

GEOLOGY OF THE MISSOURI VALLEY FILL  
AT  
ELK POINT, SOUTH DAKOTA

SOUTH DAKOTA GEOLOGICAL SURVEY  
VERMILLION, SOUTH DAKOTA

OCTOBER, 1956

SOUTH DAKOTA  
STATE GEOLOGICAL SURVEY  
STATE UNIVERSITY  
VERMILLION

OCTOBER 17, 1956

HIS HONOR THE MAYOR AND THE CITY COUNCIL  
ELK POINT, SOUTH DAKOTA

GENTLEMEN:

FOLLOWING YOUR REQUEST OF SEPTEMBER 20TH FOR HELP IN DETERMINING THE SUBSOIL CONDITIONS WHICH MAY HAVE BEEN EFFECTIVE IN CAUSING THE SETTLING OF BUILDINGS IN ELK POINT, I OBTAINED THE PERMISSION OF GOVERNOR FOSS AND SPENT SEVERAL DAYS EXAMINING THE SITUATION. TWO GEOLOGISTS FROM THE STATE SURVEY, MESSRS. M. J. TIPTON AND DR. K. Y. LEE, DRILLED A SET OF TEST HOLES AROUND THE SCHOOL AND ONE NEAR ST. JOSEPH'S CHURCH.

ALL THESE HOLES SHOWED THE SAME SUBSURFACE CONDITIONS AND GAVE AN ADEQUATE PICTURE OF THE SUBSOIL WHICH WILL BE INVOLVED IN ANY ATTEMPT TO RECTIFY THE TROUBLE.

THE HOLES AT THE SCHOOL AND CHURCH SHOWED 27 TO 28 FEET OF VERY SLIPPERY, GREASY CLAY UNDERLYING THE SURFACE. THE SOIL AND UNDERLYING CLAY WAS DRY FROM 4 TO 9 FEET AND AT DEPTHS OF 14 FEET THE CLAY WAS SATURATED WITH WATER AND VERY SLIPPERY IN ALL THE HOLES DRILLED. THIS CONDITION CONTINUED TO 27 OR 28 FEET BELOW THE SURFACE AT WHICH DEPTH IT CHANGED ABRUPTLY TO QUICKSAND TO A VERY FINE GRAINED AND VERY WET QUICKSAND.

AT BOTH THE SCHOOL AND THE CHURCH THE QUICKSAND BED CONTINUED TO A DEPTH OF 44 FEET. BELOW THIS DEPTH THERE LAY A SLIGHTLY COARSER SAND WHICH IS CLASSIFIED AT FINE TO MEDIUM GRAINED TO A DEPTH OF 69 FEET. BELOW 69 FEET LIES A STILL COARSER SAND, WHICH IS CLASSIFIED AS MEDIUM GRAIN-SIZE, GRADES INTO A COARSE SAND AND GRAVEL WHICH WAS FIRST ENCOUNTERED AT ABOUT 80 FEET. THE DEEPEST HOLE PENETRATED THE GRAVEL FOR 9 FEET BEFORE IT WAS IMPOSSIBLE TO DRILL FARTHER WITH THE EQUIPMENT AVAILABLE.

A SIMILAR GRAVEL WAS REPORTED LYING ON A SHALE BEDROCK IN AN OLD CITY WELL AND IT IS PROBABLE THAT IF OUR EQUIPMENT COULD HAVE DRILLED A LITTLE FARTHER WE WOULD HAVE ENCOUNTERED THE SAME SHALE BEDROCK AT ABOUT 100 FEET.

THE CAUSE OF THE SETTLING APPEARS TO BE THE INSTABILITY OF THE GREASY CLAY AND QUICKSAND WHICH MAKE UP THE UPPER 44 FEET OF THE SECTION BENEATH THIS END OF TOWN. SUCH MATERIALS WILL NOT SUPPORT A HEAVY WEIGHT WELL, ESPECIALLY WHEN IT HAS TO BE BORNE ON AS SMALL AN AREA AS THE FOOTINGS USUALLY PLACED ON SUCH BUILDINGS. THE

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PRESENT SETTLING APPEARS TO BE AN AGGRAVATED CASE OF SETTLING WHICH HAS OCCURRED IN THE PAST AND THE REASON WHY IT SHOULD BE AGGRAVATED AT THIS PARTICULAR TIME IS SOMEWHAT A MATTER OF CONJECTURE SINCE ACCURATE RECORDS ON WATER TABLES AND FORMER SETTLEMENTS ARE MISSING. A TRIGGER OF SOME SORT IS PROBABLY RESPONSIBLE. SUCH A TRIGGER MIGHT BE A COMPACTION DUE TO THE LOWERING OF THE WATER TABLE; AN UNUSUAL SOAKING OF A SECTION OF FOUNDATION AS BY A BROKEN WATER MAIN OR SEWER; OR THE RESULT OF UNUSUAL SUSTAINED VIBRATIONS SET UP BY SUCH THINGS AS THE OPERATION OF LARGE PUMPS OR LARGE STATIONARY ENGINES. IT IS PROBABLY A RESULT OF A COMBINATION OF CIRCUMSTANCES NO ONE OF WHICH CAN BE BLAMED FOR THE FAILURE.

A LINE OF LEVELS, RUN FROM THE WELLS AT THE SCHOOL TO THE MISSOURI RIVER, SHOWED THAT THE GROUND WATER LEVEL IN TOWN WAS IN THE NEIGHBORHOOD OF 1118 FEET SEA LEVEL WHILE THE SURFACE OF THE WATER IN THE RIVER CHANNEL WAS AT 1108 FEET, A DROP OF 10 FEET IN A DISTANCE OF A MILE. THIS IS TOO LOW A GRADIENT TO MAKE A LARGE FLUCTUATION IN THE WATER LEVEL BENEATH ELK POINT IN THE SHORT PERIODS OF SEASONAL FLUCTUATION FOUND IN THE RIVER'S FLOW. THERE PROBABLY HAS BEEN SOME LOWERING OF THE WATER TABLE DUE TO LACK OF RAIN DURING THE PAST YEAR BUT AS NO RECORDS HAVE BEEN KEPT IN OR NEAR THE CITY IT IS IMPOSSIBLE TO SAY HOW MUCH. MOST OF THE TESTS SHOWED MOISTURE 2 TO 3 FEET BELOW THE BOTTOM OF THE FOOTINGS. IF THE WATER LEVEL HAS BEEN AT THE FOOTING LEVEL AND THE SATURATION DRIED OUT IT WOULD ALLOW ENOUGH COMPACTION TO CAUSE SOME OF THE EFFECTS THAT ARE NOW NOTICEABLE, AS STATED ABOVE, HOWEVER, SUCH DRYING COULD NOT BE DUE TO THE SEASONAL FLUCTUATIONS IN RIVER LEVELS A MILE OR MORE AWAY.

WHATEVER THE TRIGGER MAY HAVE BEEN, THE PRESENCE OF SUCH THICKNESSES OF WATER SOAKED, PLASTIC, GREASY CLAY AND VERY MOBILE QUICK-SAND BENEATH IT INDICATE THAT UNUSUAL CONSTRUCTION IS NECESSARY FOR HEAVY BUILDINGS IF SUCH TROUBLES ARE TO BE AVOIDED IN THE FUTURE. THE BEDROCK WHICH OFFERS THE SUREST FOUNDATION IS SOME 100 FEET BELOW THE SURFACE. PILING TO BE EFFECTIVE WOULD HAVE TO REST IN THIS BEDROCK SHALE. PART OR ALL OF THE TROUBLE COULD ALSO BE AVOIDED BY PLACING THE BUILDINGS ON UNUSUALLY WIDE FOOTINGS OR SOME SORT OF MAT OR PLATFORMS RIGID ENOUGH TO "FLOAT" THEM ON THE UNSTABLE CLAY BENEATH. ANY CONSTRUCTION THAT IS USED MUST BE BASED ON ONE OF THESE TWO PRINCIPLES.

HOPING THIS INFORMATION WILL BE OF ASSISTANCE TO YOU AND THE ENGINEERS AND ARCHITECTS INVOLVED IN CONSTRUCTION IN ELK POINT,  
1 AM

YOURS VERY TRULY,

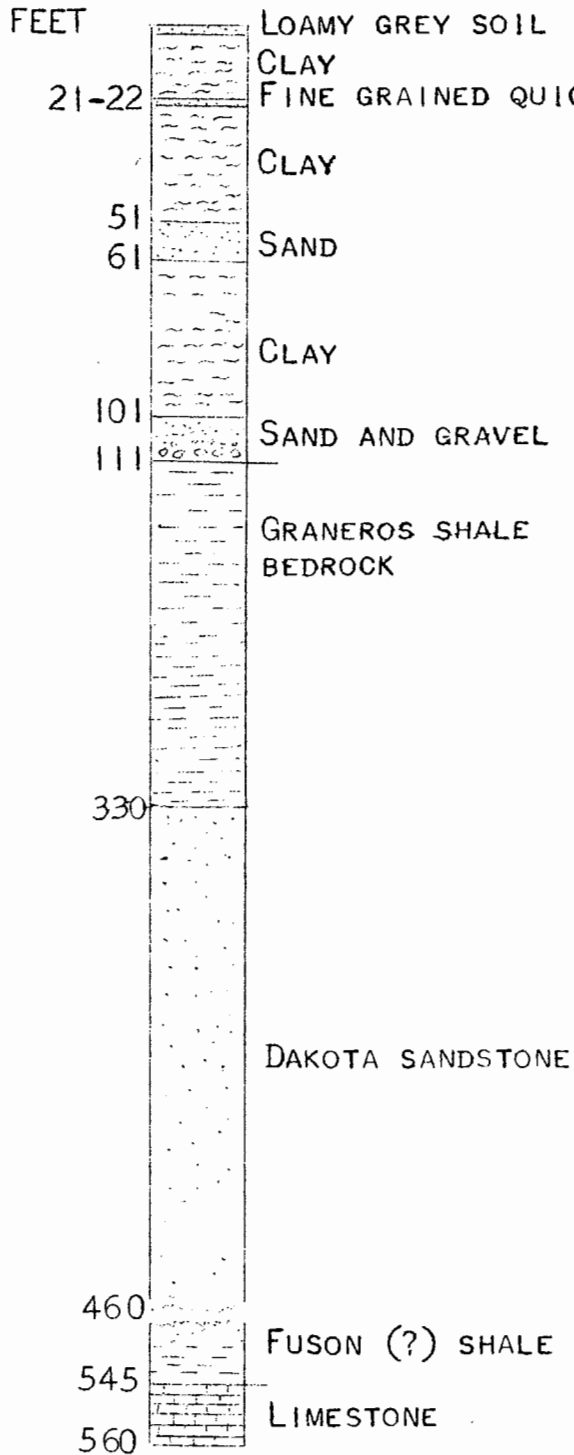


E. P. ROTHROCK  
STATE GEOLOGIST

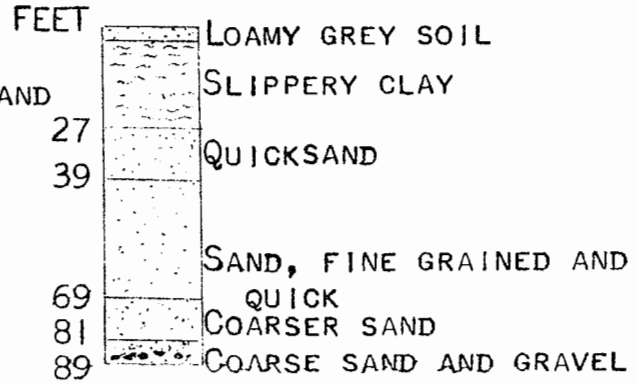
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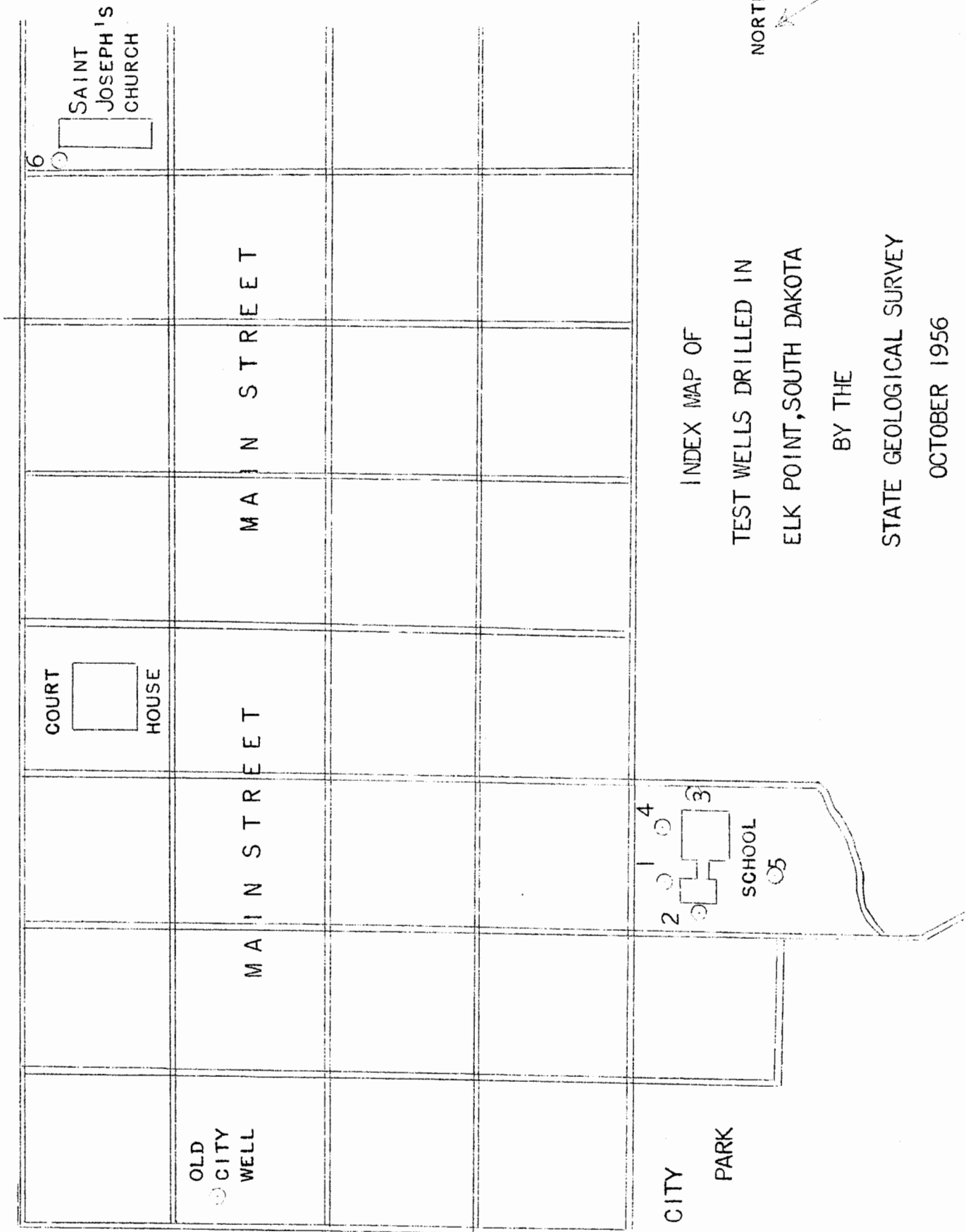
# GRAPHIC LOGS OF DRILLINGS IN ELK POINT

## OLD CITY WATER WELL



## TEST HOLE #4 AT CITY SCHOOL





INDEX MAP OF  
 TEST WELLS DRILLED IN  
 ELK POINT, SOUTH DAKOTA  
 BY THE  
 STATE GEOLOGICAL SURVEY  
 OCTOBER 1956

NORTH  
 SOUTH

## DRILLER'S LOG

LOCATION PUBLIC SCHOOL  
CITY OF ELK POINT  
 COUNTY UNION ALTITUDE 1127.14'  
 DEPTH TO WATER 27 FEET

DRILL HOLE NUMBER 1  
 DATE SEPTEMBER 26, 1956  
 DRILLER TIPTON AND LEE

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY AND SILTY
9	14	CLAY, BLACKISH GRAY, SILTY AND COMPACT
14	19	CLAY, BLACK, MOIST; WITH SOME GRANULES
19	24	CLAY, YELLOW GRAY TO BLACKISH GRAY, VERY MOIST NEAR THE BASE
24	29	CLAY, BLuish GRAY TO BLACK, VERY MOIST; ENCOUNTERING SILT AND FINE-GRAINED SAND-"QUICKSAND" AT 27' WITH WATER
29	34	SILT AND FINE-GRAINED SAND, WITH WATER
34	39	SAND AND SILT, WITH WATER
39	44	SAND, CHIEFLY FINE-GRAINED, WITH WATER
44	49	SAND, CHIEFLY FINE-GRAINED, WITH WATER; GRADING INTO MEDIUM-GRAINED NEAR THE BASE
49	54	SAND, MEDIUM-GRAINED, WITH WATER
54	59	SAND, MEDIUM-GRAINED, SOMEWHAT FINE-GRAINED NEAR THE BASE
59	64	SAND, FINE-TO MEDIUM-GRAINED; WITH WATER

## DRILLER'S LOG

LOCATION PUBLIC SCHOOL DRILL HOLE NUMBER 2  
CITY OF ELK POINT DATE SEPTEMBER 26, 1956  
 COUNTY UNION ALTITUDE 1125.94' DRILLER TIPTON AND LEE  
 DEPTH TO WATER 29 FEET

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY AND SILTY
9	14	CLAY, BLACKISH GRAY AND RATHER MOIST
14	19	CLAY, BLACKISH GRAY, STICKY AND MOIST
19	24	CLAY, BLACKISH GRAY, VERY MOIST AND STICKY
24	29	CLAY, BLUISH GRAY, AND VERY MOIST; EASY DRILLING AT ABOUT 27 FEET
29	34	CLAY, BLUISH GRAY AND VERY MOIST; ENCOUNTERED SILT AND FINE-GRAINED SAND-"QUICKSAND" AT ABOUT 29 FEET; WITH WATER

## DRILLER'S LOG

LOCATION PUBLIC SCHOOL  
CITY OF ELK POINT  
 COUNTY UNION ALTITUDE 1126.98'  
 DEPTH TO WATER 28 FEET

DRILL HOLE NUMBER 3  
 DATE SEPTEMBER 27, 1956  
 DRILLER TIPTON AND LEE

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY AND SILTY
9	14	CLAY, BLACKISH GRAY AND RATHER MOIST
14	19	CLAY, BLACKISH GRAY AND VERY MOIST
19	24	CLAY, MEDIUM GRAY, AND VERY MOIST
24	29	CLAY, BLUISH GRAY TO GRAY AND VERY MOIST; ENCOUNTERED SILT AND SAND-"QUICKSAND" WITH WATER AT 28 FEET



## DRILLER'S LOG

LOCATION <u>PUBLIC SCHOOL</u>	DRILL HOLE NUMBER <u>4</u>
CITY OF <u>ELK POINT</u>	DATE <u>SEPTEMBER 28, 1956</u>
COUNTY <u>UNION</u> ALTITUDE <u>1127.74'</u>	DRILLER <u>TIPTON AND LEE</u>
DEPTH TO WATER <u>27 FEET</u>	

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY AND SILTY
9	14	CLAY, BLACKISH GRAY AND MOIST
14	19	CLAY, BLACK AND VERY MOIST
19	24	CLAY, MEDIUM GRAY AND VERY MOIST
24	29	CLAY, BLUISH GRAY TO GRAY, AND VERY MOIST; ENCOUNTERING SILT AND FINE-GRAINED SAND-"QUICKSAND" WITH WATER AT 27'
29	34	SAND, VERY FINE-GRAINED; WITH SILT AND WATER
34	39	SAND, VERY FINE-GRAINED; ENCOUNTERING ONE FOOT GRAY, SILTY CLAY AT 35'
39	44	SAND, FINE-TO MEDIUM-GRAINED WITH WATER
44	49	SAND, SAME AS THE SAMPLE, 39-44
49	54	SAND, FINE-TO MEDIUM-GRAINED; WITH A CONSIDERABLE AMOUNT OF WATER
54	59	SAND, SAME AS THE SAMPLE, 49-54
59	64	SAND, SAME AS THE SAMPLE, 49-54
64	69	SAND, SAME AS THE SAMPLE, 49-54
69	74	SAND, CHIEFLY MEDIUM-GRAINED; WITH THE MAIN WATER BODY
74	79	SAND, CHIEFLY MEDIUM-GRAINED; WITH WATER
79	84	SAND, CHIEFLY MEDIUM-GRAINED; GRADING DOWNWARD INTO COARSE-GRAINED SAND AND GRAVEL NEAR THE BASE; WITH WATER
84	89	SAND AND GRAVEL, COARSE-GRAINED SAND INTERCALATED WITH GRANULES AND PEBBLES. (TOOK THREE SAMPLES-A, B, & C BETWEEN 84-89)

## DRILLER'S LOG

LOCATION PUBLIC SCHOOL  
CITY OF ELK POINT  
 COUNTY UNION ALTITUDE 1125.24'  
 DEPTH TO WATER 27 FEET

DRILL HOLE NUMBER 5  
 DATE SEPTEMBER 28, 1956  
 DRILLER TIPTON AND LEE

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY AND RATHER MOIST
9	14	CLAY, BLACKISH GRAY AND MOIST; SPORADICALLY WITH GRANULES
14	19	CLAY, MEDIUM TO BLACKISH GRAY, VERY MOIST AND STICKY
19	24	CLAY, MEDIUM GRAY AND VERY MOIST AND STICKY
24	29	CLAY, BLuish GRAY, AND VERY MOIST; ENCOUNTERING VERY FINE-GRAINED SAND AND SILT-"QUICKSAND" WITH WATER AT 27'

## DRILLER'S LOG

LOCATION <u>PUBLIC SCHOOL</u>	DRILL HOLE NUMBER <u>6</u>
CITY OF <u>ELK POINT</u>	DATE <u>SEPTEMBER 28, 1956</u>
COUNTY <u>UNION</u> ALTITUDE <u>1125.84'</u>	DRILLER <u>TIPTON AND LEE</u>
DEPTH TO WATER <u>27 FEET</u>	

DEPTH		LITHOLOGIC DESCRIPTION
FROM	To	
0	4	SOIL, LOAMY AND GRAY
4	9	CLAY, BLACKISH GRAY, AND RATHER MOIST
9	14	CLAY, MEDIUM TO BLACKISH GRAY, AND MOIST
14	19	CLAY, BLACKISH GRAY, AND VERY MOIST
19	24	CLAY, MEDIUM GRAY TO BLUISH GRAY AND VERY MOIST
24	29	CLAY, GRAY TO BLUISH GRAY AND VERY MOIST; ENCOUNTERING VERY FINE-GRAINED SAND -"QUICKSAND" WITH WATER AT 27'. SAND, FINE-GRAINED; WITH A CONSIDERABLE AMOUNT OF WATER

## ELK POINT CITY WELL

LOCATION CITY OF ELK POINT      REMARKS UNITED STATES GEOLOGICAL  
 COUNTY UNION    ALTITUDE 1125      SURVEY WATER SUPPLY PAPER 227

DEPTH		LITHOLOGIC DESCRIPTION
FROM	TO	
0	20	LOAMY CLAY
20	21	QUICKSAND AND GOOD WATER
21	51	CLAY
51	61	SAND, IRONY WATER
61	101	CLAY
101	111	SAND AND GRAVEL (WATER)
111	115	SHALE (GRANEROS)
115	330	SHALE AND SANDSTONE
330	460	SANDSTONE
460	545	SHALE, SOME SAND
545	560	HARD WHITE ROCK (LIMESTONE?)

THE DAKOTA SANDSTONE PROBABLY EXTENDS TO  
 ABOUT 200 TO 545 FEET IN THIS WELL.