RIVERWALK AND SHORELINE STUDY,
MARINE CITY,
ST. CLAIR COUNTY, MICHIGAN

Job #12954

April, 1984

CITY OFFICERS

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Manager	Loretta Vandric
Clerk	Carol Ouellette

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National Oceanic and Atmospheric Administration

PATE, HIRN AND BOGUE, INC.
17000 Twelve Mile Road
Southfield, Michigan 48076

SUMMARY

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The shoreline in the study area contains three kinds of erosion control measures and they vary from minimally effective to reasonably effective. The most effective erosion protection is provided by the existing steel sheeting wall that occupies the northerly 395 feet of the study area. The lengths of the existing steel sheeting are marginal and as the river bottom continues to slowly erode the stability of the wall will decrease. There are two significant deficiencies in the steel walls. The top elevation is one to two feet too low and this condition allows water to wash over the top of the existing walk which enhances the rate of erosion behind the wall. The erosion behind the wall bares or nearly bares the tie rods which are heavily corroded. The installation of a new steel wall in front of the existing steel wall would support a new river walk, one to two feet higher than the present walk. The new wall and walk would reduce or eliminate the erosion that occurs behind the present walk and also allow adequate cover to be placed on the existing tie rods. A lighter gauge section could be used for the new wall as long as the existing wall and tie rods have not failed and still contain some structural integrity.

The middle section of the study area, approximately 145 feet long, contains a timber and/or wood piling wall which supports a large concrete cap. This section of wall is seriously deteriorated as evidenced by the voids behind the concrete cap. This section of wall may remain reasonably sound as long as the wood portion is inundated. If river elevations lower sufficiently to expose the wood the wall will fail reasonably quickly. A lighter gauge steel wall installed in front of the existing wall would extend the life of the existing wall as well as reduce or eliminate

the serious erosion condition. The voids created by erosion and settlement in this section of the site and the section to the north create serious hazards to the large numbers of people that are attracted to this waterfront park.

The southerly section, approximately 80 feet long, of the study area presents the poorest shoreline condition but probably presents a lesser hazard because its condition is less attractive to waterfront visitors. A properly installed steel wall with adjacent river walk would be a significant improvement to a very valuable City asset.

INTRODUCTION

AND

PROJECT LOCATION

INTRODUCTION

This report presents the results of a site investigation of 625 feet of City owned shoreline along the St. Clair River. The existing shoreline is in very poor condition, showing signs of serious erosion, and restricting public access and safety. The City wishes to construct a new bulkhead with a riverwalk to link various public parks and commercial establishments to make greater use of their waterfront. Landscaping, lighting, park benches, and safety railing are planned. The purpose of the investigation is to obtain representative data to define the general physical characterisitcs of the shoreline, the existing bulkheads and the erosion protection, and to evaluate this data with respect to prevention of further shoreline erosion.

PROJECT LOCATION

The study area is located in Marine City, Michigan, along the St. Clair River between the south property line of lot number 126 and the north right-of-way line of Jefferson Avenue. This land is occupied by the Marine City Water Filter Plant, the Guy Center, and Civic Park. The study area is situated near the central business district which contains various retail stores, commercial establishments, and restaurants. This represents approximately 625 feet of City owned shoreline.

SITE INSPECTION

SITE INSPECTION

A topographic survey, soil borings, and site inspections have been made. A drawing of the field survey and soil borings are included in this report. The soil boring report indicates that the surface of the site is blanketed with a layer of fill consisting of soft to firm sand or clay with some wood debris. The fill extends to a depth of 7.5 feet below ground surface. Underlying the fill and extending the full depth of the borings is a blue silty clay deposit. This clay ranges in consistency from very soft to stiff.

The findings of the site inspection and other available records are summarized in the following paragraphs. For the purpose of evaluation we have segmented the shoreline into four (4) sections.

Section one (1) which is 80 feet long and shown on drawing number one (1), consists of a sloping embankment covered with broken concrete and rip rap. This apparently was placed to arrest erosion of the shoreline, although it appears a considerable amount of erosion had occurred prior to the placement of rip rap. It appears that erosion is continuing, but at a much slower rate.

Section two (2) which is 145 feet long, is a wood bulkhead with a five (5) foot wide concrete cap on wood piling. (Records which indicate the age of this portion of the wall are not available.) The bulkhead and piling are completely submerged making inspection very difficult. As long as they remain submerged we can expect the wood to be

in good condition. At extreme low water elevation the wood section of the wall may be exposed and at that time we would expect the wood to deteriorate.

Section three (3) is a steel bulkhead with a 5 foot wide reinforced concrete wale cap. Records in this office indicate that this 250 foot long section was constructed with 19 to 24 foot long steel sheet piling in 1936. Neither the sheeting thickness nor section modulus was recorded. At some later date, a 15' x 75' concrete slab was placed on the existing reinforced concrete cap, along with two diving board platforms. Based on soundings taken along the shoreline, it appears that 3 to 4 feet of river bottom scouring or dredging has occurred since construction in 1936, reducing the effective toe depth of the sheeting by about 25 percent. (Refer to drawing 1 contained in the envelope at the back of this report.) It should be realized that lateral pressure on a bulkhead wall directly increases with a decrease in water elevation. A combination of reduced toe depth and lower water greatly increases the risk of a toe kickout type of failure to the wall.

A contract agreement between Marine City and William Welser, a local contractor, indicates that this section of wall was constructed in 1953 with 12, 18, and 20 foot long 3/8 inch thick steel sheet piling. No record of the size, length, or location of the deadman anchors was made. Comparing these lengths of sheet piling with the lengths in section three (3), we can conclude that there is even a greater risk of a toe kickout type of failure should a decrease in water elevation occur.

At times the existing cap in sections 2, 3, and 4 is completely submerged. A considerable amount of erosion behind

the wall and under the concrete cap has taken place. The concrete cap has settled and the tie rods are exposed to the elements. This presents a hazard to anyone walking in this area and accelerates corrosion of the steel tie rods, reducing their effective strength. If the tie rods are allowed to remain in this condition they may break resulting in a collapse of the wall. At the very least they should be cleaned and painted with a bitumastic paint and covered with granular fill.

The concrete cap in sections 2 and 3 show signs of scaling and the handrailing is either loose or missing. This is probably due to the almost constant wet, freeze-thaw condition during the winter months. This scaling can be patched and the handrailing replaced but, as long as the relatively high water remains, it would only be a temporary solution. We believe it would only be a matter of time before the wet, freeze-thaw cycles would damage the cap and handrailing.

SOLUTIONS

There are two alternate solutions to the deteriorating shoreline in the study area. Both alternates are shown on drawing 1.

Alternate A involves the construction of a new retaining wall along the entire length. The proposed retaining wall would consist of 5 gage steel sheeting with tie rods and deadman anchors. The proposed elevation of the top of the wall would be one to two feet higher than the existing grade. The area behind the proposed wall would be back-filled and a concrete walk constructed at the new higher elevation.

Cost of Alternate A

Item	Unit	Unit Cost	Total Estimated Cost
New 5 gage steel retaining Wall (Detail 1)	640 LF	$370.00	$236,800.00
Safety Handrail	640 LF	26.00	29,440.00
Drainage Structure & Outlet	4	1,100.00	4,400.00
Engineering, Inspection and Contingencies			59,560.00
TOTAL			$330,200.00

Alternate B involves the construction of a new retaining wall along sections 1 and 2 only. There is no retaining wall at section 1 and the existing wood sheeting in section 2 is beyond its useful life. In this alternate, the steel wall in sections 3 and 4 will be strengthened by placing H-piles in front of the existing wall at 8 ft. spacing and constructing a new concrete walk above the old walk. The H-piling would prevent the toe from kicking out should there be a drop in water levels and also serve as a foundation for a new higher walk.

Cost of Alternate B

Item	Unit	Unit Cost	Total Estimaed Cost
Rebuild existing wall with H-piles @ 8 ft. spacing. (Detail 2)	395 LF	$ 380.00	$150,100.00
New 5 gage steel retaining wall (Detail 1)	245 LF	370.00	90,650.00
Safety Handrail	640 LF	46.00	29,440.00
Drainage structure & outlet	4	1,100.00	4,400.00
Engineering, Inspection, and Contingencies			60,410.00
TOTAL			$335,000.00

It is apparent from the above figures that the costs of the alternatives are very comparable but we believe there is significantly more value in Alternate A. In addition, Alternate A involves the construction of a completely new wall with known material quality and current documented design criteria. For these reasons, it is recommended that 640 linear feet of new wall be constructed as described under Alternate A.

APPENDIX

Testing Engineers & Consultants, Inc.

P.O. Box 249 • 1333 Rochester Road • Troy, Michigan 48099
313-588-6200 or Dial T-E-S-T-I-N-G

John Banicki, P.E.
Kenneth Cummins, L.S., P.E.
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T.E.C. Report Number: 9192
Date Issued: 14 March 1984

Pate, Hirn & Bogue, Inc.
17000 Twelve Mile Road
Southfield, Michigan 48076

Attention: Mr. Lawrence J. Mislinski, P.E.

Re: Soil Borings for New Seawall
City Filter Plant & Park
Marine City, Michigan

Dear Sir:

We submit herewith the results of a soils investigation performed at the above referenced site. The field and laboratory data are attached to this report.

It is a pleasure to have been of service to you. Please feel free to call if any further information is desired. We would be pleased to furnish quality control testing on the project during the construction.

Respectfully submitted,

TESTING ENGINEERS & CONSULTANTS, INC.

John Banicki, P.E.
President

JB/da
Enclosure

INTRODUCTION

This report presents the results of a soils investigation for the New Seawall at the City Filter Plant and Park in Marine City, Michigan. Authorization to perform this investigation was given by Mr. Lawrence J. Mislinski through his letter dated 28 February 1984.

The purpose of this investigation was to obtain the information necessary to determine the basic engineering properties of the soils at the site through a series of test borings and laboratory tests performed on the soil samples obtained during the field investigation.

Field Investigation

A total of 2 test borings were drilled on the site at the locations shown on the Test Boring Location Plan. The locations are accurate to within a short distance of the location shown on the plan, since they were staked by the client. The test borings were drilled on 8 March 1984 with truck-mounted auger equipment to depths ranging from 40 to 50 feet.

Drilling methods and standard penetration tests were performed in accordance with the current A.S.T.M. D-1452 and D-1586 procedures respectively. These procedures specify that a standard 2-inch O.D. split-barrel sampler be driven by a 140 pound hammer with a free fall of 30 inches. The number of

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Field Investigation (Cont'd)

hammer blows required to drive the split-barrel sampler through three successive 6-inch increments is recorded on the Test Boring Log. The first 6-inch increment is used for setting the sampler firmly in the soil, and the sum of the hammer blows for the second and third increments is referred to as the "Standard Penetration Index" (N).

From the standard penetration test a soil sample is recovered in the liner sampler tubes that are located inside the split-barrel sampler. Upon recovery of a soil sample, the liner tubes are removed from the split-barrel sampler and placed in a brass container which is sealed to prevent moisture losses during transportation to the laboratory. Standard penetration tests are usually made at depths of 3 1/2, 7 and 10 feet and at 5 foot depth intervals thereafter. These parameters may vary for a given project depending on the nature of the subsoils and the geotechnical information required.

Laboratory Testing

The laboratory testing consisted of determining the unconfined compressive strength, the natural bulk density and the natural moisture content of the soil samples recovered in the liner sampler tubes. In the unconfined compression tests, the compressive strength of the soil is determined by axially loading a soil sample under a slow strain rate until failure is

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Laboratory Testing (Cont'd)

obtained. The above referenced test data are recorded on the test Boring Logs. Some test results may deviate from the norm because of variations in texture, imperfect samples, presence of pebbles and/or sand streaks, etc. The results are still reported although they may not be relevant.

Samples taken in the field are retained in our laboratory for 60 days and are then destroyed unless special disposition is requested by the client. Samples retained over a long period of time are subject to moisture loss and are then no longer representative of the conditions initially encountered.

GENERAL SUBSOIL AND GROUNDWATER CONDITIONS

Subsoil Conditions

The subsoil conditions encountered in the test borings are presented on the individual logs of Test Borings. Each log presents the soil profile as observed at that location as well as laboratory test data, ground water data, and other pertinent information. Descriptions of the various soil consistencies, relative densities and particle sizes are given in the Appendix following the Test Boring Logs. Definitions of the terms and symbols utilized in this report may be found in ASTM D-653.

The surface is covered with soft to firm sand or clay fill that is 7 1/2 feet in depth. The underlying original soil is primarily layers of sandy clay. Medium compact grey fine sand

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Subsoil Conditions (Cont'd)

was encountered in Boring No. 1 to a depth of 11 feet. The clay ranges from very soft to stiff in consistency, generally improving with depth. The fill contains some topsoil and vegetation.

The moisture contents and natural bulk densities are quite variable for the respective soil types.

Ground Water Observations

Water level readings were taken in the bore holes during and after the completion of drilling. These observations are noted on the respective Test Boring Logs.

Afif A. Elias
Professional Engineer

Kenneth D. Cummins
Professional Engineer

AAE/KDC/da

APPENDIX

SOIL DESCRIPTIONS

In order to provide uniformity throughout our projects, the following nomenclature has been adopted to describe soil characteristics:

CONSISTENCY AND RELATIVE DENSITY

COHESIVE SOILS			GRANULAR SOILS		
"N" VALUES	"H-N" VALUES	CONSISTENCY	"N" VALUES	"H-N" VALUES	RELATIVE DENSITY
0 - 2	0 - 6	Very Soft	0 - 4	0 - 12	Very Loose
2 - 4	6 - 12	Soft	4 - 10	12 - 30	Loose
4 - 8	12 - 24	Plastic	10 - 30	30 - 90	Med. Compact
8 - 15	24 - 45	Firm	30 - 50	90 - 150	Compact
15- 30	45 - 90	Stiff	50 +	150 +	Dense
30- 60	90 - 180	Ex. Stiff			
60 +	180 +	Ex. Dense			

Material Types by Particle Size

BOULDERS	-Stones over 12" in diameter
COBBLES	-Stones 3" to 12" in diameter
GRAVEL	-1/4" to 3" diameter
FINE GRAVEL	-#10 to 1/4" Sieve

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SOIL DESCRIPTIONS

Material Types by Particle Size (Cont'd.)

PEBBLES	-Occasional pieces of gravel 1/4" to 3/4" in diameter found scattered throughout the other materials.
COARSE SAND	-#40 to #10 Sieves
FINE SAND	-#200 to #40 Sieves
SILT	-.005mm to #200 sieve material, fairly non-plastic.
CLAY	-.001mm to .005mm, plastic material that has a tendency to stick together, can be rolled into fine rods when moistened.
PEAT	-Black organic material containing partially decayed vegetable matter.
MARL	-Fresh water deposits of calcium carbonate, often containing percentages of Peat, Clay & Fine Sand.
SWAMP BOTTOM DEPOSITS	-Mixtures of Peat, Marl, Vegetation & Fine Sand containing large amounts of decayable organic material.

TESTING ENGINEERS & CONSULTANTS, INC.

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MEMBER

soil borings *soil evaluation* *foundation investigation* *instrumentation*

BORING NO. #1 JOB NO. 9192

Ground Surface (Elev.)

Datum

CLIENT: Pate, Hirn & Bogue, Inc.

PROJECT NEW SEAWALL
City Filter Plant & Park

Location: Marine City, Michigan

Started 8 March 1984 Completed 8 March 1984

Driller T. Byrnes

ELEV.	DEPTH IN FEET	SAMPLE TYPE	SAMPLE "N"	STRATA CHANGE	SOIL CLASSIFICATION	W. L.	W	γ_d	q_u
				6"	Frozen Brown Sandy Clay With Traces Of Brick & Occasional Pebbles - FILL		WATER ENCOUNTERED 3'6" AT COMPLETION 2'		
			1						
		LS	2	3'6"	Very Soft Moist Bluish Brown Sandy Clay With Traces Of Wood - FILL		27.9	109	970
			1						
	5				Loose Wet Black & Brown Sandy Clay With Broken Glass & Pebbles - FILL				
			1						
		LS	1				64.0	87	680
			2	7'6"					
			5		Medium Compact Moist Grey Fine SAND With Clay Binder				
		LS	5				23.5	112	2620
	10		6	11'0"					
					Very Soft Moist Blue CLAY				
			1						
		LS	1				34.1	116	1060
	15		2	16'0"					
					Plastic Moist Blue CLAY With Occasional Small Pebbles				
			2						
		LS	3				25.7	123	1450
	20		3						
				22'6"					
			10		Stiff Moist Blue Sandy CLAY With Pebbles				
		LS	15				13.5	125	1650
	25		10						
			10						
		LS	12	29'6"			18.8	113	
	30		11		Stiff Moist Blue Silty CLAY				
					Continued				

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
S.T. - Shelby Tube Sample
B.S. - Bottle Sample

W - H_2O% of dry weight
γ_d - Natural Density-lbs. cu. ft.
q_u - Unconfined Compression lbs. sq. ft.
W.L. - Water Level

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BORING NO. #1 JOB NO. 9192

Ground Surface (Elev.)

Datum

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City Filter Plant & Park

Location: Marine City, Michigan

Started 8 March 1984 Completed 8 March 1984

Driller T. Byrnes

ELEV.	DEPTH IN FEET	SAMPLE TYPE	SAMPLE "N"	STRATA CHANGE	SOIL CLASSIFICATION	W.L.	W	γ_d	q_u
				31'0"	Stiff Moist Blue Silty CLAY		WATER ENCOUNTERED 3'6" AT COMPLETION 2'		
					Firm Moist Blue CLAY With Occasional Small Pebbles				
		LS	5 6 7				25.6	108	2130
	35								
		LS	5 6 8				16.5	129	4950
	40								
		LS	5 7 7				15.4	127	1940
	45								
		LS	5 6 7	50'0"			26.3	101	1450
	50				END OF BORING				
	55								
	60								

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BORING NO. # 2 JOB NO. 9192

Ground Surface (Elev.)

Datum

CLIENT Pate, Hirn & Bogue, Inc.

PROJECT NEW SEAWALL
City Filter Plant & Park

Location: Marine City, Michigan

Started 8 March 1984 Completed 8 March 1984

Driller T. Byrnes

ELEV.	DEPTH IN FEET	SAMPLE TYPE	SAMPLE "N"	STRATA CHANGE	SOIL CLASSIFICATION	W. L.	W	γ_d	q_u
				6"	Frozen Brown Sandy Clay With Trace Of Organics - FILL		WATER ENCOUNTERED 5'6" AT COMPLETION None		
			3	2'0"	Firm Moist Dark Brown Sandy Clay With Pebbles & Occasional Piece Of Brick & Traces Of Topsoil FILL				
		LS	4				29.2	105	1940
			5	3'6"					
				4'0"					
	5		1		Firm Moist Dark Brown Sandy Clayey TOPSOIL With Occasional Pebbles & Trace Of Organics Possible Fill				
		LS	1	6'6"			61.2	111	1650
			2	7'6"					
			4		Loose Moist Grey Fine Silty SAND With Trace Of Topsoil - Possible Fill				
		LS	4				32.4	110	3780
	10		4						
				11'0"	Very Soft Moist Brownish Grey Sandy CLAY With Wood & Traces Of Topsoil - Possible Fill				
			1		Soft Moist Blue Silty CLAY With Traces Of Wood				
		LS	1		Firm Moist Blue Silty CLAY		34.3	104	1260
	15		1		Very Soft Moist Blue CLAY				
				16'0"					
					Plastic Moist Blue Sandy CLAY With Occasional Small Pebbles				
			3						
		LS	4				30.4	118	1740
	20		4						
			3						
		LS	3				28.6	115	1450
	25		4						
			3						
		LS	4				27.6	118	1160
	30		4						

Continued

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
L.S. - Sectional Liner Sample
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BORING NO. # 2 JOB NO. 9192

Ground Surface (Elev.)

Datum

PROJECT NEW SEAWALL
City Filter Plant & Park

CLIENT Pate, Hirn & Bogue, Inc.

Location: Marine City, Michigan

Started 8 March 1984 Completed 8 March 1984

Driller T. Byrnes

ELEV.	DEPTH IN FEET	SAMPLE TYPE	SAMPLE "N"	STRATA CHANGE	SOIL CLASSIFICATION	W. L.	W	γ_d	q_u
					Plastic Moist Blue Sandy CLAY With Occasional Small Pebbles		WATER ENCOUNTERED 5'6" AT COMPLETION None		
	35	LS	3 4 4				26.8	120	1350
	40	LS	3 4 4	40'0"			22.0	108	1450
					END OF BORING				
	45								
	50								
	55								
	60								

"N" - Standard Penetration Resistance
S.S. - 2" O.D. Split Spoon Sample
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Boring No. #2 /da