CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
ENGINEERING AND CONSTRUCTION DIVISION

FINAL
GEOTECHNICAL STUDY
MEMORIAL DRIVE FROM ABOUT 500-FT EAST OF NORTH KIRKWOOD ROAD TO THE WEST SIDE OF NORTH ELDRIDGE PARKWAY

WBS NO. N-000798-0001-3
CSJ NO. 0912-70-082
CITY OF HOUSTON, TEXAS

PROJECT NO. 09-338E

TO

CIVILTECH ENGINEERING, INC.
CYPRESS, TEXAS

BY

GEOTECH ENGINEERING AND TESTING

SERVICING

TEXAS, LOUISIANA, NEW MEXICO, OKLAHOMA

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March 21, 2014

Attention: Mr. Micheal D. Lacy, P.E.
Vice President

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Gentlemen:

Submitted here is Geotech Engineering and Testing (GET) geotechnical study on the study of subsurface conditions for the above referenced project. This study was conducted in general accordance with our Proposal No. P09-161, Revision VI, dated September 18, 2012 and was authorized by Mr. Michael D. Lacy, P.E., Vice President on January 07, 2013.

This report presents the results of our field exploration and laboratory testing together with design recommendations for the construction of roadways and underground utilities for proposed Memorial Drive Improvements in City of Houston, Texas. Slope stability analysis for the Turkey Creek was outside the scope of our work.

We appreciate the opportunity to be of service. Should you have any questions or need additional assistance, please call.

Very truly yours,

GEOTECH ENGINEERING AND TESTING
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1.0 EXECUTIVE SUMMARY

It is planned to reconstruct approximately 11,200± linear feet of Memorial Drive from 500-ft east of North Kirkwood to the west of North Eldridge Parkway in City of Houston, Texas. We understand that the new roadway will consist of a two lanes on each side with turn lanes concrete curb and gutters. In addition, underground utilities will be installed along the proposed project alignment. The invert depths for the storm sewerlines will be about 12- to 17-ft below the existing grade. The invert depths for the sanitary and water lines will be less than the storm sewer lines. We understand that the Turkey Creek is about 17-ft deep. Furthermore, box culverts and head walls will be constructed at the Turkey Creek.

We understand that the existing asphalt and concrete paving will be removed and replaced with concrete paving. A portion of paving will consists of asphalt paving. In addition, underground utilities will be constructed along the project alignment. Furnished information indicates that open-trench or augering method of construction will be used for underground utility installations. This study was conducted is general accordance with the City of Houston (COH) Department of Public Works & Engineering, Chapter 11, Geotechnical and Environmental Guidelines, dated July 2012. This report contains a description of our field and laboratory testing results together with engineering analysis and recommendations for the construction of the proposed facilities along the project alignment. Slope stability analysis for the Turkey Creek was outside the scope of our work.

The soil conditions were explored by conducting twenty-four (24) soil test borings (B-1 through B-24) for paving and underground utilities. The soil borings were drilled along the project alignment to depths ranging from 10- to 35-ft below the existing grade. **Due to the presence of cohesionless soils at the termination depths at Borings B-12, B-15 and B-23, an additional 5-ft sample was obtained.** The soil stratigraphy for the project alignment is summarized as follows:

1. In general, the soil stratigraphy along the proposed alignment indicates presence of alternate strata of Clay (CL), Clay (CH), Sand (SM) and Silt (ML) soils. Details of subsurface conditions along the project alignment are included in this report.

2. Depth to groundwater/perched water will be important for design and construction of the proposed facilities. Water level observations were made during drilling and 24 hours after drilling. Our short-term field exploration along the project alignment indicated that groundwater/perched water was encountered at depths ranging from 14- to 31-ft below the existing grade during drilling. Groundwater level rose to depths ranging from 10- to 30-ft after 24 hours of drilling.

3. Borings B-6, B-11, B-16 and B-24 were converted to Piezometers P-1, P-2, P-3 and P-4, respectively, after completion of the borings. The results of piezometers observations indicated stabilized groundwater levels at a depth of about 10-ft below the existing grade in Piezometers P-1 and P-4. No stabilized groundwater level was encountered in Piezometers P-2 and P-3.

4. We understand that either open excavation or augering methods of construction will be used for the underground utilities installations. The bedding and backfill recommendations for the construction of the proposed underground utilities are also presented in this report.

5. We understand that majority of the proposed paving for the Memorial Drive will consist of concrete pavement and the remaining areas will be asphalt paved. The concrete pavement was designed on the basis of "1993 AASHTO Guide for Design of Pavement Structures." Furthermore, the proposed pavement will be designed based on major thoroughfare traffic. Based on the information provided for the project alignment, the recommended pavement thicknesses are as follows:

Concrete Pavement

Design, ESAL × 10^6	Concrete Pavement Thickness, inch(es)	Subgrade Stabilization Thickness, inch(es)
10.0	10.0	8.0

Flexible Pavement

Flexible Pavement Section	Design, ESAL x 10^6	Asphalt Pavement Thickness, inch	Base Course Thickness, inch	Subgrade Stabilization Thickness, inch
Alternative I:	10	4.0	8.0 (Black Base)	8.0
Alternative II:	10	4.0	20.0 (Crushed Concrete)	8.0

We understand that asphalt transition pavement for temporary road during construction could be used on this project. The recommended pavement component thicknesses are summarized as follows:

Asphalt Transition Pavement

Asphalt Pavement Thickness, inch(es)	Base Course (crushed limestone) Thickness, inch(es)
2.0	8.0

The base courses (crushed limestone) should be in accordance with "City of Houston Standard Specifications, Section 02714 – Flexible Base for Temporary Roads, Detours, Shoulders and Driveways". The base course should be compacted to 95 percent of Modified Proctor density (ASTM D 1557) at a moisture contents ranging from optimum to three-percent above optimum.

6. The type of subgrade stabilization for the concrete pavement areas will depend on the final grade elevation. Furthermore, the type and amount of stabilization should be evaluated once the final grade is reached. Subgrade preparation in pavement areas should specify compaction of the upper six-inch to at least 95% of maximum Standard Proctor density (ASTM D 698) at a moisture content between ±2% of optimum. Depending on the major type of soils encountered along the project alignment, lime-fly ash stabilization of the subgrade soils should most likely be performed. The upper eight-inch of the soils should be lime-fly ash stabilized, using 2% lime and 8% fly-ash by dry weight. The application rates corresponding to these additives amounts would be 12 pounds of lime and 48 pounds of fly-ash per square yard for eight-inch of compacted thickness. City of Houston Standard Specification 02337 should be used as a procedural guide for placing, mixing and compacting the lime-fly ash stabilizer and soils.

7. We understand that the Turkey Creek is about 17-ft deep. Furthermore, box culverts will be installed at the Turkey Creek. The design and construction recommendations for the proposed box culverts including bedding requirements, lateral pressures and groundwater control are presented in this report.

8. We understand that headwalls will be constructed at the end of the Box Culverts. The wall structure should be able to resist lateral loads. The soil design parameters for design and construction of the headwalls are presented in this report.

2.0 INTRODUCTION

It is planned to reconstruct approximately 11,200± linear feet of Memorial Drive from 500-ft east of North Kirkwood to the west of North Eldridge Parkway in City of Houston, Texas. A site vicinity map of the project alignment is presented on Plate 1. We understand that the existing asphalt and concrete paving will be removed and the majority of the existing pavement will be replaced with concrete paving. A portion of Memorial Drive will also consist of asphalt paving. In addition, underground utilities will be constructed along the project alignment. Furthermore, box culverts will be constructed at the Turkey Creek. The specific project information is as follows:

Facility	Remarks
Underground Utilities	We understand that the invert depths for the storm sewers will be ranging from 12- to 17-ft deep. In addition, there will be waterlines and sanitary sewer lines. The invert depths for these utility lines will be less than the storm sewers depths.
Pavements	It is planned to reconstruct 11,200± linear feet of Memorial Drive from 500-ft east of North Kirkwood to the west of North Eldridge Parkway in City of Houston, Texas. We understand that the majority of the existing asphalt and concrete paving will be removed and replaced with concrete paving. A portion of Memorial Drive will consist of asphalt paving.
Box Culverts and Head Walls at Turkey Creek	The Turkey Creek is about 17-ft deep. We understand that box culverts with headwalls will be constructed at the Turkey Creek.

Furnished information indicates that open-trench or augering method of construction will be used for underground utility installations. This report contains a description of our field and laboratory testing programs together with engineering analysis and recommendations for the proposed project alignment. Furthermore, installation and construction considerations for the Box Culverts and Head Walls are also presented in the report. The pavement design in this study is in general accordance with ASSHTO 1993 Guide of Design of Pavement Structure (Ref. 1). Furthermore, this report provides recommendation for construction of the underground utilities along the project alignment. Our recommendations on underground utilities, site preparation and soil stabilization are in general accordance with the City of Houston (COH) Department of Public Works & Engineering, Chapter 11, Geotechnical and Environmental Guidelines, dated July 2012 (Ref. 2). Slope stability analysis for the Turkey Creek was outside the scope of our work.

3.0 FIELD EXPLORATION

3.1 Pavement Coring

The existing pavement was cored prior to drilling and sampling. The results of pavement coring show that the existing pavement generally consists of concrete and asphalt. The existing pavement thicknesses are presented on Plate 2 and on the respective boring logs. The pavement core locations were patched with ready mix grout.

3.2 Drilling and Sampling

At the request of the client, the soil conditions were explored by conducting twenty-four (24) soil borings (B-1 through B-24) for paving and underground utilities along the project alignment. The soil boring locations were discussed with Mr. Michael D. Lacy, P.E. of CivilTech Engineering, Inc., prior to drilling. The soil borings were drilled along the project alignment to depths ranging from 10- to 35-ft below the existing grade. **Due to the presence of cohesionless soils at the termination depths of Borings B-12, B-15 and B-23, additional 5-ft samples were obtained.** Approximate boring locations are presented in Appendix A, Plates A-2 and A-3. A summary of borehole coordinates, elevations and station number information is presented on Plate 3.

Samples were obtained continuously to the boring completion depths ranging from 10- to 35-ft. The relative density or consistency and load carrying capacities of the subsoils were generally obtained by performing Texas Cone Penetrometer (TCP) in accordance with the Texas Highway Department test procedure. The test is conducted by recording the number of blows required for a 170-pound weight falling 24-inches. The weight drives a three-inch diameter cone to 12-inches into the subsoils at 5-ft intervals. Driving resistance for TCP, expressed as blows per foot, is tabulated on the boring logs presented in Appendix A, Plates A-4 through A-27.

Intermittent soil samples were also obtained at each boring location from the ground surface to depths ranging from 10- to 35-ft. The cohesive soils were sampled in general accordance with the ASTM D 1587.

Cohesionless soils were generally sampled with a split-spoon sampler driven in general accordance with the Standard Penetration Test (SPT), ASTM D 1586. This test is conducted by recording the number of blows required for a 140-pound weight falling 30-inches to drive the sampler 12-inches into the soil. Driving resistance for the SPT, expressed as blows per foot of sampler resistance (N), is tabulated on the boring logs.

Soil samples were examined and classified in the field, and cohesive soil strengths were estimated using a calibrated hand penetrometer. This data, together with a classification of the soils encountered and strata limits, is presented on the boring logs in Appendix A, Plates A-4 through A-27. Boring logs for B-1 through B-23 are presented in accordance with TxDOT Wincore format and boring log for B-24 for the Turkey Creek is presented in HCFCD format using gNIT format. A key to the log terms and symbols is presented on Plate A-28 in Appendix A.

Depth to groundwater is important for design and construction of the proposed facilities. For this reason, borings were drilled dry and the depth at which groundwater was first encountered was recorded. A wet rotary technique was used thereafter to the completion depth of the borings. Water level observations made during drilling and 24 hours after drilling are indicated at the bottom portion of each individual boring log. The boreholes were grouted with non-shrink grout using tremie method after the completion of the field work.

3.3 Piezometer Installation

Piezometers P-1, P-2, P-3 and P-4 were installed to depths of 20- and 25-ft in Borings B-6, B-11, B-16 and B-24, respectively, after completion of the field work. The piezometers consisted of two-inch diameter PVC riser pipe connected to a 10-ft long section of 0.01-inch slotted well screen. Each piezometer is capped at the top with a water tight flush mounted cap. After the borings were drilled, the riser pipe and well screen assembly were installed in the borings, filter sand was placed in the bottom of the borings and in the annulus between the borehole wall and the PVC pipe/screen, and subsequently the boreholes were sealed with bentonite grout from the top of the filter sand to the ground surface. The piezometers were developed by using a bailer to purge several volumes of water from the piezometer riser pipe. Water levels will be periodically measured to evaluate the stabilized groundwater table. The piezometer installation diagram is shown on Plate 4. A summary of the piezometer readings are presented in the "Piezometer Reading Table" on Plate 5. The piezometers were abandoned, in accordance with the TDLR (Chapter 76 of TAC), the City of Houston Design Manual, Item 11.14-Site Restoration. The piezometer installation and abandonment reports are provided in Appendix B.

4.0 LABORATORY TESTS

4.1 General

Soil classifications and shear strengths were further evaluated by laboratory tests on representative samples of the major strata. The laboratory tests were performed in general accordance with ASTM Standards. Specifically, ASTM D 2487 is used for classification of soils for engineering purposes. Furthermore, summary of test results are presented in Appendix A on Plates A-29 through A-52.

4.2 Classification Tests

As an aid to visual soil classifications, physical properties of the soils were evaluated by classification tests. The tests were conducted in general accordance with ASTM standards. These tests consisted of natural moisture content tests (ASTM D 4643), percent finer than the No. 200 sieve tests (ASTM D 1140) and Atterberg limit determinations (ASTM D 4318, Method A). Similarity of these properties is indicative of uniform strength and compressibility characteristics for soils of essentially the same geological origin. Results of these tests are tabulated on the boring logs at respective sample depths.

4.3 Strength Tests

Undrained shear strengths of the cohesive soils, measured in the field, were verified by calibrated hand penetrometer tests, unconfined compressive strength tests (ASTM D 2166) and torvane tests. Natural water content and dry unit weight were determined routinely for each unconfined compressive strength test. These test results are also presented on the boring log.

4.4 Particle Size Analysis Test

This test was conducted in general accordance with ASTM D 422, the Standard Method for Particle-Size Analysis of Soils. This test was performed on selected sample obtained from Boring B-24 at a depth of 17- to 19-ft. The analysis results are presented on Plate 6.

4.5 Soil Sample Storage

Soil samples tested or not tested in the laboratory will be stored for a period of seven days subsequent to submittal of the final report. The samples will be discarded after this period, unless we are instructed otherwise.

5.0 SITE GEOLOGY

According to the soil survey of Harris County, Texas (prepared by the U.S. Department of Agriculture Soil and Conservation Service (1976), geologically the project areas at the proposed alignment lies on the Addicks-Urban land complex (Ak), Aldine-Urban land complex (An), Aris-Urban land complex (As), Clodine-Urban land complex (Ce) and Verland-Urban land complex (Mu). The geologic character of each soil type is described below:

Addicks-Urban land complex (Ak) – The areas of this mapping unit are irregular in shape and generally range in size from 30 to 850 acres. A few areas are larger than a thousand acres. The boundaries commonly coincide with the outer limits of subdivisions and other built-up areas. The surface is plane to slightly convex. The slope ranges from 0 to 1 percent and averages about 0.3 percent.

Addicks loam makes up 25 to 85 percent of the complex, Urban land 10 to 60 percent, and other soils 5 to 20 percent. The areas are so intricately mixed that it was not practical to separate them at the mapping scale for this survey.

The Addicks soil has a surface layer of friable, neutral, black loam about 11 inches thick. The layer below this that is, friable, neutral, dark gray loam about 12 inches thick. The next layer is about 26 inches thick and consists of friable, moderately alkaline, light gray loam that is about 20 percent, by volume, visible calcium carbonate. The layer at a depth of about 49 inches is firm, moderately alkaline, light gray loam that has distinct yellow and yellowish brown mottles and is about 5 percent visible calcium carbonate.

Urban land consists of soils that support buildings and other urban structures that have covered or altered the soils so that classification is not practical. Typical structures are single- and multiple- unit dwellings, streets, schools, churches, parking lots, office buildings and shopping centers less than 40 acres in size. In places Urban land consists of small areas of Addicks loam that has been altered by cutting, filling and grading. Fill material has altered the soil in places. In some areas the entire profile is covered with 6 to 24 inches of fill material. Soils in the older areas that are drained by road ditches show less evidence of alteration.

Included with this unit in mapping are a few areas of Clodine, Gessner, Bernard and Midland soils. These soils are unaltered in places.

This mapping unit has moderate to severe limitations for urban development. Poor drainage is the greatest limitation. There are no limitations for landscaping or for gardening. Chlorosis is common in areas where cuts have been made. Most of the acreage was formerly in cropland or native pasture.

Aldine-Urban land complex (An) – This is a nearly level to gently sloping complex in metropolitan areas and in rural areas where the population is increasing. This soil unit is of minor extent. Areas are irregular in shape and generally range from 30 to 250 acres in size. The slope is mainly 0 to 2 percent but ranges to 3 percent. Native pine and hardwoods are common in most areas. The Aldine soil makes up 25 to 75 percent of this complex, Urban land 10 to 70 percent, and other soils 5 to 20 percent.

The surface layer of the Aldine soil is friable, medium acid, dark grayish brown very fine sandy loam about 5 inches thick. It tongues into a layer of friable, very strongly acid, yellowish brown loam about 9 inches thick. The next layer, about 11 inches thick, is firm, very strongly acid, gray clay that has mottles of yellowish brown and red. Below that, extending to a depth of 6 inches, is a layer of firm, slightly acid, light gray clay loam that has less mottles with depth.

Urban land consists of soils that have been altered or obscured by buildings and other urban structures, making their classifications impractical. Typical structures are single- multiple-unit dwellings, garages, sidewalks, patios, driveways, streets, schools, churches, shopping centers, office buildings, paved parking lots, and industrial parks. Included with Urban land are small areas of the Aldine soil that have been altered by cutting, filling, and grading. In places, 6 to 24 inches of fill material has been added to improve drainage.

Aris-Urban Land Complex (As) – This is nearly level complex in broad, irregular areas that are 30 to 1,000 acres in size. Slopes range from 0 to 1 percent but average about 0.3 percent. The Aris soils makes up 20 to 75 percent of the complex; Urban land 10 to 75 percent, and other soils 5 to 20 percent.

The surface layer of the Aris soil is friable, neutral, dark grayish brown fine sandy loam about 7-inch thick. The layer below that is friable, slightly acid, grayish brown fine sandy loam that extends to a depth of 21-inch. The next layer, extending to a depth of 28-inch, is firm, medium acid, gray sandy clay loam that has tongues and interfingers. The layer below that extends to a depth of 46-inch and is very firm, strongly acid, dark gray clay that has mottles of red and strong brown. The next layer is very firm, medium acid, gray clay that extends to a depth of 60-inch, where it grades to very firm, slightly acid, light gray clay loam.

Clodine-Urban Land Complex (Ce) – This is nearly level complex in broad, irregular areas that range from 20 to several hundred acres in size. The slope ranges from 0 to 1 percent but averages 0.6 percent. Clodine soils make up 20 to 85 percent of the complex; Urban land, 10 to 75 percent; and other soils, 5 to 20 percent.

The surface layer of the Clodine soil is friable, dark gray loam abut 12-inch thick. It is neutral in the upper part and moderately alkaline in the lower part. The layer below that is friable, moderately alkaline, gray loam about 17-inch thick. The next layer is friable, moderately alkaline, light brownish gray loam that has irregular, pitted calcium carbonate concretions.

Verland-Urban land complex (Mu) – The soils in this mapping unit are nearly level and are in broad, irregular areas that range in size from about 30 to 600 acres. Slopes range from 0 to 1 percent, but the average is 0.5 percent. Most areas are open prairie, but some are covered with native harwood tress.

These soils make up 20 to 75 percent of this complex, Urban land, 10 to75 percent, and other soils, 15 percent or less. The surface layer is firm, strongly acid dark grayish brown silty clay loam about 7 inches thick. The next layer, extending to a depth of 50 inches, is very firm, dark gray clay that is slightly acid in the upper part and neutral in the lower part. It has slickensides in the upper part. The next layer, to a depth of 72 inches, consists of very firm, moderately alkaline clay that us mottled gray, olive yellow, and brownish yellow.

Included in mapping are small areas of Bernard, Lake Charles, Beaumont, Ozan, and Gessner soils. This mapping unit has severe limitations for urban development. Poor drainage and shrinking and swelling in the underlying layers are the main limitations.

6.0 GENERAL SOILS AND DESIGN CONDITIONS

6.1 Site Conditions

The proposed Memorial Drive improvements alignment stretches from north Kirkwood Drive to north Eldridge Parkway in City of Houston, Texas. The project alignment is an undivided two lane asphalt and concrete paved roadway. In general residences, commercial and educational facilities exist in the vicinity of the project alignment. Project site pictures were taken during our site visit. These pictures are presented in Appendix C.

6.2 Soil Stratigraphy

Field and laboratory test data indicate that soil stratigraphy along the project alignment are variable. **Details of subsoil conditions at each boring location are presented on the respective boring logs**. General soil stratigraphy for the proposed project alignment is presented in the following report sections:

6.2.1 Memorial Drive (Borings B-1 through B-8)

Based on Borings B-1 through B-8, the soils can be grouped into seven (7) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		EXISTING ASPHALT PAVEMENT (5.5" to 14" in Thickness)
		STABILIZED SUBGRADE (6" to 8" in Thickness)
I	0.9 – 10	CLAY, soft to stiff, moist, dark brown, reddish brown, brownish yellow, with root fibers, ferrous and calcareous nodules (CL)
II	1.2 – 4	SILTY SAND, loose, moist, brown, dark brown, reddish brown, with clay pockets (SM)
III	2 – 25	CLAY, very soft to very stiff, moist, gray, reddish brown, brownish yellow, with root fibers to 4', ferrous and calcareous nodules (CH)
IV	17 – 20	CLAY, very stiff, moist, reddish brown, with ferrous and calcareous nodules (CL); In Boring B-5 and B-8 only
V	17 – 25	SILT, slightly compact to compact, wet, reddish brown, with clay seams (ML)
VI	20 – 22	SILTY SAND, wet, reddish brown, with clay seams (SM); In Boring B-7 and B-8 only
VII	22 – 25	CLAY, stiff to very stiff, moist, reddish brown, with ferrous and calcareous nodules (CL)

6.2.2 Memorial Drive (Borings B-9 through B-16)

Based on Borings B-9 through B-16, the soils can be grouped into seven (7) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		EXISTING ASPHALT PAVEMENT (2.3" to 12" in Thickness)
		EXISTING CONCRETE PAVEMENT (12" in Thickness); At Boring B-12 only
		STABILIZED SUBGRADE (4" to 8" in Thickness)
I	0.5 – 5	SILTY SAND, loose, moist, dark brown, brownish yellow, with clay pockets (SM)
II	1.1 – 12	CLAY, very soft to stiff, moist, dark brown, reddish brown, brownish yellow, with ferrous and calcareous nodules (CL)
III	2 – 5	SILT, loose to very loose, moist, dark brown, brownish yellow, with clay pockets (ML); In Borings B-15 and B-16 only

Stratum No.	Range of Depth, ft.	Soil Description*
IV	7 – 30	CLAY, soft to very stiff, moist, dark brown, reddish brown, brownish yellow, with ferrous and calcareous nodules, silts (CH)
V	15 – 35	CLAY, stiff, moist, dark brown, reddish brown, brownish yellow, with ferrous and calcareous nodules (CL)
VI	22 – 24	SILTY SAND, wet, reddish brown, with clay seams (SM); In Boring B-12 only
VII	27 – 30	SILT, slightly compact, moist, reddish brown, with clay seams (ML); In Boring B-15 only

6.2.3 Memorial Drive (Borings B-17 through B-20)

Based on Borings B-17 through B-20, the soils can be grouped into five (5) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		EXISTING ASPHALT PAVEMENT (2" to 5.7" in Thickness)
		STABILIZED SUBGRADE (4" to 6" in Thickness)
I	0.5 – 5	SILTY SAND, loose, moist, dark brown, with clay pockets (SM)
II	2 – 10	CLAY, very soft to soft, moist, dark brown, brownish yellow, with ferrous and calcareous nodules (CL)
III	2 – 20	CLAY, soft to hard, moist, dark brown, reddish brown, brownish yellow, with ferrous and calcareous nodules (CH)
IV	15 – 25	CLAY, very stiff, moist, reddish brown, brownish yellow, with ferrous and calcareous nodules (CL)
V	20 – 25	SILT, slightly compact, moist to wet, reddish brown, with clay seams (ML); In Boring B-19 only

6.2.4 Memorial Drive (Borings B-21 through B-23)

Based on Borings B-21 through B-23, the soils can be grouped into six (6) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
		EXISTING ASPHALT PAVEMENT (4.1" to 11.7"in Thickness)
		STABILIZED SUBGRADE (4" to 6" in Thickness)
I	0.7 – 15	CLAY, very soft to stiff, moist, dark brown, reddish brown, brownish yellow, with ferrous and calcareous nodules (CL)

Stratum No.	Range of Depth, ft.	Soil Description*
II	1.5 – 2	SILTY SAND, moist, dark brown, with clay pockets (SM); In Boring B-23 only
III	12 – 25	SILTY SAND, loose, moist, reddish brown, with clay seams (SM); In Boring B-23 only
IV	15 – 32	SILT, slightly compact to compact, moist to wet, reddish brown, with clay seams (ML)
V	22 – 27	CLAY, soft, moist, reddish brown, with ferrous and calcareous nodules (CL); In Boring B-22 and B-23 only
VI	32 – 35	CLAY, slightly compact, moist, reddish brown, with ferrous and calcareous nodules (CH); In Boring B-23 only

6.2.5 Turkey Creek (Boring B-24)

Based on Boring B-24, the soils can be grouped into seven (7) major strata with depth limits and characteristics as follows:

Stratum No.	Range of Depth, ft.	Soil Description*
I	0 – 2	FILL: SANDY LEAN CLAY, very stiff, dark brown, with root fibers, ferrous and calcareous nodules (CL)
II	2 – 10	FILL: SILTY SAND, loose to medium dense, brownish yellow, with clay seams (SM)
III	10 – 15	FAT CLAY, stiff to very stiff, brownish yellow, with ferrous and calcareous nodules (CH)
IV	15 – 20	SILT, loose to medium dense, reddish brown (ML)
V	20 – 22	LEAN CLAY, very stiff, reddish brown, with ferrous and calcareous nodules (CL)
VI	22 – 30	SANDY SILT, medium dense, reddish brown (ML)
VII	30 – 35	FAT CLAY, very stiff, reddish brown, with ferrous and calcareous nodules (CH)

* Classification in general accordance with the Unified Soil Classification System (ASTM D 2487)

6.3 Soil Properties

6.3.1 Memorial Drive (Borings B-1 through B-8)

Soil strength and index properties and how they relate to the pavement design and underground utility installations along the project alignment are summarized below:

Stratum No.	Soil Type	TCP (s) (blow/ft)	PI (s)	SPT	Soil Expansivity	Soil Strength, tsf	Remarks
I	Clay (CL)	9 – 33	15 – 26	–	Low- to Moderately Expansive	0.56 – 2.60	–
II	Silty Sand (SM)	10	–	13	Non-Expansive	–	Moisture Sensitive
III	Clay (CH)	6 – 65	31 – 41	–	Expansive	0.31 – 2.59	–
IV	Clay (CL)	58 – 93	22 – 23	–	Low- to Moderately Expansive	1.43 – 2.63	–
V	Silt (ML)	25 – 74	–	25 – 74	Non-Expansive	–	Moisture Sensitive
VI	Silty Sand (SM)	–	–	23 – 49	Non-Expansive	–	Moisture Sensitive
VII	Clay (CL)	28 – 50 (4”)	28	–	Moderately Expansive	0.47 – 1.01	–

6.3.2 Memorial Drive (Borings B-9 through B-16)

Stratum No.	Soil Type	TCP (s) (blow/ft)	PI (s)	SPT	Soil Expansivity	Soil Strength, tsf	Remarks
I	Silty Sand (SM)	12	–	–	Non-Expansive	–	Moisture Sensitive
II	Clay (CL)	4 – 21	16 – 28	–	Non- to Moderately Expansive	0.31 – 2.81	–
III	Silt (ML)	7 – 10	–	–	Non-Expansive	–	Moisture Sensitive
IV	Clay (CH)	14 – 96	33 – 50	–	Expansive	0.46 – 2.60	–
V	Clay (CL)	30 – 50(5”)	12 – 16	–	Non-Expansive	0.31 – 1.70	–
VI	Silty Sand (SM)	–	–	43	Non-Expansive	–	Moisture Sensitive
VII	Silt (ML)	32	–	20	Non-Expansive	–	Moisture Sensitive

6.3.3 Memorial Drive (Borings B-17 through B-20)

Stratum No.	Soil Type	TCP (s) (blow/ft)	PI (s)	SPT	Soil Expansivity	Soil Strength, tsf	Remarks
I	Silty Sand (SM)	17	–	–	Non-Expansive	–	Moisture Sensitive
II	Clay (CL)	4 – 20	23 – 29	–	Moderately Expansive	0.39 – 1.89	–
III	Clay (CH)	13 – 50 (5”)	38 – 49	–	Expansive	0.73 – 2.43	–
IV	Clay (CL)	30 – 50 (5”)	14 – 15	–	Non-Expansive	0.19 – 1.50	–
V	Silt (ML)	36	–	21 – 30	Non-Expansive	–	Moisture Sensitive

6.3.4 Memorial Drive (Borings B-21 through B-23)

Stratum No.	Soil Type	TCP (s) (blow/ft)	PI (s)	SPT	Soil Expansivity	Soil Strength, tsf	Remarks
I	Clay (CL)	4 – 28	16 – 27	–	Non- to Moderately Expansive	0.31 – 2.05	–
II	Silty Sand (SM)	–	–	–	Non-Expansive	–	Moisture Sensitive
III	Silty Sand (SM)	11 – 20	–	8 – 11	Non-Expansive	–	Moisture Sensitive
IV	Silt (ML)	27 – 74	–	11 – 27	Non-Expansive	–	Moisture Sensitive
V	Clay (CL)	17	28	–	Moderately Expansive	0.46 – 0.74	–
VI	Clay (CH)	40	43	–	Expansive	1.50	–

6.3.5 Turkey Creek (Boring B-24)

Stratum No.	Soil Type	TCP (s) (blow/ft)	PI (s)	SPT	Soil Expansivity	Soil Strength, tsf	Remarks
I	Fill: Sandy Lean Clay (CL)	–	15	–	Non-Expansive	1.99	–
II	Fill: Silty Sand (SM)	11 – 12	–	10 – 16	Non-	–	Moisture Sensitive
III	Fat Clay (CH)	12	33	–	Expansive	0.91 – 1.11	–
IV	Silt (ML)	12	–	9 – 11	Non-Expansive	–	Moisture Sensitive
V	Lean Clay (CL)	–	19	–	Non-Expansive	1.69	–
VI	Sandy Silt (ML)	14	–	13 – 21	Non-Expansive	–	Moisture Sensitive
VII	Fat Clay (CH)	12	35	–	Expansive	1.28 – 1.42	–

Legend: TCP = Texas Cone Penetrometer
PI = Plasticity Index
SPT = Standard Penetration Test

6.4 Water-Level Measurements

The soil borings were first drilled dry to evaluate the presence of perched or free-water conditions. A wet rotary technique was used thereafter to the completion depths of the borings. The levels where free water was first encountered in the open boreholes during drilling and 24 hours after drilling are shown on the boring logs. Our groundwater/perched water measurements in the boreholes and piezometers are as follows:

Boring No./ Piezometer	Groundwater/Perched Water Elevation, ft. at the Time of Drilling	Groundwater/ Perched Water Elevation, ft. After 24 Hour Later	Piezometer Water Elevation, ft.	
			1st Reading	2nd Reading
B-1	Dry	Dry	–	–
B-2	61.67	61.67	–	–
B-3	62.49	62.49	–	–

Boring No./ Piezometer	Groundwater/Perched Water Elevation, ft. at the Time of Drilling	Groundwater/ Perched Water Elevation, ft. After 24 Hour Later	Piezometer Water Elevation, ft.	
			1st Reading	2nd Reading
B-4	62.94	63.94	–	–
B-5	65.00	68.00	–	–
B-6/P-1	60.30	60.30	72.30	72.30
B-7	68.48	69.48	–	–
B-8	64.95	64.95	–	–
B-9	64.80	64.80	–	–
B-10	Dry	Dry	–	–
B-11/P-2	Dry	Dry	Dry	Dry
B-12	59.89	66.89	–	–
B-13 and B-14	Dry	Dry	–	–
B-15	56.71	57.71	–	–
B-16/P-3	Dry	Dry	Dry	Dry
B-17 and B-18	Dry	Dry	–	–
B-19	64.50	64.50	–	–
B-20	Dry	Dry	–	–
B-21	62.85	62.85	–	–
B-22	63.89	63.89	–	–
B-23	63.00	63.00	–	–
B-24/P-4	58.00	64.00	64	64

Fluctuations in groundwater generally occur as a function of seasonal moisture variation, temperature, groundwater withdrawal and future construction activities that may alter the surface drainage and subdrainage characteristics of this site.

An accurate evaluation of the hydrostatic water table in the relatively impermeable clay and low permeability silts/sands requires long term observation of monitoring wells and/or piezometers. It is not possible to accurately predict the pressure and/or level of groundwater that might occur based upon short-term site exploration. In view of this, Borings B-6, B-11, B-16 and B-24 were converted to Piezometer P-1, P-2, P-3 and P-4, respectively, after completion of field work. The result of piezometer observations are presented in Plate 5.

We recommend that GET be immediately notified if a noticeable change in groundwater water occurs from that mentioned in our report. We would be pleased to evaluate the effect of any groundwater changes on our design and construction sections of this report.

7.0 UNDERGROUND UTILITIES

7.1 General

We understand that underground utility installations will include storm sewers, sanitary sewers and water lines. Furnished information indicated that the depth of storm sewers will be ranging from 12- to 17-ft deep. In addition, there will be waterlines and sanitary sewer lines. The invert depths for these utility lines will be less than the storm sewers depths. Furthermore, Open-trench or Augering method will be used for the underground utility installations. Soil Borings B-1 through B-23 were drilled along the project alignment for the underground utilities and paving to depths ranging from 10- to 35-ft below the existing grade. We understand that the proposed underground utilities will be constructed according to the "City of Houston Specifications, Section 02317 – Excavation and Backfill for Utilities, and Section 02447 – Augering Pipe and Conduit".

7.2 Open-Trench Method

7.2.1 Sewerlines

In general, where dry stable trench conditions exist, bedding and backfill for the sanitary sewerlines should be in accordance with the City of Houston Specifications Drawing No. 02317-03. Bedding for the sanitary sewerlines, where wet stable trench conditions exist (where excavations below groundwater table are required), should be in accordance with the City of Houston Specifications Drawing No. 02317-02.

The results of our field exploration and laboratory testing indicate that unsatisfactory soils for excavation, such as soft clay (CL), silty sand (SM) and silt (ML) soils, exist at various depths in the borings along the project alignment. A summary of the unsatisfactory soils, locations and depths are as follows:

Boring(s)	Depth Range, ft.
B-1	0 to 2
B-2	0 to 2 / 17 to 22
B-3	17 to 25
B-5	0 to 4 / 20 to 25
B-6	20 to 25
B-7	20 to 22
B-8	0 to 5 / 20 to 22
B-9	0 to 2

Boring(s)	Depth Range, ft.
B-10	0 to 2
B-11	0 to 2
B-12	0 to 2 / 22 to 24
B-14	0 to 5
B-15	0 to 5 / 27 to 30
B-16	0 to 5
B-17	0 to 2
B-18	0 to 2 / 22 to 25
B-19	0 to 5 / 20 to 25
B-20	0 to 2
B-21	15 to 30
B-22	15 to 22
B-23	0 to 2, 12 to 25 / 27 to 32
B-24	2 to 10, 15 to 20 / 22 to 30

If these conditions are encountered during the time of construction, suitable groundwater control measures should be implemented in accordance with the "City of Houston Standard Specifications, Section 01578 – Control of Groundwater and Surface Water". Furthermore, the contractor may have to over excavate an additional 6-inch and remove unstable or unsuitable materials with approval by geotechnical engineer, then place an equal depth of cement stabilization sand.

Due to potential variability of the on-site soils, unstable trench conditions may still exist in the areas where we did not conduct our borings. If these conditions are encountered during the time of construction, a stable trench should be provided to allow proper bedding and installation.

Sand backfill used in the cement-stabilized sand and sand backfill sections should be free of clay lumps, organic materials, or other deleterious substances, and should have a PI less than 4 for the cement-stabilized sand and less than 7 for the sand backfill section, and not more than 15% passing the No. 200 sieve. Cement stabilized sand should conform to the "City of Houston Standard Specifications, Section 02321 – Cement Stabilized Sand".

7.2.2 Water Lines

The bedding and backfill for the proposed water lines should be constructed in accordance with the City of Houston Specifications drawing No. 02317-04 for open-trench construction. Trenches for the proposed water lines must have a width below the top of the pipe of not less than the outside diameter of the pipe plus 24-inches and shall be wide enough to permit making up the joints but shall not be wider than the outside diameter of the pipe plus 36-inches.

In general, 12-inches of bank sand should be placed above the waterlines. Twelve-inch lifts of bank sand should be placed below the waterlines for dry excavation bottom. In case of wet excavation bottom, geotextile fabrics should be placed at the excavation bottom and along the excavation sides to a height of at least 24 inches.

7.3 Augering and Augering Pits

7.3.1 Sewer Lines, Water Lines and Box Culverts

We understand that Augering may be used for the underground utility installations along the proposed alignment and box culverts at the Turkey Creek in City of Houston, Texas. The augering should be conducted in accordance with the City of Houston Standard Specifications 02447 – Augering Pipe and Conduit or 02448 – Pipe and Casing Augering for Sewers. Augering should be started from approved pit locations. Excavation for pits and shoring installation should conform to the aforementioned City of Houston Standard Specifications and 02317 – Excavation and Backfill for Utilities. If the augering zone is within the cohesionless soils or collapsible soils, install casings as required by City of Houston Standard Specifications 02447 – Augering Pipe and Conduit. The augering near existing structures or utility lines should be conducted in accordance with the City of Houston Standard Specification 02233 – Clearing and Grubbing.

Diameter of auger hole should not exceed pipe bell diameter plus 2-inches. The receiving pit distance should conform to the aforementioned City of Houston Standard Specifications. A minimum spacing of 6-inches should be provided between the pipe and walls of bore pit. The maximum allowable width of pit shall be 5-ft unless approved by City Engineers. Width of pit at surface shall not be less than the pit width at the bottom.

8.0 BOX CULVERT RECOMMENDATIONS

8.1 General

We understand that the Turkey Creek is about 17-ft deep. Furthermore, box culverts and head wall will be constructed at the Turkey Creek. We understand that the founding depth for the box culverts will be about 17-ft. Excavation and groundwater control for construction of these structures should be in accordance with our recommendations provided in construction consideration section of this report (Section 11). The proposed box culverts may be designed in accordance with the parameters presented on Plate 7.

8.2 Allowable Bearing Pressure

We understand that the box culverts may be supported on a seal slab foundation at about El. +57-ft. The allowable bearing pressures for the seal slab foundation at this elevation are as follows:

Foundation Type	Elevation, ft.	Allowable Net Bearing Pressure, psf	
		Dead Load*	Total Load (Dead + Live)
Seal Slab	+57.0	1,000	1,250

* Dead load + sustained live load

Footings proportioned in accordance with the above bearing capacity values will have a safety factor of 2.5 and 2.0 with respect to shearing failure for dead and total loading, respectively.

8.3 Lateral Earth Pressures

In the event that open excavations are not used, the proposed box culvert can be installed using trench sheeting. The sheeting can be constructed in the form of cantilever sheeting or with bracing. Lateral earth pressures for each method used are summarized on Plate 8. The trenching and shoring operations should follow OSHA Standards. We recommend a geotechnical engineer monitor all phases of trench excavation and bracing to assure trench safety.

8.4 Buoyancy

The proposed box culverts will experience uplift loads from the groundwater during flood conditions. The box culverts should perform satisfactorily if a design factor of safety against uplift loads of 2.0 is used. In general, the hydrostatic pressure will be resisted by the dead weight of the structure, weight of the overburden soils above the top of the box culverts and the friction or adhesion between the walls and natural soils or fill. A submerged unit weight of 60 pounds per cubic foot (pcf) and 87 pcf can be used for soils and concrete, respectively, to compute the resistance to uplift loads. An adhesion value of 200 psf can be used between the backfill and the box culverts to resist the uplift loads. A factor of safety of 2.0 is included in the adhesion value.

9.0 HEADWALLS

9.1 General

We understand that headwall structure will be installed at the end of the box culverts. The wall structure should be able to resist lateral loads. The headwall structures can be designed in general accordance with the City of Houston Specifications, Section 02632 – Cast-In-Place Inlets, Headwalls and Wingwalls. The soil design parameters for design and construction of the wall structure are presented in the following report section. We assumed a horizontal backfill behind the headwall.

9.2 Headwall Foundation

We understand that the headwall will be supported on a strip footing type foundation. Bearing capacity is the ability of the soil to safely carry the pressure placed on the soil without undergoing a shear failure with accompanying large settlements. Based on the results of the field and laboratory testing and bearing capacity theory, a net allowable bearing capacity of 1,000 psf can be used for dead load considering the foundation depth at 17-ft. The allowable loading for total load (Dead + Live load) can be increased by 50 percent.

9.3 Lateral Earth Pressures

Based on our field exploration and laboratory testing, lateral earth pressure coefficients were developed, using correlation of soil data, for the design of the proposed wall structure. We recommend lean clay soils as backfill behind the headwalls. The assumed backfill materials behind the headwalls will have an estimated total unit weight and undrianed stress cohesion of 120 pcf and 1,000 psf, respectively. The design parameters for the backfill soils and soils in front of the wall were computed based on the assumed wall configuration, using Log-Spiral theory (Ref. 3). These data are summarized on Plate 9. We assumed a horizontal backfill behind the headwall structure. We recommend the water level behind the headwall to be assumed at the top of wall.

10.0 DRILLED SHAFT CAPACITY

We evaluated the drilled shaft capacity curves based on the borings. Our design recommendations are independent of shaft size in order to permit comparison and consideration of various shaft sizes and penetrations. This data is shown in Appendix F, in the form of accumulative allowable static friction resistance (F), and allowable point bearing component (E), as a function of shaft tip penetration below the ground level. The design factors E and F for drilled shafts shown in Appendix F define allowable capacity using TxDOT Wincore program. Furthermore, a soil reduction factor of 0.7 was used for skin friction calculations.

Shaft spacing should not be less than three diameters of the shaft; otherwise, the drilled shaft capacities would require adjustment to account for group effects. It should, however be noted that this shaft spacing is a minimum requirement and should be increased accordingly based on the anticipated drilled shaft group action.

11.0 PAVEMENT RECOMMENDATIONS

11.1 General

It is planned to reconstruct approximately 11,200± linear feet of Memorial Drive from 500-ft east of North Kirkwood to the west of North Eldridge Parkway in City of Houston, Texas. We understand that the existing asphalt and concrete pavement will be removed and replaced with new concrete paving. In addition, a portion of the Memorial Drive will be asphalt paved. The new pavement design is in accordance with the "1993 ASSHTO Guide for Design of Pavement Structures" (Ref. 1). Furthermore, our recommendations on site preparation and soil stabilization are in general accordance with the City of Houston (COH) Department of Public Works & Engineering, Chapter 11, Geotechnical and Environmental Guidelines, Dated January 2011 (Ref. 2).

11.2 Traffic Information

Based on the information provided by the client, GET estimated the traffic volume and 18-kip equivalent axle loads (EALs). Furthermore, the pavement will be designed based on major thoroughfare traffic. A design ESAL of 10×10^6 was used for the proposed project alignment. The results of the pavement design analyses are provided in the following sections.

11.3 Subgrade Stabilization

The type of subgrade stabilization for the concrete pavement areas will depend on the final grade elevation. Furthermore, the type and amount of stabilization should be evaluated once the final grade is reached. Subgrade preparation in pavement areas should specify compaction of the upper six-inch to at least 95% of maximum standard Proctor density (ASTM D 698) at a moisture content between ±2% of optimum. Depending on the major type of soils encountered along the project alignment, lime-fly ash stabilization of the subgrade soils should most likely be performed. The upper eight-inch of the soils should be lime-fly ash stabilized, using 2% lime and 8% fly-ash by dry weight. The application rates corresponding to these additive amounts would be 12 pounds of lime and 48 pounds of fly-ash per square yard for eight-inch of compacted thickness. City of Houston Standard Specification 02337 should be used as a procedural guide for placing, mixing and compacting the lime-fly ash stabilizer and soils.

As on a alternative to lime fly-ash subgrade stabilization, the sandy/silty subgrade can be stabilized with cement in accordance with City of Houston Standard Specification for Portland Cement Stabilized Subgrade, Section 02338.

Our recommendations on subgrade stabilization are preliminary. The actual depth and type of stabilization should be determined in the field at the time of construction just after site stripping and proofrolling. Furthermore, the type and amount of the stabilizer may vary depending on the final grade elevation and the soil type encountered.

11.4 Recommended Subgrade Design Values

Results of the soils test indicated that subgrade soils consist of sand (SM) and clay (CL) soils based on Unified Soils Classification System (ASTM D 2487). The recommended design parameters based on sand (SM) and clay (CL) for CBR and M_R values are 5 and 7,500 psi, respectively.

11.5 Concrete Pavement

The following design parameters (based on 1993 AASHTO Guide for Design of Pavement Structures, Ref. 1) were used in the concrete pavement design for the proposed project alignment.

AASHTO Design Parameter	Pavement Design Value
ESAL × 10^6 for 20-year design life	10.0
Reliability, R	95%
Overall Standard Deviation, S_0	0.35
Load Transfer Coefficient, J	3.2
Loss of Support, LS	1.0
Drainage Coefficient, C_d	1.2
Design Serviceability Loss, Δ psi	2.0
Concrete Modules of Rupture (28 days) in psi, S_c'	620

AASHTO Design Parameter	Pavement Design Value
Concrete Compressive Strength at 28 days in psi, f_c'	3,500
Effective Modulus of Subgrade Reaction k, in pci	125

Based on the above design parameters, the minimum concrete pavement section thickness are as follows:

Design, ESAL × 10^6	Concrete Pavement Thickness, inch(es)	Subgrade Stabilization Thickness, inch(es)
10.0	10.0	8.0

Detailed design computations are presented in Appendix E. Our design recommendations also consider excellent drainage is provided near the pavement structures, assuming the pavement are exposed to moisture levels approaching saturation from 1 to 5 percent of the time. Concrete should meet the requirements of the City of Houston design paving specifications as well as AASHTO "Guide Specifications for Highway Construction and the Structural Specifications for Transportation Materials." The construction of rigid pavement should be in accordance with the City of Houston Standard Specification Drawing No. 02751-01.

Our recommendations for the steel reinforcement placement are in general accordance with the City of Houston Standard Specification (Ref. 2) for the jointed reinforced concrete pavements. The reinforcement steel bar sized and spacing are summarized as follows:

		Longitudinal Steel			Transverse Steel
		# 4 Bars			# 4 Bars
Pavement Thickness, in.	Pavement Width, ft.	No. of Bars	Spacing, in.	End Bar Spacing, in.	Spacing, in.
10.0	45	44	12.50	3	24

The reinforcement steel should be Grade 60. We recommend a lap length of 22-inches for the No. 4 bars.

11.6 Flexible Pavement

The following design parameters (based on 1993 AASHTO Guide for Design of Pavement Structures, Ref. 1) were used in the Flexible pavement design for the proposed Memorial Drive.

AASHTO Design Parameter	Design Value
Reliability, R	95%
Overall Standard Deviation, S_0	0.45
Drainage Coefficient, m_i	1.3
Design Serviceability Loss, Δ psi	1.7

AASHTO Design Parameter	Design Value
California Bearing ratio (CBR)	5
Subgrade Resilient Modulus (M_R) in psi	7,500
Structural Layer Coefficients	
Black Base	0.34
Crushed recycled Concrete (or Raw Limestone)	0.14
Lime-Stabilized or Lime-Fly Ash Stabilized Earth	0.11
Design Structural Number, SN	5.3

We have assumed two types of base in our design. These bases may consist of either Black Base (Alternative I) or crushed concrete (Alternative II). Based on the above design parameters, the recommended asphalt pavement sections are as follows:

Alternative	Design, ESAL x 10^6	Asphalt Pavement Thickness, inches	Base Course Thickness, inches	Subgrade Stabilization Thickness, inches
			(Black Base)	
I	10.0	4.0	8.0	8.0
			(Crushed Concrete)	
II	10.0	4.0	20.0	8.0

Detailed Pavement Design Computations are presented on Plate E-3 in Appendix E. Our asphalt designs also consider excellent drainage is provided near the pavement structures, assuming the pavement are exposed to moisture levels approaching saturation from 1 to 5 percent of the time.

11.7 Asphalt Transition Pavement

We understand that asphalt transition pavement for temporary road during construction could be used on this project. The recommended pavement component thicknesses are summarized as follows:

Asphalt Pavement Thickness, inch(es)	Base Course (crushed limestone) Thickness, inch(es)
2.0	8.0

The base courses (crushed limestone) should be in accordance with "City of Houston Standard Specifications, Section 02714 – Flexible Base for Temporary Roads, Detours, Shoulders and Driveways". The base course should be compacted to 95 percent of modified Proctor density (ASTM D 1557) at a moisture contents ranging from optimum to three-percent above optimum.

12.0 CONSTRUCTION CONSIDERATIONS

12.1 Site Preparation

Majority of the project alignment have the potential for construction problems related to the surficial layer of sandy soils. These permeable surficial soils are underlain by relatively impermeable clay soils. Thus, due to poor site drainage, wet season or site geohydrology, water ponds on the clays and creates a "perched water table condition." The surficial sand soils become extremely soft when wet, and must be stabilized, aerated, or replaced. Site preparation should be conducted in accordance with the "City of Houston Standard Specifications, Section 02221 – Removing Existing Pavements and Structures and Section 02233 – Clearing and Grubbing". In general, subgrade preparation should be as follows:

1. The requirement for removal of any existing paving, and subsoil materials will depend on final grades and other alignment information. In general, remove all vegetation, tree roots, organic topsoil, existing foundations, paved areas and any undesirable materials from the construction area. Tree trucks under the pavement should be removed to a root size of less than 0.5-inches. We recommend that the stripping depth be evaluated at the time of construction by a soil technician.

2. The subgrade areas should then be proofrolled with a loaded dump truck or similar pneumatic-tired equipment with loads ranging from 25- to 50-tons. The proofrolling serves to compact surficial soils and to detect any soft or loose zones. The proofrolling should be conducted in accordance with TxDOT Standard Specification Item 216. Any soils deflecting excessively under moving loads should be undercut to firm soils and recompacted. Any subgrade stabilization should be conducted after site proofrolling is completed and approved by the geotechnical engineer. The proofrolling operations should be observed by an experienced geotechnician.

3. Off-site borrow for fill should consist of lean clays with a liquid limit not exceeding 40 and a PI between 12 and 20. These soils should be placed in loose lifts not exceeding eight-inches and compacted to at least 95% of maximum standard Proctor density (ASTM D 698) at a moisture content between optimum and 3%. Bank sands should not be used as select structural fill. On-site soils, free of organics, (with the exception of sands and silts) are also suitable for use as structural fill.

4. In cut areas, the soil should be excavated to grade and the surficial soil proofrolled and scarified to a minimum depth of six-inches and recompacted to the previously mentioned density and moisture content.
5. Positive site drainage should be developed at the beginning of the project to limit construction difficulties with wet surface soils.

12.2 Suitability of On-Site Soils for Use as Fill

12.2.1 General

Fill requirements should be in accordance with the 'City of Houston Standard Specifications, Section 02316 –Excavation and Backfill for Structures, Section 02317 – Excavation and Backfill for Utilities and Section 02320 – Utility Backfill Materials". The on-site soils can be used as fill materials as described in the following report sections.

12.2.2 Select Backfill

This is the type of fill that can be used for the structures or utilities. These soils should consist of clay (CL) with plasticity indices between 8 and 20 and amount of passing No. 200 sieve greater than 50 percent.

12.2.3 Random Backfill

This type of fill does not meet the Atterberg limit requirements for select structural fill. This fill should consist of clay (CL or (CH). They can be used for the structures or utilities after treatment.

12.2.4 General Fill

This type of fill consists of silts, sands and clays. However, the silts and sands are moisture sensitive and are difficult to compact in a wet condition (they may pump). Furthermore, these soils can erode easily. Their use is not recommended as backfill materials. They can be used for site grading and in unimproved areas.

12.2.5 On-Site Fill Soil Classification

12.2.5.1 Memorial Drive (Borings B-1 through B-8)

Based on Borings B-1 through B-8, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Use as Fill: Random Backfill	Use as Fill: General Fill	Notes
I	Clay (CL)	✓	✓	✓	2, 3
II	Silty Sand (SM)	–	–	✓	2, 4
III	Clay (CH)	–	✓	✓	2, 5
IV	Clay (CL)	–	✓	✓	2, 3
V	Silt (ML)	–	–	✓	2, 4
VI	Silty Sand (SM)	–	–	✓	2, 4
VII	Clay (CL)	–	✓	✓	2, 3

12.2.5.2 Memorial Drive (Borings B-9 through B-16)

Based on Borings B-9 through B-16, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Use as Fill: Random Backfill	Use as Fill: General Fill	Notes
I	Silty Sand (SM)	–	–	✓	2, 4
II	Clay (CL)	✓	✓	✓	2, 3
III	Silt (ML)	–	–	✓	2, 4
IV	Clay (CH)	–	✓	✓	2, 5
V	Clay (CL)	✓	✓	✓	2
VI	Silty Sand (SM)	–	–	✓	2, 4
VII	Silt (ML)	–	–	✓	2, 4

12.2.5.3 Memorial Drive (Borings B-17 through B-20)

Based on Borings B-17 through B-20, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Use as Fill: Random Backfill	Use as Fill: General Fill	Notes
I	Silty Sand (SM)	–	–	✓	2, 4
II	Clay (CL)	–	✓	✓	2, 3
III	Clay (CH)	–	✓	✓	2, 5
IV	Clay (CL)	✓	✓	✓	2
V	Silt (ML)	–	–	✓	2, 4

12.2.5.4 Memorial Drive (Borings B-21 through B-23)

Based on Borings B-21 through B-23, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Use as Fill: Random Backfill	Use as Fill: General Fill	Notes
I	Clay (CL)	✓	✓	✓	2, 3
II	Silty Sand (SM)	–	–	✓	2, 4
III	Silty Sand (SM)	–	–	✓	2, 4

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Random Backfill	General Fill	Notes
IV	Silt (ML)	–	–	✓	2, 4
V	Clay (CL)	–	✓	✓	2, 4
VI	Clay (CH)	–	✓	✓	2, 5

12.2.5.5 Turkey Creek (Boring B-24)

Based on Boring B-24, the on-site soils can be used as fill materials as described below:

Stratum No.[1]	Soil Type	Use as Fill: Select Backfill	Random Backfill	General Fill	Notes
I	Fill: Sandy Lean Clay (CL)	–	✓	✓	2
II	Fill: Silty Sand (SM)	–	–	✓	2, 4
III	Fat Clay (CH)	–	✓	✓	2, 5
IV	Silt (ML)	–	–	✓	2, 4
V	Lean Clay (CL)	✓	✓	✓	2, 3
VI	Sandy Silt (ML)	–	–	✓	2, 4
VII	Fat Clay (CH)	–	✓	✓	2, 5

Notes:
1. See soil stratigraphy and design conditions sections of this report for strata description.
2. All fill soils should be free of organics, roots, etc.
3. Soils with PI greater than 20 should be lime modified with 5% by dry weight and can be used as select backfill.
4. The on-site sands and silts soils are moisture sensitive and erode easily. These soils will pump when they get wet. Compaction difficulties will occur in these soils in a wet condition.
5. These soils once lime modified (6% by dry weight), can be used as select backfill.

12.3 Groundwater Control

12.3.1 General

We understand that the invert depths of sanitary sewer lines along the proposed project alignment will be ranging from about 12- to 17-ft below existing grade. The invert depths for the storm sewers and water lines will be less than the sanitary sewer lines. Box culverts will be installed at a depth of about 17-ft below the exiting grade. Our short-term field exploration along the project alignment indicated that groundwater/perched water was encountered at depths ranging from 14- to 31-ft below the existing grade during drilling. Groundwater level rose to depths ranging from 10- to 30-ft after 24 hours of drilling. Furthermore, piezometer observations indicated stabilized groundwater levels at a depth of about 10-ft below the existing ground surface in piezometers P-1 and P-4. Hence, groundwater dewatering will be required. Fluctuations in groundwater can occur as a function of seasonal moisture variations. Groundwater control recommendations are presented in the following report sections.

12.3.2 Dewatering Technique

In the event that groundwater is encountered during construction, it is our opinion that groundwater should be lowered to a depth of at least three-ft below the deepest excavation grade in order to provide dry working conditions and firm bedding. Any minor water inflow in cohesive soil layers can probably be removed using a sump-pump or trench sump-pump. Wellpoint system can be used in the area where sand/silt soils are present. **Due to the presence of sand/silt soils near the invert depths of the underground utilities and the hydrostatic pressure, bottom blow up may occur if an effective dewatering system is not in place at the time of construction.** The selection and proper implementation of an effective groundwater control system is the responsibility of the contractor.

Design of a wellpoint system should consider the amount of groundwater to be lowered and the permeability of the affected soils. The selection and proper implementation of an effective groundwater control system is the responsibility of the contractor. The design of groundwater and surface water should be in accordance with the "City of Houston Standard Specifications, Section 01578 − Control of Ground Water and Surface Water".

12.4 OSHA Soil Classifications

The subsoils can be classified in accordance with Occupational Safety and Health Administration (OSHA) Standards, dated October 31, 1989 of the Federal Register. OSHA classification system categorizes the soil and rock in four types based on shear strength and stability. The description of four (4) types in classification system is summarized in the Appendix D.

Based on our geotechnical exploration and laboratory test results, details of soil classifications at each boring are summarized in the OSHA Soil Classification, presented in Appendix D. Furthermore, a letter for trench safety recommendation is provided separately.

12.5 Excavations

Each side of an excavation or trench which is five-ft or deeper must be protected by sheeting/bracing shoring or sloped. Based on soil strength data and OSHA soil classifications, temporary (less than 24 hours) open-trenched, non-surcharged, and unsupported excavations should be made on slopes of about 1.5(h):1(v). Vertical cuts can be constructed, provided shoring and bracing are used for the excavation wall stability. Benched excavation can also be used with average slopes of about 1(h):1(v) and steps should not be higher than five-ft. In all cases, excavations should conform to OSHA guidelines. Flatter slopes may have to be used if large amounts of sand need to be excavated for deep installations. Specifications should require that no water be allowed to pond in the excavations. The surface slopes should be protected from deterioration and weathering if they are to be left open for more than 24 hours.

Excavations should be performed with equipment capable of providing a relatively clean bearing area. Excavation equipment should not disturb the soil beneath the design excavation bottom and should not leave large amounts of loose soil in the excavation.

12.6 Backfilling

12.6.1 Backfilling for Open-Trench

Sand backfill used in the cement-stabilized sand and sand backfill sections should be free of clay lumps, organic materials, or other deleterious substances, and should have a PI less than 4 for the cement-stabilized sand and less than 7 for the sand backfill section, and not more than 15% passing the No. 200 sieve. Cement stabilized sand should conform to the "City of Houston Standard Specifications, Section 02321 – Cement Stabilized Sand".

Random fill for zones above pipe bedding should be placed in loose lifts not exceeding eight-inches and compacted to 100% of the natural soil density. This value will be on the order of 95% of standard Proctor density (ASTM D 698) at a moisture content between optimum and +3% of optimum. These values should be verified by testing during construction.

12.6.2 Backfilling for Auger Pits and Auger Holes

Underground utilities should be placed on a well prepared, properly compacted working surface. Cast-in-place box culverts can be supported on the natural soils provided subgrade is protected from construction disturbances and surface water is not allowed to pond within the excavation. We recommend the exposed subgrade be uniformly proofrolled to at least 95 percent of Standard Proctor (ASTM D 698) maximum dry density at a moisture contents between ± 2% of optimum. The excavation, trenching, foundation, embedment, and backfilling for the proposed box culverts shall be in accordance with City of Houston Specifications, Section 02317 – Excavation and Backfill for Utilities.

Sand backfill used in the cement-stabilized sand and sand backfill sections should be free of clay lumps, organic materials, or other deleterious substances, and should have a PI less than 4 for the cement-stabilized sand and less than 7 for the sand backfill section, and not more than 15% passing the No. 200 sieve.
Cement stabilized sand should conform to the "City of Houston Specifications, Section 02321 – Cement Stabilized Sand". Backfill should be placed in accordance with "City of Houston Standard Specifications, Section 02317 – Excavation and Backfill for Utilities". City of Houston Standard Specification Drawing No. 02447-01 should be followed when backfilling the auger pits. The annular space between the pipe and the auger hole should be backfilled to a minimum of 12-inches on both sides beyond the auger pit as indicated in the City of Houston Standard Specification Drawing No. 02447-01.

12.7 Surface Water Drainage

In order to minimize pounding of surface water, site drainage should be established early in project construction so that this condition will be controlled.

12.8 Earthwork for Access and Workability

12.8.1 General

Difficult access and workability problems can occur in the surficial soils due to poor site drainage, wet season, or site geohydrology. Based on the laboratory test results, the subsurface soils at the project site consists of silty sand (SM) and lean clay (CL) soils. Considering the soils stratigraphy, the construction of this project should be conducted during the dry season to avoid major earthwork problems. Our recommendations for earthwork activity for areas with cohesive and cohessionless soils are provided separately. These recommendations should only be followed, if wet soils are encountered, otherwise, they do not have to be followed.

12.8.2 Earthwork for Cohesive Soils

Difficult access and workability problems can occur in the surficial clay (CL) soils due to poor site drainage, wet season, or site geohydrology. Should this condition develop, drying of the soils for support of pavement may be improved by the addition of 5% lime by dry weight. The application rate corresponding to this additive amount would be 23 pounds of lime per square yard for eight-inch of compacted thickness.

City of Houston Standard Specifications 02336 shall be used as procedural guides for placing, mixing, and compacting lime stabilizer and the soils.

Our recommendations on subgrade stabilization are preliminary. The actual depth and type of stabilization should be determined in the field at the time of construction just after site stripping and proofrolling. Furthermore, the type and amount of the stabilizer may vary depending on the final grade elevation and the soil type encountered.

Provided the site work is performed during dry weather and/or project schedules permit aeration of wet soils, the subgrade will be suitable for pavement support.

12.8.3 Earthwork for Cohesionless Soils

In the event the subgrade soils become wet and experience pumping problems, they can be (a) opened up to dry up, (b) removed and replaced with dry cohesive soils or (c) chemically modified or stabilized. These alternatives are discussed in the following report sections.

12.8.3.1 Subgrade Drying

The on-site wet soils can be opened up so that it would dry up. However, opening up the surficial cohesionless soils for drying purposes may not be practical, due to cyclic rainfall in the Gulf-Coast area.

12.8.3.2 Removal and Replacement

The surficial cohesionless soils can be removed and replaced with select structural fill. The actual depth of removal and replacement should be evaluated in the field, but it can be whole thickness of surficial cohesionless soils. This procedure will include removal of the surficial cohesionless soils, proofrolling and compacting the subgrade cohesive soils to a minimum of 95 percent standard proctor density (ASTM D 698). The site can then be backfilled with select structural fill, compacted to a minimum of 95 percent of standard proctor density. The proofrolling should be in accordance with the site preparation section of this report. All of the fill soils should be placed and tested in accordance with the site preparation section of this report.

12.8.3.3 Modification

We recommend that the on-site cohesionless soils be modified (to dry up), using 5 to 10 percent fly ash by dry weight. City of Houston Standard Specifications 02337, shall be used as a procedural guide for placing, mixing and compacting the fly-ash stabilizer. These recommendations should only be followed if wet soils are encountered. The estimated amount of fly ash per depth of modification are as follows:

Modification Depth, in.	Fly Ash Weight Range, lbs. per Square Yard
6	23 − 45
12	46 − 90
18	69 − 135
24	92 − 180

We recommend that five percent fly ash be used if the surficial soils are relatively moist at the time of application. Higher levels (10 percent) of fly ash should be used if wet and soggy subgrade soils are encountered.

The subgrade soils should be removed to a depth of 24-inch (or more) below existing grade. These soils should be stockpiled. The soils below a depth of 24-inch should be modified to a depth of 12-inch. These soils should be compacted to a minimum of 95 percent of standard proctor density (ASTM D 698). The stockpiled soils should then be modified and replaced in six-inch lifts and compacted to 95 percent of maximum dry density as determined by ASTM D 698 at moisture contents within ±2 percent of optimum.

The subgrade soils should be modified in six-inch lifts and compacted within four hours of mixing and placement. All of the subgrade soils should be compacted to a minimum of 95 percent of the standard Proctor density at moisture contents within ±2 percent of optimum. The degree of compaction for the lifts, below a depth of 24-inch can be relaxed to 90 percent of maximum dry density to ease the construction procedures.

The subcontractor who will be doing the subgrade modification or stabilization should be experienced with stabilization procedures and methods. Furthermore, all of the earthwork at this project should be monitored by our geotechnician to assured compliance with the project specifications.

Once the subgrade is constructed, the soils at the top of subgrade should be slicked and the subgrade needs to be crowned such that the all surface water would drain away. No low areas should be left within the subgrade areas, since these areas would hold water and destroy the subgrade structure.

12.9 Construction Surveillance

Construction surveillance and quality control tests should be planned to verify materials and placement in accordance with the specifications. The recommendations presented in this report were based on a discrete number of soil test borings. Soil type and properties may vary across the site. As a part of quality control, if this condition is noted during the construction, we can then evaluate and revise the design and construction to minimize construction delays. We recommend the following quality control procedures be followed by a qualified engineer or technician during the construction of the facility:

- Observe the site stripping and proofrolling.
- Verify the compaction of subgrade soils.
- Verify the type, depth and amount stabilizer.
- Evaluate the quality of fill and monitor the fill compaction for all lifts.
- Observe all phases of trench safety.
- Observe all excavation operations.
- Monitor concrete placement, conduct slump tests and make concrete cylinders.

It is the responsibility of the client to notify GET of when each phase of the construction is taking place so that proper quality control and procedures are implemented.

13.0 RECOMMENDED ADDITIONAL STUDIES

This report has been based on assumed conditions/characteristics of the proposed project area where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. We recommend that GET be retained to review the plans and specifications to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted as intended.

14.0 STANDARD OF CARE

The recommendations described herein were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical engineering profession practicing contemporaneously under similar conditions in the locality of the project. No other warranty or guarantee, expressed or implied, is made other than the work was performed in a proper and workmanlike manner.

15.0 REPORT DISTRIBUTION

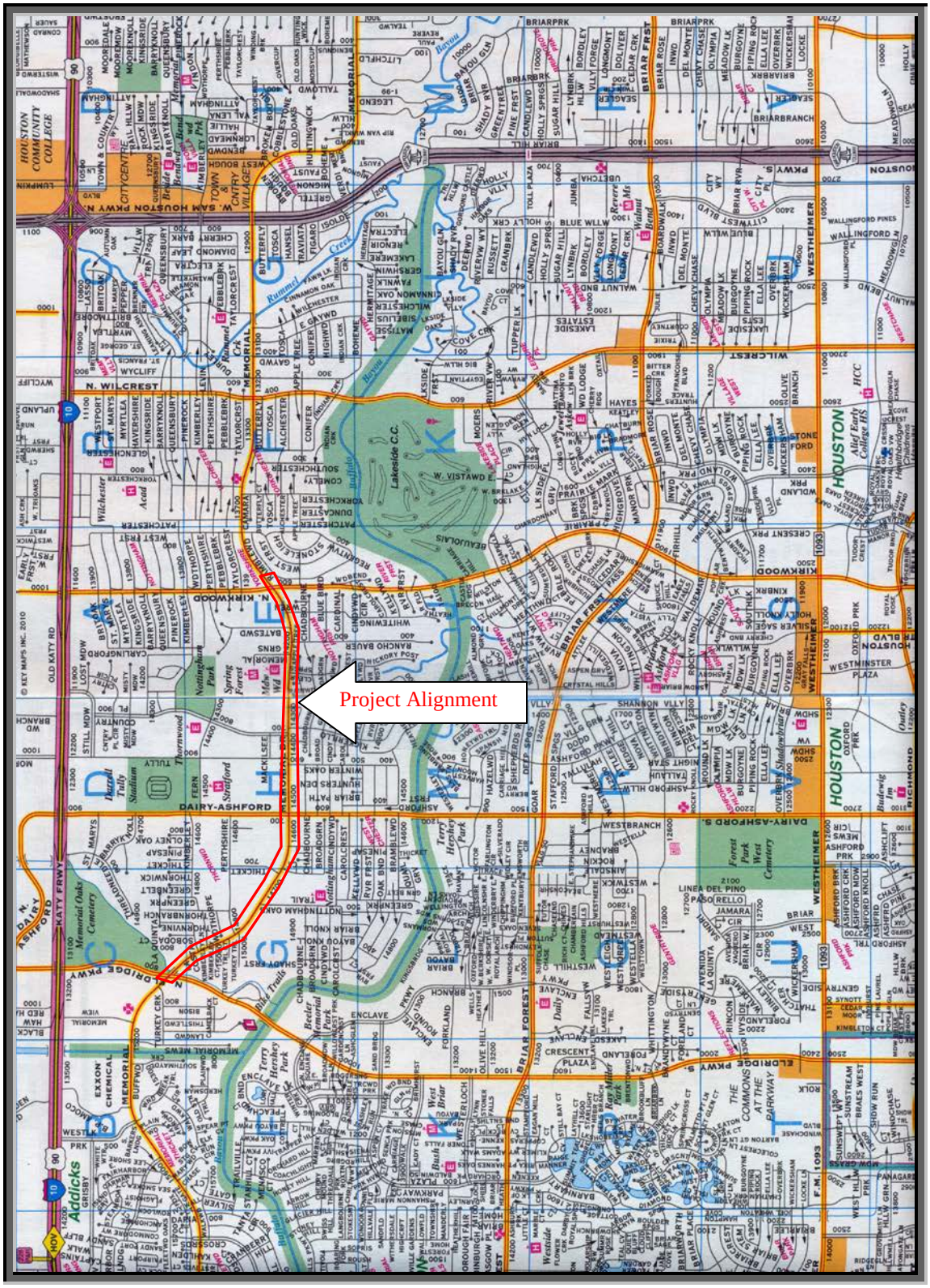
This report was prepared for the sole and exclusive use by our client (CivilTech Engineering, Inc.) and owner (City of Houston), based on specific and limited objectives. All reports, boring logs, field data, laboratory test results, maps and other documents prepared by GET as instruments of service shall remain the property of GET. GET assumes no responsibility or obligation for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and work limitations.

16.0 REFERENCES

1. AASHTO Specifications, "Guide for Design of Pavement Structures", American Association of State Highway and Transportation Officials, 1993.

2. "City of Houston Standard Construction Specifications", Department of Pubic Works and Engineering, City of Houston, January 2011.

3. Caquot, A., and Kerisel, F., "Tables for the Calculation of Passive Pressure, Active Pressure and Bearing Capacity of Foundations", Gauthier-Villers, Paris.



SITE VICINITY MAP

PROJECT: Geotechnical Study, Memorial Drive from about 500-ft East of North Kirkwood Road to the West of North Eldridge Parkway, WBS-No. N-000798-0001-3, City of Houston, Texas (CSJ No. 0912-70-082)

NORTH

SCALE: NOT TO SCALE	DATE: MARCH 2014	PROJECT NO.: 09-338E

EXISTING PAVEMENT THICKNESS

Location	Thickness, inches	
	Asphalt Pavement	Concrete Pavement
B-1	14	-
B-2	7.8	-
B-3	7.5	-
B-4	5.5	-
B-5	11.7	-
B-6	8.7	-
B-7	11.7	-
B-8	10.5	-
B-9	11.3	-
B-10	11.1	-
B-11	8.1	-
B-12	-	12.0
B-13	6.7	-
B-14	12	-
B-15	2.3	-
B-16	2.3	-
B-17	5.7	-
B-18	2	-
B-19	5.5	-
B-20	3.8	-
B-21	6	-
B-22	4.1	-
B-23	11.7	-
B-24	-	-

(CSJ No. 0912-70-082)

SUMMARY OF BORING INFORMATION

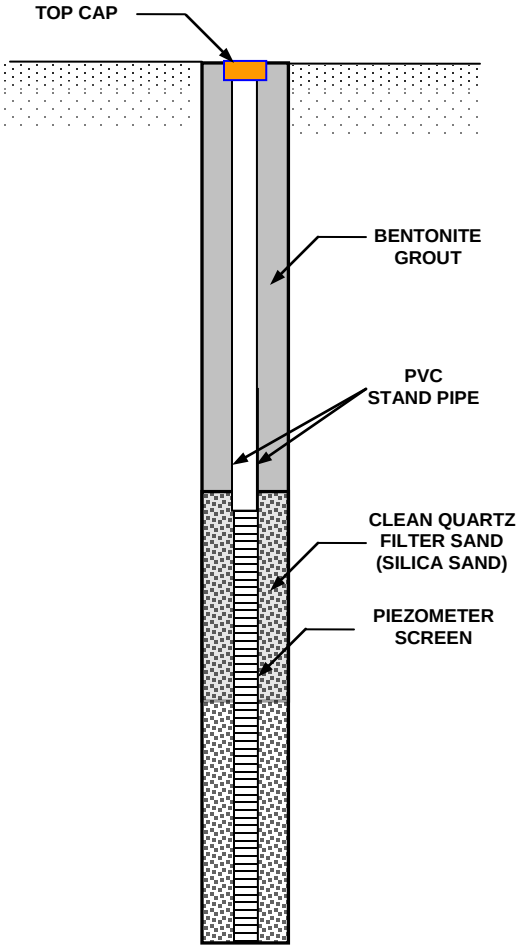
Boring No.	Alignment	Northing	Easting	Elevation	Station No.	Offset
B-1	Memorial Dr.	13845514.72	3050918.05	79.44	115+11	18.46
B-2	Memorial Dr.	13845125.81	3050446.80	77.17	109+00	20.72
B-3	Memorial Dr.	13844934.02	3050132.91	78.49	105+34	7.76
B-4	Memorial Dr.	13844800.76	3049837.49	78.94	102+13	19.81
B-5	Memorial Dr.	13844717.83	3049220.30	81.00	95+92.02	10.18
B-6	Memorial Dr.	13844740.50	3048741.11	82.30	91+12.80	12.82
B-7	Memorial Dr.	13844763.77	3048341.78	82.48	87+12.74	12.74
B-8	Memorial Dr.	13844764.14	3047721.55	83.95	80+90.95	12.23
B-9	Memorial Dr.	13844742.66	3047290.57	84.80	76+59.43	13.44
B-10	Memorial Dr.	13844719.20	3046775.13	85.39	71+43.47	12.64
B-11	Memorial Dr.	13844698.06	3046292.74	85.72	66+60.62	11.10
B-12	Memorial Dr.	13844668.17	3045814.98	85.89	61+81.98	18.50
B-13	Memorial Dr.	13844625.40	3045821.01	85.20	55+82.95	33.15
B-14	Memorial Dr.	13844621.50	3044789.45	87.14	51+55.38	16.94
B-15	Memorial Dr.	13844694.17	3044186.01	87.71	45+48.37	10.69
B-16	Memorial Dr.	13844877.62	3043801.83	87.39	41+24.12	14.21
B-17	Memorial Dr.	13845104.00	3043417.30	87.25	36+77.91	13.40
B-18	Memorial Dr.	13845374.30	3042945.24	86.20	31+33.97	18.98
B-19	Memorial Dr.	13845604.18	3042626.45	86.50	27+43.59	15.26
B-20	Memorial Dr.	13846128.57	3042268.02	84.59	21+09.94	16.81
B-21	Memorial Dr.	13846442.48	3042147.95	82.85	17+73.54	6.42
B-22	Memorial Dr.	13846903.41	3041820.78	78.89	12+02.48	19.44
B-23	Memorial Dr.	13847100.40	3041600.70	78.00	6+5.0	0.00
B-24	Memorial Dr.	13846973.40	3041730.70	74.00	9+5.0	0.00

(CSJ No. 0912-70-082)

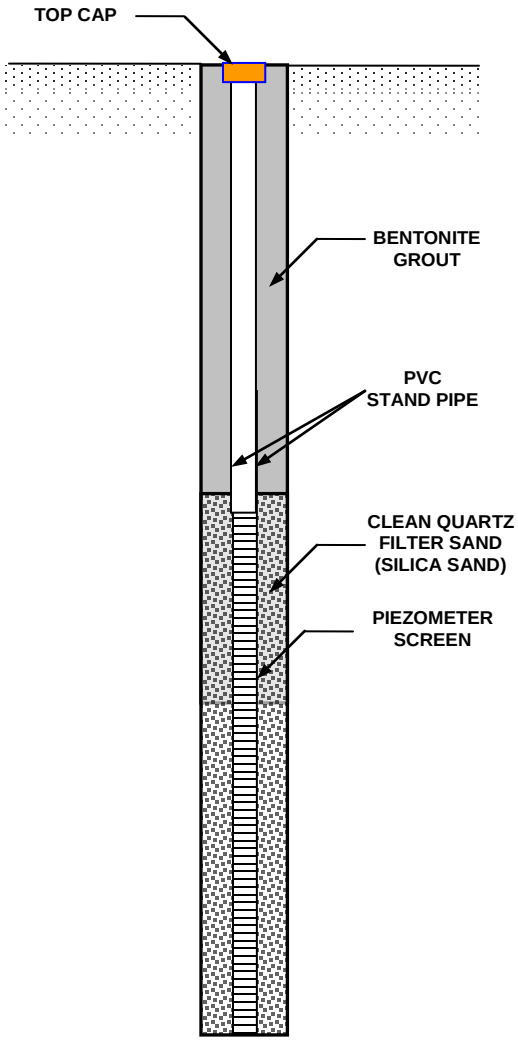
PIEZOMETER INSTALLATION DATA

Piezometer No.	Boring No.	Top of Riser-Height, ft	Piezometer Tip		Depth to Filter Sand, ft.		Bentonite Grout, ft.	
			Depth, ft.	Screen Length, ft.	Top	Bottom	Top	Bottom
P-1	B-6	0.00	25.00	10.00	13.00	25.00	0.00	13.00
P-2	B-11	0.00	25.00	10.00	13.00	25.00	0.00	13.00
P-3	B-16	0.00	20.00	10.00	8.00	20.00	0.00	8.00
P-4	B-24	0.00	25.00	10.00	13.00	25.00	0.00	13.00

Notes: (1) Depth is referenced from the existing ground surface.



Piezometer P-3



Piezometer P-1, P-2 and P-4

Note: Drawing is not to scale.
(CSJ No. 0912-70-082)

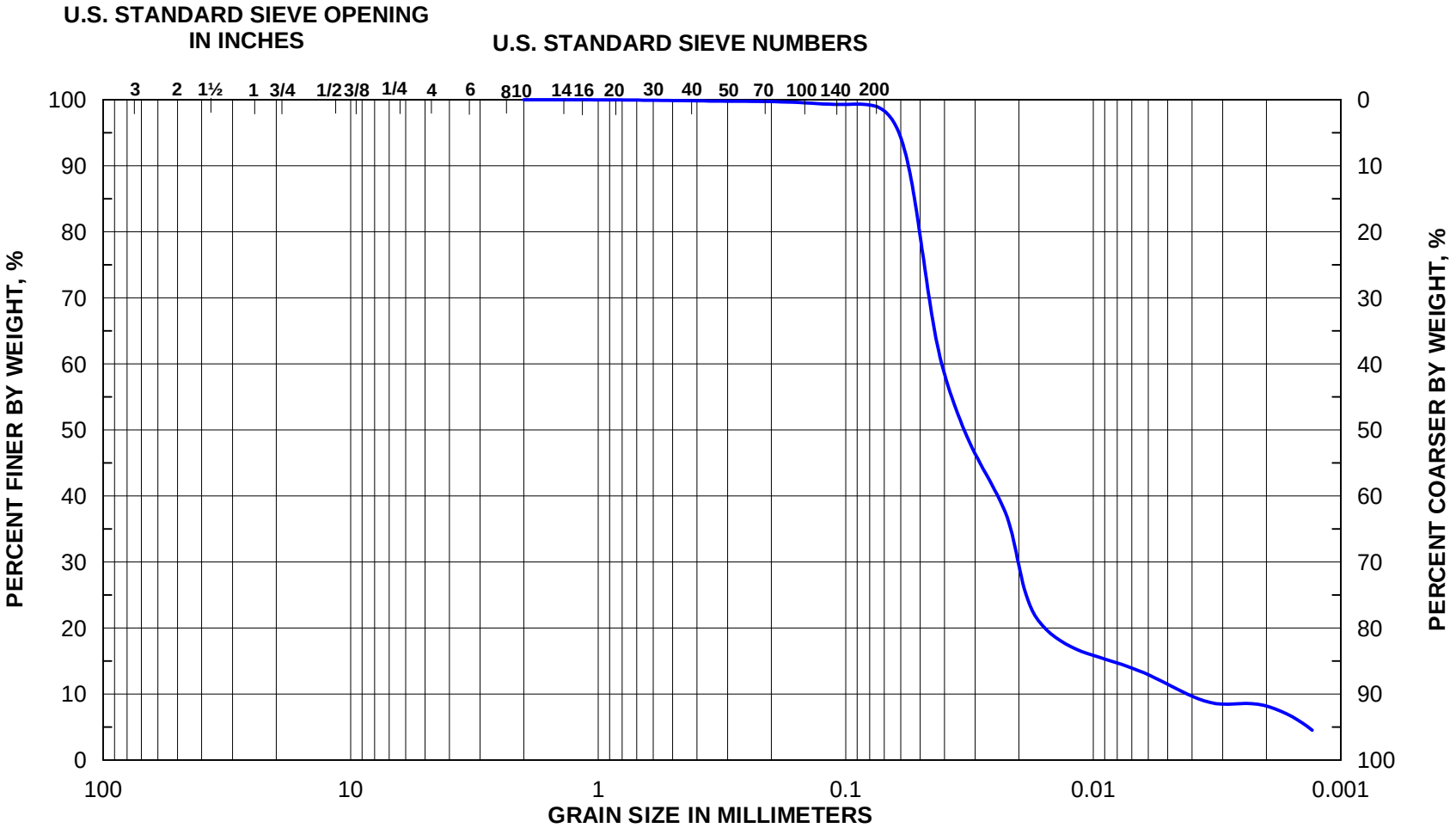
PIEZOMETER READING TABLE

Piezometer No./Depth	Groundwater Depth During Drilling from Ground Surface, ft.	Piezometric Level, ft.					
		February 10, 2013			March 10, 2013		
		Before Bailing	After Bailing				
			Time (Min.)	Depth		Time (Min.)	Depth
P-1 (25') Boring B-6	22' 0"	10' 0"	1	12' 7"	10' 0"	1	13' 0"
			2	12' 6"		2	12' 9"
			5	12' 2"		5	12' 5"
			10	12' 0"		10	12' 0"
			20	11' 5"		20	11' 5"
			30	11' 0"		30	10' 5"
			60	10' 0"		60	10' 0"
P-2 (25') Boring B-11	Dry	Dry	1	Dry	Dry	1	Dry
			2	Dry		2	Dry
			5	Dry		5	Dry
			10	Dry		10	Dry
			20	Dry		20	Dry
			30	Dry		30	Dry
			60	Dry		60	Dry
P-3 (20') Boring B-16	Dry	Dry	1	Dry	Dry	1	Dry
			2	Dry		2	Dry
			5	Dry		5	Dry
			10	Dry		10	Dry
			20	Dry		20	Dry
			30	Dry		30	Dry
			60	Dry		60	Dry

Piezometer No./Depth	Groundwater Depth During Drilling from Ground Surface, ft.	Piezometric Level, ft.					
		August 09, 2013			August 30, 2013		
		Before Bailing	After Bailing				
			Time (Min.)	Depth		Time (Min.)	Depth
P-4 (25') Boring B-24	16' 0"	10' 0"	1	13' 7"	10' 0"	1	13' 5"
			2	13' 6"		2	13' 3"
			5	13' 3"		5	13' 1"
			10	13' 0"		10	12' 7"
			20	12' 7"		20	12' 2"
			30	11' 5"		30	11' 7"
			60	10' 0"		60	10' 0"

Note: Borings B-6, B-11, B-16 and B-24 were converted to Piezometers P-1, P-2, P-3 and P-4, respectively. The piezometer depths are shown in parenthesis.

(CSJ No. 0912-70-082)



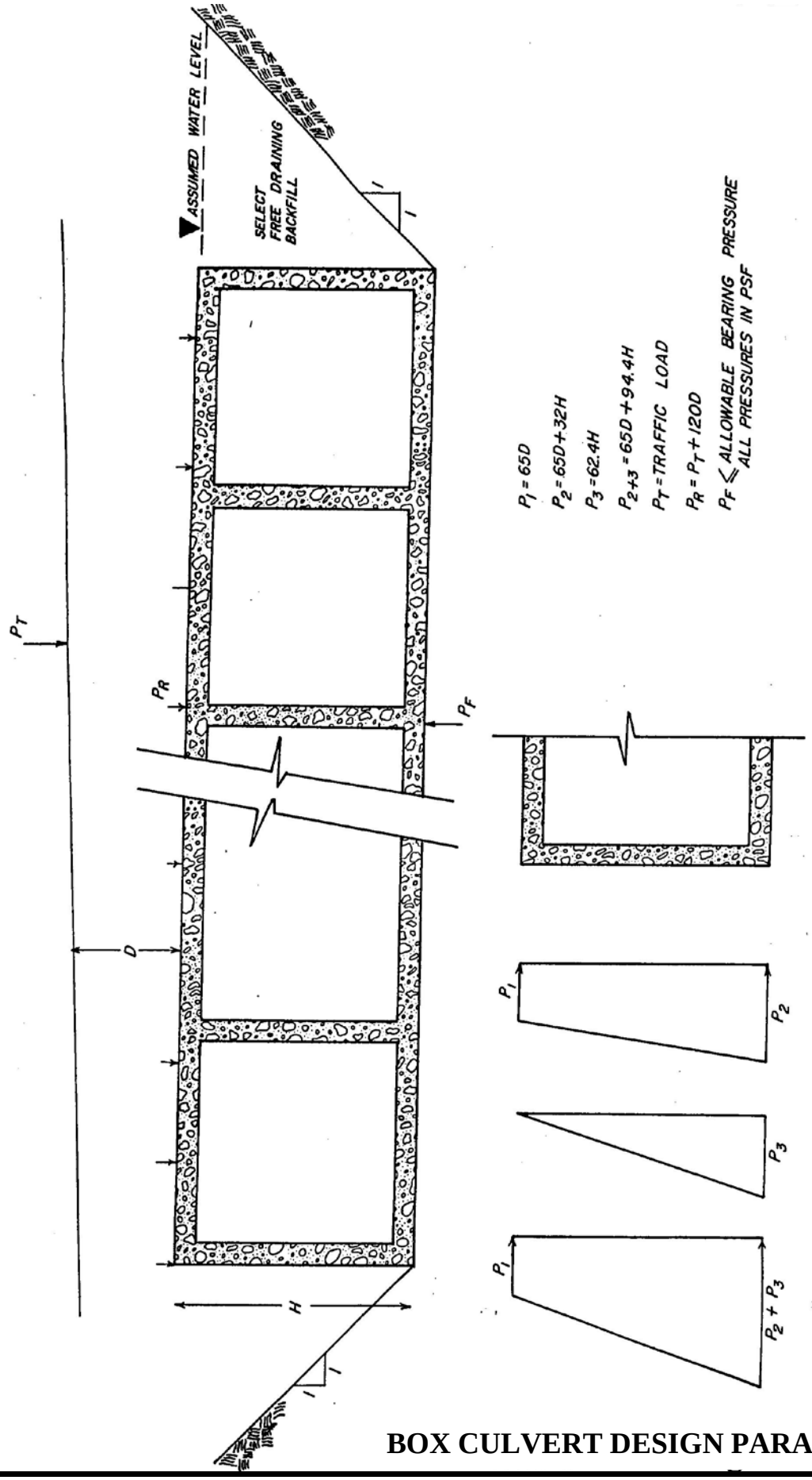
GRAVEL		SAND			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		

USCS Soil Classification: Silt (ML)

Percent Passing - 200: 98%

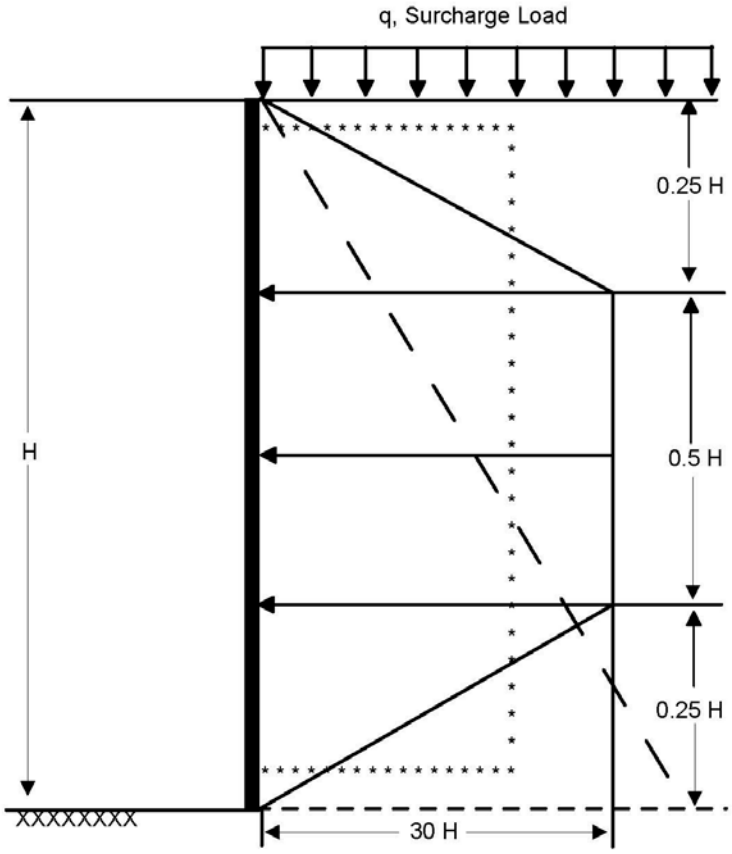
PARTICLE SIZE DISTRIBUTION CURVES FOR B- 24 (17' TO 19')

Report No. 09-338E



BOX CULVERT DESIGN PARAMETERS

LATERAL EARTH PRESSURE DIAGRAM



Legend:

——————— Braced Excavation (stiff clays)
* * * * * * * * * * * * * Braced Excavation (sands)
- - - - - - - - - - - - - - Cantilevered sheeting

Active Pressure:

(a) Braced Excavation (stiff clays) = 0.5q + 30H + 62.4H
(b) Braced Excavation (sands) = 0.4q + 18H + 62.4H
(c) Cantilevered sheeting = 0.7q + 42H + 62.4H

where: q = surcharge load, psf: A value of 250 psf can be assumed.
H = wall height, ft.

Notes:

1. The above Active Pressure Equations account for the groundwater at the surface.
2. The final lateral pressures should be reviewed prior to construction.
3. Trench excavation and construction should be observed by a geotechnical engineer.
4. The means and methods for a safe excavation is the responsibility of the contractor.
5. In case of layered soils, active pressure should be calculated based on the dominant or more critical soil conditions.

Design Soil Parameters
Based on Boring B-24

1) Soil Parameters Behind the Headwall

Soil Type (Assumed Backfill Material)	γ_t, pcf	c, psf	ϕ	c′, psf	ϕ'	Active Lateral Earth Pressure Coefficients k_a	k_a'
Lean Clay (CL)	120	1,000	0	200	20	1.00	0.75

2) Soil Parameters in Front of the Headwall

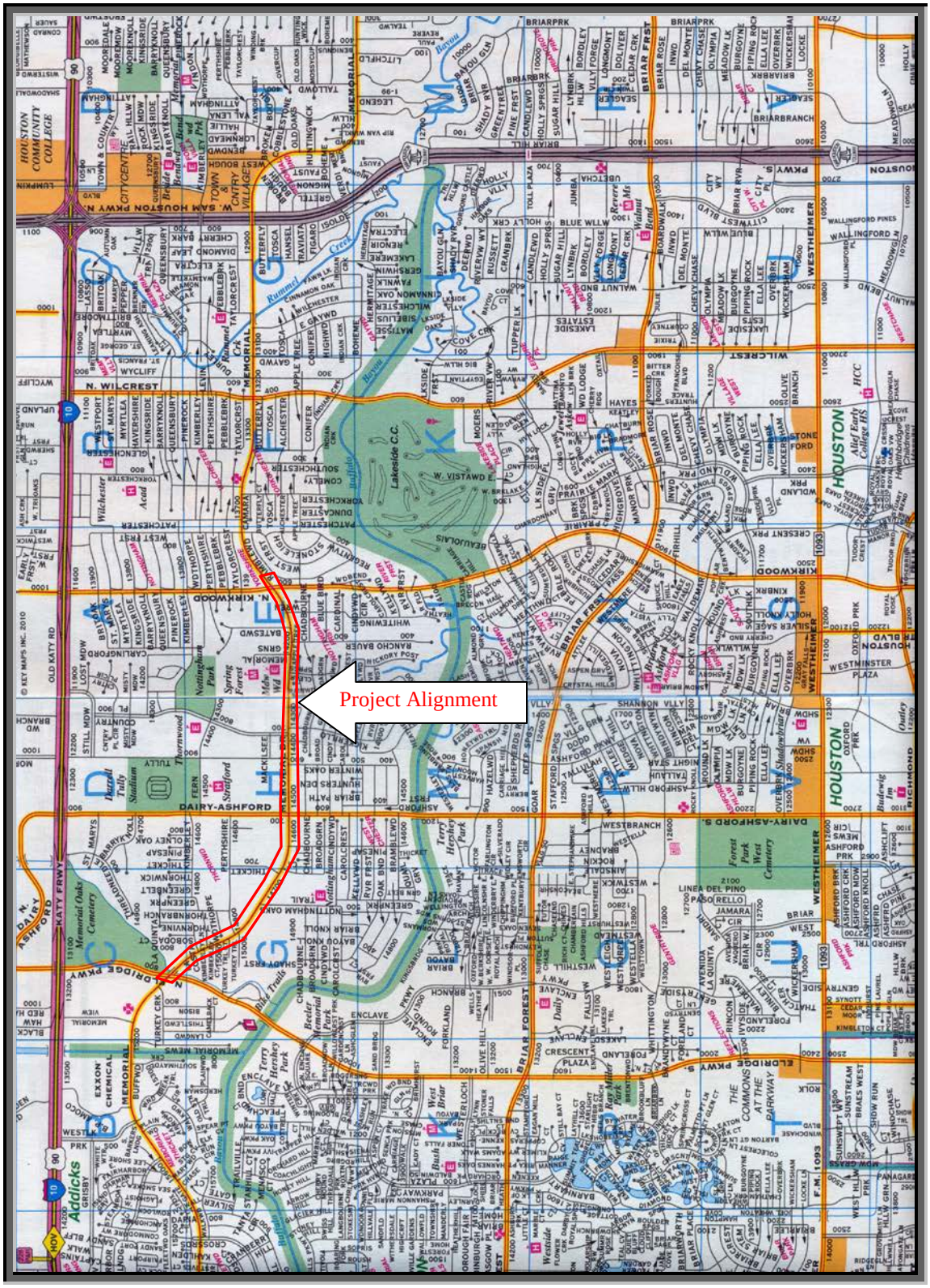
Soil Type	Depth Below Existing Ground Surface, ft.	γ_t, pcf	c, psf	ϕ	c′, psf	ϕ'	Lateral Earth Pressure Coefficients[1] k_a	k_p	k_a'	k_p'
Sandy Silt (ML)	17 – 20	115	0	26	0	26	0.40	2.53	0.40	2.53
Lean Clay (CL)	20 – 22	130	2,000	0	150	18	1.00	1.00	0.48	1.72
Sandy Silt (ML)	22 – 30	115	0	26	0	26	0.40	2.53	0.40	2.53
Fat Clay (CH)	30 – 35	125	2,000	0	300	18	1.00	1.00	0.48	1.72

Where:
γ_t = Total Unit Weight, pcf
c, c′ = Undrained and Effective Stress Cohesions
ϕ, ϕ' = Undrained and Effective Stress Angle of Internal Friction, Degrees
k_a, k_a' = Undrained and Effective Stress Coefficient of Active Earth Pressure
k_p, k_p' = Undrained and Effective Stress Coefficient of Passive Earth Pressure

Note: 1. Lateral Earth Pressure coefficients assume a horizontal backfill

APPENDIX A

Site Vicinity Map
Plan of Borings
Logs of Borings
Key to Log Terms and Symbols
Summary of Laboratory Test Results

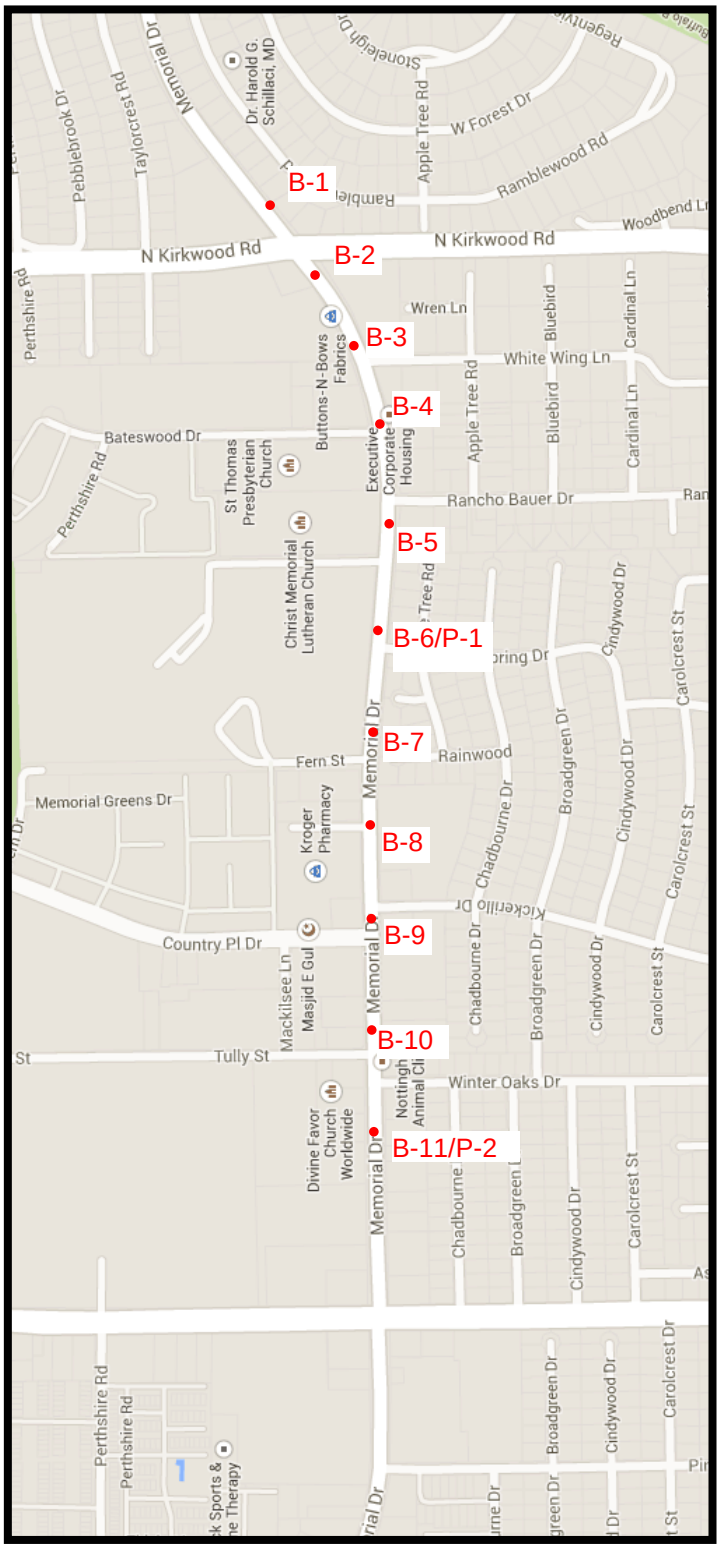


SITE VICINITY MAP

PROJECT: Geotechnical Study, Memorial Drive from about 500-ft East of North Kirkwood Road to the West of North Eldridge Parkway, WBS-No. N-000798-0001-3, City of Houston, Texas (CSJ No. 0912-70-082)

NORTH

SCALE: NOT TO SCALE	DATE: MARCH 2014	PROJECT NO.: 09-338E



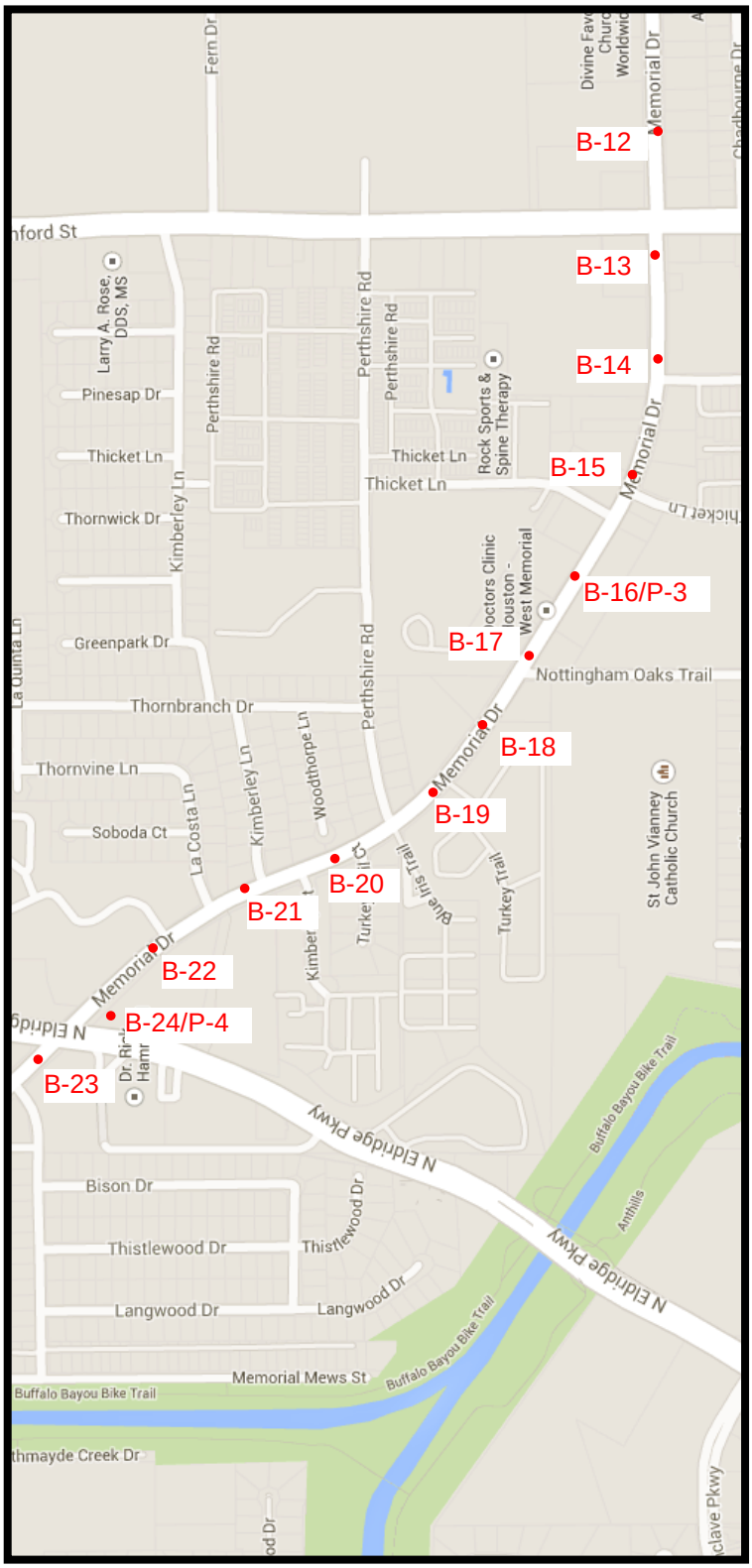
Legend:
B-1: Boring B-1
P-1: Piezometer P-1

PLAN OF BORINGS (boring dimensions and locations are approximate)

PROJECT: Geotechnical Study, Memorial Drive from about 500-ft East of North Kirkwood Road to the West of North Eldridge Parkway, WBS-No. N-000798-0001-3, City of Houston, Texas

NORTH

SCALE: 1" = 1000'±	DATE: MARCH 2014	PROJECT NO.: 09-338E



Legend:
B-12: Boring B-12
P-3: Piezometer P-3

PLAN OF BORINGS (boring dimensions and locations are approximate)

PROJECT: Geotechnical Study, Memorial Drive from about 500-ft East of North Kirkwood Road to the West of North Eldridge Parkway, WBS-No. N-000798-0001-3, City of Houston, Texas

SCALE: 1" = 1000'±	DATE: MARCH 2014	PROJECT NO.: 09-338E

NORTH

DRILLING LOG

WinCore	County	Harris	Hole	B-1	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
	CSJ	No. 0912-70-082	Station	115+11	Grnd. Elev.	79.44 ft
			Offset	18.46	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 14 inches			11				- 200: 41%
78.2			SAND, moist, brown, w/clay pockets and silt (SM)							
77.4			CLAY, soft, moist, gray, reddish brown, w/root fibers to 4', ferrous and calcareous nodules (CH)			23	56	37		- 200: 62%, PP: 0.56, T: 0.75
		6 (6) 7 (6)								
5						14				PP: 1.50, T: 1.50
						16			133.4	PP: 1.50, T: 1.50, UC: 0.97
		10 (6) 12 (6)								
70.4			CLAY, - stiff, reddish brown 9' to 10' (CH)							
69.4 10										
15										
20										
25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Conpression (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-4

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DRILLING LOG

WinCore	County	Harris	Hole	B-2	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	1/21/2013
	CSJ	No. 0912-70-082	Station	109+00	Grnd. Elev.	77.17 ft
			Offset	20.72	GW Elev.	61.67 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
76.4			ASPHALT, to 7.8 inches							
			SAND, moist, brown, w/clay pockets and silt (SM)			11				
75.2			CLAY, very stiff, moist, gray, reddish brown, with ferrous and calcareous nodules (CH)			13				PP: 1.50, T: 1.50
		41 (6) 24 (6)								
5						21				PP: 0.62, T: 0.88
						17	50	32	140.4	PP: 1.01, T: 1.50, UC: 1.29
68.2		9 (6) 13 (6)								
10			CLAY, stiff, reddish brown 9' to 15' (CH)			25				PP: 1.50, T: 1.50
						22	61	41		PP: 1.50, T: 1.50
		14 (6) 17 (6)								
15						21			131.89	PP: 1.50, T: 1.50, UC: 1.66
60.2			SILT, slightly compact, wet, reddish brown, w/clay seams and sand (ML)			25				SPT: 18, - 200: 72
		9 (6) 16 (6)								
20						21				SPT: 19
55.2			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			25	45	28	125	PP: 1.50, T: 1.50, UC: 0.47
		16 (6) 12 (6)								
52.2 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-5

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DRILLING LOG

WinCore	County	Harris	Hole	B-3	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
	CSJ	No. 0912-70-082	Station	105+34	Grnd. Elev.	78.49 ft
			Offset	7.76	GW Elev.	62.49 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 7.5 inches							
77.7			CLAY, moist, dark brown, w/root fibers, ferrous and calcareous nodules (CL)			14	38	21		PP: 1.50, T: 1.50, -200: 60
76.5			CLAY, soft, moist, gray, brownish yellow, with ferrous and calcareous nodules (CH)			17				PP: 1.50, T: 1.50
		5 (6) 7 (6)								
5						15				PP: 1.50, T: 1.50
						19	50	31	126.14	PP: 1.50, T: 1.50, UC: 0.59
69.5		3 (6) 3 (6)								
10			CLAY, very soft, gray 9' to 10' (CH)			11				PP: 0.78, T: 0.88
						17	58	38	126.36	PP: 1.50, T: 1.50, UC: 0.97
		7 (6) 11 (6)								
15						28				PP: 0.31, T: 0.38
61.5			SILT, compact, wet, reddish brown, w/clay seams (ML)			21				
		18 (6) 28 (6)								
20						17				- 200: 92, SPT 31
						20				SPT: 33
		43 (6) 31 (6)								
53.5 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-6

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DRILLING LOG

WinCore
ion 3.1

County	Harris	Hole	B-4	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
CSJ	No. 0912-70-082	Station	102+13	Grnd. Elev.	78.94 ft
		Offset	19.81	GW Elev.	63.94 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
78.4			ASPHALT, to 5.5inches							
			CLAY, stiff, moist, dark brown, w/ferrous and calcareous nodules (CL)			14				PP: 0.56, T: 0.62
						13				PP: 1.50, T: 1.50
		13 (6) 15 (6)								
5						12				PP: 1.50, T: 1.50
						12	40	20	135.52	PP: 1.50, T: 1.50, UC: 2.60
		15 (6) 18 (6)								
68.9 10			CLAY, soft, moist, reddish brown, w/ferrous and calcareous nodules (CH)			22				PP: 1.32, T: 1.50
						21				PP: 1.50, T: 1.50
		9 (6) 10 (6)								
15						22				PP: 1.50, T: 1.50
						21	51	31	131.89	PP: 1.50, T: 1.50, UC: 2.59 - 200: 95
		21 (6) 19 (6)								
59.9			CLAY, stiff, reddish brown 19' to 20' (CH)							
20						20				PP: 1.50, T: 1.50
						19				PP: 0.85, T: 0.88
		23 (6) 27 (6)								
54.9			CLAY, very stiff, reddish brown 24' to 25' (CH)							
53.9 25										

emarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers **Logger: Joshua** **Organization: GET** **PLATE A-7**

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DRILLING LOG

WinCore	County	Harris	Hole	B-5	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
	CSJ	No. 0912-70-082	Station	95+92.02	Grnd. Elev.	81.00 ft
			Offset	10.18	GW Elev.	68.00 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 11.7 inches							
80.			SAND, moist, reddish brown, w/clay pockets and silt (SM)			13				- 200: 40 %
						13				
77.		10 (6) 10 (6)	CLAY, soft, moist, reddish brown, w/ferrous and calcareous nodules (CL)							
5						16	45	26	133.4	PP: 1.08, T: 1.25, UC: 0.99
						14				PP: 1.50, T: 1.50
		7 (6) 9 (6)								
71. 10			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CH)			24				PP: 0.78, T: 0.88
						24				PP: 1.50, T: 1.50
		16 (6) 14 (6)								
15						20				PP: 1.50, T: 1.50
64.			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous (CL)			24	42	23	133.92	PP: 1.01, T: 1.12, UC: 1.432
		43 (6) 50 (5)								
61. 20			SILT, compact, wet, reddish brown, w/clay seams and sand (ML)			22				SPT: 14
						27				SPT: 15, -200: 77 %
		27 (6) 30 (6)								
56. 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane, UC: Unconfined Compression Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-8

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DRILLING LOG

WinCore
Version 3.1

County	Harris	Hole	B-6	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
CSJ	No. 0912-70-082	Station	91+12.80	Grnd. Elev.	82.30 ft
		Offset	12.82	GW Elev.	60.30 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 8.7 inches							
81.5			CLAY, soft, moist, reddish brown, w/ferrous and calcareous nodules (CL)			14				PP: 0.62, T: 0.75
						19	40	22	135.66	PP: 1.08, T: 1.12, UC: 0.65
		4 (6) 5 (6)								
5						15				PP: 1.32, T: 1.50
						16	40	22	134.56	PP: 0.56, T: 0.62, UC: 0.94 - 200: 73 %
		6 (6) 9 (6)								
72.3 10			CLAY, soft, moist, reddish brown, w/ferrous and calcareous nodules (CH)			21				PP: 1.40, T: 1.50
						29				PP: 1.50, T: 1.50
		7 (6) 12 (6)								
15						22				PP: 1.50, T: 1.50
						22				PP: 1.50, T: 1.50
		18 (6) 28 (6)								
63.3			CLAY, very stiff, reddish brown 19' to 20' (CH)							
62.3 20			SILT, compact, wet, reddish brown, w/clay seams and sand (ML)			16				- 200: 69 %
						23				SPT: 38
		25 (6) 38 (6)								
57.3 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-9

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DRILLING LOG

WinCore	County	Harris	Hole	B-7	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
	CSJ	No. 0912-70-082	Station	87+12.74	Grnd. Elev.	82.48 ft
			Offset	12.74	GW Elev.	69.48 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 11.7 inches							
81.5			CLAY, soft, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CL)			10				
						16	32	15	127.6	PP: 0.62, T: 0.75, UC: 0.57
		6 (6) 6 (6)								
5						14				PP: 1.50, T: 1.50
						15				PP: 1.01, T: 1.12
		7 (6) 7 (6)								
72.5 10			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CH)			22				PP: 1.50, T: 1.50
						25	53	33	128.75	PP: 1.50, T: 1.50, UC: 2.27
		15 (6) 16 (6)								
15						20				PP: 1.50, T: 1.50
						22				PP: 1.50, T: 1.50
		19 (6) 17 (6)								
62.5 20			SAND, wet, reddish brown, w/clay seams and silt (SM)			21				SPT: 23, -200: 48 %
60.5			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			21	46	27		PP: 0.56, T: 0.62
		50 (6) 50 (6)								
57.5 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-10

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DRILLING LOG

WinCore	County	Harris	Hole	B-8	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
	CSJ	No. 0912-70-082	Station	80+90.95	Grnd. Elev.	83.95 ft
			Offset	12.23	GW Elev.	64.95 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 10.5 inches							
83.1			SAND, loose, moist, dark brown, w/clay pockets and silt (SM)			9				
						15				SPT: 13
		4 (6) 6 (6)								
79. 5			CLAY, soft, moist, brownish yellow, w/ferrous and calcareous nodules (CL)			15				PP: 1.40, T: 1.50
						14	45	26	136.8	PP: 1.50, T: 1.50, UC: 2.03
		9 (6) 10 (6)								
74. 10			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CH)			24				PP: 1.50, T: 1.50
						25				PP: 1.40, T: 1.50
		14 (6) 17 (6)								
15						27				PP: 1.50, T: 1.50
67.			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			17	40	22	134.55	PP: 1.50, T: 1.50, UC: 2.63 - 200: 91 %
		28 (6) 30 (6)								
64. 20			SILT, wet, reddish brown, w/clay seams (ML)			15				SPT: 49
62.			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			17				PP: 1.01, T: 1.12, -200: 76 %
		36 (6) 30 (6)								
59. 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-11

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DRILLING LOG

WinCore	County	Harris	Hole	B-9	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
	CSJ	No. 0912-70-082	Station	76+59.43	Grnd. Elev.	84.80 ft
			Offset	13.44	GW Elev.	64.80 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 11.3 inches							
83.9			SAND, moist, dark brown, w/clay pockets and silt (SM)			12				
82.8			CLAY, soft, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CL)			19	47	28	122.57	PP: 1.32, T: 1.50, UC: 0.71 - 200: 58%
		6 (6) 6 (6)								
5						15				PP: 1.16, T: 1.25
						15				PP: 1.40, T: 1.50
		6 (6) 7 (6)								
10						24				PP: 0.56, T: 0.62
.8			CLAY, soft, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			24				PP: 1.50, T: 1.50
		5 (6) 9 (6)								
15						23				PP: 1.50, T: 1.50
						23				PP: 1.50, T: 1.50
65.8		26 (6) 23 (6)								
64.8 20			CLAY, very stiff, reddish brown 19' to 20' (CH)							
			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			14				PP: 1.50, T: 1.50
						18	30	13	115.64	PP: 0.93, T: 1.0, UC: 0.77 - 200: 87 %
		25 (6) 11 (6)								
59.8 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-12

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DRILLING LOG

WinCore	County	Harris	Hole	B-10	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
	CSJ	No. 0912-70-082	Station	71+43.47	Grnd. Elev.	85.39 ft
			Offset	12.64	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 11.1 inches							
84.5			SAND, moist, dark brown, w/clay seams and silt (SM)			12				
83.4			CLAY, very soft, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CL)			20				PP: 0.69, T: 0.78
		2 (6) 2 (6)								
5						20				PP: 0.31, T: 0.50
						19	40	22	132.1	PP: 0.56, T: 0.62, UC: 0.59
76.4		5 (6) 7 (6)								
75.4	10		CLAY, soft, dark brown 9' to 10' (CL)							
			CLAY, stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			25				PP: 1.08, T: 1.12
						26				PP: 0.46, T: 0.62
		14 (6) 17 (6)								
15						28				PP: 1.16, T: 1.25
						17				PP: 1.50, T: 1.50
66.4		46 (6) 50 (4)								
65.4	20		CLAY, very stiff, reddish brown 19' to 20' (CH)							
			CLAY, very stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CL)			19				PP: 1.50, T: 1.50
						17	33	16	135.7	PP: 1.08, T: 1.12, UC: 1.77 - 200: 93 %
		23 (6) 27 (6)								
60.4	25									

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-13

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DRILLING LOG

WinCore	County	Harris	Hole	B-11	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
	CSJ	No. 0912-70-082	Station	66+60.62	Grnd. Elev.	85.72 ft
			Offset	11.10	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
85.			ASPHALT, to 8.1 inches							
			SAND, moist, dark brown, w/clay pockets and silt (SM)			3				- 200: 19 %
83.7			CLAY, soft, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CL)			17	38	20	127.53	PP: 0.78, T: 0.88, UC: 1.23
		10 (6) 10 (6)								
5						16				PP: 0.78, T: 0.88
						19				PP: 1.40, T: 1.50
		8 (6) 12 (6)								
75.7 10			CLAY, stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			26				PP: 1.50, T: 1.50
						28				PP: 1.50, T: 1.50
		8 (6) 14 (6)								
15						17				PP: 1.50, T: 1.50
66.7		25 (6) 33 (6)								
			CLAY, very stiff, reddish brown 19' to 20' (CH)							
65.7 20			CLAY, stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CL)							
		7 (6) 23 (6)								
60.7 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-14

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DRILLING LOG

WinCore	County	Harris	Hole	B-12	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
	CSJ	No. 0912-70-082	Station	64+81.98	Grnd. Elev.	85.89 ft
			Offset	18.50	GW Elev.	66.89 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			CONCRETE, to 12 inches							
84.9						7				
			SAND, moist, dark brown, w/clay pockets and silt (SM)							
83.9			CLAY, soft, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CL)			20	33	16	127.2	PP: 0.56, T: 0.62, UC: 0.78\
		5 (6) 5 (6)								
5						15				PP: 0.93, T: 1.0
						16				PP: 1.50, T: 1.50
76.9		10 (6) 11 (6)								
			CLAY, stiff, dark brown 9' to 10' (CL)							
75.9 10			CLAY, stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			21	57	36	125.84	PP: 1.32, T: 1.50, UC: 0.99 - 200: 93 %
						20				PP: 1.24, T: 1.50
		11 (6) 18 (6)								
15						26				PP: 1.50, T: 1.50
						25				PP: 1.50, T: 1.50
		16 (6) 22 (6)								
20						18				PP: 1.50, T: 1.50
63.9			SAND, wet, reddish brown, w/clay seams and silt (SM)			23				SPT: 23, -200: 40 %
61.9		25 (6) 50 (5)								
			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)							
25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-15

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DRILLING LOG

WinCore	County	Harris	Hole	B-12	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
	CSJ	No. 0912-70-082	Station	64+81.98	Grnd. Elev.	85.89 ft
			Offset	18.50	GW Elev.	66.89 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			CLAY, very stiff, moist, reddish brown, w/ferrous and calcareous nodules (CL)			22				PP: 1.50, T: 1.50
						19	28	12	130.9	PP: 1.50, T: 1.50, UC: 1.76
		43 (6) 35 (6)								
55.9 30										
35										
40										
45										
50										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-15

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DRILLING LOG

WinCore
sion 3.1

County	Harris	Hole	B-13	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
CSJ	No. 0912-70-082	Station	55+82.95	Grnd. Elev.	85.20 ft
		Offset	33.15	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
84.7			ASPHALT, to 6.7 inches							
			CLAY, soft, moist, dark brown, w/ferrous and calcareous nodules (CL)			15				PP: 1.50, T: 1.50
						13				PP: 1.50, T: 1.50
		6 (6) 6 (6)								
5						13				PP: 1.50, T: 1.50
78.2			CLAY, soft, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CH)			15	54	34	135.7	PP: 1.50, T: 1.50, UC 2.60
		8 (6) 9 (6)								
10						24				PP: 1.50, T: 1.50
						28	73	50	115.2	PP: 1.50, T: 1.50, UC: 1.14
		11 (6) 15 (6)								
71.2			CLAY, stiff, dark brown 14' to 15' (CH)							
70.2 15			CLAY, very stiff, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CL)			20				PP: 1.50, T: 1.50
						21				PP: 1.50, T: 1.50
		27 (6) 29 (6)								
20						17				PP: 1.50, T: 1.50
						20	36	18	127.2	PP: 1.50, T: 1.50, UC: 1.13 - 200: 99 %
		50 (5) 50 (6)								
61.2			CLAY, hard, dark brown 23' to 25' (CL)							
60.2 25										

Remarks: PP: Pocket Penetrometer, T: Torvane, UC: Unconfined Compression Test (tsf), No grounwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-16

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DRILLING LOG

WinCore	County	Harris	Hole	B-14	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
	CSJ	No. 0912-70-082	Station	51+55.38	Grnd. Elev.	87.14 ft
			Offset	16.94	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 12 inches							
86.1			SAND, loose, moist, dark brown, w/clay pockets and silt (SM)			19				
						16				
		5 (6) 7 (6)								
82.1 5			CLAY, soft, dark brown, reddish brown, with ferrous and calcareous nodules (CL)			18				PP: 0.69, T: 0.75
						14	43	24	137.94	PP: 1.50, T: 1.50, UC: 2.31 - 200: 72 %
		6 (6) 8 (6)								
77.1 10			CLAY, stiff, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CH)			21				PP: 1.50, T: 1.50
						26	60	39	129.78	PP: 0.85, T: 1.0, UC: 1.14
		11 (6) 12 (6)								
15						26				PP: 0.93, T: 1.0
						20				PP: 1.50, T: 1.50
		14 (6) 13 (6)								
20						21				PP: 1.40, T: 1.50
						18				PP: 1.5, T: 1.50
63.1		25 (6) 19 (6)								
25			CLAY, very stiff, dark brown 24' to 30' (CH)							

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-17

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DRILLING LOG

WinCore	County	Harris	Hole	B-14	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
	CSJ	No. 0912-70-082	Station	51+55.38	Grnd. Elev.	87.14 ft
			Offset	16.94	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			CLAY, very stiff, dark brown 24' to 30' (CH)			23				PP: 1.50, T: 1.50
60.1			CLAY, w/silts, dark brown 27' to 20' (CH)			19				PP: 1.01, T: 1.12
		18 (6) 32 (6)								
57.1 30										
35										
40										
45										
50										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-17

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DRILLING LOG

WinCore
sion 3.1

County	Harris	Hole	B-15	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
CSJ	No. 0912-70-082	Station	45+48.37	Grnd. Elev.	87.71 ft
		Offset	10.69	GW Elev.	57.71 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
87.3			ASPHALT, to 2.3 inches							
			SAND, moist, dark brown, brownish yellow, w/clay pockets and silt (SM)			11				
85.7			SILT, very loose, moist, dark brown, brownish yellow, w/clay pockets and sand (ML)			10				- 200: 59 %
		3 (6) 4 (6)								
82.7 5			CLAY, soft, moist, dark brown, brownish yellow, w/ferrous and calcareous nodules (CL)			14			133.4	PP: 1.50, T: 1.50, UC: 1.56
						17	41	23	128.7	PP: 1.50, T: 1.50, UC: 1.58
		7 (6) 9 (6)								
77.7 10			CLAY, stiff, moist, dark brown, reddish brown, w/ferrous and calcareous nodules (CH)			19	52	32		PP: 1.24, T: 1.50
						19				PP: 1.50, T: 1.50, UC: 1.56
		11 (6) 13 (6)								
15						27				PP: 1.50, T: 1.50
						17				PP: 1.50, T: 1.50
		14 (6) 16 (6)								
20						20				PP: 1.40, T: 1.50
						20				PP: 1.50, T: 1.50
		18 (6) 35 (6)								
63.7			CLAY, very stiff, dark brown 24' to 25' (CH)							
62.7 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-18

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DRILLING LOG

WinCore
sion 3.1

County	Harris	Hole	B-15	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
CSJ	No. 0912-70-082	Station	45+48.37	Grnd. Elev.	87.71 ft
		Offset	10.69	GW Elev.	57.71 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
			CLAY, w/silts, dark brown 27' to 29' (CH)			23				PP: 0.62, T: 0.75
						19				SPT: 20, -200: 53 %
58.7		15 (6) 17 (6)								
57.7 30			SILT, slightly compact, moist, reddish brown, w/clay seams (ML)							
			CLAY, very stiff, moist, reddish brown, with ferrous and calcareous nodules (CL)			29				PP: 0.31, T: 0.38
						21				PP: 0.39, T: 0.50
		23 (6) 50 (6)								
52.7 35										
40										
45										
50										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-18

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DRILLING LOG

WinCore
sion 3.1

County	Harris	Hole	B-16	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
CSJ	No. 0912-70-082	Station	41+24.12	Grnd. Elev.	87.36 ft
		Offset	14.21	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
87.			ASPHALT, to 2.3 inches							
			SAND, moist, dark brown, w/clay pockets and silt (SM)			7				- 200: 21 %
85.4			SILT, loose, moist, dark brown, w/clay seams (ML)			14				
		5 (6) 5 (6)								
82.4 5			CLAY, soft, moist, dark brown, brownish yellow, w/ferrous and calcareous nodules (CL)			17				PP: 0.62, T: 0.75
						14	45	26	138	PP: 1.50, T: 1.50, UC: 2.81 - 200: 78 %
		8 (6) 9 (6)								
77.4 10			CLAY, soft, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			31				PP: 1.08, T: 1.12
						17	63	41	124	PP: 1.24, T: 1.50, UC: 1.81
		8 (6) 12 (6)								
15						32				PP: 1.40, T: 1.50
						27				PP: 0.93, T: 1.0
		12 (6) 16 (6)								
68.4			CLAY, stiff, reddish brown 19' to 20' (CH)							
67.4 20										
25										

Remarks: UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-19

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DRILLING LOG

WinCore
Version 3.1

County	Harris	Hole	B-17	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
CSJ	No. 0912-70-082	Station	36+77.91	Grnd. Elev.	87.25 ft
		Offset	13.40	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
86.8			ASPHALT, to 5.7 inches							
			SAND, moist, dark brown, w/clay pockets and silt (SM)			20				
85.3			CLAY, ery soft, moist, dark brown, w/ferrous and calcareous nodules (CL)			23				PP: 0.62, T: 0.78
		4 (6) 4 (6)								
5						17	48	29	128.7	PP: 1.50, T: 1.50, UC: 1.89
						14				PP: 1.50, T: 1.50
		9 (6) 11 (6)								
78.3			CLAY, soft, dark brown 9' to 10' (CL)							
77.3 10			CLAY, soft, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			25	65	43	127.5	PP: 1.50, T: 1.50, UC: 1.99 - 200: 93 %
						28				PP: 1.50, T: 1.50
		5 (6) 8 (6)								
15						24				PP: 0.85, T: 1.0
						24				PP: 1.50, T: 1.50
		50 (5) 50 (0)								
68.3			CLAY, hard, reddish brown 19' to 20' (CH)							
67.3 20										
25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-20

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DRILLING LOG

WinCore	County	Harris	Hole	B-18	District	Harris
	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
sion 3.1	CSJ	No. 0912-70-082	Station	31+33.97	Grnd. Elev.	86.32 ft
			Offset	18.98	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
85.9			ASPHALT, to 2 inches							
			SAND, moist, dark brown, w/clay pockets and silt (SM)			10				
84.3			CLAY, very soft, moist, dark brown, brownish yellow, w/ferrous and calcareous nodules (CL)			19				PP: 0.62, T: 1.50
		2 (6) 2 (6)								
5						19	42	23	122.6	PP: 0.62, T: 1.50, UC: 0.60
						17				PP: 0.39, T: 0.50
77.3		7 (6) 8 (6)								
			CLAY, soft, dark brown 9' to 10' (CL)							
76.3 10			CLAY, stiff, moist, reddish brown, w/ferrous and calcareous nodules (CH)			30				PP: 0.85, T: 0.88
						26	66	44	123.5	PP: 0.69, T: 0.75, UC: 0.73 - 200: 90 %
		13 (6) 15 (6)								
15						23				PP: 1.50, T: 1.50
						20				PP: 1.40, T: 1.50
		17 (6) 21 (6)								
66.3 20			CLAY, very stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CL)			17				PP: 1.50, T: 1.50
						19	31	14	128.5	PP: 0.69, T: 0.75, UC: 0.19
		21 (6) 32 (6)								
61.3 25										

Remarks: UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-21

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DRILLING LOG

WinCore
Version 3.1

County	Harris	Hole	B-19	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
CSJ	No. 0912-70-082	Station	27+43.59	Grnd. Elev.	86.50 ft
		Offset	15.26	GW Elev.	64.50 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
86.1			ASPHALT, to 5.5 inches							
			SAND, loose, moist, dark brown, w/clay seams and silt (SM)			12				
						9				
		9 (6) 8 (6)								
81.5 5			CLAY, stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CH)			19	59	38	125	PP: 1.50, T: 1.50, UC: 2.43 - 200: 80 %
						16				PP: 1.50, T: 1.50
		10 (6) 11 (6)								
10						30				PP: 0.78, T: 0.88
						23				PP: 1.32, T: 1.50
		12 (6) 21 (6)								
15						18				PP: 1.32, T: 1.50
69.5			CLAY, very stiff, moist, reddish brown, brownish yellow, w/ferrous and calcareous nodules (CL)			20	44	25	125	PP: 1.08, T: 1.12, UC: 1.03
		27 (6) 17 (6)								
66.5 20			SILT, slightly compact, moist, reddish brown, w/clay seams and sand (ML)			21				SPT: 21, - 200: 80 %
						30				SPT: 30
		10 (6) 16 (6)								
61.5 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test (tsf)

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-22

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DRILLING LOG

WinCore	County	Harris	Hole	B-20	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
	CSJ	No. 0912-70-082	Station	21+09.94	Grnd. Elev.	84.59 ft
			Offset	16.81	GW Elev.	N/A

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
84.2			ASPHALT, to 3.8 inches							
			SAND, moist, dark brown, w/clay pockets and silt (SM)			6				
82.6			CLAY, soft, moist, dark brown, w/ferrous and calcareous nodules (CH)			25	70	47	127.5	PP: 0.78, T: 0.88, UC: 1.02 - 200: 79 %
		7 (6) 7 (6)								
79.6 5			CLAY, soft, moist, dark brown, brownish yellow, with ferrous and calcareous nodules (CL)			16				PP: 1.40, T: 1.50
						16				PP: 1.40, T: 1.50
		7 (6) 6 (6)								
74.6 10			CLAY, stiff, moist, dark brown, brownish yellow, with ferrous and calcareous nodules (CH)			25				PP: 1.32, T: 1.50
						18				PP: 1.50, T: 1.50
		12 (6) 18 (6)								
69.6 15			CLAY, stiff, moist, reddish brown, brownish yellow, with ferrous and calcareous nodules (CL)			21				PP: 0.69, T: 0.75
						23	44	25	134	PP: 0.78, T: 0.88, UC: 1.06
		15 (6) 15 (6)								
20						21				PP: 0.69, T: 0.75
						19				PP: 0.56, T: 0.62
60.6		50 (6) 50 (5)								
			CLAY, hard 24' to 25' (CL)							
59.6 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), No groundwater was encountered during drilling and 24 hours after drilling.

The ground water elevation was not determined during the course of this boring.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-23

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DRILLING LOG

WinCore
Version 3.1

County	Harris	Hole	B-21	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
CSJ	No. 0912-70-082	Station	17+73.54	Grnd. Elev.	82.85 ft
		Offset	6.42	GW Elev.	62.85 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
82.4			ASPHALT, to 6 inches							
			CLAY, very soft, moist, dark brown, reddish brown, with ferrous and calcareous nodules (CL)			4				PP: 0.46, T: 0.62
						17	44	27	127.5	PP: 0.62, T: 0.88, UC: 0.66
		2 (6) 2 (6)								
5						21				PP: 0.69, T: 1.0
						20				PP: 0.39, T: 0.50
73.9		3 (6) 6 (6)								
10			CLAY, soft, dark brown 9' to 15' (CL)							
						26				PP: 0.46, T: 0.62
						28				PP: 1.24, T: 1.50
		9 (6) 11 (6)								
67.9 15			SILT, compact, moist, reddish brown, with clay seams and sand (ML)							
						18				SPT: 25, -200: 64 %
						14				SPT: 27
		14 (6) 28 (6)								
62.9 20			SILT, wet, reddish brown 20' to 30', w/sand (ML)			15				SPT: 11
						15				SPT: 11
		11 (6) 23 (6)								
25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-24

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DRILLING LOG

WinCore
Version 3.1

County	Harris	Hole	B-21	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
CSJ	No. 0912-70-082	Station	17+73.54	Grnd. Elev.	82.85 ft
		Offset	6.42	GW Elev.	62.85 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			SILT, wet, reddish brown 20' to 30', w/sand (ML)			17				SPT: 16
						13				SPT: 15
53.9		15 (6) 18 (6)								
52.9			SILT, slightly compact 29' to 30' (ML)							
30										
35										
40										
45										
50										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-24

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DRILLING LOG

WinCore	County	Harris	Hole	B-22	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
	CSJ	No. 0912-70-082	Station	12+02.48	Grnd. Elev.	78.89 ft
			Offset	19.44	GW Elev.	63.89 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	Properties MC	Properties LL	Properties PI	Properties Wet Den. (pcf)	Additional Remarks
78.5			ASPHALT, to 4.1 inches							
			CLAY, soft, moist, dark brown, brownish yellow, w/ferrous and calcareous nodules (CL)			14	40	22	131.1	PP: 1.40, T: 1.50, UC: 2.05 -200: 76 %
						15				PP: 1.50, T: 1.50
		7 (6) 6 (6)								
5						15				PP: 1.32, T: 1.50
						14	33	16	133.4	PP: 1.50, T: 1.50, UC: 1.72
69.9		13 (6) 15 (6)								
			CLAY, stiff, dark brown 9' to 10' (CL)							
10						18				PP: 0.56, T: 0.62
						21				PP: 0.31, T: 0.50
64.9		4 (6) 3 (6)								
			CLAY, very soft, dark brown 14' to 15' (CL)							
63.9 15			SILT, slightly compact, wet, reddish brown (ML)			27				SPT: 12, -200: 90 %
						30				
		10 (6) 17 (6)								
20						27				SPT: 16
56.9										
			CLAY, soft, moist, reddish brown, with ferrous and calcareous nodules (CL)			16	47	28		PP: 0.46, T: 0.56
		5 (6) 12 (6)								
53.9 25										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-25

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DRILLING LOG

WinCore	County	Harris	Hole	B-23	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
	CSJ	No. 0912-70-082	Station	6+5.0	Grnd. Elev.	78.00 ft
			Offset		GW Elev.	63.00 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test Lateral Press. (psi)	Triaxial Test Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	Additional Remarks
			ASPHALT, to 11.7 inches							
77.			SAND, moist, dark brown, w/clay pockets and silt (SM)			16				
76.			CLAY, soft, moist, dark brown, brownish yellow, with ferrous and calcareous nodules (CL)			16				PP: 1.24, T: 1.50
		7 (6) 9 (6)								
5						17	46	27	138	PP: 0.46, T: 0.50, UC: 0.8
						18				PP: 1.32, T: 1.50
		13 (6) 15 (6)								
69.			CLAY, stiff, dark brown 9' to 10' (CL)							
10						16	35	18	132.24	PP: 0.78, T: 0.88, UC: 0.56
			SAND, loose, moist, reddish brown, w/clay seams and silt (SM)			14				- 200: 37 %
		7 (6) 13 (6)								
63. 15			SAND, wet, reddish brown, w/silt 15' to 25' (SM)			20				SPT: 14
		5 (6) 6 (6)				19				SPT: 8
20						18				SPT: 17
						18				SPT: 11
		6 (6) 9 (6)								
53. 25						24	47	29	129	PP: 0.78, T: 0.88, UC: 0.74

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-26

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DRILLING LOG

WinCore	County	Harris	Hole	B-23	District	Harris
Version 3.1	Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
	CSJ	No. 0912-70-082	Station	6+5.0	Grnd. Elev.	78.00 ft
			Offset		GW Elev.	63.00 ft

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test: Lateral Press. (psi)	Triaxial Test: Deviator Stress (psi)	Properties: MC	Properties: LL	Properties: PI	Properties: Wet Den. (pcf)	Additional Remarks
			CLAY, moist, reddish brown, w/ferrous and calcareous nodules (CL)							
51.			SILT, compact, wet, reddish brown, with clay seams (ML)			23				SPT: 17
		36 (6) 38 (6)								
30						20				SPT: 15
46.						26	65	43		PP: 1.50, T: 1.50
			CLAY, slightly compact, moist, reddish brown, with ferrous and calcareous nodules (CH)							
		18 (6) 22 (6)								
43. 35										
40										
45										
50										

Remarks: PP: Pocket Penetrometer (tsf), T: Torvane (tsf), UC: Unconfined Compression Test (tsf), SPT: Standard Penetration Test

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

Driller: Matthers Logger: Joshua Organization: GET PLATE A-26

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Geotech Engineering and Testing
800 Victoria
Houston, Texas

LOG OF BORING B-24

PROJECT: Memorial Drive from N. Kirkwood Dr. to N. Elridge Pkwy.
Harris County, Texas (N-000798-0001-3)

PROJECT NO.: 09-338E

BORING TYPE: Dry Auger: 0 to 18-ft.
Wash Boring: 18 to 35-ft.

DATE: 7/30/2013

SURFACE ELEVATION: El: 74-ft

LOCATION

Northing: 13846973.4

Easting: 3041730.7

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA, P (tsf)	DRY DENSITY (pcf)	UU SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		FILL		FILL: SANDY LEAN CLAY (CL), very stiff, dark brown, with root fibers, ferrous and calcareous nodules	P = 3	117				2	31	16	15	53	
		FILL		FILL: SILTY SAND (SM), loose, brownish yellow, with clay seams	N = 10					5					
5				- medium dense 5' to 9'	TCP 6(6), 5(6) N = 14					8				43	
					N = 16					6					
10		CH	▼	FAT CLAY (CH), stiff, brownish yellow, with ferrous and calcareous nodules - very stiff 12' to 14'	TCP 6(6), 7(6) P = 1.7	91				35	52	19	33		
					P = 1.86	100				23					
15		ML	▽	SILT (ML), loose, reddish brown - medium dense 17' to 19'	TCP 4(6), 8(6) N = 9					23				97	
					N = 11					24				98	
20		CL		LEAN CLAY (CL), very stiff, reddish brown, with ferrous and calcareous nodules	TCP 6(6), 6(6) P = 2.16	112				16	35	16	19	85	
		ML		SANDY SILT (ML), medium dense, reddish brown	N = 13					23					
25					TCP 7(6), 7(6) N = 16					21					
					N = 21					22					
30		CH		FAT CLAY (CH), very stiff, reddish brown, with ferrous and calcareous nodules	TCP 7(6), 7(6) P = 3	102				23	54	19	35		
					P = 3	104				21					
35					TCP 9(6), 10(6)										

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20, 40, 60, 80)

Water Level: During: ▽ After 24 Hrs: ▼ Perched: ▼
: WATER ENCOUNTERED AT 16.0 ft. DURING DRILLING.
: WATER DEPTH AT 10.0 ft. AFTER 24 HOUR

Sample Key: SPT, Shelby Tube, Disturbed

Key to Abbreviations:
- P - Pocket Penetrometer Reading (tsf)
- N - SPT Data (Blows/Ft)
- T - Torvane (tsf)
- C_u - Undrained Cohesion (tsf)
- SS - Shear Strength (P/2, tsf)

Notes:

Driller: GET
Logger: Eric
Bottom of Boring at 35-ft.

KEY TO LOG TERMS AND SYMBOLS

UNIFIED SOIL CLASSIFICATIONS

Symbol	Material Descriptions
GW	WELL GRADED-GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL-SAND SILT MIXTURES
GC	CLAY GRAVELS, GRAVEL-SAND CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, OR GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND-SILT MIXTURES a
SC	CLAYEY SANDS, SAND-SILT MIXTURES b
ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
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
PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT
	FILL SOILS

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	-	Having incline planes of weakness that are slick and glossy in appearance.
Fissured	-	Containing shrinkage cracks frequently filled with fine sand or silt: usually vertical.
Laminated	-	Composed of thin layers of varying colors and soil sample texture.
Interbedded	-	Composed of alternate layers of different soil types.
Calcareous	-	Containing appreciable quantities of calcium carbonate.
Well Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly Graded	-	Predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.
Pocket	-	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	-	Inclusion less than ⅛-inch thick extending through the sample.
Seam	-	Inclusion ⅛- to 3-inch thick extending through the sample.
Layer	-	Inclusion greater than 3-inch thick extending through the sample.
Interlayered	-	Soils sample composed of alternating layers of different soil types.
Intermixed	-	Soil samples composed of pockets of different soil type and layered or laminated structure is not evident.

COARSE GRAINED SOILS (major portion retained on No. 200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Conditions rated according to standard penetration test (SPT) and Texas Cone Penetration (TCP) as performed in the field.

SPT		TCP	
Descriptive Terms	Blows Per Foot(1)	Descriptive Terms	Blows Per Foot(2)
Very Loose	0 – 4	Very Loose	0 – 8
Loose	5 – 10	Loose	8 – 20
Medium Dense	11 – 30	Slightly Compact	20 – 40
Dense	31 – 50	Compact	40 – 80
Very Dense*	over 50	Dense	80 to to 5"/100
		Very Dense	0" to 5"/100

1. 140 pound weight having a free fall of 30-inch
2. 170 pound weight having a free fall of 24-inches

FINE GRAINED SOILS (major portion passing No. 200 Sieve): Include (1) inorganic or organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength as indicated by hand penetrometer readings or by unconfined compression and TCP tests.

Descriptive Term	Undrained Shear Strength Ton/Sq. Ft.	Descriptive Terms	TCP Blows Per Foot(1)
Very Soft	Less than 0.13	Very Soft	0 – 8
Soft	0.13 to 0.25	Soft	8 – 20
Firm	0.25 to 0.50	Stiff	20 – 40
Stiff	0.50 to 1.00	Very Stiff	40 – 80
Very Stiff	1.00 to 2.00	Hard	80 to to 5"/100
Hard	2.00 or higher	Very Hard	0" to 5"/100

1. 170 pound weight having a free fall of 24-inches

SOIL SAMPLERS

- ■ SHELBY TUBE SAMPLER
- ☒ STANDARD PENETRATION TEST, TEXAS CONE PENETRATION TEST
- ◨ AUGER SAMPLING

TERMS CHARACTERIZING ROCK PROPERTIES

VERY SOFT OR PLASTIC	Can be remolded in hand: corresponds in consistency up to very stiff in soils.
SOFT	Can be scratched with fingernail.
MODERATELY HARD	Can be scratched easily with knife; cannot be scratched with fingernail. Difficult to scratch with knife.
VERY HARD	Cannot be scratched with knife.
POORLY CEMENTED OR FRIABLE	Easily crumbled.
CEMENTED	Bounded Together by chemically precipitated materials.
UNWEATHERED	Rock in its natural state before being exposed to atmospheric agents.
SLIGHTLY WEATHERED	Noted predominantly by color change with no disintegrated zones.
WEATHERED	Complete color change with zones of slightly decomposed rock.
EXTREMELY WEATHERED	Complete color change with consistency, texture, and general appearance or soil.

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)

COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

	SAMPLE								ATTERBERG LIMITS				SHEAR STRENGTH (TSF)				
		DEPTH (FT)															
BORING NO.	NO.	Top	Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-1	1	0	2	UD			11					41					Sand (SM)
	2	2	4	UD			23		56	19	37	62			0.56	0.75	Clay (CH)
		4	5		13										1.5	1.5	Clay (CH)
	3	5	7	UD			14										Clay (CH)
	4	7	9	UD			16	115					0.97		1.5	1.5	Clay (CH)
		9	10		22												Clay (CH)

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

TCP = TEXAS CONE PENETROMETER (BLOWS/FT)

SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)

COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE, TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-2	1	0	2	UD			11										Sand (SM)
	2	2	4	UD			13								1.5	1.5	Clay (CH)
		4	5		65										0.62	0.88	Clay (CH)
	3	5	7	UD			21										Clay (CH)
	4	7	9	UD			17	120	50	18	22		1.29		1.01	1.5	Clay (CH)
		9	10		22												Clay (CH)
	5	10	12	UD			25								1.5	1.5	Clay (CH)
	6	12	14	UD			22		61	20	41	92			1.5	1.5	Clay (CH)
		14	15		31												Clay (CH)
	7	15	17	UD			21	109					1.66		1.5	1.5	Clay (CH)
	8	17	19	SPT		18	25					72					Silt (ML)
		19	20		25												Silt (ML)
	9	20	22	SPT		19	21										Silt (ML)
	10	22	24	UD			25	100	45	17	28		0.47		1.5	1.5	Clay (CL)
		24	25		28												

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

TCP = TEXAS CONE PENETROMETER (BLOWS/FT)

SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)
COH WBS NUMBER: N-000798-0001-3
CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-3	1	0	2	UD			14		38	17	21	60			1.5	1.5	Clay (CL)
	2	2	4	UD			17								1.5	1.5	Clay (CH)
		4	5		12												Clay (CH)
	3	5	7	UD			15								1.5	1.5	Clay (CH)
	4	7	9	UD			19	106	50	19	31		0.59		1.5	1.5	Clay (CH)
		9	10		6												Clay (CH)
	5	10	12	UD			11								0.78	0.88	Clay (CH)
	6	12	14	UD			17	108	58	20	38	90	0.97		1.5	1.5	Clay (CH)
		14	15		18												Clay (CH)
	7	15	17	UD			28								0.31	0.38	Clay (CH)
	8	17	19	UD			21										Silt (ML)
		19	20		46												Silt (ML)
	9	20	22	SPT		31	17					92					Silt (ML)
	10	22	24	SPT		33	20										Silt (ML)
		24	25		74												Silt (ML)

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

TCP = TEXAS CONE PENETROMETER (BLOWS/FT)

SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)

COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-4	1	0	2	UD			14								0.56	0.62	Clay (CL)
	2	2	4	UD			13								1.5	1.5	Clay (CL)
		4	5		28												Clay (CL)
	3	5	7	UD			12								1.5	1.5	Clay (CL)
	4	7	9	UD			12	121	40	18	22		2.6		1.5	1.5	Clay (CL)
		9	10		33												Clay (CL)
	5	10	12	UD			22								1.32	1.5	Clay (CH)
	6	12	14	UD			21								1.5	1.5	Clay (CH)
		14	15		19												Clay (CH)
	7	15	17	UD			22								1.5	1.5	Clay (CH)
	8	17	19	UD			21	109	51	20	31	95	2.59		1.5	1.5	Clay (CH)
		19	20		40												Clay (CH)
	9	20	22	UD			20								1.5	1.5	Clay (CH)
	10	22	24	UD			19								0.85	0.88	Clay (CH)
		24	25		50												Clay (CH)

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COH WBS NUMBER: N-000798-0001-3
CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-5	1	0	2	UD			13					40					Sand (SM)
	2	2	4	UD			13										Sand (SM)
		4	5		20												Clay (CL)
	3	5	7	UD			16	115	45	19	26		0.99		1.08	1.25	Clay (CL)
	4	7	9	UD			14								1.5	1.5	Clay (CL)
		9	10		16												Clay (CL)
	5	10	12	UD			24								0.78	0.88	Clay (CH)
	6	12	14	UD			24								1.5	1.5	Clay (CH)
		14	15		30												Clay (CH)
	7	15	17	UD			20								1.5	1.5	Clay (CH)
	8	17	19	UD			24	108	42	19	23		1.43		1.01	1.12	Clay (CL)
		19	20		93												Clay (CL)
	9	20	22	SPT		14	22										Silt (ML)
	10	22	24	SPT		15	27					77					Silt (ML)
		24	25		57												Silt (ML)

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CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE, TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-6	1	0	2	UD			14								0.62	0.75	Clay (CL)
	2	2	4	UD			19	114	40	18	22		0.65		1.08	1.12	Clay (CL)
		4	5		9												Clay (CL)
	3	5	7	UD			15								1.32	1.5	Clay (CL)
	4	7	9	UD			16	116	40	18	22	73	0.94		0.56	0.62	Clay (CL)
		9	10		15												Clay (CL)
	5	10	12	UD			21								1.4	1.5	Clay (CH)
	6	12	14	UD			29								1.5	1.5	Clay (CH)
		14	15		19												Clay (CH)
	7	15	17	UD			22								1.5	1.5	Clay (CH)
	8	17	19	UD			22								1.5	1.5	Clay (CH)
		19	20		46												Clay (CH)
	9	20	22	UD			16					69					Silt (ML)
	10	22	24	SPT		38	23										Silt (ML)
		24	25		63												Silt (ML)

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CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE, TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-7	1	0	2	UD			10										Clay (CL)
	2	2	4	UD			16	110	32	17	15		0.57		0.62	0.75	Clay (CL)
		4	5		12												Clay (CL)
	3	5	7	UD			14								1.5	1.5	Clay (CL)
	4	7	9	UD			15								1.01	1.12	Clay (CL)
		9	10		14												Clay (CL)
	5	10	12	UD			22								1.5	1.5	Clay (CH)
	6	12	14	UD			25	103	53	20	33		2.27		1.5	1.5	Clay (CH)
		14	15		31												Clay (CH)
	7	15	17	UD			20								1.5	1.5	Clay (CH)
	8	17	19	UD			22								1.5	1.5	Clay (CH)
		19	20		36												Clay (CH)
	9	20	22	SPT		23	21					48					Sand (SM)
	10	22	24	UD			21		46	19	27				0.56	0.62	Clay (CL)
		24	25		50 (4)												Clay (CL)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-8	1	0	2	UD			9										Sand (SM)
	2	2	4	SPT		13	15										Sand (SM)
		4	5		10												Sand (SM)
	3	5	7	UD			15								1.4	1.5	Clay (CL)
	4	7	9	UD			14	120	45	19	26		2.026		1.5	1.5	Clay (CL)
		9	10		19												Clay (CL)
	5	10	12	UD			24								1.5	1.5	Clay (CH)
	6	12	14	UD			25								1.4	1.5	Clay (CH)
		14	15		31												Clay (CH)
	7	15	17	UD			27								1.5	1.5	Clay (CH)
	8	17	19	UD			17	115	40	18	22	91	2.63		1.5	1.5	Clay (CL)
		19	20		58												Clay (CL)
	9	20	22	SPT		49	15										Silt (ML)
	10	22	24	UD			17					76			1.01	1.12	Clay (CL)
		24	25		66												Clay (CL)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-9	1	0	2	UD			12										Sand (SM)
	2	2	4	UD			19	103	47	19	28	58	0.71		1.32	1.5	Clay (CL)
		4	5		12												Clay (CL)
	3	5	7	UD			15								1.16	1.25	Clay (CL)
	4	7	9	UD			15								1.4	1.5	Clay (CL)
		9	10		13												Clay (CL)
	5	10	12	UD			21								0.56	0.62	Clay (CL)
	6	12	14	UD			24								1.5	1.5	Clay (CH)
		14	15		14												Clay (CH)
	7	15	17	UD			23								1.5	1.5	Clay (CH)
	8	17	19	UD			23								1.5	1.5	Clay (CH)
		19	20		49												Clay (CH)
	9	20	22	UD			14								1.5	1.5	Clay (CL)
	10	22	24	UD			18	98	30	17	13	87	0.77		0.93	1	Clay (CL)
		24	25		36												Clay (CL)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-10	1	0	2	UD			12										Sand (SM)
	2	2	4	UD			20								0.69	0.78	Clay (CL)
		4	5		4												Clay (CL)
	3	5	7	UD			20								0.31	0.5	Clay (CL)
	4	7	9	UD			19	111	40	18	22	75	0.59		0.56	0.62	Clay (CL)
		9	10		12												Clay (CL)
	5	10	12	UD			25								1.08	1.12	Clay (CH)
	6	12	14	UD			26								0.46	0.62	Clay (CH)
		14	15		31												Clay (CH)
	7	15	17	UD			28								1.16	1.25	Clay (CH)
	8	17	19	UD			17								1.5	1.5	Clay (CH)
		19	20		96												Clay (CH)
	9	20	22	UD			19								1.5	1.5	Clay (CL)
	10	22	24	UD			17	116	33	17	16	93	1.77		1.08	1.12	Clay (CL)
		24	25		50												Clay (CL)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-11	1	0	2	UD			3					19					Sand (SM)
	2	2	4	UD			17	109	38	18	20		1.23		0.78	0.88	Clay (CL)
		4	5		20												Clay (CL)
	3	5	7	UD			16								0.78	0.88	Clay (CL)
	4	7	9	UD			19								1.4	1.5	Clay (CL)
		9	10		20												Clay (CL)
	5	10	12	UD			26								1.5	1.5	Clay (CH)
	6	12	14	UD			28								1.5	1.5	Clay (CH)
		14	15		22												Clay (CH)
	7	15	17	UD			17								1.5	1.5	Clay (CH)
	8	17	19	UD			20	110	55	21	35	96	1.91		1.5	1.5	Clay (CH)
		19	20		58												Clay (CH)
	9	20	22	UD			19								1.5	1.5	Clay (CL)
	10	22	24	UD			18		30	17	13				1.16	1.25	Clay (CL)
		24	25		30												Clay (CL)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-12	1	0	2	UD			7										Sand (SM)
	2	2	4	UD			20	106	33	17	16		0.78		0.56	0.62	Clay (CL)
		4	5		10												Clay (CL)
	3	5	7	UD			15								0.93	1	Clay (CL)
	4	7	9	UD			16								1.5	1.5	Clay (CL)
		9	10		21												Clay (CL)
	5	10	12	UD			21	104	57	21	36	93	0.994		1.32	1.5	Clay (CH)
	6	12	14	UD			20								1.24	1.5	Clay (CH)
		14	15		29												Clay (CH)
	7	15	17	UD			26								1.5	1.5	Clay (CH)
	8	17	19	UD			25								1.5	1.5	Clay (CH)
		19	20		38												Clay (CH)
	9	20	22	UD			18								1.5	1.5	Clay (CL)
	10	22	24	SPT		43	23					40					Sand (SM)
		24	25		75												Clay (CL)
	11	25	27	UD			22								1.5	1.5	Clay (CL)
	12	27	29	UD			19	110	28	16	12		1.76		1.5	1.5	Clay (CL)
		29	30		78												Clay (CL)

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B-13	1	0	2	UD			15								1.5	1.5	Clay (CL)
	2	2	4	UD			13								1.5	1.5	Clay (CL)
		4	5		12												Clay (CL)
	3	5	7	UD			13								1.5	1.5	Clay (CL)
	4	7	9	UD			15	118	54	20	34		2.6		1.5	1.5	Clay (CH)
		9	10		17												Clay (CH)
	5	10	12	UD			24								1.5	1.5	Clay (CH)
	6	12	14	UD			28	90	73	23	50	97	1.14		1.5	1.5	Clay (CH)
		14	15		26												Clay (CH)
	7	15	17	UD			20								1.5	1.5	Clay (CL)
	8	17	19	UD			21								1.5	1.5	Clay (CL)
		19	20		56												Clay (CL)
	9	20	22	UD			17								1.5	1.5	Clay (CL)
	10	22	24	UD			20	106	36	18	18	99	1.13		1.5	1.5	Clay (CL)
		24	25		50 (5)												Clay (CL)

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COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-14	1	0	2	UD			19										Sand (SM)
	2	2	4	UD			16										Sand (SM)
		4	5		12												Sand (SM)
	3	5	7	UD			18								0.69	0.75	Clay (CL)
	4	7	9	UD			14	121	43	19	24	72	2.31		1.5	1.5	Clay (CL)
		9	10		14												Clay (CL)
	5	10	12	UD			21								1.5	1.5	Clay (CH)
	6	12	14	UD			26	103	60	21	39	87	1.14		0.85	1	Clay (CH)
		14	15		23												Clay (CH)
	7	15	17	UD			26								0.93	1	Clay (CH)
	8	17	19	UD			20								1.5	1.5	Clay (CH)
		19	20		27												Clay (CH)
	9	20	22	UD			21								1.4	1.5	Clay (CH)
	10	22	24	UD			18								1.5	1.5	Clay (CH)
		24	25		43												Clay (CH)
	11	25	27	UD			23								1.5	1.5	Clay (CH)
	12	27	29	UD			19								1.01	1.12	Clay (CH)
		29	30		50												Clay (CH)

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

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SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)

COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE, TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-15	1	0	2	UD			11										Sand (SM)
	2	2	4	UD			10					59					Silt (ML)
		4	5		7												Silt (ML)
	3	5	7	UD			14	117					1.56		1.5	1.5	Clay (CL)
	4	7	9	UD			17	110	41	18	23		1.58		1.5	1.5	Clay (CL)
		9	10		16												Clay (CL)
	5	10	12	UD			19		52	20	33				1.24	1.5	Clay (CH)
	6	12	14	UD			19								1.5	1.5	Clay (CH)
		14	15		24												Clay (CH)
	7	15	17	UD			27								1.5	1.5	Clay (CH)
	8	17	19	UD			17								1.5	1.5	Clay (CH)
		19	20		30												Clay (CH)
	9	20	22	UD			20								1.4	1.5	Clay (CH)
	10	22	24	UD			20								1.5	1.5	Clay (CH)
		24	25		53												Clay (CH)
	11	25	27	UD			23								0.62	0.75	Clay (CH)
	12	27	29	SPT		20	19					53					Silt (ML)
		29	30		32												Silt (ML)
	13	30	32				29								0.31	0.38	Clay (CL)
	14	32	34				21								0.39	0.5	Clay (CL)
		34	35	73													Clay (CL)

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SUMMARY OF LABORATORY TEST RESULTS

Geotechnical Consultant's Name: Geotech Engineering and Testing

PROJECT NAME: MEMORIAL DRIVE FROM NORTH KIRKWOOD TO NORTH ELDRIDGE PARKWAY (CSJ No. 0912-70-082)
COH WBS NUMBER: N-000798-0001-3
CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-16	1	0	2	UD			7					21					Silt (ML)
	2	2	4	UD			14										Silt (ML)
		4	5		10												Silt (ML)
	3	5	7	UD			17								0.62	0.75	Clay (CL)
	4	7	9	UD			14	121	45	19	26	78	2.81		1.5	1.5	Clay (CL)
		9	10		17												Clay (CL)
	5	10	12	UD			31								1.08	1.12	Clay (CH)
	6	12	14	UD			17	106	63	22	41		1.81		1.24	1.5	Clay (CH)
		14	15		20												Clay (CH)
	7	15	17	UD			32								1.4	1.5	Clay (CH)
	8	17	19	UD			27								0.93	1	Clay (CH)
		19	20		37												Clay (CH)

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COH WBS NUMBER: N-000798-0001-3
CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-17	1	0	2	UD			20										Sand (SM)
	2	2	4	UD			23								0.62	0.78	Clay (CL)
		4	5		8												Clay (CL)
	3	5	7	UD			17	110	48	19	29		1.89		1.5	1.5	Clay (CL)
	4	7	9	UD			14								1.5	1.5	Clay (CL)
		9	10		20												Clay (CL)
	5	10	12	UD			25	102	65	22	43	93	1.99		1.5	1.5	Clay (CH)
	6	12	14	UD			28								1.5	1.5	Clay (CH)
		14	15		13												Clay (CH)
	7	15	17	UD			24								0.85	1	Clay (CH)
	8	17	19	UD			24								1.5	1.5	Clay (CH)
		19	20		50(5)												Clay (CH)

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COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	PL (%)	PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	UU TEST (CONFINING PRESSURE. TSF)	POCKET PENETROMETER	TORVANE	TYPE OF MATERIAL
B-18	1	0	2	UD			10										Sand (SM)
	2	2	4	UD			19								0.62	0.75	Clay (CL)
		4	5		4												Clay (CL)
	3	5	7	UD			19	103	42	19	23		0.6		0.62	0.75	Clay (CL)
	4	7	9	UD			17								0.39	0.5	Clay (CL)
		9	10		15												Clay (CL)
	5	10	12	UD			30								0.85	0.88	Clay (CH)
	6	12	14	UD			26	98	66	22	44	90	0.73		0.69	0.88	Clay (CH)
		14	15		28												Clay (CH)
	7	15	17	UD			23								1.5	1.5	Clay (CH)
	8	17	19	UD			20								1.4	1.5	Clay (CH)
		19	20		38												Clay (CH)
	9	20	22	UD			17								1.5	1.5	Clay (CL)
	10	22	24	UD			19	108	31	17	14		0.19		0.69	0.75	Clay (CL)
		24	25		53												Clay (CL)

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COH WBS NUMBER: N-000798-0001-3

CONSULTANT PROJECT NUMBER: 09-338E

BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-19	1	0	2	UD			12										Sand (SM)
	2	2	4	UD			9										Sand (SM)
		4	5		17												Sand (SM)
	3	5	7	UD			19	105	59	21	38	80	2.43		1.5	1.5	Clay (CH)
	4	7	9	UD			16								1.5	1.5	Clay (CH)
		9	10		21												Clay (CH)
	5	10	12	UD			30								0.78	0.88	Clay (CH)
	6	12	14	UD			23								1.32	1.5	Clay (CH)
		14	15		33												Clay (CH)
	7	15	17	UD			18								1.32	1.5	Clay (CH)
	8	17	19	UD			20	104	44	19	25		1.03				Clay (CL)
		19	20		44										1.08	1.12	Clay (CL)
	9	20	22	SPT		21	21					80					Silt (ML)
	10	22	24	SPT		30	24										Silt (ML)
		24	25		26												Silt (ML)

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B-20	1	0	2	UD			6										Sand (SM)
	2	2	4	UD			25	102	70	23	47	79	1.02		0.78	0.88	Sand (SM)
		4	5		14												Sand (SM)
	3	5	7	UD			16								1.4	1.5	Clay (CH)
	4	7	9	UD			16								1.4	1.5	Clay (CH)
		9	10		13												Clay (CH)
	5	10	12	UD			25								1.32	1.5	Clay (CH)
	6	12	14	UD			18								1.5	1.5	Clay (CH)
		14	15		30												Clay (CH)
	7	15	17	UD			21								0.69	0.75	Clay (CH)
	8	17	19	UD			23	109	44	19	25		1.06		0.78	0.88	Clay (CL)
		19	20		30												Clay (CL)
	9	20	22	UD			21								0.69	0.75	Silt (ML)
	10	22	24	UD			19								0.56	0.62	Silt (ML)
		24	25		100												Silt (ML)

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B-21	1	0	2	UD			4								0.46	0.62	Clay (CL)
	2	2	4	UD			17	109	44	17	27	83	0.66		0.62	0.88	Clay (CL)
		4	5		4												Clay (CL)
	3	5	7	UD			21								0.69	1	Clay (CL)
	4	7	9	UD			20								0.39	0.5	Clay (CL)
		9	10		9												Clay (CL)
	5	10	12	UD			26								0.46	0.62	Clay (CL)
	6	12	14	UD			28								1.24	1.5	Clay (CL)
		14	15		20												Clay (CL)
	7	15	17	SPT		25	18					64					Silt (ML)
	8	17	19	SPT		27	14										Silt (ML)
		19	20		42												Silt (ML)
	9	20	22	SPT		11	15										Silt (ML)
	10	22	24	SPT		11	15										Silt (ML)
		24	25		34												Silt (ML)
	11	25	27	SPT		16	17										Silt (ML)
	12	27	29	SPT		15	13										Silt (ML)
		29	30		33												Silt (ML)

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-22	1	0	2	UD			14	115	40	18	22	76	2.05		1.4	1.5	Clay (CL)
	2	2	4	UD			15								1.5	1.5	Clay (CL)
		4	5		13												Clay (CL)
	3	5	7	UD			15								1.32	1.5	Clay (CL)
	4	7	9	UD			14	117	33	17	16		1.72		1.5	1.5	Clay (CL)
		9	10		28												Clay (CL)
	5	10	12	UD			18								0.56	0.62	Clay (CL)
	6	12	14	UD			21								0.31	0.5	Clay (CL)
		14	15		7												Clay (CL)
	7	15	17	SPT		12	27										Silt (ML)
	8	17	19	UD			30										Silt (ML)
		19	20		27												Silt (ML)
	9	20	22	SPT		16	27					90					Silt (ML)
	10	22	24	UD			16		47	19	28				0.46	0.56	Clay (CL)
		24	25		17												Clay (CL)

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B-23	1	0	2	UD			16										Sand (SM)
	2	2	4	UD			16								1.24	1.5	Clay (CL)
		4	5		16												Clay (CL)
	3	5	7	UD			17	118	46	19	27	51	0.8		0.46	0.56	Clay (CL)
	4	7	9	UD			18								1.32	1.5	Clay (CL)
		9	10		28												Clay (CL)
	5	10	12	UD			16	114	35	17	18		0.56		0.78	0.88	Clay (CL)
	6	12	14	UD			14					37					Sand (SM)
		14	15		20												Sand (SM)
	7	15	17	SPT		14	20										Sand (SM)
	8	17	19	SPT		8	19										Sand (SM)
		19	20		11												Sand (SM)
	9	20	22	SPT		17	18										Sand (SM)
	10	22	24	SPT		11	18										Sand (SM)
		24	25		15												Sand (SM)
	11	25	27	UD			24	104	47	18	28		0.74		0.78	0.88	Clay (CL)
	12	27	29	SPT		17	23										Silt (ML)
		29	30		74												Silt (ML)
	13	30	32	SPT		15	20										Silt (ML)
	14	32	34	UD			26		65	22	43				1.5	1.5	Clay (CH)
		34	35		40												

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BORING NO.	SAMPLE NO.	DEPTH (FT) Top	DEPTH (FT) Bottom	TYPE	TCP	SPT	WATER CONTENT(%)	DRY DENSITY (pct)	ATTERBERG LIMITS LL (%)	ATTERBERG LIMITS PL (%)	ATTERBERG LIMITS PI (%)	PERCENT PASSING SIEVE 200 (%)	SHEAR STRENGTH (TSF) UNCONFINED COMPRESSION TEST	SHEAR STRENGTH (TSF) UU TEST (CONFINING PRESSURE. TSF)	SHEAR STRENGTH (TSF) POCKET PENETROMETER	SHEAR STRENGTH (TSF) TORVANE	TYPE OF MATERIAL
B-24	1	0	2	UD			2	117	31	16	15	53	1.99		1.5	1.5	Fill: Sandy Lean Clay (CL)
	2	2	4	SPT		10	5										Fill: Silty Sand (SM)
		4	5		11												Fill: Silty Sand (SM)
	3	5	7	SPT		14	8					43					Fill: Silty Sand (SM)
	4	7	9	SPT		16	6										Fill: Silty Sand (SM)
		9	10		13												Fill: Silty Sand (SM)
	5	10	12	UD			35	91	52	19	33		0.91		0.85	1.25	Fat Clay (CH)
	6	12	14	UD			22	100					1.11		0.93	1.5	Fat Clay (CH)
		14	15		14												Fat Clay (CH)
	7	15	17	SPT		9	23					97					Silt (ML)
	8	17	19	SPT		11	24					98					Silt (ML)
		19	20		11												Silt (ML)
	9	20	22	UD			16	112	35	16	19	85	1.69		1.08	1.5	Lean Clay (CL)
	10	22	24	SPT		13	23										Sandy Silt (ML)
		24	25		13												Sandy Silt (ML)
	11	25	27	SPT		16	21										Sandy Silt (ML)
	12	27	29	SPT		21	22										Sandy Silt (ML)
		29	30		14												Sandy Silt (ML)
	13	30	32	UD			23	102	54	19	35		1.28		1.5	1.5	Fat Clay (CH)
	14	32	34	UD			21	104					1.42		1.5	1.5	Fat Clay (CH)
		34	35		19												

LEGEND:

UD = UNDISTURBED SAMPLE, EXTRUDED IN FIELD

SS = SPLIT SPOON SAMPLE

TCP = TEXAS CONE PENETROMETER (BLOWS/FT)

SPT = STANDARD PENETRATION TEST

LL = LIQUID LIMIT

PL = PLASTIC LIMIT

PI = PLASTIC INDEX

UU = TRIAXIAL COMPRESSION

NOTES:

APPENDIX B

Piezometer Installation and Abandonment Reports

STATE OF TEXAS WELL REPORT for Tracking #313565

Owner:	**GEOTECH ENGINEERING AND TESTING**	Owner Well #:	**B-6PZ**
Address:	**800 VICTORIA** **HOUSTON , TX 77022**	Grid #:	**65-12-7**
Well Location:	**14171-14299 MEMORIAL DR @ CLEAR SPRINGS** **HOUSTON , TX**	Latitude:	**29° 46' 11" N**
Well County:	**Harris**	Longitude:	**095° 35' 45" W**
Elevation:	**No Data**	GPS Brand Used:	**GARMIN**
Type of Work:	**New Well**	Proposed Use:	**Test Well**

Drilling Date:	Started: **1/22/2013** Completed: **1/22/2013**
Diameter of Hole:	Diameter: **6 in From Surface To 25 ft**
Drilling Method:	**Bored**
Borehole Completion:	Gravel Packed From: **25 ft to 13 ft** Gravel Pack Size: **20/40 SAND**
Annular Seal Data:	1st Interval: **From 25 ft to 13 ft with 5 SAND (#sacks and material)** 2nd Interval: **From 13 ft to 11 ft with 1 BENT.CHIPS (#sacks and material)** 3rd Interval: **From 11 ft to 0 ft with 3 CEMENT (#sacks and material)** Method Used: **GROUT PUMP** Cemented By: **MEDI** Distance to Septic Field or other Concentrated Contamination: **No Data** Distance to Property Line: **No Data** Method of Verification: **No Data** Approved by Variance: **No Data**
Surface Completion:	**Alternative Procedure Used**

Water Level:	Static level: **No Data** Artesian flow: **No Data**
Packers:	**BENTONITE CHIPS 3/8 13'-11'**
Plugging Info:	Casing or Cement/Bentonite left in well: **No Data**
Type Of Pump:	**No Data**
Well Tests:	**No Data**

Water Quality:	Type of Water: **No Data** Depth of Strata: **No Data** Chemical Analysis Made: **No Data** Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**
Certification Data:	The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company	**MATHERS ENVIRONMENTAL DRILLING INC.**

Information:	**12243 B. FM 529 HOUSTON , TX 77041**
Driller License Number:	**4850**
Licensed Well Driller Signature:	**PATRICK L, STEPHENS**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking **#313565**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0-2' SM,BRW,RED BRW
2'-4' CL,BRW,RE BRW
4'-5' TCP
5'-7' CL, BRW, YELL, GRN, GRY
7'-9' CH, REDBRW, GRNGRY
9'-10' TCP
10'-12' CH,RDBRW, GRY
12'-14' CH, RDBRW,GRY
14'-15' TCP
15'-17' CH, RDBRW, BRW
17'-19' CH, RDBRW, BRW
19'-20' TCP
20'-22' MLW/CH RDBRW
22'-24' MLW/CH RDBRW
24'-25' TCP

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2" NEW PLASTIC SCREEN SLOT 0.010 25'-15' SCH40
2" NEW PLASTIC BLANK 15'-0 SCH40

STATE OF TEXAS WELL REPORT for Tracking #313568

Owner:	GEOTECH ENGINEERING AND TESTING	Owner Well #:	B-11PZ
Address:	800 VICTORIA HOUSTON , TX 77022	Grid #:	65-12-7
Well Location:	14511 MEMORIAL DR @ WINTER OAKS DRIVE HOUSTON , TX	Latitude:	29° 46' 12" N
Well County:	Harris	Longitude:	095° 36' 11" W
Elevation:	No Data	GPS Brand Used:	GARMIN
Type of Work:	New Well	Proposed Use:	Test Well

Drilling Date: Started: **1/22/2013**
Completed: **1/22/2013**

Diameter of Hole: Diameter: **6 in From Surface To 25 ft**

Drilling Method: **Bored**

Borehole Completion: Gravel Packed From: **25 ft to 13 ft**
Gravel Pack Size: **20/40 SAND**

Annular Seal Data: 1st Interval: **From 25 ft to 13 ft with 5 SAND (#sacks and material)**
2nd Interval: **From 13 ft to 11 ft with 1 BENT.CHIPS (#sacks and material)**
3rd Interval: **From 11 ft to 0 ft with 3 CEMENT (#sacks and material)**
Method Used: **GROUT PUMP**
Cemented By: **MEDI**
Distance to Septic Field or other Concentrated Contamination: **No Data**
Distance to Property Line: **No Data**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Alternative Procedure Used**

Water Level: Static level: **No Data**
Artesian flow: **No Data**

Packers: **BENTONITE CHIPS 3/8 13'-11'**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

Type Of Pump: **No Data**

Well Tests: **No Data**

Water Quality: Type of Water: **No Data**
Depth of Strata: **No Data**
Chemical Analysis Made: **No Data**
Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information: **MATHERS ENVIRONMENTAL DRILLING INC.**
12243 B. FM 529

	HOUSTON , TX 77041
Driller License Number:	**4850**
Licensed Well Driller Signature:	**PATRICK L, STEPHENS**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking **#313568**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0-2' SM, BRW, RED BRW
2'-4' CLW, BRW, RE BRW
4'-5' TCP
5'-7' CL, BRWYELL, BRW
7'-9' CL, BRWYELL, BRW
9'-10' TCP
10'-12' CH, RDBRW, BRW
12'-14' CH, RDBRW, GRY
14'-15' TCP
15'-17' CH, RDBRW, GRY
17'-19' CH, RDBRW, GRY
19'-20' TCP
20'-22' CH, RDBRW, GRY
22'-24' CL, RDBRW, GRY
24'-25' TCP

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2" NEW PLASTIC SCREEN SLOT 0.010 25'-15' SCH40
2" NEW PLASTIC BLANK 15'-0 SCH40

STATE OF TEXAS WELL REPORT for Tracking #313573

Owner:	**GEOTECH ENGINEERING AND TESTING**	Owner Well #:	**B-16PZ**
Address:	**800 VICTORIA HOUSTON , TX 77022**	Grid #:	**65-12-7**
Well Location:	**14747 MEMORIAL DR @ THICKET LN HOUSTON , TX**	Latitude:	**29° 46' 14" N**
Well County:	**Harris**	Longitude:	**095° 36' 39" W**
Elevation:	**No Data**	GPS Brand Used:	**GARMIN**
Type of Work:	**New Well**	Proposed Use:	**Test Well**

Drilling Date: Started: **1/22/2013**
Completed: **1/22/2013**

Diameter of Hole: Diameter: **6 in From Surface To 20 ft**

Drilling Method: **Bored**

Borehole Completion: Gravel Packed From: **20 ft to 8 ft**
Gravel Pack Size: **20/40 SAND**

Annular Seal Data: 1st Interval: **From 20 ft to 8 ft with 5 SAND (#sacks and material)**
2nd Interval: **From 8 ft to 6 ft with 1 BENT.CHIPS (#sacks and material)**
3rd Interval: **From 6 ft to 0 ft with 2 CEMENT (#sacks and material)**
Method Used: **GROUT PUMP**
Cemented By: **MEDI**
Distance to Septic Field or other Concentrated Contamination: **No Data**
Distance to Property Line: **No Data**
Method of Verification: **No Data**
Approved by Variance: **No Data**

Surface Completion: **Alternative Procedure Used**

Water Level: Static level: **No Data**
Artesian flow: **No Data**

Packers: **BENTONITE CHIPS 3/8 8'-6'**

Plugging Info: Casing or Cement/Bentonite left in well: **No Data**

Type Of Pump: **No Data**

Well Tests: **No Data**

Water Quality: Type of Water: **No Data**
Depth of Strata: **No Data**
Chemical Analysis Made: **No Data**
Did the driller knowingly penetrate any strata which contained undesirable constituents: **No Data**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.

Company Information: **MATHERS ENVIRONMENTAL DRILLING INC.**
12243 B. FM 529

	HOUSTON , TX 77041
Driller License Number:	**4850**
Licensed Well Driller Signature:	**PATRICK L, STEPHENS**
Registered Driller Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Comments:	**No Data**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking #313573) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft) Description
0-2' SM, DRKBRW
2'-4' CL, DRKBRW
4'-5' TCP
5'-7' CL, BRWYELL, BRW
7'-9' CL, BRWYELL, BRW
9'-10' TCP
10'-12' CH, RDBRW, GRY
12'-14' CH, RDBRW, BRW
14'-15' TCP
15'-17' CH, RDBRW, BRW
17'-19' CH, RDBRW, BRW
19'-20' TCP

CASING, BLANK PIPE & WELL SCREEN DATA

Dia. New/Used Type Setting From/To
2" NEW PLASTIC SCREEN SLOT 0.010 20'-10' SCH40
2" NEW PLASTIC BLANK 10'-0 SCH40

STATE OF TEXAS PLUGGING REPORT for Tracking #89841

Owner:	CITY OF HOUSTON	Owner Well #:	PZ-4
Address:	15010 MEMORIAL DRIVE HOUSTON , TX 77079	Grid #:	65-12-7
Well Location:	15010 MEMORIAL DRIVE HOUSTON , TX 77079	Latitude:	29° 46' 37" N
Well County:	Harris	Longitude:	095° 37' 05" W
		GPS Brand Used:	GARMIN
Well Type:	Monitor		

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	PATRICK STEPHENS
Driller's License Number of Original Well Driller:	4850
Date Well Drilled:	8/2/2013
Well Report Tracking Number:	337281
Diameter of Borehole:	5" inches
Total Depth of Borehole:	35' feet
Date Well Plugged:	9/13/2013
Person Actually Performing Plugging Operation:	THOMAS E. MATHERS
License Number of Plugging Operator:	3096
Plugging Method:	Tremmie pipe cement from bottom to top.
Plugging Variance #:	No Data
Casing Left Data:	1st Interval: 0 inches diameter, From 0 ft to 0 ft 2nd Interval: No Data 3rd Interval: No Data
Cement/Bentonite Plugs Placed in Well:	1st Interval: From 35 ft to 0 ft; Sack(s)/type of cement used: 6 CEMENT 2nd Interval: No Data 3rd Interval: No Data 4th Interval: No Data 5th Interval: No Data
Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	MATHERS ENVIRONMENTAL DRILLING INC. 12243 B. FM 529 HOUSTON , TX 77041
Plug Installer License Number:	3096

Licensed Plug Installer Signature:	**THOMAS E. MATHERS**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#89841**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS PLUGGING REPORT for Tracking #86459

Owner:	**GEOTECH ENGINEERING AND TESTIN**	Owner Well #:	**B-6PZ**
Address:	**800 VICTORIA HOUSTON , TX 77022**	Grid #:	**65-12-7**
Well Location:	**14171-14299 MEMORIAL DR @ CLEAR SPRINGS HOUSTON , TX**	Latitude:	**29° 46' 11" N**
Well County:	**Harris**	Longitude:	**095° 35' 45" W**
		GPS Brand Used:	**GARMIN**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**PATRICK L, STEPHENS**
Driller's License Number of Original Well Driller:	**4850**
Date Well Drilled:	**1/22/2013**
Well Report Tracking Number:	**313565**
Diameter of Borehole:	**6" inches**
Total Depth of Borehole:	**25' feet**

Date Well Plugged:	**3/14/2013**
Person Actually Performing Plugging Operation:	**PATRICK L, STEPHENS**
License Number of Plugging Operator:	**4850**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, (No Data) ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in	1st Interval: **From 25 ft to 0 ft; Sack(s)/type of cement used: 3 CEMENT** 2nd Interval: **No Data**

Well:	3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**MATHERS ENVIRONMENTAL DRILLING INC.** **12243 B. FM 529** **HOUSTON , TX 77041**
Plug Installer License Number:	**4850**
Licensed Plug Installer Signature:	**PATRICK L, STEPHENS**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#86459**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS PLUGGING REPORT for Tracking #86461

Owner:	**GEOTECH ENGINEERING AND TESTIN**	Owner Well #:	**B-11PZ**
Address:	**800 VICTORIA HOUSTON , TX 77022**	Grid #:	**65-12-7**
Well Location:	**14511 MEMORIAL DR @ WINTER OAKS DRIVE HOUSTON , TX**	Latitude:	**29° 46' 12" N**
Well County:	**Harris**	Longitude:	**095° 36' 11" W**
		GPS Brand Used:	**GARMIN**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**PATRICK L, STEPHENS**
Driller's License Number of Original Well Driller:	**4850**
Date Well Drilled:	**1/22/2013**
Well Report Tracking Number:	**313568**
Diameter of Borehole:	**6" inches**
Total Depth of Borehole:	**25' feet**

Date Well Plugged:	**3/14/2013**
Person Actually Performing Plugging Operation:	**PATRICK L, STEPHENS**
License Number of Plugging Operator:	**4850**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, (No Data) ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in	1st Interval: **From 25 ft to 0 ft; Sack(s)/type of cement used: 3 CEMENT** 2nd Interval: **No Data**

Well:	3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**MATHERS ENVIRONMENTAL DRILLING INC.** **12243 B. FM 529** **HOUSTON , TX 77041**
Plug Installer License Number:	**4850**
Licensed Plug Installer Signature:	**PATRICK L, STEPHENS**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#86461**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS PLUGGING REPORT for Tracking #86460

Owner:	**GEOTECH ENGINEERING AND TESTIN**	Owner Well #:	**B-16PZ**
Address:	**800 VICTORIA HOUSTON , TX 77022**	Grid #:	**65-12-7**
Well Location:	**14747 MEMORIAL DR @ THICKET LN HOUSTON , TX**	Latitude:	**29° 46' 14" N**
Well County:	**Harris**	Longitude:	**095° 36' 39" W**
		GPS Brand Used:	**GARMIN**

Well Type: **Monitor**

HISTORICAL DATA ON WELL TO BE PLUGGED

Original Well Driller:	**PATRICK L, STEPHENS**
Driller's License Number of Original Well Driller:	**4850**
Date Well Drilled:	**1/22/2013**
Well Report Tracking Number:	**313573**
Diameter of Borehole:	**6" inches**
Total Depth of Borehole:	**20' feet**

Date Well Plugged:	**3/14/2013**
Person Actually Performing Plugging Operation:	**PATRICK L, STEPHENS**
License Number of Plugging Operator:	**4850**
Plugging Method:	**Tremmie pipe cement from bottom to top.**
Plugging Variance #:	**No Data**
Casing Left Data:	1st Interval: **0 inches diameter, (No Data) ft to (No Data) ft** 2nd Interval: **No Data** 3rd Interval: **No Data**
Cement/Bentonite Plugs Placed in	1st Interval: **From 20 ft to 0 ft; Sack(s)/type of cement used: 3 CEMENT** 2nd Interval: **No Data**

Well:	3rd Interval: **No Data** 4th Interval: **No Data** 5th Interval: **No Data**

Certification Data:	The plug installer certified that the plug installer plugged this well (or the well was plugged under the plug installer's direct supervision) and that each and all of the statements herein are true and correct. The plug installer understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	**MATHERS ENVIRONMENTAL DRILLING INC.** **12243 B. FM 529** **HOUSTON , TX 77041**
Plug Installer License Number:	**4850**
Licensed Plug Installer Signature:	**PATRICK L, STEPHENS**
Registered Plug Installer Apprentice Signature:	**No Data**
Apprentice Registration Number:	**No Data**
Plugging Method Comments:	**No Data**

Please include the plugging report's tracking number (Tracking **#86460**) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

STATE OF TEXAS WELL REPORT for Tracking #337281

Owner:	CITY OF HOUSTON	Owner Well #:	PIEZOMETER PZ-4
Address:	15010 MEMORIAL DRIVE HOUSTON , TX 77079	Grid #:	65-12-7
Well Location:	NW OF 15010 MEMORIAL DRIVE HOUSTON , TX 77079	Latitude:	29° 46' 37" N
Well County:	Harris	Longitude:	095° 37' 05" W
Elevation:	No Data	GPS Brand Used:	GARMIN
Type of Work:	New Well	Proposed Use:	Test Well

Drilling Date:	Started: 8/2/2013 Completed: 8/2/2013
Diameter of Hole:	Diameter: 5 in From Surface To 35 ft
Drilling Method:	Mud Rotary
Borehole Completion:	Gravel Packed From: 25 ft to 13 ft Gravel Pack Size: 20/40 SAND
Annular Seal Data:	1st Interval: From 35 ft to 25 ft with 3 BENT.CHIPS (#sacks and material) 2nd Interval: From 25 ft to 13 ft with 5 SAND (#sacks and material) 3rd Interval: From 13 ft to 0 ft with 3 BENT.CEMENT (#sacks and material) Method Used: HANDMIX Cemented By: MEDI Distance to Septic Field or other Concentrated Contamination: No Data Distance to Property Line: No Data Method of Verification: No Data Approved by Variance: No Data
Surface Completion:	Surface Sleeve Installed
Water Level:	Static level: 16 ft. below land surface on 8/2/2013 Artesian flow: No Data
Packers:	BENTONITE CHIPS 3/8 13'-11'
Plugging Info:	Casing or Cement/Bentonite left in well: No Data
Type Of Pump:	No Data
Well Tests:	No Data
Water Quality:	Type of Water: No Data Depth of Strata: No Data Chemical Analysis Made: No Data Did the driller knowingly penetrate any strata which contained undesirable constituents: No Data
Certification Data:	The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the log(s) being returned for completion and resubmittal.
Company Information:	MATHERS ENVIRONMENTAL DRILLING INC. 12243 B. FM 529 HOUSTON , TX 77041

Driller License Number:	4850
Licensed Well Driller Signature:	PATRICK STEPHENS
Registered Driller Apprentice Signature:	No Data
Apprentice Registration Number:	No Data
Comments:	No Data

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking number (Tracking #337281) on your written request.

Texas Department of Licensing & Regulation
P.O. Box 12157
Austin, TX 78711
(512) 463-7880

DESC. & COLOR OF FORMATION MATERIAL

From (ft) To (ft)	Description
0-2'	CLAY
2'-10'	SAND
10'-15'	CLAY
15'-20'	SILT
20'-22'	CLAY
22'-30'	SILT
30'-35'	CLAY

CASING, BLANK PIPE & WELL SCREEN DATA

Dia.	New/Used	Type	Setting From/To
2"	NEW	PLASTIC SCREEN SLOT 0.010	25'-15' SCH.40
2"	NEW	PLASTIC BLANK	15'-0 SCH.40

APPENDIX C

Project Site Pictures

PROJECT PICTURES
Project No. 09-338E

P-1 (A Picture of Project Alignment)

P-2 (A Picture of Coring and Traffic Control)

PROJECT PICTURES
Project No. 09-338E

P-3 (A Picture of Drilling Operations and Traffic Control)

P-4 (A Picture of TCP Testing using Automatic Hammer)

PROJECT PICTURES
Project No. 09-338E

P-5 (A Picture of Piezometer Installations)

P-6 (A Picture of Borehole Grouting using Tremie Method)

APPENDIX D

OSHA Soil Classification

OSHA SOIL CLASSIFICATION

General

Occupational Safety and Health Administration (OSHA) has required a trench protective system for trenches deeper than five-ft. Trenches that are deeper than five-ft, should be shored, sheeted, braced or laid back to a stable slope, or some other appropriate means of protection should be provided where workers might be exposed to moving ground or caving. OSHA developed a soil classification system to be used as a guideline in determining protective requirements for trench excavations.

OSHA classification system categorizes the soil and rock in four types based on shear strength and stability. These classifications are summarized in the following report sections.

Stable Rock

means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type A Soil

means cohesive soils with an unconfined compressive strength of 1.5-ton per square foot (tsf) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam, silty clay loam, sandy clay loam, caliche and hardpan. No soil is Type A if:

- The soil is fissured; or
- The soil is subject to vibration from heavy traffic, pile driving or similar effects; or

The soil has been previously disturbed; or

- The soil is part of a slope, layered system where the layers dip into the excavation on a slope of 4(h): 1(v) or greater; or
- The material is subject to other factors that would require it to be classified as a less stable material.

Type B Soil

- Cohesive soil with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf; or
- Granular cohesionless soils including: angular gravel, silt, silt loam, sandy loam, and in some case, silty clay loam and sandy clay loam; or
- Previously disturbed soils except those which would otherwise be classified as Type C soil; or
- Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

- Dry rock that is not stable; or
- Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than 4(h): 1(v), but only if the material would otherwise be classified as Type B.

Type C Soil

- Cohesive soil with an unconfined compressive strength of 0.5 tsf or less; or
- Granular soils including gravel, sand, and loamy sand; or
- Submerged soil or soil from which water is freely seeping; or
- Submerged rock that is not stable; or
- Materials in a sloped, layered system where the layers dip into the excavation on a slope 4 (h) : 1(v) or steeper.

Under the assumption that appropriate groundwater control measures are carried out, and the groundwater table, if present, is lowered and maintained at least 3 feet below the excavation depths, the stable cohesive soils (CL) & (CH), with unconfined compressive strength greater than 0.5 tsf, are classified as OSHA soil Type "B". The granular soils, which are less stable, are classified as OSHA soil Type "C".

Based on our geotechnical exploration and laboratory test results details of soil classifications at each boring are summarized below:

OSHA SOIL TYPE

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-1	0 – 2	Silty Sand (SM)	C
	2 – 10	Clay (CH)	B
B-2	0 – 2	Silty Sand (SM)	C
	2 – 15.5	Clay (CH)	B
	15.5 – 17	Clay (CH)	C
	17 – 22	Silt (ML)	C
	22 – 25	Clay (CL)	C
B-3	0 – 2	Clay (CL)	B
	2 – 15	Clay (CH)	B
	15 – 17	Clay (CH)	C

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-3	17 – 25	Silt (ML)	C
B-4	0 – 10	Clay (CL)	B
	10 – 16	Clay (CH)	B
	16 – 25	Clay (CH)	C
B-5	0 – 4	Silty Sand (SM)	C
	4 – 10	Clay (CL)	B
	10 – 16	Clay (CH)	B
	16 – 17	Clay (CH)	C
	17 – 20	Clay (CL)	C
	20 – 25	Silt (ML)	C
B-6	0 – 10	Clay (CL)	B
	10 – 20	Clay (CH)	B
	20 – 25	Silt (ML)	C
B-7	0 – 10	Clay (CL)	B
	10 – 14	Clay (CH)	B
	14 – 20	Clay (CH)	C
	20 – 22	Silty Sand (SM)	C
	22 – 25	Clay (CL)	C
B-8	0 – 5	Silty Sand (SM)	C
	5 – 10	Clay (CL)	B
	10 – 17	Clay (CH)	B
	17 – 19	Clay (CL)	B
	19 – 20	Clay (CL)	C
	20 – 22	Silt (ML)	C
	22 – 25	Clay (CL)	C
B-9	0 – 2	Silty Sand (SM)	C
	2 – 12	Clay (CL)	B
	12 – 20	Clay (CH)	B
	20 – 25	Clay (CL)	C

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-10	0 – 2	Silty Sand (SM)	C
	2 – 5	Clay (CL)	B
	5 – 7	Clay (CL)	C
	7 – 10	Clay (CL)	B
	10 – 12	Clay (CH)	B
	12 – 14	Clay (CH)	C
	14 – 20	Clay (CH)	B
	20 – 25	Clay (CL)	B
B-11	0 – 2	Silty Sand (SM)	C
	2 – 10	Clay (CL)	B
	10 – 20	Clay (CH)	B
	20 – 25	Clay (CL)	B
B-12	0 – 2	Silty Sand (SM)	C
	2 – 10	Clay (CL)	B
	10 – 22	Clay (CH)	B
	22 – 24	Silty Sand (SM)	C
	24 – 26	Clay (CL)	B
	26 – 30	Clay (CL)	C
B-13	0 – 6	Clay (CL)	B
	6 – 15	Clay (CH)	B
	15 – 25	Clay (CL)	B
B-14	0 – 5	Silty Sand (SM)	C
	5 – 10	Clay (CL)	B
	10 – 30	Clay (CH)	B
B-15	0 – 2	Silty Sand (SM)	C
	2 – 5	Silt (ML)	C
	5 – 10	Clay (CL)	B
	10 – 27	Clay (CH)	B
	27 – 30	Silt (ML)	C

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-15	30 – 35	Clay (CL)	C
B-16	0 – 2	Sand (SM)	C
	2 – 5	Silt (ML)	C
	5 – 10	Clay (CL)	B
	10 – 20	Clay (CH)	B
B-17	0 – 2	Silty Sand (SM)	C
	2 – 10	Clay (CL)	B
	10 – 20	Clay (CH)	B
B-18	0 – 2	Silty Sand (SM)	C
	2 – 7	Clay (CL)	B
	7 – 10	Clay (CL)	C
	10 – 20	Clay (CH)	B
	20 – 22	Clay (CL)	B
	22 – 25	Clay (CL)	C
B-19	0 – 5	Silty Sand (SM)	C
	5 – 17	Clay (CH)	B
	17 – 20	Clay (CL)	B
	20 – 25	Silt (ML)	C
B-20	0 – 2	Silty Sand (SM)	C
	2 – 5	Clay (CH)	B
	5 – 10	Clay (CL)	B
	10 – 15	Clay (CH)	B
	15 – 25	Clay (CL)	B
B-21	0 – 2	Clay (CL)	C
	2 – 7	Clay (CL)	B
	7 – 12	Clay (CL)	C
	12 – 15	Clay (CL)	B
	15 – 30	Silt (ML)	C
B-22	0 – 12	Clay (CL)	B

Boring No.	Depth Range [1], ft	Soil Type	OSHA Soil Classification
B-22	12 – 15	Clay (CL)	C
	15 – 22	Silt (ML)	C
	22 – 25	Clay (CL)	C
B-23	0 – 2	Silty Sand (SM)	C
	2 – 12	Clay (CL)	B
	12 – 25	Silty Sand (SM)	C
	25 – 27	Clay (CL)	C
	27 – 32	Silt (ML)	C
	32 – 35	Clay (CH)	C
B-24	0 – 2	Fill: Sandy Lean Clay (CL)	B
	2 – 10	Fill: Silty Sand (SM)	C
	10 – 15	Fat Clay (CH)	B
	15 – 20	Silt (ML)	C
	20 – 22	Lean Clay (CL)	C
	22 – 30	Sandy Silt (ML)	C
	30 – 35	Fat Clay (CH)	C

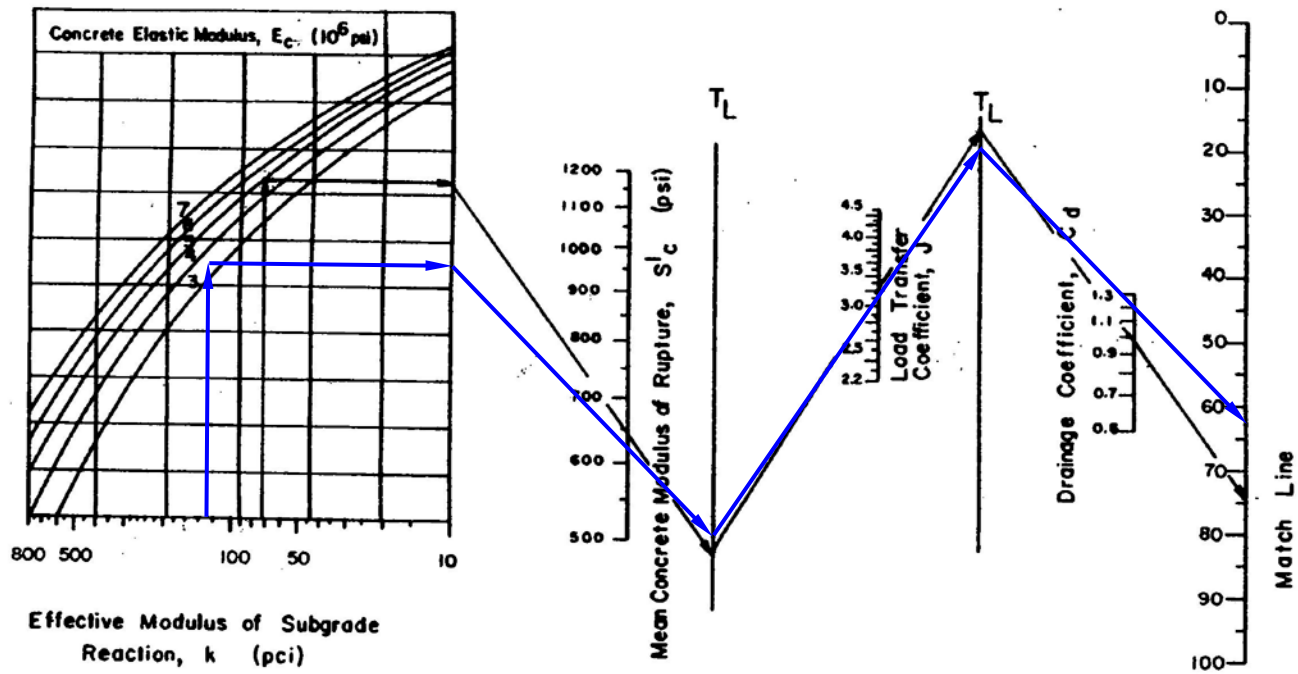
Note: 1. Refer to each boring log for soils stratigraphy

APPENDIX E

Pavement Design Computations

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 7.35 * \log_{10}(D+1) - 0.06 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.5 - 1.5}\right]}{1 + \frac{1.624 * 10^7}{(D+1)^{8.46}}} + (4.22 - 0.32 p_t) * \log_{10}\left[\frac{S_c' * C_d \left[D^{0.75} - 1.132\right]}{215.63 * J \left[D^{0.75} - \frac{18.42}{(E_c/k)^{0.25}}\right]}\right]$$



Legend :

Pavement Design for This Study

Calculation:

k = 125 pci

$E_c = 3.37 \times 10^6$

S_c = 620 psi

J = 3.2

C_d = 1.2

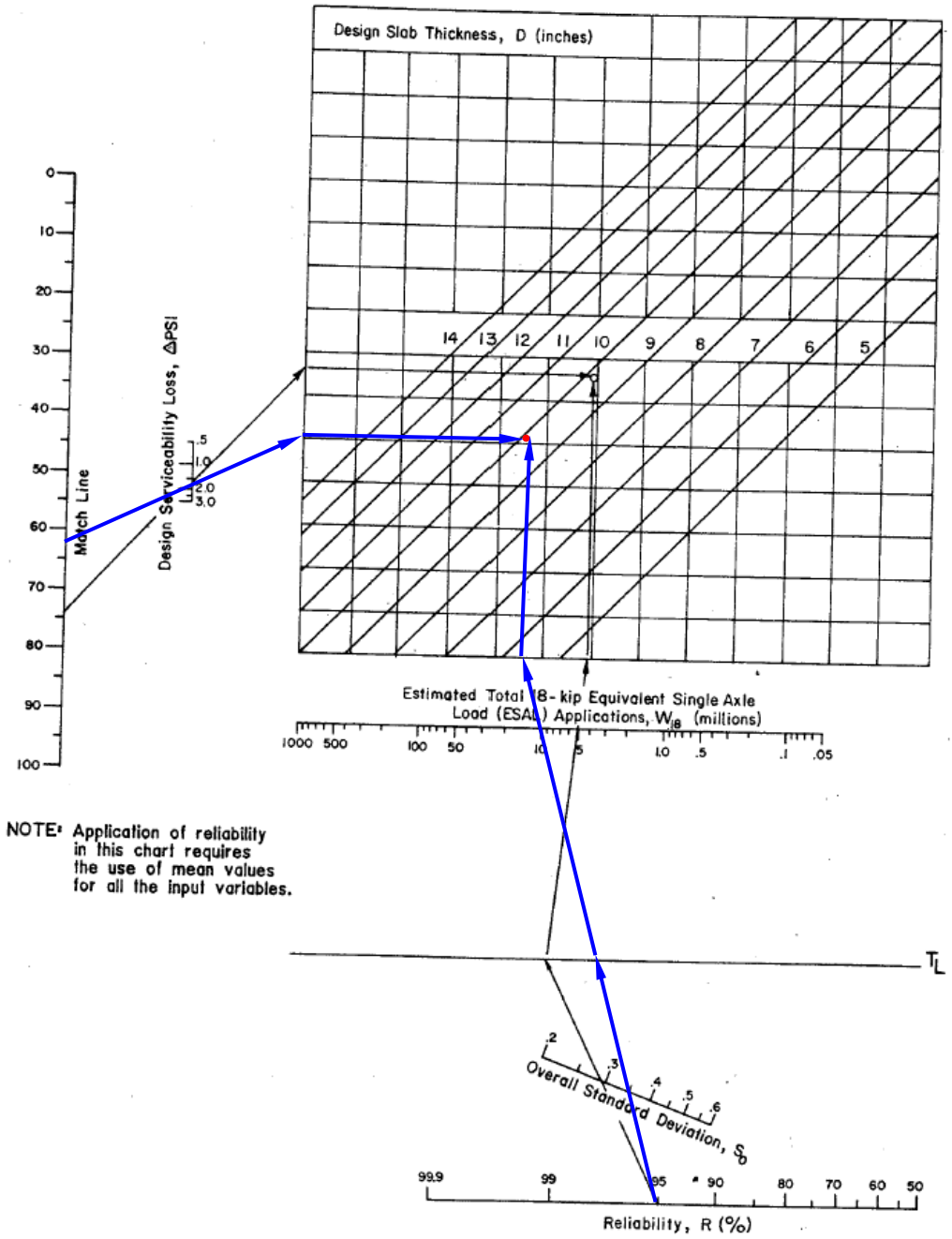
S_0 = 0.35

R = 95%

ΔPSI = 4.5-2.5 = 2.0

Solution:

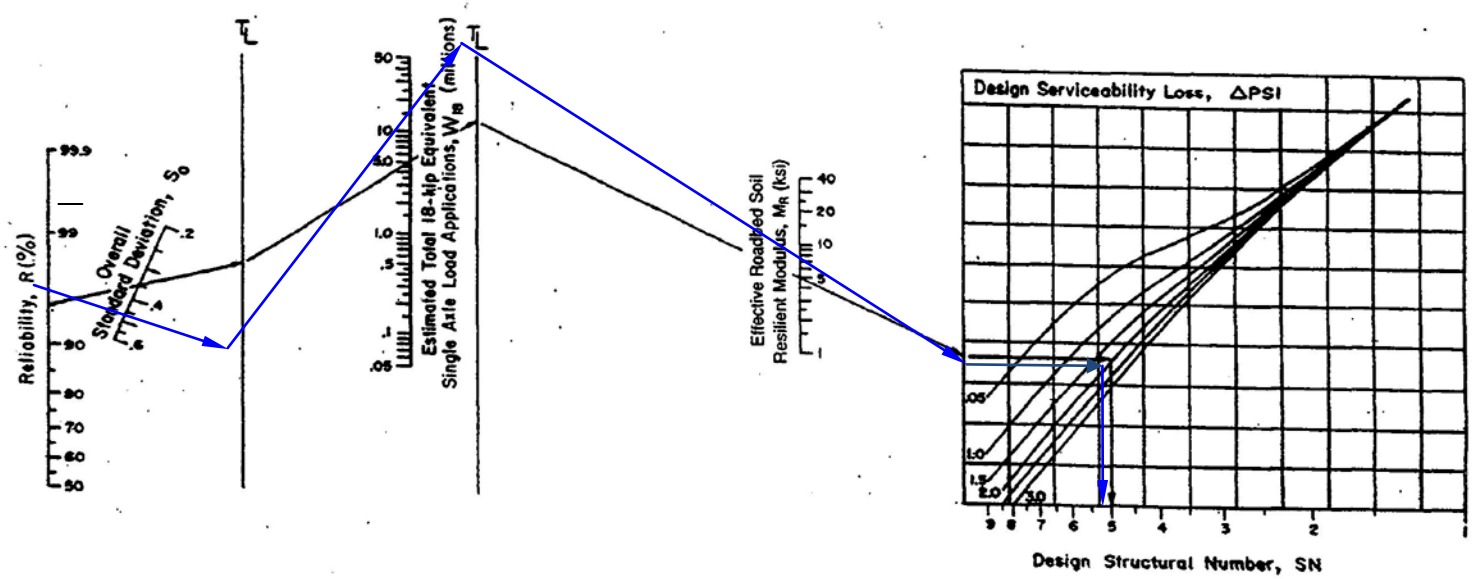
W_{18} (18kip ESAL x 10^6)	Concrete Pavement Thickness, inch(es)
10.0	10.0



DESIGN CHART FOR RIGID PAVEMENTS BASED ON USING MEAN VALUES FOR EACH INPUT VARIABLES (SEGMENT 2)

NOMOGRAPH SOLVES:

$$\log_{10} W_{18} = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$



Calculation:

$W_{18} = 10 \times 10^6$

R = 95%

$S_0 = 0.45$

$M_R = 7{,}500$psi

ΔPSI = 4.2-2.5 = 1.7

Solution:

W_{18} (18kip ESAL x 10^6)	Design Structural Number
10	5.30

Design Chart for Flexible Pavement

APPENDIX F

Drilled Shaft Capacity Curves with Data Output

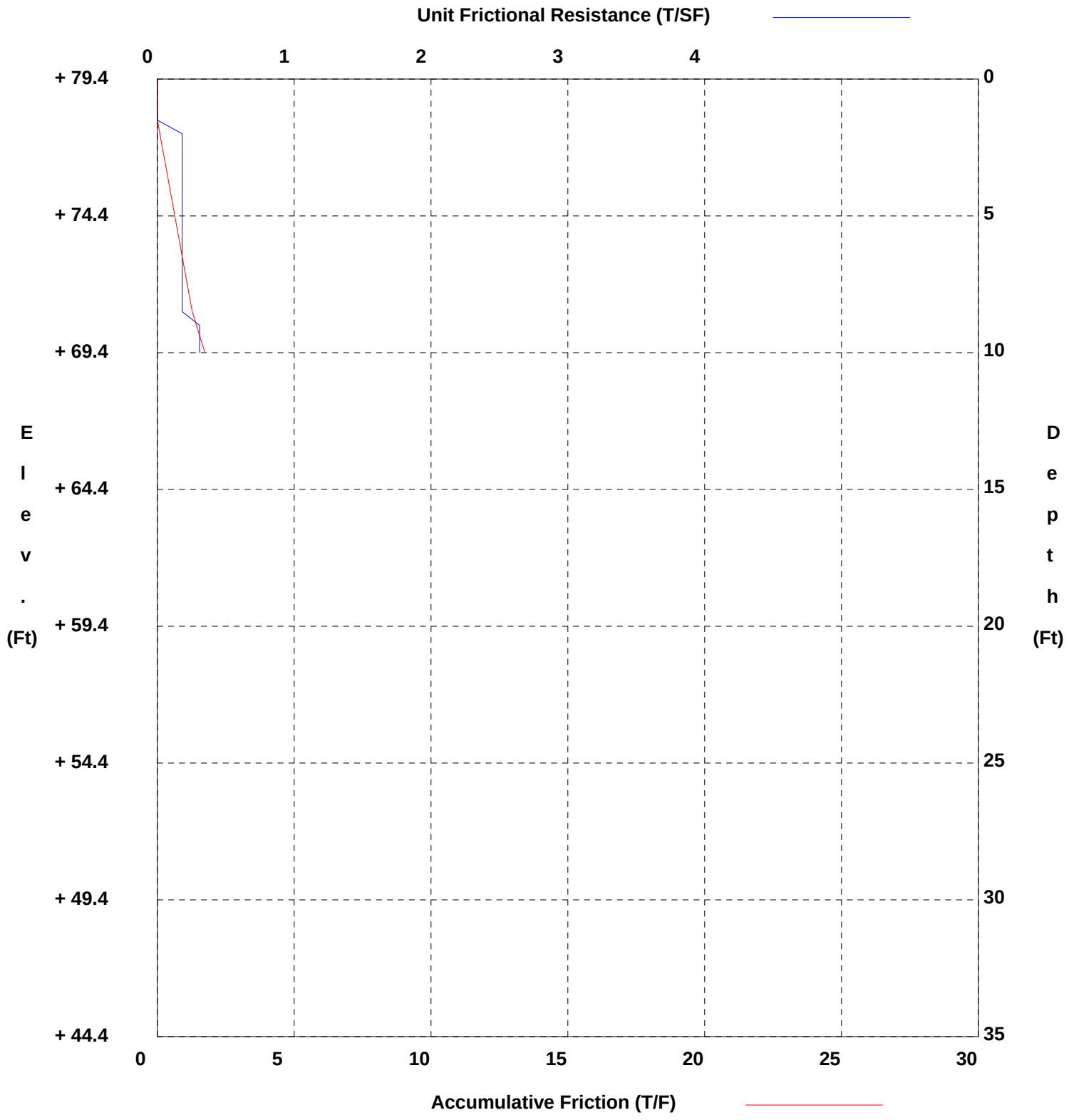
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-1	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
Control	No. 0912-70-082	Station	115+11	Grnd. Elev.	79.44 ft
		Offset	18.46	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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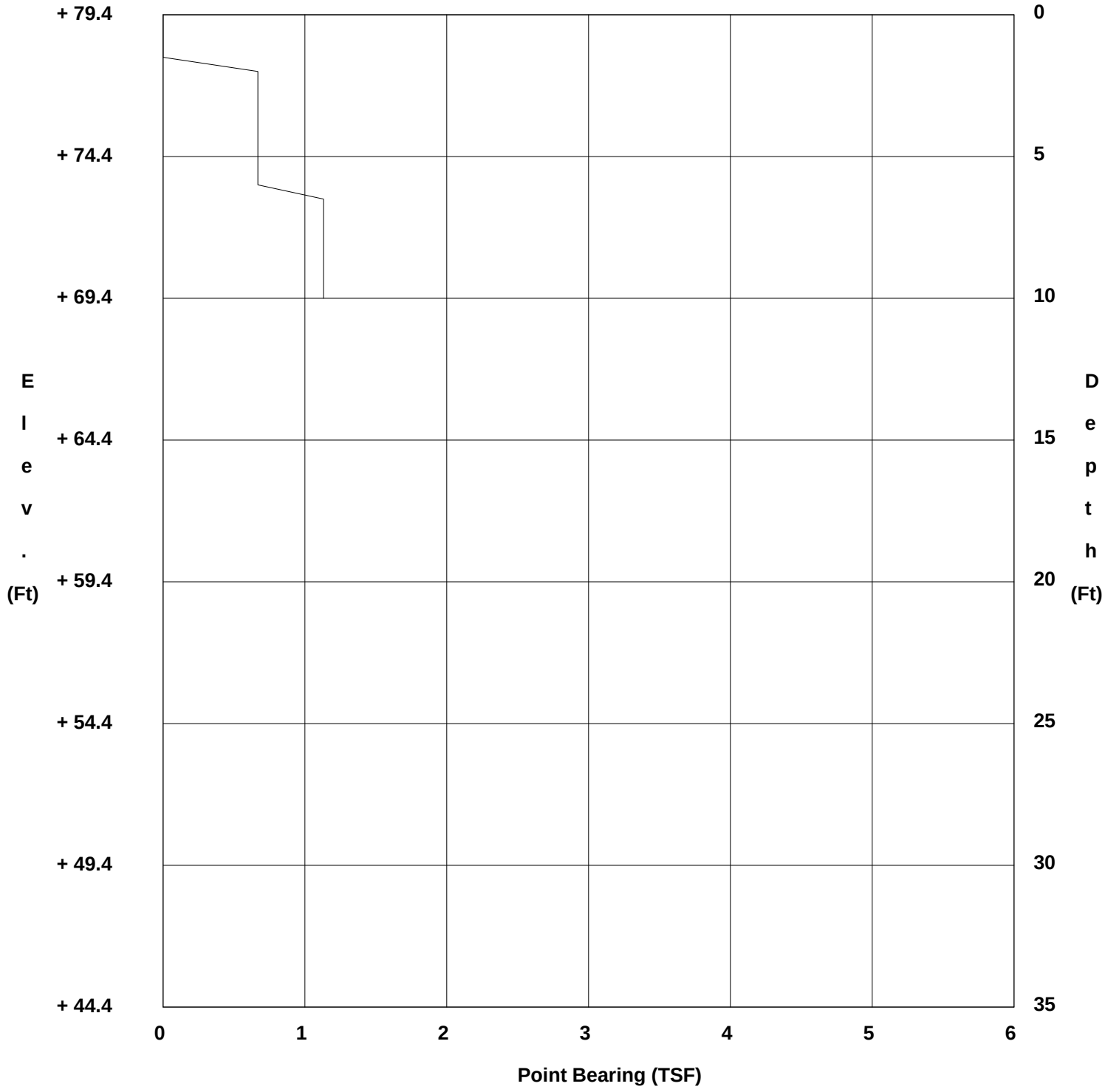
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-1	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
Control	No. 0912-70-082	Station	115+11	Grnd. Elev.	79.44 ft
		Offset	18.46	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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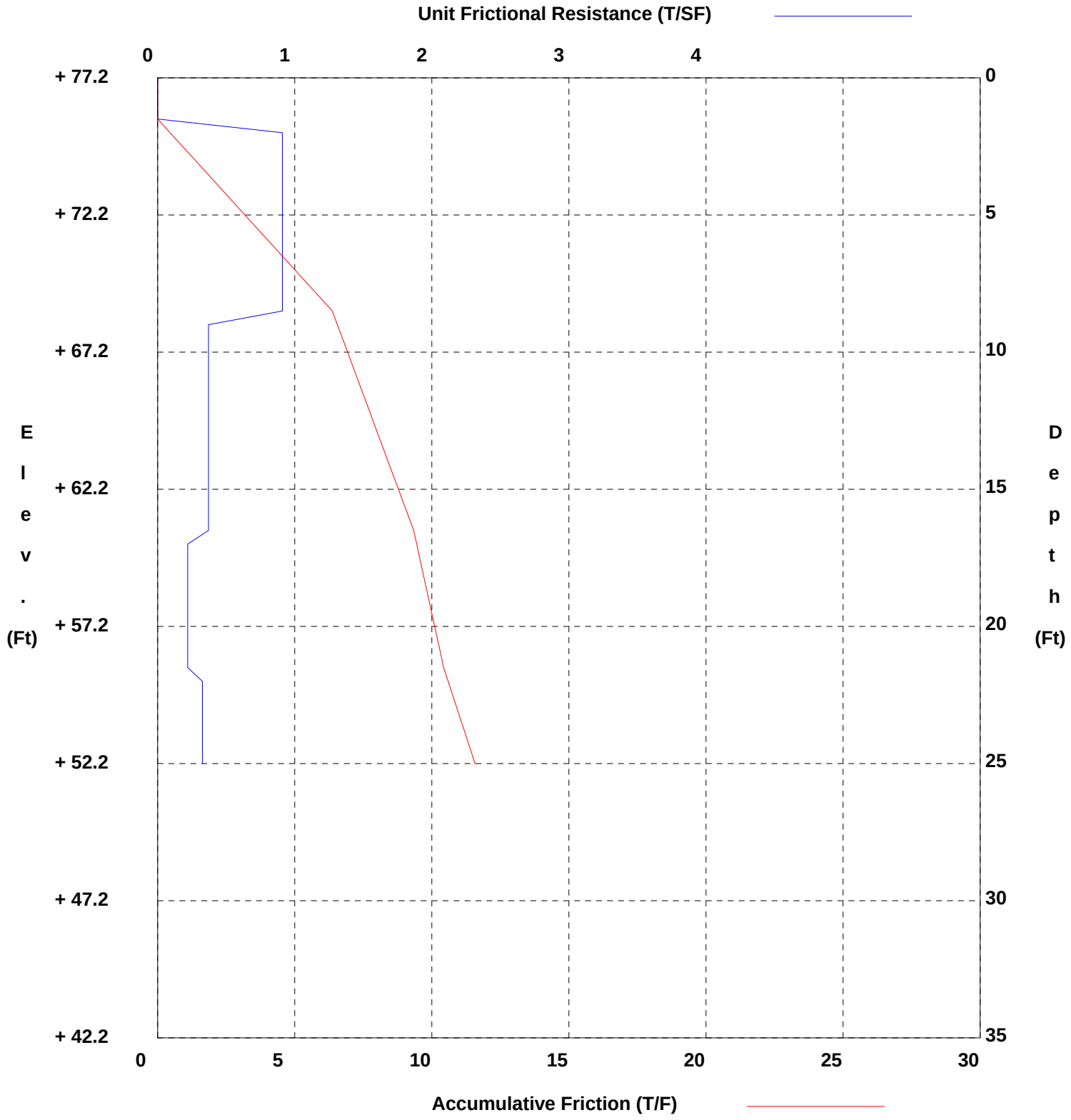
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-2	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	1/21/2013
Control	No. 0912-70-082	Station	109+00	Grnd. Elev.	77.17 ft
		Offset	20.72	GW Elev.	61.67 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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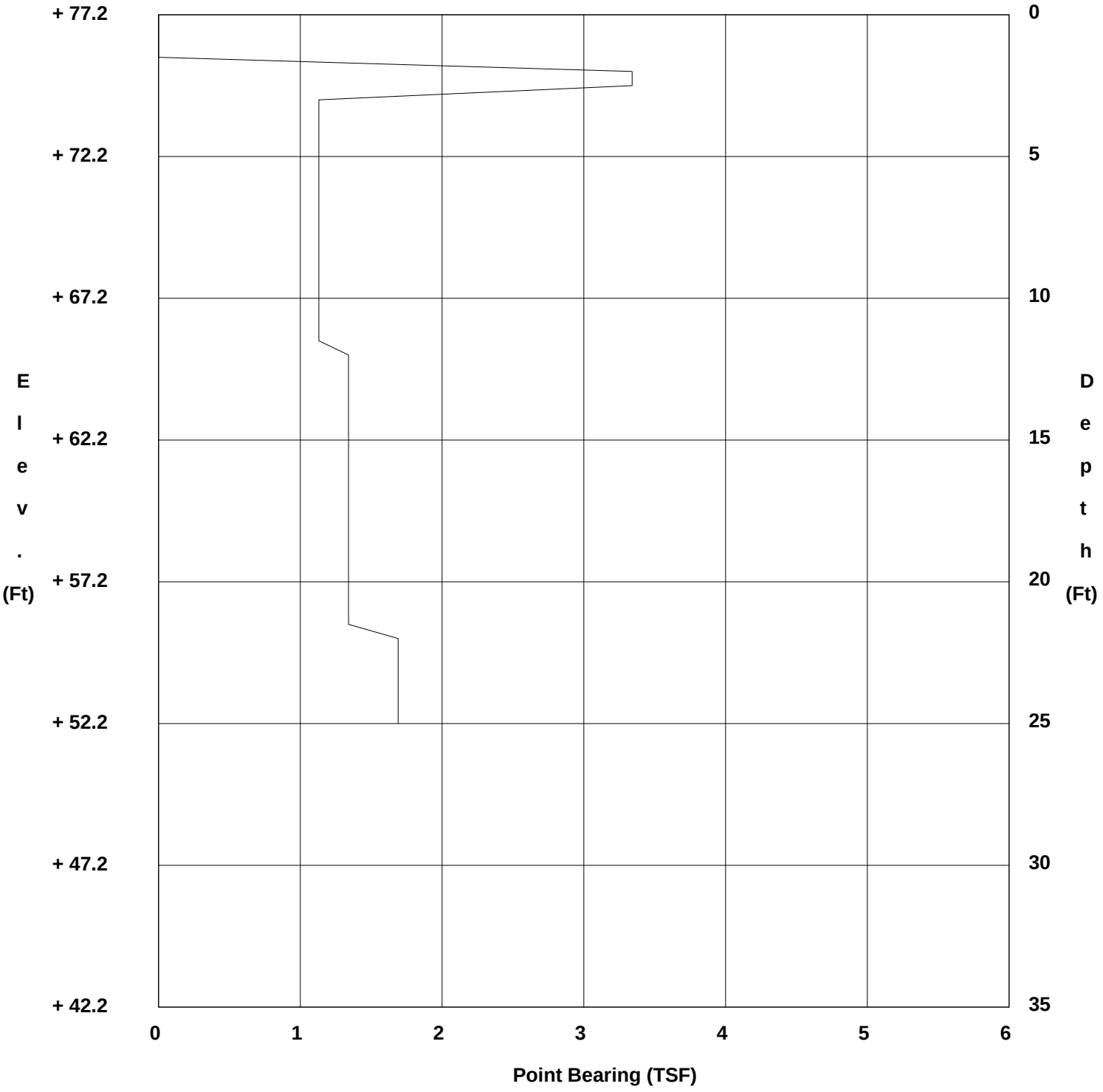
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-2	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	1/21/2013
Control	No. 0912-70-082	Station	109+00	Grnd. Elev.	77.17 ft
		Offset	20.72	GW Elev.	61.67 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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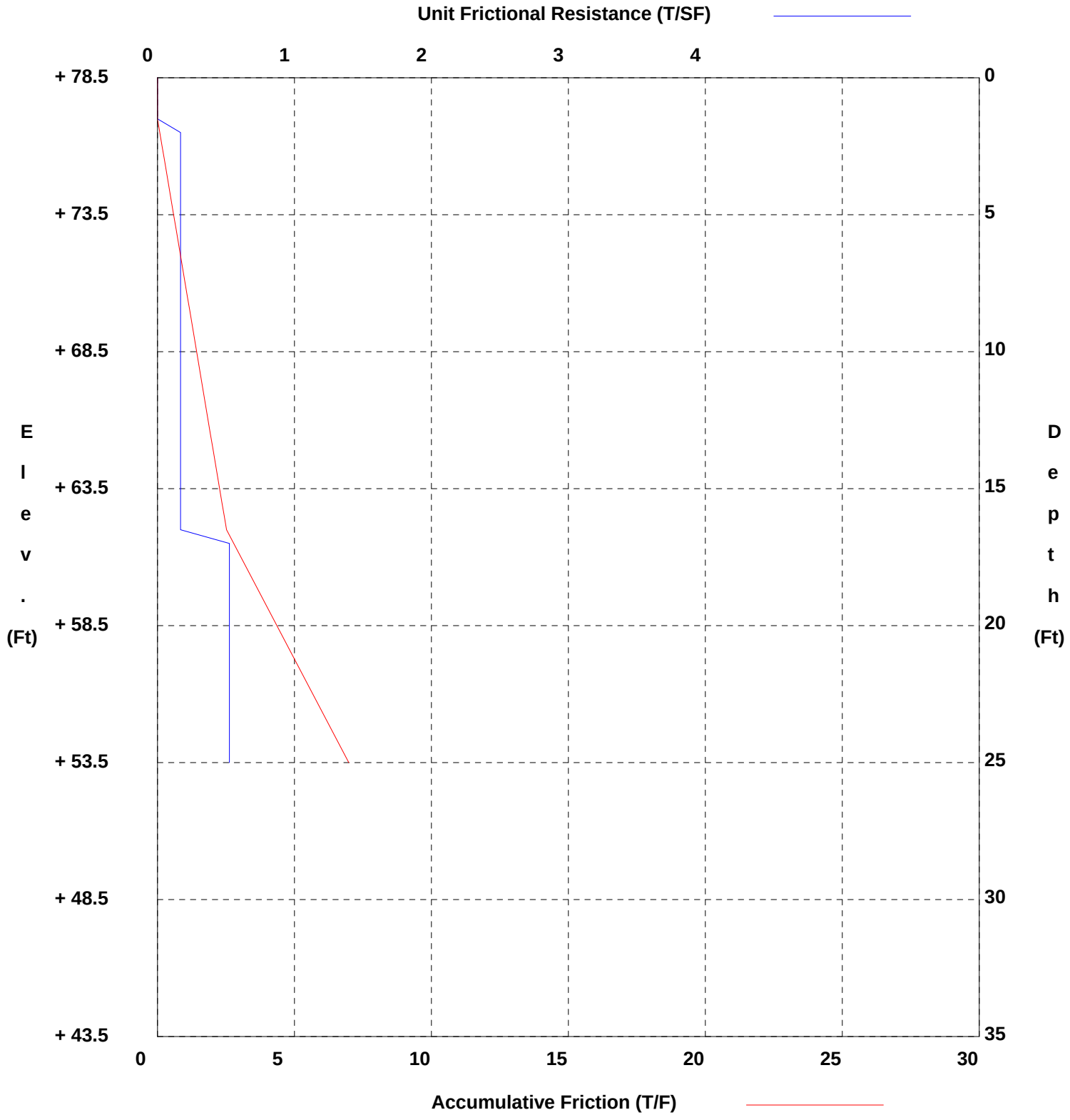
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-3	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
Control	No. 0912-70-082	Station	105+34	Grnd. Elev.	78.49 ft
		Offset	7.76	GW Elev.	62.49 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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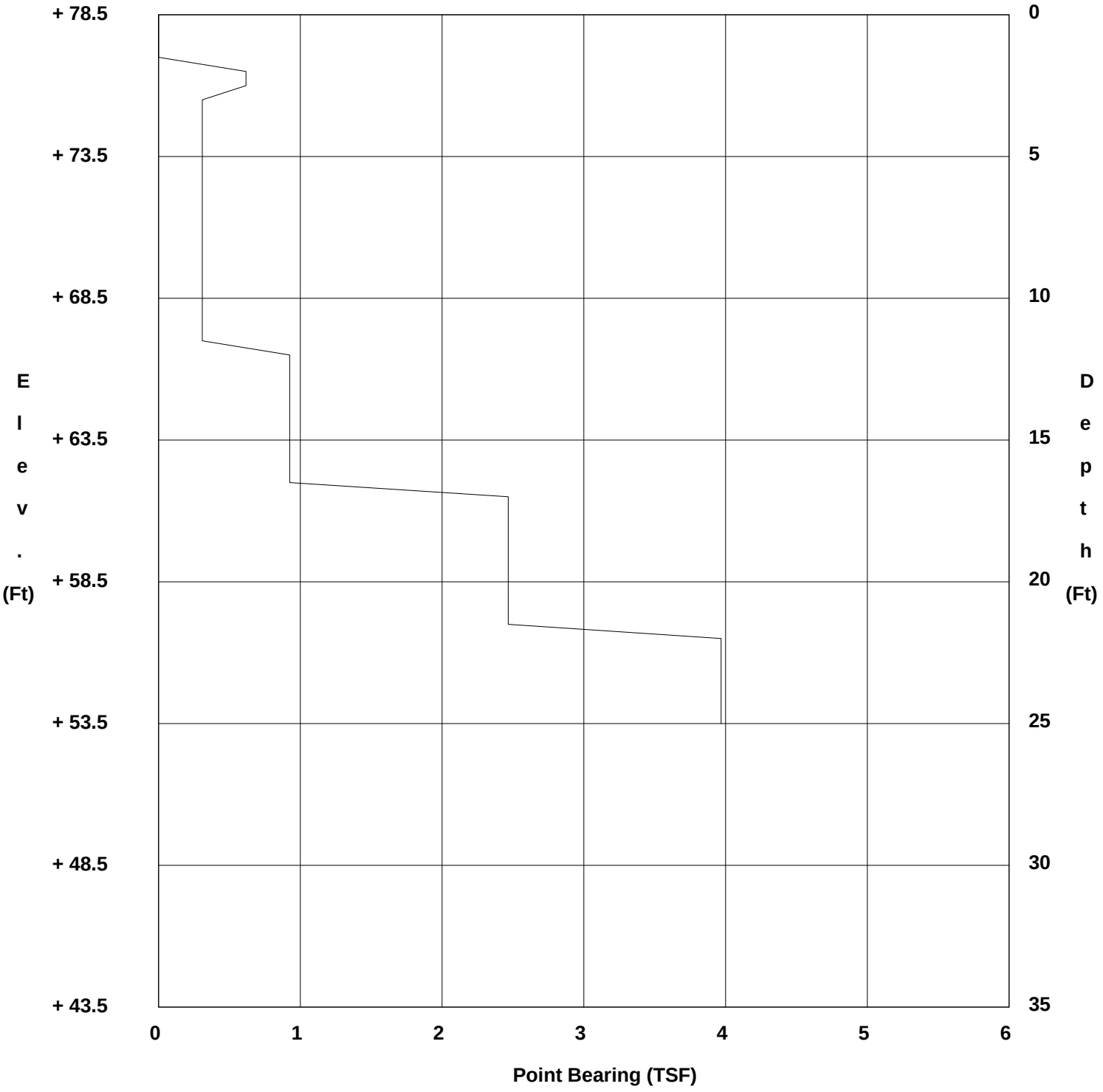
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-3	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/21/2013
Control	No. 0912-70-082	Station	105+34	Grnd. Elev.	78.49 ft
		Offset	7.76	GW Elev.	62.49 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

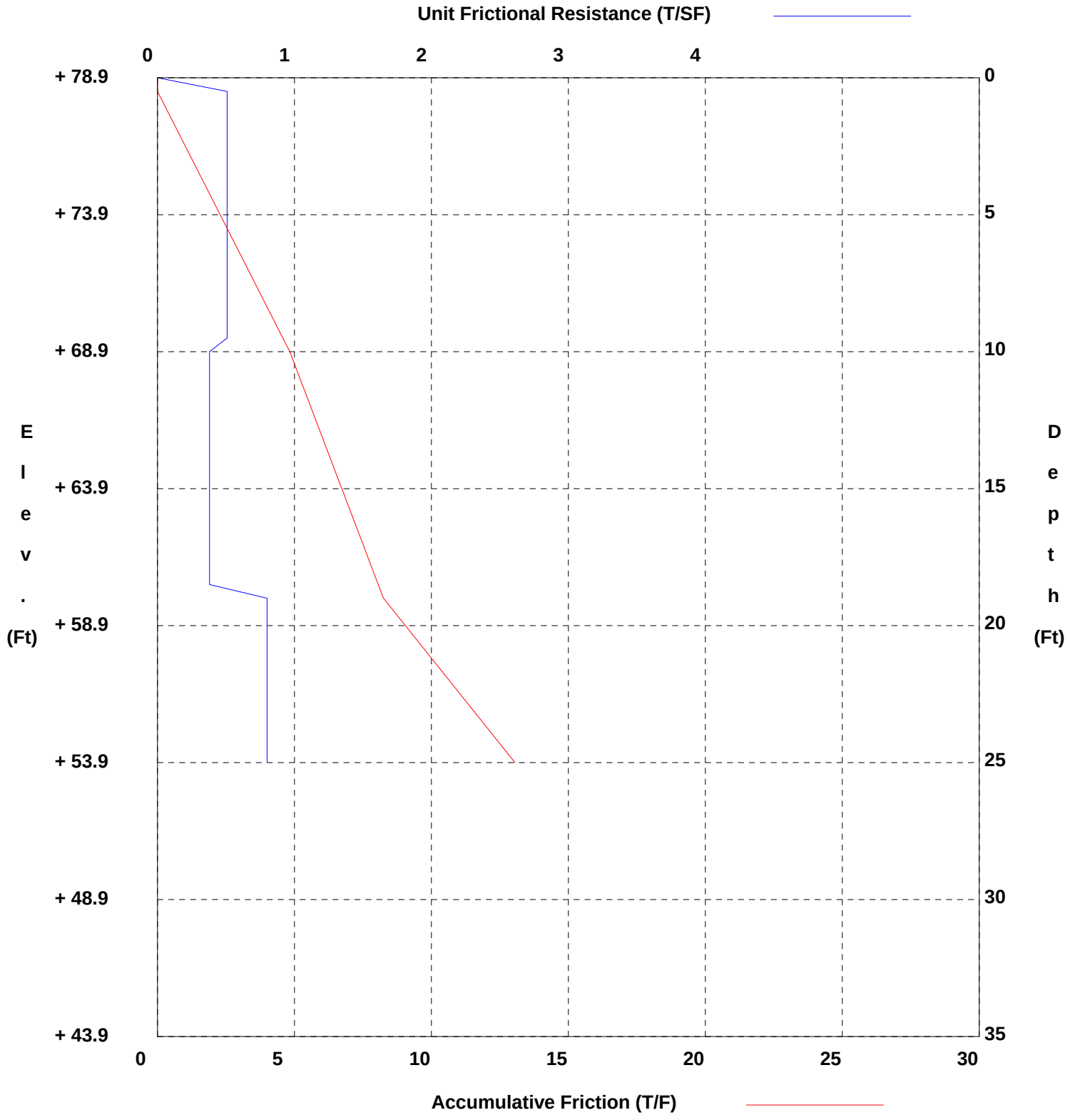
WinCore
Version 3.1

County	Harris	Hole	B-4	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	102+13	Grnd. Elev.	78.94 ft
		Offset	19.81	GW Elev.	63.94 ft

Piling Design: No Soil Reduction Factor

Average Friction Values Used

Skin Friction Limit = 1.4 tsf



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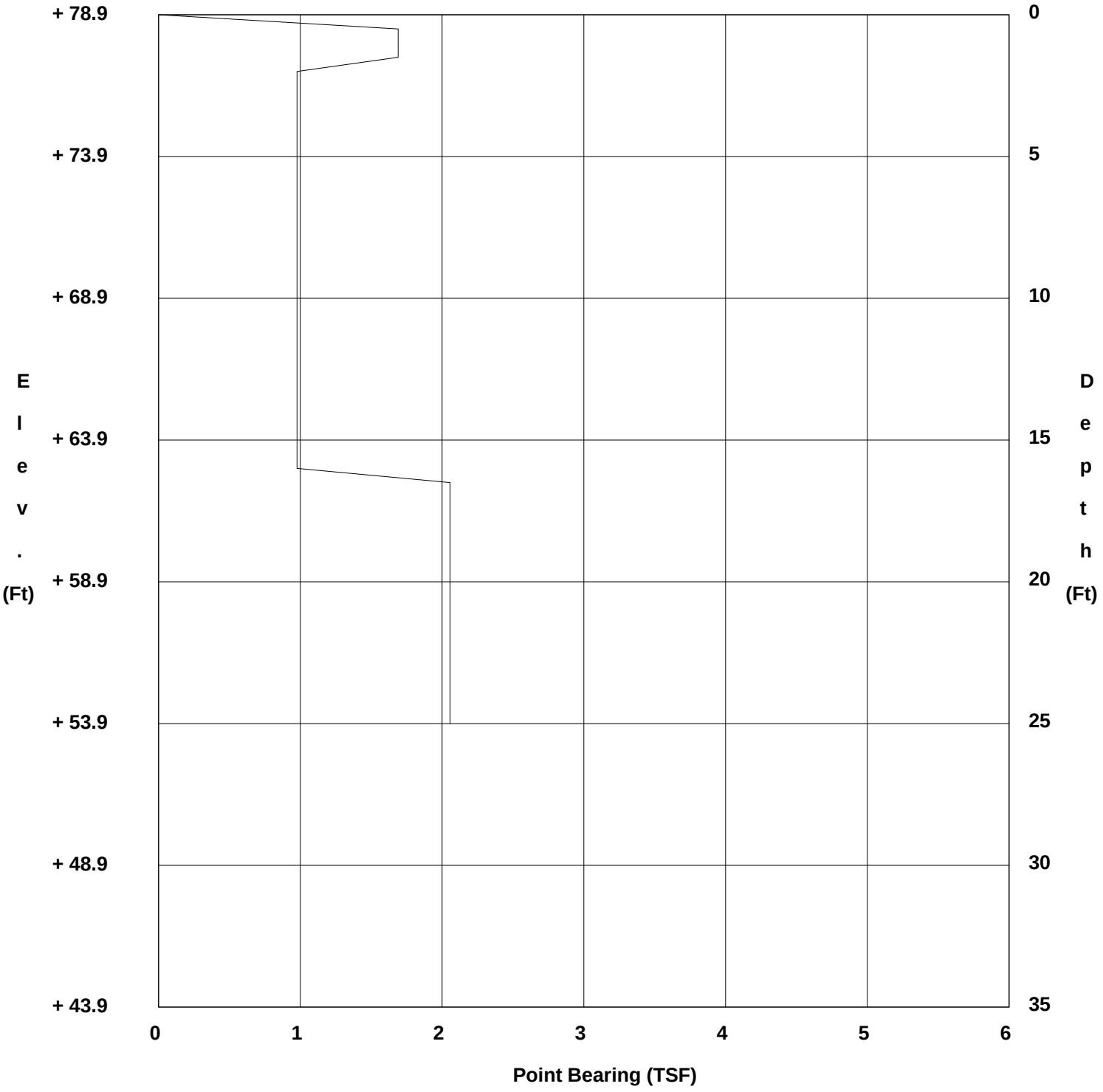
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-4	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	102+13	Grnd. Elev.	78.94 ft
		Offset	19.81	GW Elev.	63.94 ft

Diameters Below Tip Checked = 2

Average Bearing Values Used



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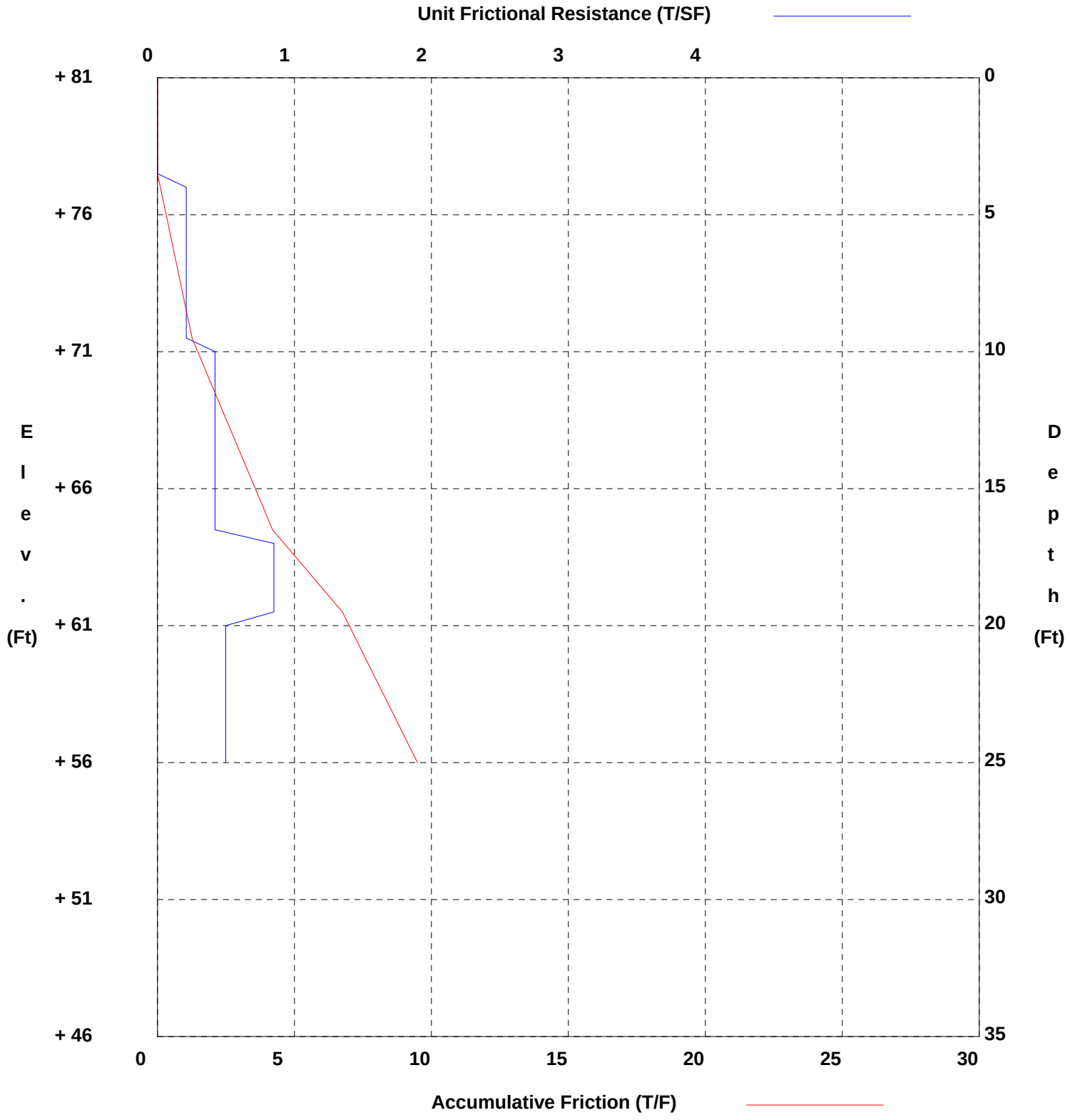
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-5	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	95+92.02	Grnd. Elev.	81.00 ft
		Offset	10.18	GW Elev.	68.00 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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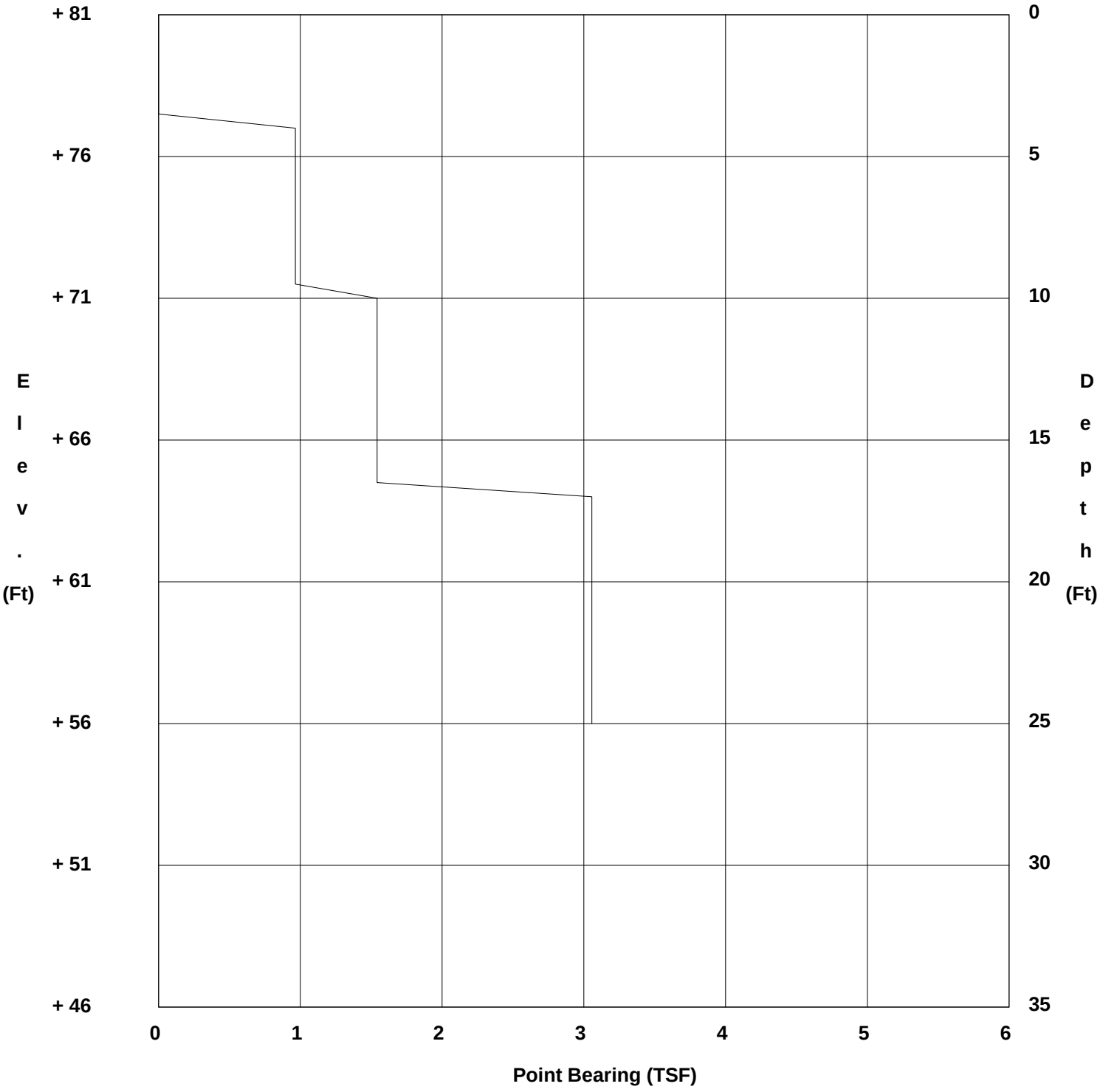
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-5	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	95+92.02	Grnd. Elev.	81.00 ft
		Offset	10.18	GW Elev.	68.00 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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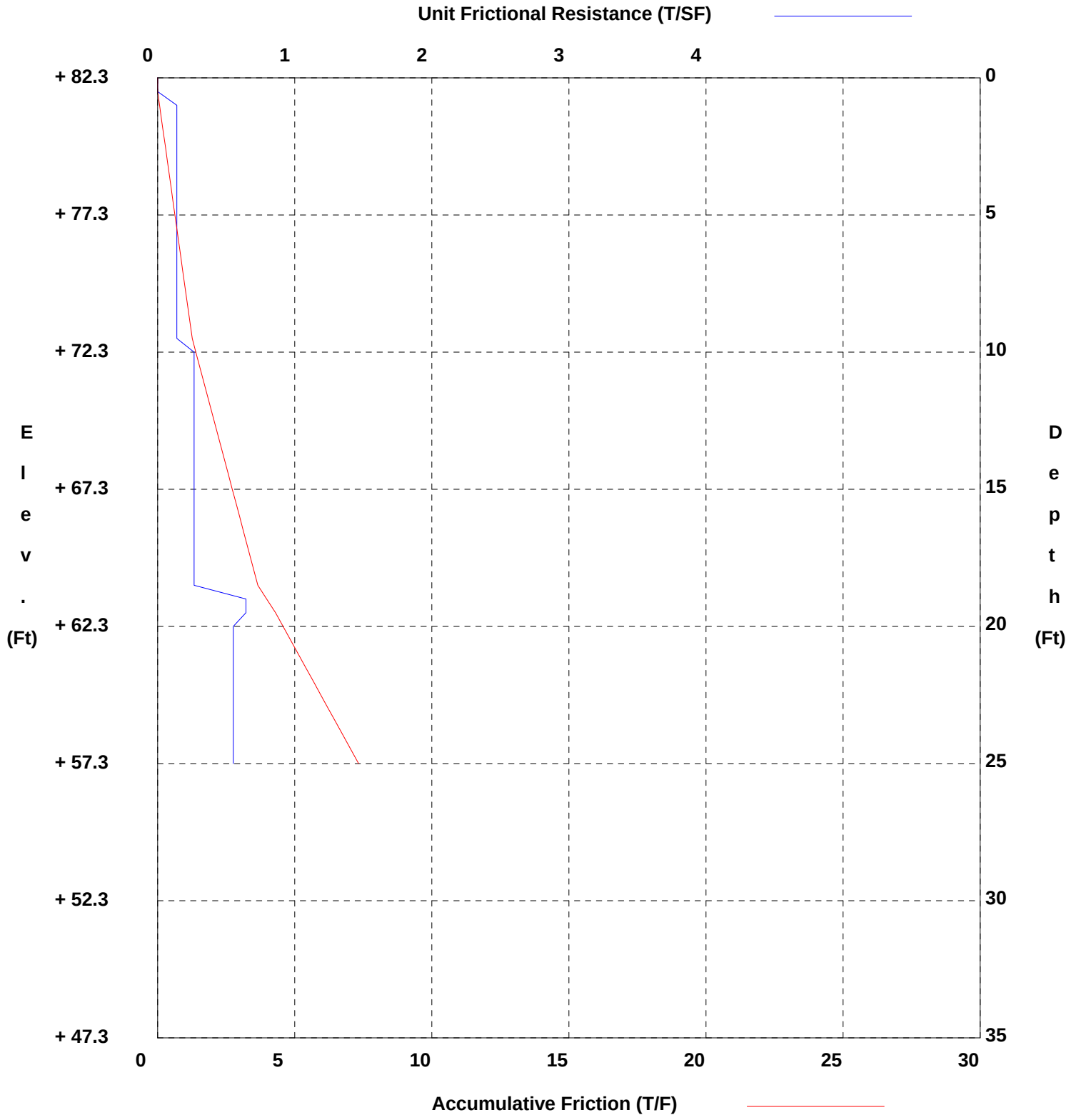
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-6	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	91+12.80	Grnd. Elev.	82.30 ft
		Offset	12.82	GW Elev.	60.30 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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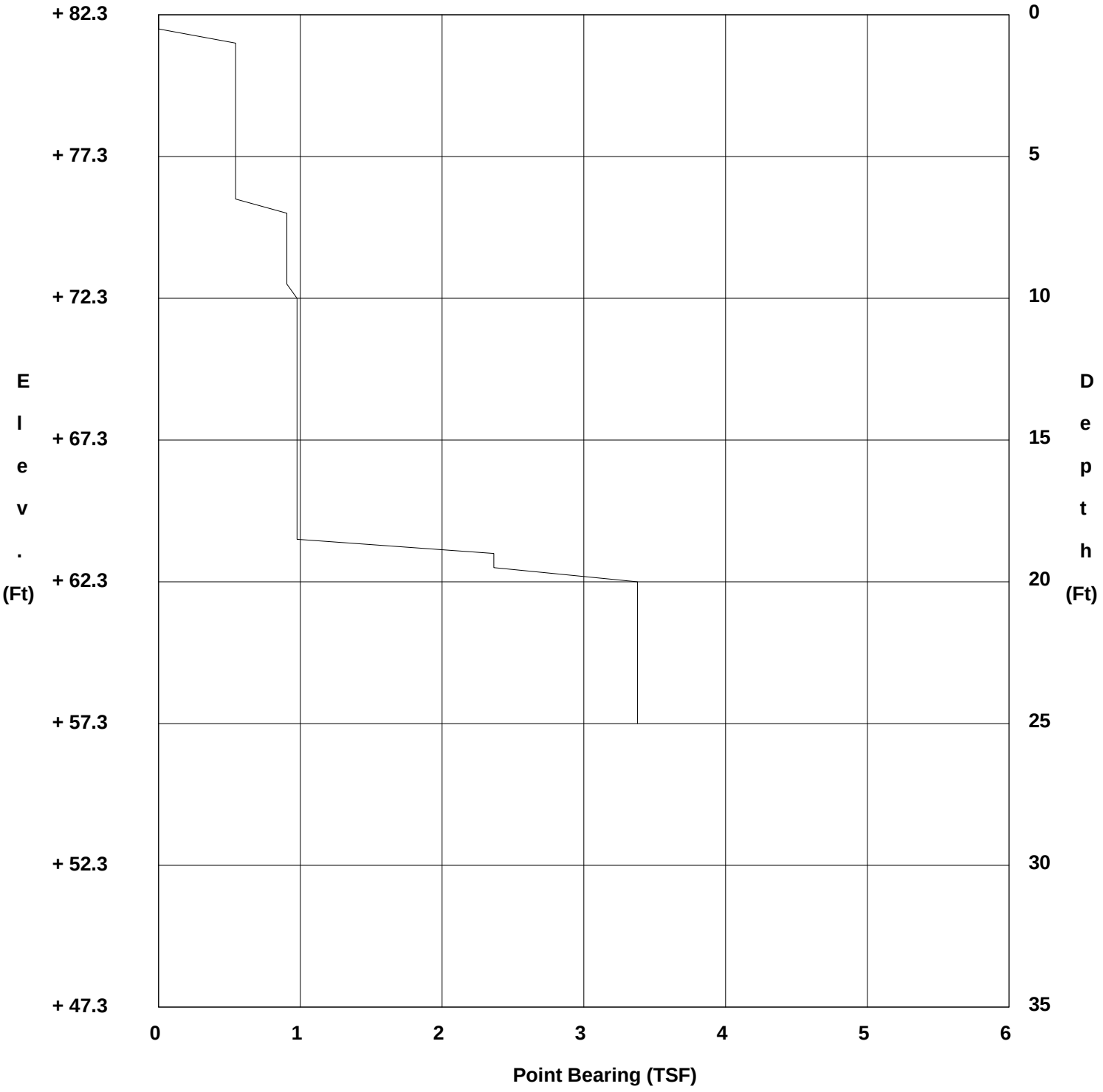
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-6	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	91+12.80	Grnd. Elev.	82.30 ft
		Offset	12.82	GW Elev.	60.30 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

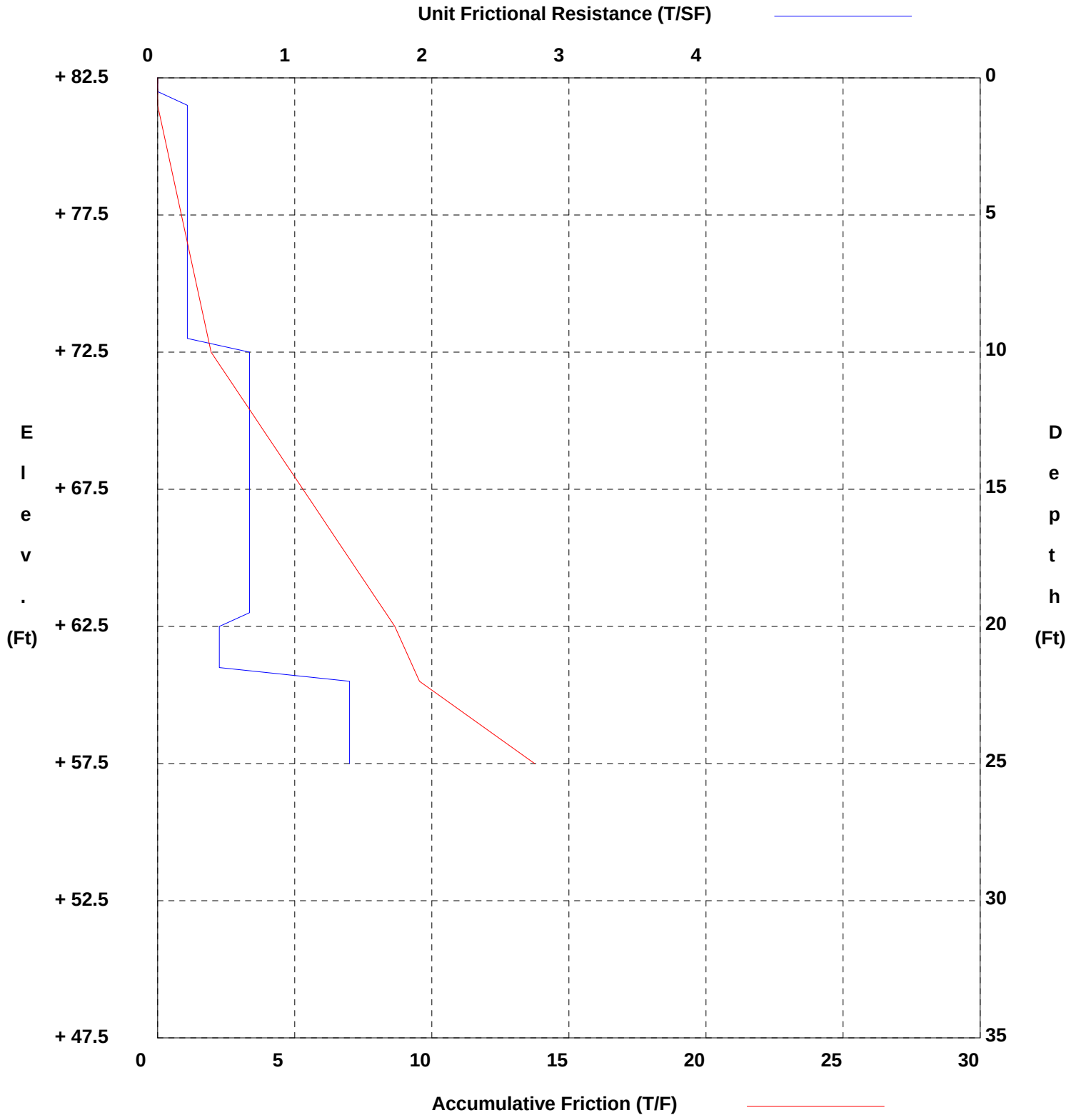
WinCore
Version 3.1

County	Harris	Hole	B-7	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	87+12.74	Grnd. Elev.	82.48 ft
		Offset	12.74	GW Elev.	69.48 ft

Piling Design: No Soil Reduction Factor

Average Friction Values Used

Skin Friction Limit = 1.4 tsf



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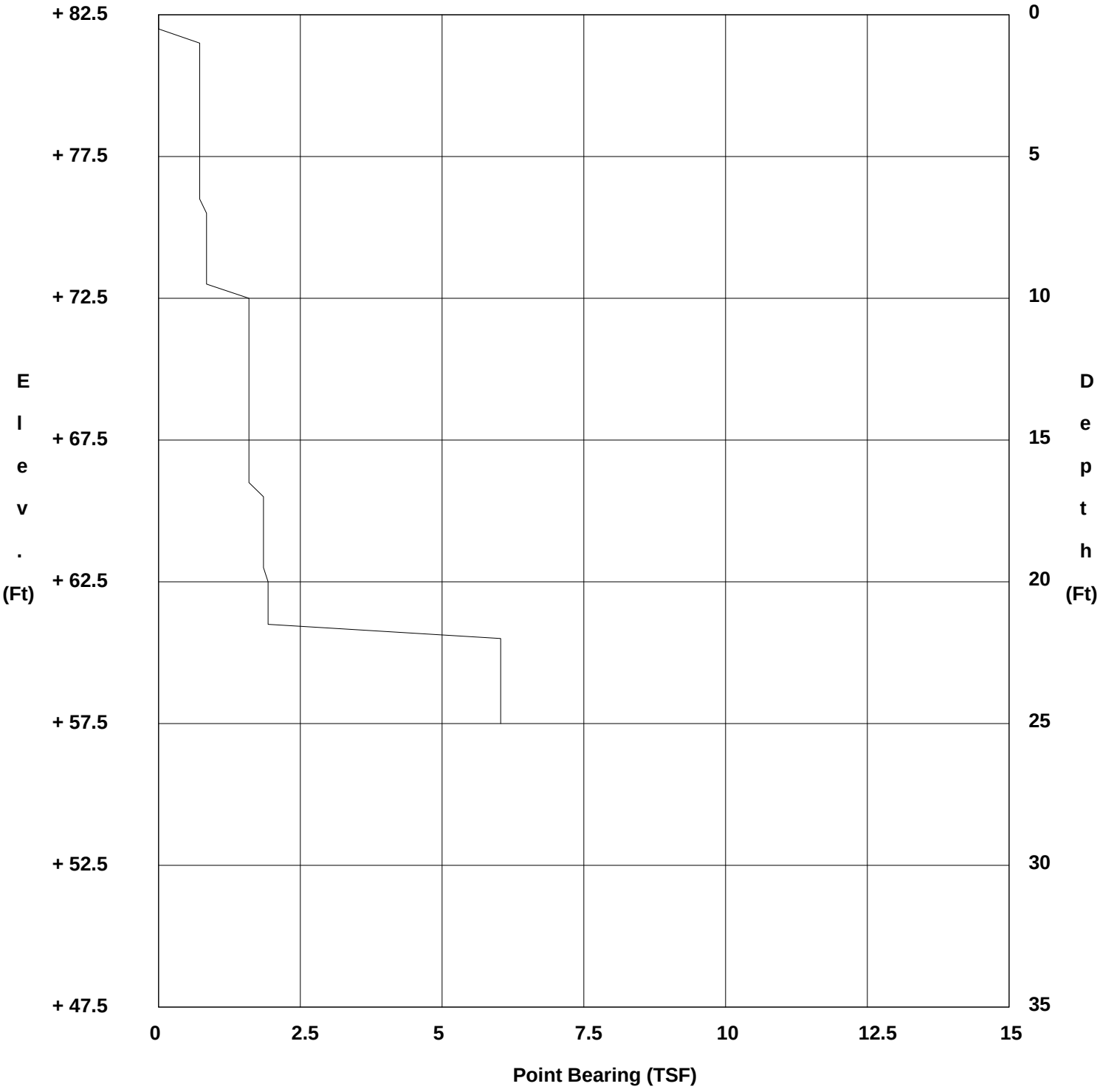
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-7	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	87+12.74	Grnd. Elev.	82.48 ft
		Offset	12.74	GW Elev.	69.48 ft

Diameters Below Tip Checked = 2

Average Bearing Values Used



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SKIN FRICTION DESIGN

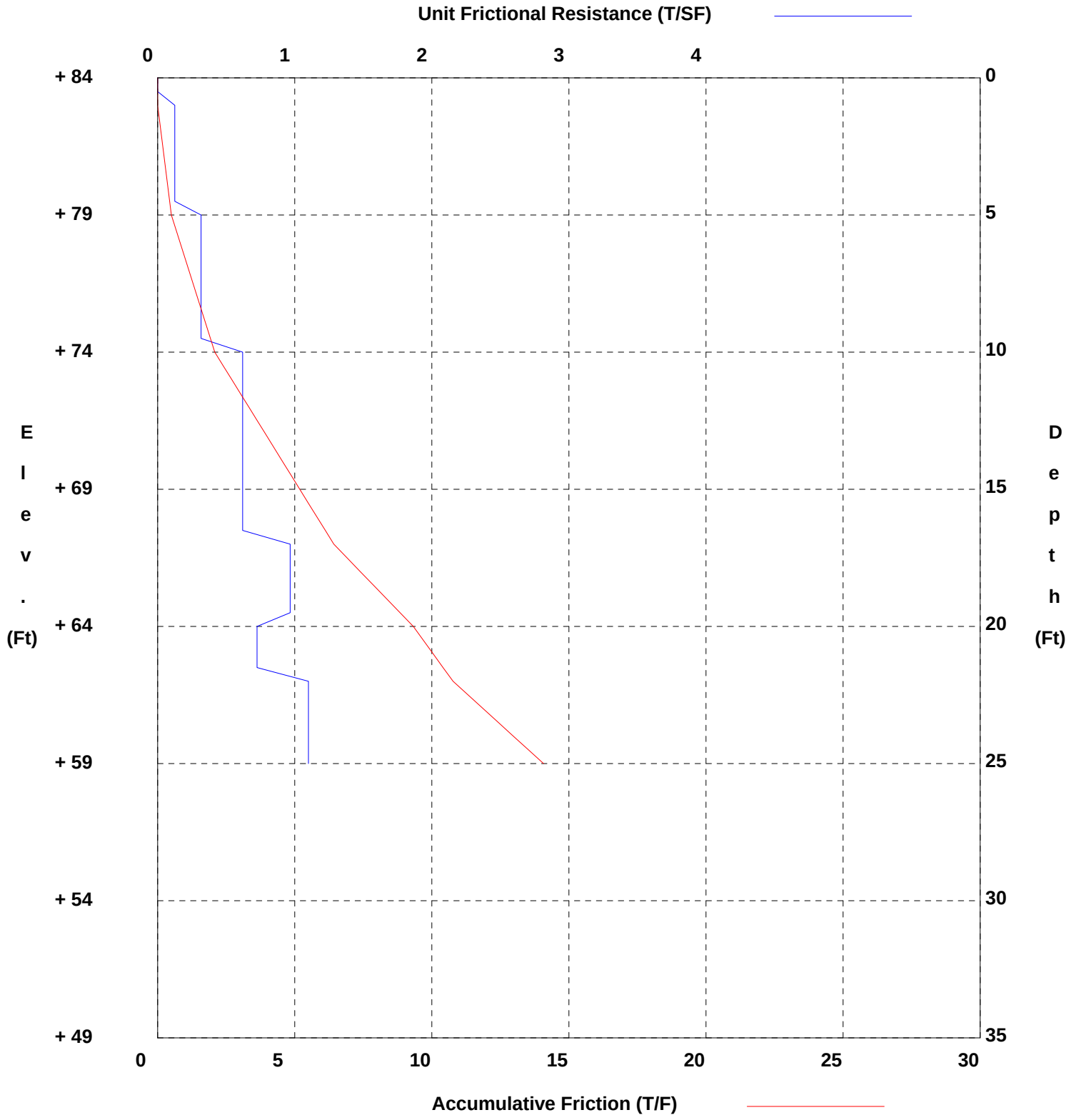
WinCore
Version 3.1

County	Harris	Hole	B-8	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	80+90.95	Grnd. Elev.	83.95 ft
		Offset	12.23	GW Elev.	64.95 ft

Piling Design: No Soil Reduction Factor

Average Friction Values Used

Skin Friction Limit = 1.4 tsf



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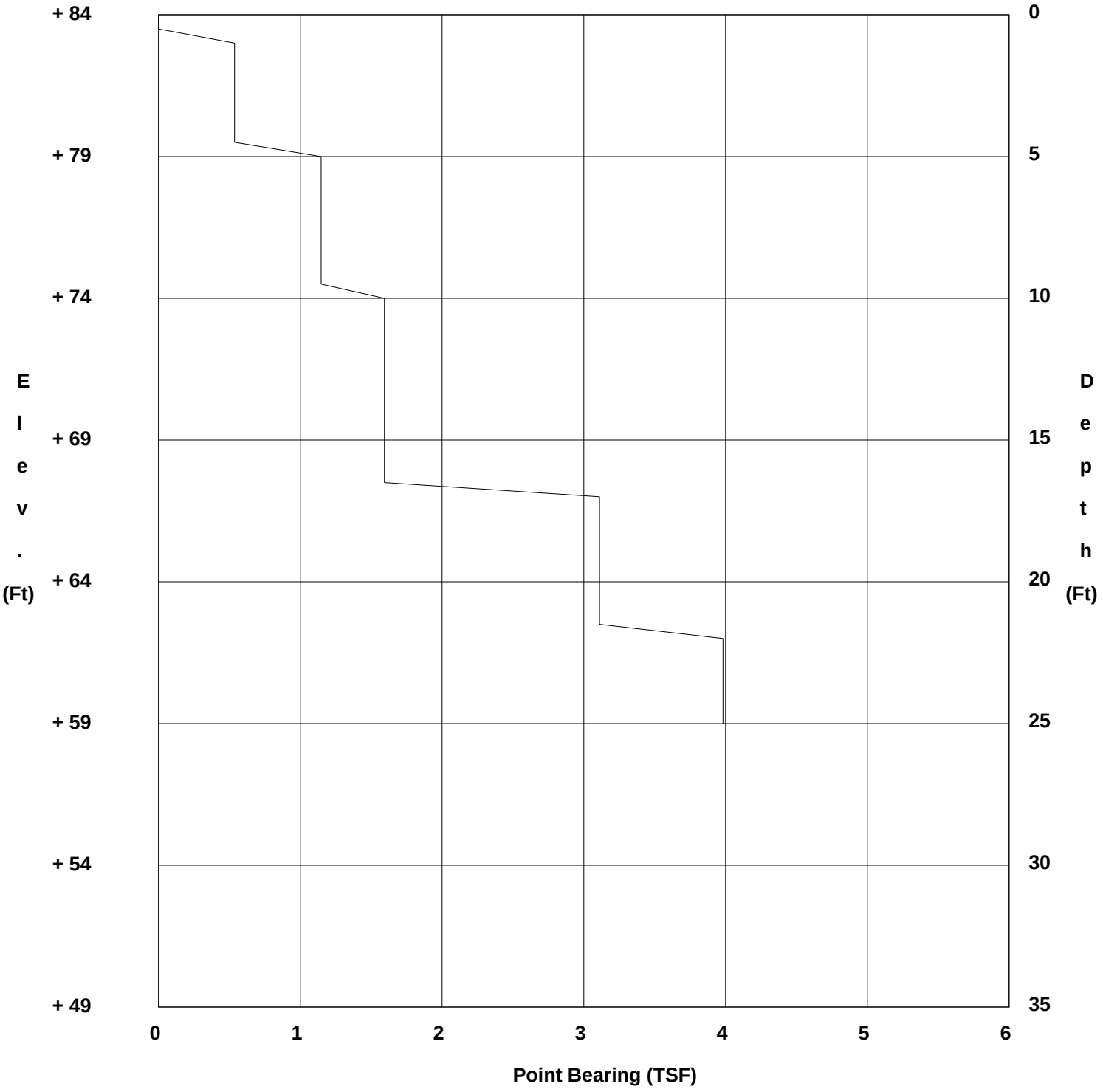
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-8	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	80+90.95	Grnd. Elev.	83.95 ft
		Offset	12.23	GW Elev.	64.95 ft

Diameters Below Tip Checked = 2

Average Bearing Values Used



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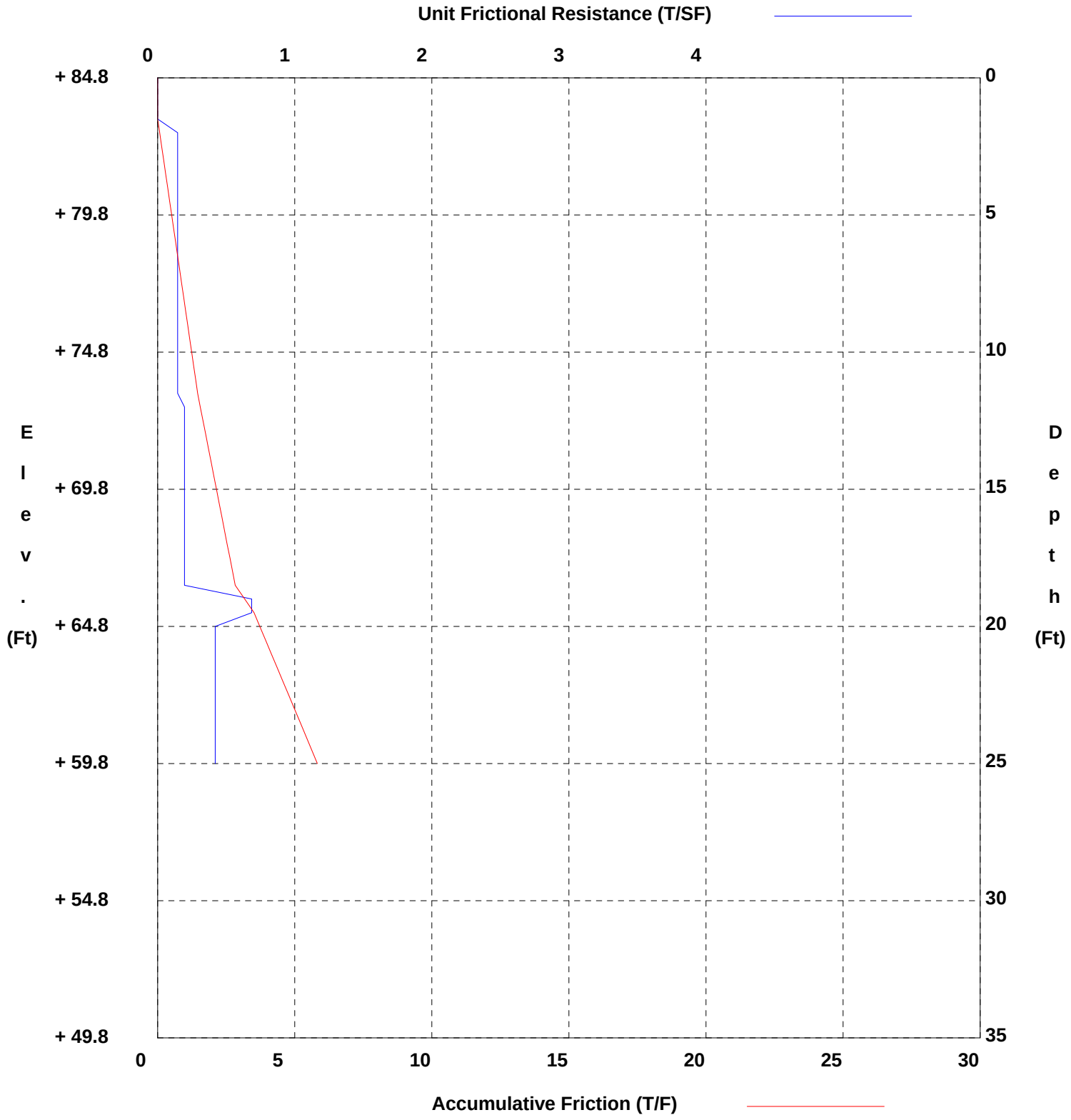
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-9	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	76+59.43	Grnd. Elev.	84.80 ft
		Offset	13.44	GW Elev.	64.80 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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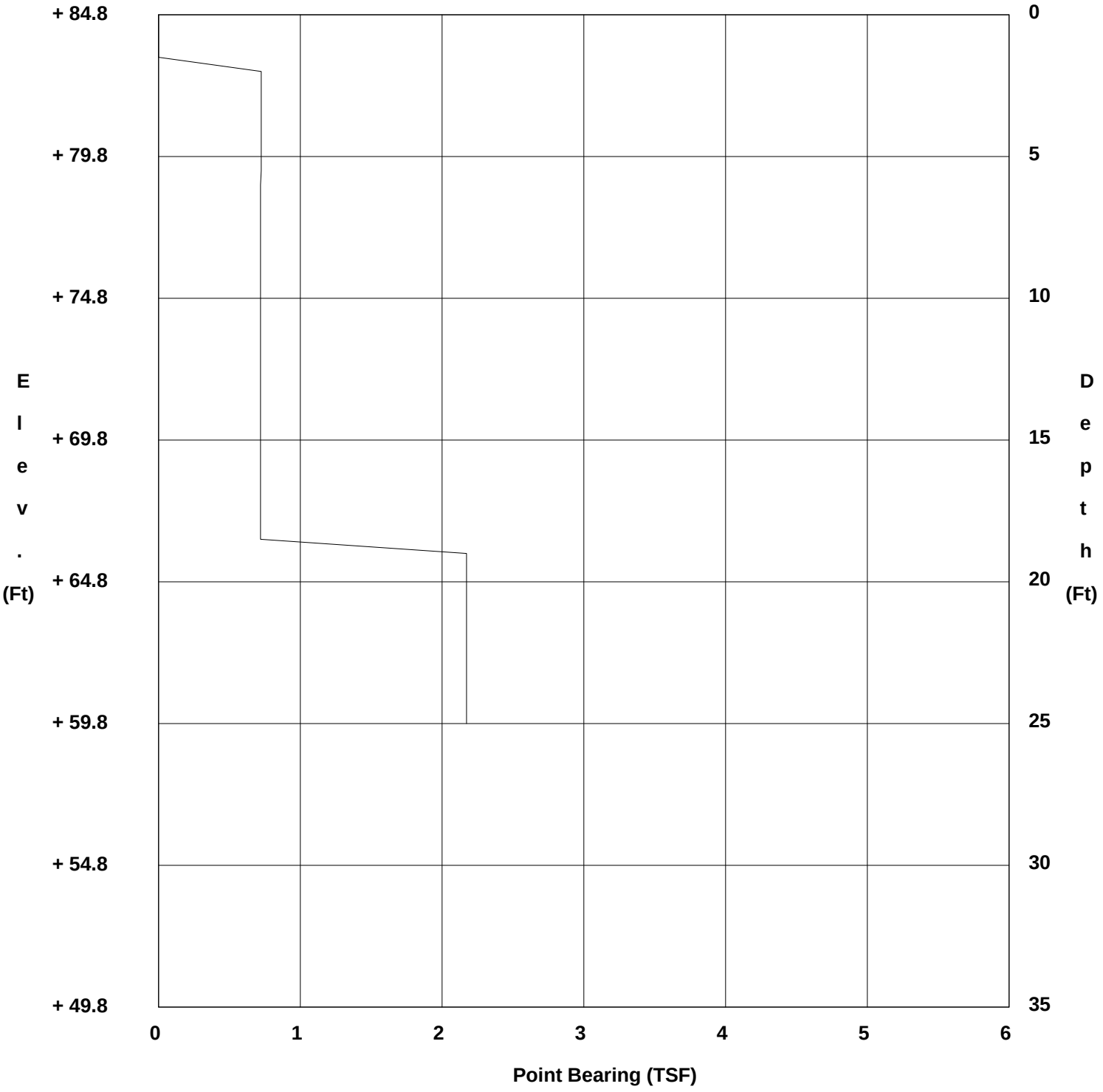
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-9	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	76+59.43	Grnd. Elev.	84.80 ft
		Offset	13.44	GW Elev.	64.80 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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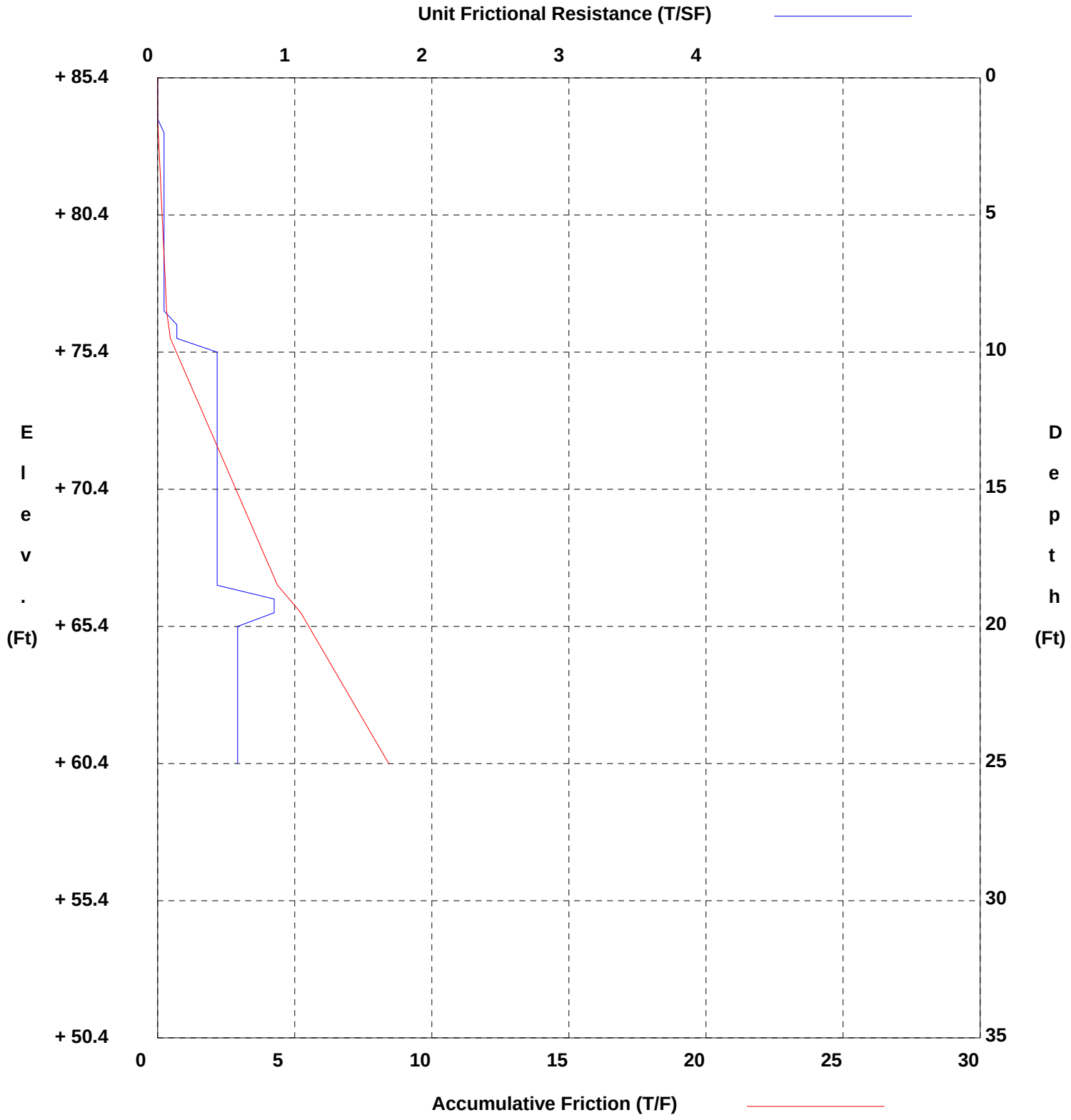
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-10	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	71+43.47	Grnd. Elev.	85.39 ft
		Offset	12.64	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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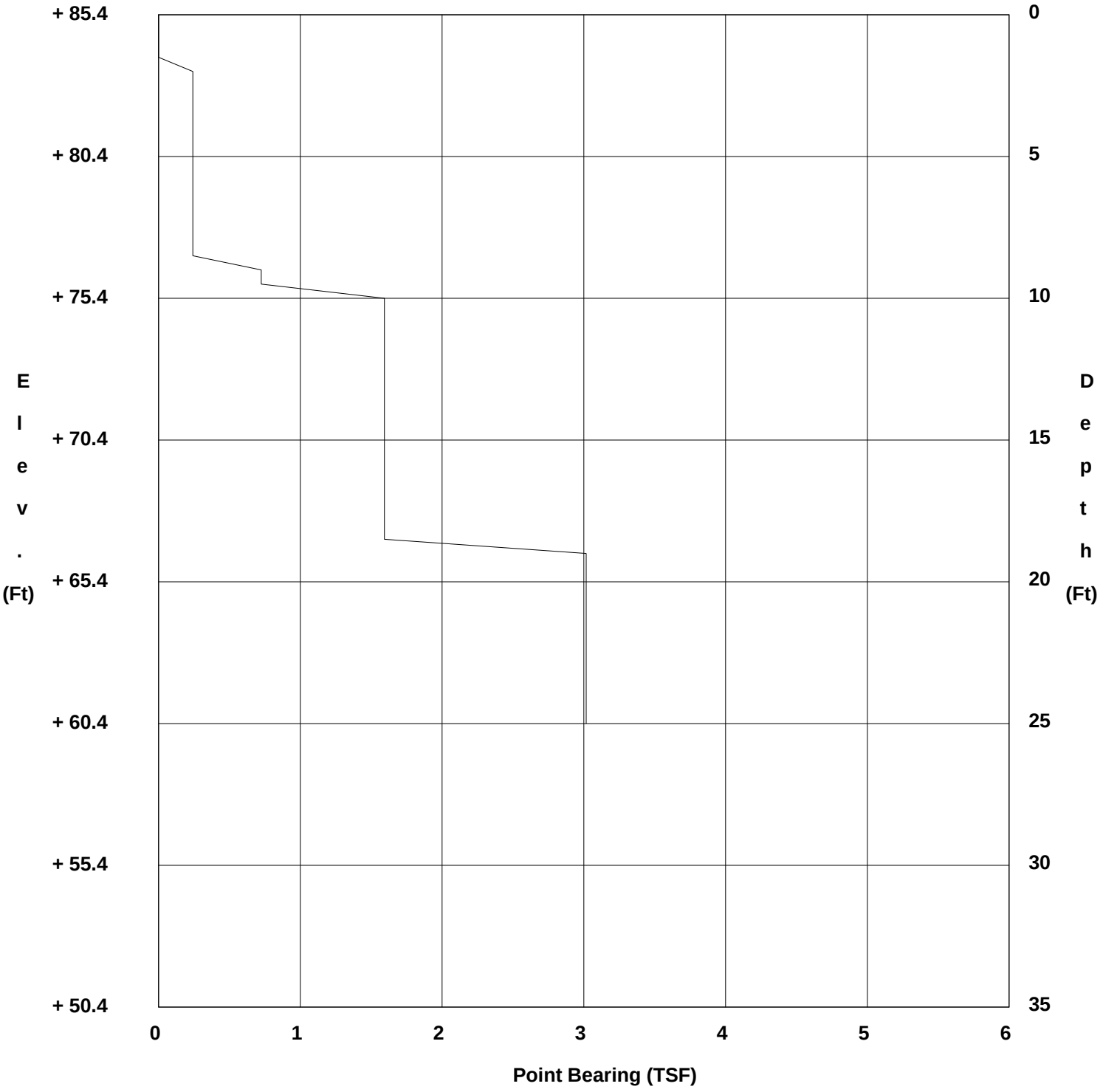
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-10	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/19/2013
Control	No. 0912-70-082	Station	71+43.47	Grnd. Elev.	85.39 ft
		Offset	12.64	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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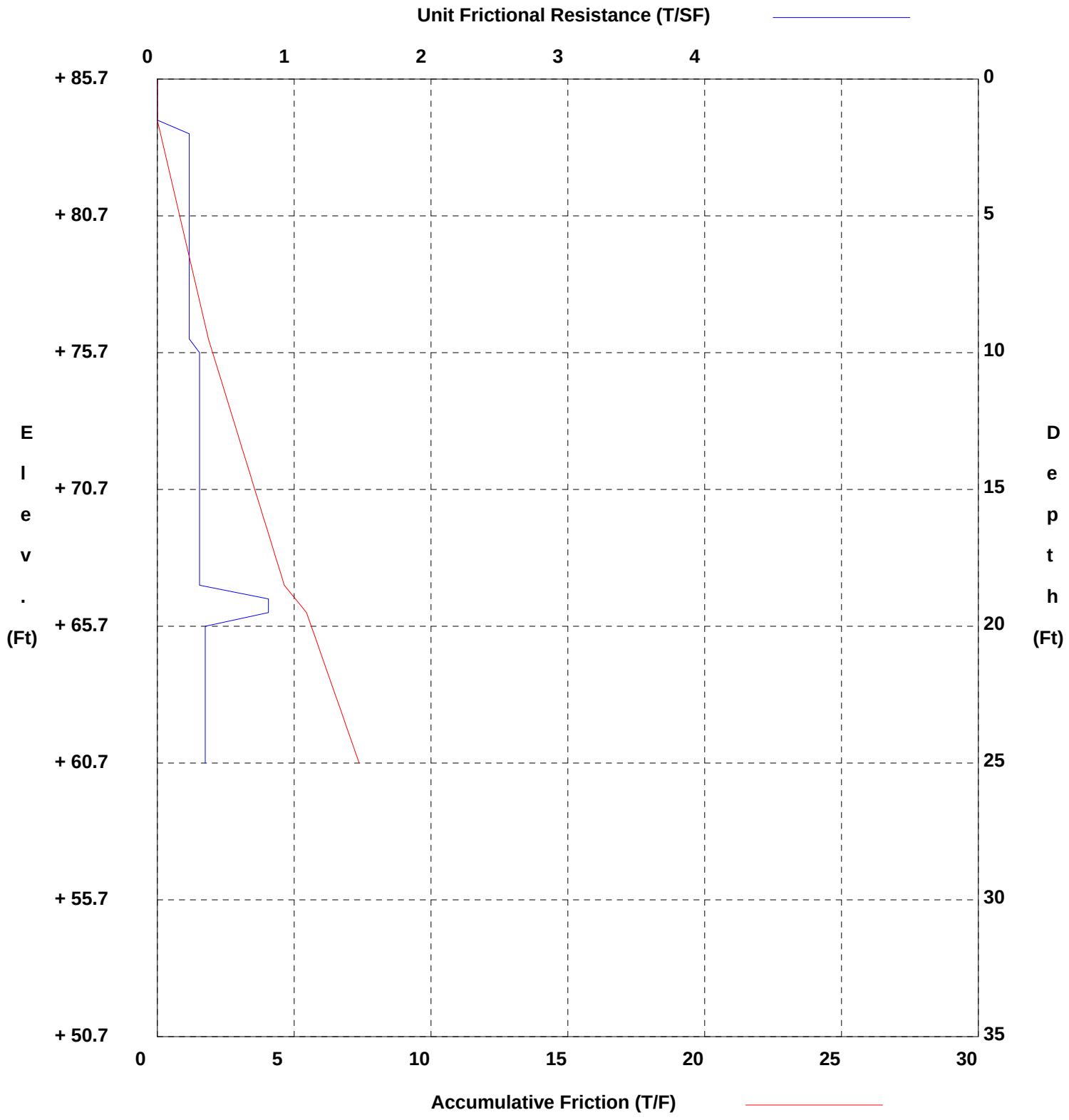
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-11	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	66+60.62	Grnd. Elev.	85.72 ft
		Offset	11.10	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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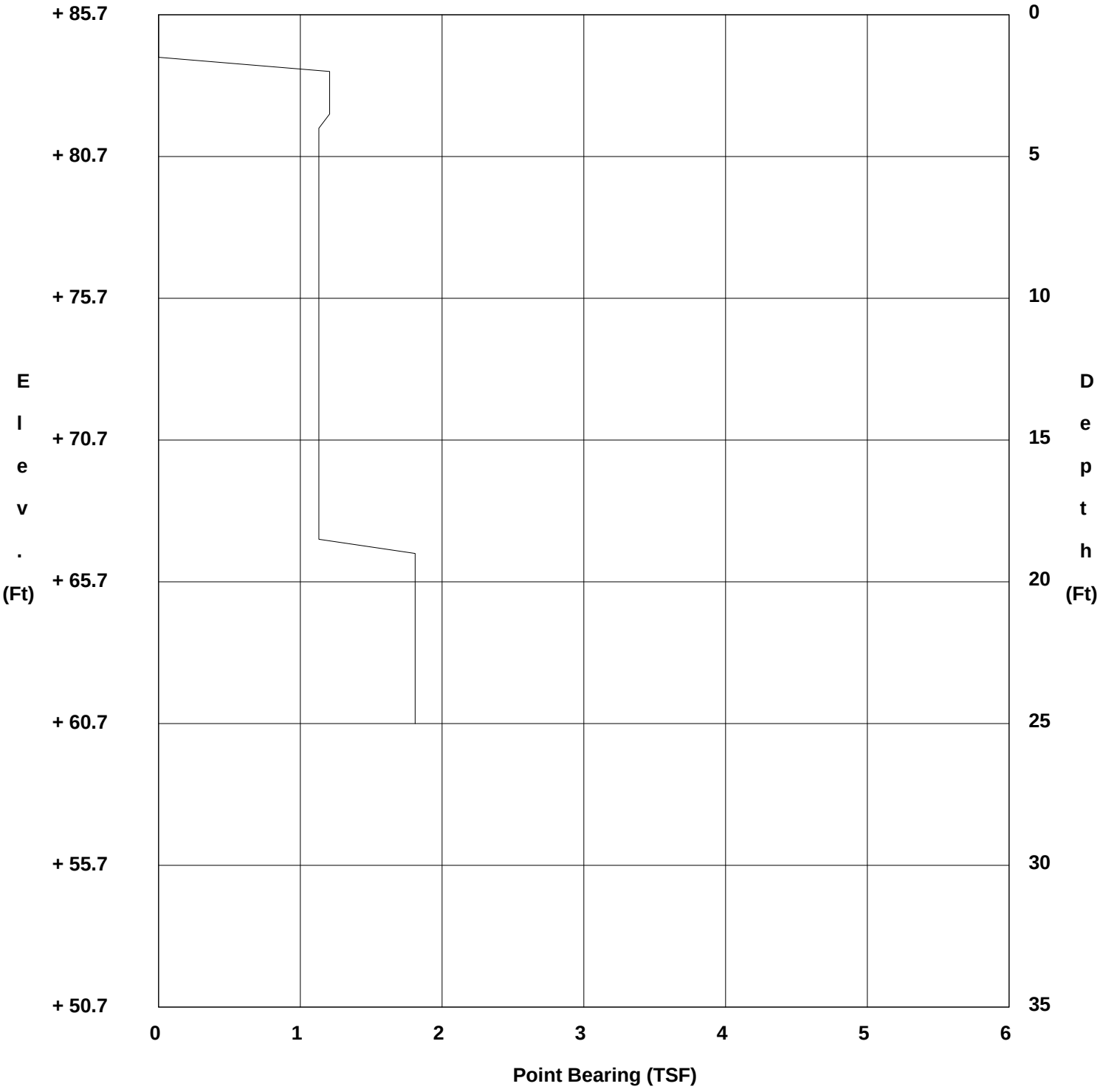
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-11	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	66+60.62	Grnd. Elev.	85.72 ft
		Offset	11.10	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

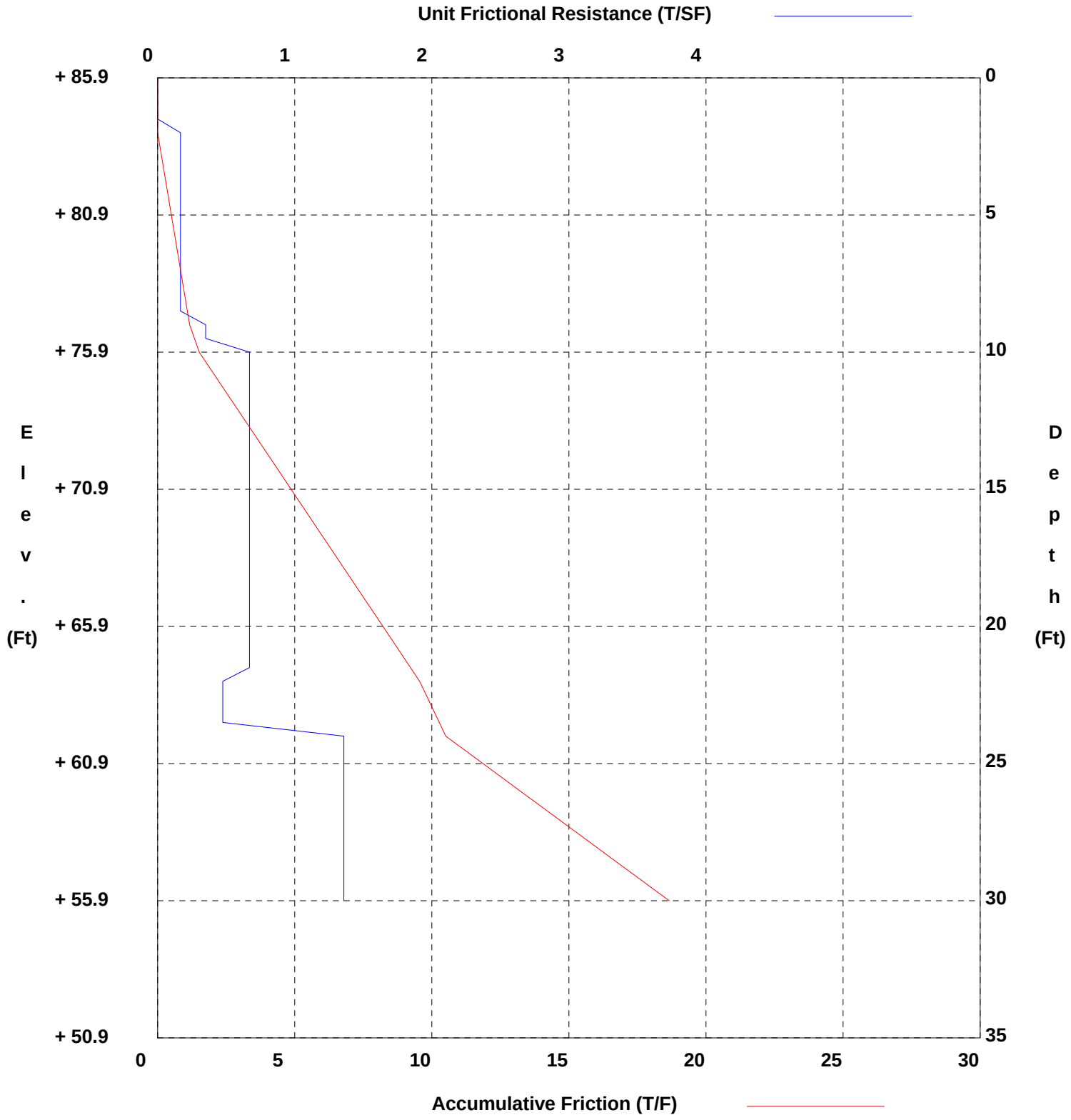
WinCore
Version 3.1

County	Harris	Hole	B-12	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	64+81.98	Grnd. Elev.	85.89 ft
		Offset	18.50	GW Elev.	66.89 ft

Piling Design: No Soil Reduction Factor

Average Friction Values Used

Skin Friction Limit = 1.4 tsf



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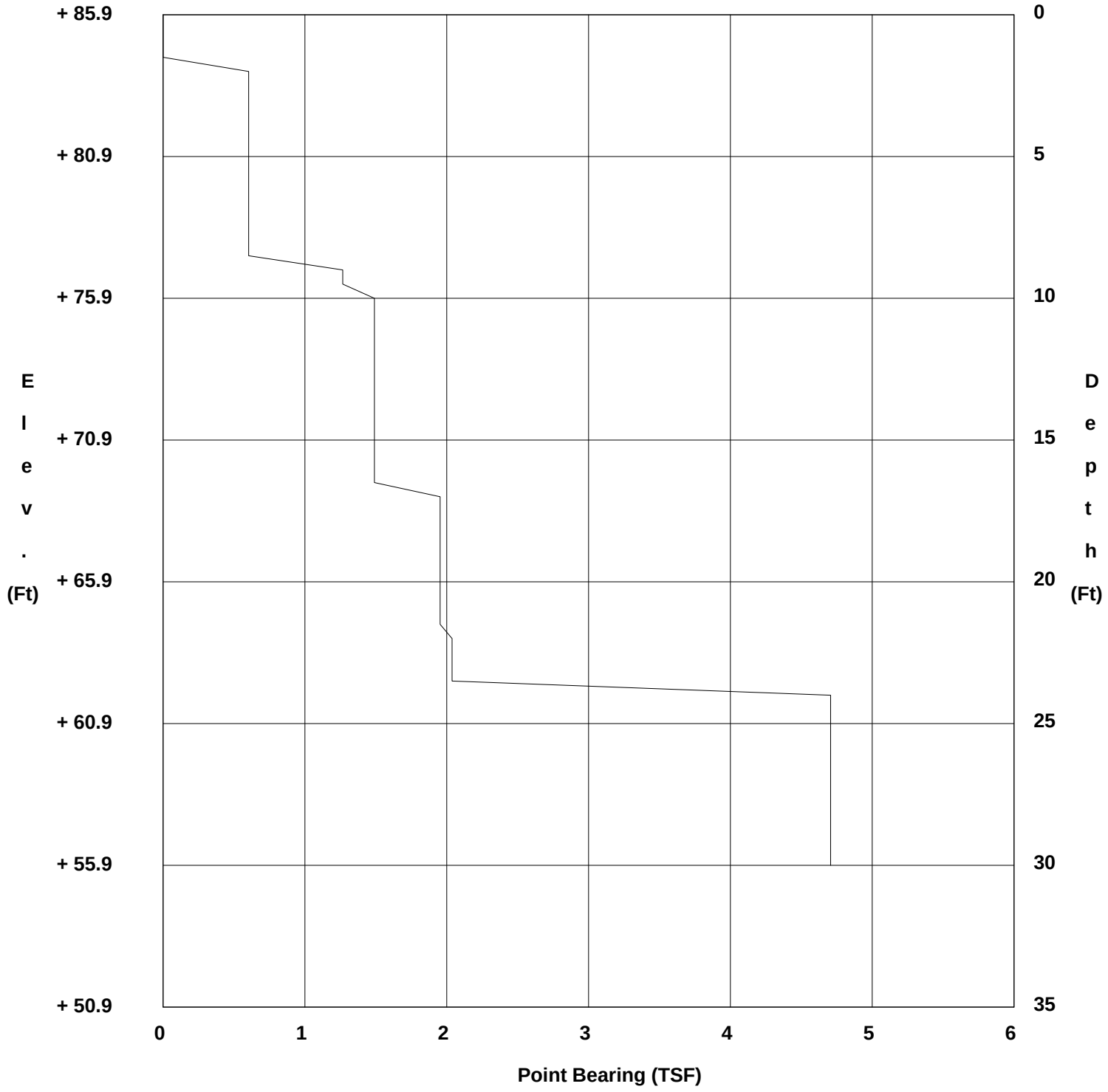
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-12	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	64+81.98	Grnd. Elev.	85.89 ft
		Offset	18.50	GW Elev.	66.89 ft

Diameters Below Tip Checked = 2

Average Bearing Values Used



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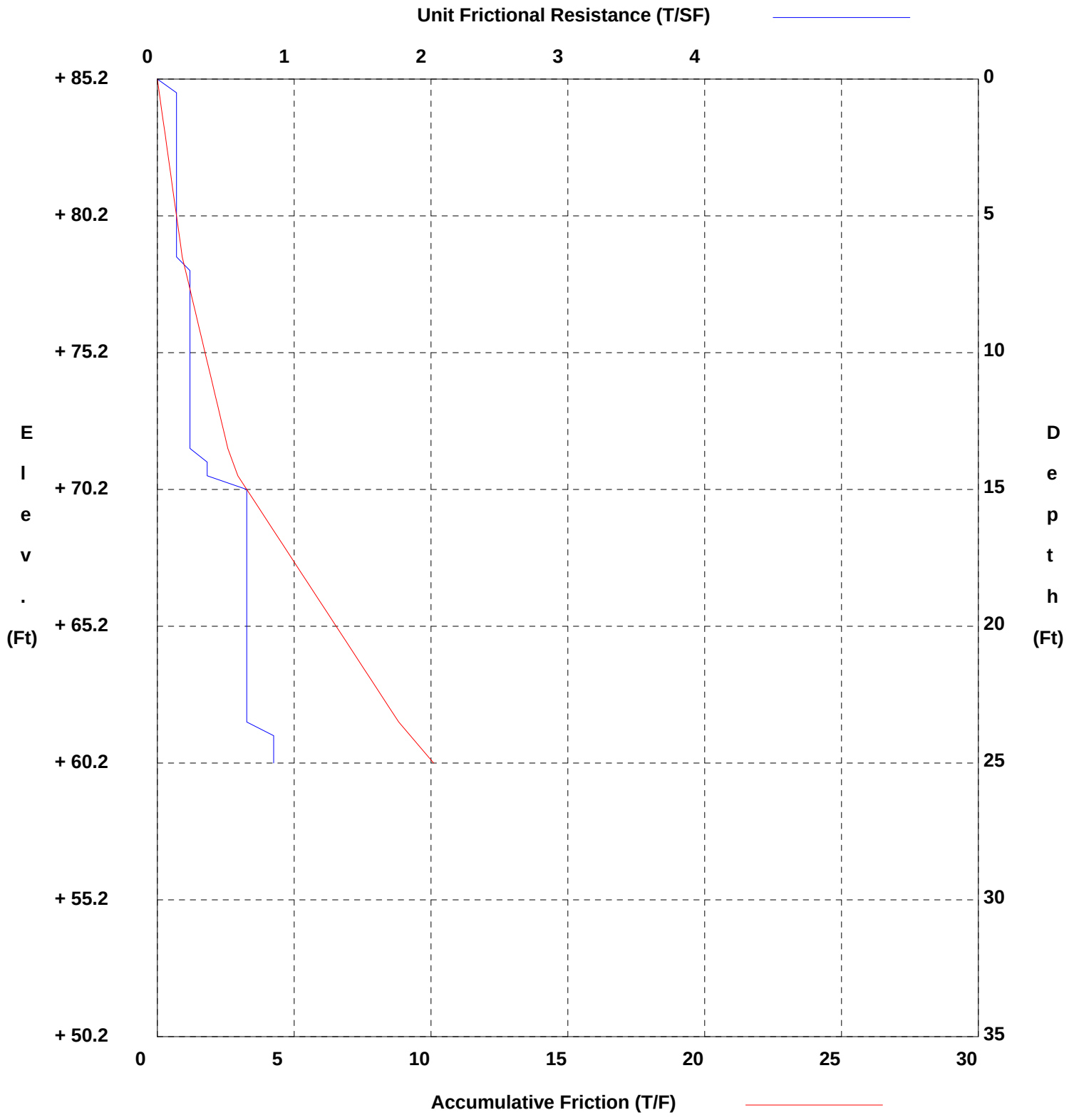
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-13	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	55+82.95	Grnd. Elev.	85.20 ft
		Offset	33.15	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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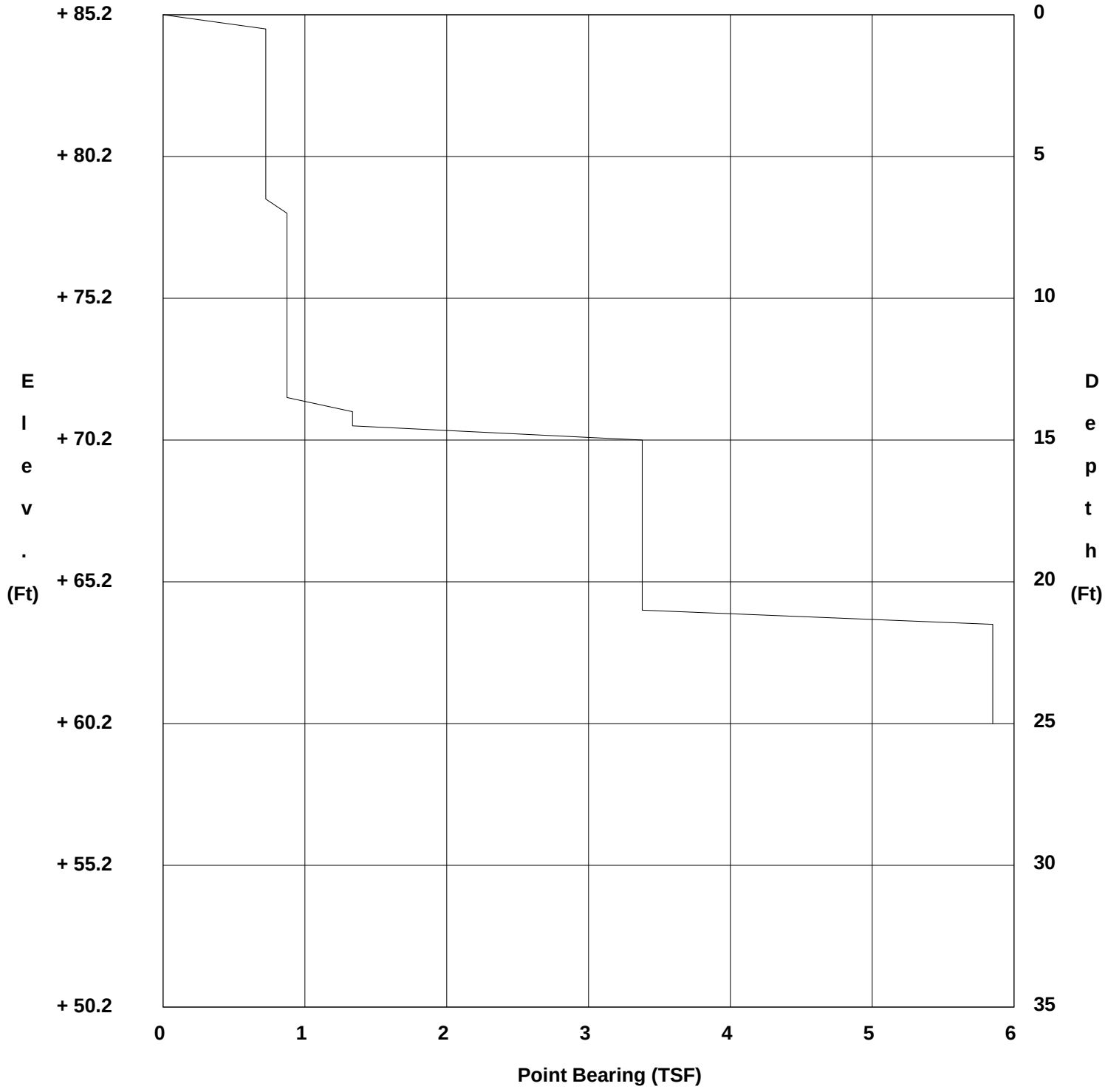
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-13	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	55+82.95	Grnd. Elev.	85.20 ft
		Offset	33.15	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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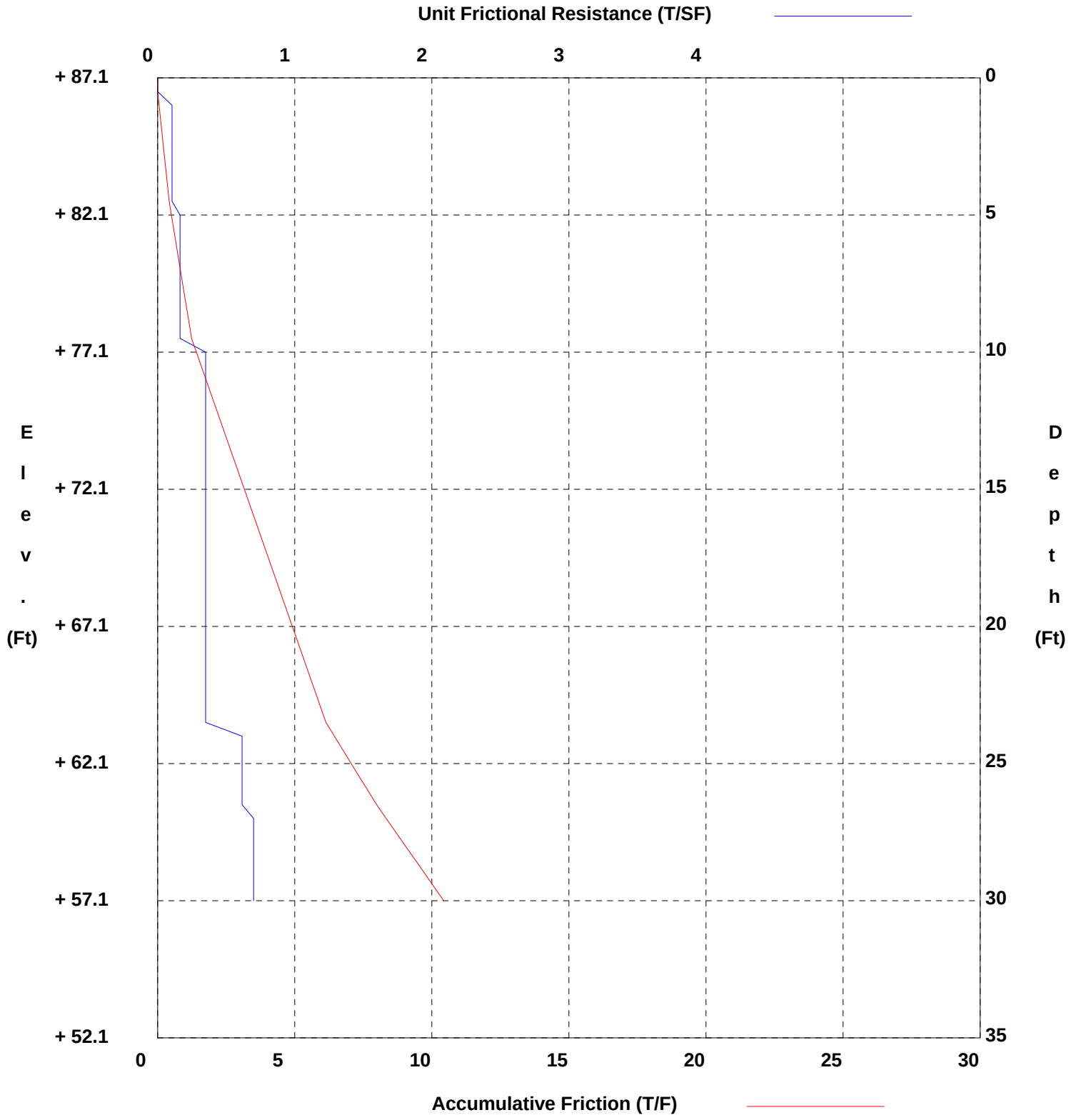
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-14	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	51+55.38	Grnd. Elev.	87.14 ft
		Offset	16.94	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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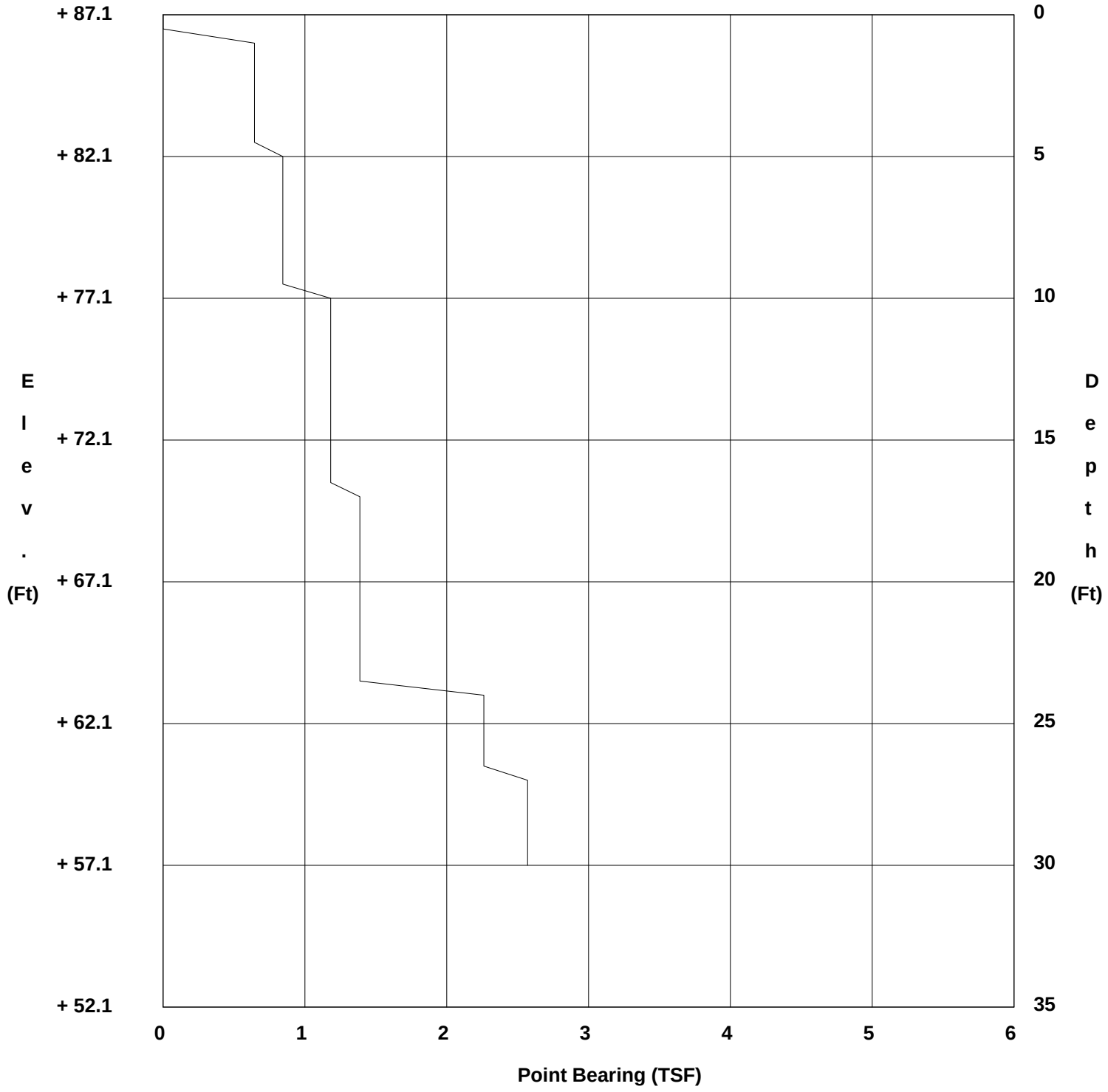
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-14	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/18/2013
Control	No. 0912-70-082	Station	51+55.38	Grnd. Elev.	87.14 ft
		Offset	16.94	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

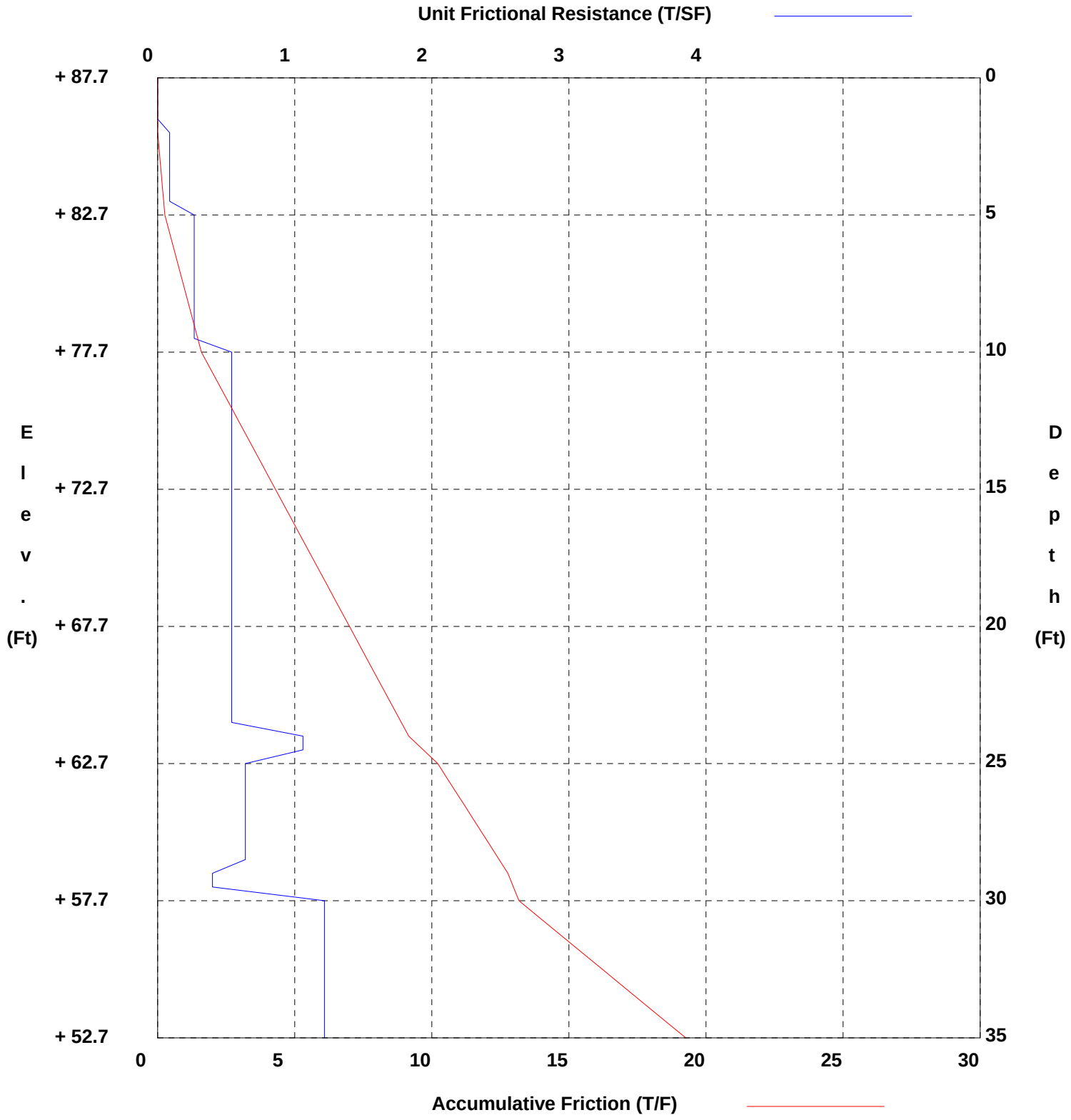
WinCore
Version 3.1

County	Harris	Hole	B-15	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	45+48.37	Grnd. Elev.	87.71 ft
		Offset	10.69	GW Elev.	57.71 ft

Piling Design: No Soil Reduction Factor

Average Friction Values Used

Skin Friction Limit = 1.4 tsf



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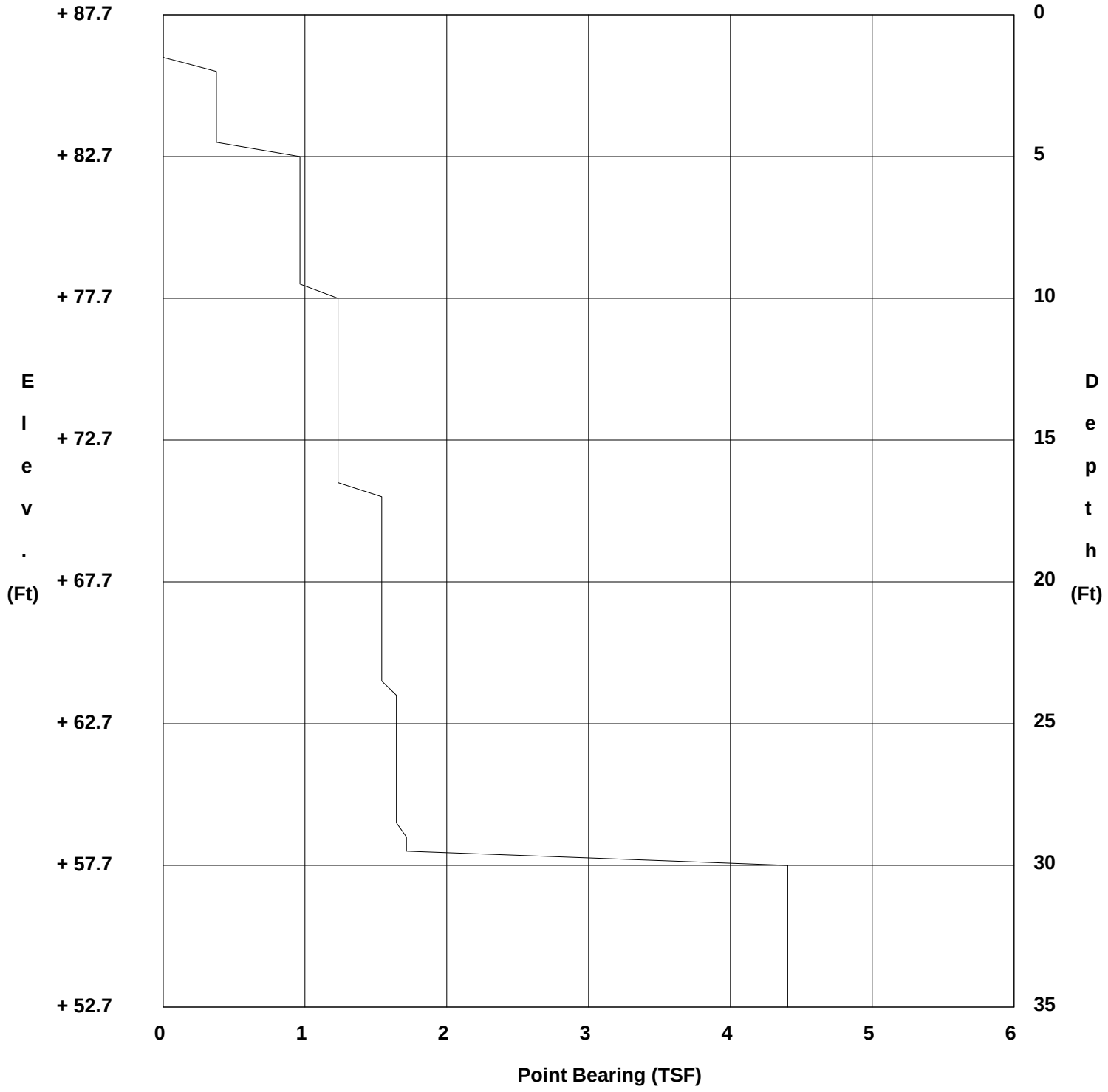
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-15	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	45+48.37	Grnd. Elev.	87.71 ft
		Offset	10.69	GW Elev.	57.71 ft

Diameters Below Tip Checked = 2

Average Bearing Values Used



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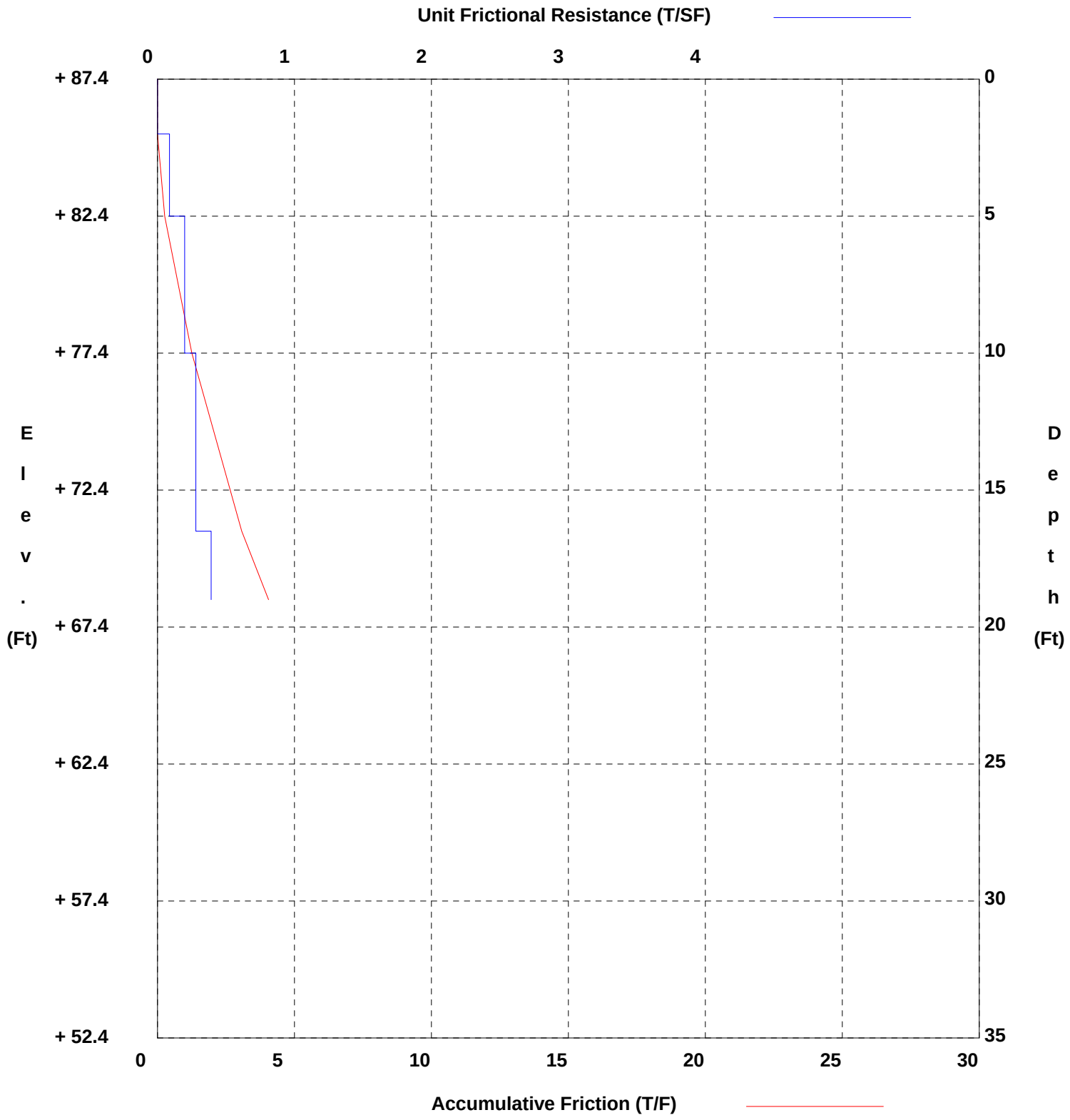
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-16	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	41+24.12	Grnd. Elev.	87.36 ft
		Offset	14.21	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TCP Friction Values Used



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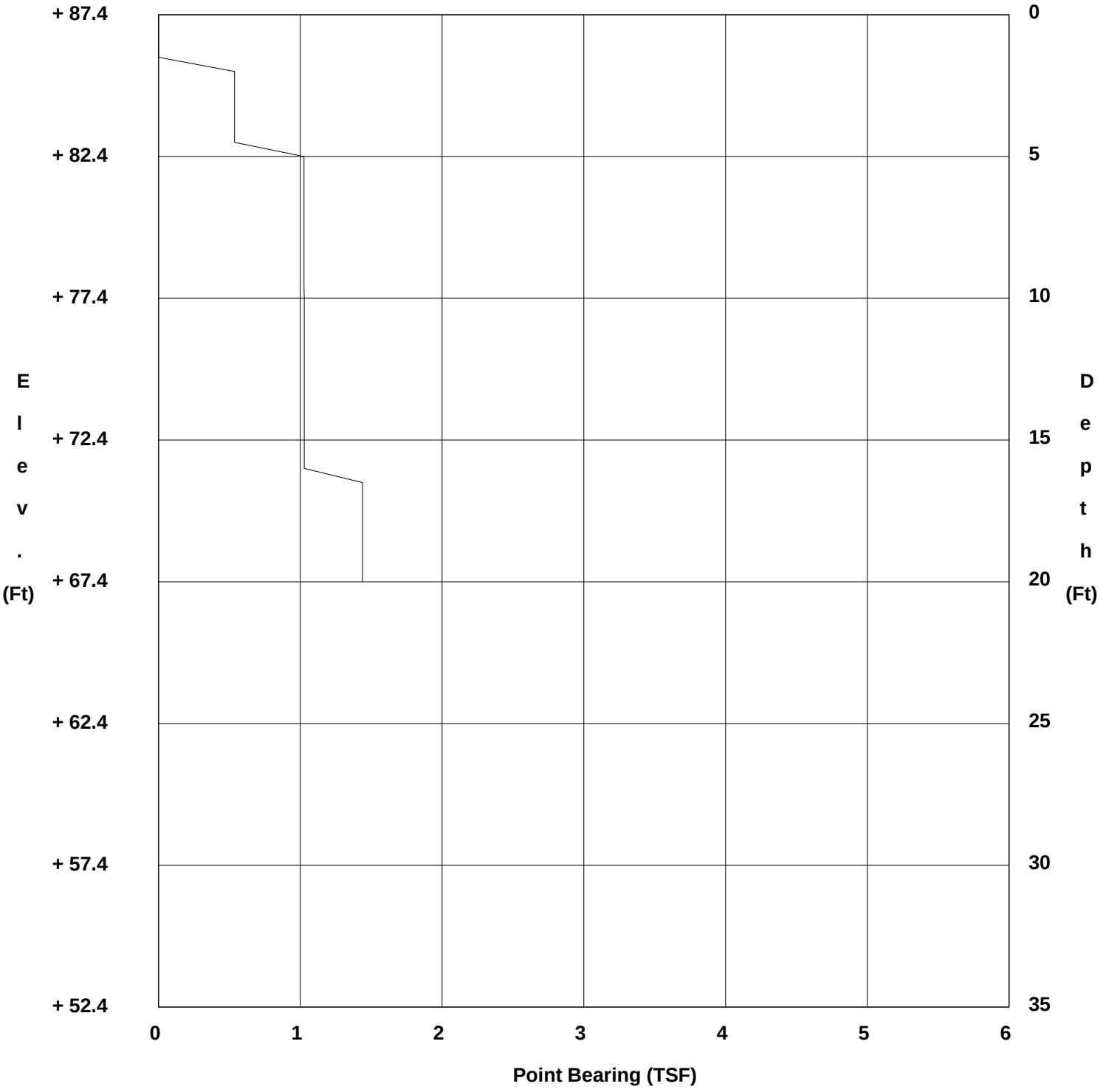
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-16	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/22/2013
Control	No. 0912-70-082	Station	41+24.12	Grnd. Elev.	87.36 ft
		Offset	14.21	GW Elev.	N/A

Diameters Below Tip Checked = 2

TCP Bearing Values Used



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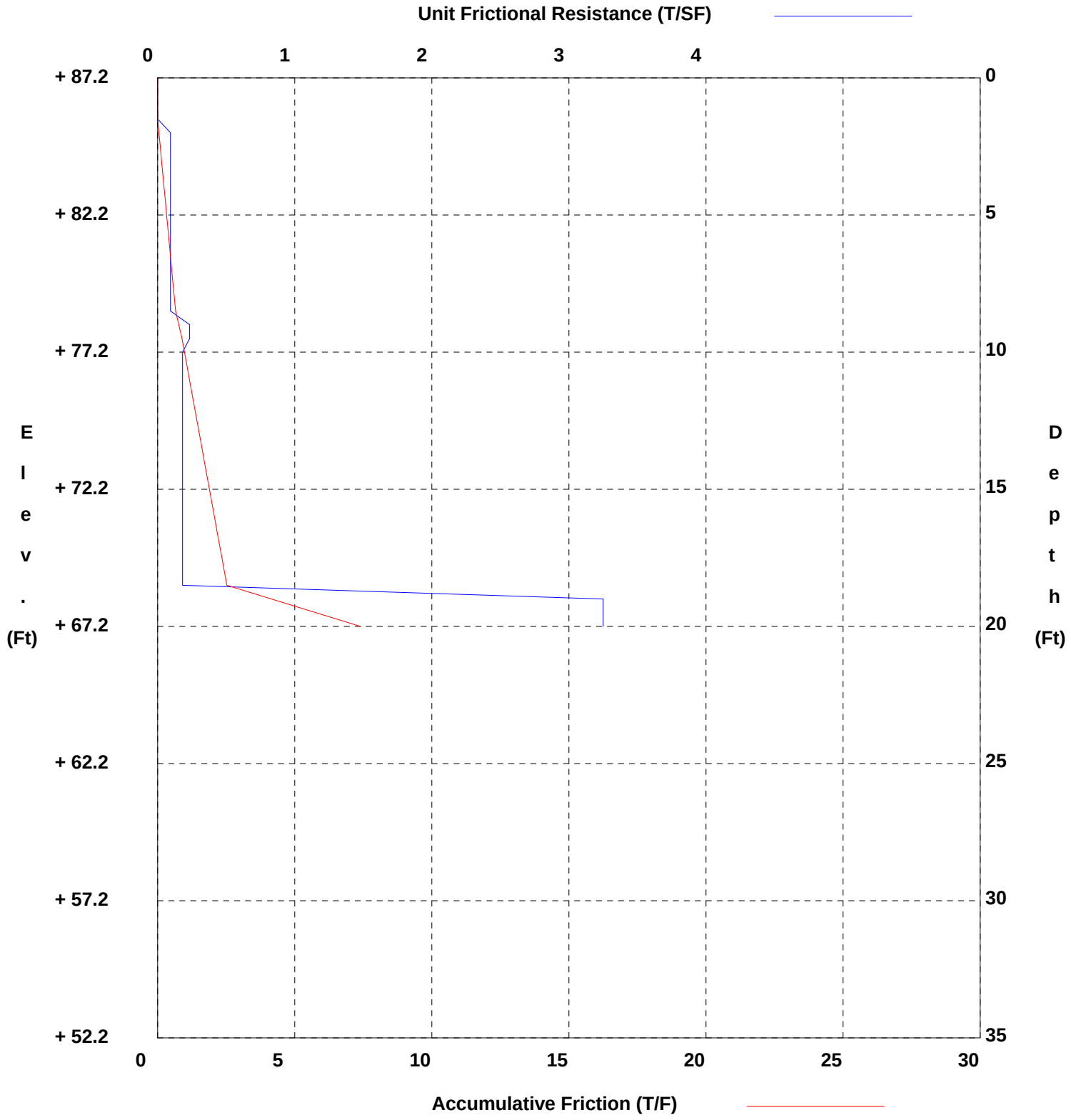
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-17	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	36+77.91	Grnd. Elev.	87.25 ft
		Offset	13.40	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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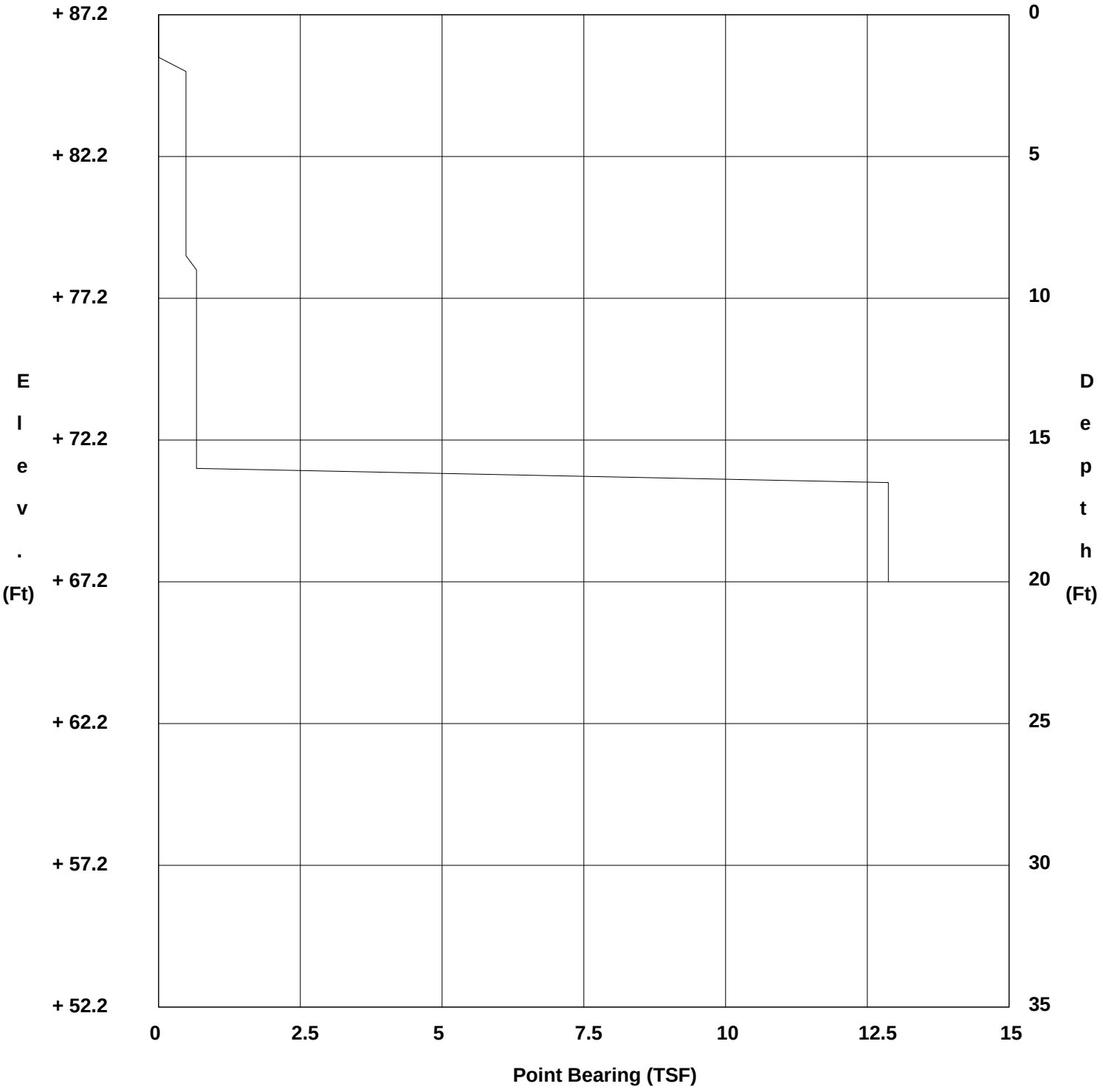
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-17	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	36+77.91	Grnd. Elev.	87.25 ft
		Offset	13.40	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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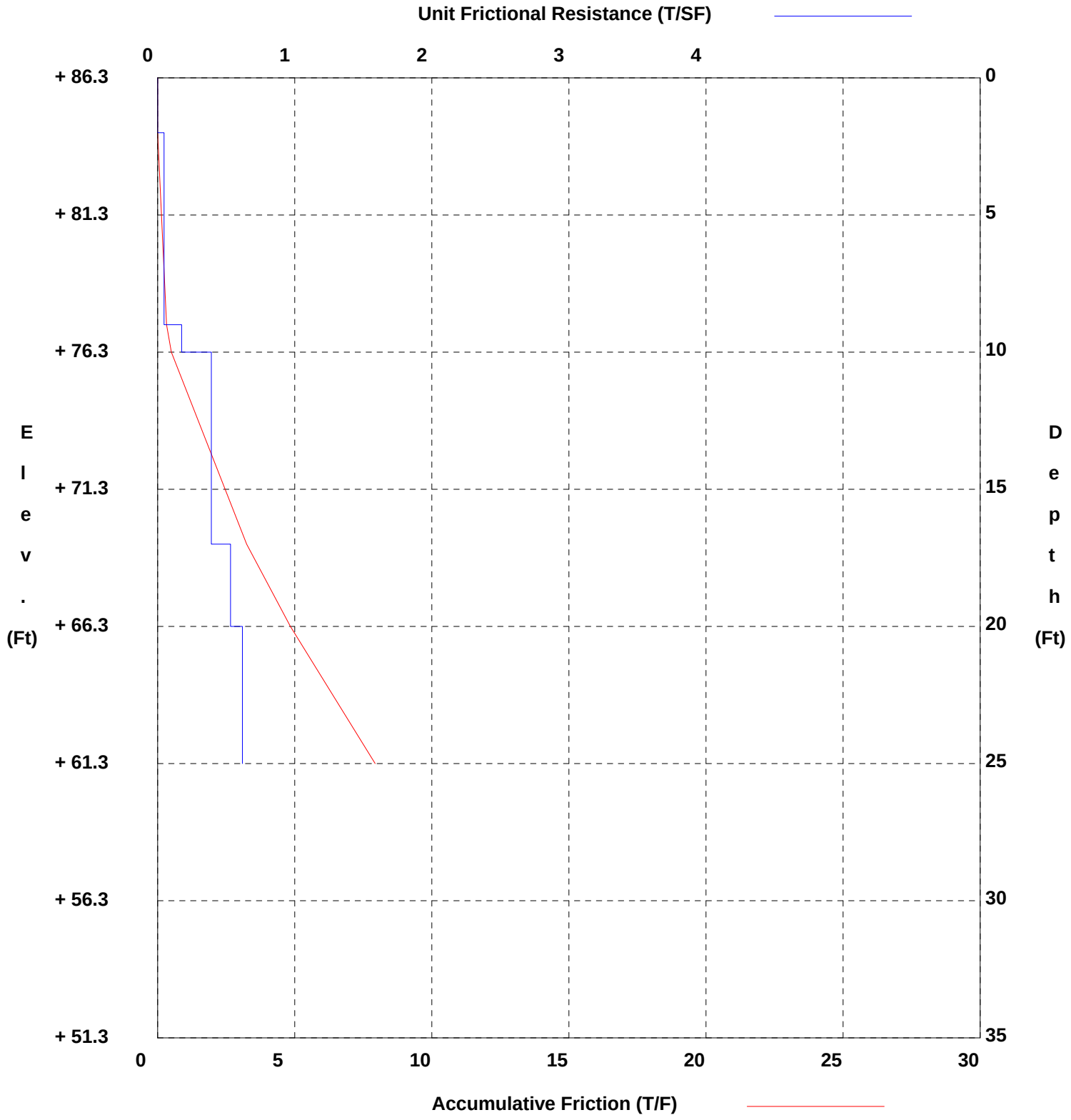
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-18	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	31+33.97	Grnd. Elev.	86.32 ft
		Offset	18.98	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TCP Friction Values Used



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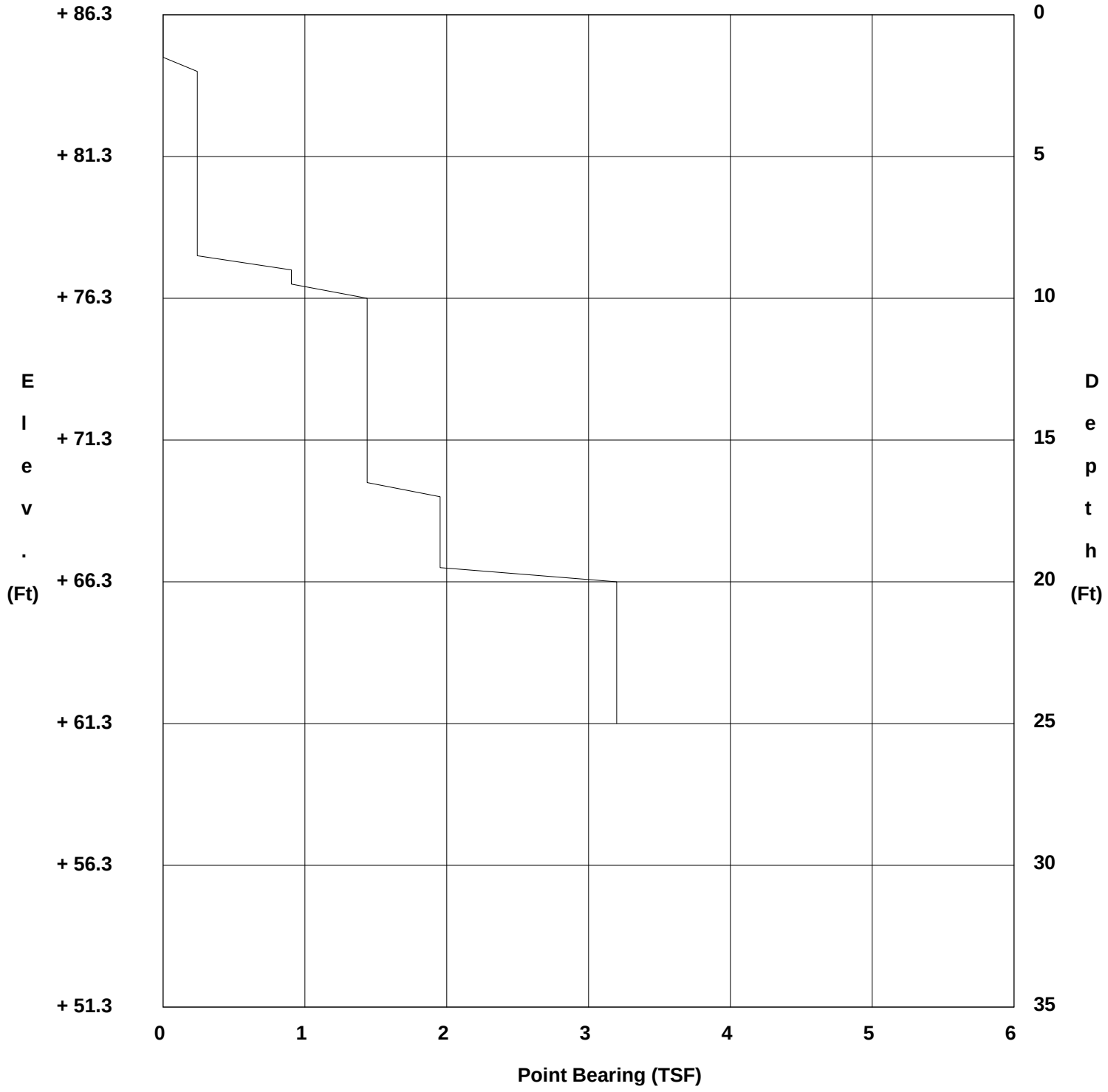
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-18	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/17/2013
Control	No. 0912-70-082	Station	31+33.97	Grnd. Elev.	86.32 ft
		Offset	18.98	GW Elev.	N/A

Diameters Below Tip Checked = 2

TCP Bearing Values Used



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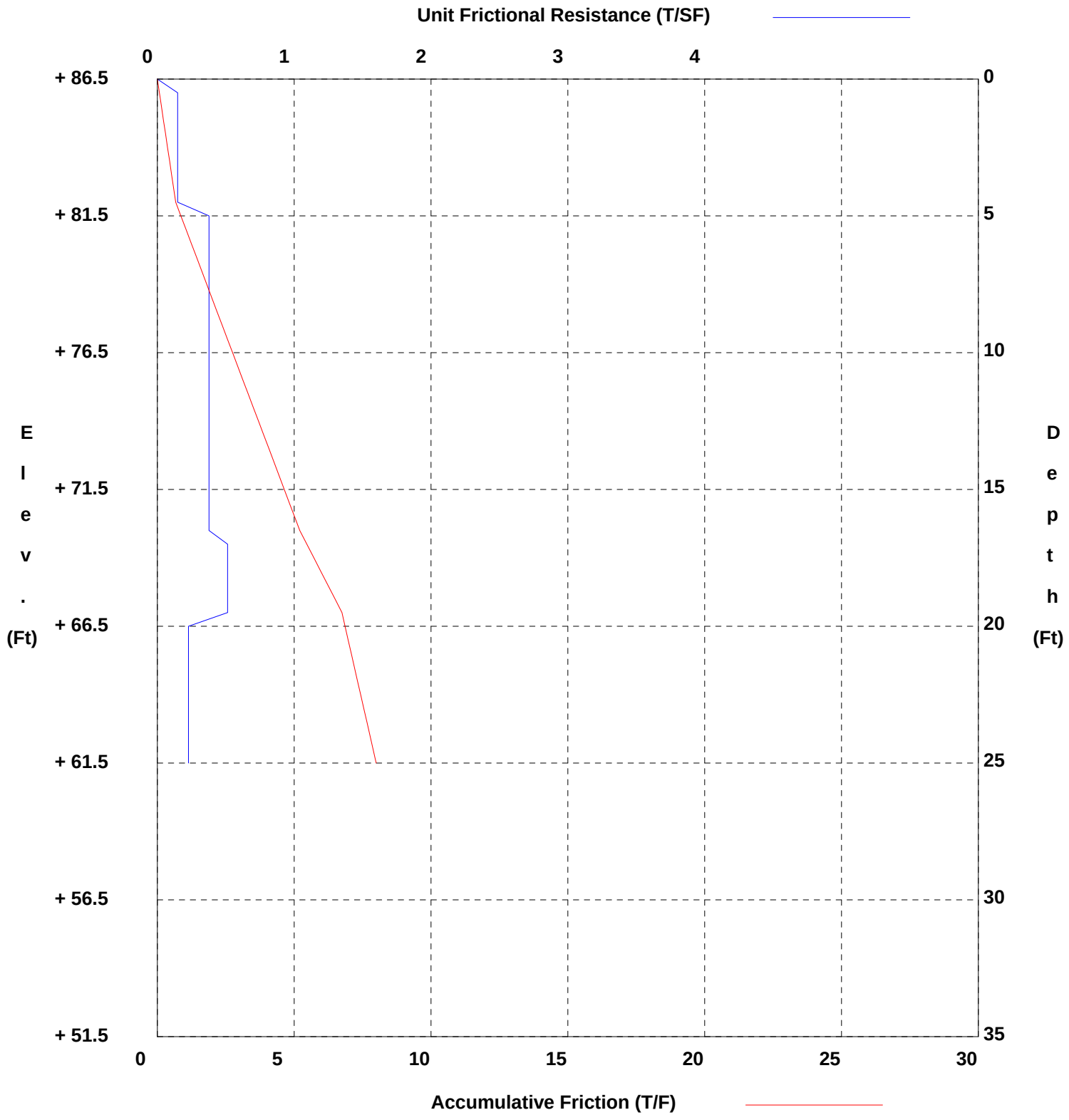
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-19	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	27+43.59	Grnd. Elev.	86.50 ft
		Offset	15.26	GW Elev.	64.50 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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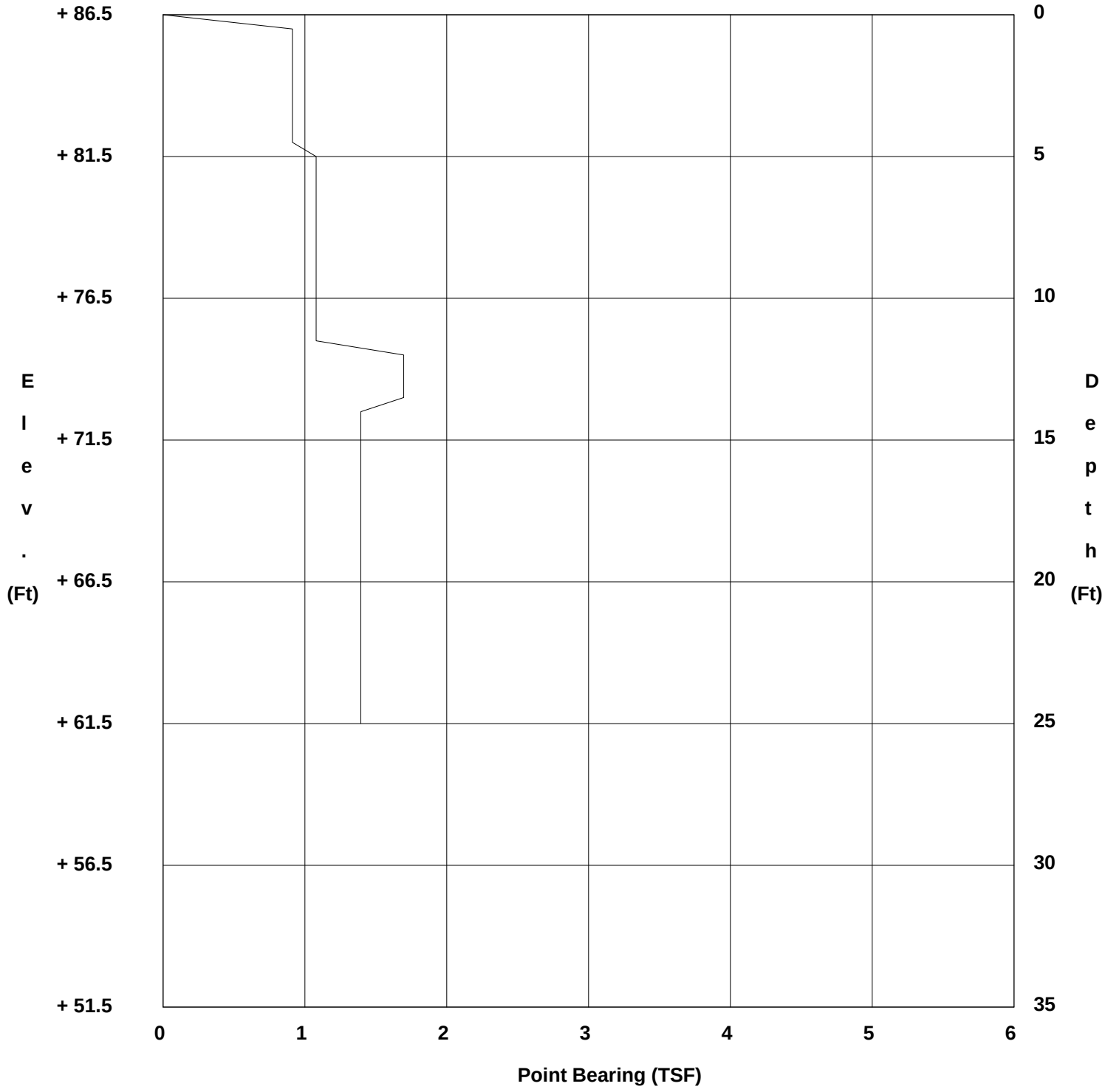
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-19	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	27+43.59	Grnd. Elev.	86.50 ft
		Offset	15.26	GW Elev.	64.50 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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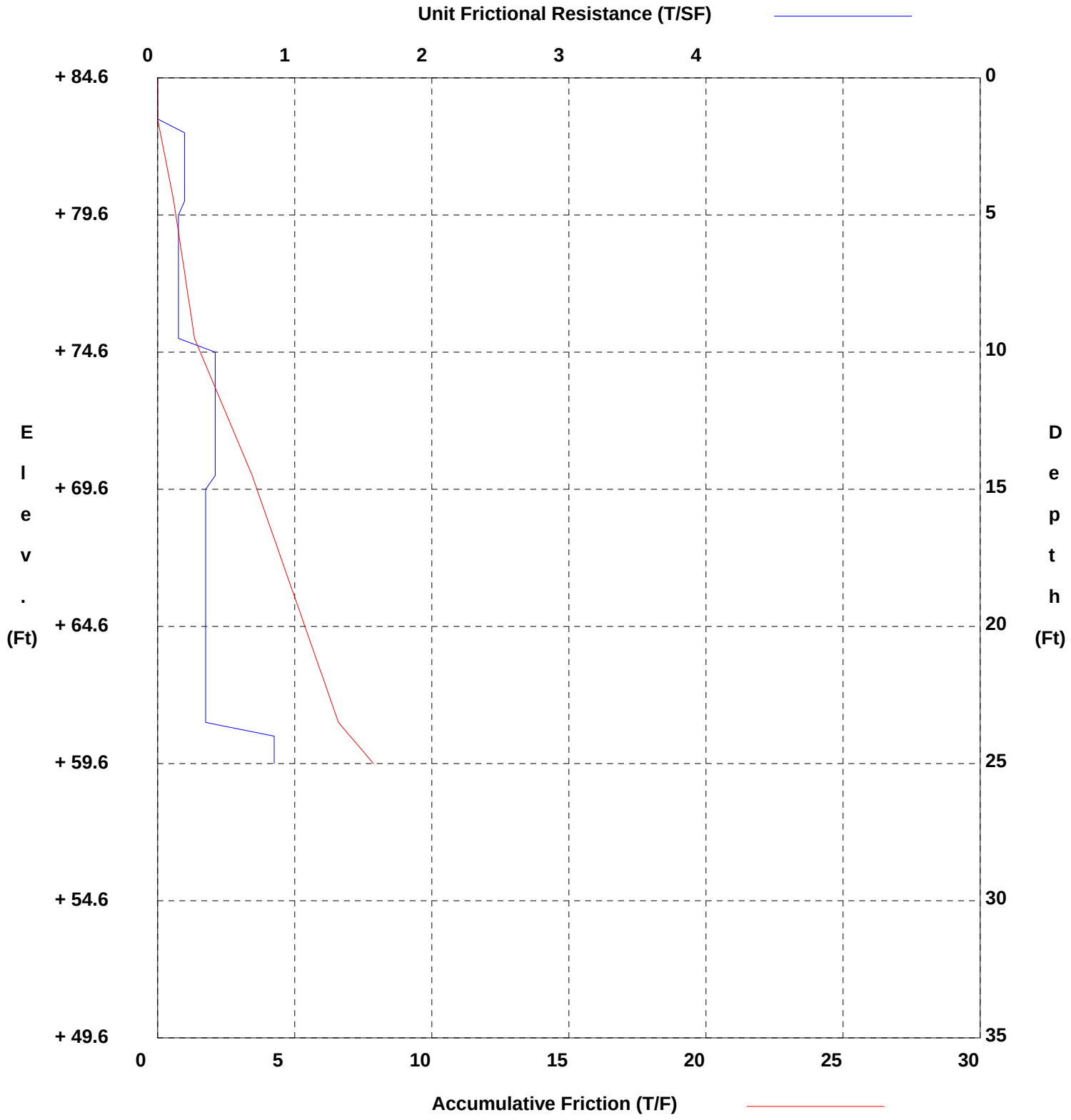
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-20	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	21+09.94	Grnd. Elev.	84.59 ft
		Offset	16.81	GW Elev.	N/A

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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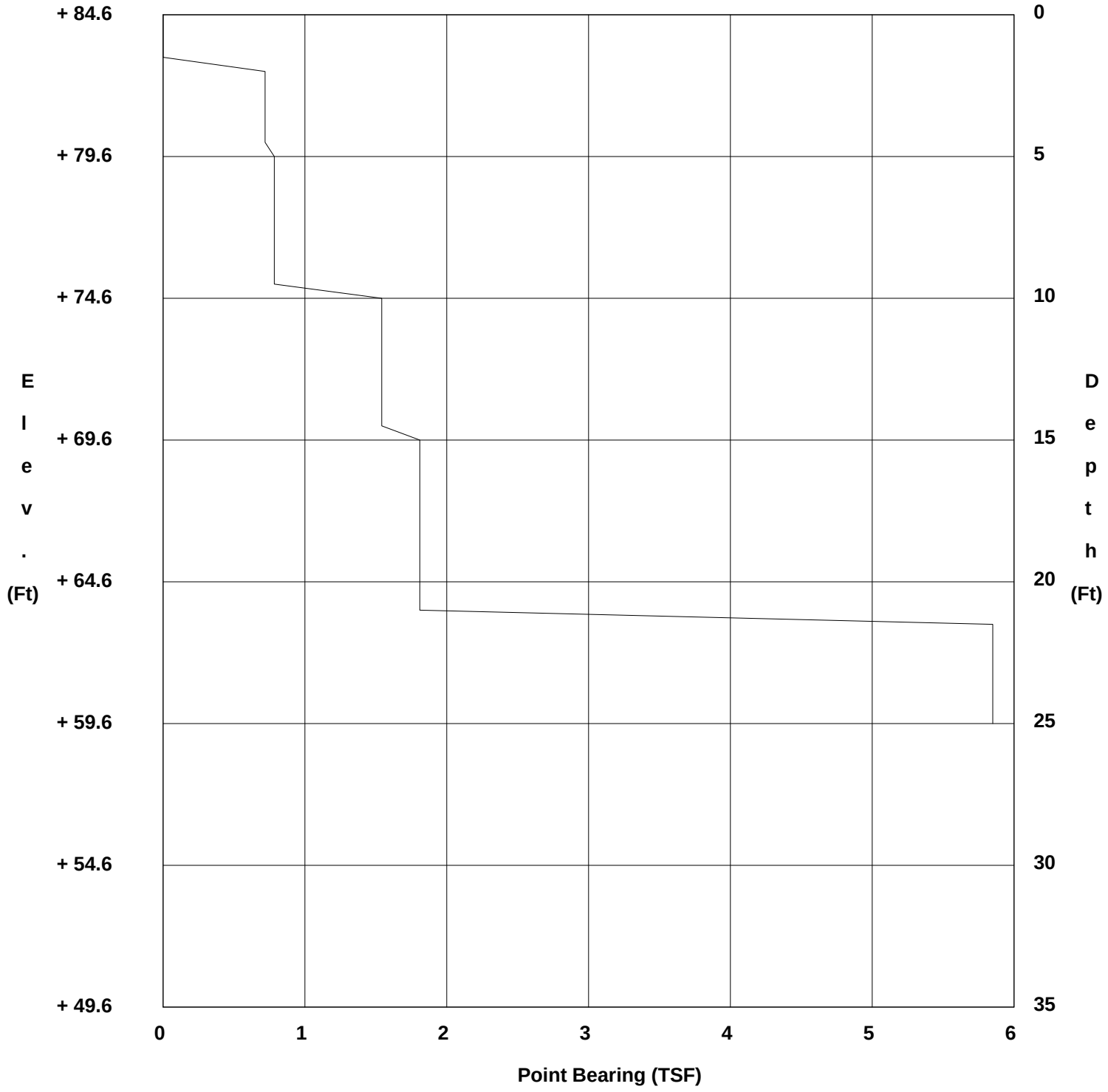
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-20	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	21+09.94	Grnd. Elev.	84.59 ft
		Offset	16.81	GW Elev.	N/A

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

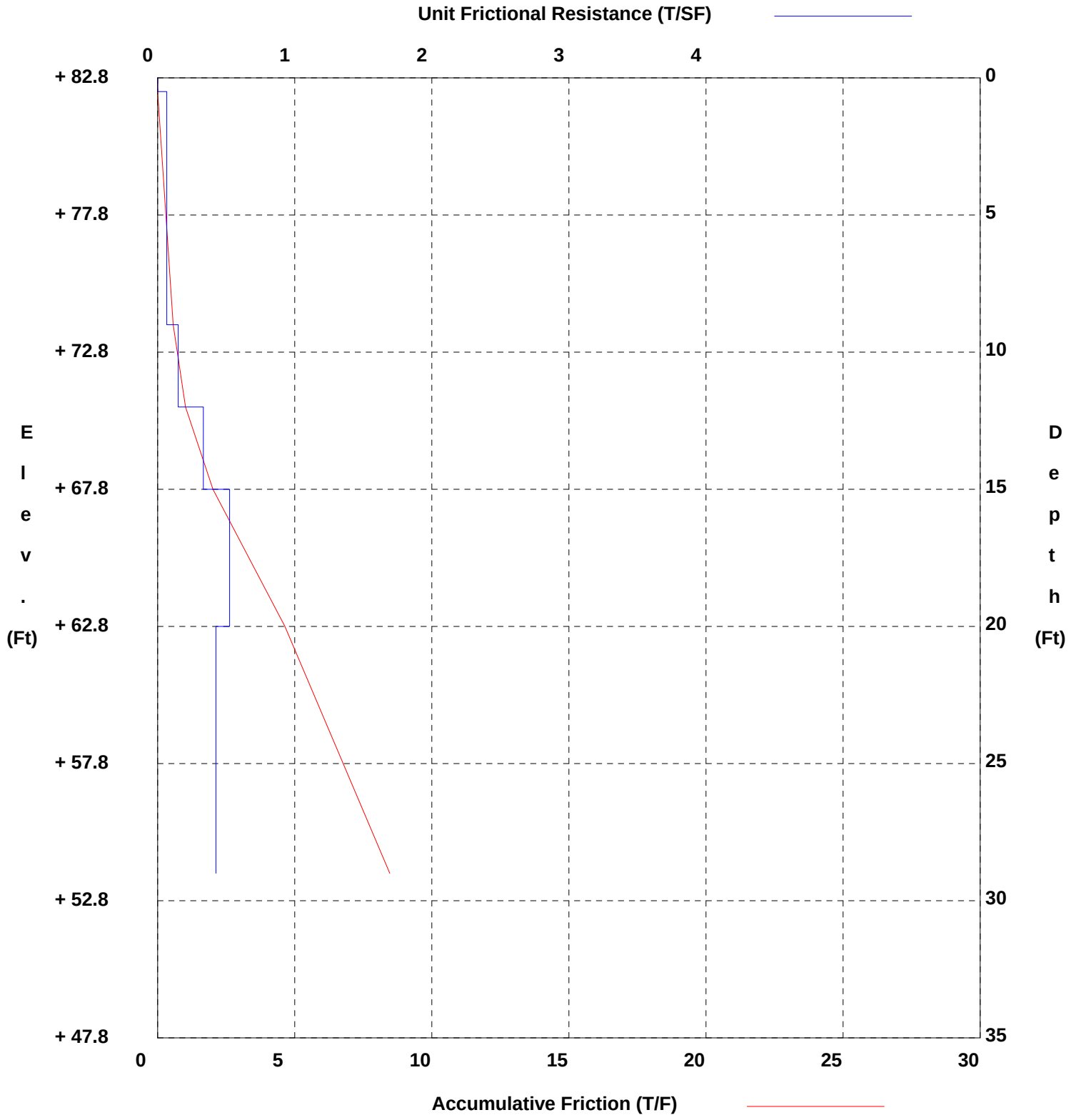
WinCore
Version 3.1

County	Harris	Hole	B-21	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	17+73.54	Grnd. Elev.	82.85 ft
		Offset	6.42	GW Elev.	62.85 ft

Piling Design: No Soil Reduction Factor

TCP Friction Values Used

Skin Friction Limit = 1.4 tsf



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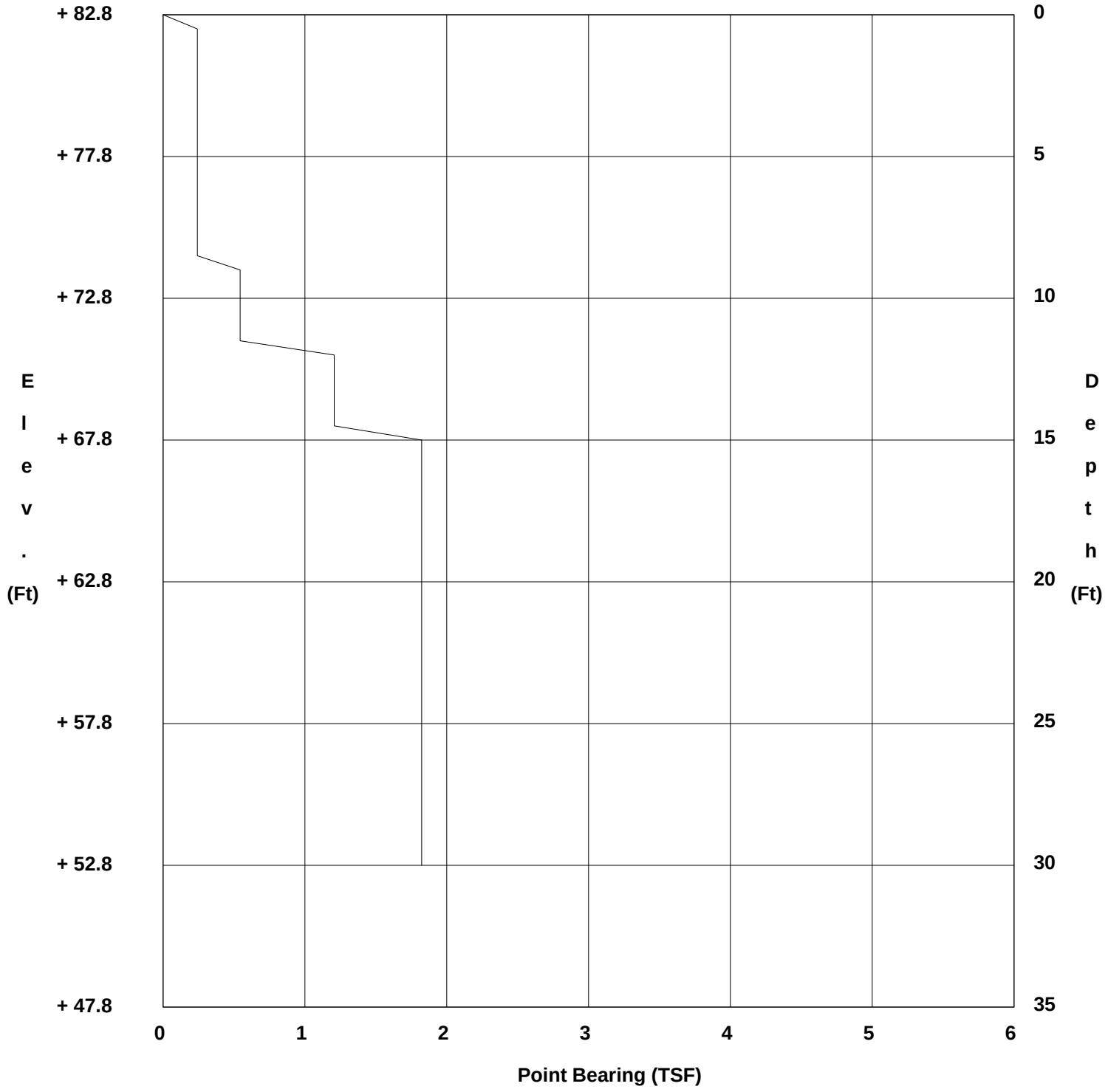
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-21	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/11/2013
Control	No. 0912-70-082	Station	17+73.54	Grnd. Elev.	82.85 ft
		Offset	6.42	GW Elev.	62.85 ft

Diameters Below Tip Checked = 2

TCP Bearing Values Used



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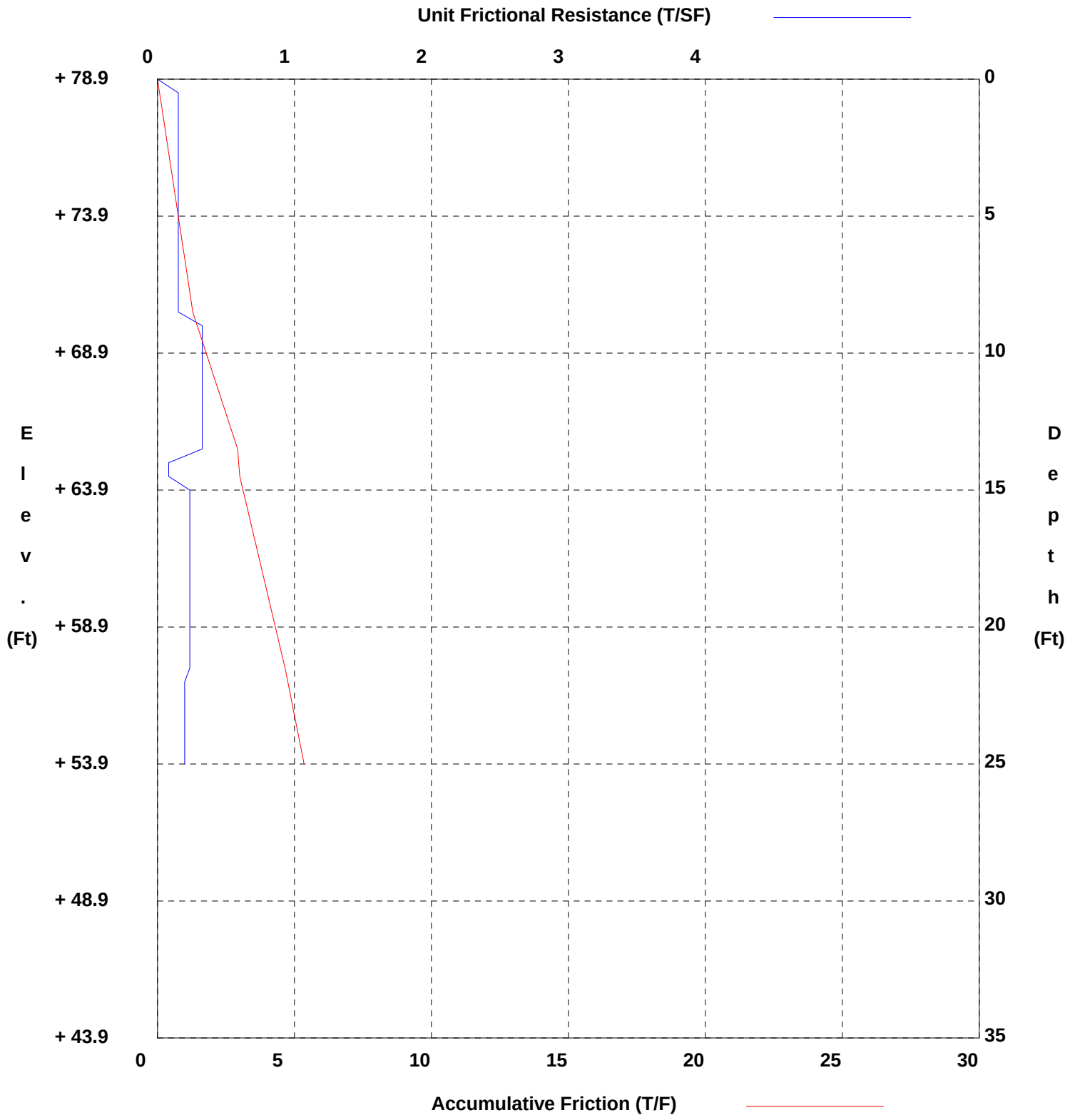
SKIN FRICTION DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-22	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
Control	No. 0912-70-082	Station	12+02.48	Grnd. Elev.	78.89 ft
		Offset	19.44	GW Elev.	63.89 ft

Drilled Shaft Design: Soil Reduction Factor = 0.7

TAT Friction Values Used



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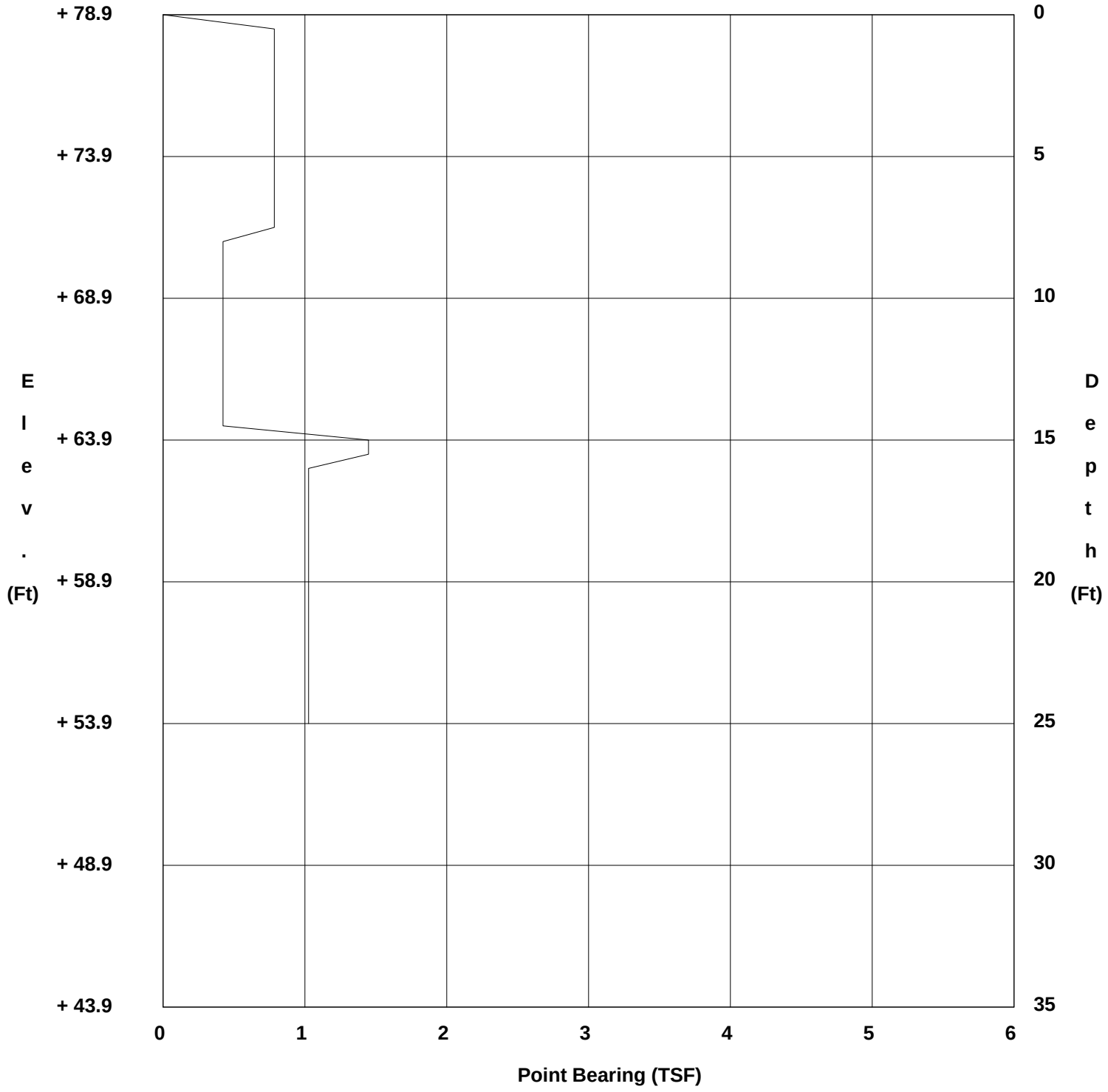
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-22	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
Control	No. 0912-70-082	Station	12+02.48	Grnd. Elev.	78.89 ft
		Offset	19.44	GW Elev.	63.89 ft

Diameters Below Tip Checked = 2

TAT Bearing Values Used



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SKIN FRICTION DESIGN

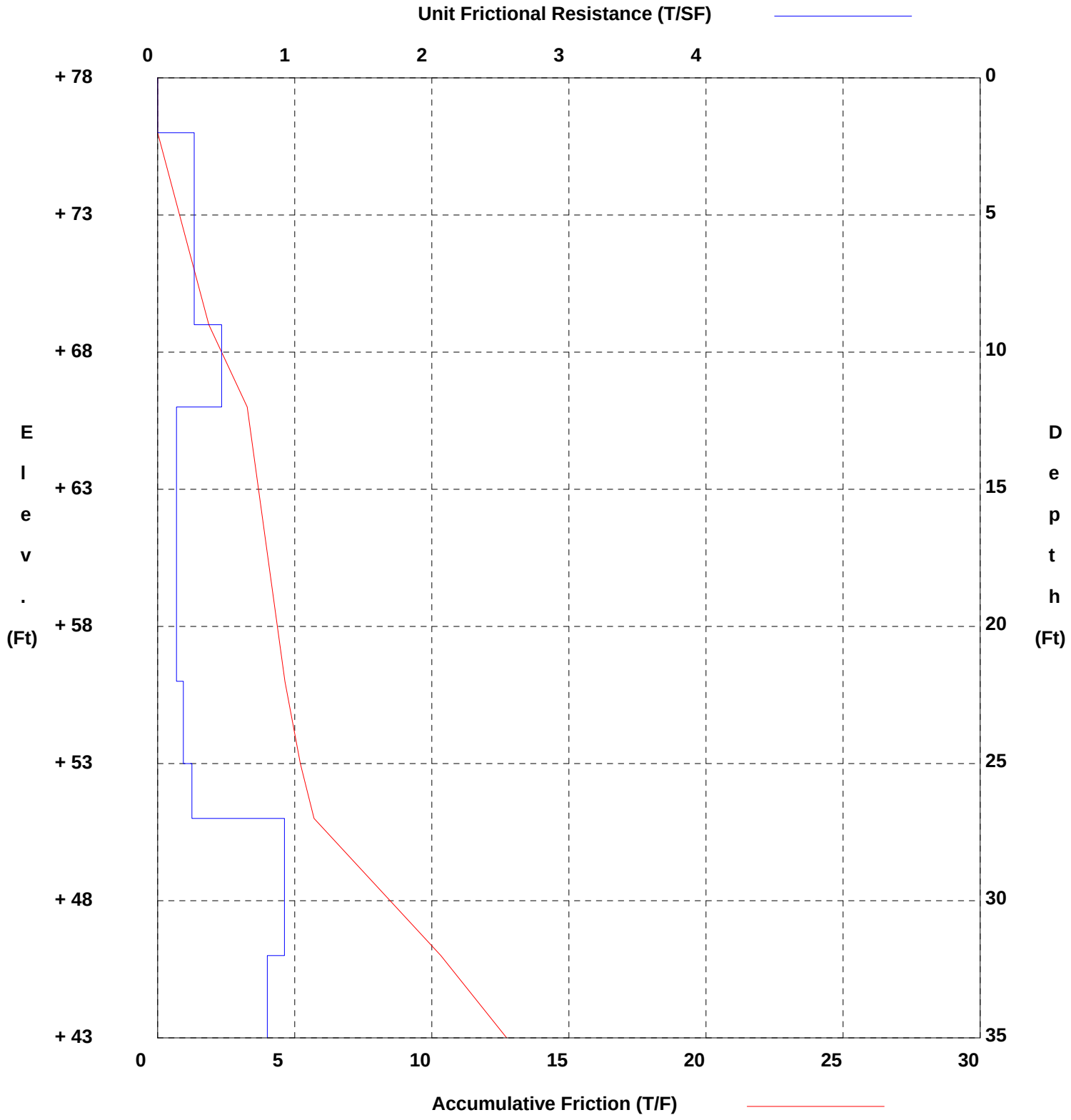
WinCore
Version 3.1

County	Harris	Hole	B-23	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
Control	No. 0912-70-082	Station	6+5.0	Grnd. Elev.	78.00 ft
		Offset		GW Elev.	63.00 ft

Piling Design: No Soil Reduction Factor

TCP Friction Values Used

Skin Friction Limit = 1.4 tsf



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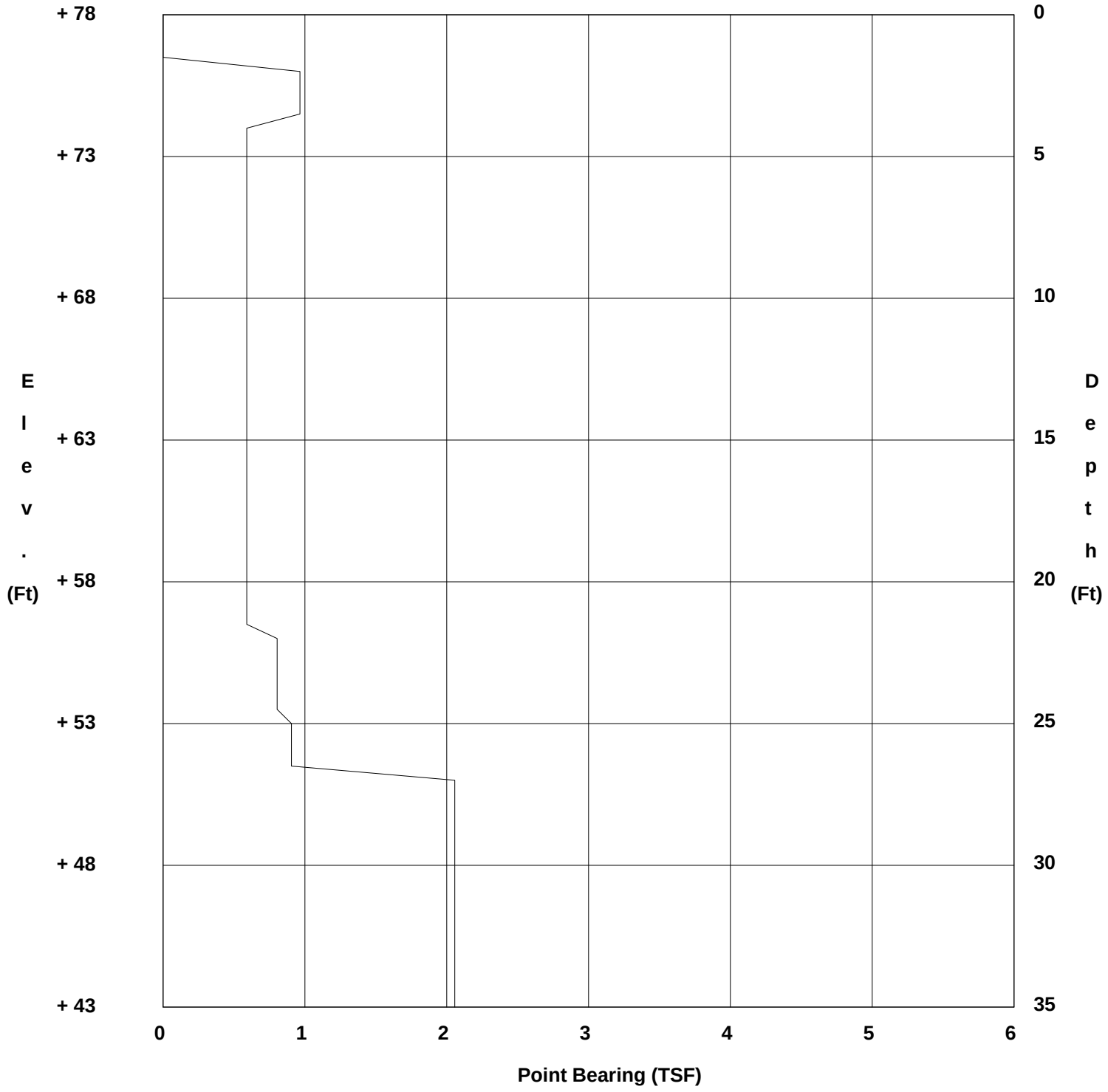
POINT BEARING DESIGN

WinCore
Version 3.1

County	Harris	Hole	B-23	District	Harris
Highway	Memorial Drive	Structure	Pavement and UU	Date	01/10/2013
Control	No. 0912-70-082	Station	6+5.0	Grnd. Elev.	78.00 ft
		Offset		GW Elev.	63.00 ft

Diameters Below Tip Checked = 2

TCP Bearing Values Used



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