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SOIL TESTING SERVICES

OF MICHIGAN, INC.

Formerly Northern Michigan Soil & Materials Testing, Inc.

550 EAST OHIO ST.

MARQUETTE, MI 49855

June 7, 1982 .

City of Marquette Engineering Department 300 W. Baraga Ave. Marquette, Michigan 49855

Attention: Mike Etelamaki

STS Job M-11771

Re: Subsurface exploration and hydrogeologic study at the Cliffs Dow Disposal Site in Marquette, Michigan

Gentlemen:

The subsurface exploration as outlined in our proposal dated March 23, 1982 has been completed. The attached report contains the logs of eleven soil borings, well installation diagrams, a summary of the subsurface conditions and our evaluation of the hydrogeologic conditions at this site. Three copies of this report have been sent to the above address.

We have appreciated this opportunity to be of service to you on this project. If you have any questions concerning this report or the data contained herein, please feel free to contact us at your convenience.

Yours very truly,

SOIL TESTING SERVICES, INC.

James J. Botz**, P.** E*.* Senior Project Engineer

. Douglas J. Hermann, P. E.

Environmental Group Manager

JJB/gm

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cc: ENCOTEC 3965 Research Park Ann Arbor, Mi. 48104

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CLIFFS DOW DISPOSAL SITE

MARQUETTE, MICHIGAN

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INTRODUCTION

The City of Marquette, Michigan owns a disposal site which was previously utilized by the Cliffs Dow Company. The site was used for disposition of waste materials from their charcoal briquet processes. It is suspected that this waste material contains contaminants which may adversely affect the quality of the ground water in the area. The horizontal fill limits can be fairly well defined by visual observation. However, the depth of the waste material at this site is not known at this time.

The purpose of this hydrogeologic study was to determine the depth of the waste material at this site, and determine the geological and hydrogeological conditions. Ground water samples have also been recovered for chemical analysis. The chemical testing or evaluation of the chemical testing was <u>not</u> included in the scope of this work.

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FIELD PROCEDURES

Eleven soil borings were performed for this exploration at the locations indicated on the Soil Boring Location Diagram included in the Appendix to this report. These borings were located in the field by Mr. James Botz of Soil Testing Services (STS). Ground surface elevations at the boring locations as well as the horizontal control of the borings were determined by personnel from the City of Marquette Engineering Department. The soil borings were performed with a trackmounted bombardier drill rig and a truck-mounted Joy Model 12-B rotary drill rig. The borings were advanced using a combination of solid stem flight augers and a washed boring technique. The washed boring technique utilizes a tri-cone bit and wash water. Steel casing was utilized in conjunction with the wash boring technique to maintain an open bore hole near the surface. The wash water was not re-circulated in the drilling operation.

Six soil borings were performed on the disposal area. The primary purpose of these borings were to determine the thickness of the fill material and to obtain samples of the underlying natural soils. The fill materials and soils were sampled in general accordance with ASTM Specifications D 1586-67, "Standard Method for Penetration Testing and Split Barrel Sampling of Soils". A 3-inch size split spoon was utilized in this sampling procedure to obtain sufficient sample for chemical analysis. The penetration blow counts should <u>not</u> be considered as standard "N" values having used the oversized spoon. 'A description of the sampling procedure is included in the Appendix to this report.

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Three additional soil borings were performed around the perimeter of fill area primarily for determining the hydrogeologic conditions. Borings 1 and 2 were sampled in general accordance with the split spoon sampling procedure utilizing the standard 2-inch 0. D. split spoon sampler. Boring 3 was sampled using a 3-inch split spoon.

Two-inch PVC observation wells were installed in Borings 1 and 2. These observation wells were installed for ground water observation. Two-inch nominal size stainless steel well casing was installed in Borings 3, 3A and 3B. The stainless steel casing was used since these observation wells were to be sampled for chemical analysis. Installation Diagrams of these observation wells are included in the Appendix to this report.

While sampling and drilling the presence of ground water was observed and recorded. Upon completion of the drilling, the presence of ground water was again observed and recorded. Several days after drilling, the observation wells were monitored and bailed. On April 26, 1982, the wells were again monitored and samples were obtained for chemical analysis. Field pH and conductivity were measured on each sample by STS. The samples were placed in containers provided by Environmental Control Technology and delivered to city personnel for transportation to the chemical testing laboratory. The ground water observations are presented on the lower left hand corner of the Boring Logs and on Table I: Water Level Summary included in the Appendix.

LABORATORY PROCEDURES

A representative portion of the soil samples were returned to the laboratory and visually examined by a Geotechnical Engineer. The samples were classified according to type using the Unified Classification System. The capitalized symbol in parenthesis on the Boring Logs is the appropriate group symbol according to this classification system. A chart describing this classification system is included in the Appendix. Most soil samples were placed in quart-sized jars and delivered to city personnel for transportation to the chemical testing laboratory.

Results of the field and laboratory tests were then plotted on boring logs. These logs are contained in the Appendix. Similar soils were grouped into strata on the logs. Please note that the strata contact lines represent approximate boundaries between soil types; the actual transition between soil types in the field may be gradual in both the horizontal and vertical directions.

SITE CONDITIONS

The project site is located on County Road 550 in Marquette, Michigan. More specifically, the project site is located north of County Road 550 and south of the Lake Superior & Ishpeming Railroad tracks. This site is also east of the intersection of the railroad tracks and County Road 550. The area surrounding the site is densely wooded. However, the immediate filled area is sparsely vegetated. Topography in the area surrounding this site is gently rolling to hilly with numerous rock outcrops. No rock outcrops were observed within the immediate vicinity of the fill area.

Soil Profile

Borings 4 to 9 were extended through the existing fill material into the underlying natural soils. The fill material ranged in thickness from 9.5 to 12.5 feet below grade. The fill consisted primarily of a silty fine to medium sand and wood fragments. A petroleum based substance was occasionally observed within the fill material. The fill ranged in relative density from very loose to medium dense. In Boring 4, a trace of wood fragments was encountered to a depth of 13.5 feet.

Below the fill material, the borings encountered a fine to medium sand or silty fine sand which extended to termination depth of the borings. The sand was saturated and was generally in a medium dense to dense condition.

Borings 1, 2 and 3 encountered a thin surface topsoil layer underlain by granular soils which extended to the termination depth of the borings. The granular soils ranged in particle size from fine to coarse with a trace of gravel. These granular soils also ranged in relative density from loose to medium dense.

Boring 3 encountered apparent bedrock at a depth of 27 feet. Greenish gray wash cuttings were observed from drilling into the apparent bedrock indicating a possible schistose bedrock material. This boring was terminated at a 2.5 foot depth into the bedrock surface.

Hydrogeology

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The ground water observations made in the observation wells were relatively consistent between readings. Borings 1 and 2 indicate little or no north/south flow vector. The three observation wells indicate that the horizontal flow gradient is predominately east. Additional readings were taken in observation well No. 4 on the abandoned UPPCO flyash site. This reading also indicates primarily a easterly direction of ground water flow. A 0.004 horizontal gradient was calculated across the disposal site. A ground water contour map of data collected on April 26, 1982 is included in the Appendix.

The well cluster at boring location 3 indicated an upward gradient of approximately 0.11 ft/ft. This upward gradient may be present due to the confinement of the relatively impermeable bedrock stratum and the potentially cleaner, more permeable granular soil overlying the bedrock. Samples at 15 and 20 feet could not be obtained in either Boring 3 or 3B. No recovery may indicate a clean, coarse granular material which could have a higher permeability.

- SOIL TESTING SERVICES OF MICHIGAN INC -----

GENERAL

The analysis and recommendations submitted in this report are based on data obtained from eleven soil borings. Variations can occur between these borings, the nature and extent of which may not become evident without further exploration. If variations are encountered, it may be necessary to make a re-evaluation of the recommendations of this report after making on-site observations and noting the characteristics of these variations.

Water-level readings have been made in the borings at the times and under the conditions stated on the boring logs. This data has been reviewed and an interpretation made in the text of this report. However, it must be noted that the period of observation was relatively short and that seasonal and annual fluctuations in the level of the ground water will likely occur. STS No. M-11771

APPENDIX

1. Soil Boring Location Diagram

General Notes

2.

3. Procedures Regarding Field Logs

Boring Logs 1 through 9

5. Unified Soil Classification Chart

6. Well Installation Diagram

7. Table I: Water Level Summary

8. Ground Water Contour Map

9. Penetration Testing Procedure



GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

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: Split Spoon - 1 3/8" 1.0., 2" 0.0., unless os Osterberg Sampler - 3" Shelby Tube SS : otherwise noted HS Hollow Stem Auger Shelby Tube - 2" O.D., unless otherwise noted ws Wash Sample ST : : FT . Fish Trail PA : Power Auger : Diamond Bit – NX: BX: AX : Auger Sample RB D8 : Rock Bit 8S **Bulk Sample** AS : PM · Pressuremeter test · in situ ·: Jar Sample . -5 VS : Vane Shear

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted.

WATER LEVEL MEASUREMENT SYMBOLS:

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Water Leves WL :

WL : Water Leve, WCI : Wet Cave In DCI : Dry Cave In WS : While Sampling WD : While Orilling BCR : Before Casing Removal

ACR: After Casing Removal

AB : After Boring Water levels indicated on the boring logs are the levels measured in the boring at the times indicated. In pervious soils, the indicated elevations are considered reliable ground water levels. In impervious soils, the accurate determination of ground water elevations is not possible in even several days observation, and additional evidence of ground water elevations must be sought.

GRADATION DESCRIPTION & TERMINOLOGY:

Coarse Grained or Granular Scils have more than 50% of their dry weight retained on a #200 sieve; they are described as: boulders, cobbies, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are described as: clays or clayey silts if they are cohesive, and silts if they are non-cohesive. In addition to gradation, granular soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their strength or consistency, and their plasticity.

Major Component Of Sample	Size Runge	Descriptive Term(s) (Of Components Also Present in Sample)	Percent of Dry Weight
Boulders	Over 8 in, (200mm)	Trace	1 – 9
Cobbles	8 in. to 3 in. (200mm to 75mm)	Little	10 - 19
Gravel	3 in. to #4 sieve {75mm to 2mm}	Some	20 - 34
Sand	#4 to #200 sieve (2mm to .074mm)	And	35 - 50
Silt	Passing #200 sieve (0.074mm to 0.005mm)		
Clay	Smaller than 0.005mm		

CONSISTENCY OF COHESIVE SOILS

RELATIVE DENSITY OF GRANULAR SOILS:

Unconfined Comp. Strength, Qu, tsf Consistency N - Blows/ft. **Relative Density** 0 - 3Very Loose < 0.25 Very Soft 0.25 - 0.494 - 9 Soft Loose Medium (Firm) 10 -- 29 Medium Dense 0.50 - 0.99 1.00 - 1.99 30 - 49Dense Stiff 2.00 - 3.99 4.00 - 8.00 Very Stiff 50 - 80Very Dense 80+ Extremely Dense Hard Very Hard >8.00

PROCEDURES REGARDING FIELD LOGS,

LABORATORY DATA SHEETS AND SAMPLES

In the process of obtaining and testing samples and preparing the report, procedures are followed that represent reasonable and accepted practice in the field of soil and foundation engineering.

Specifically, field logs are prepared during performance of the drilling and sampling operations which are intended to portray essentially field occurrences, sampling locations and other information.

Samples obtained in the field are frequently subjected to additional testing and reclassification in the laboratory by more experienced soils engineers, and differences between the field logs and the final logs exist.

The Engineer preparing the report reviews the field and laboratory logs, classifications and test data, and in his judgement in interpreting this data, may make further changes.

Samples taken in the field, some of which are later subjected to laboratory tests, are retained in our laboratory for sixty (60) days and are then destroyed unless special disposition is requested by our client. Samples retained over a long period of time, even in sealed jars, are subject to moisture loss which changes the apparent strength of cohesive soil, generally increasing the strength from what was originally encountered in the field. Since they are no longer representative of the moisture conditions initially encountered, an inspection of these samples could recognize this factor.

It is common practice in the soil and foundation engineering profession that field logs and laboratory test data sheets not be included in engineering reports, because they do not represent the engineer's final opinion as to the appropriate descriptions for conditions encountered in the exploration and testing work. On the other hand, we are aware that perhaps certain contractors and subcontractors submitting bids or proposals on work might have an interest in studying these documents before submitting a bid or proposal. For this reason, the field logs will be retained in our office for inspection by all contractors submitting a bid or proposal. We would welcome the opportunity to explain any changes that have and typically are made in the preparation of our final reports, to the contractor or sub-contractors, before the firm submits its bid or proposal, and to describe how the information was obtained to the extent the contractor or subcontractor wishes. Results of laboratory tests are generally shown on the boring logs or are described in the text of the report, as appropriate.

SOIL TESTING SERVICES

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W.L.	W.L. 2' B.C.R.]' A.C.R.]' A.C.R.	OF MICHIGAN, INC.).	RIG BOMD FC				AN JW		
W.L.						550 EAST OHIO STREET		EET DRAWN JHI		APPROVEDJJB		В		
					<u></u>	MARQUEITE, M	CHIGAN	99855	JOB 🛔	1-11;	771	SHEET	10	f 1
						between soil	ation lines types and	d tepto	sent	ine ar		nate 0		н у

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_		LOG OF BORING NO. 9															
•		OWNER						ARCHITECT-ENGINEER									
•	_	City of Marquette										ЛЕ —					
• •		Co. Rd. 550, Marquette						, Mi.	Clif	fs D	ow D	ispos	sal S	Site			
				Ī			· ·				UNCON	FINED CO	OMPRESS	IVE STRE	NGTH TO	INS/FT.?	
		ELEVATION	NO.	APLE	SAMPLE DIST.	Σ	DESCRIPTION OF MATERIAL			UNIT DAY WT. LBS./FT. 3			2 1 W4	3 4	4 <u>+</u>	5 1	
			APLE	E SAI		RECOVER					LIMIT % CONTENT % LIMIT %						
			SAN	ТҮР							STANDARD "N" PENETRATION (BLOWS/FT.)						
		Fill & Brown					Fill . Brown	wood fragme		\otimes^3			<u> </u>				
				33			moist				$ \rangle$						
			2		╢							17					
	·.	5.0	<u> </u>	33	μı		Fill - Black	silty fine	sand)					
-	\sim		-	=			[Sif] and woo	i i i agments -	wel			11					
-	 :		3	SS	Ш	ļII						Ø _					
			4	SS						1127 1127 1127	ین الای الی الی الی الی الی الی الی			32	-		
			4 A	22	╢		Brown silty	fine sand (S	M)-					₩ 			
		wet-dense						and (SP)-wet			·	•		132			
			5	55	μ		dense							×	•		
		15_0	6	55			Brown clayey medium dense	silt (ML)-m	oist-					Ì			
			<u>5 A</u>	SS	111	μι Γ	wet-mediu	m dense	d (SP)-				<u> </u>	5			
,							End of Boring	n							, 		
	Č	20 0						, , , , , , ,									
		Boring advance auger to 9 ft						t.	la stem								
1		Boring advance 16.5 ft. with wash water					Boring advand	ed from 9 ft. to roller bit and									
i 1							16.5 ft. with wash water										
:												•					
1 1							nw casing set	L TO IS TT.	lo ft.								
1 		Borehole back on-site soils						vfilled with									
1																	
- 																	
í)								-					[İ		
1 1			ATES	<u> </u>			OBSERVATIONS	· · · · · · · · · · · · · · · · · · ·	ا سو در و رو رو رو			G STAD		<u>4 -</u> 4	-82	<u> </u>	
•		W.L. 3 - 9' WD W.L. 2' B.C.R. 4' A.C.R. W.L.					W D	SOIL TESTING SERVICES			BORING COMPLETED 4-9-82				-82		
I							I. 4 A.C.R.		550 EAST OHIO STREET MARQUETTE, MICHIGAN 49855			RIG BOMD			FOREMAN JW		
								MARQUETTE, N				JOB # M-11771 SHEET 1 OF				1	
							· · · · · · · · · · · · · · · · · · ·	The stratific	ation lines	repre	esent f	the ap	proxir	nate b oradu	ounda	ry	

UNIFIED BOIL CLASSIFICATION SYSTEM

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Major divisions			Group symbols	Typical names Laboratory classification criteria						
	lion	grøvels no fines)	GW	Well-graded gravels, gravol-sand mixtures, little or no fines	$C_{u} = \frac{D_{60}}{D_{10}}$ greater than 4; $C_{c} = \frac{(D_{30})^{2}}{D_{10} \times D_{60}}$ between 1 and 3					
More than half of material is <i>larger</i> than No. 200 sieve sizel	vels coarse frac . 4 sieve size	Clean (Little or	GP	Poorly graded gravels, gravel- sand mixtures, little or no fines	Not meeting all gradation requirements for GW					
	Gra than half of rger than No	vith fines de amount nes)	GM u	Silty gravels, gravel-sand-silt mixtures	$\begin{array}{cccccccccccccccccccccccccccccccccccc$					
	(More	Gravels v (Appreciab of fi	GC	Clayey gravels, gravel-sand-clay mixtures	derline cases requiring use a c 00 c Atterberg limits above "A" of dual symbols of dual symbols					
	Sands (More than half of coarse fraction is smaller than No. 4 sleve size)	r no lines)	SW	Well-graded sands, gravelly sands, little or no fines						
		Clear (Linte o	SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW					
		ith fines ble amount bus)	SM u	Silty sands, sand-silt mixtures	Atterberg limits below "A" Limits plotting in hatched a d is a c c d d is a c c d d is a c c d d is a c c d d is a c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d is a c c c c d d d is a c c c c c d d d is a c c c c d d d d is a c c c c c d d d d is a c c c c c d d d d is a c c c c c c d d d d d d d d d d d d d d d d d d d					
		Sands w (Appreciation of fire	sc	Clayey sands, sand-clay mix- tures	Atterberg limits above "A" a d m J X G line with P.I. greater than 7					
Fine-grained soils (More than half of material is <i>smeller</i> than No. 200 sieve)		an 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clay- ey fine sands or clayey silts with slight plasticity						
	ilts and clay.	l limit les th	CL	Inorganic clays of low to me- dium plasticity, gravelly clays, sandy clays, silty clays, lean clays	50 grained soils. Atterberg Limits plotting in hatched area are borderline dassi-					
	о 	(Llquic	OL	Organic silts and organic silty clays of low plasticity	40 symbols. Equation of A-line: PI=0.73 (LL - 20)					
		r than 50)	мн	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	20					
	the and clav	limit greate	CH Inorganic clays of high plas- ticity, fat clays							
		(Liquid	он	Organic clays of medium to high plasticity, organic silts	4 ML and OL 0 0 0 10 20 30 40 50 60 70 80 90 100					
	Highly	organic soits	Pt	Peat and other highly organic soils	Liquid Limit Plasticity Chart					

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TABLE I: Water Level Summary

Marquette, Michigan STS No. M-11771 .

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			April 2	1; 1982	a kije i kongo za s	April	26, 1982		
Well No.	Ground Surface Elevation	Top of Well Pipe Elevation	Depth,ft.	Elevation	Depth,ft	Elevation	Field pH	Field Conductivity µohm/cm	
l	649.1	651.0	8.7	642.3	7.5	643.5	-	- 1	
2	646.2	648.5	6.0	642.5	5.0	643.5		-	
3	645.6	648.7	7.0	641.7	6.0	642.7	5.5	167	
3 A	645.6	647.9	6.7	641.2	6.2	641.7	6.0	1350	
3B .	645.6	649.2	7.5	641.7	6.5	642.7	5.5	550	
UPPCO ∉4	649.5	-	-		4.1	647.3		-	

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Notes:

Wells bailed after 4-21-82 readings Depths measured from top of well pipe

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PENETRATION TESTING PROCEDURE

Representative soil samples were obtained by means of the split-barrel sampling procedure in general accordance with ASTM Specification D 1586-67. In this procedure, a 2-inch OD split-barrel sampler is driven into the soil a distance of 18 inches by means of a 140-pound hammer falling 30 inches. The standard penetration resistance value is the number of blows per foot of penetration for the final 12 inches of driving. This value can be used to provide a qualitative indication of the in-place relative density of cohesionless soils. This indication is qualitative since many factors can significantly affect the standard penetration resistance value and prevent direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-spoon assemblies.

After driving, the sampler was returned to the surface and opened. The length of sample (recovery) was measured and the soil was preliminarily classified according to type by a Soils Technician. A representative portion of each sample was then sealed in a glass jar, labeled, and returned to our laboratory for further examination and testing.