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A-E QUALITY CONTROL SUMMARY REPORT FOR AQUIFER TESTS

AT THE

NAVAL INDUSTRIAL RESERVE ORDNANCE PLANT
FRIDLEY, MINNESOTA

AUGUST 1988

CONTRACT NO. DACA45-86-C-0015
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EXECUTIVE SUMMARY

RMT, Inc., (RMT) was retained by the Omaha District of the U.S. Army Corps of Engineers (USACE) in June 1986 to conduct the Remedial Investigation/Feasibility Study (RI/FS) for the Naval Industrial Reserve Ordnance Plant (NIROP) located in Fridley, Minnesota.

Ground water contamination at the NIROP was detected in 1981, and trichloroethylene was identified as the main contaminant of concern. Past disposal practices at the NIROP were initially thought to be the principal cause of contamination, and site investigations and remedial action were initiated by the USACE in 1983. This action included excavation of buried drums of waste, installation of monitoring wells, water quality analysis, and other investigative techniques intended to define the extent and magnitude of contamination. Results have indicated that multiple sources of contamination may exist, both on-site and off-site. Investigations have continued under the present contract to further define the problem and provide information for the evaluation of remedial alternatives.

This report summarizes aquifer tests conducted at the NIROP during January and February 1988. It is one of three Quality Control Summary Reports required by the USACE for recent field activities undertaken by RMT. The other two Quality Control Summary Reports summarize soil gas survey results (RMT, 1988a) and well installation and sampling activities (RMT, In Preparation.) These reports include the following information:

- Summary of field activities and data collection procedures.
- Summary of data analysis procedures and presentation of results.

- Documentation of QA/QC activities.

- Evaluation of the reliability and utility of data for preparing addendums to the Remedial Investigation and Feasibility Study reports.

Aquifer tests consisted of in-situ permeability tests (single-well response tests) on ten (10) ground water monitoring wells, and a pumping test at production well AT-2. In-situ permeability tests provided localized estimates of hydraulic conductivity. The pumping test yielded estimates of transmissivity, storativity, and boundary conditions of the unconfined aquifer near the pumping well. This information will supplement existing information on NIROP hydrogeology, and will provide preliminary design parameters for remedial alternatives under consideration.

Analysis of in-situ permeability test results indicated that hydraulic conductivities ranged from 1 to 543 ft/day in the unconsolidated aquifer, and that the conductivity range was independent of depth. These conductivities are representative of silty sands, clean sands, and gravelly sands. Hydraulic conductivity for a bedrock well (5-PC) was calculated at more than 113 ft/day.

Analysis of pumping test results provided the following information on the unconfined, unconsolidated aquifer near pumping well AT-2:

- Transmissivity is approximately 62,000 gpd/ft, and storativity is approximately 0.13 in the vicinity of well AT-2. These estimates cannot be reliably applied to the sand aquifer region south of AT-2 because of the possibility for dissimilar hydraulic properties.

- Estimates of transmissivity from wells more distant to the pumping well AT-2 ranged from 41,000 gpd/ft to 88,000 gpd/ft. Storativity ranged from 0.04 to 0.35.

- Barrier boundaries (less permeable soils) were indicated approximately 75 feet northeast of well 24-S and 150 feet southwest of well 17-S.

- The aquifer appears to be heterogeneous in the vicinity of well AT-2, based on calculated transmissivities.

- A clay lens, 28 feet below the water table, may act as a confining layer in the vicinity of the pumping test, reducing the unconfined aquifer thickness in this region compared to other locations at the NIROP. Hydraulic properties determined through this pumping test are representative of the aquifer above this clay lens, and may not be representative of the approximate 100-foot-thick homogeneous sand unit south of the NIROP.

- The radius of influence along a northwest alignment was estimated at 1,400 feet at the conclusion of the 3-day pumping period.

RMT recommends that information gained from these aquifer tests be used in subsequent analyses and in the selection and preliminary design of a remedial alternative, as appropriate.

Additional pumping tests are recommended for the sand aquifer south of AT-2 and for the confined aquifer beneath the clay lens at AT-2, if ground water extraction is included in the selected remedial alternative, because of the possibility for dissimilar hydraulic properties. These pumping tests could be conducted during a pilot study phase prior to or during remedial design.

1. INTRODUCTION

1.1 Project Description and Background

RMT, Inc., (RMT) was retained by the Omaha District of the U.S. Army Corps of Engineers (USACE) in June 1986 to conduct the Remedial Investigation/Feasibility Study (RI/FS) for the Naval Industrial Reserve Ordnance Plant (NIROP) located in Fridley, Minnesota. This project is conducted under the Navy Installation Restoration Program (IRP), under Modification No. P00003 to Contract No. DACA45-86-C-0015.

The NIROP is a government-owned, contractor-operated facility. The plant is operated by the Northern Ordnance Division of FMC Corporation. The NIROP manufactures advanced naval weapons systems. The plant is located in the northern portion of the Minneapolis/St. Paul, Minnesota metropolitan area within the city limits of Fridley, Minnesota (Figure 1-1). It is situated approximately one-half mile east of the Mississippi River and less than one mile south of Interstate 694. The facility is bordered on the west by East River Road and on the east by the Burlington Northern rail yard. The government-owned, contractor-operated portion of the plant occupies about 83 acres. The plant is located in an industrial area which has a number of adjacent manufacturing facilities.

In previous years, the storage yard in the northern quarter of the site had been used for the disposal of drummed waste by burial in 8- to 10-foot-deep trenches or in pits. The materials disposed were thought to include waste oil, plating sludge, paint sludge, cleaning solvents, and degreasing solvents, which may have contained hazardous substances

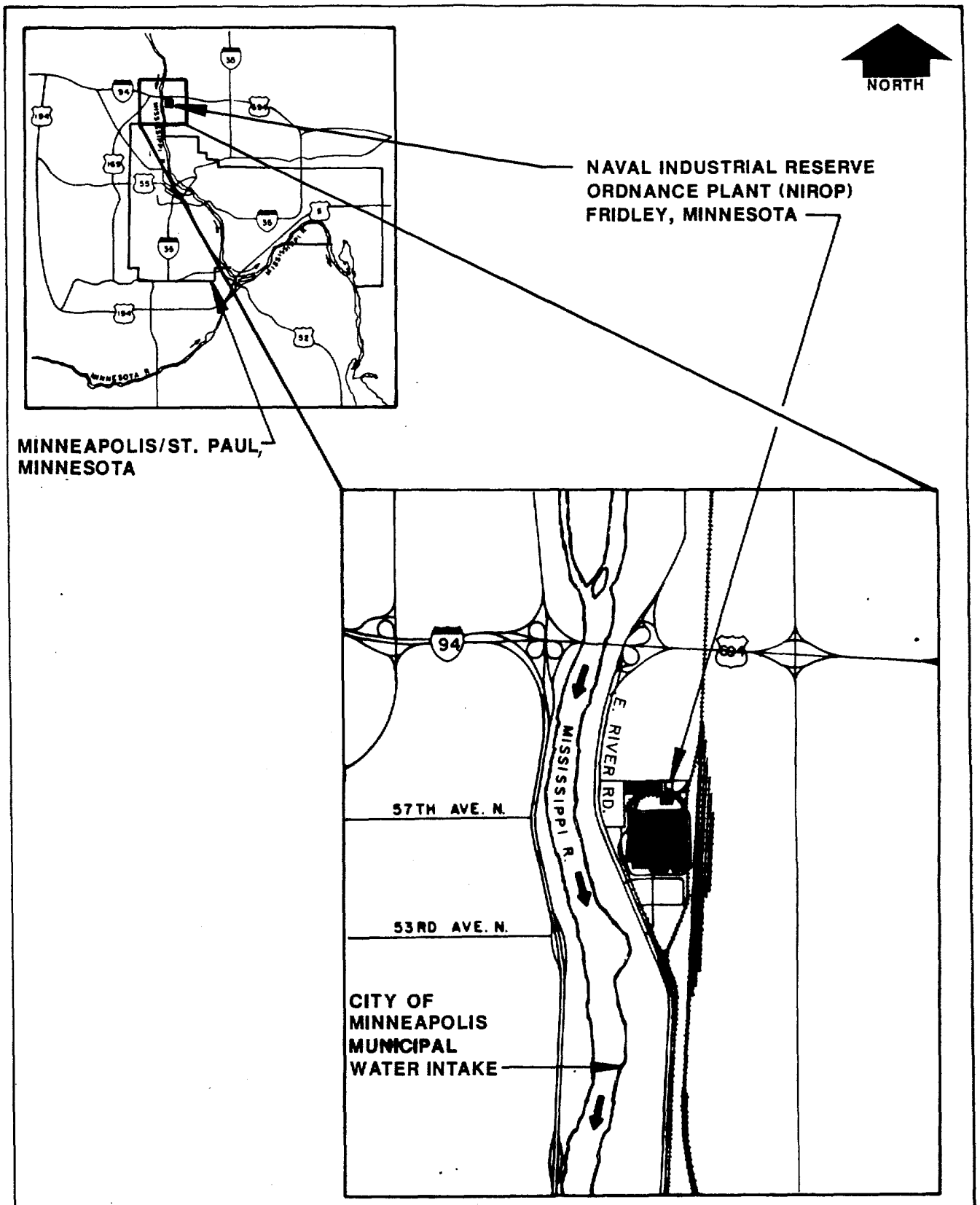

FIGURE 1-1
GENERAL VICINITIES MAP

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such as cyanide, trichloroethylene (TCE), methyl ethyl ketone (MEK), and 1,1,1-trichloroethane (RMT, 1987a). Ground water contamination was initially detected in 1981 in a production well at the NIROP. The main ground water contaminant identified was trichloroethylene.

Fourteen (14) monitoring wells were installed by the USACE at the NIROP between May and August 1983. Initial remedial action in the north storage yard area began in November 1983. Nine areas were excavated, and 43 drums and approximately 1,200 cubic yards of soil were removed. The majority of the drums contained inert solids; others contained PCB wastes, flammable solids, base solids, and inert liquids; and some were empty. The hazardous soils and drums were disposed in an EPA-approved landfill. Soil samples were subsequently taken from the bottom of the excavations and analyzed for volatile organics. Two trenches showed total VOCs above one part per million. No further testing was done at that time. The trenches were backfilled with clean fill, and removal activities were completed in March 1984. However, ground water VOC contaminant concentrations have remained above desirable levels despite the excavation and removal of drums and soil from the trenches.

Seven (7) additional on-site monitoring wells were installed by the USACE in May and June 1985, and installation of twelve (12) off-site monitoring wells was completed by the USACE in February 1986. The purpose of these wells was to provide additional information on ground water flow directions, the general extent of ground water contamination, and concentrations of contaminants. Water level measurements and samples have been collected from these wells on an intermittent basis through February 1988. Results have indicated that multiple sources of contamination may exist, both on-site and off-site.

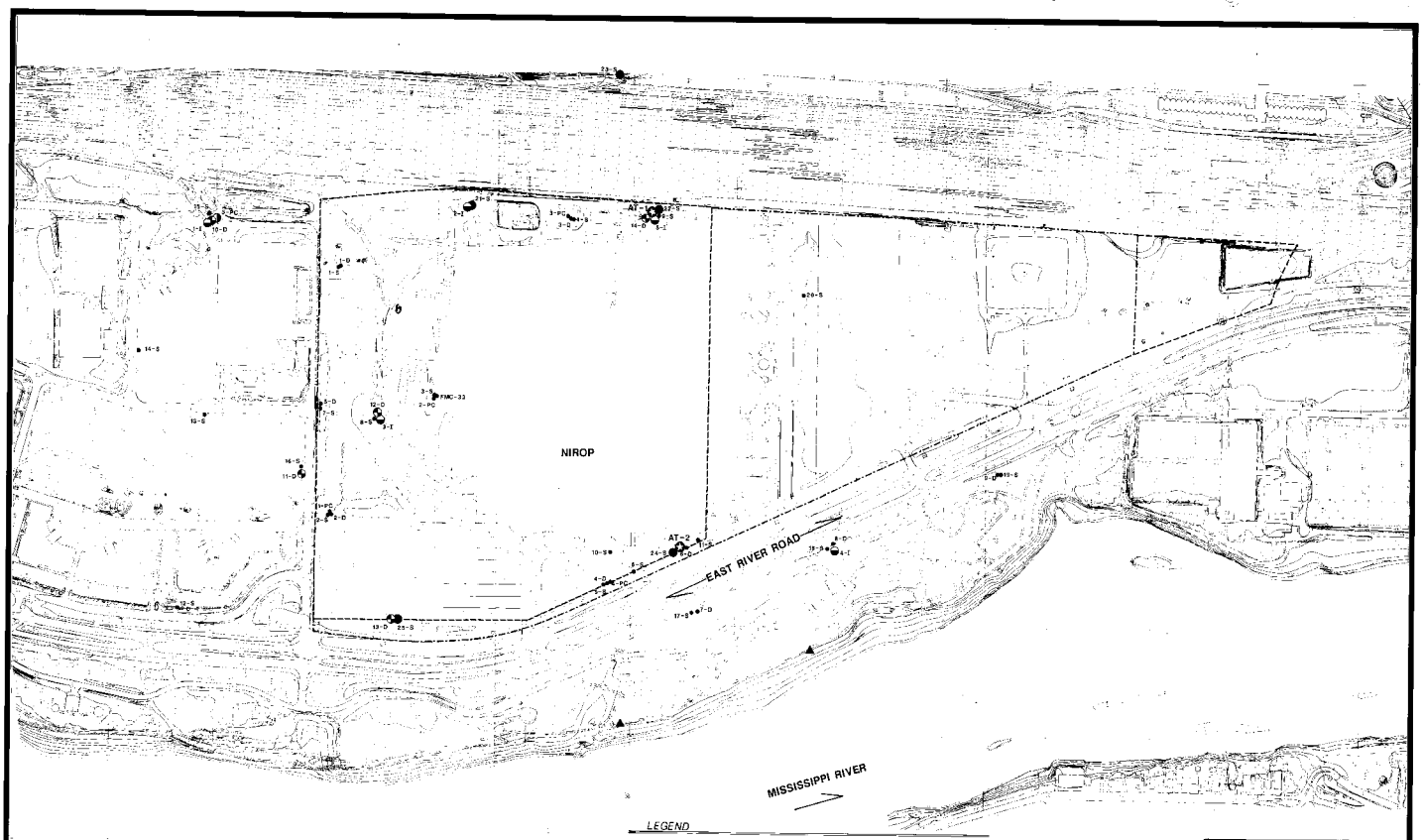
Investigations have continued under the present contract to further define the extent and source(s) of contamination, and to provide information for the development and evaluation of remedial alternatives. Soil pore-gas sampling was conducted in November 1987 to assist in this effort (RMT, 1988a), and to guide the placement of additional monitoring wells. Sixteen (16) additional monitoring wells were installed by RMT on and adjacent to NIROP property between November 1987 and February 1988 (RMT, In Preparation). Two (2) large-diameter pumping wells were also installed, one for identifying aquifer characteristics for potential design of a ground water extraction and treatment system, and the other for evaluating the likelihood of off-site contamination sources. Water quality samples were collected and analyzed from monitoring wells and storm sewers.

1.2 Purpose and Scope

The purpose of this report is to summarize aquifer tests conducted at the NIROP during January and February 1988. Tests consisted of *in-situ* permeability tests (single-well response tests) on ten (10) ground water monitoring wells, and a 72-hour pumping test at production well AT-2 (Figure 1-2). These tests were conducted in order to develop site-specific estimates of aquifer hydraulic properties that can be used later in the selection and design of a remedial alternative.

This report is one of three Quality Control Summary Reports (QCSRs) required by the USACE. The other two QCSRs are as follows:

- A-E Quality Control Summary Report for the Soil Gas Survey (RMT, 1988a)



LEGEND

- WATER TABLE OBSERVATION WELL IN UNCONSOLIDATED SEDIMENTS
- INTERMEDIATE DEPTH PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- DEEP PIEZOMETERS IN UNCONSOLIDATED SEDIMENTS
- BEDROCK PIEZOMETERS
- PRODUCTION WELLS
- STORM SEWER OUTFALL SAMPLING LOCATIONS
- NIROP APPROXIMATE PROPERTY LINE
- FMC APPROXIMATE PROPERTY LINE
- BNR APPROXIMATE PROPERTY LINE

SCALE: 1 = 200'
0 200 400 800 FEET

NO.	BY	DATE	REVISION	APP'D
A				
B				
C				

PROJECT: OCSR-AQUIFER TESTS
COE-NIROP FRIDLEY, MINNESOTA

SHEET TITLE: FIGURE 1-2
WELL LOCATION MAP

DRAWN BY: GGB | SCALE: 1"=200' | PROJ. NO. 1330.81
CHECKED BY: JJV | DRWG. NO.
APPROVED BY: | DATE PRINTED: AUG 1 1988 | SHEET OF
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- A-E Quality Control Summary Report for Well Installation and Sampling (RMT, In Preparation)

These other QCSRs describe additional field activities conducted by RMT at the NIROP from November 1987 through February 1988. This report includes the following information:

- Summary of field activities and data collection procedures.
- Summary of data analysis procedures and presentation of results.
- Documentation of QA/QC activities.
- Evaluation of the reliability and utility of data for use in preparing addendums to the Remedial Investigation and Feasibility Study reports.

Localized estimates of hydraulic conductivity at the NIROP were calculated from in-situ permeability tests. The pumping test yielded estimates of transmissivity, storativity, and boundary conditions of the unconfined aquifer near pumping well AT-2. Together, this information supplements existing information on NIROP hydrogeology.

This information will be incorporated into addendums to the Remedial Investigation and Feasibility Study reports, and for re-evaluation of the following remedial alternatives:

- No-action alternative.
- Extraction, treatment, and disposal of contaminated ground water.

Extraction and treatment of contaminated ground water was the preferred alternative identified in the draft Feasibility Study Report

prepared by RMT for reducing contaminant levels in ground water (RMT, 1987b). Hydraulic parameters determined through the pumping test will facilitate design of a ground water extraction system.

The no-action alternative relies upon natural percolation through contaminated soils, and ground water flow to flush out contaminants from the aquifer. In-situ permeability test results will be used to calculate ground water velocities and travel time, as well as radii of influence.

This report does not cover the bench-scale testing of discharge water from production well AT-2, which was collected during the aquifer pumping test. It also does not cover the TCE time-series pumping test at the AT-1 production well. The results of these tests are reported in the A-E Quality Control Summary Report for Well Installation and Sampling (RMT, In Preparation).

1.3 Report Organization

Discussion of the two types of aquifer tests (in-situ permeability and pumping test) is organized under separate sections in this report. Each section is further arranged to discuss:

- Data collection and analysis procedures.
- Quality control activities.
- Implementation problems and corrective actions.
- Data presentation.

Daily Quality Control Reports (DQCRs) were prepared during periods of field activity. These reports were typed in the field office and

sent electronically by computer modem to the RMT Madison, Wisconsin, office. The DQCRs are included in Appendix A for the period coincident to in-situ permeability and pumping test activities. Because this report incorporates information from the DQCRs, DQCRs are included for reference (Appendix A) but are not discussed or further summarized in this report.

2. FINDINGS AND CONCLUSIONS

2.1 In-situ Permeability Tests

Findings and conclusions from the in-situ permeability tests are as follows:

- Hydraulic conductivities ranged from 0.87 to at least 540 ft/day in the unconsolidated aquifer, and appeared to be independent of depth. Five shallow wells (15-S, 22-S, 23-S, 24-S, 25-S), two intermediate depth wells (1-I, 4-I), and two deep wells (10-D, 13-D) were tested (Figure 1-2).

- Hydraulic conductivity of a bedrock well (5-PC) was estimated to be more than 113 ft/day.

2.2 Pumping Test

Findings and conclusions derived from the pumping test at AT-2 are as follows:

- Transmissivity is approximately 62,000 gpd/ft and storativity is approximately 0.13 in the vicinity of well AT-2. Results are based on test data from well 24-S, located 30 feet from AT-2 (Figure 1-2). These estimates cannot be reliably applied to the more permeable sand aquifer region south of AT-2 because of the possibility for dissimilar hydraulic properties.

- Estimates of transmissivity from wells more distant to the pumping well AT-2 ranged from 41,000 gpd/ft to 88,000 gpd/ft. Storativity ranged from 0.04 to 0.35. The variability of these parameters suggests that the aquifer is heterogeneous.

- Barrier boundaries (less permeable soils) were indicated approximately 75 feet northeast of well 24-S and 150 feet southwest of well 17-S. The barrier to the northeast may be due to the pinching-out of a gravelly sand layer and the enlargement of a silty sand layer of soil. Boundary effects affected drawdown in well AT-2 after approximately 12 hours of pumping.

- A clay lens 28 feet below the water table (elevation 793.5 feet) may act as a confining layer in the vicinity of the pumping test, reducing the unconfined aquifer thickness in this region compared to other locations at the NIROP. Hydraulic properties determined through this pumping test are

representative of the aquifer above this clay lens, and may not be representative of the approximate 100-foot-thick homogeneous sand unit to the south.

- The radius of influence along the northwest alignment of wells 24-S, 6-S, and 5-S was estimated at 1,400 feet at the conclusion of the 3-day pumping test. Radius of influence estimates could not be made for other directions.

3. RECOMMENDATIONS

Recommendations resulting from in-situ permeability tests and the aquifer pumping test are as follows:

- Information obtained from these tests should be used to further characterize NIROP hydrogeology, and to provide preliminary design parameters for remediation alternatives. However, hydraulic parameters determined through the pumping test at AT-2 may not be representative of other regions that are geologically dissimilar, such as the homogeneous sand unit south of the NIROP.

- If in the future additional in-situ permeability testing is planned, where very permeable aquifer materials are anticipated during testing, test wells should be equipped with pressure transducers and automatic recorders. This would enable additional data points (for later analysis) to be gathered during the recovery period.

- An additional pump test in the homogeneous sandy soil to the south of AT-2 is recommended to evaluate aquifer properties in that region.

- If remediation is needed near well AT-2 at depths below the possible confining layer, an additional aquifer test will be required to assess aquifer properties and the potential impact of the confining layer on ground water flow.

  [The above two recommendations may be implemented during the pilot study phase of remedial design.]

4. IN-SITU PERMEABILITY TESTS

4.1 Procedures

This section summarizes data collection and analysis procedures for the in-situ permeability tests conducted on ten (10) NIROP monitoring wells. These procedures are described in the A-E Quality Control and Sampling Plan (A-E QCP) prepared by RMT prior to the start of field activities and finalized in January 1988 (RMT, 1988b).

In-situ permeability tests (single-well response tests) were conducted on wells 15-S, 22-S, 24-S, 25-S, 1-I, 4-I, 10-D, 13-D, and 5-PC (Figure 1-2). These tests required rapid removal of a predetermined volume of water from the well casing, and measurement of water level recovery with time.

Water level recovery data were plotted, and calculations of in-situ hydraulic conductivity were made, using a standard technique applicable to the site and well characteristics. The Bouwer and Rice method (Bouwer and Rice, 1976) was used for all wells except well 5-PC, where the Hvorslev method (Hvorslev, 1951) was used.

4.2 Quality Control Activities

The following quality control activities took place during in-situ permeability testing and data analysis:

- Water level indicators were calibrated following procedures outlined in the A-E QCP prior to obtaining measurements.
- All calculations and graphs were checked for accuracy and completeness.
- Where possible, calculated hydraulic conductivities were compared to borehole logs and grain-size analysis results [to be included in the QCSR for Well Installation and Sampling (RMT, In Preparation)], and to reference text values (Freeze and Cherry, 1979) to determine if results were reasonable.

4.3 Implementation Problems and Corrective Actions

Problems encountered during in-situ permeability testing and data analysis are listed below along with the corrective action.

Implementation Problem	Corrective Action
Very rapid recovery was experienced in 6 of the 10 wells after bail-down due to very permeable sandy material. This allowed only two water level measurements to be taken during the recovery period.	No corrective action was taken in the field. A lower limit was calculated for values of hydraulic conductivity during data analysis. Actual values likely exceeded this lower estimated value.

4.4 Data Presentation

In-situ permeability test results are shown in Table 4-1. The estimated permeability values range from 0.87 to greater than 540 ft/day. The range of values appear to be relatively independent of depth in the unconsolidated aquifer. Calculations for the values shown in Table 4-1 are included in Appendix C.

Absolute values could not be calculated for 6 of the 10 wells because of rapid recovery times (very permeable material). In these instances, a lower (conservative) limit was established for the estimate of hydraulic conductivity, by assuming that the first measurement of hydraulic head represented the minimum rate of recovery. This minimum recovery was then input into the appropriate analytical solutions (Hvorslev, 1951 or Bouwer & Rice, 1976) to determine a minimum hydraulic conductivity. This conservative approach means that later estimates of ground water velocity will tend to be on the low end of the possible range.

TABLE 4-1
IN-SITU PERMEABILITY TEST RESULTS

Well No.	Well Depth[4]	Hydraulic Conductivity[1],K ft/day	Method
15-S	35	> 78	B&R[2]
22-S	36	> 79	B&R
23-S	43	> 540	B&R
24-S	37	16	B&R
25-S	37	> 140	B&R
1-I	78	1.1	B&R
4-I	77	> 43	B&R
10-D	104	0.87	B&R
13-D	102	28	B&R
5-PC	193	> 110	Hvorslev[3]

[1]Values preceded by ">" are estimated minimum values. Actual values likely exceed these estimates, because the well recovery-rate was too rapid to measure following the protocols of the QCP (RMT, 1988b).

[2]Bouwer and Rice, 1976.

[3]Hvorslev, 1951.

[4]From top of well casing as installed.

Overall, the results are considered reliable estimates of hydraulic conductivity at a point in the aquifer. Although considerable variation is evident from Table 4-1, the results are consistent with materials encountered near the well screen, determined from borehole logs (Appendix B) and grain-size analysis of samples collected in the screened interval (RMT, In Preparation).

5. PUMPING TEST

5.1 Procedures

This section summarizes data collection and analysis procedures for the pumping test conducted at production well AT-2. The field procedure is described in greater detail in the A-E QCP (RMT, 1988b).

A 10-inch-diameter pumping well (AT-2) was installed to 65 feet in the unconsolidated aquifer, near wells 24-S and 6-D (Figure 1-2). The well and pump were designed to deliver between 150 and 200 gallons per minute continuously for a minimum of 72 hours. Actual pump discharge averaged 148 gpm over the 72-hour pumping period.

Electrical analog pressure transducers with microprocessor-based data acquisition systems were installed in the production well AT-2, and in monitoring wells 5-S, 6-S, 10-S, 11-S, 17-S, 24-S, 4-D, 6-D, and 7-D. These automatic recorders were capable of measuring water levels at the frequencies specified in the A-E QCP. In addition, manual water level measurements were made periodically at monitoring wells 8-S, 18-S, 4-I, 5-D, 8-D, and 4-PC during the pumping test.

The pumping duration was 72 hours (February 3-6, 1988), during which time water level and pump flow meter (totalizer) measurements were recorded. A recovery period was initiated following shut-down of the pump. The recovery period was of sufficient duration to allow water levels to recover to within 80 percent of the pre-pumping level in wells AT-2, 5-S, 6-S, 11-S, 24-S, and 6-D.

Water level data collected by automatic recorders and by manual measurements were later reviewed for the following purposes:

- To identify which observation wells showed a response to pumping at AT-2, and the start time of response.

- To determine the need for corrections to data as a result of external factors.
- To determine vertical gradients prior to the pumping test at monitored well nests, and to determine horizontal ground water gradients prior to the pumping test at shallow wells.
- To isolate subsets of the entire data base for further analysis.

Pumping test data were subsequently analyzed for three hydraulic properties of the aquifer: transmissivity, storativity, and the type and locations of boundary conditions, using methods described in standard reference texts (Kruseman, 1979; Lohman, 1972; Stallman, 1983).

Drawdown data were analyzed using Jacob's method and the type-curve method using Boulton and Theis type-curves (Kruseman, 1979; Lohman, 1972). Recovery data were analyzed using the Theis recovery method (Kruseman, 1979). Each method involves a different set of assumptions about the aquifer and wells, and a different set of procedures for analysis. Generally, Jacob's method and the Theis recovery method are more applicable after an appreciable pumping duration, and at wells closer to the pumped well. These methods involve analysis of the time-drawdown data plotted as log-time versus drawdown. The type-curve method is more generally applicable than the other two methods, although it involves more data interpretation. This method involves an analysis of the time drawdown data plotted as log-time versus log-drawdown. The method of analysis involves a comparison of the plotted data with type curves, where each type curve incorporates a different set of aquifer assumptions.

5.2 Quality Control Activities

The following quality control activities were undertaken during the pumping test and data analysis:

- Bail-down tests were performed on observation wells prior to conducting the pumping test to evaluate responsiveness.

- Manual water-level measurements were made periodically in monitoring wells equipped with automatic recorders, and results were checked for consistency with the automatic recorder readings.

- Discharge from well AT-2 was measured periodically throughout the pumping test, and compared with the average value calculated using data from the flow totalizer and the elapsed time.

- Two to three water level measurements were made at each of the observation wells between January 13 and February 19, 1988 (before and after the pumping test), and compared to static water levels measured just prior to test startup. Pumping test results were then adjusted for ambient water level fluctuations.

- For each well equipped with an automatic recorder, a subset of the complete water level record was selected for further analysis of hydraulic parameters. The data subset was always graphically compared to the full data set to ensure that no information was lost as a result of subset selection.

- Multiple methods of analysis were used to evaluate water level data for hydraulic parameters. Parameters estimated using type curves were checked against parameters estimated using the Jacob's and Theis recovery methods.

- The validity of assumptions associated with each method of analysis was checked against interpretations presented in the Remedial Investigation Report (RMT, 1987a).

- All calculations and computer-generated graphs were checked for accuracy and completeness.

5.3 Implementation Problems and Corrective Actions

Problems encountered during the pumping test and data analysis are listed below along with the corrective action.

Implementation Problem	Corrective Action
Subzero air temperatures hindered all preparation activities for the pumping test, including equipment and vehicle operation.	RMT and Layne-Northwest personnel dealt with weather conditions as effectively as possible.
A great deal of difficulty was encountered in planning for the disposal of pumped ground water from AT-2. After extensive testing of the plant sewer system by FMC plant personnel, it was determined that the plant sewer system would ultimately accept the design discharge flow rate of 150 gpm. However, FMC required that any discharge lines placed inside the plant near the location of AT-2 be hung from ceiling structures. RMT was not able to accommodate this new requirement in time for the pumping test, and was forced to look for alternative discharge points for the pumped ground water. This in turn required an additional plan approval from the Metropolitan Waste Control Commission (MWCC) and left the contractor (Layne -Northwest) short of discharge hose.	Of the options available to RMT for disposal of discharge water, the most feasible alternative that would allow adherence to the test schedule required that discharge water be routed to a 72-inch sanitary sewer interceptor located west of East River Road. The pump discharge hose was subsequently routed more than 600 feet through a 96-inch storm sewer beneath East River Road in order to reach the sanitary sewer interceptor. Heavy-duty metal ramps had to be constructed by FMC personnel at service road crossings to protect the discharge hose from vehicular traffic. Permission for the amended discharge plan was requested and received from the MWCC.
A clay lens may have been encountered approximately 28 feet below the water table while drilling well AT-2. This was not anticipated when siting the location of AT-2, based on the borehole log for well 6-D less than 30 feet to the south. This limited the pumping test to a 28-foot-thick section of aquifer, rather than the approximate 100-foot-thick homogeneous sand unit to the south.	No corrective action was taken, for the following reasons: . The well screen vendor stated that the design yield could be obtained. . The quality of geologic samples obtained while drilling was not high enough to accurately characterize lithology. . Schedule constraints made relocation unrealistic.
Drawdown trends were not detected in monitoring wells 8-S, 18-S, 4-I, 5-D, and 8-D due to the distance from pumping well AT-2.	Hydraulic parameters were not estimated from this data.

Insufficient drawdown trends were detected at wells 11-S, 4-D, 6-D and 7-D. With respect to well 11-S, insufficient well penetration below the water table (less than 2 feet) may have contributed to the lack of response during pumping.	Hydraulic parameters were not estimated from this data.
The static water level measured by the automatic recorder at well AT-2 did not agree with manual measurements by RMT and Layne-Northwest. A difference of 5.4 feet was later detected.	Since manual measurements by RMT and Layne-Northwest agreed to within 0.1 feet, the static water level listed with the automatic recorder data was adjusted accordingly.
Unreliable data were initially recorded by the automatic recorder installed in well 10-S. The cause of the problem may have been vehicular traffic over the unprotected transducer line.	The transducer line was protected with sand bags. Only data acquired through manual measurements at this well location were used for estimating hydraulic parameters.

5.4 Data Presentation

Hydraulic properties of the aquifer were evaluated using the procedures described in Section 5.1 and detailed in Appendix C. Drawdown curves are included in Appendix D.

The pumping test and subsequent analysis of hydraulic properties were apparently influenced by a clay layer encountered approximately 28 feet below the water table (elevation 793.5 feet MSL). Results are not representative of the conditions originally depicted by borehole 6-D, located less than 30 feet to the south, which showed a homogeneous sand aquifer more than 100 feet thick.

Hydraulic properties were evaluated based on the plotted water level drawdown data for observation wells 5-S, 6-S, 10-S, 17-S, and 24-S, and the pumping well AT-2 (Figure 1-2). Recovery analysis was also undertaken, but limited to wells AT-2, 24-S, and 6-S. Recovery data is

less reliable than drawdown data at more distant wells. Table 5-1 lists some of the more significant parameters used in analyzing data from this pumping test.

Observation wells that were not used to calculate hydraulic properties because of very small water table or hydraulic head fluctuations were:

- Upgradient wells 8-S and 5-D.
- Downgradient wells 11-S, 18-S, 4-I, 4-D, 6-D, 7-D, and 8-D.

Water level fluctuations in these wells were less than 0.2 feet over the duration of pumping. These small fluctuations may have been due to other factors such as ambient fluctuations or measurement inaccuracies.

At the end of the three-day pumping period, the radius-of-influence extended approximately 1,400 feet in the direction of wells 5-S, 6-S, and 24-S. Extent of the radius-of-influence was not estimated for other directions, because the technique requires at least three wells along an alignment away from the pumping well. The radius to the south and northeast would likely be different due to the presence of barrier boundary conditions (discussed below).

A correction factor to account for an unconfined aquifer (Stallman, 1983) was applied only to wells AT-2 and 24-S, where significant drawdown occurred.

5.4.1 Hydraulic Characteristics

Average values of transmissivity and storativity were calculated for the unconfined aquifer near the pumping well (AT-2) as follows:

TABLE 5-1
PUMPING TEST PARAMETERS

Well No.	Distance to AT-2 (ft)	Depth of Well* (ft)	Nominal Well Diameter (in)	Well Screen Length (ft)	Aquifer Thickness** (ft)
AT-2	0	65	10	30	28
5-S	386	35	2	15	28
6-S	236	35	2	15	28
8-S	1,540	30	2	10	105
10-S	371	31	2	10	28
11-S	57	31	2	10	105
17-S	300	39	2	10	28
18-S	780	28	2	10	104
24-S	30	37	2	15	28
4-I	820	76	2	10	104
4-D	376	121	2	10	53
5-D	1,840	117	2	10	105
6-D	27	130	2	10	104
7-D	300	118	4	10	56
8-D	820	128	4	10	104

*With respect to top of well casing.
**Aquifer thickness at well locations AT-2, 5-S, 6-S, 10-S, 17-S, 24-S, 4-D, and 7-D are with respect to a 13- to 17-foot thick clay lens.

Notes:

1. Average AT-2 discharge rate over test duration: 148.5 gpm
2. Pumping test duration: 3.01 days
3. Recovery test duration: 0.90 days
4. Average aquifer thickness for wells used to calculate hydraulic parameters: 28 feet (to clay lens)
5. Aquifer thickness for 8-S, 11-S, 18-S, 4-I, 5-D, 6-D, and 8-D is to bedrock.

- Transmissivity - 62,000 gpd/ft
- Storativity - 0.13

Average values were calculated for well 24-S using Boulton type-curves and Jacob's method; and for wells 5-S, 6-S, and 24-S using Jacob's distance-drawdown method. Calculated values at observation wells more distant to AT-2 yielded transmissivity values ranging from 41,000 to 88,000 gpd/ft, and storativity values from 0.04 to 0.35 (Table 5-2). The values calculated for well 24-S were considered more reliable than values for more distant wells, because the drawdown curve for well 24-S was more fully developed.

The storativity value calculated for well 24-S (0.13) was based upon steady-state drainage from the dewatered aquifer, achieved after 100 minutes of pumping. Estimates of storativity for wells more distant to well AT-2 (6-S and 17-S) indicated that delayed drainage may have persisted throughout the pumping test at those locations. Estimates of storativity at those locations were not considered representative of steady-state conditions.

The average transmissivity value shown above (62,000 gpd/ft) may not be applicable to the sand aquifer south of well AT-2 due to significant aquifer heterogeneities (discussed below). An additional pumping test would be necessary to define hydraulic characteristics in this region.

TABLE 5-2
RANGE OF TRANSMISSIVITY AND STORATIVITY VALUES CALCULATED
USING THEIS, BOULTON, AND STALLMAN TYPE CURVES

TRANSMISSIVITY (GPD/FT):

	Type Curve						
	Theis	Boulton				Stallman	
		No Boundary		Boundary		Boundary	Anisotropy
Well No.		Early	Late	Early	Late		
5-S	52,000	NA	NA	NA	NA	NA	NA
6-S	45,000	10,000	20,000	NA	NA	NA	36,000
17-S	NA	11,000	43,000	20,000	85,000	85,000	NA
24-S	NA	85,000	45,000	44,000	81,000	81,000	NA

STORATIVITY:

	Type Curve						
	Theis	Boulton				Stallman	
		No Boundary		Boundary		Boundary	Anisotropy
Well No.		Early	Late	Early	Late		
5-S	0.05	NA	NA	NA	NA	NA	NA
6-S	0.04	0.01	0.11	NA	NA	NA	0.009
17-S	NA	0.005	0.30	0.009	0.35	0.35	NA
24-S	NA	0.006	0.18	0.004	0.07	0.07	NA

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5.4.2 Heterogeneity

A steep water table gradient between wells AT-2 and 11-S, and the absence of a significant gradient between wells AT-2, 5-S, 6-S, and 24-S, indicate the presence of heterogeneous aquifer conditions. Heterogeneous conditions were also identified in the Remedial Investigation Report (RMT, 1987a). Geologic profiles from that report indicate the presence of a discontinuous clay lens that creates a confining layer near the pumping well, but which pinches out to the northeast (upgradient) and south (downgradient). The geologic profiles also show a gravelly sand layer in the aquifer above the clay layer that pinches out to the northeast and thickens toward well 17-S.

The calculated range of transmissivities among wells 5-S, 6-S, 10-S, 17-S, and 24-S (41,000 to 88,000 gpd/ft) are another indication of significant aquifer heterogeneities.

5.4.3 Boundary Conditions

Two barrier boundaries (lower permeability soils) were tentatively identified based on pumping test data from wells AT-2, 17-S, and 24-S. The first boundary was located approximately 75 feet northeast of well 24-S, which corresponds to the pinching-out of the permeable gravelly-sand lens mentioned in the previous section.

The second barrier boundary is located approximately 150 feet southwest of well 17-S, in the direction of the Mississippi River. This indicates that the Mississippi River bed may act as a hydraulic barrier, which is possible if the bed material contains a high percentage of silt and clay.

Data from well AT-2 support the presence of low permeability boundaries. However, the data do not indicate the direction of these boundaries. The boundaries affect the drawdown in AT-2 after approximately 12 hours of pumping.

6. REFERENCES

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APPENDIX A

DAILY QUALITY CONTROL REPORTS

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 4, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of seventeen degrees F. below zero, partly sunny, no precipitation, winds out of the west at about 20-30 mph.

WORK PERFORMED:

The cable tool rig crew welded a cap onto well AT-2 and finished cleaning up the drill site. The hollow stem auger rig crew mobilized to well 5-PC. They steam cleaned the drill rod needed for the coring at 5-PC. The crew placed the rod in well 5-PC to a depth of 165 feet.

SAMPLING PERFORMED:

None.

FIELD ANALYSIS PERFORMED:

None.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Due to the extremely cold temperatures the length of time people were able to spend outside was decreased. Additional problems that were encountered due to the cold temperatures and their solutions are as follows: the rigs would not start--vehicles that could be were plugged in, on others the oil pans were heated, batteries charged and then jump started; tools were frozen and they had to use a propane torch to heat them in order to get them to work; the welder would not start so they heated the oil pan and then jump started it; during setting of the rod in 5-PC the threads were frozen from steam cleaning and needed to be heated with a torch; the crisco used for threading compound froze and needed to be heated in order to use it.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 11, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentyfive with a low of eighteen degrees F., cloudy, light freezing rain in the afternoon, winds out of the north-northwest at about 5 mph.

WORK PERFORMED:

The cable tool rig crew bailed the residual sand out of well AT-2. They then mobilized to drill site 14-D and began steam cleaning the materials to be used downhole.
The hollow stem auger crew continued to prepare for coring at well 5-PC. After some problems they were able to core to a depth of 5 feet.
The pump and pipe to be used for the development of the wells was steam cleaned. Well 3-I was developed.

SAMPLING PERFORMED:

Samples from well 3-I were collected for pH, conductivity, temperature, and turbidity.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature were performed on the water discharged from well 3-I after pumping until there was less than a 10% change in the measured parameters. After the final development of the well a sample was collected in a clear glass jar for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The steam cleaner was not functioning properly and needed to be disassembled and cleaned.
Coring at 5-PC was a problem because water was not passing through the annular space because the adjustable clearance range between the annular space around the drill bit was not adjusted properly.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 12, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentynine degrees with temperatures dropping to minus eight degrees below by early afternoon, blizzard conditions in the morning with a snow accumulation of 5 inches, winds from 35-45 mph out of the north-west all day.

WORK PERFORMED:

The hollow stem auger crew continued coring at well 5-PC. They cored an additional 7 feet.
The cable tool rig crew advanced pipe to a depth of 50 feet.
Well 21-S was developed.

SAMPLING PERFORMED:

Samples from 21-S were collected for pH, conductivity, temperature, and turbidity measurements.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were performed on the water being discharged from well 21-S until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete a sample was collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Problems were encountered during the coring operations at well 5-PC. The water ports on the core bit became clogged with a shale-type material. They attempted to pull out the bit with the wireline winch but were unsuccessful so all the pipe had to be pulled out of the hole. They were then able to unclog the core bit.
The bit used during cable tool drilling broke off into borehole 14-D. The crew was successful in "fishing" the bit out of the hole.
Freezing conditions were encountered throughout the day wherever water needed to be used so hoses and tools needed to be thawed with a torch before using.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 13, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus eight degrees and a low of minus twelve degrees F., sunny all day, winds at about 2-5 mph out of the west shifting to a southerly direction in the afternoon at about 10-20 mph.

WORK PERFORMED:

The hollow stem auger crew continued to core at well 5-PC and completed coring by the end of the day.
The cable tool rig crew attempted to develop wells but were unable to get the pump into the wells. So they returned to 14-D to resume drilling at that location. They advanced to a depth of 57 feet.
Individual well response tests were performed on wells 11-S, 10-S, 6-S, and 5-S.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 14-D

FIELD ANALYSIS PERFORMED:

Periodic HNU readings were taken and recorded throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

In attempting to develop wells it was discovered that in some of the 2-inch wells there is some sort of internal seam in the black iron pipe. Consequently there was not enough clearance for the submersible pump to fit into the 2-inch wells. Layne notified their office to send a smaller diameter pump to the site by overnight delivery.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 14, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus five degrees F., partly cloudy in the morning to sunny in the afternoon, heavy snow flurries in the morning, winds at 15-20 mph out of the north northwest.

WORK PERFORMED:

The hollow stem auger crew pulled out the remaining core and pipe at well 5-PC. They mobilized to borehole 1-I. The appropriate work zones were delineated and set up at 1-I. The crew steam cleaned the augers, screen and black iron riser pipe to be used for 1-I. They constructed the well and began pulling the augers out.
The cable tool rig advanced the borehole at 14-D to a depth of 73 feet. They also checked wells 3-I, 21-S, and 24-S for plumbness and alignment. The crew also steam cleaned the submersible pump to be used for the development of the 2-inch wells and set the pump in well 24-S.
Well 24-S was developed and individual well response tests were performed on wells 6-D, 17-S, and 18-S.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 14-D.
Samples were collected from well 24-S for pH, conductivity, temperature, and turbidity measurments.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being discharged from well 24-S until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete a sample was collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The augers became stuck while they were pulling them out of borehole 1-I. Since it was late in the day it was decided to wait till morning to continue to try to get them out.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 15, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary
High of twentyfive degrees F., sunny, no precipitation, winds calm.

WORK PERFORMED:

The hollow stem auger crew complete constructing well 1-I and prepare to move the rig off site.
The cable tool rig crew checked well 4-I for plumbness and alignment. They also steam cleaned the pump and pipe used for well development and set the pump in well 4-I. They continue drilling at 14-D and advance the borehole to a depth of 85 feet by the end of the day.
Individual well response tests were performed on the following wells: 8-S, 5-D, 4-D, 7-D, and 8-D.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 14-D.
Samples were collected from well 4-I for pH, conductivity, temperature, and turbidity measurements.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being discharged from well 4-I until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete a sample was collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The hollow stem auger crew successfully freed the augers that were stuck in borehole 1-I.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 18, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentyeight degrees F., partly sunny, no precipitation, winds out of the south at about 5-10 mph.

WORK PERFORMED:

The second cable tool rig (cable tool rig-B) arrived on site today.. The crew that had previously operated the hollow stem auger rig will be operating the second cable tool rig. The rig and some of the pipe to be used downhole was steam cleaned. Cable tool rig-B mobilized to drill site 12-D. The appropriate work zones were deliniated and set up. They advanced their hole to a depth of 40 feet by the end of the day.
The first cable tool rig (cable tool rig-A) continued to drill at borehole 14-D. They advanced to a depth of 93 feet by the end of the day.
Individual well response tests were performed on wells 4-PC and 24-S.

SAMPLING PERFORMED:

Split spoon samples were taken at the specified intervals at both drill sites.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken and recorded throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 19, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentyeight degrees F., mostly cloudy, heavy snow in the afternoon, winds out of the north-northwest at about 25-30 mph.

WORK PERFORMED:

Cable tool rig-A advanced to a depth of 93 feet and hit sandstone. It was decided to stop and set the well screen at about 90 feet. The crew steam cleaned the screen and riser pipe and begin constructing well 14-D. The crew also checked steam cleaned the pipe and pump used for development and the alignment tool. They checked well 22-S for plumbness and alignment. The pump was set in well 22-S and was developed.
Cable tool rig-B advanced their hole to a depth of 95 feet by the end of day.

SAMPLING PERFORMED:

Split spoon samples were taken at the specified intervals at boreholes 12-D and 14-D.
Samples were collected from well 22-S for pH, conductivity, temperature, and turbidity measurements.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperture measurements were performed on the water being discharged from well 22-S until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete a sample was collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coodinator Signature: Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 20, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentytwo degrees F., snow continuing in the morning, overnight snowfall of about 12 inches, cloudy, winds out of the north-northwest at about 20-25 mph.

WORK PERFORMED:

Cable tool rig-A set the screen and riser pipe at well location 14-D and began grouting. They ran out of cement and a small amount of grout will need to be added tomorrow.
Cable tool rig-B advanced borehole 12-D to a depth of 115 feet by the end of the day.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 12-D.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The drillers don't have a compressor to operate the grout pump so they had to find a rental. Due to the freezing temperatures the grout pump kept freezing and periodically had to be thawed with a torch.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 21, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of twentyfive degrees F., partly sunny, no precipitation, winds out of the south at about 5-10 mph.

WORK PERFORMED:

Cable tool rig-A completed grouting well 14-D. They mobilized to drill site 2-I and drilled to about 4 feet.They checked wells 5-I and 25-S for plumbness and alignment. The pump was set in wells 5-I and 25-S and were developed. Cable tool rig-B advanced borehole to its estimated depth of 130 feet. they set the screen and well casing into 12-D. They added the filter pack also at 12-D.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 12-D and borehole 2-I.
Water samples were collected from wells 5-I and 25-S for pH, conductivity, temperature, and turbidity measurements.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being discharged from wells 5-I and 25-S until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete samples were collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

None

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 22, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of twenty degrees F., partly sunny, light snow most of the day, winds out of the west at about 10-25 mph.

WORK PERFORMED:

Cable tool rig-A drilled to about 12 feet at borehole 2-I. Cable tool rig-B grouted well 12-D and installed the protective casing.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 2-I.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day. Water well baildowns were performed at wells 15-S, 22-S, and 25-S.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Cable tool rig-A encountered broken concrete at a depth of about 4-5 feet. The drill rig will be moved a few inches on Monday morning.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature: Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 25, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of zero degrees F., partly sunny, winds out of the northwest at about 25-30 mph.

WORK PERFORMED:

Cable tool rig-A repositioned their rig over borehole 2-I. They advanced to a depth of 35 feet.
Cable tool rig-B loaded up their rig and mobilized to drill site 10-D. They advanced to a depth of 13 feet.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at boreholes 10-D and 2-I.
Ground water monitoring was performed at wells 10-S, 11-S, 22-S and 24-S.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being sampled for ground water monitoring until these measurements agreed to within 10%.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Due to freezing temperatures most of the engines were difficult to start in the morning also many items of the drillers were freezing and had to be thawed by use a propane torch.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 26, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of five degrees F., partly sunny, winds out of the west at about 10-20 mph.

WORK PERFORMED:

Cable tool rig-A advanced to a depth of 65 feet.
Cable tool rig-B deconed additional materials for borehole 10-D and advanced to a depth of 32 feet.
RMT personnel installed 600 feet of nylon rope down a manhole at FMC and up a manhole in the nearby city park.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at boreholes 2-I and 10-D.
RMT personnel performed ground water sampling at wells 5-I, 5-S, 6-S, 17-S, and 18-S.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being sampled for ground water monitoring until these measurements agreed to within 10%.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Due to freezing temperatures most of the engines were difficult to start in the morning also many items of the drillers were freezing and had to be thawed by use of a propane torch.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Ronald N. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 27, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of eight degrees F., partly sunny, winds out of the west northwest at about 5-10 mph.

WORK PERFORMED:

Cable tool rig-A drilled to the estimated depth of 75 feet at borehple 2-I. They set the screen and well pipe down the borehole and added the filter pack. They deconed the pump materials for developement for 14-D. They then set pump and pipe down well 14-D. Cable tool rig-A also pulled developement pump and pipe out of the well.
Cable tool rig-B advanced borehole 10-D to a depth of 65 feet.
RMT personnel performed ground water sampling at wells 4-S, 6-D, 9-S and 25-S.
A baildown test was performed at well 14-D.

SAMPLING PERFORMED:

Split spoon samples were taken at the specified depths at boreholes 2-I and 10-D.
Samples were collected from well 14-D for pH, conductivity, temperature, and turbidity measurements.
Ground water sampling was performed at wells 4-S, 6-D, 9-S, and 25-S.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being sampled for ground water monitoring and the water being discharged from 14-D until the measurements agreed to within 10%.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The Layne pump crew was off the FMC property forb about 5.5 hours to pick up a pump rig. The pump crew's flatbed truck is down due to a starter failure.

QUALITY CONTROL ACTIVITIES INITIATED:

Daily notes of the supervising geologist were reviewed for accuracy and completeness.

Site Coordinator Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 28, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of ten degrees F., partly sunny, winds out of the west at about 5-10 mph.

WORK PERFORMED:

Cable tool rig-A grouted and installed the protective casing for well 2-I. They cleaned up site and prepared the drill rig to mobilize to drill site 13-D tomorrow morning.
Cable tool rig-B advanced to a depth of 96 feet.
Pump crew deconed pump materials for pump installation at AT-1. They installed the pump into well AT-1. Performed electrical work on electrical wires for AT-1 and AT-2 pumps. They installed 550 feet of fire hose down into a manhole on FMC property and out a manhole of a nearby park.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 10-D.
RMT personnel performed ground water sampling at wells 4-S, 8-S, and 14-D.
Photographs were taken of Lanye's fire hose before being installed into the storm sewer.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being sampled for ground water monitoring until these measurements agreed to within 10%.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The air compressor which Layne rented to grout borehole 2-I did not work resulting in additional down time for cable tool rig-A because the compressor had to be returned. The rental company did not have another compressor. Therefore another rental company had to be located and another compressor rented.
Pump crew's flatbed truck still does not have a working starter therefore the truck must be pulled started resulting in additional down time.

QUALITY CONTROL ACTIVITIES INITIATED:

Daily notes of the supervising geologist were reviewed for accuracy and completeness.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: January 29, 1988 AUTHOR: Ron Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

High of thrity degrees F., sunny, winds out of the southwest at about 2-5 mph.

WORK PERFORMED:

Cable tool rig-A steam cleaned materials for drilling borehole 13-D. They moblized to 13-D and had to shovel about 5 cubic yards of snow to get the rig backed over the drill site. The 'hot zone' was set up around the rig. They drilled to a depth of 12 feet. They loaded their flatbed truck up with materials to be taken to Layne's shop in Wausau, WI.
Cable tool rig-B advanced to a depth of 101 feet at borehole 10-D. At 101 feet they encountered bedrock (sandstone). They placed the deconed screen and pipe down into the borehole. They covered the casing and well pipe for the weekend.
The pump crew installed the pump and pipe for well AT-2. These materials were steam cleaned. A water level gauge was installed at AT-2 also.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at boreholes 10-D and 13-D.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Continued problem of the Layne flatbed truck with a bad starter motor. The truck developed some overheating problems. The truck is being driven back to Milwaukee, WI. to get repaired over the weekend.

QUALITY CONTROL ACTIVITIES INITIATED:

Daily notes of the supervising geologist were reviewed for accuracy and completeness.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 1, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus five degrees F., sunny, light snow flurries in the morning, winds out of the northwest at about 10-15 mph.

WORK PERFORMED:

The crew on cable tool rig "A" continued drilling at borehole 13-D and advanced the hole to a depth of 31 feet by the end of the day.
The crew on cable tool rig "B" began pulling the pipe out of borehole 10-D and began constructing the well.
Layne-Northwest's pump crew and hydrologists arrived and began preparing for the pump tests. They installed the totalizers on both "AT" wells, completed wiring AT-1 and put the firehose in place for that well. At well AT-2 they placed a portion of the hose.

SAMPLING PERFORMED:

Split spoon samples were collected at 13-D at the specified intervals.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken throughout the day for air quality.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Due to the cold temperatures it took some time to start the rigs and support trucks. The power steering hose on the support truck for cable tool rig "A" broke and will need to be repaired before proceeding with any work tomorrow.

QUALITY CONTROL ACTIVITIES INITIATED:

The notes and boring logs of both supervising geologists were reviewed to assure that they were accurate and complete.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 2, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus ten degrees F., sunny, winds out of the northwest at about 5-10 mph.

WORK PERFORMED:

Cable tool rig "A" continues to drill at borehole 13-D and advanced that hole to a depth of 55 feet. The crew on cable tool rig "B" pulled the pipe out of borehole 10-D and constructed the well at that location. They began cleaning up the site at 10-D and mobilized to site 11-D. The pump crew finished laying hose at AT-2 and completed wiring the pump at that location. Pressure transducers were installed in the following wells:
AT-2, 24-S, 6-D, 11-S, 6-S, 10-S, 5-S, 4-D, 17-S, and 7-D. Protective barricades were set up over all manholes being used for the pump test. Wells AT-1 and AT-2 were developed. A step drawdown analysis was performed on well AT-2 to define its pumping capacity.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at drill site 13-D.
Samples were collected from wells AT-1 and AT-2 for pH, conductivity, temperature, and turbidity as part of the development process. After development was completed samples were also collected from these wells for VOC analysis.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water discharged (from a sampling valve at well head) from wells AT-1 and AT-2 until these measurements agreed to within 10%. Visual observations of the water during development were also made. After development was complete samples were collected for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

During the development of the "AT" wells several severe leaks in the pipes occurred. These were fixed by the use of teflon tape and tightening of the connections. During the pumping of AT-2 we experienced a shutdown due to some sort of blockage in the hose. The hose above ground was inspected and it was found that there were several kinks in the hose.

QUALITY CONTROL ACTIVITIES INITIATED:

Field notes of both supervising geologists were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 3, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus eight degrees F., sunny, no precipitaion, winds out of the north at about 10-15 mph.

WORK PERFORMED:

The crew on cable tool rig "A" continued to drill at borehole 13-D. They advanced that hole to a depth of 95 feet by the end of the day.
The necessary work zones were delineated and set up at drill site 11-D for cable tool rig "B". The drill casing to be used for drilling at 11-D was steam cleaned. They advanced to a depth of 11 feet.
Preparations continued for the start of the aquifer pump tests. The pump tests started at 10 A.M. today.
The tool used for the alignment checks and the pipe and pump used for well development was steam cleaned before its use. Well 2-I was checked for plumbness and alignment. Welln 2-I was also developed.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at borehole 13-D.
Samples were collected at well 2-I for pH, conductivity, temperature, and turbidity as part of the development process.
At the start of the pump test at AT-1 samples were collected at wells 9-S, 22-S, 5-I, 14-D, and AT-1 for the TCE time series analysis.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity, and temperature measurements were performed on the water being discharged from well 2-I until these measurements agreed to within 10%. Visual observations of the water being discharged throughout development were also made. After development was complete a sample was collected from 2-I for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The totalizer and flow meter on AT-1 malfunctioned. The Layne pump crew was able to locate another and replace it.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the TCE time series analysis a duplicate, a field blank, and a trip blank were collected and sent to the lab.
The field notes of both supervising geologists were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 4, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus five degrees F., snow in the morning with an accumulation of approximately one inch, partly cloudy to sunny in the afternoon, winds out of the northwest at about 12-18 mph.

WORK PERFORMED:

The crew on cable tool rig "A" drilled borehole 13-D to a final depth of approximately 99 feet which is the depth at which they encountered bedrock. They then steam cleaned the screen and riser pipe for the construction of well 13-D. The screen and riser pipe were set and they began constructing the well.
The crew on cable tool rig "B" advanced borehole 11-D to a depth of approximately 77 feet by the end of the day.
The pump crew steam cleaned the alignment tool and the pump and pipe used for the development of wells. They checked wells 10-D and 12-D for plumbness and alignment and also developed wells 10-D and 12-D.
Both pump tests continue to run without problems. Water levels were taken at the specified time intervals at wells AT-2, 24-S, 6-D, 11-S, 6-S, 10-S, 4-D, 17-S, 7-D, 4-PC, 8-S, 5-D, 18-S, 4-I, and 8-D.
Water levels were taken and samples were collected from AT-1, 9-S, 5-I, 14-D, and 22-S for the TCE time series analysis.

SAMPLING PERFORMED:

Split spoon samples were collected at the specified intervals at boreholes 13-D and 11-D.
Samples were collected from wells 10-D and 12-D for pH, conductivity, temperature and turbidity as part of the development process.
Samples were also collected for the TCE time series analysis from wells AT-1, 9-S, 5-I, 14-D, and 22-S.
Samples were collected from AT-2 for the purpose of the bench scale analysis.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.
Field pH, conductivity and temperature measurments were performed on the water being discharged from wells 10-D and 12-D until these measurements agreed to within 10%. Visual observations of the water being discharged throughout the development process were also made. After development was complete a sample was collected from wells 10-D and 12-D for the determination of the nephelometric turbidity of the water and for photographic purposes.
Bench scale testing of the pumped water from AT-2 was performed according to the procedures written.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

The flap valve on the sand pump being used bey cable tool rig "B" malfunctioned and could not be fixed. They had to switch to a flat bottom bailer.

QUALITY CONTROL ACTIVITIES INITIATED:

Field notes of both supervising geologists and the technicians taking water levels as part of the pump test were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 5, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus 15 degrees F., sunny, no precipitation, winds out of the northwest at 20 25 mph.

WORK PERFORMED:

The crew on cable tool rig "B" advanced borehole 11-D to a depth of approximately 80 feet before quiting for the day.
In conjuction with the AT-2 pump test water levels were taken and recorded at wells AT-2, 24-S, 6-D, 11-S, 6-S, 10-S, 4-D, 17-S, 7-D, 4-PC, 8-S, 5-D, 18-S, 4-I, and 8-D at the specified intervals.
Water levels and samples were taken from wells AT-1, 5-I, 9-S, 14-D, and 22-S as part of the time series analysis for TCE.

SAMPLING PERFORMED:

Split spoon samples were taken at the specified intervals at borehole 11-D.
Samples were taken from wells AT-1, 5-I, 9-S, 14-D, and 22-S for the TCE time series analysis being performed.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken for air quality throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Due to the extremely cold temperatures and low windchill temperatures grouting could not be done at 13-D. The extended forecast for Monday is for temperatures above zero. They should be able to grout then.
Also because of the cold temperatures it took a couple of hours to get cable tool rig "B" started.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the TCE time series analysis a duplicate, field blank, and a trip blank were collected and sent to the lab.
The field notes of both supervising geologists and the technicians taking water levels as part of the pump test were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 6, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of minus three degrees F., sunny, no precipitation, winds out of the northwest at about 10-15 mph.

WORK PERFORMED:

The AT-2 aquifer pump test reached the minimum 72 hour point and was terminated at 10:15 a.m. this morning. Following the termination of the test the measurement of recovery in wells AT-2, 24-S, 6-D, 11-S, 6-S, 10-S, 4-D, 17-S, 7-D, 4-PC, 8-S, 5-D, 18-S, 4-I, and 8-D began. The frequency of measurements followed the frequency specified in the procedures written. The measurement of recovery continued until the water levels in wells AT-2, 24-S, 6-D, 11-S, and 6-S recovered to within 80% of their prepumping levels. The automated recorders were left in place.
The AT-1 aquifer test continues to proceed without any problems. Water levels were taken and samples collected from wells AT-1, 5-I, 9-S, 14-D, and 22-S for the time series analysis.

SAMPLING PERFORMED:

Samples were collected from AT-1, 5-I, 9-S, 14-D, and 22-S for the TCE time series analysis.

FIELD ANALYSIS PERFORMED:

Background and individual HNU readings were taken at wells AT-1, 5-I, 9-S, 14-D, and 22-S before the start of the sampling process at these wells.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

None.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 7, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of five degrees F., sunny, no precipitation, winds out of the north at about 15-20 mph.

WORK PERFORMED:

Water levels were taken and samples were collected at wells AT-1, 5-I, 9-S, 14-D, and 22-s.

SAMPLING PERFORMED:

Samples were collected from AT-1, 5-I, 9-S, 14-D, and 22-S for the TCE time series analysis.
Samples were also collected from wells 1-S and 2-S.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at wells 1-S and 2-S until three successive readings yielded equivalent values as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

A duplicate, field blank, and trip blank were collected and shipped to the lab for analysis as part of the TCE time series analysis.
A trip blank accompanied the sampler during collection of samples from wells 1-S and 2-S and will be sent to the lab for analysis.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 8, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

High of ten degrees F., partly cloudy, snow in the morning with an accumulation of 2.5 inches, winds out of the northwest at about 5-10 mph.

WORK PERFORMED:

The crew on cable tool rig "A" grouted and completed well 13-D.
Cable tool rig "B" advanced borehole 11-D to a depth of 125 feet by the end of the day.
Aquifer test AT-1 was terminated this morning. Water levels and a final round of samples were collected at wells 5-I, 9-S, 14-D, 22-S, and AT-1 for the time series analysis.
Groundwater samples were collected from wells 13-S, 14-S, and 15-S.
Borehole 23-S was located and staked.

SAMPLING PERFORMED:

Samples were collected from AT-1, 5-I, 9-S, 14-D, and 22-S for the TCE time series analysis.
Groundwater samples were collected from wells 13-S, 14-S, and 15-S.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at wells 13-S, 14-S, and 15-S untill three successive readings yielded equivalent values as specified in the A-E QCP.
Split spoon samples were collected at the specified intervals at borehole 13-D.
Background and periodic HNU readings were taken for air quality throughout the day.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activities QA and QC duplicate sample # 3 was collected. Also QC trip blank # 6 accompanied the samples and QA field blank # 2 was collected. The field notes of the supervising geologist and the groundwater sampler were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 9, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

A high of minus five degrees F., sunny, no precipitation, winds out of the northwest at about 10-15 mph.

WORK PERFORMED:

The crew from cable tool rig "A" began cleaning up around some of the drill sites and began dissassembling the fire hose used during the pump test. Cable tool rig "B" advanced borehole 11-D to its final depth of 130 feet and began pulling the drill casing out of the hole. They steam cleaned the screen and riser pipe to be used for constructing 11-D and began constructing that well.
The tool used to check wells for plumbness and alignment and the pump to develop wells was steam cleaned before its use. Well 5-PC was checked for plumbness and alignment and developed today.
Groundwater samples were collected from wells 1-D, 2-I, 2-D, 3-S, 5-D, and 5-PC. The storm sewer outfalls were located and sampled also.

SAMPLING PERFORMED:

Samples were collected from wells 1-D, 2-I, 2-D, 3-S, 5-D, and 5-PC following the procedures specified in the A-E QCP. The two storm sewer outfalls were sampled and labeled as storm sewer outfall north and south.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at all wells sampled until three successive readings yielded equivalent values as specified in the A-E QCP.
Field pH, coductivity,and temperature measurements were performed on the water being discharged from well 5-PC as part of the development process until these measurements agreed to within 10%. Visual observations of the water being discharged at well 5-PC were made throughout the development process. After development was complete a sample was collected from 5-PC for the determination of the nephelometric turbidity of the water and for photographic purposes.
Background and periodic HNU readings were taken throughout the day for the determination of air quality.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

QC trip blank number seven accompanied the samplers throughout the day and was sent to the lab for analysis along with the samples collected during the day.
The field notes of the supervising geologist and samplers were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 10, 1988 AUTHOR: Catherine A. Kwiatkowski

WEATHER: Note: Attach Additional Sheets as Necessary

A high of minus seven degrees F., sunny, no precipitation, winds out of the northwest at about 15-20 mph.

WORK PERFORMED:

The crew from cable tool rig "A" continued to clean up around the drill sites, packing fire hose from the pump test, and loading up some of their equipment.
The crew on cable tool rig "B" grouted and completed well 11-D. They began preparations to move off of that site and mobilize to drill site 23-S.
The plumbness/alignment tool and pump used for well development was steam cleaned in preparation to develop wells. Wells 1-I and 13-D were checked for plumbness and alignment and developed today.
Groundwater samples were collected from wells 1-I, 3-I, 3-D, 4-D, 7-S, 12-S, 13-D, 20-S, and 21-S.

SAMPLING PERFORMED:

Samples were collected from wells 1-I, 3-I, 3-D, 4-D, 7-S, 12-S, 13-D, 20-S, and 21-S following the procedures specified in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken throughout the day for the determination of air quality.
Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at all wells sampled until three successive readings yielded the equivalent values as specified in the A-E QCP.
Field pH, conductivity, and temperature measurements were performed on the water being discharged from wells 1-I and 13-D as part of the development process until these measurements agreed to within 10%. Visual observations of the water being discharged from wells 1-I and 13-D were made and recorded throughtout the development process. After development was complete a sample was collected from 1-I and 13-D for the determination of the nephelometric turbidity of the water and for photographic purposes.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activities QA and QC field blanks number 3 were collected and sent to the appropriate labs. Trip blank number eight accompanied the sampler throughout the day and was also sent to the lab for analysis.
The field notes of the supervising geologist and samplers were reviewed for completeness and accuracy.

Site Coordinator Signature Catherine A. Kwiatkowski

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 11, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of minus five degrees F., sunny, no preciptatoin, winds out the northwest at about 5-10 mph.

WORK PERFORMED:

The crew from cable tool rig "A" continued to clean up around the drill sites, and loading up additational equipment into their semi trailer.
Cable tool rig "B" crew steam cleaned drilling materials for 23-S and then moblized to the off base drill site 23-S. The crew drilled to a depth of 8 feet.
Ground water samples were collected from wells 16-S and 19-S.
The work zones were delinated at the 23-S drill site.

SAMPLING PERFORMED:

Samples were collected from wells 16-S and 19-S following the procedures specified in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken throughout the day for the determination of air quality.
Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at all wells sampled until three successive readings yielded the equivalent values as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the ground water monitoring activities a QC field blank was collected and sent to the appropriate lab. The field notes of the supervising geologist and sampler were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 12, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of ten degrees F., sunny, no precipitation, winds out of the northwest at about 10-15 mph.

WORK PERFORMED:

The crew from cable tool rig "B" drilled to a depth of 42 feet.

SAMPLING PERFORMED:

Soil samples were collected as specified in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Background and periodic HNU readings were taken throughtout the day for the determination of air quality.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

The field notes of the supervising geologist were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 15, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of fifteen degrees F., partly sunny, no precipitation, winds out of the west at about 5-10 mph.

WORK PERFORMED:

Cable tool rig "B" crew added the filter pack, installed the steam cleaned screen and pipe. They ordered cement and grouted the 23-S well. The crew cleaned up at the site , loaded up their materials and moblized back to the office trailer area.
Groundwater samples were collected from 1-PC.

SAMPLING PERFORMED:

Water samples were collected from well 1-PC following the procedures specifed in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at the well sampled until three successive readings yielded the equivalent value as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activities QA and QC field blanks number 4 were collected and sent to the appropriate labs. Trip blank number 10 accompanied the samplers throughout the day and was sent to the lab for analysis.
The field notes of the supervising geologist and samplers were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 16, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of thirty degrees F., partly sunny, no precipitation, winds out of the northwest at about 5-10 mph.

WORK PERFORMED:

Cable tool rig "B" crew steam cleaned developement pump and pipe before and after developing 11-D. The pump was then installed into well 23-S to be developed on 2/17/88. The 23-S well was then secured.
The crew cleaned up office trailer site, loaded up thier materials, and hooked up thier trailer. One of the crew drove the drill rig "B" back to Wausau, WI. Another crew member drove a small flatbed and office trailer back to Milwaukee, WI. The crew boss flagged the wells and placed well caps and plugs on the remaining wells. Left site to go to the hardware store to get materials.
Groundwater samples were collected from wells 2-PC, 3-PC, 4-PC, 7-D, and 11-D. All groundwater sampling materials were cleaned as specified in the A-E QCP before sampling at each well.

SAMPLING PERFORMED:

Water samples were collected from wells 2-PC, 3-PC, 4-PC, 7-D, and 11-D following the procedures specified in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at the wells sampled until three successive readings yielded the equivalent value as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activities a QC Trip blank number 11 accompanied the samplers throughout the day and was sent to the appropiate lab.
Field notes of the samplers were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 17, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of thirtysix degrees F., sunny, no precipitation, winds out of southwest at about 5-15 mph.

WORK PERFORMED:

The last remaining Layne employee finished installing well caps and plugs. He also developed well 23-S and checked for well plumness and alignment. He picked up plastic tubing in the park. A water sample was collected from 23-S for determination of turbidity measurement and photographic proposes. Groundwater samples were collected from wells 8-D, 9-D, 10-D, and 23-S. all groundwater sampling materials were cleaned as specified in the A-E QCP before sampling at each well. Testing equipment was calibrated thoughout the day.

SAMPLING PERFORMED:

Water samples were collected from wells 8-D, 9-D, 10-D, and 23-S following the procedures specified in the A-E QCP.
A water sample was taken from well 23-S for a turbidity measurement and photograph.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at the wells sampled until three successive readings yielded the equivalent value as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Had trouble placing the purging pump down the new 3" wells. Alteration to the steel cable assembly where it attaches to the pump allowed the pump to pass freely down the well.
Well 10-D would not recover as fast as the pump rate (10 gal/min.) resulting having to shut off the pump to allow the well recover.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activites QC and QA duplicates number 5, QC and QA field blanks number 5 were collected and sent to the appropriate labs. Trip blank number 12 accompanied the samplers thoughout the day and was also sent to the lab for analysis. Field notes of the samplers and chain of custody forms were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 18, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of forty degrees F., sunny, no precipitation, winds out of the southwest at about 5-15 mph.

WORK PERFORMED:

Groundwater samples were collected from wells 12-D, FMC-33, AT-1, and AT-2. All groundwater sampling materials were cleaned as specified in the A-E QCP before sampling at each well. Testing equipment was calibrated throuthout the day. Packed up materials in the office trailer

SAMPLING PERFORMED:

Water samples were collected from wells 12-D, FMC-33, AT-1, and AT-2 following the procedures specified in the A-E QCP.

FIELD ANALYSIS PERFORMED:

Field pH, conductivity, and temperature measurements were taken after each well volume was removed during the purging process at the wells sampled until three successive readings yielded the equivalent value as specified in the A-E QCP.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

Well FMC-33 has a restriction in the well casing several feet below the static water level this resulted in having to shut the pump off several times in order to allow the well to recover.

QUALITY CONTROL ACTIVITIES INITIATED:

As part of the quality control procedures for the groundwater monitoring activites a Trip blank number 13 accompanied the samplers throughout the day and was sent to the lab for analysis.
Field notes of the samplers and chain of custody forms were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

A-E DAILY QUALITY CONTROL REPORT (DQCR)
COE-NIROP, Fridley, Minnesota
RMT, Inc. Project No. 1332 Contract No. DACA45-86-C-0015, Mod. No. P00003

DATE: February 19, 1988 AUTHOR: Ronald H. Vaughn

WEATHER: Note: Attach Additional Sheets as Necessary

A high of thirtysix degrees F., sunny, some light snow, winds out of the southwest at about 10-15 mph.

WORK PERFORMED:

A round of water levels was recorded from all 52 wells. Trash was picked up from all drill sites. Labled all new wells with a yellow paint stick. Returned the rental generator to Central Rental. Notified the following people:
Jerry Peavo from Hilltop Trailer Sales to pick up the office trailer on 2/26/88. The damaged steps were disscussed and Layne Northwest's address was given to Hilltop Trailer Sales.
Bill Gould from Collins Electric Co. to disconnect the electricity on 2/26/88.
Northwestern Bell to disconnect phone service also on 2/26/88.
Horizontal distances from AT-2 to 4-D, 6-D, 7-D, 5-S, 10-S, 11-S, 17-S, 24-S were measured.
In-situ hydraulic conductivity tests were preformed on wells 1-I, 4-I, 5-PC, 10-D, and 23-S.
Continued packing of the RMT office trailer.

SAMPLING PERFORMED:

None.

FIELD ANALYSIS PERFORMED:

None.

PROBLEMS ENCOUNTERED AND CORRECTIVE ACTIONS:

None

QUALITY CONTROL ACTIVITIES INITIATED:

Field notes of the In-situ hydraulic conductivity tests were reviewed for completeness and accuracy.

Site Coordinator Signature Ronald H. Vaughn

APPENDIX B

BOREHOLE LOGS AND WELL CONSTRUCTION DIAGRAMS

APPENDIX B - KEY TO BOREHOLE LOGS AND WELL CONSTRUCTION DIAGRAMS

AVAILABLE BOREHOLE LOG:	AND	AVAILABLE CONSTRUCTION DIAGRAM:	REPRESENTS:
6-D*, AT-2		AT-2	AT-2
5-S		5-S	5-S
6-S		6-S	6-S
8-S*		8-S	8-S
10-S*		10-S	10-S
11-S		11-S	11-S
10-D		15-S	15-S
7-D		17-S	17-S
8-D		18-S	18-S
14-D		22-S	22-S
23-S		23-S	23-S
6-D*		24-S	24-S
13-D		25-S	25-S
10-D		1-I	1-I
8-D		4-I	4-I
4-D		4-D	4-D
5-D		5-D	5-D
6-D*		6-D	6-D
7-D		7-D	7-D
8-D		8-D	8-D
10-D		10-D	10-D
13-D		13-D	13-D
5-PC		5-PC	5-PC

* Portions of original received from USACE were illegible.

BOREHOLE LOG WELL AT-2

CABLE-TOOL CUTTINGS

DEPTH (ft)	DESCRIPTION
0-5	Black organic top soil
5-40	Brown fine to coarse sand and rounded gravel
40-41	Sand & gravel; lg. gravel & cobbles (40'-41')
41-85	Brown sandy silty clay with little to some gravel

S.W.L. 22' 3:30 PM. 12-21-87

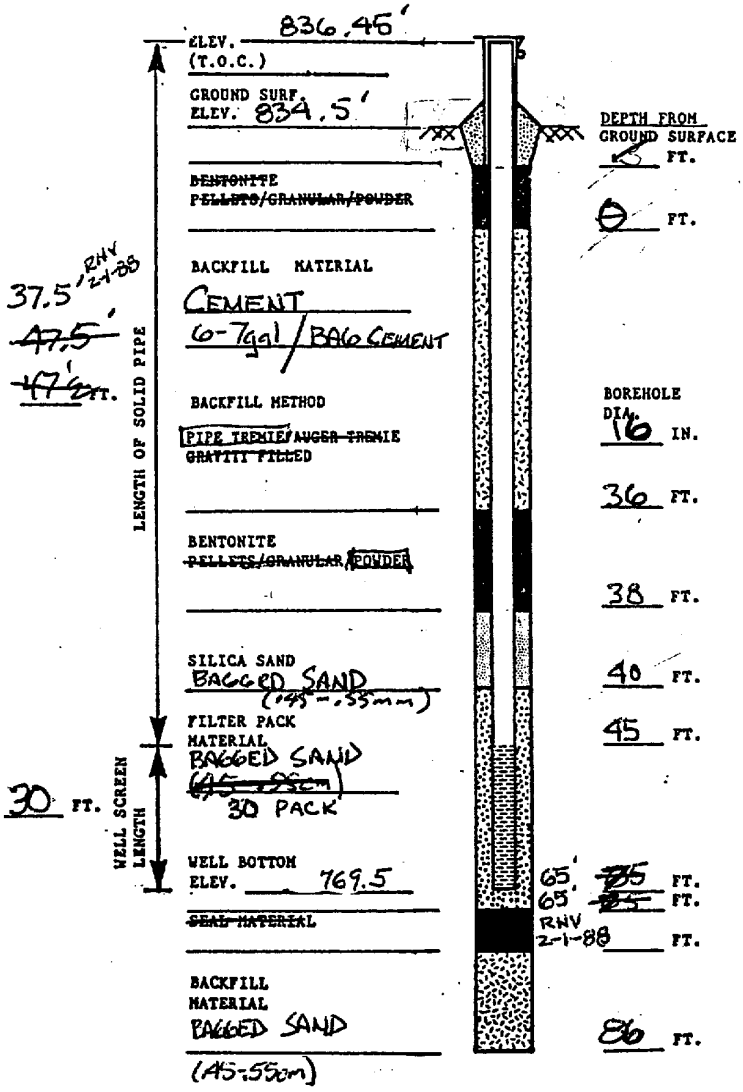
RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: ~~FRIDLEY, MN~~ COE-NTROP NO. 1332.32

WELL NO. AT-2

DATE INSTALLED 12-30-87



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON, OTHER~~ BLACK IRON

PIPE SCHEDULE (3/8 WALL) 30

B) TYPE OF PIPE JOINTS;

~~COUPLINGS, THREADED (W/TAPE?), OTHER~~ WELDED

C) WAS SOLVENT USED? YES OR [NO]

D) TYPE OF WELL SCREEN:

~~PVC,~~ [STAINLESS] ~~TEFLON, OTHER~~ _____

E) WELL SCREEN SLOT SIZE .040"

F) PIPE DIA: ID IN. 10 OD IN. 10 3/4

G) INSTALLED PROTECTOR PIPE W/LOCK? [YES] OR NO

PROTECTOR PIPE DIA. — IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, [PUMPING], SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.5 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 15,000 gal

ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, [OPAQUE]

E) WATER CLARITY AFTER DEVELOPMENT?

[CLEAR], SLIGHTLY TURBID, TURBID, ~~OPAQUE~~

F) ODOR? YES OR [NO] NTU = 3.20 (REB 7/5/88

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-17-88 (24.22') FT

DATE/TIME _____ FT

DATE/TIME _____ FT

ADDITIONAL COMMENTS: WELDED CENTRALIZERS
LOCKING WELL CAP

elevations checked 5/9/88

VCAK 3/22/89

DRILLING LOG	DIVISION	INSTALLATION	SHEET OF 4 SHEETS

1. PROJECT: Nonpoint Well [illegible]
2. LOCATION (Coordinates or Station): N1000 [illegible]
3. DRILLING AGENCY: [illegible]
4. HOLE NO. (As shown on drawing title and file number): 55
5. NAME OF DRILLER: [illegible]
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 40.3' Minimum
8. DEPTH DRILLED INTO ROCK: 0'
9. TOTAL DEPTH OF HOLE: 40.3'
10. SIZE AND TYPE OF BIT: [illegible]
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): [illegible]
12. MANUFACTURER'S DESIGNATION OF DRILL: [illegible]
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED: None; UNDISTURBED: None
14. TOTAL NUMBER CORE BOXES: ____
15. ELEVATION GROUND WATER: ≈ 200'
16. DATE HOLE: STARTED [illegible]; COMPLETED [illegible]
17. ELEVATION TOP OF HOLE: [illegible]
18. TOTAL CORE RECOVERY FOR BORING: ____ %
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		Topsoil			Started Drilling w/ 3⅞" Roller Rock Bit
			(Silty Sand)			Used clean water w/no bentonite
			brown			
			Non Plastic			
	1.0		Dense			
			V. Moist			
			V. Dk. Brown Black w/ Rootlets			Boring logged by drillcutting analysis
			Sand Fine to Med			
			w/ Occas. Coarse			
			Sand Fine grained			
	2.0		Silty Sand (SM)			
			Loose to Med Dense			
			Non Plastic.			
	3.0		Siliceous			
			Silt			
			Moist			
			Sand Fine to Coarse			
			Med Gray Brown			
	4.0		w/ V. Few Roots			
			w/ Occas. Fine to Coarse Gravel			
			Sand Clay (CL)			
			Med Stiff			
	5.0		Med to Low Plastic.			
			Siliceous			
			Moist			
			Dk Brown			
			Sand Fine to Coarse			
	6.0		Silty Sand			
			Med Dense			
			Non Plastic.			
			Siliceous			
			Moist			
	7.0		Gray			
			Sand Fine to Coarse w/ Occas. Fine Gravel			
	8.0		Clay			
			Med Stiff			
			Med. to Low Plastic			Drilled to 10'
			Siliceous			
			Moist			
	9.0		Brown			
			w/ Manganese Banding			
			Silty Sand			
			Med Dense Non Plastic.			
			Sand Moist Siliceous			
	10.0		Sand Fine to Coarse			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT [illegible] | HOLE NO.

DRILLING LOG	DIVISION M22	INSTALLATION Omaha	SHEET — OF — SHEETS

1. PROJECT Niobrara Water Control Project	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) SS	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10.5					Continued to Drill w/ clear water
	11.0		Silty Sand (SM) Med Dense Nonplastic Siliceous Moist lt to Med Brown Sand Sand fine to coarse Mostly Med to Coarse Wpocks. Fine to Coarse Gravel Wpocks. Zones containing higher concentrations of gravel			
	12.0					
	13.0					
	14.0					
	15.0					
	16.0					
	17.0					
	18.0					
	19.0					
	20.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT Niobrara Water Control HOLE NO.

DRILLING LOG	DIVISION MRD	INSTALLATION Omaha	SHEET 2 OF 4 SHEETS

1. PROJECT NIROP Monitoring Well Installation Program	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 35	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20.0		Silty Sand (SM) Med. Dense Non Plast. Siliceous Moist to Med. Brown Gray Sand Fine to Coarse Mostly Angular Fragments. w/ occas. Gravel zones			Drilled down to 20.4. Hole started sloughing, added 30 lbs of Inco Gel Bentonite/250 gal (Wyoming Source) 32 sec ACI 56 lbs/gal Hole stayed open after redrilling to 20.4
	21.0					
	22.0					
	23.0					
	24.0					
	25.0					
	26.0					
	27.0					
	28.0					
	29.0					
	30.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT NIROP Monitoring Well Installation | HOLE NO.

DRILLING LOG | NIROP | Omaha | OF 4 SHEETS

1. PROJECT: NIROP Monitoring Well Installation Phase I	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: US-Corps	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): ES	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0					
			Silty Sand (SM)			
	2.0		Med Dense Non Plast. Slightly Moist Lt. to Med Brown Sand Fine to Coarse Mostly Med-Coarse Occas. Pebble Fragments Occas Zones of Fine to Med Sand Occas Gravel Zones			Continued drilling w/ 3 5/8" D. Roller Rock Bit
	3.0					
	3.5					
	4.0					
						Terminated drilling @ 40.4 on 6-2-93
	5.0					Boring grouted to 37.3' before installation
	6.0					
	7.0					
	8.0					
			Bottom of Boring @ 40.4			
	9.0					
	10.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

No. 55

DRILLING LOG	DIVISION MRD	INSTALLATION Omaha	SHEET 1 OF 2 SHEETS

1. PROJECT Missouri River Mainstem Levees	10. SIZE AND TYPE OF BIT 5 3/8" Rock Roller
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) 6.1 MSL
3. DRILLING AGENCY USCE	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500
4. HOLE NO. (As shown on drawing title and file number) 55	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED — ; UNDISTURBED —
5. NAME OF DRILLER Krom	14. TOTAL NUMBER CORE BOXES —
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER ≅ 20.0'
	16. DATE HOLE: STARTED 6-2-83; COMPLETED 6-3-83
7. THICKNESS OF OVERBURDEN 40.3' Alluvium	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK 0'	18. TOTAL CORE RECOVERY FOR BORING — %
9. TOTAL DEPTH OF HOLE 40.3'	19. SIGNATURE OF INSPECTOR Mike Ford

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		6" Dia. Steel Protective Casing w/ Locking Lid			Permanent Stamp for 2" Dia. Instrument pipe = 1.66'
	1.99		1.99'			
			1.66'			
			Standard 2" Dia. Galv. Steel Threaded Cap (Vented)			Casing Painted International Safety Orange
	1.0		Where Pea Gravel Backfill			
			Standard 2" Galvanized Steel Riser Pipe			
	0.0					Top of Ground
	0.2		0.2'			Topsoil (0-1.0)
			6" Dia. Steel Casing with locking lid for support			Temporarily used on sure coupling connection
	1.0		Approximately = 6"			
			Cement Bentonite Grout Mixture			Silty Sand (SM) 1.0'-2.0'
						Grout is mixture of 2:1 vol. Ratio Cement to Bentonite
	2.0		2.0'			
	2.4		Bottom of 6" Dia. Protective Casing			Sand & Gravel (SW) (2.0'-40.0')
	2.6					
	3.0		Standard 2" Dia. Galv. Steel Riser Pipe			Silty Sand (SM) 4.0'-6.0'
						Sand (SW) 6.0-9.3
						Silty Sand (SM) 9.3'-40.0'
	9.3		9.3'			Fine Medium is Mixture of Coarse Sand + Fine Gravel Mostly Pea Gravel ± 3/4" (Gravel)
	10.0					
	10.4					
	10.6					
	13.1		13.1'			Painted Bentonite Seal (Inflated)
			Packing Device			Silty Sand (SM) 9.3'-40.0'
						Packing Device consists of 3'-8' lengths of steel banding material attached to instrument by 2-2½" Dia. Hose Clamps
	14.5		Washed Pea Gravel Fine Sand			
	15.5		15.5'			
	16.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO.

DRILLING LOG	M20	Omaha	OF 2 SHEETS

1. PROJECT Monitoring Well Installation NIKO	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 5S	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	15.0		Standard 2" O.D. Gray Green Fine			
	15.4					
	16.4					
	17.6		2" Dia. Stainless Steel Threaded Coupling welded together			Silty Sand (SM) 9.3'-40.3'
	17.9	17.0'	2" Dia. continuous wire wound threaded stainless steel screen .010 slot (Johnson)			
	18.2	18.0'				
	18.0					
	18.8					
	32					Silty Sand (SM)
	32.5	33.0'	Washed Coarse Sand and Pea Gravel Filter Pack			
	33.0	33.05'				
	33.8					
	37.6					Silty Sand (SM)
	37.8	37.8'	Natural Formation Slough Buffer gravel Pack Installation (Sand-Gravel Alluvium)			
	38					
	38.4					
	39.6					Silty Sand (SM)
	40.0					
	40.3	40.3'				Auger Installation. Measured W.L. = 19.39' Bottom of Installation Auger = 32.7' approx. 0.6' Fill

Bottom of Original Boring @ 40.3'

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT Niko Monitoring Well HOLE NO.

No. [illegible]

DRILLING LOG

DIVISION: [illegible]

INSTALLATION: [illegible]

SHEET 1 OF 4 SHEETS

1. PROJECT: Monitoring Well [illegible]
2. LOCATION (Coordinates or Station): [illegible]
3. DRILLING AGENCY: [illegible]
4. HOLE NO. (As shown on drawing title and file number): 65
5. NAME OF DRILLER: [illegible]
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 3.9' Alluvium
8. DEPTH DRILLED INTO ROCK: 0'
9. TOTAL DEPTH OF HOLE: 3.9'
10. SIZE AND TYPE OF BIT: 4 1/2" Roller Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): BH
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500 Hole Master
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8-Jar; UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: —
15. ELEVATION GROUND WATER: ≈ 20.1'
16. DATE HOLE: STARTED 6-6-83; COMPLETED 6-6-83
17. ELEVATION TOP OF HOLE: [illegible]
18. TOTAL CORE RECOVERY FOR BORING: —
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	0.0		Topsoil (Silty Sand) Non Plastic Moist Black			Started Drilling w/ 5 3/8 Roller Cone Bit
	0.5				D1	Pushed 3" split spoon
	0.9				0.2-0.0'	0'—2.0'
	1.0		Silty Sand (SM) loose to med dense Non Plastic. Moist to Saturated w/ orange Tinge Mottled w/ Some organic Material Sand Fine w/ occas. med. 1.5 Silty		0.2'	Rec. 1.7
					D2	Rep. 0'—0.5'
	2.0				0.4' 0.8'	Rep. 0.5'—4.0'
						Started Drilling w/ Clear water
	3.0		Colors range to Black w/ occas thin Partings of Coarse Sand 1. Silty approx 30%			
	4.0					Drilled to 5.2'
						Pushed 5.2'-7.2' w/ 3" O.D. Split spoon
	5.0		Colors range to dk. med. Gray Brown Silty approx 30% Sand Fine w/ occas. med. Sand. w/ occas. Orange Pebbles & Staining		D3	Rec. 1.3'
					5.8-6.3'	Rep. 4.0'—10.0'
	6.0					
	7.0					
	8.0					
	9.0					

FHC FORM [illegible] PROJECT [illegible] HOLE NO.

DRILLING LOG | MRD | Omaha | OF 4 SHEETS

1. PROJECT: NIROP Mon[illegible] Well [illegible] Proj	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY: US Corps	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
4. HOLE NO. (As shown on drawing title and file number): 65	
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10.0		(SM) Silty Sand; Med. Dense to Dense; Non Plast.; V. Sl. Cohe; Saturated; Med. Brown Gray Sand Medium Coarse; Occas. Fine; Occas. Fine Gravel max. dia. ± 1" sub angular to round; Silty approx 10-15%		Dry 10.4'-10.9'	Drilled and washed to 10.1'; Pushed 3" O.D. Split spoon 10.1'-12.1'; Rec. 0.9; Rep. 10.0'-12.0'; Encountered Groundwater @ approx. 20.1'
	13.0		Gravelly Sand (SP); Dense to V. Dense; Non Plast.; S. Moist; V. Moist; Med. Brown Gray Sand Medium Coarse; Occas. Fine Sand; Sl. Silty; Gravelly Fine to Coarse		D-5 13.1'-15.1'	Drilled to 13.0'; Drove 3" O.D. Split spoon w/ 300 LBS hammer 14.6'-16.5' w/ 0.4' bounce; Rec. 0.4'; Rep. 13.0'-15.0'
	15.0		Silty Sand (SM); Med. Dense to Dense; Non Plast.; V. Sl. Cohe; Saturated to V. Moist; Med. Brown Gray Sand Med. w/ occas. Coarse and Fine Sand; Silty approx 15%			Hole was drilled to complete [illegible] to water; Measured MWL 31 Sec AFE 8.6' LBS/sq.in.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT [illegible] | HOLE NO.

DRILLING LOG	DIVISION M22	INSTALLATION Omaha	SHEET 3 OF 4 SHEETS

1. PROJECT Monitoring Well NIRP Installation Proj	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 65	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20.0		(SM) Silty Sand Med. Dense to Dense Non Plastic V Sl. Cohesive Saturated Med. Brown Fine Sand Med. w/occ. Coarse and Fine Sand Silty approx 15%		D-6 20.0' 20.7'	Drilled to 20.0' Drove 3" O.D. split spoon 19.2'-21.0' including 0.8' slough Recovered 0.7' Excluding Slough Rep. 19.0'-23.0'
	21.0					
	22.0					
	23.0		Reduction in % gravel size w/ increase in % coarse sand Sand & Med. Coarse w/occ. Fine Sand			Drilled to 25.0' Slow accumulation required additional Bentonite mix. Added 100 lbs Bentonite circulating in hole measured: 34 sec. at 8.7 lbs/gal Drove 3" O.D. split spoon w/ 300 lbs Hammer 24.9' to 27.0' Rec. 0.6' sand 0.4' Foam Bottom of Spoon Rep. 23.0'-30.0'
	24.0				D-7 25.1' 25.6'	
	25.0					
	26.0					
	27.0					
	28.0					
	29.0					
	30.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT Monitoring Well HOLE NO.

DRILLING LOG | MAD | [illegible] | [illegible] OF 4 SHEETS

1. PROJECT: Monitoring Well [illegible]	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY: US-[illegible]	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED:
4. HOLE NO. (As shown on drawing title and file number): 65	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED: — COMPLETED:
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30.0		Silty Sand (SM) Dense Non-Plastic, V. Slightly Saturated to moderately Smooth into Wooden Space Sand and fine Gravel Rounded Max Diam 3"		30.0 30.3	Drilled to 30.0' 3" D.C. Drove Casing 30.0-32.0' w/300 LBS Hammer Rec. 0.3' Lost 0.4' from Bottom Shoe Rep 30.0'-35.9'
	31.0					
	32.0					
	33.0					Terminated Boring @ 35.9' on 6-6-83
	34.0					
	35.0					
	35.9		Bottom Boring 35.9'			
	36.0					
	37.0					
	38.0					
	39.0					
	40.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT [illegible] | HOLE NO.

DRILLING LOG	DIVISION MRD	INSTALLATION OMAHA	SHEET 1 OF 2 SHEETS

1. PROJECT Niagara Falls Storage Site	10. SIZE AND TYPE OF BIT 5 7/8 in Rotary
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY USACE	12. MANUFACTURER'S DESIGNATION OF DRILL Failing
4. HOLE NO. (As shown on drawing title and file number) 65	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED None; UNDISTURBED —
5. NAME OF DRILLER Keem	14. TOTAL NUMBER CORE BOXES —
6. DIRECTION OF HOLE ☒ VERTICAL ☐ ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN 35.9' Alluvium	16. DATE HOLE: STARTED 6-8-83; COMPLETED 6-7-83
8. DEPTH DRILLED INTO ROCK 0'	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE 35.9'	18. TOTAL CORE RECOVERY FOR BORING —
	19. SIGNATURE OF INSPECTOR [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			5 7/8 in Protective Steel Casing w/ locking lid			Permanent Stringpot 2 1/2 in Instrument Pipe = 1.65
	2.05					
	1.65'		Standard 2 in Galvanized Steel Threaded End Cap (Welded)			Protective Casing Painted Orange
	1.0		Grout Fill			
			2 in Galvanized Steel Riser Pipe			
	1.3					Top of Ground
	0.0					Topsoil (0.0'-0.5')
			1 1/2 in. Steel Support Tubing Welded to Casing			Silty Sand (SM) (0.5'-13.0')
	1.0					
	1.5					
	2.5					
	2.95		Cement-Bentonite Grout			Grout consists of Portland Cement and Bentonite mixture in 2 to 3 Vol. Ratio
	3.4'		Bottom of Protective Casing			
	10.6		Hole Dia approx 6"			
	11.6		Standard 2 in Galvanized Steel Pipe			Silty Sand (SM) (0.5'-13.0')
	11.6'					
	12.0		Failing Bentonite Seal (Hydrated)			4 couplings connected to pipe with teflon tape
	12.8'					
	13.0		Centering Device			13.0'
	13.4'					Gravelly Sand (SP) (13.0'-18.0')
	14.6		Washed Coarse Sand and Pea Gravel Filter Pack			Centering Device Composed of 2-2 in Dia Hose Clamps Securing 3-2 in Steel Banding Straps to pipe
	14.2'					
	15.0					

ENG FORM 1836 PROJECT HOLE NO.

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	16.0		Standard 2" Dia. Galv. Steel Riser Pipe			Gravelly Sand (SP) (13.0 - 18.0')
	16.2		Washed Coarse Sand Pea Gravel Filter Pack			Filter Medium consists of washed pea gravel (1/4" - 3/8" Dia) w/ occas. coarse sand
	17.6					
	17.8'		2" Dia. Stainless Steel Threaded Coupling (welded to screen)			
	18.0					18.0' Silty Sand (SM)
	31.6		2" Dia. Continuous Wire Wound Stainless Steel Screen .010" Slot (Johnson)			Silty Sand (SM) (18.0 - 32.0')
	32.0					
	32.05					
	33.0					After Installation of gravel pack, drilling was thinned up w/ clean water
	33.2'					
	33.7		Natural Formation Sand accumulated before gravel pack installation (Sand & Gravel Alluvial Deposit)			Total Instrument Bottom @ 32.91' Instrument Clean w/ Visual Inspection No Fill in
	34.0					
	35.0					Water Depth 20.45'
	35.0'					
	35.9		Bottom of 6" Dia. Boring			
	36.0					

ENG FORM 1077 PROJECT HOLE NO.

DRILLING LOG	MRD	OMAHA	OF 2 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT: 6" Big Hollow Stem Auger
2. LOCATION (Coordinates or Station): FRIDLEY, MN	11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
3. DRILLING AGENCY: USCE-C	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75
4. HOLE NO. (As shown on drawing title and file number): B-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED
5. NAME OF DRILLER: M O'MALLEY	14. TOTAL NUMBER CORE BOXES: N/A
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER:
	16. DATE HOLE: STARTED 6/10/85; COMPLETED 6/13/85
7. THICKNESS OF OVERBURDEN: 30' +	17. ELEVATION TOP OF HOLE:
8. DEPTH DRILLED INTO ROCK: 0	18. TOTAL CORE RECOVERY FOR BORING: N/A %
9. TOTAL DEPTH OF HOLE: 30'	19. SIGNATURE OF INSPECTOR: Thomas [illegible]

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	~~SAMPLE RECOVERY~~ (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			Topsoil			Surface gravel layer
			Med. Dense			
			Moist			
	1.0		Black			
			clayey gravel			
			Sandy			
	2.0					
	3.0					
	4.0					
				4.5		
			SAND	5	D-1	
			Loose	4	4.5-5.5	Tube [illegible]
	5.0		Med	5		
			Sl silty	4		
			xs fine gravel	5		
			Lt. yellowish Brown	4		
	6.0		Med grained	6.0		
			lean clay			
			greenish gray			
	7.0					
	8.0					
	9.0					
	10.					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS | HOLE NO. B-5

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | **Hole No.** 8-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SILT	5		
				4	D-4	
				5		
	11			6		
				8		
	12					
	13					
	14					
	15			15.0		
				7	D-3	
	16			0		
			occas sandy gravel layers	12		
	17					
	18					
	19					
			SILTY SAND			
	20			5		
				2		
	21					
	22					

FNG FORM | PROJ | HOLE NO

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. B-5

PROJECT: NIPOR WELLS | INSTALLATION: OMAHA | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SILTY SAND (SM)			
	23.0					
	24.0					
						SAND ~5'
	25.0			25.0		
				3	D-5	
				2	25-	
				3	25.5	
				7		Fill [illegible]
	26.0			5		
				7		
				[illegible]		
	27.0					
			Soil [illegible]			
	28.0					
				28.5		Soil [illegible]
				5	D-6	
				11	28.-	
	29.0			5	30	
				2		
				5		
				2		
	30.0		Bottom of Series	30.0		

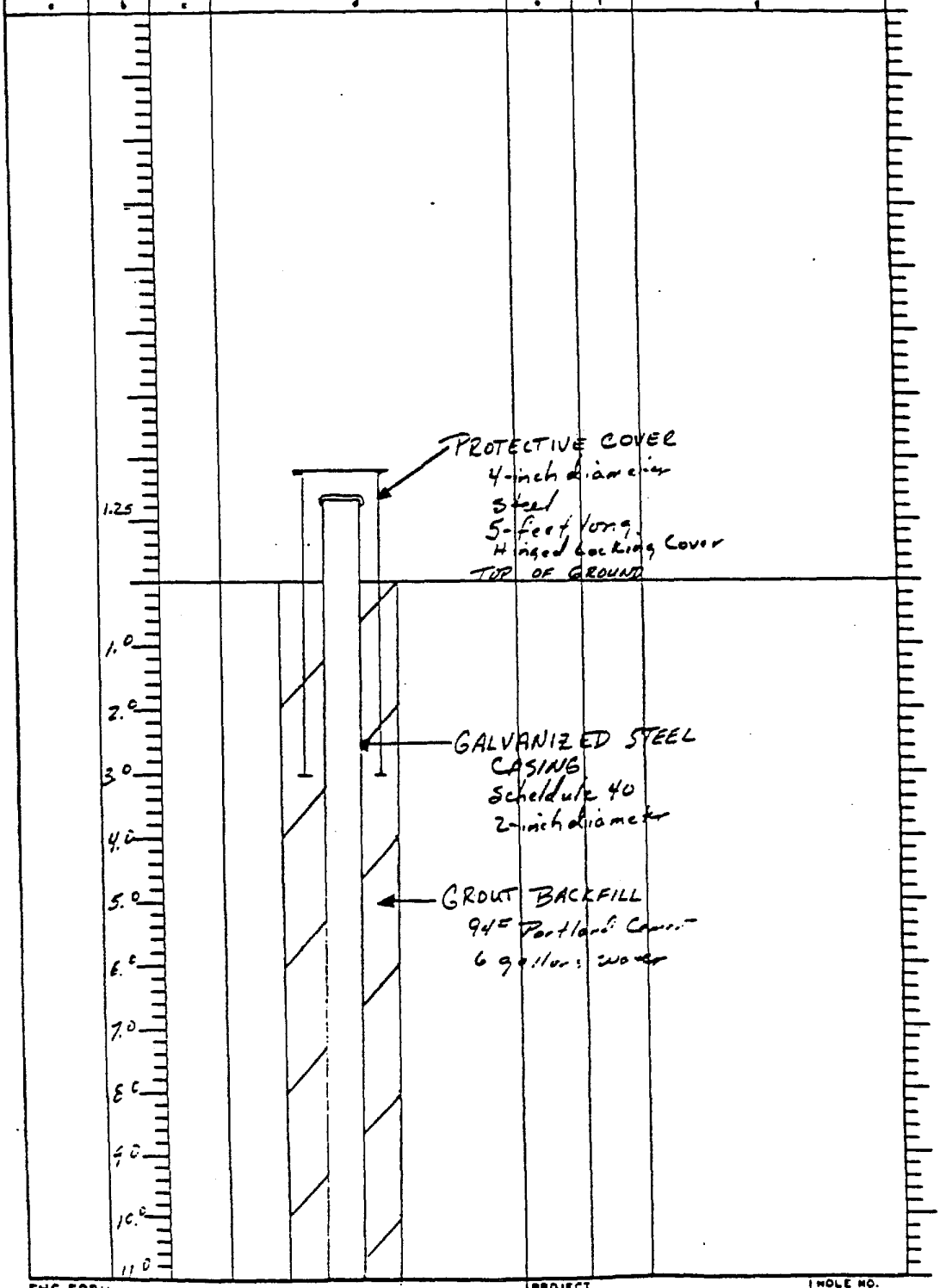
FIG. FORM [illegible] (PD 1110-1-1801) [illegible] | PROJECT [illegible] | HOLE NO. B-5

Hole No. 5-5

DRILLING LOG	DIVISION MRC	INSTALLATION OMAHA	SHEET 1 OF 1 SHEETS

1. PROJECT NIFOF WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) Fridley, Mn	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY [illegible]	12. MANUFACTURER'S DESIGNATION OF DRILL CME-75
4. HOLE NO. (As shown on drawing title and file number) 8-5	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER [illegible]	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

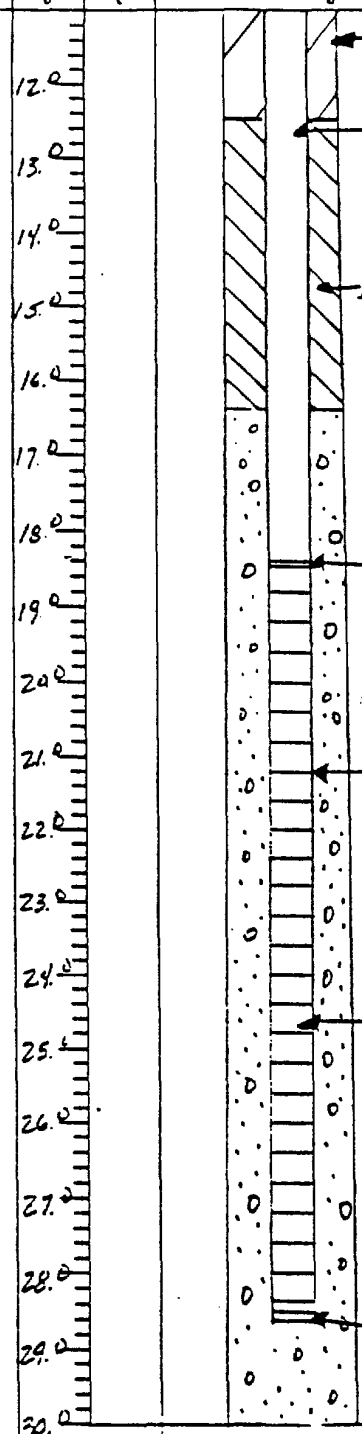


ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT [illegible] HOLE NO. [illegible]

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. B-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF-620-603 | PROJECT: NIROP WELLS | HOLE NO. B-5

DRILLING LOG | MRD | OMAHA | OF 1 SHEETS

1. PROJECT: Niio P Wells
2. LOCATION (Coordinates or Station):
3. DRILLING AGENCY: US-CE-C
4. HOLE NO. (As shown on drawing title and file number): 10-S
5. NAME OF DRILLER: M. O'Malley
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT: 6" OD Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6 | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6/7/85 | COMPLETED 6/7/85
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Tom McDaniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Topsoil			
			Clayey Sand (SC) Med. Dense Moist Black			
	1.0					
			SAND, silty, gravelly (SP) Med. Dense Moist lt. Brown Subrounded			
	2.0					
	3.0					
	4.0			4.5		
				6	D-1 4.5-6.0	Rec = 1.5'
	5.0			6		
				5		
	6.0			6.0		
	7.0					
	8.0		Turning light yellowish brown			
	9.0			5		
	10.0			5		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIIO P WELLS | HOLE NO. 10-S

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | **Hole No.** 10-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND, silty (SP)	5		
			MEDIUM	10		
			Moist	5		
	11.0		Lt Brown slt yellow	11		
			w/ some fine - med.			
			subrounded			
	12.0					
	13.0					
	14.0					
				14.5		
				5	D-3	Rec = 1.5'
				5	14.5-15.5	
	15.0					
				5		
				2		
	16.0		FINE GRAVEL	16.0		
	17.0					
	18.0		SAND (SP)			
			Loose			
			Moist - Wet			
	19.0		Brown			
			fine - med.	19.5		
			Subrounded			
				3		
	20.0			3		
				4		
	21.0					
	22.0					

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1980 OF-626-601

PROJECT: NIROP WELLS | HOLE NO. 10-5

DRILLING LOG (Cont Sheet)

Hole No. 10-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Sand Med. Dense Saturated			
	23.0		Gray Med to med - coarse grained sub-rounded quartz gravelly - up to 1½" max dia.			
	24.0			24.5		Heaved
				S 8	D-5 24.5 -26	Full barrel
	25.0			S 4		
				S 28		Gravel in barrel
	26.0			26.0		
	27.0					
	28.0					Sand heaved up [illegible]
	29.0		SAND (SP) Loose Soft Lt. Gray Med - fine sub-rounded sand [illegible] gravel			
	30.0			[illegible]		
				S 4	D-6 30.3	Rec = 1.5'
	31.0			S 5	31.8	
				S 2		
	32.0			31.8		
	33.0					
	34.0					

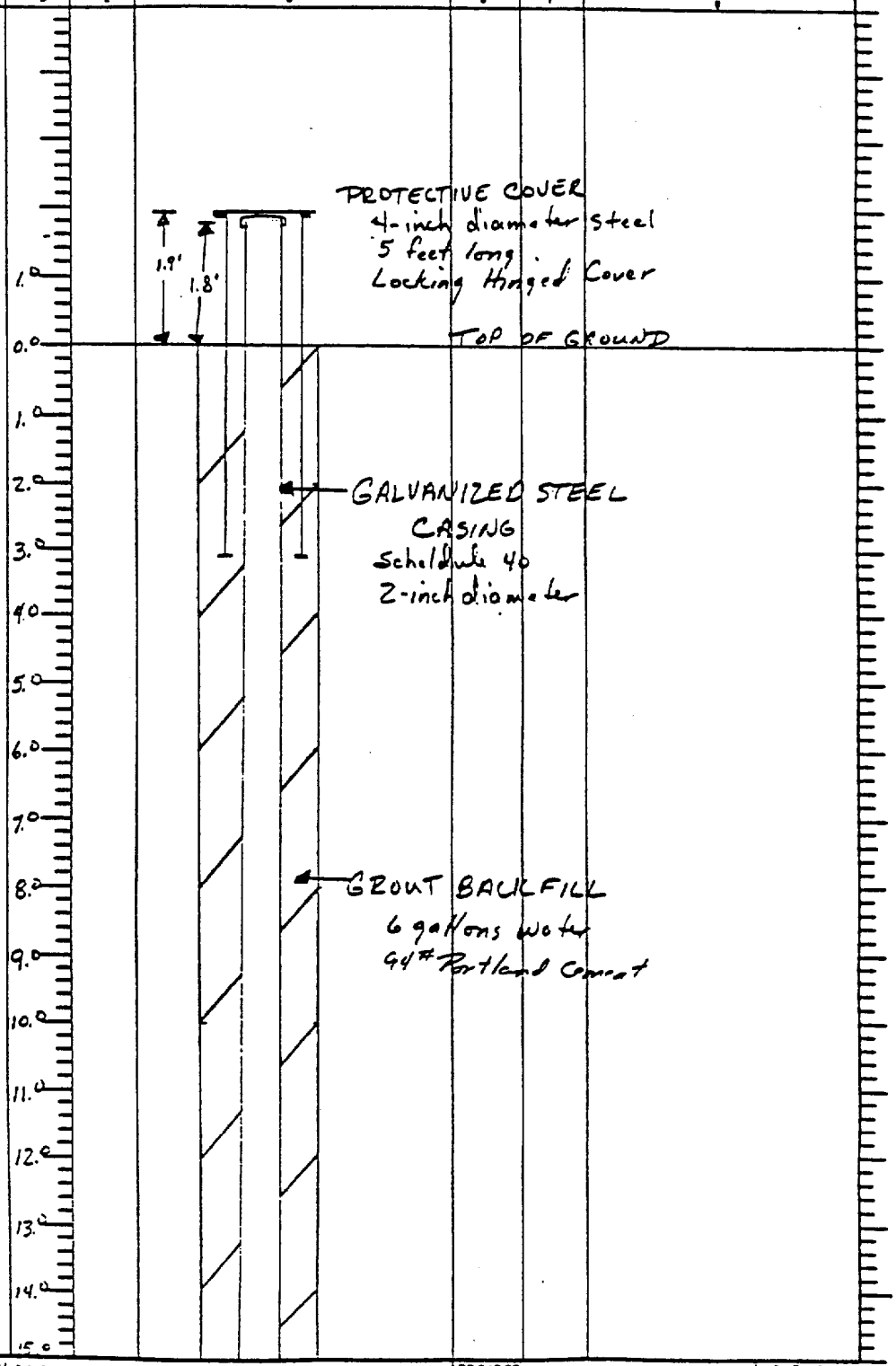
ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1960 OF-620-606

PROJECT: NIROP WELLS | HOLE NO. 10-5

DRILLING LOG | MRD | OMAHA | OF 2 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): FRIDLEY, MN	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 10-S	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: N. O'Malley	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED / COMPLETED 6/7/85
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR: Tomara McDaniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



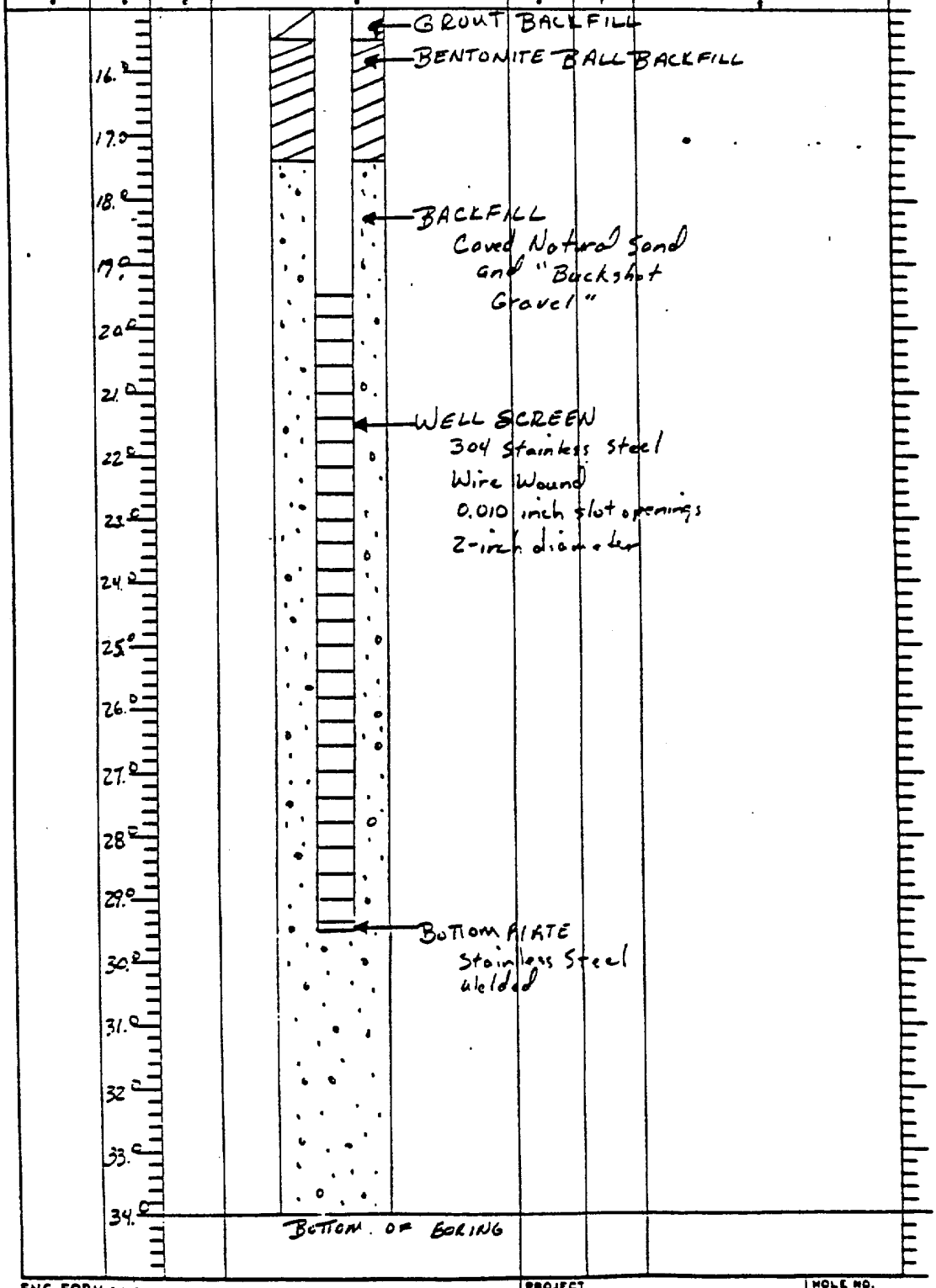
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: NIROP WELLS | HOLE NO. 10-S

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT: MIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 10-S	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG	DIVISION MRD	INSTALLATION OMAHA	SHEET 1 OF 3 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station): Fifley Mo
3. DRILLING AGENCY: US-CE-C
4. HOLE NO. (As shown on drawing title and file number): 11-5
5. NAME OF DRILLER: M. O'Molley
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 3 5'+
8. DEPTH DRILLED INTO ROCK: 0'
9. TOTAL DEPTH OF HOLE: 3 5'
10. SIZE AND TYPE OF BIT: 6" Open ~~+~~ + bailer
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): Stem angle
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0 / UNDISTURBED
14. TOTAL NUMBER CORE BOXES: —
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 6/6/85 COMPLETED 6/6/85
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Thomas W. Daniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			CLAYEY SAND (SC)			
	1.0		Med. Dense			
			Moist			
			Black			
	2.0		Medium Grained			
			Mostly subrounded			
	3.0					
	4.0					
			SAND (SP)			
	5.0		Med. Dense - Loose			
			Moist			
	6.0		Reddish Brown w/ mottled white + black little clay			
			Mostly medium grained			
			Subrounded			
	7.0		[illegible]			
	8.0					
	9.0					
	10.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT [illegible] HOLE NO.

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 11-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med. Dense - Loose Moist Reddish brown w/ [illegible] little clay reacting [illegible] possible [illegible]			
	11.0					
	12.0					
	13.0					
	14.0		SAND (SP), silty Med. Dense Brown Finer grained some silt subrounded			
	15.0					
	16.0					
	17.0					
	18.0					
	19.0					chatter from cobbles
	20.0					
	21.0					
	22.0					

ENG FORM 1836-A JUN 67 (ER 1110-1-1801) GPO 1969 OF-620-603

PROJECT: NIROP WELLS | HOLE NO. 11-5

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 11-5

PROJECT: NIROP WELLS | INSTALLATION: OMAHA | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDY CLAY (SC) Med. Stiff Wet - Sat'd Reddish brown Very Sandy subrounded grains medium grained sand occ. gravel			
	23.0					
	24.0					
	25.0					
	26.0					
			SAND Med. Dense - Dense Sat'd Brown Mostly med grained subrounded sand some silt			
	27.0					
	28.0					
	29.0					
	30.0					
	31.0					
	32.0					
	33.0					
	34.0		Bottom of Boring			

ENG FORM 1836-A JAN 67 (ER 1110-1-1801) GPO 1980 OF-625-603 | PROJECT: NIROP WELLS | HOLE NO. 11-5

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): FRIDLEY, MN	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 11-S	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: M. O'Molley	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED 6/6/85
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR: Tomasen McDaniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1.8		PROTECTIVE COVER 4-inch diameter steel 5 feet long Locking Hinged Cover			
	1.0		1.8'			
	0.0		TOP OF GROUND			
	1.0		GALVANIZED STEEL CASING Schedule 40 2-inch diameter			
	2.0					
	3.0					
	4.0		GROUT BACKFILL 6 gallons water 94# Portland Cement			
	5.0					
	6.0					
	7.0					
	8.0					
	9.0					
	10.0					
	11.0					
	12.0					
	13.0					
	14.0					
	15.0		BENTONITE BALL BACKFILL			
	16.0					
	17.0					
	18.0		SAND BACKFILL			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

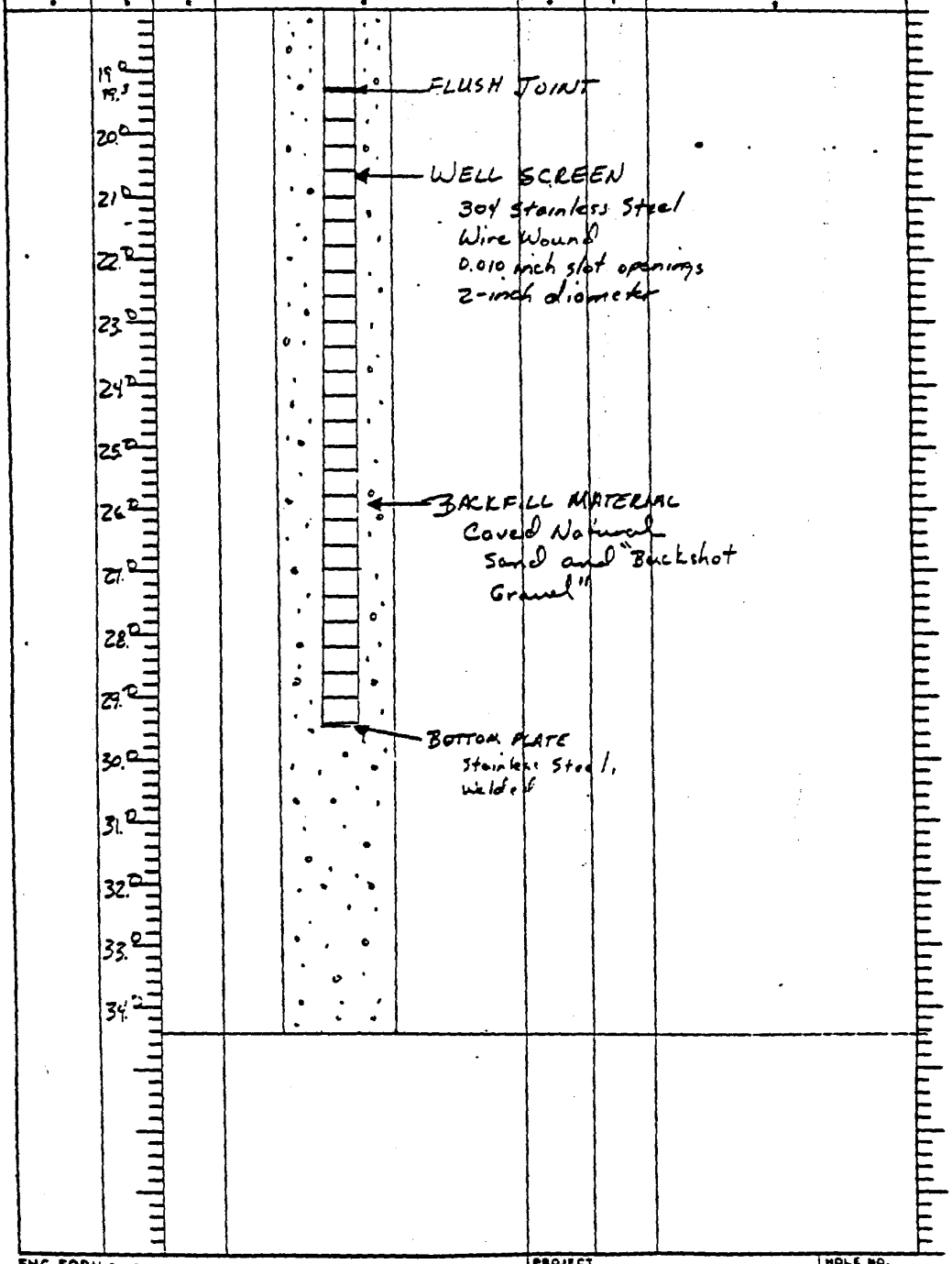
PROJECT: NIROP WELLS

HOLE NO. 11-S

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 11-S	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT NIROP WELLS

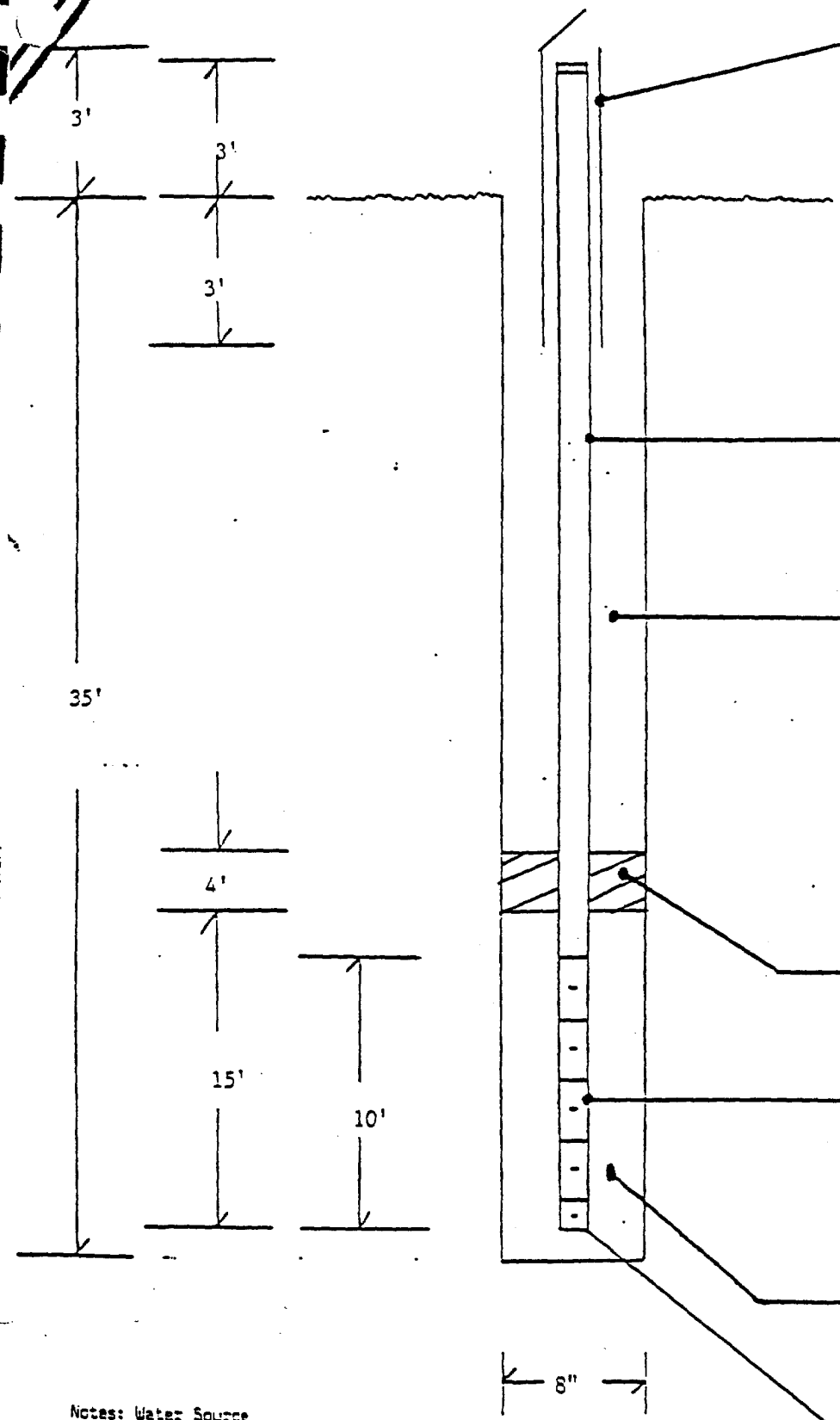
HOLE NO. 11-S

OBSERVATION WELL INSTALLATION DIAGRAM

WELL NO. 15-S

Site FMC Date: 1/8/86

By: Bergerson-Caswell Project No.: 85-20



Protective Casing **Guard Posts**

Type Steel Vented yes No. 3
Diameter 6" Locked yes Type
Length 6' Key# 10'519

Plug

Type Vented

Pipe

Type 2 "Schedule 40
O.D. 2 5/8" Manufacturer S Sr
I.D. 2 "
Length per sec. 21 No. of Sec.

Cement-Bentonite Grout

Mix 6 Cement 1 Bentonite
Cement 600 lbs. + Bentonite 50 lbs.
Water 42 gals.
Total quantity gals. 42
Manufacturers Portland & National

Joints

Threaded Flush No T & C
Teflon taped No
Manufacturer

Seal

Powder/Pellets Quant. 5 gal
Hydrated 10 gal., Time 1 hr

Screen

Type S.S. Slot Size .010
O.D. 2 5/8 No. Slots/ft.
I.D. 2" Schedule Wire Wo
Length per sec. 10' No. of sec.
Manufacturer Johnson

G.Pack

Type Eau Claire #30
Source American Sand &
Volume 10 bags gal.

Plug

Type
Water 200 gal. PDS

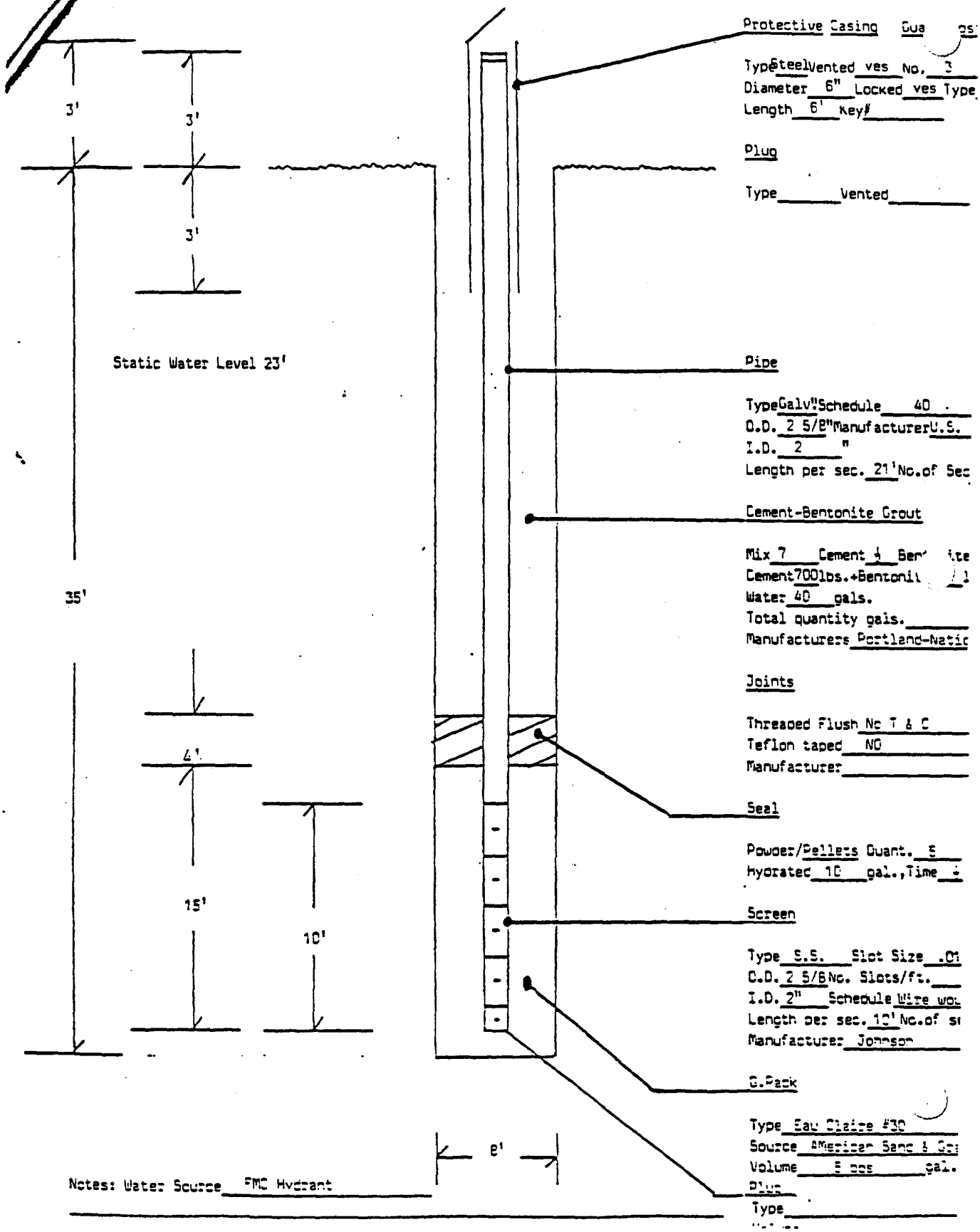
Notes: Water Source FMC Hydrant

OBSERVATION WELL INSTALLATION DIAGRAM

WELL NO. 17-S

Site FMC Date: 2/6/86

By: ~~Bergerson-Caswell, Inc~~ Project No.:



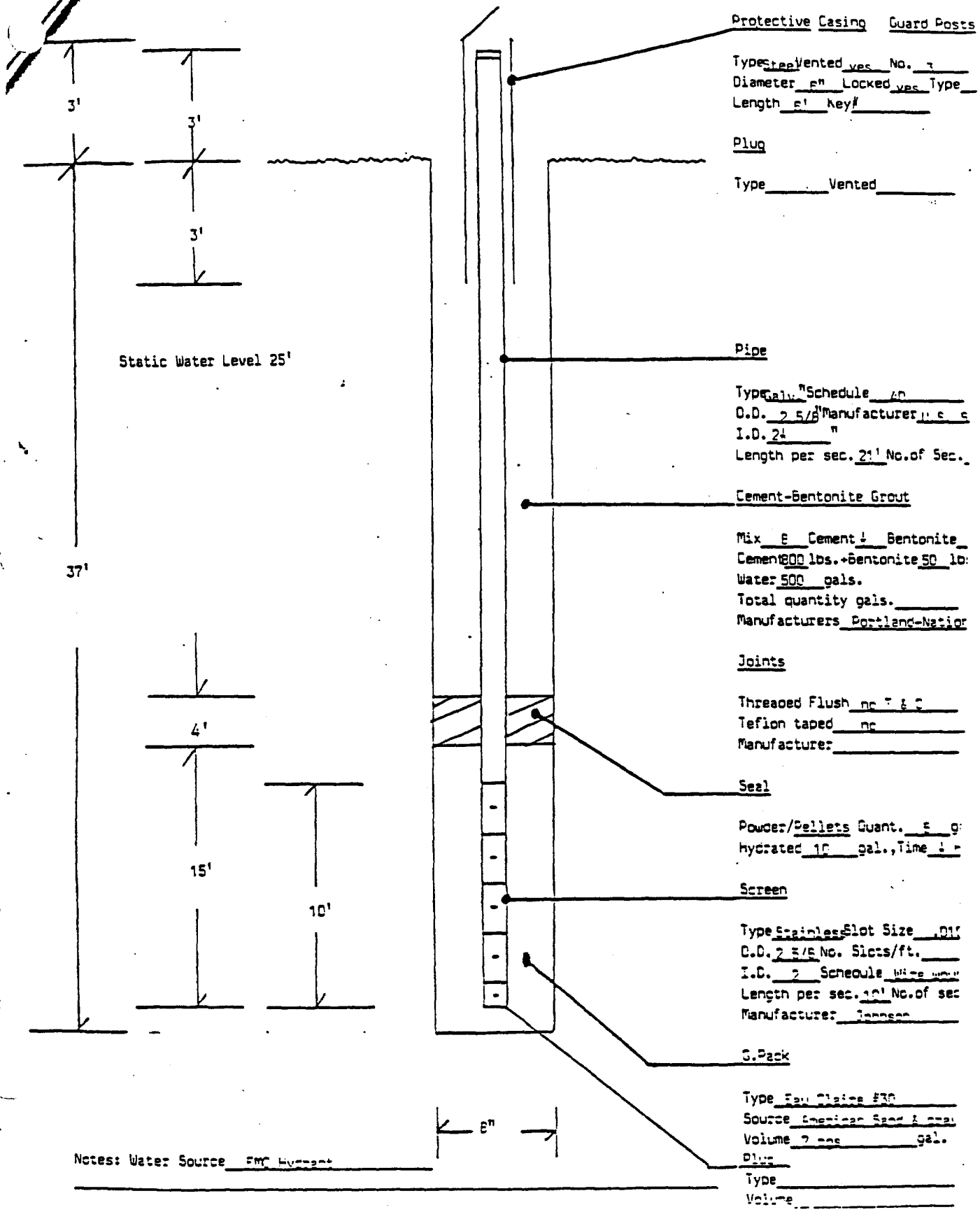
Notes: Water Source FMC Hydrant

OBSERVATION WELL INSTALLATION DIAGRAM

WELL NO. 18-S

Site FMC Date: 2/6/86

By: Bergerson-Caswell, Inc. Project No.:

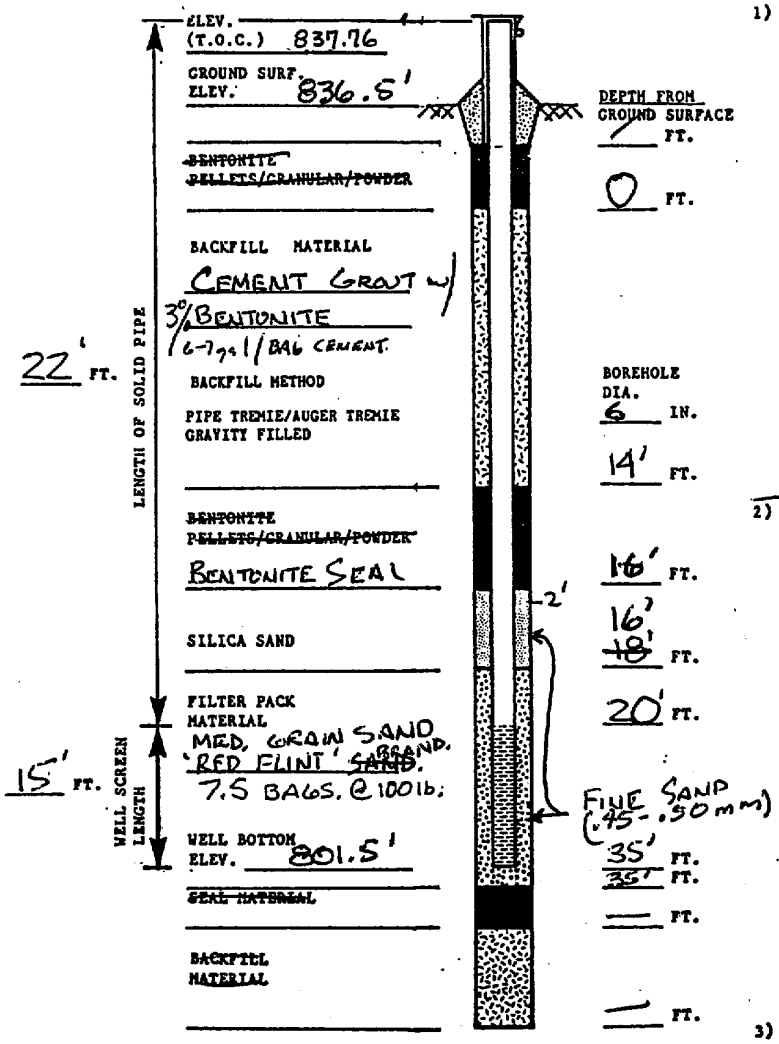


Notes: Water Source FMC Hydrant

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: NIROP NO. 133232
WELL NO. MW-22 S
DATE INSTALLED 12-11-87



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON, OTHER~~ BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?) YES-TEFLON ~~OTHER~~

C) WAS SOLVENT USED? ~~YES OR~~ NO

D) TYPE OF WELL SCREEN:

~~PVC,~~ STAINLESS, ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2" OD IN. 2 5/16"

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 6.5" IN. O.D.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.5 HRS.

C) APPROXIMATE WATER VOLUME: REMOVED 450 gal
ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, OPAQUE NTU = 2.0 (KEB 7/5/8

F) ODOR? YES OR NO

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (24.80') F

DATE/TIME F

DATE/TIME F

ADDITIONAL COMMENTS: 12 BAGS OF CEMENT PLACED IN THE ANNUALAR SPACE OUTSIDE OF WELL.
1 BAG OF BENTONITE ~~WERE~~ WAS ADDED.
2-CENTRALIZERS.

elevations checked 5/9/88 CAK

VCAK 3/22/88

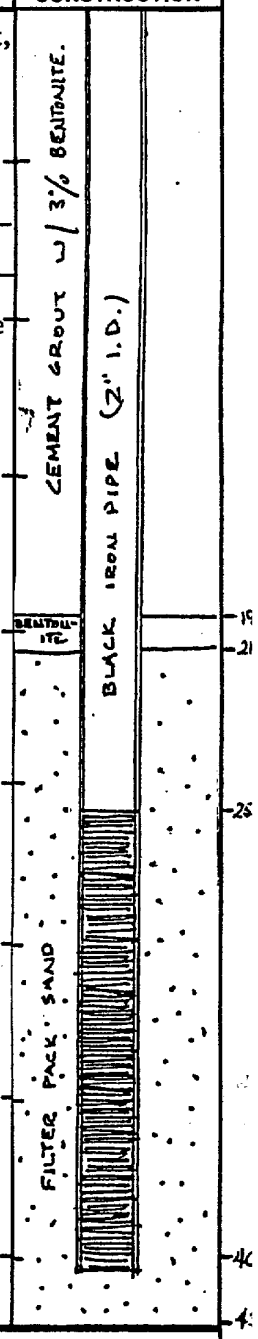
LOG OF TEST BORING

RMT INC

BORING NO.:	23-S
SHEET	1 of 1
PROJECT:	COE-NIROP
PROJECT NO.:	1332.32
LOCATION:	Fridley, MN
SURFACE ELEVATION:	844.6
DRILLED BY:	Layne-Northwest - Milwaukee
DATE STARTED:	2/11/88
DATE COMPLETED:	2/15/88
CREW CHIEF:	Ross Goldbeck
LOGGED BY:	MSM
CHECKED BY:	BWR/ 3/7/88

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
1	1" Grab				Dk. brown, SAND, fine to med., some silt, trace of clay (topsoil)
2	Grab				
				5	Brown, SAND, fine, trace of silt
	6"				Black SAND, fine to med, trace of clay
3	Grab				
4	Grab			10	Brown, SAND, fine to coarse, little fine gravel (alluvium)
	11"				
5	SS				
6				15	Brown, SAND, fine to coarse, and fine gravel
	16"				
7	SS				
8				20	Brown, SAND, fine to coarse, and fine gravel
	21"				
9	SS				
10				25	Brown, SAND, fine to med.
	26"				
11	SS				
12				30	Brown, SAND, fine to med., trace coarse sand
	31"				
13	SS				
14				35	Brown, SAND, fine to coarse.
	36"				
15	SS				
16					Brown, SAND, fine to coarse.
17	41"			40	
18	SS				EOB @ 43'

GENERAL WELL CONSTRUCTION

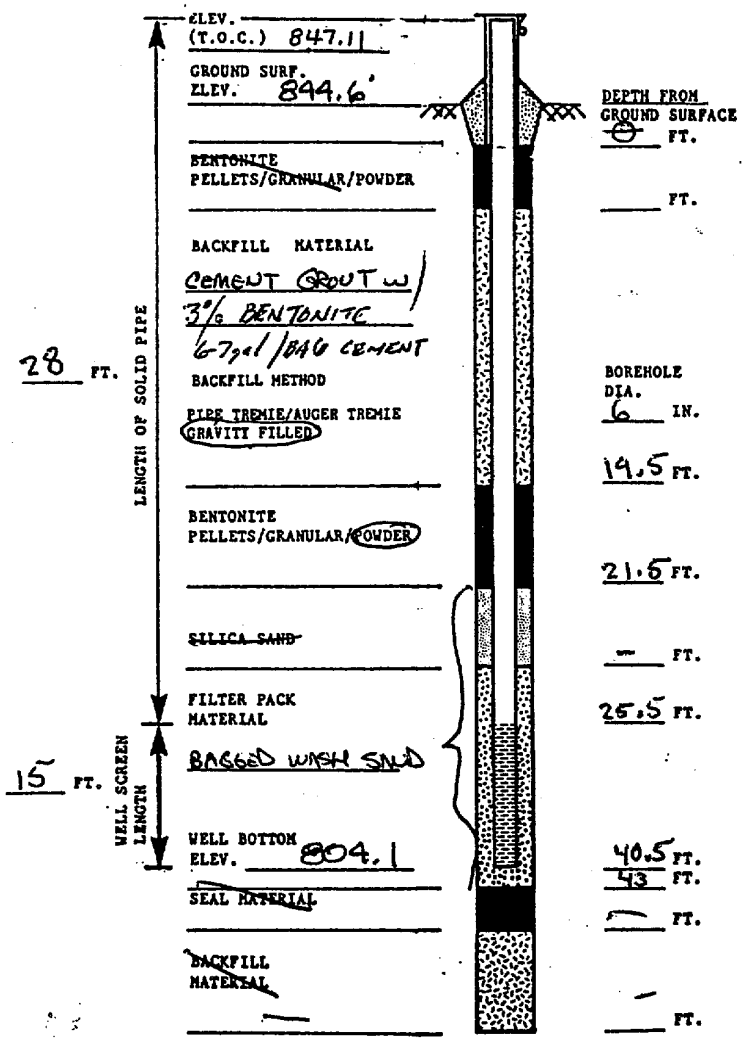


NOTES	WATER LEVEL OBSERVATIONS			
DRILLING METHODS: Cable tool	FIRST OCCURENCE:			
	DATE/TIME	2/12/88 - 12:40p	2/15/88 9:30a	
BOREHOLE DIAMETER: 8.0"	DEPTH TO WATER	35'	31'	
DRILL RIG: Bucyrus - Erie ZOR	DEPTH TO CAVE IN			

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: COE - NIROP NO. 1332.32
WELL NO. 23S
DATE INSTALLED 2-15-88 1:00pm



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, (OTHER) BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

(COUPLINGS), THREADED (W/TAPE?), OTHER W/TEFLON TA

C) WAS SOLVENT USED? YES OR (NO)

D) TYPE OF WELL SCREEN:

PVC, (STAINLESS), TEFLON, OTHER

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2 OD IN. 2 5/16

G) INSTALLED PROTECTOR PIPE W/LOCK? (YES) OR NO
PROTECTOR PIPE DIA. 6 IN.

2) WELL DEVELOPMENT

A) METHOD

~~BAILING~~, (PUMPING), ~~SURGING, COMPRESSED AIR~~

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2HRS

C) APPROXIMATE WATER VOLUME: REMOVED 480 gal
ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, [TURBID], OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

[CLEAR], SLIGHTLY TURBID, TURBID, OPAQUE NTU=1.1 (KEB 7/5/88)

F) ODOR? ~~YES OR~~ [NO]

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 31' 9:30AM 2-15-88 FT

DATE/TIME FT

DATE/TIME FT

ADDITIONAL COMMENTS: 2 STAINLESS STEEL STABILIZERS PUT ON WELL CASING. ~~ONE ABOVE SCREEN AT ABOUT 16' FROM BOTTOM, AND ANOTHER AT 37' FROM BOTTOM.~~ RAV 3-22-88

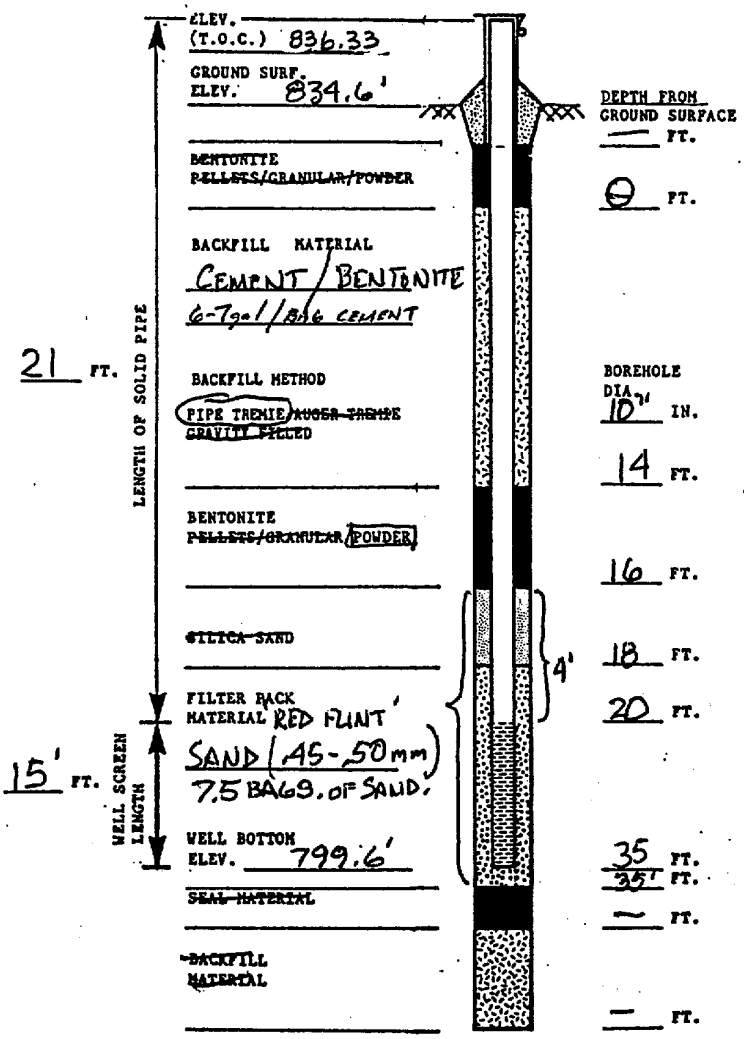
elevations checked 5/9/88 CAK

CAK 3/22/

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: NIROP NO. 1332.32
WELL NO. MW-24S
DATE INSTALLED 12-18-87



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON,~~ [OTHER] BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, [THREADED (W/TAPE?)], OTHER ~~YES: TEFLON~~ YES: TEFLON

C) WAS SOLVENT USED? ~~YES OR~~ [NO]

D) TYPE OF WELL SCREEN:

~~PVC,~~ [STAINLESS], ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2" OD IN. 2 5/16"

G) INSTALLED PROTECTOR PIPE W/LOCK? [YES] ~~OR NO~~
PROTECTOR PIPE DIA. 6.5 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, [PUMPING, SURGING,] COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.5 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 450 gal
ADDED

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, [OPAQUE]

E) WATER CLARITY AFTER DEVELOPMENT?

[CLEAR], SLIGHTLY TURBID, TURBID, [~~OPAQUE~~ SLIGHTY]

F) ODOR? YES OR [NO] NTU = 0.62 (KEB 7/5/88

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (24.12') FT

DATE/TIME _____ FT

DATE/TIME _____ FT

ADDITIONAL COMMENTS: 2 CENTRALIZERS USED.
12 BAGS OF CEMENT / 1.3 ~~BENTONITE~~ BAGS OF BENTONITE.

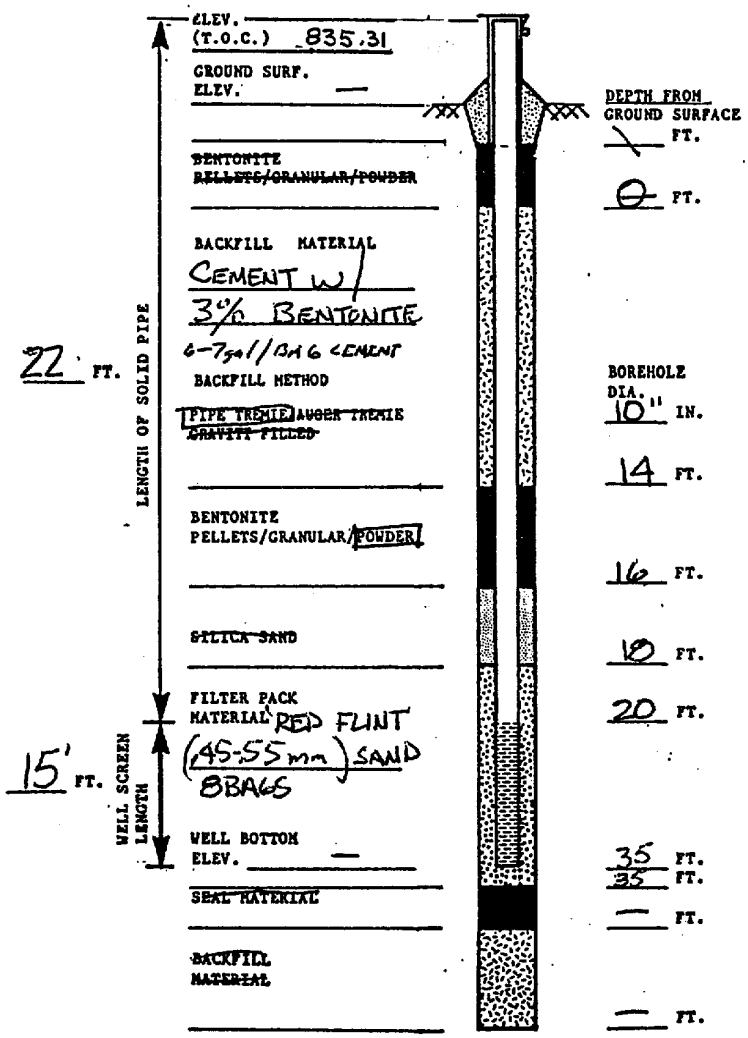
elevations checked 5/9/88 CAK

VCAK
3/22/10

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: NIROP NO. 1332.32
WELL NO. MW 25-S
DATE INSTALLED 12-21-87



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON, OTHER~~ BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?) YES: TEFLON OTHER

C) WAS SOLVENT USED? ~~YES OR~~ NO

D) TYPE OF WELL SCREEN:

~~PVC,~~ STAINLESS ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2" OD IN. 2 5/16"

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 6.5 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 3.0 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 540gal
ADDED

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR NO NTU = 0.42 (KEB, 7/5/88)

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (22.42') FT.

DATE/TIME FT.

DATE/TIME FT.

ADDITIONAL COMMENTS: 2 CENTRALIZERS INSTALLED.
1 BAG BENTONITE / 11 BAGS CEMENT @ (6-7gals/BAG OF CEM)

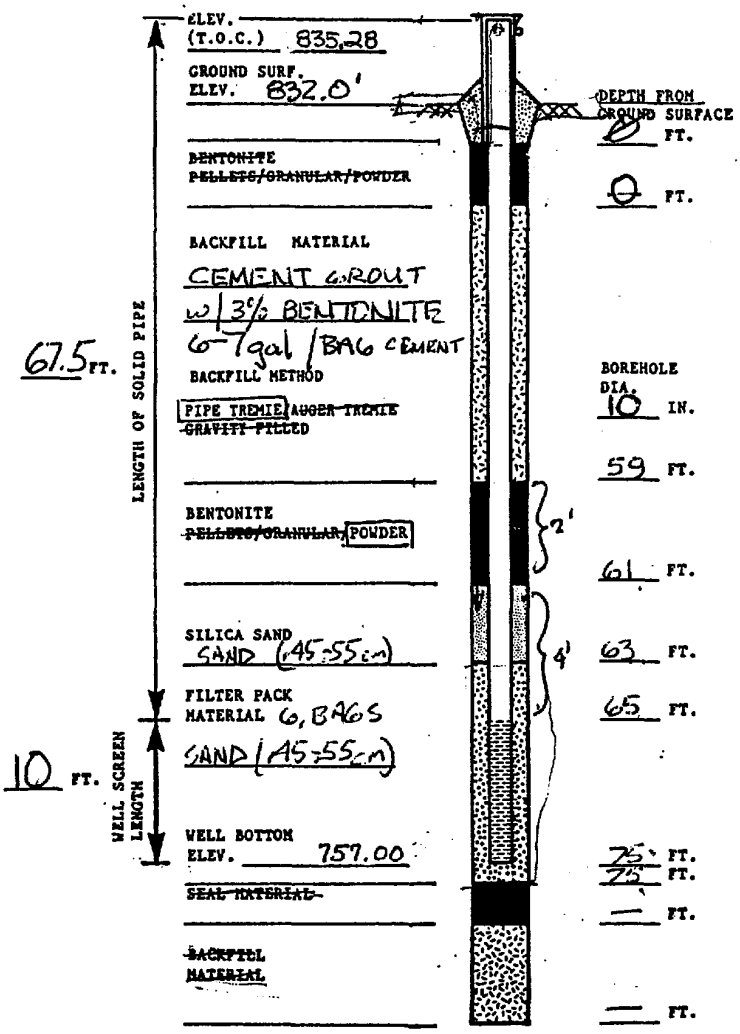
elevations checked 5/9/88 CAK

VCAK 3/22/88

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: NIROP NO. 1332.32
WELL NO. 1-I
DATE INSTALLED 1-15-88



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON, OTHER~~ BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

~~COUPLINGS~~, THREADED (W/TAPE?) YES: TEFLON, ~~OTHER~~

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

~~PVC~~, STAINLESS, ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2 OD IN. 2 5/16

G) INSTALLED PROTECTOR PIPE W/LOCK? YES ~~OR NO~~
PROTECTOR PIPE DIA. 6" IN.

2) WELL DEVELOPMENT

A) METHOD

~~BAILING~~, PUMPING ~~SURGING, COMPRESSED AIR~~

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.5 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 450 gal
ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, ~~OPAQUE~~ SLIGHTLY

F) ODOR? YES OR NO NTU = 3.4 (KEB 7/5/88)

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (21.94') FT.

DATE/TIME — FT.

DATE/TIME — FT.

ADDITIONAL COMMENTS: 3 CENTRALIZERS INSTALLED.
40 ~~35~~ BAGS CEMENT PUT DOWN HOLE @ 6-7gal/BAG
~~40 BAGS~~

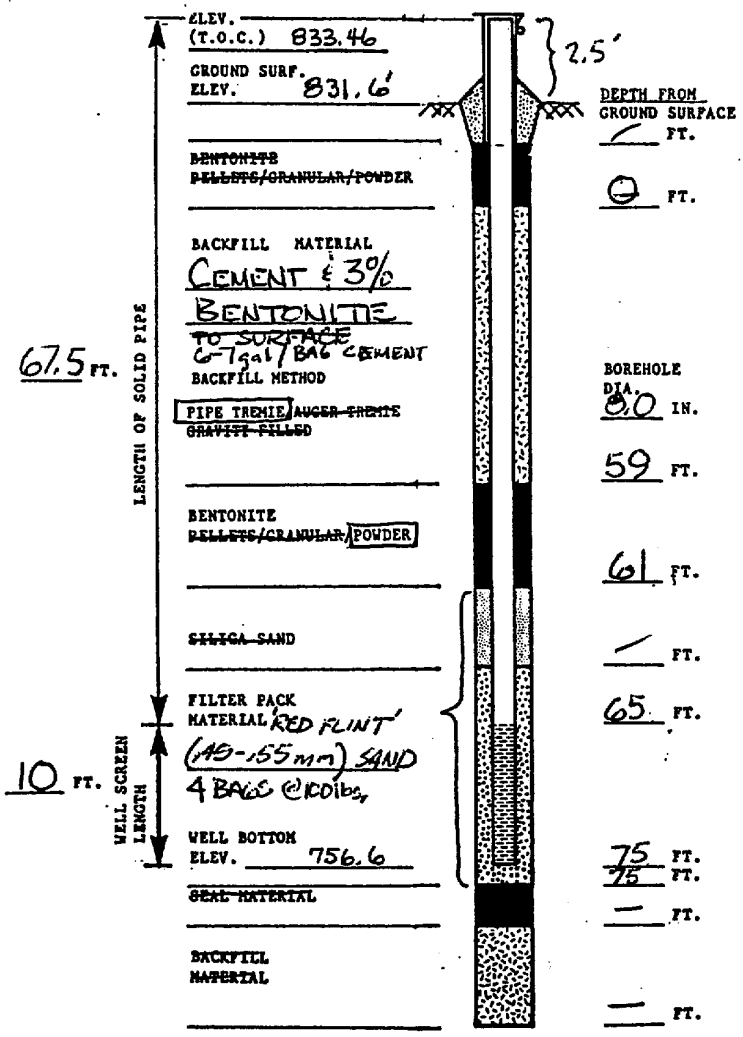
elevations checked 5/9/88 CAK

✓ CAK 3/22/88

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: NIROP NO. 1332.32
WELL NO. MW 4-T
DATE INSTALLED 12-22-87



1) CASING DETAILS

A) TYPE OF PIPE:

~~PVC, STAINLESS, TEFLON, OTHER~~ BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

~~COUPLINGS~~, THREADED (W/TAPE?) → YES: TEFLON., ~~OTHER~~

C) WAS SOLVENT USED? ~~YES OR~~ NO

D) TYPE OF WELL SCREEN:

~~PVC~~, STAINLESS, ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 2.0 OD IN. 2 5/16

G) INSTALLED PROTECTOR PIPE W/LOCK? YES ~~OR NO~~
PROTECTOR PIPE DIA. 6.5 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 3 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 540 gals
ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, ~~OPAQUE~~ ~~SLIGHTLY~~

F) ODOR? YES OR NO NTU = 1.0 (XED 7/5/88)

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (27.81') F

DATE/TIME _____ F

DATE/TIME _____ F

ADDITIONAL COMMENTS: 1.5 BAGS OF BENTONITE MIXED INTO 45 BAGS @ 6-7 gal/BAG: USED ~3 BAGS.

3 CENTRALIZERS USED ON WELL CASING.

elevations checked 5/9/88 CAK

VCAK 3/22/8

DRILLING LOG ... ION: [illegible]

INSTALLATION: [illegible]

SHEET 1 OF 12 SHEETS

1. PROJECT: Monitoring Well [illegible]
2. LOCATION (Coordinates or Station): [illegible]
3. DRILLING AGENCY: [illegible]
4. HOLE NO. (As shown on drawing title and file number): 4D
5. NAME OF DRILLER: [illegible]
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 120.4' [illegible]
8. DEPTH DRILLED INTO ROCK: 1.0 [illegible]
9. TOTAL DEPTH OF HOLE: 121.4
10. SIZE AND TYPE OF BIT: [illegible]
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing 1500 [illegible]
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 3 [illegible]; UNDISTURBED —
14. TOTAL NUMBER CORE BOXES: —
15. ELEVATION GROUND WATER: ≈ 20 [illegible]
16. DATE HOLE: STARTED 5-31-92; COMPLETED 6-2-92
17. ELEVATION TOP OF HOLE: [illegible]
18. TOTAL CORE RECOVERY FOR BORING: —
19. SIGNATURE OF INSPECTOR: [illegible]

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		Topsoil			Started Drilling w/ 5 7/8" D. Roller Bit
	1.0		Silty Sand (SM) Loose Non Plastic Glassy Dark Moist Dusky-Black High Organic w/ Root Fragments Sand Fine to Medium Coarse Sand		D-1 0.0'-0.6'	Started Drilling w/ Clean Water. Pushed 2" Diam. Split Spoon 0.0'-1.5'. Rec. 0.6'. Rep 0'-3.0'
	3.0		Silty Fine Sand Loose Non Plastic Moist Slight Reaction w/ 10% Organic Mixed Sand (Fine) Fine Grained Sand Some 1.5-4.0' Dark Brown to Black		D-2 5.5' 6.1'	Drilled to 5.0'. Pushed 5.0'-7.5' w/ 2" O.D. Split Spoon. Rec. 0.9'. Rep. 3.0'-6.1'.
	5.0				D-3 6.1' 6.4'	Rep. 6.1'-9.0'
	6.1		Slight increase in Amt of Medium Coarse Sand w/ Reduction in Amt of Silt & Organics			
	7.0					Drilled to 10.0'
	8.0					

*PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: [illegible] HOLE NO.: [illegible]

DRILLING LOG | OF SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10.0		Silty Sand (SM)			Drilled and washed to 10.8'
			loose		D-4	Pushed 10.8'-12.8' w/ 2" Dia. Split spoon
	11.0		Non Plastic		10.8'-	V. low rec.
			V. Sl. Cake		11.2'	Pushed only 2.0'
			Moist			Rec. 0.4'
			Lt. Gray			Rep 9.0'-13.0'
			Sand Fine to			
	12.0		Med. w/ trace			
			of coarse sand			
			Silty			
			w/ trace of Clay			
	13.0					
	14.0		Gravelly Sand (SM)			Drilled and Washed to 15.3'
			Med Dense			
			Non Plastic			
			Sl. moist			
	15.0		Moist		D-5	Pushed 2" Dia. Split spoon 15.3'-17.3'
			Lt to Med Gray		15.3'-	
			Sand Fine to Med		16.0	
			Mostly Med to Coarse			Rec. 0.7'
	16.0		Gravel Fine to			Rep. 13.0'-23.0'
			Subangular to Round			
	17.0					
	18.0					
	19.0					
	20.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG

DIVISION: MRD

INSTALLATION: [illegible]

SHEET 3 OF 3 SHEETS

1. PROJECT: [illegible]	10. SIZE AND TYPE OF BIT
	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
2. LOCATION (Coordinates or Station)	
	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY: [illegible]	
4. HOLE NO. (As shown on drawing title and file number): 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		Gravelly Sand (SP) Med Dense Non Plast. Siliceous Moist dk. to Med. Gray Sand Fine to Coarse Mostly Med to Coarse Gravel Fine ONLY Subangular to Round			Drilled and washed to 29.2' Pushed 20.2'-22.2' 2'0.-Spl-spoon Rec. 0 w/ Gravel Jammed in bottom of shoe
	21.0					
	22.0					
	23.0					
	24.0		(SM) Silty Sand Red Dense Non Plast. 1.Silt Saturated dk.-to-Med. Gray Sand-Fine-to-Med Silt 10% - 20%			Drilled and washed to 25.2' Pushed 25.2'-27.2' w/ 2" 2" Split spoon Rec. 1.0
	25.0				0.6	Rep. 23.0'-25.7'
	25.7				25.2-25.7'	
	26.0				0.7	Rep. 25.7'-30.0'
					25.7-26.0	
	27.0		Silt-Loose sediment of Med Gray to Coarse Sand Mostly Med-to-Coarse			Drilled to 30.0'
	28.0					
	29.0					
	30.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: [illegible] HOLE NO.

DRILLING LOG MW | Mono | OF 12 SHEETS

1. PROJECT Monitoring Well	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	30.0		(SM) Silty Sand			Attempted Sample @30.0 BGS Encountered Sand Prevented Sampling
	31.6		Med Dense Moist Pinkish Tan Calcareous Saturated Sand Fine to Med Sand Trace Coarse Sand Silty approx 20%		0-8 31.0'	Mixed Mud Super Gel-X (Medium Consist) 50 gal 250 gal Circulated in Hole Mixed 800 Gallons Super Gel-X 20 lbs Bentonite 1 sec AF 0.2 lbs Polymer Drilled to 31.0'
	33.0					SB (2" O.D. Split Spoon) Seated to 30.1' Pushed 30.1'-33.1' Rec. 0.1' Rep. 30.0'-34.0'
	34.0		Fairly uniform w/depth			Drilled to 35.0'
	35.0		[redacted] Increase in % med to coarse sand Trace Fine Gravel Increase Max. diam.		0-9 37.0' 35.4'	Pushed 35.7'-37.7' w/10.3' Sample Obtained Drilled to 37.0' Switched to 3" O.D. Split Spoon Pushed 37.0'-39.6' Rec. 0.9' Rep. 34.0'-40.0'
	37.6					
	38.6					
	39.6					
	40.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT Monitoring Well HOLE NO.

DRILLING LOG

DIVISION: NAD

INSTALLATION: [illegible]

SHEET [illegible] OF [illegible] SHEETS

1. PROJECT: Nonmoving Wave [illegible]	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: [illegible]	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED:
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED: — COMPLETED:
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	40.5		Silty Gravelly Sand (SM-SW)			Drilled and washed to 40.5'
					D10	Pushed 40.5'-42.5'
	41.0		Med Dense Moist V. Sl. Calc Saturated Lt to Med Gray Sand fine to Coarse Fine to Med gravel Gravel fine Approx 15% Round to Subangular Silty approx 15%		40.7	
					41.3	w/ 3" Dia split spoon Rec. 0.8' Rep 40.0'-43.0'
	42.0					
	43.0					
	44.0		Silty Sand (SM) Med Dense Moist. V. Sl. Calc Saturated Med to Lt. Gray Wood. thin [illegible] Gray, [illegible] [illegible] Sand fine [illegible] Wood [illegible] Sub angular Gravel Silty approx 25%		D11	Drilled and washed to 44.4'
					44.5	Push 3" Dia split spoon 44.4'-47.4'
	45.0				46.0	Rec. 0.8' Rep 43.0'-49.0'
	46.0					
	47.0					
	48.0		Lean Clay (CL) Soft Med Plas. V. Sl. Calc Saturated Med Brown Gray Wood Fine Coarse Sand Fine Gravel Round to Subangular Silty			
	49.0					
	50.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: [illegible] HOLE NO.

DRILLING LOG MRD | OF 12 SHEETS

1. PROJECT Monroe Water Intake Wind Pa.	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY DS-CC-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	50.0		Lean Clay (CL)			Drilled and washed to 50.4'
						Pushed 3" Dia
			Stiff		D-12	Split spoon 50.4'-51.4'
	51.6		Med Plast.		51.9'-53.3'	Rec 1.9'
			Intermixed			Rep. 49.0'-55.0'
			Sat. varved			
			Med Brown Gray			
			Wood fragments			
	52.6		Sand and fine			
			Gravel up to			
			1" max dia			
			Silty			
	53.0					
			Sl. increase in % silt			Drilled to 55.4'
						Pushed 3" Dia
			Sandy			Split spoon
	54.0		Clay (CL)		D-13	55.4'-57.4'
			Stiff		56.0'-56.7'	Rec. 1.2'
			Med Plast			Lost 1.2' from bottom of hole
			Int. and			
			Varved			
	55.0		Med Gray Brown			Sample highly disturbed by glass fragments lodged in shoe & start of push
			Silty			
			Sand Fine to Coarse			
			Upper Fine Gravel			
	56.0					Rep. 53.0'-59.0'
	57.0		Sand increasing in amt of silt & clay			
	58.0		Fat Clay (CH)			
			Stiff			
			Medium to med plast.			
			Int. and			
			Varved			
	59.0		Sl. silty			
			Sl. sandy			
			Med Gray Brown			
			Sand Fine to Coarse			
			W. trace of fine gravel			
	60.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT Monroe Water Intake | HOLE NO. 40

DRILLING LOG

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
4. HOLE NO. (As shown on drawing title and file number)	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	60.0		Fat Clay (CH)			Drilled and washed to 60.0'
			Soft		D-4	Pushed 3" dia. split spoon 60.1'-62.1'
	61.0		High Plastic		61.2'	Rec. 1.7'
			Visc. Clay		61.6'	Set 0.3' from Bottom of Shoe
			Saturated			Rep 59.0'-63.0'
			Slickery			
			Spongy			
			Med. Gray Brown			
	62.0		Fine Fine to Coarse			
			w/ trace of Fine Gravel			
	63.0					Drilled and washed to 65.0'
	64.0		Wood Sand Zones		D-5	Pushed 3" dia. split spoon 65.0'-66.6'
					65.9'	Rep 63.0'-66.9'
					66.2'	Rec. 1.6'
	65.0				D-6	Rep. 66.9'-69.0'
					66.4'	
					66.6'	
			Silty Sand (SM)			
	66.0		(Assume contact)			
	66.5		Dense			
			Med. Plastic			
	67.0		Visc. Clay			
			Saturated			
			Med. Brown			
			Sand Fine to Med.			
			Moderately			
			Silty, approx. 15%			
	68.0					
			Lean Clay (CL)			
			Soft			
	69.0		Med. to Low Plastic			
			Visc. Clay			
			Saturated			
			Med. Gray w/ Wood			
			Med. Brown Mottling			
			Visc.			
			Sandy			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT

HOLE NO.

DRILLING LOG | OF SHEETS

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	70.0		Lean Clay (CL)		D-17 70.1-70.4	Vibracored to 70.0 Pushed 70.2'-71.3' w/ 3" O.D. split spoon Rec. 1.3' Rep. 69.0'-70.0'
	71.0		Stiff Medium Plastic Silt Some Sand Fine Sand Med. Coarse Wood Med. Brown Mottled V. Silty Sand Fine Some Med. Coarse V. Silty Fine Some Coarse Wood Silty Sand (Peat) Wood Gravel			
	72.0					Drilled and Washed to 75.6'
	73.0		(SM) Silty Sand Dense Non Plastic Silt Some Med. to Dark Brown Silty Sand Fine Wood Med. to Coarse Sand Gravel		D-18 75.8-76.1 D-19 76.7-77.0	Tried to push 3" O.D. split spoon w/ no success. Drove 3" O.D. split spoon 75.6'-77.1' w/ 300 lbs Hammer (58 Blows) Rec. 1.4' Lost 0.1' from bottom of spoon Rep. 73.0-76.7' Rep. 76.7-79.0' W.L. 5.8 Bags End Sp. 5-31-83
	76.0		Increase in % Cobbles			
	77.0		Silty Fine Sand Dense to V. Dense Non to Non Plastic Silt Some Med. to Dark Brown Gray V. Silty Sand Interbedded Wood Cobbles Gravel			Start En. at 6-1-83 W.L. 15.82' Mixed Mud 50 lbs Bentonite in 1 inch Gel w/ 250 gal water [illegible] 9.4 lbs/gal.
	79.0					
	80.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

DRILLING LOG

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	80.2		(SM-SC) Silty Clayey Sand		D20	Drilled to 80.4' Drove 3" O.D. split spoon 80.4'-81.9' w/ 300 lbs hammer
	81.0		Dense to v. dense Non-plastic v. silty coarse Sand Medium to dark Brown Gray v. silty, some medium to coarse Sand Clayey approx 15% Micaceous fine Gravel sub-angular to round		80.5 80.8	Rec. 1.3' Rep. 79.0'-80.0'
	81.4					
	82.0					
	83.0		v. clayey			
	84.0		Lean Clay (CL) Stiff Med. plastic v. silty Sandy Med. Gray Brown v. silty, some fine sand with trace of fine Gravel and micaceous			Drilled to 85.2'
	85.0				D21	Drove 3" O.D. split spoon 85.2'-86.7' w/ 300 lbs hammer Total (5) for Drill = 41
	85.6				85.3 85.6	
	86.0				D22	Rep. 82.0'-85.6'
					85.6 86.2 9	Rec. 0.7' not 0.3 in bottom of spoon Rep 85.6'-89.0'
	87.0		Clayey Gravelly Sand (SC-GC) Dense to v. dense Non-plastic med. plastic v. silty Sandy Med. Gray Brown v. silty, approx 15% Clay Gravelly fine micaceous sub-round medium Sandy v. micaceous			
	88.0					
	89.0					
	90.0		Silty Sand (SM)			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

DRILLING LOG | M22 | Omaha | OF 13 SHEETS

1. PROJECT: Monitoring Well Nitrate Study	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: USGS-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 417	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	90.0		(SM) Silty Sand; Dense; None Plast.; Silica; Subangular; Dark Brown; Thin Organic Band; Sand Fine to Med.; Silty approx 15%		D23 90.2-90.7	Drilled to 90.2'; Drove 3' O.D. split spoon 90.2-91.7 w/ 300 lbs hammer; Rec 0.5 lost 0.4' in bottom of spoon; Total (5) for run = 42; Rep. 89.0'-93.0'
	91.0					
	92.0					
	93.0					Drilled to 93.0'
	94.0					
	95.0		(SM-SC) Silty Gravelly Sand; Dense; None Plast.; Silica; Subangular; Medium Brown; Silty approx 15%; Sand Fine to Coarse; Gravel approx 25% Fine to Coarse; Mostly Fine		D24 95.0-96.5	Drove 3' O.D. split spoon 95.0-96.5 w/ 300 lbs hammer; Total (5) = 26; Rec .03'; Rep. 93.0'-98.0'
	96.0					
	97.0					
	98.0		Silty Sand (SM); Dense; None Plast.; Silica; Subangular; Med. Gray			
	99.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT | HOLE NO.

No. [illegible]

DRILLING LOG	DIVISION MRD	INSTALLATION OMAHA	SHEET 1 OF 13 SHEETS

1. PROJECT Monitoring Well Nibop Instrumentation Proj	10. SIZE AND TYPE OF BIT
	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
2. LOCATION (Coordinates or Station)	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY US-CE-C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
4. HOLE NO. (As shown on drawing title and file number) 40	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	100.0		Silty Sand (SM) Dense to V. Dense Moist Fine Sand Some Silt Trace Gravel Sand Fine to Med Silt Some Coarse Sand		D05 100.0-101.5	Drive 3" O.D. Split Spoon 100.0'-101.5' w/ 300 lbs hammer Rec. 0.5' Rep. 98.0'-104.7'
	106					
	108					Sewer or utility encountered @ 107.7'
	108					Drilled to 105.2'
			Gravel (GP)			
	104.0		Dense Moist Sand Some Coarse Trace Fine to Med Gravel Fine Some Coarse Sub-angular to round Max. 1½"			
	104.7					
	105.0				D06 105.4 105.8	Drive 3" O.D. Split Spoon 105.2'-106.7' Rec. 0.6' Rep. 104.7'-108.0'
	106					
	108					
	108					
	108		(SC-SP) Clayey Gravelly Sand V. Dense Moist Brown Shale			Hole was dri-ven open-ended to 110.0' Hole appears [illegible] Sand [illegible] to 110.3'
	110.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT DRILL HOLE NO. HOLE NO.

DRILLING LOG | MSD | [illegible] | OF 2 SHEETS

1. PROJECT Niagara Power Project	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 4D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED: — UNDISTURBED:
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED: — COMPLETED:
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	110		(SC-SP) Clayey Gravelly Sand V. Dense Moist. V. Silty Sand Medium Brown Silty Sand Fine to Coarse Gravel Fine to Coarse Rounded Mostly Fine		110.3 110.5 110.5 110.8'	Drilled 110.3' Drove 3' 2" Split Spoon 110.5'-111.8' Rec 0.5' Rep 108.0'-110.5' Rep 110.5-113.0'
	111					
	112					
	113		Silty Sand (SM) Dense to V. Dense Non Plastic Slightly Mod. Silty Sand Medium Brown			
	114		Sand Med w/ Little Fine and Trace of Coarse Sand Silty Approx 15% Sandstone Fragments		114.7 115.7	Drilled to 114.7' Drove 2' 2" Split Spoon 114.7'-116.2' Rec 0.5' Rep 113.0'-117.0'
	115		Sheen 1 Creek 100% of Coarse Sand Stone Frag. and Fine Gravel Frags. Gravel Occurring in Sandstone Fragments			
	116					W.L. 12.4' Below Top of Casing End of Day 6-1-82 Start on 6-2-82 W.L. 20.06 Below Top of Ground Mixed Mud Approx 20 gal/250 gal water Inco Gel
	117					
	118		Silty Gravelly Sand (SM-SP) V. Dense Non Plastic V. Silty Sand Saturated Med Orange Brown Silty Approx 15% V. Gravelly Mostly Sandstone Frags			Mixed 50 gal Bentonite Inco Gel 56 sec. Mf. 9.2 lb/gal Hole [illegible] caving off [illegible] 77 sec 90 lb/ 9.7 lb/gal
	119					
	120					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE | PROJECT Niagara Power Project | HOLE NO.

DRILLING LOG

DIVISION: MCD

INSTALLATION:

SHEET 13 OF 13 SHEETS

1. PROJECT: [illegible]
2. LOCATION (Coordinates or Station): [illegible]
3. DRILLING AGENCY: [illegible]
4. HOLE NO. (As shown on drawing title and file number): 40
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED / COMPLETED
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	120		(SM - SP) Silty Gravelly Sand v. Dense Non-Plastic v. Fine Saturated Med. Orange Brown S.W. approx. 120 Sand Fine to Med. w/ some Gravel v. Gravelly Fine to Coarse Med. Gravel Angular Non-Uniform Granitic (120.0 - 120.8 Fracture Zone) High Fracture Zone Massive (Granite Rock)		D-30	Drilled to 120.2' Drive 3' 2" split spoon sampler 120.2' - 121.4' Rec. 1.0' Rep. 117.0 - 120.4' Rep. 120.4' - 121.4
	120.2					
	120.4					
	120.6					
	120.8					
	121.0					
	121.2					
	121.4				D-31	Terminate Boring 121.4' on 6-2-83
	121.6					
	121.8					
	122					
	122.2					
	122.4					
	122.6					
	122.8					
	123					
	123.2					
	123.4					
	123.6					
	123.8					
	124		Sandstone Thin Bedded Fine Grained v. Dense Brown Dense w/ Gray Streaks Fine Grained Solid Poorly Cemented Greater Frequency Cemented w/ Hairline Fracture Some Sample Poorly Indurated			Sandstone unit Encountered Upper of St. Peter FM.
	124.2					
	124.4					
	124.6					
	124.8					
	125					
	125.2					
	125.4					
	125.6					
	125.8					
	126					
	126.2					
	126.4					
	126.6					
	126.8					
	127					
	127.2					
	127.4					
	127.6					
	127.8					
	128					
	128.2					
	128.4					
	128.6					
	128.8					
	129					
	129.2					
	129.4					
	129.6					
	129.8					
	130					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT: [illegible] HOLE NO.

DRILLING LOG	DIVISION MRD	INSTALLATION Omaha	SHEET 1 OF 2 SHEETS

1. PROJECT Monitoring Well DIRON Installation Project	10. SIZE AND TYPE OF BIT 5 7/8" Diamond Rock
2. LOCATION (Coordinates or Station) Installation Oregon	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL Failing 1500 Holemaster
4. HOLE NO. (As shown on drawing title and file number) 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 31 Jars; UNDISTURBED None
5. NAME OF DRILLER Kroom	14. TOTAL NUMBER CORE BOXES —
6. DIRECTION OF HOLE ☒ VERTICAL ☐ ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER ≈ 20.0'
7. THICKNESS OF OVERBURDEN 120.4' Alluvium	16. DATE HOLE: STARTED 6-2-83; COMPLETED 6-3-83
8. DEPTH DRILLED INTO ROCK 1.0' Sandstone	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE 121.4	18. TOTAL CORE RECOVERY FOR BORING — %
	19. SIGNATURE OF INSPECTOR Mark S. Ruhl

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	3.0		6" Dia Protective Steel Casing & Locking Cap			
	2.0		2.0'			Permanent Stickup for 2" Dia. Instrument Pipe = 1.63'
	1.63		1.63'			
	1.40		1.40'			Standard 2" Dia. Galvanized Threaded Steel Cap (Vented)
	1.0		Cement Grout			Protective Casing Painted Intervention Orange
						Top of Ground
	0.0					
	0.2		0.2'			Topsoil
			8" Dia Steel Support Casing			Silty Sand (SM) (0.0'-3.0')
	1.0					Bottom Hole Dia. = 6"
						All couplings & connections to pipe w/ Teflon Tape only
	2.0		2.0			Couplings located @ following depths 12.6', 17.8', 38.1', 58.3', 78.6', 98.8' and 109.1'
			Cement-Bentonite Grout			Bottom of Protective Casing (2.0')
						2" Dia Galvanized Steel Riser Pipe
	3.0					3.0'
	3.4					Silty Fine Sand (SM) (3.0'-13.0')
	11.6					
	12.0					Silty Sand (SM) 3.0'-13.0'
						2" Dia Stainless Steel Threaded Coupling welded to Stainless Steel Pipe
	12.6		12.6			Grout consists of Cement / Bentonite Mixture in a 3:1 Ratio
						3.126' Stick of 2" Dia Stainless Steel Riser Pipe
	13.0					13.0'
	13.4					Gravelly Sand (SM) (13.0'-33.0')
	20.0					
	26.0					Silty Sand (SM) 33.0'-100'
	26.3		26.3			Silty Gravelly Sand (SM-GW) (100'-49.0')
						Lean Clay (CL) (49.0'-53.0')
						Sandy Clay (CL) (53.0'-69.0')
						Fat Clay (CH) (69.0'-66.0')
						Silty Sand (SM) (66.0'-60.0')
						Lean Clay (CL) (60.0'-72.0')
	27.0					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO.

DRILLING LOG	DIVISION MRD	INSTALLATION Omaha	SHEET 2 OF 2 SHEETS

1. PROJECT Monitoring Well NIKE Installation Proj.	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY USCE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 40	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	97.0		Pellet Seal; Bentonite Seal (Hydrated)			Silty Sand (SM) 72.0-79.0; Silty Clay Sand (SM-SC) 79.0-82.0
	102.0					
	103.0		103.1' / 30.06			Lean Clay (CL) 82.0-85.6'; Gravelly Clay Sand (SC-SM) 85.6-89.0'; Silty Sand (SM) 89.0-93.0'; Silty Gravelly Sand (SM-SP) 93.0-98.0'; Silty Sand (SM) 98.0-104.1'
	104.0		104.1' Centering Device			Gravel (GP) 104.1'-108.0'; Fine Sand Consisting of Washed Pea Gravel in 1/4"-3/8" Dia. Medium Coarse Sand
	105.0		105.6			
	106.0					
	108.0		109.10 / 109.22			Coarse Gravelly Sand (SP-SW) 108.0'-110.0'; Silty Sand (SM) 110.0'-117.0'; Centering Device composed of 3" x 2' lengths of Steel Sand Screen Sections attached at three equally spaced points on Pipe by 2" Diameter Bolts
	110.0		2" Dia. Continuous Slot Stainless Steel Wire Wound Johnson Well Screen (.010" Slot)			
	113.6					Silty Gravelly Sand (SM-SP) 117.0'-122.4'; 3 Centering Devices attached to Screen at following depths: 33.2'-34.7', 73.6'-75.2', 104.1'-105.6'
	115.0		115.25 / 119.30			
	119.3		Bottom of Well Screen			
	119.7		119.7			
	120.0		Natural Formation Sloughed Sand and Gravel Alluvial Deposits accumulated below screen; Olive-Black Information			(Kansas Group) Sandstone (St. Peters Fm) Dolomite was thinned with clean creek water
	121.0					
	121.4		121.4			
	122.0		Bottom of Casing Boring @ 121.4'			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO.

DRILLING LOG | DIVISION: MRD | INSTALLATION: Conch. | SHEET 1 OF 12 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station): Fridley Mn
3. DRILLING AGENCY: US-CE-C
4. HOLE NO. (As shown on drawing title and file number): 5-D
5. NAME OF DRILLER: M. O'Malley
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 119.8'
8. DEPTH DRILLED INTO ROCK: —
9. TOTAL DEPTH OF HOLE: 119.8'
10. SIZE AND TYPE OF BIT: 6" dia. hollow stem auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 14 | UNDISTURBED
14. TOTAL NUMBER CORE BOXES: —
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 5/21/85 | COMPLETED 5/24/85
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: — %
19. SIGNATURE OF INSPECTOR: Tomasin McDaniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY SPT	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDY CLAY (CL) stiff moist black some fine sand w/ occ. fine gravel and coarse sand			Began drilling w/ a flight auger. Switched to 6" dia. hollow stem auger at 4.5 feet. Numbers in column are standard Penetration Test blow counts
	1.0					
	2.0					
	3.0					
	4.0					
				4.5		
				3		SPT
	4.9			6		recovery = 1.4'
	5.0		SANDY CLAY (CL) stiff moist lt brn large amount of v. fine sand	3	D-1 4.9-5.4	
				5		
				3		
				7		drill chatter, gravel
	6.0			6.0		
			SAND (SP) med. dense sl. moist - dry Tan subrounded sand occ. gravel			
	7.0					
	8.0					
			SAND (SP) med. dense moist lt. brown med. - coarse grained subrounded sand occ. gravel, 1½" max dia. gravel	9.0		
	9.0			3	D-2 7.0-9.9	SPT
				6		rec = 0.9'
				3		
	10.0			6		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: NIROP WELLS | HOLE NO. 5-D

TRANSLUCENT

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Sand (SP)		S	
			med. dense		7	
			moist			
	11.0		lt brown			
			medium sand			
			occasional gravel			
			max. dia. ~1"-rounded			
	12.0		subrounded			
	13.0					
	14.0					
				14.5		
				S		rec = 1.5'
	15.0			B	D-3	
				S	14.5-	
				9	16	
				S		
				8		
	16.0			16.0		
	17.0					
	18.0					
	19.0					
				19.5	D-4	
					19.5-	rec = 1.4'
				4	21.0	
	20.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP Wells. HOLE NO. 5-D

Hole No. 5-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 3 OF 12 SHEETS

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Sand (SP) MED. Dense Wet - Sat'd brown subrounded Sand	5 7		
				5 7 8		
	21.0			21.0		
		▽	5/21 2:05			Water encountered during drilling
	22.0					
	23.0					
	24.0					
				24.5	D-5 24.5 - 25.5	Sand heaved 1' Knocked barrel through heaving material. Filled barrel, bogged off @ app. 25.5'.
				5 9		
	25.0			5 17		
				X		
	26.0			26.0		
	27.0					
	28.0					Sand still heaving. Added water to augers. 1.7' heaved @ sample depth. Took sample through heaving.
	29.0			29.5		
				5 14		
	30.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT NIROP WELLS | HOLE NO. 5-D

1. PROJECT WELLS	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
2. LOCATION (Coordinates or Station)	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
4. HOLE NO. (As shown on drawing title and file number) 5-D	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP)	5	D-6	
			Med. dense	6	29.5	
			sat'd	5	31.0	
			brown	10		End Shift 5/21
	31.0		subrounded	31.0		Start Shift 5/22
						Drilled to 34.5' Sand heaved to ~30'. Pulled auger Drilled back down to 34.5'. Sand heaved again to same depth. Had filled auger w/ ~~sand~~ water before pulling inner rod.
	32.0					
	33.0					
			Color change to gray			Took sample for logging purposes of material in the auger
	34.0					
	35.0					
	36.0					
	37.0				D-7	Sample taken of heaving material in auger at appr. 34 feet. Hole had been drilled to 39.5 feet. Blow counts not taken
					39.5 -41.0	
	38.2					
	39.2					
	40.0					

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PROJECT NIROP WELLS

HOLE NO. 5-D

Hole No. 5-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 5 OF 12 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURB. / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med dense Sat'd Gray occas. fine gravel subrounded			
	41.0					
	42.0					
	43.0					Hole was heaving @ 5 @ 44.5' did not take a sample.
	44.0					
	45.0					
	46.0					
	47.0					
	48.0					Added water as we came out and as sample barrel was low in hole down the hole
	49.0					Hole heaved 1 foot ~~took~~ sample.
				49.5	D-8 49.5'	rec = 0.7'
				5 / 16	50.2	

DRILLING LOG | DIVISION | INSTALLATION | SHEET 6 OF 12 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 5-0
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dense Sat'd gray occas. fine gravel subrounded sand		5 11 / 5 7 / 51.0	
	51.0					
	52.0					
	53.0					
	54.0		increase in fine - medium gravel			
	55.0					
	56.0					
	57.0					Hole heaved 1'
				57.7	57.3	
	58.0			5 / 2	57.7 / 58.3	REC = 0.7'
				5 / 4		
	59.0			5 / 5		
				59.3		
	60.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT NIROP WELLS | HOLE NO. 5-0

DRILLING LOG

INSTALLATION

SHEET 7 OF 12 SHEETS

1. PROJECT: PILOT WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 5-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED / COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dense Sat'd gray			
	61.0		becoming gravelly, fine - medium subrounded gravel and sand			
	62.0					
	63.0					
	64.0					
	65.0					
	66.0					added water in and out
	67.0					Sand heaved 1½' of height
	68.0			68.0 / 5		No recovery
				5 / 15		
	69.0			5 / 8		
				69.5		
	70.0					

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PROJECT: NIKI'S WELLS

HOLE NO. 5-D

1. PROJECT: U.F.S. WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dens - Dense Sat'd gray gravelly - fine - med subrounded gravel & sand			
	71					
	72					
	73					
	74					
	75					
	76					
	77					
	78				D-0 90 91	Cutting [illegible] 90
	79					
	80					

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PROJECT: U.F.S. WELLS | HOLE NO. 5-D

Hole No. [illegible]

DRILLING LOG	DIVISION	INSTALLATION	SHEET [illegible] OF 12 SHEETS

1. PROJECT [illegible]	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) [illegible]	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Sand (SP)			
			Med dense			
			saturated			
	81.0		noncemented			
			occas. fine-med.			
			gravel			
			subrounded grains			
	82					
	83					
	84					
	85					
	86					
	87					drill chatter
	88					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT | HOLE NO.

DRILLING LOG | OF 12 SHEETS

1. PROJECT: L.F.U.P. Wells	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): S-C	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	91.0		SANDY CLAY (CH) Very Stiff Satu'd Dk gray w/ fine gravel & sand	7, 3, 14, 5, 12	D-11 90'-91.5	No bearing on this sample rec = 1.5' End shift 5/22/85
				91.5		Start shift 5/23/85 Hole Depth 90' W.L. 19.9' w/ auger in ~~Drill the~~ hole ~~[illegible]~~
	92.0		SAND (SP) Med Dense Satu'd Gray Coarse subrounded sand w/ fine gravel			
	93					hole heaved again 91.0 rods w/ barrel to 93.5, heaved w/ hammer in 94.0
	94.0			94.0, 5, 5, 5, 6		No Recovery
	95			5, 9, 95.5'		
	96					
	97					
	98					
	99					

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PROJECT: NIAGARA FALLS | HOLE NO. S-C

NIROP WELLS

2. LOCATION (Coordinates or Station)

3. DRILLING AGENCY

4. HOLE NO. (As shown on drawing title and file number) 5-2

5. NAME OF DRILLER

6. DIRECTION OF HOLE
VERTICAL ☐ INCLINED _____ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN

8. DEPTH DRILLED INTO ROCK

9. TOTAL DEPTH OF HOLE

10. SIZE AND TYPE OF BIT

11. DATUM FOR ELEVATION SHOWN (TBM or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL

13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED

14. TOTAL NUMBER CORE BOXES

15. ELEVATION GROUND WATER

16. DATE HOLE | STARTED | COMPLETED

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING %

19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dense Sat'd Gray medium; subrounded sand w/ some fine gravel	5		Hole had heaved 90+ sampler down by pulling up on auger [illegible]
				6	D-12	
				5	100 -	
	101			8	101.5	
				5		
				10		
				101.5		END SHIFT 5/23/85 Start Shift 5/24/85
	102					
	103					
	104					
	105					
	106					
	107					
	108					Drilled to 109.5' Sand heaved to app. 100 feet Got [illegible] down to ~105' [illegible] sample.
	109			109.5		
				5		
	110			5		

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(TRANSLUCENT)

PROJECT NIROP WELLS

HOLE NO. 5-2

DRILLING LOG | OF 12 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med. Dense Sat'd Brown, lt medium-fine grained sub-Rounded Some fine gravel a very thin slightly clayey layer	5 8 5 12	D-13 109.5 111.0	TCC = 1.5'
	111			111.0		
	112					
	113					
	114					
	115					Drill chatter @ 16.5'
	116		Sand (SW) Dense Sat'd Yellow brown medium grained sub rounded			hole heaved up auger to 15.5 feet
	117				D-14 116.5 119	Drive sampler [illegible] thru heaving material from 116.5' to 119'
	118					
	119					Auger refusal @ 119.5'
	120		Bottom of Boring			

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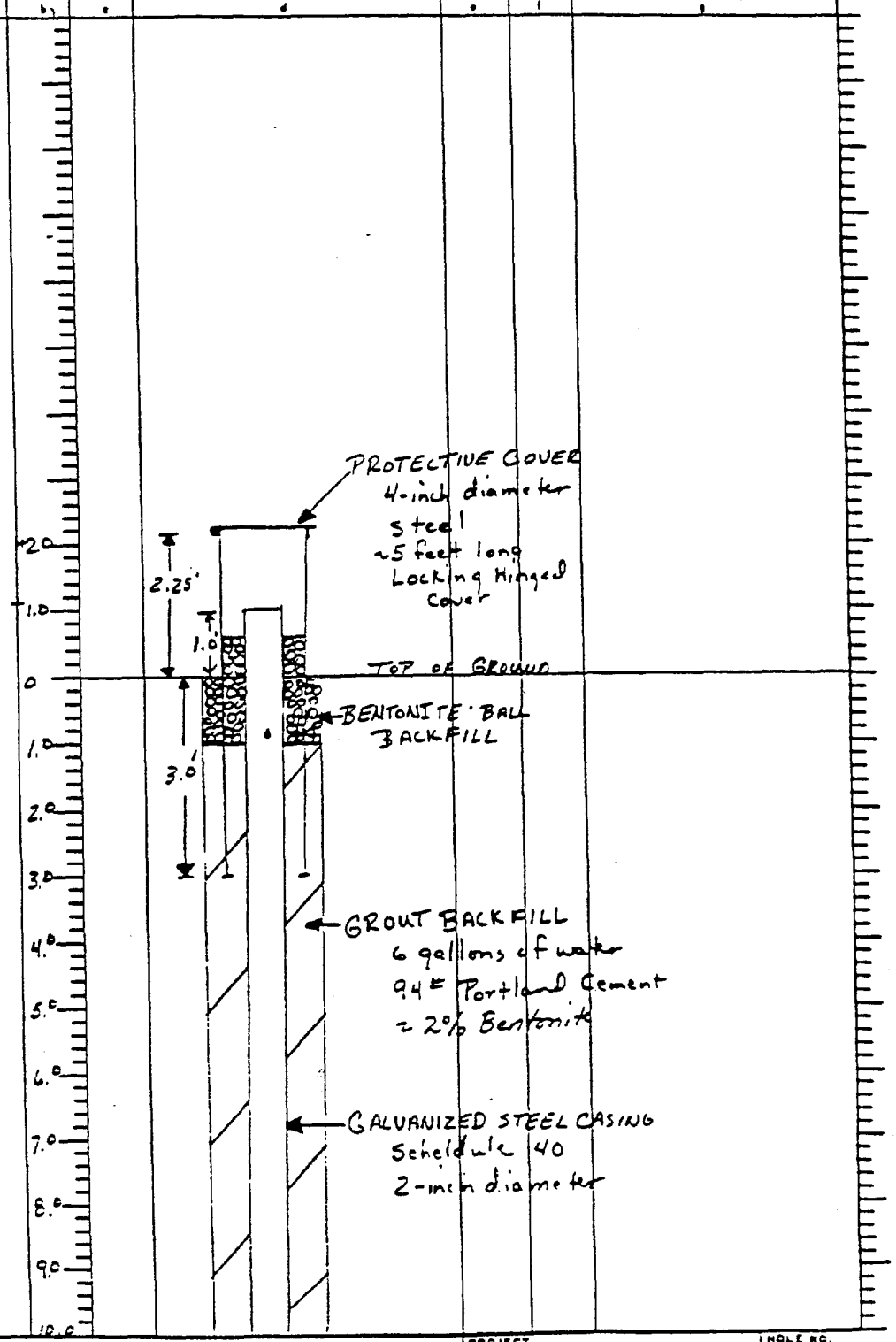
PROJECT: NIROP WELLS | HOLE NO. 5-D

DRILLING LOG	DIVISION MRD	INSTALLATION OMAHA	SHEET 1 OF 4 SHEETS

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number)	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



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PROJECT NIROP WELLS

HOLE NO. 5-D

DRILLING LOG | SHEET 2 OF 4 SHEETS

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10.0					
	11.0					
	12.0		GALVANIZED STEEL CASING Schedule 40 2-inch diameter			
	13.0					
	14.0					
	15.0					
	16.0					
	17.0					
	18.0					
	19.0					
	20.0	19.9'	FLUSH JOINT			
	21.0					
	22.0		STAINLESS STEEL CASING Schedule 5 2-inch diameter			
	23.0					
	24.0					
	25.0		GROUT BACKFILL 6 gallons of water 94# Portland Cement ~2% Bentonite			
	26.0					
	27.0					
	28.0					
	29.0					
	30.0					

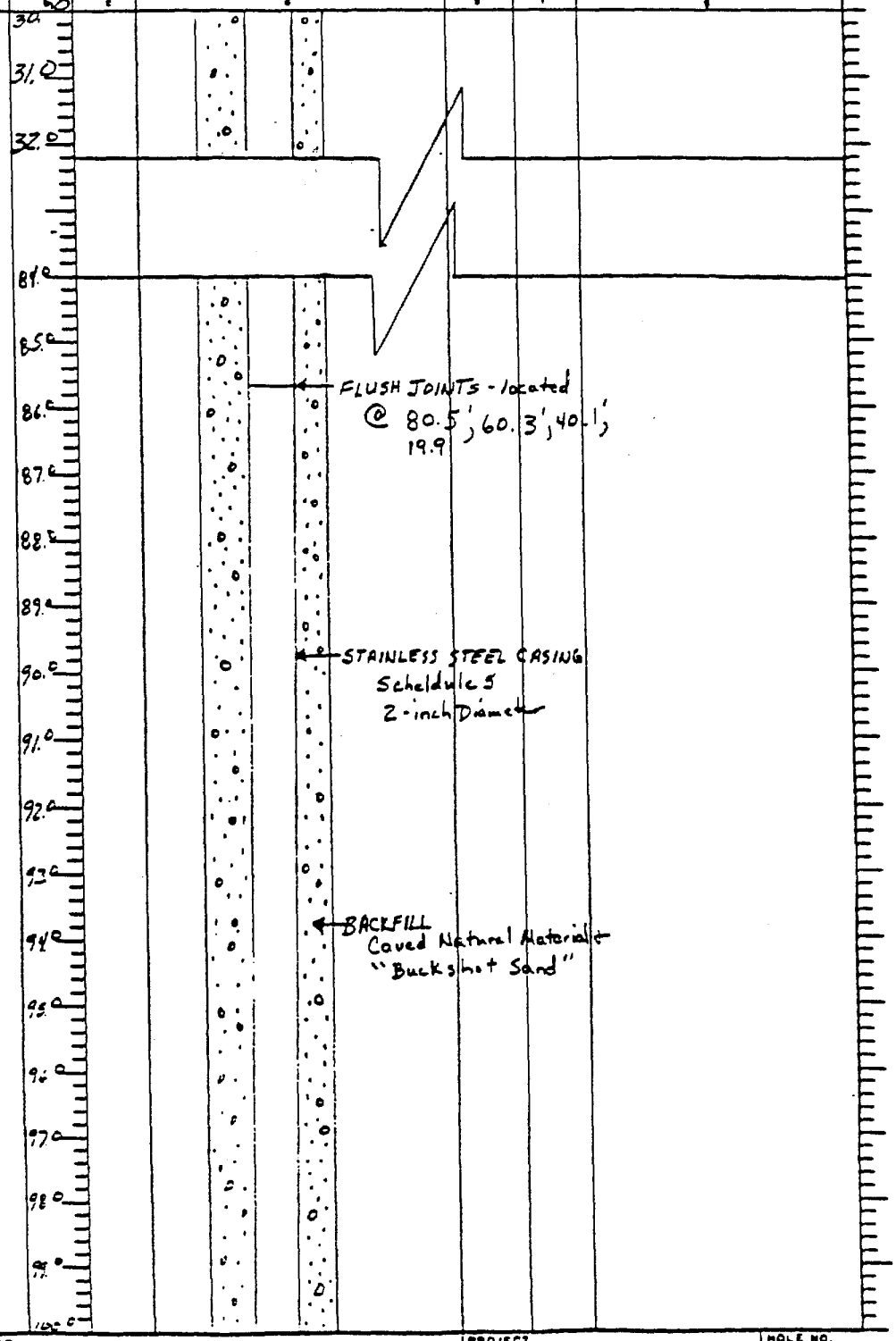
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT NIROP WELLS | HOLE NO. 5-D

DRILLING LOG | INSTALLATION | SHEET 3 OF 4 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



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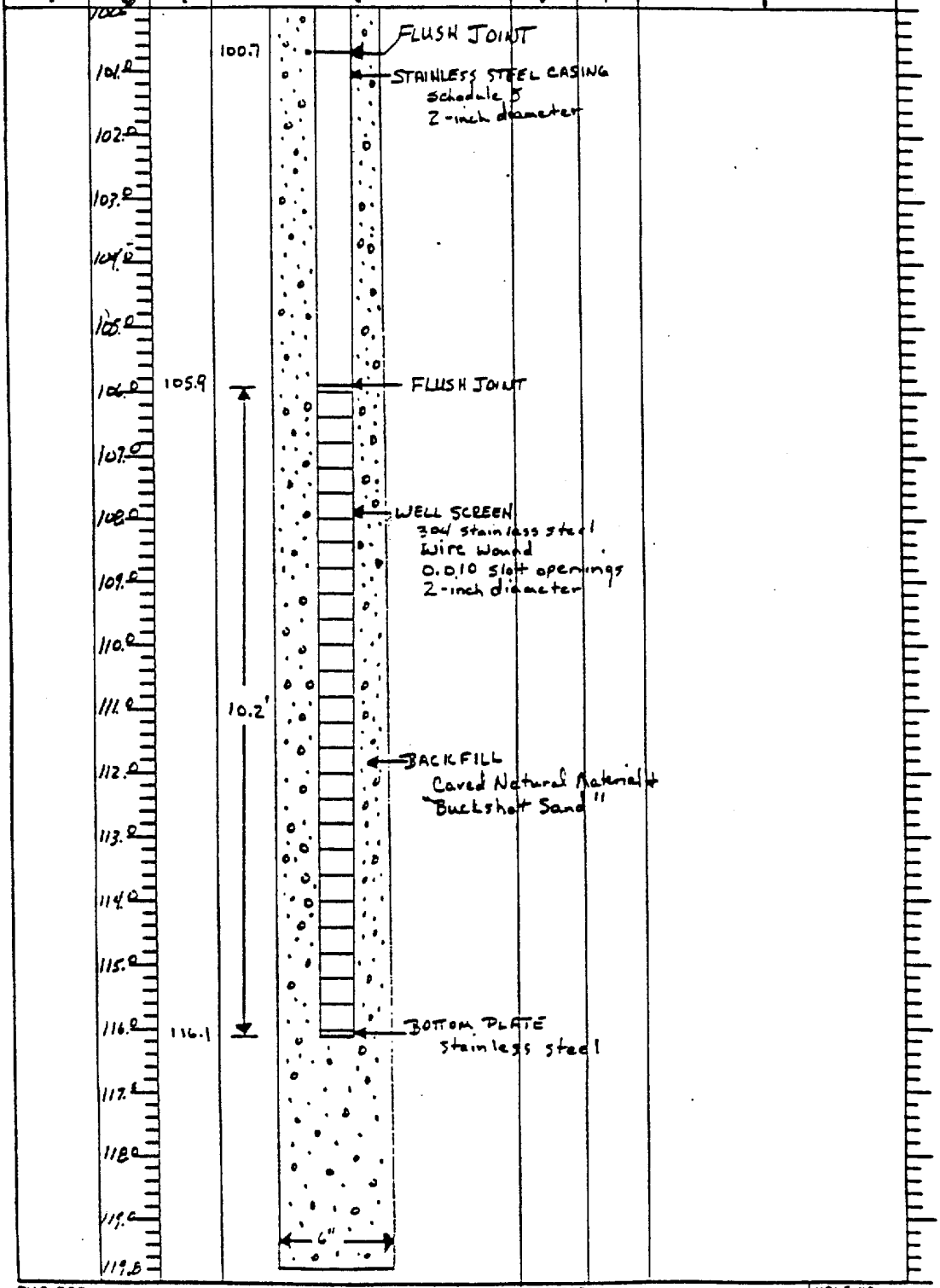
PROJECT: NIROP WELLS | HOLE NO. 5-D

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 5-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



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PROJECT NIROP WELLS | HOLE NO. 5-D

DRILLING LOG	DIVISION MRD	INSTALLATION OMAHA	SHEET 1 OF 14 SHEETS

1. PROJECT: NIKOP WELLS
2. LOCATION (Coordinates or Station): Fridley, MN
3. DRILLING AGENCY: US-CE-C
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER: Mike O'Malley
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 132'+
8. DEPTH DRILLED INTO ROCK: 0
9. TOTAL DEPTH OF HOLE: 132'
10. SIZE AND TYPE OF BIT: 6" DM Hollow Stem Auger
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 13 UNDISTURBED D
14. TOTAL NUMBER CORE BOXES: —
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 5/29/85 COMPLETED 6/5/85
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: — %
19. SIGNATURE OF INSPECTOR: Thomas M. Daniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	10		Sand, silty (SP) Med. Dense			
			Moist Yellowish brown fine-med sand ~~slightly~~ Some silt			
	20					
	30					
	40					
				4.5		
				5	D1	
	50			5	5.0-	Pen = 1.5'
			SAND (SP)	5	6.0	
				4		
			Loose	5		
	60		Moist	3		
				6.0		
			lt. brown subrounded sand mostly medium -occ. fine gravel			
	70					
	80					
	90					
				6.5		
				5	D-2	
				4	7.5-11.0	Pen = 1.5'
	100					

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PROJECT: NIKOP WELLS

HOLE NO. 6-D

Hole No. 6-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 14 SHEETS

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Loose Moist lt. brown subrounded sand mostly med. grained; occas. fine gravel	5 2 5 3 11.0		
	11.0					
	12.0					
	13.0		occ coarse sand seam ~1/2" thick			
	14.0					
	15.0			5 3 1 2 1	D-3 14.5-16.0	Rec = 1.5'
	16.0					
	17.0					
	18.0					
	19.0		SANDY CLAY Loose Moist - Soft Reddish - Brown V. Sandy - fine Med Sand	19.5 5 3	D-4 19.5-21.0	Rec = 1.5'
	20.0					

ENG FORM 1836 — PROJECT — HOLE NO.

Hole No. 6-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 3 OF 4 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SANDY CLAY (CL) Loose ~~Wet~~ - sat'd Reddish Brown Very sandy - Subrounded Med sand occ. gravel - up to ~1½"	5 5 5 4 21°	-	
	21.0					
	22.0					
	23.0					
	24.0					
	25.0					
	26.0					
	28.0	5/29/85 1000	SAND Med Dense - Dense Sat'd Brown			Measured water in auger [illegible] 28.5'
	28.0					Boring issued 3 feet knocked auger to depth. Blow counts were very high
	29.0				D-5 29.5 31°	Rec = 100% ±
	30.0			100+		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: [illegible] | HOLE NO. 6-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 4 OF 14 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND Med Dense - Dense Sat'd Brown Mostly med. grned & subrounded			
	31.0					
	32.0					
	33.0					
	34.0					
	35.0					
	36.0					
	37.0					
	38.0		GRAVELLY SAND			Hammer ~ 2.5 feet into
	39.0			39.5 5 10	D-6 39.5 41	
	40.0					

TM 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS | HOLE NO. 6-D

DRILLING LOG | DIVISION | INSTALLATION | SHEET 5 OF 14 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			GRAVELLY SAND Dense - Med. Dense Sat'd lt. Brown Med. Sand - sub-rounded - Med - fine grave	5 7 5 5 41.0		
	41.0					
	42.0					
	43.0					
	44.0					
	45.0					
	46.0					
	47.0					
	48.0		Increase in amount of gravel			Heaved 2.3' after drilling to 46.5'
	49.0			49.5 5 4		
	50.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS | HOLE NO. 6-D

DRILLING LOG

1. PROJECT	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED — COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			GRAVELLY SAND Med. Dense Sat'd brown Med.-coarse Sand - sub-rounded - subangular 20-30% gravel - layer of fine gravel at bottom of spoon	5 12 5 14 51.0	D-7 49.5-51.0'	Full recovery plus slough = full barrel Blow counts not represent.
	51.0					
	52.0					
	53.0					
	54.0					
	55.0					
	56.0					
	57.0					
	58.0		SAND (SP) Dense - V. Dense Sat'd Brown Med. grained Subrounded occas. gravel some silt	59.5 5 49		Rec = 1.5'
	59					
	60					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT NIAGARA WELLS

HOLE NO. 6-D

DRILLING LOG	DIVISION	INSTALLATION	SHEET 7 OF 14 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP)	5		Started test 1/2' inside auger
			Dense - V. Dense	38	D-8 59.5 - 61.0	
			Sat'd	5		
			Brown	14		
	61.0		Med grained			
			subrounded			
			occas. gravel			
			some silt.			
	62.0		-Sand turning			
			finer grained			
			less gravel			
	63.0					
	64.0					
	65.0					
	66.0					
	67.0					Drilled to 69.5
						Hole heaved to ~ 61.5'
	68.0					Rodded rod to 67.5' - [illegible] @ 67'
	69.0					
				69.5		
				5		
	70.0			3		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: NIROP WELLS | HOLE NO. 6-D

DRILLING LOG | OF 14 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dense Sat'd Brown medium grained subrounded occas. gravel Some silt	5 5		No Recovery
				5 7		
	71.0			71.0		
	72.0					
	73.0					
	74.0					
	75.0					
	76.0					
	77.0					Sand blowed to ~ 71.5 tracked # sampler to 77.8 w/ auger @ 76.8.
	78.0					
	79.0					
				79.5	D-9	Recovery = 1.1'
				5 7	79.5-80.6	
	80.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS | HOLE NO. 6-D

1. PROJECT NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

OF 14 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP)	5		
			MED. Dense	8		
			Sat'd	5		
	81.0		Brown	7		
			Mostly Medium grained + sub rounded.	81.0		
	82.0		occ. fine-med. grained subrounded gravel			
	83.0					
	84.0					
	85.0					
						Drilled to 89.5
	86.0					86.8' - Start Sampling
						86.5' - bottom of Auger.
				86.8		
	87.0			5		
				5		Hole had heaved to 78.5'
				5		
				11		
	88.0			5		No Recovery
				16		FILLED AUGERS w/ WATER
						END SHIFT 5/29/85
				68.3		Start Shift 5/30/85
	89.0					Bottom of hole @ ~89'
						W.L. @ 25.5'
	90.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT NIROP WELLS | HOLE NO. 6-D

DRILLING LOG

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med Dense Sat'd Brown Mostly Med. grned, subrounded ocass fine gravel some silt			
	91.0					
	92.0					
	93.0					
	94.0					
	95.0					
	96.0					
	97.0					Drilled to 99.5' Hole heaved ~15' Worked sampler to 90.9 hyper @ 97.4
	98.0		occassional small clayey blebs			started blows @ 98.5'
	99.0			95.5 / 5	D-10 99.5-100.9	Blow counts not representative Very HIGH
	100.0			60		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS HOLE NO. 6-D

DRILLING LOG

SHEET 11 OF 11 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) Med. Dense - Dense Sat'd Brown Mostly Med grned, Subrounded ocass. fine gravel w/ some silt			Drill Rig Down Pulled 65' auger
	101.0					END SHIFT 5/30/85 START SHIFT 6/3/85 Reposition Rig Redrilled to 60'
	102.0					START SHIFT 6/4/85 Hole Depth 60' W.L. 25.1' Pulled out drill auger, hole bridged in auger Drilled back to 80'
	103.0					
	104.0					
	105.0					
	106.0					
	107.0					
	108.0					
	109.0					
	110.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS

HOLE NO. 6-D

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			SAND (SP) MED. DENSE SAT'D Brown Mostly med. grained Some gravel - fine - medium subrounded Small amount of silt			Drilled to 115' Put sampler into 112.5'. One tap w/ hammer put it down to 115'.
	111.0					
	112.0					
	113.0					
	114.0					
	115.0		CLAYEY SAND Finer grained sand w/o small amount of clay	115.0		
				S	D-11	
				6	1152	
				S	-1162	
				9		
	116.0			S		
			GRAVEL	13		
				116.5		
	117.0					
	118.0					
	119.0					
	120					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS HOLE NO. 6-D

Hole No. 6-D

DRILLING LOG		INSTALLATION	SHEET 13 OF 14 SHEETS
1. PROJECT	NIROP Wells	10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY		12. MANUFACTURER'S DESIGNATION OF DRILL	
4. HOLE NO. (As shown on drawing title and file number)	6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE	☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER	
		16. DATE HOLE	STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK		18. TOTAL CORE RECOVERY FOR BORING	%
9. TOTAL DEPTH OF HOLE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	121		SAND (SP) Med. Dense Sat'd Brown Med. sand, sub-rounded w/ some fine-med. gravel			
	122					
	123					
	124					
	125		Silty SAND (SM) Med Dense Sat'd ~~Brown~~ Fine Sand Subrounded.	124.5 S 23 S 15 S 6 126.1	D-12 124.5 -125.9	0.6' recovered
	126					
	127.8					
	128.5		SAND (SP) Med. Dense Sat'd Brown Med sand - subrounded some fine-med gravel.			
	129					
	130.8			130.8 S 13		

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT NIROP WELLS | HOLE NO. 6-D

DRILLING LOG | SHEET 14 OF 14 SHEETS

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

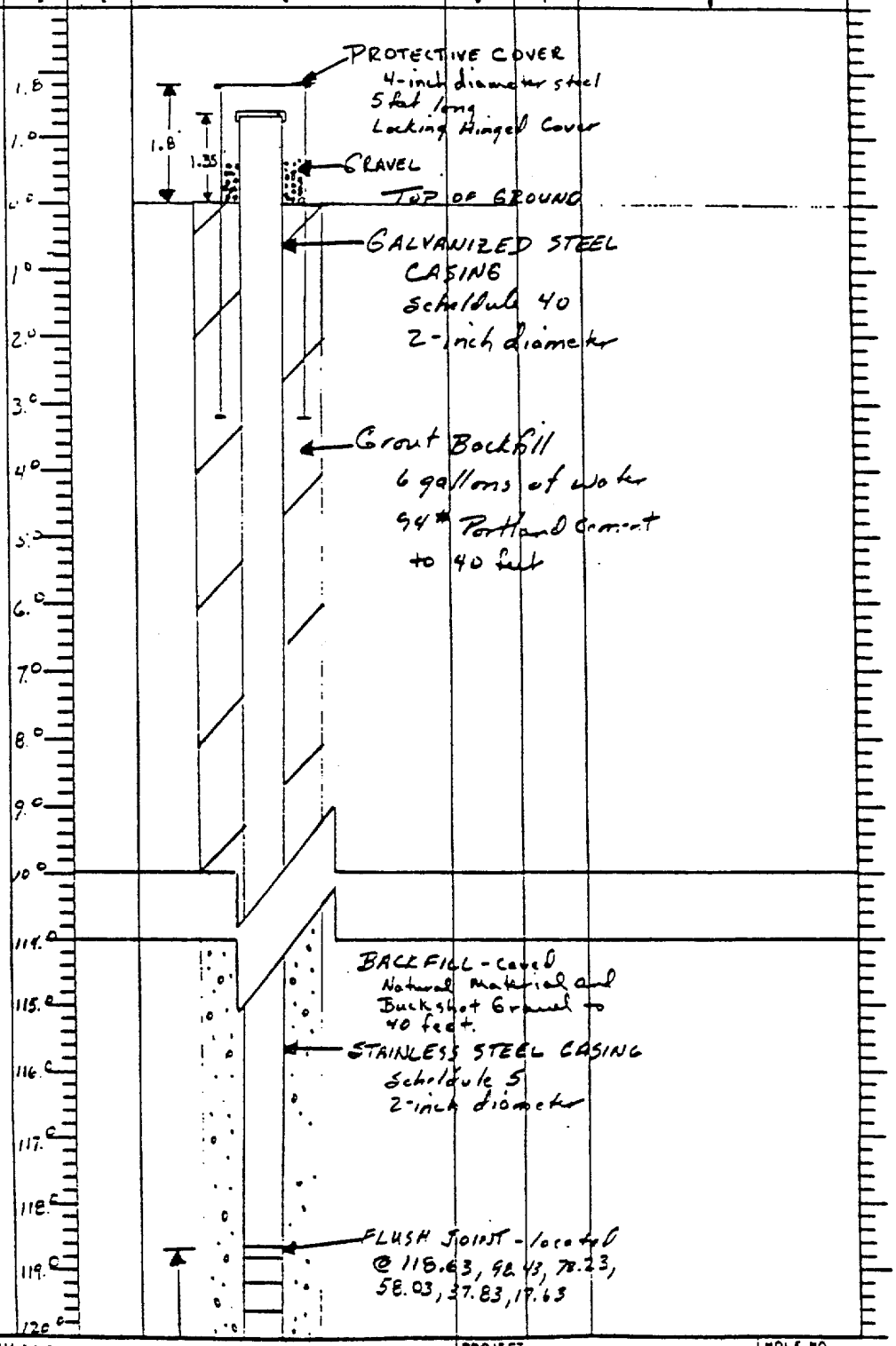
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	130.0		SAND, silty (SP) Dense Sat'd Brown Mostly medium grained, subrounded	5		Rec = 1.5'
				13		
				5	D-13	
				19	130	
	131.0			5	131.5	
				37		
			occas small gravelly lenses	131.5		
						END SHIFT 2/5/95
	132.0		Bottom of Boring			
	133.0					
	134.0					
	135.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: NIROP WELLS | HOLE NO. 6-D

1. PROJECT: NIROP WELLS	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): FRIDLEY, MN	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: US-CE-C	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): 6-D	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: M. O'MALLEY	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE: STARTED / COMPLETED 6/5/85
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR: Thomas McDaniel

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g



ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS | HOLE NO. 6-D

DRILLING LOG

SHEET 2 OF 2 SHEETS

1. PROJECT: NIROP WELLS
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): 6-D
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	121.0					
	122.0					
	123.0					
	124.0		10.2			
	125.0		BACKFILL Caved Natural Material + Buckshot Gravel			
	126.0					
	127.0		WELL SCREEN 304 Stainless Steel Wire Wound 0.010 slot openings 2-inch diameter			
	128.0					
	129.0		BOTTOM PLATE Stainless Steel			
	130.0					
	131.0					
	132.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: NIROP WELLS

HOLE NO. 6-D

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring Wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA

Date: Feb. 5, 1986
Boring No.: 7-D

SOIL DESCRIPTION			FIELD TESTING DATA				LABORATORY TESTING DATA				
Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
5	Yellowish Brown Med. Sand Trace Silt	(SP)	22	25	34	81					
10	Brown Sand, Trace Gravel		19	18	19	56					
15	Brown Sand, Trace Gravel		10	12	16	38					
20	Brown Sand, Trace Gravel		8	15	15	38					
25	Brown Sand, Trace Gravel		8	9	14	31					
30	Brown Sand, Trace Gravel		5	6	8	19					
35	Brown Sand, Trace Gravel		5	6	10	21					

Water Level Observations

W.L. 23' @ While Drilling
W.L. _____ @ _____

Boring Initiated: Feb. 5, 1986
Boring Completed: Feb. 7, 1986
Type of Boring: Mud Rotary
Drilled by: D. Erickson

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site monitoring wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA

Date: Feb. 5, [illegible]
Boring No.: 7.

SOIL DESCRIPTION			FIELD TESTING DATA				LABORATORY TESTING DATA				
Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
40	Gray Fine Sand Trace Grvl	(SP)	16	19	16	51					
45	Gray Fine-Coarse Sand Trace Gravel	(SP)	29	19	20	68					
50	Gray Fine-Coarse Sand, Trace Gravel	(SP)	20	17	17	54					
55	Gray-Brown Silty Clay, Trace Fine Sand	(CL)	21	23	30	74					
60	Gray-Brown Sandy Clay Trace Gravel	(CL-SC)	20	30	40	90					
65	Gray-Brown Silty Clay	(CL-ML)	19	29	32	80					
70	No recovery		15	24	29	69					

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

Drilled by _____

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring Wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA

Date: Feb. 5, 1986
Boring No.: 7-D

SOIL DESCRIPTION			FIELD TESTING DATA				LABORATORY TESTING DATA				
Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
75	Brown-Gray Silt	(ML)	25	35	42	102					
80	Gray-Brown Fine Sand Trace Gravel & Clay	(SM-SC)	22	35	43	100					
85	Gray-Brown Fine Sand, Trace Gravel & Clay	(SM-SC)	60	80	80	220					
90	Gray-Brown Fine Sand, Trace Gravel & Clay	(SM-SC)	20	27	26	73					
95	Gray-Brown Fine Sand, Trace Gravel & Clay	(SM-SC)	60	60	60	180					
100	Gray-Brown Fine Sand, Trace Gravel & Clay	(SM-SC)	25	40	60	125					
105	Fine Sand, Little Silt & Gravel	(SP-SM)	30	50	56	136					

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

Drilled by _____

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring Wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA

Date: Feb. 5, 19[illegible]
Boring No.: 7-D

Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
110	Fine Sand, Trace Gravel, Trace Silt	(SP-SM)	22	15	15	52					
115	Fine Sand, Trace Gravel, Trace Silt	(SP-SM)	66	85	100	231					
120	Weathered Dolomite Yellow-Brown		65	80	200	345					
	E.O. Boring										

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

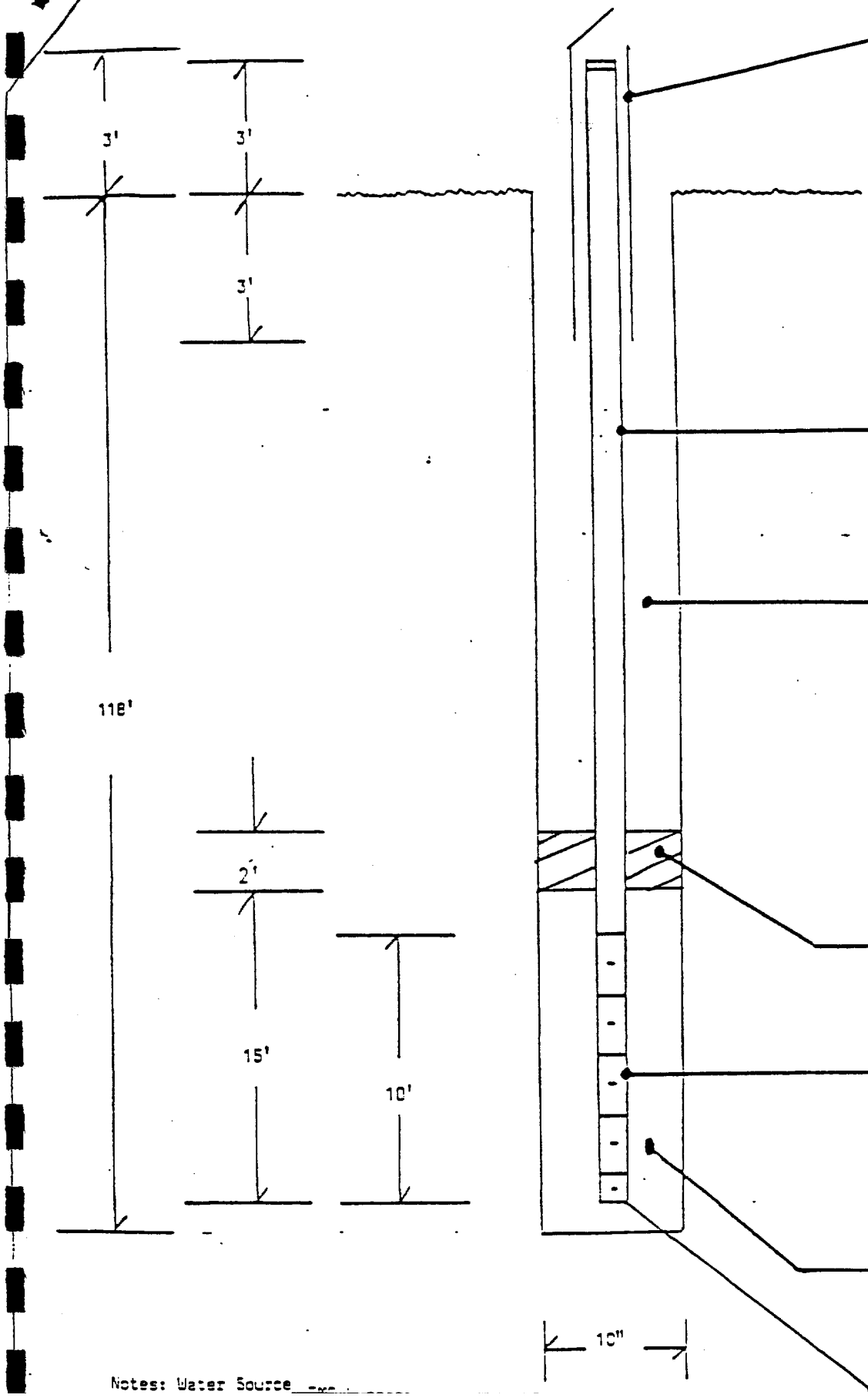
Drilled by _____

O RVATION WELL INSTALLATION DIAGR

WELL NO. 7-D

Site FMC Date: 2/18/86

By: Bergerson-Caswell, Inc. Project No.:



Protective Casing Guard Pc

Type Steel Vented yes No. 3
Diameter 6" Locked yes Typ
Length 6' Key#

Plug

Type Vented

Pipe

Type Galv. Schedule 40
O.D. " Manufacturer U.S.
I.D. 4" "
Length per sec. 18' No. of Se

Cement-Bentonite Grout

Mix 50 Cement 1 Bentonit
Cement 500 lbs. + Bentonite 100
Water 300 gals.
Total quantity gals.
Manufacturers Portland-Nat

Joints

Threaded Flush no T & C
Teflon taped no
Manufacturer

Seal

Powder/Pellets Quant. 2
Hydrated 6 gal., Time 1

Screen

Type S.S. Slot Size .01
O.D. No. Slots/ft.
I.D. 4" Schedule Wire wr
Length per sec. 10' No. of s
Manufacturer Johnson

G.Pack

Type Eau Claire #20
Source Morrison Sand & Gra
Volume 5 cu. yd. gal.
Plug

Notes: Water Source

LOG OF SUBSURFACE DATA

Client FMC
Project Off-Site Monitoring wells
Location Fridley, MN.

Project No. 85-20
Surface Elevation NA

Date Feb. 17, 1986
Boring No. B-D

Depth (ft.)	SOIL DESCRIPTION: Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	FIELD TESTING DATA: Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	LABORATORY TESTING DATA: q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
5	Lt Brown Sand Med. to Coarse	(SP)	10	20	22	52					
10	Brown Sand Medium	(SP)	7	10	10	27					
15	Lt Brown Fine Sand	(SP)	6	7	20	33					
20	Brown Silty Sand Tc of Gravels	(SP-SM)	8	15	15	38					
25	Fine Brown Silty Sand	(SM)	5	5	5	15					
30	Fine Brown Sand	(SP-SM)	5	3	5	13					
35	Fine Brown Sand	(SP-SM)	12	8	12	32					

Water Level Observations

W.L. 25' @ While Drilling
W.L. _____ @ _____

Boring Initiated 2/17/86
Boring Completed 2/18/86
Type of Boring Mud Rotary
Drilled by Dan Erickson

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring Wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA
Date: Feb. 17, 1985
Boring No.: 6-2

SOIL DESCRIPTION			FIELD TESTING DATA				LABORATORY TESTING DATA				
Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
40	Fine Brown Sand	(SP-SM)	10	12	12	34					
45	Fine Sand - Brown	(SP)	9	12	18	39					
50	Fine Brown Sand	(SP)	12	15	21	46					
55	Fine Brown Sand	(SP)	15	17	31	63					
60	Fine Brown Sand-Trace Gravel	(SP)	10	19	21	50					
65	Fine Brown Sand - Trace Gravel	(SP)	13	25	21	59					
70	Fine Brown Sand-Trace Gravel	(SP)	21	25	30	77					

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

Drilled by _____

Sheet 4

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring wells
Location: Fridley, MN.

Project No.: 85-20
Surface Elevation: NA

Date: Feb. 17, 1986
Boring No.: B-D

Depth (ft.)	Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
75	Fine Brown Sand	(SP)	32	54	32	118					
80	Fine to Med. Brown Sand Trace Gravel	(SP)	14	20	20	54					
85	Fine-Coarse Brown Sand Trace Gravel	(SW)	10	12	11	33					
90	Fine-Medium Brown Sand	(SP)	13	19	25	57					
95	Fine-Med. Brown Sand	(SP)	15	19	23	57					
100	Fine-Med. Brown Sand	(SP)	19	20	23	62					
105	Fine-Coarse Brown Sand & Gravel	(SW)	15	15	11	43					

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

Drilled by _____

LOG OF SUBSURFACE DATA

Client: FMC
Project: Off-Site Monitoring Wells
Location: Fridley, MN.

Project No. 85-20
Surface Elevation: NA
Date: Feb. 17, [illegible]
Boring No. [illegible]

Depth (ft)	SOIL DESCRIPTION: Color, Texture, Consistency, Drilling Notes, Remarks	Geologic Material	FIELD TESTING DATA: Blows 1st 6"	Blows 2nd 6"	Blows 3rd 6"	Total Blow Count	LABORATORY TESTING DATA: q_{est} psf	s_{est} psf	q_u psf	DD pcf	MC %
110	Fine-Med. Brown Sand Trace Gravel	(SP)	23	25	19	67					
115	Brown Sand, Little Gravel	(SW)	33	28	19	80					
120	Fine Brown Sand	(SP)	22	22	50	94					
125	Sandy Gravel Brown	(GW)	20	29	31	80					
130	Dolomite		25	25	25	75					
133	Prairie Du Chein Dolomite Bedrock										
	E.O. Boring										

Water Level Observations

W.L. _____ @ _____

W.L. _____ @ _____

Boring Initiated _____

Boring Completed _____

Type of Boring _____

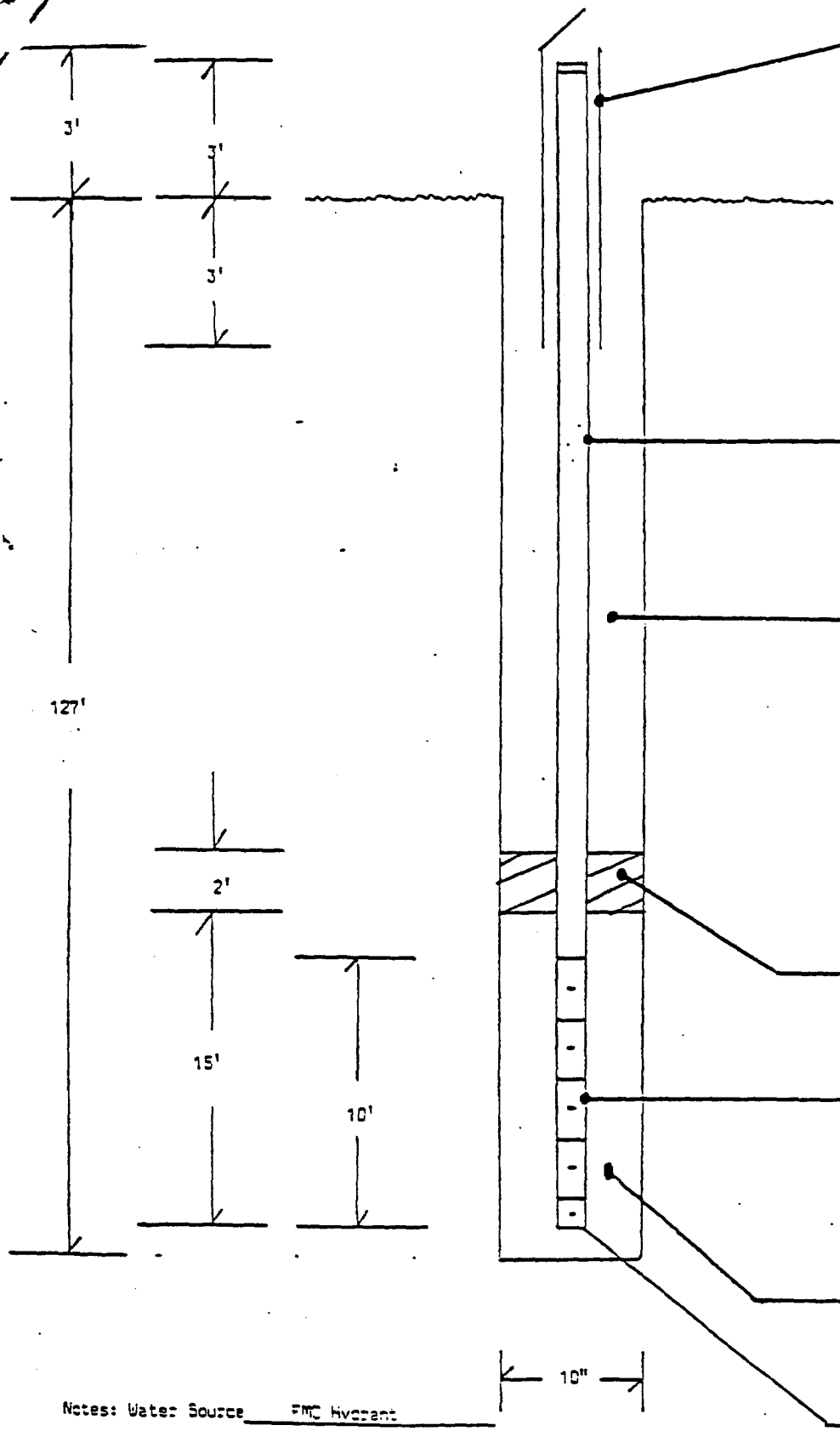
Drilled by _____

O. RVATION WELL INSTALLATION DIAGR

WELL NO. 8-D

Site FMC Date: 2/24/85

By: Bergerson-Caswell, Inc. Project No.:



Protective Casing Guard Post

Type Steel Vented yes No. 3
Diameter 6" Locked yes Type
Length 6' Key#

Plug

Type Vented

Pipe

Type Galv Schedule 40
O.D. " Manufacturer U.S.
I.D. 4" "
Length per sec. 18 No.of Sec.

Cement-Bentonite Grout

Mix 55 Cement 1 Bentonite
Cement 550 lbs. + Bentonite 100 l
Water 330 gals.
Total quantity gals.
Manufacturers Portland-Natior

Joints

Threaded Flush no T & C
Teflon taped no
Manufacturer

Seal

Powder/Pellets Quant. 2 c
Hydrated 5 gal., Time 1 h

Screen

Type S.S. Slot Size .010
O.D. No. Slots/ft.
I.D. 4" Schedule Wire wo
Length per sec. 10' No.of se
Manufacturer Johnson

G.Pack

Type Eau Claire #30
Source American Sand & Gra
Volume 7 cys gal.

Plug

Type

Notes: Water Source FMC Hydrant

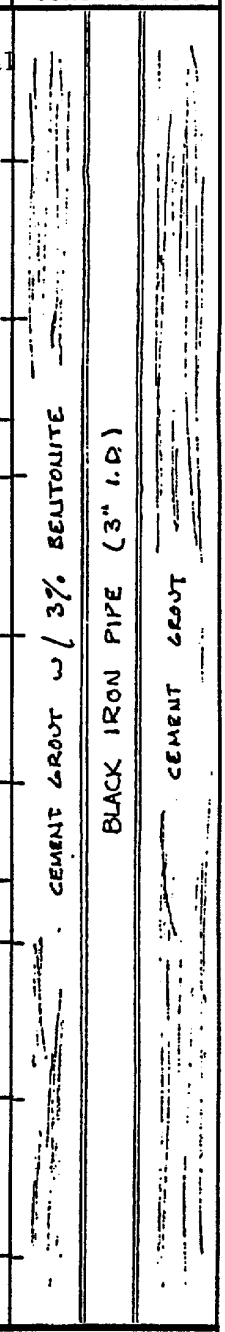
LOG OF TEST BORING

RMT INC

BORING NO.:	10-D
SHEET	1 of 3
PROJECT:	COE-NIROP
PROJECT NO.:	1332.32
LOCATION:	Fridley, MN
SURFACE ELEVATION:	832.1'
DRILLED BY:	Layne Northwest-Milwaukee
DATE STARTED:	1-28-88
DATE COMPLETED:	2-2-88
CREW CHIEF:	Ross Goldbeck
LOGGED BY:	R. Vaughn
CHECKED BY:	BWR/9 Mar. 88

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
1	1.5' Grab	--	--	0	Dark brown, SANDY TOP SOIL, vegetative matter, trace of fill material (brick, metal and glass).
				5	Dark brown, SAND, fine to coarse, trace fine gravel.
2	6.5' Grab	--	--		
				10	Dark brown, SAND, fine to coarse, trace fine gravel.
3	11.5' SS	--	--		
				15	Grey brown, SAND, med to coarse.
4	16.5' SS	--	--		
				20	Grey brown, SAND, med to coarse, trace of fine gravel.
5	21.5' SS	--	--		
				25	Grey brown, SAND, med to coarse, trace of fine gravel.
6	26.5' SS	--	--		
				30	Lt. grey brown, SAND, fine to med. poorhigh graded
7	31.5' SS	--	--		
				35	Lt. grey brown, SAND, fine to med. poorhigh graded
8	36.5' SS	--	--		
				40	Lt. grey brown, SAND, fine to med. poorhigh graded
9	41.5' SS	--	--		

GENERAL WELL CONSTRUCTION



NOTES	WATER LEVEL OBSERVATIONS			
DRILLING METHODS: Cable tool rig using a 300 lb split-spoon hammer and a 3" split-spoon sampler	FIRST OCCURENCE:			
	DATE/TIME			
BOREHOLE DIAMETER: 8"	DEPTH TO WATER			
DRILL RIG: Bucyrus-Erie ZOR	DEPTH TO CAVE IN			

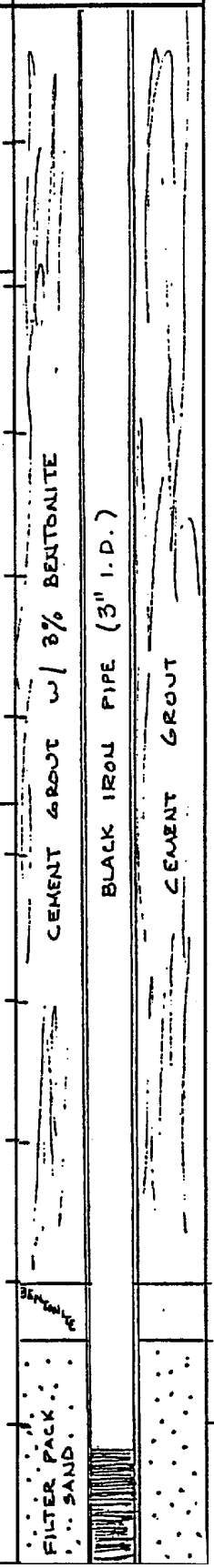
LOG OF TEST BORING

RMT

BORING NO.:	10-D
SHEET	2 of 3
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY, MN	SURFACE ELEVATION: ------

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
				45	Lt. grey brown, SAND, fine to med. little silt.
10	46.5' SS	--	--		
				50	Brown, SAND, fine, some coarse sand, trace of silt. (till)
11	51.5' SS	--	--		
				55	Brown, SAND, med. some clay and gravel, trace of silt.
12	56.5' SS	--	--		
				60	Brown, SAND, med. some clay and gravel, trace of silt.
13	61.5 SS	--	--		
				65	
14	66.5' SS	--	--		
				70	Brown, sand, fine to med.
15	71.5' SS	--	--		
				75	Brown, SAND, med. to coarse trace of cobble.
16	76.5' SS	--	--		
				80	Brown, SAND, med. to coarse, trace of silt. *
17	91.5' SS	--	--		
				85	Brown, SAND, coarse.
18	86.5' SS	--	--		
				90	Dark brown, SAND, med to coarse trace of fine to coarse gravel, and little silt **
19	91.5' SS	--	--		

GENERAL WELL CONSTRUCTION



LOG OF TEST BORING

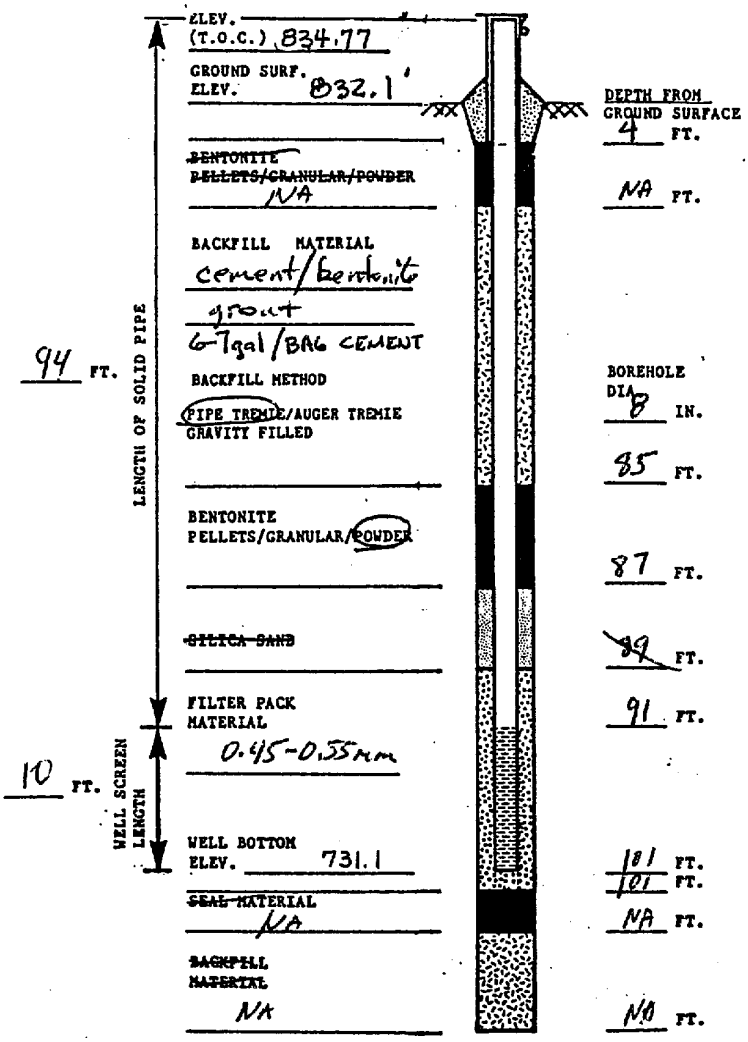
BORING NO.:	10-D
SHEET	3 of 3
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY,MN	SURFACE ELEVATION: -----

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS	GENERAL WELL CONSTRUCTION
				95	Dark brown, SAND, med to coarse trace of fine gravel.	FILTER PACK SAND
20	96.5 SS	--	--			
				100	Lt. brown, SAND, med. to coarse, trace of sandstone fragments (St. Peter Sandstone)	10
21	101.5 SS	--	--			
					EOB at 101'	
					*Top half of split-spoon sample contained a petroleum-like odor after allowing the sample to warm in the office.	
					**Same odor as above noted in the bottom half of split-spoon sample.	

RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: COE-NIROP/FRIDLEY NO. 1332.32
WELL NO. 10D
DATE INSTALLED 2-1-88, 2-2-88



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER Black steel

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

COUPLINGS, THREADED (W/TAPE?), OTHER

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

PVC, STAINLESS, TEFLON, OTHER

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 3.0" OD IN. 3.5"

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO
PROTECTOR PIPE DIA. 6 IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.5 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 450 gal
ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, ~~OPAQUE~~

F) ODOR? YES OR NO NTU = 40.0 (KEB 7/5/8

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (21.39') FT

DATE/TIME FT

DATE/TIME FT

ADDITIONAL COMMENTS: 4 centralizers - Above screen, then 25' centers

elevations checked 5/9/88 CAK

VCAK
3/22/88

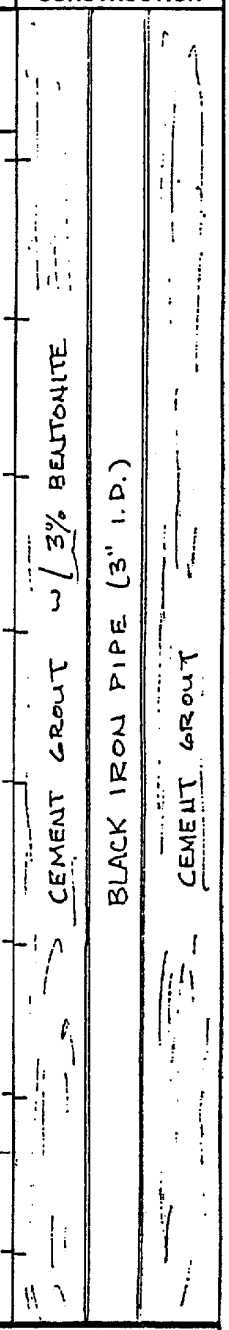
LOG OF TEST BORING

RMT INC

BORING NO.: 13-D	
SHEET 1 of 3	
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: Fridley, MN	SURFACE ELEVATION: 833.3'
DRILLED BY: Layne Northwest - Milwaukee	DATE STARTED: 1-29-88 / DATE COMPLETED: 2-8-88
CREW CHIEF: Dick Hornburg	LOGGED BY: Ron Vaughn / CHECKED BY: BWR/3-4-88

SAMPLING NOTES: INTERVAL NO.	INTERVAL TYPE	RECOVERY BLOWS	RECOVERY %	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
1	Grab	* -	-		Black, SILTY SANDY CLAY, and fill materials, soft
				5'	
2	Grab	-	-		Light brown sand, fine to med.
				10'	
3	SS	35	80		Light brown SAND, fine to med.
				15'	
4	16.3' SS	38	95		Light brown, SAND, little fine gravel
				20'	
5	21.5' SS	82	95		Brown, SAND, med to coarse, some coarse gravel
				25'	
6	26.5' SS	88	60		Brown SAND, med to coarse, some coarse gravel
				30'	
7	31.5' SS	85	80		Grey brown, sand, fine to med. trace of fine gravel
				35'	
8	36.5' SS	83	90		Light brown, SAND, med to coarse.
				40'	(Trace fine gravel @37')
9	41.5' SS	100/.8'	100		Dark grey, CLAYEY SILT, dense

GENERAL WELL CONSTRUCTION



NOTES	WATER LEVEL OBSERVATIONS			
DRILLING METHODS: Cable tool w/Split Spoon (S.S.) Sampler *300lb. Hammer and 3" Split Spoon	FIRST OCCURENCE:			
	DATE/TIME			
BOREHOLE DIAMETER: 8"	DEPTH TO WATER			
DRILL RIG: BUCYRUS-ERIE 22R	DEPTH TO CAVE IN			

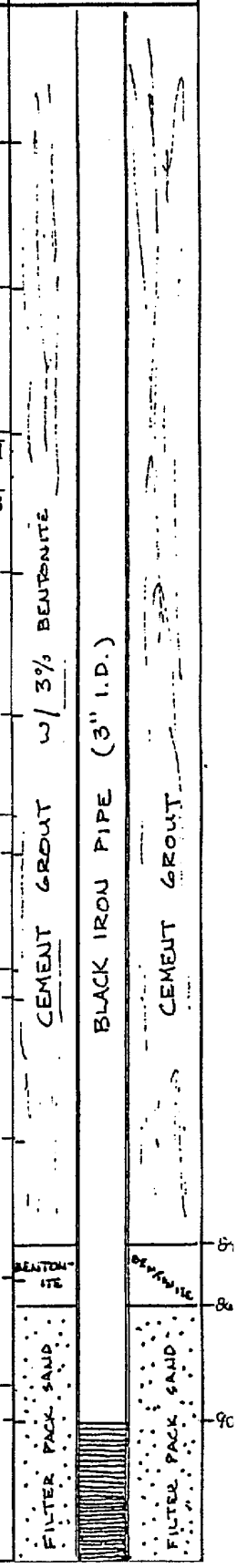
LOG OF TEST BORING

RMT

BORING NO.: 13-D	
SHEET 2 of 3	
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: Fridley, MN	SURFACE ELEVATION: ----

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
-	-	-	-	40	See page 1 @44'
				45'	
10	46.5' SS	100/ .6'	100		Brown CLAYEY SILTY SAND, little coarse gravel, dense
				50'	
11	51.5' SS	200/ .5'	100		Brown SILTY CLAY, trace coarse sand, trace fine gravel @55.5'
				55'	
12	56.5' SS	200/ 1.5'	80		Dark grey, SANDY SILT, little fine sand uniform Brown SAND, little clay @56.3
				60'	
13	61.5' SS	190/ 1.5'	90		Brown, SAND, fine
				65'	
14	66.6' SS	180/ 1.6'	80		Brown SAND, fine to med. @68.5
				70'	
15	71.5' SS	180/ 1'	80		Brown SAND, med to coarse, trace fine gravel, trace of cobbles @74'
				75'	
16	76.5' SS	200/ 1.5	80		Brown, SAND, med to coarse
				80'	
17	81.5 SS	215/ 1.5'	80		Brown, SAND, med to coarse
				85'	
18	86.5' SS	190/ 1.5'	70		Brown, SAND, fine to coarse Trace fine gravel. @89'
				90'	
19	91.5' SS	202/ .3'	50		Brown, GRAVELLY SAND, little cobbles, trace sandstone fragments
				95'	

GENERAL WELL CONSTRUCTION



LOG OF TEST BORING

BORING NO.: 13-D	
SHEET 3 of 3	
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: Fridley, MN	SURFACE ELEVATION: ____

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS	GENERAL WELL CONSTRUCTION
				95'		
20	96.5' SS	204/ .8'	40		Brown, GRAVELLY SAND, little cobbles, trace of fragmented sandstone.	FILTER PACK SAND
				100'		
21	Grab	-	-		Yellow brown, SANDSTONE, soft, well sorted, fine to med., trace med sand. (St. Peter Sandstone)	
				105'		
					E.O.B. 101'	

F-204B (R 09-87)

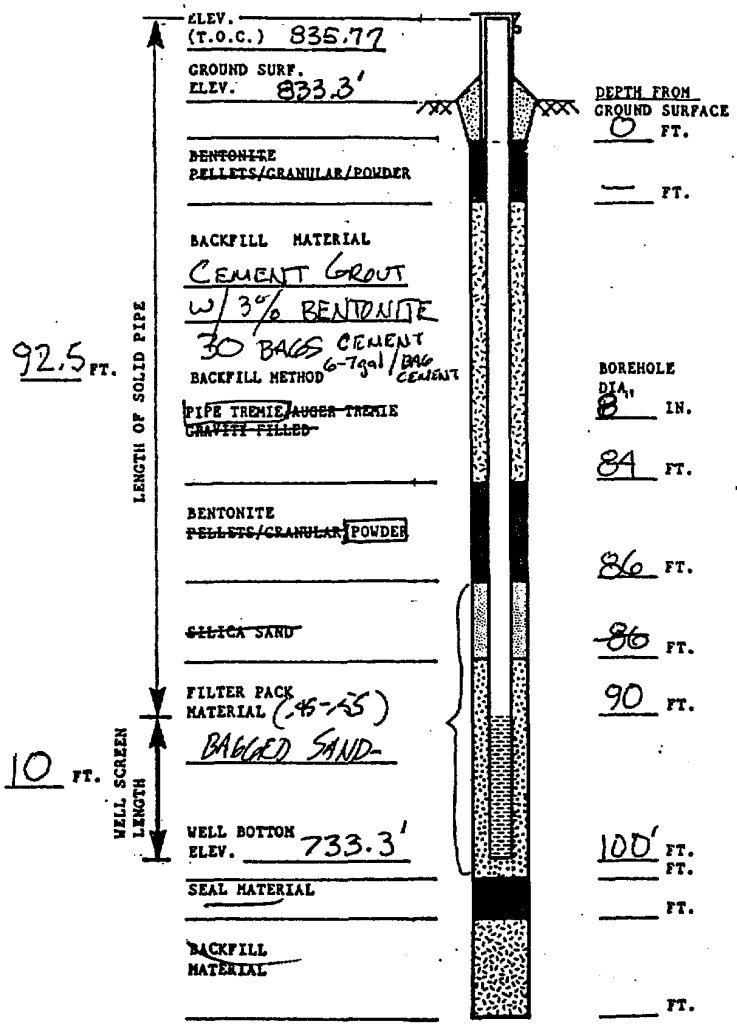
RMT

Well Diagram
F-17 (R 11-85)

PROJECT NAME: COE-NIROP NO. ~~13-D~~ 15SC.SC

WELL NO. 13-D

DATE INSTALLED 2-8-88



1) CASING DETAILS

A) TYPE OF PIPE:

PVC, STAINLESS, TEFLON, OTHER BLACK IRON

PIPE SCHEDULE 40

B) TYPE OF PIPE JOINTS;

~~COUPLINGS~~, THREADED (~~W/TAPE?~~), ~~OTHER~~ NO

C) WAS SOLVENT USED? YES OR NO

D) TYPE OF WELL SCREEN:

~~PVC~~, STAINLESS, ~~TEFLON, OTHER~~

E) WELL SCREEN SLOT SIZE .010"

F) PIPE DIA: ID IN. 3" OD IN. 3½"

G) INSTALLED PROTECTOR PIPE W/LOCK? YES OR NO

PROTECTOR PIPE DIA. 6" IN.

2) WELL DEVELOPMENT

A) METHOD

BAILING, PUMPING, SURGING, COMPRESSED AIR

OTHER —

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 2.0 HRS

C) APPROXIMATE WATER VOLUME: REMOVED 360 gal.

ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, TURBID, OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

CLEAR, SLIGHTLY TURBID, TURBID, ~~OPAQUE~~ ~~SLIGHTLY~~

F) ODOR? YES OR NO NTU = 6.0 (KEB 7/5/88)

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 (22.57') FT

DATE/TIME FT

DATE/TIME FT

ADDITIONAL COMMENTS: 4 CENTRALIZERS

30 BAGS of CEMENT @ 6-7 gal/bag

elevations checked 5/5/88 CAK

VCAK 3/22/88

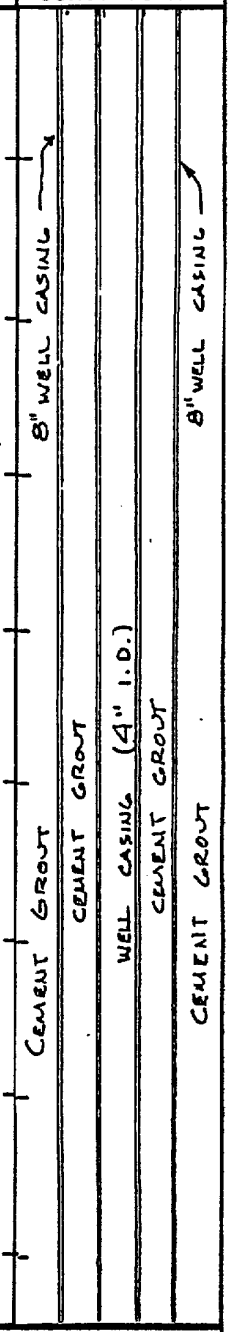
LOG OF TEST BORING

RMT INC

BORING NO.:	5-PC
SHEET	1 of 4
PROJECT:	COE-NIROP
PROJECT NO.:	1332.32
LOCATION:	FRIDLEY, MN
SURFACE ELEVATION:	832.2'
DRILLED BY:	Layne Northwest - Milwaukee
DATE STARTED:	
DATE COMPLETED:	
CREW CHIEF:	
LOGGED BY:	Mark McColloch
CHECKED BY:	BWR 9 Mar. 88

SAMPLING NOTES NO.	INTERVAL TYPE	RECOVERY BLOWS	RECOVERY IN	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
1	WS	0, 2, 3		0	Black, SAND, fine to med. some to little fine gravel, trace of silt and clay, plant roots.
2				5	Brown, SAND, and GRAVEL, med. to coarse pieces of wood.
3	WS	5.5 – 9.5		10	
4	WS	10.5 – 14.5			Brown, SAND and GRAVEL, med. to coarse, pieces of wood.
5	WS	15.5 – 19.5		15	Light brown, SAND, fine to coarse.
6	WS	20.5 – 25.5		20	Light brown, SAND, fine to coarse.
7	WS	26.5 – 30.5		25	Light brown, SAND, fine to coarse.
8	WS	31.5 – 35.5		30	Light brown, SAND, fine to coarse.
9	WS	36.5 – 40.5		35	Light brown, SAND, fine to coarse.
		41.5		38'	More coarse sand and fine gravel
				40	

GENERAL WELL CONSTRUCTION



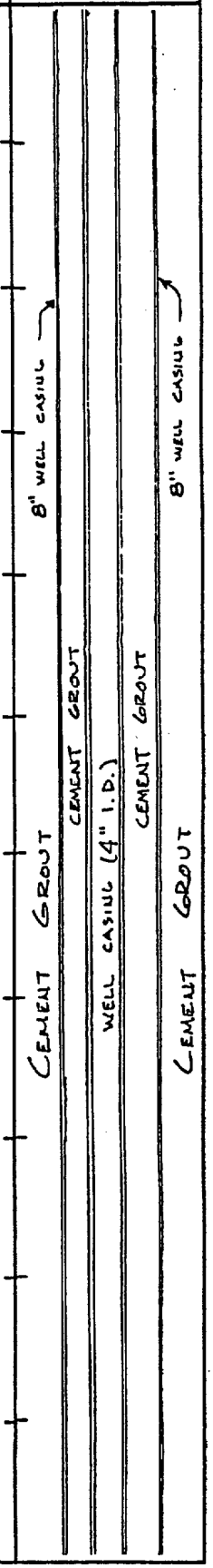
NOTES	WATER LEVEL OBSERVATIONS			
DRILLING METHODS: Mud rotary grab samples composited of wash cuttings over 5 ft. intervals.	FIRST OCCURENCE:			
	DATE/TIME			
BOREHOLE DIAMETER: 8" to 6.5" to 3"	DEPTH TO WATER			
DRILL RIG: TH-60: Well Casing Gus Peck Bratt 22R: Rock Core	DEPTH TO CAVE IN			

LOG OF TEST BORING

BORING NO.:	5-PC
SHEET	2 of 4
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY,MN	SURFACE ELEVATION:

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
				40	Brown, SAND, Med. to coarse, trace cobbles.
10	WS				
				45	Brown, SAND, med. to coarse little silt and clay.
11	WS			49	No clay present at 49'
				50	Brown SAND and GRAVEL, med to coarse, little silt and clay.
12	WS				
				55	Brown, SAND, some clay and fine gravel.
13	WS			60	
					Brown, SAND, some clay and fine gravel.
14	WS			63' – 65'	Clay becoming more abundant.
				65	Brown, SAND, some clay and fine gravel.
15	WS				
				70	Brown, SAND, some clay and fine gravel.
16	WS			72' – 73'	Clay becoming less abundant.
				75	Brown, SAND, med. to coarse, little fine gravel.
17	WS			80	
					Brown, SAND, med. to coarse, little fine gravel.
18	WS			85	
					Brown, SAND, med. to coarse, little fine gravel.
19	WS			90	
					Brown, SAND, med. to coarse, little fine gravel.
20	WS			95	

GENERAL WELL CONSTRUCTION



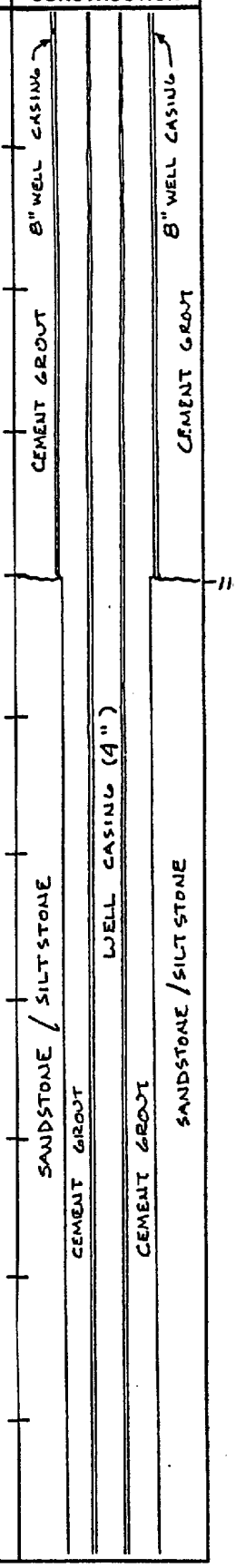
F-204B (R 09-87)

LOG OF TEST BORING

BORING NO.:	5-PC
SHEET	3 of 4
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY, MN	SURFACE ELEVATION:

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
				95	Dark brown, SAND, med to coarse, trace of siltstone with interbedded shale.
21	G				
				100	Yellow brown, SILTSTONE, interbedded with soft pale yellow shale.
22	G				
				103	Yellow brown, SILTSTONE.
	G			105	
24	G				Yellow brown, SILTSTONE.
				110	8" casing grouted. Begain 6.5" borehole.
				110	Yellow brown, SILTSTONE and greenish grey siltstone.
25	G			112	
26	G				
				115	
27	G				Yellow brown, SILTSTONE and greenish grey siltstone.
				120	
28	G				Yellow brown, SILTSTONE and greenish grey siltstone.
				125	
29	G				Yellow brown, SILTSTONE and greenish grey siltstone.
				130	Tan, SANDSTONE/SILTSTONE, very fine
30	G			133	
31	G			135	Tan, SANDSTONE/SILTSTONE, some greenish white shale. Fractured zone, drilling method losing water into bedrock.
32	G			140	Reddish brown, SILTSTONE, and white SANDSTONE/SILTSTONE.
	G			145	

GENERAL WELL CONSTRUCTION

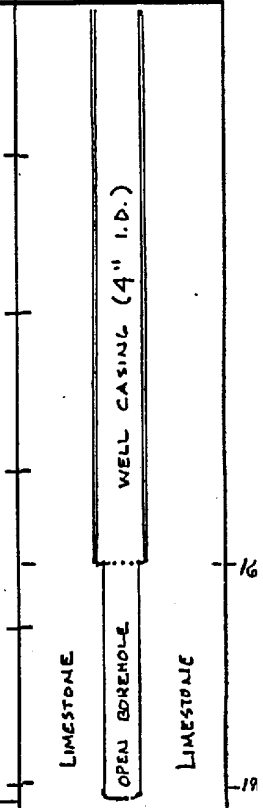


LOG OF TEST BORING

BORING NO.:	5-PC
SHEET	4 of 4
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY, MN	SURFACE ELEVATION:

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
33	G			145	Reddish brown, SILTSTONE, and white, SANDSTONE/SILTSTONE.
34	G			150	Orange brown, SANDSTONE. White, SANDSTONE/SILTSTONE.
				155	Orange brown, SANDSTONE. White, SANDSTONE/SILTSTONE.
35	G			160	
36					
	Rock Core				Yellow orange brown, LIMESTONE, interbedded with siltstone, few interbeds of sand, fractured, vugs lined with chalcopynte, pyrite, and calcite.
				190	EOB at 190.5'

GENERAL WELL CONSTRUCTION



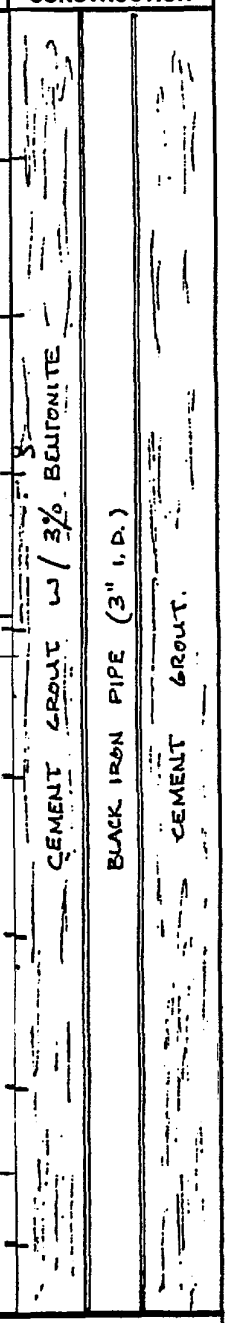
LOG OF TEST BORING

RMT INC

BORING NO.:	14-D
SHEET	1 of 2
PROJECT:	COE-NIROP
PROJECT NO.:	1332.32
LOCATION:	FRIDLEY, MN
SURFACE ELEVATION:	835.3'
DRILLED BY:	Layne-Northwest-Milwaukee
DATE STARTED:	1-11-88
DATE COMPLETED:	1-20-88
CREW CHIEF:	Dick Hornburg
LOGGED BY:	Ron Vaughn
CHECKED BY:	BWR/ 4 Mar 88

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
--	--	--	--	0	(No samples collected 0' - 30', see log for 9S and 5I)
1	31.5' SS	--	80	30	Brown, SAND, fine
2	36.5' SS	--	70	35	Brown, SAND, fine
3	41.5' SS	--	--	40	Brown, SAND, fine to coarse, little fine gravel
4	46.5 SS	--	80	45	Brown, GRAVELLY SAND, fine to coarse, Brown, CLAYEY SAND, fine sand, uniform
				50	At 50' Drilling methods changed from hollow stem augers to cable-tool rig.
5	SS	--	40	50	Dark red brown, CLAYEY SAND, fine sand, Brown, GRAVELLY SAND, fine to coarse, trace of cobbles.
6	55.5' SS		10	55	Ban, SAND, fine to coarse, trace fine gravel
				60	Change to hard drilling at 56.8'

GENERAL WELL CONSTRUCTION



NOTES	WATER LEVEL OBSERVATIONS			
DRILLING METHODS: Hollow stem augers to 50' cable tool after 50': w/ 3" split-spoon sampler using a 300lb hammer.	FIRST OCCURENCE:			
	DATE/TIME			
BOREHOLE DIAMETER: 8"	DEPTH TO WATER			
DRILL RIG: Bucyrus-Erie 22R	DEPTH TO CAVE IN			

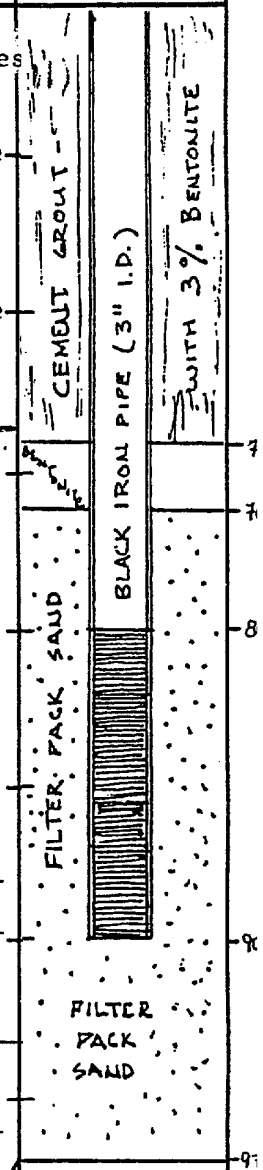
F-204A (R 09-87)

LOG OF TEST BORING

BORING NO.:	14-D
SHEET	2 of 2
PROJECT: COE-NIROP	PROJECT NO.: 1332.32
LOCATION: FRIDLEY,MN	SURFACE ELEVATION: ----

SAMPLING NOTES INTERVAL NO.	TYPE	RECOVERY BLOWS	%	DEPTH (ft.)	VISUAL CLASSIFICATION AND GENERAL OBSERVATIONS
7	60.3 SS	--	100	60	Brown, SAND, fine to coarse sand, trace silty gravel, track of clay, trace cobbles (till). (Very hard to drill in.)
8	65.5 SS	200 / .5'	100	65	Brown, Silty SAND, fine to coarse, trace coarse gravel (till)
9	SS	--	100	70	Brown, silty SAND, fine to coarse, trace coarse gravel, trace cobbles (till) @73.5'
10	76.4 SS	200 / 1.4'	100	75	Red brown, SAND, fine to med., trace of fine gravel.
11	81.2 SS	200 / 1.2'	100	80	Red brown, SAND, fine to med., trace of fine gravel. Yellow brown, SAND, fine.
12	86.5 SS	196 / 1.4'	50	85	Redish brown, SAND, fine at 88' Gravelly SAND at 90'
13	90.7 SS	200 / .7'	60	90	Red brown, SAND med. to coarse, some clay, some gravel. at 93'
14	95.5 SS	200 / .5'	70	95	Brown, SAND, fine to coarse, some gravel
				100	EOB 97'

GENERAL WELL CONSTRUCTION



F-204B (R 09-87)

RMT

Well Diagram

PROJECT NAME: COE.-NIROP NO. 1332.32

WELL NO. 5-PC

DATE INSTALLED 1/14/88

1.) CASING DETAILS

A.) Type of pipe: BLACK IRON PIPE

Pipe schedule 8" DIA : 30

4" DIA : 40

B) Type of pipe joints welded.

C) was solvent used? NO

d.) Type of well screen: open borehole.

E) PIPE DIA: EXTERNAL: 8" I.D.

INTERNAL: 4" I.D.

F.) EXTERNAL 8" Pipe used AS protective pipe w/LOCK.

2) WELL DEVELOPMENT

A) METHOD

BAILING, [PUMPING], SURGING, COMPRESSED AIR

OTHER _____

(NOTE ADDITIONAL COMMENTS BELOW)

B) TIME SPENT FOR DEVELOPMENT? 5 HRS.

C) APPROXIMATE WATER VOLUME: REMOVED 900 gals.

ADDED —

D) WATER CLARITY BEFORE DEVELOPMENT?

CLEAR, [TURBID], OPAQUE

E) WATER CLARITY AFTER DEVELOPMENT?

[CLEAR], SLIGHTLY TURBID, TURBID, OPAQUE

F) ODOR? YES OR [NO] NTU = 1.4 (KEB 7/5/88)

3) WATER LEVEL SUMMARY

A) DEPTH FROM TOP OF CASING AFTER DEVELOPMENT?

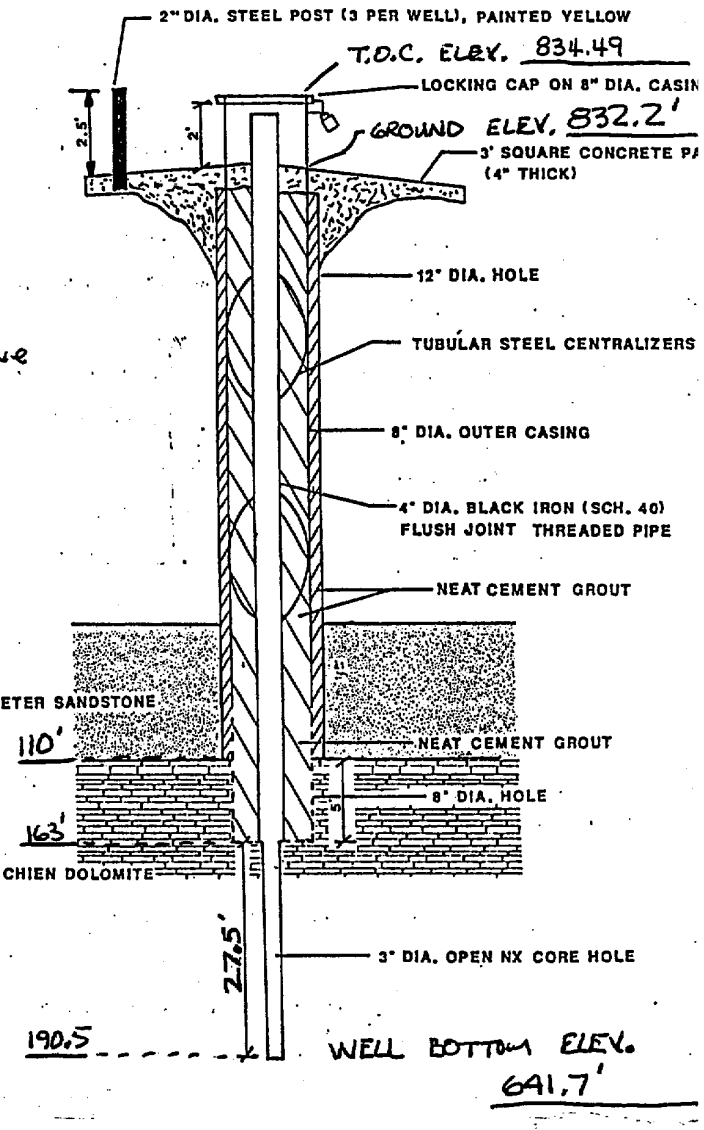
— FT. OR DRY

B) OTHER MEASUREMENTS (T.O.C.):

DATE/TIME 2-19-88 / 21.08' FT.

DATE/TIME _____ FT.

DATE/TIME _____ FT.



ADDITIONAL COMMENTS: _____

elevations checked 5/2/88 CAK

CK'd CAK 5-4-8

APPENDIX C

CALCULATIONS

IN-SITU PERMEABILITY CALCULATIONS

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 15-S

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 12.3
H - SCREEN BASE TO WATER TABLE (FT): 12.3
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 21.84

Rc was corrected for response in well screen filter material to 2.864 inches

---

TIME (H,M,S)	DEPTH (FT)
0,0,20	24.72
0,0,50	21.84

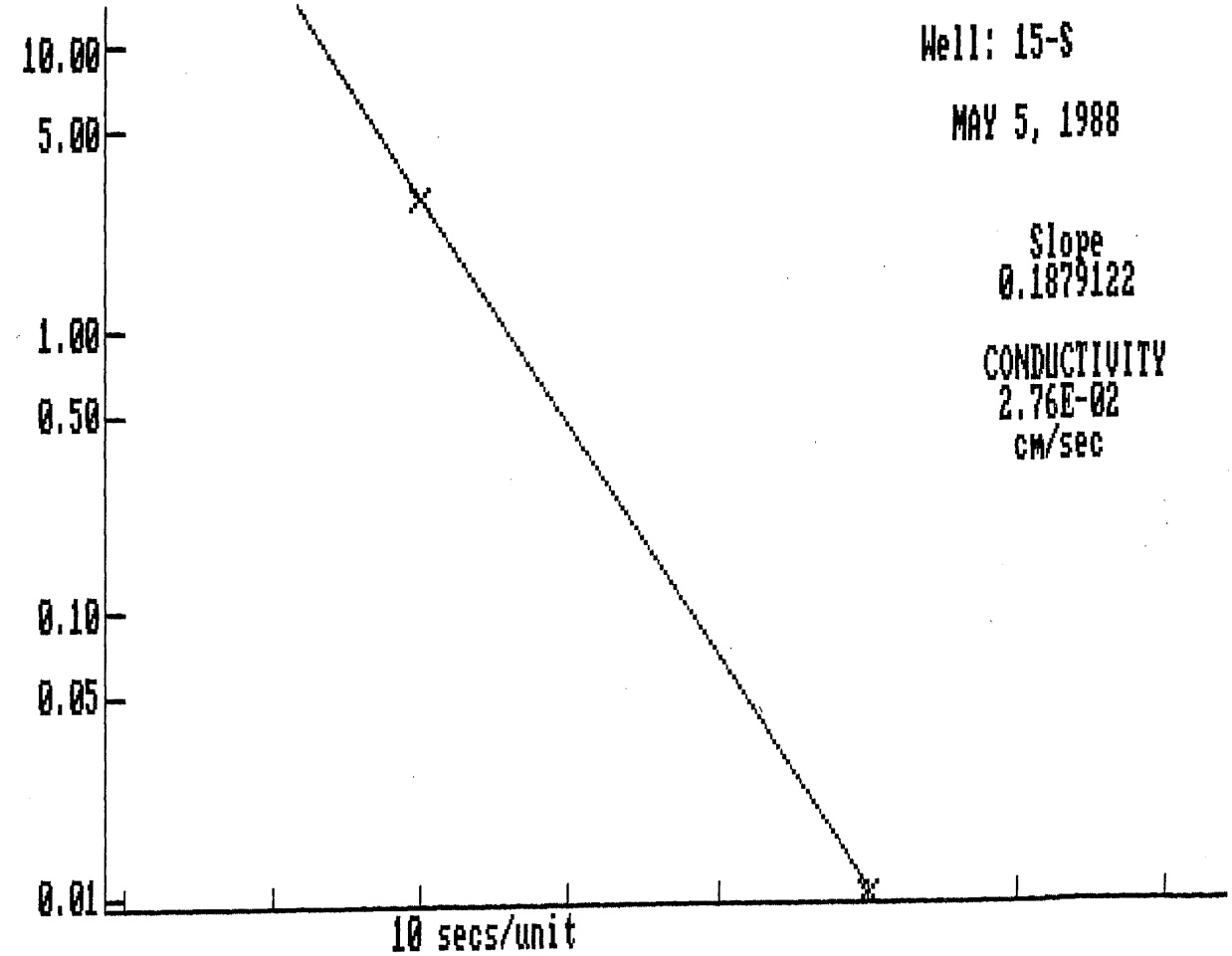
(1/t) (ln(Yo/Yt))= 0.1879122

PARTIALLY PENETRATING: A= 2.49 B= 0.40

HYDRAULIC CONDUCTIVITY: 9.04E-04 ft/sec
2.76E-02 cm/sec

JEK 5/6/

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



Well: 15-S

MAY 5, 1988

Slope
0.1879122

CONDUCTIVITY
2.76E-02
cm/sec

DRK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 22-S

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 11.57
H - SCREEN BASE TO WATER TABLE (FT): 11.57
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 24.78

Rc was corrected for response in well screen filter material to 2.864 inches

---

TIME (H,M,S)	DEPTH (FT)
0,0,30	27.63
0,1,0	24.78

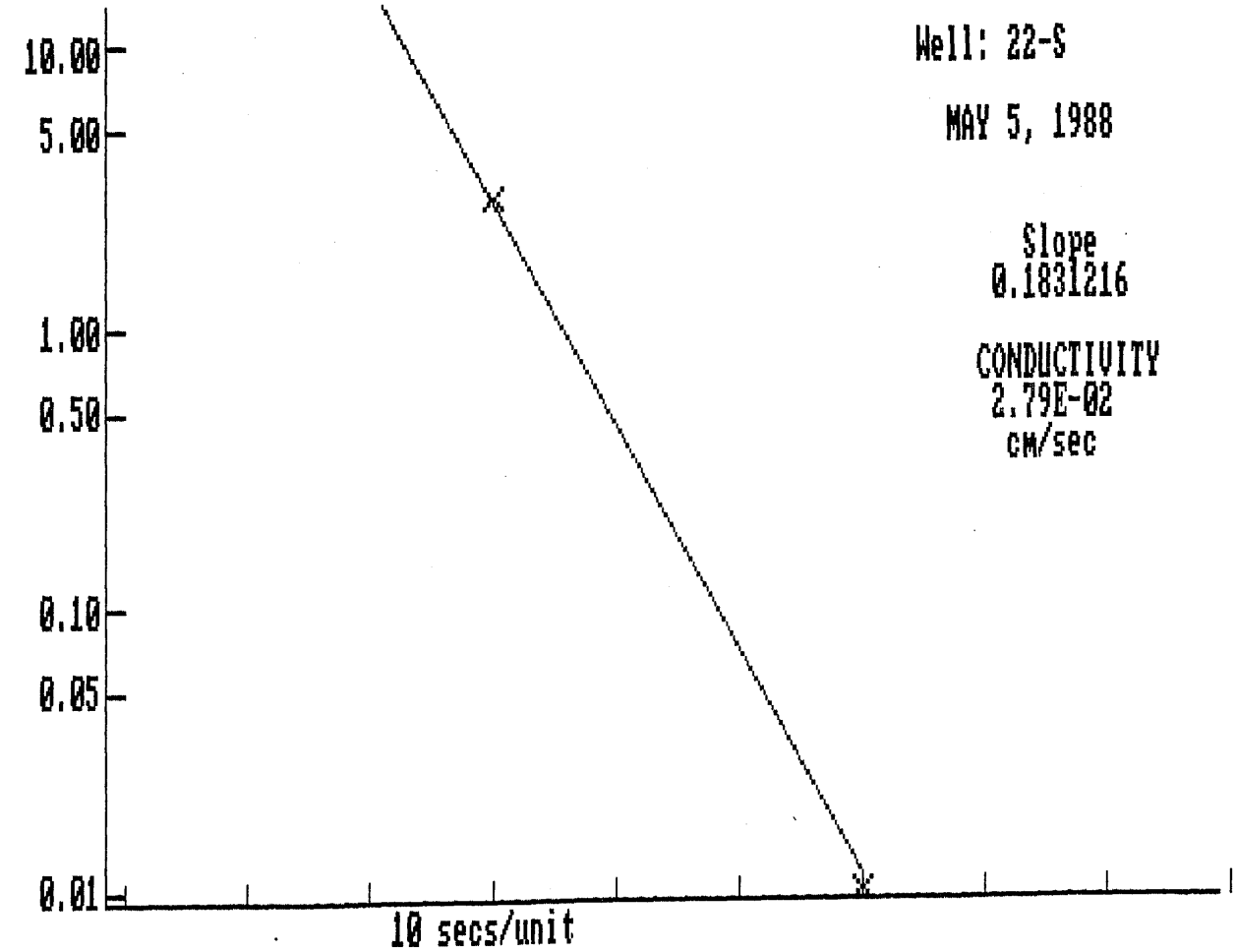
(1/t) (ln(Yo/Yt))= 0.1831216

PARTIALLY PENETRATING: A= 2.43 B= 0.39

HYDRAULIC CONDUCTIVITY: 9.14E-04 ft/sec
2.79E-02 cm/sec

TCK 5/6/88

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



Well: 22-S

MAY 5, 1988

Slope
0.1831216

CONDUCTIVITY
2.79E-02
cm/sec

JEK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 23-S

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 9.6
H - SCREEN BASE TO WATER TABLE (FT): 9.6
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 33.81

Rc was corrected for response in well screen filter material to 2.864 inches

---

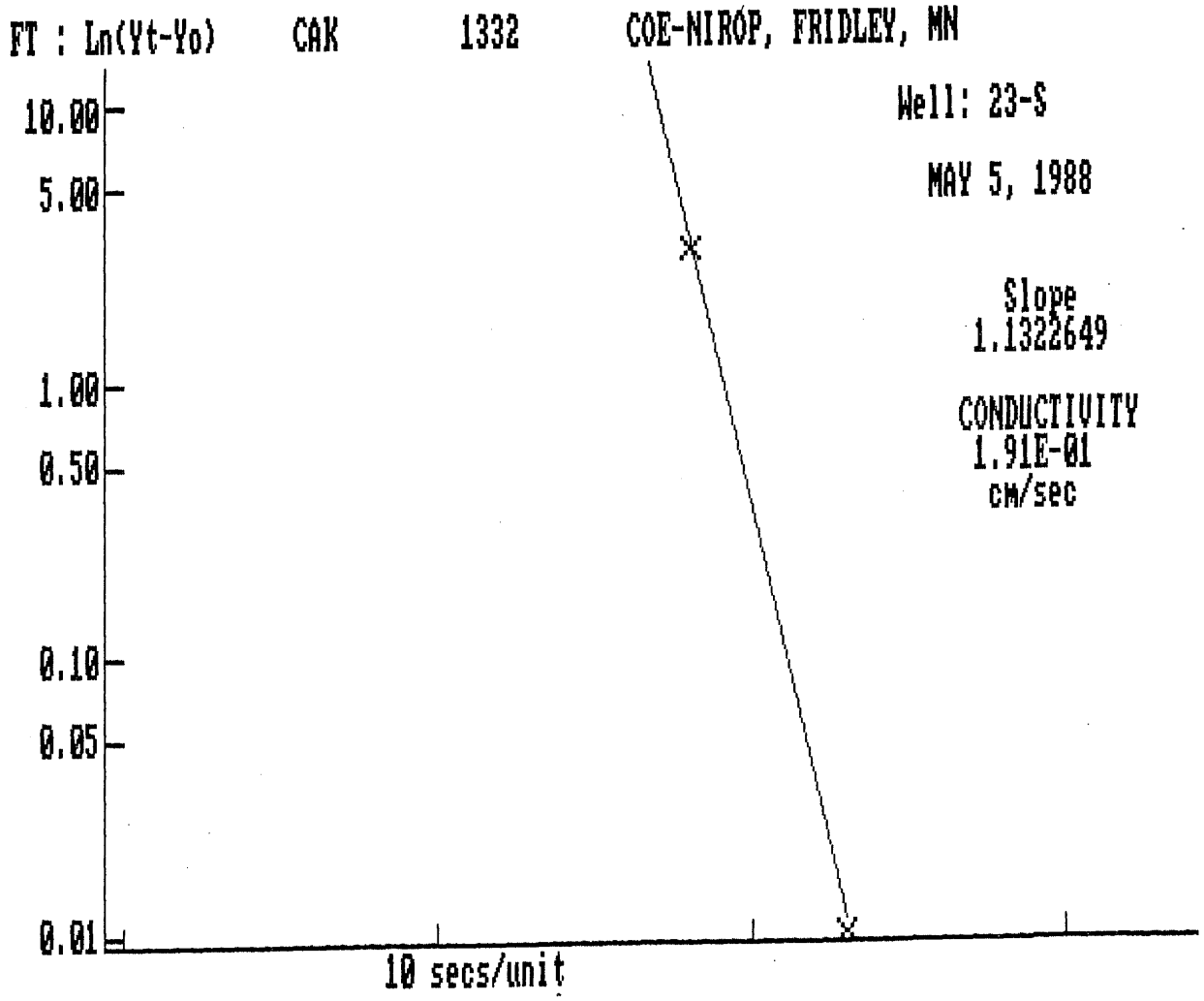
TIME (H,M,S)	DEPTH (FT)
0,0,18	36.72
0,0,23	33.81

(1/t) (ln(Yo/Yt))= 1.1322649

PARTIALLY PENETRATING: A= 2.29 B= 0.36

HYDRAULIC CONDUCTIVITY: 6.28E-03 ft/sec
1.91E-01 cm/sec

78 c/c


FT : Ln(Yt-Yo)
CAK
1332
COE-NIROP, FRIDLEY, MN
Well: 23-$
MAY 5, 1988
Slope
1.1322649
CONDUCTIVITY
1.91E-01
cm/sec
10.00
5.00
1.00
0.50
0.10
0.05
0.01
10 secs/unit

JPK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 24-S

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 12.14
H - SCREEN BASE TO WATER TABLE (FT): 12.14
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 24.06

Rc was corrected for response in well screen filter material to 2.864 inches

---

TIME (H,M,S)	DEPTH (FT)
0,0,15	24.56
0,0,30	24.42
0,0,45	24.22
0,1,0	24.15
0,1,15	24.09

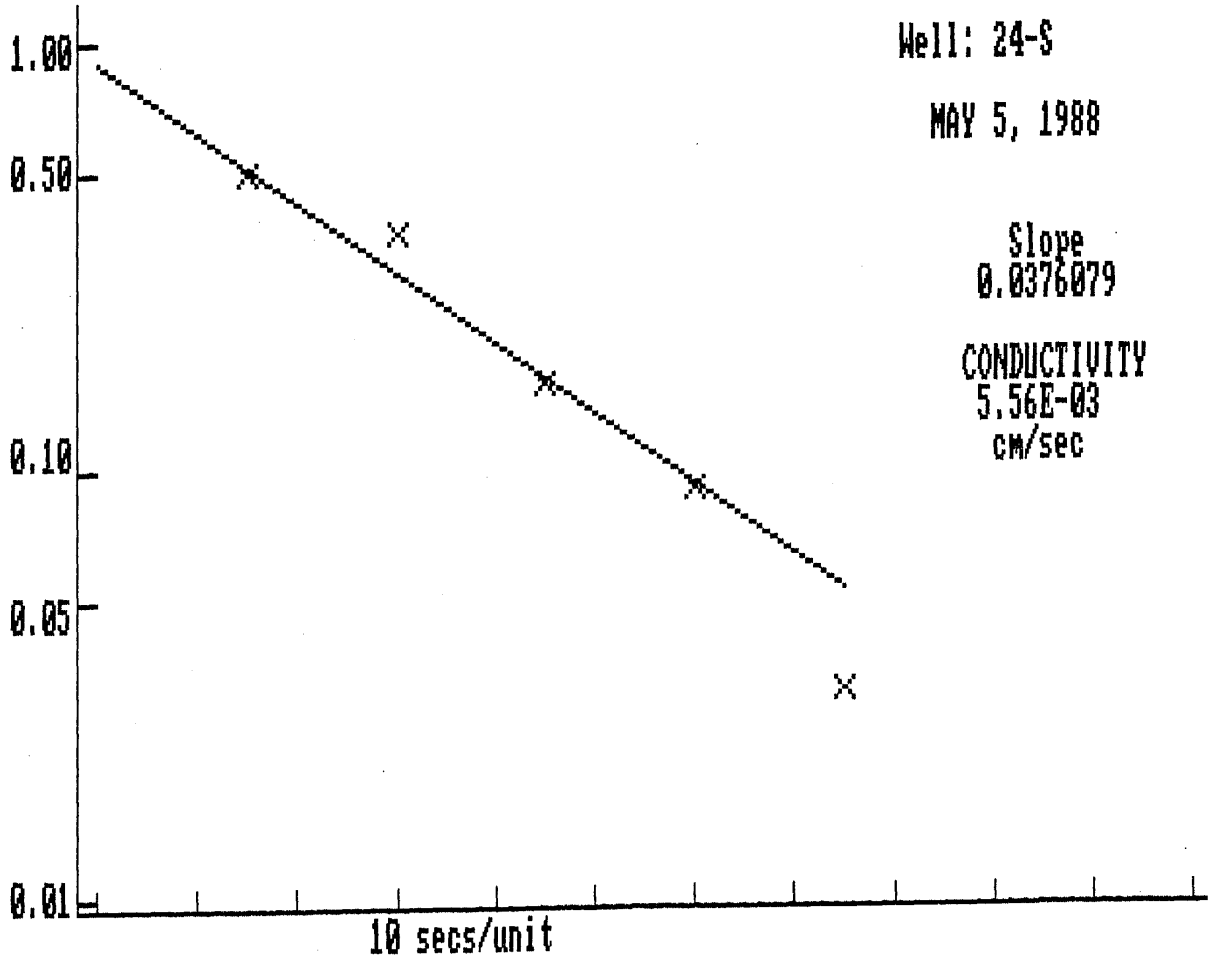
(1/t) (ln(Yo/Yt))= 0.0376079

PARTIALLY PENETRATING: A= 2.47 B= 0.39

HYDRAULIC CONDUCTIVITY: 1.82E-04 ft/sec
5.56E-03 cm/sec

7 of 8

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



Well: 24-S

MAY 5, 1988

Slope
0.0376079

CONDUCTIVITY
5.56E-03
cm/sec

TGK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 25-S

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 14.43
H - SCREEN BASE TO WATER TABLE (FT): 14.43
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 22.41

Rc was corrected for response in well screen filter material to 2.864 inches

---

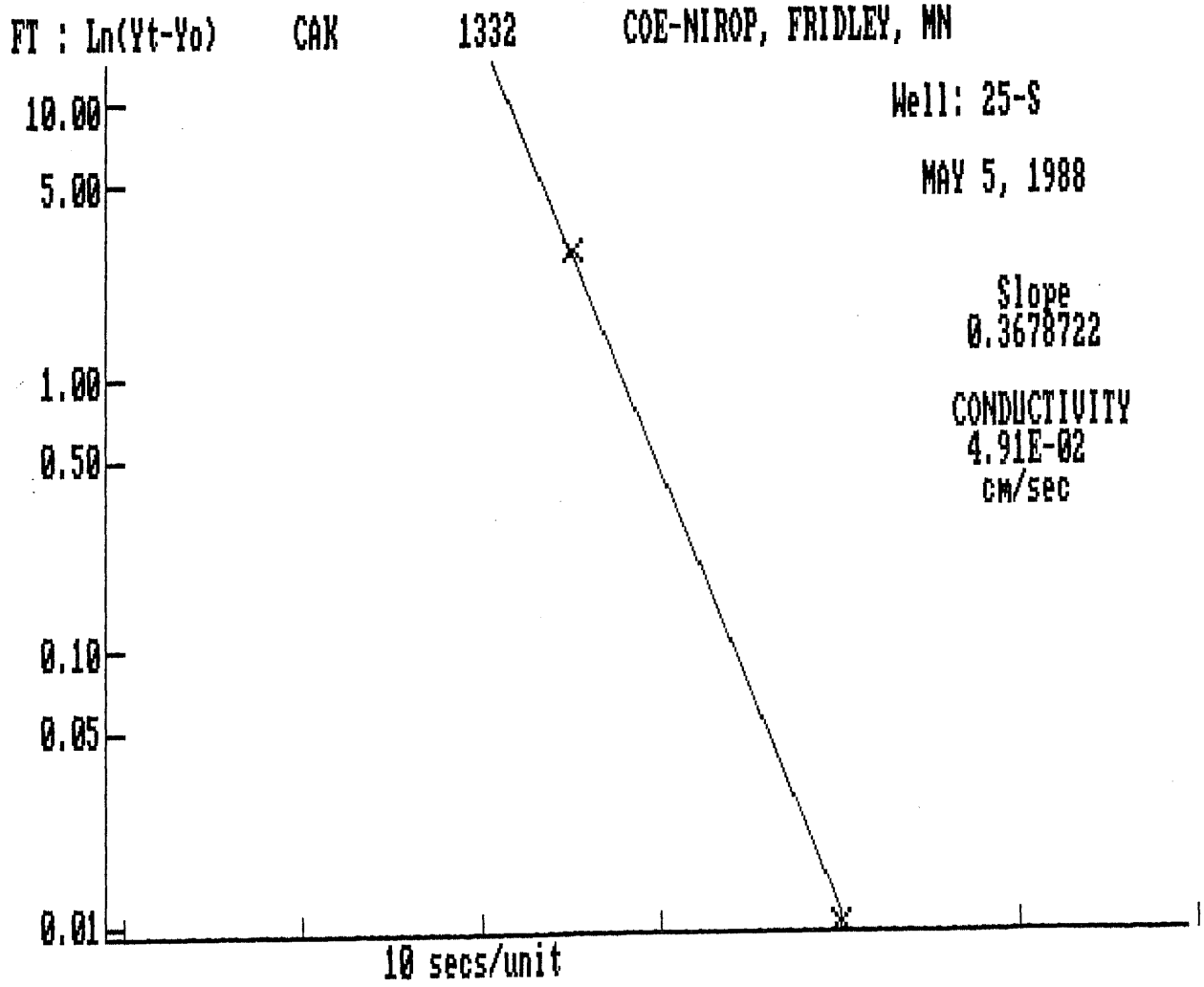
TIME (H,M,S)	DEPTH (FT)
0,0,25	25.29
0,0,40	22.41

(1/t) (ln(Yo/Yt))= 0.3678722

PARTIALLY PENETRATING: A= 2.59 B= 0.43

HYDRAULIC CONDUCTIVITY: 1.61E-03 ft/sec
4.91E-02 cm/sec

TRF 5/6/88


FT : Ln(Yt-Yo)
CAK
1332
COE-NIROP, FRIDLEY, MN
Well: 25-S
MAY 5, 1988
Slope
0.3678722
CONDUCTIVITY
4.91E-02
cm/sec
10.00
5.00
1.00
0.50
0.10
0.05
0.01
10 secs/unit

TGK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 1-I

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 54
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 85
STATIC WATER LEVEL READING (FT): 21.94

TIME (H,M,S)	DEPTH (FT)
0,0,18	27.49
0,0,23	26.76
0,0,28	26.37
0,0,33	25.91
0,0,38	25.66
0,0,43	25.38
0,0,48	25.09
0,1,18	23.94
0,1,48	23.24
0,2,18	22.83
0,2,48	22.55
0,3,18	22.37
0,4,18	22.19
0,5,18	22.11
0,6,18	22.03
0,8,18	21.99
0,10,18	21.98

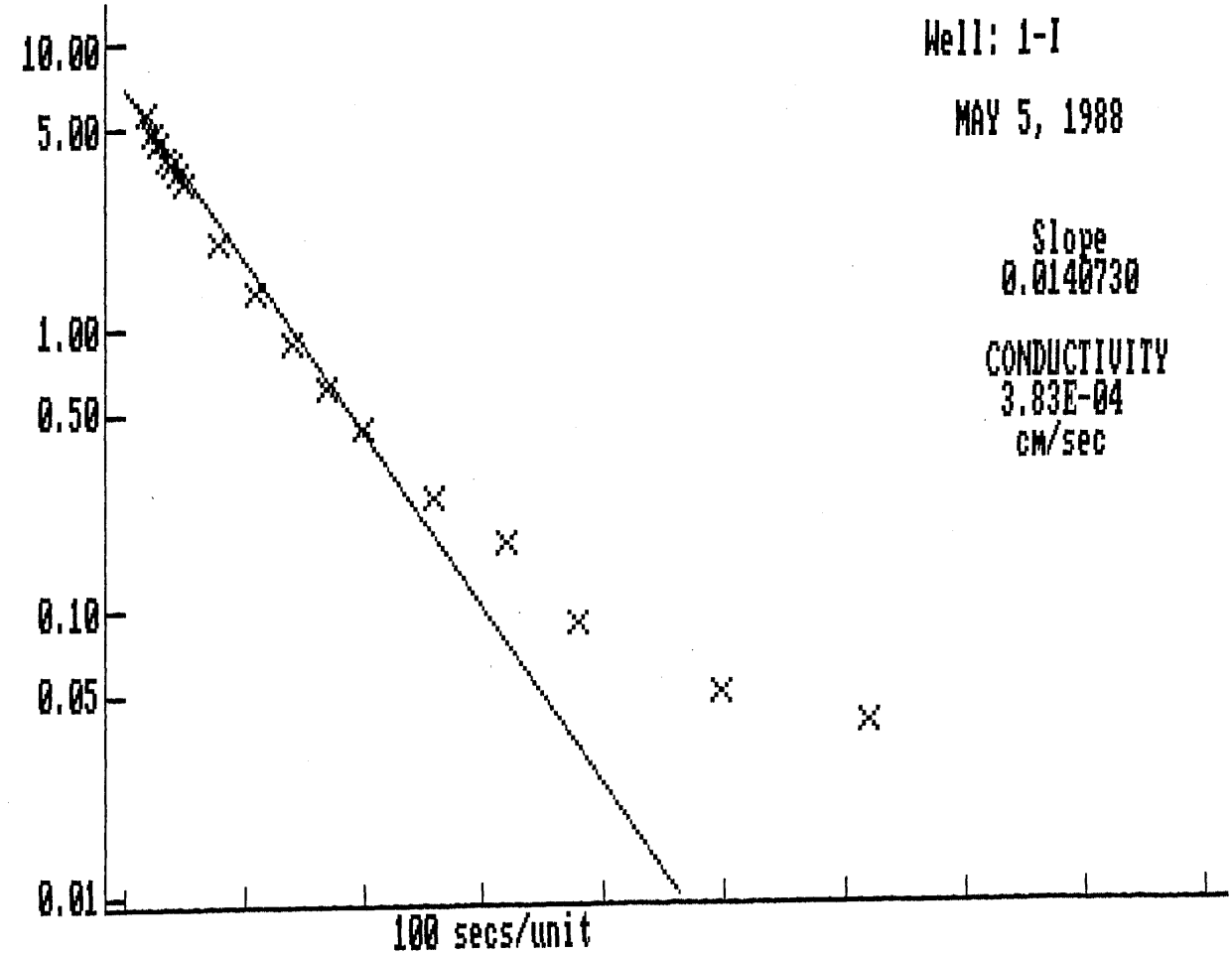
(1/t) (ln(Yo/Yt))= 0.0140730

PARTIALLY PENETRATING: A= 2.32 B= 0.37

HYDRAULIC CONDUCTIVITY: 1.26E-05 ft/sec
3.83E-04 cm/sec

✓ 5/6

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



Tyr 5/6/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 4-I

PROJECT NAME: CDE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 48.53
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 27.81

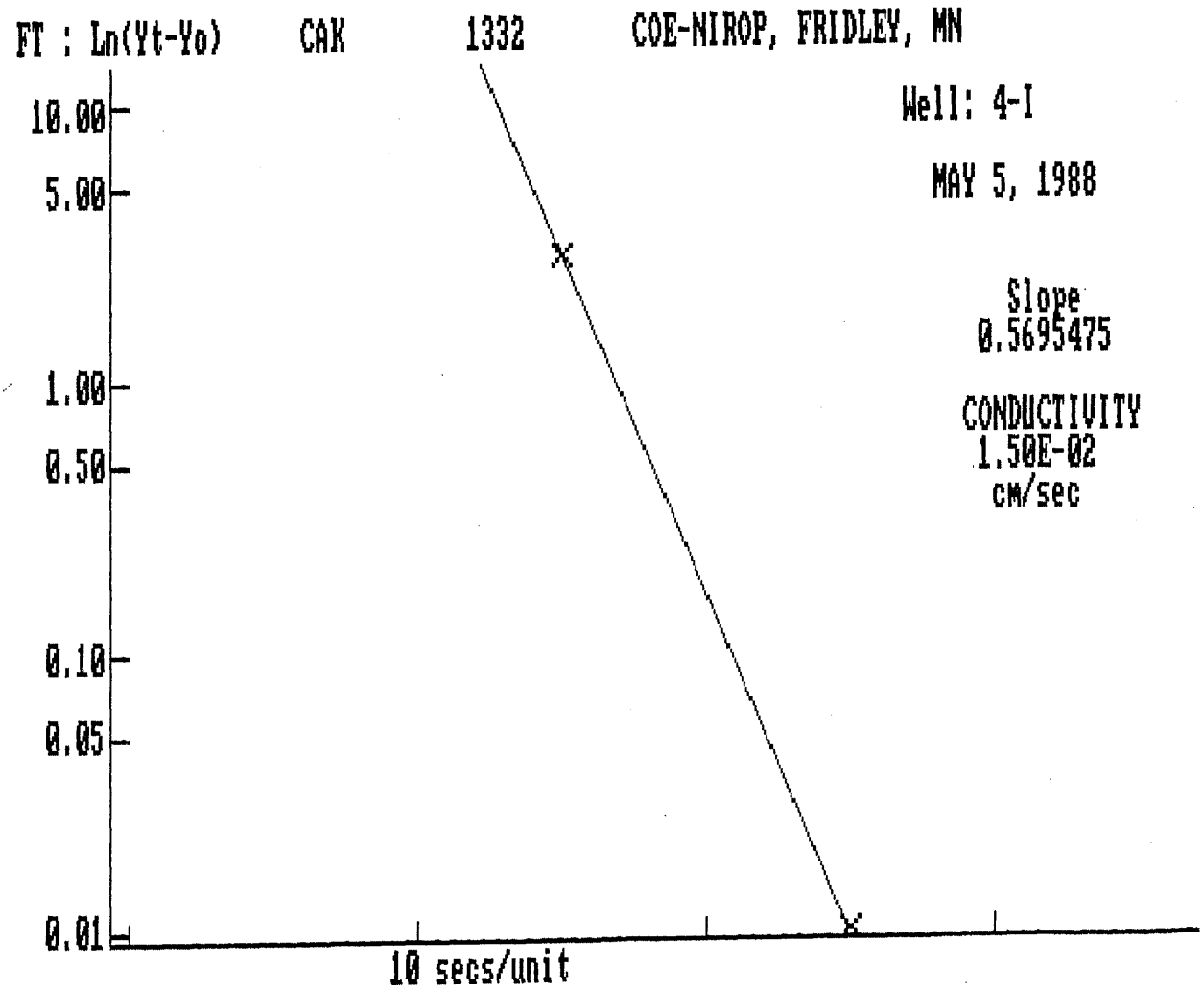
TIME (H,M,S)	DEPTH (FT)
0,0,15	30.69
0,0,25	27.81

(1/t) (ln(Yo/Yt))= 0.5695475

PARTIALLY PENETRATING: A= 2.32 B= 0.37

HYDRAULIC CONDUCTIVITY: 4.93E-04 ft/sec
1.50E-02 cm/sec

JRP 5/6/88


FT : Ln(Yt-Yo)
CAK
1332
COE-NIROP, FRIDLEY, MN
Well: 4-I
MAY 5, 1988
Slope
0.5695475
CONDUCTIVITY
1.50E-02
cm/sec
10.00
5.00
1.00
0.50
0.10
0.05
0.01
10 secs/unit

TEK 5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 10-D

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 81.9
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1.5
D - AQUIFER THICKNESS (FT): 85
STATIC WATER LEVEL READING (FT): 21.39

TIME (H,M,S)	DEPTH (FT)
0,0,18	29.69
0,0,28	29.43
0,0,38	29.11
0,0,48	28.55
0,1,18	27.65
0,1,48	26.94
0,2,18	26.32
0,3,18	25.02
0,4,18	24.21
0,5,18	23.86
0,6,18	23.29
0,7,18	22.84
0,8,18	22.48
0,10,18	22.01
0,12,18	21.69
0,16,18	21.43

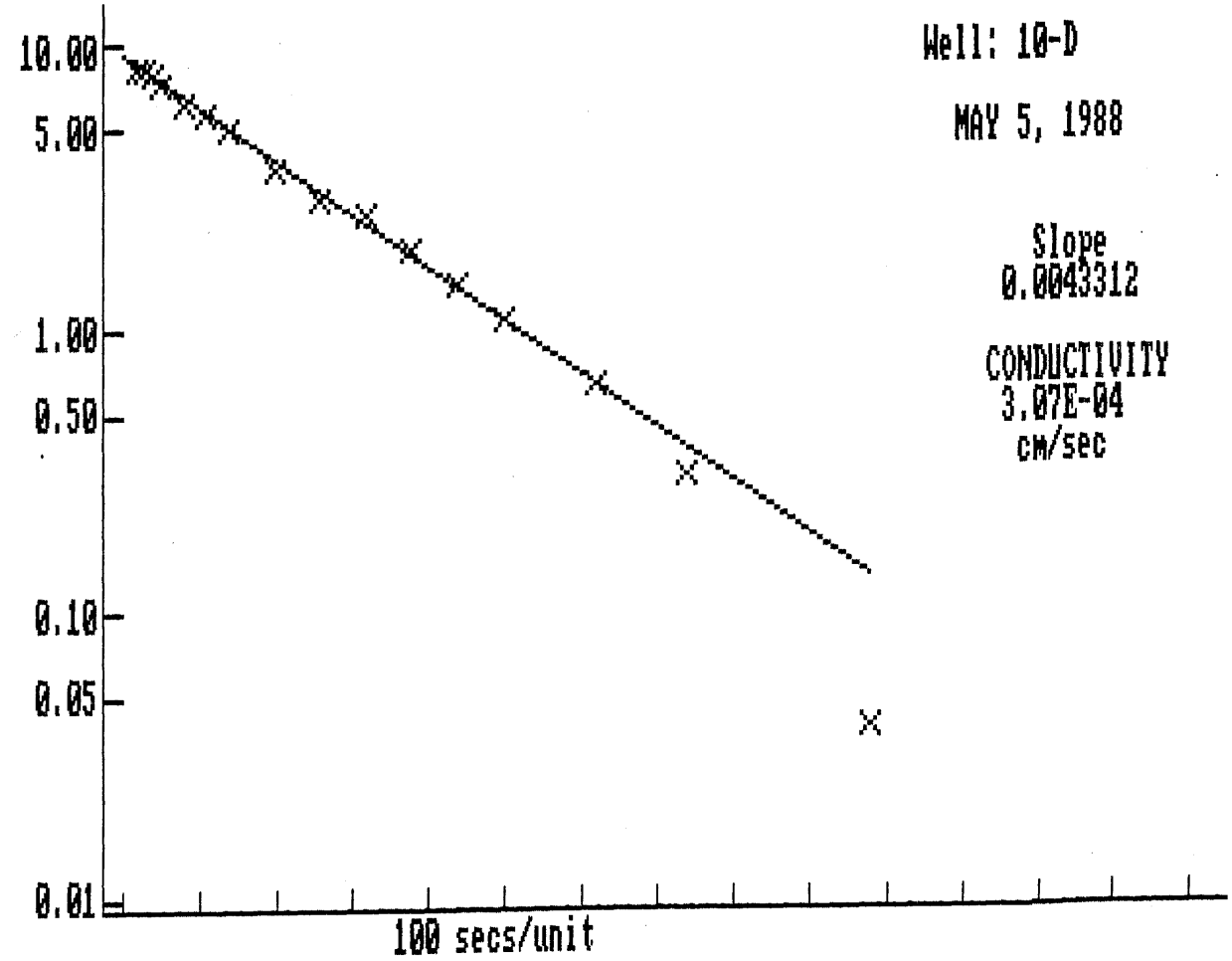
(1/t) (ln(Yo/Yt))= 0.0043312

PARTIALLY PENETRATING: A= 2.32 B= 0.37

HYDRAULIC CONDUCTIVITY: 1.01E-05 ft/sec
3.07E-04 cm/sec

194
5/9/88

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



VPK
5/9/88

RMT, INC.

HYDROCON - 1.01
HYDRAULIC CONDUCTIVITY
Bouwer and Rice Method

Well: 13-D

PROJECT NAME: COE-NIROP, FRIDLEY, MN
PROJECT NUMBER: 1332
FIELD WORK DATE(S): JANUARY-FEBRUARY 1988

USER NAME: CAK
DATE: MAY 5, 1988

Rw - BORING RADIUS (IN): 5
L - SCREEN LENGTH (FT): 10
H - SCREEN BASE TO WATER TABLE (FT): 80
START TIME (H,M,S): 0,0,0

Rc - WELL RADIUS (IN): 1.5
D - AQUIFER THICKNESS (FT): 100
STATIC WATER LEVEL READING (FT): 22.57

TIME (H,M,S)	DEPTH (FT)
0,0,11	23.01
0,0,16	22.78
0,0,21	22.71
0,0,26	22.62
0,0,31	22.62
0,0,36	22.57

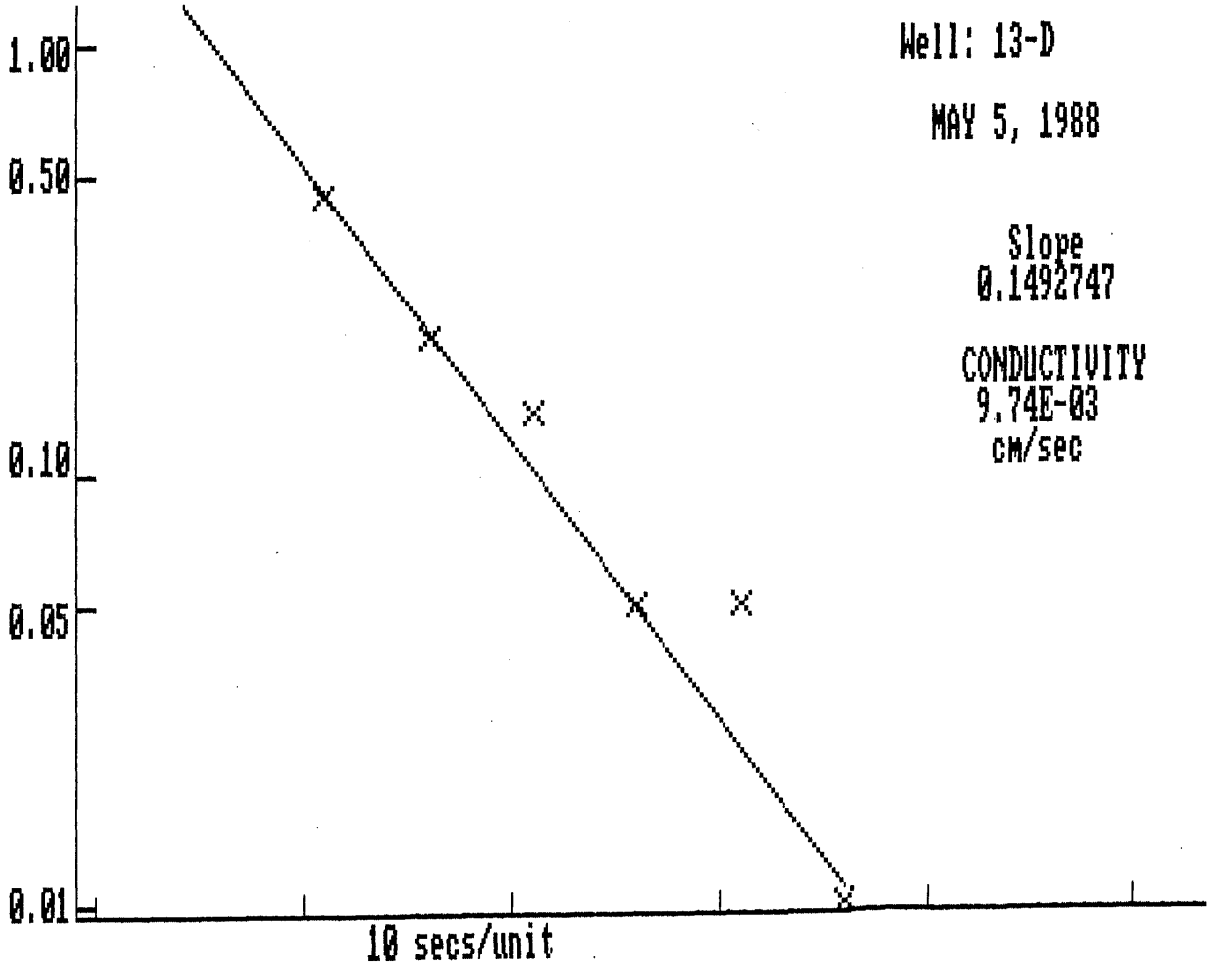
(1/t) (ln(Yo/Yt))= 0.1492747

PARTIALLY PENETRATING: A= 2.32 B= 0.37

HYDRAULIC CONDUCTIVITY: 3.20E-04 ft/sec
9.74E-03 cm/sec

JCF 5/9/88

FT : Ln(Yt-Yo) CAK 1332 COE-NIROP, FRIDLEY, MN



Well: 13-D

MAY 5, 1988

Slope
0.1492747

CONDUCTIVITY
9.74E-03
cm/sec

TPK
5/9/88

COMPUTATION SHEET

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SHEET 1 OF 1

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
COE-NIROP Fridley, MN	TPV	5-9-88	BWR	5-9-88	1332.51

Calculation of hydraulic conductivity at well 5-PC using Hvorslev's method.

$D = 3'' = 0.25$ ft $\qquad S_1 = 0.286$

$d = 4'' = 0.33$ ft $\qquad S_2 = 0.013$

$L = 27.5$ ft $\qquad t_1 = 17$ sec

$m = 1 \qquad t_2 = 23$ sec

1st case: Overlying sand has a lower hydraulic cond. than the bedrock

$$K_h = \frac{d^2}{8L(t_2 - t_1)} \ln\left(\frac{4mL}{D}\right) \ln\left(\frac{S_1}{S_2}\right)$$

$$K_h = 1.6 \times 10^{-3} \text{ ft/sec} = 4.7 \times 10^{-2} \text{ cm/sec}$$

2nd case: Overlying sand has an identical hydraulic conductivity.

$$K_h = \frac{d^2}{8L(t_2 - t_1)} \ln\left(\frac{2mL}{D}\right) \ln\left(\frac{S_1}{S_2}\right)$$

$$K_h = 1.4 \times 10^{-3} \text{ ft/sec} = 4.2 \times 10^{-2} \text{ cm/sec}$$

∴ Due to lack of additional data points, recommend expressing results as $> 4 \times 10^{-2}$ cm/sec

PUMPING TEST CALCULATIONS

COMPUTATION SHEET

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SHEET 11 OF

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE-NIROP	SAM	5/13/88			1332.51

NOTE

The set of calculations entitled "Analysis of Pump Test Data..." has been editted for inclusion in Appendix ~~D~~ C. The editted calculation set includes the following topics, in the order presented below:

Section	Description	Sheet
I	Objective	1
Attachment A	References	49A
V	Data Analysis	
A	Objective	21
B	Method	21
C	Analysis – only results are included	
1	Jacob's Method	26, 27
2	Theis Recovery Method	29
3	Type Curve Method	38-47
4	Estimated Transmissivity and Storativity	48, 49

The sheets not listed above have been checked for quality control and are on file at RMT.

COMPUTATION SHEET

RMT INC.

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SHEET 1 OF 49

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SVAM	4/28/88	SLM	5/2/88	1332.51

I. Objective:

Evaluate hydraulic properties of unconfined aquifer, for use in designing an aquifer pumping system. The location of the pumping well, AT-2, is near the possible location of proposed ground water remediation wells. The design of AT-2 is such that it may be converted to part of the remediation system.

The hydraulic properties to be evaluated are:

1. transmissivity
2. stratativity
3. boundary conditions

Although not part of the final Quality Control Plan (Section 4.5.4, p. 68), the estimated parameters may also be used for evaluating contaminant plume travel time, under the no-action remedial alternative.

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SAM	4/28/88	SLM	5/9/88	1332.51

V. DATA ANALYSIS:

A. Objective

Estimate values for transmissivity, storativity and boundary locations based on reduced set of pump test data for wells AT-2, 5-S, 6-S, 10-S, 17-S and 24-S.

B. Method

1. The data is analyzed by the following methods:
   a. Jacob's Method (Cooper and Jacob, 1946 in Ref. 4)
   b. Theis Recovery Method (Ref. 4)
   c. Type Curve Method (Ref. 4 and 5)
2. The application of these methods and assumptions are discussed in V. C. 1 - 3.
3. The above methods are applied to time-drawdown data with methods a. and b. applied to log time vs. drawdown data and method c. applied to log time vs. log drawdown data. Method a. also applies to log distance vs. drawdown data.
4. Methods 1.a and b are used as first cut analyses. They require more assumptions than for method 1.c.

COMPUTATION SHEET

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SHEET 26 OF 49

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SMM	4/28/88	SCM	5/4/88	1332.51

V.C. 1. Jacob's Method (cont'd).

e. Results

1. Time - Drawdown Results

Hydraulic Parameters

Well No.	Transmissivity (gpd/ft) Elapsed Time log cycle (min) 100 - 1000	1000-10000	Storativity (-) Elapsed Time log cycle (min) 100-1000	1000-10000
AT-2	45000	10000	NA	NA
24-S	58000	32000	0.15	0.67
6-S	158000	41000	0.04	0.06
5-S	NA	46000	NA	0.05
17-S	NA	88000	NA	0.21
10-S	198000	60000	0.01	0.04

Note: All data is from Hermit System measurements except for 10-S.

2. Distance - Drawdown Results.

Hydraulic Parameters

Wells	Elapsed Time (min)	Transmissivity (gpd/ft)	Storativity (-)	Radius of Influence, R_o, ft
24-S, 6-S, 5-S	1000	75000	0.04	1600
	4300	62000	0.03	1400
~~Above + 17-S, 10-S~~	~~4300~~	~~65000~~	~~0.03~~	~~1500~~

Note: All data is from Hermit System measurements

JM.

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PROJECT / PROPOSAL NAME	PREPARED By	Date	CHECKED By	Date	PROJECT/PROPOSAL NO.
USACE-NIROP	SAM	4/20/88	SLM	5/9/88	1332.51

V.C.1. Jacob's Method (cont'd)

e. Results (cont'd)

3. The computations were performed with the Plimplot and Distdraw software of Ref. 2, following the procedures outlined in 1.c.

4. The time-drawdown and distance-drawdown data sets are presented in Appendix D, along with the T and S values computed for the distance-drawdown analysis.

5. The graphs of the data along with the fitted lines and T, S and ΔS values for the time-drawdown analyses are presented in Appendix E.

6. The results will be evaluated in V.C.4 along with the type curve results.

7. In order to check the computations, the values of ΔS are presented below, which may be plugged into the equations on Sheet 25.

Well No.	ΔS, ft log cycle 100-1000	ΔS, ft log cycle 1000-10000	Time min
AT-2	0.87	3.8	NA
24-S	0.67	1.2	NA
6-S	0.25	0.97	NA
5-S	NA	0.86	NA
17-S	NA	0.45	NA
10-S	0.20	0.66	NA
24-S, 6-S, 5-S	1.0	NA	1000
" " "	1.3	NA	4300
~~17-S, 10-S~~	~~1.2~~	~~NA~~	~~4300~~ → NA

COMPUTATION SHEET

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SHEET 29 OF 49

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE-NIROP	SAM	4/24/88	SLM	5/9/88	1332.51

I.C.2. Theis Recovery Method (cont'd).

d. Results

1. Transmissivity

Well No.	Transmissivity (gpd/ft) t/t' log cycle 1-10	10-100	Δs' (ft) t/t' log cycle 1-10	10-100
AT-2	NA	47000	NA	0.83
24-S	32000	54000	1.2	0.73
6-S	79000	280000	0.50	0.14

2. The computations were performed with the Pumpplot software of Ref. 2, following the procedure outlined in 2.c, using Hermit System measurements.

3. The data sets are presented in Appendix ~~D~~ C and the graphs and fitted lines are presented in Appendix ~~E~~ D.

4. No meaningful recovery data was obtained for the more distant observation wells 5-S, 17-S and 10-S.

5. The data will be evaluated in I.C. 4 (sheet 49) along with the type curve data.

6. The computations may be checked with the Δs' values listed above.

V.C.3. Type Curve Method (cont'd)

d. Results

1. Pumped well AT-2 cannot be evaluated using type curve analysis.

2. Observation well 24-S : $r = 30$ ft

a. Two interpretations are reasonable for the data at well 24-S, Boulton Type Curve matches with and without a boundary condition.

b. Boulton Type Curve without a boundary condition.

1. Graph of data with match points is in Appendix E.

2. Match points: for $W(u_E, r/B) = u_E^{-1} = 1.0$ and $W(u_L, r/B) = u_L^{-1} = 1.0$

where E = early time and L = late time, and $r/B = 1.5$.

	s, ft	t, min
Early time	0.20	0.18
Late time	0.38	9.7

3. $T_E = (17000)(0.20)^{-1} = 8500$ gpd/ft (1100 ft²/day)

$S_E = (6.3)(0.18)(0.20)^{-1}(30)^{-2} = 0.006$

4. $T_L = (17000)(0.38)^{-1} = 4500$ gpd/ft (600 ft²/day)

$S_L = (6.3)(9.7)(0.38)^{-1}(30)^{-2} = 0.18$

5. $\gamma = 1 + (0.18/0.006) = 31$

$B = 30/1.5 = 20$ ft

V.C.3 d.2. Obs. Well 24-S (cont'd)

b. Boulton (no boundary)

6. $\alpha^{-1} = (20)^2(0.18/6000) = 0.012$ day

$(\alpha^{-1})^{-1} t_{WT} = 5.8$ (See Figure, Sheet 40, from Ref. 4).

$t_{WT} = 0.07$ days
$= 100$ minutes

∴ This curve may be used for $t > 100$ min. at well 24-S, assuming no barrier boundary. Delayed yield may be neglected for $t > 100$ min.

c. Boulton Type Curve with a barrier boundary condition.

1. Graph of data with match points is in Appendix E.

2. Match points: $W(u_E, r/B) = W(u_L, r/B) = u_E^{-1} = u_L^{-1} = 1.0$

with $r/B = 2.0$

	s, ft	t, min
Early time	0.39	0.23
Late time	0.21	2.2

3. $T_E = (17000)(0.39)^{-1} = 44000$ gpd/ft (5800 ft²/day)

$S_E = 16.3(0.23)(0.39)^{-1}(30)^{-2} = 0.004$

4. $T_L = (17000)(0.21)^{-1} = 81000$ gpd/ft (11000 ft²/day)

$S_L = 16.3(2.2)(0.21)^{-1}(30)^{-2} = 0.07$

5. $\gamma = 1 + (0.07/0.004) = 19$

$B = 30/2.0 = 15$ ft

6. $\alpha^{-1} = (15)^2(0.07/11000) = 0.0014$

$(\alpha^{-1})^{-1} t_{WT} = 7$

$t_{WT} = 0.01$ days
$= 14$ min. (Neglect delayed yield after 14 min.)

USACE - NIRDP
#1332.51

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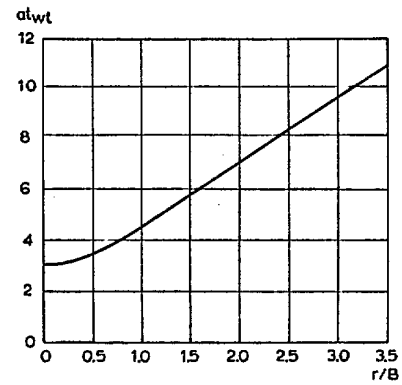

Fig. 33. Boulton's delay-index curve

– Eventually, the effects of delayed gravity drainage become negligible, and the type-Y curve merges with the Theis curve. Determine the merging point of the type-Y curve for a particular value of r/B by measuring the value of αt_{wt} for the particular value of r/B on the vertical axis of the 'Boulton delay-index curve' (Fig. 33). Because $1/\alpha$ is known, now calculate t_{wt}. The factor t_{wt} is the time-coordinate of the merging point of the time-drawdown curve that matches the type curve with the particular value of r/B and the right-hand Theis curve.
– Repeat the procedure with the observed data from each of the available piezometers. The calculations of kD, S_A and S_Y from the data of the different piezometers should give approximately equal results.

Remarks
– It should be noted that for values of $\gamma > 100$ the slope of the line joining the corresponding type-A and type-Y curves is essentially zero. For values $10 < \gamma < 100$ the slope of this line is small and can be approximated by a line tangent to both curves. The points on the observed data curve that could not be superimposed on the type-A or type-Y curve should fall along this tangent (BOULTON, 1964).
– If no influence of delayed yield is apparent the observed-data curve will fall completely along the left hand Theis-type curve.
– If sufficient observations are made after the delayed yield has ceased to influence the time-drawdown curve, the observed data for which $t > t_{wt}$, together with the right-hand Theis curve, can be used to calculate kD and S_Y.
– If the Boulton method is applied to pumping tests in semi-unconfined aquifers, it gives no information about the properties of the covering layer, because B is defined in properties of an unconfined aquifer.

Example
From the pumping test 'Vennebulten' the data from the piezometer at 90 m (Table 13) are used for a numerical example.

Reference 4 (Kruseman, 1979)

V.C.3.d.2. Obs. Well 24-S (cont'd)

d. Stallman Type Curve for a barrier boundary (w/ Boulton 2.c)

1. Graph of data with match point is in Appendix D. Same match point as for Boulton Type Curve (w/ boundary) Late t.

2. Match is for $K = 10$, with $s = 0.21$ ft and $t = 2.2$ min.

3. From 2.c, $T = T_L = 81000$ gpd/ft, $S = S_L = 0.07$

4. $r_i = K r_p = (10)(30) = 300$ ft.

∴ Boundary is approx 150 ft ($r_i/2$) from well 24-S.

3. Observation Well 6-S: $r = 236$ ft

a. Three reasonable interpretations are presented for the data at well 6-S: Theis, Boulton and Stallman anisotropy type curves. A graph of the data with the match points is in Appendix E.

b. Theis Type Curve

1. Match points for $W(u) = u^{-1} = 1.0$ are $s = 0.38$ ft and $t = 140$ min

2. $T = 17000(0.38)^{-1} = 45000$ gpd/ft (6000 ft²/day)

$S = (6.3)(140)(0.38)^{-1}(236)^{-2} = 0.04$

c. Boulton Type Curve

1. Match points: $W(u_E; r/B) = W(u_L; r/B) = u_E^{-1} = u_L^{-1} = 1.0$

with $r/B = 2.5$

	s, ft	t, min
Early time	1.7	210
Late time	0.83	800

COMPUTATION SHEET

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PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SAM	4/28/88	SLM	5/9/88	1332.51

V. C.3. d.3. Obs. Well 6-S (cont'd)

c. Boulton (cont'd)

2. $T_E = (17000)(1.7)^{-1} = 10000$ gpd/ft (1300 ft²/d)

$S_E = (6.3)(210)(1.7)^{-1}(236)^{-2} = 0.01$

3. $T_L = (17000)(0.83)^{-1} = 20000$ gpd/ft (2700 ft²/d)

$S_L = (6.3)(800)(0.83)^{-1}(236)^{-2} = 0.11$

4. $\gamma = 1 + (0.11/0.01) = 12$

$B = 236/2.5 = 94$ ft

5. $\alpha^{-1} = (94)^2(0.11/2700) = 0.36$

$(\alpha^{-1})^{-1} t_{wr} = 8.2$

$t_{wr} = 3.0$ days (Delayed yield affects drawdown over duration of test)

d. Stallman Anisotropy

1. Match point for $W(u,\psi)/4\pi = u^{-1}/4 = 1.0$ is $s = 6.0$ ft and $t = 120$ min. with $\psi = 0.154$

2. Match is for type curve where pumped well is screened over bottom 1/3 of aquifer and top of obs. well screen is at the water table.

3. $T = (4\pi)(17000)(6.0)^{-1} = 36000$ gpd/ft (4800 ft²/d)

$S = (4)(6.3)(120)(6.0)^{-1}(236)^{-2} = 0.009$

4. $\psi = (r/b)(K_z/K_r)^{1/2} = 0.154$

$K_z/K_r = \psi^2(r/b)^{-2} = (0.154)^2(236/28)^{-2} = 0.0003$

~~$K_r = 3300\ K_z$: strong anisotropy is indicated by analysis.~~ SM 8-1-8

Too much uncertainty in data match to type curve to estimate anisotropy.

V.C.3.d.4. Observation Well 5-S : r = 3.86 ft

a. Neglect data for t < 500 min, as s < 0.1 ft and may be affected by noise in Hermit data collection. Also, there is a major break in the curve at t = 500 min.

b. Theis Type Curve.

1. Match point for $W(u) = u^{-1} = 1.0$ is s = 0.33 ft and t = 410 min.

2. $T = 17000(0.33)^{-1} = 52000$ gpd/ft (7000 ft²/day)

$S = (6.3)(410)(0.33)^{-1}(386)^{-2} = 0.05$

5. Observation Well 17-S: r = 300 ft

a. Two reasonable interpretations are presented for the data at well 17-S: a Boulton Type Curve match with no boundary condition and a Boulton match with the boundary condition estimated by a Stallman boundary type curve match. The data is graphically presented with the match points in Appendix D.

b. Boulton Type Curve: no boundary condition

1. Match points: $W(u_E, r/B) = W(u_L, r/B) = u_E^{-1} = u_L^{-1} = 1.0$, with r/B = 3.5.

	s, ft	t, min
Early time	1.6	110
Late time	0.4	1700

2. $T_E = (17000)(1.6)^{-1} = 11000$ gpd/ft (1500 ft²/day)

$S_E = (6.3)(110)(1.6)^{-1}(300)^{-2} = 0.005$

V.C.3.d.5. Obs. Well 17-S (cont'd)

b. Boulton Type Curve (cont'd)

3. $T_L = (17000)(0.4)^{-1} = 43000$ gpd/ft (5700 ft²/day)

$S_L = (6.3)(1700)(0.4)^{-1}(300)^{-2} = 0.30$

4. $\gamma = 1 + (0.30/0.005) = 61$

$B = 300/3.5 = 86$ ft

5. $\alpha^{-1} = (86)^2(0.30/5700) = 0.39$ days

$(\alpha^{-1})^{-1} t_{WT} = 10.8$

$t_{WT} = 4.2$ days — delayed yield may affect drawdown over duration of test.

c. Boulton Type Curve: barrier boundary condition.

1. Match points: $W(u_E, r/B) = W(u_L, r/B) = u_E^{-1} = u_L^{-1} = 1.0$

with $r/B = 3.0$

	s, ft	t, min
Early time	0.87	110
Late time	0.20	1000

2. $T_E = (17000)(0.87)^{-1} = 20000$ gpd/ft (2600 ft²/day)

$S_E = (6.3)(110)(0.87)^{-1}(300)^{-2} = 0.009$

3. $T_L = (17000)(0.20)^{-1} = 85000$ gpd/ft (11000 ft²/day)

$S_L = (6.3)(1000)(0.20)^{-1}(300)^{-2} = 0.35$

4. $\gamma = 1 + (0.35/0.009) = 40$

$B = 300/3.0 = 100$

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USACE-NIROP	SAM	4/28/88	SLM	5/9/88	1332.51

V.C.3.d.5. Obs. Well 17-S (cont'd)

c. Bouwer: boundary (cont'd)

5. $\alpha^{-1} = (100)^2 (0.35/11000) = 0.32$ days

$(\alpha^{-1})^{-1} t_{WT} = 9.5$

$t_{WT} = 3.0$ days – delayed yield may effect drawdown over duration of test.

d. Stallman Type Curve: Barrier Boundary

1. Values for match point, T and S are the same as for Bouwer: barrier boundary late time (5.c, sheet 44).

2. Match occurs for $K = 2$.

3. $r_i = K r_p = (2)(300) = 600$ ft

∴ Boundary is approx. 300 ft ($r_i/2$) from well 17-S.

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USACE - NIROP	SAM	4/20/88	SLM	5/9/88	1332.51

V.C.3. Type Curve Method (cont'd).

e. Summary of Results.

1. The transmissivity and storativity values estimated for the four wells using Type Curve analysis of Hennet data are presented on Sheet 47.

2. Boulton's Delayed Yield Factors.

BOULTON TYPE CURVE

Well No.	NO BOUNDARY γ	Drainage Factor B, ft	Delay Index α^{-1}, days	Delayed Yield Time, days	BOUNDARY γ	Drainage Factor B, ft	Delay Index α^{-1}, days	Delayed Yield Time, days
6-S	12	94	0.36	3.0	NA	NA	NA	NA
17-S	61	86	0.39	4.2	40	100	0.32	3.0
24-S	31	20	0.012	0.07	19	15	0.0014	0.01

3. Boundary Condition: Barrier

a. 24-S: distance to boundary - 150 ft
" to image well - 300 ft

b. 17-S: distance to boundary - 300 ft
" " image well - 600 ft

c. Boundary is in-between pumped and image wells

~~4. Radial-Vertical Anisotropy: $K_r = 3300 K_z$~~ SM Uncertain Results

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SHEET 47 OF 49

PROJECT/PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SYM	4/26/88	SCM	5/9/88	1332.51

TRANSMISSIVITY (GPD/FT)

WELL NO.	THEIS	TYPE CURVE BOULTON NO BOUNDARY EARLY	TYPE CURVE BOULTON NO BOUNDARY LATE	TYPE CURVE BOULTON BOUNDARY EARLY	TYPE CURVE BOULTON BOUNDARY LATE	STALLMAN BOUNDARY	STALLMAN ANISOTROPY
5-S	52000	NA	NA	NA	NA	NA	NA
6-S	45000	10000	20000	NA	NA	NA	36000
17-S	NA	11000	43000	20000	85000	85000	NA
24-S	NA	85000	45000	44000	81000	81000	NA

STORATIVITY

WELL NO.	THEIS	TYPE CURVE BOULTON NO BOUNDARY EARLY	TYPE CURVE BOULTON NO BOUNDARY LATE	TYPE CURVE BOULTON BOUNDARY EARLY	TYPE CURVE BOULTON BOUNDARY LATE	STALLMAN BOUNDARY	STALLMAN ANISOTROPY
5-S	0.05	NA	NA	NA	NA	NA	NA
6-S	0.04	0.01	0.11	NA	NA	NA	0.009
17-S	NA	0.005	0.30	0.009	0.35	0.35	NA
24-S	NA	0.006	0.18	0.004	0.07	0.07	NA

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PROJECT / PROPOSAL NAME	PREPARED By	Date	CHECKED By	Date	PROJECT/PROPOSAL NO.
USACE - NIROP	SAM	4/26/88	SLM	5/9/88	1332.51

I.C.4. Estimated Transmissivity and Stratrivity

a. Most reliable data are for well 24-5 and from the distance-drawdown curve. Well 24-5 is the closest to AT-2, with a more fully developed time-drawdown curve than for the other observation wells.

b. WELL 24-5 & distance-drawdown average TRANSMISSIVITY.

WELL NO.	METHOD	TRANSMISSIVITY (GPD/FT)
24-5	BOULTON TYPE CURVE:	
	— NO BOUNDARY	
	— EARLY TIME	85 000
	— LATE TIME	45000
	— BOUNDARY	
	— EARLY TIME	44 000
	— LATE TIME	81 000
	JACOB'S METHOD	
	— TIME-DRAWDOWN	58 000
24-5, 6-5, 5-5	JACOB'S METHOD	
	— DISTANCE-DRAWDOWN (t=4300 min)	62000
	AVERAGE	62,000 GPD/FT

COMPUTATION SHEET

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SHEET 49 OF 49

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE - NIROP	SAM	4/28/88	SLM	5/2/88	1332.51

T.C.4 Estimated T+S (cont'd)

c. STORATIVITY

1. Use data from 24-S, as storativity is more sensitive to distance than transmissivity.

2. Do not use early time Boulton data, as it represents a confined aquifer storativity

3.

METHOD	STORATIVITY
BOULTON TYPE CURVE	
— NO BOUNDARY	0.18
— BOUNDARY	0.07
JACOB'S METHOD	
— TIME - DRAWDOWN	0.15
	0.13

COMPUTATION SHEET

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SHEET 49A OF 49

PROJECT / PROPOSAL NAME	PREPARED By:	Date:	CHECKED By:	Date:	PROJECT/PROPOSAL NO.
USACE-NIROP	SAM	4/28/88	SLM	5/9/88	1332.51

ATTACHMENT A - REFERENCES

1. Driscoll, Fletcher G. 1986. Ground Water and Wells. 2nd Ed. Johnson Division, St. Paul, Minn.

2. Hall Ground Water Consultants, Inc. 1984. Ground Water Micro-Computer Programs, IBM-PC. Ground Water Consultants Group, St. Albert, Alberta, CAN

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4. Kruseman, G.P. and De Ritter, N.A. 1979. Analysis and Evaluation of Pumping Test Data. Intern. Instit. for Land Reclamation and Improvement, Wageningen, The Netherlands.

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6. Stallman, Robert W. 1983. Aquifer Test Design, Observation and Data Analysis. Techniques of Water-Resources Investigations of the United States Geological Survey Chapter B1, Book 3, Applic. of Hydraulics. USDI.

7. Walton, William C. 1970. Ground Water Resource Evaluation. McGraw-Hill Book Co., New York, NY.

8. RMT, Inc. Proposal...

9. COE Scope of Services...

10. RMT, Inc. Final Quality Control Plan...

11. RMT, Inc. 1987. Remedial Investigation Report...

12. RMT, Inc. 1987. Draft Feasibility Study Report...

APPENDIX D

DRAWDOWN CURVES FROM PUMPING TEST

APPENDIX D TABLE OF CONTENTS

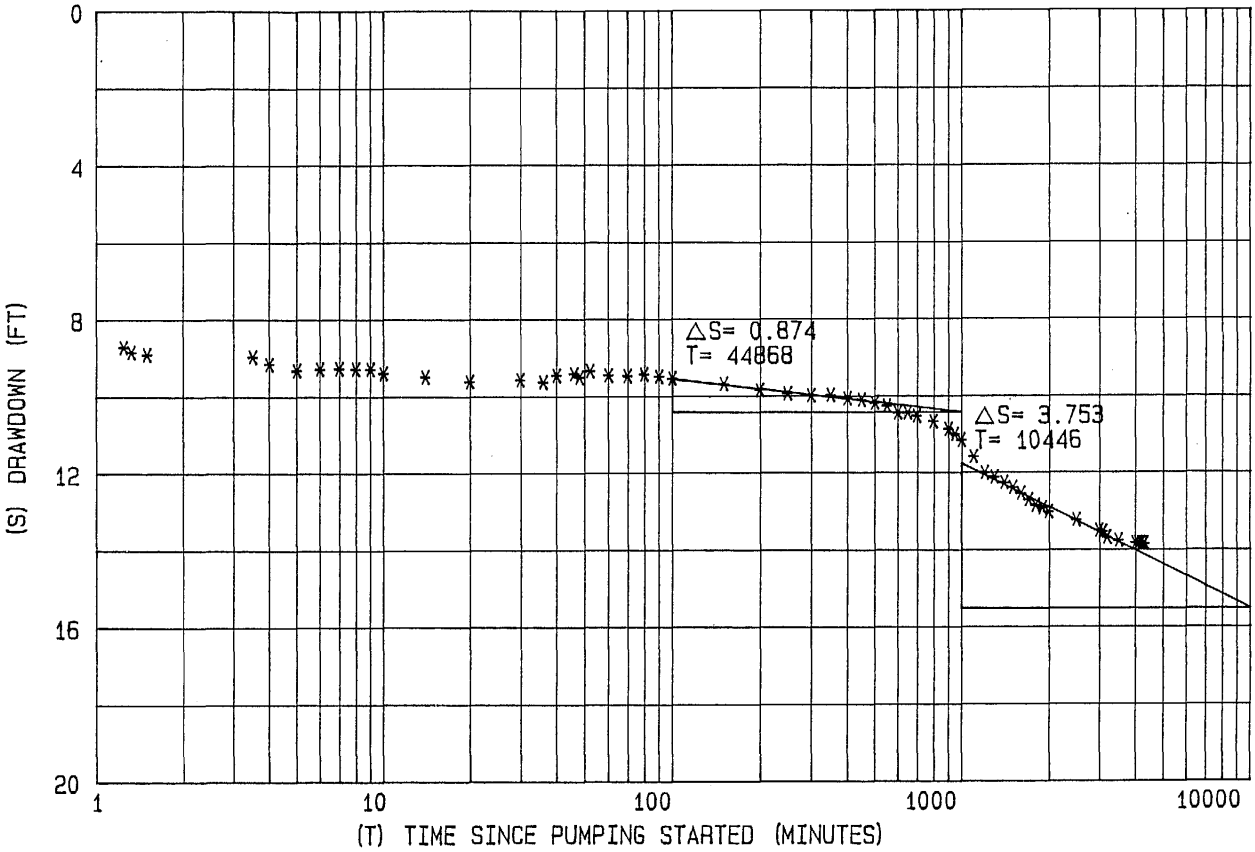
1. SEMI-LOGARITHMIC TIME-DRAWDOWN GRAPHS

2. LOGARITHMIC TIME-DRAWDOWN GRAPHS

3. DISTANCE-DRAWDOWN GRAPHS

4. SEMI-LOGARITHMIC RECOVERY GRAPHS

PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT:	COE-NIROP-FRIDLEY	WELL NO.:	AT2
FILE:	1332.51	Q=	148.5 USGPM
LOCATION:	MINNESOTA	S.W.L.=	24.4

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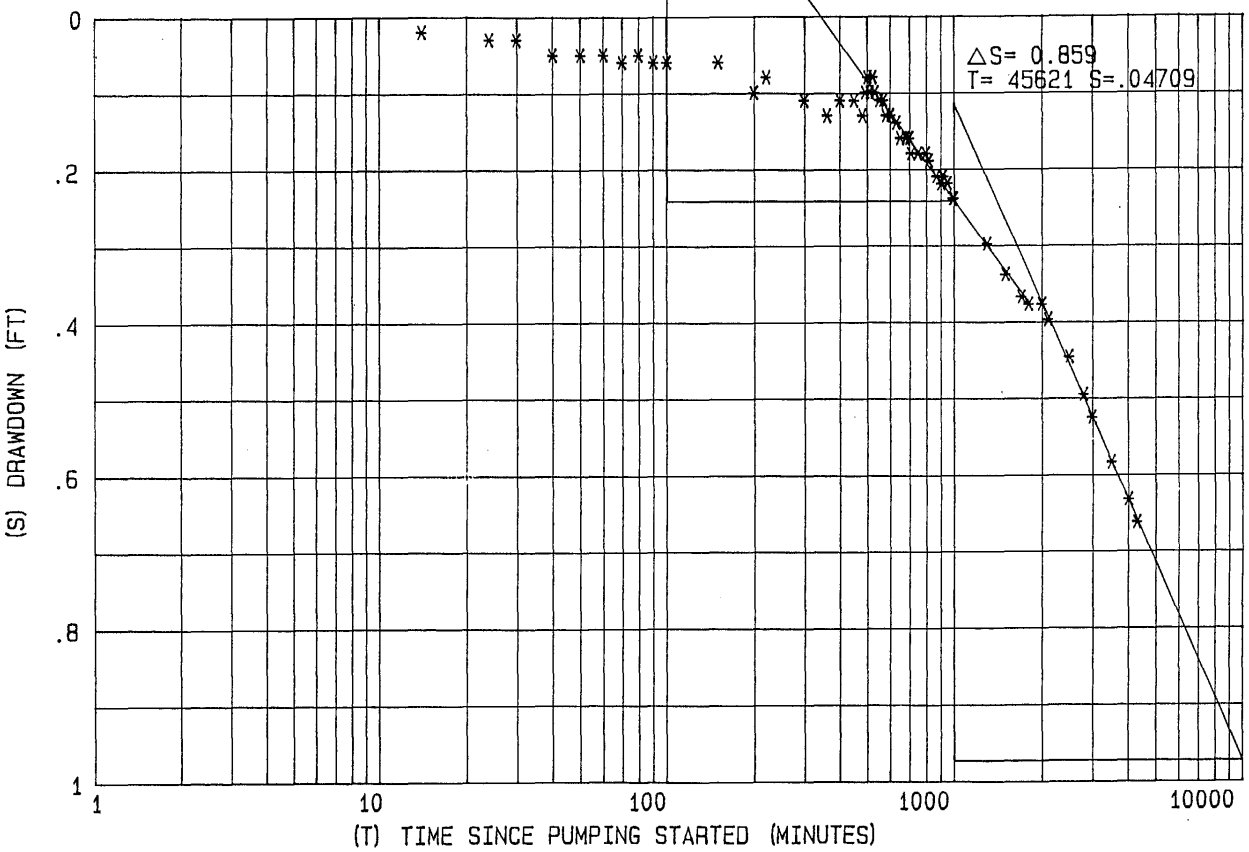
PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT: COE-NIROP-FRIDLEY FILE: 1332.51 LOCATION: MINNESOTA	WELL NO.: 5S Q= 148.5 USGPM S.W.L.= 22.71	

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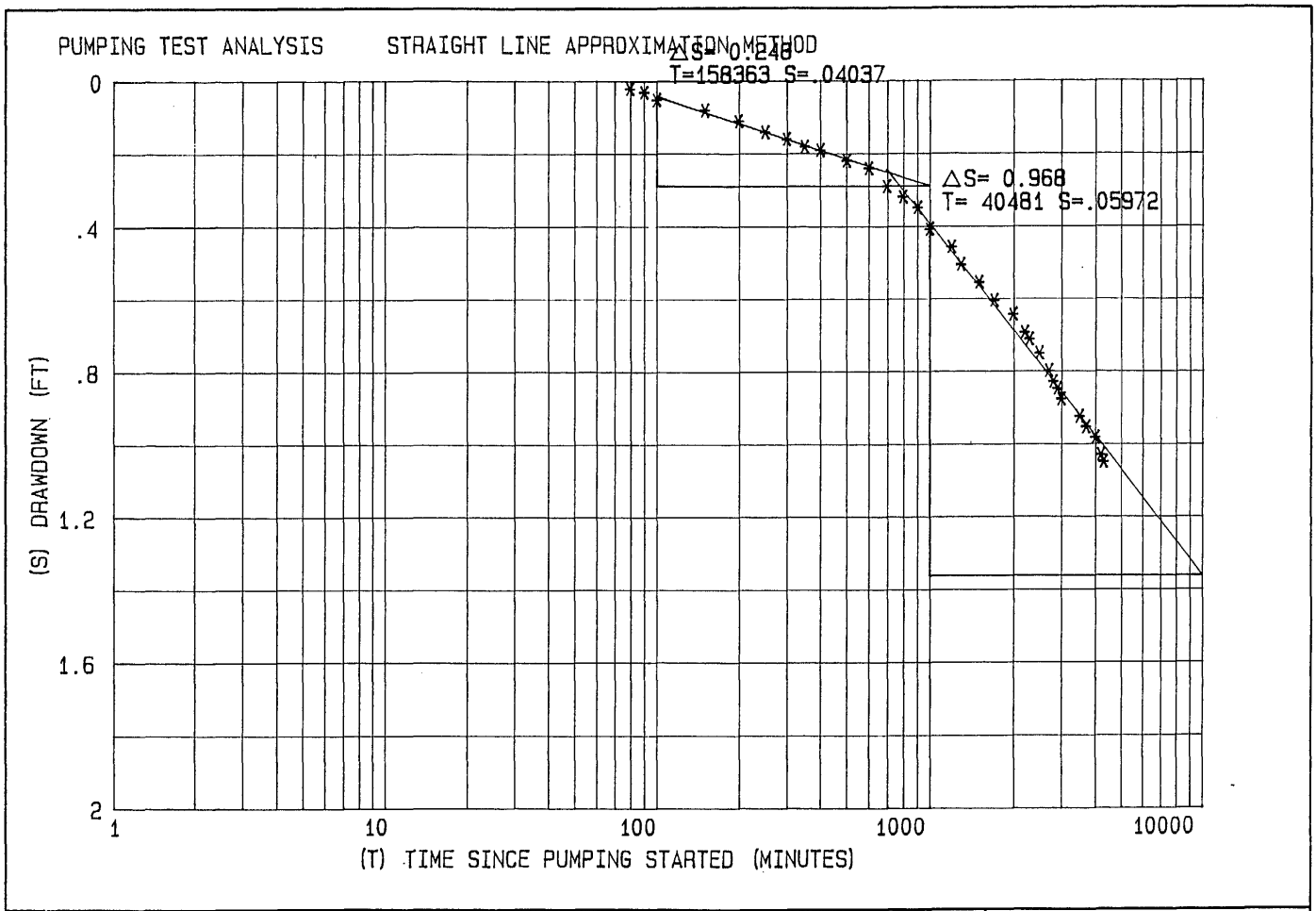

PROJECT:	COE-NIROP-FRIDLEY	WELL NO.:	6S
FILE:	1332.51	Q=	148.5 USGPM
LOCATION:	MINNESOTA	S.W.L.=	23.75

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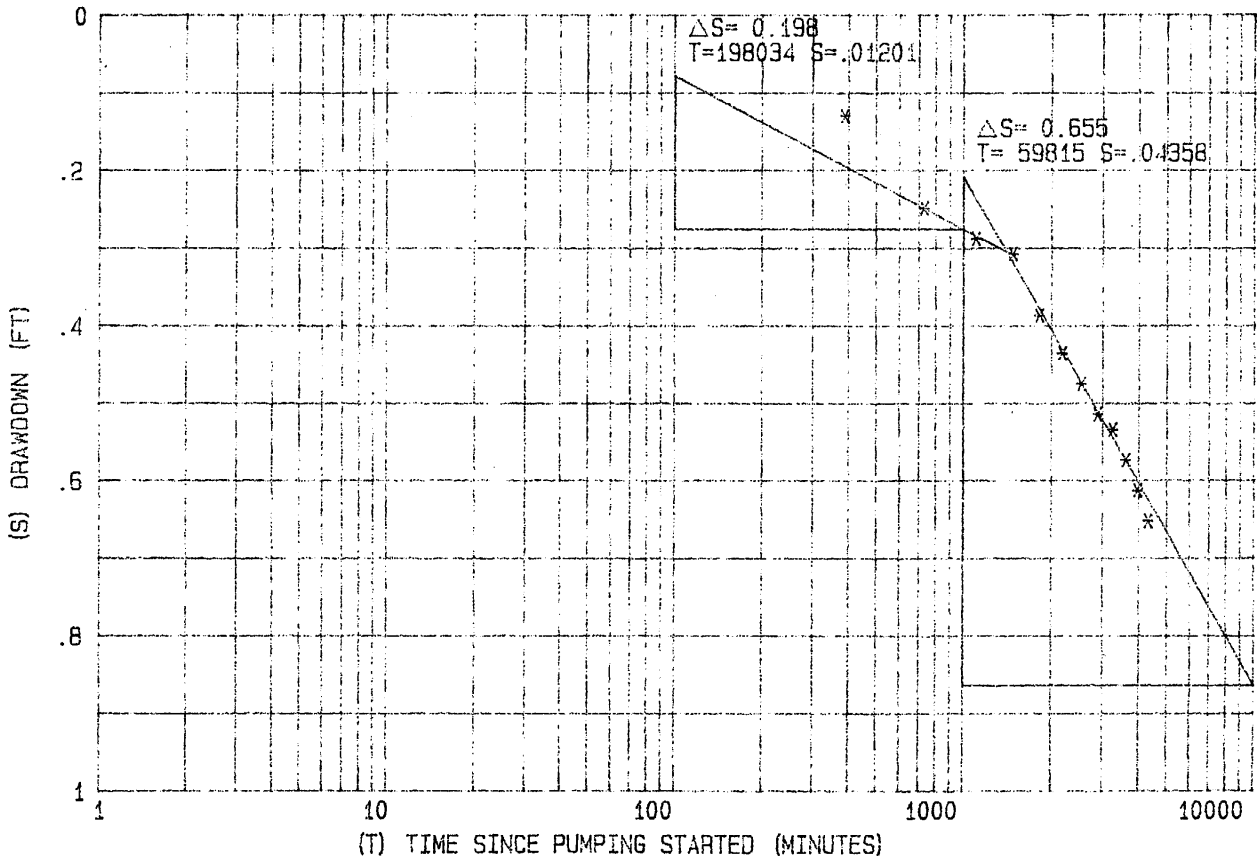
PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT:	COE-NIROP-FRIDLEY	WELL NO.:	10-S
FILE:	1332.51	Q=	148.5 USGPM
LOCATION:	MINNESOTA	S.W.L.=	23.3 FT

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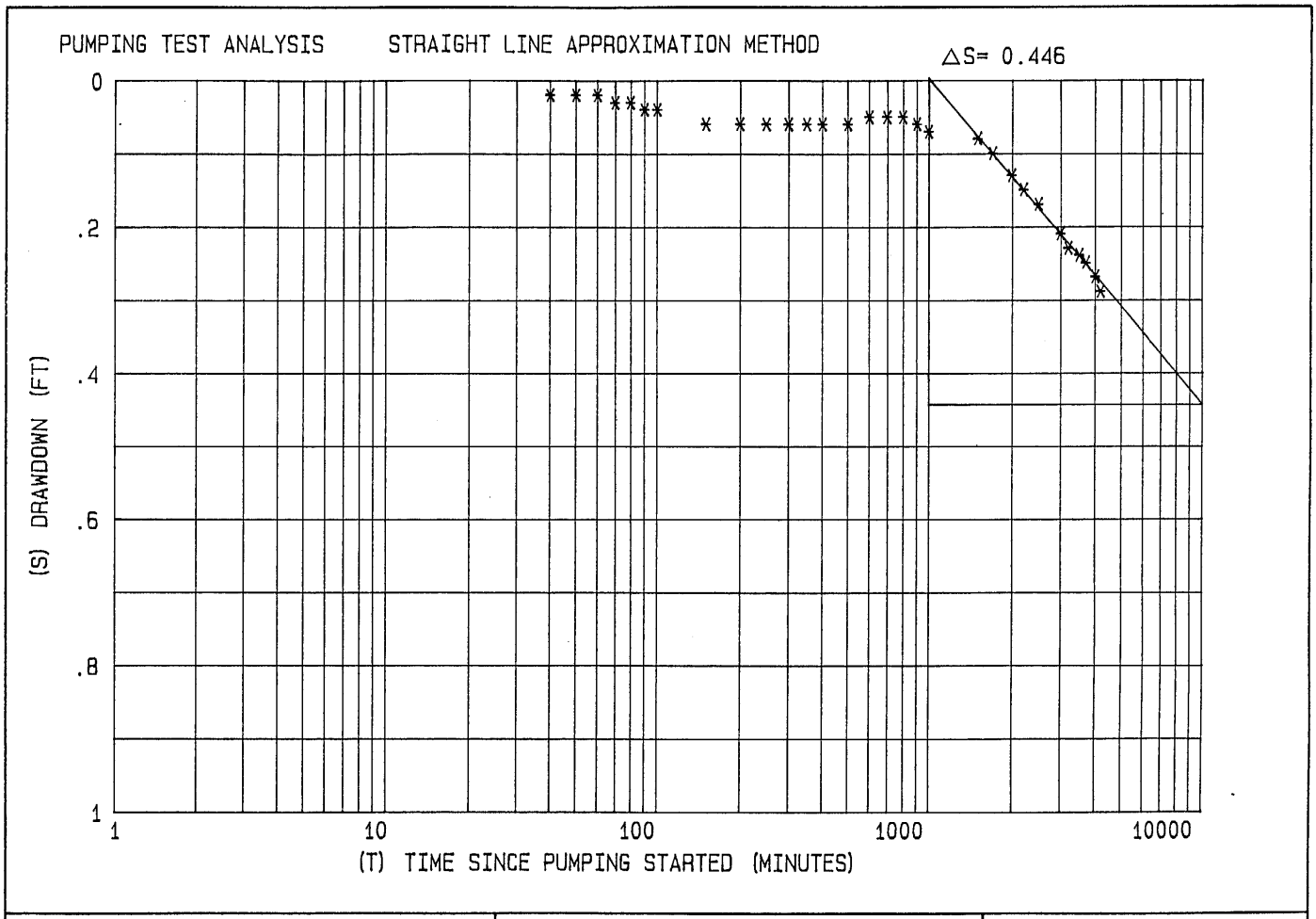

PROJECT: COE-NIROP-FRIDLEY FILE: 1332.51 LOCATION: MINNESOTA	WELL NO.: 17S Q= 148.5 USGPM S.W.L.= 25.8	△S= 0.446 FT T= 87840 USGPD/FT S= .20656

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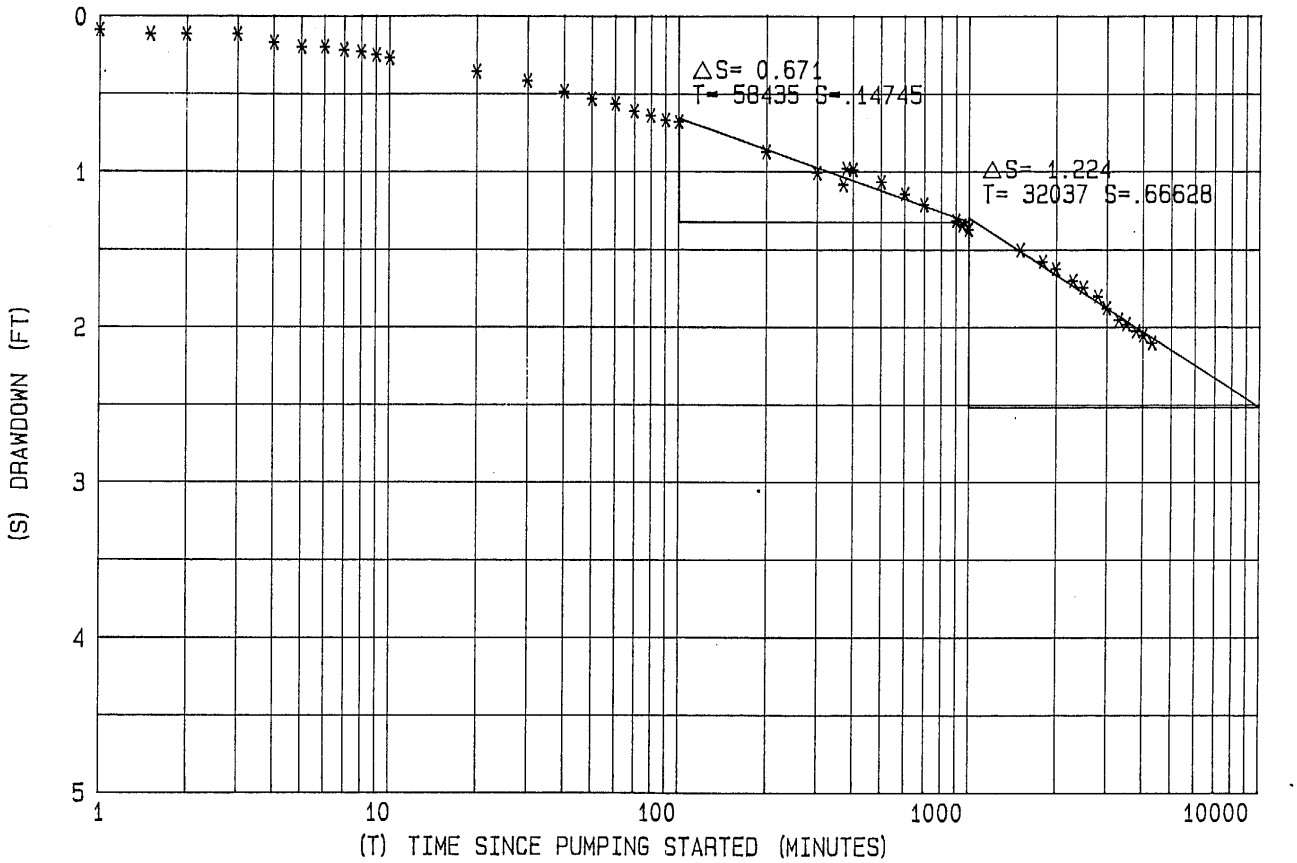
PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT:	COE-NIROP-FRIDLEY	WELL NO.:	24S
FILE:	1332.51	Q=	148.5 USGPM
LOCATION:	MINNESOTA	S.W.L.=	24.1

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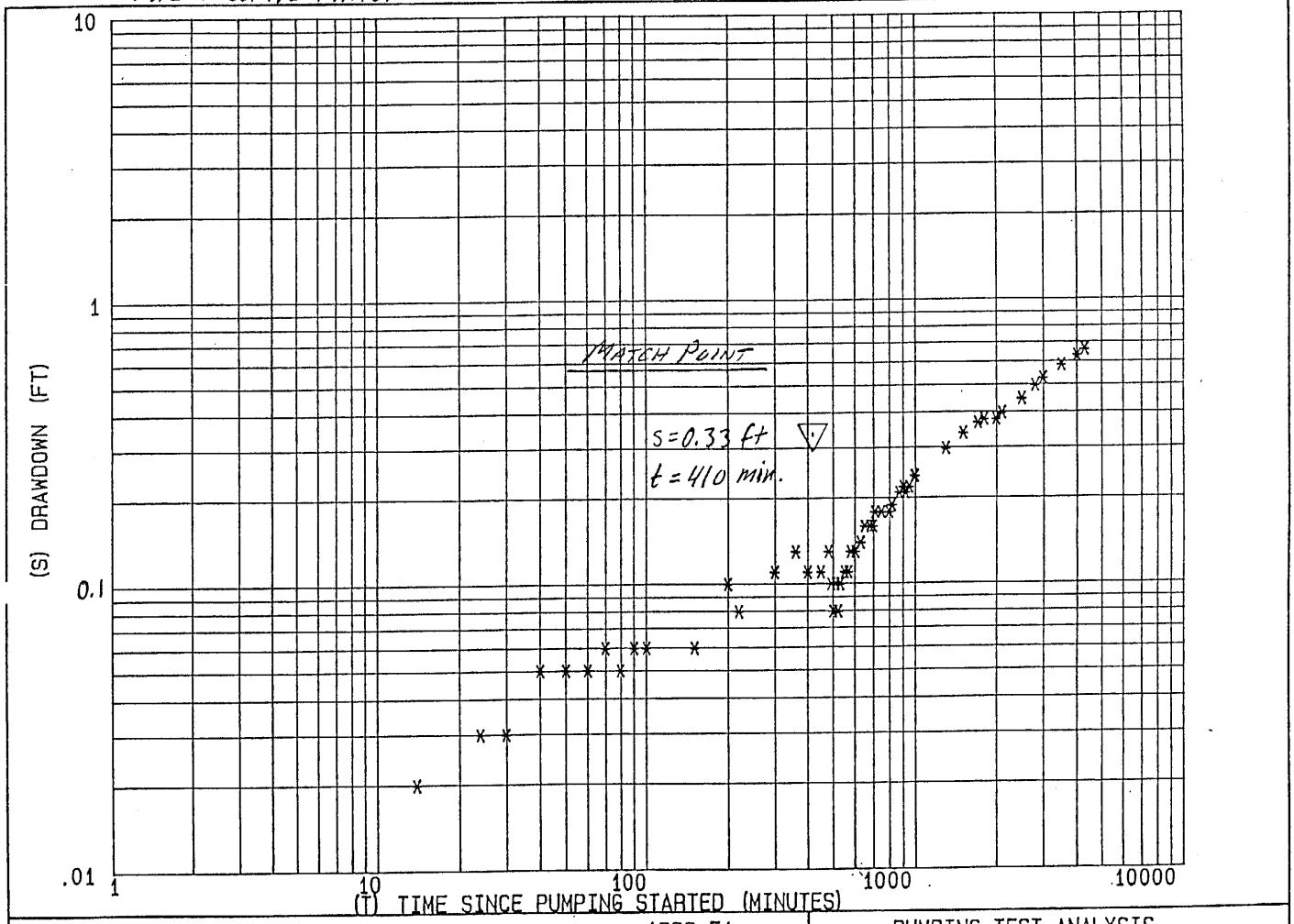
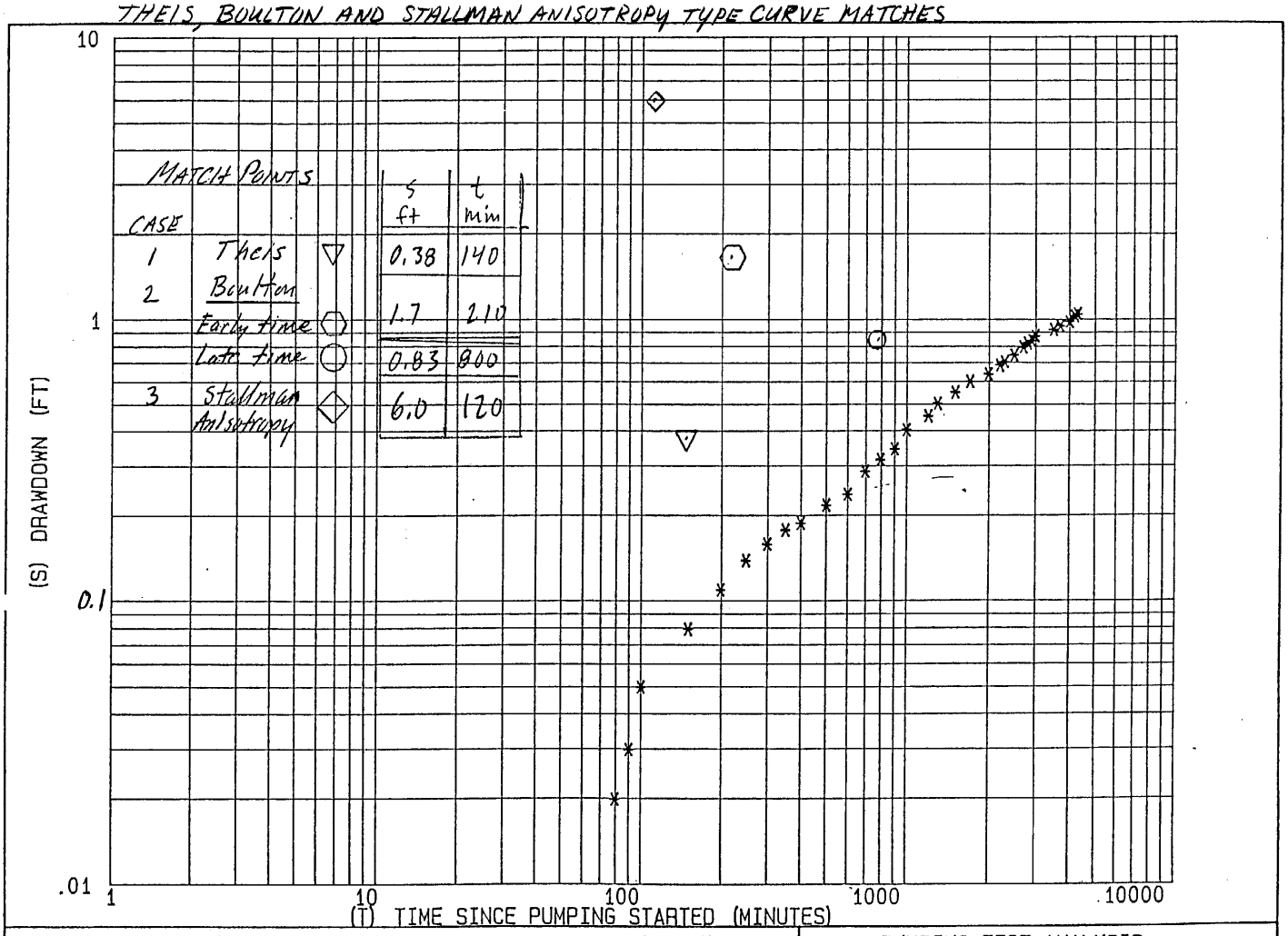
THEIS CURVE MATCH



PROJECT LOCATION	COE-NIROP-FRIDLEY MINNESOTA	FILE WELL No.	1332.51 5S	PUMPING TEST ANALYSIS TYPE CURVE SOLUTION

RMT INC.

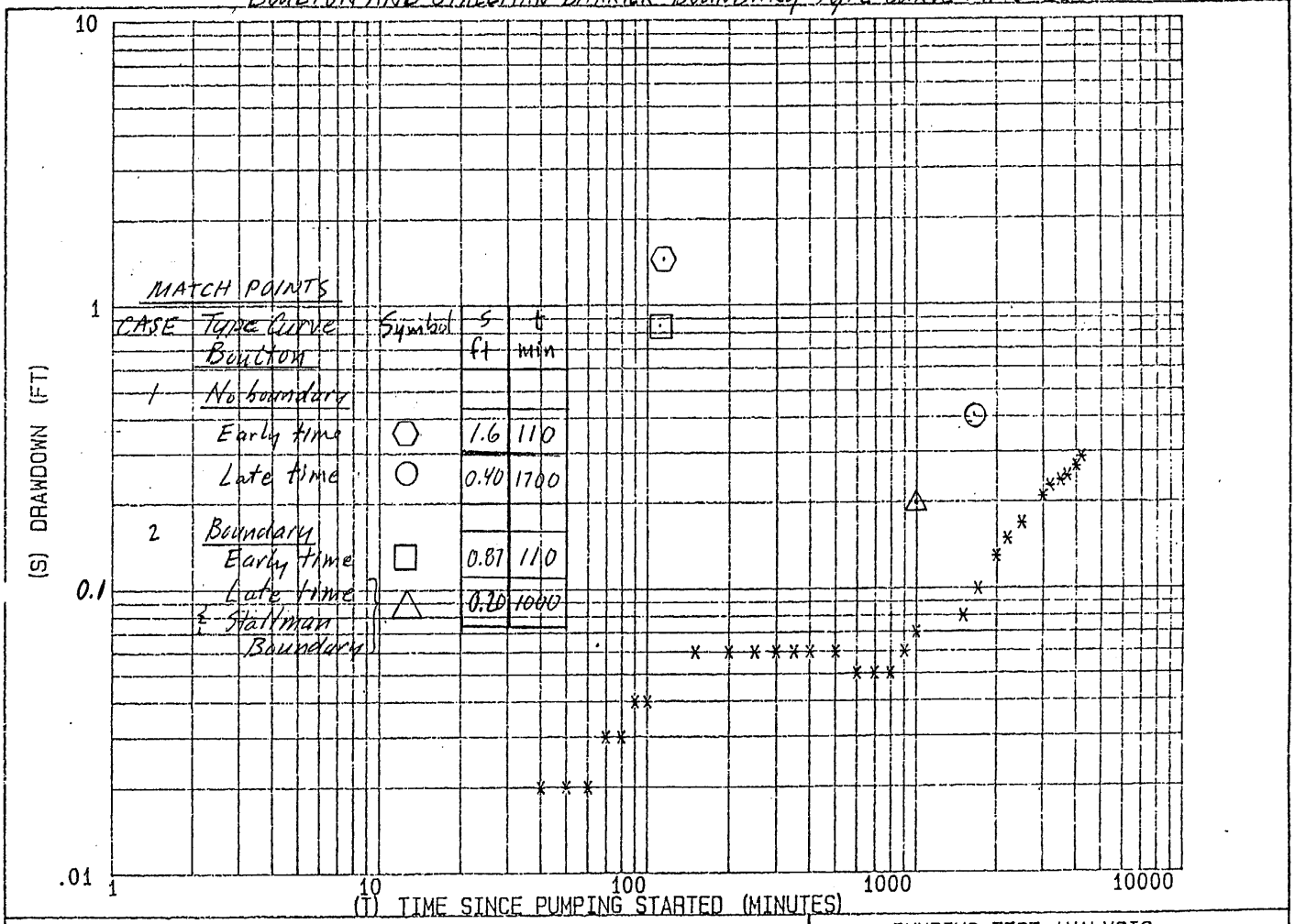
THEIS, BOULTON AND STALLMAN ANISOTROPY TYPE CURVE MATCHES



PROJECT	COE-NIROP-FRIDLEY	FILE	1332.51	PUMPING TEST ANALYSIS
LOCATION	MINNESOTA	WELL No.	6S	TYPE CURVE SOLUTION

RMT INC.

BOULTON AND STALLMAN BARRIER BOUNDARY TYPE CURVE MATCHES



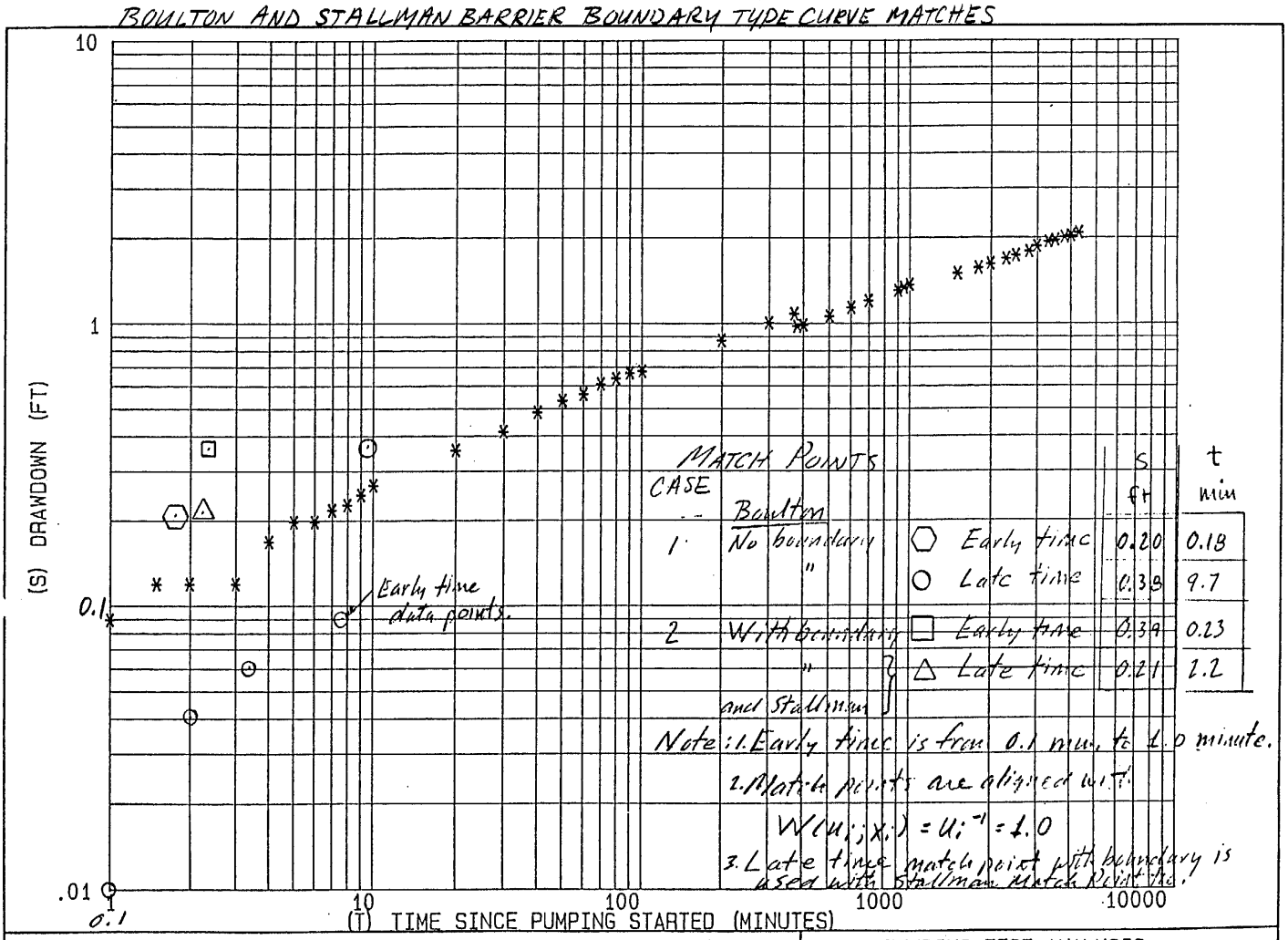
MATCH POINTS

CASE	Type Curve Boulton	Symbol	s ft	t min
1	No boundary			
	Early time	⬡	1.6	110
	Late time	○	0.40	1700
2	Boundary			
	Early time	□	0.87	110
	Late time	△	0.20	1000
	Stallman Boundary			

PROJECT	COE-NIROP-FRIDLEY	FILE	1332.51	PUMPING TEST ANALYSIS TYPE CURVE SOLUTION
LOCATION	MINNESOTA	WELL No.	17S	

RMT INC.

BOULTON AND STALLMAN BARRIER BOUNDARY TYPE CURVE MATCHES



PROJECT	COE-NIROP-FRIDLEY	FILE	1332.51
LOCATION	MINNESOTA	WELL No.	24S

PUMPING TEST ANALYSIS
TYPE CURVE SOLUTION

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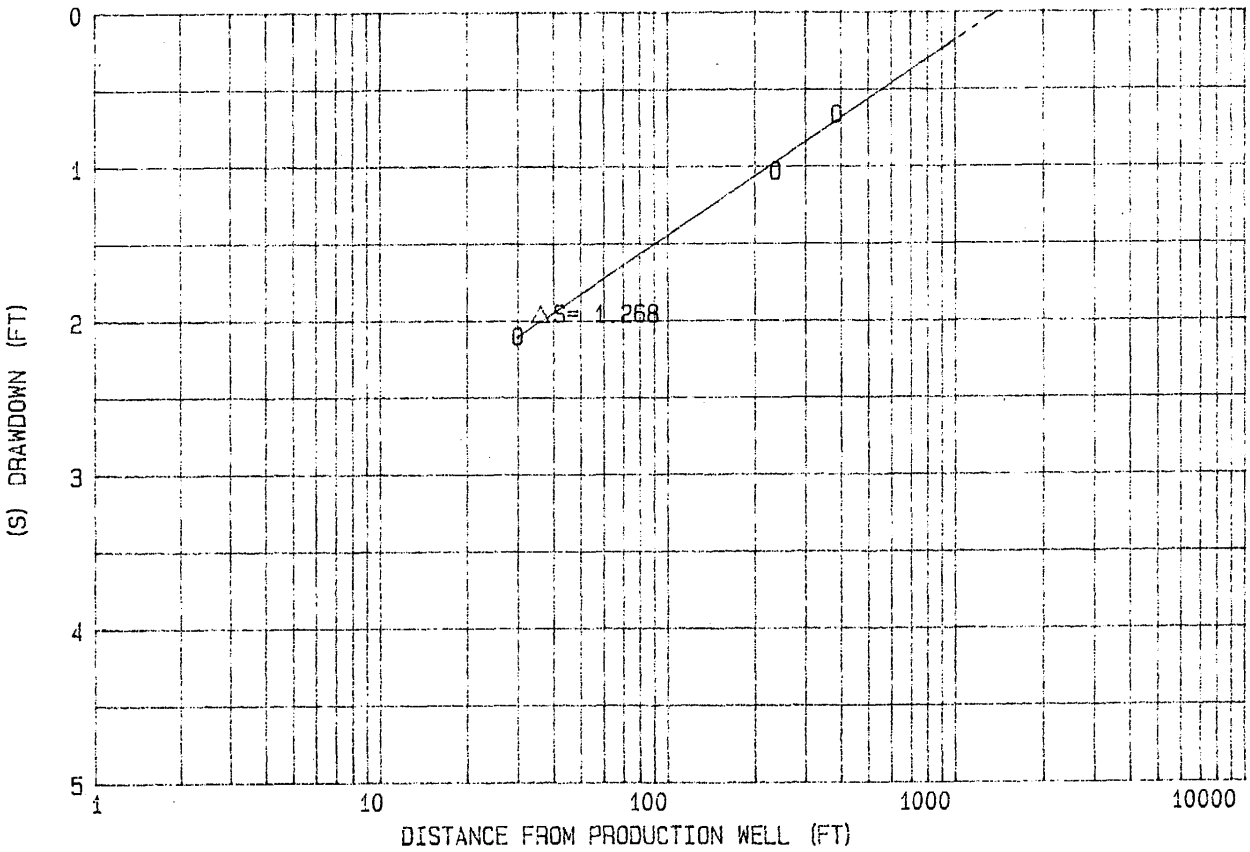
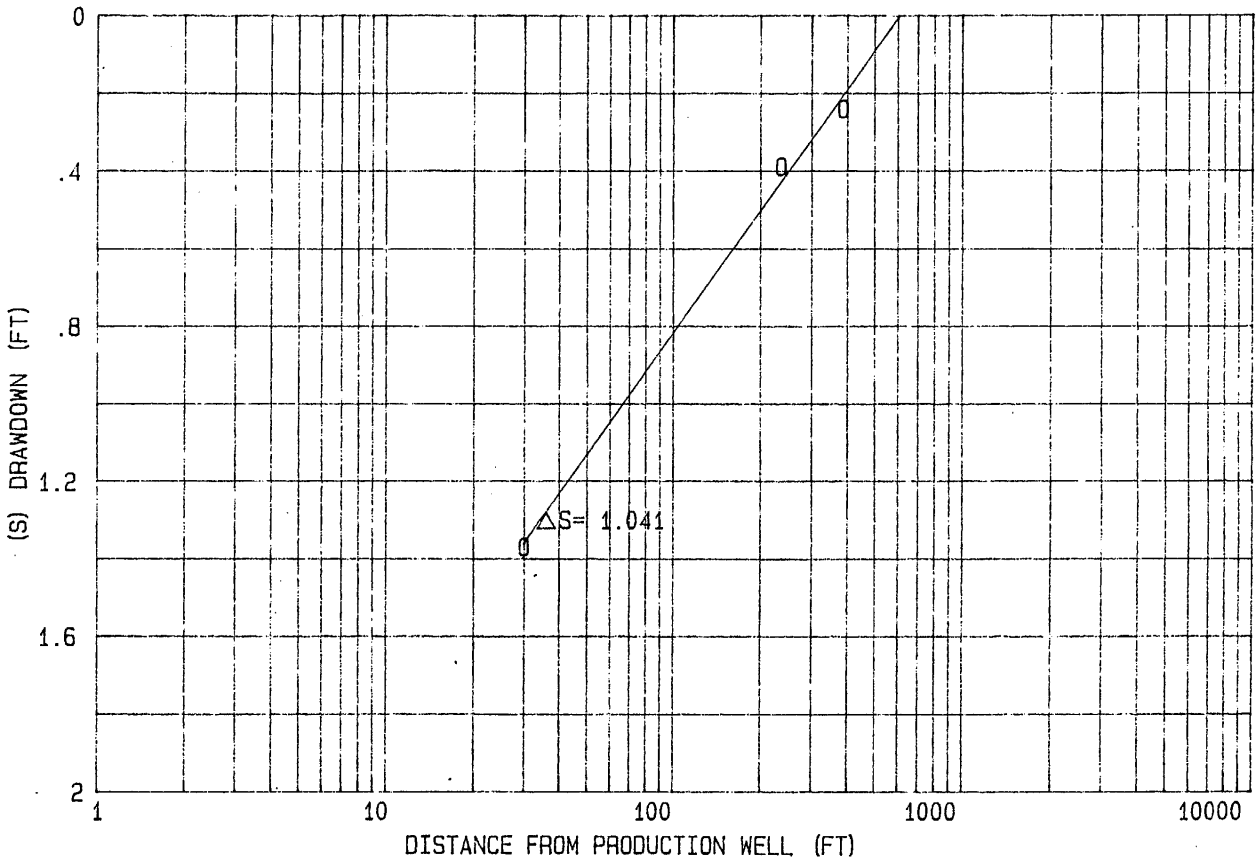
PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT: COE-NIAOP-FAIDLEY FILE: 1332.51 LOCATION: MINNESOTA	PUMPING RATE FOR PRODUCTION WELL AT2 = 148.5 USGPM	
RMT INC.		

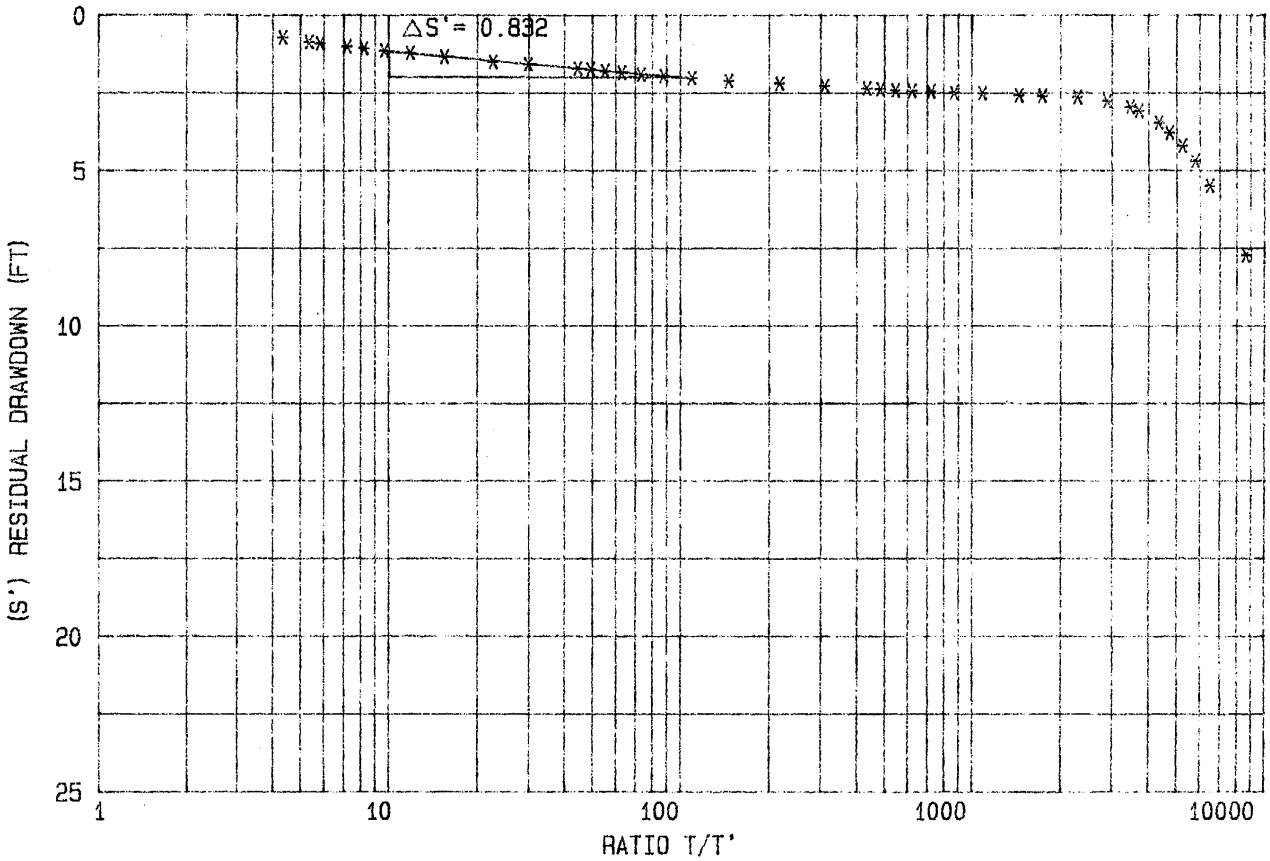
PUMPING TEST ANALYSIS STRAIGHT LINE APPROXIMATION METHOD



PROJECT: COE-NIROP-FRIDLEY FILE: 1332.51 LOCATION: MINNESOTA	PUMPING RATE FOR PRODUCTION WELL AT2 = 148.5 USGPM	

RMT INC.

RECOVERY ANALYSIS



PROJECT: COE-NIROP-FRIDLEY FILE: 1332.51 LOCATION: MINNESOTA	WELL NO.: AT2 Q= 148.5 USGPM S.W.L.= 24.4	ΔS' = 0.832 FT T= 47100 GPD/FT

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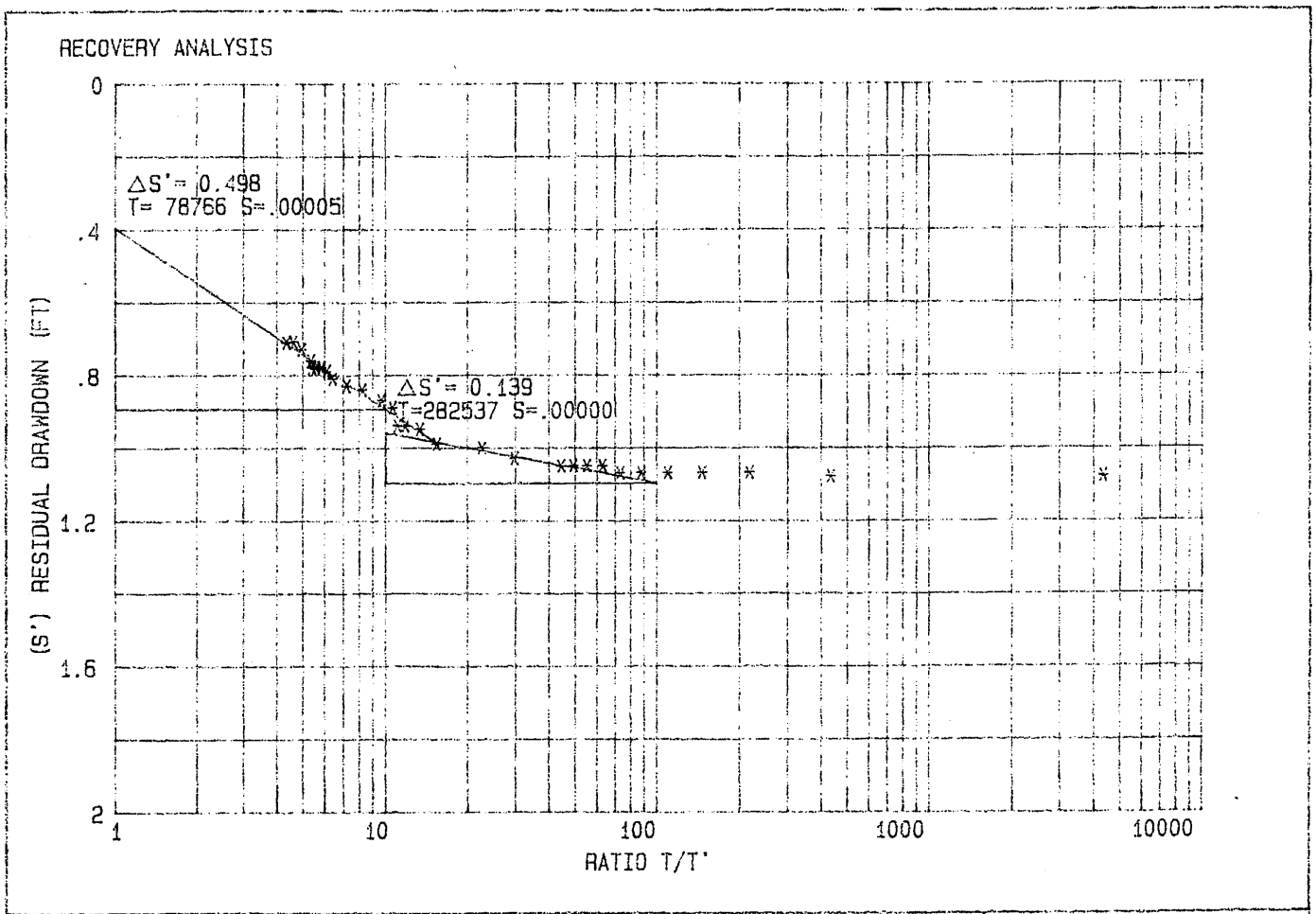
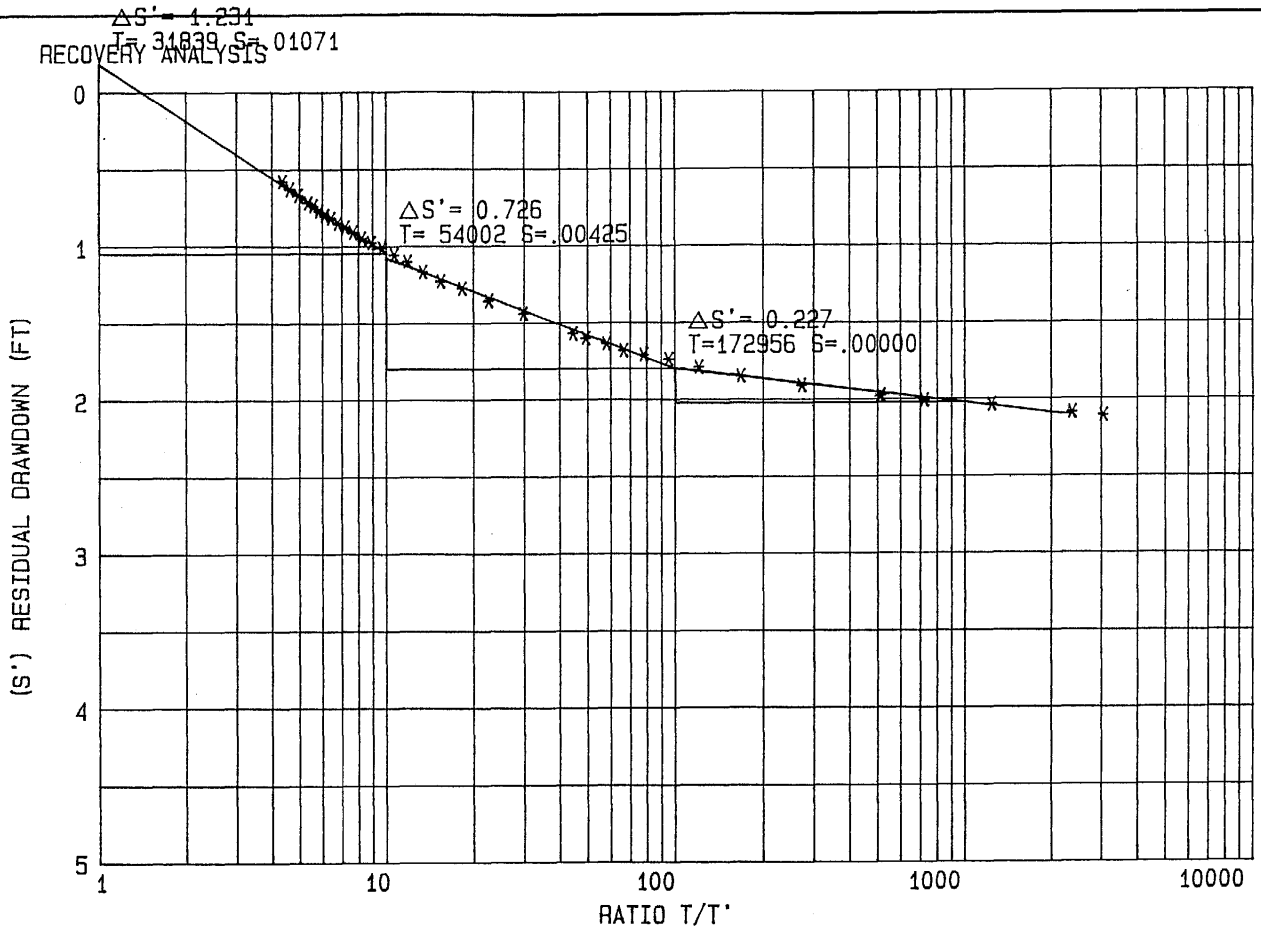


PROJECT: COE-NIROP-FRIDLEY FILE: 1332.51 LOCATION: MINNESOTA	WELL NO.: 6S Q= 148.5 USGPM S.W.L.= 23.75	

RMT INC.



PROJECT:	COE-NIROP-FRIDLEY	WELL NO.:	24S
FILE:	1332.51	Q=	148.5 USGPM
LOCATION:	MINNESOTA	S.W.L.=	24.1

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