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NTC Great Lakes

UNDERGROUND WATER TABLE INVESTIGATION AND STUDY - BASE WIDE EXCEPT CAMP PORTER

NAVAL TRAINING CENTER
CONTRACT NO.
N62427-87-C-7743

for the
DEPARTMENT OF THE NAVY
NAVY PUBLIC WORKS CENTER
Great Lakes, Illinois

prepared by
RUN Environmental Associates, Inc
Consulting Engineers
Wheaton, Illinois

April, 1990

13

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RJN ENVIRONMENTAL ASSOCIATES, INC.

CONSULTING ENGINEERS

WHEATON, ILLINOIS

APRIL, 1990

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

April 16, 1990

Mr. Fred Estilo, P.E.
Engineer-In-Charge
Code 101B
Department of Navy
Navy Public Works Center
Building 1A
Great Lakes, IL 60088-5600

Subject: Final Report
Underground Water Table Investigation and Study
Base Wide Except Camp Porter
Naval Training Center
Great Lakes, Illinois
Contract N62472-87-C-7743

Dear Mr. Estilo:

RJN Environmental is pleased to submit twelve copies of the Final Report for the underground water table investigation and study at the Naval Training Center, Great Lakes, Illinois. It is the intent of this report to satisfy the requirements for the Underground Water Table Investigation and Study - Base Wide Except Camp Porter, as given in the scope of work for Contract No. N62472-87-C-7743.

This report contains a comprehensive overview of the behavior of the groundwater table to storm events, and its effect on the steam manholes and steam lines. Alternatives are proposed to reduce the groundwater infiltration into the steam manholes and recommendations are presented with associated cost estimates. The information in this report is based on various maps of the Naval Training Center, Great Lakes, Illinois, interviews with Naval Training Center personnel, review of previous reports, results of soil sampling and testing, and rainfall monitoring conducted during the study period.

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The review comments of Public Works Center personnel arising from the 100 Percent Report and the Revised 100 Percent Report have been addressed in this report. We wish to express our appreciation for your cooperation and request your approval of this report. Please feel free to contact RJN Environmental if additional information is required.

Very truly yours,

RJN ENVIRONMENTAL ASSOCIATES, INC.

Catherine L. Morley

Catherine L. Morley, P.E.
Project Engineer

Bruce J. Aderman

Bruce J. Aderman
Project Engineer

CLM/BJA:pgm/358C
Enclosure

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EXECUTIVE SUMMARY

Chapter I

EXECUTIVE SUMMARY

Introduction

RJN Environmental was retained by the Navy Public Work Center (PWC), Great Lakes, Illinois to perform a detailed groundwater investigation and study of the Naval Training Center, Great Lakes, Illinois (NTC), excluding Camp Porter, VA Hospital, and NTC Golf Course. The purpose of this study was to analyze the cause of the high groundwater table and to make recommendations for solutions associated with groundwater problems.

The NTC has experienced significant flooding in steam manholes and corrosion problems to underground steam lines throughout the area. The result of groundwater infiltration and consequent corrosion of the steam lines has reduced the life of the steam facilities, caused significant energy losses, and increased maintenance costs.

Methodology

Investigations included 89 soil borings to determine soil characteristics and underlying groundwater levels. Piezometer installations were monitored for response to rainfall events from which groundwater/hydrograph profiles were determined. In addition, the soils were tested for corrosion potential and a representative sample of steam manholes were inspected for construction and evidence of deterioration. Interviews were conducted with NTC personnel to determine the effect of groundwater infiltration on the steam line system and numerous atlases and earlier reports were reviewed to determine the historical development of the area.

Conclusions

1. The majority of the NTC area is constructed on fill material which overlie the relatively impermeable natural Wadsworth Till.

2. The groundwater table is seasonally variable, however with the exception of a few isolated areas, it is typically below the floor elevation of steam manholes.

3. Perched water table conditions occur throughout the NTC at or above the permeable fill/impermeable till interface. The elevation of the perched water varies from 1.5 feet to 10 feet below the ground surface and is typically five feet below the ground surface. This results in a soil classification for the design of underground steam distribution systems of Class A severe.

4. Groundwater infiltration into the steam manholes through defects such as cracked walls and pipe seals occurs as a result of the perched water table.

5. A perched water table has a more dramatic response to rainfall events than the underlying groundwater table and recharges quickly after or during rainfall events.

6. Groundwater infiltration into steam manholes results in flooding and causes humid, corrosive conditions, significant damage, and energy losses to the steam distribution system.

7. Five areas of corrosive soils were detected on Mainside. However, the variability of the soils suggests that pockets of soil of a corrosive nature are spread randomly throughout the NTC and it is impossible to predict their

location. Consequently, it is necessary to assume that all the soils and groundwater have the potential to be corrosive and to protect the structures and pipes accordingly.

8. The cost effective solution for reduction of groundwater infiltration into the steam manholes includes disconnection of floor drains and installation of sump pumps in manholes subject to surcharging from storm sewer backups through floor drains, and rehabilitation of defective manholes. The construction cost estimate (January, 1992) for the recommended improvements is $743,000 with a savings to investment ratio (SIR) of 2.17.

Recommendations

1. It is recommended that defective steam manholes be grouted to eliminate groundwater infiltration into steam manholes at an estimated cost of $545,000. (January, 1992)

2. It is recommended that floor drains be disconnected and sumps/sump pumps be installed in those steam manholes which are subject to flooding from storm sewer backups at an estimated cost of $198,000. (January, 1992)

3. In addition, all sump pumps should be maintained in good working order and check valves fitted on all discharges (where not currently installed).

4. It is also recommended that the NTC continue with the cathodic protection of the external buried lines as a suitable method of reducing the deterioration of the exterior pipe work from corrosive soils.

REPORT

Chapter II

INTRODUCTION

General Background

The Naval Training Center (NTC), Great Lakes, Illinois is located approximately 35 miles north of downtown Chicago on the shores Lake Michigan. The NTC comprises of approximately 1,820 acres and is divided into eight main subareas. The main subareas at the NTC are as follows:

1. Forrestal Village
2. NTC Golf Course 1/
3. Veterans Administration (VA) Hospital 1/
4. Halsey Village
5. Nimitz Village
6. Camp Porter 1/
7. Camp Moffett
8. Mainside

The NTC is generally bordered by the Chicago and Northwestern (CNW) Railroad on the west, the Elgin Joliet and Eastern (EJ&E) Railroad, First Avenue, and G Street on the south, Lake Michigan on the east and 24th Street, between the CNW and EJ&E Railroads, and Foss Park on the north. A location map of the Study Area is shown on Exhibit 1.

The majority of NTC is completely developed with residential housing units, apartment buildings, large sized buildings for classrooms, training, and recreation, barracks, public safety buildings, and administrative offices.

1/ Areas not studied in this report.

The remaining areas are characterized by impervious areas such as streets, sidewalks, parking lots and tennis courts and by non paved areas around buildings, park areas, open fields, ravines, drainage ditches and recreational fields. Topography varies from gently rolling hills to deep ravines and a steep bluff.

Basis of Study

RJN Environmental was retained by the NTC, Great Lakes, Illinois to perform a detailed groundwater investigation and study for the NTC excluding Camp Porter, VA Hospital, and NTC Golf Course. The purpose of the study was to determine and analyze the cause of the high groundwater table and to make recommendations for solutions associated with groundwater problems. The results of the study will be used to develop a recommended long term solution to the groundwater problem associated with utility damages and energy losses.

Utility problems identified for analysis in general occur throughout the NTC. Although the frequency of flooding and severity of the damages vary, they are directly related to groundwater infiltration. During periods of significant precipitation, varying levels of infiltration occur into steam manholes from the surrounding elevated groundwater table. From historic flooding information obtained through various interviews with NTC and Public Works Center (PWC) personnel, under certain conditions, groundwater infiltration into steam manholes can become severe enough to inundate steam lines in the manholes and backup in the steam pipe chases. Flooding results in damage to the steam lines in manholes and to steam lines outside of the manholes. Humid conditions caused by groundwater infiltration into manholes and by condensation, significantly contributes to corrosion of steam lines and appurtenances in the manholes. Recurrent flooding of the manholes has resulted in significant energy losses and expensive repairs.

Description of Study Area

The subareas included in this study are described in the following sections. Subareas were determined from NTC maps provided by the government. Subarea boundaries are shown on Exhibit 1. Topography at the NTC was determined from a United States Geological Survey (USGS) topographic map, dated 1960 with the most recent revision 1972 and from field reconnaissance. The general topography of the area has a ridge that extends along Green Bay Road at an elevation of approximately 725 feet which is the high point of the area. For the purposes of this report, all elevations will be referenced to Mean Tide, New York Harbor Datum (MTD). (0.00 Naval Training Center, Great Lakes Datum is 580.91' above MTD.) The terrain slopes to the west from this ridge to an elevation of 670 feet at the Skokie River on the western edge of Forrestal Village. From the ridge along Green Bay Road, the terrain slopes towards Lake Michigan, from an elevation of 725 feet to an elevation of 650 feet at the top of the bluff and then drops 70 feet to the Lake.

Forrestal Village

Forrestal Village is located in the southwestern portion of the NTC and is bordered by the CNW Railroad on the west, Buckley Road on the north, Green Bay Road on the east, and the EJ&E Railroad on the south and comprises 490 acres. The topography of the area is characterized by gently rolling hills. The ground falls from an elevation of 725 feet in the northeast corner of the Village to 670 feet at the Skokie River along its western edge. This corresponds to a drop to the southwest of 55 feet over 3,200 feet for an average land slope of 1.7 percent.

Halsey Village

Halsey Village is located in the northwestern portion of the NTC and is generally bordered by Green Bay Road on the west, 24th Street on the north, Lewis Avenue on the east, and Buckley Road on the south and comprises 90 acres. The topography of the area is characterized by rolling hills with a natural drainage ditch in the southern half of the area. The terrain falls from an elevation of 720 feet along the western edge of the area to 685 feet on the eastern edge of the area which corresponds to a drop to the east of 35 feet over 1,850 feet for an average slope of 1.9 percent.

Nimitz Village

Nimitz Village is located in the north central portion of the NTC and is bordered by Lewis Avenue on the west, West 15th Avenue on the north, the EJ&E Railroad on the east, and Buckley Road on the south and comprises 65 acres. Topography of the area is characterized by gradually sloping terrain which falls to the east from an elevation of 685 feet along the western edge of the area to 660 feet along the eastern edge of the area. This corresponds to a drop of 25 feet over 1,250 feet for an average slope of 2.0 percent.

Camp Moffett

Camp Moffett is located in the northeastern portion of the NTC and is generally bordered by the EJ&E Railroad on the west, West 15th Avenue extended, on the north, CNW Railroad on the east and Buckley Road on the south and comprises 60 acres. The topography of the area is characterized by gradually sloping terrain which falls 15 feet to the east from an elevation of 660 feet along the western edge of the area to an elevation of 645 feet over 1,250 feet for an average slope of 1.2 percent.

Mainside

Mainside is located in the eastern portion of the NTC and is bordered by Sheridan Road on the west, Nimitz Avenue and Foss Park on the north, Lake Michigan on the east, and G Street on the south and comprises 525 acres. The topography of the area is characterized by gently rolling hills, gradual slopes, deep ravines and a steep bluff.

Topography north of Pettibone Creek is characterized by a steep bluff along the eastern edge of the area which falls 70 feet to the east towards Lake Michigan from an elevation of 660 feet to an elevation of 590 feet over 130 feet for an average slope of 54 percent. Topography west of the bluff and north of Pettibone Creek is characterized by gently rolling hills and gradually sloping terrain which falls 25 feet to the southwest from an elevation of 670 feet at the northeast corner of Mainside to an elevation of 645 feet at the top of the ravine of Pettibone Creek over 3,100 feet for an average slope of 0.8 percent. Topography south of Pettibone Creek (Hospital Side) is characterized by gently sloping terrain, excluding the ravine from the south branch of Pettibone Creek, which falls five feet towards the south branch of Pettibone Creek from an elevation of 650 feet to an elevation of 645 feet over 1,500 feet for an average slope of 0.3 percent. The ravines along Pettibone Creek are characterized by steep slopes. The terrain falls 55 feet towards the creek from an elevation of 645 feet to an elevation of 590 feet over 130 feet for an average slope of 42 percent.

Land Use

Forrestal Village

Forrestal Village is almost completely developed and comprises single and multi-family housing units, apartments, mobile homes, elementary school, warehouses, storage tanks, administrative buildings, roads, sidewalks, and parking lots.

These areas are impervious and contribute large quantities of storm water runoff.

The remainder of Forrestal Village consists of pervious areas which contribute to groundwater recharge and comprise grass strips around buildings and paved areas, open undeveloped areas and athletic fields. The land use for the groundwater drainage area north of Forrestal Village includes the NTC Golf Course.

Halsey Village

Halsey Village is completely developed with the exception of Oaks Park in the southeast corner of the area. Halsey Village comprises single and multi-family housing units, roads, sidewalks, parking lot, and gas station at the corner of Buckley and Green Bay Roads. These areas are impervious and contribute large quantities of storm water runoff.

The remainder of Halsey Village consists of pervious areas which contribute to groundwater recharge and comprise grass strips around buildings and paved areas, open undeveloped areas and Oaks Park.

Nimitz Village

Nimitz Village is almost completely developed and comprises single and multi-family housing units, administrative buildings, roads, sidewalks, and parking lots. These areas are impervious and contribute large quantities of storm water runoff.

The remainder of Nimitz Village consists of pervious areas which contribute to groundwater recharge and comprise grass strips around buildings and paved areas, a large section of undeveloped park, and baseball field.

Camp Moffett

Camp Moffett is partially developed comprising classrooms, barracks, administrative buildings, roads, sidewalks, parking lots, and a large parking storage area. These areas are impervious and contribute moderate quantities of storm water runoff.

The majority of Camp Moffett consists of pervious areas which contribute to groundwater recharge and comprise grass strips around buildings and paved areas, and large undeveloped areas.

Mainside

Mainside is almost completely developed and comprises classrooms, barracks, administrative buildings, dormitories, residential housing, hospital, power plant, roads, sidewalks, parking lots, and large parking areas. These areas are impervious and contribute large quantities of storm water runoff.

The pervious areas which contribute to groundwater recharge are comprised of grass strips around buildings, and paved areas are as large undeveloped areas, parks, recreational and athletic fields, Ross Field and gravel parking lots.

Soils

Site reconnaissance revealed generally a gradually sloping site atop the steeply sloping shoreline of Lake Michigan. The southeast end of the NTC is deeply dissected by ravines formed by streams flowing down the side of the slope into Lake Michigan.

The majority of the NTC overlies deposits of glacial till upon which have developed the large amount of silty clay soils that are found at the NTC. Because of its clayey composition, glacial till typically produces silty clay or clayey silt soils.

The two main soil materials at the NTC are glacial till and fill. Natural soil at the NTC is considered glacial till and unnatural soil is considered fill. Glacial till is unsorted, ice-deposited sediment composed of a matrix of silt, clay, and sand. Fill material at the NTC consists of silt, clay, sand, organic material, rubble, gravel and building materials.

The majority of the NTC is overlain with non-indigenous surface materials consisting of fill material, asphalt and concrete with the remaining surface consisting of topsoil and natural glacial till. Most of the non-indigenous surface is located in Nimitz Village, Camp Moffett, and Mainside. The majority of the overlying natural soil is located in Forrestal Village, Halsey Village and in the ravines in Mainside.

Forrestal Village

The majority of Forrestal Village is overlain with fill material consisting of topsoil, organic material, silty clay, and trace sand and gravel. The remaining soil at Forrestal Village is natural soils consisting of silt loams and silty clay loams. The natural soils are classified as Morley Silt Loam, Peotone Silty Clay Loam, Markham Silt Loam, Wauconda Silt Loam, Grays Silt Loam, and the Grays and Markham Silt Loam.

The Morley, Peotone, Markham, and the Grays and Markham Series are characterized by low permeability, high available moisture content and are developed on silty clay loams. The Wauconda and Grays Series are characterized by high permeability, high available moisture content and are developed on stratified silt and sand. The Morley and Grays Series vary

from being slightly to strongly acidic. The water table may typically be found at the surface in the Spring and one to four feet below the surface the rest of the year in the Peotone, one to three feet below the surface in the Spring in the Wauconda, and at least three feet below the surface in the Morley, Markham, Grays, and Grays and Markham Series.

Halsey Village

A portion of Halsey Village is overlain with fill consisting of topsoil, silty clay, trace organic material, and trace sand and gravel. The remaining soil at Halsey Village is natural soil consisting of silt loam. The natural soil is classified as the Morley Silt Loam.

The Morley Series is characterized by low permeability, high available moisture content, slightly to strongly acidic, and are developed on silty clay loams. The water table may typically be found at least three feet below the surface.

Nimitz Village

The majority of Nimitz Village is overlain with fill material consisting of topsoil, silty clay, trace sand and organics, gravel, and cinders. The remaining soil at Nimitz Village is natural soil consisting of silt loams. The natural soils are classified as the Morley Silt Loam and the Wauconda Silt Loam.

The Morley Series is characterized by low permeability, high available moisture content, slightly to strongly acid, and are developed on silty clay loams. The Wauconda Series is characterized by high permeability, high available moisture content, slightly to medium acidic and is developed on

stratified silt and sand. The water table may typically be found at least three feet below the surface in the Morley and one to three feet below the surface in the Spring in the Wauconda Series.

Camp Moffett

The majority of Camp Moffett is overlain with fill material consisting of topsoil, silty clay, trace sand and gravel, and trace cinders. The remaining soil at Camp Moffett is natural soil consisting of silt loam. The natural soil is classified as the Wauconda Silt Loam.

The Wauconda Series is characterized by high permeability, high available moisture content, slightly to medium acidic, and is developed on stratified silt and sand. The water table may typically be found one to three feet below the surface in the Spring.

Mainside

The majority of Mainside is overlain with fill material consisting of topsoil, silty clay, trace sand and gravel, cinders, crushed limestone, building materials, and organic materials. The remaining soil at Mainside is natural soil consisting of loams, sand, and silt loam. The natural soils are classified as the Hennepin Loam, Morley Silt Loam, Beecher Silt Loam, Markham Silt Loam, Wauconda Silt Loam and Beach Sand.

The Wauconda Series is characterized by high permeability, high available moisture content, and is developed on stratified silt and sand. The Hennepin Series is characterized by moderate permeability, moderate available moisture content, and is developed on calcareous silt loam. The Morley, Beecher, and Markham Series are characterized by low permeabilities, high available moisture content and are developed on silty clay

loams. The Morley and Wauconda Series are typically slightly to strongly acid soils. The water table may typically be found one to three feet below the surface in the Wauconda, at least three below the surface in the Morley, Beecher, and Markham Series, and three feet below the surface in the Hennepin Series.

Direct observation of the subsurface soils could not be made in any area of the NTC with the exception of the ravines in Mainside. A reconnaissance of the soils exposed in the ravine between Mainside and Hospital side showed sandy soils typical of Lake Michigan deposition at the east end of the ravine. Further west and throughout the majority of the ravine typical clayey glacial till soils of the Hennepin Series were found. The transition zone between the two soil types was noted at the first major bend in the creek approximately parallel with Seventh Street.

Geology

The NTC is underlain by glacial till classified as the Wadsworth Till Member of the Wedron Formation which is located at the southern end of the Zion City Moraine of the Lake Border Morainic System. The glacial till is described as being clay and silty clay and containing shale and dolomite pebbles. A possibility of transition between the various textural units exists within the Wadsworth Till Member. Cross sections suggest that bodies of sand and gravel may separate these units, even though sand and gravel zones are relatively thin and generally local and discontinuous (Larsen, 1973).

Geology of the NTC is the result of glacial activity, erosion and deposition from Lake Michigan. The Lake Border moraines were created from a lobe of glacial ice that advanced just past the current shorelines of Lake Michigan. The moraines were formed from material deposited from the melting ice as the glaciers retreated from the area. During its retreat, ice blocked the drainage path of waters from Lake Michigan and the

levels of the Lake rose to elevations much higher than present. During this high water period, much of the area around the Zion City moraine was eroded and several sand bars and beach deposits were formed. After the final retreat of the ice, Lake Michigan drainage was restored and the waters reverted to current levels. In the process, the existing lake side bluff and beaches were formed.

The Lake Border moraines consist of poorly sorted deposits of silt and clay with occasional layers of silt or sand. This glacially deposited material is called Till. The sand deposits formed during the high water levels of Lake Michigan are referred to as the Dolton sand which belongs to the Equality Formation.

Climate

Climate at the NTC is characterized by seasonal differences in temperature and precipitation. Large variations in temperature and precipitation occur throughout the year. The summers are warm and rainy and the winters are cold and snowy.

Precipitation

Precipitation at the NTC occurs as rain, hail, sleet, and snow. Average annual precipitation for northeastern Illinois measured at O'Hare International Airport is 35.4 inches for the period 1958 through 1987, expressed as water equivalent. Precipitation varies from trace accumulations, to high intensities with long and short durations. The most significant periods of runoff typically occur in the Spring during the snow melt, and during high intensity rainfall events.

Temperature

Temperature at the NTC varies daily and seasonally. The average temperature for northeastern Illinois for the period 1958 through 1987 is 49° Fahrenheit as measured at O'Hare International Airport. Average monthly temperatures vary from a low of 20° Fahrenheit in January to a high of 73° Fahrenheit in July.

A summary of average monthly temperatures and precipitation is given in Table II-1.

Table II-1

AVERAGE MONTHLY TEMPERATURE AND PRECIPITATION 1/

O'HARE INTERNATIONAL AIRPORT, ILLINOIS

Month	Temperature (°F)	Precipitation (Inches)
January	20	1.6
February	26	1.4
March	36	2.7
April	49	3.8
May	59	3.2
June	68	3.9
July	73	3.7
August	72	3.9
September	65	3.8
October	53	2.3
November	40	2.6
December	27	2.4
Average Annual	49	35.4

1/ Averages for years 1958 through 1987.

Chapter III

DATA COLLECTION

Introduction

Data collection consisted primarily of subsurface investigations. The purpose of data collection was to obtain background information necessary to determine the causes and sources of groundwater problems at the NTC and the associated effect on existing utilities, particularly the corrosion of underground steam and condensate lines. In general, data collection consisted of review of available mapping, review of previous studies and reports, personnel interviews, field meetings and reconnaissance, utility inspection and survey, and soils and hydrogeologic investigations.

Existing Maps

Several types of base maps were provided by Navy Public Works Center (PWC) personnel to be used in the subsurface study. These included topographic maps, utility maps for steam lines (HTHW), and atlases of sanitary sewers, storm sewers, and water mains. Proposed Master Plan maps and Master Plan Demolition maps were also provided.

Topographic Maps

The PWC provided a copy of an undated topographic map of the area in the vicinity of Building 5. The map is plotted with five foot contour intervals. The map indicates the original topography prior to the construction of Building 5. Two United States Geological Survey (USGS) topographic maps of the Illinois-Wisconsin, Waukegan Quadrangle were obtained from

outside sources. One of these topographic maps is dated February, 1906 and reprinted in 1939. The contour interval is 10 feet and the scale is one inch equals one mile. The other topographic map is dated 1960 and photo revised in 1972. The contour interval is 10 feet and the scale is one inch equals 2,000 feet. The topographic maps show building, streets, spot elevations, railways and waterways. The maps were used to determine surface slopes and to estimate areas of fill as the region has been developed over the years.

Utility Maps

The utility maps obtained from the PWC were used to locate isolated areas of fill material, potential problem areas with conflicting utilities, areas possibly subject to surface flooding, and to develop an inspection program for the steam manholes.

Master Plan Maps

The master plan demolition maps provided by the PWC were used to evaluate potential areas of fill created by the demolition of the buildings and the resulting impact on the water table. The proposed master plan maps were used to determine the increase in the impervious area created by the new construction. The master plan demolition maps latest revision was in June, 1987 and the proposed master plan maps latest revision was in November, 1988.

Historic and Future Development

Historical development of the NTC was researched to determine any topographic changes from the previous natural terrain. Future development of the watershed was also researched to determine if this would have any significant impact on existing groundwater conditions.

Historic Development

Historical development of the NTC was researched through interviews with NTC personnel and review of old topographic and utility maps.

Forrestal Village The 1908 USGS topographic map shows Forrestal Village as undeveloped. The area sloped from an approximate elevation of 730 feet at the northeastern corner of the Village to an elevation of 670 feet at the southwest corner of the Village adjacent to the Skokie River. Both sides of the Skokie River are shown to be marshy areas at an approximate elevation of 675 feet. The 1960 USGS topographic map shows essentially the same elevation and slope. The 1960 map does indicate an extensive area of fill on both sides of the river to an approximate elevation of 680 feet. The 1960 map also indicates a more gradual sloping of the land from an elevation of 725 feet at the northeast corner to 670 feet at the southwest corner.

Halsey Village The 1908 USGS topographic map shows Halsey Village as undeveloped. The area sloped from an elevation of 720 feet at the southwest corner of the area to an approximate elevation of 675 feet at the northeast corner. The map also indicates a drainage way across the northwest corner of the area and another drainage way in the southeast corner. The 1960 USGS topographic map shows the area being developed. A review of the 1960 map shows basically the same elevation and slope as the 1908 map. The 1960 map does indicate that the northeast corner of the area and the drainage way in the northwest corner have been filled. The 1960 map also indicates a more gradual sloping of the land from an elevation of 719 feet at the southwest corner to an approximate elevation of 680 feet.

Nimitz Village The 1908 USGS topographic map shows Nimitz Village as undeveloped. The area sloped from an elevation of 700 feet at the southwest corner of the area to an elevation of 660 feet at the northeast corner. A drainage way is also indicated on the map. The 1960 USGS topographic map shows the area being developed sometime between 1960 and the photo revision of 1972. A review of the 1960 map shows basically the same overall elevation and slope. The 1960 map also indicates that the drainage way has been filled and the area is shown to have a gradual slope. The area slopes from an approximate elevation of 695 feet at the southwest corner to an elevation of 660 feet.

Camp Moffett The 1908 USGS topographic map shows Camp Moffett as undeveloped. The area sloped from an approximate elevation of 665 feet at the southwest corner of the area to an approximate elevation of 645 feet at the northeast corner. The 1960 USGS topographic map shows the area to be developed and has a relatively constant slope. The area is shown to be sloped from an approximate elevation of 665 feet at the southwest corner to an elevation of 650 feet at the northeast corner.

Mainside The undated topographic map provided by the PWC indicates an extensive area of fill in the area around Building 5. A drainage way is shown on this map crossing the area to the east and north and is tributary to Pettibone Creek. The 1908 USGS topographic map shows the area near Building 5 to be filled approximately 20 feet. The 1908 map also shows Mainside being partially developed with the development concentrated in the southern half of the area. The Camp Barry and Hospital Side areas are shown to be relatively flat with an average elevation of 645 feet, excluding the ravines. The remainder of Mainside, north of Pettibone Creek, is shown to be sloping from the northeast to the southwest from an approximate elevation of 670 feet at the northeast corner of Mainside along

the bluff to an approximate elevation of 640 feet at the top of the ravine of Pettibone Creek. The 1960 USGS topographic map shows Mainside to have the same basic slopes and elevations. The 1960 map indicates a more gradual sloping of the land.

Future Development

Future development of the NTC was determined through review of maps provided by PWC personnel. The proposed master plan maps were used to determine new construction and the proposed master plan demolition maps were used to determine demolition. The proposed master plan demolition maps were most recently revised in June, 1987 for Forrestal Village, Halsey Village, Nimitz Village, Camp Moffett, and Mainside. The proposed master plan maps were most recently revised in June, 1987 for Forrestal Village, in November, 1988 for Mainside, and June, 1989 for Halsey Village, Nimitz Village and Camp Moffett.

A review of the master plan maps, project demolition of approximately 850,000 square feet of buildings and project new construction of approximately 1,075,000 square feet. Since planned new construction is greater than proposed demolition, there will be an increase in impervious area, and the proposed future development will have little appreciable effect on groundwater levels.

Review of Previous Reports

Previous engineering reports were used to collect background information on hydrogeology of the NTC.

Engineering Enterprises prepared a report in 1982 on the steam distribution system for Camp Porter entitled "Underground Heat Distribution System Classification - Camp Porter and Camp Moffett, Great Lakes, Illinois". This report includes a soils map, a map evaluating the depth to groundwater, and a soil corrosivity study. The report concludes that the majority of

Camp Porter has an underground water condition classification of Class A-Severe. This means that the water table is expected to be frequently above the bottom of the system, or the water table is expected to be occasionally above the bottom of the system and surface water is expected to accumulate and remain for long periods in the soil surrounding the system. The report also concludes that the soil is corrosive.

Donohue & Associates prepared a report in August, 1989 to study groundwater levels at Camp Porter entitled "Planning (Pre-Design) Study, P-378 Storm Sewer Underdrains - Recruit Training Area (Camp Porter), Naval Training Center, Great Lakes, Illinois". Several surface and subsurface investigations were performed to investigate groundwater levels at Camp Porter. The report concludes that groundwater seeps into steam manholes from the surrounding elevated water table resulting in significant damages and energy losses. The report also concludes that the storm sewer system does not have a significant impact on groundwater levels and precipitation is the cause of the high groundwater table at Camp Porter. Donohue & Associates's recommendation is to waterproof the steam manholes by pressure grouting at an estimated cost of $430,000.

Donohue & Associates also prepared a storm sewer study in July, 1989 for the NTC, entitled "Comprehensive Stormwater Analysis and Preliminary Design, Naval Training Center, Great Lakes (Basewide Except Camp Porter)". The storm sewer system, Pettibone Creek and the Skokie River watersheds were analyzed to investigate flooding problems at the NTC. Several areas were identified as major flooding areas. Six major capital improvement projects were recommended to solve the major surface flooding problems at the NTC at an estimated cost of $1,655,000.

Historical Surface Water Flooding and Groundwater Problems

Several NTC employees were interviewed to obtain historical information of groundwater problems and related surface water flooding to identify areas of concern, and to help identify problem areas and potential sources and causes of problems associated with groundwater throughout the NTC. The following employees were contacted.

Mr. Brad Baley, PWC Supervisory Utilities Engineer
Mr. Bob Grulke, PWC Utilities Civil Engineer
Mr. Jason Kang, PWC Civil Engineer
Mr. John Peterson, PWC Utilities Engineering Technician
Mr. Chester Chase, PWC Pipe Fitter

Mr. Mike Wierzbicki, foreman for the Douglas and Company, piping contractors, Skokie, Illinois, was also interviewed during one of the site visits.

Historical Surface Water Flooding

Information of surface water flooding was obtained from interviews and review of the 1989 Donohue & Associates stormwater report. Eleven areas were described in the 1989 Donohue & Associates report as major flood prone areas. A description of these areas is given in Table III-1. Installation of the Bronson Avenue relief storm sewer has solved the flooding problems to date at Constitution Field and along Bronson Avenue corresponding to Area No. 1, Area No. 4 and Area No. 10 on Table III-1.

Historical Groundwater Problems

High water tables relative to the steam distribution system have been experienced at the NTC. Steam manholes have experienced recurrent flooding from groundwater infiltration during and immediately after rainfall events of varying

Table III-1

FLOOD-PRONE AREAS
FROM 1989 DONOHUE & ASSOCIATES STORM WATER STUDY

Area No.	Description and Location
1	Bronson Avenue - Street flooding with westbound flow from MacDonough Street to Sampson Street. 1/
2	Basement and loading dock area of Building 230 floods.
3	Sampson Street - Street flooding from Building 332 to Ross Field.
4	Corner of Bronson Avenue and Isherwood - Street floods to curb depth, flow direction not visible. 1/
5	Flooding at southwest corner of Ross Field and street flooding at the intersection of Decatur Avenue and Sampson Street.
6	Buildings 142 and 143 have first floor water entry.
7	Cluverius Avenue - Street flooding to curb depth, mainly west of Building 332 extending to the 22nd Street entry gate. Very slow drainage once ponding occurs.
8	Courtyard of Building 38-H floods.
9	Flooding along Ziegemeier Road north of Building 11.
10	Flooding at southwest corner of Constitution Field. 1/
11	Flooding where 10 by 6 foot box culvert from North Chicago changes to twin 48 inch conduits.

1/ Eliminated by installation of Bronson Avenue Relief Storm Sewer.

intensities and duration. The water table above the impervious layer of glacial till increases dramatically in response to rainfall, subsequently creating a perched water table situation.

Steam Manhole Flooding

The rise in the water table which is directly related to precipitation, contributes to the flooding of steam manholes. Direct precipitation through open grate covers and storm sewer backups through floor drains connected to the storm sewer may also contribute to the flooding of steam manholes.

It has been observed that the worst flooding occurs during and/or immediately following heavy rainfall events. Infiltration into manholes is attributed to defects in the manhole structure through cracks, holes in the walls and defective pipe seals. Some of the manholes have open grate covers which allow direct precipitation to enter the manhole. Flooding also occurs through floor drains that are connected to the storm sewer system. Problems have been aggravated by the failure of sump pumps. These failures have been attributed to the build-up of lime deposits in the steam ejector sump pumps and power failures in the electric sump pumps.

Recurrent flooding of the steam manholes has resulted in extensive damage to the steam lines in the manholes and to the underground steam lines. Damage to the underground steam lines is concentrated, but not limited to, within 15 feet of the manhole. Corrosion of the steam lines and the resulting reduced facility life has been the most serious problem caused by the flooding because it has resulted in significant energy losses and expensive repairs to the system.

Cathodic Protection

Based on interviews with NTC personnel, it was determined that cathodic protection has been installed for the last 10 to 12 years. The type of cathodic protection used at the NTC is the Sacrificial Anode System. Anodes are buried along the length of the steam lines and the anodes are "sacrificed" instead of the steam lines deteriorating.

Approximately 60 percent to 70 percent of the underground steam lines have cathodic protection. At present, cathodic protection seems to be effectively combating deterioration of the underground steam lines. Excavation and inspection of the steam line between Manholes 246 and 106 indicates that cathodic protection is operating properly. The steam line was installed in 1985 with cathodic protection and shows no sign of deterioration. Currently, all new underground steam line installations are protected with cathodic protection.

Hydrogeologic Field Investigations

Hyrogeologic field work included the drilling of 89 soil borings, including the installation of 25 piezometers. Fifteen (15) infiltration tests were performed using the double ring method or the auger hole method and 10 slug tests were conducted to determine field permeability in the piezometers. Locations of the field investigations are shown on Exhibit 2, Exhibit 3 and Exhibit 4.

Soil Borings

Locations of the soil borings were made in accordance with the scope and direction of the project as well as general instructions from the NTC. Locations of the soil borings are shown on Exhibit 2, Exhibit 3 and Exhibit 4. The primary instruction from the NTC was that 75 percent of the work be

conducted in Mainside and the remaining 25 percent be divided between the residential areas. The number of soil borings and piezometers were allocated accordingly. The locations were then assigned to give random coverage of the NTC that would provide information representative of conditions throughout the NTC to a depth of 25 feet. The twenty deep borings were first distributed across the site on a roughly drawn grid system that was adjusted for the non-linear boundary lines. The 25 piezometers were similarly placed on the grid and then the 44 shallow borings were assigned locations to fill in the remaining areas of the grid.

In addition to achieving random coverage throughout the NTC, boring locations were also selected to monitor the difference between the soils near steam lines and vaults and soils that were distant from the steam distribution system. Approximately 50 percent of the borings in each of the three categories were placed near various portions of the steam distribution system and the remaining 50 percent were located in neutral areas that were not affected by the steam distribution system.

Piezometers

The 23 piezometers were constructed of either 1.0 or 1.25 inch diameter flush joint Schedule 40 PVC pipe and screen. Locations of the piezometers are shown on Exhibit 2, Exhibit 3 and Exhibit 4. The screens were either 2.5 or 5.0 feet in length and had 0.010 inch machine cut slots. The length of the screen was dependent on the thickness of the soil layer being monitored by the piezometer. Generally a 5.0 foot screen was used unless the shorter screen was found to be adequate. The annular space around the screen was filled with a uniformly graded, coarse grained sand that is 98.1 percent pure silica dioxide (SiO_2). A grain size analysis of the sand shows that 98.2 percent of the sand is retained on the Number 20 Sieve.

Overlying the sand, a bentonite seal was placed to the ground surface. The seal consisted of chips of bentonite placed in the borehole and hydrated to form a dense, yet plastic seal. Five piezometers will remain as permanent features by the placement of a steel protective cover over the PVC pipe and by imbedding the cover in the bentonite seal material. An area 2.0 - 3.0 feet in depth will be excavated around the piezometer and refilled with concrete to secure the piezometer and cover.

Hydrogeologic Data Collection

The soil borings were made according to currently recommended American Society for Testing and Materials (ASTM) procedures. They were advanced by either solid or hollow stem auger methods. The soil samples were obtained using split spoon methods on 2.5 foot intervals for the soil borings and continuous intervals for the piezometer borings. These intervals were used to provide economically detailed stratigraphic information of the subsurface soils. Continuous soil sampling in the piezometers was required to identify all layers of water bearing soils no matter how small in order to determine the correct portion of the soil for the piezometer to screen. A field log of each boring was prepared as the drilling was performed. The boring log contains the drilling and sampling intervals, the drilling data pertinent to the samples and the soil descriptions. A copy of each boring log is included in the Testing Service Corporation (TSC) report presented in Appendix A. The samples obtained from the soil borings were examined and described in the field, and representative portions were placed in glass jars and returned to laboratory.

Soil Classification

The soil descriptions were verified from laboratory tests for permeability, grain size, and Atterburg Limits, and Unified Soil Classifications were assigned to the samples. Results of the laboratory tests for grain size, Atterburg limits, and soil classifications are presented in the TSC report in Appendix A. Representative samples of the fill material, the silty clay till soils, and the sandy soils were selected for additional testing. Twenty five samples were tested for moisture content and Atterburg limits. Fifteen of these samples were also tested for permeability by the triaxial laboratory procedure and also subject to grain size analysis. An additional 10 samples of sandy soils were selected for permeability testing by the constant head laboratory method and were subject to sieve analysis to determine the grain size distribution.

Laboratory Permeability Tests

Whenever possible, samples selected for permeability testing were taken from the soil layers that were screened by the piezometers. This was to effect a correlation between the laboratory results and those obtained during field testing. If those samples were not available or were not appropriate for laboratory testing, then a representative sample of that soil from another boring was used. It was also a goal of the testing program to include representative samples of all the different soils found in the borings. Nine samples of the fill material were selected; thirteen samples of the silty clay till soils were used; three samples of silty soils from the glacial till were tested and ten samples of sandy soils either from layers of sand within the glacial till or from deposits formed by the past high water levels of Lake Michigan. The results of the laboratory permeability tests are given in Table III-2 and Table III-3.

Table III-2

LABORATORY PERMEABILITY TESTS ON COHESIVE SOILS 1/

BORING NO.	LOCATION	DEPTH (feet)	PERMEABILITY (cm/sec)
1	Forrestal Village	2-4	1.09×10^{-8}
5	Forrestal Village	6-7.5	2.44×10^{-8}
14	Nimitz Village	4-6	1.21×10^{-8}
17	Halsey Village	0-2	4.29×10^{-8}
25	Mainside	2-4	7.29×10^{-8}
35	Mainside	2-4	3.20×10^{-8}
39	Mainside	2-4	1.02×10^{-7}
43	Mainside	0-1.5	2.13×10^{-8}
54	Mainside	6-7.5	3.57×10^{-6}
63	Mainside	3.5-5	4.27×10^{-7}
80	Mainside	3.5-5	7.47×10^{-9}
83	Mainside	1-2.5	6.69×10^{-9}
85	Mainside	3.5-5	9.28×10^{-7}
84	Mainside	18-20	2.28×10^{-8}
89	Mainside	1-2.5	7.26×10^{-8}

1/ Performed by the Triaxial Method.

Table III-3

LABORATORY PERMEABILITY TESTS ON NON-COHESIVE SOILS 1/

BORING NO.	LOCATION	DEPTH (feet)	PERMEABILITY (cm/sec)
7	Forrestal Village	0-4	6.55×10^{-4}
12	Nimitz Village	4-7	2.11×10^{-4}
46	Mainside	13.5-15	3.67×10^{-4}
62	Mainside	18.-22.5	2.61×10^{-3}
69	Mainside	6-7.5	2.46×10^{-4}
82	Mainside	11-13	8.99×10^{-5}
86	Mainside	8.5-12.5	3.26×10^{-4}
88	Mainside	13.5-15	3.00×10^{-4}
89	Mainside	6-7.5	3.15×10^{-4}
91	Forrestal Village	13.5-15	5.24×10^{-4}

1/ Performed by the Constant Head Method.

Field Permeability Tests

Field permeability tests involved the measurement of the permeability of the soils being monitored by the piezometers. The rising head slug method was used for these tests. The procedure was performed in 10 piezometers, selected at random. The test procedure consisted of either bailing the piezometer dry or removing as large a volume of water as was possible in a very short period of time, the amount of which was controlled by the recharge rate of the water in the soil layer being monitored, and then measuring the amount of water re-entering the piezometer at a series of timed intervals. The permeability was then calculated using a formula for a well point-filter in uniform soil that was developed by Hvorslev. The results of the slug tests are given in Table III-4.

Another field permeability test may be performed using the borehole method. The borehole method is designed to be performed in saturated soil to obtain a true permeability rate. However, a saturated condition was not obtained because the water table elevation at the test sites was never high enough to fully saturate the soil. Therefore, the borehole method measured in actuality an infiltration (percolation) rate.

Field Infiltration Tests

Ten of the shallow borings were selected at random for field tests using a borehole method. At the test locations, a 1.5 inch diameter Schedule 40 PVC pipe with an attached 5.0 foot screen was placed in the completed borehole. A coarse grained sand was placed in the annular space around the screen and a bentonite seal was placed atop the sand in the uppermost 1.0 foot of the borehole. This created in each of these 10 borings a 5.0 foot section of soil in which to measure water movement. The results of the borehole tests are presented in Table III-5.

Table III-4

FIELD PERMEABILITIES FROM SLUG TESTS

BOREHOLE NO.	LOCATION	TEST INTERVAL (feet)	PERMEABILITY (cm/sec)
5	Forrestal Village	1.5 - 7.5	9.70×10^{-9}
69	Nimitz Village	4.6 - 9.6	5.70×10^{-6}
72	Halsey Village	10.5 - 13.0	1.83×10^{-8}
74	Mainside	5.0 - 10.0	3.64×10^{-8}
76	Mainside	4.8 - 8.0	2.70×10^{-7}
80	Mainside	7.0 - 10.0	5.70×10^{-7}
82	Mainside	9.5 - 12.0	4.99×10^{-6}
83	Mainside	8.8 - 12.0	1.39×10^{-7}
88	Mainside	12.0 - 19.0	1.75×10^{-6}
91	Forrestal Village	11.0 - 16.7	4.72×10^{-6}

Table III-5

INFILTRATION RATES FROM BOREHOLE TESTS

BORING NO.	LOCATION	DEPTH (feet)	PERCOLATION RATE (cm/hour)	SOIL TYPE
11	Forrestal Village	1.0-6.0	0.69	Fill/Silty Clay
14	Halsey Village	1.0-6.0	0.60	Fill
35	Mainside	1.0-6.0	5.40	Fill/Silty Clay
36	Mainside	1.0-6.0	5.63	Fill/Silty Clay
41	Mainside	1.0-6.0	> 80.00 1/	Fill
43	Mainside	1.0-6.0	15.20	Fill/Silty Clay
66	Forrestal Village	1.0-6.0	1.61	Fill/Sandy Clay
21	Mainside	1.0-6.0	0.30	Silty Clay
25	Mainside	1.0-6.0	0.52	Silty Clay
12	Nimitz Village	1.0-6.0	44.11	Sands

1/ Too fast to measure, possibly adjacent to a hole or conduit.

Infiltration was measured at the ground surface using the double ring infiltrometer method. These tests were conducted in accordance with ASTM procedure D 3385-88. Two steel rings 12 and 24 inches in diameter were used. A water supply tank with a capacity of 10.3 liters was used for the smaller inner ring while a tank with a 25.5 liter capacity was used for the annular space in the large ring. Both tanks had graduated sight tubes for measurement of the water used during the test. The water level in both rings was held at a constant reading during each of the tests. The levels were generally between 12 and 14 inches for all of the tests. The total volume of water used during each test was calculated and divided by the total area of both the inner ring and the annular space in the large ring. The infiltration rates determined by the double ring method are vertical infiltration rates. The results of the double ring infiltrometer tests are given in Table III-6.

Corrosion Tests

Fifteen samples were selected for corrosion potential testing based on random representative samples from the entire site. The samples were all taken from a depth of approximately 4.0 feet which is the depth at which, it is anticipated, the steam pipes are buried. The samples were subjected to a series of tests including pH, resistivity, sulfide content and oxidation-reduction potential.

Rainfall Data

Rainfall data was obtained form the rain gauge installed near the pump house of the Sewage Containment Facility in the southwestern corner of Forrestal Village at the NTC. Rainfall was continuously monitored to the nearest 0.01 inch. The rain gauge was serviced and checked once a week during the study period. A summary of the rainfall data is given in Table III-7.

Table III-6

INFILTRATION RATES FROM DOUBLE RING INFILTROMETER TESTS

TEST NO.	LOCATION	INFILTRATION RATE INNER RING (cm/hour)
1	Forrestal Village - Meridian	25.75
2	Forrestal Village - Alabama	14.60
3	Mainside - Evans	8.11
4	Mainside - Isherwood	0.00 1/
5	Mainside - Camp Barry	11.93

1/ Result considered unreliable owing to presence of frozen ground.

Table III-7

RAINFALL DATA

Precipitation Date		Amount (inch)	Precipitation (type)
1989			
November			
	13	0.20	rain
	15	1.23	rain
	17	0.05	rain
	21	0.50 1/	snow
	27	0.07	rain
	28	0.05	rain
December			
	29	0.03 1/	snow
	30	0.02 1/	snow
	31	0.02 1/	snow
1990			
January			
	2	0.05	rain
	3	0.02	rain
	4	0.39	rain
	8	0.06	rain
	16	0.07	rain
	17	0.18	rain

1/ Equivalent rainfall amount.

When unreliable results were encountered, rainfall data was obtained from the North Chicago Wastewater Treatment Plant.

Groundwater Level Data

Groundwater level data was obtained from the 25 piezometers located throughout the NTC including piezometers installed under previous contracts at Camp Porter and at Building 11. Groundwater level readings were taken during or immediately after rainfall events, weekly or as required. Readings began in the middle of November, 1989 and continued through January, 1990. Depth to water level readings for December 21, 1989 are shown on Exhibit 5, Exhibit 6 and Exhibit 7. These readings were used to develop the groundwater elevation maps. Groundwater elevations are shown on Exhibit 8, Exhibit 9, and Exhibit 10. Typical groundwater elevations at Camp Porter are shown on Exhibit 11. These readings were made on May 15, 1989 and the exhibit is taken from the Donohue & Associates report of August, 1989. Precipitation and water level hydrographs are shown on Exhibit 12 through Exhibit 24. Water level data collected during the study period is presented in Appendix B.

Field Surveys

Steam Manhole Inspections

Inspections were performed on 40 of the 267 (15 percent) steam manholes located at the NTC, excluding Camp Porter. Locations of the steam manhole inspections are shown on Exhibit 2, Exhibit 3, and Exhibit 4. A comprehensive manhole inspection was performed to locate potential sources and/or causes of groundwater infiltration which result in energy losses and damage to the steam distribution system. Depth of the manholes was also measured and compared to the depth of the surrounding water table. Observations during the manhole inspections included, but were not limited to the following:

1. Manhole number and location.
2. Cover type and type of venting.
3. Structural condition and construction type.
4. Evidence of surcharging.
5. Depth
6. Type of drainage (sump pump or floor drain)

Steam manhole inspection forms collected during the study period are presented in Appendix C. The summary of the steam manhole inspections are given in Table III-8.

Elevation Survey

An elevation survey was performed and ground elevations were obtained at all piezometer locations and all top of slab elevations of the inspected steam manholes. Bench mark locations and elevations were provided by PWC personnel. All elevations were recorded as NTC datum and converted to Mean Tide, New York Harbor Datum. Floor elevations of the inspected steam manholes are shown on Exhibit 8, Exhibit 9, and Exhibit 10 and can be compared with groundwater contours on these exhibits.

Table III-8

SUMMARY OF STEAM MANHOLE INSPECTIONS

STEAM MH NO.	LOCATION	EVIDENCE SURCHARGE	SUMP PUMP OPERATIONAL	FLOOR DRAIN	DEPTH
003	Forrestal Village			YES	6.74
011	Forrestal Village	Yes		Unknown	5.40
246	Camp Moffett		Yes		25.65
246A	Camp Moffett		Yes		25.80
1711	Camp Moffett		Yes	Yes	8.94
011	Mainside	Yes			8.46
018	Mainside		None 4/	None 4/	5.20
029	Mainside			Yes	3.70
033	Mainside			Yes	3.99
045	Mainside			Yes	5.74
054	Mainside			Yes	4.17
069	Mainside	Yes	No		10.50
073	Mainside		Yes		6.94
079	Mainside	Could Not Inspect 2/			
088	Mainside		Yes		8.64
097	Mainside			Yes	4.54
105	Mainside	Yes	No		4.17
106	Mainside		Yes		14.83
114	Mainside	Yes		Yes	5.80
118	Mainside		Yes		5.68
126	Mainside		Unknown 3/	Unknown 3/	7.10
137	Mainside		None 4/	None 4/	8.50
141A	Mainside	Yes	Yes		7.70

Table III-8 (Cont.)

SUMMARY OF STEAM MANHOLE INSPECTIONS

STEAM MH NO.	LOCATION	EVIDENCE SURCHARGE	SUMP PUMP OPERATIONAL	FLOOR DRAIN	DEPTH
164	Mainside			Yes	5.80
168	Mainside		Yes		6.50
172	Mainside		Yes		7.22
177	Mainside		Yes		10.54
180	Mainside		Yes		5.52
185	Mainside			Yes	5.70
187	Mainside	Yes	Yes		8.20
191	Mainside			Yes	5.50
191B	Mainside		Yes		7.90
198	Mainside		Yes		5.80
204	Mainside	Could Not Locate			
205	Mainside		No		6.70
207	Mainside		Yes		7.70
210	Mainside		Yes		9.88
216	Mainside			Yes	5.48
226	Mainside	Yes	Yes		9.20
231	Mainside		Yes		6.00
TOTAL	40	8 - Yes	19 - Yes 3 - No 1 - Unknown 2 - None	12 - Yes 2 - Unknown 2 - None	

1/ Could not determine, debris on floor.
2/ Fence around structure.
3/ Could not determine, steam in manhole.
4/ No sump pump or floor drain present in manhole.

Chapter IV

ANALYSIS OF DATA

Introduction

Previous chapters have described the collection of data needed to identify the soil and groundwater characteristics. This chapter presents the results of the data collection. The behavior of the groundwater system is determined from monitored data and an analysis of the permeability data.

Soil Boring and Permeability Results

Eighty nine soil borings were undertaken throughout the NTC. Of these borings, 43 were shallow (to a maximum depth of six feet); 21 were deep borings (to a maximum depth of 25 feet); and 25 contained piezometers which were monitored for groundwater level and rainwater response. The borehole logs are presented in Appendix A. Samples were obtained from 15 boreholes in the cohesive soils and ten boreholes in the non-cohesive soils to determine the laboratory values for permeability. These results are presented in Table III-2 and Table III-3. Field permeabilities were determined using slug tests and the results are presented in Table III-4. The field permeabilities are considered more representative than the laboratory results which test only a very small soil sample and consequently the field values will be used to describe the soil behavior in the individual subareas.

Forrestal Village

Data was collected from eleven shallow boreholes, four deep boreholes (to a maximum depth of 25 feet) and four piezometer borings. In addition, two double ring infiltration tests and two percolation rate tests were undertaken.

The boreholes indicate that the majority of the area is overlain with fill which comprises silty clay, trace sand and gravels. The fill varies in depth from 2.5 feet to 5.5 feet with an average depth of 3.0 feet. Six boreholes exhibited no fill and were generally located to the west of the drainage ditch. These boreholes exhibited brown and gray silty clays in the upper five feet indicative of the Beecher Series. The topsoil and fill overlie the Wadsworth Till, layers of silty clays, interspersed with trace sands and gravel. The permeability of the underlying till was 9.7×10^{-9} cm/sec at Borehole No. 5 indicative of a impervious clay and 4.72×10^{-6} cm/sec at Borehole No. 91 which indicates the presence of a sandy clay.

Halsey Village

Data was collected from four shallow boreholes, one deep borehole (to a maximum depth of 25 feet) and one piezometer boring. In addition, one percolation rate test was undertaken.

Seventy percent of the boreholes indicate that the area is covered by a layer of fill with a depth varying from 2.5 feet to 13 feet. The upper soils in Borehole No. 71 and No. 72 are described as brown silty clay, indicative of the Morley Series. The fill and topsoil overlies brown silty clays with trace sand and gravels. The permeability of the sample at Borehole No. 72 was 1.83×10^{-8} cm/sec which is indicative of the silty clay encountered.

Nimitz Village

Data was collected from two shallow boreholes, one deep borehole (to a maximum depth of 25 feet) and two piezometer borings. In addition, one percolation rate test was undertaken.

All five boreholes indicate the presence of fill to a depth of three to six feet. The consistency of the fill was very variable containing sand, gravel and cinders. The fill overlies brown sand in the two boreholes on the east side of the area adjacent to the EJ&E Railroad and stiff clay in the remaining three boreholes. The permeability of the soils at Borehole No. 69 was 5.7×10^{-6} cm/sec. A laboratory test of a sand sample taken from Borehole No. 12 indicated a permeability of 2.11×10^{-4} cm/sec which is typical of a sandy non-cohesive soil.

Camp Moffett

Data was collected from one shallow borehole and one deep borehole. The boreholes indicate fill overlying firm clay, silts, and clayey sands. The brown sand encountered in Borehole No. 50 at 6.5 feet was similar in nature to that encountered at 8.5 feet at Borehole No. 69 in Nimitz Village immediately opposite Borehole No. 50 on the west side of the EJ&E railroad tracks.

Mainside

Data was collected from 25 shallow boreholes, 14 deep boreholes (to a maximum depth of 25 feet) and 18 piezometer borings. In addition, three double ring infiltration tests and six percolation rate tests were undertaken.

The boreholes indicated that most of the area is covered with a layer of fill which varies in depth from 1.5 feet to 6.0 feet depending on location. The average depth of fill is about 3.0 feet. The fill typically comprises silty clay, with traces of sand and gravel. However, its consistency is variable in nature and samples containing bricks, cinders, leaves and concrete were identified. None of the borehole samples from the Camp Barry area contained fill material. The yellow silty clays identified in Borehole No. 76 and No. 77 are indicative of the

Hennepin Series. Underlying the fill material are layers of silty clays interspersed with occasional sandy seams. Permeability tests indicated that these silty clays have low permeabilities in the range of 1.39×10^{-7} cm/sec to 3.64×10^{-8} cm/sec. Tests of the sandy clays indicated higher permeabilities in the range of 1.75×10^{-6} cm/sec to 5.0×10^{-6} cm/sec.

Double Ring Infiltrometer and Borehole Tests

Double ring infiltrometer tests were undertaken at five locations throughout the NTC. The results are presented in Table III-6. The test measures the absorption of rainwater in the upper inches of the soil. There is a wide variation in the data as the rate will be dependent on the consolidation of the topsoil, the presence of root channels and wormholes. Test No. 4 is considered unreliable and consequently the average of the four remaining tests provides a figure of 15.1 cm/hour (0.42×10^{-3} cm/sec) for an initial infiltration rate.

Borehole (percolation) tests were undertaken at ten locations throughout the NTC. The results are presented in Table III-5. The tests were performed in the upper five feet of auger borings in the fill, the clay and the sands. These are tests on unsaturated soils and measure the rate at which groundwater from a rainfall event infiltrates the upper portion of the soil. The tests performed at Borehole No. 21 and No. 25 were in the silty clays and give an average infiltration rate of 0.4 cm/hour (1.1×10^{-4} cm/sec). Tests at Borehole Nos. 11, 14, 35, 36, 43, and 66 were performed in the fill material and give an average infiltration rate of 5.0 cm/hour (1.4×10^{-3} cm/sec). The test at Borehole No. 12 was performed in the sandy soils and resulted in an infiltration rate of 44.11 cm/hour (1.2×10^{-2} cm/sec).

Overview of Soil Conditions for NTC

The borehole records and permeability tests for the five areas indicate sufficient similarity that a composite picture can be derived for the NTC. Typically the area is covered with three to five feet of fill (with a few previously noted exceptions). This fill is a silty clay with the presence of foreign materials such as cinders, brick, concrete, and gravels.

The fill has an average infiltration rate at the surface of 15.1 cm/hour indicating a high rate of initial absorption into the underlying soils. The infiltration rate through the fill derived from the borehole tests is typically 5.0 cm/hour. The fill depth varies from 1.5 to 13 feet, with the majority of boreholes indicating fill in the 3.5 to 5.0 feet depth range. The infiltration of groundwater in the fill occurs at a high rate until it encounters the glacial till (silty clays) with a much lower infiltration rate of approximately 0.4 cm/hour and consequently the water is "perched" at the interface of the permeable fill and the relatively impermeable till. The existence of perched water tables was confirmed during the groundwater depth studies and is discussed further in the following section.

Beneath the fill the groundwater travels through the till at the till infiltration rate if the ground is unsaturated. Once the infiltration encounters the true groundwater surface where the soil is in a saturated condition, the flow rate is then determined by the permeability of the particular soil. The field permeabilities are presented in Table III-4. Averaging the silty clays a figure of 1.73×10^{-7} cm/sec for the permeability of the silty clay till is obtained. The average permeability of the sandy clays is 4.29×10^{-6} cm/sec and the laboratory tests of the non-cohesive sails indicated an average permeability of 5.64×10^{-4} cm/sec for sandy soils.

Groundwater Level Data

The depth to groundwater was measured at the 25 piezometers during the period from November 15, 1989 to January 19, 1990. Measurements were also taken during this period in permanent piezometers installed previousely in Camp Porter. The results are presented in Appendix B. During this period it was possible to evaluate the response of the groundwater level to three significant storm events. The November 15, 1989 storm measured 1.23 inches of precipitation. The November 21, 1989 storm measured 0.5 inches of precipitation and the January 4, 1990 storm measured 0.39 inches of precipitation. The precipitation and water level hydrographs for the piezometers are presented in Exhibit 12 through Exhibit 24. The readings taken on December 21, 1989 are presented on Exhibit 8, Exhibit 9 and Exhibit 10 as being typical groundwater elevation contours. The data for all areas is presented as depth to water level contour maps on Exhibit 5, Exhibit 6, and Exhibit 7. The depth to water level at Mainside on December 21, 1989 ranged from four feet to approximately 10 feet depending on the stratigraphy of the subsurface and the topography.

During borehole drilling and installation of piezometers, the presence and level of water in the soils was noted. In many cases after the borehole had been completed the water level did not recover to its previous level. This behavior would indicate the presence of a "perched" groundwater table. This situation arises when rainwater percolates through a soil with a high permeability and then encounters a soil, such as the silty clay which is relatively impervious. Consequently the groundwater is suspended at a level above the true groundwater surface. This phenomenon is described as a perched water table and can give an erroneous indication of a high water table unless its behavior is understood. The comparison of borehole data at the adjacent Boreholes No. 82 and No. 83 indicate an initial "perched" water

table at 3.5 feet below the ground surface at Borehole No. 83 while the true groundwater level was in the region of 9.0 feet below the ground surface, and more than 13 feet deep at Borehole No. 83.

The response of the groundwater elevation to a rainfall event is dependent on the topography, the ability of the groundwater to move through the saturated soils in that vicinity and the proximity of the water bearing layer to the ground surface. Boreholes in the shallow sandy clays such as Borehole No. 81 exhibit a rapid response to a rainfall event whereas the groundwater profile at Borehole No. 88, which is much deeper, (approximately 15 feet) indicates little response to the same rainfall event.

A perched water table has a more dramatic response to rainfall events than the underlying groundwater table. In years with lower than normal rainfall, as experienced in recent years, the elevation of the perched water table is, on the average, lower than in years with normal rainfall. Elevations of the perched water table vary dramatically with rainfall and recharge quickly even during years with lower than normal annual rainfall. Effects on the perched water table may be seen as a result of rainfall events. Variations in the perched water table elevations and response to rainfall are shown graphically on Exhibit 12 through Exhibit 24.

Movement of Groundwater

The flow of groundwater in Forrestal Village as shown on Exhibit 8 is from the northwest to the southeast; in Halsey Village, Nimitz Village and Camp Moffett (Exhibit 9) the flow of groundwater is from west to east, towards the Lake. On Mainside, the groundwater flow is more complex. This is due to the proximity of the lake, the presence of the ravines which dissect the area and a high ridge which extends north south.

Generally, groundwater on the east side flows towards the lake and that on the west side towards Sheridan Road. However, components of the groundwater in the area of Camp Barry, the Hospital and Ross Field flow towards the ravines.

A comparison of the depth of the steam manholes with the generalized depth of water contours (Exhibits 8, 9, and 10) indicates that in most cases the groundwater level is below the floor of the manholes. Since flooding problems occur in steam manholes during and immediately following rainfall events, it would suggest that the water entering the steam manholes is from rainwater infiltrating through the fill and not groundwater seepage from the glacial till. The evidence of the presence of perched water tables would confirm this theory and the rapid rise of these water tables in the permeable fill would increase the seepage rates at any defects or cracks in the manhole walls or pipe seals. The elevation of an initial perched groundwater table at the fill/till interface varies from 1.5 feet to 10 feet below the ground surface. Typically the water elevation is 3 to 5 feet below the ground surface which is generally above the floor of steam manholes. This condition would be classified as Class A Severe for the purposes of design of an underground steam distribution system.

Soil Corrosion Potential

Corrosion of the steam and condensate piping in the steam manholes has been experienced at the NTC. Direct buried pipelines have also been subject to external corrosion. There is the potential for pipes to corrode when they are in contact with a soil that is corrosive or when the groundwater contains a high dissolved salt content of aggressive salts.

Soil Analysis

When determining the corrosive potential of a soil, it is necessary to evaluate five factors; resistivity, pH, redox potential, sulfides, and moisture content.

1. Earth Resistivity - Resistivity measures the resistance of soil to the flow of an electrical current. Resistivity of a soil relates primarily to its water content and the concentration of dissolved ions. The latter is particularly high in the case of clays. Typical resistivities are given in Table IV-1.

2. pH - In the pH range 0.0 to 4.0, the soil serves well as an electrolyte and total acidity is important. In the pH range of 6.5 to 7.5 soil conditions are optimum for sulfate reduction. In the pH range 8.5 to 14.0, soils are generally quite high in dissolved soils yielding a low soil resistivity.

3. Oxidation Reduction (redox) Potential - The oxidation-reduction (redox) potential of a soil is significant because the most common sulfate reducing bacteria can live only under anaerobic conditions. A redox potential greater than +100 mV shows the soil to be sufficiently aerated so that it will not support sulfate reducers. Potentials of 0 to +100 mV may or may not indicate anaerobic conditions; however, a negative redox potential definitely indicates anaerobic conditions under which sulfate reducers thrive. Experience has shown that heavy clays,fill, and organic soils are often anaerobic, and these soils should be regarded as potentially corrosive.

Table IV-1

REPRESENTATIVE SOIL RESISTIVITIES

Resistivity (ohm-cm)	Soils
1,000	Clay, Saturated Silt
2,500	Sandy or Silty Clay
5,000	Clayey Sand or Saturated Sand
15,000	Sand
50,000	Gravel

4. Sulfides - The sulfide determination is recommended because of its field expediency. A positive sulfide reaction reveals a potential problem because of sulfate reducing bacteria.

5. Moisture Content - Since prevailing moisture content is extremely important to all soil corrosion, it is necessary to determine this condition.

Soil Test Evaluation

Results for each of the above tests are categorized according to their contribution to corrosivity, and points are assigned based on that level of contribution. Table IV-2 refers to Soil Test Evaluation. When results of these five test observations are available, the assigned points are totaled. If the sum is equal to ten or more, the soil is considered corrosive.

To evaluate the extent and distribution of corrosive soils and groundwater at NTC, corrosion potential testing was undertaken on 15 soil samples. The results are presented in Table IV-3.

The five samples that exhibit corrosion potential are all located on the Mainside. However, the variability of the soils would suggest that pockets of soil of a corrosive nature are spread randomly through the site and it is impossible to predict their location. Consequently, it is necessary to assume that all the soils and groundwater have the potential to be corrosive and to protect the structures and pipe work accordingly.

Table IV-2

SOIL TEST EVALUATION

SOIL CHARACTERISTICS	POINTS
Resistivity - ohm-cm	
< 700	10
700 - 1000	8
1000 - 1200	5
1200 - 1500	2
1500 - 2000	1
> 2000	0
pH:	
0 - 2	5
2 - 4	3
4 - 6.5	0
6.5 - 7.5	0
7.5 - 8.5	0
>8.5	3
Redox potential:	
> + 100 mV	0
+ 50 to + 100 mV	3.5
0 to + 50mV	4
Negative	5
Sulfides:	
Positive	3.5
Trace	2
Negative	0
Moisture:	
Poor drainage, continously wet	2
Fair drainage, generally moist	1
Good drainage, generally dry	0

Table IV-3

SOIL/WATER ANALYSIS FOR CORROSION POTENTIAL

BORING NO.	LOCATION	DEPTH	pH	RESITIVITY ohm-cm	REDOX mV	SULFIDES	CORROSION POTENTIAL	SOIL TYPE
10	Forrestal Village	4'-6'	8.0	1425.6	50	Trace	Negative	Brown and gray silty clay.
17	Camp Moffett	2'-4'	6.65	1454.3	10	Trace	Negative	Fill
20	Mainside	4'-6'	7.70	929.5	70	Negative	Positive	Brown and gray silty clay.
25	Mainside	4'-6'	8.25	994.5	310	Positive	Positive	Gray and brown very silty clay.
28	Mainside	3'-5'	8.31	1200.5	90	Trace	Negative	Gray and brown very silty clay.
35	Mainside	4'-6'	8.43	966.5	70	Negative	Positive	Brown and gray silty clay.
42	Mainside	3.5'-5'	7.60	3291.3	40	Trace	Negative	Stiff brown clay.
50	Camp Moffett	3.5'-5'	7.04	1112.1	30	Negative	Negative	Soft brown clayey silt.
53	Mainside	3.5'-5'	8.04	800.5	70	Negative	Positive	Dark brown and gray silty clay.
59	Mainside	5'-7'	8.33	939.3	80	Trace	Positive	Brown silty clay.
60	Mainside	3.5'-5'	7.85	1409.4	60	Negative	Negative	Brown and gray silty clay.
62	Mainside	3.5'-5'	7.86	874.8	60	Negative	Positive	Brown silty clay.
68	Mainside	2'-4'	8.02	1425.6	50	Trace	Negative	Brown and gray silty clay.
85	Mainside	6'-7.5'	8.20	1532.6	80	Trace	Negative	Brown silty clay.
88	Mainside	3.5'-5'	7.60	3291.3	40	Trace	Negative	Brown and gray silty clay.

Other Sources of Groundwater Infiltration

In addition to the groundwater infiltration from storm events, the data collection effort identified several other potential sources of groundwater infiltration including leaky water mains, lawn sprinkling, exfiltration from leaky sewers, and stormwater ponding.

Leaky Water Mains

Leaky water mains could contribute to the high groundwater problems. However, according to PWC personnel, no significant leaks were detected at this time which would contribute to groundwater. Therefore, leaky water mains do not contribute significant inflows to the ground water system.

Lawn Sprinkling

Lawn sprinkling can contribute a significant volume of water to the soil moisture and groundwater systems. However, according to PWC personnel, lawn sprinkling is conducted on a building by building basis, as needed. Because the sprinkling occurs on an as needed basis, and not basewide on a regular basis, it is unlikely sprinkling contributes significantly to groundwater leaks. Further, most of the water would be taken up to replenish soil moisture during dry periods, when sprinkling is most likely to occur. Therefore sprinkling is not considered a significant source of inflow to the groundwater system.

Sewer Exfiltration Portions of the NTC have experienced significant sanitary sewer infiltration problems (RJN Environmental Infiltration/Inflow Study, February, 1989). Because some of these sewers leak large volumes of groundwater into the sanitary system, the potential for storm sewers to leak storm water into the groundwater system was examined. In the Donohue & Associates Study of August, 1989, calculations were

made to estimate the significance of leaky storm sewers which could exfiltrate stormwater when surcharged. The study stated that "..... based on the hydrogeological investigation, groundwater monitoring data, infiltration of 0.1 inches could result in a rise in the water table of one inch." Although calculations show that leaky sewers can contribute to groundwater, significant surcharging of the entire storm system does not occur on a frequent enough basis to affect the groundwater table.

Stormwater Ponding Interviews with NTC personnel and results of the Donohue & Associates Storm Study of July, 1989 identified 11 major problem areas prone to flooding on Mainside. These areas are generally limited to the street by curb. However, flooding does extend overland at Ross Field/Sampson Street and Constitution field onto pervious areas. The surface flooding has little effect on the underlying groundwater levels. However, it does have a marked response locally on the perched water table as all standing water on pervious areas will percolate rapidly through the topsoil and fill layers. This effect can be seen in the high perched water table at Sampson Street shown on Exhibit 10.

Several potential sources of groundwater have been identified. While they all contribute to groundwater, infiltration into the permeable fill from precipitation is clearly the most significant contributor. This conclusion is supported by the groundwater level monitoring data which showed a rapid and significant response after rainfall events.

Steam Manhole Inspections

Inspections of 40 (15 percent of 267) steam manholes were performed. The manholes were inspected for floor drain connections, sump pumps, and evidence of surcharge. In addition, the condition of the manhole and any deterioration was

noted. The manhole inspection data is presented in Appendix C. A summary of the steam manholes inspected is presented on Table III-8. The inspections indicated that 30 manholes (79 percent of those inspected) exhibited cracking and general deterioration, 13 manholes (34 percent of those inspected) had floor drains, 22 manholes (58 percent of those inspected) had sump pumps, and four manholes (11 percent of those inspected) had neither a floor drain nor a sump pump.

Chapter V

ANALYSIS AND RECOMMENDATIONS

Introduction

This chapter addresses the alternatives to reduce groundwater infiltration into the steam manholes. As discussed in Chapter IV, this infiltration is a function of perched groundwater in the (overlying) fill material and not the underlying groundwater levels. Groundwater enters the manholes through cracks in the walls, at construction joints, and pipe seals.

In proposing remedial measures, it was intended that any solution should address local steam manhole flooding, not area wide lowering of the groundwater table. Seepage into the steam manholes and the associated corrosive damage to the steam lines is the primary concern of PWC personnel.

Disconnection of floor drains in steam manholes was also analyzed. A two year level of protection for storm sewers, as determined by Donohue & Associates (1989), was used for the purpose of this investigation. Steam manholes, with floor drains located in areas with a two year level of protection or less, were assumed to flood during a two year rainfall event as a result of storm water backup through floor drains. Therefore, disconnection of floor drains and installation of sump pumps would be required in steam manholes located in areas with a two year or less level of protection in the storm sewer system.

Cost Estimate Procedure

Cost estimates for the technically feasible alternatives were determined using locally developed unit costs for utilities construction and current bid prices for manhole rehabilitation.

Estimates were broken down into material and labor costs where practicable. The estimates were prepared on NAVFAC 11013/7 forms.

General conditions overhead and profit (SIOH) and design contingency costs were included as separate line items applied to the subtotals of the major divisions of work. All costs were escalated to the Anticipated Date of Construction Contract Award (ADCA). The following specific data was used to prepare the estimates:

General Conditions Overhead & Profit (SIOH) - 5.5%
Design contingencies = 5%
Escalation to ADCA = 5.8%
ADCA = January, 1992

Computation of the 5.8 percent escalation factor is shown on a separate 11013/7 form in Appendix D. The factor is computed by compounding monthly escalation rates from January, 1990 to December, 1991.

Discussion of Alternatives

Based on the specific site conditions, physical constraints and design criteria, three potential options were considered to minimize the volume of water entering the steam manholes and to prevent them from flooding. The three options are:

A. Disconnection of Floor Drains and Installation of Sump Pumps
B. Waterproofing of Steam Manholes
C. Installation of Foundation Drains

Well point dewatering was not considered as a feasible option as the problems arising from groundwater infiltration are essentially caused by the perched water table which is basewide and well point dewatering is only a localized solution.

A. Disconnection of Floor Drains and Installation of Sump Pumps

To prevent the backup of stormwater into the steam manholes, it was proposed to investigate the disconnection and plugging of storm water connections through floor drains. It would also be necessary to install a collection sump together with a sump pump and associated pipework in these manholes, in order to remove water from the manholes that would still collect from condensation and direct precipitation through manhole gratings. A review of the Donohue & Associates 1989 Stormwater Study indicates that 96 steam manholes are located in areas with a two year or less level of protection in the storm sewer system. Of those 96 manholes, 15 were inspected. Field surveys of the steam manholes indicated that 5 (33 percent) of the inspected steam manholes located in these areas have floor drains that would require disconnection. It is therefore projected that 32 manholes (33 percent of 96 manholes) would require floor drain disconnection and installation of sump pumps.

At the request of PWC personnel, disconnection of existing sump pumps and gravity connection to adjacent storm sewers in areas with a greater than two year level of storm protection was investigated. In areas with greater than a two year level of protection, storm sewers were assumed to be five feet deep. Based on the depths of steam manholes inspected in these areas, it was determined that steam manholes in these areas cannot be drained by gravity through floor drains. However, additional investigation of

the storm sewer system relative to steam manholes would be required to analyze the feasibility of installation of floor drains in the steam manholes. Based on the review of Donohue & Associates 1989 Stormwater Study, 136 steam manholes are located in areas with greater than two year level of protection. Twelve of the remaining 22 inspected manholes (63 percent of 136) contain sump pumps. It is projected that 86 manholes (63 percent of 136) contain sump pumps and may need further investigation to analyze the feasibility of installing floor drains.

Disconnection of the floor drains would be undertaken by breaking through the base of the manhole, disconnecting the last pipe segment and plugging the end with a mortar seal. The new sump would be installed by breaking out the concrete floor at a suitable location. The concrete floor would then be restored and a surface screed applied to slope towards the new sump. The total estimated cost for this option is $198,000.00. Detailed cost breakdowns are presented in Appendix D.

B. Waterproofing of Steam Manholes

Waterproofing of the manholes was considered as a potential solution to eliminating groundwater seepage. This alternative consists of pressure grouting and sealing of the cracks, joints and pipe inlet/outlet connections and patching and grouting of eroded or poorly patched areas. The grouting is undertaken by injecting a urethane gel grout into the walls of the manhole. Injection holes are drilled through the walls and the manholes at two feet intervals horizontally and three feet vertically and the holes are staggered with those in the rows above and below. Additional injection holes are provided near major defects and pipe seals. The grout is a tough, flexible, chemically resistant, elastomeric gel which has expansive properties

when exposed to water. Minor movement of the structure will not disturb the integrity of the flexible grout. Typical grout specifications and chemical data are included in Appendix G. Some steam manholes may be brick rather than cast-in-place concrete. For brick manholes the same grouting technique is employed. However, it is necessary to coat the interior of the manhole with two coats of a hydraulic cement prior to grouting to ensure that grout travels to the defect and to reduce the grout loss through the mortar joints.

RJN Environmental has extensive experience of manhole rehabilitation and grouting in the Chicagoland area. Manhole grouting has been shown to be an effective method of removing groundwater infiltration and inflow (Nogaj, Operations Forum, 1984 presented in Appendix F) . Our experience indicates that there is no substantial difference between the cost of grouting a brick or a pre-cast manhole. Additionally, the costs do not vary significantly according to the level of deterioration in the structure. The main cost incurred in rehabilitation is the initial "set-up" and not the amount of grout used. Consequently a unit price was adopted for the grouting of each manhole assuming a typical manhole was eight feet square and 10 feet deep. Steam manhole surveys indicated that 79 percent of manholes were found to be deteriorated and 211 manholes would require sealing. It is recommended that all deteriorated manholes be rehabilitated as deterioration is progressive and the distribution of corrosive soil is random. The estimated cost for this work is $545,000.00. A detailed breakdown is presented in Appendix D.

C. Installation of Foundation Drains Around Steam Manholes

A foundation drain system was considered in which a trench would be excavated around each manhole to a depth below the floor elevation of the manhole. Groundwater collected from the trench could then be pumped to the existing storm sewer system. Sump pumps would still be required in the manholes for collection of direct precipitation, condensation or potential surface inflow into the manhole during heavy rains, but groundwater seepage would be intercepted by a drain constructed around the manhole. The drain would be constructed adjacent to the perimeter of the steam manhole at a depth of about 1-1.5 feet below the floor of the manhole. An average depth of the steam manholes is 10 feet although steam manhole inspection records indicate depths ranging from 4 feet to 25 feet. The drain tile would, therefore, be laid at a depth of 11.5 to 12.0 feet below the ground surface (the pipe would slope towards the collection sump). The drain trench would comprise a four inch diameter drain tile pipe, backfilled with two feet of washed gravel, and surrounded by geotextile fabric to prevent migration of fines into the foundation drain. The remaining trench would be backfilled with excavated soil, if suitable, and restored to its original condition. If the excavated material is from the fill layer, this would serve as suitable permeable backfill. Any silty clays excavated from the lower level Wadsworth Tills would not be suitable because of their low permeabilities and would have to be replaced with additional granular or other fill material. The estimated cost for this option is $1,640,000. A detailed breakdown is presented in Appendix D.

As it is desirable to remove all possible sources of extraneous water entering the steam manholes, the disconnection and plugging of storm drain connections, new sumps and sump pumps (Option A) would be recommended as part of any solution. Consequently the two feasible alternatives concern the removal of the groundwater from the outside of the manholes by foundation drain or the prevention of infiltration of groundwater by grouting the manholes. The two alternatives analyzed for their cost effectiveness are:

Alternative 1: Combination of Option A and Option B at an initial capital cost of $743,000 (1992).

Alternative 2: Combination of Option A and Option C at an initial capital cost of $1,838,000 (1992).

Economic Analysis

The two alternatives presented are intended to extend the life of the steam lines to 20 years from the 15 years that is now expected with the level of corrosion currently being experienced.

The cost estimates in Appendix D are for initial capital costs. Waterproofing of the manholes can typically be expected to last fifteen years and cannot be considered a permanent solution to groundwater infiltration. However, the grouting will significantly reduce the infiltration and therefore, the associated corrosion.

It is recommended that a routine inspection program be undertaken and that manholes be regrouted if necessary at the fifteen year interval.

Net Present Worth Analysis

For the purpose of this analysis, the cost of regrouting the manholes after a fifteen year interval was considered and a present worth analysis of the two alternatives compared. The results are presented in Table V-1. In accordance with PWC personnel's request, a discount rate of ten percent and an inflation rate of zero percent were used in computing the net present worth.

It can be seen that over 20 years it is cost effective to undertake Alternative A with a net present worth of $823,500 (January, 1990).

Cost Benefit Analysis

Alternative A was compared with the cost of maintaining the present system (status quo) including replacement of pipes at 15 year intervals, and the heat loss due to deterioration of insulation. The analysis is presented in Appendix E. At the request of PWC personnel, pipe replacement costs were those used by Donohue & Associates (August, 1989). Heat loss rates were provided by PWC personnel. Accordingly, the analysis of heat loss and pipeline replacement costs was based on the rates provided and adjusted for the pipe lengths and number of steam manholes in the current study area.

The Net Present Worth of Alternative A, including regrouting at 15 years and pipe replacement at 20 years is $3.14 million, while the Net Present Worth of the status quo including pipe replacement at 15 years and 30 years, is $6.83 million. The savings to investment ratio is therefore 2.18. These figures are based on January, 1990.

Table V-1

NET PRESENT WORTH OF ALTERNATIVES

(January, 1990)

	FLOOR DRAIN DISCONNECTION	MANHOLE GROUTING	MANHOLE GROUTING (YR. 2000)	FOUNDATION DRAIN INSTALLATION	TOTAL PRESENT NET WORTH 1/
Alternative A	$619,448	$514,217	$198,230.65		$823,500
Alternative B	$619,448	- - -	- - -	$550,000	$1,736,500 2/

1/ Does not include internal sump pump operation maintenance which is common factor to both calculations.

2/ Does not include operation and maintenance of foundation drain sump pumps.

Conclusions

The analysis indicates that it would be cost effective to adopt Alternative A.

Waterproofing will not remove or reduce the localized groundwater. However, it will prevent significant problems associated with the infiltration of groundwater into the manholes.

Recommendations

1. It is recommended that defective steam manholes be grouted to eliminate groundwater infiltration into steam manholes at an estimated cost of $545,000. (January, 1992)

2. It is recommended that floor drains be disconnected and sumps/sump pumps be installed in those steam manholes that are subject to flooding from storm sewer backups at an estimated cost of $198,000. (January, 1992)

3. In addition, all sump pumps should be maintained in good working order and check valves fitted on all discharges (where not currently installed).

4. It is recommended that the PWC continue with the cathodic protection of the external buried lines as a suitable method of reducing the deterioration of the exterior pipework from corrosive soils.

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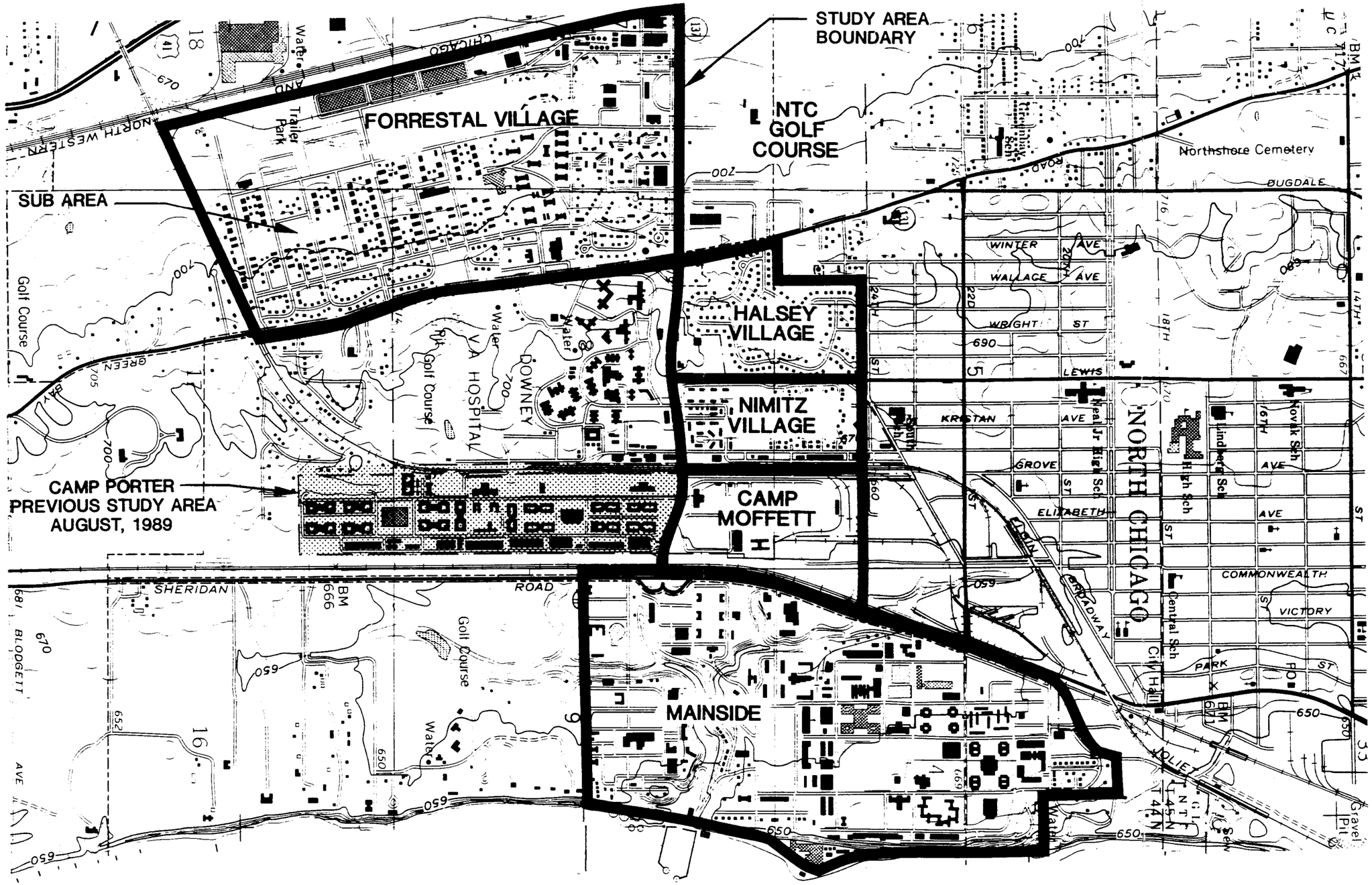
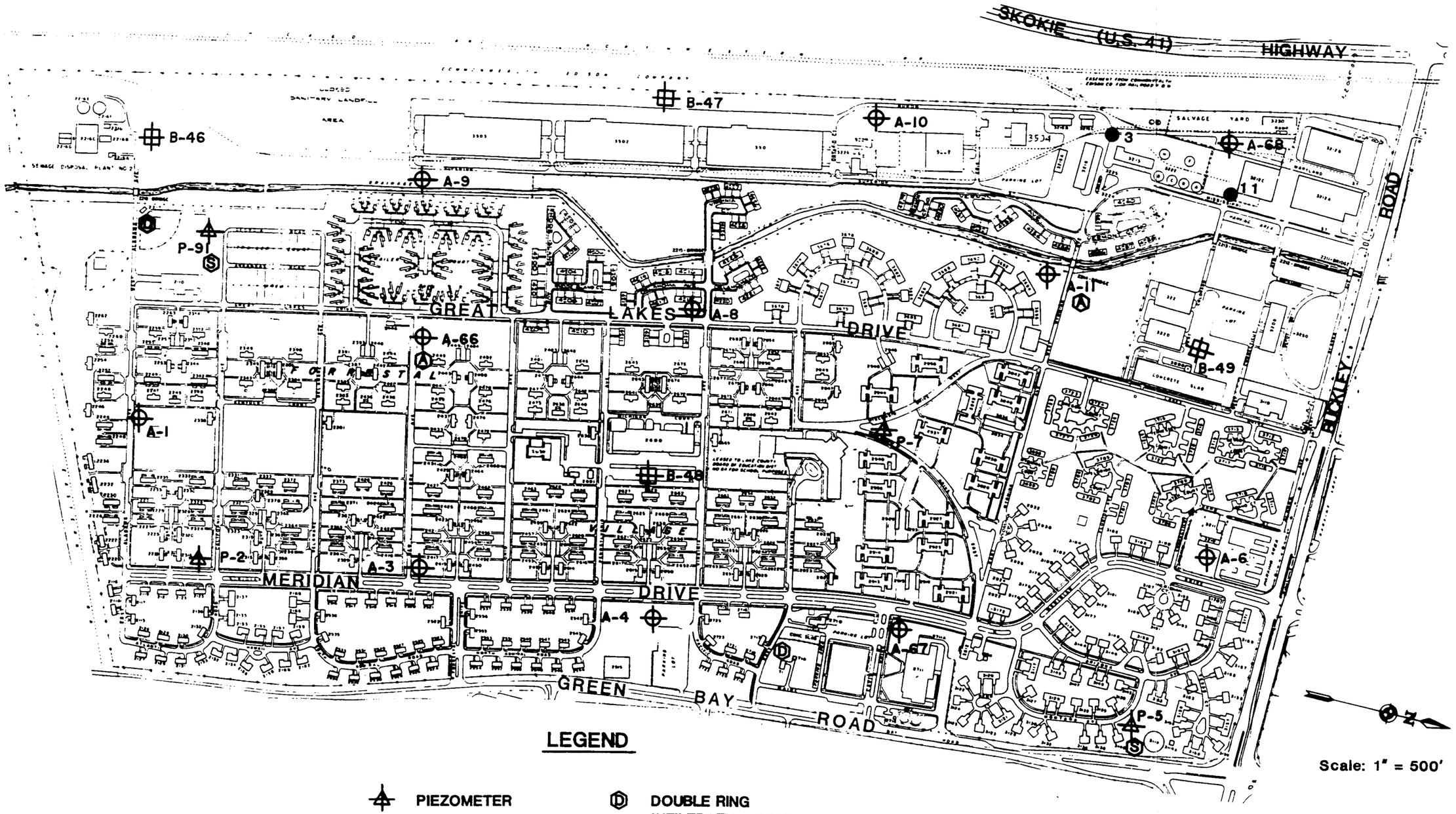
EXHIBITS



RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

STUDY AREA LOCATION MAP
EXHIBIT 1



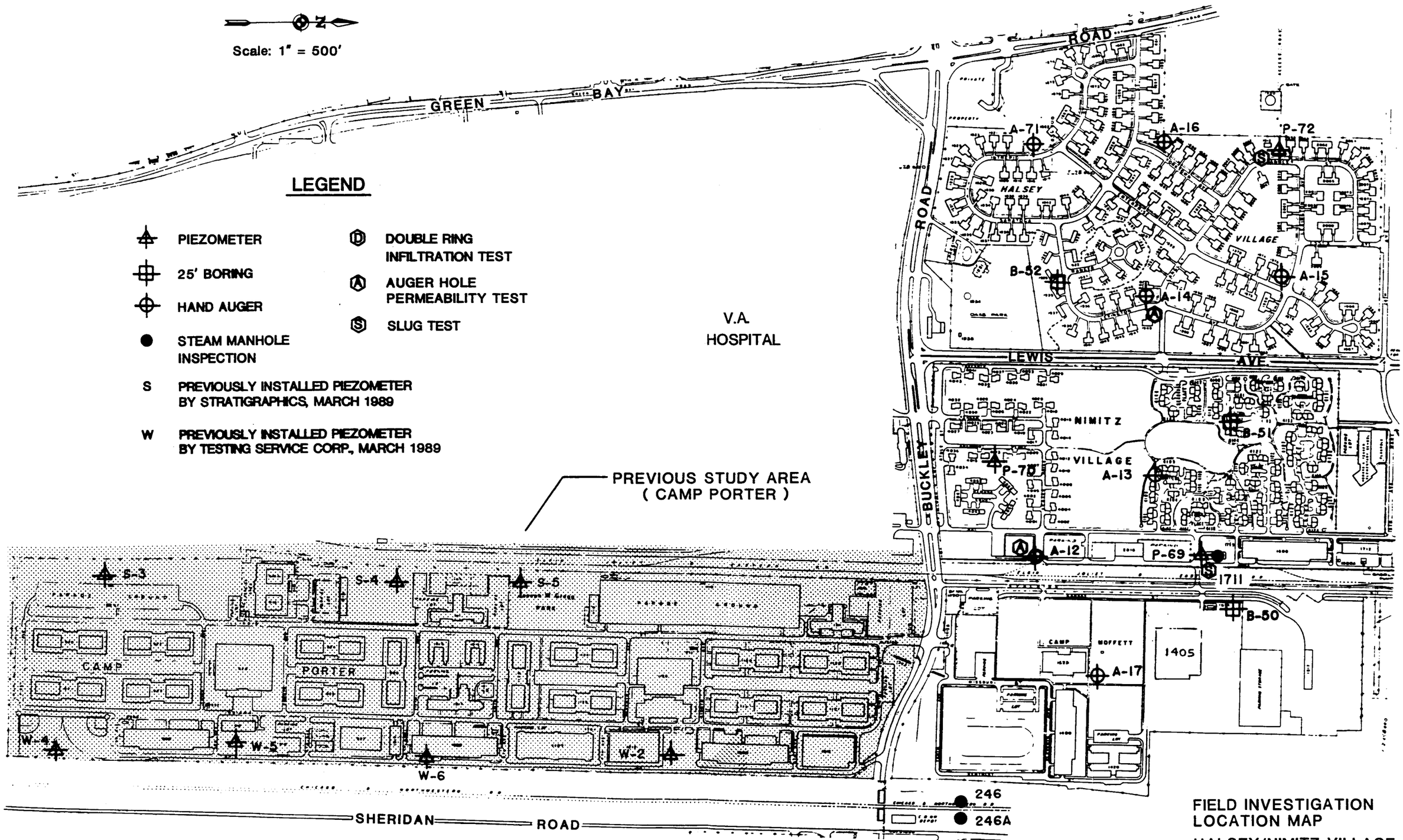
Scale: 1" = 500'

LEGEND

- PIEZOMETER
- 25' BORING
- HAND AUGER
- STEAM MANHOLE INSPECTION
- DOUBLE RING INFILTRATION TEST
- AUGER HOLE PERMEABILITY TEST
- SLUG TEST

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

FIELD INVESTIGATION LOCATION MAP
FORRESTAL VILLAGE
EXHIBIT 2

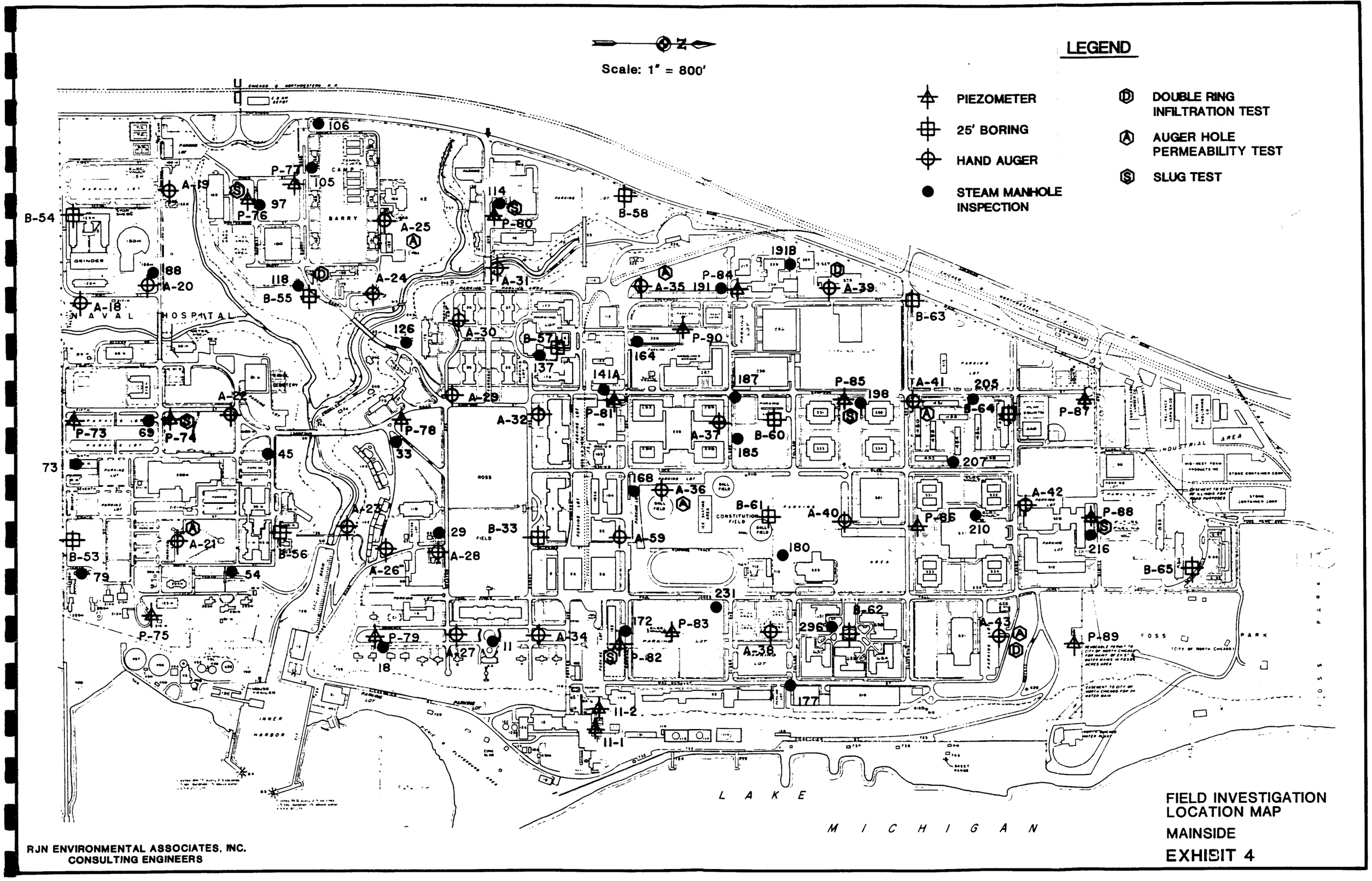


FIELD INVESTIGATION LOCATION MAP

HALSEY/NIMITZ VILLAGE
CAMP PORTER/MOFFETT

EXHIBIT 3

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

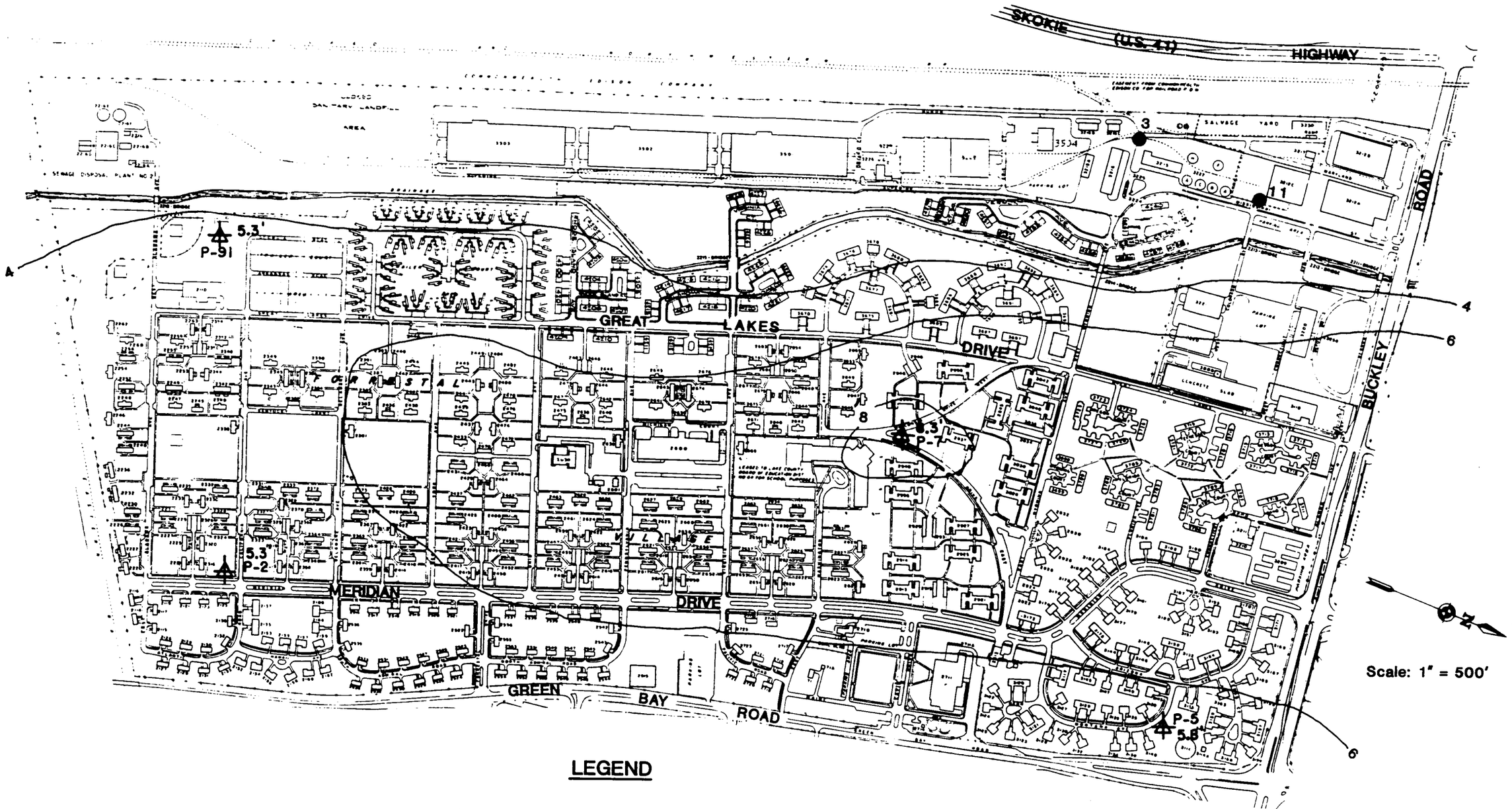


RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

FIELD INVESTIGATION LOCATION MAP

MAINSIDE

EXHIBIT 4



LEGEND

PIEZOMETER

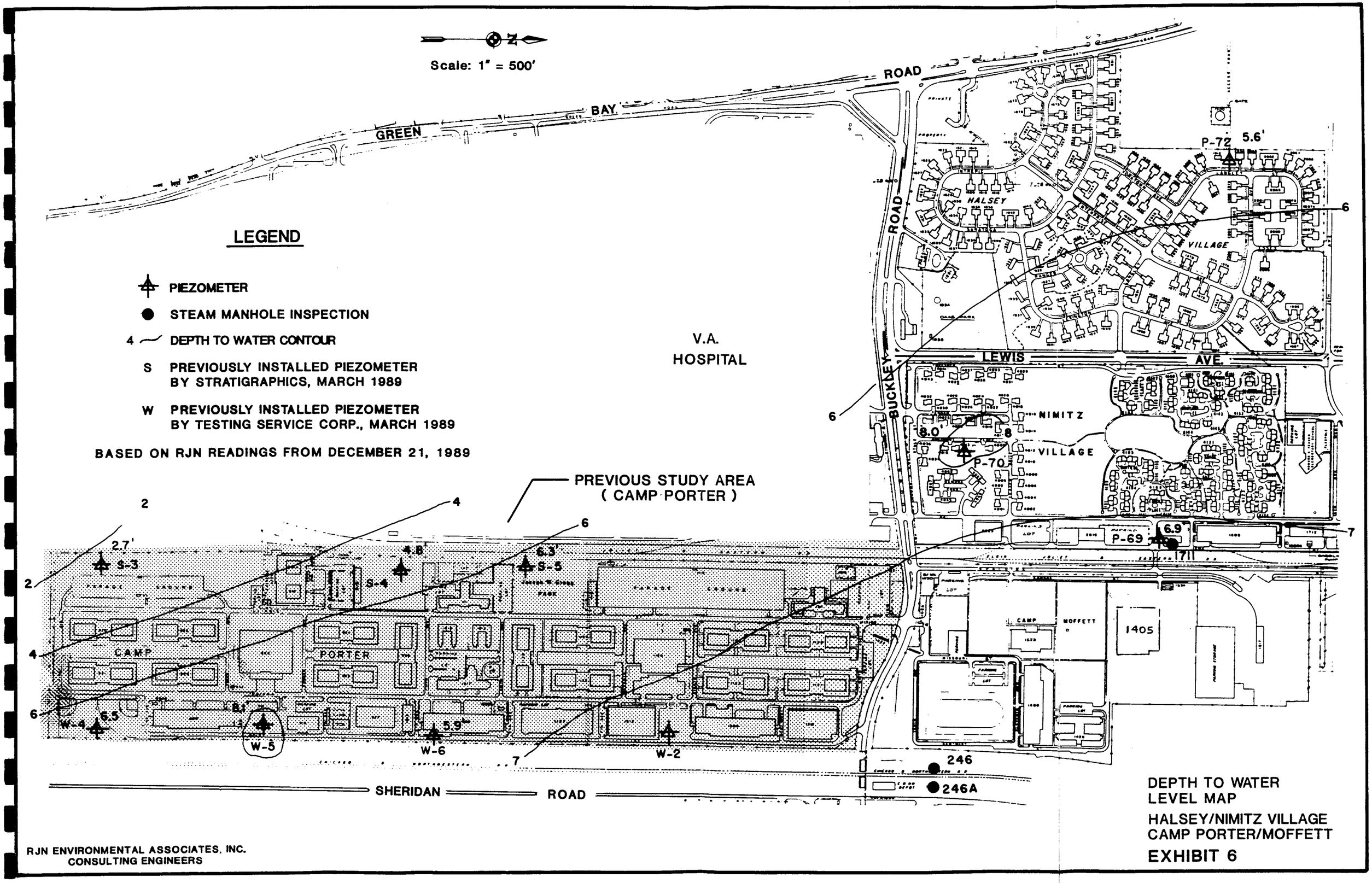
STEAM MANHOLE INSPECTION

6 DEPTH TO WATER CONTOUR

NOTE: BASED ON RJN READINGS FROM DECEMBER 21, 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

DEPTH TO WATER
LEVEL MAP
FORRESTAL VILLAGE
EXHIBIT 5

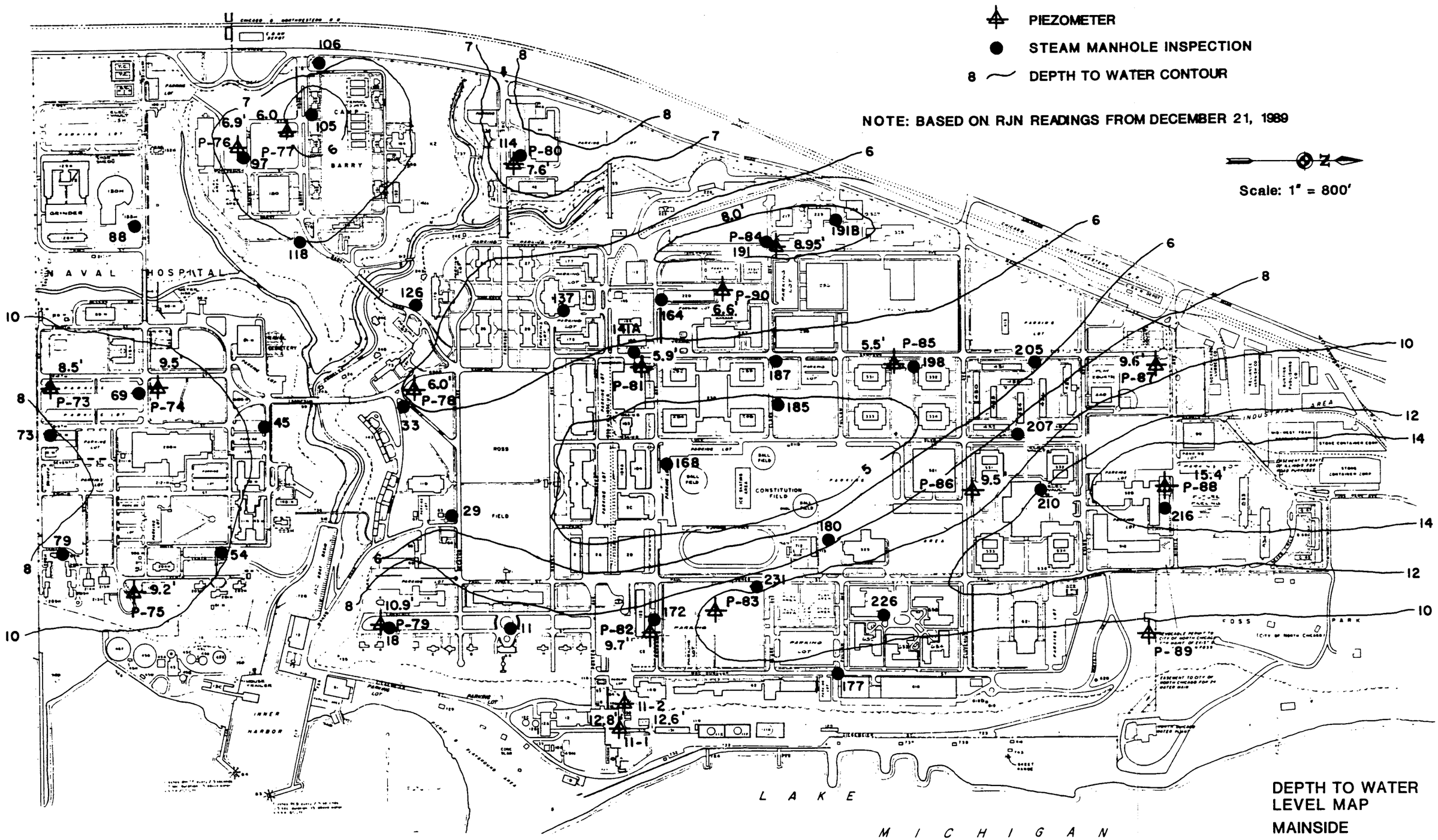


DEPTH TO WATER LEVEL MAP

HALSEY/NIMITZ VILLAGE
CAMP PORTER/MOFFETT

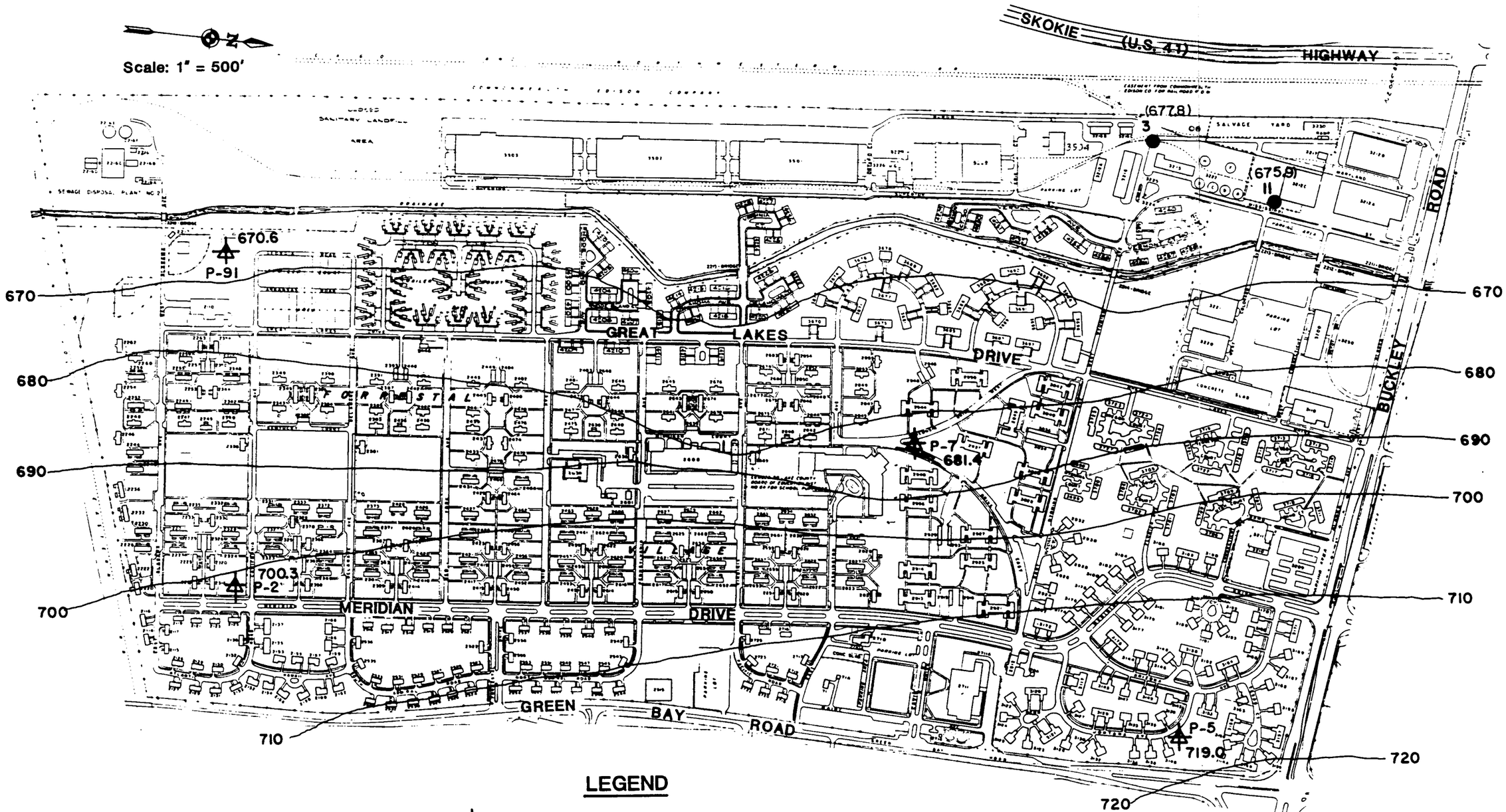
EXHIBIT 6

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS



RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

DEPTH TO WATER LEVEL MAP
MAINSIDE
EXHIBIT 7



LEGEND

670.6 ✛ PIEZOMETER LOCATION AND ELEVATION

P-91 PIEZOMETER NUMBER

● STEAM MANHOLE NUMBER AND INSPECTION LOCATION

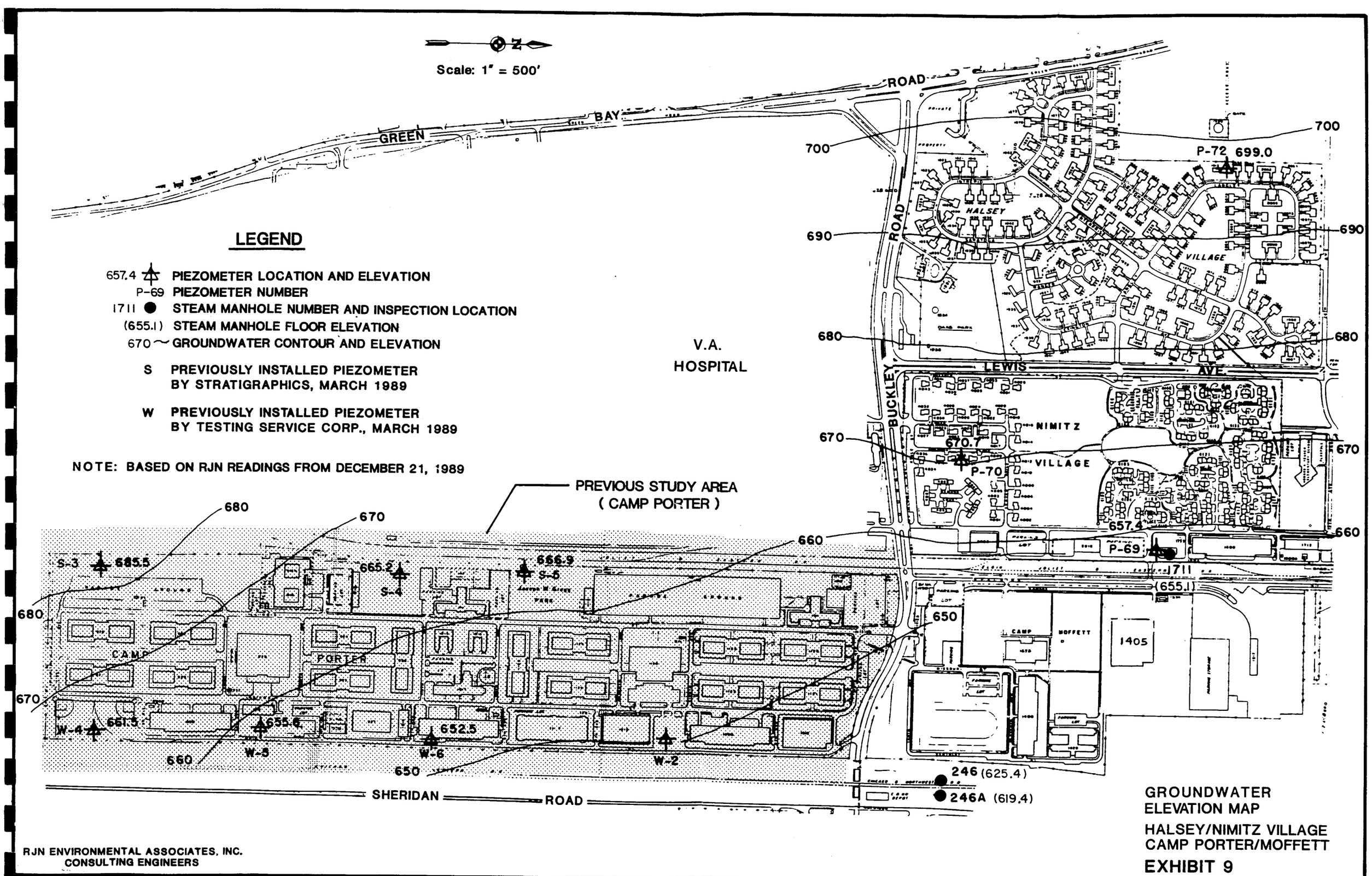
(677.8) STEAM MANHOLE FLOOR ELEVATION

700 ~ GROUNDWATER CONTOUR AND ELEVATION

BASED ON RJN READINGS FROM DECEMBER 21, 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

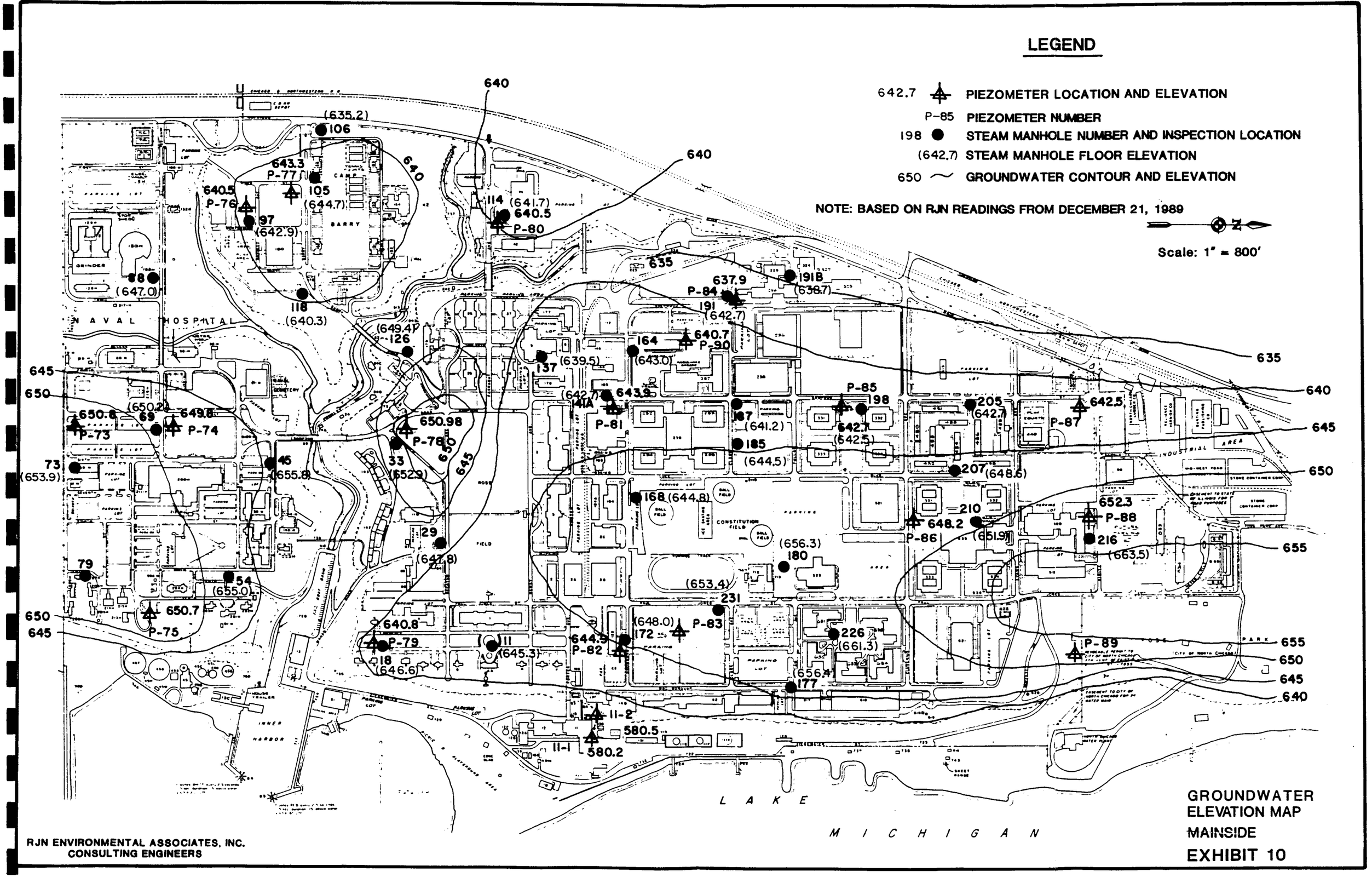
GROUNDWATER ELEVATION MAP
FORRESTAL VILLAGE
EXHIBIT 8

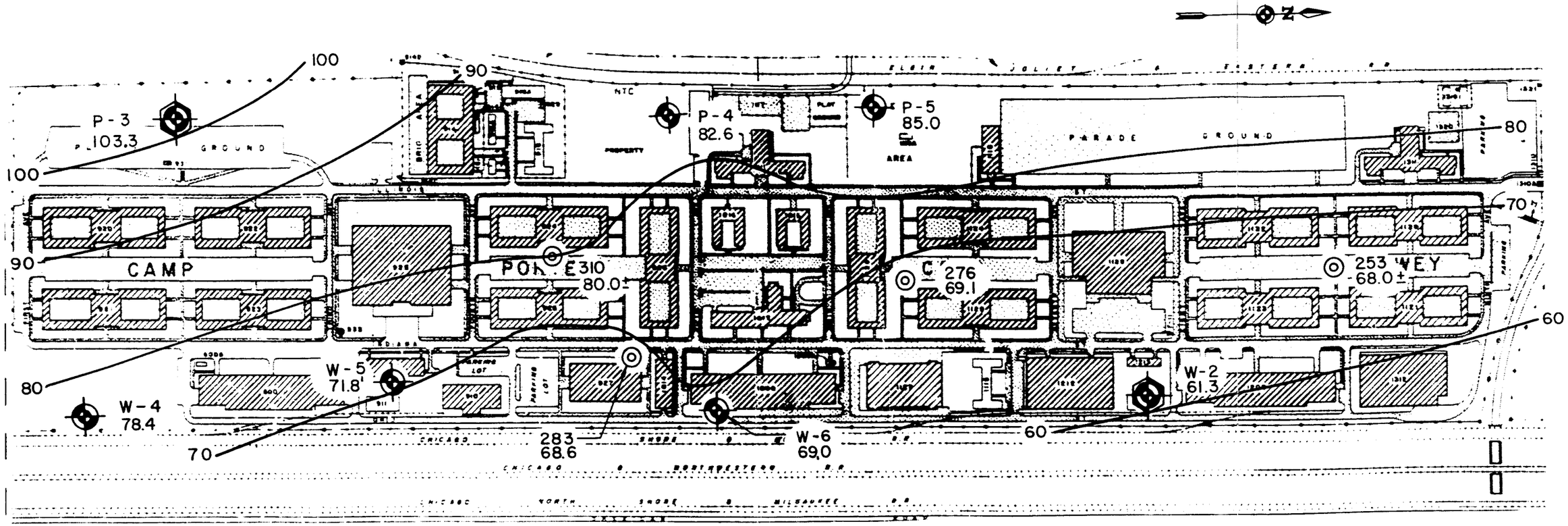


RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

GROUNDWATER ELEVATION MAP
HALSEY/NIMITZ VILLAGE
CAMP PORTER/MOFFETT

EXHIBIT 9


LEGEND
642.7 PIEZOMETER LOCATION AND ELEVATION
P-85 PIEZOMETER NUMBER
198 STEAM MANHOLE NUMBER AND INSPECTION LOCATION
(642.7) STEAM MANHOLE FLOOR ELEVATION
650 GROUNDWATER CONTOUR AND ELEVATION
NOTE: BASED ON RJN READINGS FROM DECEMBER 21, 1989
Scale: 1" = 800'
N
NAVAL HOSPITAL
CAMP BARRY
INDUSTRIAL AREA
CONSTITUTION FIELD
INNER HARBOR
LAKE MICHIGAN
640
635
645
650
655
106 (635.2)
105 (644.7)
97 (642.9)
88 (647.0)
118 (640.3)
126 (649.4)
114 (641.7)
P-80 640.5
P-77 643.3
P-76 640.5
P-84 637.9
191 (642.7)
191B (638.7)
164 (643.0)
P-90 640.7
137 (639.5)
141A (642.7)
P-81 643.9
187 (641.2)
185 (644.5)
P-85 198
642.7 (642.5)
205 (642.7)
P-87 642.5
207 (648.6)
210 (651.9)
P-86 648.2
P-88 652.3
216 (663.5)
168 (644.8)
180 (656.3)
231 (653.4)
P-83 (648.0)
172 644.9
P-82
226 (661.3)
177 (656.4)
P-89
P-78 650.98
33 (652.9)
45 (655.8)
69 (650.2)
P-73 650.8
P-74 649.8
73 (653.9)
29 (647.8)
54 (655.0)
79
P-75 650.7
P-79 640.8
18 (646.6)
11 (645.3)
11-2
11-1
580.5
580.2
RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS
GROUNDWATER
ELEVATION MAP
MAINSIDE
EXHIBIT 10



LEGEND

CONTOUR INTERVAL 10 FT.

NOTES:

1. DATA FROM W-2 OF CLUSTER W-1, 2 AND 3
2. DATA FROM P-3 OF CLUSTER P-1, 2 AND 3

P — MONITORING WELL INSTALLED BY STRATIGRAPHICS, MARCH 1989

W — MONITORING WELL INSTALLED BY TESTING SERVICES CORP., MARCH 1989

◎ — STEAMLINE AND/OR RETURN LINE MANHOLE

MONITORING WELL

MONITORING WELL CLUSTER

NOTES:

BASED ON DONOHUE READINGS FROM MAY 15, 1989

ADD 580.91 FT. TO ELEVATIONS TO OBTAIN MEAN TIDE, NEW YORK HARBOR DATUM

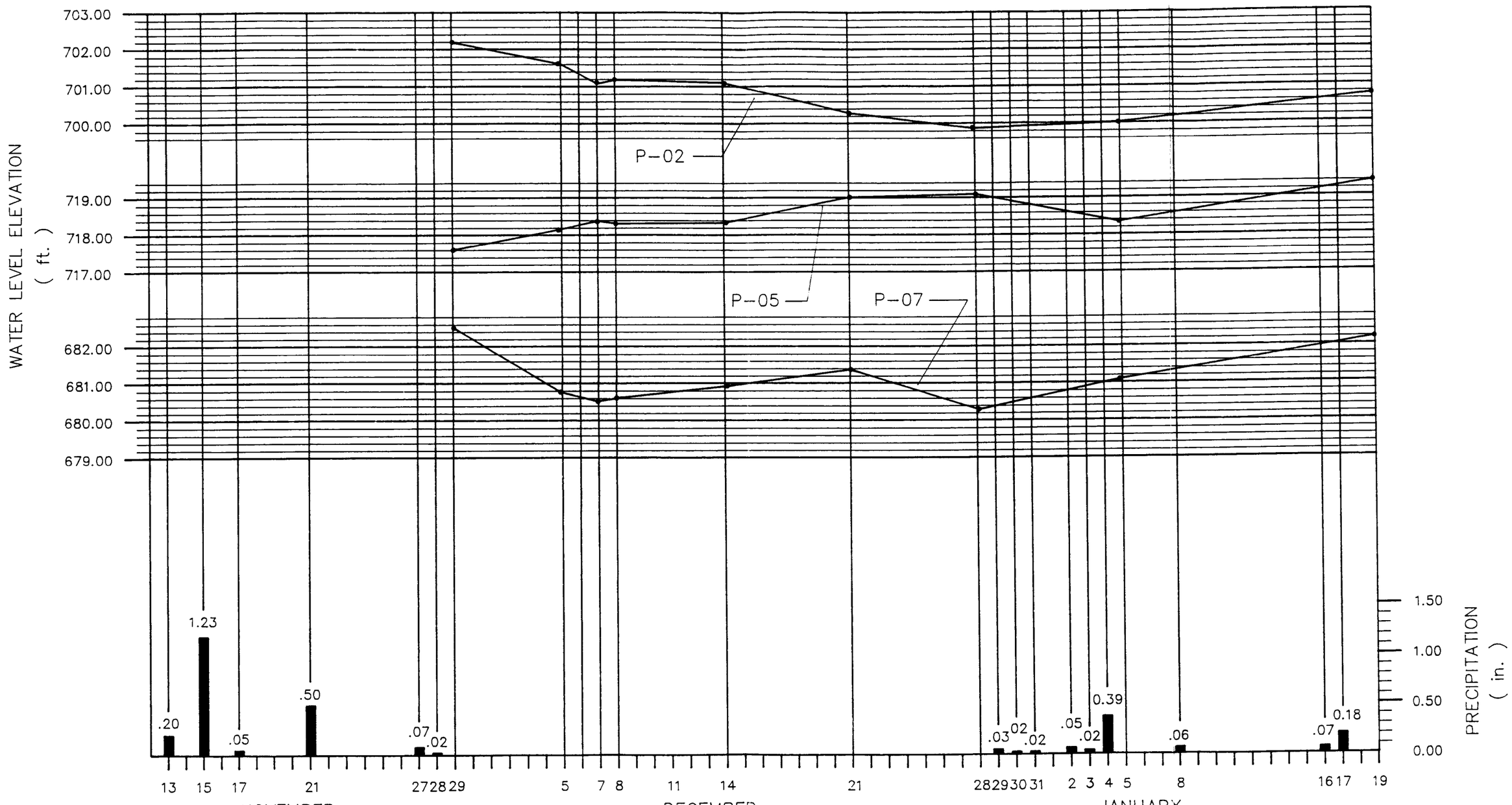
GROUNDWATER ELEVATION MAP

MAY 15, 1989 BY DONOHUE

CAMP PORTER

EXHIBIT 11

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

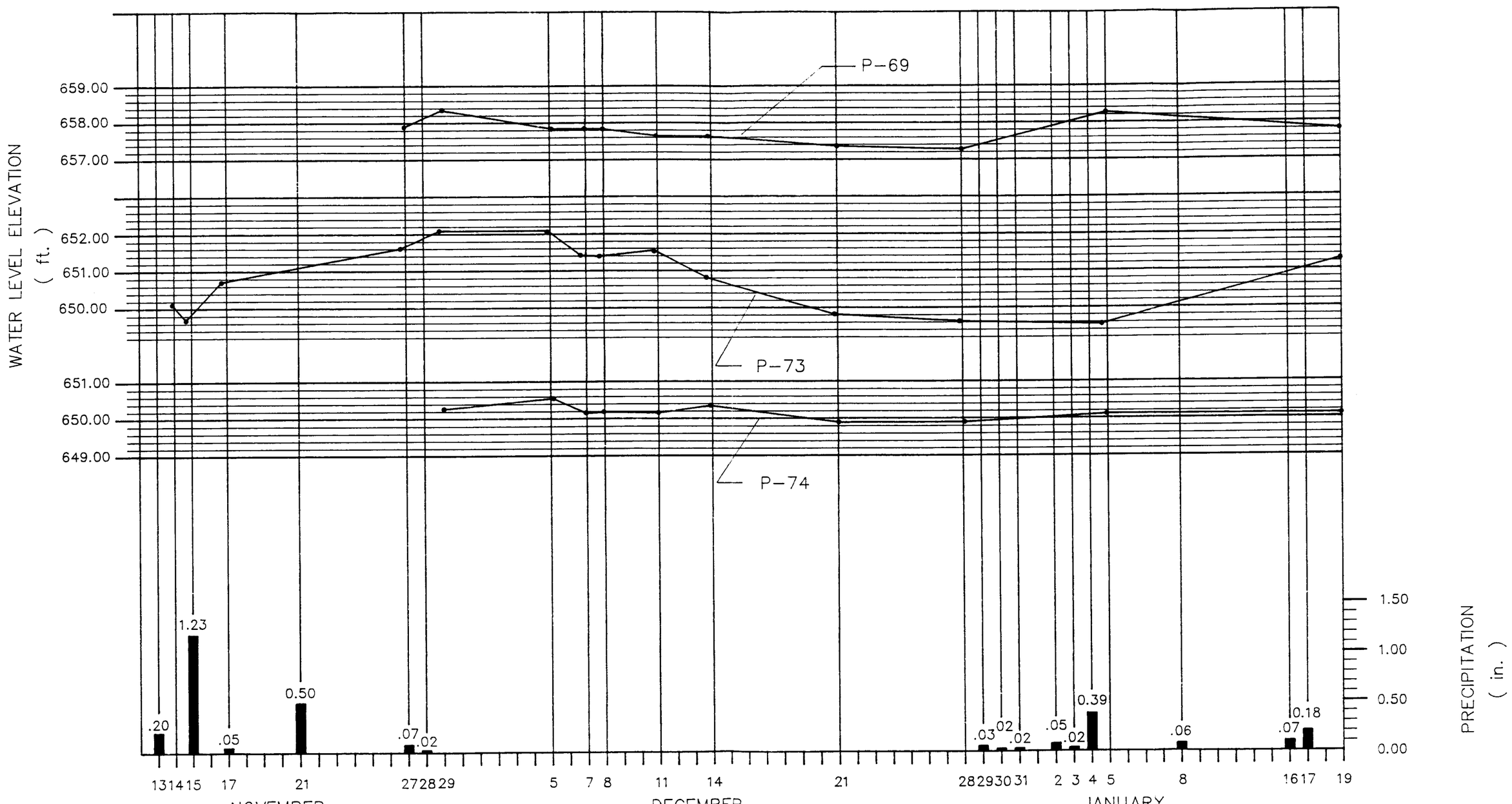


NOTE: P-05 INDICATES PIEZOMETER NUMBER

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-02, P-05, P-07

EXHIBIT 12

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

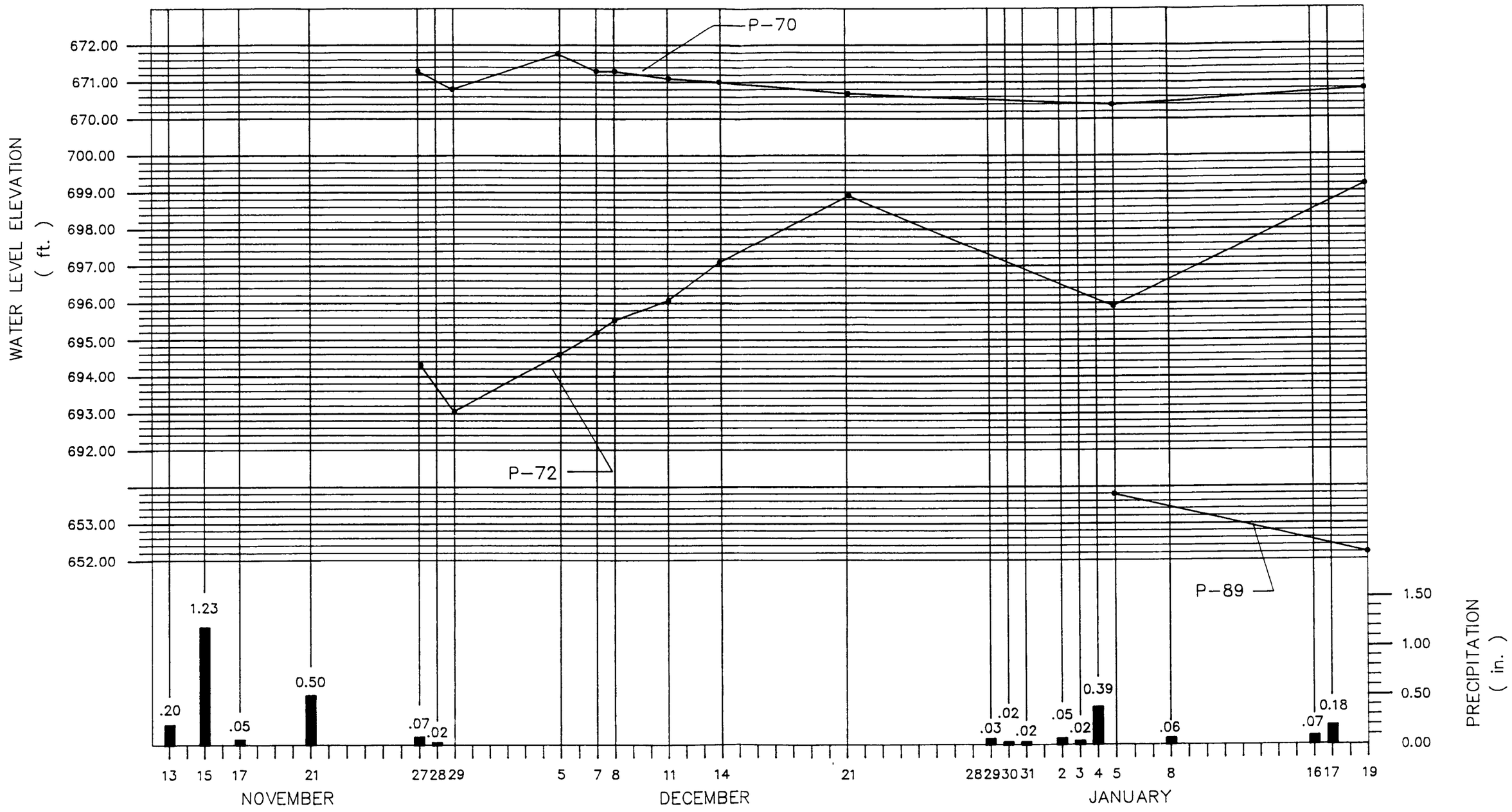


NOTE: P-73 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-69, P-73, P-74

EXHIBIT 13

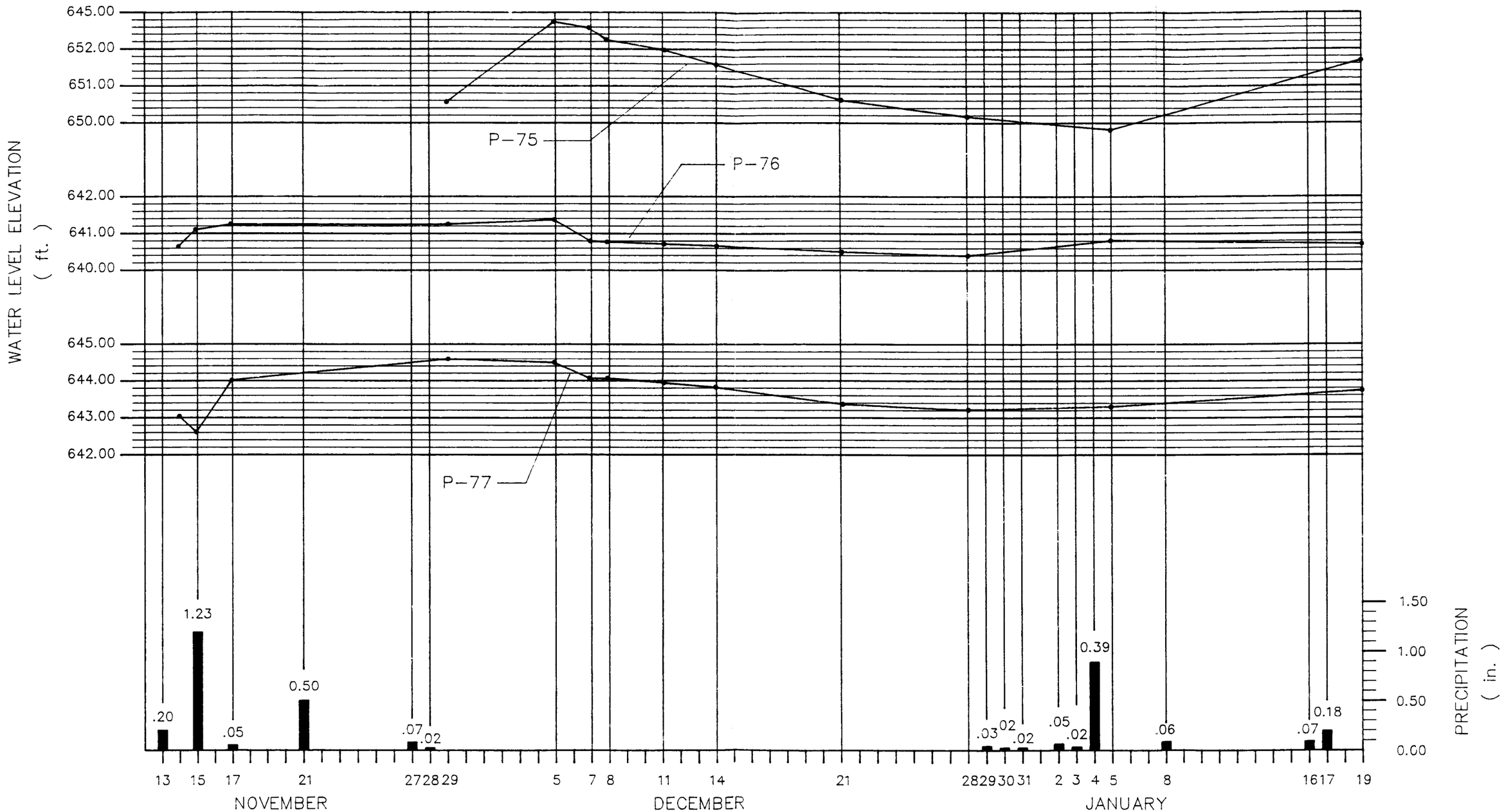


NOTE: P-72 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-70, P-72, P-89

EXHIBIT 14

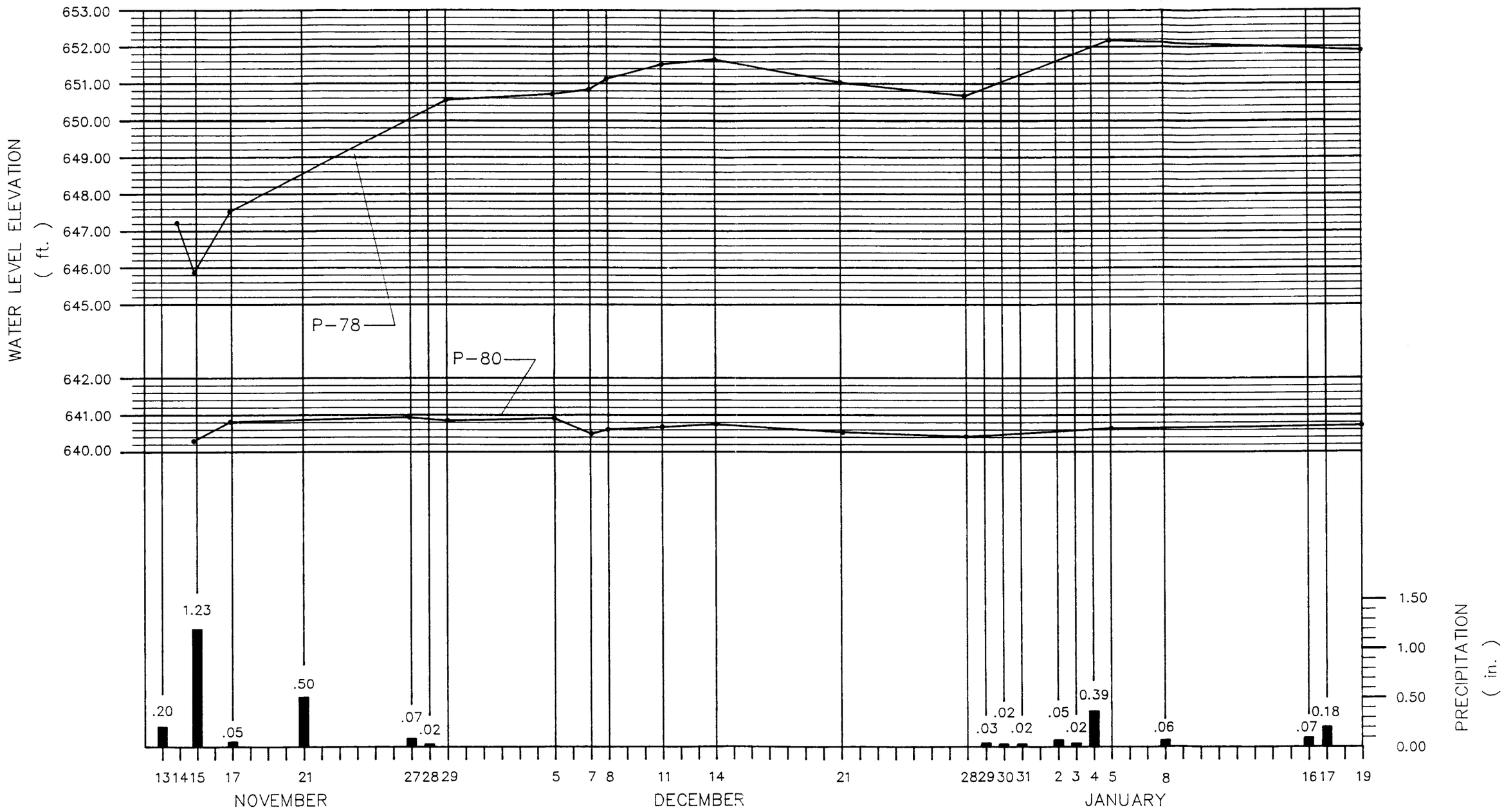


NOTE: P-76 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-75, P-76, P-77

EXHIBIT 15

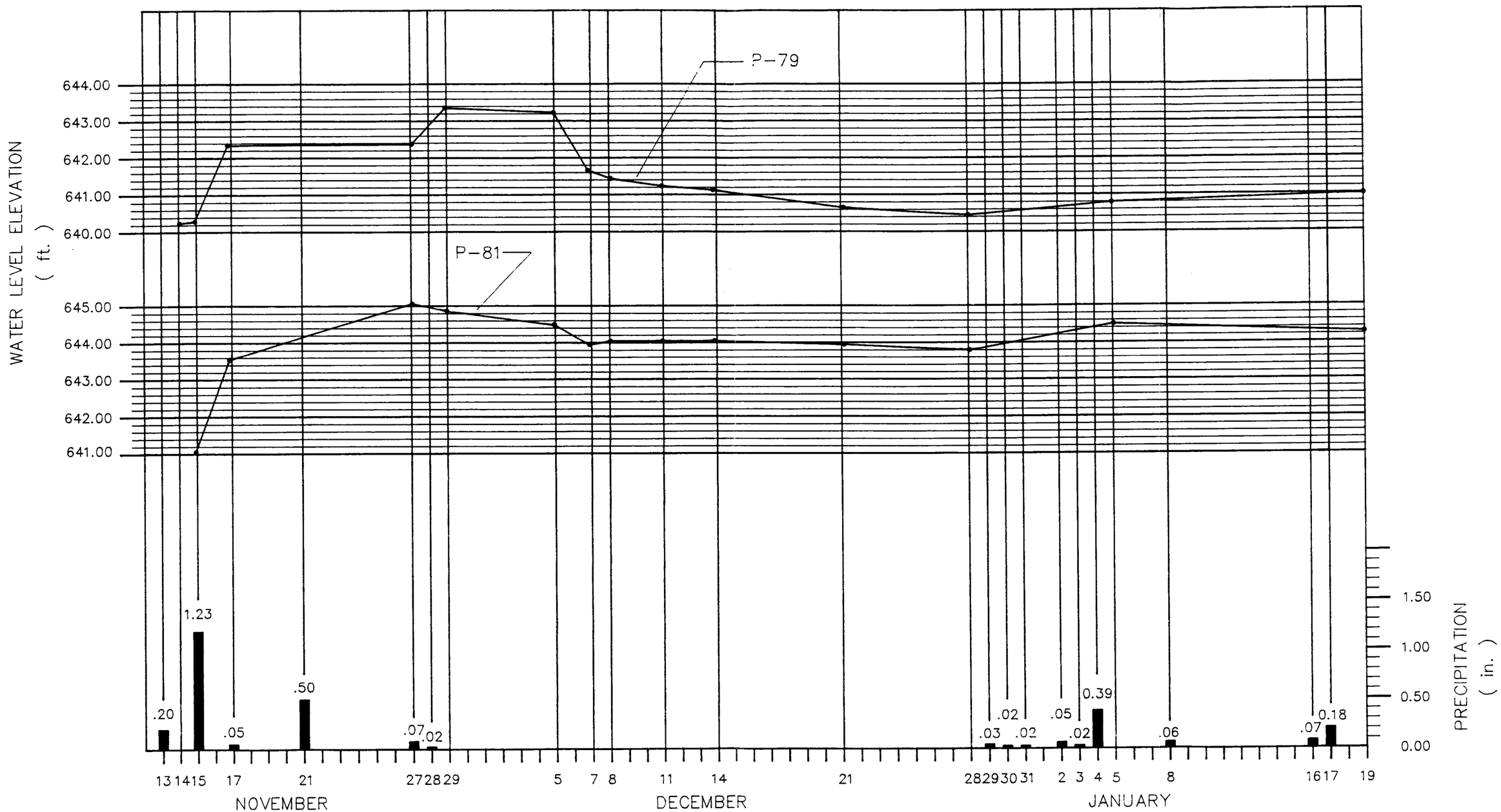


NOTE: P-80 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-78, P-80

EXHIBIT 16

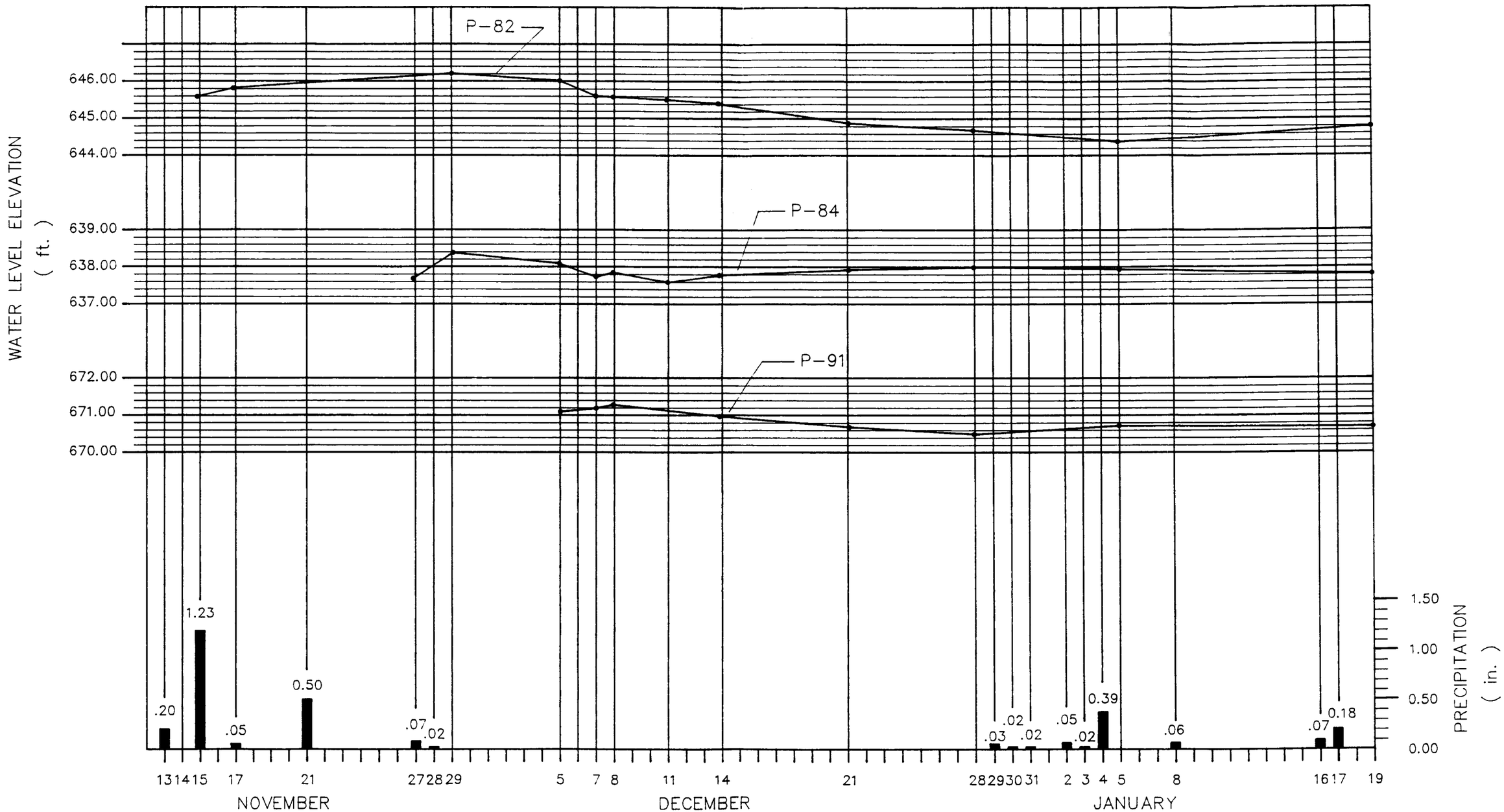


NOTE: P-81 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-79, P-81

EXHIBIT 17

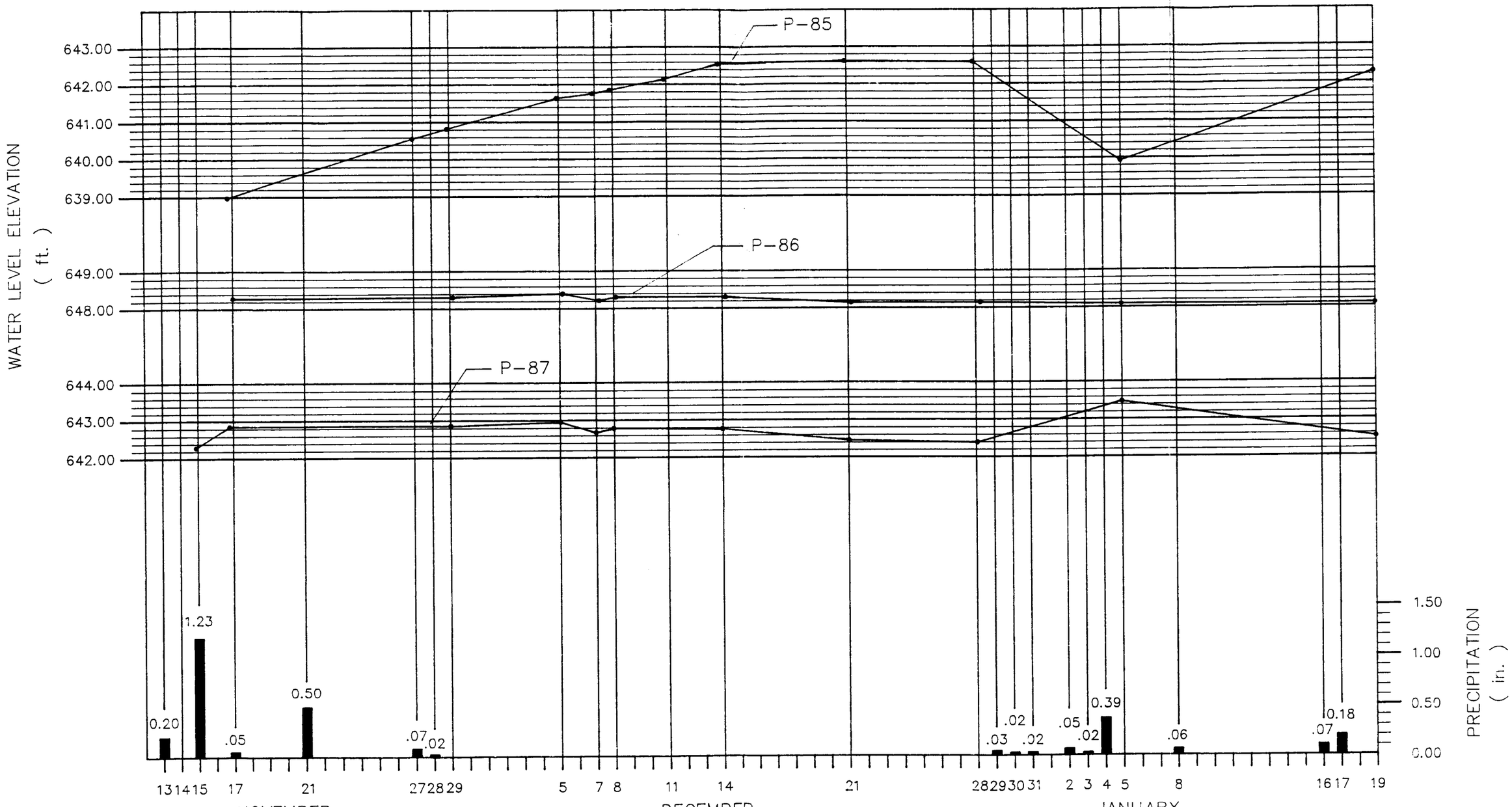


NOTE: P-84 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-82, P-84, P-91

EXHIBIT 18

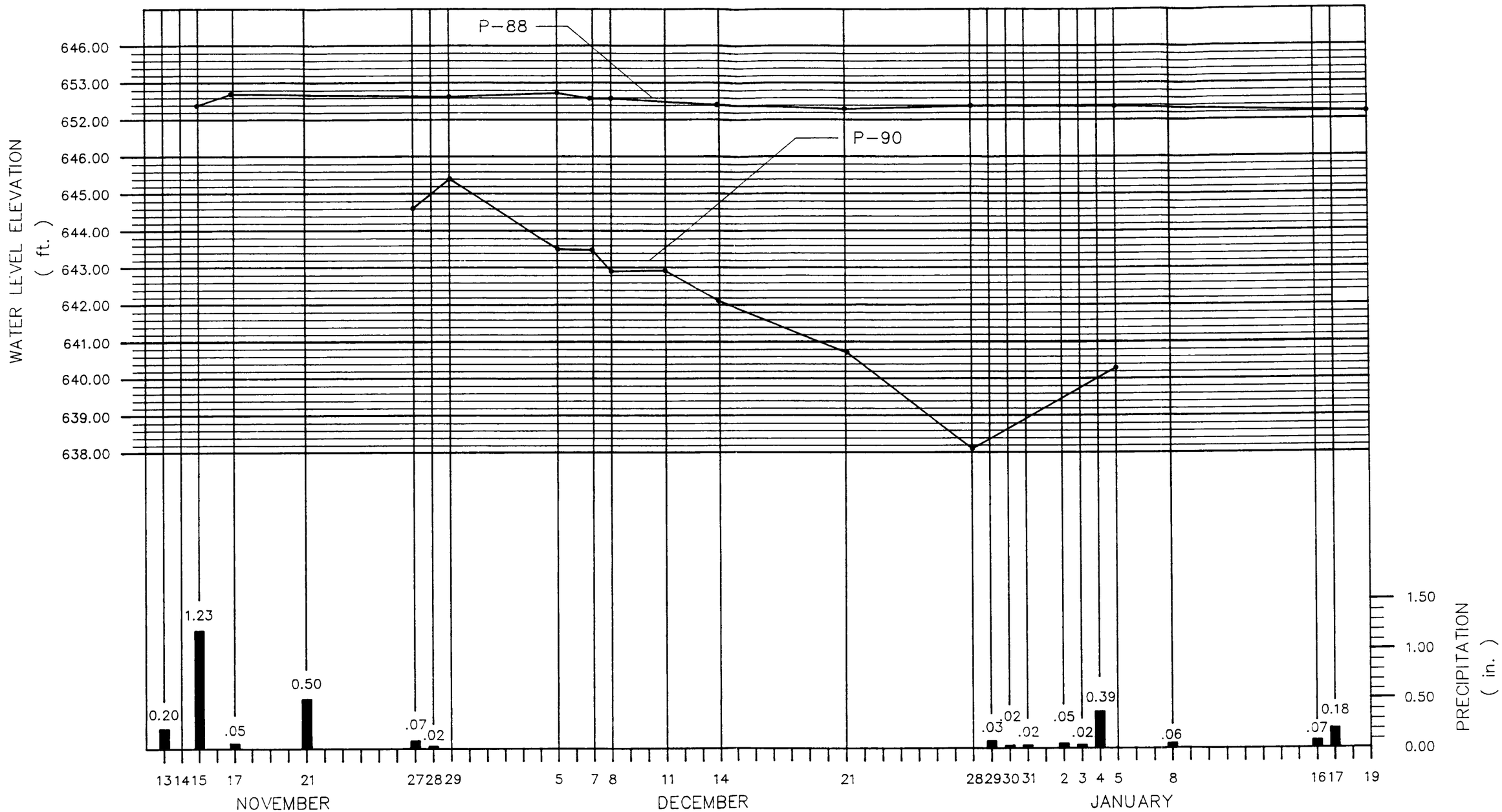


NOTE: P-86 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-85, P-86, P-87

EXHIBIT 19

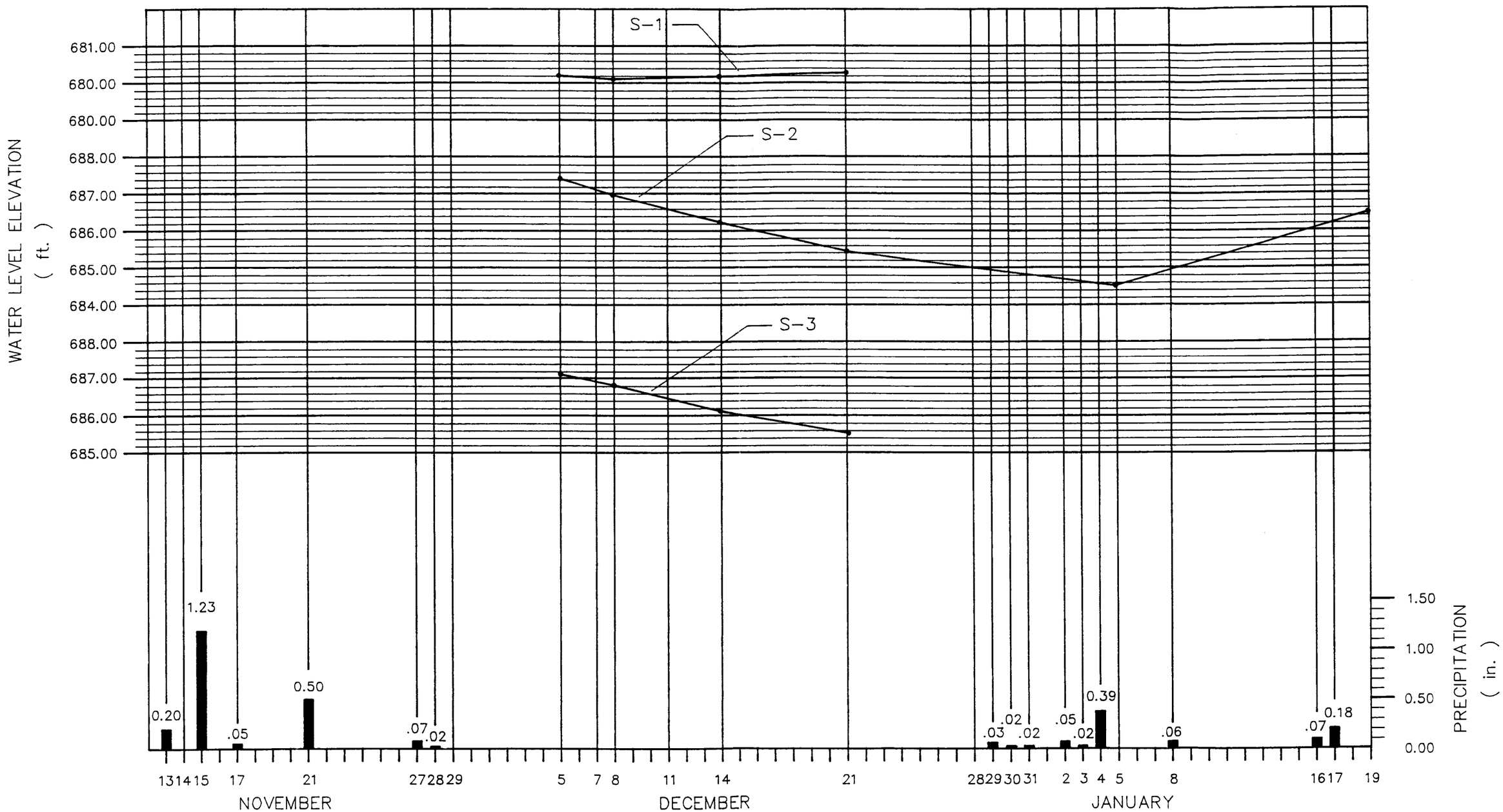


NOTE: P-90 INDICATES PIEZOMETER NUMBER

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
PIEZOMETERS P-88, P-90

EXHIBIT 20

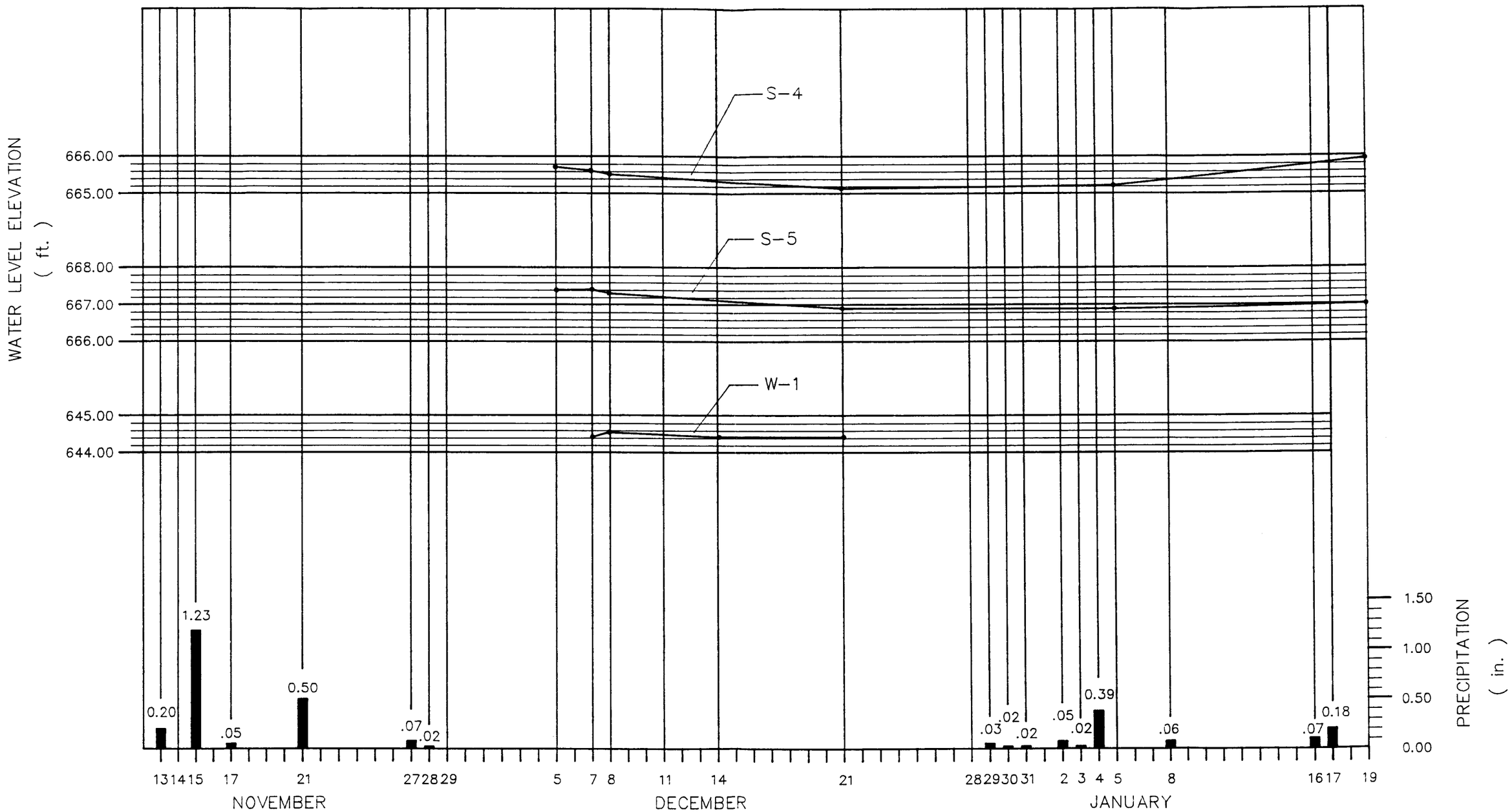


NOTE: S-2 INDICATES PREVIOUSLY INSTALLED PIEZOMETER
BY STRATIGRAPHICS - CAMP PORTER, MARCH 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
CAMP PORTER S-1, S-2, S-3

EXHIBIT 21

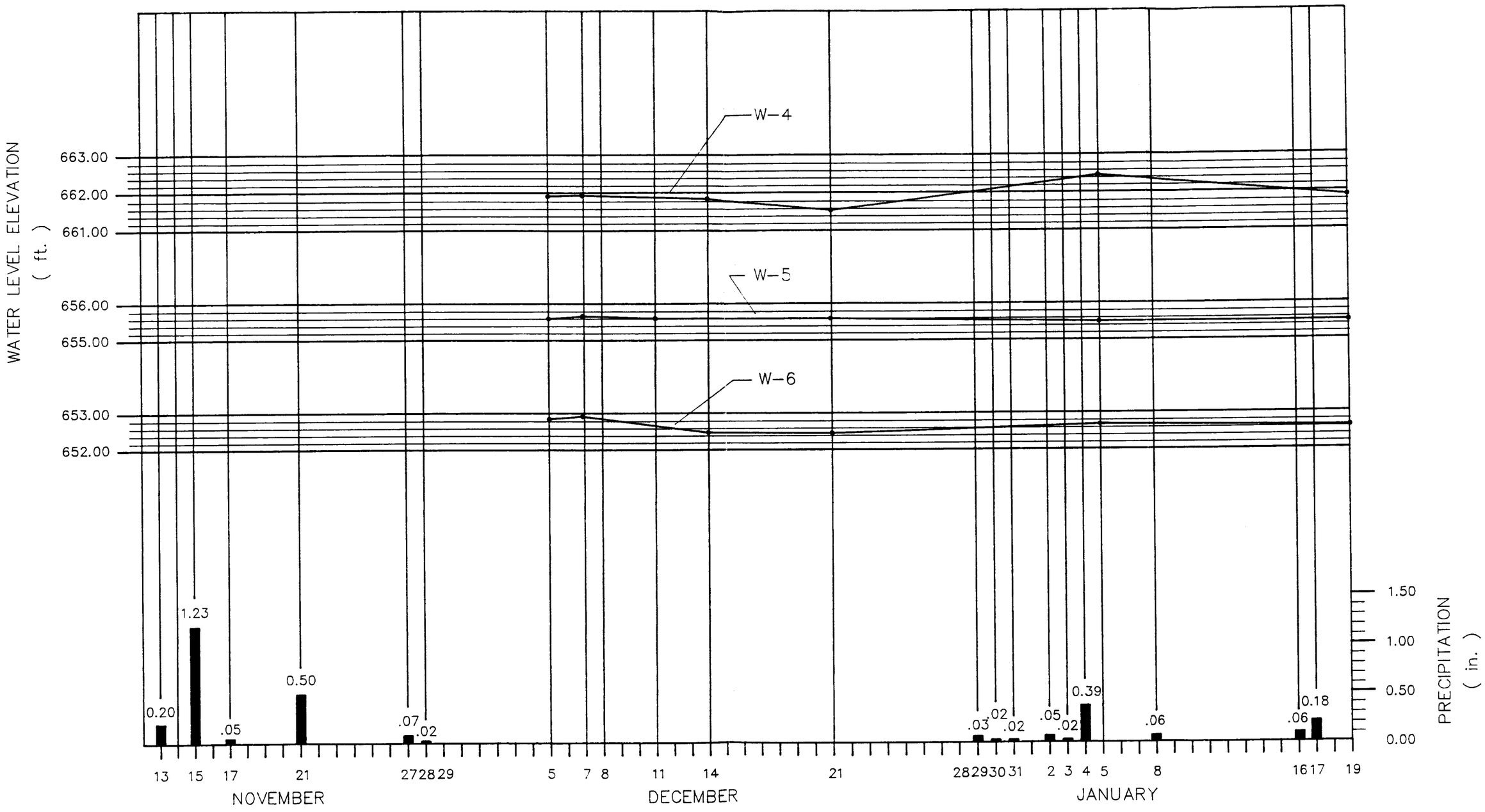


NOTES: S-4 INDICATES PREVIOUSLY INSTALLED PIEZOMETER
BY STRATIGRAPHICS - CAMP PORTER, MARCH 1989
W-1 INDICATES PREVIOUSLY INSTALLED PIEZOMETER
BY TESTING SERVICE CORP. - CAMP PORTER, MARCH 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
CAMP PORTER S-4, S-5, W-1

EXHIBIT 22

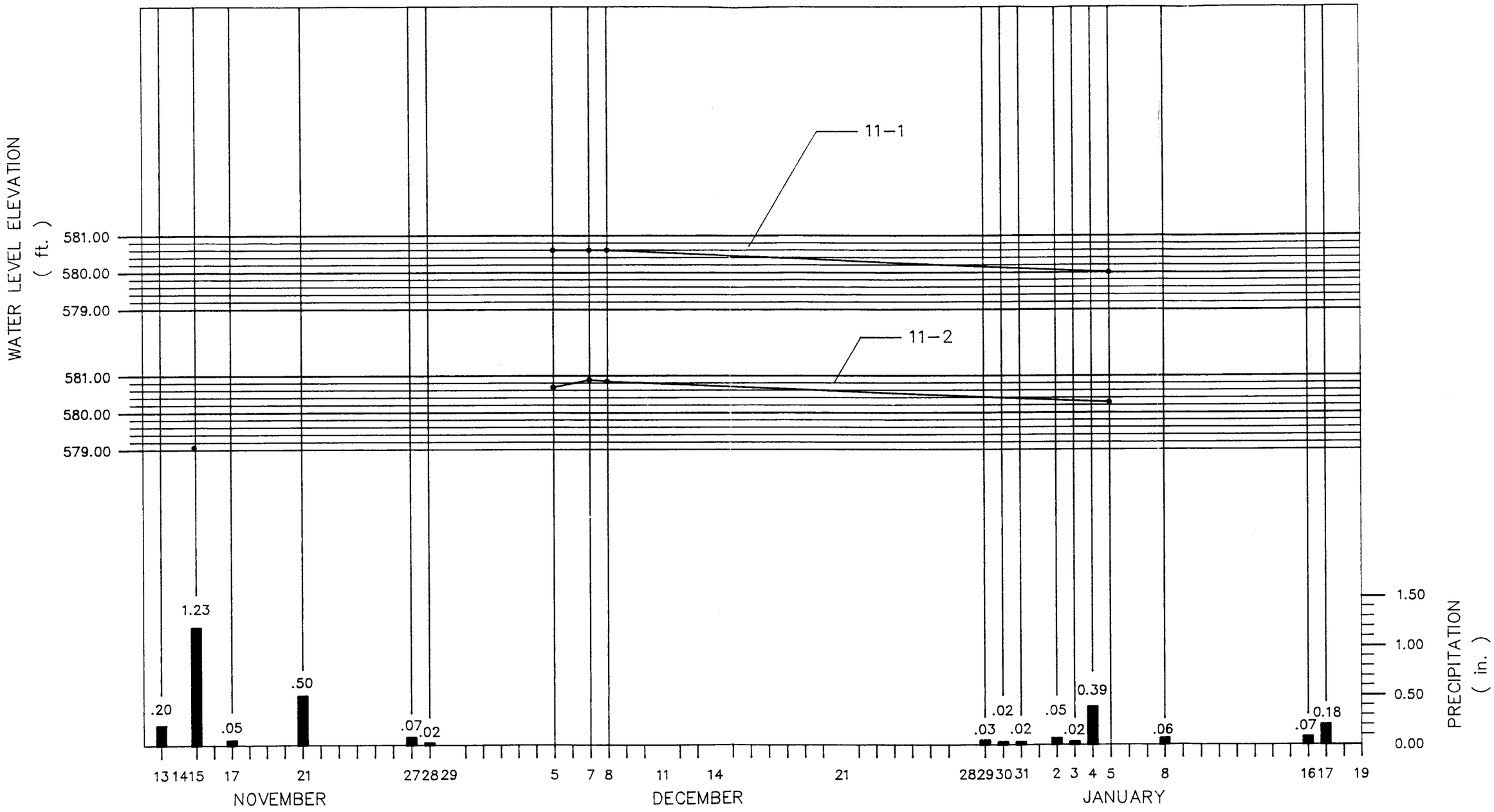


NOTE: W-5 INDICATES PREVIOUSLY INSTALLED PIEZOMETER
BY TESTING SERVICE CORP. - CAMP PORTER, MARCH 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL
HYDROGRAPHS
CAMP PORTER W-4, W-5, W-6

EXHIBIT 23

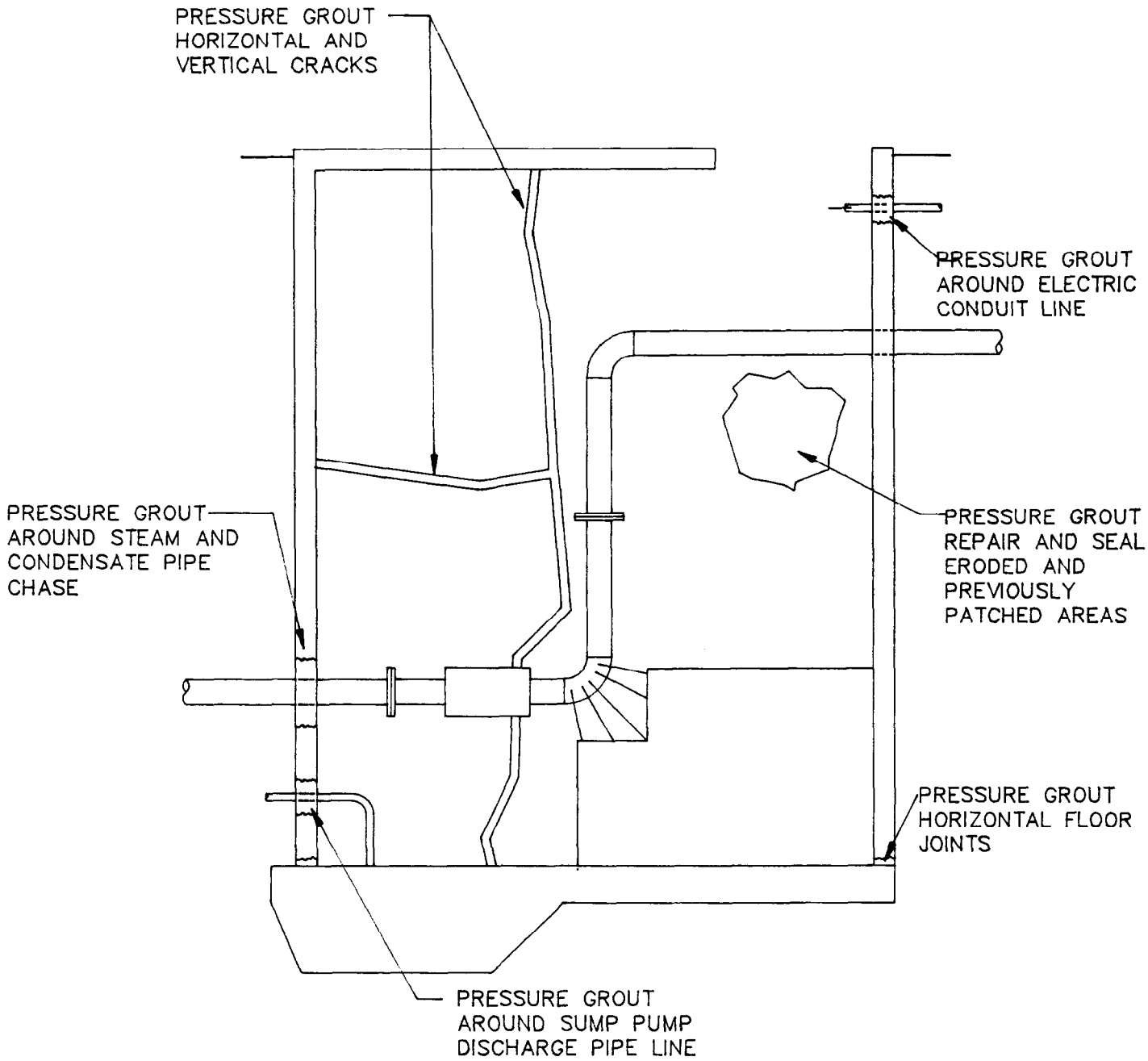


NOTE: 11-2 INDICATES PREVIOUSLY INSTALLED PIEZOMETER
BY SOIL TESTING SERVICE - BUILDING 11, APRIL 1989

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

PRECIPITATION AND WATER LEVEL HYDROGRAPHS
BUILDING 11 11-1, 11-2

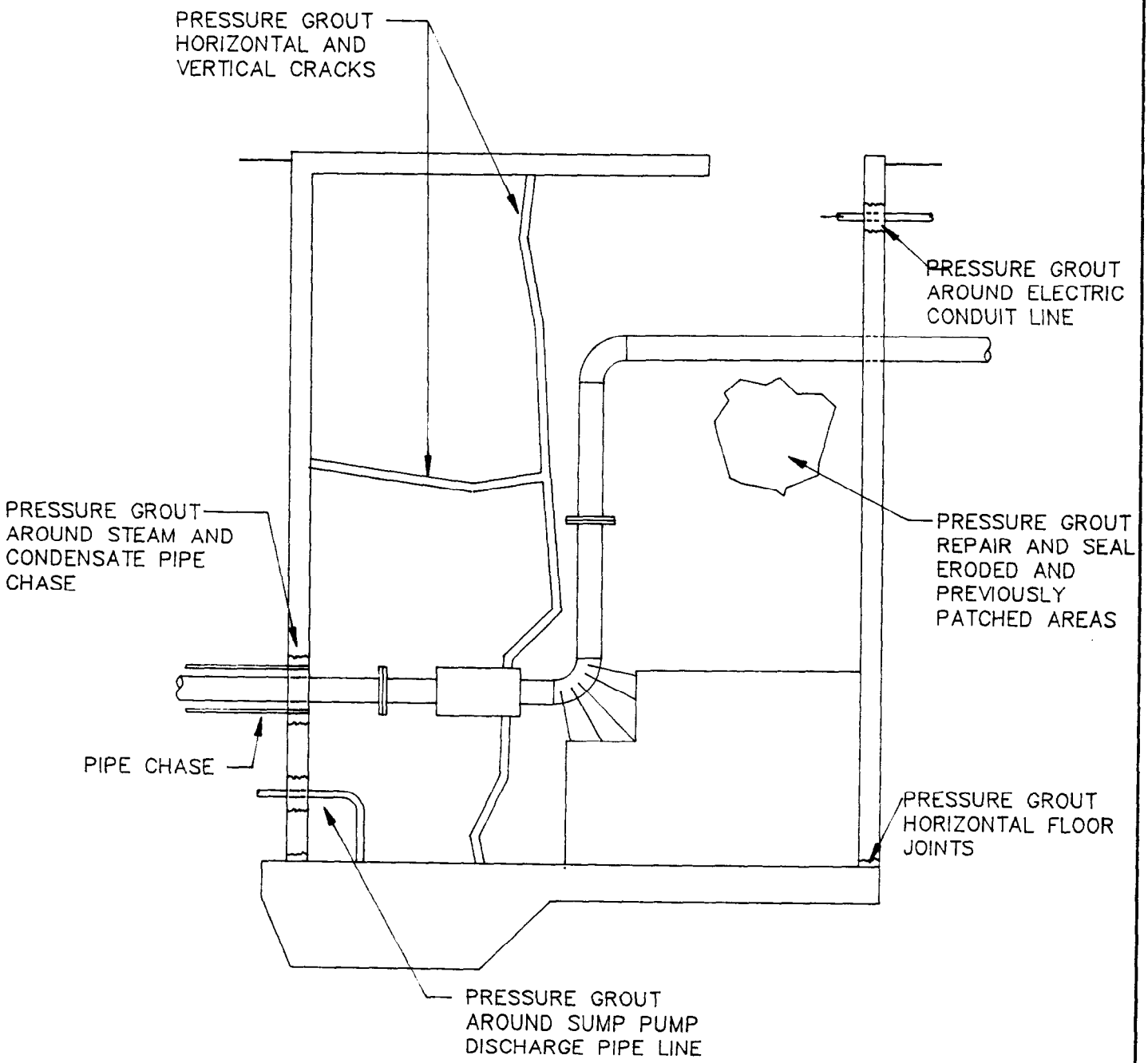
EXHIBIT 24



TYPICAL STEAM MANHOLE WITH DIRECT BURY WATERPROOFING SCHEMATIC

EXHIBIT 25

RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS



RJN ENVIRONMENTAL ASSOCIATES, INC.
CONSULTING ENGINEERS

TYPICAL STEAM MANHOLE WITH PIPE CHASE WATERPROOFING SCHEMATIC
EXHIBIT 26

APPENDICES

LIST OF APPENDICES

Letter	Title
A	Testing Service Corporation Report
B	Piezometer Water Level Data
C	Steam Manhole Inspection Forms
D	Cost Estimates
E	Cost Benefit Analyses
F	Operations Forum, Sewer Rehab by Richard J. Nogaj
G	Grout Specifications

APPENDIX A

TSC

TESTING SERVICE CORPORATION

457 EAST GUNDERSEN DRIVE • CAROL STREAM, ILLINOIS 60188-2492 • FAX: (312) 653-2726 • Telephone 312 653-3920

January 8, 1989

RJN Environmental Associates, Inc.
202 West Front Street
Wheaton, Illinois 60187

Attention Mr. Bruce Aderman

RE: L - 27,681
Great Lakes Naval
Training Center
Great Lakes, Illinois

Dear Mr. Aderman:

Testing Service Corporation (TSC) has completed the work required for a groundwater investigation at Great Lakes Naval Training Center. This investigation was prompted by occurrences of high water levels in the soils and corrosion of buried pipes that are part of the steam distribution system for the Training Center. The purpose of the investigation was to determine the cause of and extent of these conditions.

The work was conducted in three phases. The first phase involved reviewing background information pertinent to the work being performing and conducting a site reconnaissance. The second phase consisted of a program of field work which included soil borings, piezometer installations and tests for infiltration and permeability. The third phase concerned analysis of the results from the field work and preparation of a report. The work was performed generally during November and December of 1989.

The search for background information conducted during the first phase of work was aimed toward the geology, soils and physical environment of the site. Sources for this information were available through the Illinois State Geological Survey, the Soil Conservation Service, local maps of topography and drainage, and reports of past work performed at the site. A bibliography is included with this correspondence. A site reconnaissance was also conducted to correlate the existing soils and geology with the background information obtained.

The geology of the Training Center area is the result of both glacial activity and erosion and deposition from Lake Michigan. The training center lies at the southern end of the Zion City Moraine which is part of the Lake Border Morainic System. The Lake Border moraines were created from a lobe of glacial ice that advanced just past the current shorelines of Lake Michigan. The moraines were formed from material deposited from the melting ice as the moraines retreated from the area. During its retreat the ice blocked the drainage path of waters from Lake Michigan and the levels of the Lake rose to elevations much higher than present. During this high water period, much of the area around the Zion City moraine was eroded and several sand bars and beach deposits were formed. After final retreat of the ice, Lake Michigan drainage was restored and the waters reverted to current levels. In the process, the existing lake side cliff and beaches were formed.

The Lake Border moraines consist of poorly sorted deposits of silt and clay with occasional layers of silt or sand. This glacially deposited material is called Till and in the Lake Border moraines it is referred to as the Wadsworth Till which belongs to the Wedron Formation. The sand deposits formed during the high water levels of Lake Michigan are referred to as the Dolton sand which belongs to the Equality Formation.

The soils found throughout the site correspond to the type of geologic material deposited. The vast majority of the site lies on deposits of glacial till upon which have developed the large amount of silty clay soils that are found at the site. Because of its clayey composition glacial till typically produces silty clay or clayey silt soils. At the northern end of the Mainside area, approximately north of Pullam Avenue and east of Luce Boulevard, and in Forrestal Village along the creek on the west side the deposits are sand from bars created by Lake Michigan or alluvial deposits from stream flow. The soils that have developed from these deposits are typically fine grained silty or clayey sands. Rarely, were any coarse grained granular soils found at the site and those that were consisted of thin layers of sand and gravel that formed as inclusions in the glacial till.

The third major soil type found at the Training Center site was fill material placed as a result of construction activities that have occurred during the history of the site. The majority of the fill material was found on the Mainside portion of the site where 47 of the 54 soil borings in that area found fill material either at ground surface or directly below the topsoil. All of the 12 borings in the Halsey/Nimitz area found fill material while 15 of the 18 borings in Forrestal Village encountered fill material. The fill was found in thicknesses ranging from 1.5 to 6.0 feet. The fill consists generally of silty clay soils mixed with varying amounts of sand, gravel, cinders, brick fragments, glass, wood and other construction debris. Placement of the fill generally consisted of spreading by a dozer type vehicle. It is unknown if any compaction was applied to the fill as it was placed. Therefore the presence of voids or pockets of loosely compacted material should be anticipated in the fill material.

The site reconnaissance revealed a generally level site atop the steeply sloping shoreline of Lake Michigan. The south end of the site is deeply dissected by ravines formed by streams flowing down the side of the slope into Lake Michigan. As the site moves farther from the lakeshore in the Halsey/Nimitz and Forrestal areas the ground surface rises gently by approximately 50.0 feet. Along the immediate lakeshore, the ground surface drops steeply to the lake surface for a vertical distance of approximately 50.0 feet. A typical beach environment exists at the base of the slope with the predominant soils being beach sand.

The land use at the Training Center consists of a campus type setting with various buildings, parking lots and roads with intervening areas of grass lawn. The two residential areas consist of multifamily housing units, roadways and grassed lawns. With the exception of the ravines, there are no areas where the subsurface soils can be directly observed. A reconnaissance of the soils exposed in the ravine between Mainside and Hospitalside showed sandy soils typical of Lake Michigan deposition at the east end of the ravine. Further west and throughout the majority of the ravine typical clayey glacial till soils were found. The contact point between the two soil types was noted at the first major bend in the creek approximately parallel with Seventh street.

The second phase of work for this project consisted of performing the field investigations. This work included drilling a series of 89 soil borings, the installation of 25 piezometers, performing 15 infiltration tests using both double ring and auger hole methods, and performing slug tests for permeability in the completed piezometers. The scope and quantities of work to be performed were determined by the Department of the Navy prior to the start of work. The locations for the various procedures noted above were selected by Testing Service Corporation. Those locations were verified and located in the field and ground surface elevations were determined by RJN Environmental Associates, Inc.

The locations of the soil borings were made in accordance the scope and direction of the project as well as general instructions from the Department of the Navy. The primary instruction from the Navy was that 75.0 percent of the work be conducted in the Mainside area and the remaining 25.0 percent be divided between the two residential areas. The number of soil borings and piezometers were so allocated. The locations were then assigned so as to provide random coverage of the site that would provide information representative of conditions over the entire site to a depth of 25.0 feet. The twenty deep borings were first distributed across the site on a roughly drawn grid system that was adjusted for the non-linear boundary lines of the site. The 25 piezometers were likewise placed on the grid and then the 45 shallow boring were assigned locations to fill in the remaining areas of the grid.

In addition to achieving random coverage of the site, the boring locations were also selected to monitor the difference between the soils near the pipes and vaults of the steam distribution system and soils that were distant from the system. Approximately fifty percent of the borings in each of the three categories were placed near various portions of the distribution system and the remaining fifty percent were located in neutral areas that were not affected by the system. Mainside is the area most significantly affected by this location pattern. A list of the borings that are both close and distant with respect to the steam distribution system is shown on Table 1 which is included with this correspondence.

There is no extension of the steam distribution system into Halsey/Nimitz Village, so all borings in that area are in neutral ground. Only borings 12, 17 and 69 in Camp Moffett are located near the distribution system in the Halsey/Nimitz area. In Forrestal Village, the steam system is found only along the far north and west sides of the area so that only borings 6, 9, 10, 47, 49, and 68 are located near the steam pipes.

The soil borings were made according to currently recommended American Society for Testing and Materials procedures. They were advanced by either solid or hollow stem auger methods. The soil samples were obtained using split spoon methods on 2.5 foot intervals for the soil borings and continuous intervals for the piezometer borings. These intervals were used to economically provide detailed stratigraphic information of the subsurface soils. The continuous sampling in the piezometers was required to identify all layers of water bearing soils no matter how small in order to determine the correct portion of the soil for the piezometer to screen. The borings were numbered 1 through 91, however numbers 44 and 45 were unknowingly omitted so the total number of borings is 89.

The depths of the soil borings were determined by the Department of the Navy prior to the start of work with minor adjustments made during the course of the work. The borings were grouped into three categories by depth. Forty-four of the borings were drilled to shallow depths ranging from 6.0 to 12.5 feet below ground surface. Only 3 of these borings however, were deeper than 7.5 feet. Although only 44 borings were made the total linear feet of the shallow borings equaled the originally specified 292 feet. Twenty of the boring were drilled to a depth of 25.0 feet and the 25 piezometer borings were drilled to depths ranging from 5.5 to 22.0 feet. Although the depths of the individual piezometer borings varied, the total depth of the 25 piezometers was 316 linear feet. A field log of each boring was prepared as the drilling was performed. The boring log contains the drilling and sampling intervals, the drilling data pertinent to the samples and the soil descriptions. A copy of each log is included with this correspondence as well as a legend explaining the log.

The piezometers were constructed of either 1.0 or 1.25 inch diameter flush joint Schedule 40 PVC pipe and screen. The screens were either 2.5 or 5.0 feet in length and had 0.010 inch machine cut slots. The length of the screen was dependent on the thickness of the soil layer being monitored by the piezometer. Generally a 5.0 foot screen was used unless the shorter screen was found to be adequate. The annular space around the screen was filled with a uniformly graded, coarse grained sand that is 98.1 percent pure silica dioxide (SiO_2). A grain size analysis of the sand shows that 98.2 percent of the sand is retained on the Number 20 Sieve. Overlying the sand, a bentonite seal was placed to ground surface. The seal consisted of chips of bentonite placed in the borehole and hydrated to form a dense yet plastic seal. At the completion of the project all but 5 of the piezometers will be removed and the area around the borehole restored to natural conditions. The 5 piezometers that remain will be constructed as permanent features by placing a steel protective cover over the PVC pipe and imbedding the cover in the bentonite seal material. An area 2.0 - 3.0 feet in depth will then be excavated around the piezometer and refilled with concrete to secure the piezometer and cover. Readings from the piezometers were taken by RJN Environmental Associates, Inc. "As-built" drawing of the 5 permanent piezometers will be prepared when the 5 permanent locations are designated.

The samples obtained from the soil borings were examined and described in the field and representative portions were placed in glass jars and returned to the TSC laboratory. Therein, the descriptions were verified and Unified Soil Classifications were assigned to the samples. Representative samples of the fill material, the silty clay till soils and the sandy soils were selected for additional testing. Twenty-five samples were tested for moisture content and Atterburg limits. Those samples are identified and the results of the testing are listed in Tables 2 and 3 included with this correspondence. Fifteen of these samples were also tested for permeability by the triaxial laboratory procedure. An additional 10 samples of sandy soils were selected for permeability testing by the constant head laboratory method. The 15 samples tested for triaxial permeability were also subject to grain size analysis including the hydrometer. The 10 samples tested by the constant head procedure were subject to sieve analysis to determine the grain size distribution. The results of the permeability testing are presented in Table 4. The grain size data are shown on the enclosed graphs.

When ever possible samples selected for permeability testing were taken from the soil layers that were screened by the piezometers. This was done to correlate the laboratory results with the results of the field testing. If those samples were not available or were not appropriate in some manner for the laboratory test, then a representative sample of that soil from another boring was used. It was also a goal of the testing program to include representative samples of all the different soils found in the borings. Nine samples of the fill material were selected; thirteen samples of the silty clay till soils were used; three samples of silty soils from the glacial till were tested and ten samples of sandy soil either from layers of sand within the glacial till or from deposits formed by the past high water levels of Lake Michigan.

The final set of laboratory tests to be performed was an analysis of selected samples for corrosion potential. Fifteen samples were selected for this testing based on obtaining random representative samples from the entire site. The samples were all taken from a depth of approximately 4.0 feet which is the depth at which, it is anticipated, the pipes would be buried. The samples were subjected to a series of tests including pH, Resistivity, Sulfide content and Oxidation-Reduction potential. The results of these tests were then evaluated on the basis of a point system established by the Cast Iron Pipe Research Association. A copy of the table explaining the point system is included with this correspondence. The total number of points for each set of tests determines whether the soil has a positive or negative potential for corrosion. The results of the testing are listed on Table 5.

Ten of the shallow borings were selected on a random representative basis for field permeability tests using a borehole method. At these locations, a 1.5 inch diameter schedule 40 PVC pipe with attached 5.0 foot screen was placed in the completed borehole. The coarse grained sand noted previously was placed in the annular space around the screen and a bentonite seal was placed atop the sand in the uppermost 1.0 foot of the borehole. This created in each of these 10 borings a 5.0 foot section of soil in which to measure water movement. The 10 borings that were used are identified in the following list.

BORINGS	
11	35
12	36
14	41
21	43
25	66

The soil interval measured in these borings generally included more than one soil type. They were selected to give representative coverage to all the soils found at the site with some priority to measuring areas of fill material as that was the most prevalent near surface soil type found at the site. Borings 11, 14, 35 and 36 measured intervals that were combinations of fill material over silty clay till soils. Borings 43 and 66 measured intervals that consisted primarily of fill material. Borings 21 and 25 measured primarily silty clay till soils. Boring 41 sampled an interval of fill material that was extremely porous and showed a rate of water movement into the fill that was too fast to measure.

These tests were initially intended to measure permeability of the near surface soils, however the drilling logs showed that the groundwater level across the site was generally lower than the 6.0 foot depth to which the boreholes were drilled. Therefore, all but one of the locations encountered dry unsaturated soils in the test interval. It is not possible to measure permeability in an unsaturated soil because the water movement that is measured would not be mass movement of water through the soil but movement of water into the empty pores between soil particles. This will give a higher rate than true permeability. Because of this a percolation test was performed in the borehole rather than a permeability test. The infiltration rate of water into the unsaturated soils was determined. The test was performed by filling the PVC pipe with water and allowing it to soak into the ground to achieve an initial saturation. The pipe was then refilled and the drop in the water level inside the pipe was measured at a series of timed intervals. The total volume of water used during the test was then calculated and divided by the total surface area of the test interval in the borehole. This determined the horizontal infiltration rate in centimeters per hour (cm/Hr). The results of the tests are listed in Table 6.

Infiltration was also measured at the ground surface using the double ring infiltrometer method. These tests were conducted in accordance with ASTM procedure D 3385-88. Two steel rings 12 and 24 inches in diameter were used. A water supply tank with a capacity of 10.3 liters was used for the smaller inner ring while a tank with a 25.5 liter capacity was used for the annular space in the large ring. Both tanks had graduated sight tubes for measurement of the water used during the test. The water level in both rings was held at a constant reading during each of the tests. The levels were generally between 12 and 14 inches all of the tests. The total volume of water used during each test was calculated and divided by the total area of both the inner ring and the annular space in the large ring. The results are listed on Table 7 and shown on the enclosed graphs. The infiltration rates determined by the double ring method are vertical infiltration.

Test number four measured zero infiltration over a 2.0 hour monitoring period. This result is abnormal in comparison to the other 4 tests. It is likely this result has been affected by a source other than the test procedure itself. That source may have been imposed by the cold weather present at the time or the particular soil conditions at the exact site of the test.

The final set of field tests involved measuring the permeability of the soils monitored by the piezometers. This was done by means of a rising head slug test. The procedure was performed in 10 of the piezometers that were selected on a random representative basis. The test procedure consisted of either bailing the piezometer dry or removing as large a volume of water as possible in a very short period of time, the amount of which is controlled by the recharge rate of the water in the soil layer being monitored, and then measuring the amount of water that reenters the piezometer at a series of timed intervals. The permeability was then calculated using a formula for a well point-filter in uniform soil that was developed by Hvorslev. The formula and the test results are detailed on Table 8.

It has been a pleasure to be of assistance with this project. Please call if there are any questions concerning this work.

Respectively submitted:

TESTING SERVICE CORPORATION

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Enclosures

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TABLE 1

MAIN SIDE BORING LOCATIONS WITH
RESPECT TO STEAM DISTRIBUTION SYSTEM

BORINGS CLOSE TO SYSTEM	BORINGS DISTANT FROM SYSTEM
20	18
22	19
25	21
27	23
28	24
32	26
33	29
34	30
35	31
40	36
41	37
42	38
53	39
54	43
55	58
56	61
57	63
59	64
60	65
62	75
76	77
79	78
80	83
81	86
82	87
84	89
85	
88	

TABLE 2
WATER CONTENTS AND SOIL CLASSIFICATIONS

BORING	SAMPLE	WATER CONTENT	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION
1	2A	16.1 %	CL	Brown and gray silty CLAY, trace sand, gravel and organic material, moist
5	3	16.8 %	CL	Brown and gray silty CLAY, trace roots, sand and gravel, moist
6	2A	19.3 %	CL	Brown silty CLAY, trace sand and gravel
7	1B+2	10.0 %	SM	Brown silty SAND, trace gravel, moist
10	1	9.1 %	CL	Brown silty CLAY, trace sand and gravel with organic material, moist
12	3&4	10.1 %	SW	Brown fine to coarse SAND and small gravel, occasional cobble, damp
13	2A	26.4 %	CL	FILL - Brown and gray silty CLAY, trace topsoil, sand and small gravel, moist
14	3B	20.6 %	CL	Brown and gray silty CLAY, trace sand, gravel, moist
17	1A	21.2 %	CL	FILL - Dark brown silty CLAY, trace sand gravel, moist
17	2A	12.6 %	CL	Brown and gray silty CLAY, trace sand, gravel and organic, moist
25	2	17.6 %	CL	Brown and gray very silty CLAY, trace sand and gravel, trace silt seams, damp
35	2A	16.4 %	CL	FILL - Brown and gray very silty CLAY, trace sand and gravel, trace organic, damp
39	2B	18.7 %	CL	FILL - Brown and gray silty CLAY, trace sand, gravel and organic material, moist
43	1B	11.7 %	CL	FILL - Brown silty CLAY, trace sand and gravel and organic material, moist
46	6	NC	SM	Brown and gray fine silty SAND, small to large gravel, wet
47	5	18.8 %	CL	Gray silty to very silty CLAY, trace to little sand, trace gravel, moist
53	3	25.9 %	CL	Dark brown and gray silty CLAY, little sand, moist

TABLE 2
WATER CONTENTS AND SOIL CLASSIFICATIONS

BORING	SAMPLE	WATER CONTENT	UNIFIED SOIL CLASSIFICATION	SOIL DESCRIPTION
54	3	21.3 %	CL	Brown and gray silty CLAY, trace sand, small gravel and topsoil, moist
56	1	21.0 %	CL	FILL - Gray very silty CLAY, trace sand, moist
57	4	23.6 %	ML	Brown clayey SILT, very moist
62	8&9	NC	SM	Brown silty SAND, trace clay, damp
63	2	NC	ML	Brown to gray fine sandy SILT, damp
64	2	17.8 %	CL	Brown and gray silty CLAY, little sand, trace gravel, moist
69	3B	NC	SW	Brown medium grained SAND, wet
79	1	22.4 %	CL	FILL - Brown and gray silty CLAY, little sand, trace gravel, damp
80	2	21.2 %	CL	Brown and gray silty CLAY, little sand, trace gravel, moist
82	5A	NC	SP	Brown medium grained SAND, trace silt and gravel, moist
83	1	14.3 %	CL	FILL - Brown silty CLAY, little sand and gravel, trace cinders, bricks, damp
85	2	8.7 %	CL	FILL - Brown silty CLAY, little sand and gravel, trace cinders, damp
86	4&5	NC	SW	Yellow brown fine to medium SAND, trace small gravel
87	9	NC	ML	Gray SILT, little fine sand, occasional layer coarse sand, wet
88	6	NC	SP	Gray fine SAND with little silt, wet
89	1	18.9 %	CL	Brown to dark brown silty CLAY, little sand, moist
89	3	21.9 %	SC	Brown clayey fine SAND, little silt, moist
91	6A	NC	GW	Gray SAND and GRAVEL, wet

NC - Non cohesive soil - water contents not possible

TABLE 3
ATTERBERG LIMITS

BORING	SAMPLE	DEPTH IN FEET	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
1	2A	2.0-4.0	53	23	30
5	3	6.0-7.5	31	15	16
6	2A	2.0-4.0	28	15	13
10	1	0.0-2.0	28	17	11
13	2A	3.5-5.0	58	19	39
14	3B	4.0-6.0	35	16	19
17	1A	0.0-2.0	50	19	31
17	2A	2.0-4.0	31	15	16
25	2	2.0-4.0	30	15	15
35	2A	2.0-4.0	50	19	31
39	2B	2.0-4.0	23	37	40
43	1B	0.0-2.0	32	17	15
47	5	11.0-12.5	32	14	18
53	3	6.0-7.5	43	38	5
54	3	6.0-7.5	28	16	12
56	1	1.0-2.5	40	18	22
57	4	8.5-10.0	20	19	1
63	2	3.5-5.0	24	14	10
64	2	3.5-5.0	37	13	24
79	1	1.0-2.5	34	16	18
80	2	3.5-5.0	29	19	10
83	1	1.0-2.5	44	18	26
85	2	3.5-5.0	52	18	34
87	9	18.0-20.0	16	16	0
89	1	1.0-2.5	29	16	13

TABLE 4

LABORATORY PERMEABILITY VALUES

TRIAXIAL PERMEABILITY TEST ON COHESIVE SOILS

BORING	SAMPLE	DEPTH (in feet)	COEFFICIENT OF PERMEABILITY (cm/sec)
1	2A	2.0-4.0	1.09×10^{-7}
5	3	6.0-7.5	2.44×10^{-8}
14	3B	4.0-6.0	1.21×10^{-8}
17	1A	0.0-2.0	4.29×10^{-8}
25	2	2.0-4.0	7.29×10^{-8}
35	2B	2.0-4.0	3.20×10^{-8}
39	2B	2.0-4.0	1.02×10^{-8}
43	1B	0.0-1.5	2.13×10^{-7}
54	3	6.0-7.5	3.57×10^{-8}
63	2	3.5-5.0	4.27×10^{-6}
80	2	3.5-5.0	7.47×10^{-7}
83	1	1.0-2.5	6.69×10^{-9}
85	2	3.5-5.0	9.28×10^{-9}
87	9	18.0-20.0	2.28×10^{-7}
89	1	1.0-2.5	7.26×10^{-8}

TABLE 4

CONSTANT HEAD TESTS ON NON-COHESIVE SOILS

BORING	SAMPLE	DEPTH (in feet)	COEFFICIENT OF PERMEABILITY (cm/sec)
7	1B&2	0.0-4.0	6.55×10^{-4}
12	3&4	4.0-7.0	2.11×10^{-4}
46	6	13.5-15.0	3.67×10^{-4}
62	8&9	18.5-22.5	2.61×10^{-3}
69	3B	6.0-7.5	2.46×10^{-4}
82	5A	11.0-13.0	8.99×10^{-5}
86	4&5	8.5-12.5	3.26×10^{-4}
88	6	13.5-15.0	3.00×10^{-4}
89	3	6.0-7.5	3.15×10^{-4}
91	6A	13.5-15.0	5.24×10^{-4}

TABLE 5

SOIL/WATER ANALYSIS FOR CORROSION POTENTIAL

BORING	SAMPLE	DEPTH IN FEET	pH	RESISTIVITY	REDOX	SULFIDES	CORROSION POTENTIAL *
10	3	4.0-6.0	8.00	1425.6	50	Trace	Negative
17	2B	2.0-4.0	6.65	1454.3	10	Trace	Negative
20	3	4.0-6.0	7.70	929.5	70	Negative	Positive
25	3B	4.0-6.0	8.25	994.5	310	Positive	Positive
28	2	3.0-5.0	8.31	1200.5	90	Trace	Negative
35	3	4.0-6.0	8.43	966.5	70	Negative	Positive
42	2	3.5-5.0	7.60	3291.3	40	Trace	Negative
50	2A	3.5-5.0	7.04	1112.1	30	Negative	Negative
53	2	3.5-5.0	8.04	800.5	70	Negative	Positive
59	3	5.0-7.0	8.33	939.3	80	Trace	Positive
60	3	3.5-5.0	7.85	1409.4	60	Negative	Negative
62	2	3.5-5.0	7.86	874.8	60	Negative	Positive
68	2	2.0-4.0	8.02	1425.6	50	Trace	Negative
85	3	6.0-7.5	8.20	1532.6	80	Trace	Negative
88	2B	3.5-5.0	7.60	3291.3	40	Trace	Negative

TABLE 6

PERCOLATION RATES FROM AUGER BORINGS

BORING	DEPTH IN FEET	ELAPSED TIME (HR)	PERCOLATION RATE (cm/hr)	
11	1.0-6.0	0 - 1	0.65	
		1 - 2	0.60	Average Rate 0.69
		2 - 3	0.83	
12	2.0-7.0	0 -0.25	45.35	
		0.25-0.50	44.68	Average Rate 44.11
		0.50-0.67	42.31	
14	1.0-6.0	0 - 1	0.80	
		1 - 2	0.55	Average Rate 0.65
		2 - 3	0.60	
21	1.0-6.0	0 - 1	0.41	
		1 - 2	0.27	Average Rate 0.30
		2 - 3	0.22	
25	1.0-6.0	0 - 1	0.85	
		1 - 2	0.64	Average Rate 0.52
		2 - 3	0.49	
		3 - 4	0.10	
35	1.0-6.0	0 - 1	1.11	
		1 - 2	3.69	Average Rate 5.40
		2 - 3	11.41	
36	1.0-6.0	0 - 1	6.90	
		1 - 2	5.37	Average Rate 5.63
		2 - 3	4.61	
41	1.0-6.0	Flow from pipe was too fast to measure. Ultimately a hose was placed in the end of the pipe placed in the hole and 45 gallons of water were pumped in during 29.25 minutes and it was all easily absorbed. These numbers would translate to a rate of 79.76 cm/hr, however, the actual rate is even faster. The actual rate could not be measure due to the rapid infiltration.		
43	1.0-6.0	0 -0.17	16.80	
		0.17-0.42	14.40	Average Rate 15.22
		0.42-0.77	14.46	
66	1.0-6.0	0 - 1	1.90	
		1 - 2	1.48	Average Rate 1.61
		2 - 3	1.44	

TABLE 7

DOUBLE RING INFILTRATION TEST RESULTS

ELAPSED TIME (HOURS)	FLOW READING (cm) INNER RING	FLOW READING (cm) ANNULAR SPACE	INFILTRATION RATE (cm/hr) INNER RING	INFILTRATION RATE (cm/hr) ANNULAR SPACE
(1)				
0 - 1	197.21	351.43	22.70	29.76
1 - 2	247.19	370.14	28.45	31.42
2 - 2.5	207.87	193.55	47.85	32.78
(2)				
0 - 1	140.82	292.00	16.21	24.73
1 - 2	103.63	205.74	11.93	17.42
2 - 3	135.94	396.85	15.65	33.61
(3)				
0 - 1	71.32	480.67	8.21	40.71
1 - 2	77.72	495.00	8.95	41.92
2 - 2.83	51.82	296.87	7.16	30.17
(4)				
2 hours of readings = no flow - 0 infiltration				
(5)				
0 - 1	122.83	84.43	14.14	7.15
1 - 2	110.03	50.90	12.67	4.31
2 - 3	78.03	71.63	8.98	6.07

TABLE 8

FIELD PERMEABILITY FROM PIEZOMETERS

BORING	TEST INTERVAL	PERMEABILITY (cm/sec)
5	1.5 - 7.5 feet	9.70×10^{-9}
69	4.6 - 9.6 feet	5.70×10^{-6}
72	10.5 -13.0 feet	1.83×10^{-8}
74	5.0 -10.0 feet	3.64×10^{-8}
76	4.75- 8.0 feet	2.70×10^{-7}
80	7.0 -10.0 feet	5.70×10^{-7}
82	9.5 -12.0 feet	4.99×10^{-6}
85	8.8 -12.0 feet	1.39×10^{-7}
88	12.0 -19.0 feet	1.75×10^{-6}
91	11.0 -16.7 feet	4.72×10^{-6}

Formula from Hvorsleu for well point-filter in uniform soil.

$$K = \frac{d^2 \cdot \ln \frac{2L}{D}}{8 \cdot L \cdot (t_2 - t_1)} \ln \frac{H_1}{H_2} \quad \text{where}$$

K - Permeability

d - Diameter of PVC pipe (see boring log)

L - Length of test interval (see boring log)

D - diameter of test interval (3 inches)

t - time at measurement of H

H - Head measurement in piezometer

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

TSC

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IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used*:

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage*, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

APPENDIX

PROCEDURES FOLLOWED IN FIELD
INVESTIGATION AND LABORATORY TESTING

ASTM D: 1586-84 "Standard Method for
PENETRATION TEST AND SPLIT-BARREL
SAMPLING OF SOILS"

UNIFIED CLASSIFICATION CHART

LEGEND FOR BORING LOGS

BORING LOGS

BORING LOCATION PLAN

GRAIN SIZE ANALYSES

SIEVE ANALYSIS

PROCEDURES FOLLOWED IN

FIELD INVESTIGATION AND LABORATORY TESTING

These borings were made using a truck-mounted drill rig with the bore holes being advanced by continuous auger flight methods. Samples were taken according to currently recommended ASTM procedures for Split-Spoon Sampling of Soils. A copy of the procedure which is entitled "Standard Method for PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS, ASTM Designation: 1586-84" is included in the Appendix. The Split-Spoon sampler had an outside diameter of 2 inches, an inside diameter of 1-3/8 inches and a length of 2 feet. This sampler was advanced by driving with a 140-pound weight falling freely from a height of 30 inches. The penetration resistance was the number of blows required to advance the sampling spoon a distance of 12 inches after an initial driving of 6 inches has been used to seat the sampler. The penetration resistance or the "N" value is a measure of the softness or the toughness of a clay soil and is, in general, related to the bearing capacity of the materials. Other factors are usually taken into consideration in arriving at a design bearing capacity value and these include the type of soil, the type of loading, the dimensions and depths of footings below the ground surface and the proximity of the ground water table to the base of the footings.

Representative portions of the Split-Spoon samples were placed in glass containers with screw-type lids and taken to the laboratory for further examination and testing. Laboratory work consisted of the water content determinations for most of the samples with unconfined compression strength tests being performed for representative samples. Also, approximate measurements of the unconfined compression strengths were made for some of the samples using a calibrated pocket penetrometer. The pocket penetrometer is an indirect method for evaluating the compression strength of a clay soil. Usually, the unconfined compression strength of a clay soil is considered to represent the bearing capacity which may be used for design purposes for footings placed on clay. All samples were examined by a qualified Geotechnical Engineer with the field classifications being verified.

Designation: D 1586 – 84

Standard Method for PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The *N*-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the

[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.

beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "*N*-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb

(63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

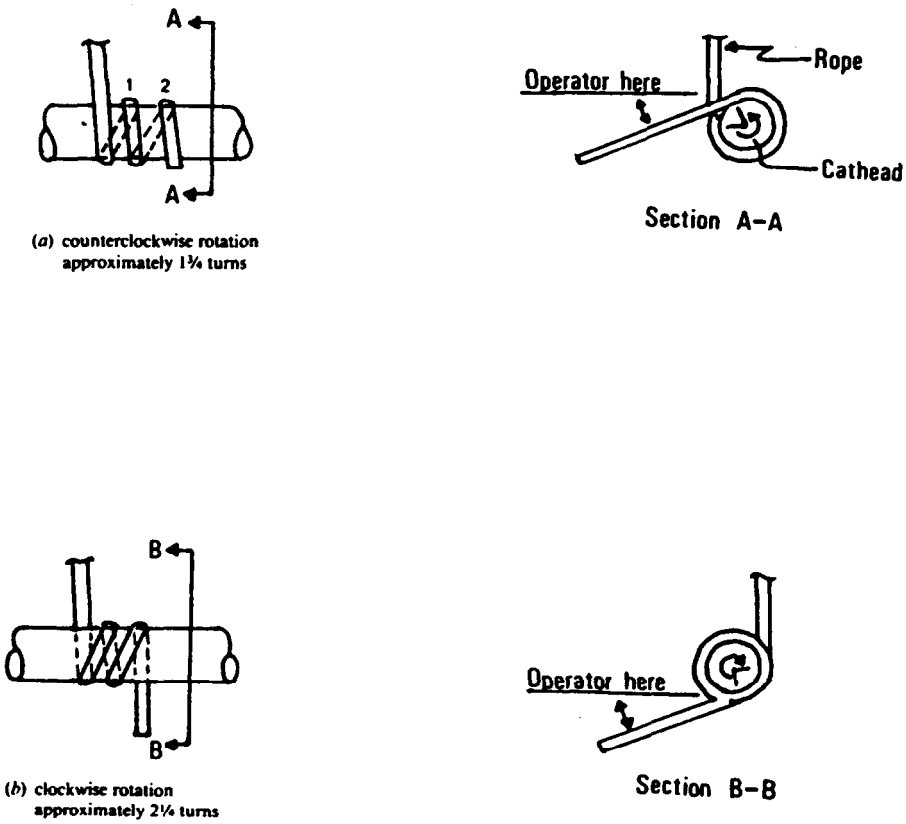
9. Precision and Bias

9.1 Variations in *N*-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, *N*-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in *N*-values

obtained between operator-drill rig systems.

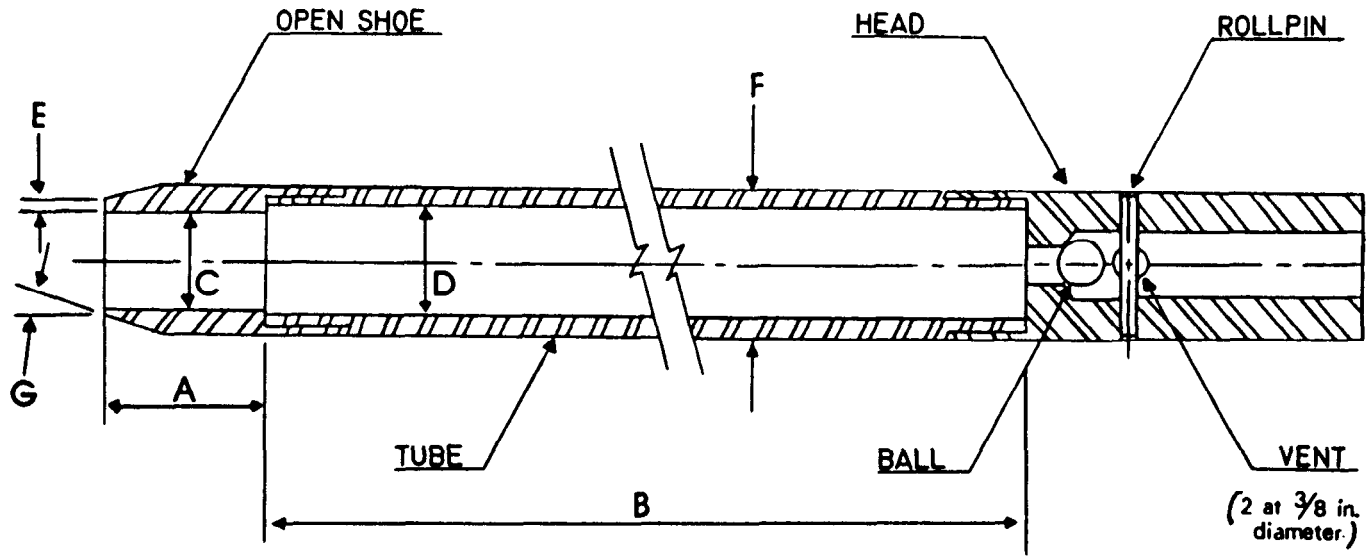
9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.



(*a*) counterclockwise rotation approximately 1¾ turns

(*b*) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (*a*) Counterclockwise Rotation and (*b*) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, Pa. 19103.

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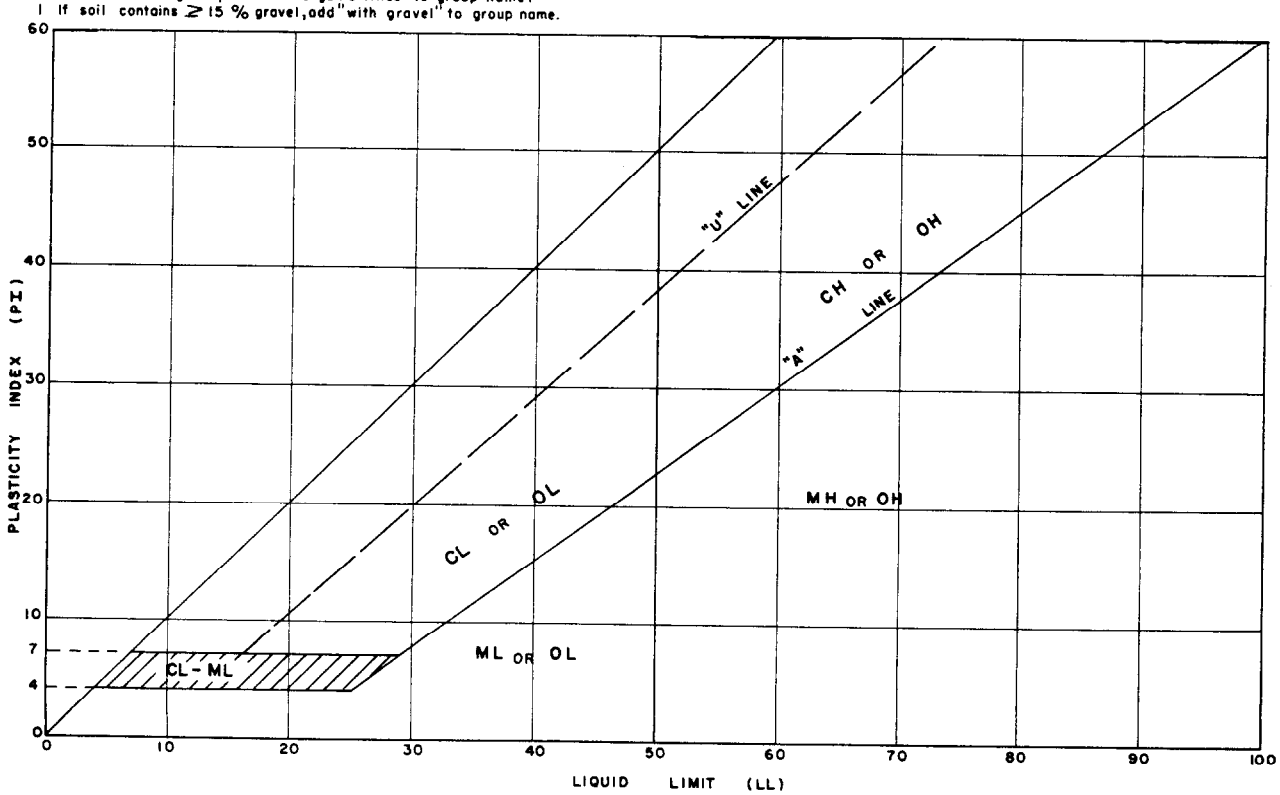
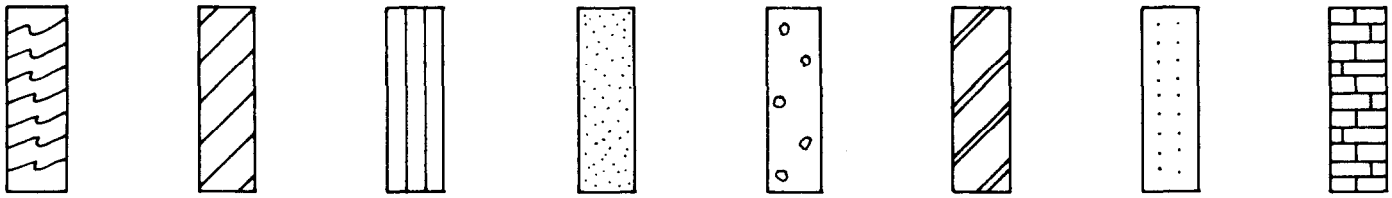
CRITERIA FOR ASSIGNING GROUP SYMBOLS AND GROUP NAMES USING LABORATORY TESTS [a]				SOIL CLASSIFICATION	
				GROUP SYMBOL	GROUP NAME [b]
COARSE-GRAINED SOILS more than 50 % retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines [c]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [e]	GW	Well graded gravel [f]
			$C_u < 4$ and/or $1 > C_c > 3$ [e]	GP	Poorly graded gravel [f]
		GRAVELS WITH FINES More than 12 % fines [c]	Fines classify as ML or MH	GM	Silty gravel f,g,h
			Fines classify as CL or CH	GC	Clayey gravel f,g,h
	SANDS 50 % or more of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5 % fines [d]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [e]	SW	Well-graded sand [i]
			$C_u < 6$ and/or $1 > C_c > 3$ [e]	SP	Poorly graded sand [i]
		SANDS WITH FINES More than 12 % fines [d]	Fines classify as ML or MH	SM	Silty sand g,h,f
			Fines classify as CL or CH	SC	Clayey sand g,h,f
FINE-GRAINED SOILS 50 % or more passed the No. 200 sieve	SILTS & CLAYS Liquid limit less than 50 %	Inorganic	PI > 7 and plots on or above "A" line j	CL	Lean clay [k,l,m]
			PI < 4 or plots below "A" line j	ML	Silt [k,l,m]
		Organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$	OL	Organic clay [k,l,m,n] Organic silt [k,l,m,n]
	SILTS & CLAYS Liquid limit 50 % or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k,l,m]
			PI plots below "A" line	MH	Elastic silt [k,l,m]
		Organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$	OH	Organic clay [k,l,m,p] Organic silt [k,l,m,q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

a. Based on the material passing the 3-in (75-mm) sieve.
b. If field sample contained cobbles and/or boulders, add "with cobbles and/or boulders" to group name.
c. Gravels with 5 to 12 % fines require dual symbols
GW-GM well graded gravel with silt
GW-GC well graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
d. Sands with 5 % to 12 % fines require dual symbols
SW-SM well graded sand with silt
SW-SC well graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
e.
$C_u = D_{60}/D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
f. If soil contains ≥ 15 % sand, add "with sand" to group name.
g. If fines classify as CL-ML, use dual symbol GC-GM, SC-SM.
h. If fines are organic, add "with organic fines" to group name.
i. If soil contains ≥ 15 % gravel, add "with gravel" to group name.
j. If Atterberg Limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30 % plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI ≥ 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



TESTING SERVICE CORPORATION

LEGEND FOR BORING LOGS



PEAT AND ORGANIC SOIL | CLAY | SILT | SAND | GRAVEL | SHALE | SANDSTONE | LIMESTONE

ST = THIN WALLED TUBE SAMPLE
A = Auger Sample
SS = Split Spoon Sample
WC = In situ water content
γ_D = Dry unit weight in pounds per cubic foot
N = Penetration Resistance in Blows per Foot - by driving 2" O.D. Split Spoon Sampler a distance of 12 inches with a 140-pound weight freely falling 30 inches
▽ = water level at end of boring
▼ = water level after elapsed time interval
▽ = water level while Drilling
Qu = Unconfined compression strength in Tons per Square Foot
* = Denotes strength was based on pocket penetrometer measurements . Maximum range = 5.0

MATERIAL	SIZE RANGE
BOULDER	Over 8 inches
COBBLE	8 inches to 2-1/2 inches
Coarse GRAVEL	2-1/2 inches to 1 inch
Medium GRAVEL	1 inch to 3/8 inch
Small GRAVEL	3/8 inch to No. 4 sieve
Coarse SAND	No. 4 sieve to No. 20 sieve
Medium SAND	No. 20 sieve to No. 60 sieve
Fine SAND	NO. 60 sieve to No. 200 sieve
SILT or CLAY	Finer than No. 200 sieve

COHESIVE SOILS

Classification	Qu
Very Soft	0.35
Soft	0.35 to 0.59
Stiff	0.60 to 0.99
Tough	1.00 to 1.99
Very Tough	2.00 to 3.99
Hard	4.00 and over

COHESIONLESS SOILS

Classification	N
Very Loose	0 - 4
Loose	5 - 9
Firm	10 - 29
Dense	30 - 49
Very Dense	50 and over

MAJOR MODIFIER: SILTY, SANDY, CLAYEY, GRAVELLY

Modifying Term	Per Cent by Weight
Trace	1 - 10
Little	10 - 20
Some	20 - 35
And	35 - 50

SOIL BORING LOGS
FORRESTAL VILLAGE

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 1 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1	SS	9	33.9			2.5		FILL: Brown silty CLAY, trace sand and gravel, with organics.
			2	SS	10	16.1	2.5*				Very tough brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL			3	SS	10	21.9	3.0*				
				End of Boring at 6.0 feet							

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 2 DATE STARTED 11/27/89 DATE COMPLETED 11/27/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 12.07 feet

24 HOURS

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0										6"		FILL: Black sandy CLAY, trace organic
				1	SS	30						FILL: Brown and gray silty CLAY, little sand and gravel, bricks, moist
				2	SS	51						
5										5.5		
	CL			3	SS	41						Brown and gray silty CLAY, little sand, trace gravel, moist 0.5 inch sand layer at 7.0 feet (CL)
				4	SS	25						occasional pockets of yellow silt below 8.5 feet.
10										11.5		
				5	SS	19						Gray silty CLAY, trace sand and gravel, moist (CL)
					End of Boring at 12.5 feet							
15												
20												Piezometer
												1.25 inch PVC screen from 12.7 to 7.7 feet.
25												Sand pocket between 12.7 and 6.0 feet bentonite sand from 6.0 to ground surface.
												1.25 inch PVC pipe from 7.7 feet to ground surface with 2.3 feet of stick up.
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 3 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	7				6"		TOPSOIL moist
								2.0		Brown silty CLAY, trace sand and gravel, trace organic, moist
		2	SS	15				3.0		Brown silty CLAY trace sand, trace organic, trace silt seams, moist
										Brown silty SAND and GRAVEL, moist
		3	SS	18				5.0		Brown and gray silty CLAY, trace sand and gravel, moist
			End of Boring at 6.0 feet							

DISTANCE BELOW SURFACE IN FEET

0 5 10 15 20 25 30 35 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 4 DATE STARTED 11/21/89 DATE COMPLETED 11/21/89 JOB 27,68

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1A	SS	13				18"		FILL: Black, clayey topsoil, little sand, moist
		2	SS	12						FILL: Brown silty CLAY, trace sand and gravel, with organic, trace concrete, large rock, moist
		3	SS	8						

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 5 DATE STARTED 11/16/89 DATE COMPLETED 11/16/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
1 A	SS	12	13.5			6"		FILL: Dark brown silty CLAY, trace sand, trace gravel, trace organic
1 B			11.2					
2	SS	20	16.6			3.0		Brown and gray silty CLAY, trace roots, trace sand and gravel, moist
3	SS	14						
4	SS	25				5.5		Brown and gray silty CLAY, trace sand and gravel, moist
	End of Boring at 7.5 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.25 inch PVC screen from 7.5 to 2.5 feet.

Sand pack from 7.5 to 1.5 feet. Bentonite seal from 1.5 to ground surface.

1.25 Inch PVC pipe from 2.5 feet to ground surface with 2.5 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 6 DATE STARTED 11/21/89 DATE COMPLETED 11/21/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1 A/B	SS	13				5"		Black clayey TOPSOIL, moist
		2	SS	9				2.5		FILL: Brown and gray silty CLAY, trace sand and gravel, trace organic, moist
		3	SS	17				4.0		Brown silty CLAY, trace sand and gravel, moist
										Brown and gray silty CLAY, trace sand and gravel, moist

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 7 DATE STARTED 11/27/89 DATE COMPLETED 11/27/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING

24 HOURS

WHILE DRILLING 11' 10"

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		A						6"		TOPSOIL
		1	SS	21						FILL: Brown silty CLAY, trace sand and gravel
		B						2.0		
SM		2	SS	25				4.0		Brown silty SAND, trace gravel, moist (SM)
CL		3	SS	19						Brown and gray silty CLAY, trace sand and gravel, moist (CL)
CL		4	SS	32				8.0		
CL		5	SS	33						Gray silty CLAY, with little sand, trace organic, damp (CL)
GW		6	SS	21				11'10"		
			End of Boring at 12.0 feet							Gray coarse sand and gravel, wet (GW)

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.25 Inch PVC screen from 10.7 to 5.7 feet.

Sand pack from 10.7 to 6.0 feet

Bentonite SAND from 6.0 feet to ground surface.

1.25 inch PVC pipe from 5.7 feet to ground surface with 4.3 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 8 DATE STARTED 11/16/89 DATE COMPLETED 11/16/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1	SS	13				4"		Brown clayey TOPSOIL, moist
CL			2 A B	SS	17				3.75		FILL: Brown and gray silty CLAY, trace sand and gravel, trace organic moist (CL)
OH			3	SS	7						Brown organic CLAY, trace silt, moist (OH)
				End of Boring at 6.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 9 DATE STARTED 11/29/89 DATE COMPLETED 11/29/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1	SS	55						Black sandy clayey TOPSOIL, trace sand, trace small gravel, moist
									3.0		
			2	SS	17						Brown and gray silty CLAY, trace organic, trace sand, trace small gravel, moist
									5.5		
CL									6.0		Brown and gray very silty CLAY, trace sand and small gravel, moist (CL)
CL			3 A/B	SS	15						Brown and gray silty CLAY, trace sand and small gravel, moist (CL)
				End of Boring at 7.5 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 10 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
	1	SS	12						Brown silty CLAY, trace sand and gravel with organic, moist
	2	SS	10				3.5		
C1	3	SS	7						Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
		End of Boring at 6.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

DRILL RIG NO. 107

TESTING SERVICE CORPORATION

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 11 DATE STARTED 11/21/89 DATE COMPLETED 11/21/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1 A/B	SS	9						FILL: Brown-black clayey TOPSOIL
CL			2 A/B	SS	7				2.5		Brown and gray silty CLAY, trace sand and gravel, trace organic moist (CL)
CL			3 A/B	SS	11				4.0		Brown and gray clayey SILT with SAND and GRAVEL, trace sand seams, moist (ML
									5.5		Brown silty CLAY, trace and and gravel, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 46 DATE STARTED 11-6-89 DATE COMPLETED 11-6-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 16.0 feet

24 HOURS

WHILE DRILLING - 9.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									10"		Black and dark brown clayey TOPSOIL
CL			1	SS	24	20.3		108.8			FILL - Brown and gray silty CLAY, some sand, moist (CL)
			2 A	SS	8	16.6		114.4	4.0		
			2 B			36.7					
OL							1.5*				Black clayey TOPSOIL (OL)
			3 A	SS	4	28.5	0.83		6.5		
			3 B			22.6					
CH											Gray/brown organic CLAY, little sand, very moist (CH)
			4 A	SS	8	30.9	1.03		9.0		
SC			4 B			23.6					Brown clayey SAND, trace gravel, wet (SC)
									10.5		
SM			5	SS	9						Loose brown and gray fine silty SAND, small to large gravel, wet (SM)
			6	SS	12						
			7	SS	11						
									18.0		
CL			8	SS	17	17.9	2.0*				Tough gray silty CLAY, trace sand and small gravel, moist (CL)
			9	SS	34						
			10	SS	49	24.9					

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 47 DATE STARTED 11-3-89 DATE COMPLETED 11-3-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 19.0 feet

24 HOURS

WHILE DRILLING - 19.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL									13"		Brown silty CLAY, little sand, trace gravel, damp (CL)
CL			1	SS	22	16.1	4.5+*				Brown silty CLAY, little sand, trace gravel, moist (CL)
			2	SS	16	16.4	7.23				
									5.5		
CL			3	SS	10	18.0	2.35				Stiff brown and gray silty CLAY, little sand, trace gravel, moist (CL)
			4	SS	13	20.2	2.25*				
									10.5		
CL			5	SS	12	18.8	2.15				Tough gray silty to very silty CLAY, trace to little sand, trace gravel, moist (CL)
			6	SS	10	21.6	1.5*				
			7	SS	18	17.8	2.94				Occasional sand seams from 19.0 to 22.0 feet
			8	SS	25	15.4	5.41				
			9	SS	23	15.4	4.25*				
			10	SS	24	17.6	4.26				
			End of Boring at 25.0 feet								

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 48 DATE STARTED 11-6-89 DATE COMPLETED 11-6-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 17.0 feet

24 HOURS

WHILE DRILLING - 12.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									13"		Black to dark brown clayey TOPSOIL moist (OL)
CL			1	SS	10	14.5	3.5*				Stiff brown silty CLAY, trace sand, small gravel, moist (CL)
			2	SS	11	18.0	2.68		5.5		
CL			3	SS	16	17.5	4.5*				Tough brown silty CLAY, trace sand, small gravel, moist (CL)
									8.0		
CL			4	SS	11	14.2	1.0*				Stiff to tough gray silty CLAY, little sand, trace gravel, moist (CL)
			5 A/B	SS	15	15.8	2.02		12.0		
SC											Dense brown and gray fine to coarse SAND, trace small to large gravel, wet (SC)
									14.0		
CL			6	SS	10	22.4	0.5*				Stiff gray very silty CLAY, little sand, trace silt (layers), very moist (CL)
			7	SS	13	15.0	1.25*				
									18.0		
CL			8	SS	15	16.1	4.13				Stiff gray silty CLAY, little sand, moist (CL)
			9	SS	18	17.5	3.95				
			10	SS	27	16.2	3.75*				
			End of Boring at 25.0 feet								

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 49 DATE STARTED 11-3-89 DATE COMPLETED 11-3-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL											Dark brown sandy CLAY, trace cinder moist (CL)
CL			1	SS	11	11.7			1.0		FILL - Dark brown sandy CLAY, trace cinder, moist (CL)
									3.0		
CL			2	SS	14	19.5					Tough brown silty CLAY, little sand, moist (CL)
			3	SS	29	16.8					
			4	SS	14	17.4					
									10.5		
CL			5	SS	19	17.5					Tough gray silty CLAY, little sand, trace gravel, moist (CL)
			6	SS	16	17.7					
			7	SS	14	20.2					
			8	SS	14	18.2					
			9	SS	15	20.9					
			10	SS	16	21.9					
			End of Boring 25.0 feet								

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 66 DATE STARTED 11-21-89 DATE COMPLETED 11-21-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0								3"		Black clayey TOPSOIL (OL)
CL		1	SS	10						FILL - Brown silty CLAY, trace sand and gravel, trace organic, moist (CL)
		2	SS	12						
5		3	SS	4						
CL								5.5		Brown and gray silty CLAY, trace sand and gravel and organic, moist (CL)
		End of Boring at 6.0 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 67 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL			1	SS	18				1.0		Black sandy CLAY LOAM with organics moist
CL			2	SS	19						FILL - Brown silty CLAY, little sand and gravel, trace bricks and cinders, moist to very moist
CL			3	SS	3				5.5		Brown silty CLAY, little sand, trace gravel, moist (CL)
			4	SS	22						

End of Boring at 10.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 68 DATE STARTED 11-17-89 DATE COMPLETED 11-17-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL		1	SS	13						Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
		2	SS	14						
		3	SS	11						
		End of Boring at 6.0 feet								

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 91 DATE STARTED 12/4/89 DATE COMPLETED 12/4/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING -5.5 feet

24 HOURS

WHILE DRILLING -8.5 feet

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
							5"		Black clayey TOPSOIL trace sand, trace small gravel, moist
	1	SS							Black TOPSOIL and brown silty clay, trace sand, trace small gravle, moist
							3.5		
CL	2	SS							Brown sandy clay, trace small gravel moist (CL)
							5.5		
CL	3	SS							Brown gray SAND, trace silt seams, trace small gravel, damp (CL)
							8.0		
									Gray SILT with light fine sand, trace small gravel, wet
	4	SS					9.75		
CW							10.5		Gray SAND and GRAVEL, wet (CW)
	5	SS							Gray silty CLAY, trace sand, trace small gravel, moist
							13.0		
CW							13.5		Gray SAND and GRAVEL, wet (CW)
CL	6	SS							Gray silty CLAY, trace small gravel, moist (CL)
CL	7	SS							

End of Boring at 20.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.25 inch PVC pipe from 16.7 to 11.7 feet.

Sand pack from 16.7 feet to 11.0 feet

Bentonite seal from 11.0 feet to ground surface.

1.25 inch PVC pipe from 11.7 feet to ground surface with 3.3 feet of stick up.

Bentonite seal from 20.0 to 16.7 feet.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

SOIL BORING LOGS
HALSEY VILLAGE

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 14 DATE STARTED 11/20/89 DATE COMPLETED 11/20/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	9				4"		Black clayey TOPSOIL, moist
		2	SS	16						FILL: Brown silty CLAY with sand, trace organic, moist
		3 A	SS	8	14.6	3.5*		4.5		Brown and gray silty CLAY, trace sand, trace gravel, moist (CL)
		3 B			20.6	2.5*				

End of Boring at 6.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 15 DATE STARTED 11/16/89 DATE COMPLETED 11/16/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		A 1 B	SS	14				6" 1.0 2.0		FILL: Brown clayey TOPSOIL FILL: Brown and gray silty CLAY, trace sand and gravel, trace organic
		2	SS	11						Brown organic clay with organic materia moist (OH)
		A 3 B	SS	9						
			End of Boring at 6.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 16 DATE STARTED 11/16/89 DATE COMPLETED 11/16/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	9				6"		FILL: Brown clayey TOPSOIL
										FILL: Brown and gray silty CLAY, trace sand and gravel, trace organic
		2	SS	12				3.0		Brown and gray clayey SAND and GRAVEL, very moist (SC)
		3	SS	19				4.5		Brown and gray silty CLAY, trace sand and gravel, moist (CL)
			End of Boring at 6.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 52 DATE STARTED 11-7-89 DATE COMPLETED 11-7-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING -23.5 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									6"		Black clayey TOPSOIL (OL)
CL			1	SS	12	15.7	3.18				FILL - Brown silty CLAY, little sand, trace gravel, moist (CL)
			2	SS	18	15.4	5.63				
			3	SS	20	15.7	4.5+*				
			4	SS	18	15.3	8.49				
			5	SS	21	13.0	4.5+*				
									13.0		
CL			6	SS	19	16.9	4.25*				Tough brown silty CLAY, little sand, trace gravel, moist (CL)
									15.5		
CL			7	SS	12	15.3	3.24				Gray silty CLAY, little sand, trace gravel, moist (CL)
			8	SS	16	15.7	2.46				
			9	SS	14	17.3	2.75*				Occasional silt layers below 18.0 feet
			10	SS	17	18.2	1.42				
			End of Boring at 25.0 feet								

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 71 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									4"		Black clayey TOPSOIL, moist (OL)
CL			1	SS	28						Brown silty CLAY, little sand, trace gravel, moist (CL)
			2	SS	32						
			3	SS	48						
									8.0		
CL			4	SS	20						Brown and gray silty CLAY, with trace sand and gravel, damp (CL)
			5	SS	27						
			End of Boring at 12.5 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 72 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 13.2 feet

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									0.7		Black clayey TOPSOIL, moist (OL)
CL			1	SS	21						Brown silty CLAY, little sand, trace gravel, moist (CL)
			2	SS	30						
			3	SS	48				8.0		
CL			4	SS	22						Gray silty CLAY, little sand, trace gravel, moist (CL)
			5	SS	24						Occasional 1/2" sand seams, wet below 9.0 feet
											Thin layer of sandy silt with mediu sand at 13.0 feet
			End of Boring at 13.0 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 13.0 to 10.5 feet
- Sand pack from 13.0 to 8.0 feet
- Bentonite seal from 8.0 feet to ground surface
- 1.25 inch PVC pipe from 10.5 feet to ground surface with 4.3 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

SOIL BORING LOGS
NIMITZ VILLAGE

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 12 DATE STARTED 11/8/89 DATE COMPLETED 11/8/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
	1	SS	36				2.0		FILL: Brown and gray silty CLAY, trace sand and small-large gravel, trace organic.
SW	2	SS	8	24.5		100.8			Brown fine-coarse SAND and small gravel, occasional cobble, damp. (SW)
	3	SS	17	10.1					
	4	SS	31						
		End of Boring at 7.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 13 DATE STARTED 11/29/89 DATE COMPLETED 11/29/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								8"		Black clayey TOPSOIL, trace sand, trace small gravel, moist
		1	SS	21						FILL: Brown and gray silty CLAY, trace TOPSOIL, trace sand, trace small gravel moist.
		2	SS	19				4.75		Brown and gray silty CLAY, trace sand and trace small gravel, moist (CL)
CL		3	SS	10						

End of Boring at 7.5 feet

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 51 DATE STARTED 11-8-89 DATE COMPLETED 11-8-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING

24 HOURS

WHILE DRILLING 19.0 feet

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						0		Black clayey TOPSOIL (OL)
1	SS	23	15.4		116.2	1.0		FILL - Brown and gray silty CLAY, little sand, small gravel, trace organic, moist (CL)
2	SS	18	16.9		111.0	3.0		Virgin tough brown and gray silty CLAY, trace sand and organic, moist (CL)
3	SS	9	27.5	1.95		5.5		Stiff brown and gray silty CLAY, little sand, trace organic, moist (CL)
4	SS	14	20.1			8.0		Stiff brown and gray clayey SAND, little gravel, moist (SC)
5	SS	20	17.5	2.61		10.5		Tough gray silty CLAY, little sand, trace gravel, moist (CL)
6	SS	19	16.1	2.28				
7	SS	22	15.3	3.0*				
8	SS	19	17.8	2.15				
9	SS	20	16.5	0.75*				
10	SS	21	16.8	2.55				
End of Boring at 25.0 feet								

OL, CL, CL, CL, SC, CL

LENGTH RECOVERY

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 69 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 4.8 feet

24 HOURS

WHILE DRILLING 5.5 feet

DISTANCE BELOW SURFACE IN FEET

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	15						FILL - Brown silty CLAY, trace sand, trace cinders, moist
		2	SS	12						
SW		3	SS	5				6'3"		Brown medium SAND with some clay wet (SW)
SC		4	SS	15				8.5		Gray sandy CLAY with some silt, trace small gravel, moist (SC)

End of Boring at 10.0 feet

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen between 9.6 and 4.6 feet
- Sand pack between 9.6 and 4.6 feet
- Bentonite seal between 4.6 feet and ground surface
- 1.25 Inch PVC pipe from 4.6 to ground surface with 5.4 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 70 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
							3"		Black CLAY LOAM with little sand and organics, moist
	1	SS	14						FILL - Brown silty CLAY, little sand, trace topsoil and cinders
	2	SS	27						
							5.5		
CL	3	SS	41						Brown silty CLAY with trace sand and gravel, damp (CL)
	4	SS	31				9.5		
	5	SS	22						Gray silty CLAY with little sand, trace gravel, damp (CL)
CL	6	SS	14						Occasional thin layers of very fine sand below 14.0 feet
	7	SS	20						
	8	SS	16						
	End of Boring at 20.0 feet								

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 14.0 to 19.0 feet
- Sand pack from 19.0 to 11.0 feet
- Bentonite seal from 11.0 feet to ground surface
- 1.25 PVC pipe from 14.0 feet to ground surface with 1.0 foot of stickup.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

SOIL BORING LOGS
CAMP MOFFETT

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 17 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1 A	SS	28	21.2			6"		FILL: Dark brown silty CLAY, trace sand and gravel, moist
		1 B			11.3					
		2	SS	14				2.5		FILL: brown and gray silty CLAY, trace sand and gravel, trace organic moist
SC		3	SS	10				4.5		Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
										Brown and gray clayey SAND and GRAVEL, moist (SC)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 50 DATE STARTED 11-20-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 7.5 feet

24 HOURS

WHILE DRILLING - 7.5 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL			1	SS	13				1.5		FILL - Black clayey TOPSOIL, trace sand and gravel, trace cinders, moist
CL			2	SS	3				4.0		Stiff brown silty CLAY, trace sand and gravel, trace organic, moist (CL)
ML									5.0		Soft brown clayey SILT with sand and gravel, very moist (ML)
SC			3	SS	15				6.5		Firm brown and gray clayey SAND, some gravel, very moist (SC)
CL									8.0		Tough brown and gray silty CLAY, trace sand and gravel, moist (CL)
CL			4	SS	14						
CL			5	SS	20						Tough gray silty CLAY, trace sand and gravel, moist (CL)
CL			6	SS	25						
CL			7	SS	26						
CL			8	SS	24						
SP			9	SS	32				20.5		Dense gray fine SAND, trace gravel, moist (SP)
CL			10	SS	24				23.0		Tough gray silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 25.0 feet

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

SOIL BORING LOGS
MAINSIDE

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 18 DATE STARTED 11/14/89 DATE COMPLETED 11/14/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								3"		Brown clayey TOPSOIL
		1	SS	9				1.0		FILL: Brown silty CLAY, trace sand and gravel, trace organic, moist
								2.0		FILL: Black clayey TOPSOIL
		2	SS	7				2.5		FILL: Brown silty CLAY, trace sand and gravel with organic, moist
		3	SS	14				4.5		FILL: SAND and GRAVEL with CINDERS and SLAB dry
										Brown and gray silty CLAY, trace sand and gravel, moist

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 19 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								4"		Brown clayey TOPSOIL, moist
		1	SS	7						FILL - Brown and gray silty CLAY, trace sand and gravel with organic, trace brick, moist
								2.0		Brown silty CLAY, trace sand and gravel, moist (CL)
		2A B	SS	7				3.0		Brown very silty CLAY with sand, trace gravel, moist (CL)
								4.0		Brown sandy CLAY, moist (CL)
		3A B	SS	5				5.0		Brown clayey SAND, very moist (SC)
		End of Boring at 6.0 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 20 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL			1 A B	SS	24				3"		Black clayey TOPSOIL, moist (OL)
			2	SS	9				2.0		FILL - Brown silty CLAY, trace sand, trace gravel with crushed limestone and organic, moist (CL)
CL			3	SS	11						Brown and gray silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 21 DATE STARTED 11-22-89 DATE COMPLETED 11-22-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
CL			1	SS	9				1.5		FILL - Brown silty CLAY with brown clayey topsoil, trace sand and gravel, trace organic moist (CL)
CL									2.5		Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
			2	SS	24						
CL			3	SS	32						Brown and gray silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 22 DATE STARTED 11-13-89 DATE COMPLETED 11-13-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									10"		Black clayey TOPSOIL, moist (OL)
SM			1 A B	SS	15	18.5		112.1	2.5		FILL - Brown fine to medium SAND, moist (SM)
CL			2	SS	18	17.1		115.3	5.0		Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL			3	SS	22	18.1		112.5			Brown and gray silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 7.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO.

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 23 DATE STARTED 11-17-89 DATE COMPLETED 11-17-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0				1 A B	SS	17				1.5		Black sandy CLAY, trace gravel, moist
				2 A B	SS	17				3'4"		FILL - Brown and gray silty CLAY, some sand, gravel, bricks damp
5	CL			3 A B	SS	28				6.5		Brown silty CLAY with trace sand and small gravel, damp (CL)
	ML											Gray and brown clayey SILT, trace very fine sand, damp (ML)
				End of Boring at 7.0 feet								
10												
15												
20												
25												
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 24 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
ML			1	SS	14				4"		Black sandy TOPSOIL, moist
									1.5		Brown sandy SILT, trace organic dry (ML)
CL			2	SS	15						Brown and gray very silty CLAY, trace sand and gravel, dry (CL)
ML			3 A B	SS	26				4.5		Brown and gray SILT, trace sand and gravel, dry (ML)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 25 DATE STARTED 11-22-89 DATE COMPLETED 11-22-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL			1 A B	SS	14	17.6			7"		Brown clayey TOPSOIL, moist (OL)
CL									2.0		Brown and gray very silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL			2	SS	26						Brown and gray very silty CLAY, trace sand and gravel, trace silt seams, dry (CL)
CL			3 A B	SS	24				5.0		Gray and brown very silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 26 DATE STARTED 11-17-89 DATE COMPLETED 11-17-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0												
				1	SS	51				1.0		Black silty CLAY, some sand, trace gravel and organic, damp
										2.5		FILL - Brown silty CLAY, trace sand, trace cinder, damp
				2	SS	64						Brown silty CLAY with little sand trace gravel, damp (CL)
5	CL			3	SS	66						
				End of Boring at 7.0 feet								
10												
15												
20												
25												
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 27 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0								4"		FILL - Black clayey TOPSOIL, moist
		A			13.7		115.9			FILL - Brown and gray silty CLAY, trace sand and gravel, trace organic, moist
		1B	SS	12	18.8		111.3	2.0		
	CL	2	SS	19	17.2	4.5+*				Brown and gray silty CLAY, trace sand and gravel, trace roots and organics, moist (CL)
5								5.0		
	CL	3	SS	47	17.4	4.5+*				Gray silty CLAY, little sand, trace gravel, moist (CL)
		End of Boring at 7.0 feet								
10										
15										
20										
25										
30										
35										
40										

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 28 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									6"		Black clayey TOPSOIL, moist (OL)
CL			1 A	SS	10	26.8		94.6	1.5		FILL - Brown silty CLAY, trace sand and gravel with organic moist (CL)
CL			1 B			26.0	3.20		3.0		Brown and gray silty CLAY, trace sand and gravel, very moist (CL)
CL			2	SS	16	19.3	6.40		5.0		Brown and gray silty CLAY, trace sand and gravel, moist (CL)
CL			3	SS	32	21.2	4.5+*				Brown and gray silty CLAY, trace sand and gravel, trace silt seams, moist (

End of Boring at 7.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 29 DATE STARTED 11-13-89 DATE COMPLETED 11-13-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									8"		Black clayey TOPSOIL, moist (OL)
			1 A	SS	12	12.5	4.5+*				Brown very silty CLAY, trace roots and sand, moist (CL)
			1 B			24.1	4.5+*		2.5		
			2	SS	17	23.0	4.5+*		3.5		Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL			3	SS	25	16.2	4.5+*		5.0		Brown and gray silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 7.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 30 DATE STARTED 11-13-89 DATE COMPLETED 11-13-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 6.57 feet

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0										6" 1.0		Black sandy LOAM with little clay, trace gravel, damp
												Crushed Limestone
	CL			1	SS	20						FILL - Brown silty CLAY with sand, gravel, cinders, topsoil, damp, Desiccated and friable
				2	SS	28						
5				3	SS	38				6'1"		
▼	CL											Brown silty CLAY, fine sand, small gravel, damp (CL)
				End of Boring at 7.0 feet								
10												
15												
20												
25												
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 31 DATE STARTED 11-16-89 DATE COMPLETED 11-16-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 5.42'

24 HOURS

WHILE DRILLING 5.0 feet

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
	1	SS	13						FILL - Dark gray silty CLAY, little sand, trace concrete, leaves, wood
	2	SS							
	3	SS							
	4	SS							
	End of Boring at 6.0 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 32 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0	OL											Black clayey TOPSOIL, moist (OL)
	CL			A 1	SS	15	22.1			10"		FILL - Brown silty CLAY, trace sand and gravel with organics, moist (CL)
				B			16.4	4.5+*		2.5		
	CL			2	SS	13	19.3	2.63				Brown and gray silty CLAY, trace sand and gravel, trace silt seams, moist (CL)
5				A 3	SS	15	17.3	2.25*		5.0 5.5		Tough brown silty CLAY, trace sand and gravel with silt seams, moist
	CL			B			15.0	5.04				Tough brown and gray silty CLAY, trace sand and gravel, moist (CL)
				End of Boring at 7.0 feet								
10												
15												
20												
25												
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 33 DATE STARTED 11-29-89 DATE COMPLETED 11-29-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 17.5 feet

24 HOURS

WHILE DRILLING - 18.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black clayey TOPSOIL, trace sand and some gravel, moist (OL)
CL			1	SS	24						Tough brown and gray silty CLAY, trace sand and gravel, moist (CL)
			2	SS	27						
			3	SS	26						
									8.0		
CL			4	SS	50						Tough brown and gray silty CLAY, trace sand and gravel, trace silt seams, moist (CL)
									10.5		
CL			5	SS	23						Tough gray silty CLAY, trace sand and gravel, moist (CL)
			6	SS	21						
									15.5		
CL			7	SS	38						Hard gray silty CLAY, trace sand trace small gravel, moist (CL)
									18.0		
CL			8	SS	64						Dense gray silty CLAY, trace sand and gravel, moist (CL)
									20.5		
CL			9	SS	41						Hard gray silty CLAY, trace sand and gravel, moist (CL)
			10	SS	51						

End of Boring at 25.0 feet

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 34 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									6"		Black clayey TOPSOIL (OL)
CL			1	SS	9	21.5		104.2	3.0		Stiff brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL) (Possible FILL
CL			2	SS	7	30.5	1.60		5.0		Stiff brown and gray silty CLAY, trace sand and gravel, moist (CL)
CL			3	SS	10	22.1	2.68				Stiff brown and gray very silty CLAY, trace sand and gravel, moist (CL)

End of Boring at 7.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 35 DATE STARTED 11-22-89 DATE COMPLETED 11-22-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL			1	SS	9				8"		Brown clayey TOPSOIL, trace sand and gravel, moist (OL)
CL			2	SS	15	16.4			2.5		FILL - Brown and gray very silty CLAY, trace sand and gravel, trace organic, dry (CL)
CL			3	SS	15				4.0		Tough brown and gray very silty CLAY, trace sand and gravel, trace organic, dry (CL)
			End of Boring at 6.0 feet								Tough brown and gray silty CLAY, trace sand and gravel, moist (CL)

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 36 DATE STARTED 11-22-89 DATE COMPLETED 11-22-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	15				1.0		FILL - Brown silty CLAY, trace sand and gravel, with organics, moist
CL		2	SS	13				2.0		FILL - Sand, gravel, cinders, brick
CL		3	SS	9				3.0		FILL - Brown silty CLAY, trace sand and gravel, with organics, moist (CL)
		End of Boring at 6.0 feet								Stiff brown and gray silty CLAY, trace sand and gravel, moist (CL)

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 37 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL		1	SS	24				6"		Brown clayey TOPSOIL, moist (OL)
CL		2	SS	13				3.5		FILL - Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL		3	SS	7						Stiff brown and gray very silty CLAY, trace sand and gravel, dry (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 38 DATE STARTED 11-17-89 DATE COMPLETED 11-17-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						3"		Brown clayey TOPSOIL, moist (OL)
1	SS	11				1.5		FILL - Brown silty CLAY, trace sand and gravel, trace organic, moist (CL)
2	SS	9				2.5		Firm brown clayey fine to medium SAND, moist (SM)
3	SS	5				5.5		Stiff brown silty CLAY, trace sand and gravel, trace organic, moist (CL
								Firm brown fine to medium SAND, trace gravel, moist (SM)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

LENGTH RECOVERY

OL, SM, CL, SM

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 39 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
							2"		Black clayey TOPSOIL, moist (OL)
OL	1	SS	15				1.5		FILL - Brown silty CLAY, trace sand and gravel, with organic, moist
CL	2A	SS	14	10.4			2.0		FILL - Black clayey TOPSOIL, moist
	2B			18.7					
	3	SS	8	16.9					FILL - Brown and gray silty CLAY, trace sand and gravel, trace organic, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 40 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1 A	SS	10				3"		Black clayey TOPSOIL, moist (OL)
		1 B						1.0		Stiff brown sandy CLAY, trace gravel, moist (CL)
		2	SS	7						Firm fine to medium brown SAND
		3	SS	7				4.0		Stiff brown very sandy CLAY, moist

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 41 DATE STARTED 11-27-89 DATE COMPLETED 11-27-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 5.3 feet

24 HOURS

WHILE DRILLING 5.5 feet

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	12				6"		Black sandy LOAM with some clay, trace gravel and organics
		2	SS	20						FILL - Brown and gray silty CLAY with glass, cinders, sand, and gravel,
				End of Boring at 6.0 feet						

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 42 DATE STARTED 11-24-89 DATE COMPLETED 11-24-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						6"		Black clayey TOPSOIL, trace sand and gravel, moist (CL)
1	SS	7						Firm brown clayey SAND, trace small gravel, damp (SM)
						3.0		
2	SS	9						Stiff brown and gray silty CLAY, little sand, trace gravel, moist
						5.5		
3	SS	8						Stiff brown silty CLAY, trace sand and small gravel, moist (CL)
						7.0		Loose gray SAND, trace small gravel damp (SM)

End of Boring at 7.5 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

LENGTH RECOVERY

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 43 DATE STARTED 11-22-89 DATE COMPLETED 11-22-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									6"		Brown clayey TOPSOIL, moist (OL)
CL			1	SS	10						FILL - Brown silty CLAY, trace sand and gravel, trace organic, moist (CL)
CL			A 2	SS	11	11.7			2.5		Stiff brown and gray silty CLAY, trace sand and gravel, trace sand seams, moist (CL)
CL			3	SS	20				4.0		Tough brown and gray silty CLAY, trace sand and gravel, trace silt seams, moist (CL)

End of Boring at 6.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 53 DATE STARTED 11-6-89 DATE COMPLETED 11-6-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0	OL									1.0		Dark brown clayey TOPSOIL (OL)
	CL			1	SS	11	25.4	4.5*		3.0		FILL - Gray and brown silty CLAY, little sand, moist (CL)
5	CL			2	SS	12	21.7	3.2				Dark brown and gray silty CLAY, little sand, moist (CL)
				3	SS	14	25.9	3.67				
10	ML			4	SS	24	15.6			8.5		Brown clayey SILT, some sand below 10.0 feet, moist (ML)
	SC			5 A B	SS	15	21.4 11.4			12.0 13.0		Gray clayey SAND, some silt, little gravel, moist (SC)
15	CL			6	SS	10	16.0	1.49				
				7	SS	29	12.1	4.5*				Gray silty CLAY, little sand, trace gravel, damp (CL)
20				8	SS	37	14.6	9.22				
	SP			9	SS	42				20.5		Gray fine SAND, damp (SP)
25				10	SS	44						
				End of Boring at 25.0 feet								
30												
35												
40												

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 54 DATE STARTED 10-30-89 DATE COMPLETED 10-30-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 23.0 feet

24 HOURS

WHILE DRILLING - 20.5 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL											Black clayey TOPSOIL (OL)
CL			1 A	SS	14	20.4			10"		FILL - Brown silty CLAY, trace sand, trace gravel, damp (CL)
			1 B			23.5	4.5+*		2.0		
CL			2	SS	16	21.6	4.25*				Brown and gray silty CLAY, trace sand, small gravel, moist, trace topsoil, (CL)
			3	SS	15	21.3	3.25*				
ML			4	SS	20	24.8			8.0		Brown SILT, trace clay, trace sand, moist (ML)
CL			5	SS	11	16.5	1.5*		10.5		Gray very silty CLAY, trace sand, very moist (CL)
			6	SS	10	15.5	2.5*		13.0		
			7	SS	11	15.4	1.75*				
CL			8	SS	13	14.8	3.0*				Gray silty CLAY, trace sand, moist (CL)
			9	SS	16	14.4	2.5*				
			10	SS	13	16.0	2.0*				

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 55 DATE STARTED 10-31-89 DATE COMPLETED 10-31-89 JOB 27,68

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 12.0 feet

24 HOURS

WHILE DRILLING - 10.5 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									13"		Dark brown clayey TOPSOIL, (OL)
CL			1	SS	8	23.2	2.59				Brown and gray silty CLAY, trace sand, trace gravel, trace topsoil, moist (CL)
			2	SS	9	25.8	2.25*		5.0		
ML			3	SS	5						Brown and gray SILT, trace clay, trace sand, moist (ML)
			4 A B	SS	16				9.0		
ML									10.5		Gray SILT, trace clay, moist (ML)
CL			5	SS	8	17.9	1.94				Gray silty CLAY, trace sand, trace gravel, moist (CL)
			6	SS	7	16.2	2.72				
			7	SS	20	16.8	3.25*				
			8	SS	16	16.7	3.43				
			9	SS	21	16.1	2.75*				
			10	SS	15	16.6	3.63				
			End of Boring at 25.0 feet								

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 56 DATE STARTED 10-30-89 DATE COMPLETED 10-30-89 JOB 27,68

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 24.5 feet

24 HOURS

WHILE DRILLING - 11.0 feet

DISTANCE BELOW SURFACE IN FEET

	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL							6"		Dark brown clayey TOPSOIL (OL)
CL	1	SS	9	21.0	4.5+*		3.0		FILL - Gray very silty CLAY, trace sand, moist (CL)
CL	2	SS	19	19.6					Gray and brown very silty CLAY, trace sand, moist (CL)
CL	3	SS	18	22.1	4.0*				
CL	4	SS	18	21.4	3.5*		10.5		
ML	5	SS	14	26.7			13.0		Brown clayey SILT, some sand layers, moist (ML)
CL	6	SS	12		3.5*		15.5		Gray silty CLAY, trace sand, moist (CL)
CL	7	SS	13	14.5	3.0*				Gray very silty CLAY, trace sand, trace gravel, moist (CL)
CL	8	SS	16	14.1	4.5+*				
CL	9	SS	16	15.0	4.5+*				
	10	SS	15	14.0	4.5+*				

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 57 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0 OL									6"		Black clayey TOPSOIL, moist (OL)
CL			1 A	SS	16	10.9		117.1			FILL - Dark gray and brown silty CLAY, some sand, damp (CL)
			1 B								
SW CL			2 A	SS	9	14.8		117.5			FILL - Dark gray and brown medium to coarse SAND and silty CLAY, damp (SW/CL)
			2 B			15.5	4.25*		4.5		
5 CL			3	SS	14	23.7	2.09				Brown and gray silty CLAY, little sand, moist (CL)
									8.0		
ML			4	SS	19						Brown clayey SILT, very moist (ML)
10			5	SS	26	23.6					
									13.0		
ML									14.0		Gray clayey SILT, very moist (ML)
15 CL			6 A B	SS	12						Gray very silty CLAY, trace sand and gravel, moist (CL)
									15.5		
			7	SS	22						
CL											Gray silty CLAY, trace sand and gravel, moist (CL)
20			8	SS	22						
									20.5		
			9	SS	31						
CL											Gray silty CLAY, trace sand and gravel, moist (CL)
25			10	SS	37						
			End of Boring at 25.0 feet								
30											
35											
40											

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 58 DATE STARTED 11-6-89 DATE COMPLETED 11-6-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								1" 2"		Crushed Limestone
								12"		Asphalt
CL		1	SS	12	14.4					Brown SAND and GRAVEL, subbase material
ML		2	SS	20						FILL - Brown silty CLAY, trace sand, trace gravel, moist (CL)
								5.5		Brown SILT, trace clay, damp (ML)
		3	SS	35	22.2					Gray clayey SILT, occasional fine sand layers, damp to moist (ML)
ML		4 A	SS	18	18.8					
		4 B			23.8					
								10.5		
		5	SS	12	15.9	1.88				Gray silty CLAY, trace sand and gravel, moist (CL)
		6	SS	14	15.2	1.94				
CL		7	SS	17	14.9	2.75*				
		8	SS	20	14.7	2.46				
		9	SS	15	14.7	3.75*				
		10	SS	23	14.9	3.95				

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 59 DATE STARTED 11/10/89 DATE COMPLETED 11/10/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0										6"		Black clayey TOPSOIL
				1	SS	14	19.1					FILL: Dark gray and brown silty CLAY, trace cinders, little sand, little gravel, moist
										3.5		
	CL			2A	SS	13	21.0					Brown and gray silty CLAY, little sand trace gravel, trace cinders, moist (CL)
				2B			26.9	2.07		4.5		
5				2C			19.3			5.0		Brown and gray clayey SAND, trace gravel, trace clay layer
				3	SS	28	23.2	4.07				
	CL											Brown silty CLAY, little sand, moist, occasional silt seams (CL)
										9.0		
				4	SS	20						
10	CL											Brown and gray silty CLAY with sand and gravel, moist (CL)
										10.5		
	Cl			5	SS	21						Gray silty CLAY, trace sand and gravel trace silt, trace sand seams, moist (CL)
				6	SS	23						
15										15.5		
	SW			7	SS	29						Gray fine to medium sand, trace gravel moist (SW)
				8	SS	30						
20												
				9	SS	35						
				10	SS	32						
25												
					End of Boring at 25.0 feet							
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 62 DATE STARTED 10-31-89 DATE COMPLETED 10-31-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						6"		Black clayey TOPSOIL (OL)
1	SS	16	11.2	4.5+*				FILL - Brown silty CLAY, trace sand, trace to little gravel fragments, moist
						3.5		
2	SS	12	18.4	4.5+*				Brown silty CLAY, trace sand, trace to little gravel, trace gravel, moist (CL)
3	SS	18	19.4	3.24				
4A B	SS	39	13.9	4.01		9.0		Brown fine SAND, damp (SP)
						10.5		Brown clayey fine SAND, damp (SC)
5A B	SS	59				12.0		Brown fine SAND, moist (SP)
6	SS	50						
						15.5		Brown silty SAND, trace clay, damp (SM)
7	SS	78						
8	SS	76						
9	SS	48						
10	SS	62						

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 60 DATE STARTED 11/2/89 DATE COMPLETED 11/2/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING -10.0 feet

24 HOURS

WHILE DRILLING -6.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0											
									12"		Black clayey sandy topsoil
			1	SS	13	13.5					FILL: Dark brown silty CLAY, trace sand and gravel, trace topsoil, moist
									3.0		
			2	SS	9	23.7	2.33				Brown and gray silty CLAY, trace sand and gravel, trace topsoil, moist
5											
			3A B	SS	9	32.6	1.49		7.0		
	SM								8.0		Brown silty SAND, trace clay, wet (SM)
10	CL		4	SS	18	17.3	3.0*				Brown silty CLAY, trace sand, small gravel, moist (CL)
									10.5		
			5	SS	18	14.4	4.14				Gray silty CLAY, trace sand, trace gravel, moist (CL)
15	CL		6	SS	21	14.2	4.25*				
			7	SS	17	15.6	3.11				
			8	SS	19	16.6	3.5*				
20									20.0		
	ML		9	SS	20						Gray SILT, trace clay, trace sand, damp (ML)
									23.0		
25			10	SS	24	15.8	4.21				Gray silty CLAY, trace sand, trace clay, moist (CL)
				End of Boring at 25.0 feet							
30											
35											
40											

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 61 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 15.0 (Caved)

24 HOURS 4.0 (Caved)

WHILE DRILLING 6.0 feet

DISTANCE BELOW SURFACE IN FEET		LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0									2.5"		ASPHALT
									10.0"		Crushed Limestone Subbase
	CL		1	SS	13	23.6	1.89				Brown and gray silty CLAY, little sand, moist (CL)
			2 A	SS	12	19.0	2.42		4.0		
5	SP		2 B								Brown fine SAND, trace silt (SP)
			3	SS	28				7.0		
	SP		4	SS	25						Gray fine to medium SAND, very moist (SP)
10	SP		5	SS	34						
			6	SS	29				15.0		
15	SW		7	SS	101						Gray and brown SAND with trace of gravel, very moist (SW)
20			8	SS	67						
			9	SS	66						
25			10	SS	70						
				End of Boring at 25.0 feet							
30											
35											
40											

TESTING SERVICE CORPORATION

DRILL RIG NO. 107

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 63 DATE STARTED 11-2-89 DATE COMPLETED 11-2-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0	OL			A			12.5					Brown clayey TOPSOIL with crushed limestone
	CL	X	X	1 B	SS	8	24.3	4.5+*		18"		FILL - Dark brown to black silty CLAY, and topsoil, some sand, trace gravel, moist
										3.0		
	ML	X	X	2	SS	13						Brown to gray fine sandy SILT, damp (ML)
5										5.5		
	CL	X	X	3	SS	14	21.8	4.0*				Brown and gray silty CLAY, trace sand, trace gravel, moist (CL)
										8.0		
	ML	X	X	4	SS	19	20.7	2.5*				Brown SILT, trace clay, moist (ML)
10	CL									9.5		
										10.5		Brown and gray silty CLAY, trace sand, trace weathered gravel, moist (CL)
		X	X	5	SS	14	15.2	3.37				
		X	X	6	SS	16	15.3	3.82				
15												
	CL	X	X	7	SS	19	15.6	4.5*				Gray silty CLAY, trace sand, trace gravel, moist (CL)
		X	X	8	SS	21	14.7	5.05				
20												
		X	X	9	SS	19	15.2	4.0*				
		X	X	10	SS	20	15.9	3.30				
25												
				End of Boring at 25.0 feet								
30												
35												
40												

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 64 DATE STARTED 11-2-89 DATE COMPLETED 11-2-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING - 15.0 feet

24 HOURS

WHILE DRILLING - 13.0 feet

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0	OL									2"		Black and brown clayey TOPSOIL moist (OL)
	CL OL			1	SS	9	24.1	4.5+*				FILL - Dark brown and black silty CLAY and TOPSOIL, little sand, moist (CL/OL)
										3.0		
5	CL			2	SS	15	17.8	3.75*				Brown and gray silty CLAY, little sand, trace gravel, moist (CL)
				3	SS	16	14.0	5.24				
10				4	SS	16	16.0	4.5+*				
										10.5		
	CL			5	SS	21	15.8	4.21				Gray silty CLAY, little sand, trace gravel, moist (CL)
15										13.5		
				6	SS	13						
				7	SS	9						
20	SP			8	SS	9						Gray fine to medium SAND, trace silty, moist (SP)
				9	SS	22						Trace layer of silty CLAY at 19.5 feet
25				10	SS	23						
				End of Boring at 25.0 feet								
30												
35												
40												

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 65 DATE STARTED 11-2-89 DATE COMPLETED 11-2-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

	LENGTH RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								2"		Black clayey TOPSOIL (OL)
CL		1	SS	14	19.1	4.25*				Brown silty CLAY, little sand, trace gravel, moist (CL)
		2	SS	13	13.3	4.5*				
		3	SS	15	14.7	4.5*				
								8.0		
ML		4	SS	15	26.3					Brown clayey SILT, moist (ML)
								10.5		
CL		5 A	SS	12	13.4	1.0*				Brown very silty CLAY, little sand, little gravel, very moist (CL)
								11.5		
ML		5 B			23.9	-				Stiff gray clayey SILT, trace sand seams, moist (ML)
		6 A	SS	9	17.4					
								14.0		
		6 B			15.1					
CL		7	SS	10	14.7	1.55				Stiff gray very silty CLAY, little sand, trace gravel, very moist (CL
		8	SS	11	14.5	1.5*				
								20.5		
SP		9	SS	53						Very dense fine to medium SAND, trace silt, very moist (SP)
		10	SS	46						

End of Boring at 25.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

TESTING SERVICE CORPORATION

DRILL RIG NO. 117

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 73 DATE STARTED 11-9-89 DATE COMPLETED 11-9-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 12.13' at 11-9-89

24 HOURS 9.9' at 11-10-89

WHILE DRILLING 11.0'

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1	SS	23				1.0		Black sandy CLAY, trace topsoil, moist
											FILL - Brown silty CLAY, little sand, gravel, cinders, damp
CL			2	SS	29				3.5		Brown and gray mottled SILT with little clay and very fine sand, damp (CL)
CL			3	SS	28				6.0		Brown silty CLAY with trace sand and occasional thin coarse sand layers, damp (CL)
CL			4	SS	17				9'6"		Gray silty CLAY, trace sand and small gravel, moist (CL)
ML			5	SS	20				11.0		Gray SILT with some very fine sand, very moist (ML)
			End of Boring at 12.5 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 12.5 feet to 7.5 feet
- Sand pack from 12.5 feet to 5.0 feet
- Bentonite seal from 5.0 feet to ground surface
- 1.25 Inch PVC pipe from 7.5 feet to ground surface with 2.6 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 74 DATE STARTED 11-9-89 DATE COMPLETED 11-9-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 12.5 feet

24 HOURS 1" wet sand at end of tip-dry

WHILE DRILLING 9.0 feet

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									0.5		Black sandy CLAY topsoil, moist (OL)
			1	SS	14						FILL - Brown sandy CLAY, little sand and gravel, trace cinders, damp
			2	SS	18						
									5.5		
ML			3	SS	25						Yellow brown sandy SILT, trace clay, occasional thin very fine sand layer, damp to moist (ML)
			4	SS	36						2.0 inch layer of silt with very fine sand at 10.0 feet
			End of Boring at 10.0 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 10.0 to 7.5 feet
- Sand pack from 10.0 to 5.0 feet
- Bentonite seal from 5.0 feet to ground surface
- 1.25 inch PVC pipe from 7.5 feet to ground surface with 2.5 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 75 DATE STARTED 11-9-89 DATE COMPLETED 11-9-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET		LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
0	OL									6"		Black sandy CLAY topsoil, moist (OL)
				1	SS	19				2.5		FILL - Brown to black silty CLAY, little sand and gravel, trace cinders, moist
5	CL			2	SS	21				6.0		Pale brown and gray very silty CLAY, with trace small gravel and sand, damp (CL)
	ML			3	SS	25				8.5		Yellow clayey SILT with trace very fine sand, damp (ML)
10	CL			4	SS	32						Light brown silty CLAY with trace sand and small gravel, damp (CL)
				5	SS	24				12.0		
15	CL			6	SS	24						Gray silty CLAY, trace sand and gravel, damp (CL)
20				7	SS	44						
				8	SS	49						
25				End of Boring at 22.0 feet								PIEZOMETER AT THIS LOCATION - 1.25 PVC screen from 13.0 to 8.0 feet - Sand pack from 13.0 to 6.0 feet - Bentonite seal from 6.0 feet to ground surface - 1.25 inch PVC pipe from 8.0 feet to ground surface with 2.0 feet of stickup - Bentonite seal placed from 22.0 to 13.0 feet
30												
35												
40												

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 76 DATE STARTED 11-9-89 DATE COMPLETED 11-9-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 8.67 feet

24 HOURS 8.75 feet

WHILE DRILLING 4.75 feet

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy TOPSOIL, Moist (OL)
CL			1	SS	18				2.5		Yellow silty CLAY, trace sand, some gravel, damp, friable (CL)
ML			2	SS	12				4.75		Yellowish gray fine sandy SILT, trace clay, moist (ML)
SW			3	SS	7						Brown, coarse SAND, some gravel, moist to wet (SW)

End of Boring at 8.0 feet

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 8.0 to 3.0 feet
- Sand pack from 8.0 to 3.0 feet
- Bentonite seal from 3.0 feet to ground surface
- 1.25 inch PVC pipe from 3.0 feet to ground surface with 2.0 feet of stickup

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 77 DATE STARTED 11-9-89 DATE COMPLETED 11-9-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 10.9 feet

24 HOURS 8.5 feet

WHILE DRILLING 11.5 feet

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy TOPSOIL, moist (OL)
SM			1	SS	29				2.5		Yellow fine silty SAND with some clay, damp (SM)
CL			2	SS	24						Yellow and gray mottled silty CLAY with trace sand and gravel damp (CL)
			3	SS	15				8.5		
ML			4	SS	11						Yellow and gray mottled clayey SILT, some sand, moist (ML)
			5	SS	10						

End of Boring at 11.5 feet

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 11.5 feet to 9.0 feet
- Sand Pack from 11.5 to 7.0 feet
- Bentonite seal from 7.0 feet to ground surface
- 1.25 inch PVC pipe from 9.0 feet to ground surface with 14 inches of stickup

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 78 DATE STARTED 11-10-89 DATE COMPLETED 11-20-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 9.65 feet

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy TOPSOIL, moist (OL)
ML			1	SS	15	18.8			3.0		Brown to dark gray clayey SILT, trace sand, trace topsoil, moist (ML)
CL			2	SS	18	18.4	2.5*				Firm brownish gray silty to very silty CLAY, little sand, trace gravel, moist (CL)
			3	SS	29	22.9	4.66 4.5+*				
			4	SS	26	15.9	4.5+*				
ML			5	SS	32	22.1			10.5		Firm yellowish brown clayey SILT, trace sand, moist (ML)
			End of Boring at 12.5 feet								

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 11.5 to 6.5 feet
- Sand pack from 11.5 to 5.5 feet
- Bentonite seal from 5.5 feet to ground surface
- 1.25 inch PVC pipe from 6.5 feet to ground surface with 3.5 feet of stickup
- Bentonite seal from 12.5 feet to 11.5 feet

TESTING SERVICE CORPORATION

DRILL RIG NO. 136

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 79 DATE STARTED 11-10-89 DATE COMPLETED 11-10-89 JOB 27,68

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 12.4 feet

WHILE DRILLING DRY

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									8"		Black sandy CLAY topsoil, trace gravel, moist (OL)
CL			1	SS	10	22.4		104.8	3.0		FILL - Brown and gray silty CLAY, little sand, trace gravel, damp (CL)
			2	SS	10	27.3	2.22				Brown and gray silty CLAY, little sand, trace gravel, moist (CL)
CL			3	SS	19	21.8	4.99				Occasional 0.5 inch layer of silt and very fine sand, damp
			4	SS	26	21.3	3.25*				
CL			5A	SS	25	25.0	1.75*		12.0		Gray silty CLAY, trace very fine sand and small gravel, damp (CL)
			5B			22.7	4.26				

End of Boring at 13.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 12.7 to 7.7 feet
- Sand pack from 12.7 to 6.0 feet
- Bentonite seal from 6.0 feet to ground surface
- 1.25 inch PVC pipe from 7.7 feet to ground surface with 2.3 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 80 DATE STARTED 11-13-89 DATE COMPLETED 11-13-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 8.94 feet

24 HOURS 8.20 feet

WHILE DRILLING 8.00 feet

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									0.5		Black sandy TOPSOIL, Moist (OL)
CL			1	SS	18	14.9			3.0		FILL - Dark brown silty CLAY, trace sand, cinders and bricks, trace roots, moist
CL			2	SS	23	21.2	2.5*				Brown to gray silty CLAY, little sand, trace gravel, moist (CL)
			3 A/B	SS	16				7.0		
ML			4	SS	32						Yellowish brown sandy SILT, trace clay and gravel, moist to wet (ML) Occasional 1" medium sand seams below 8.5 feet

End of Boring at 10.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 10.0 to 7.5 feet
- Sand pack from 10.0 to 3.0 feet to ground surface
- 1.25 inch PVC pipe from 7.5 feet to ground surface with 2.6 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 81 DATE STARTED 11-14-89 DATE COMPLETED 11-14-89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 9.19 feet at 11-15-89

WHILE DRILLING DRY

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
								10"		Black sandy TOPSOIL, trace gravel damp
		1	SS	60						FILL - Brown silty CLAY, little sand and gravel, moist, asphalt and crushed limestone found at 2.25 feet
		2	SS	8						
								5.5		
		3	SS	11						Brown and gray mottled silty CLAY, with trace sand and gravel, damp (CL)
CL		4	SS	35						Becomes all gray below 9.0 feet with occasional 0.5 inch layers of medium sand
								11.0		
ML		5	SS	24						Gray clayey SILT with some fine to medium sand, trace small gravel damp to moist (ML)

End of Boring at 13.0 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER AT THIS LOCATION

- 1.25 inch PVC screen from 12.5 to 7.5 feet
- Sand pack from 12.5 to 6.0 feet
- Bentonite seal from 6.0 feet to ground surface
- 1.25 inch PVC pipe from 7.5 feet to ground surface with 2.6 feet of stickup

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 82 DATE STARTED 11/14/89 DATE COMPLETED 11/14/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING

24 HOURS

WHILE DRILLING

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy clayey TOPSOIL, damp (OL)
			1	SS	16	14.3			3.0		Brown silty CLAY, little sand and gravel, trace cinders, bricks, damp
CL			2	SS	26	15.1	4.5+*				Brown silty CLAY, trace sand and gravel, occasional 1/2 inch sand layers below 7.0 feet moist (CL)
CL			3	SS	34						
CL			4	SS	45				8.5		Gray silty CLAY, little fine sand and small gravel, moist (CL)
SP			5 A B	SS	33				10.5		Brown medium SAND, trace silt trace gravel, moist (SP)
				End of Boring at 13.0 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER

1.25 inch PVC screen from 12.0 to 9.5 feet.

Sand pack from 12.0 to 6.0 feet

Bentonite Seal from 6.0 feet to ground surface.

1.25 inch PVC pipe from 9.5 feet to ground surface.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 83 DATE STARTED 11/14/89 DATE COMPLETED 11/14/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING 3.5

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γDRY	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									6"		Black sandy TOPSOIL, damp (OL)
	X	X	1	SS	14	14.3			3.0		FILL: Brown silty CLAY, little sand and gravel, trace cinders, bricks, damp.
CL	X	X	2	SS	24				4.5		Yellow SILT with some very fine sand, very moist to wet, (ML)
											Brown and pink silty CLAY with trace of small gravel, damp (CL)

End of Boring at 5.5 feet

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.25 inch PVC screen from 5.5 to 3.0 feet.

Sand pack from 5.5 feet to 4.0 feet.

Bentonite Seal from 4.0 feet to ground surface.

1.25 inch PVC pipe from 3.0 feet to ground surface with 1.7 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 84 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 9.6

24 HOURS 9.8

WHILE DRILLING 6.0

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy TOPSOIL, moist (OL)
			1	SS	8						FILL: Brown silty CLAY, little sand, trace gravel, wood, cinders, damp
			2	SS	6						
									6.0		
ML			3	SS	44						Yellow SILT with some very fine silty sand, very moist (ML)
SM									8.5		Brown very fine to fine silty SAND, very moist (SM)
ML			4	SS	39				9.5		Gray SILT with some very fine sand, wet (ML)

End of Boring at 10.0 feet

DISTANCE BELOW SURFACE IN FEET

0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.0 inch PVC screen from 9.5 to 4.5 feet.

Sand pack from 9.5 to 3.0 feet

Bentonite Seal from 3.0 feet to ground surface.

1.25 inch PVC pipe from 4.5 feet to ground surface with 0.5 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 85 DATE STARTED 11/14/89 DATE COMPLETED 11/14/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS DRY

WHILE DRILLING 10.2 feet

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
									0.8		Black clayey TOPSOIL, trace sand, damp.
			1	SS	21	8.7					FILL: Brown silty CLAY, little sand and gravel, trace cinders, damp.
			2	SS	11						
									5.5		
CL			3	SS	10						Brown silty CLAY, trace sand and gravel, moist (CL)
			4	SS	31				9.0		
CL			5	SS	31						Gray silty CLAY, trace sand and gravel, moist (CL) 1" silt layer at 11.25 feet
				End of Boring at 12.5 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.0 inch PVC screen from 12.0 to 7.0 feet.

Sand pack from 12.0 feet to 8.8 feet.

Bentonite seal from 8.8 feet to ground surface.

1.0 inch PVC pipe from 7.0 feet to ground surface with 0.4 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 86 DATE STARTED 11/14/89 DATE COMPLETED 11/14/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 12.5 feet

24 HOURS 11.5 feet

WHILE DRILLING 9.5 feet

LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
		1	SS	9				1.0		FILL: Stiff black sandy TOPSOIL with some clay, little organic, damp
		2	SS	11				5.5		FILL: Loose yellow brown fine sand trace clay and cinders, damp
		3	SS	6						Dense yellow brown fine-medium sand, trace small gravel, damp wet below 9.5 feet. (SW)
		4	SS	30						
		5	SS	43						
			End of Boring at 12.5 feet							

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

PIEZOMETER

1.0 inch PVC screen from 13.0 to 8.0 feet.

Sand pack from 8.0 to 5.5 feet

Bentonite seal from 5.5 feet to ground surface.

1.0 inch PVC pipe from 8.0 feet to ground surface with 2.0 feet stick up

DRILL RIG NO. 138

TESTING SERVICE CORPORATION

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 87 DATE STARTED 11/10/89 DATE COMPLETED 11/13/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 12.7 feet

24 HOURS 10.5 feet

WHILE DRILLING 8.0 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
			1	SS	17	13.6		115.8	2.5		FILL: Brown silty CLAY, trace sand and small gravel, moist
SC			2	SS	4	20.5					Brown clayey SAND, some small gravel, moist (SC)
			3	SS	19	14.1			7.5		
CL			4 A B	SS	31				9.0		Brown and gray silty CLAY, trace sand and gravel, damp (CL)
CL			5	SS	15						Gray silty CLAY, trace sand and gravel, moist (CL)
			6	SS	16						2.0 inch thick wet sand seam at 16.0 feet
			7	SS	15						
ML			8	SS	15				18.0		Gray SILT, little very fine sand, occasional 2.0 inch coarse sand layers, wet (ML)

End of Boring at 20.0 feet

PIEZOMERTER

1.25 inch PVC screen from 19.0 to 14.0 feet.

Sand pack from 19.0 to 9.0 feet.

Bentonite seal from 9.0 feet to ground surface.

1.25 inch PVC pipe from 14.0 feet to ground surface with 2.0 feet of stick up.

DRILL RIG NO. 138

TESTING SERVICE CORPORATION

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 88 DATE STARTED 11/10/89 DATE COMPLETED 11/13/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING 18.24 feet

24 HOURS 16.33 feet

WHILE DRILLING 13.5 feet

SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
						1.0		Black to dark brown clayey TOPSOIL, moist
1	SS	5	18.6		108.4			FILL: Brown silty CLAY, little sand and gravel, trace topsoil, damp
						3.0		
2 A	SS	7	18.9*	3.0*				Brown silty CLAY, some sand, trace gravel, moist (CL)
2 B			23.2	2.81		5.0		
3	SS	17	16.1*	4.5*				Yellow brown-brown fine sand, some silt, moist (SM)
4	SS	21	10.4					
5 A	SS	40	16.9			12.0		
5 B			13.7*	4.5+*				Gray fine SAND with little silt, wet (SP)
6	SS	55						
7	SS	60						
8	SS	45						
	End of Boring at 20.0 feet							

SM

DISTANCE BELOW SURFACE IN FEET: 0, 5, 10, 15, 20, 25, 30, 35, 40

LENGTH RECOVERY

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER

1.25 inch PVC screen from 19.0 to 14.0 feet

Sand pack from 19.0 feet to 12.0 feet.

Bentonite seal from 12.0 feet to ground surface.

1.25 inch PVC pipe from 4.0 feet to ground surface with 1.0 foot of stick up.

Bentonite seal from 20.0 feet to 14.0 feet.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 89 DATE STARTED 11/10/89 DATE COMPLETED 11/10/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING

24 HOURS DRY

WHILE DRILLING DRY

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									1.0		Black sandy TOPSOIL, damp (OL)
	X	X	1	SS	10	18.9	2.5*		3.0		Brown to dark brown silty CLAY, little sand, moist (CL)
SC	X	X	2	SS	6	20.4					Brown clayey fine SAND, little silt, moist (SC)
	X	X	3	SS	8	21.9			7.5		
CL	X	X	4	SS	19	17.4	1.0*				Brown and gray silty CLAY, little sand, very moist (CL)

End of Boring at 10.0 feet

* Approximate unconfined compression strength based on measurements with a calibrated pocket penetrometer.

PIEZOMETER

1.25 inch PVC screen from 8.0 to 3.0 feet.

Sand pack from 8.0 to 3.0 feet

Bentonite seal from 3.0 feet to ground surface.

1.25 inch PVC pipe from 3.0 feet to ground surface with 1.8 feet of stick up.

Soil cuttings from 10.0 to 8.0 feet

TESTING SERVICE CORPORATION

DRILL RIG NO. 138

PROJECT GREAT LAKES NAVAL TRAINING CENTER, GREAT LAKES, ILLINOIS

CLIENT RJN ENVIRONMENTAL ASSOCIATES, INC., 202 WEST FRONT STREET, WHEATON, ILLINOIS

BORING 90 DATE STARTED 11/17/89 DATE COMPLETED 11/17/89 JOB 27,681

ELEVATIONS

GROUND SURFACE

END OF BORING

WATER TABLE

AT END OF BORING DRY

24 HOURS 3.0 feet

WHILE DRILLING 3.5 feet

DISTANCE BELOW SURFACE IN FEET

	LENGTH	RECOVERY	SAMPLE NO.	SAMPLE TYPE	N	WC	Q_u	γ_{DRY}	DEPTH	ELEV.	SOIL DESCRIPTIONS
OL									8"		Black clayey TOPSOIL, moist (OL)
	X	X	1	SS	24						FILL: Brown silty CLAY, little sand and gravel, trace cinders, damp.
									3.0		
ML	X	X	2	SS	20						Brown fine sandy SILT, trace organic material, moist (ML)
	X	X	3	SS	26						
									8.5		
CL	X	X	4	SS	14						Gray very silty CLAY, trace fine sand, moist (CL)
				End of boring at 10.0 feet							

PIEZOMETER

1.25 inch PVC screen from 10.0 to 5.0 feet.

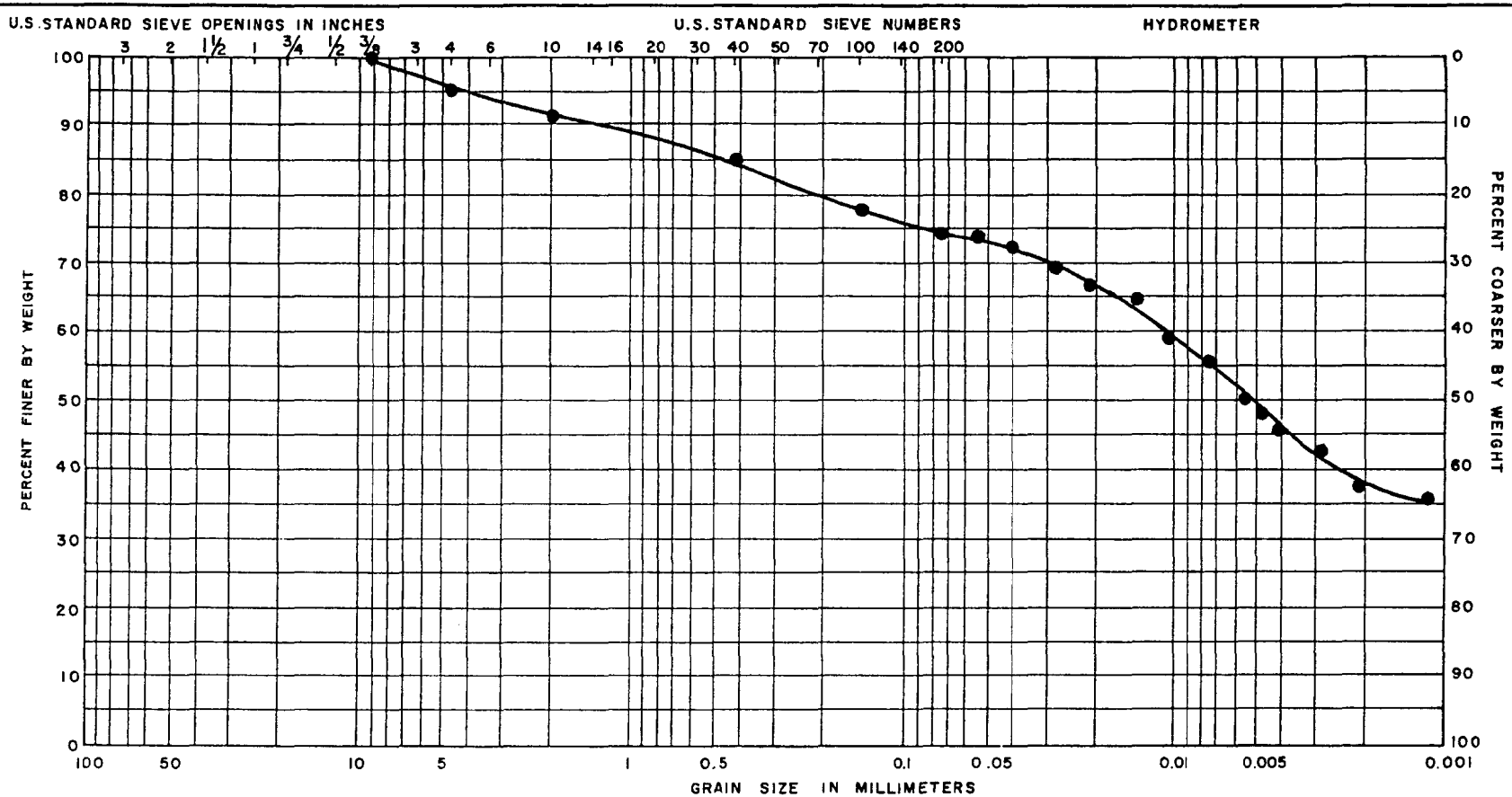
Sand pack from 10.0 to 4.0 feet

Bentonite seal from 4.0 feet to ground surface.

1.25 inch PVC pipe from 5.0 feet to ground surface with 0 feet of stick up.

TESTING SERVICE CORPORATION

DRILL RIG NO. 138



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

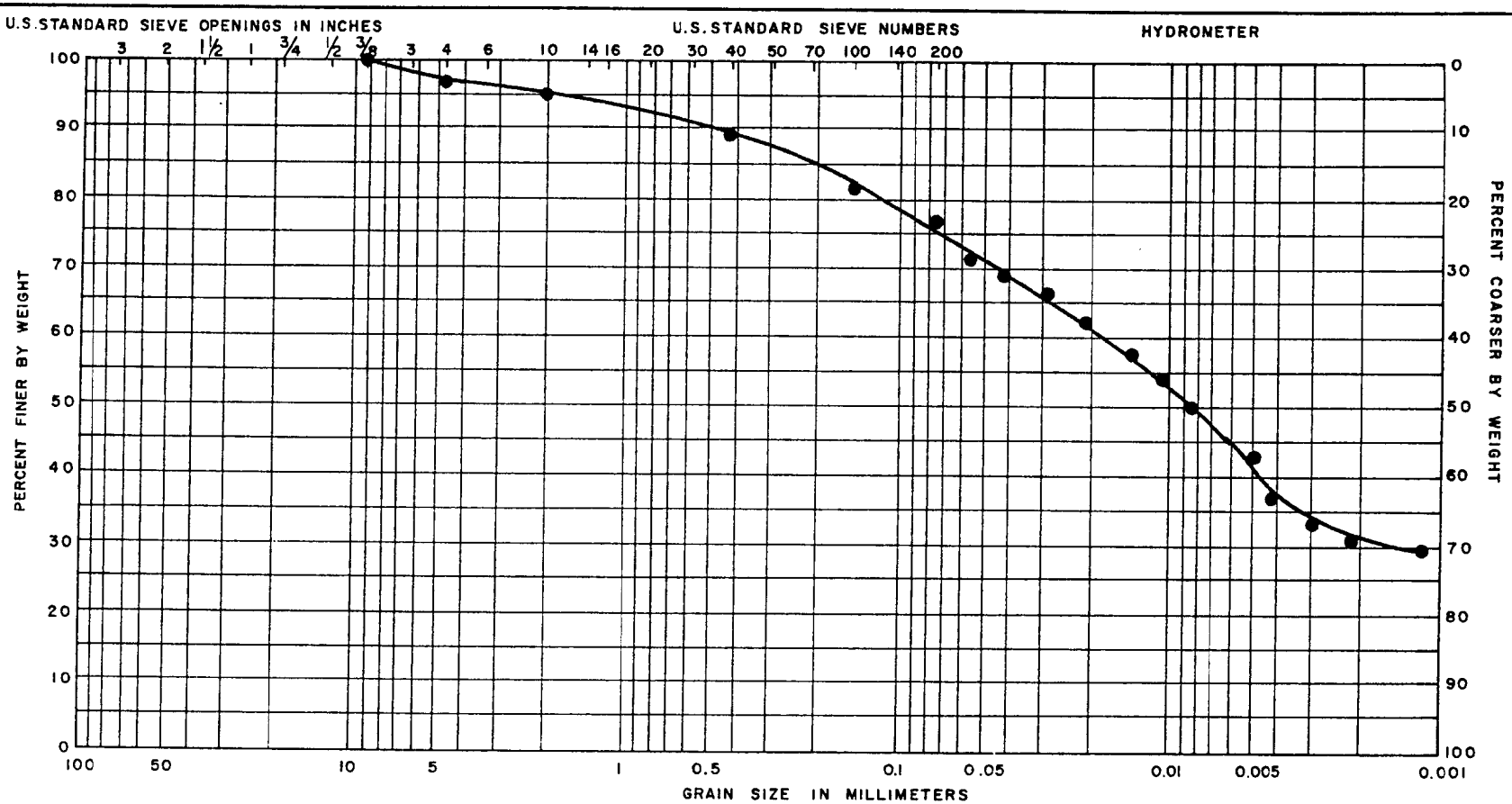
NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-1	2.0-4.0'	16.1	53	23	Brown and gray silty CLAY, trace
S-2A					sand and gravel, (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 27
% silt - 26
% clay - 48

GRAIN SIZE ANALYSIS

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL		SAND		SILT OR CLAY	
AASHTO	GRAVEL		COARSE	FINE	SILT	CLAY

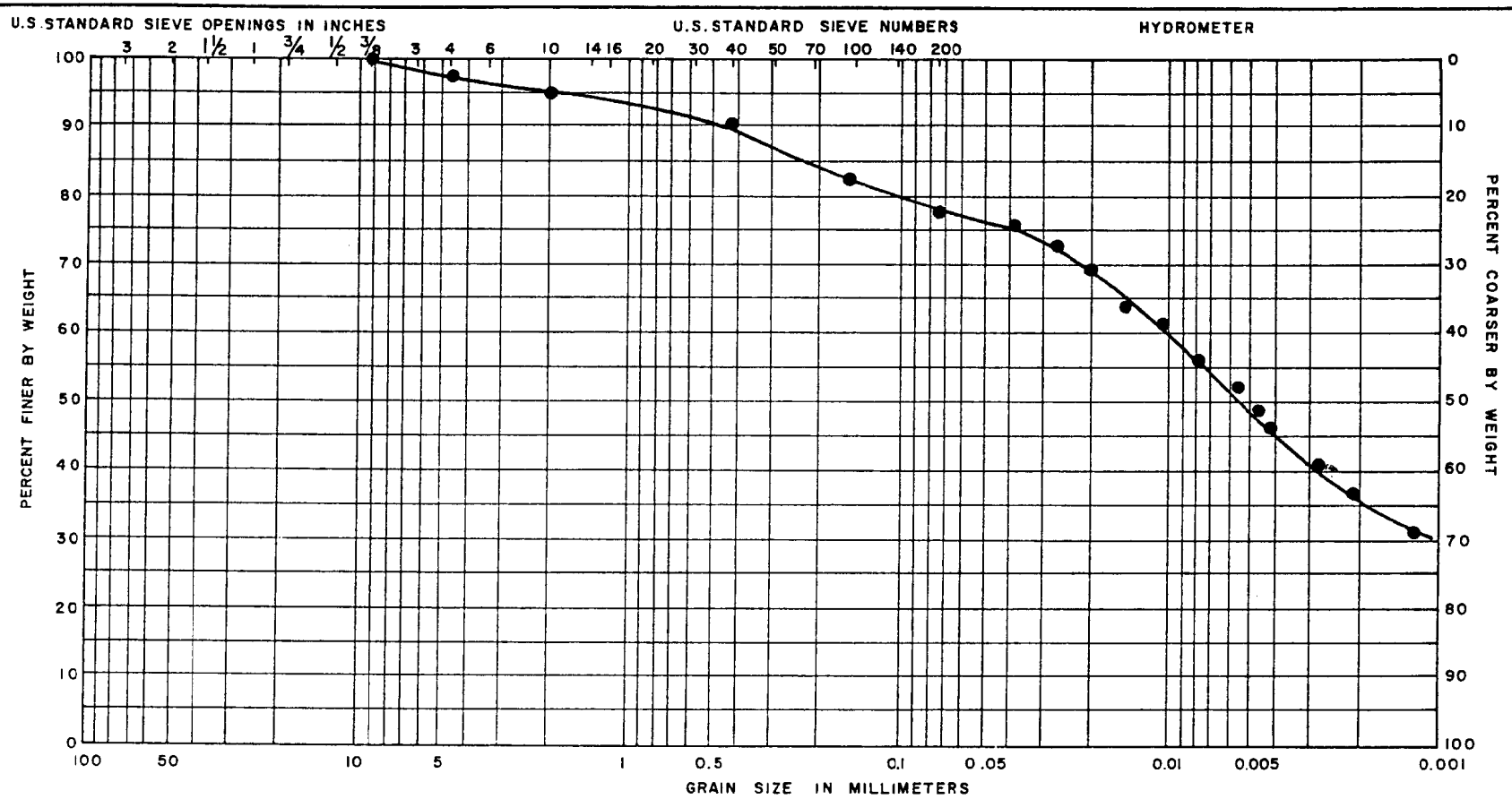
NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-5	6.0-7.5'	16.6	31	15	Brown and gray silty CLAY, trace
S-3					sand, gravel and roots (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 23
% silt - 36
% clay - 41

GRAIN SIZE ANALYSIS



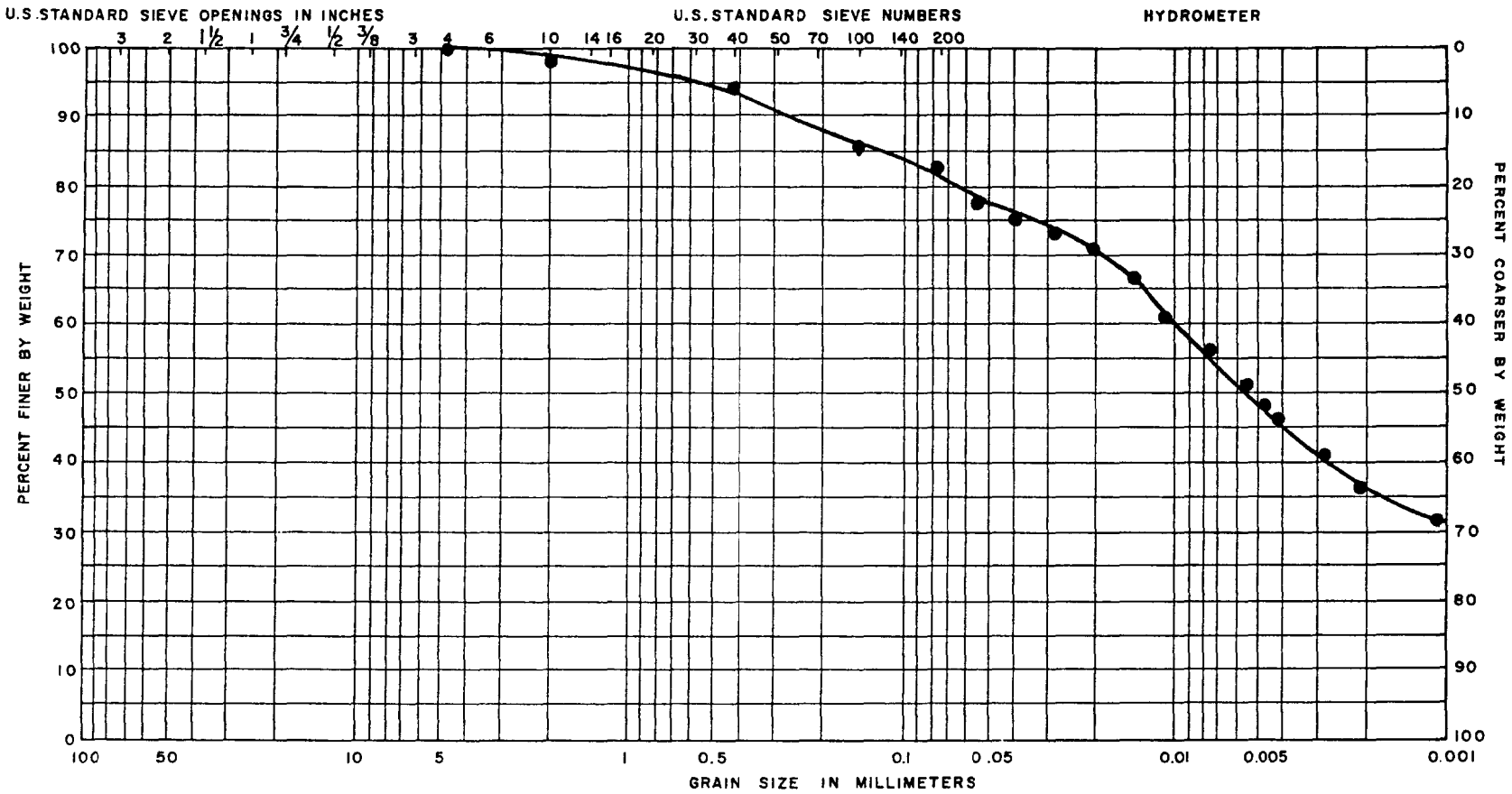
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-14	4.0-6.0'	20.6	35	16	Brown and gray silty CLAY, trace
S-3B					sand and gravel, (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 22
% silt - 30
% clay - 49

GRAIN SIZE ANALYSIS



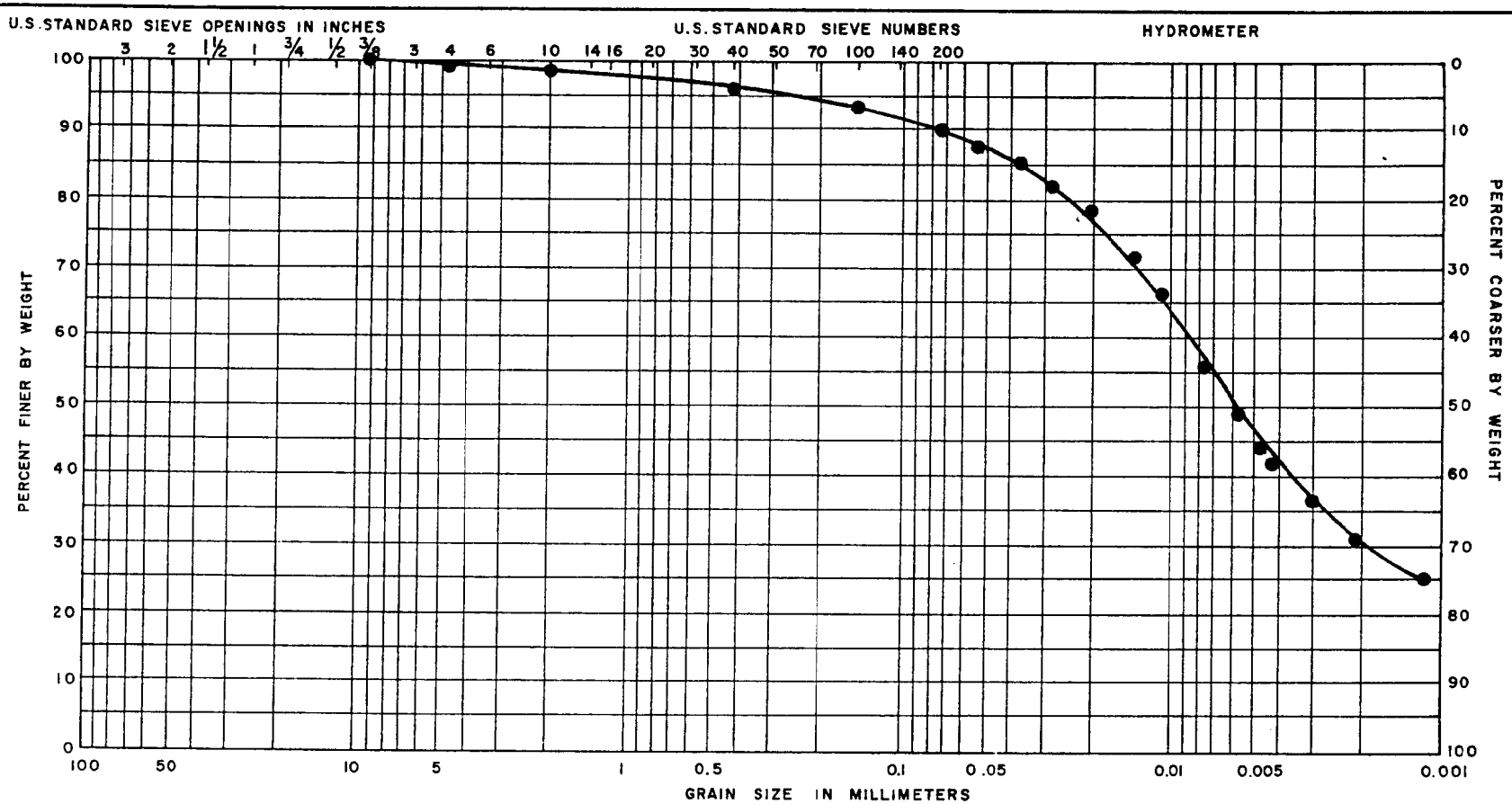
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
A ASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-17	2.0'-4.0'	21.2	50	19	Dark brown silty CLAY, trace sand,
1A					gravel and organic (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 18
% silt - 34
% clay - 48

GRAIN SIZE ANALYSIS



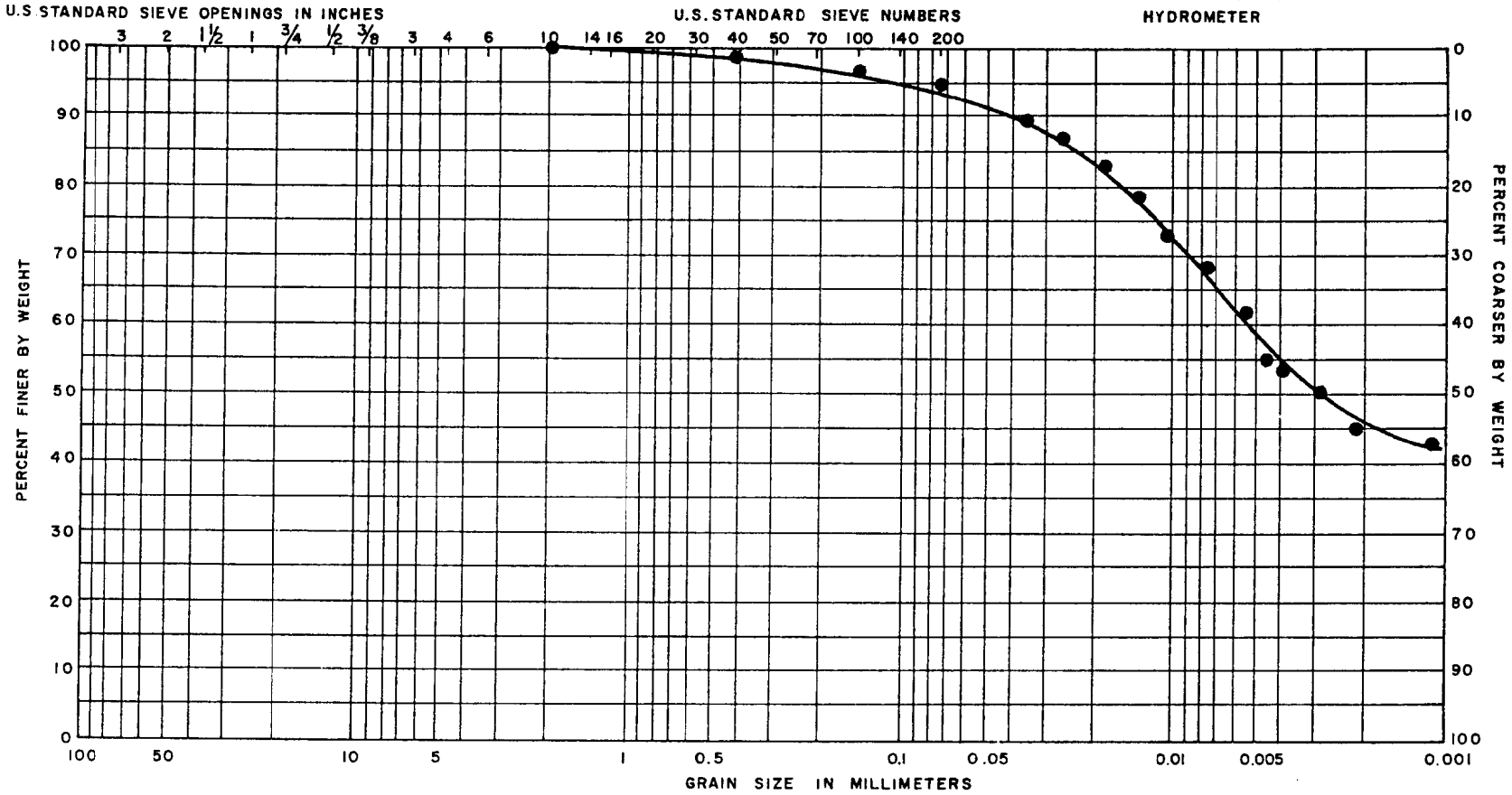
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-25	2.0-4.0'	17.6	30	15	Brown and gray very silty CLAY,
S-2					trace sand and gravel, trace silt
					seams (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 10
% silt - 46
% clay - 44

GRAIN SIZE ANALYSIS



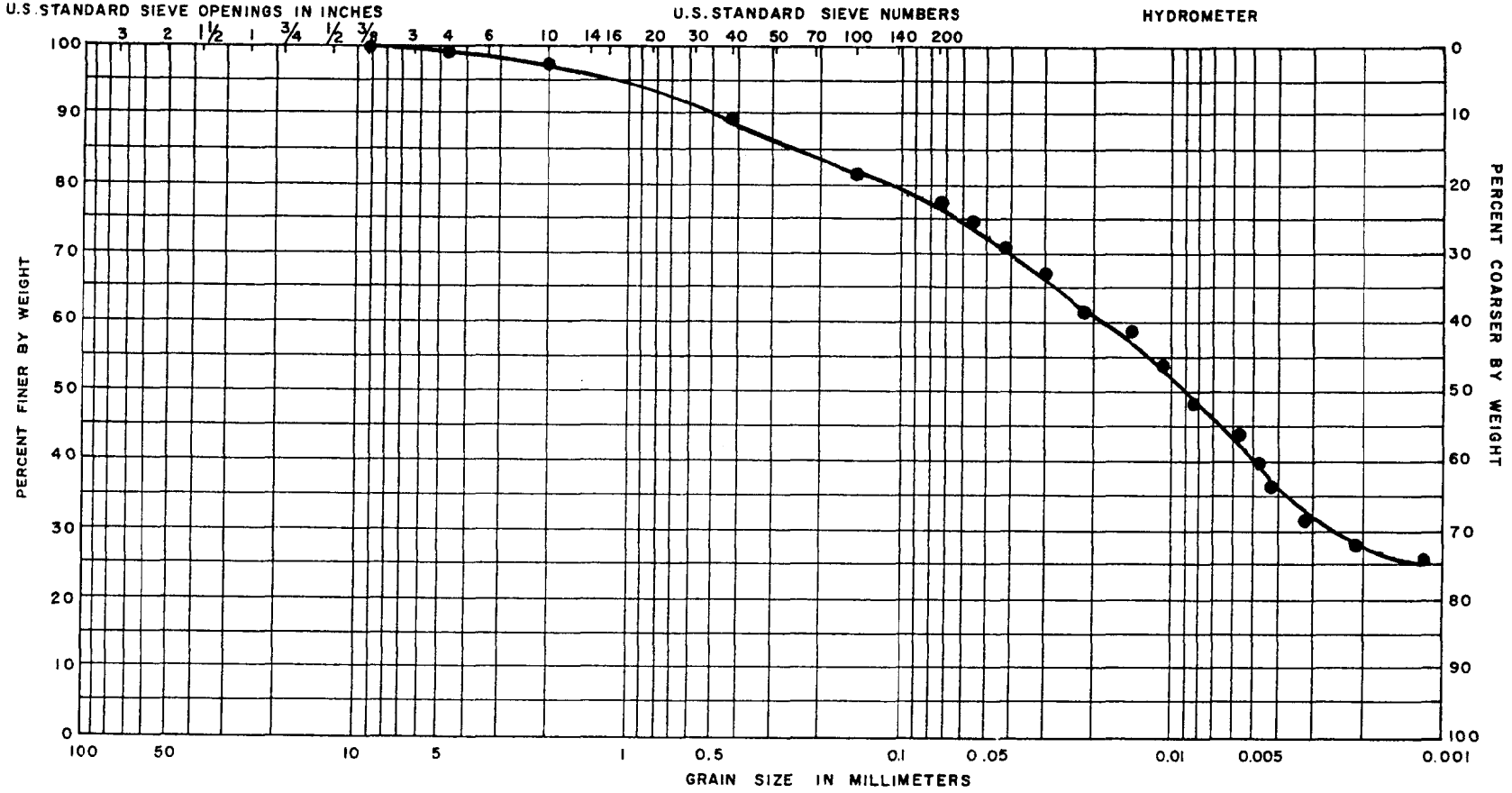
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-35	2.0-4.0	16.4	50	19	FILL - Brown and gray very silty
S-2A					CLAY, trace sand and gravel and
					organic material (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 5
% silt - 40
% clay - 55



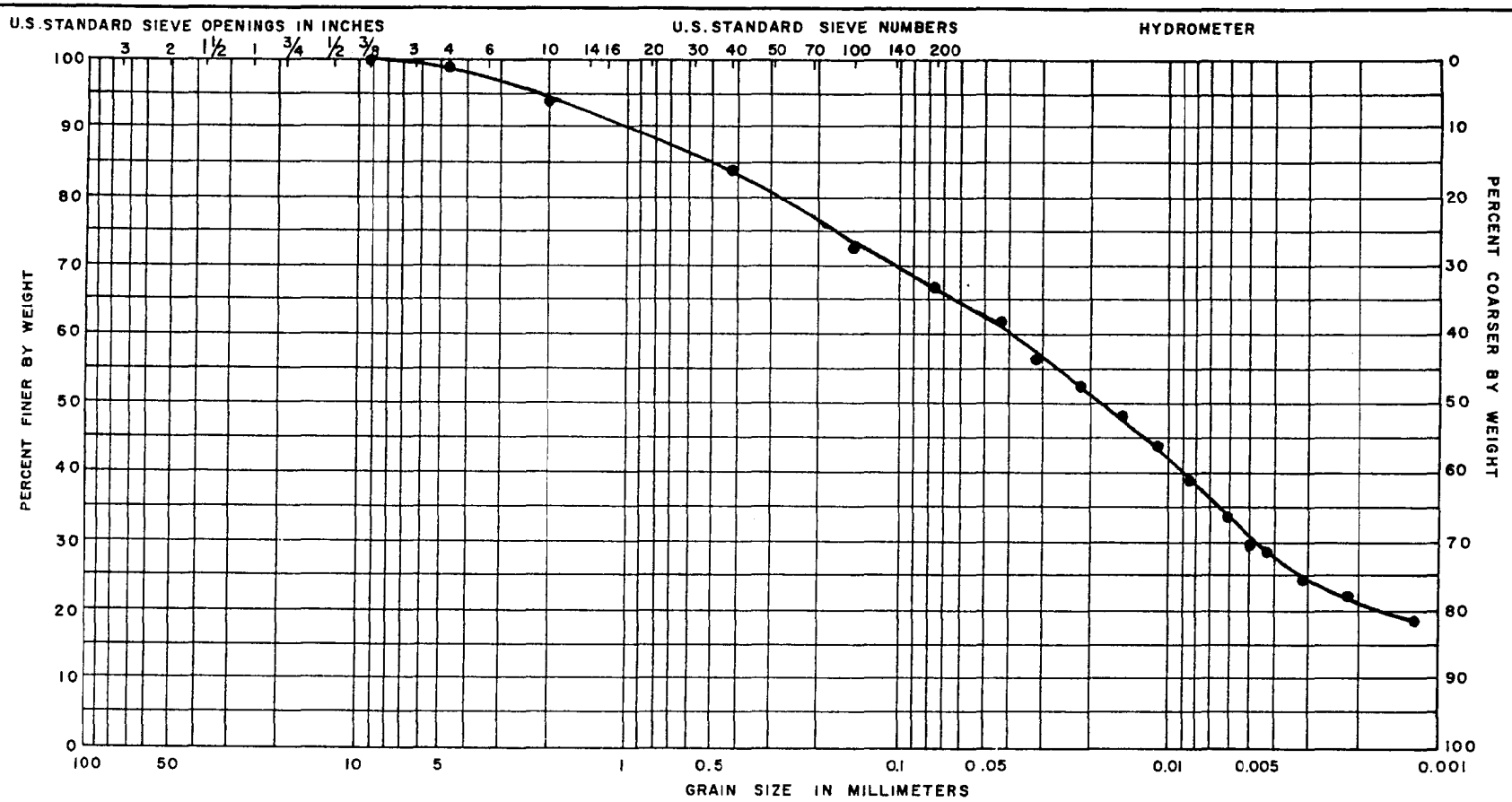
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-39	2.0-4.0	18.7	23	37	FILL - Brown and gray silty CLAY,
2B					trace sand, gravel and organic
					material (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 23
% silt - 37
% clay - 40

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

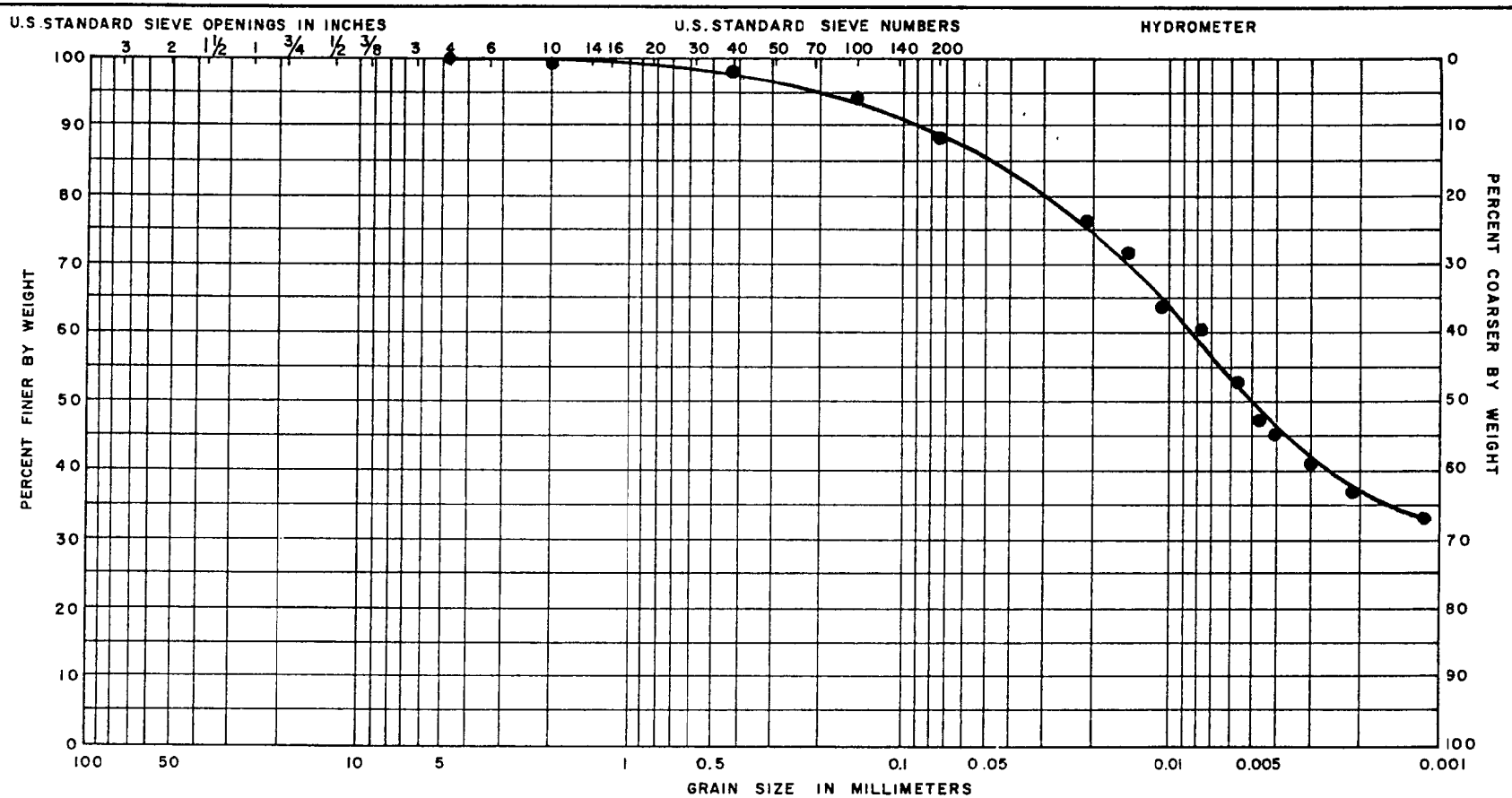
NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-43	0.0-2.0'	11.7	32	17	FILL - Brown silty CLAY, trace sand,
S-1B					gravel and organic material (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 34
% silt - 38
% clay - 29

GRAIN SIZE ANALYSIS



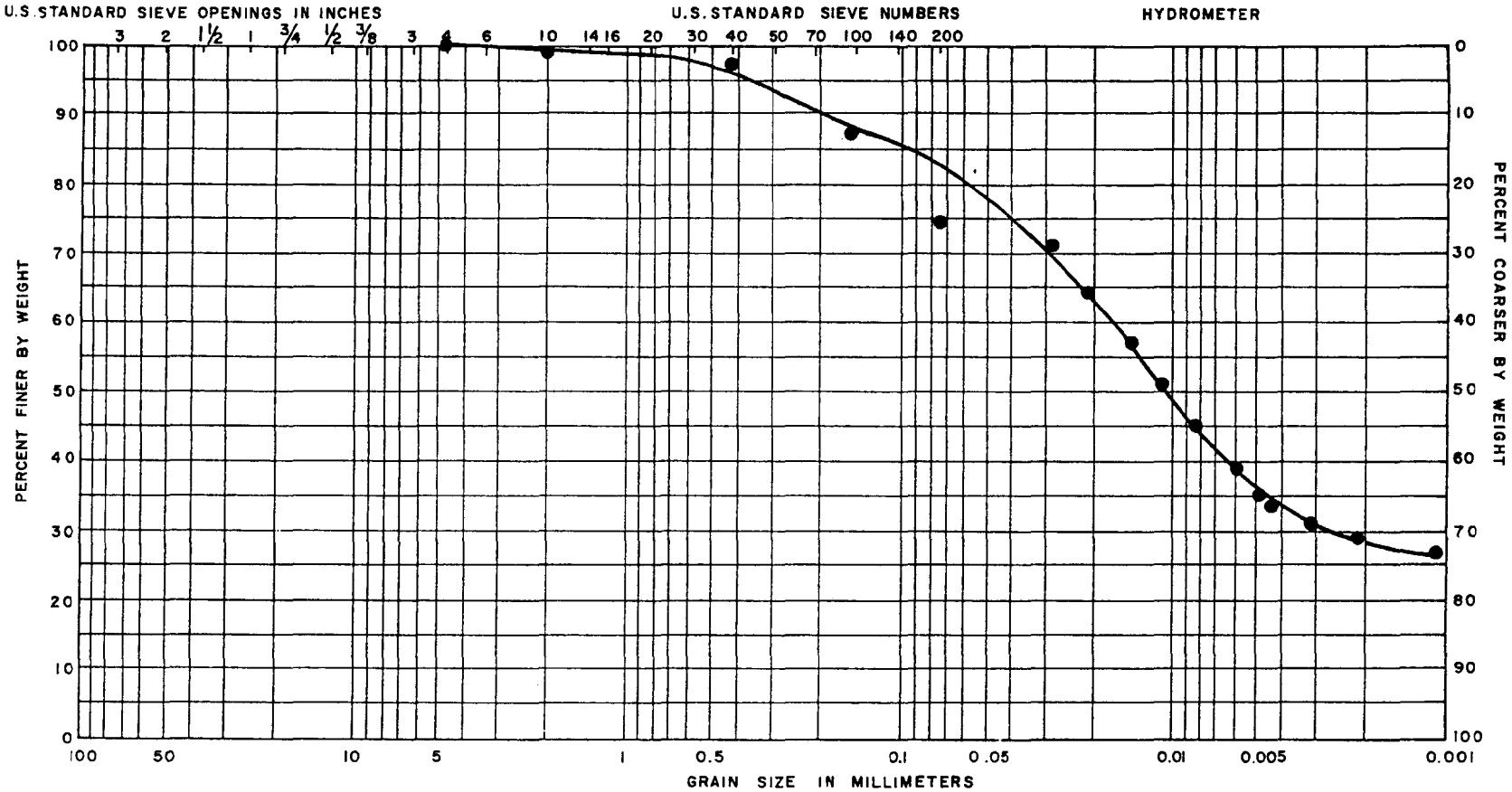
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-54	6.0-7.5'	21.3	28	16	Brown and gray silty CLAY, trace
S-3					sand, small gravel and topsoil (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 12
% silt - 41
% clay --47

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

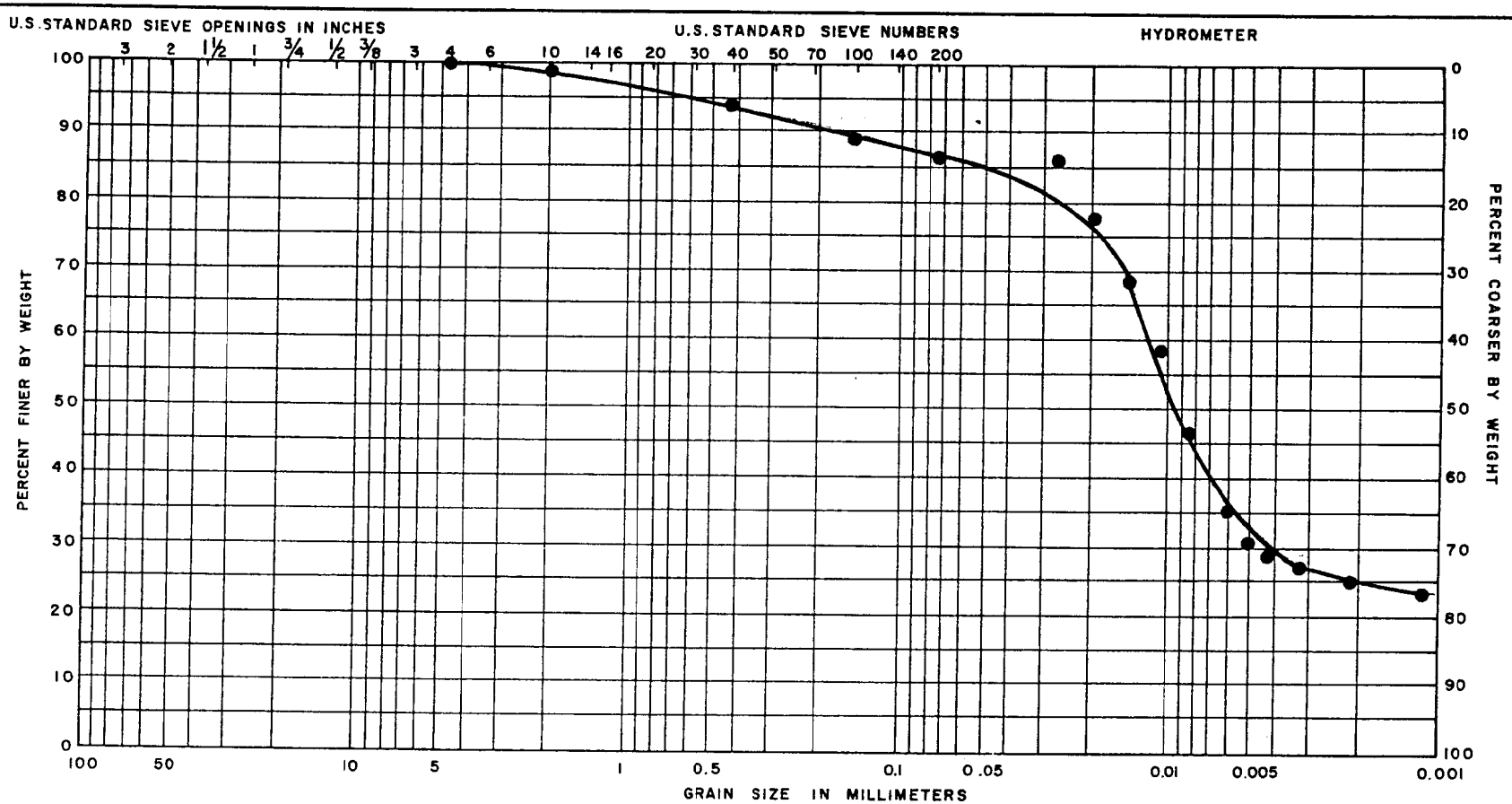
NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-63	3.5-5.0'	NC	24	14	Brown and gray fine sandy SILT (ML)
S-2					
					See text of Report concerning this
					sample

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 26
% silt - 39
% clay - 35

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-80	3.5-5.0'	21.2	29	19	Brown and gray silty CLAY, little sand, trace grave (CL)

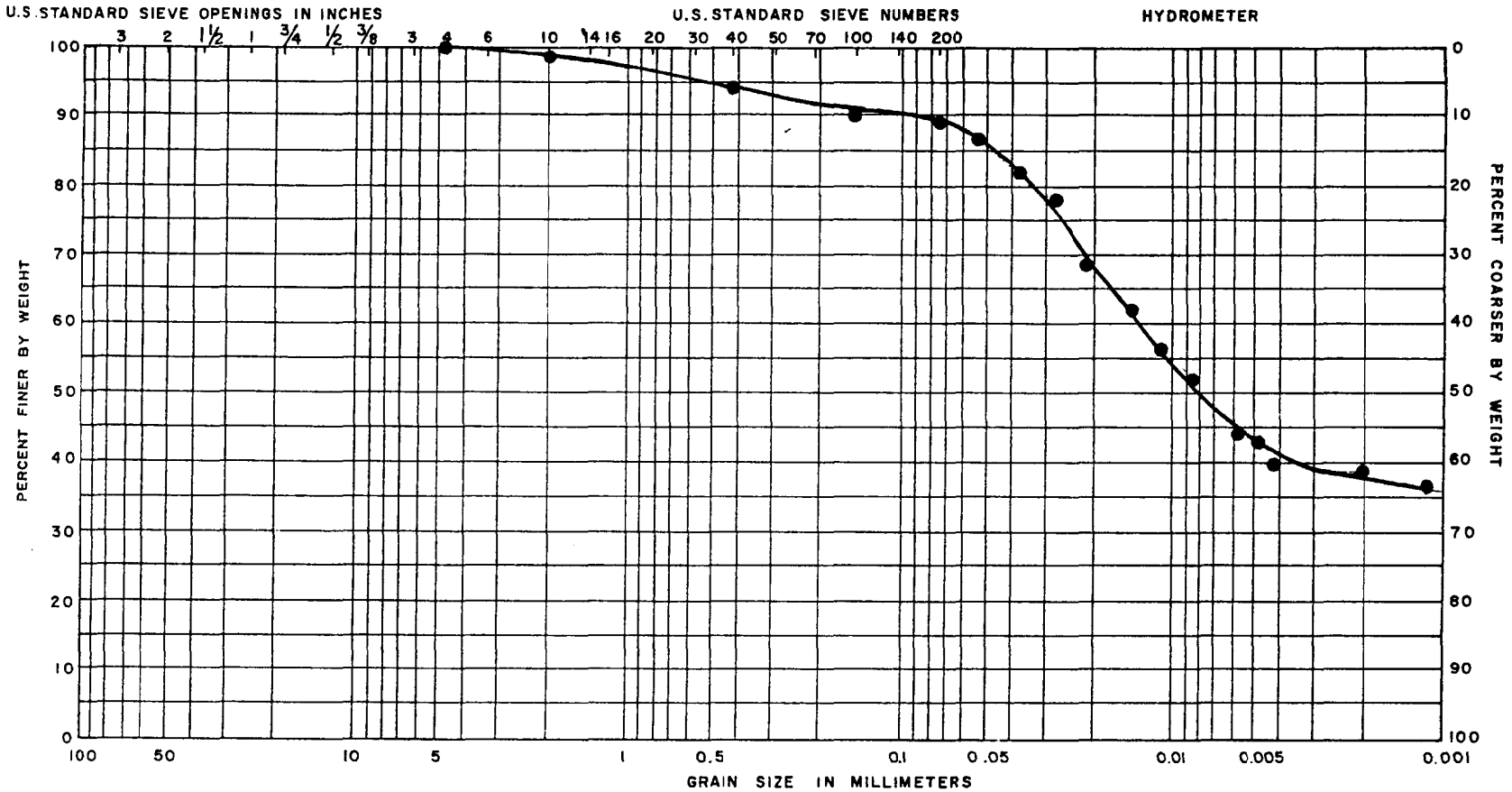
TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 14
% silt - 55
% clay - 31

GRAIN SIZE ANALYSIS

GRAIN SIZE ANALYSIS



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

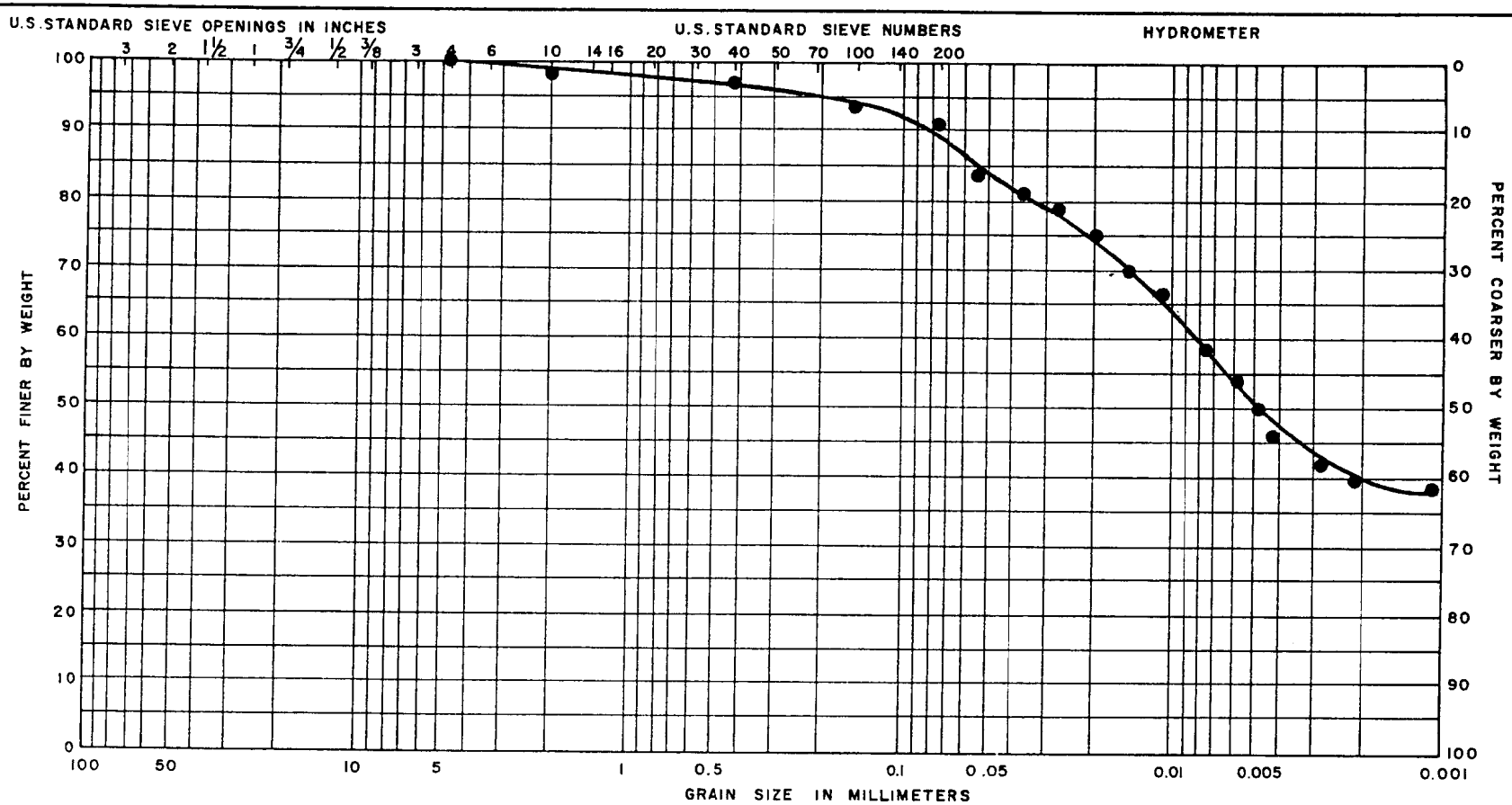
NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-83	1.0-2.5'	14.3	44	18	FILL - Brown silty CLAY, little sand
S-1					and gravel, trace cinders and brick
					(CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 10
% silt - 48
% clay - 43

GRAIN SIZE ANALYSIS

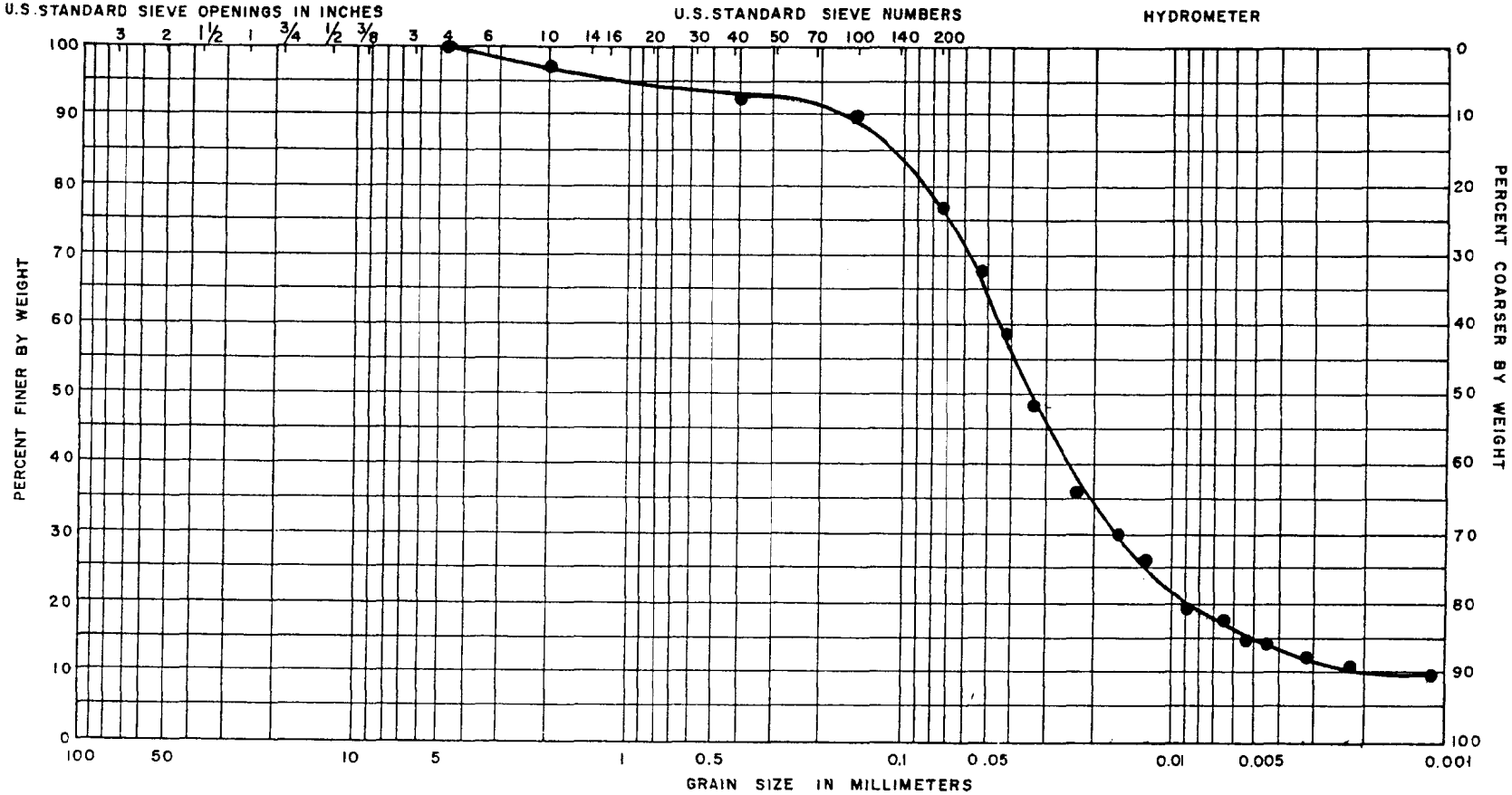


UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-85	3.5-5.0'	8.7	52	18	FILL - Brown silty CLAY, little sand
S-2					and gravel, trace cinders (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 9
% silt - 41
% clay - 50



UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-87	18.0-20.0'	NC	16	16	Gray SILT, little fine sand,
					occasional layer course sand (ML)

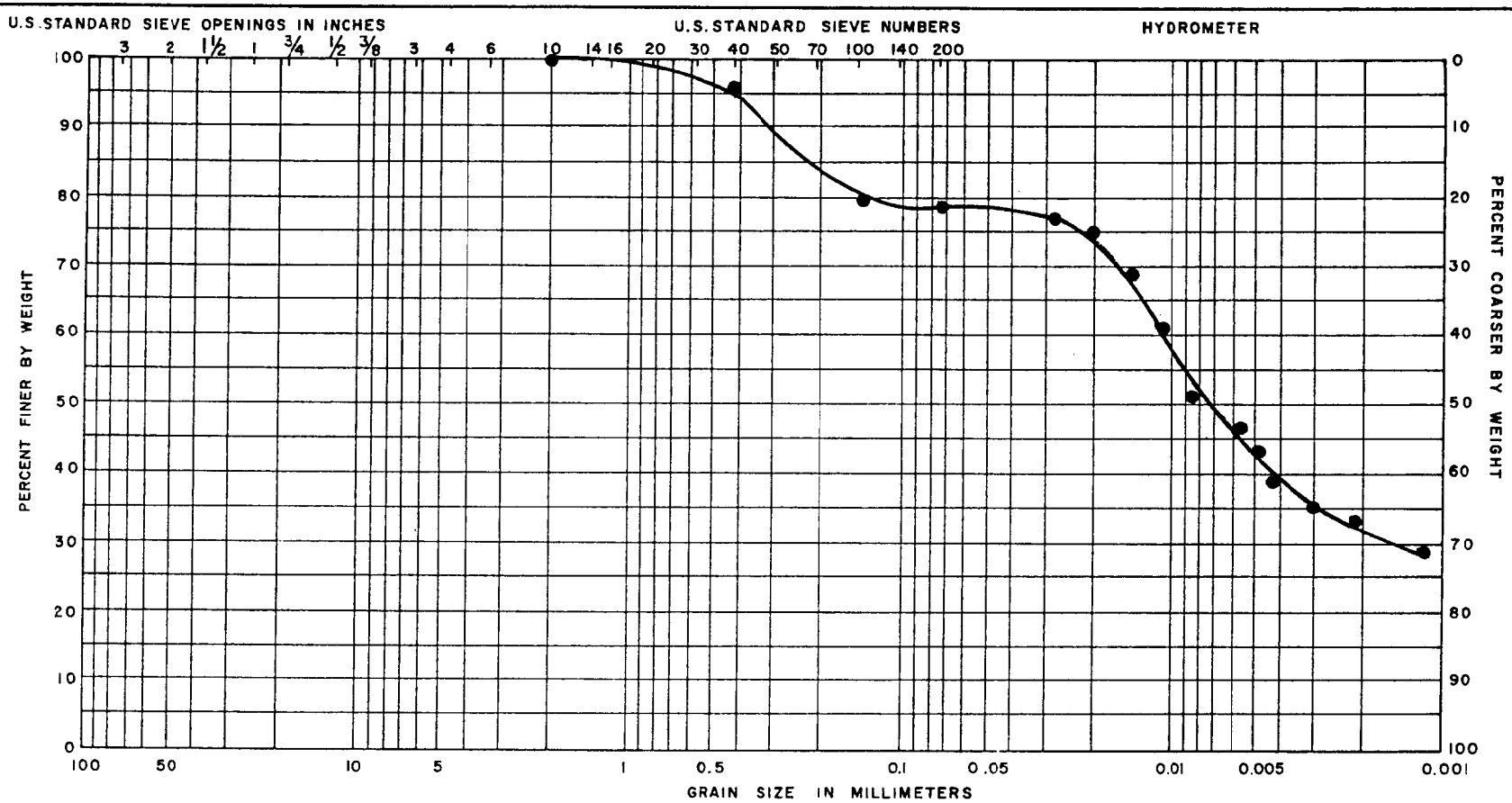
TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681

% sand and gravel - 24
% silt - 62
% clay - 15

GRAIN SIZE ANALYSIS

GRAIN SIZE ANALYSIS



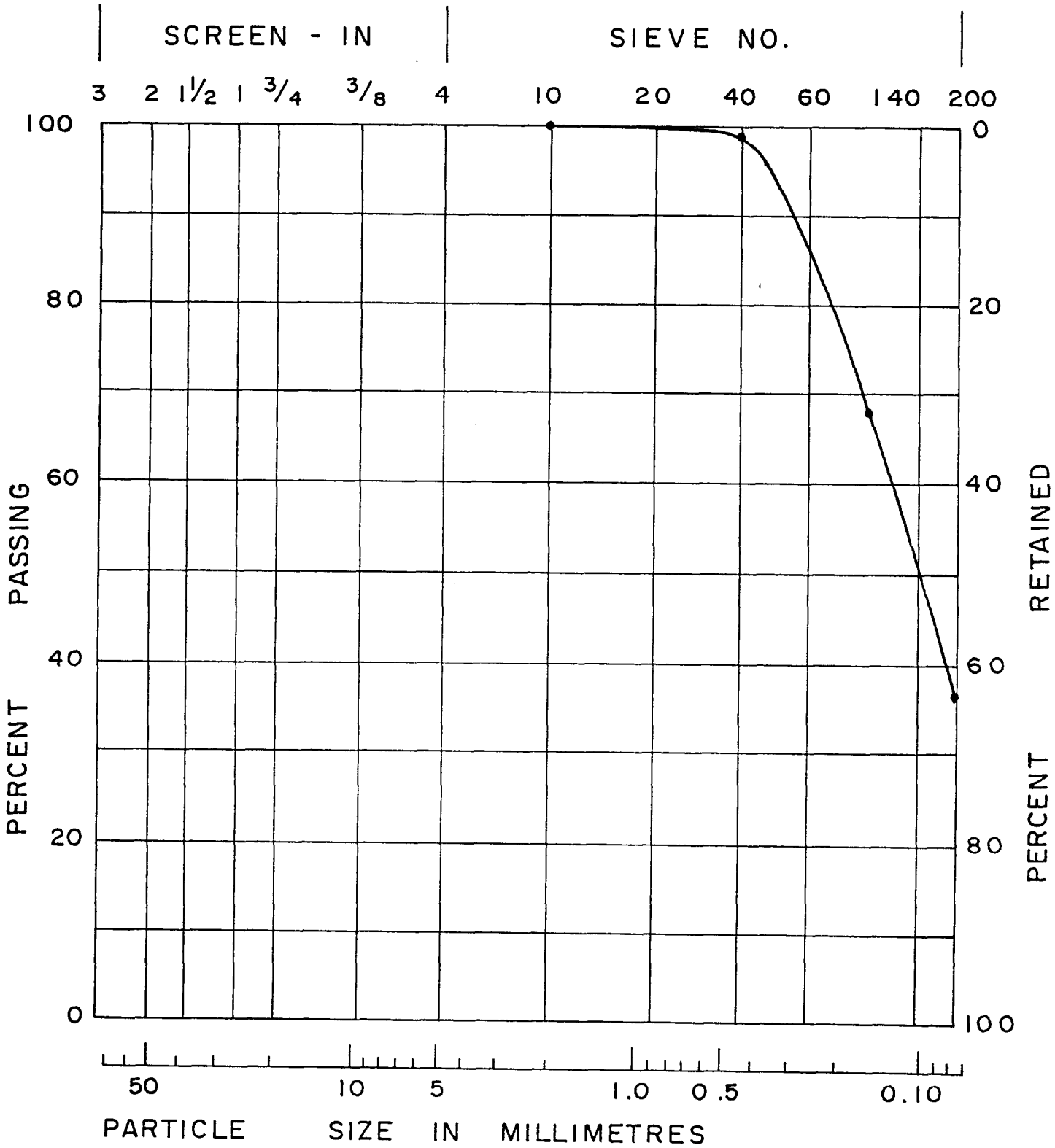
UNIFIED	GRAVEL	SAND		SILT OR CLAY	
AASHTO	GRAVEL	COARSE	FINE	SILT	CLAY

NUMBER	DEPTH	W	W_L	W_P	CLASSIFICATION
B-89	1.0-2.5'	18.9	29	16	Brown to dark brown silty CLAY,
					little sand (CL)

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L - 27,681
% sand and gravel - 20
% silt - 37
% clay - 43

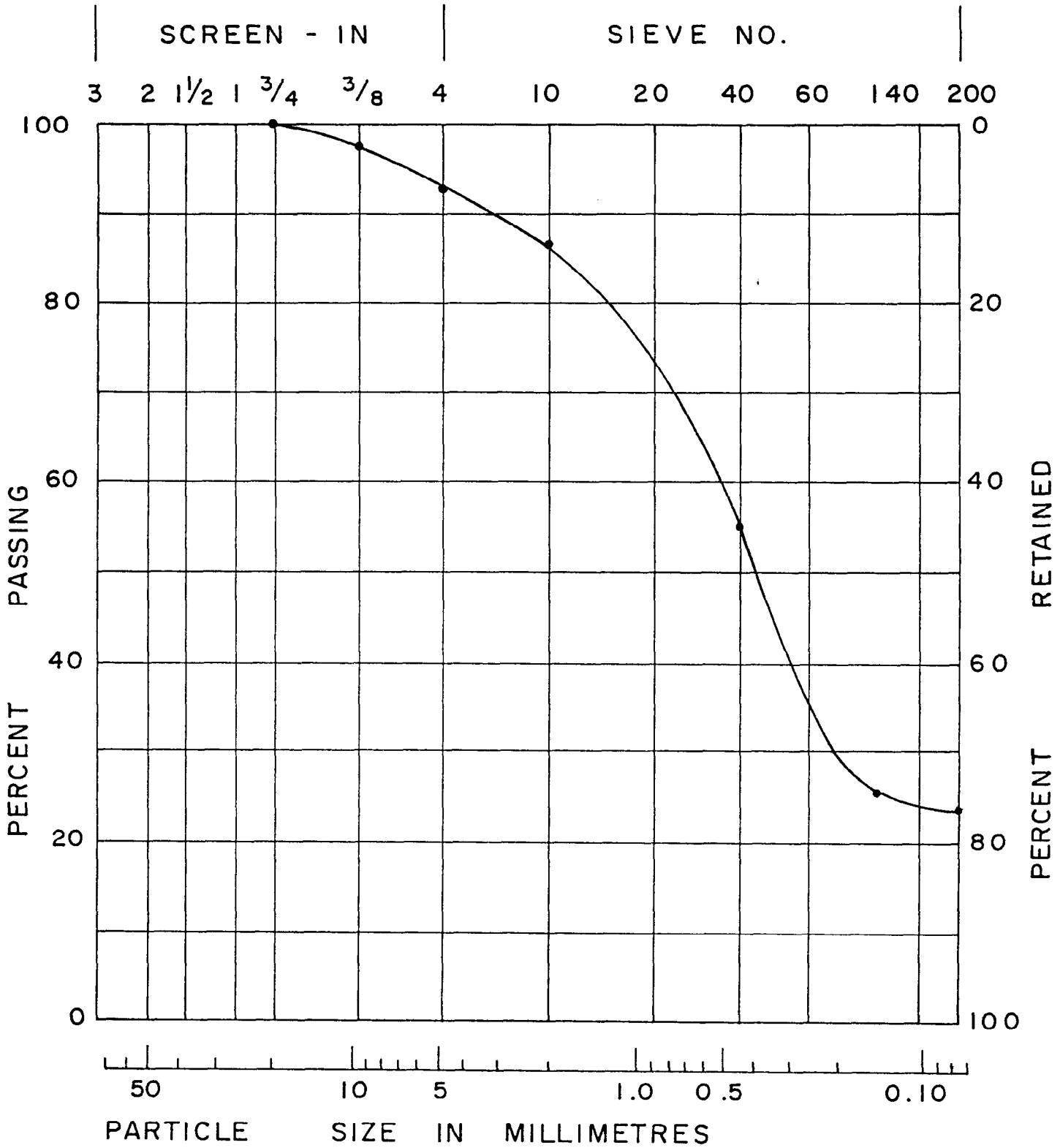
SIEVE ANALYSIS



BORING NO. B-88
SAMPLE NO. S-6
DEPTH 13.5-15.0

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

SIEVE ANALYSIS

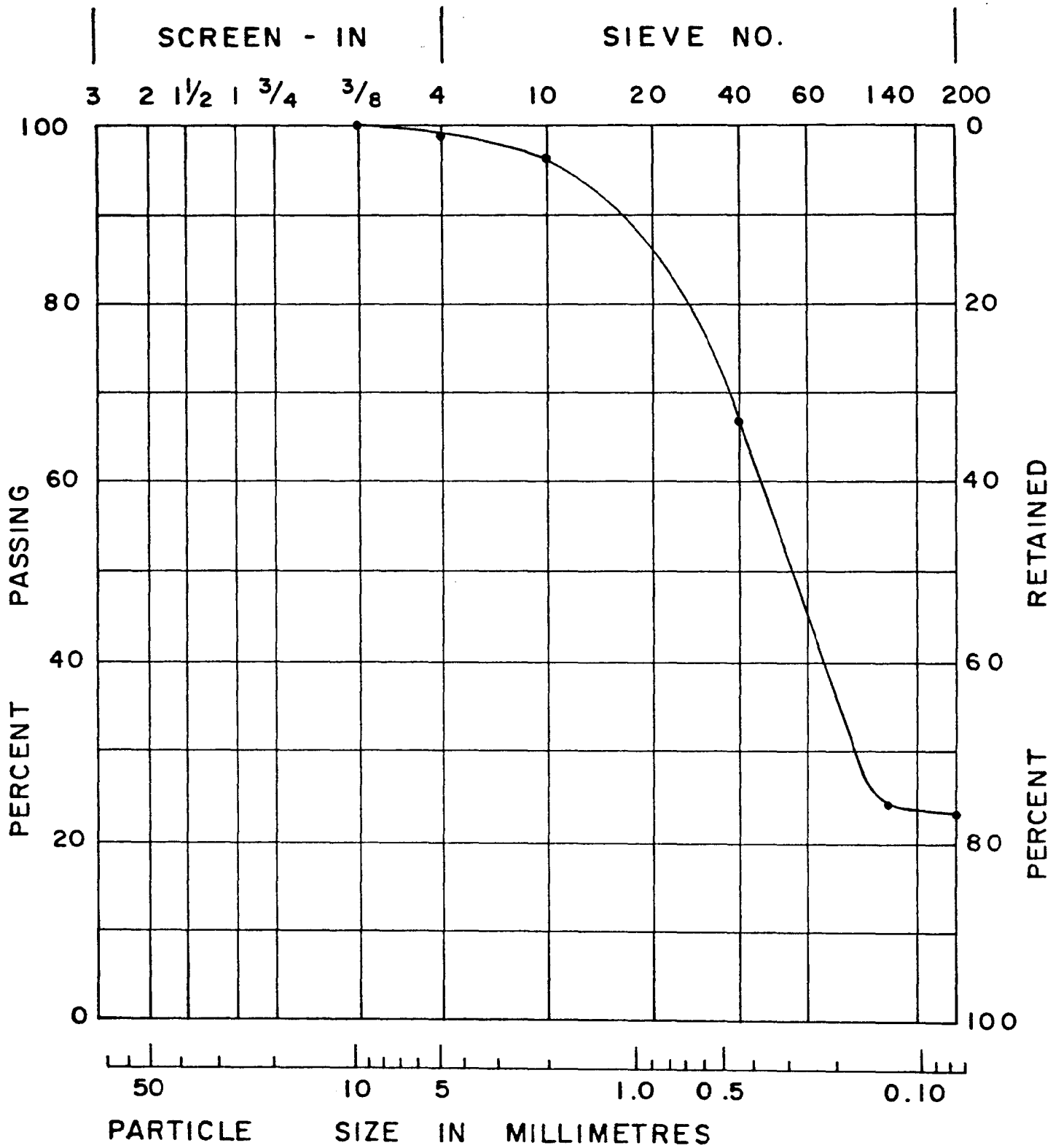


BORING NO. B-89
SAMPLE NO. S-3
DEPTH 6.0-7.5'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L- 27,681

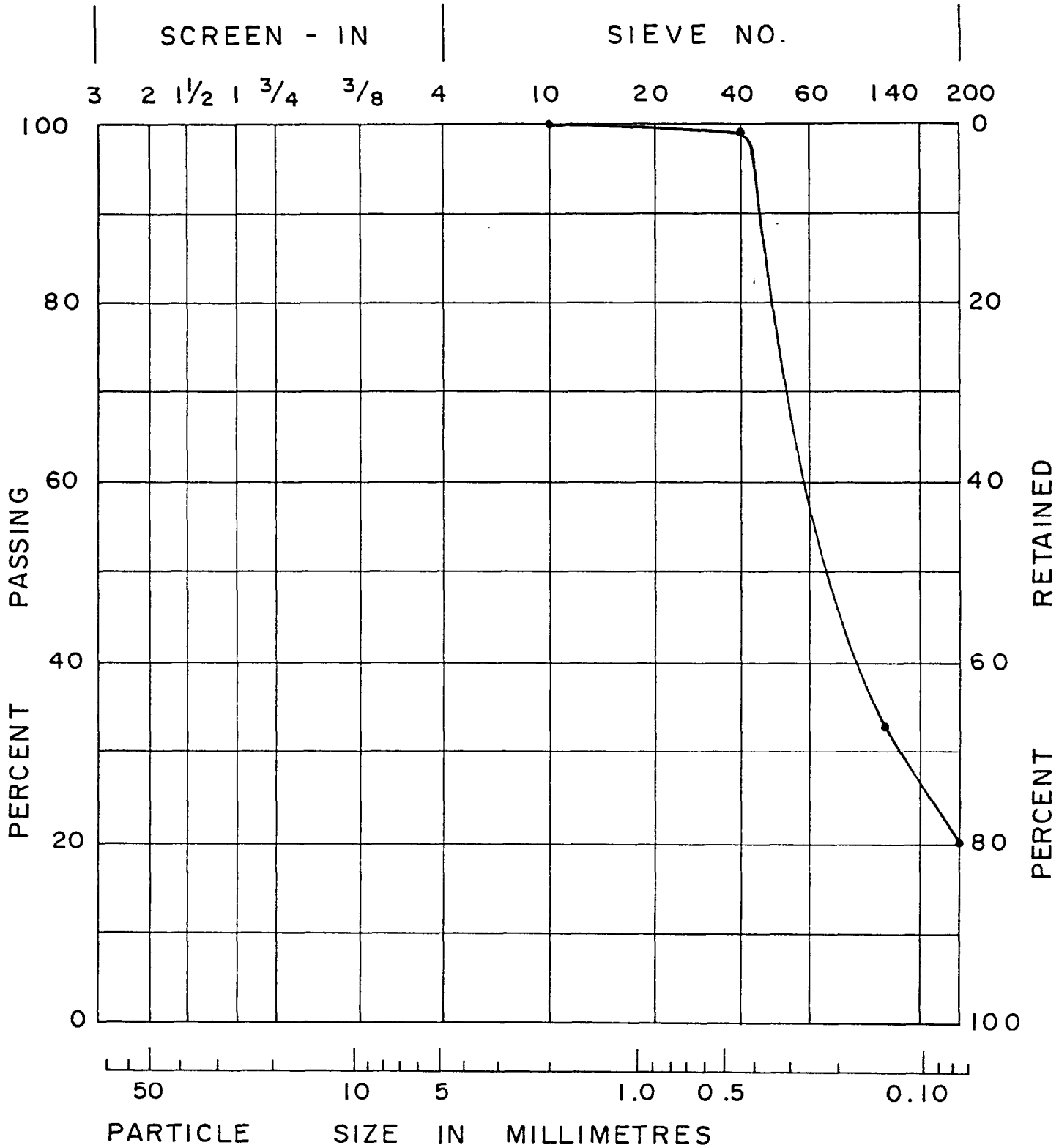
SIEVE ANALYSIS



BORING NO. 82
SAMPLE NO. S-5A
DEPTH 11"-3'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

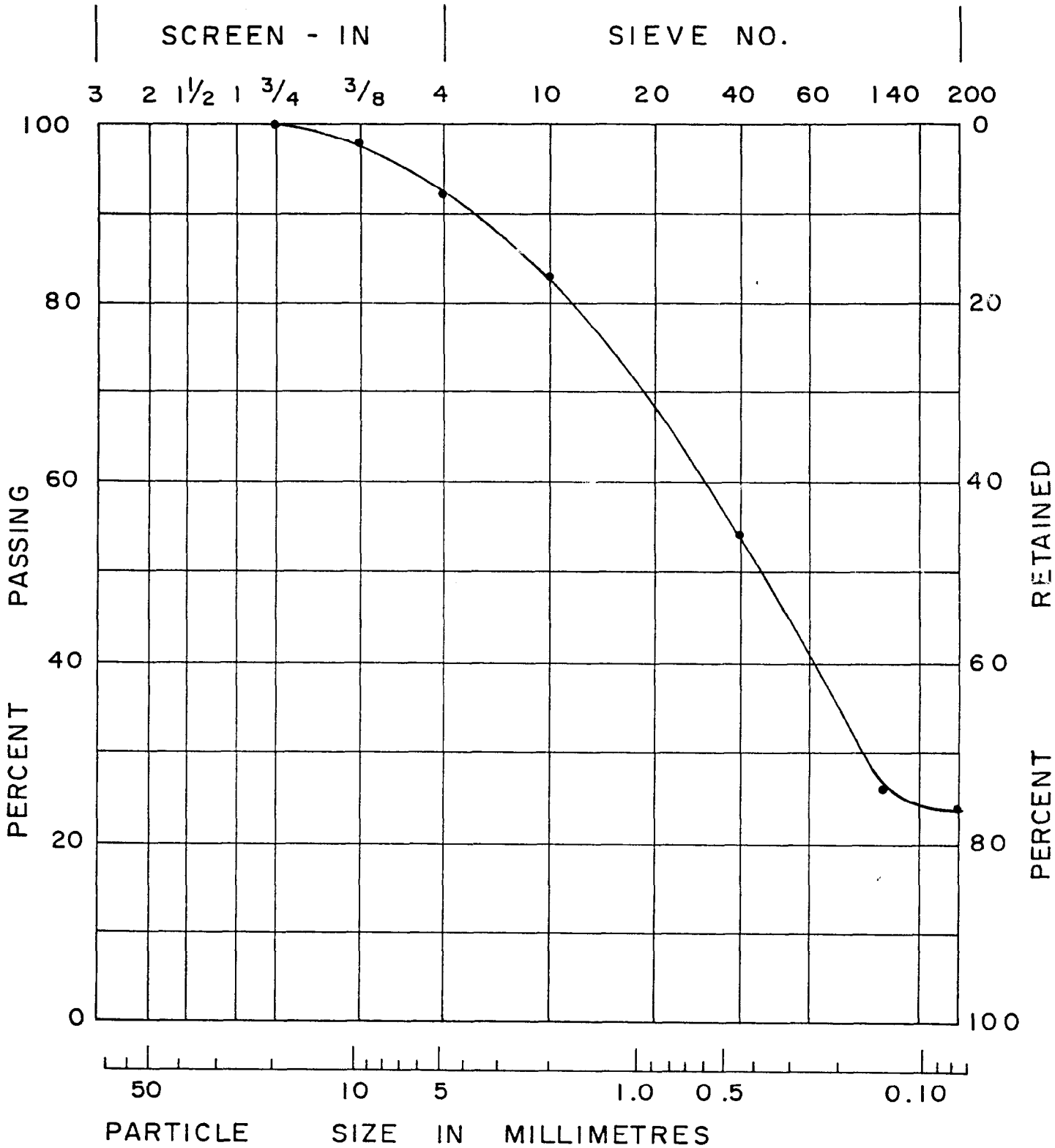
SIEVE ANALYSIS



BORING NO. B-86
SAMPLE NO. 4,5
DEPTH 8.5'-12.5'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

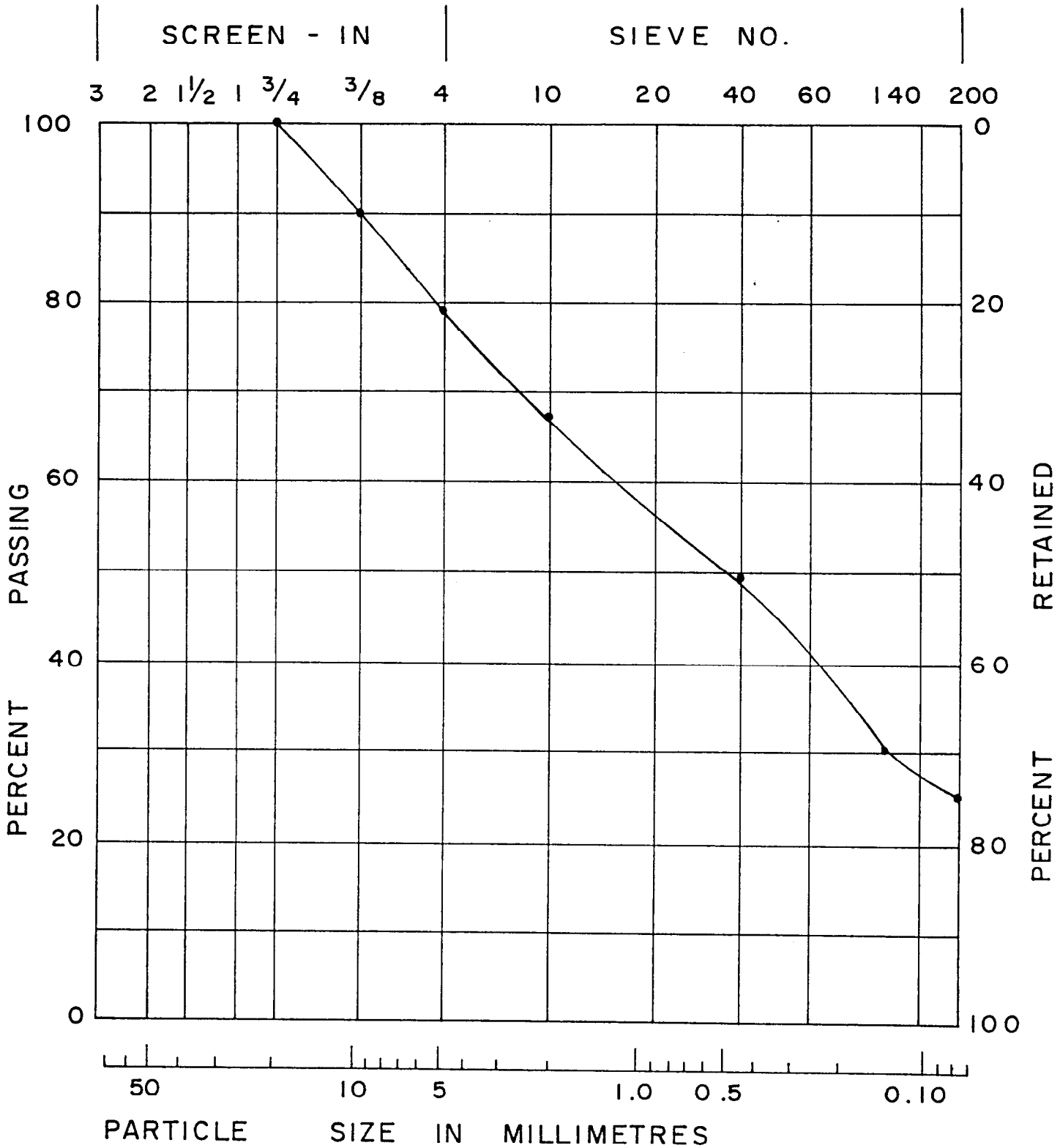
SIEVE ANALYSIS



BORING NO. B-69
SAMPLE NO. S-3B
DEPTH 6.-7.5'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

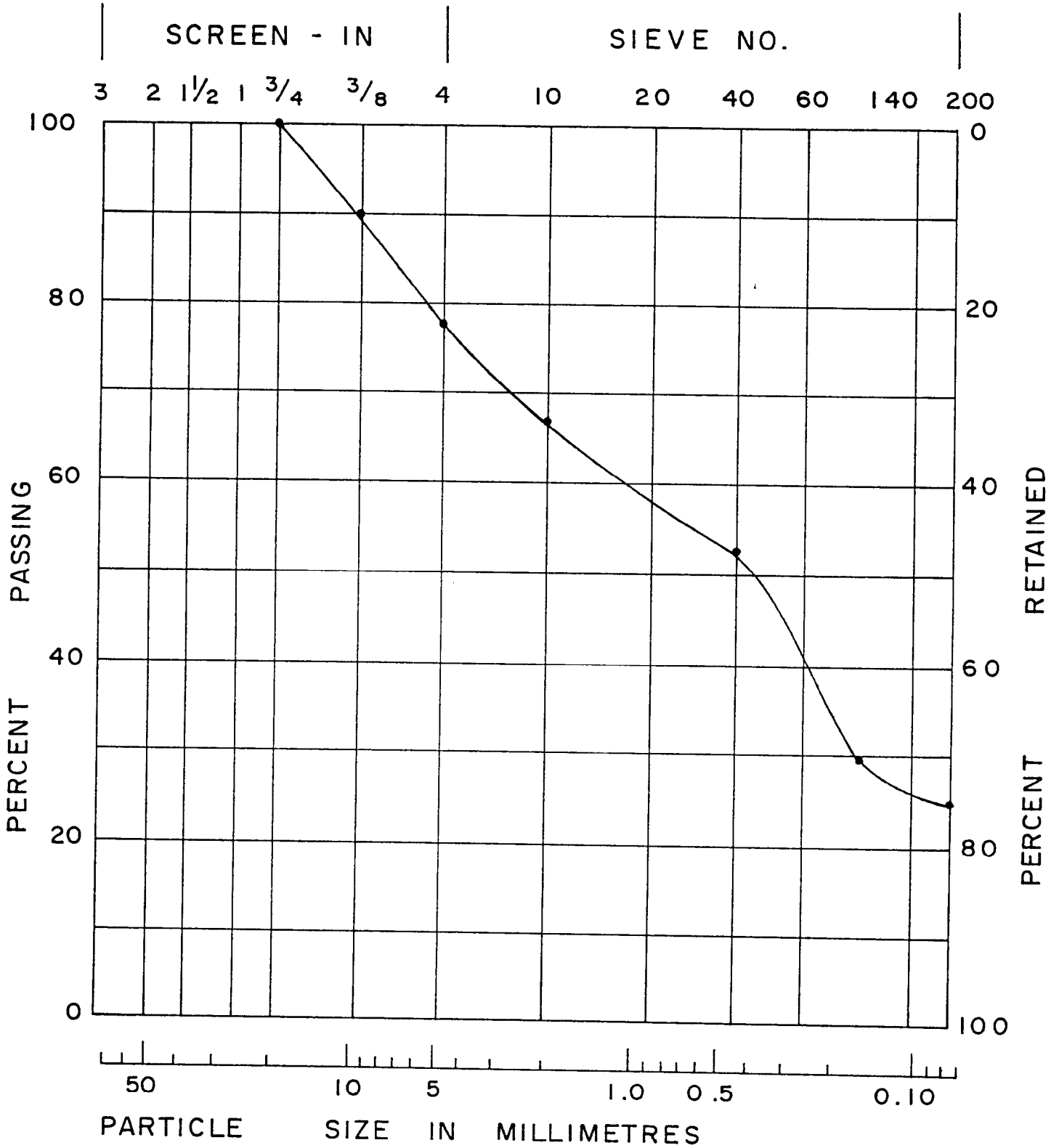
SIEVE ANALYSIS



BORING NO. B-7
SAMPLE NO. 1B+2
DEPTH 0-4.0'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

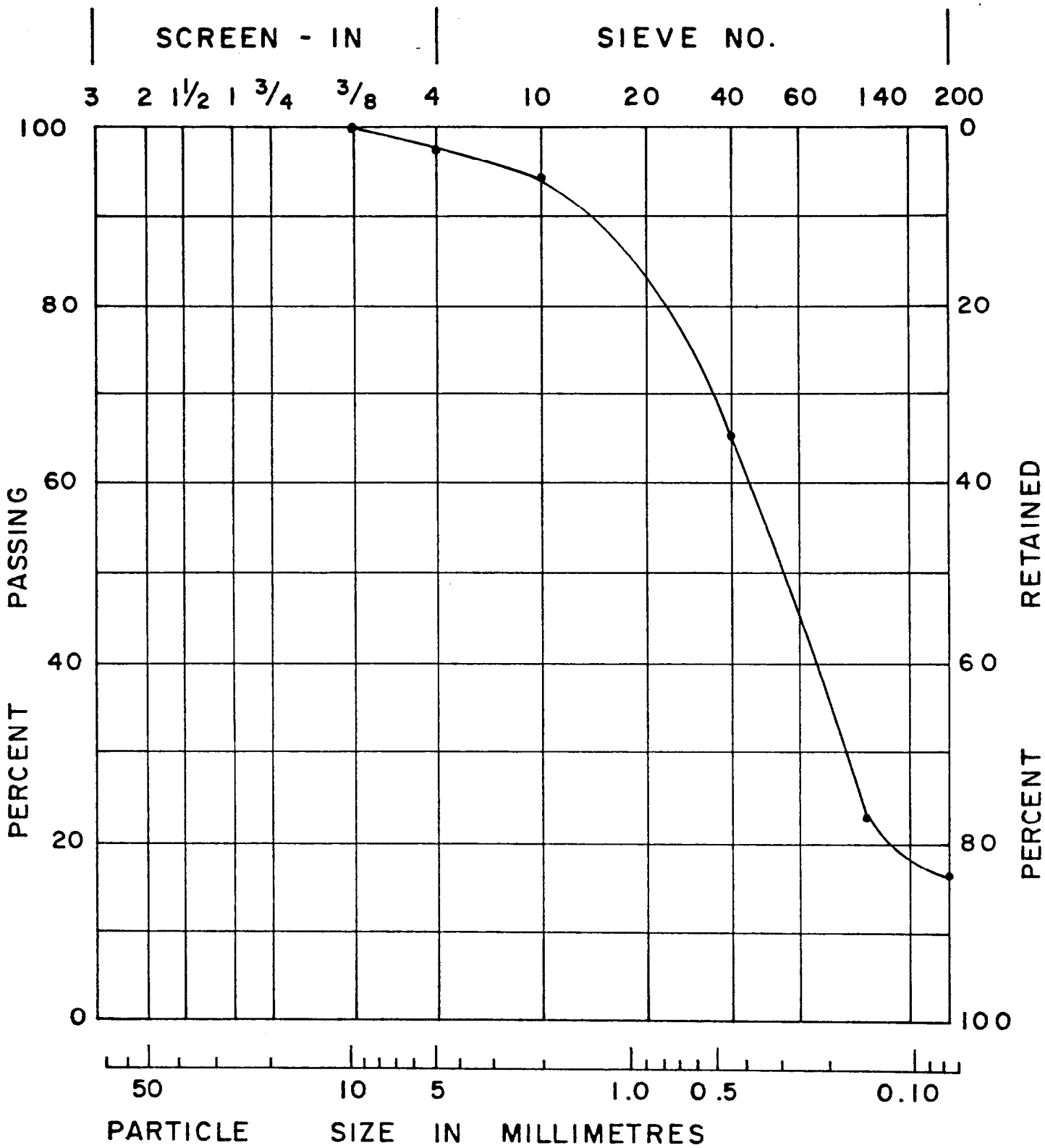
SIEVE ANALYSIS



BORING NO. B-12
SAMPLE NO. S-3 & 4
DEPTH 4.0'-7.0'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188
L- 27,681

SIEVE ANALYSIS

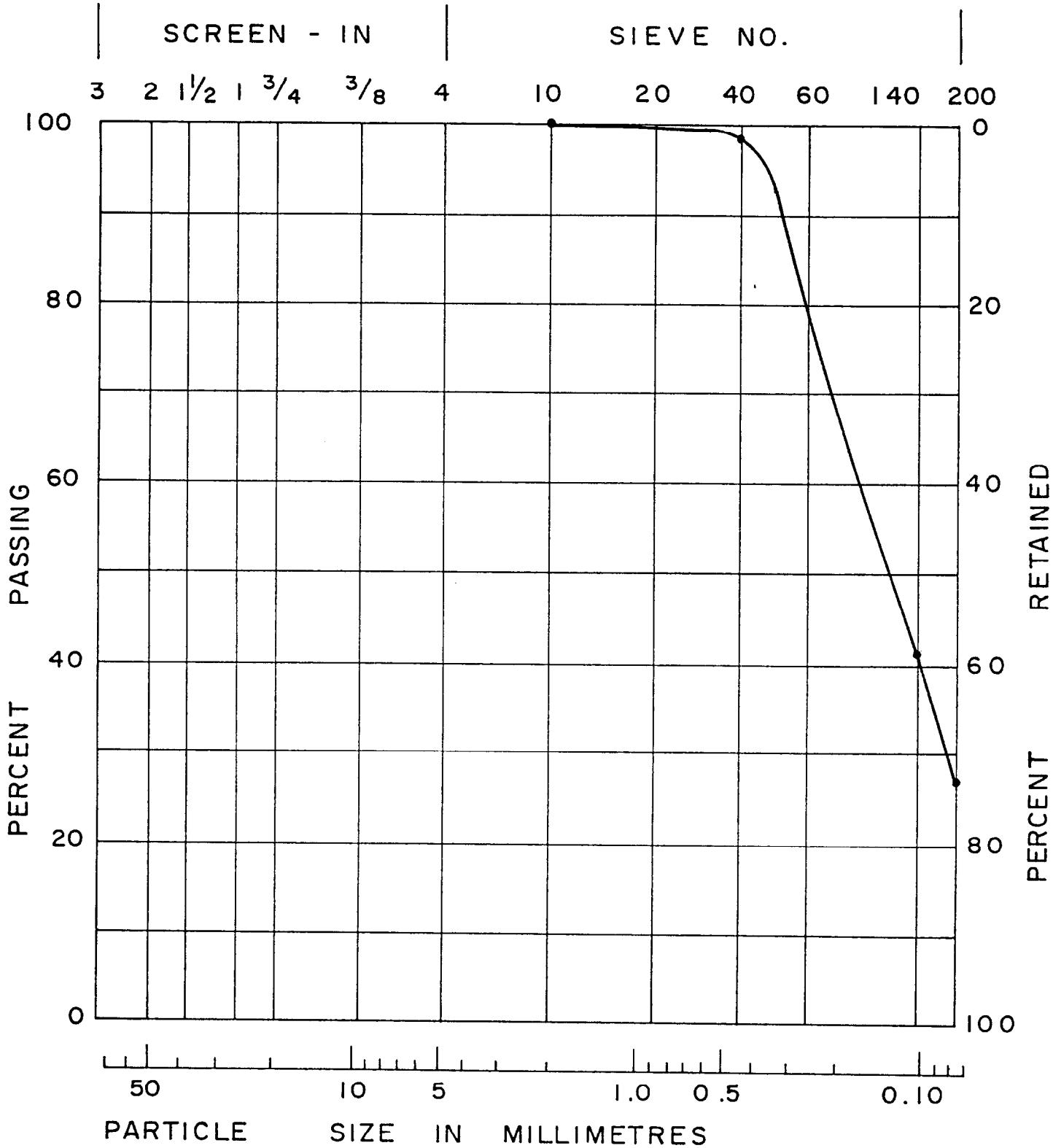


BORING NO. B-46
SAMPLE NO. S-6
DEPTH 13.5'-15.0'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L- 27,681

SIEVE ANALYSIS



BORING NO. B-62
SAMPLE NO. S-8 & 9
DEPTH 13.5-15.0'

TESTING SERVICE CORPORATION
457 EAST GUNDERSEN DRIVE
CAROL STREAM, ILLINOIS 60188

L- 27,681

APPENDIX B

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
02	Forrestal Village	Southwest Corner of Meridian Dr. and California Av.	11/27/89	12.90	705.56	11/29/89	3.35	702.21
						12/05/89	3.90	701.66
						12/07/89	4.40	701.16
						12/08/89	4.35	701.21
						12/14/89	4.40	701.16
						12/21/89	5.25	700.31
						12/28/89	5.65	699.91
						01/05/90	5.50	700.06
						01/19/90	4.80	700.76
05	Forrestal Village	Montana Av. at Water Tank	11/16/89	7.40	724.80	11/29/89	7.20	717.60
						12/05/89	6.60	718.20
						12/07/89	6.40	718.40
						12/08/89	6.45	718.35
						12/14/89	6.05	718.75
						12/21/89	5.80	719.00
						12/28/89	5.60	719.20
						01/05/90	6.45	718.35
						01/19/90	5.60	719.20
07	Forrestal Village	North of Corner of East Wisconsin Dr. and West Wisconsin Dr.	11/27/89	10.90	689.74	11/29/89	7.20	682.54
						12/05/89	9.00	680.74
						12/07/89	9.20	680.54
						12/08/89	9.10	680.64
						12/14/89	8.80	680.94
						12/21/89	8.30	681.44
						12/28/89	9.45	680.29
						01/05/90	8.55	681.19
						01/19/90	7.50	682.24

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
69	Nimitz Village	Northwest Corner of Iowa St. and Seawolf Pl.	11/20/89	9.70	664.27	11/27/89	6.30	657.97
						11/29/89	5.90	658.37
						12/05/89	6.30	657.97
						12/07/89	6.40	657.87
						12/08/89	6.40	657.87
						12/11/89	6.50	657.77
						12/14/89	6.60	657.67
						12/21/89	6.85	657.42
						12/28/89	6.78	657.49
						01/05/90	6.00	658.27
						01/19/90	6.45	657.82
70	Nimitz Village	Argonaut Pl. Between Yeager Dr. and Atule St.	11/20/89	19.45	678.70	11/27/89	7.45	671.25
						11/29/89	7.90	670.80
						12/05/89	6.90	671.80
						12/07/89	7.40	671.30
						12/08/89	7.40	671.30
						12/11/89	7.60	671.10
						12/14/89	7.70	671.00
						12/21/89	8.00	670.70
						12/28/89	8.30	670.40
						01/05/90	8.30	670.40
						01/19/90	7.90	670.80
72	Halsey Village	Langley St. South of Lexington Av.	11/20/89	13.00	704.56	11/27/89	10.30	694.26
						11/29/89	11.50	693.06
						12/05/89	9.90	694.66
						12/07/89	9.30	695.26
						12/08/89	9.10	695.46
						12/11/89	8.50	696.06
						12/14/89	7.45	697.11
						12/21/89	5.60	698.96
						12/28/89	4.85	699.71
						01/05/90	8.60	695.96
						01/19/90	5.40	699.16

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
73	Hospital Side	North of G St. Between 5th St. and 6th St.	11/09/89	12.60	659.32	11/14/89	8.15	651.17
						11/15/89	8.60	650.72
						11/17/89	7.60	651.72
						11/27/89	6.75	652.57
						11/29/89	6.25	653.07
						12/05/89	6.20	653.12
						12/07/89	6.90	652.42
						12/08/89	6.90	652.42
						12/11/89	6.80	652.52
						12/14/89	7.50	651.82
						12/21/89	8.50	650.82
						12/28/89	8.75	650.57
						01/05/90	8.80	650.52
						01/19/90	8.00	651.32
74	Hospital Side	Northeast Corner D St. and 5th St.	11/09/89	10.20	659.31	11/14/89	dry	dry
						11/15/89	dry	dry
						11/17/89	dry	dry
						11/29/89	9.05	650.26
						12/05/89	8.85	650.46
						12/07/89	9.25	650.06
						12/08/89	9.20	650.11
						12/11/89	9.30	650.01
						12/14/89	9.00	650.31
						12/21/89	9.50	649.81
						12/28/89	9.50	649.81
						01/05/90	9.30	650.01
						01/19/90	9.20	650.11
75	Hospital Side	E St. Across From #216-H	11/09/89	13.00	659.92	11/14/89	dry	dry
						11/17/89	dry	dry
						11/29/89	9.30	650.62
						12/05/89	7.10	652.82
						12/07/89	7.30	652.62
						12/08/89	7.65	652.27
						12/11/89	7.90	652.02
						12/14/89	8.35	651.57
						12/21/89	9.20	650.72
						12/28/89	9.70	650.22
						01/05/90	10.10	649.82
						01/19/90	8.25	651.67

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
76	Camp Barry	South of Bassett Av. Between Hines St. and Wurtsbaugh St.	11/09/89	8.10	647.34	11/14/89	6.60	640.74
						11/15/89	6.20	641.14
						11/17/89	6.00	641.34
						11/29/89	6.00	641.34
						12/05/89	5.90	641.44
						12/07/89	6.50	640.84
						12/08/89	6.50	640.84
						12/11/89	6.60	640.74
						12/14/89	6.65	640.69
						12/21/89	6.85	640.49
						12/28/89	5.95	641.39
						01/05/90	6.55	640.79
						01/19/90	6.65	640.69
77	Camp Barry	Southeast Corner Barry Rd. and Hines St.	11/09/89	11.40	649.34	11/14/89	6.30	643.04
						11/15/89	6.70	642.64
						11/17/89	5.30	644.04
						11/29/89	4.75	644.59
						12/05/89	4.85	644.49
						12/07/89	5.20	644.14
						12/08/89	5.20	644.14
						12/11/89	5.40	643.94
						12/14/89	5.50	643.84
						12/21/89	6.00	643.34
						12/28/89	6.10	643.24
						01/05/90	6.00	643.34
						01/19/90	5.60	643.74
78	Mainside	Northeast Corner Sampson Rd. and Fisher Rd.	11/09/89	11.90	656.93	11/14/89	9.70	647.23
						11/15/89	11.05	645.88
						11/17/89	9.40	647.53
						11/29/89	6.40	650.53
						12/05/89	6.15	650.78
						12/07/89	6.10	650.83
						12/08/89	5.80	651.13
						12/11/89	5.40	651.53
						12/14/89	5.30	651.63
						12/21/89	5.95	650.98
						12/28/89	6.30	650.63
						01/05/90	4.70	652.23
						01/19/90	4.95	651.98

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
79	Mainside	South of Decatur Rd. Between Lawrence Rd. and Perry St.	11/10/89	13.00	651.65	11/14/89	11.30	640.35
						11/15/89	11.25	640.40
						11/17/89	9.20	642.45
						11/27/89	9.20	642.45
						11/29/89	8.20	643.45
						12/05/89	9.30	642.35
						12/07/89	9.80	641.85
						12/08/89	10.00	641.65
						12/11/89	10.20	641.45
						12/14/89	10.40	641.25
						12/21/89	10.90	640.75
						12/28/89	11.10	640.55
						01/05/90	10.70	640.95
						01/19/90	10.65	641.00
80	Mainside	Farragut Av. #111	11/13/89	9.80	648.05	11/15/89	7.80	640.25
						11/17/89	7.20	640.85
						11/27/89	7.10	640.95
						11/29/89	7.20	640.85
						12/05/89	7.10	640.95
						12/07/89	7.60	640.45
						12/08/89	7.40	640.65
						12/11/89	7.40	640.65
						12/14/89	7.35	640.70
						12/21/89	7.60	640.45
						12/28/89	7.70	640.35
						01/05/90	7.40	640.65
						01/19/90	7.35	640.70
81	Mainside	Southeast Corner Bronson Av. and Sampson St.	11/14/89	12.55	649.82	11/15/89	8.75	641.07
						11/17/89	6.35	643.47
						11/27/89	4.80	645.02
						11/29/89	5.00	644.82
						12/05/89	5.65	644.17
						12/07/89	5.90	643.92
						12/08/89	5.80	644.02
						12/11/89	5.70	644.12
						12/14/89	5.70	644.12
						12/21/89	5.90	643.92
						12/28/89	6.05	643.77
						01/05/90	5.35	644.47
						01/19/90	5.50	644.32

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
82	Mainside	Bronson Av. Between Paul Jones St. and Mac Donough St.	11/14/89	11.90	654.63	11/15/89	9.05	645.58
						11/17/89	8.80	645.83
						11/29/89	8.40	646.23
						12/05/89	8.60	646.03
						12/07/89	8.90	645.73
						12/08/89	8.90	645.73
						12/11/89	9.10	645.53
						12/14/89	9.25	645.38
						12/21/89	9.70	644.93
						12/28/89	9.90	644.73
						01/05/90	10.25	644.38
						01/19/90	9.80	644.83
83	Mainside	East of Paul Jones St. Between Bronson Av. and Clark Av.	11/14/89	6.10	76.32	11/15/89	dry	dry
						11/17/89	dry	dry
						11/29/89	dry	dry
						12/05/89	dry	dry
						12/07/89	dry	dry
						12/14/89	dry	dry
						01/05/90	dry	dry
						01/19/90	dry	dry
84	Mainside	Northwest Corner Clark Av. and Isherwood Av.	11/17/89	10.00	646.82	11/27/89	9.05	637.77
						11/29/89	8.45	638.37
						12/05/89	8.70	638.12
						12/07/89	9.05	637.77
						12/08/89	8.85	637.97
						12/11/89	9.25	637.57
						12/14/89	9.00	637.82
						12/21/89	8.95	637.87
						12/28/89	8.75	638.07
						01/05/90	8.85	637.97
						01/19/90	9.00	637.82

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
85	Mainside	Sampson St. Between Fullam Av. and Culverius Av.	11/14/89	12.65	648.16	11/17/89	9.15	639.01
						11/27/89	7.55	640.61
						11/29/89	7.20	640.96
						12/05/89	6.45	641.71
						12/07/89	6.35	641.81
						12/08/89	6.20	641.96
						12/11/89	5.95	642.21
						12/14/89	5.55	642.61
						12/21/89	5.45	642.71
						12/28/89	5.45	642.71
						01/05/90	8.20	639.96
						01/19/90	5.90	642.26
86	Mainside	Culverius Av. Between Luce Bd. and Paul Jones St.	11/14/89	12.65	657.61	11/17/89	9.35	648.26
						11/29/89	9.35	648.26
						12/05/89	9.20	648.41
						12/07/89	9.40	648.21
						12/08/89	9.35	648.26
						12/14/89	9.35	648.26
						12/21/89	9.45	648.16
						12/28/89	9.45	648.16
						01/05/90	9.45	648.16
						01/19/90	9.50	648.11
87	Mainside	North end of Sampson St.	11/10/89	19.20	652.09	11/15/89	9.80	642.29
						11/17/89	9.10	642.99
						11/29/89	9.10	642.99
						12/05/89	9.00	643.09
						12/07/89	9.35	642.74
						12/08/89	9.25	642.84
						12/14/89	9.30	642.79
						12/21/89	9.60	642.49
						12/28/89	9.70	642.39
						01/05/90	8.60	643.49
						01/19/90	9.60	642.49

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
88	Mainside	Nimitz Av. #520	11/13/89	19.20	667.66	11/15/89	15.30	652.36
						11/17/89	15.00	652.66
						11/29/89	15.20	652.46
						12/05/89	15.10	652.56
						12/07/89	15.20	652.46
						12/08/89	15.20	652.46
						12/14/89	15.30	652.36
						12/21/89	15.35	652.31
						12/28/89	15.40	652.26
						01/05/90	15.40	652.26
						01/19/90	15.45	652.21
89	Mainside	North of Moffett Rd. Between Paul Jones St. and the bluff	11/10/89	9.45	661.31	11/15/89	dry	dry
						11/17/89	dry	dry
						11/29/89	dry	dry
						12/05/89	dry	dry
						12/07/89	dry	dry
						12/14/89	dry	dry
						12/28/89	dry	dry
						01/05/90	7.50	653.81
						01/19/90	9.05	652.26
90	Mainside	Parking Lot for #220 South of Clark Av.	11/17/89	10.30	647.29	11/27/89	2.65	644.64
						11/29/89	1.85	645.44
						12/05/89	3.75	643.54
						12/07/89	3.80	643.49
						12/08/89	4.35	642.94
						12/11/89	4.45	642.84
						12/14/89	5.15	642.14
						12/21/89	6.60	640.69
						12/28/89	9.15	638.14
						01/05/90	7.00	640.29

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

PIEZOMETERS

No.	Area	Location	Date Installed	Piezom. Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
91	Forrestal Village	California Av. Between Georgia Rd. and Arkansas Rd.	12/02/89	16.70	675.91	12/05/89	4.90	671.01
						12/07/89	4.80	671.11
						12/08/89	4.75	671.16
						12/14/89	5.00	670.91
						12/21/89	5.30	670.61
						12/28/89	5.50	670.41
						01/05/90	5.20	670.71
						01/19/90	5.25	670.66

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

EXISTING MONITORING WELLS - BUILDING 11

No.	Area	Location	Date Installed	Well Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
11-1	Mainside	8 Ft. West of Build. 11	04/13/89	16.00	593.00	12/05/89	12.40	580.60
						12/07/89	12.40	580.60
						12/08/89	12.40	580.60
						01/05/90	13.00	580.00
11-2	Mainside	West of Build. 11 at Foot of Bluff	04/13/89	16.00	593.06	12/05/89	12.30	580.76
						12/07/89	12.10	580.96
						12/08/89	12.20	580.86
						01/05/90	12.75	580.31

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

EXISTING MONITORING WELLS - CAMP PORTER

No.	Area	Location	Date Installed	Well Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
S-1	Camp Porter	Center Well of Cluster at South Parade Ground	03/08/89	20.00	688.42	12/05/89	8.20	680.22
						12/08/89	8.25	680.17
						12/14/89	8.20	680.22
						12/21/89	8.10	680.32
S-2	Camp Porter	North Well of Cluster at South Parade Ground	03/08/89	10.00	688.62	12/05/89	1.20	687.42
						12/08/89	1.65	686.97
						12/14/89	2.40	686.22
						12/21/89	3.20	685.42
						01/05/90	4.15	684.47
						01/19/90	2.10	686.52
S-3	Camp Porter	South Well of Cluster at South Parade Ground	03/09/89	5.00	688.24	12/05/89	1.10	687.14
						12/08/89	1.45	686.79
						12/14/89	2.10	686.14
						12/21/89	2.70	685.54
S-4	Camp Porter	South of South Parking Lot for Buillding 1111	03/09/89	9.00	670.02	12/05/89	4.25	665.77
						12/07/89	4.35	665.67
						12/08/89	4.40	665.62
						12/21/89	4.80	665.22
						01/05/90	4.80	665.22
						01/19/90	4.15	665.87
S-5	Camp Porter	Southwest Corner of Joesph W. Gregg Park	03/09/89	9.60	673.20	12/05/89	5.80	667.40
						12/07/89	5.85	667.35
						12/08/89	5.90	667.30
						12/21/89	6.30	666.90
						01/05/90	6.30	666.90
						01/19/90	6.20	667.00

GREAT LAKES NAVAL TRAINING CENTER

UNDERGROUND WATER TABLE INVESTIGATION & STUDY

EXISTING MONITORING WELLS - CAMP PORTER

No.	Area	Location	Date Installed	Well Depth	Ground Elev.	Date Measured	Water Depth	Water Elev.
W-1	Camp Porter	Center Well of Cluster Southwest of Ohio St. and Eigth Ave.	03/01/89	20.00	654.56	12/07/89	10.15	644.41
						12/08/89	10.05	644.51
						12/14/89	10.15	644.41
						12/21/89	10.15	644.41
W-2	Camp Porter	South Well of Cluster Southwest of Ohio St. and Eigth Ave.	03/01/89	10.00	654.66	12/07/89	dry	dry
						12/08/89	dry	dry
						12/14/89	dry	dry
						12/21/89	dry	dry
						01/19/90	dry	dry
W-3	Camp Porter	North Well of Cluster Southwest of Ohio St. and Eigth Ave.	03/01/89	5.15	653.85	12/07/89	dry	dry
						12/08/89	dry	dry
						12/14/89	dry	dry
						12/21/89	dry	dry
W-4	Camp Porter	East of Indiana St. and South of Second Ave.	03/01/89	10.15	668.03	12/07/89	6.15	661.88
						12/08/89	6.10	661.93
						12/14/89	6.20	661.83
						12/21/89	6.50	661.53
						01/05/90	5.50	662.53
						01/19/90	6.05	661.98
W-5	Camp Porter	Norhtwest of Ohio St. and Third Ave	03/04/89	10.00	663.70	12/07/89	8.10	655.60
						12/08/89	8.05	655.65
						12/14/89	8.10	655.60
						12/21/89	8.10	655.60
						01/05/90	8.20	655.50
						01/19/90	8.25	655.45
W-6	Camp Porter	West Side of Ohio St. North of Fifth Ave.	03/06/89	10.15	658.30	12/07/89	5.45	652.85
						12/08/89	5.45	652.85
						12/14/89	5.75	652.55
						12/21/89	5.85	652.45
						01/05/90	5.65	652.65
						01/19/90	5.70	652.60

APPENDIX C

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME _____ BY 44.862 DATE 1/4/90

1) MANHOLE NO. ( ) 216 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☒YES ☐NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☒LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1/2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE ___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM QTY. 2 DIRECTION: W, E

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL ___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT ___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT ___.___FT.

TOP SLAB TO FLOOR 5.48 FT TOP SLAB ELEV 669.00 FT

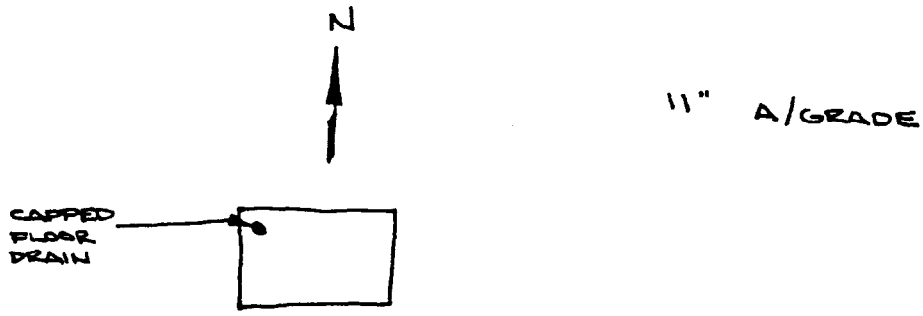
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO CAPPED

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 663.52

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN- ____ PROJECT NAME GREAT LAKES BY 44. ___.___ DATE 1/5/90

1) MANHOLE NO. (____) 226 2) AREA MAIN SIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED ____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): ____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): ____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS ____ INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE ___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM QTY. 2 DIRECTION: N,S

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☒YES ☐NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT 0.5 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 9.20 FT TOP SLAB ELEV 670.51 FT

SUMP PUMP: ☒YES ☐NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC WORKS

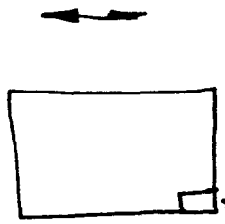
FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 661.31

SKETCH/COMMENTS:

10" A/GRADE



FAIRLY NEW STRUCTURE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/14/90

1) MANHOLE NO. (_____) 231 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☐ PAVED ESMT. 7☒ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☐ POURED 3☐ BLOCK 4☐ FLATTOP 5☒ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☒ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒ YES ☐ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☒ NONE 2☐ MUD 3☐ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☐ SOUND 2☒ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☒ YES ☐ NO RATE ___ ___.___ ___ GPM QTY. 1 DIRECTION: W

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT ___.___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 6.00 FT TOP SLAB ELEV 659.43 FT

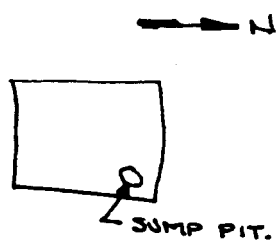
SUMP PUMP: ☒ YES ☐ NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐ YES ☒ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 653.43

SKETCH/COMMENTS:



4" A/GRADE
CRACKS IN WALL
& FLOORS NOT BAD
NEW STRUCTURE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY AH. DATE 1/8/90

1) MANHOLE NO. (_____) 210 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1/2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 9.88 FT TOP SLAB ELEV 661.82 FT

SUMP PUMP: ☒YES ☐NO WORK IF YES, ☒STEAM DRIVEN ☐ELECTRIC

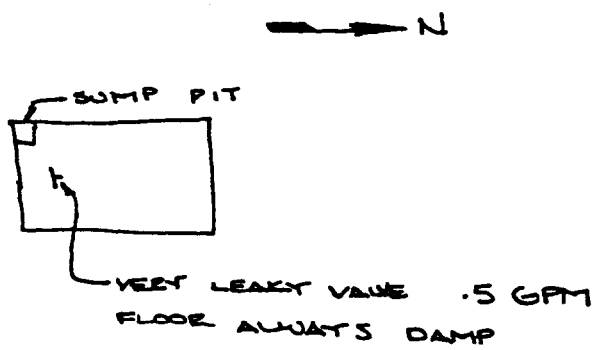
FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 651.94

SKETCH/COMMENTS:

E/GRADE



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY AH. DATE 1/18/90

1) MANHOLE NO. (_____) 207 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 7.70 FT TOP SLAB ELEV 656.33 FT

SUMP PUMP: ☒YES ☐NO WORKS IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐YES ☐NO

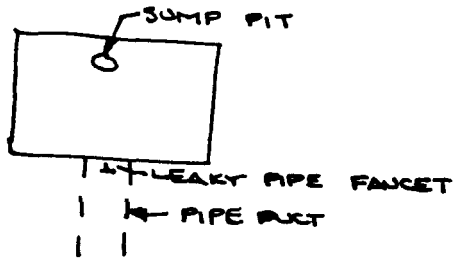
SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 648.63

SKETCH/COMMENTS:

1.8' A/GRADE

PIPES LOOK GOOD



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/18/89

1) MANHOLE NO. ( ) 3 2) AREA FORRESTAL VILLAGE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☒DAMP 3☐WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 1 DIRECTION: S

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 6.74 FT TOP SLAB ELEV 684.58 FT

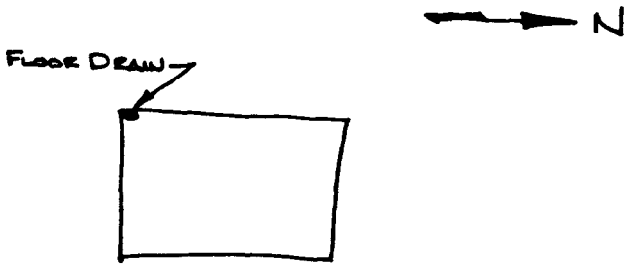
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 677.84

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/8/89

1) MANHOLE NO. (_____) 11 2) AREA FORRESTAL VILLAGE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☒DAMP 3☐WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☒YES ☐NO DEPTH FROM RIM TO WATER LEVEL___.___FT. 6"

34) EVIDENCE OF SURCHARGING: ☒YES ☐NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT 5.4 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.40 FT TOP SLAB ELEV 681.32 FT

SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

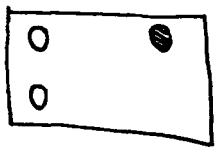
FLOOR DRAIN: ☐YES ☐NO UNKNOWN

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 675.92

SKETCH/COMMENTS:

N



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 . ___ . ___ DATE 1/8/90

1) MANHOLE NO. (_____) 1711 2) AREA CAMP MOFFETT

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☐ PAVED ESMT. 7☒ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐ STORM/VENT IF SOLID, VENT: ☒ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒ YES ☐ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☒ NONE 2☐ MUD 3☐ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___ . ___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT ___ . ___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___ . ___ FT.

TOP SLAB TO FLOOR 8.94 FT TOP SLAB ELEV 663.99 FT

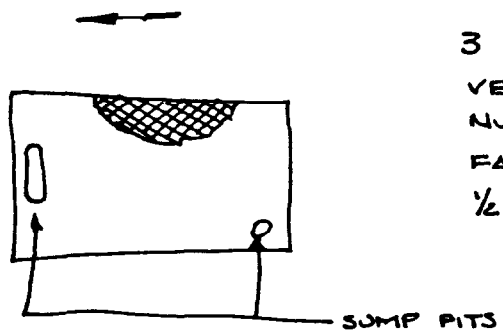
SUMP PUMP: ☒ YES ☐ NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☒ YES ☐ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 655.05

SKETCH/COMMENTS:



3 SUMPS ALL WORK

VERY SLIGHT WALL LEAK

NW CORNER OF STRUCTURE

FAIRLY NEW

½" STANDING WATER IN SHADED AREA FROM DRIP IN PIPE

STEAM MANHOLE INSPECTION FORM
GREAT LAKES

PROJECT NO. RJN-_____ PROJECT NAME CAMP MOFFETT BY 44.___.___ DATE 1/18/90

1) MANHOLE NO. (_____) 246 2) AREA _____

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☒YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION (1☒SOUND) 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 25.65 FT TOP SLAB ELEV 651.06 FT

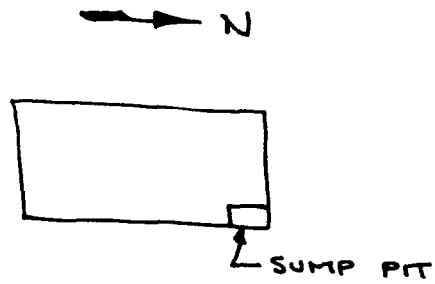
SUMP PUMP: ☒YES ☐NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 625.41

SKETCH/COMMENTS:



½" H_2O ON FLOOR
VERT HEART CONDENSATIO
12" A/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/8/90

1) MANHOLE NO. (_____) 246A 2) AREA CAMP MOFFETT

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☒YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED SPALLING

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 25.80 FT TOP SLAB ELEV 645.17 FT

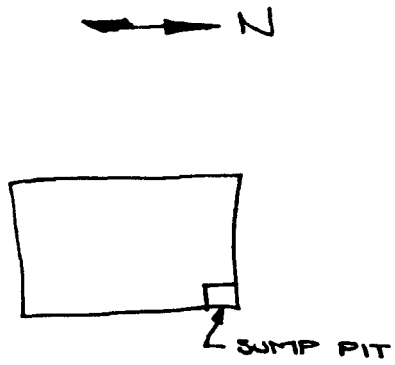
SUMP PUMP: ☒YES ☐NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 619.37

SKETCH/COMMENTS:



BRAND NEW STRUCTURE

1/2" H_2O ON FLOOR

VERY HEAVY CONDENSATION

WALL LEAK NOT BAD

12" A/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/4/80

1) MANHOLE NO. (_____) 11 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☐ PAVED ESMT. 7☒ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐ STORM/VENT IF SOLID, VENT: ☐ YES ☒ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☐ NONE 2☐ MUD 3☒ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☐ SOUND 2☐ CRACKED 3☒ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☒ YES ☐ NO DEPOSITS ON: 1☐ STEPS 2☒ WALLS HEIGHT ABOVE INVERT 1.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 8.46 FT TOP SLAB ELEV 653.75 FT

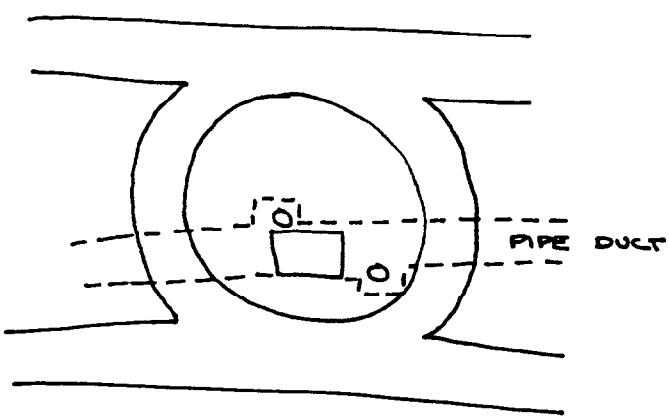
SUMP PUMP: ☐ YES ☒ NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐ YES ☒ NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 645.29

SKETCH/COMMENTS:



BIG ENOUGH TO WALK THROUGH

INSULATION FALLING APART ON PIPE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/4/90

1) MANHOLE NO. (_____) 18 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE STANDARD MH COVER 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☒FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☒MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☐CRACKED 3☒NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.20 FT TOP SLAB ELEV 651.81 FT

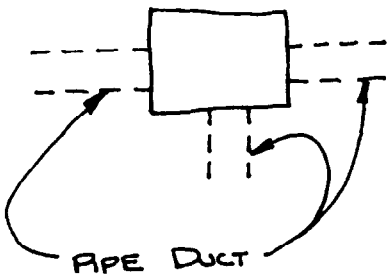
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 646.61

SKETCH/COMMENTS:



COULD NOT LOCATE ANY TYPE OF DRAIN

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- PROJECT NAME GREAT LAKES BY 44. DATE 1/8/90

1) MANHOLE NO. ( ) 29 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☐ PAVED ESMT. 7☒ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED ____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐ STORM/VENT IF SOLID, VENT: ☐ YES ☒ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☐ POURED 3☐ BLOCK 4☐ FLATTOP 5☒ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): ____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE BAD CRACKS DON'T LOOK LIKE THE LEAK

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): ____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☒ NONE 2☐ MUD 3☐ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS ____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☐ SOUND 2☐ CRACKED 3☒ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. ____ DIRECTION: ____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT ___.___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 3.70 FT TOP SLAB ELEV 651.46 FT

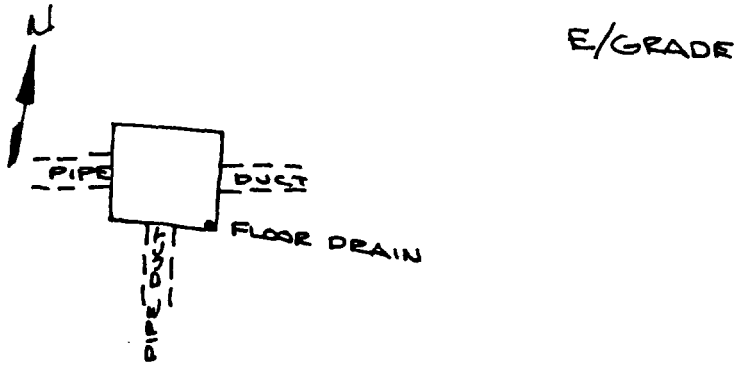
SUMP PUMP: ☐ YES ☒ NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒ YES ☒ NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 647.76

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/4/90

1) MANHOLE NO. (_____) 33 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☐SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☒DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☒MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☐CRACKED 3☒NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 3.99 FT TOP SLAB ELEV 656.88 FT

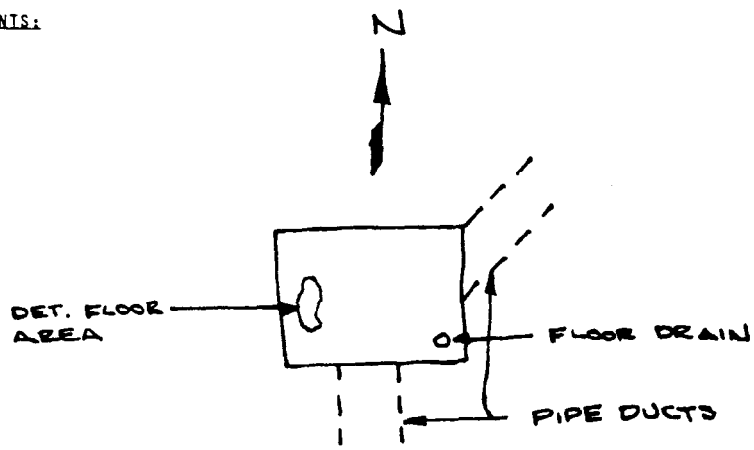
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 652.89

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN- _____ PROJECT NAME GREAT LAKES BY 44 DATE 1/5/90

1) MANHOLE NO. ( ) 45 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☒ PAVED ESMT. 7☐ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☒ YES ☐ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒ YES ☐ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): 12" x 18" (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☐ NONE 2☐ MUD 3☒ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☒ YES ☐ NO DEPTH FROM RIM TO WATER LEVEL 0.25 FT.

34) EVIDENCE OF SURCHARGING: ☒ YES ☐ NO DEPOSITS ON: 1☐ STEPS 2☒ WALLS HEIGHT ABOVE INVERT 0.5 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 5.74 FT TOP SLAB ELEV 661.50 FT

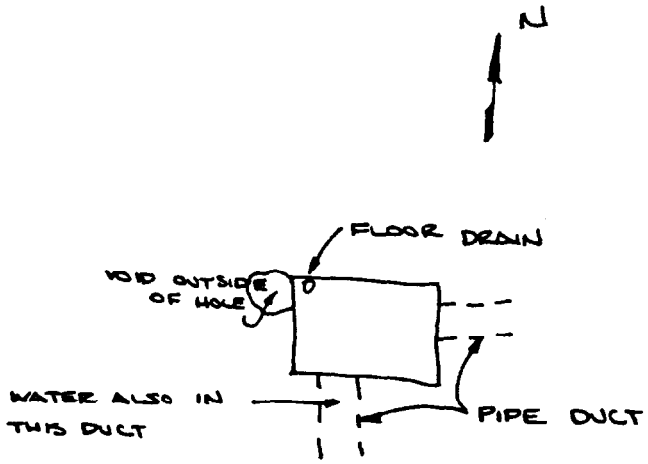
SUMP PUMP: ☐ YES ☒ NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒ YES ☐ NO 6" above floor slab

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 655.76

SKETCH/COMMENTS:



EVEN/GRADE
SLIGHT PIPE CORRISON

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/5/90

1) MANHOLE NO. (_____) 54 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☒YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☐SOUND 2☐CRACKED 3☒DETERIORATED (STARTING TO FALL APART) 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: E, E

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 4.11 FT TOP SLAB ELEV 659.16 FT

SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

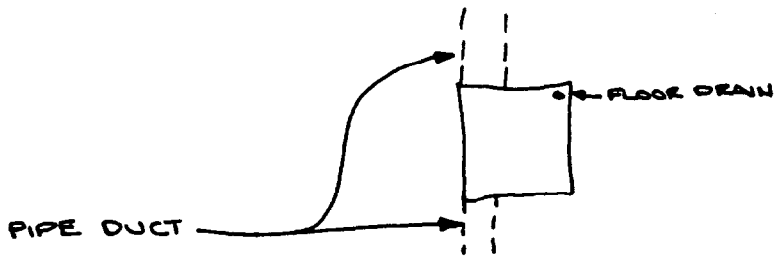
FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 654.99

SKETCH/COMMENTS:

EVENGRADE



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY AA. DATE 1/5/90

1) MANHOLE NO. (_____) 69 2) AREA MAINSIDE

3) PRECIPITATION: 1 ☑ NONE 2 ☐ LIGHT RAIN 3 ☐ HEAVY RAIN 4 ☐ SNOW 4) GROUND: 1 ☐ DRY 2 ☐ DAMP 3 ☒ WET 4 ☐ STANDING WATER

5) LOCATION: 1 ☐ BURIED 2 ☐ NOT FOUND 3 ☐ CNTR.ST. 4 ☐ CURB 5 ☐ GUTTER 6 ☐ PAVED ESMT. 7 ☒ GRASS ESMT. 8 ☐ DITCH 9 ☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED_____ SQ. FT.

7) COVER: TYPE 3 ☐ SOLID 4 ☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1 ☐ BRICK 2 ☐ POURED 3 ☐ BLOCK 4 ☐ FLATTOP 5 ☒ NONE

19) CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1 ☐ BRICK 2 ☐ BLOCK 3 ☐ PRECAST 4 ☒ POURED 5 ☐ NONE

22) CONDITION: 1 ☑ SOUND 2 ☒ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒ YES ☑ NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1 ☐ PRECAST 2 ☐ BRICK 3 ☒ POURED 4 ☐ NONE

25) FLOOR CONDITION: 1 ☑ SOUND 2 ☐ CRACKED 3 ☐ RAISED 4 ☐ DEPRESSED 5 ☐ UNFINISHED 6 ☐ DETERIORATED

26) FLOOR DEPOSITION: 1 ☑ NONE 2 ☐ MUD 3 ☐ DEBRIS 4 ☐ SLUDGE DEPTH OF DEPOSITS_____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☑ NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1 ☑ SOUND 2 ☐ CRACKED 3 ☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☑ NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☑ NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☑ YES ☐ NO DEPOSITS ON: 1 ☐ STEPS 2 ☑ WALLS HEIGHT ABOVE INVERT 1.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☑ NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 10.50 FT TOP SLAB ELEV 662.66 FT

SUMP PUMP: ☒ YES ☐ NO IF YES, ☑ STEAM DRIVEN ☒ ELECTRIC

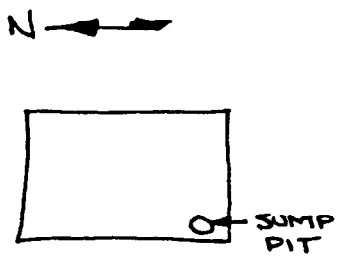
FLOOR DRAIN: ☐ YES ☒ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 650.16

SKETCH/COMMENTS:

14½" A/GRADE
non-functioning sump
VERY SLIGHT CRACKS IN WALLS
FAIRLY NEW STRUCTURE



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY H. DATE 1/5/89

1) MANHOLE NO. (_____) 73 2) AREA MAINLINE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 1 DIRECTION: W

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 6.94 FT TOP SLAB ELEV 660.83 FT

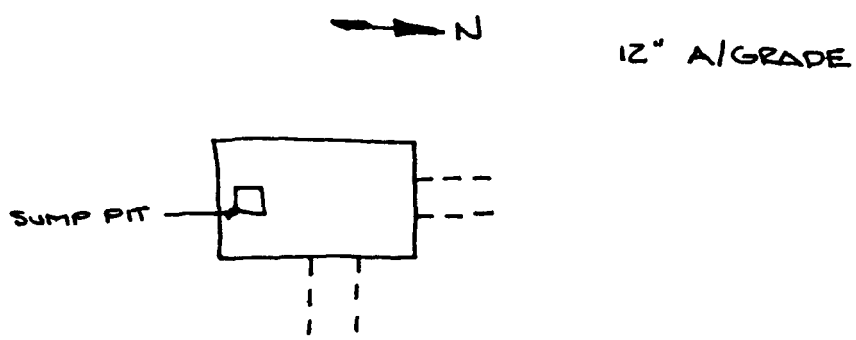
SUMP PUMP: ☒YES ☐NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC WORKS!

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 653.89

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY 44.___.___ DATE 1/15/90

1) MANHOLE NO. (_____) 79 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☒NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☐SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☐POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☐POURED 4☐NONE

25) FLOOR CONDITION: 1☐SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☐NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☐NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☐NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☐NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☐NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR ___ ___.___ ___ FT TOP SLAB ELEV 661.50 FT

SUMP PUMP: ☐YES ☐NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

SKETCH/COMMENTS:

DID NOT INSPECT
FENCED IN BY RESIDENT
ALSO GRILL AND CHILDS
PIKNIK TABLE ON TOP OF IT.

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/5/89

1) MANHOLE NO. (_____) 88 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: N.S

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 8.64 FT TOP SLAB ELEV 655.61 FT

SUMP PUMP: ☒YES ☐NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

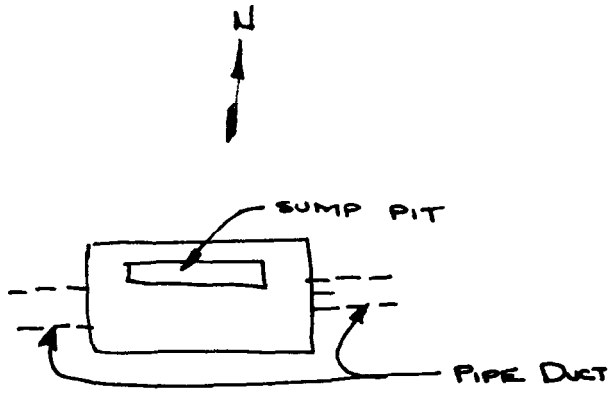
FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 646.97

SKETCH/COMMENTS:

12" A/GRADE



APPENDIX D

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: January 1990

SHEET 1 OF 4

ACTIVITY AND LOCATION: Naval Training Center, Great Lakes, Illinois

PROJECT TITLE: Underground Water Table Investigation

CONSTRUCTION CONTRACT NO.: N62472-87-C-7743

ESTIMATED BY: RJN Environmental Associates, Inc.

STATUS OF DESIGN: [X] PED [ ] 30% [ ] 100% [ ] FINAL [ ] Other (Specify) _____

IDENTIFICATION NUMBER

CATEGORY CODE NUMBER

JOB ORDER NUMBER

ITEM DESCRIPTION	QUANTITY		MATERIAL COST		LABOR COST		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
Escalation Calculation								
Date of Estimate = January 1990								
ADCA = January 1992								
Escalation Rates:								
FY 90 = 3.0%								
FY 90 = 2.7%								
Escalation = 1.03 x 1.027								
= 1.058								
= 5.8%								

S/N 0105-LF-010-1335

U.S. Government Printing Office: 1993—[illegible]

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: February, 1990

SHEET 2 OF 4

ACTIVITY AND LOCATION: Naval Training Center, Great Lakes, Illinois

CONSTRUCTION CONTRACT NO.: N62472-87-C-7743

IDENTIFICATION NUMBER:

PROJECT TITLE: Underground Water Table Investigation

ESTIMATED BY: RJN Environmental Associates,

CATEGORY CODE NUMBER:

STATUS OF DESIGN: [X] PED [ ] 30% [ ] 100% [ ] FINAL [ ] Other (Specify)

JOB ORDER NUMBER:

ITEM DESCRIPTION	QUANTITY		MATERIAL COST		LABOR COST		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
Option A - Floor Drain Disconnection								
Disconnect Floor Drain	32	EA	250	8,000	1,175	37,600	1,425	45,600
Excavate New Sump	32	EA	90	2,880	780	24,960	870	27,840
Screed Manhole Floor	32	EA	40	1,280	225	7,200	265	8,480
Install Sump Pump and Ancillaries	32	EA	2,400	76,800	300	9,600	2,700	86,400
Subtotal								168,320.00
Design Contingency 5%								8,416.00
Total Contract Cost								176,736.00
SIOH (5.5%)								9,720.48
Total Request - January 1990								186,456.48
Excalation to ADCA (5.8%)								10,814.48
Total Request - January 1992								$197,270.95
							Say	$198,000.00

S/N 0105-LF-010-1335

U.S. Government Printing Office: 1983—[illegible] 2-1

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: January 1990

SHEET 3 OF 4

ACTIVITY AND LOCATION: Naval Training Center, Great Lakes, Illinois

PROJECT TITLE: Underground Water Table Investigation

CONSTRUCTION CONTRACT NO.: N62472-87-C-7743

ESTIMATED BY: RJN Environmental Associates, Inc.

STATUS OF DESIGN: [X] PED [ ] 30% [ ] 100% [ ] FINAL [ ] Other (Specify) _____

IDENTIFICATION NUMBER:

CATEGORY CODE NUMBER:

JOB ORDER NUMBER:

ITEM DESCRIPTION	QUANTITY		MATERIAL COST		LABOR COST		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
Option B - Manhole Grouting								
Waterproofing Manholes	211	EA	400	84,400	1,800	379,800	2,200	464,200.00
Subtotal								464,200.00
Design Contingency (5%)								23,210.00
Total Contract Cost								487,410.00
Overhead (5.5%)								26,807.55
Total Request January 1990								514,217.55
Escalation to ADCA (5.8%)								29,824.62
Total Request January 1992								544,042.17
							Say	$545,000.00

S/N 0105-LF-010-1335

U.S. Government Printing Office: 1983—[illegible] 3-1

NAVFAC 11013/7 (1-78)
Supersedes NAVDOCKS 2417 and 2417A

COST ESTIMATE

DATE PREPARED: January 1990

SHEET 4 OF 4

ACTIVITY AND LOCATION: Naval Training Center, Great Lakes, Illinois

PROJECT TITLE: Underground Water Table Investigation

CONSTRUCTION CONTRACT NO.: N62472-87-C-7743

ESTIMATED BY: RJN Environmental Associates, Inc.

STATUS OF DESIGN: [X] PED [ ] 30% [ ] 100% [ ] FINAL [ ] Other (Specify) _____

IDENTIFICATION NUMBER:

CATEGORY CODE NUMBER:

JOB ORDER NUMBER:

ITEM DESCRIPTION	QUANTITY		MATERIAL COST		LABOR COST		ENGINEERING ESTIMATE	
	NUMBER	UNIT	UNIT COST	TOTAL	UNIT COST	TOTAL	UNIT COST	TOTAL
Option C - Foundation Drains								
Backhoe & Operator	8	HR	30	240	50	400	80	640.00
Laborers	48	HR	-	-	35	1,680	35	1,680.00
Backfill	30	CY	30	900	-	-	30	900.00
4" Pipe	45	LF	5	225	-	-	5	225.00
Restoration - sod	7	SY	6	42	-	-	6	42.00
Restoration - paved	8	SY	27	216	-	-	27	216.00
Curb and Gutter	10	LF	5	50	10	100	15	150.00
Pumps and Ancillaries	1	EA	2,300	2,300	470	470	2,770	2,770.00
Total Per Manhole								6,623.00
Total x 211 Manholes								1,397,453.00
+5% Design Contingency								69,872.65
Total Contract Cost								1,467,325.65
+ SIOH (5.5%)								80,702.91
Contract Cost January 1990								1,548,028.56
Escalation ADCA (5.8%)								89,785.66
Contract Cost January 1991								1,637,814.21

S/N 0105-LF-010-1335

U.S. Government Printing Office: 1983—[illegible] 2-1

Say $1,640,000.00

APPENDIX E

RJN ENVIRONMENTAL ASSOCIATES, INC.	SUBJECT Cost Benefit Analysis Great Lakes	PROJECT Groundwater Study
	COMPUTED CLM CHECKED CLM	NO. N62472-87-C-7743
		DATE Feb 90 PAGE 1 OF 3 PAGES

NTC requests the following.

1. Life of pipeline without rehabilitation is 15 years.
2. Life of pipeline with rehabilitation is 20 years.
3. Heat loss costs $4.06/MBTU.
4. 0% inflation
5. 10% discount rate.
6. Re-grout at 15 years.

Alternate A (1990 prices)

Disconnection of floor drains, installation of sump pumps	=	$186,456.48
Manhole grouting 1990	=	$514,000.00
Manhole grouting 2005.	=	$514K \times \left(\frac{P}{F}\right)_{15}^{10}$
	=	514K × 0.2394
	=	$123,051.60
∴ PW alternative A	=	$823,508.

Alternative B.

Disconnection floor drains etc	=	$186,456.48
Foundation Drains	=	$1,550,000
∴ PW alternative B	=	$1,736,456

RJN ENVIRONMENTAL ASSOCIATES, INC.	SUBJECT Cost Benefit Analysis Great Lakes	PROJECT
	COMPUTED CLM. CHECKED WV	NO.
		DATE Feb 1990 PAGE 2 OF 3 PAGE

Need to compare recommended option - Alternative A with cost of doing nothing "Status quo".

1. Assumption : If "A" is adopted, pipes will have 20 year life, manholes will require grouting at 0, 15, 30 years (1990, 2005, 2020) significant heat/energy savings will be achieved

2. Assumption : If no work is undertaken. pipes will require replacement at 15 years (PWC personnel) and at 30 years.

Present Worth Status Quo

Total pipework at NTC (approximate)

Camp Porter	14,710
Mainside	55,950
Forrestal	5,350
Camp Moffett	3,940
	79,950 .

Donohue Report estimated heat loss at Camp Porter = 12960 MBTU/yr.

$\therefore$ prorating for other areas $= \frac{12960 \times 65,240}{14710}$

$= 57,480$

Cost/MBTU $= \$4.06$.

$\therefore$ cost/year heat loss $= 57,480 \times 4.06$

$= \$233,368.80$

PW of BTU $= 0.233K \times \left(\frac{P}{A}\right)_{30}^{10}$

$= \$2.2M$

Cost of pipe replacement:

Donohue report indicates 144 ft/manhole (average)

cost/ft = \$406 per foot.

No of manholes = 267.

∴ 1990 cost of pipe = \$15.6M.

PW Cost of 2005 " " " $= 15.6 \times \left(\frac{P}{F}\right)^{10}_{15}$ = \$3.735 M.

PW Cost of 2020 $= 15.6 \times \left(\frac{P}{F}\right)^{10}_{20}$ = \$0.894M

Present Worth of Existing Condition (30 years)

= \$3.735 + 0.894 + 2.2

= \$6.83 M

Present Worth of Alternative A (30 years)

= initial capitilization + regrouting (15 years) + new pipe (20 years)

$= \$0.7K + 0.514K\left(\frac{P}{F}\right)^{10}_{15} + 15.6K\left(\frac{P}{F}\right)^{10}_{20}$

= \$700,500 + 123,000 + 2.32M

= \$3.14 M

Savings to Investment Ratio.

∴ SIR = 2.18.

APPENDIX F

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/4/90

1) MANHOLE NO. (_____) 97 2) AREA MAINSIDE

3) PRECIPITATION: 1☐NONE 2☒LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☒PRECAST 4☐POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☒PRECAST 2☐BRICK 3☐POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

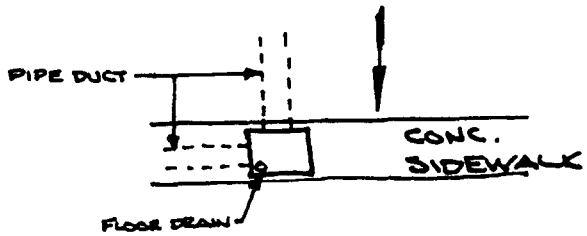
TOP SLAB TO FLOOR 4.54 FT TOP SLAB ELEV 647.47 FT

SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN FLOOR ELEV. 642.93

SKETCH/COMMENTS:



FRAME IS EVEN GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44.862 DATE 1/4/90

1) MANHOLE NO. ( ) 105 2) AREA MAINSIDE

3) PRECIPITATION: 1☐NONE 2☒LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☒PRECAST 4☐POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☒PRECAST 2☐BRICK 3☐POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☐NO RATE ___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM QTY. 4 DIRECTION: N,W,W,E

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL ___.___FT.

34) EVIDENCE OF SURCHARGING: ☒YES ☐NO DEPOSITS ON: 1☐STEPS 2☒WALLS HEIGHT ABOVE INVERT 1.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT ___.___FT.

TOP SLAB TO FLOOR 4.17 FT TOP SLAB ELEV 648.90 FT

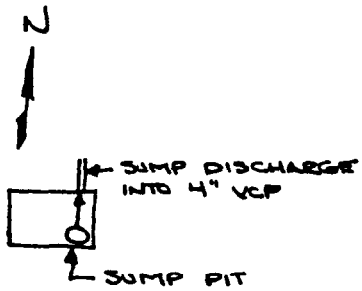
SUMP PUMP: ☒YES ☐NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☒ UNKNOWN

FLOOR ELEV. 644.73

SKETCH/COMMENTS:



SUMP DOESN'T WORK
2' A/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY 44.82 DATE 1/4/90

1) MANHOLE NO. (_____) 106 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 14.83 FT TOP SLAB ELEV 650.00 FT

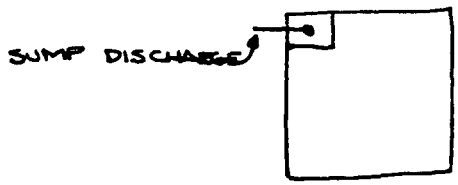
SUMP PUMP: ☒YES ☐NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 635.17

SKETCH/COMMENTS:



BRAND NEW STRUCTURE
ALWAYS FILLED WITH STEAM
4" A/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44.867 DATE 1/4/90

1) MANHOLE NO. ( ) 114 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☒LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE ___ ___.___ ___GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOW DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1/2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE ___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☐CRACKED 3☒NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE ___ ___.___ ___GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL ___.___FT.

34) EVIDENCE OF SURCHARGING: ☒YES ☐NO DEPOSITS ON: 1☐STEPS 2☒WALLS HEIGHT ABOVE INVERT 1.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT ___.___FT.

TOP SLAB TO FLOOR 5.80 FT TOP SLAB ELEV 647.52 FT

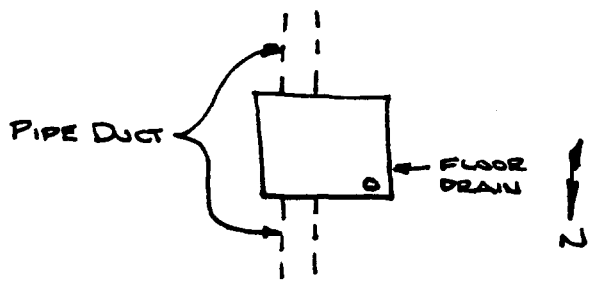
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐ NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 641.72

SKETCH/COMMENTS:



1/2" WATER ON BENCH

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY HH. DATE 1/5/89

1) MANHOLE NO. (_____) 118 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: N & S

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.68 FT TOP SLAB ELEV 645.99 FT

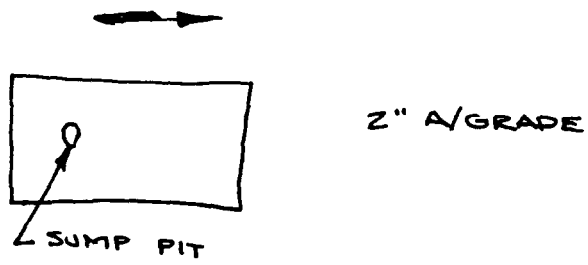
SUMP PUMP: ☒YES ☐NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 640.31

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY H. DATE 1/ /90

1) MANHOLE NO. (_____) 126 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☒DAMP 3☐WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE STANDARD MH COVER 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 4 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

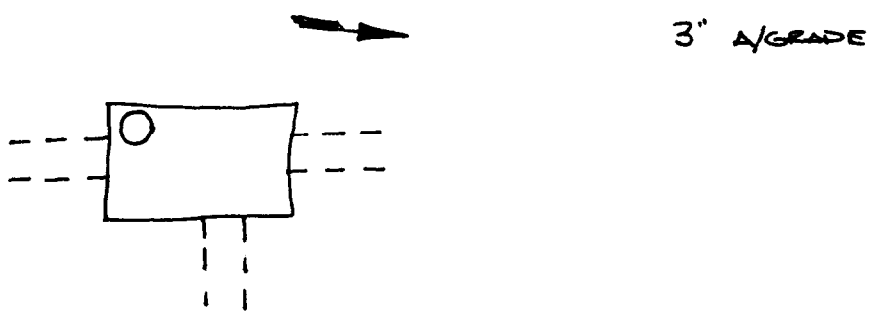
TOP SLAB TO FLOOR 7.10 FT TOP SLAB ELEV 656.51 FT

Can't see either { SUMP PUMP: ☐YES ☐NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC
FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 649.41

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44 . ___ . ___ DATE 1 1 90

1) MANHOLE NO. (____) 137 2) AREA MAINSIDE

3) PRECIPITATION: 1 ☒ NONE 2 ☐ LIGHT RAIN 3 ☐ HEAVY RAIN 4 ☐ SNOW 4) GROUND: 1 ☐ DRY 2 ☐ DAMP 3 ☒ WET 4 ☐ STANDING WATER

5) LOCATION: 1 ☐ BURIED 2 ☐ NOT FOUND 3 ☐ CNTR.ST. 4 ☐ CURB 5 ☐ GUTTER 6 ☒ PAVED ESMT. 7 ☐ GRASS ESMT. 8 ☐ DITCH 9 ☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE Std. manhole cover 3 ☒ SOLID 4 ☐ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO concealed

18) TOP SLAB: CONSTRUCTION 1 ☐ BRICK 2 ☒ POURED 3 ☐ BLOCK 4 ☐ FLATTOP 5 ☐ NONE

19) CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1 ☐ BRICK 2 ☐ BLOCK 3 ☐ PRECAST 4 ☒ POURED 5 ☐ NONE

22) CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1 ☐ PRECAST 2 ☐ BRICK 3 ☒ POURED 4 ☐ NONE

25) FLOOR CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ RAISED 4 ☐ DEPRESSED 5 ☐ UNFINISHED 6 ☐ DETERIORATED

26) FLOOR DEPOSITION: 1 ☒ NONE 2 ☐ MUD 3 ☐ DEBRIS 4 ☐ SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM

28) PIPE SEALS: CONDITION 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___ . ___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1 ☐ STEPS 2 ☐ WALLS HEIGHT ABOVE INVERT ___ . ___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___ . ___ FT.

TOP SLAB TO FLOOR 8.50 FT TOP SLAB ELEV 647.95 FT

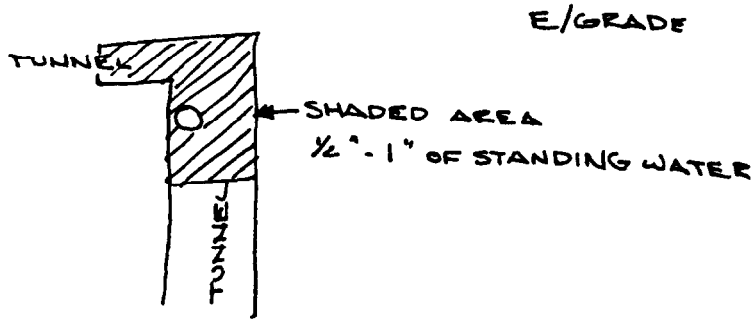
SUMP PUMP: ☐ YES ☒ NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐ YES ☒ NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 639.45

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44. DATE 1/8/90

1) MANHOLE NO. ( ) 141A 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☑ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☒ PAVED ESMT. 7☐ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☐ POURED 3☐ BLOCK 4☐ FLATTOP 5☒ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE (W.SIDE NOT BAD)

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☐ NONE 2☐ MUD 3☐ DEBRIS 4☒ SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☒ YES ☐ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT 3.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 7.70 FT TOP SLAB ELEV 650.42 FT

SUMP PUMP: ☒ YES ☐ NO WORKS IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

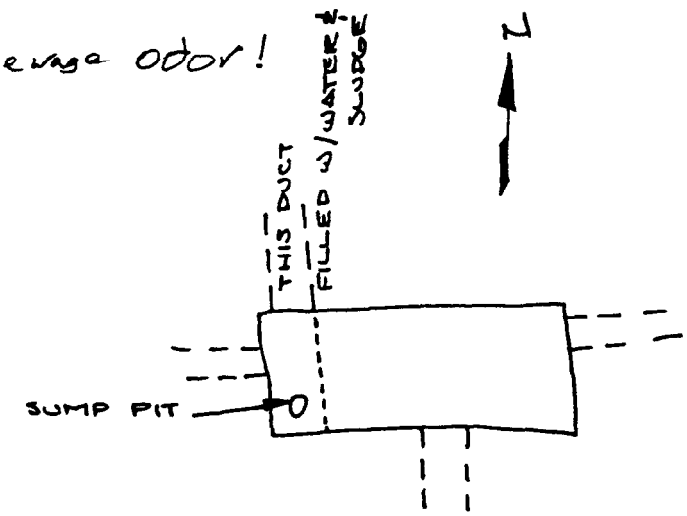
FLOOR DRAIN: ☐ YES ☐ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 642.72

SKETCH/COMMENTS:

heavy sewage odor!



12" A/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY H. DATE 1/8/90

1) MANHOLE NO. (_____) 164 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE NOT BAD

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.80 FT TOP SLAB ELEV 648.83 FT

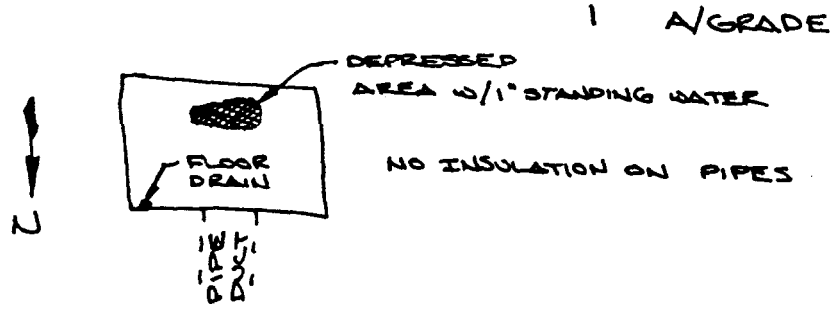
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 643.63

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44. ___.___ DATE 1/8/90

1) MANHOLE NO. (_____) 168 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☒ PAVED ESMT. 7☐ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☐ NONE 2☐ MUD 3☒ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS 2 INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT ___.___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 6.50 FT TOP SLAB ELEV 651.32 FT

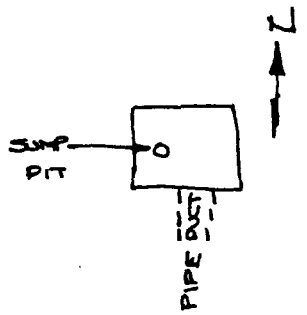
SUMP PUMP: ☒ YES ☐ NO works IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐ YES ☒ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 644.82

SKETCH/COMMENTS:



WALL LEAKS MED. WET

MINERAL DEPOSITS

1.1' N/GRADE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/8/90

1) MANHOLE NO. (_____) 205 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 1/2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: N,S

33) SURCHARGED AT TIME OF INSPECTION: ☒YES ☐NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☒YES ☐NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 6.70 FT TOP SLAB ELEV 649.44 FT

*SUMP PUMP: ☒YES ☐NO IF YES, ☒STEAM DRIVEN ☐ELECTRIC

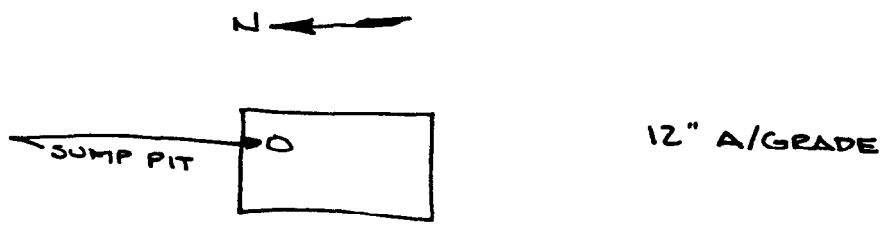
FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 642.74

SKETCH/COMMENTS:

* sump does not trip automatically



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1/8/90

1) MANHOLE NO. (_____) 198 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☒POURED 3☐BLOCK 4☐FLATTOP 5☐NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE 5.00 GPM QTY. 1 DIRECTION: W

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.80 FT TOP SLAB ELEV 648.34 FT

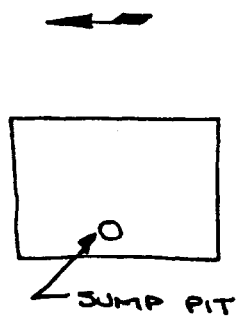
SUMP PUMP: ☒YES ☐NO WORKS IF YES, ☒STEAM DRIVEN ☐ELECTRIC

FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 642.54

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME_____ BY 44.862 DATE 1/4/88

1) MANHOLE NO. (_____) 1T2 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 1 DIRECTION: N

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 1.22 FT TOP SLAB ELEV 655.19 FT

SUMP PUMP: ☒YES ☐NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

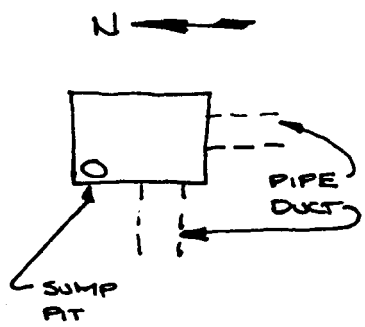
FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 647.97

SKETCH/COMMENTS:

7" A/GRADE



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY HH. DATE / /

1) MANHOLE NO. (_____) 177 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☒DAMP 3☐WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☐PAVED ESMT. 7☒GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: N.N.

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 10.54 FT TOP SLAB ELEV 666.97 FT

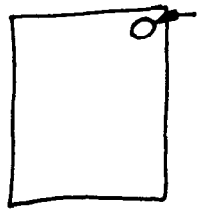
SUMP PUMP: ☒YES ☐NO IF YES, ☒STEAM DRIVEN ☐ELECTRIC

FLOOR DRAIN: ☐YES ☐NO

SUMP PIT: ☒SEALED BOTTOM ☐UNSEALED BOTTOM ☐UNKNOWN

FLOOR ELEV. 656.43

SKETCH/COMMENTS:



SUMP PIT 12" A/GRADE

CONSTRUCTION IN PROGRESS ON THIS STRUCTURE

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN-_____ PROJECT NAME GREAT LAKES BY 44 DATE 1 15 90

1) MANHOLE NO. (_____) 180 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☒ SOLID 4☐STORM/VENT IF SOLID, VENT: ☐YES ☒NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☒SOUND 2☐CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED

26) FLOOR DEPOSITION: 1☐NONE 2☐MUD 3☒DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS 2 INCHES

27) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☐SOUND 2☒CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM QTY. 2 DIRECTION: N,S

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.52 FT TOP SLAB ELEV 661.85 FT

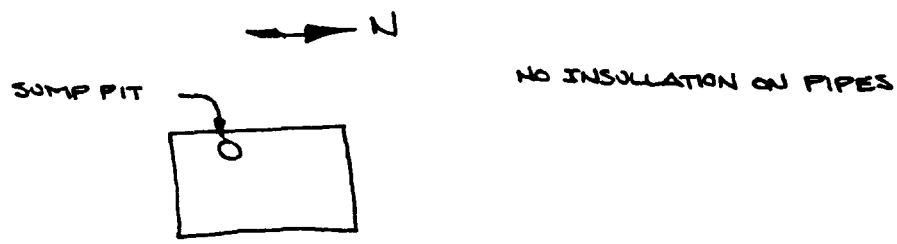
SUMP PUMP: ☒YES ☐NO IF YES, ☒ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☐YES ☒NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 656.33

SKETCH/COMMENTS:



STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN- _____ PROJECT NAME GREAT LAKES BY 44 . ___ . ___ DATE 1 18 90

1) MANHOLE NO. (____) 191 2) AREA MAINSIDE

3) PRECIPITATION: 1 ☒ NONE 2 ☐ LIGHT RAIN 3 ☐ HEAVY RAIN 4 ☐ SNOW 4) GROUND: 1 ☐ DRY 2 ☐ DAMP 3 ☒ WET 4 ☐ STANDING WATER

5) LOCATION: 1 ☐ BURIED 2 ☐ NOT FOUND 3 ☐ CNTR.ST. 4 ☐ CURB 5 ☐ GUTTER 6 ☐ PAVED ESMT. 7 ☒ GRASS ESMT. 8 ☐ DITCH 9 ☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3 ☐ SOLID 4 ☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1 ☐ BRICK 2 ☐ POURED 3 ☐ BLOCK 4 ☐ FLATTOP 5 ☒ NONE

19) CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1 ☐ BRICK 2 ☐ BLOCK 3 ☐ PRECAST 4 ☒ POURED 5 ☐ NONE

22) CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ DETERIORATED 4 ☐ ROOTS 5 ☐ LEAKING JOINTS 6 ☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1 ☐ PRECAST 2 ☐ BRICK 3 ☒ POURED 4 ☐ NONE

25) FLOOR CONDITION: 1 ☒ SOUND 2 ☐ CRACKED 3 ☐ RAISED 4 ☐ DEPRESSED 5 ☐ UNFINISHED 6 ☐ DETERIORATED

26) FLOOR DEPOSITION: 1 ☐ NONE 2 ☐ MUD 3 ☒ DEBRIS 4 ☐ SLUDGE DEPTH OF DEPOSITS 1/2 INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___ . ___ ___ GPM

28) PIPE SEALS: CONDITION 1 ☐ SOUND 2 ☒ CRACKED 3 ☐ NONE

29) EVIDENCE OF INFILTRATION: ☒ YES ☐ NO RATE ___ ___ . ___ ___ GPM QTY. 1 DIRECTION: ABANDON WEST

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___ . ___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1 ☐ STEPS 2 ☐ WALLS HEIGHT ABOVE INVERT ___ . ___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___ . ___ FT.

TOP SLAB TO FLOOR 5.50 FT TOP SLAB ELEV 648.21 FT

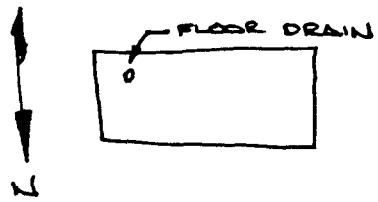
SUMP PUMP: ☐ YES ☒ NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒ YES ☐ NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 642.71

SKETCH/COMMENTS:



1.1' A/GRADE

3/4" PIPE LEAKING 3 DROP PER SEC

FLOOR ALWAYS WET DUE TO LEAKS

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RIN- _____ PROJECT NAME GREAT LAKES BY 44 DATE 11 8 90

1) MANHOLE NO. ( ) 1918 2) AREA MAINSIDE

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☒ PAVED ESMT. 7☐ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 2-STANDARD MH COVERS 3☒ SOLID 4☐ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO CONCEALED

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☒ NONE 2☐ MUD 3☐ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☐ YES ☒ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT ___.___ FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 7.90 FT TOP SLAB ELEV 646.58 FT

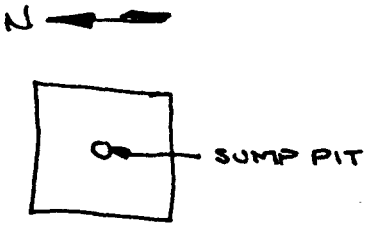
SUMP PUMP: ☒ YES ☐ NO WORKS IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐ YES ☐ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 638.68

SKETCH/COMMENTS:



VERY HEAVY CONDENSATION

½" H_2O ON FLOOR DUE TO CONDENSATION

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME GREAT LAKES BY HH. DATE 1/8/90

1) MANHOLE NO. (_____) 185 2) AREA MAINSIDE

3) PRECIPITATION: 1☒NONE 2☐LIGHT RAIN 3☐HEAVY RAIN 4☐SNOW 4) GROUND: 1☐DRY 2☐DAMP 3☒WET 4☐STANDING WATER

5) LOCATION: 1☐BURIED 2☐NOT FOUND 3☐CNTR.ST. 4☐CURB 5☐GUTTER 6☒PAVED ESMT. 7☐GRASS ESMT. 8☐DITCH 9☐NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐YES ☒NO POTENTIAL AREA DRAINED_____SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒STORM/VENT IF SOLID, VENT: ☐YES ☐NO

18) TOP SLAB: CONSTRUCTION 1☐BRICK 2☐POURED 3☐BLOCK 4☐FLATTOP 5☒NONE

19) CONDITION: 1☒SOUND 2☐CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐YES ☒NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐BRICK 2☐BLOCK 3☐PRECAST 4☒POURED 5☐NONE NOT BAD

22) CONDITION: 1☐SOUND 2☒CRACKED 3☐DETERIORATED 4☐ROOTS 5☐LEAKING JOINTS 6☐LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM HOLE SIZE (IF ANY):_____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐PRECAST 2☐BRICK 3☒POURED 4☐NONE

25) FLOOR CONDITION: 1☐SOUND 2☒CRACKED 3☐RAISED 4☐DEPRESSED 5☐UNFINISHED 6☐DETERIORATED NOT BAD

26) FLOOR DEPOSITION: 1☒NONE 2☐MUD 3☐DEBRIS 4☐SLUDGE DEPTH OF DEPOSITS_____INCHES

27) EVIDENCE OF INFILTRATION: ☒YES ☐NO RATE___ ___.___ ___GPM

28) PIPE SEALS: CONDITION 1☒SOUND 2☐CRACKED 3☐NONE

29) EVIDENCE OF INFILTRATION: ☐YES ☒NO RATE___ ___.___ ___GPM QTY._____ DIRECTION:_____

33) SURCHARGED AT TIME OF INSPECTION: ☐YES ☒NO DEPTH FROM RIM TO WATER LEVEL___.___FT.

34) EVIDENCE OF SURCHARGING: ☐YES ☒NO DEPOSITS ON: 1☐STEPS 2☐WALLS HEIGHT ABOVE INVERT___.___FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐YES ☒NO HEIGHT ABOVE INVERT___.___FT.

TOP SLAB TO FLOOR 5.10 FT TOP SLAB ELEV 650.24 FT

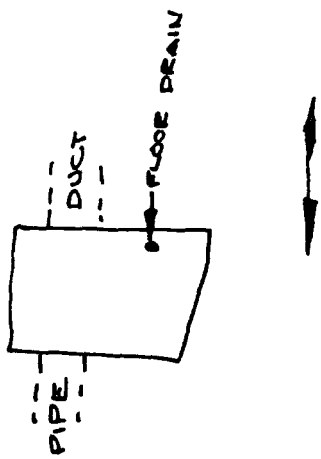
SUMP PUMP: ☐YES ☒NO IF YES, ☐ STEAM DRIVEN ☐ ELECTRIC

FLOOR DRAIN: ☒YES ☐NO

SUMP PIT: ☐ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

FLOOR ELEV. 644.54

SKETCH/COMMENTS:



1.1' A/GRADE

3/4" PIPE LEAKING FLOOR ALWAYS WET IN THESE AREAS

STEAM MANHOLE INSPECTION FORM

PROJECT NO. RJN-_____ PROJECT NAME Great Lakes BY 44 DATE 1/8/90

1) MANHOLE NO. (_____) 187 2) AREA Mainside

3) PRECIPITATION: 1☒ NONE 2☐ LIGHT RAIN 3☐ HEAVY RAIN 4☐ SNOW 4) GROUND: 1☐ DRY 2☐ DAMP 3☒ WET 4☐ STANDING WATER

5) LOCATION: 1☐ BURIED 2☐ NOT FOUND 3☐ CNTR.ST. 4☐ CURB 5☐ GUTTER 6☒ PAVED ESMT. 7☐ GRASS ESMT. 8☐ DITCH 9☐ NOT INSP.

6) LOCATION CHARACTERISTICS: SUBJECT TO PONDING ☐ YES ☒ NO POTENTIAL AREA DRAINED _____ SQ. FT.

7) COVER: TYPE 3☐ SOLID 4☒ STORM/VENT IF SOLID, VENT: ☐ YES ☐ NO

18) TOP SLAB: CONSTRUCTION 1☐ BRICK 2☒ POURED 3☐ BLOCK 4☐ FLATTOP 5☐ NONE

19) CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

20) EVIDENCE OF INFLOW: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

21) WALLS: CONSTRUCTION 1☐ BRICK 2☐ BLOCK 3☐ PRECAST 4☒ POURED 5☐ NONE

22) CONDITION: 1☐ SOUND 2☒ CRACKED 3☐ DETERIORATED 4☐ ROOTS 5☐ LEAKING JOINTS 6☐ LEAKING STEP/LIFTING HOLE

23) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ 3.00 GPM HOLE SIZE (IF ANY): _____ (EXCLUDING LIFTING HOLE)

24) FLOOR: FLOOR CONSTRUCTION 1☐ PRECAST 2☐ BRICK 3☒ POURED 4☐ NONE

25) FLOOR CONDITION: 1☒ SOUND 2☐ CRACKED 3☐ RAISED 4☐ DEPRESSED 5☐ UNFINISHED 6☐ DETERIORATED

26) FLOOR DEPOSITION: 1☒ NONE 2☐ MUD 3☐ DEBRIS 4☐ SLUDGE DEPTH OF DEPOSITS _____ INCHES

27) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM

28) PIPE SEALS: CONDITION 1☒ SOUND 2☐ CRACKED 3☐ NONE

29) EVIDENCE OF INFILTRATION: ☐ YES ☒ NO RATE ___ ___.___ ___ GPM QTY. _____ DIRECTION: _____

33) SURCHARGED AT TIME OF INSPECTION: ☐ YES ☒ NO DEPTH FROM RIM TO WATER LEVEL ___.___ FT.

34) EVIDENCE OF SURCHARGING: ☒ YES ☐ NO DEPOSITS ON: 1☐ STEPS 2☐ WALLS HEIGHT ABOVE INVERT 1.0 FT.

35) INDICATION OF GROUNDWATER LEVEL: ☐ YES ☒ NO HEIGHT ABOVE INVERT ___.___ FT.

TOP SLAB TO FLOOR 8.20 FT TOP SLAB ELEV 649.35 FT

SUMP PUMP: ☒ YES ☐ NO IF YES, ☐ STEAM DRIVEN ☒ ELECTRIC

FLOOR DRAIN: ☐ YES ☐ NO

SUMP PIT: ☒ SEALED BOTTOM ☐ UNSEALED BOTTOM ☐ UNKNOWN

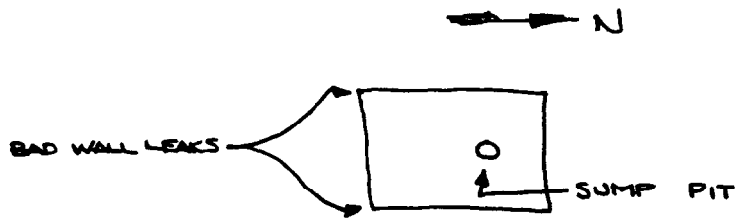
FLOOR ELEV. 641.5

SKETCH/COMMENTS:

* works, but disch. pipe leaks heavily

smells like sewage

10½" A/GRADE



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SEWER•REHAB

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SEWER•REHAB

New Concepts and Technology for Collection Systems

During 1983 and early 1984, the U.S. Environmental Protection Agency (EPA) sponsored a series of Technology Transfer Seminars conducted throughout the country on the topic "New Concepts in I/I Evaluation and Sewer System Rehabilitation." This article is a condensation of the new rehabilitation techniques and repair methods presented at that seminar. The techniques developed are designed to solve such infiltration/inflow (I/I) problems as high cost for treatment of excess infiltration, serious consequences from sanitary sewer backups in residential homes, or overflows into receiving streams that violate water pollution control law. The article is based on a presentation at the UPCF Collection Systems Pre-Conference Workshop held in New Orleans in October.

Richard J. Nogaj
RJN Environmental Associates, Inc.
Wheaton, Illinois

New technology being developed is designed to address a multitude of defects that exist in the sanitary system. It is essential that the I/I problem be addressed in a comprehensive manual so that financial expenditures result in anticipated and needed I/I reduction. Circumstances and defects that cause I/I occur in many forms. It used to be thought that a few major problem sources could be dealt with and that would suffice. This, however, is not the case with the many types of sources that need to be identified, effectively repaired, or permanently removed. Various types of rehabilitation methods used today for system defects are shown as a guide in Table 1. The guide also lists a flow range for each type of defect, the cost to rehabilitate the defect, and a best estimate of the percent effectiveness of the repair experienced today in the field. System defects generally can be categorized into three areas. Manhole defects and main sewer defects comprise the public sector while a third category can be classified as private sector defects.

Manhole Rehabilitation

Manhole rehabilitation can be categorized into repairs required to reduce inflow sources and those required to remove infiltration-type sources. Inflow sources generally occur at the surface and usually

Bill Michel checks sewer infiltration under the U.S. Senate in Washington, D.C.

boot that requires excavation and uses a sealant inside the serrated edges of the boot. Both techniques have been tested by the Milwaukee Metropolitan Sewerage District and have met with some success. Other techniques for repairing manhole defects such as cracks in the manhole walls include application of a flash coat of cement followed by insertion of 12-gauge wire mesh and spraying of concrete over the entire manhole from the surface of the manhole to the bench. This procedure, however, may not be optimum for manholes subject to freeze-and-thaw cycles. Individual leaks can also be repaired by drilling holes and injecting acrylamide grout.

Some of the testing techniques used to test the effectiveness of manhole repair include isolating and cleaning the manhole area and allowing dyed water to pond over the surface of the manhole after which the change in depth is measured over a period of time. After removing the dyed water from the surface, evidence of dyed water in the frame seal or the manhole after the duration of the test can be observed.

Main Sewer Rehabilitation

The second major category of sewer system repair involves main sewer defects. These defects can be divided into two major categories, cross connections and defective pipe sections, as shown in Table 1. Cross connections have been defined as the intrusion of water into the main sewer from either a storm sewer or ditch or as an indirect connection such as a seam in the soil from a storm drainage system to the sanitary system. A defective main line pipe can consist of any series of cracks, offsets, or deteriorated joints. Cross connection repair generally involves excavation to solve the problem. Cross connections can be initially identified through smoke testing and dyed water flooding.

A popular repair for defective pipes is simply to excavate and replace the defective section. In some cases, however, this may not be practical or it may be very costly. Lining techniques have been developed and used extensively throughout this country. One popular approach is the Insituform™ technique. A scaffold arrangement is used to develop sufficient head through an inversion tube to push a felt-liner impregnated with liquid resin down through the manhole and into the damaged line requiring repair. The liner sets up inside the pipe and serves as a seal through offset sections.

Slip lining is another process that uses polyethylene pipe. The Napa Sanitation District has developed a comprehensive approach to not only line mainlines, but also service laterals. A pull hole, at a length of 3 to 4 times the depth of the line, is normally located adjacent to a manhole. Liner pipe is pulled downstream but also can be pulled upstream, if necessary. The pull hole is excavated and properly shored. Generally 38-ft lengths of polyethelene pipe and fittings are hauled to the site with a joining jig adjacent to the truck where the pipe is ready to be welded.

To properly weld the pipe,

the ends of two lengths have to be square with each other. Facing tools are used to trim the edges of the pipe. Two lengths of the pipe to be welded are clamped to a joining jig. A heating plate is then placed on the joining jig. Two pieces of pipe are heated until a bead of molten plastic appears around the entire circumference of both ends of the pipe. The melt cycle takes approximately 15 seconds.

The heating plate is then removed and the pipe is brought together. Steady pressure is maintained for about 3 minutes. After 3 minutes of cooling, the pipe is removed from the jig. A pulling head is welded to the front end of the polyethelene pipe that has been welded together and to be pulled into the pipe line. The pipe is relatively flexible and moveable. At the downstream end section of the sewer pipe to be lined, a winch is located over a manhole that pulls the liner pipe into the pipe being lined. A liner pipe is pulled into the pull hole and into the piping line. After the pipe has been inserted into the end of the pipe that is still above the ground, it is hammered with a sledge hammer to remove the pulling stresses. The liner pipe is then cut to the proper length and inserted into the manhole.

Lateral linear pipe can also be used in conjunction with the main line. A push hole is dug over the main line where a lateral is attached to the main. The liner pipe is pushed from the main toward the house. A tee for welding the lateral to the main line with a curved heating iron heats the tee and also heats the main line where the tee is to be welded. The heating iron is pressed against the main line and rocked back and forth. The tee is held on for a couple of minutes after which it is firmly welded to the main. A hole saw is inserted into the tee and a hole cut into the main line. The lateral is connected to the tee with a Caulder coupling.

The Napa Sanitation District has also used slip line for house laterals from the main back to the foundation of the house. The District reports that the cost over the last two years for performing this work is approximately $1000 for a typical 50-ft length of house lateral. Lining cost for the main line of 6 in. or 8 in. diameter pipe is approximately $12 to $18/ft. The District feels that slip lining produces a high quality and infiltration free installation as well as a low maintenance system.

A defective main line pipe can consist of any series of cracks, offsets, or deteriorated joints.

Service Lateral Repair Techniques

Repairing the service lateral by slip lining or by some other technique along with removal of other major sources from the private sector is now being recognized as a major requirement to achieving successful I/I reduction. In the past, efforts to reduce I/I concentrated on repairs of mains and manhole holes. This was largely unsuccessful in some cases because infiltration water that was prevented from leaking into the main now migrated to other leaking points in the system, usually the laterals and lateral connections. This phenomenon of ground water migration to non-remediated sources has been studied by the Washington Suburban Sanitary Commission in conjunction with FMN Environmental Consulting Engineers and the National Water Well Association. A paper was presented at the WPCF meeting in New Orleans, October 1984, that discussed the impacts of migration and a model to predict the migration effect. The model allows for implementation of a cost-effective methodology that will result in effective rehabilitation of the sanitary sewer system. In the future, rehabilitation of the system for infiltration control is definitely going to have to include service lateral repair, at least at the building lateral connection for successful results in infiltration reduction.

Another technique to repair the service lateral is to excavate and replace main line sections with PVC sections and wye, and couplings on the main line and the lateral. An alternative is new equipment capable of both testing and grouting lateral sewers that functions internally from the main line without the need for excavation or entry from surface points and private property. A new lateral sealing packer, cylindrically shaped and approximately 3-ft long, is sized to operate in an 8-in. diameter main line sewer pipe. A main line sewer camera is used to

require either replacing the manhole cover or adjusting the frame seal as well as raising the cover and frame to grade. Infiltration sources generally are repaired by grouting and relining the manhole from the corbel down through the bench, trough, and pipe seals. One of the most neglected or underrated inflow sources in the system is the deteriorated frame seal. The most common repair techniques include excavating the area down to the sound part of the manhole and removing the existing frame with adjusting rings. Two rings of butyl-joint sealant in rope form are then set down on top of the exposed wall with adjusting rings added as needed with the frame set 1/8-in. below and parallel to the surface to complete the repair. Further application of elastomeric sealant on the outside of the manhole frame seal area can increase the effectiveness of the repair. Repairing the frame seal with hydraulic cement and various joint sealant materials on the inside of the frame seal have met with some success.

Another method of sealing the frame seal is with the use of an internal boot which fits on the inside of the frame. The boot can be installed without excavating around the manhole after the frame is cleaned. Alternately, there is an external

TABLE 1
Suggested guide for sewer system rehabilitation methods.

I/I Source	*Flow Rate (gpm)*	*Rehabilitation Method*	*Estimated Construction Cost*	*Percent Effectiveness*
Manhole Defects				
Cracked Manhole Wall	0.1–0.3	Chisel Cracks/Cement/Epoxy, Pressure Grout	$300–500	70–90
Cracked Pipe Seals	0.1–0.3	Chisel Cracks/Cement/Epoxy, Pressure Grout	100–400	70–90
Cracked Bench/Trough	0.1–0.3	Chisel Cracks/Cement/Epoxy, Pressure Grout	300–400	70–90
Broken Bench	0.1–0.3	Replace Bench/Trough	700–1000	70–90
Ponding Manhole	1–10	Raise to Grade/Replace Cover	100–500	70–90
Pick Hole at Rim Seal	1–5	Replace Manhole Cover	60–120	80–95
Corbel Leak	0.5–1.5	Chisel Cracks/Cement/Epoxy, Grout Corbel	300–400	70–90
Cracked Frame Seal	0.5–1.5	Adjust Frame and Seal	300–400	70–90
Broken Frame	1.0–2.0	Replace Frame	250–450	100
Main Sewer Defects				
Cross Connections	5–25	Excavate and Repair	$3000–5000	70–95
Defective Pipe Section	1.5–3	Excavate and Replace	2000–5000	70–95
		Insituforming (for 300-ft line)	10 000–20 000	60–95
		Sliplining (for 300-ft line)	10 000–20 000	80–95
		Grouting (for 300-ft line)	1000–3000	50–70
Private Sector Sources				
Building Lateral Service	0.1–0.5	Replace Lateral Sewer	$2500–5000	70–90
Building Lateral Cleanout	0.5–1.0	Repair/Replace Cleanout	70–200	80–95
Building Lateral Wye Connection	0.1–0.5	Lateral Sealing with Packer	300–1000	50–90
Storm Sump to Sanitary Sewer	3–6	Disconnect and Repipe	300–600	100
Storm Sump with Diverter Valve	3–6	Remove Diverter Valve	100–300	100
Unsealed Sanitary Sump	0.5–1.0	Seal Sanitary Sump/Install Storm Sump	100–2000	100
Combination Sump	3–6	Repipe/Install Storm Sump	300–2000	100
Foundation Drain	3–6	Disconnect/Install Storm Sump	3000–5500	100
Downspout	15–20	Disconnect and Reroute	100–200	100
Driveway Drain	10–15	Excavate/Disconnect and Reroute	1500–4000	100
Window Well/Stairway Drain	0.5–1.0	Excavate/Disconnect and Reroute	1500–4000	100

position the packer at the lateral connection. Once the unit is in place, the end bladders are inflated and expanded against the main line pipe wall thereby isolating the lateral connection in the void area between them. A rotating center drum is then aligned with the connection. As air pressure is applied, an inflatable inversion tube extends from the center drum into the lateral connection. When the bladder and tubes are inflated, the service connection to the main is isolated from the remainder of the pipe permitting an air test to be performed in the void area to determine whether any leaks are present.

If connection joints or any portion of the section of the lateral tested by the unit are leaking, then the machine injects a chemical sealant that penetrates voids, cracks, fractures or other defects to form an impermeable soil grout curtain on the exterior of the pipe. After the sealing process is complete, it can be retested. The tube is retracted and the two end bladders are deflated. The lateral sealing packer is then pulled down the line to the next connection joint where the test process is repeated.

Other Private Sector Sources

Repairing only infiltration-type sources such as the building lateral leaking joints and defective building service lateral connections will not result in a satisfactory operating system unless attention is also given to direct inflow sources that inundate the system during rainfall. Not only are the infiltration sources critical but so are the private sector inflow sources. The weighted average from 20 recent studies indicates that approximately 63% of the inflow originates from the private sector. Many of the sources responsible for this inflow can often be detected by smoke testing. Defective service lateral and main connections detected by smoke testing need to be repaired by excavation, slip lining, grouting, or by use of the new lateral packer approach. Other direct sources that are also detected by smoke testing, such as downspouts, window wells, and driveway drains, need to be removed from the system either by direct disconnection, by repiping after excavation, or by installation of separate storm sumps.

Studies indicate that approximately 63% of the inflow originates from the private sector.

There are also various types of storm sumps that can directly discharge to the sanitary sewer. One of the most common is the combination sump pump. In this case, the sump discharges to the sanitary sewer and takes internal washtub water along with outside foundation drain water. To correct this condition, the combination sump must be separated. One technique that has been successfully used is to install a portable in-line drain pump below the washtub and pipe the discharge directly to the sanitary sewer, thus allowing the existing combination sump, after repiping to the outside of the building, to function as a properly discharging separate storm sump.

Conclusions

It is important that both public and private sector sources be identified, examined, and removed from the system. Experience by RJN Environmental indicates that 30 to 40% of the infiltration in the system can be effectively removed by implementing a program of the techniques discussed above while accounting for migration through an area or system wide approach. Furthermore, a comprehensive program will identify inflow sources in both the public and private sectors, and approximately 70% of the inflow can be effectively reduced and kept out of the system if an effective enforcement program is implemented. Although it will not be easy, it will be worthwhile as it becomes evident that I/I reduction must be achieved in most existing sanitary sewer systems.

Acknowledgments

Contribution of material and cooperation were provided from the following participants of the EPA Technology Transfer Seminars: Frank A. Wellstein, Milwaukee Metropolitan Sewerage District; Michael Burkhard, Washington Suburban Sanitary Commission; and, Dennis Scherzinger, Napa Sanitation District.

APPENDIX G

RECD. - RJN ENVIRONMENTAL ASSOC., INC. APR 09 1990

3M Construction Markets Department

3M Center
St. Paul, MN 55144-1000
612/733 1140

3M

April 5, 1990

Catherine C. Morley, P.E.
RJN ENVIRONMENTAL, INC.
202 W. Front St.
Wheaton, IL 60187

Ref: Great Lakes Naval Training Center

Dear Catherine:

This letter is to confirm our telephone conversation of April 4, 1990 regarding the longevity of 3M Scotch-Seal™ Chemical Grout 5610.

The Scotch-Seal™ 5610 Gel Grout functions well in an environment with a pH of 5 to 9. Deterioration will occur if the grout is exposed to acid or caustic conditions outside this range. Ultraviolet light will cause deterioration if the grout is exposed for long durations. The grout is resistant to biological attack.

Proper formulation and application of Scotch-Seal™ 5610 grout should prove to be an effective method of waterproofing manholes for a period of fifteen years. This longevity is based on the manhole remaining structurally sound and undisturbed.

Thank you for your continued interest in Scotch-Seal™ Chemical Grout. If I may be of any further assistance, do not hesitate to contact me.

Sincerely,

Dan Johnson/cma

Daniel C. Johnson
Senior Technical Engineer
3M CONSTRUCTION MARKETS DEPARTMENT
207-1W-08, 3M Center
St. Paul, MN 55144-1000
612-736-9234

Scotch-Seal
Chemical Grout Products

Chemical Resistance Data
Scotch-Seal™ Brand Chemical Grout 5610 (Gel)

The following table shows the effect of chemicals and solvents on Chemical Grout 5610 (Gel) samples. These environments represent different types of effluents found in typical industrial wastewater. The concentration in parentheses is probably many times more severe than that which exists in the waste stream.

Environment/Concentration in Water	Time (Weeks)	Appearance (Visual)
Acids		
Hydrochloric (2%)	26	Slight shrinkage
Acetic (2%)	26	No change
Sulfuric (2%)	26	No change
Bases		
Sodium Hydroxide (1%)	26	Swells
Potassium Hydroxide (1%)	26	Swells
Salts		
Sodium Chloride (saturated)	26	Moderate shrinkage
Ammonium Sulfate (2%)	26	Slight shrinkage
Potassium Chlorate (5%)	26	Slight shrinkage
Organic Solvents		
Ethylene Glycol (100%)	26	Slight shrinkage
Isopropanol (100%)	26	Slight swelling
Heptane (gasoline) (100%)	26	No change
Carbon Tetrachloride (100%)	26	No change
Methyl Ethyl Ketone (100%)	26	Slight shrinkage
Toluene (100%)	26	No change
Gas		
Hydrogen Sulfide (10%)	26	No change

All statements, technical information and recommendations contained herein are based on information and tests we believe to be reliable. The accuracy and completeness are not guaranteed.

98-0701-1787-8(86-5-.25)R

Litho in U.S.A.

Contractor Products/3M
Building 223-4N-06, 3M Center
St. Paul, Minnesota 55144-1000

3M

Scotch-Seal™ Brand

Chemical Grout 5610 (Gel)

3M

Product Specification **Dated:** October, 1983

PRODUCT DESCRIPTION

Scotch-Seal Brand Chemical Grout 5610 (Gel) is a solution of a polymer which cures upon reaction with water. During the chemical reaction, Scotch-Seal Brand Chemical Grout 5610 (Gel) remains hydrophilic; that is, it absorbs water plus holds it within a cured gel mass. Upon being cured, the resultant gel is resistant to infiltration of water.

Scotch-Seal Brand Chemical Grout 5610 (Gel) is used with other materials which are added to the "water-side". Properly compounded, the 5610 (Gel) resists shrinkage and degradation from the action of biological agents and most chemicals and solvents.

Note: Since this polymer is cured by water, contamination by water must be avoided. Important: The section regarding handling should be read and understood thoroughly prior to using this material.

PHYSICAL PROPERTIES -- UNCURED MATERIAL

Appearance: A blue liquid solution having a moderate viscosity and a sweet odor (ketone solvent).
Solids Content: 77-83% ASTM D-1010.
Viscosity: 600-1200 cps @ 70°F (21°C) ASTM D-1638.
Weight Per Gallon: 8.65 lbs./gallon (1.04 kg/l) ASTM D-1638.
Flash Point (SETA Flash): 16°F (-9°C) ASTM D-93.
Corrosiveness: Non-corrosive.
Toxicity: See handling instructions.
Storage Conditions: Store in cool, dry area where temperatures do not exceed 80°F (24°C) for prolonged periods.
Container Size: 5-gallon pail, closed head with 2" barrel flange and plastic plug.
Net Weight Per Container: 40 lbs./18.16 kg.
Shipping Classification: Flammable Liquid, NOS (Caulking Compound, NOI).

MIX RATIO

Scotch-Seal Brand Chemical Grout 5610 (Gel) is designed to cure with and absorb water into the reaction mass. The volume of water depends on the specific application and the strength desired. The following table give characteristics of the material at different Water:Chemical Grout 5610 (Gel) ratios where no other compounding ingredients are used [22°C (72°F) with de-ionized water].

Scotch-Seal Brand Chemical Grout 5610 (Gel) (by volume)	Results
1:1 to 4:1	Foam
5:1 to 15:1	Strong Gel

Adhesives, Coatings and Sealers Division/3M
3M Center
St. Paul, MN 55144

For most applications the Water:Chemical Grout 5610 (Gel) volume ratio is 5:1 to 15:1. The data in this specification sheet is based upon an 8:1 ratio. (The water used to react the product should be in the pH range of 5 to 9. Water outside of this pH range may affect the final properties of the system.)

COMPOUNDING

THE FORMULATIONS REFERENCED BELOW SHOULD BE USED ONLY AS GUIDELINES. The actual formulation used for a specific job MAY NOT include all of the compounding ingredients described.

Compounding of Scotch-Seal Brand Chemical Grout 5610 (Gel) is suggested to maximize the strength and minimize the shrinkage of the cured gel.

Although the formulations for Scotch-Seal Brand Chemical Grout 5610 (Gel) included herein involve an 8:1 ratio of compounded material, higher ratios can be used for soil stabilization. In many applications compounding with other materials may not be necessary.

FORMULATION RANGE

The following is a suggested formulation range for the "water-side" of the Scotch-Seal Brand Chemical Grout 5610 (Gel) System for a 50-gallon tank.+

	VOLUME	APPROXIMATE WEIGHT
Component 1:Water	40 - 45 gallons	333 - 375 lbs.
Component 2:Shrink Control 5612*	10 - 5 gallons	80 - 40 lbs.
Component 3:Celite 292**		50 lbs.

[The total volume of water plus Scotch-Seal Brand Shrink Control Agent 5612* should equal 50 gallons or approximately 415 lbs.]

+The 8:1 ratio is given herein for information purposes only. It is not necessarily the ratio to use in specific applications.
*Scotch-Seal Brand Shrink Control Agent 5612 (see separate specification sheet).
**Celite(R) is a product of Johns Manville.

Procedure: First, water is added to the tank. Then, Scotch-Seal Brand Shrink Control Agent 5612* is added and mixed thoroughly. This is followed by the addition of an optional filler, Celite(R) 292**. The mixture containing filler is continuously agitated.

Use: Under use conditions, 8-10 gallons of this mixture react with each gallon of Scotch-Seal Chemical Grout 5610 (Gel) at the point of mixing.

PHYSICAL PROPERTIES -- CURED MATERIAL

Properties of two formulations compounded at the extremes of the recommended 5610/5612* formulation range are as follows:

Formulation A:	Formulation B:
40 gallons	45 gallons water
10 gallons 5612*	5 gallons 5612*
50 lbs. Celite(R) 292** (Optional)	50 lbs. Celite(R) 292** (Optional)
Specific Gravity: 1.03	Specific Gravity: 1.03
Viscosity: 60 ± 5 cps	Viscosity: 55 ± 5 cps
(Brookfield RVT Spindle #1 @ 100 RPM)	(Brookfield RVT Sp. #1 @ 100 RPM)
Appearance: Milky tan dispersion	Appearance: Milky tan dispersion
pH: 6.5 - 7.5	pH: 6.8 - 7.5

Gel Time: Reaction of 8 gallons of Formulation A with one gallon of Scotch-Seal Brand Chemical Grout 5610 (Gel) produces the following gel times:

Gel Time @ 86°F (30°C) = 35 ± 5 seconds
Gel Time @ 72°F (22°C) = 40 ± 5 seconds
Gel Time @ 53°F (12°C) = 55 ± 5 seconds

Wet Tensile Strength: 25-45 psi (Instron Die C @ 2"/Minute). ASTM D-1564
Elongation: 200-300% (wet). ASTM D-1564
Shrinkage: 5% maximum [72°F (22°C) 1 week 50-60% R.H.].
Resistance to Chemicals: Resistant to most organic solvents, mild acids and alkali.
Toxicity: Essentially non-toxic in cured form.

Gel Time: Reaction of 8 gallons of Formulation B with one gallon of Scotch-Seal Brand Chemical Grout 5610 (Gel) produces the following gel times:

Gel Time @ 86°F (30°C) = 30 ± 5 seconds
Gel Time @ 72°F (22°C) = 40 ± 5 seconds
Gel Time @ 53°F (12°C) = 55 ± 5 seconds

Wet Tensile Strength: 20-30 psi (Instron Die C @ 2"/Minute). ASTM D-1564
Elongation: 200 ± 50% (wet). ASTM D-1564
Shrinkage: 8% maximum [72°F (22°C) 1 week 50-60% R.H.]. ASTM D-1042
Resistanct to Chemicals: Resistant to most organic solvents, mild acids and alkali.
Toxicity: Essentially non-toxic in cured form.

TESTS

The compounded materials have been subjected to several tests. Shrinkage, re-swelling, and compression test results for Formulations A & B follow. Solvent and chemical resistance test results are available upon request.

Shrinkage Conditions:
Shrinkage conditions were: 72°F (22°C) -- 1 week 100% R.H. -- Wet Condition
72°F (22°C) -- 1 week 50-60% R.H. -- Average Condition
(Oven) 130°F (55°C) -- 1 week 10% R.H. -- Dry Condition

	WET CONDITION	AVERAGE CONDITION	DRY (OVEN) CONDITION
Formulation A	0% Shrinkage	5% Shrinkage	15% Shrinkage
Formulation B	0% Shrinkage	8% Shrinkage	25% Shrinkage

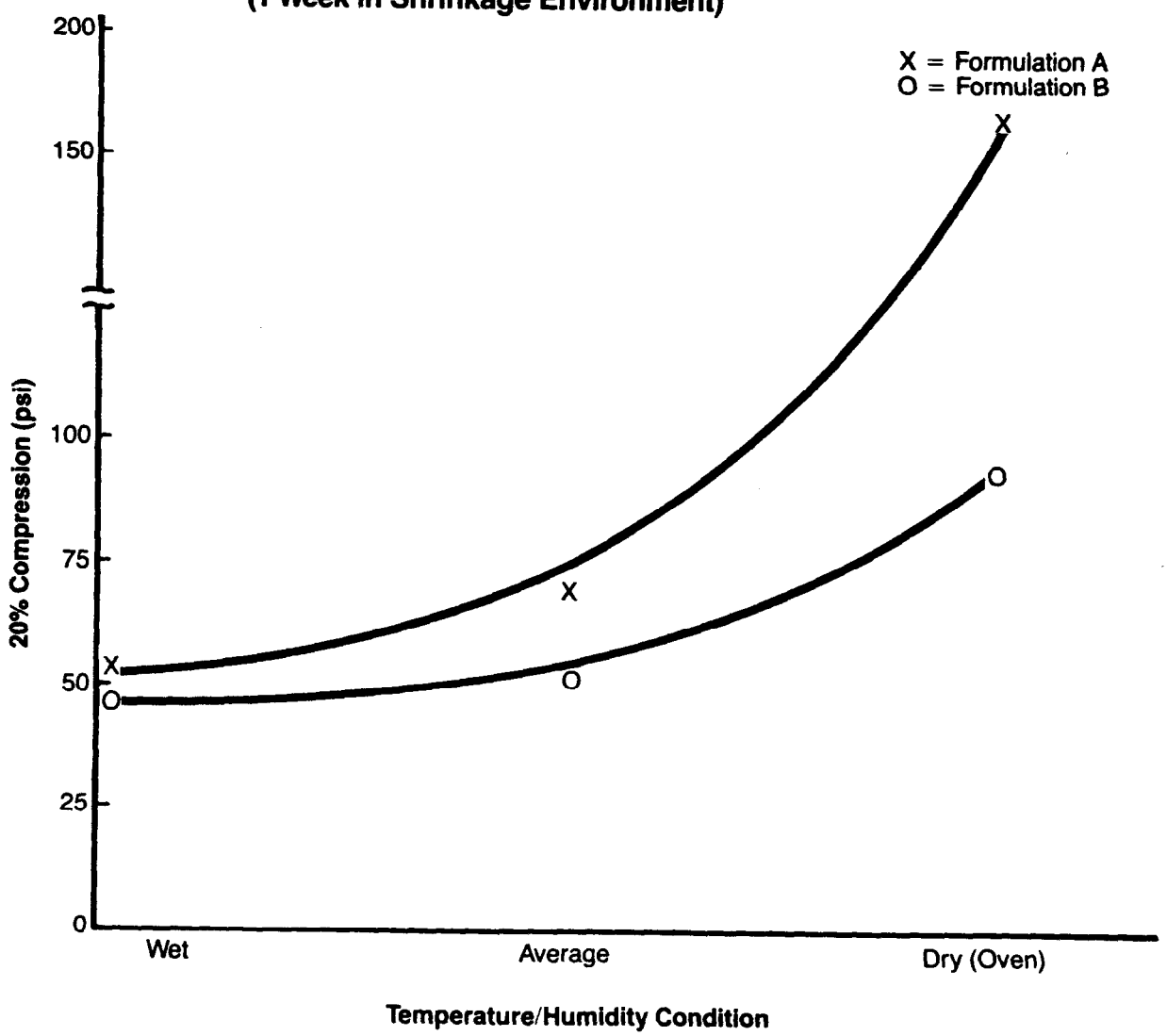
Re-swelling: After shrinkage, the samples with maximum shrinkage obtained through oven conditions were placed into a 100% R.H. environment.

FORMULATION A: Recovered to 98% of original volume after 1 week @ 100% R.H. Recovered to 100% of original volume after 2 weeks.

FORMULATION B: Recovered to 100% of original volume after 1 week @ 100% R.H.

Compression (ASTM D-1056 - modified): Figure 1 gives values of 20% compression strength based on the environments used in the shrinkage tests.

Figure 1: Compression Strength of Formulations A and B (1 Week in Shrinkage Environment)



INSTRUCTIONS FOR USE (SOIL STABLIZATION)

Scotch-Seal Brand Chemical Grout 5610 (Gel) can function as a soil stablizer. Generally, applications such as concrete joint rehabilition and subterranean void filling involve some soil stabilization. In certain applications where soil stabilization is the major need, Chemical Grout 5610 (Gel) can also achieve longer gel times by control of water temperature and mixed grout concentrations. The following graphs give details on the controlling variables related to extended gel times.

Figure 2:
Effect of 5610:
Water Ratio on Gel Time Using Scotch-Seal Extender 5621

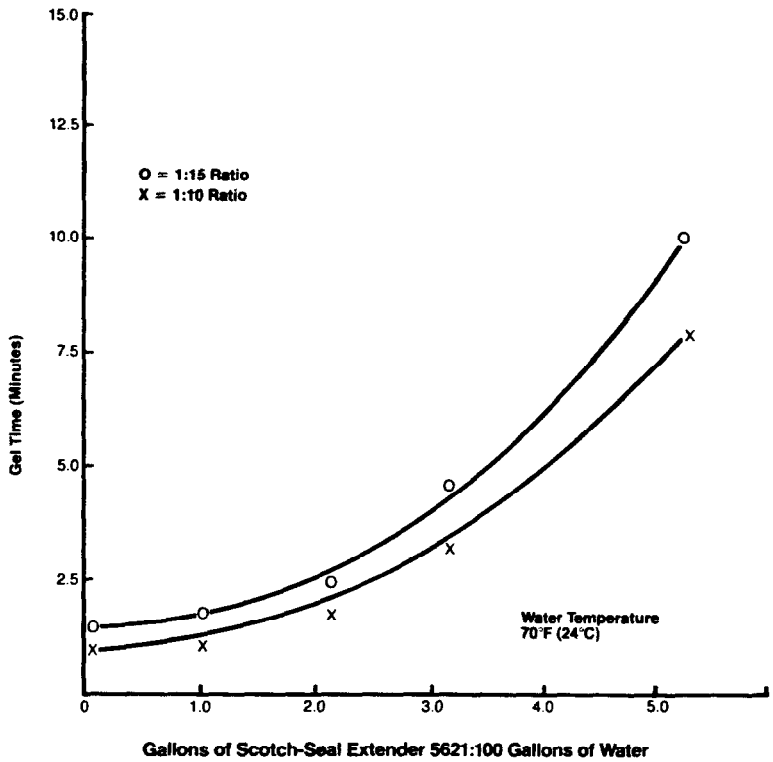


Figure 3:
Effect of Water Temperature on the Gel Time of Scotch-Seal Chemical Grout 5610 Using Scotch-Seal Extender 5621 on the Water Side

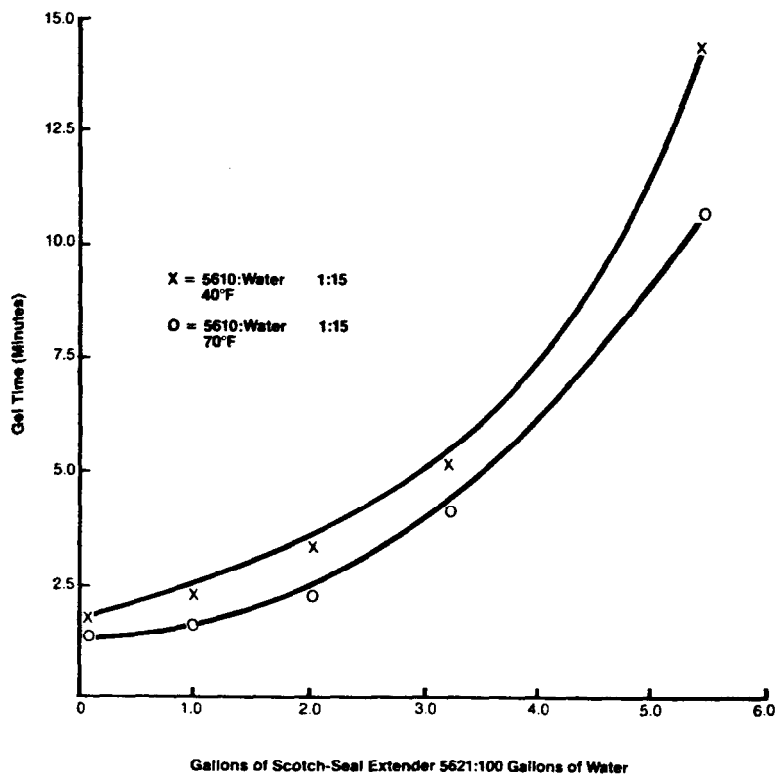


Figure 4:
Viscosity Build of 15:1
Water: 5610 Blend

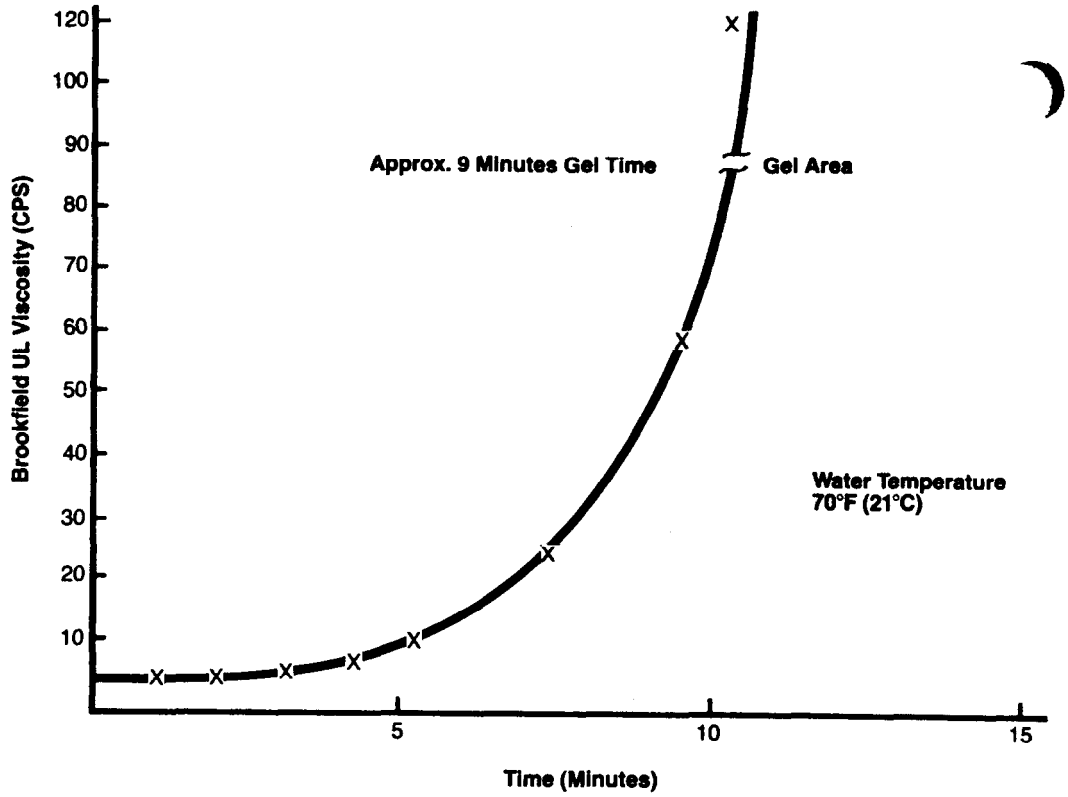
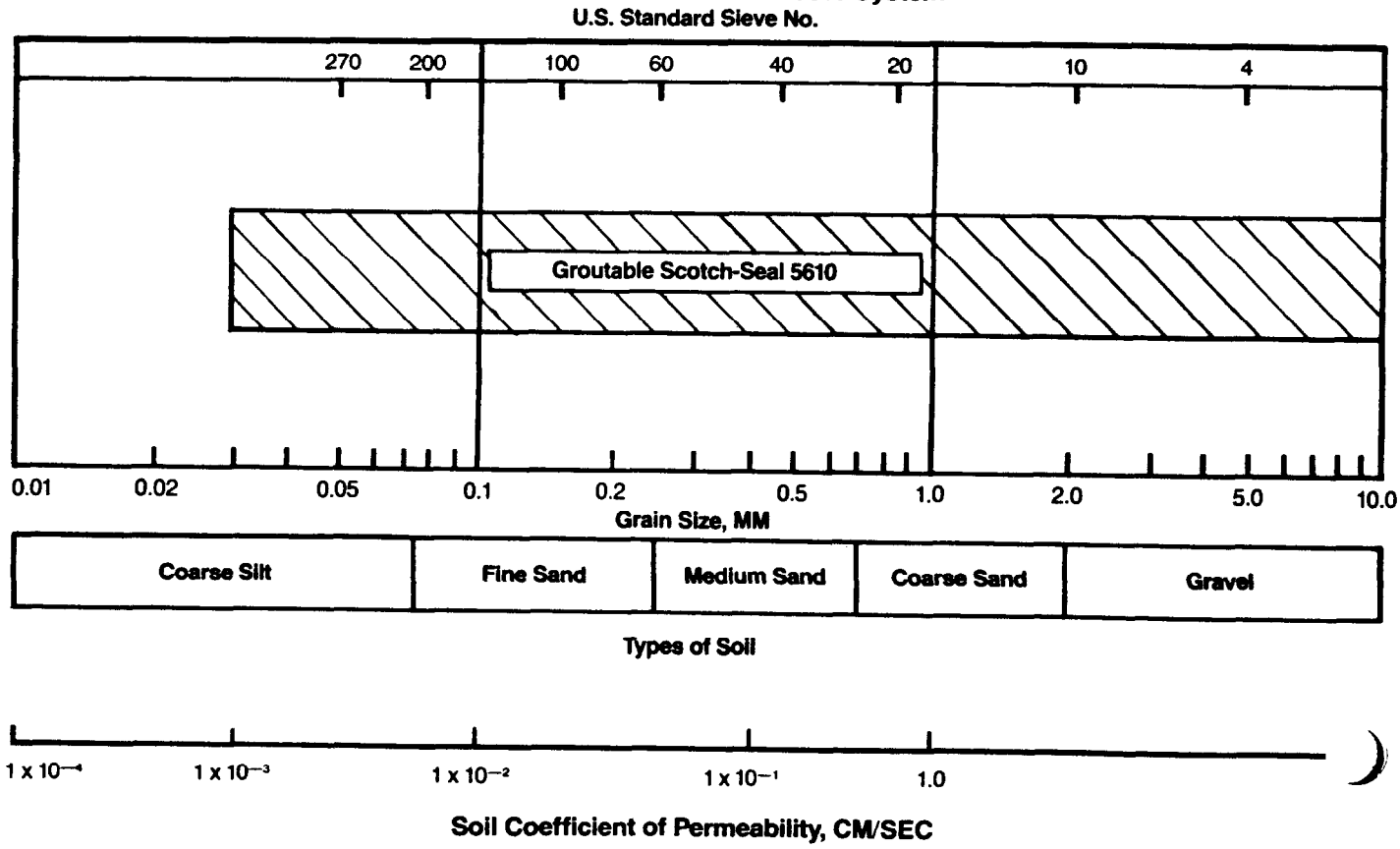


Figure 5:
Types of Soil Groutable with the
Scotch-Seal Chemical Grout 5610 System



STORAGE AND HANDLING

Care must be taken in the storage and handling of Scotch-Seal Brand Chemical Grout 5610 (Gel). The material is sensitive to moisture and moderately sensitive to high storage temperature. Optimum storage is 40-60°F under fairly dry conditions. Storage temperature should not exceed 80°F. Properly stored, the material should have a useful life of one year. Once a container has been opened, the useful life of the material is greatly reduced and therefore it should be used as quickly as possible and not be resealed for later use.

Scotch-Seal Brand Chemical Grout 5610 (Gel) will have limited stability in application equipment, e.g. pumps, hoses, etc. -- and should not be allowed to stand in the equipment for more than 60 hours. The possibility of moisture-contamination is high. Hoses, check valves and other equipment used to apply the grout should be designed to have low moisture permeability. The hose equipment should be flushed thoroughly with acetone* as soon as practically possible after use. Cleaning of equipment surfaces having some gelled product is accomplished by acetone* soaking.

*NOTE: Although acetone is preferred, MEK may be used. When using solvent for cleanup, extinguish all sources of ignition in the area and observe proper precautionary measures for handling such materials.

Scotch-Seal Brand Chemical Grout 5610 (Gel) contains a flammable solvent (acetone); therefore, precautions should be taken to avoid conditions which would cause ignition, e.g. open flames, cigarettes, sparks, etc. Scotch-Seal Chemical Grout 5610 (Gel) is designed to be pumped directly from its shipping container, reducing any physical contact. Once the material has been mixed with water the resulting liquid material itself is non-flammable, but confined vapors may still be flammable. The diluted material has been found to be compatible with conventional commercial chemical grouting equipment.

PRODUCT SAFETY

DANGER. EXTREMELY FLAMMABLE. VAPOR HARMFUL. MAY CAUSE RESPIRATORY IRRITATION AND SENSITIZATION. LIQUID CAUSES EYE IRRITATION. MAY CAUSE SKIN IRRITATION.

The vapors released by this product can easily be ignited and may burn explosively.

Contains toluene diisocyanate (TDI) and acetone.

PRECAUTIONS:
Keep product and its vapors away from heat, sparks and open flames. Do not breathe vapors. Use only in areas adequately ventilated with enough air movement to remove vapors and prevent atmospheric concentrations of isocyanates from exceeding current threshold limit values. Until such ventilation can be made available, wear an approved respirator rated for isocyanate vapors. Avoid contact with eyes and skin. Keep container closed when not in use. Keep out of reach of children.

SUGGESTED FIRST AID:
Respiratory Difficulty: Provide fresh air and call a physician.
Eye Contact: Immediately flush eyes with plenty of water for at least 10 minutes and call a physician.
Skin Contact: Wash thoroughly with soap and water.

GROUTING SPECIFICATION

The grouting compound shall be a hydrophilic polymer which cures to a gel. The uncured material shall be a blue-colored, translucent liquid in the 600-1200 cps range, containing non-volatile materials constituting approximately 80% of its total weight.

When Formulation A or B are prepared with Scotch-Seal Brand Chemical Grout 5610 (Gel), Scotch-Seal Brand Shrink Control Agent 5612 and suggested fillers, the material will gel and cure to a tough, flexible elastomeric condition. When wet, the gel shall exhibit strength properties of at least 25 psi tensile and 150% elongation. The material shall not change in linear dimension more than 25% when subjected to wet and dry cycles. Handling and use of the gel compound may be hazardous under certain conditions and caution shall be exercised in accordance with the recommendations of the manufacturer.

INSTRUCTIONS FOR USE

Scotch-Seal Brand Chemical Grout 5610 (Gel) is intended for use by Scotch-Seal Chemical Grout product applicators having the proper equipment as determined by the user for the specific application. Grouting equipment designed for the application of this material is available. Additional information is available in a brochure entitled, "Equipment and Techniques For Using Scotch-Seal Chemical Grouts". Several techniques have been used for applying Chemical Grout 5610 (Gel) in leaking areas. Some include the use of supporting materials such as dried hemp rope or non-oily hemp rope.

IMPORTANT NOTICE TO PURCHASER

Our recommendations for use of this product are based upon tests believed to be reliable. Since field conditions vary widely, the user must determine the suitability of the product for his particular use and specific method(s) of application.

The following is made in lieu of all warranties, express or implied: Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising out of the use or the inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and user assumes all risk and liability whatsoever in connection therewith.

The foregoing may not be altered except by an agreement signed by the officers of seller and manufacturer.

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St. Paul, Minnesota
612/733-2914

Z-CG5610

Litho in U.S.A.

Adhesives, Coatings and Sealers Division/3M
3M Center
St. Paul, Minnesota 55144
612/733 1140

Scotch-Seal™ Brand

Gel Reinforcing Agent 5612

3M

Product Specification **Dated: January, 1985**

PRODUCT DESCRIPTION

Scotch-Seal Brand Gel Reinforcing Agent 5612 is a water-based emulsion used with Scotch-Seal Brand Chemical Grout 5610 (Gel). It reduces shrinkage and improves the strength of the gel. It is compatible with a wide variety of compounding additives and has good mechnaical stability. Scotch-Seal Brand Gel Reinforcing Agent 5612 provides the cured material with improved hydrostatic pressure resistance, better low temperature flexibility and enhanced resistance to solvents and chemicals. It does not contain any organic solvents.

PHYSICAL PROPERTIES

Appearance: Milky white liquid
Solids Content: 49% minimum ASTM D-1010
pH: 7.5 - 8.5, 8.0 average
Viscosity: 120 cps @ 77°F (25°C) ASTM D-1638
Density: 8.5 lbs./gal. (1.02 Kg/1) ASTM D-1564W
Solvent: Water

INSTRUCTIONS FOR USE

Typical formulation for use of Scotch-Seal Brand Gel Reinforcing Agent 5612 is given in the "Compounding" section of the Scotch-Seal Brand Chemical Grout 5610 (Gel) Specification Sheet.

Care must be taken to be sure that the pH of the water in the tank is from 5 to 9. As a precaution against the possibility of the pH being outside this range, take a small amount of water from the tank to which Gel Reinforcing Agent 5612 is to be added. Add a few drops of 5612 to this test sample. Scotch-Seal Brand Gel Reinforcing Agent 5612 should disperse readily. If precipitation occurs, drain the tank and retest. Repeat as necessary until dispersion occurs. If dispersion does not occur, do not use Scotch-Seal Brand Gel Reinforcing Agent 5612.

STORAGE AND HANDLING

Scotch-Seal Brand Gel Reinforcing Agent 5612 MUST BE PROTECTED FROM FREEZING as indicated on the product container. Freezing may cause irreversible precipitation. The presence of lumps or non-homogeneity in the container indicates that freezing may have occurred. Do not use any 5612 containing lumps.

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St. Paul, MN 55144

Formulated Gel Reinforcing Agent 5612 should not be allowed to stand in application equipment, e.g. hoses, for extended periods of time, but rather should be purged as soon as practically possible after use. All equipment in contact with this material is easily cleaned with water. Scotch-Seal Brand Gel Reinforcing Agent 5612 is an aqueous, non-flammable material and is shipped as a non-hazardous material.

PRODUCT SAFETY

CAUTION. LIQUID MAY CAUSE SKIN IRRITATION.

PRECAUTIONS:
Avoid skin contact. KEEP OUT OF REACH OF CHILDREN.

SUGGESTED FIRST AID:
Skin Contact: Wash with soap and water.

IMPORTANT NOTICE TO PURCHASER

Our recommendations for use of this product are based upon tests believed to be reliable. Since field conditions vary widely, the user must determine the suitability of the product for his particular use and specific method(s) of application.

The following is made in lieu of all warranties, express or implied: Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct or consequential, arising out of the use or the inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and user assumes all risk and liability whatsoever in connection therewith.

The foregoing may not be altered except by an agreement signed by the officers of the seller and manufacturer.

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AVANTI INTERNATIONAL
16920 TEXAS AVENUE, SUITE C-7, WEBSTER, TEXAS 77598 - (713) 554-7541 TLX 287611

April 5, 1990

Catherine Morley, P.E.
R.J.N. ENVIRONMENTAL ASSOC. INC.
202 W. Front St.
Wheaton, IL 60187

RE: Longivity of Acrylamide Chemical Grout with regard to the underground water table study: U.S.N.T.C., Great Lakes, IL

Dear Ms. Morley:

We include with this letter, data pertaining to the longivity of Acrylamide Chemical Grout.

I understand the Washington steam tunnel job is on hold; but should you require further information on this project, Mr. Jack Pennel of Team, Inc. (phone # 713-331-6154) will be glad to help.

Thank you for your consideration of our products.

Very truly yours,

AVANTI INTERNATIONAL

William O'Donnell
Chemical Sealing Manager

WO/jn

NASSCO
Reports on the Longevity and Effectiveness of Chemical Grouting of Sewers & Manholes

The members of NASSCO want you to know that chemical grouting is an effective process for stopping groundwater infiltration into sewer collection systems. Chemical grouting is not a structural repair. Chemical grout stabilizes the soil and forms an impermeable mass outside of leaking pipe joints and manhole walls . . . thereby stopping infiltration, or exfiltration.

This brochure is intended to document that chemical grouting is effective and long lasting. The case studies contained herein have been taken from numerous engineering and municipal publications.

Hollywood, FL

The city began using acrylamide grout about 1960. Articles were published about several dig-ups in Hollywood which showed the acrylamide grout to be intact and effective after 13 years.

In 1981, urethane gel was used to grout the city's sewer lines. The joints were retested in 1982. In 1985, several joints were dug up and inspected by the EPA. The city affirmed there were no problems with the grout's effectiveness as of September, 1987.

Fairfax County, VA

Paul Huston reported in 1984 that the county has used acrylamide grout in sewers and manholes for the previous twelve years. They have been successful in stopping leaks. A line grouted in 1972 was retested in 1983 and found to be effectively sealed.

Bradenton, FL

Every joint in 75,000 feet of sanitary sewer (8-inch to 27-inch) was tested & sealed in February, 1986. The sealing was done by IPM, Inc. and GS&L Contractors using acrylamide grout. Ten manhole sections with GK joints averaging 2½ feet were retested 28 months later by IPM. Ernie Beadle of Smith & Gillespie Engineers supervised the retesting program. Of the joints which had been sealed, 98% passed the retest.

El Lago, TX

Frank Adams reported in 1985 on the sealing of a 42" storm sewer by Naylor Industries in 1977. Urethane foam grout had been used successfully to seal the joints and stop the cave-ins of streets and sidewalks above the storm sewer.

Gresham, OR

Roy Perkins and John Garrett reported on their success using acrylamide grout to seal manholes. Reduced flows in the first year saved $30,000 in treatment costs . . . with about $3,000 cost of grout.

Fort Myers, FL

In 1983, L.D. Smith reported on the excavation of a deep 21" sewer that had been grouted with acrylamide in 1961. The sealed joints were "in perfect shape" after more than 20 years.

Albany, GA

In 1984, Billy Daniel reported on the successful use of urethane gel grout to seal brick and concrete manholes in high groundwater areas of the city. Leaks of 2-100 gpm had been stopped. Grouting saved replacement of manholes and reduced flows at the treatment plant.

Paxton, IL

In 1981, a sewer rehabilitation project provided for sealing of sewer joints with acrylamide and sealing manhole frames with urethane foam grout. In 1984, James Lynch reported that the city is pleased with the work. He recommends grouting.

Casselberry, FL

Bill Thompson, Altair Maintenance Services, reported in 1984 that his team used acrylamide grout in sewers for this city during the summer of 1982. In the fall of 1983, approximately 1000 joints were retested under warranty. Every joint passed the test, and no regrouting was required.

Ontario, Canada

David Robichaud, Underwater Tel-Eye, reports in 1988 that UTE has never had to regrout a sewer joint due to grout failure. UTE has used chemical grout for over 15 years and they use grout concentrations exceeding the standard recommendations. This major Canadian contractor has utmost confidence in its ability to permanently seal sewer pipe joints.

Cape Coral, FL

In 1985, Bill Geertse reported on the success of a 3-year manhole rehabilitation program. Using acrylamide grout (and polyethylene linings for structural repairs), the city reduced flows at the treatment plant by 1,000,000 gpd.

Little Rock, AR

Large-diameter pipe grouting with urethane foam in 1973 was confirmed to be effective in 1987. The 60-inch sanitary sewers under the Municipal Airport were built in the 1930's and about 1900 joints had remained sealed.

Washington Suburban Sanitary Commission, MD

Mike Burkhard reported in 1984 that the WSSC collection system contained acrylamide-grouted joints that were still effective as long as 17 years after they were sealed.

Cocoa, FL

In 1985, Carl Dunn of C&L Waterproofing reported on their use of acrylamide and urethane foam grouts to seal manholes and lift stations. Citing reduced infiltration of groundwater and soil into the system, reduced pumping costs, and elimination of street settlement; Mr. Dunn suggested contacting Mr. Larrabee with the city for further information.

Tipton, IA

In 1984, Robert Snaveley reported on the success of a contract sewer grouting program in place there since the 1970's. Acrylamide and urethane grouts have been used in both sewers and manholes. Decreased flows in the collection system are apparent.

Oswald Sewer Service, NJ

John Oswald reported in 1984 that he was confident in sealing sewer joints with acrylamide grout, that he would regrout a joint free if it ever failed, and that he had never had to regrout a joint sealed by his company.

St. Louis, MO

In 1984, Bill Skinner reported on the sealing of 14 pipe-to-manhole seals in 7 manholes. Twelve gallons of urethane foam grout was used. Exfiltration tests showed no leaks after several hours with water to the top of each manhole.

North Lauderdale, FL

Grouting with acrylamide in sewers and manholes has reduced electricity at pump stations and treatment plants. Ed Goebel, Director of Public Works, reported in 1984 that he knows the grouting work done by Shenandoah General Construction Co. has been effective.

Washington Suburban Sanitary Commission, MD

In 1984, Frank Skillman reported that WSSC call-backs on manholes grouted by Tri-States Grouting averaged 1.2%.

Austin, TX

Floyd Henry reported in 1985 that the collection system contained acrylamide-grouted joints that were still effective after 17 years. An 8" and 12" sewer line on Greenlawn Parkway was TV inspected and tested in 1984. The retest confirmed the joints had no leaks and the acrylamide gel was still effective.

Neenah, WI

John Wilke, City Engineer, reported in 1984 on a grouting contract with urethane gel and diatomaceous earth in 1982. None of the grouted joints had leaked.

Lakeland, FL

Grouting of sanitary sewer joints in 1982 with urethane gel grout has reduced flows by 1,000,000 gpd and permitted an additional 3,700 service connections. Effectiveness confirmed in 1987.

Donnelly, Conklin, Phipps & Buzzell Report

In 1981, Gerald Conklin published an article on the EPA study conducted on 18 cities with sewer rehab projects done in the 1970's. The cities were all over the United States. The article reported that TV inspection revealed that chemical grouting was generally successful in sealing out groundwater. The remaining infiltration/inflow was from sources other than the grouted joints.

Minneapolis, MN

Manholes grouted in 1980 with urethane foam grout and oakum, plus urethane gel grout, successfully sealed and effective through 1987.

Hollywood, FL

Manhole grouting done in 1981 with urethane gel grout on brick manholes, some near 25 years old, reported to be effective in 1987.

Plaquemine, LA

Grouting of 48" to 72" storm sewers in 1975 was reported to be effective in 1987. Urethane foam grout was used with a large-diameter packer. Approximately 650 joints were sealed, eliminating surface subsidence.

Orlando, FL

Greiner Engineering Services presented a paper in 1985 on a project involving grouting of 36" to 48" storm sewers under runways at the International Airport. Urethane foam and acrylamide grouts were used to seal the joints; cement was used to fill voids under the runways. The project was several years old at the time and long-term success was predicted.

Oakdale, MN

Cost-effective repair reported in 1987. Manhole repaired with urethane foam and oakum, plus urethane gel in 1980.

New Orleans, LA

In 1980, a deep manhole below the groundwater table was successfully sealed with urethane foam and urethane gel grouts. Effectiveness confirmed in August, 1987.

Cocoa Beach, FL

Chuck Billias reported in 1984 on a 2-year grouting program conducted about 1975. Flows at the treatment plant were reduced by 800,000 gpd, and reduced flows are still being experienced -- nine years later.

Lake Charles, LA

1972 grouting of 60-inch storm sewer in "gumbo mud" soil declared effective in 1987. Sealing this storm sewer eliminated street cave-ins.

Jacksonville Beach, FL

Tests of joints grouted in 1965 showed acrylamide gel to be intact and preventing infiltration. Altair Maintenance Services reported in 1984 of the retest. These sewers were shallow and subject to saltwater and fluctuating groundwater level. After 19 years, the grouted joints were still effectively sealed.

* * *

The information contained herein has been taken from published studies and written reports. NASSCO members hope that you have a better understanding of the longevity and effectiveness of chemical grouting... when done correctly.

Compliments of

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Longevity and CHEMICAL GROUTS

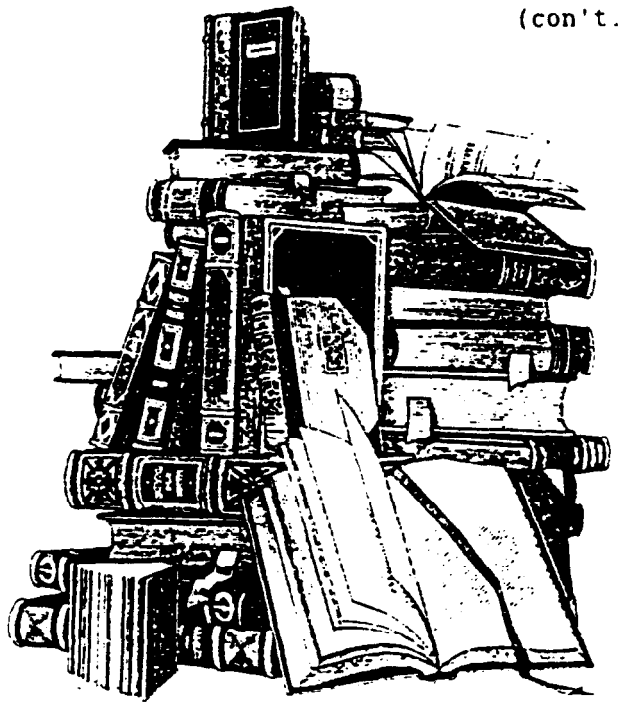
A recorded history of the use of chemical grouts in sewer and manhole repairs and sealing goes back something over two, maybe three decades. Documented placement and testing of grouts for about twenty years gives a good indication of the longevity and durability of various kinds of chemical grouts. Most appear to be capable of equaling or surpassing the life of the sewers they are designed to seal and protect. This publication discusses the sealing and repair of two seperate sewers, utilizing injected chemical grouts, and a controlled test of chemical grout gel stability. With the passing of time, more and more evidence is uncovered (no pun intended) that chemical grouts are durable, stable and boast a very long life when placed correctly.

There is an old expression, "Out of sight, out of mind!" In our society, sewers and sewer systems are certainly, for the most part, out of our sight. But for those in the business of maintaining those same sewer systems, they must never be completely out of mind. As a matter of fact, sometimes the systems become a nightmare when asked to process more infiltrated water than actual sewage. Water from where? The obvious answer, of course, is that it finds its way into the system through cracks, flaws and joints in the sewer system that were not meant to be open to flow. But, as is common knowledge, the water does flow and it does create problems.

One of the best methods of containing this infiltration is a technique referred to as chemical grouting. There are several types of chemical grouts and each is very effective. Different grouts exist, of course, for various applications and environments. But, as a whole, after the grouts are placed, water infiltration is contained or completely stopped for very long periods of time. But "long periods of time" is an indefinite expression and could mean anything to anyone. It could mean six days while a section of line is being replaced or it could mean six years while the city government is deciding when to replace a complete sewer system. Something much more definite, something more explicit, would certainly be more appropriate to describe the longevity of a typical grout application in terms that would interest those paying the bills as well as those involved in the rehabilitation work.

Problem is, not a lot of durability, or longevity, testing of placed grout has been attempted. After the grouts have are in and containing the water flow, there is usually no reason to bother the system further. In most cases, very few instances have been recorded of grout failure. Even with this enviable history of success, there are a few instances on record of tests to determine the durability of chemical grout. A typical test of a successful grout placement has been recorded by the community of Hollywood, Florida. To determine how permanent chemical grout repairs that have been made on leaking sewer systems in an effort to stop infiltration of ground water, a decision was made to excavate a section of sewer that had been treated.

(con't.)



....a very brief history

In a typical grouting application, leaks or other faults are located by a remote TV camera that is pulled or pushed through the suspected sewer pipe. Any opening that appears to be leaking is then repaired by injecting a chemical grout into and around the leak and the surrounding soil. Normally injected as a liquid of very low viscosity, the grout turns into a solid product to effectively seal the leak.

Then what? Does the placed grout begin to deteriorate immediately? Or after some period of time? Is it affected by we t conditions? Dry conditions? How about alternating wet and dry cycles? Is there a chemical reaction with the components of the soil? Is there a chemical reaction with the sewage?

CASE HISTORY #1

In Hollywood, Florida, an extensive effort was undertaken to find out some answers to these and other questions concerning grout longevity. Here are the results of this effort:

Even before the planned evacuation of the area to evaluate various grouted joints began, there existed a pretty good basis for judging the performance of the placed grout was available. The acrylamide-based grout had been used since 1960 and, in an informal survey, no member of the municipal department involved with its use could remember any defect attributable to grout failure. Additionally, on several occasions, work crews had uncovered grouted segments of sewer lines while digging in their vicinity and no faults were noted.

Since Hollywood is a community that has invested large sums of money in sewer maintenance and rehabilitation, and no formal, documented excavation results were available, the city maintenance department decided that it would be worthwhile to uncover a grouted joint that had been exposed to severe, but typical, conditions for many years, take samples of grout and then return the pipe to service.

For the test, an 8-inch transverse main was chosen that had been grouted about six years before the excavation and examination. Located in a section of the city where the sandy soil is subjected to occasional salt water intrusion as well as periodic fresh water flooding during the wet season and prolonged dry spells at other times. The particular line for the test carried primarily household sewage but with some industrial waste and was located in an alley area heavily trafficked by maintenance trucks, sanitatin trucks and other vehicles. Since the pipe was shallow and the pavement overhead was only a thin layer of asphalt, vibration and shock on the pipe was heavier than average. In short, if any grouted joint was going to fail or be damaged, this line was a logical candidate.

The decision had been made to excavate and discover just how effective the chemical grouting was. A trench was carefully dug around the joint, with an effort being made to make certain that the ring of grouted soil around the joint was not distrubed. The joint was exposed and thoroughly inspected.

A careful inspection of the gel revealed no signs of physical deterioration. Although the chemically grouted soil was above the water table, there were no signs of grout desiccation. Nor were there any indications of liquid flow into or out of the pipe. Inspection cuts were carefully made into the gel ring and it was found to be a solid matrix of sand and gel, all the way to the outside of the pipe.

Slicing deeper into the grouted joint, where an aperture had once admitted approximately 10 gallons of water per minute, the gel was found to be firmly in contact with the surface of the pipe, apparently unaffected by layers of accumulated soil on the pipe surface before the grout was applied.

Before the excavated section was returned to service, samples of the gel were tagged and packaged for later evaluation. Several samples were forwarded to the manufacturer of the grout and their laboratory could find no signs of appreciable shrinkage or chemical degradation. Same findings were noted by the municipal department of Hollywood, Florida. In summation, it can be stated that no notable change or deterioration of the chemical grout was discovered in some six years of placement. Additonally, no infiltration of ground water was noted after each of several periodic TV inspections of the grouted joints.

In short, the Hollywood municipal council received reports that grouted joints, past and future, appear to have a very long term life expectancy, perhaps as long as the sewer remains in service. As a result, suitable appropriations for further grouting have continued.

(con't.)

Basically, the grouts that are sold by Avanti should perform their intended functions for a considerable length of time, as long as twenty years or more. The design of the project, the proper application of the materials and other influences can all have an effect on the ultimate life. Research has shown the grouts to be resistant to most chemicals found in sewers and all are unaffected by the sewer environment. Animals and insects found in sewers and adjacent soils have little appetite for the materials. Additionally, they are chemically inert (stable) after placement. There are no known reasons to expect chemical grouts to fail in their intended applications and purposes.

CASE HISTORY #2

In 1960, Florida Water and Utilities, Inc., Cutler Ridge, Florida, requested a private contractor to inspect several manhole sections of a sanitary sewer collection system with closed circuit television. The inspection revealed several areas of serious soil and water infiltration. The several areas of infiltration were repaired by injection of an acrylamide grout. The solution was proportionately pumped through a closed hydraulic system created by a packer-rejointer positioned on the line. Pressure built up in this hydraulic system forced the grout solution out through the leaking areas. The grout subsequently set up in the joints and surrounding soil areas to successfully seal off the leaks.

All the work on the Florida system was performed in very shallow lines at a time when the ground water table was unusually high. For an unseasonably length of time after the work was completed, little rainfall was recorded and, for some time, the lines in which repairs were made were above the ground water table. There was concern that the gelled grout may have completely dehydrated and pulled or fallen away from the pipe. Even though the concensus was that the gel would swell when atain completely saturated with water, there was also concern that the re-swelling wuld not occur fast enough to prevent leakage. For this reason, the Florida utilities people and the contractor mutually agreed to remove the soil cover by excavation so that the gel formations could be visually inspected.

Various representatives from Florida utilities and the contractor met at the inspectin site. A small hydraulic backhoe was used to excavate to within one foot of the pipe. Hand tools were then used to continue the excavation. As the first traces of gel were located, excavation efforts were continued by hand so none of the gel mass would be distrubed. Three typical joints were inspected and each showed substantial amounts of gel around the joints. None of the gel masses that were inspected showed any signs of dehydration, shrinkage, deterioration or other changes from time of placement.

Based on the facts derived from this excavation and inspection, it is evident that gelled chemical grout is not affected by rise and fall of the ground water table, even though it may be subjected to dry soil conditions for extended length of time. It is also apparent that normal sewage gases, chemicals and acids have no effect on the gel. It was collectively agreed that chemical grout is a very satisfactory water sealing material and, because of its flexibility and durability, is far superior to a cement grout.

CONTROLLED TEST OF CHEMICAL GROUT GEL STABILITY

In the summer of 1959, two field experiments were begun to evaluate the long term performance of chemical grout (gel) that is placed under conditions of relative humidity of less than 100% in the gel environement. The field site is an area near Princeton, New Jersey. The site location is about 100 feet from a creek which generally has water flowing in it throughout the year. The water table at the location of these experiments varies between five to six feet below surface to as close as 18 inches.

In one of the experiments, a 30 gallon drum, with the bottom removed, was buried flush with the ground surface. The drum was then filled with gel and left exposed to the elements. Periodic photographs, along with visual inspections, record the condition and any changes in the gel.

In the second of the experiments, an 18 inch diametersection of reinforced concrete pipe about three feet long was buried flush with the surface and the lower half filled with sand stabilized with chemical grout. The sand was covered with natural fill to the ground surface. Again, periodic photographs and visual inspections have recorded the condition of the gel.

At various intervals throughout the intervening years, the drum of gel has been observed, with particular attention to the depth to which physical deterioration has occured. Up to the most recent examination, only the upper two inches of gel show any signs of physical change. These minimal changes are apparently the result of alternate cycles of dessication and rewetting. The extent of change is exceedingly small in view of the direct exposure of the gel to sun, wind, rain and snow for several years.

The deeper interior of the concrete pipe was examined about seven years after initiation of the experiment. At that time, earth was removed from stabilized sand on the inside of the pipe. The stabilized sand was excavated in one quadrant to a depth of about six inches. On close inspection, the portion of the concrete pipe in contact with the stabilized sand proved to be in relatively the same condition as when it was originally placed. The stabilized sand itself showed little or no change from its initial condition. The remainder of the experiment was again covered with natural fill, flush to the surface, and subsequent exposures and inspections have proven the longevity and worth of chemical gel.

In any grouting application, however, full expected longevity can be realized primarily only if proper, recommended placement procedures are followed. For additional information on particular Avanti International chemical grouts, it is recommended that applicators refer to appropriate literature. Write or call Avanti International for additional details.

The following is a summary of illustrations that CHEMICAL GROUTING WORKS!, taken from past issues of our NEWSLETTER. Use this material to confirm the proven value of chemical grout rehabilitation. Demonstrate to your clients and customers the longevity and effectiveness of chemical grouts, whether a project involves sanitary sewers, combined sewers, storm sewers, manholes, pump stations (structural water control applications) or any combination of requirements. We earnestly solicit your success stories with chemical grouts so that we may continue to show that CHEMICAL GROUTING WORKS!

L. D. Smith, CITY OF FT. MYERS, FLORIDA, reports on sanitary sewers, deep grouted 1961 by Penetryn Systems, excavated, grout found intact - 22 years in-place service.

AV-100 Chemical Grout (acrylamide)

CITY OF CASSELBERRY, FLORIDA. Bill Thompson, Altair Maintenance Services, Longwood, Florida, reports on project involving 1000 joints sealed in 1982. Retested one year later (1983), all joints passed - no failures at all.

AV-100 Chemical Grout (acrylamide)

COUNTY OF FAIRFAX, VIRGINIA. Paul Huston reports on successes in stopping infiltration over last 12 years. Extremely successful. Manholes, too.

AV-100 Chemical Grout (acrylamide)

Donnelly, Conklin, Phipps & Buzell, Inc. report to E.P.A. on 18 sewer rehab projects reveals chemical grouting generally successful in sealing out groundwater. Remaining I/I in the sewers was from sources other than the grouted joints.

CITY OF JACKSONVILLE, FLORIDA. Altair Maintenance Services, Longwood, Florida. Retest of joints grouted in 1965 showed gel intact and successful in sealing out groundwater - 19 years of in-place service.

AV-100 Chemical Grout (acrylamide)

CITY OF COCOA BEACH, FLORIDA. Chuck Billras reports on success of their grouting program in 1k975. Grout still holding to keep flows low at the sewage treatment plant - 9 years in-place service.

AV-100 Chemical Grout (acrylamide)

CITY OF TIPTON, IOWA. Robert Snavely reports on success of tv/grout program from mid-1970's to present. City contracts some work each year to maintain and rehabilitate their system.

AV-220 Hydracure (urethane)
AV-100 Chemical Grout (acrylamide)

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND. Mike Burkhard reports acrylamide grout in place for 17 years. Still strong and effective as the day it was put in.

AV-100 Chemical Grout (acrylamide)

BOROUGH OF EPHRATA, PENNSYLVANIA. Jay Snyder reports on stability of grout in solution. 3-4 years old.

AV-100 Chemical Grout (acrylamide)

Oswald Sewer Service, Belford, New Jersey. John Oswald reports on success in sealing pipe joints, never having to reseal a grouted joint.

AV-100 Chemical Grout (acrylamide)

CITY OF AUSTIN, TEXAS. Floyd Henry reports on success of sealed joints repaired in 1967. 17 years of in-place service.

AV-100 Chemical Grout (acrylamide)

CITY OF NEENAH, WISCONSIN. John Wilkes, City Engineer, reports on 1982 successes sealing slip-lined pipes at the manhole with the EGP technique. Also reported on success in sealing sanitary sewers.

AV-220 Hydracure (urethane)
AV-219 Fibrotite (oakum)
AV-250 Poly Gel (urethane)

CITY OF PAXTON, ILLINOIS. Exco, Inc., Cullom, Illinois, contractor. June, 1981, project. Sewers and manholes. James Lynch, Paxton, verified work is still holding up well.

AV-220 Hydracure (urethane) - manholes
AV-100 Chemical Grout (acrylamide) - sewers

CITY OF NORTH LAUDERDALE, FLORIDA. Ed Goebel reports on Shenandoah General Construction Company, Pompano Beach, Florida, sealing sewers, manholes and pump stations. Electricity costs for pumping sewage are declining due to effectiveness of grouting over a period of years.

AV-100 Chemical Grout (acrylamide)

ILLINOIS ASSOCIATION OF WPC OPERATORS. Norm Sirna, Specialty Sewer Services, Hazelwood, Missouri, gave an excellent talk covering all aspects of rehabilitation. Norm's long experience in this industry means good advice. Chemical grouting is recommended for manholes and sanitary sewers. Specialty Sewer uses all of our grouts.

CITY OF CAPE CORAL, FLORIDA. Bill Geertse reports on success of grouting program over three-year period. 20% flow reduction at the plant, chloride count in sewers was 1800 ppm, now 600 ppm, due to reduction of infiltration from saltwater canals.

AV-100 Chemical Grout (acrylamide)

CITY OF MANKATO, MINNESOTA. Successfully sealing sanitary sewers using remote packer up to 42" in diameter. Also manholes with AVANTI 'Performer Pump'.

AV-100 Chemical Grout (acrylamide)

CITY OF ALBANY, GEORGIA. Billy Daniel reports on how serious, long-term problems are solved with AVANTI 'Performer Pump' and grouting trailer.

AV-250 Poly Gel (urethane)

Eastern Utilities Specialists, Inc., Manassas, Virginia. Charles LeFon reports on successes in four years using 'Honeybee' hand pump.

AV-220 Hydracure (urethane)

CITY OF GRESHAM, OREGON. General Chemical Company, Salem, Oregon, reports $36,000 annual savings with $3,000 in grout. Case study printed and distributed.

AV-100 Chemical Grout (acrylamide)

CITY OF ALBANY, GEORGIA. Brick and RCP manhole leaks stopped, 2 - 100 gpm. AVANTI 'Performer Pump'.

AV-250 Poly Gel (urethane)

CITY OF FALMOUTH, MAINE. SSESCO, Inc., Hyde Park, Maine. Less holes required than anticipated to get good soil penetration and seal.

AV-250 Poly Gel (urethane)

WASHINGTON SUBURBAN SANITARY COMMISSION, MARYLAND. Tri-State Grouting, Inc., Newark, Delaware, reports only 1.2% regrouting required on 1000 manholes.

AV-100 Chemical Grout (acrylamide)

CITY OF PRINCETON, NEW JERSEY. Rousos Construction Company, Old Bridge, New Jersey. 471 manhole frames sealed to top of manhole with EGP Technique. Also Princeton seals its own manholes with AVANTI 'Performer Pump'.

AV-220 Hydracure (urethane)
AV-219 Fibrotite (oakum)
AV-250 Poly Gel (urethane)
AV-202 Multi-Grout (urethane)

Two Oregon cities on the coast. Camapbell Stekete, Westech Engineering, Salem, Oregon, reported on two projects. The $8,000 and $12,000 manhole rehab programs turned the systems around, reduced I/I and restored integrity of pump stations and sewer systems.

COUNTY OF FAIRFAX, VIRGINIA. Paul Huston reports on success of manhole grouting.

AV-100 Chemical Grout (acrylamide)

ST. LOUIS, MISSOURI. Bill Skinner reports on sealing pipe-to-manhole connections.

AV-202 Multi-Grout (urethane)

Photos and comments on manhole grouting units. Tri-State Grouting, Newark, Delaware.

AV-100 Chemical Grout (acrylamide)

CITY OF PRINCETON, NEW JERSEY. Avanti 'Performer Pump'.

AV-250 Poly Gel (urethane)

CITY OF TALLAHASSEE, FLORIDA. Avanti 'Performer Pump'.

AV-250 Poly Gel (urethane)

MINNEAPOLIS, MINNESOTA. Area Waste Control Commission Richard Arbour and Jerry Tschida report on effectiveness of sealing manholes. Over 5 years. Economics explained.

AV-250 Poly Gel (urethane)

CITY OF COCOA, FLORIDA. Carl Dunn, C & L Waterproofing, Sandford, Florida, reports on success of sealing manholes and lift stations.

AV-100 Chemical Grout (acrylamide)
AV-220 Hydracure (urethane)

CITY OF MIDDLETON, OHIO. Success reported in sealing 96" CMP budgeted for replacement. Grout costs: $1,000; replacement costs: $10,0000. EGP Technique used.

AV-220 Hydracure (urethane)
AV-219 Fibrotite (oakum)

EGP Technique. Thousands of joints sealed, 24" in diameter and greater. Explanation of the problem and the solution.

AV-220 Hydracure (urethane)

CITY OF EL LAGO, TEXAS. Frank Adams reports on sealing work done in 1977 by Naylor Industries, Inc., Pasadena, Texas. 42" storm sewer, joints leaking, streets and sidewalk caving in. Now watertight. 8 years in-place service.

AV-220 Hydracure (urethane)
AV-219 Fibrotite (oakum)

Orlando International Airport, Florida. Gene Balters, Greiner Engineering Sciences, Inc., Longwood, Florida, on 36" - 48" storm sewer repairs.

AV-100 Chemical Grout (acrylamide)
AV-220 Hydracure (urethane)

AVANTI INTERNATIONAL

TECHNICAL MANUAL

AV-100 Chemical Grout

AVANTI INTERNATIONAL

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AV-100 Chemical Grout

Introduction

AV-100 Chemical Grout is a dry granular material that dissolves easily in water to make a low-viscosity solution. When a catalyst is added to the solution, the resulting grout mixture has about the same viscosity as water. This mixture penetrates any pathway through which water will flow and at about the same rate. In a predetermined period of time, the AV-100 solution solidifies into a stiff gel.

This predetermined time, or "gel" time, may be closely controlled from a few seconds to a few hours by changing the amount of catalyst. In this way all voids containing grout solution are sealed with a flexible, continuous gel that prevents water passage. In soil, the gel also binds the soil particles together and gives a small increase in shear strength. No natural ground deposit has yet been found in which a gel will not form.

The viscosity of an AV-100 grout solution essentially stays the same as water until the instant gel forms. With equipment that takes advantage of this special property, successful injections can be made in a fraction of the time needed for suspended particle grouts.

AV-100 Chemical Grout belongs to that type called true solution grouts, in contrast to the other major type of grout containing suspended solids such as cement, bentonite, fly ash and other materials. The ability of a suspended solids grout to penetrate a formation is limited by the size of the void it must enter.

Obviously, the particle cannot be bigger than the space it enters. Actually, to stay within reasonable pressure and injection rates without blinding or fracturing, the particle cannot be bigger than about one third the size of the void. This fact, more than any other, determines the types of soil in which any grout may be used.

On the other hand, the ability of AV-100 to penetrate a formation is limited only by its viscosity. Every chemical grout has a usable viscosity range which is less than the complete viscosity range it exhibits. This "usable viscosity range" (Figure 1) is dictated by good field grouting practice and simple economics. Most importantly, it will vary for each product, depending on the site, the weather and many other factors.

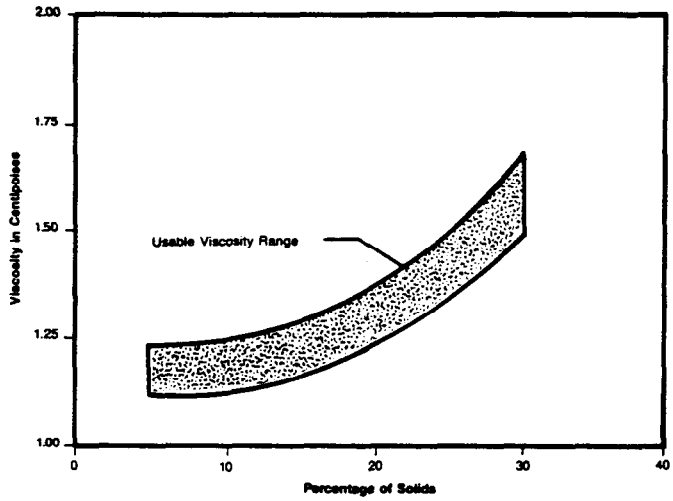

Figure 1. Usable viscosity range of AV-100 Chemical Grout.

AV-100 has been used to cut off and control underground water flow in grout curtains, coffer dams, mine shafts, tunnels, missile silos, sewer pipe joints, drill holes, oil wells, and caissons. Many times AV-100 is used as a supplement to other grouting techniques. Other grouts may be used to fill the voids in gravel or large rock fissures; then the final seal is made with AV-100 Chemical Grout. Because it is so easy to apply, AV-100 is often the most economical answer to problems that might be solved in other ways, especially for smaller jobs.

In Figure 2, various grouts are compared with several non-grout methods of underground water control as they relate to applicable formation soil grain sizes. The upper five bars show grouting materials that are dependent on void-filling for their effectiveness while the bottom five depict several common, mechanical water control techniques.

Notice that the range for each technique overlaps the range of one or more of the others. Every potential application should be examined carefully before any decisions are made. Points for consideration should include time for completion of the work, manpower requirements, simplicity of the operation, probable degree of control over the end result and ease of blending the chosen method of application into the overall work-site operation. AV-100 Chemical Grout is very satisfactory on all these points.

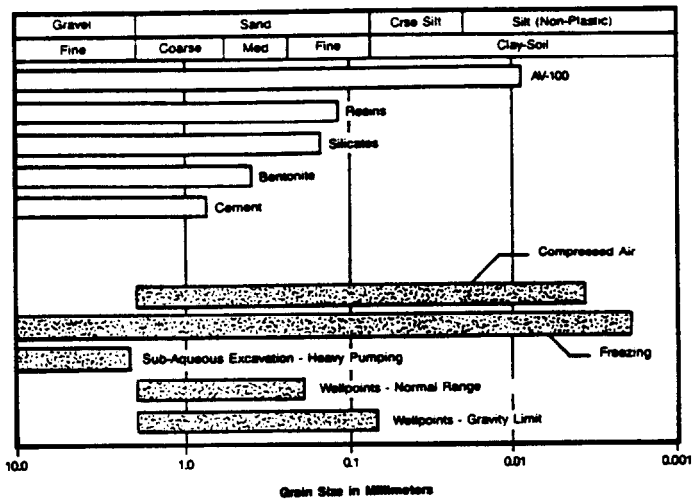

Figure 2. Comparison of grout and non-grout methods of underground water control.

General Considerations

"Waterproofing" pipe joints, soil, rock, or structures with AV-100 Chemical Grout involves a timed chemical reaction that is easily controlled under job site conditions.

Although more expensive, pound for pound, than many other grouting materials, AV-100 solutions fill more void space than equal volumes of most cement slurries. For example, each gallon of AV-100 produces at least one full gallon of impermeable gel; ten gallons of a thin cement grout may be required to yield one gallon of grout in place.

Furthermore, experienced contractors estimate that grouting with AV-100 can be completed in 10-20 per cent of the time required for grouting with cement. The reason for this, primarily, is that large volumes of pumped liquid are required to place small, effective volumes of cement. Also, due to the low viscosity of AV-100 solutions and excellent control of gel time, grout waste can usually be eliminated. The comparison of AV-100 with cement does not mean that these two products are interchangeable but simply is meant to show that raw material cost alone is not a good basis for economic judgment.

Before a successful application can be made with AV-100, five fundamental basics should be evaluated. These are:

1. The desired result.
2. The nature of the grout zone.
3. The application equipment.
4. Alternative methods.
5. The plan of injection.

The grout injection plan should include gel times to be used, quantities of AV-100 required and the probable layout for grout injection points. After work starts, the work plan can be modified based on additional information that is developed during the job.

Formations Which Can Be Treated

No natural soil or rock formation has yet been found in which a gel will not form. However, the injected solution must remain in the grout zone until gelation occurs. In dry soils and in flowing ground water, there often is a tendency for the grout to disperse.

Gravity and capillary forces in dry soils disperse the grout solution and may cause the gel to be ineffective. As in pipe joint grouting, dispersion can be avoided by saturating the soil prior to grouting and by the use of very short gel times. In soil stabilization work, however, a dry soil mass cannot be as efficiently stabilized as a soil mass below the water table.

Dilution around the outer edges of the grout bulb may occur in wet soil when long gel times are used. The flowing ground water distorts the normal shape of the stabilized mass and displaces it in the direction of flow. In turbulent flow conditions, dilution can be minimized by short gel times. In open formation or in fissures, solids such as bentonite or cement may be added to the grout solution to help produce a more complete block to flowing water.

Due to its low viscosity, AV-100 solution can be pumped into any soil through which water will flow. Considering the relationship of permeability to pumping time, however, stabilization of clay, very fine silt, or very silty sand is generally not economical.

Permissible pumping pressures must also be considered. If the effective head is limited to a few feet, fine sand near the ground surface usually cannot be economically treated. On the other hand, treatment of fine sandstone in a deep shaft might be very effective with 2000 psi pumping pressure.

Product Descriptions

AV-100 Chemical Grout

AV-100 Chemical Grout is a mixture of three or more water soluble chemicals which produce stiff gels from properly catalyzed solutions. AV-100 is also the name of the base chemical in the mixture.

AV-101 Catalyst T+

AV-101 Catalyst T+ acts as a buffer and sometimes appears to act as a catalyst in the AV-100 gel mix. Triethanolamine (TEA) is the primary ingredient in AV-101 Catalyst T+. The proprietary blend of other additives with the TEA makes up a liquid which actually functions as an activator for the reaction. These other ingredients allow field use of AV-101 in cold weather without the annoying occurrence of crystallization or "freezing" to which normal TEA is subject.

AV-102 Catalyst AP

AV-102 Catalyst AP (ammonium persulfate) is a granular material and a strong oxidizing agent. It is the initiator that triggers the reaction. The gel time begins with its addition. Generally, AP is dissolved in water and added as a 5 to 20 percent solution to the AV-100 Chemical Grout solution through a separate pump.

Special Additives

AV-105 Shrink Control Agent

AV-105 Shrink Control Agent is a greenish liquid which is added to the AV-100 mix when protection against freezing temperatures or dehydrating conditions is required for the gel.

AV-108 and AV-109 Catalyst Aids

AV-108 and AV-109 Catalyst Aids are granular materials which can be added to the AV-100 Chemical Grout mix to reduce the amount of other catalysts required to achieve a specific gel time.

AV-257 Icoset

AV-257 Icoset is a white milky liquid which can be added to the AV-100 Chemical Grout mix to achieve increases in compressive and tensile strength as well as superior elongative potential in the gel.

Potassium Ferricyanide (KFe)

Potassium Ferricyanide (KFe) is a reddish, granular material used to extend the gel time. It behaves as an inhibitor in very small quantities and must be used cautiously. KFe does not affect the strength of the final gel when used in the recommended concentrations.

Buffers

Buffers are chemicals used to control pH in AV-100 solutions. In a few rare cases, acidic water needs buffers to bring the pH to 8. AV-100 solutions can be gelled at high temperatures with ammonium persulfate alone, and in this case buffers will almost always be required; disodium phosphate heptahydrate (DSP) is recommended, although sodium carbonate may be used in soft water.

Root Inhibitors

Many studies of damaged sewer lines reveal that root intrusion is a common cause of flow problems. It is no secret that roots require water and thrive in its presence. Roots sense water even at great distances and are virtually undeterred in their quest for it. The sewer maintenance field is continually plagued by this problem. Roots are generally not stopped for long by conventional sewer line joints, no matter how carefully and efficiently they are constructed. Vapor leaks at the top of an otherwise water-tight joint will encourage microscopic growth. As cells multiply, roots grow rapidly. Nourished by the sewage flowing within the line, a blockage in the line can soon develop. Cutting out the roots does not solve the problem because they generally grow back thicker and stronger than before.

Dichlobenil

The most acceptable solution to the problem of root invasion into subsurface lines is a root growth inhibitor that may be mixed with AV-100 Chemical Grout: 2,6 dichlorobenzonitrile (dichlobenil). Tests have shown that a concentration of 100 ppm of dichlobenil in the grout will stop root intrusion into the sewer line for two years and longer.

Dichlobenil is a powerful root growth inhibitor. Its low (20 ppm) solubility in water extends its effectiveness because the initial dosage is released slowly. Aboveground vegetation is unaffected by the root inhibitor in the grout. Dichlobenil works to discourage root growth only in its presence, thereby forcing the root to travel elsewhere for its water supply. Dichlobenil is a specific, non-systemic growth inhibitor functioning only in the area of the treated sewer joint.

For satisfactory results when using dichlobenil with AV-100 Chemical Grout, the sewer line should first be cleaned and light root growth removed so the grouting packer can be operated easily and freely. All the joints in an entire section (between manholes) that has been invaded by roots should be sealed with AV-100 containing dichlobenil. All manufacturer's directions for using dichlobenil should be followed.

If root growth is heavy and well-developed, the joint space may be mostly filled with woody root material. In such cases, very little grout may penetrate the joint and the entire section between manholes should be pretreated with a solution containing vapam and dichlobenil in accordance with manufacturer's directions. When root deterioration has been verified, usually after 9-12 months, the joints should then be grouted as described above. Do not add solutions containing vapam to any grout solution.

No product other than dichlobenil has been accepted by the sewer grouting industry for root treatment. Other chemicals have been suggested and field tested without much success. The best known of these is copper sulfate. Copper sulfate is not recommended for use with AV-100 Chemical Grout as a root inhibitor in sewer pipe joints.

Dichlobenil becomes a suspended solid when mixed in a grout solution. To avoid settlement, continuous mixing is recommended. Dichlobenil mixed with an inert talc or clay will stay in solution much longer without mixing. A coarse (10-20 mesh) stainless steel filter should be used in systems employing filters to prevent removal of suspended particles.

NOROSAC 50W

The AVANTI dichlobenil product is NOROSAC 50W, a powder containing 50% active dichlobenil and 50% inert filler to keep the dichlobenil in suspension. NOROSAC 50W should be used in the 400 ppm range. It is available in four pound packages, packed six bags per case.

Do not add solutions containing vapam to any grout solution.

Using NOROSAC 50W with AV-100 Chemical Grout

The manufacturer recommends incorporation of 0.04% NOROSAC 50W in the grout mixture. To do this in a sewer grouting rig using two thirty-gallon grout tanks, add 0.2 pounds (3.2 oz) of NOROSAC 50W to about one gallon of water in a small container. Stir completely, and pour this mixed concentrate into the AV-100 tank. This mixture gives a concentration of about 400 ppm in a sixty-gallon batch of AV-100 Chemical Grout.

Safety Instructions

The directions and comments contained herein and elsewhere are supplied for information purposes only. In all cases users should read and follow only the manufacturer's directions printed on the product label. Herbicides may be harmful if used improperly.

Do not breathe dust. Do not allow contact with eyes or skin. If swallowed, induce vomiting by drinking water and touching the back of the throat with a finger. If inhaled, remove to fresh air. If in eyes, rinse with water for 15 minutes and contact a physician. If on skin, wash with soap and water.

Do not apply NOROSAC 50W to any body of water. Do not contaminate water by cleaning of equipment or disposal of wastes.

Chemical Reactions

AV-100 gels are formed by a two-step process. First, a solution of AV-100 containing AV-101 Catalyst T+ is prepared. Then, AP in solution is added to the solution of AV-100. The gel time starts when the two solutions come together.

Two reactions then occur in sequence:

Catalysts	----->	Free Radicals
Free Radicals + AV-100	----->	Polymer

Proper balance in the catalyst system allows a predetermined amount of time to elapse before polymerization of AV-100 occurs. This is called the gel time, during which the viscosity of the solution remains almost constant. The importance of holding a constant low viscosity right up to the moment of gelation must not be underestimated. This property will be discussed in more detail later.

At the end of the gel time, heat is evolved. Long, flexible polymer chains form and simultaneously crosslink into a stiff matrix which binds the water into a gel. The gel reaches maximum strength in a matter of minutes.

Chemical Reaction Data

The relationships between gel time, catalyst concentrations, inhibitor concentration, and temperature have been determined for a wide range of conditions. These relationships are shown on graphs in this manual. The chemical percentages in these graphs refer always to parts of chemical per 100 parts of grout solution.

Catalyst Concentration

Changes in concentration of one or all of the catalysts of the mixture have a very significant effect on gel times. Too much KFe or too little AP or Catalyst T+ will produce weak gels or no gel at all. Excess AP may reduce pH to the point where a gel will not form. The recommended lower limits are 0.25% for AV-101 Catalyst T+ and 0.2% for AV-102 Catalyst AP. The upper limit for KFe is 0.035%.

Reducing the AV-100 concentration from 15 percent down to 5 percent causes a slight increase in gel time.

Temperature

Unless otherwise noted in this manual, temperature always refers to the temperature of the AV-100 Chemical Grout solution. If the formation temperature or the temperature of the area through which grout hoses pass is very different from the solution temperature, adjustments in gel time estimates may be necessary.

Gel times increase when temperature falls and decreases when temperature rises. As a rough rule of thumb, the gel time is reduced by half if the temperature goes up ten degrees Fahrenheit. When short gel times at low temperatures are needed, warming the grout solution may be more economical than large amounts of catalyst, but the solutions must be stirred while the heaters are in use.

Heating of AV-100 solutions must be done cautiously and is recommended only when temperatures at the mixing site are low. If warm solutions are injected into cold formations, the heated grout will cool quickly and the effects of heating will be lost. In soil stabilization or waterproofing work, low temperatures are usually best handled through the use of AV-108 and AV-109 Catalyst Aids. AV-108 and AV-109 should generally not be used in pipe joint grout rigs.

Pressure

The gel time of an AV-100 Chemical Grout solution is not affected by changes in pressure up to at least several thousand psi.

pH

The solution pH may affect the gel time. Up to about a one-hour gel time, the pH should be in the range of 7 to 11. Except under very unusual conditions (presence of large amounts of acid), AV-101 Catalyst T+ maintains the pH between 8 and 9. Gel times become long and indefinite below a solution pH of 6.5.

When very long gel times are needed, especially in acid ground water conditions, pH is maintained above 7 by a buffer such as disodium phosphate heptahydrate (DSP). Acid water usually leaches out minerals. These minerals may compensate for the low pH and in some cases cause faster than normal gel times.

Air

AV-100 solutions should be mixed gently because air entrained by vigorous mixing will lengthen gel times. Bubbler mixers should not be used.

Metals

Certain metals such as iron, copper, and copper alloys accelerate gel times. If iron mixing tanks must be used, they should be coated to prevent rust.

Mix Water

Either groundwater or local drinking water may be used for mixing a solution, depending on which is most suitable. Because many of the variables which influence gel time are related to the characteristics of the mix water, gel times should be verified by tests with the water which will be used in a particular application.

Sunlight

The ultraviolet rays in direct sunlight can cause gelation of AV-100 solutions. To avoid this, cover the tanks.

Hydrogen Sulfide

Hydrogen Sulfide has a very complicated effect on AV-100 Chemical Grout. In general, it acts as an accelerator under ordinary working conditions.

Salts

Salts, such as sodium chloride, calcium chloride, sulfates, and phosphates, have an accelerating effect. The amount of acceleration depends on salt concentration and should be measured by a field test. Salts may also increase gel strength.

Certain salts, such as calcium chloride, decrease the water loss rate from gels under dehydrating conditions. Salts may also change the pH of the solution and will affect the gel time.

Freezing

Freezing of AV-100 solutions has little effect on their activity after thawing. To avoid freezing during application, salt or AV-105 Shrink Control Agent may be added. The effect that these additives have on the gel time must be checked.

Tests indicate that repeated freeze-thaw and complete wet-dry cycles will cause eventual deterioration of stabilized soil masses due to the rupture of gel-soil bonds. The effects of partial wet-dry cycles are less severe, and the effects of normal ambient temperature variations above freezing are negligible.

Beware of attempts to inject AV-100 solutions into frozen formations. Any water already in the zone to be grouted will be solid ice into which the liquid solution will probably not penetrate. This may be very important when grouting shallow sewers during the winter.

Particulate Materials

Most insoluble materials, such as clay, bentonite, and diatomaceous earth slow down gelation. If such fillers are used, the concentration of AV-101 Catalyst T+ must be increased.

Properties of AV-100 Chemical Grout

Understanding the properties of AV-100 Chemical Grout in its various forms from initial chemical components that make up the product to the in-place final gel is important. An awareness of the inherent hazards of handling any chemical component can minimize potential dangers to workers and the environment by assuring proper application of a product. Strict adherence to the SAFE OPERATING PRACTICES PROGRAM is critical and will assure safe and successful application programs. Following in this manual are descriptions of the physical and chemical properties of three different states of AV-100 Chemical Grout. The first part discusses the properties of the basic chemical components that make up the product. Knowledge of the product at this level is necessary for handling, storage and safety.

The second part discusses AV-100 in solution or its form for application. A thorough knowledge of the product in this state is important for planning a successful application program. Properties of the product in solution must be considered when testing and planning proper gel times for a particular application. Properties of the product while in solution are also critical for safe operating procedures.

The third part discusses AV-100 Chemical Grout in its final form as a gel in place. It is in this state that the product stops the passage of water to seal a leaking pipe joint, stabilize soil or waterproof a substructure. The physical and chemical properties of the product in this form are essential to assure an application that satisfies the requirements of the program.

Properties of AV-100 Chemical Components

Toxicity

Safe use of millions of pounds of AV-100 Chemical Grout indicates that no health problems arise when basic safety and handling precautions are followed. If improperly used, AV-100 Chemical Grout can be hazardous. The measures detailed in AVANTI's SAFE OPERATING PRACTICES PROGRAM FOR AV-100 CHEMICAL GROUT minimize the health hazards. No illness to workmen handling acrylamide grout as recommended has been discovered in over twenty-five years of use.

In powder or solution form, AV-100 contains a large amount of acrylamide. This compound may be absorbed into the body through the unbroken skin, by inhalation of dust (or droplets of solution), or by swallowing. Although small, single doses of acrylamide are not particularly hazardous, the product can have a high degree of cumulative toxicity. The acute oral LD-50 for rodents is approximately 200 mg./kg. of body weight.

Repeated and prolonged intake of small quantities by experimental animals results in disturbances of the nervous system. The effects include muscular weakness and disorders of equilibrium and movement.

If exposure ends when signs of poisoning are first observed, complete recovery may be expected in a short time. If poisoning is caused by exposure which continues after evidence of poisoning has developed, recovery may take longer.

Handling of Solid AV-100 Chemical Grout

Skin which comes in contact with solid AV-100 should be washed immediately in running water, and dust inhalation should be avoided. Use the same protective measures as described below under "Handling of AV-100 Solutions". Avoid rough handling of AV-100 containers to prevent spilling.

Solid AV-100 is shipped in disposable containers and should be stored in the original containers until used. Empty containers should be buried in an approved landfill and not used for any other purpose.

Corrosiveness

AV-100 solutions containing AV-101 Catalyst T+ are noncorrosive to common steels, aluminum, brass and rubber.

To protect against skin irritation from AV-101 Catalyst T+, operators should wear rubber gloves and glasses. Spills on the skin should be washed off with water. In case of contact with eyes, wash the eyes immediately for at least 15 minutes with plenty of water and then seek proper medical attention.

AV-102 Catalyst AP is a strong oxidizing agent and should always be handled with glasses and rubber gloves. Skin areas which have come in contact with AP should be washed with water. If spilled on clothing, AP will discolor or make holes in some fabrics.

Solubility

At normal temperatures, AV-100 solutions up to 40% are easy to prepare. Catalyst and inhibitors also dissolve easily at concentrations which are much higher than those normally used. Sodium carbonate will dissolve easily in sufficient amounts to bring the solution pH up to 10. Disodium phosphate requires vigorous mixing.

Stability

AV-100 powder will retain its properties for years at temperatures below 70 degrees F (21 degrees C) if stored dry in the original containers. Storage at higher temperatures will cause small insolubles to form and may cause small changes in gel time. After filtering, AV-100 solutions which contained insolubles are acceptable for use.

AV-102 Catalyst AP and AV-101 Catalyst T+ may be stored in their original containers for a year or more.

Properties of AV-100 Solutions

Density

The density of a 10% solution (catalyst at 68° F) of AV-100 is 1.04 grams per cubic centimeter.

Viscosity

The viscosity of a 10% solution (catalyst at 68° F) of AV-100 is 1.2 centipoise (water = 1 centipoise).

Toxicity

Standard protective clothing should be worn when working with AV-100, including:

1. Waterproof coat and pants.
2. Rubber gloves.
3. Rubber boots or rubber overshoes.
4. Eye protection (either glasses or goggles).
5. Respirators approved by the U.S. Bureau of Mines for protection against toxic dusts and vapors in confined or poorly ventilated places.

Long-sleeved coveralls or long-sleeved shirts may be worn instead of waterproof clothing if contaminated clothing is removed promptly and washed before re-use.

Use care in handling of solutions to prevent liquid from coming in contact with skin or clothing. If solutions are splashed on skin or clothing, the clothing should be removed promptly and the part of the body coming in contact with the solution washed with water. Change to clean clothing.

If contact is only on clothing that is not worn next to the skin, changing is not required, although it should not be worn again without laundering. If waterproof clothing is worn, it may not need to be changed if splashed, but the splash should be washed off with water.

Wash hands with soap and water before eating or smoking, and take a shower at the end of the work day. Work clothing should not be worn home.

Areas where spills have occurred should be washed down with water. If the gel reaction is completed, ground contamination should not occur.

See the SAFE OPERATING PRACTICES PROGRAM booklet for additional information.

Penetrability

AV-100 solutions can generally be pumped anywhere water will flow at the same flow-rate-pressure relationship required for water.

Stability

A 10 to 30 percent solution [uncatalyzed 68 to 122 degrees F (20 to 50 degrees C)] will usually be stable for at least four months. Keep solutions from contact with brass, copper, or iron. Solutions should be kept out of direct sunlight.

pH

The pH of AV-100 is 4.5 to 5.0 (uncatalyzed).

Properties of AV-100 Gel

Density

The density of AV-100 gel is essentially the same as a solution, 1.04 grams per cubic centimeter or slightly above that of water.

Toxicity

In gel form, AV-100 Chemical Grout contains very little acrylamide. Gel produced by a properly catalyzed ten percent solution contains less than 0.03% acrylamide. In one pound of grout, this works out to be about equal to the weight of a common tailor's pin. Even so, the gel is not a toy and should not be treated casually.

Microorganisms in soil and natural waters biodegrade ungelled AV-100, so possible hazards from unreacted material last only for a relatively short time. These organisms do not affect the gel itself. However, an application near water used for drinking or recreation should be made only when no AV-100 will find its way into such water. Under most circumstances, contamination will be unlikely.

Excessive dilution of all grout solutions, whether catalyzed or not, should be prevented until the gel reaction is completed.

Corrosion

AV-100 and sand gelled with AV-100 have about the same corrosion rate on mild steel as ordinary tap water.

Strength

AV-100 gel is a rubbery, elastic material which by itself has little supportive value.

Adhesion

Gels have low adhesion to a smooth surface. When placed in a fine material, however, the large surface area results in significant total adhesive force.

Extrusion

The impermeability of a stabilized soil mass depends on the resistance of the gel to extrusion from the soil pores. Assuming that penetration into the mass is adequate, the gel cannot be extruded at pressures less than the pumping pressure required to place the solution. The pumping pressure should always exceed the static water head in the grout zone.

Resistance to extrusion is probably the most important measure of gel strength. Tests to evaluate extrusion have been performed on gel and on gelled sands and gravels. These tests all indicate that extrusion resistance depends on the length-to-diameter ratio of the extrusion path. Extrusion resistance increases as this ratio increases.

Tests in small stainless steel pipes show that 0.1 psi (0.007 kg/cm 2) is a very conservative value for skin-friction in computing extrusion resistance. Even this low value, applied to a tube 0.01 (0.25mm) inch in diameter by 12 (30.5cm) inches long, gives an extrusion resistance of about 500 psi (35 kg/cm2). These dimensions roughly match the void channels in a medium sand and suggest that a one foot thick wall of stabilized sand can withstand hydrostatic heads of 1000 feet (305 m).

For most conditions, the gel can resist much higher pressures than that at which it was placed. In fine sand and silt, stabilized cores several inches in length can effectively resist gel extrusion at hydrostatic pressures of up to 2500 psi. In pea gravel, gels may be expected to withstand water pressures over 150 psi.

Extrusion may occur from cracks in rock into which too little grout has penetrated. This problem can be solved by pumping larger volumes (at higher pressure if necessary) to give greater penetration. No case of gel extrusion from within a treated soil or rock mass has ever been reported.

Gel extrusion often occurs from a grouted drill hole after the grout has set. In long grout holes, the total volume of extruded gel may give an incorrect impression that the grouting operation was ineffective.

Two extremes result from grouting in a particular area: 1) complete shutoff of all water-bearing fissures, and 2) no shutoff of any water-bearing fissure. In the first case gel will not extrude from the hole, but in the second it usually will. The fact should never be overlooked that at every point of successful application between those extremes, some gel normally extrudes. Therefore, gel extrusion is not an indication of failure but only a sign that shutoff is less than 100 per cent.

Since fissures are never exactly the same size, the degree of grout penetration will vary. Since many fissures are often treated with a fixed amount of grout, chances are good that penetration into some of the fissures will not be sufficient to prevent gel extrusion. This could lead to extrusion even though most fissures have been effectively sealed. Regrouting after gel extrusion occurs will seal the remaining open fissures.

If fissure sizes vary from small to large, the first treatment may not penetrate fine cracks, and may not fill up big ones enough to prevent extrusion. Several "tries," therefore, may be needed for complete water shutoff. Total grout use in a multi-step treatment is usually less than that needed for an effective one step treatment.

If gel immediately extrudes after packer removal, some larger channels remain unfilled. If some time passes before extrusion occurs, the unsealed fissures are small. Grout treatment effectiveness can be checked by measurements of flow from the grout hole before and after grouting.

Chemical Attack

AV-100 gels are resistant to attack by fungi, dilute acids, alkalies, and the salts and gases normally found in the ground.

Shrinkage

A 10% AV-100 solution is about 90% water by weight and volume. After gelation, this water is confined by the polymer-chain lattice of the gel structure. When gel is exposed in low humidity, water will evaporate slowly and the gel will shrink. When a gel from which water has evaporated returns to 100% humidity conditions, it reswells to its original volume.

Gels in soil, rock or concrete fissures also respond to changes in humidity. In medium to dense soils, however, shrinkage of the soil mass as a whole does not occur, even though the solid gel in the soil may shrink in dry conditions.

When shrinkage in soil does occur, it produces tensile forces which increase apparent unconfined compression strength. However, these forces will never exist below the water table. If drying is severe, rupture of the bond between gel and soil grains will occur. This may appear as a visible shrinkage crack.

When rewetted, the gel will swell to its initial volume and again fill the voids. Ruptures will not heal, however, and the stabilized mass may not have quite the strength it first had. The degree of permeability of dried stabilized sand that is re-wetted has been measured at 10-4 to 10-6 cm/sec.

Loose soils will show shrinkage when gel dries, since tensile forces move the soil grains closer together. Job excavations indicate that under moist conditions, gels are unchanged for at least 20 years.

Shrinkage due to drying does not occur below the water table. Field experience also indicates that drying is usually not significant in soils that are six to seven feet below ground surface (even if above the water table) as long as the soil humidity level exceeds 80% to 90%. Shrinkage due to drying is a problem only when the stabilized soil is close to an underground heat source or is very close to the ground surface. AV-100 gels shrink if heated under low humidity but, when heated in water, are stable to at least 150 degrees F (77 degrees C).

Syneresis

Syneresis is a process whereby water is squeezed out of a gel under gravitational forces due to the weight of the gel. AV-100 gels are not subject to syneresis.

Permeability

AV-100 gels are substantially impermeable ($k = 10^{-10}$ cm/sec), except that gels containing less than eight to ten percent AV-100 will swell slightly when immersed. The gels are impermeable to gases and to hydrocarbons such as kerosene. Ions will migrate through the gel.

Almost any grout zone can be made impermeable by completely filling the voids with AV-100. Residual permeability after injections is usually due to non-uniform conditions in which solution has not completely displaced ground water from voids. By proper control of gel time, injection patterns and pumping rates, even large masses can be made essentially impermeable.

Pressure

Pressure alone does not affect the permanence of AV-100 gels. A one foot thick stabilized soil mass is sufficient to resist extrusion at the highest heads found in dams.

Very high mechanical pressure can cause a gel to decrease in volume but hydrostatic pressure has the opposite effect. Unconfined gels subjected to hydrostatic pressure will swell slightly, but the swelling pressure is much less than the dead weight of normal fill materials. Swelling, therefore, can never fracture a soil or rock formation and fissures stay closed as hydrostatic pressures rise.

Longevity

Chemical data and job histories from over 25 years lead to the conclusion that, for all practical purposes, AV-100 gels may be considered permanent.

Additives to Control Freezing Point

Salt

Salt (NaCL, sodium chloride), like many other soluble additives, increases the solution density and viscosity and lowers the freezing point. Salt also shortens the gel time. When using very short gel times in cold weather, it may be easier to add salt in weight percentages as high as 25 to 30 rather than using very high catalyst percentages.

Additives to Reduce Shrinkage

Calcium Chloride

If gel shrinkage may be a problem, inert solids such as silica flour, sawdust, bentonite, or cement will permanently improve gel shrinkage characteristics. Except for portland cement, these materials lengthen the gel time. Where these solids, however, cannot be used due to grain size limitations, calcium chloride in weights equal to the AV-100 will reduce shrinkage. Very little strength loss will occur with calcium chloride, but the gel time will be greatly reduced. This is overcome by adding potassium ferricyanide (KFe). As calcium chloride will eventually (maybe months or years, depending upon local conditions) leach out of the gel, its effects should not be considered permanent. Calcium chloride may also cause some stainless steel to become brittle.

Portland Cement

Portland Cement, like all other solid additives, will increase the viscosity and reduce the penetrability of an AV-100 solution. Cement will also shorten the normal gel time. Cement particles suspended in an AV-100 gel hydrate normally and give considerable strength and stiffness to the gel.

Where strength is needed, cement percentages above 25% (based on the total solution weight) add significant strength to AV-100 gels. When this weight percent approaches 100%, the resulting grout, after set and cure, has strengths equal to or greater than heavy cement grout slurry alone.

In some cases, the AV-100 solution may be used to hold cement in place until hydration can occur. A good mix for 50 gallons of such slurry is 50 lbs. of AV-100 and two to four 94 lb. bags of cement. When using cement, bentonite (one to two percent by weight) will help keep the cement in suspension.

Properties of Gelled Sands

The strength of gelled sands depends upon several factors. In discussing strengths of soils gelled with AV-100, it is the "wet" strength that is important. When drying occurs, forces similar to capillary tension cause strengths to develop in the grout which approach those of cement mortars. On most sites, however, the grouted mass will not dry out, so these high strengths are misleading.

All strength values for AV-100 referred to here are measured without drying action. When comparing the strength of AV-100 with that of other grouts, make sure all data refers to samples cured under water.

AV-100 gels are rubbery, elastic materials, so very loose soils are also rubbery and elastic when stabilized. Lab tests on stabilized sand samples show unconfined compressive strengths to be very low. Such samples also show large strain prior to rupture.

If grout injection procedures induce a "quick" condition in part of the grout zone and gelation occurs while the soil grains are suspended in the grout fluid, the strength of the stabilized mass in that area will be very low. Injection rates and pressures must always be controlled to avoid any such "quick" condition in the stabilized soil.

The actual strength of a stabilized soil is primarily a function of relative density and AV-100 concentration. It is also influenced by the average grain size and the grading curve. Figures 3 and 4 illustrate the effects of density and AV-100 concentration on the strength of stabilized soil. This data is the result of both unconfined compression tests and triaxial tests on the soil whose grain size is illustrated by curve No. 2 on Figure 5.

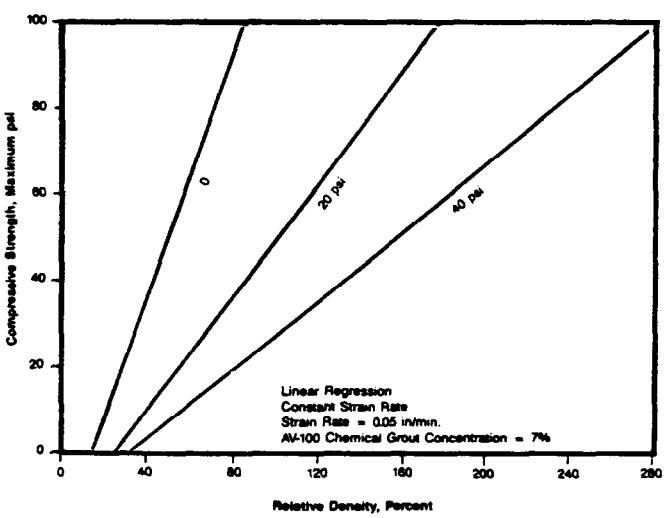

Figure 3. Strength and relative density for Soil No. 2, Figure 5.

The strength of sands gelled with AV-100 will usually be greater than single-solution silicate grouts and less than two-solution silicate grouts. The unconfined compressive strength of stabilized sands will usually vary between 50 and 250 psi (3.5 and 17.5 kg/cm 2) for a ten percent AV-100 solution. Strength increases with higher AV-100 concentration, high density, smaller particle size and more uniform gradation.

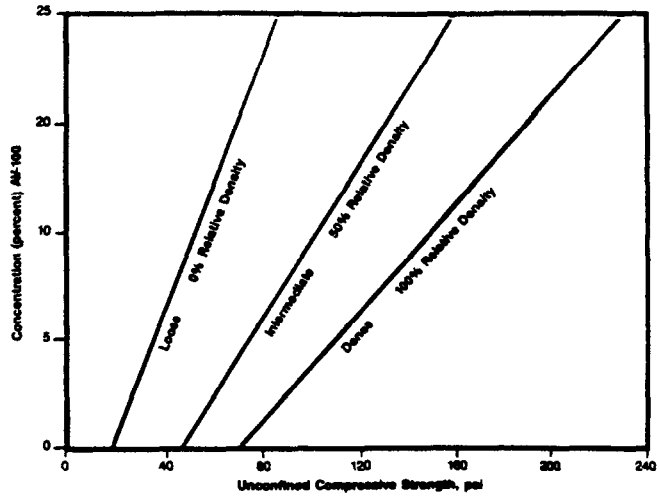

Figure 4. Unconfined compressive strength vs. per cent AV-100 for Soil No. 2, Figure 5.

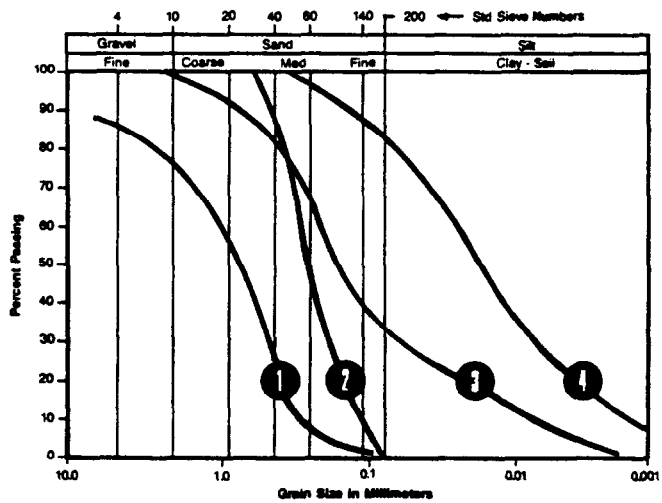

Figure 5. Typical soils injected with AV-100 Chemical Grout.

Permanence

Since AV-100 gel is resistant to attack by fungi, bacteria, dilute acids, alkali and the salts and gases normally found in the ground, gelled soil masses will have similar resistance and permanence. The oldest field jobs for which records are available date back over 25 years. There are no indications of failure or deterioration due to aging. Based on these data and the chemical make-up of the gel, it may be considered permanent.

Resistance to Erosion

Since water will flow around the edges of stabilized soil masses in the ground, resistance to erosion is important. Lab and field experiments to measure this property were conducted in the past by the manufacturer of the acrylamide grout which preceded AV-100.

In the lab, three 4" (10 cm) thick walls of stabilized sand were made using 5, 10 and 15% grout concentrations.

Weirs measuring 1" deep by 4" wide were cut into the top of each stabilized sand wall and water was pumped through the weirs at 7 gpm (0.4 liter/sec). After seven years of continuous flow, the walls and weirs were still in original condition.

In other tests, small dams were constructed of stabilized sand and placed in flowing water. One stretched across a small creek in New Jersey and the other across a large drainage ditch in northern Canada. After more than three years, neither showed signs of erosion or deterioration. Erosion caused by flowing water is not expected to cause any problems in the field.

Permeability

The permeability of a sand or rock mass grouted with AV-100 depends on the extent to which voids or fissures have been filled. The permeability of the mass is essentially that of the gel itself and is on the order of 10^{-9} to 10^{10} cm/sec. This value corresponds to those of the less permeable clays. For most purposes, a completely grouted mass may be considered impermeable.

Creep

Soil masses without intrinsic structural strength may be subject to creep after stabilization when left unsupported under sustained loads. Creep failure should be expected when stress in the mass is a large part of the unconfined compressive strength of the stabilized soil. Shoring or bracing should be used in these cases.

Creep is usually small when soil stresses are below 25% of the highest values obtained from unconfined compression tests.

Consolidation

Consolidation is the decrease in volume due to water loss caused by mechanical pressures. Since AV-100 does have a permeability value (however low), gelled masses will be subject to consolidation under the right conditions. These conditions usually will not exist in water shutoff work with AV-100.

Also, hydrostatic pressure causes AV-100 to absorb water and swell. Since most applications of AV-100 are below the water table, consolidation is not likely to occur.

Properties of Gelled Rock Masses

Rock masses have so much strength that the small amount added by the AV-100 gel is insignificant. The main effect of grouting in rock is to decrease permeability. If grout is placed at fracturing pressures, the shear strength of a rock mass may be reduced by gel entry into new fissures. Fracturing pressure should generally be avoided.

Application Equipment

The many advantages of AV-100 Chemical Grout may not be realized if the right kinds of equipment are not used.

Three basic types of equipment have been used. These are usually called (1) proportioning systems, (2) two-solution systems and (3) batch systems. Of these, the proportioning system is the best, the two-solution system is the easiest to use and the batch system is the most likely to get you into trouble.

Proportioning System

A proportioning, or metering, pumping system allows a degree of gel time control as grout is being placed.

This is very important on many field jobs because it permits almost instant response to changing conditions. For instance, if seepage some distance from the grouting point is determined to be grout, the gel time can be adjusted immediately to stop the seepage.

The range of gel times with a proportioning pumping system is limited only by the percentages of catalysts in the tank solutions. Several examples shown in Figure 6 illustrate how gel times can be controlled by adjusting pump volume ratios. This data is in terms of the volume ratio between pumps and is for equipment containing two pumps. A wider range of gel times could be obtained with a three pump system. Again, this data is based on tests utilizing distilled water and should be used only as a guideline. Gel times obtained with proportioning systems can be accurately tested by drawing a sample of grout from a point between the 'Y' fitting and the grout pipe.

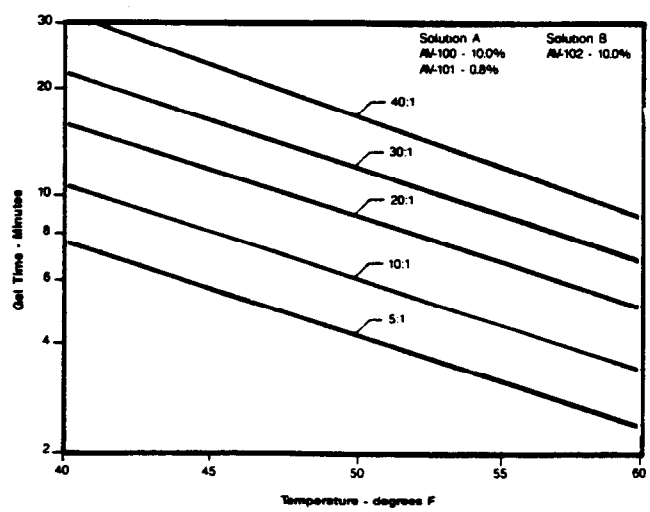

Figure 6. AV-100 gel time control with a proportioning pump system.

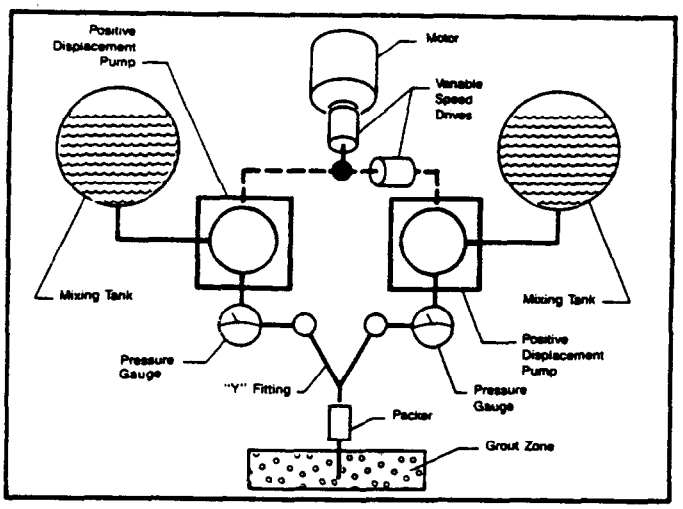

Figure 7. Diagram of a proportioning pump system.

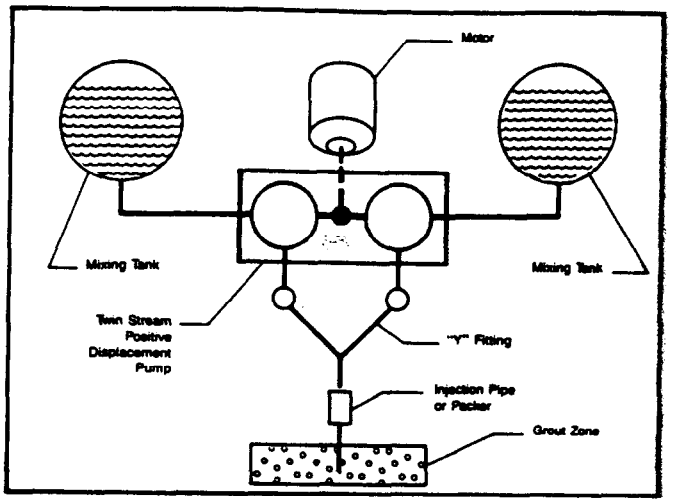

Figure 8. Two-solution pumping system.

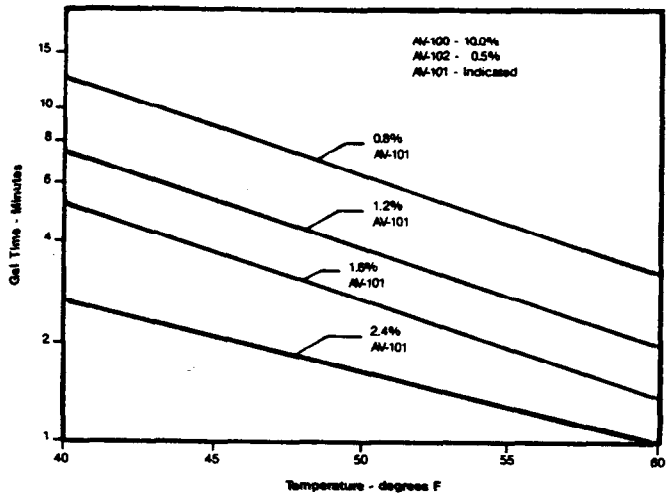

Figure 9. AV-100 gel time data with various AV-101 concentrations and 0.5% AV-102.

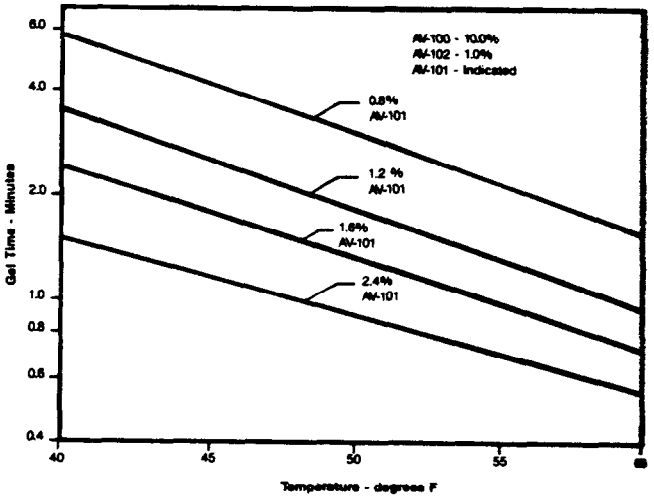

Figure 10. AV-100 gel time data with various AV-101 concentrations and 1.0% AV-102.

Flexibility is the main virtue of a proportioning system. A grout crew often changes gel times, pumping rates and pressures at various times during any application. A proportioning pump system (Figure 7) allows one man to control all of these variables rapidly and precisely. Altering the concentrations of solutions when mixing new batches during application is also eliminated.

Catalyst concentration is the most critical factor affecting gel time. Any dilution by formation water will decrease the catalyst concentration and increase the gel time in the formation. Always consider this factor when pumping grout into rapidly flowing ground water. Except in the case of rapidly flowing ground water, dilution is generally negligible at gel times of five minutes or less.

AV-100, AV-101 Catalyst T+, and KFe (if required) are mixed in one tank and AV-102 Catalyst AP in another.

The pump may be adjusted to move a small volume of AP solution relative to the volume of AV-100 solution. The flow of AP can be altered to produce large changes in gel time without materially changing the concentration of AV-100 in the final mix or the total volume of solution entering the ground. The pump rate can also be changed without changing the gel time.

Dilution by formation water may also affect gel times in the presence of dissolved minerals or water that is acidic or basic. Always use formation water for testing and to make chemical grout solutions to compensate for these factors.

Temperature differences between the grout solution and the formation will also affect gel times, especially when using long gel times.

The capacity of the AV-100 pump is usually about 5 to 15 times that of the AP pump. A separate water source should always be available so that water may be pumped through the system to clear the injection points or the formation next to them.

Proportioning pump systems can be built to handle a wide variety of pressures. These systems also can be used to proportion AV-100 and catalyst solutions into the suction side of many standard grouting pumps.

Two-solution System

The two-solution system (Figure 8) permits working conveniently with only one predetermined gel time. If the gel time must be changed, AP, AV-101 Catalyst T+ or KFe must be added to their respective tanks. Figures 9 and 10 contain data depicting gel times related to AV-102 Catalyst AP concentrations.

AV-100, AV-101 Catalyst T+ and KFe are mixed in one tank and AP in another. Tanks should be identical in size and mounted at the same elevation. Equal volumes of solution are drawn from each tank and fed to separate sides of the pump. The concentrations of chemicals in each tank must be twice that desired in the final grout solution. This system does permit use of very short gel times. A separate water supply is also recommended for this system.

Batch System

By common definition, a "batch" is a mixture of all the materials that make up a grout. By this method, AV-100 and catalysts are mixed in one tank. The batch can then be pumped with almost any type of pump. This system has three major limitations:

1. The entire batch must be placed during the induction period. This is not always possible and the danger of gelation in the equipment is always present.
2. It is hard to change the gel time during pumping.
3. The batch system cannot be used with very short gel times.

For these reasons the batch system is seldom used.

Using Short Gel Times

Cement and other grouts normally placed by batch systems must, naturally, have setting times longer than the time it takes to place the batch. Applicators accustomed to working with such grouts are apt to apply the same procedures and techniques when using AV-100 Chemical Grout. Often it is difficult to visualize how grout can consistently be pumped through a mass that has already gelled. Nevertheless, AV-100 can be placed with gel times somewhat less than the total pumping time with a resulting solid, stabilized mass. The mass is identical, both visually and physically, to that which is obtained by longer gel times. No lenses or fingers of grout can be detected and there is no fracturing of the formation.

The major advantage of short gel times is the limitation of liquid grout flow in the formation. When grout is allowed to move freely in the formation, especially for long periods of time before it turns into a solid gelled mass, its final location and volume is, at best, an educated guess and, at worst, completely unknown. This area of guesswork makes the execution of a grouting design matching specifications simply impossible. In contrast, however, if short gel times are used to make the grout set soon after it leaves the grout pipe or hole, the location of the stabilized mass can be known with reasonable accuracy. Under these conditions, a grout design and field grouting operation is feasible in a predictable manner.

Field Tests

Gel time should always be checked (before grouting starts) for any effect that local water impurities might have on gel time. If gel samples are mixed with soil in the test, they should be made with dry soil to show the true characteristics of the gelled mass. During extended pumping, gel checks should also be taken at regular intervals.

Grout and Catalyst Concentrations

The usual purpose for grouting with AV-100 will be to reduce permeability in a formation. The concentration chosen, therefore, depends on the desired safety factor against dilution. This factor should never be less than three and more often should be higher.

The minimum monomer concentration at which a gel will form is dependent on temperature. Using a safety factor of three against dilution, concentration of AV-100 at 60 degrees F to 80 degrees F (15.6 degrees C to 26.7 degrees C) must be about 10 percent. See Figure 11.

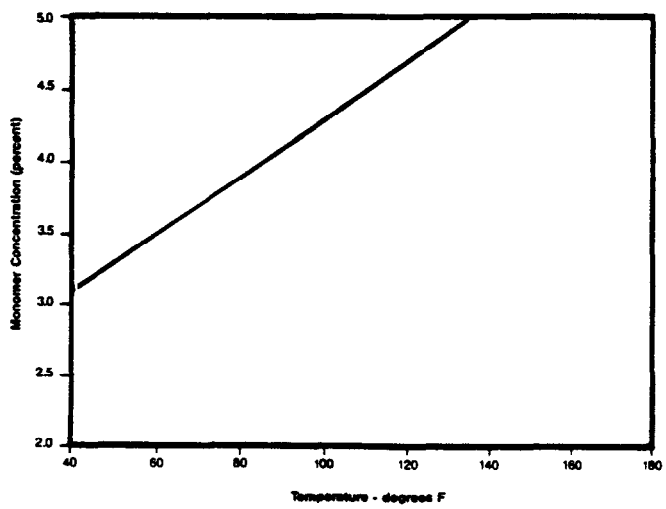

Figure 11. Minimum concentrations for AV-100 gelation.

The concentration of AV-102 Catalyst AP can be changed easily with a proportioning or metering pump system. The AV-101 Catalyst T+, therefore, will stay reasonably constant while the AP concentration can be varied between wide limits. As the proportion of AP to T+ increases, the relative change in gel time decreases. This is demonstrated by the data in Figures 12 and 13 in terms of gel times of 10 percent AV-100 solution at two different temperatures.

Increasing the AP concentration above 1 percent has little effect in decreasing the gel time. Best control (widest range) of gel times is obtained when the AV-102 Catalyst AP concentration is lower than the AV-101 Catalyst T+ concentration.

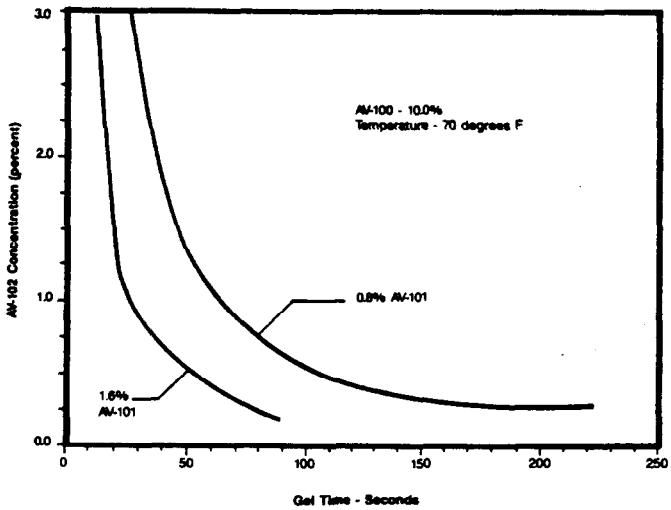

Figure 12. Altering AP concentration with a proportioning pump system.

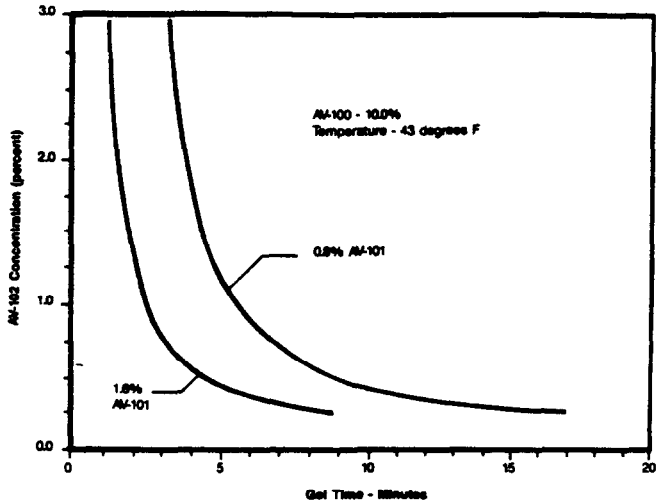

Figure 13. Altering AP concentration with a proportioning pump system.

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American Public Works Association

★ Avanti Product Guide ★

UPDATED DECEMBER 1989

PRODUCT NAME	DESCRIPTION	VISCOSITY	PRIMARY USES
1. **AV-100 ACRYLAMIDE GROUT** AV-101 Catalyst T+ AV-102 Catalyst AP AV-105 Gel Guard	White granular powder, water soluble mixture; gel times from 5 seconds to several hours with variety of additives including portland cement. Uses AV-101 and AV-102 Catalysts.	1.2 CPS in solution	Sewer joint sealing, soil stabilization, water proofing, controlling heavy water flows.
2. **AV-118 DURIFLEX ★ NEW ★** AV-101 Catalyst T+ AV-103 Sodium Persulfate (Initiator)	Duriflex is a non-toxic water solution of acrylic resins. Gel times from 5 seconds to several hours even in flowing water. May be used with various additives. Uses AV-101 and AV-103 catalysts. Resultant gel is firm and adhesive.	1 to 2 CPS in solution	Sewer joint sealing, soil stabilization, waterproofing, controlling flows. High gel compressive strength. Excellent for manhole grouting.
3. **AV-202 MULTI-GROUT** AV-208 Acetone AV-202 Cartridges	Dark brown liquid prepolymer which reacts freely with water in any proportion to form a strong film, foam, or gel. Ideal for complex grouting situations.	2500 CPS to 15-30 CPS in solution	Excellent soil stabilizer. May be pumped initially as foam, then backed up as firm gel. Ideal for use as remedial water stop and void filler.
★ 4. **AV-220 HYDRACURE INJECTION RESIN** AV-221 Accelerator AV-222 Cleaner AV-220 Cartridges	Amber color, water activated prepolymer forms a flexible foam grout with excellent bonding capabilities. AV-221 accelerator can be used to control set time. Use AV-222 Cleaner and AV-208 Acetone solvent.	300-500 CPS	Designed for sealing leaks in cracks and joints in concrete using Variable Pressure Application Technique and EGP techniques.
5. **AV-230 FLEXIFIX** AV-231 Flexiset	Light yellow; a structural 2 component polyurethane resin; flexible. Used in combination with additives.	200 CPS	Crack injection in structural or loadbearing members where movement is large and frequent.
6. **AV-233 FLEXICAST** AV-235 Isoflex	Light yellow; a structural 2 component polyurethane resin; rigid. Used in combination with various additives.	350 CPS	Water cut-off in concrete members, particularly in wet environment where movement is slow and not pronounced and high sealant strength is needed.
★ 7. **SCOTCH-SEAL CHEMICAL GROUT 5600** (Foam) 5601 Accelerator 5602 Cleaner	Light brown liquid prepolymer; reacts with water to form stiff rubber-like solid. Premix appearance like 20 wt. oil. Set time from 5 min. to 24 hours. Used with 5601 Accelerator, 5602 Cleaner, and AV-208 Acetone solvent.	350 CPS+	Injection resin for water leakage through cracks and expansion joints in concrete and masonry structures. Used with Variable Pressure Application Technique or EGP Technique.
8. **SCOTCH-SEAL 5610 GEL** 5611 Gel Control Agent 5612 Gel Reinforcing Agent	Blue liquid resin 600 to 1200 CPS prepolymer. Reacts with 6 to 10 parts water to form stiff gel. Reaction time controllable from 5 seconds to 1 minute. Gel time and strength influenced by 5611 Gel Control Agent and 5612 Gel Reinforcing Agent added to reaction water.	10 CPS in solution	Sewer pipe joints, manholes and vaults; sewage treatment plant structures.
9. **EGP TECHNIQUE** (sealing) AV-219 Fibrotite Oakum AV-215 Resin-Rod	Use Fibrotite Oakum or Resin-Rod with either AV-202 Multi-Grout, Scotch-Seal 5600 (Foam) or AV-220 Hydracure.		Seal large diameter sewer pipe joints, manhole frames, gradierings, and pipe to manhole connections - seals annular space for slipline pipe.
10. **AV-500 HIGH MOD EPOXY GEL** Part A Resin Part B Hardener	A two-component 100% solids epoxy resin system that cures at room temperature. Paste consistency, non-sag, does not shrink, adheres to clean concrete and steel with excellent bond strength.		Formulated to use as a patching grout for holes in manholes, concrete walls, or as a plug while using other grouting materials or injection resins.
11. **AV-510 LOW MOD EPOXY GEL** Part A Resin Part B Hardener	A two-component 100% solids epoxy flexible sealant that cures at room temperature. Paste-like material, easy to trowel and use.		Formulated for filling expansion joints, cracks and openings in concrete floors and walls. After curing, it retains minimal resilience to allow for a small amount of expansion and contraction of the structural joint

★ EGP - Expanded Gasket Placement Technique

PRODUCT NAME	DESCRIPTION	VISCOSITY	PRIMARY USES
12. **AV-530 EPOXY INJECTION RESIN** Part A Resin Part B Hardener	A two-component moisture insensitive 100% solids low viscosity epoxy resin injection system.	125-150 cps Mixture of Part A & Part B	Designed for pressure injection into cracks, delaminations and hollow planes of concrete structures. Used to bond the separated structure back into a monolithic part. Does not shrink during or after curing.
13. **AV-540 STANDARD EPOXY INJECTION RESIN** Part A Resin Part B Hardener	A two-component moisture insensitive 100% solids epoxy resin injection system.	250-350 cps Mixture of Part A & Part B	Designed for pressure injection. Used to bond the separated structure back into a monolithic part. Designed to be injected into concrete cracks, wet or dry. Does not shrink during or after curing.
14. **AV-390 CONCRETE CURE, HARDENER, & SEALER**	A one-component, clear liquid that hardens, seals, cures, dustproofs, stainproofs, and enhances bonding of other materials to the surface of concrete and masonry.		Designed to harden, seal, and assist in the cure of concrete. Will not change appearance or discolor.

OTHER PRODUCTS	DESCRIPTION	PRIMARY USES
15. **OTHER MATERIALS**		
Root Inhibitor - Norosac-AC50-W 4 lb. bag	Dichlobenil herbicide	Mixed with AV-100 or AV-118 to inhibit root growth.
Potassium Ferricyanide (KFe)	Reddish granular material	Used to extend the gel time.
16. **EQUIPMENT** **The Performer™ LPMR** Universal Pump	Air or Hydraulic Drive operation Ratio 1:1 to 18:1. Two models to choose from.	High pressure high volume system used for crack injection and soil stabilization.
Double-Shot Injection Pump	Manual operation switches from low pressure/high volume to high pressure/low volume in seconds.	Hand pump for remote, or inaccessible work sites. Easy to clean. Used for crack injection.
Portable Manhole Pump Pail-Mounted 1:1 x 1:1 Ratio	Pumps 3M Scotch-Seal 5600 and 5610, AV-220 Hydracure and AV-202 Multigrout.	Precast and brick manhole grouting. Resin placement in pipe joints.
Dyes - Water Soluble	Tracer dyes available in several colors	To monitor the flow of chemical sealing gels in the soil or structures.
17. **INJECTORS & MECHANICAL PACKERS**	Used for injection of polyurethanes and epoxies.	
EZ-1 INJECTORS	Most economical high pressure port on the market; easy to install and remove.	
EZ-2 INJECTORS	More flow-thru with same exterior dimensions as the EZ-1. Zerk fitting .19" dia. nozzle port.	
EZ-3 INJECTORS	Button-head fitting adds safety feature. More flow-thru with .28 dia. nozzle port.	
FULL-VENT	Improved design for counter-sinking and for poor concrete. One piece CS shaft, removable zerk for full-vent feature.	
CRACK ATTACK	With .375 dia. nozzle port.	
18. **OTHER INJECTION TOOLS**	S.S. Grout Needles 1/4" and 3/16 Dia. S.S. Wall Spears	
19. **SEWER CLEANING TOOLS**	For cleaning catch basins and manholes without dangerous man entry	
Sewer Tongs	"Ice-tong" design, heavy duty steel construction for lifting heavy objects.	
Sewer Scoop	Collects sand and debris for easy cleaning, spring loaded 5" x 9" scoops.	
20. **SEWER CLEANING NOZZLES**	The nozzle that "really cleans" the bottom of the pipe.	
Sewer Wedge 9#	Tapered wedge design, angled jets - for 6"-10" pipe.	
Sewer Wedge 17#	For 12"-24" pipe.	

★Avanti offers several high pressure Graco and Wagner pumps for your crack injection requirements.

AVANTI INTERNATIONAL

Newsletter

Serving the Industries Which Manage the Movement of Water
In NORTH AMERICA and AROUND the WORLD

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AV-220 Works for Power Substation

by Jerry Boyd

Many ancient cave dwellers were forced to move their families and belongings to another shelter after a heavy rain. This relocation was largely due to the failure of the local waterproofing contractor to hold back the intrusion of water. A primitive form of waterproofing may have consisted of four or five of the contractor's employees stopping the water by holding their fingers in the holes for hours at a time.

Due to the fact that man's belongings and water do not mix, a valuable niche for certain specialists exists. Those that can cope with wearing big rubber boots all the time are known as "waterproofers." The procedural aspects of resolving leaks have improved dramatically. Nevertheless, the frustrations that waterproofers encounter will sometimes echo the cries of our prehistoric ancestors.

Alexandria, Virginia was involved in a project that would tie their station to the Washington MTA's vast system. A room was designed to contain the electrical equipment required to power this multi-million dollar project. For approximately two years, the power substation was a thorn in the side of Dillingham Construction, N.A., the general contractor.

This thorn was due to numerous water leaks which had developed in the electrical equipment room. Sizable amounts of money were spent on redesigning the exterior waterproofing. However, the efforts to redirect the ground water from the room did not have any lasting effects. The water began to intrude when cracks developed in the concrete structure, both in the walls and the floor.

A local waterproofing contractor, Concrete Preservation Corporation (CPC), was called to inspect. The cracks in the walls were the most obvious source of leaking. The following morning, CPC mobilized onto the site and began to dry up the areas. The water was squeegeed to a low spot chipped out in the floor. Then the water could be pumped from this spot to drains located nearby.

AV-220 solves another problem. Eight electrical conduits were leaking at a rate of one gallon per hour.

During the initial inspection, CPC noted that the electrical conduits in the concrete were leaking at a pretty good rate, maybe one gallon per hour. The water from the conduit access had to be drained; therefore, a crude gutter had been installed. This gutter was made from PVC pipe that had been cut in half. It was directing the water to the drain. The conduit access would later prove to be one of the major sources of the depth of water.

High velocity fans were installed in conjunction with the pumps. Soon the room was reasonably dry. Leaking cracks in the walls were noted and marked. The marked cracks were drilled and pumped with an expanding urethane grout. The grout required precise amounts of accelerator to be added and the manufacturer's recommendations were followed to the letter. At the conclusion of the repairs, all the leaks appeared to be sealed against the hydrostatic pressure being applied.

CPC proudly received many pats on the back and statements such as, "It's been a long time since I've seen this room this dry."Unfortunately, the repairs did not hold and CPC had to return for an inspection.

After a few days, the majority of the cracks in the walls were leaking again while some were merely wet. The procedures and products used were discussed with the engineer. He suggested that another product be used, Avanti's AV-220. The engineer had seen AV-220 used successfully on other Metro projects. CPC agreed to give it another go. This time the floor cracks and any other blatant source of visible leaks would be pumped with AV-220.

In the meantime, while the floor was free of standing water, the general contractor applied a penetrating sealer to the floor. The gutters used to divert the flow of water had been removed during the application of the sealer.

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Now CPC had to deal with the leaking water on a daily basis, while pumping the cracks with AV-220.

In an attempt to stem the flow, the general contractor had taken apart and readjusted the seals between the electrical wires and the conduit on three or four separate occasions. A foam was also installed, but to no avail. The water continued to flow rather freely through the conduits.

The conduits continued to be a serious threat to any drying process. The conduits would be repaired after all of the cracks in the concrete were pumped with AV-220. After so many attempts, little confidence was expressed by the general contractor that CPC would be able to successfully stop the flow of water from the conduits.

An EPIC 440e airless piston pump with a Graco control valve was purchased from Avanti and used to install the AV-220. With the exception of decreased volume noted on the smaller model pump, the 440e was found by CPC to be unmatched in the ease of material application, with the exception of decreased volume. The pump provided more than enough pressure. At the end of the day, the 440e was easy to clean with its incorporated by-pass valve. Combined with the forgiving nature of the AV-220, CPC was able to complete the injection of nearly 3,000 lineal feet of crack with minimal crews in a short period of time.

Due to the conditions encountered, technicians found that the mechanical packers were found to be less effective compared to Avanti's EZ-1 injectors. The mechanical packers were unable to withstand the pressures necessary to fill the hairline cracks. A more viable and economical procedure entailed installing the sleeves of the EZ-1 injectors into the holes, pumping the AV-220, and then reusing the injector. CPC found that, with a little extended care, the sleeve could be extracted from the hole. Thus, the sleeve could be reused to pump approximately five or six holes and the injector could be reused on hundreds of holes.

At the conclusion of the crack injection, the walls and the floor were dry with the exception of half a dozen wall cracks. The problems associated with the continued wetness at these cracks were not the fault of the applicator or AV-220. Only the six-inch conduits now remained to be repaired.

The first problem was to get the AV-220 into the conduit. The components that normally sealed the conduits were impossible to access without disassembly and modification. This procedure would consume a large amount of time without guaranteed results.

CPC decided that the best course of action would be to go directly through the conduit. The electrical wires were "hot." Therefore, extreme care was taken to measure the conduit wall thickness in order to avoid nicking the live wires. To accidentally nick one of the wires would be a life threatening mistake. Holes were drilled on the underside of the conduit and threaded with standard tap and die tools. Mechanical packers were then disassembled. The threaded portion (with the zerk fitting) was tightly screwed into the threaded hole in the conduit. This procedure provided

access to the interior of the conduit with capabilities of withstanding any pressure exerted by the pumping operation.

The water flow in the conduit increased as the AV-220 grout displaced the standing water. The first sign of any internal activity was noticed as the flowing water began to carry the activated AV-220. The material was in its infancy of activation. As the pumping continued, the foam began to display more and more signs of maturing. The 440e pump was showing no signs of backpressure. The pumping ceased after one gallon or so of AV-220 was injected.

Expansion continued and within five minutes the semi-activated AV-220 grout was the only thing between the electrical wires and the conduit. Within ten minutes all flow had ceased. Additional AV-220 was pumped into the conduit for good measure. This same procedure was repeated on the remaining conduits with equal success. Within two hours, all six conduits and the floor beneath them were bone dry.

The repairs were received with a "We'll see" skepticism. Previous attempts to stop the leaks had also yielded a day or so of dry conduits. Only time would tell.

Three weeks after the conduits were repaired, a leak did reappear in two of the conduits. It was surmised that the conduits had passed so much water for so long that perhaps the interior walls were dirty. The two conduits were again pumped with approximately one gallon of AV-220. More back pressure was noted during this operation. The first failure, most likely, occurred because the activated AV-220 had fully expanded with little surface to expand against. There has been no further evidence of water.

This method of conduit repair may yield excellent results on the first application, but should be expressed as a "may have to come back" repair technique. Prior to any repair, the material being used should be evaluated and completely explained. This evaluation will often eliminate the automatic assuption of material failure.

Continued on page 4

Presidential Message

F. David Magill, Jr.

We're pleased to feature Charly Hilton in "At Your Service" in this Newsletter. Charly is certainly service-oriented; he is inclined to jump on the next airplane to visit job sites and help our customers. He has been with us since May 15, 1989, and his responsibilities include pumps, injectors, and chemical grouts for concrete repairs, principally in the Eastern U.S. and Canada. Give Charly a call for your grouting needs!

Our next grout seminar will be held April 30-May 1, 1990 at the new Comfort Inn near Dulles airport (Washington, D.C. area). We did not have enough participation to do the Los Angeles-area seminar in February, but would like to do one in that area at some future date. Let us know of your interest. There is a form included in this issue to register for the Washington, D.C. seminar, or to tell us about your interest in another seminar location.

We have tentatively planned a two-day seminar for Myrtle Beach, SC on July 23-24, 1990. We'll arrive on Saturday, of course, and suggest that you do the same. These seminars are excellent opportunities to really learn about chemical grouting products, application techniques, pumps, injectors, and grout costs. We hope you can attend one soon.

We're pleased to announce that Susan Stockton has been promoted to Marketing Manager for the Western United States. Susan will be calling on municipal and industrial customers in states west of the Mississippi River. Debra Hoiseth replaced Susan as Editor of the Avanti Newsletter, and we're proud to have Debra as a new member of the Avanti team.

Avanti now has three outside salespeople, plus one inside salesperson, plus myself, to help you with your water control problems and their solutions. Call us toll-free at 1-800-877-2570, and we'll ship to you from any one of our six regional warehouses in CA, MN, IL, NJ, FL, and TX. We have a complete stock of 3M grout products in each warehouse except IL. AV-100 is stocked at all warehouses except MN. AV-202 is now stocked in TX, FL, CA, and NJ. AV-118 and the catalysts, additives, and cleaners you need are stocked at various locations around the country.

Our new Los Angeles-area warehouse should be fully stocked by the time you receive this Newsletter. We are continually evaluating regional warehouse possibilities to enhance our service to you. Avanti is evaluating several new grouts which will be offered if, and only if, they prove to offer an advantage over existing products in the marketplace.

At the World of Concrete show in Houston, we saw a continuation of the trend for companies to introduce new urethane grouts for sealing cracks in concrete. Some of these are no better than packing foam. They have no adhesion to concrete, no tear strength, no tensile strength, and no compressive strength (they flake and come apart readily under pressure). Do not be misled; just because a product will foam and expand does not mean it will stop water.

Cracks in concrete usually exist because of movement. The successful sealant must be capable of withstanding that movement. A hard, brittle foam will not last in a moving crack. We have over ten years' experience in this field. Check out your needs with our experienced personnel. We can help, and we want to be of service to you!

Have a good day!

F. David Magill, Jr., P.E.
President
Avanti International

AV-100 Longevity Tested

Able Industrial Maintenance and Cleaning, Inc., Fairview Heights, IL, was hired to conduct a longevity check on a 980-foot, 36-inch pipe, for the City of Sauget, IL. This pipe had 326 joints sealed with acrylamide grout. The initial grouting was accomplished during August and September 1985. The product used was AV-100 chemical grout distributed by Avanti International. Approximately 20 gallons of grout were used per joint.

This pipe contained the flow from the chemical/industrial area of Sauget to the treatment plant. The effluent had a pH level which varies between two and 12. The testing began at the treatment plant working upstream. The joints were air tested to a pressure of 12 psi with a hold time of two minutes. The first 50 joints were tested with no failures or leakage whatsoever. At this point the consulting firm terminated the checks on the grouting, totally satisfied that it was still performing to its expectation.

Announcement

For the convenience of our southern California customers, we now have a warehouse location in the Los Angeles area. You may place your order with Avanti and pick your products up at our Webber warehouse located at 13530 Rosecrans Ave., Santa Fe Springs, CA 90670. If you need delivery we will arrange for a local transportation company to deliver to you from the L.A. warehouse, to save on shipping costs.

Guest Editorial

by Jay Schrock
"Mr. Rehab"

The Client

The theme of this Newsletter is stressing service for the customer, the user, and/or the client. It is extremely important to provide these people with a quality product and quality information. This also applies to the Engineering Consultant Community. Consulting is selling a professional service in a professional manner. When this service is inadequate and/or incomplete, it certainly affects the consumer. He is not getting what he expects, wants and/or deserves.

The Consultant must keep himself up to date and participate in continuing education in his practicing field. He must permit his young engineers the opportunity to keep apprised of expanding, evolving technologies. This, of course, uses some of his productive work time; however, ultimately this will also speed up his study and reaction times on subsequent work. Overall, he will like and perform his job more effectively. The client will be happier, and the rewards will be ongoing, and will increase.

Announcement

Mr. B. Jay Schrock, our guest editorial writer (also known as "Mr. Rehab"), is the American Society of Civil Engineers' Pipeline Division 1990 Bechtel Award recipient.

Cement and Chemical Combination

by Todd Edmunds

In early June 1989, Groundation Chemicals Inc. of Georgetown, Ontario received a call regarding an infiltration problem. This particular problem was located in an unfinished Light Rail Transit tunnel. The tunnel runs under a main street near Toronto's Harbourfront.

The tunnel was constructed with reinforced slurry walls with a concrete roof slab. Several vertical construction joints were actively leaking due to failed waterstops and a high water table. There was evidence that fines had washed out. This indicated the existence of voids behind the walls. The infiltration rate was calculated to be in the range of 1-20 gpm, depending on the location, with approximately 20 joints actively leaking.

These joints had been leaking for several months. As the project neared completion, the general contractor had to reduce the water flow to an acceptable leve.

Groundation proposed the use of High Early cement, with an intrusion aid, to grout any large voids within or behind the joints. This procedure was followed with AV-202 Multi-Grout in order to create a final flexible seal against the inflow of water.

Groundation was awarded the contract and mobilized on the site in mid-June. After three (3) weeks the infiltration from 23 joints had been reduced 95%. Two (2) months later, after the completion of the initial contract, an additional seven (7) joints began to leak. Groundation was required to grout the leaks during a follow-up visit.

The entire operation included a total of 180 bags of High Early cement, 10 bags of Intrusion Aid and 30 gallons of AV-202 Multi-Grout.

The general contractor passed his final inspection with no deficiency mentioned regarding the infiltration problem.

The results were so positive that the owners have recommended Groundation to other contractors with similar problems.

Todd Edmunds, General Manager of Groundation Chemicals, Inc., has been in the grouting business for approximately eight (8) years. He is a member of the American Concrete Institute (ACI) and the International Association of Concrete Repair Specialists (IACRS). Groundation Chemicals was developed out of the Cementation Company. Groundation Chemicals has an affiliated company located in Tennessee. Groundation's address is: P.O. Box 9, Brampton, Ontario, Canada L6V 2K7, phone (416) 454-0678.

AV-220 Works . . .

Continued from page 2

Additionally, owners and their engineers should determine the suitability of this product for their particular cable jacketing material. AV-220 contains some acetone and TDI, and these materials may have an adverse effect on the cables themselves.

AV-220 has proven to work in this instance where other materials have failed. Avanti was anxious to support CPC's applicators. Their literature provided excellent technical product information and application techniques. This, coupled with the simplicity of handling and installing Avanti's AV-220, resulted in CPC no longer finding it necessary to employ full time crews to hold their fingers in the holes for even the severest of water leaks.

Jerry Boyd, President of Concrete Preservation, has been in the structural repair business for over 20 years. He is a member of the American Concrete Institute (ACI). Jerry can be reached at 306 S. Kennedy Rd., Sterling, VA 22170, phone (703) 478-9773.

Message from NASSCO President

by Norm Sirna

As I close out my second year as President of NASSCO, I just want to thank all the people and companies who have helped and supported our organization. My 1988 theme NASSCO ON THE MOVE and 1989 theme MISSION POSSIBLE have become a reality. Membership has nearly doubled, the bank balance is in the black, NASSCO is being recognized as a leader in sewer line collection system inspection and rehabilitation (as shown by the sale of spec books and inspection handbooks and by the number of phone calls Jim receives from people wanting information), and by the membership working together. AND A BIG THANKS to the great team of Jim Conklin and Mary Radz, who have made it all come together.

There is no market for gloom. You cannot sell it. What the world wants, needs, and will buy is cheer.

Runway Re-Opened at Municipal Airport

A sixty-inch diameter sanitary sewer pipe was seeping a very fine, silky sand. This pipe was installed in the 1930's and ran directly under Little Rock Municipal Airport, in Little Rock, Arkansas. The seepage caused a 1½-foot depression in the runway. The runway had to be closed to commercial jet traffic.

In 1973, approximately 1,900 joints were grouted with 3M Scotch-Seal 5600 foam grout using an injection device made of ¼" copper tubing. The combination of water and grout was pumped into the pipe joints and cured into a rubbery, flexible, custom-fit gasket.

After inspection, none of the 1,900 seals failed. The runway was reopened after the repair job was completed. This repair is still intact and leak-free (8-1-87).

Buchen S.I.S. Purchases TV/Sealing Div. of Cherne Ind., Inc.

Buchen S.I.S., Inc., of Hopkins, Minnesota announces the purchase of the TV/Sealing Division of Cherne Industries, Inc. Cherne has manufactured television inspection and sealing equipment for sewer lines since 1971. Of particular interest, says Dick Larson, VP and General Manager of Buchen, is the fact that the Cherne sealing system has patents which allow the use of urethane grout as well as all other chemical grouts on the market for this type of equipment. Dick Larson claims this is the best system for urethane grouts manufactured today. "I'm a little partial," says Mr. Larson, "because I was involved in the development of the systems in the early '70s." Buchen claims that because of Cherne's continued development both the TV and sealing systems are very effective and versatile.

The purchase of the TV/Seal division was completed effective January 1, 1990. Buchen physically moved the inventory and assets to their location and was in production within two weeks. "It couldn't have been completed without the right people," claims Mr. Larson. Those "right people" just happened to be the ones Buchen was able to get from Cherne. Buchen brings over 70 years combined experience with their four top management personnel plus two employees in manufacturing. Their experience is in the area of sales, manufacturing, engineering and electronics. These six employees all worked at Cherne for as many as 21 years.

For more information contact Dick Larson, Buchen S.I.S., Inc., 1023 Hill Street, Hopkins, MN 55343. Phone (612) 931-0327, Fax (612) 931-0816.

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Debra Holseth, Editor

At Your Service

Charly Hilton, Avanti's Industrial Marketing Manager (East), has been a member of our team since May 15, 1989. Charly brings with him seven years of experience in designing hydraulic equipment for the oil business. His sales experience includes urethane knowledge obtained in the four years he spent at a chemical company.

Charly can assist you with pumps, injectors and chemical grouting for concrete repairs. Charly's territory covers the area east of the Mississippi River, Canada, the Houston area, and all international customers.

You definitely would not want to step on Charly's toes. He has two black belts in martial arts, one 4th degree in Karate, and one 3rd degree in Jiu-Jitsu. He is also a 2nd level instructor in Kali and a State Representative for the U.S. Karate Association as a police instructor. Charly teaches martial arts four nights a week when he is not traveling. His wife, Susan, works part time as a bookkeeper. They have one child, Heather.

Charly is very service-oriented and able to assist you with your grouting needs. When you call Avanti for help with leaking concrete structures, ask for Charly! 713-554-7541

AV-202 Multi-Grout "Versatility Says It All"

by Charly Hilton

AV-202 Multi-Grout is one of the most versatile injection resins on the market today in the concrete repair industry. Over the last seven years it has been used in more kinds of applications than any other grout in the industry. Many contractors are applying AV-202 in crack injection in dams, tunnels and subways, void filling, soil stabilization, expansion joint repair (with oakum), and most recently the precast manhole industry with excellent results.

There is no other product on the market that you can use which will give you the ability to inject a crack in a wall at 1:1 with a foam. Then with a minor adjustment to your pumping system change your ratio to 8:1 to get a dense, strong gel and consolidate the soil beyond the wall. Many other products have made these claims, but none have stood up to the true test of time like AV-202.

Multi-Grout as a foam has excellent elastomeric properties and less shrinkage than most hydrophilic resins. A tough rubbery end product can be achieved when used in expansion joints with oakum. It will produce a foam when used in ratios of 1:1 to 4:1.

As a gel, Multi-Grout can be used to consolidate soils; and with AV-257 Icoset (reinforcing agent) it will suit almost any environment. It will produce an expansive gel in the 7:1 to 10:1 range or a soft gel in the 12:1 to 20:1 range.

Multi-Grout reacts directly with water, even salt-water, to form a flexible gasket that will shut off water inflow and protect the structure from further deterioration. If high water flow is your problem, AV-202's high viscosity can be a valuable asset to you. It will never form a solid mass even when you let it sit in an open container, and interestingly enough it does foam even without the addition of water. No catalyst or other component is required.

AV-202 is a non-flammable product that can be shipped without red labels, so a lower cost can be paid on freight. It comes packaged in convenient to use caulking-gun cartridges, 1-gallon cans, 5-gallon pails or 55-gallon drums. Many additives can be used and an accelerator is available if your job happens to require either. AV-202 is a very competitively priced product that can work for you on most grouting applications. For your convenience AV-202 Multi-Grout is in stock at our warehouses located in Webster, TX; Orlando, FL; Richmond, CA; and Elizabeth, NJ.

So, next time you have a job to do, call me and let's discuss how AV-202 can help you to solve the problem.

In the Big Inning . . .

by Bill O'Donnell

In the Big Inning, God created Heaven and Earth and Rain. Along came Man and he created Leaky Sewers and Manhole Covers subject to Inflow. And for many years no one cared and waste flowed down the Sewers to the Rivers and Seas.

And Females Shod in Canvas went to Congress in the silent spring and they begat the EPA. And they made a Law, "Thou shalt dump thy Untreated Waste Nevermore."

And terror reigned in the Land of Dumpers. Consultants wept, Officials gnashed their dentures, Developers moratoriumed, Tax Payers rended their minks and Studies were made.

And it came to pass that the Sewers which leaked, were made good, when the Treatment Plants built by Grants begat by studies, begat by Consultants were paid by the EPA begat by Congress. And clean water came to the Land of Dumpers.

And it was that Rich Men in the East driving Royces begat by Rolls came to the West bearing price increases. And the rains came and all was gloom in the Land of Dumpers.

And it came to Pass that the cost of the crude (which makes the volts to cleanse the Crap at the plants that Jack built) increased four fold. And the water table went up and the streets flowed with water and entered unto the Leaks unto the Sanitary Sewer unto the Treatment Plant. And the plant was not able to hold it all and the gates opened and the untreated waste was dumped into the Rivers and Seas.

And the people gathered unto each other and called it INFLOW/INFILTRATION. They raised questions: "Why," they spoke unto their leaders, "do we pay high prices for energy to treat storm water which is good and needs no treatment?"

And Lo, it came to pass, a company came out of the Land of Texas with a chemical which stops Inflow and Infiltration. And it was called "GROUT," and it was Good!

And Dry Basements came to the Land of America and the Land beyond, to the Rivers and Seas, and there was cleanliness to the water forever and ever.

Announcement

Julie Neubauer has recently joined Avanti International as our Receptionist/Secretary. Julie is available to assist you with your sales orders, literature requests and routing your call to the proper person. We're pleased to have her here, and we know you'll be pleased with the service she will give you. When you call Avanti, Julie will be there to receive your call.

STRUCTURAL WATER CONTROL

JAMES APPLEGATH HANK TAYLOR

Epoxy Design Systems Inc.
CONCRETE DOCTORS

1800 SHERWOOD FOREST BLDG. E HOUSTON, TX 77043

HOUSTON, TX 713/461-8733
SAN ANTONIO, TX 512-732-4199

CONCRETE REPAIR

Call Avanti International at 713-554-7541 for information about any of these products.

Epoxies

Avanti has the epoxy you need for trowelable and injectable applications. The trowelable gels are AV-500 Hi-Mod gel and AV-510 Lo-Mod gel. AV-500 can be used for patching holes in manholes, concrete walls, or for filling other openings in concrete. AV-510 can be used for filling expansion joints, cracks and openings in concrete floors and walls providing an effective long-lasting durable filler. The AV-500 and AV-510 can be used as a "plug" while using other grouting materials or injection resins.

The injectable epoxies are AV-530 and AV-540. Both AV-530 and AV-540 can be used for bonding the separated structure back into a monolithic part with a strength equal to or exceeding the original. These materials are designed to be injected into concrete cracks or openings.

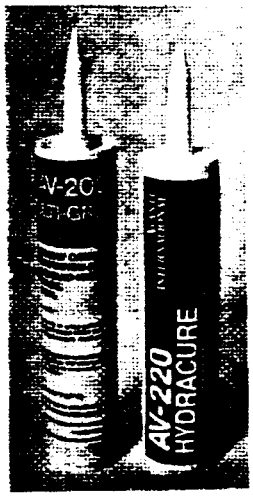
These two component products are sold in 1-, 2-, and 5-gallon quantities. Call Avanti for technical data sheets and samples, or to place your order.

Pumps

Avanti carries a wide selection of pumps to assist you in your waterproofing projects. We carry small pumps for small crack injection jobs and large pumps for high-pressure injection jobs. Call Avanti for assistance in deciding which pump is right for your application project.

AV-215 Resin-Rod

The Avanti Resin Rod is available in 5/8" to 2" diameters and can be used to fill cracks, joints, or holes in a number of different types of pipe or concrete structures. Resin-Rod can be used in the EGP (Expanded Gasket Placement) Technique for sealing cracks, joints, holes, or slipline terminals. Call Avanti for more information.



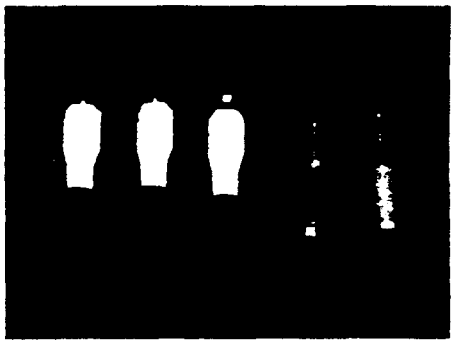
Cartridges

The AV-220 and AV-202 cartridges are available for that small project. The cartridge provides many advantages including: convenience, no loss of product due to open pails or larger containers, and no pumping equipment needed - only a caulking gun. For more information, or to place your order, call Avanti.

For all your manhole grouting needs, AVANTI'S REAL PORTABLE PUMP

AV-102 Ammonium Persulfate

AV-102 Ammonium Persulfate and AV-103 Sodium Persulfate are now available in 25# plastic pails. These products are oxidizing materials and cannot be shipped by UPS in the 50# pails. UPS will transport these materials in the NEW 25# pails now offered by Avanti. If you want your AP or SP shipped via UPS, order the 25# size.



Injectors

Avanti offers a wide selection of injectors and mechanical packers. The EZ-1 injectors are used for placement of urethanes and epoxies. This injector features a .12" dia. nozzle port and a zerk fitting. The EZ-2 injector allows more flow-thru with the same exterior dimensions as the EZ-1. The nozzle port is .19" dia. with a zerk fitting. The EZ-3 injector includes a button-head fitting which adds safety. Also noteworthy is more flow-thru with the .28" dia. nozzle port.

The Full-Vent injector has an improved design for counter-sinking and for use in poor concrete. It has a one-piece CS shaft and a removable zerk for full-vent feature.

The Crack Attack Injector is used to pump urethanes. This injector is reusable. It is a hot item! The nozzle port is .375" diameter.

To order any of these injectors or for more information about their uses, call Avanti.

Rot for Grout Usage in Crack Injection

by Charly Hilton

Almost daily I get calls from a specifier, engineer or contractor on how to estimate the amount of grout they will need for a particular job. My feeling is that experience with a given product is the only true answer but a good "guesstimate" is necessary when bidding a job.

Below I have put together a quick reference chart for "guesstimating" purposes only. This chart looks at the voided crack area only, which we are filling with pure resin. We have to assume that there will be no waste, no expansion, no honeycombing in the wall, no voids to fill beyond the wall, that the crack is consistent throughout and lastly that there is only one crack. I know that seems to be assuming quite a bit, but from the feedback I have received from a few contractors, this chart seems to come close to actual usage.

If your wall thickness is not 12", proportion the thickness you have and multiply that percentage by the chart estimate. I hope this chart helps both of us do our jobs more efficiently.

Volume of Grout in Various Crack Widths

Wall thickness is standard 12"

Crack Width in.	Crack Width mm	Estimate of grout in 100 linear feet of crack
1/2"	12.700	31 gallons
3/8"	9.525	23 gallons
1/4"	6.350	16 gallons
1/8"	3.175	8 gallons
1/16"	1.588	4 gallons
1/32"	.794	2 gallons
1/64"	.397	1 gallon

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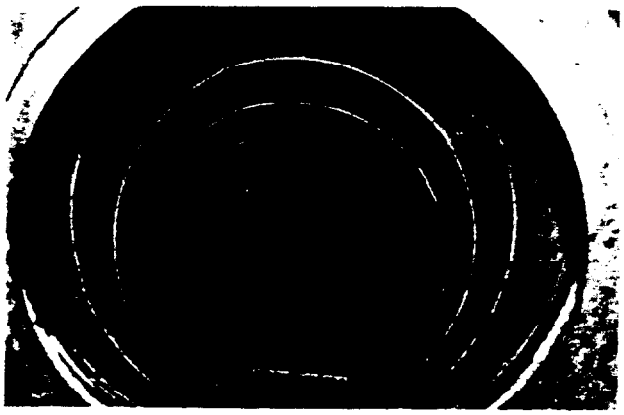

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Out-of-sight pipes lead to out-of-mind problems

by George W. Peak

A bridge collapses outside Memphis, Tenn., killing seven. In New York City, a bridge is shut down to 250,000 commuters. A sewer line collapses, and then a street cracks, swallowing a beer truck in St. Louis.

Sound familiar? It should.

With increasing frequency, we see newspaper and TV reports of bridge and street collapses, we feel the deterioration of interstate highways and we experience the growing inadequacies of airports.

A "Report on Public Works" by the National Council on Public Works Improvements found that the nation's infrastructure is inadequate to sustain a stable and growing economy.

In a report-card grading system for eight public works categories, the highest grade awarded by the council was a B, with others ranging downward to a D.

One reason cited was the drop in public works spending at all levels from nearly 20% of total expenditures in 1950, to less than 7% in 1984.

The council estimates the total capital asset base of U.S. public works at nearly $1 trillion. Unless governments at all levels increase their infrastructure investments by nearly 100% each year, portions of those assets could literally go down a drain.

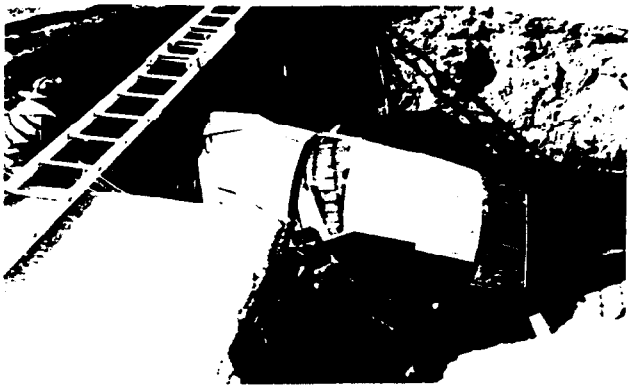
The problem is immense. The council has commissioned more than 60 research papers. The conclusion is that our infrastructure is inadequate to sustain a stable and growing economy.

The recommendation: A national commitment shared by all levels of government, the private sector and the public to vastly improve the country's infrastructure.

Through the 1990s this would mean a doubling of the current level of real public works expenditures from the current $45 billion to $90 billion per year.

Deteriorated bridges, streets, highways, overworked airports, landfill problems and even polluted lakes and streams are often highly visible to elected officials and voting public. Consequently, they have attracted the most rehabilitation dollars in the past.

According to a May 1989 report by Merrill Lynch, spending on infrastructure projects is expected to accelerate in the 1990s. But, most of this is directed toward visible infrastructure.



St. Louis' crumbling infrastructure led to this accident, where a car fell through the pavement.

In the meantime, leaking and otherwise deteriorating underground piping systems take their toll. Many older communities, for example, experience declines in drinking water quality and water pressure due to pipe leaks.

Replacement costs may run as high as $1 billion annually. Leaking water mains mean lost revenue to the water utility and/or higher pass-through costs to consumers.

Leaking underground sanitary sewer systems cause additional problems. Exfiltration of raw sewage and industrial discharge through leaking pipes contaminate soil and groundwater. In other cases, infiltration of ground water through leaky joints and cracks in the pipe can lead to excess cost at the treatment plant or pipe collapse.

One EPA study from several years ago noted that 3,000 sewer systems suffered severe infiltration/inflow problems resulting in the treatment of one third more wastewater than necessary.

Billions have been spent at all levels of government to meet requirements of the Clean Water Act. As a result, in its 1988 Needs Survey, the federal Environmental Protection Agency has proclaimed that 87% of the nation's 15,591 wastewater treatment facilities are now in compliance.

Unfortunately, very little of the EPA's construction grants have gone toward rehabilitation or replacement of the country's 19,782 collection systems. Of the $67.9 billion required to meet 1988 wastewater needs the EPA says 64.5%, or $43.8 billion, is sewer related.

Included in this are need categories for infiltration/inflow correction, replacement/rehabilitation, new collectors and new interceptors and combined sewer overflows.

Funding for these needs is short and a deferred maintenance, out-of-sight, out-of-mind philosophy still prevails in many areas across the country.

Now, however, technologies are in place that can solve underground infrastructure problems. Others are appearing on the scene for future consideration.

New alternative-financing methods have been proposed that range from a national infrastructure bank to privatization to leasing. Most, however, end up with the same final concept - the user pays.

Water and sewer utilities across the country, both public and private, are examining their user-fee base and restructuring fees upwards to meet projected needs. Concurrently, utilities are instituting developer fees to cover the cost of new water and sewer lines. These, in turn, are passed on in the form of higher construction costs.

Utilities are defining and evaluating their needs. Many are looking for creative ways to reduce spending on capital and maintenance as well as ways to extend the useful life of their underground assets.

The nation's underground arterial lifelines must be preserved. To reverse years of neglect, the following steps are suggested:

· Assess the condition of your current piping system, evaluate proven cost-effective alternatives for repair, and budget accordingly. Develop a master

Continued on page 12

SHOW BIZ

World of Concrete

The 1990 World of Concrete Show was "bigger and better than ever" as promised. Houston's Astro Hall, Arena and Dome were filled to capacity with exciting new technology for the concrete industry.

Visitors to the Avanti booth were greeted by David Magill, Charly Hilton, Susan Stockton, and Jayne Gilker. Bill O'Donnell couldn't resist the fun of a show and dropped in to "mix up" Avanti's magic materials.

Avanti hosted a hospitality suite at the Astro Village Hotel in conjunction with the show. Thanks to all of our friends, valued customers, and new acquaintances for attending. A good time was had by all!

SWRI

Charly Hilton attended the SWRI annual meeting held at the South Seas Plantation on the breathtaking Captiva Island located off the west coast of Florida. The new officers and board members were placed into office. Attendance was good with 118 out of 130 members participating. Charly's wife, Susan, was able to accompany him. The facilities and food were great. Charly's condo had a fabulous view overlooking the beach. Beautiful weather was enjoyed along with the jet skiing and boating.

NASSCO Annual Meeting

David Magill and Bill O'Donnell attended the NASSCO annual meeting. This year's meeting was held March 4-7 at the Belleview Biltmore Resort Hotel in Belleair/Clearwater, Florida. The first international president, Doug Runge, took office for the new term.

IACRS

The Royal Plaza Trade Center hosted the first IACRS Conference and Trade Show in Marlborough, MA. Charly Hilton manned the Avanti booth. Forty-two exhibitors participated in the New England show. Two seminars per day were offered with approximately 35-40 participants each.

Cues Seminars

William O'Donnell was guest speaker at two of the Cues Seminars. The first seminar was held February 21 in Richmond, Virginia. The second seminar was held February 22 in Annapolis, Maryland. Willie's presentations were about grouting and sealing in sewer and manhole rehabilitation. Attendance was good with over 90 participants in each seminar.

Charly Hilton was guest speaker at the Cues Seminars held in Salt Lake City, Utah and Denver, Colorado in March.

Upcoming Events

Avanti Grout Seminar

On April 30 and May 1, Avanti will hold a Grout Seminar at the new Dulles Comfort Inn in the Washington, DC area. Make your plans now to attend this two-day course. Dan Johnson (3M Company), Dick Larson (Buchen S.I.S.), Allen Thomas (Cues, Inc.), David Magill, Charly Hilton, and Bill O'Donnell (Avanti) will be speakers. Debra Hoiseth (Avanti) will be there to assist you in any way possible. The cost of the seminar is $295 per person and $195 for an additional person from the same organization. Handouts, seminar materials, breakfasts and breaks will be provided. The hotel is conveniently located near the airport for easy access to fly-in clients.

To register, please call, and we will send you the hotel brochure and registration form. We have obtained a discount for the hotel rooms. Call today! 1-800-877-2570

The following Grout Seminar is tentatively scheduled for July 23-24, 1990 in Myrtle Beach, SC. We will keep you posted with future fliers.

CUES Seminars

CUES, Inc. has tentatively scheduled two one-day seminars in the month of April. The first seminar is scheduled for April 17 in Charlotte, NC, and the second seminar is scheduled for April 19 in Birmingham, AL. For more information, or to register for these or other upcoming CUES SEMINARS, call Joy Markowitz at 407-849-0190.

SPECcon Southeast

The 10th Anniversary SPECcon Southeast Trade Show and Conference will be held at the Orlando Expo Centre in Orlando, FL, May 16 and 17. Avanti International will be exhibiting in booth 379. We're looking forward to seeing you there!

Fundamentals of Grouting 12th Annual Short Course

Engineering Continuing Education, University of Missouri-Rolla, will present a grouting course April 30-May 4, 1990. The course covers a variety of grouting methods. It will be held at the Sheraton Hotel & Conference Center, Lakewood, CO. The fee for the course is $1,250.00. For more information, please call 1-800-752-5057.

Sewer Rehabilitation Seminar

by F. David Magill, Jr.

The sewer rehabilitation industry is relatively young, compared to the science of new pipe installation, for example. For most of the techniques to be described, commonplace usage dates back only to the 1960's at the latest. Engineers, inspectors, and owners of sewer systems may be seeing certain rehabilitation techniques for the first time.

As seen in the United Kingdom and Europe, there is a great need for sewer rehabilitation. Not only is removal and replacement of sewers more expensive than in-place rehabilitation in a general sense, but also the increase in population density has greatly increased the complexity and cost of removing and replacing old or broken sewers. Today's underground pipelines are overlaid by conduits placed by telephone, electric, water and gas companies, in addition to storm sewers, cables, and industrial pipelines in some cases. We are increasingly aware of the value of the "tunnel in the ground" represented by an existing sewer. This has been apparent in other countries with older sewer systems; consequently, sewer rehabilitation has advanced more rapidly abroad. Likewise, it has been demonstrated in several cities that the value of the entire sewage system is primarily the collection system, not the sewage treatment plants as some of us might suspect.

The equipment, skilled operators, and materials used in today's sewer rehabilitation efforts are complex compared to only a few years ago. As changes occur in the design and implementation of sewer rehabilitation techniques, a "technology transfer" is necessary to inform interested groups of these advantages. Avanti International wants you to have the facts on the proper application of sewer rehab techniques. Avanti offers a Sewer and Concrete Rehabilitation Seminar to provide an overview of the uses, advantages, limitation, and costs of chemical grouting.

Some contractors prefer that their clients remain in the dark about the hows and whys of their rehab techniques. We want you to have confidence in the project you are considering - to rehabilitate rather than remove and replace. Sewer rehabilitation is that body of techniques and procedures that we need to maintain our infrastructure. After all, each of us is a taxpayer; and all of us want to see our tax dollars used in the most cost-effective manner. We all have a stake in making sewer rehabilitation the specialty industry that it deserves to be - an industry that is vital to our economy and our well-being.

To insure that you do not "remain in the dark" on the hows and whys of rehab techniques, contact Avanti International and sign up for the Washington, DC seminar scheduled for April 30th and May 1st!

AVANTI INTERNATIONAL

The Water Stops Here

Catalog Update

If your catalog has not been updated within the past two years, or should you require a catalog, please let us know so we may send you our current literature. The current catalog is distinguished by the yellow index located in the front. For your updated catalog, call 713-554-7541.

To register for the Avanti Grout Seminar in **Washington, D.C. April 30-May 1,** please fill out the information below and mail to: **Avanti International, 16920 Texas Ave., Ste. C-7, Webster, TX 77598**

Organization _____

Address _____

City, State, Zip _____ Telephone (___)_____

Names of attendees:

Name _____ Title _____

Name _____ Title _____

The cost of the seminar is $295.00, additional attendees from the same organization may attend for $225.00 each. You must notify Avanti 7 days prior to the seminar date for registration refund.

- ☐ Charge my MasterCard Account # _____
- ☐ Charge my Visa Account # _____
- ☐ Enclosed is my check in the amount of $ _____
- ☐ Please send more information on this seminar.
- ☐ Please send information on other Avanti grouting seminars.

Your hotel brochure and hotel registration form will be mailed to you upon receipt of this form. If you have any questions, please call Debra Hoiseth, 1-800-877-2570.

Continued from page 9

plan for time-framed implementation that starts with the most critical portion of the system.

· Examine your user and connection fees and develop a program for bringing them to appropriate levels to match assessed needs.

· Evaluate funding alternatives including grants, loans and creative financing techniques.

· Develop a creative, meaningful communications program that will carry your message to the voting public and to others who can influence funding appropriations and rates.

· Institute programs on a timely basis, adjust as required and report progress in a meaningful manner to constituents, pointing out savings received and other benefits.

George Peak is chairman of the Infrastructure Awareness Task Groups of both the ASCE Pipeline Infrastructure Committee (PINS) and the National Association of Sewer Service Companies (NASSCO).

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