MACTEC

December 19, 2003

Mr. Lance V. Borden, P.E.
Modjeski and Masters, Inc.
4909 Louise Drive
Mechanicsburg, Pennsylvania 17055

Subject: **Report of Geotechnical Exploration**
Gilmerton Bridge Replacement
Chesapeake, Virginia
VDOT Project No. 7013-131-V03, PE101, B615
MACTEC Project No. 20400-2-1213

Dear Mr. Borden:

MACTEC Engineering and Consulting, Inc. (MACTEC) is pleased to submit six copies of our report of geotechnical exploration for the Gilmerton Bridge Replacement project. Our services were provided in general accordance with our contract dated September 23, 2002. This report presents a review of the information provided to us, a discussion of the site and subsurface conditions encountered, and our geotechnical recommendations. The appendices contain site and boring location plans, site geology map, results of our field and laboratory tests, and the results of selected engineering analyses.

We would be happy to discuss our recommendations with you and would welcome the opportunity to provide the additional studies or services necessary to complete this project. We look forward to serving as your geotechnical engineer on the remaining portions of this project and on future projects.

Very truly yours,

MACTEC ENGINEERING AND CONSULTING, INC.

J. Randy Wirt
J. Randy Wirt, P.E.
Project Engineer

C. Eric Burke
C. Eric Burke, P.E.
Principal/Project Manager

J. Allan Tice
J. Allan Tice, P.E. by _____ with permission
Senior Principal

COMMONWEALTH OF VIRGINIA
C. ERIC BURKE
No. 031152
12/19/03
PROFESSIONAL ENGINEER

JRW/CEB/JAT:jrw/lzb

cc: Fred Aicholtz (1)
Larry Moore (1)
File (1)

MACTEC Engineering and Consulting, Inc.
1606 Ownby Lane • Richmond, VA 23220
804-358-7111 • Fax: 804-358-6646

TABLE OF CONTENTS

Section **Page**

1.0 INTRODUCTION 1-1
1.1 GENERAL 1-1
1.2 SCOPE OF SERVICES 1-1
1.3 AUTHORIZATION 1-2

2.0 PROJECT INFORMATION 2-1
2.1 PROJECT OVERVIEW 2-1
2.2 EXISTING STRUCTURES 2-1
2.3 DESIGN INFORMATION 2-1
2.3.1 Vertical Lift Span 2-2
2.3.2 Approach Spans 2-3
2.3.3 Bridge Abutments and Wingwalls 2-3
2.3.4 Bridge Approach Embankments 2-4
2.3.5 Dolphin and Fender System 2-4
2.3.6 Construction Staging 2-5

3.0 SITE CONDITIONS 3-1

4.0 GEOLOGIC CONDITIONS 4-1
4.1 REGIONAL GEOLOGY 4-1
4.2 SITE GEOLOGY 4-1

5.0 FIELD EXPLORATION 5-1
5.1 SUBSURFACE EXPLORATION PROGRAM 5-1
5.1.1 Piezocone Penetration Testing (CPTu) 5-2
5.1.2 Flat Blade Dilatometer (DMT) 5-3
5.1.3 Standard Penetration Testing (SPT) 5-4
5.2 PREVIOUS FIELD EXPLORATION PROGRAM 5-5

6.0 LABORATORY TESTING 6-1
6.1 CLASSIFICATON AND INDEX PROPERTY TESTING 6-1
6.2 CONSOLIDATION TESTING 6-1
6.3 CONSOLIDATED-UNDRAINED TRIAXIAL SHEAR STRENGTH TESTING 6-2
6.4 TOTAL ORGANIC CARBON (TOC) TESTING 6-2
6.5 PREVIOUS LABORATORY TESTING DATA 6-2

7.0 GEOTECHNICAL RECOMMENDATIONS 7-1
7.1 METHODOLOGY 7-1
7.2 STRATIFICATION 7-1
7.2.1 Holocene Alluvium Sand and Clay 7-1
7.2.2 Norfolk Formation 7-2
7.2.3 Yorktown Formation 7-3
7.2.3.1 Yorktown Y2 7-3
7.2.3.2 Yorktown Y1 7-4
7.3 GROUND-WATER CONDITIONS 7-4

8.0 BASIS FOR RECOMMENDATIONS 8-1
8.1 EVALUATION OF ENGINEERING PROPERTIES 8-1
8.1.1 Unit Weight 8-2
8.1.2 Effective Friction Angle 8-2
8.1.3 Undrained Shear Strength 8-2
8.1.4 Poisson's Ratio 8-3
8.1.5 Soil Modulus 8-3
8.1.6 Small-Strain Shear Modulus 8-3
8.1.7 Soil Strain 8-4
8.1.8 Allowable Unit Side Resistance 8-4
8.1.9 Unit End Bearing 8-4
8.2 FOUNDATION ALTERNATIVES 8-5
8.2.1 Concrete-Filled Steel Pipe Piles 8-5
8.2.2 Drilled Shafts 8-6
8.3 VERTICAL LIFT SPAN 8-7
8.3.1 Subsurface Conditions 8-7
8.3.2 Axial Capacity Analyses 8-8
8.3.3 Foundation Settlement 8-8
8.3.4 Lateral Load Analyses 8-9
8.4 APPROACH PIERS 4 – 8 AND 11 – 15 8-10
8.4.1 Axial Capacity Analyses 8-11
8.4.2 Foundation Settlement 8-12
8.4.3 Lateral Load Analyses 8-12
8.5 APPROACH PIERS 1 – 3 AND 16 – 18 8-13
8.5.1 Axial Capacity Analyses 8-13
8.5.2 Foundation Settlement 8-13
8.5.3 Lateral Load Analyses 8-14
8.6 BRIDGE ABUTMENTS AND WINGWALLS 8-14
8.6.1 Axial Capacity Analyses 8-14
8.6.2 Downdrag Considerations 8-15
8.7 DOLPHINS AND FENDER SYSTEM 8-15
8.8 CONSTRUCTION RECOMMENDATIONS 8-16
8.8.1 Drilled Shaft Construction Recommendations 8-16
8.8.1.1 Drilled Shaft Installation Monitoring 8-16
8.8.1.2 Drilled Shaft Load Test Program 8-18
8.8.2 Driven Pile Construction Recommendations 8-19
8.8.2.1 Pile Installation 8-19
8.8.2.2 Pile Installation Monitoring 8-19
8.8.2.3 Pile Load Test Program 8-20
8.8.3 Concrete-Filled Steel Pipe Construction Recommendations 8-22
8.9 ADDITIONAL GEOTECHNICAL CONSIDERATIONS 8-22
8.9.1 Pre-construction Condition Surveys 8-22
8.9.2 Scour Analysis 8-22
8.9.3 Typical Foundation Costs 8-23
8.9.4 Construction Plans and Specification Review 8-24

9.0 BASIS FOR RECOMMENDATIONS 9-1

10.0 REFERENCES 10-1

APPENDICES

APPENDIX A - FIGURES

Figure 1: Site Vicinity Map
Figure 2: Geology Site Location Map
Figure 3: Boring Location Plan
Figure 4: Subsurface Profile
- Figure 4A: Subsurface Profile Abutment A - Pier 3
- Figure 4B: Subsurface Profile Piers 3 - 7
- Figure 4C: Subsurface Profile Piers 8 - 10
- Figure 4D: Subsurface Profile Piers 11 - 15
- Figure 4E: Subsurface Profile Pier 16 – Abutment B

APPENDIX B - FIELD OPERATIONS

Field Operations
Soil Sampling Procedures
Key to Symbols and Classifications
Test Boring Records – (6)
Previous Test Boring Records – (11)
CPTu Sounding Logs (22)
CPTu Dissipation Data
CPTu Seismic Data
DMT Sounding Logs (3)
DMT Dissipation Data

APPENDIX C - LABORATORY TESTING

Laboratory Tests
Table C1: Laboratory Testing Summary
Table C2: Previous Y2 Laboratory Testing Summary
Summary of Soil Classification Test Data (6)
Consolidation Test Reports (4)
Consolidated-Undrained Triaxial Test Reports (5)
Particle Size Analysis Test Reports (32)
Total Organic Carbon (TOC) Test Reports (14)
Previous Laboratory Test Data
- Water Content (6)
- Atterberg Limits (6)
- Wash No. 200 Sieve Analysis (6)
- Consolidation Test Report (1)
- Consolidated-Undrained Triaxial Test Report (1)

APPENDIX D – TIME RATE OF SETTLEMENT AND LATERAL LOAD ANALYSES

Time Rate of Settlement Graph
GROUP Output Files

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the design of approach pier substructure foundations, vertical lift span substructure foundations, abutments, and retaining walls for construction relative to the Gilmerton Bridge Replacement project. The project consists of the construction of a replacement bridge for the State Route 13 (SR 13) crossing over the Southern Branch of the Elizabeth River in Chesapeake, Virginia.

The recommendations developed for this report are based on project information supplied by the Virginia Department of Transportation (VDOT), Modjeski & Masters, Inc. and Gannett Fleming, Inc. This report contains the results of our subsurface explorations and laboratory testing programs, site characterization, engineering analyses, and recommendations for the design and construction of the Gilmerton Bridge Replacement project.

1.2 SCOPE OF SERVICES

To obtain the necessary geotechnical information required for design of the replacement bridge and associated abutments and retaining walls, six standard penetration test (SPT) soil test borings, twenty-two piezocone penetration tests (CPTu), and three flat blade dilatometer (DMT) soundings were performed at locations selected by MACTEC and VDOT. In general, the borings and soundings were located at regular intervals along the planned alignment of the replacement bridge to include approximately one exploration at each proposed pier or tower foundation location. Two explorations were located at each abutment location and four explorations located at planned locations of abutment wing walls. A laboratory testing program on samples collected from the SPT borings was also implemented to aid in characterizing the physical and engineering properties of the subsurface soils.

This report discusses our exploratory and testing procedures, presents our findings and evaluations and includes the following:

- A brief review and description of our field and laboratory test procedures and the results of testing conducted.
- A review of surface topographical features and site conditions.
- A review of area and site geologic conditions.

- A review of subsurface soil stratigraphy with pertinent available physical properties.
- Final copies of our soil test boring logs.
- Estimated subsurface profiles to illustrate subsurface conditions encountered.
- A review of previous foundation and earthwork construction experience in the area of the proposed project.
- Review of alternative foundation types for bridges and retaining walls including performance and constructability issues.
- Recommended foundation types for the project structures, including design capacities and estimated bearing depths.
- An evaluation of potential downdrag forces on abutment and retaining wall piles.
- Evaluation of foundation performance (settlement) based on available data.
- Evaluation of the proposed construction on the existing site and adjacent site infrastructure and recommendations to minimize impacts to these facilities.
- Recommended lateral earth pressures for use in design and construction of retaining walls and abutment walls, including general construction criteria.
- Recommendations for site preparation and construction of compacted fills, including an evaluation of on-site soils for use as compacted fills.

Engineering Geology sheets presenting logs of the SPT soil test borings will be provided under separate cover.

1.3 AUTHORIZATION

Our services were provided in accordance with our Stage II Proposal No. 20399-0-0000.823 dated August 13, 2002 and the subsequent contract between Modjeski and Masters and MACTEC dated September 23, 2002.

2.0 PROJECT INFORMATION

2.1 PROJECT OVERVIEW

Our understanding of the project is based on discussions with Messrs. Lance Borden and Mike Irwin of Modjeski & Masters, Mr. Fred Aicholtz of Gannett Fleming, and various VDOT personnel and review of the various plans that were provided to us over the course of the project.

The Gilmerton Bridge Replacement project will consist of the construction of a replacement bridge for the SR 13 crossing over the Southern Branch of the Elizabeth River. The Gilmerton Bridge replacement will be an 82- to 92-foot wide, four-lane bridge and will be constructed approximately 26 feet higher than the existing bridge. The proposed replacement bridge is located and laid out as shown in Figure 1 in Appendix A.

2.2 EXISTING STRUCTURES

The existing bridge is a four-lane, fourteen-span drawbridge located approximately 40 to 50 feet north of an existing railroad truss drawbridge. At the centerline of the existing channel, the vertical clearance is approximately 15 feet and the channel width is approximately 125 feet. As shown on as-built plans dated July 16, 1938, the existing Gilmerton Bridge approach and bascule piers are supported on timber piles ranging from 40 to 60 feet in length corresponding to pile tip elevations ranging from -60 to -70 feet. Based on as-built drawings dated July 23, 1965, we understand that the piers of the existing railroad bridge are supported on vertical timber piles ranging in length from 30 to 60 feet corresponding to a range of bearing elevations of –55 to –80 feet respectively.

2.3 DESIGN INFORMATION

Our understanding of the project grades and bridge details is based on a review of the Stage II 60-percent design plans provided by Modjeski & Masters and dated September 2003. The replacement bridge will consist of eighteen 88-foot long approach spans with a 334-foot long vertical lift span above the navigable channel. The approach span spacing was chosen to minimize impacts on existing structures. Detailed information regarding the planned design and construction of the replacement bridge is presented in the following subsections.

2.3.1 Vertical Lift Span

The lift span bridge section will consist of an 89-foot wide and 334-foot long steel vertical lift girder located at the main channel crossing. The legs of the towers for the lift span are spaced approximately 89 feet center-to-center transversely and 38 feet center-to-center longitudinally. The ultimate navigable channel width will be approximately 200 feet following replacement of the existing railroad bridge at a future date. The replacement Gilmerton Bridge will be constructed approximately 26 feet higher than the existing truss drawbridge, thus reducing the number of openings required.

The southern side of the replacement bridge will be located approximately 20 to 30 feet north of the northern edge of the railroad bridge. At their closest point, the foundations for the proposed lift towers will be about 15 feet (edge-to-edge) north of the existing railroad bridge foundations.

Loading conditions for the vertical lift span were provided by Messrs. Mike Irwin and Kevin Johns of Modjeski and Masters in September 2003. Two controlling loading conditions were provided to MACTEC for lateral and axial capacity analyses and evaluation of foundation settlement. The loads, as applied to the group of four foundation elements for each lift span tower, are summarized in Table 2.3.1.1.

Table 2.3.1.1
Summary of Loading Conditions for Vertical Lift Span Foundations

Load Type and Direction[1]	Maximum Lateral Loading Combination	Service Loading with Ship Impact Distributed Load
Vertical Force, F_x (kips)	10,662	7,946
Horizontal Force, F_y (kips)	558	5,500 [2]
Horizontal Force, F_z (kips)	552	0
Torsional Moment, M_x (kip-ft)	242	0
Moment, M_y (kip-ft)	24,848	64,408
Moment, M_z (kip-ft)	10,488	0

Notes:

[1] X = vertical direction
Y = transverse direction
Z = longitudinal direction

[2] The 5,500 kip ship impact lateral load was applied as a distributed load of 100 kips per foot over 55 feet of the tower leg foundation element from elevation +19 to -36 ft.

The new lift span will straddle the existing bridge. Accordingly, construction of the new approach spans will be performed in two stages to allow for maintenance of traffic requirements. The first stage will consist of construction of the southern portion of the bridge between the existing Gilmerton Bridge and the railroad bridge.

2.3.2 Approach Spans

Piers for the approach spans will be constructed east and west of the vertical lift span structure. The approach spans will consist of eighteen spans ranging from 82- to 92-feet wide with a length of 88 feet. The superstructure of the approach piers, which will be constructed as prestressed concrete type PCBT-61 beam spans, will connect to the pile cap via concrete pier columns.

Gannett Fleming provided MACTEC two controlling loading conditions for the approach spans which are summarized in Table 2.3.2.1. The loads presented are per pile or shaft including 5- and 6-foot diameter drilled shafts and 24-inch prestressed concrete (PSC) piles. We understand that Piers 1 through 3 and 16 through 18 will be supported on PSC piles and Piers 4 through 8 and 11 through 15 will be supported on drilled shafts or large diameter concrete-filled steel pipe piles.

Table 2.3.2.1
Summary of Loading Conditions for Approach Pier Foundations

Load Type and Direction [1]	Maximum Vertical Service Load			Maximum Lateral Loading		
	5-foot diameter foundations	6-foot diameter foundations	24-inch PSC piles	5-foot diameter foundations	6-foot diameter foundations	24-inch PSC piles
Axial Load, F_x (kips)	671	770	143	558	558	160
Lateral Load, F_z (kips)	-	-	-	22	22	9
Bending Moment, M_y (kip-ft)	-	-	-	761	761	-

Notes:

[1] X = vertical direction
Y = transverse direction
Z = longitudinal direction

2.3.3 Bridge Abutments and Wingwalls

Pile-supported abutments and associated wingwalls are proposed to support the roadway approach fill. MACTEC was provided with loading conditions for the abutments and wingwalls in October and

November 2003, respectively. Currently, 24-inch PSC piles are planned as the foundation alternative for the abutments. As of the Stage II 60 percent design stage, a total of 30 piles will be used to support Abutment A and 32 piles will be used to support Abutment B. The front row of piles (closest to the river) will be driven on a 3(H):12(V) batter and spaced at 3D center-to-center, where D is the diameter of the PSC pile. The back row of piles will be vertical with a spacing of approximately 6.5D. The anticipated loading per pile is approximately 150 kips and 130 kips for the front and back row piles respectively.

2.3.4 Bridge Approach Embankments

Maximum fills on the order of 12 feet will be required along SR 13 to construct the bridge approaches. Concrete wingwalls as part of the abutment will be used to support the approach fills. Two rows of 24-inch PSC piles are proposed to support the retaining walls. The front row of piles will be battered at 3(H):12(V) and spaced approximately 4D center-to-center. The back row of vertical piles will spaced at 4D center-to-center. The two rows of piles are spaced 3D center-to-center along the length of the walls.

2.3.5 Dolphin and Fender System

Sheet pile dolphins are planned north of the proposed alignment to protect the approach and vertical lift span bridge piers from vessel collision. A summary of the location and size of the proposed dolphins is presented in Table 2.3.5.1.

Table 2.3.5.1
Summary of Sheet Pile Dolphins

Station	Diameter of Dolphin (ft)	Offset Distance[1] (ft)	Offset Direction (Left/Right)
28+84	35	94	Left
29+69	35	94	Left
30+54	35	94	Left
31+39	35	94	Left
32+19	45	88	Left
32+72	35	28	Right
34+34	35	28	Right
34+87	45	88	Left
35+70	40	91	Left

Notes: [1] Distance measured from centerline of new bridge.

A new fender system will be installed to protect the drilled shaft foundations located on both the east and west sides of the vertical lift span bridge. The new fender system will connect the 45- and 35-foot diameter dolphins and will consist of 5-foot thick, 15-foot wide, and 18-foot long precast concrete fender panels (Type I, IB, 2, and 2B). The fender system panels will be founded on battered (1.5(H):4(V) and 1.5(H):2(V) and vertical 36-inch diameter steel pipe piles.

2.3.6 Construction Staging

The replacement structure will be constructed so that it straddles the existing bridge. In general, construction of the new approach spans will be performed in two stages to allow for maintenance of traffic during construction. A brief summary of the anticipated construction sequence is provided in the 60-percent plans and summarized as follows:

- Construct eight new 12-foot diameter drilled shafts and diaphragm/strut system between between the existing Gilmerton Bridge and the Norfolk Southern Railroad Bridge.
- Construct new vertical-lift bridge towers and Stage I approach roadways and abutments.
- Remove 7-foot wide south side section of the existing Gilmerton Bridge, while maintaining 2 lanes of traffic on the remaining portion of the existing bridge.
- Construct Stage I two-lane approach spans along south side of the existing structure.
- Under intermittent waterway and roadway closures, remove existing bascule arms and upper portion of the existing operator's house and float-in vertical lift span and make operational.
- Re-open roadway and shift traffic onto Stage I approach structure and lift span.
- With 12-hour night-only channel closures remove the existing bascule counterweights, piers and fender system, and complete new fender system.
- Remove the south construction trestles and remainder of the existing bridge approach structures.
- Complete construction of the new Stage II approach spans and abutments.
- Expand roadway traffic to full four-lane operation on new structure.
- Remove the north construction trestles and install remainder of new dolphins.

3.0 SITE CONDITIONS

The Gilmerton Bridge is located along Military Highway (SR 13) in Chesapeake, Virginia. At this location, SR 13 runs in an east-west direction as the bridge crosses the Southern Branch of the Elizabeth River. The Southern Branch of the Elizabeth River flows in a north-south direction beneath the existing bridge. The river turns to the west just north of the bridge.

The area around the proposed project is mainly developed with industrial facilities. Overhead electrical and underground communication lines run parallel to SR 13 and are located just north and south of the existing roadway. A communication line is located south of the existing bridge between the Gilmerton Bridge and the existing railroad bridge, and a buried fiber optic cable runs parallel to the existing bridge approximately 60 feet north of Military Highway.

The southwest quadrant of the site is bounded on the south by the Norfolk Southern Railroad and on the east by the Southern Branch of the Elizabeth River. The narrow strip of land between the railway and roadway is generally open with scattered brush and heavy marsh vegetation. The centerline spacing between the railway and existing SR 13 ranges from approximately 90 to 100 feet. At the existing western abutment of the Gilmerton Bridge, the edge-to-edge spacing between the bridge and tracks is approximately 66 feet. The terrain is mostly flat with the existing ground surface at about the same elevation of the existing SR 13. The ground surface ranges from approximately elevation +3 to +12 feet, msl with the higher elevations near the embankment for the railroad. Near the over-water bridge approaches of the existing Gilmerton Bridge the terrain slopes gently down to the water level of the Elizabeth River. This area serves mainly as a natural drainage swale is covered with heavy marsh-like grasses and vegetation.

The southeast quadrant of the site is bounded on the south by the Norfolk Southern Railroad and on the west by the Elizabeth River. This area is currently covered with thick low-lying brush and marsh vegetation along with a few trees near the toe of the existing embankment of SR 13. The ground surface in this area ranges from about elevation +2 to elevation +14 feet. The centerline spacing between the railway and existing SR 13 ranges from approximately 70 to 75 feet. At the existing eastern abutment of the Gilmerton Bridge, the edge-to-edge spacing between the bridge and tracks is approximately 50 feet. Heading south from the existing ground surface of SR 13, the elevation of the ground decreases approximately 10 to 15 feet to a drainage swale that slopes gently towards the river channel to the west.

The northwest quadrant of the site is relatively flat with large trees and thick marsh vegetation. This quadrant of the site is bounded both on the north and east by the Elizabeth River (due to the natural bend along this stretch of the river) and on the south by the existing SR 13. At approximately 10 feet north of the existing shoulder of westbound Military Highway, the ground surface drops approximately 4 to 5 feet to a natural drainage swale. Continuing north, an existing berm that is approximately 10 feet in height runs parallel to the existing roadway. We understand from Mr. John Deusebio of VDOT, the earthen berm is constructed of spoils from nearby dredging activities.

The northeast quadrant of the subject site consists of a narrow strip of land that is bound on the north by an existing Southern States facility, on the south by the existing SR 13, and on the west by the Elizabeth River. Approximately 12 to 15 feet north of the edge of pavement of westbound SR 13, the existing ground surface drops slightly to a concrete-lined drainage ditch that runs parallel to the existing roadway. A dirt and gravel access road owned by Southern States is located approximately 15 feet north of the drainage ditch and parallels SR 13 from Station 37+00 to 43+00. The northern edge of the access road coincides with the proposed temporary construction easement for the subject project. We understand that the roadway is used to access holding tanks located at the southwest corner of the Southern States property.

4.0 GEOLOGIC CONDITIONS

4.1 REGIONAL GEOLOGY

The proposed interchange site is located in the Coastal Plain Physiographic Province of Virginia. The Coastal Plain geology is primarily comprised of sedimentary deposits that increase in thickness from zero near the Fall Zone to more than 12,000 feet under the continental shelf. Approximately two-thirds of this wedge is comprised of late Jurassic and Cretaceous clay, sand, and gravel formations. These formations dip slightly to the east at approximately 40 to 50 feet per mile, with decreasing dip in the upper stratigraphic units. Sediments transported by the inland rivers and waterways have deposited on this "basement" surface, creating sequences of thin, fossiliferous marine sand formations of Tertiary age. The Late Tertiary and Quaternary sand, silt, and clay layers, which cover much of the Coastal Plain, were deposited during interglacial highstands of the sea under conditions similar to those that exist in the modern Chesapeake Bay and its tidal tributaries.

Regionally, the stratigraphic framework of the outer Coastal Plain consists of tertiary and quaternary age sediments, primarily consisting of sands, silts, and clays in a variety of distinct formations. Isolated shelly zones exist in the sediments, and distinct color changes occur between the various formations. The colors of Coastal Plain sediments include but are not limited to gray to greenish-gray, tan to buff, brown to brownish-gray, blueish-gray, and red to reddish-orange.

4.2 SITE GEOLOGY

Based on the U.S. Geological Survey, the site of the proposed Gilmerton Bridge lies within the Coastal Plain and is underlain by several geologic formations (Barker). An overview of the general site geology is shown in Figure 2 in Appendix A.

Certain natural processes contribute directly to the geologic depositional environment of the site. The Southern Branch of the Elizabeth River is the primary contributor to the transportation of inland sediment throughout the project site. Higher energy stream action is dominant on the outer edge, or cut-bank side, of a stream or river. Locally at the Gilmerton Bridge site, the river flows south to north and experiences a bend to the west. This bend in the river causes the finer-grained alluvial sediment (clays and silts) to be suspended in the higher energy eastern side of the river and be deposited on the western and northwestern part of the bend where lower energy, slower moving water allows for deposition of these particles. Overall, the outside portion of the river bend lacks deposition of fine grained particles and only the heavier coarse-grained sands and gravels have been deposited. This

natural phenomenon is magnified based on the overall energy of the river with faster moving water keeping finer grained sediments in suspension longer. The faster or higher the energy of the water body, the coarser the sediment size that is suspended. Based on this geologic/hydrologic process, silts, clays, and muds have been deposited on the western and northwestern slip-off slope, or inner bend, of the river, and sands and gravels deposited on the eastern, cutbank side, or outer bend, of the river.

This trend is presented graphically on the subsurface profiles, Figures 4 and 4A through 4E, provided in Appendix A. Locally four stratagraphic formations have been observed at the site. These formations are the result of similar depositional processes as described above. The meandering river, tidal fluctuations, and sea level variations have resulted in formations of varying thicknesses and sediment type.

The near surface soils typically consist of Holocene age alluvium which is deposited along the streams, tidal marshes, and rivers. This is predominantly fluvial silt, sand, and clay with varying amounts of organic material. The Holocene alluvial sands, silts, and clays are underlain by formations of the Quaternary period include the Pleistocene age Norfolk Formation which consist of brackish marine silty sands and fluvial and estuarine, silty sands and the younger upper Pleistocene age clayey sands and lagoonal silty clay that make up the Sand Bridge Formation. The Norfolk and Sandbridge Formations are underlain by the Tertiary period Yorktown formation which consists of near shore fossiliferous, silty coarse sands and coquina. Most of the formation is a massively bedded, compact, greenish-gray, fossiliferous, fine sand with silty clay layers and shell material. The depth to the top of the Yorktown Formation ranges from approximately 20 to 60 feet in the subject geologic quadrangle trending deeper from northwest to southeast. In the vicinity of the Gilmerton Bridge the top of the Yorktown Formation is generally consistent and ranges from elevation -60 to -70 feet. Additional details and descriptions of these formations as observed in our exploration are presented in section 7.2.

5.0 FIELD EXPLORATION

5.1 SUBSURFACE EXPLORATION PROGRAM

Subsurface explorations were completed under the direct supervision of a MACTEC geotechnical engineer. The field exploration was planned with the objective of characterizing the project site in general geotechnical and geological terms and to evaluate subsequent field and laboratory data to assist in the determination of geotechnical recommendations. The subsurface conditions were explored by drilling six standard penetration test (SPT) borings and conducting twenty-two piezocone penetration test (CPTu) soundings and three flat blade dilatometer (DMT) soundings during February and March 2003. The approximate as-drilled boring locations are shown on Figure 3 of Appendix A.

The borings and soundings were located at regular intervals along the planned alignment of the replacement bridge to include approximately one exploration at each proposed pier or tower foundation location. Two explorations were located at each abutment location and four explorations were located at planned locations of approach fill retaining walls. Table 5.1.1 provides a breakdown of the boring/sounding designations and the corresponding proposed structure for which they were completed.

Table 5.1.1
Summary of Field Explorations

Structure	Boring/ Sounding*	Structure	Boring/ Sounding*
RW-1**	MC-1, MS-1	East Tower	MS-5, MS-6
RW-2**	MC-2, MC-27	Pier 10	MS-5, MS-6
West Abutment	MS-1, MC-27	Pier 11**	MS-6
Pier 1	MC-3, MD-1	Pier 12	MC-17
Pier 2	MC-4, MD-2	Pier 13	MC-18
Pier 3**	MD-2, MC-5	Pier 14	MC-25
Pier 4	MC-5	Pier 15	MC-19
Pier 5	MC-6	Pier 16	MD-3
Pier 6	MS-2	Pier 17	MC-20
Pier 7	MC-7	Pier 18	MC-21
Pier 8**	MC-7	East Abutment	MC-22, MC-26
Pier 9**	MS-4, MS-3	RW-2**	MC-26, MC-24
West Tower	MS-4, MS-3		

* MS = Soil Testing Boring with Standard Penetration Tests (SPT)
MC = Piezocone Penetrometer Sounding (CPTu)
MD = Flat Blade Dilatometer Sounding (DMT)
** No boring/sounding along centerline of proposed structure

A laboratory-testing program on samples collected from the SPT borings was also implemented to aid in characterizing the physical and engineering properties of the subsurface soils. Details of the laboratory testing program are presented in Section 6.0.

5.1.1 Piezocone Penetration Testing (CPTu)

Twenty-two CPTu soundings were completed by Southern Earth Sciences to supplement the SPT soil test borings and DMT soundings. CPTu testing consisted of pushing a series of cylindrical rods with a standard size cone at the base into the soil at a constant rate of 2 cm/sec. Continuous measurements of penetration resistance on the cone tip and friction on a friction sleeve were recorded with depth during the penetration. The CPTu includes a pore-pressure transducer to record pore pressures in addition to point (tip) and friction (sleeve) resistance. At selected sounding locations, porewater pressure dissipation tests were conducted to evaluate the coefficient of consolidation and permeability of the soils at the respective depth. At four locations, downhole shear wave velocities were measured for determination of the initial small-strain stiffness. The CPTu soundings were completed with a 10 cm^2 cone with the pore pressure filter located in the u_2 position.

The near continuous data profile obtained from CPTu soundings has been used to assist in evaluating general stratigraphy, soil type, and various engineering properties of the subsurface materials. The CPTu data has also been used in direct-method evaluations of foundation performance for compressibility and strength characteristics of driven piles and drilled shafts. A summary of the CPTu soundings, including station and offset, total depth, and interpreted soil strata elevations, is presented in Table 5.1.1.1. The CPTu test reports are provided in Appendix B and CPTu sounding locations are presented in Figure 3 of Appendix A.

Table 5.1.1.1
Summary of CPTu Soundings

CPTu Sounding Designation	Station	Offset Distance and Direction (ft)	Ground Surface Elevation (ft)	Total Depth (ft)	Elevation* (ft)			
					Top of AL	Top of N2	Top of Y2	Top of Y1
MC-1	23+40	22 L	8.6	100	9	-43	-64	-
MC-2	23+40	23 R	8.9	100	9	-35	-	-59
MC-3	24+95	40 R	6.2	125	6	-56	-62	-
MC-4	25+83	35 L	7.7	123	8	-54	-64	-
MC-5	27+60	31 L	9.5	126	9	-61	-65	-
MC-6	28+45	32 R	2.7	126	3	-	-60	-
MC-7	30+23	44 R	1.4	125	1	-	-61	-
MC-8	31+93	131 L	-21.9	177	-22	-	-62	-
MC-10	31+03	135 L	-6.0	176	-6	-62	-66	-
MC-14	35+12	127 L	-33.5	175	-34	-42	-68	-
MC-15	34+90	175 R	-44.9	126	-45	-51	-73	-
MC-17	36+96	86 L	6.9	116	7	-19	-70	-
MC-18	37+85	20 R	11.1	114	11	-20	-69	-
MC-19	39+60	55 L	7.2	126	7	-20	-67	-
MC-20	41+37	61 L	7.5	125	8	-30	-52	-
MC-21	42+20	18 R	9.7	129	10	-27	-51	-
MC-22	43+17	42 L	8.7	128	9	2	-49	-
MC-23	43+70	43 L	9.0	102	9	3	-49	-
MC-24	43+70	17 R	9.8	102	10	0	-48	-
MC-25	38+69	43 L	7.1	127	7	-22	-70	-
MC-26	43+20	19 R	9.6	127	10	-2	-50	-
MC-27	24+06	14 R	8.5	125	9	-41	-	-61

* AL = Alluvial clays, silts, and sands
N2 = Norfolk Formation
Y2 = Yorktown Formation sandy silts and silty sand
Y1 = Yorktown Formation clay

5.1.2 Flat Blade Dilatometer Testing (DMT)

Three flat blade dilatometer (DMT) tests were performed by Southern Earth Sciences in February 2003. The DMT data were evaluated to assist in the interpretation of subsurface stratigraphy and establishment of engineering properties. DMT testing consisted of pushing a flat blade located at the end of a series of rods to a respective testing depth. A circular steel membrane located at the center of the blade is then expanded horizontally into the soil. The pressure is recorded at three specific moments during the test, and then the blade is advanced to the next testing depth. A summary of the DMT soundings including station and offset, total depth, and interpreted soil strata

elevations is presented in Table 5.1.2.1. The DMT test reports are presented in Appendix B and DMT sounding locations are presented in Figure 3 of Appendix A.

Table 5.1.2.1
Summary of DMT Soundings

DMT Sounding Designation	Station	Offset Distance and Direction (ft)	Ground Surface Elevation (ft)	Total Depth (ft)
MD-1	24+46	18 R	7.3	60
MD-2	26+18	22 R	6.0	124
MD-3	40+48	14 R	8.9	90

5.1.3 Standard Penetration Testing (SPT)

Soil test borings with standard penetration tests (SPT) were completed in general accordance with the ASTM procedures presented in Appendix B. Boring locations and elevations were surveyed by GTS Technologies, Inc. prior to mobilization of our drilling equipment; however, some of the borings were offset due to utility conflicts, traffic control issues, or general operational considerations. Offset boring coordinates and elevations were estimated by MACTEC personnel based on field measurements and available site topographic information. The approximate as-drilled boring locations are shown on Figure 3 of Appendix A. Logs of the SPT borings are provided in Appendix B. Table 5.1.3.1 provides a summary of selected SPT boring information.

Table 5.1.3.1
Summary of SPT Borings

Boring Designation	Station	Offset Distance and Direction (ft)	Ground Surface Elevation (ft)	Total Depth (ft)	Land/ Water	Elevation (ft)*			
						Top of AL	Top of N2	Top of Y2	Top of Y1
MS-1	24+06	33 L	8.0	125	Land	8	-38	-60.5	-
MS-2	29+30	41 L	-5.0	125	Water	-5	-	-58.5	-
MS-3	32+25	44 L	-22	150	Water	-22	-	-64	-147
MS-4	32+25	44 R	-22	175	Water	-39	-	-65	-144
MS-5	34+82	44 L	-23	171	Water	-	-41	-66.5	-149
MS-6	35+20	44 R	-23	150	Water	-23	-31	-70	-156

* AL = Alluvial clays, silts, and sands
N2 = Norfolk Formation
Y2 = Yorktown Formation sandy silts and silty sand
Y1 = Yorktown Formation clay

Depending on the boring location accessibility, an all-terrain vehicle (ATV) drill rig or a barge mounted CME 550 drill rig was utilized to drill the soil test borings. Borings were generally advanced to a predetermined depth ranging from 125 to 175 feet.

Standard penetration tests (SPTs) were conducted in the borings at regular intervals in general accordance with ASTM D 1586. Representative samples were obtained during these tests and were used to classify the soils encountered. The standard penetration resistances obtained also provide a general indication of soil shear strength and compressibility. Undisturbed thin walled "Shelby" tube samples were collected for subsequent laboratory testing at predetermined locations agreed upon by MACTEC and VDOT. The undisturbed samples were collected in the near surface alluvial silt and clay deposit from MS-1 and from the fine grained stratum of the Yorktown Formation.

5.2 PREVIOUS FIELD EXPLORATION PROGRAM

A preliminary geotechnical exploration program was performed by GTS Technologies and was summarized in their report dated June 28, 2001. Eleven soil test borings (B-1 through B-11) were drilled along the planned roadway and bridge alignment in April and May 2001. Locations of these borings along the planned bridge alignment (B-3 through B-10) are presented on Figure 3 of Appendix A. Copies of the soil test boring logs are provided in Appendix B.

6.0 LABORATORY TESTING

The laboratory testing performed by MACTEC for this project consisted of the following tests on samples obtained during our drilling operations.

- Classification and index property tests
- Consolidation tests
- Consolidated-undrained (CU) triaxial shear strength tests
- Total Organic Carbon (TOC) testing

The following paragraphs briefly discuss the completed laboratory testing program. A summary of the laboratory test results is presented in Table C1 in Appendix C. In addition, laboratory test reports along with brief descriptions of the test procedures are also presented in Appendix C.

6.1 CLASSIFICATION AND INDEX PROPERTY TESTING

Classification and index property tests were performed on representative soil samples obtained from the test borings in order to aid in classifying soils in general accordance with the Unified Soil Classification System and to quantify and correlate engineering properties. The classification and index property tests performed for this project included natural moisture content, Atterberg limits, and particle gradation (sieve) analyses. Table 6.1.1 summarizes the classification and index property tests performed for this project.

Table 6.1.1
Summary of Laboratory Classification and Index Property Tests

Test Description	Number of Tests Performed
Water Content	59
Atterberg Limits (Liquid and Plastic Limits)	35
Wash No. 200 Sieve	35

6.2 CONSOLIDATION TESTING

One-dimensional consolidation tests were performed on four selected specimens from Shelby tube samples. Consolidation testing was completed to evaluate the stress-history of the sampled soils and consolidation parameters for evaluation of magnitude and time-rate of settlement of respective soils under application of load. Two of the tests were completed on alluvial clayey silt sampled from MS-1 and the other two tests were completed on Yorktown Y1 low-to high plasticity clay sampled from MS-3 and MS-5.

6.3 CONSOLIDATED-UNDRAINED TRIAXIAL SHEAR STRENGTH TESTING

Isotropically consolidated-undrained (CU) triaxial shear strength tests were completed on four Shelby Tube samples collected from MS-2, MS-3, MS-4, and MS-5. The tests were conducted to evaluate the stress-strain characteristics and strength values of the alluvial clay/silt and Yorktown Y1 clay soils encountered during our exploration.

6.4 TOTAL ORGANIC CARBON (TOC) TESTING

Total Organic Carbon testing was performed on selected undisturbed samples of the upper 10 feet of subsurface materials at two over-water SPT boring locations to satisfy project environmental requirements. MACTEC was provided descriptions of the proposed laboratory tests on the respective samples from Mr. Dean Devereaux of VDOT in March and April 2003. MACTEC completed ten grain size analysis tests and ten analytical tests for total organic carbon (TOC). Results of the TOC testing are presented in Appendix C. Additional details regarding the evaluation of engineering parameters based on results of the aforementioned laboratory tests are presented in Section 8.1.

6.5 PREVIOUS LABORATORY TESTING PROGRAM

Limited laboratory testing was conducted for the preliminary geotechnical exploration. A summary of the tests that were conducted is presented in Table 6.5.1.

Table 6.5.1
Summary of Laboratory Tests from Preliminary Geotechnical Exploration

Test Description	Number of Tests Performed
Water Content	6
Atterberg Limits (Liquid and Plastic Limits)	6
Wash No. 200 Sieve	6
One-Dimensional Consolidation	1
Consolidated Undrained Triaxial (CU)	1

7.0 SUBSURFACE CONDITIONS

7.1 METHODOLOGY

The descriptions of the subsurface conditions provided in the Test Boring Records and sounding logs (Appendix B) and in subsequent paragraphs were prepared primarily by visual classification (ASTM D 2488) in general accordance with the Unified Soil Classification System and published correlations. Laboratory analyses of selected, representative soil samples (Appendix C) aided our visual descriptions.

7.2 STRATIFICATION

The subsurface conditions encountered were generally consistent with published geological mapping and our experience with other projects in the area. The following sections provide generalized descriptions of the soil strata encountered during our subsurface investigation and are outlined below. For subsurface information at a specific location, refer to the Test Boring Records and sounding logs in Appendix B.

In the area of the proposed Gilmerton Replacement Bridge, the borings encountered three basic strata within their termination depths. These strata and substrata are briefly described in the following paragraphs. Soil strata information including respective top elevations as interpreted from SPT, CPTu, and DMT data has been previously presented in tabular format in Sections 5.1.1, 5.1.2, and 5.1.3.

7.2.1 Holocene Alluvium Sand and Clay

The near surface soils in the vicinity of the Gilmerton Bridge include a variety of clays, silts and sands of Holocene age. The composition of the recent alluvium, sand, and marsh sediments is variable with alternating silt and sand layers with some thick layers of clayey and organic silts. The thicker layers of soft cohesive soil generally occur in the vicinity of the western abutment and the western approach piers. For evaluation of engineering properties, we have divided these soils into two substrata entitled Alluvium Sand (AL Sand) and Alluvium Clay (AL Clay). In general, the thickness of the AL Sand ranged from about 0 to 42 feet with SPT resistances ranging from 4 to 26 bpf. The thickness of the AL Clay ranged from 0 to 22 feet respectively with SPT resistances ranging from 4 to 8 bpf. Average SPT N-values in these substrata are 11

and 5 respectively, indicating firm relative density for the coarse grained alluvial sand and firm consistency for the finer grained alluvial clay.

Laboratory classification tests were performed on selected field samples from these substrata. The classification tests indicated that the percent fines was 90 percent for the AL Clay with a liquid limit of 40 and a plasticity index of 9. For the AL Sand, the percent fines ranged from 5 to 42 percent, the liquid limit ranged from non-plastic to 31, and the plasticity index ranged from non-plastic to 4.

Based on one-dimensional consolidation test results on the AL clay samples, the estimated preconsolidation pressure, σ'_p, was approximately 1.5 ksf with corresponding overconsolidation ratios (OCR) slightly greater than 1 indicating some preconsolidation in this cohesive stratum. The compression ratio was estimated at approximately 0.15 with a recompression ratio of 0.01.

7.2.2 Norfolk Formation

Beneath the alluvial clays, silts, and sands is the Pleistocene-age Norfolk Formation. The Norfolk Formation is characterized by an upper facies consisting of clayey silty sand and a lower facies consisting of clean quartz sand and fine gravel. As presented in the subsurface profiles in Figures 4A through 4E Appendix A, the Norfolk Formation is relatively thin west of the centerline of the river main channel and of considerable thickness to the east of the main channel centerline. In general, the thickness of the Norfolk soils east of the centerline of the Elizabeth River ranged from about 4 to 52 feet. West of the centerline the thickness ranged from 0 to 24 feet. The average thickness on the west side of the centerline, beneath the approach piers, is approximately 3 to 5 feet. East of the centerline beneath the approach piers, the Norfolk Formation, is approximately 40 to 45 feet. SPT resistances ranged from about 4 to 29 bpf. The average SPT N-value in the Norfolk Formation is 16 blows per foot (bpf) indicating a firm relative density.

Laboratory classification tests were performed on selected field samples from this stratum. The classification tests indicated that the percent fines ranged from 8 to 9 percent. Results of the Atterberg limits tests indicated that the samples from this stratum were non-plastic.

7.2.3 Yorktown Formation

The Yorktown Formation underlies the Norfolk Formation at this site. The Yorktown Formation contains greenish-gray, medium dense, preconsolidated, fossiliferous fine sand with varying amounts of fine grained material. The top of the Yorktown Formation is generally consistent along the planned bridge alignment ranging from approximately elevation -60 to -70 feet. The formation can be subdivided into two distinct substrata based on the percentage of fine-grained soils. A description for each substratum in the Yorktown Formation at the subject site is given below.

7.2.3.1 Yorktown Y2

The more granular substrata, which we have designated as Yorktown Y2, is the sandy silt and silty sand facies of the Yorktown that contains approximately 10 to 35 percent fines according to Martin et al. The Yorktown Y2 soils generally classify as greenish-gray silty fine to medium sand. SPT N-values in the Y2 ranged from 5 to 47 blows per foot (bpf) with the majority of values ranging from 20 to 30 bpf. The average SPT N-value was 18 bpf. Regional experience and corresponding literature suggest that engineering properties are underestimated when based on SPT N-values directly (Martin, et al). In general, the soil loses strength during the SPT due to the generation of excess pore pressures which results in a reduction of the penetration resistance values.

Laboratory classification tests were performed on selected field samples from these substrata. The classification tests indicate that the percent fines ranged from 13 to 40 percent, which is consistent with published information. The liquid limit (LL) for samples gathered during SPT drilling ranged from non plastic to 26. The plasticity index (PI) indicated these samples ranged from non plastic to 12.

We have evaluated laboratory test results from the recently completed geotechnical exploration program in addition to laboratory data from previous MACTEC projects completed in the area. One-dimensional consolidation test results suggest that the Yorktown Y2 soils are preconsolidated with an OCR range from 4 to 10+. Respective preconsolidation pressures range from approximately 6.6 to 20+ kips per square foot (ksf). Compression ratios range from 0.1 to 0.2 with a recompression ratio range of 0.003 to 0.006. The effective stress friction angle, ϕ',

from previously completed CU triaxial tests ranged from 33 to 44 degrees. Laboratory test results from previous MACTEC projects in the vicinity of the subject site are summarized in Table C2.

7.2.3.2 Yorktown Y1

The Yorktown Y2 at this site is underlain by the more fine-grained Yorktown Y1. The Yorktown Y1 soils generally classify as green-gray and blue-gray low to high plasticity CLAY with SPT N-values ranging from 4 to 21 bpf. The average N-value was 16 bpf. The Yorktown Y1 was observed in the deeper SPT borings conducted in the vicinity of the main channel (MS-3 through MS-6). The top of the Y1 ranged from Elevation -144 feet to -156 feet in these borings.

Based on one-dimensional consolidation test results on the Y1 samples the estimated preconsolidation pressure ranges from 6 to 18 ksf with a corresponding OCR of approximately 1.0 to 2.3. The compression ratio ranged from approximately 0.2 to 0.3 with a recompression ratio in the range of 0.03 to 0.06.

7.3 GROUND-WATER CONDITIONS

Water levels were measured in our borings as noted on the soil test boring records in Appendix B. Ground water was encountered in boring MS-1 at 8.0 feet below the existing ground surface, which corresponds to approximately elevation 0 feet or mean sea level (msl). Water depths varied throughout our field exploration for the remaining overwater SPT borings (MS-2 through MS-6) and ranged from elevation +2 to elevation -2 feet msl. We have assumed a ground-water elevation of 0 feet for final design analyses and evaluations.

Ground-water elevations are generally highest in the late winter and early spring and tend to be lowest in the late summer and early fall. Variations in the long-term water table may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors.

8.0 GEOTECHNICAL RECOMMENDATIONS

The following sections present our geotechnical recommendations for the design and construction of the various structures of the Gilmerton Replacement Bridge including approach piers and foundations, lift span foundations, bridge abutments and wingwalls, and dolphins and fender system. Section 8.1 presents a summary of the engineering properties used in MACTEC's analyses and evaluations in support of our geotechnical recommendations. Section 8.2 presents an overview of the proposed foundation alternatives applicable to specific structures planned for the project. Sections 8.3 through 8.7 provide design and construction recommendations for the various structures and are separated by structure and/or foundation type. Section 8.8 presents a summary of additional geotechnical recommendations and considerations including pre-construction surveys, construction plan and specifications review, and scour.

8.1 EVALUATION OF ENGINEERING PROPERTIES

Data collected along the planned project alignment, including SPT, CPT, and DMT in addition to laboratory and load test data from various nearby projects, have been evaluated to estimate the geotechnical engineering properties of the soils at the project site. The properties and the respective values for each soil type are summarized in Table 8.1.1.

Table 8.1.1
Summary of Geotechnical Engineering Parameters

Engineering Parameter		Soil Stratum				
		Alluvial Sand	Alluvial Clay	Norfolk Formation	Yorktown Formation Y2	Yorktown Formation Y1
Total Unit Weight (pcf)		115	110	115	120	115
Effective Unit Weight (pcf)		53	48	53	58	53
Effective Stress Friction Angle, ϕ' (deg)		30	-	33	35	-
Undrained Shear Strength, S_u (psf)			600			3,500
Poisson's Ratio, v		0.2	0.45	0.2	0.2	-
Lateral Subgrade Modulus, k_h (pci)		60	100	60	60	
Small-strain Shear Modulus, G (ksf)		1,600	900	2,100	2,600	-
Soil Strain, ε_{50}			0.01			
Allowable Unit Skin Resistance, f_s (ksf)	Concrete	0.4	0.4	1.2	3.75	-
	Driven Steel	0.3	0.3	0.8	2.63	-
	Screwed Steel	0.2	0.2	0.7	2.25	-
Allowable Unit End Bearing, f_b (ksf)					50	
GROUP p-y Curve Soil Model		Sand (Reese, et al.)	Submerged Soft Clay	Sand (Reese, et al.)	Sand (Reese, et al.)	Stiff Clay
Compression Ratio, CR			0.15		0.2	0.25
Recompression Ratio, RR		-	0.01	-	0.006	0.05

8.1.1 Unit Weight

Unit weights of the subsurface soils were estimated to determine the overburden stresses with depth at the subject site. Correlations with penetration values from the SPT data were used initially to estimate values of unit weight for each soil unit (McGregor and Duncan, 1998 and Sharma, 2000). Correlations with CPTu data were also implemented and provided reasonable agreement with the values based on SPT data. Laboratory data from CU triaxial tests on samples obtained from MS-1, MS-3, and MS-5 also show general agreement with the values correlated from SPT and CPTu data. Evaluation of the estimates from these three methods resulted in the average unit weight values presented in Table 8.1.1 and are typical values based on the soil types observed at the Gilmerton Bridge site.

8.1.2 Effective Friction Angle

SPT data was used to estimate values of effective angle of internal friction, φ', for each granular soil unit based on correlations with average SPT N-values (McGregor & Duncan and Sharma). Correlations with CPTu data (Mayne) were also evaluated. The CPTu correlations resulted in a wide range of values for the effective friction angle of the granular deposits. Laboratory data from CU triaxial tests were also used in the determination of effective friction angle for the granular soils. In general, the interpreted effective stress friction angle from CU triaxial test data was slightly higher than the values obtained from SPT data. Evaluation of the values from the CU triaxial and SPT correlations resulted in the average values presented in Table 8.1.1.

8.1.3 Undrained Shear Strength

SPT data correlations were initially used to estimate values of undrained shear strength, S_u, for each cohesive soil unit (McGregor and Duncan, 1998 and Sharma, 2000). Correlations with CPTu data (Mayne, 2003) were also used to estimate the undrained shear strength, S_u, for each cohesive soil stratum observed at the site. The CPTu correlations showed a wide range of values in the Alluvial Clay, but the values were in general agreement with those from SPT correlations and CU triaxial lab test data. CPTu data in the Yorktown Y1 formation also showed a wide range, but were consistently higher than the S_u estimates from SPT correlations. CU triaxial test data showed values lower than those from SPT correlations. For final design a value at the upper end of the SPT correlated values was used for the cohesive soil strata observed at the site.

8.1.4 Poisson's Ratio

General soil classification data was used to estimate a range of typical values for Poisson's ratio, υ, for each soil stratum. These ranges were given in tabular format in Coduto, Bowles, and Huang. Each of the references provided consistent ranges of typical values; however, the values were much higher than typical Poisson ratios based on measured strains using special internal high-resolution instrumentation (Mayne). Accordingly, Poisson ratio values for each soil stratum were chosen based on the more recent literature using a more appropriate Poisson ratio for small strains at working load levels.

8.1.5 Lateral Subgrade Modulus

General soil type information was used to estimate the lateral subgrade modulus, k_h, value for each soil unit based on ranges of typical values provided in the GROUP 6.0 and COM624 user manuals. The lateral subgrade modulus was used in lateral capacity analyses.

8.1.6 Small-Strain Shear Modulus

The small-strain shear modulus, G, is a soil stiffness parameter used in lateral load analyses to determine the soil's response to various types of loading. Correlations with SPT N-values were used to estimate values of small-strain shear modulus for each soil unit based on expressions provided by Kramer, FHWA (GEC No. 5), and the CGPR SPT Manual. In addition to direct correlations with SPT N-values, the small-strain shear modulus, G can be calculated from the soil mass density, p_T, and the shear wave velocity, V_s, according to the following equation:

$$G = p_T V_s^2$$

Shear wave velocities were obtained by direct measurement from seismic CPTu data and estimated from SPT data according to correlations provided in FHWA GEC No. 5. In general, shear moduli estimated from SPT and soil type correlations described herein were evaluated and showed reasonably good agreement with values correlated from CPTu correlated values. Average values from these methods were calculated and are presented in Table 8.1.1.

8.1.7 Soil Strain

General classification data was used to estimate values of soil strain at 50 percent of the maximum stress, ε_{50}, for the alluvial clay stratum observed at the site. A range of typical values for different soil types is provided by Coduto as well as the LPILE 4.0 and COM624 user manuals. Each reference provided a consistent range of typical values for cohesive materials. Soil stratum for the Y1 Yorktown Stratum was not considered as foundation elements will not extend into this material. For modeling granular soils in GROUP, the soil strain, ε_{50}, is not an applicable input parameter.

8.1.8 Allowable Unit Side Resistance

Unit side resistance, f_s, for the various soil strata at the site was estimated based on evaluation of the results of four full-scale load tests performed on drilled shafts at the nearby Pinners Point Interchange in Portsmouth, Virginia, side resistance values calculated using FHWA design procedures, and correlations with CPTu data. The Pinners Point load test data was referenced from LOADTEST, Inc. and Applied Foundation Testing, Inc. Various unit skin friction values based on CPTu correlations were provided by Dr. Paul Mayne and are presented in his interpretation report dated October 14, 2003.

In general, four methods of estimating unit skin friction values from CPTu data were evaluated by Takesue, et al, Powell, Fiorvante, et al, and Mayne) and resulted in a relatively wide range of unit skin friction values (Mayne). The average of these four values was slightly lower than the unit skin friction values interpreted from the Pinners Point Interchange Load test data.

Unit skin friction values are a function of foundation type, construction methods, construction materials, etc. Accordingly, we have provided unit skin friction values for a steel-soil interface and a concrete-soil interface. The steel-soil interface friction value is appropriate for driven, pushed, or screwed-in steel casing or pipe pile while the concrete-soil friction value is for portions of foundation elements that will be constructed with a concrete-soil interface (i.e. drilled shaft constructed under slurry methods).

8.1.9 Unit End Bearing

The unit end bearing capacity, f_b, of the Yorktown bearing stratum was estimated based on the results of four full-scale load tests performed on drilled shafts at the Pinners Point Interchange

and values calculated using FHWA design procedures. The end bearing capacity values based on FHWA design procedures were much lower and very conservative compared to the actual end bearing capacities interpreted from Pinners Point Interchange Load Test Data. Two of the Pinners Point Interchange load tests were conducted with Osterberg Cells while the other two were conducted as Statnamic tests. In general, our evaluation of the final design end bearing values included emphasis on the reported results from the O-CELL testing rather than the Statnamic testing. The results from the Statnamic tests indicate very conservative end bearing values as, in our opinion, the applied dynamic loads may not have mobilized the full end-bearing capacity of the shafts during the test. Accordingly, for final design of drilled shaft foundations for the subject project, we recommend a lower-bound value from Pinners Point O-Cell load tests results.

8.2 FOUNDATION ALTERNATIVES

Drilled shafts and concrete-filled pipe piles foundations have been proposed for the over-water approach piers and the vertical lift span foundations. A brief summary of the proposed alternatives, including MACTEC's recommended foundation type, is presented in Sections 8.2.1 and 8.2.2.

8.2.1 Concrete-Filled Steel Pipe Piles

MACTEC has evaluated 60-inch diameter concrete-filled steel pipe piles as a deep foundation alternative for the over-water approach piers. For this alternative steel pipe piles would be driven open end to approximately 20 feet below the top of the Yorktown Formation, cleaned out to a few feet into the Yorktown, and filled by the wet method with high-slump concrete. In our opinion, the concrete-filled steel pipe pile alternative is essentially a drilled shaft foundation with permanent casing because the steel pipe pile is left in place.

One disadvantage to this alternative is that an impact hammer pile driving system will likely be required to install the steel pipe piles to the bearing elevation. The pile driving may create vibrations that could have detrimental effects on the existing bridge and railroad foundations that are approximately 20 feet nearby at their closest point. We have evaluated the Woodrow Wilson Bridge Vibration Study (Parsons Transportation Group) provided to us by VDOT in October 2003. In our opinion, vibration induced movements are likely due to the close proximity of existing structures and based on the different subsurface materials at the Gilmerton Bridge site.

At the Woodrow Wilson Bridge project, the steel pipe piles were driven through a shallow, relatively thin layer of dense sands and then through a thick layer of very stiff to hard clay of the Potomac Formation. A different subsurface profile exists at the Gilmerton Bridge project, attenuation of vibrations could be significantly different compared to the attenuation behavior observed at the Woodrow Wilson Bridge project. With medium dense sands of the Yorktown Formation present at the project site we expect considerably different driving conditions which may require the contractor to use a combination of drilling and driving to install the casing full depth. Accordingly, installation of the open-ended steel pipe piles may require intervals of augering and driving to install them to the desired pile tip elevation as the piles are installed through thick layers of granular material. If this were to occur, the installation time would likely increase significantly as the contractor would have to remove the hammer off the pile to clean out to advance the driving.

Due to the vibrations associated with the driving of open-ended steel pipe piles we recommend that existing bridge structures be monitored during construction. If the vibrations become excessive, few options are available to continue with unimpeded construction activities. In addition, driving of open-ended steel pipe piles creates significant noise as compared to typical drilled shaft construction.

With the steel pipe pile alternative, the length of steel will likely be much longer than that required for construction of drilled shafts. In general the casing used to construct the drilled shafts is advanced deep enough for initial open hole stability; at which point a slurry is typically utilized to prevent borehole collapse for the remainder of augering.

Due to the potential detrimental geotechnical and environmental issues associated with the installation of concrete-filled steel pipe piles MACTEC does not recommend this type of deep foundation to support the over-water bridge piers.

8.2.2 Drilled Shafts

Drilled shafts offer several advantages over concrete-filled steel pipe piles and offer minimal negative impacts to adjacent structures when compared to other driven pile foundation alternatives.

Drilled shaft construction creates minimal vibrations compared to driving of steel pipe piles which will minimize the potential for adverse effects on nearby structures. Casing used to stabilize the borehole can be advanced by pushing, twisting, and/or vibrating as opposed to driving techniques that create considerably greater vibrations that could be detrimental to nearby existing structures. Based on our discussions with contractors who have constructed drilled shafts in the project area, we understand that the casing may be pushed and/or screwed in approximately 10 feet into the Yorktown formation with the remaining foundation length being supported by various wet methods or slurry alternatives.

We recommend drilled shafts to support the vertical lift span tower foundations. If the same foundation type is selected for the approach piers, the need for a second contractor to mobilize to the site is eliminated which will ultimately help minimize construction costs. In general, if the lift span and approach span foundations are constructed with the same foundation type, it increases the total number of drilled shafts and creates a more competitive bid environment for prospective drilled shaft contractors, likely reducing the overall construction bid estimates.

Although both foundations described herein are feasible for the over-water piers of the Gilmerton Replacement Bridge, MACTEC recommends that drilled shafts be used to support the over-water approach piers and the vertical lift span.

8.3 VERTICAL LIFT SPAN

8.3.1 Subsurface Conditions

The subsurface conditions in the vicinity of the vertical lift span are presented graphically on Figures 4 and 4C in Appendix A. At the proposed locations of Piers 9 and 10, alluvial clays and sands are present at the current mudline and overlie the Yorktown Formation. The top of the Yorktown Formation is fairly consistent at Piers 9 and 10 and ranges from elevation -60 to -70 feet. The existing mudline is at approximately elevation -25 feet.

Each of the towers for vertical lift span will be supported on four 12-foot diameter foundation elements spaced 89 feet center-to-center transversely and 38 feet center-to-center longitudinally. Proposed foundations include drilled shafts constructed using slurry methods and large-diameter concrete-filled steel pipe piles. Design recommendations for both foundation types have been provided herein.

8.3.2 Axial Capacity Analyses

Axial capacity analyses were completed using procedures outlined in FHWA's Drilled Shafts Design Manual with the engineering parameters discussed in Section 8.1. The estimated tip elevations and the corresponding allowable axial capacities for both foundation types are presented in Table 8.3.2.1.

Table 8.3.2.1
Allowable Capacity and Estimated Tip Elevation for Vertical Lift Span Tower Foundations

Structure	Material Interface*	Estimated Tip Elevation (ft)	Foundation Length (ft)	Estimated Allowable Axial Capacity (kips)
Piers 9 -10	Concrete-Soil	-125	145	5,300
	Steel-Soil	-150	170	5,300

*Steel casing assumed to elevation -90 feet.

Drilled shafts constructed using the slurry method with permanent casing to approximately 20 feet (elevation -90 feet) into the Yorktown bearing stratum have been designated in Table 8.3.2.1 with a concrete-soil interface designation under the material interface column. Concrete filled steel pipe piles have been designated with a steel-soil interface designation. A safety factor of 2.5 has been applied to the estimated allowable capacities provided above.

As presented in Table 8.3.2.1.1, foundations constructed with the full-length permanent casing require approximately 25 feet of additional length to obtain approximately the same capacity of a drilled shaft constructed using the wet method. The steel-soil interface unit skin friction values have been reduced to 60 percent of the concrete-soil unit skin friction values to account for the reduced adhesion that results from pushed, twisted, screwed-in, or driven permanent steel casing.

8.3.3 Foundation Settlement

Settlement of the vertical lift span foundations has been evaluated using several methods presented in FHWA's Drilled Shafts Manual and in Dr. Paul Mayne's Gilmerton Bridge In-Situ Soil Parameters and Properties Interpretation Report. These methods include simple first-order estimates from Vesic to more precise approximations including the normalized load-transfer method from Reese and O'Neill and the elastic continuum solution from Poulos and Randolph &

Wroth. These procedures were used to estimate the magnitude of distortion settlement under the maximum anticipated vertical service load applied to the 12-foot diameter shaft in addition to the buoyant unit weight of the shaft above mudline.

Based on the planned spacing of the lift span drilled shafts and loads provided; the settlement of each shaft has been approximated individually. We estimate settlements on the order of 3/4 to 1 inch for the front drilled shafts of each tower foundation. Settlement estimates for the rear drilled shafts of each tower foundation are approximately one-half of the values approximated for the front shafts, or 3/8 to 1/2 inch. Based on the predominantly cohesionless nature of the in-situ soils in the vicinity of the base of the drilled shafts, we estimate that the settlements will occur within approximately one month after completion of the vertical lift span and supporting towers.

Although the soils beneath the base of the drilled shafts will drain relatively quickly upon application of load and initial settlements will occur rapidly, the drilled shafts may exhibit additional settlement with time due to creep of the bearing soils. The creep movement is associated with additional volume change of the Yorktown formation soils without additional loading. We have approximated the time rate of settlement due to creep using various methods including Duncan and Buchignani and Terzaghi, Peck, and Mesri. Refer to the Time Rate of Settlement plot presented in Appendix D for the estimated settlement values with time. Accordingly we estimate that approximately 0.5 inches of additional settlement will occur over a 30-year period following completion of the immediate distortion settlement discussed in the preceding paragraph.

We understand that the lift span tower superstructure will have jacking capabilities to account for differential and/or time-dependent settlements. For planning purposes, the Time Rate of Settlement plot should be used to evaluate jacking lengths at periodic times after construction. Post-construction monitoring should be performed to evaluate the actual long-term settlements and jacking requirements.

8.3.4 Lateral Load Analyses

Soil structure interaction analyses have been completed by the design team for the vertical lift span pier of the subject bridge. MACTEC completed the lateral load analyses using the computer program GROUP with geotechnical and structural input. The geotechnical input parameters used in the analysis were previously discussed in Section 8.1.

The lateral load capacity of a 12-foot diameter foundation for the vertical lift span has been evaluated for vessel impact loading. Accordingly, a lateral load of 5,500 kips was analyzed on the front shaft along with the maximum service loads provided to us by Modjeski and Masters in October and November 2003. Maximum bending moment, top deflection, and point of fixity were estimated and are presented graphically on the respective plots in Appendix D and summarized in Table 8.3.4.1.

Table 8.3.4.1
Summary of Lateral Capacity Results for Vertical Lift Span Piers

Loading Condition	Material Interface	Estimated Top of Shaft Elevation (ft)	Estimated Top Deflection (in)	Maximum Bending Moment (kip-ft)	Estimated Point of Fixity Elevation[1] (ft)
Vessel Impact	Concrete-Soil	+20	1.0	3.6 E6	-109
	Steel-Soil	+20	0.9	3.5 E6	-109
Service Loading	Concrete-Soil	+20	0.3	1.6 E6	-105
	Steel-Soil	+20	0.3	1.6 E6	-107
Wind Loading	Concrete-Soil	+20	0.5	1.3 E6	-104
	Steel-Soil	+20	0.2	1.4 E6	-123

Notes: [1] Point of fixity was determined as the depth corresponding to 1D beyond the initial point of zero deflection as shown on the respective load-displacement curves from the GROUP output.

8.4 APPROACH PIERS 4 - 8 AND 11 - 15

MACTEC recommends that drilled shafts be used to support the water piers for this project. Two foundation types including drilled shafts constructed using slurry methods and concrete-filled steel pipe piles have been proposed. Based on preliminary structural designs utilizing drilled shaft foundations we understand that 5- to 6-foot diameter drilled shafts are feasible to support the planned superstructures. The proposed drilled shaft design for the over-water approach piers would be similar to that which was submitted as a conceptual design to VDOT in August 2001. The drilled shafts would extend to 1 foot above Mean High Tide (MHT) and would be capped with a reinforced concrete pile cap. Above the pile cap, a typical concrete column pier is planned to support the superstructure.

At the time of this writing the foundation type has not been selected by the design team in coordination with VDOT. Accordingly, design recommendations for drilled shafts constructed using slurry methods and concrete-filled full-length steel pipe piles have been provided herein.

8.4.1 Axial Capacity Analyses

Foundation elements supporting the over-water approach piers derive their capacity from side friction and end bearing of the underlying soils of the Norfolk and Yorktown formations. Axial capacity analyses were completed using procedures outlined in FHWA's Drilled Shaft Design Manual with the engineering parameters previously discussed in Section 8.1. The estimated tip elevation and the corresponding allowable axial capacity for both foundation types are presented in Table 8.4.1.1.

Table 8.4.1.1
Allowable Capacity and Estimated Tip Elevation for Approach Piers 4-8 and 11-15

			5-foot Diameter Foundation Elements			6-foot Diameter Foundation Elements		
Material Interface	Structure	Estimated Top of Shaft Elevation (ft)	Estimated Tip Elevation[1] (ft)	Foundation Length (ft)	Estimated Allowable Axial Capacity (kips)	Estimated Tip Elevation[1] (ft)	Foundation Length (ft)	Estimated Allowable Axial Capacity (kips)
Concrete-Soil	Pier 4	7	-75	82	920	-70	77	1,050
	Piers 5-7	7	-80	87	850	-75	82	950
	Pier 8	7	-85	92	930	-80	87	1,060
	Piers 11-12	8	-75	83	1,150	-75	83	1,510
	Piers 13-15	8	-75	83	1,120	-75	83	1,460
Steel-Soil	Pier 4	7	-80	87	840	-70	77	910
	Piers 5-7	7	-90	97	880	-80	87	960
	Pier 8	7	-95	102	930	-80	87	920
	Piers 11-12	8	-75	83	890	-75	83	1,180
	Piers 13-15	8	-75	83	870	-75	83	1,160

Notes: [1] Minimum Tip Elevation is 1D into the Yorktown Formation, where D is the diameter of the foundation element

Each of the over-water approach piers (4 through 8 and 11 through 15) will be supported on 5- or 6-foot diameter foundation elements. We recommend a minimum center-to-center spacing of 2.5D where D is the diameter of the foundation element.

8.4.2 Foundation Settlement

Settlement of the approach piers has been evaluated using methods previously described in Section 8.3.2.2. Due to the granular subsoils at the base of the shafts, the foundations may undergo immediate distortion settlements on the order of about 1/4 inch or less. These settlements should occur rapidly due to the free-draining nature of the foundation soils and will likely be complete after approximately one to two months upon completion of the respective superstructure.

8.4.3 Lateral Load Analyses

Lateral load analyses have been completed for the over-water approach piers of the subject bridge. MACTEC completed the lateral load analyses using the computer program GROUP with geotechnical and structural input. The geotechnical input parameters used in the analysis are discussed in Section 8.1. A steel casing thickness of 3/4 inches was used in our lateral capacity analyses of the shaft-supported approach piers. A summary of the estimated top deflection, maximum bending moment, and point of fixity values for each of the approach piers is provided in Table 8.4.3.1. GROUP output plots in support of the data presented below can be found in Appendix D.

Table 8.4.3.1
Summary of Lateral Capacity Results for
Approach Piers 4-8 and 11-15

			5-foot Diameter Foundation Elements			6-foot Diameter Foundation Elements		
Material Interface	Structure	Estimated Top of Shaft Elevation (ft)	Estimated Top Deflection (in)	Maximum Bending Moment (kip-ft)	Estimated Point of Fixity Elevation[1] (ft)	Estimated Top Deflection (in)	Maximum Bending Moment (kip-ft)	Estimated Point of Fixity Elevation[1] (ft)
Concrete-Soil	Pier 4	+ 7	0.7	1.9 E5	-35	0.4	1.9 E5	-36
	Piers 5-7	+ 7	0.1	5.3 E4	-28	0.2	1.5 E5	-30
	Pier 8	+ 7	1.1	1.5 E5	-54	1.4	2.3 E5	-56
	Piers 11-12	+ 8	0.2	5.6 E4	-30	0.2	1.5 E5	-33
	Piers 13-15	+ 8	0.2	1.3 E5	-20	0.1	5.8 E5	-34
Steel-Soil	Pier 4	+ 7	0.7	1.9 E5	-35	0.4	1.8 E5	-36
	Piers 5-7	+ 7	0.2	6.5 E4	-37	0.2	1.6 E5	-30
	Pier 8	+ 7	1.1	1.5 E5	-54	1.2	2.4 E4	-56
	Piers 11-12	+ 8	0.2	3.7 E4	-33	0.2	1.5 E5	-33
	Piers 13-15	+ 8	0.2	1.3E4	-24	0.1	1.3 E5	-24

Notes: [1] Point of fixity was determined as the depth corresponding to 1D beyond the initial point of zero deflection as shown on the respective load-displacement curves from the GROUP output.

8.5 APPROACH PIERS 1-3 AND 16-18

Approach Piers 1 through 3 and 16 through 18 are located on land. Based on the design plans to date, these piers are proposed as pier caps with columns connected to a PSC pile supported cap. PSC piles are suitable for support of the land-based approach piers of the Gilmerton Replacement Bridge. PSC piles are the preferred deep foundation alternative due to extensive local experience in this area, and they are readily available. Based on the anticipated loading provided by Gannett Fleming in October and November 2003, we recommend 18-inch or 24-inch PSC piles for support of these piers. The piles should be designed with a minimum center-to-center spacing of 2.5D where D is the diameter of the pile.

8.5.1 Axial Capacity Analyses

Static capacity analyses were completed using methods proposed for PSC piles in the Tidewater geographic area (Martin, et al). The design methods include correlations for concrete pile design that take into account pile setup for piles embedded in the Yorktown Formation. A summary of the allowable axial capacity and estimated tip elevation for the PSC pile supported piers is provided in Table 8.5.1.1.

Table 8.5.1.1
Allowable Capacity and Estimated Tip Elevations for Approach Piers 1 – 3 and 16 – 18

Structure	Pile Butt Elevation (ft)	Estimated Tip Elevation[1] (ft)	Foundation Length (ft)	Estimated Allowable Axial Capacity (kips)	
				18-inch PSC	24-inch PSC
Piers 1-2	3	-75	78	270	360
Pier 3	3	-65	68	330	450
Piers 16-17	4	-65	69	200	260
Pier 18	4	-60	64	210	280

Notes: [1] Minimum Tip Elevation is 5 feet into the Yorktown Formation.

8.5.2 Foundation Settlement

We have evaluated the immediate distortion settlement of the pile supported approach piers based on the anticipated service loading provided by Gannett Fleming. We estimate settlements on the

order of 1/4 inch or less occurring throughout the superstructure construction. We estimate that the settlement will be essentially complete approximately one month after completion of the superstructure.

8.5.3 Lateral Load Analyses

Lateral load analyses were completed for the land-based PSC pile supported piers using the computer program GROUP. Table 8.5.1.3.1 provides a summary of the lateral capacity analysis results. GROUP output plots are attached in Appendix D.

Table 8.5.3.1
Summary of Lateral Capacity Results for
Approach Piers 1 - 3 and 16-18

Structure	Estimated Top of Shaft Elevation (ft)	Estimated Top Deflection (in)	Maximum Bending Moment (kip-ft)	Estimated Point of Fixity Elevation[1] (ft)
Piers 1-3	3	0.0	4	-7
Piers 16-18	4	0.0	1	-7

Notes: [1] Point of fixity was determined as the depth corresponding to 1D beyond the initial point of zero deflection as shown on the respective load-displacement curves from the GROUP output.

8.6 BRIDGE ABUTMENTS AND WINGWALLS

Bridge abutments and the associated wingwalls will be supported on 24-inch PSC piles. The current plans indicate that the front row of abutment piles are battered at 3(H):12(V) spaced at approximately 6 feet center-to center. The piles on the back row are vertical and are spaced approximately 13 feet center-to-center.

8.6.1 Axial Capacity Analyses

Static capacity analysis of PSC piles was completed using methods proposed for PSC piles in the Tidewater geographic area (Martin, et al). The design methods include correlations for concrete pile design that account for pile setup in the Yorktown Formation. A summary of the allowable axial capacity and estimated tip elevation for the bridge abutments and wingwalls is provided in Table 8.6.1.1.

Table 8.6.1.1
Allowable Capacity and Estimated Tip Elevations for Bridge Abutments and Wingwalls

Structure	Pile Butt Elevation (ft)	Estimated Tip Elevation[1] (ft)	Approximate Pile Length (ft)	Estimated Allowable Axial Capacity (kips)	
				18-inch PSC	24-inch PSC
Abutment A	8	-70	78	230	300
Abutment B	9	-65	74	150	210
Wingwall A	10	-70	80	230	300
Wingwall B	10	-65	75	150	210

Notes: [1] Minimum Tip Elevation is 5 feet into the Yorktown Formation.

8.6.2 Downdrag Considerations

The PSC piles supporting the western abutment have been designed for downdrag, or negative skin friction. Downdrag occurs when soils, in this case the underlying alluvial soils, consolidate or settle relative to an adjacent foundation. In the vicinity of the western abutment the underlying silt and silty sand soils will settle due to the applied load of the embankment fill. Our settlement analysis suggests that the magnitude of consolidation settlement will be large enough to initiate downdrag forces on the abutment and wingwall piles. Accordinlgy, we have added the resulting downdrag load to the applied load on the individual piles.

We understand that VDOT has completed the roadway design portion of this project including settlement analysis of the underlying soils due to embankment loading. At the time of this writing, MACTEC has not received a copy of the roadway report to review its contents relative to proposed settlement acceleration methods or fill placement recommendations with respect to the timing of pile installation.

8.7 DOLPHINS AND FENDER SYSTEM

Static capacity analysis of steel pipe piles for the new fender system was completed using the same steel-soil interface side and end-bearing resistances used for the vertical lift span foundations. We recommend fender piles at an estimated tip elevation of -135 feet corresponding to an estimated allowable capacity of 800 kips in compression and 630 kips in tension.

8.8 CONSTRUCTION RECOMMENDATIONS

8.8.1 Drilled Shaft Construction Recommendations

The following sections present MACTEC's recommendations for the geotechnical aspects of construction of the vertical lift span and approach pier drilled shaft foundations including installation monitoring and recommended load testing.

Due to the close proximity of foundations of the existing Gilmerton Bridge and the Norfolk Southern Railroad bridge, we recommend construction measures be implemented to minimize impacts on the existing foundations. We recommend that the drilled shafts be constructed with permanent casing to a depth of at least 10 feet below the tip of the existing foundations. In addition we recommend that the steel casing be installed by pushing and twisting methods as opposed to driven and vibratory methods. Based on our discussions with drilled shaft contractors we understand that casing installed to the recommended depth of 10 feet below the tip of the existing foundations (approximately elevation –90 feet) is feasible using pushing and twisting methods. We understand that installing full-length casing will likely require impact and/or vibratory type equipment.

The installation of full-length steel casing by vibratory and/or impact methods creates the potential for settlement of the adjacent foundations of the existing Gilmerton Bridge and the Norfolk Southern Railroad bridge. Upon final selection of the foundation alternative for the vertical lift span foundations, MACTEC should be retained to assist the design team in preparing and reviewing special provisions relative to construction procedures to minimize impacts to adjacent foundations.

8.8.1.1 Drilled Shaft Installation Monitoring

Close observation and monitoring by a geotechnical engineer familiar with the subsurface conditions at the site and considerable experience with foundation installation procedures is considered necessary during construction in order to confirm that the foundations are installed satisfactorily to meet the design intent and criteria.

During shaft installation, the engineer should:

- Confirm that the shafts are within the tolerances for location and verticality

- Measure and record the shaft dimensions, including elevations of top and bottom of casing
- Record the shaft tip elevation
- Confirm that the shaft slurry or drilling fluid has been properly cleaned of cuttings prior to concreting
- Confirm that soil and ground-water intrusion is properly controlled
- Monitor concreting of the shaft for any unexpected loss of concrete into voids. The drilled shaft inspector should also log and record the soil and rock strata encountered by the drilling process to confirm that the shafts have penetrated the anticipated load bearing materials. Reinforcing steel placed in the shafts should be checked by the geotechnical engineer prior to installation into the shaft for compliance with plans and specifications.

Particular attention is required during concrete placement in order to confirm that a structurally sound and continuous shaft has been constructed. A representative number of concrete test cylinders should be formed each day of installation, with a minimum of one set of four test cylinders per shaft for subsequent laboratory compressive strength testing.

Direct inspection of the shaft excavation is not possible when using the wet method; however, it is possible to use various remote inspection methods to ensure quality construction. We recommend that consideration be given to using a system such as the Shaft Inspection Device (SIC) or Mini-SID developed by the Florida Department of Transportation. As with drilled shaft contractors, experienced drilled shaft inspectors are critical to the success of most drilled shaft projects. Procedures for inspecting drilled shaft inspectors are critical to the success of most drilled shaft projects. Procedures for inspecting drilled shaft construction will vary by project depending on construction methodology, the contractor's crew's experience, subsurface conditions, load test results, etc. Therefore, it is important that the drilled shaft inspector be well experienced in various construction methodologies so that the best inspection procedures for this project can be developed to ensure the successful installation of the drilled shafts. Crosshole sonic logging (CSL) testing should be performed on each lift span drilled shaft and a representative number (approximately 10 percent) of the approach pier shafts.

Should drilled shafts be selected as the preferred vertical lift span foundation, MACETC should be retained to assist/review the drilled shaft special provisions. At that time, we expect to provide additional recommendations including slurry requirements, maximum length of time for individual shaft construction, restrictions on selected installation methods, etc. would be provided.

8.8.1.2 Drilled Shaft Load Test Program

Drilled shaft construction experience in the Tidewater area is limited and as indicated in MACTEC's preliminary foundation study for this project dated October 26, 2001 drilled shaft design capacities developed from conventional design methodologies (i.e., FHWA 1999) result in significantly lower capacities than those measured during the recent load tests at the nearby Pinners Point Interchange Project. Drilled shaft capacities and corresponding lengths may vary significantly based on designs from load test data versus conventional FHWA design procedures. A full-scale, instrumented production-phase load testing program for drilled shafts is highly recommended for this project for the following reasons:

- To confirm the minimum factor of safety with regard to the recommended drilled shaft design.
- To confirm that the installation techniques employed by the selected drilled shaft contractor can successfully produce a drilled shaft that will support the anticipated design loads in accordance with the project specifications. This will be especially important for this project since different shaft construction procedures could be utilized for shaft installation.
- To provide settlement information of the tested shafts under various test loads which may be used to confirm or refine the predicted settlement estimates for remaining production shafts under the design working loads.

For the smaller diameter over-water approach pier foundations, we recommend that at least three full-scale static load tests be performed. It is intended that the tests be conducted at the eastern and western extents of the over-water approach piers and one near the vertical lift span piers. Accordingly, we recommend that static load tests be performed on one shaft at pier 5 or 6, one shaft at pier 8, and one shaft at pier 11. The test shafts should be instrumented with strain gauges to allow delineation of the side resistance components of the various strata. The test loads should be provided by Osterberg cells (O-CELLs). Installation and testing should be performed under the direction of the geotechnical engineer by an experienced specialty subcontractor experienced in O-CELL load testing. One of the test shafts may be tested by the Statnamic method. The Statnamic test method is a dynamic test method that measures the applied load by the use of accelerometers. Deflections are measured by fast reading lasers, and stresses within the shafts are measured by strain gauges.

8.8.2 Driven Pile Construction Recommendations

The following sections present recommendations related to the geotechnical aspects of construction of driven pile foundations.

8.8.2.1 Pile Installation

Pile installation should be performed in accordance with the applicable provisions of Section 403 of the Virginia Department of Transportation and Bridge Specifications. Compatibility of the pile driving equipment with the pile type being driven is an essential element in achieving the required penetration and a satisfactory pile foundation. Pile driving equipment proposed for use should be reviewed by the geotechnical engineer. The pile driving hammer should be selected with respect to size, weight, and type of pile being driven. The pile hammer should be capable of operation at reduced energy levels (approximately one-half of its rated energy or less). We also recommend that the driving hammer have leads that are fixed to the rig to further reduce the potential for damage to the tops of the piles during the installation process.

Actual project requirements for pile hammer type and ram weight should be determined by a pile test program as described in Section 8.8.2.3. The contractor should be responsible for providing the appropriate equipment to properly install the piles to the desired compressive and tensile capacities.

The sequence of driving piles in groups can affect the pile lengths and driving resistances due to densification of the ground. We recommend that the piles in the center of the pile cap be driven first and subsequent piles be driven proceeding outward from the center. This procedure reduces pile drift and generally makes driving easier.

To the extent possible, the installation of a pile should be a continuous operation without termination of driving until the point of acceptable resistance or embedment is achieved. If driving is interrupted, the pile should be driven at least 1 foot after driving is resumed prior to evaluating whether the termination criteria have been obtained.

8.8.2.2 Pile Installation Monitoring

Continuous driving and installation records should be maintained for all test and production piles. Production piles should be driven utilizing the same hammer and equipment as used to drive the

test piles based upon the driving criteria established as a result of the test program. Test piles which satisfy the geotechnical engineer's requirements for proper installation may also be used as production piles. The geotechnical engineer, or his designated representative, should observe and record the installation of all test and production piles. His duties should include the following:

1. Keeping an accurate record of pile installation and driving procedures.
2. Documenting that piles are installed to the proper driving resistance and to a depth indicative of the intended bearing formation.
3. Confirm that the pile driving equipment is generally operating properly.
4. Confirming that the piles are not noticeably damaged during installation and observing the piles prior to installation for apparent defective workmanship.
5. Documenting other required installation procedures and conditions such as predrilling, jetting, and hammer and pile cushion conditions.
6. Documenting the pilot hole construction procedure including description, depth, and elevations of materials removed and rate of drilling (seconds per foot of advancement).
7. Being aware of various aspects of the installation, including type of pile driving equipment, driving criteria, and pile installation tolerances.
8. Recording the number of blows for each foot of driving.
9. Informing the owner's representative of any unusual subsurface conditions or driving conditions.

The geotechnical engineer should review all production pile driving and preboring construction records on a daily basis and all records prior to pile cap or abutment construction.

8.8.2.3 Pile Load Test Program

Prior to ordering of piles, we recommend that the first production pile at each end of the bridge (*e.g.*, one pile at Piers 1-3 and one pile at Piers 16-18) be tested using the Pile Driving Analyzer (PDA). The PDA test results will measure actual stresses at the top of the pile and provide an estimate of the installed capacity. The piles should be dynamically tested during the initial driving and upon restrike. We recommend a minimum of three days between initial drive and restrike tests. The test piles should be installed using the same equipment and method of installation proposed for production pile installation. The purpose of the test pile program is to

verify the axial capacity, assist in the estimation of pile lengths, and confirm that the contractor's equipment and installation methods and procedures are acceptable.

Prior to dynamic testing, we recommend that wave equation analyses be performed to assist in establishing initial installation criteria and estimating driving stresses. The wave equation is a computer software package developed to perform a dynamic analysis of the pile-hammer system, considering the weight and size of the pile, the subsurface conditions, and the characteristics of a given pile hammer to be used for the project. Given this information, the engineer can formulate initial installation criteria necessary to achieve the desired allowable pile capacity, as well as anticipating problems that may arise prior to the field testing program. The installation criteria can then be refined based on actual parameters determined during PDA testing and subsequent CAPWAP analyses.

The CAPWAP analysis is an analysis procedure that models the pile and soil similar to the wave equation, except that it replaces the assumed hammer and driving system with actual measured pile top force and velocity obtained from PDA testing. With these measurements, it is possible, using wave propagation theory, to determine the boundary forces, (soil resistances). The measured velocity is input with an assumed set of soil parameters (resistance, quake, damping, etc.) for each element of the pile shaft and pile toe. The corresponding pile top force to achieve equilibrium is then calculated and compared with the measured force. As the computed and measured forces usually do not agree, the soil parameters are adjusted and the analysis repeated until the match is of sufficiently quality; thus, the wave equation analysis is refined using the new soil parameters giving an improved estimated ultimate pile capacity. CAPWAP analyses can also be performed on the PDA results to provide a more refined estimate of pile capacity and termination criteria. Based on our experience, we anticipate that driving criteria of 8 to 12 blows per inch will provide the necessary pile capacities; however, this should be confirmed by wave equation analyses and PDA testing. Additionally, we recommend that dynamic formula such as the ENR formula (or other similar formula) not be used to determine driving criteria due to inherent uncertainties with these methods.

We recommend that each test pile and production pile installation be observed and documented by the Engineer. The primary purpose of this observation is to determine if the production piles are installed in accordance with the pile driving criteria established by the dynamic load testing. Continuous driving records should be kept for each pile installed. Production piles should be

driven utilizing the same hammer running at the same energy level as was used to install the test pile. The Engineer should review all pile driving installation records prior to construction of the pile cap.

8.8.3 Concrete-Filled Steel Pipe Pile Construction Recommendations

As mentioned previously the concrete-filled steel pipe pile foundation alternative consist of first installing a full-length permanent steel casing then augering out inside the pile and filling with concrete. In our opinion, this alternative is similar to a fully-cased drilled shaft and should follow the provided recommendations for drilled shaft construction.

8.9 ADDITIONAL GEOTECHNICAL CONSIDERATIONS

8.9.1 Pre-construction Condition Surveys

We recommend that pre-construction crack and damage (condition) surveys be performed at the site to determine and document the condition of the existing bridges and nearby structures prior to construction. Structures that exist within the zone of influence of excavation operations and vibration inducing activities should be included in the survey. We note that the recommended deep foundation construction procedures discussed in this report including drilled shaft construction and/or pile installation can result in damage claims. The existing site conditions and conditions of nearby structures should be appropriately documented by photographs, crack surveys (and crack monitoring gauges if necessary), and video recordings prior to demolition of the existing bridge or construction of new structures.

From our site reconnaissance we have identified two structures within the anticipated zone of influence of pile driving vibrations and/or drilled shaft excavations. The first structure is the existing railroad bridge south of and parallel to the existing Gilmerton Bridge. The second structure is the existing Gilmerton Bridge. We recommend that pre-construction surveys for these structures also include several control points along the base of the structure to closely monitor any changes in elevation from pre-construction elevations.

8.9.2 Scour Analysis

Scour of the underlying alluvial soils in the channel has been evaluated by Modjeski and Masters. A copy of the scour analysis report was provided to MACTEC on October 10, 2003. The

summary report details the hydrology and site characteristics in the vicinity of the proposed project. A summary of scour depths and respective elevations at over-water pier locations is presented in Table 8.9.2.1.

Table 8.9.2.1
Summary of Scour Depths and Elevations

Structure Description	Estimated Mudline Elevation (ft)	Estimated 100-year Scour Depth (ft)	Estimated 100-year Scour Elevation (ft)
Approach Pier 5	-10	8	-18
Approach Pier 6	-18	10	-28
Approach Pier 7	-21	14	-35
Approach Pier 8	-30	14	-44
Lift Span Pier 9	-26	17	-43
Lift Span Pier 10	-29	17	-46
Approach Pier 11	-10	11	-21
West Guide Dolphins	-20	26	-46
East Guide Dolphin	-10	16	-26
West Fender Dolphins	-36	39	-75
East Fender Dolphins	-36	27	-63

Axial and lateral capacity analyses were completed by MACTEC using the estimated scour elevations provided in Table 8.9.2.1. Existing soils above the estimated scour elevation at the location of the over-water pier foundations have been ignored for contribution of axial soil capacity. Soil resistance at elevations below the current mudline and above the estimated scour profile was also neglected in MACTEC's analyses of foundation deflections and stresses due to lateral loading. The 100-year flood event scour depths were used in MACTEC's design of bridge pier foundations. Bridge pier foundations were evaluated with the 500-year flood event scour depth to verify a minimum safety factor of 1.0.

8.9.3 Typical Foundation Costs

We have reviewed available construction cost data to assist the design team in construction cost estimates for proposed bridge foundations. Limited data is available for drilled shaft construction in the subject area and our estimate of 5- and 6-foot diameter drilled shaft costs are based mainly on the submitted contractors costs from the Pinners Point Interchange Project. Accordingly, we recommend an installed unit cost of $450 per foot for 5-foot diameter drilled shafts and $550 per foot for 6-foot diameter drilled shafts. For 12-foot diameter shafts, we recommend a unit cost of

$1,600 to $1,800 per foot installed. This estimate is based mainly on data from the Cooper River Bridge project located in Charleston, South Carolina, which utilized 10-foot diameter shafts for over-water pier support and 12-foot diameter drilled shafts for piers on land.

8.9.4 Construction Plans and Specification Review

MACTEC should be retained to review final design construction plans and contract documents to verify our design intent relative to the geotechnical aspects of the proposed construction. We should assist the design team with preparation and review of contract specifications and special provisions relative to the recommendations provided in this report.

9.0 BASIS FOR RECOMMENDATIONS

The recommendations provided are based in part on project information provided to us, and they only apply to the specific project and site discussed in this report. If this information is incorrect or if additional information is available, the correct or additional information should be conveyed to us for review and possible modification to our report.

Regardless of the thoroughness of a geotechnical exploration, there is always a possibility that conditions between borings will be different from those at specific boring locations and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered during construction. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created.

We recommend that this complete report be provided to the various design team members, the contractors and the project owner. Potential contractors should be informed of this report in the "Instructions to bidders" section of the bid documents. The report should not be included or referenced in the actual contract documents.

10.0 REFERENCES

Applied Foundation Testing, Inc. (2002). *Statnamic Load Test Results – Pier 41 and Pier 4,* Pinners Point Interchange Project.

Barker, W. J. and Bjorken, E. D. (1978). *Geology of the Norfolk South Quadrangle, Virginia*: Virginia Division of Mineral Resources Publication 9, text and 1:24,000 scale map.

Bowles, J.E. (1996). *Foundation Analysis and Design*; Fifth Edition; McGraw-Hill; New York, Table 2-7.

Coduto, D.P. (2001). *Foundation Design: Principles and Practices*; Second Edition; Prentice Hall; New Jersey, Table 14.1.

Duncan, J. M. and Buchignani, A. L. (1987). *An Engineering Manual for Settlement Studies*, Virginia Tech Course Pack, Table 6.

Federal Highway Administration. (1999). *Drilled Shafts: Construction Procedures and Design Methods*, ADSC Publication No. ADSC-TL 4, Dallas, Texas.

Federal Highway Administration. (2002). *Geotechnical Engineering Circular No. 5: Evaluation of Soil and Rock Properties*, Equation 55.

Huang, Y. (1993). *Pavement Analysis and Design*; Prentice Hall; New Jersey.

Kramer, S.L. (1996). *Geotechnical Earthquake Engineering*; Prentice Hall; New Jersey.

Loadtest, Inc. (May 2001). *Report on Drilled Shaft Load Testing – Test Shafts 1 and 2*, Pinners Point Interchange Project.

Martin, R. E., Seli, J. J., Powell, G. W., and Bertoulin, M. (1987). *Concrete Pile Design in Tidewater Virginia*: ASCE Journal of Geotechnical Engineering, Vol. 113, No. 6.

McGregor, J.A., Duncan, J.M. (1998). *Performance and use of the Standard Penetration Test in Geotechnical Engineering Practice*; CGPR, Figure 48.

Mayne, P.W. (2003). *Gilmerton Bridge In-Situ Soil Parameters and Properties Interpretation Report.*

Parsons Transportation Group. (2000). *Woodrow Wilson Bridge Vibration Study.*

Sharma, S. (2001). *Fall 2001 Course Notes.*

Terzaghi, K., Peck, R., and Mesri, G. (1996). *Soil Mechanics in Engineering Practice, 3rd edition*, Wiley and Sons, New York.

Correa, Ricardo, PE

From: Johns, Kevin [KWJohns@modjeski.com]
Sent: Friday, July 11, 2008 7:10 AM
To: Martin, Russell L., P.E.
Cc: Correa, Ricardo, PE; Gupta, Ramesh C., P.E.
Subject: FW: Gilmerton Bridge Geotechnical Report
Attachments: 040309 Report Addendum No. 1.pdf

Russ,

For your convenience, attached is the Addendum No. 1 – Report of Geotechnical Exploration which was originally forwarded to Dina Kukreja on March 16, 2004.

Kevin Johns

From: Borden, Lance V.
Sent: Tuesday, March 16, 2004 10:38 AM
To: Kukreja, Dina, P.E.(Dina.Kukreja@VirginiaDOT.org)
Cc: Irwin, Michael C.; Randy Wirt (jrwirt@mactec.com)
Subject: FW: Gilmerton Bridge Geotechnical Report

Dina,

Here is an addendum to MACTEC's Report of Geotechnical Exploration. Please also forward to Ramesh Gupta or whom ever else may have a copy of MACTEC's Report.

This is not part of our response to the foundation concerns. We will submit our response as one complete document rather than in portions.

Thank you.

Lance V. Borden
Modjeski and Masters, Inc
Phone 717-790-9565
Fax 717-790-9564

-----Original Message-----
From: Wirt, Randy [mailto:JRWIRT@mactec.com]
Sent: Thursday, March 11, 2004 4:17 PM
To: Borden, Lance V.
Cc: Irwin, Michael C.; Burke, Eric; Tice, Al; Paul Mayne; pm29@ce.gatech.edu
Subject: Gilmerton Bridge Geotechnical Report

Lance,

Please find attached MACTEC's Addendum No. 1 to our Report of Geotechnical Exploration for the subject project. The report addendum addresses MACTEC's evaluation of variable shaft tip elevations for the vertical lift span foundations per Modjeski's February 11, 2004 request from Mr. Mike Irwin.

The addendum also addresses a discrepancy noted in our original lateral load analyses and the results of our revised GROUP runs. The results provided in the attached addendum have been provided to Modjeski over the course of the last week or so via discussions between myself and Mr. Irwin.

Please call if you have any questions or need clarification on the attached addendum.
We will follow up with a hard copy of the addendum and noted enclosure files.

Regards,
Randy

****
J. Randy Wirt, P.E.
Senior Engineer
MACTEC Engineering and Consulting, Inc.
1606 Ownby Lane
Richmond, VA 23220
phone: 804.358.7111
fax: 804.358.6646
http://www.mactec.com
****

MACTEC

March 11, 2004

Mr. Lance V. Borden, P.E.
Modjeski & Masters, Inc.
P.O. Box 2345
Harrisburg, Pennsylvania 17105

SUBJECT: **Addendum No. 1 – Report of Geotechnical Exploration**
Gilmerton Bridge Replacement – Stage II Final Design
Chesapeake, Virginia
VDOT Project No. 7013-131-V03, PE-101, B615
MACTEC Project No. 20400-2-1213.02.RPT

Dear Mr. Borden:

On February 11, 2004, MACTEC was requested by Modjeski & Masters via e-mail to evaluate variable front and rear tip elevations for the vertical lift span drilled shafts. The intent of our analysis was to evaluate the feasibility of shortening the rear tower shafts to produce an approximately equivalent settlement of the front of rear shafts. This would ultimately minimize the resulting magnitude of differential settlement between the front and rear of each tower foundation. Our evaluations were based on the soil properties and loading conditions summarized in our original Report of Geotechnical Exploration dated December 19, 2003, and conversations between MACTEC and Modjeski in February and March 2004.

Item 1. Based on our evaluation of variable shaft tip elevations, we do not recommend raising the rear shaft tip elevation. The results of our lateral load analyses indicate that the vessel collision load case controls the founding depths and that fixity of the rear drilled shaft foundations is not achievable when shortening the rear drilled shafts more than 5 to 15 feet for the concrete shafts and steel pipe pile shafts, respectively. The front and rear shafts should bear at the same minimum tip elevations provided in revised Table 8.3.2.1 below.

Item 2. During our evaluation of variable shaft tip elevations, we discovered a discrepancy in our lateral load analyses including selected results presented in Tables 8.3.2.1 and 8.3.4.1 of our original report. Accordingly, we have revised our GROUP runs and have attached the results which should replace the respective Appendix D GROUP output. Revisions from our original foundation recommendations are presented on the following tables which should be used in place of the original Tables 8.3.2.1 and 8.3.4.1.

Revised Table 8.3.2.1
Allowable Capacity and Estimated Tip Elevation for
Vertical Lift Span Tower Foundations

Structure	Material Interface	Estimated Tip Elevation (ft)	Foundation Length (ft)	Estimated Allowable Axial Capacity (kips)
Piers 9 -10	Concrete-Soil*	-140	160	6,100
	Steel-Soil	-150	170	5,300

* Steel casing assumed to elevation -90 feet.

Revised Table 8.3.4.1
Summary of Lateral Capacity Results for
Vertical Lift Span Piers

Loading Condition	Material Interface	Estimated Top of Shaft Elevation (ft)	Estimated Top Deflection (in)	Maximum Bending Moment (kip-ft)	Estimated Point of Fixity Elevation[1] (ft)
Vessel Impact	Concrete-Soil	+20	5.2	92,000	-119
	Steel-Soil	+20	5.3	93,000	-120
Service Loading	Concrete-Soil	+20	0.3	11,000	-105
	Steel-Soil	+20	0.3	11,000	-107
Wind Loading	Concrete-Soil	+20	0.5	9,500	-104
	Steel-Soil	+20	0.5	9,500	-105

Notes: [1] Point of fixity was determined as the depth corresponding to 1D beyond the initial point of zero deflection as shown on the respective load-displacement curves from the GROUP output.

MACTEC evaluated the anticipated settlement of the tower shafts based on the revised minimum tip elevation for the concrete-soil drilled shafts. Our settlement estimates for the front and rear shafts remain the same as originally reported in our December 2003 Report of Geotechnical Exploration.

Item 3. In our review of engineering properties in Table 8.1.1 of our original Report of Geotechnical Exploration, we discovered an error with the label headings associated with the unit skin friction and end bearing resistance values presented. The engineering parameters titled "**allowable** unit skin friction, f_s" and "**allowable** unit end bearing, f_b" should be "**ultimate** unit skin friction, f_s" and "**ultimate** unit end bearing, f_b". The following table presents these corrections and replaces Table 8.1.1 of our December 2003 Report. Allowable unit values (reduced by an appropriate factor of safety) were used in developing the allowable capacities and estimated tip elevations for the bridge foundations that are presented in our report.

Revised Table 8.1.1
Summary of Geotechnical Engineering Parameters

Engineering Parameter		Soil Stratum				
		Alluvial Sand	Alluvial Clay	Norfolk Formation	Yorktown Formation Y2	Yorktown Formation Y1
Total Unit Weight (pcf)		115	110	115	120	115
Effective Unit Weight (pcf)		53	48	53	58	53
Effective Stress Friction Angle, ϕ' (deg)		30	-	33	35	-
Undrained Shear Strength, S_u (psf)		-	600	-	-	3,500
Poisson's Ratio, ν		0.2	0.45	0.2	0.2	-
Lateral Subgrade Modulus, k_h (pci)		60	100	60	60	-
Small-strain Shear Modulus, G (ksf)		1,600	900	2,100	2,600	-
Soil Strain, ε_{50}		-	0.01	-	-	-
Ultimate Unit Skin Resistance, f_s (ksf)	Concrete	0.4	0.4	1.2	3.75	-
	Driven Steel	0.3	0.3	0.8	2.63	-
	Screwed Steel	0.2	0.2	0.7	2.25	-
Ultimate Unit End Bearing, f_b (ksf)		-	-	-	50	-
GROUP p-y Curve Soil Model		Sand (Reese, et al.)	Submerged Soft Clay	Sand (Reese, et al.)	Sand (Reese, et al.)	Stiff Clay
Compression Ratio, CR		-	0.15	-	0.2	0.25
Recompression Ratio, RR		-	0.01	-	0.006	0.05

We trust that this memorandum and the attached calculations adequately summarize our evaluation of variable tip elevations for the vertical lift span and present appropriate corrections to erratum in our original Report of Geotechnical Exploration. Please do not hesitate to call if you have questions or need additional information.

Very truly yours,

MACTEC ENGINEERING AND CONSULTING, INC.

J. Randy Wirt

J. Randy Wirt, P.E.
Senior Engineer

C. Eric Burke

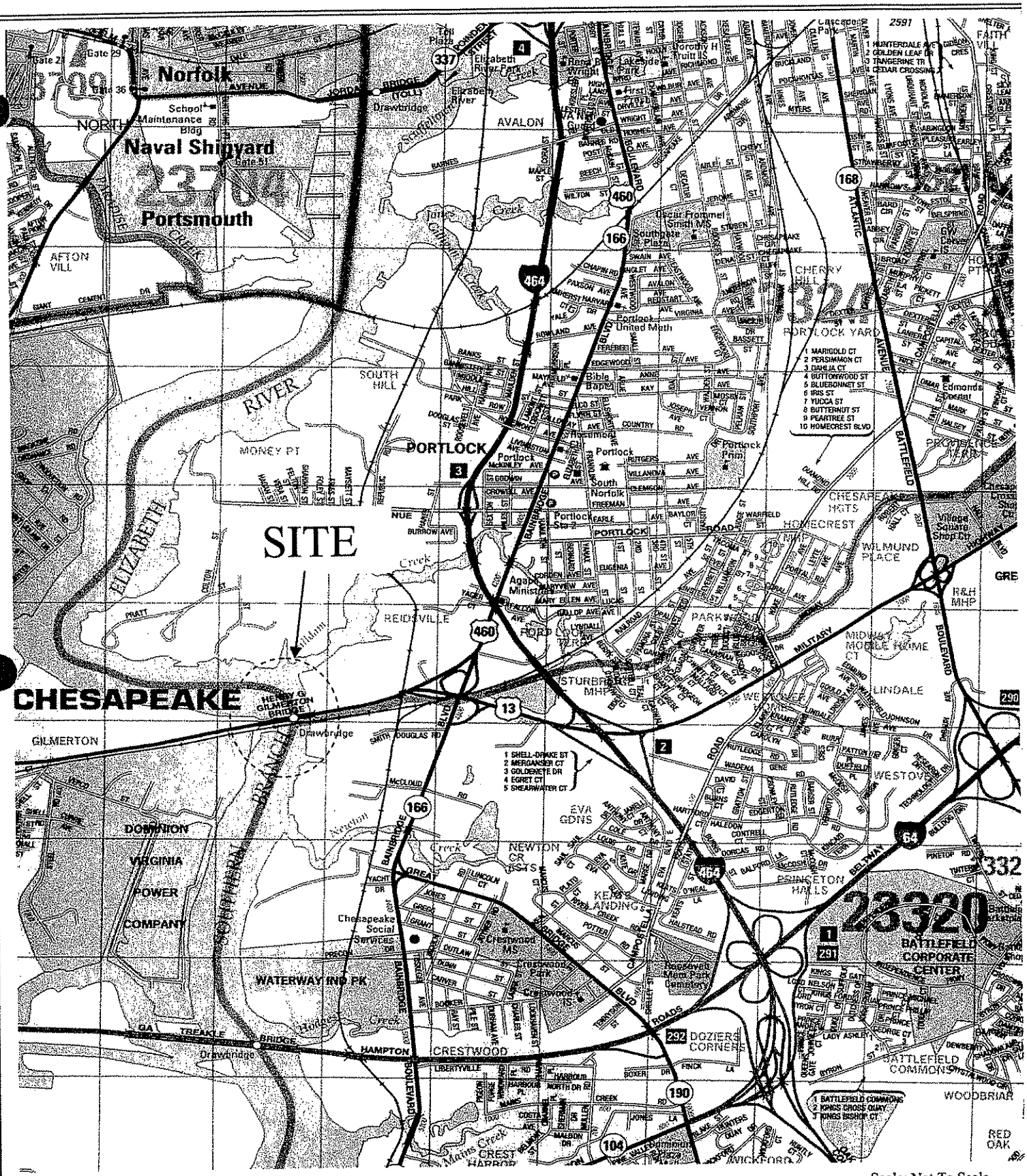
C. Eric Burke, P.E.
Principal/Project Manager

Enclosure: GROUP results for Vertical Lift Span Lateral Load Analysis (under separate cover)

cc: J. Al Tice, P.E.
Mike C. Irwin, P.E.
Paul Mayne, PhD, P.E.
File

JRW/CEB:jrw

P:\1200\1213 Gilmerton Bridge\Reports\Final Report\040309 Report Addendum No. 1.doc



ADC Street Map of Greater Hampton Roads, Virginia ,2nd Edition ,2001.

Scale: Not To Scale.

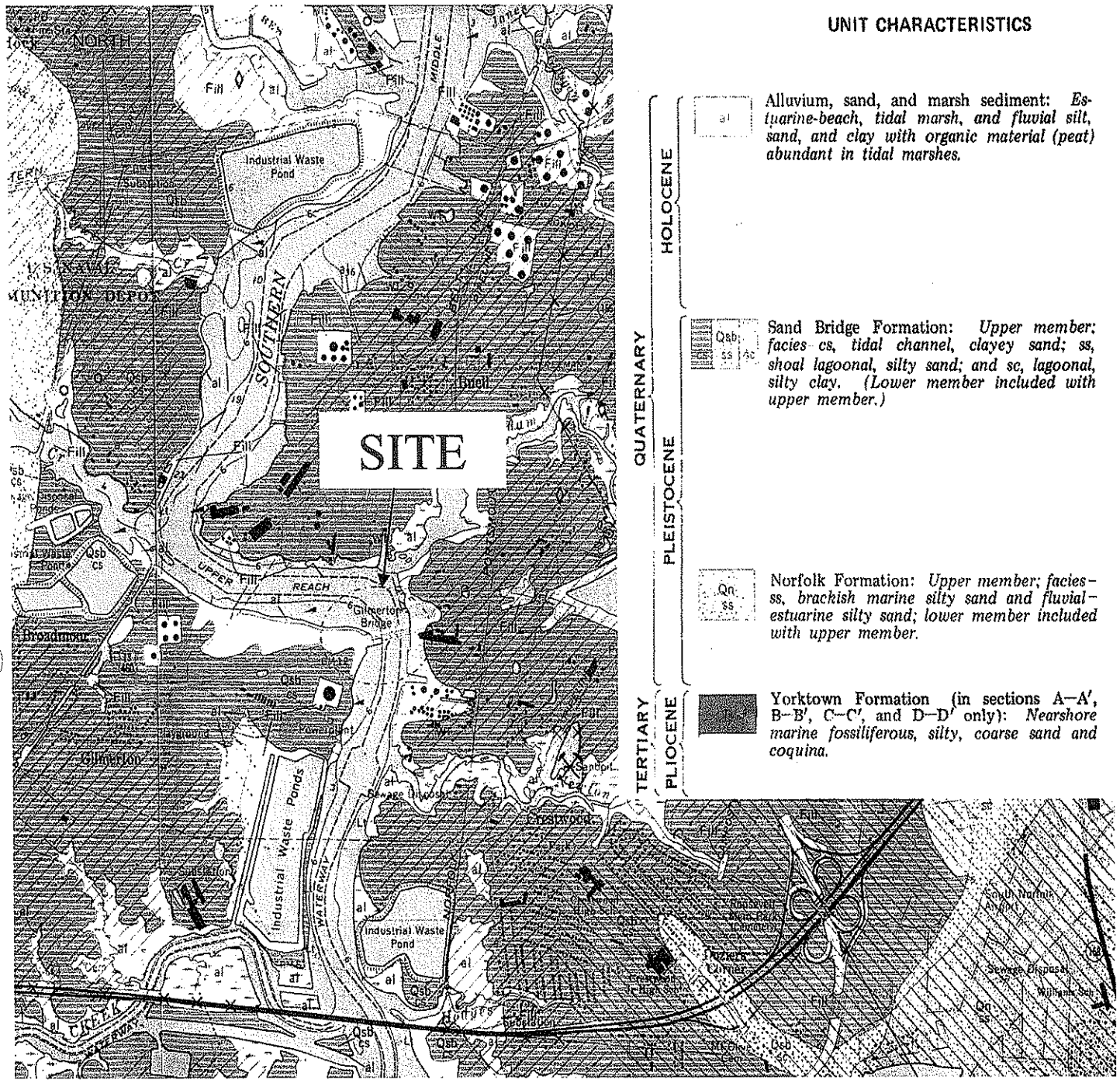
MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
1606 Ownby Lane Richmond, VA 23220

FIGURE 1

SITE VICINITY MAP
GILMERTON BRIDGE REPLACEMENT
CHESAPEAKE, VIRGINIA

Project# 20400-2-1213.02 August 2003



Barker, W. J. and Bjorken, E. D., 1978, Geology of the Norfolk South quadrangle, Virginia: Virginia Division of Mineral Resources Publication 9, text and 1:24,000 scale map.

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
1606 Ownby Lane Richmond, VA 23220

FIGURE 2

GEOLOGY SITE LOCATION MAP

GILMERTON BRIDGE REPLACEMENT

CHESAPEAKE, VIRGINIA

Project # 20400-2-1213.02 August 2003

Beginning of Bridge
Back of Backwall
Sta. 24+04.92

Finished Grade

MC-1 3/3/2003

MC-2 3/4/2003

Fill

ABUTMENT A

MC-27 3/4/2003

Edge of Berm

MS-1 5/9/2003

Span 1

MD-1 2/28/2004

PIER 1

MC-3 2/25/2003

Span 2

PIER 2

Proposed Parking Area for Bridge Tenders

MC-4 3/3/2003

MD-2 2/27/2004

Span 3

PIER 3

Fix

Fix

MATCHLINE STA. 26+33.50 (SEE FIGURE 5 B)

Retaining Wall

Class II Riprap Slope Protection

Existing Profile Along Construction ℄

0.0

-20.0

-40.0

-60.0

-80.0

-100.0

-120.0

LEGEND

Alluvial Clay/Silt

Alluvial Sand

Norfolk Formation

Yorktown Y2 Formation

Yorktown Y1 Formation

SCALE 0' 15' 30' 60'

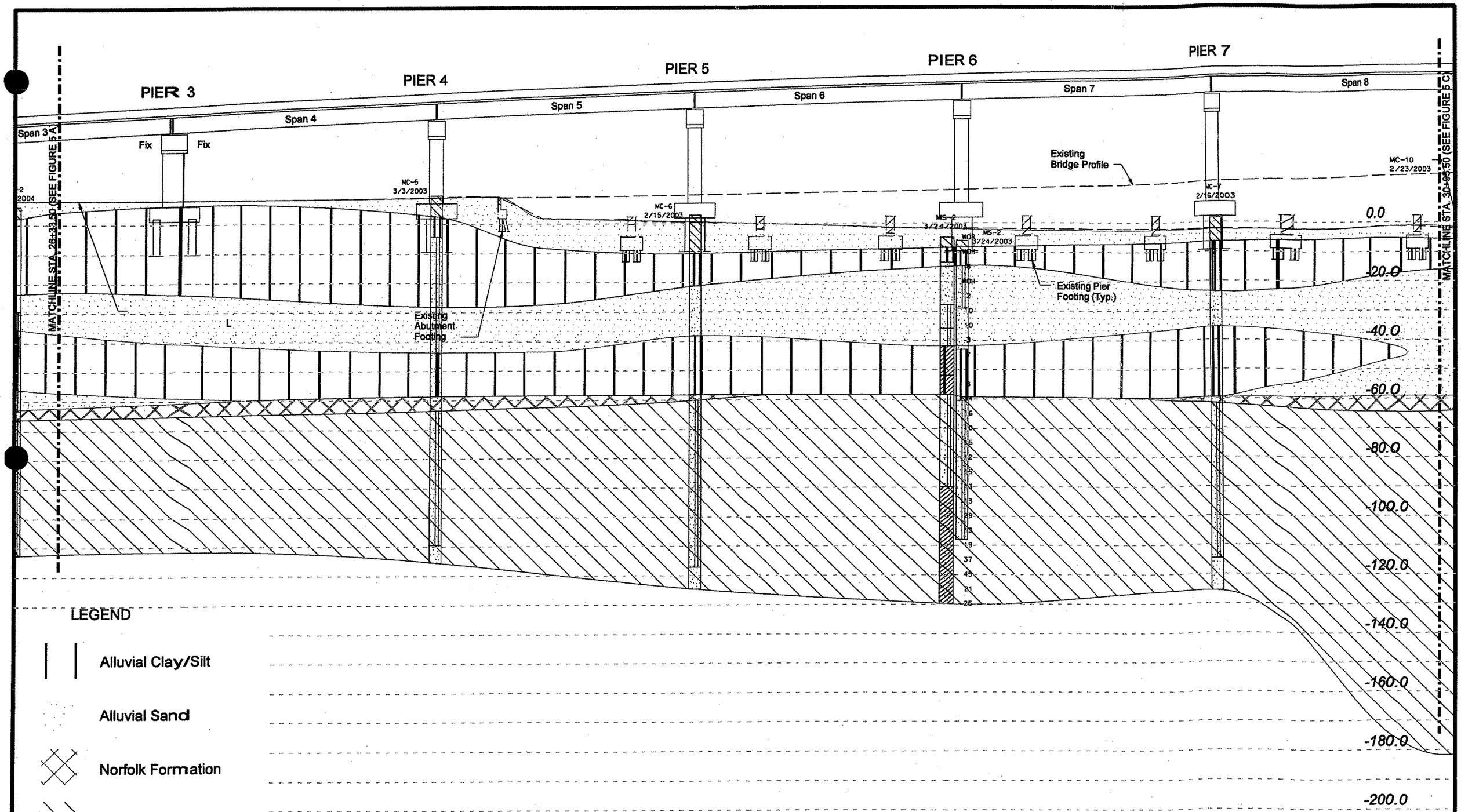
MACTEC, Inc.

Des. by	D.C.V.
Drn. by	D.C.V.
Rev. by	C.E.B.

Figure 4A - Estimated Subsurface Profile
Gilmerton Bridge, Stage II
V.D.O.T. PROJECT No. 7013-131-V03, PE101, B615

20400-2-1213	December 2003	Scale: 1" = 30'

bsurfacePart1.dgn 12/17/2003 05:19:12 PM



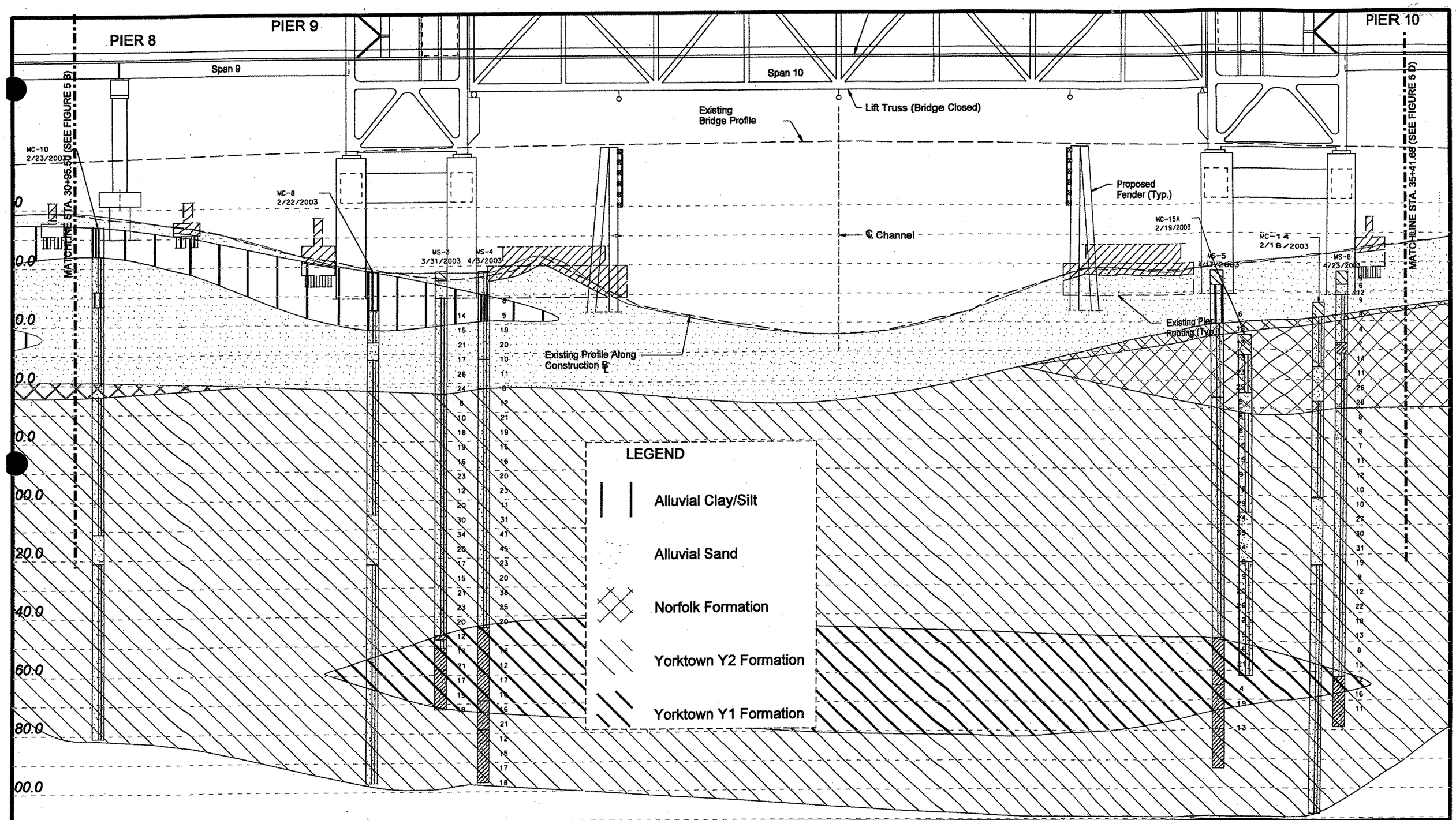
MACTEC, Inc.

Des. by	D.C.V.
Drn. by	D.C.V.
Rev. by	C.E.B.

Figure 4B - Estimated Subsurface Profile
Gilmerton Bridge, Stage II
V.D.O.T. PROJECT No. 7013-131-V03, PE101, B615

20400-2-1213	December 2003	Scale: 1" = 30'

bsurfacePart2.dgn 12/17/2003 05:18:16 PM



MACTEC, Inc.

Des. by	D.C.V.
Drn. by	D.C.V.
Rev. by	C.E.B.

Figure 4C - Estimated Subsurface Profile
Gilmerton Bridge, Stage II
V.D.O.T. PROJECT No. 7013-131-V03, PE101, B615

20400-2-1213	December 2003	Scale: 1" = 30'

bsurfacePart3.dgn 12/17/2003 05:20:24 PM

PIER 11 | PIER 12 | PIER 13 | PIER 14 | PIER 15

Span 11 | Span 12 | Span 13 | Span 14 | Span 15 | Span 16

MATCHLINE STA. 35+41.68 (SEE FIGURE 5 C)

MATCHLINE STA. 40+03.50 (SEE FIGURE 5 E)

Existing Bridge Profile

MC-17 2/10/2003

MC-18 2/13/2003

MC-25 2/11/2003

MC-19 2/10/2003

Existing Profile Along Construction ℄

Existing Pier Footing (Typ.)

0.0

-20.0

-40.0

-60.0

-80.0

-100.0

-120.0

-140.0

-160.0

-180.0

-200.0

LEGEND

Alluvial Clay/Silt

Alluvial Sand

Norfolk Formation

Yorktown Y2 Formation

Yorktown Y1 Formation

SCALE 0' 15' 30' 60'

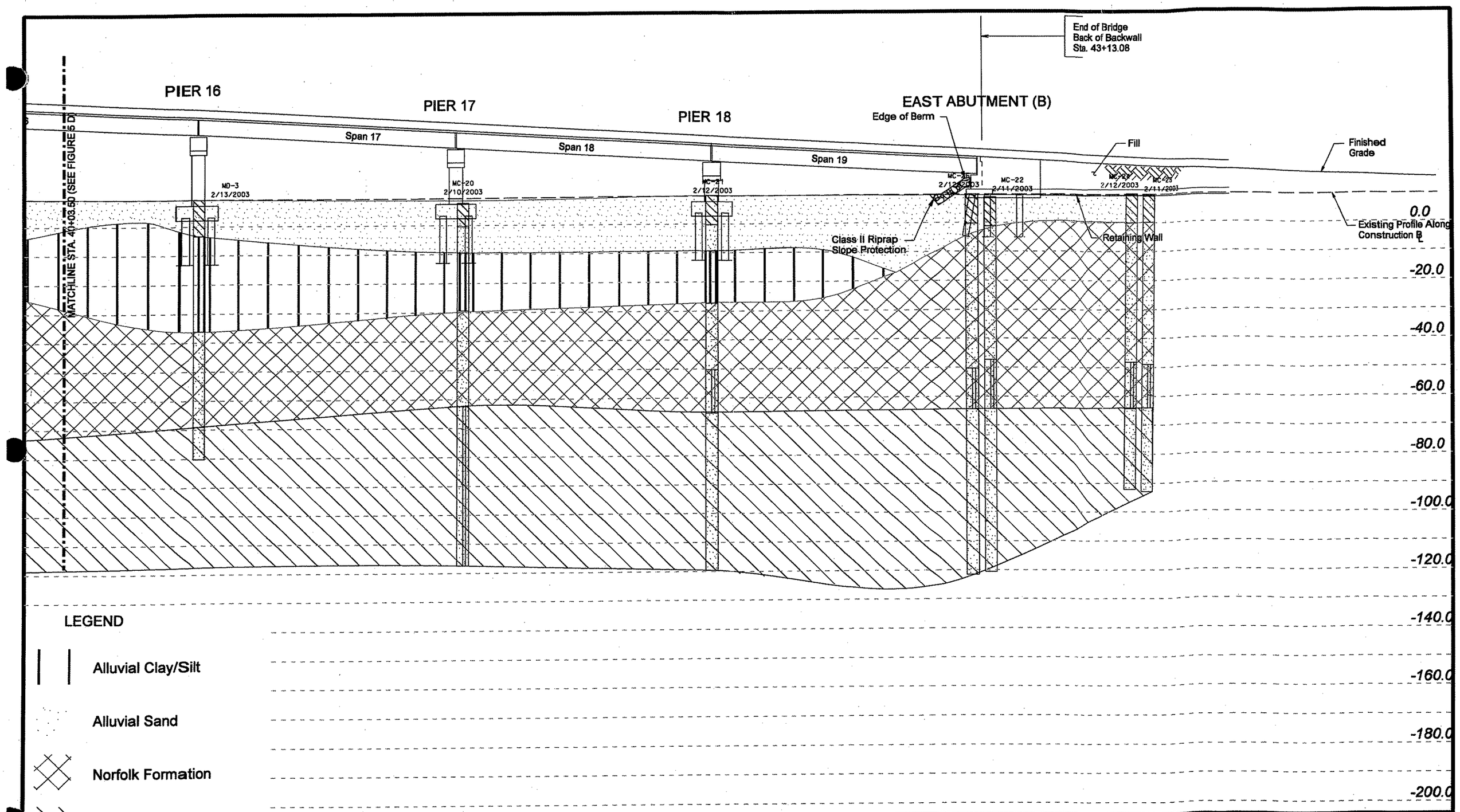
MACTEC, Inc.

Des. by	D.C.V.
Dm. by	D.C.V.
Rev. by	C.E.B.

Figure 4D - Estimated Subsurface Profile
Gilmerton Bridge, Stage II
V.D.O.T. PROJECT No. 7013-131-V03, PE101, B615

20400-2-1213	December 2003	Scale: 1" = 30'

ubsurfacePart4.dgn 12/17/2003 05:21:17 PM



MACTEC, Inc.

Des. by	D.C.V.
Dm. by	D.C.V.
Rev. by	C.E.B.

Figure 4E - Estimated Subsurface Profile
Gilmerton Bridge, Stage II
V.D.O.T. PROJECT No. 7013-131-V03, PE101, B615

20400-2-1213	December 2003	Scale: 1" = 30'

SubsurfacePart5.dgn 12/17/2003 05:22:05 PM

FIELD OPERATIONS

The general field procedures employed by MACTEC are summarized in ASTM Specification D 420 entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground-water conditions. These methods include geophysical and in-situ methods as well as borings.

Borings are drilled to depths to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques are:

(a) Continuous 3¼ or 4¼-inch I.D. hollow stem augers;
(b) Wash borings using roller cone or drag bits (mud or water);
(c) Continuous flight augers (ASTM D 1452).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observation of ground water. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM Specification D 2488 and prepares the final boring records that are the basis for evaluations and recommendations.

The final test boring records represent our interpretation of the contents of the field records based on the results of the engineering examination and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground-water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The actual transition between materials may be gradual. The final Test Boring Records are included in this appendix.

SOIL SAMPLING PROCEDURES

Penetration Test and Split-barrel Sampling

The borings were drilled using hollow-stem augers or solid-flight augers (or as noted on the Test Boring Records). Penetration testing and split-barrel sampling were conducted in the borings at regular intervals.

The standard penetration test (SPT) provides an indication of the soil strength and compressibility. The SPT resistances and split-barrel sampling are conducted simultaneously according to ASTM Specification D 1586. At regular intervals, soil samples are obtained with a standard split-tube sampler. The sampler is first seated 6 inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the 12-inch increment is recorded and is designated the "penetration resistance."

Representative portions of the soil samples obtained from each split-barrel sample are placed in glass jars, sealed, and transported to our laboratory. Descriptions of the split-tube samples and the penetration resistances are shown on the attached Test Boring Records.

Water Level Measurements

Water level readings and caved depths are measured in completed borings as noted on the Test Boring Records. These water level readings indicate the approximate location of the ambient ground-water table at the time of our field investigation. In some instances, the caved depths may possibly indicate ground-water activity.

The time of boring water level reported on the Test Boring Records is determined by field crews as the drilling tools are advanced. Additional water table readings are generally obtained approximately one day after the borings are completed. The time lag is used to permit stabilization of the ground-water table that has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel - sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel - sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel - sand - silt mixtures.
			GC	Clayey gravels, gravel - sand - clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 Sieve Size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand - silt mixtures
			SC	Clayey sands, sand - clay mixtures.
FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts and with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts.
DECOMPOSED ROCK			DR	Residual material that retains the relict structure of the parent bedrock & exhibits SPT resistances consistently over 60 bpf.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)

Undisturbed Sample	Auger Cuttings
Split Spoon Sample	Bulk Sample
Rock Core	Grab Sample
Dilatometer	Pressure Meter
Packer	No Recovery
Water Table at time of drilling	Water Table after 24 hours

Correlation of Penetration Resistance with Relative Density and Consistency

SAND & GRAVEL		SILT & CLAY	
No. of Blows	Relative Density	No. of Blows	Consistency
0 - 4	Very Loose	0 - 1	Very Soft
5 - 10	Loose	2 - 4	Soft
11 - 20	Firm	5 - 8	Firm
21 - 30	Very Firm	9 - 15	Stiff
31 - 50	Dense	16 - 30	Very Stiff
Over 50	Very Dense	Over 31	Hard

KEY TO SYMBOLS AND DESCRIPTIONS

MACTEC

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-1

STATION: 24+06
EASTING: 3925673.5
SURFACE ELEVATION: 8.0 ft
OFFSET: 33 ft. N
NORTHING: 168249.3

FIELD DATA

Date(s) Drilled: 5/8/03 - 5/9/03
Drilling Method(s): Auger 10 ft./Mud-Rotary 10-125 ft.
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER
FIRST ENCOUNTERED AT: 8.0 ft DEPTH
STABILIZED AT: 8.0 ft (0.0ft ELEV.)

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
0											0.0 / 8.0 TOPSOIL			
2		6 7 5	100		0 – 1.5						1.5 / 6.5 Firm, gray with brown mottling, silty, clayey SAND, some sand, trace organics, moist. [ALLUVIUM] **SC-SM**			
4	5													
6		3 2 3	100		4.5 – 6							20	4	24.3
8	0										7.0 / 1.0 Very loose, tan-brown wih dark gray mottling, poorly graded fine to coarse SAND, trace silt, moist. [ALLUVIUM] **SP-SM**			
10		3 2 2	100		8.5 – 10									
12	-5										Loose, light brown with brown mottling, fine to coarse SAND, trace silt, wet. [ALLUVIUM] **SP-SM**			
14		3 4 6	100		13.5 – 15									
16														
18	-10													
20		8 8 10	100		18.5 – 20									
22														
24	-15	9 4 2	100		23.5 – 25						Firm, orange-brown, poorly graded fine to coarse SAND, trace silt, wet. [ALLUVIUM] **SP-SM**			
26											24.0 / -16.0 Firm, green-gray, SILT, trace sand and mica, wet. [ALLUVIUM] **ML**			
28	-20													
30		1 2 2	100		28.5 – 30									
32			0		31 – 33							40	9	47.4
34	-25				34									
36			50		36							50	21	55.2
38	-30		0		38									
40		2 2	100		38.5						38.0 / -30.0 Loose, green-gray, fine to medium silty SAND, wet.	31		45.7

REMARKS:

MS-1

© 2003, Commonwealth of Virginia

SPT_LOG-123102_1213-2.GPJ 12/17/03 JRW

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-1

STATION: 24+06
EASTING: 3925673.5
SURFACE ELEVATION: 8.0 ft

OFFSET: 33 ft. N
NORTHING: 168249.3

Date(s) Drilled: 5/8/03 - 5/9/03
Drilling Method(s): Auger 10 ft./Mud-Rotary 10-125 ft.
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER
FIRST ENCOUNTERED AT: 8.0 ft DEPTH
STABILIZED AT: 8.0 ft (0.0ft ELEV.)

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		4			40						[ALLUVIUM] **SM**			
42											41.0 / -33.0 Firm, green-gray, SILT, little sand, wet. [ALLUVIUM] **ML**			
	-35				43.5									
44		3 3 5	100		45									
46											46.0 / -38.0 Firm, green-gray, fine to medium SAND, little silt, wet. [NORFOLK] **SM**			
48	-40				48.5									
		5 6 9	100		50									
50														
52														40.4
	-45				53.5									
54		7 7 7	100		55									
56											Very firm, green-gray with black mottling, fine to medium SAND, little silt, wet. [NORFOLK] **SM**			
58	-50				58.5									35.3
		7 11 12	100		60									
60														
62														
	-55				63.5									
64		8 7 7	100		65									
66														
68	-60				68.5						68.5 / -60.5 Loose, blue-gray, fine to medium SAND some silt, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
		9 3 4	100		70									
70														
72														
	-65				73.5									
74		5 4 6	100		75									
76														
78	-70				78.5									
		3 3	100											
80														

REMARKS:

SPT_LOG-123102 1213 V5.GPJ 12/17/03

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-1

STATION: 24+06
EASTING: 3925673.5
SURFACE ELEVATION: 8.0 ft
OFFSET: 33 ft. N
NORTHING: 168249.3

Date(s) Drilled: 5/8/03 - 5/9/03
Drilling Method(s): Auger 10 ft./Mud-Rotary 10-125 ft.
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER
FIRST ENCOUNTERED AT: 8.0 ft DEPTH
STABILIZED AT: 8.0 ft (0.0ft ELEV.)

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		7			80									
82														
	-75													
84		3 7 10	100		83.5 85						Stiff to very stiff, loose blue-gray, fine to medium SAND some silt, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
86														
88	-80													
90		4 4 9	100		88.5 90									
92														
	-85													
94		6 6 5	100		93.5 95									
96														
98	-90													
100		5 6 10	100		98.5 100									
102														
	-95													
104		6 8 11	100		103.5 105									
106														
108	-100													
110		7 8 10	100		108.5 110									
112														
	-105													
114		7 7 9	100		113.5 115									
116												22		35.8
118	-110													
120		7 8	100		118.5									

REMARKS:

© 2003, Commonwealth of Virginia

SPT_LOG-123102 1213 VS.GPJ 12/17/03

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

STATION: 24+06
EASTING: 3925673.5
SURFACE ELEVATION: 8.0 ft

OFFSET: 33 ft. N
NORTHING: 168249.3

Date(s) Drilled: 5/8/03 - 5/9/03
Drilling Method(s): Auger 10 ft./Mud-Rotary 10-125 ft.
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER
FIRST ENCOUNTERED AT: 8.0 ft DEPTH
STABILIZED AT: 8.0 ft (0.0ft ELEV.)

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		10			120									
122														
	-115				123.5									
124		6 9 13	100		125						Boring terminated at 125 feet below ground surface.			

REMARKS:

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-1A
PAGE 1 OF 1

STATION: 24+06
EASTING: 3925673.5
SURFACE ELEVATION: 8.0 ft

OFFSET: 36 ft. N
NORTHING: 168249.3

FIELD DATA

Date(s) Drilled: 5/9/03 - 5/9/03
Drilling Method(s): Auger 10 ft./Mud-Rotary 10-125 ft.
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER
FIRST ENCOUNTERED AT: 8.0 ft DEPTH
STABILIZED AT: 8.0 ft (0.0ft ELEV.)

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
											0.0 / 8.0 Offset boring to obtain undisturbed samples.			
2														
	5													
4														
6														
8	0													
10														
12														
	-5													
14														
16														
18	-10													
20														
22														
	-15													
24														
26			0	26										
28	-20			28										
			75											
30				30								45	14	48.4
32				32										
	-25		100											
34				34							Offset boring terminated at 34 feet below ground surface.	41	16	47.5

REMARKS:

© 2003, Commonwealth of Virginia

SPT_LOG-123102 1213 V5.GPJ 12/17/03

Virginia Department of Transportation

VDOT

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-2

STATION: 29+30
EASTING: 3926188.3
SURFACE ELEVATION: -5.0 ft

OFFSET: 41 ft. N
NORTHING: 168366

Date(s) Drilled: 3/19/03 - 3/24/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP STRATA	ROCK: DIP JOINTS	STRATA LEGEND
0		WOR WOR WOR	0		0					
2			5		1.5					
		WOR WOH WOH			3					
4			100		3.5					
	-10	1 WOH 1			5					
6			100		6					
		WOH WOH WOH			7.5					
8					8.5					
10	-15	2 3 5	100		10					
12										
14		2 WOH WOH	100		13.5					
	-20				15					
16										
18					18.5					
20	-25	1 1 1	100		20					
22										
24		5 6 4	100		23.5					
	-30				25					
26										
28					28.5					
30	-35	3 3 7	100		30					
32										
34		3 1 2	100		33.5					
	-40				35					
36										
38					38.5					
40	-45	3 3	100							

DESCRIPTION OF STRATA

DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
0.0 / -5.0 Very loose, green-gray, fine to medium SAND, some silt, wet. [ALLUVIUM] **SM**			
3.5 / -8.5 Very soft, green-gray, SILT, some sand, trace organics sampled as root material and wood fragments at 7.5 feet, wet, [ALLUVIUM] **ML**			135.2
8.5 / -13.5 Loose to very loose, green-gray, poorly graded fine to medium SAND, little silt, wet. [ALLUVIUM] **SP**			35.6
			44.2
23.0 / -28.0 Loose, gray, fine to medium SAND, trace silt, wet. [ALLUVIUM] **SP-SM**			30.0
31.0 / -36.0 Very loose, gray with black mottling, fine to medium SAND, some silt, wet. [ALLUVIUM] **SM**			
37.0 / -42.0 Firm, gray, lean CLAY, trace sand, wet. [ALLUVIUM] **CL**			39.8

REMARKS:

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-2

STATION: 29+30
EASTING: 3926188.3
SURFACE ELEVATION: -5.0 ft
OFFSET: 41 ft. N
NORTHING: 168366

FIELD DATA

Date(s) Drilled: 3/19/03 - 3/24/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		4		40									
42				42									
			100										
44				44									
	-50										45	21	39.0
46													
48										Firm, gray, lean CLAY, some sand, wet. [ALLUVIUM] **CL**			
		1 4 4	100	48.5									
50	-55			50									
52				52									
			80	53.6									
54				54						53.5 / -58.5 Loose to firm, green-gray, fine to medium SAND, some silt, wet. [YORKTOWN Y2] **SM**			
	-60	7 6 8	100										
56				55.5									
58				58.5									
		3 6 10	100										
60	-65			60									
62													
64				63.5									
		6 4 6	100										
	-70			65								33.8	
66													
68				68.5									
		5 7 8	100										
70	-75			70									
72													
74				73.5									
		5 5 7	100										
	-80			75									
76													
78				78.5									
		4 6	100										
80	-85												

REMARKS:

JBW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-2
PAGE 3 OF 4

STATION: 29+30 OFFSET: 41 ft. N
EASTING: 3926188.3 NORTHING: 168366
SURFACE ELEVATION: -5.0 ft

Date(s) Drilled: 3/19/03 - 3/24/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA												LAB DATA		
DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		9			80									
82														
84		4 6 7	100		83.5 85									
	-90										85.0 / -90.0 Firm to dense, blue-gray, fine to coarse SAND, some silt, clay and marine shell fragments, wet. [YORKTOWN Y2] **SC-SM**			
86														
88														
90	-95	5 8 21	100		88.5 90									
92														
94	-100	5 6 7	100		93.5 95									
96														
98														
100	-105	3 6 7	100		98.5 100									28.8
102														
104	-110	11 9 10	100		103.5 105									
106														
108														
110	-115	18 19 18	100		108.5 110									
112														
114	-120	19 21 24	100		113.5 115									
116														
118														
120	-125	16 11	100		118.5							26	6	26.4

REMARKS:

SPT_LOG-123102 1213 V5.GPJ 12/17/03

JRW

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-2
PAGE 4 OF 4

STATION: 29+30
EASTING: 3926188.3
SURFACE ELEVATION: -5.0 ft

OFFSET: 41 ft. N
NORTHING: 168366

FIELD DATA

Date(s) Drilled: 3/19/03 - 3/24/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		10			120									
122														
124		10	0		123.5									
	-130	10 13			125						Boring terminated at 125 feet below mudline.			

REMARKS:

© 2003, Commonwealth of Virginia

SPT_LOG-123102 1213 V5.GPJ 12/17/03

JRW

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-3

STATION: 32+25
EASTING: 3926359.7
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. N
NORTHING: 168405.6

Date(s) Drilled: 3/26/03 - 3/31/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
			100		0						0.0 / -22.0 Black, organic SILT, some sand, wet. [ALLUVIUM] **OH**			
2			100		1.5									
	-25		100		3						3.0 / -25.0 Green-gray, fine to coarse SAND, some silt, wet. [ALLUVIUM] **SP**			
4			100		4.5									
6			100		6									
			100		7.5									
8	-30		100		9						9.0 / -31.0 Firm to very firm, green-gray, poorly graded fine to medium SAND, trace silt. [ALLUVIUM] **SP-SM**			
10			100		10.5									
12														
	-35				13.5									27.6
14		7 7 7	100		15									
16														
18	-40				18.5									
		6 7 8	100		20									
20														
22														
	-45				23.5									
24		10 10 11	100		25									
26														
28	-50				28.5									42.2
		7 6 11	100		30									
30														
32														
	-55				33.5									
34		6 13 13	100		35									
36														
38	-60				38.5									
		12 13	100											
40														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing. Sample from 126-128 feet to VDOT Materials Section.

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-3

STATION: 32+25
EASTING: 3926359.7
SURFACE ELEVATION: -22.0 ft
OFFSET: 44 ft. N
NORTHING: 168405.6

Date(s) Drilled: 3/26/03 - 3/31/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA / **LAB DATA**

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		11			40									
42														
	-65										42.0 / -64.0 Loose to very firm, green-gray, fine to coarse SAND, some silt, wet. [YORKTOWN Y2] **SM**			
44		3 3 5	100		43.5 45									
46														31.2
48	-70													
		3 4 6	100		48.5 50									
50														
52														
	-75													
54		6 7 11	100		53.5 55									
56														
58	-80													
		5 7 12	100		58.5 60									
60														
62														
	-85													
64		4 5 11	100		63.5 65									
66														
68	-90													
		6 9 14	100		68.5 70									
70														
72														
	-95													
74		5 5 7	100		73.5 75									
76														
78	-100													
		6 10	100		78.5									
80														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing. Sample from 126-128 feet to VDOT Materials Section.

© 2003, Commonwealth of Virginia

SPT_LOG-123102 1213 V5.GPJ 12/17/03

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

STATION: 32+25
EASTING: 3926359.7
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. N
NORTHING: 168405.6

FIELD DATA

Date(s) Drilled: 3/26/03 - 3/31/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		10			80						Firm to dense, blue-gray, fine to coarse SAND, some silt and marine shell fragments, wet. [YORKTOWN Y2] **SM**			
82														
	-105				83.5									
84		12 14 16	100		85									
86														
88	-110				88.5									
		16 16 18	100		90									
90														
92														
	-115				93.5									
94		18 11 9	100		95									
96														
98	-120				98.5									
		7 9 8	100		100									
100														
102														
	-125				103.5									
104		7 7 8	100		105									
106														
108	-130				108.5									
		8 10 11	100		110									
110														
112														
	-135				113.5									
114		9 10 13	100		115									
116														
118	-140				118.5									
		10 9	100											
120														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing. Sample from 126-128 feet to VDOT Materials Section.

SPT_LOG-123102_1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-3

STATION: 32+25
EASTING: 3926359.7
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. N
NORTHING: 168405.6

FIELD DATA

Date(s) Drilled: 3/26/03 - 3/31/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		11			120									
122														
	-145													
124		12 8 4	100		123.5 125						124.5 / -146.5 Stiff, green-gray, lean CLAY, little sand, wet. [YORKTOWN Y1] **CL**	45	27	34.6
126			25		126						126.0 / -148.0 Firm, green-gray, fine to coarse SAND, some silt, wet. [YORKTOWN Y2] **SM**			
128	-150	5 7 10	100		128 129.5						129.0 / -151.0 Very stiff, blue-gray, fat CLAY, little sand, wet. [YORKTOWN Y1] **CH**			
130														
132														
	-155													
134		8 10 11	100		133.5 135									37.8
136			75		136 137.5							60	35	38.5
138	-160	6 8 9	100		138.5 140									
140														
142														
	-165													
144		6 9 10	100		143.5 145							56	34	36.4
146														
148	-170	7 8 11	100		148.5 150									
150											Boring terminated at 150 feet below mudline.			

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing. Sample from 126-128 feet to VDOT Materials Section.

JPW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-4

STATION: 32+25
EASTING: 3926490.1
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. S
NORTHING: 168347.1

FIELD DATA

Date(s) Drilled: 4/1/03 - 4/3/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
2	-25		100		0						0.0 / -22.0 Green-gray, poorly graded fine to medium SAND, little silt, wet. [ALLUVIUM] **SM**			
4			100		2									
6			100		4									
8	-30	6 4 4	100		6						8.0 / -30.0 Firm, green-gray, inorganic SILT, some sand, trace mica, wet. [ALLUVIUM] **ML**			45.6
10					8									
12	-35	2 2 3	100		9.5									59.1
14					13.5									
16					15									
18	-40	6 9 10	100		18.5						17.0 / -39.0 Loose to firm, green-gray, fine to medium SAND, little silt, trace organics sampled as root material, wet. [ALLUVIUM] **SP-SM**			33.5
20					20									
22	-45	12 10 10	100		23.5									
24					25									
26														
28	-50	4 3 7	100		28.5									
30					30						30.0 / -52.0 Firm to very firm, green-gray, fine to medium SAND, some silt, wet. [ALLUVIUM] **SM**			
32	-55	3 3 8	100		33.5									
34					35									
36														
38	-60	3 3	100		38.5									
40														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-4

STATION: 32+25
EASTING: 3926490.1
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. S
NORTHING: 168347.1

FIELD DATA

Date(s) Drilled: 4/1/03 - 4/3/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		5			40									
					41									
42			0											
	-65				43									
44		4 5 8	100		43.5						Firm to very firm, green-gray, fine to medium SAND, some silt, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
					45									
46														
48	-70				48.5									
		6 10 11	100											36.6
50					50									
52														
	-75													
54		5 7 12	100		53.5									
					55									
56														
58	-80				58.5									
		5 5 11	100											
60					60									
62														
	-85													
64		4 5 11	100		63.5									
					65									
66														
68	-90				68.5									
		5 8 12	100											
70					70									
72														
	-95													
74		6 8 15	100		73.5									
					75									
76														
78	-100				78.5									
		3 4	100											
80														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

STATION: 32+25 OFFSET: 44 ft. S
EASTING: 3926490.1 NORTHING: 168347.1
SURFACE ELEVATION: -22.0 ft

Date(s) Drilled: 4/1/03 - 4/3/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		7			80						81.0 / -103.0 Dense, blue-gray, fine to coarse SAND, some silt, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
82														
	-105													
84		5 13 18	100		83.5 85									
86														
88	-110										87.0 / -109.0 Hard, blue-gray, SILT, some shells and shell fragments, little fine sand, wet. [YORKTOWN Y2] **ML**			
		20 29 18	100		88.5 90									
90														
92														
	-115													
94		23 22 23	100		93.5 95									
96														
98	-120										Very firm to dense, blue-gray with black mottling, fine to coarse SAND, some marine shell fragments, wet. [YORKTOWN Y2] **SM**			
		12 10 13	100		98.5 100									
100														
102														
	-125													
104		7 8 12	100		103.5 105									26.4
106														
108	-130													
		13 16 22	100		108.5 110									
110														
112														
	-135													
114		9 12 13	100		113.5 115									
116														
118	-140													
		10 10	100		118.5									
120														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-4
PAGE 4 OF 5

STATION: 32+25
EASTING: 3926490.1
SURFACE ELEVATION: -22.0 ft

OFFSET: 44 ft. S
NORTHING: 168347.1

FIELD DATA

Date(s) Drilled: 4/1/03 - 4/3/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		10			120									
122											122.0 / -144.0 Stiff to very stiff, green-gray, fat CLAY, trace sand, wet. [YORKTOWN Y1] **CH**			
	-145													
124			100		123.5									
					125.5									
126					127									
128	-150		100									52	27	37.5
		8 9 9			129									
130			100		130.5									
132														
	-155													
134		3 5 7	100		133.5							51	29	36.2
					135									
136														
138	-160													
		6 7 10	100		138.5									
140					140									
					141									
142			0											
	-165				143									
144		6 7 9	100		143.5									
					145									
146														
148	-170										147.0 / -169.0 Stiff to very stiff, green-gray, lean CLAY, trace sand, wet. [YORKTOWN Y1] **CL**			
		5 6 10	100		148.5									
150					150									
					151									
152			50											
	-175				153									
154		8 9 12	100		153.5							33	19	24.7
					155									
156														
158	-180										157.0 / -179.0 Stiff, green-gray, lean CLAY, some sand, trace marine shell fragments, wet. [YORKTOWN Y2] **SC**			
		6 7	100		158.5									
160														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

SPT_LOG-123102 1213 V5.GPJ 12/17/03
© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-4
PAGE 5 OF 5

STATION: 32+25 OFFSET: 44 ft. S
EASTING: 3926490.1 NORTHING: 168347.1
SURFACE ELEVATION: -22.0 ft

Date(s) Drilled: 4/1/03 - 4/3/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA											LAB DATA		
		SOIL				ROCK							
								DIP					
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	% SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	% CORE RECOVERY	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	LIQUID LIMIT	PLASTICITY INDEX	MOISTURE CONTENT (%)
		5			160								
162													
	-185												
164		4 6 9	100		163.5 165								
166													
168	-190												
		5 7 10	100		168.5 170								
170													
172													
	-195												
174		6 8 10	100		173.5 175						26	12	26.8

DESCRIPTION OF STRATA

Boring terminated at 175 feet below mudline.

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

PAGE 5 OF 5
MS-4

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-5

STATION: 34+82 OFFSET: 44 ft. N
EASTING: 3926777.8 NORTHING: 168413.5
SURFACE ELEVATION: -23.0 ft

FIELD DATA

Date(s) Drilled: 4/14/03 - 4/17/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: Shane Clark, E.I.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
0				0						0.0 / -23.0 Black, organic SILT, some sand, wet. [ALLUVIUM] **OH**			
2	-25		100	2									
4			100	4									
6			100	6						5.0 / -28.0 Green-gray, SILT, little clay and sand, wet. [ALLUVIUM] **ML**			
8	-30		100	8									
10			100	10									
12	-35												
14		3 3 3	100	13.5 / 15									
16													
18	-40									18.0 / -41.0 Firm to very firm, green-gray, fine to coarse SAND, trace silt, wet. [NORFOLK] **SP-SM**			
20		5 8 10	100	18.5 / 20									
22	-45												
24		6 6 7	100	23.5 / 25								36.0	
26													
28	-50												
30		6 6 7	100	28.5 / 30									
32	-55												
34		10 12 11	100	33.5 / 35									
36													
38	-60												
40		6 11	100	38.5									

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

STATION: 34+82 OFFSET: 44 ft. N
EASTING: 3926777.8 NORTHING: 168413.5
SURFACE ELEVATION: -23.0 ft

Date(s) Drilled: 4/14/03 - 4/17/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: Shane Clark, E.I.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		18		40									
42	-65												
44		2 2 3	100	43.5 / 45						43.5 / -66.5 Loose to firm, gray, silty SAND, wet. [YORKTOWN Y2] **SM**			33.4
46	-70												
48		3 3 5	100	48.5 / 50									
50													
52	-75												
54		3 3 5	100	53.5 / 55									29.2
56	-80												
58		4 5 11	100	58.5 / 60									
60			100	62									
62	-85												
64		4 4 11	100	63.5 / 65									31.8
66	-90												
68		4 3 6	100	68.5 / 70									32.4
70													
72	-95												
74		5 6 10	100	73.5 / 75						Very firm, blue-gray, fine to coarse silty SAND, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			31.6
76	-100												
78		10 14	100	78.5									
80													

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-5

STATION: 34+82 OFFSET: 44 ft. N
EASTING: 3926777.8 NORTHING: 168413.5
SURFACE ELEVATION: -23.0 ft

FIELD DATA

Date(s) Drilled: 4/14/03 - 4/17/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: Shane Clark, E.I.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		15			80						Very firm to dense, fine to coarse silty SAND, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
82	-105													
84		15 13 11	100		83.5 85									
86														
	-110													
88					88.5									
90		18 15 20	100		90									20.0
92	-115													
94		20 15 19	100		93.5 95									
96											Firm to very firm, blue-gray, silty SAND, trace marine shell fragments,wet. [YORKTOWN Y2] **SM**			
	-120													
98					98.5									
100		9 12 6	100		100									32.6
102	-125													
104		6 7 12	100		103.5 105									
106														
	-130													
108					108.5									
110		10 8 12	100		110									25.2
112	-135													
114		8 11 15	100		113.5 115									
116														
	-140													
118					118.5									
120		7 6	100											

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

JPW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-5

STATION: 34+82
EASTING: 3926777.8
SURFACE ELEVATION: -23.0 ft

OFFSET: 44 ft. N
NORTHING: 168413.5

Date(s) Drilled: 4/14/03 - 4/17/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: Shane Clark, E.I.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		6			120									
122	-145													
					123.5									25.4
124		7 6 9	100		125									
126					126.5						126.0 / -149.0 Very stiff, green-gray, fat CLAY, trace sand,wet. [YORKTOWN Y1] **CH**			
	-150		50											
128					128.5							52	32	36.8
		6 7 9	100		130									
130														
132	-155													
134					135									
136			50											
	-160				137									
138		7 9 12	100		138.5									
140														
142	-165										142.0 / -165.0 Soft, green-gray, fat CLAY, some sand, wet. [YORKTOWN Y1] **CH**			
					143.5									
144		5 1 3	100		145							68	40	39.1
146			50		147						Very stiff, green-gray, lean CLAY, some sand, wet. [YORKTOWN Y1] **CL**	38	23	28.0
	-170	6 9 10	100		148.5									
148														
150														
152	-175													
154		5 6 7	100		154 155.5									26.6
156														
	-180										157.0 / -180.0 Firm, blue-gray, fine to medium silty, clayey SAND, wet. [YORKTOWN Y2] **SC-SM**			
158		5 9 7	0		158 159.5									
160														

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-5
PAGE 5 OF 5

STATION: 34+82
EASTING: 3926777.8
SURFACE ELEVATION: -23.0 ft

OFFSET: 44 ft. N
NORTHING: 168413.5

FIELD DATA

Date(s) Drilled: 4/14/03 - 4/17/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: Shane Clark, E.I.

GROUND WATER

DESCRIPTION OF STRATA

LAB DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
162	-185												
164		4 8 6	100		164 – 165.5						26	7	26.2
166	-190												
168													
170		5 3 9	100		169 – 170.5								
172	-195												
174													

Boring terminated at 170.5 feet below mudline.

REMARKS:
Upper 10 feet of soils collected for Total Organic Carbon (TOC) testing.

© 2003, Commonwealth of Virginia

SPT_LOG-123102_1213 V5.GPJ 12/17/03

JRW

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-6

STATION: 35+20
EASTING: 3927121.3
SURFACE ELEVATION: -23.0 ft

OFFSET: 44 ft. S
NORTHING: 168490.8

FIELD DATA

Date(s) Drilled: 4/22/03 - 4/23/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND / SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
			100	0						0.0 / -23.0 Medium stiff, black, organic SILT, little wood fragments, trace sand, wet. [ALLUVIUM] **OH**			
2	-25	WOH 2 3	25	2									
4		3 2 4	50	4						4.5 / -27.5 Loose to firm, gray, poorly graded fine to medium SAND, trace silt, wet. [ALLUVIUM] **SP**			
6	-30	5 6 6	100	6									
8		8 5 4	100	8						8.0 / -31.0 Very loose to loose, green-gray, fine to medium SAND, some silt, wet. [NORFOLK] **SM**			
10				10									
12	-35												
14		5 3 5	100	13.5 15									
16	-40												
18		3 2 2	0	18.5 20									
20													
22	-45												
24		2 4 3	100	23.5 25						24.5 / -47.5 Loose, green-gray, fine to medium SAND, some silt or clay, wet. [NORFOLK] **SC-SM**			
26	-50												
28		4 5 9	100	28.5 30						28.0 / -51.0 Firm, green-gray, fine to medium SAND, little silt, wet. [NORFOLK] **SM**			37.6
30													
32	-55												
34		5 5 6	100	33.5 35									
36	-60												
38		11 12	100	38.5						37.0 / -60.0 Very firm, green-gray, poorly graded fine to coarse SAND, trace silt, wet. [NORFOLK] **SP-SM**			26.5
40													

REMARKS:

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-6
PAGE 2 OF 4

STATION: 35+20
EASTING: 3927121.3
SURFACE ELEVATION: -23.0 ft

OFFSET: 44 ft. S
NORTHING: 168490.8

Date(s) Drilled: 4/22/03 - 4/23/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA												LAB DATA		
		SOIL				ROCK								
								DIP						
DEPTH (ft)	ELEVATION (ft)	STANDARD PENETRATION TEST HAMMER BLOWS	% SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	% CORE RECOVERY	ROCK QUALITY DESIGNATION	STRATA	JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
		14			40									
42	-65													
44		15 16 12	100		43.5 45									
46														
48	-70										47.0 / -70.0 Loose, blue-gray, fine to medium silty SAND, wet. [YORKTOWN Y2] **SM**			
50		2 3 5	100		48.5 50									31.7
52	-75													
54		3 3 5	100		53.5 55									
56														
58	-80													
60		3 3 4	100		58.5 60									
62	-85													
64		3 4 7	100		63.5 65						Loose to dense, blue-gray, poorly graded fine to medium silty SAND, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			35.6
66	-90													
68		4 4 8	100		68.5 70									30.6
70														
72	-95													
74		3 3 7	100		73.5 75									
76	-100													
78		3 3	100		78.5									
80														

REMARKS:

SPT_LOG-123102 1213 V5.GPJ 12/17/03
© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-6

STATION: 35+20
EASTING: 3927121.3
SURFACE ELEVATION: -23.0 ft

OFFSET: 44 ft. S
NORTHING: 168490.8

Date(s) Drilled: 4/22/03 - 4/23/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

FIELD DATA

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		7			80									
82	-105													
		17 15 12	100		83.5 – 85							17	2	22.1
84														
86														
	-110													
88		14 16 14	100		88.5 – 90									
90														
92	-115													
94		13 18 13	100		93.5 – 95									
96														
	-120													
98		6 9 10	100		98.5 – 100									
100														
102	-125													
104		7 5 4	0.11		103.5 – 105									28.1
106														
	-130													
108		5 5 7	0		108.5 – 110									
110														
112	-135										Loose to very firm, blue-gray, fine to medium SAND, little silt, trace marine shell fragments, wet. [YORKTOWN Y2] **SM**			
114		11 10 12	100		113.5 – 115							20	2	26.8
116														
	-140													
118		6 5	100		118.5									
120														

REMARKS:

JRW

SPT_LOG-123102 1213 V5.GPJ 12/17/03

© 2003, Commonwealth of Virginia

Virginia Department of Transportation

PROJECT #: 20400-2-1213
LOCATION: Chesapeake, Virginia
STRUCTURE: Gilmerton Replacement Bridge

MS-6

STATION: 35+20
EASTING: 3927121.3
SURFACE ELEVATION: -23.0 ft
OFFSET: 44 ft. S
NORTHING: 168490.8

FIELD DATA

Date(s) Drilled: 4/22/03 - 4/23/03
Drilling Method(s): Mud-Rotary
SPT Method: Safety Hammer
Other Test(s):
Driller: MACTEC Engineering & Consulting
Logger: David Gordinier, E.I.T.

GROUND WATER

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: % SOIL RECOVERY	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: % CORE RECOVERY	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP: STRATA	ROCK: DIP: JOINTS	STRATA LEGEND	DESCRIPTION OF STRATA	LAB DATA: LIQUID LIMIT (LL)	LAB DATA: PLASTICITY INDEX (PI)	LAB DATA: MOISTURE CONTENT (%)
		13			120									
122	-145													
124		7 8 7	100		123.5 125									
126														
	-150													
128														
130		8 4 4	100		128.5 130									30.5
132	-155													
134		4 5 8	100		133.5 135						133.0 / -156.0 Stiff to very stiff, gray, lean CLAY, trace sand, wet. [YORKTOWN Y1] **CL**	49	29	38.0
136														
	-160													
138														
140		5 4 8	100		138.5 140									
142	-165													
144		4 9 7	100		143.5 145									
146														
	-170													
148														
150		5 4 7	100		148.5 150						Boring terminated at 150 feet below mudline.			

REMARKS:

© 2003, Commonwealth of Virginia

SPT_LOG-123102 1213 V5.GPJ 12/17/03

JRW

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-1
Sheet	1 Of 5
Date: Start:	05/17/01
End:	05/17/01
O.G. Elev.	5.00'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 21+36 Offset from Centerline: 91.3 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: CME 45B ATV Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.25" ID HSA Depth: 24.0' Water: Depth: 5.0' Time: 0 HR Date: 05/17/01
Checked By: M. DeLozier Date: 05/22/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 5.0'	
		2 1 2						TOPSOIL 1.0' 4.0'	*Boring moved from Sta 21+40, 45.7 R to Sta 21+36, 91.3 L, due to wetlands and underground utilities, new elevation approximately 5.0'*
	S-1	2 3 4 5	1.0	50	-	2.0	M	Silty SAND (sm, a-2-4), brown, moist, loose to medium dense (Alluvial)	
	S-2	6 2 2 2	0.4	20	-	4.0	M	4.0' 1.0'	
5	S-3	3 2 1 2	1.1	55	-	6.0	M	Elastic SILT with sand (mh, a-5), dark brown, moist, soft, sand is fine grained, samples contain organic material (Alluvial) 6.0' -1.0'	
	S-4	2 6 9 8	2.0	100	-	8.0	W	Poorly graded SAND (sp, a-3), gray to yellow brown, wet, medium dense, sand is fine to medium grained (Alluvial)	
10	S-5	3 4 3 3	2.0	100	-	10.0	W		
	S-6	2 2 4 5	2.0	100	-	12.0	W		
	S-7	5 2 2 6	2.0	100	-	14.0	W		
15	S-8	6 3 6 9	2.0	100	-	16.0	W		
	S-9	12 8 9 10	2.0	100	-	18.0	W		
20	S-10	11	2.0	100	-	20.0	W		

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 21+36 Offset from Centerline: 91.3 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-1
Sheet 2 of 5
Date: Start: 05/17/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Poorly graded SAND (sp, a-3), gray to yellow brown, wet, medium dense, sand is fine to medium grained (Alluvial)	
		2 1						25.0' -20.0'	
25	S-11	2	1.5	100	-	25.5	W-M	Elastic SILT with sand (mh, a-5), dark brown to dark gray, moist, soft to medium stiff, sand is fine grained and is laminated with silt layers (Alluvial)	
		W WOH							
30	S-12	1	1.5	100	-	30.5	M		
									32.0'-34.0': Shelby Tube sample taken
	ST-1		2.0	100		34.0			
		2 2							
35	S-13	3	1.5	100	-	35.5	M		
								39.0' -34.0'	
		4 5							
40									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-1
Sheet	3 of 5
Date: Start:	05/17/01
End:	05/17/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 21+36 Offset from Centerline: 91.3 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	4	1.5	100	-	40.5	M	Poorly graded SAND (sp, a-3), gray, moist to wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
		2							
45	S-15	3 5	1.5	100	-	45.5	M		
		6							
50	S-16	11 13	1.5	100	-	50.5	M		
		11							
55	S-17	12 13	1.5	100	-	55.5	M		
		10							
60		9							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 21+36 Offset from Centerline: 91.3 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-1
Sheet 4 of 5
Date: Start: 05/17/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	13	1.5	100	-	60.5	M-W	Poorly graded SAND (sp, a-3), gray, moist to wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
		9							
5	S-19	11 17	1.5	100	-	65.5	M-W		
		7							
70	S-20	7 9	1.5	100	-	70.5	M-W	70.4' -65.4' Poorly graded SAND with silt (sp-sm, a-3), gray, moist to wet, medium dense to dense, sand is fine to medium grained (Alluvial)	*70.4'-80.5': Shell fragments noted in samples*
		7							
75	S-21	17 20	1.5	100	-	75.5	M-W		
		5							
80		7							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 21+36 Offset from Centerline: 91.3 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-1
Sheet 5 of 5
Date: Start: 05/17/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	12	1.5	100	-	80.5	M	80.5' -75.5' End of Boring	
85									
90									
95									
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-2
Sheet	1 Of 5
Date: Start:	05/16/01
End:	05/17/01
O.G. Elev.	5.00'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 23+33 Offset from Centerline: 119.2 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: CME 45B ATV Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.25" ID HSA Depth: 24.0' Water: Depth: 5.0' Time: 0 HR Date: 05/17/01
Checked By: M. DeLozier Date: 05/22/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 5.0'	
		2 1 2						TOPSOIL 1.0' 4.0'	*Moved boring from Sta 24+01, 64.2 L to Sta 23+33, 119.2 L, due to underground utilities and wetlands, no change in elevation*
	S-1	3 2 2 2	0.2	10	-	2.0	D	Elastic SILT with sand (mh, a-5), dark brown, moist to wet, soft to medium stiff, sand is fine grained, samples contain organic material and tree roots	
	S-2	1 3 24	1.0	50	-	4.0	M	(Alluvial) 4.0' 1.0'	
5		3						Poorly graded SAND (sp, a-3), gray to yellow brown, wet, loose to medium dense, sand is fine to medium grained	
	S-3	3 2 3	0.4	20	-	6.0	W	(Alluvial)	
	S-4	4 5 4	2.0	100	-	8.0	W		
10	S-5	4 5 4 2	1.5	75	-	10.0	W		
	S-6	8 3 5 3	1.0	50	-	12.0	W		
	S-7	6 6 7 2	1.1	55	-	14.0	W		
15	S-8	2 3 4 3	2.0	100	-	16.0	W		
	S-9	3 5 7 4	2.0	100	-	18.0	W		
20	S-10	7 7 9	2.0	100	-	20.0	W		

Drawn by: HCT
Revised: 6/20/2001

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-2
Sheet	2 of 5
Date: Start:	05/16/01
End:	05/17/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 23+33 Offset from Centerline: 119.2 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Poorly graded SAND (sp, a-3), gray to yellow brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
		2 1						25.0' -20.0'	
25	S-11	2	1.5	100	-	25.5	M	Elastic SILT with sand (mh, a-5), dark brown to dark gray, moist, soft to medium stiff, sand is fine grained and is laminated with silt layers (Alluvial)	*26.0'-28.0': Shelby tube sample taken*
	ST-1		2.0	100		28.0			
		1 2							
30	S-12	1	1.5	100	-	30.5	M		
		2							
35	S-13	4 3	1.5	100	-	35.5	M		
		2 2							
40									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 23+33 Offset from Centerline: 119.2 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-2
Sheet 3 of 5
Date: Start: 05/16/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	3	1.5	100	-	40.5	M	Elastic SILT with sand (mh, a-5), dark brown to dark gray, moist, soft to medium dense, sand is fine grained and is laminated with silt layers (Alluvial)	
		1						44.5' -39.5'	
45	S-15	3 6	1.5	100	-	45.5	M	Poorly graded SAND (sp, a-3), gray, moist, medium dense, sand is fine to medium grained (Alluvial)	
		3							
50	S-16	3 5	1.5	100	-	50.5	M		
		6							
55	S-17	9 15	1.5	100	-	55.5	M		
		7							
60		10							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 23+33 Offset from Centerline: 119.2 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-2
Sheet 4 of 5
Date: Start: 05/16/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	11	1.5	100	-	60.5	M	Poorly graded SAND (sp, a-3), gray, moist, medium dense, sand is fine to medium grained (Alluvial)	
		13							
		17							
65	S-19	12	1.1	73	-	65.5	M		
		7						69.5' -64.5'	
		13						Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense to dense, sand is fine to medium grained, soil reacts with HCl (Alluvial)	*69.5'-80.5': Shell fragments noted in samples*
70	S-20	16	1.5	100	-	70.5	M		
		5							
		8							
75	S-21	15	1.5	100	-	75.5	M		
		6							
80		16							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 23+33 Offset from Centerline: 119.2 ft Left
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-2
Sheet 5 of 5
Date: Start: 05/16/01
End: 05/17/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	20	1.5	100	-	80.5	M	80.5' -75.5' End of Boring	
85									
90									
95									
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-3
Sheet	1 Of 6
Date: Start:	04/25/01
End:	04/30/01
O.G. Elev.	9.00'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: CME 45 Truck Mounted Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.0" ID FJ Depth: 15.0' Water: Depth: 7.0' Time: 0 HR Date: 04/30/01
Checked By: P. Lowe Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
								0.0' 9.0'	
0	S-1	6 8 12 17	1.2	60	-	2.0	M	Poorly graded SAND with gravel (sp, a-1-b), orangish brown, moist, medium dense (Fill)	*Boring moved from Sta 27+15, 49.2 L to Sta 26+14, 33.3 R, due to underground utilities and location near water*
								3.0' 6.0'	
	S-2	7 3 3 3	1.0	50	-	4.0	M	Elastic SILT with sand (mh, a-7-5), dark gray, moist, very soft to soft (Alluvial)	*Approximately +5.0' to staked elevation*
5	S-3	WOR /2.0	2.0	100	-	6.0	M		*24 HR water reading not taken due to location near roadway*
	S-4	WOH /1.5 1	1.5	75	-	8.0	M		*3.0'-30.0': Some organic material present in samples*
10	S-5	1 1 1 1	2.0	100	-	10.0	M		
	S-6	WOR /2.0	0.8	40	-	12.0	W		
	S-7	1 0 1 1	2.0	100	-	14.0	M		
15	S-8	WOH /2.0	2.0	100	-	16.0	M		
	S-9	WOH /2.0	2.0	100	-	18.0	M		
20	S-10	WOH /2.0	2.0	100	-	20.0	M		

Drawn by: HCT

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-3
Sheet 2 of 6
Date: Start: 04/25/01
End: 04/30/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Elastic SILT with sand (mh, a-7-5), dark gray, moist, very soft to soft (Alluvial)	
25	S-11	WOH /2.0	2.0	100	-	26.0	M		
30	S-12	1 1 1 1	0.8	40	-	31.0	W	30.0' -21.0' Poorly graded SAND (sp, a-3), dark gray, wet, very loose to loose, sand is fine to medium grained (Alluvial)	
35	S-13	6 3 1 3	1.0	50	-	36.0	W		
40		1 4							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-3
Sheet	3 of 6
Date: Start:	04/25/01
End:	04/30/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	2 3	1.0	50	-	41.0	W	Poorly graded SAND (sp, a-3), dark gray, wet, very loose to loose, sand is fine to medium grained (Alluvial)	
								44.0' -35.0'	
45	S-15	2 2 2 2	2.0	100	-	46.0	M	Elastic SILT with sand (mh, a-7-5), dark gray, moist, soft, sand is fine grained and is laminated with silt layers (Alluvial)	*44.0'-64.0': Some organic material noted in samples*
50	S-16	2 3 4 2	2.0	100	-	51.0	M		
55	S-17	2 2 2 3	2.0	100	-	56.0	M		
60		2 1							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-3
Sheet 4 of 6
Date: Start: 04/25/01
End: 04/30/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	2 3	2.0	100	-	61.0	M	Elastic SILT with sand (mh, a-7-5), dark gray, moist, soft, sand is fine grained and is laminated with silt layers (Alluvial)	
								64.0' -55.0'	
65	S-19	10 12 28 29	1.0	50	-	66.0	M	Poorly graded SAND (sp, a-3), gray, moist to wet, medium dense, sand is fine to medium grained (Alluvial)	
								69.0' -60.0'	
70	S-20	3 6 8 12	2.0	100	-	71.0	M	Poorly graded SAND with silt (sp-sm, a-3), gray, moist to wet, medium dense, sand is fine to medium grained (Alluvial)	
75	S-21	3 5 5 15	2.0	100	-	76.0	M-W		
80		4 4							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-3
Sheet	5 of 6
Date: Start:	04/25/01
End:	04/30/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	6 13	2.0	100	-	81.0	M-W	Poorly graded SAND with silt (sp-sm, a-3), gray, moist to wet, medium dense, sand is fine to medium grained (Alluvial)	
85	S-23	3 7 9 13	2.0	100	-	86.0	W		*84.0'-106.0': Shell fragments noted in samples*
90	S-24	6 7 10 15	2.0	100	-	91.0	M-W		
95	S-25	7 7 13 15	2.0	100	-	96.0	M-W		
100		5 5							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 26+14 Offset from Centerline: 33.3 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-3
Sheet 6 of 6
Date: Start: 04/25/01
End: 04/30/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-26	10 15	2.0	100	-	101.0	M-W	Poorly graded SAND with silt (sp-sm, a-3), gray, moist to wet, medium dense, sand is fine to medium grained (Alluvial)	
105	S-27	6 6 10 10	2.0	100	-	106.0	M-W	106.0' -97.0' End of Boring	
110									
115									
120									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-4
Sheet	1 Of 6
Date: Start:	04/20/01
End:	04/23/01
O.G. Elev.	2.55'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: CME 45 Skid Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 4.0" ID FJ Depth: 99.0' Water: Depth: 0.5' Time: 0 HR Date: 04/23/01
Checked By: J. Gerhoff Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 2.5'	
		1 2 2						Poorly graded SAND with gravel (sp, a-1-b), dark gray to dark brown, moist to wet, very loose (Alluvial)	*Boring moved from Sta 28+50, 20.8 R to Sta 28+77, 35.8 R, due to underground fiber optic cable; elevation changed from 1.55' to 2.55'*
	S-1	2 2	1.0	50	-	2.0	M		
		1 1						4.0' -1.4'	
	S-2	1 2	1.0	50	-	4.0	W	Poorly graded SAND (sp, a-3), gray, wet, very loose to loose, sand is fine to medium grained (Alluvial)	
5		3 2							
	S-3	2	1.8	90	-	6.0	W		
	S-4	50/0	0.0	0	-	6.0	-		*6.0': Spoon refusal*
		2 1 2							
	S-5	1	0.3	15	-	10.0	W		
10		1 WOH 1						10.5' -8.0' Elastic SILT (mh, a-7-5), dark gray, wet, soft to very soft (Alluvial)	*10.5'-13.0': Some organic material present*
	S-6	1	2.0	100	-	12.0	W		
								13.0' -10.4' Poorly graded SAND with silt (sp-sm, a-2-4), dark gray, wet, very loose, sand is fine grained (Alluvial)	
	S-7	WOH /2.0	2.0	100	-	14.0	W		
15								15.0' -12.4' Elastic SILT with sand (mh, a-5), dark gray, wet, very soft (Alluvial)	*15.0'-50.0': Some organic material present*
	S-8	WOH /2.0	0.1	5	-	16.0	W		
	S-9	WOH /2.0	2.0	100	-	18.0	W		*18.0'-20.0': Shelby tube sample taken*
20	ST-1		2.0	100		20.0			

Drawn by: HCT

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-4
Sheet 2 of 6
Date: Start: 04/20/01
End: 04/23/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20		2 1 1						21.0' -18.4'	
	S-10	2 WOH /1.0	2.0	100	-	22.0	W	Poorly graded SAND with silt (sp-sm, a-2-4), dark gray, wet, very loose, sand is fine grained (Alluvial)	
	S-11	3 3 1	1.5	75	-	24.0	W	24.0' -21.4' Elastic SILT with sand (mh, a-5), gray, wet, very soft (Alluvial)	
25	S-12	1 1 1	1.2	60	-	26.0	W		
	S-13	2 1 2	2.0	100	-	28.0	W	28.0' -25.4' Poorly graded SAND (sp, a-3), gray, moist to wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
30	S-14	1 5 6	2.0	100	-	30.0	M-W		
	S-15	8 8 8	2.0	100	-	32.0	M		
	S-16	9 8 6	1.0	50	-	34.0	W		
35	S-17	8 8 8	2.0	100	-	36.0	W		
	S-18	8 4 4	2.0	100	-	38.0	W		
40	S-19	6 6 8	2.0	100	-	40.0	W		
		7 10 12 14							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-4
Sheet	3 of 6
Date: Start:	04/20/01
End:	04/23/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
		9 10 15						Poorly graded SAND (sp, a-3), gray, moist to wet, loose to medium dense, sand is fine to medium grained	
	S-20	20	2.0	100	-	42.0	W	(Alluvial)	
		8 11 13							
	S-21	21	2.0	100	-	44.0	W	44.0' -41.5'	
		3 3 4						Elastic SILT with sand (mh, a-5), gray, moist, medium stiff to stiff	
45	S-22	3	2.0	100	0.50	46.0	M	(Alluvial)	*46.0'-48.0': Shelby tube sample taken*
	ST-2		2.0	100		48.0			
50	S-23	WOH /2.0	2.0	100	1.00	50.0	M		
		4 4 5							
	S-24	5	2.0	100	1.00	52.0	M		
		3 4 3							
	S-25	4	2.0	100	1.00	54.0	M		
55		WOH /1.5							
	S-26	1	2.0	100	0.50	56.0	M		
		4 5 5							
	S-27	5	2.0	100	>0.5	58.0	M		
		5 7 7							
60	S-28	6	2.0	100	0.50	60.0	M		

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-4
Sheet 4 of 6
Date: Start: 04/20/01
End: 04/23/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
		5 4 4						Elastic SILT with sand (mh, a-5), gray, moist, medium stiff to stiff (Alluvial) 62.0' -59.5'	
	S-29	6 5	2.0	100	0.50	62.0	M	Poorly graded SAND (sp, a-3), gray, moist, medium dense to dense, sand is fine to medium grained (Alluvial) 66.0' -63.5'	
	S-30	4 5 7 2 2	2.0	100	0.50	64.0	M		
65	S-31	3 8 7	0.0	0	-	66.0	-	Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense to dense, sand is fine to medium grained (Alluvial)	*66.0'-100.5': Shell fragments noted*
	S-32	12 13 14 7	2.0	100	-	68.0	M		
70	S-33	13 21 20	2.0	100	-	70.0	M		
75	S-34	6 9 13	1.5	100	-	75.5	M		
80		7 11							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No. B-4
Sheet 5 of 6
Date: Start: 04/20/01
End: 04/23/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-35	16	1.5	100	-	80.5	M	Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense to dense, sand is fine to medium grained (Alluvial)	
		9 12							
85	S-36	18	1.5	100	-	85.5	M		
		8 13							
90	S-37	19	1.5	100	-	90.5	M		
		7 11							
95	S-38	16	1.5	100	-	95.5	M		
		14 15							
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 28+77 Offset from Centerline: 35.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-4
Sheet 6 of 6
Date: Start: 04/20/01
End: 04/23/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-39	17	1.5	100	-	100.5	M	100.5' -98.0' End of Boring	
105									
110									
115									
120									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-5
Sheet	1 Of 6
Date: Start:	04/10/01
End:	04/11/01
O.G. Elev.	-22.03'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: Skid Rig on Barge
Drilling Methods: 5' Interval SS
Casing: Size: 4.0" ID FJ Depth: 40.0' Water: Depth: - Time: - Date: -
Checked By: J. Gerhoff Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
								0.0' -22.0'	
0		WOH /1.0						Mud and soft sediments (Alluvial)	*Elevation of staked location is 20.67'*
	S-1	1 2	0.0	0	-	2.0	-	2.0' -24.0' Poorly graded SAND (sp, a-3), greenish gray, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	*Mud line is 42.1' below staked elevation* *Started sampling 0.6' below mudline*
5	S-2	4 5 6	0.8	53	-	6.5	W		
10	S-3	2 4 5	1.5	100	-	11.5	W	10.5' -32.5' Sandy elastic SILT (mh, a-7-5), dark gray, wet, soft, sand is fine grained (Alluvial)	
15	S-4	2 2 2	1.5	100	0.25	15.5	W	17.5' -39.5' Poorly graded SAND (sp, a-3), gray, moist to wet, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	
20		5 6							

Drawn by: HCT

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-5
Sheet 2 of 6
Date: Start: 04/10/01
End: 04/11/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20	S-5	9	1.0	67	-	20.5	W	Poorly graded SAND (sp, a-3), gray, moist to wet, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	
25	S-6	6, 15, 20	1.5	100	-	25.5	W-M	25.0' -47.0' Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense, sand is fine to medium grained and is laminated with silt layers (Alluvial)	
30	S-7	2, 3, 9	1.3	87	-	30.5	M		
35	S-8	3, 2, 9	1.5	100	-	35.5	M	34.5' -56.5' Sandy elastic SILT (mh, a-7-5), dark gray, moist, soft (Alluvial) 35.0' -57.0' Poorly graded SAND with silt (sp-sm, a-3), medium gray, moist, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	
40		7, 6							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31+99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-5
Sheet 3 of 6
Date: Start: 04/10/01
End: 04/11/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / ROD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-9	6	0.8	53	-	40.5	W	Poorly graded SAND with silt (sp-sm, a-3), medium gray, moist, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	
		4							*44.0': Gravel size material, thickness less than 0.3', gravel is rounded to subrounded*
45	S-10	4 12	1.5	100	-	45.5	M		
		6 10							
50	S-11	24	1.5	100	-	50.5	M		
		7 10							
55	S-12	24	1.5	100	-	55.5	M		
		10 19							
60									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-5
Sheet 4 of 6
Date: Start: 04/10/01
End: 04/11/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-13	31	1.5	100	-	60.5	M	Poorly graded SAND with silt (sp-sm, a-3), medium gray, moist, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	
		6 8							
65	S-14	13	1.5	100	-	65.5	M		
		15 20							
70	S-15	28	1.5	100	-	70.5	M		
		8 12							
75	S-16	16	1.5	100	-	75.5	M		
		5 6							
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-5
Sheet	5 of 6
Date: Start:	04/10/01
End:	04/11/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-17	13	1.5	100	-	80.5	M-W	Poorly graded SAND with silt (sp-sm, a-3), medium gray, moist, medium dense to dense, sand is fine to medium grained, some organic material present (Alluvial)	*80.0'-87.0': Shell fragments noted*
85	S-18	5 8 17	1.3	87	-	85.5	W		
								87.0' -109.0' Poorly graded SAND with gravel (sp, a-1-b), medium gray, wet, medium dense, sand is coarse grained, few fines, gravel is fine grained (Alluvial)	*87.0'-100.5': Shell fragments noted*
90	S-19	9 11 13	1.3	87	-	90.5	W		
95	S-20	5 8 13	1.5	100	-	95.5	W		
100		5 9						100.0' -122.0'	

Drawn by: HCT

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 31+99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-5
Sheet 6 of 6
Date: Start: 04/10/01
End: 04/11/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-21	13	1.5	100	-	100.5	W	Poorly graded SAND with silt (sp-sm, a-3), medium gray, wet, medium dense (Alluvial) 100.5' -122.5' End of Boring	

5

110

115

120

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 34+99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-6
Sheet 2 of 6
Date: Start: 04/12/01
End: 04/14/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20	S-5	8	0.8	53	-	20.5	W	Poorly graded SAND (sp, a-3), gray, wet, medium dense, sand is fine to medium grained, some organic material present (Alluvial)	
		11 11							
25	S-6	14	1.5	100	-	25.5	W		
		8 7							
30	S-7	9	1.2	80	-	30.5	W		
		5 6							
35	S-8	6	1.5	100	-	35.5	W		
		13 15							
40									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 34+99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-6
Sheet 3 of 6
Date: Start: 04/12/01
End: 04/14/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-9	20	1.5	100	-	40.5	W	Poorly graded SAND (sp, a-3), gray, wet, medium dense, sand is fine to medium grained, some organic material present (Alluvial)	
								42.0' -63.8' Poorly graded SAND with silt (sp-sm, a-2-4), gray, moist to wet, medium dense to dense, sand is fine grained (Alluvial)	*42.0'-100.5': Shell fragments noted*
		21 24							
45	S-10	27	1.5	100	-	45.5	M-W		
		6 7							
50	S-11	10	1.0	67	-	50.5	M-W		
		15 19							
55	S-12	27	1.1	73	-	55.5	M-W		
		9 19							
60									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-6
Sheet	4 of 6
Date: Start:	04/12/01
End:	04/14/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 34 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-13	24	0.8	53	-	60.5	M-W	Poorly graded SAND with silt (sp-sm, a-2-4), gray, moist to wet, medium dense to dense, sand is fine grained (Alluvial)	
								64.0' -85.8'	
		5 17						Poorly graded SAND (sp, a-3), gray, wet to moist, dense, sand is fine to medium grained (Alluvial)	
65	S-14	23	1.3	87	-	65.5	W-M		
		9 13							
								70.0' -91.8'	
70	S-15	18	1.5	100	-	70.5	W-M	Poorly graded SAND with silt (sp-sm, a-2-4), gray, moist to wet, very dense, sand is fine grained (Alluvial)	
		15 28							
75	S-16	38	1.5	100	-	75.5	M		
								78.0' -99.8'	
		7 13						Poorly graded SAND with gravel (sp, a-1-b), gray, wet, dense, sand is medium to coarse grained, gravel is fine grained, subrounded to rounded (Alluvial)	
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 34 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-6
Sheet 5 of 6
Date: Start: 04/12/01
End: 04/14/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-17	21	1.5	100	-	80.5	W	Poorly graded SAND with gravel (sp, a-1-b), gray, wet, dense, sand is medium to coarse grained, gravel is fine grained, subrounded to rounded (Alluvial)	
85	S-18	19 22 27	1.5	100	-	85.5	W	85.0' -106.8' Poorly graded SAND with silt (sp-sm, a-3), gray, wet, dense to very dense (Alluvial)	
90	S-19	21 38 42	1.5	100	-	90.5	W-M		
95	S-20	11 13 24	1.5	100	-	95.5	W		
100		10 13							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 34 + 99 Offset from Centerline: 20.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-6
Sheet 6 of 6
Date: Start: 04/12/01
End: 04/14/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-21	21	1.5	100	-	100.5	W	100.5' -122.3' End of Boring	
105									
110									
115									
120									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-7
Sheet	1 Of 5
Date: Start:	04/17/01
End:	04/19/01
O.G. Elev.	1.03'
G.W. Elev.	-0.47'

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 36+45 Offset from Centerline: 37.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing
Equipment Used: CME 45 Skid Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 4.0" ID FJ Depth: 94.0' Water: Depth: 1.5' Time: 0 HR Date: 04/19/01
Checked By: J. Gerhoff Date: 05/09/01 Depth: 1.5' Time: 24 HR Date: 04/20/01
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 1.0'	
	S-1	1 3 3 5	0.1	7	-	1.5	W	Poorly graded SAND with silt (sp-sm, a-3), dark gray, wet, loose (Alluvial)	*Boring moved from Sta 36+40, 34.8 R to Sta 36+45, 37.8 R, to move out of high tide zone*
	S-2	6 8 4 6	0.1	7	-	3.0	W	3.0' -2.0'	
	S-3	11 8 7	1.2	80	-	4.5	W	Poorly graded SAND (sp, a-3), orange brown, wet, medium dense, sand is fine to medium grained (Alluvial)	
5	S-4	9 9 5	1.3	87	-	6.0	W		
	S-5	7 8 9	1.0	67	-	7.5	W	7.5' -6.5'	
	S-6	10 3	1.5	100	-	9.0	W	Elastic SILT with sand (mh, a-7-5), light brown, moist to wet, soft, sand is fine to medium grained and is laminated with silt layers (Alluvial)	*8'-9' was spooned twice*
10	S-7	4 3 3 4	1.3	65	0.50	10.0	W		
	S-8	3 3 3 3	2.0	100	0.50	12.0	W		
	S-9	3 2 2 2	2.0	100	0.50	14.0	M		
15								15.0' -14.0'	
	S-10	2 2 2 2	2.0	100	0.25	16.0	M	Poorly graded SAND with silt (sp-sm, a-3), brown to dark gray, moist, very loose to loose, sand is fine to medium grained and is laminated with silt layers (Alluvial)	*S-10: Separate recovery into 2 jars, S-10A and S-10B due to change in strata*
	S-11	3 1 1 5	2.0	100	-	18.0	M		
20	S-12	6	2.0	100	-	20.0	M	20.0' -19.0'	

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 36+45 Offset from Centerline: 37.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-7
Sheet 2 of 5
Date: Start: 04/17/01
End: 04/19/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20		2 6 12						Poorly graded SAND (sp, a-3), medium gray, wet to moist, medium dense to dense, sand is fine to medium grained	
	S-13	17	1.0	50	-	22.0	M-W	(Alluvial)	
		12 11 12							
	S-14	13	1.8	90	-	24.0	W		
		6 7 9							
25	S-15	9	2.0	100	-	26.0	W		
		10 13 10							
	S-16	15	2.0	100	-	28.0	W		
		16 16 18							
30	S-17	21	2.0	100	-	30.0	M		
		3 5 11							
	S-18	12	2.0	100	-	32.0	M		
		5 7 12							
	S-19	12	2.0	100	-	34.0	M		
		12 12 16							*34.0'-38.0': Some organic material present*
35	S-20	18	2.0	100	-	36.0	M		
		9 15 18							
	S-21	20	2.0	100	-	38.0	M		
		11 15 17							
40	S-22	15	2.0	100	-	40.0	M		

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 36+45 Offset from Centerline: 37.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-7
Sheet 3 of 5
Date: Start: 04/17/01
End: 04/19/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
		2 9 13						Poorly graded SAND (sp, a-3), medium gray, wet to moist, medium dense to dense, sand is fine to medium grained	
	S-23	12 9 8	2.0	100	-	42.0	M	(Alluvial)	
	S-24	11 12 7	2.0	100	-	44.0	M		
45	S-25	9 11 11	1.5	75	-	46.0	M		
	S-26	18 20 32	2.0	100	-	48.0	M		
50	S-27	4 5 5 12	2.0	100	-	50.0	W		
	S-28	13 13 12 12	2.0	100	-	52.0	M		
	S-29	4 5 6 6	2.0	100	-	54.0	W		
55	S-30	4 3 5 6	2.0	100	-	56.0	W		
	S-31	9 7 8 7	2.0	100	-	58.0	M-W		
60	S-32	7 14 21 13	2.0	100	-	60.0	W		

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-7
Sheet	4 of 5
Date: Start:	04/17/01
End:	04/19/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 36+45 Offset from Centerline: 37.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
		10 13 13						Poorly graded SAND (sp, a-3), medium gray, wet to moist, medium dense to dense, sand is fine to medium grained	
	S-33	14 9 11	2.0	100	-	62.0	W	(Alluvial)	
		13							
	S-34	13 8 7	2.0	100	-	64.0	W		
65		9							
	S-35	13 15 8	2.0	100	-	66.0	W		
		6							
	S-36	6 7 9	2.0	100	-	68.0	W	68.0' -67.0'	
		12						Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense to dense, sand is fine to medium grained	
70	S-37	17	2.0	100	-	70.0	W	(Alluvial)	
		6 7 7							
75	S-38	8	2.0	100	-	76.0	M		
		9 11							
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 36+45 Offset from Centerline: 37.8 ft Right
Inspector: M. Morykin Drillers Name/Company: R. Smith/McCallum Testing

Boring No. B-7
Sheet 5 of 5
Date: Start: 04/17/01
End: 04/19/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-39	13 13	2.0	100	-	81.0	M	Poorly graded SAND with silt (sp-sm, a-3), gray, moist, medium dense to dense, sand is fine to medium grained (Alluvial)	
85	S-40	6 7 7 8	1.8	90	-	86.0	M		*84.0'-96.0': Shell fragments noted*
90	S-41	9 11 13 11	0.3	15	-	91.0	M		
95	S-42	17 19 23 23	1.3	65	-	96.0	M	96.0' -95.0' End of Boring	
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-8
Sheet	1 Of 6
Date: Start:	05/02/01
End:	05/02/01
O.G. Elev.	6.40'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing
Equipment Used: CME 45 Truck Mounted Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.25" ID HSA Depth: 30.0' Water: Depth: 7.5' Time: 0 HR Date: 05/02/01
Checked By: P. Lowe Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
								0.0' 6.4'	
0		9 7 9						Silty SAND (sm, a-2-4), yellow brown, moist, loose to medium dense (Fill)	*Boring moved from Sta 37+70, 54.2 L to Sta 37+70, 64.2 L, due to overhead and underground utilities*
	S-1	6 4 4	1.4	70	-	2.0	M		
	S-2	4 2 3	2.0	100	-	4.0	M		
5	S-3	2 4 4	2.0	100	-	6.0	M	6.0' 0.4'	
								Poorly graded SAND (sp, a-3), light brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
	S-4	3 5 3	2.0	100	-	8.0	M		
10	S-5	3 4 4	1.7	85	-	10.0	W		
	S-6	5 6 3	1.6	80	-	12.0	W		
	S-7	6 8 11	2.0	100	-	14.0	W		
15	S-8	3 1 1	2.0	100	-	16.0	W		
								17.5' -11.1'	
	S-9	2 2 3	2.0	100	-	18.0	W	Poorly graded SAND with silt (sp-sm, a-3), brown to dark brown, wet, very loose to loose, sand is fine grained, some organic material present (Alluvial)	
20	S-10	1 1 3	2.0	100	-	20.0	W		

Drawn by: HCT

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-8
Sheet 2 of 6
Date: Start: 05/02/01
End: 05/02/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Poorly graded SAND with silt (sp-sm, a-3), brown to dark brown, wet, very loose to loose, sand is fine grained, some organic material present (Alluvial)	
25	S-11	2 2 2	1.5	100	-	25.5	W		
30	S-12	8 17 15	1.5	100	-	30.5	W	29.0' -22.6' Poorly graded SAND (sp, a-3), yellow brown to gray, wet, medium dense to dense, sand is fine to medium grained (Alluvial)	
35	S-13	12 18 15	1.3	87	-	35.5	W		
40		9 12							

Drawn by: HCT
Revised: 6/20/2001

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-8
Sheet 3 of 6
Date: Start: 05/02/01
End: 05/02/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	16	0.8	53	-	40.5	W-M	Poorly graded SAND (sp, a-3), yellow brown to gray, wet, medium dense to dense, sand is fine to medium grained (Alluvial)	
		9 12							
45	S-15	16	1.5	100	-	45.5	W		
		4 5							
50	S-16	5	1.0	67	-	50.5	W		
		7 9							
55	S-17	10	1.0	67	-	55.5	W		
		12 14							
60									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-8
Sheet 4 of 6
Date: Start: 05/02/01
End: 05/02/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	11	1.0	67	-	60.5	W	Poorly graded SAND (sp, a-3), yellow brown to gray, wet, medium dense to dense, sand is fine to medium grained (Alluvial)	
		4 5							
65	S-19	5	1.1	73	-	65.5	W		
		16 18							
70	S-20	24	0.9	60	-	70.5	W		
		10 7						74.5' -68.1'	
75	S-21	6	1.5	100	-	75.5	W	Poorly graded SAND with silt (sp-sm, a-3), gray, wet to moist, medium dense, sand is fine to medium grained (Alluvial)	
		8 8							
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-8
Sheet	5 of 6
Date: Start:	05/02/01
End:	05/02/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	6	1.5	100	-	80.5	W	Poorly graded SAND with silt (sp-sm, a-3), gray, wet to moist, medium dense, sand is fine to medium grained (Alluvial)	
		12							
		10							
85	S-23	13	1.5	100	-	85.5	M		
								89.0' -82.6'	
		7						Poorly graded SAND with gravel (sp, a-1-b), gray, wet, medium dense to dense, sand is medium to coarse grained, gravel is fine grained, angular shell fragments, soil reacts to HCl (Alluvial)	
		13							
90	S-24	15	1.5	100	-	90.5	M-W		
		10							
		20							
95	S-25	24	1.1	73	-	95.5	W		
		10							
100		12							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 37+70 Offset from Centerline: 64.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-8
Sheet 6 of 6
Date: Start: 05/02/01
End: 05/02/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-26	12	1.5	100	-	100.5	W	100.5'	
								-94.1' End of Boring	
105									
110									
115									
120									

Drawn by: HCT
Revised: 6/20/2001

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-9
Sheet	1 Of 5
Date: Start:	05/03/01
End:	05/04/01
O.G. Elev.	9.00'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 40+20 Offset from Centerline: 58.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing
Equipment Used: CME 45 Truck Mounted Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.25" ID HSA Depth: 24.0' Water: Depth: 7.0' Time: 0 HR Date: 05/04/01
Checked By: P. Lowe Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 9.0'	
	S-1	7 7 9 12 12 10	1.0	50	-	2.0	M	Silty SAND (sm, a-2-4), yellow brown, moist, medium dense, sand is fine to medium grained (Fill)	*Boring moved from Sta 40+20, 34.8 R, to Sta 40+20, 58.2 L, due to accessibility problem*
	S-2	7 8 2 1	1.2	60	-	4.0	M		
5								5.0' 4.0'	
	S-3	1 1 2 2	2.0	100	-	6.0	M-W	Poorly graded SAND (sp, a-3), yellow brown to light brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
	S-4	2 3 5 5	2.0	100	-	8.0	W		
10	S-5	5 10 6 6	2.0	100	-	10.0	W		
	S-6	7 7 7 9	2.0	100	-	12.0	W		
	S-7	12 13 3 4	2.0	100	-	14.0	W		
15	S-8	6 8 3 5	1.0	50	-	16.0	W		
	S-9	6 9 2 1	2.0	100	-	18.0	W		
								18.5' -9.5'	*18.5'-34.0': Some organic material present in samples*
20	S-10	1 2	1.2	60	-	20.0	M	Elastic SILT with sand (mh, a-7-5), dark gray, wet to moist, soft (Alluvial)	

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 40+20 Offset from Centerline: 58.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-9
Sheet 2 of 5
Date: Start: 05/03/01
End: 05/04/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Elastic SILT with sand (mh, a-7-5), dark gray, wet to moist, soft (Alluvial)	*20.0'-22.0': Shelby tube sample taken*
	ST-1		1.8	90		22.0			
		1 1							
25	S-11	2	1.5	100	-	25.5	M		
		2 2							
30	S-12	2	1.5	100	-	30.5	M		
									31.0'-33.0': Shelby tube sample taken
	ST-2		2.0	100		33.0			
								34.0' -25.0'	
		3 2						Poorly graded SAND (sp, a-3), gray, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	*34.0'-64.0': Some organic material present in samples*
35	S-13	2	1.5	100	-	35.5	W		
		3 2							
40									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 40+20 Offset from Centerline: 58.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-9
Sheet 3 of 5
Date: Start: 05/03/01
End: 05/04/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	2	1.0	67	-	40.5	W	Poorly graded SAND (sp, a-3), gray, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
		3							
		5							
45	S-15	8	0.8	53	-	45.5	W		
		3							
		4							
50	S-16	3	1.5	100	-	50.5	W		
		3							
		6							
55	S-17	8	1.5	100	-	55.5	W		
		6							
60		5							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 40+20 Offset from Centerline: 58.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-9
Sheet 4 of 5
Date: Start: 05/03/01
End: 05/04/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	5	1.5	100	-	60.5	W	Poorly graded SAND (sp, a-3), gray, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
								64.0' -55.0'	
		3 4						SILT with sand (ml, a-5), gray, wet, loose, sand is fine to medium grained (Alluvial)	
65	S-19	5	1.5	100	-	65.5	W-M		
		9 5							
70	S-20	4	1.5	100	-	70.5	W		
								74.0' -65.0'	
		3 5						Poorly graded SAND with gravel (sp, a-1-b), gray, wet, medium dense, sand is medium to coarse grained, gravel is fine grained, angular shell fragments, soil reacts to HCl (Alluvial)	
75	S-21	3	1.5	100	-	75.5	W		
		12 12							
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-9
Sheet	5 of 5
Date: Start:	05/03/01
End:	05/04/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 40+20 Offset from Centerline: 58.2 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	13	1.5	100	-	80.5	W	Poorly graded SAND with gravel (sp, a-1-b), gray, wet, medium dense, sand is medium to coarse grained, gravel is fine grained, angular shell fragments, soil reacts to HCl (Alluvial)	
		13 8							
85	S-23	11	1.5	100	-	85.5	W	85.5' -76.5'	
								End of Boring	
90									
95									
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-10
Sheet	1 Of 6
Date: Start:	04/30/01
End:	05/01/01
O.G. Elev.	8.68'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing
Equipment Used: CME 45 Truck Mounted Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.0" ID FJ Depth: 24.0' Water: Depth: 7.5' Time: 0 HR Date: 05/01/01
Checked By: P. Lowe Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 8.7'	
		2 2 2						TOPSOIL 1.0' 7.7'	*Boring moved from Sta 42+76, 59.7 L to Sta 42+68, 66.7 L, due to utilities*
	S-1	2 2 2 2	1.5	75	-	2.0	M	Poorly graded SAND (sp, a-3), orangish brown, moist, very loose, sand is fine to medium grained (Alluvial)	*No change in elevation*
	S-2	2 2 2 2	1.2	60	-	4.0	M		
5								5.0' 3.7'	
	S-3	1 2 2 2	1.5	75	-	6.0	M	Poorly graded SAND (sp, a-3), light brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
	S-4	3 2 4 4	2.0	100	-	8.0	M-W		
10	S-5	7 5 5 7	1.5	75	-	10.0	W		
	S-6	7 7 6 9	2.0	100	-	12.0	W		
	S-7	10 6 9 7	2.0	100	-	14.0	W		
15	S-8	6 3 2 2	1.2	60	-	16.0	W		
	S-9	3 2 3 3	2.0	100	-	18.0	W	18.0' -9.3'	
20	S-10	6	2.0	100	-	20.0	W	Poorly graded SAND with silt (sp-sm, a-3), dark brown to gray, wet, very loose, sand is fine to medium grained and is laminated with silt layers (Alluvial)	

Drawn by: HCT

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-10
Sheet	2 of 6
Date: Start:	04/30/01
End:	05/01/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Poorly graded SAND with silt (sp-sm, a-3), dark brown to gray, wet, very loose, sand is fine to medium grained and is laminated with silt layers (Alluvial)	
25	S-11	1 2 2	1.5	100	-	25.5	W		
								29.5' -20.8'	
30	S-12	3 3 4	1.5	100	-	30.5	W	Poorly graded SAND (sp, a-3), yellow brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
35	S-13	9 9 9	1.0	67	-	35.5	W		
40		12 13							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-10
Sheet 3 of 6
Date: Start: 04/30/01
End: 05/01/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	9	1.0	67	-	40.5	W	Poorly graded SAND (sp, a-3), yellow brown, wet, loose to medium dense, sand is fine to medium grained (Alluvial)	
45	S-15	8 7 10	0.8	53	-	45.5	M-W		
50	S-16	3 3 2	0.8	53	-	50.5	W		
55	S-17	6 7 9	1.0	67	-	55.5	W		
								58.5' -49.8' SILT with sand (ml, a-5), gray, wet, medium stiff, sand is fine to medium grained (Alluvial)	
60		2 2							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-10
Sheet	4 of 6
Date: Start:	04/30/01
End:	05/01/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	3	1.5	100	1.00	60.5	M	SILT with sand (ml, a-5), gray, wet, medium stiff, sand is fine to medium grained (Alluvial)	
		2 3							
65	S-19	3	1.5	100	1.00	65.5	M		
								69.0' -60.3'	
		6 7						Poorly graded SAND with gravel (sp, a-1-b), gray, wet, medium dense to dense, sand is medium to coarse grained, gravel is fine grained, shell fragments (Alluvial)	*69.0'-100.5': Soil reacts with HCl due to shell hash present*
70	S-20	10	1.3	87	-	70.5	M		
		10 12							
75	S-21	12	1.0	67	-	75.5	W		
		8 10							
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-10
Sheet 5 of 6
Date: Start: 04/30/01
End: 05/01/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-22	11	0.8	53	-	80.5	W	Poorly graded SAND with gravel (sp, a-1-b), gray, wet, medium dense to dense, sand is medium to coarse grained, gravel is fine grained, shell fragments (Alluvial)	
		17							
		18							
85	S-23	13	1.5	100	-	85.5	W		
		15							
		18							
90	S-24	15	0.8	53	-	90.5	W		
		10							
		18							
95	S-25	13	1.0	67	-	95.5	W		
		16							
		25							
100									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-10
Sheet	6 of 6
Date: Start:	04/30/01
End:	05/01/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 42+68 Offset from Centerline: 66.7 ft Left
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-26	23	1.0	67	-	100.5	W	100.5' -91.8' End of Boring	
105									
110									
115									
120									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-11
Sheet	1 Of 4
Date: Start:	05/04/01
End:	05/04/01
O.G. Elev.	10.08'
G.W. Elev.	

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 47+40 Offset from Centerline: 56.9 ft Right
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing
Equipment Used: CME 45 ATV Rig
Drilling Methods: Cont. SS/5' Interval SS
Casing: Size: 3.25" ID HSA Depth: 50.0' Water: Depth: 6.4' Time: 0 HR Date: 05/04/01
Checked By: P. Lowe Date: 05/08/01 Depth: - Time: - Date: -
Not Encountered ☐

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
0								0.0' 10.1'	
		1 1 1						Poorly graded SAND (sp, a-3), yellowish to light brown, wet, loose to medium dense, sand is fine to medium grained	
	S-1	1 1 1	1.5	75	-	2.0	W	(Alluvial)	
	S-2	1 2 3	0.8	40	-	4.0	W		
5		2 1 1							
	S-3	2 4 6	1.0	50	-	6.0	W		
	S-4	6 7 7	1.0	50	-	8.0	W		
10	S-5	5 6 5	1.5	75	-	10.0	W		
	S-6	4 4 5	1.0	50	-	12.0	W		
	S-7	6 2 2	1.0	50	-	14.0	W		
15	S-8	4 3 2	2.0	100	-	16.0	W		
	S-9	1 3 3	2.0	100	-	18.0	W	18.0' -7.9'	
		3 2 3						Silty SAND (sm, a-2-4), dark gray, wet, loose	
		8 10 10						(Alluvial)	
20	S-10		2.0	100	-	20.0	W		

Drawn by: HCT

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-11
Sheet	2 of 4
Date: Start:	05/04/01
End:	05/04/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 47+40 Offset from Centerline: 56.9 ft Right
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
20								Silty SAND (sm, a-2-4), dark gray, wet, loose (Alluvial)	
25	S-11	3 5 7	1.5	100	-	25.5	M		
30	S-12	3 3 4	1.5	100	-	30.5	M		
35	S-13	7 6 3	1.5	100	-	35.5	W	35.0' -24.9' Poorly graded SAND (sp, a-3), gray, wet, loose, sand is fine to medium grained (Alluvial)	
40		5 2						39.0' -28.9'	

Drawn by: HCT

File: 7802-BOR
Job # 7802

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 47+40 Offset from Centerline: 56.9 ft Right
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Boring No. B-11
Sheet 3 of 4
Date: Start: 05/04/01
End: 05/04/01

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-14	2	1.5	100	-	40.5	W	Poorly graded SAND with gravel (sp, a-1-b), light gray, wet, loose to medium dense, sand is medium to coarse grained, gravel is fine grained, angular shell fragments, soil reacts with HCl (Alluvial)	
		5							
15	S-15	6 10	1.5	100	-	45.5	W		
		7							
50	S-16	7 5	1.5	100	-	50.5	W		
		3							
55	S-17	3 5	1.2	80	-	55.5	W		
		5							
60		5							

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR

GTS Technologies, Inc.

ENGINEERS FIELD BORING LOG

Boring No.	B-11
Sheet	4 of 4
Date: Start:	05/04/01
End:	05/04/01

Project Name: Gilmerton Bridge - Project No. 7013-131-V03, PE 101, B615
Route Number: Route 13 Location: City of Chesapeake, VA
Station: 47+40 Offset from Centerline: 56.9 ft Right
Inspector: M. Morykin Drillers Name/Company: D. Lubhe/McCallum Testing

Depth (ft)	Sample No. & Type/Core Run	Blows/0.5ft on Sampler	Recovery (ft)	Recovery (%) / RQD (%)	Penetrometer	Depth of SS or Run	Moisture	Description	Remarks
	S-18	7	1.5	100	-	60.5	W	Poorly graded SAND with gravel (sp, a-1-b), light gray, wet, loose to medium dense, sand is medium to coarse grained, gravel is fine grained, angular shell fragments, soil reacts with HCl (Alluvial)	
		6							
65		6							
	S-19	7	1.5	100	-	65.5	W	65.5' -55.4' End of Boring	
70									
75									
80									

Drawn by: HCT
Revised: 6/20/2001

File: 7802-BOR
Job # 7802

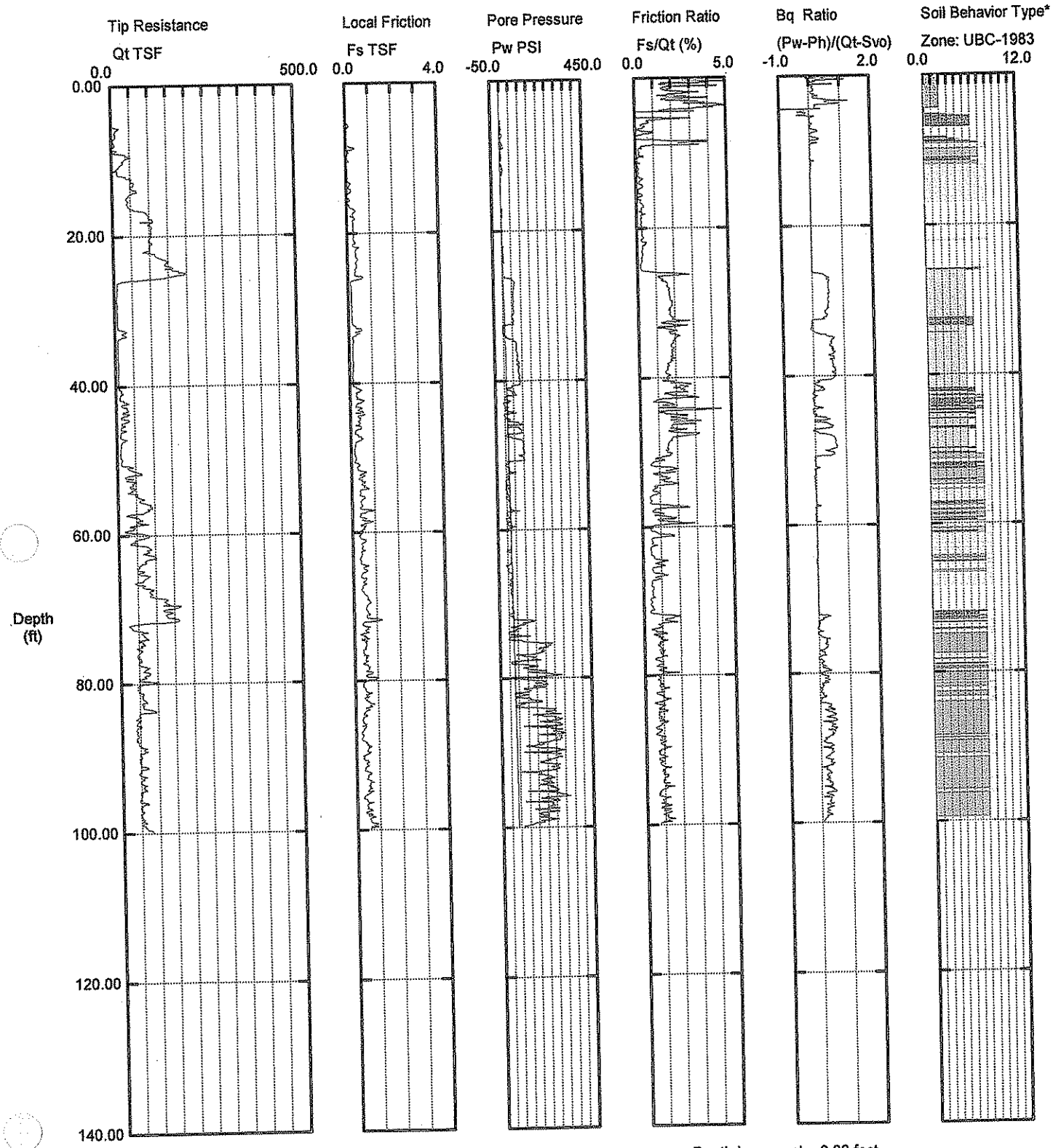
CPT DATA

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-1 (Ele.= 8.56')
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 1:10:49 PM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 99.87 feet

Depth Increment = 0.00 feet

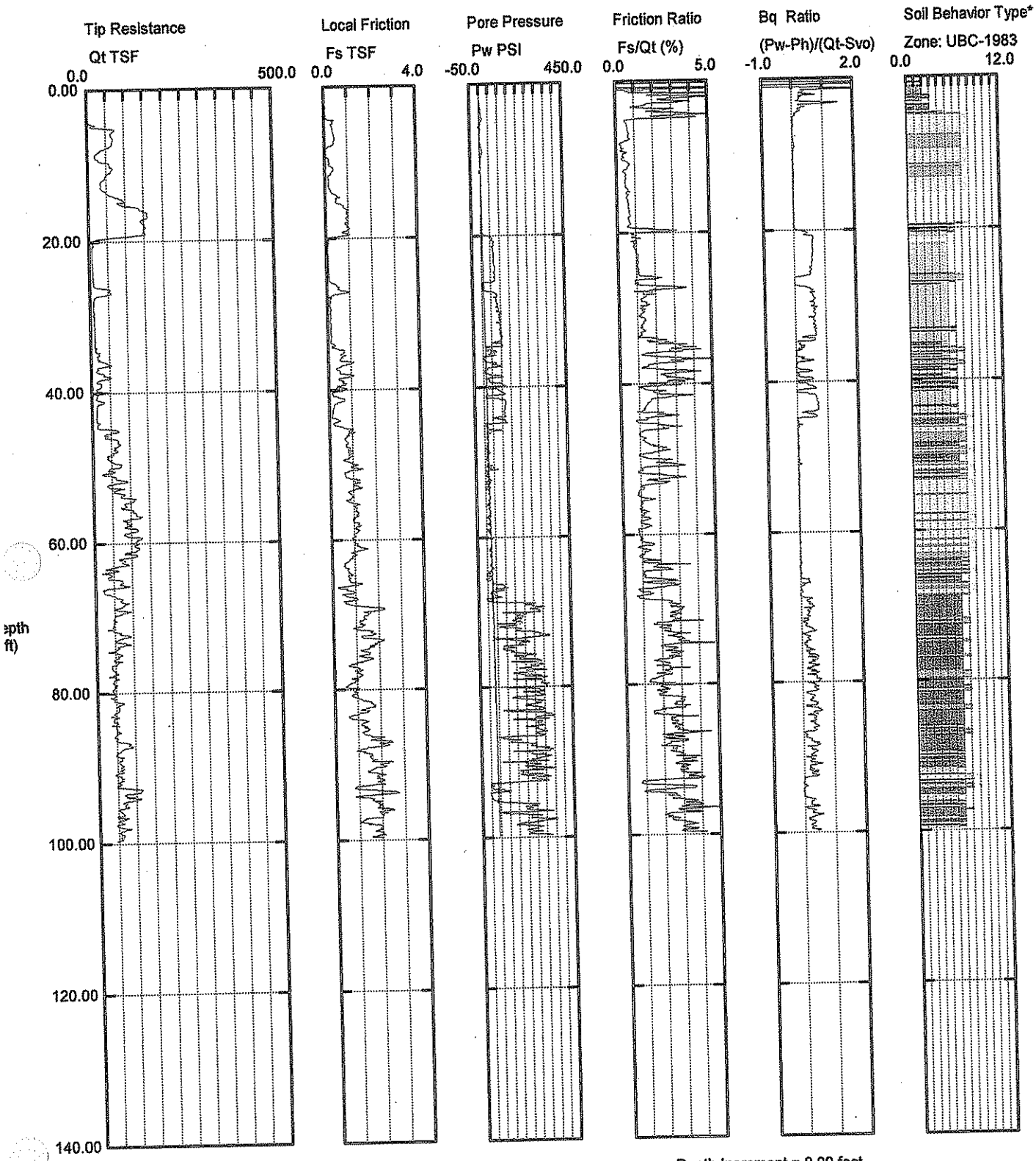
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

oil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-2 (Ele.= 8.88')
Cone Used: DTA0848

CPT Date/Time: 3/4/2003 8:36:50 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 99.74 feet

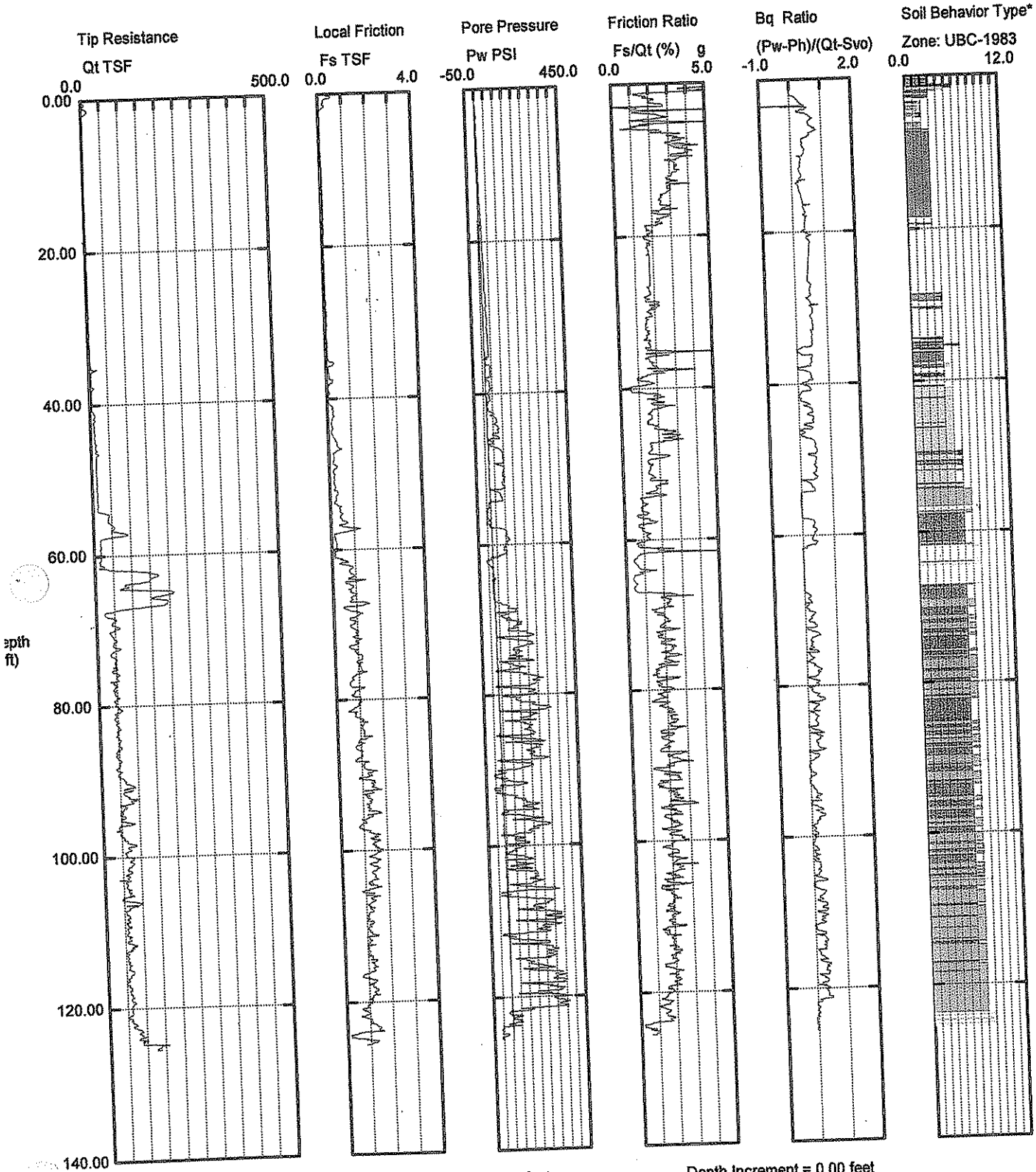
Depth Increment = 0.00 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-3 (Ele.=6.19')
Cone Used: DSA0764

CPT Date/Time: 2/25/2003 1:48:55 PM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 125.56 feet

Depth Increment = 0.00 feet

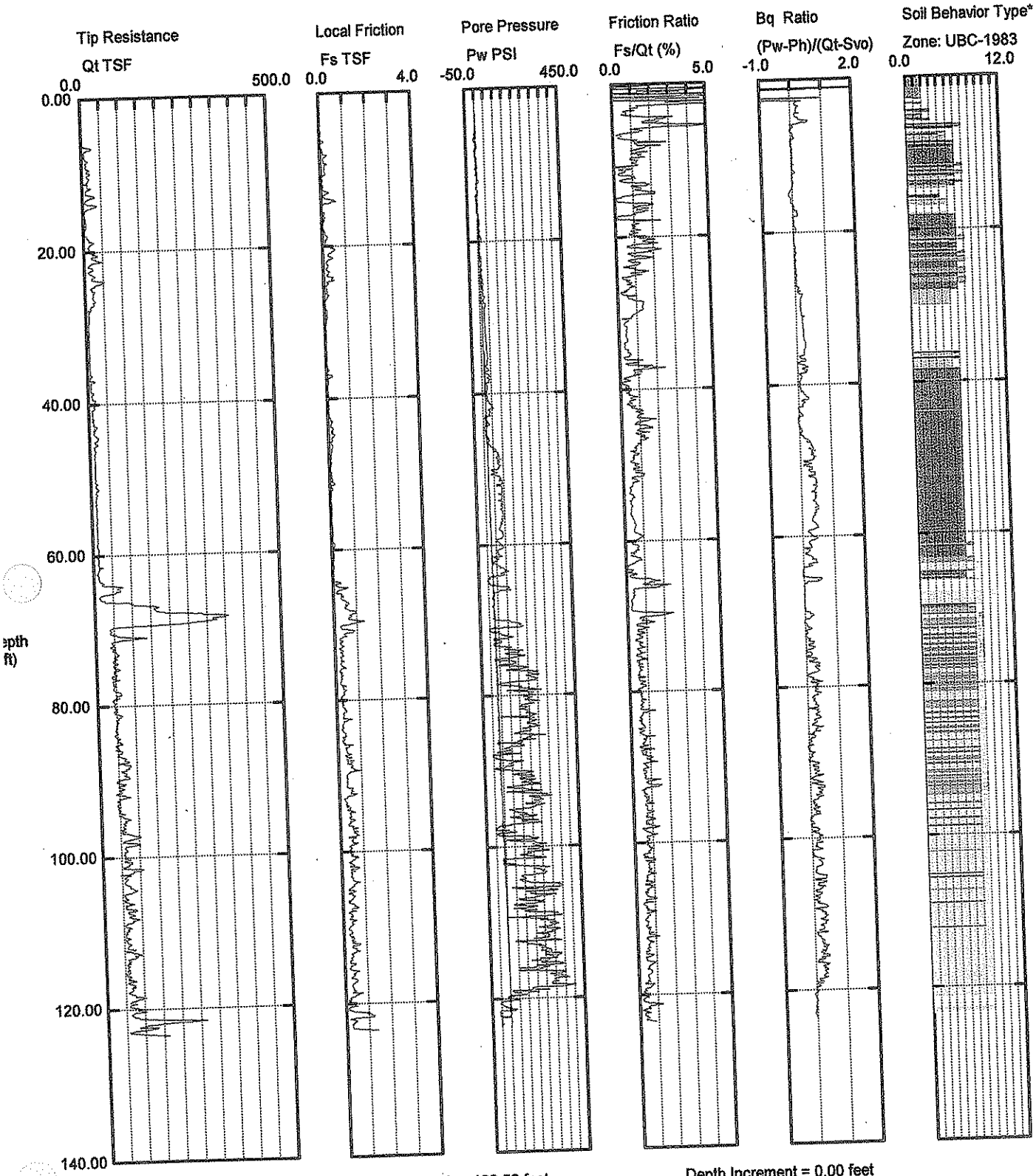
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

oil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-4 (Ele.=7.69')
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 8:41:15 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 123.52 feet

Depth Increment = 0.00 feet

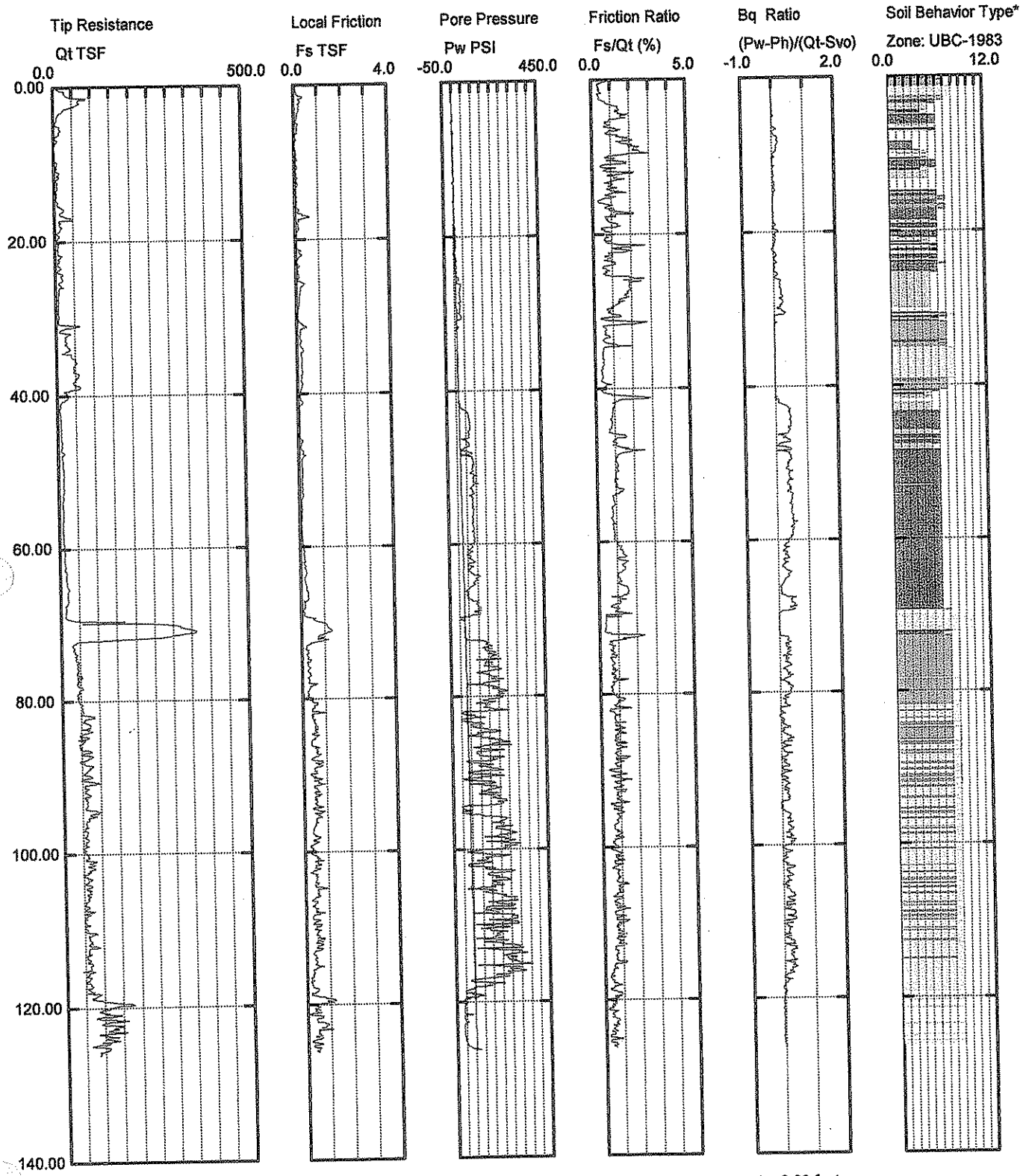
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

oil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-5 (Ele.= 9.47')
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 10:40:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 126.18 feet

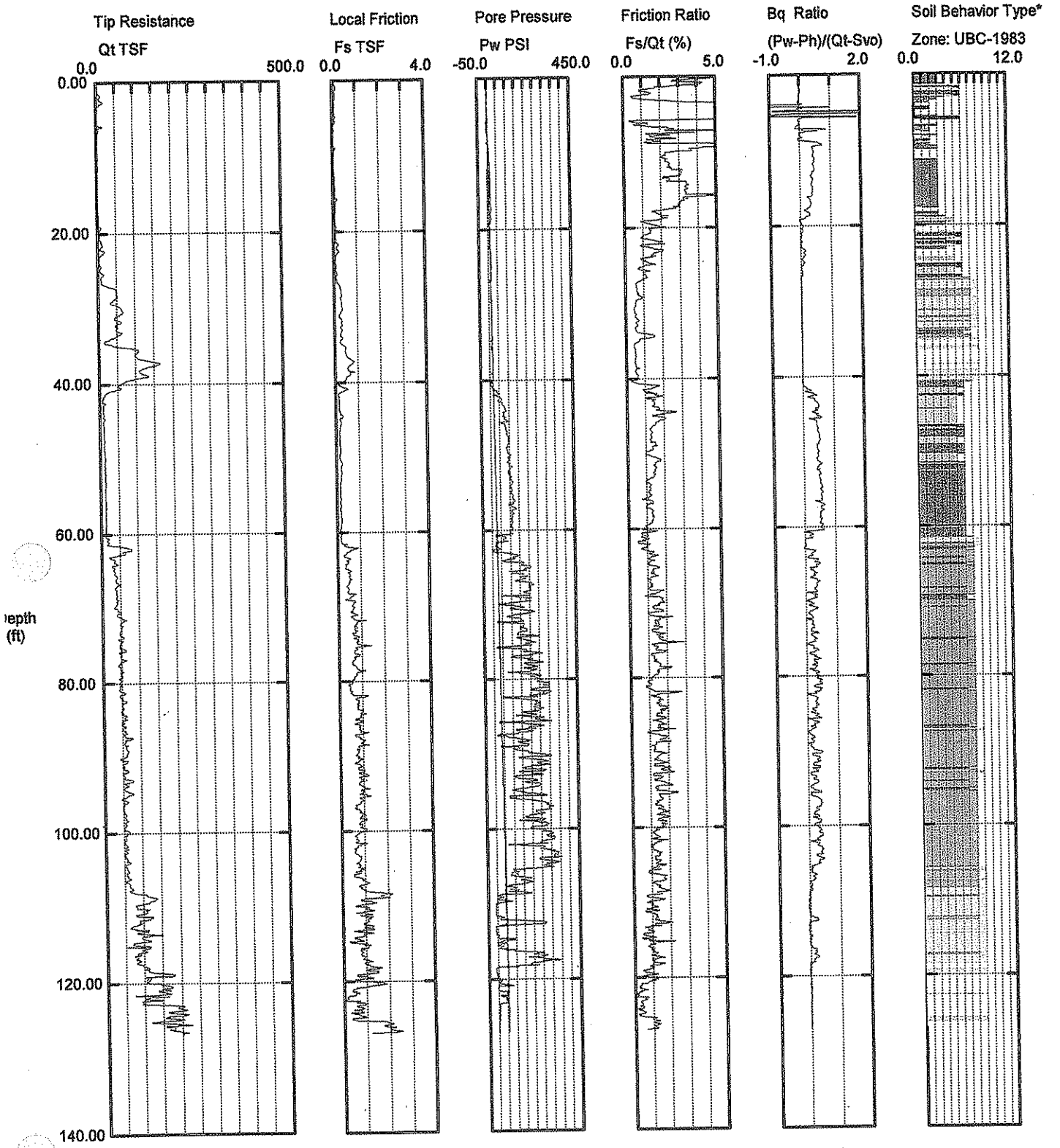
Depth Increment = 0.00 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-6 (Ele.=2.71')
Cone Used: DSA0807

CPT Date/Time: 2/15/2003 9:09:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 126.87 feet

Depth Increment = 0.00 feet

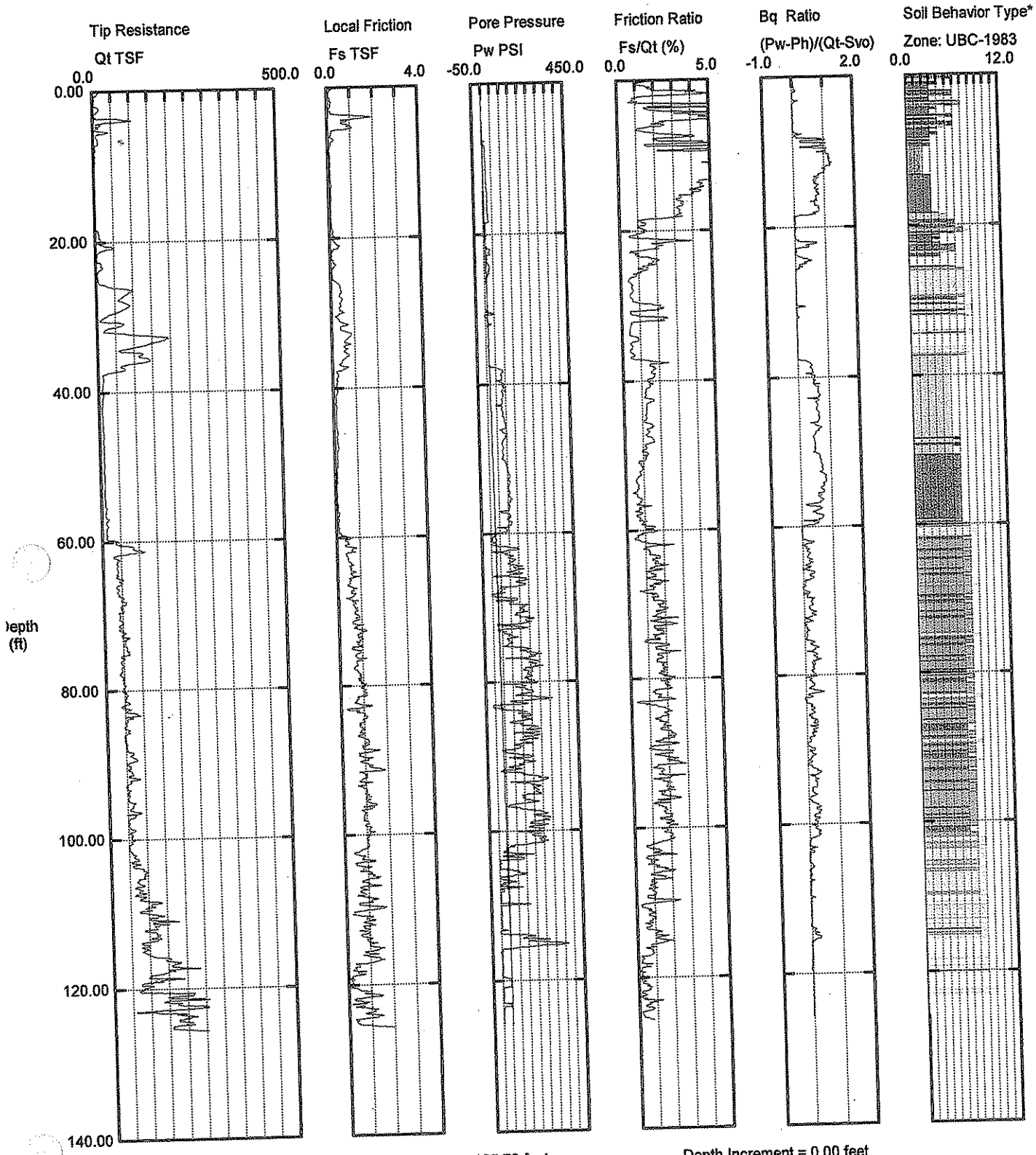
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-7 (Ele.=1.41')
Cone Used: DSA0807

CPT Date/Time: 2/16/2003 12:36:46 PM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 125.72 feet

Depth Increment = 0.00 feet

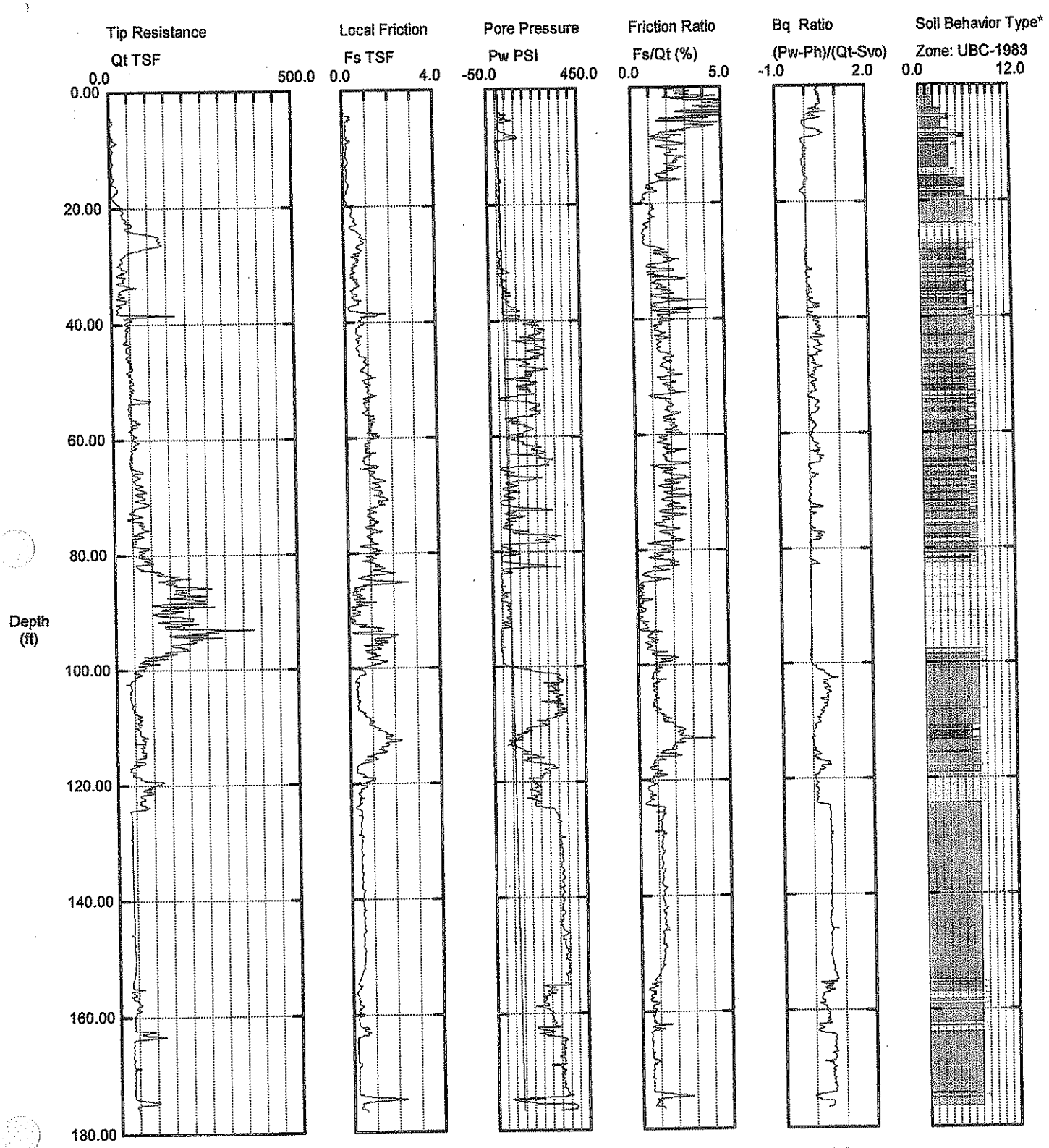
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-8 (Ele.=-21.9)
Cone Used: DSA0764

CPT Date/Time: 2/22/2003 8:42:48 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 176.61 feet

Depth Increment = 0.00 feet

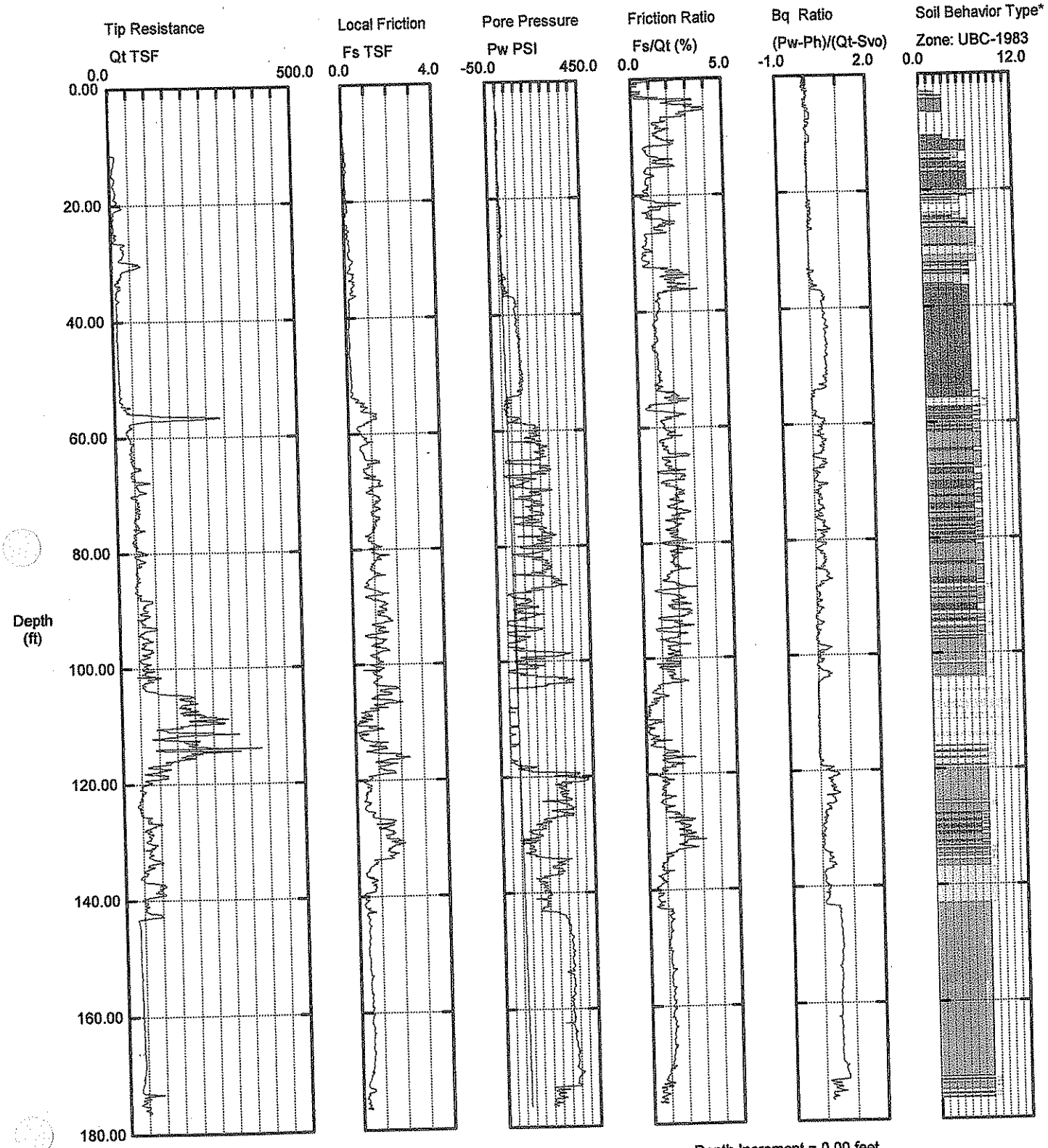
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-10 (Ele.= -6.0)
Cone Used: DSA0764

CPT Date/Time: 2/23/2003 6:32:45 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 176.54 feet

Depth Increment = 0.00 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

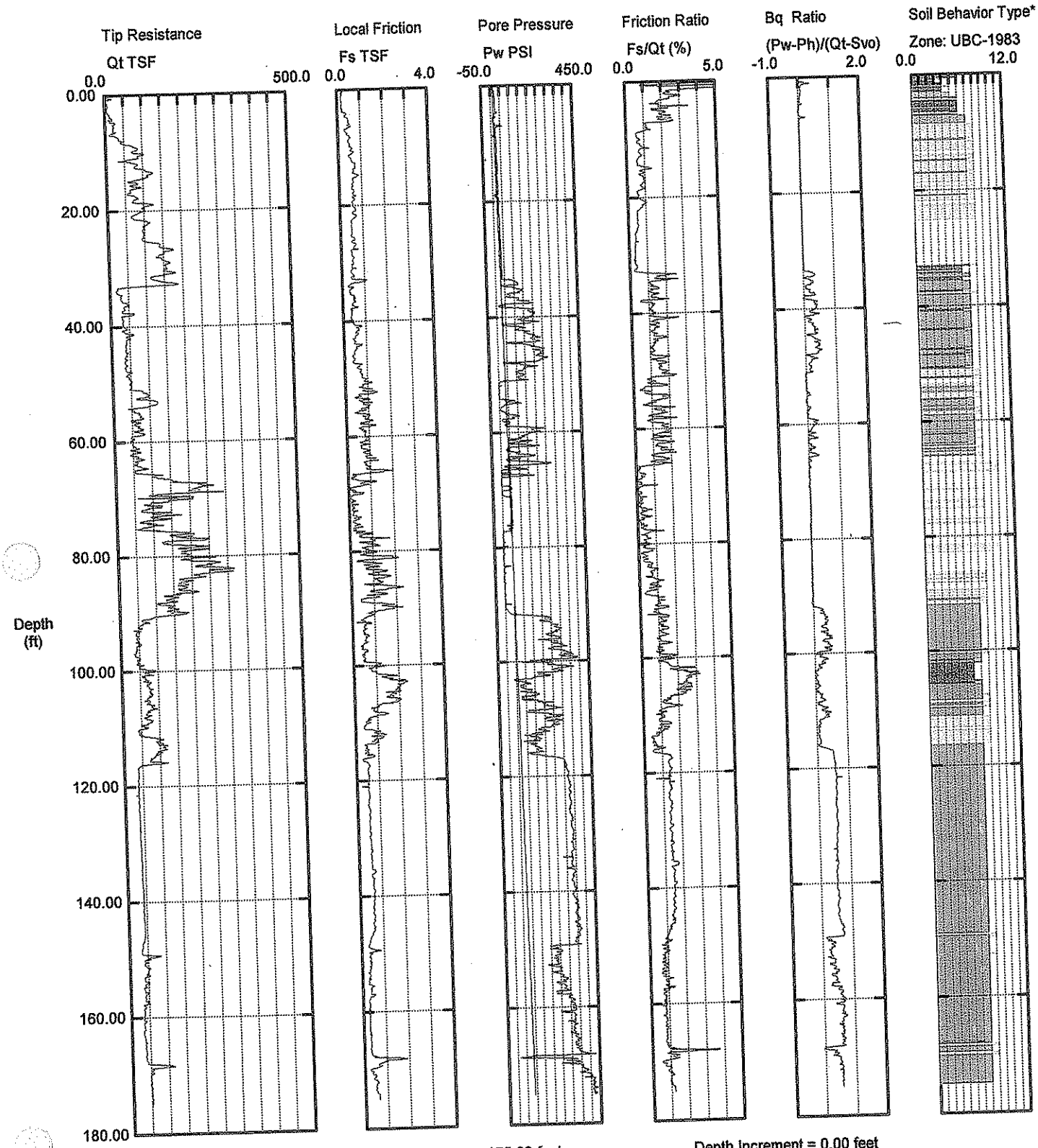
Footer1

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-14 (Ele.= -33.5)
Cone Used: DSA0807

CPT Date/Time: 2/18/2003 1:56:00 PM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 175.03 feet

Depth Increment = 0.00 feet

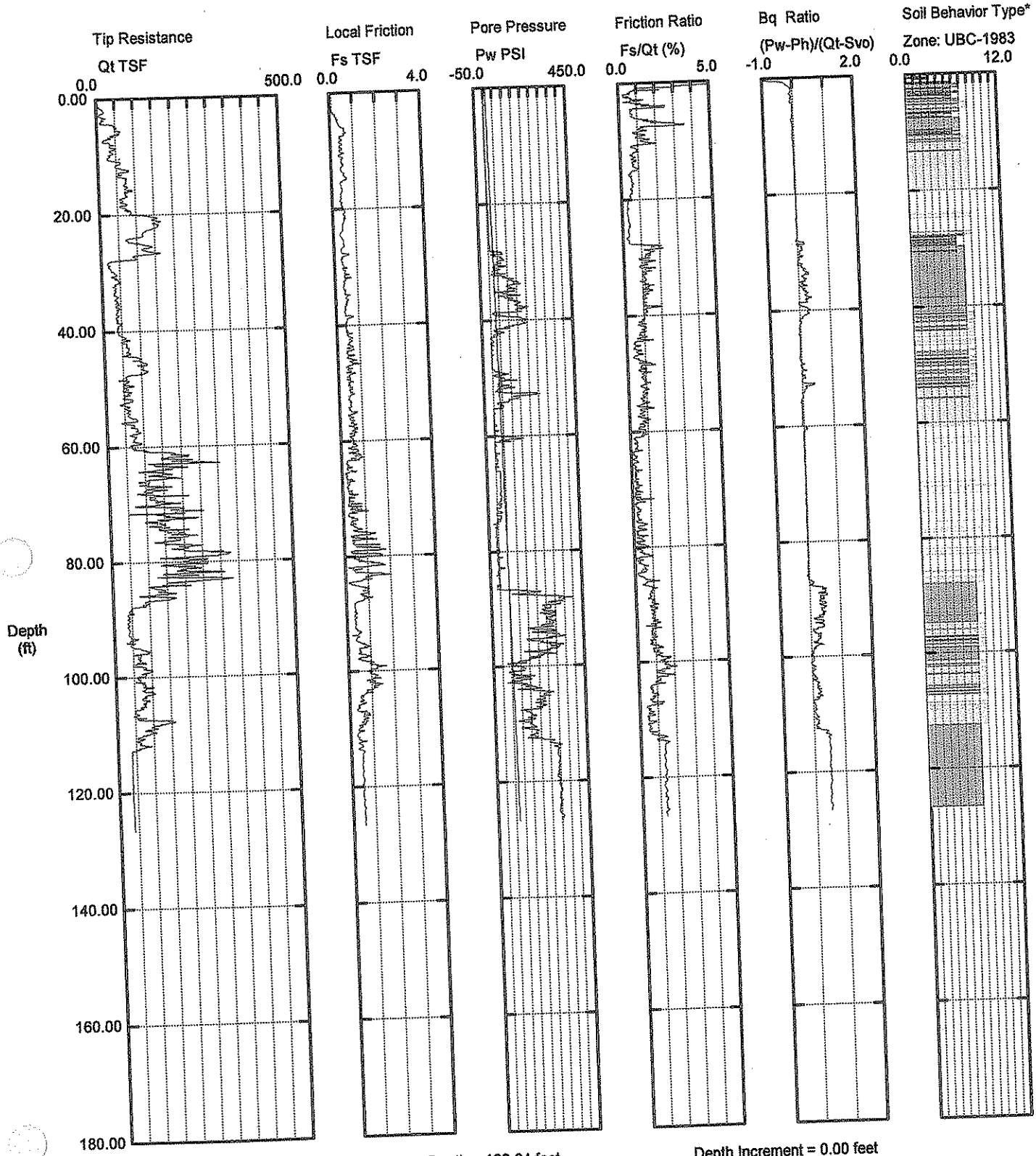
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-15 (Ele.= -44.86)
Cone Used: DSA0825

CPT Date/Time: 2/19/2003 10:13:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 126.64 feet

Depth Increment = 0.00 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

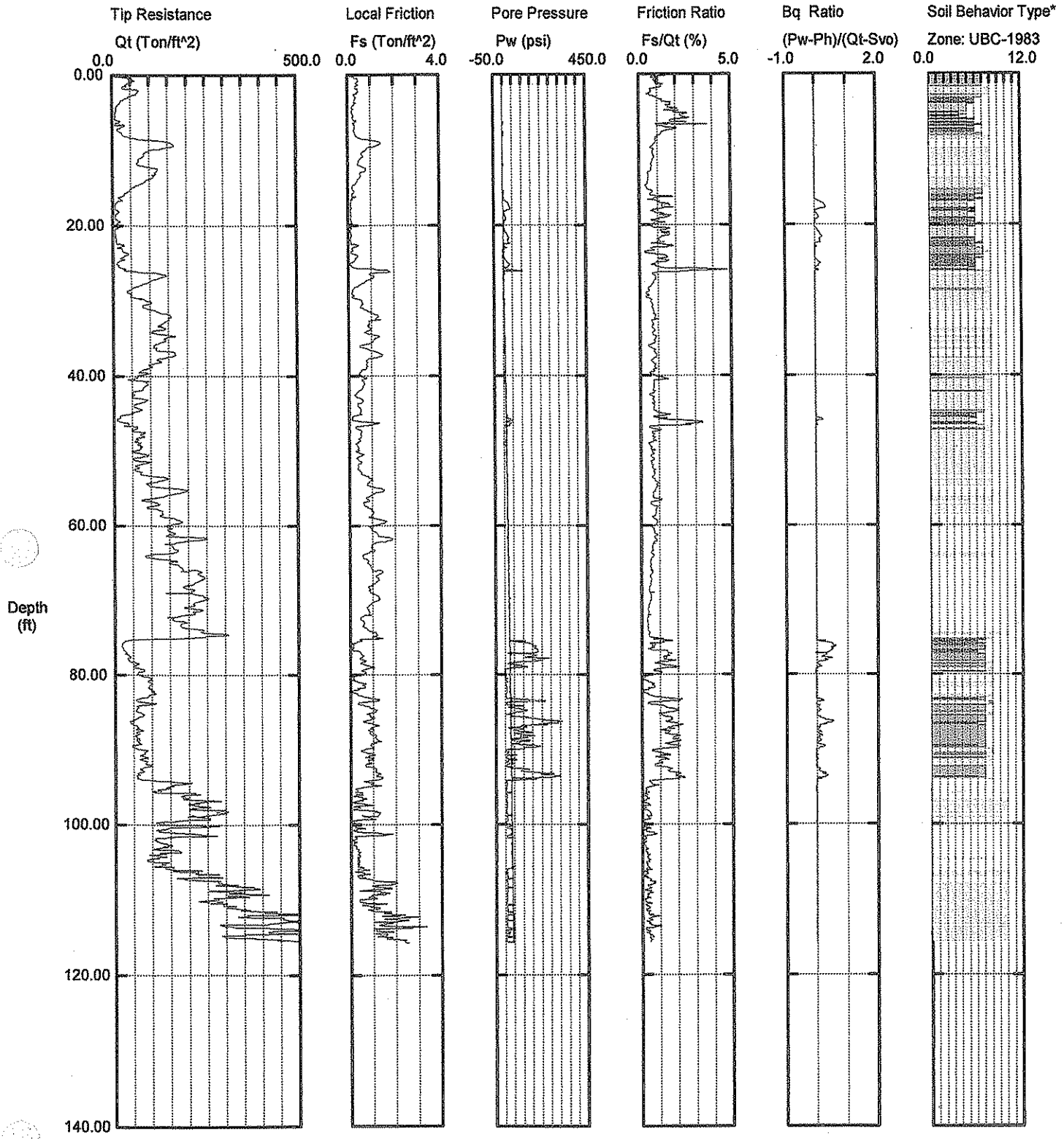
Footer1

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences Inc.

Operator: DH
Sounding: MC-17 6.86ft
Cone Used: 10T4CHSEIS

CPT Date/Time: 02-10-03 10:43
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 115.65 feet

Depth Increment = 0.08 feet

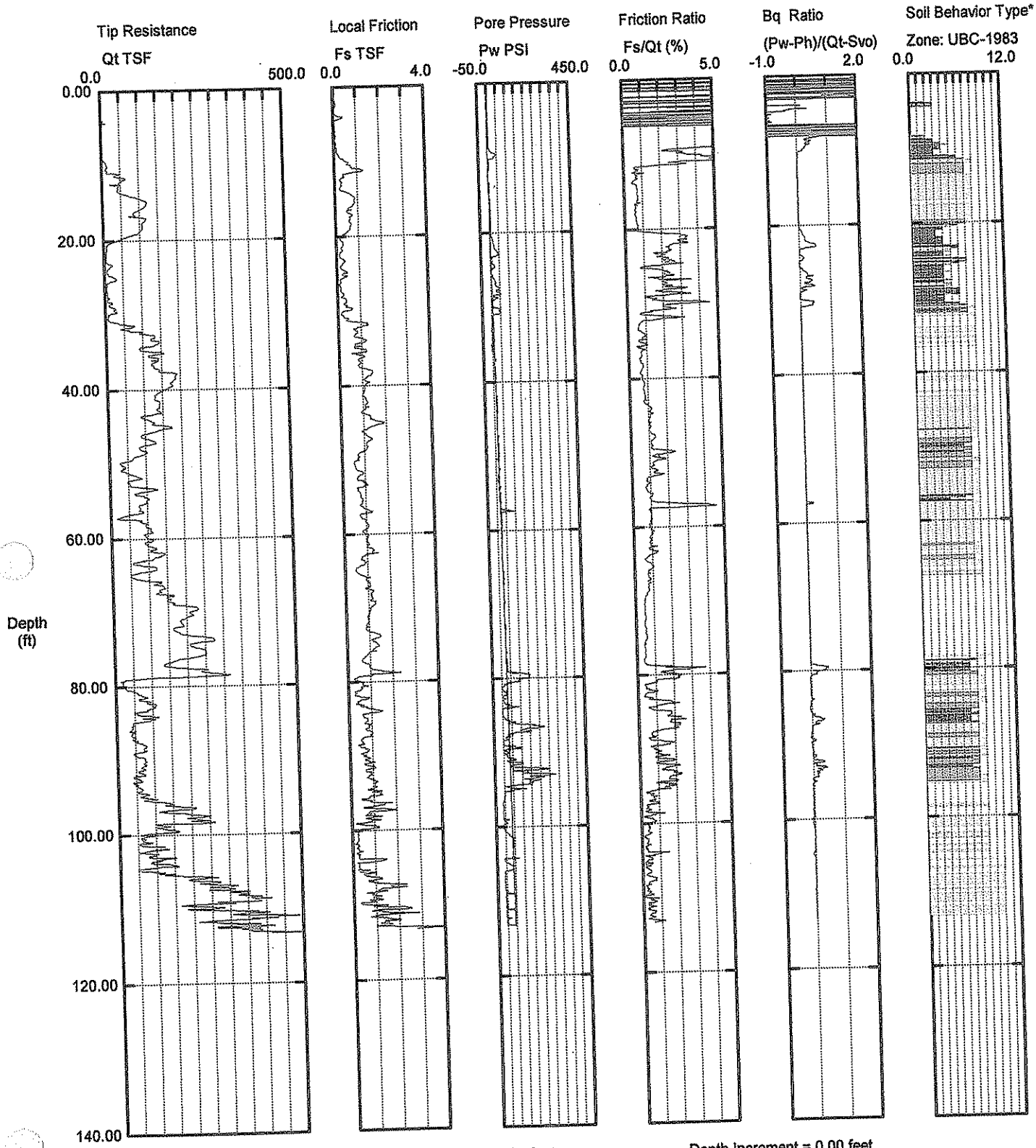
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-18 (Ele.= 11.05')
Cone Used: DTA0848

CPT Date/Time: 2/13/2003 8:10:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 113.25 feet

Depth Increment = 0.00 feet

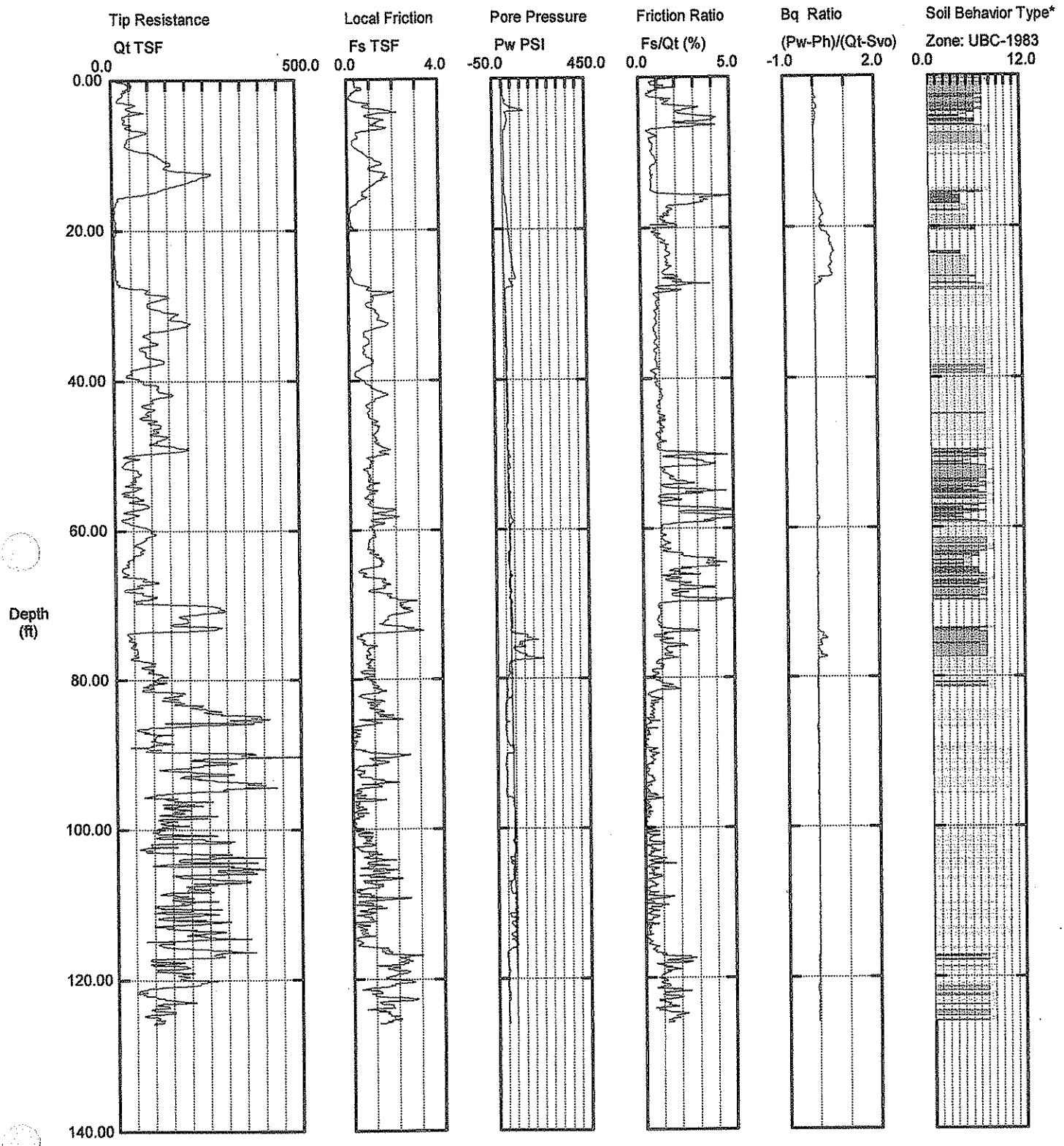
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

SOUTHERN EARTH SCIENCES,INC

Operator: D.H.
Sounding: MC-19 (Ele.= 7.19')
Cone Used: DTA0848

CPT Date/Time: 2/10/2003 8:13:34 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 125.89 feet

Depth Increment = 0.00 feet

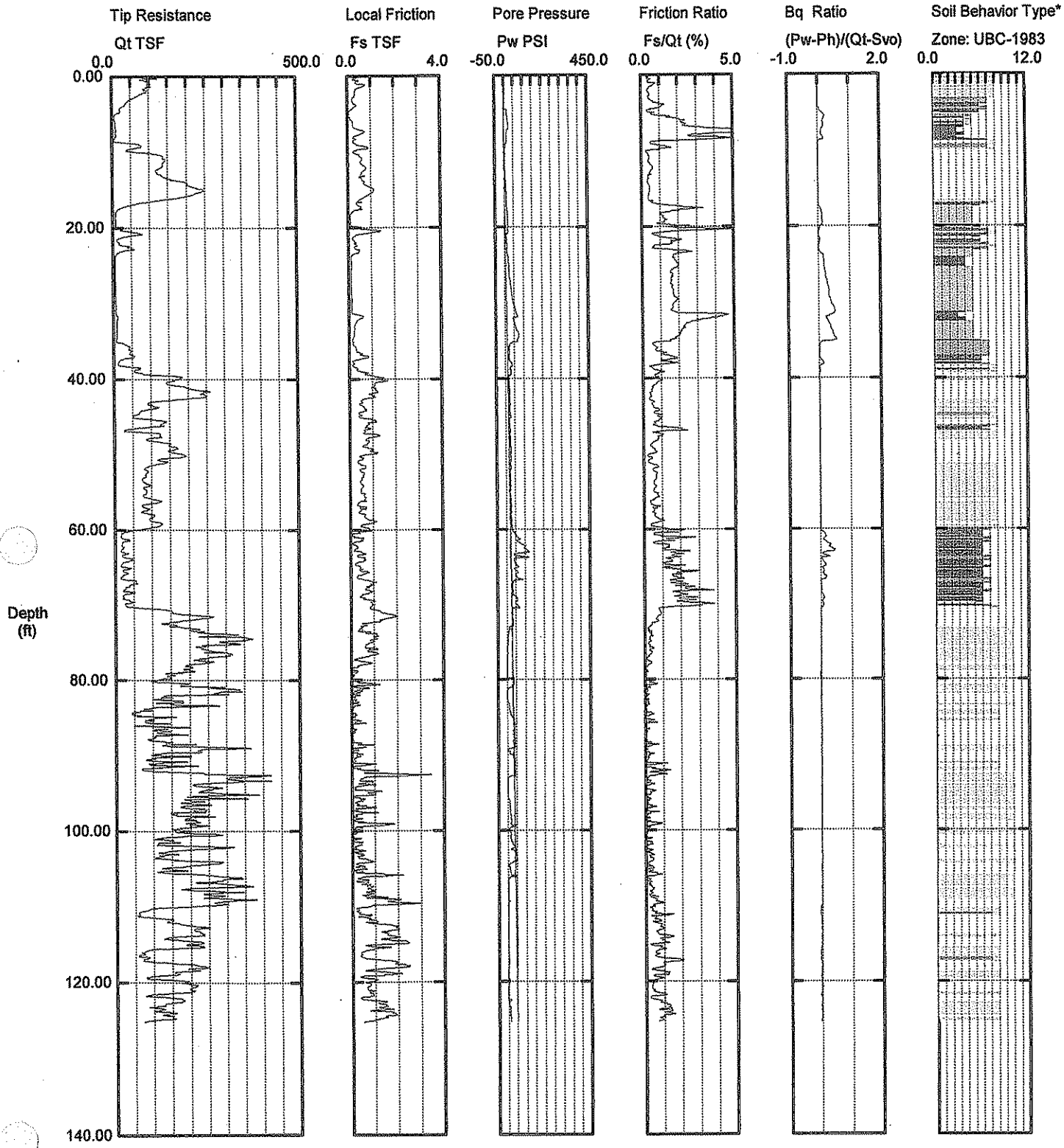
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

SOUTHERN EARTH SCIENCES,INC

Operator: D. H.
Sounding: MC-20 (Ele.= 7.54')
Cone Used: DSA0807

CPT Date/Time: 2/10/2003 6:44:53 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 125.23 feet

Depth Increment = 0.00 feet

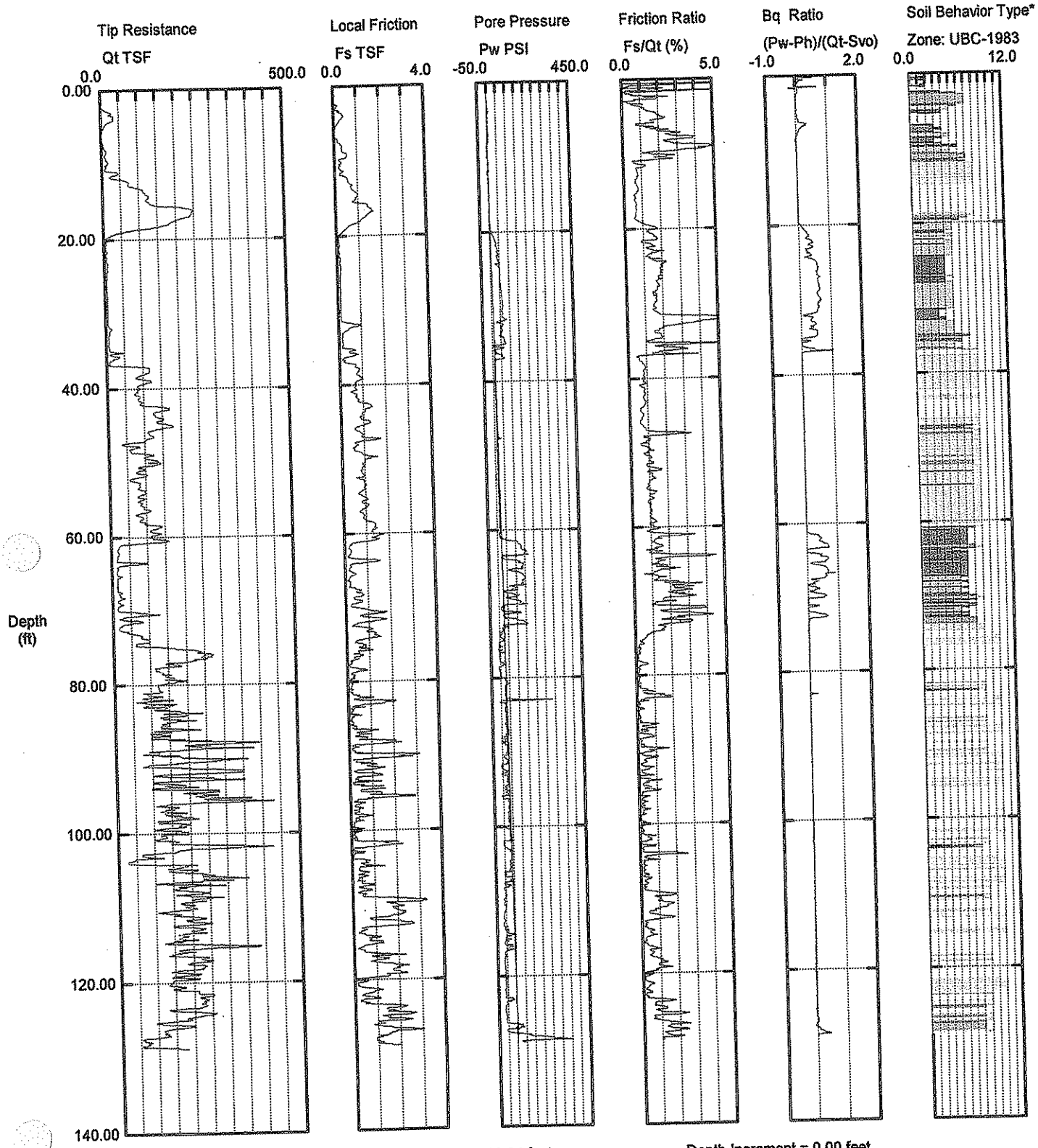
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences Inc.

Operator: DH
Sounding: MC-21 (Ele.= 9.69')
Cone Used: DTA0848

CPT Date/Time: 2/12/2003 1:44:12 PM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 128.84 feet

Depth Increment = 0.00 feet

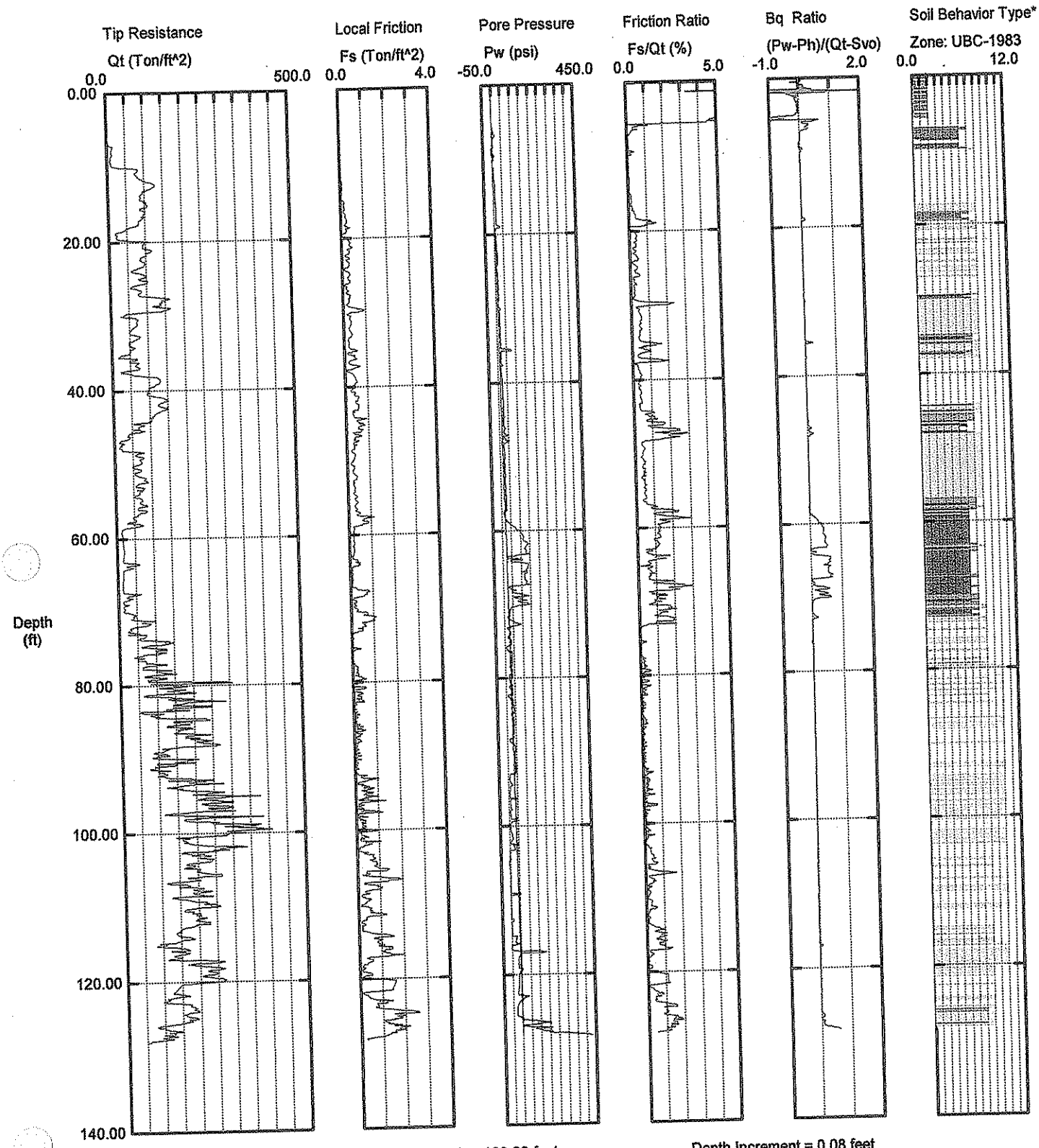
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences Inc.

Operator: DH
Sounding: MC-22 (Ele.=8.69')
Cone Used: 5T4CH

CPT Date/Time: 02-11-03 09:19
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 128.22 feet

Depth Increment = 0.08 feet

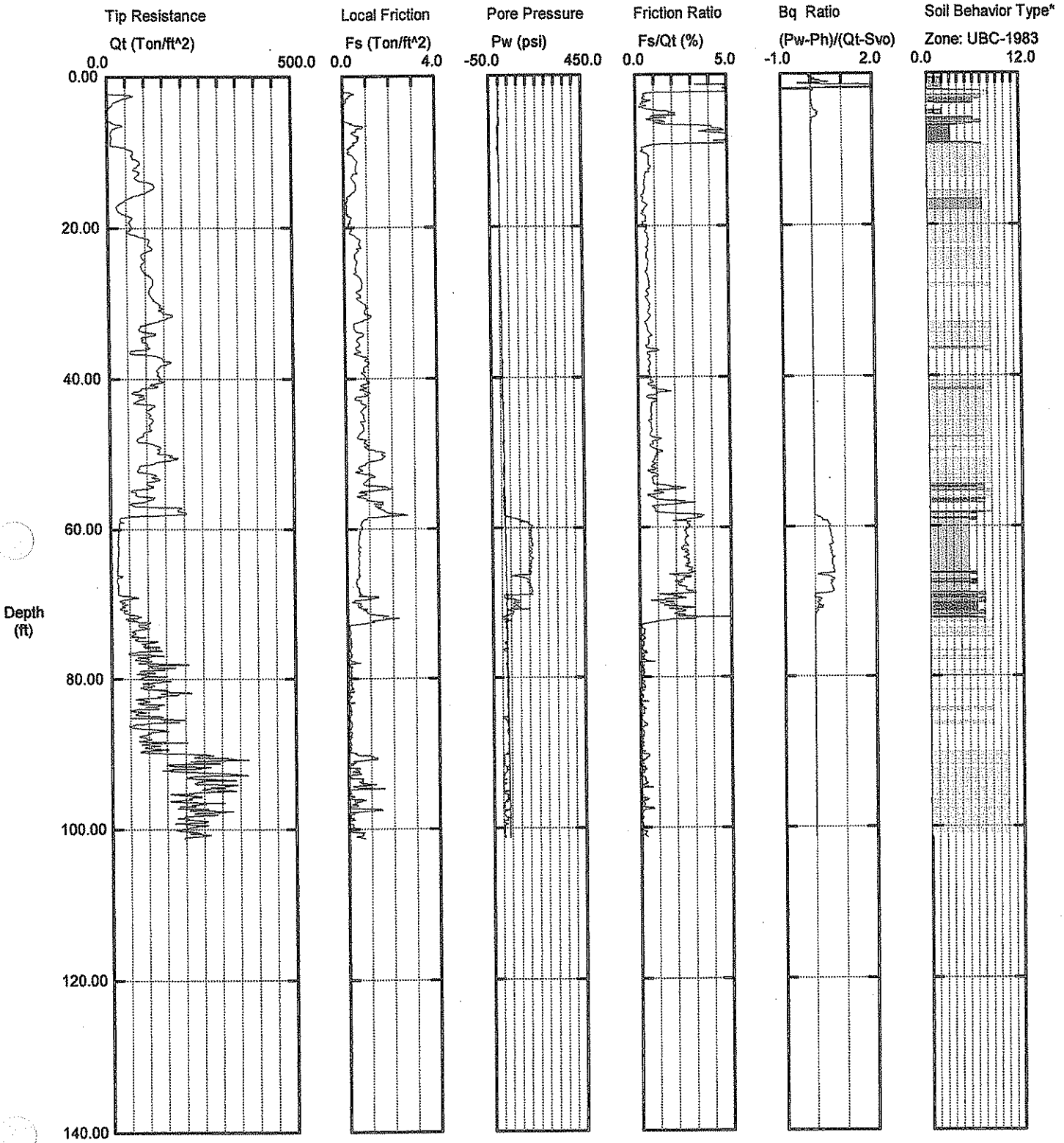
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences Inc.

Operator: DH
Sounding: MC-23 (Ele.= 9.04')
Cone Used: 10T4CHSEIS

CPT Date/Time: 02-11-03 12:11
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 101.31 feet

Depth Increment = 0.08 feet

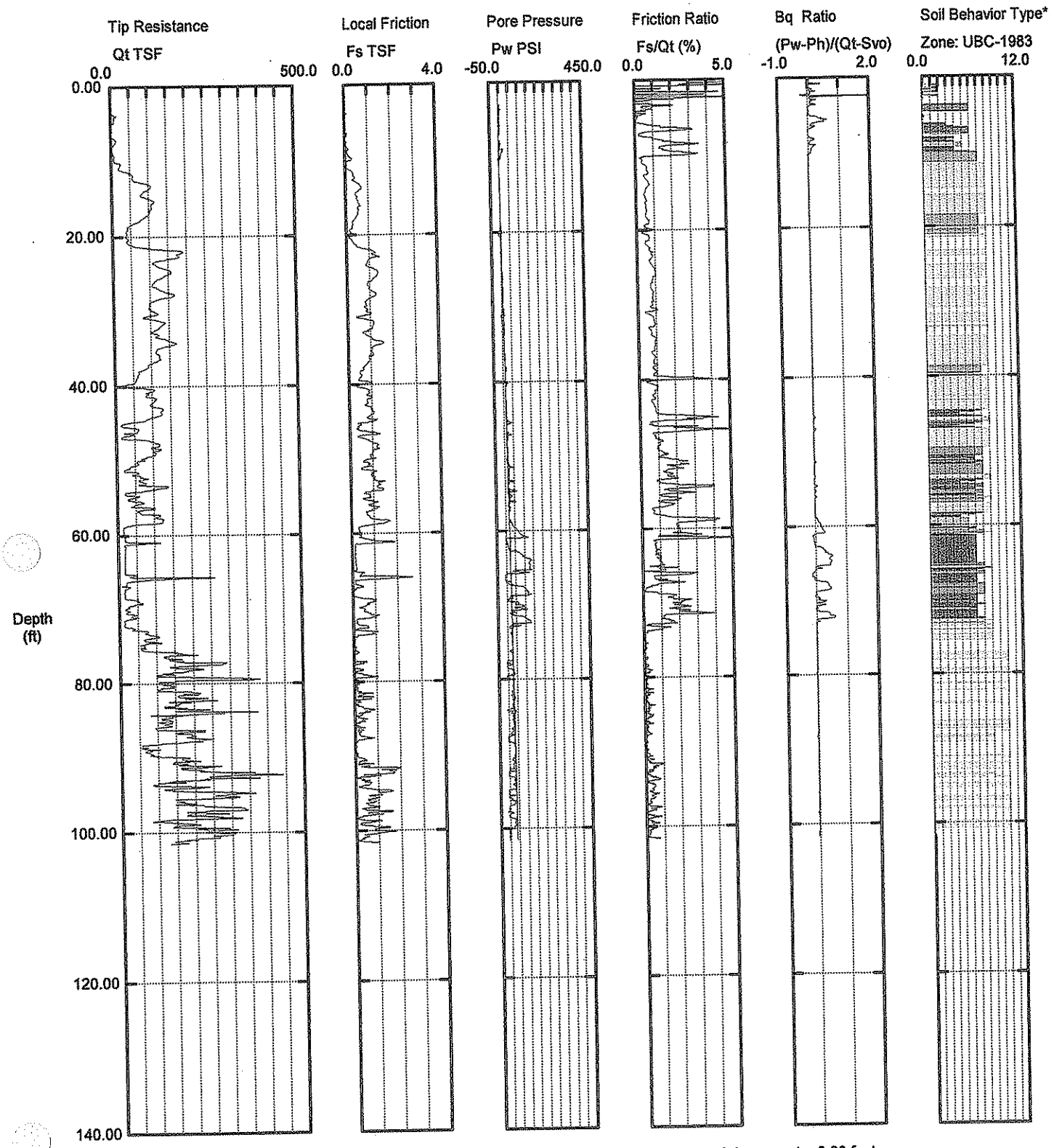
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: Peter
Sounding: MC-24 (Ele.= 9.79')
Cone Used: DTA0848

CPT Date/Time: 2/12/2003 8:46:53 AM
Location: Hogentogler
Job Number: Gilmerton Bridge



Maximum Depth = 101.61 feet

Depth Increment = 0.08 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

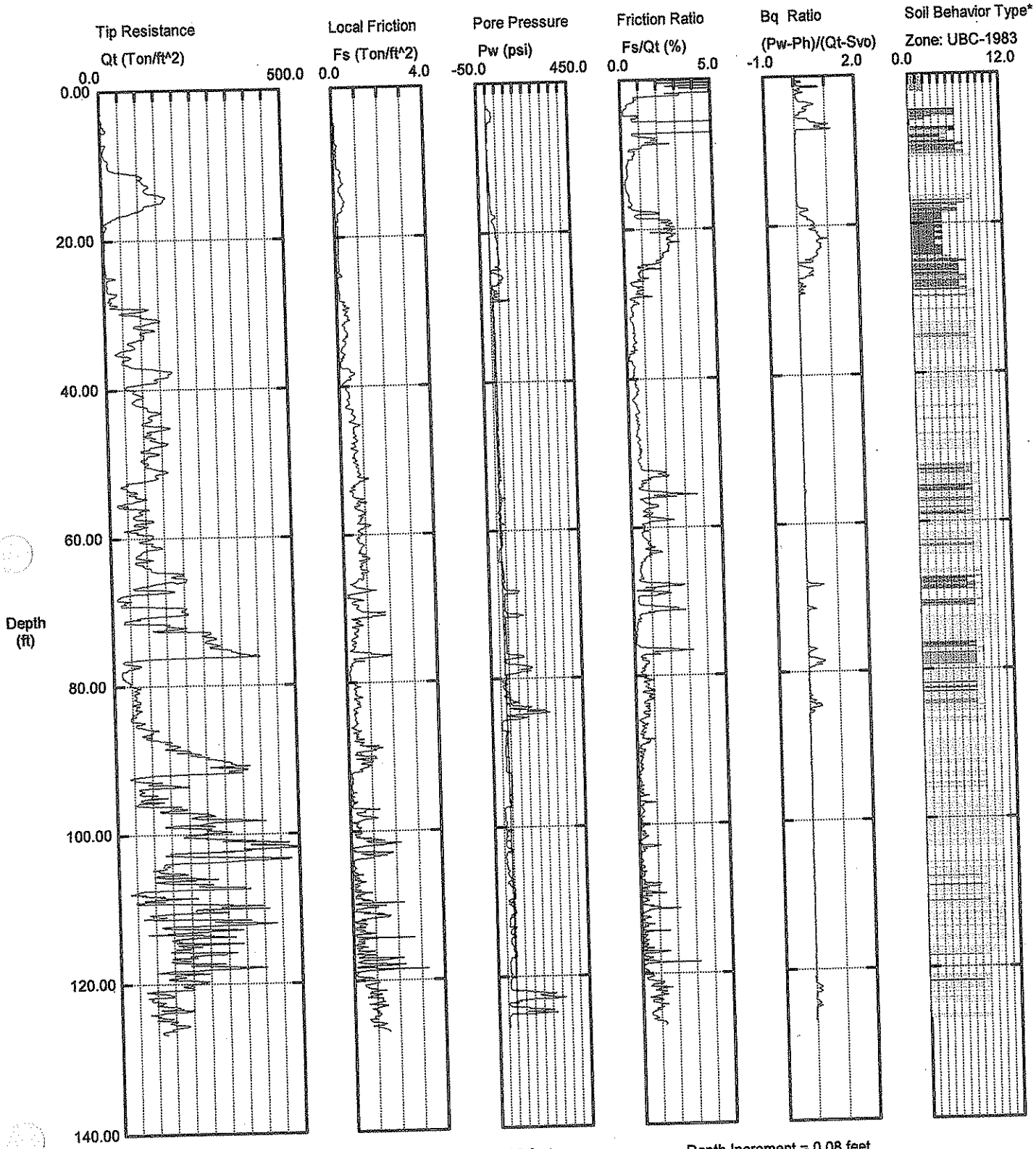
Footer1

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences Inc.

Operator: DH
Sounding: MC-25 (Ele.= 7.14')
Cone Used: 5T4CH

CPT Date/Time: 02-11-03 07:14
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 126.80 feet

Depth Increment = 0.08 feet

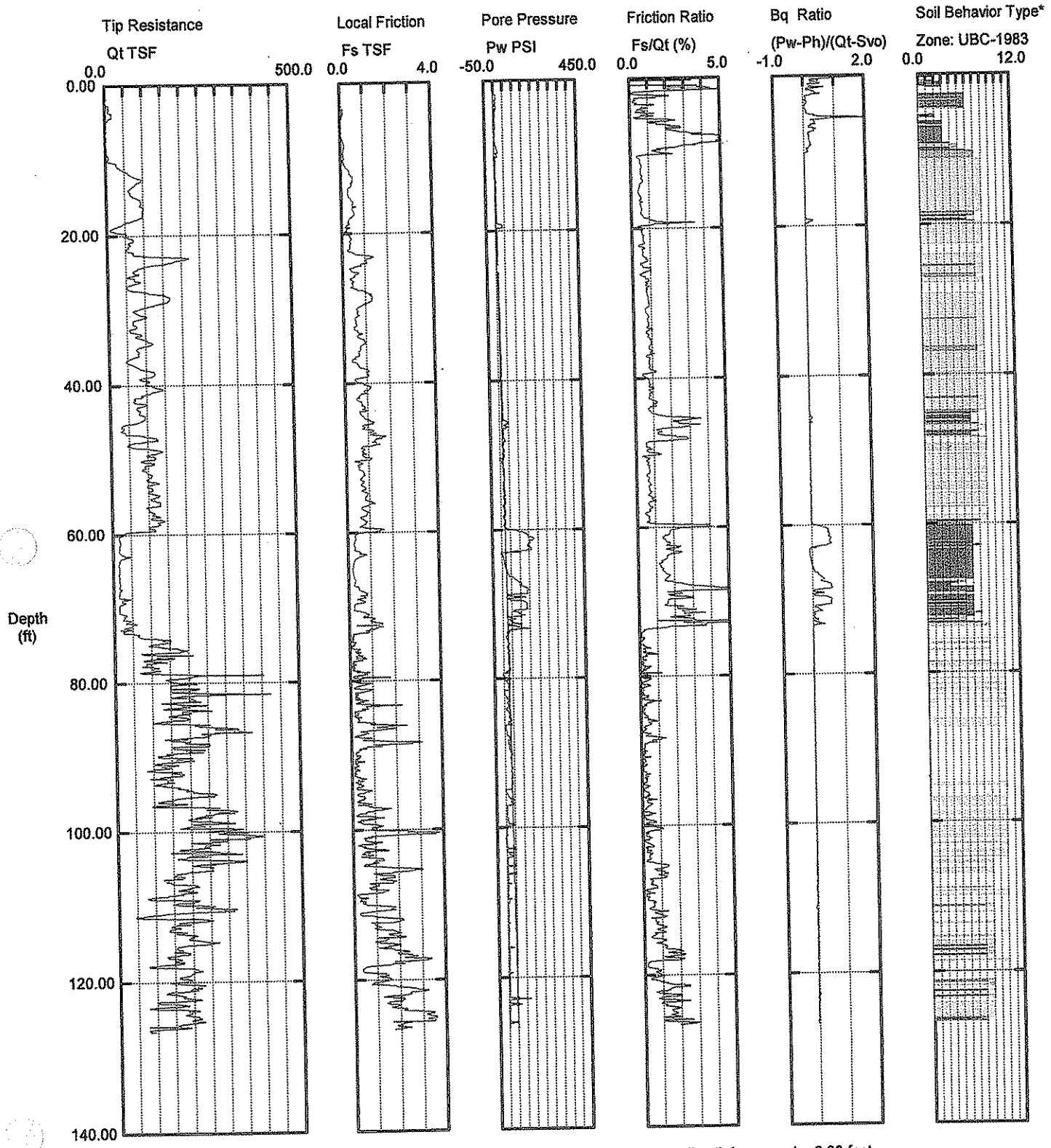
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-26 (Ele.= 9.61')
Cone Used: DTA0848

CPT Date/Time: 2/12/2003 10:32:32 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 126.64 feet

Depth Increment = 0.08 feet

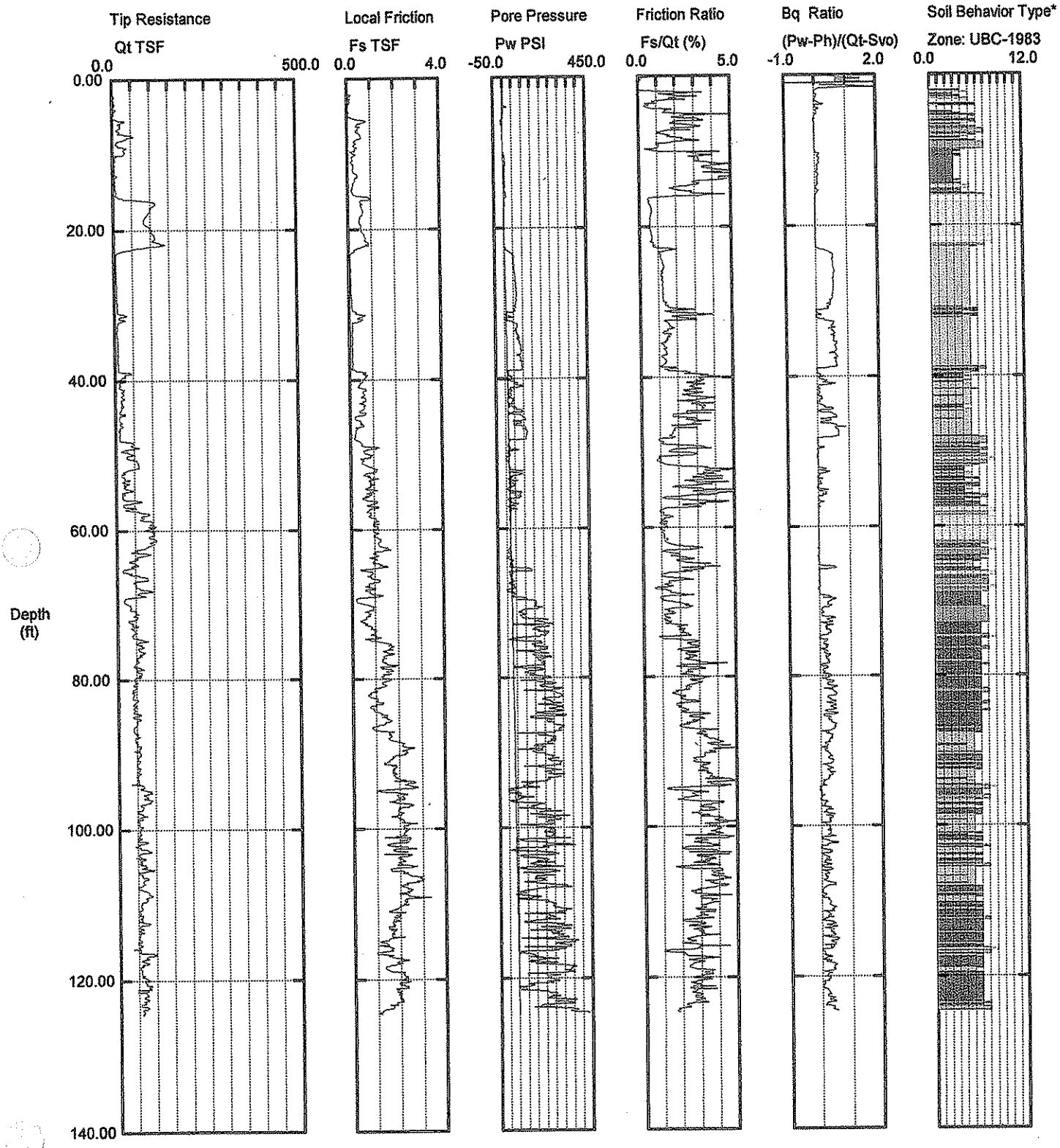
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Southern Earth Sciences, Inc.

Operator: DH
Sounding: MC-27 (Ele.= 8.51')
Cone Used: DTA0848

CPT Date/Time: 3/4/2003 10:02:34 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



Maximum Depth = 124.57 feet

Depth Increment = 0.08 feet

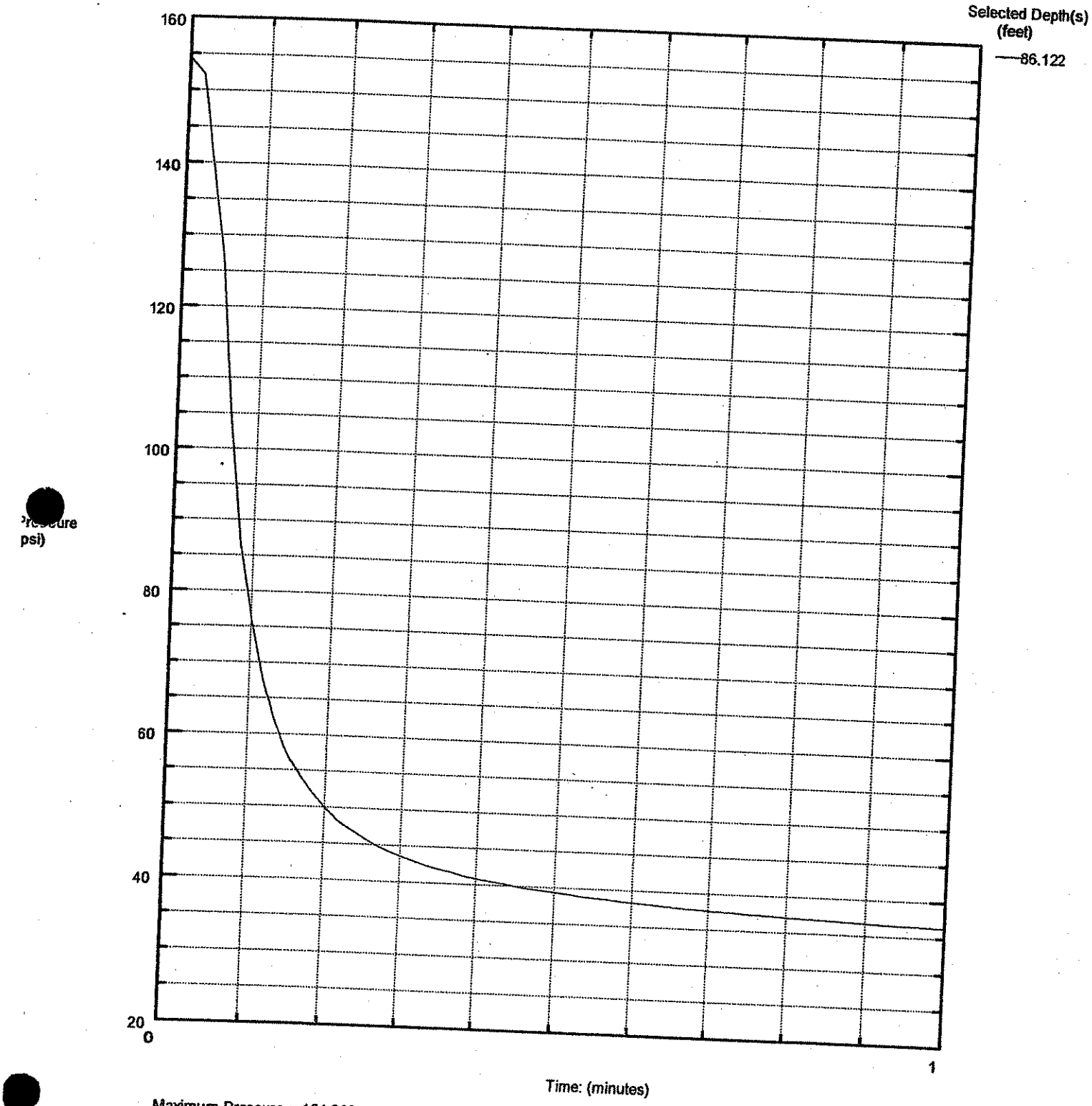
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

DISSIPATION DATA

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-4
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 8:41:15 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



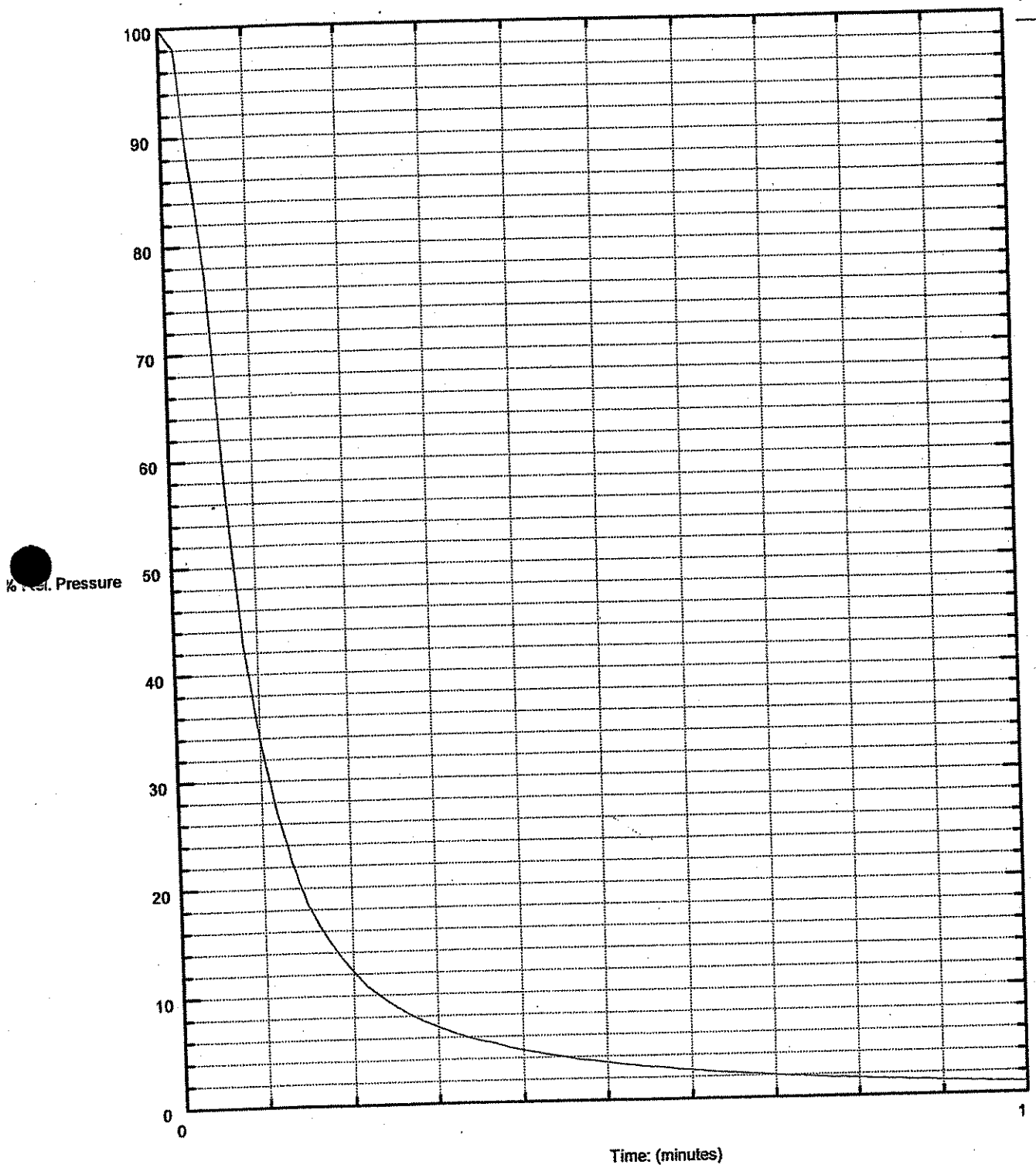
Maximum Pressure = 154.393 psi
Hydrostatic Pressure = 35.213 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-4
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 8:41:15 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

Selected Depth(s) (feet)
86.122

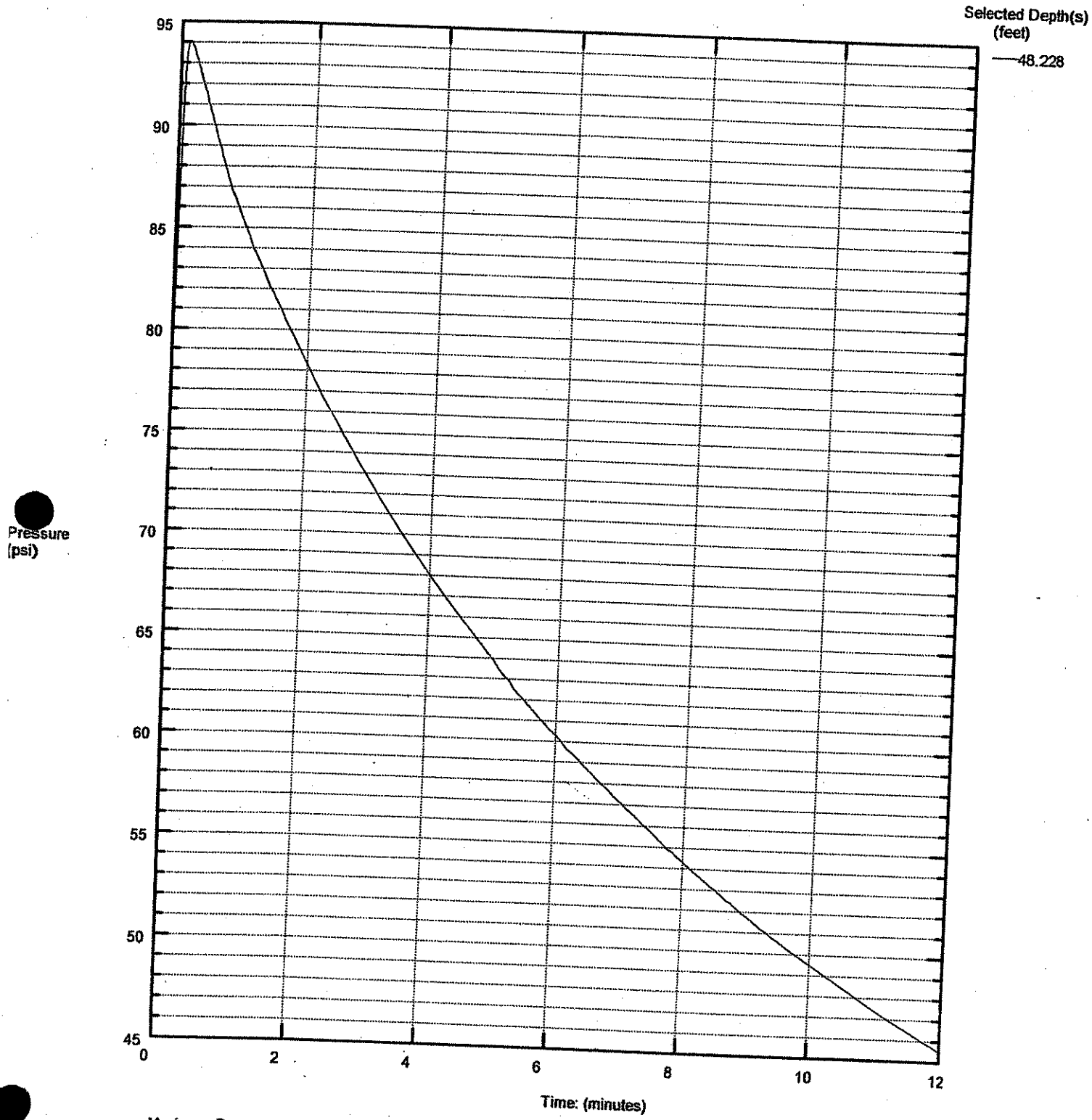


Maximum Pressure = 154.393 psi
Hydrostatic Pressure = 35.213 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-5
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 10:40:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

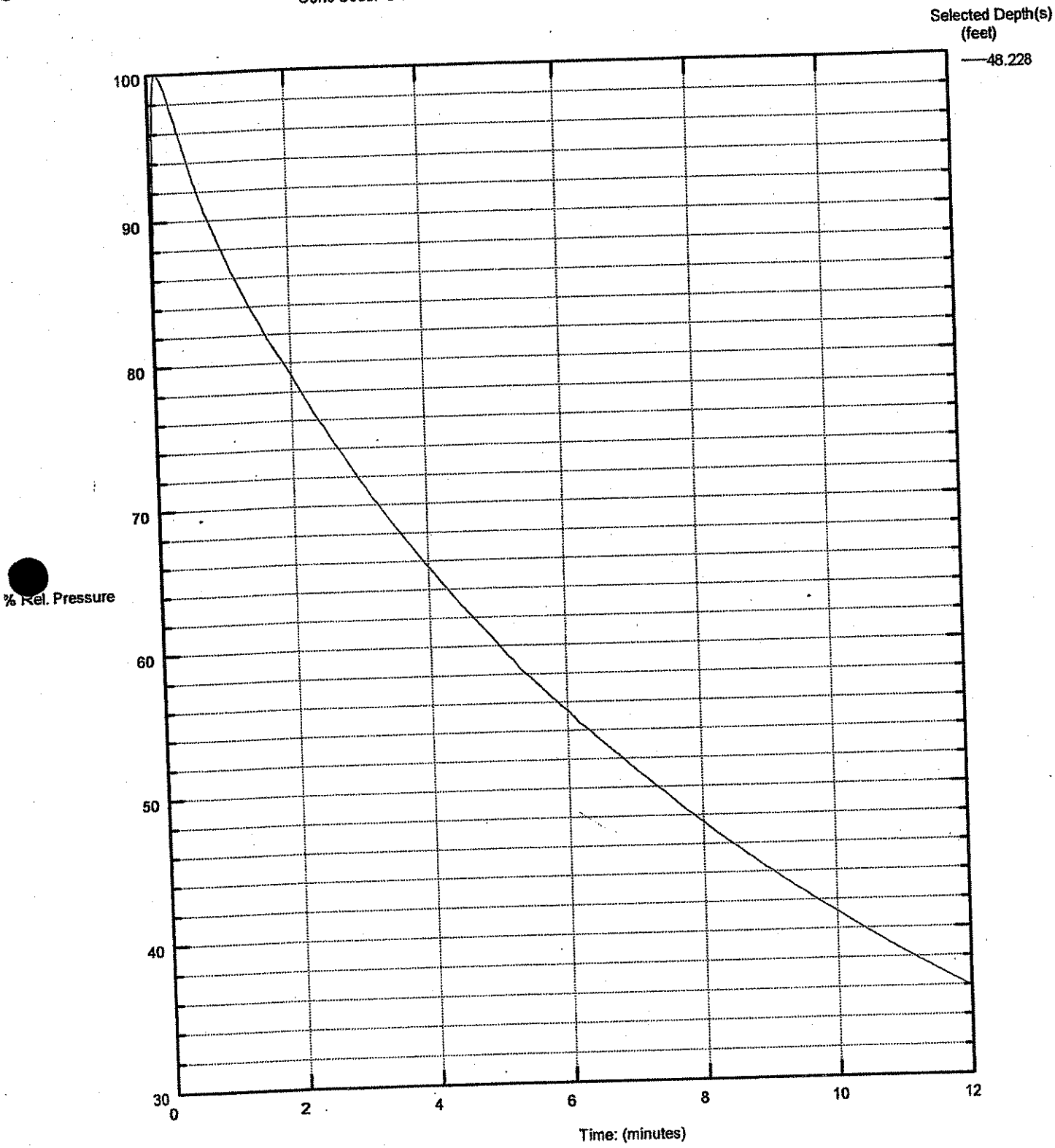


Maximum Pressure = 94.053 psi
Hydrostatic Pressure = 18.339 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-5
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 10:40:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



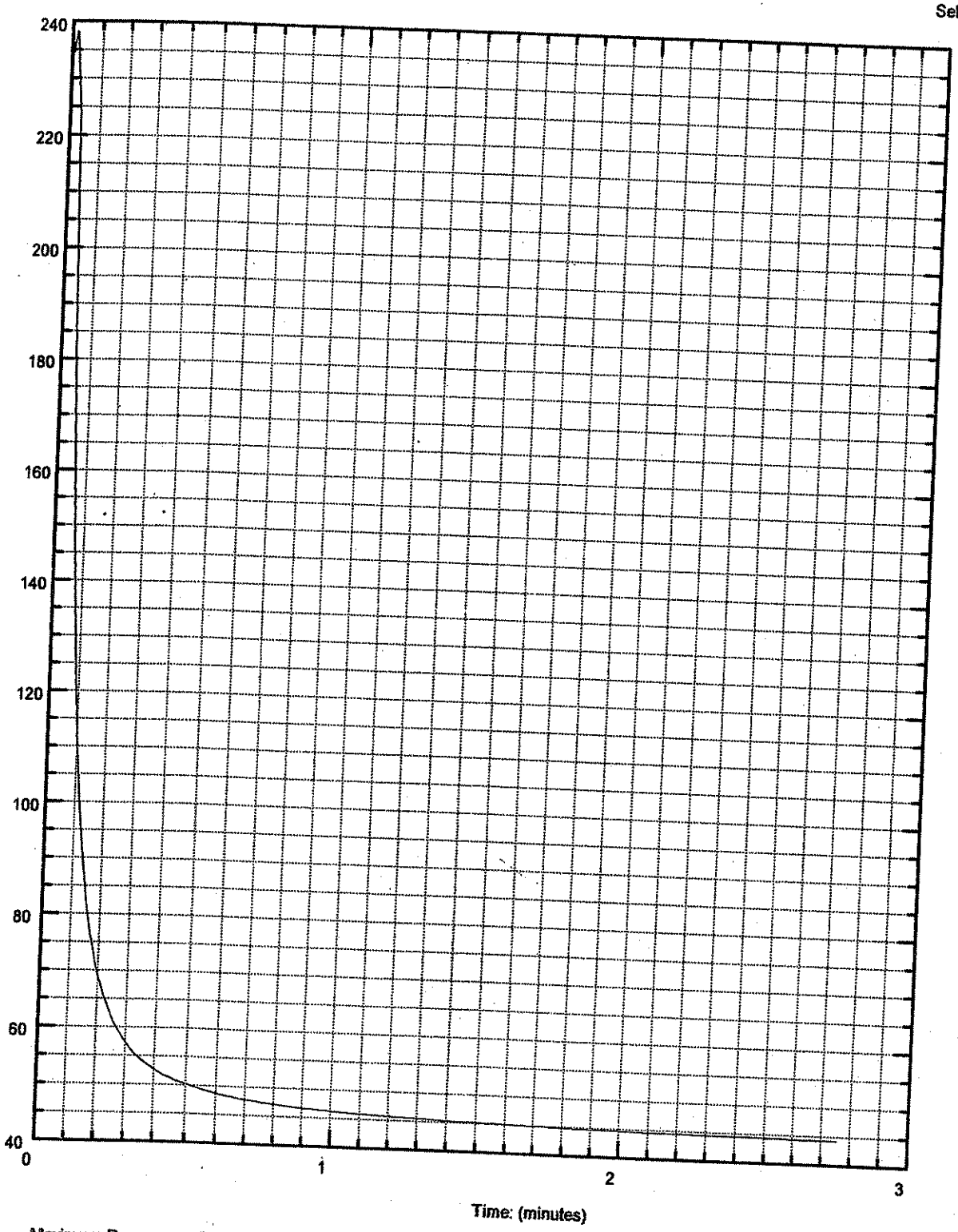
Maximum Pressure = 94.053 psi
Hydrostatic Pressure = 18.339 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-5
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 10:40:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

Selected Depth(s) (feet)
109.777



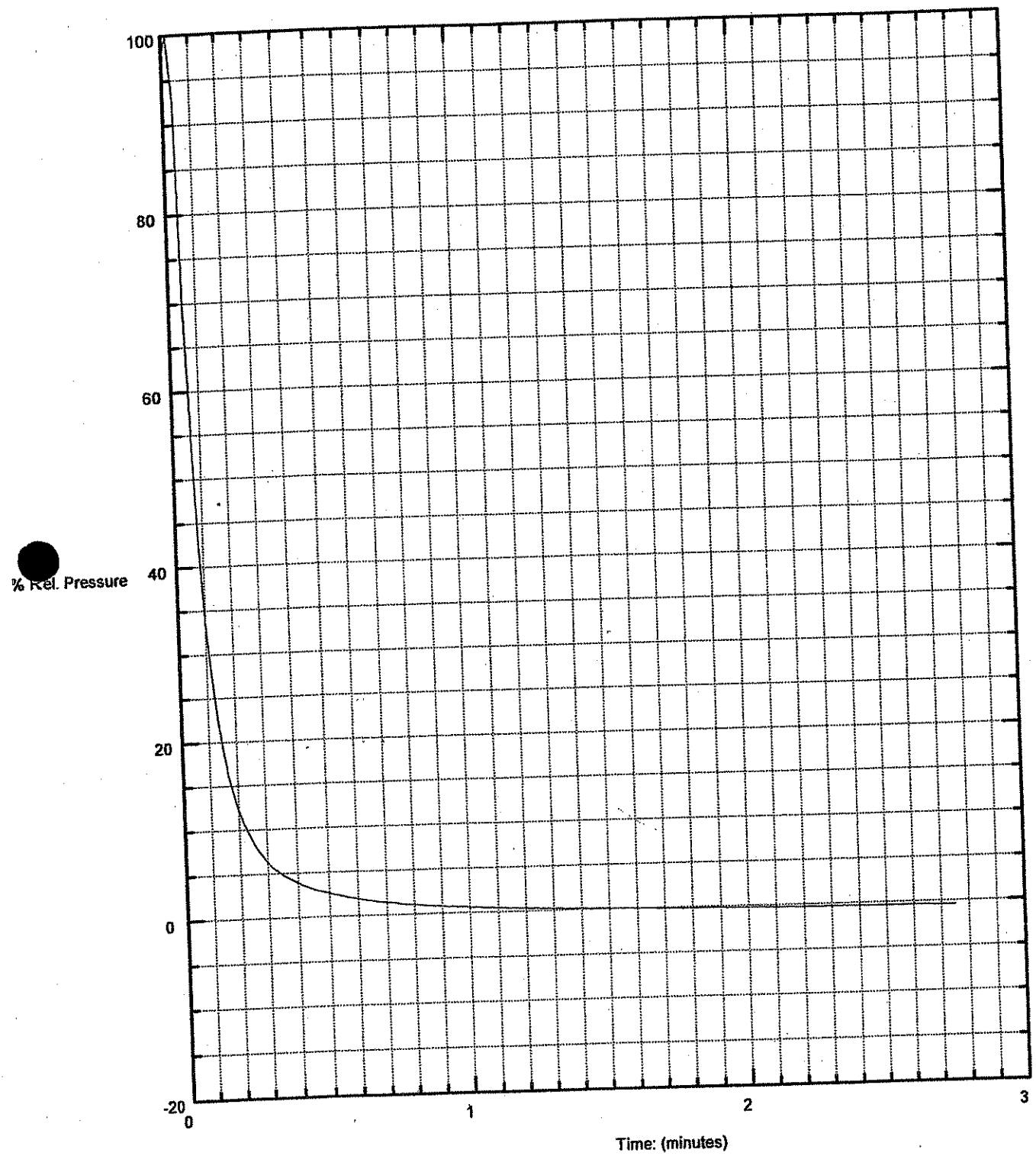
Maximum Pressure = 238.21 psi
Hydrostatic Pressure = 45.052 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-5
Cone Used: DSA0825

CPT Date/Time: 3/3/2003 10:40:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

Selected Depth(s) (feet)
109.777

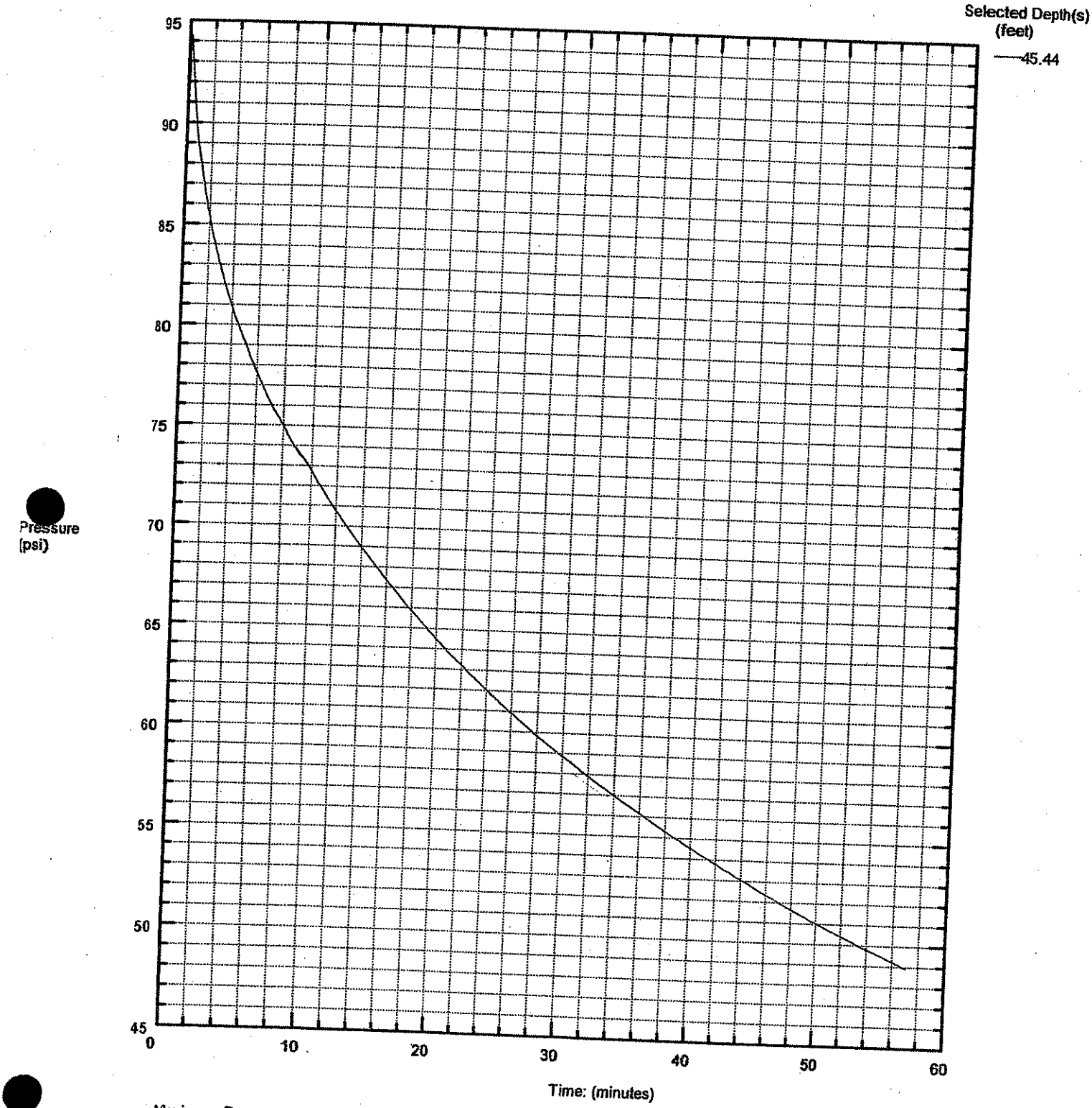


Maximum Pressure = 238.21 psi
Hydrostatic Pressure = 45.052 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-6
Cone Used: DSA0807

CPT Date/Time: 2/15/2003 9:09:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

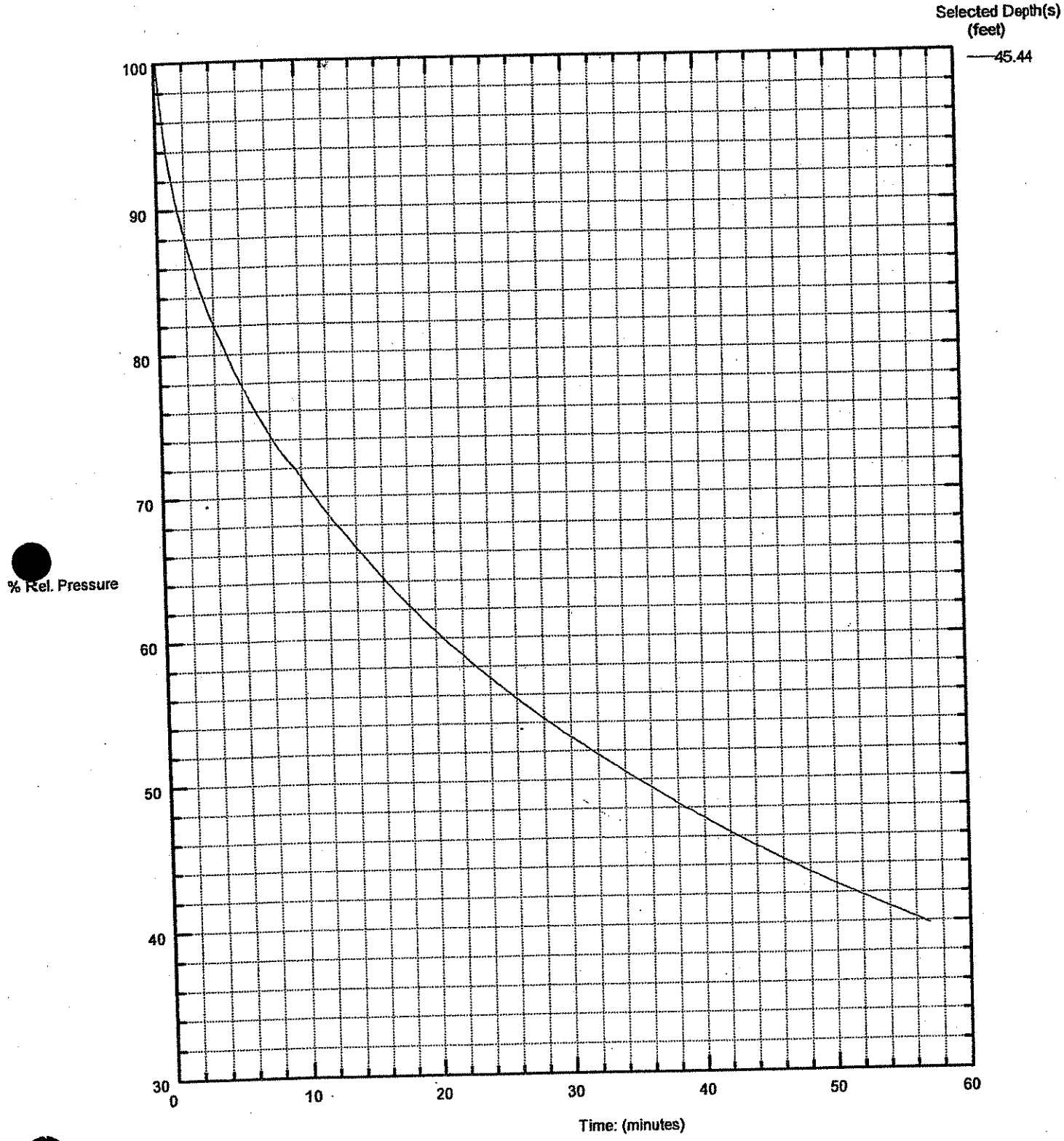


Maximum Pressure = 94.304 psi
Hydrostatic Pressure = 18.867 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-6
Cone Used: DSA0807

CPT Date/Time: 2/15/2003 9:09:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



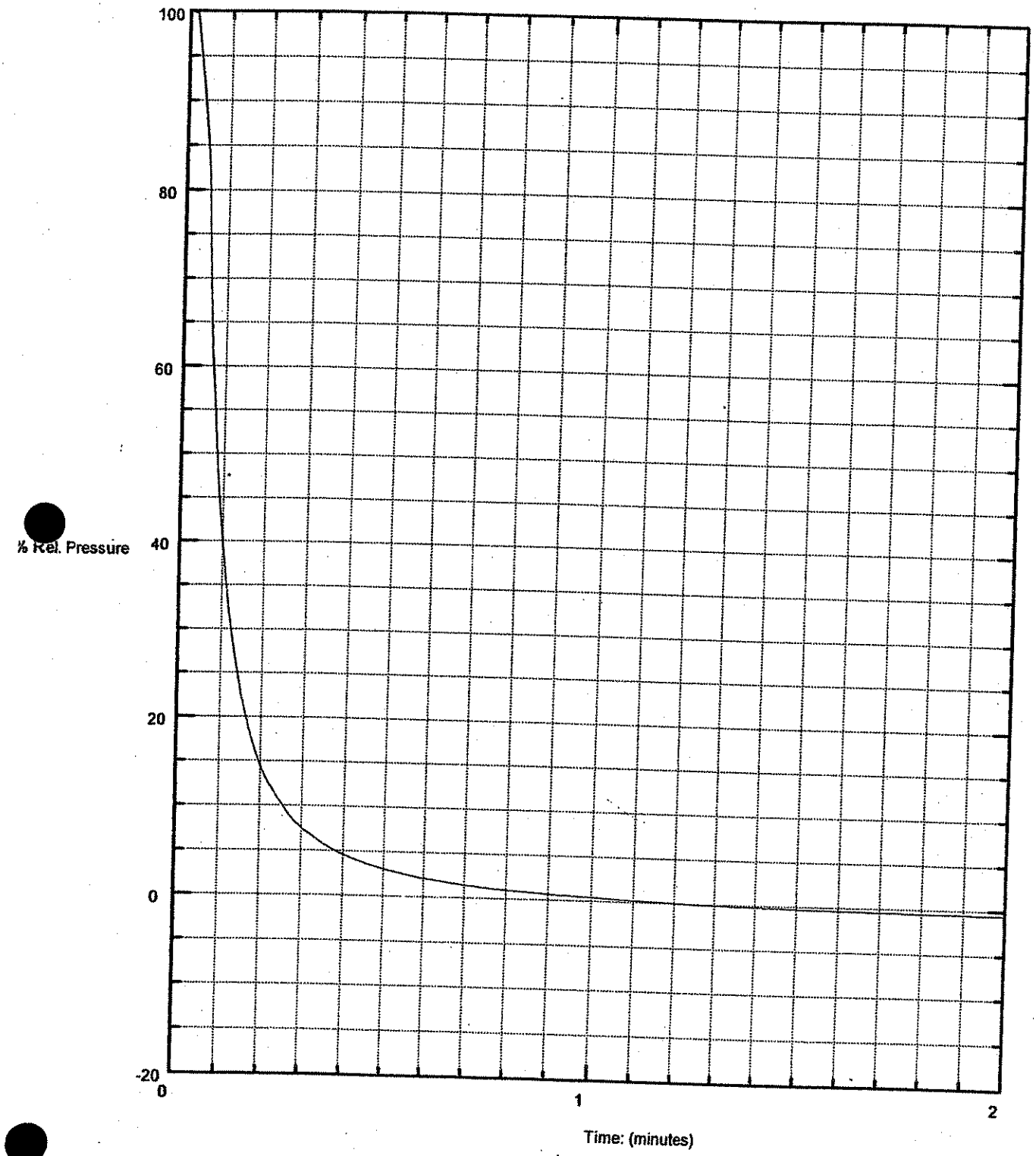
Maximum Pressure = 94.304 psi
Hydrostatic Pressure = 18.867 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-6
Cone Used: DSA0807

CPT Date/Time: 2/15/2003 9:09:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

Selected Depth(s) (feet)
105.315



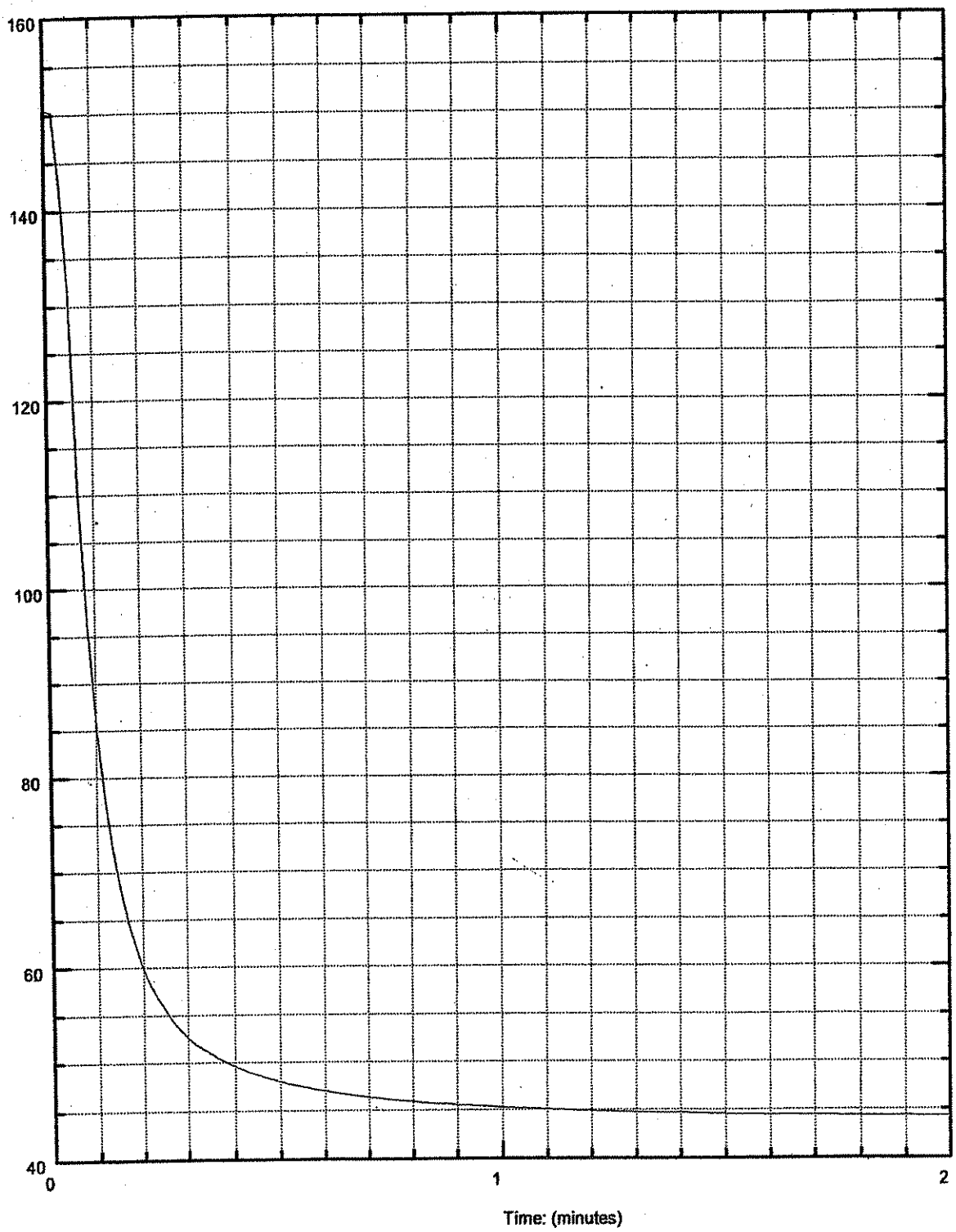
Maximum Pressure = 150.528 psi
Hydrostatic Pressure = 44.852 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-6
Cone Used: DSA0807

CPT Date/Time: 2/15/2003 9:09:19 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

Selected Depth(s) (feet)
105.315

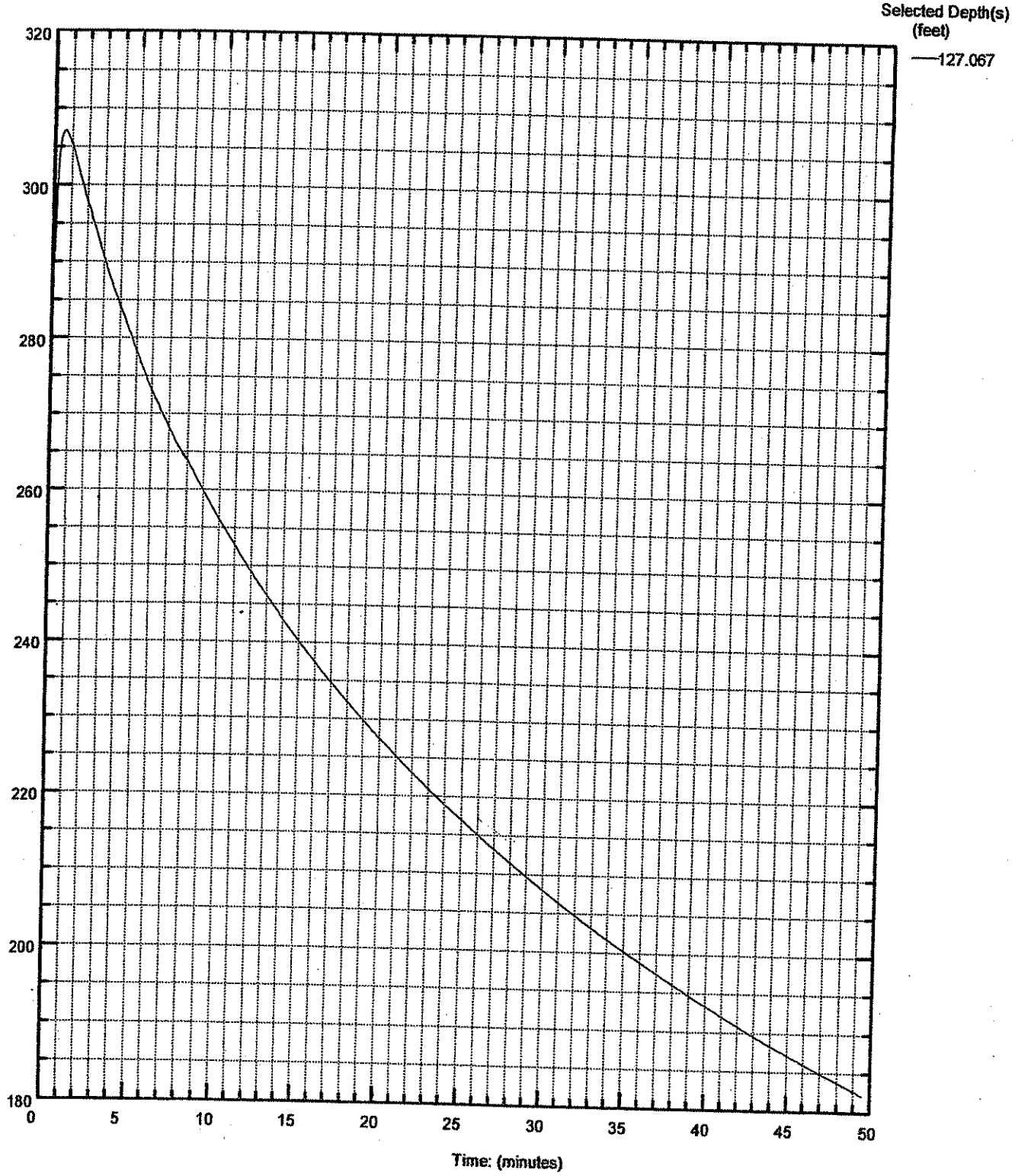


Maximum Pressure = 150.528 psi
Hydrostatic Pressure = 44.852 psi

Southern Earth Sciences, Inc.

Operator DH
Sounding: MC-15
Cone Used: DSA0825

CPT Date/Time: 2/19/2003 10:13:35 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

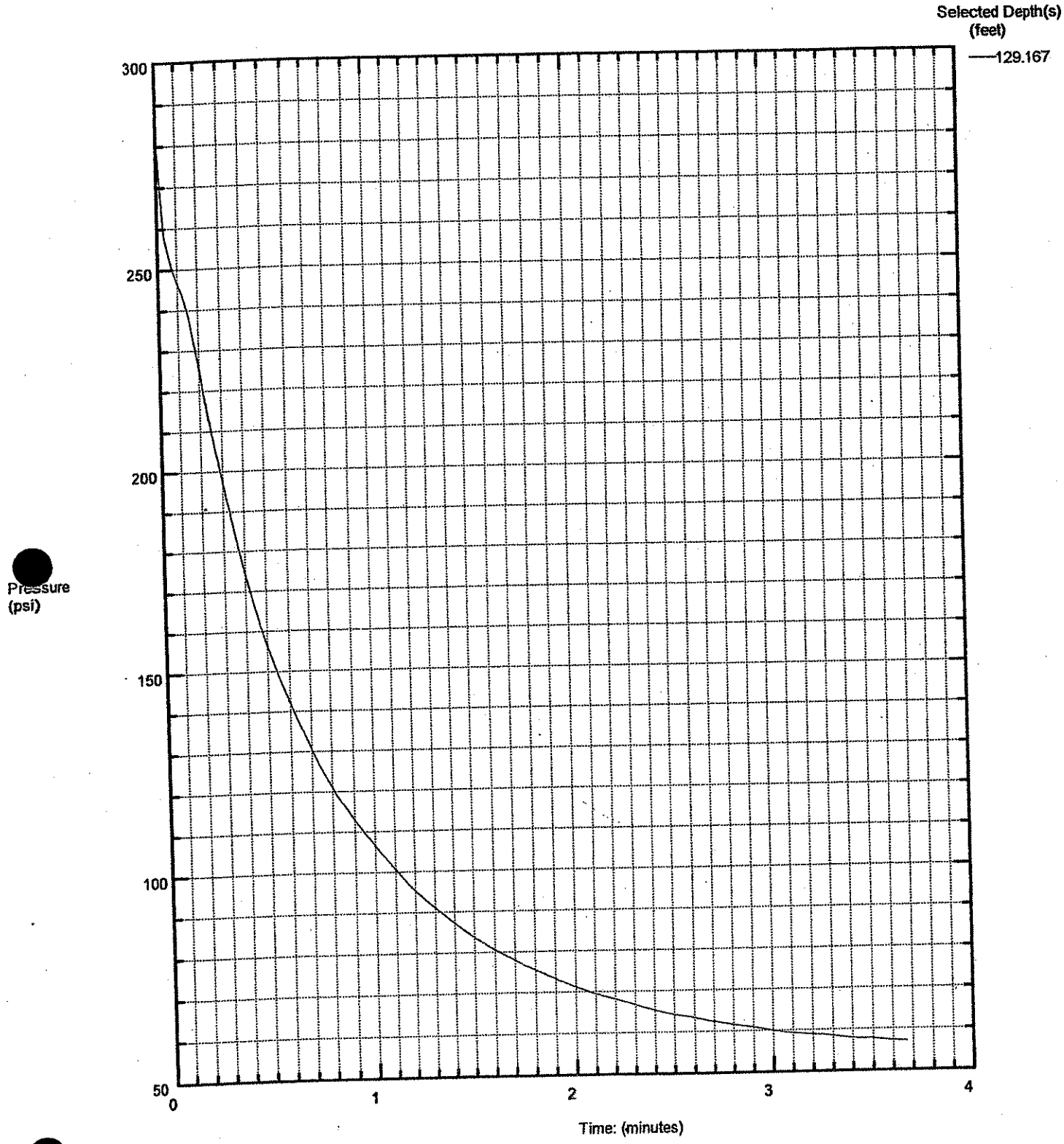


Maximum Pressure = 307.089 psi
Hydrostatic Pressure = 70.326 psi

Southern Earth Sciences Inc.

Operator DH
Sounding: MC-26
Cone Used: DTA0848

CPT Date/Time: 2/12/2003 10:32:32 AM
Location: GILMERTON BRIDGE
Job Number: 03-029

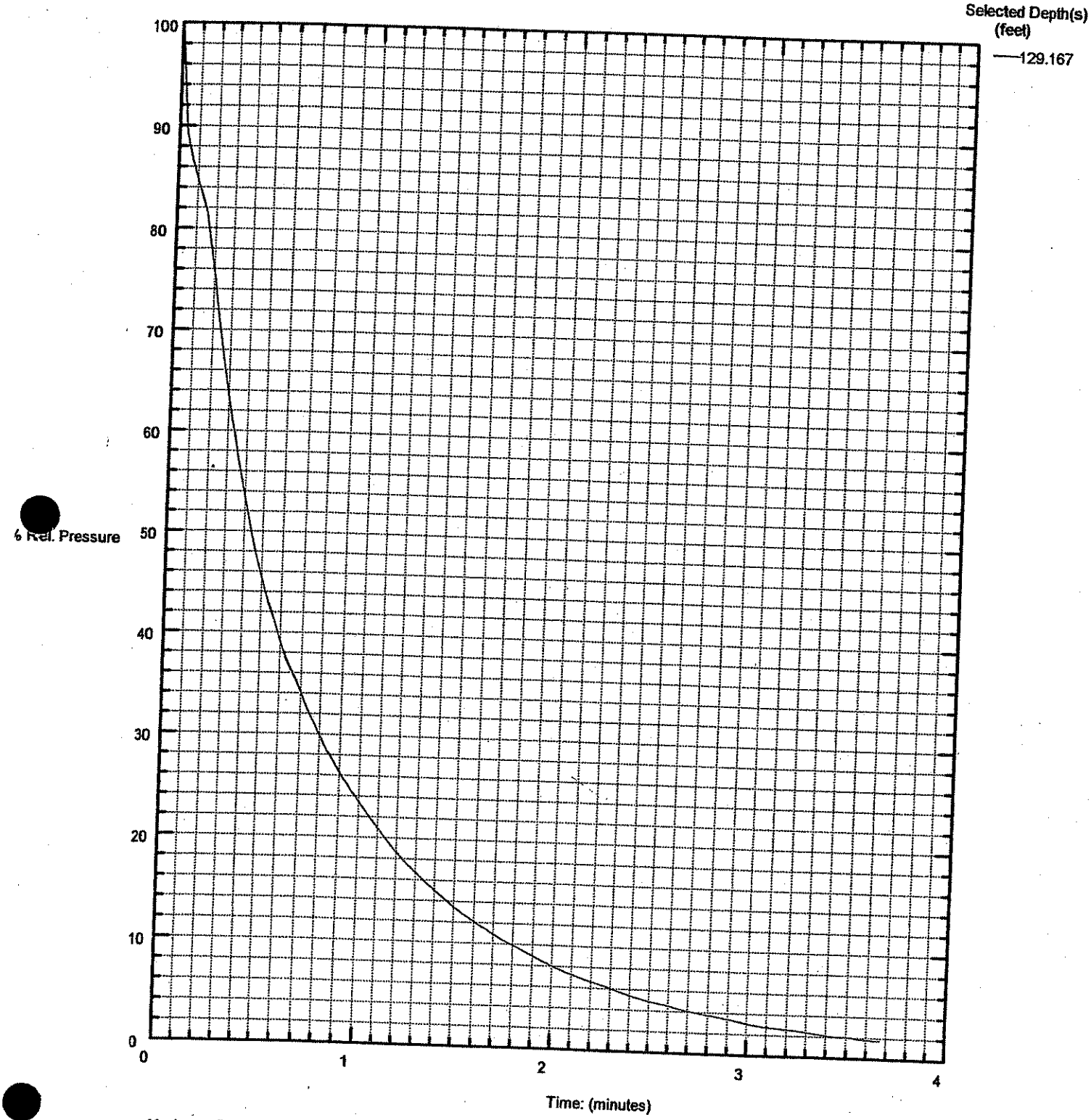


Maximum Pressure = 281.422 psi
Hydrostatic Pressure = 52.997 psi

Southern Earth Sciences Inc.

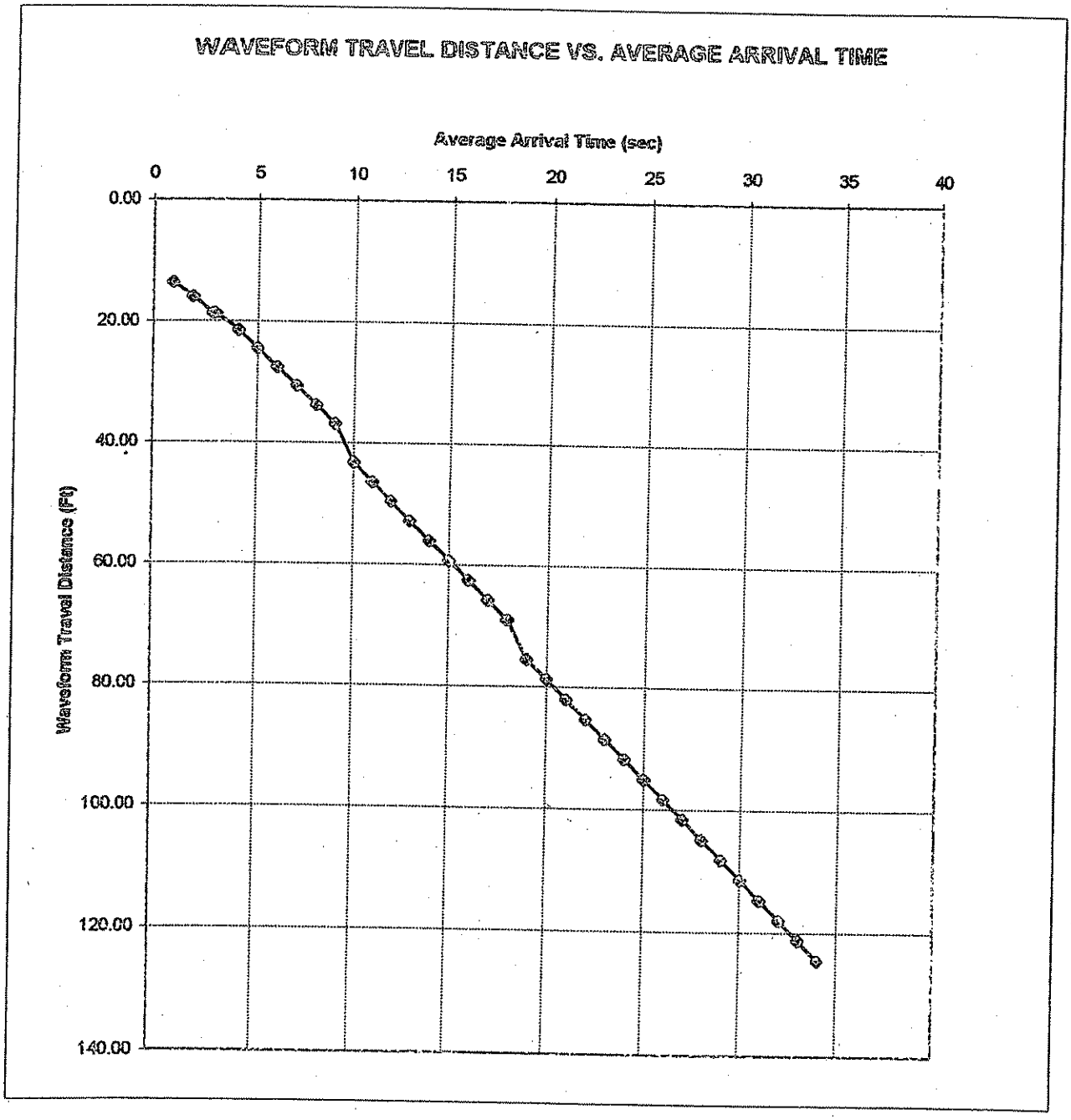
Operator DH
Sounding: MC-26
Cone Used: DTA0848

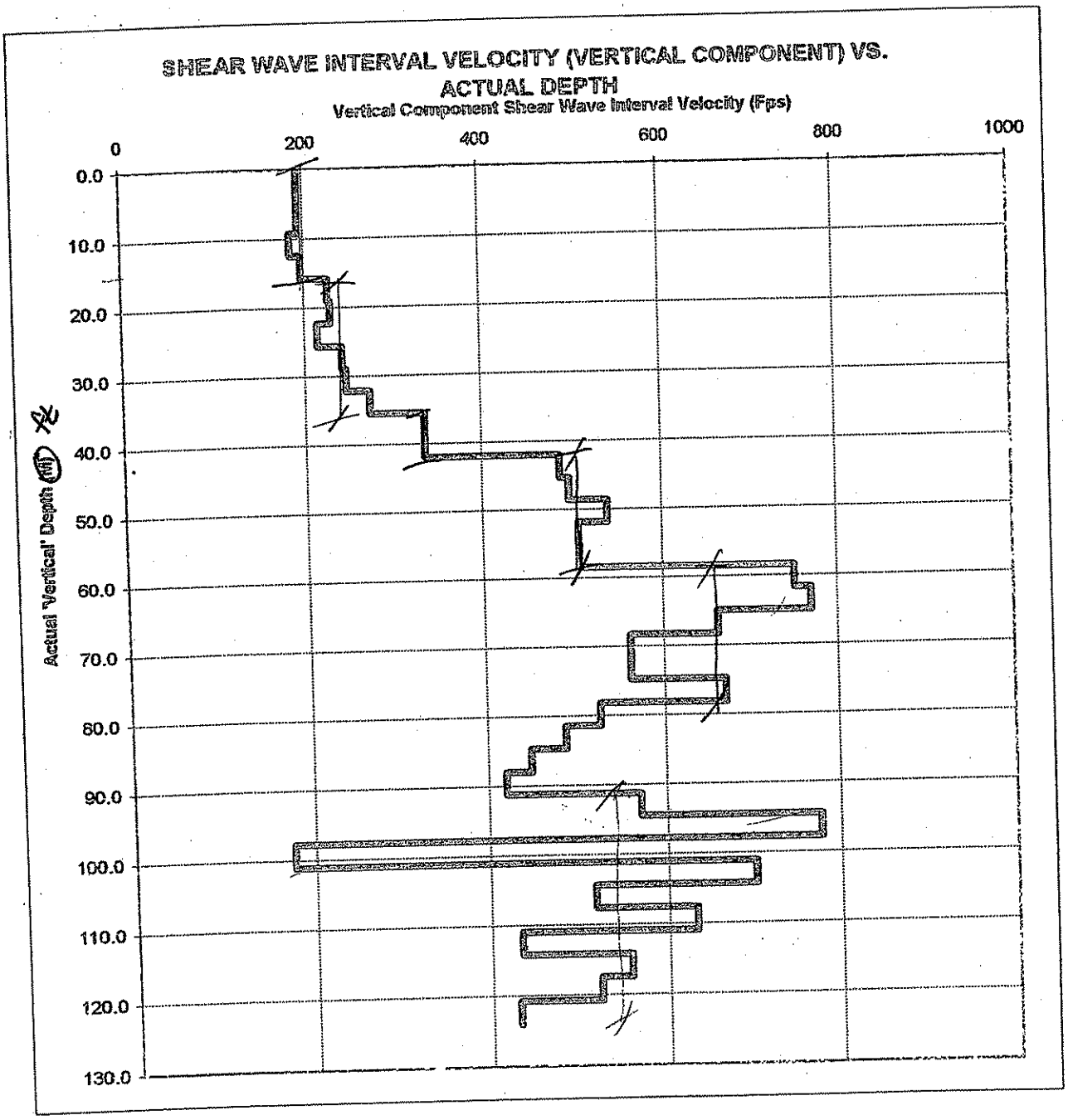
CPT Date/Time: 2/12/2003 10:32:32 AM
Location: GILMERTON BRIDGE
Job Number: 03-029



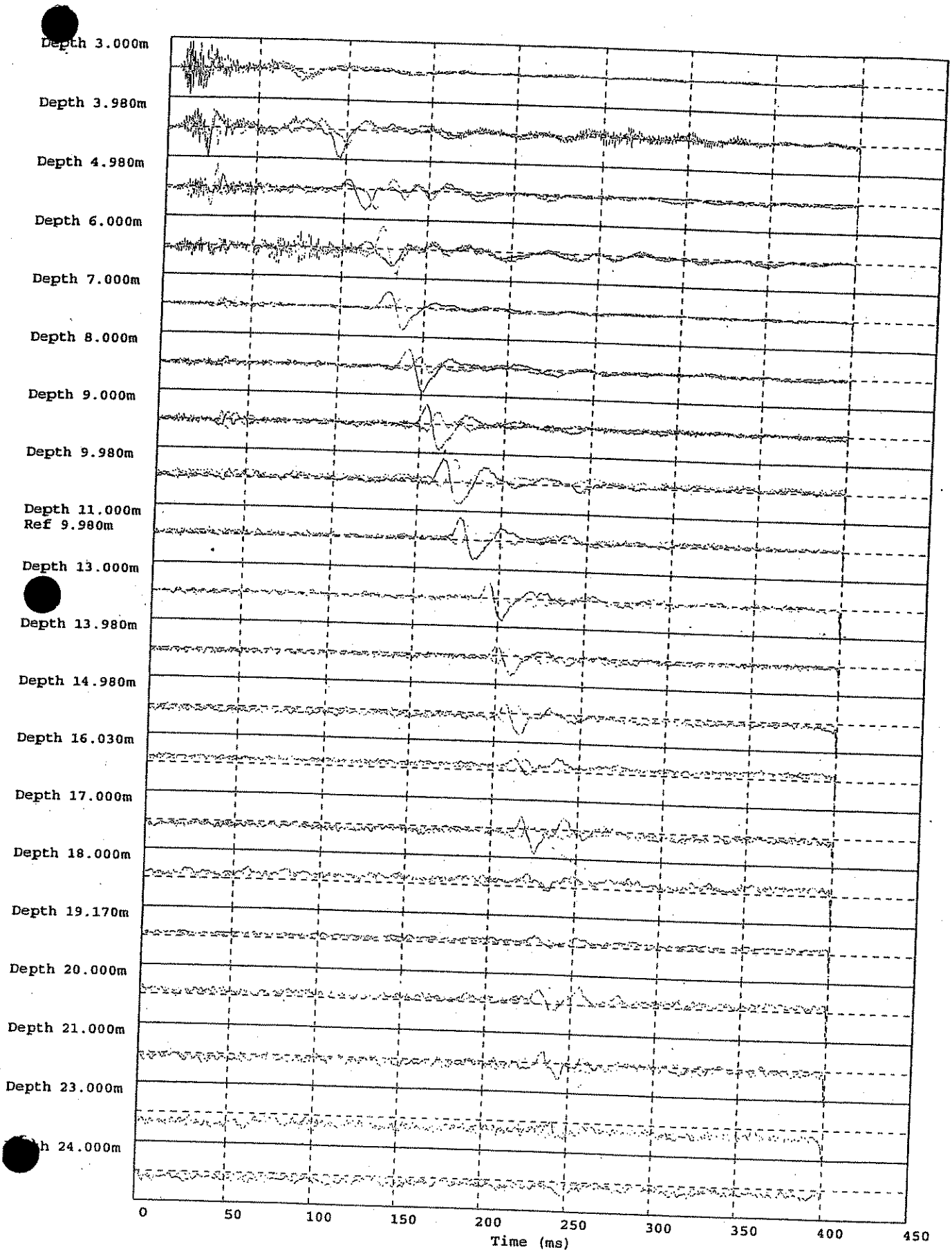
Maximum Pressure = 281.422 psi
Hydrostatic Pressure = 52.997 psi

SEISMIC DATA


WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME
Average Arrival Time (sec)
0
5
10
15
20
25
30
35
40
Waveform Travel Distance (Ft)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00

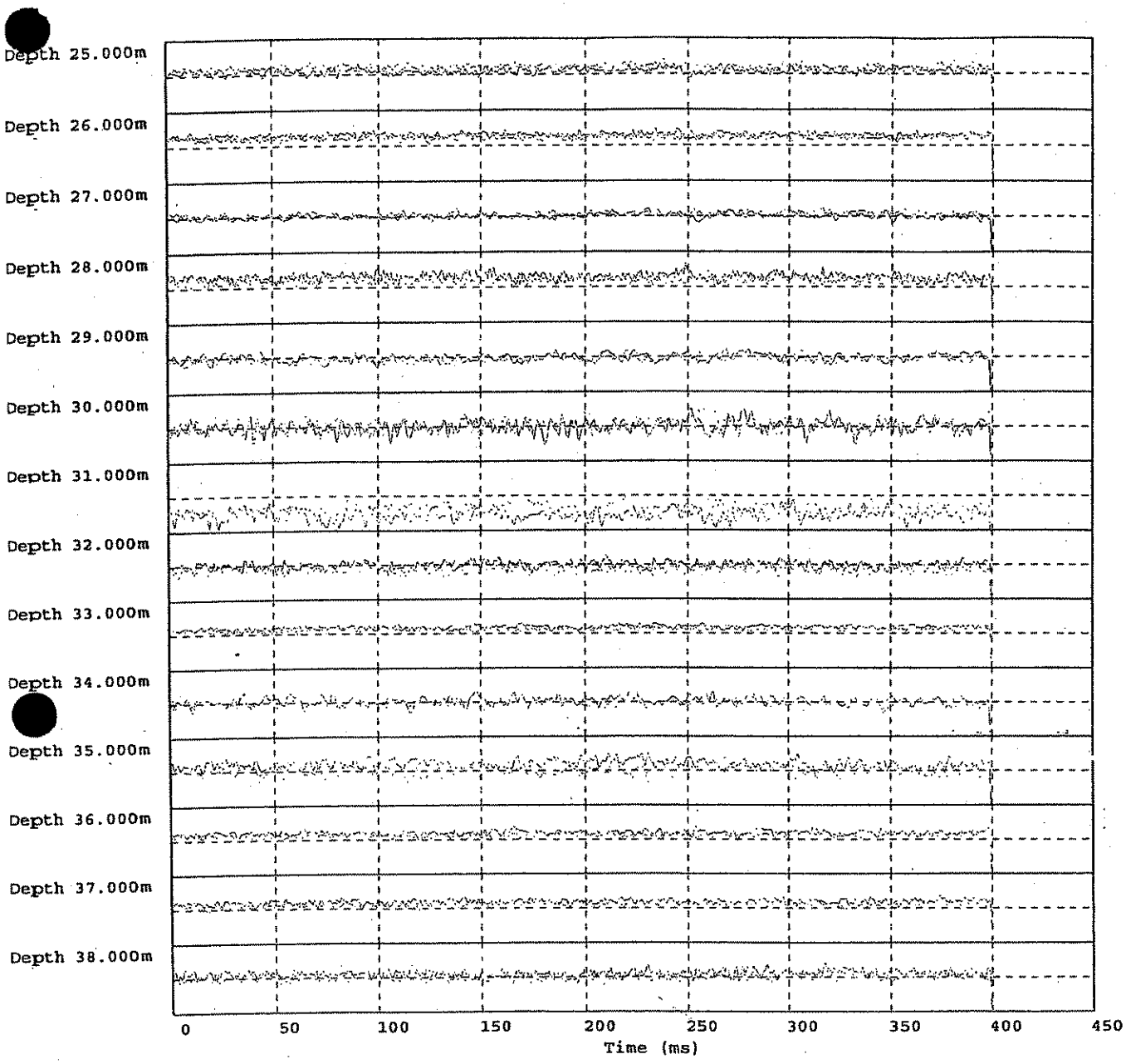

SHEAR WAVE INTERVAL VELOCITY (VERTICAL COMPONENT) VS.
ACTUAL DEPTH
Vertical Component Shear Wave Interval Velocity (Fps)
0
200
400
600
800
1000
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
120.0
130.0
Actual 'Vertical' Depth (ft)

Southern Earth Sciences Inc.
MC-3

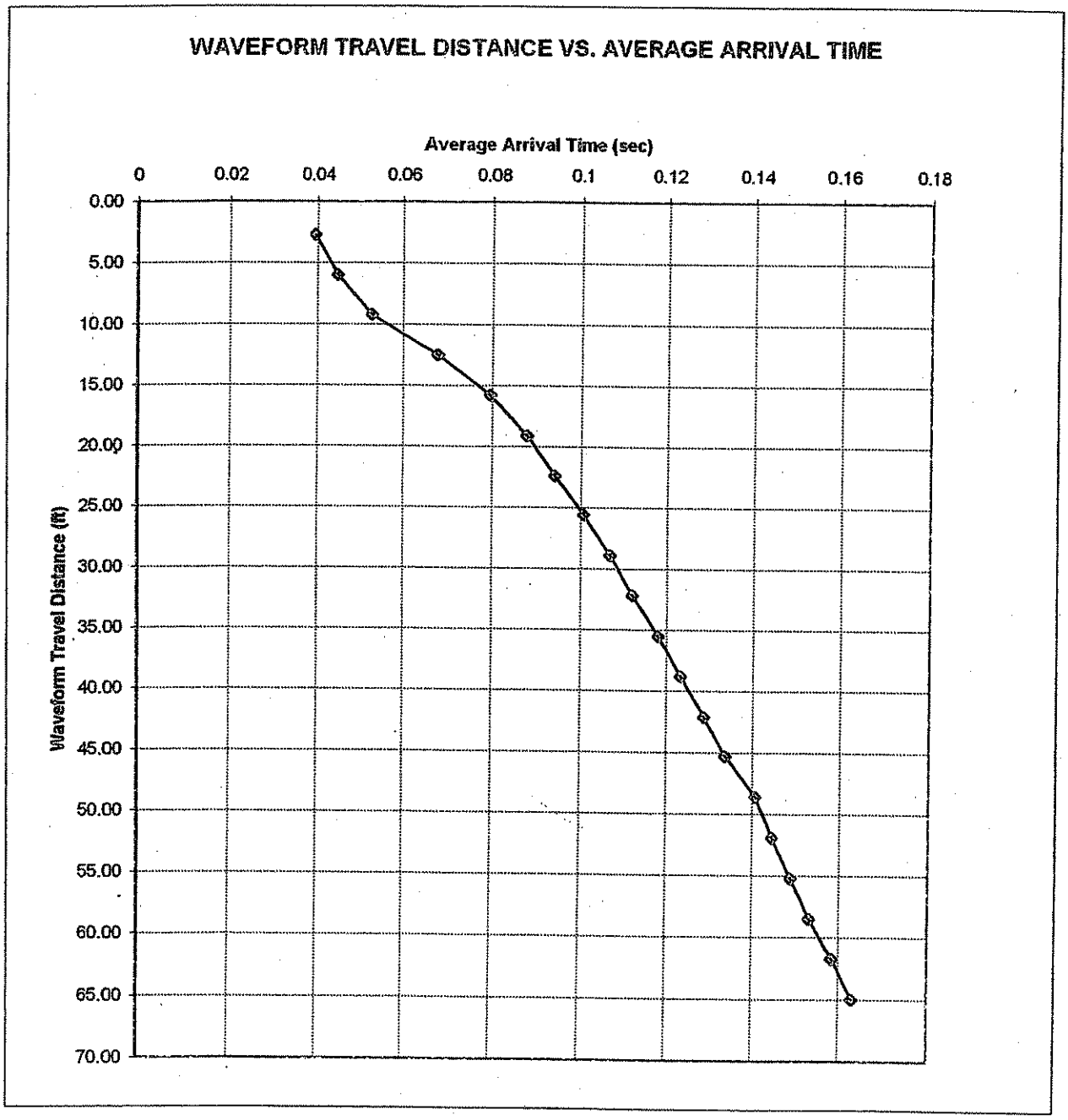


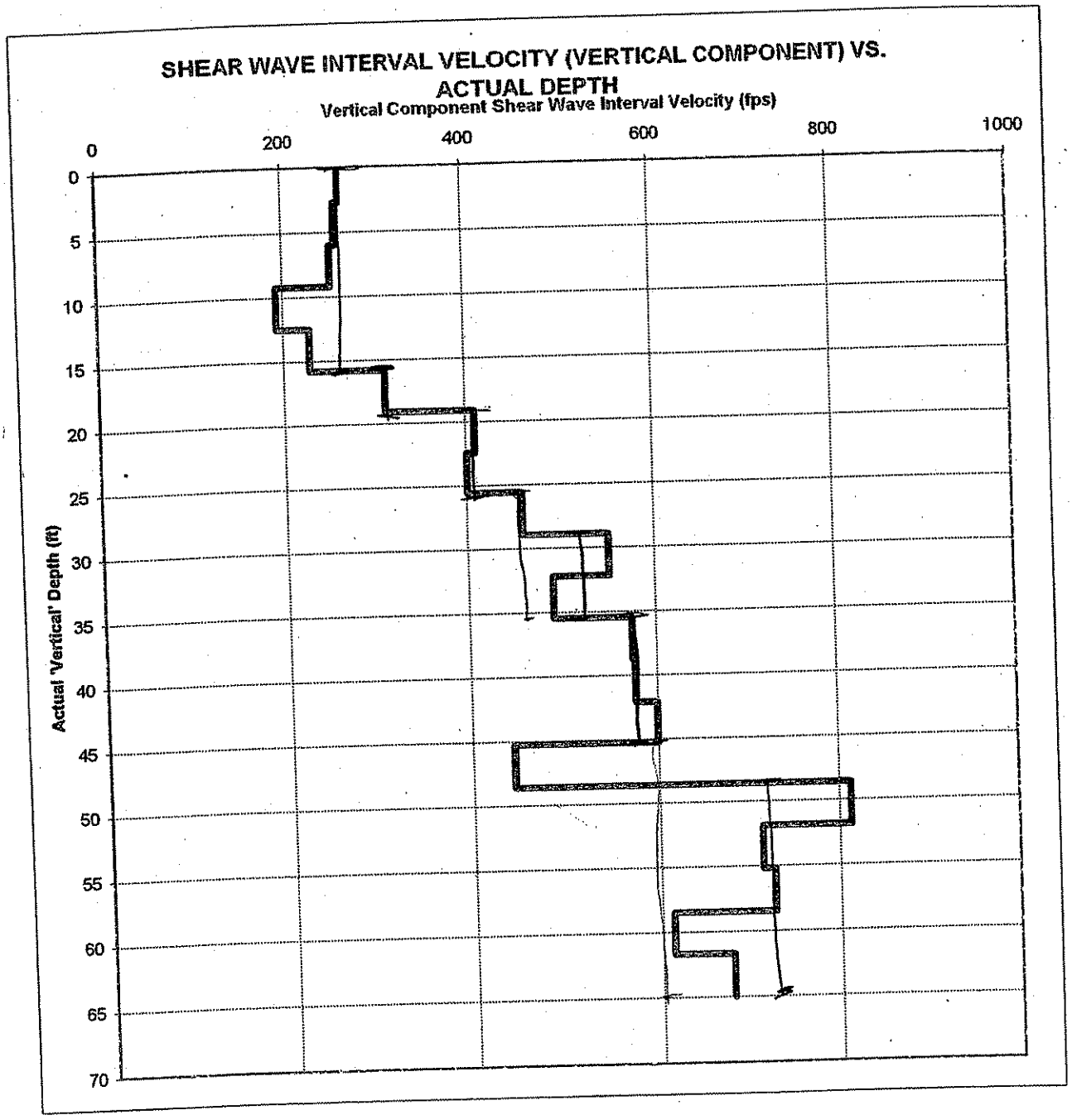
Hammer to Rod String Distance 3.2(m)

Southern Earth Sciences Inc.
MC-3

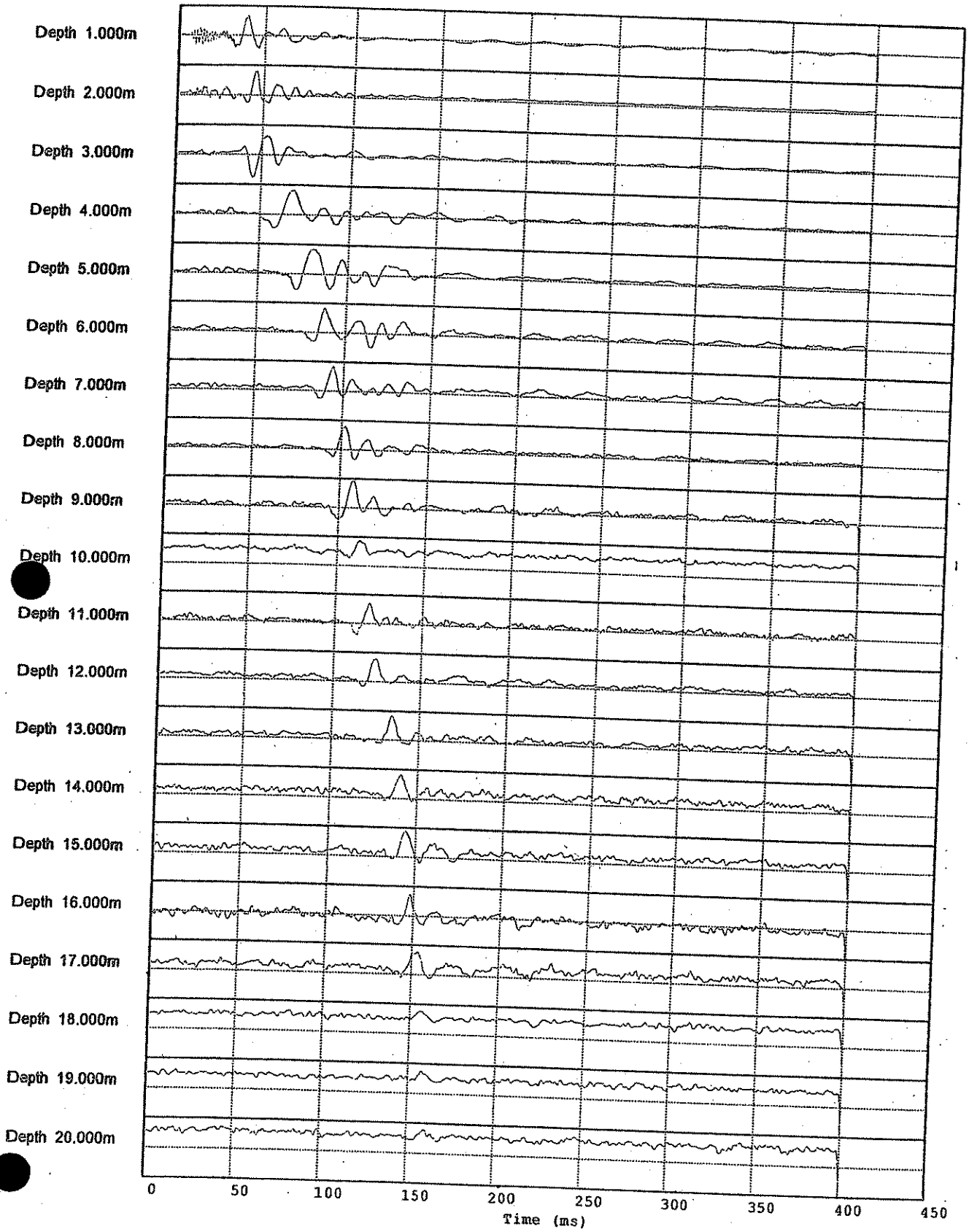


Hammer to Rod String Distance 3.2 (m)

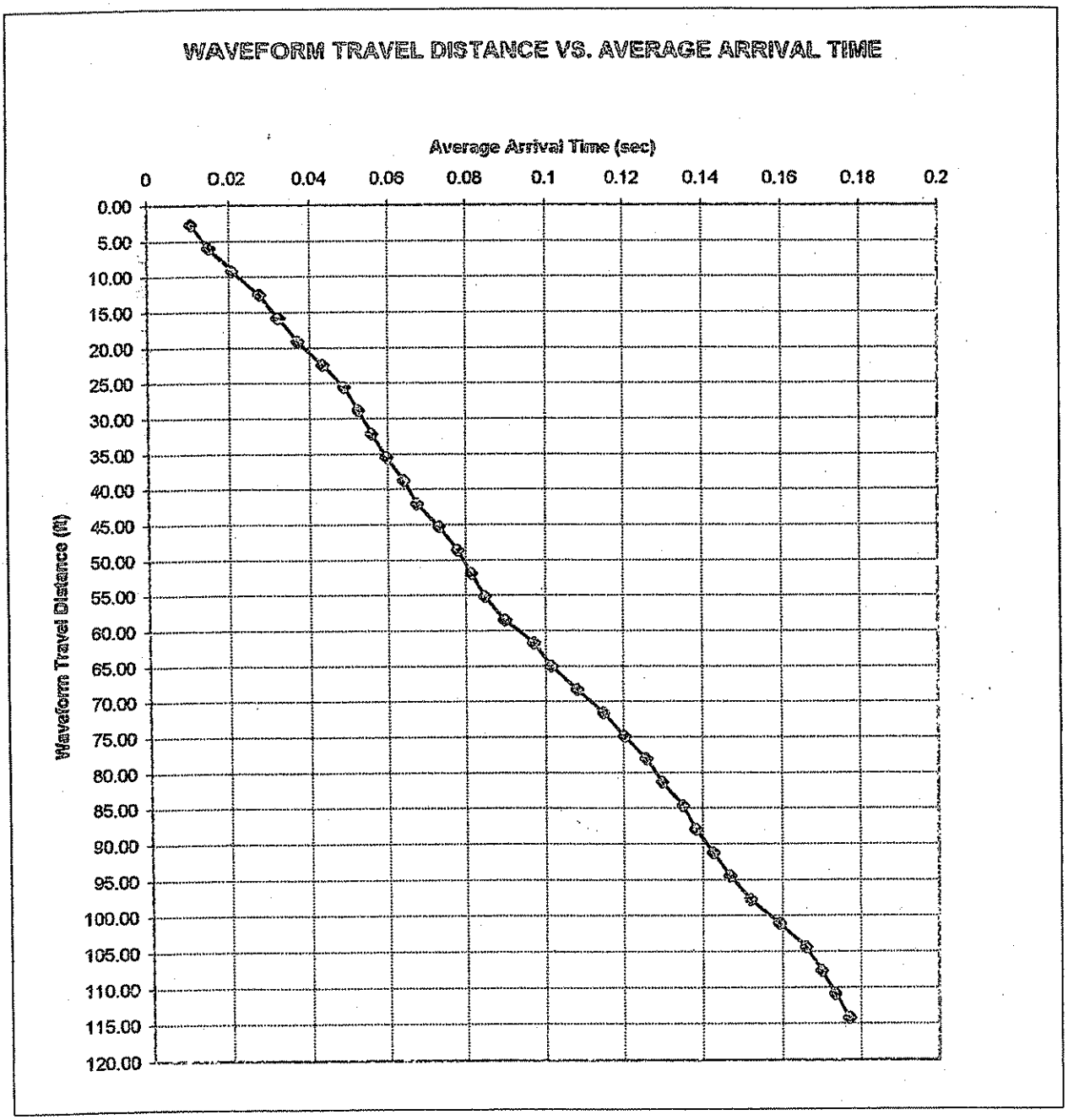

WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME
Average Arrival Time (sec)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
Waveform Travel Distance (ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00

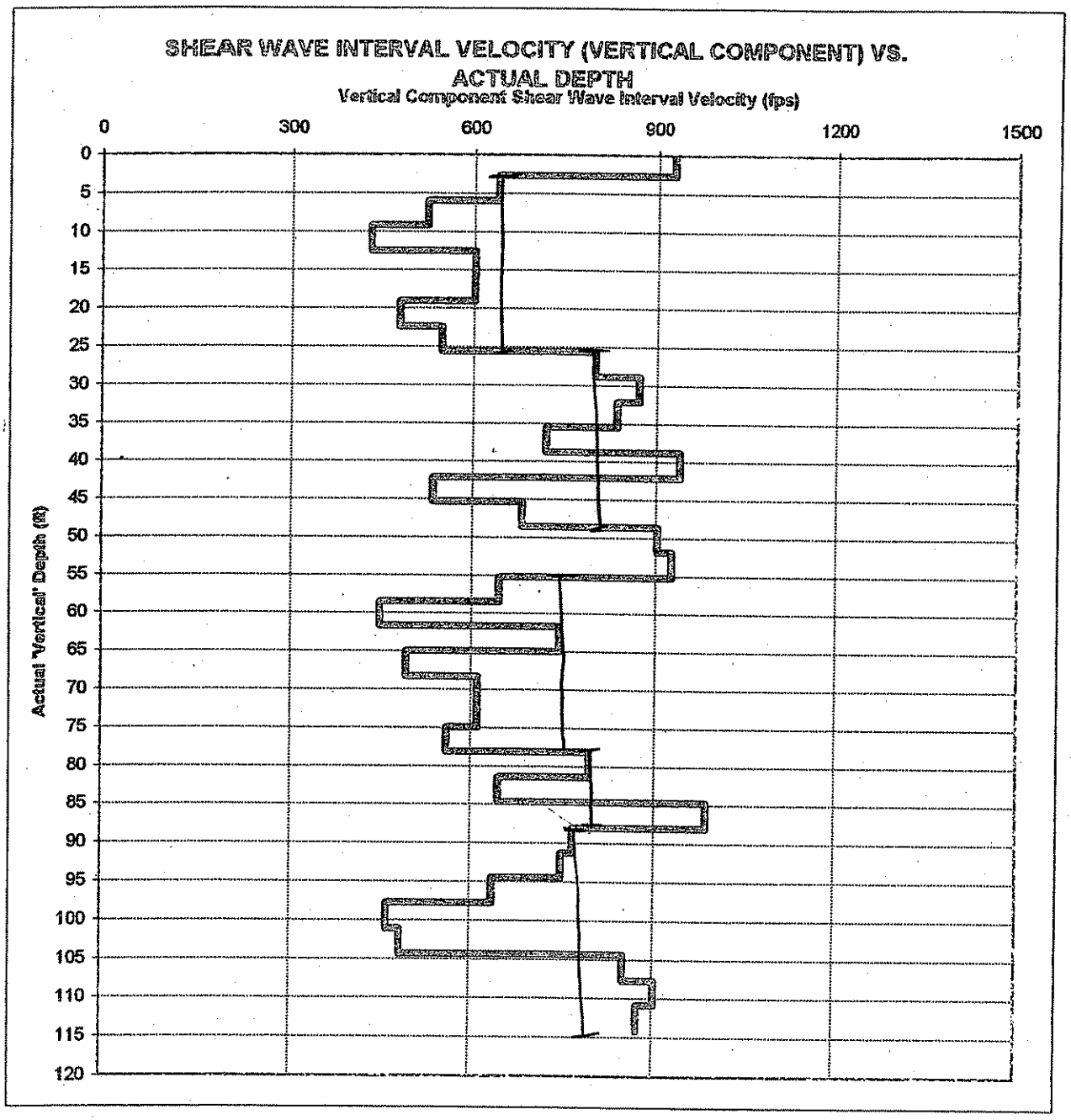

SHEAR WAVE INTERVAL VELOCITY (VERTICAL COMPONENT) VS. ACTUAL DEPTH
Vertical Component Shear Wave Interval Velocity (fps)
0
200
400
600
800
1000
Actual 'Vertical' Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

Southern Earth Sciences Inc.
MC-7

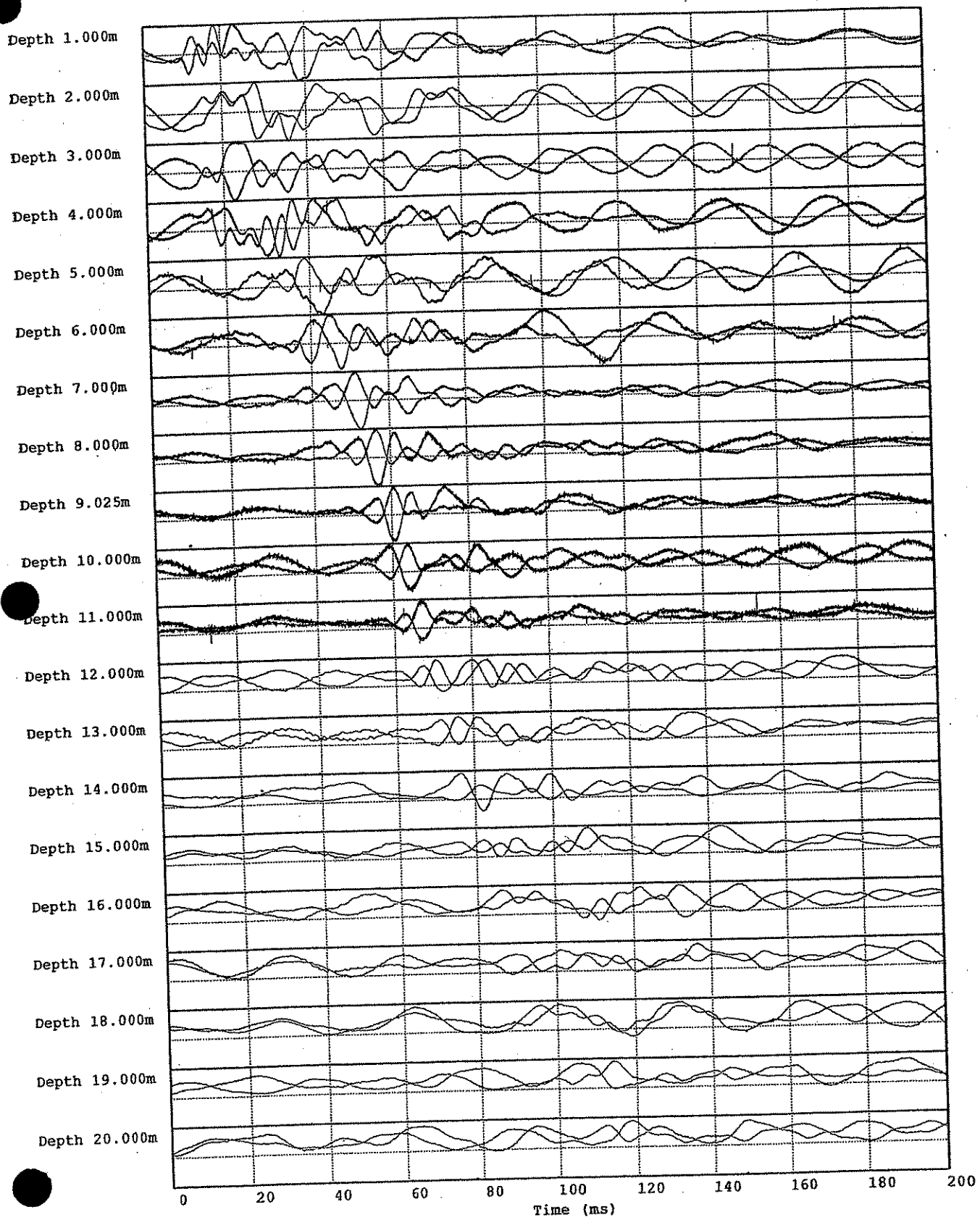


Hammer to Rod String Distance 3.2(m)


WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME
Average Arrival Time (sec)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
Waveform Travel Distance (ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00
110.00
115.00
120.00

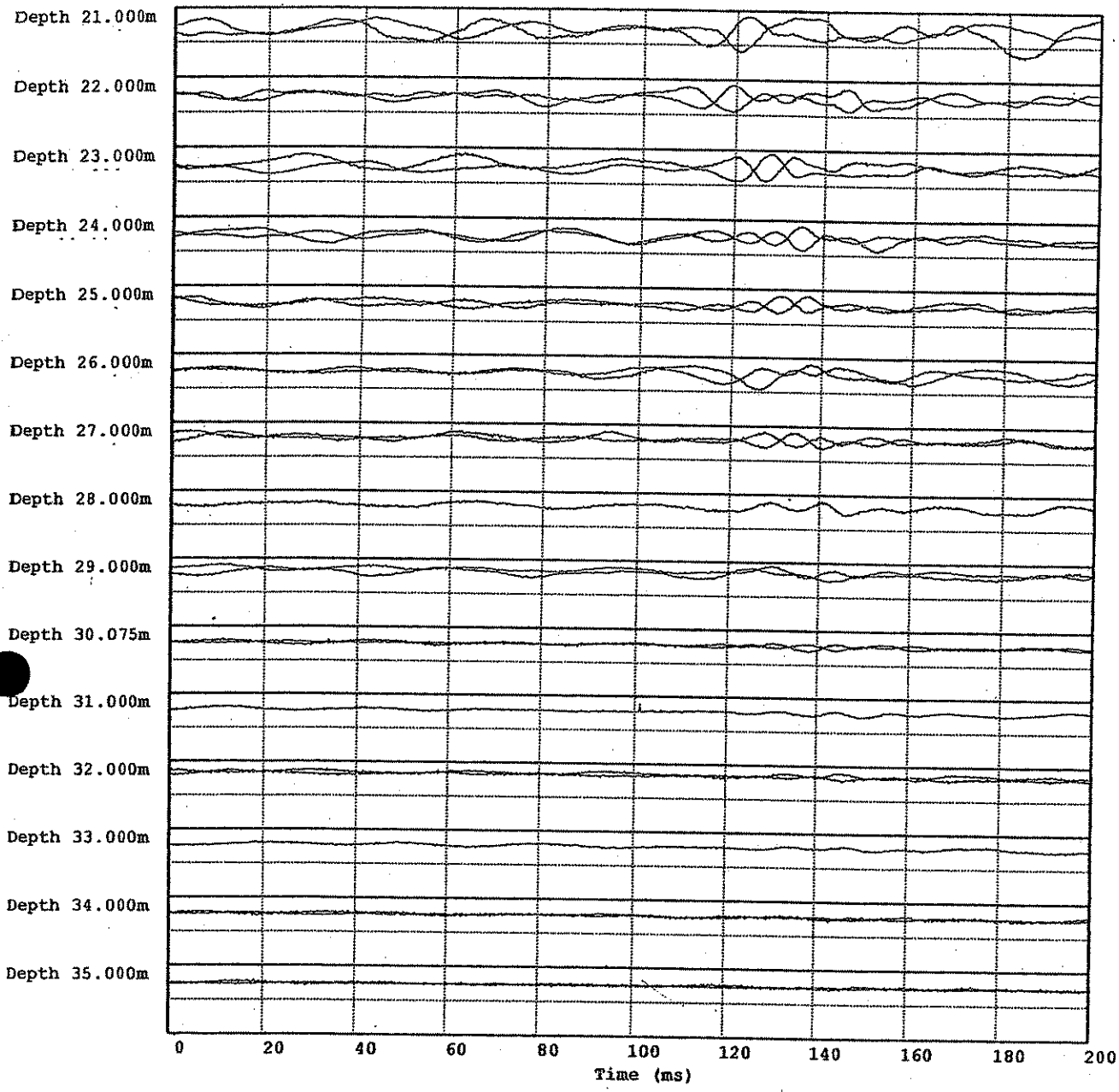

SHEAR WAVE INTERVAL VELOCITY (VERTICAL COMPONENT) VS.
ACTUAL DEPTH
Vertical Component Shear Wave Interval Velocity (fps)
0
300
600
900
1200
1500
Actual Vertical Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120

Southern Earth Sciences Inc.
MC-17

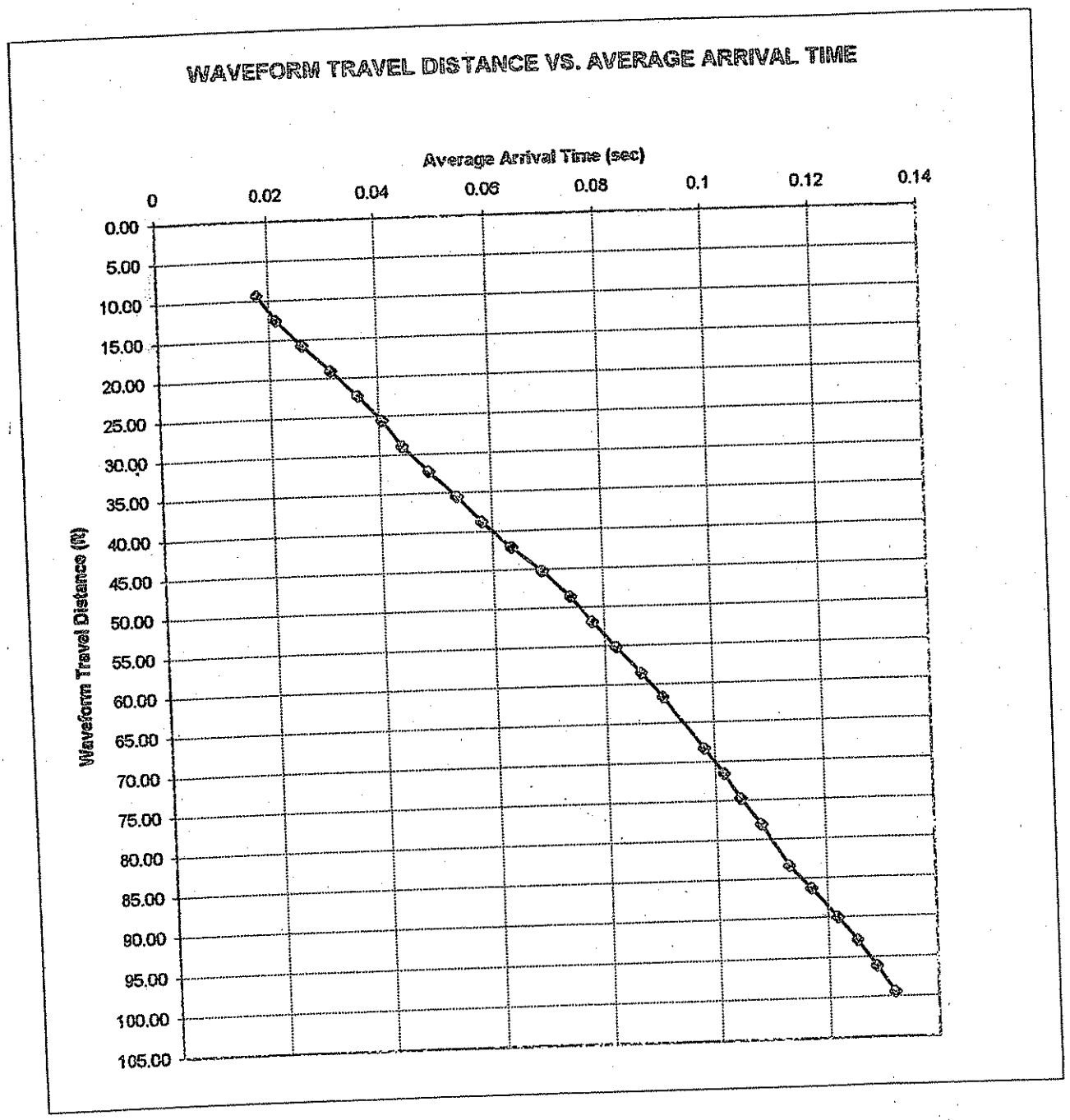


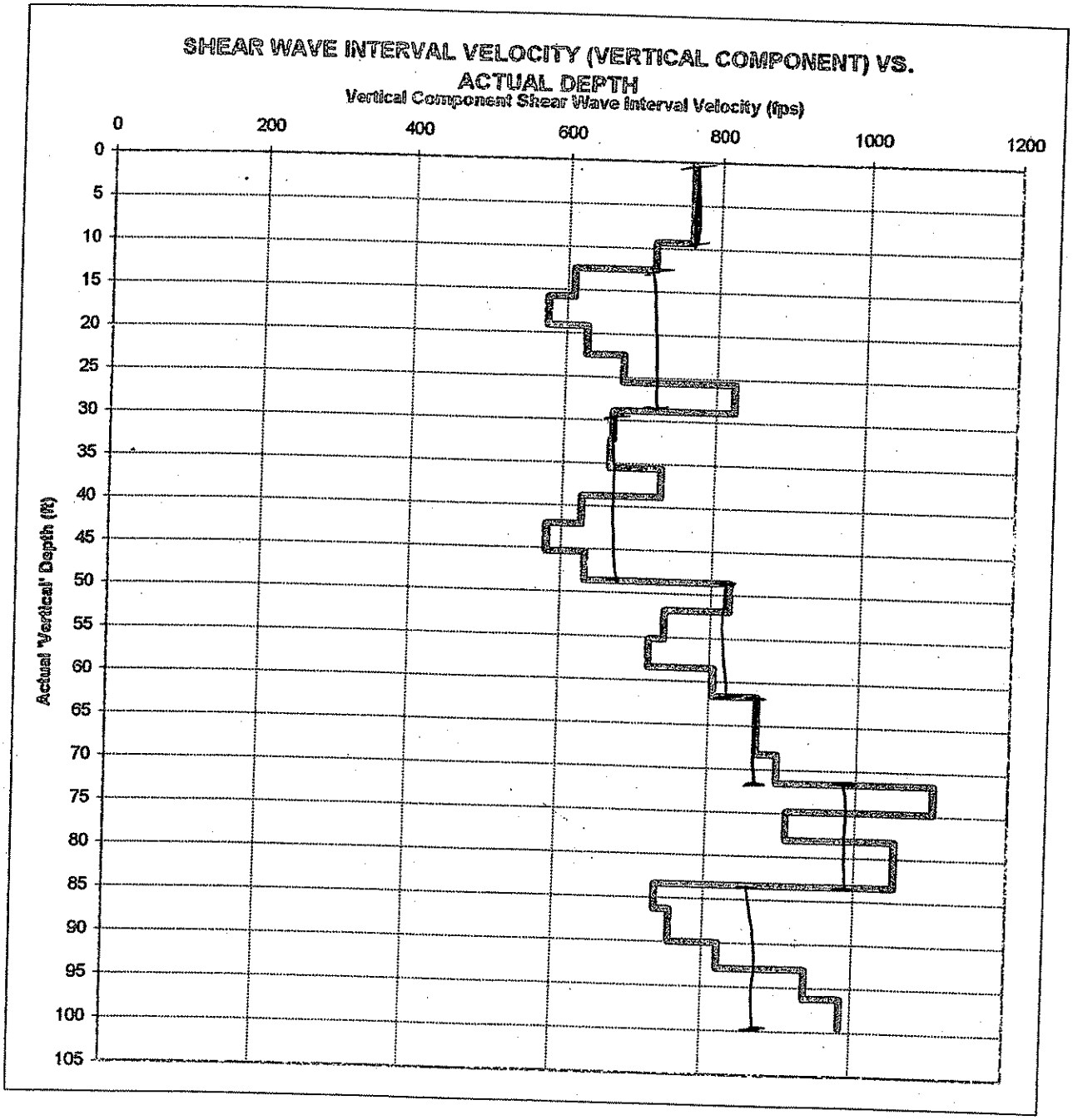
Hammer to Rod String Distance 3.2(m)

Southern Earth Sciences Inc.
MC-17

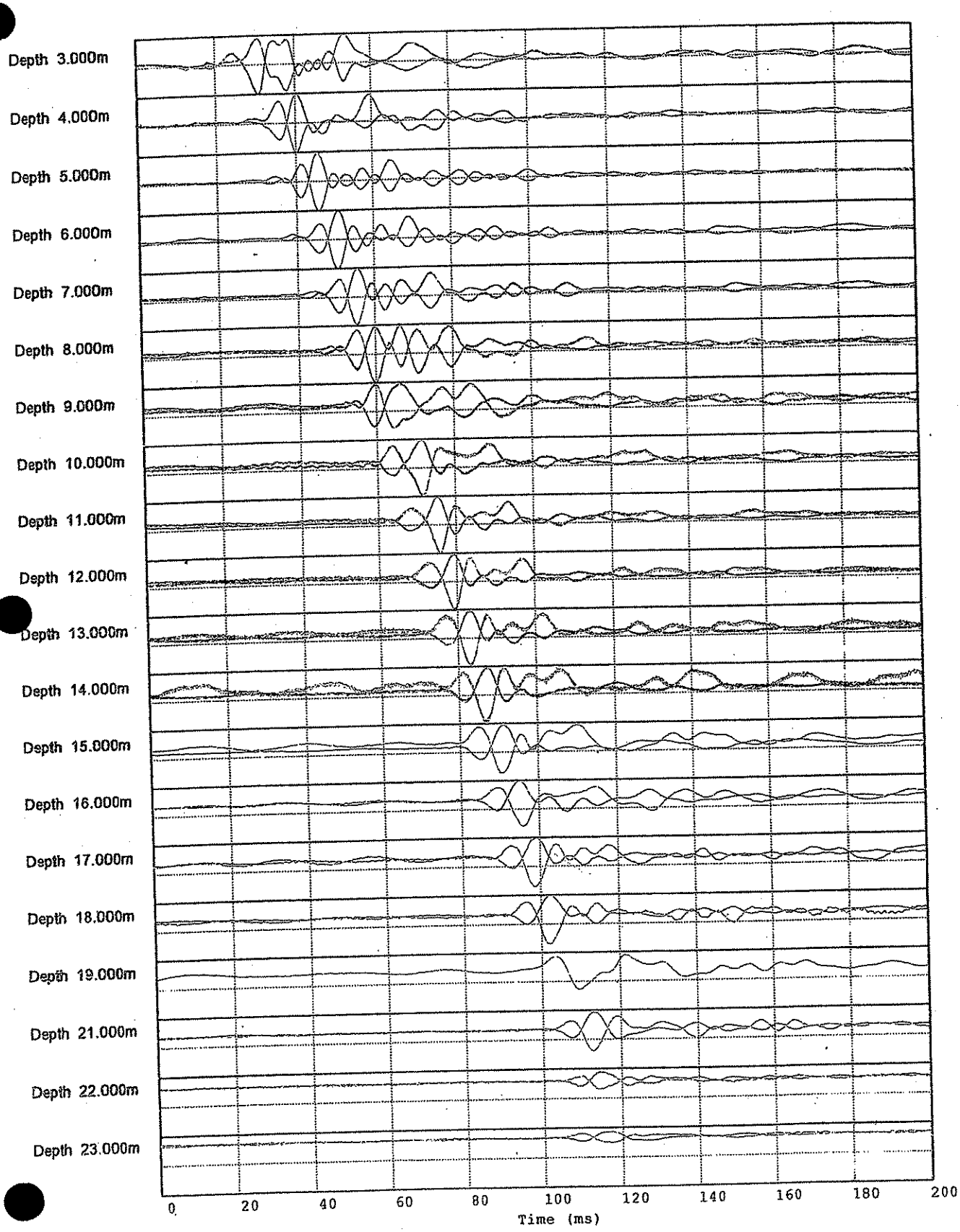


Hammer to Rod String Distance 3.2 (m)


WAVEFORM TRAVEL DISTANCE VS. AVERAGE ARRIVAL TIME
Average Arrival Time (sec)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
Waveform Travel Distance (ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
60.00
65.00
70.00
75.00
80.00
85.00
90.00
95.00
100.00
105.00

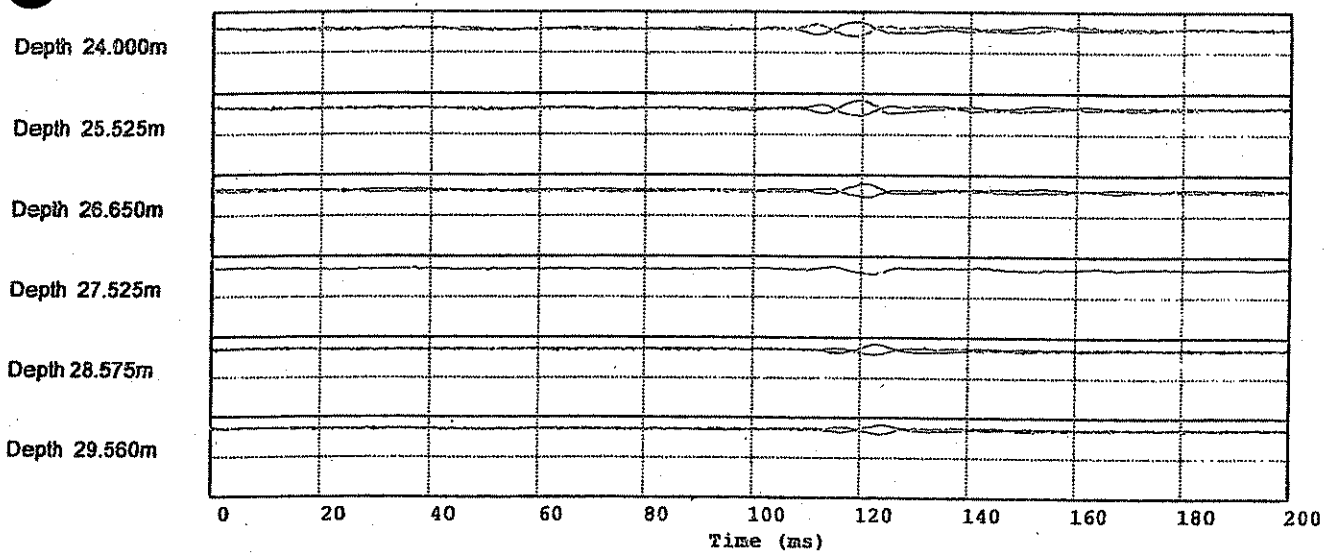

SHEAR WAVE INTERVAL VELOCITY (VERTICAL COMPONENT) VS.
ACTUAL DEPTH
Vertical Component Shear Wave Interval Velocity (fps)
0
200
400
600
800
1000
1200
Actual "Vertical" Depth (ft)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105

Southern Earth Sciences Inc.
MC-23



Hammer to Rod String Distance 3.2(m)

Southern Earth Sciences Inc.
MC-23



Hammer to Rod String Distance 3.2 (m)

Dilatometer Sounding No. MD-1

Project No. 03-029 **Date** 02/28/03

Project/Client MACTEC

DMT Operator / Co. J. NESS / SESI

Location GILMERTON BRIDGE

Rig Operator / Co. D. HINES / SESI

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type _____

Rod Diameter _____ cm

Rod Weight _____ kgf/m

Frict. Red. Diam. _____ cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth _____ m

Predrill Depth _____ m

Initial Depth z_i _____ m

Tot.Vert.Stress σ_{vi} _____ bars

Rig Type _____

Blade No. _____

Blade Width _____ mi

Blade Thickness _____ mi

Pore Pressure u_{0i} _____ ba

Eff.Vert.Stress σ'_{vi} _____ ba

Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.12	ΔB = 0.45	
1.0	PRE	PUNCH	"GRAVEL	FILL"
1.2	500	0.40	3.45	ABOVE
1.4	475	1.40	3.00	PHREATIC
1.69	500	1.70	5.65	SURFACE
1.8	500	2.10	5.075	↓
2.0	475	2.25	5.05	↓
2.2	450	1.875	5.15	0.15
2.4	475	1.45	3.525	0.10
2.6	475	1.325	2.975	0.175
2.8	450	1.20	2.525	0.15
3.0	450	1.15	2.425	0.00
3.2	475	1.25	2.85	0.10
3.4	550	2.35	8.15	0.00
3.61	600	3.10	11.10	0.00
3.81	600	2.45	5.15	0.075
4.0	575	1.85	6.25	0.00
4.25	575	2.30	4.975	0.075
4.4	575	1.825	5.075	0.10
4.6	550	1.90	4.225	0.25
4.8	500	2.30	3.45	1.10
5.0	500	2.425	3.60	1.30
5.2	500	2.35	3.55	1.375
5.4	475	2.55	3.70	1.575
5.6	500	2.50	3.725	1.65
5.8	500	2.425	3.425	1.45
6.0	500	2.45	3.65	1.60
6.2	500	2.55	3.15	1.575
6.41	425	3.225	4.925	2.20
6.6	500	3.025	4.35	1.80

Depth (m)	Thrust (psi)	A bars	B bars	C bars
6.81	450	2.750	3.875	1.72
7.0	475	2.625	3.65	1.75
7.2	500	2.600	3.725	1.60
7.4	500	1.875	4.425	0.30
7.6	525	2.325	3.225	1.45
7.8	500	2.300	3.275	1.425
8.0	500	2.425	3.45	1.55
8.2	500	2.70	3.875	1.60
8.4	500	2.70	3.70	1.75
8.6	500	2.90	4.075	1.925
8.8	500	2.85	3.825	1.95
9.0	500	2.925	4.00	1.95
9.2	525	2.725	3.55	1.90
9.4	500	2.70	3.625	1.80
9.6	550	2.60	4.875	0.55
9.83	600	1.85	3.10	0.50
10.0	575	2.20	3.05	1.00
10.2	525	2.40	3.425	0.80
FO.4	550	2.475	3.625	0.925
10.61	575	3.75	5.30	1.80
10.8	600	4.775	6.975	2.45
11.0	650	4.275	6.10	2.25
11.2	625	4.85	6.90	2.95
11.4	650	4.70	6.60	2.30
11.6	675	4.725	6.15	2.00
11.8	750	4.275	10.70	0.85
12.0	500	4.05	7.30	0.60
12.2	500	4.325	7.075	1.15
12.4	500	3.825	8.70	0.90
12.6	600	3.80	7.55	0.85

Notes Developed leak @ 6.2-m (12:45pm) Fired restarted @ 2:20
STOPPED @ 3:30PM 02/28/03

Dilatometer Sounding No. MD-1

Page 2 of 2

Project No. 03-029

Date 03/01/03

Project/Client MACTEC

DMT Operator / Co. J. NESS / SESI

Location GILMERTON BRIDGE

Rig Operator / Co. D. HINES / SESI

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type CPT

Rod Diameter _____ cm

Rod Weight _____ kgf/m

Frict. Red. Diam. _____ cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth _____ m

Predrill Depth _____ m

Initial Depth z_i _____ m

Tot.Vert.Stress σ_v _____ bars

Rig Type _____

Blade No. _____

Blade Width _____ mm

Blade Thickness _____ mm

Pore Pressure u_o _____ bars

Eff.Vert.Stress σ'_v _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.12	ΔB = 0.45		18.6				
12.8	575	4.00	8.525	0.875	18.8				
13.0	500	4.125	6.40	1.00	19.0				
13.2	550	4.55	7.025	1.425	19.2				
13.4	525	4.05	7.55	1.00	19.4				
13.6	525	4.175	7.225	1.075	19.6				
13.8	550	5.90	8.175	3.45	19.8				
14.0	500	5.925	7.90	3.35	20.0				
14.2	600	6.075	14.70	1.125	20.2				
14.4	650	4.10	6.875	0.70	20.4				
14.6	600	4.525	13.10	1.025	20.6				
14.8	675	4.875	10.90	1.20	20.8				
15.0	625	4.075	9.00	0.95	21.0				
15.2	650	4.15	7.225	0.80	21.2				
15.4	625	5.675	10.90	1.45	21.4				
15.6	750	5.25	12.30	0.925	21.6				
15.8	750	5.55	12.20	1.25	21.8				
16.0	600	7.075	9.80	3.85	22.0				
16.2	600	6.45	10.30	1.70	22.2				
16.4	650	5.15	8.625	1.00	22.4				
16.6	675	5.625	8.475	1.85	22.6				
16.8	700	6.35	10.80	1.475	22.8				
17.0	750	5.10	12.50	1.25	23.0				
17.2	800	5.825	12.00	1.20	23.2				
17.41	900	5.90	>60	BROKE MEMBRANE	23.4				
17.6	875	4.55	13.8	1.35	23.6				
17.8	825	3.70	9.325	1.25	23.8				
18.0	800	3.80	9.575	1.10	24.0				
18.2	900	5.20	>60	BROKE MEMBRANE	24.2				
							ΔA =	ΔB =	

Notes

Dilatometer Sounding No. ~~MD-3~~ MD-2

Page 1 of 4

Project No. 03-029 Date 02/26/03

Project/Client MACTEC

DMT Operator / Co. J. NESS

Location GILMERTON BRIDGE

Rig Operator / Co. D. HINES

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type CONE ROD

Rod Diameter 3.6 cm

Rod Weight 5.91 kgf/m

Frict. Red. Diam. N.A. cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth _____ m

Predrill Depth _____ m

Initial Depth z_i _____ m

Tot.Vert.Stress σ_{vi} _____ bars

Rig Type 20-TON TRACK "CPT"

Blade No. 842

Blade Width 93 mm

Blade Thickness 16 mm

Pore Pressure u_0 _____ bars

Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.05	ΔB = 0.7		6.0	525	1.60	2.475	0.975
.22	550	1.95	N.A.		6.2	525	1.625	2.475	0.95
.4	1000	N.A.	N.A.		6.4	500	1.70	1.625	1.05
.605	800	7.05	30		6.6	500	1.75	2.675	1.1
.8	800	8.90	N.A.		6.8	525	1.775	2.70	1.125
1.0	550	5.30	15		7.0	550	1.85	2.75	1.15
1.2	425	1.20	2.15		7.2	550	1.80	2.75	1.05
1.4	400	1.35	2.15	0.40	7.4	525	1.80	2.775	1.15
1.6	400	1.20	2.05	0.35	7.6	525	1.90	2.85	1.15
1.8	400	1.10	1.9	0.30	7.8	550	1.95	2.85	1.25
2.0	425	1.05	1.8	0.25	8.0	575	2.05	3.025	1.35
2.2	400	1.10	1.9	0.30	8.2	600	2.15	3.10	1.50
2.4	400	1.15	1.9	0.35	8.4	550	2.25	3.175	1.55
2.6	400	1.10	1.9	0.40	8.6	550	2.25	3.225	1.45
2.8	425	1.15	1.9	0.45	8.8	600	2.15	3.10	1.45
3.0	425	1.15	1.95	0.40	9.0	600	2.75	5.25	0.70
3.2	425	1.3	1.9	0.35	9.2	600	1.85	3.05	0.70
3.4	400	1.15	1.95	0.45	9.4	600	2.275	5.70	0.50
3.61	425	1.25	2.00	0.55	9.6	700	2.15	7.15	0.475
3.8	450	1.25	1.95	0.55	9.8	675	2.20	3.65	0.75
4.0	500	1.25	2.00	0.55	10.01	700	2.15	3.55	0.80
4.2	475	1.30	2.10	0.55	10.2	775	3.70	14.20	0.525
4.4	425	1.30	2.15	0.60	10.4	700	4.00	14.60	0.525
4.6	475	1.45	2.35	0.70	10.6	925	4.65	17.40	0.50
4.8	550	1.38	2.34	0.70	10.8	1000	5.80	21.80	0.55
5.0	500	1.40	2.30	0.75	11.01	700	4.55	14.80	0.65
5.2	500	1.50	2.35	0.84	11.21	1200	7.06	20.2	0.66
5.4	500	1.52	2.45	0.86	11.41	1175	6.86	18.7	0.79
5.6	500	1.55	2.45	0.90	11.61	1100	4.20	9.7	0.675
5.8	500	1.67	2.455	0.97			ΔA =	ΔB =	

Gravel
Gravel
Gravel

Notes Replaced membrane @ 10.8-meters. ΔA = 0.06, ΔB = 0.65

FROM 11.21 meters usual casing.

MD-2

Dilatometer Sounding No. ~~MAD-3~~

Project No. 03-029 Date 02/26/03

Project/Client MALTEC

Location GILMERTON BRIDGE

DMT Operator / Co.

Rig Operator / Co.

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type _____

Rod Diameter _____ cm

Rod Weight _____ kgf/m

Frict. Red. Diam. _____ cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth _____ m

Predrill Depth _____ m

Initial Depth z_i _____ m

Tot.Vert.Stress σ_{vi} _____ bars

Rig Type 20 TON CPT

Blade No. _____

Blade Width _____ mm

Blade Thickness _____ mm

Pore Pressure u_{0i} _____ bars

Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.06	ΔB = 0.65		17.6	525	7.75	10.3	5.4
11.8	1075	5.65	17.80	0.70	17.8	575	7.75	10.7	5.425
12.01	1200	6.025	17.80	0.725	18.0	575	7.50	10.1	5.55
12.2	1300	6.60	19.30	0.75	18.2	600	8.10	11.5	5.55
12.41	1325	6.95	19.20	0.75	18.4	600	7.75	11.00	5.55
12.6	1375	6.45	17.00	0.75	18.6	575	7.85	11.00	5.575
12.8	1375	7.45	19.30	0.85	18.8	600	7.75	10.7	5.60
13.0	1400	6.75	19.80	0.725	19.0	600	7.65	10.1	5.60
13.2	1800	6.35	16.70	0.825	19.2	600	7.60	10.4	5.40
13.4	1500	3.70	6.675	0.725	19.4	600	7.625	10.6	5.575
13.6	1400	3.95	6.82	0.825	19.6	600	8.00	10.8	5.90
13.8	1350	4.95	8.65	1.075	19.8	650	7.55	9.65	5.15
14.0	1325	4.65	7.30	1.325	20.0	675	6.425	8.425	3.5
14.2	1400	5.25	7.75	1.75	20.2	700	5.15	8.725	1.85
14.49	1375	5.40	7.25	1.85	20.4	1400	7.45	22.8	1.40
14.6	1400	4.95	7.65	1.325	20.69	2400	29.1	>59.5	>59.9
14.8	1400	5.20	8.05	1.65	20.8	2300	25.7	57.7	1.75
15.0	1400	8.70	13.20	4.15	21.0	2000	19.1	47.1	1.65
15.2	500	7.55	10.90	4.95	21.2	1775	13.7	31.1	1.60
15.4	500	8.05	11.50	4.925	21.4	975	3.075	6.45	1.65
15.6	500	7.55	10.40	5.225	21.6	775	3.95	7.90	1.25
15.8	500	7.55	10.30	4.85	21.8	900	6.00	14.3	1.15
16.0	500	7.65	10.30	5.225	22.0	925	6.75	17.3	1.20
16.2	500	6.85	9.05	4.95	22.2	1000	7.80	18.1	1.15
16.53	500	6.75	8.725	4.85	22.41	1000	8.00	19.3	1.10
16.6	475	6.575	8.75	4.65	22.6	950	8.10	18.6	0.95
16.8	500	6.75	8.90	4.875	22.8	1000	8.85	20.1	0.65
17.0	525	7.00	9.45	4.85	23.0	1025	9.65	23.5	1.25
17.2	500	7.225	9.30	5.15	23.2	1025	8.50	18.8	0.825
17.4	525	7.40	9.85	5.225			ΔA =	ΔB =	

Notes STOPPED TEST @ 13-meters, 4:20 PM 02/26/03;
RESUMED TEST @ 13.2-meters; 10:45 AM 02/27/03;
SWITCHED BACK TO CPT RODS @ 15-meters

Dilatometer Sounding No. ~~MD-3~~ MD-2

Page 3 of 4

Project No. 03-029 Date 02/27/03

Project/Client MACTEC

DMT Operator / Co. J. NESS / SESI

Location GILMERTON BRIDGE

Rig Operator / Co. D. HINES / SESI

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type _____

Rod Diameter _____ cm

Rod Weight _____ kgf/m

Frict. Red. Diam. _____ cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth _____ m

Predrill Depth _____ m

Initial Depth z_i _____ m

Tot.Vert.Stress σ_{vi} _____ bars

Rig Type _____

Blade No. _____

Blade Width _____ mm

Blade Thickness _____ mm

Pore Pressure u_0 _____ bars

Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.06	ΔB = 0.65		29.21	1600	14.00	30.0	1.5
23.4	1050	8.20	18.00	1.05	29.4	1600	11.20	27.0	2.30
23.6	1000	8.25	18.30	1.95	29.6	1600	14.60	32.4	2.0
23.8	1025	9.05	19.5	1.40	29.81	1500	13.10	28.3	2.2
24.03	1075	11.10	24.8	2.20	30.0	1575	11.20	26.2	2.30
24.2	1100	9.20	20.9	2.30	30.2	1425	12.20	24.7	1.75
24.4	1100	9.10	21.3	1.85	30.4	1525	12.80	26.8	1.50
24.6	1150	9.55	22.1	2.25	30.6	1700	11.30	24.7	1.80
24.8	1200	9.75	21.0	1.80	30.8	1600	10.90	24.3	1.475
25.0	1200	8.45	19.0	1.95	31.0	1600	10.90	21.9	1.975
25.2	1200	11.10	23.3	1.95	31.2	1600	11.10	25.7	1.55
25.4	1250	8.70	21.7	1.45	31.4	1625	13.4	30.5	1.70
25.61	1175	10.60	22.6	1.90	31.6	1600	13.8	29.5	2.10
25.81	1275	12.10	28.1	1.675	31.81	1600	14.3	26.3	1.90
26.0	1400	10.80	26.0	1.90	32.0	1600	10.8	21.6	1.65
26.2	1425	10.40	24.7	1.80	32.2	1600	12.2	26.3	1.50
26.4	1425	10.30	26.0	1.55	32.4	1600	11.1	25.8	2.30
26.6	1300	12.30	26.0	1.35	32.6	1625	13.5	31.6	2.00
26.8	1400	10.40	24.9	1.70	32.8	1625	13.6	30.0	1.70
27.0	1450	8.60	22.7	2.225	33.0	1700	12.0	29.7	1.60
27.21	1400	11.80	25.6	2.30	33.23	1600	11.9	26.3	2.25
27.4	1250	10.70	22.6	2.225	33.4	1575	12.3	26.9	1.65
27.6	1300	12.0	24.9	1.80	33.6	1500	10.6	23.1	1.25
27.81	1250	8.95	17.5	1.675	33.8	1550	11.3	24.0	1.70
28.0	1400	10.7	24.5	1.80	34.0	1600	11.7	27.6	1.90
28.2	1400	9.15	21.4	1.95	34.2	1600	11.3	24.3	1.30
28.41	1500	11.10	24.5	2.2	34.4	1625	14.0	27.3	1.55
28.6	1500	11.40	25.8	1.70	34.6	1600	12.8	29.8	1.75
28.8	1475	11.10	24.8	2.35	34.8	1500	9.875	22.6	1.50
29.0	1500	13.60	30.8	1.80			ΔA =	ΔB =	

Notes

Dilatometer Sounding No. ~~MD-3~~ MD-2

Page 4 of 4

Project/Client WILMERTON BRIDGE / MACTEC
Location CHESAPEAKE, VIRGINIA
Project No. 03-029
Date
DMT Operator / Co. J. NESS
Rig Operator / Co. D. HINES

Low Range Gage 0 _____ bars
HighRange Gage 0 _____ bars
Rod Type CPT
Rod Diameter 3.6 cm
Rod Weight _____ kgf/m
Frict. Red. Diam. N.A. cm

Ground Surf. Elev. _____ m
Ground Water Dpth. _____ m
Casing Depth ø m
Predrill Depth ø m
Initial Depth z_i ø m
Tot.Vert.Stress σ_{vi} _____ bars

Rig Type 20-TON TRACK RIG
Blade No. GBB
Blade Width 95.8 mm
Blade Thickness 15.0 mm
Pore Pressure u_0 _____ bars
Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth ( )	Thrust ( )	A bars	B bars	C bars
		ΔA = 0.06	ΔB = 0.65						
35.0	1600	13.1	27.1	1.65					
35.2	1600	12.0	26.7	1.95					
35.4	1600	10.7	23.0	1.90					
35.6	1625	12.0	27.0	1.75					
35.8	1675	12.1	26.4	1.80					
36.0	1600	12.0	24.3	1.55					
36.2	1650	11.7	25.1	2.15					
36.4	1600	10.1	26.7	1.50					
36.6	1675	14.1	30.0	2.25					
36.8	1600	12.3	28.1	2.00					
37.0	1700	12.6	29.7	1.55					
37.2	1800	10.0	28.6	1.85					
37.4	1750	13.1	31.3	1.60					
37.6	1850	11.8	36.2	2.30					
37.81	1950	15.3	35.2	2.00					
						FINAL:	ΔA = 0.06	ΔB = 0.60	

Notes

Dilatometer Sounding No. MD-3

Project No. 03-029 Date 02/13/03

Project/Client WILMERTON BRIDGE / MACTEC
DMT Operator / Co. JEFF NESS / SESI
Location CHESAPEAKE, VIRGINIA
Rig Operator / Co. D. HINES / SESI

Low Range Gage 0 _____ bars
HighRange Gage 0 _____ bars
Rod Type CPT
Rod Diameter 3.6 cm
Rod Weight _____ kgf/m
Frict. Red. Diam. N.A. cm

Ground Surf. Elev. _____ m
Ground Water Dpth. _____ m
Casing Depth Ø m
Predrill Depth Ø m
Initial Depth z_i Ø m
Tot.Vert.Stress σ_{vi} _____ bars

Rig Type 20-TON CPT TRACK
Blade No. GBB
Blade Width 95.8 mm
Blade Thickness 15.0 mm
Pore Pressure u_0 _____ bars
Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
Ø	Ø	ΔA = 0.1	ΔB = 0.6	Ø	6.0	500	2.75	4.25	
0.2	500	0.84	4.75		6.2	475	2.37	3.55	
0.4	700	5.20	14.80		6.4	450	2.88	4.95	
0.6	700	3.55	9.25		6.6	450	3.00	4.15	
0.81	600	1.86	5.19		6.8	450	2.85	5.50	
1.0	500	1.56	4.39		7.0	475	3.40	4.75	
1.2	500	1.46	3.12		7.2	450	3.35	4.75	
1.4	450	0.75	2.94		7.4	425	3.60	4.95	
1.6	450	1.00	2.57		7.6	450	3.60	5.10	
1.8	475	1.06	2.76		7.8	475	3.55	5.05	
2.0	500	1.66	3.06		8.0	500	3.70	5.25	
2.2	500	1.66	2.99		8.2	500	3.95	5.50	
2.4	500	1.56	4.80		8.4	500	4.10	5.65	
2.6	500	2.26	4.60		8.62	475	4.35	6.10	
2.8	450	2.26	3.71		8.8	500	4.45	6.15	
3.0	525	1.80	4.00		9.0	500	4.35	6.15	
3.2	600	2.90	7.80		9.2	500	4.30	6.20	
3.4	600	2.60	7.46		9.44	500	4.30	6.05	
3.6	775		4.55		9.6	500	4.30	5.95	
3.8	900	6.50	17.60		9.8	500	4.70	6.35	
4.0	1000	7.25	19.50		10.0	500	5.10	6.80	
4.2	1000	9.20	21.80		10.2	500	5.25	6.95	
4.4	950	6.90	17.80		10.4	500	5.40	7.15	
4.6	1300	8.16	23.80		10.6	550	5.20	7.00	
4.8	1500	17.50	38.50		10.8	550	5.20	6.90	
5.0	1375	13.20	30.80		11.01	600	5.00	6.80	
5.27	1100	8.09	20.60		11.2	600	5.15	6.90	4.60
5.4	775	2.60	12.70		11.4	600	5.00	6.70	6.05
5.6	600	2.76	6.85		11.6	600	4.95	6.50	4.90
5.8	500	1.96	4.26				ΔA =	ΔB =	

Notes _____

Dilatometer Sounding No. MD-3

Project No. 03-029 Date 02/13/03

Project/Client WILMERTON BRIDGE / MACTEC

DMT Operator / Co. J. NESS

Location CHESAPEAKE, VIRGINIA

Rig Operator / Co. D. HINES

Low Range Gage 0 _____ bars

HighRange Gage 0 _____ bars

Rod Type CPT

Rod Diameter 3.6 cm

Rod Weight _____ kgf/m

Frict. Red. Diam. N.A. cm

Ground Surf. Elev. _____ m

Ground Water Dpth. _____ m

Casing Depth ø m

Predrill Depth ø m

Initial Depth z_i ø m

Tot.Vert.Stress σ_v _____ bars

Rig Type 20-TON TRACK RIG

Blade No. GB8

Blade Width 95.8 mm

Blade Thickness 15.0 mm

Pore Pressure u_{0i} _____ bars

Eff.Vert.Stress σ'_v _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.1	ΔB = 0.6		17.61	1150	8.30	19.00	7.60
11.8	600	4.70	6.20	4.55	17.8	1100	6.80	15.20	6.70
12.0	700	4.56	8.25	3.45	18.0	1100	6.50	15.00	6.60
12.2	1000	6.40	20.00	7.10	18.2	1000	6.65	15.40	5.75
12.4	800	5.70	12.20	5.15	18.4	825	6.35	13.60	4.85
12.61	675	4.90	6.40	4.25	18.6	900	5.00	11.20	2.95
12.8	675	5.35	7.45	4.00	18.8	800	3.90	8.65	3.20
13.0	725	4.40	6.15	3.95	19.0	900	5.45	12.80	5.40
13.21	825	5.20	8.30	4.30	19.2	1000	6.35	14.40	6.70
13.4	875	5.10	7.25	4.85	19.4	1100	7.40	15.80	5.65
13.6	875	5.85	11.00	5.50	19.6	1000	8.30	17.80	5.85
13.82	800	7.85	13.60	7.30	19.8	950	6.20	13.60	6.05
14.0	1000	3.40	6.80	3.75	20.0	1000	6.15	15.20	7.70
14.21	1325	11.80	25.60	13.80	20.2	1075	7.00	15.00	5.85
14.4	1325	11.20	24.00	9.60	20.4	1025	7.40	16.20	6.95
14.6	1400	13.20	29.20	14.00	20.6	1200	8.95	20.40	10.00
14.8	1300	11.00	24.60	11.20	20.8	1050	8.30	17.60	4.30
15.0	1200	8.90	16.00	1.80	21.0	1000	7.70	14.80	4.00
15.2	1000	6.15	14.00	5.50	21.2	950	6.10	7.80	4.45
15.4	900	4.20	8.80	4.70	21.4	750	5.35	10.00	4.65
15.6	925	4.90	10.40	5.75	21.6	800	5.05	9.80	5.20
15.81	850	7.11	16.00	8.00	21.8	900	6.65	14.60	6.60
16.0	1000	5.80	13.00	6.35	22.0	1000	7.45	16.60	6.95
16.2	900	4.85	11.20	5.05	22.2	900	4.85	7.65	4.95
16.4	1000	6.30	13.60	5.75	22.4	1400	9.45	25.80	11.00
16.6	900	4.20	9.25	5.25	22.6	1400	13.20	28.60	17.40
16.81	825	3.80	7.80	4.10	22.8	900	4.95	7.15	3.00
17.0	900	4.30	9.25	5.65	23.01	900	5.55	11.50	3.15
17.21	900	5.05	11.00	5.30	23.2	925	5.60	12.40	2.75
17.4	1150	5.80	14.40	5.55			ΔA =	ΔB =	

Dilatometer Sounding No. MD-3

Page 3 of ~~4~~ 3

Project/Client WILMERTON BRIDGE, MACTEC
Location CHESAPEAKE, VIRGINIA
Project No. 03-029
Date 02/13/03
DMT Operator / Co. J. NESS
Rig Operator / Co. D. HINES

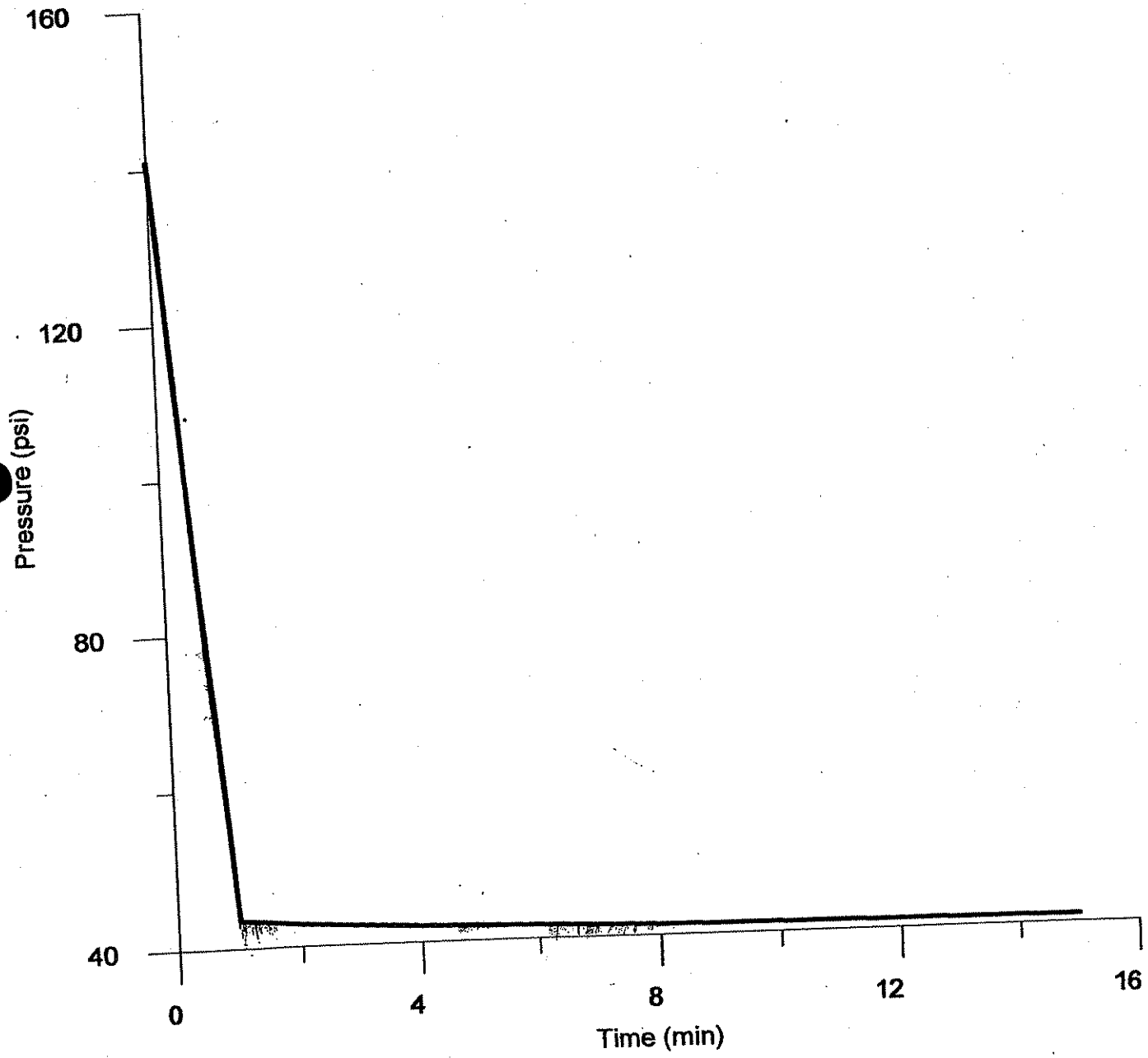
Low Range Gage 0 _____ bars
HighRange Gage 0 _____ bars
Rod Type CPT
Rod Diameter 3.6 cm
Rod Weight _____ kgf/m
Frict. Red. Diam. N.A. cm

Ground Surf. Elev. _____ m
Ground Water Dpth. _____ m
Casing Depth ø m
Predrill Depth ø m
Initial Depth z_i ø m
Tot.Vert.Stress σ_{vi} _____ bars

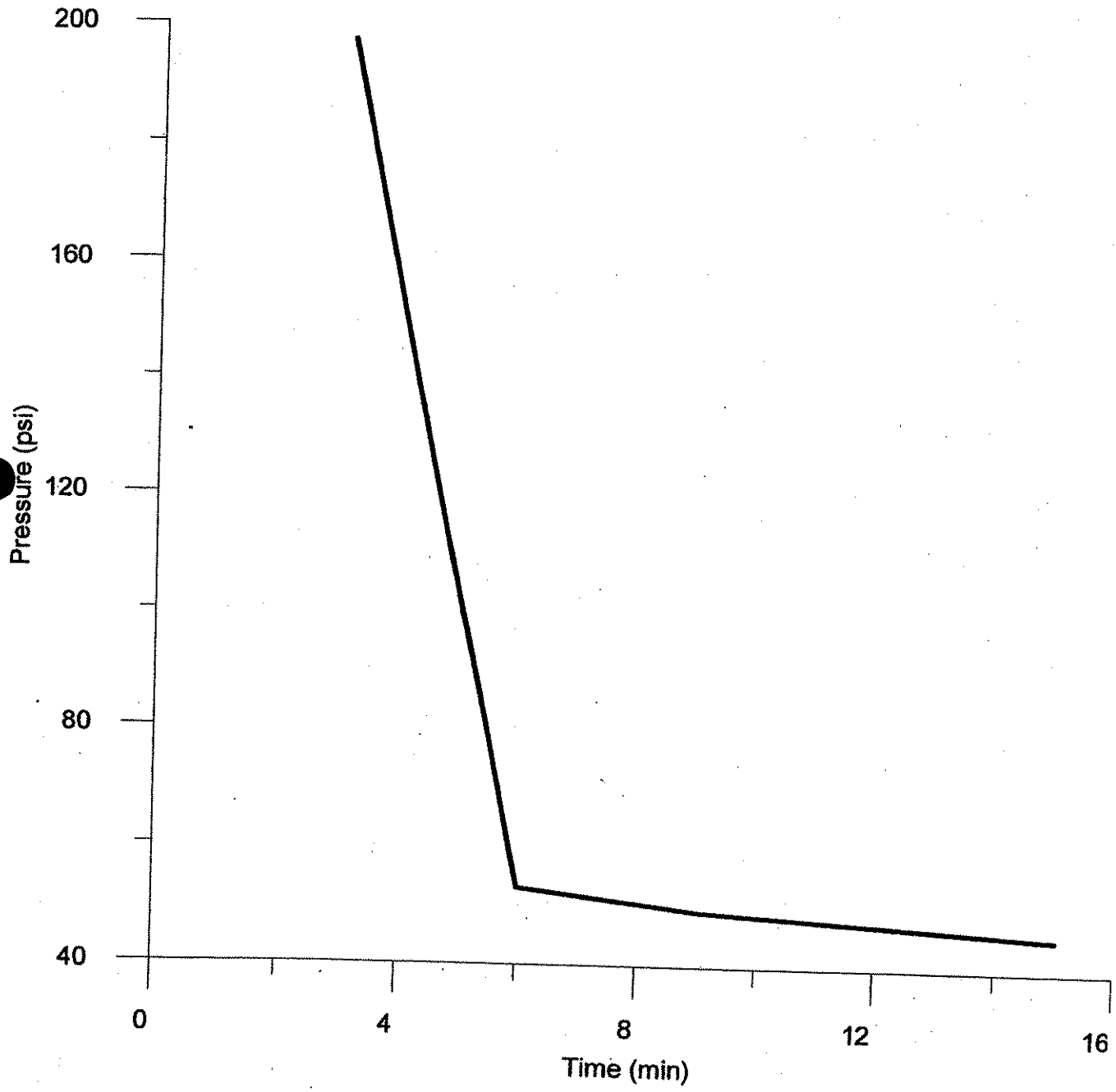
Rig Type 20-TON TRACK RIG
Blade No. GBB
Blade Width 95.8 mm
Blade Thickness 15.0 mm
Pore Pressure u_{0i} _____ bars
Eff.Vert.Stress σ'_{vi} _____ bars

Depth (m)	Thrust (psi)	A bars	B bars	C bars	Depth (m)	Thrust (psi)	A bars	B bars	C bars
		ΔA = 0.1	ΔB = 0.6		29.2				
23.4	1050	7.30	18.2	3.60	29.4				
23.6	1150	6.40	17.6	3.85	29.6				
23.81	1400	11.80	35.6	7.10	29.8				
24.0	1475	7.50	25.2	7.70	30.0				
24.2	1600	12.00	35.0	8.80	30.2				
24.4	2050	14.00	36.5	8.90	30.4				
24.61	2200	14.20	40.2	11.00	30.6				
24.8	2680	16.00	55.2	35.00	30.8				
25.01	2250	20.80	40.0	5.55	31.0				
25.2	2200	20.00	51.0	17.00	31.2				
25.4	2000	15.50	37.8	6.70	31.4				
25.6	1400	5.10	21.0	2.60	31.6				
25.8	1650	7.60	23.6	3.95	31.8				
26.0	1200	5.60	13.0	2.70	32.0				
26.2	1025	4.80	10.4	2.60	32.2				
26.4	1500	5.25	11.4	2.75	32.4				
26.6	1600	9.55	24.6	5.00	32.6				
26.8	1725	8.70	26.8	6.00	32.8				
27.0	1400	8.70	27.0	5.45	33.0				
27.21	1900	8.65	>60	—	33.2				
27.4	1225	>60	—	—	33.4				
27.61	1100	>60	—	—	33.6				
27.8					33.8				
28.0					34.0				
28.2					34.2				
28.4					34.4				
28.6					34.6				
28.8					34.8				
29.0							ΔA =	ΔB =	

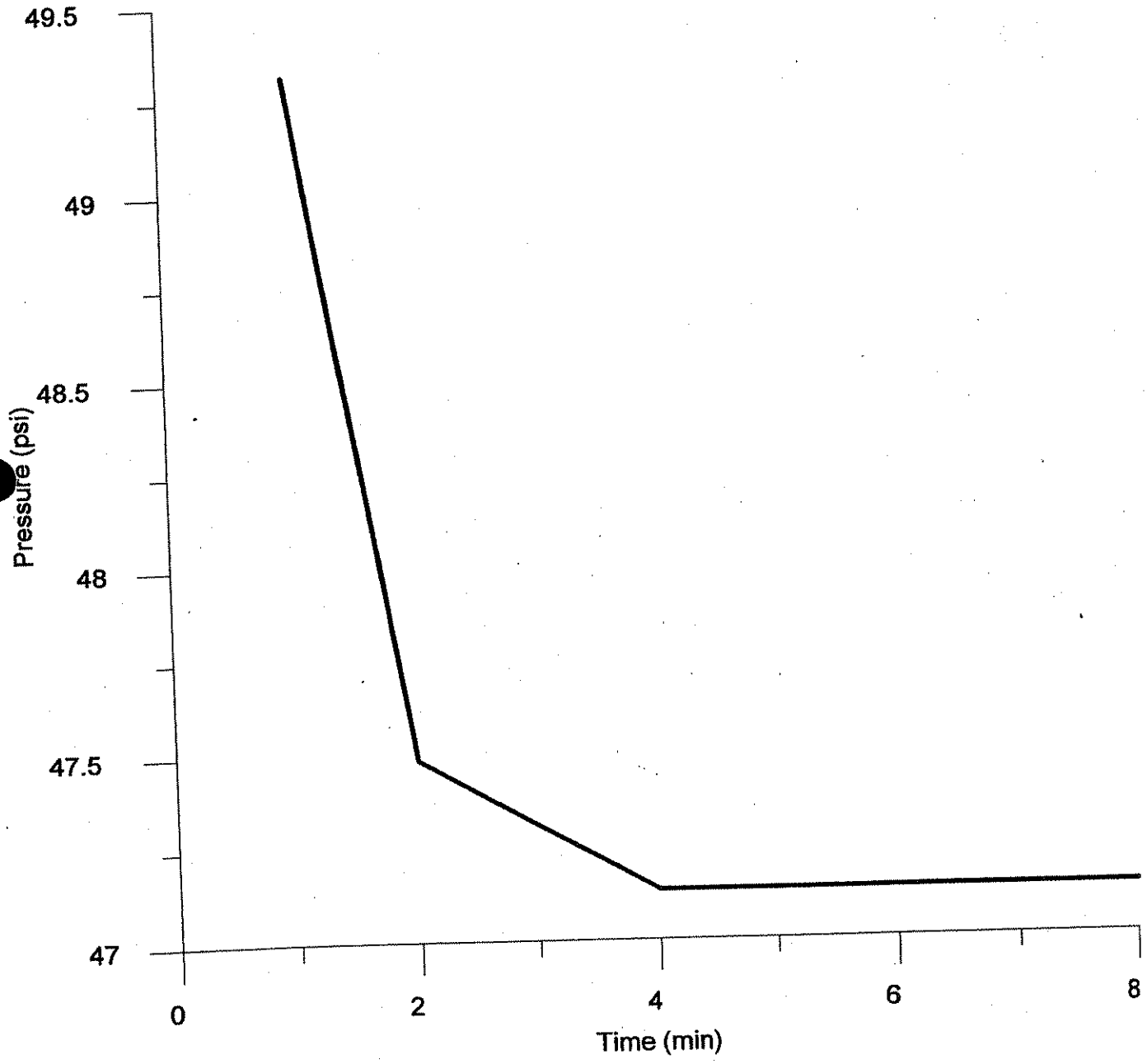
MD-2 @ 81.4'
DMT DIssipation



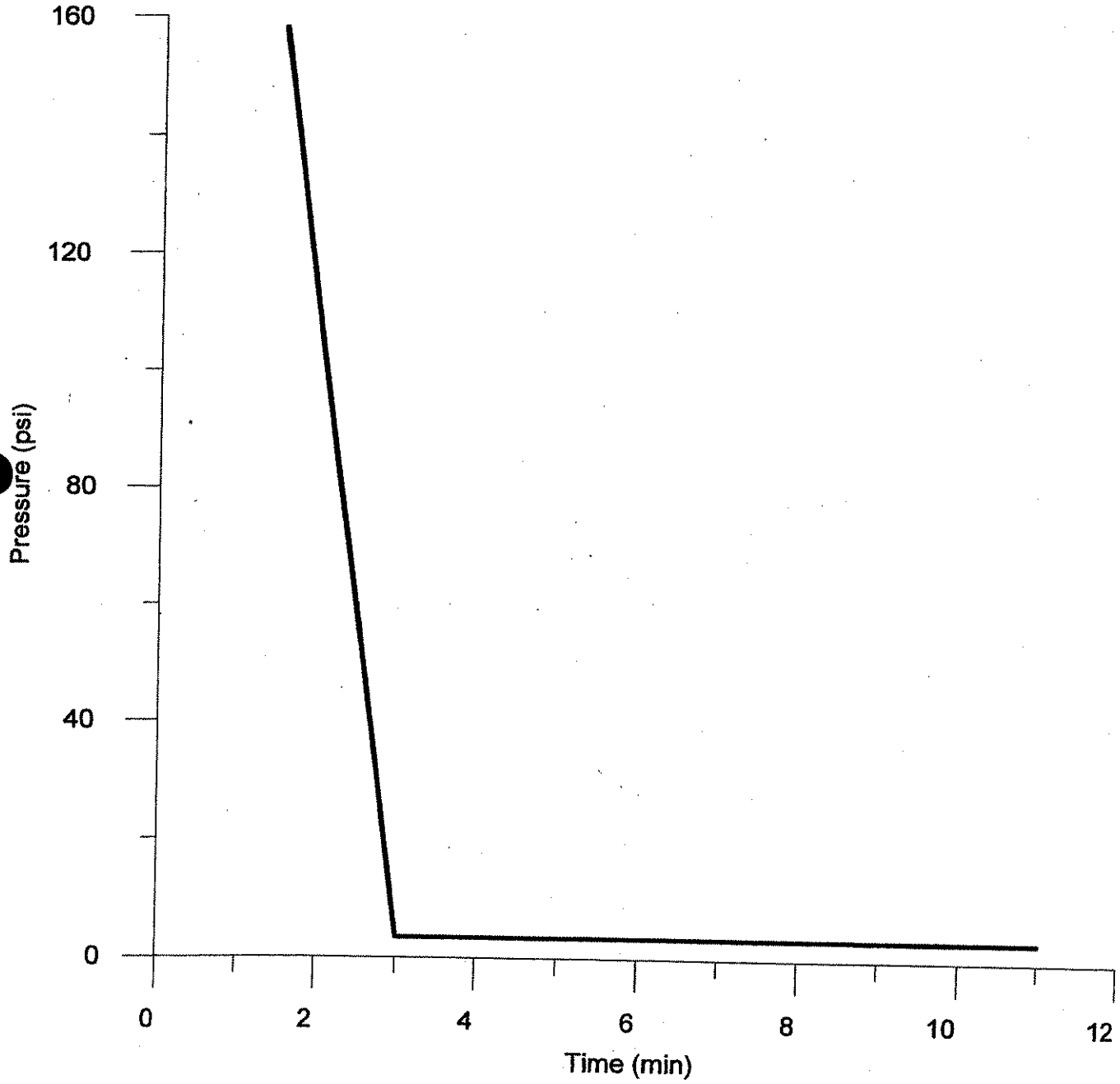
MD-2 @ 95.1'
DMT Dissipation



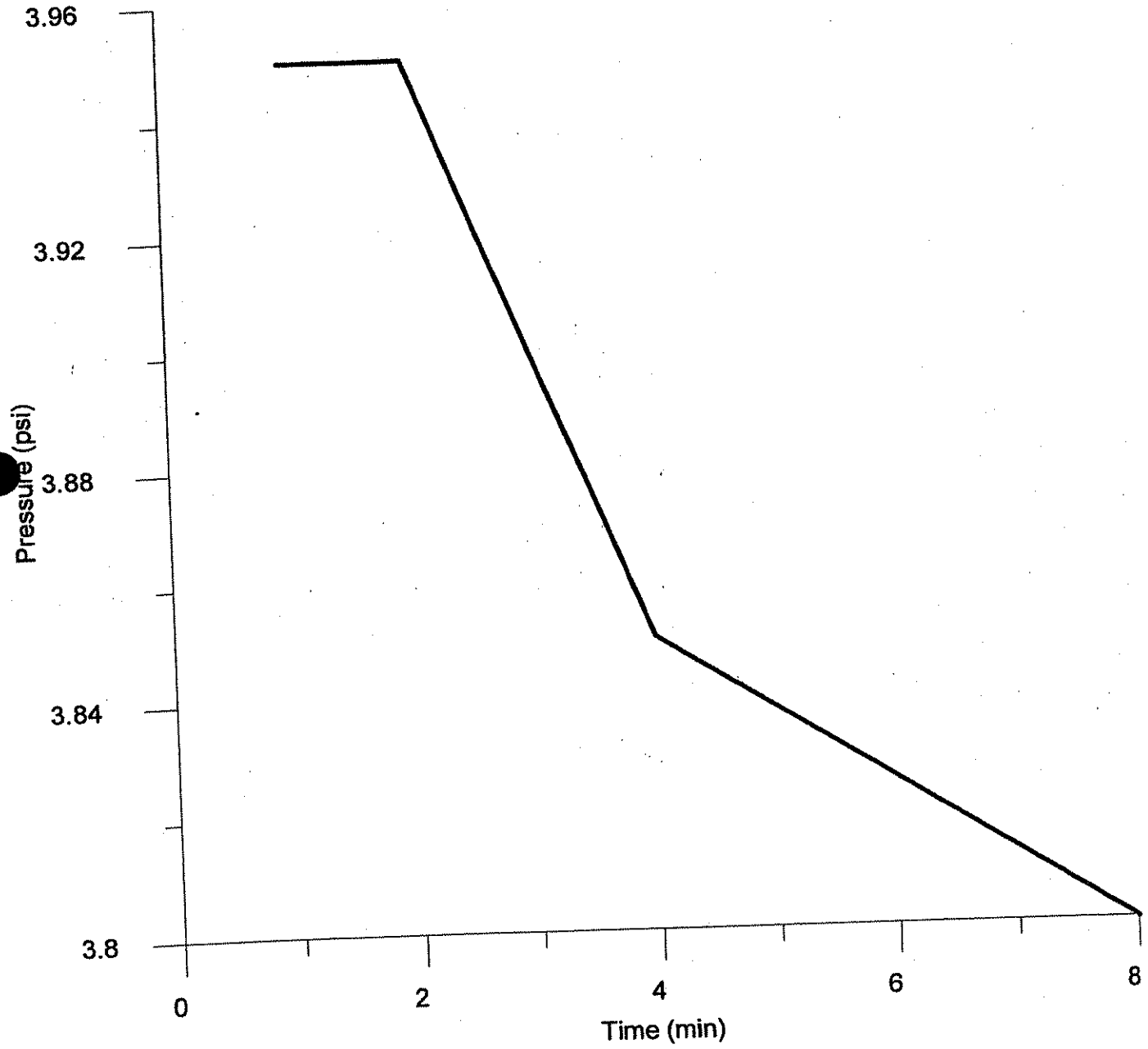
MD-2 @ 98'
DMT Dissipation



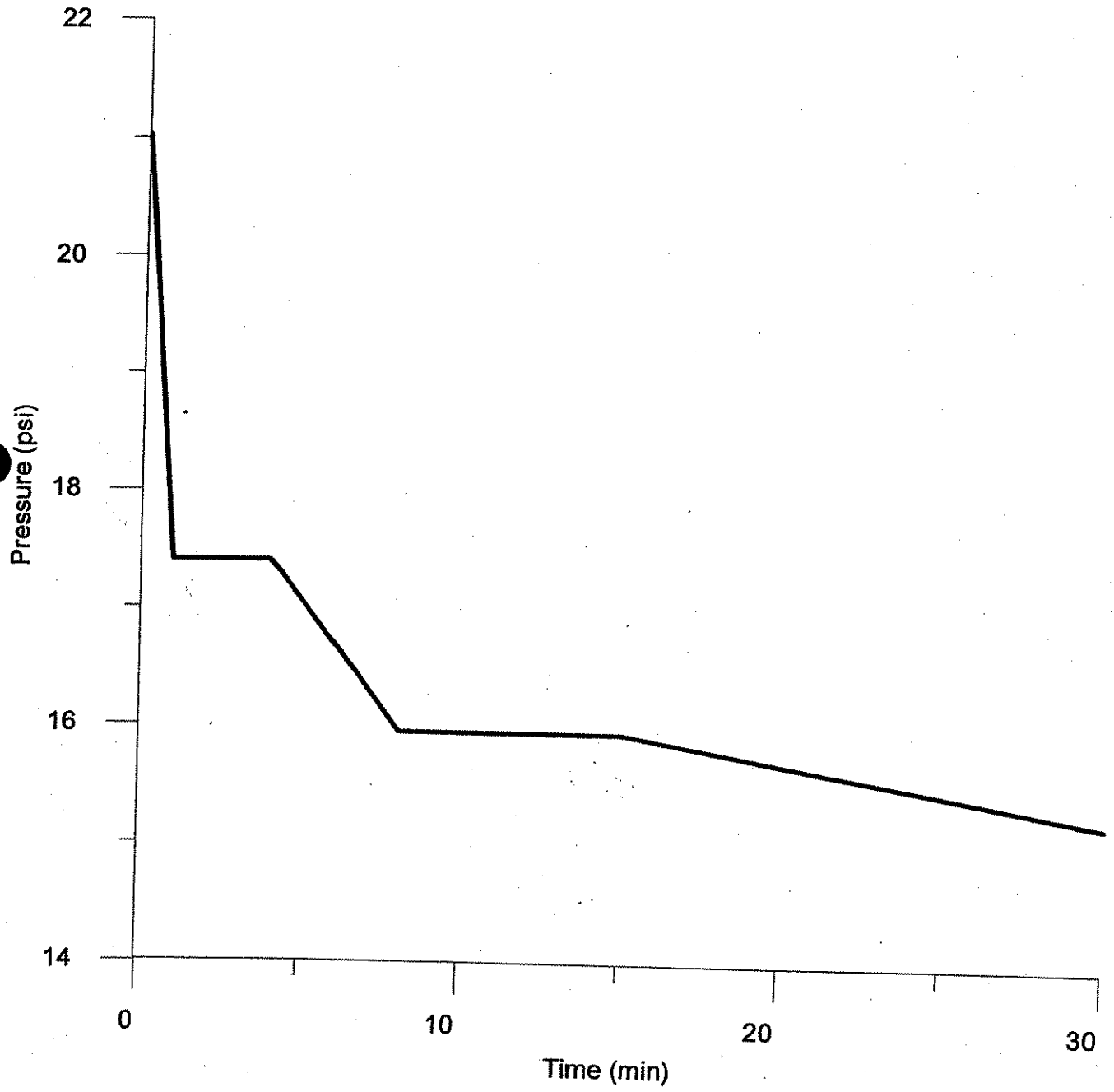
MD-2 @ 101.8
DMT Dissipation



MD-2 @ 112'
DMT Dissipation



MD-3@ 15.1
DMT Dissipation



LABORATORY TESTS

SOIL CLASSIFICATION

Soil classifications provide a general guide to the engineering properties of various soil types. Representative samples obtained during drilling operations are examined in our laboratory by an engineer. Soils are visually classified according to ASTM D 2488 based on color, texture, and consistency (determined from the number of blows per foot in standard penetration tests).

The classification system discussed above is primarily qualitative. For detailed soil classification, two laboratory tests are required: grain size analysis and index tests. Using these test results, soil can be classified according to the AASHTO, FAA, or UNIFIED Classification Systems (ASTM D 2487). Soil classifications, along with in-place physical soil properties, provide an index for estimating the behavior of a soil.

GRAIN SIZE ANALYSIS

Grain size analysis (ASTM D 422) are performed to determine the distribution of particle sizes in soil. Samples are prepared for testing according to ASTM D 2217. Particles passing the No. 200 sieve (0.074 mm opening) are labeled as fines (silts and clays). Particles retained on the No. 200 sieve are labeled the coarse fraction of the sample (sands and gravels). Further differentiation is possible by passing the sample through a standard set of nested sieves and/or by performing hydrometer tests, in which particles are suspended in water and the particle size distribution is calculated from the measured settlement rate.

INDEX TESTS

Index tests (ASTM D 4318) are performed to determine the moisture content boundaries between the liquid, plastic, and solid states of soils. These boundaries are called the Liquid Limit (LL) and Plastic Limit (PL). From these we derive the Plasticity Index (PI). Together, the LL, PL, and PI are referred to as the Atterberg Limits.

MOISTURE CONTENT

The natural moisture content is determined in accordance with ASTM D 854 by oven-drying and weighing the sample.

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
RICHMOND, VIRGINIA

TABLE C1

LABORATORY TESTING SUMMARY

PROJECT NAME: GILMERTON BRIDGE REPLACEMENT PROJECT
MACTEC PROJECT NUMBER: 20400-2-1213.01.LAB
DATE: 11/17/03

SAMPLE IDENTIFICATION							INDEX PROPERTIES						STRENGTH				1-D CONSOLIDATION				
BORING	TYPE	GROUND SURFACE ELEVATION	DEPTH (bgs)		ELEVATION (msl)		NATURAL MOISTURE	LIQUID & PLASTIC LIMITS			% FINER #200 SIEVE	USCS CLASSIFICATION	CIU TRIAXIAL				σ'p STATIC (ksf)	σ'p CASAGRANDE (ksf)	OCR	CR	RR
			From	To	From	To	(%)	LL (%)	PL (%)	PI (%)			c' (ksf)	c' (ksf)	φ' (°)	φ' (°)					
MS-1	SS	8.0	4.5	6	3.5	2.0	24.3	20	16	4	30.2	SC-SM	-	-	-	-	-	-	-	-	-
	SS	8.0	28.5	30	-20.5	-22.0	47.4	40	31	9	90.0	ML	-	-	-	-	-	-	-	-	-
	SS	8.0	38.5	40	-30.5	-32.0	45.7	31	32	NP	42.2	SM	-	-	-	-	-	-	-	-	-
	SS	8.0	53.5	55	-45.5	-47.0	40.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	8.0	58.5	60	-50.5	-52.0	35.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	8.0	113.5	115	-105.5	-107.0	35.8	22	23	NP	33.3	SM	-	-	-	-	-	-	-	-	-
MS-1A	UD	8.0	28	30	-20.0	-22.0	48.4	45	31	14	94.6	ML	-	-	-	-	1.4	1.5	1.0	0.15	0.01
MS-1A	UD	8.0	32	34	-24.0	-26.0	47.5	41	25	16	82.2	CL	-	-	-	-	1.6	1.6	1.0	0.14	0.01
MS-1	UD	8.0	34	36	-26.0	-28.0	55.2	50	29	21	67.6	ML	-	-	-	-	-	-	-	-	-
MS-2	SS	-5.0	3.5	5	-8.5	-10.0	135.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-5.0	8.5	10	-13.5	-15.0	35.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-5.0	18.5	20	-23.5	-25.0	44.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-5.0	23.5	25	-28.5	-30.0	30.0	NP	NP	NP	5.6	SP-SM	-	-	-	-	-	-	-	-	-
	SS	-5.0	38.5	40	-43.5	-45.0	39.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-5.0	63.5	65	-68.5	-70.0	33.8	NP	NP	NP	31.7	SM	-	-	-	-	-	-	-	-	-
	SS	-5.0	98.5	100	-103.5	-105.0	28.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-5.0	118.5	120	-123.5	-125.0	26.4	26	20	6	29.0	SC-SM	-	-	-	-	-	-	-	-	-
	UD	-5.0	42.0	44.0	-47.0	-49.0	39.0	45	24	21	96.4	CL	110	170	27	19	-	-	-	-	-
MS-3	SS	-22.0	13.5	15	-35.5	-37.0	27.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	28.5	30	-50.5	-52.0	42.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	43.5	45	-65.5	-67.0	31.2	NP	NP	NP	34.6	SM	-	-	-	-	-	-	-	-	-
	SS	-22.0	123.5	125	-145.5	-147.0	34.6	45	18	27	79.9	CL	-	-	-	-	-	-	-	-	-
	SS	-22.0	133.5	135	-155.5	-157.0	37.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	143.5	145	-165.5	-167.0	36.4	56	22	34	99.0	CH	-	-	-	-	-	-	-	-	-
	UD	-22.0	136	138	-158.0	-160.0	38.5	60	25	35	95.6	CH	860	980	12	8	6.0	6.0	1.0	0.19	0.03
MS-4	SS	-22.0	8	9.5	-30.0	-31.5	45.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	13.5	15	-35.5	-37.0	59.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	18.5	20	-40.5	-42.0	33.5	NP	NP	NP	11.9	SP-SM	-	-	-	-	-	-	-	-	-
	SS	-22.0	48.5	50	-70.5	-72.0	36.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	103.5	105	-125.5	-127.0	26.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-22.0	133.5	135	-155.5	-157.0	36.2	51	22	29	99.2	CH	-	-	-	-	-	-	-	-	-
	SS	-22.0	153.5	155	-175.5	-177.0	24.7	33	14	19	56.2	CL	-	-	-	-	-	-	-	-	-
	SS	-22.0	173.5	175	-195.5	-197.0	26.8	26	14	12	39.7	SC	-	-	-	-	-	-	-	-	-
	UD	-22.0	127	129	-149.0	-151.0	37.5	52	25	27	98.9	CH	960	1140	19.0	11.6	-	-	-	-	-
MS-5	SS	-23.0	23.5	25	-46.5	-48.0	36.0	NP	NP	NP	9.1	SP-SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	43.5	45	-66.5	-68.0	33.4	NP	NP	NP	30.4	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	53.5	55	-76.5	-78.0	29.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	68.5	70	-91.5	-93.0	32.4	NP	NP	NP	31.7	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	73.5	75	-96.5	-98.0	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	88.5	90	-111.5	-113.0	20.0	NP	NP	NP	23.0	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	98.5	100	-121.5	-123.0	32.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	108.5	110	-131.5	-133.0	25.2	NP	NP	NP	12.8	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	123.5	125	-146.5	-148.0	25.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	128.5	130	-151.5	-153.0	36.8	52	20	32	96.9	CH	-	-	-	-	-	-	-	-	-
	SS	-23.0	147	148.5	-170.0	-171.5	28.0	38	15	23	69.5	CL	-	-	-	-	-	-	-	-	-
	SS	-23.0	154	155.5	-177.0	-178.5	26.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	164	165.5	-187.0	-188.5	26.2	26	19	7	38.4	SC-SM	-	-	-	-	-	-	-	-	-
	UD	-23.0	145	147	-168.0	-170.0	39.1	68	28	40	97.1	CH	-	-	-	-	7.7	18	2.3	0.31	0.06
	UD	-23.0	60	62	-83.0	-85.0	29.8	NP	NP	NP	31.8	SM	0	160	38.4	37.4	-	-	-	-	-
MS-6	SS	-23.0	28.5	30	-28.5	-30.0	37.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	38.5	40	-38.5	-40.0	26.5	NP	NP	NP	8.2	SP-SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	48.5	50	-48.5	-50.0	31.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	63.5	65	-63.5	-65.0	35.6	NP	NP	NP	31.4	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	68.5	70	-68.5	-70.0	30.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	83.5	85	-83.5	-85.0	22.1	17	15	2	15.8	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	103.5	105	-103.5	-105.0	28.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	113.5	115	-113.5	-115.0	26.8	20	18	2	14.7	SM	-	-	-	-	-	-	-	-	-
	SS	-23.0	128.5	130	-128.5	-130.0	30.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SS	-23.0	133.5	135	-133.5	-135.0	38.0	49	20	29	97.2	CL	-	-	-	-	-	-	-	-	-

REMARKS: NP=NON-PLASTIC

PREPARED BY: TAW
CHECKED BY: JRW

P:\1200\1213 Gilmerton Bridge\Laboratory\Lab Summaries\[031113 Lab Testing Summary.xls]SUMMARY

MACTEC

MACTEC ENGINEERING AND CONSULTING, INC.
RICHMOND, VIRGINIA

TABLE C2

SUPPLEMENTARY Y2 LABORATORY TESTING SUMMARY FROM PREVIOUS MACTEC PROJECTS

PROJECT NAME: GILMERTON BRIDGE REPLACEMENT PROJECT
MACTEC PROJECT NUMBER: 20400-2-1213.01.LAB
DATE: 11/14/03

SAMPLE IDENTIFICATION							INDEX PROPERTIES						STRENGTH		1-D CONSOLIDATION					
BORING	TYPE	GROUND SURFACE ELEVATION	DEPTH (feet)		ELEVATION (feet)		NATURAL MOISTURE	LIQUID & PLASTIC LIMITS			% FINER #200 SIEVE	USCS CLASSIFICATION	CIU TRIAXIAL		GEOSTATIC σ'_{vo} (ksf)	CASAGRANDE σ'_c (ksf)	SOWERS σ'_c (ksf)	CCR	CR	RR
			From	To	From	To	(%)	LL (%)	PL (%)	PI (%)			c (psf)	φ (°)						
CB-2	UD	32.5	26	28	6.5	4.5	30.1	25	NP	-	25.3	SM		36	1.5	25.0	13.5	16.7	0.16	0.003
	UD	32.5	36	38	-3.5	-5.5	30.9	38	30	8	44.1	SC		-	1.9	20.0	12.0	10.4	0.14	0.004
CB-4	UD	40.0	27	29	13.0	11.0	38.1	32	NP	-	50	SM		36	2.1	24.0	13.5	11.4	0.21	0.004
CB-26	UD	33.8	20	22	13.8	11.8	33.3	36	NP	-	27	SM		41	1.5	6.6	5.0	4.3	0.10	0.004
CB-36	UD	34.1	18	20	16.1	14.1	41.5	36	21	15	70	CL		-	1.4	7.1	4.9	5.1	0.16	0.006
	UD	34.1	28	30	6.1	4.1	29.2	30	22	8	30	SC		44	2.0	-	-	-	-	-
PB-6	UD	31.9	43	45	-11.1	-13.1	35.2	-	-	-	-	SC		33	2.5	-	-	-	-	-

REMARKS: NP=NON-PLASTIC

PREPARED BY: MLH
CHECKED BY: JRW

P:\1200\1213 Gilmerton Bridge\Laboratory\Lab Summaries\[Old Y2 Lab Testing Summary.xls]SUMMARY

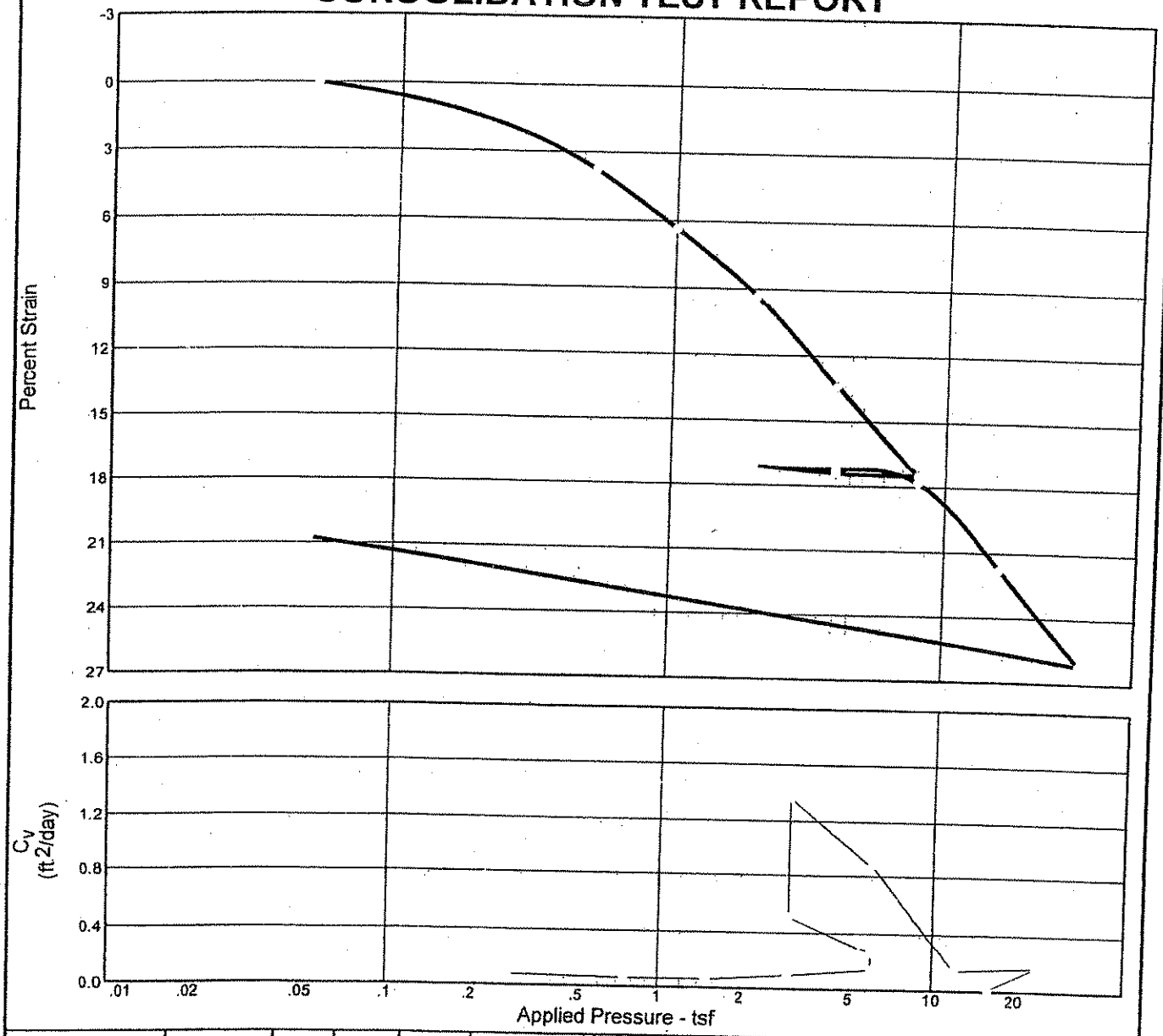
CONSOLIDATION TESTS

One-dimensional consolidation tests are conducted to determine the compression characteristics of soils under applied vertical stresses. Test results may provide information including the magnitude of settlement, the time-rate effects, and the past stress history of the soil.

Tests are conducted in general accordance with ASTM D 2435. A soil sample 2.5 inches in diameter and 1.0 inch thick is fitted into a stainless steel ring, with porous stones above and below the soil. The sample is then placed in a loading device and subjected to a series of increasing vertical stresses under conditions of no lateral strain. Time-deformation readings are recorded for each applied stress, and the resultant strain or void ratio is calculated.

Typically, test results include a plot of void ratio or percent strain versus the log of the applied stress. The virgin compression index (C_c), the rebound or swelling index (C_s), the coefficient of consolidation (C_V), the constrained modulus ($M=1/m_v$), and the preconsolidation stress (P'_c) are all important parameters obtained from this test.

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
95.8 %	48.4 %	71.0	45	14	2.67		2.37	0.34	0.03			1.349

MATERIAL DESCRIPTION	USCS	AASHTO
DARK GRAY SILT	ML	ND

Project No. 2040021213 **Client:**

Project: Gilmerton Bridge Replacement Project

Location: MS-1A 28-30 ft

Remarks:
SPECIFIC GRAVITY IS ASSUMED
ND=NOT DETERMINED

CONSOLIDATION TEST REPORT

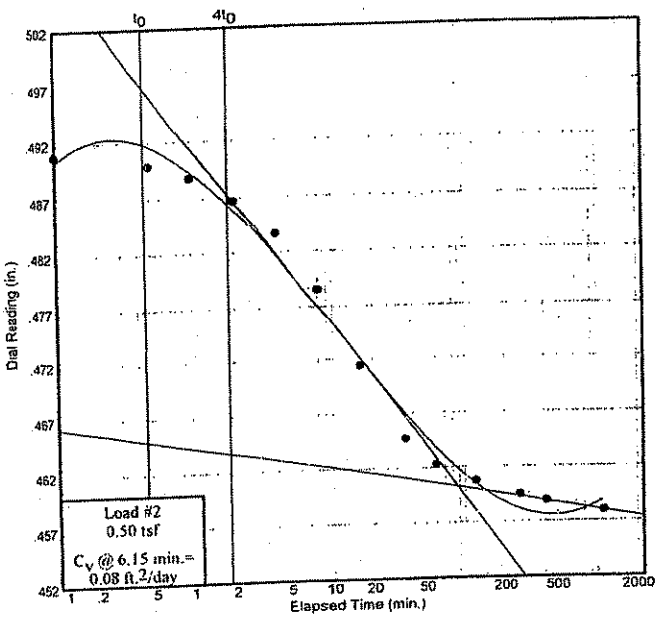
MACTEC ENGINEERING & CONSULTING, INC.

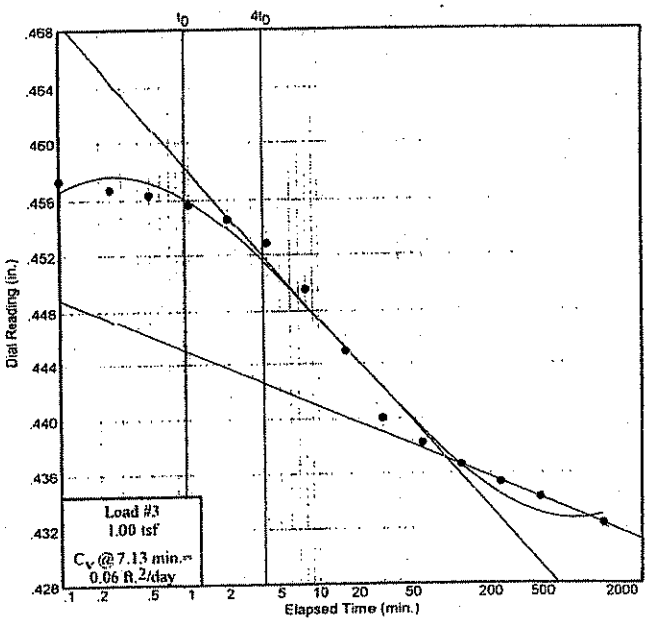
Plate 1A

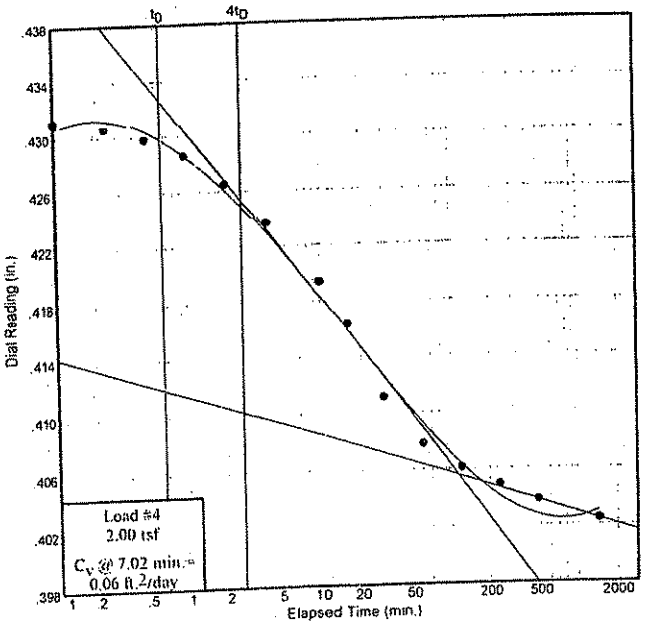
Dial Reading vs. Time

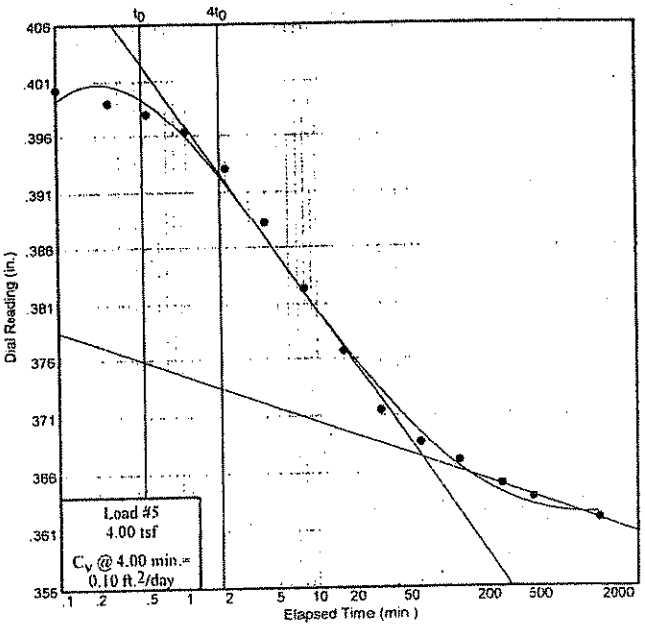
Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A 28-30 ft









Dial Reading vs. Time

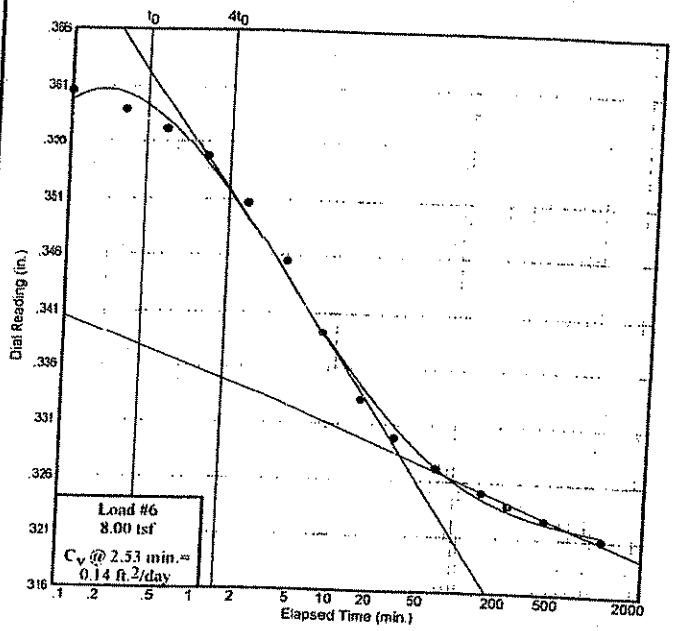
MACTEC ENGINEERING & CONSULTING, INC.

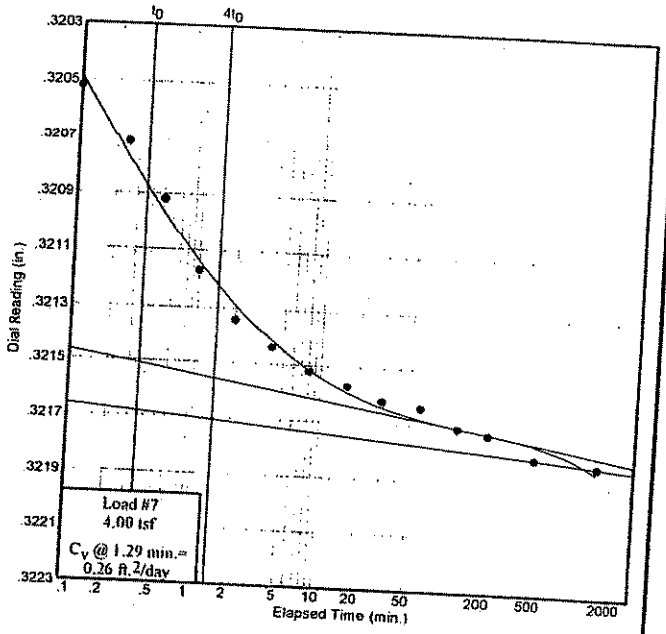
Plate 2A

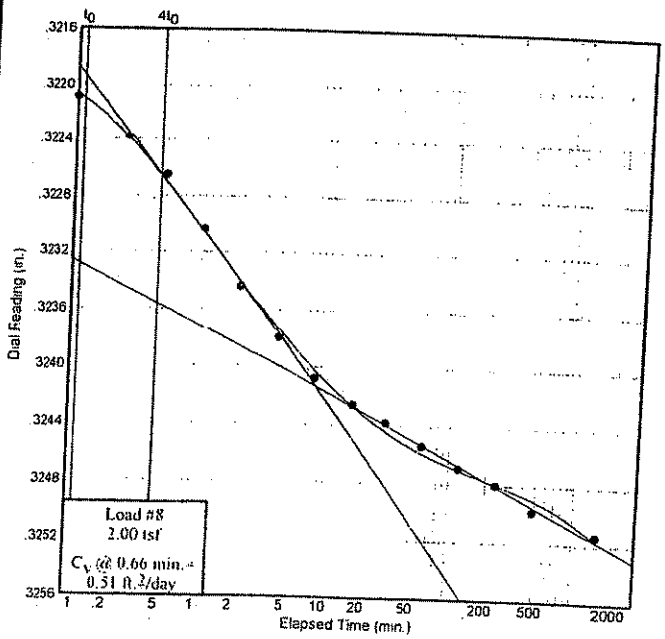
Dial Reading vs. Time

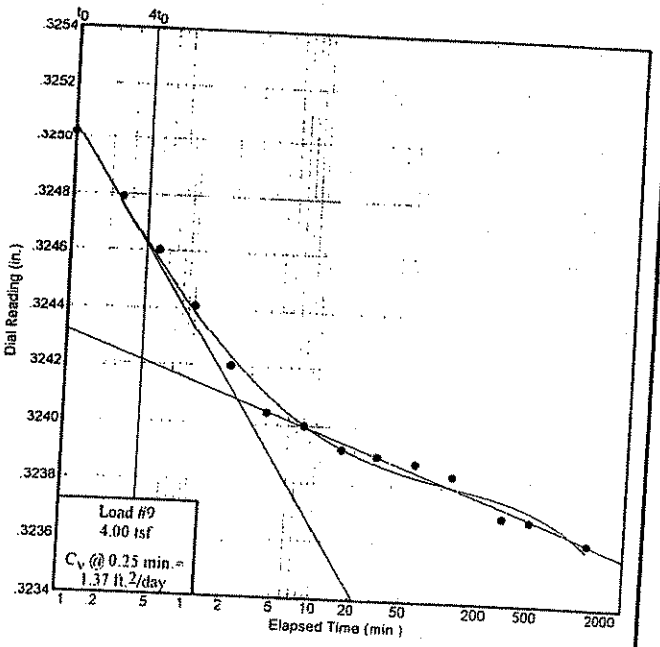
Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A 28-30 ft









Dial Reading vs. Time

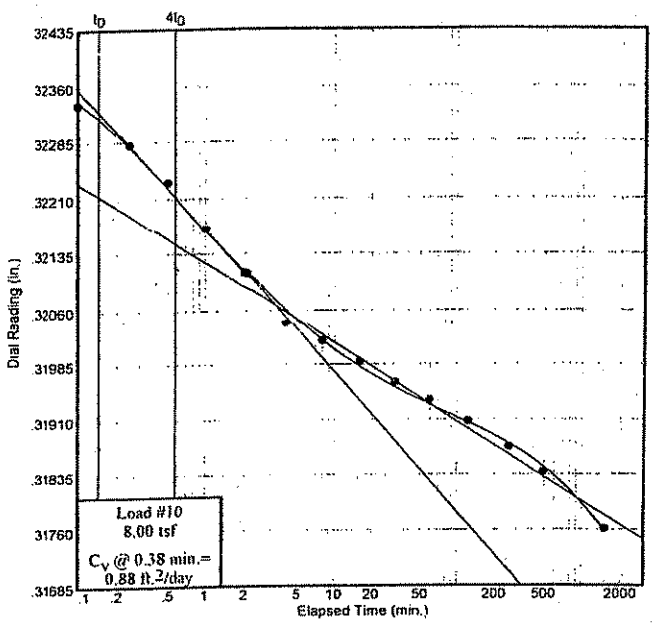
MACTEC ENGINEERING & CONSULTING, INC.

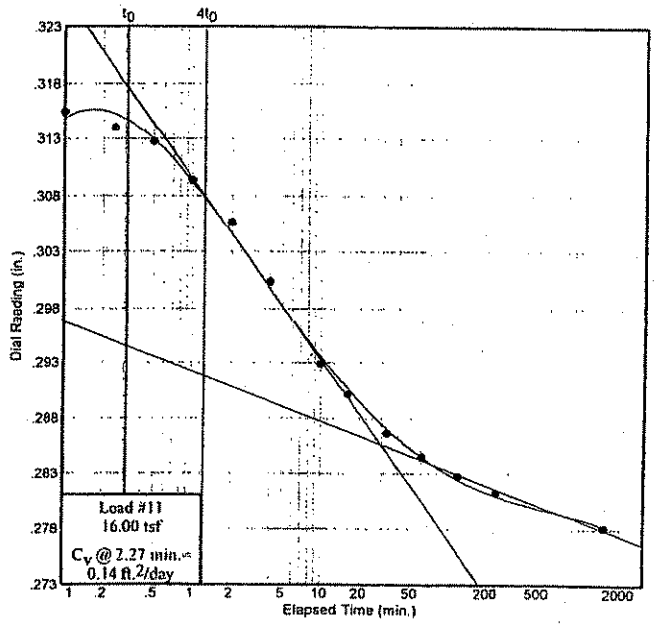
Plate 3A

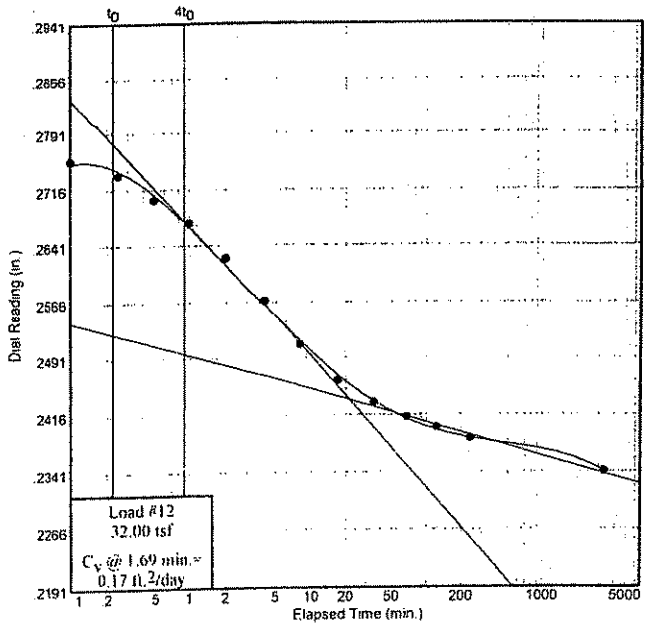
Dial Reading vs. Time

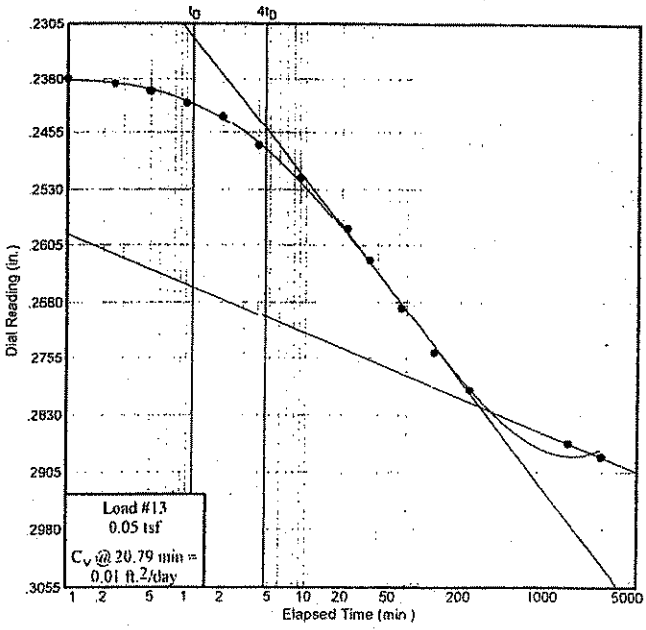
Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A 28-30 ft







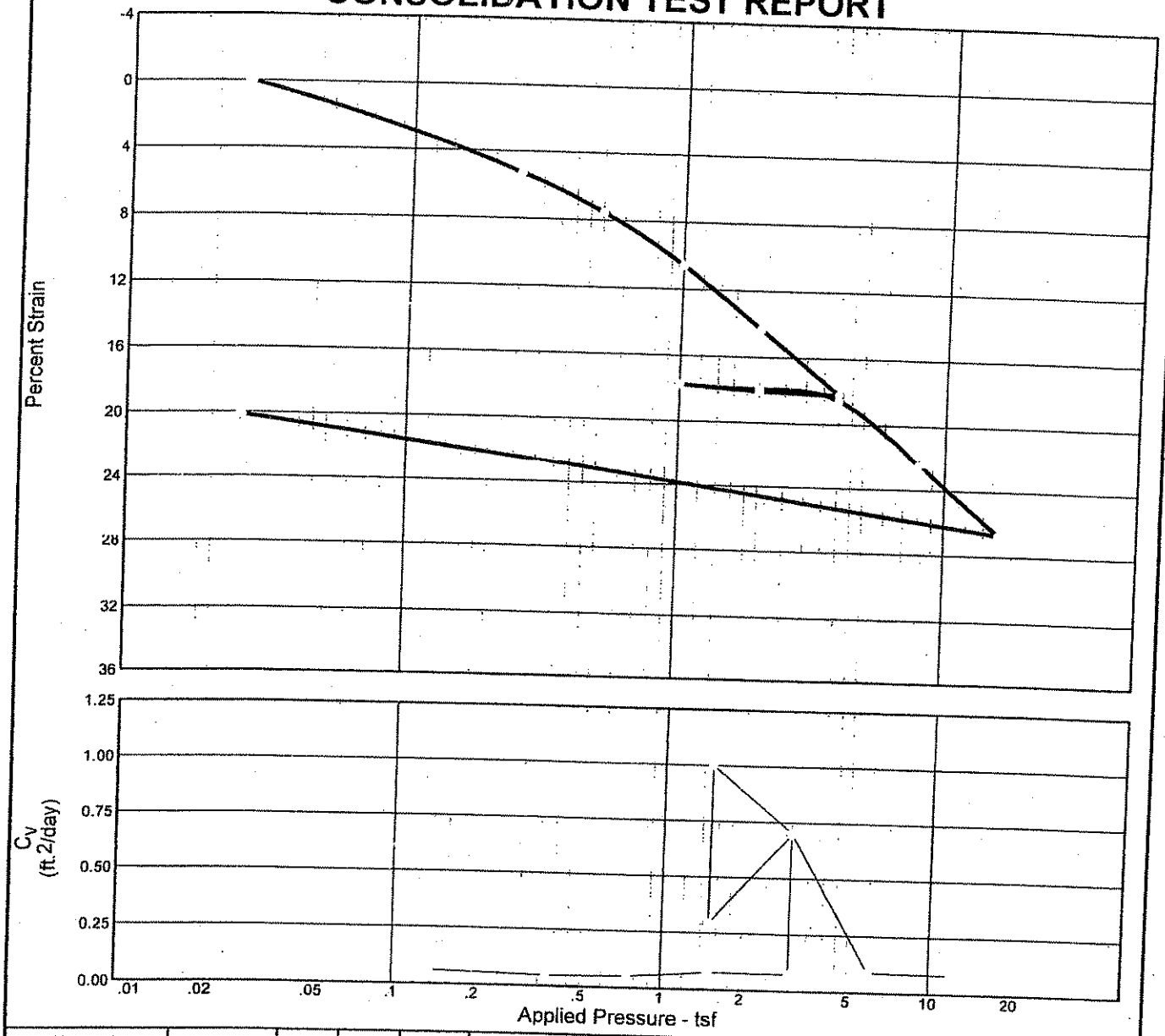


Dial Reading vs. Time

MACTEC ENGINEERING & CONSULTING, INC.

Plate 4A

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Swell Press. (tsf)	Swell %	e_o
99.9 %	47.5 %	73.4	41	16	2.67		0.77	0.32	0.03			1.270

MATERIAL DESCRIPTION	USCS	AASHTO
Dark gray lean clay with sand	CL	ND

Project No. 2040021213 **Client:**

Project: Gilmerton Bridge Replacement Project

Location: MS-1A UD-2 32-34 FT

Remarks:
SPECIFIC GRAVITY IS ASSUMED
ND=NOT DETERMINED

CONSOLIDATION TEST REPORT

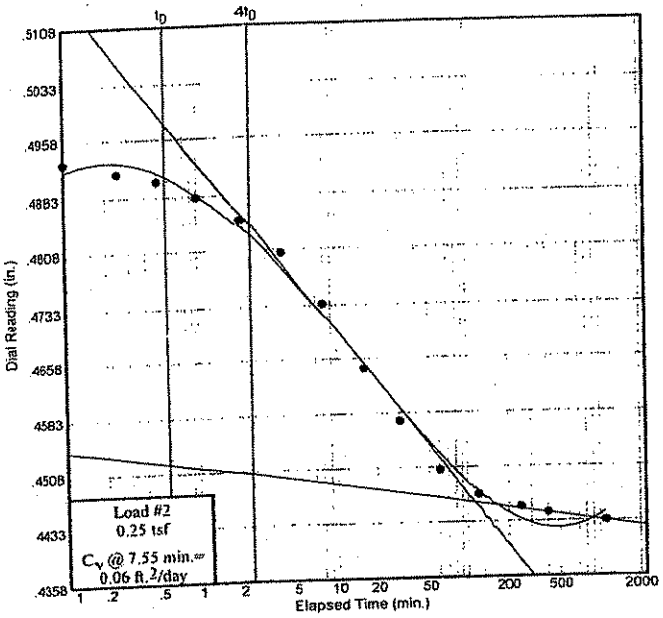
MACTEC ENGINEERING & CONSULTING, INC.

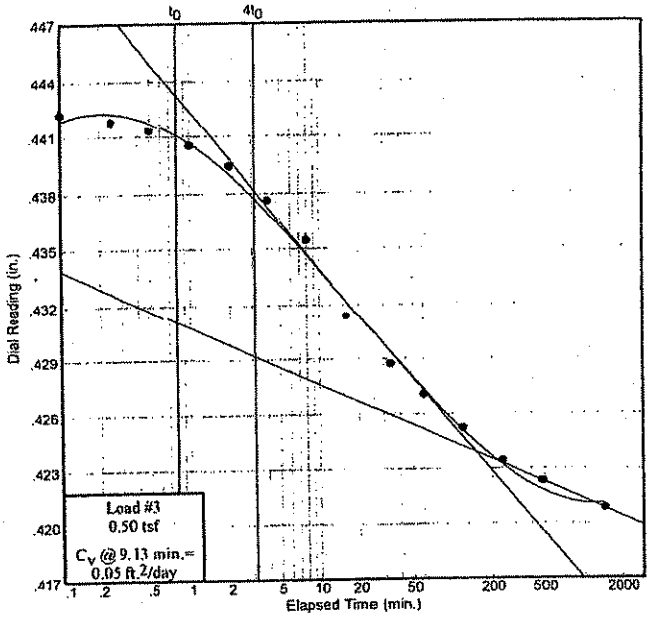
Plate 1a

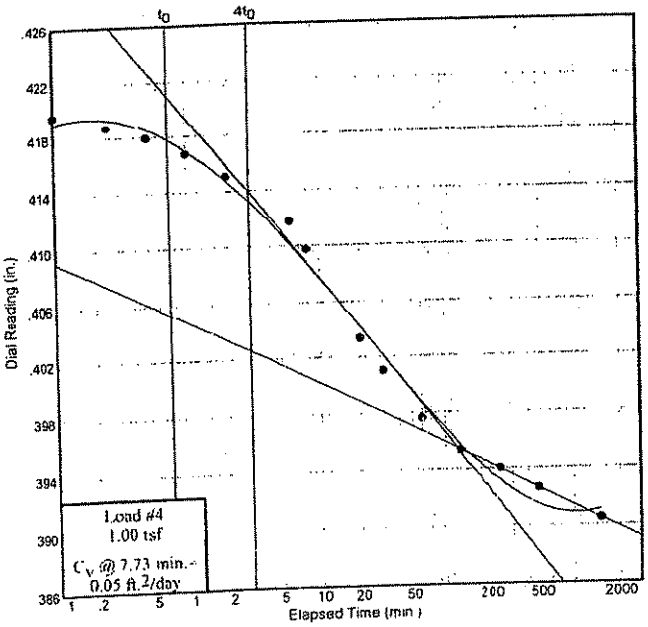
Dial Reading vs. Time

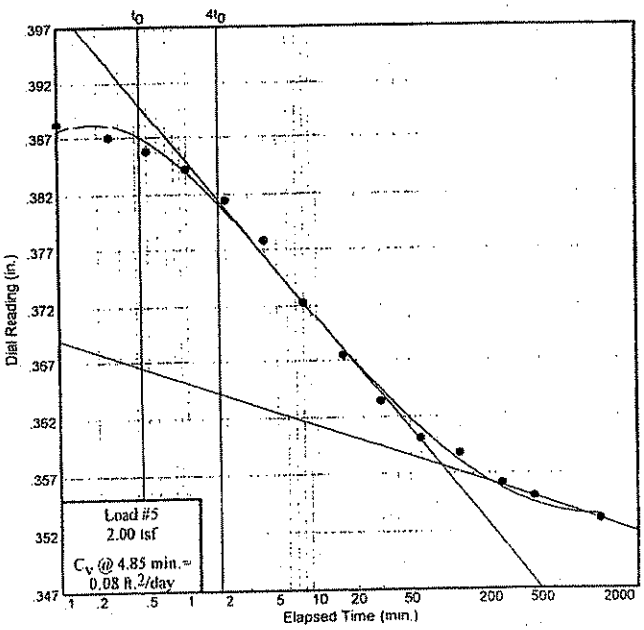
Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A UD-2 32-34 FT









Dial Reading vs. Time

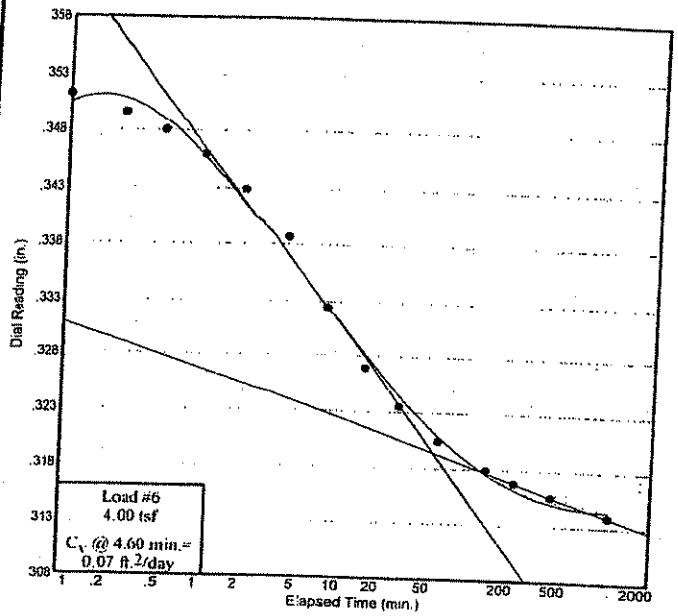
MACTEC ENGINEERING & CONSULTING, INC.

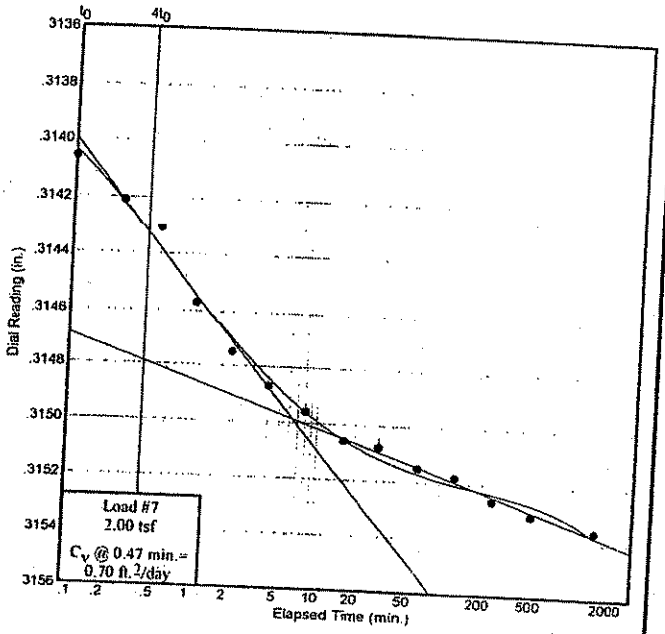
Plate 2a

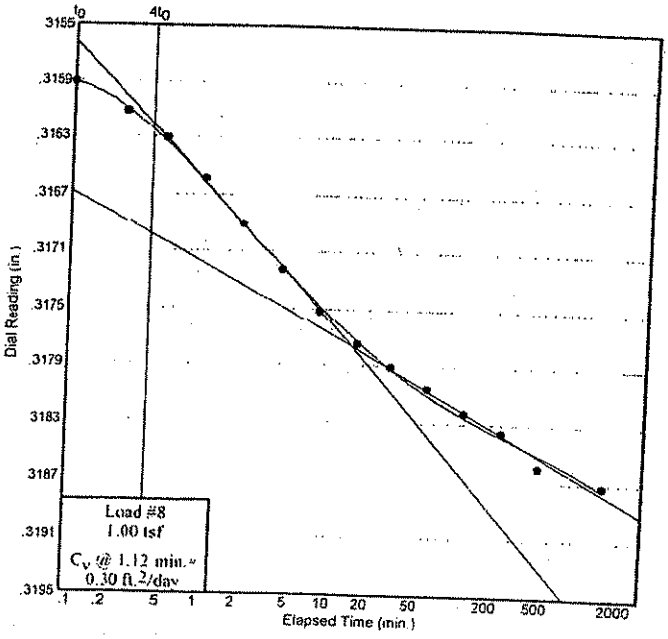
Dial Reading vs. Time

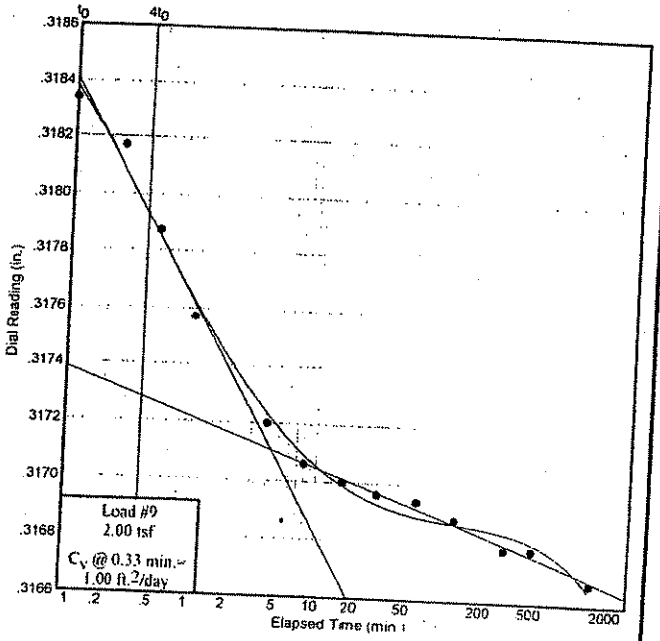
Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A UD-2 32-34 FT









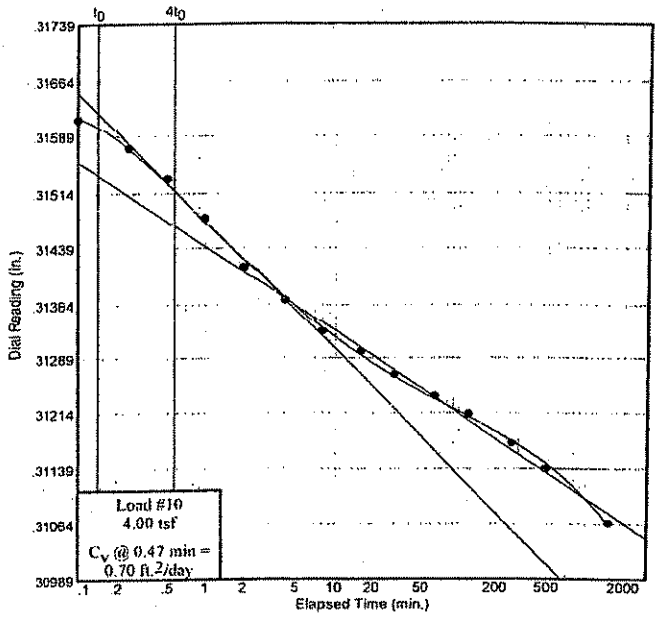
Dial Reading vs. Time

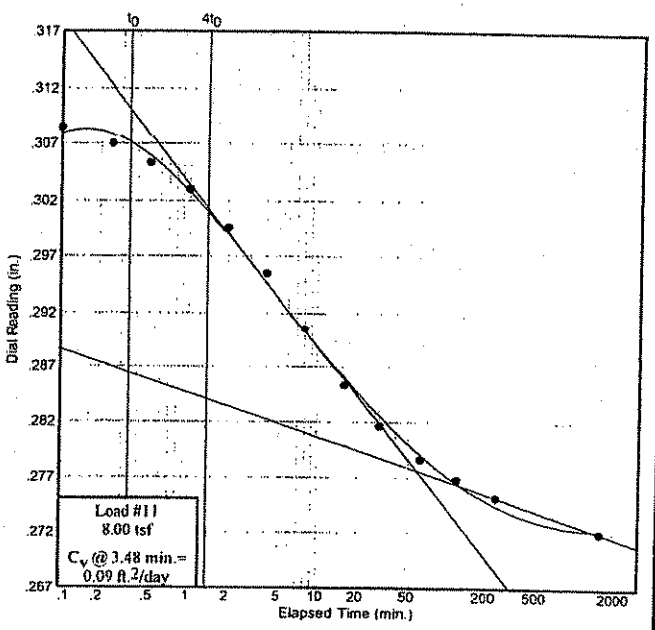
MACTEC ENGINEERING & CONSULTING, INC.

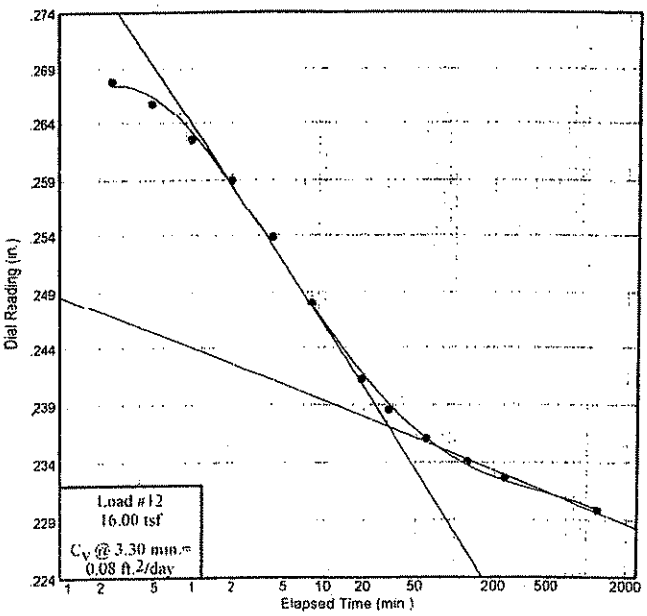
Dial Reading vs. Time

Project No.: 2040021213
Project: Gilmerton Bridge Replacement Project

Location: MS-1A UD-2 32-34 FT





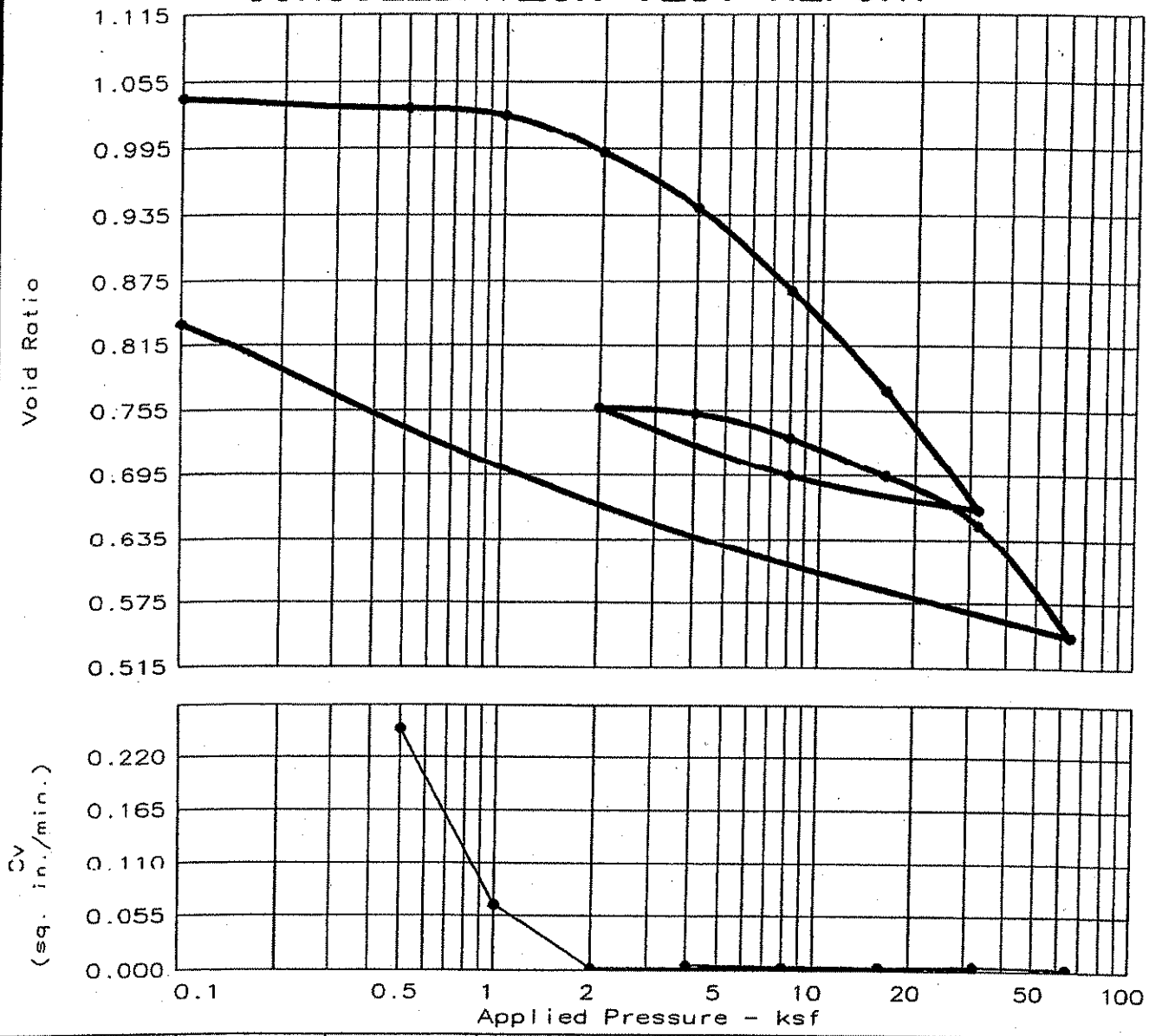


Dial Reading vs. Time

MACTEC ENGINEERING & CONSULTING, INC.

Plate 4a

CONSOLIDATION TEST REPORT



Wet Density	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Precons. (ksf)	C_c	e_o
118.6	38.5 %	85.6	60	35	2.700	38.39	0.37	1.0405

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index - 0.37	Grey Silty Fat Clay Class: CH
Project No.: 20400-2-1213 Phase 04 Project: Gilmerton Bridge Replacement Project Location: MS-3, UD-1 @ 136'-138' Date: 07-28-03	Remarks: A-7-6(39)
CONSOLIDATION TEST REPORT LAW ENGINEERING AND ENVIRONMENTAL SERVICES	Fig. No. _____

11:54, 7-29-1903 CONSOLIDATION TEST PROJECT DATA Test No. 196

Project Number: 20400-2-1213 Phase 04
Project: Gilmerton Bridge Replacement Project
Date: 07-28-03
Location 1: MS-3, UD-1 @ 136'-138'
2:
Remarks 1: A-7-6(39)
2:
3:
4:
5:
Material description Grey Silty Fat Clay

Classification: CH
Liquid limit: 60
Plasticity index: 35
Figure Number:

CONSOLIDATION TEST SPECIMEN DATA

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 132.11 g.	Oedometer No. = 3	Wet w+t = 124.52 g.
Dry w+t = 95.39 g	Machine No. = 3	Dry w+t = 95.39 g.
Tare wt. = 0.00 g.	Spec. Gravity = 2.700	Tare wt. = 0.00 g.
Height = 5.9010 in.	Height = 0.9880 in.	
Diameter = 2.8460 in.	Diameter = 2.3810 in.	
Weight = 1168.20 g.		
Moisture = 38.5 %	Ht. Solids = 0.4842 in.	Moisture = 30.5 %
Wet Den. = 118.6 pcf	Dry wt. = 98.85 g.	Dry wt. = 95.39 g. *
Dry Den. = 85.6 pcf	Void ratio = 1.0405	Void ratio = 0.8340
	Saturation = 99.9 %	

* Final dry weight used in calculations

CONSOLIDATION TEST READINGS SUMMARY

LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
Initial	0.25000			1.0405	
0.10	0.25000	0.0000	0.25000	1.0405	0.0
0.50	0.24550	0.0002	0.24570	1.0316*	0.4 Comprs.*
1.00	0.24090	0.0004	0.24130	1.0251*	0.8 Comprs.*
2.00	0.22490	0.0007	0.22560	0.9915*	2.4 Comprs.*
4.00	0.20000	0.0011	0.20110	0.9412*	4.9 Comprs.*
8.00	0.16280	0.0018	0.16460	0.8657*	8.6 Comprs.*
16.00	0.11680	0.0029	0.11970	0.7729*	13.1 Comprs.*
32.00	0.06380	0.0046	0.06840	0.6630*	18.5 Comprs.*
8.00	0.08200	0.0018	0.08380	0.6948	16.9 Comprs.
2.00	0.11340	0.0007	0.11410	0.7574	13.9 Comprs.
4.00	0.10910	0.0011	0.11020	0.7524*	14.1 Comprs.*
8.00	0.09770	0.0018	0.09950	0.7299*	15.2 Comprs.*
16.00	0.07950	0.0029	0.08240	0.6946*	17.0 Comprs.*

CONSOLIDATION TEST READINGS SUMMARY

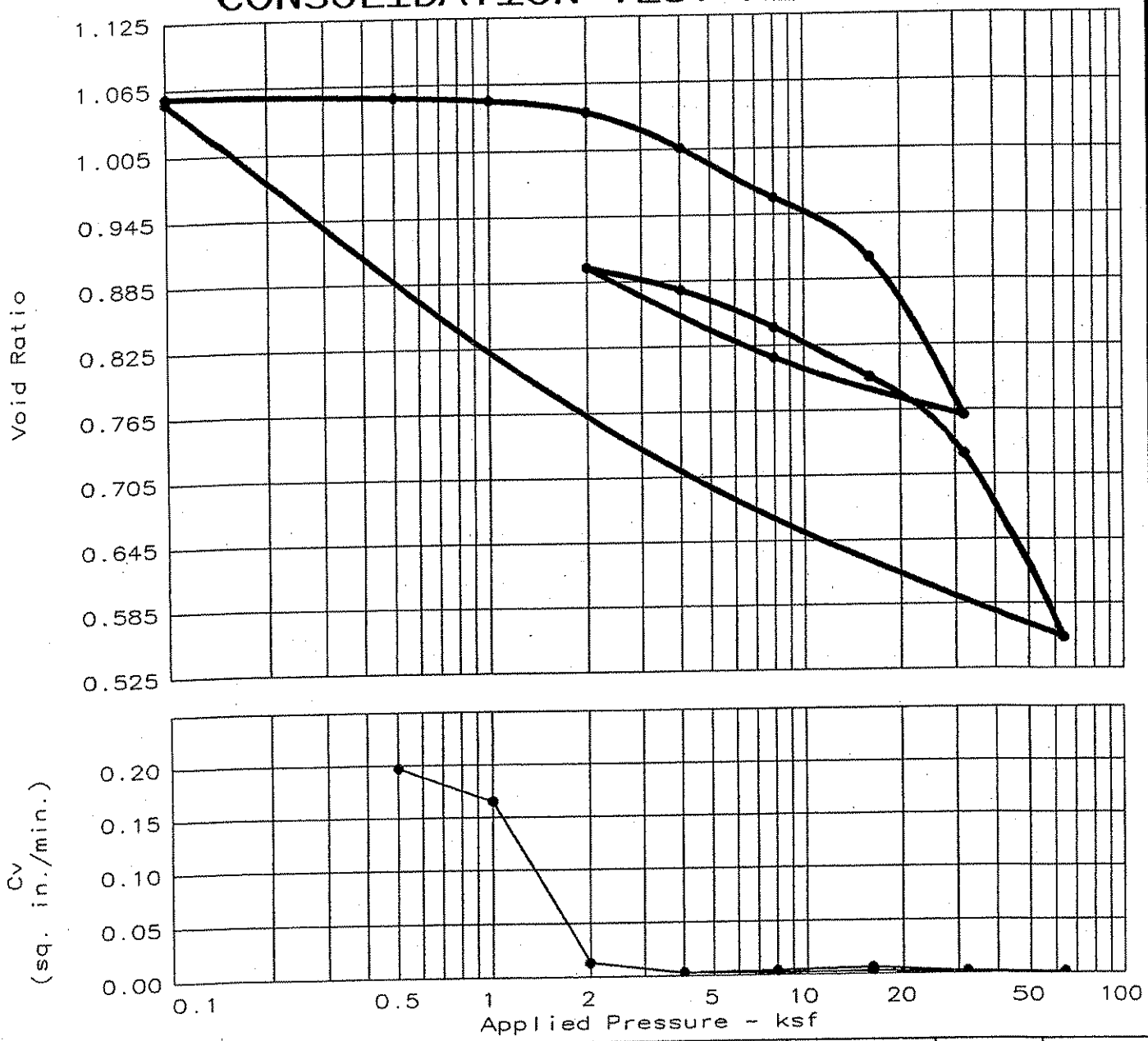
LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
32.00	0.05160	0.0046	0.05620	0.6484*	19.2 Comprs.*
64.00	0.00000	0.0076	0.00760	0.5435*	24.4 Comprs.*
0.10	0.14830	0.0000	0.14830	0.8340	10.1 Comprs.

* CALCULATED USING D100 INSTEAD OF FINAL READING

CONSOLIDATION TEST RESULTS

Compression index = 0.37
Preconsolidation pressure = 38.39 ksf

CONSOLIDATION TEST REPORT



Wet Density	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Precons. (ksf)	C_c	e_o
114.2	39.1 %	82.1	68	40	2.700	18.62	0.63	1.0574

TEST RESULTS

Compression Index = 0.63

MATERIAL DESCRIPTION

Grey Silty Fat Clay
A-7-6(46)

Class: CH

Project No.: 20400-2-1213 Phase 04
Project: Gilmerton Bridge Replacement Project
Location: MS-5, UD-4 @ 145.0'-147.0'

Date: 08-04-03

Remarks:

CONSOLIDATION TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No. _____

:58, 8-05-1903 CONSOLIDATION TEST PROJECT DATA Test No. 198

Project Number: 20400-2-1213 Phase 04
Project: Gilmerton Bridge Replacement Project
Date: 08-04-03
Location 1: MS-5, UD-4 @ 145.0'-147.0'
2:
Remarks 1:
2:
3:
4:
5:
Material description Grey Silty Fat Clay
A-7-6(46)
Classification: CH
Liquid limit: 68
Plasticity index: 40
Figure Number:

CONSOLIDATION TEST SPECIMEN DATA

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 128.98 g.	Oedometer No. = 4	Wet w+t = 129.52 g.
Dry w+t = 92.72 g	Machine No. = 4	Dry w+t = 92.72 g.
Tare wt. = 0.00 g.	Spec. Gravity = 2.700	Tare wt. = 0.00 g.
Height = 1.9330 in.	Height = 0.9790 in.	
Diameter = 2.8360 in.	Diameter = 2.3680 in.	
Weight = 366.13 g.		
Moisture = 39.1 %	Ht. Solids = 0.4758 in.	Moisture = 39.7 %
Wet Den. = 114.2 pcf	Dry wt. = 92.94 g.	Dry wt. = 92.72 g. *
Dry Den. = 82.1 pcf	Void ratio = 1.0574	Void ratio = 1.0525
	Saturation = 99.9 %	

* Final dry weight used in calculations

CONSOLIDATION TEST READINGS SUMMARY

LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
Initial	0.25000			1.0574	
0.10	0.25000	0.0000	0.25000	1.0574	0.0
0.50	0.24805	0.0004	0.24845	1.0542*	0.2 Comprs.*
1.00	0.24600	0.0007	0.24670	1.0505*	0.3 Comprs.*
2.00	0.23980	0.0010	0.24080	1.0392*	0.9 Comprs.*
4.00	0.22380	0.0016	0.22540	1.0060*	2.5 Comprs.*
8.00	0.20100	0.0024	0.20340	0.9598*	4.7 Comprs.*
16.00	0.16990	0.0036	0.17350	0.9051*	7.4 Comprs.*
32.00	0.09870	0.0053	0.10400	0.7599*	14.5 Comprs.*
8.00	0.12720	0.0024	0.12960	0.8137	11.8 Comprs.
2.00	0.16890	0.0010	0.16990	0.8984	7.7 Comprs.
4.00	0.16220	0.0016	0.16380	0.8768*	8.8 Comprs.*
8.00	0.14550	0.0024	0.14790	0.8414*	10.5 Comprs.*
16.00	0.12200	0.0036	0.12560	0.7955*	12.7 Comprs.*

CONSOLIDATION TEST READINGS SUMMARY

LOAD (ksf)	DIAL (in.)	DEFLECTION (in.)	CORRECTED DIAL (in.)	VOID RATIO	% SWELL/COMPRS.
32.00	0.08460	0.0053	0.08990	0.7244*	16.2 Comprs.*
64.00	0.00960	0.0000	0.00960	0.5534*	24.5 Comprs.*
0.10	0.24710	0.0000	0.24710	1.0525	0.2 Comprs.

* CALCULATED USING D100 INSTEAD OF FINAL READING

CONSOLIDATION TEST RESULTS

Compression index = 0.63
Preconsolidation pressure = 18.62 ksf

TRIAXIAL SHEAR TESTS

Triaxial shear tests are used to measure the stress-strain characteristics and strength of soils under various loading conditions expected in the field. Tests may be undrained, semi-drained or fully-drained to simulate field behavior. Triaxial shear tests are performed in accordance with ASTM D 4767.

Triaxial shear tests are conducted either on relatively undisturbed samples or on remolded/compacted specimens of soil. Diameters of specimens range between 1.4 and 6.0 inches and a minimum length/diameter ratio of 2 is standard. Either stress-controlled or strain-controlled tests are performed. Loads are measured using proving rings or electronic load cells, deformations are monitored using electronic LVDT's or dial indicators, and pore water pressure is measured with transducers. Normally, samples are saturated, consolidated and sheared to failure under compression loading, although extension loading is also possible.

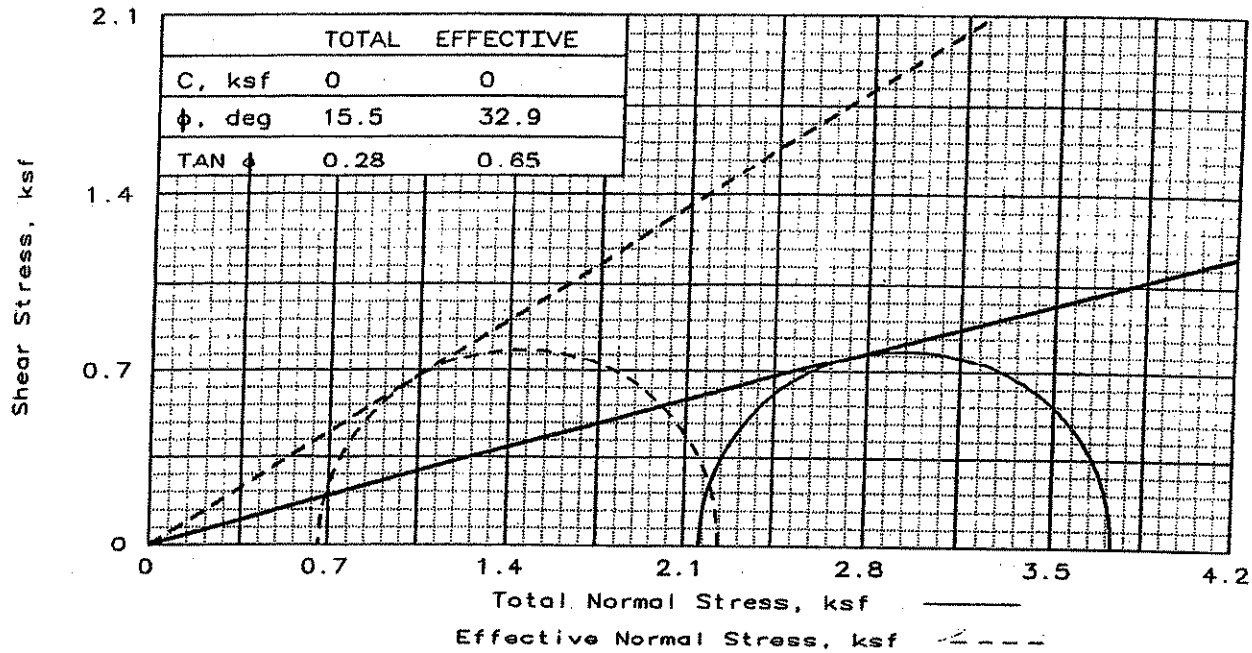
Various consolidation conditions may be implemented in the triaxial apparatus. Stress and deformation occur in three dimensions under triaxial conditions. The three most common types of triaxial compression tests in routine use include:

CU = isotropically-consolidated undrained (i.e., CIU)

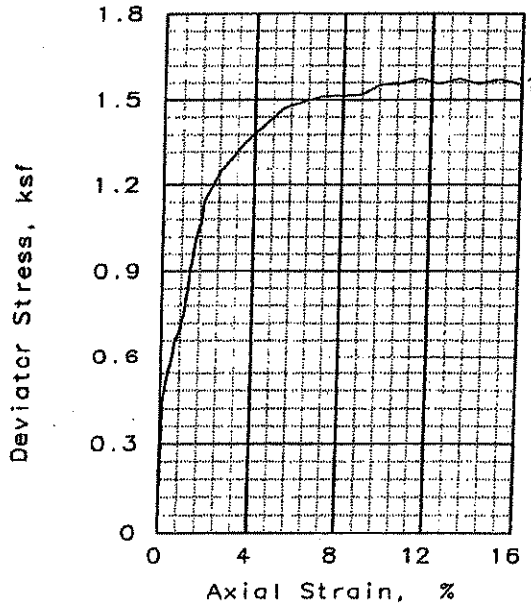
CD = isotropically-consolidated drained (i.e., CID)

UU = unconsolidated-undrained shear tests

The results of the tests are presented in terms of stress-strain curves and stress paths to failure. Alternatively, the strength may be represented by Mohr-Coulomb circles at failure. Short-term undrained strengths may be represented by total stress parameters (ϕ and C) or by undrained shear strengths (Su). The long-term drained strengths (condition of zero excess pore pressure response) are described by the effective stress parameters (ϕ and C').



	TOTAL	EFFECTIVE
C, ksf	0	0
ϕ, deg	15.5	32.9
TAN ϕ	0.28	0.65



SAMPLE NO.:		1
INITIAL	WATER CONTENT, %	55.2
	DRY DENSITY, pcf	66.0
	SATURATION, %	95.8
	VOID RATIO	1.555
	DIAMETER, in	2.87
	HEIGHT, in	5.68
AT TEST	WATER CONTENT, %	40.7
	DRY DENSITY, pcf	80.3
	SATURATION, %	100.0
	VOID RATIO	1.099
	DIAMETER, in	2.60
	HEIGHT, in	5.68
Strain rate, %/min		0.04
BACK PRESSURE, ksf		7.20
CELL PRESSURE, ksf		9.36
FAIL. STRESS, ksf		1.57
TOTAL PORE PR., ksf		8.70
ULT. STRESS, ksf		
TOTAL PORE PR., ksf		
$\bar{\sigma}_1$ FAILURE, ksf		2.24
$\bar{\sigma}_3$ FAILURE, ksf		0.66

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Grey-Brown Sandy Clayey Silt, A-7-6(14)
LL= 50 PL= 29 PI= 21
SPECIFIC GRAVITY= 2.7
REMARKS: USCS: ML

CLIENT:

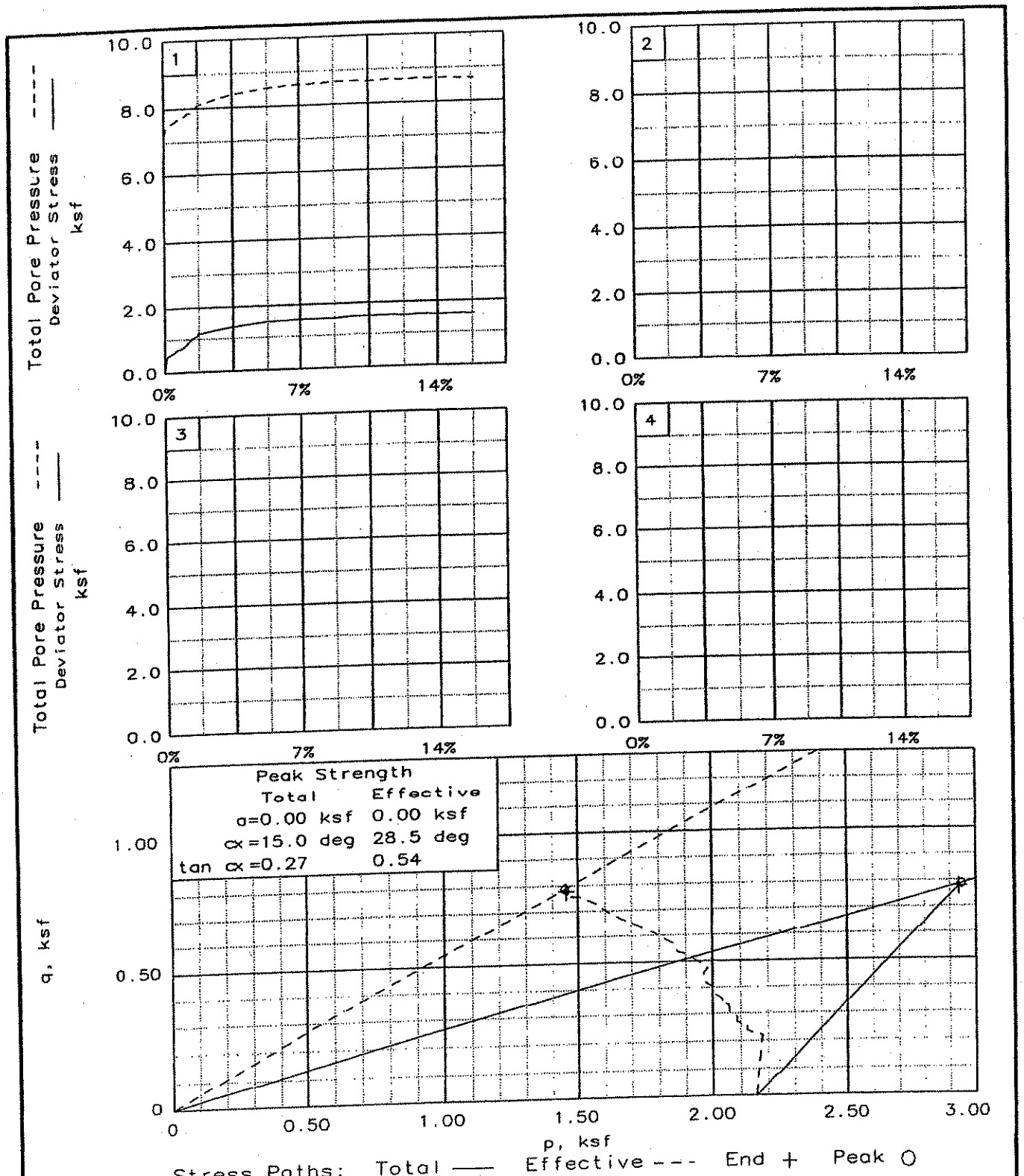
PROJECT: Gilmerton Bridge Replacement Project
SAMPLE LOCATION: MS-1, UD-1 @ 34.0'-36.0'

PROJ. NO.: 20400-2-1213.04 DATE: 07-09-03

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig No.: _____

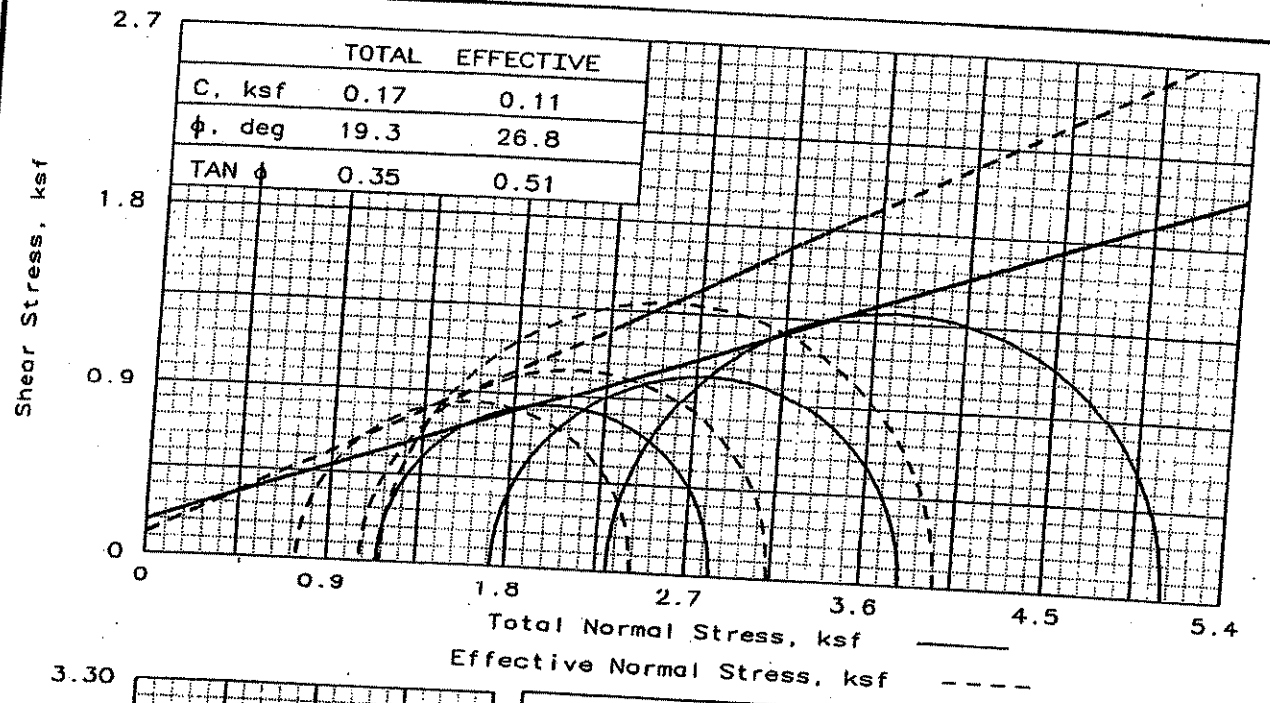


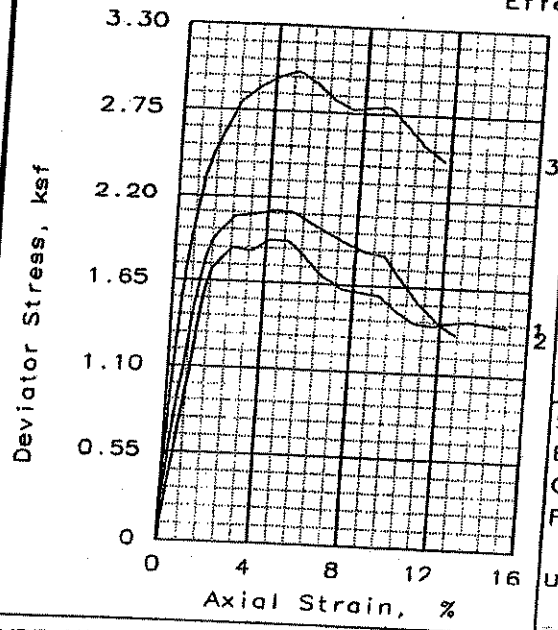
Client:

Project: Gilmerton Bridge Replacement Project

Location: MS-1, UD-1 @ 34.0'-36.0'

File: GIL-2 Project No.: 20400-2-1213.04 Fig. No.: ____





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	38.7	39.9	38.3
	DRY DENSITY, pcf	85.9	81.5	83.4
	SATURATION, %	108.4	101.0	101.2
	VOID RATIO	0.963	1.068	1.021
	DIAMETER, in	2.84	2.84	2.83
	HEIGHT, in	6.03	5.94	6.06
AT TEST	WATER CONTENT, %	39.5	40.7	37.4
	DRY DENSITY, pcf	81.5	80.3	83.9
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.067	1.099	1.009
	DIAMETER, in	2.92	2.88	2.84
	HEIGHT, in	6.00	5.89	5.98
Strain rate, %/min		0.03	0.03	0.03
BACK PRESSURE, ksf		8.64	8.64	8.64
CELL PRESSURE, ksf		9.79	10.37	10.94
FAIL. STRESS, ksf		1.68	2.07	2.80
TOTAL PORE PR., ksf		9.04	9.30	9.78
ULT. STRESS, ksf				
TOTAL PORE PR., ksf				
$\bar{\sigma}_1$ FAILURE, ksf		2.43	3.13	3.97
$\bar{\sigma}_3$ FAILURE, ksf		0.75	1.07	1.17

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Grey Silty Clay, A-7-6(23)
LL= 45 PL= 24 PI= 21
SPECIFIC GRAVITY= 2.7
REMARKS: USCS: CL

CLIENT:

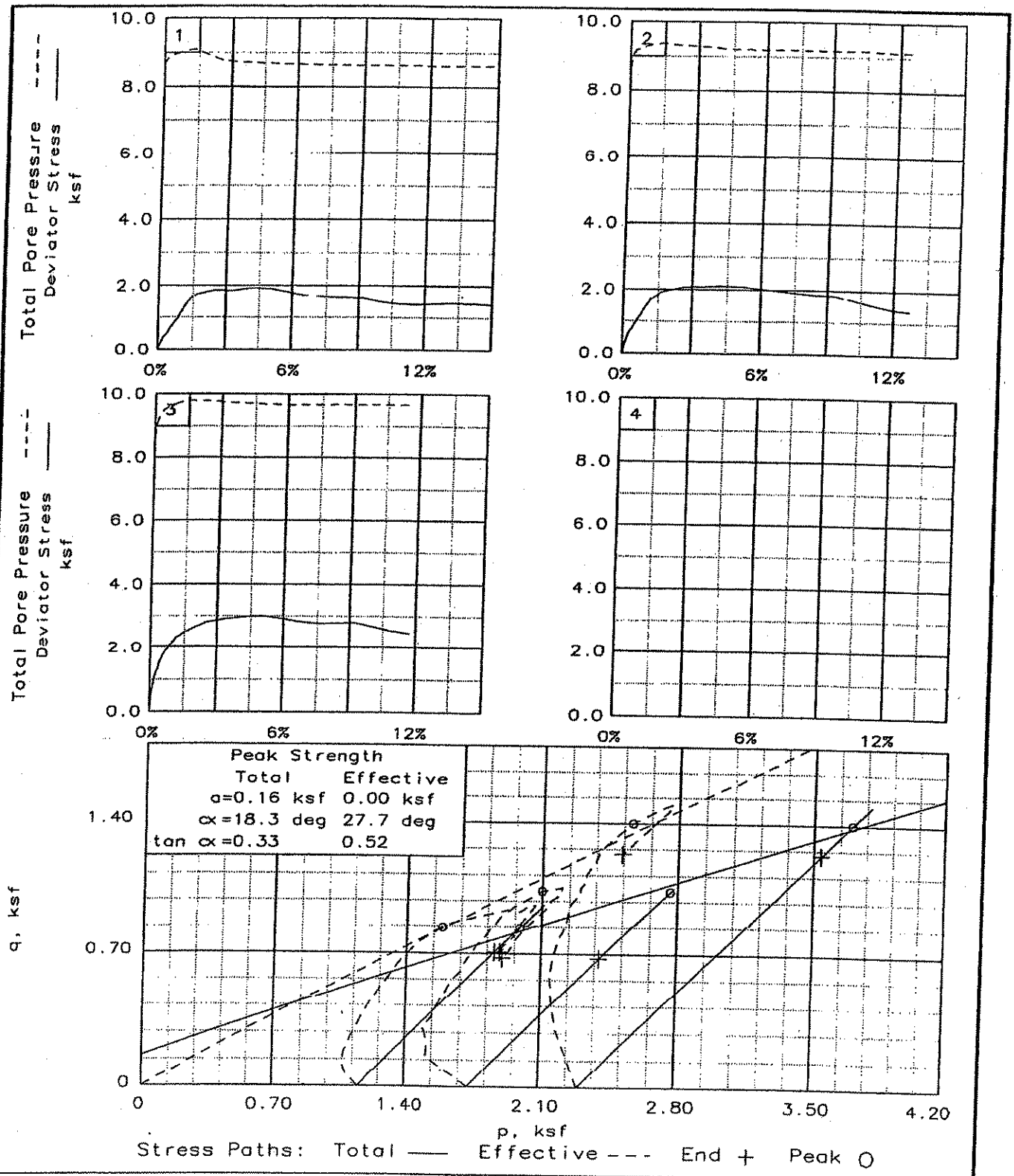
PROJECT: Gilmerton Bridge Replacement Project
SAMPLE LOCATION: MS-2, UD-1 @ 42.0'-44.0'

PROJ. NO.: 20400-2-1213.04 DATE: 07-09-03

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

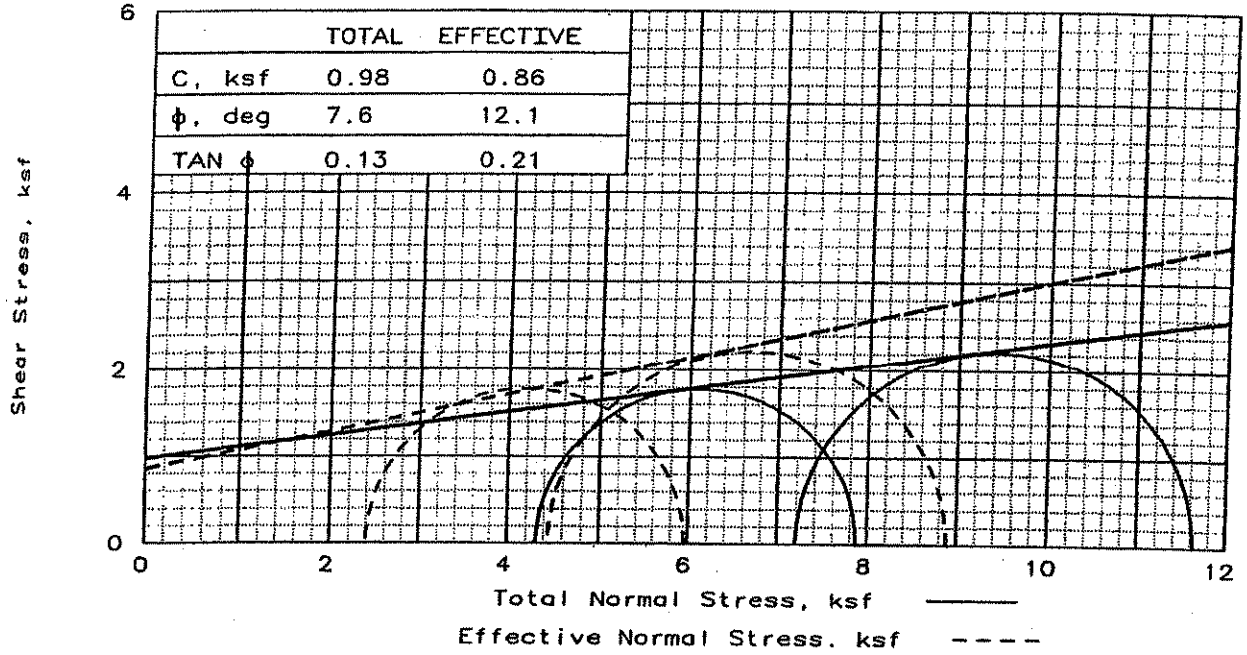


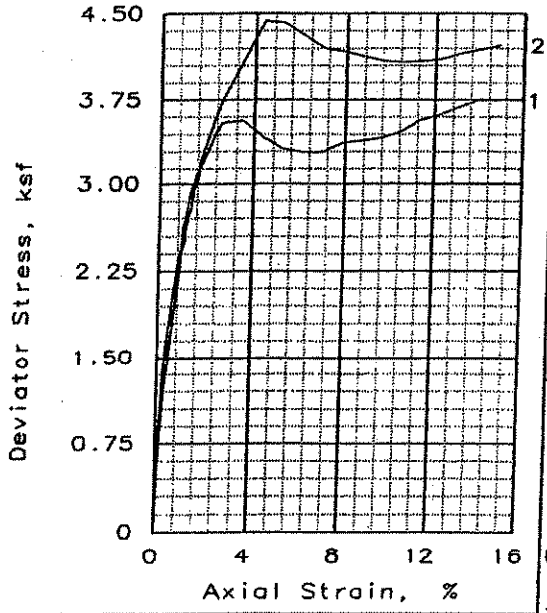
Client:

Project: Gilmerton Bridge Replacement Project

Location: MS-2, UD-1 @ 42.0'-44.0'

File: GIL-1 Project No.: 20400-2-1213.04 Fig. No.: ____





SAMPLE NO.:		1	2
INITIAL	WATER CONTENT, %	36.5	36.6
	DRY DENSITY, pcf	86.9	86.4
	SATURATION, %	104.7	104.0
	VOID RATIO	0.941	0.950
	DIAMETER, in	2.85	2.85
	HEIGHT, in	5.90	6.03
AT TEST	WATER CONTENT, %	36.4	35.5
	DRY DENSITY, pcf	85.0	86.1
	SATURATION, %	100.0	100.0
	VOID RATIO	0.983	0.958
	DIAMETER, in	2.91	2.93
	HEIGHT, in	5.75	5.72
Strain rate, %/min		0.03	0.03
BACK PRESSURE, ksf		7.20	7.20
CELL PRESSURE, ksf		11.52	14.40
FAIL. STRESS, ksf		3.55	4.44
TOTAL PORE PR., ksf		9.12	9.95
ULT. STRESS, ksf			
TOTAL PORE PR., ksf			
$\bar{\sigma}_1$ FAILURE, ksf		5.96	8.89
$\bar{\sigma}_3$ FAILURE, ksf		2.40	4.45

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Grey Silty Clay, A-7-6(39)
LL= 60 PL= 25 PI= 35
SPECIFIC GRAVITY= 2.7
REMARKS: USCS: CH

CLIENT:

PROJECT: Gilmerton Bridge Replacement

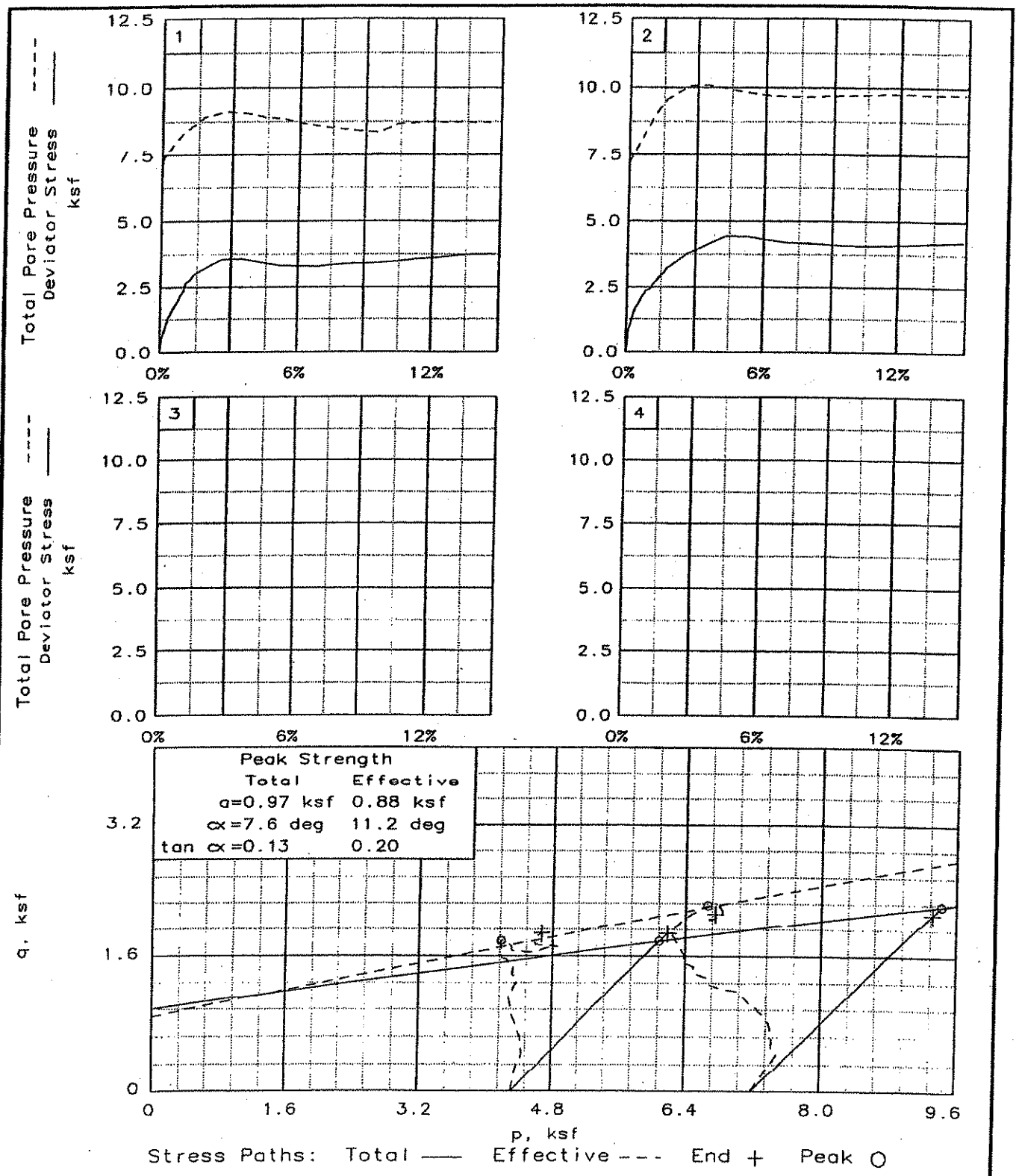
SAMPLE LOCATION: MS 3, UD 1 @ 136' 138'

PROJ. NO.: 20400-2-1213.04 DATE: 07-09-03

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

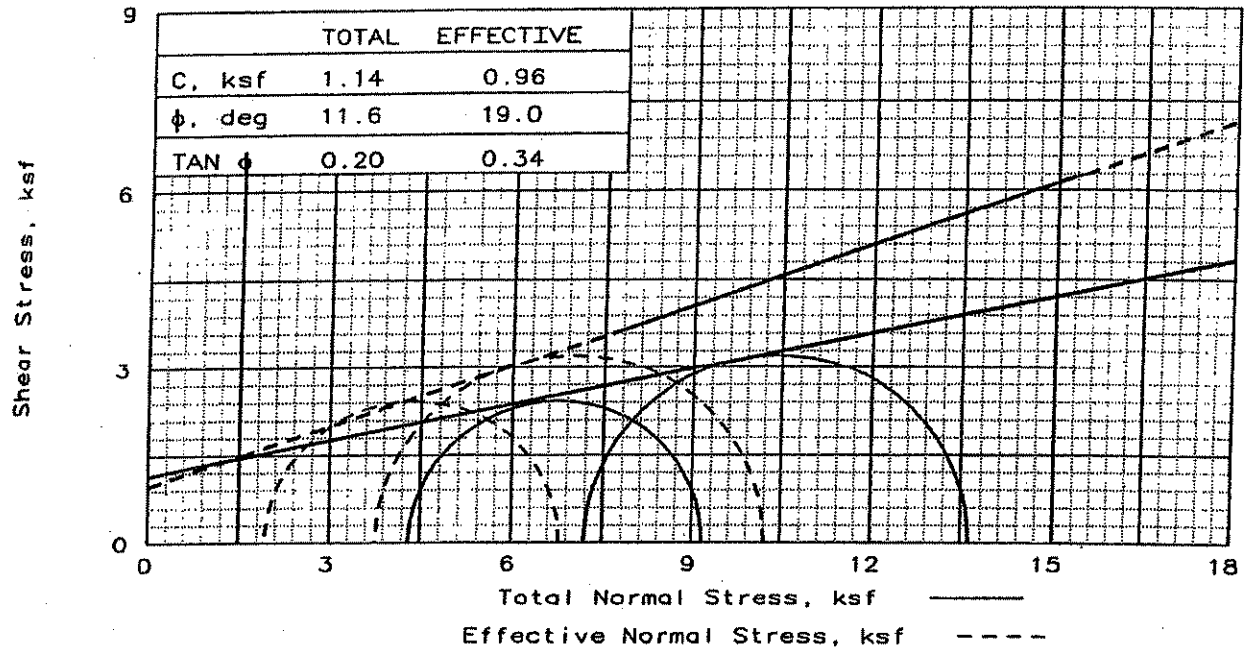


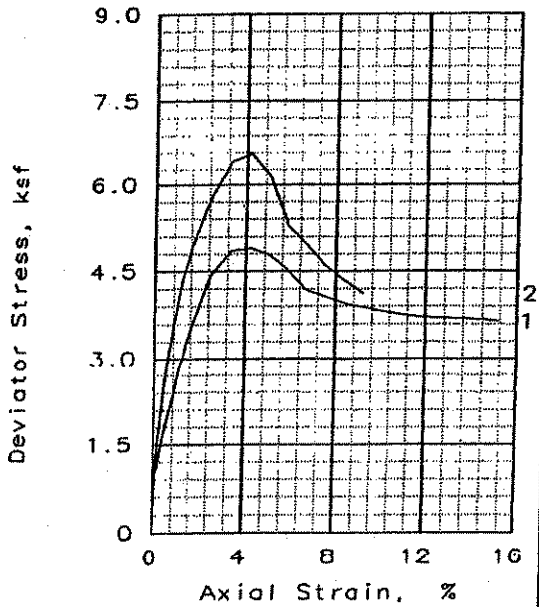
Client:

Project: Gilmerton Bridge Replacement

Location: MS-3, UD-1 @ 136'-138'

File: GIL-3 Project No.: 20400-2-1213.04 Fig. No.: ____





SAMPLE NO.:		1	2
INITIAL	WATER CONTENT, %	37.7	37.2
	DRY DENSITY, pcf	83.5	84.1
	SATURATION, %	100.0	100.0
	VOID RATIO	1.017	1.004
	DIAMETER, in	2.84	2.84
	HEIGHT, in	6.08	6.11
AT TEST	WATER CONTENT, %	36.4	35.9
	DRY DENSITY, pcf	85.0	85.5
	SATURATION, %	100.0	100.0
	VOID RATIO	0.983	0.971
	DIAMETER, in	2.85	2.85
	HEIGHT, in	5.94	5.95
Strain rate, %/min		0.03	0.03
BACK PRESSURE, ksf		7.9	7.9
CELL PRESSURE, ksf		12.2	15.1
FAIL. STRESS, ksf		4.8	6.4
TOTAL PORE PR., ksf		10.3	11.3
ULT. STRESS, ksf			
TOTAL PORE PR., ksf			
$\bar{\sigma}_1$ FAILURE, ksf		6.8	10.2
$\bar{\sigma}_3$ FAILURE, ksf		1.9	3.8

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Grey Silty Fat Clay, A-7-6(31)
LL= 52 PL= 25 PI= 27
SPECIFIC GRAVITY- 2.7
REMARKS: USCS: CH

CLIENT:

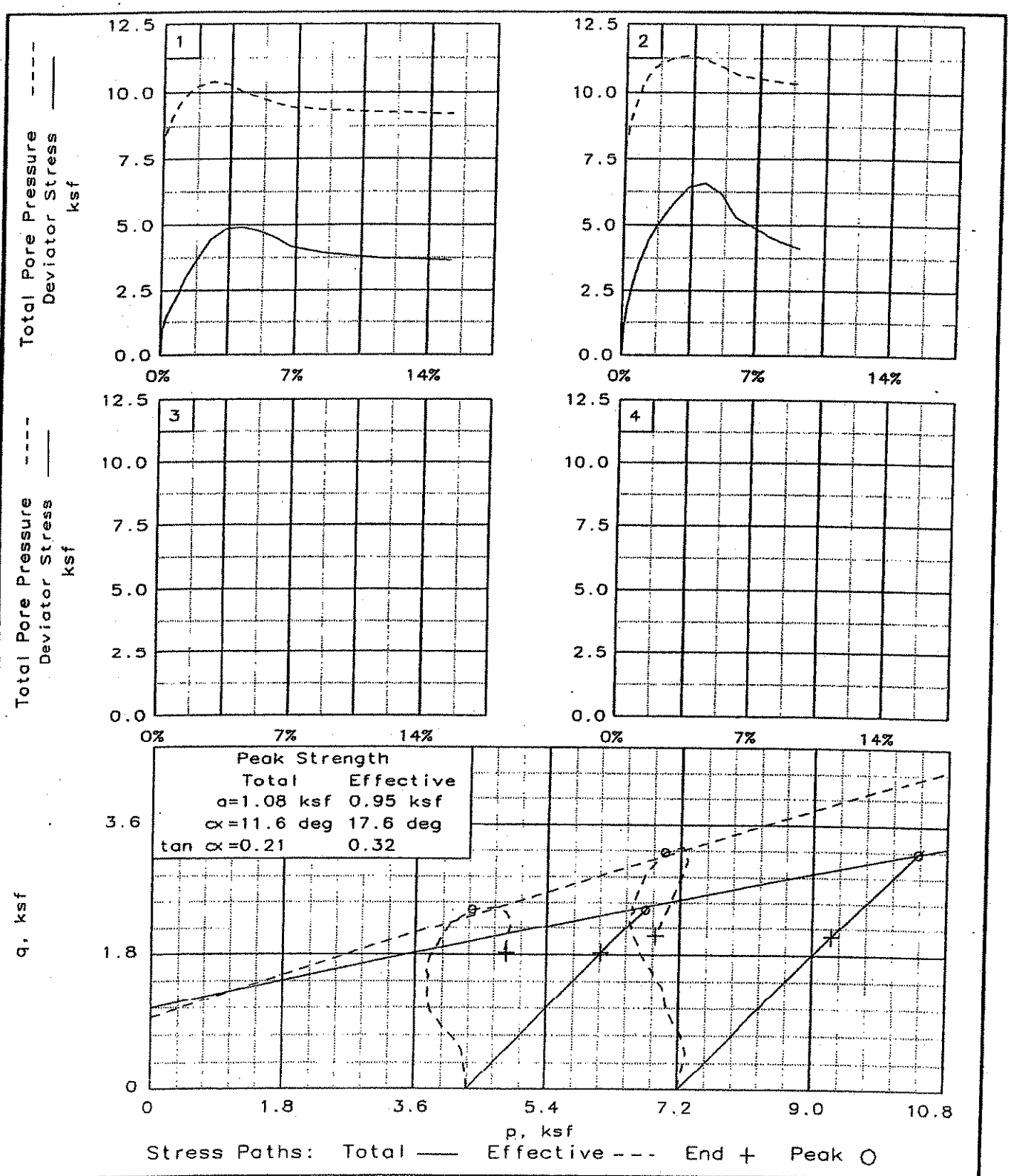
PROJECT: Gilmerton Bridge Replacement Project
SAMPLE LOCATION: MS-4, UD-1 @ 127'-129'

PROJ. NO.: 20400-2-1213.04 DATE: 07-29-03

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

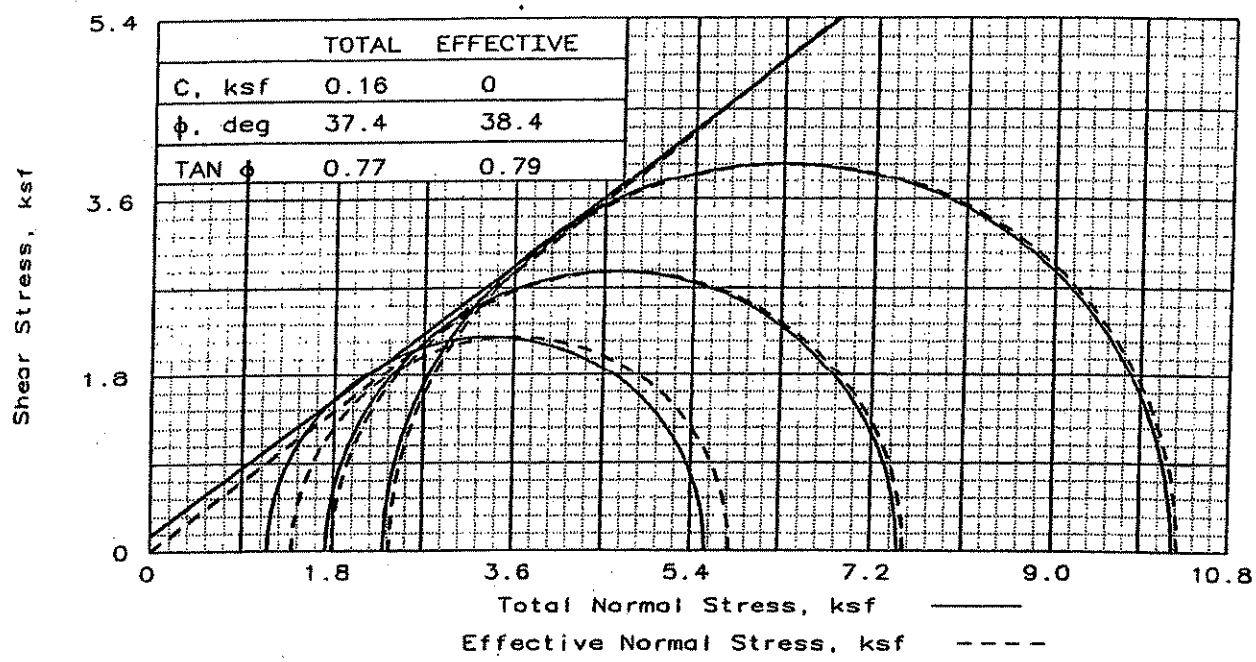


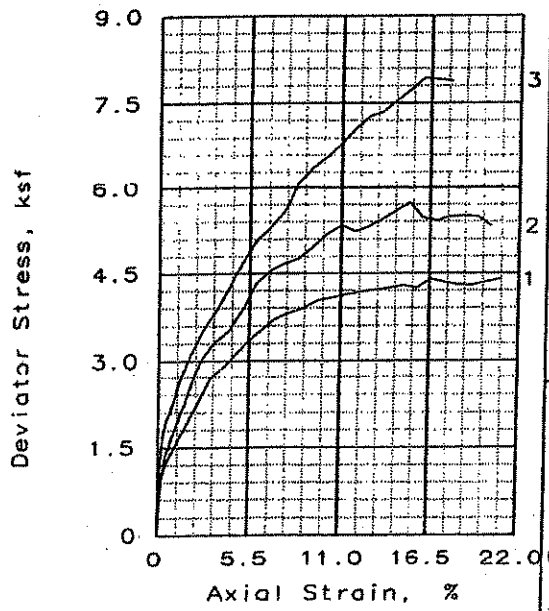
Client:

Project: Gilmerton Bridge Replacement Project

Location: MS-4, UD-1 @ 127'-129'

File: GIL-4 Project No.: 20400-2-1213.04 Fig. No.: ____





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	29.9	29.9	29.6
	DRY DENSITY, pcf	94.5	94.2	94.7
	SATURATION, %	99.9	99.9	100.0
	VOID RATIO	0.829	0.826	0.813
	DIAMETER, in	2.82	2.83	2.83
	HEIGHT, in	5.75	5.94	5.97
AT TEST	WATER CONTENT, %	28.5	27.0	26.4
	DRY DENSITY, pcf	96.7	98.6	99.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.789	0.745	0.726
	DIAMETER, in	2.79	2.77	2.77
	HEIGHT, in	5.74	5.91	5.91
Strain rate, %/min		0.09	0.09	0.09
BACK PRESSURE, ksf		8.6	8.6	8.6
CELL PRESSURE, ksf		9.8	10.4	10.9
FAIL. STRESS, ksf		4.4	5.7	7.9
TOTAL PORE PR., ksf		8.4	8.6	8.6
ULT. STRESS, ksf				
TOTAL PORE PR., ksf				
$\bar{\sigma}_1$ FAILURE, ksf		5.8	7.5	10.3
$\bar{\sigma}_3$ FAILURE, ksf		1.4	1.8	2.4

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Grey Silty Sand, A-2-4(0)

SPECIFIC GRAVITY- 2.77
REMARKS: USCS: SM

CLIENT:

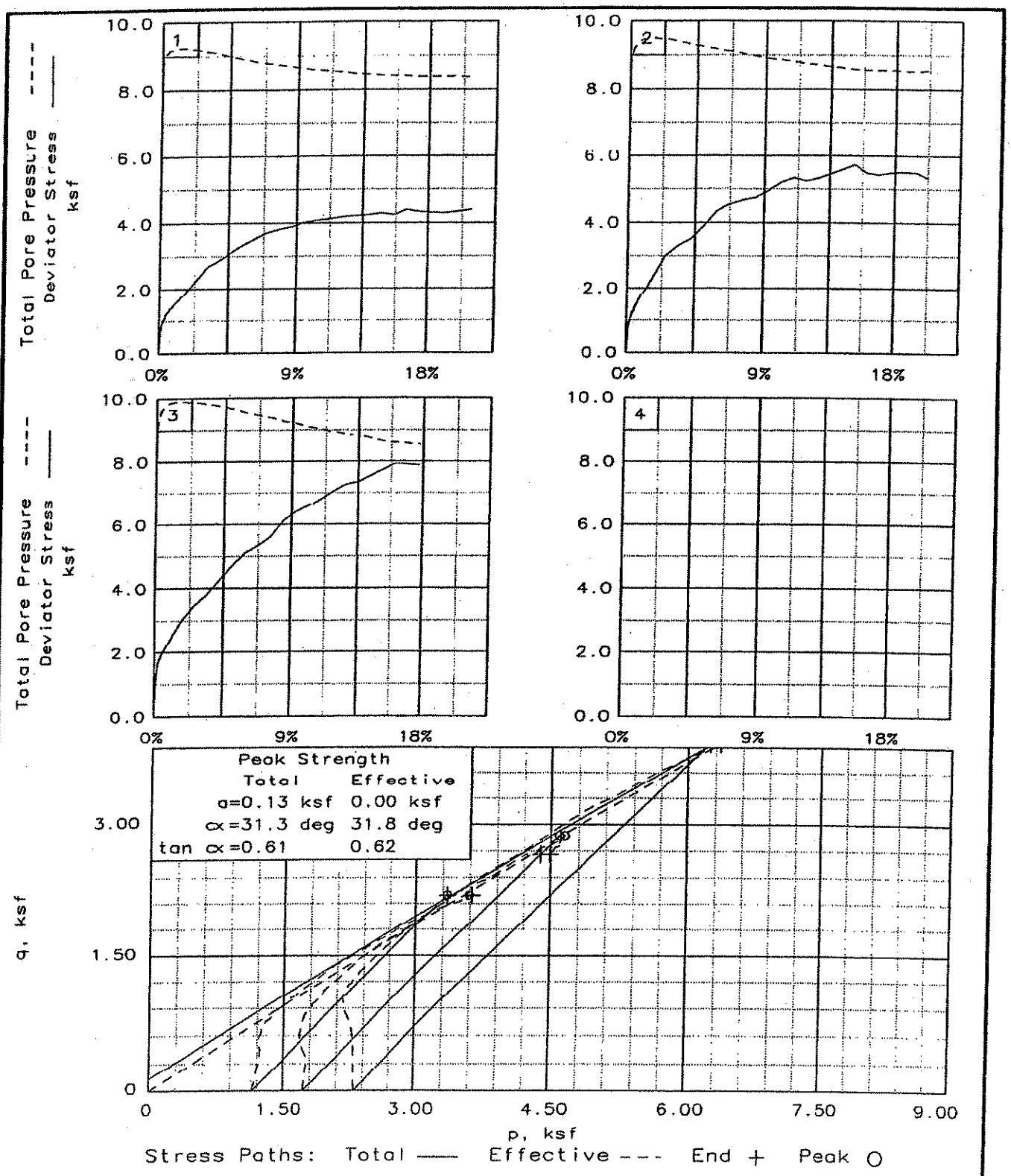
PROJECT: Gilmerton Bridge Replacement Project
SAMPLE LOCATION: MS-5, UD-1 @ 60.0'-62.0'

PROJ. NO.: 20400-2-1213.04 DATE: 07-29-03

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____



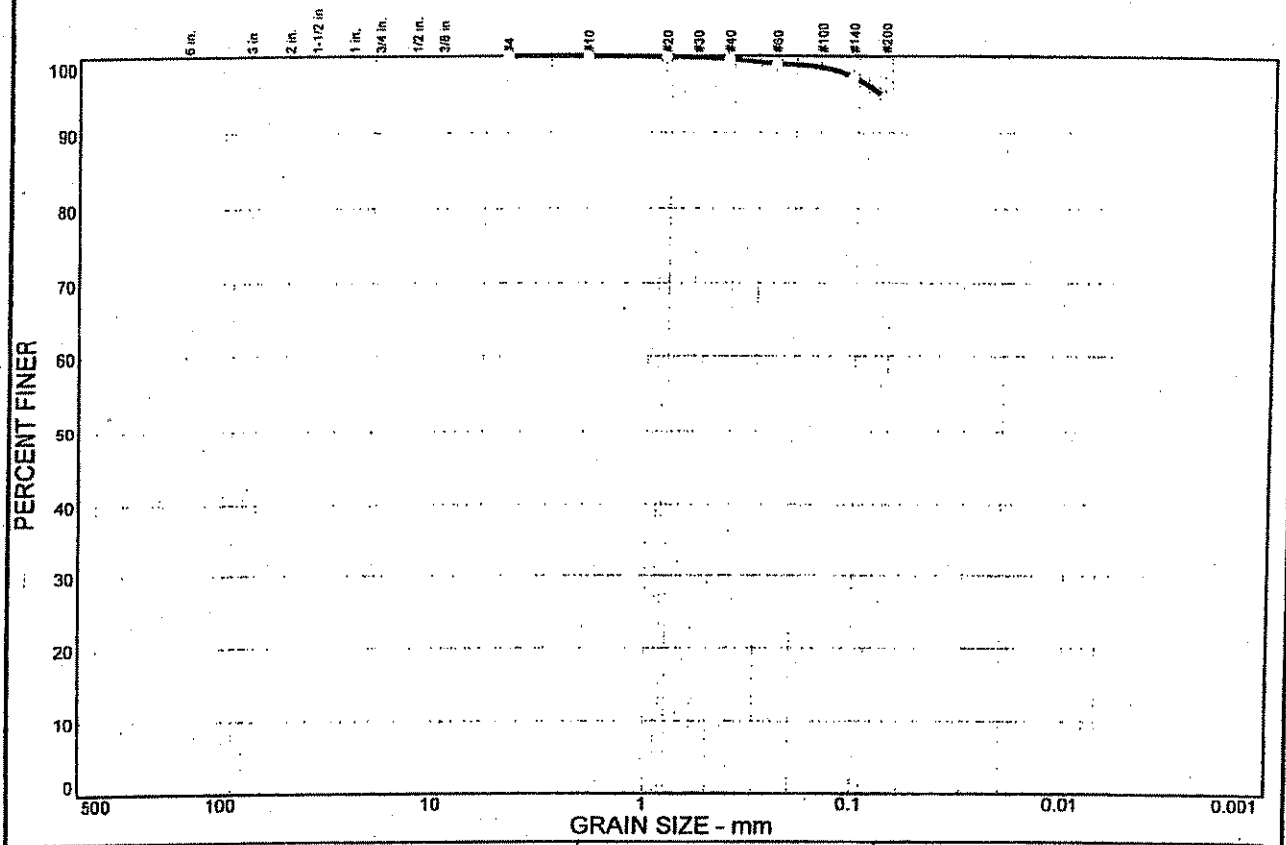
Client:

Project: Gilmerton Bridge Replacement Project

Location: MS-5, UD-1 @ 60.0'-62.0'

File: GIL-5 Project No.: 20400-2-1213.04 Fig. No.: ____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	5.4	94.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.6		
#60	99.0		
#140	97.2		
#200	94.6		

* (no specification provided)

Soil Description

DARK GRAY SILT

Atterberg Limits

PL= 31 LL= 45 PI= 14

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= ND

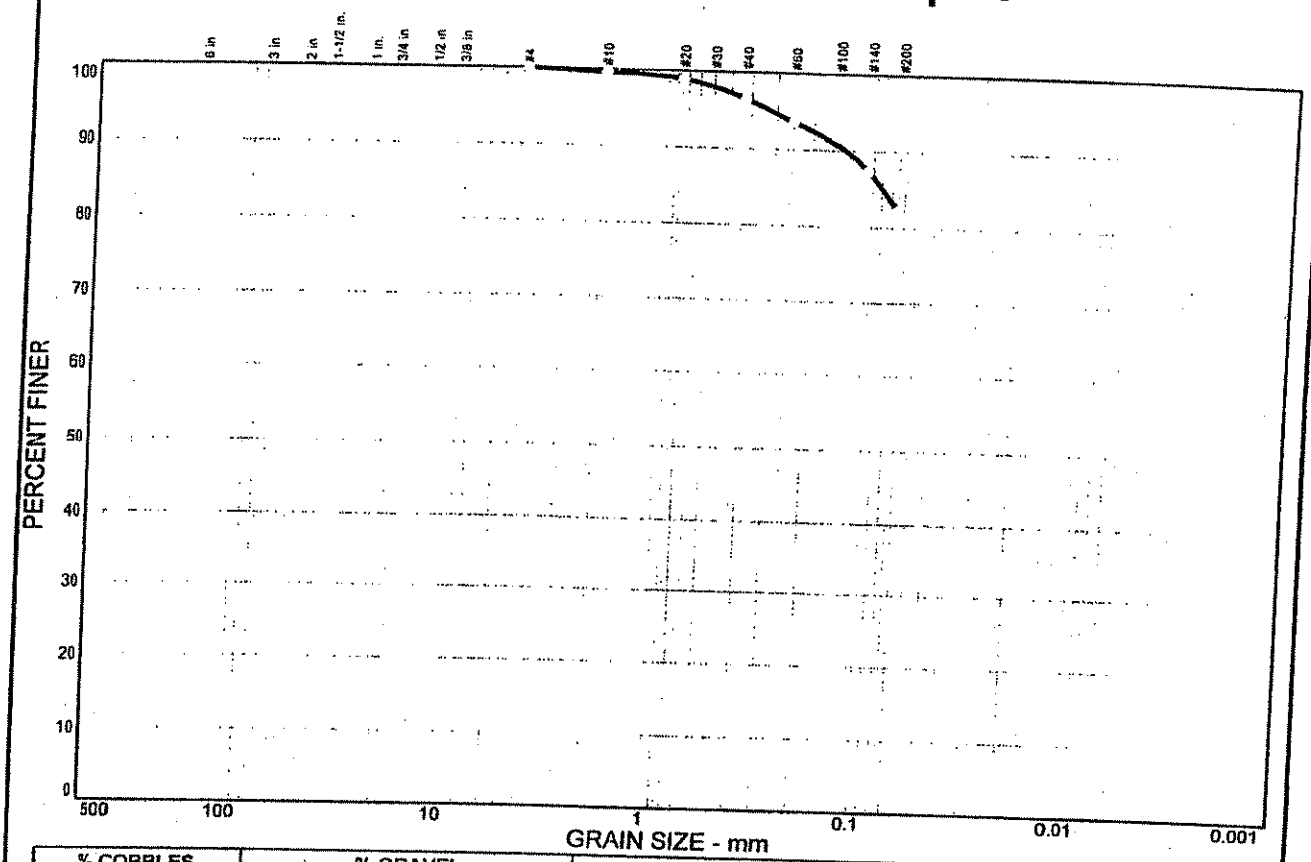
Remarks

ND=NOT DETERMINED

Sample No.: UD 1 **Source of Sample:** MS-1A **Date:** 7/9/03
Location: MS-1A UD-1 28-30 ft **Elev./Depth:** 28-30 FT

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: Gilmerton Bridge Replacement Project
	Project No: 2040021213 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.4	17.4	82.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.6		
#20	98.9		
#40	96.5		
#60	93.5		
#140	87.3		
#200	82.2		

* (no specification provided)

Soil Description

Dark gray lean clay with sand

Atterberg Limits

PL= 25 LL= 41 PI= 16

Coefficients

D_{85}= 0.0898 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= ND

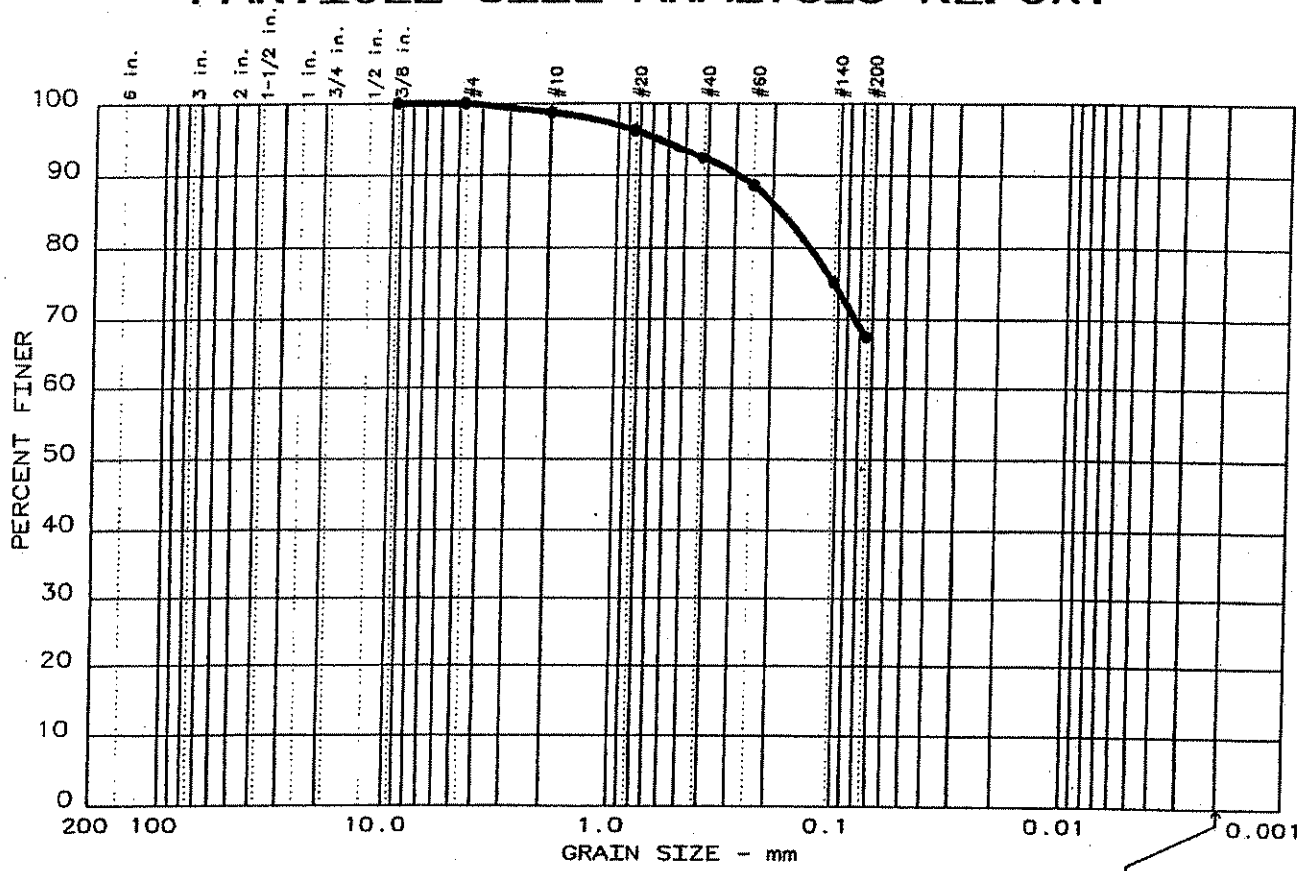
Remarks

ND=NOT DETERMINED

Sample No.: UD-2 32-34 FT **Source of Sample:** MS-1A **Date:** 7/9/03
Location: MS-1A UD-2 32-34 FT **Elev./Depth:** 32-34 FT

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: Gilmerton Bridge Replacement Project
	Project No: 2040021213 Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	11	0.0	1.2	31.2	67.6	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	50	21	0.184							

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Sandy Clayey Silt	ML	A-7-6(14)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-1, UD-1 @ 34.0'-36.0'

Date: 07-09-03

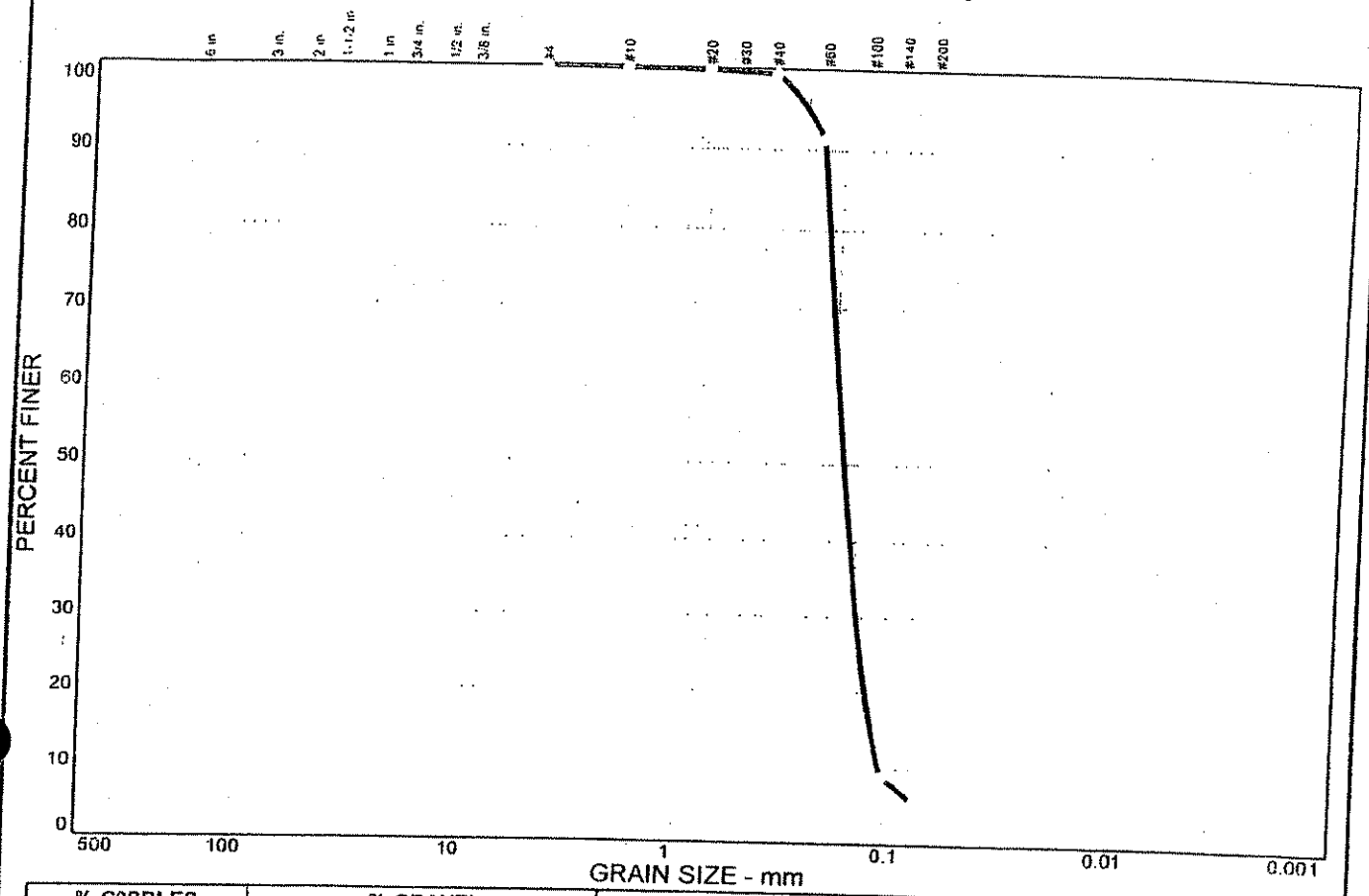
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.7		
#40	99.4		
#60	91.4		
#140	8.9		
#200	5.6		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.237 D_{60}= 0.193 D_{50}= 0.177
D_{30}= 0.146 D_{15}= 0.120 D_{10}= 0.109
C_u= 1.77 C_c= 1.01

Classification

USCS= SP-SM AASHTO= ND

Remarks

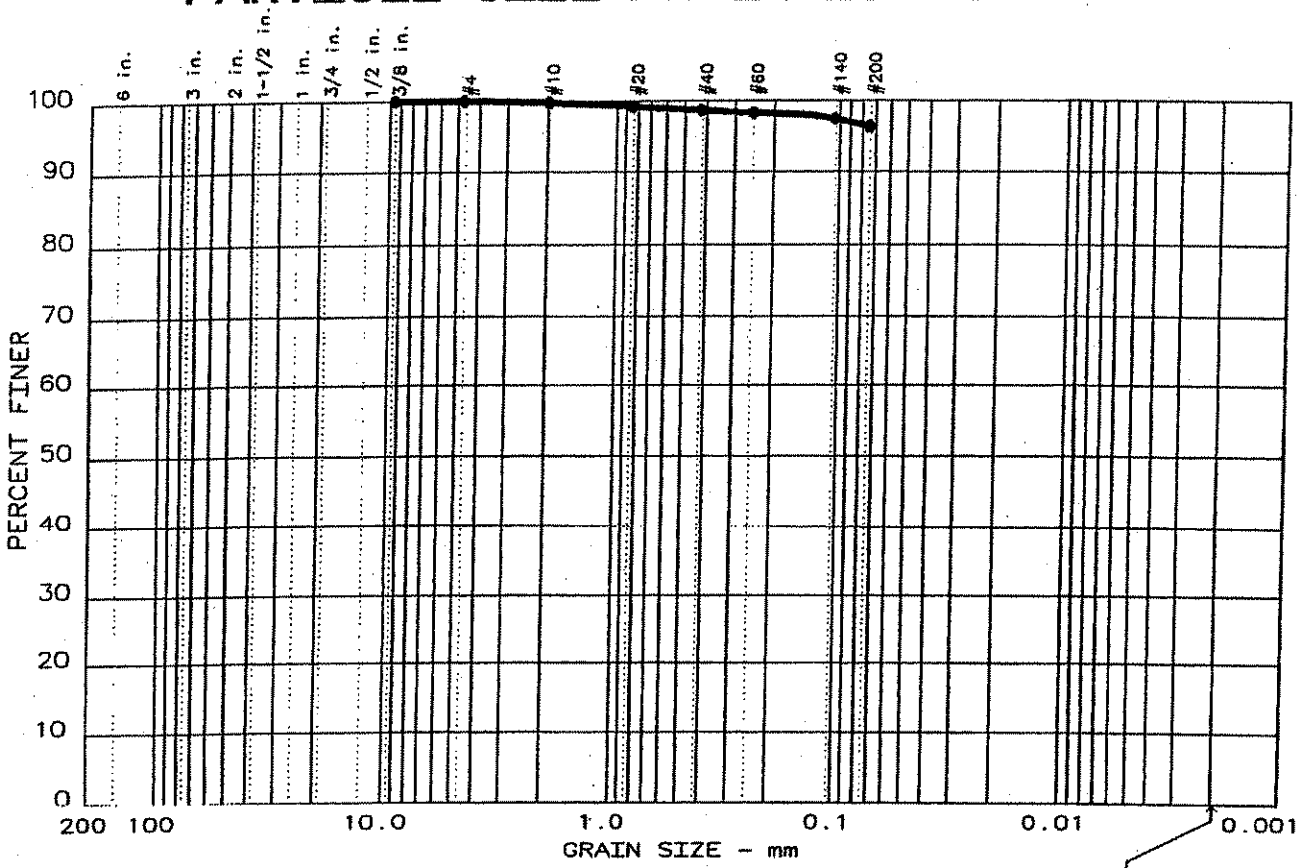
NP=NON-PLASTIC
ND=NOT DETERMINED

Sample No.: MS-2 SS-8 Source of Sample:
Location: MS-2

Date: 5-13-03
Elev./Depth: 23.5-25'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	0.2	3.3	96.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	45	21								

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Clay	CL	A-7-6(23)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-2, UD-1 @ 42.0'-44.0'

Date: 07-09-03

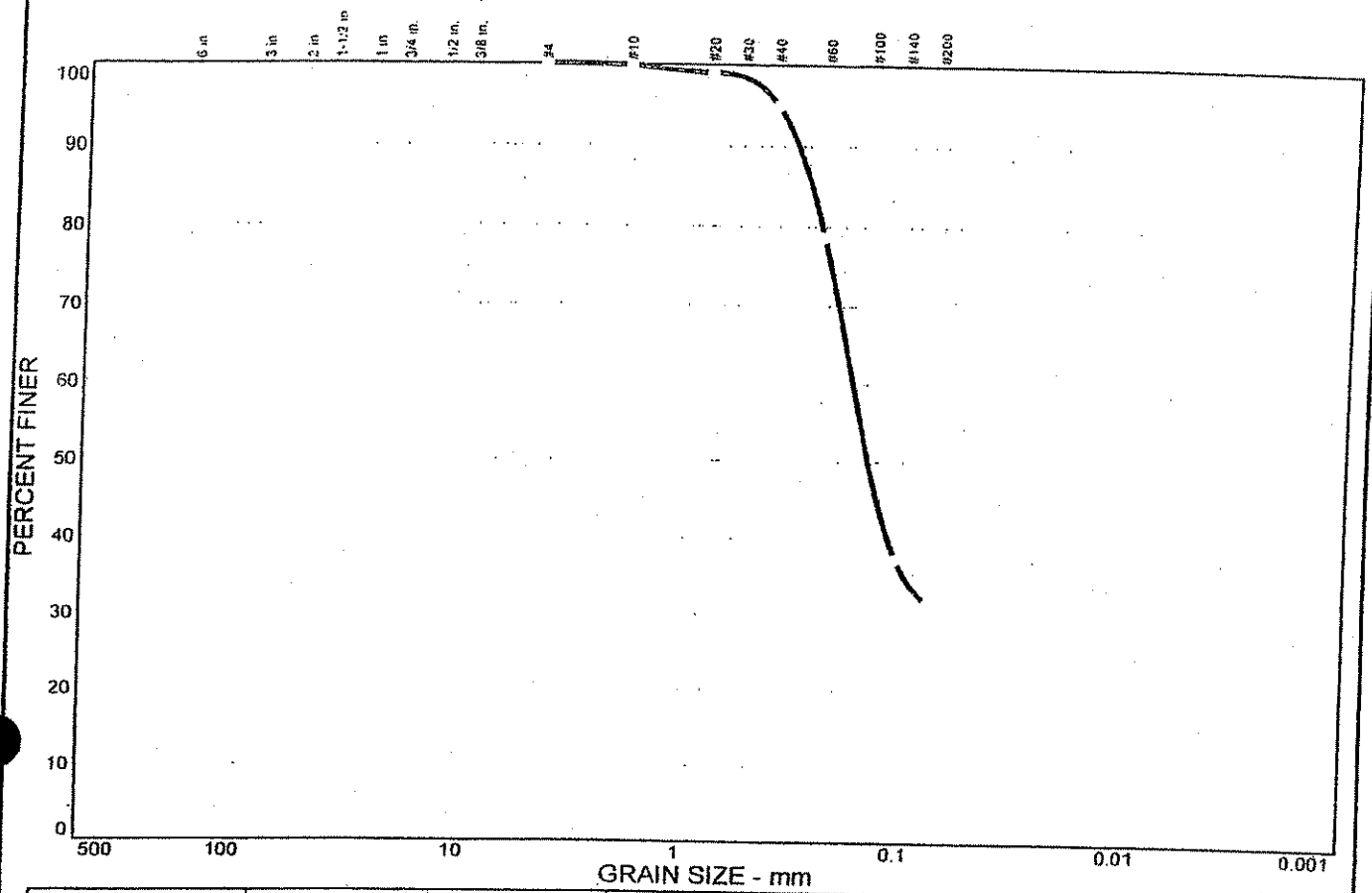
Remarks.

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.0		
#40	95.0		
#60	78.7		
#140	37.4		
#200	31.7		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.291 D_{60}= 0.175 D_{50}= 0.145
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

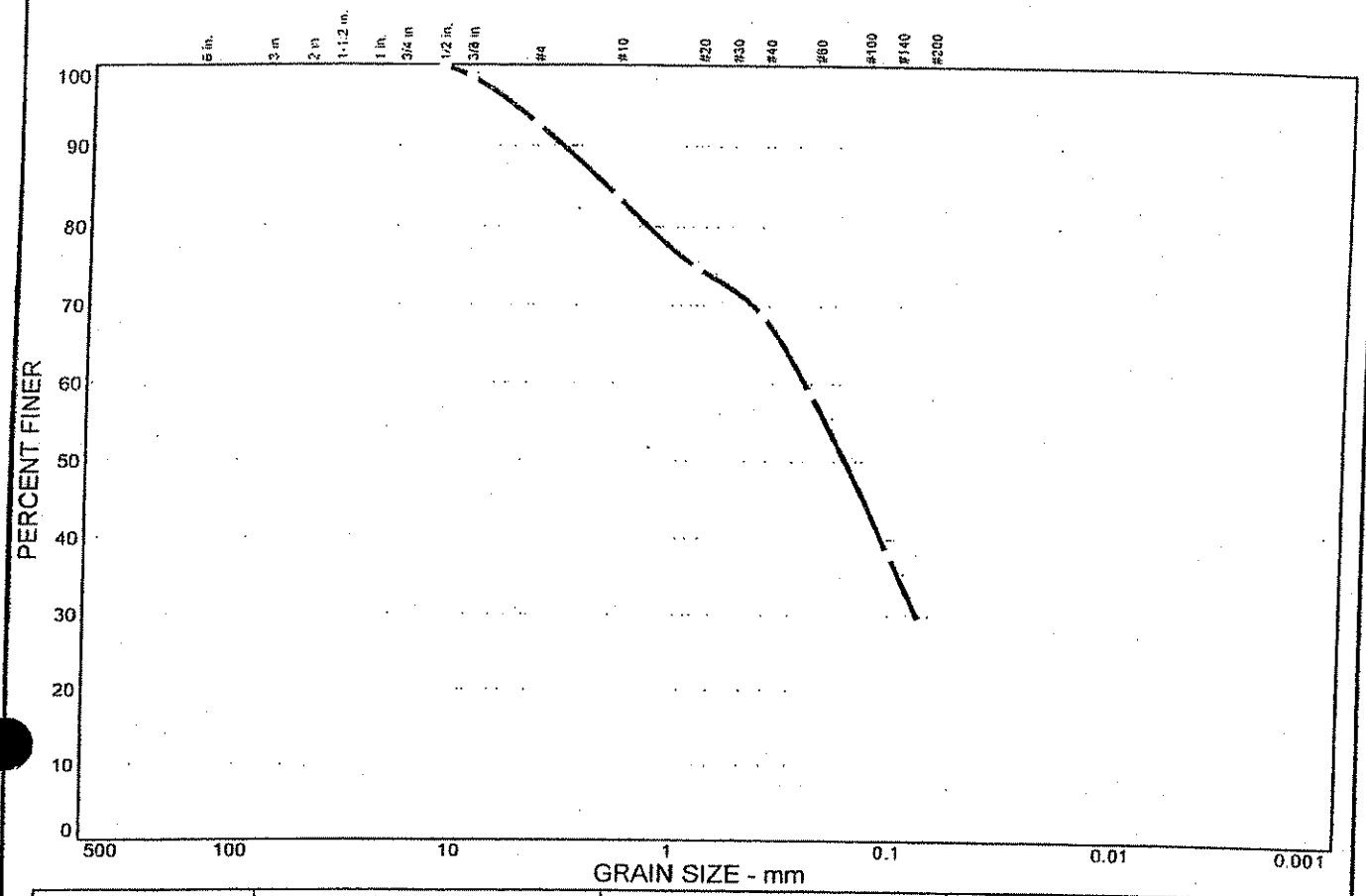
Remarks

NP=NON-PLASTIC
ND= NOT DETERMINED

Sample No.: MS-2: 63.5'-65' Source of Sample: Date: 5 13 03
Location: MS-2 Elev./Depth: 63.5-65'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	16.3	83.7		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.50 in.	100.0		
.375 in.	98.5		
#4	92.7		
#10	83.7		
#20	74.8		
#40	68.7		
#60	58.7		
#140	38.0		
#200	29.0		

* (no specification provided)

Soil Description

Silty, clayey sand

Atterberg Limits

PL= 20 LL= 26 PI= 6

Coefficients

D_{85}= 2.25 D_{60}= 0.265 D_{50}= 0.172
D_{30}= 0.0779 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO= ND

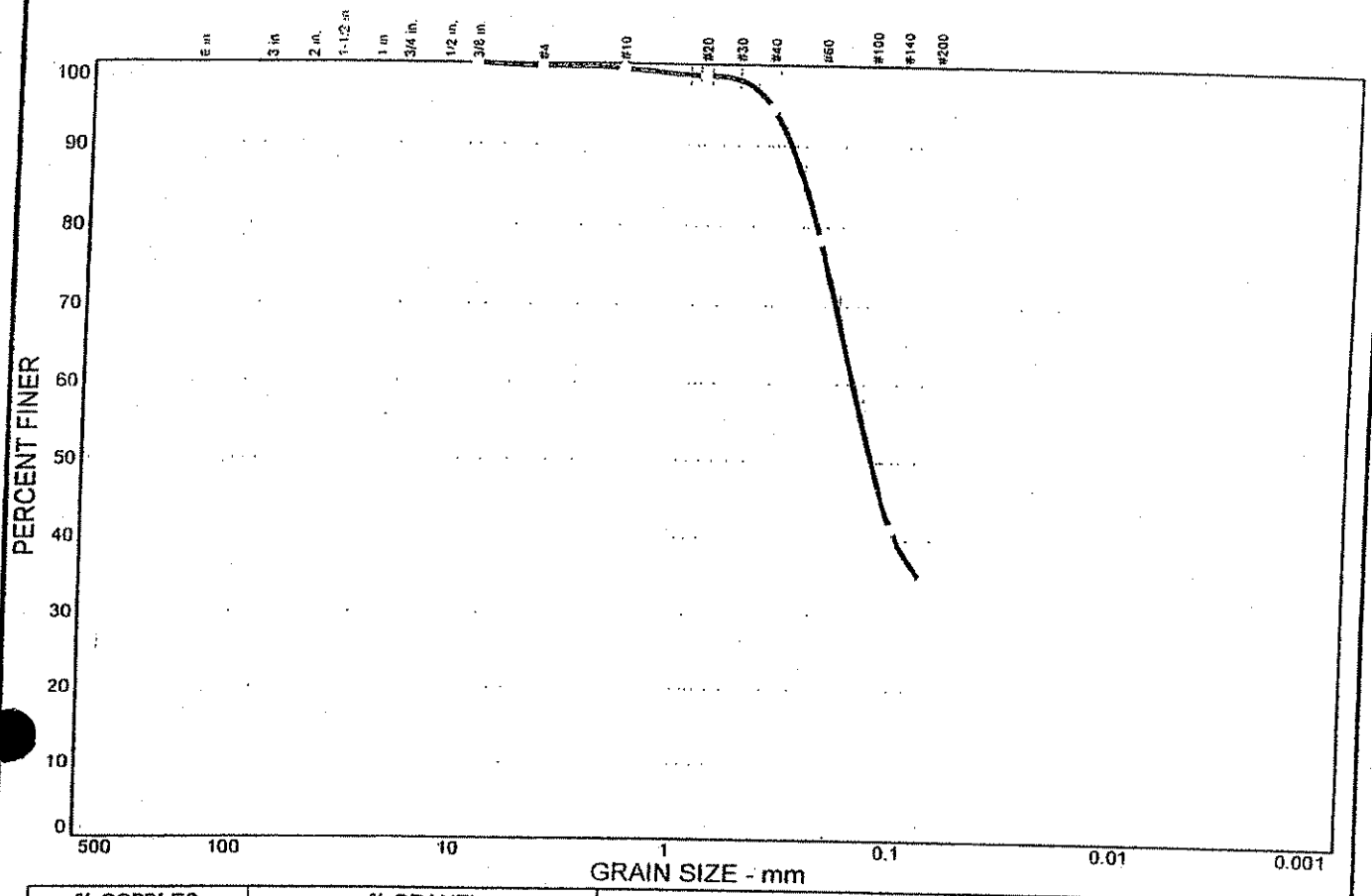
Remarks

ND=NOT DETERMINED
F.M.=0.09

Sample No.: MS-2: 118.5-120' Source of Sample: Date: 5/13/03
Location: MS-2 Elev./Depth: 118.5-120'

MACTEC ENGINEERING & CONSULTING, INC.	Client: Project: GILMERTON Project No: 20400-2-1213.01	Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.6	99.4		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	99.4		
#20	98.6		
#40	94.6		
#60	78.4		
#140	41.4		
#200	34.6		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.296 D_{60}= 0.168 D_{50}= 0.135
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

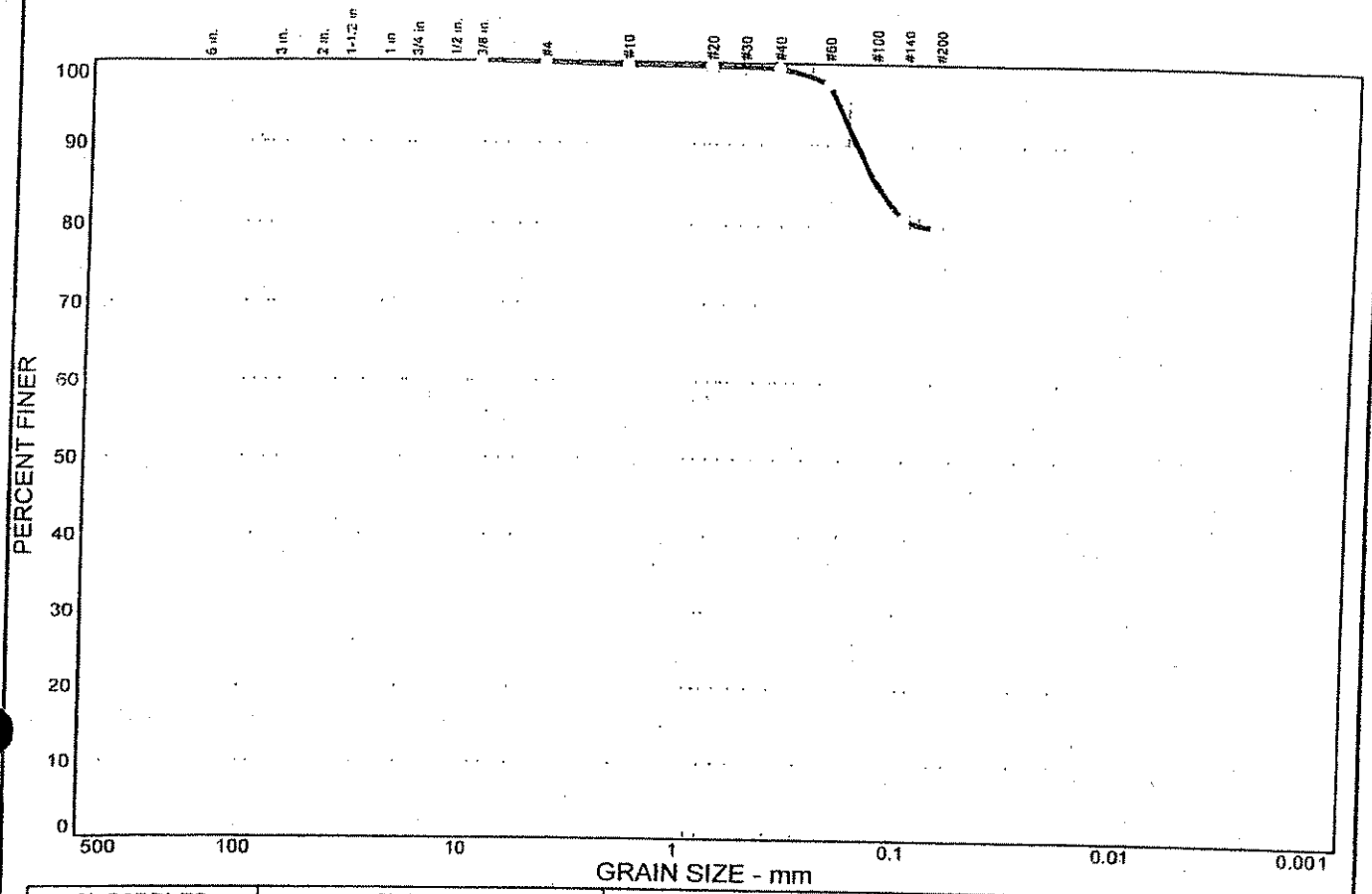
Remarks

NP=NON-PLASTIC
ND=NOT DETERMINED
F.M.=0.00

Sample No.: MS-3; 43.5-45' Source of Sample: Date: 5-13-03
Location: MS-3 Elev./Depth: 43.5-45'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	99.7		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.7		
#20	99.6		
#40	99.4		
#60	97.5		
#140	81.1		
#200	79.9		

* (no specification provided)

Soil Description

Lean clay with sand

Atterberg Limits

PL= 18 LL= 45 PI= 27

Coefficients

D_{85}= 0.142 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= ND

Remarks

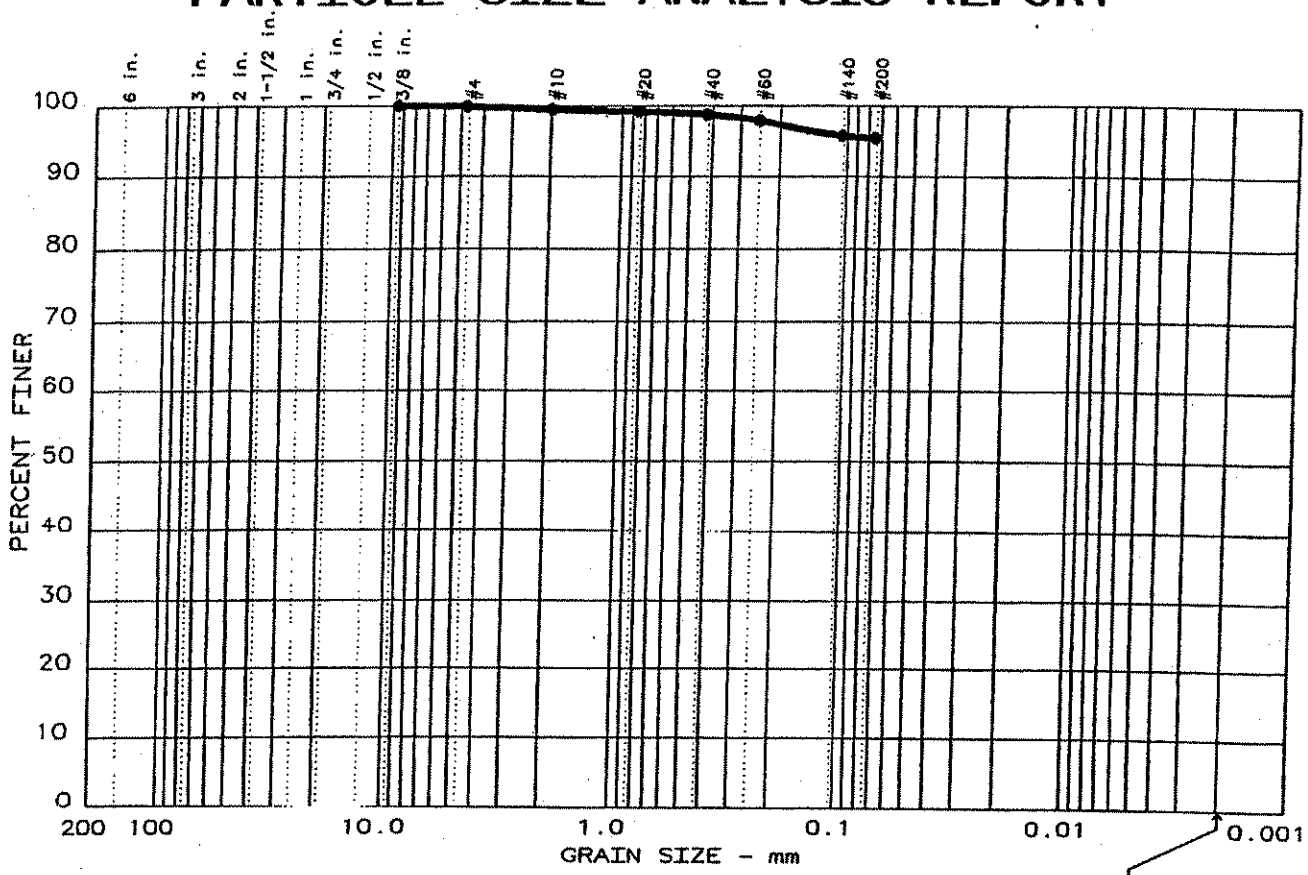
ND=NOT DETERMINED
F.M.=0.00

Sample No.: MS-3: 123.5-125' Source of Sample:
Location: MS-3

Date: 5-13-03
Elev./Depth: 123.5-125'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	13	0.0	0.2	4.3	95.5	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	60	35								

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Clay	CH	A-7-6(39)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-3, UD-1 @ 136.0'-138.0'

Date: 07-09-03

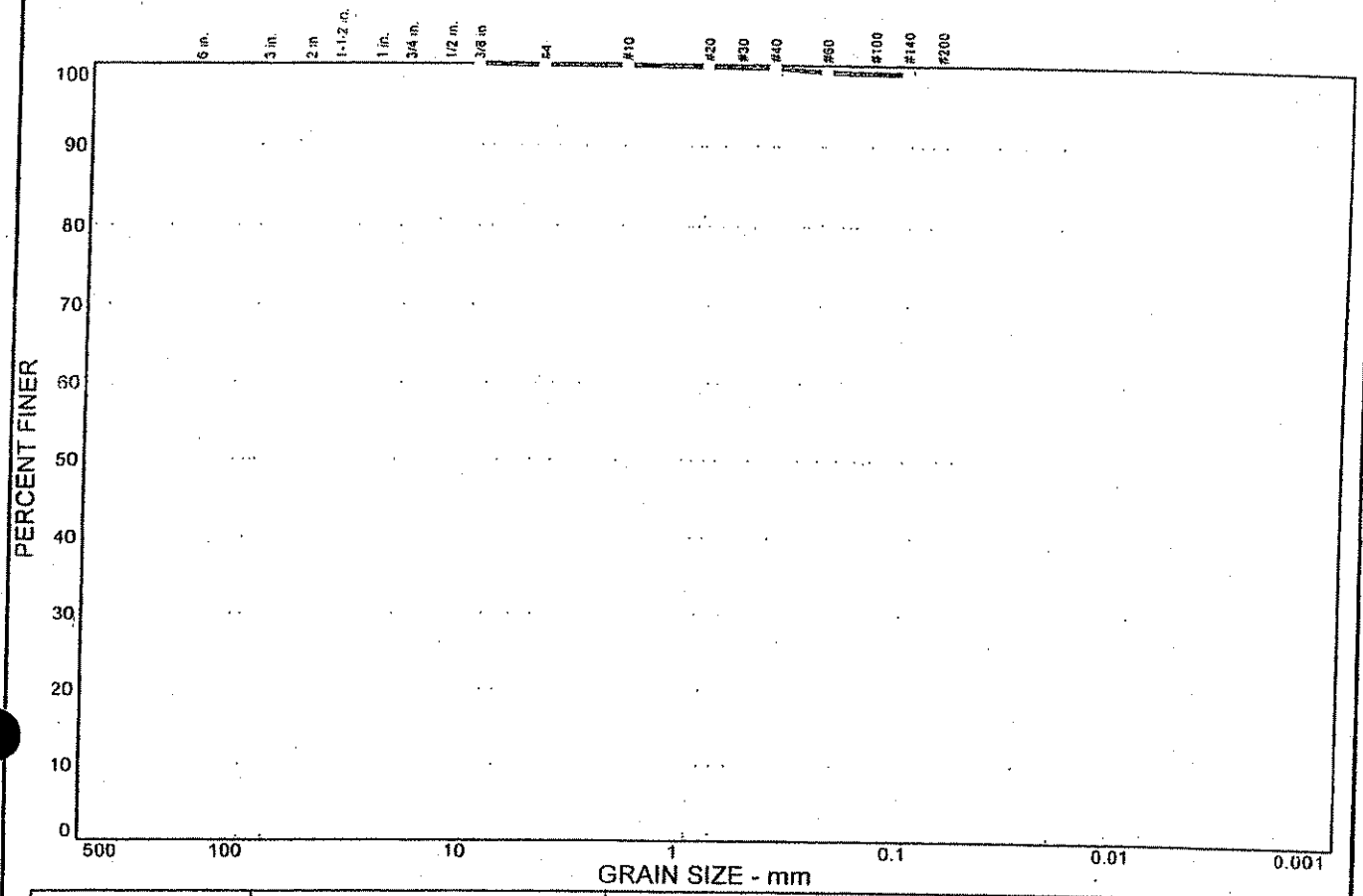
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	99.9		
#20	99.8		
#40	99.7		
#60	99.2		
#140	99.0		

* (no specification provided)

Soil Description

CLAY

Atterberg Limits

PL= 22 LL= 56 PI= 34

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= ND

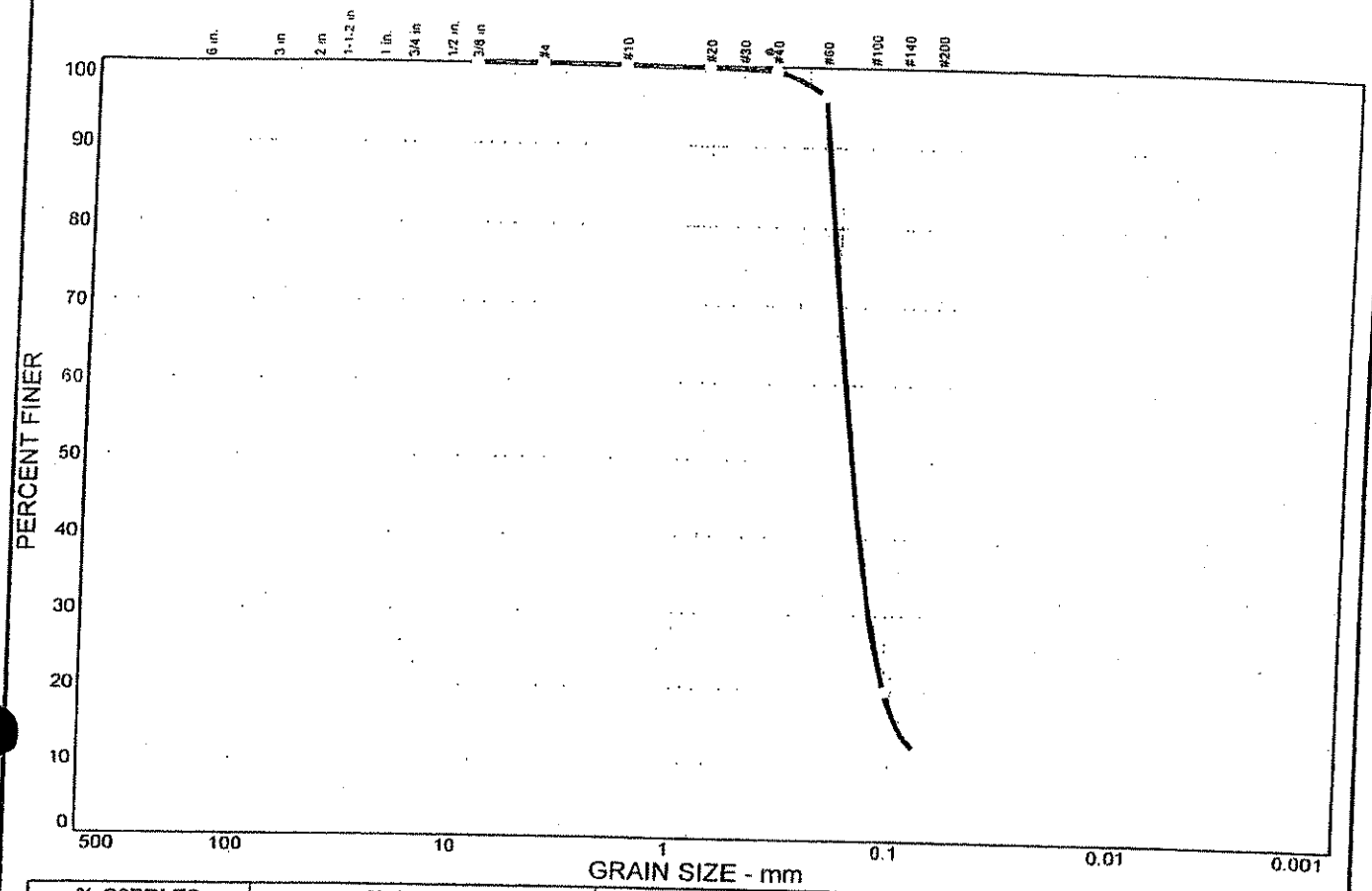
Remarks

ND=NOT DETERMINED
F.M.=0.00

Sample No.: MS-3;143.5-145 Source of Sample: Date: 5/13/03
Location: MS-3 Elev./Depth: 143.5-145'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.8		
#40	99.5		
#60	96.5		
#140	19.9		
#200	11.9		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.225 D_{60}= 0.179 D_{50}= 0.161
D_{30}= 0.127 D_{15}= 0.0907 D_{10}=
C_u= C_c=

Classification

USCS= SP-SM AASHTO= ND

Remarks

NP=NON-PLASTIC
ND=NOT DETERMINED

Sample No.: MS-4: 18.5-20' Source of Sample:
Location: MS-4

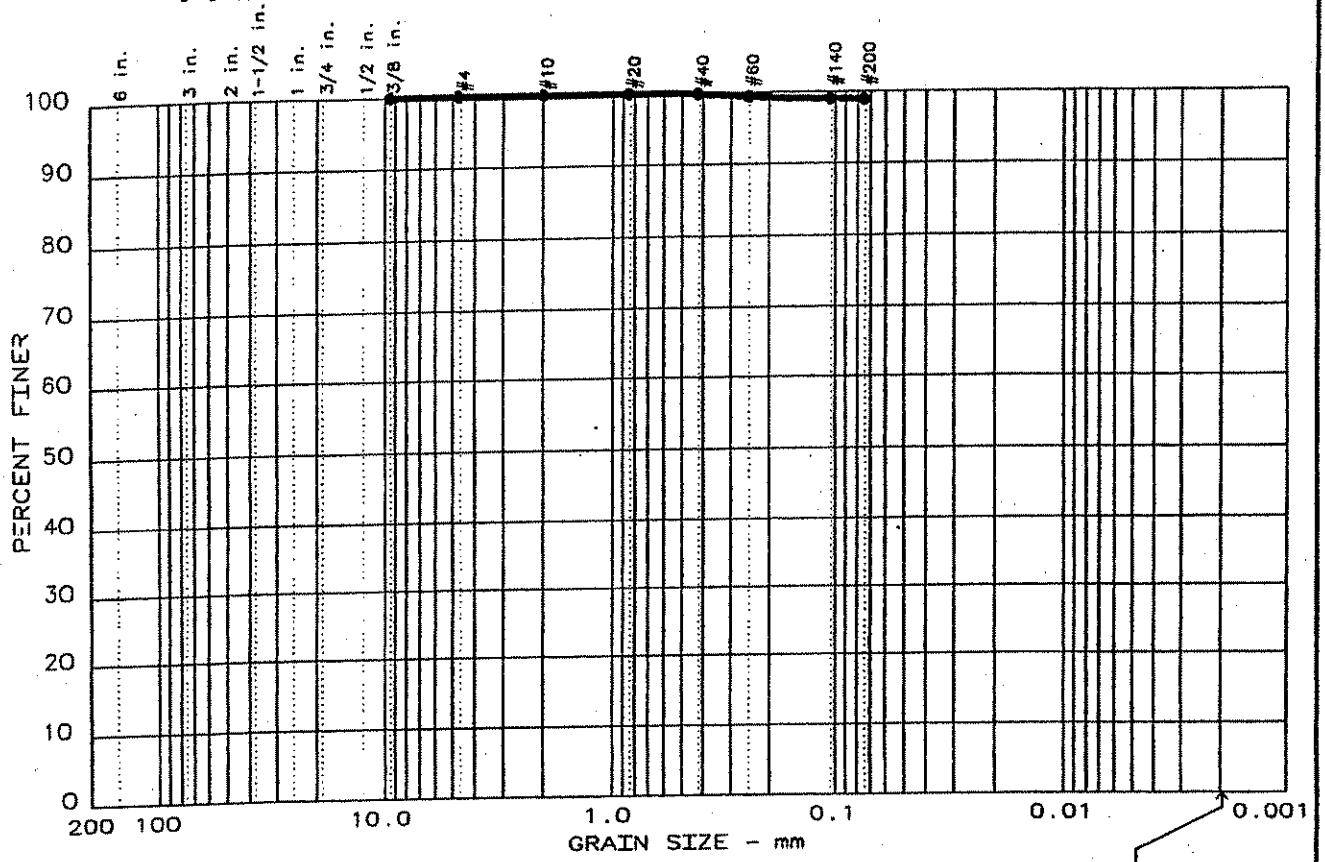
Date: 5/13/03
Elev./Depth: 18.5-20'

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01

Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	18	0.0	0.0	1.1	98.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	52	27								

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Clay	CH	A-7-6(31)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-4, UD-1 @ 127.0'-129.0'

Date: 07-28-03

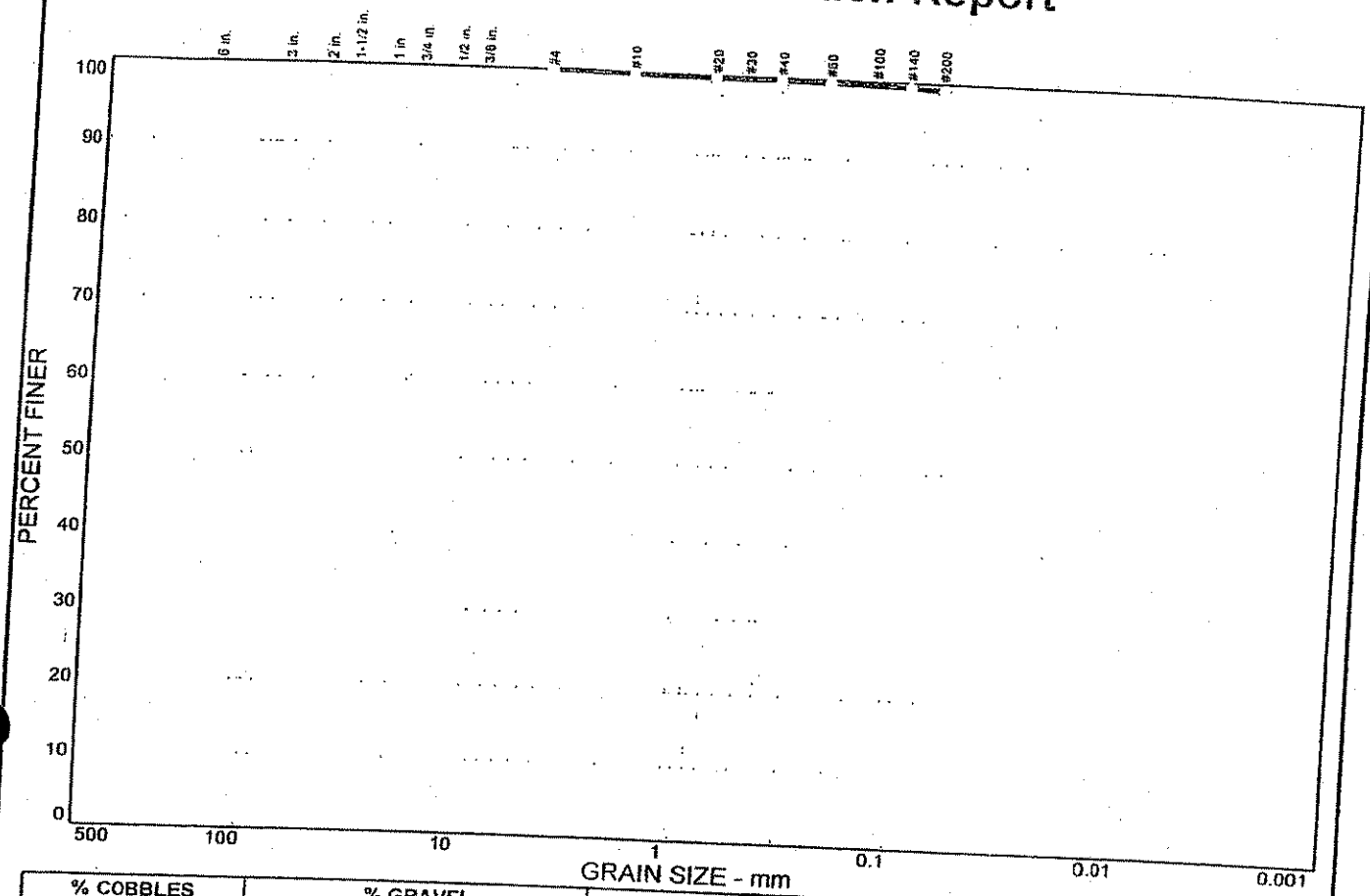
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	99.8		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#20	99.7		
#40	99.7		
#60	99.6		
#140	99.4		
#200	99.2		

* (no specification provided)

Soil Description

Fat clay

Atterberg Limits

PL= 22 LL= 51 PI= 29

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= ND

Remarks

ND=NOT DETERMINED

Sample No.: MS-4; 133.5-135 Source of Sample:
Location: MS-4

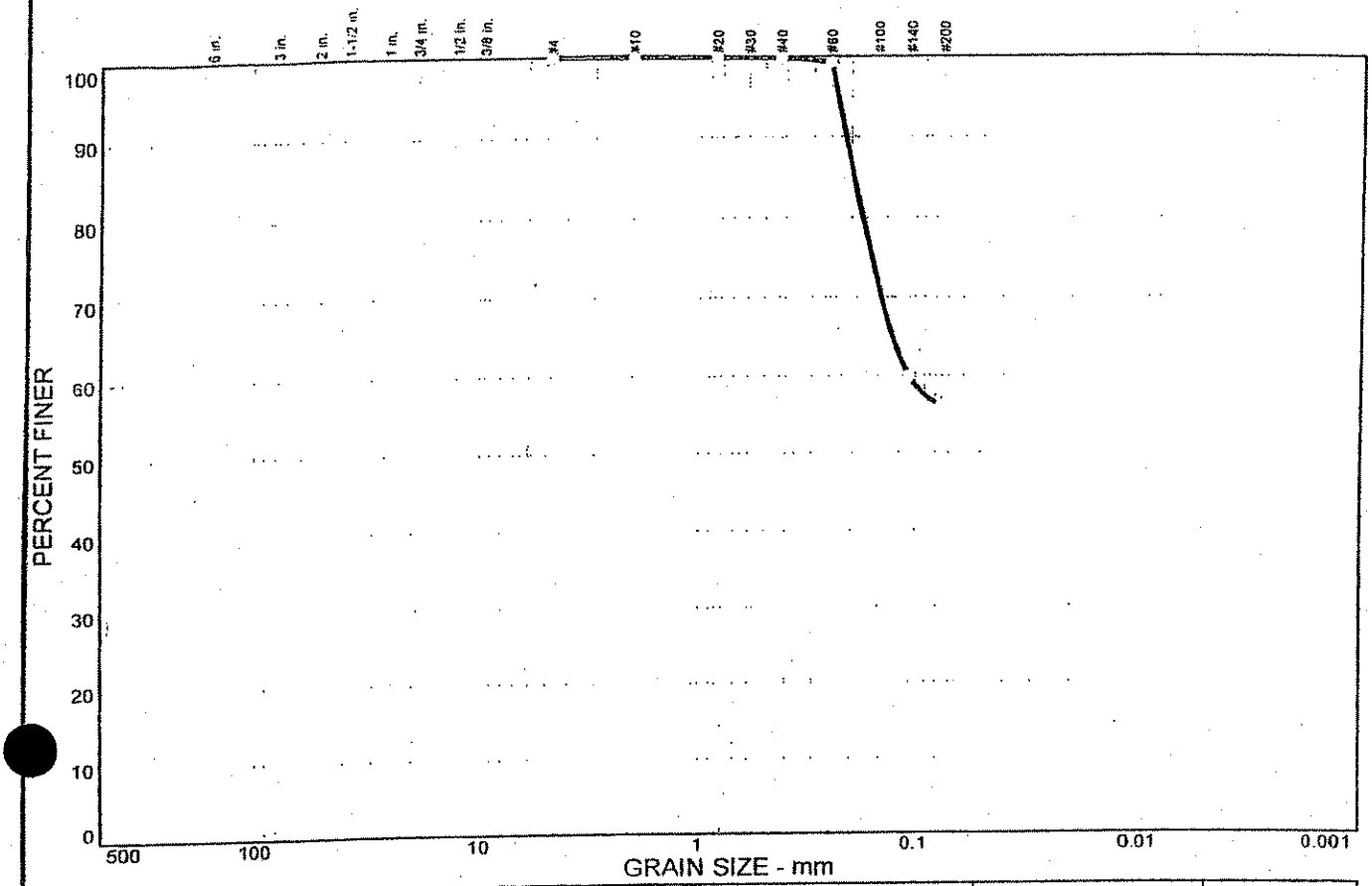
Date: 5-13-03
Elev./Depth: 133.5-135'

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	100.0		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.8		
#60	99.3		
#140	59.9		
#200	56.2		

* (no specification provided)

Soil Description

Sandy lean clay

Atterberg Limits

PL= 14 LL= 33 PI= 19

Coefficients

D_{85}= 0.195 D_{60}= 0.107 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= ND

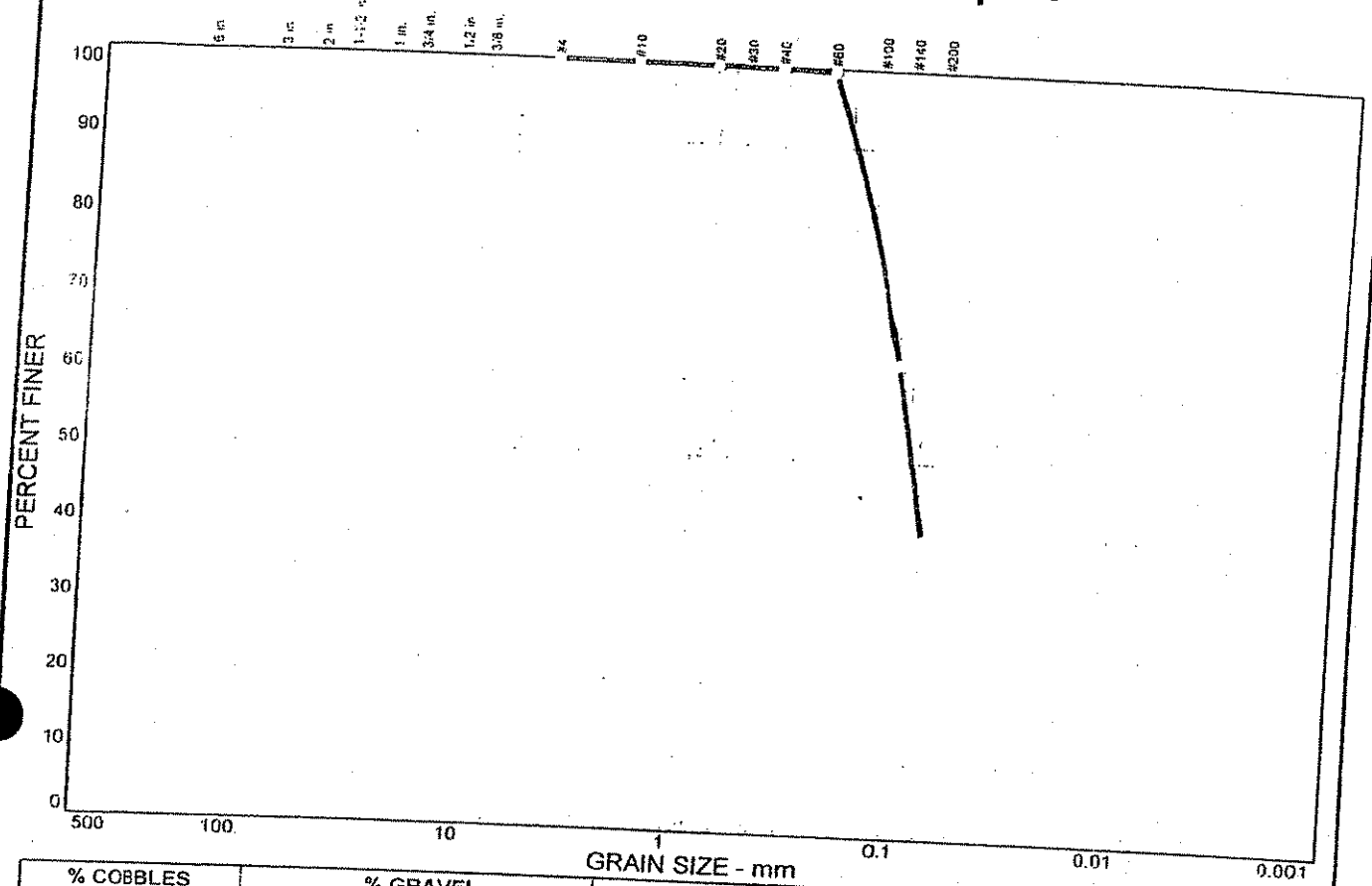
Remarks

ND=NOT DETERMINED

Sample No.: MS-4; 153.5-155 Source of Sample: Date: 5/13/03
Location: MS-4 Elev./Depth: 153.5-155'

MACTEC ENGINEERING & CONSULTING, INC.	Client: Project: GILMERTON Project No: 20400-2-1213.01	Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.8		
#60	99.6		
#140	62.8		
#200	39.7		

* (no specification provided)

Soil Description

Clayey sand

Atterberg Limits

PL= 14 LL= 26 PI= 12

Coefficients

D_{85}= 0.167 D_{60}= 0.101 D_{50}= 0.0870
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= ND

Remarks

ND=NOT DETERMINED

Sample No.: MS-4: 173.5-175 Source of Sample:
Location: MS-4

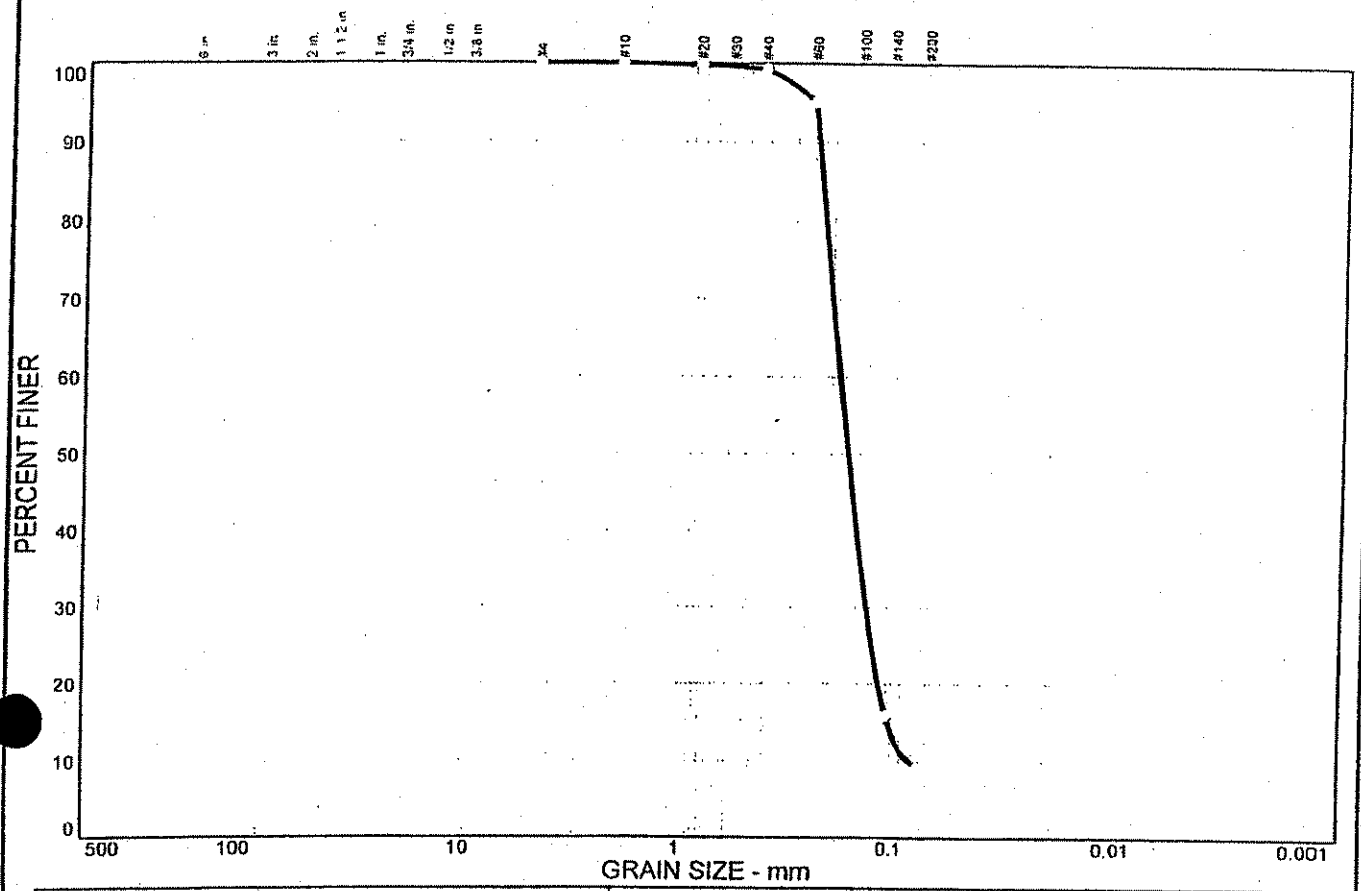
Date: 5 13 03
Elev./Depth: 173.5-175

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01

Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.8		
#40	99.3		
#60	95.1		
#140	15.9		
#200	9.1		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.229 D_{60}= 0.184 D_{50}= 0.167
D_{30}= 0.134 D_{15}= 0.104 D_{10}= 0.0823
C_u= 2.23 C_c= 1.19

Classification

USCS= SP-SM AASHTO= ND

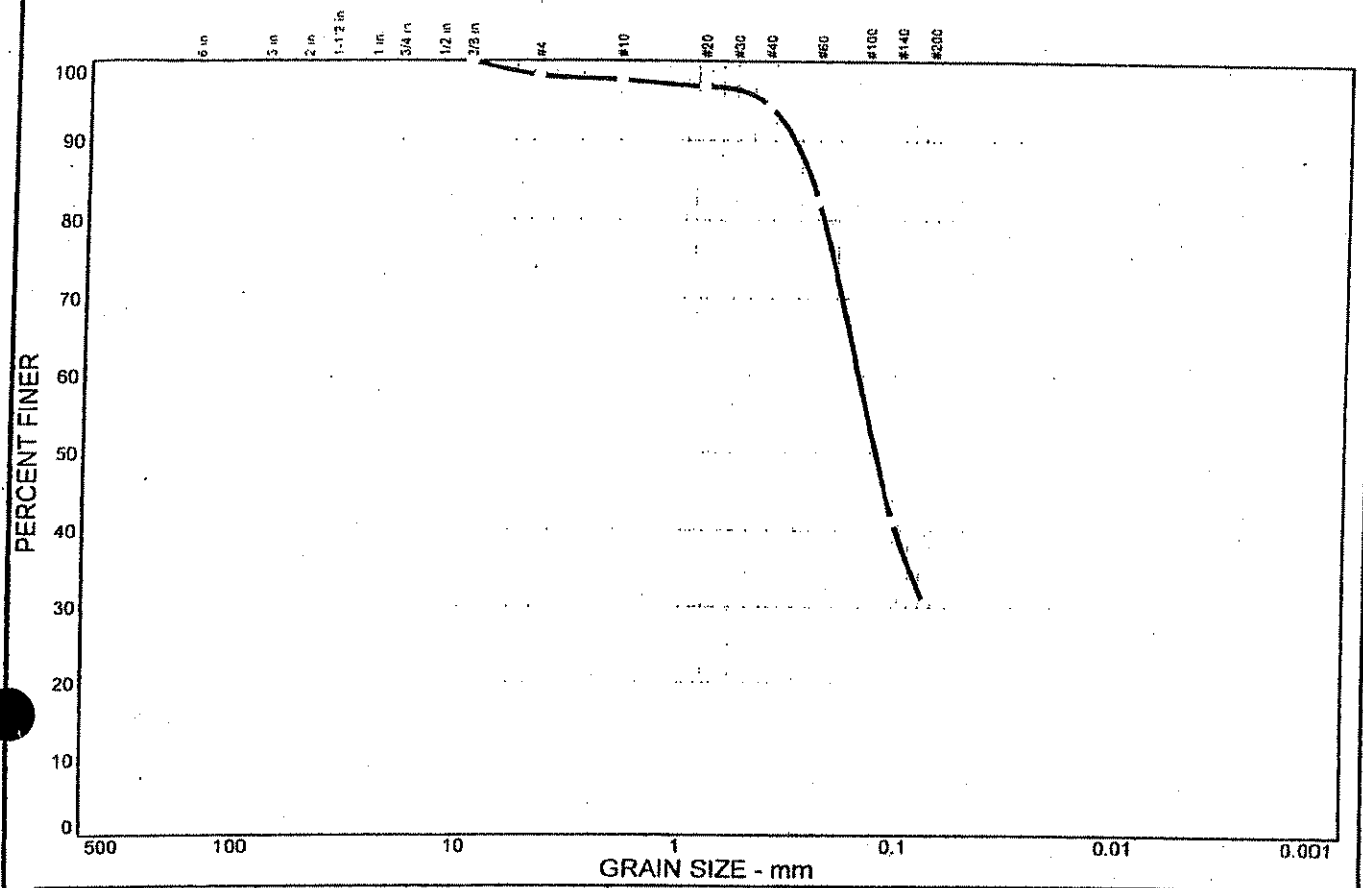
Remarks

NP=NON-PLASTIC
ND=NOT DETERMINED

Sample No.: MS-5; 23.5-25 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 23.5-25'

MACTEC ENGINEERING & CONSULTING, INC.	Client: Project: GILMERTON Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.4	97.6		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.2		
#10	97.6		
#20	96.8		
#40	94.3		
#60	82.4		
#140	41.2		
#200	30.4		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.269 D_{60}= 0.157 D_{50}= 0.129
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

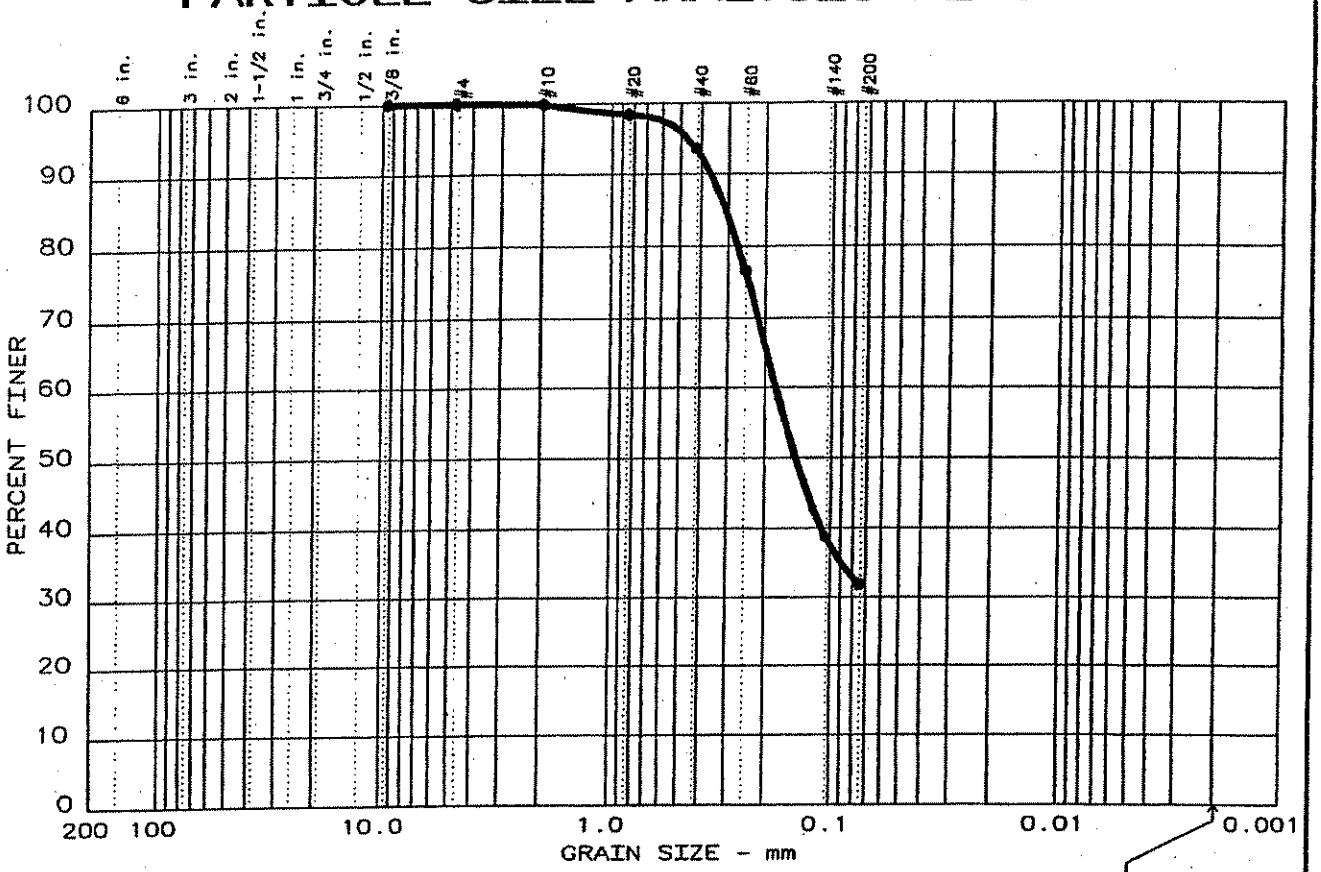
Remarks

NP=NON-PLASTIC
ND=NOT DETERMINED
F.M.=0.02

Sample No.: MS-5: 43.5-45 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 43.5-45'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	8	0.0	0.1	68.0	31.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NV	NP	0.309	0.177	0.143					

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Sand	SM	A-2-4(0)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-5, UD-1 @ 60.0'-62.0'

Date: 07-28-03

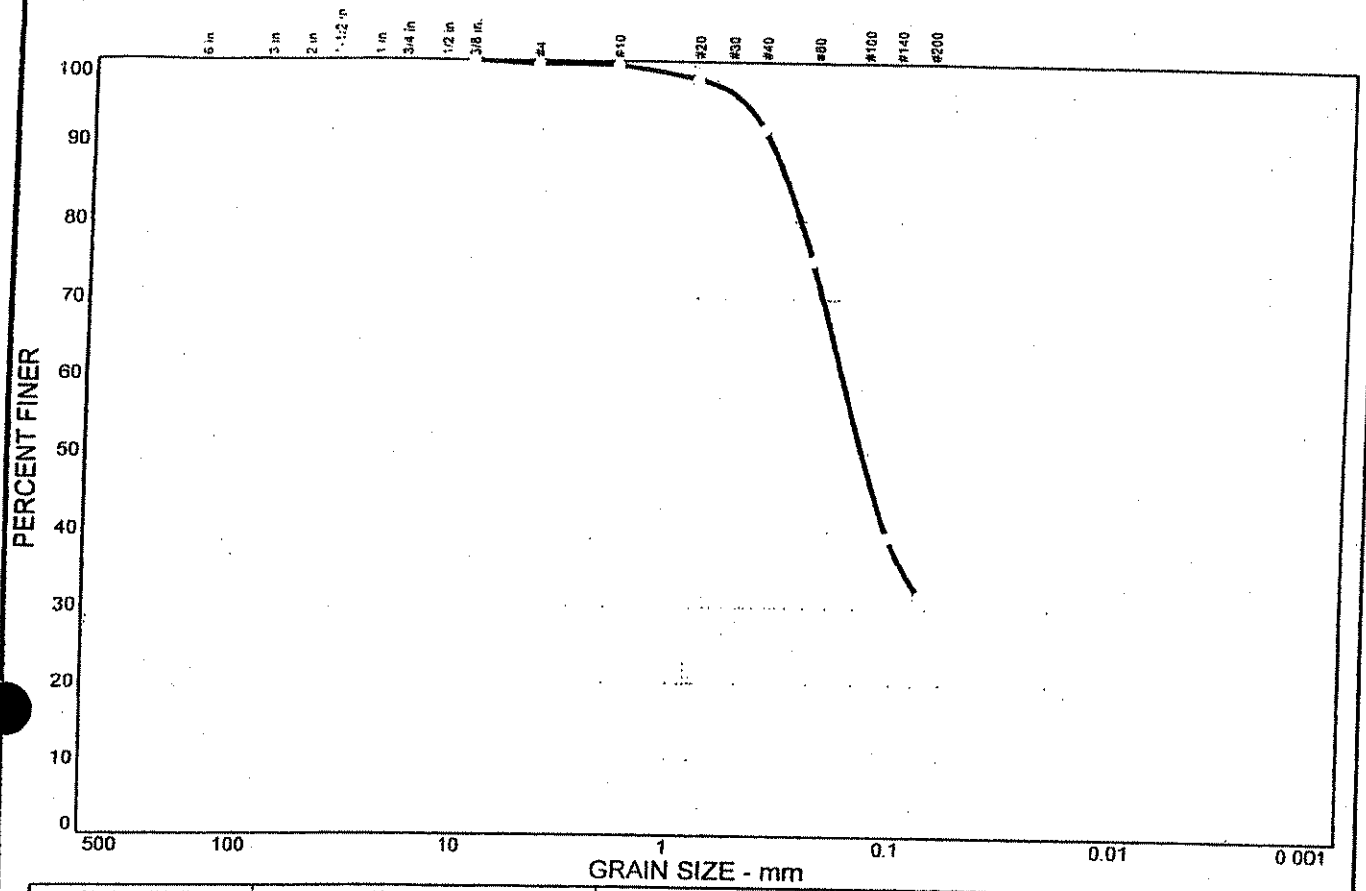
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	99.5		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.6		
#10	99.5		
#20	97.8		
#40	91.5		
#60	74.9		
#140	39.3		
#200	31.7		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.330 D_{60}= 0.179 D_{50}= 0.142
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

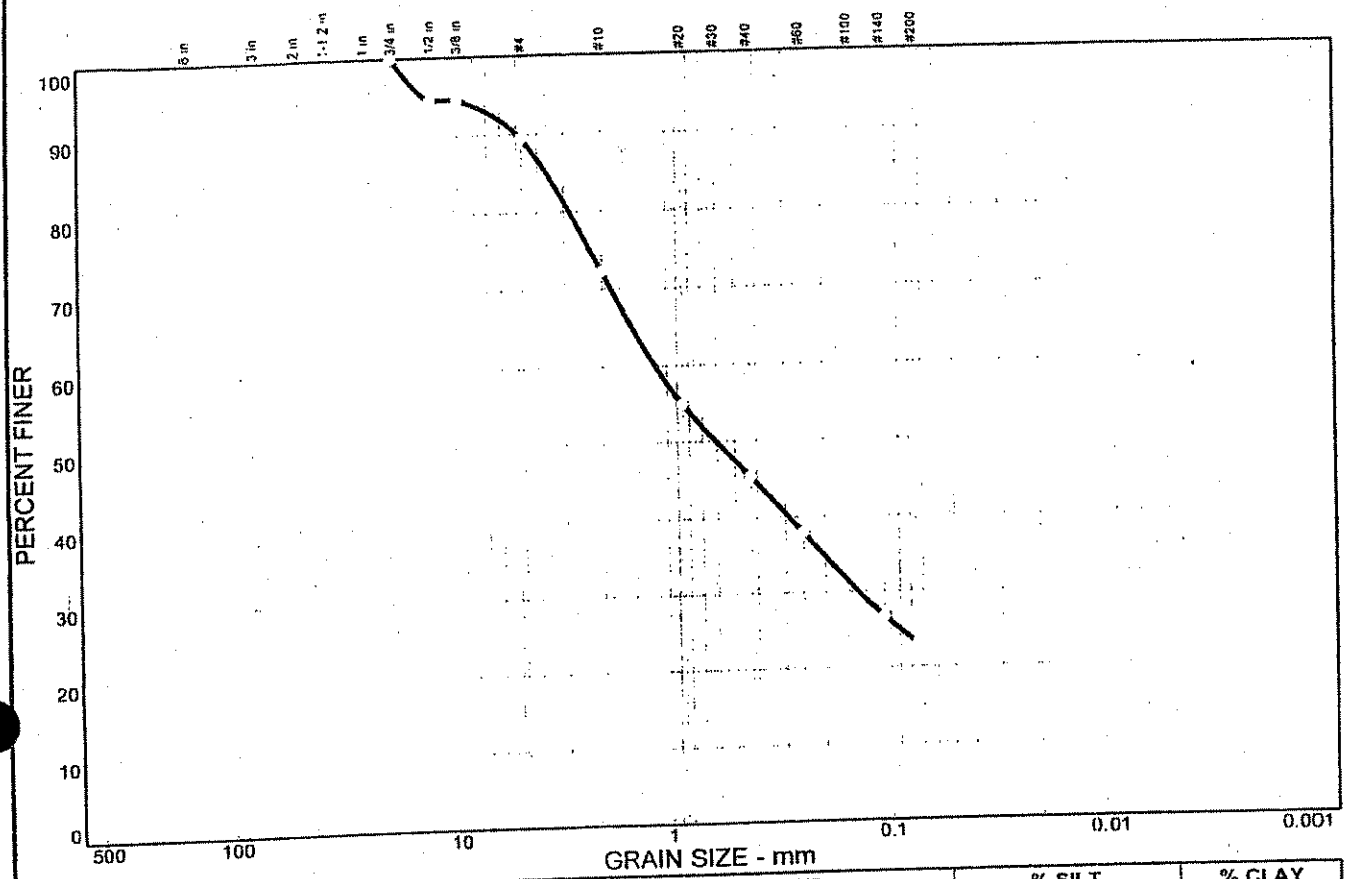
Remarks

NP=NON-PLASTIC ND=NOT DETERMINED
F.M.=0.00

Sample No.: MS-5: 68.5-70 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 68.5-70'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	27.7	72.3		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.50 in.	94.6		
.375 in.	94.6		
#4	89.5		
#10	72.3		
#20	55.0		
#40	45.4		
#60	37.9		
#140	26.7		
#200	23.0		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 3.59 D_{60}= 1.12 D_{50}= 0.603
D_{30}= 0.140 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

Remarks

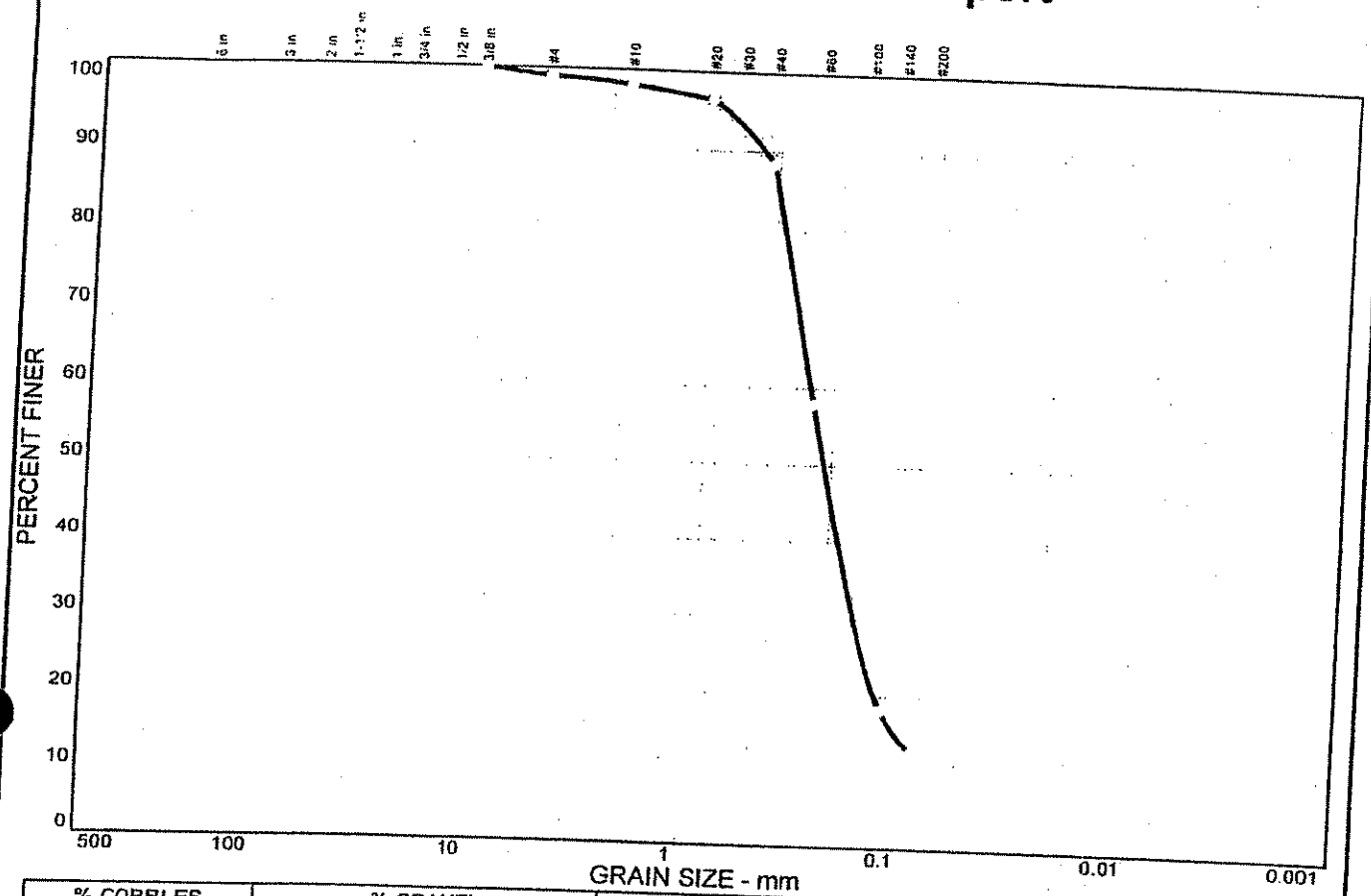
NP=NON-PLASTIC
ND=NOT DETERMINED
F.M.=0.16

Sample No.: MS-5: 88.5-90 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 88.5-90'

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	98.1		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.0		
#10	98.1		
#20	96.5		
#40	88.4		
#60	58.0		
#140	18.2		
#200	12.8		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.400 D_{60}= 0.259 D_{50}= 0.218
D_{30}= 0.148 D_{15}= 0.0896 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

Remarks

NP=NON-PLASTIC ND=NOT DETERMINED
F.M.=0.01

Sample No.: MS-5: 108.5-110 **Source of Sample:**
Location: MS-5

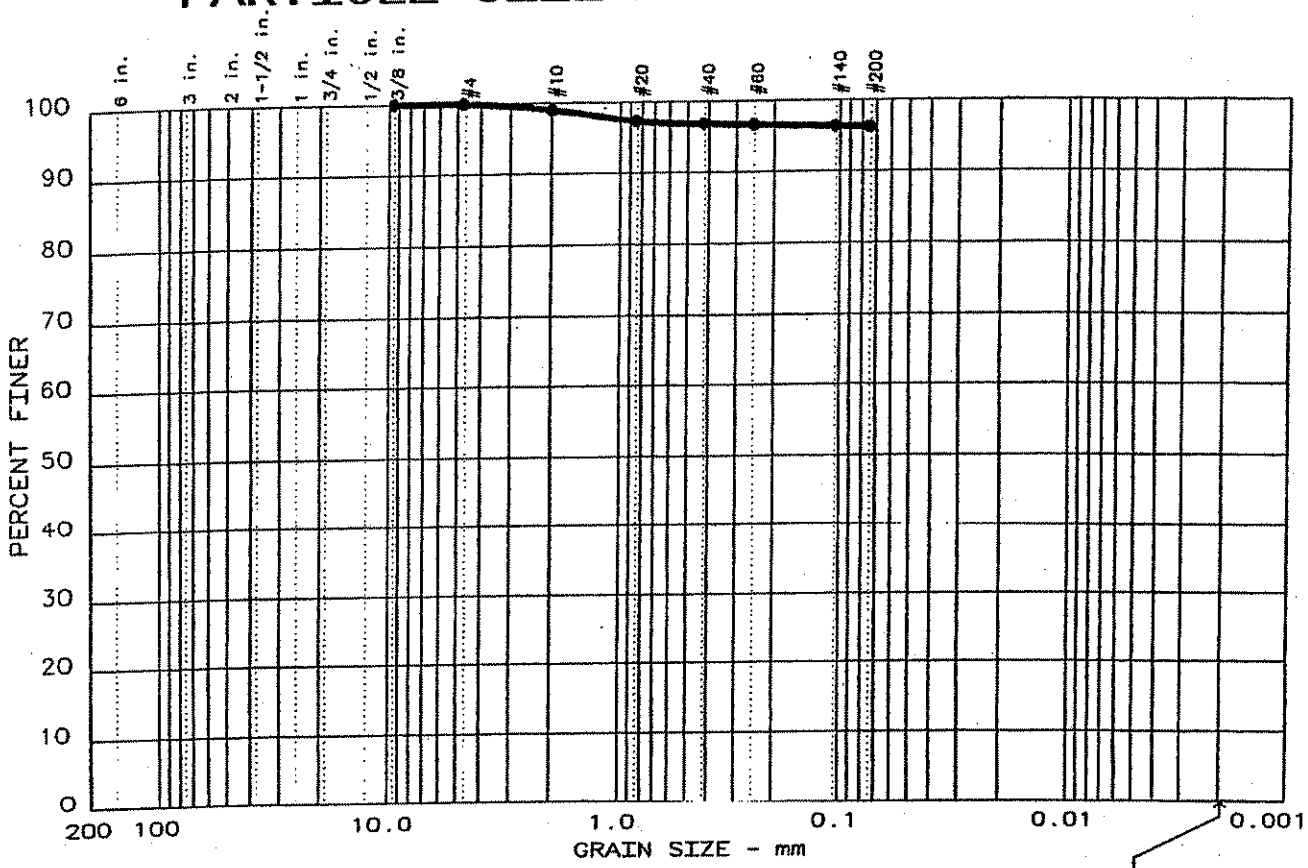
Date: 5/13/03
Elev./Depth: 108.5-110'

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01

Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	10	0.0	1.0	2.7	96.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	56	30								

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Clay	CH	A-7-6(33)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-5, UD-2 @ 126.5'-128.5'

Date: 07-28-03

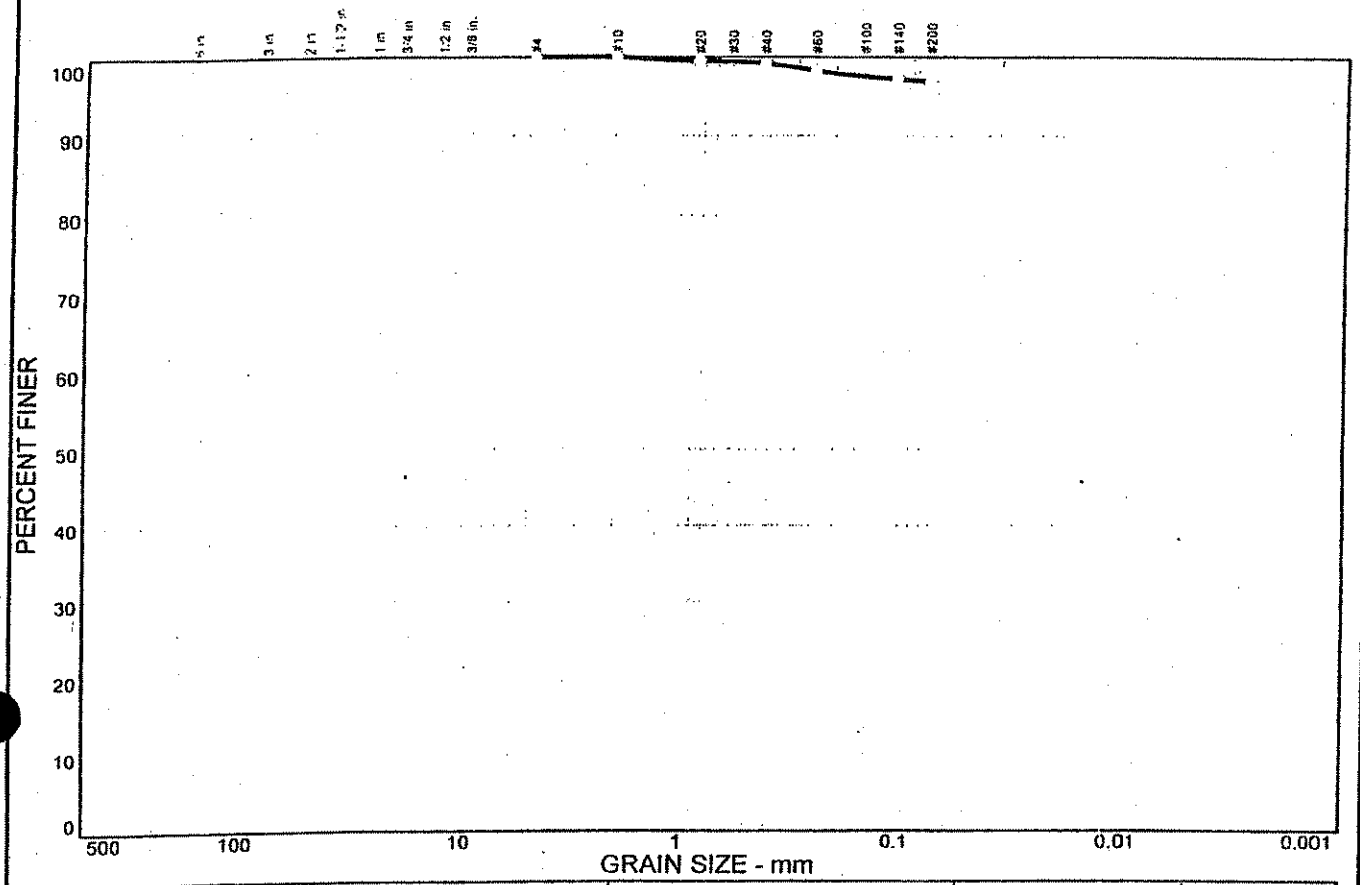
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	100.0		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.5		
#40	99.2		
#60	98.3		
#140	97.2		
#200	96.9		

* (no specification provided)

Soil Description

Fat clay

Atterberg Limits

PL= 20 LL= 52 PI= 32

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO= ND

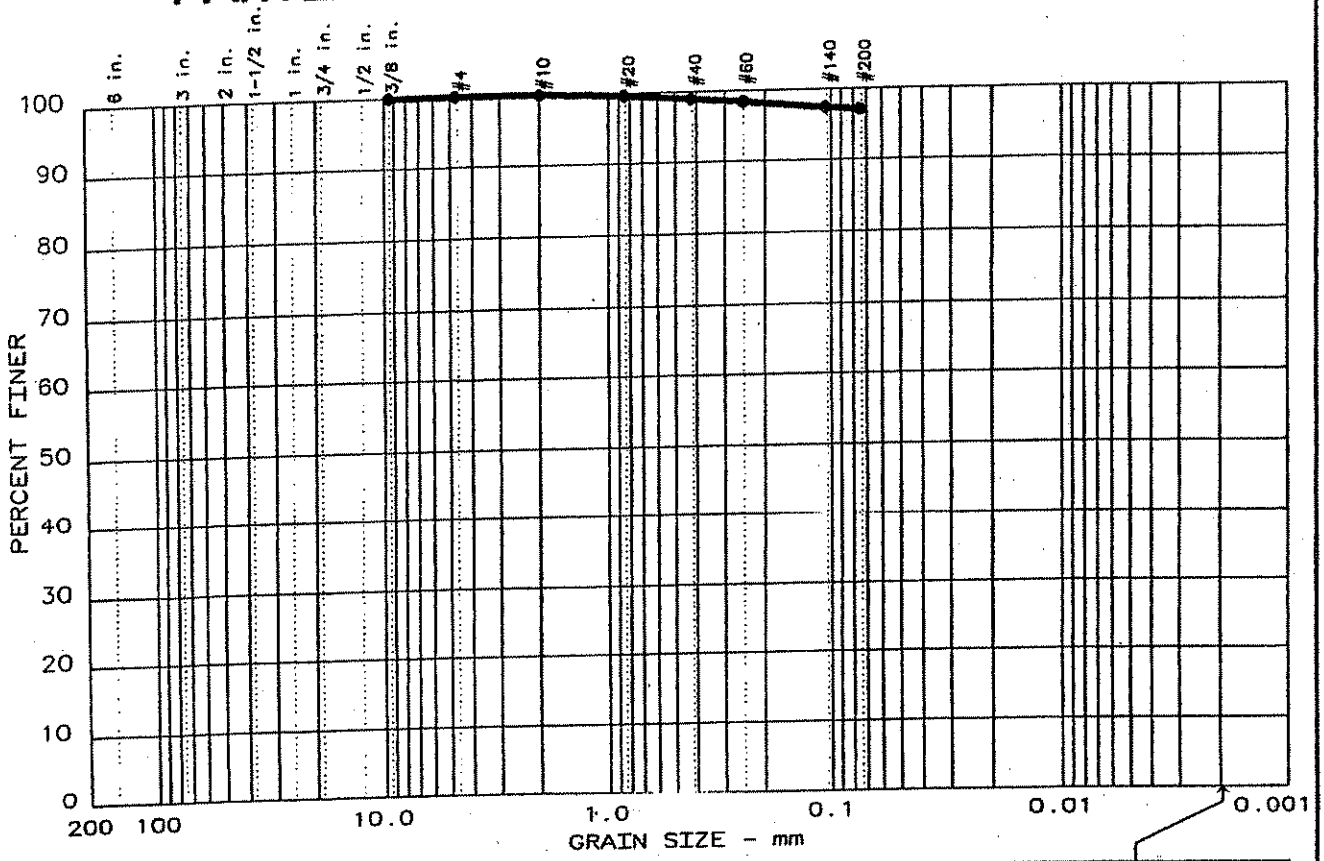
Remarks

ND=NOT DETERMINED

Sample No.: MS-5: 128.5-130 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 128.5-130'

MACTEC ENGINEERING & CONSULTING, INC.	Client: Project: GILMERTON Project No: 20400-2-1213.01 Plate

PARTICLE SIZE ANALYSIS REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	9	0.0	0.0	2.9	97.1	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	68	40								

MATERIAL DESCRIPTION	USCS	AASHTO
● Grey Silty Clay	CH	A-7-6(46)

Project No.: 20400-2-1213.04
Project: Gilmerton Bridge Replacement Project
● Location: MS-5, UD-4 @ 145.0'-147.0'

Date: 07-28-03

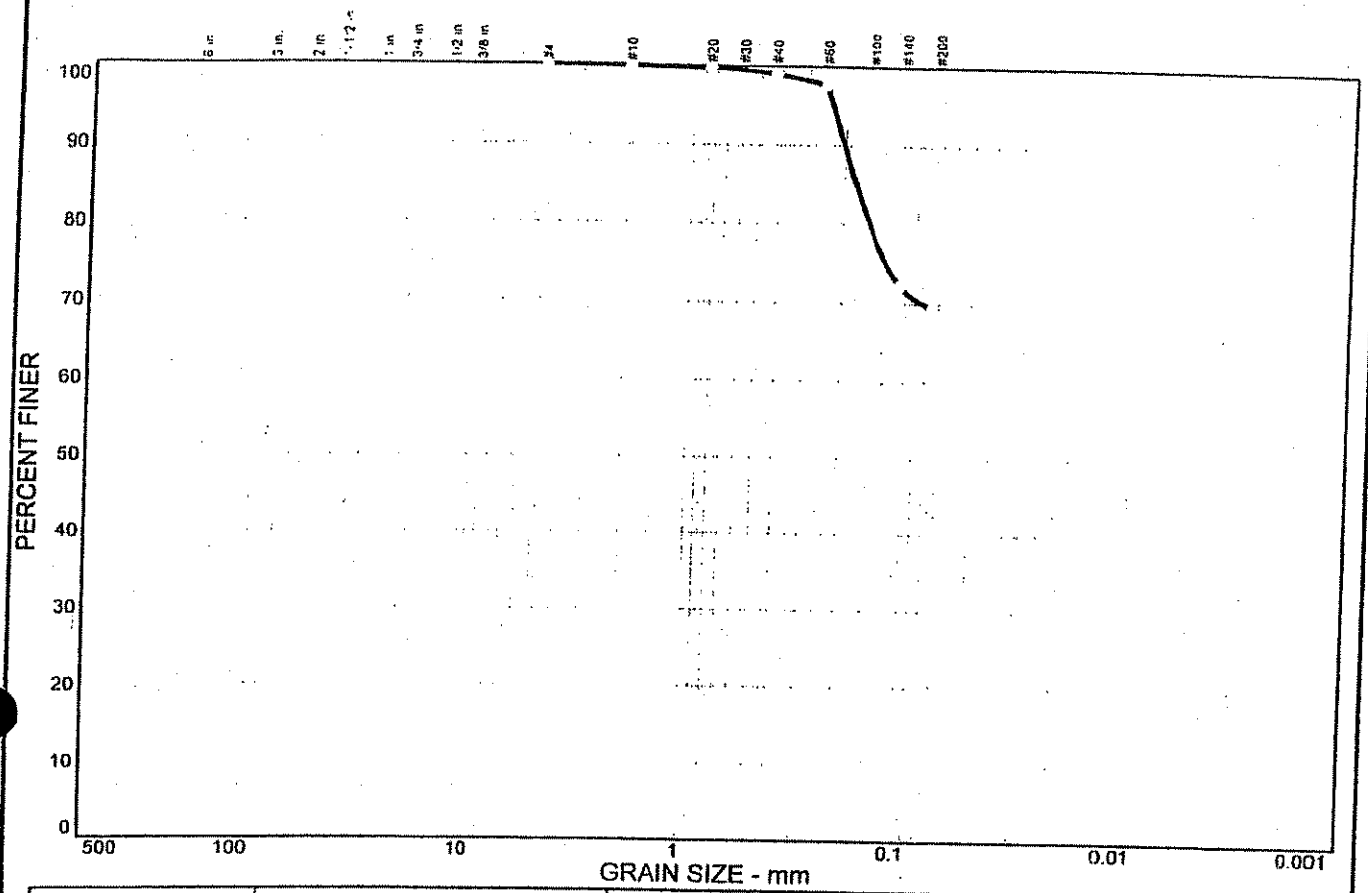
Remarks:

PARTICLE SIZE ANALYSIS REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

Fig. No.: _____

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.7		
#40	99.0		
#60	97.7		
#140	72.3		
#200	69.5		

* (no specification provided)

Soil Description

Sandy lean clay

Atterberg Limits

PL= 15 LL= 38 PI= 23

Coefficients

D_{85}= 0.175 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= ND

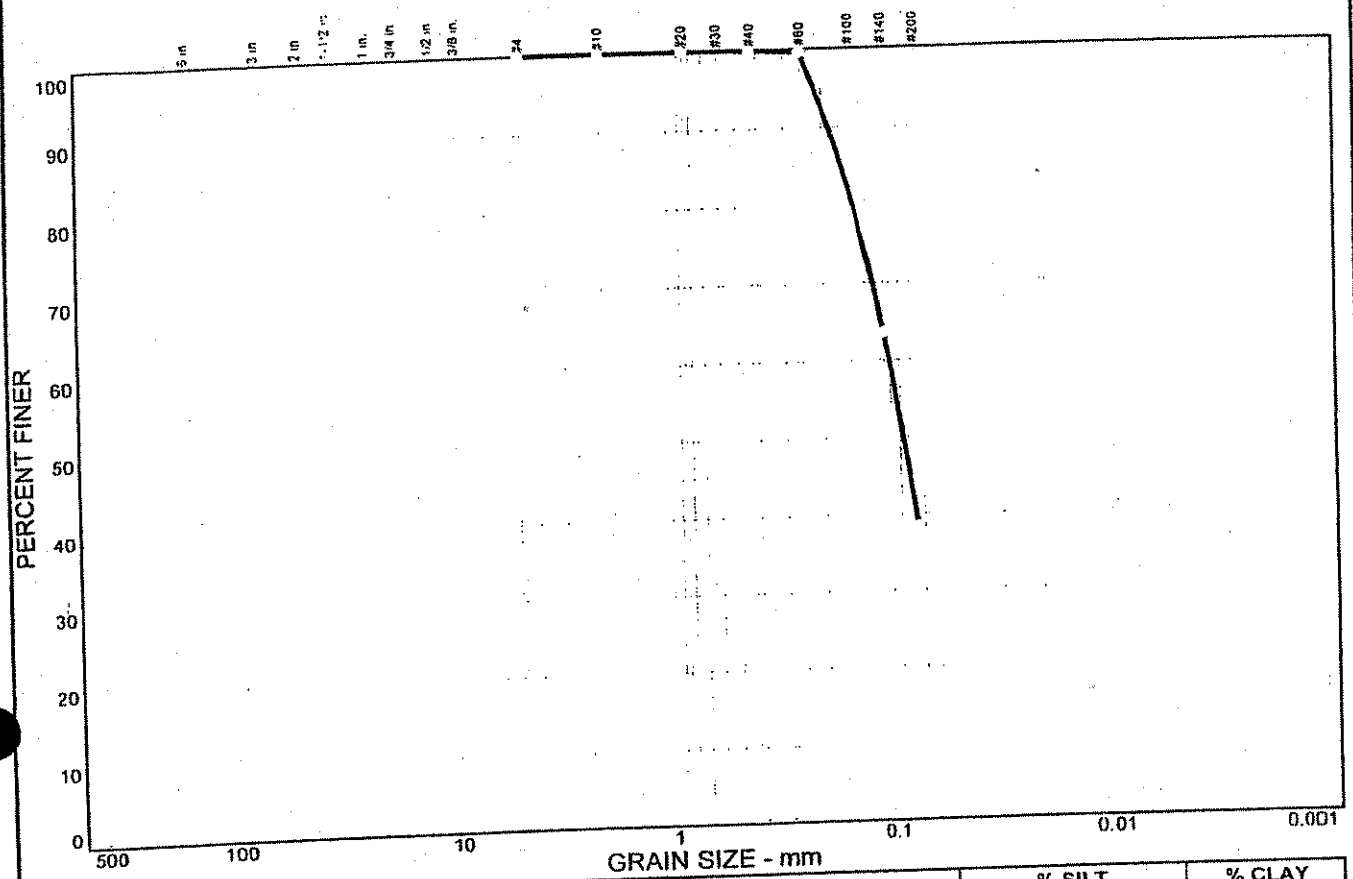
Remarks

ND=NOT DETERMINED

Sample No.: MS-5: 147-148.5 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 147-148.5'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	100.0		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	99.9		
#60	99.6		
#140	63.6		
#200	38.4		

* (no specification provided)

Soil Description

Silty, clayey sand

Atterberg Limits

PL= 19 LL= 26 PI= 7

Coefficients

D_{85}= 0.162 D_{60}= 0.100 D_{50}= 0.0873
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO= ND

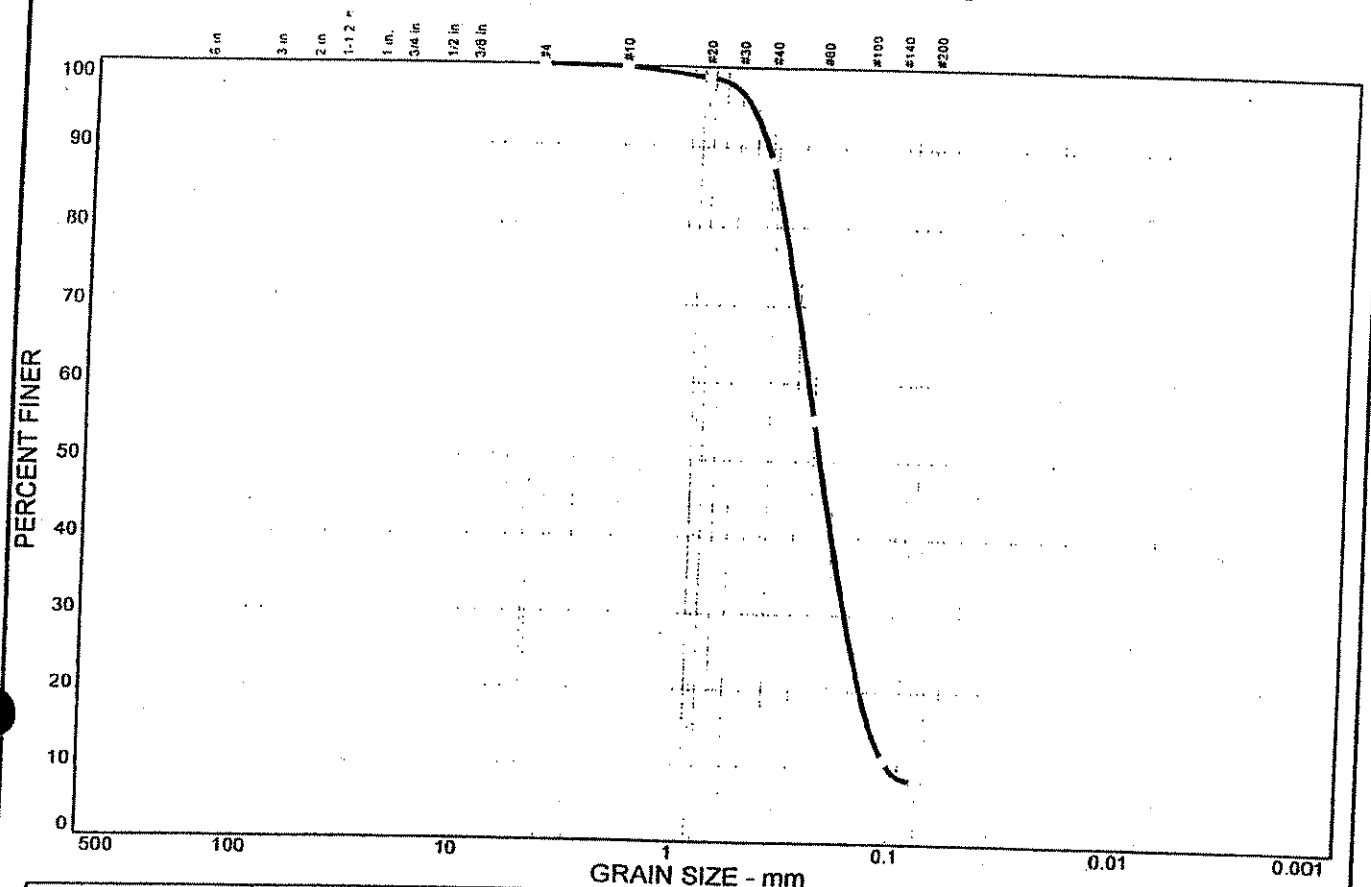
Remarks

ND=NOT DETERMINED

Sample No.: MS-5; 164-165.5 Source of Sample: Date: 5/13/03
Location: MS-5 Elev./Depth: 164-165.5'

MACTEC ENGINEERING & CONSULTING, INC.	Client: Project: GILMERTON Project No: 20400-2-1213.01	Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	98.7		
#40	88.1		
#60	55.3		
#140	10.9		
#200	8.2		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.397 D_{60}= 0.267 D_{50}= 0.232
D_{30}= 0.170 D_{15}= 0.123 D_{10}= 0.101
C_u= 2.66 C_c= 1.07

Classification

USCS= SP-SM AASHTO= ND

Remarks

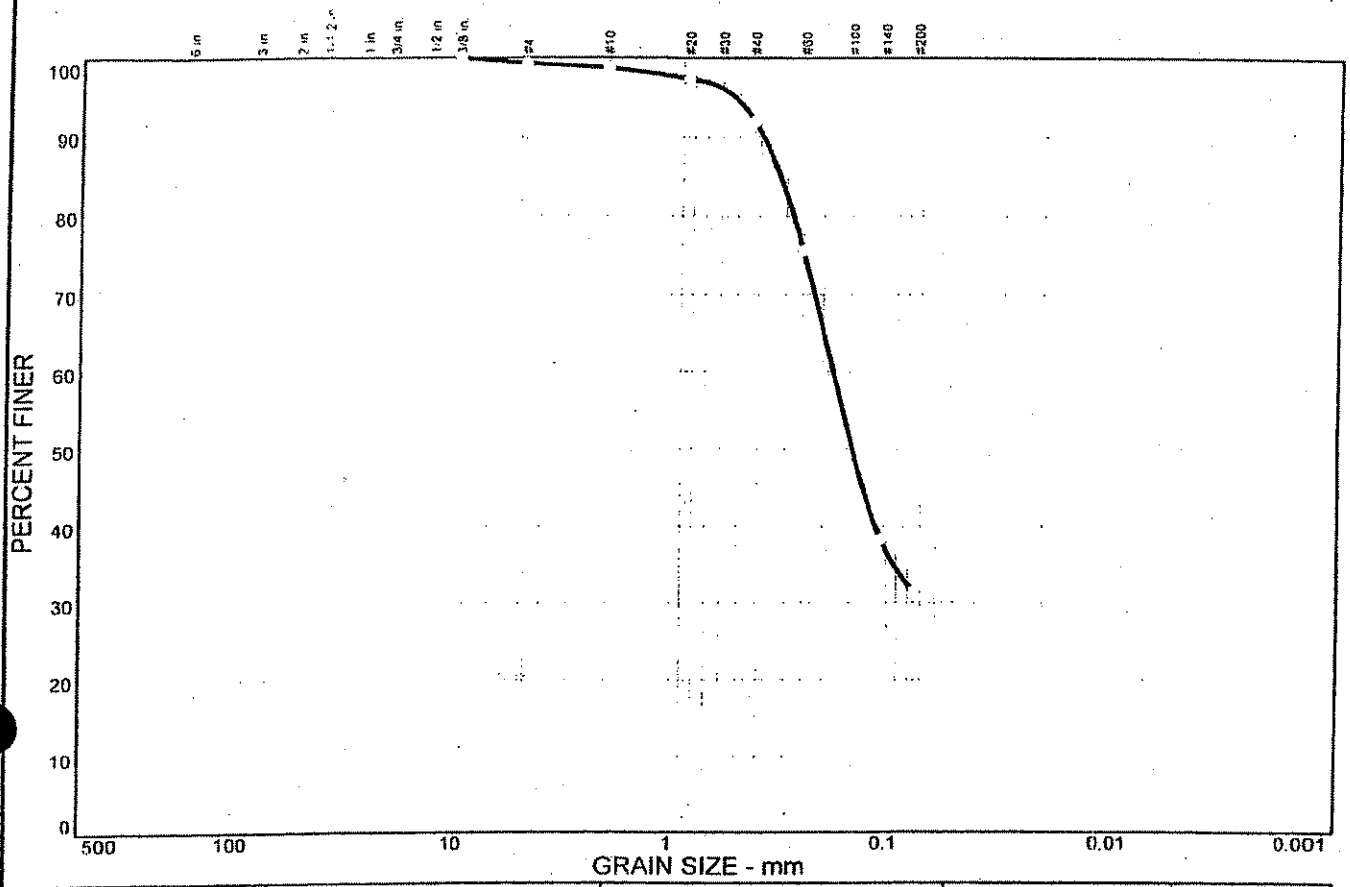
NP=NON-PLASTIC
ND=NOT DETERMINED

Sample No.: MS-6; 38.5-40 **Source of Sample:**
Location: MS-6

Date: 5/13/03
Elev./Depth: 38.5-40'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.3	98.7		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.3		
#10	98.7		
#20	97.4		
#40	92.0		
#60	75.6		
#140	38.3		
#200	31.4		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.322 D_{60}= 0.179 D_{50}= 0.145
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

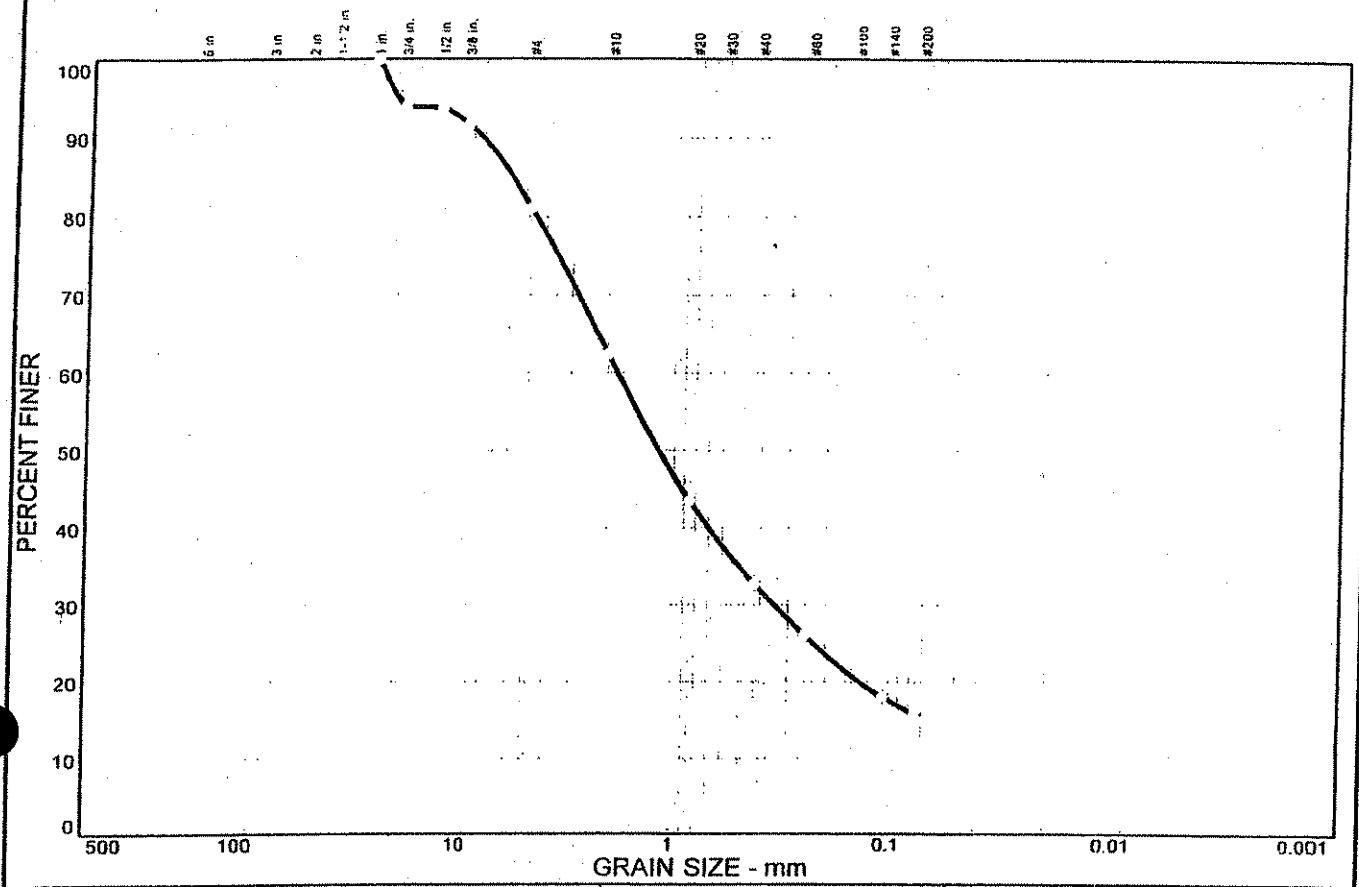
Remarks

NP=NON-PLASTIC ND=NOT DETERMINED
F.M.=0.01

Sample No.: MS-6: 63.5-65 Source of Sample: Date: 5/13/03
Location: MS-6 Elev./Depth: 63.5-65'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	37.6	62.4		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.0 in.	100.0		
.75 in.	93.9		
.50 in.	93.9		
.375 in.	91.7		
#4	81.1		
#10	62.4		
#20	43.5		
#40	32.7		
#60	26.0		
#140	18.0		
#200	15.8		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= 15 LL= 17 PI= 2

Coefficients

D_{85}= 5.87 D_{60}= 1.80 D_{50}= 1.17
D_{30}= 0.347 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

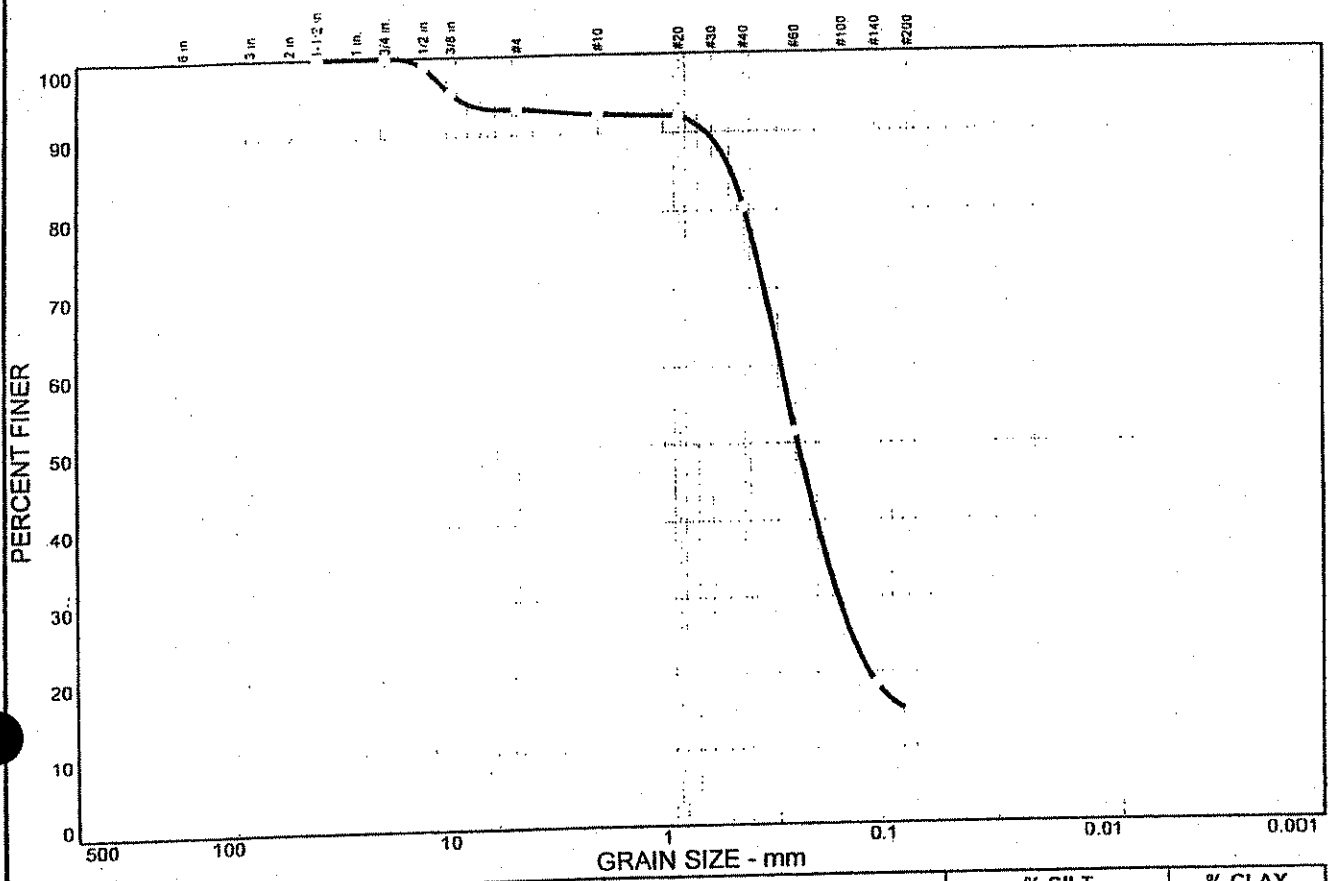
Remarks

ND=NOT DETERMINED
F.M.=0.33

Sample No.: MS-6; 83.5-85 **Source of Sample:** **Date:** 5/13/03
Location: MS-6 **Elev./Depth:** 83.5-85'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.5	92.5		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
.75 in.	100.0		
.50 in.	98.8		
.375 in.	95.5		
#4	93.3		
#10	92.5		
#20	92.2		
#40	80.4		
#60	51.6		
#140	18.4		
#200	14.7		

* (no specification provided)

Soil Description

SILTY SAND

Atterberg Limits

PL= 18 LL= 20 PI= 2

Coefficients

D_{85}= 0.488 D_{60}= 0.289 D_{50}= 0.243
D_{30}= 0.160 D_{15}= 0.0781 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= ND

Remarks

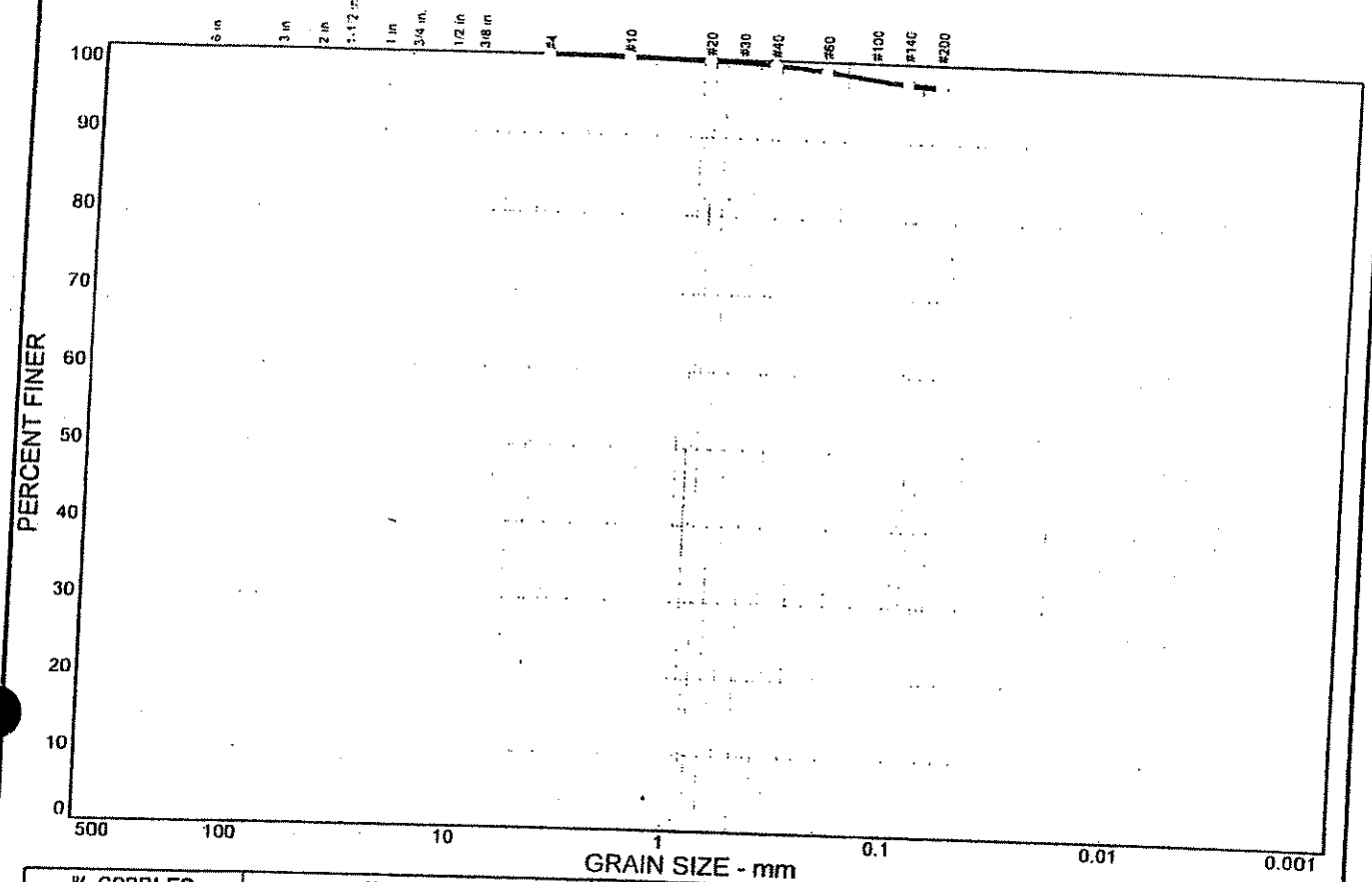
ND=NOT DETERMINED
F.M.=0.11

Sample No.: MS-6: 113.5-115 Source of Sample: Date: 5/13/03
Location: MS-6 Elev./Depth: 113.5-115'

MACTEC
ENGINEERING & CONSULTING, INC.

Client:
Project: GILMERTON
Project No: 20400-2-1213.01 Plate

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	99.9		

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.7		
#40	99.4		
#60	98.8		
#140	97.5		
#200	97.2		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 20 LL= 49 PI= 29

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= ND

Remarks

ND=NOT DETERMINED

Sample No.: MS-6: 133.5-135 **Source of Sample:**
Location: MS-6

Date: 5/13/03
Elev./Depth: 133.5-135'

MACTEC ENGINEERING & CONSULTING, INC.	Client:
	Project: GILMERTON
	Project No: 20400-2-1213.01 Plate

Boring	Sample Depth	Soil Characterization				TOC Test Results	
		% Gravel	% Sand	% Silt	% Clay	% Dry Weight	TOC (mg/kg)
MS-3	0-1.5	24.3	12.8	21.8	41.1	44.2	42,600.00
	1.5-3	3.2	11.4	32.5	52.9	42.4	50,300.00
	3-4.5	0.1	78.4	6.5	15.0	73.8	5,260.00
	4.5-6	0.0	58.6	23.6	17.8	71.7	9,370.00
	6-7.5	0.1	83.7	5.0	11.2	77.6	4,740.00
	7.5-9	0.0	69.5	14.5	16.0	67.7	10,400.00
	9-10.5	0.1	71.1	8.3	20.5	69.9	7,660.00
MS-4	0-2	16.2	74.8	2.6	6.4	77.3	8,000.00
	2-4	12.8	77.9	3.0	6.3	78.1	8,220.00
	4-6	0.0	64.3	22.1	13.6	64.4	3,020.00
	6-8	1.7	87.7	3.9	6.7	78.3	ND
MS-5	0-2	22.1	73.0	0.9	0.4	81.2	997,000.00
	4-6	1.0	86.9	5.2	6.9	74.3	1,000,000.00
	8-10	0.2	89.9	4.7	5.2	78.4	998,000.00

TestAmerica
ANALYTICAL TESTING CORPORATION

2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66313
Sample ID: MS-3 UD-1 0-1.5
Sample Type: Soil
Site ID:

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	44.2	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	42600	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66314
Sample ID: MS-3 UD-2 1.5-3
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	42.4	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	50300	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION

2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66315
Sample ID: MS-3 UD-3 3-4.5
Sample Type: Soil
Site ID:

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	73.8	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	5260	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66316
Sample ID: MS-3 UD-4 4.5-6
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	71.7	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	9370	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66317
Sample ID: MS-3 UD-5 6-7.5
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	77.6	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	4740	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66318
Sample ID: MS-3 UD-6 7.5-9
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	67.7	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	10400	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION

2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66319
Sample ID: MS-3 UD-7 9-10.5
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	69.9	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	7660	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66320
Sample ID: MS-4 UD-1 0-2
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	77.3	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	8000	mg/kg	1000	1	5/ 1/03	13:59	J.Mehall	9060M	2969

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION

2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66321
Sample ID: MS-4 UD-2 2-4
Sample Type: Soil
Site ID:

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	78.1	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	8220	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66322
Sample ID: MS-4 UD-3 4-6
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	64.4	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	3020	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66323
Sample ID: MS-4 UD-4 6-8
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	78.3	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	ND	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66324
Sample ID: MS-5 UD-1 0-2
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	81.2	%			5/ 5/03	18:10	M. Cauthen	CLP	4242
TOC	997000	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION

2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Lab Number: 03-A66325
Sample ID: MS-5 UD-3 4-6
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	74.3	%			5/ 5/03	19:00	M. Ricke	CLP	4243
TOC	1000000	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

TestAmerica
ANALYTICAL TESTING CORPORATION
2960 Foster Creighton Drive • Nashville, Tennessee 37204
800-765-0980 • 615-726-3404 Fax

ANALYTICAL REPORT

MACTEC 2387
BECKY SHANAHAN
3301 ATLANTIC AVENUE
RALEIGH, NC 27604

Project: 20400-2-1213,01.LAB
Project Name: GILMERTON
Sampler:

Lab Number: 03-A66326
Sample ID: MS-5 UD-5 8-10
Sample Type: Soil
Site ID:

Date Collected:
Time Collected:
Date Received: 4/29/03
Time Received: 8:20
Page: 1

Analyte	Result	Units	Report Limit	Dil Factor	Date	Time	Analyst	Method	Batch
GENERAL CHEMISTRY PARAMETERS									
% Dry Weight	78.4	%			5/ 5/03	19:00	M. Ricke	CLP	4243
TOC	998000	mg/kg	1000	1	5/ 2/03	14:30	M.Checolle	9060M	4399

LABORATORY COMMENTS:

ND = Not detected at the report limit.
B = Analyte was detected in the method blank.
J = Estimated Value below Report Limit.
E = Estimated Value above the calibration limit of the instrument.
# = Recovery outside Laboratory historical or method prescribed limits.
All reported results for metals or Organic analyses have been corrected for dry weight.
Extracted TOC result corrected for dry weight.

End of Sample Report.

LAW
LAWGIBB Group Member

Law Engineering and Environmental Services, Inc.
22455 Davis Drive, Suite 100
Sterling, Virginia 20164
(703)404-7000

DRAFT

Summary of Soil Classification Test Data

PROJECT NAME: GTS Technologies, Inc.
PROJECT NUMBER: 20390-1-2828
DATE: 5/23/01

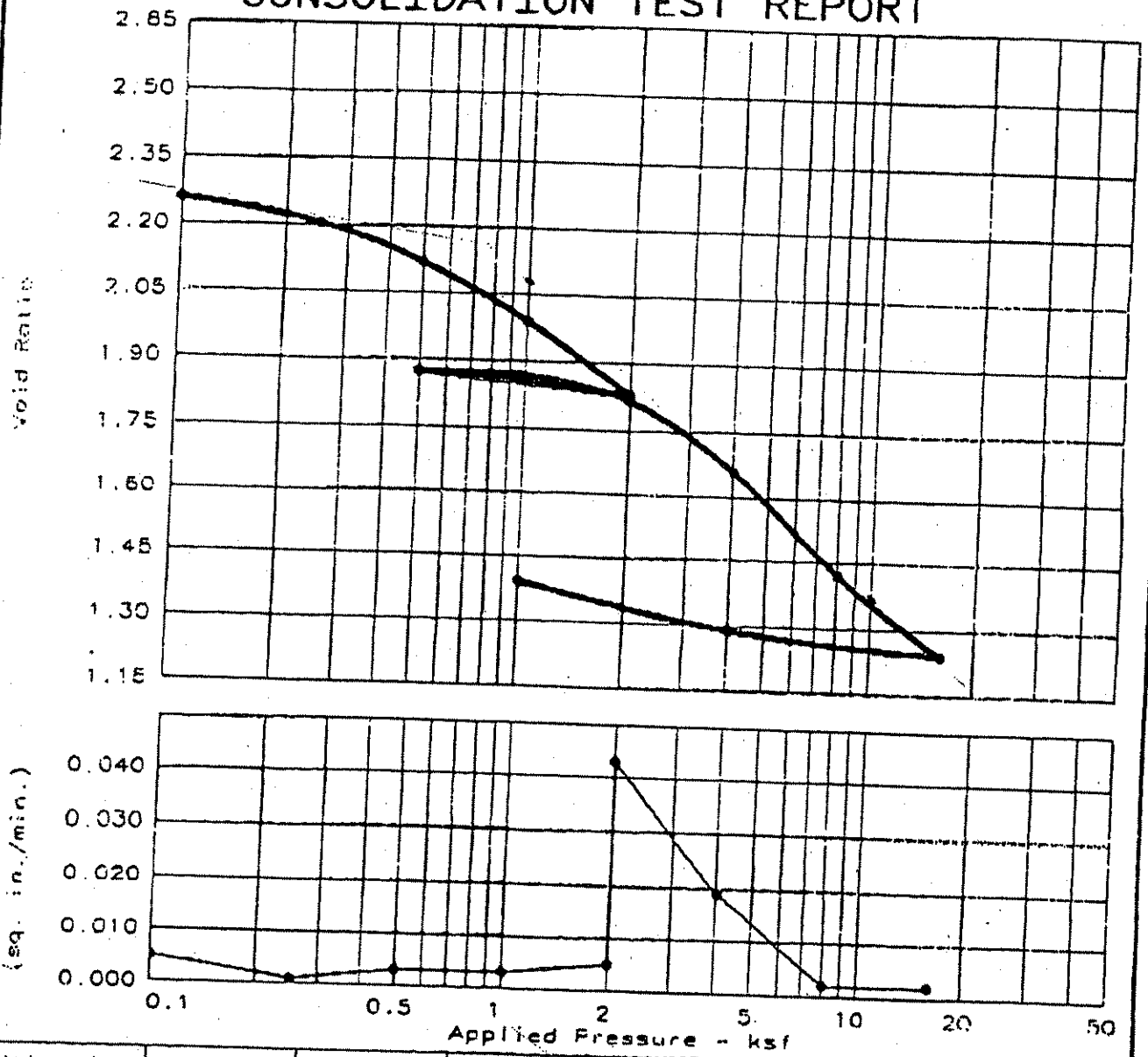
Elevation Range (ft.)	SAMPLE ID	SAMPLE DEPTH (ft.)	SAMPLE TYPE	SOIL DESCRIPTION	SOIL CLASS.	% RETAINED NO. 4 SIEVE	% FINER NO. 200 SIEVE	NAT. MOIST. (%)	ATTERBERG LIMITS L.L.	ATTERBERG LIMITS P.L.	ATTERBERG LIMITS P.I.	COMMENTS
-15 → -17	B-4	18.0 - 20.0	UD	Dark gray fat CLAY with sand	CH	0.0	78.3	78.7	62	30	32	
-91 → -103	B-5	69.0 - 80.5	Jar	Dark gray silty SAND	SM	0.0	29.4	27.6	NII	NP	—	
-86 → -93	B-6	64.0 - 70.5	Jar	Gray poorly graded SAND	SP	4.1	4.5	11.0	NII	NP	—	
-101 → -108	B-6	79.0 - 85.5	Jar	Gray poorly graded SAND	SP	2.9	3.6	9.6	NII	NP	—	
-59 → -65	B-7	60.0 - 66.0	Jar	Olive brown poorly graded silty SAND	SP-SM	0.0	11.9	25.1	NII	NP	—	
-11 → -13	B-9	20.0 - 22.0	UD	Dark gray clayey SAND	SC	0.0	47.4		56	26	30	

NOTES:
1. Soil classification and testing in accordance with USCS, ASTM D2487, D421, D422 & D4318
2. L.L.= Liquid Limit N.P.= Non Plastic
   P.L.= Plastic Limit N.L.L.=No Liquid Limit
   P.I. = Plasticity Index
3. Soil color determined from Munsell Soil Chart

Reviewed
Chan Tin
Manager, Laboratory Services

USCS Summary 1-2902

CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Initial void ratio
92.2 %	78.7 %	131.0			2.700	2.3032

TEST RESULTS

MATERIAL DESCRIPTION

Project No.: 20360-1-2828
Project: GTS Technologies Lab Testing
Location: Boring B-4 @ 18' - 20'

Date: 6/13/01

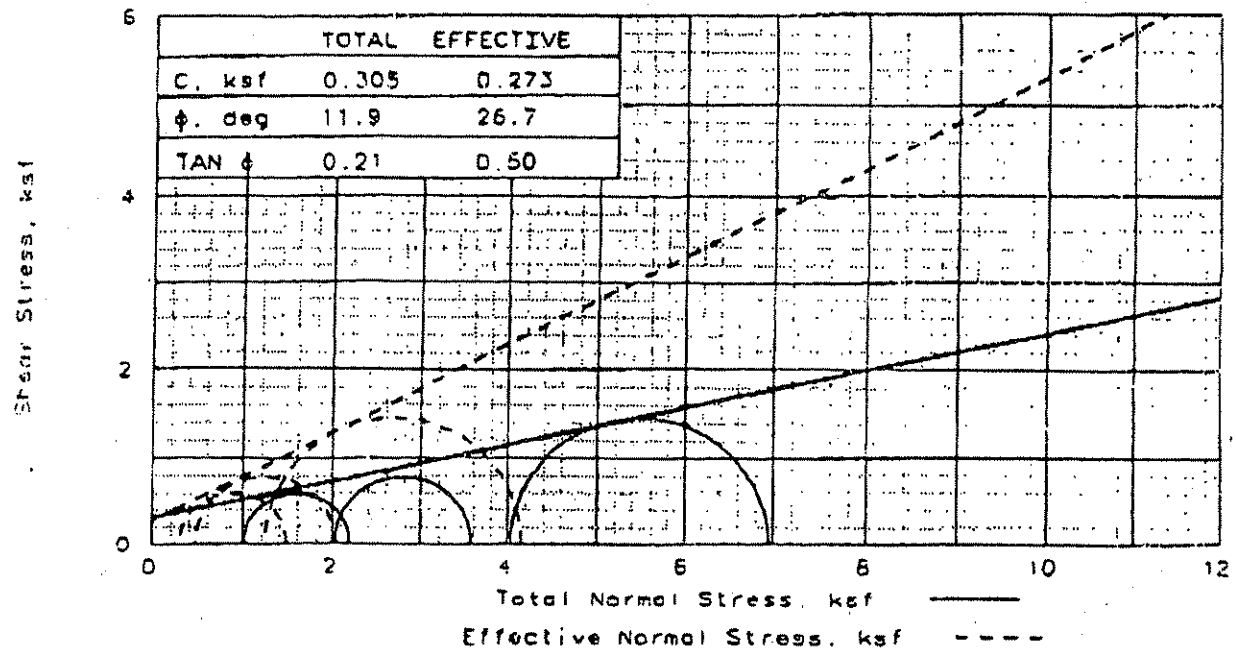
Remarks:

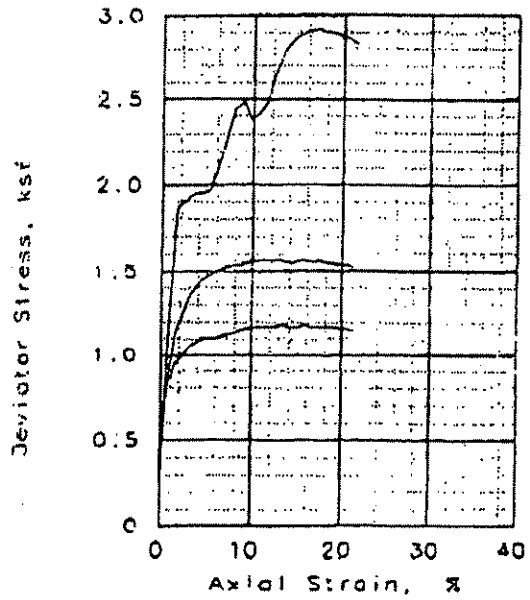
DRAFT

CONSOLIDATION TEST REPORT

LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC.

Fig. No. 1 1





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	72.1	83.9	69.9
	DRY DENSITY, pcf	55.1	48.6	58.2
	SATURATION, %	94.6	91.9	99.6
	VOID RATIO	2.058	2.467	1.895
	DIAMETER, in	2.831	2.869	2.829
	HEIGHT, in	5.494	5.492	5.450
AT TEST	WATER CONTENT, %	60.8	67.4	49.8
	DRY DENSITY, pcf	61.8	57.7	70.5
	SATURATION, %	95.1	94.8	96.6
	VOID RATIO	1.725	1.921	1.392
	DIAMETER, in	2.673	2.833	2.572
	HEIGHT, in	5.494	5.492	5.450
Strain rate, %/min		0.00	0.00	0.00
BACK PRESSURE, ksf		5.616	5.616	5.616
CELL PRESSURE, ksf		6.624	7.632	9.648
FAILURE STRESS, ksf		1.180	1.563	2.918
TOTAL PORE PR., ksf		6.322	7.157	8.410
ULTIMATE STRESS, ksf				
TOTAL PORE PR., ksf				
$\bar{\sigma}_1$ FAILURE, ksf		1.483	2.038	4.157
$\bar{\sigma}_3$ FAILURE, ksf		0.302	0.475	1.238

TYPE OF TEST:
CU with Pore Pressures
SAMPLE TYPE: Undisturbed
DESCRIPTION:

SPECIFIC GRAVITY= 2.7
REMARKS:

Fig No.: 1

CLIENT: GTS Technologies, Inc.

PROJECT: US Route 13 Gilmerton Bridge

SAMPLE LOCATION: Boring B-4

DRAFT

PROJ. NO.: 2C380-1-2828 DATE: 6/13/01

TRIAXIAL SHEAR TEST REPORT

LAW ENGINEERING AND ENVIRONMENTAL SERVICES

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT

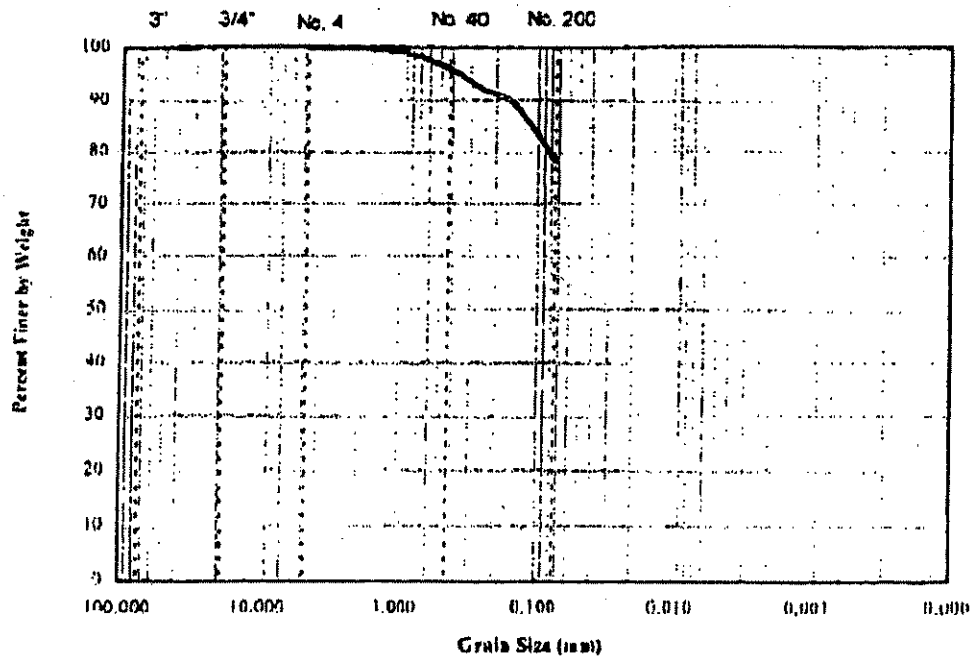
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-4 @ 18' -70'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
# 4	0.00	0.0	100.0
# 10	0.13	0.1	99.9
# 20	1.24	1.1	98.6
# 40	3.68	2.4	95.9
# 60	7.09	3.4	92.1
# 100	9.54	2.5	89.3
# 200	19.41	9.9	78.3
Wt. of Soil, g	89.53		

Particle Size Analysis
U.S. Standard Sieve Sizes



Reviewed by: _____

B-4@18-70

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT

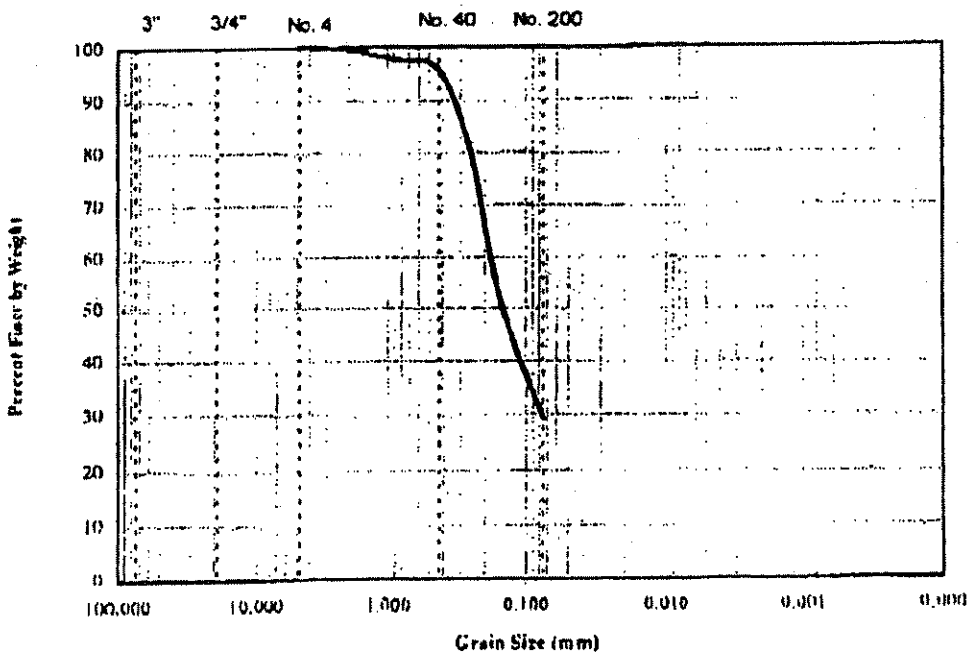
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-5 @ 69' -80.5'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
# 4	0.00	0.0	100.0
# 10	0.48	0.5	99.5
# 20	2.30	1.8	97.5
# 40	4.10	1.8	95.6
# 60	18.86	14.8	79.7
# 100	45.81	27.0	50.7
# 200	65.64	19.8	35.4
Wt. of Soil, g	92.94		

Particle Size Analysis
U.S. Standard Sieve Sizes



Reviewed by: _____

B-5@69-80.5

DRAFT

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

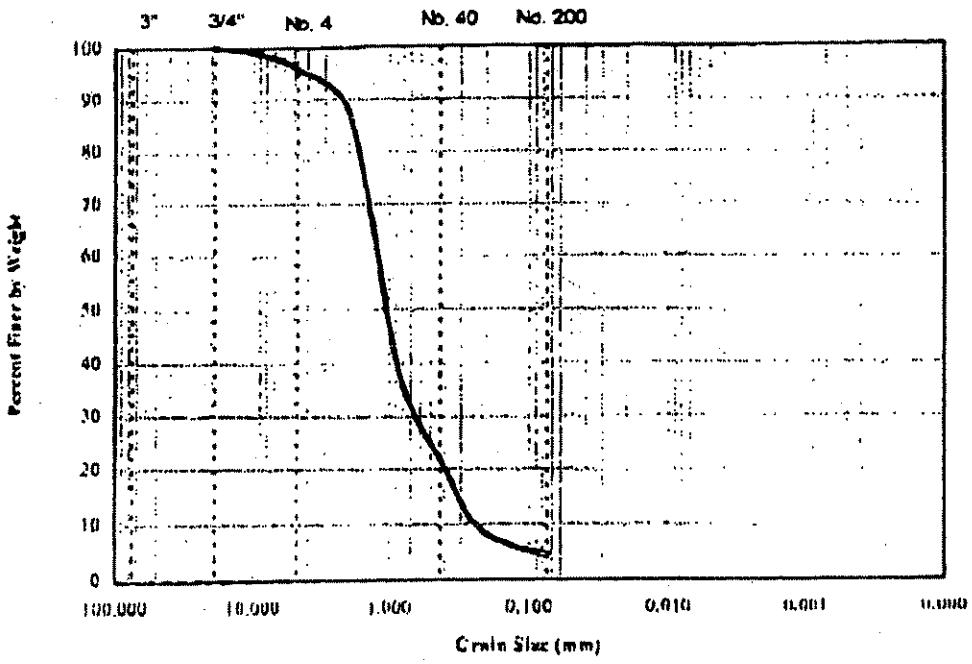
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-6 @ 64' -70.5'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
3/4 in.	0.00	0.0	100.0
3/8 in.	1.20	1.2	98.9
# 4	4.40	3.2	95.9
# 10	13.46	9.1	87.4
# 20	66.25	52.8	38.0
# 40	83.54	17.3	21.8
# 60	95.27	11.7	10.8
# 100	99.68	4.4	6.7
# 200	102.03	2.3	4.5
Wt. of Soil, g	106.83		

Particle Size Analysis
U.S. Standard Sieve Sizes



Reviewed by: _____

B-6@64-70.5

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT

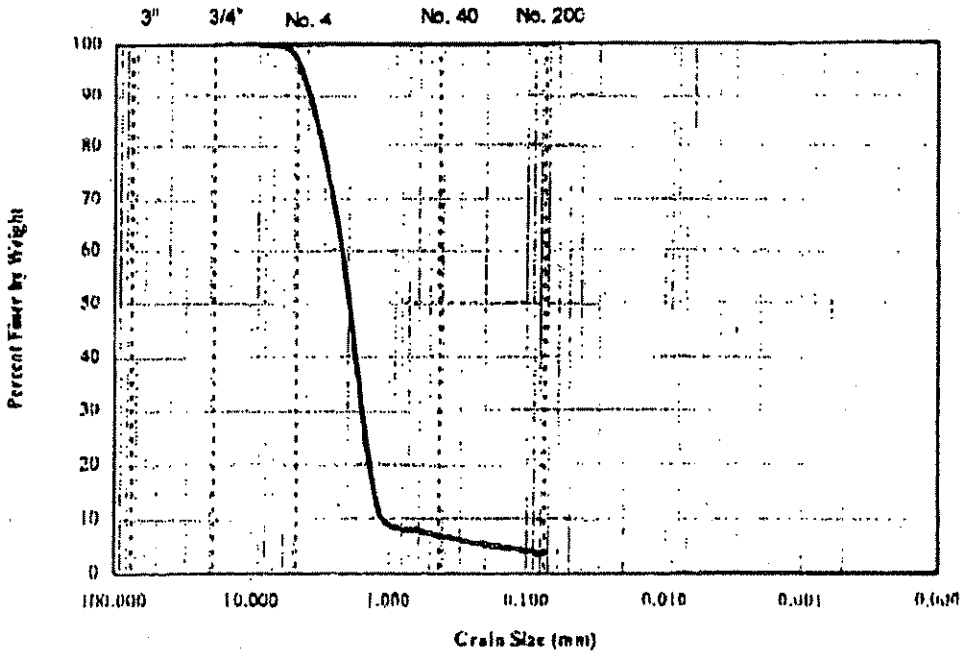
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-6 @ 79' -85.5'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
3/8 in.	0.00		100.0
# 4	2.87	2.9	97.1
# 8	35.09	32.2	64.2
# 16	86.98	51.9	11.3
# 30	90.32	3.3	7.9
# 50	91.98	1.7	6.2
# 100	93.38	1.4	4.8
# 200	94.52	1.1	3.6
Wt. of Soil, g	96.05		

Particle Size Analysis
U.S. Standard Sieve Sizes



Reviewed by: _____

P-0@/9-85 6

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT

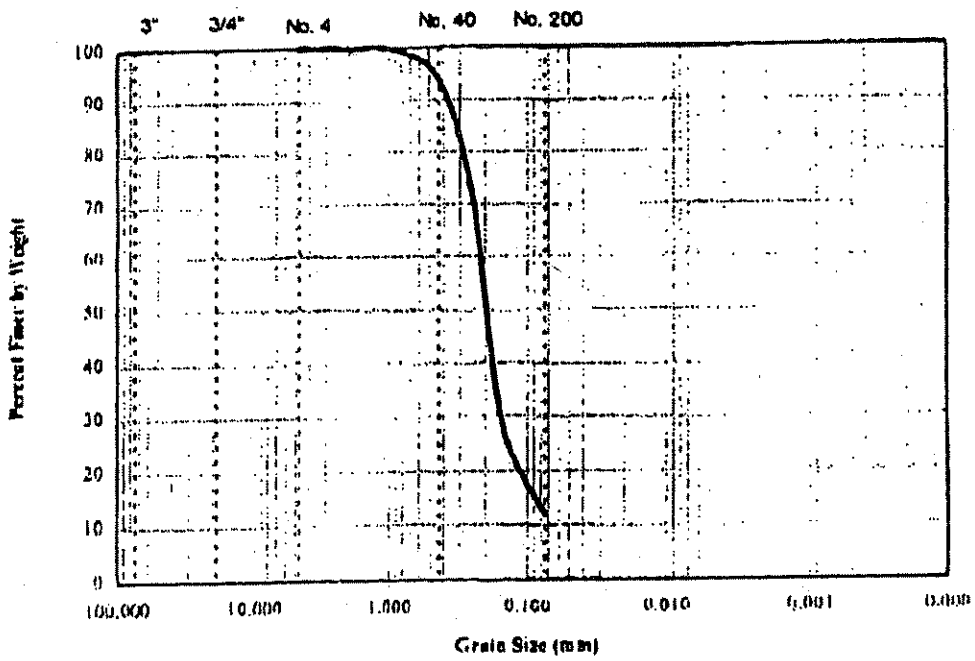
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-7 @ 60' -66'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
# 4	0.00	0.0	100.0
# 10	0.05	0.1	99.9
# 20	0.66	0.6	99.4
# 40	6.23	5.6	94.0
# 60	28.49	22.3	72.6
# 100	73.88	45.4	28.9
# 200	91.60	17.7	11.9
Wt. of Soil, g	103.98		

Particle Size Analysis
U.S. Standard Sieve Sizes



Reviewed by: _____

B-7@60-66

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

DRAFT

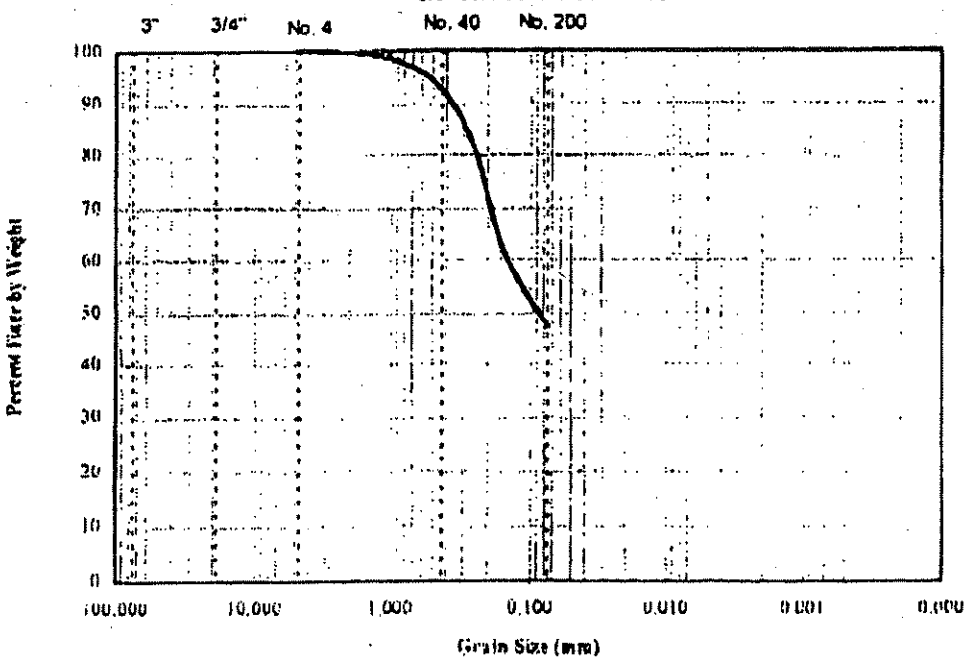
Project Name: GTS Technologies, Inc.
Project Number: 20310-1-2828
Report Date: 5/31/01

Washed Particle Size/Gradation Test Report
ASTM D422

Sample Number: B-9 @ 20' -22'

Sieve Size	Cumulative Wt. Retained (g)	Wt. Retained Each Sieve (g)	Cumulative % Passing
# 4	0.00	0.0	100.0
# 10	0.23	0.2	99.7
# 20	1.59	1.4	97.9
# 40	5.64	4.1	92.5
# 60	14.26	8.6	81.1
# 100	29.53	15.3	60.8
# 200	39.63	10.1	47.4
Wt. of Soil, g	75.33		

Particle Size Analysis
U.S. Standard Sieve Sizes

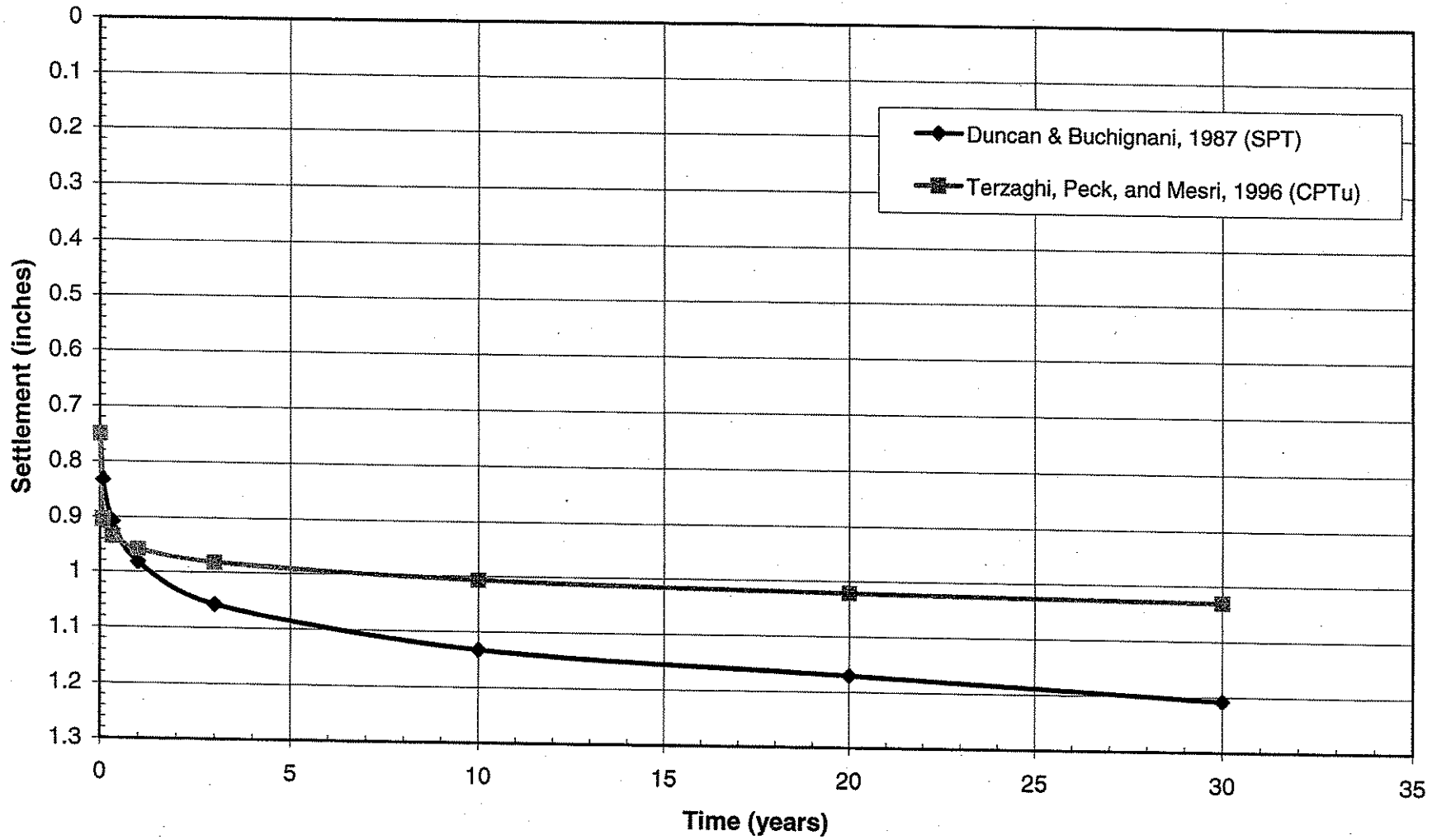


Reviewed by: _____

0.0@10.22

** TOTAL PAGE.10 **

Time Rate of Settlement for 12-ft Diameter Front Shaft



Note: Immediate Settlement Approximately 0.75 inches

P:\1200\1213 Gilmerton Bridge\Analyses\Settlement\Settlement Magnitude and Time Rate-Vertical Lift Span ShaftsTime Rate Graph-Front Shaft

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation 12 ft drilled shaft
Concrete Steel

Tip elevation
Element Length 240 240 inches

	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	20	240	0
Ground Surface	6.2	74.4	165.6
Top of AL (Sand)	6	72	168
Top of AL (Clay)	-28	-312	552
Top of Norfolk	-56	-672	912
Top of Yorktown (Y2)	-62	-744	984
Top of Yorktown (Y1)	-100	-1200	1440

Foundation Element Properties

Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
12 ft shaft	12	144	113.09616	16285.85	1017.865	21106458	3.85E+03	3.85E+06	6.00E+13
12 ft pipe pile	12	144	113.09616	16285.85	1017.865	21106458	3.96E+03	3.96E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_R (pci)	Shear Modulus, G (ksi)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

Lift Span

Composite Modulus Calculation

Material Properties

$E_c =$ 3.60E+06 psi
$E_s =$ 2.90E+07 psi

Standard Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
12	113.10	16286

Area of Steel in Shaft
Assume 1% of total area

Diameter (ft)	Area of Steel (in^2)	Revised Area of Shaft
12	162.86	16122.99

Calculate the Composite Modulus

$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
12	3.85E+06

Fully Cased Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
12	113.10	16286

Area of Steel in Fully Cased Shaft
Assume 1% of total area with 0.75 inch casing
Assume casing surrounds the finished shaft therefore no reduction in size

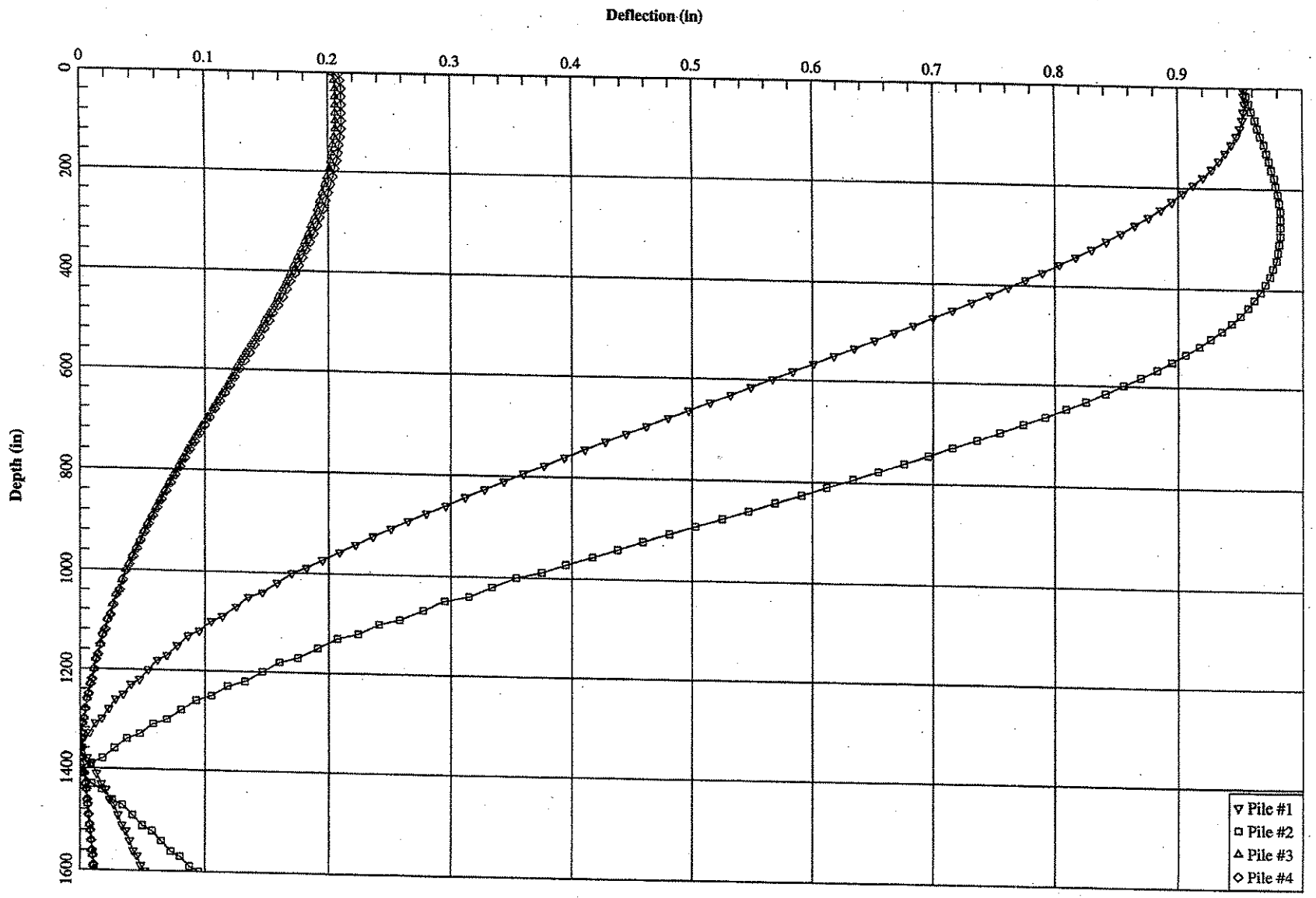
Diameter (ft)	Area of Steel (in^2)
12	192.02

Calculate the Composite Modulus

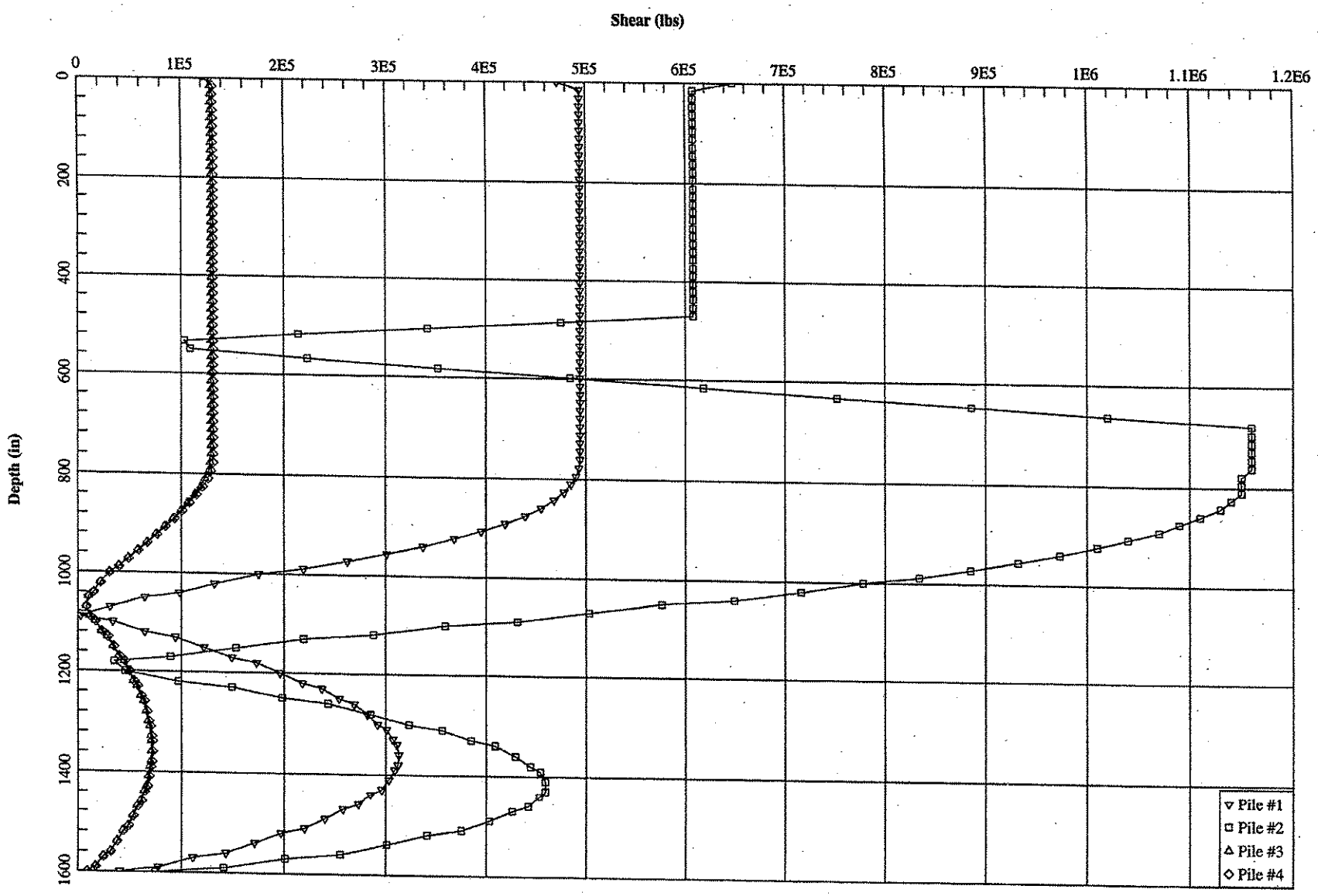
$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
12	3.90E+06

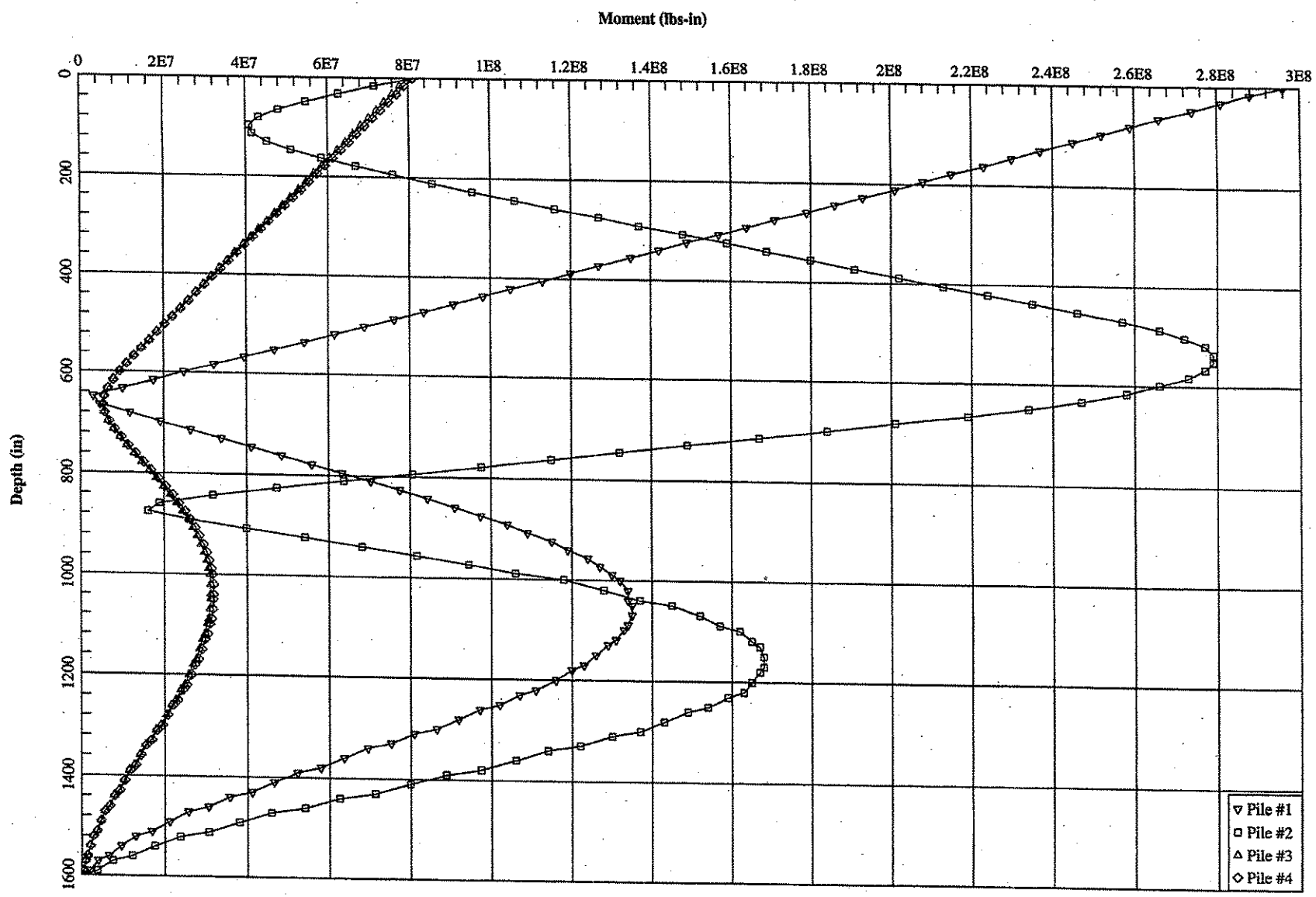
```
Gilmerton Bridge- Tower Shafts with Ship Impact (Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
1 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
7.9460000E+06 0.0000000E+00 7.7290000E+08 0.0000000E+00 0.0000000E+00 0.0000000E+00
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 1 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1620 3853000 2
0 1440 144 16286 21106458 21106458 0 0 6E13
2 4 4 0
1 4 744 1020 60
2 4 1020 2040 60
744 0.03
1020 0.03
1020 0.033
2040 0.033
744 0 30 0 2.78 0 0
1020 0 30 0 2.78 0 0
1020 0 35 0 27.78 347.22 0
2040 0 35 0 27.78 347.22 0
1.0000000E+00
1
1 2
468 8333.33 0
672 8333.33 0
```



Lift Span Tower with Ship Impact (Concrete Shafts)



Lift Span Tower with Ship Impact (Concrete Shafts)



Lift Span Tower with Ship Impact (Concrete Shafts)

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation 12 ft drilled shaft
Concrete Steel
Tip elevation
Element Length 240 240 inches

	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	20	240	0
Ground Surface	6.2	74.4	165.6
Top of AL (Sand)	6	72	168
Top of AL (Clay)	-26	-312	552
Top of Norfolk	-56	-672	912
Top of Yorktown (Y2)	-62	-744	984
Top of Yorktown (Y1)	-100	-1200	1440

Foundation Element Properties

Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
12 ft shaft	12	144	113.09616	16285.85	1017.865	21106458	3.85E+03	3.85E+06	6.00E+13
12 ft pipe pile	12	144	113.09616	16285.85	1017.865	21106458	3.96E+03	3.96E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

Lift Span

Composite Modulus Calculation

Material Properties

E_c = 3.60E+06 psi
E_s = 2.90E+07 psi

Standard Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
12	113.10	16286

Area of Steel in Shaft
Assume 1% of total area

Diameter (ft)	Area of Steel (in^2)	Revised Area of Shaft
12	162.86	16122.99

Calculate the Composite Modulus

$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
12	3.85E+06

Fully Cased Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
12	113.10	16286

Area of Steel in Fully Cased Shaft
Assume 1% of total area with 0.75 inch casing
Assume casing surrounds the finished shaft therefore no reduction in size

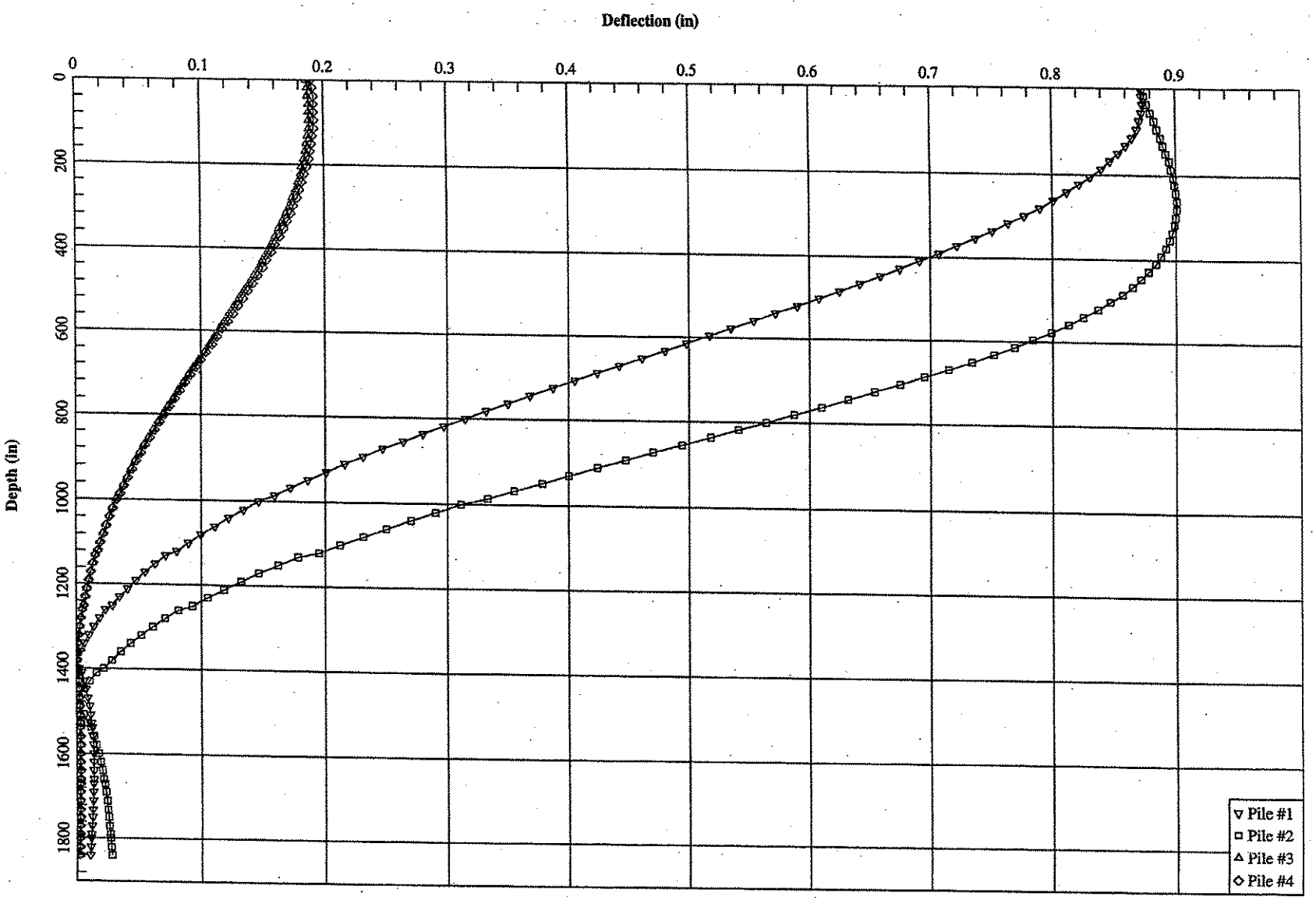
Diameter (ft)	Area of Steel (in^2)
12	192.02

Calculate the Composite Modulus

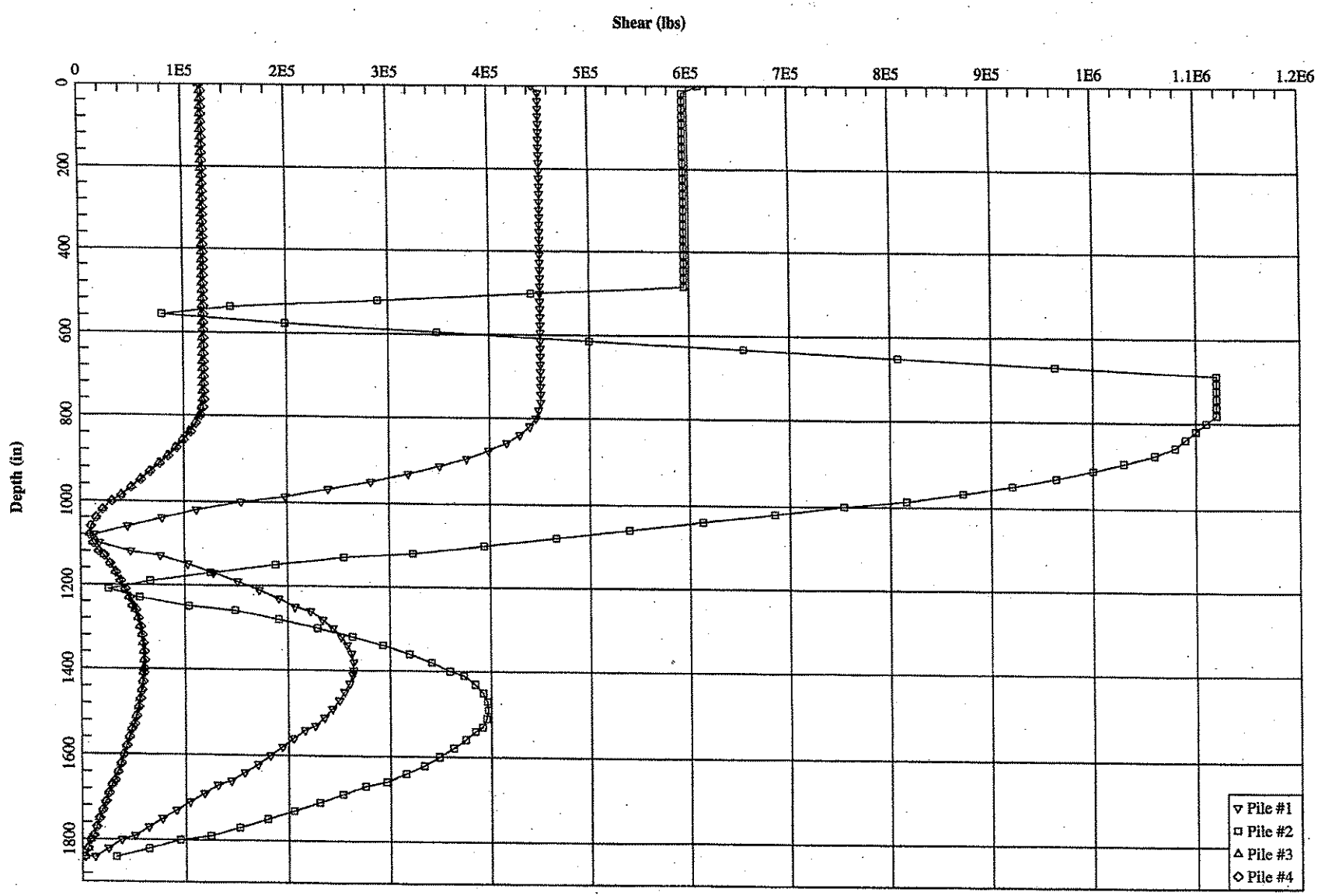
$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
12	3.90E+06

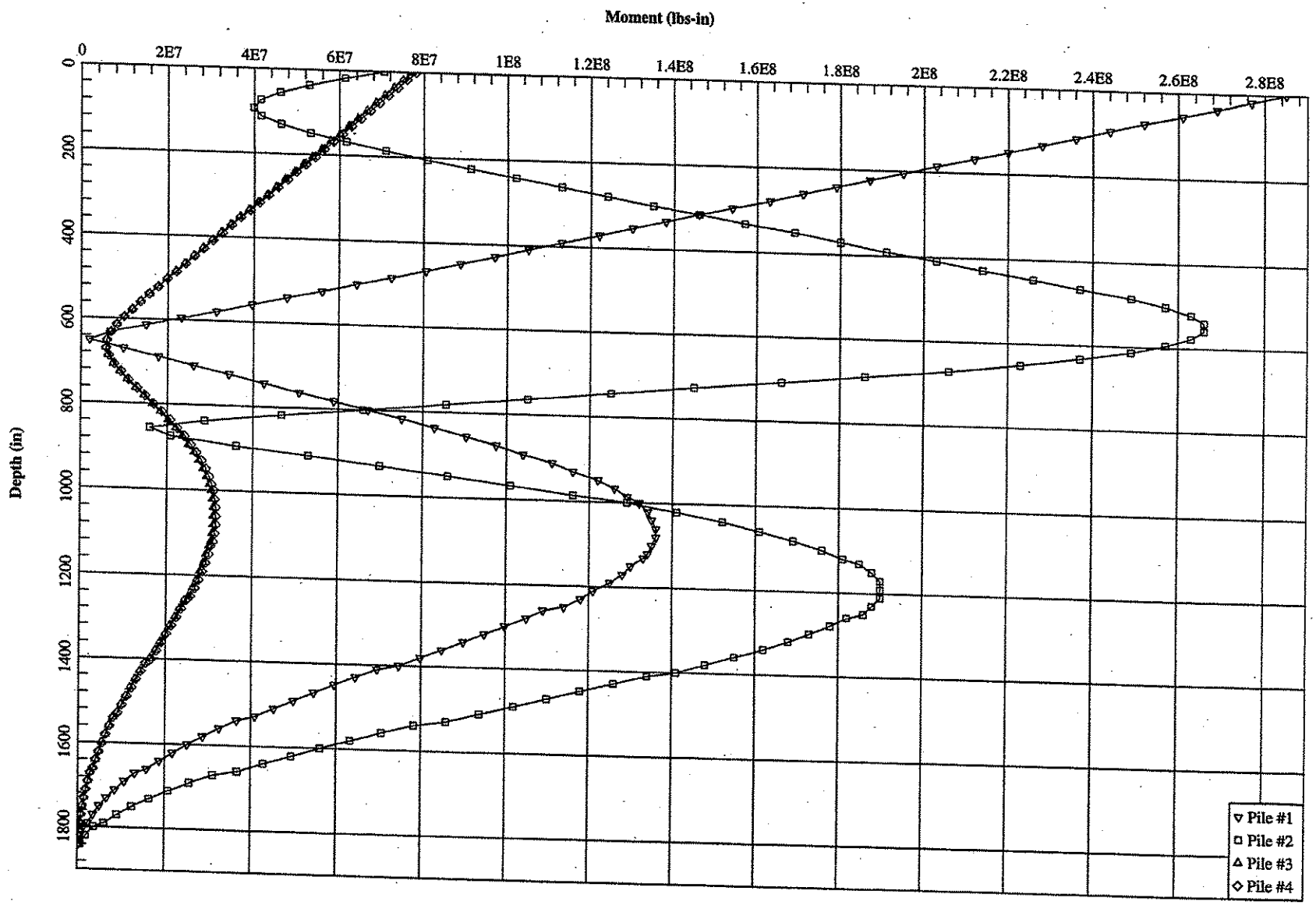
```
Lift Span Tower Shafts with Ship Impact (Steel Cased Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
1 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
7.9460000E+06 0.0000000E+00 7.7290000E+08 0.0000000E+00 0.0000000E+00 0.0000000E+00
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 1 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1860 3900000 2
0 1860 144 16286 21100000 21100000 0 0 6E13
2 4 4 0
1 4 744 1020 60
2 4 1020 2040 60
744 0.03
1020 0.03
1020 0.033
2040 0.033
744 0 30 0 1.946 0 0
1020 0 30 0 1.946 0 0
1020 0 35 0 19.446 347.22 0
2040 0 35 0 19.446 347.22 0
1.0000000E+00
1
1 2
468 8333.33 0
672 8333.33 0
```



Lift Span Tower with Ship Impact (Steel Cased Concrete Shafts)

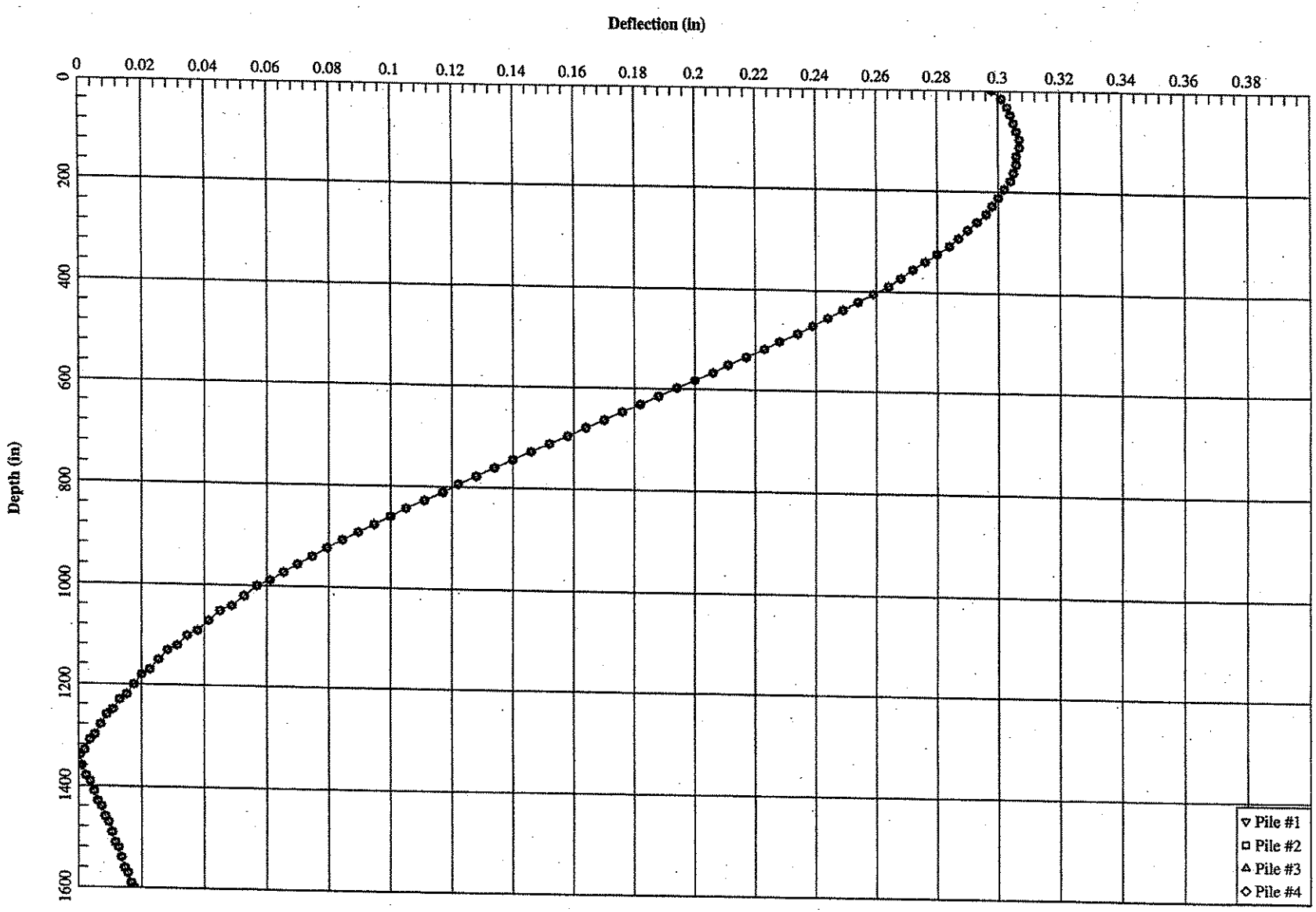


Lift Span Tower with Ship Impact (Steel Cased Concrete Shafts)

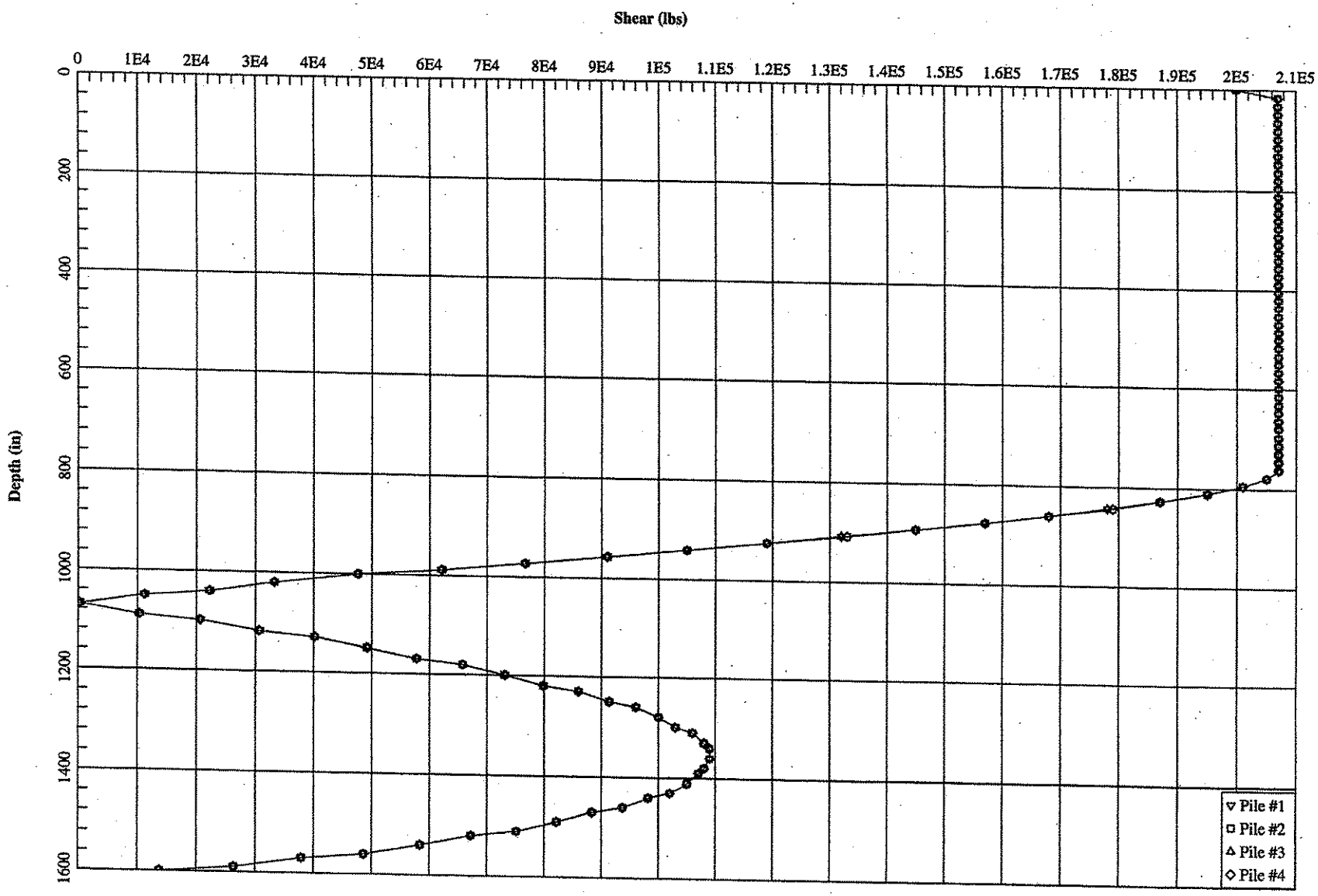


Lift Span Tower with Ship Impact (Steel Cased Concrete Shafts)

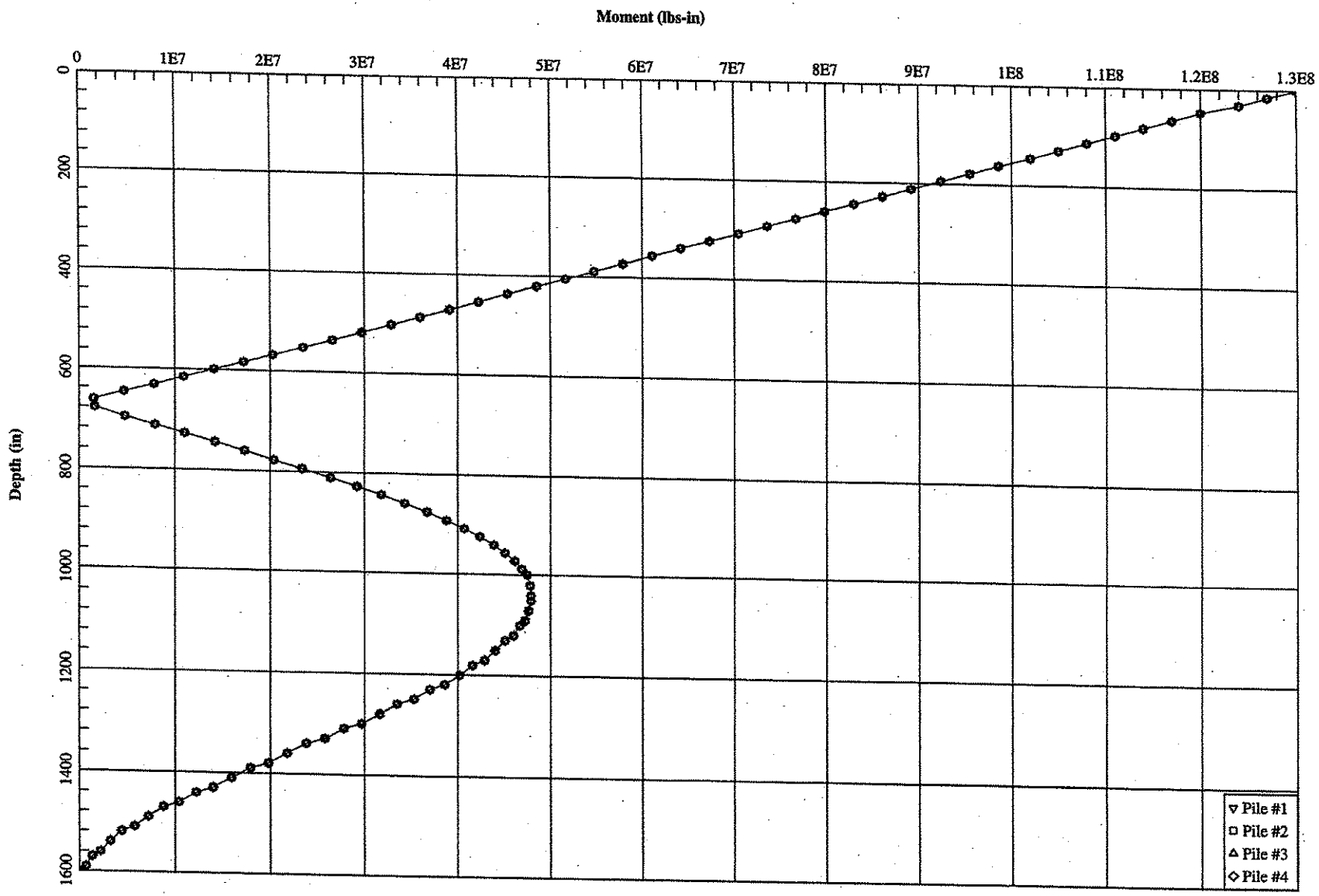
```
Lift Span Tower Shafts with Service Loads (Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
1 1
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
1.2786000E+07 8.0000000E+05 9.6170400E+08 0.0000000E+00 0.0000000E+00 0.0000000E+00
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 0 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1620 3900000 2
0 1440 144 16286 21100000 21100000 0 0 6E13
2 4 4 0
1 4 744 1020 60
2 4 1020 1968 60
744 0.03
1020 0.03
1020 0.033
1968 0.033
744 0 30 0 2.78 0 0
1020 0 30 0 2.78 0 0
1020 0 35 0 27.78 347.22 0
1968 0 35 0 27.78 347.22 0
1.0000000E+00
```



Lift Span Tower with Service Loads (Concrete Shafts)

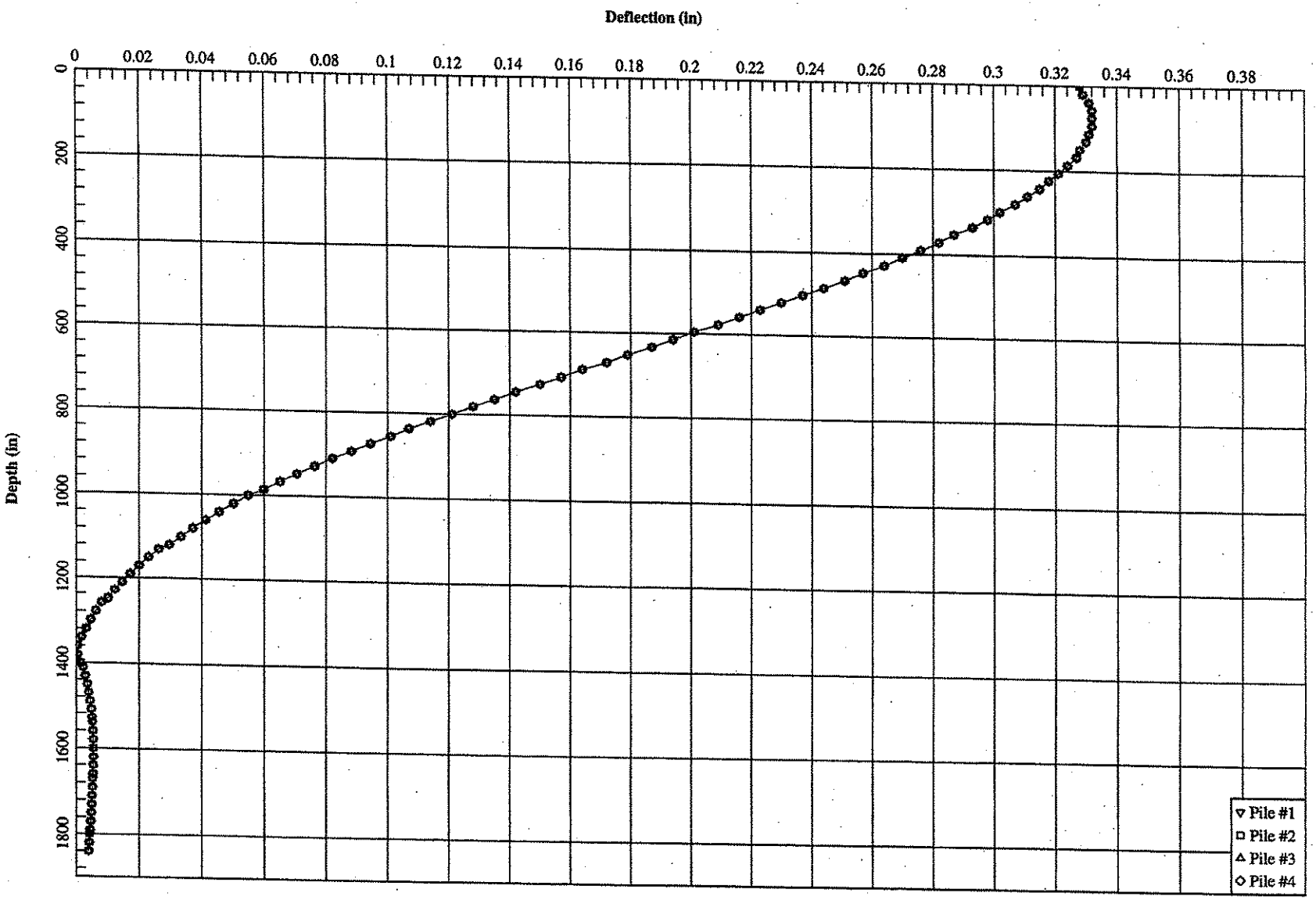


Lift Span Tower with Service Loads (Concrete Shafts)

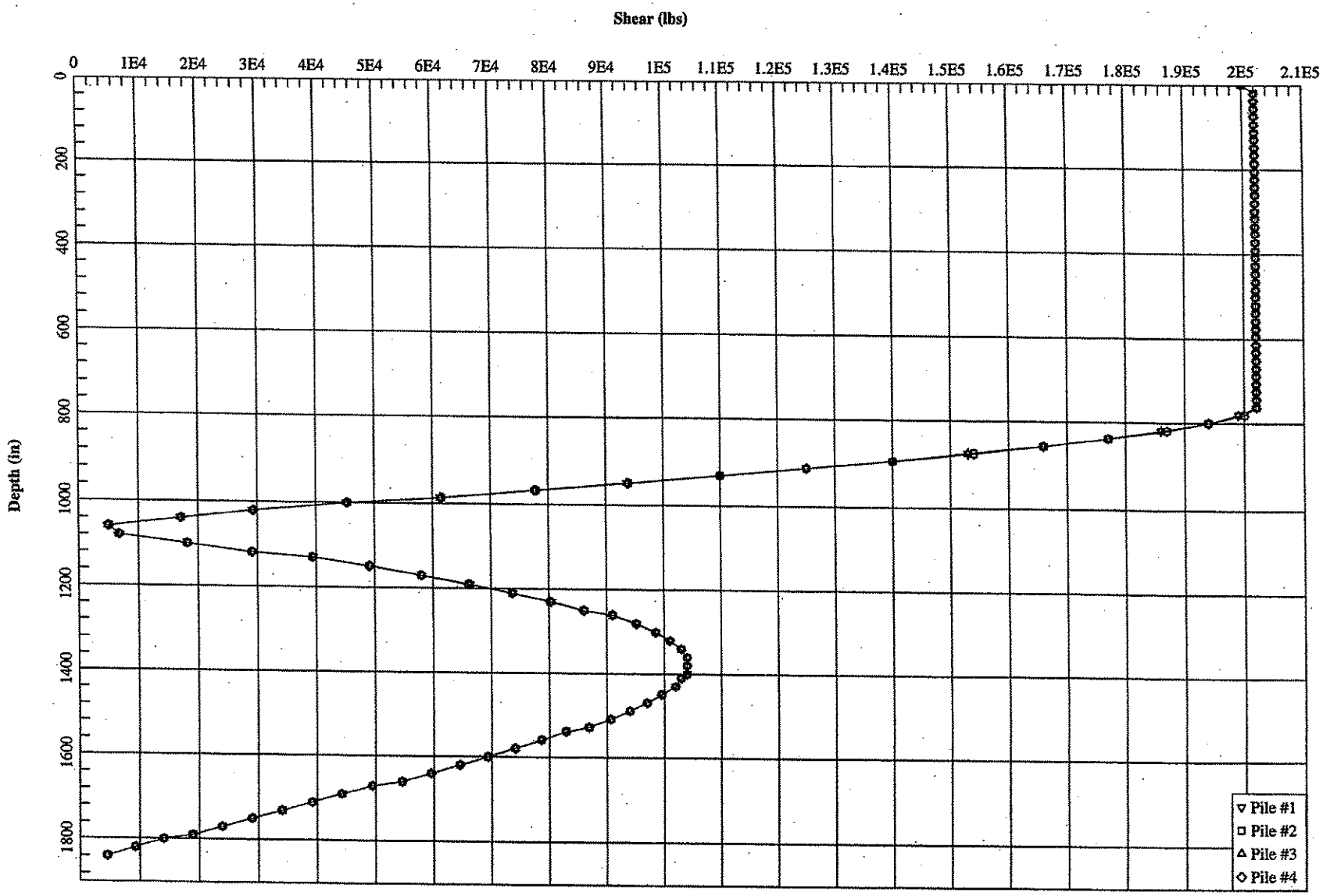


Lift Span Tower with Service Loads (Concrete Shafts)

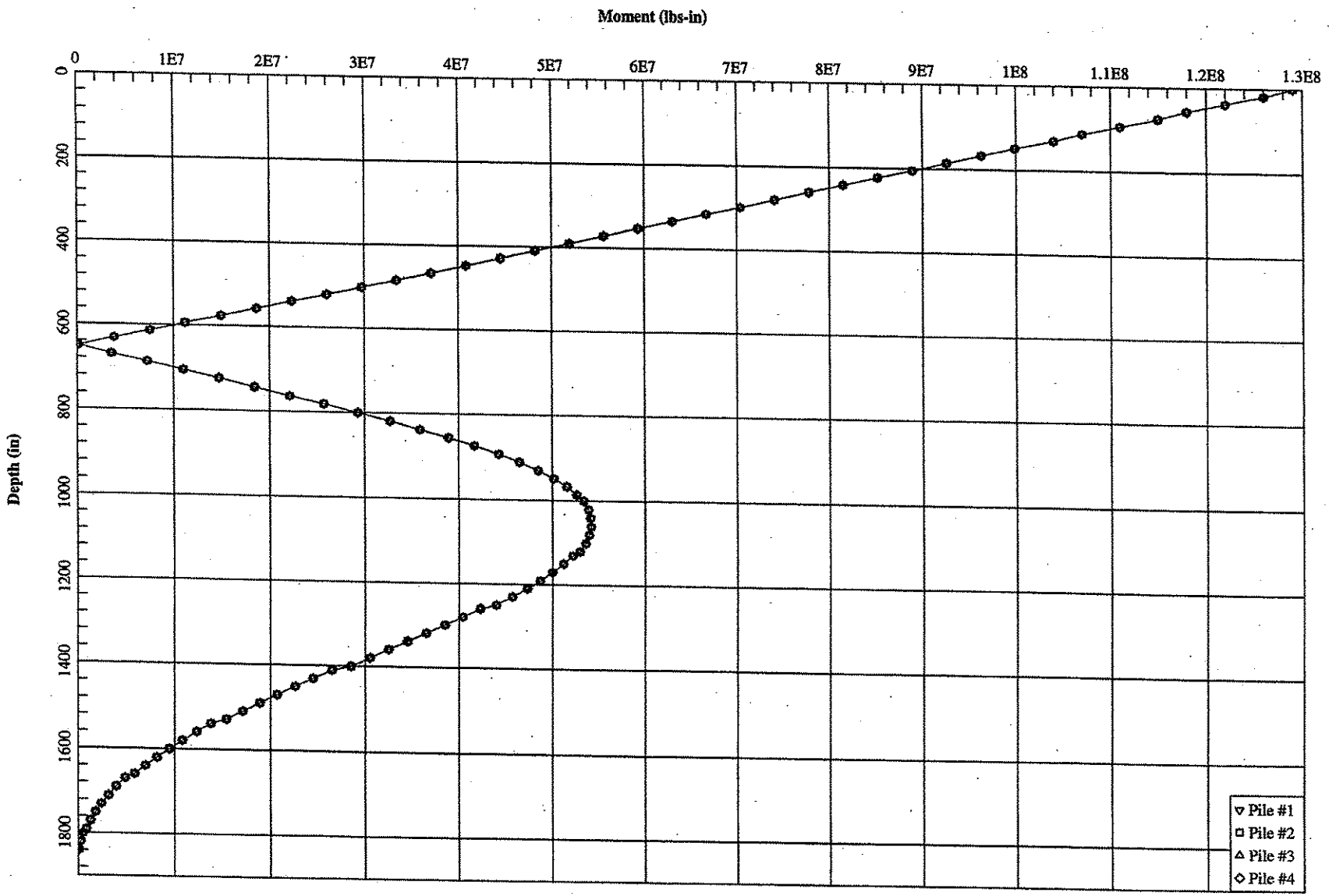
```
Lift Span Tower Shafts with Service Loads (Steel Cased Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
1 1
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
1.2786000E+07 8.0000000E+05 9.6170400E+08 0.0000000E+00 0.0000000E+00 0.0000000E+00
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 0 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1860 3900000 2
0 1860 144 16286 21100000 21100000 0 0 6E13
2 4 4 0
1 4 744 1020 60
2 4 1020 1968 60
744 0.03
1020 0.03
1020 0.033
1968 0.033
744 0 30 0 2.78 0 0
1020 0 30 0 2.78 0 0
1020 0 35 0 27.78 347.22 0
1968 0 35 0 27.78 347.22 0
1.0000000E+00
```



Lift Span Tower with Service Loads (Steel Cased Concrete Shafts)



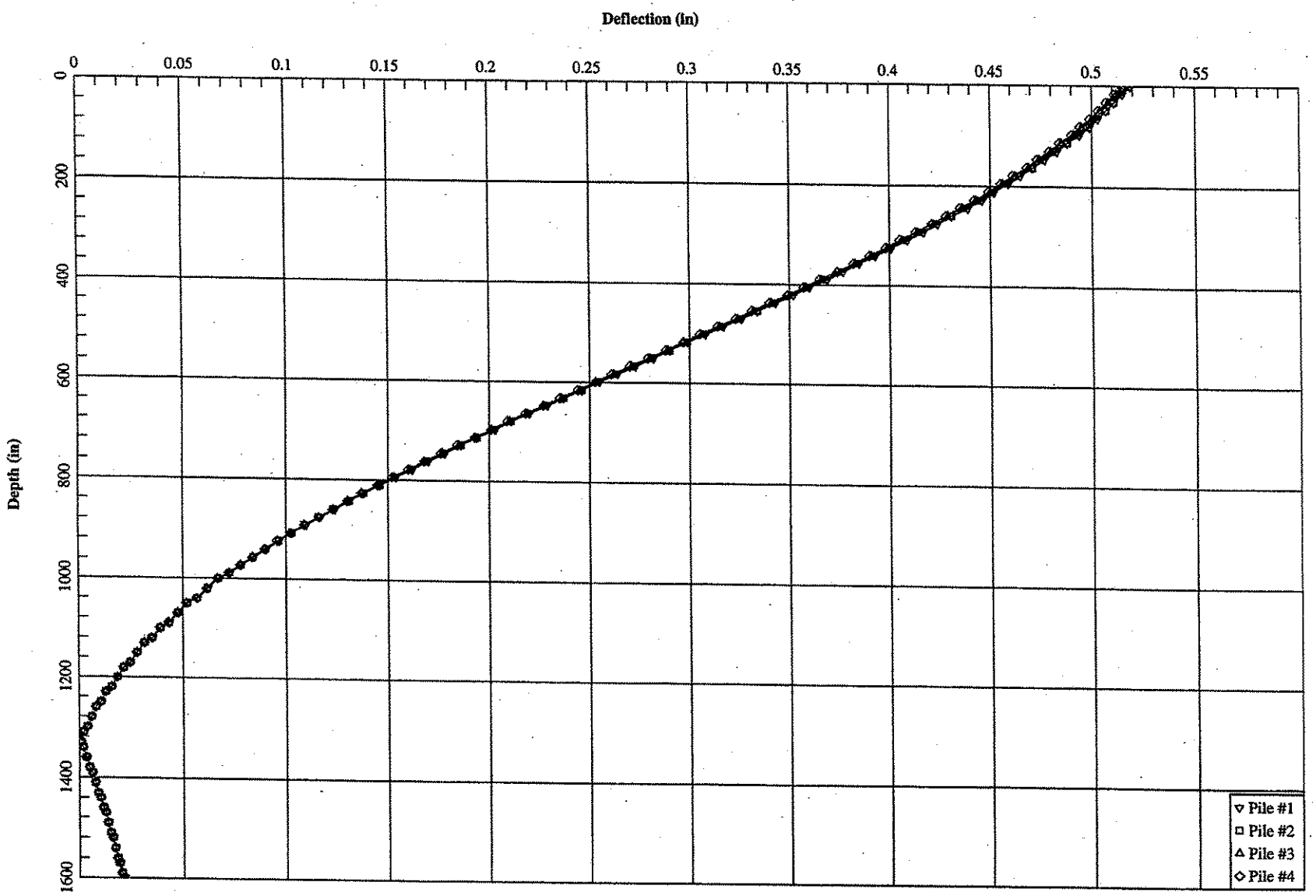
Lift Span Tower with Service Loads (Steel Cased Concrete Shafts)



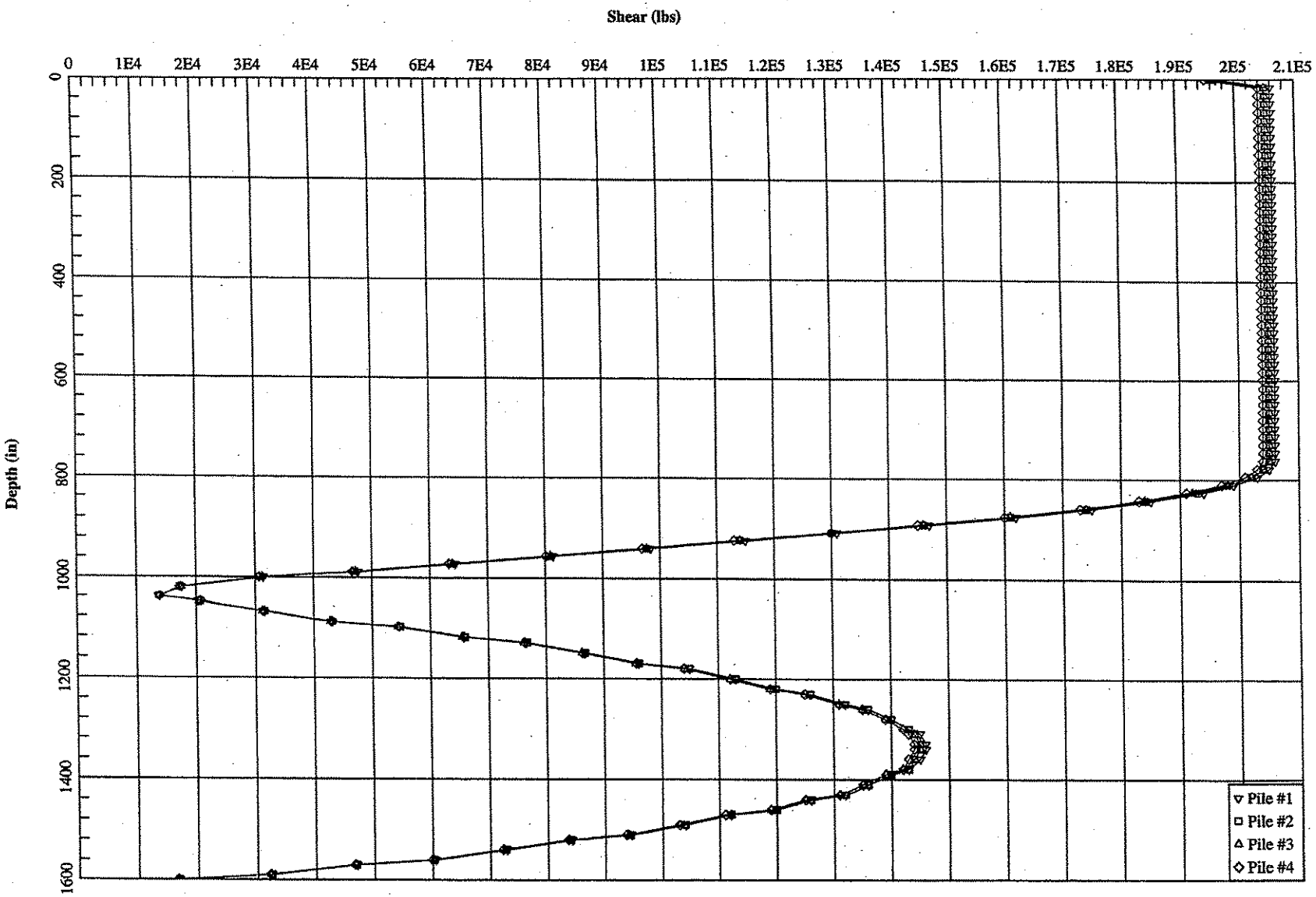
Lift Span Tower with Service Loads (Steel Cased Concrete Shafts)

windDS

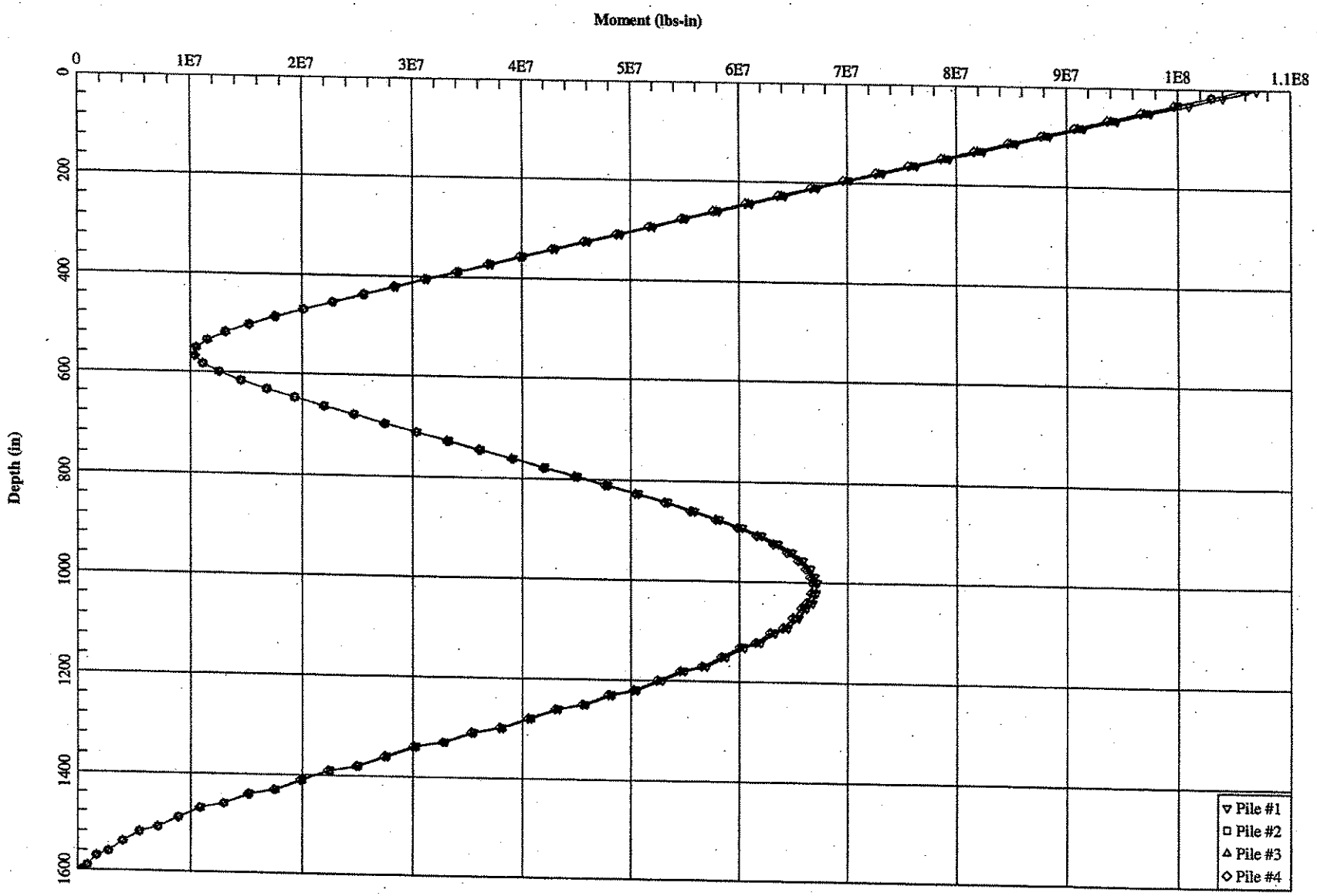
```
Lift Span Tower Shafts with Wind Loading (Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
1.0662000E+07 5.5200000E+05 -2.9818000E+08 -5.5840000E+05 1.2585600E+08 2.8992000E+06
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 0 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1620 3853000 2
0 1440 144 16286 21100000 21100000 0 0 6E13
3 5 5 0
1 4 744 1020 60
2 4 1020 2040 60
3 2 2040 2500 100
744 0.03
1020 0.03
1020 0.033
2040 0.033
2500 0.03
744 0 30 0 2.78 0 0
1020 0 30 0 2.78 0 0
1020 0 35 0 27.78 347.22 0
2040 0 35 0 27.78 347.22 0
2500 20.8 0 0.01 2.78 0 0
1.0000000E+00
```



Lift Span Tower with Wind Loads (Concrete Shafts)



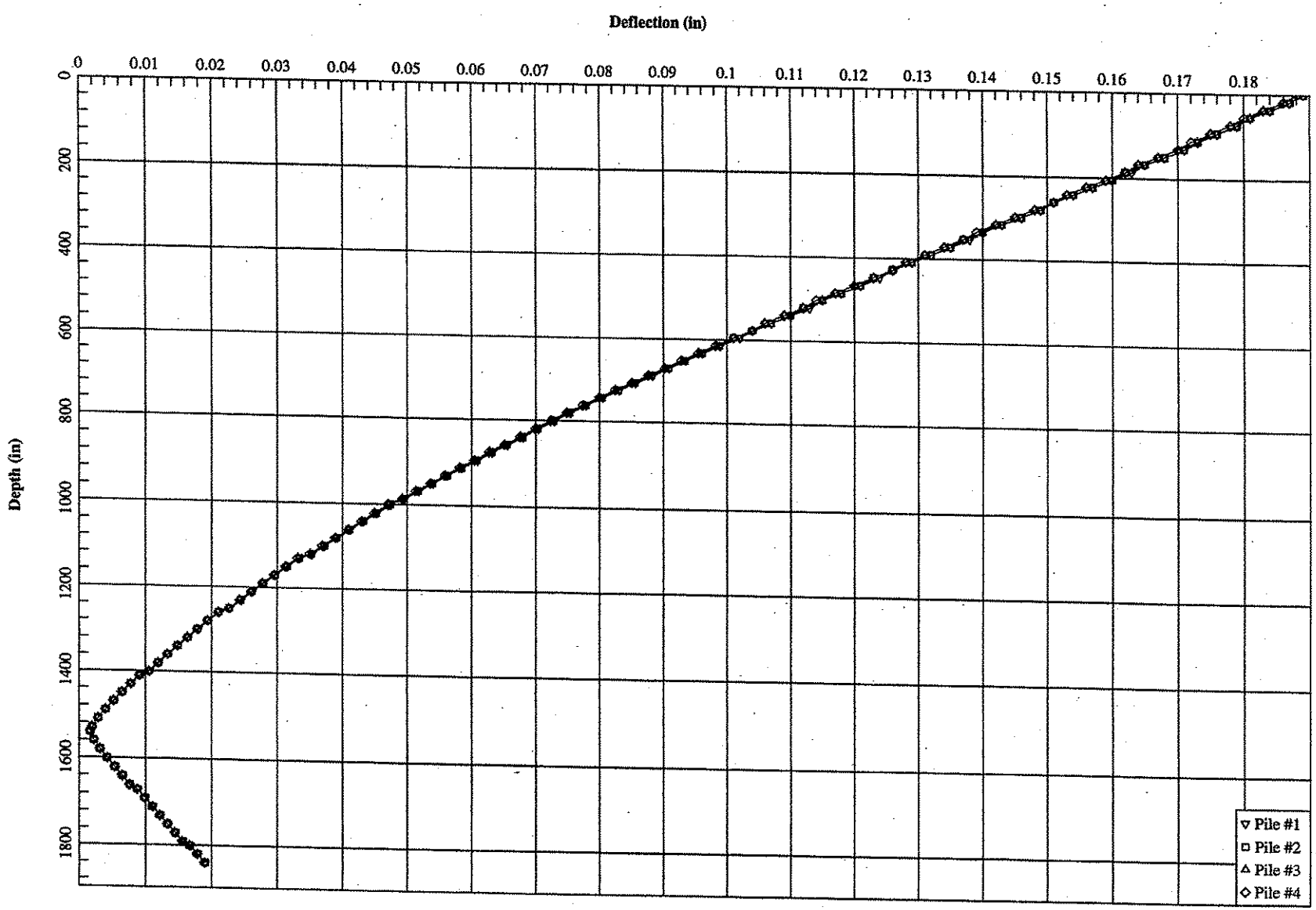
Lift Span Tower with Wind Loads (Concrete Shafts)



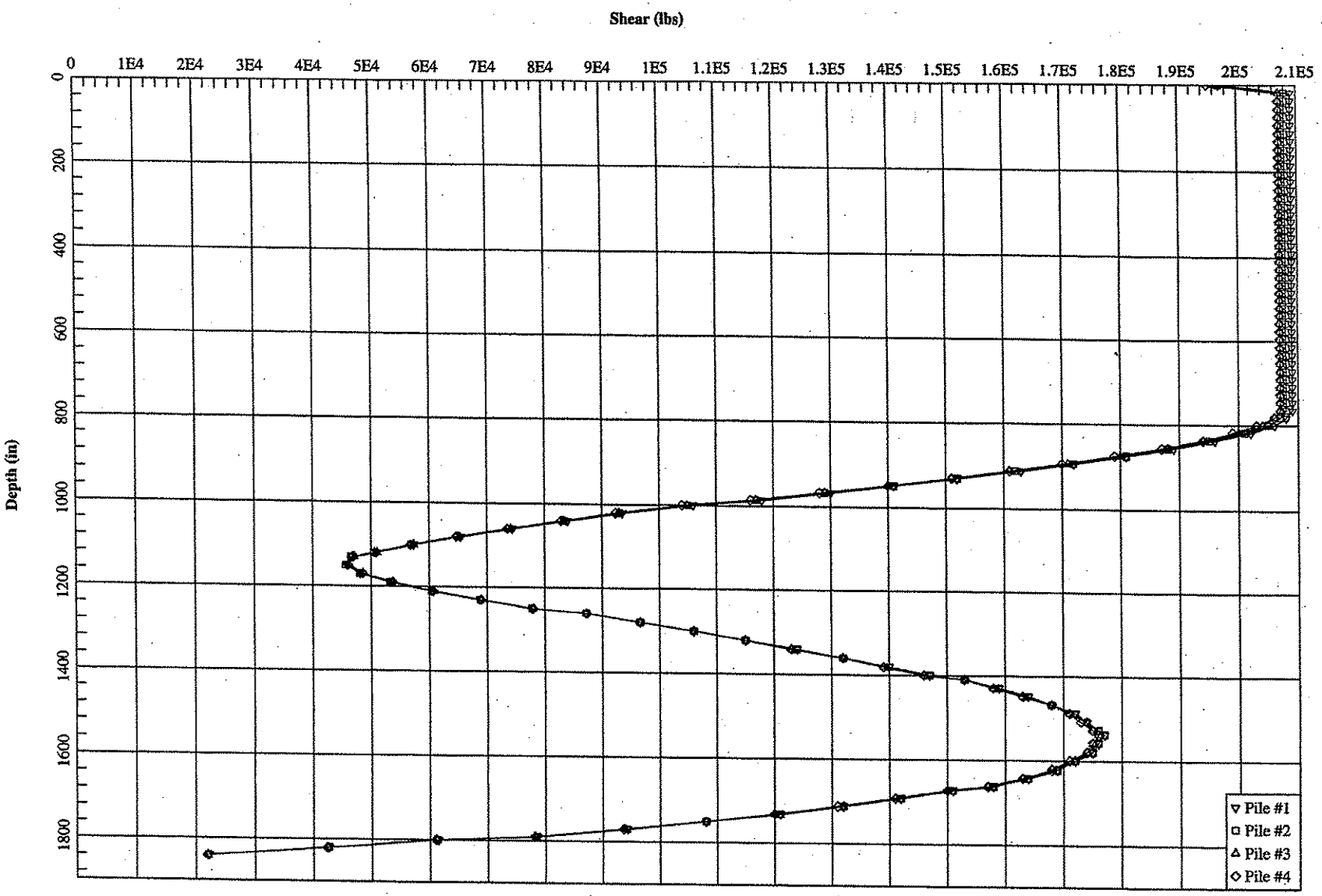
Lift Span Tower with Wind Loads (Concrete Shafts)

windPP

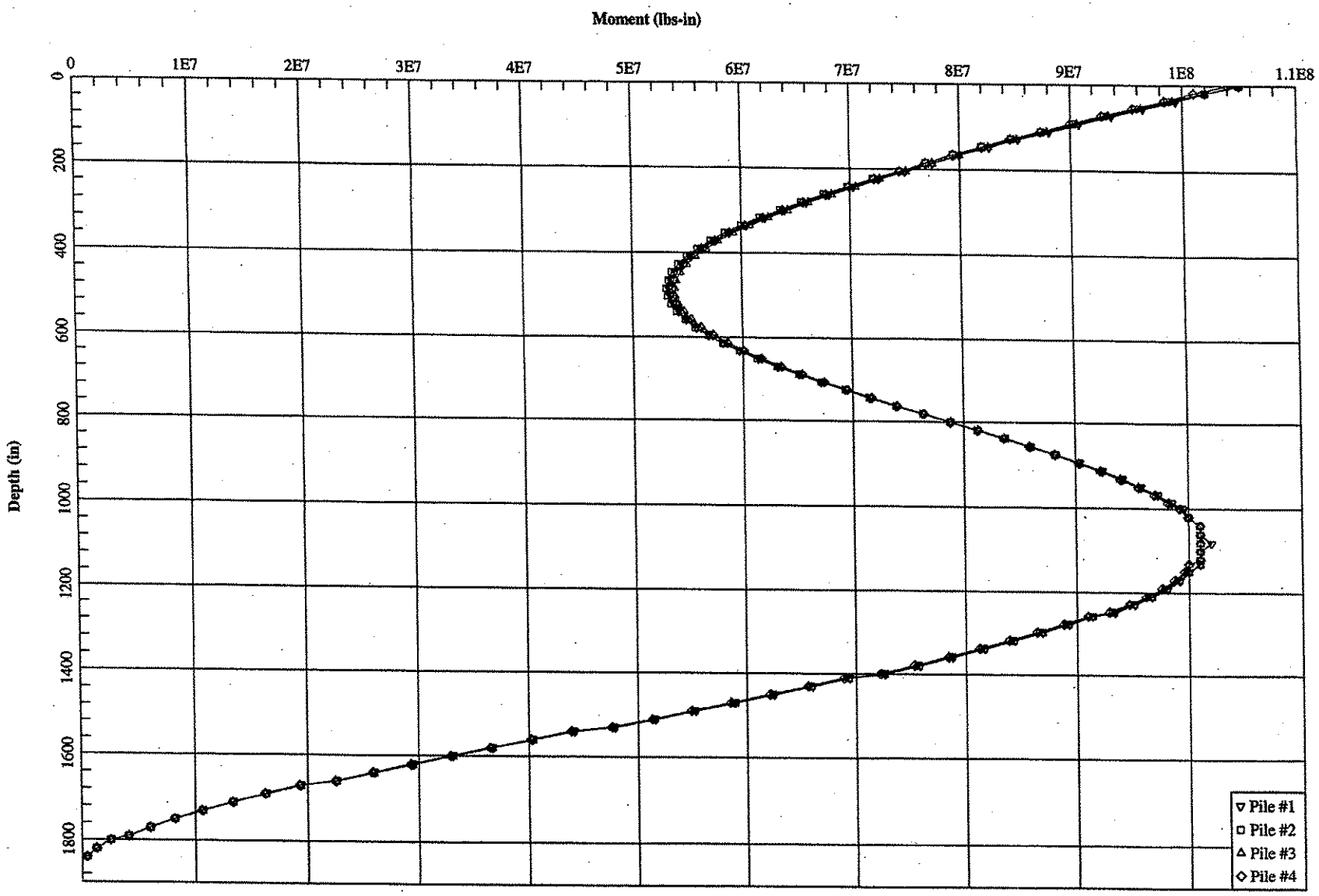
```
Lift Span Tower Shafts with Wind Loads (Steel Cased Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
1.0662000E+07 5.5200000E+05 -2.9818000E+08 -5.5840000E+05 1.2585600E+08 2.8992000E+06
4
2 1   1 0 0 0 0 0 -228 -534 0 90 744 0
2 1   1 0 0 0 0 0 228 -534 0 90 744 0
2 1   1 0 0 0 0 0 -228 534 0 90 744 0
2 1   1 0 0 0 0 0 228 534 0 90 744 0
1
1 1 100 1860 44476420 2
0 1440 144 16286 21100000 21100000 0 0 6E13
3 5 5 0
1 4 744 1020 60
2 4 1020 2040 60
3 2 2040 2500 100
744 0.03
1020 0.03
1020 0.033
2040 0.033
2500 0.03
744 0 30 0 1.946 0 0
1020 0 30 0 1.946 0 0
1020 0 35 0 19.446 347.22 0
2040 0 35 0 19.446 347.22 0
2500 20.8 0 0.01 1.946 0 0
1.0000000E+00
```



Lift Span Tower with Wind Loads (Steel Cased Concrete Shafts)

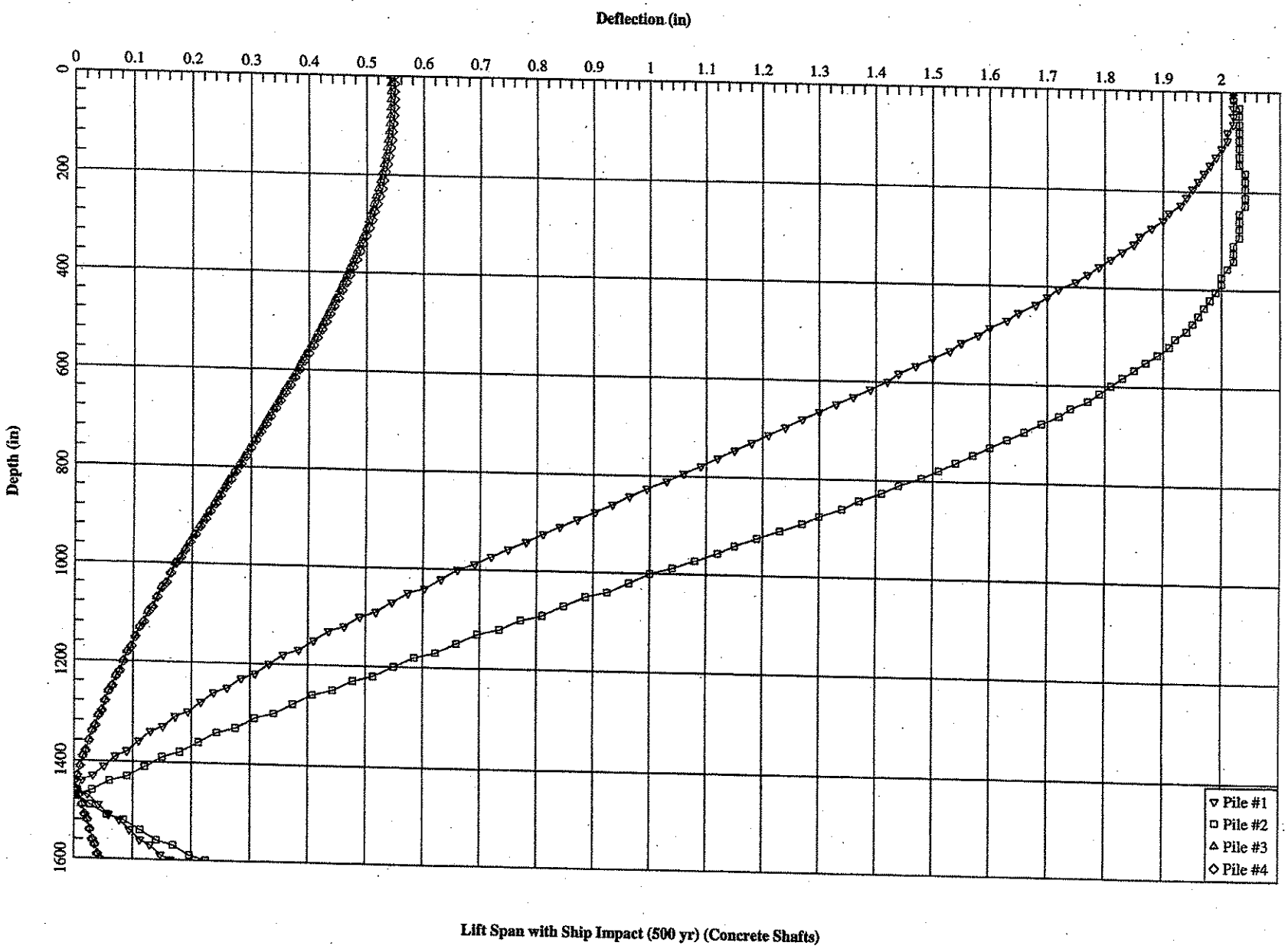


Lift Span Tower with Wind Loads (Steel Cased Concrete Shafts)



Lift Span Tower with Wind Loads (Steel Cased Concrete Shafts)

```
Lift Span Tower Shafts with Ship Impact (500 yr) (Concrete Shafts)
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
1 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
7.9460000E+06 0.0000000E+00 7.7290000E+08 0.0000000E+00 0.0000000E+00 0.0000000E+00
4
2 1   1 0 0 0 0 0 -228 -534 0 90 960 0
2 1   1 0 0 0 1 0 228 -534 0 90 960 0
2 1   1 0 0 0 0 0 -228 534 0 90 960 0
2 1   1 0 0 0 0 0 228 534 0 90 960 0
1
1 1 100 1620 3853000 2
0 1440 144 16286 21106458 21106458 0 0 6E13
2 4 4 0
1 4 960 1020 60
2 4 1020 2040 60
960 0.03
1020 0.03
1020 0.033
2040 0.033
960 0 30 0 2.78 0 0
1020 0 30 0 2.78 0 0
1020 0 35 0 27.78 347.22 0
2040 0 35 0 27.78 347.22 0
1.0000000E+00
1
1 2
468 8333.33 0
672 8333.33 0
```


Deflection (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
Depth (in)
0
200
400
600
800
1000
1200
1400
1600
Pile #1
Pile #2
Pile #3
Pile #4
Lift Span with Ship Impact (500 yr) (Concrete Shafts)

Composite Modulus Calculation

Material Properties

$E_c =$ 3.60E+06 psi
$E_s =$ 2.90E+07 psi

Standard Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
5	19.63	2827
6	28.27	4071

Area of Steel in Shaft
Assume 1% of total area

Diameter (ft)	Area of Steel (in^2)	Revised Area of Shaft
5	28.27	2799.13
6	40.71	4030.75

Calculate the Composite Modulus

$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
5	3.85E+06
6	3.85E+06

Pile Modulus

f'c =	4500 psi
E = 57000*f'c^0.5	
E =	3.82E+06 psi

Loads Applied
5 and 6 ft diameter shaft
558 kips
22.3 kips horzontal
761 kip-ft

Fully Cased Shaft

Cross-sectional area of shafts

Diameter (ft)	Area (ft^2)	Area (in^2)
5	19.63	2827
6	28.27	4071

Area of Steel in Fully Cased Shaft
Assume 1% of total area with 0.75
Assume casing surrounds the finished shaft then

Diameter (ft)	Area of Steel (in^2)
5	40.94
6	55.74

Calculate the Composite Modulus

$E_{COMP} = (A_C E_C + A_S E_S)/(AC+A_S)$

Diameter (ft)	E_{COMP} (in^2)
5	3.96E+06
6	3.94E+06

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation 24 inch PSC
Concrete
Tip elevation -65
Element Length 804

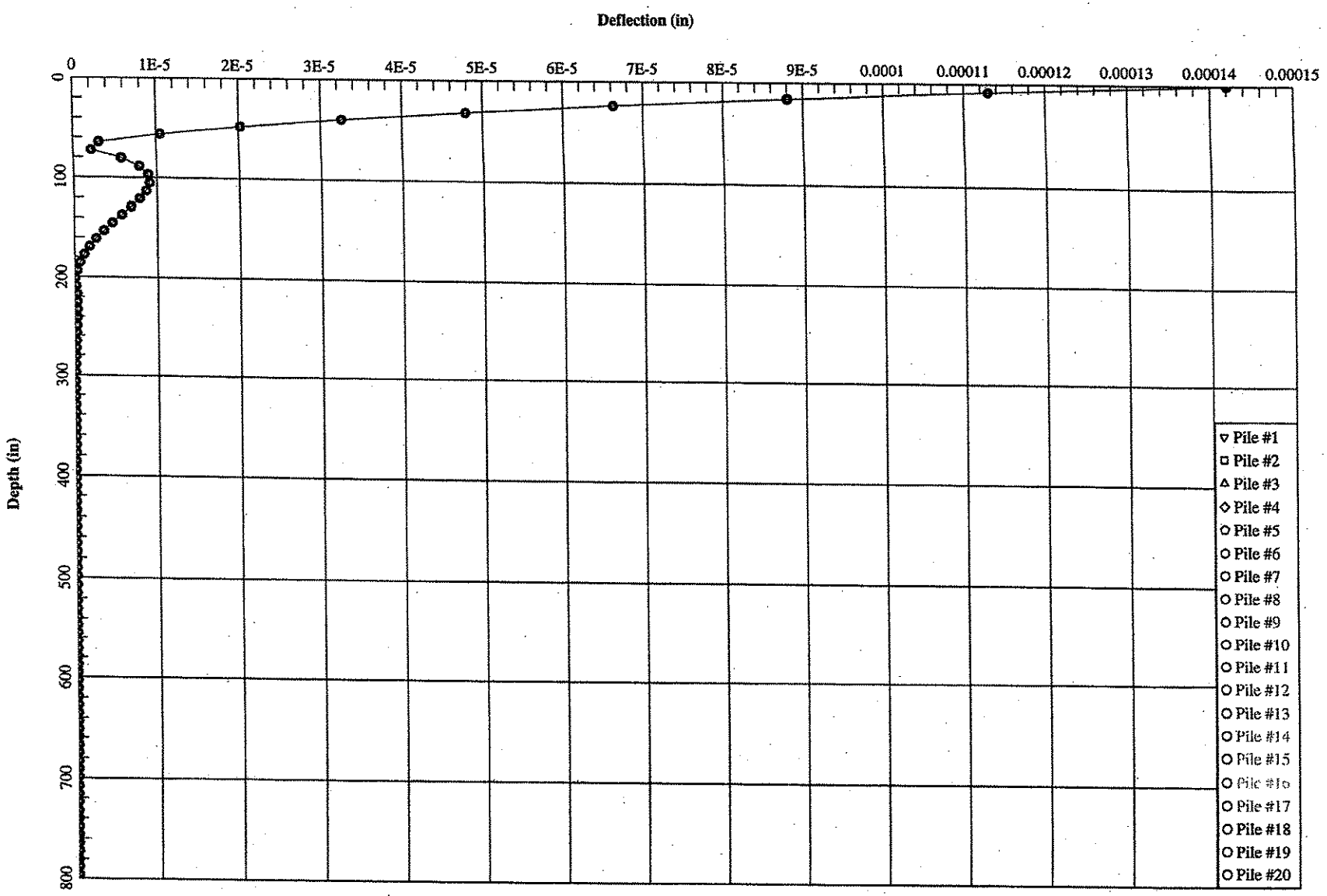
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	2	24	0
Top of AL (Sand)	2	24	0
Top of AL (Clay)	-24	-288	312
Top of Norfolk	-50	-600	624
Top of Yorktown (Y2)	-61	-732	756
Top of Yorktown (Y1)	-143	-1716	1740

Foundation Element Properties

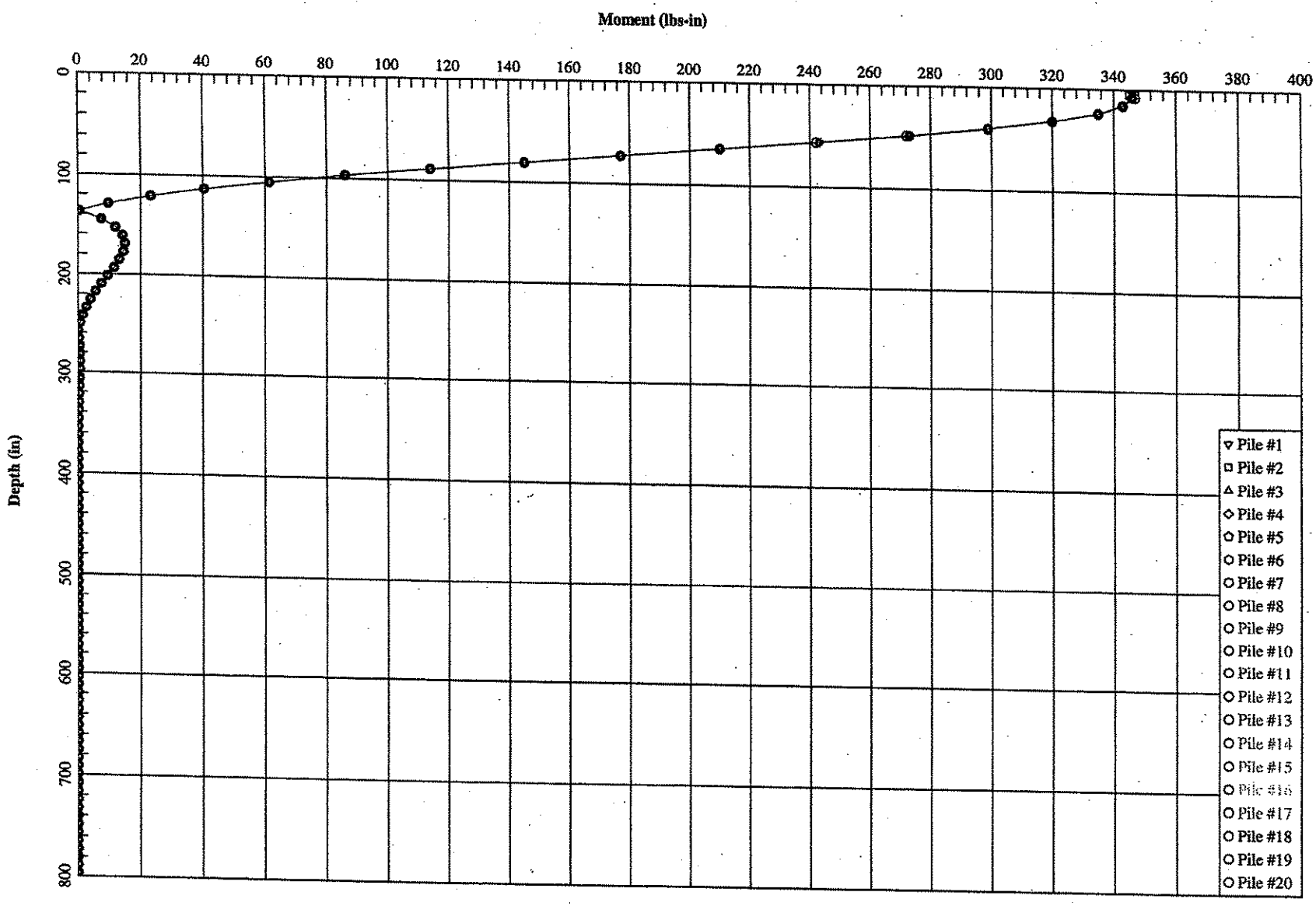
Element Type	Diameter		Area		Moment of Inertia		Young's Modulus		Torsional Stiffness
	feet	inches	feet^2	inch^2	feet^4	inch^4	ksi	psi	lb-in^2
24- inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.65E+03	3.65E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, ν	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksi)	Soil Strain, ε_{50}	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL: GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL: GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,500	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

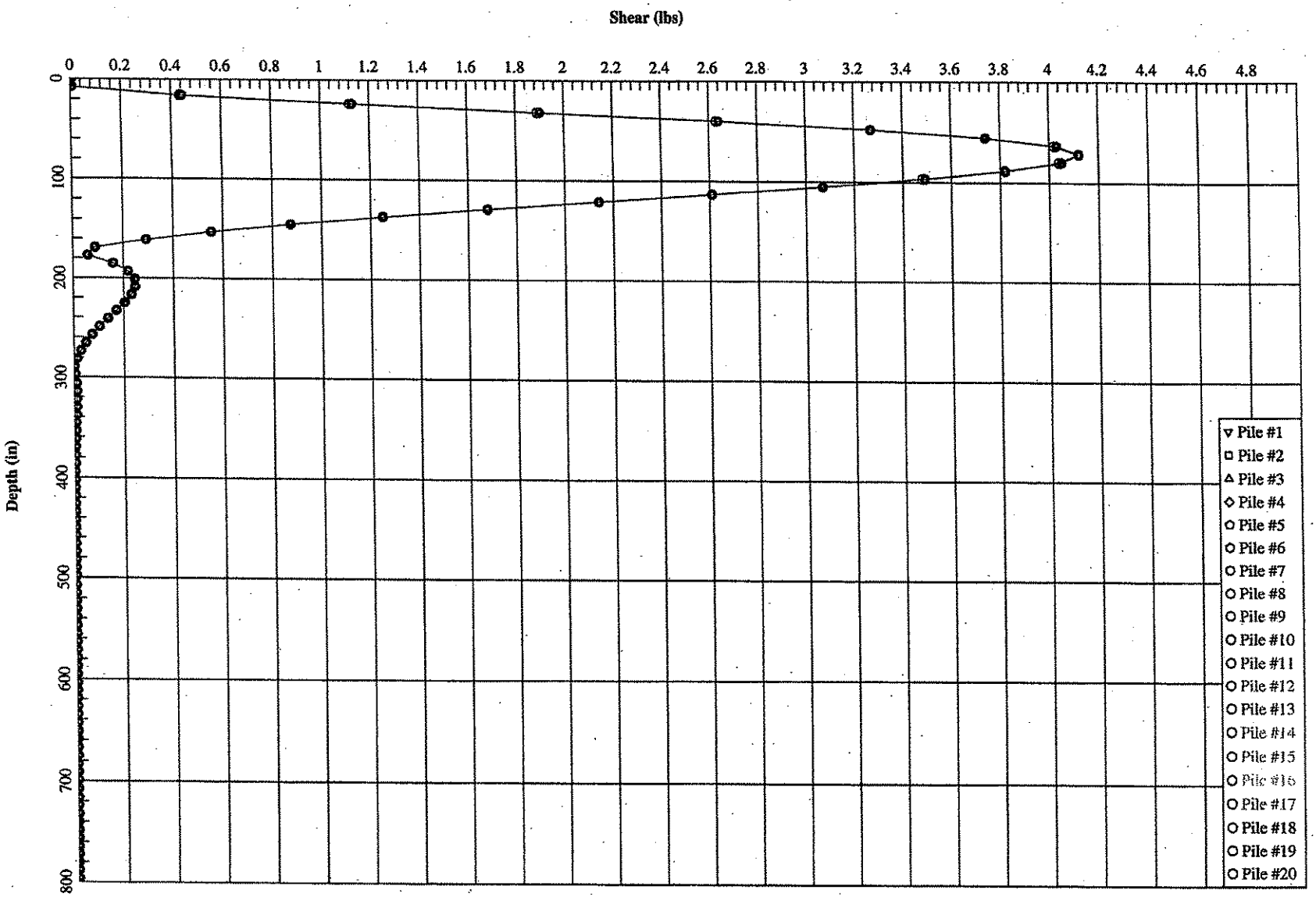
```
Pier 2 - 24 inch piles
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.1577600E+05 0.0000000E+00 4.7606000E+07 0.0000000E+00 3.3480000E+05 0.0000000E+00
26
2 1   1 0 0 0 0 0 -552 48 0 90 0 0
2 1   1 0 0 0 0 0 -552 -48 0 90 0 0
2 1   1 0 0 0 0 0 -469 48 0 90 0 0
2 1   1 0 0 0 0 0 -469 -48 0 90 0 0
2 1   1 0 0 0 0 0 -386 48 0 90 0 0
2 1   1 0 0 0 0 0 -386 -48 0 90 0 0
2 1   1 0 0 0 0 0 -303 48 0 90 0 0
2 1   1 0 0 0 0 0 -303 -48 0 90 0 0
2 1   1 0 0 0 0 0 -220 48 0 90 0 0
2 1   1 0 0 0 0 0 -220 -48 0 90 0 0
2 1   1 0 0 0 0 0 -137 48 0 90 0 0
2 1   1 0 0 0 0 0 -137 -48 0 90 0 0
2 1   1 0 0 0 0 0 -54 48 0 90 0 0
2 1   1 0 0 0 0 0 -54 -48 0 90 0 0
2 1   1 0 0 0 0 0 29 48 0 90 0 0
2 1   1 0 0 0 0 0 29 -48 0 90 0 0
2 1   1 0 0 0 0 0 102 48 0 90 0 0
2 1   1 0 0 0 0 0 102 -48 0 90 0 0
2 1   1 0 0 0 0 0 175.5 48 0 90 0 0
2 1   1 0 0 0 0 0 175.5 -48 0 90 0 0
2 1   1 0 0 0 0 0 249 48 0 90 0 0
2 1   1 0 0 0 0 0 249 -48 0 90 0 0
2 1   1 0 0 0 0 0 322.5 48 0 90 0 0
2 1   1 0 0 0 0 0 322.5 -48 0 90 0 0
2 1   1 0 0 0 0 0 396 48 0 90 0 0
2 1   1 0 0 0 0 0 396 -48 0 90 0 0
1
1 1 100 804 3823670 1
0 804 24 576 1728 1728 0 0 6E13
4 8 8 0
1 4 0 312 60
2 2 312 624 60
3 4 624 756 60
4 4 756 1740 60
0 0.03
312 0.03
312 0.027
624 0.027
624 0.033
756 0.033
756 0.033
1740 0.033
0 0 30 0 2.77 0 0
312 0 30 0 2.77 0 0
312 4.2 0 0.01 2.77 0 0
624 4.2 0 0.01 2.77 0 0
624 0 33 0 8.3 0 0
756 0 33 0 8.3 0 0
756 0 35 0 27.78 347 0
1740 0 35 0 27.78 347 0
1.0000000E+00
```



Piers 1-3 - 24 inch piles



Piers 1-3 - 24 inch piles



Piers 1-3 - 24 inch piles

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft		
	Concrete	Steel	Concrete	Steel	
Tip elevation	-75	-80	-70	-70	feet
Element Length	984	1044	924	924	inches

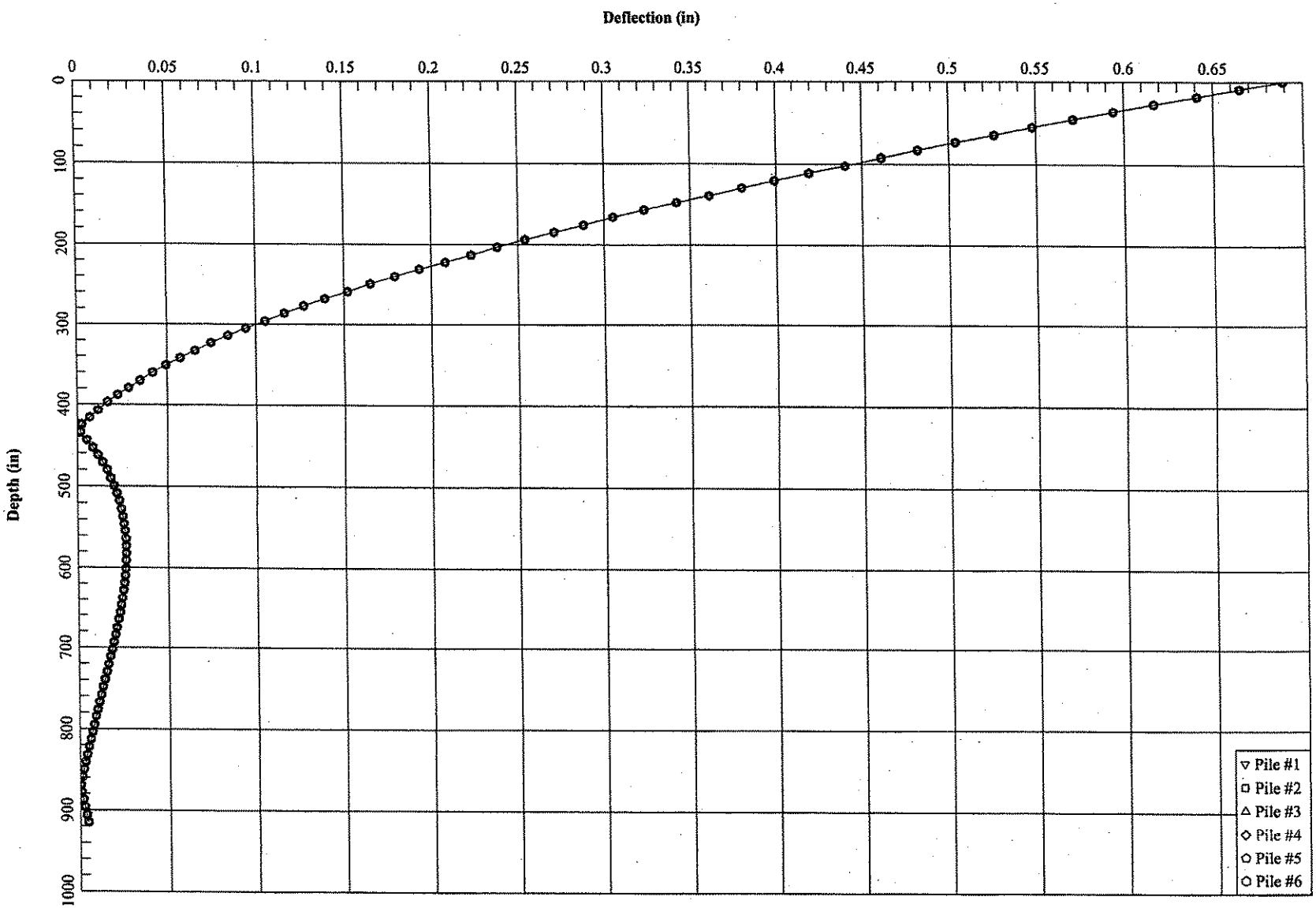
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	7	84	0
Top of AL (Sand)	-9	-108	192
Top of AL (Clay)	-30	-360	444
Top of Norfolk	-53	-636	720
Top of Yorktown (Y2)	-63	-756	840
Top of Yorktown (Y1)	-143	-1716	1800

Foundation Element Properties

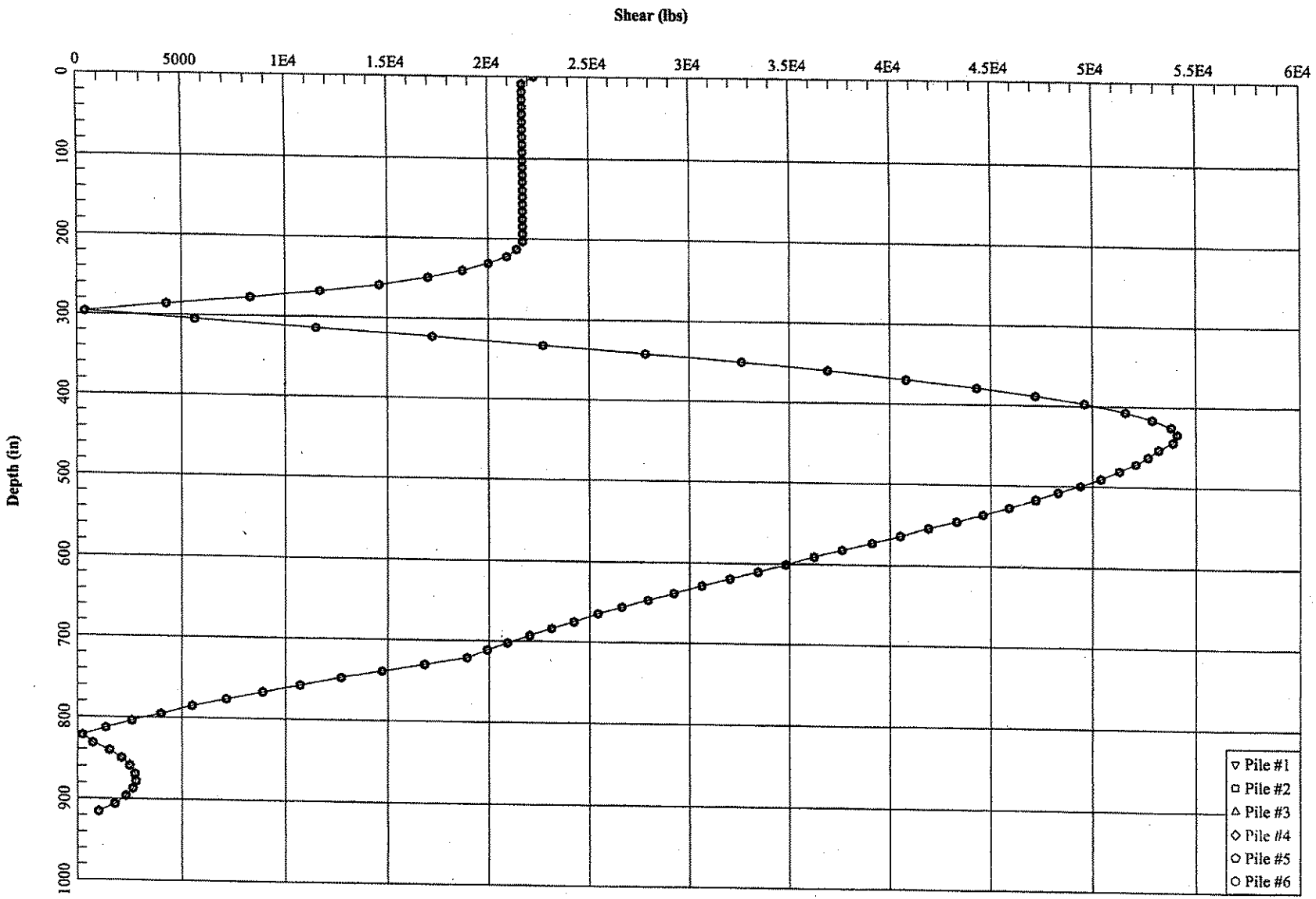
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
24- Inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

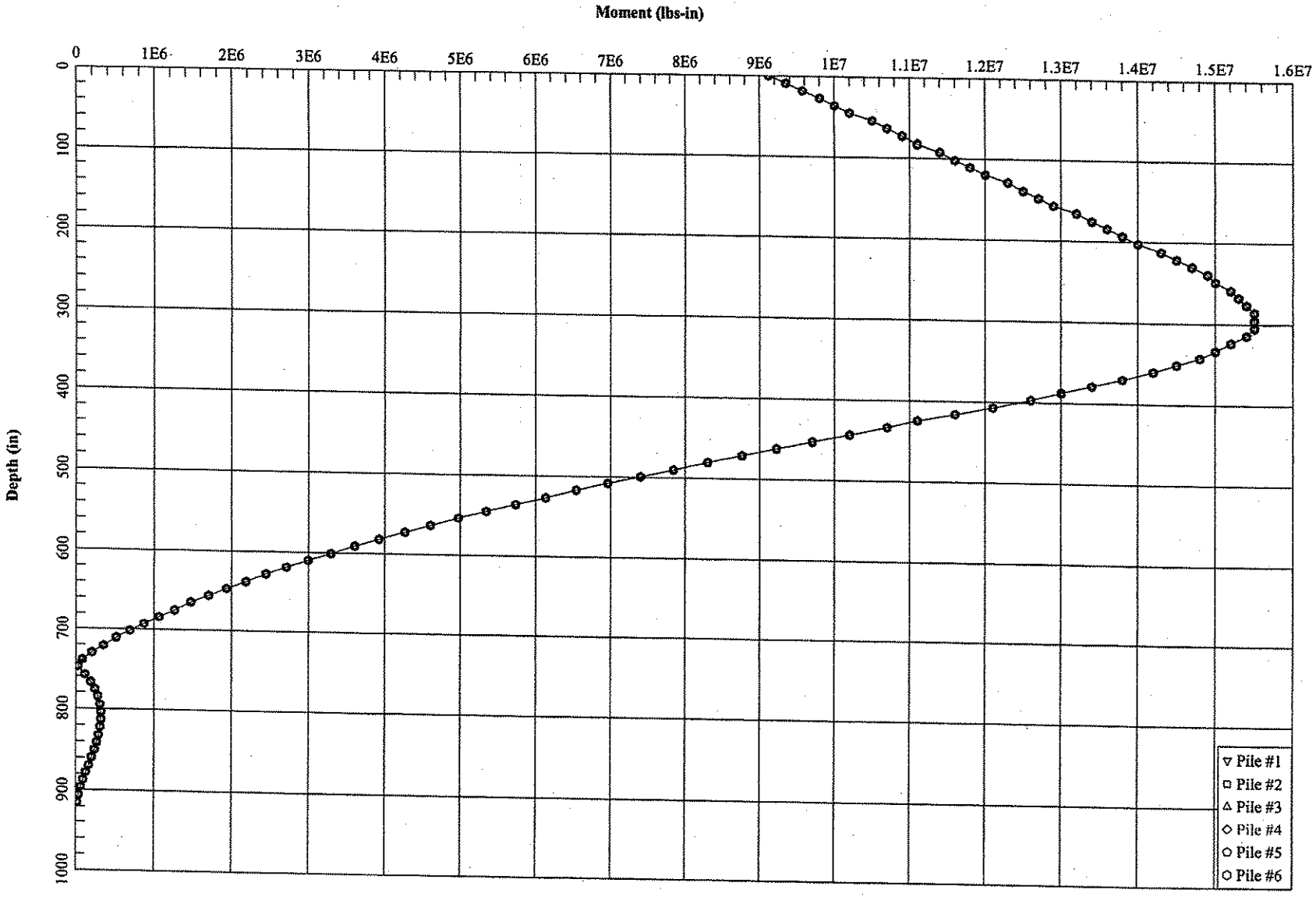
```
PB 3&4 SIX 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 192 0
2 1   1 0 0 0 0 0 0 225 0 90 192 0
2 1   1 0 0 0 0 0 0 75 0 90 192 0
2 1   1 0 0 0 0 0 0 -75 0 90 192 0
2 1   1 0 0 0 0 0 0 -225 0 90 192 0
2 1   1 0 0 0 0 0 0 -375 0 90 192 0
1
1 1 100 924 3950000 2
0 924 60 2827 636172 636172 0 0 6E13
4 8 8 0
1 4 192 444 60
2 2 444 720 100
3 4 720 840 60
4 4 840 1800 60
192 0.03
444 0.03
444 0.027
720 0.027
720 0.03
840 0.03
840 0.033
1800 0.033
192 0 30 0 2.77 0 0
444 0 30 0 2.77 0 0
444 4.16 0 0.01 2.77 0 0
720 4.16 0 0.01 2.77 0 0
720 0 33 0 8.33 0 0
840 0 33 0 8.33 0 0
840 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 3&4 SIX 5' CONCRETE SHAFTS

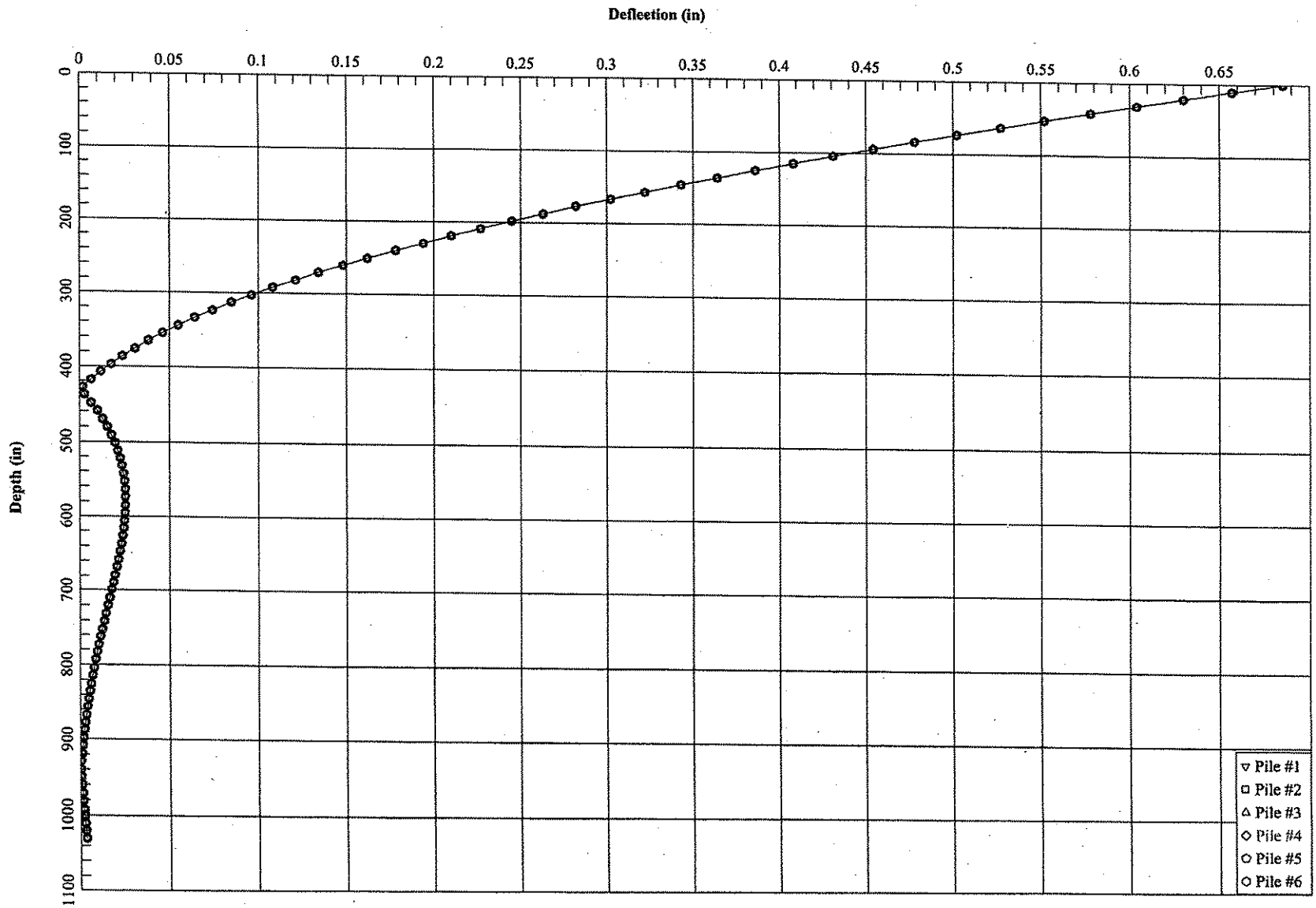


PB 3&4 SIX 5' CONCRETE SHAFTS

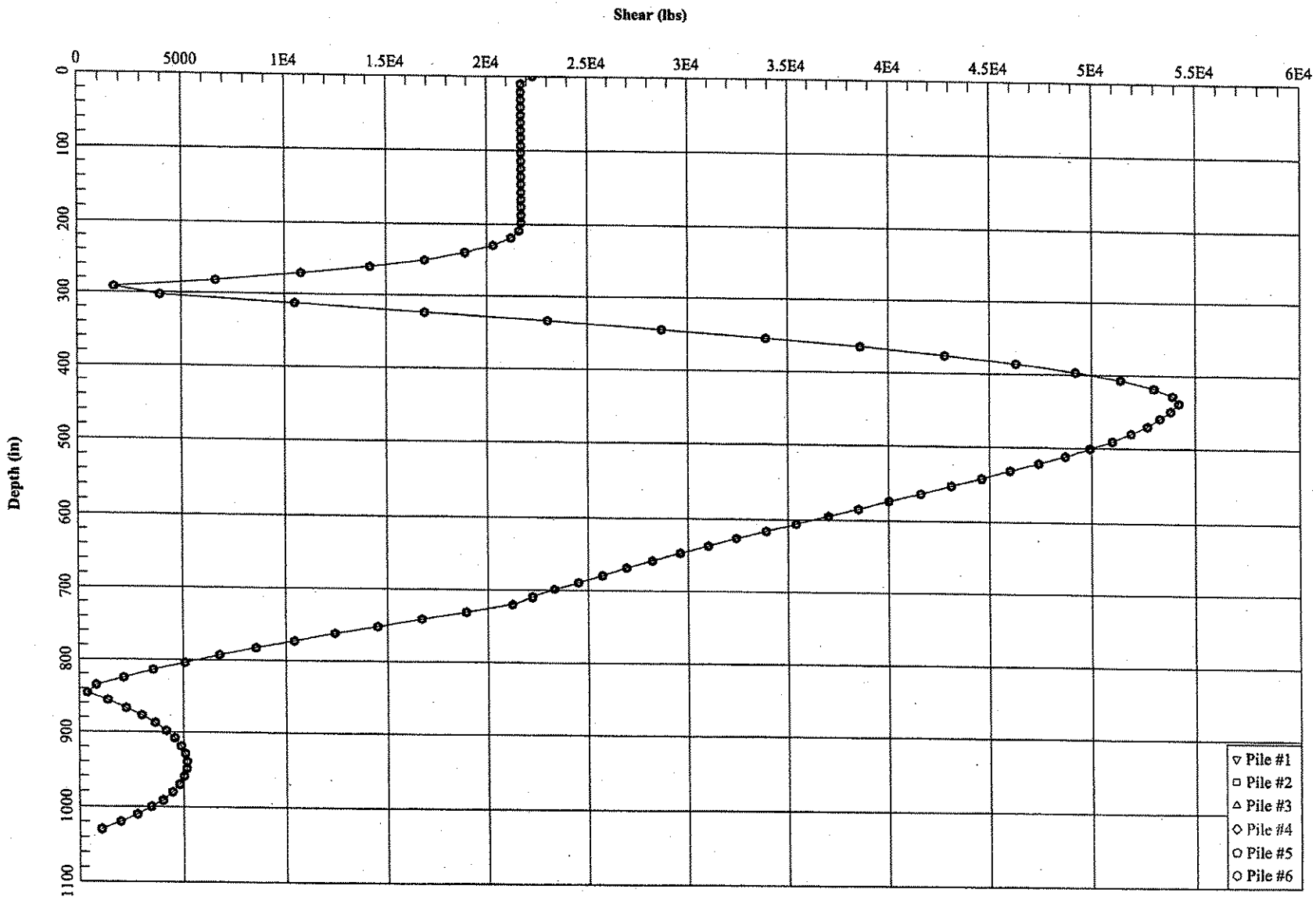


PB 3&4 SIX 5' CONCRETE SHAFTS

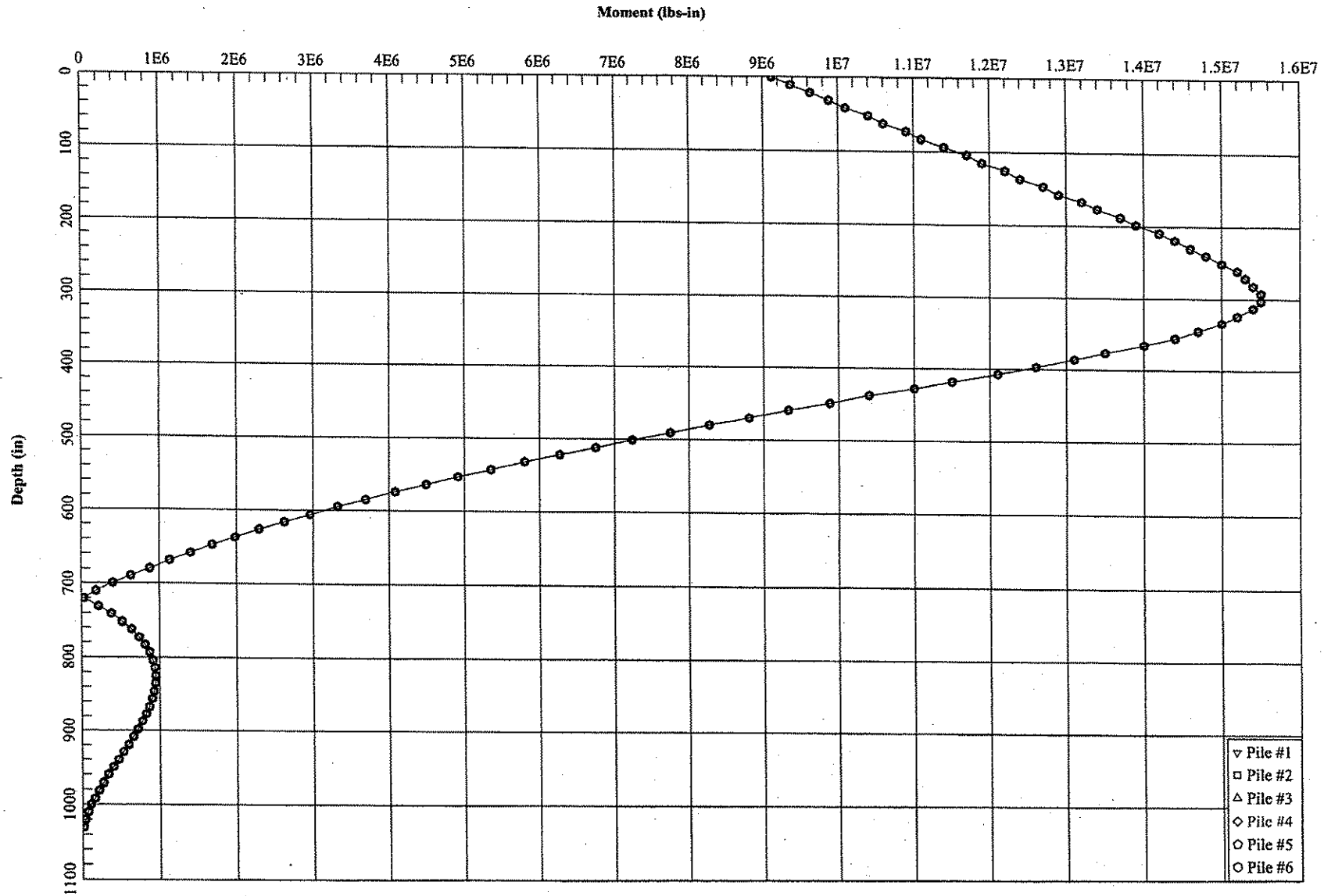
```
PB 3&4 SIX 5' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 192 0
2 1   1 0 0 0 0 0 0 225 0 90 192 0
2 1   1 0 0 0 0 0 0 75 0 90 192 0
2 1   1 0 0 0 0 0 0 -75 0 90 192 0
2 1   1 0 0 0 0 0 0 -225 0 90 192 0
2 1   1 0 0 0 0 0 0 -375 0 90 192 0
1
1 1 100 1044 3960000 2
0 1044 60 2827 636172 636172 0 0 6E13
4 8 8 0
1 4 192 444 60
2 2 444 720 100
3 4 720 840 60
4 4 840 1800 60
192 0.03
444 0.03
444 0.027
720 0.027
720 0.03
840 0.03
840 0.033
1800 0.033
192 0 30 0 1.7 0 0
444 0 30 0 1.7 0 0
444 4.16 0 0.01 1.7 0 0
720 4.16 0 0.01 1.7 0 0
720 0 33 0 5 0 0
840 0 33 0 5 0 0
840 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 3&4 SIX 5' STEEL CASED CONCRETE SHAFTS

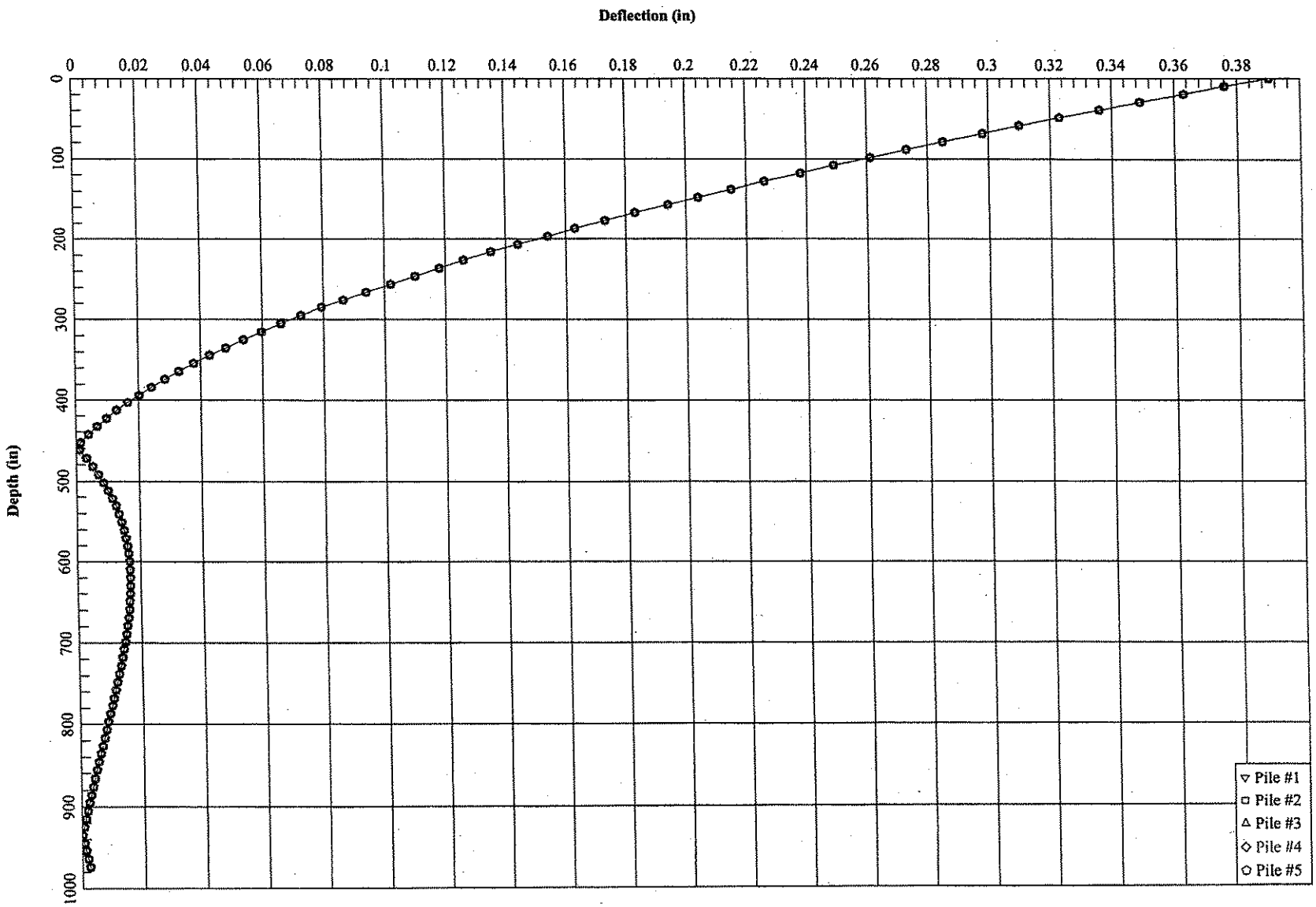


PB 3&4 SIX 5' STEEL CASED CONCRETE SHAFTS

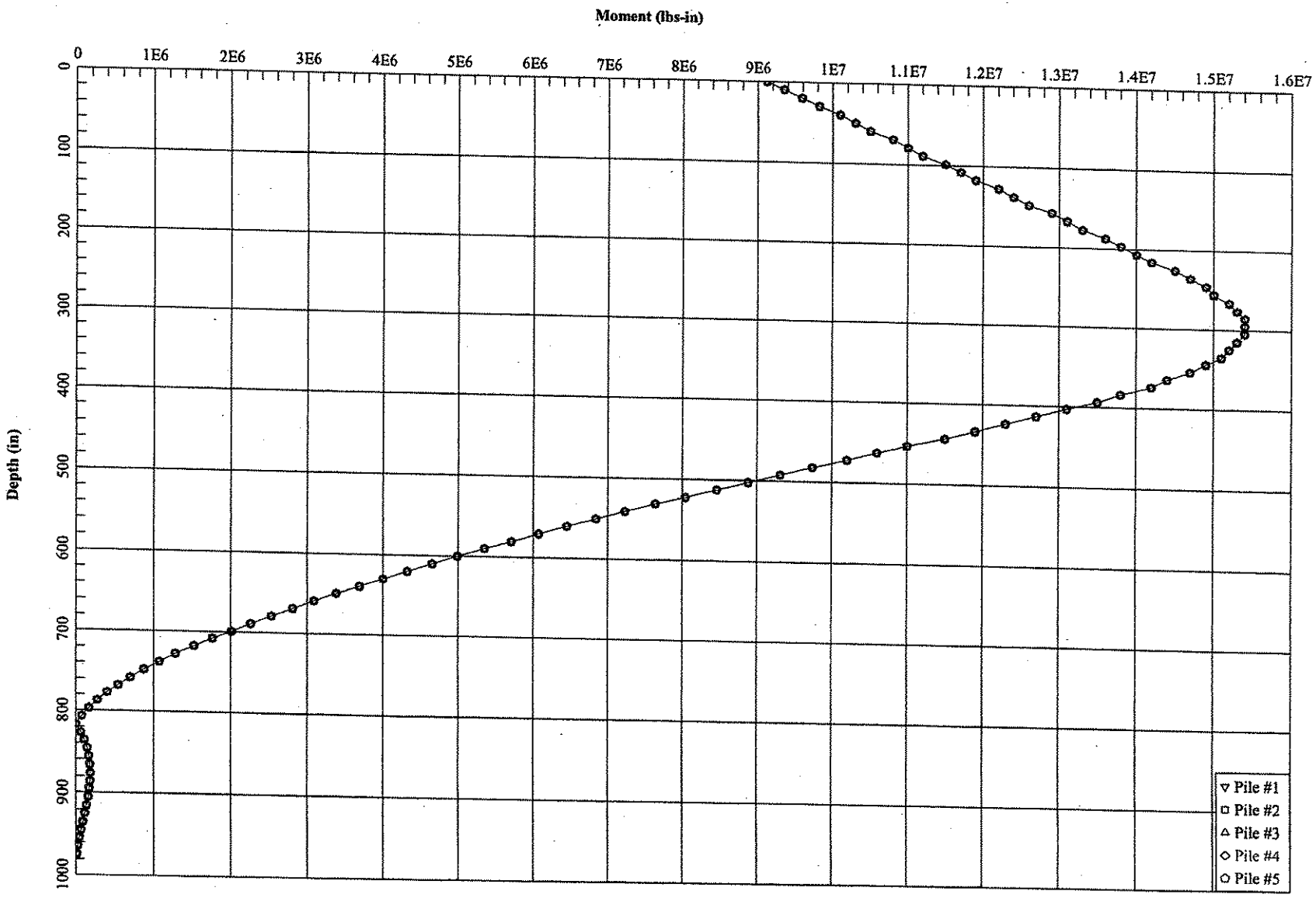


PB 3&4 SIX 5' STEEL CASED CONCRETE SHAFTS

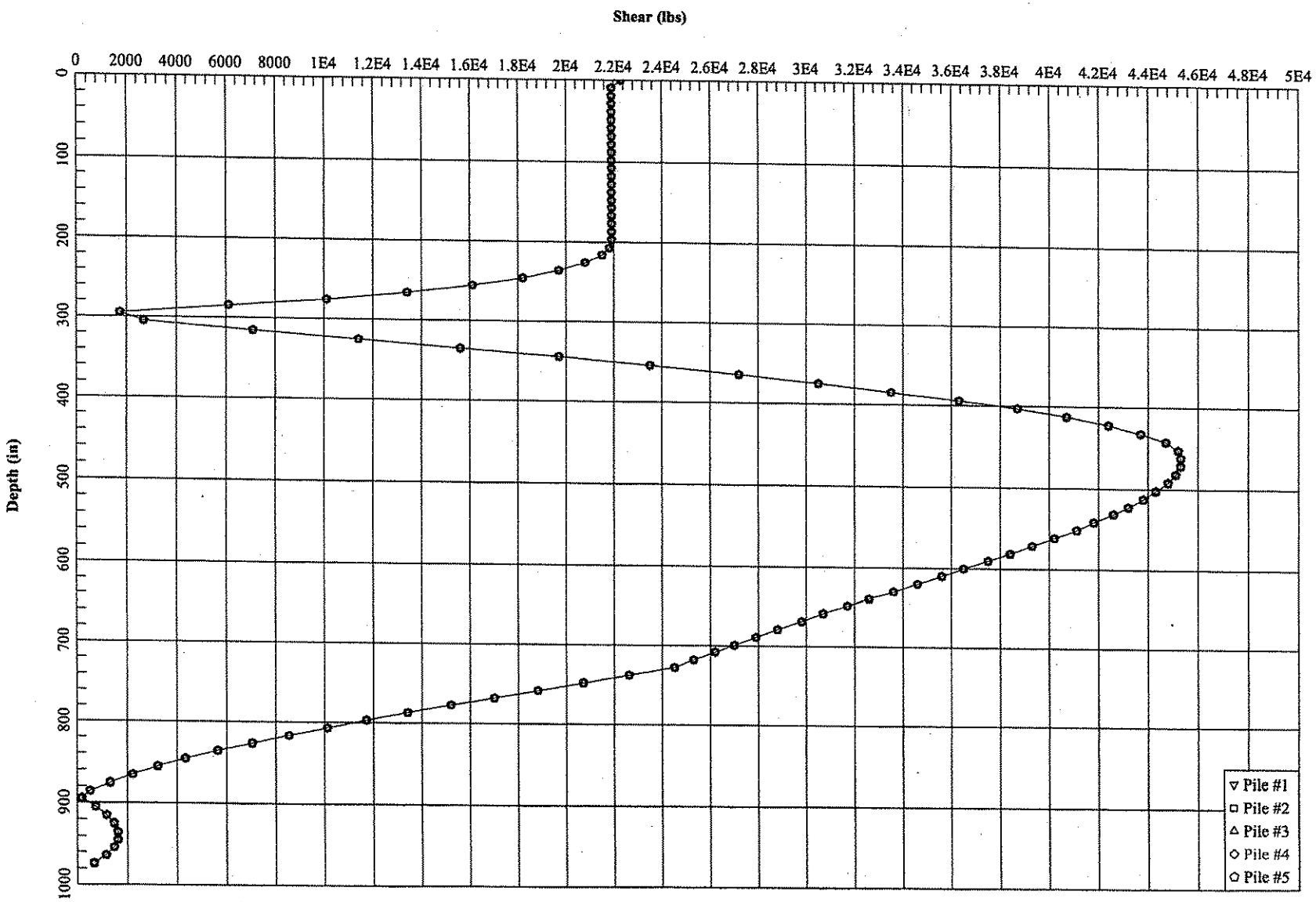
```
PB 3&4 FIVE 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 192 0
2 1   1 0 0 0 0 0 0 180 0 90 192 0
2 1   1 0 0 0 0 0 0 0 0 90 192 0
2 1   1 0 0 0 0 0 0 -180 0 90 192 0
2 1   1 0 0 0 0 0 0 -360 0 90 192 0
1
1 1 100 984 3850000 2
0 984 72 4071 1319167 1319167 0 0 6E13
4 8 8 0
1 4 192 444 60
2 2 444 720 100
3 4 720 840 60
4 4 840 1800 60
192 0.03
444 0.03
444 0.027
720 0.027
720 0.03
840 0.03
840 0.033
1800 0.033
192 0 30 0 2.77 0 0
444 0 30 0 2.77 0 0
444 4.16 0 0.01 2.77 0 0
720 4.16 0 0.01 2.77 0 0
720 0 33 0 8.33 0 0
840 0 33 0 8.33 0 0
840 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 3&4 FIVE 6' CONCRETE SHAFTS

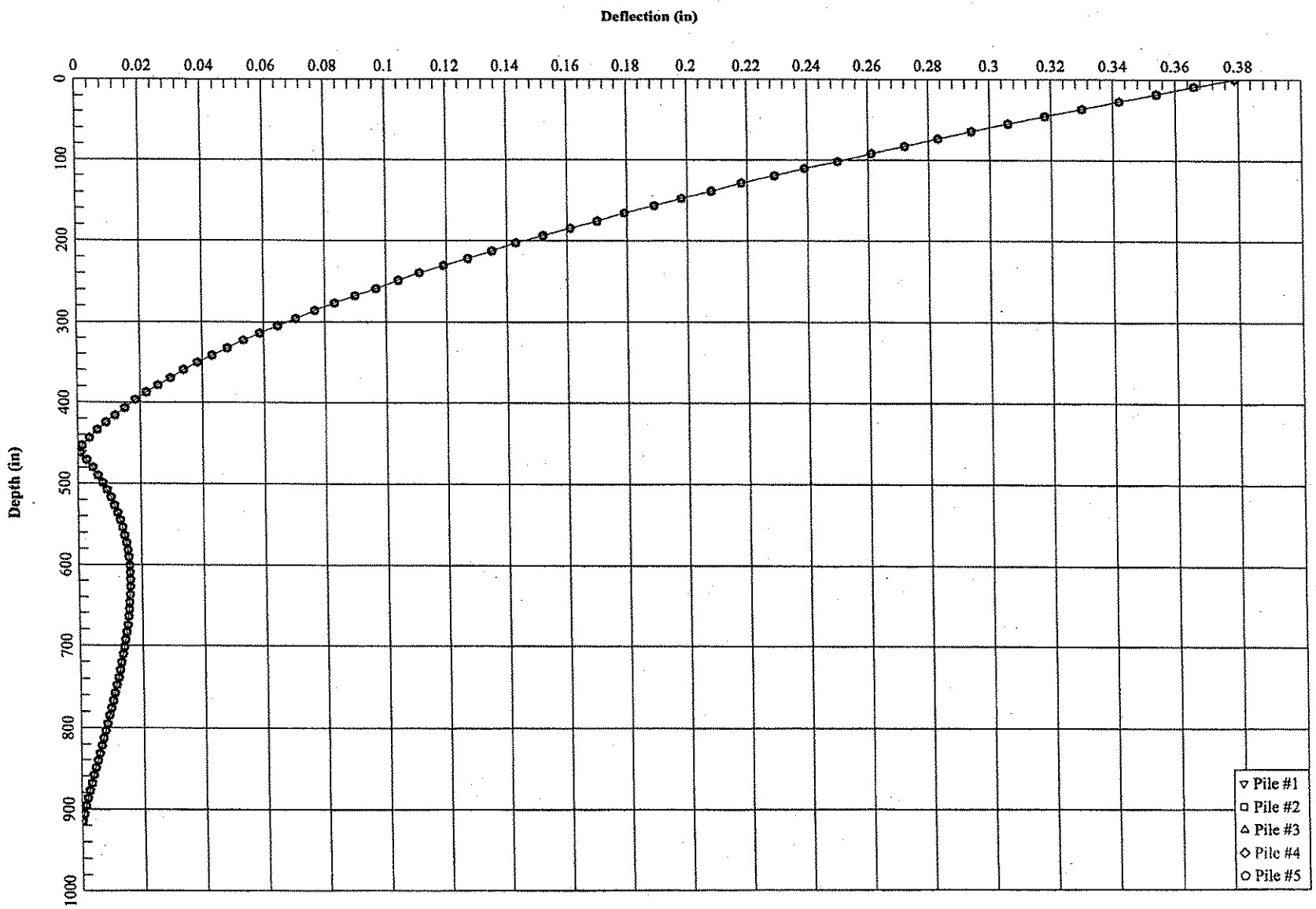


PB 3&4 FIVE 6' CONCRETE SHAFTS

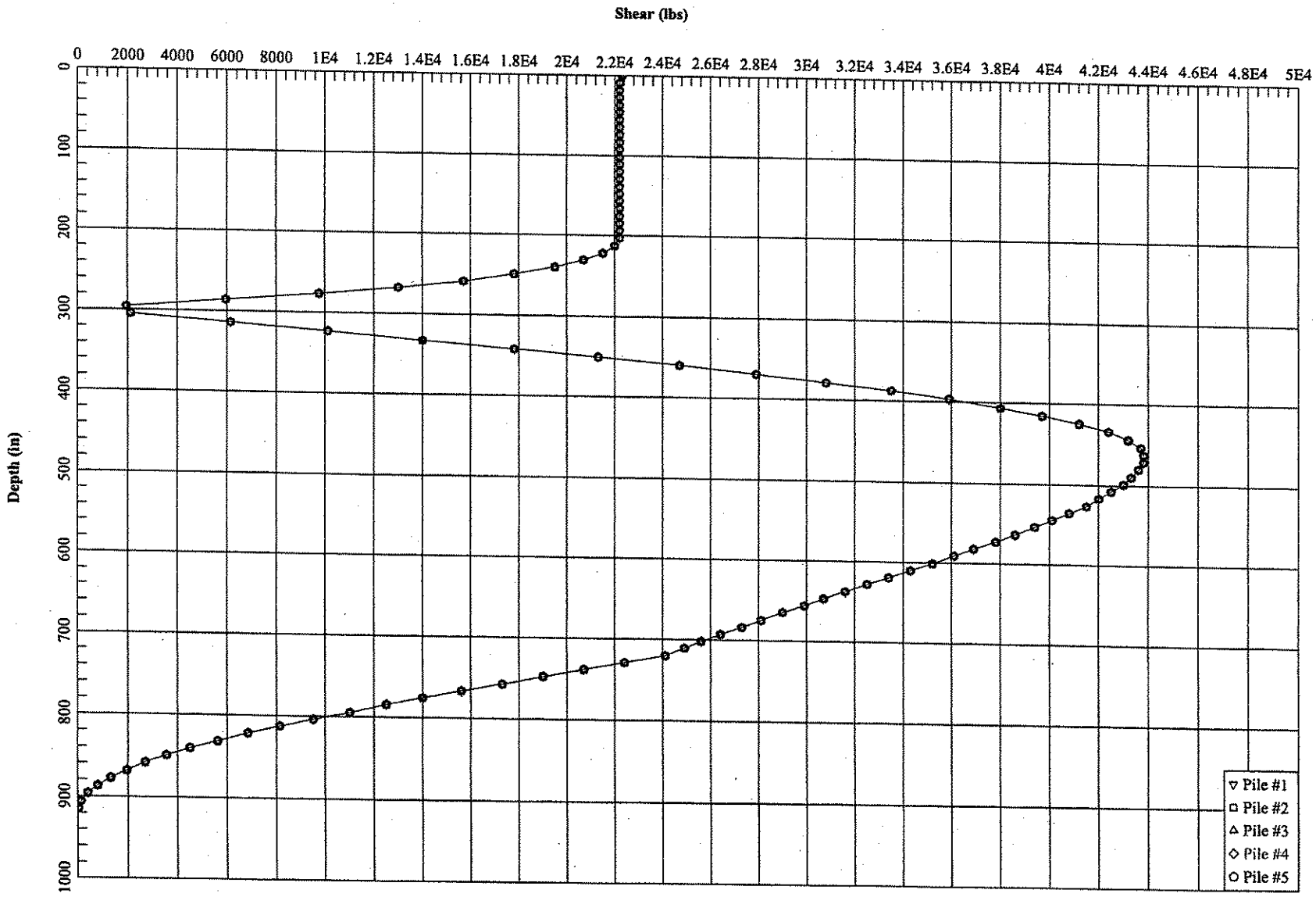


PB 3&4 FIVE 6' CONCRETE SHAFTS

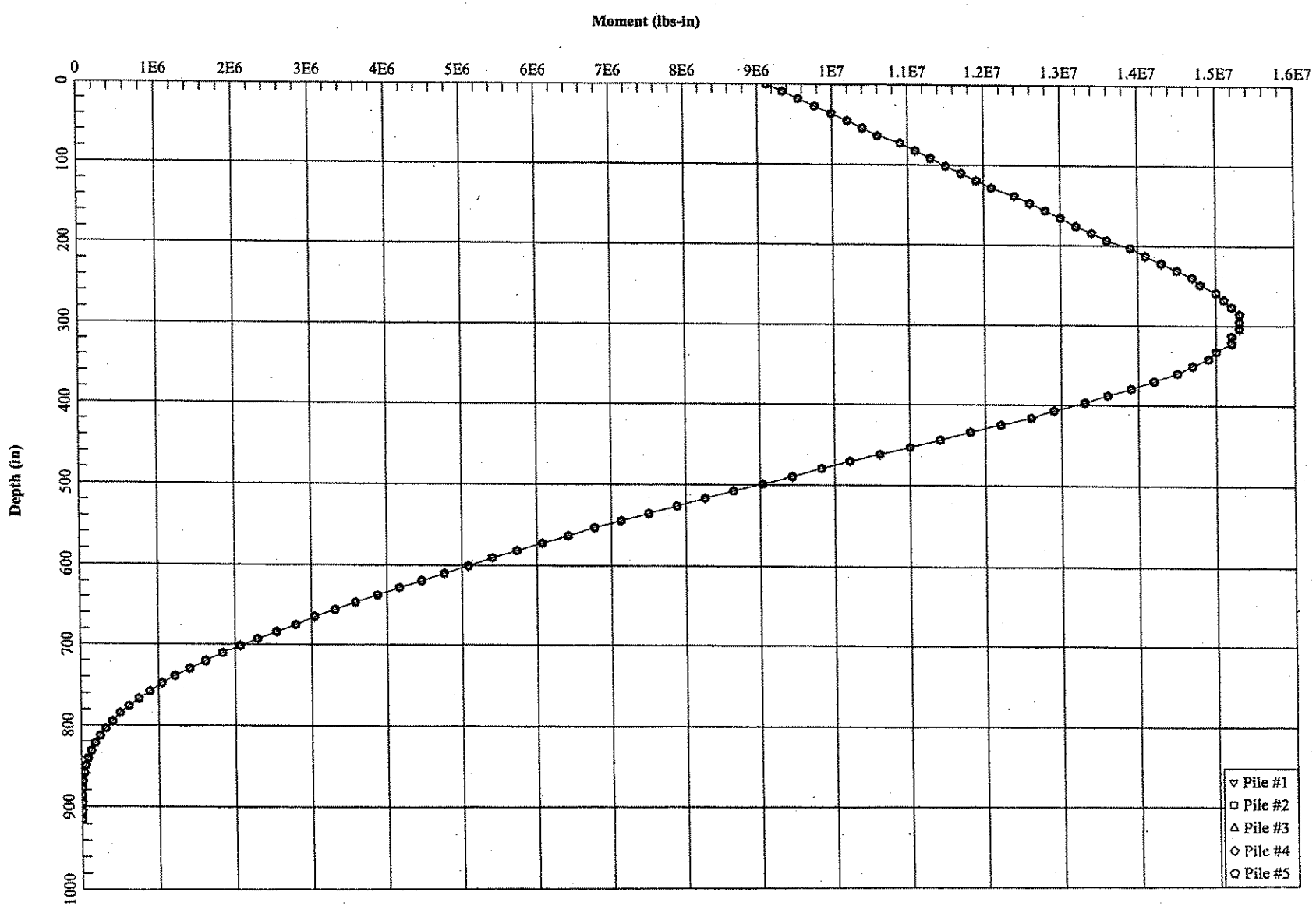
```
PB 3&4 FIVE 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 192 0
2 1   1 0 0 0 0 0 0 180 0 90 192 0
2 1   1 0 0 0 0 0 0 0 0 90 192 0
2 1   1 0 0 0 0 0 0 -180 0 90 192 0
2 1   1 0 0 0 0 0 0 -360 0 90 192 0
1
1 1 100 924 3960000 2
0 924 72 4071 1319167 1319167 0 0 6E13
4 8 8 0
1 4 192 444 60
2 2 444 720 100
3 4 720 840 60
4 4 840 1800 60
192 0.03
444 0.03
444 0.027
720 0.027
720 0.03
840 0.03
840 0.033
1800 0.033
192 0 30 0 1.77 0 0
444 0 30 0 1.77 0 0
444 4.16 0 0.01 1.77 0 0
720 4.16 0 0.01 1.77 0 0
720 0 33 0 5 0 0
840 0 33 0 5 0 0
840 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 3&4 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 3&4 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 3&4 FIVE 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft	
	Concrete	Steel	Concrete	Steel
Tip elevation	-80	-80	-75	-80
Element Length	1044	1164	984	1044 inches

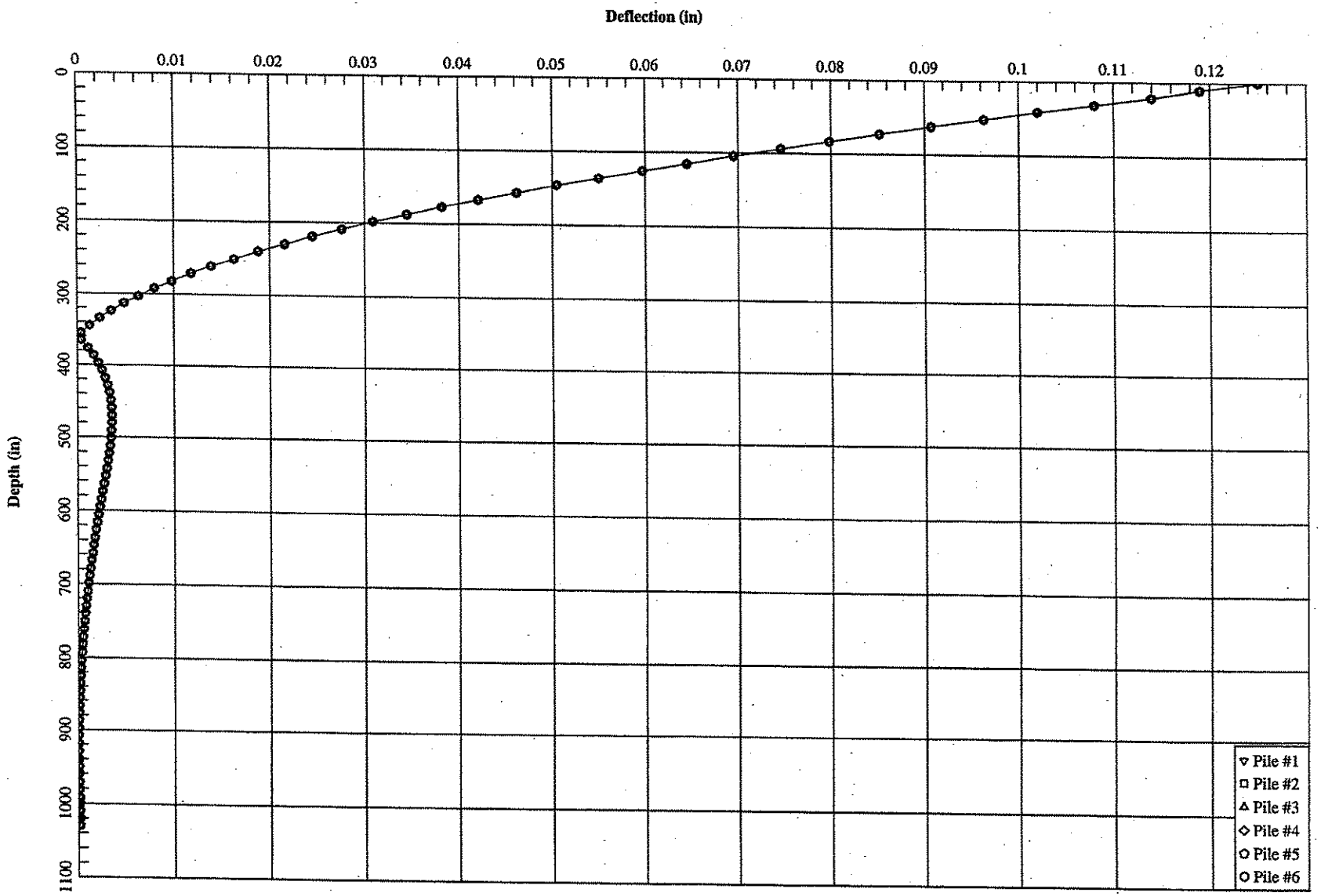
	Elevation (feet)	Elevation (Inches)	GROUP Input (inches)
Top of Element	7	84	0
Top of AL (Sand)	1	12	72
Top of AL (Clay)	-44	-528	612
Top of Yorktown (Y2)	-66	-792	876
Top of Yorktown (Y1)	-143	-1716	1600

Foundation Element Properties

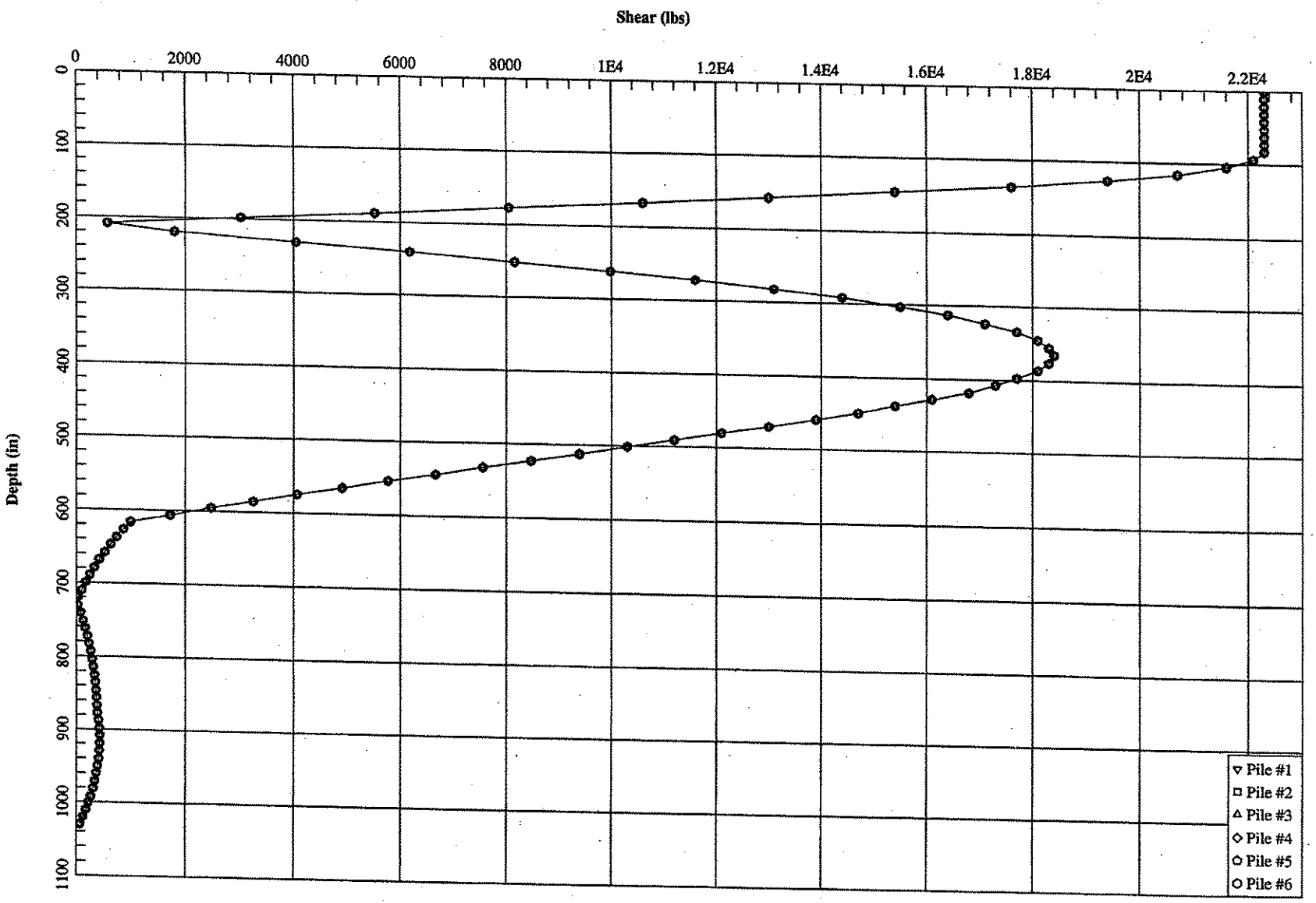
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
24- inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

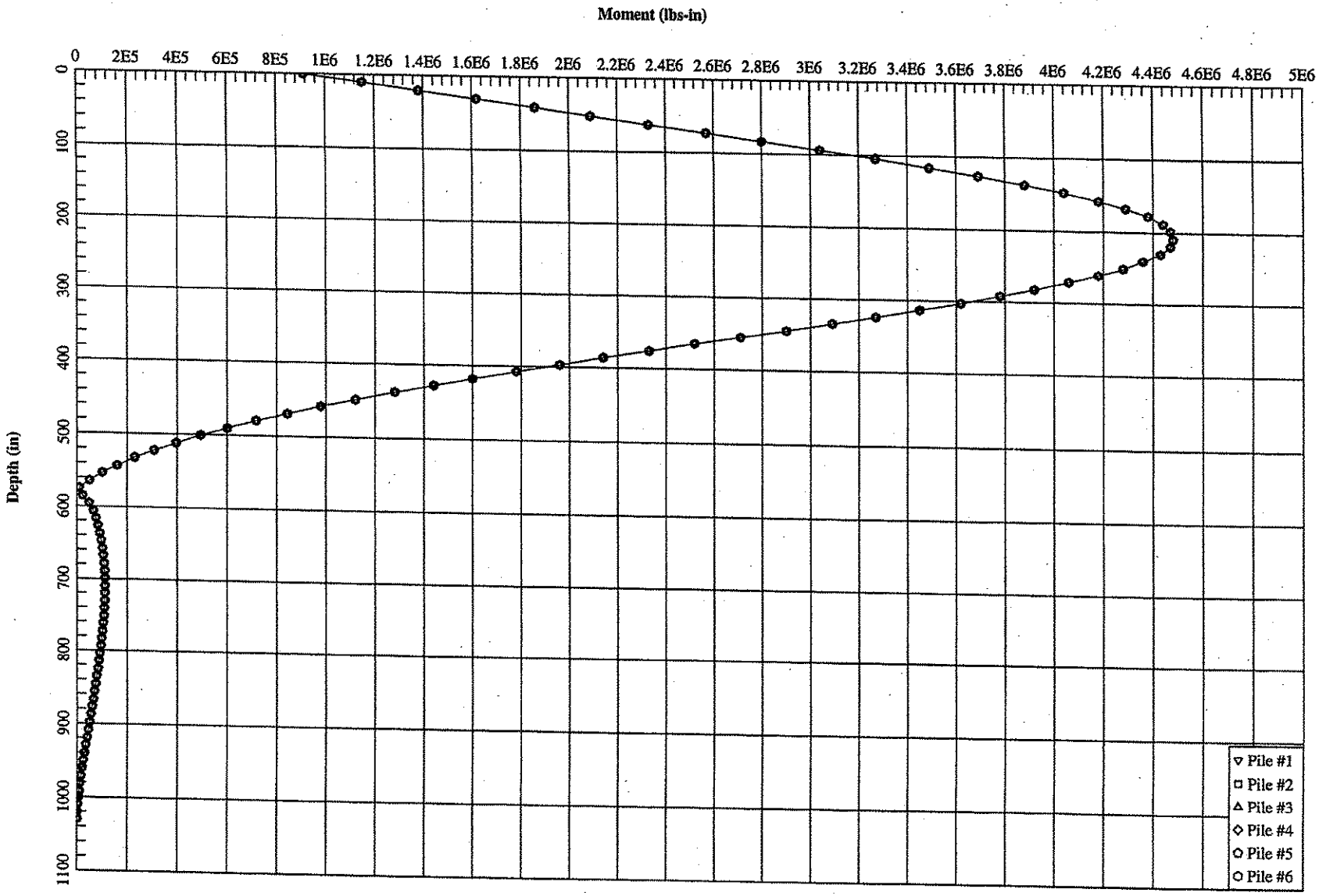
```
PB 5-7 SIX 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 72 0
2 1   1 0 0 0 0 0 0 225 0 90 72 0
2 1   1 0 0 0 0 0 0 75 0 90 72 0
2 1   1 0 0 0 0 0 0 -75 0 90 72 0
2 1   1 0 0 0 0 0 0 -225 0 90 72 0
2 1   1 0 0 0 0 0 0 -375 0 90 72 0
1
1 1 100 1044 3850000 2
0 1044 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 72 612 60
2 2 612 876 100
3 4 876 1800 60
72 0.03
612 0.03
612 0.027
876 0.027
876 0.033
1800 0.033
72 0 30 0 2.77 0 0
612 0 30 0 2.77 0 0
612 4.16 0 0.01 2.77 0 0
876 4.16 0 0.01 2.77 0 0
876 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 5-7 SIX 5' CONCRETE SHAFTS

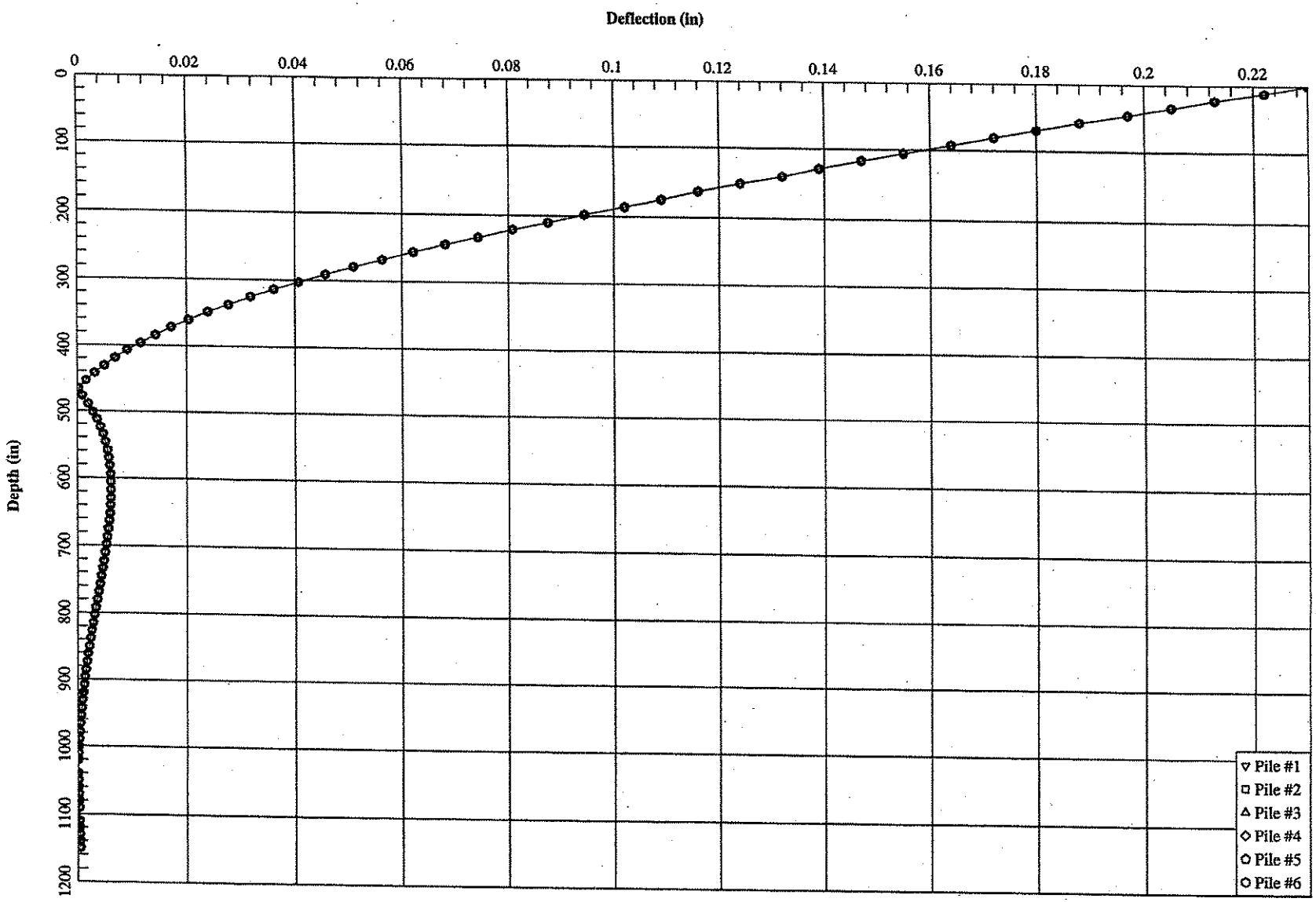


PB 5-7 SIX 5' CONCRETE SHAFTS

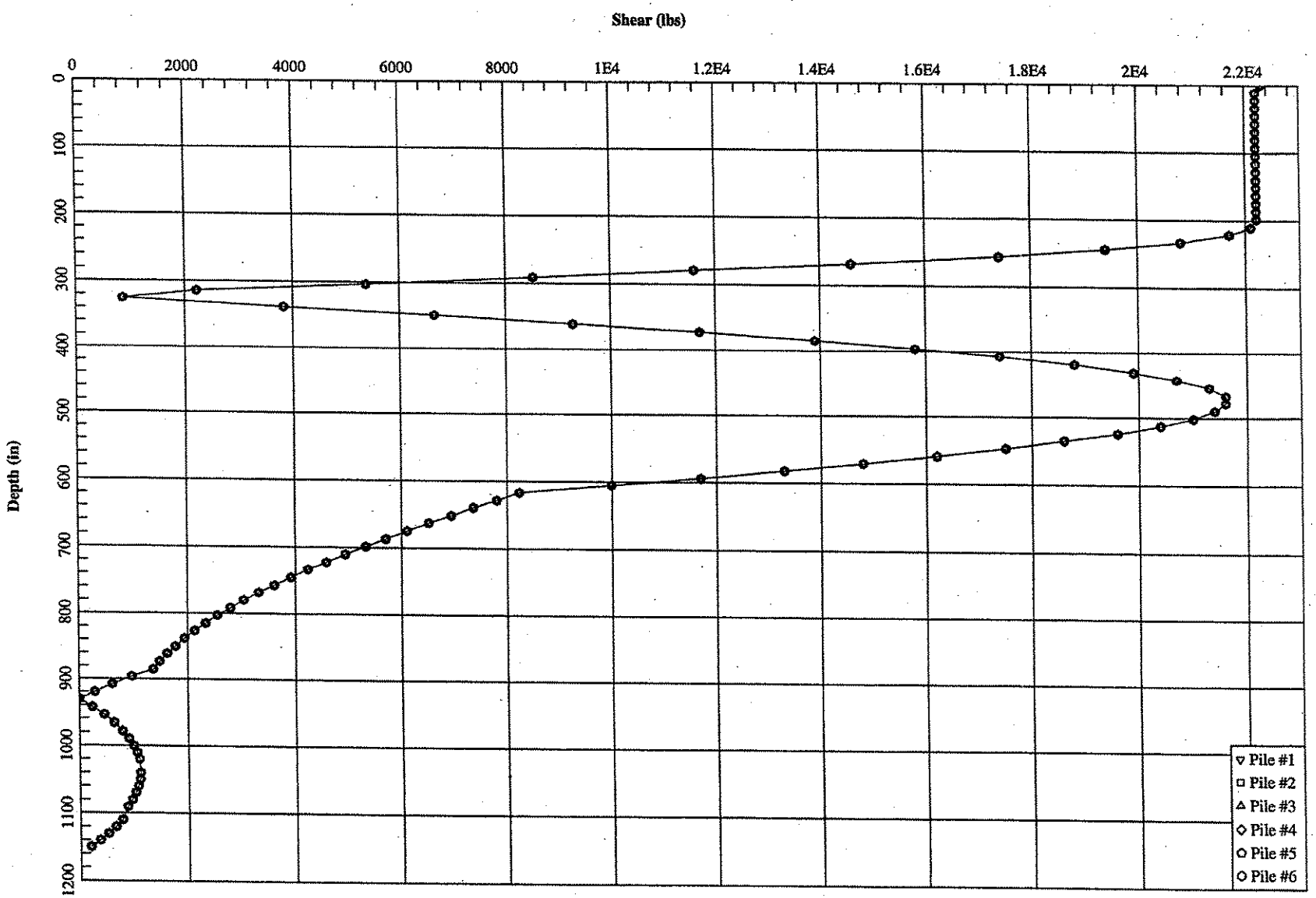


PB 5-7 SIX 5' CONCRETE SHAFTS

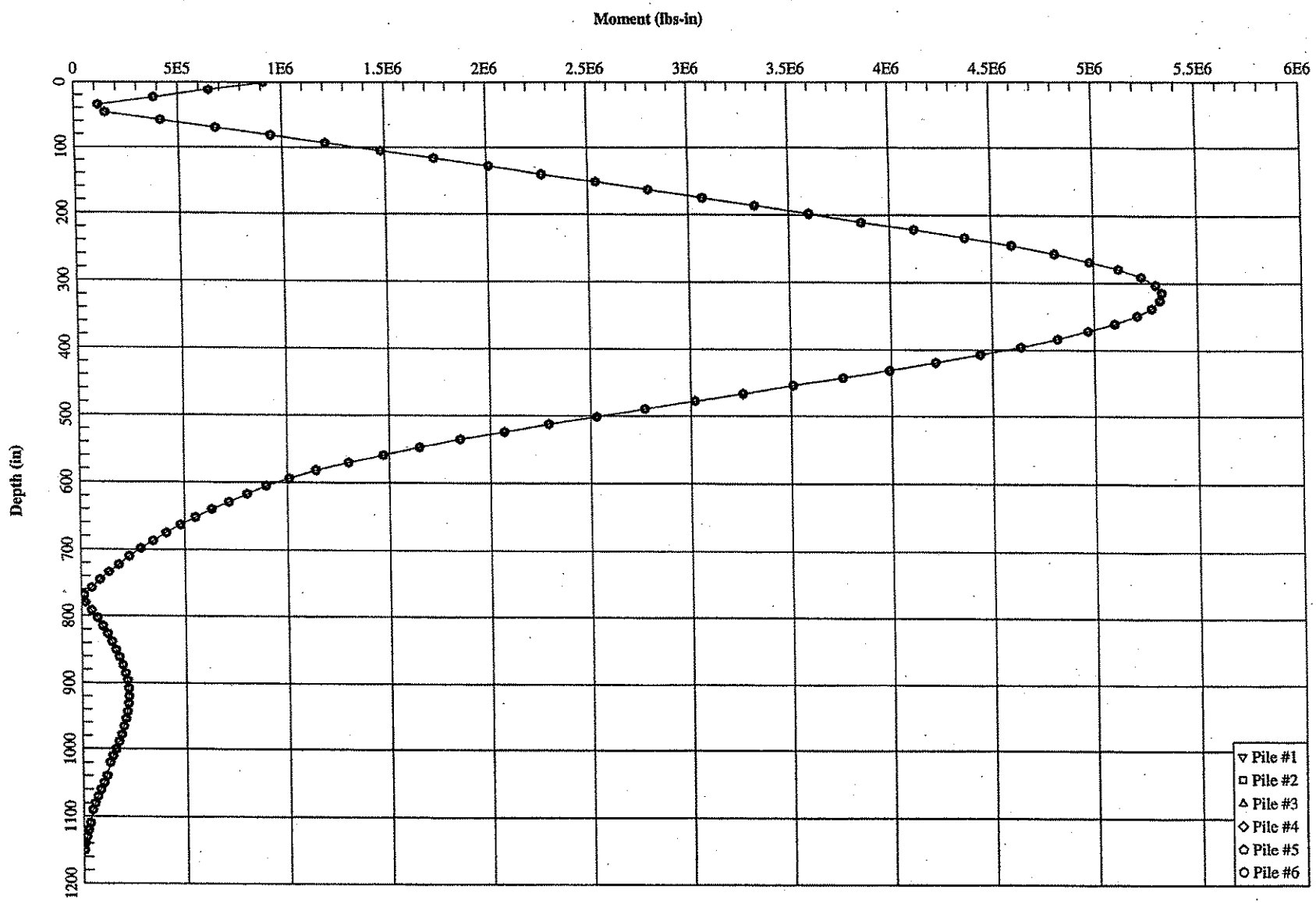
```
PB 5-7 SIX 5' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 5.4790000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 72 0
2 1   1 0 0 0 0 0 0 225 0 90 72 0
2 1   1 0 0 0 0 0 0 75 0 90 72 0
2 1   1 0 0 0 0 0 0 -75 0 90 72 0
2 1   1 0 0 0 0 0 0 -225 0 90 72 0
2 1   1 0 0 0 0 0 0 -375 0 90 72 0
1
1 1 100 1164 3960000 2
0 1164 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 72 612 60
2 2 612 876 100
3 4 876 1800 60
72 0.03
612 0.03
612 0.027
876 0.027
876 0.033
1800 0.033
72 0 30 0 1.77 0 0
612 0 30 0 1.77 0 0
612 4.16 0 0.01 1.77 0 0
876 4.16 0 0.01 1.77 0 0
876 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 5-7 SIX 5' STEEL CASED CONCRETE SHAFTS

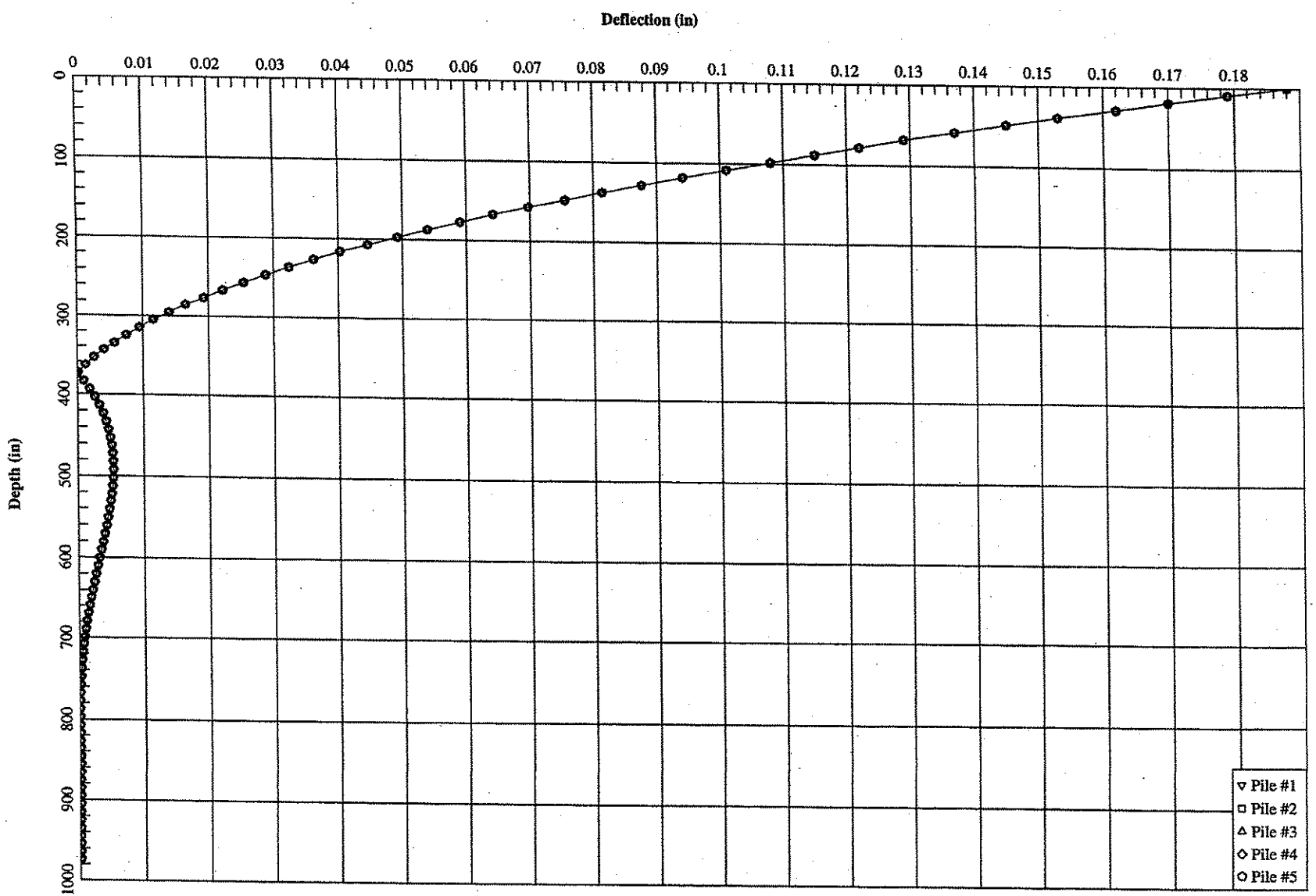


PB 5-7 SIX 5' STEEL CASED CONCRETE SHAFTS

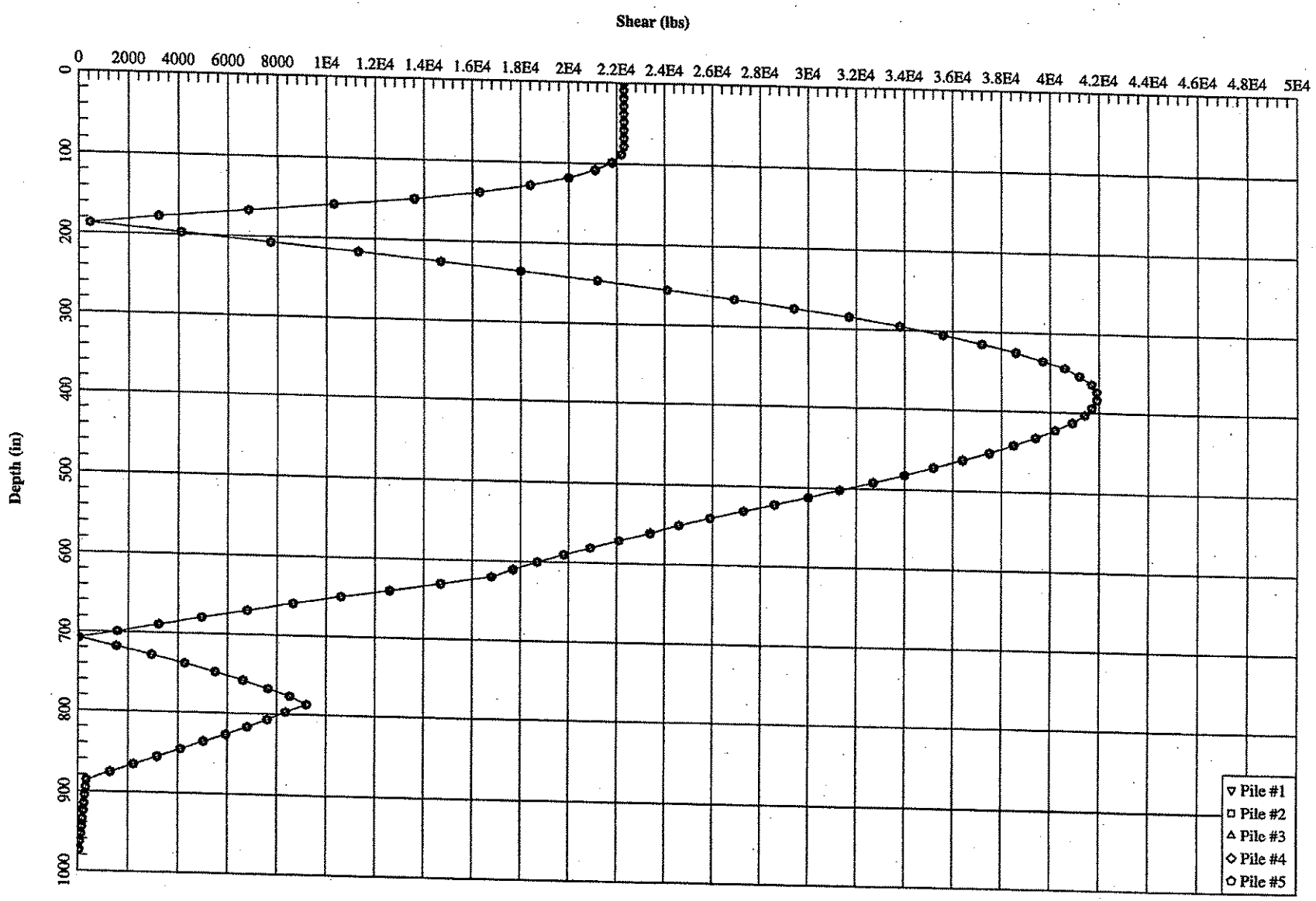


PB 5-7 SIX 5' STEEL CASED CONCRETE SHAFTS

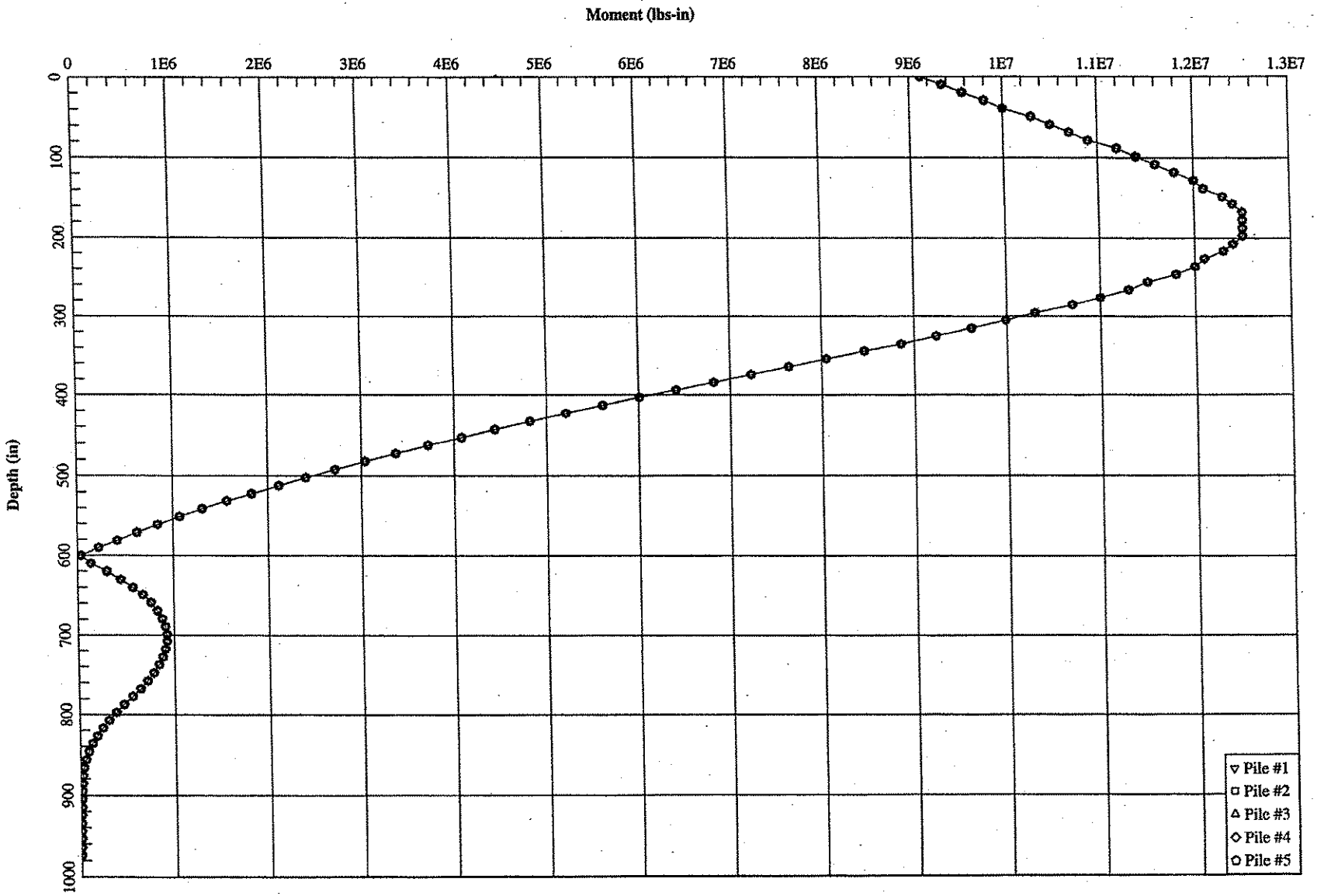
```
PB 5-7 FIVE 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 72 0
2 1   1 0 0 0 0 0 0 180 0 90 72 0
2 1   1 0 0 0 0 0 0 0 0 90 72 0
2 1   1 0 0 0 0 0 0 -180 0 90 72 0
2 1   1 0 0 0 0 0 0 -360 0 90 72 0
1
1 1 100 984 3850000 2
0 984 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 72 612 60
2 3 612 876 100
3 4 876 1800 60
72 0.03
612 0.03
612 0.027
876 0.027
876 0.033
1800 0.033
72 0 30 0 2.77 0 0
612 0 30 0 2.77 0 0
612 4.16 0 0.01 2.77 0 0
876 4.16 0 0.01 2.77 0 0
876 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 5-7 FIVE 6' CONCRETE SHAFTS

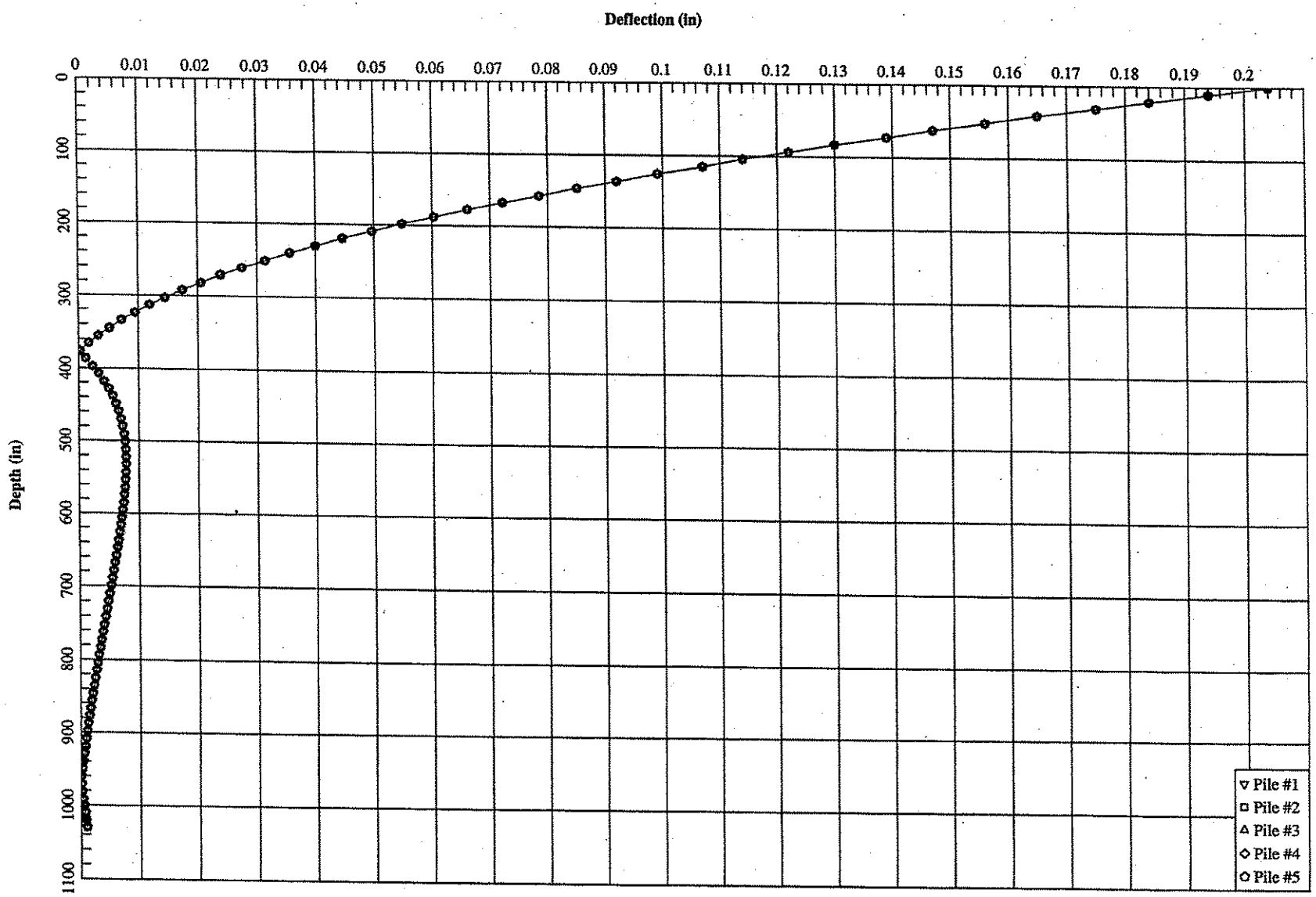


PB 5-7 FIVE 6' CONCRETE SHAFTS

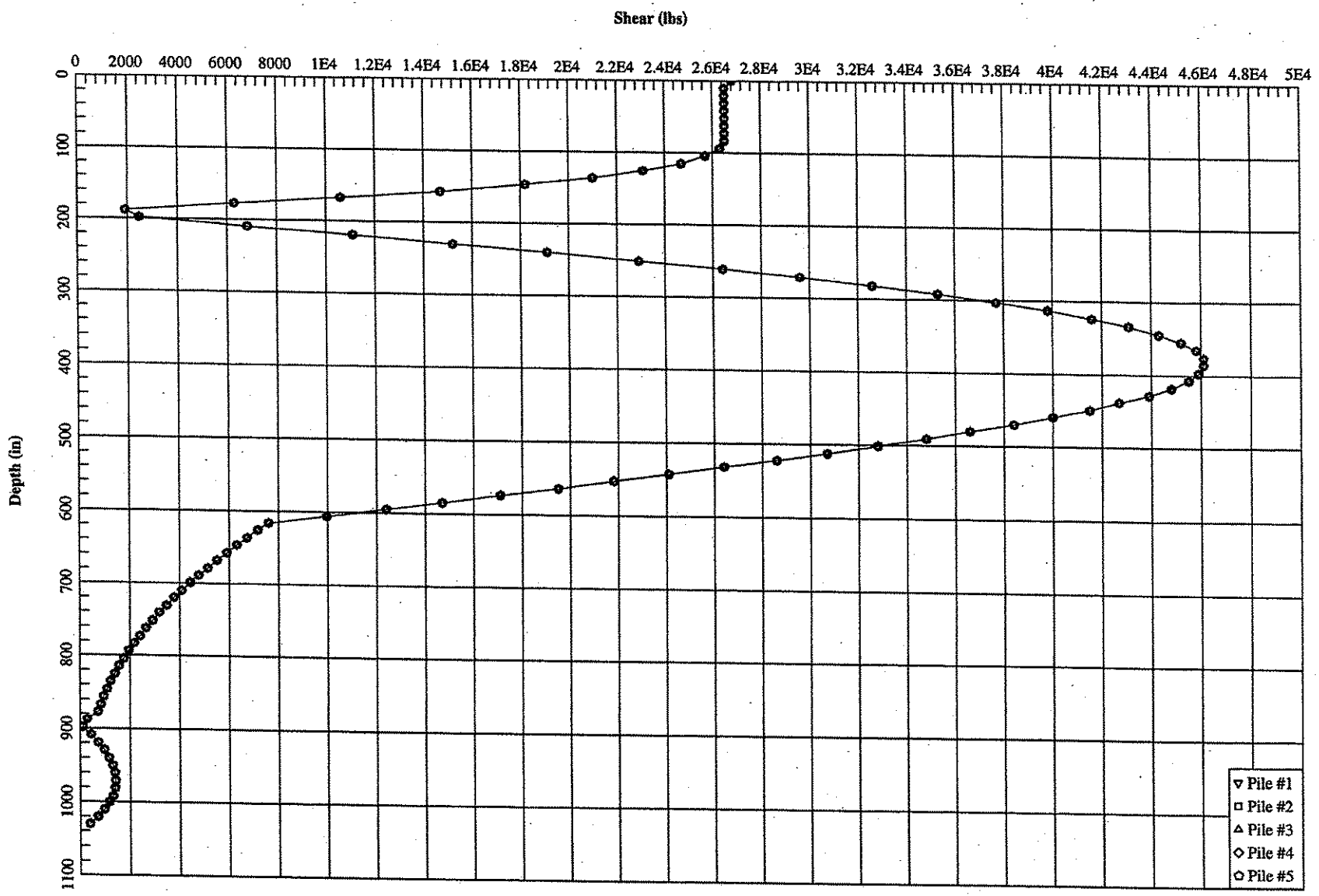


PB 5-7 FIVE 6' CONCRETE SHAFTS

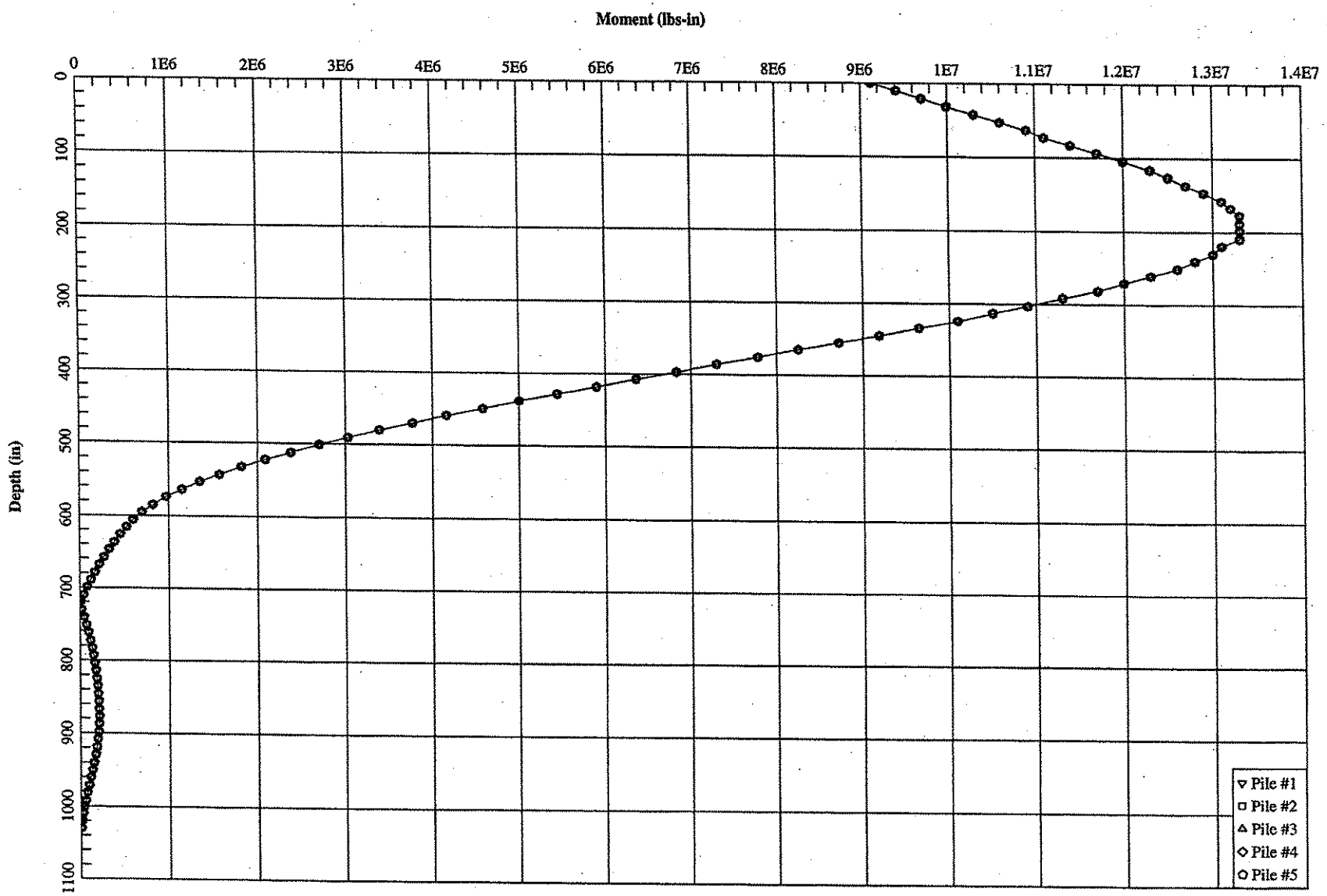
```
PB 5-7 FIVE 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.3380000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 72 0
2 1   1 0 0 0 0 0 0 180 0 90 72 0
2 1   1 0 0 0 0 0 0 0 0 90 72 0
2 1   1 0 0 0 0 0 0 -180 0 90 72 0
2 1   1 0 0 0 0 0 0 -360 0 90 72 0
1
1 1 100 1044 3960000 2
0 1044 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 72 612 60
2 2 612 876 100
3 4 876 1800 60
72 0.03
612 0.03
612 0.027
876 0.027
876 0.033
1800 0.033
72 0 30 0 2.77 0 0
612 0 30 0 2.77 0 0
612 4.16 0 0.01 2.77 0 0
876 4.16 0 0.01 2.77 0 0
876 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 5-7 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 5-7 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 5-7 FIVE 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft	
	Concrete	Steel	Concrete	Steel
Tip elevation	-85	-95	-80	-80
Element Length	1104	1224	1044	1044 inches

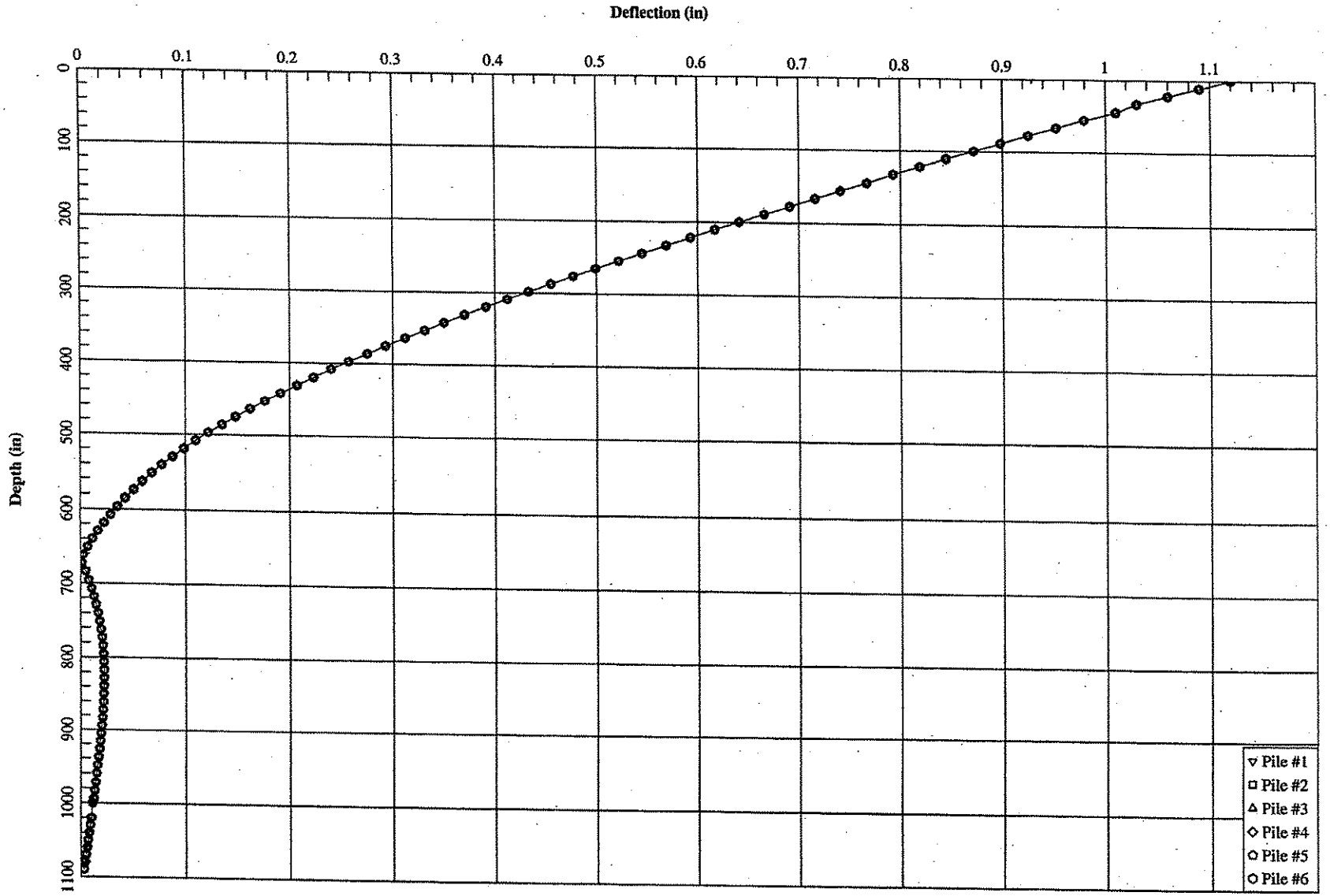
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	7	84	0
Top of AL (Sand)	-28	-336	420
Top of AL (Clay)	-40	-480	564
Top of Yorktown (Y2)	-76	-936	1020
Top of Yorktown (Y1)	-143	-1716	1800

Foundation Element Properties

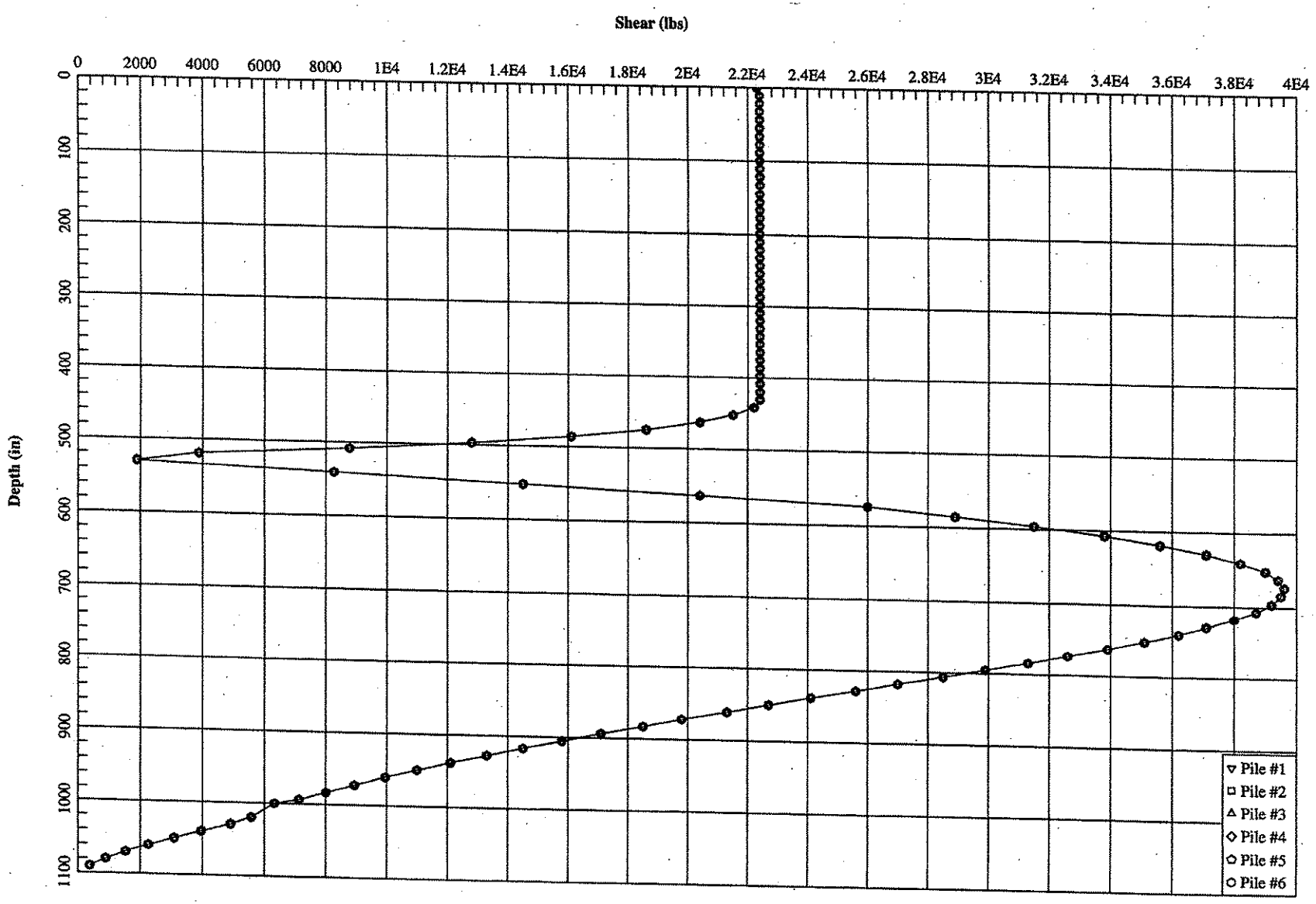
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksf	Young's Modulus psf	Torsional Stiffness lb-in^2
24- inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, ν	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

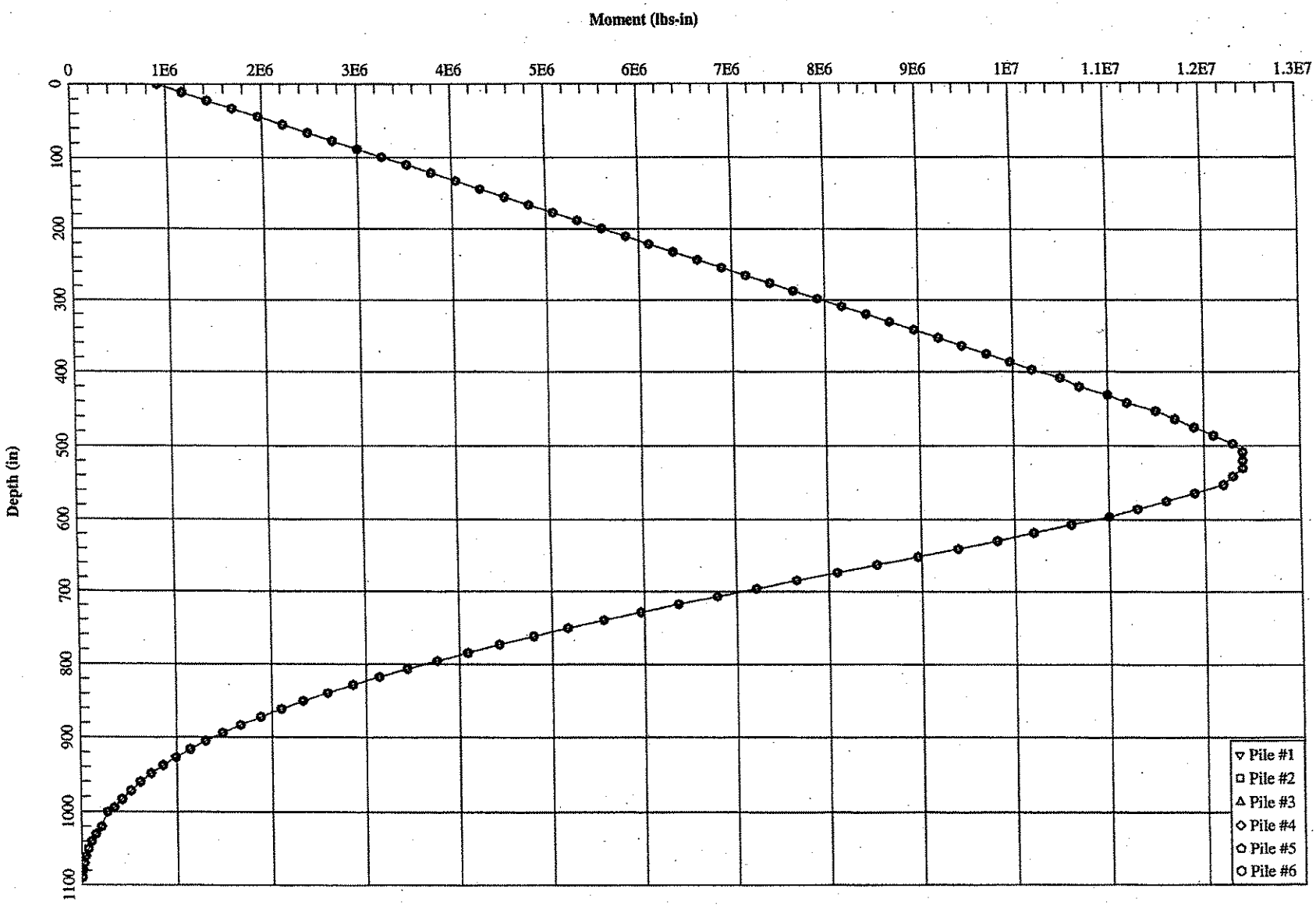
```
PB 8 SIX 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 420 0
2 1   1 0 0 0 0 0 0 225 0 90 420 0
2 1   1 0 0 0 0 0 0 75 0 90 420 0
2 1   1 0 0 0 0 0 0 -75 0 90 420 0
2 1   1 0 0 0 0 0 0 -225 0 90 420 0
2 1   1 0 0 0 0 0 0 -375 0 90 420 0
1
1 1 100 1104 3850000 2
0 1104 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 420 564 60
2 2 564 1020 100
3 4 1020 1800 60
420 0.03
564 0.03
564 0.027
1020 0.027
1020 0.033
1800 0.033
420 0 30 0 2.77 0 0
564 0 30 0 2.77 0 0
564 4.16 0 0.01 2.77 0 0
1020 4.16 0 0.01 2.77 0 0
1020 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 8 SIX 5' CONCRETE SHAFTS

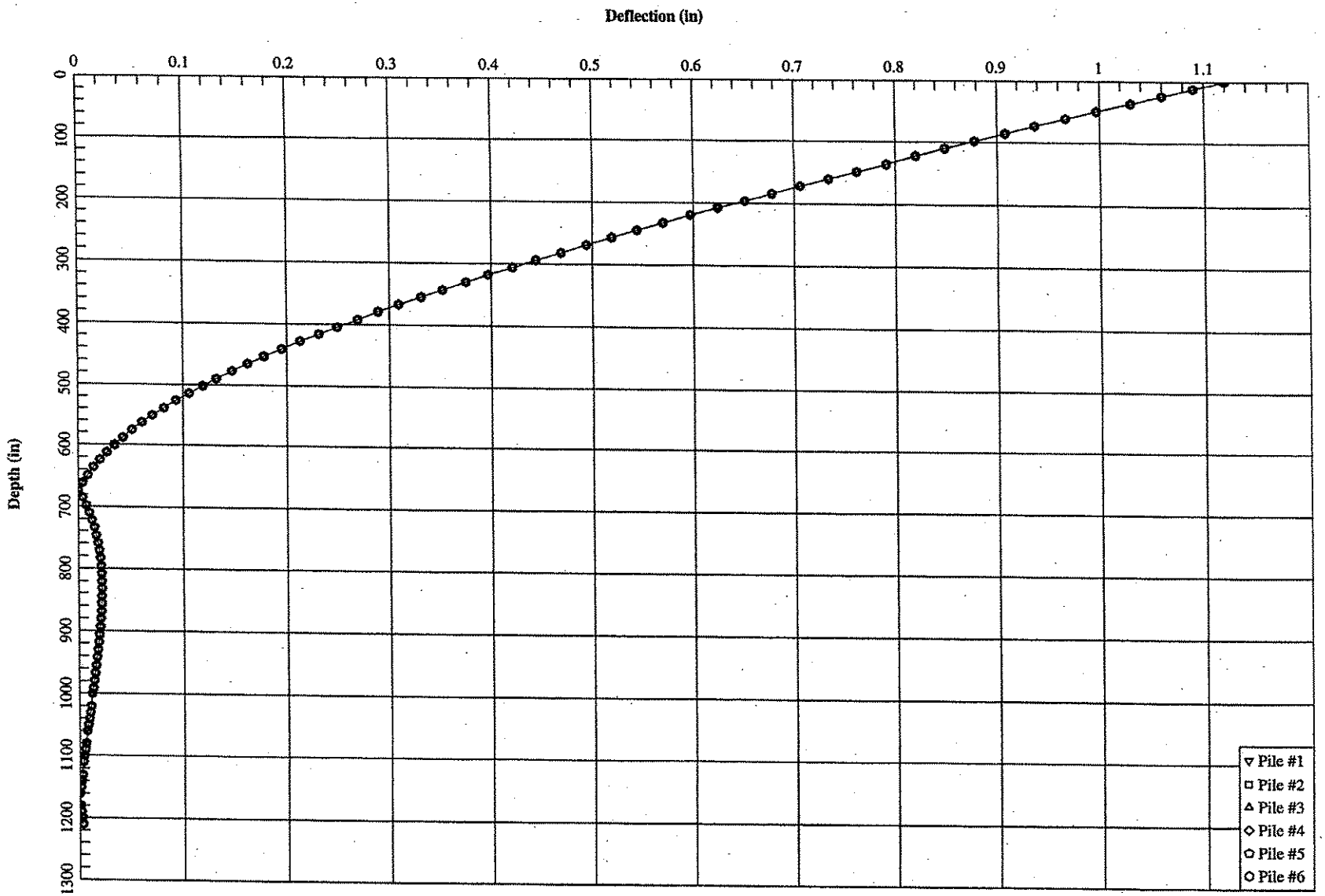


PB 8 SIX 5' CONCRETE SHAFTS

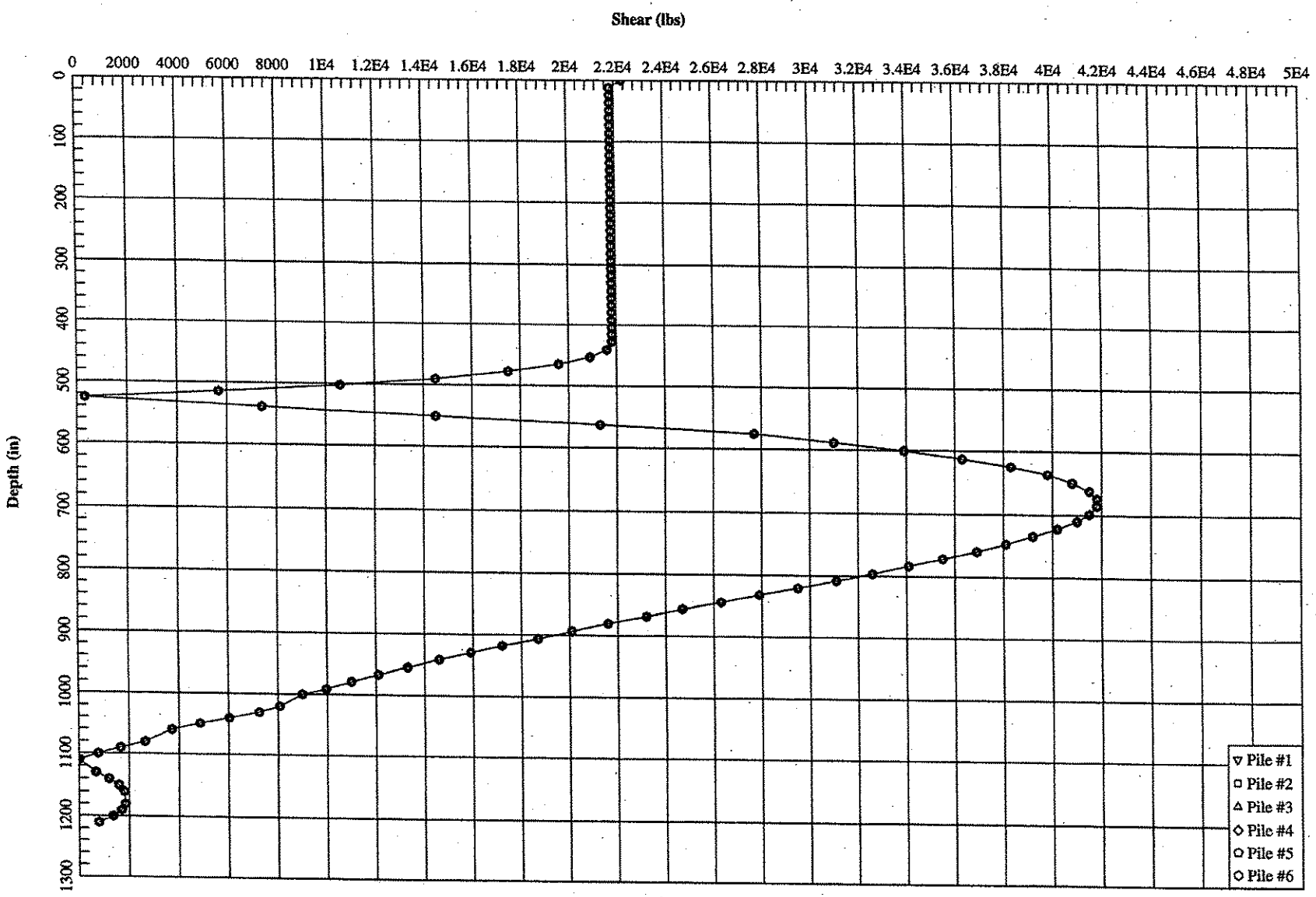


PB 8 SIX 5' CONCRETE SHAFTS

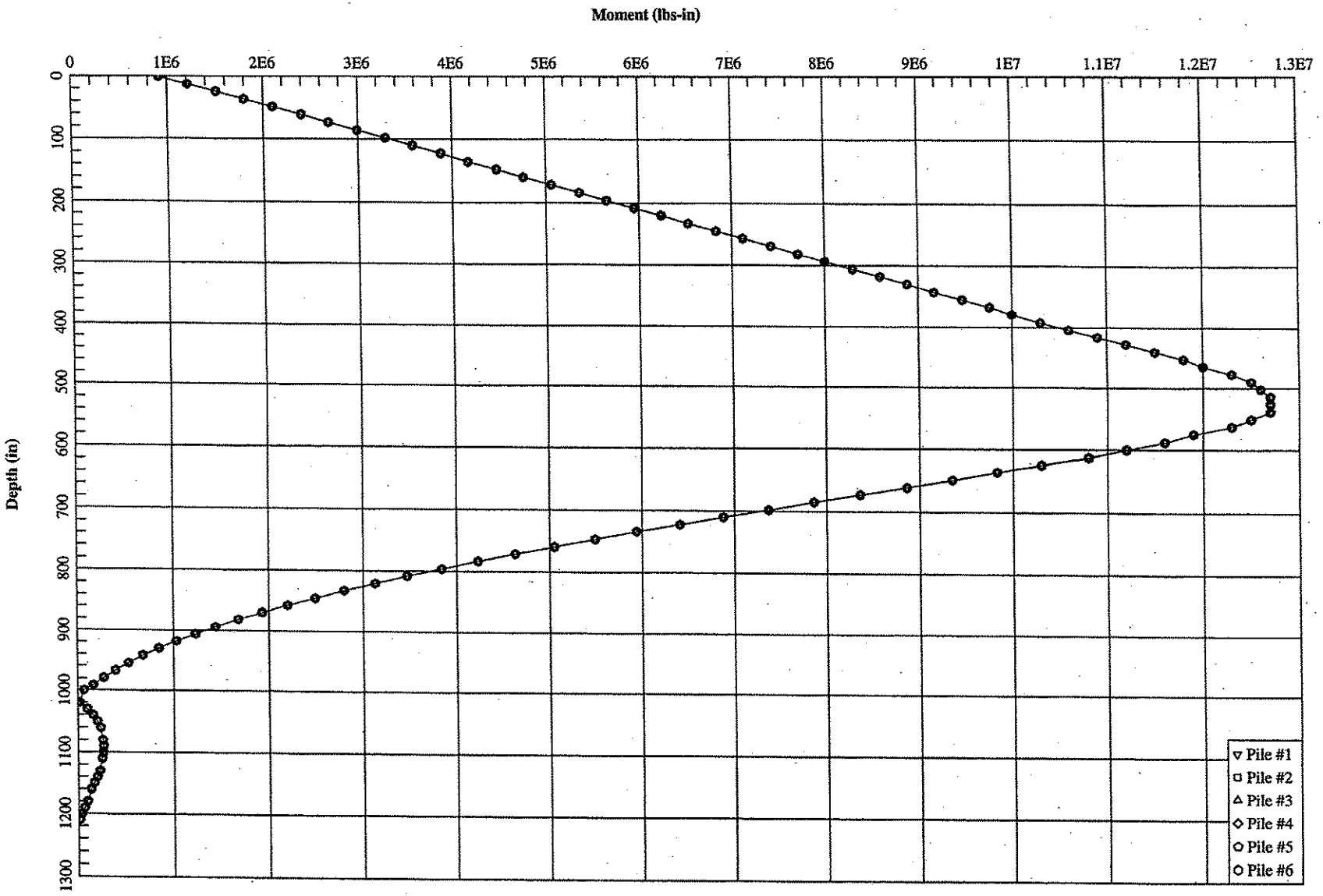
```
PB 8 SIX 5' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4790000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 420 0
2 1   1 0 0 0 0 0 0 225 0 90 420 0
2 1   1 0 0 0 0 0 0 75 0 90 420 0
2 1   1 0 0 0 0 0 0 -75 0 90 420 0
2 1   1 0 0 0 0 0 0 -225 0 90 420 0
2 1   1 0 0 0 0 0 0 -375 0 90 420 0
1
1 1 100 1224 3960000 2
0 1224 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 420 564 60
2 2 564 1020 100
3 4 1020 1800 60
420 0.03
564 0.03
564 0.027
1020 0.027
1020 0.033
1800 0.033
420 0 30 0 1.77 0 0
564 0 30 0 1.77 0 0
564 4.16 0 0.01 1.77 0 0
1020 4.16 0 0.01 1.77 0 0
1020 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 8 SIX 5' STEEL CASED CONCRETE SHAFTS

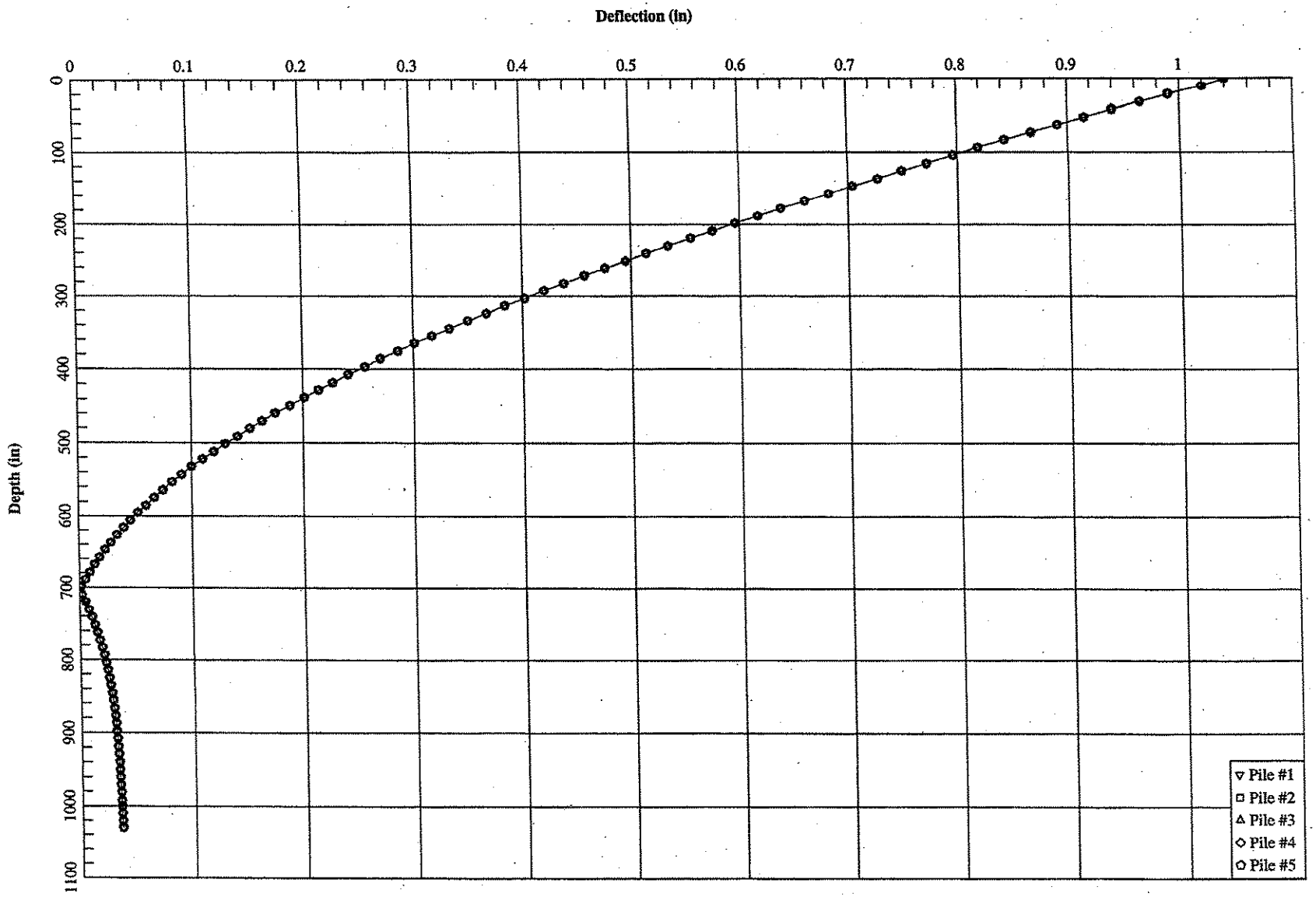


PB 8 SIX 5' STEEL CASED CONCRETE SHAFTS

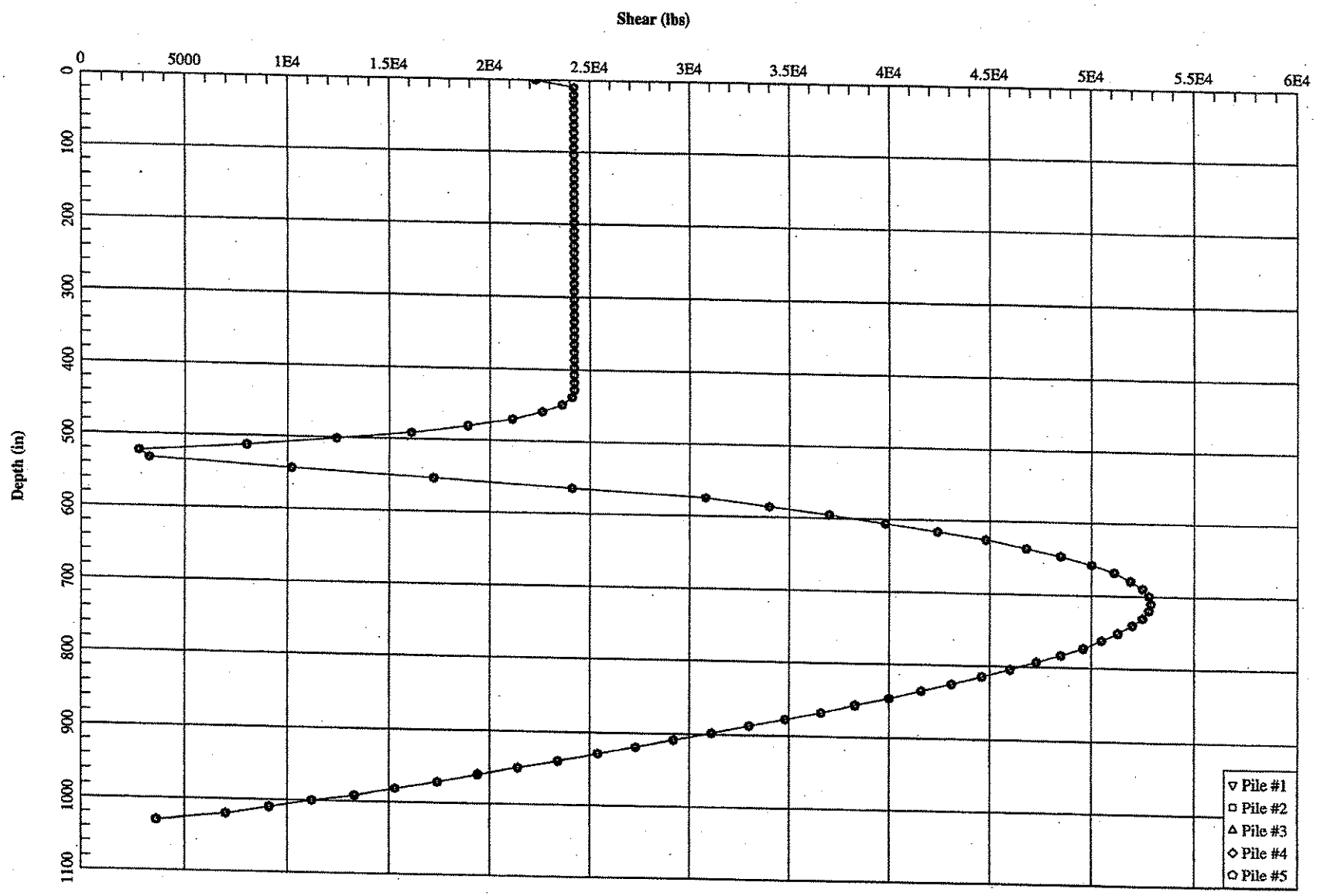


PB 8 SIX 5' STEEL CASED CONCRETE SHAFTS

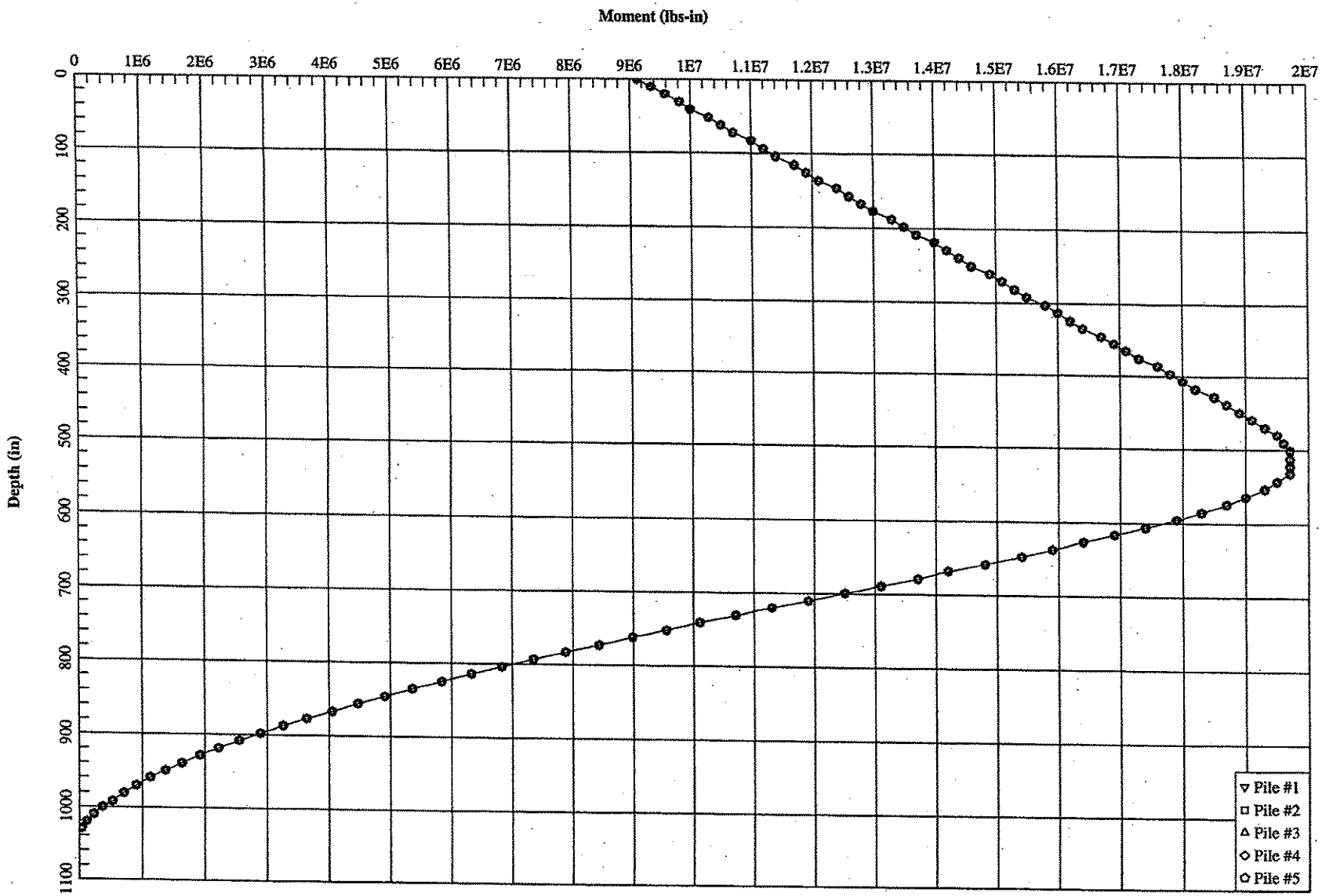
```
PB 8 FIVE 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 420 0
2 1   1 0 0 0 0 0 0 180 0 90 420 0
2 1   1 0 0 0 0 0 0 0 0 90 420 0
2 1   1 0 0 0 0 0 0 -180 0 90 420 0
2 1   1 0 0 0 0 0 0 -360 0 90 420 0
1
1 1 100 1044 3850000 2
0 1044 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 420 564 60
2 2 564 1020 100
3 4 1020 1800 60
420 0.03
564 0.03
564 0.027
1020 0.027
1020 0.033
1800 0.033
420 0 30 0 2.77 0 0
564 0 30 0 2.77 0 0
564 4.16 0 0.01 2.77 0 0
1020 4.16 0 0.01 2.77 0 0
1020 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 8 FIVE 6' CONCRETE SHAFTS

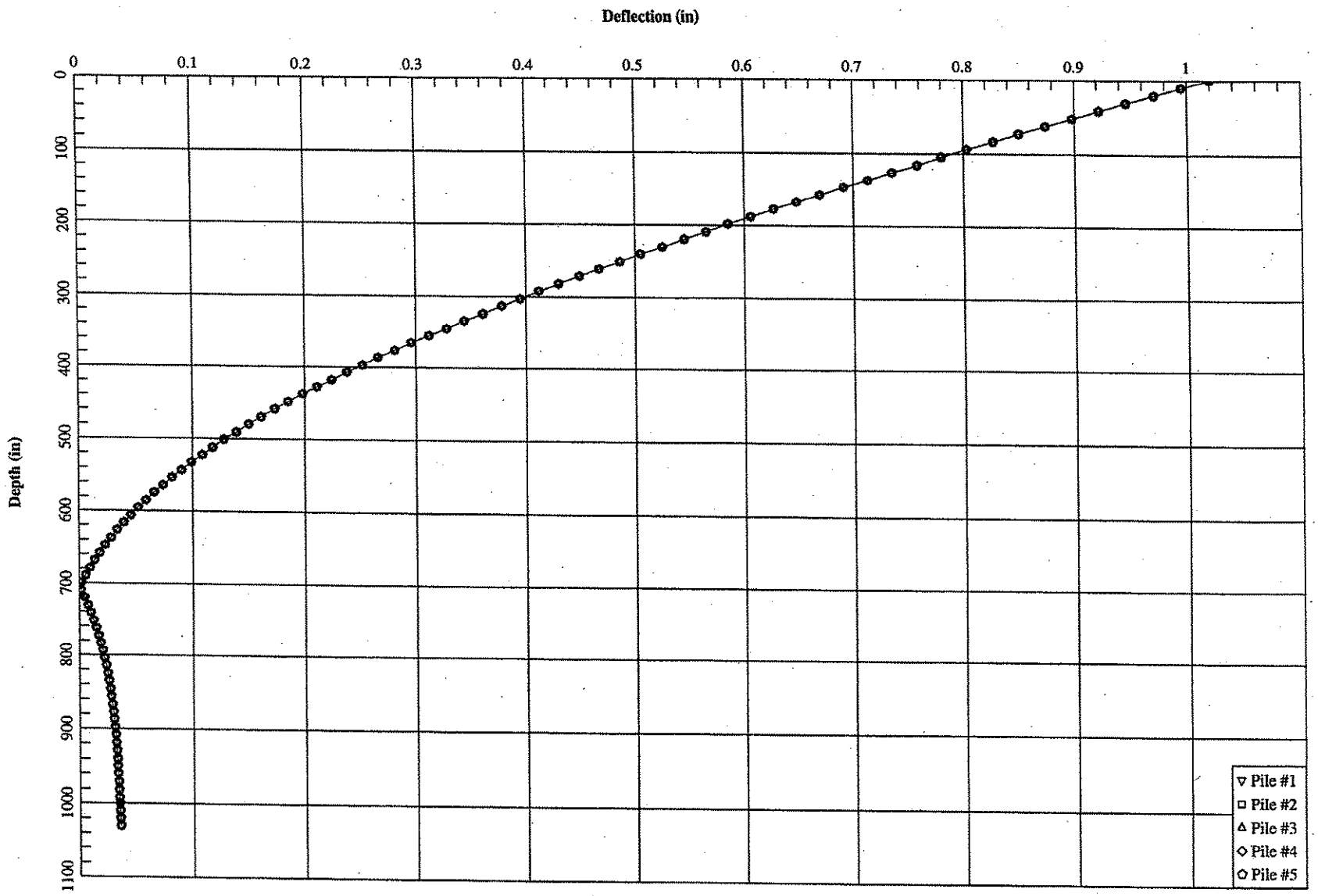


PB 8 FIVE 6' CONCRETE SHAFTS

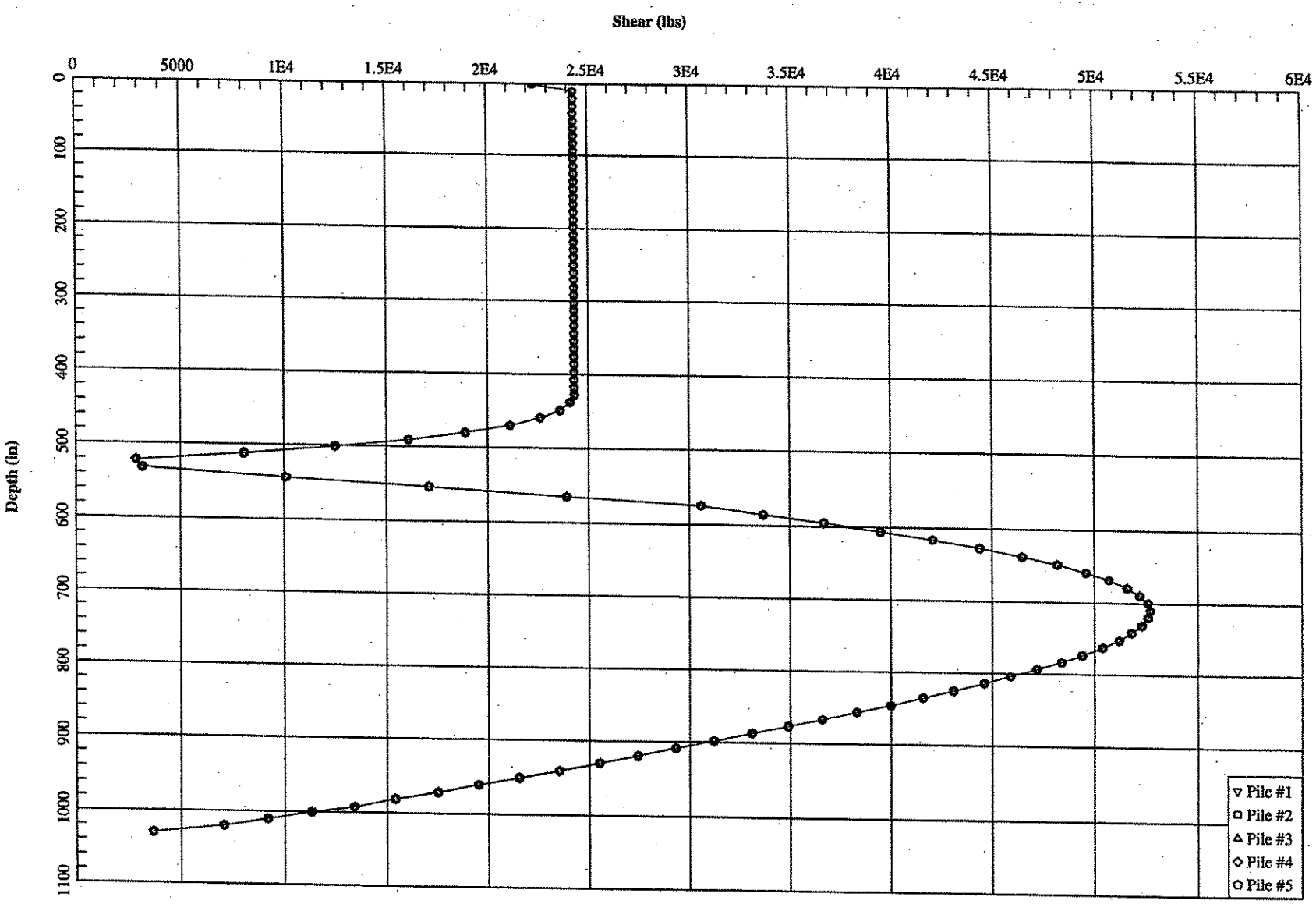


PB 8 FIVE 6' CONCRETE SHAFTS

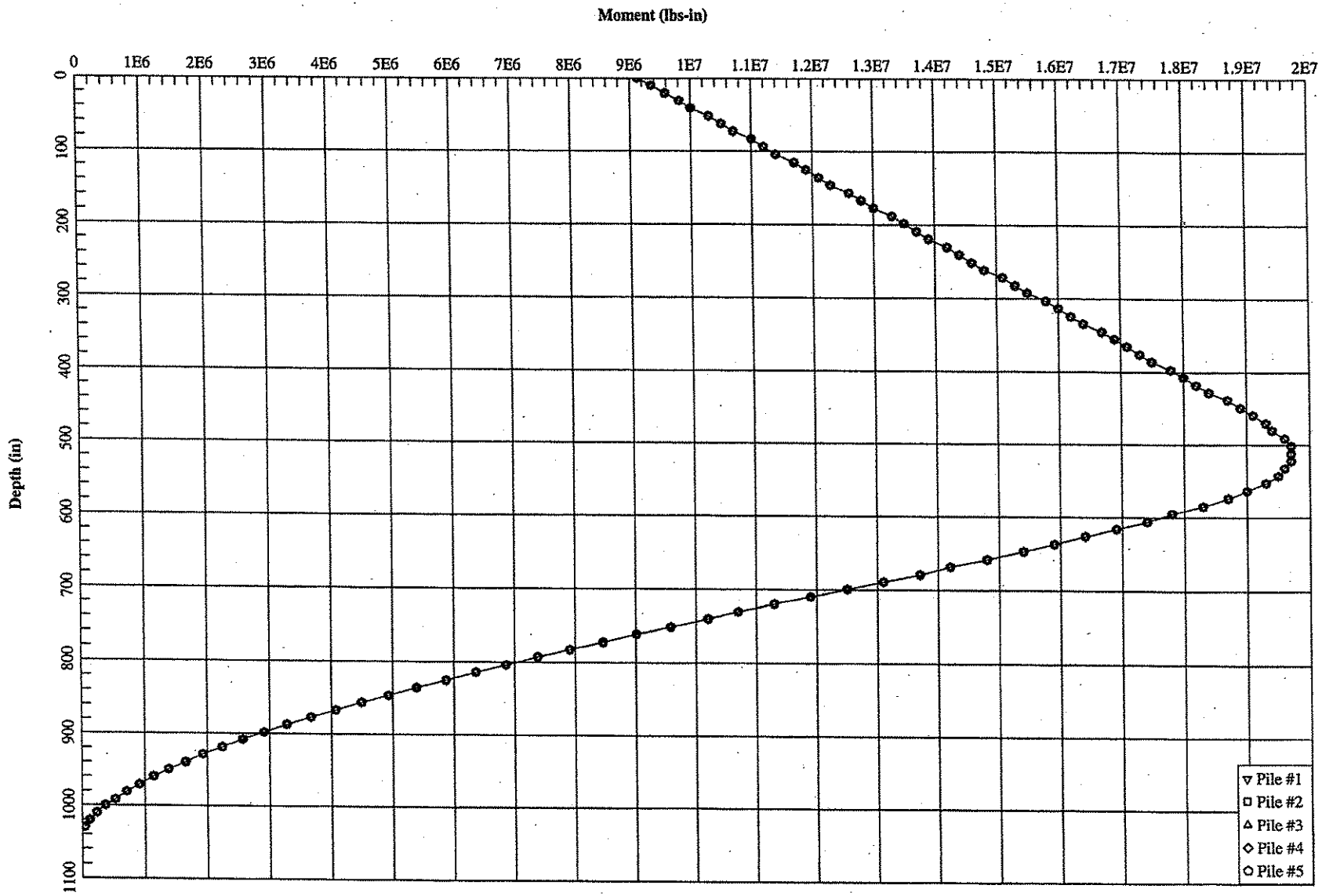
```
PB 8 FIVE 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 420 0
2 1   1 0 0 0 0 0 0 180 0 90 420 0
2 1   1 0 0 0 0 0 0 0 0 90 420 0
2 1   1 0 0 0 0 0 0 -180 0 90 420 0
2 1   1 0 0 0 0 0 0 -360 0 90 420 0
1
1 1 100 1044 3940000 2
0 1044 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 420 564 60
2 2 564 1020 100
3 4 1020 1800 60
420 0.03
564 0.03
564 0.027
1020 0.027
1020 0.033
1800 0.033
420 0 30 0 2.77 0 0
564 0 30 0 2.77 0 0
564 4.16 0 0.01 2.77 0 0
1020 4.16 0 0.01 2.77 0 0
1020 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 8 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 8 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 8 FIVE 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft		
	Concrete	Steel	Concrete	Steel	
Tip elevation	-75	-75	-75	-75	
Element Length	996	996	996	996	inches

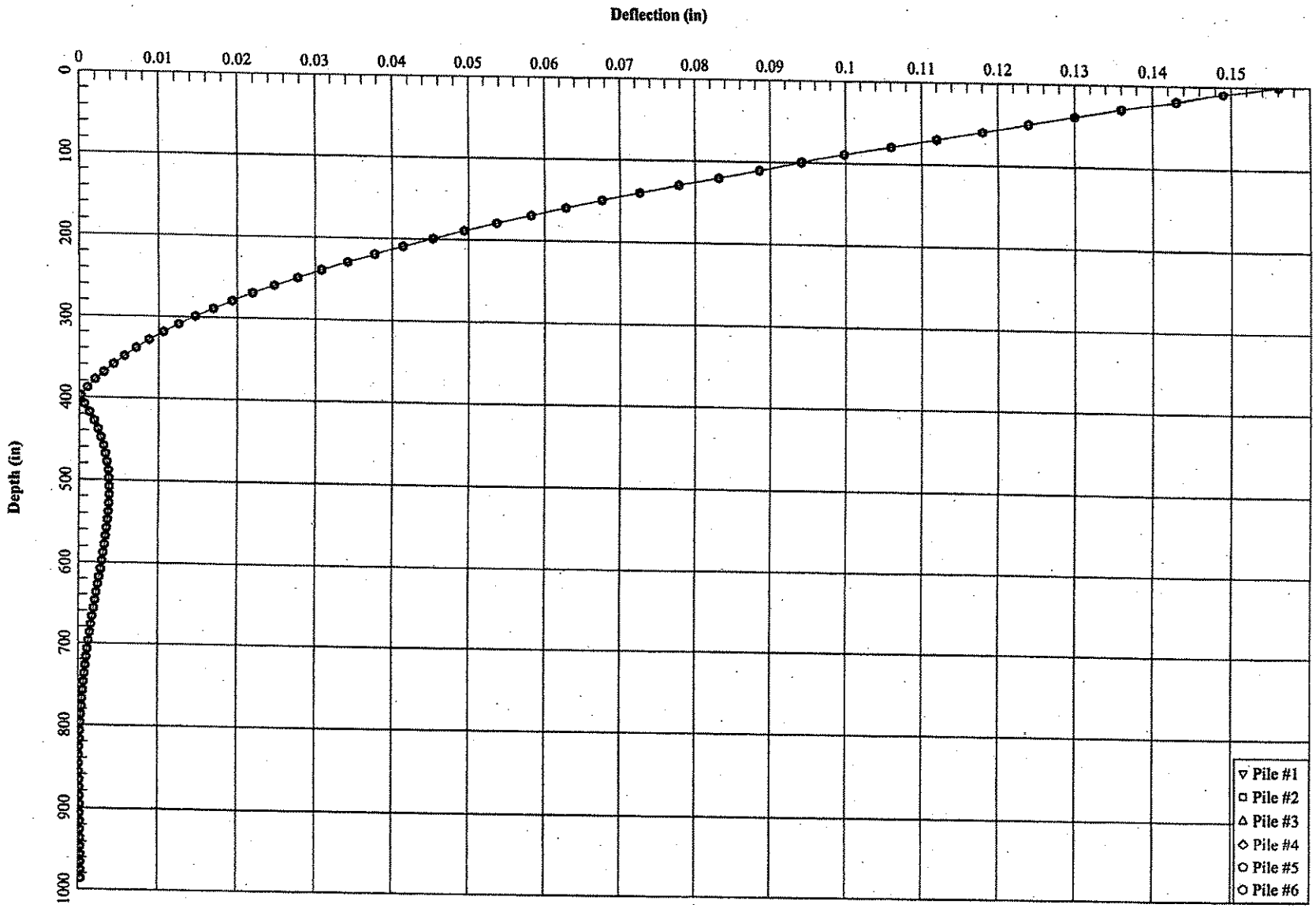
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	8	96	0
Top of AL (Sand)	1	12	84
Top of AL (Clay)	-7	-84	180
Top of Norfolk	-19	-228	324
Top of Yorktown (Y2)	-67	-804	900
Top of Yorktown (Y1)	-142	-1704	1800

Foundation Element Properties

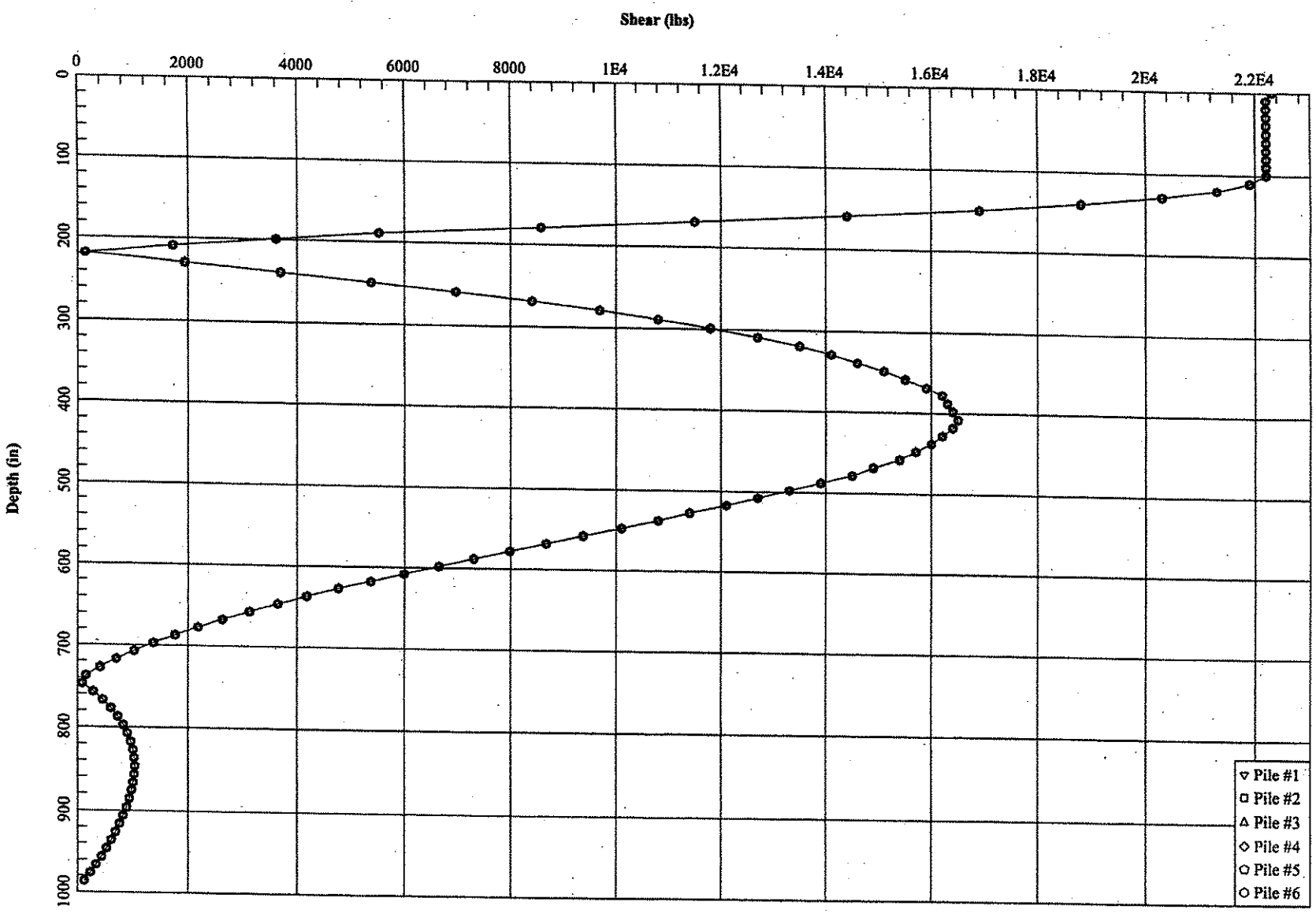
Element Type	Diameter		Area		Moment of Inertia		Young's Modulus		Torsional Stiffness
	feet	inches	feet^2	inch^2	feet^4	inch^4	ksi	psi	lb-in^2
24- inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.98E+03	3.98E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)'	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL: GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL: GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

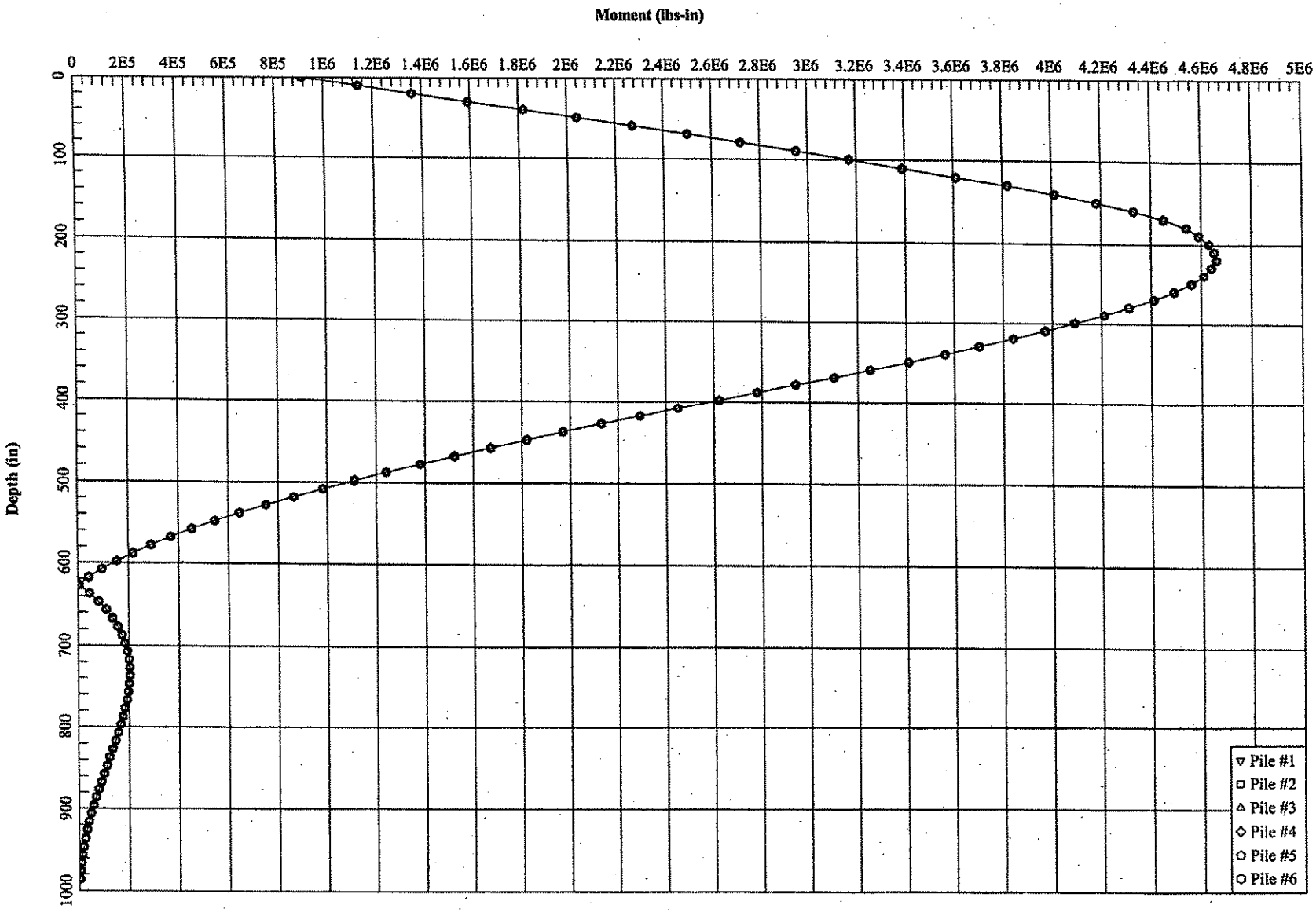
```
PB 11&12 SIX 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 84 0
2 1   1 0 0 0 0 0 0 225 0 90 84 0
2 1   1 0 0 0 0 0 0 75 0 90 84 0
2 1   1 0 0 0 0 0 0 -75 0 90 84 0
2 1   1 0 0 0 0 0 0 -225 0 90 84 0
2 1   1 0 0 0 0 0 0 -375 0 90 84 0
1
1 1 100 996 3850000 2
0 996 60 2827 636172 636172 0 0 6E13
4 8 8 0
1 4 84 180 60
2 2 180 324 100
3 4 324 900 60
4 4 900 1800 60
84 0.03
180 0.03
180 0.027
324 0.027
324 0.03
900 0.03
900 0.033
1800 0.033
84 0 30 0 2.77 0 0
180 0 30 0 2.77 0 0
180 4.16 0 0.01 2.77 0 0
324 4.16 0 0.01 2.77 0 0
324 0 33 0 8.33 0 0
900 0 33 0 16.7 0 0
900 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 11&12 SIX 5' CONCRETE SHAFTS

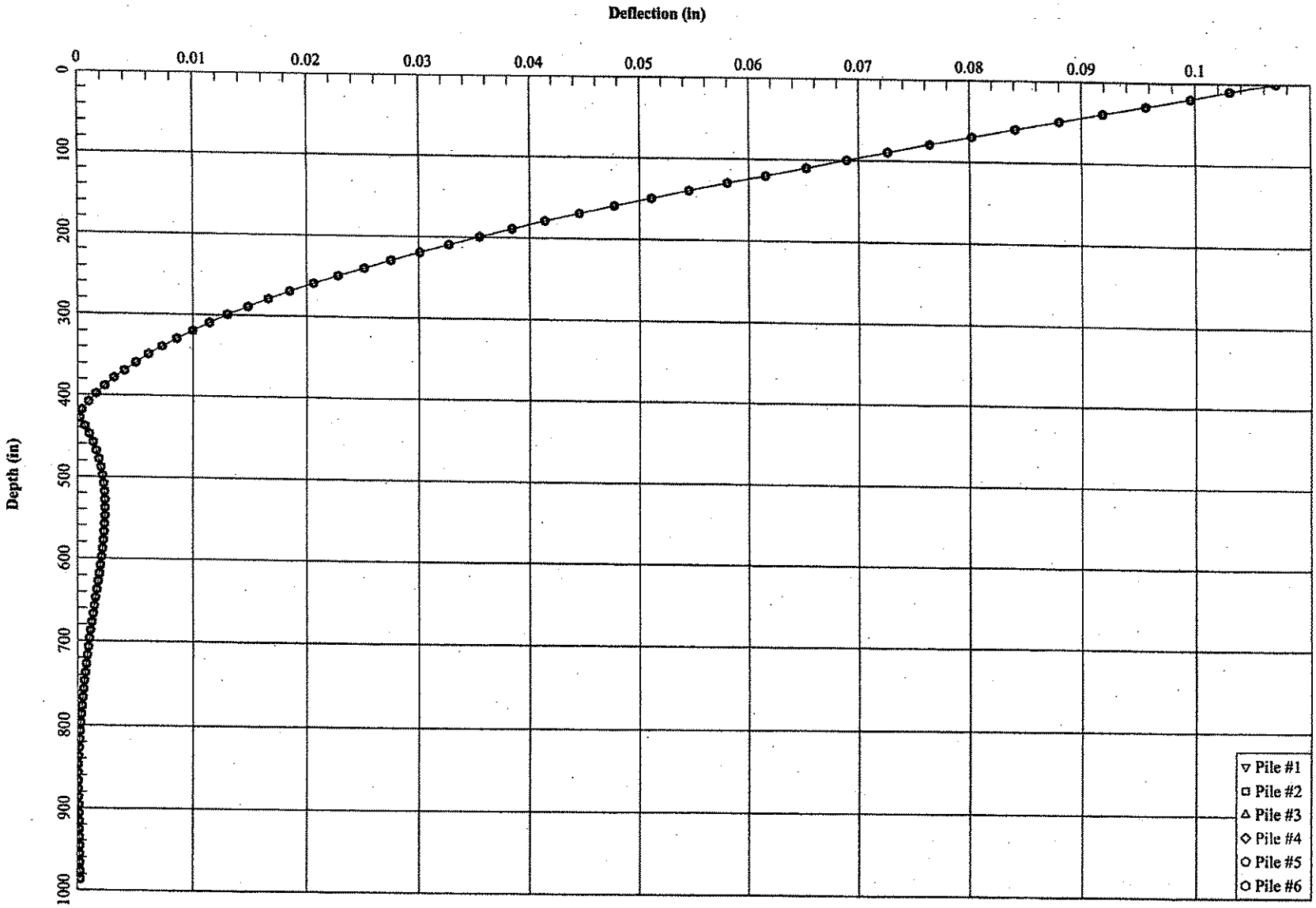


PB 11&12 SIX 5' CONCRETE SHAFTS

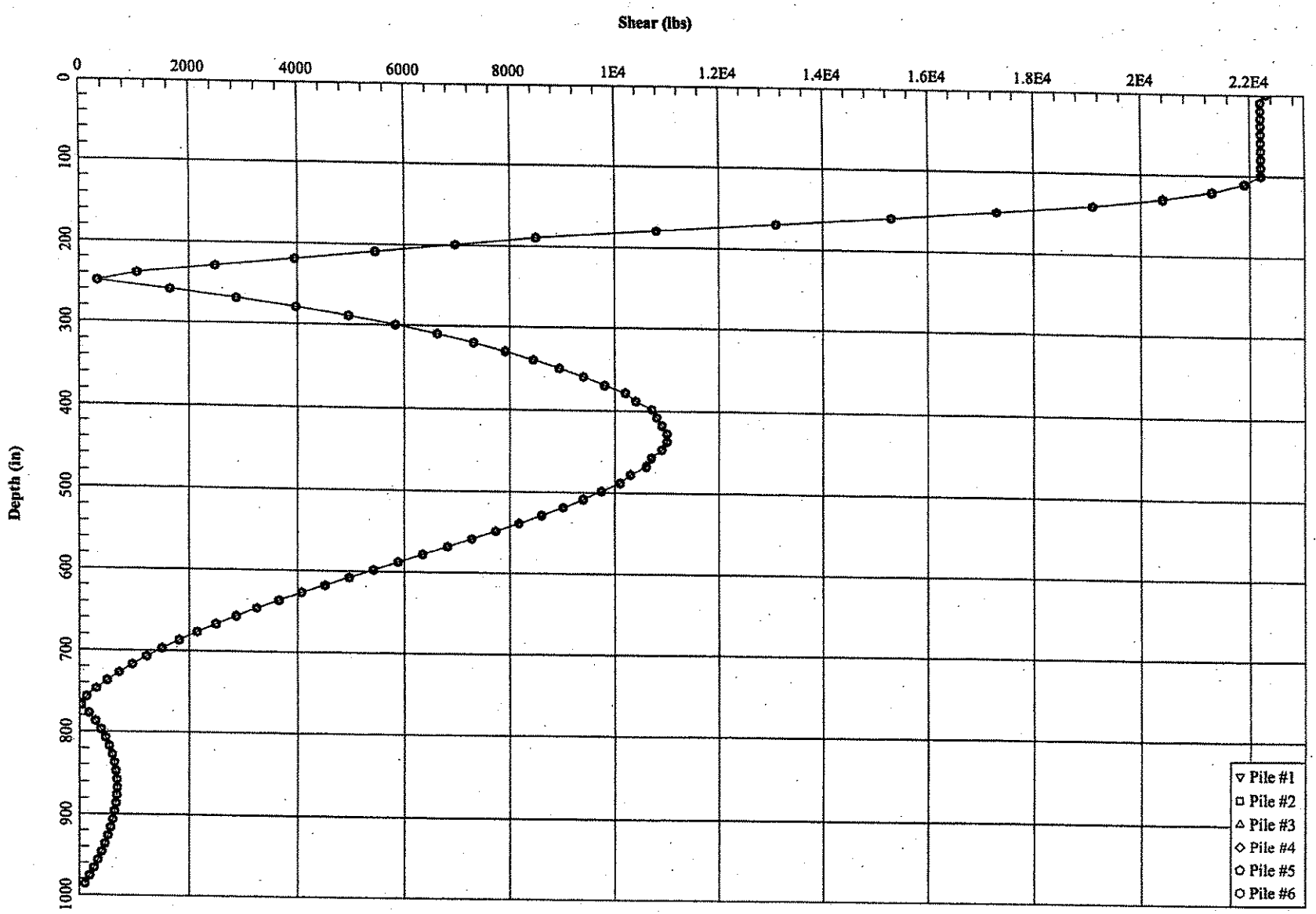


PB 11&12 SIX 5' CONCRETE SHAFTS

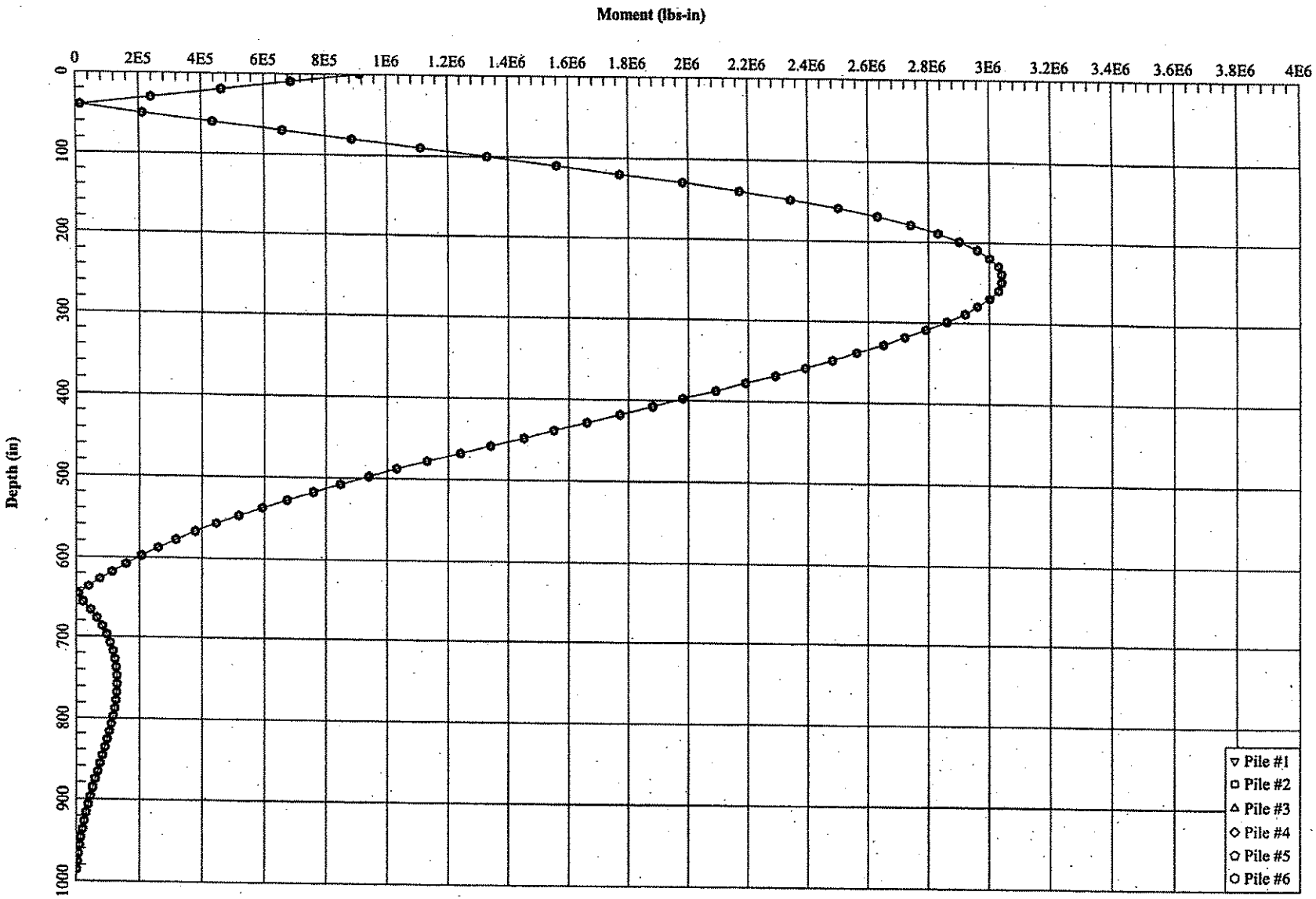
```
PB 11&12 SIX 5' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 5.4790000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 84 0
2 1   1 0 0 0 0 0 0 225 0 90 84 0
2 1   1 0 0 0 0 0 0 75 0 90 84 0
2 1   1 0 0 0 0 0 0 -75 0 90 84 0
2 1   1 0 0 0 0 0 0 -225 0 90 84 0
2 1   1 0 0 0 0 0 0 -375 0 90 84 0
1
1 1 100 996 3960000 2
0 996 60 2827 636172 636172 0 0 6E13
4 8 8 0
1 4 84 180 60
2 2 180 324 100
3 4 324 900 60
4 4 900 1800 60
84 0.03
180 0.03
180 0.027
324 0.027
324 0.03
900 0.03
900 0.033
1800 0.033
84 0 30 0 1.77 0 0
180 0 30 0 1.77 0 0
180 4.16 0 0.01 1.77 0 0
324 4.16 0 0.01 1.77 0 0
324 0 33 0 5 0 0
900 0 33 0 5 0 0
900 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
0.0000000E+00
```



PB 11&12 SIX 5' STEEL CASED CONCRETE SHAFTS

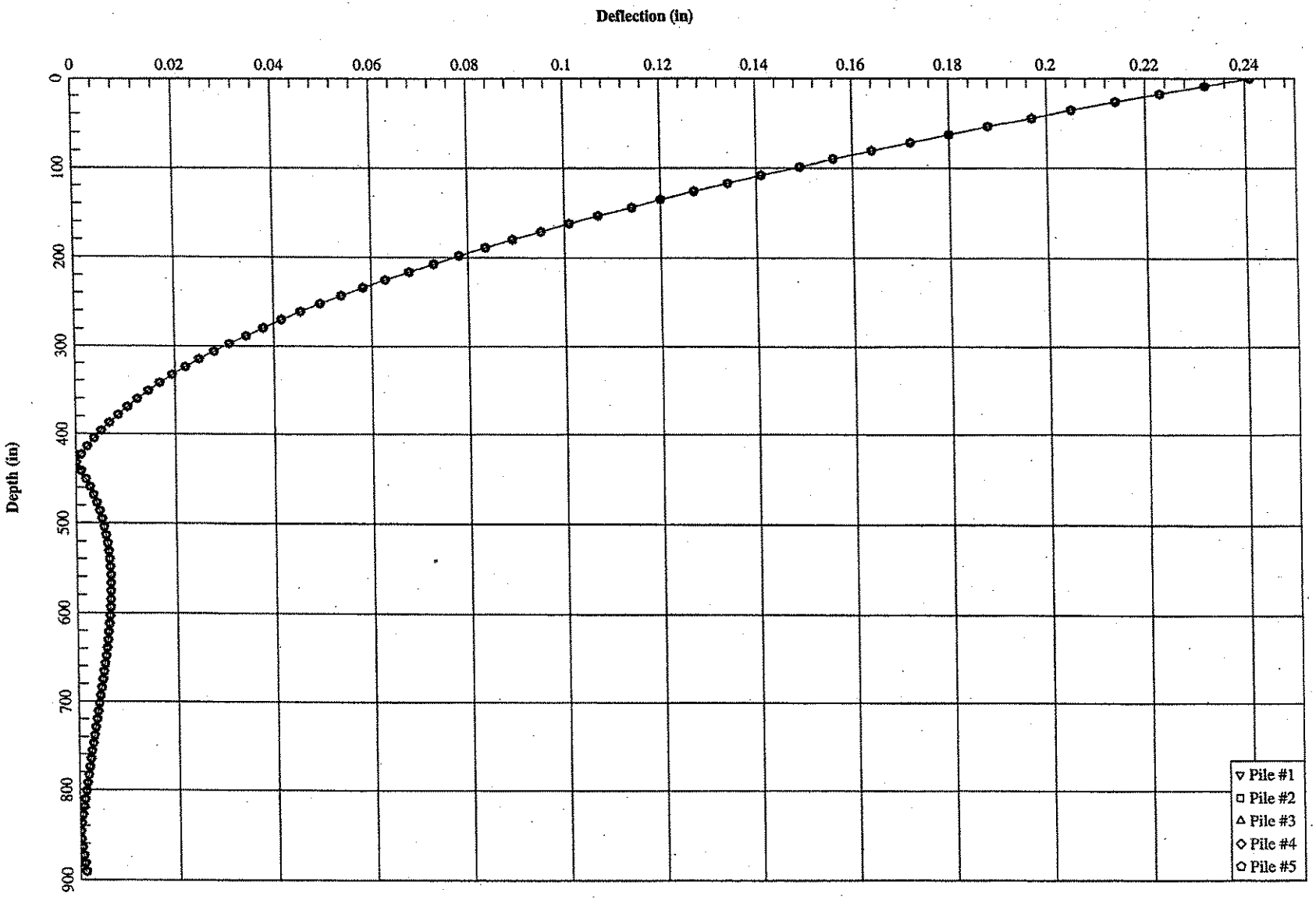


PB 11&12 SIX 5' STEEL CASED CONCRETE SHAFTS

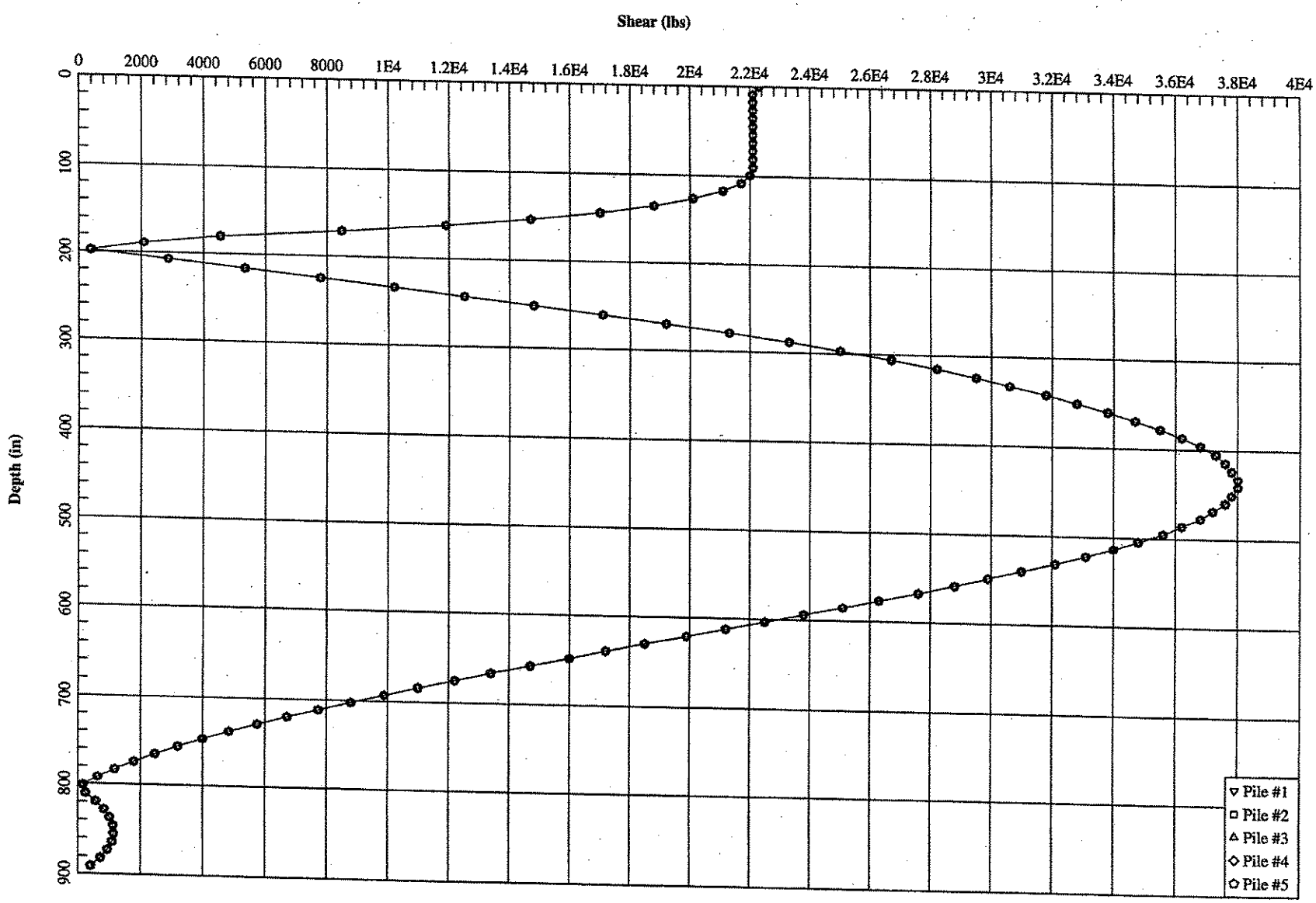


PB 11&12 SIX 5' STEEL CASED CONCRETE SHAFTS

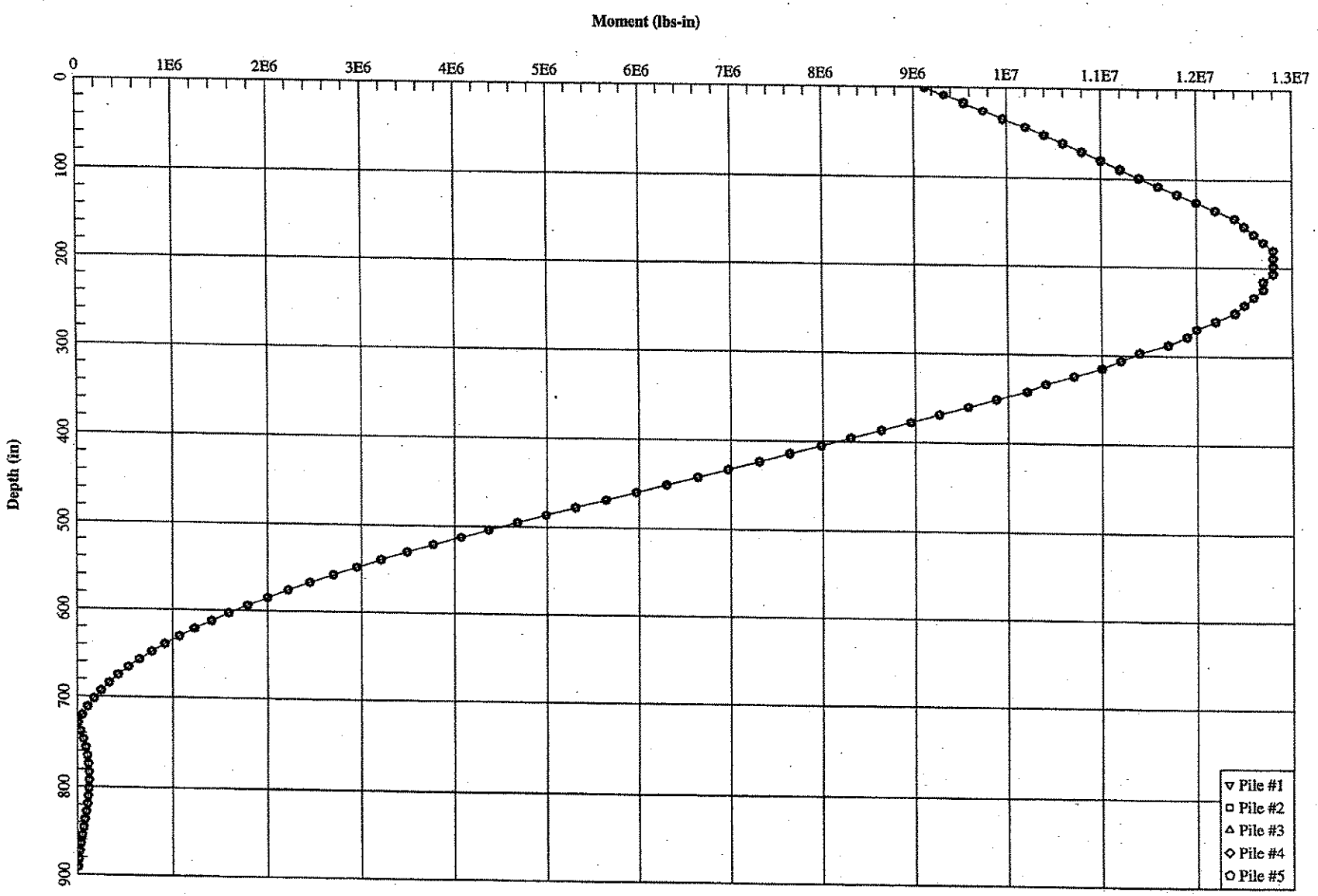
```
PB 11&12 FIVE 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 84 0
2 1   1 0 0 0 0 0 0 180 0 90 84 0
2 1   1 0 0 0 0 0 0 0 0 90 84 0
2 1   1 0 0 0 0 0 0 -180 0 90 84 0
2 1   1 0 0 0 0 0 0 -360 0 90 84 0
1
1 1 100 900 3950000 2
0 900 72 4071 1319167 1319167 0 0 6E13
4 8 8 0
1 4 84 180 60
2 2 180 324 100
3 4 324 900 60
4 4 900 1800 60
84 0.03
180 0.03
180 0.027
324 0.027
324 0.03
900 0.03
900 0.033
1800 0.033
84 0 30 0 2.77 0 0
180 0 30 0 2.77 0 0
180 4.16 0 0.01 2.77 0 0
324 4.16 0 0.01 2.77 0 0
324 0 33 0 8.33 0 0
900 0 33 0 8.33 0 0
900 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 11-12 FIVE 6' CONCRETE SHAFTS

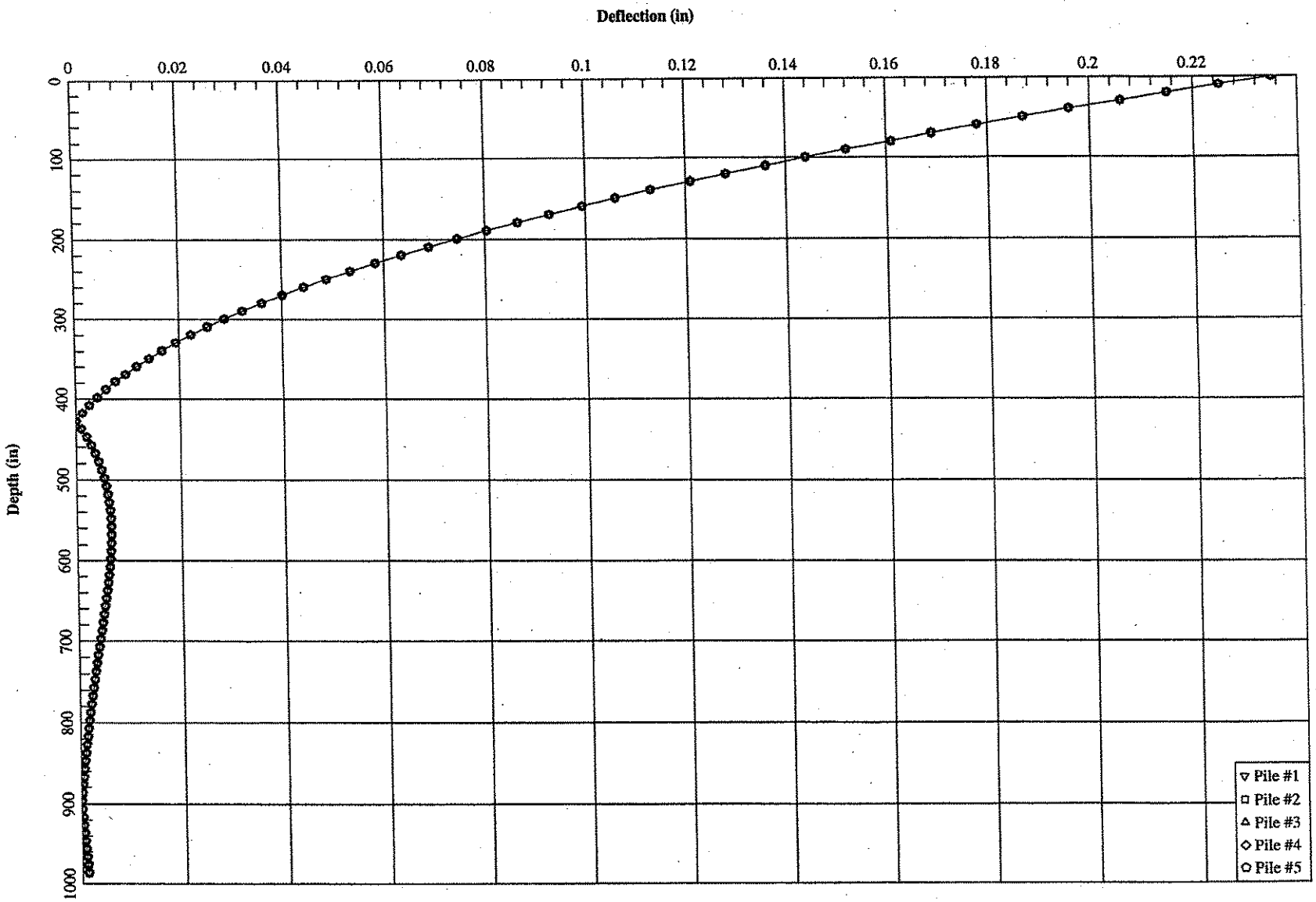


PB 11-12 FIVE 6' CONCRETE SHAFTS

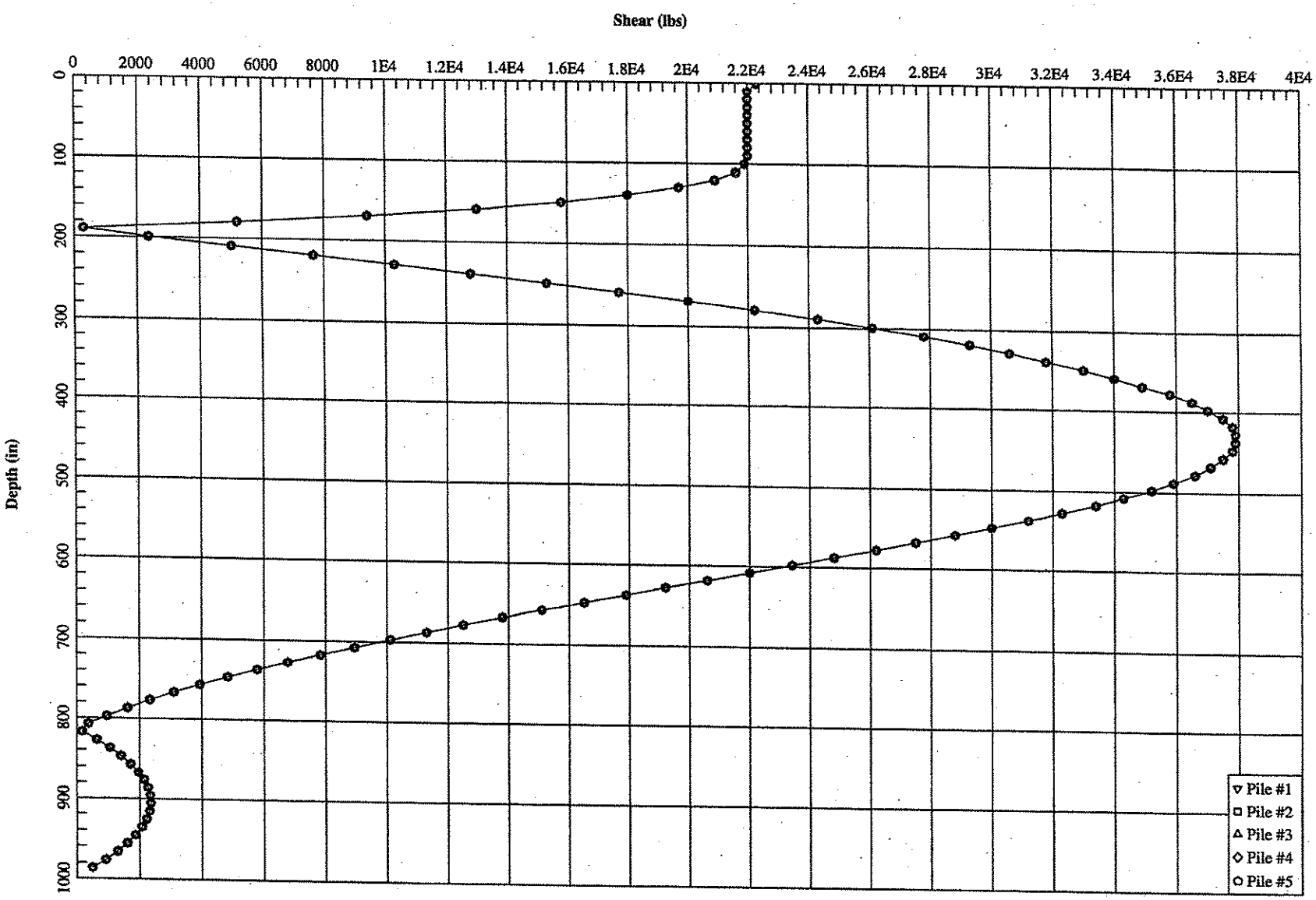


PB 11-12 FIVE 6' CONCRETE SHAFTS

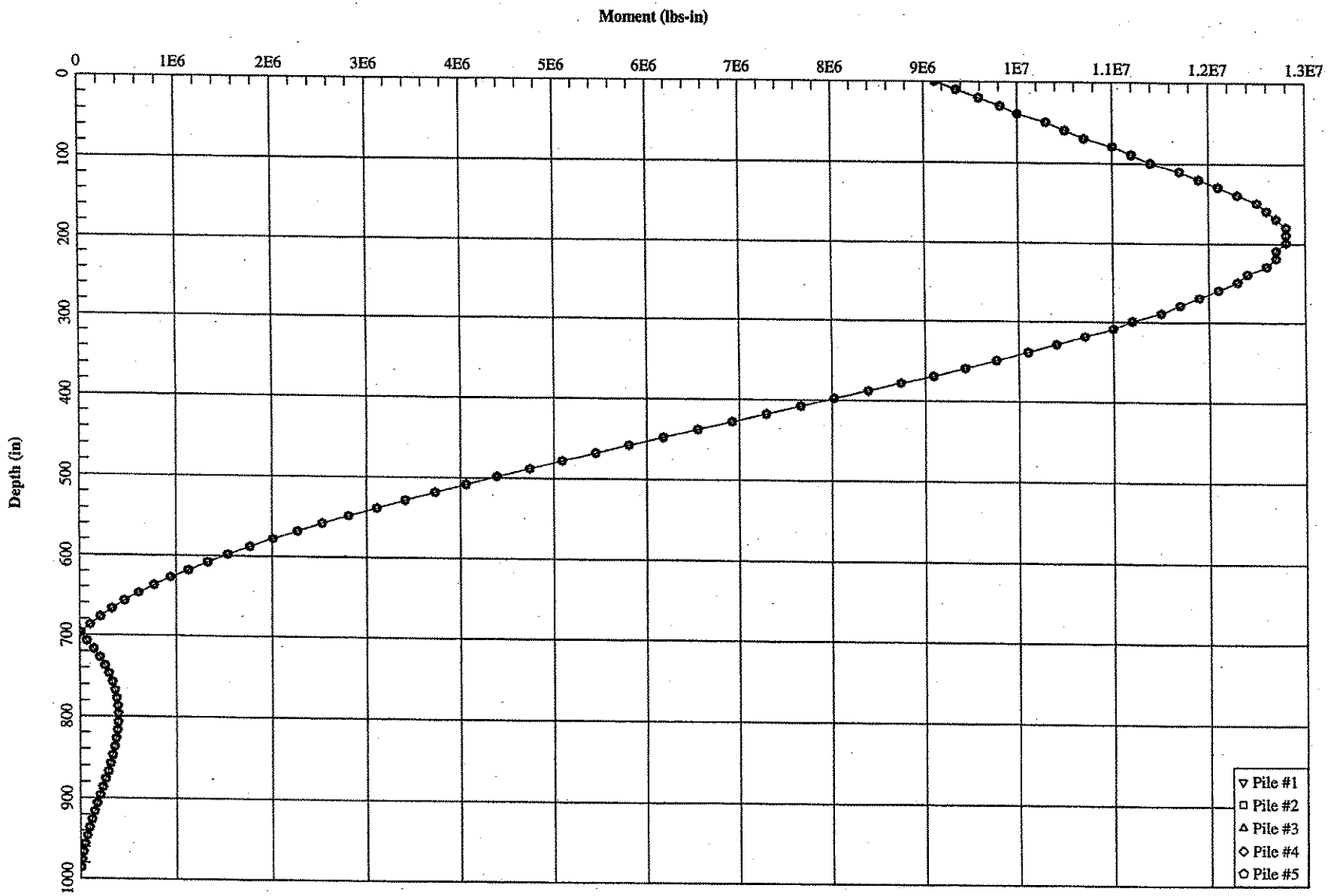
```
PB 11&12 FIVE 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 84 0
2 1   1 0 0 0 0 0 0 180 0 90 84 0
2 1   1 0 0 0 0 0 0 0 0 90 84 0
2 1   1 0 0 0 0 0 0 -180 0 90 84 0
2 1   1 0 0 0 0 0 0 -360 0 90 84 0
1
1 1 100 996 3960000 2
0 996 72 4071 1319167 1319167 0 0 6E13
4 8 8 0
1 4 84 180 60
2 2 180 324 100
3 4 324 900 60
4 4 900 1800 60
84 0.03
180 0.03
180 0.027
324 0.027
324 0.03
900 0.03
900 0.033
1800 0.033
84 0 30 0 1.77 0 0
180 0 30 0 1.77 0 0
180 4.16 0 0.01 1.77 0 0
324 4.16 0 0.01 1.77 0 0
324 0 33 0 5 0 0
900 0 33 0 5 0 0
900 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 11-12 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 11-12 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 11-12 FIVE 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft	
	Concrete	Steel	Concrete	Steel
Tip elevation	-75	-75	-75	-75
Element Length	996	996	996	996 inches

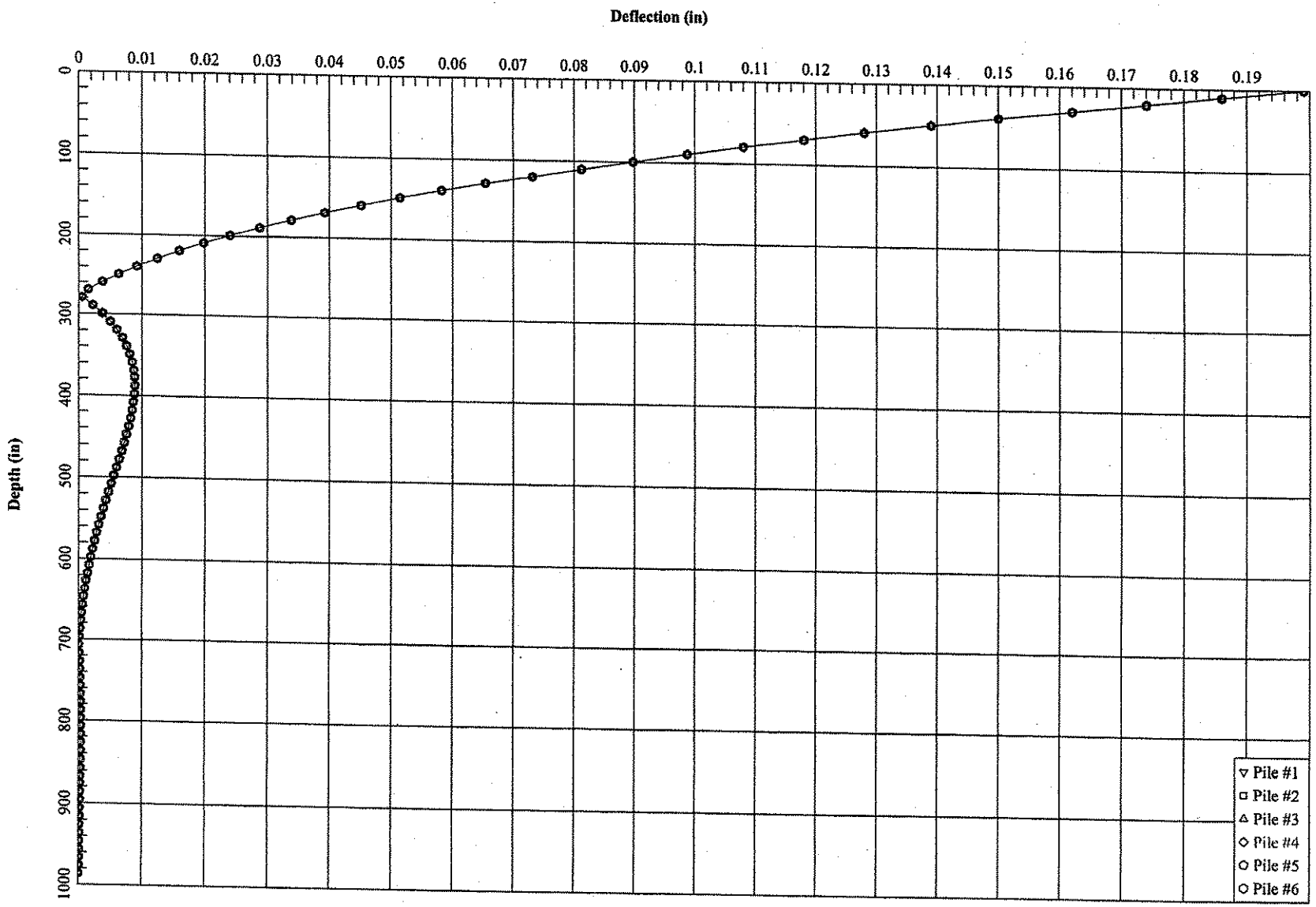
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	8	96	0
Top of AL (Sand)	7	84	12
Top of Norfolk	-20	-240	336
Top of Yorktown (Y2)	-68	-816	912
Top of Yorktown (Y1)	-142	-1704	1800

Foundation Element Properties

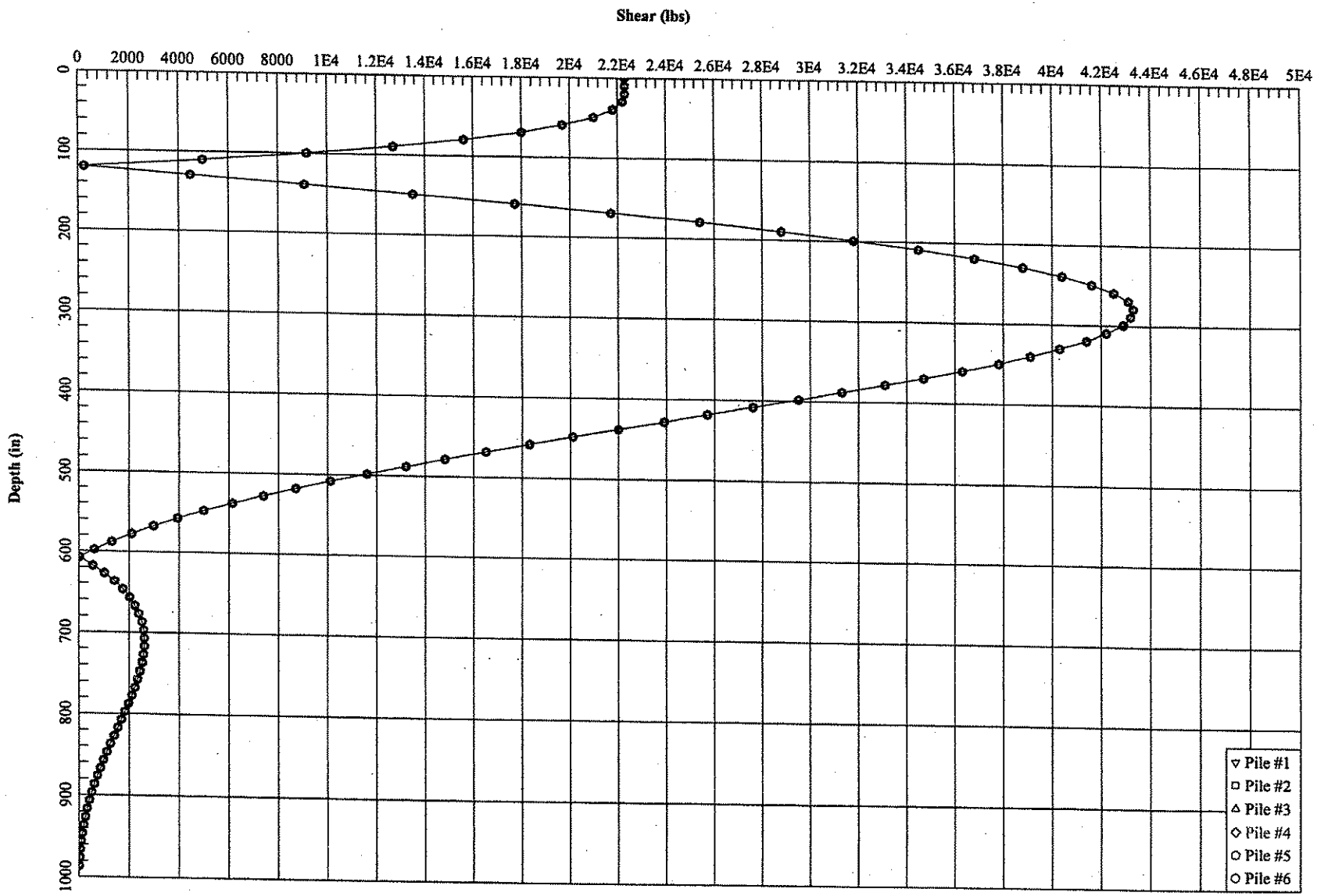
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
24- Inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, v	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

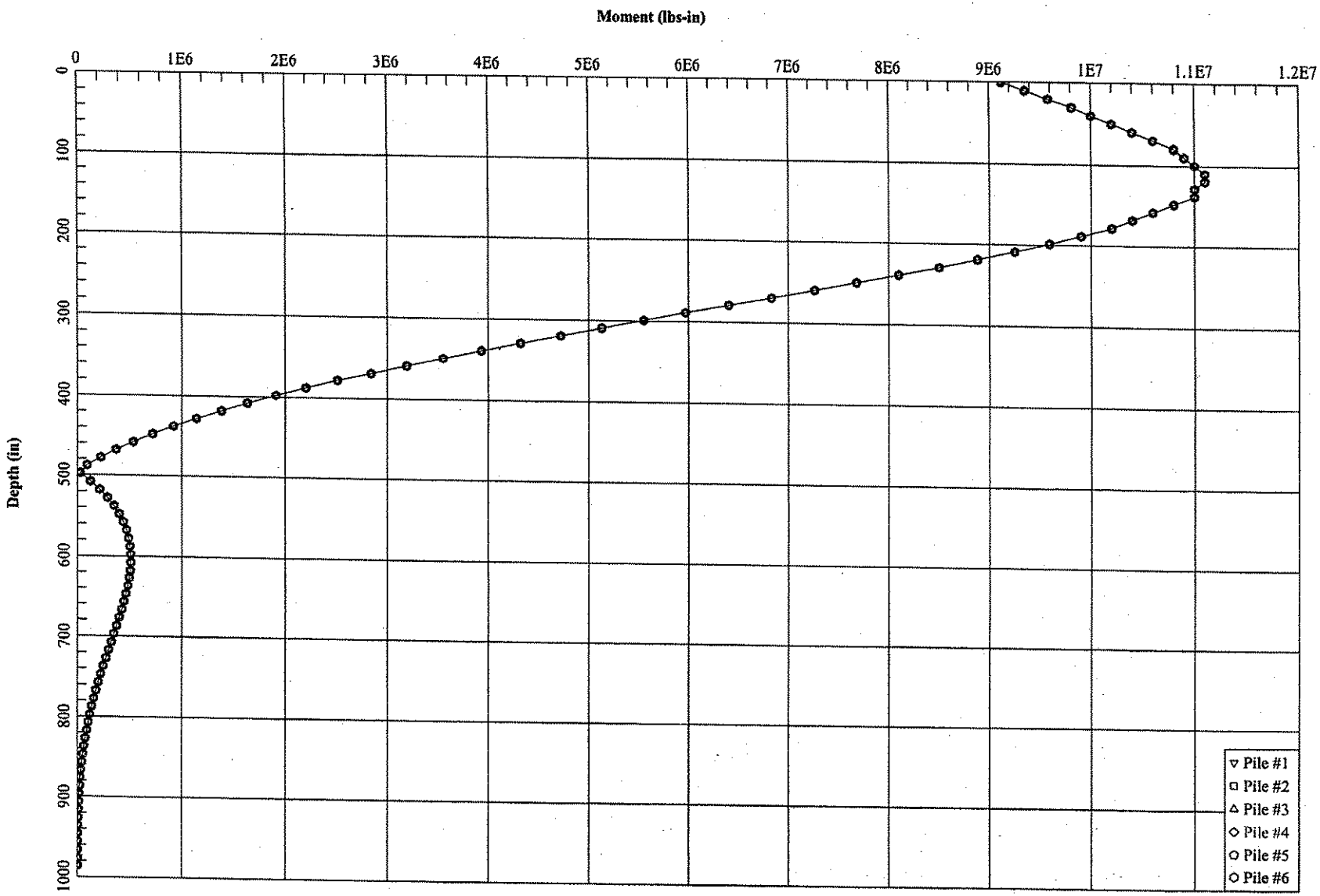
```
PB 13&14 SIX 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4720000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 12 0
2 1   1 0 0 0 0 0 0 225 0 90 12 0
2 1   1 0 0 0 0 0 0 75 0 90 12 0
2 1   1 0 0 0 0 0 0 -75 0 90 12 0
2 1   1 0 0 0 0 0 0 -225 0 90 12 0
2 1   1 0 0 0 0 0 0 -375 0 90 12 0
1
1 1 100 996 3850000 2
0 996 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 12 324 60
2 4 324 912 60
3 4 912 1800 60
12 0.03
324 0.03
324 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 2.77 0 0
324 0 30 0 2.77 0 0
324 0 33 0 8.33 0 0
912 0 33 0 8.33 0 0
912 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 13&14 SIX 5' CONCRETE SHAFTS

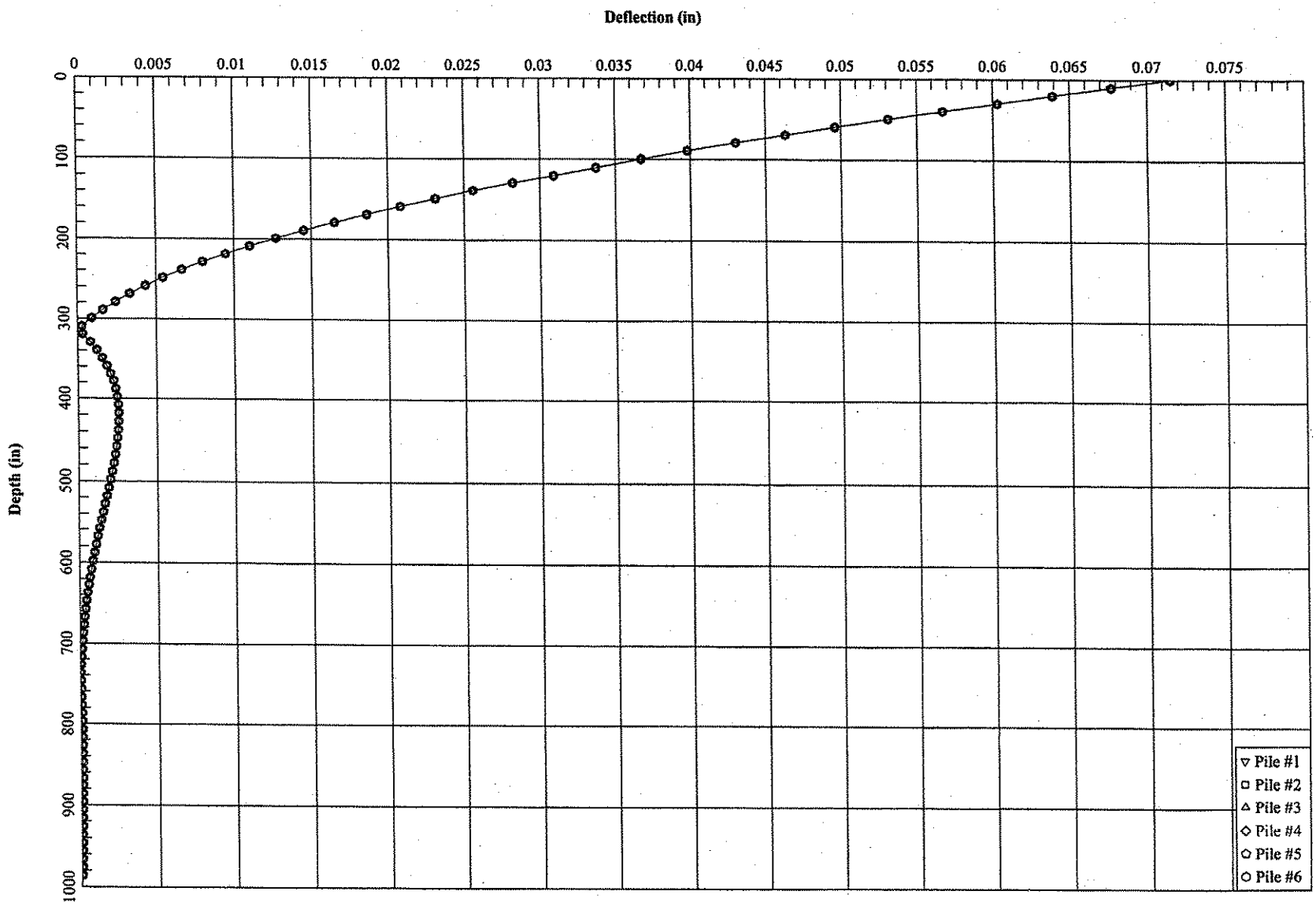


PB 13&14 SIX 5' CONCRETE SHAFTS

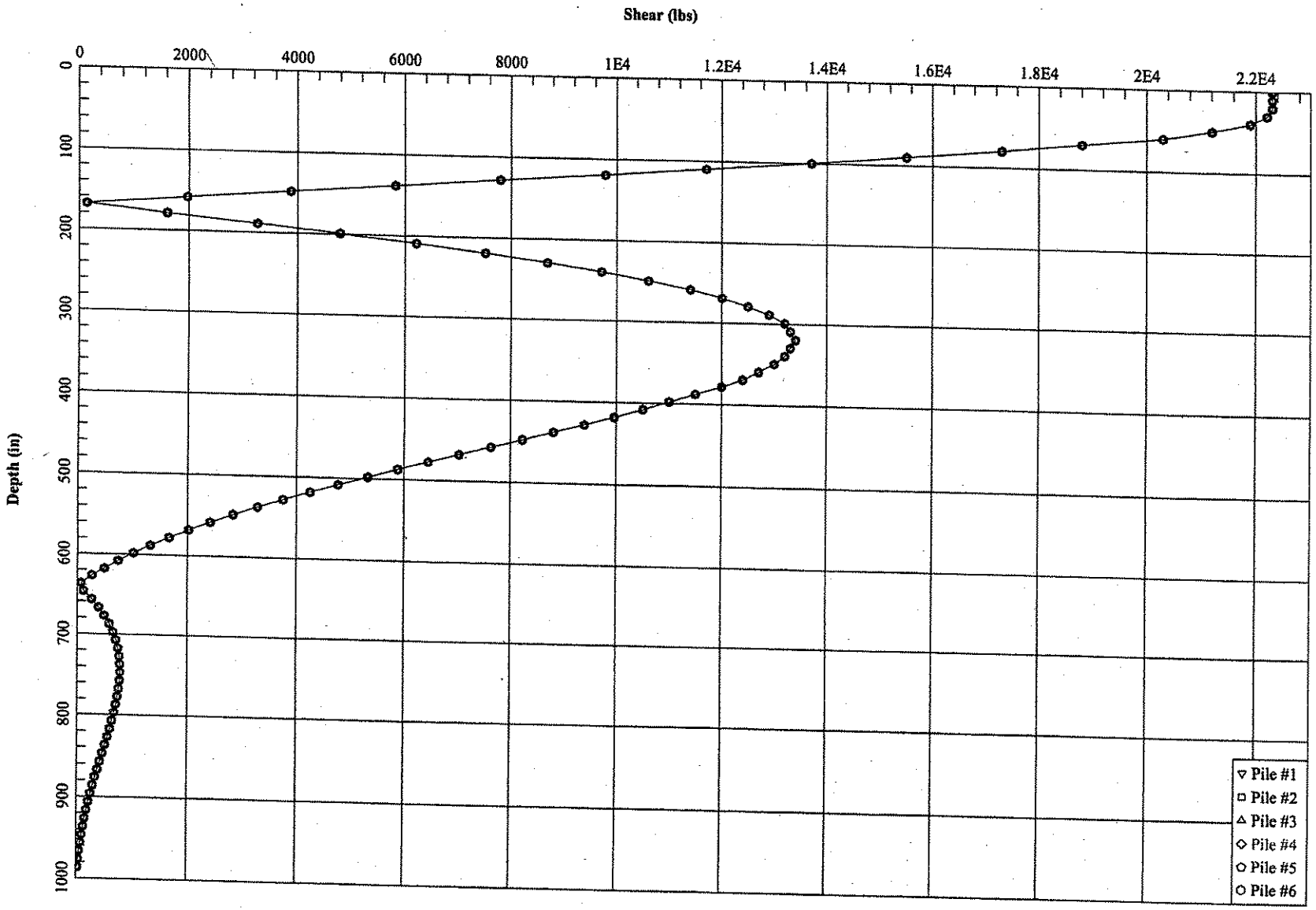


PB 13&14 SIX 5' CONCRETE SHAFTS

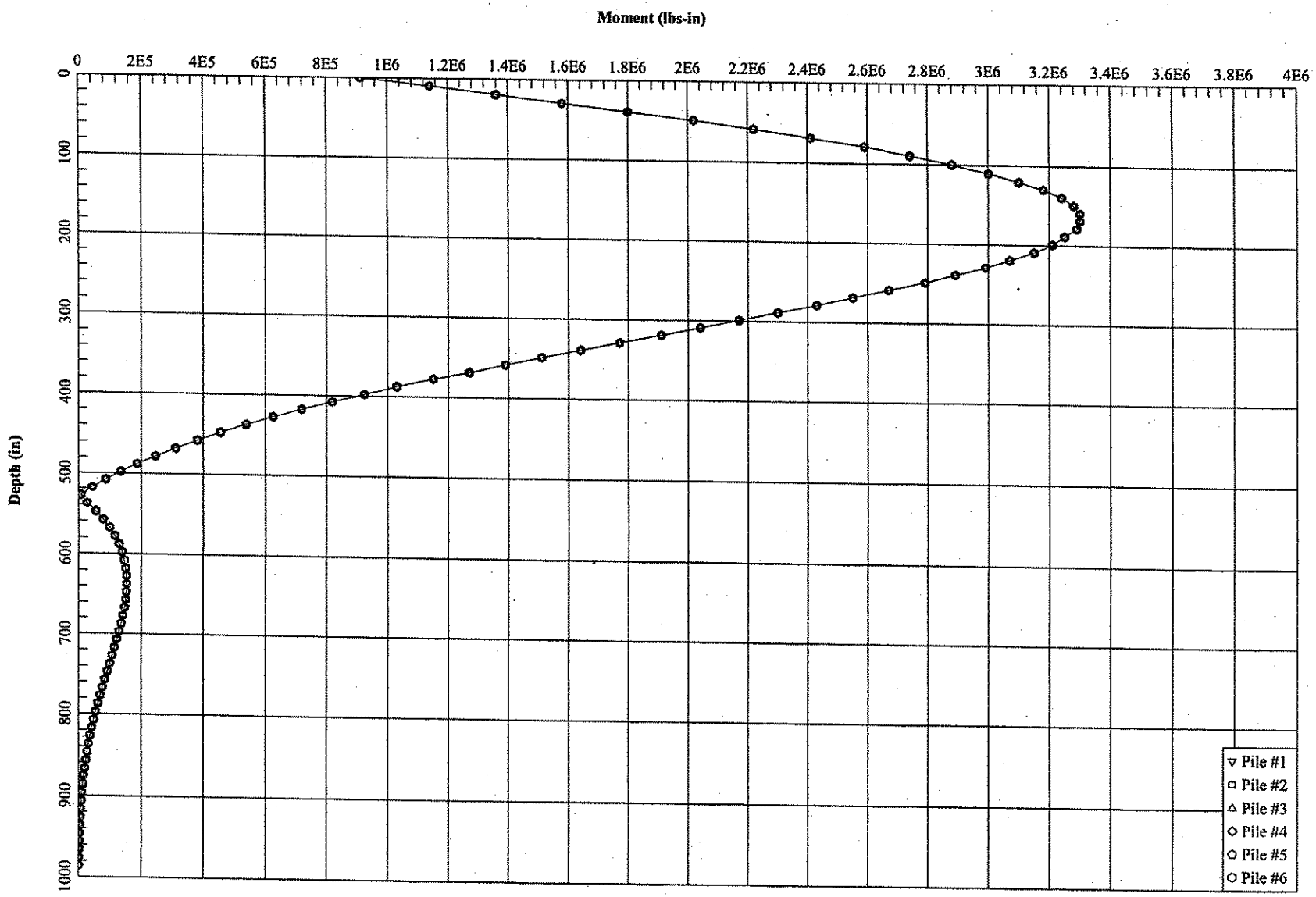
```
PB 13&14 SIX 5' Steel Cased Concrete
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.3480000E+06 1.3380000E+05 -5.4790000E+06 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 375 0 90 12 0
2 1   1 0 0 0 0 0 0 225 0 90 12 0
2 1   1 0 0 0 0 0 0 75 0 90 12 0
2 1   1 0 0 0 0 0 0 -75 0 90 12 0
2 1   1 0 0 0 0 0 0 -225 0 90 12 0
2 1   1 0 0 0 0 0 0 -375 0 90 12 0
1
1 1 100 996 3960000 2
0 996 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 12 324 60
2 4 324 912 60
3 4 912 1800 60
12 0.03
324 0.03
324 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 1.77 0 0
324 0 30 0 1.77 0 0
324 0 33 0 5 0 0
912 0 33 0 5 0 0
912 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 13&14 SIX 5' Steel Cased Concrete

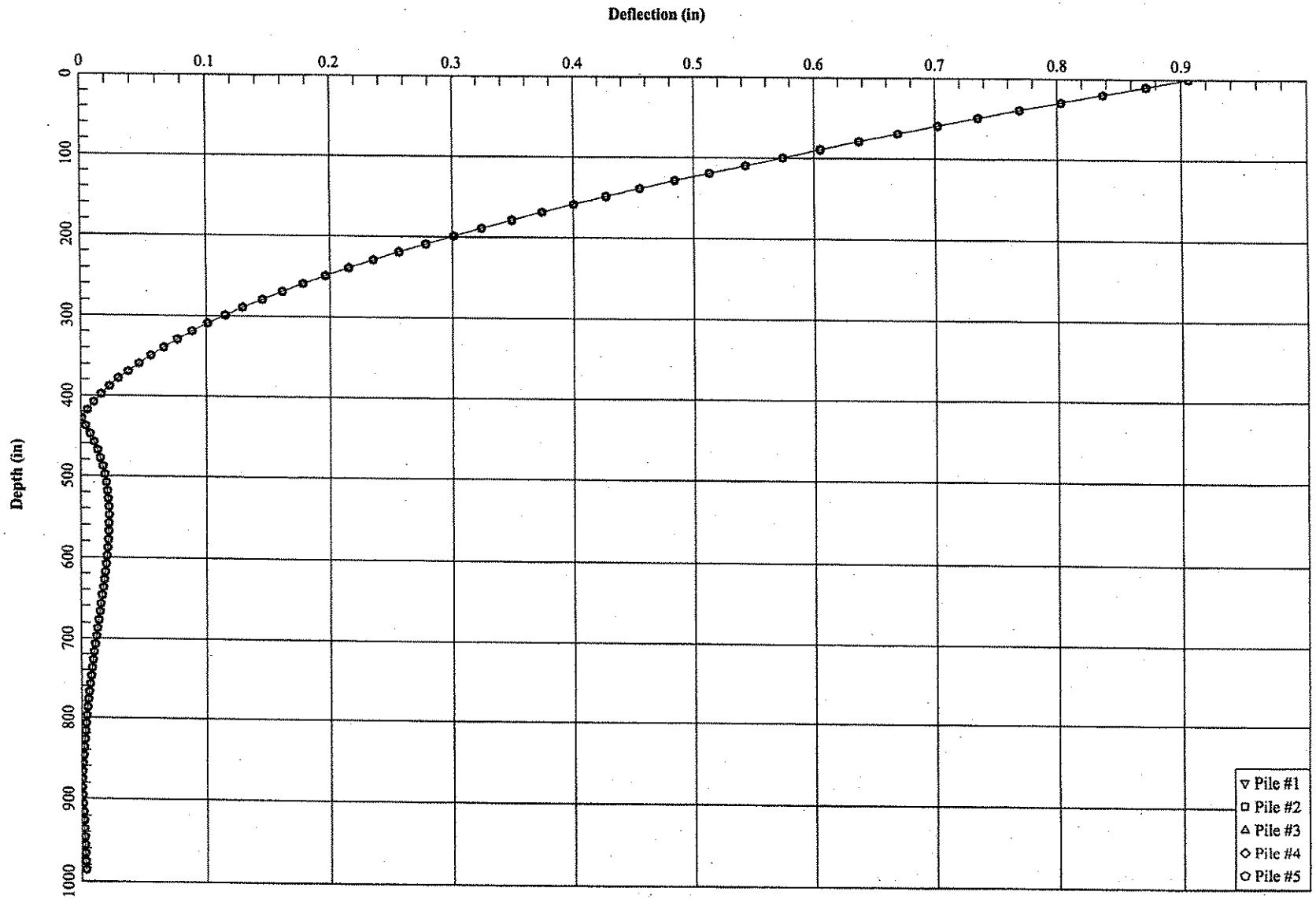


PB 13&14 SIX 5' Steel Cased Concrete

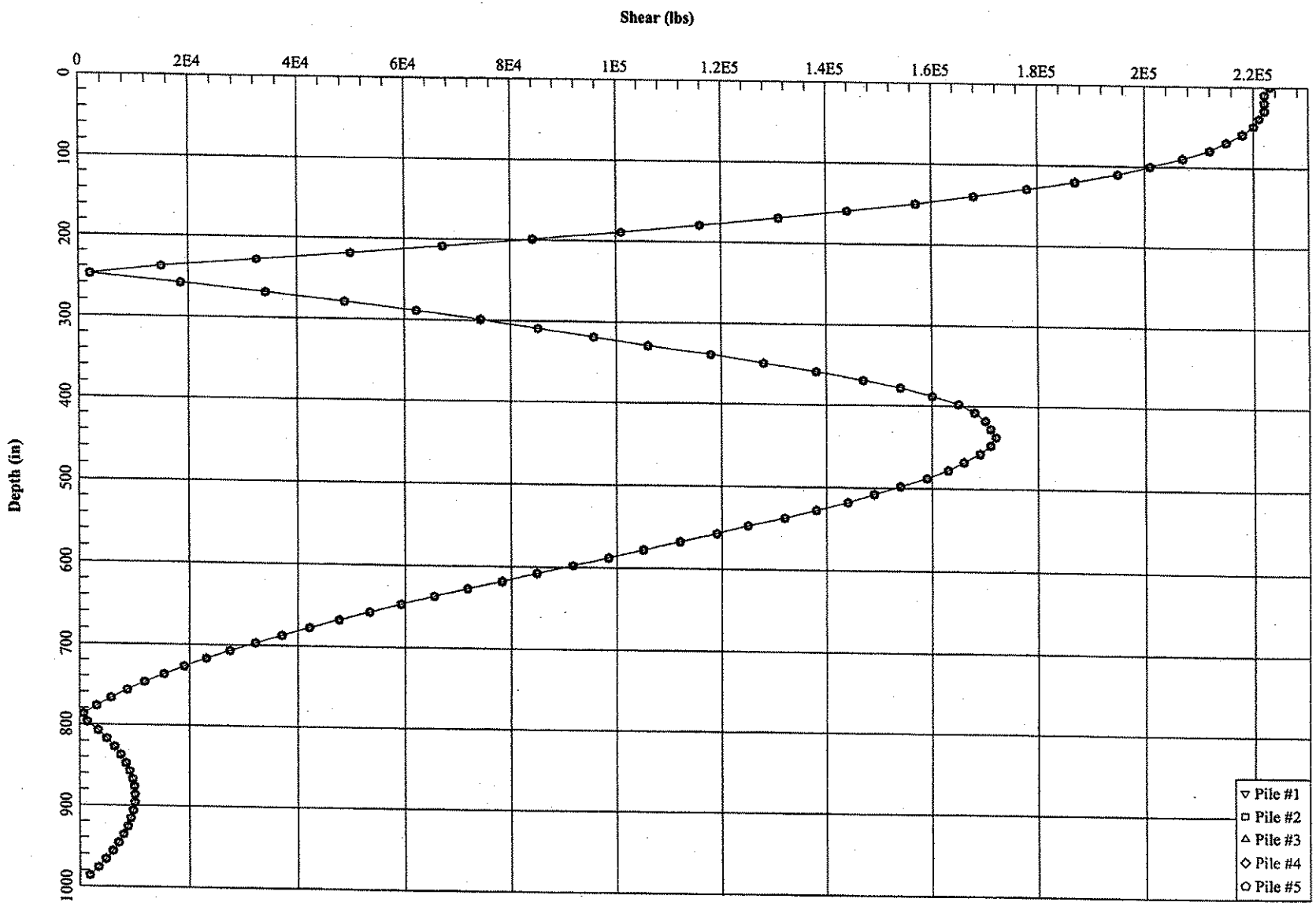


PB 13&14 SIX 5' Steel Cased Concrete

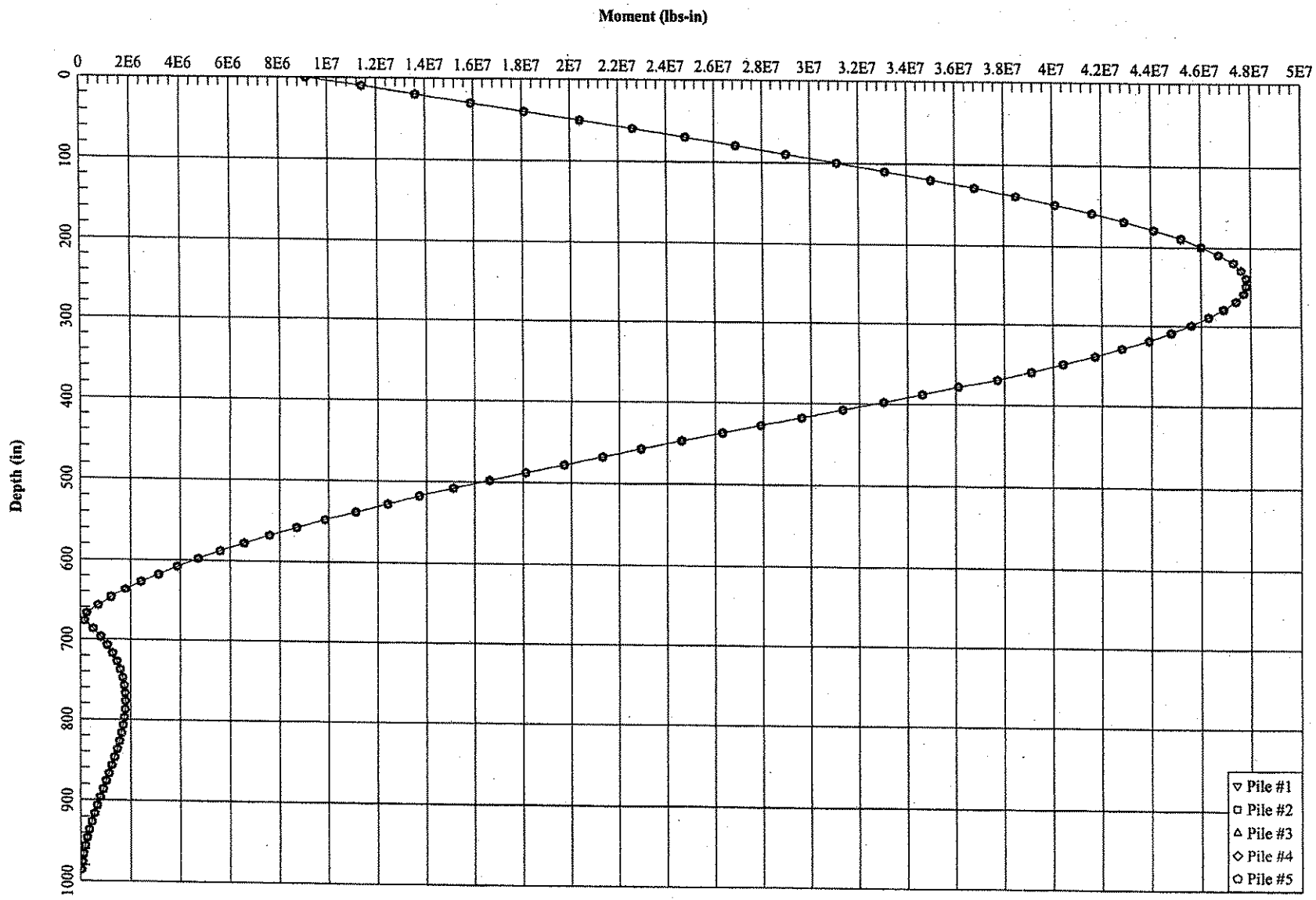
```
PB 13&14 FIVE 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+06 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 12 0
2 1   1 0 0 0 0 0 0 180 0 90 12 0
2 1   1 0 0 0 0 0 0 0 0 90 12 0
2 1   1 0 0 0 0 0 0 -180 0 90 12 0
2 1   1 0 0 0 0 0 0 -360 0 90 12 0
1
1 1 100 996 3850000 2
0 996 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 12 324 60
2 4 324 912 60
3 4 912 1800 60
12 0.03
324 0.03
324 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 2.77 0 0
324 0 30 0 2.77 0 0
324 0 33 0 8.33 0 0
912 0 33 0 8.33 0 0
912 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 13&14 FIVE 6' CONCRETE SHAFTS

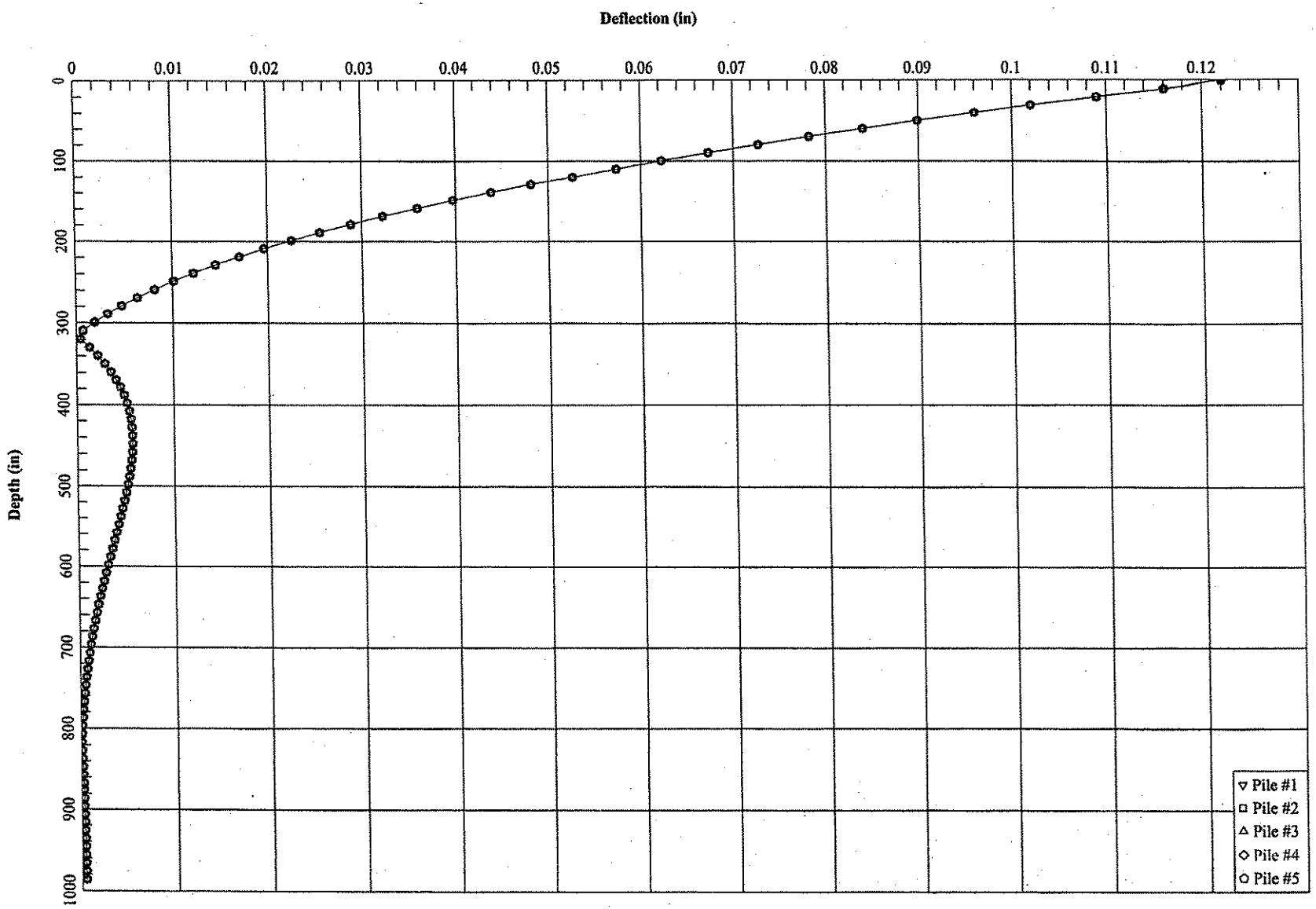


PB 13&14 FIVE 6' CONCRETE SHAFTS

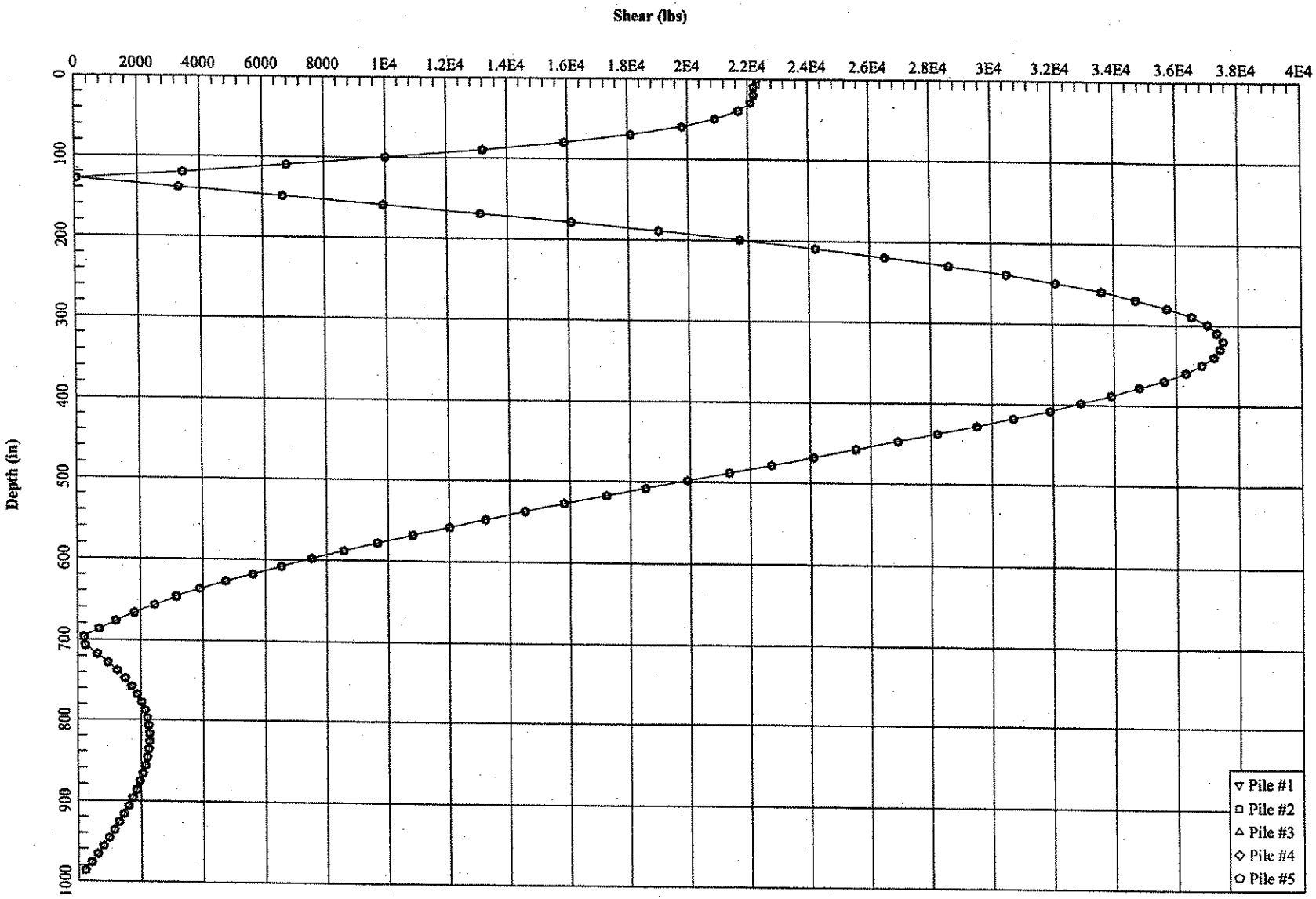


PB 13&14 FIVE 6' CONCRETE SHAFTS

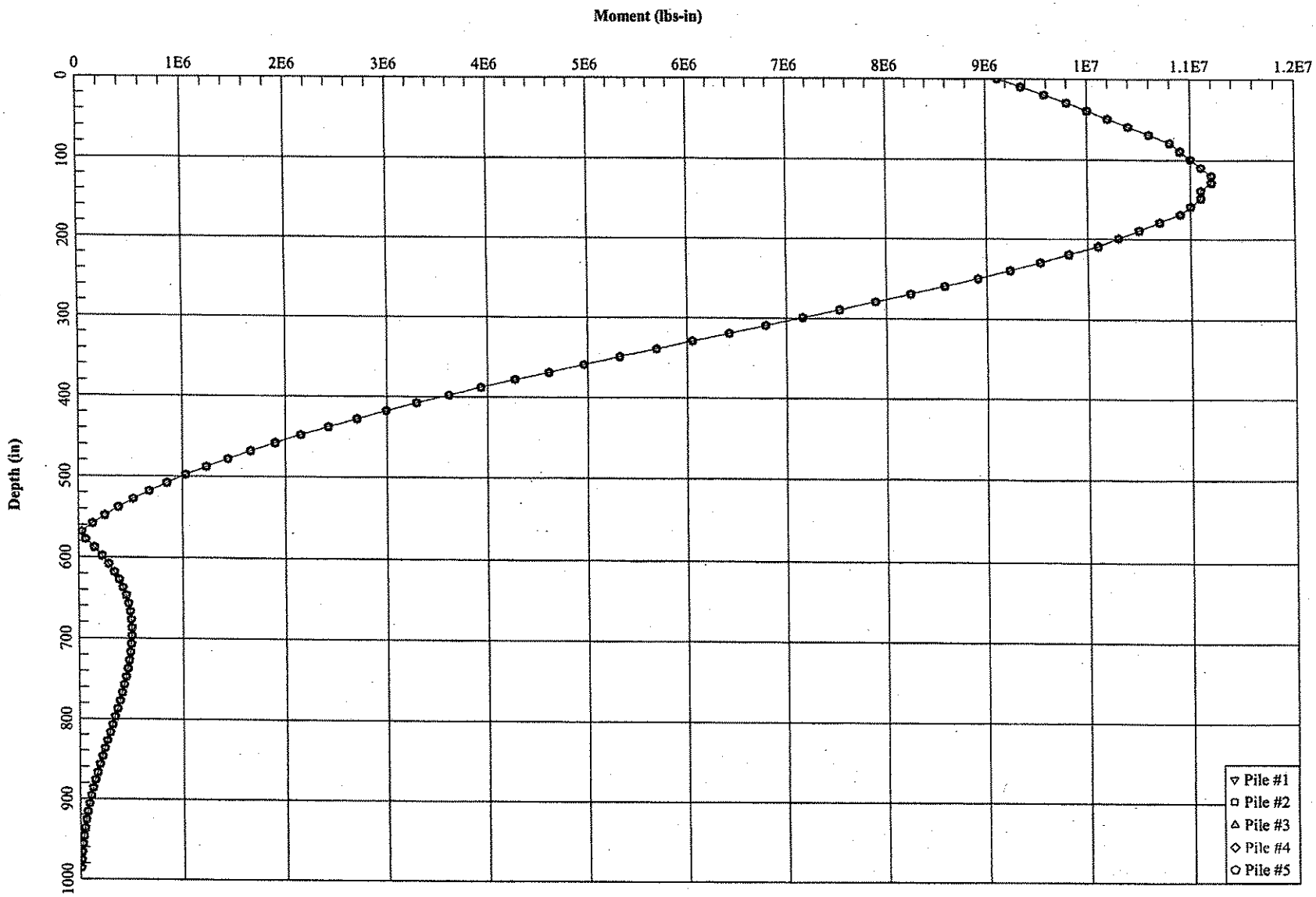
```
PB 13&14 FIVE 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.8500000E+06 1.1150000E+05 -4.5600000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
5
2 1   1 0 0 0 0 0 0 360 0 90 12 0
2 1   1 0 0 0 0 0 0 180 0 90 12 0
2 1   1 0 0 0 0 0 0 0 0 90 12 0
2 1   1 0 0 0 0 0 0 -180 0 90 12 0
2 1   1 0 0 0 0 0 0 -360 0 90 12 0
1
1 1 100 996 3960000 2
0 996 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 12 324 60
2 4 324 912 60
3 4 912 1800 60
12 0.03
324 0.03
324 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 1.77 0 0
324 0 30 0 1.77 0 0
324 0 33 0 5 0 0
912 0 33 0 5 0 0
912 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 13&14 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 13&14 FIVE 6' STEEL CASED CONCRETE SHAFTS



PB 13&14 FIVE 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation

	5 ft drilled shaft		6 ft drilled shaft		
	Concrete	Steel	Concrete	Steel	
Tip elevation	-75	-75	-75	-75	
Element Length	996	996	996	996	inches

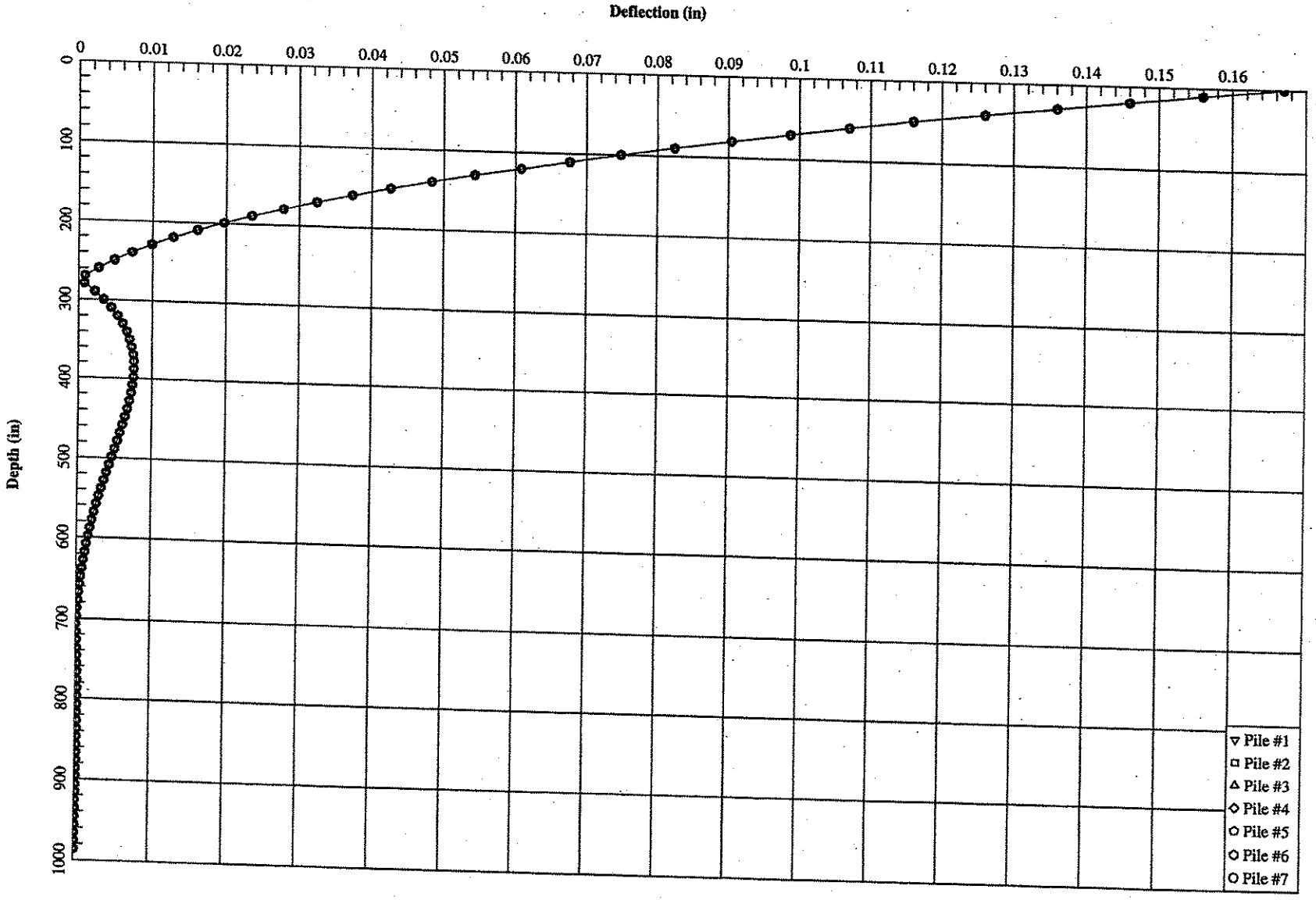
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	8	96	0
Top of AL (Sand)	7	84	12
Top of Norfolk	-20	-240	336
Top of Yorktown (Y2)	-68	-816	912
Top of Yorktown (Y1)	-142	-1704	1800

Foundation Element Properties

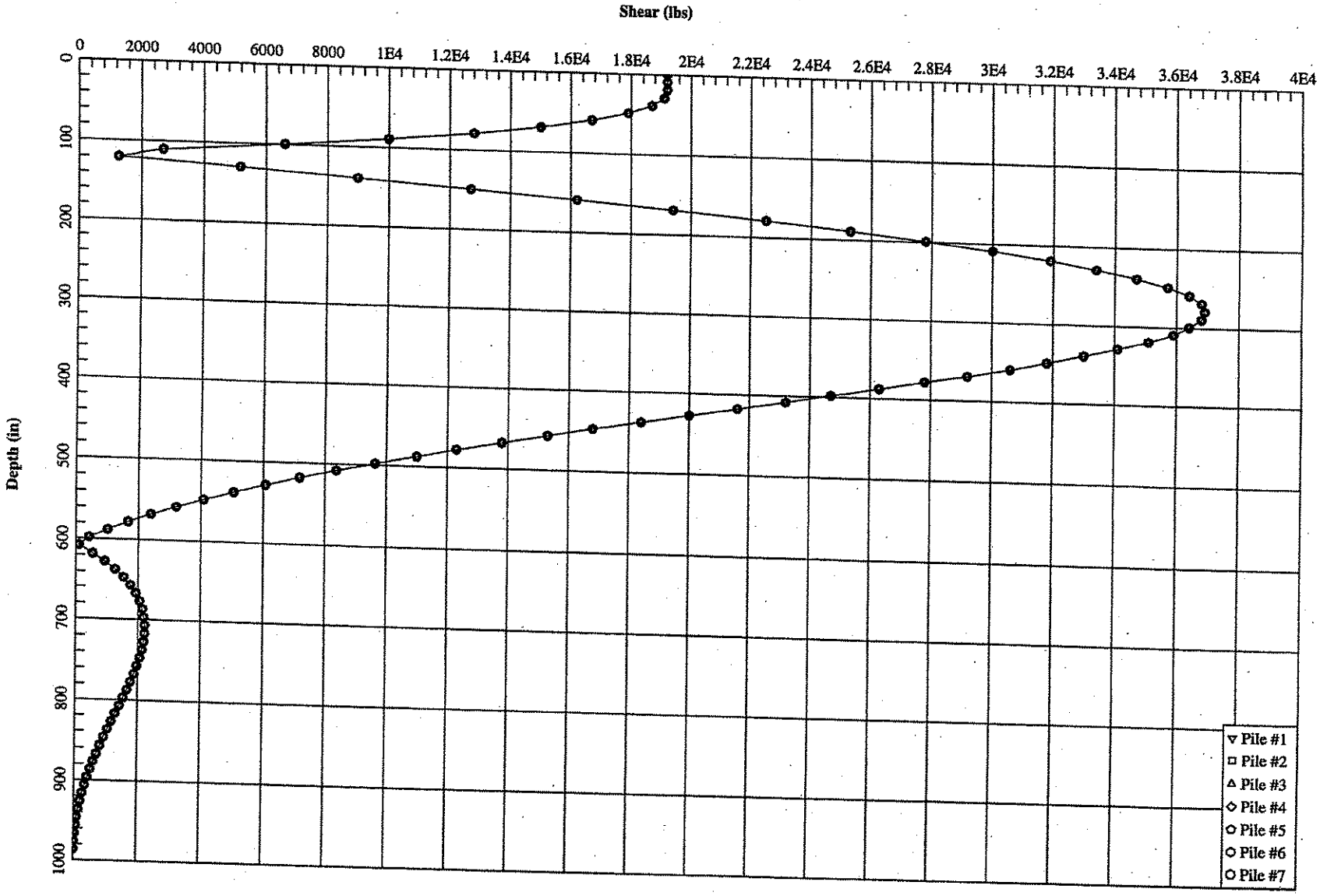
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
24- Inch PSC	2	24	4	576	1.333333	2304	3820	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, ν	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

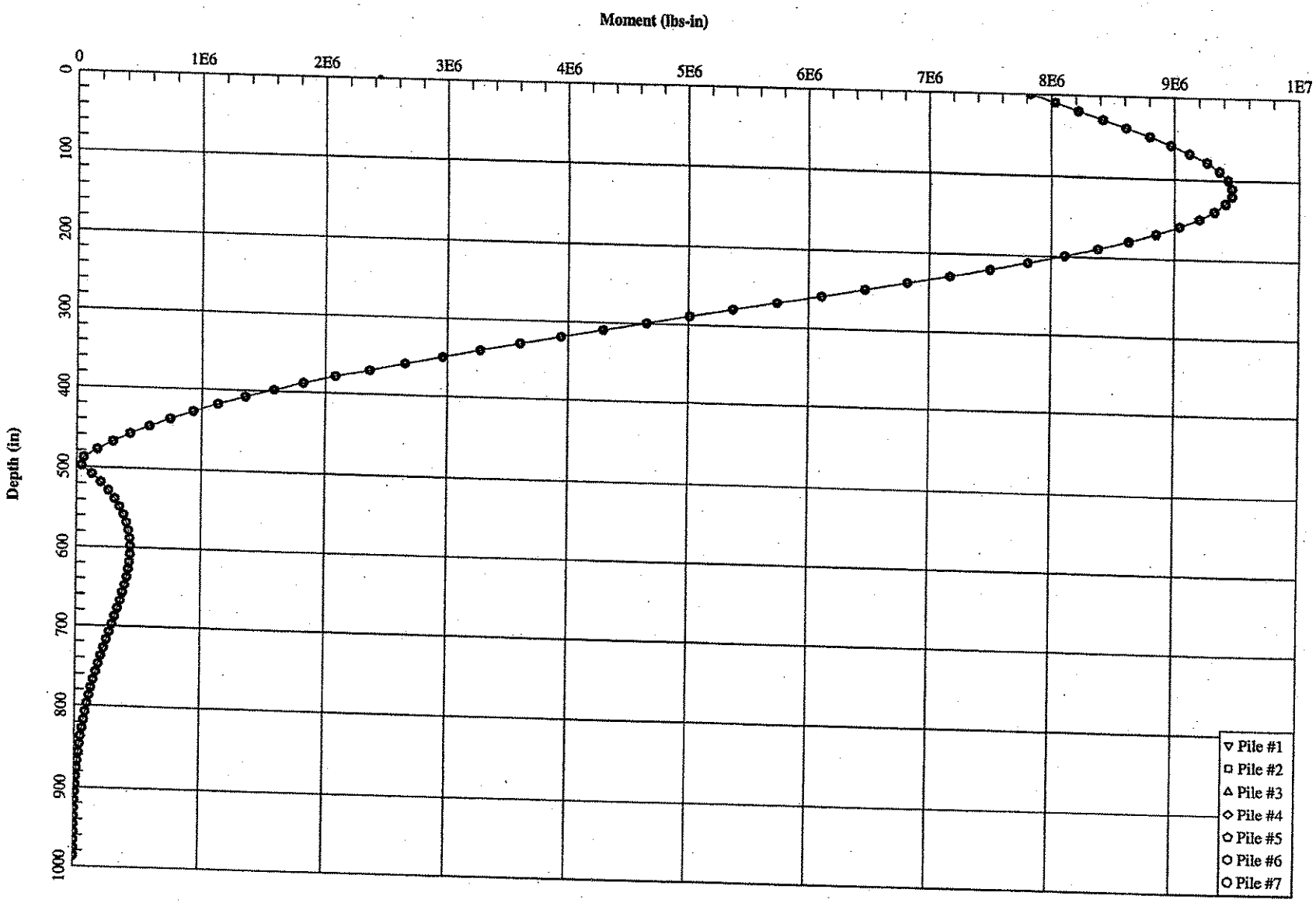
```
PB 15 SEVEN 5' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
4.6200000E+06 1.3440000E+05 -5.4790000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
7
2 1   1 0 0 0 0 0 0 450 0 90 12 0
2 1   1 0 0 0 0 0 0 300 0 90 12 0
2 1   1 0 0 0 0 0 0 150 0 90 12 0
2 1   1 0 0 0 0 0 0 0 0 90 12 0
2 1   1 0 0 0 0 0 0 -150 0 90 12 0
2 1   1 0 0 0 0 0 0 -300 0 90 12 0
2 1   1 0 0 0 0 0 0 -450 0 90 12 0
1
1 1 100 996 3850000 2
0 996 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 12 336 60
2 4 336 912 60
3 4 912 1800 60
12 0.03
336 0.03
336 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 2.77 0 0
336 0 30 0 2.77 0 0
336 0 33 0 8.33 0 0
912 0 33 0 8.33 0 0
912 0 35 0 27.7 347 0
1800 0 35 0 27.7 347 0
1.0000000E+00
```



PB 15 SEVEN 5' CONCRETE SHAFTS

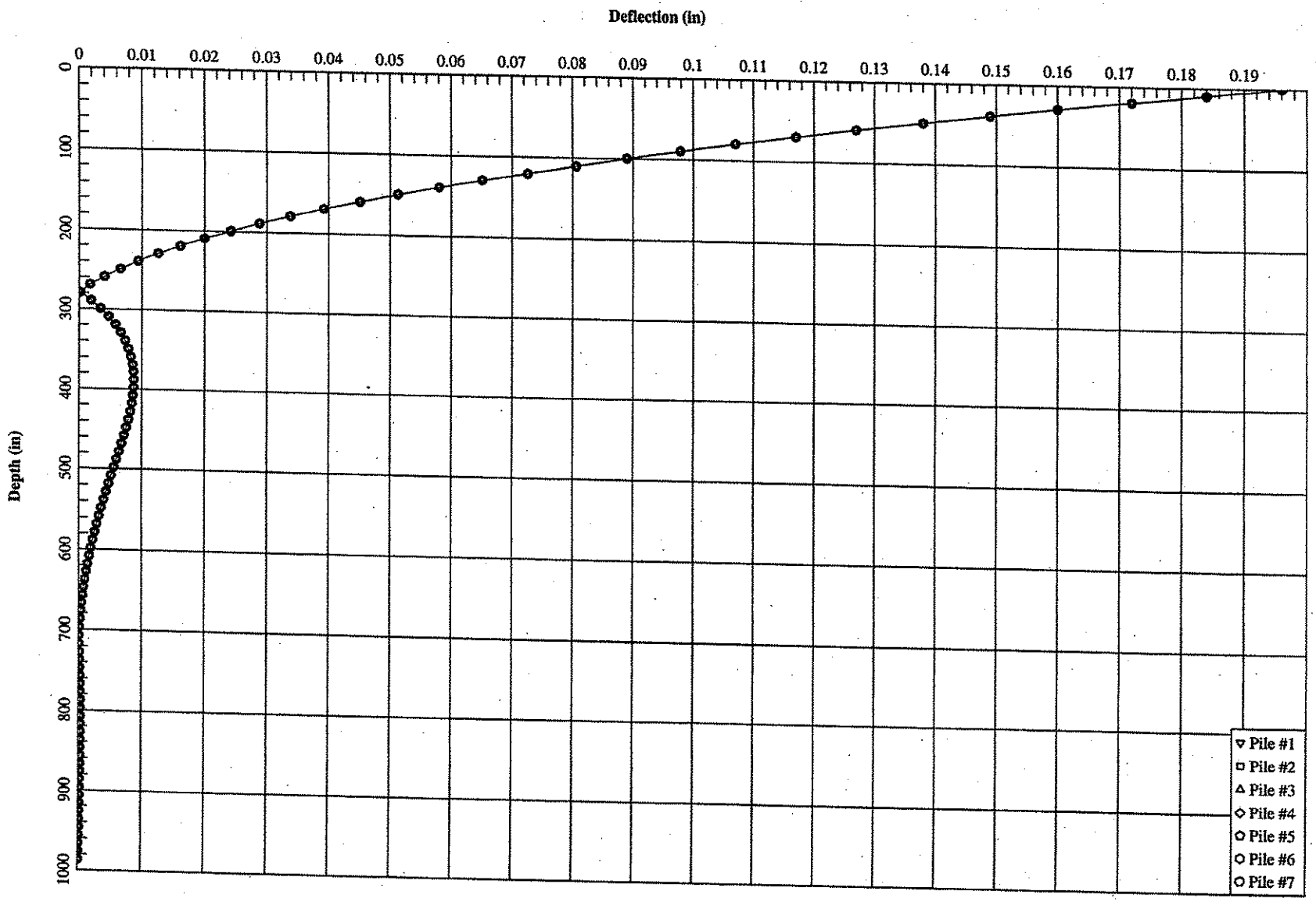


PB 15 SEVEN 5' CONCRETE SHAFTS

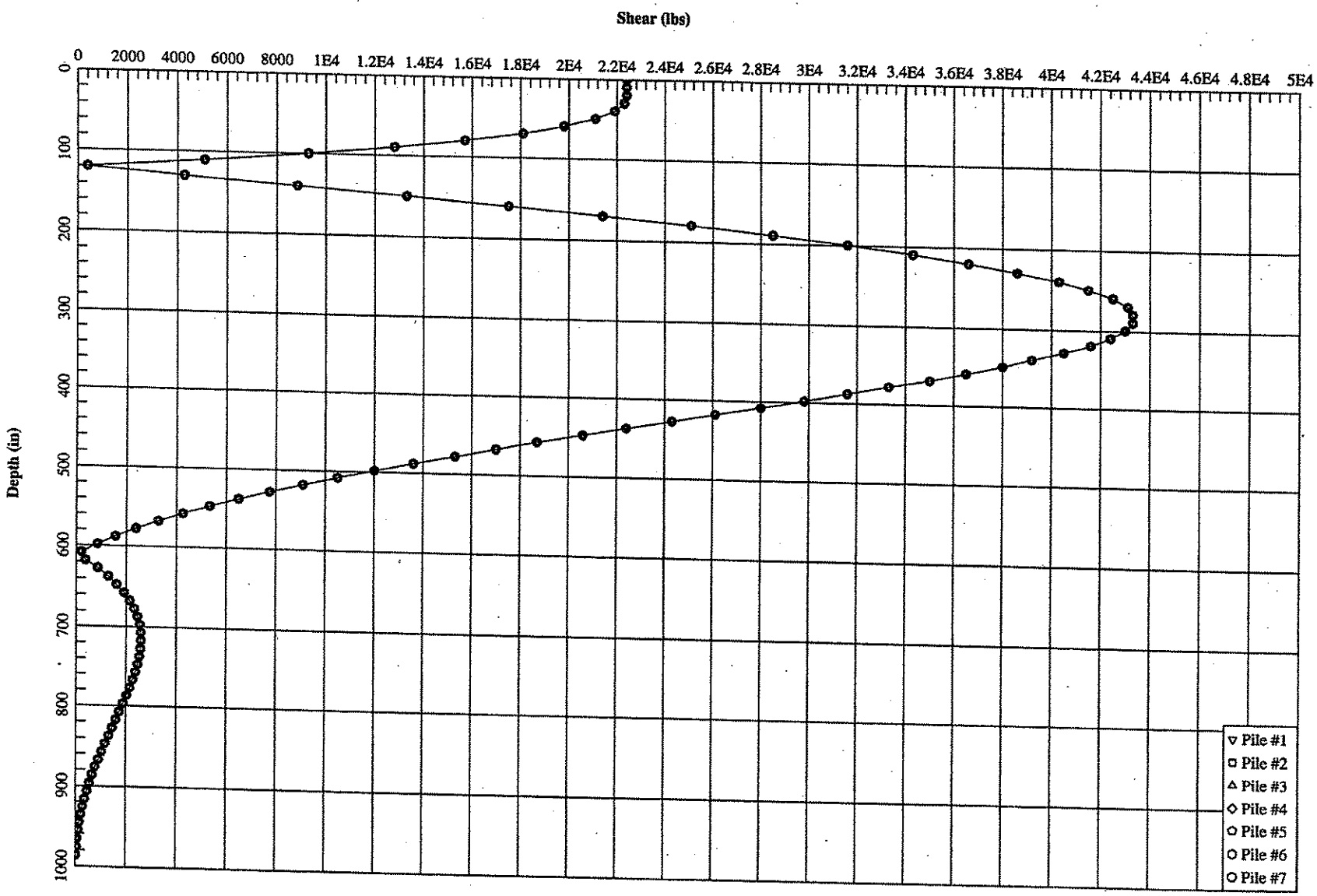


PB 15 SEVEN 5' CONCRETE SHAFTS

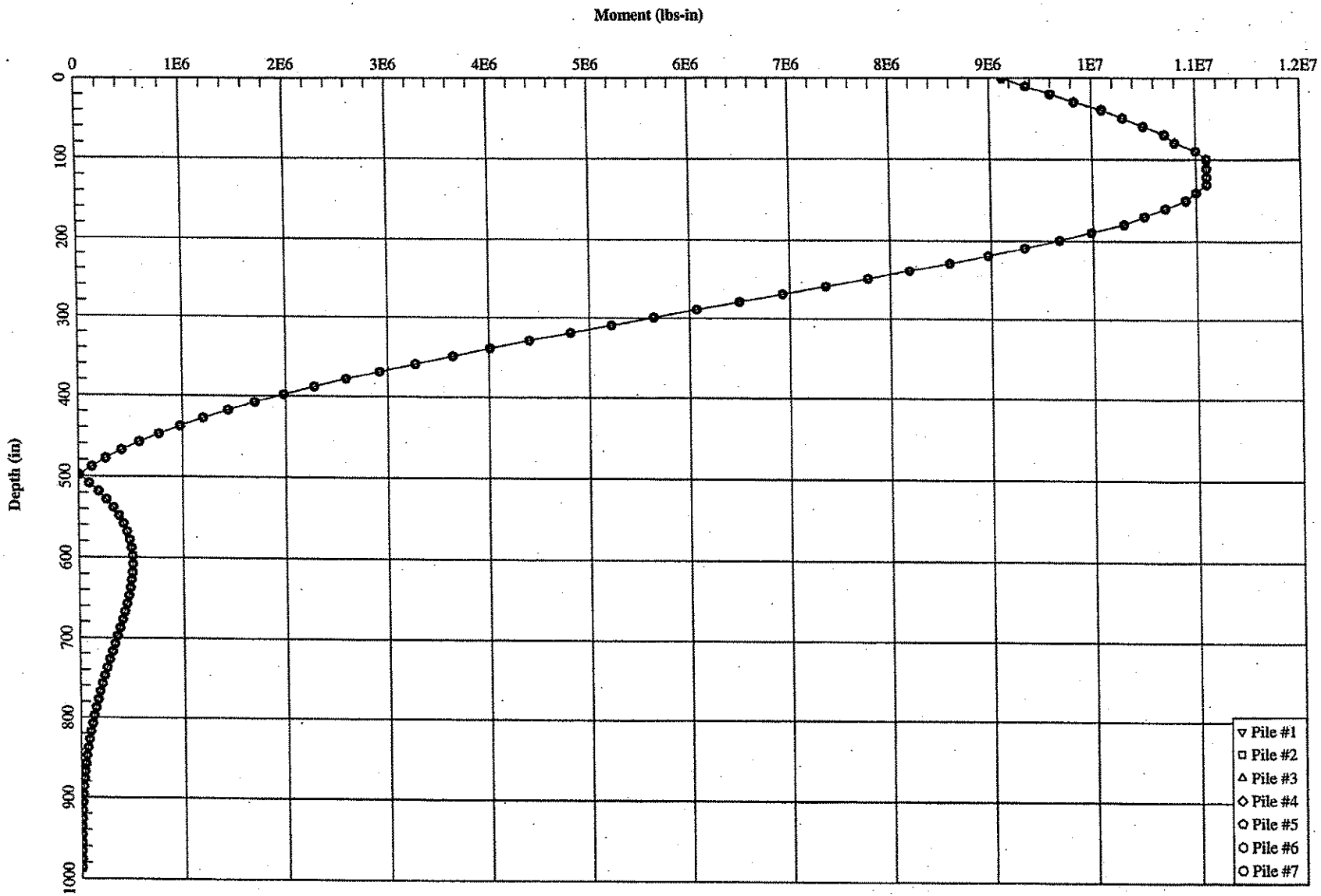
```
PB 15 SEVEN 5' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
5.3900000E+06 1.5680000E+05 -6.3924000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
7
2 1   1 0 0 0 0 0 0 450 0 90 12 0
2 1   1 0 0 0 0 0 0 300 0 90 12 0
2 1   1 0 0 0 0 0 0 150 0 90 12 0
2 1   1 0 0 0 0 0 0 0 0 90 12 0
2 1   1 0 0 0 0 0 0 -150 0 90 12 0
2 1   1 0 0 0 0 0 0 -300 0 90 12 0
2 1   1 0 0 0 0 0 0 -450 0 90 12 0
1
1 1 100 996 3960000 2
0 996 60 2827 636172 636172 0 0 6E13
3 6 6 0
1 4 12 336 60
2 4 336 912 60
3 4 912 1800 60
12 0.03
336 0.03
336 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 1.77 0 0
336 0 30 0 1.77 0 0
336 0 33 0 5 0 0
912 0 33 0 5 0 0
912 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
0.0000000E+00
```



PB 15 SEVEN 5' STEEL CASED CONCRETE SHAFTS

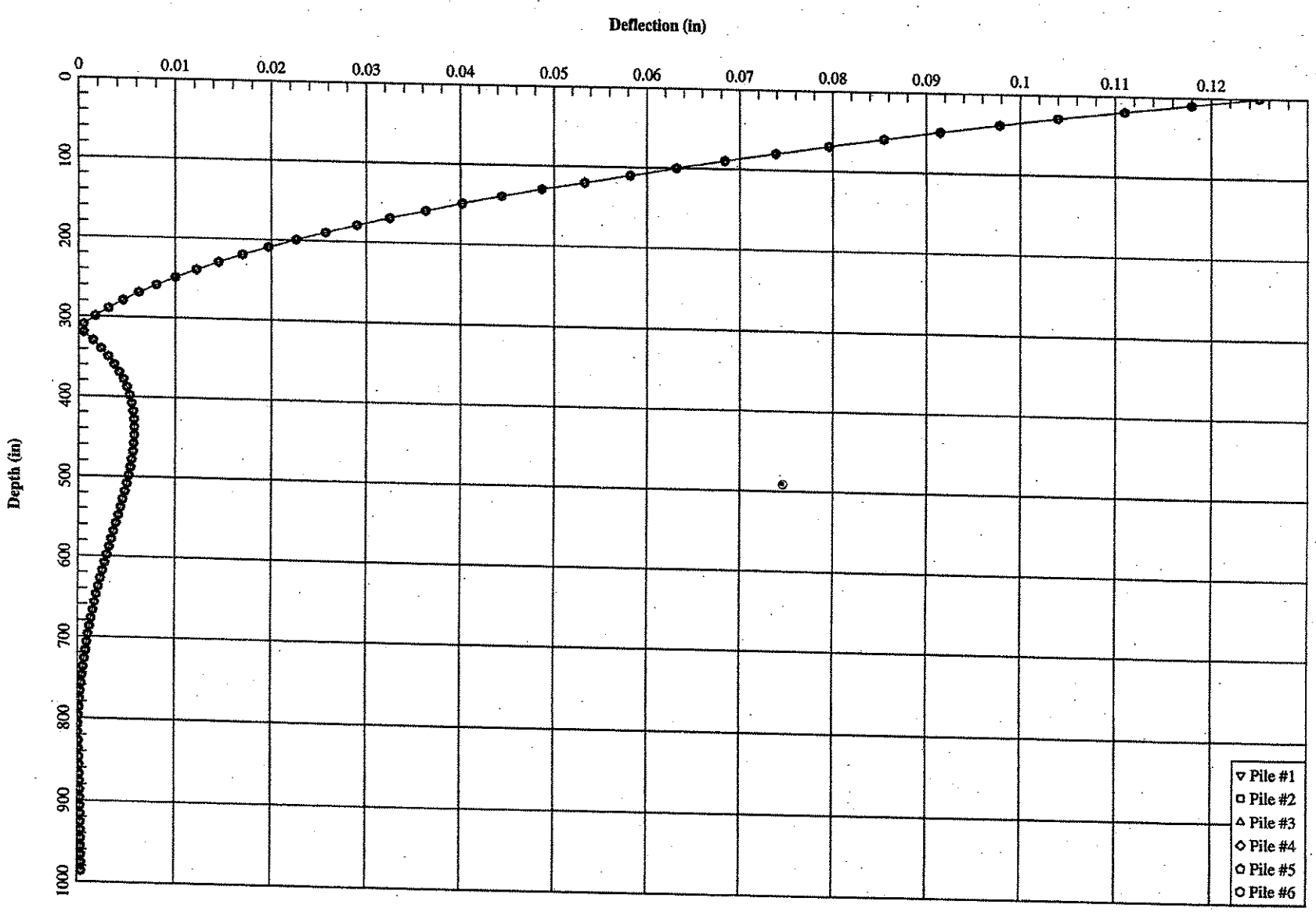


PB 15 SEVEN 5' STEEL CASED CONCRETE SHAFTS

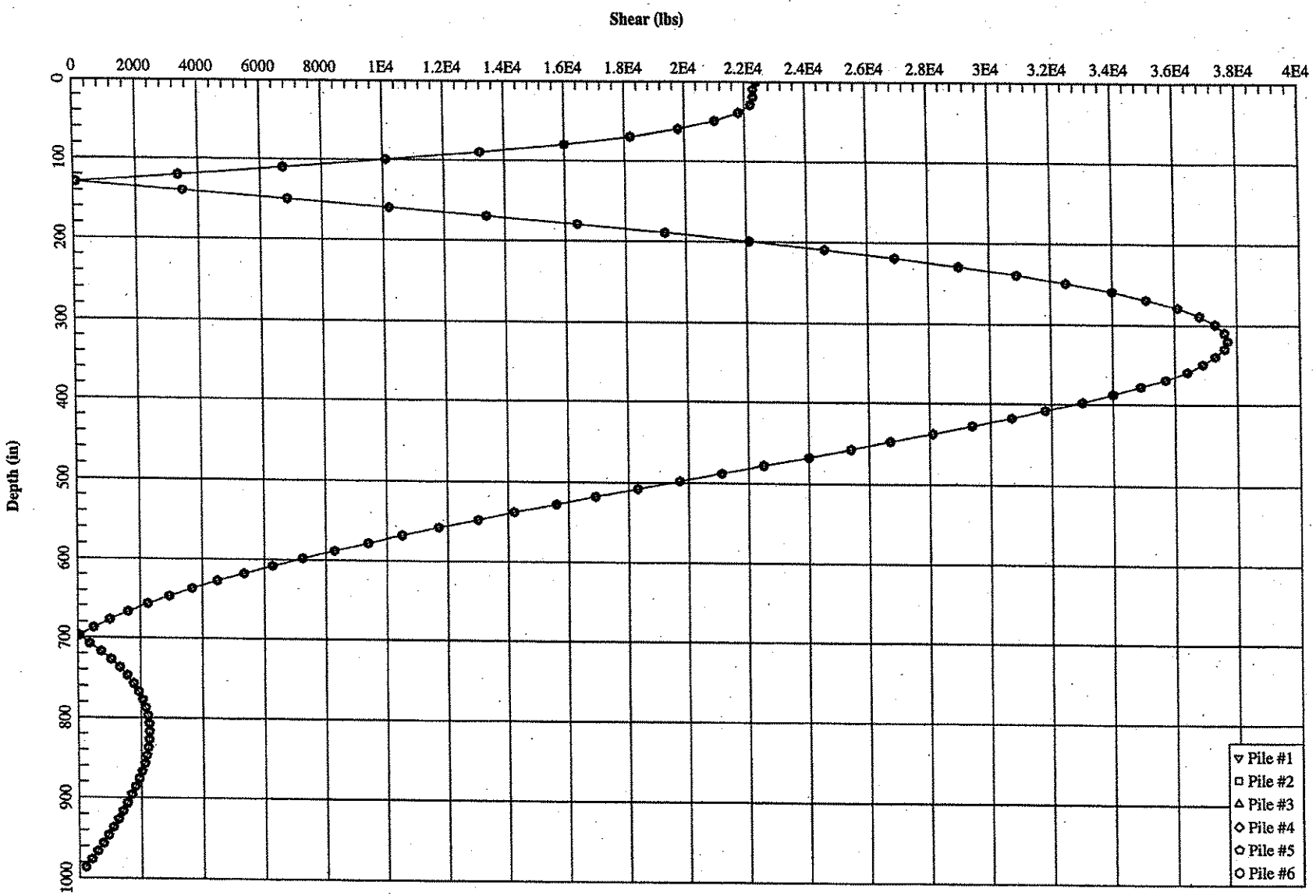


PB 15 SEVEN 5' STEEL CASED CONCRETE SHAFTS

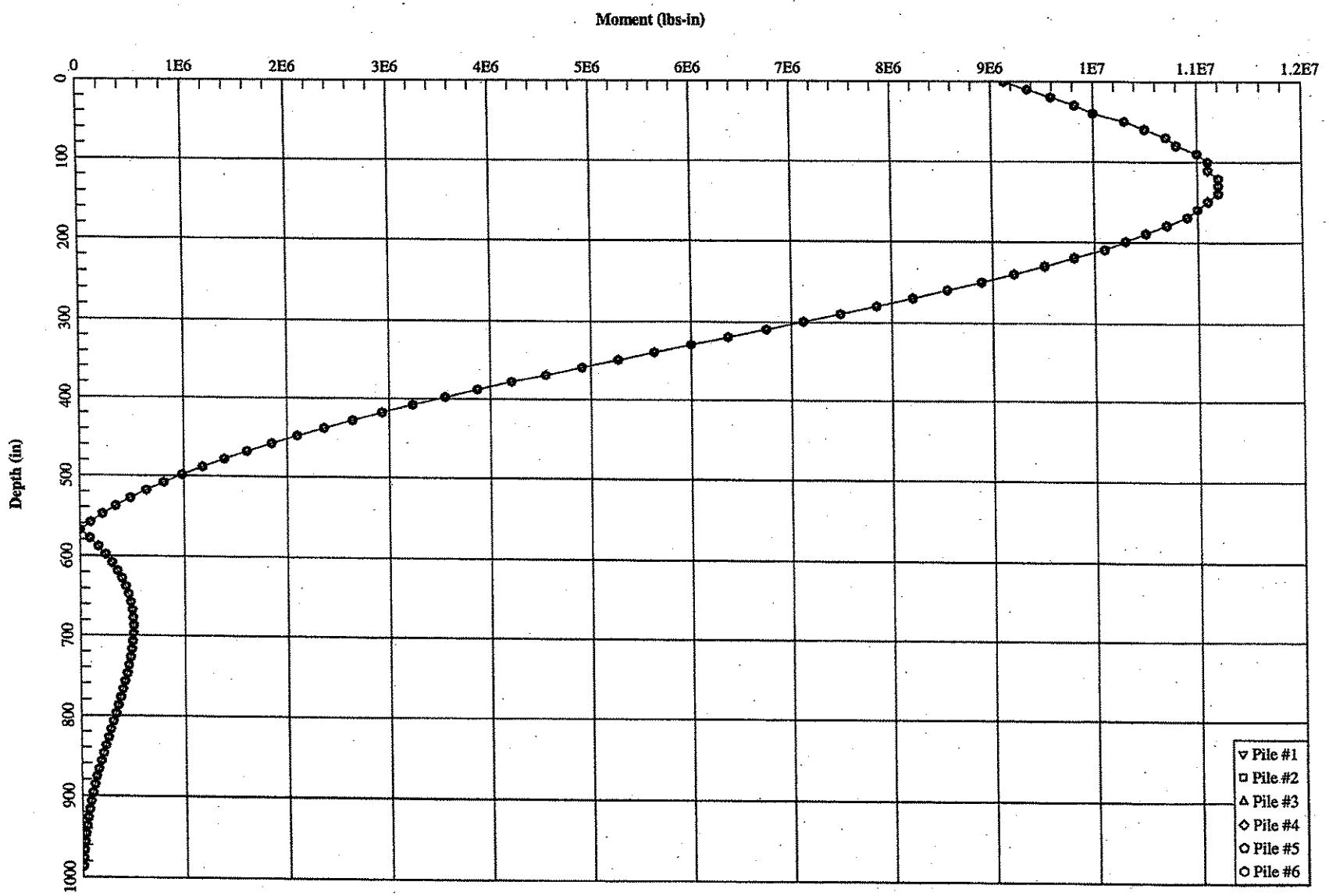
```
PB 15 SIX 6' CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
4.6200000E+06 1.3440000E+05 -5.4792000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 450 0 90 12 0
2 1   1 0 0 0 0 0 0 270 0 90 12 0
2 1   1 0 0 0 0 0 0 90 0 90 12 0
2 1   1 0 0 0 0 0 0 -90 0 90 12 0
2 1   1 0 0 0 0 0 0 -270 0 90 12 0
2 1   1 0 0 0 0 0 0 -450 0 90 12 0
1
1 1 100 996 3850000 2
0 996 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 12 336 60
2 4 336 912 60
3 4 912 1800 60
12 0.03
336 0.03
336 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 2.8 0 0
336 0 30 0 2.8 0 0
336 0 33 0 8.3 0 0
912 0 33 0 8.3 0 0
912 0 35 0 27.8 347 0
1800 0 35 0 27.8 347 0
1.0000000E+00
```



PB 15 SIX 6' CONCRETE SHAFTS

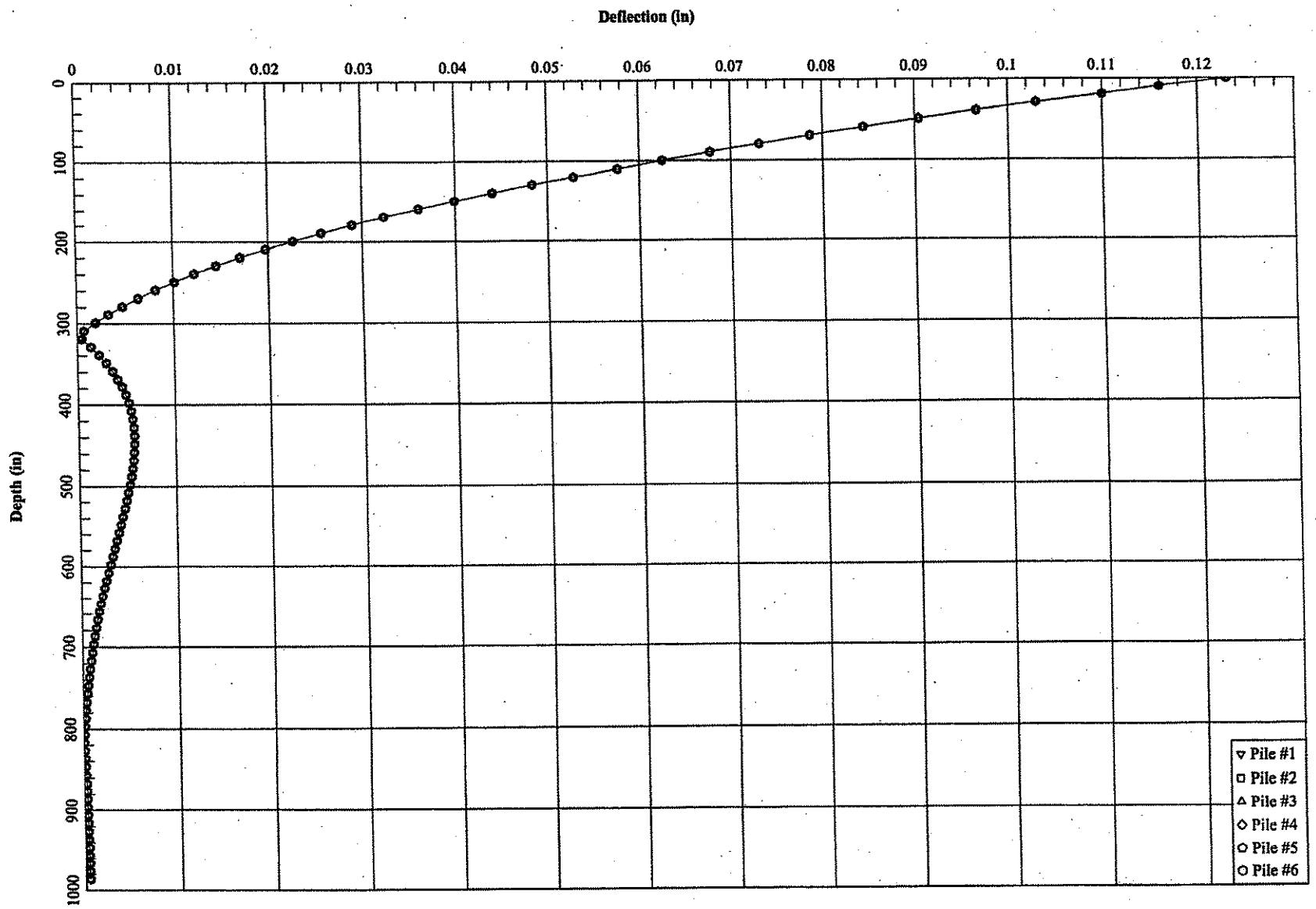


PB 15 SIX 6' CONCRETE SHAFTS

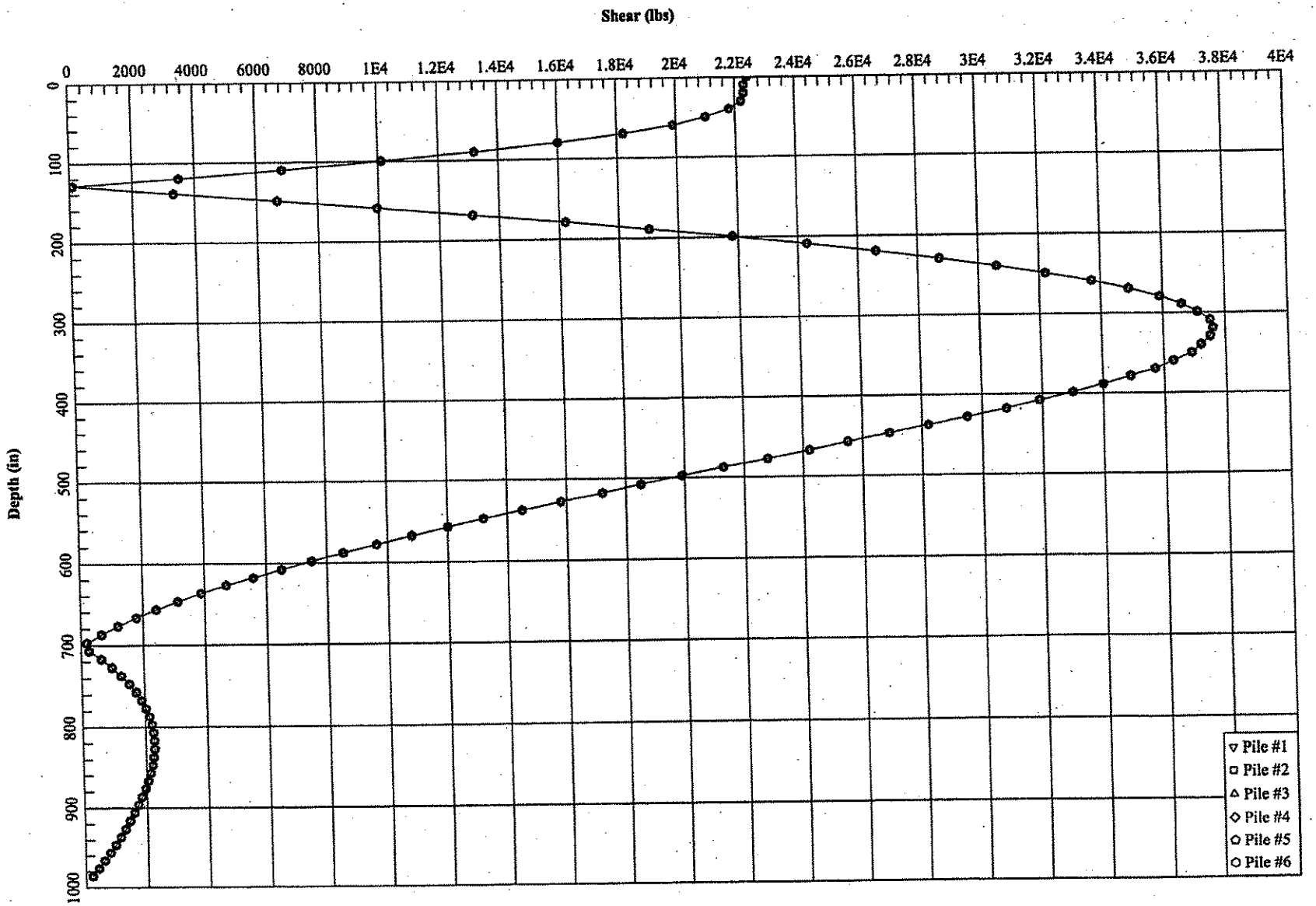


PB 15 SIX 6' CONCRETE SHAFTS

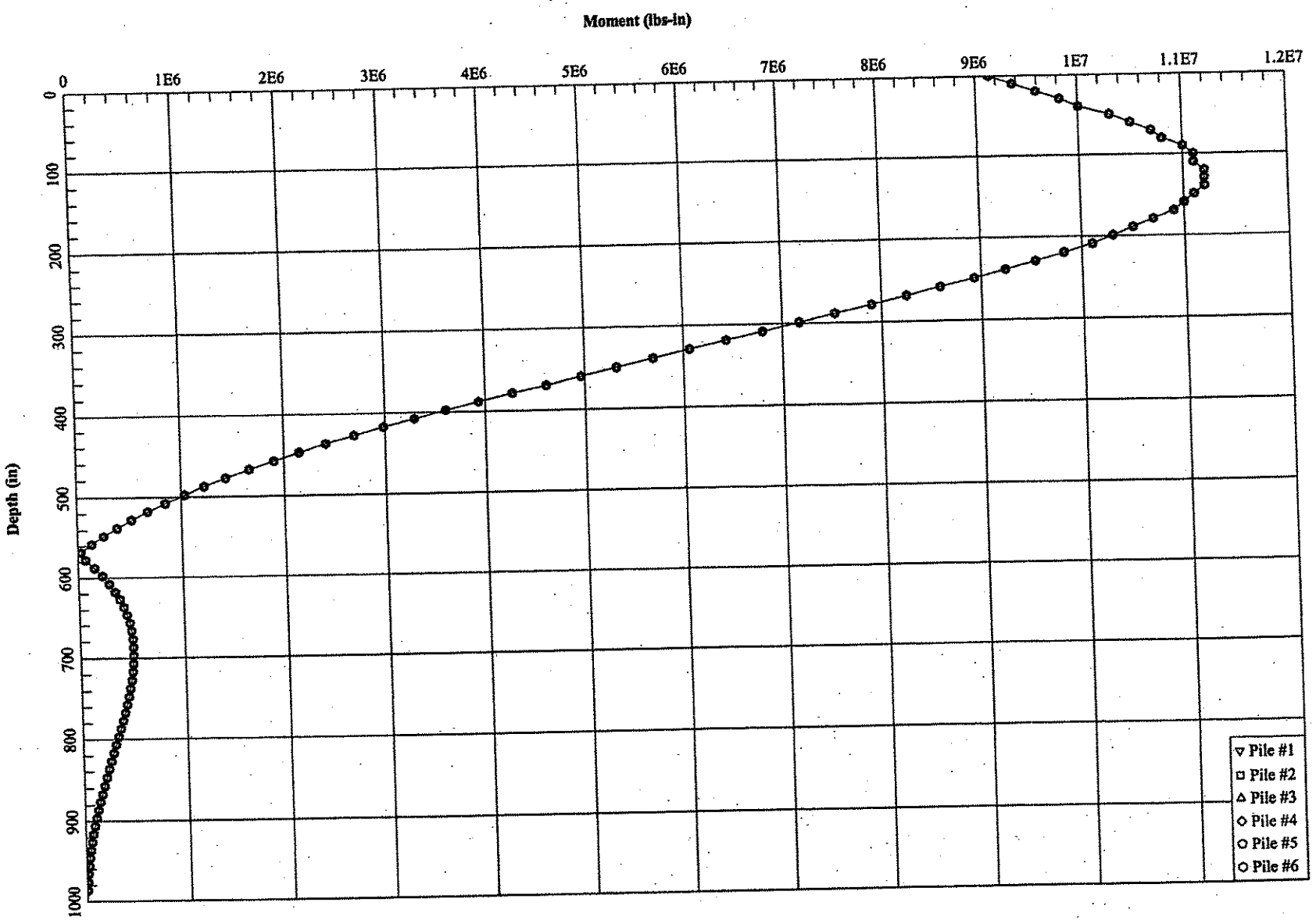
```
PB 15 SIX 6' STEEL CASED CONCRETE SHAFTS
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
4.6200000E+06 1.3440000E+05 -5.4790000E+07 0.0000000E+00 0.0000000E+00 0.0000000E+00
6
2 1   1 0 0 0 0 0 0 450 0 90 12 0
2 1   1 0 0 0 0 0 0 270 0 90 12 0
2 1   1 0 0 0 0 0 0 90 0 90 12 0
2 1   1 0 0 0 0 0 0 -90 0 90 12 0
2 1   1 0 0 0 0 0 0 -270 0 90 12 0
2 1   1 0 0 0 0 0 0 -450 0 90 12 0
1
1 1 100 996 3940000 2
0 996 72 4071 1319167 1319167 0 0 6E13
3 6 6 0
1 4 12 336 60
2 4 336 912 60
3 4 912 1800 60
12 0.03
336 0.03
336 0.03
912 0.03
912 0.033
1800 0.033
12 0 30 0 1.77 0 0
336 0 30 0 1.77 0 0
336 0 33 0 5 0 0
912 0 33 0 5 0 0
912 0 35 0 16.7 347 0
1800 0 35 0 16.7 347 0
1.0000000E+00
```



PB 15 SIX 6' STEEL CASED CONCRETE SHAFTS



PB 15 SIX 6' STEEL CASED CONCRETE SHAFTS



PB 15 SIX 6' STEEL CASED CONCRETE SHAFTS

GROUP Input Parameters

Input by : Shane Clark
Date: 12/19/2003

Location
Foundation 24 inch PSC
Concrete
Tip elevation -65
Element Length 804 inches

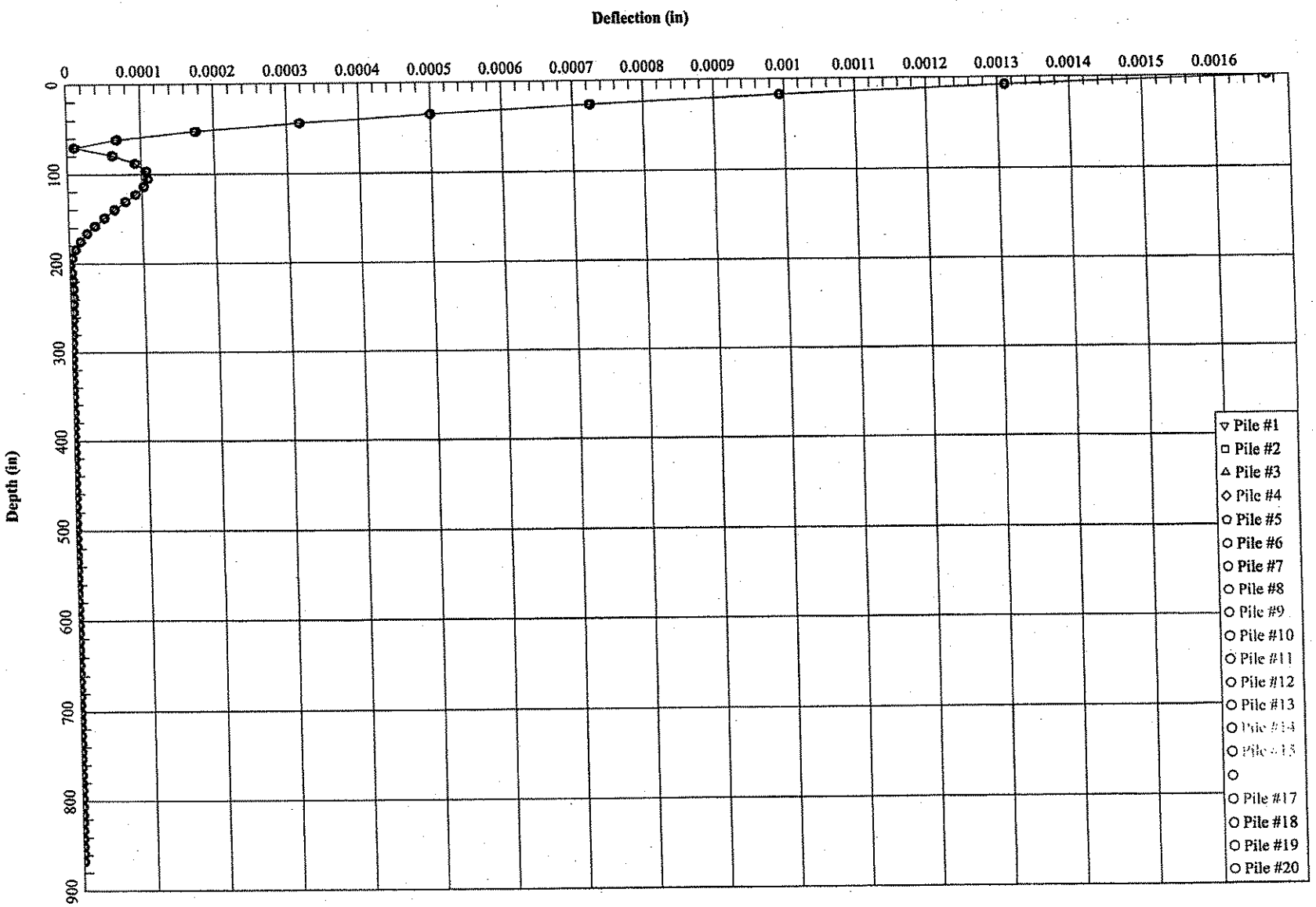
	Elevation (feet)	Elevation (inches)	GROUP Input (inches)
Top of Element	2	24	0
Top of AL (Sand)	2	24	0
Top of Norfolk	-25	-300	324
Top of Yorktown (Y2)	-62	-744	768
Top of Yorktown (Y1)	-141	-1692	1716

Foundation Element Properties

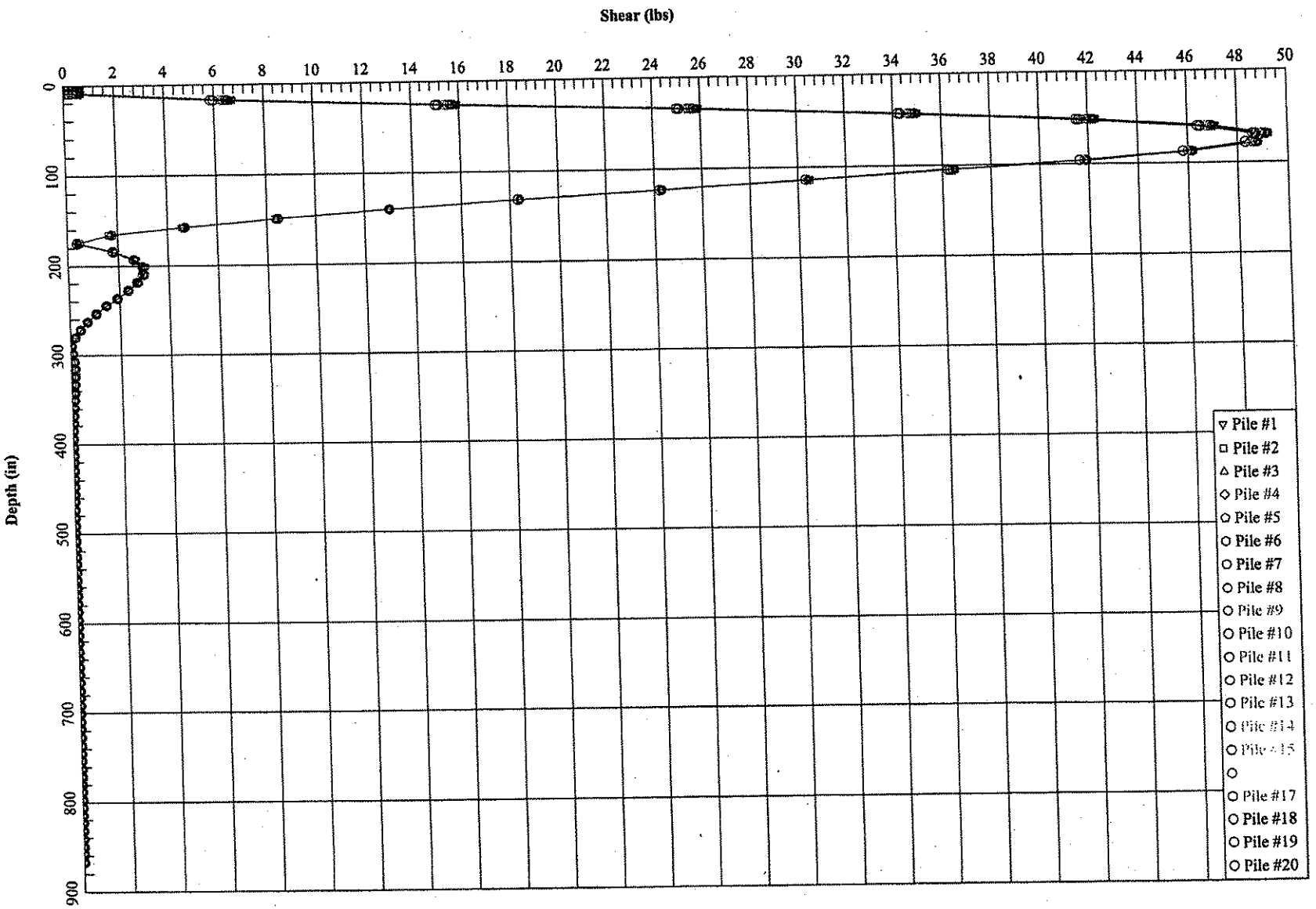
Element Type	Diameter feet	Diameter inches	Area feet^2	Area inch^2	Moment of Inertia feet^4	Moment of Inertia inch^4	Young's Modulus ksi	Young's Modulus psi	Torsional Stiffness lb-in^2
24- inch PSC	2	24	4	576	1.333333	2304	3.82E+03	3.82E+06	6.00E+13
5 ft shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.85E+03	3.85E+06	6.00E+13
5 ft cased shaft	5	60	19.63475	2827.404	30.6793	636165.9	3.96E+03	3.96E+06	6.00E+13
6 ft shaft	6	72	28.27404	4071.462	63.61659	1319154	3.85E+03	3.85E+06	6.00E+13
6 ft cased shaft	6	72	28.27404	4071.462	63.61659	1319154	3.94E+03	3.94E+06	6.00E+13

Material	Total Unit Weight, γ_T (pcf)	Total Unit Weight, γ_T (pci)	Effective Unit Weight, γ' (pci)[1]	Internal Friction Angle, ϕ' (deg)	Undrained Shear Strength, S_u (psf)	Undrained Shear Strength, S_u (psi)	Poisson's Ratio, ν	Static Horizontal Subgrade Modulus, k_H (pci)	Shear Modulus, G (ksf)	Soil Strain, ε_{50}	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	CONCRETE: Ultimate Side Friction or Limiting Shear, τ_f (psi)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (ksf)	STEEL: Ultimate Side Friction or Limiting Shear, τ_f (psi)	Ultimate Tip Resistance, q_p (ksf)	Ultimate Tip Resistance, q_p (psi)	SOIL MODEL: GROUP 4.0 p-y curve input (Code No. / Internal Soil Type)	SOIL MODEL: GROUP 6.0 p-y curve input (Integer / Lateral Soil Model)
Alluvial Sand	115	0.067	0.030	30	-	-	0.30	60	1,600	-	0.4	2.8	0.2	1.7	-		4 / Sand (Reese, et al.)	4 / Sand (Reese, et al.)
Alluvial Clay	110	0.064	0.027	-	600	4.2	0.45	100	900	0.01	0.4	2.8	0.2	1.7	-			1/ Submerged Soft Clay
Norfolk Formation	115	0.067	0.030	33	-	-	0.30	60	2,100	-	1.2	8.3	0.7	5.0	-		1 / Submerged Soft Clay	4 / Sand (Reese, et al.)
Yorktown Formation (Y2)	120	0.069	0.033	35	-	-	0.35	60	2,600	-	4.0	27.8	2.4	16.7	50	347.2		4 / Sand (Reese, et al.)
Yorktown Formation (Y1)	115	0.067	0.030	-	3,000	-	-	-	-	-	-				-		4 / Sand (Reese, et al.)	2 / Stiff Clay w/ Free Water

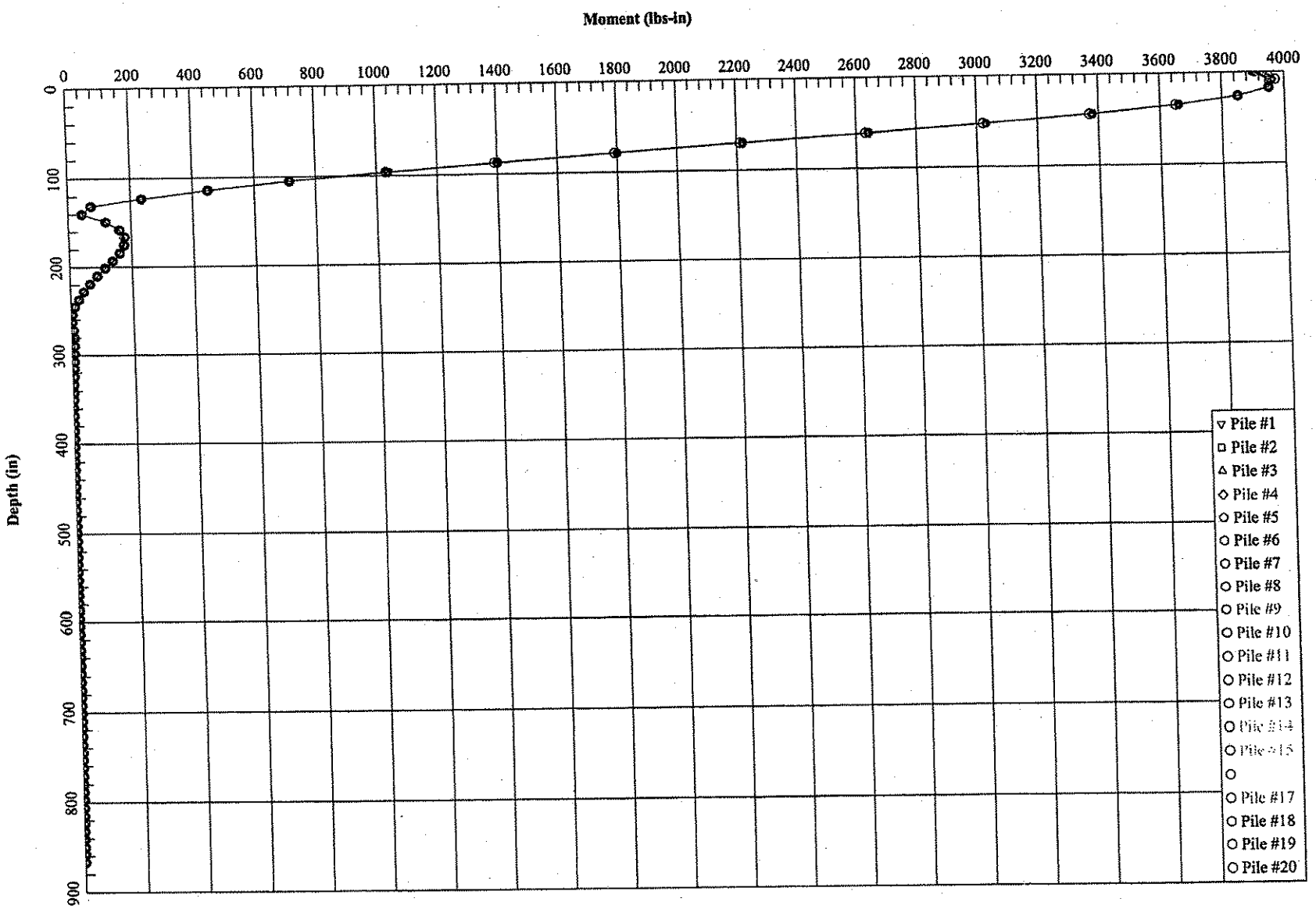
```
Piers 16-18 - 24 inch piles
GROUP6.03
1 0 0 1 0 0 0 0 0 3 0 0
0 100
0 100 100 1.0000000E-05 1.0000000E-05 1.0000000E+00 1.0000000E+00
3.4390000E+06 0.0000000E+00 5.4660000E+07 0.0000000E+00 2.7600000E+05 0.0000000E+00
30
2 1   1 0 0 0 0 0 -468 48 0 90 0 0
2 1   1 0 0 0 0 0 -468 -48 0 90 0 0
2 1   1 0 0 0 0 0 -390 48 0 90 0 0
2 1   1 0 0 0 0 0 -390 -48 0 90 0 0
2 1   1 0 0 0 0 0 -312 48 0 90 0 0
2 1   1 0 0 0 0 0 -312 -48 0 90 0 0
2 1   1 0 0 0 0 0 -234 48 0 90 0 0
2 1   1 0 0 0 0 0 -234 -48 0 90 0 0
2 1   1 0 0 0 0 0 -156 48 0 90 0 0
2 1   1 0 0 0 0 0 -156 -48 0 90 0 0
2 1   1 0 0 0 0 0 -78 48 0 90 0 0
2 1   1 0 0 0 0 0 -78 -48 0 90 0 0
2 1   1 0 0 0 0 0 0 48 0 90 0 0
2 1   1 0 0 0 0 0 0 -48 0 90 0 0
2 1   1 0 0 0 0 0 78 48 0 90 0 0
2 1   1 0 0 0 0 0 78 -48 0 90 0 0
2 1   1 0 0 0 0 0 156 48 0 90 0 0
2 1   1 0 0 0 0 0 156 -48 0 90 0 0
2 1   1 0 0 0 0 0 234 48 0 90 0 0
2 1   1 0 0 0 0 0 234 -48 0 90 0 0
2 1   1 0 0 0 0 0 306 48 0 90 0 0
2 1   1 0 0 0 0 0 306 -48 0 90 0 0
2 1   1 0 0 0 0 0 379.5 48 0 90 0 0
2 1   1 0 0 0 0 0 379.5 -48 0 90 0 0
2 1   1 0 0 0 0 0 453 48 0 90 0 0
2 1   1 0 0 0 0 0 453 -48 0 90 0 0
2 1   1 0 0 0 0 0 526.5 48 0 90 0 0
2 1   1 0 0 0 0 0 526.5 -48 0 90 0 0
2 1   1 0 0 0 0 0 600 48 0 90 0 0
2 1   1 0 0 0 0 0 600 -48 0 90 0 0
1
1 1 100 876 3823670 1
0 876 24 576 1728 1728 0 0 6E13
3 6 6 0
1 4 0 324 60
2 4 324 768 60
3 4 768 1800 60
0 0.03
324 0.03
324 0.03
768 0.03
768 0.033
1800 0.033
0 0 30 0 2.77 0 0
324 0 30 0 2.77 0 0
324 0 33 0 8.33 0 0
768 0 33 0 8.33 0 0
768 0 35 0 27.78 347 0
1800 0 35 0 27.78 347 0
1.0000000E+00
```



Piers 16-18 - 24 inch piles



Piers 16-18 - 24 inch piles



Piers 16-18 - 24 inch piles