REPORT OF SUBSURFACE EXPLORATION

Proposed Loosahatchie Sewer Relocation
Memphis, Tennessee

PSI File No. 502-95051

PREPARED FOR

Allen & Hoshall, Inc.
2430 Poplar Avenue
Memphis, Tennessee 38112

June 1, 1989

BY

PROFESSIONAL SERVICE INDUSTRIES, INC.

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1.0 INTRODUCTION AND AUTHORIZATION

Professional Service Industries, Inc. (PSI) has completed a subsurface exploration for the proposed relocated Loosahatchie sewer to be constructed in Memphis, Tennessee. This work was authorized by Mr. Ted L. Winstead of Allen and Hoshall and was performed in general accordance with PSI Proposal No. 502-083 dated April 3, 1989. The purpose of this study was to explore the subsurface conditions at the site to enable an evaluation of the soil and ground water conditions with respect to construction of the underground sewer. This report briefly outlines the testing procedures, describes the site and subsurface conditions, and discusses the sewer design recommendations.

2.0 TESTING PROCEDURES

2.1 Field Operations

Five soil test borings were made at the site at the approximate locations shown on the attached Boring Location Plan. The boring locations were identified on the site plan obtained from Allen & Hoshall. Furthermore, Allen & Hoshall staked the borings in the field as shown on the site plan and provided elevations of the ground surface at the boring locations.

The borings were advanced into the ground using hollow stem augers. At regular intervals throughout the boring depths, soil samples were obtained with either a 1.4 inch I.D., 2.0 inch O.D., split spoon sampler or a 3 inch diameter Shelby Tube. When the split spoon sampler was used, the sampler was first seated 6 inches to penetrate any loose cuttings and then driven an additional foot with blows of a 140 pound hammer falling 30 inches. The number of hammer blows required to drive the sampler each six inch increment is recorded on the boring logs. The penetration resistance "N-value" is designated as the number of hammer blows required to drive the sampler the final foot and, when properly evaluated, is an index to cohesion for clays and relative density for sands. The split spoon sampling procedures used during this exploration are in basic accordance with ASTM Designation D 1586.

Split spoon samples are suitable for visual examination and classification tests, but generally are not sufficiently intact for quantitative laboratory testing. Relatively undisturbed (Shelby tube) samples were obtained by forcing sections of three inch diameter steel tubing into the soil at the desired sampling levels. This sampling procedure is described by ASTM Designation D 1587. Each tube, together with the encased soil, was carefully removed from the ground and sealed.

Test Boring Records are attached which include soil descriptions, stratifications, penetration resistances, and locations of the Shelby tube samples. Water level information obtained after completion of the drilling is also shown on these records. The stratification shown on the boring logs represents the soil conditions at the actual boring locations. Variations may occur between the borings. Lines of demarcation represent the approximate boundary between the soil types; however, the transition may be gradual.

The scope of services did not include any environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, ground water, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors, colors or unusual or suspicious items or conditions are strictly for the information of the client. Prior to purchase or development of this site, an environmental assessment is recommended.

2.2 Laboratory Testing

The soil samples obtained during the field exploration were transported to the laboratory and examined by a soils engineer. Approximate Unified soil classifications were determined by visual inspection.

Representative samples of the subsurface soils were tested. The analyses included determining the natural moisture content of all soils. Additionally, Atterberg limits and strength parameters were determined for selected samples. All test procedures were in basic accordance with the applicable ASTM Designations or with other accepted laboratory practice.

Test results are shown on the attached Test Boring Records. Those samples which were not altered by testing will be retained at our office for 60 days from the date of this report and then discarded.

3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Description and Topography

The project starts at the existing 42-inch Loosahatchie sanitary sewer at the north end of the Benjistown Road where it terminate at the Loosahatchie River on the north side of Memphis, Tennessee and extends to the southwest where it connects again with the existing interceptor sewer. At the time of the field exploration, the majority of the route along the proposed relocated sewer was found to be under cultivation. The ground is generally fairly level in this vicinity.

3.2 Subsurface Conditions

The soils encountered at the six borings primarily include an upper layer of fine-grained silty, clayey, or sandy clay soil which is underlain at Borings B-2, B-4 and B-6 by predominantly granular soils. These soil stratra are described in more detail in the following paragraphs.

The upper layer of fine-grained soil extends to depths ranging from about 20 feet to over 45 feet at the boring locations. The standard penetration N-values indicate the materials to be generally firm to very stiff in consistency and the results of Atterberg limits tests indicate these soils are low plasticity silts or clays (ML or CL) in accordance with the Unified Soil Classification System (USCS). Cinders were encountered in Boring B-6 indicating fill to a depth at least 8 feet at this location.

Below the fine-grained soils in Borings B-2, B-4 and B-6 sand is present which extends to the terminal depths of the borings. The more cohesive soils were stiff in consistency while the more granular soils were noted to be loose to very dense. The deeper sandy soils are found to be fairly clean sands (SM or SP) in accordance with the USCS.

The above description is of a generalized nature to highlight the major soil stratification features and soil characteristics. The attached Test Boring Records (Appendix II) should be reviewed for specific information at each boring location.

3.3 Ground Water Conditions

Checks within the bore holes upon completion of drilling indicated ground water to be present at depths ranging from 9 feet to 29 feet, Boring B-5 was dry. Ground water levels will fluctuate depending upon recent climatic conditions and are also likely to be influenced by the water level in the Loosahatchie River.

4.0 PROJECT INFORMATION

Preliminary information regarding the proposed construction was provided by Allen & Hoshall. The existing interceptor sewer runs along the southern bank of the Loosahatchie River and due to ongoing erosion of the river bank, there is some concern that erosion may undermine and damage the sewer. Therefore, it has been decided to relocate the existing sewer to the general vicinity indicated on the attached site plan. The proposed relocated sewer will have an overall length of approximately 4,000 feet and will have approximately 20 to 40 feet of backfill over the sewer pipe.

5.0 SEWER DESIGN COMMENTS

5.1 Bearing Capacity

The subsurface exploration data indicate that the soils in the test boring which were encountered at the proposed invert elevations have sufficient bearing strength to adequately support the sewer pipe. We recommended that Modified Minimum Bedding (See Plate 1) be used at locations where the pipe is supported on granular soil (USCS: SM, SW, SP, GW, or GP). Also, Modified First Class Bedding (See Plate 2) is recommended where the pipe is supported on fine grained soils (USCS: SC, CL, CH, ML, or MH) since these soils are extremely difficult to excavate and shape with any type of mechanical equipment without causing remolding and loss of shear strength.

All pipe should be made to bear along the full length of the barrel. Gasketed tongue and groove pipe is preferred, but if pipe with bells is permitted a grove in the bedding surface must be provided at each joint to prevent the bell from bearing on the bedding material.

Beneath manholes and junction structures a minimum of 24 inches of compacted well graded granular backfill should be used to provide a stable working surface and to reduce the possibility of a "quick" condition developing. When the sewer is supported on fine-grained soil any soft or loose soil zones encountered at the bottom of the sewer trench should be removed to the level of the stiff natural soils and backfilled with well graded gravel as described in Section 6.5.

Stability of Open Excavations

From the logs of the borings it can be observed that a considerable amount of fine-grained soil will be encountered during excavation to or below the invert elevation. These fine-grained soils generally have a USCS classification of either low or high plasticity clay, but the liquid limit seldom exceeds 60 and in most cases it is less than 50. During excavation, particularly during the dryer seasons, these soils will exhibit considerable cohesive shear strength; however, because they are generally silty, low plasticity clays they will probably lose a considerable quantity of their cohesive strength if they become wet from exposure to the weather; consequently, for any open excavations in predominantly clayey materials, it is recommended that the slopes be designed on a basis of cohesion = 0 and angle of internal friction = 25^{0}.

If the cohesive soils indicate adequate silt content, such that the liquid limit is less than 40 and a tow-dimensional plot of liquid limit versus plasticity index falls below the "a" line of the plasticity chart of the unified classification system, the slopes could be designed on the basis of cohesion = 0 and angle of internal friction = 28°. The decisions concerning soil properties and final slope configuration can be made during excavation. The indicated parameters included in the summary which follows assumes a dewatered excavation using a dewatering system that does not include surface sumps to remove ground water.

SUMMARY OF RECOMMENDED PARAMETERS
FOR DESIGN OF OPEN OR BRACED EXCAVATIONS

General Soil Type	Cohesion	Ø	Ko	Kp	Ka
Clay (LL greater than 40)	0	25°	0.5	2.46	0.41
Silt (LL less than 40)	0	28°	0.5	2.76	0.36
Silty Sand	0	32°	0.5	3.25	0.31
Sand	0	35°	0.5	3.69	0.28
Sand & Gravel	0	38°	0.5	4.20	0.24

With cohesion taken as zero the factor of safety for a dewatered slope in any soil type can be estimated from the formula:

F.S. = tan (Ø) / tan (slope angle)

5.3 Hydrostatic Uplift of Structures

Because the sewer pipe will contain fluids during flooding of the Loosahatchie and Mississippi rivers, the hydrostatic pressures beneath the pipe should be counteracted by the fluids in the pipe, fill above the pipe, and the flood water above ground surface; however, hydrostatic pressure below manhole and junction structures will probably exceed the weight of the structures plus their contents; consequently, the structures should be designed to resist hydrostatic uplift due to a 100 flood water level at the top of the structure.

Resistance is usually provided in unconsolidated ground by one of, or a combination of, three methods as follows:

(1) Increase the weight of the structure by thickening the walls.

(2) Attach the base of the structure to friction piles.

(3) Extend the base of the structure so that the weight of the soils directly above the extended base plus the structure contents exceeds the hydrostatic uplift (shear strength of the soil is usually neglected to provide an added safety factor).

6.0 CONSTRUCTION CONSIDERATIONS

6.1 General Comments

The three most common types of construction used for sewer construction are:

1. Braced trench

2. Open cut with sloping banks

3. Tunneling

For the depths involved an open trench is not permitted for safety reasons and braced trench and tunneling are probably not economically feasible. Therefore, this report will discuss only the open cut method. Since the route crosses primarily cultivated fields the cost of temporary easements for side slopes and temporary stockpiling or excavated soil should not be excessive.

6.2 Open Cut Method

For the open cut method a trapezoidal shaped excavation is made with the bottom wide enough to accommodate a backhoe for excavating a relatively shallow trench (subditch) in which the sewer pipe is placed. This subditch should be deep enough to accommodate the class of bedding and hand compacted backfill specified (Plates 1 and 2), and its width should be as narrow as feasible to permit proper compaction of bedding material or backfill around the sides of the pipe (these dimensions should be determined by the project engineer and specified in the contract documents). The subditch is usually not braced except in granular or unstable soils where it will need to be sheeted; however, workmen in the ditch must be protected at all times in accordance with OSHA and local building code requirements.

6.3 Dewatering

Where the sewer is to be supported on granular soils and is below or just above the water table it will be necessary to dewater these locations to stabilize the soil and avoid the possibility of a "quick" condition. Also, in areas where fine-grained soils are below the water table dewatering may be required to stabilize these soils. Since the water table was found to be above the invert of the proposed relocated sewer at three of the five borings considerable dewatering is likely to be needed.

The actual dewatering required will depend on the groundwater conditions and the insitu soil moisture at the time of construction.

A "quick" or "boiling" condition will be impending in a sand when the hydraulic gradient causing an upward flow of water reaches a critical value which is equal to the submerged weight of the sand divided by the unit weight of water-approximately equal to unity. When sand becomes quick any object with a unit weight greater than the submerged weight of the sand will settle as long as it remains in the zone of quick condition.

Leaking joints in a sewer line can produce a quick condition and permit sand to flow into the pipe, so it is imperative that the joints in a sewer line below the water table be water-tight. The quick condition which occurs is basically the same as that described above except that the "quick" zone is more localized. Lateral displacement of the pipe can occur if the flow of water is from the side, or the bedding or backfill is not uniform. Flotation of a sewer pipe can occur when the water table is allowed to rise with very little backfill above the pipe or a relatively large diameter pipe is located very near the surface and the water table is above the pipe.

On one project in Greenville, Mississippi a complete section of large diameter cast iron pipe disappeared and was not found with extensive probing for a depth of several feet. Also, a problem developed in 1975 on the West Raleigh Trunk Sewer extension. The problem encountered on this project involved the movement of the sewer line and the infiltration of sand into the sewer pipe. Movements of six inches both vertically and laterally were estimated and it was reported that the pipe was approximately half full of sand at some locations. The pipe was laid in a firm bed of sand with the water table lowered below the bottom of the excavation by means of well points. In our opinion the displacement of the sewer was due to a "quick" condition which occurred because of a too rapid shutdown of the dewatering system or leaking joints, or a combination of these with possible joint leakage occurring after initial movement of the pipe.

Gravel can become quick as well as sand but this is not common since its high permeability requires a relatively large flow of water to produce the critical gradient.

6.4 Termination of Dewatering

Where granular bedding materials are required above fine-grained materials, the natural water level should be re-established very slowly by "shutting down" the dewatering system in stages.

If the dewatering system is suddenly "shut down" such that there is a rapid increase in the hydrostatic pressure in a granular stratum below a thin, fine-grained stratum just below the pipe bed, the fine material could become quick and "blow" into the granular bedding material causing settlement of the pipe. The staging of the termination of dewatering is recommended, along with the use of the well graded bedding material as previously discussed.

6.5 Bedding and Backfill Requirements

Excavations for both the sewer pipe and the junction and manhole structures should be backfilled with granular bedding material in 12-inch lifts and hand tamped (with hand operated mechanized tamping machines) to the bearing surfaces shown in Plates 1 & 2 conforming to the following requirements:

95% passing a 3/4-inch (19.0 mm) sieve

95% retained on a No. 200 (0.74 mm) sieve

PI of the material passing the No. 40 sieve less than 7.

Be <u>well graded</u> according to the following criteria:

$$\frac{D_{60}}{D_{10}} \text{ greater than } 4$$

$$\frac{(D_{30})^2}{D_{10} \times D_{60}} \text{ between 1 and 3}$$

The backfill should be compacted to 100% of maximum density according to the Standard Proctor Method (ASTM D698), with each fill lift inspected for thickness and tested for degree of compaction prior to placing additional fill.

If the excavation for the concrete pipe is carried to granular material, the backfill between the bedding material and 24 inches above the pipe should have the USCS classification of SM, SP, SW, or GW. This backfill should be placed in 12-inch lifts and compacted to 100% of maximum density according to the Standard Proctor Method (ASTM D698) with each fill lift inspected for thickness and tested for density prior to placing additional fill.

If the excavation for the concrete pipe is carried to fine-grained soil, the backfill should be granular fill compacted as recommended above, or fine-grained fill placed in 8-inch lifts and compacted to 95% of maximum density according to the Standard Proctor Method (ASTM D698) with each fill lift inspected for thickness and tested for density prior to placing additional fill.

All fill placed above the fill indicated on Plates 1 & 2 24 inches below finish grade should be placed in 12-inch compacted lifts compacted to 90% of maximum density for fine-grained soils, or 95% of maximum density for granular soils, according to the Standard Proctor Method.

The top 24 inches of fill (at ground surface or roadway subgrade) should be placed in 8-inch compacted lifts to 95% of maximum density for fine-grained soils, or 100% of maximum density for granular soils according to the Standard Proctor Method. The moisture content of the final 48 inches of fill be controlled to within ± 2% of the optimum moisture according to the Proctor curve.

6.6 Compaction by Jetting

Compaction by "jetting" should only be permitted on a trial basis where the natural bedding soil and the backfill both contain less than 10% of fine-grained material (passing the No. 200 sieve) and when the material passing the No. 200 sieve has a PI less than 7. All materials placed up to the mid-height of the pipe should be hand tamped even if "jetting" is permitted for higher lifts.

6.7 Inspection During Construction

Because of the critical nature of the required dewatering, bedding and backfilling for the complete length of the project it is recommended that an engineer inspector be available on a full-time basis for the project and that he be assisted with adequate technical inspection and testing personnel to assure that all elements of the project are constructed according to the plans and specifications.

It is recommended that all construction with regard to dewatering, excavation, bedding and backfilling of all structures including the pipe be under continuous inspection and that a system of communication between quality control personnel, the contractor's representatives and the supervising engineer be established prior to initiation of construction.

7.0 General Comments

The exploration and analysis of the soil conditions reported herein are considered in sufficient detail and scope to form a reasonable basis for the sewer design. The recommendations submitted are based on the available soil information obtained by PSI and preliminary design details furnished by Allen & Hoshall, Inc. for the proposed sewer relocation. Any revision of the plans for the proposed sewer from those enumerated in this report should be brought to the attention of the soils engineer so that he may determine if changes in the geotechnical recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the soils engineer.

The soils engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made after being prepared in accordance with generally accepted professional engineering practice in the fields of soil mechanics, and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are more complete, it is recommended that the soils engineer be provided the opportunity to review the final design and specifications in order that the earthwork and bedding recommendations may be properly interpreted and implemented. At this time, it may be necessary to submit supplementary recommendations.

This report has been prepared for the exclusive use of Allen & Hoshall for the specific application to the relocation of a portion of the Loosahatchie Interceptor Sewer.

PROFESSIONAL SERVICE INDUSTRIES, INC.

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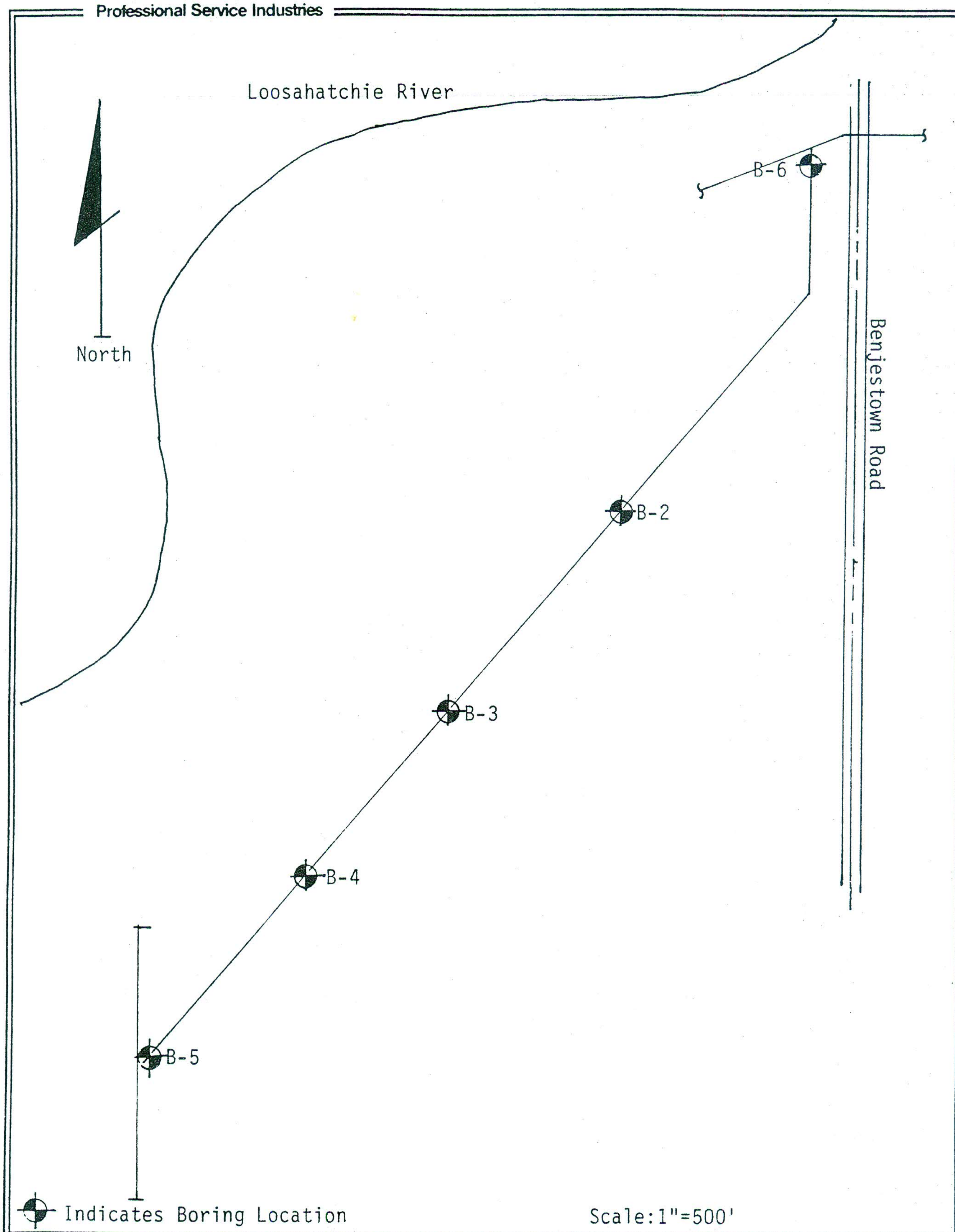
APPENDIX I - DRAWING

Professional Service Industries



PROJECT NAME
Loosahatchie Sewer Relocation
Memphis, Tennessee

Boring Location Plan

PROJECT NO.	DATE
502-95051	june, 1989

APPENDIX II - SUBSURFACE MATERIALS

SOIL CLASSIFICATION CHART - ASTM D2487

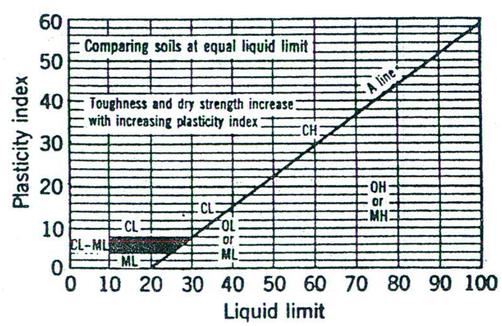
Coarse-grained soils — More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye). (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size).

Major division	Subdivision	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)	Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Gravels: More than half of coarse fraction is larger than No. 4 sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
		Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
	Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics	Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
		Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
Sands: More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
		Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
	Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
		Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7

Laboratory classification (coarse-grained soils): Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than *No.* 200 sieve size) coarse grained soils are classified as follows:
Less than 5% — *GW, GP, SW, SP*
More than 12% — *GM, GC, SM, SC*
5% to 12% — *Borderline* cases requiring use of dual symbols

Fine-grained soils — More than half of material is *smaller* than No. 200 sieve size. Identification Procedures on Fraction Smaller than No. 40 Sieve Size

Major division	Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols [a]	Typical Names	Information Required for Describing Soils
Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
	Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
	Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
	High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
	Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity.	
Highly Organic Soils	Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW–GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

CORRELATION OF PENETRATION RESISTANCE WITH RELATIVE DENSITY AND CONSISTENCY

	Penetration Resistance, N*	Relative Density
SAND AND GRAVEL	0 - 4	Very Loose
	5 - 10	Loose
	11 - 30	Medium Dense
	31 - 50	Dense
	50+	Very Dense

	Penetration Resistance, N	Consistency
SILTS AND CLAYS	0 - 2	Very Soft
	3 - 4	Soft
	5 - 8	Firm
	9 - 15	Stiff
	16 - 30	Very Stiff
	30+	Hard

*N: Indicates Standard Penetration Resistance, Blows Per Foot (ASTM D 1586)

psi

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled April 26, 1989 Job No. 502-95051

Project Sewer Relocation - Loosahatchie
Memphis, Tennessee

Surface Elevation +227.96 Boring No. B-2

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
0	CL		Stiff Grayish Brown Silty CLAY		5-5-6	19	
					3-4-5	26	
5					4-5-7	25	
					5-7-7	25	
10					5-5-6	29	
15	ML		Stiff to Firm Brown to Gray Clayey SILT		4-4-5	29	
20					2-3-3	31	
25	SP		Dense Tan SAND		14-19-24	19	
30	SC		Loose Gray Clayey SAND		6-3-4	23	
35	SP		Very Dense White Fine SAND		23-50/6"	20	Free water was at a depth of 25 feet during drilling. At completion it was at a depth of 18 feet.
			Boring Terminated @ 35.5' due to blow-in.				

N = No. Blows for 140-Lb. Hammer falling 30 inches
w = Moisture Content, per cent

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Split-Spoon Sample   Shelby Tube Sample   Dynamic Cone Penetrometer

Sheet

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled May 1, 1989 Job No. 502-95051

Project Sewer Relocation - Loosahatchie
Memphis, Tennessee

Surface Elevation +236.21 Boring No. B-3

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
0	CL		Stiff to Firm Brown to Grayish Brown Silty CLAY		5-5-6	22	
					4-4-5	28	
5					3-4-6	29	
					3-3-4	31	
10					3-3-3	33	
15	ML		Stiff to Firm Brown and Gray Clayey SILT		7-6-7	30	
20					3-4-3	29	
25					3-3-3	27	
30	CL		Stiff Gray Silty CLAY		5-6-8	25	
35	CH		Very Stiff Gray CLAY		11-10-13	23	
40	CL		Very Stiff Gray Sandy CLAY		6-8-13	18	

N = No. Blows for 140-Lb. Hammer falling 30 inches

w = Moisture Content, per cent

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Split-Spoon Sample Shelby Tube Sample Dynamic Cone Penetrometer

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled: May 1, 1989 — Job No. 502-95051

Project: Sewer Relocation - Loosahatchie, Memphis, Tennessee

Surface Elevation: +236.21 — Boring No. B-3

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
40			Very Stiff Gray Silty CLAY				
45	CL				8-7-10	22	
			Boring Terminated @ 45.5'				Free water was at a depth of 10 feet during drilling. At completion it was at a depth of 9 feet.

N = No. Blows for 140-Lb. Hammer falling 30 inches

w = Moisture Content, per cent

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Split-Spoon Sample Shelby Tube Sample Dynamic Cone Penetrometer

Sheet 2 of 2

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled May 3, 1989 — Job No. 502-95051

Project Sewer Relocation - Loosahatchie
Memphis, Tennessee

Surface Elevation +220.92 — Boring No. B-4

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
0	CL		Firm Brown Silty CLAY		4-4-4	20	
					4-4-4	26	
5	ML		Firm Brown Clayey SILT		3-4-4	26	LL = 35, PI = 8
					3-3-4	27	
10					3-3-3	25	
15					5-3-2	24	
	CH		Firm Brown and Gray CLAY				
20					3-3-5	23	
25					3-4-3	21	
	SC		Loose Gray Clayey SAND				
30					2-3-4	23	
	SP		Medium Dense Brown SAND				
35					5-5-7	23	
40					12-10-10	24	

N = No. Blows for 140-Lb. Hammer falling 30 inches
w = Moisture Content, per cent

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Split-Spoon Sample — Shelby Tube Sample — Dynamic Cone Penetrometer

Sheet 1 of 2

Professional Service Industries, Inc.

TEST BORING RECORD

Date Drilled May 3, 1989 Job No. 502-95051

Project Sewer Relocation - Loosahatchie
Memphis, Tennessee

Surface Elevation +220.92 Boring No. B-4

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
40	SP		Medium Dense Brown SAND				
45					9-11-13	20	
			Boring Terminated @ 45.5'				Free water was encountered at a depth of 34 feet during drilling. At completion it was at a depth of 28.7 feet.

N = No. Blows for 140-Lb. Hammer falling 30 inches
w = Moisture Content, per cent

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Split-Spoon Sample Shelby Tube Sample Dynamic Cone Penetrometer

Sheet 2 of 2

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled May 3, 1989 Job No. 502-95051

Project Sewer Relocation - Loosahatchie
Memphis, Tennessee

Surface Elevation +210.00 Boring No. B-5

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
0	CH	Split-Spoon	Stiff to Firm Brown and Gray CLAY		3-4-4	22	
		Split-Spoon			3-5-5	28	LL = 75, PI = 55
5		Split-Spoon			4-6-9	29	
		Shelby Tube					C = 2.16 ksf @ 6.2% strain Dry Density = 91 pcf
10		Split-Spoon			4-5-7	34	
15		Split-Spoon			3-3-3	25	
20	ML	Split-Spoon	Firm Brown and Gray to Gray Clayey SILT		3-3-3	28	
25		Split-Spoon	- sandy		2-3-3	28	
			Boring Terminated @ 25.5'				No free ground water was encountered while drilling and the hole was dry upon completion.

N = No. Blows for 140-Lb. Hammer falling 30 inches

w = Moisture Content, per cent

( ) Hrs. after completion of Boring for water level

Split-Spoon Sample   Shelby Tube Sample   Sample not recovered

TYPE OF DRILLING:

- ☐ Solid Flight Auger
- ☒ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger

Professional Service Industries, Inc.
TEST BORING RECORD

Date Drilled: April 26, 1989 Job No. 502-95051

Project: Sewer Relocation - Loosahatchie, Memphis, Tennessee

Surface Elevation: +211.06 Boring No. B-6

DEPTH		SAMPLE	DESCRIPTION		N/6"	w	Surface elevation was estimated from topographic information provided.
0	CH		Firm to Stiff Brownish Gray CLAY		2-2-4	34	
					3-3-4	32	
5					4-4-5	31	
					4-5-8	24	
10					4-4-5	26	
15	CL		Stiff Brown and Gray Silty CLAY		3-4-5	29	
20	SM		Medium Dense Gray Silty SAND		2-6-10	28	
			Boring terminated @ 20.5'				Free water was at a depth of 20 feet during drilling. At completion it was at a depth of 11.6 feet.
25							

N = No. Blows for 140-Lb. Hammer falling 30 inches

w = Moisture Content, per cent

( ) Hrs. after completion of Boring for water level

Split-Spoon Sample Shelby Tube Sample Sample not recovered

TYPE OF DRILLING:

- ☐ Solid Flight Auge
- ☐ Hollow-Core Auger
- ☐ Hydraulic Rotary
- ☐ Hand Auger