HYDROGEOLOGIC STUDY AND

WASTE EVALUATION

THE O.K. TOOL COMPANY SITE,

MILFORD, NEW HAMPSHIRE

Prepared for

O. K. TOOL COMPANY
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R-569

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APPENDICES

## LIST OF ABBREVIATIONS USED IN THE O.K. TOOL REPORT

| | |
|---|---|
| B | bottom of hole |
| °C | degrees Centigrade |
| c | coarse |
| cm | centimeters |
| E | east |
| EPA | Environmental Protection Agency |
| et al. | et alii (and others) |
| f | fine |
| ft | feet or foot |
| $ft^2$ | square feet |
| $ft^3$ | cubic feet |
| g | grams |
| GC/MS | gas chromatography and mass spectrometry |
| gpd | gallons per day |
| gpm | gallons per minute |
| Hendrix | Hendrix Wire & Cable Corp. |
| Hitchiner | Hitchiner Manufacturing Co., Inc. |
| HNU | HNU Model 101 photoionization analyzer |
| ibid. | ibidem (in same book) |
| I.D. | inside diameter |
| i.e. | id est. (that is) |
| in. | inches |
| K | coefficient of permeability (or hydraulic conductivity) |
| ℓ | liters |
| L.L.S. | licensed land surveyor |
| m | medium |
| mg. | milligrams |
| mi. | miles |
| ml. | milliliters |
| N | north |
| NAI | Normandeau Associates, Inc. |
| ND | not detected |

| | |
|---|---|
| No. | number |
| O. K. Tool | O. K. Tool Company, Inc. |
| OVA | organic vapor analyzer |
| OWM | Office of Waste Management |
| oz. | ounces |
| ppb | parts per billion |
| ppm | parts per million |
| Prof. | professional |
| PVC | polyvinyl chloride |
| Q | rate of yield or discharge |
| RAI | Resource Analysts, Inc. |
| s | drawdown |
| S | south |
| SC | specific capacity |
| sec. | seconds |
| T | transmissivity (also trace) |
| TR | trace |
| USGS | United States Geological Survey |
| v | very |
| W | west |
| WL | water level |
| WSPCC | Water Supply and Pollution Control Commission |
| µg | micrograms |
| > | greater than |
| < | less than |
| ' | feet |
| " | inches |
| ° | degrees |

## 1.0 INTRODUCTION

This project has been conducted in accordance with a workscope submitted to O.K. Tool Co., Inc. (O.K. Tool) on June 10, 1983 to conduct a hydrogeologic study, and a volatile organic compounds source evaluation program at their facility in Milford, NH. The workscope was modified to address State agency comments and was approved by the State of New Hampshire's Office of Waste Management (OWM) and Water Supply and Pollution Commission (WSPCC) in their letter of August 1, 1983 (received by O.K. Tool on August 8, 1983). The OWM and WSPCC are concerned about the possibility of volatile organic compounds in the ground water from sources on O.K. Tool's property. Volatile organic compounds were first detected on February 3, 1983 in a Milford public water supply well (known as the Savage Well), roughly 3500 feet east of O.K. Tool.

## 1.1 PURPOSE AND SCOPE

The purpose of this study is to define ground water movement, evaluate levels of volatile organic compounds in the ground water, and locate sources of these compounds. Achieving this required: 1) extensive field work such as geophysical surveys, observation and monitoring well installations, soil and waste evaluation, and water sampling, 2) laboratory analysis of soil, waste, and water samples, and 3) data analysis to determine hydrogeologic parameters and occurrence of volatile organic compounds.

## 1.2 SITE HISTORY

The O.K. Tool Company site is located along State Highway Route 101 in the northwest part of the Town of Milford, New Hampshire (Figure 1.2-1). The site borders the Souhegan River and currently contains one main building and several small structures (Figure 1.2-2).

Operations by the O.K. Tool Company began on the present site in Milford during the early 1940's. The company manufactures machine parts such as cutters, grinders, mills and reamers. The site of the

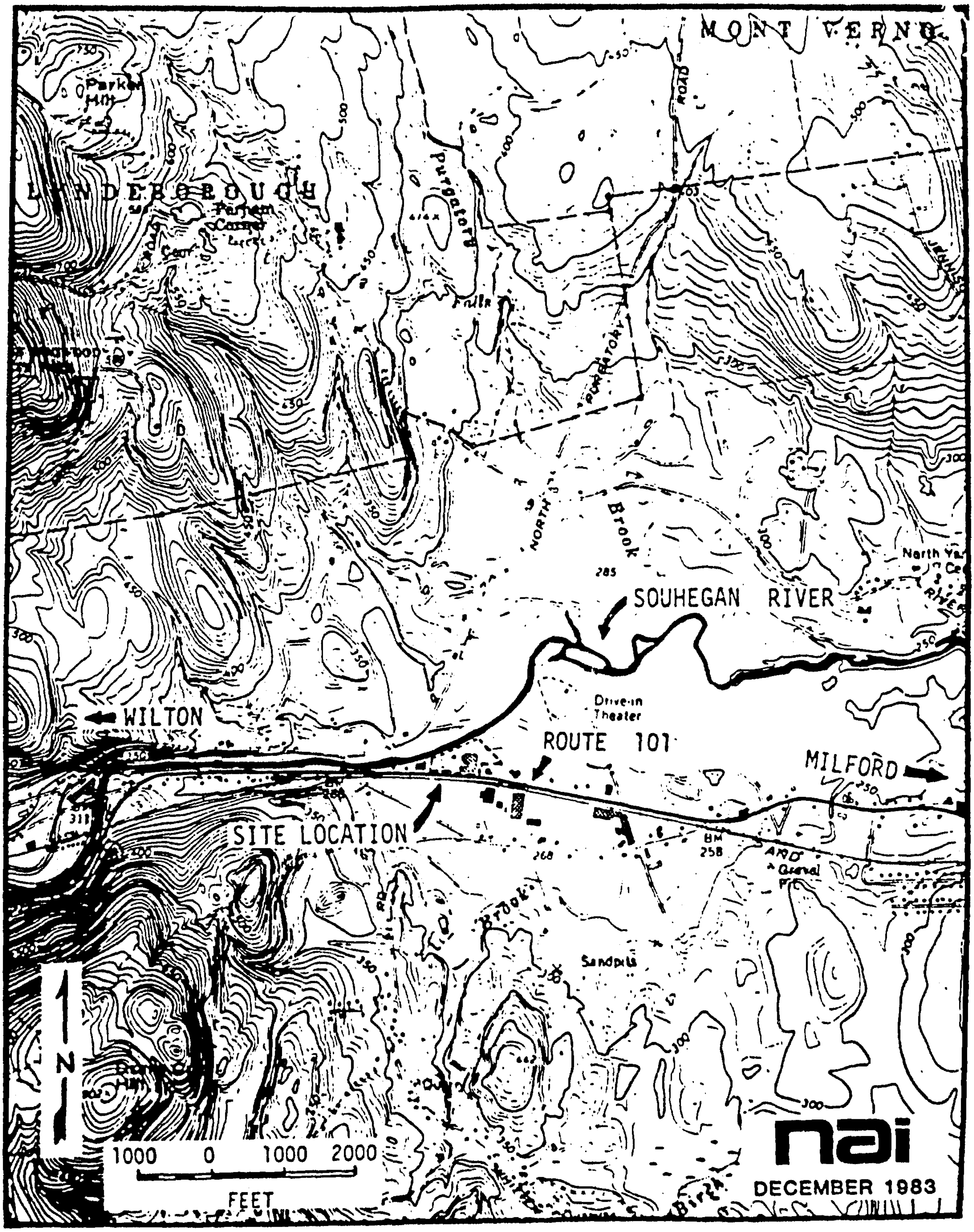


Figure 1.2-1 Site location map. O.K. Tool Co., Inc., Milford, New Hampshire (from U.S.G.S. Milford Quadrangle, photorevised, 1974) O.K. Tool Report.

present main building was previously occupied by a gasoline station. In the past (before 1977), a smaller plant existed where the present main plant is now located and a second small plant existed on the west part of the property where a continuation of the State Highway 101 by-pass now overlaps the site. In 1977 the west building was removed after the State acquired the land by eminent domain for the by-pass construction. The east building was then expanded to its present dimensions and all Milford operations were combined under one roof.

## 2.0 METHODS

### 2.1 SITE SURVEY

A base map and a benchmark property grid (see maps in pocket) were established as a result of a site survey carried out by Eric Mitchell, L.L.S. (a surveyor subcontracted to NAI) during the months of September and October, 1983. The base map, drawn on a scale of 1":50', describes physical landmarks such as buildings, roads, rivers, property boundaries and topography (2-foot contour interval). Development of the grid involved marking the property with stakes and other appropriate marks on 50-foot centers. The grid was then used to accurately locate observation wells, staff gages, monitoring wells, seismic lines, and waste/soil-sampling locations.

### 2.2 SEISMIC REFRACTION AND GRAVITY SURVEYS

A seismic refraction and gravity investigation was performed by Dr. John F. Kick, Consulting Geophysicist, on August 25-26, 1983 in order to obtain preliminary estimates of: 1) depth to bedrock, 2) depth to the water table, and 3) character of the overburden materials, whether glacial till or stratified glacial deposits. The results of this investigation appear in Appendix A.

### 2.3 EVALUATION OF SUBFLOOR SOIL

Three holes, roughly 18 to 30 inches deep and 12 inches in diameter, were excavated beneath the concrete floor inside the O. K. Tool main plant building on September 14 and 15, 1983. The holes (A, B, and C) were located in the vicinity of the degreasing tank (Figures 2.3-1 and 2.3-2), which is suspected to have leaked degreasing fluid into a nearby floor drain. Soil samples were taken from each hole in order to determine the levels of volatile organic compounds in the unsaturated soils.

After breaking through the concrete floor (with a pneumatic drill, where necessary), the subfloor soil was excavated with a hand-

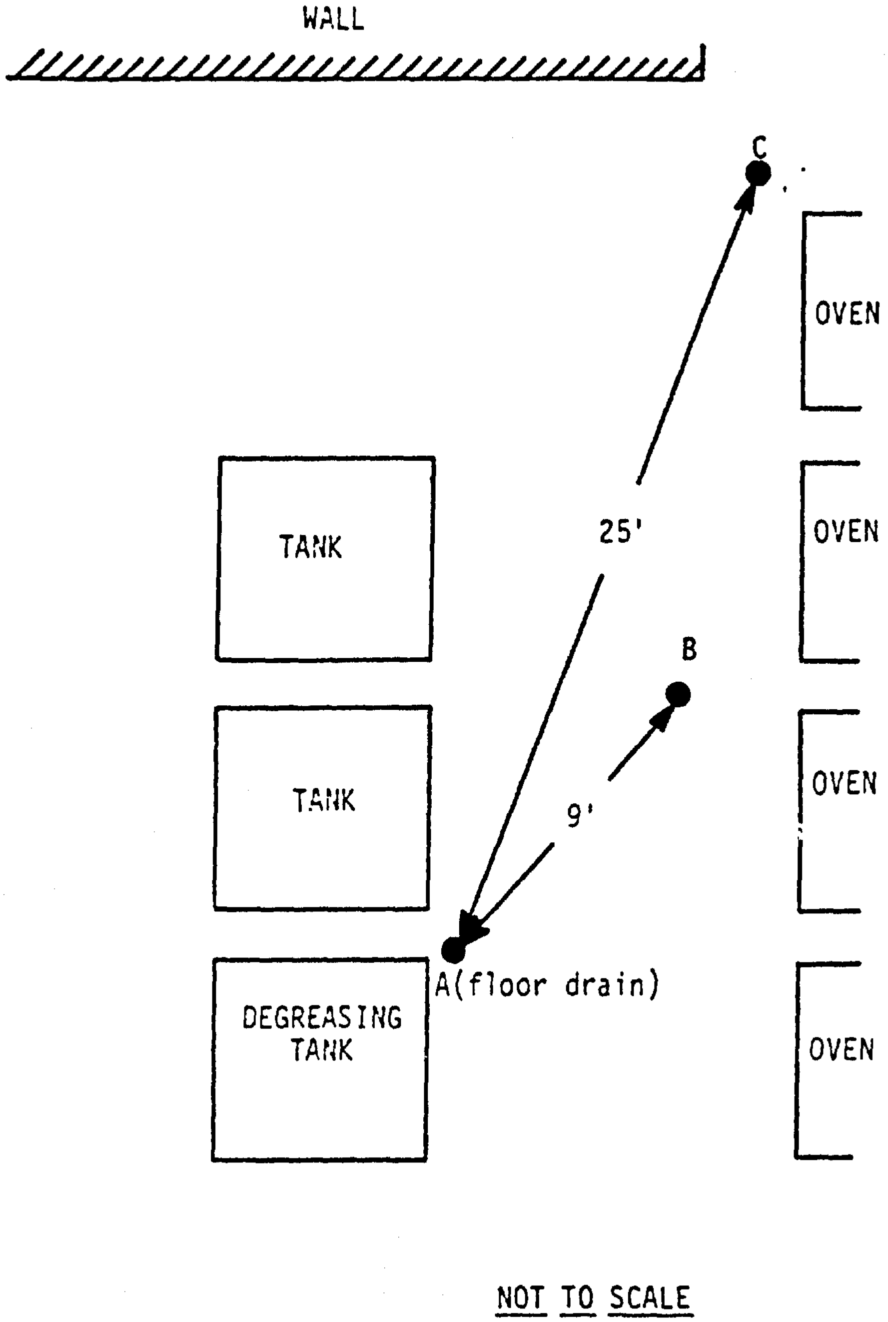


Figure 2.3-2. Location of test holes in the vicinity of the degreasing tank in the main plant building. O.K. Tool Report.

operated soil auger, spoons, and by hand. A portable HNU organic vapor detector (HNU) and a Century Organic Vapor Analyser (OVA) were used to measure levels of organic vapors in the atmosphere during the excavation of the subfloor soil, both for safety to workers and to obtain a preliminary estimate of soil vapor concentrations. Soil samples were then submitted to Resource Analysts, Inc. (RAI) for specific volatile organic compound identification.

## 2.4 SURFACE SOIL AND WASTE EVALUATION

The survey consisted of a description of soils and wastes, sample-screening by OVA, and laboratory analysis by gas chromatography and mass spectroscopy (GC/MS). One hundred and three samples were collected, generally from locations between the Souhegan River and the paved access road and parking lot. Soil and waste conditions were described at each location. Soil samples were then screened for volatile organics using the OVA and headspace method. On the basis of observation and screening, six locations that showed high organic vapor levels were chosen for sampling, and analysis by GC/MS for volatile organic priority pollutants. Two locations were chosen for sampling, and analysis for semi-volatile organic priority polltants.

Comparison between the screening results and the GC/MS results has been useful in estimating the level of volatile organic compounds in soil samples that were screened, but not submitted for GC/MS analysis.

**Field Methods**. The survey was conducted in four phases:

Phase 1 - Samples were obtained from: 1) each grid point, located between the Souhegan River and the paved access road and parking lot; 2) selected locations with visible stain, waste or stressed vegetation; 3) undisturbed, natural soils considered free of synthetic volatile organic compounds on the east side of the company property, to serve as a background and to help verify that these areas were free of volatile organic compounds; 4) four locations offsite, to serve as a background. Soil samples were obtained from an approximate depth of 6 inches.

Phase 2 - Sampling was conducted at those Phase 1 locations in which the screening process had shown an above background concentration of organic vapors. Phase 2 samples were obtained from an approximate depth of one foot.

Phase 3 - Sampling was conducted at those Phase 2 locations in which the screening process had shown an above background concentration of organic vapors. Samples were obtained from a depth of about 2 feet and, where possible, 3 and 4 foot depths.

Phase 4 - Based on observations and results from the OVA screening, six locations were chosen for sampling, with analysis by GC/MS for volatile organic priority pollutants and two locations for semi-volatile organic priority pollutants.

For Phases 1-3 each sample consisted of a 40 (ml) vial filled 3/4 full with sample material and closed with a septum cap. Data recorded at each location include the time, depth, grid location and a brief description of soil/waste conditions at the sample location. Samples were obtained using a shovel or soil auger and transferred using a stainless steel spoon. Sampling tools were cleaned by rinsing with distilled water between each sample. Samples were field stored on ice and transferred to 4°C storage at the NAI laboratory.

Samples collected during Phase 4 consisted of a filled 8 ounce (oz.) jar with a threaded lid with a Teflon liner. Samples were stored on ice while in the field and transferred to a refrigerator for storage.

**Laboratory Methods.** Sample-screening by OVA was done under standardized conditions at the NAI laboratories. Samples were removed from storage and allowed to equilibrate for four hours at room temperature. They were then placed in a 55°C oven for 20 minutes (55°C is the temperature at which many volatile organics readily vaporize). Upon removal from the oven, a gas-tight syringe was used to remove a 5 ml volume of "air" from the headspace of the vial. This was injected into the probe of the OVA and the resulting meter reading recorded. The syringe was purged between each sample and a blank injected into the probe. A deflection of less than 1 ppm indicated adequate purging.

The GC/MS analysis was conducted by RAI. Analytical methods are noted on the data sheets in Appendix F.

## 2.5 OBSERVATION WELL INSTALLATION

Initially, ten machine-augered observation wells (slotted-PVC and pipe) were planned for selected locations on the O. K. Tool property. Because of a boulder zone, encountered generally between 5 and 25-foot depths, machine-augering produced only one hole where an observation well could be installed (September 8, 9). This well, OW-1 (see Figure 2.3-1), penetrated to a depth of about 25 feet.

Three other observation wells (OW-2, -3 and -4) were installed in pits 12 feet to 15 feet deep excavated by a backhoe on September 23 and 26, 1983. In order to maintain the PVC pipe in a vertical position while backfilling, ropes were secured to the pipe and then tied to stakes at some distance from the pit. The pit was backfilled with hand-shovels in the immediate vicinity of the pipe, otherwise with the backhoe. Excavation by backhoe also afforded the opportunity to observe the subsurface deposits. Logs for these pits appear in Appendix B. The HNU and OVA were used to indicate levels of organic vapor in the excavated soil and ground water, both for safety to workers and to obtain a preliminary estimate of soil vapor concentrations. Information from observation wells was later used to assist in plotting water table maps.

## 2.6 STAFF GAGES

Three staff gages or water gaging points (S-1, -2, and -3) were installed at selected points in the Souhegan River (see Figure 2.3-1) on September 15, 1983 to provide additional water-level information for use in preparing a ground water elevation map.

## 2.7 MONITORING WELL SYSTEM DESIGN

Results from the geophysical investigations (Appendix A) indicated preliminary depths to bedrock. Water level information (Appendix B) obtained from staff gages and observation wells, indicated the direction of ground water movement. The monitoring well system was designed on the basis of bedrock depth, ground water movement and potential sources of volatile organic compounds.

## 2.8 MONITORING WELL INSTALLATION

Monitoring wells were installed at six locations (see Figure 2.3-1) between September 26 and October 14, 1983. Three of the monitoring locations contain multi-level installations with separate wells in the overburden (M-1b, M-3b and M-5b) and bedrock (M-1a, M-3a and M-5a). The other three installations (M-2, M-4 and M-6) were single-zone containing a single overburden well. The monitoring wells were installed by Clarence Welti Associates of Glastonbury, Connecticut using a Mobile/Bombadier type drill rig. An NAI hydrogeologist was on-site at all times during well-installation to: 1) keep a log of subsurface materials retrieved, 2) supervise drilling operations and monitoring well installation, and 3) monitor air quality (with HNU) both "downhole" and in the general work area of the drilling. The HNU was on-site both for personal protection as well as for obtaining a preliminary estimate of organic vapor concentrations. Test-boring logs appear in Appendix D. Well construction details are shown in Figures 2.6-1 to 2.6-6 and on Table 2.6-1. Two bedrock wells, M-3a and M-5a, were developed by flushing with clean water after well installation. In the process, some accumulated silt was removed from the well-bottoms.

## 2.9 GEOLOGIC RECONNAISSANCE

Glacial deposits in the aquifer area were observed at a number of sand and gravel pits and other locations using a glacial geologic map

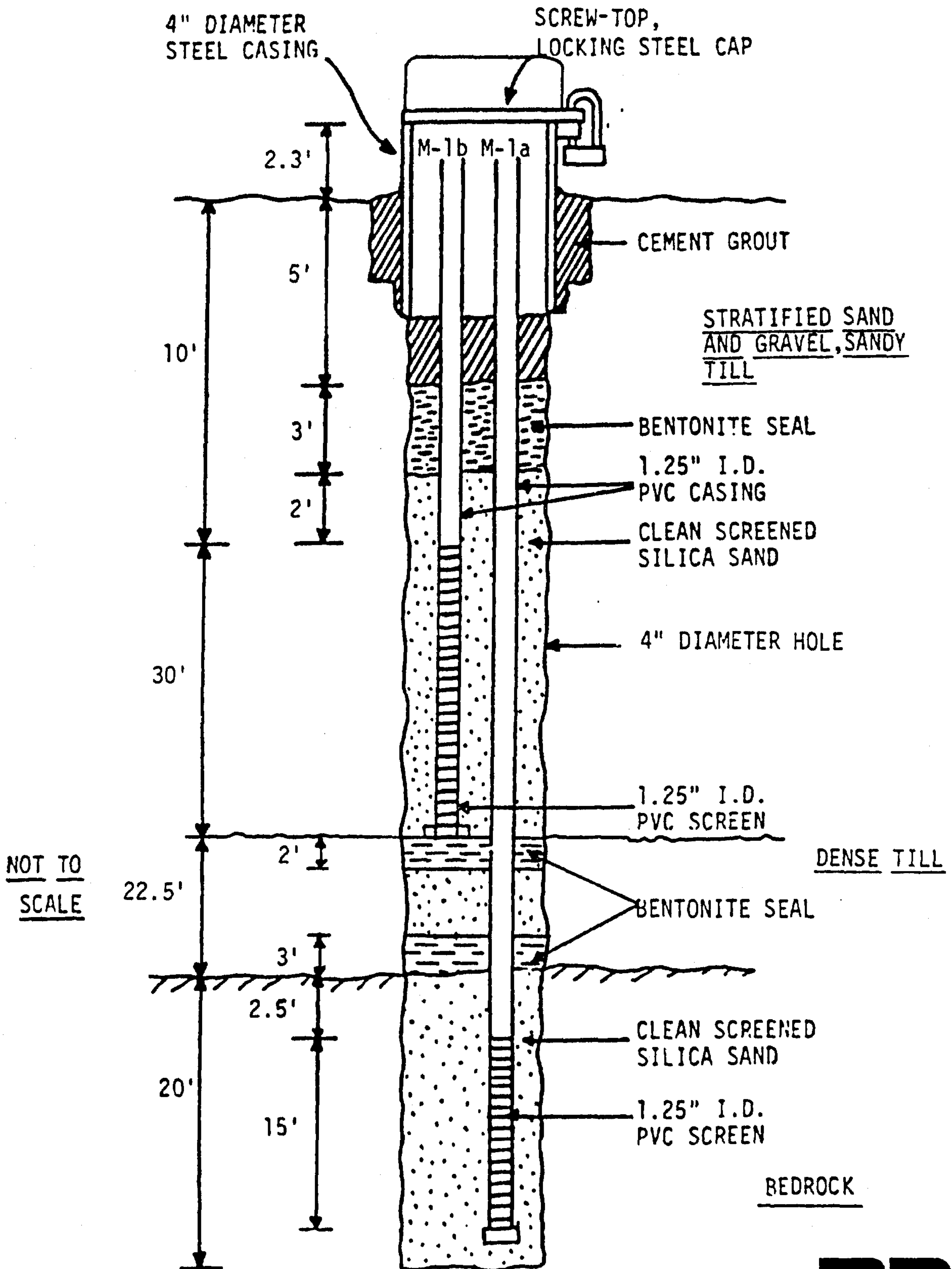


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Figure 2.6-1 Overburden and Bedrock Monitoring Well, M-1. O.K. Tool Report.

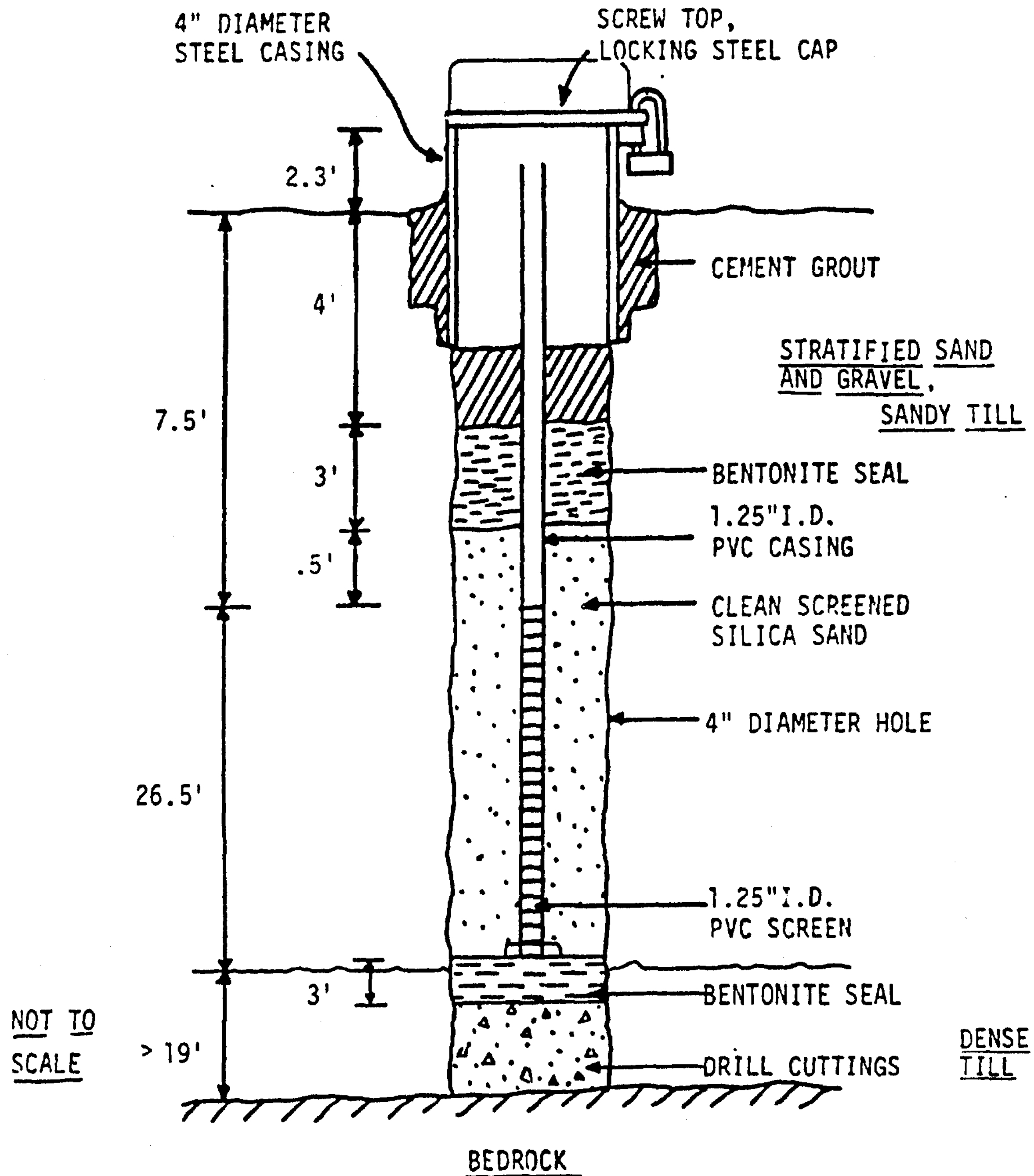


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Figure 2.6-2 Overburden Monitoring Well, M-2.
O.K. Tool Report.

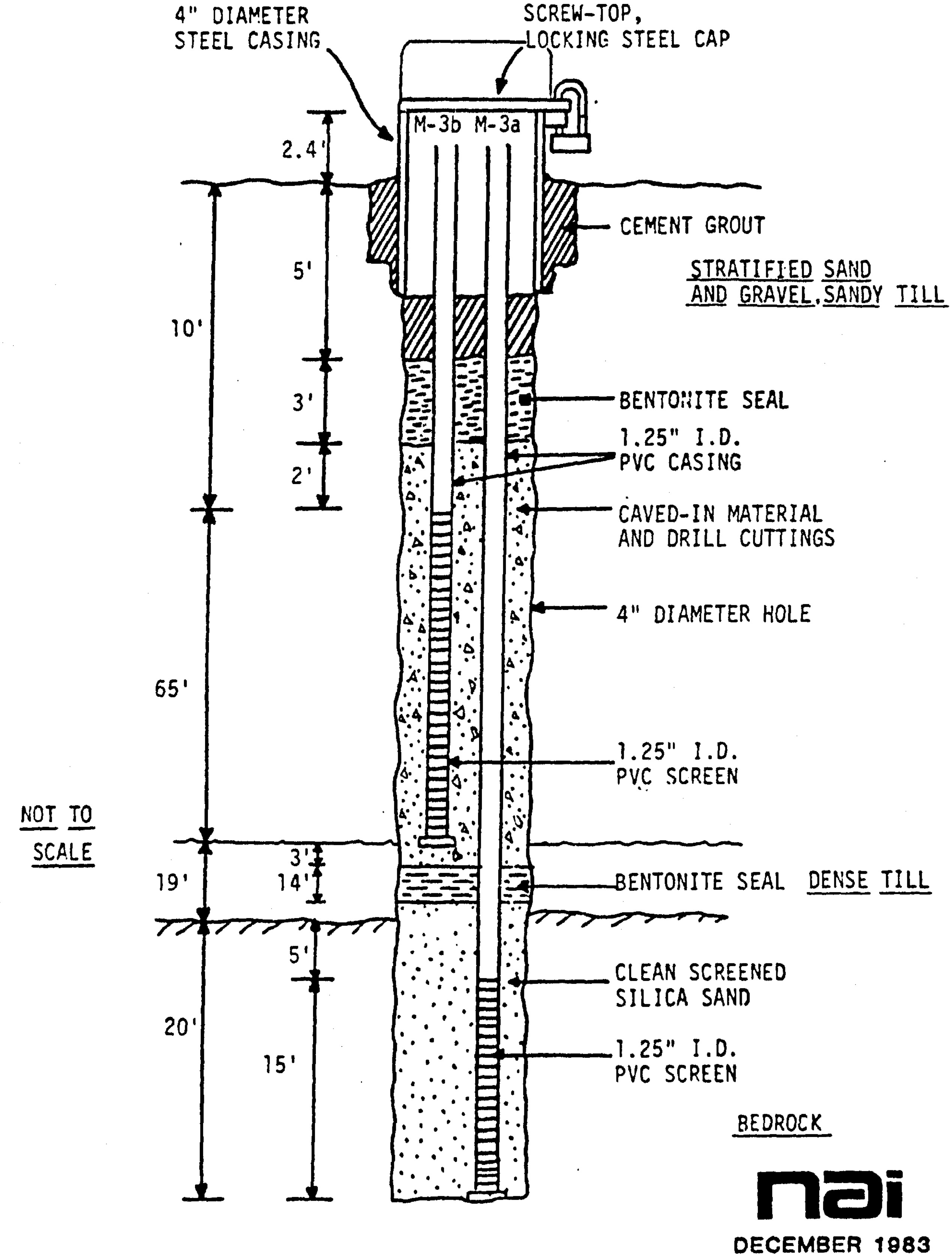


Figure 2.6-3 Overburden and Bedrock Monitoring Well, M-3.
O.K. Tool Report.

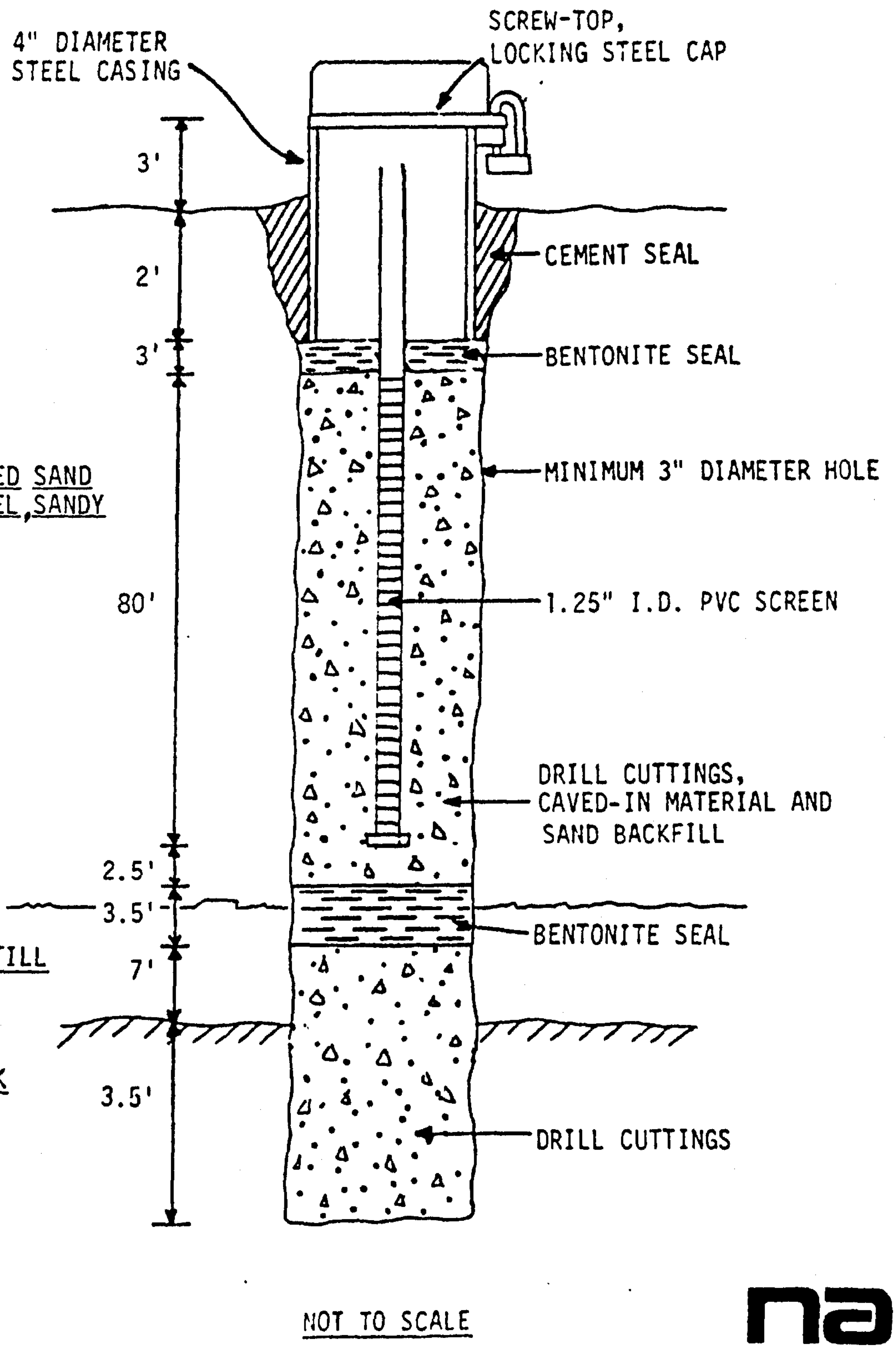


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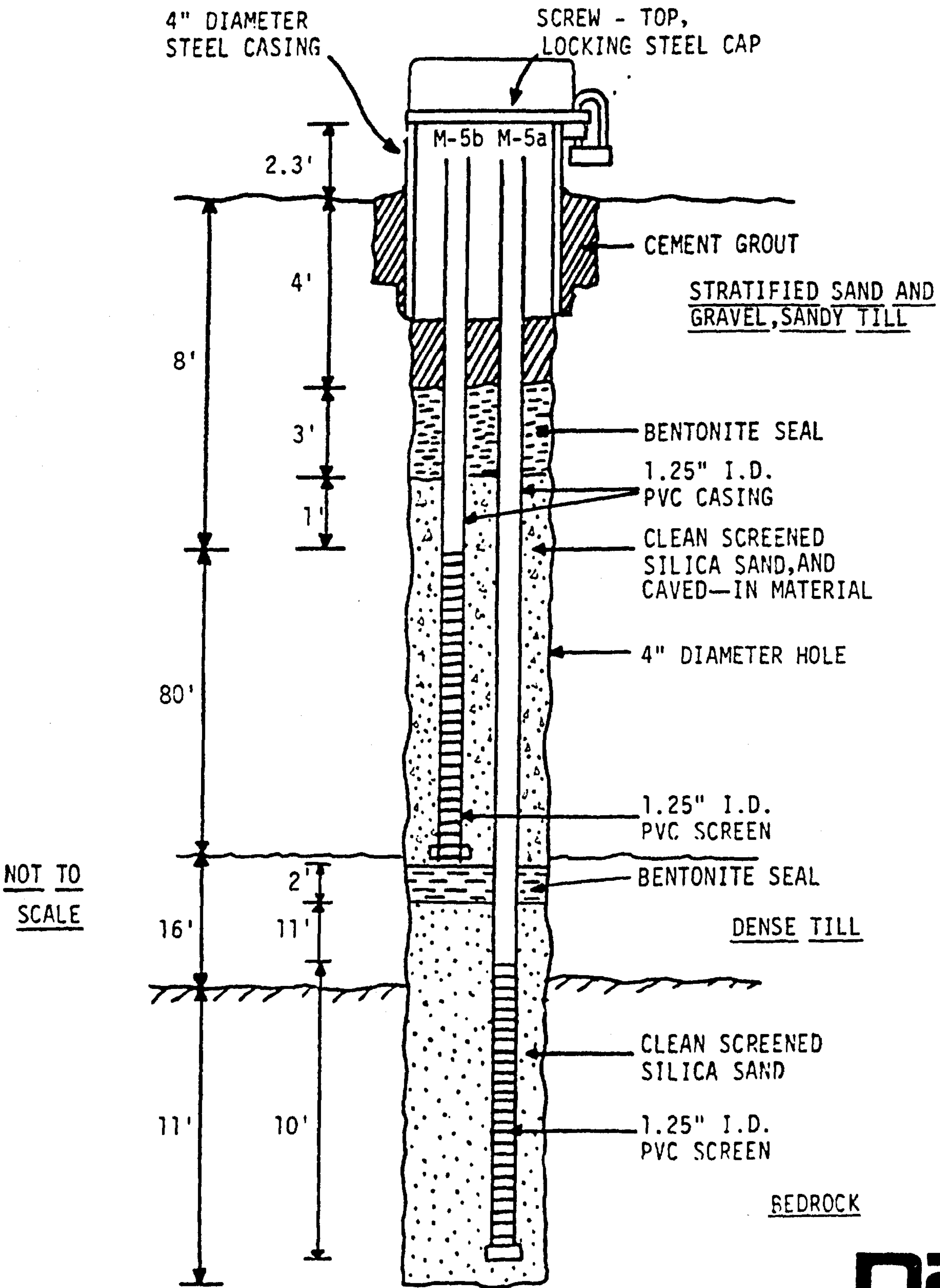
Figure 2.6-4 Overburden Monitoring Well, M-4.
O.K. Tool Report.

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Fifure 2.6-5 Overburden and Bedrock Monitoring Well, M-5.
O.K. Tool Report.

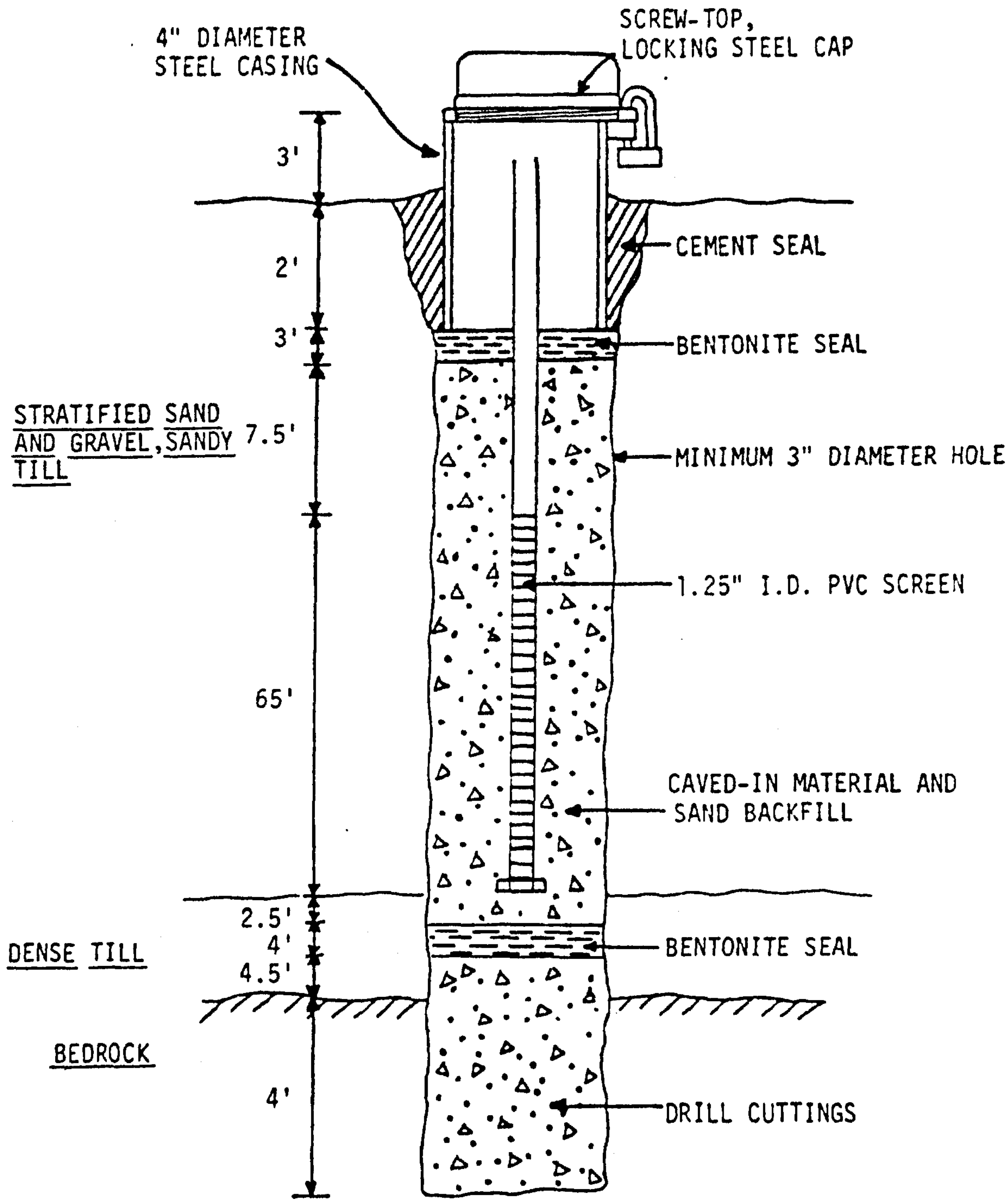


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Figure 2.6-6 Overburden Monitoring Well, M-6.
O.K. Tool Report.

TABLE 2.6-1. SUMMARY OF MONITORING WELL CONSTRUCTION AND SAMPLING DEPTHS
O.K. TOOL REPORT, DECEMBER 1983, NORMANDEAU ASSOCIATES, INC.

(Measurements in feet)

| WELL NO. (SURFACE ELEVATION) | PROTECTIVE CASING ELEVATION | PROTECTIVE CASING STICK-UP | WELL DEPTH (ELEVATION) | SCREEN DEPTH | SAMPLING DEPTH(S) |
|---|---|---|---|---|---|
| M-1a (275.6) | 277.9 | 2.3 | 80 (195.6) | 65-80 | 71-73 |
| M-1b (275.6) | 277.9 | 2.3 | 40 (235.6) | 10-40 | 16-18<br>31-33 |
| M-2 (273.0) | 275.3 | 2.3 | 40 (233.0) | 15-40 | 16-18<br>27-29 |
| M-3a (269.9) | 272.3 | 2.4 | 114 (155.9) | 99-114 | 104-106 |
| M-3b (269.9) | 272.3 | 2.4 | 75 (197.3) | 10-75 | 16-18<br>42-44<br>68-70 |
| M-4 (270.6) | 273.4 | 2.8 | 85 (185.6) | 10-85 | 15-17<br>52-54<br>77-79 |
| M-5a (270.1) | 272.35 | 2.3 | 111 (159.1) | 101-111 | 104 106 |
| M-5b (270.1) | 272.3 | 2.3 | 88 (182.1) | 8-88 | 16-18<br>50-52<br>76-78 |
| M-6 (270.7) | 273.5 | 2.8 | 78 (192.7) | 13-78 | 15-17<br>43-45<br>69-71 |

published by the U.S. Geological Survey[1] as a guide. Bedrock was observed at fewer locations. This brief geologic reconnaissance, performed concurrently with drilling, provided a general context for the geologic materials encountered during drilling at the O. K. Tool site.

## 2.10 WATER SAMPLING

Ground water samples were obtained from representative depths in each of the nine monitoring wells using 3/4 inch I.D. PVC bailers on November 7, 1983. Sampling depths are shown on Table 2.6-1. In order to avoid cross-contamination, bailers were "dedicated" to each well, i.e., one bailer for each of the nine wells.

Each bailer was pre-assembled with a length of 1/16" nylon cord, knotted along its length to facilitate sampling at intended depths. The other end of the cord was fastened to a spool.

After sampling, the bailer cord was spooled and tied off, and the bailer was stored inside the well above the water table. This was done to facilitate future rounds of sampling.

Surface water samples were collected from the Souhegan River at two staff gages S-1 and S-3, also on November 7, 1983.

All samples were preserved according to EPA guidelines and analyses were conducted within EPA recommended holding times. NAI's chain-of-custody sample handling procedures were used to ensure accurate delivery to the analytical laboratories.

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[1]Koteff, C., 1970, Surficial Geologic Map of the Milford Quadrangle, Hillsborough Cty, New Hampshire, GQ-881:U.S. Geological Survey, Washington, D.C.

## 2.11 FIELD PERMEABILITY TESTING

In order to obtain estimates of permeability in the field, a simple apparatus was designed. The apparatus consists of lengths of 3/4 inch I.D. hose, a ball-valve, and a water meter with a capacity of 30 gpm. One length of the hose was fastened to a source of clean water (an outdoor faucet), another length was inserted into one of the monitoring wells, and the two lengths were joined with the water meter and the valve. Water was injected into the well while the flow was measured by the water meter. During the same time period, height of recharge was monitored in the monitoring well with a steel tape. Pre-test static water levels were obtained prior to injection. Three wells, M-1a, M-1b and M-2, were tested on November 11, 1983 in this manner.

## 2.12 WATER LEVEL MEASUREMENTS

Water levels were measured in both observation and monitoring wells on several occasions during the period of investigation. (The last measurements were made on November 7, 1983, prior to water sampling.) A chalked steel tape was used to measure levels. Prior to measurement in monitoring wells, the tape was decontaminated with a methenol and distilled water rinses in order to minimize the chance for cross-contamination.

# 3.0 RESULTS

## 3.1 GEOLOGY

### 3.1.1 Bedrock Geology

A reconnaissance study of field information and available geologic maps was undertaken in order to delineate bedrock structures which might control the movement of ground water. Such structures consist of "fractures", i.e., surfaces of breakage that are capable of transmitting ground water. "Joints" are natural, roughly planar surfaces of breakage along which no movement has occurred. In contrast, "faults" are surfaces along which movement has occurred.

The bedrock underlying the O.K. Tool site consists of pink, massive granite and grey foliated granite gneiss. In three of the five core holes that penetrated bedrock, bedrock is relatively unweathered with a few nearly vertical joints. In contrast, in the other two bedrock holes (M-3 and M-5), bedrock is found to be extremely weathered, to the point of being "rotten", i.e., it can be crumbled in the hand. Some bedrock core here is extremely broken with several minor fault surfaces. Both the fault surfaces and movement directions on the surfaces are commonly nearly vertical.

The orientation of joints and faults could not be obtained from bedrock cores in the field. However, the New Hampshire state geologic map[1] shows a prominent fault trending roughly N20°E to N30°E in the vicinity of the site. Orientations of fractures in bedrock can also be suggested by topography. The most prominent topographic feature is the roughly east-west trending water gap of the Souhegan River, located less than one half-mile west of the site (see Figure 1.2-1).

[1]Billings, M.P., 1955, Geologic Map of New Hampshire: New Hampshire Planning and Development Commission; Division of Geological Sciences, Harvard University; U.S. Geological Survey.

### 3.1.2 Glacial and Post-Glacial Geology

The O.K. Tool site lies on the western edge of a body of stratified glacial deposits and alluvium, roughly 4 square miles in area[1]. The body is nearly entirely surrounded by bedrock and glacial till. The term "overburden" is used to collectively describe both glacial and post-glacial deposits.

Two types of till have been recognized in the area. The older of the two ("lower till") is extremely compact, contains a large fraction of silt and clay, may contain joints which may transmit ground water, and averages roughly 10 feet in thickness. The second type is a sandy, noncompact till ("upper till") that may be quite permeable.

Stratified glacial deposits on the surface are composed chiefly of pebble to boulder gravel, and mixed sand and gravel, and become generally finer to the southeast. Some of the features present are ice-channel deposits and delta foreset beds. Stratified glacial sediments at the O.K. Tool site were deposited by melt-water streams originating from: 1) melting ice located roughly one-half mile or less north of the Souhegan River, and 2) the Wilton area to the west. Meltwater drained to the east toward the center of Milford (see Figure 1.2-1).

A thin layer of alluvium has resulted in some areas from minor modification of the glacial landscape by the present-day Souhegan River.

The drilling of monitoring wells, provided more detailed information on the nature of subsurface materials underlying the O.K. Tool site. Geologic cross section A-A' (west to east, see Figures 2.3-1, and 3.1-1) shows that bedrock becomes deeper toward the east, from 62.5' at monitoring well M-1 to 94 feet at M-3. Bedrock is overlain by an olive-drab, compact, silty lower till, averaging greater than 10 feet in thickness. In testament to the compactness of the lower till, 15 feet

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[1]Ibid. Koteff, C., 1970.

Geologic Cross Section A-A'

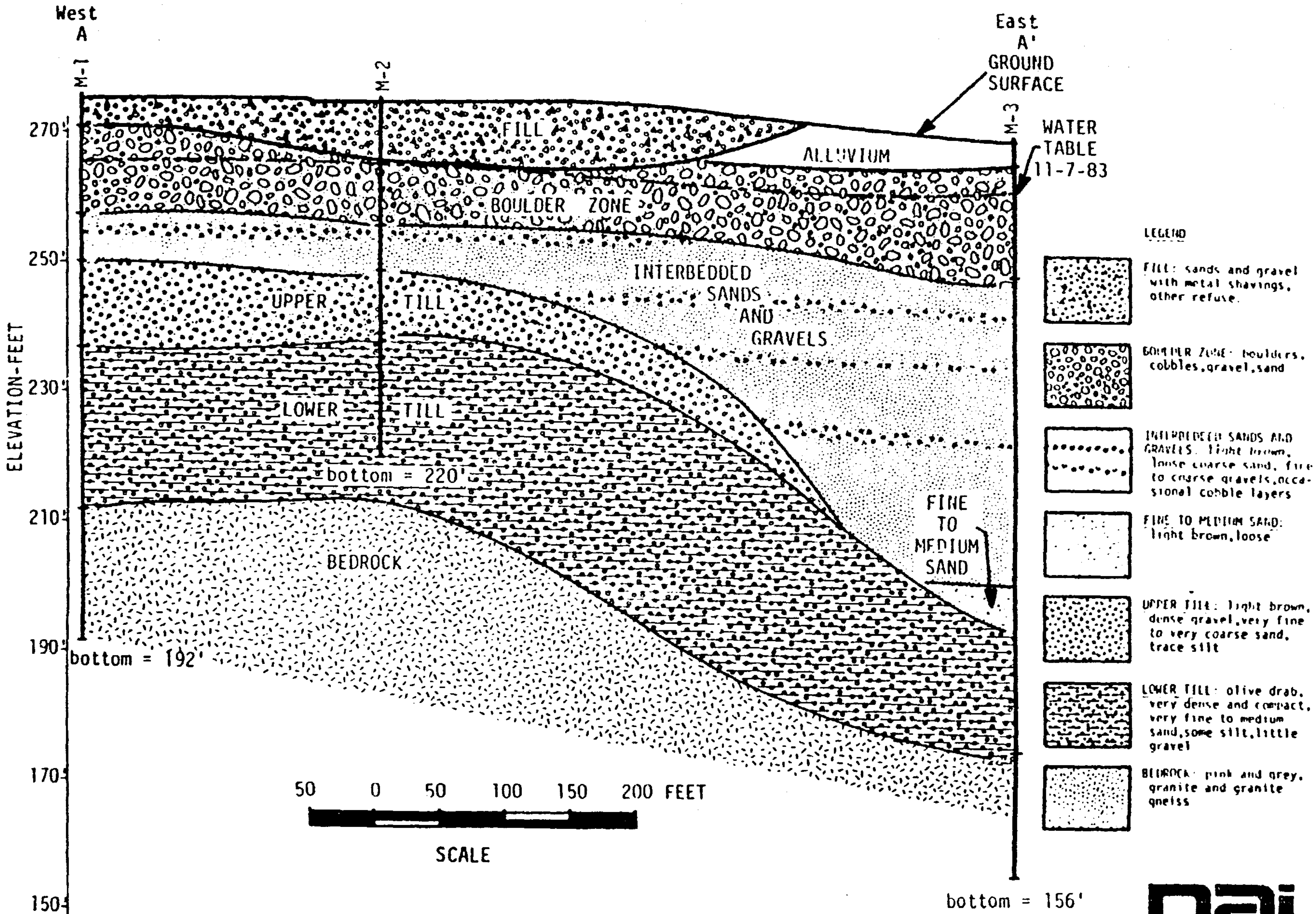


Figure 3.1-1 Geologic Cross Section A-A'. O.K. Tool Report.

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of lower till was recovered in one drill hole by using bedrock coring methods. Sieve analyses for the lower till show that it is composed of very fine to medium sand, some silt, little gravel (see Figure 3.1-2). Dense sandy upper till overlies the lower till and apparently pinches out to the east. Sieve analyses on three samples of upper till show that it is composed of gravel, and very fine to very coarse sand, trace silt (Figure 3.1-3). Uniformity coefficients for upper till are greater than 50. The uniformity coefficient is used to rank the relative sorting of granular materials. A coefficient of unity indicates perfect sorting (only one grain size), while a large number indicates a large variation in grain sizes. In general, well sorted (or uniform) materials have higher permeabilities than poorly sorted materials.

A wedge of loose, interbedded sands and gravels overlies the upper till and thickens from roughly 10 feet in the west to nearly 50 feet in the east. It is difficult to determine the thickness of individual sand or gravel interbeds. Sieve analyses of three samples (Figure 3.1-2) show that this unit is composed of medium to very coarse sand, with varying amounts of gravel and a trace of silt. The analyses may have been slightly biased, downplaying the proportion of coarser gravels which could not fit into the split spoon. This unit also includes occasional cobble layers which could be detected by indirect means during drilling. A thin, fine to medium sand unit underlying the sand and gravel unit in hole M-3 could be included as a member of the interbedded sands and gravels.

A boulder zone whose thickness (15 feet) and depth below the ground surface (5 feet to 20 feet) are reasonably consistent forms the uppermost glacial deposit. Test pits dug during installation of observation wells revealed that the boulder zone is composed primarily of boulders and cobbles whose flat dimensions are roughly horizontal, and which give the appearance of a stone wall. Gravel and coarse sand fill the interstices. Because of the coarse nature of the boulder zone no split-spoon samples were obtained.

# GRAIN SIZE DISTRIBUTION CURVES

LABORATORY NO. ______________________ ACCT ABBR. O.K. Tool Company

FIELD SAMPLE NOS. M-5-6, M-5-2, M-3-2, LT(M-5) ACCT. NO '569

DATE TESTED 1983 TESTED BY D. DeNatle

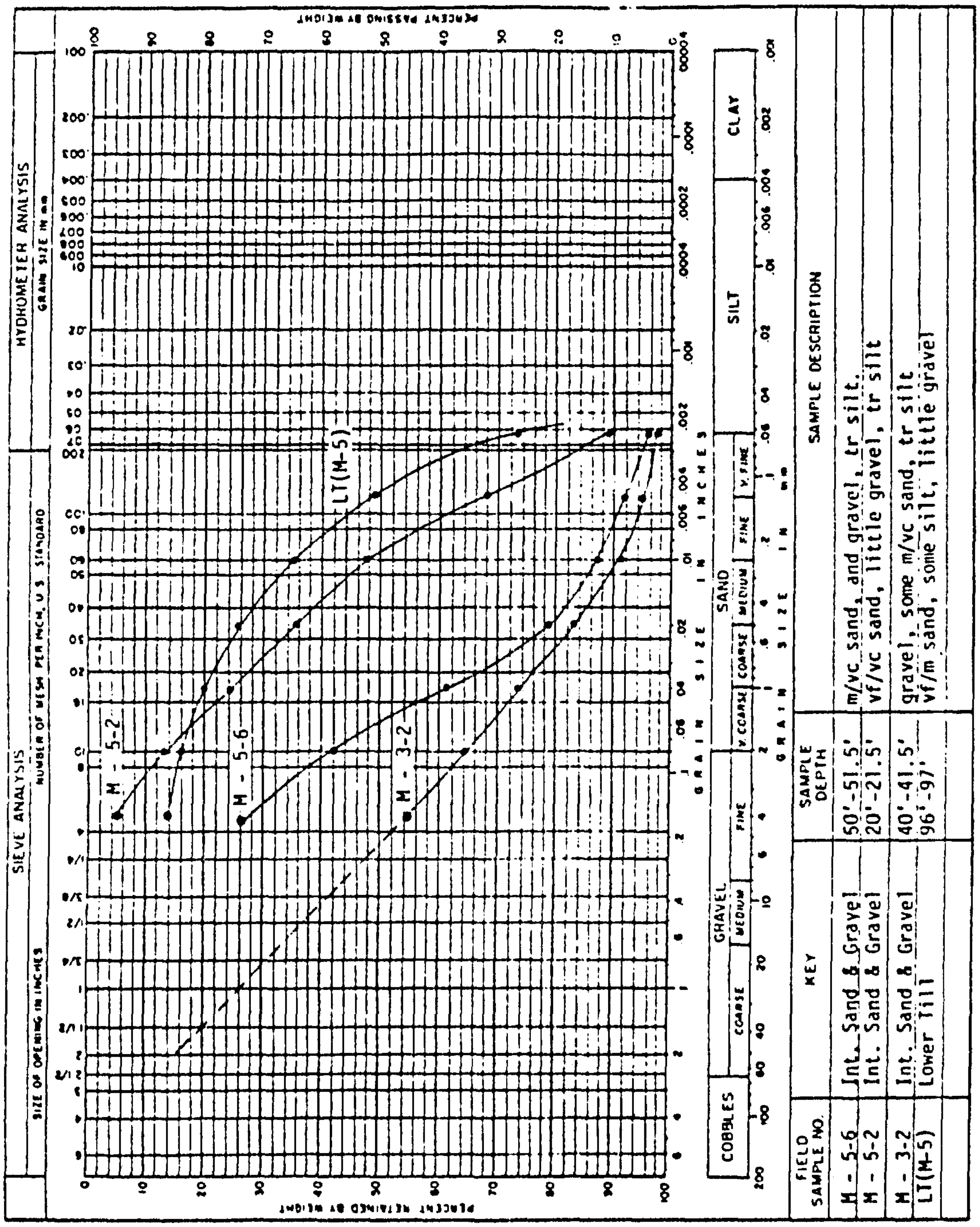


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Figure 3.1-2 Grain Size Analysis Curves.O.K. Tool Report.

# GRAIN SIZE DISTRIBUTION CURVES

LABORATORY NO. ____________

FIELD SAMPLE NOS. M-1-2, M-3-7, M-4-10, M-5-8

DATE TESTED 1983

ACCT ABBR. O.K. Tool Company

ACCT. NO. 569

TESTED BY D. DeNatale

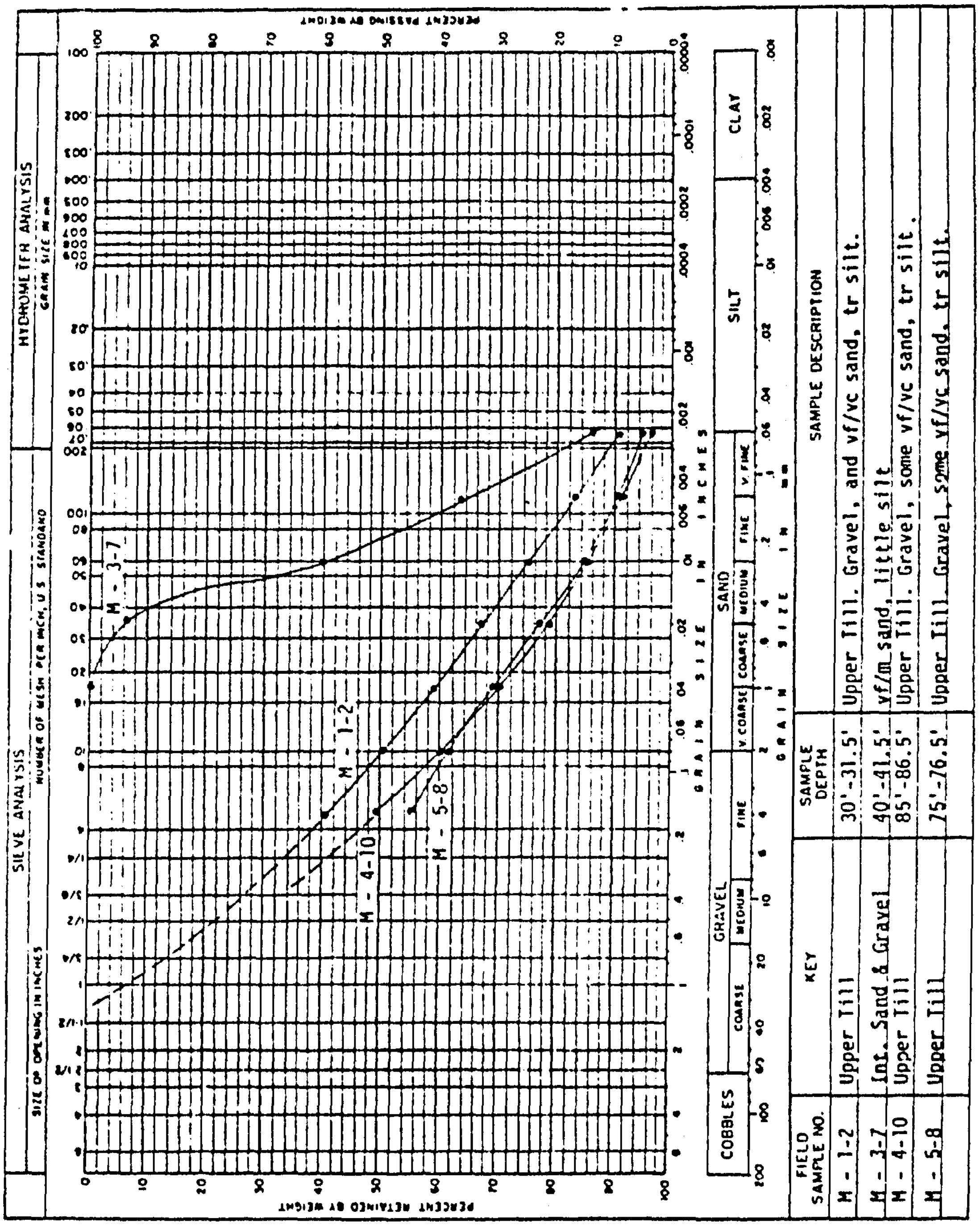


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Figure 3.1-3 Grain Size Analysis Curves. O.K. Tool Report.

At the surface, mixed fill/waste and river alluvium overlie the boulder zone. The river alluvium is composed of fine to medium sand, with varying amounts of silt and fine gravel. A more complete description of natural soils and mixed fill/waste is reserved for the section on Soil and Waste Evaluation (3.2).

Geologic cross section B-B' (north to south, see Figures 2.3-1 and 3.1-4) shows that bedrock is consistently 80 to 90 feet deep on the eastern edge of the property. Lower till averages roughly 10 feet in thickness, and upper till apparently pinches out to the north. The unit of interbedded sands and gravels ranges from 40 to 50 feet thick, and the boulder zone averages roughly 15 feet in thickness.

## 3.2 SOIL AND WASTE EVALUATION

### 3.2.1 Surface Soil and Waste Evaluation

A survey of surface soil and waste was conducted at the O.K. Tool site in order to evaluate the type and extent of wastes and affected soil, particularly in regard to volatile organic priority pollutants. Table 3.2-1 summarizes the data from the soil and surface waste survey and includes: sample number, grid location, date, time, depth, description and OVA-screen readings. Waste materials have been confined primarily to four locations, outlined on Figure 3.2-1. Area No. 1 is a small patch of stressed vegetation which reflects the presence of tetrachloroethylene. Areas No. 2, 3 and 4 have several waste types present.

#### OVA Screening.

Results from the OVA-screen are presented in Table 3.2-1 and summarized in Figure 3.2-2, which presents the maximum reading recorded at each location, regardless of depth. Readings above 1000 ppm (all OVA-screen readings are methane equivalent) were recorded at four locations, at depths of up to 4 feet. Four locations had readings above 100 ppm and four had readings above 10 ppm. Most locations had readings at

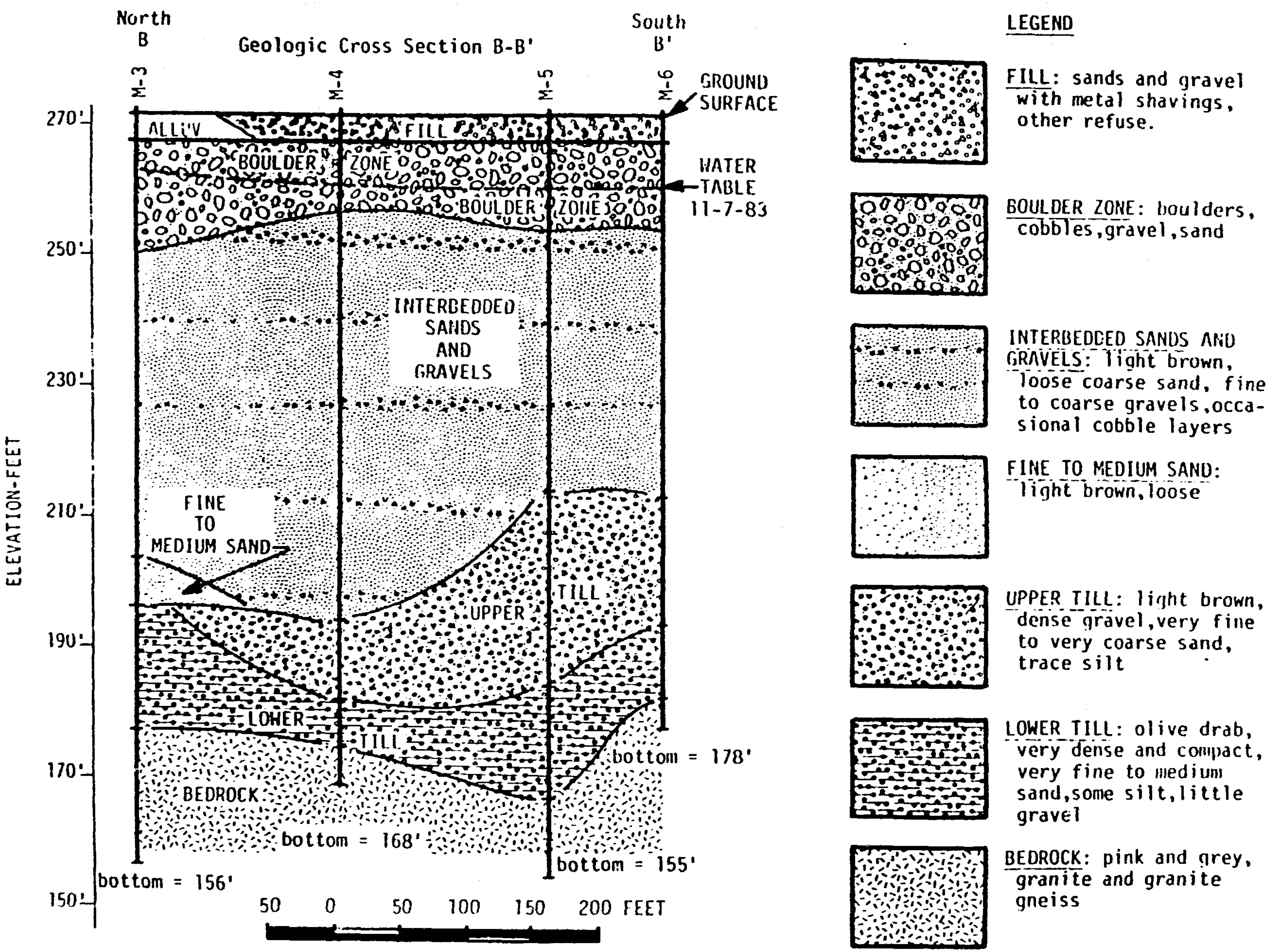


Figure 3.1-4 Geologic Cross Section B-B'. O.K. Tool Report.

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TABLE 3.2-1. RESULTS OF THE SURFACE SOIL AND WASTE EVALUATION, PHASES 1-3.[1]
O.K. TOOL REPORT, DECEMBER 1983, NORMANDEAU ASSOCIATES, INC.

| SAMPLE NO. | GRID LOCATION | DEPTH (ft) | OVA SCAN READING (ppm) | DESCRIPTION | GC/MS SAMPLE NUMBER |
|---|---|---|---|---|---|
| 1 | I-6 | .5 | 03 | Gravel fill | |
| 1A | I-6 | 1 | 10 | Waste and fill | |
| 1B | I-6 (Streambank) | 3 | 0.5 | fill | |
| 1C | I-6 (Streambank) | 4.5 | 20 | Rust waste, oily layer, grey waste | IC-V |
| 1D | I-6 (Streambank) | 6 | 0 | Natural fine sand, silt cobbles | IC-SV |
| 2 | I-7 | .5 | 2.5 | Waste and fill | |
| 2A | I-7 | 1 | 3.5 | Waste and fill | |
| 2B | I-7 | 3 | 0 | Natural soil | |
| 3 | H-8 | .5 | 2.5 | Natural woods soil | |
| 3A | H-8 | 1 | 2.5 | Sandy natural subsoil | |
| 3B | H-8 | 2 | 0 | Fine sand natural sub soil | |
| 3C | H-8 | 3 | 0.2 | Fine sand natural sub soil | |
| 4 | I-8 | .5 | 6 | Natural woods soil | |
| 4A | I-8 | 1 | 9.5 | Natural soil | |
| 4B | I-8 | 2 | 0 | Fine sand natural subsoil | |
| 4C | I-8 | 3 | 0.3 | Fine sand natural subsoil | |
| 5 | H-9 | .5 | 1.5 | Natural woods soil | |
| 6 | J-9 | .5 | 2 | Lawn turf over fill | |
| 7 | G-10 | .5 | 2 | Natural woods soil | |
| 8 | H-10 | .5 | 2 | Natural woods soil | |
| 9 | J-10 | .5 | 2 | Lawn turf over fill | |
| 10 | G-11 | .5 | 4.8 | Rust waste and soil | |
| 10A | G-11 | 1 | 300 | Rust waste | |

continued

TABLE 3.2-1. (Continued)

| SAMPLE NO. | GRID LOCATION | DEPTH (ft) | OVA SCAN READING (ppm) | DESCRIPTION | GC/MS SAMPLE NUMBER |
|---|---|---|---|---|---|
| 11 | F-12 | .5 | 8.5 | Rust waste | |
| 11A | F-12 | 1 | 3 | Fill under waste | |
| 11B | F-12 | 2 | 0 | Sandy fill | |
| 11C | F-12 | 3 | 0 | Sandy fill | |
| 12 | G-12 | .5 | 1.5 | Sod over fill, bricks and rubble | |
| 13 | F-13 | .5 | 3 | Rust waste and soil | |
| 13A | F-13 | 1 | 60 | Fill | |
| 13B | F-13 | | | No sample, rocky fill | |
| 14 | SP-3 | .5 | 3.2 | Rust waste | |
| 14A | SP-3 | 1 | 35 | Rust waste | |
| 14B | SP-3 | | | No sample, cavity | |
| 14C | SP-3 | 3 | 55 | Rust waste | |
| 14D | SP-3 | 4 | 120 | Rust waste | 14D-V, 14D-SV |
| 15 | E-14 | .5 | 1.5 | Natural soil | |
| 16 | F-14 | .5 | 30.5 | Waste and stained soil | |
| 16A | F-14 | 1 | >1000 | Waste and stained soil | 16A-V |
| 16B | F-14 | 1.5 | >1000 | Waste and stained soil | |
| 17 | F-14 | Surface | 2.5 | Brown sludge waste on surface | |
| 18 | D-15 | .5 | 1.5 | Natural woods soil | |
| 19 | E-15 | .5 | 1.5 | Natural soil | |

continued

TABLE 3.2-1. (Continued)

| SAMPLE NO. | GRID LOCATION | DEPTH (ft) | OVA SCAN READING (ppm) | DESCRIPTION | GC/MS SAMPLE NUMBER |
|---|---|---|---|---|---|
| 20 | F-15 | .5 | 3.3 | Fill | |
| 20A | F-15 | 1.0 | 100+ | Fill | |
| 20B | F-15 | 2 | 70 | Sand fill | |
| 20C | F-15 | 3 | 70 | Sand fill | |
| 21 | E-16 | .5 | >1000 | Stained sand fill over white and grey waste layers | 21A-V |
| 22 | E-16 | .5-1 | >1000 | Grey waste layer, 6 inches thick | |
| 23 | D-16 | .5 | 5 | Brown sludge, stained fill | |
| 23A | D-16 | 1 | 30+ | Stained fill | |
| 23B | D-16 | 2 | 10 | Sandy fill | |
| 24 | C-17 | .5 | 1.5 | Natural meadow soil | |
| 25 | D-17 | .5 | 2.5 | Natural soil of oil tank berm | |
| 25A | D-17 | 1 | 4 | Soil of berm | |
| 25B | D-17 | 2 | 5 | Sandy loam | |
| 25C | D-17 | 3 | 4.2 | Sandy subsoil | |
| 26 | 13 ft south of D-17 | .5 | 3 | Brown sludge, fill | |
| 26A | 13 ft south of D-17 | 1 | 2.5 | Sand fill | |
| 26B | 13 ft south of D-17 | 2 | 2.2 | Sand fill | |
| 26C | 13 ft south of D-17 | 3 | 2.2 | Sand fill | |
| 27 | E-17 | .5 | 500+ | Brown sludge waste | |
| 27A | E-17 | 1 | >1000 | Waste and fill | |
| 27B | E-17 | 2 | 480 | Waste and fill | |
| 28 | B-18 | .5 | 3 | Natural soil of River Bank | |
| 28A | B-18 | 1 | 6 | Natural soil of River Bank | |

continued

TABLE 3.2-1. (Continued)

| SAMPLE NO. | GRID LOCATION | DEPTH (ft) | OVA SCAN READING (ppm) | DESCRIPTION | GC/MS SAMPLE NUMBER |
|---|---|---|---|---|---|
| 29 | C-18 | .5 | 2.5 | Natural meadow soil | |
| 29A | C-18 | 1 | 6 | Natural meadow soil | |
| 29B | C-18 | 2 | 4 | Medium sand subsoil | |
| 29C | C-18 | 3 | 9 | Fine sand subsoil | |
| 30 | D-18 | .5 | 1.5 | Natural meadow soil | |
| 31 | E-18 | .5 | 2 | Brown sludge waste and fill | |
| 31A | E-18 | 1 | 40 | Stained fill | |
| 31B | E-18 | 2 | 300 | Stained fill | |
| 32 | 9 ft west of E-18 | .5 | 300 | Brown sludge waste and fill | |
| 33 | B-19 | .5 | 1.5 | Natural meadow soil | |
| 34 | C-19 | .5 | 1.4 | Natural meadow soil | |
| 35 | D-19 | .5 | 1.4 | Natural meadow soil | |
| 36 | E-19 | .5 | 1.6 | Natural meadow soil and fill | |
| 37 | 10 ft south of E-19 | .5 | 2 | Brown sludge waste and fill | |
| 38 | A-20 | .5 | 1.5 | Natural meadow soil | |
| 39 | B-20 | .5 | 1.5 | Natural meadow soil | |
| 40 | C-20 | .5 | 1 | Natural meadow soil | |

continued

TABLE 3.2-1. (Continued)

| SAMPLE NO. | GRID LOCATION | DEPTH (ft) | OVA SCAN READING (ppm) | DESCRIPTION | GC/MS SAMPLE NUMBER |
|---|---|---|---|---|---|
| Background 5 | Along Route 101 | .5 | 2.6 | Natural spodisol from pine woods | |

The initial high readings for Background 1 and 2 are unexplained. A resampling at a later date did not verify the initial results. There are several naturally occurring organic gas constituents which can be found in soil.

DATES OF WORK:

| Phase | Field Sample | Laboratory |
|---|---|---|
| 1 | 9/28-9/29/83 | 9/30/83 |
| 2 | 10/11-10/12/83 | 10/14/83 |
| 3 | 10/19 and 10/20/83 | 10/27/83 |
| 4 | 10/31/83 | -- |

or only a few ppm above background. Elevated readings (about 10 ppm) were generally found at locations with observable waste or stained soil.

**GC/MS Analyses**

Results of the GC/MS analyses are summarized in Table 3.2-2. Laboratory data sheets are included in Appendix F.

**Soil and Waste Descriptions**

Conditions at each sample point are summarized on Figure 3.2-1 as waste (W), fill (F) or natural, undisturbed soil (S).

**Natural Soils.** Natural soils from open meadow areas were characterized by a well developed sod and A horizon over a subsoil of fine to medium alluvial sand. Soils from wooded areas were similar, with an O horizon (duff layer) substituted for the sod. The well developed A horizons and gradual transition to subsoil indicate these soils had been undisturbed for many years. These soils typically had OVA-screen readings at or just above background (1 ppm, see below).

**Fill.** In several areas on-site, the natural soil or wastes are buried under fill material. Fill material was typically sand and gravel but in some locations included construction rubble.

**Rust Waste.** This material was commonly a reddish-brown granular material consisting of rusted metal filings chips shavings, scrap metal, abrasive and grinding wheel fragments. In places, the waste was still oily and in many locations had hardened into a slag-like material, due probably to cementing by oxides. OVA-screen readings from wastes of this type average about 50 ppm (Locations I-6, I-7, G-11, F-12, F-13 and SP-3), with a maximum of 300 ppm at Location G-11 (see Figure 3.2-2). GC/MS analyis of samples from this waste type (Location SP-3, samples 140-V and 140-SV) for volatile and semi-volatile priority pollutants

TABLE 3.2-2. RESULTS OF GC/MS SOIL AND WASTE ANALYSES AND OVA SCANS.
O.K. TOOL REPORT, DECEMBER 1983. NORMANDEAU ASSOCIATES, INC.

| SAMPLE NUMBER | AREA | GRID LOCATION | DEPTH (Feet) | OVA SCAN READING (ppm) | PARAMETER (ppb) SEMIVOLATILE | | | PARAMETER (ppb) VOLATILE | | | | | | WASTE TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | FLUORANTHENE | PHENANTHRENE | PYRENE | BENZENE | TETRACHLOROETHYLENE | TOLUENE | 1,2-TRANS-DICHLOROETHYLENE | 1,1,1-TRICHLOROETHANE | TRICHLOROETHYLENE | |
| 1C-SV | 4 | I-6 | 4.5 | 20 | | 4,000 | | | | | | | | Rust oily Rust grey |
| 1C-SV | 4 | I-6 | 4.5 | 20 | | | | | | | | | | Rust Grey |
| 14D-SV | 3 | SP-3 | 4 | 120 | T | | T | | | | | | | Rust |
| 14D-V | 3 | SP-3 | 4 | 120 | | | | | 500 | T | | | | Rust |
| 16A-V | 3 | F-14 | 1 | >1000 | | | | T | 75,000 | T | | | 840 | Stained |
| 21A-V | 2 | E-16 | .5-1 | >1000 | | | | | 100 | 50 | 1100 | | T | Brown grey white |
| 42AB-V | 1 | 15 feet south of D-20 | 1-2 | >1000 | | | | | 61,000 | | | 320 | | Stained soil |
| 41AB-V | Just North of Area 1 | D-20 | 1-2 | 60 | | | | | 1,300 | | | 1800 | | Natural meadow soil |

T=Trace
Laboratory Report is in Appendix F.

showed tetrachloroethylene at 500 ppb and a trace of toluene. This waste type was found on the surface in Area 3 or buried under fill in Area 4.

**Grey Waste.** This material is a grey, fine-grained, compact, clay-like material. An OVA-screen reading of a sample of this material (Location E-16) was over 1000 ppm. Two samples including waste of this type, which were analyzed for volatile priority pollutants (Samples 1C-V, Location I-6; Sample 21A-V, Location E-16) and one sample analyzed for semi-volatile priority polutants (Sample IC-SV, Location I-6) showed phenanthrene (4,000 ppb), tetrochloroethylene (100 ppb), toluene (50 ppb) and 1,1,1-trichloroethylene (1,100 ppb). A layer of this waste was found in Area 2 and Area 4.

**White Waste.** A white, clay-like material was found in one thin layer in Area 2. OVA-screening and GC/MS sample results from location E-16, included material of this type (see grey waste, above).

**Brown Sludge.** An oily, dark brown to black, hardened sludge was widespread on the surface of Area 2. OVA-screen readings from samples containing brown sludge were variable: Location D-16, 30 ppm; Location E-18, 300 ppm; and Location E-17, >1000 ppm. Brown sludge analysed in GC/MS sample 21A-V, Location E-16 (see grey waste, above).

**Stained Soils.** The OVA-screening of samples from Locations F-14 (Area 3) and a location 15 feet south of D-20 (Area 1) had readings over 1000 ppm in both instances. Analytical GC/MS results from samples obtained from these locations (samples 16A-V and 42AB-V) showed the highest concentrations of tetrachloroethylene (75 and 61 ppm, respectively).

**Waste Locations.**

Because of the various filling and grading operations which have taken place it is difficult to make a final determination as to the exact extent of the wastes. Company grounds east of gridline 20 and north of gridline D appear to be free from significant amounts of waste. Here, vegetation and soil were undisturbed and typical of a rich meadow. OVA-screen readings were at or just above background for samples from this area.

Area 1. Area 1 is a small patch (approximately 8 square feet) of stressed vegetation resulting from the presence of tetrachloroethylene. Detected concentrations were high, with OVA-screen readings above 1000 ppm and a GC/MS-determined concentration of tetrachloroethylene of 61,000 ppb (sample 42AB-V). Sample 41AB-V obtained at Location D-20, 15 feet north of Area 1 also had elevated concentrations of tetrachloroethylene (1,300 ppb) and 1,1,1-trichloroethane (1,800 ppb).

Area 2. Area 2 is characterized by elevated OVA-screen readings (>1000 ppm), white, grey and brown sludge wastes and solvent odors. Sand and fill material covers the waste and acts as sorbent material. Distinct waste layers were present at Location E-16: white waste between 2 and 4 inches in depth, and grey waste from 6 to 10 inches depth. Much of the surface was covered with brown sludge.

Areas 3 and 4. Areas 3 and 4 are characterized by layers of rust waste, often buried under fill, initial development of top soil, and partial revegetation. However, OVA -screen readings and results of GC/MS sampling did not indicate high levels of volatile organic compounds in rust waste, as previously noted.

At seismic shot point SP-3 (Area 3) rust waste and discolored soil were encountered down to a depth of four feet and may have continued deeper. Maximum OVA-screen readings were 120 ppm (4 foot depth). GC/MS samples 140-V and 140-SV showed trace concentrations of toluene, pyrene and fluoranthene, and 500 ppb of tetrachloroethylene.

The sample with the highest levels of volatile organic compounds (16A-V, at Location F-14) was located in Area 3, an area of stained fill. OVA-screen readings were >1000 ppm and GC/MS analysis showed a tetrachloroethylene concentration of 75,000 ppb.

In Area 4, at the intersection of gridline 6 and the Souhegan River a vertical soil profile was excavated in the stream bank. Gravel fill material was encountered from the land surface to a depth of 3 feet, with maximum OVA-screen readings of 10 ppm at 6 inches. A waste layer was found from 3 to 6 feet. Material is largely of the rust-waste type, with small pockets of grey waste. Maximum OVA-screen readings in this interval were 20 ppm. GC/MS samples 1C-V and 1C-SV showed 4,000 ppb of phenanthrene. Below the waste layer is natural fine sand, silt and cobbles.

Volume of Wastes and Affected Soil

Due to the grading and filling operations which have occurred, and the inability to profile the waste and soil conditions to full depth at each location, it is difficult to estimate the exact volume of affected soil. However, a conservative estimate for the volume of affected soil in each area can be estimated by multiplying the surface area by the estimated average thickness of the waste layer observed at each location.

Area 1: Approximate surface area = 5000 $ft.^2$
Location I-6. Approximate thickness of waste layer = 3 feet
Location I-7. Approximate thickness of waste layer = 3 feet
Average approximate thickness of waste layer = 3 feet
Approximate volume of waste and affected soil = 15,000 $ft^3$

Area 2: Approximate surface area = 15,000 $ft^2$
Location G-11. Approximate thickness of waste layer = unknown
Location F-12. Approximate thickness of waste layer = 1 foot
Location F-14. Approximate thickness of waste layer = 1.5 feet
Location SP-3. Approximate thickness of waste layer = 4 feet
Average approximate thickness of waste layer = 1.6 feet
Approximate volume of waste and affected soil = 24,000 $ft^3$

Area 3: Approximate surface area = 7,500 $ft^2$

Location F-15. Approximate thickness of waste layer = 3 feet

Location D-16. Approximate thickness of waste layer = 2 feet

Location E-16. Approximate thickness of waste layer = 2 feet

Location E-17. Approximate thickness of waste layer = 2 feet

Location E-18. Approximate thickness of waste layer = 2 feet

Average approximate thickness of waste layer = 2.2 feet

Approximate volume of waste and affected soil = 16,500 $ft^3$

Area 4: The volume of soil for this area is calculated using the following method. Liquid tetrachloroethylene was found in soil at a location 15 feet south of Location D-20. Tetrachloroethylene was also detected at Location D-20. Assuming that tetrachloroethylene dispersed uniformly to a depth of 8 feet, then the volume of affected soil is equal to the volume of a cylinder 8 feet long with a diameter of 30 feet. This would give an approximate volume of affected soil of 5,700 $ft^3$.

### 3.2.2 Subfloor Soil Sampling

Results of the subfloor soil sampling and analysis are presented in Table 3.2-3. The location of this work is shown on Figures 2.3-1 and 2.3-2. Because of the tough cobbly material, holes could be advanced to a maximum depth of only two feet.

The analytical results of the sampling confirmed the presence of tetrachloroethylene in soils beneath the floor in the vicinity of the floor drain. Levels of volatile organic compounds decrease with distance from the floor drain, but are measurable in the ppm range at a distance of at least 25 feet away (Hole C). The elevated levels of tetrachloroethylene at a depth of 2 feet indicate that that significant levels of tetrachloroethylene probably extend to a greater depth and possibly to the water table.

Assuming that the floor drain is the source (Hole A) for these concentrations, the volume of affected soil is equal to that of a

**TABLE 3.2-3. RESULTS OF THE SUBFLOOR SOIL TESTS CONDUCTED ON SEPTEMBER 14 AND 15, 1983. O.K. TOOL REPORT, 1983, NORMANDEAU ASSOCIATES, INC.**

| HOLE[1] | SOIL TYPE | DEPTH | MAX[2] OVA (ppm) | MAX[3] HNU (ppm) | SAMPLE NUMBER | RESULTS[4] (PPB) TETRACHLOROETHYLENE | TRICHLOROETHYLENE | 1,1,1 TRICHLOROETHANE |
|---|---|---|---|---|---|---|---|---|
| A | Fill-fine sand, silt, gravel, cobbles, yellow to buff | 1-2 inches | 9 | 10-50 | A1 | 12,000 | TR | TR |
| | Same | 2 feet | >1000 | 300 | A2 | 300,000 | TR | TR |
| B | Fill-fine sand silt, gravel cobbles, medium brown | 1-2 inches | 6 | 10-15 | B1 | 28,000 | - | TR |
| | Same | 1 foot 6 inches | 24 | 10-15 | B2 | 3,400 | - | TR |
| C | Fill fine to medium sand, cobbles. medium brown | 1-2 inches | -- | 0 | C1 | 1,900 | - | - |
| | Same | 2 feet | -- | 4 | C2 | 4,200 | - | TR |

[1]Locations are presented in Figures 2.3-1 and 2.3-2.
[2]ppm Methane equivalent
[3]ppm Benzene equivalent (10.2 EV probe)
[4]See Appendix F for Laboratory Data Sheets
TR = Trace

cylinder-with a radius of 25 feet (farthest known distance of affected soil), and a height of 8 feet (assumed depth of the water table). The computed volume is approximately 16,000 cubic feet.

## 3.3 WATER

### 3.3.1 Surface Water Hydrology

The major surface water feature at the site is the Souhegan River which bounds the site on the north (see Figures 1.2-1 and 1.2-2). The Souhegan River is roughly 30 to 50 feet wide with an approximately 6-foot high streambank in the vicinity of the site. The Souhegan River originates near Ashburnham, Massachusetts, flows northward to Wilton, New Hampshire, then eastward to the Merrimack River.

The nearly flat topography of the site limits the amount of surface runoff which may occur after storms and in the springtime. Surface runoff is directed primarily toward the river or into parking lot drains.

### 3.3.2 Ground Water Hydrology

Overburden Aquifer. Ground water moves in small open spaces between individual grains in the "overburden aquifer", i.e., water-bearing sediments of predominantly glacial origin. Figures 3.3-1 to 3.3-4 are water table maps of the overburden aquifer on four separate dates during the fall of 1983. The maps are based on the shallow observation wells that penetrate a few feet beneath the water table. The water table maps show that ground water flows generally in an east-southeasterly or easterly direction, while the hydraulic gradient averages .01 feet/feet and is greatest in the west.

Ground water in glacial aquifers in New England normally discharges into streams. In this instance, however, ground water is supplied (recharged) by the Souhegan River. Ground water is also recharged by precipitation on the land surface. The reversal in flow may be caused by: 1) an eastward thickening of the overburden aquifer (Figure 3.1-1), 2) by pumping water from the aquifer (Savage well, Hitchiner Manufacturing Co., Inc. well and others), or 3) both. These factors may also produce the slight downward movement of ground water toward the east-southeast. The downward movement has been detected by comparing water levels in the monitoring wells (fully-penetrating) with those in the observation wells (water table).

The coefficient of permeability[1] of materials in the overburden aquifer was determined by field testing and from sieve analyses. From the field tests, the specific capacity (SC)[2] of wells was estimated using the relationship between pumping rate (Q) and drawdown (s)[3]:

$$SC=Q/s$$

Transmissivity (T)[4] was estimated to exceed 15,000 gpd/ft for the overburden aquifer at wells M-1b and M-2 from the relationship:

$$T=SC \times 2000$$

[1]Coefficient of permeability. The rate of flow of water in gallons per day through a cross section of one square foot under a unit hydraulic gradient. Generally expressed as gallons per day per square foot (gpm/$ft^2$) or in centimeters per second (cm/sec).

[2]Specific capacity. The discharge or yield of a well expressed as a rate of yield per unit of drawdown, generally gallons per minute per foot of drawdown (gpm/ft).

[3]Drawdown. The vertical distance that water in an aquifer is lowered by pumping or draining, generally in feet.

[4]Transmissivity. Capacity of an aquifer to transmit water through its entire thickness. It is equal to the coefficient of permeability multiplied by the saturated thickness of the aquifer. Units used in this report are gallons per day per foot (gpd/ft).

A number of analytical methods were used to obtain coefficients of permeability from grain-size curves. The methods involve such parameters as uniformity coefficient, median grain-size and effective grain-size[1]. In general, the coarser the grain-size, the greater the permeability. The "effective size" is considered to be related to permeability and is the maximum diameter of the smallest 10 percent of the grains of the materials.

Figure 3.3-5 shows that the boulder zone has been rated as the most permeable unit in the overburden aquifer, having a permeability (K) of greater than 10,000 gpd/ft$^2$ (.48 cm/sec). The boulder zone was too coarse to penetrate by split-spoon methods, and thus permeability was estimated on the basis of visual soil classification. Two units, the interbedded sands and gravels and the upper till are very similar in overall grain-size and thus may have similar permeabilities. They differ in that the upper till is the more dense of the two. Thus, the interbedded unit has a permeability of 500 to 5000 gpd/ft$^2$ (.024 to .24 cm/sec) or more. The upper till permeability is 500 or less to 5000 gpd/ft$^2$.

<u>Bedrock Aquifer</u>. Unlike the overburden aquifer, the bedrock transmits ground water along discrete fractures, that is, along faults and joints. Geologic reconnaissance work has suggested fracture orientations trending N 20°-N30°E and east-west (Section 3.1.1). The spacing and orientation of fractures is generally not uniform and thus bedrock permeability tends to be highly variable. At the O.K. Tool site, bedrock can be classified as one of two kinds: 1) generally sound,

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[1] See 1) Cherry, J.A., and Freeze, R.A., 1979, Groundwater: Prentice-Hall, Englewood Cliffs, N.J.; 2) Wilson, W.E., <u>et al</u>, 1974, Water Resources Inventory of Connecticut, Part 5, Lower Housatonic River Basin, Connecticut Water Resources Bulleton No. 19: U.S. Geological Survey; 3) Thomas, M.P., <u>et al</u>, 1967, Water Resources Inventory of Connecticut, Part 2, Shetucket River Basin, Connecticut Water Resources Bulletin No. 11: U.S. Geological Survey.

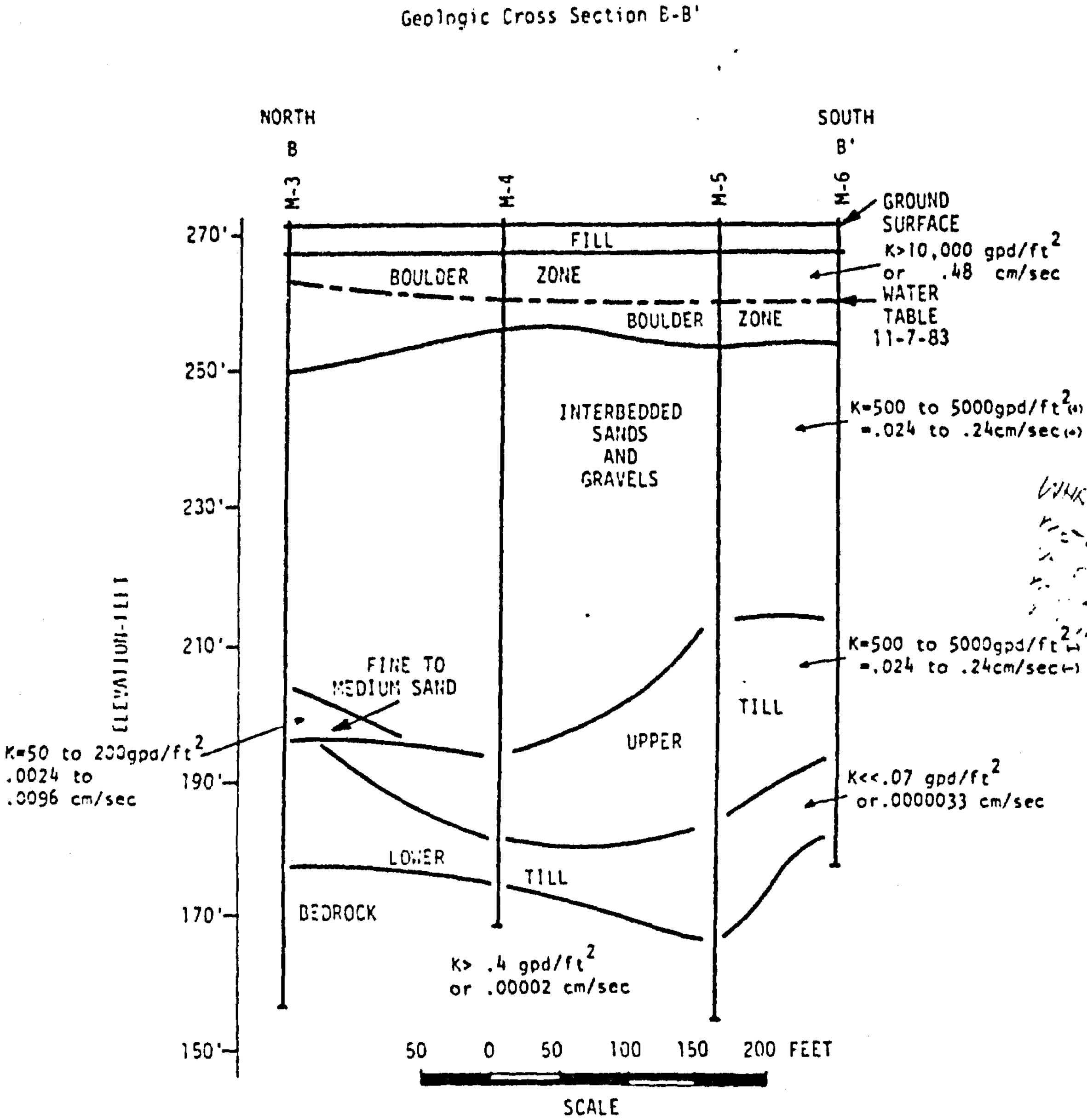


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Figure 3.3-5 Vertical Distribution of Permeability (K) within geologic cross section B-B'. O.K. Tool Report.

unweathered bedrock with widely-spaced joints with a low permeability, and 2) weathered, often "rotten" bedrock, showing vertical fault surfaces and thus having presumably higher permeabilities. Three monitoring wells penetrate into the upper part of the bedrock and afford a view of the bedrock hydrology. Figures 3.3-6 to 3.3-7 depict the potentiometric (water level elevation) surface in the bedrock and show that ground water flow is easterly with a hydraulic gradient of roughly .008 ft/ft. The results of field testing in bedrock well M-1a, completed in sound bedrock show that permeability (K) is roughly 0.4 $gpd/ft^2$ (0.00002 cm/sec).[1] Other wells, M-3a and M-5a, are completed in faulted bedrock. Permeabilities, although not measured here could be considerably higher than at M-1a.

Lower Till. Of the five drill-holes which reached bedrock, all of them encountered seven feet or more of lower till. On the basis of grain-size alone, a value of 0.07 $gpd/ft^2$ (0.0000033 cm/sec) was obtained for permeability in the lower till. The grain-size method, however, does not account for the extreme compactness of the lower till. Thus, permeabilities for the lower till are undoubtedly considerably lower than 0.07 $gpd/ft^2$.

Potential for Ground Water Exchange Between Aquifers. The thickness of lower till at all drill-hole locations suggests that the overburden and bedrock aquifers may be completely separated by the lower till. In such a situation exchange of ground water between the two

[1] See "slug" test, Lohman, S.W., 1972, "Groundwater Hydraulics":U.S. Geological Survey Prof. Paper 708, pp. 27-30.

aquifers would be very unlikely or would require many years to achieve. However, the results of laboratory analyses show a considerable presence of volatile organic compounds in one bedrock well (M-3a) indicating that ground water may have moved from the overburden to the bedrock. Head conditions at M-3 apparently favor such ground water movement (compare water level elevations for M-3a and M-3b, Appendix 3). Potential "windows" in the lower till, where permeable overburden and bedrock are in direct contact, or possible fractures in the lower till could be conduits for ground water exchange. Affected ground water could also have been carried down into the bedrock well during the drilling or well-development processes and, because of the relatively low permeability of the bedrock, has not had sufficient time to flush. Note that monitoring well M-3 is located near an area where waste was observed (Figure 3.2-1).

### 3.3.3 Ground Water Quality

O.K. Tool Company Monitoring System. The presence of volatile organic compounds in ground water underlying the O.K. Tool site is considerable. The major and most frequently detected chemical compounds are tetrachloroethylene and trichloroethylene. Elevated concentrations of 1,2-trans-dichloroethylene, 1,1,1-trichloroethane, and toluene have also been found, as well as trace levels of chloroform, 1,1-dichloroethylene, benzene, vinyl chloride, and methylene chloride.

Figures 3.3-8 and 3.3-9 depict the distribution of tetrachloroethylene that was found on November 7, 1983 in overburden and bedrock aquifers, respectively. The figures also include data of August 17, 1983 obtained from monitoring wells of the Hitchiner Manufacturing Company to the east and south (MW-1, MW-5) and provided by the WSPCC. Because water samples for wells at both O.K. Tool and Hitchiner were obtained on different dates, the data may not be directly correlated.

Concentrations of volatile organic compounds are higher in some of the wastes and affected soil than the highest concentrations detected in the ground water. These compounds may potentially migrate downward to the water table by either gravity drainage or flushing by rainfall on the land surface. Soils and wastes that contain these compounds are, therefore, potential sources of volatile organic compounds that are found in the ground water.

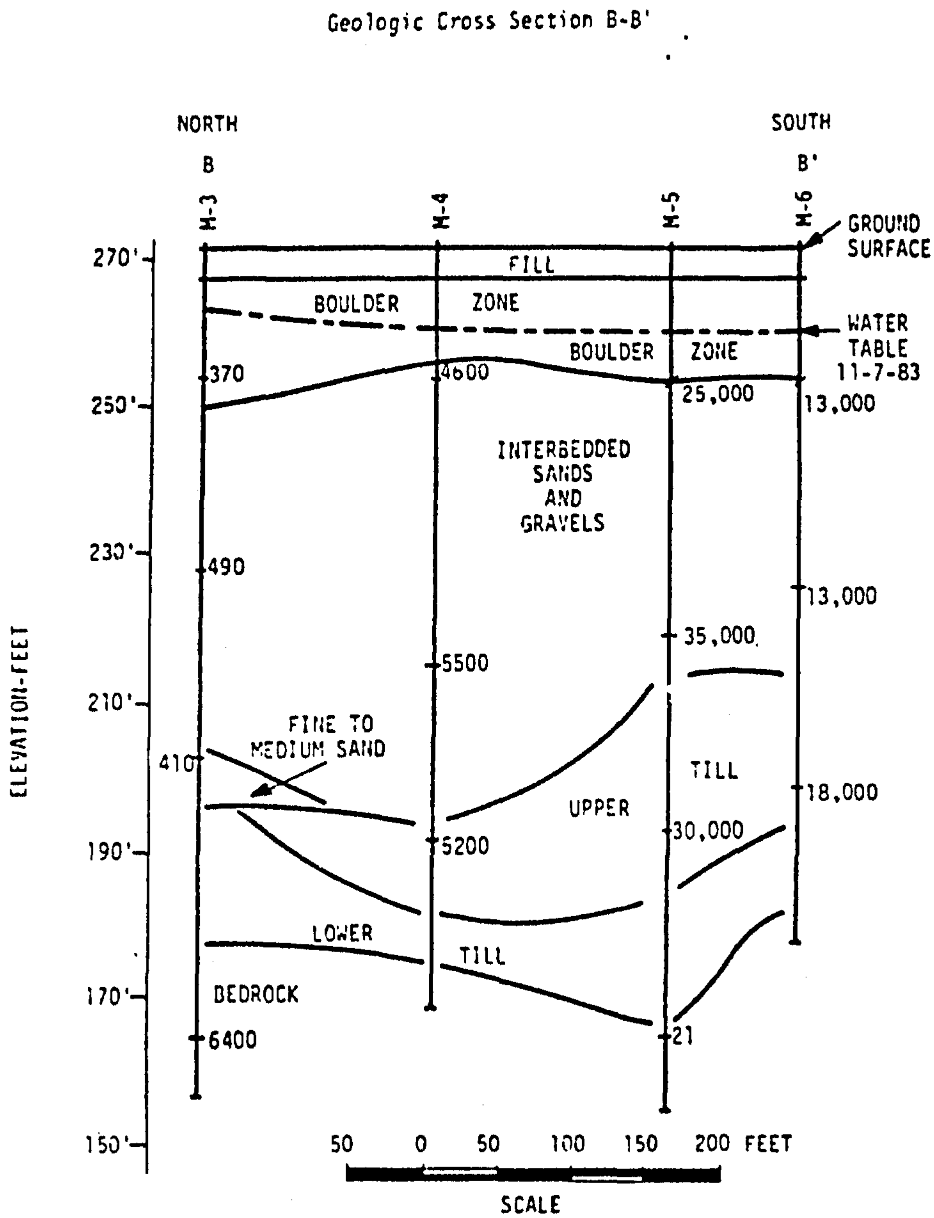
In the overburden aquifer, concentrations of up to 35,000 µg/ℓ (ppb) tetrachloroethylene and 930 µg/ℓ trichloroethylene were found on the down-gradient side of the O.K. Tool site. Up to 6400 µg/ℓ tetrachloro-ethylene was found in the bedrock aquifer. Possible explanations for the bedrock levels were discussed in Section 3.3.2.

The vertical distribution of volatile organic compounds in the ground water is shown in Figures 3.3-10 and 3.3-11. The figures indicate that the concentrations are rather evenly distributed in the overburden aquifer, but that they tend to be slightly greater in the lower two-thirds.

Estimated Ground Water Migration Rate in Overburden Aquifer. Computations based on permeability values generated during this investigation were used to estimate the time that is required for ground water (and dissolved substances) to flow in the overburden aquifer from the O.K. Tool Co. site downgradient to (1) the Savage well site and (2) ultimate discharge back into the Souhegan River east of the Savage well. The computations indicate that ground water would move at about 1.6 feet per day given the following parameters:

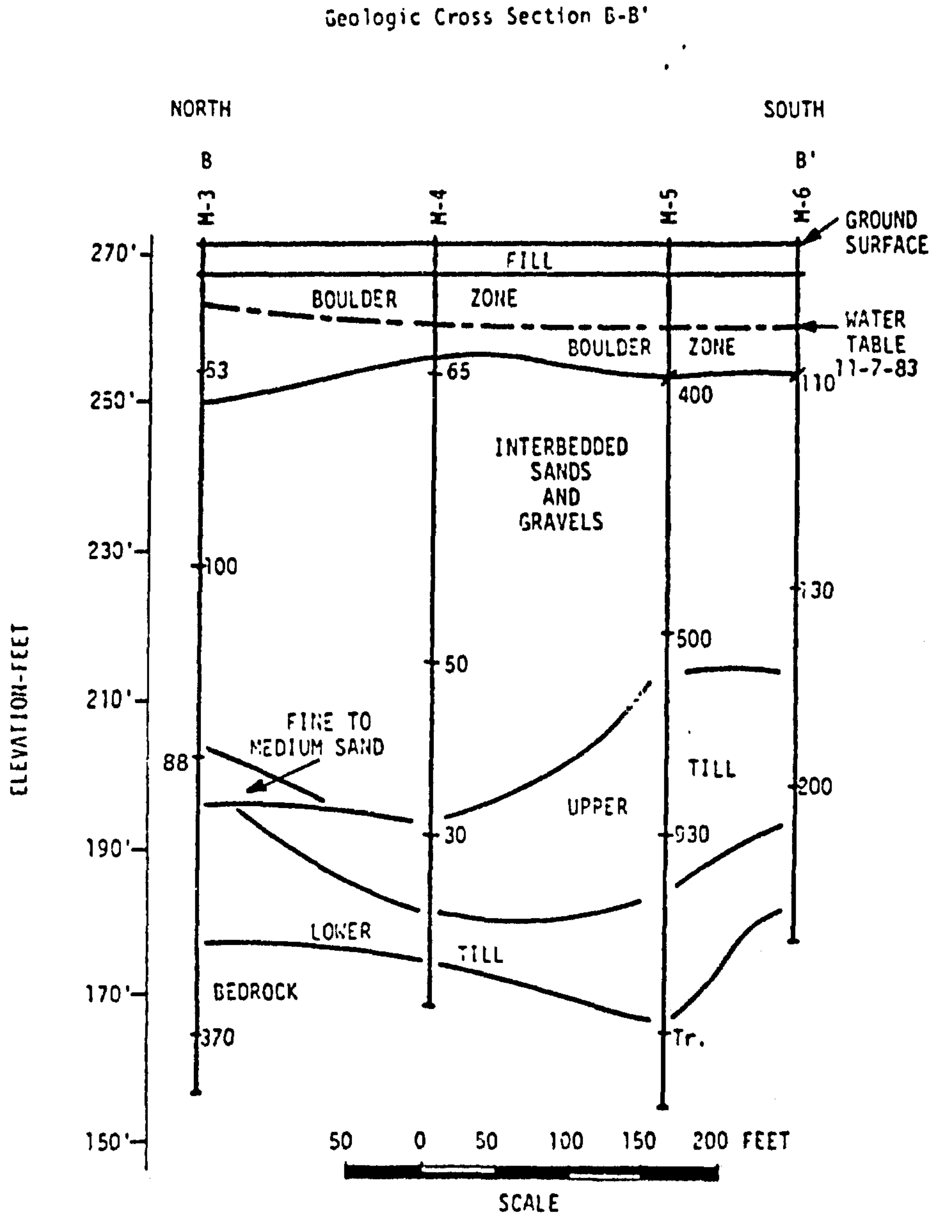
1. Hydraulic conductivity = 1000 gpm/$ft^2$
2. Gradient = 0.003 ft/ft
3. Specific yield = 0.25

At the rate of 1.6 feet per day the flow time from the O.K. Tool site to the Savage well would be about 6.3 years and about 12.8 years would be required for ultimate discharge back to the Souhegan River at an estimated point about 7500 feet from the site. This migration path would be expected in an unpumped aquifer. The migration path is undoubtedly affected by all the various pressures on the aquifer.




**nai**
**DECEMBER 1983**

Figure 3.3-10 Vertical Distribution of Tetrachloroethylene in monitoring wells on November 7, 1983 (ppb). O.K. Tool Report.

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DECEMBER 1983

Figure 3.3-11 Vertical Distribution of Trichloroethylene in monitoring wells on November 7,1983 (ppb). O.K. Tool Report.

The flow would be complex and require aquifer-wide studies for resolution.

Savage Well Contamination. The contamination found to date in the Savage Well has included high levels of five (5) organic compounds. The compound found in the highest concentrations in the Savage Well is tetrachloroethylene as shown in Table 3.3-1. The concentration of 1,1,1 trichloroethane is higher at the Savage Well than at OK Tool and the trichloroethylene concentration appears higher than would be normally expected, after migrating over 3000 feet. These two concentrations and the presence of 1,1 dichloroethane (which was not detected in soil or ground water or ever used at O.K. Tool) imply multiple contributers to the Savage Well contamination. Until a broader ground water investigation is conducted, no definitive judgements can be made relative to the sources of volatile organic compounds found in the Savage Well.

**TABLE 3.3-1. COMPARISON OF VOLATILE ORGANIC COMPOUNDS FOUND IN THE SAVAGE WELL WITH THOSE FOUND IN THE O.K. TOOL MONITORING WELLS. O.K. TOOL REPORT, DECEMBER 1983, NORMANDEAU ASSOCIATES, INC.**

| | MAXIMUM CONCENTRATIONS (ppb) | |
|---|---|---|
| | SAVAGE WELL[1] | O.K. TOOL MONITORING WELLS[2] |
| chloroform | ND | Trace |
| 1,1 dichloroethane | 53.1 | ND |
| 1,1 dichloroethylene | ND | Trace |
| methylene chloride | ND | Trace |
| tetrachloroethylene | >862.8 | 35,000 |
| toluene | ND | 19 |
| 1,2 trans-dichloroethylene | 75.9 | 270 |
| 1,1,1 trichloroethane | 343.9 | 200 |
| trichloroethylene | 468 | 930 |
| vinyl chloride | ND | Trace |

ND - Not Detected
[1]WSPCC Data, 2/3/83 and 2/15/83
[2]NAI Data, 11/7/83

# 4.0 CONCLUSIONS AND RECOMMENDED MONITORING AND REMEDIAL ACTIONS

## 4.1 CONCLUSIONS

Apparent sources of volatile organic compounds in the ground water were identified on the site by the surface waste and soil evaluation and by the subfloor drain study. An initial sampling and analyses from the 6-well ground water monitoring system shows that apparent sources of volatile organic compounds in the ground water are on the site. Specific conclusions that were drawn as a result of the investigation are as follows:

1. Two major aquifer systems underlie the O.K. Tool Company site. They include a glacial outwash sand and gravel aquifer which ranges from about 40 to 90 feet in thickness and a fractured bedrock aquifer.

2. The glacial sand and gravel aquifer is generally separated from the bedrock aquifer by a layer of dense, poorly permeable glacial till which ranges in thickness from 7 to 20 feet in the five monitoring wells which were drilled into bedrock.

3. Ground water flow under the site in the sand and gravel aquifer is in an east-southeasterly direction as shown in Figures 3.3-1, 3.3-2, 3.3-3 and 3.3-4. Much of this ground water is believed to be recharge from the Souhegan River.

4. Ground water flow in the bedrock aquifer is roughly parallel to that in the sand and gravel aquifer as shown in Figure 3.3-6 and 3.3-7.

5. The water-level (potentiometric surface) in the bedrock aquifer is somewhat lower than that of the overlying sand and gravel aquifer indicating a potential for downward movement of ground water from one aquifer to another.

6. Ground water flow computations indicate that downgradient movement in the sand and gravel aquifer is at an estimated average rate of 1.6 feet per day.

7. Analyses of water samples from the monitoring wells indicate no presence, beyond a trace, of volatile organic compounds in the two upgradient monitoring wells (M-1 and 2) and the presence of volatile organic compounds in the four downgradient monitoring wells (M-3, 4, 5 and 6).

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8. Waste materials are present on-site in an area between the main O. K. Tool Company plant building and the Souhegan River.

9. Some of these waste materials and affected soil can be considered potential sources of volatile organic compounds in the ground water.

10. NAI soil sampling and laboratory results for samples from a floor drain in the plant building indicate that this drain is a potential source of the volatile organic compounds found in the ground water.

11. Laboratory results for water samples collected by the N.H. WSPCC from a dug well in the plant building indicate a potential source of volatile organic compounds in the ground water (tetrachloroethylene and 1,1,1 trichloroethane, 2/23/83).

12. N.H. WSPCC results for Milford's Savage Well (Table 3.3-1) indicate one contaminant in the Savage well (1,1 dichloroethane) that was not detected on the O.K. Tool Company site. Two other contaminants (1,1,1 trichloroethane and trichloroethylene) were detected at higher levels in the Savage well than would be expected after a migration of some 3000 feet. This implies multiple contributers to the concentrations detected in the Savage well. An aquifer-wide ground water investigation would be needed to resolve the sources and relative contributions.

## 4.2 RECOMMENDED MONITORING AND REMEDIAL ACTIONS

From the preceding conclusions, it is recommended that the following monitoring and remedial actions be undertaken by the O. K. Tool Company.

1. Water quality monitoring for U.S. EPA priority volatile organic compounds should be continued at the O.K. Tool Company site. Samples should be collected quarterly from each monitoring well and surface water gaging station S-1. At the time of sample collection water-levels should be measured in the monitoring and observation wells.

2. Removal of waste materials from identified areas between paved areas north of the main building and the Souhegan River that are potential sources of volatile organic compounds. This task should include the following subtasks.

a. Test drilling and continuous split-spoon sampling to further define the vertical distribution of waste materials.

b. Laboratory analyses and characterization of affected soil and waste materials to indicate which are potential sources of volatile organic compounds in the ground water.

c. Removal of affected soils and waste materials that are potential sources of volatile organic compounds in the ground water.

d. Restoration of areas that have been stripped of affected soils and waste materials. This subtask should include recontouring the land surface to promote normal overland drainage, covering with topsoil, and establishing appropriate cover vegetation.

3. The affected soil beneath the floor drain at the vapor degreaser in the main plant building should be removed and disposed of properly. Selected samples should be tested in the laboratory for volatile organic compounds by GC/MS to verify that all affected soils have been removed. After laboratory verification the excavation should be backfilled with a clean granular aggregate or soils. The excavation should be capped with concrete to match the existing floor.

4. The dug well in the main plant building should be further assessed as a potential source of volatile organic compounds in the ground water. Samples of standing water and bottom sediment should be collected for laboratory analyses by GC/MS for volatile organic priority pollutants. Affected sediment and/or liquid should be disposed of in an appropriate manner. The hole should then be backfilled with clean granular aggregate or soils. A concrete cap to match the existing floor should finish this remedial action.

5. The ground water in the aquifer underlying the site could be allowed to flush clean by natural means (precipitation and infiltration from the Souhegan River). The aquifer is highly permeable and will purge itself with time. Specific hydrologic pathways would need to be investigated on an aquifer-wide basis before the effectiveness of this flushing action could be evaluated.

6. As it is clear from the data that concentrations of volatile organic compounds in the Savage Well are from multiple sources, the State agencies should use their authority to have all potential contributors conduct hydrogeological and source material investigations similar in scope to the one performed by O.K. Tool Company. The investigations should be coordinated to achieve a comprehensive and integrated profile of the entire aquifer.

# APPENDIX A

## SEISMIC REFRACTION AND GRAVITY INVESTIGATION

## REPORT OF JOHN KICK, CONSULTING GEOPHYSICIST

*Resource Analysts, Incorpora*
*Box 4778 Hampton, NH 03*
(603) 926-7

## VOLATILE PRIOTITY POLLUTANT DETERMINATION

Lab No. 2606 Analyst RDF Date Analyzed 8-29-83

EPA Method 624 [X] ASTM Method D 3781-79 [ ]

| Parameter | Sample Designation | | | |
|---|---|---|---|---|
| | 2606-5 | 2606-6 | 2606-7 | Trip Balnk |
| Acrolein | MW-3 | MW-4 | MW-5 | |
| Acrylonitrile | | | | |
| Benzene | 5 | | | |
| Bis(chloromethyl)ether | | | | |
| Bromoform | | | | |
| Carbon Tetrachloride | | | | |
| Chlorobenzene | | | | |
| Chlorodibromomethane | | | | |
| Chloroethane | | | | |
| 2-Chlorovinylether | | | | |
| Chloroforr | | | | |
| Dichlorobromomethane | | | | |
| Dichlorodifluromethane | | | | |
| 1,1-Dichloroethane | 25 | 12 | 260 | |
| 1,2-Dichloroethane | | | 8 | |
| 1,1-Dichloroethylene | | 11 | 44 | |
| 1,2-Dichloropropane | | | | |
| 1,3-Dichloropropylene | | | | |
| Ethylbenzene | | | | |
| Methyl bromide | | | | |
| Methyl chloride | | | | |
| Methylene chloride | | | | |
| 1,1,2,2-Tetrachloroethane | | | | |
| Tetrachloroethylene | 8 | 390 | >10,000 | 19 |
| Toluene | Tr | | | 47 |
| 1,2-trans-Dichloroethylene | | 8 | 1000 | |
| 1,1,1-Trichloroethane | | 63 | 1200 | |
| 1,1,2-Trichloroethane | | | | |
| Trichloroethylene | | 20 | >1600 | |
| Trichlorofluoromethane | | | | |
| Vinyl chloride | | | | |
| Method Detection Limit: | 5 ug/L | 5 ug/L | 5 ug/L | 5 ug/L |

NOTES: No entry denotes "not detected".