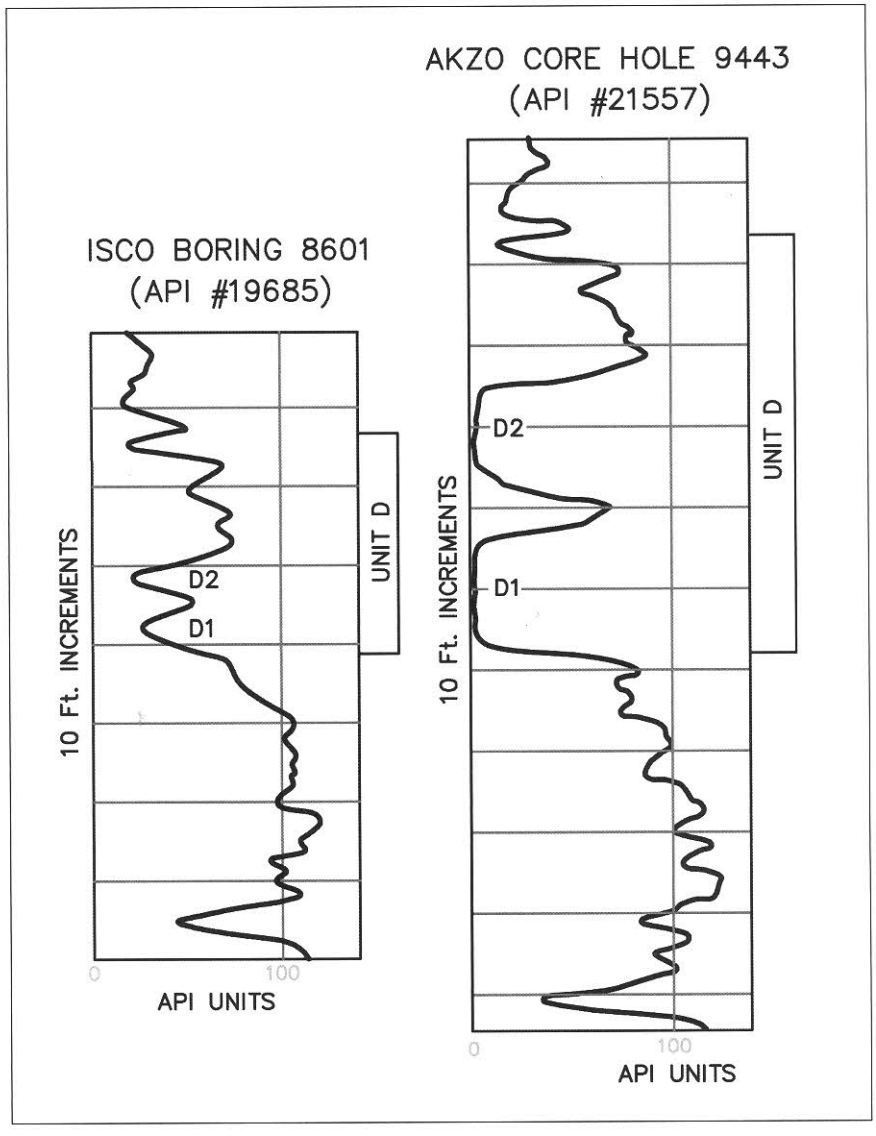


Figure 3: Comparison of Gamma Ray Signatures for Holes 19685 and 21557.

through the interval where the D-1 and D-2 salt beds would have been expected (Langill and Associates, 1987A). Both salt beds were present in the core from hole 9443. The gamma-ray log and core data for 9443 (Figure 3) indicate that the D-1 and D-2 beds are approximately 15 and 11 feet thick, respectively, and that the salt signatures on the gamma log are very clear and blocky in appearance. The corresponding gamma-ray signatures at the D-1 and D-2 horizons on the log for 8601 are weak and rounded.

The lack of salt in Unit D at hole 8601 also corresponds with a significant reduction in the overall thickness of the unit. Unit D has a thickness of approximately 28 feet at the 8601 location and 51 feet at hole 9443. The Unit D thickness and geophysical log signatures for the salt beds were correlated for holes near the Retsof Salt Mine to determine the salt limit (Figures 4 and 5). The analysis indicates that the salt limit is reached when the Unit D thickness shrinks to approximately 30 feet.

The cumulative salt thickness within Unit D

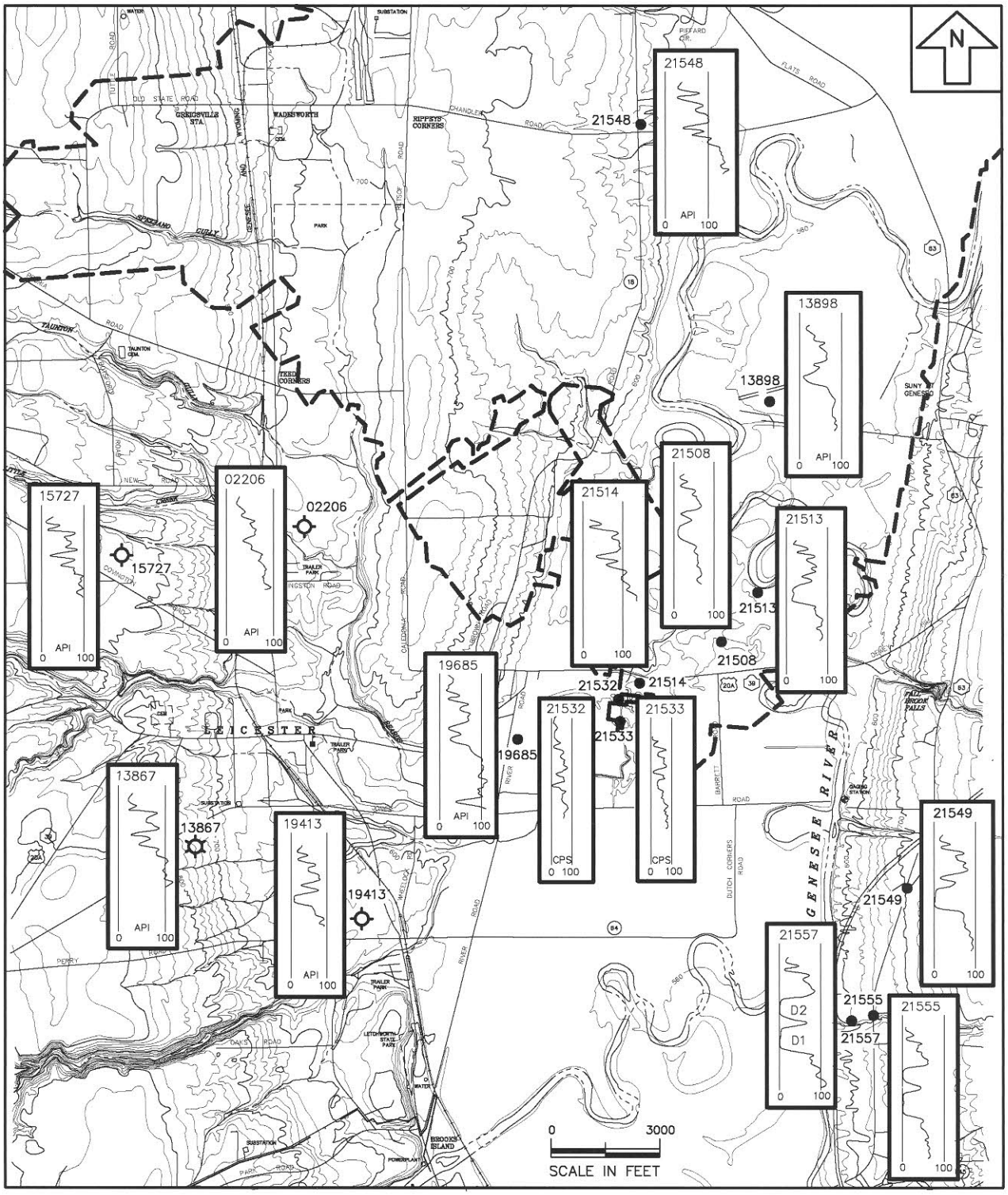


Figure 4: Regional Distribution and Gamma Signatures for the Drill Hole Data Presented on Figure 5.

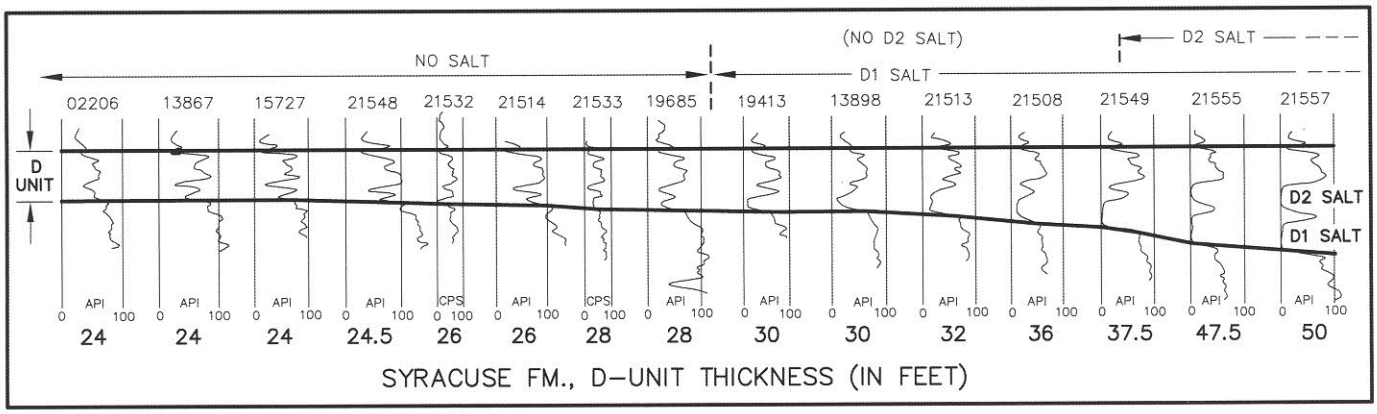


Figure 5: Comparison of Gamma Ray Signatures and Unit D Thickness for Holes in the vicinity of the Retsof Mine.

increases toward the southern end of the study area where the number of beds increases to three or four, as compared to the more typical two. The cumulative salt thickness is greatest at hole 14498 where it reaches a total thickness of 51 feet (Plate 8). The number of salt beds and total salt thickness diminishes to the north and west, with the D-2 disappearing near the eastern boundary of the Genesee Valley, and the D-1 disappearing on the western valley side, north of the Retsof Salt Mine. The lateral limit of salt is also reflected in the Unit D thickness map represented by Plate 9. That portion of Unit D, where salt is not present, generally maintains a thickness of 20 to 30 feet. The geophysical log signatures suggest that the dolostone and shale layers distributed within Unit D generally persist throughout the study area regardless of whether or not salt is present.

Natural brine was encountered at the Unit D salt horizon beyond the northern limit of salt and at hole 8601, just west of the Retsof Salt Mine collapse (Gowan and Trader, 2000). The northern brine pool at Piffard (Plates 8 and 9) was recognized as naturally occurring when the first operating brine wells were drilled in the district in the late nineteenth century (Bishop, 1886). The southern brine pool near River Road in Leicester was initially thought to have been created by the historical brine solution operations of the Phoenix Dairy Company. ISCO commissioned an investigation to evaluate the hazard of mining near the pool (Langill and Associates, 1986C) and to conduct an analysis establishing a barrier pillar around the hazard (Langill and Associates, 1987B). The data derived from those investigations provided the basis for determining that the southern brine was actually a natural pool that formed at the lateral limit of the Syracuse D salt long before the historical solution and rock salt mining operations occurred (Gowan and Trader, 2000).

The persistence of the nonsalt portion of the Unit D and the existence of brine near the northwestern salt limit raises questions regarding the origin of the geographic limit of the Syracuse salts observed today. It may be that the current extent of the salt represents the original margin of Syracuse salt deposition; however, it may also indicate that the salt was initially present but has been removed as the result of dissolution related to its updip position proximal to weathering forces and sources of circulating fresh water. The data suggest that salt had been deposited beyond the current limit.

Units E and F

Units E and F of the upper portion of the Syracuse Formation are lithologically similar. They are both predominantly dolostone with relatively minor shale interbeds, which are more common near the top of each unit. The boundary between Unit E and Unit F is in fact taken at the top of a shale sequence as indicated in the correlations conducted southwest of the study area by Rickard (1969). Both Unit E and Unit F contain anhydrite and gypsum in the shale section, and they are gen-

erally devoid of salt except for a few salt-filled fractures, lenses, and inclusions in the lowest one-fifth of Unit E.

Camillus Formation

The Camillus Formation, which is also known as Unit G of the Salina Group, is well defined by the bracketing dolostone horizons of the Bertie Group above and the Syracuse Formation below. The upper contact is defined in the core at the position where the shale, or interbedded shale and dolostone, of the Camillus Formation changes over to all dolostone in the Bertie Group. An anhydrite layer caps the top of the Camillus Formation at most locations. The lower contact is not always as well defined on the natural gamma-ray log due to a greater number of dolostone interbeds near the base of the Camillus Formation.

BERTIE GROUP

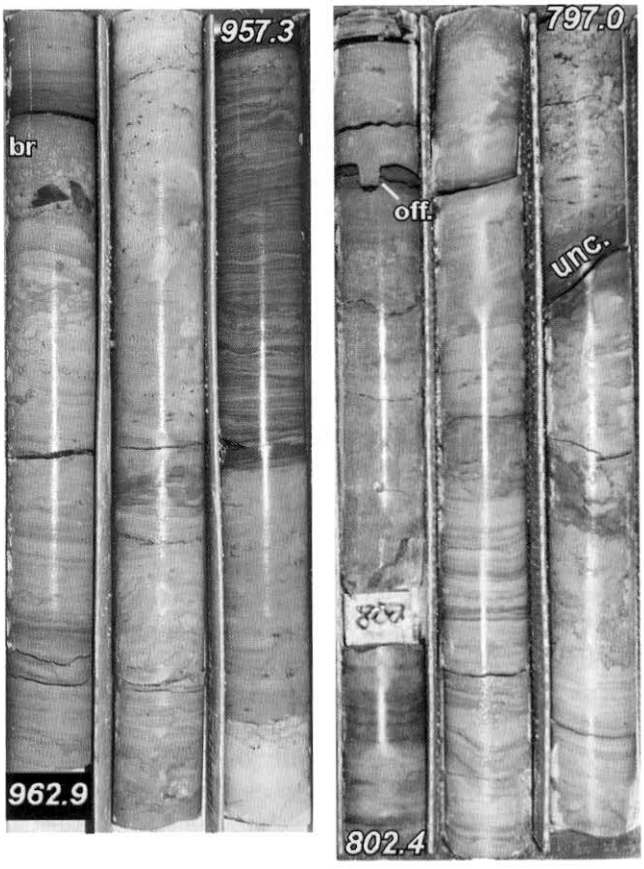
The nomenclature of the Upper Silurian rock units above the Camillus Formation is in flux and does not appear to be clearly resolved. Rickard (1975) identified the Bertie Formation as Unit H of the Salina Group, and he included the Fiddlers Green, Scajaquada, and Williamsville dolostones, in ascending order, within the Bertie Formation. Rickard (1975) placed the discontinuous Rondout Formation (Uppermost Silurian) above the Bertie Formation and noted that the Rondout Formation included the Cobleskill-Akron and Chrysler members. The Cobleskill Limestone and the Akron Dolostone have been considered lateral equivalents, with the Akron primarily in western New York and the Cobleskill occurring in central and eastern New York (Ciurca and Hamell, 1994; Rickard, 1969, 1975). Ciurca (1982, 1990), and Ciurca and Hamell (1994) have suggested that the Bertie Formation be raised to group status in order to combine all of the Upper Silurian eurypterid-bearing rocks in western New York into one package. The Bertie Group of Ciurca and Hamell (1994) incorporates, in ascending order, the Fort Hill, Oatka, Fiddlers Green, Scajaquada, Williamsville, Akron-Cobleskill, and Moran Corner.

The Bertie Group framework was used for the present investigation; however, only the discontinuous Cobleskill Limestone and the Akron Dolostone were differentiated from the rest of the Bertie Group. The remainder of the Bertie Group beneath these formations is referred to in this study as Unit H, which originally encompassed all of the Bertie rock units up through the Williamsville (Rickard, 1975). Further work is necessary on the Hampton Corners rock cores in order to differentiate the buried Bertie Group rocks of that area and correlate them with those in the outcrop belt to the north.

The lower Unit H in the rock cores consists of laminated dolostone and dolomitic shale with anhydrite nodules and a petroliferous odor. Oil shows typically oozed from the core at various intervals for several days after core retrieval. The lower Unit H is separated from the upper Unit H in the study area by an interval of dolomitic shale that has a characteristically high gamma-ray peak with respect to the more typical, low-gamma dolostones of Unit H. This mid-Bertie, dolomitic shale interval rests on a 4- to 10-foot-thick anhydrite layer and typically contains disseminated granules, pebbles, and nodules of chert, gypsum, anhydrite, and sphalerite. The most regionally correlatable feature of the entire Bertie Group lies within this mid-Bertie dolomitic shale interval and is identified by Rickard (1969) as the "hp" (high peak) marker (Plate 2). Interestingly, this marker does not appear to translate to anything of note in the cores. The "hp" marker apparently coincides with the first appearance of pyrite or marcasite-like films, downsection, on the dark, carbonaceous partings between beds.

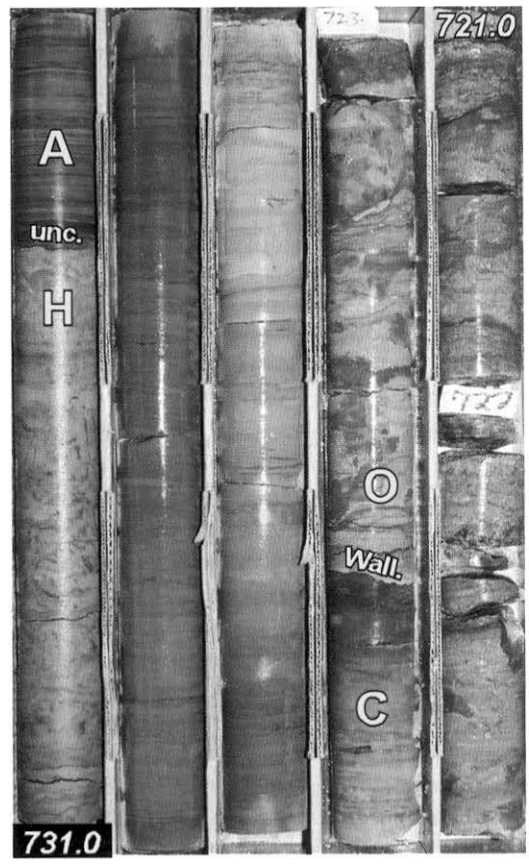
The upper half of Unit H consists of laminated to massive dolostone displaying desiccation features, laminae offset (possibly due to filling of mudcracks), carbonaceous bed partings, and frequent bands of apparent rip-up clast breccias and clay pebble conglomerates (Photographs 6a and 6b). It is possible that some of the carbonaceous partings may be the remains of eurypterids that are so characteristic of the Bertie in outcrop or in quarries. The upper half of Unit H is commonly vuggy, and the core also displayed oil shows oozing from the core.

The top few feet of Unit H in the Hampton Corners area is distinctly different in appearance from the remainder of the Bertie Group. It consists of light olive gray, fine-grained sandstone, rather than dolostone, with characteristic black wisps of mottling (possible root bioturbation) and distinct,



Photograph 6a left: Rip-up clast breccia (**br**) in core of upper Unit H of the Bertie Group from Hampton Corners hole 9453 (API #21572).

Photograph 6b right: Laminae offset (**off.**) and dark, carbonaceous partings within dolostones of the upper Unit H of the Bertie Group. Note unconformity (**unc.**) at the base of the olive grey siltstone with wispy, black mottling. Core is from Hampton Corners hole 9441 (API #21559).



Photograph 7: Bertie Group transition from the wispy-mottled top of Unit H (**H**), through Akron (**A**) and Cobleskill (**C**) Formations, and into the cherty Edgecliff Member of the Onondaga Formation (**O**), above the Wallbridge Unconformity (**Wall.**). Core is from Hampton Corners hole 9443 (API #21557).

unconformable upper and lower contacts marked by sudden color change to the more typical dark yellowish-brown and brownish-gray of the rest of the Bertie Group (Photographs 6b and 7). Oval cross sections of structures that may be fossil plant stems or roots were observed in the core of this interval from Akzo core #9453 (API #21572). No petroliferous odors or oil shows were observed in this mottled horizon. This upper horizon of Unit H was described at the Livonia Shaft as a very light gray sandstone with "no lines of bedding" (Luther, 1894). "Gas and oil" were also described by Luther (1894) as being present in the rocks above and below this sandstone but not within it, just as is the case in the Hampton Corners rock core.

The rock core from the 13 core hole locations at Hampton Corners revealed that the majority of the Bertie Group below the Cobleskill Limestone appeared to be barren of macrofossils, although further inspection may prove otherwise. An exception to this is at hole 9455 (API #21575), where an apparently allochthonous, round (in cross section)

fragment of tabulate coral, approximately 0.15 feet in diameter, was noted at a position 21 feet below the top of the aforementioned wispy-mottled, light gray top of Unit H. No tabulate corals or macrofossils of any kind were noted within Unit H at any of the other 12 core hole locations. It is interesting to note that Luther (1894) reported several *Favosites* coral fragments within the Bertie package at the Livonia Shaft. Just as in hole 9455, Luther's *Favosites* were encountered 21 feet below the top of the "very light gray sandstone." The apparent sparse distribution of solitary tabulate coral fragments at the exact same horizon within an otherwise barren section of Bertie Group rocks over six miles apart may be further evidence of seismite or tsunamite deposition suggested by Ciurca and Hamell (1994).

The Cobleskill Limestone and Akron Dolostone, which lie above Unit H, are discontinuous in the study area. These two units, while typically treated as lateral equivalents, or even as diagenetic forms of the same formation, are differentiated vertically in this publication based on examination of the Hampton Corners rock core. The Akron Dolostone, which lies between Unit H and the Cobleskill Limestone, was differentiated from the Cobleskill primarily by the absence of limestone and the presence of a strong, petroliferous odor. Neither the Cobleskill nor the underlying, wispy-mottled top of Unit H gave off any petroliferous odors. The strong, petroliferous odor of the Akron Dolostone in Livingston County is consistent with the fact that the formation has been a commercial oil producer farther west in Chautauqua County, New York (Copley and Gill, 1983). The Cobleskill Limestone was identified as such based on the fact that it was essentially the only limestone encountered within the Bertie Group. Brachiopods, which may prove useful for age dating, were occasionally observed in the cores through the Cobleskill, but not within the Akron. The Cobleskill contained occasional, thin, dolomitic intervals at some locations.

Recognizable unconformities, commonly consisting of sharp, irregular contacts overlain by conglomeratic or brecciated horizons, and occasionally underlain by apparent rooting structures, are observable between each of the upper Bertie Group units (the wispy-mottled top of Unit H, the Akron Dolostone, and the Cobleskill Limestone). The Akron Dolostone maintains a relatively consistent thickness of 3 to 5 feet in the cores from Hampton Corners, whereas the Cobleskill Limestone ranges in thickness from zero to 10 feet. Both of these units, along with the wispy-mottled top of Unit H, display a distinct pattern on the gamma-ray logs.

The upper limit of the Bertie Group is clearly defined in the study area by a very high gamma-ray signature (Plate 2) at the Wallbridge Unconformity (Brett and Ver Straeten, 1994). In Livingston County, the Wallbridge Unconformity marks the boundary between the Upper Silurian and the Middle Devonian. The rock core from the Hampton Corners area revealed that the erosive down-cutting at the Wallbridge Unconformity had removed the Cobleskill in the central portion of the Hampton Corners area. In fact, based on the distinctive pattern on the gamma-ray logs associated with the upper Bertie Group at Hampton Corners, the erosion at the Wallbridge Unconformity completely removed the Cobleskill and Akron formations, as well as the upper Unit H, north and northwest of Hampton Corners.

Rickard (1989) constructed a paleogeologic map on the top of the Upper Silurian that indicated the presence of the eroded Rondout Formation on the east and the Bertie Formation on the west side of the study area. These findings by Rickard are revised somewhat by the current study based on the core results and the utilization of the nomenclature proposed by Ciurca and Hamell (1994). This revision is represented in the paleogeologic and paleo-relief map (Plate 10).

Vital to the construction of Plate 10 was the relationship between the gamma-ray logs and the rock cores of the Hampton Corners area. The gamma-ray log pattern for the Bertie Group was extrapolated beyond Hampton Corners by the interpretation of existing gamma-ray logs. In this manner, it was determined which formation of the Bertie Group (Unit H, Akron, or Cobleskill) was present directly beneath the Wallbridge Unconformity at the base of the Onondaga Formation.

The paleo-relief aspect of Plate 10 is predicated on the assumption that the "hp" marker represents a relatively level depositional platform upon which the subsequent formations of the Bertie were deposited. Indeed, no physical evidence in the Hampton Corners cores was present to indicate an unconformable surface at the position of the "hp" marker of the mid-Bertie. The thickness of the

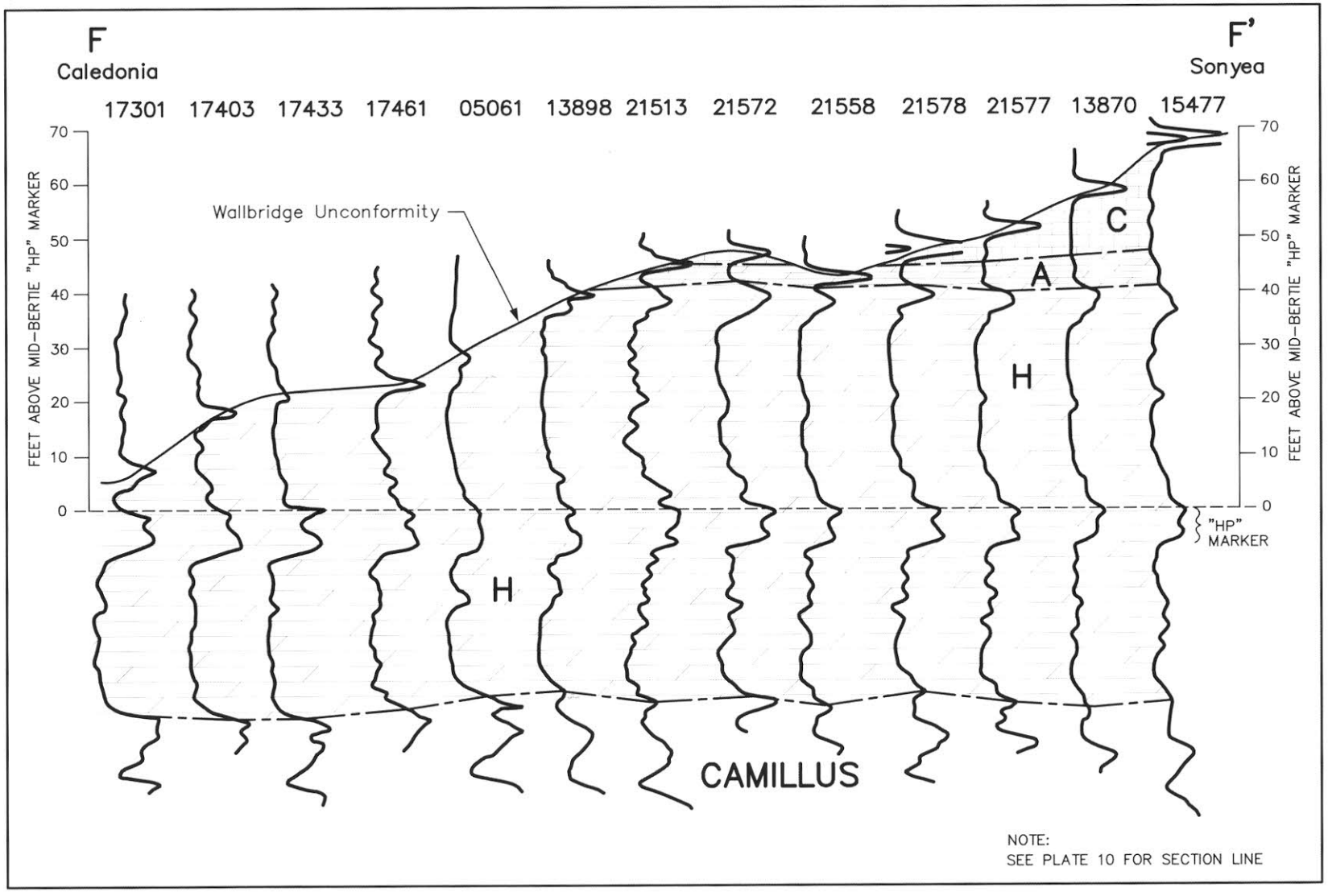
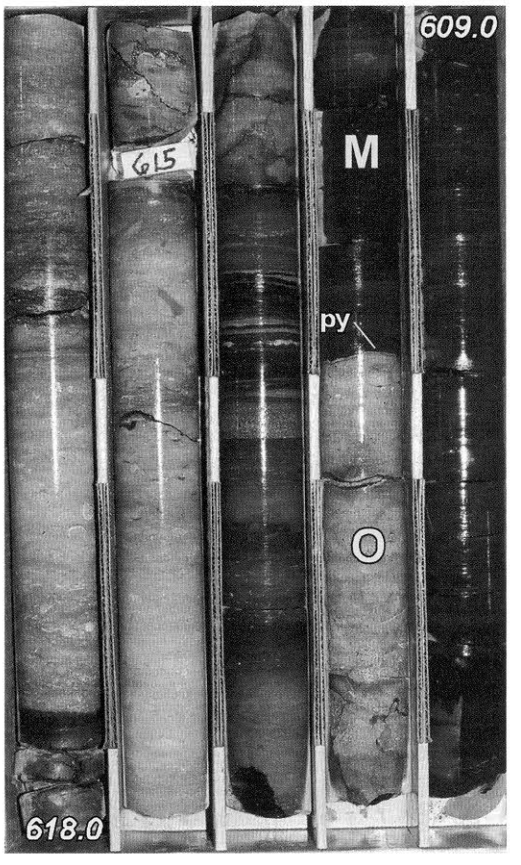


Figure 6: Gamma Ray correlation chart for the Bertie Group in Livingston County. C = Cobleskill Limestone; A = Akron Dolostone; H = Unit H.

Bertie Group above the "hp" marker was mapped to determine the paleo-relief of the pre-Onondaga depositional surface that was created via erosion at the Wallbridge Unconformity.

The Wallbridge Unconformity was an irregular, subaerial erosional surface that in places left a soil horizon with evidence of possible root structures and gravel lag deposits in the Livingston County area. The paleogeologic and paleo-relief map generally shows that the surface was highest to the south and east where the Cobleskill Formation occupied the local highlands. The surface generally sloped down to the north and west where the Cobleskill was stripped away, followed by the Akron and the upper portion of Unit H, with nearly 60 feet of relief. This interpretation is also illustrated on Figure 6, which represents the correlation of gamma-ray signatures using the "hp" mid-Bertie marker as a datum. The section line, shown on Plate 10, proceeds from Caledonia in the north (F), where the Bertie rock package above the "hp" marker is thinnest, southward to Sonyea (F') where this interval is at its thickest. The generalized surface shown on Plate 10 has a broad, dendritic pattern that suggests the paleo-drainage that must have existed. Although the generalized paleo-relief map likely reflects the general trends and drainage patterns, the actual surface was probably much more irregular with locally steeper slopes as suggested by mapped areas where the data density is greater (Plate 10).



Photograph 8: Transition from Seneca Limestone Member of the Onondaga Formation (**O**) to the black shales of the Marcellus Subgroup (**M**). Note thin pyrite lag (**py**) at the unconformity between the two rock units. Core is from Hampton Corners hole 9444 (API #21555).

ONONDAGA FORMATION

The Onondaga Formation is represented in the study area by four members, which consist of the basal Edgecliff Member overlain successively by the Nedrow, Moorehouse, and Seneca members. The Onondaga Formation is bounded at the base by the previously noted Wallbridge Unconformity (Brett and Ver Straeten, 1994) and at the top by an unconformity at the Marcellus Formation contact. Both unconformities are regional marker horizons showing distinct, high gamma-ray counts (Plate 2).

The entire section of cherty (25 to 75 percent chert nodules) limestone at the base of the Onondaga is mapped here as the Edgecliff Member, as suggested by Brett and Ver Straeten (1994). In the Hampton Corners cores, the Edgecliff is separated from the more argillaceous, darker gray, overlying Nedrow Member by a 0.5-foot to 1.0-foot-thick bed of grayish olive green, glauconitic, calcareous shale. This glauconitic bed, which is intensely burrowed and contains occasional pyrite modules, is unique within the Onondaga Formation, if not the entire Devonian sedimentary package within Livingston County. The glauconitic shale bed at the Nedrow base likely represents an unconformity related to a deepening event and sediment starvation, as opposed to the subaerial, exposure-induced Wallbridge Unconformity at the Onondaga base. The argillaceous nature of the Nedrow produces a distinctively higher natural

gamma-ray signature (Plate 2), which was relied on by Rickard (1989) as a regional marker.

The Nedrow Member grades vertically into the overlying, chert-bearing Moorehouse Member. The contact is indistinct and can be taken from the geophysical log where the high gamma-ray reading of the Nedrow Member drops to levels more typical of most of the rest of the Onondaga Formation. The upper contact of the Moorehouse Member is clearly defined by the distinctive geophysical log signature of a thin (0.2 to 0.4 feet) claystone or metabentonite layer known as the Tioga "B" Bentonite or Onondaga Indian Nation Bentonite (OIN) (Brett and Ver Straeten, 1994). The Tioga "B" has major regional significance as an isochronous marker bed.

The Seneca Member contains less chert than the underlying Moorehouse Member. The top of the Seneca Member is defined by an unconformable, abrupt contact beneath a thin, pyrite and shell hash layer (Photograph 8). The upper layers of the Seneca include black shale layers, although the rugose corals present in the Seneca Member are absent in the overlying shales of the Marcellus Formation.

MARCELLUS SUBGROUP

The distinctly black, carbonaceous Marcellus Shale lies beneath the Stafford Limestone and rests uncomfortably on top of the Onondaga Formation. Ver Straeten et al. (1994) suggest that the Marcellus Shale, which is known formally as the Marcellus Formation, should be raised to a subgroup status due to distinct differences in faunal assemblages relative to the units above and below it. The Marcellus Formation in the study area is composed of the Oatka Creek Member and Union Springs Member, both of which would be raised to formation status by Ver Straeten et al. (1994). This nomenclature is adopted for the present study.

The lower limit of the Oatka Creek Formation is defined in the study area as the base of a thin, brownish-black, styliolinid grainstone. This grainstone appears to be the western extension of the Cherry Valley Limestone. Ver Straeten et al. (1994) indicate that both the Cherry Valley Limestone and the underlying Union Springs Formation (which also contains abundant styliolinids) pinch out west of Rochester and are only sporadically known in the subsurface west of the study area.

HAMILTON GROUP

The Hamilton Group of the Middle Devonian is locally comprised of the Skaneateles, Ludlowville, and Moscow formations. This group, like the overlying group of the Upper Devonian, represents a cycle initiated by the deposition of the black shales of the Marcellus Subgroup on an eroded surface at the top of the Onondaga Formation. The overlying shales are dark gray, calcareous, and occasionally separated by thin limestone beds.

The top units of the Moscow Formation appear at the surface in and around the Hampton Corners Mine site along with the overlying units of the Genesee, Sonyea, and West Falls groups. The exposed unit contacts were mapped and correlated with the bedrock cores to generate a bedrock geologic map (Plate 11). Similar mapping was not completed for the rest of the investigation area.

Skaneateles Formation

The Skaneateles Formation consists of the Levanna Shale and underlying Stafford Limestone. The boundaries of the Levanna are well defined by the regionally persistent Centerfield Limestone at the top and the Stafford Limestone at the base. The Levanna Shale is dark gray to olive black and is interlayered with limestone beds within the central portion of the unit. The limestone beds are 1.0 to 6.0 feet thick but are apparently laterally discontinuous. The basal Stafford Limestone is generally 2 feet or less in thickness and also discontinuous in the site area; however, it is recognized as a marker bed throughout western New York (Rickard, 1989).

Ludlowville Formation

The Ludlowville Formation consists of the basal Centerfield Limestone Member overlain by the Ledyard, Wanakah, and Jaycox Shale members. The shale interval is well defined on the geophysical logs by the bracketing Centerfield and Tichenor limestones at the base and top of the Ludlowville, respectively.

The fine-scale, stratigraphic sequences from the Jaycox Member were described by Mayer (1994) for the type section at Jaycox Creek, which is located in the Genesee Valley north of the study area. The fine-scale stratigraphy of the Jaycox Creek Section

was not correlated with the cored lithologies during the present investigation; however, the calcareous, fossiliferous Jaycox Member caused a distinctive drop on the gamma-ray log that was relied on to define the unit throughout the area.

Mayer (1994) places the Stafford Shale Member, which consists of a zone barren of fossils, between the Jaycox Shale and the underlying Wanakah Shale. The basal, calcareous zone appears as a relatively minor drop on the natural gamma-ray log. The contact between the Jaycox and the Wanakah that was selected in the cores follows Mayer (1994) and is apparently slightly higher in the section than the contact chosen by Rickard (1989), which was based on the geophysical log signature from the McBride well (API # 11403) on the west side of the Genesee River Valley in the town of Leicester.

Moscow Formation

The Moscow Formation consists of the basal Tichenor Limestone overlain by the Kashong and Windom Shale members. The Kashong and Windom shales are both dark gray and generally appear quite similar in the cores with both containing scattered fossils and distinct fossil hash layers. The primary differences between the two shale beds is the presence of ambocoellid brachiopods in the Windom Shale that are not present in the underlying unit, and the apparent increase in fossil hash layers toward the base of the Kashong Shale. Some of the fossil hash layers have been correlated regionally (Brett and Baird, 1994), but no attempt was made during the present investigation to correlate those observed in the core with those identified by others. The base of the Windom Shale is defined by a persistent 0.2-foot interval of grayish-black, subangular phosphate pebbles that is locally known as the "Little Beards Creek Phosphate Bed." Brett and Baird (1994) associate this bed with two disconformities.

No distinct geophysical log markers were noted in the shale horizons, though the natural gamma-ray drops off near the base of the Kashong Shale in apparent response to an increase in carbonate content. The basal Tichenor Limestone produces a notable and persistent drop in natural gamma-ray. The Tichenor Limestone is dark gray and highly fossiliferous.

GENESEE GROUP

The Upper Devonian Genesee Group represents a depositional cycle and consists of the black Geneseo Shale overlain by the dark gray Penn Yan and West River shales. The dark gray shales are separated by the thin Genundewa Limestone, which had an average thickness of 2.3 feet in the core holes that intersect that unit between the Genesee Valley and Conesus Lake. Both shale beds contain fossils, calcareous concretions, and septarian nodules, though the Penn Yan Shale has a slightly greater abundance of these features than the overlying West River Shale. The basal Geneseo Shale typically consists of two black shale layers separated by an interval of thin limestone beds and fossil hash horizons containing styliolinids and brachiopods. The Leicester Pyrite, which is recognized as a persistent marker at the erosional base of the Geneseo Shale (Kirchgasser et al., 1994), was present as burrow casts or fossil replacements in all of the cores.

The Genundewa Limestone appears as a distinctive, persistent, sharp drop in the natural gamma-ray reading. The increase in the geophysical log signature in the Geneseo Shale was also persistent, though less distinctive, than the Genundewa marker. The Geneseo Shale signature is quite irregular with multiple spikes as the apparent result of variations in the presence of the fossil hash zones.

SONYEA GROUP

The Upper Devonian Sonyea Group, like the overlying West Falls Group, is a cyclic sequence defined by the basal, brownish-black Middlesex Shale overlain by the interbedded gray and brownish-black Pultney Shale and capped by the dark gray Cashaqua Shale. Fossils in the section were relatively rare, though occasional pelecypod, cephalopod, brachiopod, and plant fragments were encountered. The Pultney and Middlesex shales have nearly indistinguishable appearances on the natural gamma-ray, but their combined signature is a very distinctive, highly irregular series of spikes on the log.

The boundary between the Cashaqua Shale and

the overlying Rhinestreet Shale is marked by a small drop in the natural gamma-ray signature, which did not persist very far down into the bed. This drop in the natural gamma-ray may represent an increase in carbonate content associated with the Shurtleff Septarian Horizon that is visible in outcrops (Kirchgasser et al., 1994) though it is not evident in the core. A closer look might be fruitful.

WEST FALLS GROUP

The Upper Devonian West Falls Group is represented by the Rhinestreet Shale and the overlying Hatch Shale. Both shales appear in the core as interlayered gray and brownish black shale though the Rhinestreet is predominantly brownish black and highly fissile toward the base, and the Hatch contains argillaceous limestone bands and concretions. These two shales represent the lower portion of a typical cyclic sequence in the Upper Devonian of western New York that consists of a basal black shale overlain by a gray shale and a general coarsening-upward sequence capped by the black shale of the succeeding cycle (Kirchgasser et al., 1994).

The Rhinestreet Shale is a persistent marker bed that extends throughout western New York (Kirchgasser et al., 1994). This unit is one of the major, basin-wide marker beds that defines the boundary between lithologic groups in the Upper Devonian in New York (Rickard, 1975; Woodrow, 1985; Woodrow et al., 1989). The natural gamma-ray log indicates a moderately high gamma-ray count in the Rhinestreet Shale that generally falls off in the ascent through the overlying Hatch Shale. Insufficient data are available to evaluate the lateral continuity of this signature. The Hatch Shale is known to be discontinuous to the west where it grades laterally to the Gordeau Shale, which is mapped above the Rhinestreet Shale in Letchworth Gorge on the west side of the Genesee Valley (Kirchgasser et al., 1994).

STRUCTURE

A structural contour map was generated for the top of the Tioga Bentonite (Plate 12). This map shows a surface that dips southward at a rate of approximately 53 feet per mile (0.58°). The gently undulating surface does not reveal any significant structures, though minor folds or faults could be present but are not detectable due to the broad spacing of the data and the fact that the elevations provided for many of the oil and gas wells are estimates from topographic maps. The estimated elevations likely produced errors of as much as 20 feet that restrict the interpretation to a generalized representation of the Tioga Bentonite surface.

The Tioga Bentonite was chosen for structural analysis due to its' being a distinctive marker that is ubiquitous throughout the area except where removed by glacial scouring in the Genesee Valley. The bed is also an isochronous marker that has been correlated across several states, and the feature appears to be embedded in a continuous depositional sequence within the Onondaga Formation. Other distinctive markers with a broad regional distribution would be suitable for structural mapping for a much broader area, but many of these areally persistent markers, such as the top of the Onondaga Formation and the top of the Bertie Group, represent unconformable surfaces that can obfuscate the interpretations on a local scale. This problem arose during the investigation of the Retsof Mine collapse, when various researchers developed structural interpretations of the collapse area from different marker horizons, most of which were unconformities. The results of the various interpretations were contradictory in many cases and did not reveal a defensible structural anomaly associated with the collapse.

ACKNOWLEDGEMENTS

The authors would like to thank Akzo Nobel Salt, Inc. and American Rock Salt, Inc. for the opportunity to publish much of the data contained herein. We greatly appreciate the talent of Terrel Broiles in the preparation of many of the figures and plates. We are also thankful to the staff of Alpha Geoscience, especially John Nadeau, Diane Welch and Carol Eisler. A debt of gratitude is owed to our significant others who have been ever helpful and supportive throughout the years of work leading to this publication.

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APPENDIX A

CORE LOG OF AKZO

CORE HOLE 9455 (API #21575)

ROCK LOG LEGEND

ROCK QUALITY PARAMETERS

Grades of Decomposition

D - 1 Fresh Rock
D - 2 Slightly Altered Rock (Joints Stained)
D - 3 Moderately Altered Rock (Matrix somewhat weakened)
D - 4 Highly Altered Rock (Matrix weak)
D - 5 Residual Soil (Soil-like saprolite)

Grades of Fracturing

F - 1 Massive (Fracture spacing greater than 3 feet)
F - 2 Moderately Jointed (Fracture spacing 8 inches to 3 feet)
F - 3 Very Jointed (Fracture spacing 4 inches to 8 inches)
F - 4 Extremely Jointed (Fracture spacing 2 inches to 4 inches)
F - 5 Crushed (Fracture spacing less than 2 inches)

Grades of Strength

S - 1 Strong (Metallic sound, breaks with difficulty with hammer)
S - 2 Moderately Strong (Dull sound; breaks with moderte hammer blow)
S - 3 Weak (Cuts easily with knife)
S - 4 Very Weak (Breaks with finger pressure)

RELATIVE HARDNESS SCALE

Very Hard - Cannot be scratched with steel blade.
Hard - Scratches with difficulty with steel blade.
Moderately Hard - Easily scratched with steel blade, but not with fingernail.
Soft - Scratches with fingernail.

ROCK QUALITY DESIGNATION (R.Q.D.) is based on a modified core logging procedure which, in turn, is based indirectly on the number of fractures and the amount of softening or alteration in the rock mass as observed in the rock cores. Instead of counting the fractures, an indirect measure is obtained by summing up the total length of core recovered - but counting only those pieces of core which are four inches (10 cm) in length or longer, and which are hard and sound. This procedure obviously penalizes the rock where recovery is poor. This is appropriate because poor core recovery usually indicates poor quality rock. It has been found that there is a good relationship between the numerical values of the R.Q.D. and the general quality of the rock for engineering purposes. This relationship is as follows:

0 - 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Excellent

D.U. Deere, (1968) Rock Mechanics in Engineering Practice, Stagg & Zienkiewicz, ed., Wiley

ROCK COLOR SCALE

Neutral Scale

N-1 Black
N-2 Grayish Black
N-3 Dark Gray
N-4 Med. Dark Gray
N-5 Medium Gray
N-6 Med. Light Gray
N-7 Light Gray
N-8 Very Light Gray
N-9 White

ALPHA GEOSCIENCE

CORE LOG

Version Date 4/14/95

ALPHA GEOSCIENCE

Hole No. 9455

Client Akzo Nobel Salt, Inc. Logged by Steve Trader/Steve Winkley Date Logged 2/2/1995-3/15/1995 Sheet 1 of 34

Project Hampton Corners Drilling Co. Longyear Depth 1976.3'

Project No. 94124 Driller Raymond Quesenberry/Gerry Creggler Rig Type 44-TMV Elev. 1117.9'

Location Livingston Co., NY Started 1/25/1995 Finished 2/23/1995 Core Dia. 2 3/8" (HQ)

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				Drilled to 40' with tricone roller bit; cored with PQ rock bit from 40-200' using 40 feet of PW rods as casing; removed PW casing and set surface casing (PQ rods) to 200 feet.				
			10	0-34' Till				
			20					
			30					
				34.0-75.2 Shale; medium dark gray (N4), brownish black (5 YR 2/1); interlayered; claystone; laminated: brownish black intervals; carbonaceous; petroliferous odor; 0.01-0.05' thick; medium dark gray intervals, 0.05-0.15' thick; non-calcareous; with rare, argillaceous, limestone beds less than 0.3' thick, occasionally with a rippled texture; fissile; dimpled surface; rock quality D-1, S-2, F-2, moderately hard		WEST FALLS GROUP	Hatch Shale	
			40					
1	71	63						
2	94	88	50					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 2 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
3	98	98		75.2-112.5 Shale, medium gray (N4), brownish black (5 YR 2/1), interlayered; claystone; similar to 34.0-75.2' with more frequent argillaceous limestone beds; carbonate concretion 95.3-95.4'; fissile; rock quality D-1, S-2, F-2, moderately hard		WEST FALLS GROUP	Hatch Shale	vertical fracture 82.0-82.9' Core is crushed and broken 87.9-95.0'
4	96	96	60					
5	99	99	70					
6	100	100	80					
7	78	78						
8	45	12	90					
9	40	28						
10	100	100	100 110					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 3 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				112.5-169.3 Shale; medium gray (N4) with brownish black (5 YR 2/1) intervals; laminated; brownish black intervals are carbonaceous with petroliferous odor, 0.01 to 0.8' thick; non-calcareous; fissile; pyrite granules prevalent in medium gray intervals; carbonized plant debris at 116.2'; septarian nodule at 126.3-126.7'; rock quality D-1, S-2,F-2, moderatly hard		WEST FALLS GROUP	Rhinestreet Shale	112.5' base of Hatch Shale beneath lowest argillaceous limestone. Pyrite ovoids at contact
11	95	95	120					
12	100	100	130					
13	98	98	140					
14	98	98	150					
15	100	100	160					
16	100	100	170					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 4 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				169.3-181.0 Shale; brownish black (5 YR 2/1); laminated; interlayered with intervals of gray and brownish black laminae; non-calcareous; petroliferous odor; carbonaceous; high fissility; rock quality D-1, S-2, F-2, moderately hard		WEST FALLS GROUP	Rhinestreet Shale	vertical fracture 173.3-174.4'
17	100	100	180					
				181.0-231.0' Shale; dark gray (N3) to medium dark gray (N4); claystone; laminated; slightly calcareous; abundant pyrite lenses (burrow casts); rare fossils include brachiopods and carbonized plant debris; high fissility and platy fracture; rock quality D-1, S-2, F-2, moderately hard		SONYEA GROUP	Cashaqua Shale	
18	100	100	190					
19	90	90	200					Begin HQ core at 200 feet
20	100	97	210					
			220					
21	100	100						
			230					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 5 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				231.0-299.0 Shale; dark gray (N3) to medium dark gray (N4); claystone; laminated; slightly calcareous; similar to 181.0-231.0'; very rare fossils include brachiopods, cephalopods (coiled and straight), plant debris; high fissility; rock quality D-1, S-2, F-2, moderately hard		SONYEA GROUP	Cashaqua Shale	
22	100	100	240					
23	100	100	250 260					
24	97	97	270					
25	100	96	280					
26	100	100	290					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 6 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
27	100	100	300	299.0-356.9 Shale; dark gray (N3); same as above; very rare fossils include brachiopods and plant debris; rock quality D-1, S-2, F-2, moderately hard		SONYEA GROUP	Cashaqua Shale	
28	97	97	310 320					
29	100	100	330					
30	100	100	340 350					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 7 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						SONYEA GROUP	Cashaqua Shale	
31	100	100	360	356.9-383.0 Shale; dark gray (N3), interbedded with brownish black (5 YR 2/1); dark gray intervals: claystone; 0.05' to 0.5' thick; massive to laminated; with pyritized burrow casts; brownish black intervals: claystone; 0.05' to 0.8' thick; laminated; petroliferous odor; both dark gray and brownish black intervals are non-calcareous; rock quality D-1, S-2, F-2, moderately hard			Pulteney Shale	
32	100	100	370 380					
33	98	98	390	383.0-399.3 Shale; brownish black (5 YR 2/1); claystone; laminated; carbonaceous; non-calcareous; petroliferous odor; rare fossils include gastropods and plant debris; rock quality D-1, S-2, F-2, moderately hard				Pulteney/ Middlesex contact from Gamma Log 390'
34	100	100	400 410	399.3-407.0 Shale; dark gray (N3) interbedded and interlaminated with brownish black (5 YR 2/1) laminated; styliolinids concentrated in thin whitish bands in dark gray shale beds; brownish black beds with petroliferous odor; bottom contact is at base of 0.01' thick pyrite and styliolinid lag; fossils include gastropods, plant debris, styliolinids; rock quality D-1, S-2, F-2, moderately hard			Middlesex Shale West River	grayish black carbonate concretion 396.8-397.2' Middlesex-West River contact at 407'

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 8 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				407.0-472.3 Shale; similar to 399.3-407.0'; dark gray (N3.5) interbedded and interlaminated with brownish black (5 YR 2/1); claystone; fossils include pelecypods, styliolinids (as calcareous white bands in gray shale), plant debris; pyrite nodules; rock quality D-1, S-2, F-2, moderately hard		GENESEE GROUP	West River Shale	
35	98	96	420					
			430					
36	98	97						
			440					
37	100	100	450					
			460					
38	98	98						
			470					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 9 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				472.3-475.7 Limestone; dark gray (N3) to olive black (5 Y 2/1); nodular wackestone and grainstone; black, carbonaceous material between nodules; fossils include brachiopods and styliolinids; rock quality D-1, S-1, F-2 to F-3, hard		GENESEE GROUP	GEN	GEN=Genundewa Limestone
39	87	83	480	475.7-512.4 Shale; dark gray (N3) interbedded with brownish black (5 Y 2/1); claystone; laminated to massive; frequent gray carbonate nodules 0.1 to 0.3' thick; calcareous; small pyrite ovoids; rare fossils include styliolinids and pelecypods; rock quality D-1, S-1 to S-2, F-2, moderately hard to hard; fissile			Penn Yan Shale	vertical fracture 484.4-486.0
40	100	100	490 500					
41	97	97	510					vertical fracture 506.4-508.7'
				512.4-537.8 Shale; same as 475.5-512.4 without carbonate nodules; pyrite nodules; rock quality D-1, S-2, F-2, moderately hard; fissile				
42	100	100	520 530					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 10 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						GENESEE GROUP	Penn Yan Shale	
43	100	100	540	537.8-545.9 Shale; brownish black (5 YR 2/1) interlaminated with black (N1); claystone; carbonaceous; petroliferous odor; non-calcareous with calcareous, thin, white laminae; rock quality D-1, S-2, F-2, moderately hard; fissile; vertically fractured			Geneseo Shale	vertical fracture 538.4-541.8'
			550	545.9-553.9 Limestone; medium gray (N4); mudstone; argillaceous limestone beds (1.0-1.5' thick interbedded with brownish black (5 YR 2/1), carbonaceous shale with petroliferous odor; rock quality D-1, S-1 to S-2, F-2, hard to moderately hard				vertical fracture 549-550'
44	100	100		553.9-562.6 Shale; olive black (5 Y 2/1) interlaminated with brownish black (5 YR 2/1); claystone; mild petroliferous odor; non-calcareous; fissile; rock quality D-1, S-2, F-2, moderately hard; with vertical fractures				"Geneseo Limestone" 545.9-553.9'
			560	562.6-562.8 Pyrite lag with sharp irregular upper and lower contacts; visible fossils include crinoids and burrow casts	PYRITE			562.6-562.8 "Leicester Pyrite"
45	100	100	570	562.8-598.0 Shale; medium dark gray (N4); claystone; very faint laminations; calcareous to non-calcareous; mild petroliferous odor; pyrite nodules (0.01 to 0.03' thick) common in upper 9.0'; thin (0.01 to 0.05' thick) fossil hash layers include crinoids, bryozoans, brachiopods; rock quality D-1, S-2, F-2, moderately hard; horizontal platy fractures		MOSCOW FORMATION	Windom Shale	
46	100	98	580					
			590					

ALPHA GEOSCIENCE

Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 11 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
47	100	100	600	598.0-613.1 Shale; medium dark gray (N4); same as above, except fossil hash layers are less common, and ambocella brachiopods are prevalent; slightly calcareous; rock quality D-1, S-2, F-3, moderately hard; horizontal platy fractures		MOSCOW FORMATION	Windom Shale	
48	100	100	610 620	613.1-660.4 Shale; medium dark gray (N4); claystone; massive; non-calcareous; fossils include crinoids, brachiopods (no ambocella brachiopods), pelecypods; pyritized burrow casts; rock quality D-1, S-2, F-2, moderately hard			Kashong Shale	phosphate granules at base of Windom Shale, from 612.9-613.1'
49	100	100	630					
50	98	98	640 650					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 12 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
51	100	100	660	660.4-695.2 Shale; medium dark gray (N4); claystone; massive; slightly calcareous; occasional to frequent fossil hash beds (packstone/grainstone) with crinoids, bryozoans, brachiopods (from 0.01 to 0.1' thick); rock quality D-1, S-2, F-2; moderately hard		MOSCOW FORMATION	Kashong Shale	
52	100	100	670					
			680					
53	100	100	690	695.2-696.1 Limestone; medium dark gray (N4) to medium gray (N3); packstone with frequent stylolites; fossiliferous, with crinoids, brachiopods, trilobites, and tabulate coral; rock quality D-1, S-2, F-2; hard; core breaks along stylolites that display slickensided, carbonaceous surfaces				0.9' thick Menteth Limestone at 695.2'
				696.1-700.2 Shale; medium dark gray (N4); claystone; bioturbated and burrowed; fossiliferous, with frequent crinoids, bryozoans, brachiopods, trilobites; rock quality D-1, S-2, F-2, moderately hard				
54	98	98	700	700.2-702.3 Limestone; olive gray (5 Y 5/1) to medium gray (N3); packstone/wackestone, fine crystalline; upper 0.9' is nodular, (boundstone), with abundant tabulate corals; lower 1.2' is massive, calcarenite; other fossils include abundant crinoids and frequent brachiopods and bryozoans; rock quality D-1, S-2, F-2, hard			TICH	TICH=Tichenor Limestone Pyrite bands at 702.2-702.6'
				702.3-715.2 Shale; medium dark gray (N4); claystone; fossiliferous; with frequent bryozoans, brachiopods, crinoids, trilobites, pelecypods, and rare corals; fossils often occur in 0.1 to 0.2' thick bands; slightly calcareous; pyrite burrow casts and disseminated pyrite in upper 0.8'; upper contact and lower contact are gradational; rock quality D-1, S-2, F-2, moderately hard		LUDLOWVILLE	Jaycox Shale	
			710					

ALPHA GEOSCIENCE

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
							Jaycox Shale	
55	100	100	720	715.2-750.9 Shale; medium dark gray (N4); claystone; bioturbated; slightly to non-calcareous; fossiliferous, with occasional brachiopods, trilobites, bryozoans, crinoids, styliolinids, pelecypods, cephalopods; rare rugose and tabulate corals; primary brachiopods are ambocoellids, which are commonly replaced/filled with pyrite; cephalopods commonly preserved as compressed mud steinkerns; pyrite common also as platy, horizontal fractures; fossil content decreases across gradational lower contact		LUDLOWVILLE	Wanakah Shale	argillaceous limestone 739.3-740.3'
56	100	100	730					abundant pyrite-replaced ambocoellids from 748.6-750.1'
57	100	100	740					
58	100	100	750	750.9-820.4 Shale; medium dark gray (N4), brownish black (5 Y 2/1), olive black (5 Y 2/1), claystone; laminated; non-calcareous to slightly calcareous; with occasional pelecypods, brachiopods, bryozoans, styliolinids, crinoids, trilobites and rare rugose coral; occasional pyrite a small nodules, burrow casts, and fossil replacement; rock quality D-1, S-2, F-2, moderately hard; with horizontal fractures			Ledyard Shale	0.1' thick shell hash layer at 750.9'
			760					
			770					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 14 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			780			LUDLOWVILLE	Ledyard Shale	
60	100	100	790					
61	100	100	800					
			810					
62	100	100	820	820.4-827.6 Limestone; medium dark gray (N4) to medium gray (N5); nodular wackestone/ packstones interbedded with massive, stylolitic, medium crystalline zones, and rare grainstones and calcarenite; abundantly fossiliferous; fossils include rugose and tabulate corals, brachiopods, crinoids, bryozoans, and trilobites; with rare pyrite; gradational upper and lower contacts, marked by decrease in fossil abundance, and by lack of hard, crystalline grainstones; rock quailty D-1, S-1 (medium gray calcarenites) to S-2 (wackestones and packstones), no fractures, hard to moderately hard			Centerfield	
63	100	96	830					high angle (vertical) fracture 828.5-830.5

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			840	827.6-903.2 Shale; olive black (5 Y 3/1) to medium dark gray (N4.5); claystone; laminated; calcareous to slightly calcareous; with frequent styliolinids, occasional small brachiopods and pelecypods; occasional pyrite nodules and burrow casts; occasional high angle (80-90 degrees) fractures; slight to moderate petroliferous odor; rock quality D-1, S-2, F-2, moderately hard		SKANEATELES	Levanna	high angle (vertical) fracture from 834-835' and 836-837.5'
64	100	100	850					
			860					
65	100	100						
			870					
66	100	100						vertical fracture 873.0-878.0'
67	100	87	880					
68	100	96	890					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
69	100	99	900	903.2-993.3 Shale; medium dark gray (N4), rarely brownish black (5 YR 2/1); claystone; laminated slightly calcareous; occasional brachiopods and nautiloid cephalopods (coiled and straight); with petroliferous odor; pyrite occasional as cephalopod replacement, and as burrow casts; frequent styliolinids; interlayered with bioturbated, medium gray (N5), argillaceous limestones averaging 1 to 3 feet thick, occasional crinoids, brachiopods, pelecypods, and stylolites; contacts between shales and limestones are gradational; rock quality D-1, S-2, F-2, moderately hard		SKANEATELES	Levanna	argillaceous limestone 903.2-904.8'
70	100	100	910					
71	100	100	920					argillaceous limestone 914.4-919.8'
72	100	100	930					argillaceous limestone 927.4-928.1'
73	100	100	940					argillaceous limestone 937.4-940.6'
74	100	100	950					argillaceous limestone 945.7-948.7'

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						SKANEATELES	Levanna	
75	100	100	960					bioturbates, argillaceous limestones at 955-955.7', 958.7-960.3', and 967.7-968.6'
76	100	100	970					
77	100	100	980					
78	100	100	990					
				993.3-1051.3 Shale; same as above with rare argillaceous limestone beds; interlaminated and interlayered with brownish black (5 YR 2/1), carbonaceous shale with petroliferous odor; lower contact is gradational				limestone 991.3-993.3
79	100	100	1000					
80	100	100	1010					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 18 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
81	100	100	1020			SKANEATELES	Levanna	
82	100	100	1030					
83	100	100	1040					
84	100	100	1050	1051.3-1070.0 Shale; same as above; with brownish black (5 YR 2/1) intervals becoming more common				Brownish black petroliferous shale from 1051.3-1052.0' and 1055.0-1055.6'
85	100	100	1060					
86	100	87	1070					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 19 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1080	1070.0-1080.7 Shale; brownish black (5 YR 2/1) to olive black (5 Y 3/1); claystone; laminated; carbonaceous; strong petroliferous odor; abundant styliolinids, and occasional small brachiopods and pelecypods; occasional, small pyrite nodules and granules; rock quality D-1, S-2, F-2, moderately hard; occasional vertical fractures		SKANEATELES	Levanna	vertical fracture 1073.3-1078.0'
87	100	92		1080.7-1082.5 Limestone; brownish black (5 YR 3/1); wackestone/packstone; massive; stylolitic; bioturbated; abundant brachiopods, pelecypods, occasional styliolinids; rare pyrite granules; sharp upper contact and gradational lower contact; rock quailty D-1, S-2, F-2, hard			STAF	STAF=Stafford Limestone
88	91	52	1090	1082.5-1111.6 Shale; black (N1); claystone; massive to faintly laminated; carbonaceous; non-calcareous to 1106.2'; slightly calcareous below 1106.2'; pyrite abundant as blebs, granules, and ovoid nodules; rare, fossiliferous carbonate concretions; rare styliolinids, brachiopods, and occasional carbonized plant debris; styliolinids extremely abundant below 1106.2'; strong petroliferous odor throughout; rock quality D-1, S-2, F-3, moderately hard; frequent vertical fractures, commonly along 2 vertical fracture planes that intersect at 60 and 120 degrees		MARCELLUS SUBGROUP OATKA CREEK FORMATION		1083.1-1083.4' fossiliferous carbonate concretion
89	97	73	1100	1111.6-1113.4 Limestone; brownish black (5 YR 3/1); packstone; massive; bioturbated and burrowed; abundant styliolinids, brachiopods, pelecypods; pyrite common as burrow replacement and brachiopod replacement; lower 0.7' is laminated styliolinid grainstone/packstone; rock quality D-1, S-1 to S-2, F-2, hard to moderately hard				
90	99	99	1110	1113.4-1119.0 Shale; brownish black (5 YR 2/1); claystone; laminated; slightly calcareous; carbonaceous; extremely abundant styliolinids; styliolinid pack/grainstone from 1114.2-1117.2'; petroliferous odor; rock quality D-1, S-2, F-2, moderately hard			CV	CV=Cherry Valley Limestone
91	100	100	1120	1119.0-1136.3 Limestone; olive gray (5 Y 3/1) to medium dark gray (N4); fine to medium crystalline; commonly packstone, with abundant brachiopods, crinoids, bryozoans, styliolinids, and rugose corals; frequent (15%) brownish black (5 YR 2/1) chert nodules; rare white calcite crystals partially filling brachiopod vugs; upper contact irregular and marked by 0.01' thick pyrite lag; upper 0.8' (1119-1119.8') marked by concentrated shell hash with very small fish bones, teeth, and abundant coarse, dark and commonly angular granules; 1119.8-1121.4' consists of black (N1), carbonaceous, slightly calcareous shale, extremely abundant styliolinids (frequently concentrated as white styliolinid laminae); 1121.4 to 1121.6' consists of grayish black (N2), carbonaceous shale with extremely abundant fish bones (spine columnals); unit contains frequent stylolites below 1121.6'; lower contact beneath 0.4' thick metabentonite layer; rock quality D-1, S-1, F-2, hard; with fractures occasionally along slickensided chert/limestone contacts			USF Bakoven	USF=Union Springs Formation
92	100	100	1130			ONONDAGA	Seneca	high angle, slickensided fractures, lined with calcite and granular coalified material

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						ONONDAGA	Seneca	
93	100	100	1140	1136.3-1183.0 Limestone; brownish black (5 YR 3/1), medium gray (N5), and light brownish gray (5 YR 6/1); fine to medium crystalline, occasionally packstone; massive; fossiliferous, frequent brachiopods, bryozoans, crinoids abundant (25%) chert nodules, ranging in color from pale brown (5 YR 5/2), brownish gray (5 YR 4/1), to dark gray (N3); frequent stylolites, and carbonaceous, wispy, anastomozing laminae; mild, rarely strong, petroliferous odor; pyrite rare; upper contact at base of bentonite layer; lower contact gradational with color change from medium gray to brownish black; rock quality D-1, S-1 to S-2, F-2, moderately hard to hard; irregular fractures and core breaks associated with chert/limestone contacts.				1135.9-1136.3' OIN Ash Bed "Tioga B Bentonite"
94	98	98	1150					
95	100	100	1160				Moorehouse	
96	100	99	1170					
97	98	98	1180	1183.0-1197.0 Limestone; brownish black (5 YR 2/1) to dark gray (N3); fine crystalline, to mudstone; massive; bioturbated and burrowed; stylolitic, with rare, small brachiopods, rare (5%) dark gray chert, and occasional pyrite as small rounded nodules (in cross section); lower 1.6' is interlaminated, intensely burrowed, grayish olive green (5 GY 3/2; wet) and dark gray (N3); mudstone; small, bright, dusky blue green (5 BG 3/2) crystals and very fine laminae occur within lower 1.6'; lower contact is sharp and irregular with underlying brachiopod and crinoid rich packstone; rock quality D-1, S-2, F-2, hard			Nedrow	distinct, burrowed interval from 1187-1187.4'
			1190					

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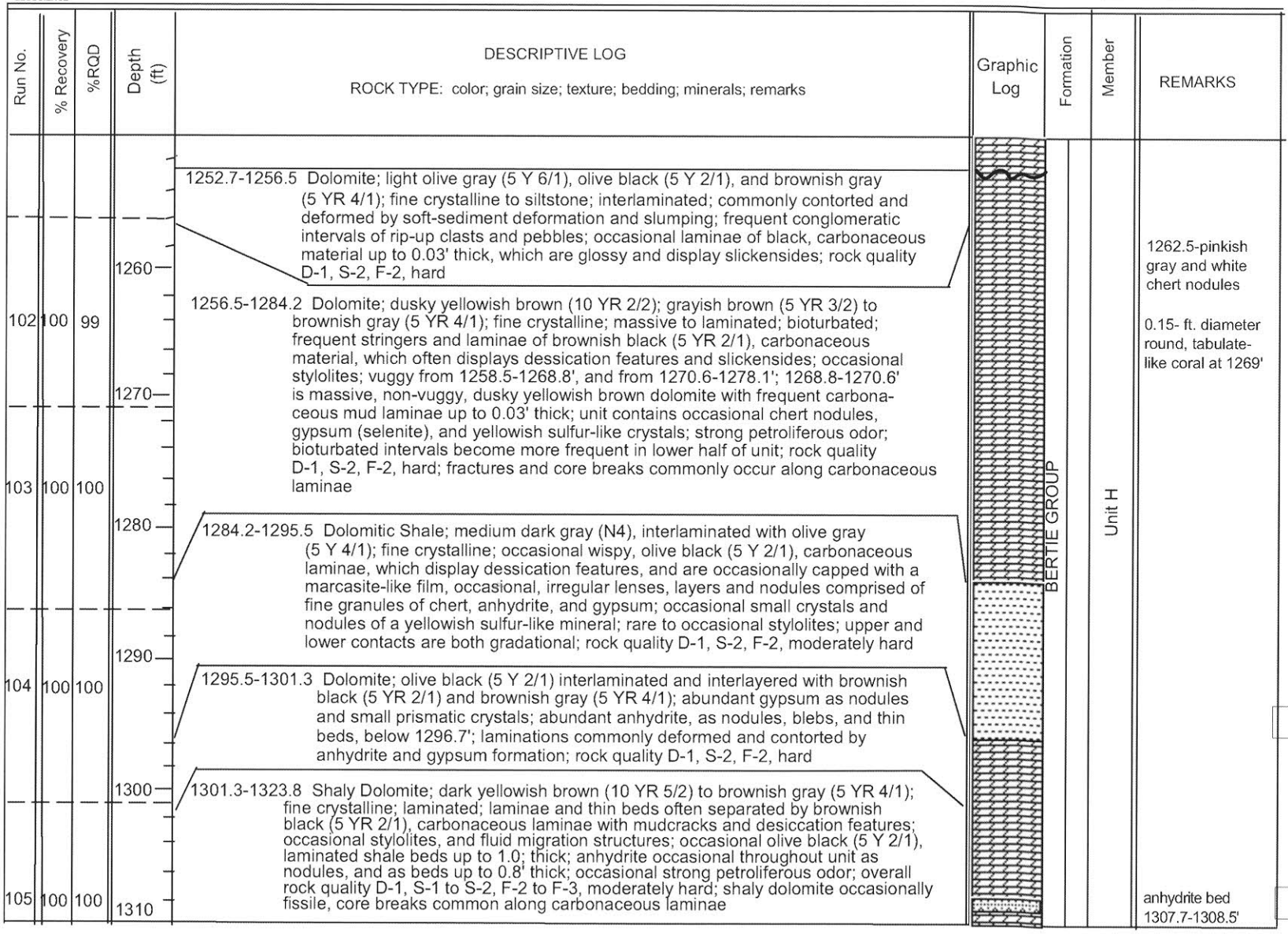
Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						ONONDAGA	Nedrow	
98	100	100	1200	1197.0-1240.1 Limestone; medium dark gray (N4), medium light gray (N6), brownish gray (5 YR 3/1) and olive gray (5 YR 4/1); fine crystallline, to packstone; massive, with abundant, anastomozing wisps of dark, organic material; stylolitic; extremely abundant (25-75%) chert nodules, characterized by very thin calcite-healed fractures that extend inward from nodule edges; chert nodule color ranges from brownish black (5 YR 2/1) to dark gray (N3); fossiliferous, with frequent crinoids, brachiopods, trilobites, rugose and tabulate corals; pyrite rare overall, except beneath upper contact; rock quality D-1, S-1, F-2, hard; fractures and core breaks generally occur along chert/limestone contacts, and along dark, carbonaceous, wispy laminae			Edgecliff Member Clarence Facies	
			1210					
99	100	97	1220					
100	100	100	1230	1240.1-1246.0 Limestone; medium gray (N5); medium crystalline, to packstone; stylolitic; abundant crinoids, brachiopods; rare (5%) chert nodules; lower 0.9' is conglomeratic, with fragments of dark gray (N3) dolomite, ranging in size from granules to rip-up clasts up to 0.15 feet thick; lower contact is sharp and irregular, beneath 0.1' thick brownish black dolomite with rare yellow sulfur crystals; D-1, S-1 to S-2, F-2, moderately hard to hard				
			1240	1246.0-1248.0 Dolomite; dark yellowish brown (10 YR 3/2) to brownish gray (5 YR 4/1); fine crystalline; laminated; strong petroliferous odor; rock quality D-1, S-2, no fractures; upper contact has 0.01' thick concentration of rounded sand-sized grains				
101	100	100	1250	1248.0-1252.7 Siltstone to Sandstone; light olive gray (5 Y 6/1); massive; mottled appearance due to dark gray, irregular wisps (root bioturbation); occasional lenses of sand and pebble-sized grains; 0.3' thick laminated interval at 1250.2'; light brownish gray (5 YR 6/1) mud rip-up/clay pebble conglomerate interval from 1251.1 to 1251.5'; occasional stylolites; no petroliferous odor; sharp, irregular upper and lower contacts; rock quality D-1, S-2, no fractures; moderately hard	BG A W			BG=Bertie Groyp A=Akron Dolostone W=Williamsville Formation


Run No.
% Recovery
%RQD
Depth (ft)
DESCRIPTIVE LOG
ROCK TYPE: color; grain size; texture; bedding; minerals; remarks
Graphic Log
Formation
Member
REMARKS
1252.7-1256.5 Dolomite; light olive gray (5 Y 6/1), olive black (5 Y 2/1), and brownish gray (5 YR 4/1); fine crystalline to siltstone; interlaminated; commonly contorted and deformed by soft-sediment deformation and slumping; frequent conglomeratic intervals of rip-up clasts and pebbles; occasional laminae of black, carbonaceous material up to 0.03' thick, which are glossy and display slickensides; rock quality D-1, S-2, F-2, hard
1260
1262.5-pinkish gray and white chert nodules
102 100 99
1256.5-1284.2 Dolomite; dusky yellowish brown (10 YR 2/2); grayish brown (5 YR 3/2) to brownish gray (5 YR 4/1); fine crystalline; massive to laminated; bioturbated; frequent stringers and laminae of brownish black (5 YR 2/1), carbonaceous material, which often displays dessication features and slickensides; occasional stylolites; vuggy from 1258.5-1268.8', and from 1270.6-1278.1'; 1268.8-1270.6' is massive, non-vuggy, dusky yellowish brown dolomite with frequent carbonaceous mud laminae up to 0.03' thick; unit contains occasional chert nodules, gypsum (selenite), and yellowish sulfur-like crystals; strong petroliferous odor; bioturbated intervals become more frequent in lower half of unit; rock quality D-1, S-2, F-2, hard; fractures and core breaks commonly occur along carbonaceous laminae
1270
0.15- ft. diameter round, tabulate-like coral at 1269'
103 100 100
1280
1284.2-1295.5 Dolomitic Shale; medium dark gray (N4), interlaminated with olive gray (5 Y 4/1); fine crystalline; occasional wispy, olive black (5 Y 2/1), carbonaceous laminae, which display dessication features, and are occasionally capped with a marcasite-like film, occasional, irregular lenses, layers and nodules comprised of fine granules of chert, anhydrite, and gypsum; occasional small crystals and nodules of a yellowish sulfur-like mineral; rare to occasional stylolites; upper and lower contacts are both gradational; rock quality D-1, S-2, F-2, moderately hard
1290
104 100 100
1295.5-1301.3 Dolomite; olive black (5 Y 2/1) interlaminated and interlayered with brownish black (5 YR 2/1) and brownish gray (5 YR 4/1); abundant gypsum as nodules and small prismatic crystals; abundant anhydrite, as nodules, blebs, and thin beds, below 1296.7'; laminations commonly deformed and contorted by anhydrite and gypsum formation; rock quality D-1, S-2, F-2, hard
1300
1301.3-1323.8 Shaly Dolomite; dark yellowish brown (10 YR 5/2) to brownish gray (5 YR 4/1); fine crystalline; laminated; laminae and thin beds often separated by brownish black (5 YR 2/1), carbonaceous laminae with mudcracks and desiccation features; occasional stylolites, and fluid migration structures; occasional olive black (5 Y 2/1), laminated shale beds up to 1.0; thick; anhydrite occasional throughout unit as nodules, and as beds up to 0.8' thick; occasional strong petroliferous odor; overall rock quality D-1, S-1 to S-2, F-2 to F-3, moderately hard; shaly dolomite occasionally fissile, core breaks common along carbonaceous laminae
105 100 100
1310
BERTIE GROUP
Unit H
anhydrite bed 1307.7-1308.5'

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1320			BERTIE GROUP	Unit H	
106	100	100	1330	1323.8-1417.2 Shale; olive black (5 Y 2/1), greenish black (5 G 2/1), olive gray (5 Y 4/1), and grayish black (N2); claystone, occasionally fine crystalline; massive, to faintly laminated; laminations greatly disrupted by anhydrite formation and fluid migration; frequent irregular laminae of carbonaceous, olive black, slickensided material; anhydrite common throughout as rounded nodules, stringers, blebs; anhydrite is light bluish gray to bluish white on core surface, and grayish black on fresh surface; anhydrite abundant in upper 6.0' of unit, comprising up to approximately 75% of matrix; occasional gypsum, as fracture fill and small blebs; occasional intervals of dolomite averaging 2.0' thick; dolomite intervals are brownish gray (5 YR 4/1), pale brown (5 YR 5/2), and dusky yellowish brown (10 YR 2/2); fine crystalline; laminated; occasional stylolites; and occasional gypsum-healed fractures; dolomite commonly interlaminated with anhydrite; overall rock quality D-1, S-1 to S-2, F-2, moderately hard to hard		CAMILLUS	Unit G	1337.2-1339.4' dolomite (possibly stromatolite)
107	100	100	1340					
108	100	100	1350					
			1360					
109	100	96	1370					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1380			CAMILLUS	Unit G	
110	100	100	1390					
111	100	100	1400					dolomite 1395.4-1397.4' dolomite 1400.4-1404.2'
112	100	100	1410					
113	100	85	1420	1417.2-1428.9 Dolomite; brownish gray (5 YR 4/1) and dusky yellowish brown (5 YR 2/2); fine crystalline; thin bedded to laminated; frequent brownish black (5 YR 2/1), carbonaceous laminae, displaying mudcracks and desiccation features, as well as glossy, black (N1) carbonized and slickensided surfaces (revealed by core breaks); occasional stylolites and gypsum-healed fractures; anhydrite frequent as laminae; occasional speckled appearance due to small, brownish, randomly oriented gypsum crystals; petroliferous odor; core breaks common along thin beds separated by carbonaceous laminae; rock quality D-1, S-1 to S-2, F-2 to F-3, hard		SYRACUSE	Unit F	
			1430					

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				1428.9-1489.2 Shale, interbedded with dolomite: Shale = olive gray (5 YR 3/2), olive black (5 Y 2/1) and medium dark gray (N3.5); claystone; fine crystalline; laminated; laminae often completely disrupted by fluid migration, slumping and anhydrite formation; abundant anhydrite as stringers, blebs, granules and nodules; frequent angular fractures (50-80 degrees from horizontal) healed with gypsum; occasional carbonaceous, slickensided surfaces exposed at fractures and core breaks: Dolomite =brownish gray (5 YR 3/1) and dusky yellowish brown (10 YR 2/2); fine crystalline; occasionally shaly; massive to thin bedded; occasionally interlaminated and interlayered with anhydrite; laminations and bedding often very contorted; frequent brownish black, carbonaceous laminae; frequent desiccation features; occasionally with carbonized, black, slickensided surfaces; occasional speckled appearance in some massive intervals due to small, prismatic, randomly oriented, brownish gypsum crystals; frequent gypsum-healed angular fractures (30-90 degree fracture angle); rare brecciated intervals of dolomite fragments within gypsum matrix; occasional stylolites; petroliferous odor; core breaks common along carbonaceous partings; overall rock quality D-1, S-1 to S-2, F-2 to F-3, moderately hard to hard				
			1440					dolomite 1437.1-1439.6'
114	100	95						
			1450					
115	100	96				SYRACUSE	Unit F	Shale 1455.2-1457.5'
			1460					
			1470					
116	100	97						
			1480					
117	100	100	1490				Unit F	

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				1489.2-1506.8 Shale; olive black (5 Y 3/1) and dark greenish gray (5 GY 4/1); claystone; laminated, with laminations commonly contorted by anhydrite formation and fluid migration; anhydrite abundant as stringers, nodules and laminae; rare gypsum-healed fractures, fracture angle 30 to 45 degrees; rare olive black, glossy, slickensided surfaces exposed on core break surfaces; rock quality D-1, S-2, F-2, moderately hard				
			1500					
118	100	98						
				1506.8-1572.2 Dolomite; dark yellowish brown (10 YR 4/2), dusky yellowish brown (10 YR 2/2), and brownish gray (5 YR 4/1); fine crystalline; massive to laminated; occasional contorted laminations and bedding; stylolites common; frequent soft-sediment deformation and small-scale slumping; gypsum (selenite) as lenses, laminae, nodules and as fracture fill; occasional thin bedded intervals, with brownish black, carbonaceous laminae (frequently with black, carbonized, slickensided surfaces); desiccation features separating individual beds; petroliferous odor; and thin (<2.0') intervals of shale as in 1489.2 to 1506.8'; thin bedded dolomite intervals are often fissile, breaking easily along carbonaceous partings; rock quality D-1, S-1 to S-2, F-2 to F-3, moderately hard to hard;				
			1510					Shale 1508.5-1509.7'
119	100	97						
			1520					
			1530					
120	100	95						Shale 1530.8-1533.2'
			1540					Shale 1537.7-1539.4'
121	100	96	1550					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1560			SYRACUSE	Unit E	
122	100	100	1570					
				1572.2-1576.5 Dolomite; dark yellowish brown (10 YR 4/2) to dusky yellowish brown (10 YR 2/2); fine crystalline; laminated to thin bedded; dessication features on partings between beds; anhydrite bed comprising upper 1.0'; salt dissolution vugs from 1573.2-1575.1'				1573.2' Contact between Units D & E
123	100	100	1580	1576.5-1592.4 Shale; medium dark gray (N4), dark gray (N3), olive black (5 Y 2/1), and rarely dark greenish gray (5 G 4/1); claystone; laminated, with laminations frequently contorted, disrupted and obliterated by fluid migration, anhydrite formation, small-scale slumping, and syneresis structures; anhydrite frequent as stringers, nodules, and pebbles; lower 3 feet is brecciated with fragmented shale and halite, and conglomeratic intervals of mud rip-ups and claystone pebbles; rare halite (frequent in lower 2.0') as fracture-fill and syneresis structures; overall rock quality D-1, S-2, F-2, moderately hard			Unit D	
			1590					
124	100	100		1592.4-1617.1 Halite; white; transparent; occasionally gray and translucent; coarse to very coarse crystalline; rare to occasional shale fragments and lenses throughout; upper and lower contacts are both sharp; 2.0 feet of shale above upper contact is contorted and brecciated with frequent halite; solid core lengths from 0.2 to 1.6 feet				1592.4'
			1600					D-2 Salt
125	97	97	1610					

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
								D-2 Salt
								1617.1'
			1620	1617.1-1619.4 Dolomite; dark yellowish brown (10 YR 4/2) to dusky yellowish brown (10 YR 2/2) fine crystalline, possibly gypsiferous matrix; laminated; occasional possible cross-bedding; rare stylolites; frequent halite laminae and blebs, and anhydrite nodules, which commonly deform laminations; powdery, dark yellowish brown surface rind possibly created during coring ("core weathering"); rock quality D-1 to D-2 ("core-weathering"), S-2, F-2, moderately hard		SYRACUSE	Unit D	
126	97	97						
			1630	1619.4-1625.1 Shale; same as interval from 1576.5-1592.4'; occasional halite as lenses, fracture-fill, and syneresis structures				1625.1'
				1625.1-1641.6 Halite; white, rarely gray, and translucent; very coarse crystalline; occasional to frequent shale and anhydrite fragments and lenses in "chicken wire" structure throughout unit; sharp upper contact; lower contact is extremely brecciated, halite transparent, anhydrite and brownish shale in a contorted mix within the lower 1.5 feet; solid core lengths from 0.2 to 1.6 feet				D-1 Salt
127	100	100						
			1640					1641.6'
				1641.6-1685.8 Shale, light olive gray (10 Y 5/4), grayish olive (10 Y 4/2), light olive brown (5 Y 5/6), dark greenish gray (5 G 5/1); interlaminated and interlayered; occasionally mottled with grayish red (10 R 4/2) to dark reddish brown (10 R 3/4); claystone; repeating, partial to complete bedding sequences in the following general pattern (from bottom to top of pattern): thin (<2.0') conglomeratic intervals of anhydrite clasts and claystone pebbles, interlaminated with anhydrite laminae and stringers; overlain by thicker zones of massive, to laminated, olive and red mottled claystone, abundant fluid escape structures, and reddish brown halite streaks, fracture fill, and syneresis structures; capped by massive, non-mottled olive claystone, occasional rounded anhydrite nodules, and rare halite; abundant small (<0.01') grayish black, micaceous, tabular, striated, metallic minerals (hematite) often associated with reddish brown halite veins; overall rock quality D-1, S-2 to S-3, F-2, soft; occasional slickensided surfaces at shale/halite contacts		VERNON	Unit C	sandstone 1647.8-1648.4
			1650					
128	100	100						
			1660					hematite crystals
129	100	100						
130	100	100	1670					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1680			VERNON	Unit C	sandstone 1681.0-1681.5'
131	100	100		1685.8-1688.9 Shaly Dolomite; dark yellowish brown (10 YR 4/2) to dusky yellowish brown (10 YR 2/2); claystone; laminated; occasional laminae of anhydrite and halite; rock quality D-1, S-2, F-2, moderately hard				
			1690	1688.9-1763.5 Shale; claystone; same as shale interval from 1641.0-1685.8, but with absence of reddish brown mottling between 1641 to 1733.5'; rock core is highly altered, weakened and soft from 1710 to 1710.5'				
132	100	100	1700					
133	100	94	1710					vertical fracture 1710.5-1712.1'
134	100	87	1720					
135	79	79	1730					

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Project Akzo Nobel Salt, Inc.-Hampton Corners Project No. 94124 Sheet 30 of 34 Hole No. 9455

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1740			VERNON	Unit C	
136	100	100	1750					
			1760					
137	100	100		1763.5-1774.3 Dolomite; dusky yellowish brown (10 YR 2/2), dark yellowish brown (10 YR 4/2), and brownish black (5 YR 2/1); claystone, interlayered and interlaminated with fine crystalline; occasional contorted laminations; anhydrite frequent as laminae, and as occasional small nodules; occasional halite in syneresis structures, as fracture fill and occasionally as lenses and laminae; core surface has brownish "core-weathered" surface rind; rock quality D-2 ("core-weathering"), S-2, F-2, moderately hard				
			1770					
138	100	100	1780	1774.3-1812.9 Shale; interlayered and interlaminated grayish olive (10 Y 4/2), dark greenish gray (5 G 5/1), olive gray (5 Y 3/1), medium dark gray (N4), and olive black (5 Y 2/1); claystone, with repeating sequences of olive black claystone, olive gray, flattened claystone pebbles and anhydrite clasts; overlain by laminated greenish gray, olive gray, and medium dark gray claystone, characterized by fluid escape structures, small scale slumping, laminae off-set, and syneresis structures of halite; capped by massive grayish olive claystone with occasional halite-filled fractures and syneresis structures; anhydrite common throughout unit as laminae, blebs, pebbles, nodules; reddish orange halite bed from 1806.1 to 1806.8'; overall rock quality D-1, S-3, F-2, soft				
139	100	100	1790					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
			1800			VERNON	Unit C	Halite: reddish orange 1806.1 to 1806.8'
140	100	100	1810					
				1812.9-1839.9 Halite; gray and translucent; coarse crystalline; frequent shale clasts and fragments in upper 1.5'; extremely rare shale fragments below 1814.4'; brecciated upper contact and sharp lower contact; unit is underlain by 4.2' of brecciated and contorted shale and halite; solid lengths of 0.2 to 2.0'			Unit B	1812.9'
			1820					
141	100	100						B-6 Salt
			1830					
142	100	100						
			1840					1839.9'
				1839.9-1846.7 Dolomite; light olive gray (5 Y 5/1), brownish gray (5 YR 4/1), dusky brown (5 YR 2/2); fine crystalline, massive to laminated; extremely contorted and brecciated in upper 4.2', with abundant halite as laminae, lenses, fracture-fill and syneresis structures; brownish, powdery, "core-weathered" surface rind; sharp lower contact beneath 0.2' thick clear, translucent halite beds; rock quality D-1 to D-2 ("core-weathering"), S-2, F-2, moderately hard				0.2' thick, transparent halite beds at 1844.4 & 1846.5'
143	100	100						
			1850					

Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				1846.7-1857.3 Shale; dark greenish gray (5 G 5/1) to olive gray (5 Y 4/1); claystone; massive to laminated; abundant anhydrite nodules, blebs, and pebbles; reddish brown to reddish orange halite as fracture-fill, lenses, and syneresis structures; large vertical fracture filled with halite in upper 2.0' (halite comprises ~90% of core volume); D-1, S-2, F-2, soft		VERNON	Unit B	
			1860	1857.3-1866.2 Dolomite; olive black (5 Y 3/1), brownish gray (5 YR 4/1), and light brownish gray (5 YR 6/1); laminated to thin bedded; occasional thin beds of anhydrite pebbles; abundant syneresis structures of reddish brown to transparent halite; occasional anhydrite nodules and fluid escape structures; D-1, S-2, F-2, moderately hard				
140	100	100						
			1870	1866.2-1877.6 Shale; same as interval 1846.7 to 1857.3 feet				
145	100	100	1880	1877.6-1885.3 Halite; white and translucent to gray and translucent; very coarse crystalline; occasional to frequent shale fragments and blebs throughout; sharp, irregular upper and lower contacts; solid core lengths of 0.2 to 1.1 feet				1877.6' B-5 Salt 1885.3'
				1885.3-1890.7 Shale; same as interval 1846.7 to 1857.3'				
			1890	1890.7-1895.0 Halite; dark gray and translucent; coarse to very coarse crystalline; frequent shale blebs and fragments throughout; sharp, irregular upper and lower contacts; solid core lengths from 0.3 to 1.1 feet				
146	100	100		1895.0-1897.6 Shale; grayish olive (10 Y 4/2) and olive black (5 Y 2/1); claystone; laminated; occasional halite syneresis structures and fracture-fill; anhydrite common as lenses, nodules and very small clasts; contorted laminations, often off-set by fluid escape structures; rock quality D-1, S-2, F-2, moderately hard				1897.6'
			1900	1897.6-1909.0 Halite; dark gray and translucent, with occasional thin (<1.0') bands of white and translucent; coarse to very coarse crystalline; occasional to frequent shale blebs, fragments and lenses throughout; sharp, irregular upper and lower contacts; solid core length from 0.1 to 1.4'				B-4 Salt
147	100	100						
			1910					1909.0'

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
				1909.0-1911.0 Shale; same as interval from 1895.0-1897.6'				
				1911.0-1922.7 Halite; dark gray and translucent, occasionally white and translucent; coarse to very coarse crystalline; shale fragments and blebs abundant in upper 5.0', rare below 1916.0'; halite surfaces in upper 5.0' of core have a frosted appearance; brecciated upper and lower contacts; solid lengths of 0.2 to 1.7 feet				1911.0' B-3 Salt 1922.7'
			1920					
148	100	100		1922.7-1924.3 Shale; same as interval from 1985 to 1897.6'; with abundant halite as fracture fill, and as laminae; extremely brecciated and contorted				1924.3'
				1924.3-1941.0 Halite; dark gray and translucent; coarse to very coarse crystalline; shale abundant as fragments, thin beds less than 0.1' thick, and blebs in upper 5.0'; rare from 1929.3 to 1938.5', and abundant in lower 2.5'; halite in upper 5.0' has frosted appearance on surface; brecciated upper contact and sharp, irregular lower contact; solid lengths from 0.1 to 1.5 feet		VERNON	Unit B	B-2 Salt
			1930					
149	100	100						1941.0'
			1940	1941.0-1944.1 Shale; brownish black (5 YR 3/1) interlaminated with olive black (5 Y 3/1); claystone; frequent fluid escape structures; reddish brown to reddish orange halite frequent as syneresis structures; lower contact with halite is brecciated and irregular; rock quality is D-1, S-2, F-2, moderately hard				1944.1'
				1944.1-1953.4 Halite; dark gray and translucent; coarse to very coarse crystalline; occasional shale blebs throughout unit; brecciated upper contact, sharp lower contact; solid lengths from 0.1 to 1.1 feet				B-1 Salt 1953.4'
			1950					
150	100	100		1953.4-1976.3 Shale; olive black (5 Y 2/1), brownish black (5 Y 2/1), light olive gray (5 Y 6/1), olive gray (5 Y 4/1), brownish gray (5 YR 4/1), grayish olive green (5 GY 3/2); claystone; laminated, to massive and thin bedded; laminated zones have frequent fluid escape structures, and are frequently contorted and off-set; occasional syneresis structures and fractures filled with reddish brown halite; occasional conglomeratic intervals with flattened anhydrite and claystone pebbles; occasional intervals are massive due to extensive fluid migration; anhydrite frequent throughout as nodules, laminae, lenses, blebs; overall rock quality D-1, S-2, F-2, moderately hard			Unit A	
			1960					
151	100	100						
			1970					

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Run No.	% Recovery	%RQD	Depth (ft)	DESCRIPTIVE LOG ROCK TYPE: color; grain size; texture; bedding; minerals; remarks	Graphic Log	Formation	Member	REMARKS
						VERNON	Unit A	
				Total Depth = 1976.3 feet				
			1980					
			2000					

APPENDIX B

WELL IDENTIFICATION AND SUBSURFACE DATA

Appendix B
Stratigraphy and Coordinates for the Wells used in this Study

API Well, Hole, or Shaft Number	Alternate Well Identification	Surface Elevation (ft amsl)	Bedrock Top Elevation (ft amsl)	Group, Formation, and Member Top Elevations (ft amsl)																							Well Bottom Elevation (ft amsl)	Well Location Coordinates**	
				West Falls	Sonyea	Genesee	Genundewa LS	(btm Genundewa)	Moscow	Tichenor LS	Ludlowville	Centerfield LS	Skaneateles Levanna	Stafford LS	Marcellus	Onondaga	Trioga Bentonite	Bertie	Camillus Unit G	Syracuse Unit F	Syracuse Unit E	Syracuse Unit D	Vernon Unit C	Vernon Unit B	Vernon Unit A			Northing (ft)	Easting (ft)
01272	Retsof Fuller Shaft	737.1								695.0	687.0	566.0	562.0	324.0	322.0	287.0		143.0	71.0					-318.9		-418.0	1029999	686929
01273	Griegsville Shaft																												
01845	Sterling B Shaft	614														139.0										-510.0	1034255	682283
	Sterling C Shaft																										1016214	691718
02206		660.0	495.4									436.4	430.4	194.9	190.9	157.9	141.4	19.9	-55.6	-147.6	-217.6	-294.1	-317.6	-464.6	-590.6	-1265.0	1017060	691718
03277	Livonia Shaft	1082														216.0	194.3	76.0					-344.0				1016488	685031
03282	Retsof #1 Shaft	710+/-													333.0	277.0		165.0								-431.0	1022071	742806
03284	Retsof #2 Shaft																										1033755	687537
03305		1613.0														-192.0		-287.0	-396.0	-494.0	-561.5	-694.0	-748.5	-942.0	-1073.0	-1795.3	1034326	687866
04053		1371	1347											81.0	77.0	37.5	20.0	-77.0	-179.0	-277.0	-348.5	-431.0	-495.0	-675.0	-869.0	-1640.0	984909	745912
04069		881										720.7	712.7	484.7	479.7	449.7	436.7	318.7	249.7	162.7	97.7	29.7	7.2	-111.3	-221.3	-3661.3	1008745	748132
04089		951				838.0	789.0	786.0	721.0	604.0	597.0	478.0	473.0	243.0	238.0	205.5	186.0	67.0	5.5	-85.0	-152.0	-226.0	-247.0	-376.0	-491.0	-1156.0	1046928	674568
04117		976.1				811.1	764.1	758.1	697.1	580.1	575.1	458.1	450.1	223.1	217.1	187.1	169.1	46.1	-19.9	-105.9	-117.9	-244.9	-270.9	-292.9	-494.9	-1118.9	1021867	671131
04129		916							747.0	627.0	621.0	505.0	499.0	269.0	264.0	232.0	217.0	88.0	27.0	-65.0	-129.0	-203.0	-233.0	-357.0	-470.0	-1103.0	1020653	669060
04138		972.0							732.0	613.0	607.0	495.0	486.0	257.0	250.0	221.0	205.0	79.0	18.0	-74.0	-139.0	-222.0	-233.0	-367.0	-470.0	-1106.0	1023416	673942
04149		563	468														none	416.0	353.0								1024060	669480
04151		957.0							759.0	641.0	634.0	519.0	511.0	284.0	279.0	247.0	233.0	106.0	41.0	-49.0	-115.0	-191.0	-211.0	-341.0	-357.0	-1116.5	1055487	712069
04167		960.0								797.4				none	304.4	257.4		112.4	47.4							-1105.6	1025628	672025
04188		1146.0	1139						620.0	497.0	488.0	369.0	361.0	108.0	106.0	65.5	49.0	-62.0	-144.0	-217.0	-290.0	-392.0	-458.0	-632.0	-766.0	-1479.0	1026396	674721
04213		562.8	397.8													310.8		183.8	114.3	23.8	-46.2	-122.2	-147.2	-295.2	-421.2	-1111.2	1009028	722393
04218		893										770.5	763.5	537.5	533.5	503.5	485.5	368.5	302.5	213.5	148.5	77.5	55.5	-59.5	-172.5	-829.5	1034498	706357
04363		618	306													306.0	none	289.0								-983.0	1051862	673919
04391		1014.0				905.3	860.3	857.3	795.3	675.3	675.3	552.3	545.3	315.3	309.3	253.3	261.3	135.3	72.3	-42.7	-84.7	-155.7	-178.7	-301.7	-402.7	-1062.7	1043644	706048
04495		1092				901.0	853.0	850.0	791.0	674.0	667.0	553.0	545.0	316.0	313.0	284.0	266.0	138.0	75.0	-14.0	-80.0	-153.0	-176.0	-303.0	-396.0	-1043.0	1030889	673761
04531		1106												340.3	334.8	304.3	288.3	161.3	96.3	7.3	-49.7	-129.7	-154.7	-280.7	-376.7	-1073.4	1030581	669662
04552		988.5							813.5	696.5	691.0	572.5	565.5	333.5	330.5	300.5	283.5	159.5	94.5	4.5	-62.5	-132.5	-152.5	-277.5	-369.5	-1059.5	1032431	669868
05061		601.0	284	none	none	none	none	none	none	none	none	none	none	none	none	284.0	none	262.0	195.5	107.0	41.0	-35.0	-62.0	-210.0	-335.0	-1085.0	1033696	673359
10920		1082				894.0	823.0	819.5	742.0	598.0	595.0	475.0	467.0	210.5	207.0	166.0	148.0	28.0	-72.0	-165.0	-240.0	-318.0	-382.5	-553.5	-688.0	-1425.0	1040588	705456
10922		1064							904.0	764.0		639.0	631.0	372.0	370.0	331.0	314.0	196.0	102.5	7.0	-62.0	-143.0	-199.0	-376.0	-511.0	-1266.0	1016100	722901
11003		905.0							733.0	612.0	606.0	492.5	485.0	255.0	251.0	219.0	203.0	82.0	11.0	-80.0	-144.0	-219.5	-242.5	-375.5	-491.0	-1197.0	1034262	751721
11403		1096															-116.0	ND	-294.0	-367.5	-442.5	-514.5	-535.5	-676.0	-785.0	-1499.0	1021064	674250
12706	ISCO 7603	582	556							538.0	532.0	415.0	406.0	167.0	164.0	130.0	114.0	-3.0								-74.0	993762	669419
13700		873.0															-196.0	-306.0	-381.0		-550.0	-632.5	-669.0			-5513.0	1016042	691915
13841		1070	1040		800.0	595.0	542.0	540.0	462.0	344.0	340.0	224.0	217.0	-16.0	-18.0		-68.5	-186.0	-244.0		-402.0	-480.5	-503.5	-640.0	-765.0	-1576.0	983464	685860
13867		755				693.0	648.0	646.0	565.0	443.0	437.0	321.0	314.0	75.0	71.0	41.0	20.0	-102.5	-173.0	-265.0	-334.0	-412.0	-435.0	-382.0	-701.0	-1416.0	997118	669380
13870		579.0	422							324.0	321.0	206.0	197.0	-48.0	-52.0	-94.0	-103.0	-203.5	-299.0	-395.0	-467.0	-544.0	-611.0	-788.0	-921.0	-1713.0	1007541	682003
13898	ISCO 7901	559.8	75.8													75.8	none	33.8	-40.2	-135.2	-204.2	-279.2	-311.0	-470.2		-482.2	991106	705640
13950		1060																			-374.0	-452.5	-477.0			-1505.0	1019666	697832
13979		960.0	904		697.0	526.0	477.0		386.0	273.0		155.0	149.0	-89.0	-92.0	-122.0	-139.0	-255.0	-316.5	-409.0	-479.0	-559.0	-584.0	-731.0	-856.0	-1591.0	1000868	671765
13980		930			769.5	556.0			423.0	300.0	297.5	181.0	174.0	-65.5	-72.0	-95.5	-102.5	-226.5	-291.0	-382.0	-450.0	-531.0	-557.5	-707.5	-827.0	-1565.0	991275	671665
14100	ISCO 6701	600.0	531.5							443.5	441.0	313.5	307.5	50.5	47.0	27.0		-108.5	-192.5	-279.0	-346.5	-430.0	-480.5	-646.5	-797.5	-835.6	993361	674705
14380		1005.0	985.3																							-1470.0	1001026	699860
14479	7902-Sterling Disposal	580.0	469.3									449.3	441.3	200.3	195.3	165.3	150.3	32.3			-395.7	-477.7	-505.2			-6.7	998504	673867
14482		922.0	900			748.0	681.0	679.0	598.0	460.0	458.0	338.0	331.0	86.0	83.0	35.0	28.0	-85.0	-162.0	-255.0	-331.0	-405.5	-462.0	-627.0	-754.0	-1526.0	1017650	692401
14498		600	300 +/-30																-436.0	-527.0	-604.0	-682.0	-770.0	-948.0	-1057.0	-1892.0	1007663	710380

Appendix B

Stratigraphy and Coordinates for the Wells used in this Study

API Well, Hole, or Shaft Number	Alternate Well Identification	Surface Elevation (ft amsl)	Bedrock Top Elevation (ft amsl)	Group, Formation, and Member Top Elevations (ft amsl)																						Well Bottom Elevation (ft amsl)	Well Location Coordinates**	
				West Falls	Sonyea	Genesee	Genundewa LS	(btm Genundewa)	Moscow	Tichenor LS	Ludlowville	Centerfield LS	Skaneateles Levanna	Stafford LS	Marcellus	Onondaga	Tioga Bentonite	Bertie	Camillus Unit G	Syracuse Unit F	Syracuse Unit E	Syracuse Unit D	Vernon Unit C	Vernon Unit B	Vernon Unit A		Northing (ft)	Easting (ft)
14537		1077			861.0	632.0	579.0	497.0	497.0	383.0		261.0	254.5	24.0	21.0	-13.0	-26.0	-145.0	-203.0	-294.0	-363.0	-441.5	-464.0	-607.5	-732.0	-1505.0	1000074	668867
15051	ISCO 8001-C	727	702.6						702.6	660.6	652.6	533.6	526.6	293.6	290.6	258.6	241.1	118.6									71.6	1028395	688537
15477		570	133 +/-30															-311.0	-426.0	-514.0	-592.0	-669.0	-754.0	-932.0	-1086.0	-1902.0	978291	707692
15592		872.0					603.5	600.0	522.0	396.0		275.0	267.0	32.0	29.0	-3.0	-21.5	-139.0	-204.0	-297.0	-367.5	-444.0	-468.5	-619.5	-745.0	-1471.0	1001200	678792
15593		895					617.0	615.0	534.5	416.0	409.5	268.5	285.5	50.5	244.5	16.5	8.5	-117.0	-180.0	-272.5	-341.5	-422.0	-446.0	-585.5	-703.0	-1428.5	1003385	676304
15726		865.0	844							466.0	461.0	344.5	336.0	102.0	98.0	68.0	48.0	-75.5	-142.0	-233.0	-300.0	-376.0	-399.0	-537.0	-663.0	-1387.0	1009116	678410
15727		820.0							678.0	552.0	549.0	432.0	425.0	189.0	188.0	156.5	138.5	14.0	-56.0	-149.0	-214.0	-290.5	-314.0	-455.0	-583.0	-1322.0	1015743	679880
15728		883.0							661.0	540.0	534.5	417.5	410.0	177.0	174.0	143.5	127.5	1.0	-65.0	-155.0	-220.5	-295.0	-322.5	-468.0	-686.5	-1303.0	1014212	676668
15737		1010.0																	-325.0	-415.0	-485.5	-566.0	-588.0	-732.5	-962.0	-1583.0	990155	669596
15784		920.0			795.0	580.0	532.0	530.0	450.0	330.0	324.0	208.0	201.0	-31.0	-33.0	-66.0	-81.0	-197.0	-260.0	-353.0	-420.0	-497.0	-527.0	-673.0	-793.0	-1497.0	995914	675362
15961		910	845														-72.0	-187.0	-255.0			-496.0	-518.5	-670.0	-785.0	-1502.0	997128	677304
15964		535.0																								481.5	1014275	691579
15965		538.0																								457.0	1014071	691529
15976		649.0	605														-8.0	-124.0	-198.5	-288.0	-359.0	-438.0	-470.5	-624.0	-742.0	-1480.0	1002413	686051
16073		700.0	643				583.0		491.0	375.0		251.0	244.0	10.0	7.0	-27.0	-45.0	-160.0	-231.0	-322.0	-395.0	-475.0	-501.0	-657.0	-771.0	-1487.0	1000795	685544
16079	ISCO HL1-81	632.0	594							532.0	529.0	408.0	402.0	163.0	159.0	128.0	111.5	-8.0	-81.0	-174.5	-241.0					-301.0	1016032	691545
16080	ISCO HL2-81	599.0								533.0	530.0	411.0	403.0	165.0	161.0	127.0	111.5	-7.0								-19.0	1016544	691820
16154		920	898			626.0	572.0		484.0	368.0		297.0	240.0	4.0	1.0	-27.0	-46.0	-164.5	-229.5	-320.0	-392.0	-471.0	-499.0	-637.0	-758.0	-1495.0	1000402	679357
16190		780												648.0	645.0	615.0	600.0	485.0	421.0	334.0	268.0	199.0	177.0	48.0	-55.0	-883.0	1062554	695526
16197		925												646.0	643.0	614.0	599.0	479.0	416.0	329.0	265.0	198.0	176.0	94.0	-33.0	-826.0	1062783	678389
16198		910																482.0	421.5							-788.0	1048207	676821
16199		890														614.0	599.0	485.5	423.0	335.0	272.0	205.0	183.0	65.0	-41.0	-755.0	1062859	679173
17300		920												632.0	629.0	596.0	581.0	466.0	400.0	316.0	251.0	182.0	158.0	41.0	-60.0	-822.0	1060767	678314
17301		840												661.0	658.0	625.0	614.0	482.0	435.0	349.0	285.0	218.0	194.0	77.0	-32.0	-854.0	1063085	682365
17304		920										854.0	847.0	623.0	618.0	588.0	572.0	451.0	387.0	298.0	233.0	166.0	145.0	28.0	-70.0	-818.0	1060047	674753
17305		950	908									845.0	837.0	613.0	611.0	580.0	563.0	444.0	378.0	290.0	225.0	157.0	134.0	18.0	-78.0	-832.0	1058140	672796
17306		920										819.0	812.0	583.5	580.0	547.0	534.0	415.0	349.0	262.0	199.0	128.0	108.0	-13.0	-116.0	-890.0	1056449	678337
17307		910	888									817.0	812.0	585.0	582.0	549.0	535.0	417.0	351.0	263.0	198.0	131.0	109.5	-7.0	-107.0	-913.0	1056042	675296
17309		930										812.0	804.0	578.0	575.0	543.0	526.0	408.5	343.0	256.0	191.0	123.0	101.0	-17.0	-113.0	-862.0	1055945	671631
17310		890												598.5	595.0	563.0	549.0	430.5	365.0	282.0	214.0	145.0	121.0	2.0	-105.0	-853.0	1057004	680375
17311		890.0												651.5	647.0	614.0		482.0	420.5								1060588	682337
17312		805												630.0	626.0	594.0	579.0	463.0	400.0			180.0	158.0	18.0	-72.0	-852.0	1060125	684527
17336		845														439.0	425.5	307.0	232.0	142.5	65.0	-8.5	-35.5	-190.0	-315.0	-1043.0	1047194	727302
17337		868.0	827.5									766.0	755.0	506.0	504.0	473.0	457.0	340.0	264.0	170.0	106.5	18.0	-8.0	-163.0	-286.0	-1025.0	1047648	732504
17353		810												659.5	656.5	627.5	617.0	496.0	435.0	347.0	284.0	218.0	195.0	77.0	-34.0	-745.0	1059436	684541
17354		735												669.5	666.0	634.0	622.0	502.0	440.0	354.0	289.0	223.0	200.0	124.0	-40.0	-829.0	1063337	689475
17356		925												645.0	642.0	611.5		473.5	413.5							-816.0	1061621	676073
17357		890												638.0	634.5	602.0	588.0	469.0	407.0	321.0	256.0	189.0	166.0	47.0	-55.5	-824.0	1061034	680251
17358		840														557.0		430.0	364.0	278.0	214.0	149.0	125.5	4.0	-95.5	-905.0	1057926	683912
17368		930										806.0	801.0	572.5	569.5	537.0		405.4	342.5	255.0	189.0	120.0	97.0	-19.0	-120.0	-836.0	1054070	674301
17369		870												577.0	575.0	543.0	531.0	412.5	345.5	260.0	195.0	127.0	105.0	-16.0	-115.0	-896.0	1055598	682299
17370		730.0	686											629.0	627.0	595.0	582.0	464.0	400.0	314.0	250.0						1060182	688821
17371		905										799.0	791.0	563.5	560.5	528.5	514.0	394.5	331.0	246.0	180.0	112.0	91.0	-29.0	-132.0	-865.0	1054127	678795
17372		830										809.0	804.0	572.0	569.0			405.0	341.0	255.0	191.0	124.0	100.0	-23.0	-119.0	-906.0	1055405	684555
17373		870												537.5	534.5	504.0		373.0	306.0	215.0	152.0	82.0	59.5	-64.0	-165.0	-930.0	1051747	682422
17375		860										800.0	792.5	563.5	561.0	533.0	517.0	397.5	333.0	248.5	182.5	115.5	92.5	-28.0	-133.0	-896.0	1053632	683468
17377		920										778.0	771.0	542.0	538.0	507.0	493.0	473.0	309.0	223.0	158.0	90.0	66.0	-52.0	-162.0	-917.0	1051418	680052
17380		740	691											614.0	611.0	581.0	556.0	446.0	392.0	302.0							1060035	695020
17392		810																	312.0	225.5	157.5	78.0	51.0	-102.0	-218.0	-1042.0	1053918	727983

Appendix B
Stratigraphy and Coordinates for the Wells used in this Study

API Well, Hole, or Shaft Number	Alternate Well Identification	Surface Elevation (ft amsl)	Bedrock Top Elevation (ft amsl)	Group, Formation, and Member Top Elevations (ft amsl)																						Well Bottom Elevation (ft amsl)	Well Location Coordinates**	
				West Falls	Sonyea	Genesee	Genundewa LS	(btm Genundewa)	Moscow	Tichenor LS	Ludlowville	Centerfield LS	Skaneateles Levanna	Stafford LS	Marcellus	Onondaga	Tioga Bentonite	Bertie	Camillus Unit G	Syracuse Unit F	Syracuse Unit E	Syracuse Unit D	Vernon Unit C	Vernon Unit B	Vernon Unit A		Northing (ft)	Easting (ft)
17399		800	784													>329				244.0	179.0	109.0	88.0	-37.0	-137.0	-912.0	1053762	685922
17400		820										768.0	763.0	530.5	527.0	497.0	482.0	362.5	300.0	212.0	147.0	76.5	55.0	-67.5	-170.0	-945.0	1051729	684767
17403		760																473.0	415.5	327.0	260.0	194.0	172.0	20.0	-67.0	-831.0	1061720	693130
17404		730												628.0	625.5	594.5	581.0	462.5	398.0	310.5	245.0	182.0	155.0	27.0	-80.0	-861.0	1060188	690801
17405		900										791.0	785.0	556.0	552.0	521.0	506.0	386.0	321.5	235.5	171.0	102.0	80.0	-42.0	-140.0	-875.0	1053282	681198
17406		725												665.0	662.0	630.5	618.0	500.0	438.0	350.0	285.0	219.0	196.0	71.0	-44.0	-825.0	1063557	691823
17408		725																		267.0	196.0	103.0	77.0	-71.0	-134.0	-855.0	1062055	728851
17409		815																		252.5	181.0	98.0	70.0	-80.5	-175.5	-860.0	1058078	733099
17422		750																		251.0	180.0	84.5	54.5	-97.0	-141.0	-900.0	1064735	741536
17424		605	539													533.0	519.0	396.0	334.0	247.0	180.0	109.0	86.0	-41.0		-866.0	1058733	701197
17425		730													607.0	577.0	564.0	445.5	382.0		228.0	164.0	142.0	12.0	-89.0	-883.0	1059506	692878
17426		720	535													535.0			343.0	254.5	190.0	102.5	73.0	-26.0	-129.0	-887.0	1055735	690480
17429		835																346.5	283.5	195.0	130.0	60.0	38.0	-84.0	-193.5	-965.0	1049696	683891
17430		795	757											521.0	517.0	497.0	472.0	350.0	287.0	241.0	136.0	67.0	45.0			-969.0	1051326	687073
17432		590.0																				27.0	-6.0	-146.0	-263.0	-995.0	1047978	709662
17433		680	641											575.0	570.0	542.0	525.0	406.0	347.0	258.0	192.0	122.0	98.0				1058172	697520
17434		750	635											629.0	624.0	593.0	581.0	463.0	399.5		246.0	178.0	156.0	33.0	-78.0	-855.0	1059755	686923
17435		850	767									691.0	684.0	453.5	449.5	419.0	404.5	286.0	220.5	131.0	75.0	-3.0	-26.0	-151.0	-238.0	-1011.0	1045942	683002
17439		710	659									635.0	629.0	395.5	391.5	362.5	353.0	231.0	162.0	76.0	10.0	-60.0	-83.0	-224.0	-283.0	-1080.0	1041899	690012
17445		590	395														none				159.0	89.5	65.5	-63.0		-921.0	1056685	701687
17447		580	410														none				165.0	86.0	62.0	-70.0	-120.0	-912.0	1060439	705688
17452		760																		340.0	275.0	208.0	185.0	60.0	-47.0	-827.0	1061654	686084
17460		910																443.0	379.0	292.0	228.0	160.5	138.5	18.0	-86.0	-862.0	1059113	680658
17461		610	455													455.0	none	378.5	317.0	230.0	163.0	93.5	71.0			-920.0	1055580	699976
17466		640	585													529.0					174.0	104.0	82.0	-41.5		-935.0	1056179	698068
17467		700																		255.0	187.2	121.5	99.0	-63.0	-131.0	-900.0	1056539	692877
17503		860												667.0	663.0	633.0	614.0	497.5	438.0	354.0	288.0	220.0	198.0	281.0	181.0	-793.0	1064419	681023
17518		905														571.0	556.0	438.0	374.0	283.0	220.0	153.0	132.0	7.0	-90.0	-884.0	1058370	677912
17522		775.0	730											589.0	587.0	563.0	550.5	431.0	365.0	278.0	214.0					-875.0	1057444	686031
17523		810	790											589.5	585.5	558.0	542.0	421.0	357.0	270.0	205.0	138.0	114.0	-15.0	-112.0	-927.0	1055583	686737
19408		900														548.0		417.0	351.0	264.0	200.0	132.0	108.0	-13.0	-113.0	-866.0	1055110	680462
19409		935														589.0	574.0	453.5	390.0	302.0	237.0	168.0	145.0	28.0	-74.0	-851.0	1059903	676807
19413		650	579						567.0			331.0	322.0	87.5	82.5	49.5	31.5	-85.0	-170.5	-260.5	-332.0	-410.0	-439.0	-592.0	-717.0	-1500.0	1005654	686613
19416		800	780			653.0	604.0	601.0	516.0	399.0	393.0	277.0	269.0	34.0	30.0	-1.5	-21.0	-140.5	-209.0	-300.0	-369.0	-447.0	-470.0	-620.0	-736.0	-1465.0	1003473	682406
19431		906												435.0	433.0	399.0	382.5	264.0	185.0	89.0	24.0	-66.0	-96.5	-253.0	-377.0	-1268.0	1042313	737225
19438		908												392.0	389.0	348.0	336.0	220.0	132.0	39.0	-32.0	-112.0	-159.0	-326.0	-451.0	-1267.0	1037100	738833
19609		1400.0	1380																		100.0	23.0	-0.5	-149.0	-226.0	-1002.0	999135	677189
19610		1065				677.0	631.0		550.5	434.0		313.0	307.5	76.0	72.5	41.0	26.5	-92.0	-152.5	-243.0	-303.0	-385.0	-407.0	-540.5	-659.0	-1381.0	1005733	668774
19611		1050			883.0	667.0	614.0		535.0	420.0		298.0	291.0	63.0	60.0	28.0	11.0	-109.5	-172.0	-259.0	-326.0	-405.0	-428.0	-564.0	-638.0	-1475.0	1004242	670138
19612		1005				674.0	622.0	620.0	538.0	423.0	419.0	302.0	295.0	65.0	61.0	30.0	12.0	-105.0	-166.0	-255.0	-324.0	-401.0	-424.0	-556.0	-678.0	-1408.0	1004604	671736
19619		725															-53.0	-171.0	-239.0			-479.5	-503.0	-657.5			1002043	684051
19633		910																				-444.0	-467.5	-615.5		-1483.0	1000460	677869
19679		1070			989.0	717.0	669.0		592.0	472.0		349.0	341.0	109.5	106.5	74.5	57.0	-62.0	-124.0	-215.0	-280.0	-357.0	-383.0	-518.0	-637.0	-1453.0	1005437	670629
19685	ISCO 8601	~565	385									367.0	363.0	123.5	121.0	89.0	81.0	-41.0	-126.0	-221.0	-292.0	-368.0	-396.0	-551.0		-587.0	1010646	690790
20575		770	710											608.0	606.0	574.0	557.0	439.5	362.0	256.5	176.0	96.0	67.5	-80.0	-132.0	-920.0	1062056	731876
21406		895				500.5	443.0	440.5	363.5	222.5	219.5	103.5	96.0	-146.0	-149.0	-186.0	-204.5	-313.0	-391.0	-485.0	-556.0	-641.0	-688.5	-854.5	-989.0	-1777.0	982363	685920
21508	Akzo 9401	555.2	20.6														none	-21.4	-113.4	-197.4	-270.4	-350.4	-386.4	-540.4		-579.4	1013275	696495
21509	Akzo 9406	561.4	67														none	-21.5	-101.5							-147.6	1012955	694044
21510	Akzo 9405	559.8	34.8															-37.2	-115.2							-160.2	1012206	694655
21511	Akzo 9404	560.1	31.3														none	-39.9	-121.4							-453.9	1011855	694555

Appendix B
Stratigraphy and Coordinates for the Wells used in this Study

API Well, Hole, or Shaft Number	Alternate Well Identification	Surface Elevation (ft amsl)	Bedrock Top Elevation (ft amsl)	Group, Formation, and Member Top Elevations (ft amsl)																					Well Bottom Elevation (ft amsl)	Well Location Coordinates**	
				West Falls	Sonyea	Genesee	Genundewa LS	(btm Genundewa)	Moscow	Tichenor LS	Ludlowville	Centerfield LS	Skaneateles Levanna	Stafford LS	Marcellus	Onondaga	Tioga Bentonite	Bertie	Camillus Unit G	Syracuse Unit F	Syracuse Unit E	Syracuse Unit D	Vernon Unit C	Vernon Unit B	Vernon Unit A		Northing (ft)	Easting (ft)
21513	Akzo 9402	553.4	35.1														none	-16.6	-97.6	-187.0	-260.0	-337.0	-368.9	-526.5		-531.6	1014837	697534
21514	Akzo 9411	560.6	48.6															-30.4	-110.4	-204.4	-276.0	-356.9	-382.4			-439.4	1012151	694252
21515	Akzo 9408	561.0	44.5															-37.5	-118.0							-141.0	1011904	694305
21516	Akzo 9409	560.4	41.4															-41.6	-120.6	-212.6						-277.6	1011753	694156
21520	Akzo 9414	558.4	45.4															-41.6	-115.6	-208.6						-279.6	1012002	694254
21522	Akzo 9416	557.8	37.8														none									-37.2	1011198	693960
21523	Akzo 9417	558.0	58.5															-32.5	-111.0							-144.0	1012098	693552
21525	Akzo 9419/9419A	561.3	48.3															-39.2	-103.7							-143.7	1011749	693705
21527	Akzo 9421	560.1	43.6															-42.4								-132.4	1011598	693857
21530	Akzo 9424	552.4	52.4															-28.6	-102.1							-149.6	1012451	694344
21531	Akzo 9425	561.0	52.5															-38.5	-116.0								1011699	693757
21532	Akzo 9426	559.1	50.6															-40.4	-116.9	-209.4	-279.4	-357.4	-382.9			-418.9	1011647	693706
21533	Akzo 9427	560.4	44.4															-41.1	-118.6	-213.1	-286.1	-363.6	-390.6			-446.6	1011085	693641
21534	Akzo 9428	559.7	75.7															-38.8	-118.3							-192.3	1011391	693158
21539	Akzo 9433	558.4	30.4															-32.6								-441.6	1012289	694624
21548	Akzo 9440	564.2	228														none	132.2	62.2	-32.3	-101.8	-174.8	-199.3	-346.3		-377.8	1027804	696392
21555	Akzo 9444	634.5	556.7						556.7	432.1	429.5	313.5	302.0	51.0	48.5	23.0	2.3	-107.5	-179.5	-279.0	-350.5	-432.1	-479.5	-641.1	-782.5	-792.5	1002888	700684
21556	Akzo 9445	559.8	114.8														none	22.8	-53.2							-118.2	1017818	694222
21557	Akzo 9443	618.6	542.6						542.6	432.4	430.0	312.6	303.9	none	72.3	23.6	2.1	-105.9	-185.6	-277.2	-347.4	-428.4	-478.7	-644.6	-785.1	-796.4	1002712	700194
21558	Akzo 9442	888.3	863.3		863.3	711.9	651.7	649.3	567.6	432.3	428.6	312.8	303.9	63.3	60.3	19.8	2.5	-107.8	-187.2	-283.2	-357.7	-436.1	-488.0	-651.3	-794.3	-821.7	1003387	706305
21559	Akzo 9441/ 9441A*	700.6	655.6			655.6			581.9	448.1	445.8	327.6	317.6	79.6	74.6	39.0		-90.4	-171.4	-263.4	-327.6	-413.4	-448.8	-617.1	-757.9	-769.4	1006454	701690
21561	Akzo 9446	559.1	79.1														none									39.1	1011490	692982
21564	Akzo 9449	567.4	209.4											90.4	87.4	49.4	32.4	-82.6								-111.6	1005793	696836
21569	Akzo 9565	573.1	-176.9													-186.4	-203.9	-304.9								-336.9	979373	710063
21571	Akzo 9452	948.0	920		920.0	706.1	644.5	642.2	558.5	421.6	419.3	304.0	292.7	47.4	45.9	3.9	-12.5	-122.5	-203.2	-294.9	-366.1	-451.2	-503.8	-672.0	-818.0	-832.0	1001913	709343
21572	Akzo 9453	875.6			845.6	740.2	681.8		598.3	462.5	460.9	343.1	334.4	93.9	92.2	55.6	36.8	-74.0	-156.7	-248.4	-319.4	-402.4	-452.5	-616.7	-745.4	-773.2	1008382	706909
21573	Akzo 9459	889.9	854.9		854.9	713.2	653.3		569.2	433.6	431.4	313.2	306.9	65.1	63.3	22.3		-106.4	-186.6	-281.8	-356.7	-432.8	-487.6	-646.7	-792.0	-829.4	1003398	706305
21574	Akzo 9454	967.2	935.2		935.2	754.1	692.7	691.1	608.9	471.9	469.9	352.5	340.6	94.8	93.2	57.1	37.4	-78.2	-157.6	-250.7	-310.5	-404.8	-459.7	-635.0	-764.4	-803.8	1009527	714453
21575	Akzo 9455	1117.9	1083.9	1083.9	936.9	710.9	645.6	642.2	553.3	417.7	415.6	297.5	290.3	37.2	35.4	-1.1	-18.4	-128.1	-205.9	-299.3	-371.3	-455.3	-523.7	-695.0	-835.5	-858.4	1001681	716432
21576	Akzo 9456	934.5	904.5	904.5	881.2	661.5	593.4	591.1	500.3	365.5	362.5	247.2	238.4	-13.0	-15.0	-53.1	-70.8	-171.9	-257.7	-352.9	-425.5	-506.3	-576.5	-755.2	-901.1	-920.7	994746	714598
21577	Akzo 9457	832.9	729.6		729.6	665.5	601.9	600.3	513.9	378.8	376.2	258.4	250.2		9.0	-34.1		-158.0	-246.1	-340.2	-411.5	-486.8	-541.9	-719.1	-866.2	-907.4	996875	706485
21578	Akzo 9458	919.0	891		891.0	701.4	640.2	638.4	554.1	418.9	416.5	297.9	289.7	39.3	36.0	6.8		-124.2	-205.0	-298.9	-369.7	-450.1	-498.7	-670.6	-821.1	-853.0	1000684	706450
21579	Akzo 9460	566.8	23.6													23.6	none									-4.2	1004994	691636
21603	Akzo 9569	599.9	404.9													404.9	none	374.4								343.9	1054797	705785
21620	Akzo 9572	601.3	575.3													133.3		17.3	-57.0	-148.0			-324.0	-479.0		-483.7	1017900	692198
61557	ISCO 7401	614.0								542.0	534.0	416.0	408.0	169.5	166.5	132.0	117.0									34.0	1016545	691911
61558	ISCO 8202	595.0	571							540.0	537.0	418.0	410.0	171.5	168.0	135.0		1.0								-67.0	1016645	692061
61559	ISCO 8207	609.5								531.5	528.5	408.5	401.0	160.0	156.0	125.0	109.5	-10.0	-84.0							-145.0	1016144	691915
none	ISCO 6702	580.0	476						455.0	326.0	325.0	226.0	219.0	-66.0	-69.0	-94.0	-101.0	-207.5	-297.0	-392.0	-461.0	-544.0	-609.0	-787.0	-917.7	-942.0	991900	705000
none	ISCO 7403	634.0								535.0	532.0	412.0	496.0	168.0	164.0	130.0	115.0										1016408	691496
none	ISCO 8208	582.5								533.5	530.5	411.5	403.5	161.5	118.0	129.5	112.0	-6.5	-83.0	-157.0						-174.5	1016393	691964
none	ISCO 8209	629.0								531.5	529.0	410.0	402.5	164.5	161.5	127.5	111.5	-5.0	-79.5							70.0	1016460	691570
none	ISCO 8210	596.0								537.0	534.0	415.0	407.0	169.0	164.5	134.0	116.0	-1.0	-75.0							-164.0	1016718	691889

Notes:

* The bottom of borehole 9441 is at -611.4. The hole was terminated due to loss of drill pipe. Alternate hole 9441(a) was cored beginning at -611.4.

** Northing and Easting are the distances north and east, respectively, from the origin of the NYS Plane Coordinate System.

APPENDIX C

SALT THICKNESS DATA FROM THE VERNON FORMATION (UNIT B)

Appendix C

Unit B and Unit B Salt Thickness
Livingston County, New York

API Well ID	Alternative Well ID	Vernon Fm Unit B	B-6 Salt top	B-6 Salt base	B-5 Salt top	B-5 Salt base	B-4 Salt top	B-4 Salt base	B-3 Salt top	B-3 Salt base	B-2 Salt top	B-2 Salt base	B-1 Salt top	B-1 Salt base	Unit B	B-6 Salt	B-5 Salt	B-4 Salt	B-3 Salt	B-2 Salt	B-1 Salt
		ELEVATION (ft amsl)													THICKNESS (ft)						
	Retsof Fuller																				
01272	Shaft	-318.9	-318.9	-336.9	-366.9	-371.9	-398.9	-405.9	-408.9							18.0	5.0	7.0			
02206		-464.6	-464.6	-485.6	none	none	-531.6	-541.6	-544.6	-557.6	-561.6	-576.6	-579.1	-590.6	126.0	21.0	0.0	10.0	13.0	15.0	11.5
04053		-675.0	-675.0	-693.0	-774.5	-784.0	-805.0	-818.0	-820.0	-838.0	-841.0	-855.0	-859.0	-869.0	194.0	18.0	9.5	13.0	15.0**	14.0	10.0
04069		-111.3	none	none	none	none	-165.3	-173.3	-176.3	-189.3	-199.3	-205.3	-212.3	-221.3	110.0	0.0	0.0	8.0	13.0	6.0	9.0
04089		-376.0	-376.0	-394.0	-424.0	-430.0	-441.0	-449.0	-452.0	-471.0	-469.0	-478.0	-486.0	-491.0	115.0	18.0	6.0	8.0	19.0	9.0	5.0
04117		-292.9	-292.9	-300.9	-432.9	-437.9	none	none	-461.9	-470.9	-472.9	-485.9	-488.9	-494.9	202.0	8.0	5.0	0.0	6.0**	13.0	6.0
04129		-357.0	-357.0	-380.0	-408.0	-412.0	-422.0	-427.0	-431.0	-442.0	-444.0	-459.0	-462.0	-470.0	113.0	23.0	4.0	5.0	11.0	15.0	8.0
04138		-367.0	-367.0	-378.0	-405.0	-408.0	-422.0	-427.0	-432.0	-441.0	-443.0	-450.0	-455.0	-470.0	103.0	11.0	3.0	5.0	9.0	7.0	15.0
04151		-341.0	-341.0	-363.0	-396.0	-401.0	-411.0	-418.0	-421.0	-434.0	-436.0	-444.0	-449.0	-457.0	16.0	22.0	5.0	7.0	13.0	8.0	8.0
04188		-632.0	-632.0	-652.0	-691.0	-696.0	-709.0	-720.0	-722.0	-736.0	-739.0	-753.0	-756.0	-766.0	134.0	20.0	5.0	11.0	14.0	14.0	10.0
04213		-295.2	-295.2	-320.2	-346.2	-351.2	-367.2	-376.2	-378.2	-388.2	-394.2	-408.2	-412.2	-421.2	126.0	25.0	5.0	9.0	10.0	14.0	9.0
04218		-59.5	-62.5	-67.5	-94.5	-101.5	-111.5	-119.5	-130.5	-144.5	-146.5	-159.5	none	none	113.0	5.0	7.0	8.0	14.0	13.0	0.0
04391		-301.7	-301.7	-324.7	-354.7	-359.7	-369.7	-374.7	-377.7	-384.7	-386.7	-394.7	-396.7	-402.7	101.0	23.0	5.0	5.0	7.0	8.0	6.0
04495		-303.0	-303.0	-319.0	none	none	-357.0	-366.0	-369.0	-378.0	-385.0	-390.0	-392.0	-396.0	93.0	16.0	0.0	9.0	9.0	5.0	4.0
04531		-280.7	-280.7	-298.7	-327.7	-332.7	-341.7	-346.7	-348.7	-360.7	-368.7	-376.7	none	none	96.0	18.0	5.0	5.0	12.0	8.0	0.0
04552		-277.5	-277.5	-291.5	-317.5	-324.5	-334.5	-343.5	-345.5	-351.5	-353.5	-360.5	-362.5	-369.5	92.0	14.0	7.0	9.0	6.0	7.0	7.0
05061		-210.0	-210.0	-230.0	-263.0	-269.0	-279.0	-290.0	-292.0	-305.0	-307.0	-322.0	-325.0	-335.0	125.0	20.0	6.0	11.0	13.0	15.0	10.0
10920		-553.5	-553.3	-577.0	-613.0	-620.0	-632.0	-642.0	-645.0	-657.0	-660.0	-675.5	-678.0	-688.0	134.5	23.7	7.0	10.0	12.0	15.5	10.0
10922		-376.0	-376.0	-391.0	-431.0	-438.0	-450.0	-464.0	-467.0	-482.0	-484.0	-500.0	-503.0	-511.0	135.0	15.0	7.0	14.0	15.0	16.0	8.0
11003		-375.5	-375.5	-393.0	-425.5	-431.5	-441.5	-450.0	-452.0	-466.5	-468.5	-479.5	-482.5	-491.0	115.5	17.5	6.0	8.5	14.5	11.0	8.5
11403		-676.0	-676.0	-695.0											109.0	19.0					
13867		-382.0	-582.0	-595.0	-631.0	-638.0	-647.0	-656.0	-658.0	-670.0	-672.0	-688.0	-690.0	-701.0	319.0	13.0	7.0	9.0	12.0	16.0	11.0
13870		-788.0	-788.0	-806.0	-844.0	-851.0	-864.0	-875.0	-877.0	-893.0	-894.0	-908.0	-910.0	-921.0	133.0	18.0	7.0	11.0	16.0	14.0	11.0
13979		-731.0	-731.0	-751.0	-780.0	-785.0	-794.0	-803.0	-806.0	-829.0	-833.0	-848.0	-853.0	-856.0	125.0	20.0	5.0	9.0	23.0	15.0	3.0
13980		-707.5	-707.5	-730.5	-762.0	-766.0	-779.0	-787.0	-789.5	-800.0	-802.0	-810.0	-814.5	-827.0	119.5	23.0	4.0	8.0	8.0**	8.0	12.5
14100	ISCO 6701	-646.5	-646.5	-660.5	-712.5	-716.5	-734.5	-748.5	-751.5	-766.5	-769.5	-784.0	-787.0	-797.5	151.0	14.0	4.0	14.0	15.0	14.5	10.5
14482		-627.0	-627.0	-644.0	-680.0	-687.5	-698.5	-708.5	-711.0	-725.0	-727.0	-742.5	-746.0	-754.0	127.0	17.0	7.5	10.0	14.0	15.5	8.0
14498		-948.0	-948.0	-971.0	-1010.0	-1013.0	-1026.0	-1029.0	-1032.0	-1034.0	-1036.0	-1045.0	-1047.0	-1057.0	109.0	17.0**	3.0	3.0	2.0	9.0	10.0
14537		-607.5	-607.5	-621.0	-653.0	-659.5	-671.5	-681.0	-684.0	-696.0	-698.5	-713.0	-721.5	-732.0	124.5	13.5	6.5	9.5	12.0	14.5	10.5
15477		-932.0	-932.0	-960.0	-995.0	-1002.0	-1016.0	-1029.0	-1042.0	-1065.0	-1068.0	-1079.5	-1083.5	-1086.0	154.0	28.0	7.0	13.0	23.0	11.5	2.5
15592		-619.5	-619.5	-641.0	-672.5	-678.5	-689.5	-698.0	-700.5	-712.0	-714.0	-731.0	-734.5	-745.0	125.5	21.5	6.0	8.5	11.5	17.0	10.5
15593		-585.5	-585.5	-604.0	-635.0	-641.5	-652.5	-661.5	-664.0	-677.5	-679.5	-687.0	-693.5	-703.0	117.5	18.5	6.5	0.0	13.5	7.5	9.5
15726		-537.0	-537.0	-558.0	-591.0	-597.5	-607.5	-617.0	-620.0	-631.5	-634.0	-647.0	-650.0	-663.0	126.0	21.0	6.5	9.5	11.5	13.0	13.0
15727		-455.0	-455.0	-474.5	-508.0	-516.0	-528.0	-536.0	-538.0	-550.0	-552.0	-569.0	-571.5	-583.0	128.0	19.5	8.0	8.0	12.0	17.0	11.5
15728		-468.0	-468.0	-481.5	-515.0	-521.5	-531.5	-541.5	-545.0			-672.5	-675.5	-686.5	218.5	13.5	6.5	10.0			11.0
15737		-732.5	-732.5	-758.0	-884.0	-890.0	-908.0	-916.0	-918.0	-931.5	-934.5	-944.0	-951.0	-962.0	229.5	25.5	6.0	8.0	13.5	9.5	11.0
15784		-673.0	-673.0	-700.0	-724.0	-729.0	-732.0	-747.0	-750.0	-764.0	-770.0	-773.0	-785.0	-793.0	120.0	27.0	5.0	15.0	14.0	3.0	8.0
15961		-670.0	-670.0	-709.0	-724.0	-728.5	-738.5	-744.0	-747.0	-757.5	-760.0	-770.0	-777.0	-785.0	115.0	39.0	4.5	5.5	10.5	10.0	8.0
15976		-624.0	-624.0	-643.0	-675.5	-682.0	-693.0	-701.5	-704.0	-715.0	-719.0	-728.0	-732.0	-742.0	118.0	19.0	6.5	8.5	11.0	9.0	10.0
16073		-657.0	-657.0	-683.0	-709.0	-715.0	-723.0	-730.0	-732.0	-742.0	-744.0	-759.0	-761.0	-771.0	114.0	26.0	6.0	7.0	10.0	15.0	10.0
16154		-637.0	-637.0	-659.0	-692.0	-698.0	-710.0	-717.0	-719.0	-730.0	-732.0	-747.0	-750.0	-758.0	121.0	22.0	6.0	7.0	11.0	15.0	8.0
16190		48.0	48.0	38.0	18.0	13.0	4.0	-4.0	-7.0	-21.0	-23.0	-37.0	-46.0	-55.0	103.0	10.0	5.0	8.0	14.0	14.0	9.0
16197		94.0	none	none	35.0	30.0	17.0	12.0	2.0	-4.0	-8.0	-20.0	-24.0	-33.0	127.0	0.0	5.0	5.0	6.0	12.0	9.0
16199		65.0	none	none	38.0	33.0	22.0	10.0	8.0	-7.0	-9.0	-32.0	-35.0	-41.0	106.0	0.0	5.0	12.0	15.0	21.0**	6.0
17300		41.0	none	none	12.0	6.0	-3.0	-13.0	-16.0	-27.0	-30.0	-32.0	-34.0	-60.0	101.0	0.0	6.0	10.0	11.0	2.0	26.0
17302		-597.0	none	none	none	none	-690.5	-698.0	-701.0	-711.0	-715.0	-719.0	-729.0	-737.0	140.0	0.0	0.0	7.5	10.0	4.0	8.0
17304		28.0	none	none	0.0	-3.0	-13.0	-23.0	-25.0	-41.0	-45.0	-59.0	-62.0	-70.0	98.0	0.0	3.0	10.0	16.0	14.0	8.0
17305		18.0	none	none	-8.0	-15.0	-25.0	-34.0	-36.0	-48.0	-52.0	-62.0	-69.0	-78.0	96.0	0.0	7.0	9.0	12.0	10.0	9.0
17306		-13.0	none	none	-44.0	-49.0	-60.0	-70.0	-74.0	-85.0	-87.0	-113.0	-114.0	-116.0	103.0	0.0	5.0	10.0	11.0	26.0	2.0
17307		-7.0	none	none	-36.0	-44.0	-55.0	-65.0	-67.0	-80.0	-87.0	-95.0	-99.0	-107.0	100.0	0.0	8.0	10.0	13.0	8.0	8.0
17309		-17.0	none	none	-46.0	-54.0	-64.0	-73.0	-75.0	-87.0	-89.0	-103.0	-107.0	-113.0	96.0	0.0	8.0	9.0	12.0	14.0	6.0
17310		2.0	none	none	-33.0	-38.0	-48.0	-58.0	-61.0	-87.0	-91.0	-95.0	-99.0	-105.0	107.0	0.0	5.0	10.0	26.0	4.0	6.0
17312		18.0	18.0	14.0	0.0	-7.0	-20.0	-28.0	-34.0	-46.0	-49.0	-57.0	-62.0	-72.0	90.0	4.0	7.0	8.0	12.0	8.0	10.0
17336		-190.0	-190.0	-209.0	-243.0	-249.0	-264.0	-268.0	-272.0	-284.0	-287.0	-301.0	-304.0	-315.0	125.0	19.0	6.0	4.0	12.0	14.0	11.0
17337		-163.0	-163.0	-183.0	-215.0	-221.0	-232.0	-243.5	-246.0	-257.0	-261.5	-273.0	-280.0	-286.0	123.0	20.0	6.0	11.5	11.0	11.5	6.0
17353		77.0	none	none	42.0	37.0	27.0	18.0	15.0	3.0	1.0	-9.0	-30.0	-34.0	111.0	0.0	5.0	9.0	12.0	10.0	4.0
17354		124.0	none	none	43.0	38.0	27.0	17.0	15.0	0.0	-2.0	-30.0	-33.0	-40.0	164.0	0.0	5.0	10.0	15.0	28.0	7.0
17357		47.0	none	none	17.0	10.0	-1.0	-11.5	-13.5	-25.0	-27.0	-44.0	-47.0	-55.5	102.5	0.0	7.0	10.5	11.5	17.0	8.5
17358		4.0	none	none	-32.0	-40.0	-50.0	-61.0	-63.0	-72.0	-74.5			-95.5	99.5	0.0	8.0	11.0	9.0		
17368		-19.0	none	none	-50.0	-55.0	-69.0	-75.0	-78.0	-89.0	-92.0	-106.0	-108.0	-120.0	101.0	0.0	5.0	6.0	11.0	12.0**	12.0

Appendix C continues

API Well ID	Alternative Well ID	Vernon Fm Unit B	B-6 Salt top	B-6 Salt base	B-5 Salt top	B-5 Salt base	ELEVATION (ft amsl) B-4 Salt top	B-4 Salt base	B-3 Salt top	B-3 Salt base	B-2 Salt top	B-2 Salt base	B-1 Salt top	B-1 Salt base	THICKNESS (ft) Unit B	B-6 Salt	B-5 Salt	B-4 Salt	B-3 Salt	B-2 Salt	B-1 Salt
17369		-16.0	-18.0	-20.0	-46.0	-54.0	-63.0	-74.0	-76.0	-89.0	-91.0	-104.0	-107.0	-115.0	99.0	2.0	8.0	11.0	13.0	13.0	8.0
17371		-29.0	none	none	-64.0	-67.0	-80.0	-88.0	-91.0	-102.0	-108.0	-122.0	-130.0	-132.0	103.0	0.0	3.0	8.0	11.0	14.0	2.0
17372		-23.0	none	none	-61.0	-64.0	-74.0	-83.0	-85.0	-96.0	-99.0	-111.0	-114.0	-119.0	96.0	0.0	3.0	9.0	11.0	12.0	5.0
17373		-64.0	none	none	none	none	-110.0	-119.0	-123.0	-133.0	-141.0	-148.5	-157.0	-162.0	101.0	0.0	0.0	6.0**	6.0**	7.5	5.0
17375		-28.0	none	none	-63.0	-71.0	-81.0	-90.0	-93.0	-117.0	-119.0	-129.0	none	none	105.0	0.0	8.0	7.2	24.0	10.0	0.0
17377		-52.0	none	none	-85.0	-94.0	-104.0	-114.0	-118.0	-128.0	-131.0	-149.0	-156.0	-162.0	110.0	0.0	9.0	10.0	10.0	18.0	6.0
17392		-102.0	-102.0	-115.0	-149.0	-154.0	-164.0	-172.0	-178.0	-190.0	-192.0	-205.0	-211.0	-218.0	116.0	13.0	5.0	8.0	12.0	13.0	7.0
17399		-37.0	-37.0	-44.0	-72.0	-78.0	-88.0	-98.0	-100.0	-115.0	-121.0	-125.0	-131.0	-137.0	100.0	7.0	6.0	10.0	15.0	4.0	6.0
17400		-67.5	-67.5	-72.0	-103.5	-109.0	-119.0	-129.0	-131.0	-139.0	-141.0	-145.0	-152.5	-170.0	102.5	4.5	5.5	10.0	8.0	4.0	17.5
17403		20.0	none	none	14.0	8.0	-1.0	-11.0	-14.0	-25.5	-27.5	-42.5	-52.0	-67.0	87.0	0.0	6.0	9.0**	11.5	15.0	15.0
17404		27.0	27.0	24.5	-8.0	-14.5	-24.5	-35.0	-36.5	-47.5	-49.5	-65.0	-70.0	-80.0	107.0	2.5	6.5	10.5	11.0	15.5	10.0
17405		-42.0	none	none	-75.0	-80.0	-89.0	-100.0	-103.0	-116.0	-117.0	-122.0	-130.0	-140.0	98.0	0.0	5.0	11.0	13.0	5.0	10.0
17406		71.0	64.0	62.0	39.0	34.0	24.5	17.0	12.0	0.0	-2.0	-24.0	-32.0	-44.0	115.0	2.0	5.0	7.5	12.0	22.0	12.0
17409		-80.5	none	none	none	none	-123.0	-134.0	-136.0	-147.0	-150.0	-165.0	-168.0	-175.5	95.0	0.0	0.0	11.0	11.0	15.0	7.5
17424		-41.0	none	none												0.0					
17425		12.0	12.0	10.0	-14.0	-18.0	-39.0	-48.0	-50.0	-62.0	-65.0	-75.0	-78.0	-89.0	101.0	2.0	4.0	9.0	12.0	10.0	11.0
17426		-26.0	none	none	-61.5	-69.0	-78.5	-88.0	-90.5	-106.5	-108.0	-114.5	-117.0	-129.0	103.0	0.0	7.5	9.5	16.0	6.5	12.0
17428		4.0	4.0	-2.0	-33.0	-37.0	-47.0	-57.0	-59.0	-71.0	-73.0	-89.0	-93.0	-102.0	106.0	6.0	4.0	10.0	12.0	16.0	9.0
17429		-84.0	-84.0	-88.0	-120.0	-126.0	-136.0	-145.0	-149.0			-178.0	-181.0	-193.5	109.5	4.0	6.0	9.0			12.5
17432		-146.0	-146.0	-162.5	-196.0	-201.0	-212.0	-219.5	-222.5	-234.0	-238.0	-250.0	-253.5	-257.5	117.0	16.5	5.0	7.5	11.5	12.0	4.0
17434		33.0	none	none	-6.0	-13.0	-24.0	-34.0	-36.0	-49.0	-51.0	-62.0	none	none	111.0	0.0	7.0	10.0	13.0	11.0	0.0
17435		-151.0	none	none	-175.0	-180.0	-190.0	-198.0	-200.0	-207.0	-211.0	-226.0	-229.0	-238.0	87.0	0.0	5.0	8.0	7.0	15.0	9.0
17439		-224.0	-224.0	-233.0	none	none	-255.0	-262.0	-268.0			-273.0	-279.0	-283.0	59.0	9.0	0.0	7.0			4.0
17445		-63.0	-63.0	-67.0	-93.0			-117.0								4.0					
17452		60.0	none	none	27.0	19.0	11.0	1.0	-1.0	-13.0	-15.0	-28.0	-38.0	-47.0	107.0	0.0	8.0	10.0	12.0	13.0	9.0
17460		18.0	18.0	15.0	-17.5	-22.5	-32.0	-42.0	-45.0	-55.0	-59.0	-74.0	-76.0	-86.0	104.0	3.0	5.0	10.0	10.0	15.0	10.0
17466		-41.5	-41.5	-49.0												7.5					
17467		-43.0	-43.0	-49.0	-69.0	-73.0	-84.0	-92.0	-95.0	-108.0	-111.0	-120.0	-123.0	-131.0	88.0	6.0	4.0	8.0	13.0	9.0	8.0
17503		281.0	none	none	256.0	250.0	241.0	232.0	230.0	216.0	213.0	194.0	191.0	181.0	100.0	0.0	6.0	9.0	14.0	19.0	10.0
17518		7.0	none	none			-37.0	-47.0	-49.0	-64.0	-66.0	-80.0	-83.0	-90.0	97.0	0.0		10.0	15.0	14.0	7.0
17523		-15.0	none	none	-45.0	-51.0	-61.0	-70.0	-72.0	-85.0	-95.0	-103.0	-105.0	-112.0	97.0	0.0	6.0	9.0	13.0	8.0	7.0
19408		-13.0	none	none	none	none	none	none	none	none	none	none	none	none	100.0	0.0	0.0	0.0	0.0	0.0	0.0
19409		28.0	none	none	-1.0	-5.0	-18.0	-26.0	-29.0	-44.0	-50.0	-64.0	-69.0	-74.0	102.0	0.0	4.0	8.0	15.0	14.0	5.0
19413		-592.0	-592.0	-619.0	-648.5	-656.0	-664.0	-672.5	-675.0	-688.5	-691.0	-701.5	-704.0	-717.0	125.0	27.0	7.5	8.5	13.5	10.5	13.0
19416		-620.0	-620.0	-638.0	-667.0	-673.0	-683.0	-690.0	-693.0	-706.0	-709.0	-722.0	-724.0	-736.0	116.0	18.0	6.0	7.0	13.0	13.0	12.0
19431		-253.0	-253.0	-266.0	-301.0	-309.0	-320.0	-331.0	-334.0	-348.5	-351.0	-364.5	-367.0	-377.0	124.0	13.0	8.0	11.0	14.5	13.5	10.0
19438		-326.0	-326.0	-341.0	-380.0	-384.0	-398.0	-408.0	-410.0	-423.0	-429.0	-439.0	-443.0	-451.0	125.0	15.0	4.0	10.0	13.0	10.0	8.0
19609		-149.0	none	none	none	none	none	none	-206.0	-208.5	none	none	-221.0	-226.0	77.0	0.0	0.0	0.0	2.5	0.0	4.0**
19610		-540.5	-540.5	-563.0	-596.0	-603.0	-615.0	-623.5	-625.5	-637.0	-639.0			-659.0	118.5	22.5	7.0	8.5	11.5		
19611		-564.0	none	none	-614.0	-619.0	none	none	-634.0	-638.0	none	none	none	none	74.0	0.0	5.0	0.0	4.0	0.0	0.0
19612		-556.0	-556.0	-571.0	-611.0	-615.0	-628.0	-636.0	-638.0	-651.0	-653.0	-667.0	-669.0	-678.0	122.0	15.0	4.0	8.0	13.0	14.0	9.0
19633		-615.5	-615.5	-634.5												19.0					
19679		-518.0	-518.0	-532.0	-563.0	-570.0	-580.0	-589.0	-591.0	-604.0	-606.0	-613.0	-616.0	-637.0	119.0	14.0	7.0	9.0	12.0**	7.0	21.0
19685	ISCO 8601	-551.0	-551.0	-579.0												28.0					
20575		-80.0	none	none	none	none	none	none	none	none	none	none	none	none	52.0	0.0	0.0	0.0	0.0	0.0	0.0
21406		-854.5	-854.5	-871.5	-910.5	-916.5	-930.5	-940.5	-943.5	-957.5	-960.0	-975.0	-977.5	-989.0	134.5	17.0	6.0	10.0	14.0	15.0	11.5
21555	Akzo 9444	-641.1	-641.1	-663.8	-706.6	-711.4	-728.1	-741.2	-742.4	-753.6	-755.2	-770.0	-771.8	-782.5	141.4	22.7	4.8	13.1	11.2	14.8	10.7
21557	Akzo 9443	-644.6	-644.6	-664.6	-709.0	-714.7	-729.8	-741.7	-743.8	-754.6	-755.8	-772.0	-774.4	-785.1	140.5	20.0	5.7	11.9	10.8	16.2	10.7
21558	Akzo 9442	-651.3	-651.3	-663.3	-708.3	-716.5	-730.7	-743.1	-744.9	-763.5	-765.9	-780.4	-783.1	-794.3	143.0	12.0	8.2	12.4	18.6	14.5	11.2
	Akzo 9441																				
21559	Akzo 9441A*	-617.1	-617.1	-638.2	-674.8	-681.9	-692.4	-704.0	-705.8	-719.7	-720.9	-735.9	-738.6	-749.8	140.8	21.1	7.1	11.6	13.9	15.0	11.2
21571	Akzo 9452	-672.0	-672.0	-687.7	-742.0	-750.0	-761.0	-774.5	-779.0	-788.0	-789.3	-805.0	-807.8	-818.0	146.0	15.7	8.0	13.5	9.0	15.7	10.2
21572	Akzo 9453	-616.7	-616.7	-635.4	-670.5	-677.4	-689.4	-701.4	-706.8	-715.1	-716.5	-732.8	-735.5	-745.4	128.7	18.7	6.9	12.0	8.3	16.3	9.9
21573	Akzo 9459	-646.7	-646.7	-664.3	-705.9	-713.5	-725.9	-737.3	-739.3	-761.1	-763.6	-778.2	-780.9	-792.0	145.3	17.6	7.6	11.4	21.8	14.6	11.1
21574	Akzo 9454	-635.0	-635.0	-650.3	-690.1	-696.6	-708.9	-721.0	-722.7	-735.5	-736.8	-752.1	-755.3	-764.4	129.4	15.3	6.5	12.1	12.8	15.3	9.1
21575	Akzo 9455	-695.0	-695.0	-722.0	-759.7	-767.4	-779.7	-791.1	-793.1	-804.8	-806.4	-823.1	-826.2	-835.5	140.5	27.0	7.7	11.4	11.7	16.7	9.3
21576	Akzo 9456	-755.2	-755.2	-777.5	-822.8	-830.9	-844.2	-856.9	-859.3	-870.1	-874.1	-888.7	-892.0	-901.1	145.9	22.3	8.1	12.7	10.8	14.6	9.1
21577	Akzo 9457	-719.1	-719.1	-736.4	-796.6	-800.5	-812.8	-821.6	-824.1	-835.3	-836.7	-855.3	-857.9	-866.2	147.1	17.3	3.9	8.8	11.2	18.6	8.3
none	ISCO 6702	-787.0	-587.0	-609.0	none	none	-865.0	-873.0	-876.0	-879.0	-891.0	-905.0	-909.0	-917.7	130.7	22.0	0.0	8.0	3.0	14.0	8.7

Notes:

* The bottom of borehole 9441 is at -611.4. The hole was terminated due to loss of drill pipe. Alternate hole 9441(a) was cored beginning at -611.4.

** The B-3 salt unit in borehole 04053 is actually 2 separate units. There is no salt between the depths of 2207' and 2210'.

** The B-3 salt unit in borehole 04117 is actually 2 separate units. There is no salt between the depths of 1444' and 1446'.

** The B-3 salt unit in borehole 13980 is actually 2 separate units. There is no salt between the depths of 1735.5' and 1738'.

** The B-6 salt unit in borehole 14498 is actually 2 separate units. There is no salt between the depths of 1570' and 1576'.

** The B-2 salt unit in borehole 16199 is actually 2 separate units. There is no salt between the depths of -23' and -25'.

** The B-4 salt unit in borehole 17403 is actually 2 separate units. There is no salt between the elevations of -6' amsl and -7' amsl.

** The B-2 salt unit in borehole 17368 is actually 2 separate units. There is no salt between the elevations of -97' amsl and -99' amsl.

** The B-3 salt unit in borehole 17373 is actually 3 separate units. There is no salt between the elevations of -125' amsl and -127' amsl and between -128' amsl and -130' amsl.

API Well ID	Alternative Well ID	ELEVATION (ft amsl) Vernon Fm Unit B	B-6 Salt top	B-6 Salt base	B-5 Salt top	B-5 Salt base	B-4 Salt top	B-4 Salt base	B-3 Salt top	B-3 Salt base	B-2 Salt top	B-2 Salt base	B-1 Salt top	B-1 Salt base	THICKNESS (ft) Unit B	B-6 Salt	B-5 Salt	B-4 Salt	B-3 Salt	B-2 Salt	B-1 Salt
** The B-4 salt unit in borehole 17373 is actually 2 separate units. There is no salt between the elevations of -114' amsl and -117' amsl.																					
** The B-1 salt unit in borehole 19609 is actually 2 separate units. There is no salt between the depths of 1623' and 1624'.																					
** The B-3 salt unit in borehole 19679 is actually 2 separate units. There is no salt between the elevations of -595' amsl and -596' amsl.																					
** The B-6 salt unit in borehole 14498 is actually 2 separate units. There is no salt between the depths of 1570' and 1576'.																					
** The B-4 salt unit in borehole 17302 is actually 2 separate units. There is no salt between the depths of 1619' and 1633'.																					

APPENDIX D

SALT THICKNESS DATA FROM SYRACUSE FORMATION (UNIT D)

Appendix D

Unit D and Unit D Salt Thickness
Livingston County, New York

Note: Where D-1 Salt is not present, elevation given is base of Unit D.

API Well Identification	Alternative Well ID	ELEVATION Syracuse Fm Unit D	D-4 Salt top	D-4 Salt base	D-3 Salt top	D-3 Salt base	D-2 Salt top	D-2 Salt base	D-1 Salt top	D-1 Salt base	THICKNESS Unit D	D-4 Salt	D-3 Salt	D-2 Salt	D-1 Salt	Unit D Salt
2206		-291.5	none	none	none	none	none	none	none	-317.5	26.0	0.0	0.0	0.0	0.0	0.0
3277	Livonia Shaft	-277.0	none	none	-292.0	-295.0	-296.5	-321.0	-328.5	-344.0	67.0	0.0	3.0	24.5	15.5	43.0
3305		-694.0	none	none	none	none	-698.0	-714.0	-734.0	-748.5	54.5	0.0	0.0	16.0	14.5	30.5
4053		-431.0	none	none	none	none	-450.0	-474.0	-479.0	-495.0	64.0	0.0	0.0	24.0	16.0	40.0
4069		29.7	none	none	none	none	none	none	none	7.2	22.5	0.0	0.0	0.0	0.0	0.0
4089		-226.0	none	none	none	none	none	none	none	-247.0	21.0	0.0	0.0	0.0	0.0	0.0
4117		-244.9	none	none	none	none	none	none	none	-270.9	26.0	0.0	0.0	0.0	0.0	0.0
4128		-213.0	none	none	none	none	none	none	none	-233.0	20.0	0.0	0.0	0.0	0.0	0.0
4129		-203.0	none	none	none	none	-218.0	-223.0	none	-233.0	30.0	0.0	0.0	5.0	0.0	5.0
4151		-191.0	none	none	none	none	none	none	none	-211.0	20.0	0.0	0.0	0.0	0.0	0.0
4188		-392.0	none	none	none	none	-411.0	-436.0	-442.0	-458.0	66.0	0.0	0.0	25.0	16.0	41.0
4213		-122.2	none	none	none	none	none	none	none	-147.2	25.0	0.0	0.0	0.0	0.0	0.0
4218		77.5	none	none	none	none	none	none	none	55.5	22.0	0.0	0.0	0.0	0.0	0.0
4391		-165.2	none	none	none	none	none	none	none	-188.2	23.0	0.0	0.0	0.0	0.0	0.0
4495		-153.0	none	none	none	none	none	none	none	-176.0	23.0	0.0	0.0	0.0	0.0	0.0
4531		-129.7	none	none	none	none	none	none	none	-154.7	25.0	0.0	0.0	0.0	0.0	0.0
4552		-132.5	none	none	none	none	none	none	none	-152.5	20.0	0.0	0.0	0.0	0.0	0.0
5061		-35.0	none	none	none	none	none	none	none	-62.0	27.0	0.0	0.0	0.0	0.0	0.0
10920		-318.0	none	none	none	none	-337.0	-362.0	-366.0	-382.5	64.5	0.0	0.0	25.0	16.5	41.5
10922		-143.0	none	none	none	none	-159.0	-177.0	-183.0	-199.0	56.0	0.0	0.0	18.0	16.0	34.0
11003		-219.5	none	none	none	none	none	none	none	-242.5	23.0	0.0	0.0	0.0	0.0	0.0
11403		-514.5	none	none	none	none	none	none	none	-535.5	21.0	0.0	0.0	0.0	0.0	0.0
13700		-633.0	none	none	none	none	none	none	-657.0	-668.0	35.0	0.0	0.0	0.0	11.0	11.0
13841		-481.0	none	none	none	none	none	none	none	-503.5	22.5	0.0	0.0	0.0	0.0	0.0
13867		-412.0	none	none	none	none	none	none	none	-435.0	23.0	0.0	0.0	0.0	0.0	0.0
13870		-544.0	none	none	none	none	-564.0	-589.0	-595.0	-611.0	67.0	0.0	0.0	25.0	16.0	41.0
13898	ISCO 7901	-281.0	none	none	none	none	none	none	-302.0	-311.0	30.0	0.0	0.0	0.0	9.0	9.0
13950		-452.5	none	none	none	none	none	none	none	-477.0	24.5	0.0	0.0	0.0	0.0	0.0
13979		-447.0	none	none	none	none	none	none	none	-472.0	25.0	0.0	0.0	0.0	0.0	0.0
13980		-531.0	none	none	none	none	none	none	none	-557.5	26.5	0.0	0.0	0.0	0.0	0.0
14100	ISCO 6701	-430.0	none	none	none	none	-449.5	-460.5	-466.5	-480.5	50.5	0.0	0.0	11.0	14.0	25.0
14380		-567.7	none	none	none	none	none	none	none	-595.2	27.5	0.0	0.0	0.0	0.0	0.0
14482		-405.5	none	none	none	none	-420.5	-440.0	-444.5	-462.0	56.5	0.0	0.0	19.5	17.5	37.0
14498		-683.0	none	none	-704.0	-710.0	-718.0	-748.0	-755.0	-770.0	87.0	0.0	6.0	30.0	15.0	51.0
14537		-441.5	none	none	none	none	none	none	none	-464.0	22.5	0.0	0.0	0.0	0.0	0.0
15477		-669.0	-688.0	-695.0	-699.0	-701.0	-725.0	-733.0	-740.0	-754.0	85.0	7.0	2.0	8.0	14.0	31.0
15592		-476.0	none	none	none	none	none	none	none	-500.5	24.5	0.0	0.0	0.0	0.0	0.0
15593		-422.0	none	none	none	none	none	none	none	-446.0	24.0	0.0	0.0	0.0	0.0	0.0
15726		-376.0	none	none	none	none	none	none	none	-399.0	23.0	0.0	0.0	0.0	0.0	0.0
15728		-295.0	none	none	none	none	none	none	none	-322.5	27.5	0.0	0.0	0.0	0.0	0.0
15737		-566.0	none	none	none	none	none	none	none	-588.0	22.0	0.0	0.0	0.0	0.0	0.0
15784		-497.0	none	none	none	none	none	none	-521.0	-527.0	30.0	0.0	0.0	0.0	6.0	6.0
15961		-495.5	none	none	none	none	none	none	none	-518.5	23.0	0.0	0.0	0.0	0.0	0.0
15976		-408.0	none	none	none	none	none	none	-432.0	-441.0	33.0	0.0	0.0	0.0	9.0	9.0
16073		-475.0	none	none	none	none	-497.0	-501.0	none	-501.0	26.0	0.0	0.0	4.0	0.0	4.0
16154		-471.0	none	none	none	none	none	none	none	-499.0	28.0	0.0	0.0	0.0	0.0	0.0
16190		199.0	none	none	none	none	none	none	none	177.0	22.0	0.0	0.0	0.0	0.0	0.0
16197		198.0	none	none	none	none	none	none	none	176.0	22.0	0.0	0.0	0.0	0.0	0.0

Appendix D continues

API Well Identification	Alternative Well ID	Syracuse Fm Unit D	ELEVATION D-4 Salt top	D-4 Salt base	D-3 Salt top	D-3 Salt base	D-2 Salt top	D-2 Salt base	D-1 Salt top	D-1 Salt base	THICKNESS Unit D	D-4 Salt	D-3 Salt	D-2 Salt	D-1 Salt	Unit D Salt
16199		205.0	none	none	none	none	none	none	none	183.0	22.0	0.0	0.0	0.0	0.0	0.0
17300		182.0	none	none	none	none	none	none	none	158.0	24.0	0.0	0.0	0.0	0.0	0.0
17301		218.0	none	none	none	none	none	none	none	194.0	24.0	0.0	0.0	0.0	0.0	0.0
17304		166.0	none	none	none	none	none	none	none	145.0	21.0	0.0	0.0	0.0	0.0	0.0
17305		157.0	none	none	none	none	none	none	none	134.0	23.0	0.0	0.0	0.0	0.0	0.0
17306		128.0	none	none	none	none	none	none	none	108.0	20.0	0.0	0.0	0.0	0.0	0.0
17307		131.0	none	none	none	none	none	none	none	109.5	21.5	0.0	0.0	0.0	0.0	0.0
17309		123.0	none	none	none	none	none	none	none	101.0	22.0	0.0	0.0	0.0	0.0	0.0
17310		145.0	none	none	none	none	none	none	none	121.0	24.0	0.0	0.0	0.0	0.0	0.0
17336		-8.5	none	none	none	none	none	none	none	-35.5	27.0	0.0	0.0	0.0	0.0	0.0
17337		18.0	none	none	none	none	none	none	none	-8.0	26.0	0.0	0.0	0.0	0.0	0.0
17353		218.0	none	none	none	none	none	none	none	195.0	23.0	0.0	0.0	0.0	0.0	0.0
17354		223.0	none	none	none	none	none	none	none	200.0	23.0	0.0	0.0	0.0	0.0	0.0
17357		189.0	none	none	none	none	none	none	none	166.0	23.0	0.0	0.0	0.0	0.0	0.0
17358		149.0	none	none	none	none	none	none	none	125.5	23.5	0.0	0.0	0.0	0.0	0.0
17368		120.0	none	none	none	none	none	none	none	97.0	23.0	0.0	0.0	0.0	0.0	0.0
17369		127.0	none	none	none	none	none	none	none	105.0	22.0	0.0	0.0	0.0	0.0	0.0
17371		112.0	none	none	none	none	none	none	none	91.0	21.0	0.0	0.0	0.0	0.0	0.0
17372		124.0	none	none	none	none	none	none	none	100.0	24.0	0.0	0.0	0.0	0.0	0.0
17373		82.0	none	none	none	none	none	none	none	59.5	22.5	0.0	0.0	0.0	0.0	0.0
17375		115.5	none	none	none	none	none	none	none	92.5	23.0	0.0	0.0	0.0	0.0	0.0
17377		90.0	none	none	none	none	none	none	none	66.0	24.0	0.0	0.0	0.0	0.0	0.0
17392		78.0	none	none	none	none	none	none	none	51.0	27.0	0.0	0.0	0.0	0.0	0.0
17399		109.0	none	none	none	none	none	none	none	88.0	21.0	0.0	0.0	0.0	0.0	0.0
17400		76.5	none	none	none	none	none	none	none	55.0	21.5	0.0	0.0	0.0	0.0	0.0
17403		194.0	none	none	none	none	none	none	none	172.0	22.0	0.0	0.0	0.0	0.0	0.0
17404		182.0	none	none	none	none	none	none	none	155.0	27.0	0.0	0.0	0.0	0.0	0.0
17405		102.0	none	none	none	none	none	none	none	80.0	22.0	0.0	0.0	0.0	0.0	0.0
17406		219.0	none	none	none	none	none	none	none	196.0	23.0	0.0	0.0	0.0	0.0	0.0
17408		103.0	none	none	none	none	none	none	none	77.0	26.0	0.0	0.0	0.0	0.0	0.0
17409		98.0	none	none	none	none	none	none	none	70.0	28.0	0.0	0.0	0.0	0.0	0.0
17422		84.5	none	none	none	none	none	none	none	54.5	30.0	0.0	0.0	0.0	0.0	0.0
17424		109.0	none	none	none	none	none	none	none	86.0	23.0	0.0	0.0	0.0	0.0	0.0
17425		164.0	none	none	none	none	none	none	none	142.0	22.0	0.0	0.0	0.0	0.0	0.0
17426		102.5	none	none	none	none	none	none	none	73.0	29.5	0.0	0.0	0.0	0.0	0.0
17428		153.0	none	none	none	none	none	none	none	128.0	25.0	0.0	0.0	0.0	0.0	0.0
17429		60.0	none	none	none	none	none	none	none	38.0	22.0	0.0	0.0	0.0	0.0	0.0
17430		67.0	none	none	none	none	none	none	none	45.0	22.0	0.0	0.0	0.0	0.0	0.0
17432		27.0	none	none	none	none	none	none	none	-6.0	33.0	0.0	0.0	0.0	0.0	0.0
17433		122.0	none	none	none	none	none	none	none	98.0	24.0	0.0	0.0	0.0	0.0	0.0
17434		178.0	none	none	none	none	none	none	none	156.0	22.0	0.0	0.0	0.0	0.0	0.0
17435		-3.0	none	none	none	none	none	none	none	-26.0	23.0	0.0	0.0	0.0	0.0	0.0
17439		-60.0	none	none	none	none	none	none	none	-83.0	23.0	0.0	0.0	0.0	0.0	0.0
17445		89.5	none	none	none	none	none	none	none	65.5	24.0	0.0	0.0	0.0	0.0	0.0
17447		91.0	none	none	none	none	none	none	none	67.0	24.0	0.0	0.0	0.0	0.0	0.0
17452		209.0	none	none	none	none	none	none	none	185.0	24.0	0.0	0.0	0.0	0.0	0.0
17460		160.5	none	none	none	none	none	none	none	138.5	22.0	0.0	0.0	0.0	0.0	0.0
17461		93.5	none	none	none	none	none	none	none	71.0	22.5	0.0	0.0	0.0	0.0	0.0
17466		104.0	none	none	none	none	none	none	none	82.0	22.0	0.0	0.0	0.0	0.0	0.0
17467		121.5	none	none	none	none	none	none	none	99.0	22.5	0.0	0.0	0.0	0.0	0.0
17503		220.0	none	none	none	none	none	none	none	198.0	22.0	0.0	0.0	0.0	0.0	0.0
17518		153.0	none	none	none	none	none	none	none	132.0	21.0	0.0	0.0	0.0	0.0	0.0
17523		138.0	none	none	none	none	none	none	none	114.0	24.0	0.0	0.0	0.0	0.0	0.0
19408		132.0	none	none	none	none	none	none	none	108.0	24.0	0.0	0.0	0.0	0.0	0.0

API Well Identification	Alternative Well ID	ELEVATION Syracuse Fm Unit D	D-4 Salt top	D-4 Salt base	D-3 Salt top	D-3 Salt base	D-2 Salt top	D-2 Salt base	D-1 Salt top	D-1 Salt base	THICKNESS Unit D	D-4 Salt	D-3 Salt	D-2 Salt	D-1 Salt	Unit D Salt
19409		168.0	none	none	none	none	none	none	none	145.0	23.0	0.0	0.0	0.0	0.0	0.0
19413		-410.0	none	none	none	none	none	none	-432.5	-439.0	29.0	0.0	0.0	0.0	6.5	6.5
19416		-447.0	none	none	none	none	none	none	none	-470.0	23.0	0.0	0.0	0.0	0.0	0.0
19431		-66.0	none	none	none	none	none	none	none	-96.5	30.5	0.0	0.0	0.0	0.0	0.0
19438		-112.0	none	none	none	none	-129.0	-134.0	-141.0	-159.0	47.0	0.0	0.0	5.0	18.0	23.0
19609		23.0	none	none	none	none	none	none	none	-0.5	23.5	0.0	0.0	0.0	0.0	0.0
19610		-385.0	none	none	none	none	none	none	none	-407.0	22.0	0.0	0.0	0.0	0.0	0.0
19611		-405.0	none	none	none	none	none	none	none	-428.0	23.0	0.0	0.0	0.0	0.0	0.0
19612		-401.0	none	none	none	none	none	none	none	-424.0	23.0	0.0	0.0	0.0	0.0	0.0
19619		-480.0	none	none	none	none	none	none	none	-502.0	22.0	0.0	0.0	0.0	0.0	0.0
19633		-444.0	none	none	none	none	none	none	none	-467.5	23.5	0.0	0.0	0.0	0.0	0.0
19679		-357.0	none	none	none	none	none	none	none	-383.0	26.0	0.0	0.0	0.0	0.0	0.0
19685	ISCO 8601	-368.0	none	none	none	none	none	none	none	-396.0	28.0	0.0	0.0	0.0	0.0	0.0
20575		96.0	none	none	none	none	none	none	none	67.5	28.5	0.0	0.0	0.0	0.0	0.0
21406		-641.0	none	none	none	none	-658.0	-665.0	-669.0	-688.5	47.5	0.0	0.0	7.0	19.5	26.5
21508	Akzo 9401	-350.4	none	none	none	none	none	none	-374.4	-386.4	36.0	0.0	0.0	0.0	12.0	12.0
21513	Akzo 9402	-337.0	none	none	none	none	none	none	-357.9	-368.9	31.9	0.0	0.0	0.0	11.0	11.0
21514	Akzo 9411	-356.9	none	none	none	none	none	none	none	-382.4	25.5	0.0	0.0	0.0	0.0	0.0
21532	Akzo 9426	-357.4	none	none	none	none	none	none	none	-382.9	25.5	0.0	0.0	0.0	0.0	0.0
21533	Akzo 9427	-363.6	none	none	none	none	none	none	none	-390.6	27.0	0.0	0.0	0.0	0.0	0.0
21548	Akzo 9440	-174.8	none	none	none	none	none	none	none	-199.3	24.5	0.0	0.0	0.0	0.0	0.0
21555	Akzo 9444	-432.1	none	none	none	none	-450.4	-456.8	-463.7	-479.5	47.4	0.0	0.0	6.4	15.8	22.2
21557	Akzo 9443	-428.4	none	none	none	none	-445.9	-456.9	-463.9	-478.7	50.3	0.0	0.0	11.0	14.8	25.8
21558	Akzo 9442	-436.1	none	none	none	none	-453.5	-465.2	-473.0	-488.0	51.9	0.0	0.0	11.7	15.0	26.7
21559	Akzo 9441	-413.4	none	none	none	none	-428.0	-430.5	-438.7	-448.8	35.4	0.0	0.0	2.5	10.1	12.6
21571	Akzo 9452	-451.2	none	none	none	none	-469.5	-480.6	-487.9	-503.8	52.6	0.0	0.0	9.3**	15.9	25.2
21572	Akzo 9453	-402.4	none	none	none	none	-421.0	-429.4	-437.8	-452.5	50.1	0.0	0.0	8.4	14.7	23.1
21573	Akzo 9459	-432.8	none	none	none	none	-451.5	-466.4	-474.4	-487.6	54.8	0.0	0.0	14.9	13.2	28.1
21574	Akzo 9454	-404.8	none	none	none	none	-423.2	-436.4	-444.2	-459.7	54.9	0.0	0.0	13.2	15.5	28.7
21575	Akzo 9455	-455.3	none	none	none	none	-474.5	-499.2	-507.2	-523.7	68.4	0.0	0.0	24.7	16.5	41.2
21576	Akzo 9456	-506.3	none	none	none	none	-524.0	-553.0	-559.8	-576.5	70.2	0.0	0.0	29.0	16.7	45.7
21577	Akzo 9457	-486.8	none	none	none	none	-505.6	-517.6	-525.2	-541.9	55.1	0.0	0.0	12.0	16.7	28.7
21578	Akzo 9458	-450.1	none	none	none	none	-468.0	-475.3	-483.2	-498.7	48.6	0.0	0.0	7.3	15.5	22.8
none	ISCO 6702	-544.0	none	none	none	none	-561.0	-586.0	-594.0	-609.0	65.0	0.0	0.0	25.0	15.0	40.0

** The D-2 salt unit in borehole 21571 is actually 2 separate units. There is no salt between 473.5' bmsl and 475.3' bmsl.