Indiana Department of Transportation

Materials and Tests Division

120 South Shortridge Road P. O. Box 19389
Indianapolis, Indiana 46219-0389
Phone: (317) 610-7251 Fax: (317) 356-9351

September 14, 2004

Mr. Gary Mroczka
Chief, Design Division
Room N642-IGCN

Attention: Ms. Annamarie Eubanks

Subject: Des No. 9901670
Project No. STP-088-6 ()
S. R. 32, 1.6 Mile West of U. S. 31
County: Hamilton
District: Greenfield

Gentlemen:

The Geotechnical Investigation for the subject project has been completed and copies of the Geotechnical Report are being forwarded to those listed below.

If you have any questions concerning this matter, please call us.

Very truly yours,

Athar Khan
Chief Geotechnical Engineer

Steve Morris
Geotechnical Engineering Group Leader

KJ
cc: The Corradino Group-Attn: Mr. Jeff Hill
Mr. J. Wright- Attachment
Mr. B. Williams- Attn: Mr. G. Pankow- Attachment (2)
Ms. J. Somers - Attachment
Mr. D. Cohen – Attachment
File

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GEOTECHNICAL EVALUATION

PROJECT NO. STP-088-6 ( )
DES. NO. 9901670
SR 32 IMPROVEMENTS
SPRING MILL ROAD TO US 31
HAMILTON COUNTY, INDIANA

Prepared for

INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
120 SOUTH SHORTRIDGE ROAD
INDIANAPOLIS, INDIANA 46219

By

EARTH EXPLORATION, INC.
7770 WEST NEW YORK STREET
INDIANAPOLIS, INDIANA 46214-2988

September 9, 2004

EARTH EXPLORATION Inc

SUMMARY OF RECOMMENDATIONS[1]
GEOTECHNICAL EVALUATION
PROJECT NO STP-088-6 ( )
DES. NO. 9901670
SR 32 IMPROVEMENTS
SPRING MILL ROAD TO US 31
HAMILTON COUNTY, INDIANA

Pavement Subgrade and Design Considerations

In general, the subsurface conditions at the boring locations appear to be suitable for support of the proposed pavement sections and drainage structures. However, at several boring locations soft soils and soil with trace to little amounts of organics were encountered at or near the pavement subgrade. Where soft cohesive soils are encountered which will not readily compact, we recommend they be stabilized in accordance with the current edition of ISS Section 203.09. Based on the boring locations, such conditions are anticipated in the vicinity of Borings RB-2, RB-8, RB-9A, RB-11, and RB-13. Soil with organics should not be used within 2 ft of the pavement subgrade. Based upon the test results, the projected traffic volume (33,700 VPD), we recommend using a Type IA subgrade treatment (per ISS 207.04) with a Resilient Modulus of 7,240 psi. For the realignment of Spring Mill Road, we recommend a Type I subgrade treatment (per ISS 207.04) with a Resilient Modulus of 7,240 psi, as well. Due to the presence of a high amount of silt, it is recommended that the subsurface drainage system be wrapped with a filter fabric.

Drainage Structure and Sewer Considerations

Based on the soil conditions encountered at Test Borings TB-1 and TB-2, it is our opinion that the four-sided box culvert at Anna Kendall Drain can be supported on conventional spread foundations. In our opinion, the cohesive subgrade soils are capable of supporting foundations designed for a net allowable bearing pressure of 1,500 lbs/sq ft (psf). Due to the presence of soft/loose soil conditions anticipated in the existing flow line of the ditch, some undercutting will be necessary for adequate support of the foundation. Based on the soundings, about 24 to 30 in. of very soft/loose soils are anticipated to be replaced prior to establishing foundation grade.

In general the conditions encountered at the proposed pipe invert elevations should be adequate for support of the proposed structures. Where soft or otherwise unsuitable soils are encountered at the base of the trench, they should be removed and replaced with compacted granular structural backfill material to achieve a stable base. If this is not feasible due to the depth of the unstable soils, the use of a compacted crushed aggregate may be required to stabilize the base of the trench. In this case, a minimum of 12 in. of the soft soils should be removed prior to stabilization. For support of pipe, we recommend a minimum 6-in. thick bedding layer consisting of granular structural backfill material. Since the alignment of the pipe may be located beneath or adjacent to the roadway, we also recommend that the trenches are backfilled to grade with granular structural backfill material. In our opinion, the structural backfill material should be compacted to 95 percent of maximum dry density obtained in accordance with AASHTO T 99.

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[1] The purpose of this summary is to provide an abbreviated discussion of our recommendations contained in the attached evaluation. In our opinion, the recommendations in this summary are the "most significant" geotechnical issues affecting the proposed construction. For additional discussion and recommendations, our geotechnical report should be consulted and/or Earth Exploration, Inc. should be contacted.

September 9, 2004

EARTH EXPLORATION INC.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690 (FAX) 317-273-2250

Mr. Arthar Kahn, P.E.
Indiana Department of Transportation
Department of Materials and Tests
120 South Shortridge Road
Indianapolis, IN 46219

Re: Geotechnical Evaluation
Project No. STP-088-6 ( )
Des. No. 9901670
SR 32 from Spring Mill Road to US 31
Hamilton County, Indiana
EEI Project No. 1-04-189

Dear Mr. Kahn:

We are pleased to submit our geotechnical evaluation for the above-referenced project. This report presents the results of our subsurface exploratory program and provides geotechnical recommendations for the proposed roadway improvements and drainage structures. As you are aware, project authorization was provided by the Indiana Department of Transportation (INDOT), Division of Materials and Tests, on May 25, 2004, via a notification letter. Our geotechnical services were performed in accordance with the Consultant Agreement for Geotechnical Investigations dated March 18, 2004.

The opinions and recommendations submitted in this report are based, in part, on our interpretation of the subsurface information at the test boring locations as indicated on an attached plan. This report does not reflect variations in subsurface conditions between or beyond these locations. Variations in these conditions should be expected, and fluctuation of the groundwater levels may occur with time. Other important limitations of this report are discussed in Appendix A.

PROJECT DESCRIPTION

We understand that INDOT is planning to make improvements to SR 32 from Spring Mill Road to just west of US 31, in Hamilton County. Based on plans and information provided by INDOT, the project will, in part, include: removal and replacement of the existing pavement with a widened asphaltic concrete section and installation of curb and gutter and new storm sewers along portions of the alignment. The centerline of construction along SR 32 will follow Line "P-R-A" beginning at Station 201+50 and ending at Station 290+67. Similar improvements are also planned for Spring Mill Road at its intersection with SR 32. The centerline of construction along Spring Mill Road will follow Line "PR-S-1-A" beginning

Mr. Arthar Kahn, P.E.
Indiana Department of Transportation

at Station 12+50 and ending at Station 27+50. Considering both roadways, the total project length is about 2 mi. Other intersecting roadways and drives are planned to include minor improvements and realignments, as well, with their intersection of SR 32. Refer to the General Site Map (Drawing No. 1-04-189.A1) and the Test Boring Location Plan (Drawing No. 1-04-189.B2) in Appendix C for the project location and approximate boring locations along the alignment.

An existing 10 ft by 7 ft, four-sided box culvert at Station 261+35 is planned to be lengthened to accommodate the widened pavement section at Anna Kendall Drain. The invert of the culvert is planned to be placed about 11 ft (Elevation 889) below the proposed grade. Storm sewer pipe sizes are planned to range from 12 to 48 in. in diameter and have inverts at depths ranging from 4 to 15 ft beneath the proposed surface. The storm sewers are planned to be of the gravity type and convey effluent to nearby ditches and legal drains. Maximum earth cuts and fills along the centerline are anticipated to be on the order of 3 and 4 ft, respectively. Based on information provided by INDOT, earth slopes are not anticipated to exceed 3 Horizontal (H): 1 Vertical (V). Additionally, the roadway is anticipated to consist of bituminous paving materials supported by a layer of compacted aggregate sub-base (INDOT No. 53) material for the complete pavement reconstruction. From information provided on the plans, the projected (i.e., year 2025) annual average daily traffic (AADT) is estimated to be about 33,700 vehicles per day (VPD) for SR 32. The projected (i.e., year 2025) annual average daily traffic (AADT) for Spring Mill Road is estimated to be about 6760 VPD. Construction is anticipated for some time in 2006.

At this time, additional information is not known. In the event that the nature, design or location of the proposed construction changes, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions are modified or confirmed in writing.

FIELD EXPLORATION AND LABORATORY TESTING

Subsurface conditions for the proposed improvements were explored by performing 17 road borings (designated RB-1 through RB-17) to depths of 7½ to 20 ft below the existing ground surface and two structure borings (designated TB-1 and TB-2) to a depth of 20 ft. Two soundings were also performed (designated S-1 and S-2). The number, location and depths of the test borings and soundings were selected by EEI and were approved by INDOT, Materials and Test Division, Geotechnical Section. Additionally, the borings and soundings were located in the field by EEI personnel referencing identifiable features shown on the previously mentioned plans. Ground surface elevations at the boring locations were interpolated to the nearest 1-ft based on topographic information provided on the plan and profile sheets. The boring locations and elevations should be considered accurate only to the degree implied by the methods used.

Mr. Arthar Kahn, P.E.
Indiana Department of Transportation

Exploratory field activities were performed by EEI on June 28 and 29, 2004, and on August 3, 2004. In general, exploratory activities were performed using hollow stem augers to advance the boreholes. Representative samples of the soil conditions using Standard Penetration Test (SPT) procedures (AASHTO T 206) were obtained at predetermined intervals. After obtaining final groundwater observations, each borehole was backfilled with auger cuttings and a bentonite chip plug and, where applicable, a concrete patch, was placed at the surface. (i.e., in accordance with the "Aquifer Protection Guidelines" [revised October 30, 1996] developed by INDOT). Select borings performed off the pavement but within the right-of-way in ditches and private yards were left open for periods of 24 to 48 hr to obtain water level readings. Additional details of the drilling and sampling procedures are provided in Appendix B.

Following the field activities, the soil samples were visually classified by an EEI engineering technician and later reviewed by an EEI geotechnical engineer. After visually classifying the soils, representative samples were selected and submitted for index property testing. These tests included: natural moisture content (AASHTO T 265); grain size analysis (AASHTO T 88); Atterberg limits (AASHTO T 89 and T 90); loss-on-ignition (organic content; AASHTO T 267); soil pH; unit density; and numerous hand penetrometer readings. Other tests included moisture-density relations (AASHTO T 99), California Bearing Ratio (CBR) (AASHTO T 193), and resilient modulus (AASHTO T 307). The results of these tests as well as water level observations are provided on the boring logs in Appendix C and/or respective summary sheets in Appendix D. For your information, soil descriptions on the boring logs are in general accordance with the AASHTO system [AASHTO designation, e.g., A-7-6(24)] and the INDOT Standard Specifications (ISS[2]) (textural classification, e.g., loam). The final boring logs represent our interpretation of the individual samples and field logs and results of the laboratory tests. The stratification lines on the boring logs represent the approximate boundary between soil types; although, the transition may actually be gradual.

SITE CONDITIONS

Surface Conditions

Based on our observations, the existing two-lane road is paved with asphaltic concrete, and there are minimal to nonexistent shoulders. Where present, the shoulders are generally level with the road or slope gently towards drainage ditches or adjacent properties. Based on our observations, existing drainage ditches along the alignment are generally shallow and close to the edge of the road, and many are part of maintained lawns fronting

[2] References the Indiana Department of Transportation (INDOT) Standard Specifications, 1999 Edition.

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residences. In general, the topography of the ground surface along the length of the project is relatively level to gently rolling terrain with ground surface elevations ranging from about Elevation 934 near Station 206+50 to Elevation 896 near Station 271+00

Soil Conditions

Based on the information gathered during our field activities, the subsurface profile at the roadway borings generally consisted of cohesive-type soils from beneath the surficial conditions to the maximum depth explored. The surficial conditions encountered at the boring locations consisted of asphaltic concrete ranging from about 3 to 12 in. in thickness or topsoil ranging from about 2 to 3 in. in thickness. At some locations, subbase was observed and ranged from about 5 to 7 in. in thickness. Beneath the surficial conditions, the profile consisted of clay, silty clay loam, clay loam, or sandy loam to depths ranging from 1½ to 8 ft. The soil beneath the surficial conditions was noted as fill or possible fill at many boring locations to depths of 3 ft or less. In even fewer occurrences, sand or sand and gravel fill was observed beneath the surficial conditions. Loam was observed at depths ranging from 1½ to 8 ft and extended to the maximum depth explored. Naturally-occurring seams or layers of sand or sandy loam were noted within the loam stratum at Borings RB-7, RB-8, and RB-16.

The sand fill at Borings TB-1 and TB-2 extended to depths ranging from 2 to 6 ft beneath the surface and was underlain by silty clay loam. The silty clay loam extended to a depth of about 16 ft at Boring TB-2 and to the maximum depth explored (i.e., 20 ft) at Boring TB-1. At Boring TB-2, the silty clay loam was underlain by gravelly sand that extended to the maximum depth explored.

From our observations, the consistency of the cohesive-type soils observed beneath the surficial conditions ranged from very soft to medium stiff with N-values ranging from 1 to 10 blows/ft (bpf), based on N-value criteria established by INDOT. Hand penetrometer readings generally ranged from ¼ to over 3½ tons/sq ft (tsf). Moisture contents were typically on the order of 16 to 32 percent. The results of unconfined compression tests performed on soil samples from a depth of about 12½ ft at Borings TB-1 and TB-2 indicate undrained shear strengths of 2.4 and 1.2 tsf, respectively. The consistency of the underlying loam ranged from soft to very stiff with N-values ranging from 4 to 22 bpf, based on N-value criteria established by INDOT. Hand penetrometer readings generally ranged from ½ to over 4½ tons/sq ft (tsf) with the majority of readings between 2 and 4½ tsf. Moisture contents were typically on the order of 10 to 16 percent. For your information, the moisture content is directly related to the shear strength characteristics of cohesive soils, i.e., as the moisture content increases the strength decreases. Two Loss-on-ignition (LOI) tests were performed on soils with traces of organic matter. The results of the LOI tests indicate organic contents ranging from 6 to 9 percent. Where described as such, the

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relative density of the sandy loam was very loose to medium dense with N-values ranging from 4 to 22 bpf.

Based on a comparison of the moisture contents and Atterberg limits, the cohesive soils beneath the surficial conditions were of moderate plasticity with plasticity indices in the range of 12 to 30. The underlying loam was observed to have low plasticity and over-consolidated based on a plastic index of 7. Furthermore, several samples were also tested for pH level, (i.e., hydrogen-ion content), and these results indicated that the pH levels ranged from 6.2 to 7.1. These results are provided in Appendix C on the logs or on the grain size distribution curves in Appendix D.

Groundwater Conditions

Groundwater level observations made up to 48 hrs after completion of the exploratory activities are shown at the bottom of the logs. The table below presents a synopsis of the groundwater levels observed at the borehole locations. For specific groundwater information at the boring locations, refer to the boring logs in Appendix C.

TABLE 1. GROUNDWATER LEVEL OBSERVATIONS

Boring No.	Station	Ground Surface Elevation	Depth (Elevation) *		
			During	At Completion	24- to 48-Hour
RB-3	216+50	924	6 (918)	5 (919)	2 (922)
RB-4	223+00	919	6 (913)	--	4 (914)
RB-6	236+00	913	6 (907)	--	--
RB-7	242+00	917	6 (911)	NW	4.5
RB-8	250+00	903	6 (897)	6 (897)	1 (902)
RB-9	256+00	898	6 (892)	NW	--
RB-10	265+00	902	8 (896)	--	NW
RB-11	270+70	897	NW	NW	8 (891)
RB-13	284+00	899	NW	NW	5 (894)
RB-15	17+50	924	NW	6 (918)	3 (921)
RB-16	22+00	927	9 (918)	4 (923)	2 (925)
RB-17	25+00	930	NW	NW	5 (925)

* Depth units are in ft.

In our opinion, these elevations likely represent a condition where water is trapped in sand seams or perched above the loam stratum, and the actual "piezometric" groundwater level is deeper than the maximum depth explored. Information obtained from the Hamilton County Soil Survey suggests that the soil conditions in the area are prone to perched groundwater levels. It should be recognized that groundwater levels either static or perched can fluctuate due to changes in precipitation, infiltration, surface run-off, and other hydrogeological factors.

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DISCUSSION AND RECOMMENDATIONS

In general, the subsurface conditions at the boring locations appear to be suitable for support of the proposed pavement sections and drainage structures. However, at several boring locations soft cohesive soils and soils with trace amounts of organic matter are anticipated to be encountered at or near the foundation grades for the pavement and invert of the culvert at Anna Kendall Drain. Additional discussion and recommendations regarding these issues are presented in the paragraphs below.

Cut and Fill Considerations

Based on the project plans, the maximum earth cuts are anticipated to be about 3 ft, and the maximum fill placement is anticipated to be about 4 ft. Based on the information obtained at the boring locations, we anticipate that standard embankment construction practices outlined in the ISS should provide an adequate subgrade for embankment construction. Where soft cohesive soils are encountered which will not readily compact, we recommend they be stabilized in accordance with the current edition of ISS Section 203.09. Based on the boring locations, such conditions are anticipated in the vicinity of Borings RB-2, RB-8, RB-9A, RB-11, and RB-13. Other areas of soft subgrade conditions not mentioned previously should be anticipated. Where encountered, the soft subgrade conditions should be stabilized. Stabilization techniques may include undercut and replacement with a No. 2 stone or a combination of high tensile modulus geogrid and stone. Chemical treatment of the subgrade soil could be considered if widespread subgrade failure is observed during the proof-roll observation. The extent and treatment method may be dependent on the time of year that construction takes place.

Based on observations of the soil conditions and the above discussion, it is our opinion that the stability of the proposed 3H:1V side slopes are generally not a concern, provided adequate subgrade preparation and compaction of the fill soils is achieved. In general, the majority of natural soils encountered on this project are suitable for reuse as embankment fill. If cut and fill quantities are not anticipated to balance and imported fill material is required, then EEI should be retained to evaluate the characteristics of the soil source for use as earth fill.

Pavement Design Considerations

Based on information provided on the plans, the projected (i.e., year 2025) annual average daily traffic (AADT) is estimated to be about 33,700 vehicles per day (VPD) for SR 32 and 6,760 VPD for Spring Mill Road. Based on the proposed pavement grades and the profile of the existing ground surface, the roadway subgrade is anticipated to consist primarily of

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clay, silty clay loam, clay loam, loam, sandy loam or engineered fill similar to those cohesive soils observed herein. The results of the California Bearing Ratio (CBR) test are presented in Table 4.

TABLE 4. CBR TEST RESULTS

Boring No.	Soil Type	CBR Value at		
		93% of MDD	95% of MDD	97% of MDD
RB-8A	Clay, A-7-6(24)	2.2	3.0	4.1
MMD – Maximum Dry Density				

Based upon the test results, the projected traffic volume (33,700 VPD), we recommend using a Type IA subgrade treatment (per ISS 207.04) with a Resilient Modulus of 7,240 psi. For the realignment of Spring Mill Road, we recommend a Type I subgrade treatment (per ISS 207.04) with a Resilient Modulus of 7,240 psi, as well.

Water infiltration into cohesive subgrade soils can reduce the life of a pavement section. Since the majority of the subgrade soils have a relatively low permeability, we would anticipate that any water which may infiltrate the subgrade would affect the long-term performance of the pavement. Under these conditions, we recommend that consideration be given to the use of subsurface pavement drains with screened outlets in the design of the pavement system. Due to the presence of a high amount of silt, it is recommended that the subsurface drainage system be wrapped with a filter fabric.

Drainage Structure Considerations

A drainage structure and sewers are proposed along portions of the alignment. Based on the soil conditions encountered at Test Borings TB-1 and TB-2, it is our opinion that the four-sided box culvert can be supported on conventional spread foundations. Excavations for the foundation established near an Elevation of 889 (i.e., anticipated to be at a depth of approximately 11 to 12 ft below the proposed roadway surface) are anticipated to expose soft to medium stiff silty clay loam. In our opinion, the cohesive subgrade soils are capable of supporting foundations designed for a net allowable bearing pressure of 1,500 lbs/sq ft (psf). Due to the presence of soft/loose soil conditions anticipated in the existing flow line of the ditch, some undercutting will be necessary for adequate support of the foundation. Based on the soundings, about 24 to 30 in. of very soft/loose soils are anticipated to be removed prior to establishing foundation grade. Once the soft/loose soil conditions are removed, we recommend that the bearing surfaces be observed by an EEI representative to verify the subsurface conditions. Where necessary, we recommend that the foundation be re-established on imported granular fill consisting of a No. 53 compacted aggregate.

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Indiana Department of Transportation

Furthermore, we recommend that the aggregate be compacted to 95 percent of maximum dry density obtained in accordance with AASHTO T 99 and INDOT Specifications. Based on these recommendations, total and differential settlements are not anticipated to exceed ½ in., respectively.

Storm Sewer Considerations

The proposed sewers are planned to be established at depths of 4 to 15 ft below the proposed ground surface. In general, the placement of pipes within the soil profile does not increase the load on the underlying soil. However, it is important to have proper support to prevent the pipe from becoming overstressed in bending or compression. In general the conditions encountered at the proposed pipe invert elevations should be adequate for support of the proposed structures. Where soft soils are encountered at the base of the trenches (as previously mentioned), it is our opinion they should be removed and replaced with compacted granular structural fill material to achieve a stable base. If this is not feasible due to the depth of the unstable materials, the use of a woven geotextile and/or compacted crushed aggregate may be required to stabilize the trench. In this case, a minimum of 24-in. of the soft soils should be removed prior to stabilization.

For smaller pipe structures (i.e., less than 1.2 m in diameter or width), we recommend a minimum 6-in. thick bedding layer, consisting of granular structural backfill material be provided for pipe support. Since the pipe trenches will be primarily located beneath the proposed roadway, the trenches should be backfilled to grade with granular structural backfill material. In our opinion, the granular structural backfill material should be compacted to 95 percent of maximum dry density obtained in accordance with AASHTO T 99 and INDOT Specifications. Hand- or remote-guided vibratory compactors are recommended for compacting the bedding material and material on either side of the pipe. The first several lifts of backfill over the pipe should also be compacted with small vibratory compactors to assure proper compaction is achieved and to prevent damage to the pipe from heavier, high-energy compactors.

In addition to downward forces, the effects of buoyancy should also be considered for the subsurface structures. In our opinion and based on information obtained at the boring locations, the structures should generally be designed such that the water level could rise to levels of 1 to 4 ft beneath the surface particularly if the structure is backfilled with granular soils. The weight of the structure in addition to the weight of the soil above the "lip" of the base of the structure should be considered to provide the necessary resistance to the uplift forces. We recommend that a unit weight of the soil of 125 and 63 lb/cu ft (pcf) be utilized for this purpose above and below the water table, respectively.

Mr. Arthar Kahn, P.E.
Indiana Department of Transportation

CONSTRUCTION CONSIDERATIONS

Subgrade Preparation

Prior to placing any fill or pavement components, we recommend that all topsoil, wet or soft/loose soils, and existing pavement components and utilities (where necessary) be removed from within the construction limits. In areas to receive new fill and pavement components, proof-rolling of the exposed subgrade should be performed in accordance with the ISS, Section 203.26. Where soft cohesive soils are encountered which will not readily compact, we recommend they be addressed as mentioned previously.

Engineered Fill Placement and Compaction

We recommend that engineered fill used to raise grades or backfill of undercut areas be placed in loose lift thicknesses not exceeding 8-in. and be compacted to 95 percent of the maximum density obtained in accordance with AASHTO T 99 as specified in the ISS. In our opinion, the soils as observed at the test boring locations are generally suitable for reuse as engineered fill except over sewer pipe beneath pavement sections as discussed previously. In addition, at several boring locations trace amounts of organic matter were typically observed within the upper 2 to 3 ft of the profile. Based on the moisture contents of these soils, it is our opinion that these soils can be reused as fill in landscaped areas. The decision to reuse these soils should be made in the field at the time of construction based on visual observation and additional laboratory testing. If concentrated areas of organic matter are encountered during grading operations, they should be completely removed and replaced with inorganic fill soils.

From our observations, the natural moisture content of the cohesive soils will typically exceed the optimum. Therefore, it is likely that some drying (by aeration) of the fill will be required before placement in order to satisfy the ISS if these soils are utilized. Aeration of the soils will also be required where encountered within the range of subgrade treatment. Under some climatic conditions, such as cold or rainy weather, or in confined areas, adequate moisture conditioning may be difficult to achieve, and in this case, granular fill could be required to expedite construction activities.

Excavations

Excavations made for the project will require: 1) cut slopes adequate to prevent cave-ins/subsidence; or 2) braced excavations for safe construction operation. All excavations should conform with Occupational Safety and Health Administration (OSHA) requirements (i.e., 29 CFR Part 1926). The Contractor is solely responsible for constructing and maintaining stable excavations. Additionally, soil should not be stockpiled immediately

adjacent to the top of the excavation. In our opinion, the cohesive soil encountered on this project may be classified as Type A or B depending on their strength characteristics and the granular soils may be classified as Type C (according to OSHA), and should be treated accordingly.

Groundwater Control

Based on the information obtained at the boring locations and published in the Soil Survey of Hamilton County and depending on the time of the year that construction takes place, excavations will likely encounter groundwater, particularly for the box culvert at Anna Kendall Drain. Excavations are anticipated to expose cohesive soils, and groundwater infiltration into the excavation is anticipated to be slow. However, where granular seams and layers are encountered within the cohesive soils, groundwater may enter the excavation at a faster rate. In most instances, sump pumps should be adequate to remove groundwater from excavations. However, where granular seams and layers are encountered, a more elaborate method of dewatering is anticipated.

CONCLUDING REMARKS

In closing, we recommend that EEI be provided the opportunity to review the final design and project specifications to confirm that earthwork and foundation requirements have been properly interpreted and implemented in the design and specifications. We also recommend that EEI be retained to provide construction observation services during the earthwork and foundation construction phases of the project. This will allow us to verify that the construction proceeds in compliance with the design concepts, specifications and recommendations. It will also allow design changes to be made in the event that subsurface conditions differ from those anticipated.

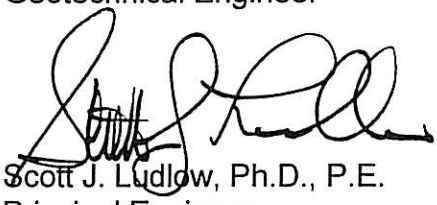
Mr. Arthar Kahn, P.E.
Indiana Department of Transportation

We appreciate the opportunity to provide our services to you on this project. Please contact our office if you have any questions or need further assistance with the project.

Sincerely,

EARTH EXPLORATION, INC.

Michael S. Wigger, P.E.
Geotechnical Engineer



Scott J. Ludlow, Ph.D., P.E.
Principal Engineer

Attachments –

APPENDIX A - Important Information about Your Geotechnical Report
APPENDIX B - Field Methods for Exploring and Sampling Soils and Rock
APPENDIX C - General Site Map (Drawing No. 1-04-189.A1)
Test Boring Location Plan (Drawing No. 1-04-189.B2)
Log of Test Boring - General Notes
Log of Test Boring (19)
Summary of Soundings
APPENDIX D - Summary of Special Laboratory Test Results
Summary of Classification Test Results
Grain Size Distribution Curve (5)
Unconfined Compression Test (2)
Moisture-Density Relation (1)
Summary of CBR Test Results (1)
California Bearing Ratio (1)
Resilient Modulus of Subgrade Soils (performed by others)

APPENDIX A

IMPORTANT INFORMATION ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one—not even you*—should apply the report for any purpose or project except the one originally contemplated.

Read the full report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, *do not rely on a geotechnical engineering report* that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject To Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce such risks, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations", many of these provisions indicate where geotechnical engineers responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Rely on Your Geotechnical Engineer for Additional Assistance

Membership in ASFE exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE

8811 Colesville Road Suite G106 Silver Spring, MD 20910
Telephone: 301-565-2733 Facsimile: 301-589-2017
email: info@asfe.org www.asfe.org

UGER1000.10M

APPENDIX B

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

A. Boring Procedures Between Samples

The boring is extended downward, between samples, by a hollow stem auger (AASHTO* Designation T251-77), a continuous flight auger, driven and washed-out casing, or rotary boring with drilling mud or water.

B. Penetration Test and Split-Barrel Sampling of Soils
(AASHTO* Designation: T206-87)

This method consists of driving a 2-inch outside diameter split-barrel sampler using a 140 pound weight falling freely through a distance of 30 inches. The sampler is first seated 6-inches into the material to be sampled and then driven 12 inches. The number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance or N-Value. The blow counts are reported on the Test Boring Records per 6 inch increment. Recovered samples are first classified as to texture by the driller. Later, in the laboratory the driller's classification is reviewed by a soils engineer who examines each sample.

C. Thin-walled Tube Sampling of Soils
(AASHTO* Designation: T207-87)

This method consists of pushing a 2-inch or 3-inch outside diameter thin wall tube by hydraulic or other means into soils, usually cohesive types. Relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings
(AASHTO* Designation: T203-82)

This method consists of augering a hole and removing representative soil samples from the auger flight or bucket at 5-foot intervals or with each change in the substrata. Relatively disturbed samples are obtained and its use is therefore limited to situations where it is satisfactory to determine approximate subsurface profile.

E. Diamond Core Drilling for Site Investigation
(AASHTO* Designation: T225-83)

This method consists of advancing a hole in bedrock or other hard strata by rotating downward a single tube or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings. Normally, a 3-inch outside diameter by 2-inch inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and laboratory. Cores are stored in partitioned boxes and the length of recovered material is expressed as a percentage of the actual distance penetrated.

* American Association of State Highway and Transportation Officials, Washington D.C.

APPENDIX C

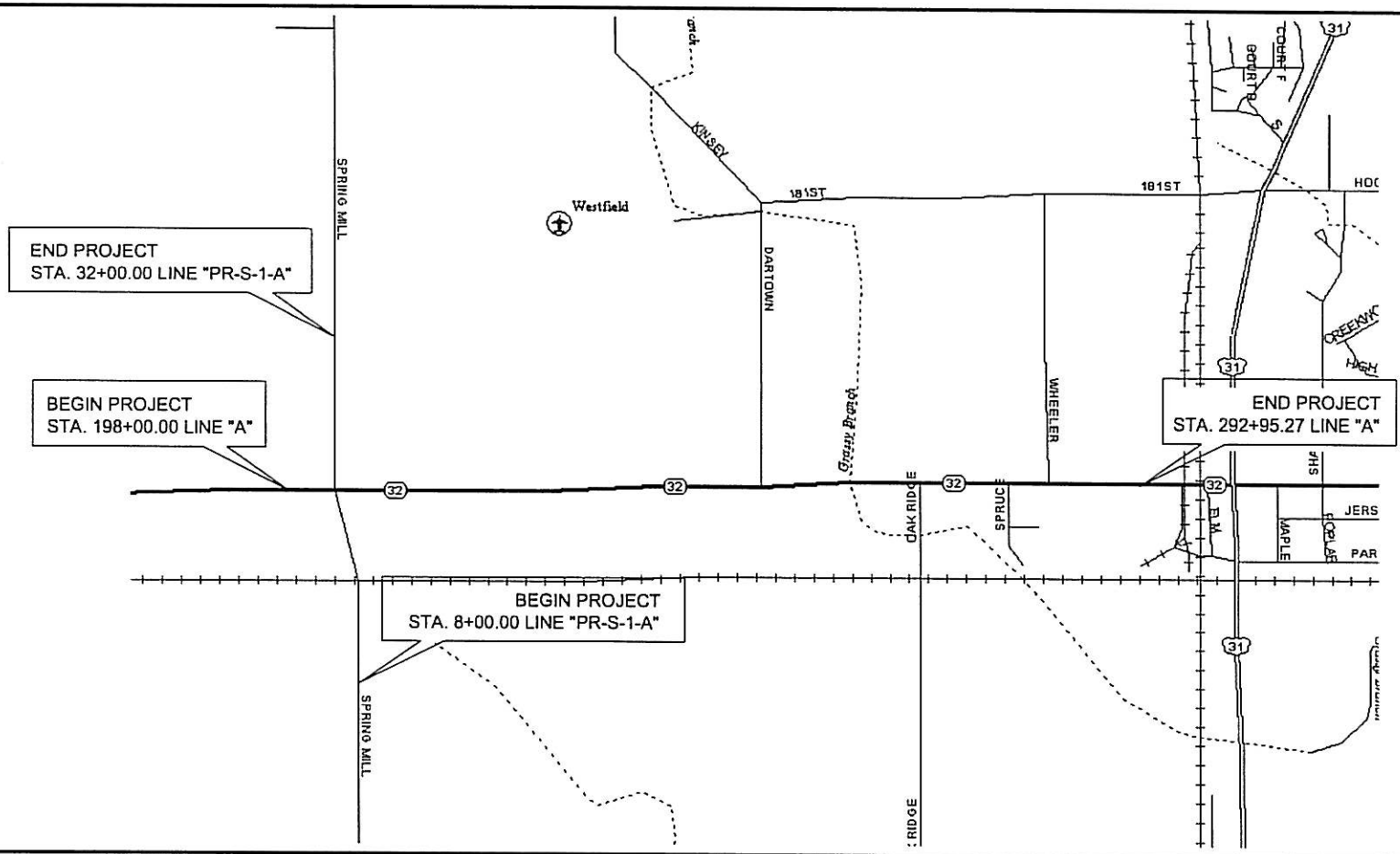
GENERAL SITE MAP
(Drawing No. 1-04-189.A1)

TEST BORING LOCATION PLAN
(Drawing No. 1-04-189.B2)

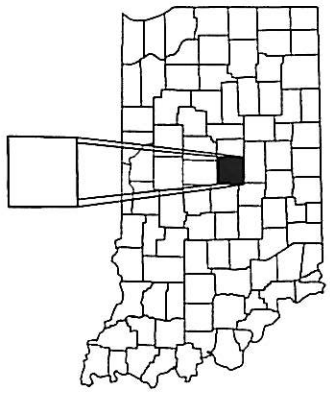
LOG OF TEST BORING - GENERAL NOTES

LOG OF TEST BORING (19)

SUMMARY OF SOUNDINGS



VICINITY MAP
N.T.S.



Hamilton County, Indiana

NOTES

1. Vicinity map generated using commercially-available software by Delorme (Street Atlas USA ver. 3.0/7.0).
2. Base map developed from an electronic file provided by Corradino Group.

LEGEND

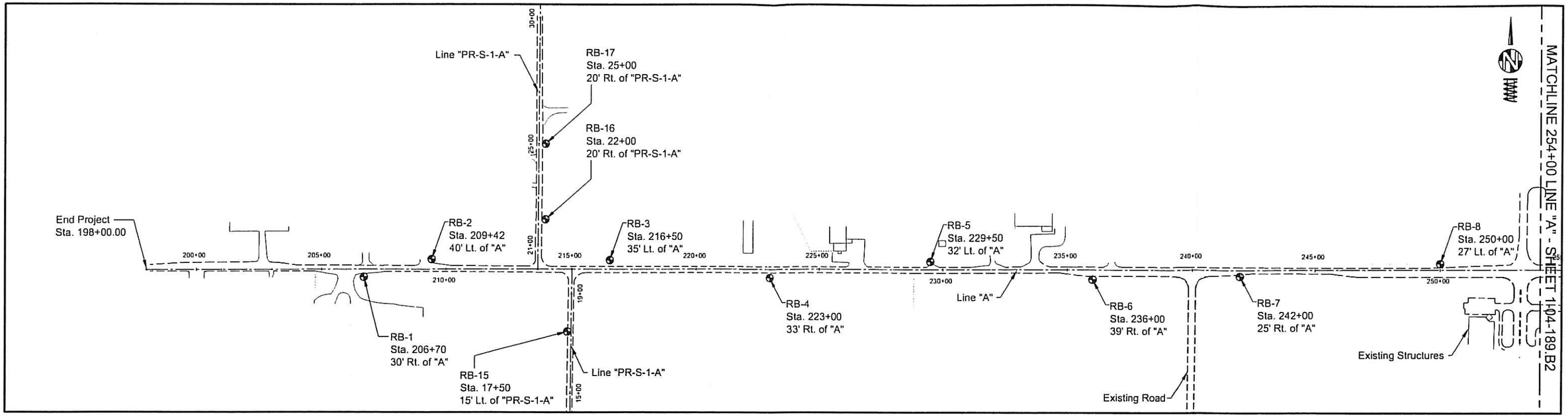
GENERAL SITE MAP

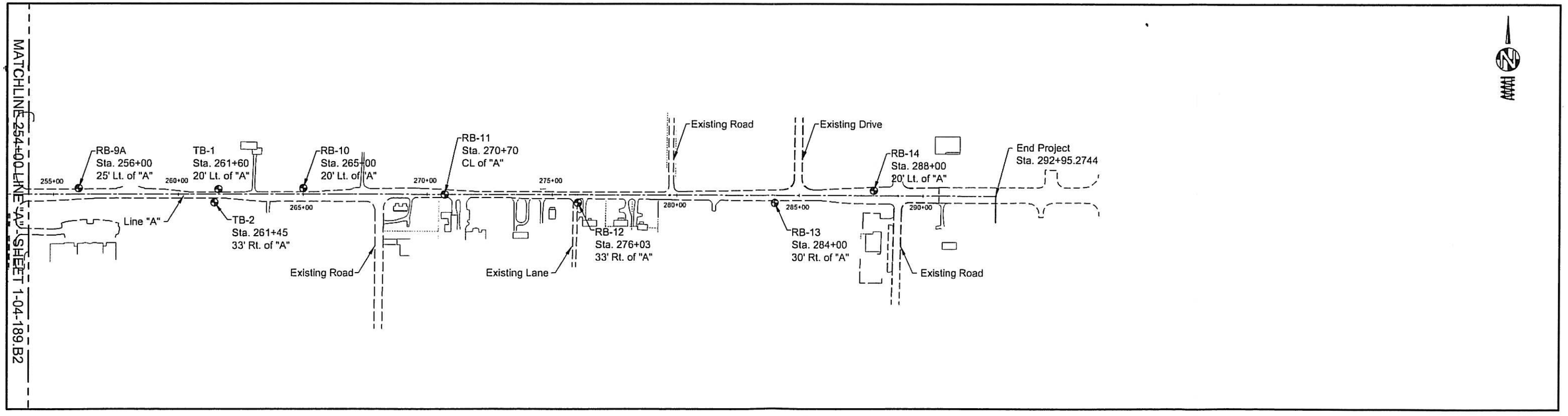
PROJECT:	SR 32 Improvements
DES NO.:	9901670
PROJECT NO.:	STP-088-6
LOCATION:	Hamilton County, Indiana
CLIENT:	Indiana Department of Transportation
EEI PROJECT NO.:	1-04-189
SCALE:	No Scale

PROJECT ENG: DRP
APPROVED BY: SJL
DRAWN BY: JDR
DATE AND TIME: 8-17-04 15:00:00

EARTH EXPLORATION, Inc.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690
(FAX) 317-273-2250

1-04-189.A1





LEGEND

RB-1 Sta. 206+70 30' Rt. of "A" — Test Boring Location, Designation, Station and Offset

NOTES

1. Base map developed from an electronic file provided by Corradino Group.
2. Refer to the Log of Test Boring (19) in Appendix C for a description of the subsurface conditions encountered at the test boring locations.
3. Borings were located in the field by Earth Exploration, Inc.
4. Boring locations are approximate.
5. Soundings not shown for clarity. Please refer to the summary of soundings in Appendix C for locations.

TEST BORING LOCATION PLAN

PROJECT:	SR 32 Improvements
DES NO.:	9901670
PROJECT NO.:	STP-088-6 ( )
LOCATION:	Hamilton County, Indiana
CLIENT:	Indiana Department of Transportation
EEI PROJECT NO.:	1-04-189
SCALE:	1" = 400'

PROJECT ENGINEER:	DRP
APPROVED BY:	SJL
DRAWN BY:	JDR
DATE AND TIME:	7-13-04 3:00:00
DRAWING NUMBER:	1-04-189.B2

EARTH EXPLORATION, INC.
7770 West New York Street
Indianapolis, IN 46214-2988
317-273-1690
(FAX) 317-273-2250

LOG OF TEST BORING - GENERAL NOTES

DESCRIPTIVE SOIL CLASSIFICATION

GRAIN SIZE TERMINOLOGY

Soil Fraction		Particle Size	US Standard Sieve Size
Boulders		Larger than 75 mm	Larger than 3"
Gravel		2.00 to 75 mm	#10 to 75 mm
Sand:	Coarse	0.425 to 2.00 mm	#40 to #10
	Fine	0.075 to 0.425 mm	#200 to #40
Silt		0.002 to 0.075 mm	Smaller than #200
Clay		Smaller than 0.002 mm	Smaller than #200

Plasticity characteristics differentiate between silt and clay.

GENERAL TERMINOLOGY

Physical Characteristics
- Color, moisture, grain shape, fineness, etc.

Major Constituents
- Clay, silt, sand, gravel

Structure
- Laminated, varved, fibrous, stratified, cemented, fissured, etc.

Geologic Origin
- Glacial, alluvial, eolian, residual, etc.

RELATIVE PROPORTIONS OF COHESIONLESS SOILS

Term	Defining Range by % of Weight
Trace	1 - 10%
Little	11 - 20%
Some	21 - 35%
And	36 - 50%

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	LOI
w/ trace organic matter	1 - 6%
w/ little organic matter	7 - 12%
w/ some organic matter	13 - 18%
Organic Soil (A-8)	19 - 30%
Peat (A-8)	More than 30%

RELATIVE DENSITY

Term	"N" Value
Very loose	0 - 5
Loose	6 - 10
Medium dense	11 - 30
Dense	31 - 50
Very Dense	51+

CONSISTENCY

Term	"N" Value
Very soft	0 - 3
Soft	4 - 5
Med stiff	6 - 10
Stiff	11 - 15
Very Stiff	16 - 30
Hard	31+

PLASTICITY

Term	Plastic Index
None to slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High/Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6-in. penetrations of the 2-in. split-barrel sampler. The sampler is driven with a 140-lb weight falling 30 in. and is seated to a depth of 6 in. before commencing the standard penetration test.

SYMBOLS

DRILLING AND SAMPLING

- AS - Auger Sample
- BS - Bag Sample
- C - Casing: Size 2½", NW; 4", HW
- COA - Clean-Out Auger
- CS - Continuous Sampling
- CW - Clear Water
- DC - Driven Casing
- DM - Drilling Mud
- FA - Flight Auger
- FT - Fish Tail
- HA - Hand Auger
- HSA - Hollow Stem Auger
- NR - No Recovery
- PMT - Borehole Pressuremeter Test
- PT - 3" O.D. Piston Tube Sample
- PTS - Peat Sample
- RB - Rock Bit
- RC - Rock Coring
- REC - Recovery
- RQD - Rock Quality Designation
- RS - Rock Sounding
- S - Soil Sounding
- SS - 2" O.D. Split-Barrel Sample
- 2ST - 2" O.D. Thin-Walled Tube Sample
- 3ST - 3" O.D. Thin-Walled Tube Sample
- VS - Vane Shear Test
- WPT - Water Pressure Test

LABORATORY TESTS

- qp - Penetrometer Reading, tsf
- qu - Unconfined Strength, tsf
- W - Moisture Content, %
- LL - Liquid Limit, %
- PL - Plastic Limit, %
- PI - Plasticity Index
- SL - Shrinkage Limit, %
- LOI - Loss on Ignition, %
- γ - Dry Unit Weight, pcf
- pH - Measure of Soil Alkalinity/Acidity

WATER LEVEL MEASUREMENT

- BF - Backfilled upon Completion
- NW - No Water Encountered

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

EARTH EXPLORATION Inc

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

Boring No. TB-1
Elevation 898
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 85° F | Driller T.H.
Des. No. 9901670 | Station 261+60 | Offset 20' Lt. "A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						ASPHALTIC CONCRETE, (14 in.)							
SS-1	X	90	9-5-5										
					895	**SAND**, loose to very loose, moist, brown, (fill; visual)							
SS-2	X	0	2-2-2	5									
SS-3	X	45	2-2-2			**SILTY CLAY LOAM**, soft, very moist, brown, A-7-6, Lab No. 6236SL	---			32.2			
					890								
SS-4	X	90	2-3-5	10			2.5			21.4			
SS-5	X	90	3-5-7				2.0	2.4	108.8	20.4			
					885								
SS-6	X	100	2-3-5	15		**SILTY CLAY LOAM**, medium stiff to stiff, moist, brown to gray below 10', with intermittant silt partings, A-6, Lab No. 6232SL	1.25			20.9			
SS-7	X	100	2-3-6				2.5			22.9			
					880								
SS-8	X	100	2-4-4	20			1.25			24.0			
						End of Boring at 20 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	NW	NW	BF
To Cave-in		16½	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 8/3/04 End 8/3/04 Rig CME 75
Drilling Method 3¼" I.D. HSA Truck
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

LOG OF TEST BORING

EARTH EXPLORATION, Inc.

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. TB-2
Elevation 898
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 85° F	Driller	T.H.
Des. No.	9901670	Station	261+45	Offset	33' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (6 in.)							
SS-1	X	90	2-1-2			**SAND**, very loose, moist, brown, (fill; visual)	1.5			22.5			
					895	**SILTY CLAY LOAM**, soft, moist, brown, with sand seams (fill), A-7-6, Lab No. 6236SL							
SS-2	X	90	2-2-3	5			1.5			20.5			
SS-3	X	100	2-2-4		890		1.0			22.7			
SS-4	X	100	2-2-3	10		**SILTY CLAY LOAM**, medium stiff to very soft, moist to very moist, brown and gray to gray below 6', with intermittant silt partings, A-6, Lab No. 6232SL	1.0			23.4			
SS-5	X	100	2-2-2		885		0.5	1.2	103.3	23.3			
SS-6	X	100	0-0-1	15			0.25			25.6			
SS-7	X	100	3-6-7		880	**GRAVELLY SAND**, medium dense, wet, gray, (visual)							
SS-8	X	100	7-7-8	20									
						End of Boring at 20 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	11	6½	BF
To Cave-in		13	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 8/3/04 End 8/3/04 Rig CME 75
Drilling Method 3¼" I.D. HSA Truck
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-1
Elevation 932
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	206+70	Offset	30' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (2 in.)							
SS-1	X	45	3-4-4		930	SILTY CLAY LOAM, medium stiff, moist, brown, A-6, Lab No. 6232SL	3.5			15.7			
SS-2	X	100	3-5-7	5		LOAM, stiff to very stiff, moist, brown, A-4, Lab No. 6233SL	>4.5			10.9			
SS-3	X	100	6-8-11		925		>4.5			10.9			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	⊻ 48 hrs After Drilling
To Water	NW	NW	NW
To Cave-in		4½	5

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

Boring No. RB-2
Elevation 929
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 80° F | Driller J.M.
Des. No. 9901670 | Station 209+42 | Offset 40' Lt. "A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
				0		**ASPHALTIC CONCRETE**, (3 in.)							
SS-1	X	55	1-3-4			**GRANULAR SUBBASE**, (7 in.; sand and gravel)	2.25		94.4	27.9			
						CLAY, medium stiff, moist, brown and gray, (fill), A-7-6, Lab No. 6234SL							
SS-2	X	100	1-2-2		925		0.5			15.4			
				5		**LOAM**, soft to medium stiff, moist, brown, A-4, Lab No. 6233SL							
SS-3	X	100	2-5-5				4.0			11.1			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	NW	NW	BF
To Cave-in		4	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-3
Elevation 924
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) Struct. No. --- Weather Mostly Sunny 79° F Driller J.M.
Des. No. 9901670 Station 216+50 Offset 35' Lt. "A" Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
				0		**TOPSOIL**, (3 in.)							
						SAND AND GRAVEL (visual; fill)							
SS-1	X	70	4-5-5			**SILTY CLAY LOAM**, medium stiff, moist, dark brown and gray, with trace organic matter (fill), A-6(13), Lab No. 6232SL	>4.5			21.9	36	19	17
SS-2	X	90	3-4-4	5	920	**SANDY LOAM**, medium stiff, moist, brown and gray, (visual)	0.75			20.8			
SS-3	X	80	1-2-3				0.5			16.4			
SS-4	X	90	3-4-7	10	915	**LOAM**, soft to stiff, moist, brown to gray below 11', A-4, Lab No. 6233SL	3.5			12.5			
SS-5	X	55	4-6-8				2.5			10.9			
						End of Boring at 12.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	48 hrs After Drilling
To Water	5½	5	2½
To Cave-in		5	5½

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-4
Elevation 919
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	223+00	Offset	33' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (2 in.)							
SS-1	X	70	2-3-4			**CLAY**, medium stiff, moist, brown and gray, A-7-6, Lab No. 6234SL	2.0		98.1	25.6			
SS-2	X	100	1-2-4		915	**LOAM**, medium stiff, moist, brown, A-4, Lab No. 6233SL	2.5			10.7			
				5									
SS-3	X	50	3-4-7			**SAND AND GRAVEL**, medium dense, wet, brown, (visual)	2.5			12.9			
						LOAM, stiff, moist, brown to gray below 8½',							
SS-4	X	100	3-6-7		910	A-4, Lab No. 6233SL	>4.5			11.1			
				10									
						End of Boring at 10 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 48 hrs After Drilling
To Water	6	---	5
To Cave-in		---	7

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

Boring No. RB-5
Elevation 920
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	229+50	Offset	32' Lt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
						SAND AND GRAVEL, (visual; fill)							
SS-1	X	80	2-3-5			**CLAY**, soft, moist, brown and gray, A-7-6, Lab No. 6234SL	2.0		98.4	25.3			
						CLAY LOAM, medium stiff, moist, brown and gray, A-6, Lab No. 6235SL							
SS-2	X	90	2-4-5				1.5			12.9			
				5	915								
						LOAM, medium stiff, moist, brown, A-4, Lab No. 6233SL							
SS-3	X	90	2-4-4				3.0			11.9			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 24 hrs After Drilling
To Water	NW	NW	NW
To Cave-in		4½	5½

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

LOG OF TEST BORING

EARTH EXPLORATION Inc

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-6
Elevation 913
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	236+00	Offset	39' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						ASPHALTIC CONCRETE, (12 in.)							
SS-1	X	100	3-5-10			**SANDY LOAM**, with some gravel, loose, wet, dark gray, (fill; visual)							
					910	**LOAM**, very stiff, moist, brown, (possible lime treated soils; fill; visual)							
SS-2	X	100	1-3-4	5		**CLAY**, medium stiff, moist, brown and gray, A-7-6, Lab No. 6234SL	1.5		97.2	25.8			
SS-3	X	20	1-1-3			**SANDY LOAM**, with some gravel, very loose, wet, brown, (visual)							
					905								
SS-4	X	100	2-4-6	10			<0.25			15.2			
SS-5	X	100	4-6-8			**LOAM**, medium to very stiff, moist, brown to gray below 13', with occasional wet sand seams, A-4, Lab No. 6233SL	4.25			12.3			
					900								
SS-6	X	10	5-8-10	15			---			---			
						End of Boring at 15 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ After Drilling
To Water	6	---	BF
To Cave-in		---	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-7
Elevation 917
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	242+00	Offset	25' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
SS-1	X	55	2-3-5		915	**CLAY LOAM**, medium stiff, moist, brown and gray, with trace roots (possible fill), A-6, Lab No. 6235SL	1.25		111.2	17.7			
SS-2	X	100	3-7-9	5		**LOAM**, very stiff, moist, brown, A-4, Lab No. 6233SL	>4.5			10.5			
SS-3	X	70	2-5-7		910	**SANDY LOAM**, medium dense, wet, brown, with wet sand seams (visual)							
SS-4	X	100	3-7-10	10			>4.5			12.7			
SS-5	X	100	6-8-9		905		4.25			10.8	20	13	7
SS-6	X	100	4-6-7	15		**LOAM**, very stiff to medium stiff, moist, brown to gray below 11', A-4(1), Lab No. 6233SL	3.25			11.3			
SS-7	X	100	2-4-6		900		3.0			11.2			
SS-8	X	100	3-3-5	20			2.5			12.2			
						End of Boring at 20 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 24 hrs After Drilling
To Water	6	NW	4½
To Cave-in		---	8

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-8
Elevation 903
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 80° F | Driller J.M.
Des. No. 9901670 | Station 250+00 | Offset 27' Lt. "A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
SS-1	X	70	1-2-3			**CLAY**, soft, moist, brown and gray, A-7-6(24), Lab No. 6234SL	1.5		102.4	22.9			
					900								
SS-2	X	55	1-1-1			**CLAY LOAM**, very soft, moist, brown and gray, A-6, Lab No. 6235SL	0.5			18.8			
				5									
SS-3	X	100	2-4-5				2.25			12.2			
					895								
SS-4	X	100	2-4-6			**LOAM**, medium stiff, moist, gray, A-4, Lab No. 6233SL	3.0			11.1			
				10									
SS-5	X	100	2-4-5				1.0			11.4			
					890								
SS-6	X	80	7-11-11			**SANDY GRAVEL**, medium dense, wet, gray, (visual)							
				15		End of Boring at 15 ft							

Sample BS-1 was obtained adjacent to boring from depth of 1 to 2 ft: LL = 47%, PL = 15%, PI = 32%

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 24 hrs After Drilling
To Water	5½	6	1
To Cave-in		11	8

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

LOG OF TEST BORING

EARTH EXPLORATION, Inc.
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

Boring No. RB-9A
Elevation 898
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	256+00	Offset	25' Lt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						ASPHALTIC CONCRETE, (12 in.)							
SS-1	X	55	4-4-5			**GRANULAR SUBBASE**, (sand and gravel)							
					895	**SILTY CLAY LOAM**, medium stiff, moist, gray, with little organic matter, A-7-6, Lab No. 6236SL SS-1B: LOI = 8.9%	3.25			27.2			
SS-2	X	40	2-2-3	5		**CLAY LOAM**, soft, moist, brown, A-6, Lab No. 6235SL	1.0			23.3			
SS-3	X	100	2-4-6				3.5			13.0			
					890								
SS-4	X	100	2-3-5	10		**LOAM**, medium stiff, moist, brown to gray below 8', A-6, Lab No. 6233SL	4.0			10.9			
SS-5	X	100	2-4-5				1.25			10.5			
						End of Boring at 12.5 ft							
						Alternate boring location.							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	5½	NW	BF
To Cave-in		8½	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-10
Elevation 902
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	265+00	Offset	20' Lt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
SS-1		50	1-3-4		900		2.5			19.6			
						CLAY LOAM, medium stiff, moist, brown, A-6(6), Lab No. 6235SL							
SS-2		55	1-3-4	5			1.5			16.3	27	15	12
SS-3		80	4-4-4		895		>4.5			11.9			
						LOAM, medium stiff, moist, brown to gray below 8', with wet sand seam near 7½', A-4, Lab No. 6233SL							
SS-4		100	4-4-6	10			>4.5			10.5			
						End of Boring at 10 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 24 hrs After Drilling
To Water	7½	---	NW
To Cave-in		---	5½

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-11
Elevation 897
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 80° F | Driller J.M.
Des. No. 9901670 | Station 270+70 | Offset C.L. "A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (4 in.)							
SS-1	X	35	1-1-2		895	**SILTY CLAY LOAM**, very soft, moist, brown and gray, (possible fill), A-7-6, Lab No. 6236SL	1.25			26.6			
SS-2	X	30	1-2-2	5		**CLAY**, very soft, moist, brown and gray, A-7-6, Lab No. 6234SL	---			25.8			
SS-3	X	100	3-5-7		890		3.75			12.2			
SS-4	X	100	8-10-12	10		**LOAM**, stiff to very stiff, moist, brown to gray below 11', A-4, Lab No. 6233SL	>4.5			11.3			
SS-5	X	100	4-7-10		885		>4.5			10.0			
						End of Boring at 12.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 24 hrs After Drilling
To Water	NW	NW	8
To Cave-in		9½	8

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

LOG OF TEST BORING

EARTH EXPLORATION Inc

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-12
Elevation 901
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	276+03	Offset	33' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						ASPHALTIC CONCRETE, (7 in.)							
					900	**GRANULAR SUBBASE**, (5 in.;sand and gravel)							
SS-1	X	70	6-7-7			**SILTY CLAY LOAM**, stiff, moist, brown and gray, (fill), A-6, Lab No. 6232SL	4.0		107.5	19.3			
SS-2	X	100	2-4-6			**CLAY**, stiff, moist, brown and gray, A-7-6, Lab No. 6234SL	1.75			14.6			
				5		**CLAY LOAM**, medium stiff, moist, brown and gray, A-6, Lab No. 6235SL							
					895								
SS-3	X	100	4-4-6			**LOAM**, medium stiff, moist, brown, A-4, Lab No. 6233SL	>4.5			11.5			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	NW	NW	BF
To Cave-in		---	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-13
Elevation 899
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 80° F	Driller	J.M.
Des. No.	9901670	Station	284+00	Offset	30' Rt. "A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
SS-1	X	30	2-3-4			**CLAY**, medium stiff, moist, brown and gray, with trace roots, A-7-6, Lab No. 6234SL	2.5			22.6			
SS-2	X	45	1-1-2	5	895	**CLAY LOAM**, very soft, moist, brown and gray, A-6, Lab No. 6235SL	0.25			26.6			
SS-3	X	100	3-6-10			**LOAM**, very stiff, moist, brown, A-4, Lab No. 6233SL	>4.5			11.7			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	24 hrs After Drilling
To Water	NW	NW	5
To Cave-in		4½	5

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-14
Elevation 899
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 80° F | Driller J.M.
Des. No. 9901670 | Station 288+00 | Offset 20' Lt. "A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						ASPHALTIC CONCRETE, (8 in.)							
						GRANULAR SUBBASE, (sand and gravel)							
SS-1	X	80	22-19-7			**SAND AND GRAVEL**, medium dense, moist, brown and gray, with trace concrete fragments (fill; visual)							
SS-2	X	45	1-2-3		895	**SILTY CLAY LOAM**, soft, moist, brown and gray, A-7-6(21), Lab No. 6236SL	1.5			26.4	47	17	30
				5									
SS-3	X	80	1-2-2			**CLAY LOAM**, soft, moist, brown and gray, A-6, Lab No. 6235SL	3.0			21.7			
SS-4	X	100	2-3-5		890	**LOAM**, medium stiff, moist, brown, A-4, Lab No. 6236SL	2.25			16.2			
				10									
						End of Boring at 10 ft							

WATER LEVEL OBSERVATIONS

Depth ft	While Drilling	Upon Completion	After Drilling
To Water	NW	NW	BF
To Cave-in		5½	

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/29/04 End 6/29/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings, bentonite chips and concrete patch at surface.

EARTH EXPLORATION, Inc.

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-15
Elevation 924
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) Struct. No. --- Weather Sunny 80° F Driller J.M.
Des. No. 9901670 Station 17+50 Offset 15' Lt. "PR-S-1-A" Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
SS-1	X	50	3-4-5			**SILTY CLAY LOAM**, medium stiff, moist, dark brown, with little organic matter, A-7-6, Lab No. 6236SL SS-1B LOI = 6.6%	1.5			24.3			
SS-2	X	55	1-2-3		920	**CLAY**, soft, moist, brown and gray, A-7-6, Lab No. 6234SL	1.5			22.4			
				5 ▼									
SS-3	X	80	1-2-3			**LOAM**, soft to medium stiff, moist, brown to brown and gray below 8', A-4, Lab No. 6233SL	0.25			12.4			
SS-4	X	100	3-4-5		915		>4.5			11.0			
				10		End of Boring at 10 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 48 hrs After Drilling
To Water	NW	5½	2½
To Cave-in		7	6

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-16
Elevation 927
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No. STP-088-6( ) | Struct. No. --- | Weather Sunny 82° F | Driller J.M.
Des. No. 9901670 | Station 22+00 | Offset 20' Rt. "PR-S-1-A" | Inspector ---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
						TOPSOIL, (3 in.)							
SS-1	X	55	2-3-4		925	**CLAY**, soft, moist, dark gray, with trace organic matter, A-7-6, Lab No. 6234SL	2.75		98.7	25.7			
						CLAY LOAM, medium stiff, moist, brown and gray, (possible fill), A-6, Lab No. 6235SL							
SS-2	X	100	1-2-2	5			2.75			12.9			
SS-3	X	80	2-3-5		920	**LOAM**, very soft to stiff, moist, brown to gray below 11', with wet sand seam near 10', A-4, Lab No. 6233SL	4.25			11.6			
SS-4	X	70	2-1-1	10			1.75			13.9			
SS-5	X	100	6-7-8		915		3.25			9.6			
						End of Boring at 12.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 48 hrs After Drilling
To Water	8½	3½	2
To Cave-in		8	6

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

EARTH EXPLORATION Inc

LOG OF TEST BORING

Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation

7770 West New York Street - Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

Boring No. RB-17
Elevation 930
Datum USC & GS
EEI Proj. No. 1-04-189
Sheet 1 of 1

Proj. No.	STP-088-6( )	Struct. No.	---	Weather	Sunny 82° F	Driller	J.M.
Des. No.	9901670	Station	25+00	Offset	20' Rt. "PR-S-1-A"	Inspector	---

SAMPLE No.	Type	Rec %	Blow Counts	Depth ft	Elev	DESCRIPTION/CLASSIFICATION and REMARKS	q_p tsf	q_u tsf	γ_d pcf	W %	LL %	PL %	PI %
				0		**TOPSOIL**, (3 in.)							
						SAND AND GRAVEL, (visual; fill)							
SS-1	X	70	2-3-5				2.5			18.9			
						CLAY LOAM, medium stiff, moist, brown and gray, A-6, Lab No. 6235SL							
SS-2	X	80	3-4-5	5	925		3.0		122.4	15.3			
						LOAM, medium stiff, moist, brown, A-4, Lab No. 6233SL							
SS-3	X	80	2-3-5				>4.5			12.2			
						End of Boring at 7.5 ft							

WATER LEVEL OBSERVATIONS

Depth ft	▽ While Drilling	▼ Upon Completion	▽ 48 hrs After Drilling
To Water	NW	NW	5
To Cave-in		4½	5½

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

GENERAL NOTES

Start 6/28/04 End 6/28/04 Rig D120 ATV
Drilling Method 3¼" I.D. HSA
Remarks: Backfilled with auger cuttings and bentonite chip plug near surface.

SUMMARY OF SOUNDINGS

Project: SR 32 Improvements
Location: Hamiton County, Indiana
Project No.: STP-088-6 ()
Client: Indiana Department of Transportation
EEI Project No.: 1-04-189
Date: August 3, 2004
Method: Hand Auger

Sounding No.	Station	Offset Line	Depth Interval in.	**Description** – Field Observations
S-1	261+25	80 ft Lt. "A"	0 – 6 6 – 24 24	Sand and Gravel Very Soft Silty Loam (Sediment) Stiff Silty Clay
S-2	261+55	100 ft Rt. "A"	0 – 5 6 – 30 30	Sand and Gravel Very Soft Silty Loam (Sediment) Stiff Silty Clay

APPENDIX D

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

SUMMARY OF CLASSIFICATION TEST RESULTS

GRAIN SIZE DISTRIBUTION CURVE (5)

UNCONFINED COMPRESSION TEST (2)

MOISTURE-DENSITY RELATION (1)

SUMMARY OF CBR TEST RESULTS (1)

CALIFORNIA BEARING RATIO (1)

RESILIENT MODULUS OF SUBGRADE SOILS (performed by others)

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

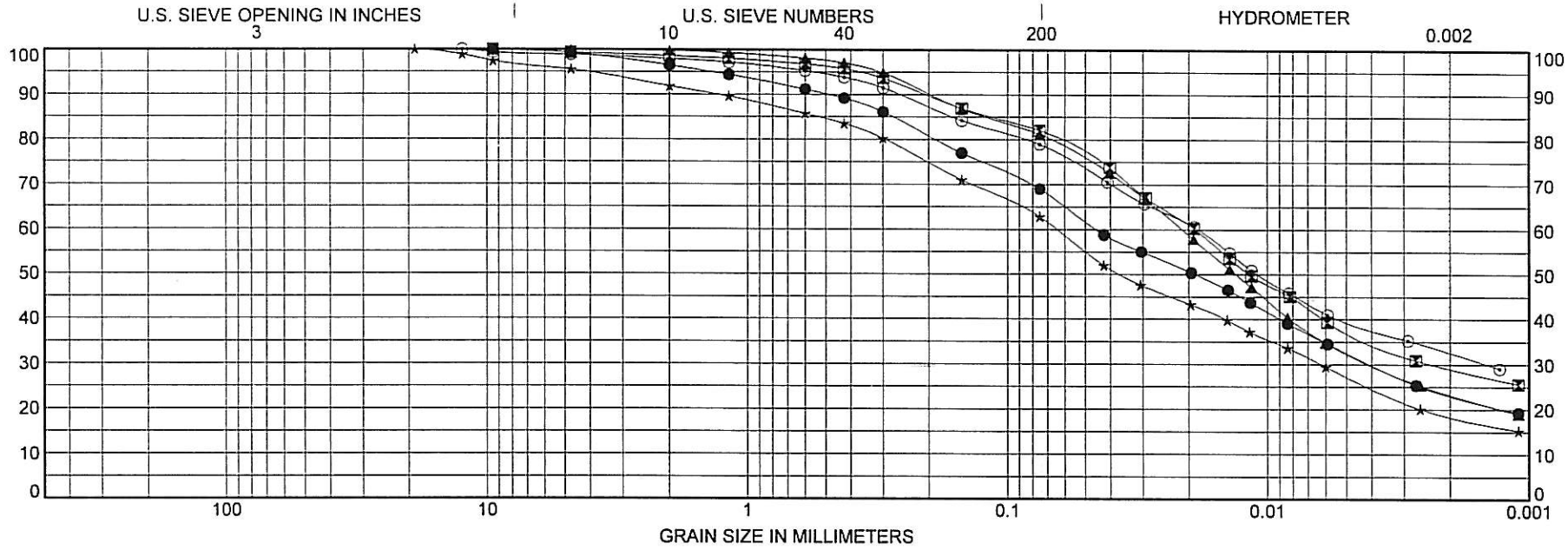
Project No.: STP-088-6( )
Des. No.: 9901670
Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
EEI Project No.: 1-04-189

Laboratory Number	Test Boring No.	Sample Number	Sample Depth Interval, ft	Moisture Content, %	pH	LOI
6237SL	TB-1	SS-3	6-7.5	32.2		
6237SL		SS-4	8.5-10	21.4		
6237SL		SS-6	13.5-15	20.9		
6237SL		SS-7	16-17.5	22.9		
6237SL		SS-8	18.5-20	24.0		
6237SL	TB-2	SS-1	1-2.5	22.5		
6237SL		SS-2	3.5-5	20.5		
6237SL		SS-3	6-7.5	22.7		
6237SL		SS-4	8.5-10	23.4		
6237SL		SS-6	13.5-15	25.6		
6237SL	RB-1	SS-1	1-2.5	15.7		
6237SL		SS-2	3.5-5	10.9		
6237SL		SS-3	6-7.5	10.9		
6237SL	RB-2	SS-2	3.5-5	15.4		
6237SL		SS-3	6-7.5	11.1		
6232SL	RB-3	SS-1	1-2.5	21.9	6.4	
6237SL		SS-2	3.5-5	20.8		
6237SL		SS-3	6-7.5	16.4		
6237SL		SS-4	8.5-10	12.5		
6237SL		SS-5	11-12.5	10.9		
6237SL	RB-4	SS-2	3.5-5	10.7		
6237SL		SS-3	6-7.5	12.9		
6237SL		SS-4	8.5-10	11.1		
6237SL	RB-5	SS-2	3.5-5	12.9		
6237SL		SS-3	6-7.5	11.9		
6237SL	RB-6	SS-4	8.5-10	15.2		
6237SL		SS-5	11-12.5	12.3		
6237SL	RB-7	SS-2	3.5-5	10.5		
6237SL		SS-4	8.5-10	12.7		
6233SL		SS-5	11-12.5	10.8	6.8	
6237SL		SS-6	13.5-15	11.3		
6237SL		SS-7	16-17.5	11.2		
6237SL	RB-7	SS-8	18.5-20	12.2		
6237SL	RB-8	SS-2	3.5-5	18.8		
6237SL		SS-3	6-7.5	12.2		
6237SL		SS-4	8.5-10	11.1		
6237SL		SS-5	11-12.5	11.4		

SUMMARY OF SPECIAL LABORATORY TEST RESULTS

Project No.: STP-088-6( )
Des. No.: 9901670
Project: SR 32 Improvements
Location: Hamilton County, Indiana
Client: Indiana Department of Transportation
EEI Project No.: 1-04-189

Laboratory Number	Test Boring No.	Sample Number	Sample Depth Interval, ft	Moisture Content, %	pH	LOI
6234SL	RB-8A	BS-1	1-2.5		6.2	
6238SL	RB-9A	SS-1	1-2.5	27.2		8.9
6237SL		SS-2	3.5-5	23.3		
6237SL		SS-3	6-7.5	13.0		
6237SL		SS-4	8.5-10	10.9		
6237SL		SS-5	11-12.5	10.5		
6237SL	RB-10	SS-1	1-2.5	19.6		
6235SL		SS-2	3.5-5	16.3	7.1	
6237SL		SS-3	6-7.5	11.9		
6237SL		SS-4	8.5-10	10.5		
6237SL	RB-11	SS-1	1-2.5	26.6		
6237SL		SS-2	3.5-5	25.8		
6237SL		SS-3	6-7.5	12.2		
6237SL		SS-4	8.5-10	11.3		
6237SL		SS-5	11-12.5	10.0		
6237SL	RB-12	SS-2	3.5-5	14.6		
6237SL		SS-3	6-7.5	11.5		
6237SL	RB-13	SS-1	1-2.5	22.6		
6237SL		SS-2	3.5-5	26.6		
6237SL		SS-3	6-7.5	11.7		
6236SL	RB-14	SS-2	3.5-5	26.4	7.0	
6237SL		SS-3	6-7.5	21.7		
6238SL	RB-15	SS-1	1-2.5	24.3		6.6
6237SL		SS-2	3.5-5	22.4		
6237SL		SS-3	6-7.5	12.4		
6237SL		SS-4	8.5-10	11.0		
6237SL	RB-16	SS-2	3.5-5	12.9		
6237SL		SS-3	6-7.5	11.6		
6237SL		SS-4	8.5-10	13.9		
6237SL		SS-5	11-12.5	9.6		
6237SL	RB-17	SS-1	1-2.5	18.9		
6237SL		SS-2	3.5-5	15.3		
6237SL		SS-3	6-7.5	12.2		



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Lab No.	Boring	Station/Offset/Line	Sample No.	Depth ft	Classification	% Passing			% Gravel	% Sand	% Silt	% Clay	% Coll.	LL	PL	PI	Opt. Moist.	γ_{max} pcf	* CBR at	
							No.10	No.40	No.200											93%	97%
●	6235SL	RB-10	265+00 20' Lt. "A"	SS-2	3.5 - 5.0	CLAY LOAM A-6 (6)	96.5	89.2	69.1	3.5	27.5	45.7	23.4	16.7	27	15	12				
⊠	6236SL	RB-14	288+00 20' Lt. "A"	SS-2	3.5 - 5.0	SILTY CLAY LOAM A-7-6 (21)	98.6	95.8	82.1	1.4	16.6	52.9	29.1	25.2	43	17	26				
▲	6232SL	RB-3	216+50 35' Lt. "A"	SS-1	1.0 - 2.5	SILTY CLAY LOAM A-6 (13)	99.7	97.1	81.2	0.3	18.5	57.8	23.4	16.5	36	19	17				
★	6233SL	RB-7	242+00 25' Rt. "A"	SS-5	11.0 - 12.5	LOAM A-4 (1)	91.9	83.6	62.9	8.1	29.0	44.2	18.6	15.1	20	13	7				
⊙	6234SL	RB-8A	250+02 27' Lt. "A"	BS-1	1.0 - 2.0	CLAY A-7-6 (24)	98.0	93.9	79.0	2.0	19.0	46.6	32.4	27.1	47	15	32	19.1	104.7	2.2	4.1

EARTH EXPLORATION

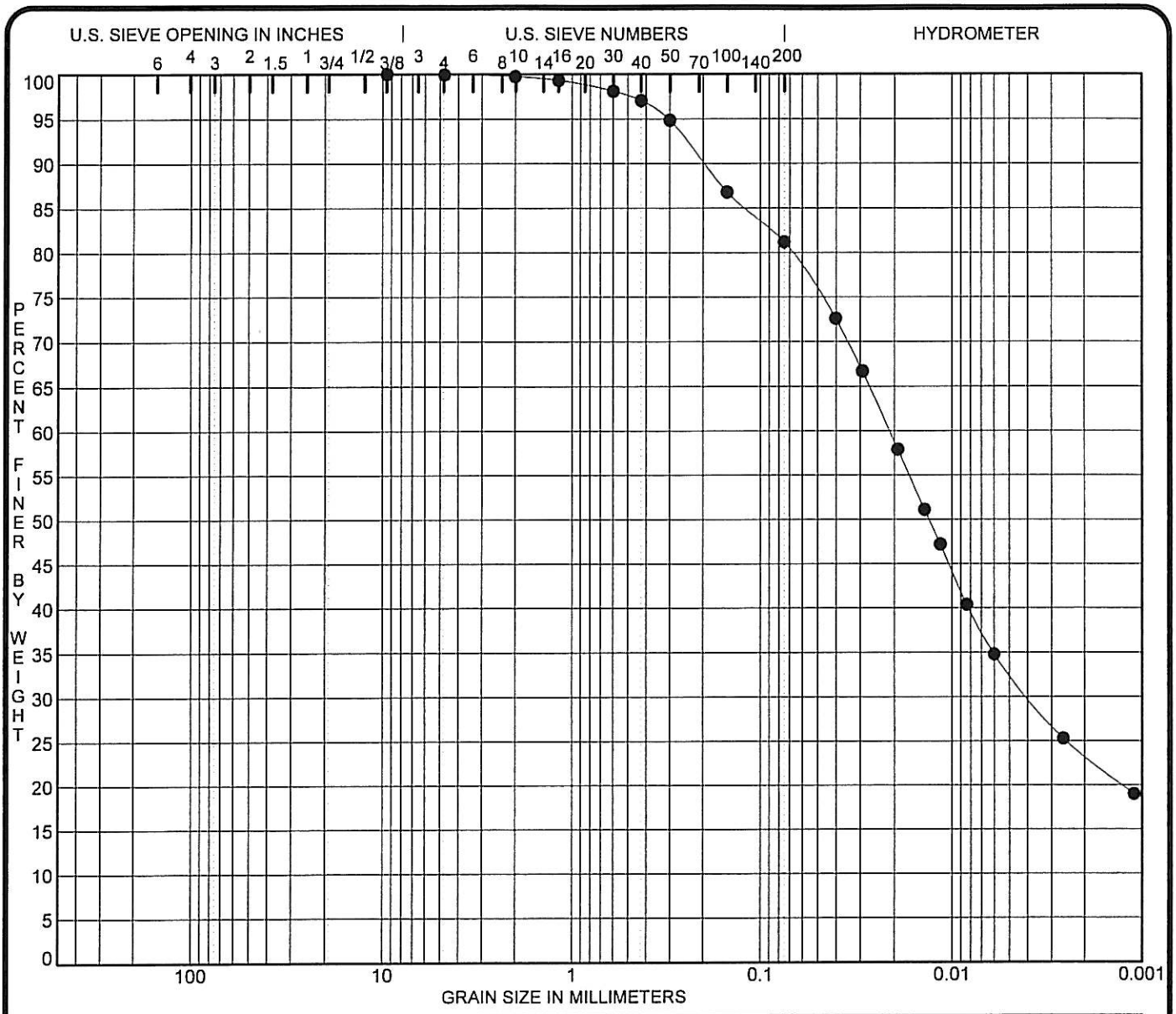
Project No. STP-088-6( )
Structure No. ---
EEI Project No. 1-04-189

Project SR 32 Improvements
Location Hamilton County, Indiana
Client Indiana Department of Transportation

SUMMARY OF CLASSIFICATION TEST RESULTS

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

* See text for recommended values.



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
●	RB-3	SS-1	216+50 35' Lt. "A"	1.0 - 2.5 ft.	923.0 - 921.5

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
6232SL	SILTY CLAY LOAM A-6 (13)	6.4	0.3	18.5	57.8	23.4	21.9	36	19	17

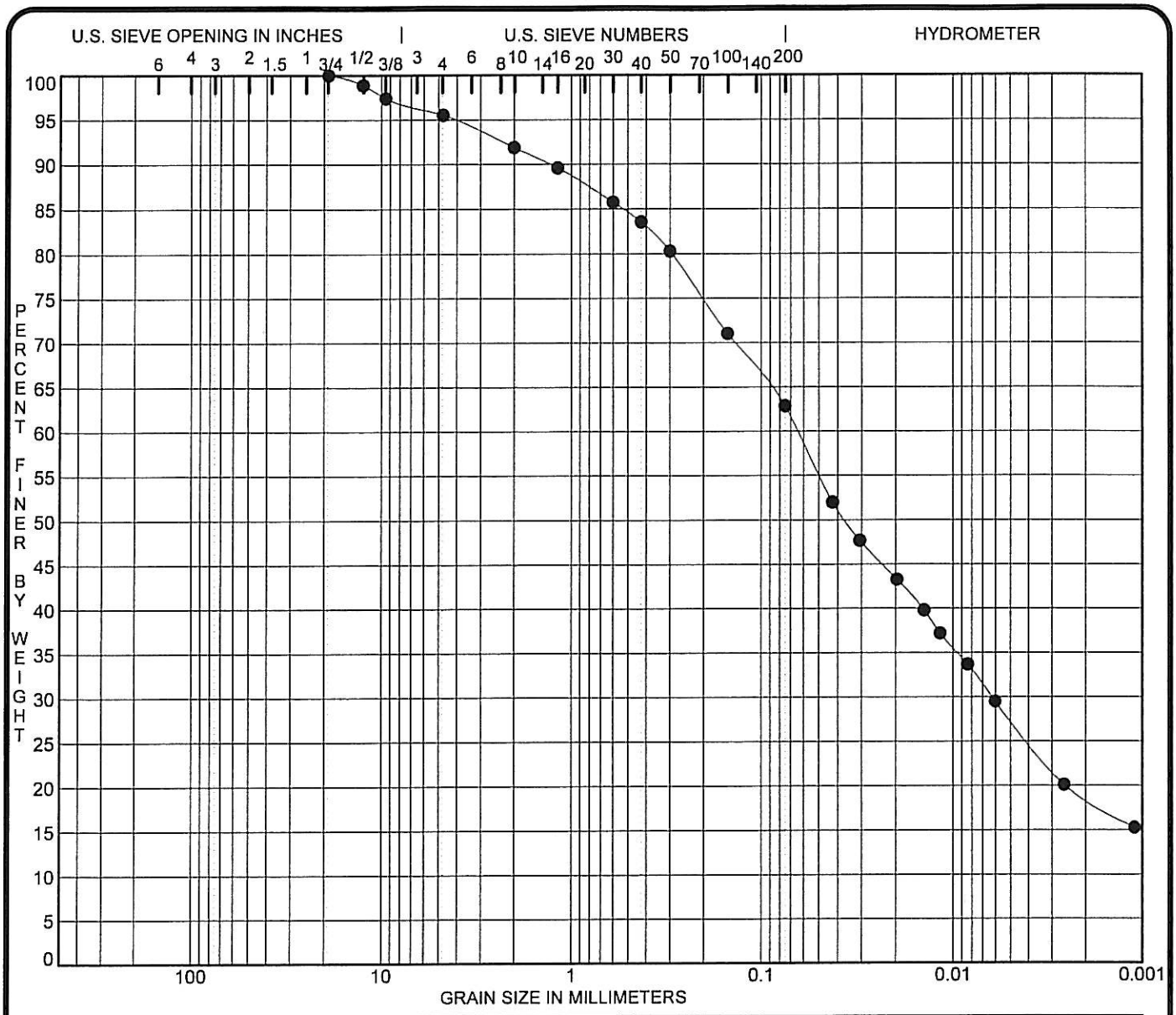
Remarks:

EARTH EXPLORATION, Inc.

Project No. STP-088-6( ) **Project** SR 32 Improvements
Structure No. --- **Location** Hamilton County, Indiana
EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
● RB-7	SS-5	242+00 25' Rt. "A"	11.0 - 12.5 ft.	906.0 - 904.5

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
6233SL	LOAM A-4 (1)	6.8	8.1	29.0	44.2	18.6	10.8	20	13	7

Remarks:

EARTH EXPLORATION, Inc.

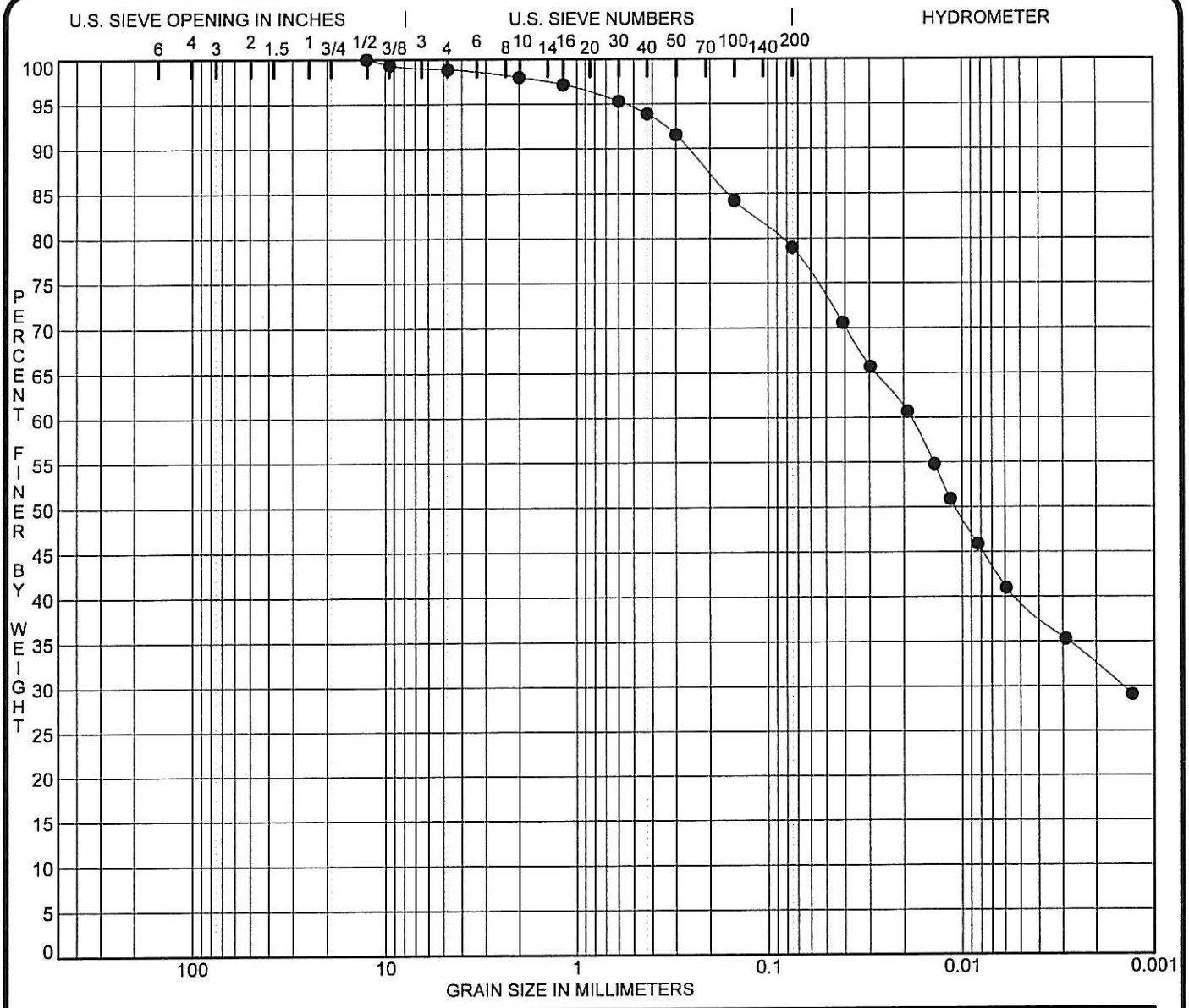
Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
●	RB-8A	BS-1	250+02 27' Lt. "A"	1.0 - 2.0 ft.	902.0 - 901.0

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
6234SL	CLAY A-7-6 (24)	6.2	2.0	19.0	46.6	32.4	---	47	15	32

Remarks:

EARTH EXPLORATION, Inc.

Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

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7770 West New York Street Indianapolis, Indiana 46214
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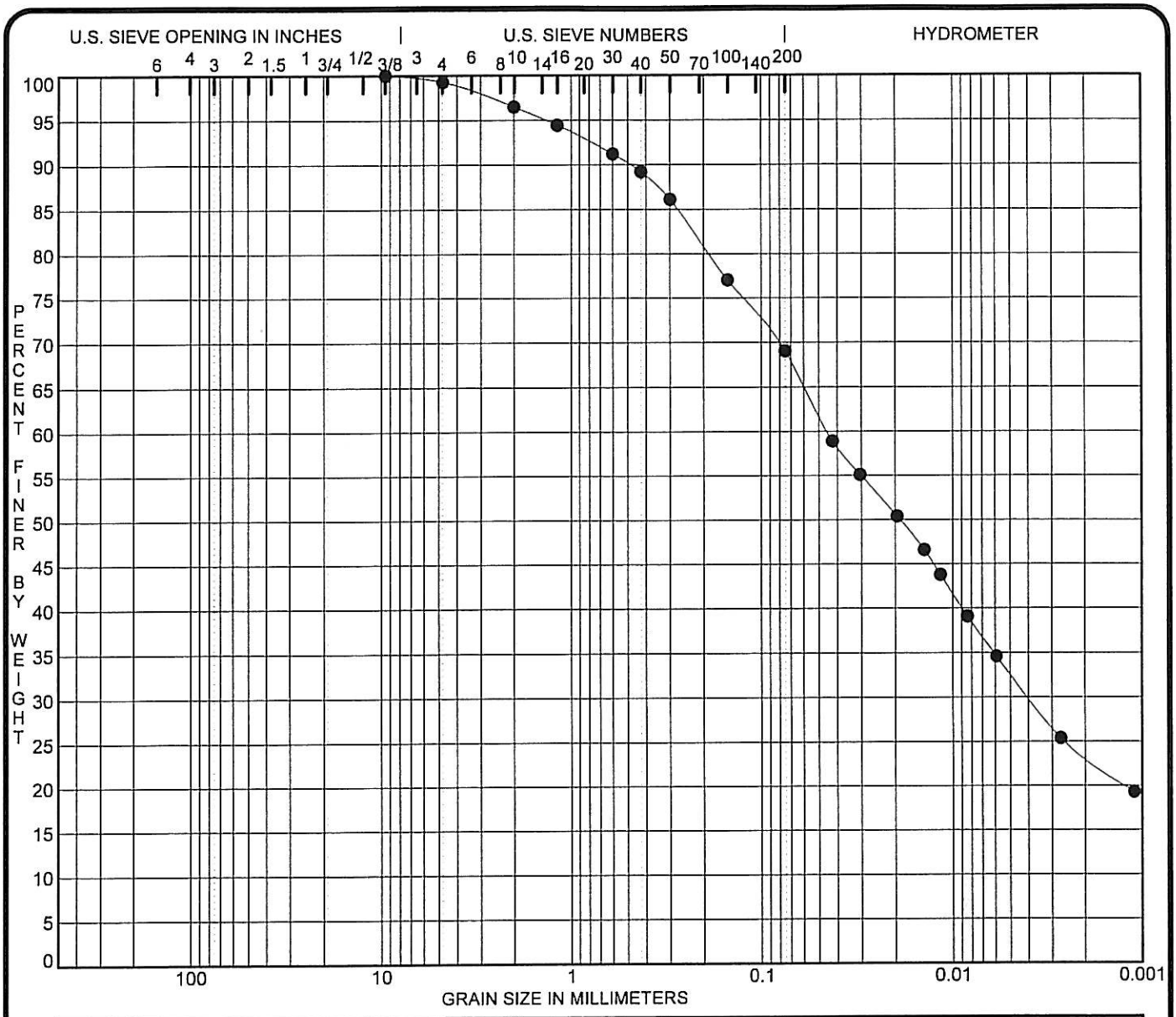

BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
●	RB-10	SS-2	265+00 20' Lt. "A"	3.5 - 5.0 ft.	898.5 - 897.0

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
6235SL	CLAY LOAM A-6 (6)	7.1	3.5	27.5	45.7	23.4	16.3	27	15	12

Remarks:

EARTH EXPLORATION, Inc.

Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

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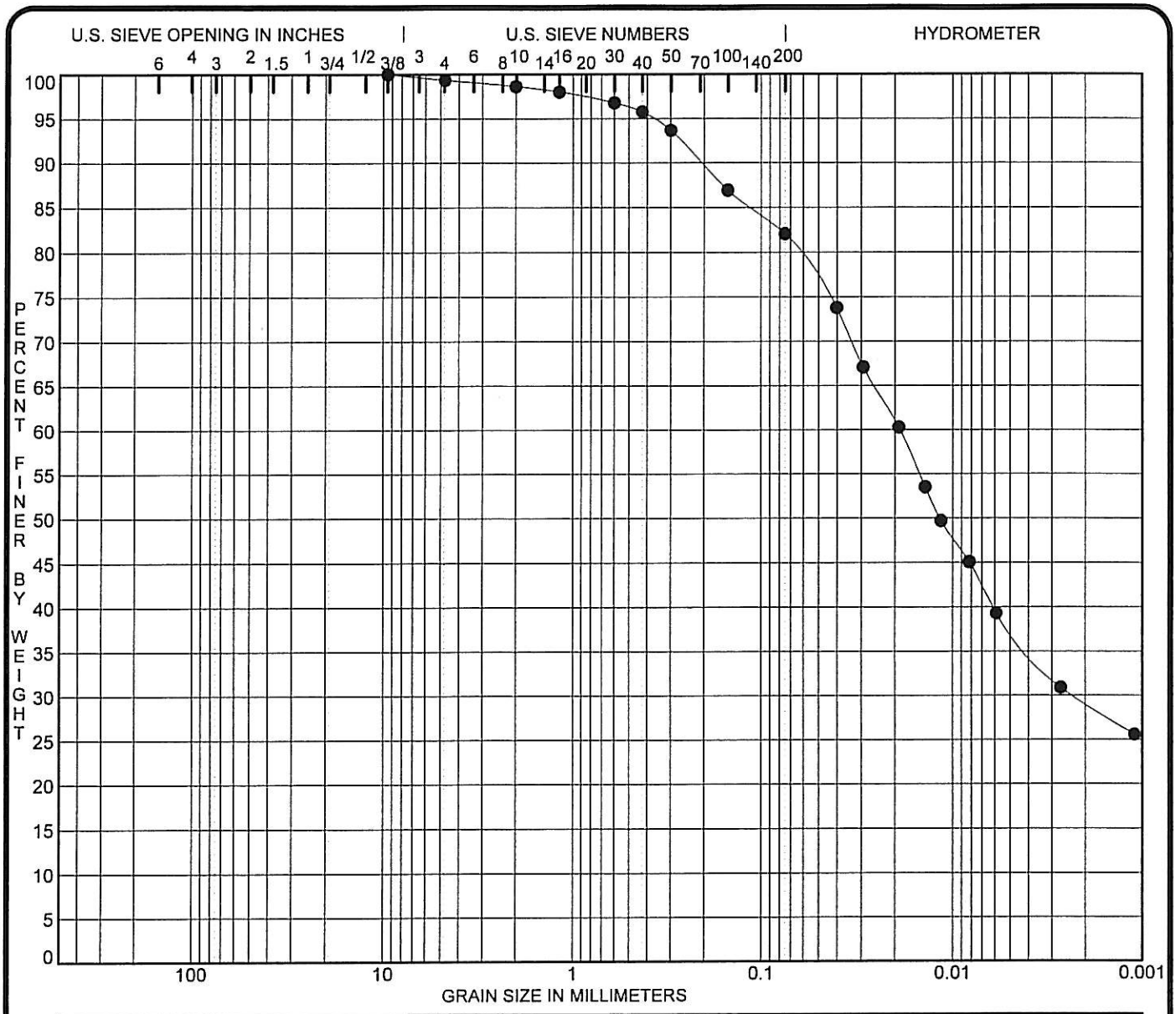
317-273-1690 / 317-273-2250 (Fax)



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Sample Identification		Station / Offset / Line	Depth, ft.	Elevation, USCGS
●	RB-14	SS-2	288+00 20' Lt. "A"	3.5 - 5.0 ft.	895.5 - 894.0

Lab No.	Classification	pH	%Gravel	%Sand	%Silt	%Clay	MC%	LL	PL	PI
6236SL	SILTY CLAY LOAM A-7-6 (21)	7.0	1.4	16.6	52.9	29.1	26.4	43	17	26

Remarks:

EARTH EXPLORATION, Inc.

Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE

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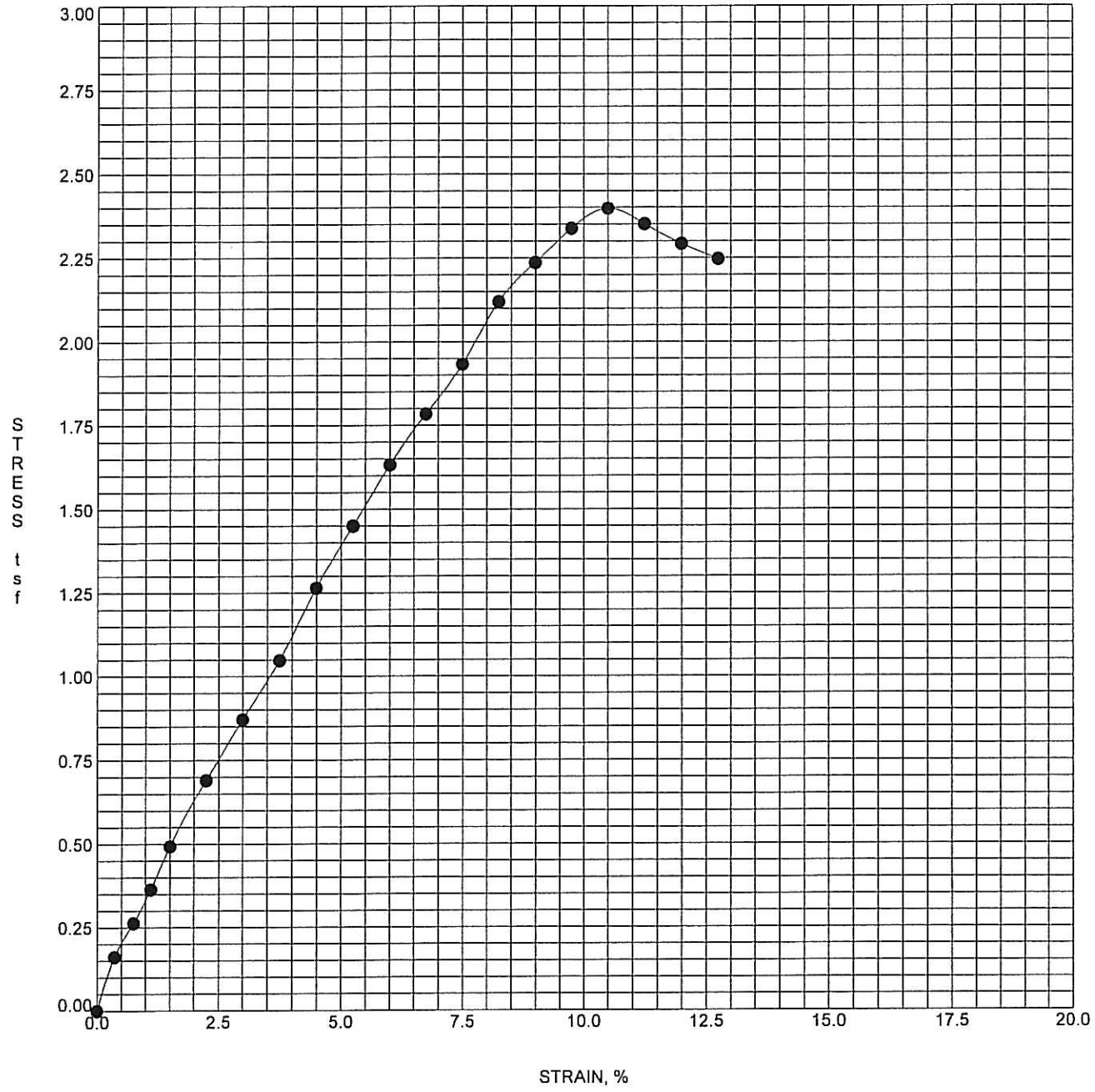


	Sample Identification	Station / Offset / Line	Depth, ft	Classification
●	TB-1 SS-5	---	11.0 - 12.5	SILTY CLAY LOAM

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5258SL	71.2	35.6	20.4	131.0	108.8	95.2	2.40	10.5	1.5

EARTH EXPLORATION, Inc.

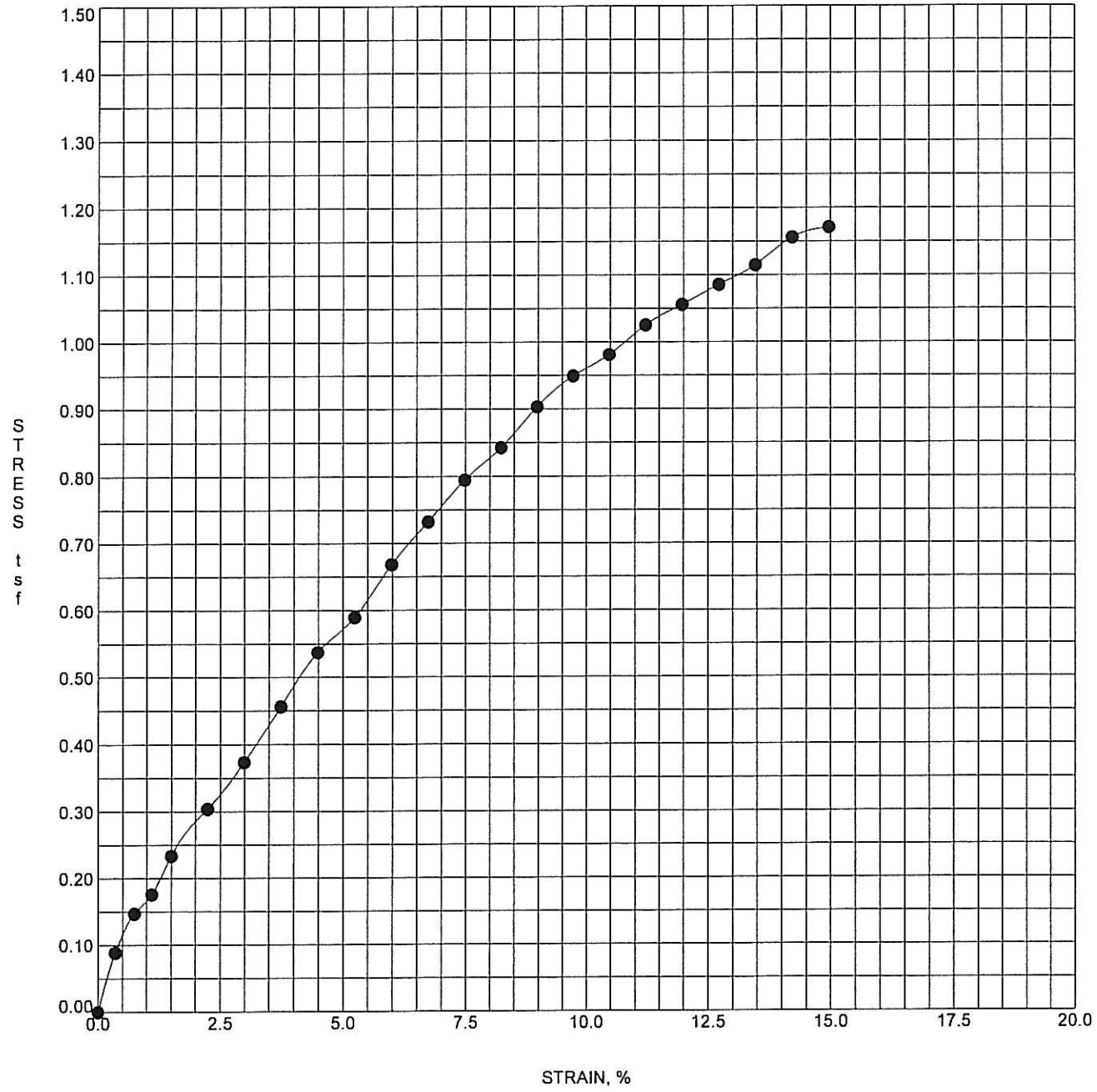
Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

UNCONFINED COMPRESSION TEST

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



Sample Identification	Station / Offset / Line	Depth, ft	Classification
● TB-2 SS-5	---	11.0 - 12.5	SILTY CLAY LOAM

Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
5259SL	71.3	35.5	23.3	127.3	103.3	95.1	1.17	15.0	1.5

EARTH EXPLORATION, Inc.

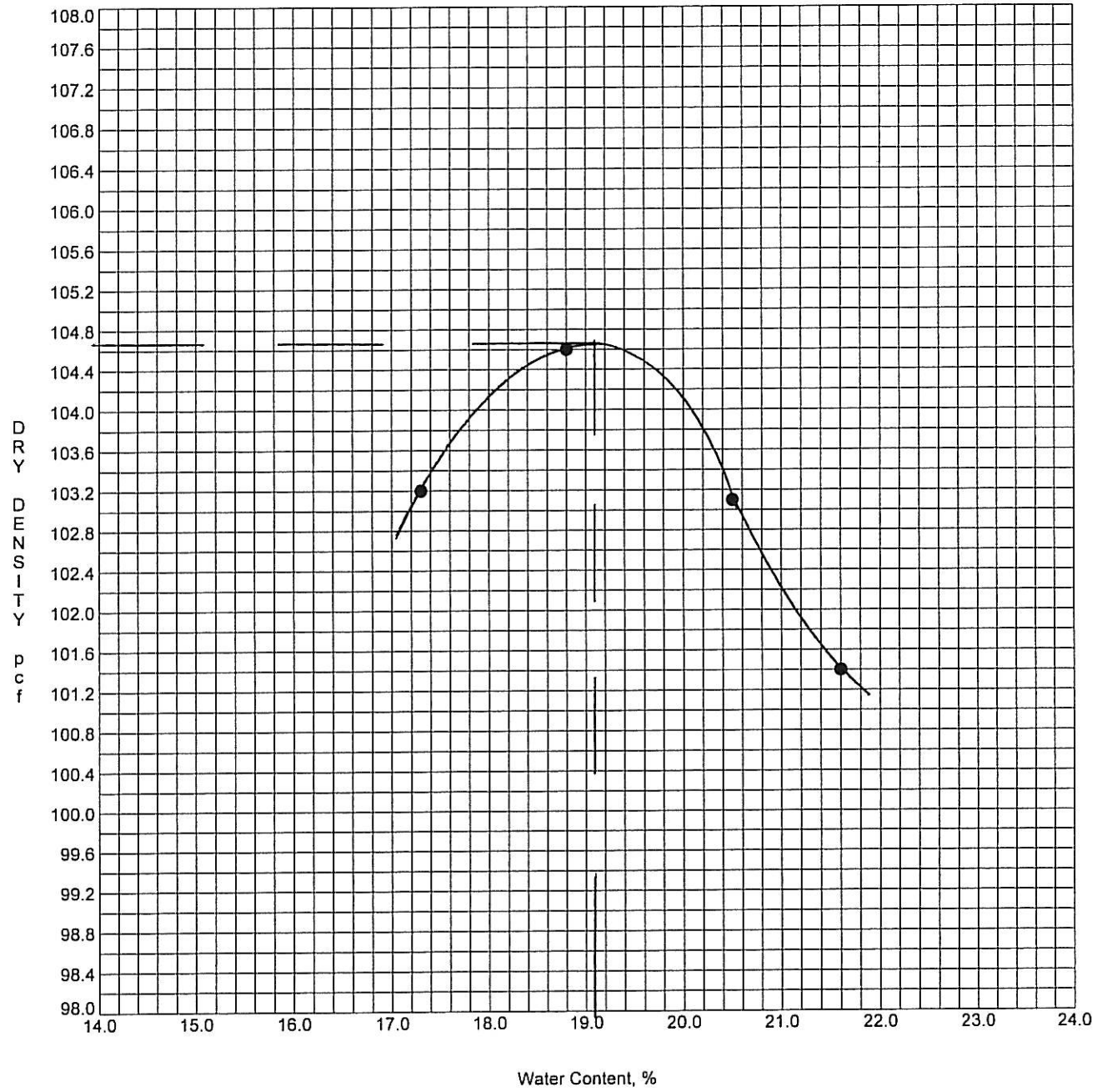
Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

UNCONFINED COMPRESSION TEST

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



Sample Identification	Station / Offset / Line	Depth, ft.	Elevation, USC+GS
● RB-8A BS-1	250+02 27' Lt. "A"	1.0 - 2.0	902.0 - 901.0

Lab No.	Classification	As Received M.C., %	Optimum M.C., %	Maximum Dry Den., pcf	Test Method
6234SL	CLAY A-7-6 (24)	---	19.1	104.7	AASHTO T 99

EARTH EXPLORATION, Inc.

Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

MOISTURE - DENSITY RELATIONS

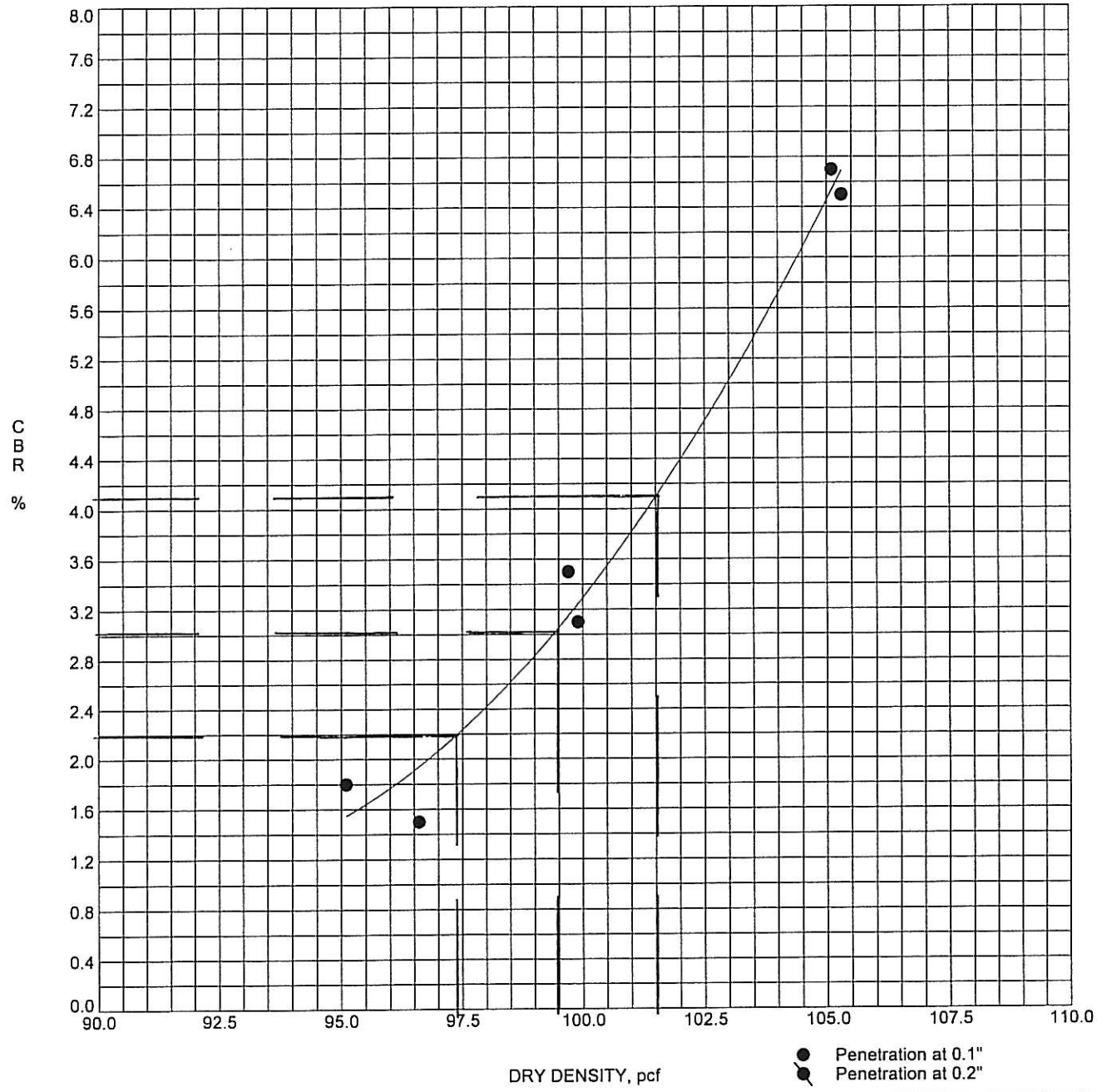
Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)

SUMMARY OF CBR TEST RESULTS

PROJECT:	SR 32 Improvements
LOCATION:	Hamilton County, Indiana
CLIENT:	Indiana Department of Transportation
EEI PROJECT NO.:	1-04-189
BORING NO.:	RB-8A
LOCATION:	250+02, 27 ft Lt. "A"
SAMPLE DEPTH, ft:	1 to 2
SOIL DESCRIPTION:	Clay, A-7-6(24)
MAXIMUM DRY DENSITY, lb/ft^3:	104.7
OPT. MOISTURE CONTENT, %:	19.1
SURCHARGE WEIGHT, lb:	25

TEST DATA								
Specimen No.	Blows/ Layer	Initial Dry Density, lb/ft^3	% Max. Dry Density	Avg. Water Content, %		Swell, %	CBR, % @ 0.1 in. Pen.	CBR, % @ 0.2 in. Pen.
				As Molded	After Soaking			
1	56	105.3	100.6	18.9	20.6	.68	6.5	6.8
2	56	105.1	100.4	19.2	20.3	.7	6.7	5.9
3	30	99.9	95.4	19.2	23.5	1.22	3.1	3.1
4	30	99.7	95.2	19.1	22.5	1.11	3.5	3.5
5	20	96.6	92.3	18.9	25.6	1.75	1.5	1.5
6	18	95.1	90.8	19.1	24.6	1.59	1.8	1.8

TEST RESULTS		
Dry Density, lb/ft^3	Percent Maximum Dry Density	CBR, %
97.4	93.0	2.2
99.5	95.0	3.0
101.6	97.0	4.1



Sample Identification		Station / Offset / Line	Depth, ft.	Classification
RB-8A	BS-1	250+02 27' Lt. "A"	1.0 - 2.0	CLAY A-7-6 (24)

Lab No.	Maximum Wet Den, pcf	Maximum Dry Den, pcf	Optimum M.C., %	LL	PL	PI	CBR at 93%	CBR at 95%	CBR at 97%
6234SL	124.7	104.7	19.1	47	15	32	2.2	3.0	4.1

% Passing No. 10	% Passing No. 40	% Passing No. 200	%Gravel	%Sand	%Silt	%Clay
98.0	93.9	79.0	2.0	19.0	46.6	32.4

EARTH EXPLORATION, Inc.

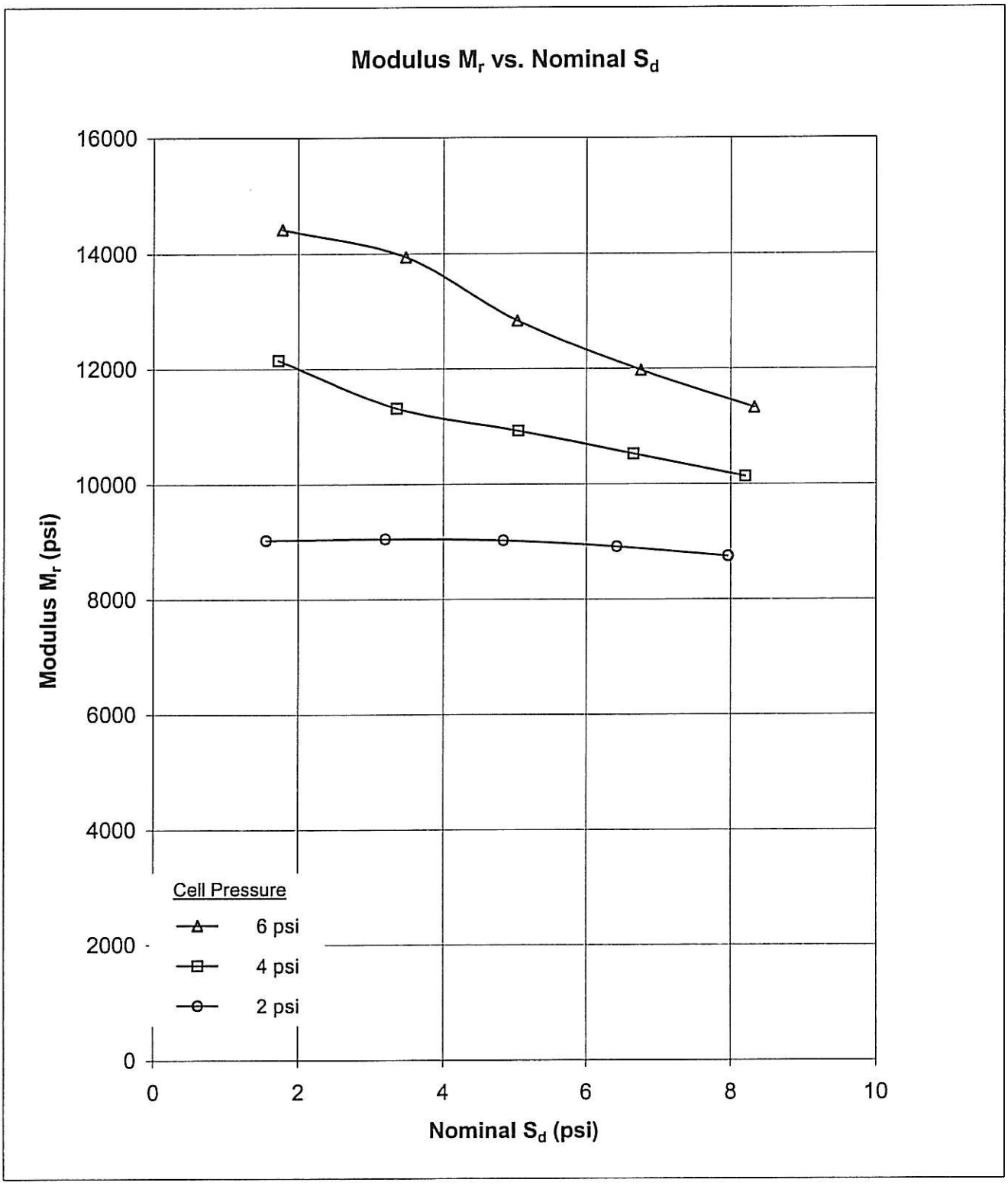
Project No. STP-088-6( ) **Project** SR 32 Improvements

Structure No. --- **Location** Hamilton County, Indiana

EEI Proj. No. 1-04-189 **Client** Indiana Department of Transportation

CALIFORNIA BEARING RATIO

Earth Exploration, Inc.
7770 West New York Street Indianapolis, Indiana 46214
317-273-1690 / 317-273-2250 (Fax)



Resilient Modulus Test Results

RB-8A_BS-1a

SR 32 Improvements

Compacted Specimen at 95% Optimum Dry Density, Optimum Moisture

TRIAXIAL TEST (AASHTO T-307-99): Specimen Setup / Take Down

Project Number: 0401-1533 Test Type: Res Mod Cell No.: _____ File Name: RB-8A_BS-1a

Task No.: _____

Project Name: 1-04-189

Assig. Remarks: Compact to 95% of max dry density at opt. Moisture content Specific Gravity: 2.740 [ ] Meas.; [X] Assumed

[ ] Tube [ ] Field Extruded [ ] Liner [ ] Remolded	[ ] Tamping	[ ] Constant Effort:	Blows/Tamps per Layer =
Boring No.: RB-8A [X] Reconstituted	[ ] Impact/Rammer	Rammer Wgt.(lbf)=	No. Layers =
Sample No.: BS-1 Compostite No.:	[ ] Pluviated:	Tamper Force (lbf)=	Drop (in.) =
Depth (ft): 1-2' Specimen No.: a	[ ] Kneading	[ ] Undercompaction: U_{ni} (%) =	Dia. (in.) =
[ ] Spec. Selection by X-ray; [ ] Geomarine Sample	[ ] ? Notation	Ref. Effort = ?? % Comp. = ??	± Opt. = ??

Water Content (WC);	Initial - Trimming Location			Final, W_{at}
	Top ($W_{o,1}$)	Bottom ($W_{o,2}$)	Sides ($W_{o,3}$)	(see below)
Container No	112			1
Mass Moist Soil + Cont. (g)	140.79			1296.09
Mass Dry Soil + Container (g)	123.10			1117.49
Mass Container (g)	31.97			203.35
Water Content, $W_{o,n}$ (%)	19.41			19.54
Avg. Initial WC, $W_{o,avg}$ (%)	19.41	Final (W_{at}); [X] Slice ; [ ]		Whole Spec.

[ ] See attached data sheet(s) for additional water contents

SOIL MASSES:	Initial	Final
Moist + Tare (etc.)(g)	1093.00	1093.40
Tare (etc.) (g)	0.00	0.00
Mass Moist Spec., $M_{t,n}$ (g)	1093.00	1093.40
Excess Dry Soil (soil not included in final mass measurement)		
Container No.		
Mass Dry Soil + Cont. (g)		
Mass Container (g)		
Mass Excess Dry Soil, $M_{d,es}$ (g)		0.00

Specimen Dimensions, (mm)

	Height			Dia., X indicates with membrane		
	Initial (H_o)	Final (H_{at})		Initial (D_o)	Final (D_{at})	
GB	127.000	127.000	1 T	71.20	71.50	[ ] For
1	17.06	16.91	2 M	71.20	72.00	Wedge
2	17.34	17.34	3 B	71.20	71.50	Failure
3	17.08	17.64	1'T			= d_{max}
4	17.13	17.33	2'M			= d_{min}
5	17.12	17.32	3'B			= Δd
Avg.	144.15	144.31	Avg.	71.20	NA	xxxxx

Measuring Devices:
Pi Tape: [X] Dia
Calipers: [ ] Ht.; [ ] Dia
Dial Comparator: [X] Ht.; [ ] Dia
Remarks:

$A_o = \pi D^2/400$ (cm^2)	39.82
V_o (cm^3)	573.92
$A_{atb,m} = \pi (D^*_{at})^2 /400$ (cm^2)	NA
$A_{atw,m} = (d_{min} - 2\Delta d) d_{max} \pi /400$ (cm^2)	NA
$D^*_{at} = (D_T + 2D_M + D_B)/4$ (mm)	NA

Estimated Initial Unit Weight

Total, $\gamma_{t,o}$ (lbf/ft^3) 118.89 Dry, $\gamma_{d,o}$ (lbf/ft^3) 99.56

Membrane / Filter Paper / Apparatus

Membrane (mm):		Top	Bottom
Number: = 1	Thickness: [ ] Single; [X] Double	1.40	1.40
		1.40	1.40
	Circumference ($C_{rm,o}$)	220.0	225.0
(1) Total thickness, if 2+ membranes		Thickness (1)	Dia.($C_{rm,o}/\pi$)
	Average:	0.70	70.82

Filter Paper: Top + Bottom: [X] Yes ; [ ] No
Filter Strips: [ ] Yes ; [X] No Number =
Type of Filter Strips: [ ] Vertical: ¼ in. & Whatman #54
[ ] Sprial: ¼ in. & Whatman #1

Apparatus: Mass Top Cap, M_{tc} = 585.0 g, 1.29 lbf
Mass Displ. System, M_{ds} (cap, dial, piston, etc.) = NA g, NA lbf

Top Cap Attached: [ ] Yes; [X] No; Piston Dia.(in.) [X] ½; [ ] ¾; [ ] Load Cell: [X] External [ ] Internal
Top Cap; Rotation: [ ] Fixed,<1°; [X] Limited,<5°; [ ] Unlimited, >5°
App. with: [ ] Frictionless End Caps; [ ] Lat. Movement Top Cap
[ ] Internal LVDT Jacket

[ ] Photo Taken.

Failure Sketch

ε_a=
20%→

Failure Mode: [ ] Bulge [ ] Wedge [ ] Parabolic
Wedge/Bulge Ht.= _____ (mm)

NA - Not Applicable
GB - Gage Block
Other Remarks:

Final Visual Classification: Sandy Clay, olive gray with roots

Trimmed / Reconstituted By: dbn Date: 7/31/2004
Prelim. Calc. By: dbn
[ ] See more detailed sketch on attached sheet. Reviewed By: mnm

Setup By: mnm Date: 8/2/2004
Final Calc. By: mnm
Spot Chk. By: JDLD

Take Down By: mnm Date: 8/2/2004
Checked By: _____

Resilient Modulus Test Data Sheet

AASHTO Designation: T 307-99 (1999)

Project Number: 0401-1533 | Task Number: | Boring/Exploration No.: RB-8A

Project Name: 1-04-189 | Assignment Number: NA | Sample No.: BS-1

Project Engineer: | Penetration/Depth (ft): 1-2'

Specific Gravity: 2.740 [ ] Measured; [X] Assumed

Soil Description: Sandy Clay, olive gray with roots

Soil Masses	Initial	Final
Tare + Wet Soil (g):	NA	NA
Mass of Wet Soil Used(g):	NA	

After Resilience Testing

Final Wet Mass (g): 1093.40

Mass Dried Spec. (g): 914.69

Water Content (%): 19.54

Initial Specimen Parameters

Initial Area (in^2): 6.17

Volume (cm^3): 573.92

Compaction w_c

Water Content (%): 19.41

Saturation (%): NA

Wet Density (pcf): 118.89

Dry Density (pcf): 99.56

Specimen Measurements--(mm)

*Diameter: Top: 71.20

Middle: 71.20 Average: 71.20

Bottom: 71.20

Specimen Measurements--(in)

Net Diameter NA Ht. Platens: NA

Inside Diameter Of Mold NA

Membrane Thickness: NA X2

	Initial	Final
Ht. Spec. + Platens:	NA	NA
Specimen height:	5.68	NA

*Total of specimen diameter plus twice the membrane thickness.

Cell Pressure (psi)	Nominal S_d (psi)	Load Cell Chart Reading	K_1	Axial Load (lbs)	S_d (psi)	DT Chart Reading	K_1	Recov. Def. mm (in.)	E_r mm/mm (in./in.)	$M_r = S_d/E_r$ (psi)
6	2	10.99773624	1	10.99773624	1.782054133	0.017798888	0.0394	0.000701276	0.000123572	14421.13257
6	4	21.43528506	1	21.43528506	3.473336467	0.035886815	0.0394	0.001413941	0.000249152	13940.65846
6	6	31.03393272	1	31.03393272	5.028684709	0.056434369	0.0394	0.002223514	0.000391807	12834.59239
6	8	41.71968592	1	41.71968592	6.760185651	0.081302476	0.0394	0.003203318	0.000564459	11976.39739
6	10	51.36316112	1	51.36316112	8.32279767	0.105842811	0.0394	0.004170207	0.000734835	11326.07201
4	2	10.65780608	1	10.65780608	1.726972439	0.02047382	0.0394	0.000806669	0.000142144	12149.4851
4	4	20.69851086	1	20.69851086	3.353950851	0.042697397	0.0394	0.001682277	0.000296435	11314.27269
4	6	31.12756364	1	31.12756364	5.043856501	0.066495275	0.0394	0.002619914	0.000461657	10925.54935
4	8	41.08065778	1	41.08065778	6.656638638	0.091131138	0.0394	0.003590567	0.000632697	10521.06091
4	10	50.61830006	1	50.61830006	8.202101674	0.116571829	0.0394	0.00459293	0.000809324	10134.51302
2	2	9.64310626	1	9.64310626	1.562552237	0.024919444	0.0394	0.000981826	0.000173008	9031.659249
2	4	19.73638418	1	19.73638418	3.19804951	0.050887572	0.0394	0.00200497	0.000353297	9052.005313
2	6	29.87453998	1	29.87453998	4.840818718	0.077233529	0.0394	0.003043001	0.00053621	9027.849011
2	8	39.67812182	1	39.67812182	6.42937414	0.103866086	0.0394	0.004092324	0.000721111	8915.922398
2	10	49.15935116	1	49.15935116	7.965696121	0.131125296	0.0394	0.005166337	0.000910364	8750.011026

RB-8A_BS-1a Optimum	Confining Pressure	Deviator Stress	Resilient Modulus	Bulk Stress	Octahedral Shear Stress	Resilient Strain	Resilient Modulus
Sequence	σ_3	σ_d	Mr	θ	τ_{oct}	Strain	log Mr
	psi	psi	psi	psi	psi	in/in	psi
1	6	1,782	14,421	19.782	0.840	0.000124	4.1590
2	6	3,473	13,941	21.473	1.637	0.000249	4.1443
3	6	5,029	12,835	23.029	2.371	0.000392	4.1084
4	6	6,760	11,976	24.760	3.187	0.000564	4.0783
5	6	8,323	11,426	26.323	3.923	0.000735	4.0541
6	4	1,727	12,749	13.727	0.814	0.000142	4.0846
7	4	3,354	11,314	15.354	1.581	0.000296	4.0536
8	4	5,044	10,926	17.044	2.378	0.000462	4.0384
9	4	6,657	10,521	18.657	3.138	0.000633	4.0221
10	4	8,202	10,135	20.202	3.867	0.000809	4.0058
11	2	1,563	9,932	7.563	0.737	0.000173	3.9558
12	2	3,198	9,052	9.198	1.508	0.000353	3.9567
13	2	4,841	9,028	10.841	2.282	0.000536	3.9556
14	2	6,429	8,916	12.429	3.031	0.000721	3.9502
15	2	7,966	8,750	13.966	3.755	0.000910	3.9420
				2.520	-0.049		

Regression Coefficient	Resilient Modulus Non-Linear Model			
	Boudreau	Universal	k1-k7	2002 DG
k1	8,080	455	454.682	946
k2	-0.093	0.482	0.126	0.486
k3 (k5)	0.331	-0.223	-0.241	-2.009
k6			2.538	
k7			0.001	
Se/Sy	0.26	0.20	#NUM!	0.09
R^2	0.93	0.96	#NUM!	0.99

User Input sample ID. Also used on charts as title.
User input Mr data from T-307 test results.
Model parameters
Ratio to be minimized through regression

IMPORTANT "Solver..." must appear in your Tools menu for the application to run
If it is missing, check the Excel help on how to "install Solver"

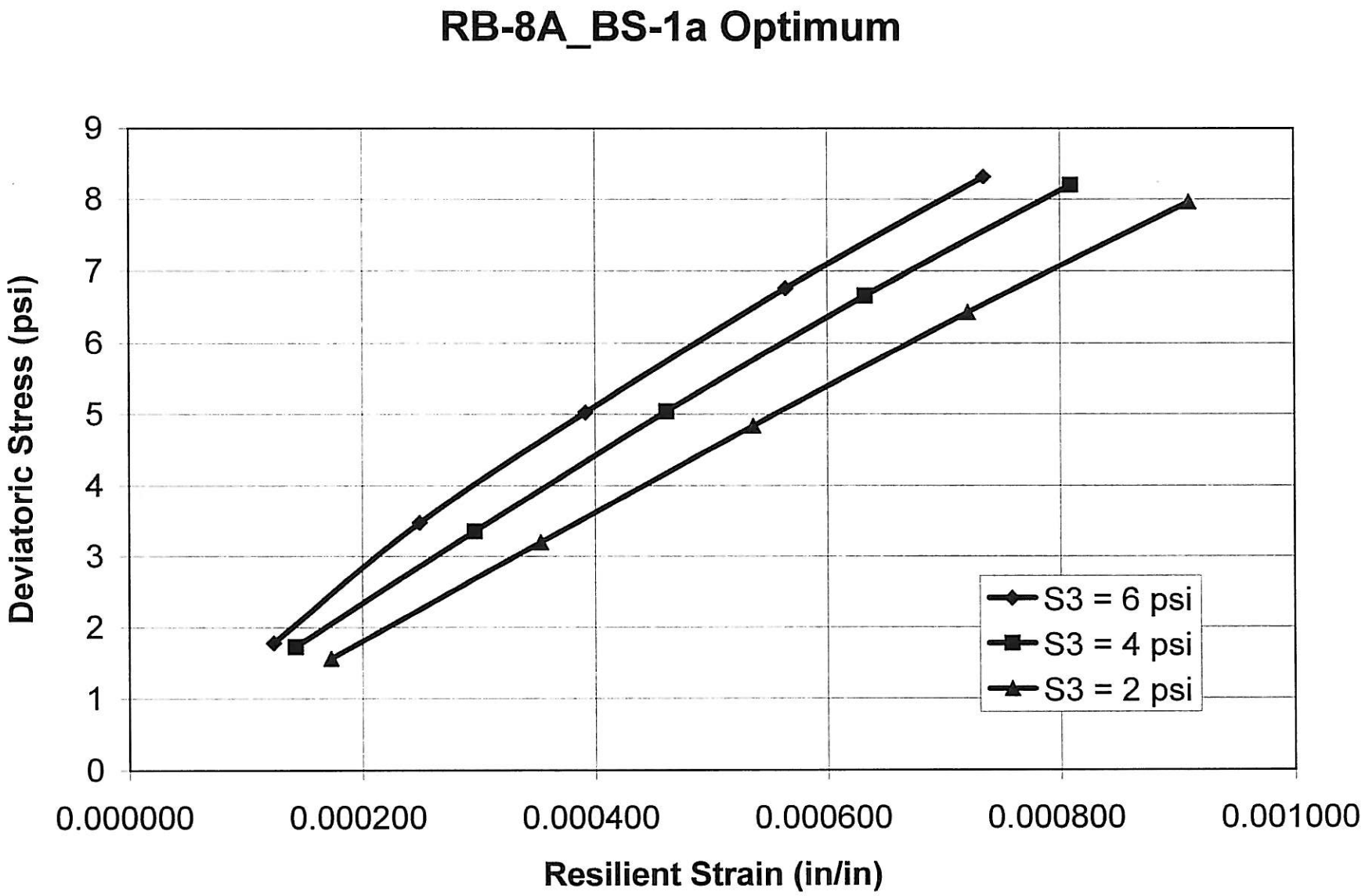
Predicted Non-Linear Resilient Modulus — Solve

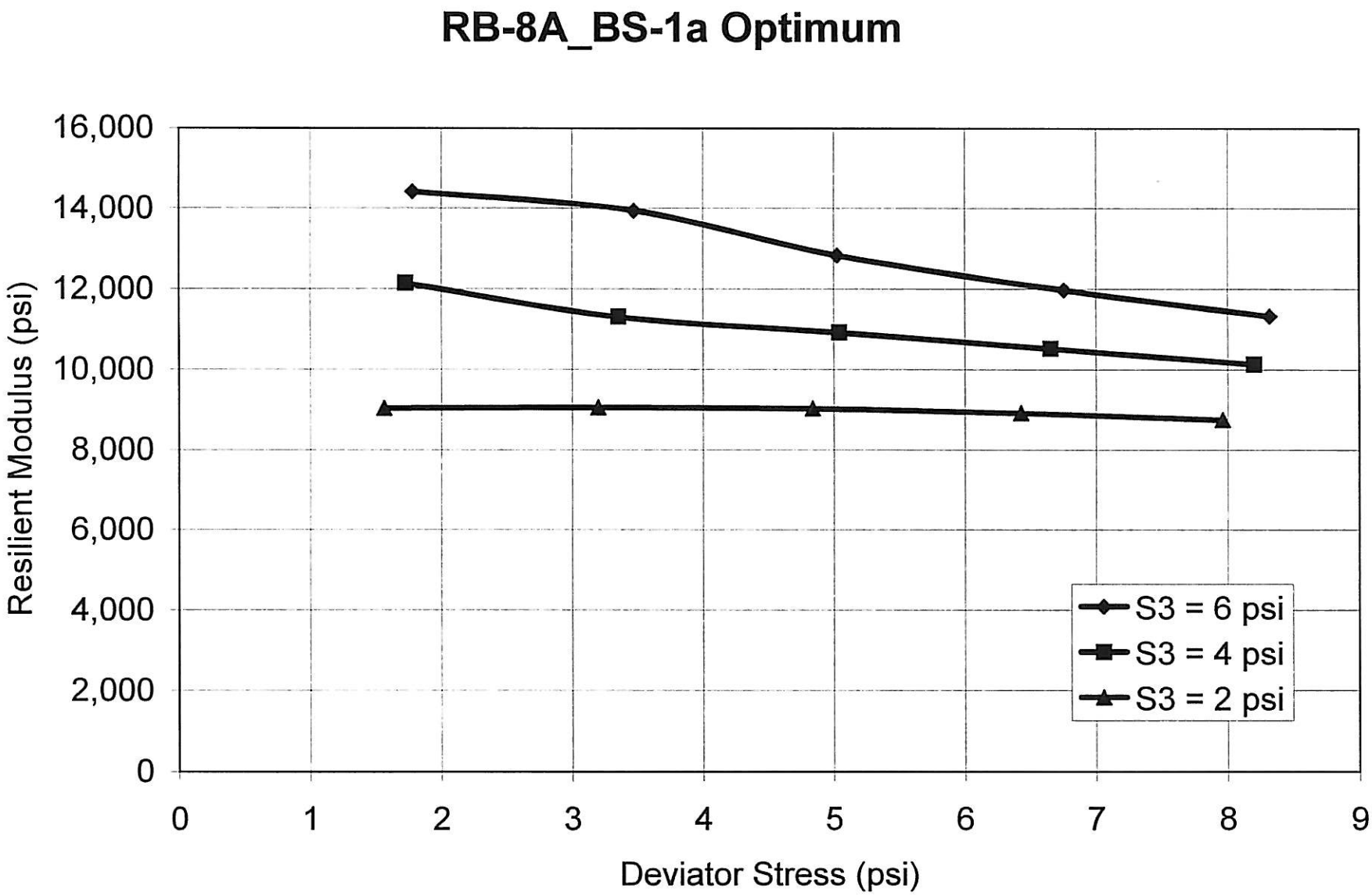
Boudreau			
Parameter	Result	Mr_{pred}	Error
k1	8,080	13,857	3.007E-04
k2	-0.093	13,025	8.696E-04
k5	0.331	12,586	7.198E-05
n	15	12,246	9.332E-05
SES	0.0042785	12,012	6.521E-04
Sy	0.0723655	12,152	9.418E-09
Se	0.0188823	11,427	1.856E-05
Se/Sy		11,003	9.398E-06
R^2	0.93	10,724	6.857E-05
		10,518	2.603E-04
		9,752	1.109E-03
		9,125	1.223E-05
		8,781	1.447E-04
		8,553	3.253E-04
		8,385	3.424E-04

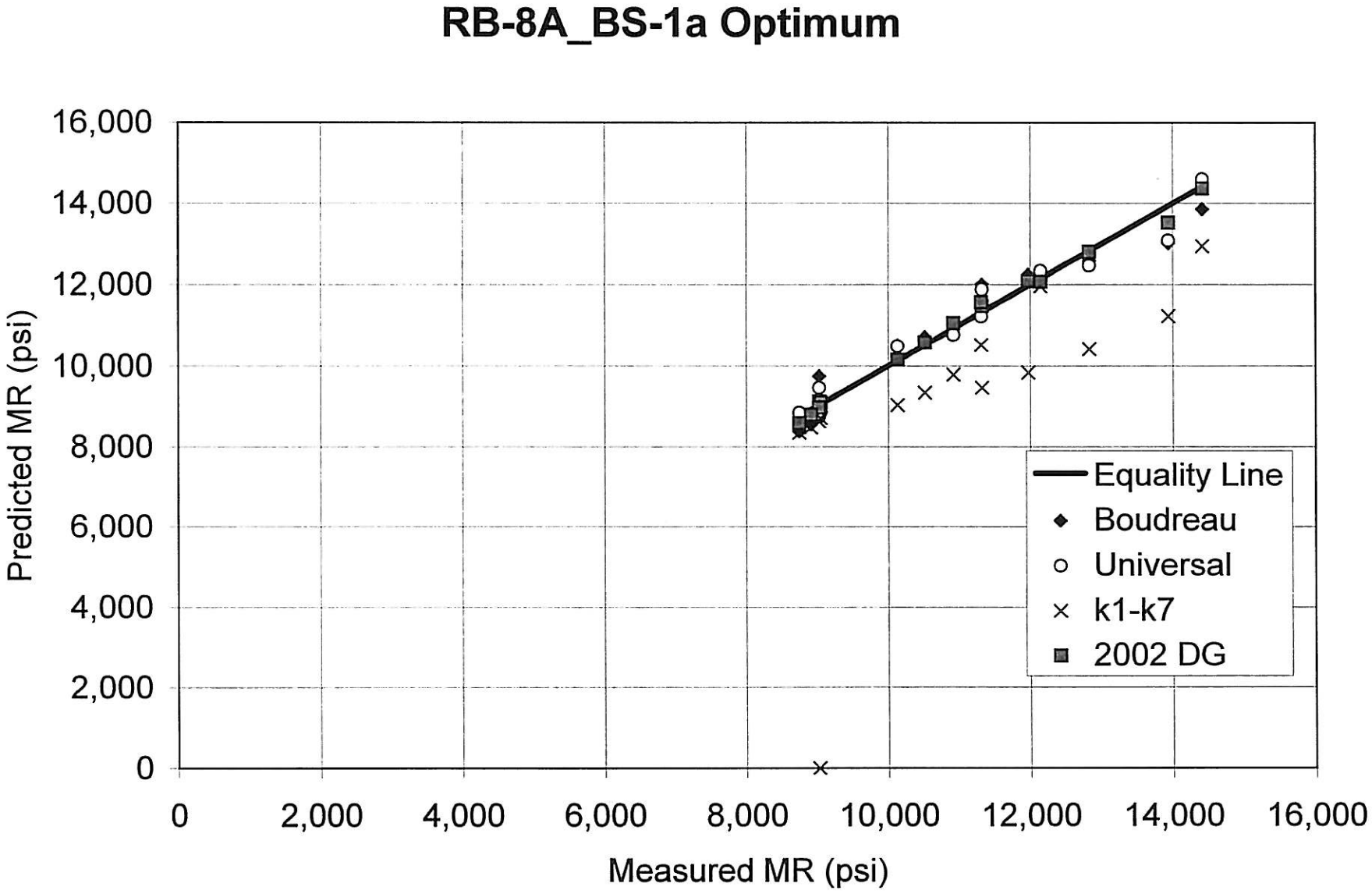
Universal (Uzan/Witczak)			
Parameter	Result	Mr_{pred}	Error
k1	455	14,606	3.065E-05
k2	0.482	13,093	7.420E-04
k3	-0.223	12,469	1.577E-04
n	15	12,087	1.604E-05
SES	0.0024664	11,885	4.374E-04
Sy	0.0723655	12,333	4.246E-05
Se	0.0143365	11,225	1.171E-05
Se/Sy		10,778	3.501E-05
R^2	0.96	10,582	6.304E-06
		10,495	2.310E-04
		9,461	4.076E-04
		8,862	8.467E-05
		8,745	1.906E-04
		8,768	5.271E-05
		8,842	2.056E-05

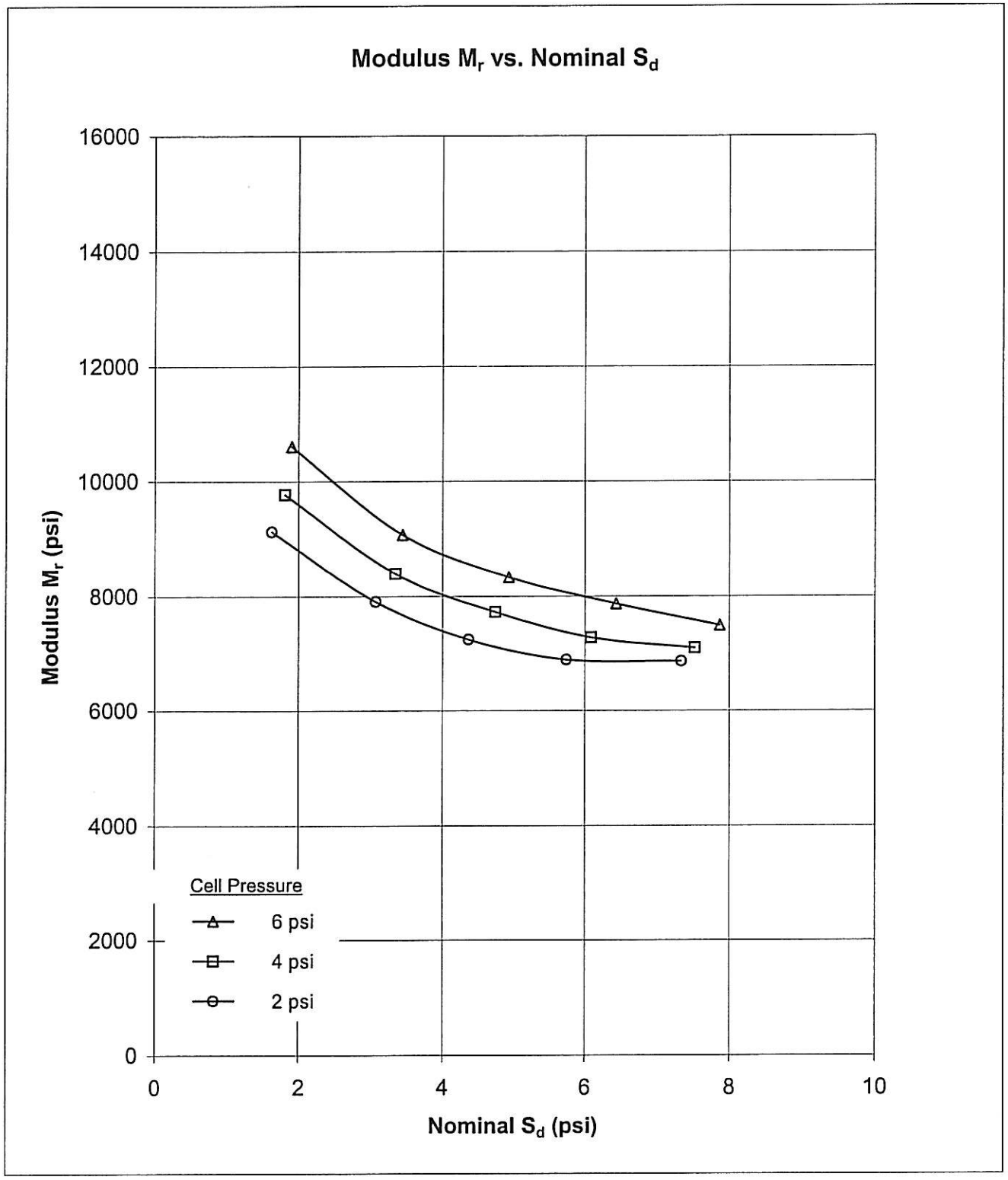
k1-k7 (University of Maryland)			
Parameter	Result	Mr_{pred}	Error
k1	454.682	12,950	2.182E-03
k2	0.126	11,231	8.810E-03
k3	-0.241	10,419	8.204E-03
k6	2.538	9,837	7.307E-03
k7	0.001	9,461	6.104E-03
n	15	11,964	4.473E-05
SES	#NUM!	10,524	9.884E-04
Sy	0.0723655	9,786	2.287E-03
Se	#NUM!	9,341	2.670E-03
Se/Sy		9,032	2.500E-03
R^2	#NUM!	#NUM!	#NUM!
		8,717	2.684E-04
		8,635	3.740E-04
		8,484	4.644E-04
		8,345	4.228E-04

2002 Design Guide Stress-Dependent			
Parameter	Result	Mr_{pred}	Error
k1	946	14,370	2.401E-06
k2	0.486	13,525	1.732E-04
k3	-2.009	12,811	6.268E-07
n	15	12,082	1.462E-05
SES	0.0004929	11,478	3.347E-05
Sy	0.0723655	12,071	7.906E-06
Se	0.0064088	11,569	9.360E-05
Se/Sy		11,058	2.736E-05
R^2	0.99	10,587	7.330E-06
		10,154	7.163E-07
		9,125	1.990E-05
		9,100	5.317E-06
		8,975	6.519E-06
		8,795	3.489E-05
		8,589	6.506E-05


RB-8A_BS-1a Optimum
Deviatoric Stress (psi)
9
8
7
6
5
4
3
2
1
0
0.000000
0.000200
0.000400
0.000600
0.000800
0.001000
Resilient Strain (in/in)
S3 = 6 psi
S3 = 4 psi
S3 = 2 psi


RB-8A_BS-1a Optimum
Resilient Modulus (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0
1
2
3
4
5
6
7
8
9
Deviator Stress (psi)
S3 = 6 psi
S3 = 4 psi
S3 = 2 psi


RB-8A_BS-1a Optimum
Predicted MR (psi)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Measured MR (psi)
Equality Line
Boudreau
Universal
k1-k7
2002 DG



Resilient Modulus Test Results

RB-8A_BS-1b

SR 32 Improvements

Compacted Specimen at 95% Optimum Dry Density, Optimum Moisture +2%

TRIAXIAL TEST (AASHTO T-307-99): Specimen Setup / Take Down

Project Number: 0401-1533 Test Type: Res Mod Cell No.: _____ File Name: RB-8A_BS-1b

Task No.: _____

Project Name: 1-04-189

Assig. Remarks: Compact to 95% of max dry density at +2% of opt. Moisture content Specific Gravity: 2.740 [ ] Meas.; [X] Assumed

[ ] Tube [ ] Field Extruded [ ] Liner [ ] Remolded		[ ] Tamping	[ ] Constant Effort: Blows/Tamps per Layer =
Boring No.: RB-8A [X] Reconstituted		[ ] Impact/Rammer	Rammer Wgt.(lbf)= _____ No. Layers =
Sample No.: BS-1 Compostite No.: _____		[ ] Pluviated:	Tamper Force (lbf)= _____ Drop (in.) =
Depth (ft): 1-2' Specimen No.: b		[ ] Kneading	[ ] Undercompaction: U_{ni} (%) = _____ Dia. (in.) =
[ ] Spec. Selection by X-ray; [ ] Geomarine Sample		[ ] ? Notation	Ref. Effort = ?? % Comp. = ?? ± Opt. = ??

Water Content (WC);	Initial - Trimming Location			Final, W_{at}
	Top ($W_{o,1}$)	Bottom ($W_{o,2}$)	Sides ($W_{o,3}$)	(see below)
Container No	174			101
Mass Moist Soil + Cont. (g)	133.10			1320.13
Mass Dry Soil + Container (g)	115.18			1122.03
Mass Container (g)	31.59			207.34
Water Content, $W_{o,n}$ (%)	21.44			21.66
Avg. Initial WC, $W_{o,avg}$ (%)	21.44	Final (W_{at}); X Slice ;		Whole Spec.

[ ] See attached data sheet(s) for additional water contents

SOIL MASSES:	Initial	Final
Moist + Tare (etc.)(g)	1111.10	1113.40
Tare (etc.) (g)	0.00	0.00
Mass Moist Spec., $M_{t,n}$ (g)	1111.10	1113.40
Excess Dry Soil (soil not included in final mass measurement)		
Container No.		
Mass Dry Soil + Cont. (g)		
Mass Container (g)		
Mass Excess Dry Soil, $M_{d,es}$ (g)		0.00

Specimen Dimensions, (mm)

	Height			Dia., X indicates with membrane		
	Initial (H_o)	Final (H_{at})		Initial (D_o)	Final (D_{at})	
GB	127.000	127.000	1 T	71.20	71.20	For
1	17.24	16.92	2 M	71.20	71.30	Wedge
2	17.10	17.47	3 B	71.20	71.30	Failure
3	17.29	17.54	1'T			= d_{max}
4	17.10	17.01	2'M			= d_{min}
5	17.31	17.30	3'B			= Δd
Avg.	144.21	144.25	Avg.	71.20	NA	xxxxx

Measuring Devices:
Pi Tape: [X] Dia
Calipers: [ ] Ht.; [ ] Dia
Dial Comparator: [X] Ht.; [ ] Dia
Remarks:

$A_o = \pi D^2/400$ (cm^2)	39.82
V_o (cm^3)	574.17
$A_{atb,m}=\pi (D^*_{at})^2/400$ (cm^2)	NA
$A_{atw,m}=(d_{min}-2\Delta d)d_{max}\pi/400$ (cm^2)	NA
$D^*_{at}=(D_T+2D_M+D_B)/4$ (mm)	NA

Estimated Initial Unit Weight

Total, $\gamma_{t,o}$ (lbf/ft^3) 120.81 Dry, $\gamma_{d,o}$ (lbf/ft^3) 99.48

Membrane / Filter Paper / Apparatus

Membrane (mm):		Top	Bottom
Number: = 1	Thickness: [ ] Single; [X] Double	1.40	1.40
		1.40	1.40
	Circumference ($C_{rm,o}$)	220.0	225.0
(1) Total thickness, if 2+ membranes		Thickness (1)	Dia.($C_{rm,o}/\pi$)
	Average:	0.70	70.82

Filter Paper: Top + Bottom: [X] Yes ; [ ] No
Filter Strips: [ ] Yes ; [X] No Number =
Type of Filter Strips: [ ] Vertical: ¼ in. & Whatman #54
[ ] Sprial: ¼ in. & Whatman #1

Apparatus: Mass Top Cap, M_{tc} = 585.0 g, 1.29 lbf
Mass Displ. System, M_{ds} (cap, dial, piston, etc.) = NA g, NA lbf

Top Cap Attached: [ ] Yes; [X] No; Piston Dia.(in.) [X] ½; [ ] ¾; [ ] Load Cell: [X] External [ ] Internal
Top Cap; Rotation: [ ] Fixed,<1°; [X] Limited,<5°; [ ] Unlimited, >5°
App. with: [ ] Frictionless End Caps; [ ] Lat. Movement Top Cap
[ ] Internal LVDT Jacket

[ ] Photo Taken.

Failure Sketch

ε_a=

20%→

Failure Mode: NA - Not Applicable
[ ] Bulge GB - Gage Block
[ ] Wedge Other Remarks:
[ ] Parabolic
Wedge/Bulge Ht.= _____ (mm)

Final Visual Classification: Sandy Clay, olive gray with roots

Trimmed / Reconstituted By: dbn Setup By: mnm Take Down By: mnm
Date: 7/31/2004 Date: 8/2/2004 Date: 8/2/2004
Prelim. Calc. By: dbn Final Calc. By: mnm
[ ] See more detailed sketch on attached sheet. Reviewed By: mnm Spot Chk. By: WLD Checked By: _____

Resilient Modulus Test Data Sheet

AASHTO Designation: T 307-99 (1999)

Project Number: 0401-1533 | Task Number: | Boring/Exploration No.: RB-8A

Project Name: 1-04-189 | Assignment Number: NA | Sample No.: BS-1

Project Engineer: | Penetration/Depth (ft): 1-2'

Specific Gravity: 2.740 [ ] Measured; [X] Assumed

Soil Description: Sandy Clay, olive gray with roots

Soil Masses	Initial	Final
Tare + Wet Soil (g):	NA	NA
Mass of Wet Soil Used(g):	NA	
After Resilience Testing		
Final Wet Mass (g):	1113.40	
Mass Dried Spec. (g):	915.19	
Water Content (%):	21.66	

Initial Specimen Parameters	
Initial Area (in^2):	6.17
Volume (cm^3):	574.17
Compaction w_c	
Water Content (%):	21.44
Saturation (%):	NA
Wet Density (pcf):	120.81
Dry Density (pcf):	99.48

*Total of specimen diameter plus twice the membrane thickness.

Specimen Measurements--(mm)

*Diameter: Top: 71.20

Middle: 71.20 Average: 71.20

Bottom: 71.20

Specimen Measurements--(in)

Net Diameter NA Ht. Platens: NA

Inside Diameter Of Mold NA

Membrane Thickness: NA X2

	Initial	Final
Ht. Spec. + Platens:	NA	NA
Specimen height:	5.68	NA

Cell Pressure (psi)	Nominal S_d (psi)	Load Cell Chart Reading	K_1	Axial Load (lbs)	S_d (psi)	DT Chart Reading	K_1	Recov. Def. mm (in.)	E_r mm/mm (in./in.)	$M_r = S_d/E_r$ (psi)
6	2	11.74301089	1	11.74301089	1.902817146	0.025861866	0.0394	0.001018958	0.000179474	10602.1832
6	4	21.23697078	1	21.23697078	3.441201964	0.054641683	0.0394	0.002152882	0.000379198	9074.949148
6	6	30.43971392	1	30.43971392	4.932398524	0.08530696	0.0394	0.003361094	0.000592006	8331.664988
6	8	39.68802008	1	39.68802008	6.430978037	0.117813196	0.0394	0.00464184	0.00081759	7865.769113
6	10	48.55034312	1	48.55034312	7.867013513	0.151485181	0.0394	0.005968516	0.001051265	7483.380905
4	2	11.1613898	1	11.1613898	1.808572272	0.026663013	0.0394	0.001050523	0.000185034	9774.279401
4	4	20.63170062	1	20.63170062	3.343125036	0.057390046	0.0394	0.002261168	0.000398271	8394.100266
4	6	29.27464894	1	29.27464894	4.743613413	0.088537009	0.0394	0.003488358	0.000614422	7720.448805
4	8	37.54015924	1	37.54015924	6.082942386	0.120527779	0.0394	0.004748794	0.000836429	7272.515488
4	10	46.4221057	1	46.4221057	7.522157608	0.152861972	0.0394	0.006022762	0.001060819	7090.895355
2	2	10.03115372	1	10.03115372	1.625430776	0.025656986	0.0394	0.001010885	0.000178052	9128.952483
2	4	18.9675967	1	18.9675967	3.073476519	0.056029833	0.0394	0.002207575	0.000388831	7904.395766
2	6	26.94889952	1	26.94889952	4.366753005	0.086904014	0.0394	0.003424018	0.000603089	7240.639025
2	8	35.430967	1	35.430967	5.741172529	0.12016098	0.0394	0.004734343	0.000833883	6884.862035
2	10	45.27881378	1	45.27881378	7.336900565	0.154138928	0.0394	0.006073074	0.001069681	6858.962121

RB-8A_BS-1b Optimum+2	Confining Pressure	Deviator Stress	Resilient Modulus	Bulk Stress	Octahedral Shear Stress	Resilient Strain	Resilient Modulus
Sequence	σ_3	σ_d	Mr	θ	τ_{oct}	Strain	log Mr
	psi	psi	psi	psi	psi	in/in	psi
1	6	1,903	10,802	19.903	0.897	0.000179	4.0254
2	6	3,441	9,075	21.441	1.622	0.000379	3.9578
3	6	4,932	8,332	22.932	2.325	0.000592	3.9207
4	6	6,431	7,866	24.431	3.032	0.000818	3.8957
5	6	7,867	7,483	25.867	3.709	0.001051	3.8741
6	4	1,809	9,774	13.809	0.853	0.000185	3.9901
7	4	3,343	8,394	15.343	1.576	0.000398	3.9240
8	4	4,744	7,720	16.744	2.236	0.000614	3.8876
9	4	6,083	7,273	18.083	2.868	0.000836	3.8617
10	4	7,522	7,091	19.522	3.546	0.001061	3.8507
11	2	1,625	9,129	7.625	0.766	0.000178	3.9604
12	2	3,073	7,904	9.073	1.449	0.000389	3.8979
13	2	4,367	7,241	10.367	2.059	0.000603	3.8598
14	2	5,741	6,885	11.741	2.706	0.000834	3.8379
15	2	7,337	6,859	13.337	3.459	0.001070	3.8363
				2.541	-0.051		

Predicted Non-Linear Resilient Modulus — Solve

Boudreau			
Parameter	Result	Mr_{pred}	Error
k1	9,277	10,273	1.880E-04
k2	-0.225	8,993	1.550E-05
k5	0.138	8,295	3.729E-06
n	15	7,815	7.905E-06
SES	0.0010785	7,469	6.770E-07
Sy	0.0571309	9,827	5.450E-06
Se	0.0094804	8,561	7.284E-05
Se/Sy		7,914	1.155E-04
R^2	0.97	7,484	1.551E-04
		7,136	7.439E-06
		9,150	1.019E-06
		7,931	2.075E-06
		7,329	2.792E-05
		6,892	2.311E-07
		6,523	4.752E-04

Universal (Uzan/Witczak)			
Parameter	Result	Mr_{pred}	Error
k1	309	10,483	2.429E-05
k2	0.200	9,024	5.907E-06
k3	-0.278	8,276	8.627E-06
n	15	7,785	2.004E-05
SES	0.0005236	7,445	4.861E-06
Sy	0.0571309	9,883	2.302E-05
Se	0.0066053	8,509	3.477E-05
Se/Sy		7,856	5.737E-05
R^2	0.99	7,445	1.039E-04
		7,127	4.784E-06
		9,042	1.738E-05
		7,842	1.171E-05
		7,305	1.474E-05
		6,940	1.220E-05
		6,650	1.800E-04

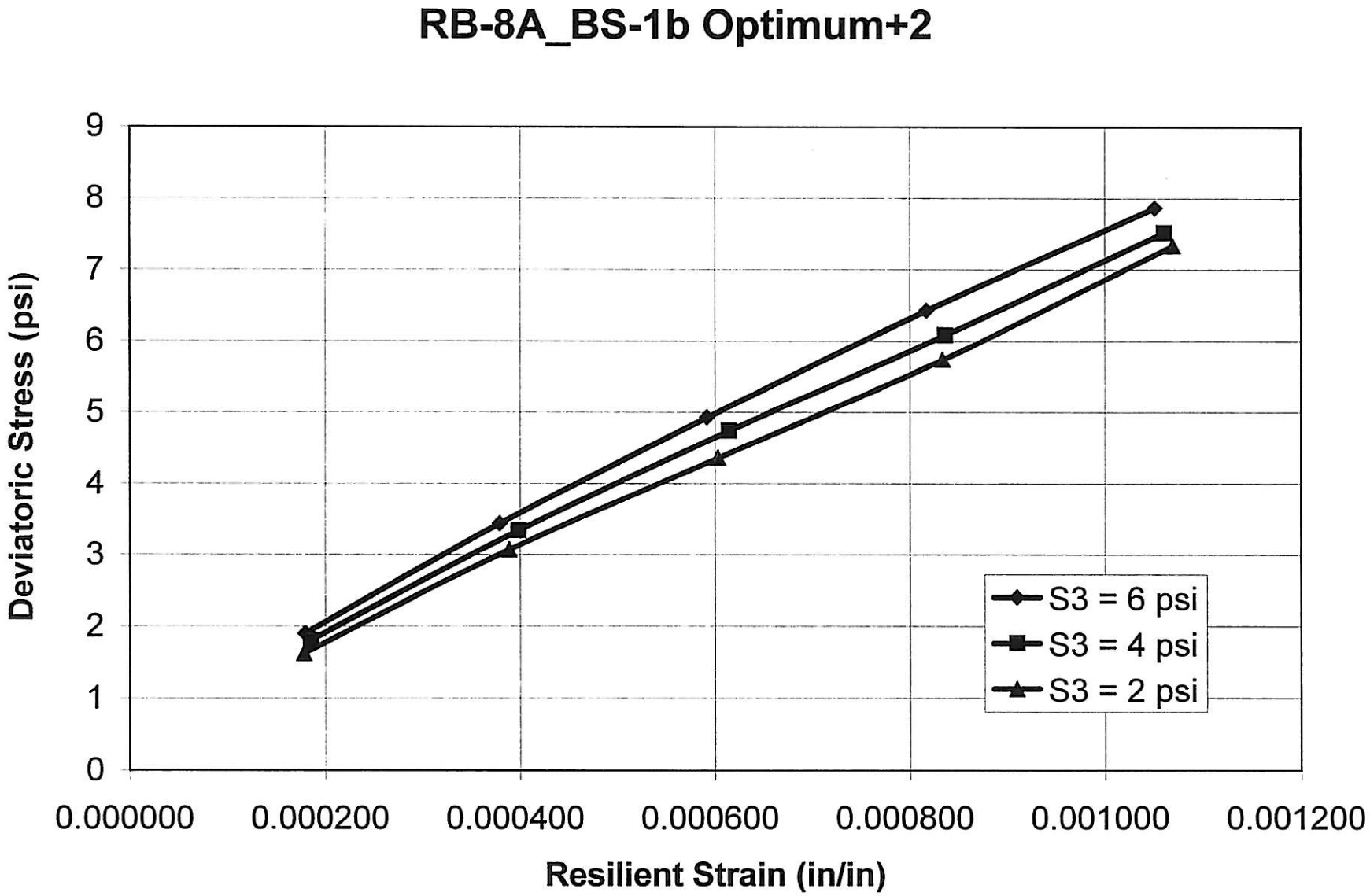
Regression Coefficient	Resilient Modulus Non-Linear Model			
	Boudreau	Universal	k1-k7	2002 DG
k1	9,277	309	308.581	754
k2	-0.225	0.200	0.026	0.195
k3 (k5)	0.138	-0.278	-0.306	-2.412
k6			2.541	
k7			0.007	
Se/Sy	0.17	0.12	0.48	0.29
R^2	0.97	0.99	0.77	0.91

k1-k7 (University of Maryland)			
Parameter	Result	Mr_{pred}	Error
k1	308.581	10,310	1.472E-04
k2	0.026	8,743	2.621E-04
k3	-0.306	7,892	5.543E-04
k6	2.541	7,315	9.956E-04
k7	0.007	6,903	1.228E-03
n	15	10,268	4.582E-04
SES	0.0073808	8,682	2.142E-04
Sy	0.0571309	7,875	7.382E-05
Se	0.0271676	7,344	1.795E-05
Se/Sy		6,918	1.153E-04
R^2	0.77	8,644	5.631E-04
		8,511	1.030E-03
		7,816	1.104E-03
		7,289	6.140E-04
		6,836	2.173E-06

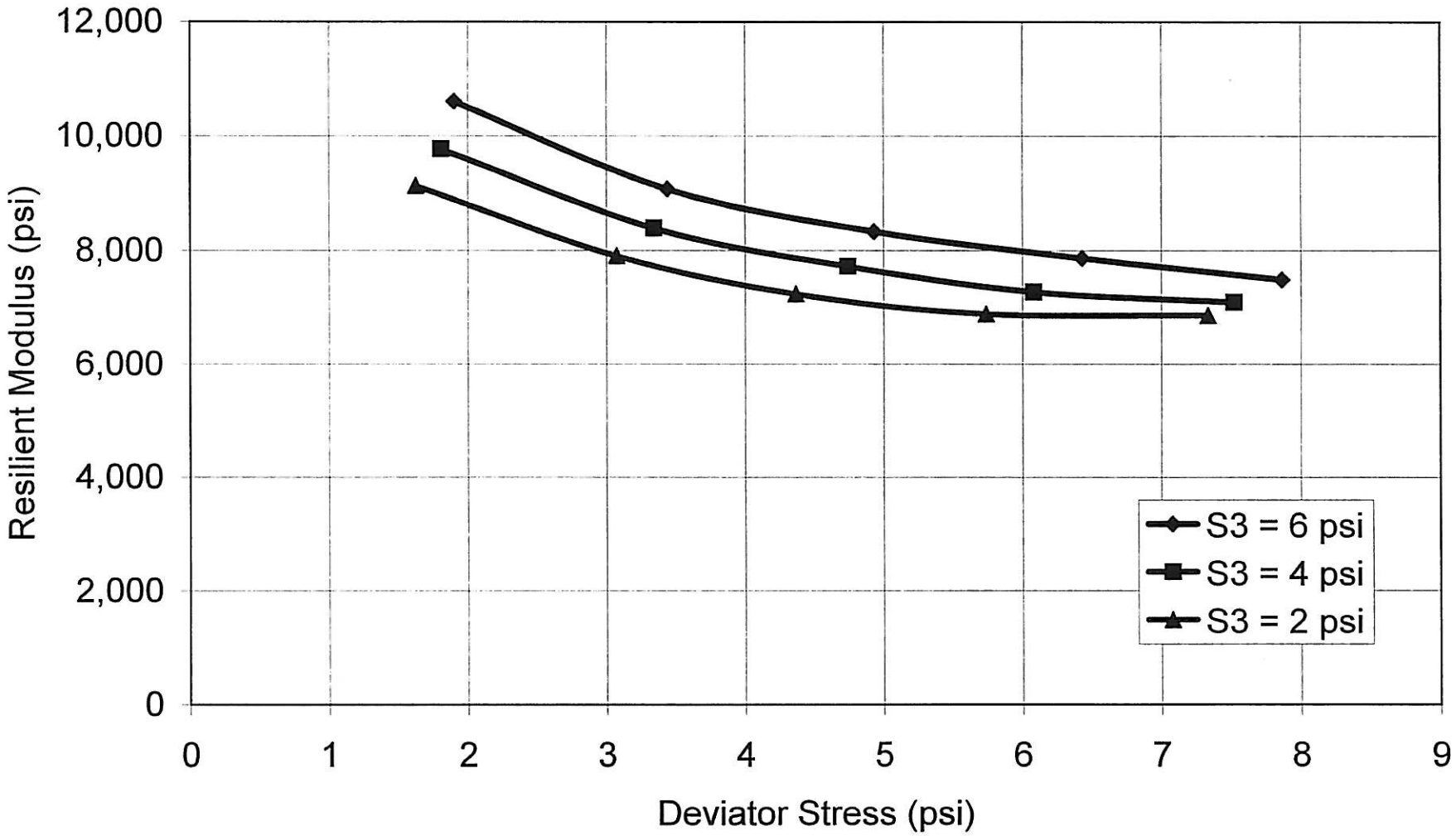
2002 Design Guide Stress-Dependent			
Parameter	Result	Mr_{pred}	Error
k1	754	10,190	2.961E-04
k2	0.195	9,266	8.179E-05
k3	-2.412	8,480	5.902E-05
n	15	7,784	2.072E-05
SES	0.003358	7,191	2.999E-04
Sy	0.0571309	9,554	9.774E-05
Se	0.0167282	8,740	3.072E-04
Se/Sy		8,077	3.845E-04
R^2	0.91	7,506	1.890E-04
		6,954	7.182E-05
		8,624	6.105E-04
		8,039	5.379E-05
		7,545	3.203E-04
		7,055	1.122E-04
		6,531	4.533E-04

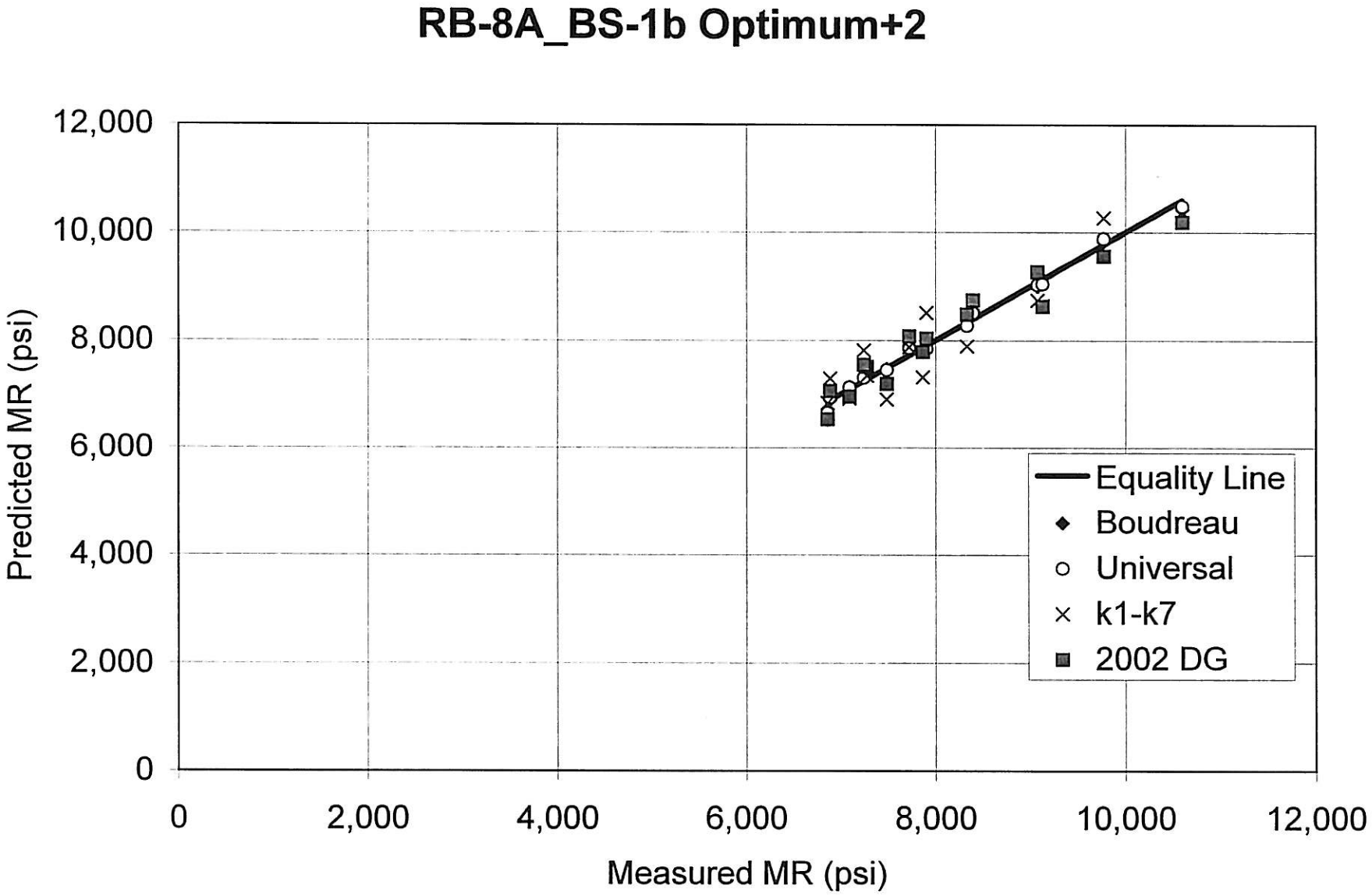
User Input sample ID. Also used on charts as title.
User input Mr data from T-307 test results.
Model parameters
Ratio to be minimized through regression

IMPORTANT "Solver..." must appear in your Tools menu for the application to run
If it is missing, check the Excel help on how to "Install Solver"


RB-8A_BS-1b Optimum+2
Deviatoric Stress (psi)
9
8
7
6
5
4
3
2
1
0
0.000000
0.000200
0.000400
0.000600
0.000800
0.001000
0.001200
Resilient Strain (in/in)
S3 = 6 psi
S3 = 4 psi
S3 = 2 psi

RB-8A_BS-1b Optimum+2




RB-8A_BS-1b Optimum+2
Predicted MR (psi)
12,000
10,000
8,000
6,000
4,000
2,000
0
0
2,000
4,000
6,000
8,000
10,000
12,000
Measured MR (psi)
Equality Line
Boudreau
Universal
k1-k7
2002 DG