

GEOTECHNICAL FEASIBILITY INVESTIGATION
157+ ACRE PROPOSED RESIDENTIAL DEVELOPMENT
NORTH SAN BERNARDINO, CALIFORNIA
PREPARED FOR
SIGLAND & ASSOCIATES
JOB NO. 89724-3



GEOTECHNICAL
INCORPORATED

P.O. Box 1790 • 1355 E. Cooley Drive, Suite E, Colton, CA 92324
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August 25, 1989

Sigland & Associates
364 Orange Show Lane
San Bernardino, California 92408
Attention: Mr. Richard Siegmund

Job No. 89724-3

Gentlemen:

Attached herewith is the Geotechnical Feasibility Investigation report, prepared for the proposed 157+ acre residential development to be located in North San Bernardino, California.

This report was based upon a scope of services generally outlined in our "Authorization for Service", dated July 28, 1989, and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
C.H.J. GEOTECHNICAL, INC.


Donald M. Matthews, Staff Engineer

DMM:mmc

Distribution: Sigland & Associates (6)

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SCOPE

During August of 1989, a Geotechnical Feasibility Investigation for the proposed 157+ acre residential development located in North San Bernardino, California was performed by this firm. The purpose of this investigation was to explore the general geotechnical conditions at the subject site with respect to the proposed residential structures and on-site street pavement design.

To orient our investigation at the site, a 200-scale Topographic Map, prepared by Sigland & Associates, was furnished for our use.

It is our understanding that a geological feasibility investigation is being completed by another firm. Information contained within that report should be considered with this report.

The results of our investigation are presented in this report.

PROJECT CONSIDERATIONS

Information furnished this office indicates that the subject 157+ acre site will be developed with single family residential type structures. One and/or two-story structures of wood frame and stucco construction are anticipated. Light foundation loads are normally associated with such structures.

The project grading plan was not available at the time of our investigation. However, observation of site topography indicates that development of this site will entail loose cuts and fills.

SITE DESCRIPTION

The subject site consists of four non-contiguous parcels, situated in the Badger Canyon Area of the San Bernardino Mountains.

The subject site was primarily vacant. Topography consisted of variable hillside terrain with drainages in the north portion, becoming flatter in the south portion of the site. The north higher portion of the site was inaccessible to conventional equipment. Several dirt roads traversed the site. Vegetation consisted of a moderate to dense growth of brush.

Two marked graves were present in the east portion of the site. These graves were apparently for dogs.

No other surface features pertinent to this investigation were noted.

FIELD INVESTIGATION

The soil conditions underlying the subject site were explored by means of eight exploratory trenches excavated with a tractor-mounted backhoe to a maximum depth of 15 feet below the existing ground surface. The approximate locations of our exploratory trenches are indicated on the attached Plat (Enclosure "A").

Continuous logs of the subsurface conditions, as encountered within the exploratory trenches, were recorded at the time of excavation by a staff geologist from this firm. In-place density determinations were performed at selected levels within the

trenches. Bulk samples of typical soil types were obtained and returned to the laboratory in sealed containers for testing and evaluation.

Our exploratory trench logs, together with our moisture-density data, are presented on Enclosures "B-1" through "B-8". The stratification lines presented on the trench logs represent the approximate boundaries between soil types, which may include gradual transitions.

LABORATORY INVESTIGATION

Included in our laboratory testing program were field moisture content determinations on all samples returned to the laboratory. The results are included on the trench logs. Optimum moisture content - maximum dry density relationships were established for typical soil types in order that the relative compaction of the subsoils might be evaluated. A direct shear test was performed on a selected sample in order to determine the shear strength of on-site soils. Sieve analysis, sand equivalent and R-value tests were performed on probable street pavement subgrade soil to develop criteria for street pavement design recommendations.

Summaries of our laboratory test results appear on Enclosures "C-1" through "C-3".

SUBSURFACE SOIL CONDITIONS

Data from our exploratory trenches indicates that the soil profile at the site typically consists of surficial silty sands underlain by additional silty sands, poorly to well graded sands and isolated strata of silty sandy gravels and sandy gravels. Gravel, cobbles and occasional boulders were encountered throughout the soil strata.

All material encountered was granular and considered to be non-critically expansive.

Our in-place density testing indicates that the upper native soils are generally in-place in loose to medium dense states, grading denser with depth.

Our R-value testing indicates that the upper subgrade soils exhibit high R-value characteristics for support of asphalt concrete pavement.

No bedrock, fill or free groundwater was encountered within any of our exploratory trenches to the maximum depths attained. Isolated areas of fill may be present throughout the site.

A more detailed description of the subsurface conditions encountered within our exploratory trenches is presented on the attached trench logs.

CONCLUSIONS

On the basis of our field and laboratory investigations, it is the opinion of this firm that the proposed single family residential development of the site is feasible from a soil engineering standpoint. After specific development plans are prepared, a more thorough soils investigation should be conducted to provide necessary foundation and grading recommendations.

At this time, it appears that in deep cut areas, such cuts should expose dense native soils suitable for foundation support. Structures to be placed at or above existing grade will require subexcavation and recompaction of the upper soils for

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foundation support. Within the drainages of the site, loose, compressible soils which exist will require removal prior to the placement of compacted fill. These removals are anticipated to be relatively minor compared to the mass quantity of excavation required for the site rough grading.

All material encountered was granular and considered non-critically expansive, therefore, it does not appear at this time, that any specialized construction procedures to specifically resist expansive soil forces will be necessary at the site.

The subject site has large quantities of gravel, cobbles and boulders. Construction procedures will be necessary to deal with oversized material specifically in large cut areas.

No bedrock was encountered within any of exploratory trenches. No free groundwater was encountered within any of exploratory trenches to the maximum depths attained. If necessary, the depth to groundwater and bedrock should be determined by the engineering geologist during the geologic feasibility investigation. This is most important within the higher elevations of the site.

The result of a direct shear test on a selected sample indicates the subgrade soils have good shear strength characteristics and should provide adequate bearing capacity and lateral resistance.

Based upon our preliminary sampling and testing, it appears that the structural sections tabulated below should provide satisfactory pavements for the subject traffic indices.

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Traffic IndexRecommended Section

5.0	0.25' AC/Native Subgrade Soils
6.0	0.25' AC/Native Subgrade Soils
7.0	0.32' AC/Native Subgrade Soils

The above structural sections are predicated upon proper compaction of the utility trench backfills and the subgrade soils.

It should be noted that the above pavement design and all conclusions within this geotechnical feasibility investigation are based upon the results of preliminary sampling and testing and should be verified by a more thorough site specific soils investigation.

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this office.



Respectfully submitted,
C.H.J. GEOTECHNICAL, INC

A handwritten signature in black ink, appearing to read "Donald M. Matthews".

Donald M. Matthews, Staff Engineer

A handwritten signature in black ink, appearing to read "Robert J. Johnson".

Robert J. Johnson, G.E. 443
President

DMM:mmc

Enclosures: Plat "A"
Trench Logs "B-1" - "B-8"
Test Data Summary "C-1" - "C-3"

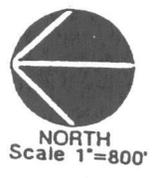
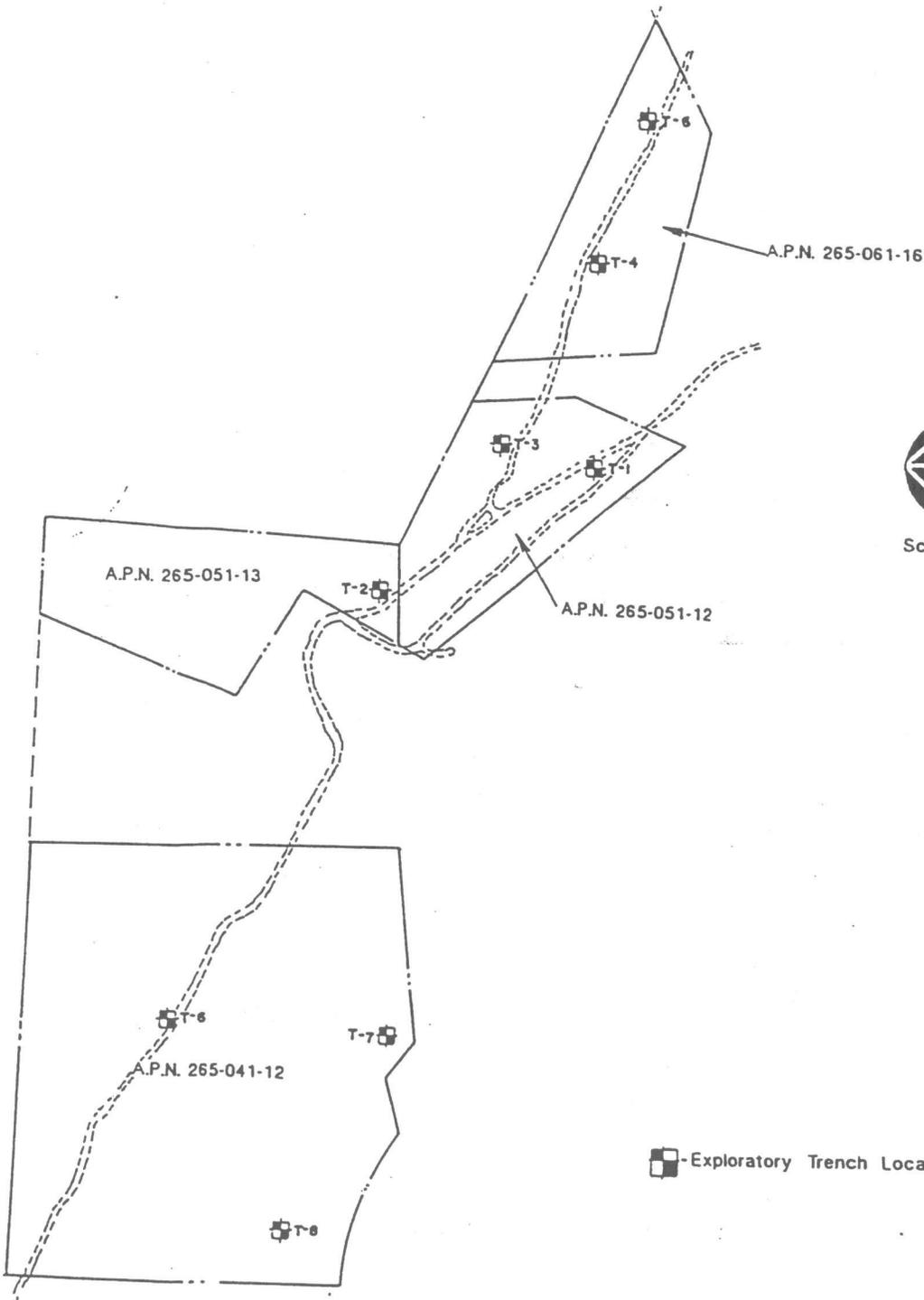
LIMITATIONS

C.H.J. Geotechnical, Inc., has performed our services within the limits prescribed by our client, with the usual thoroughness and competence of the engineering profession. C.H.J. Geotechnical, Inc., makes no other warranty or representation, either expressed or implied.

The conclusions in this report are based upon data obtained from separate sampling locations and interpolation between them, carried out for the project and scope of services described. It is assumed and expected that the conditions between locations are similar to those encountered at the individual locations. However, it is possible that conditions between sampling locations may vary. Should conditions be encountered in the field that appear different than those described in this report, we should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only, and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.



☒ - Exploratory Trench Locations

PLAT

FOR: Gland & Associates

157± ACRE PROPOSED RESIDENTIAL DEVELOPMENT
NORTH SAN BERNARDINO, CALIFORNIA

ENCLOSURE
"A"

DATE: August 1989

JOB NUMBER
89724-3



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KEY TO LOGS



SAMPLES:

- Ring Indicates Undisturbed Ring Sample. Undisturbed Ring Samples are obtained with a C.H.J. Sampler (3-1/4" O.D. and 2-1/2" I.D.) driven with a 140 pound weight falling 30 inches. The blows per foot are converted to equivalent SPT N-values.
- SPT Indicates Standard Penetration Test. The SPT N-value is the number of blows required to drive an SPT sampler 12 inches using a 140 pound weight falling 30 inches. The SPT sampler is 2" O.D. and 1-3/8" I.D.
- Bulk Indicates Disturbed or Bulk Sample
- Den Indicates In-Place Density Test. The In-Place Density Test is taken by the sand cone method generally described in ASTM D 1556-82.

DENSITY:

No Rec. Indicates No Recovery of Sample

SOIL CONSISTENCY:

Compactness of Granular Soils

<u>Description</u>	<u>No. of SPT Blows (N)</u>	<u>Approximate Relative Density (%)</u>
Very Loose	0-4	0-15
Loose	4-10	15-40
Medium Dense	10-30	40-70
Dense	30-50	70-85
Very Dense	Over 50	85-100

Consistency of Plastic Soils

<u>Description</u>	<u>No. of SPT Blows (N)</u>	<u>Approximate Shear Strength (PSF)</u>
Very Soft	0-2	Less Than 250
Soft	2-4	250-500
Medium Stiff	4-8	500-1000
Stiff	8-15	1000-2000
Very Stiff	15-30	2000-4000
Hard	Over 30	More Than 4000

SOIL CLASSIFICATION CHART

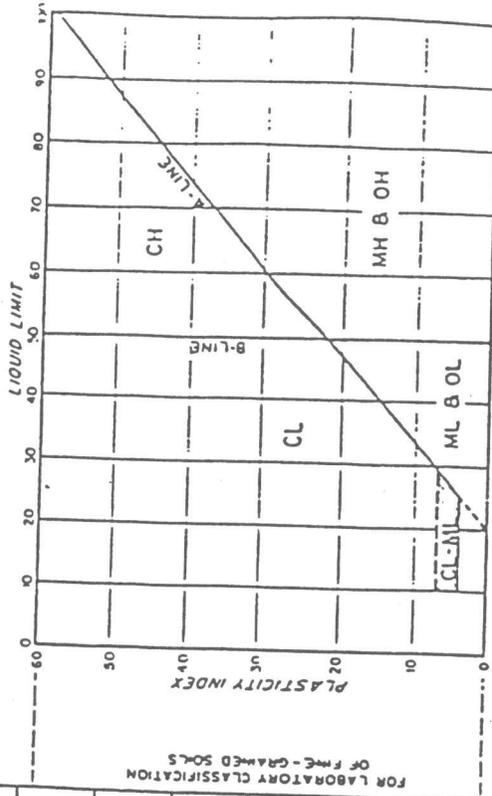
MAJOR DIVISIONS		LETTER SYMBOL	TYPICAL DESCRIPTIONS
GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
FINE GRAINED SOILS	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SILTS AND CLAYS	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SC	CLAYEY SANDS, SAND-CLAY MIXTURES
HIGHLY ORGANIC SOILS	SILTS AND CLAYS	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
	SILTS AND CLAYS	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SAND CLAYS, SILTY CLAYS, LEAN CLAYS
HIGHLY ORGANIC SOILS	SILTS AND CLAYS	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
HIGHLY ORGANIC SOILS	SILTS AND CLAYS	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	SILTS AND CLAYS	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS	SILTS AND CLAYS	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

GRADATION CHART

MATERIAL SIZE	PARTICLE SIZE	
	LOWER LIMIT	UPPER LIMIT
SAND	MILLIMETERS	MILLIMETERS, % OF SIZE
	0.75	0.42
	0.42	0.25
GRAVEL	2.00	4.75
	4.75	19.0
COBBLES	19.0	75.0
	75.0	250.0
BOULDER	250.0	750.0
	750.0	2000.0

U.S. STANDARD *CLEAR SQUARE OPENINGS

PLASTICITY CHART



UNIFIED SOIL CLASSIFICATION SYSTEM



For: Sigland & Associates
 Date Explored: 8-07-89
 Equipment: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 2
 Enclosure: "8-2"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. Content (%)	Rel. Comp. (%)	Sample Type	Foot	Visual Classification
		1.1		Bulk	1	[SM] Silty Sand, fine to medium, with traces coarse and organics, brown
		1.6		Bulk	2	[SW] Sandy Gravel, fine to coarse, gravel to 3", cobbles to 8" boulders to 18" and silt, light brown
					3	
					4	
					5	
		2.7		Bulk	6	[SP] Sand, fine to medium, with traces coarse, gravel to 3", cobbles to 12", boulders to 18" and silt, light brown
					7	
					8	
					9	
					10	
		4.4		Bulk	11	[SM] Silty Sand, fine to medium, with traces coarse, gravel to 3", cobbles to 12" and boulders to 24", light brown
					12	
					13	
					14	
					15	END OF TRENCH
					16	NO BEDROCK NO REFUSAL NO GROUNDWATER SLIGHT CAVING NO FILL
					17	
					18	
					19	
					20	
					21	
					22	



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For: Sigland & Associates
 Date Explored: 8-07-89
 Equipment: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 3
 Enclosure: "B-3"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. Content (%)	Rel. Comp. (%)	Sample Type	Depth (ft)	Visual Classification
		2.9		Bulk	1	[SN] Silty Sand, fine, with traces medium to coarse and gravel to 3", brown
108		2.9	81	Den	2	
		3.2		Bulk	3	Silty Sand, fine, with traces medium to coarse and gravel to 3", brown
108		3.4	79	Den	4	
					5	Silty Sand, fine, with traces medium to coarse, gravel to 3" and cobbles to 8", brown
					6	
					7	
		3.2		Bulk	8	Silty Sand, fine to coarse, with traces gravel to 3" and cobbles to 8", brown
					9	
		2.9		Bulk	10	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 8" and silt, light brown
					11	
					12	
					13	
					14	
					15	END OF TRENCH
					16	
					17	
					18	NO BEDROCK
					19	NO REFUSAL
					20	NO GROUNDWATER
					21	NO CAVING
					22	NO FILL

For: Sigland & Associates
 Date Explored: 8-07-89
 Equipaent: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 4
 Enclosure: "3-4"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. Content (%)	Rel. Comp. (%)	Sample Type	Foot	Visual Classification
		0.9		Bulk		[SM] Silty Sand, fine, with traces medium to coarse, brown
		3.9		Bulk	1	
104		3.2	81	Den	2	Silty Sand, fine, with traces medium to coarse, gravel to 2", brown
					3	
107		3.7	83	Den	4	
					5	
		3.7		Bulk	6	[SF] Sand, fine to medium, with traces coarse, gravel to 3" and cobbles to 6", brown
					7	
					8	
					9	
					10	
					11	
					12	
					13	
					14	
					15	
					16	
					17	
					18	
					19	
					20	
					21	
					22	

END OF TRENCH

NO BEDROCK
 NO REFUSAL
 NO GROUNDWATER
 NO CAVING
 NO FILL

For: Sigland & Associates
 Date Explored: 8-07-89
 Equipment: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 5
 Enclosure: "B-5"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. (%)	Rel. Comp. (%)	Sample Type	Depth (ft)	Visual Classification
	94	2.5	74	Bulk Density	1	[SM] Silty Sand, fine, with traces medium to coarse, brown
		1.3		Bulk Density	2	Silty Sand, fine to coarse, with gravel to 3", cobbles to 12" and boulders to 24", brown
					3	
					4	
		1.8		Bulk Density	4	[GM] Silty Sandy Gravel, fine to coarse, gravel to 3", cobbles to 8" and boulders to 24", light brown
					5	
					6	
					7	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					8	
					9	
	2.0			Bulk Density	8	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					9	
					10	
					11	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					12	
					13	
					14	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					15	
					16	
					17	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					18	
					19	
					20	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", light brown
					21	
					22	

END OF TRENCH

NO BEDROCK
 NO REFUSAL
 NO GROUNDWATER
 NO CAVING
 NO FILL



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For: Sigland & Associates
 Date Explored: 8-07-89
 Equipment: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 6
 Enclosure: "B-6"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. Content (%)	Rel. Comp. (%)	Sample Type	Foot	Visual Classification
		3.2		Bulk	1	[SM] Silty Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 18", brown
					2	
					3	
		2.9		Bulk	4	Silty Sand, fine to coarse, with traces gravel to 3", cobbles to 12" and boulders to 24", brown
					5	
					6	
					7	
					8	
					9	
					10	
		1.8		Bulk	11	[GW] Sandy Gravel, fine to coarse and gravel to 3", with traces cobbles to 12", light brown
					12	
		2.3		Bulk	13	[SW] Sand, fine to coarse, with traces gravel to 3", cobbles to 6" and silt, light brown
					14	
					15	END OF TRENCH
					16	NO BEDROCK NO REFUSAL NO GROUNDWATER CAVING BELOW 11.0' NO FILL
					17	
					18	
					19	
					20	
					21	
					22	

For: Sigland & Associates
 Date Explored: 8-07-99
 Equipment: Tractor-Mounted Backhoe

Job Number: 89724-3
 Trench Number: 8
 Enclosure: "B-8"

SPT Blows Per Foot	Dry Density (pcf)	Field Moist. Content (%)	Rel. Comp. (%)	Sample Type	Foot	Visual Classification
		2.5		Bulk	1	[SM] Silty Sand, fine, with traces medium to coarse, dark brown
109		2.3	85	Den	2	
		2.7		Bulk	3	Silty Sand, fine, with traces medium to coarse, light brown
115		2.5	90	Den	4	
		2.0		Bulk	6	Silty Sand, fine, with traces medium to coarse, gravel to 3" and cobbles to 6", light brown
					7	
					8	
					9	
	3.2			Bulk	10	[SP] Sand, fine to medium, with traces coarse, gravel to 3" and cobbles to 6" and silt, light brown
					11	
					12	
					13	
					14	
					15	END OF TRENCH
					16	
					17	
					18	NO BEDROCK
					19	NO REFUSAL
					20	NO GROUNDWATER
					21	NO CAVING
					22	NO FILL

TEST DATA SUMMARYOPTIMUM MOISTURE - MAXIMUM DENSITY RELATION:

ASTM D 1557-70, Method C; 4-Inch Diameter Mold; 1/30 Cubic Foot Volume; 5 Layers; 25 Blows per Layer; 10-Pound Rammer; 18-Inch Fall; minus 3/4" Material.

<u>Soil Type</u>	<u>Classification</u>	<u>Optimum Moisture (Percent)</u>	<u>Maximum Dry Density (PCF)</u>
A	Silty Sand, fine to medium, with gravel and traces organics, brown (SM)	9.0	128.5
B	Silty Sand, fine, with traces medium, coarse and gravel, brown (SM)	9.5	127.5

DIRECT SHEAR TEST: Remolded to 90% Relative Compaction (Saturated)

<u>Soil Type</u>	<u>Depth of Sample (Ft.)</u>	<u>Angle of Internal Friction (°)</u>	<u>Apparent Cohesion (PSF)</u>
B	2.0	38	50

C.H.J

Enclosure "C-2"
Job No. 89724-3

TEST DATA SUMMARY

<u>SAMPLE:</u>	1B	3C	5A	7A	8B
<u>TRENCH NO:</u>	1	3	5	7	8
<u>DEPTH (FT.):</u>	2.0	4.0	1.0	1.0	3.0
<u>SIEVE ANALYSIS:</u>					
<u>SIEVE SIZE:</u>	<u>PERCENT PASSING</u>				
1"		100	100	100	
3/4"	100	79	98	85	100
1/2"	96	74	91	81	95
3/8"	94	70	88	78	94
No. 4	90	58	83	71	92
No. 10	81	49	75	64	84
No. 16	72	44	68	58	75
No. 40	51	35	50	44	52
No. 50	42	31	44	39	44
No. 100	27	23	35	29	33
No. 200	14	16	20	20	19
<u>SAND EQUIVALENT:</u>	50	20	28	25	29
<u>R-VALUE:</u>	--	--	--	70	--

TEST NO.	DIST.			CO.			RTE.			SEC.			Job No. 89724-3		
TEST SPECIMEN	A	B	C	D	E	F	G	H	SP. GR.	FINE	COARSE				
DATE TESTED 8-22-89	1	2	3						AS REC'D						
MPACTOR AIR PRESS-PSI	350	350	350						CRUSHED						
INITIAL MOISTURE-%	2.3	2.3	2.3						L.L.	P.L.	P.I.	SPEC.			
SOAK WATER-ML	40	40	40						¾ CRUSHED		SPEC.				
WATER ADDED-ML (TOTAL)	45	35	38						P.I. x 200		SPEC.				
WATER ADDED-%	7.5	6.6	6.9						AS REC'D	25	SPEC.				
MOISTURE AT COMPACTION-%	9.8	8.9	9.2						CRUSHED		SPEC.				
WET WEIGHT OF BRIQUETTE-GMS.	1160	1160	1160						COMBINED		SPEC.				
HEIGHT OF BRIQUETTE-INCHES	2.52	2.53	2.52						100 REV.		SPEC.				
DENSITY-LB. PER CU. FT.	127.0	127.6	127.8						500 REV.		SPEC.				
STABILOMETER PH AT 1000 LBS.	20	13	14						FINE		SPEC.				
2000 LBS.	36	24	25						COARSE		SPEC.				
DISPLACEMENT	562	505	510						SUBBASE						
R-VALUE	61	74	73						BASE						
EXUDATION PRESSURE-P.S.I.	210	410	360						SURFACE						
STAB. THICK-FEET									GRAVEL EQUIVALENT FACTOR						
EXPANSION PRESSURE	0	0	0						TRAFFIC INDEX						
EXPAN PRESS THICK-FEET									R-VALUE	BY EXUD PRESS	70				
								BY EXPAN PRESS							
								AT EQUIL			SPEC.				
									COVER FOR ABOVE COND. (FEET)						

