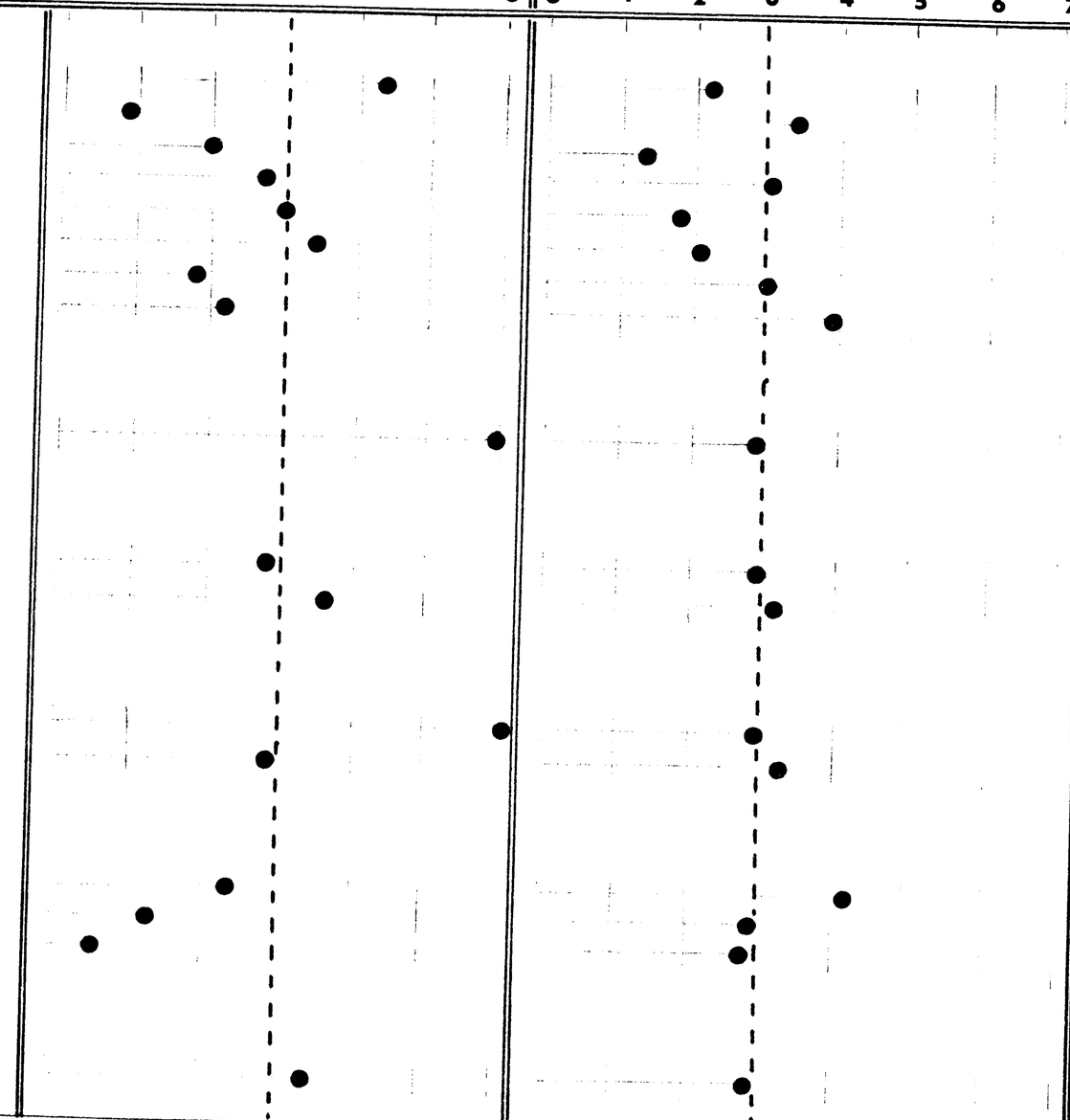
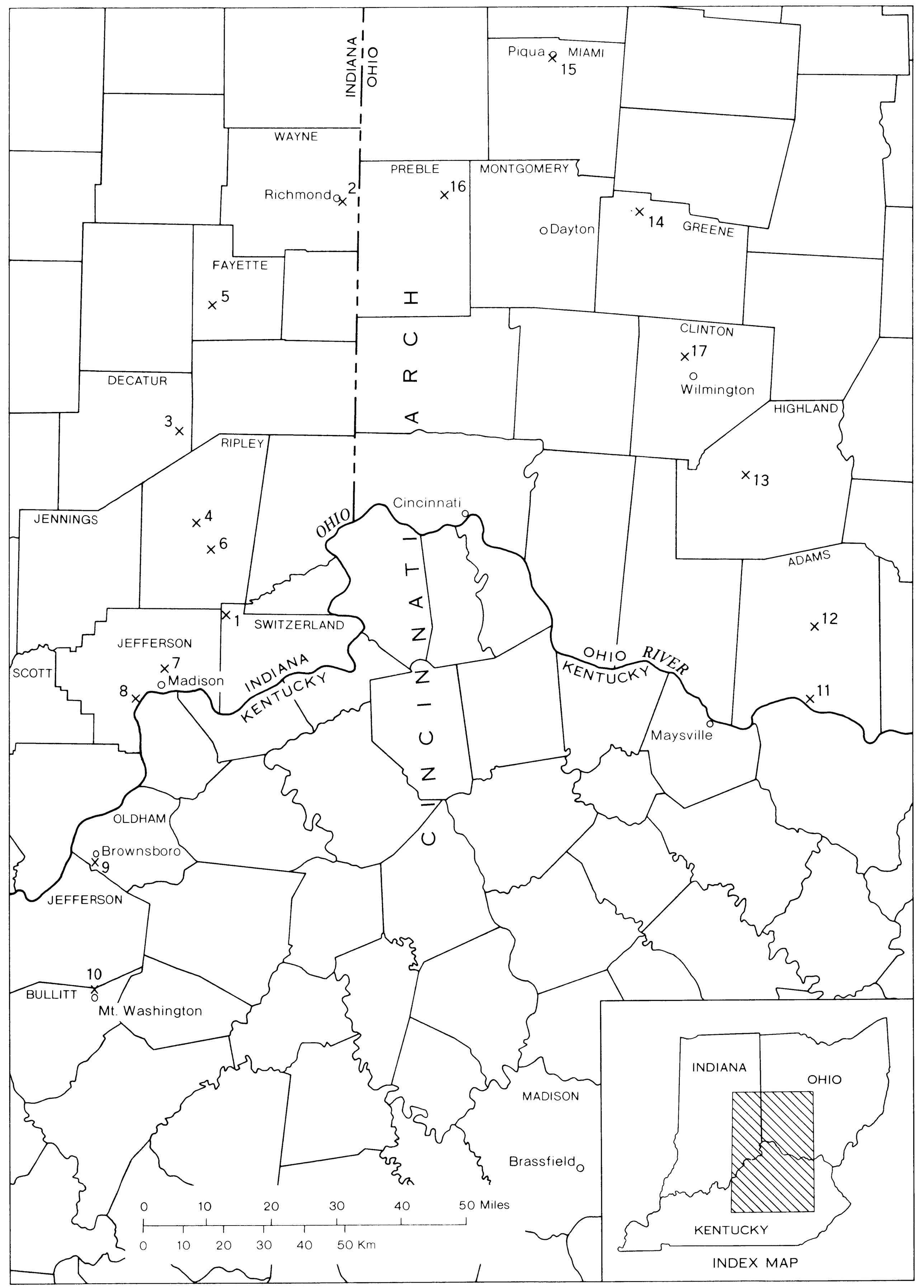


COUNTY	SEC. TWP. RGE.	Common Brick	Paving Brick	Sewer Tile	Cement	REMARKS
SAGINAW SHALE						
Bay	NW 4, T14N, R5E					overshale, Winonia Cool Mine (abd)
Eaton	3, T4N, R4W	X		X		mixed shale as used in plant
Eaton	3, T4N, R4W	X		X		black carbonaceous shale
Eaton	3, T4N, R4W	X		X		grey carbonaceous shale
Genesee	22, T8N, R5E		X			upper shale
Ingham	1, T3N, R1E	X				
Jackson	11, T2N, R1W			X		composite sample
Saginaw	6, T11N, R5E					under shale, Standard Cool Mine (abd)
MICHIGAN SHALE						
Kent	2, T6N, R12W	X				above gypsum
COLDWATER SHALE						
Branch	32, T6S, R6W			X		old Wolverine Ptl. Cem. Qy. shore bluff; 50' high
Huron	32, T15N, R16E					
ELLSWORTH SHALE						
Antrim	26, T32N, R8W			X		composite sample, Penn-Dixie Qy. red. cut, weathered shale
Antrim	13, T32N, R8W					
ANTRIM SHALE						
Alpena	30, T31N, R7E			X		upper 5', Payton qy. 1.5 mi. N. of Chestonia N. side Walloon Lake
Antrim	E 17, T31N, R6W					
Emmet	36, T34N, R6W					
TRAVERSE & Ferron Pt. Shale						
Alpena	18, T32N, R9E			X		Abd. shale quarry.


INDIANA
OHIO
Piqua
MIAMI
15
WAYNE
PREBLE
MONTGOMERY
Richmond
2
16
Dayton
14
GREENE
FAYETTE
5
CLINTON
17
Wilmington
DECATUR
3
HIGHLAND
RIPLEY
13
Cincinnati
JENNINGS
4
6
OHIO
ADAMS
12
1
SWITZERLAND
JEFFERSON
OHIO RIVER
KENTUCKY
SCOTT
7
Madison
INDIANA
KENTUCKY
8
11
Maysville
OLDHAM
Brownsboro
9
JEFFERSON
10
BULLITT
Mt. Washington
MADISON
Brassfield
0 10 20 30 40 50 Miles
0 10 20 30 40 50 Km
INDIANA
OHIO
KENTUCKY
INDEX MAP

	1	2	3	4	5	6	7	8	9	10	11	
Los Angeles Abrasion Loss	1.000	-.279	-.126	.003	-.007	.322	-.457	.258	-.361	.103	.171	1
Soundness Loss		1.000	.572	-.375	.079	-.180	.204	-.159	.399	-.723	-.318	2
Absorption			1.000	-.526	.450	-.229	-.169	-.129	.026	-.353	.228	3
Specific Gravity				1.000	-.274	.019	.197	-.066	.276	.199	-.064	4
Compressive Strength					1.000	-.424	-.144	.089	.028	.061	.358	5
Mean Grain Size						1.000	-.148	.338	-.339	.037	.002	6
Insoluble Residues							1.000	-.104	.844	.138	-.684	7
Grain Sorting								1.000	-.334	.345	.225	8
Clay Content									1.000	-.155	-.651	9
Location East										1.000	.335	10
Location North											1.000	11

EXPLANATION

.061	.572	.844	
$\lvert r \rvert < 0.482$	$0.482 < \lvert r \rvert < 0.606$	$\lvert r \rvert > 0.606$	n = 17
Insignificant	*Significant (95% significance level)*	*Highly significant (99% significance level)*	

	10	11	12	13	14	15	16	17	18	19	20	21	
Location East	1.000	.335	.248	-.286	.030	-.221	-.078	.029	.216	-.372	.053	-.651	10
Location North		1.000	.312	-.194	-.418	-.778	-.315	-.613	-.351	.552	.334	-.555	11
$CaCO_3$			1.000	-.969	-.600	-.708	-.757	-.653	-.653	-.039	.001	-.554	12
$MgCO_3$				1.000	.392	.575	.612	.518	.539	.225	-.010	.443	13
SiO_2					1.000	.672	.836	.706	.718	-.517	.049	.592	14
Al_2O_3						1.000	.651	.846	.558	-.514	-.118	.652	15
Fe_2O_3							1.000	.654	.740	-.232	.208	.608	16
TiO_2								1.000	.716	-.566	.059	.497	17
MnO									1.000	-.226	-.091	.395	18
CO_2										1.000	-.056	-.038	19
S											1.000	-.131	20
P_2O_5												1.000	21

EXPLANATION

.059	.552	.846
$\lvert r \rvert < 0.482$	$0.482 < \lvert r \rvert < 0.606$	$\lvert r \rvert > 0.606$
Insignificant	*Significant (95% significance level)*	*Highly significant (99% significance level)*

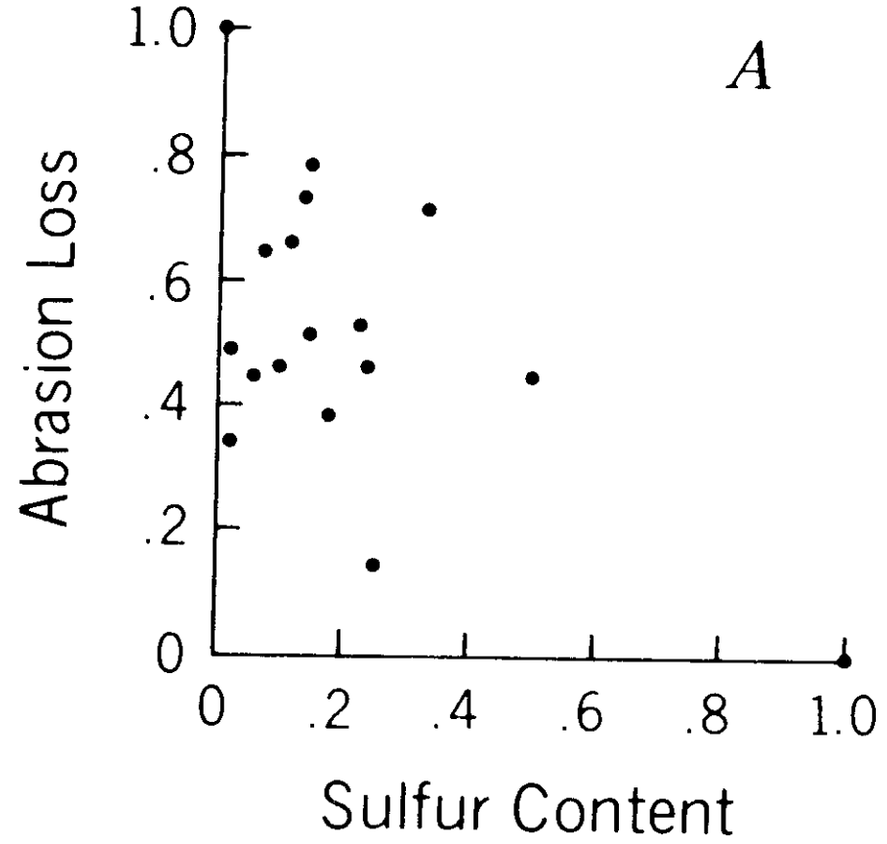
n = 17

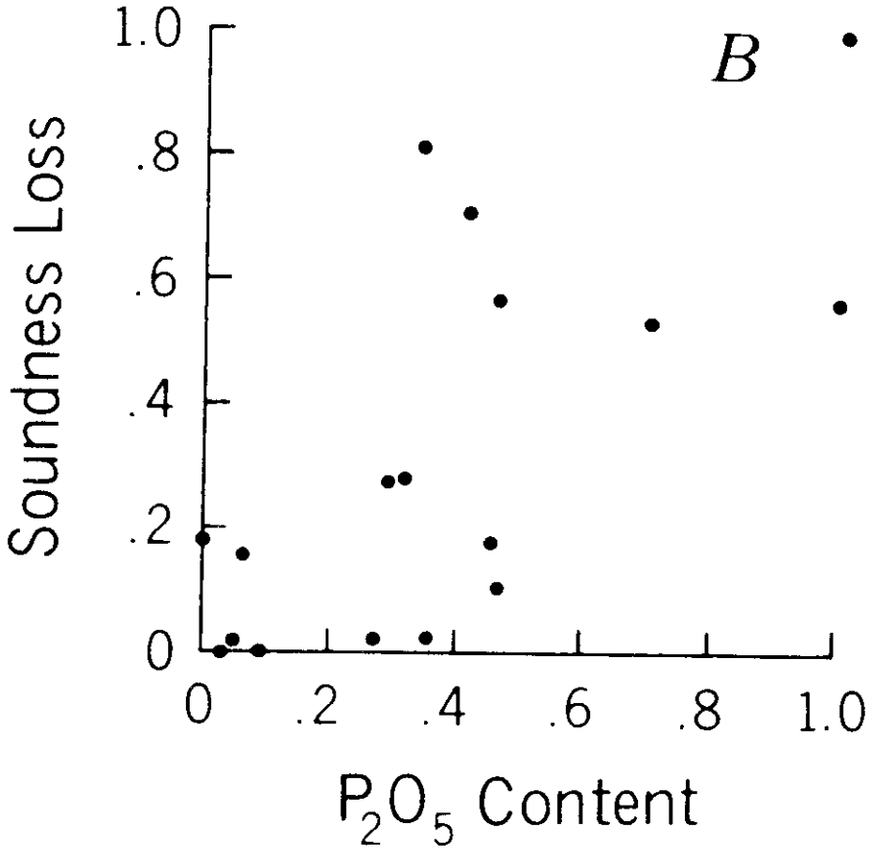
	1	2	3	4	5	6	7	8	10	11	12	15	20	21	
Los Angeles Abrasion Loss	1.000	-.279	-.126	.003	-.007	.322	-.457	.258	.103	.111	.347	-.371	-.587	-.449	1
Soundness Loss		1.000	.572	-.375	.079	-.180	.204	-.159	-.723	-.318	-.522	.389	-.008	.690	2
Absorption			1.000	-.526	.450	-.229	-.169	-.129	-.353	.228	-.373	-.075	.039	.342	3
Specific Gravity				1.000	-.274	.019	.197	-.066	.199	-.064	-.031	.266	.015	.114	4
Compressive Strength					1.000	-.424	-.144	.089	.061	.358	-.094	-.115	-.125	-.166	5
Mean Grain Size						1.000	-.148	.338	.037	.002	.321	-.328	-.042	-.271	6
Insoluble Residues							1.000	-.104	.134	-.684	-.530	.832	.088	.334	7
Grain Sorting								1.000	.345	.225	.578	-.315	-.065	-.351	8
Location East									1.000	.335	.248	-.221	.053	-.651	10
Location North										1.000	.312	-.778	.335	-.555	11
$CaCO_3$											1.000	-.708	.001	-.554	12
Al_2O_3												1.000	-.118	.653	15
S													1.000	-.131	20
P_2O_5														1.000	21

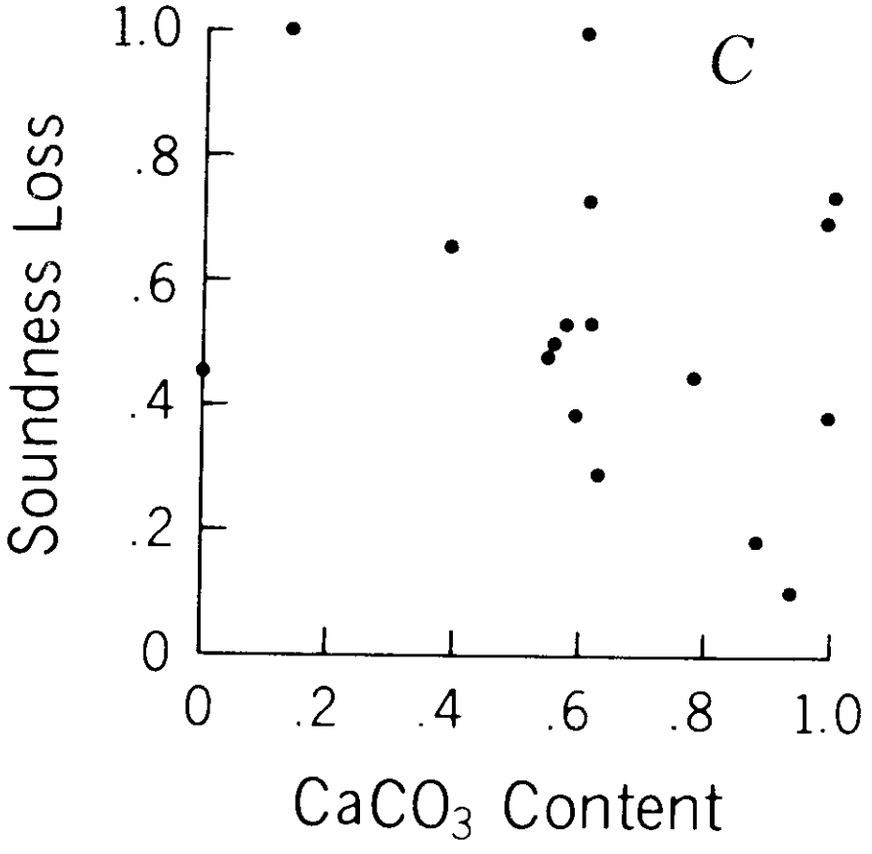
EXPLANATION

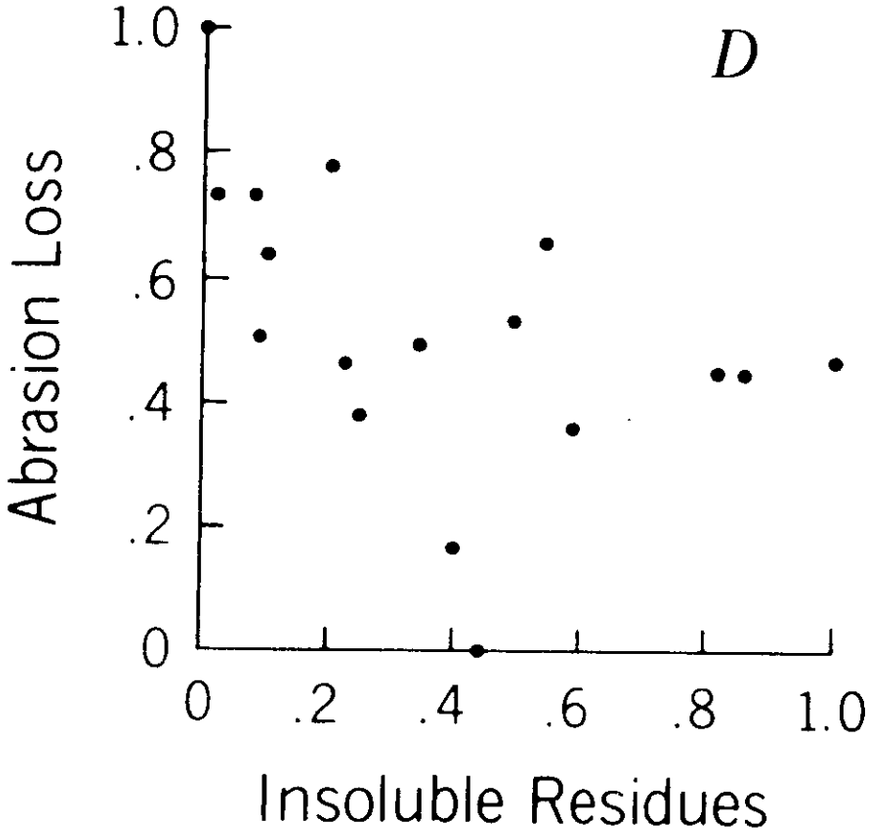
.061	.572	.832
$\lvert r \rvert < 0.482$	$0.482 < \lvert r \rvert < 0.606$	$\lvert r \rvert > 0.606$
Insignificant	*Significant (95% significance level)*	*Highly significant (99% significance level)*

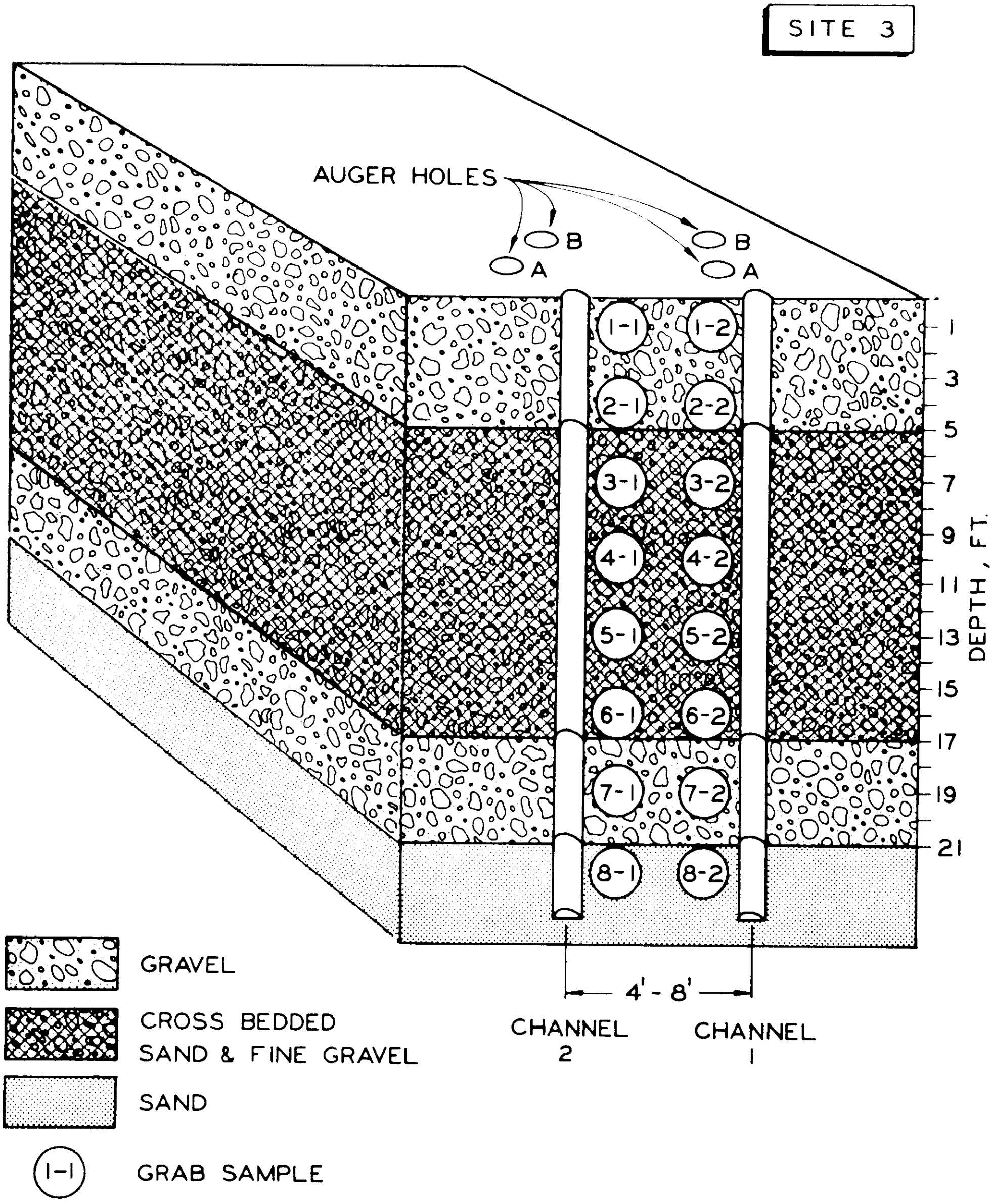
n = 17

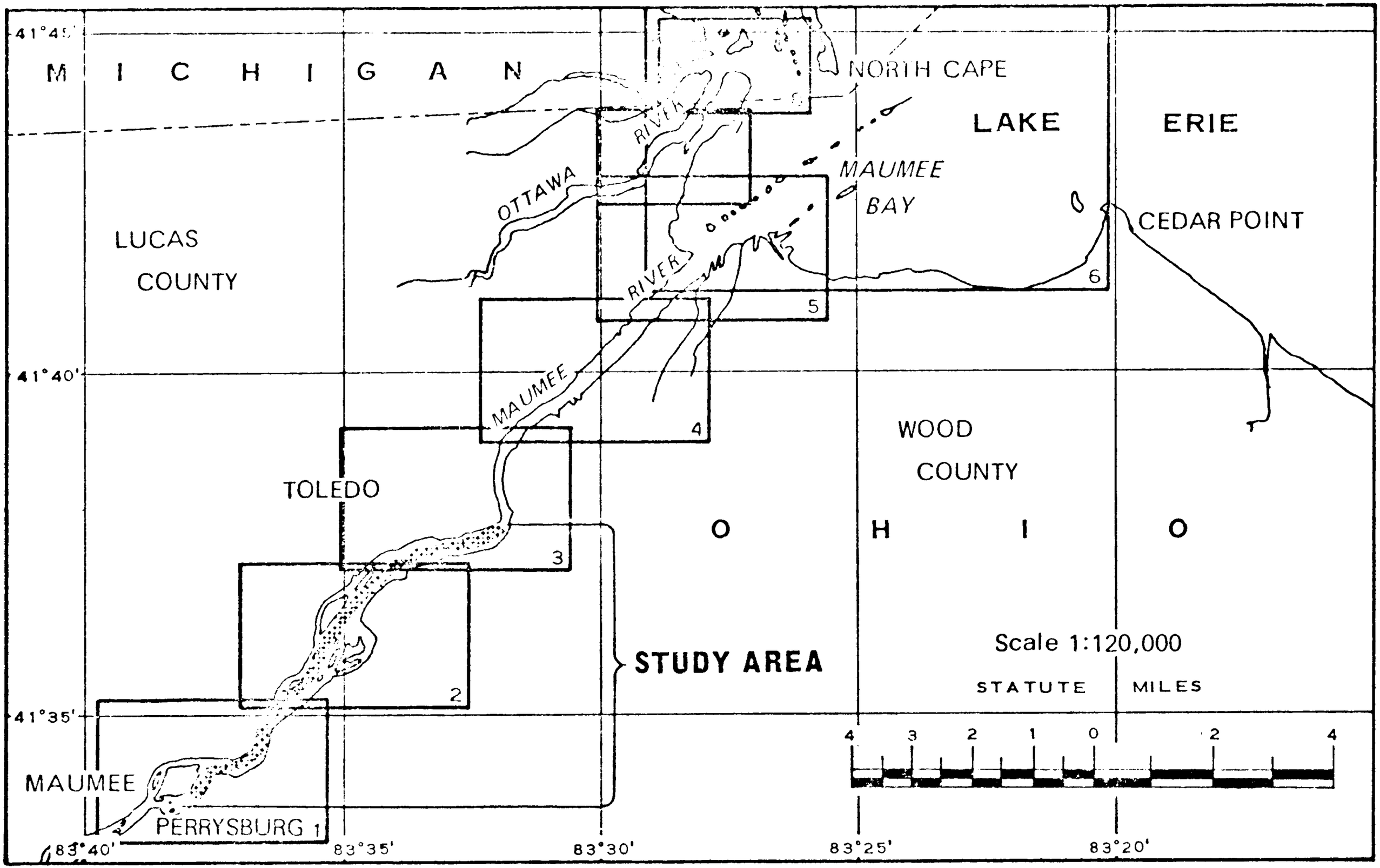

A
Abrasion Loss
1.0
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1.0
Sulfur Content

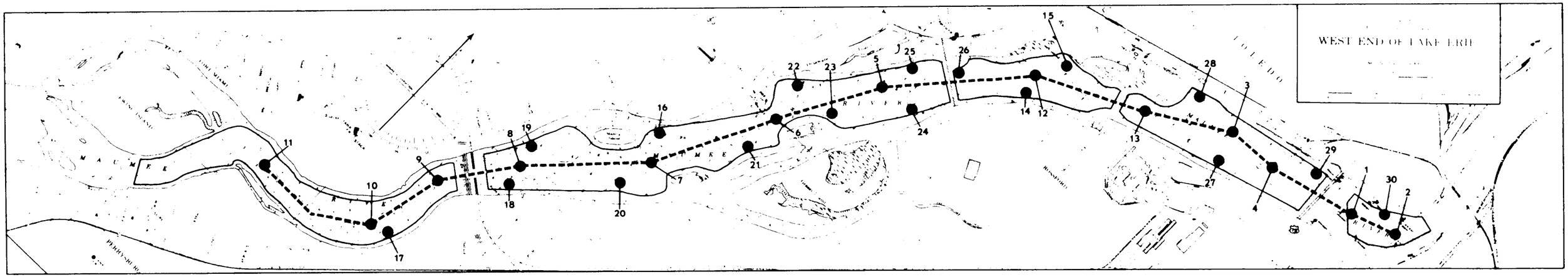

B
Soundness Loss
1.0
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1.0
P_2O_5 Content

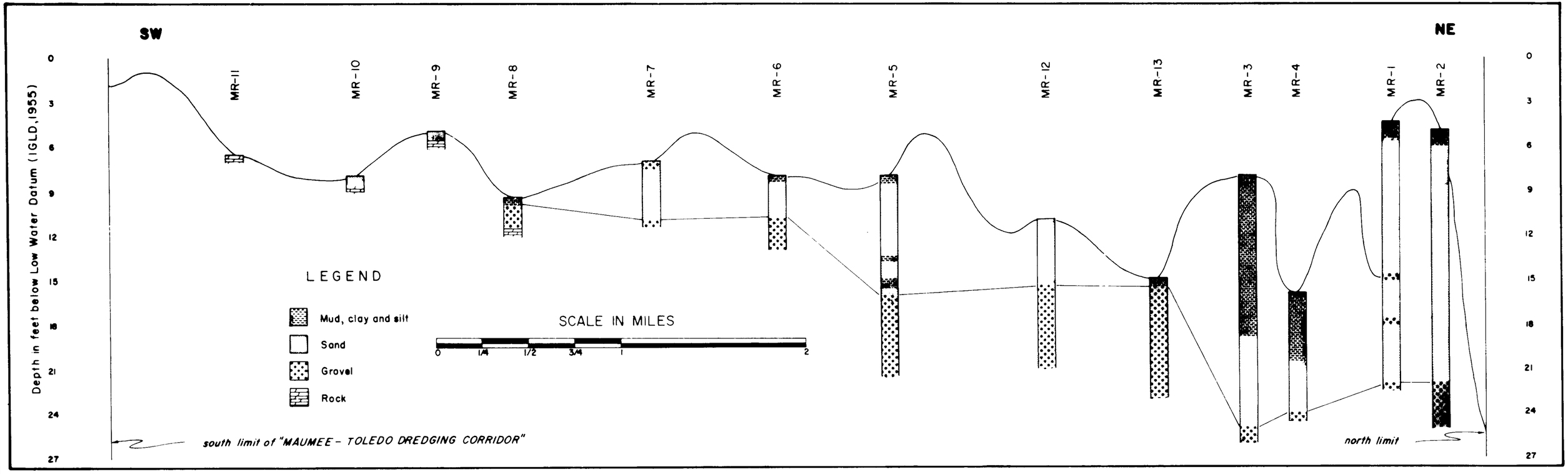

C
Soundness Loss
1.0
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1.0
$CaCO_3$ Content


D
Abrasion Loss
1.0
.8
.6
.4
.2
0
0
.2
.4
.6
.8
1.0
Insoluble Residues

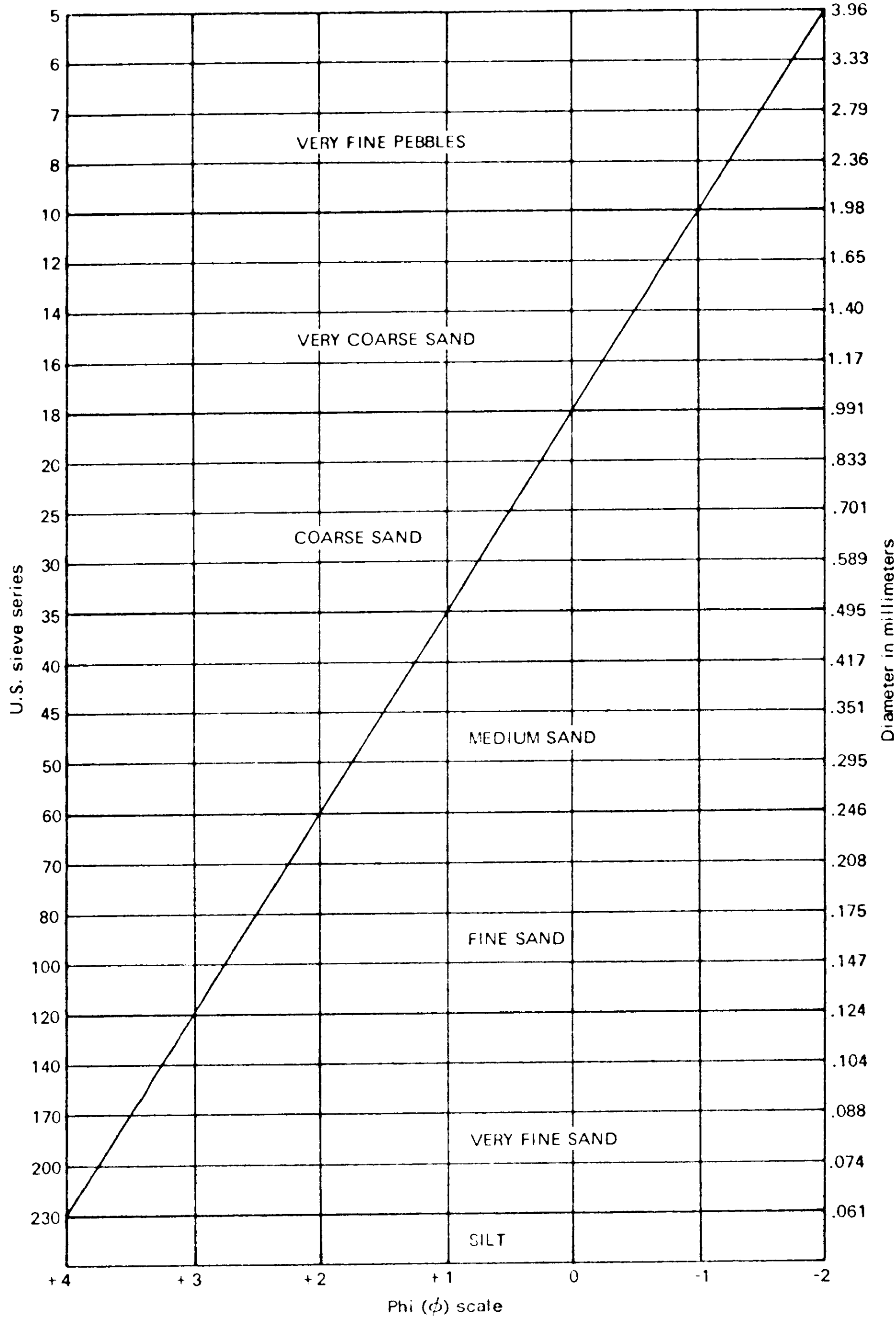

SITE 3
AUGER HOLES
A
B
B
A
1-1
1-2
2-1
2-2
3-1
3-2
4-1
4-2
5-1
5-2
6-1
6-2
7-1
7-2
8-1
8-2
1
3
5
7
9
11
13
15
17
19
21
DEPTH, FT.
4' - 8'
CHANNEL 2
CHANNEL 1
GRAVEL
CROSS BEDDED SAND & FINE GRAVEL
SAND
1-1
GRAB SAMPLE

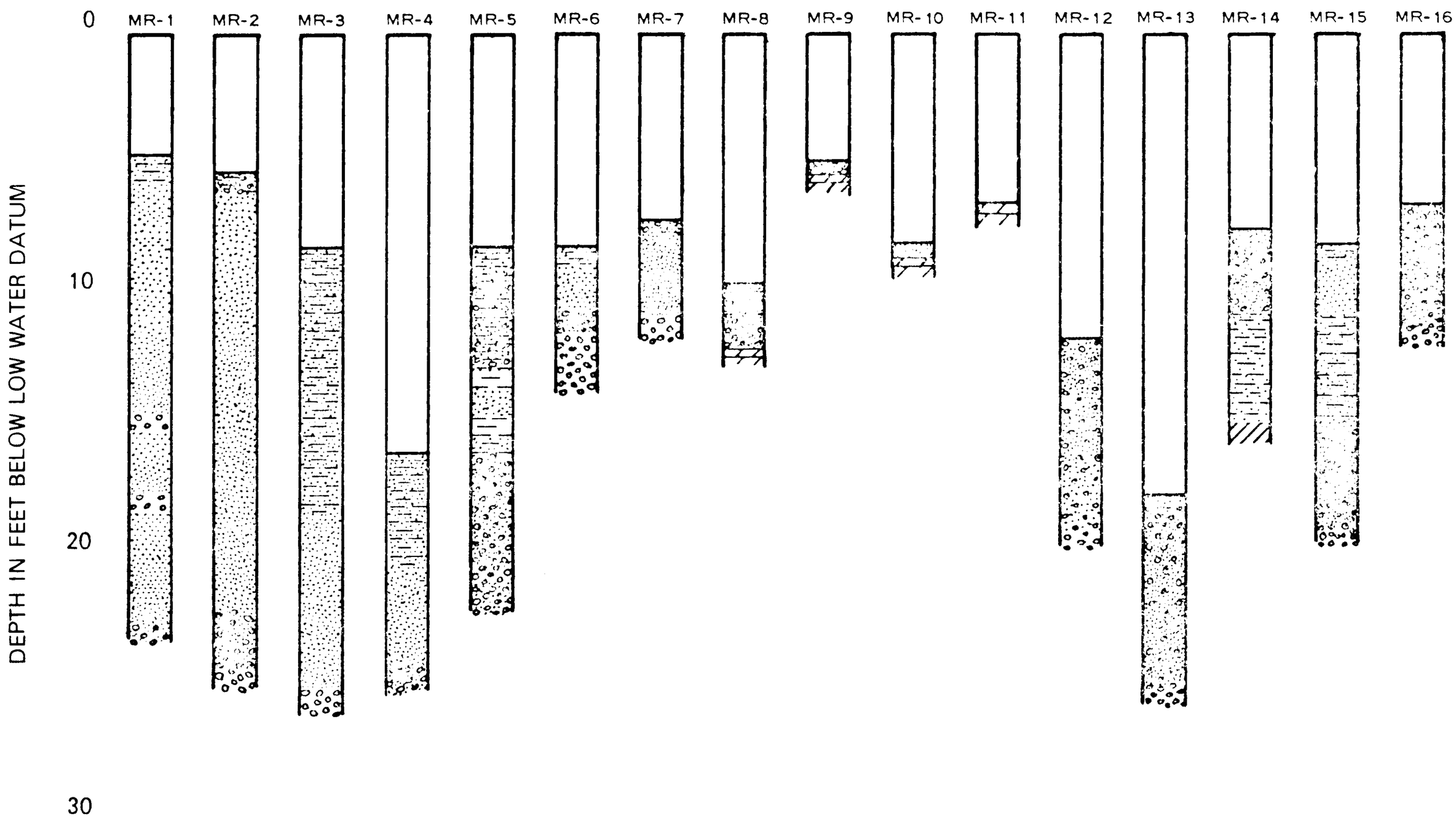

41°45'
41°40'
41°35'
83°40'
83°35'
83°30'
83°25'
83°20'
M I C H I G A N
NORTH CAPE
LAKE
ERIE
MAUMEE
BAY
CEDAR POINT
OTTAWA
RIVER
RIVER
MAUMEE
LUCAS
COUNTY
WOOD
COUNTY
TOLEDO
O H I O
STUDY AREA
MAUMEE
PERRYSBURG
1
2
3
4
5
6
Scale 1:120,000
STATUTE MILES
4 3 2 1 0 2 4

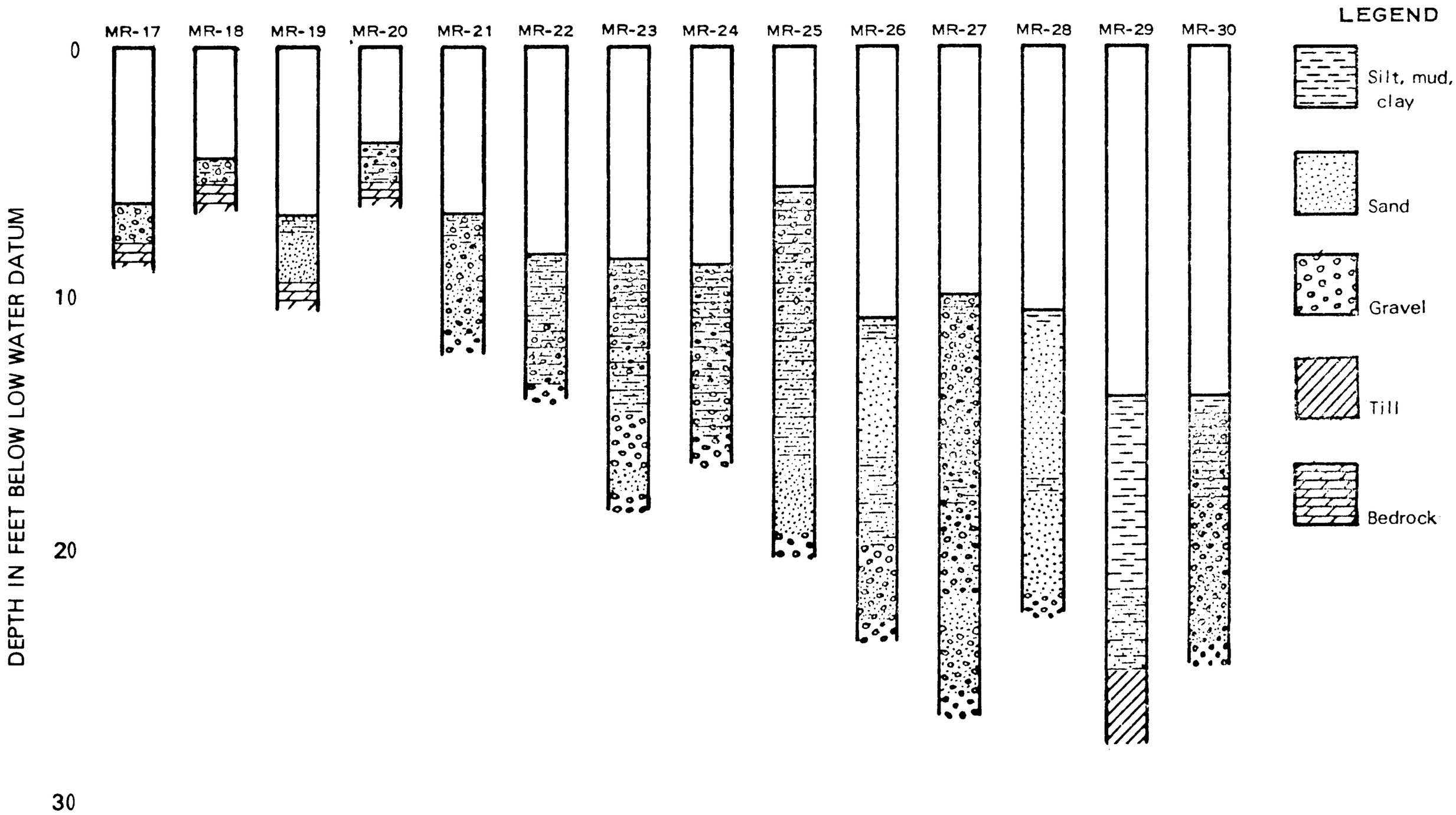

WEST END OF LAKE ERIE
MAUMEE
RIVER
TOLEDO
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

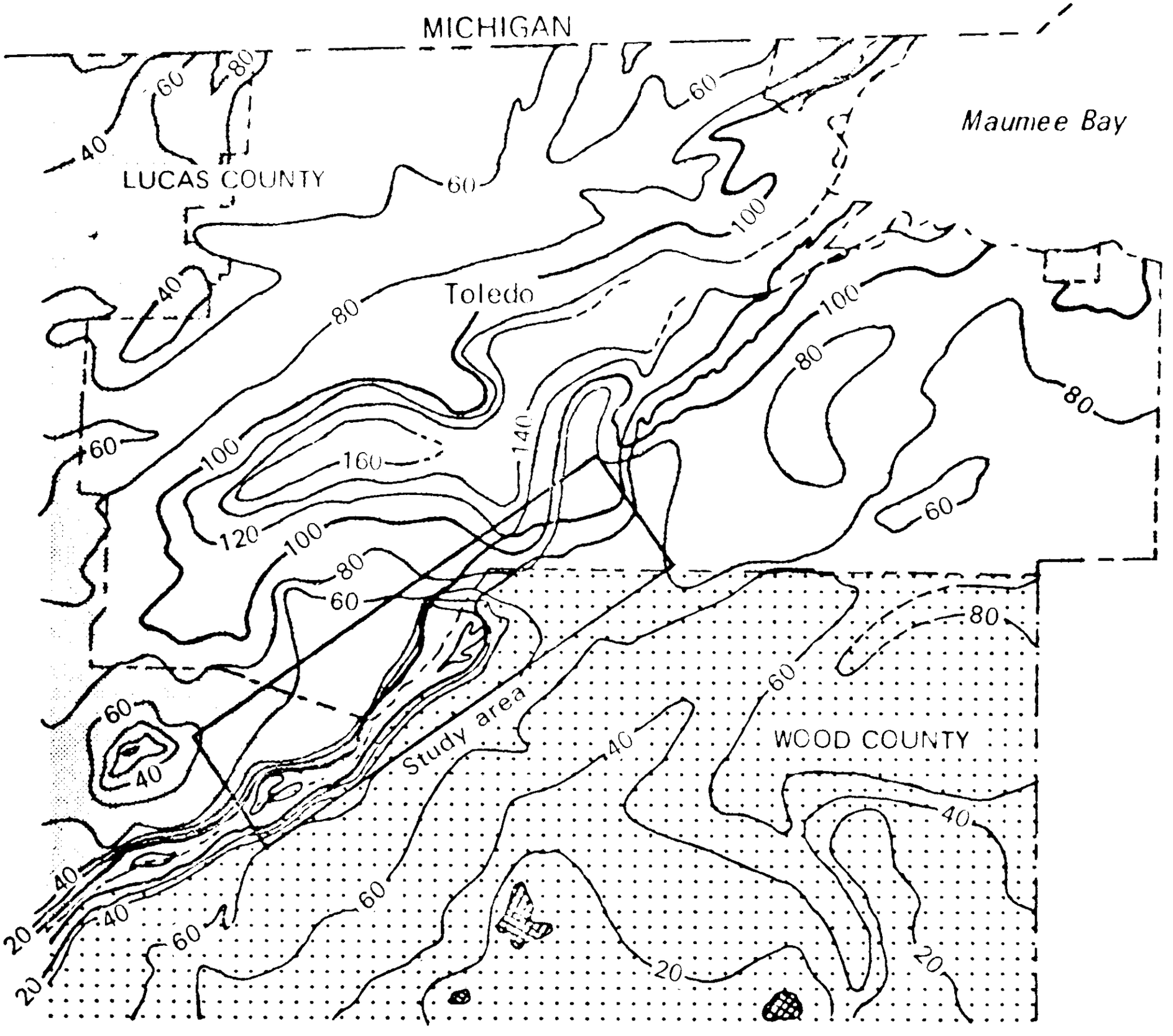

SW
NE
Depth in feet below Low Water Datum (IGLD, 1955)
0
3
6
9
12
15
18
21
24
27
MR-11
MR-10
MR-9
MR-8
MR-7
MR-6
MR-5
MR-12
MR-13
MR-3
MR-4
MR-1
MR-2
LEGEND
Mud, clay and silt
Sand
Gravel
Rock
SCALE IN MILES
0
1/4
1/2
3/4
1
2
south limit of "MAUMEE - TOLEDO DREDGING CORRIDOR"
north limit

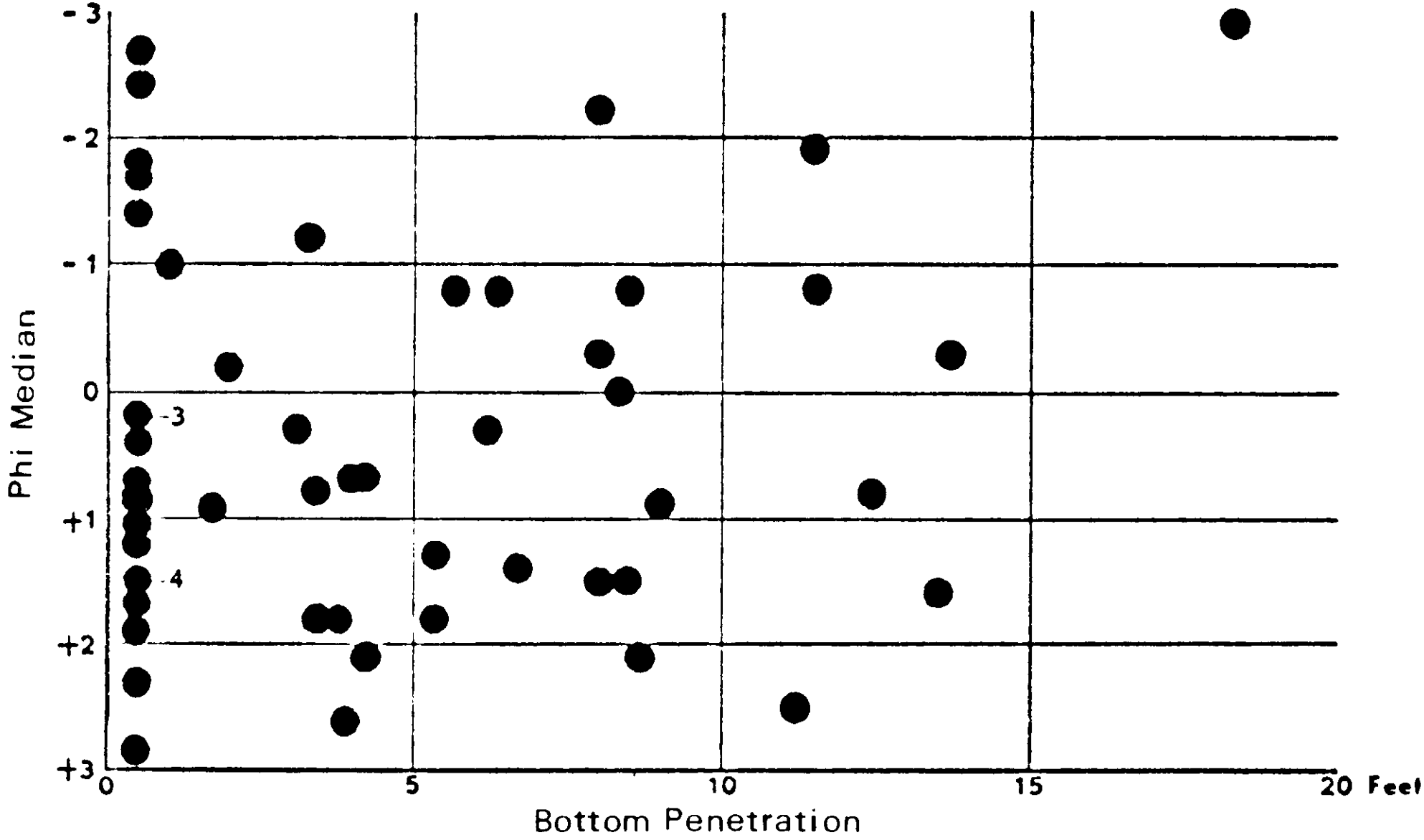
Sieve Number	Size Grade	Phi Units	Total Percent Passing			
			Portland Cement	Mortar & Grout	Asphalt Concrete	Sand Cover
3/8"	Pebbles		100	—	100	100
4		-3	95-100	100	90-100	90-100
8		-2	70-95	95-100	65-100	65-100
16	Coarse Sand	-1	45-80	85-100	40-85	40-85
30		0	25-60	—	20-60	20-60
50	Medium Sand	1	10-30	—	7-40	7-40
100	Fine Sand	2	1-10	0-10	0-20	0-20
200		3	0-4	0-4	0-10	0-10
	Silt	4				

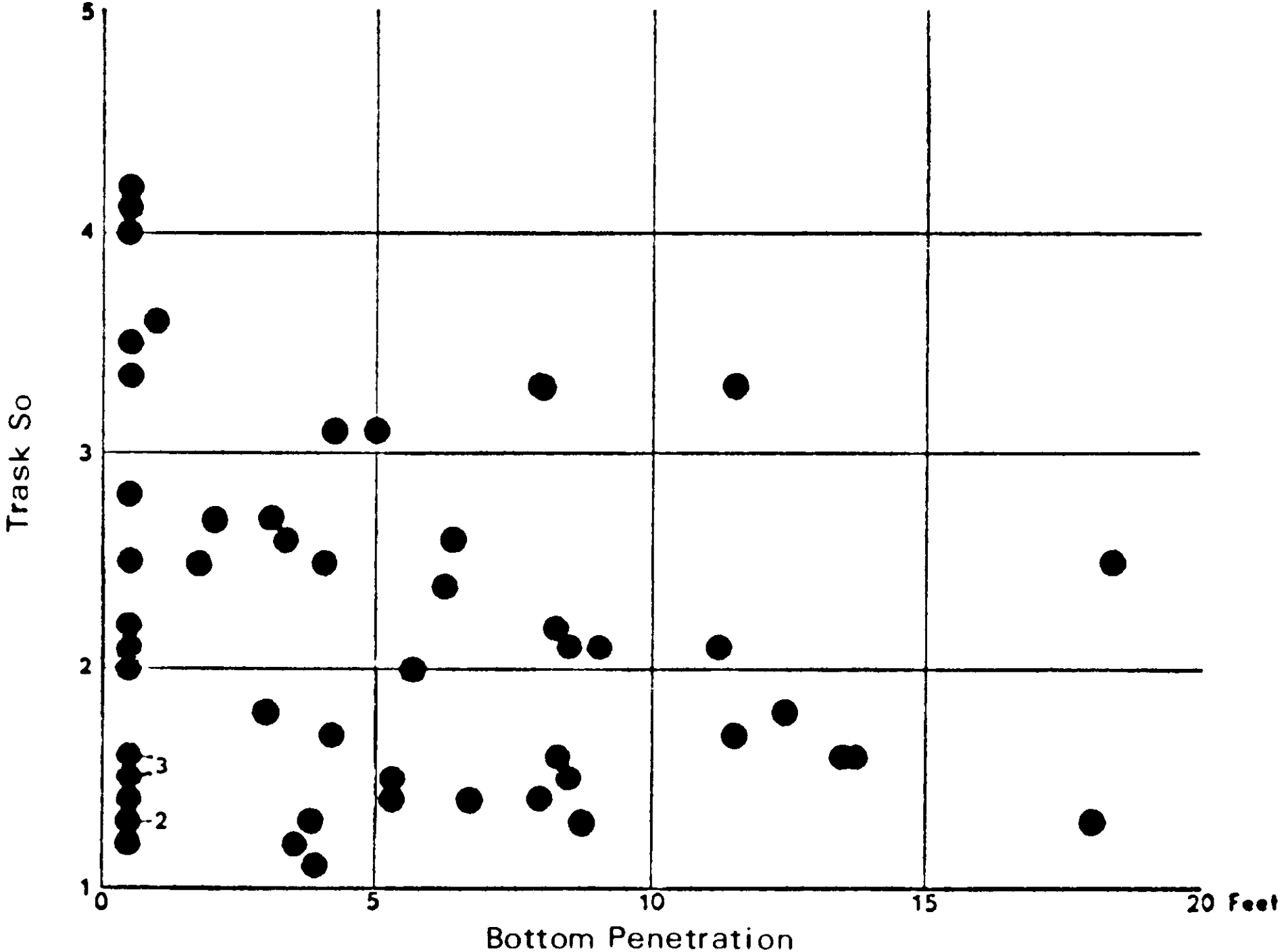

U.S. sieve series
5
6
7
8
10
12
14
16
18
20
25
30
35
40
45
50
60
70
80
100
120
140
170
200
230
Diameter in millimeters
3.96
3.33
2.79
2.36
1.98
1.65
1.40
1.17
.991
.833
.701
.589
.495
.417
.351
.295
.246
.208
.175
.147
.124
.104
.088
.074
.061
VERY FINE PEBBLES
VERY COARSE SAND
COARSE SAND
MEDIUM SAND
FINE SAND
VERY FINE SAND
SILT
+4
+3
+2
+1
0
-1
-2
Phi (ϕ) scale

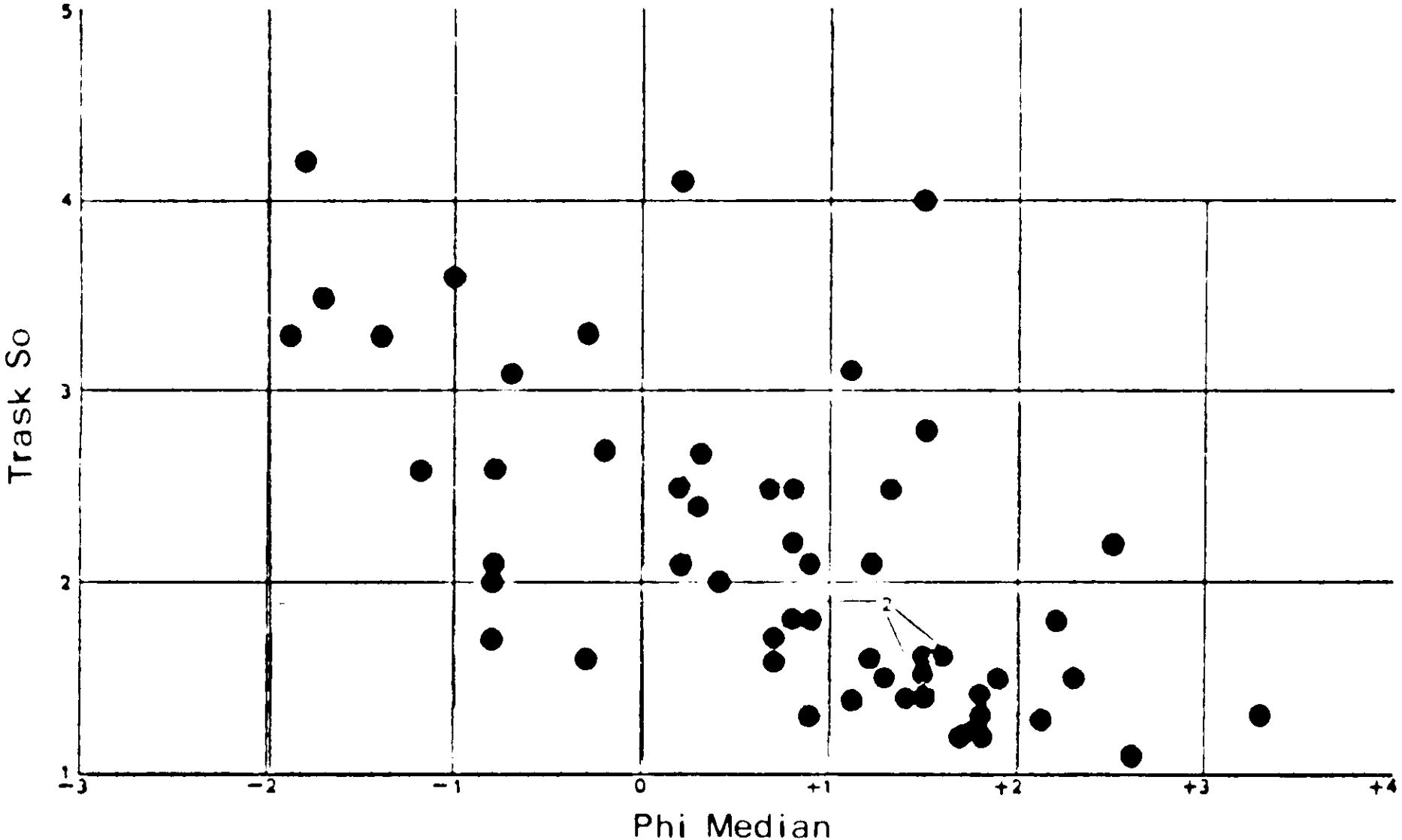

DEPTH IN FEET BELOW LOW WATER DATUM
0
10
20
30
MR-1
MR-2
MR-3
MR-4
MR-5
MR-6
MR-7
MR-8
MR-9
MR-10
MR-11
MR-12
MR-13
MR-14
MR-15
MR-16

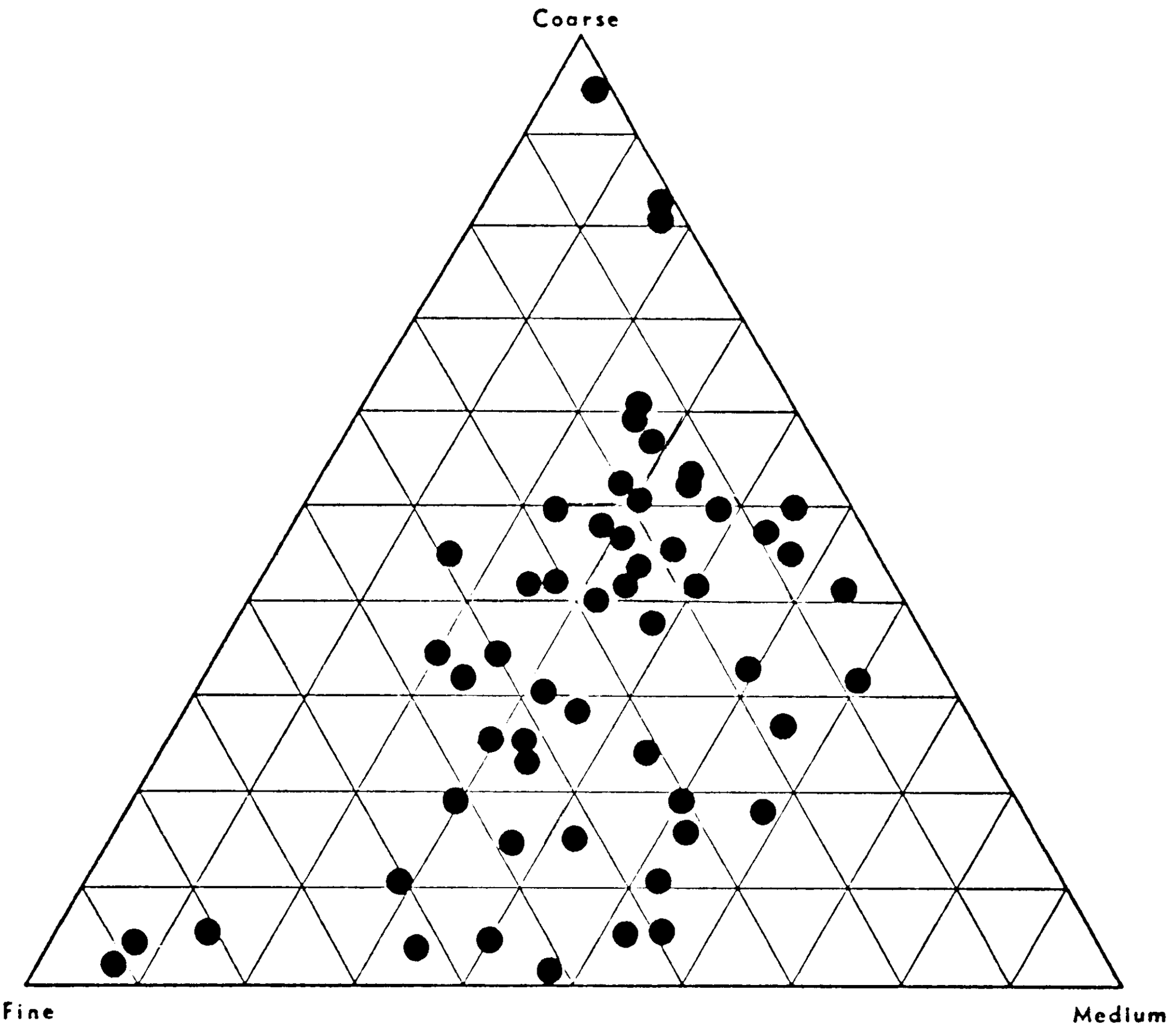

DEPTH IN FEET BELOW LOW WATER DATUM
0
10
20
30
MR-17
MR-18
MR-19
MR-20
MR-21
MR-22
MR-23
MR-24
MR-25
MR-26
MR-27
MR-28
MR-29
MR-30
LEGEND
Silt, mud, clay
Sand
Gravel
Till
Bedrock

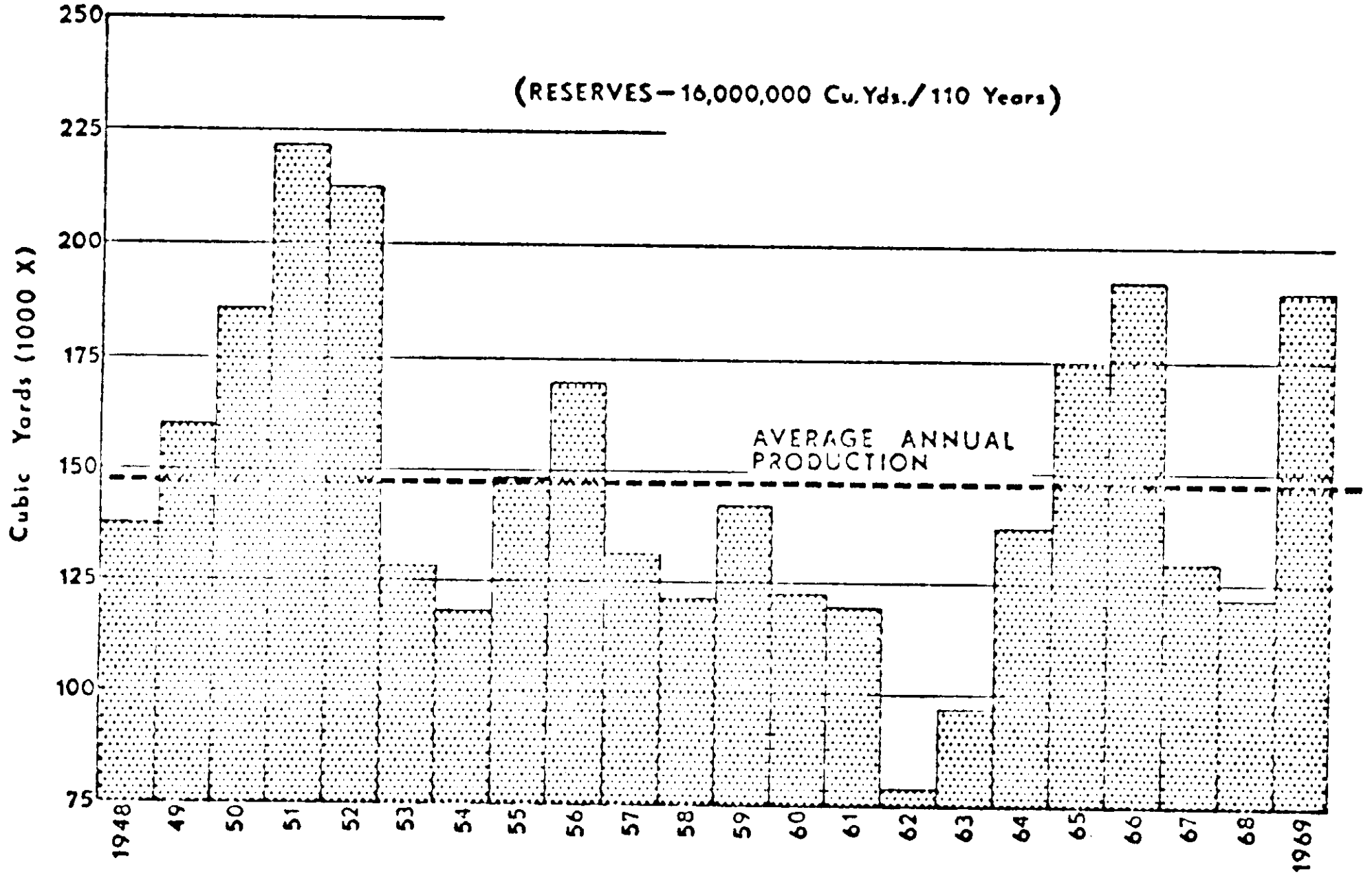

MICHIGAN
Maumee Bay
LUCAS COUNTY
Toledo
Study area
WOOD COUNTY
Bedrock less than three feet deep
Contour interval 20 feet


-3
-2
-1
0
+1
+2
+3
Phi Median
-3
-4
0
5
10
15
20 Feet
Bottom Penetration


Trask So
5
4
3
2
1
3
2
0
5
10
15
20 Feet
Bottom Penetration


Trask So
Phi Median
5
4
3
2
1
−3
−2
−1
0
+1
+2
+3
+4
2


Coarse
Fine
Medium


(RESERVES—16,000,000 Cu.Yds./110 Years)
AVERAGE ANNUAL PRODUCTION
Cubic Yards (1000 X)
250
225
200
175
150
125
100
75
1948
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
1969

APPENDIX

TABLE A.—*Logs of Maumee River test borings*

Boring no. Water depth Date	Sample number	Particle size (percent)				Depth and *elevation* (ft)	Bottom penetration (ft)	Field description
		Gravel	Sand	Silt	Clay			
MR-1 4.5 ft 8-25-64	MR-1-1	0.00	35.80	64.20	0.00	4.5 *564.1*	0.0-0.5	Sand, mixed with olive-gray mud, shells
	MR-1-2	0.00	89.20	10.80	0.00	7.5 *561.1*	3.0-3.4	Sand, medium- to coarse-grained
	MR-1-3	0.00	14.90	77.30	7.80	12.5 *556.1*	8.0-8.7	Sand, medium- to fine-grained
						14.5 *554.1*	10.0	No sample, appeared to be gravel layer with sand below
						17.5 *551.1*	13.0	No sample, appeared to be gravel layer with sand below
	MR-1-4	69.30	6.44	24.18	0.08	22.5 *546.1*	18.0-18.3	Sand, coarse-grained; with gravel
						23.0 *545.6*	18.5	No sample, refusal in compact sand and gravel layer
MR-2 5.0 ft 8-25-64	MR-2-1	16.08	65.52	18.40	0.00	5.0 *563.6*	0.0-0.5	Sand and gravel, medium- to fine-grained; mixed with brown mud, shell fragments, and wood detritus
	MR-2-2	1.15	77.95	20.90	0.00	8.0 *560.6*	3.0-3.8	Sand, medium- to fine-grained; with shell fragments
	MR-2-3	0.00	89.60	10.40	0.00	13.0 *555.6*	8.0-8.7	Sand, medium- to fine-grained, with shell fragments and wood detritus
	MR-2-4	1.95	85.65	12.40	0.00	18.0 *550.6*	13.0-13.5	Sand, fine- to coarse-grained; with shell fragments
						22.0 *546.6*	17.0	No sample, appeared to be compact gravel layer
	MR-2-5	20.35	75.65	4.00	0.00	23.0 *545.6*	18.0-18.4	Sand, coarse-grained; with pebbles and shell fragments
						25.0 *543.6*	20.0	No sample, refusal in compact gravel layer
MR-3 8.0 ft 8-25-64	MR-3-1	0.00	36.50	63.50	0.00	8.0 *560.6*	0.0-0.5	Mud, gray-brown, silty; with fine-grained sand
	MR-3-2					13.0 *555.6*	5.0-6.5	Mud, gray, laminated; with silt and fine-grained sand, shell fragments
	MR-3-3					18.0 *550.6*	10.0-10.5	Mud, gray-brown, silty
	MR-3-4					18.5 *550.1*	10.5-11.0	Sand, medium- to coarse-grained
	MR-3-5					23.0 *547.6*	15.0-15.4	Sand, medium- to coarse-grained; with clay material
						25.0 *543.6*	17.0	No sample, appeared to be gravel layer
						26.0 *542.6*	18.0	No sample, refusal in compact gravel layer
MR-4 16.0 ft 5-19-65	MR-4-1	0.00	51.90	46.70	1.40	16.0 *552.6*	0.0-0.5	Mud, dark-brown, silty, sandy
	MR-4-2					20.0 *548.6*	4.0-5.0	Mud, dark-brown, silty
						20.5 *548.1*	4.5	No sample, appeared to be sand layer
						24.0 *544.6*	8.0	No sample, appeared to be gravel layer
	MR-4-3					24.5 *544.1*	8.5-8.6	Sand, fine-grained; with pebbles, shell fragments, and wood detritus
						25.0 *543.6*	9.0	No sample, refusal in compact sand and gravel layer

TABLE A.—*Logs of Maumee River test borings*—Continued

Boring no. Water depth Date	Sample number	Particle size (percent)			Depth and *elevation* (ft)	Bottom penetration (ft)	Field description
		Gravel	Sand	Silt and clay			
MR-5 8.0 ft 5-19-65	MR-5-1	0.09	93.19	6.72	8.0 *560.6*	0.0-0.5	Sand, dark-brown, medium- to fine-grained, silty; with shells and wood detritus
	MR-5-2	7.40	87.12	5.48	13.0 *555.6*	5.0-5.3	Sand, coarse-grained; with pebbles and gray-brown silt
					13.5 *555.1*	5.5	No sample, appeared to be compact clay layer with sand below
					15.0 *553.6*	7.0	No sample, appeared to be compact clay layer with sand below
	MR-5-3	1.70	97.27	1.03	15.5 *553.1*	7.5-8.0	Sand, medium-grained, silty; with shells
	MR-5-4	41.35	58.49	0.16	16.0 *552.6*	8.0-8.5	Sand, medium- to coarse-grained; with pebbles
	MR-5-5	9.23	86.77	4.00	20.0 *548.6*	12.0-12.4	Sand, medium- to coarse-grained, silty; with pebbles
					20.5 *548.1*	12.5	No sample, appeared to be compact gravel layer
	MR-5-6	5.21	93.39	1.40	21.5 *547.1*	12.5-13.7	Sand, medium- to coarse-grained; with pebbles and shell fragments
					22.0 *546.6*	14.0	No sample, refusal in compact gravel layer
MR-6 8.0 ft 5-3-67	MR-6-1	2.11	96.61	1.28	8.0 *560.6*	0.0-0.5	Sand, medium- to fine-grained, silty; shells
	MR-6-2	50.29	49.12	0.58	10.5 *558.1*	2.5-3.3	Sand, medium- to coarse-grained; with gravel and snail shells
					11.5 *557.1*	3.5-5.5	No sample, appeared to be gravel layer
					13.5 *555.1*	5.5	No sample, refusal in compact gravel layer
MR-7 7.0 ft 5-3-67	MR-7-1	57.08	42.01	0.91	7.0 *561.6*	0.0-0.5	Sand, poorly sorted; gravel up to 0.2 ft in diameter
	MR-7-2	1.82	93.93	4.25	10.5 *558.1*	3.5-4.2	Sand, medium- to fine-grained; shell fragments
					11.5 *557.1*	4.5	No sample, refusal in compact gravel layer
MR-8 9.5 ft 5-3-67	MR-8-1	15.49	83.32	1.19	9.5 *559.1*	0.0-0.5	Sand and gravel, thin layer of brown sand and gravel over dark-gray mud mixed with sand and gravel
	MR-8-2	39.16	60.14	0.70	10.0 *558.6*	0.5-2.0	Sand, medium- to coarse-grained; with gravel
					12.0 *556.6*	2.5	No sample, refusal at bedrock
MR-9 5.0 ft 5-3-67	MR-9-1	4.63	94.99	0.38	5.0 *563.6*	0.0-0.5	Sand, medium-grained, clean; pebbles
					5.5 *563.1*	0.5	No sample, refusal at bedrock
MR-10 8.0 ft 5-3-67	MR-10-1	2.40	96.96	0.64	8.0 *560.6*	0.0-0.5	Sand, medium- to coarse-grained; with a few pebbles
					8.5 *560.1*	0.5	No sample, refusal at bedrock
MR-11 6.5 ft 5-3-67					6.5 *562.1*	0.0	No sample, bedrock at bottom surface
MR-12 11.7 ft 5-3-67	MR-12-1	5.33	94.17	0.50	11.7 *556.9*	0.0-0.5	Sand, medium- to coarse-grained; pebbles, shells
					12.3 *556.3*	0.5-4.5	No sample, appeared to be compact sand and gravel layer
	MR-12-2	42.86	56.27	0.87	16.2 *552.4*	4.5-5.0	Sand, medium- to coarse-grained; with pebbles and shells
	MR-12-3	72.20	25.62	2.18	18.7 *549.9*	7.0-8.0	Sand and gravel; coarse-grained sand and pebbles
					19.7 *548.9*	8.0	No sample, refusal in compact gravel layer

TABLE A.—*Logs of Maumee River test borings*—Continued

Boring no. Water depth Date	Sample number	Particle size (percent)			Depth and *elevation* (ft)	Bottom penetration (ft)	Field description
		Gravel	Sand	Silt and clay			
MR-13 17.7 ft 5-3-67	MR-13-1	78.55	21.08	0.37	17.7 *550.9*	0.0-0.5	Mud, gray-brown; mixed with sand, pebbles, and plant detritus
	MR-13-2	23.66	75.36	0.98	18.7 *549.9*	1.0-1.7	Sand, medium- to fine-grained; pebbles
	MR-13-3	45.62	54.06	0.32	23.7 *544.9*	6.0-6.4	Sand, medium- to coarse-grained; with pebbles and shells
					25.7 *542.9*	8.0	No sample, refusal in compact gravel layer
MR-14 7.6 ft 11-14-67	MR-14-1	30.19	62.59	7.22	7.6 *561.0*	0.0-0.5	Sand, medium-grained; mixed with silt and gravel
					10.5 *558.1*	2.9	No sample, appears to be clay
	MR-14-2	3.39	28.63	67.98	12.0 *556.6*	4.4-5.7	Clay, medium-gray, smooth, sandy
	MR-14-3		2.08	97.92	15.0 *553.6*	7.4-7.7	Glacial till, very hard compact yellow-brown till clay
					15.6 *553.0*	8.0	No sample, refusal in hard till clay
MR-15 8.1 ft 11-15-67	MR-15-1	3.30	89.41	7.29	8.1 *560.5*	0.0-0.5	Sand, medium- to fine-grained; silty at surface
	MR-15-2	0.37	44.35	55.28	10.6 *558.0*	2.5-3.6	Clay, smooth, soft, sandy
	MR-15-3	0.41	37.78	61.81	11.7 *556.9*	3.6-3.8	Sand, silty; with shell fragments
					14.7 *553.9*	6.5	No sample, appeared to be a gravel layer
	MR-15-4	44.66	48.08	7.26	15.6 *553.0*	7.5-8.0	Sand and gravel, with shell fragments
					18.6 *550.0*	10.5	No sample, hard layer, appeared to be sand and gravel
					19.4 *549.2*	11.3	No sample, refusal in compact gravel layer
MR-16 6.4 ft 11-15-67	MR-16-1	28.09	67.09	4.82	6.4 *562.2*	0.0-0.5	Sand, medium- to coarse-grained; with gravel
					11.5 *557.1*	5.1	No sample, appeared to be coarse sand and gravel
					11.9 *556.7*	5.5	No sample, refusal in compact gravel layer
MR-17 6.1 ft 11-15-67	MR-17-1	44.52	54.41	1.07	6.1 *562.5*	0.0-0.5	Sand, brown; with pebbles and cobbles
					7.6 *561.0*	1.5	No sample, refusal at bedrock
MR-18 4.3 ft 11-15-67	MR-18-1	63.10	25.12	11.78	4.3 *564.3*	0.0-0.5	Sand and gravel, mixed with mud
	MR-18-2	46.46	43.36	10.18	4.8 *563.8*	0.5-1.0	Sand, with silt and gravel
					5.3 *563.3*	1.0	No sample, refusal at bedrock
MR-19 6.6 ft 11-15-67	MR-19-1	17.78	80.85	1.37	6.6 *562.0*	0.0-0.5	Sand, medium- to coarse-grained; silty at surface
					9.4 *559.2*	2.8	No sample, refusal at bedrock
MR-20 3.7 ft 11-15-67	MR-20-1	92.10	7.13	0.77	3.7 *564.9*	0.0-0.5	Gravel, pea-sized pebbles with sand and silt
					5.2 *563.4*	1.5	No sample, refusal at bedrock
MR-21 6.5 ft 11-15-67	MR-21-1	62.62	32.30	5.08	6.5 *562.1*	0.0-0.5	Gravel, mixed with sand and mud
	MR-21-2	14.41	85.14	0.45	12.0 *556.6*	5.5-5.7	Sand and gravel, medium- to coarse-grained; with shell fragments
					12.2 *556.4*	5.7	No sample, refusal in compact gravel layer
MR-22 8.2 ft 11-15-67	MR-22-1	0.00	28.19	71.81	8.2 *560.4*	0.0-0.5	Mud and sand, gray-brown, smooth
	MR-22-2	37.43	58.78	3.79	11.0 *557.6*	2.8-5.3	Sand, coarse-grained; with gravel and silt
					14.0 *554.6*	5.8	No sample, refusal in compact gravel layer

TABLE A.—*Logs of Maumee River test borings*—Continued

Boring no. Water depth Date	Sample number	Particle size (percent)			Depth and *elevation* (ft)	Bottom penetration (ft)	Field description
		Gravel	Sand	Silt and clay			
MR-23 8.4 ft 11-16-67	MR-23-1	9.52	86.64	3.84	8.4 *560.2*	0.0-0.5	Sand and gravel, medium-grained; silty at surface
	MR-23-2	39.22	54.41	6.37	11.5 *557.1*	3.1-3.5	Silt, gray-brown; mixed with sand and gravel
	MR-23-3	0.52	92.46	7.02	11.9 *556.7*	3.5-3.9	Sand, yellow-brown, fine-grained
	MR-23-4	33.40	61.22	5.38	12.3 *556.3*	3.9-4.2	Sand, gray-brown, very fine-grained; mixed with silt and gravel
	MR-23-5	0.00	46.41	53.59	12.6 *556.0*	4.2-4.5	Clay, yellow-brown, compact, sandy
					14.5 *554.1*	6.1-8.3	No sample, appeared to be compact gravel layer
	MR-23-6	1.02	96.05	2.93	16.7 *551.9*	8.3-8.5	Sand, brown, medium- to coarse-grained
					17.5 *551.1*	9.1	No sample, appeared to be compact gravel layer
					18.5 *550.1*	10.1	No sample, refusal in compact gravel layer
MR-24 8.7 ft 11-16-67	MR-24-1	74.50	23.19	2.31	8.7 *559.9*	0.0-0.5	Sand and gravel; brown sand, cobbles; silty
	MR-24-2	37.11	58.72	4.17	11.5 *557.1*	2.8-3.1	Sand, with fine-grained gravel and compact clay
					15.5 *553.1*	6.8	No sample, appeared to be compact gravel layer
					16.5 *552.1*	7.8	No sample, refusal in compact gravel layer
MR-25 5.6 ft 11-16-67	MR-25-1	55.64	37.24	7.12	5.6 *563.0*	0.0-0.5	Sand and gravel, 0.2 ft of brown mud at surface over silty sand to cobbles
	MR-25-2	27.45	70.45	2.10	11.5 *557.1*	5.9-6.2	Sand and gravel, coarse-grained sand and fine-grained pebbles, with shells
	MR-25-3	0.54	36.47	62.99	11.8 *556.8*	6.2-6.7	Sand, fine-grained; with gray-brown clay
	MR-25-4	19.78	76.60	3.62	16.5 *552.1*	10.9-11.2	Sand, medium- to coarse-grained; with shells
					19.5 *549.1*	13.9	No sample, appeared to be compact gravel layer
					20.2 *548.4*	14.6	No sample, refusal in compact gravel layer
MR-26 10.8 ft 11-16-67	MR-26-1	9.21	86.66	4.13	10.8 *557.8*	0.0-0.5	Sand, medium-grained; silty at surface; shells
	MR-26-2	12.79	81.30	5.91	16.8 *551.8*	6.0-6.7	Sand, medium- to fine-grained, silty; clay at base
					19.7 *548.9*	8.9-9.9	No sample, appeared to be gravel layer
	MR-26-3	68.41	29.37	2.22	21.8 *546.8*	11.0-11.5	Sand, with abundant snail shells and pea-sized pebbles
					23.7 *544.9*	12.9	No sample, refusal in gravel layer
MR-27 9.9 ft 11-16-67	MR-27-1	81.50	11.45	7.05	9.9 *558.7*	0.0-0.5	Sand and gravel, silty; cobbles, shells
	MR-27-2	18.76	78.29	2.95	16.9 *551.7*	7.0-9.0	Sand, medium- to fine-grained; shells, pebbles; two thin (0.1 ft) clay layers
	MR-27-3		100.00		21.9 *546.7*	12.0-12.5	Sand, medium- to fine-grained; shell fragments
					23.7 *544.9*	13.8	No sample, appeared to be compact sand and gravel layer
					26.5 *542.1*	16.6	No sample, refusal in gravel layer
MR-28 10.5 ft 11-16-67	MR-28-1	0.72	85.36	13.92	10.5 *558.1*	0.0-0.5	Mud, gray-brown; mixed with fine-grained sand and plant detritus
	MR-28-2	3.88	93.01	3.11	16.8 *551.8*	6.3-8.3	Sand, medium-grained; shells; thin (0.2 ft) clay layer at 7.0 ft penetration
	MR-28-3	51.74	46.47	1.79	21.8 *546.8*	11.3-11.5	Sand, with pebbles and shells
					22.3 *546.8*	11.8	No sample, refusal in compact gravel layer

TABLE A.—*Logs of Maumee River test borings*—Continued

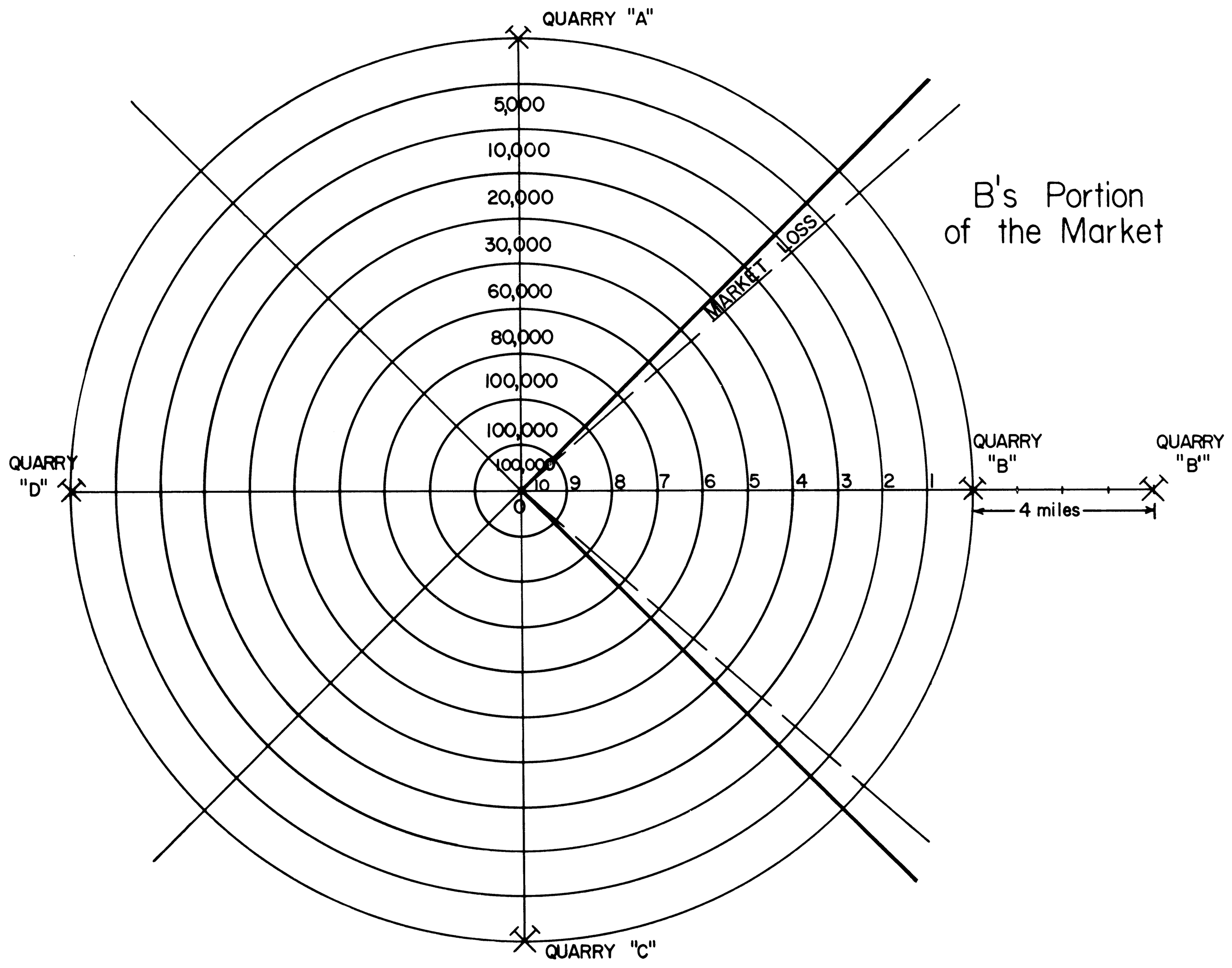
Boring no. Water depth Date	Sample number	Particle size (percent)			Depth and *elevation* (ft)	Bottom penetration (ft)	Field description
		Gravel	Sand	Silt and clay			
MR-29 13.8 ft 11-16-67	MR-29-1	0.00	7.77	92.23 (silt only)	13.8 *554.8*	0.0-0.5	Mud, gray-brown, sandy
	MR-29-2	0.66	9.73	89.61 (silt only)	16.8 *551.8*	3.0-4.5	Clay, gray-brown, smooth
	MR-29-3	7.10	34.16	58.74 (silt only)	21.8 *546.8*	8.0-8.3	Clay, medium-gray, compact; with fine-grained sand
					24.8 *543.8*	11.0	No sample, hard layer, appeared to be top of till
	MR-29-4	7.13	38.64	54.23 (silt only)	26.8 *541.8*	13.0-13.7	Glacial till, reddish-gray, compact, gritty; till clay
					27.8 *540.8*	14.0	No sample, refusal in hard till clay
MR-30 13.8 ft 11-16-67	MR-30-1		12.86	87.14	13.8 *554.8*	0.0-0.5	Mud, gray-brown, smooth, sandy
	MR-30-2	30.93	53.31	15.76	16.8 *551.8*	3.0-4.0	Sand and gravel, silty
	MR-30-3	33.04	65.30	1.66	21.8 *546.8*	8.0-8.3	Sand and gravel, medium-grained sand to fine-grained pebbles; shells
					24.3 *543.3*	10.5	No sample, refusal in compact gravel layer

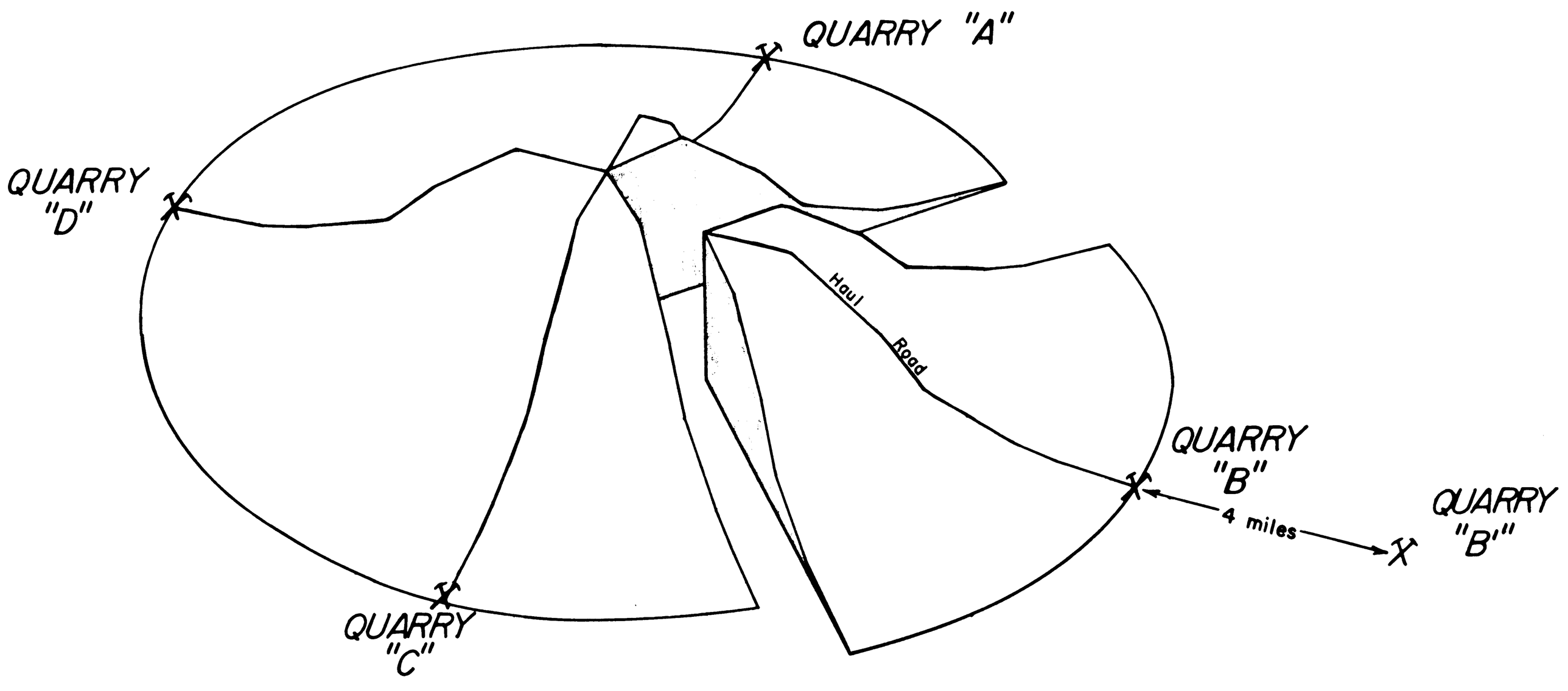
TABLE B.—*Sieve analyses of Maumee River test boring samples*

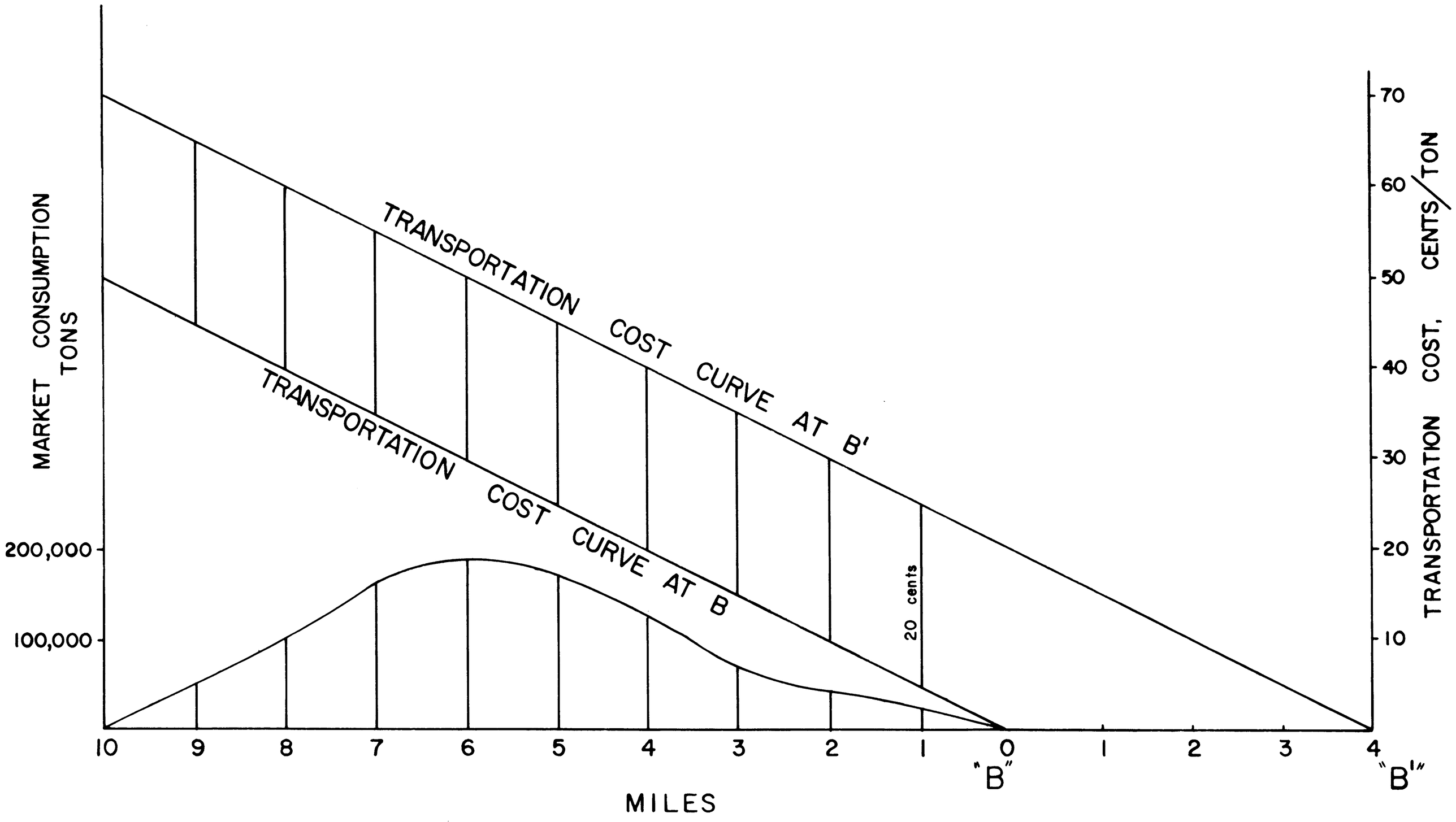
Sample number	U.S. sieve series (percent passing)								ϕm	So	Water depth (ft)	Bottom penetration (ft)
	⅜ in	4	8	16	30	50	100	200				
MR-1-2	100.00	100.00	100.00	91.75	54.74	8.20	0.31	0.00	0.8	1.8	4.5	3.0-3.4
MR-1-4	100.00	34.35	8.68	1.68	0.68	0.42	0.20	0.08	-2.9	1.3	4.5	18.0-18.3
MR-2-1	100.00	91.05	84.61	73.66	50.57	24.14	17.98	2.94	0.8	2.2	5.0	0.0-0.5
MR-2-2	100.00	100.00	98.46	97.88	94.39	54.93	9.77	0.79	1.8	1.3	5.0	3.0-3.8
MR-2-3	100.00	100.00	100.00	99.94	98.17	62.91	14.68	1.19	2.1	1.3	5.0	8.0-8.7
MR-2-4	100.00	100.00	97.77	94.26	83.17	48.04	6.16	0.78	1.6	1.6	5.0	13.0-13.5
MR-2-5	100.00	90.37	85.18	75.73	63.31	36.41	3.49	0.39	1.3	2.5	5.0	18.0-18.4
MR-5-1	100.00	100.00	99.91	99.26	95.77	65.34	20.24	6.72	1.9	1.5	8.0	0.0-0.5
MR-5-2	100.00	97.25	92.60	87.36	79.37	33.83	9.41	5.48	1.3	1.5	8.0	5.0-5.3
MR-5-3	100.00	99.12	98.30	97.41	92.13	39.24	3.31	1.03	1.5	1.4	8.0	7.5-8.0
MR-5-4	100.00	81.58	59.83	35.39	10.58	0.94	0.22	0.16	-0.8	2.1	8.0	8.0-8.5
MR-5-5	100.00	98.91	90.77	79.27	52.39	18.22	7.39	4.00	0.8	1.8	8.0	12.0-12.4
MR-5-6	100.00	100.00	94.79	52.91	19.27	2.48	1.81	1.40	-0.3	1.6	8.0	13.5-13.7
MR-6-1	100.00	99.25	97.89	95.85	92.48	42.59	4.41	1.28	1.5	1.5	8.0	0.0-0.5
MR-6-2	100.00	75.44	75.44	36.64	21.57	8.68	2.82	0.62	-1.2	2.6	8.0	2.5-3.3
MR-7-1	100.00	66.02	46.57	34.47	20.48	7.46	2.00	0.99	-1.4	3.3	7.0	0.0-0.5
MR-7-2	100.00	100.00	98.18	84.40	50.37	21.67	11.60	4.25	0.7	1.7	7.0	3.5-4.2
MR-8-1	100.00	94.30	88.95	83.29	72.30	28.31	5.11	1.25	1.5	1.6	9.5	0.0-0.5
MR-8-2	100.00	82.10	66.60	53.51	36.37	6.63	1.82	0.77	-0.2	2.7	9.5	0.5-2.0
MR-9-1	100.00	98.43	95.81	87.27	56.85	5.63	1.04	0.38	0.9	1.3	5.0	0.0-0.5
MR-10-1	100.00	99.79	97.60	90.89	66.91	8.01	1.04	0.64	1.1	1.4	8.0	0.0-0.5

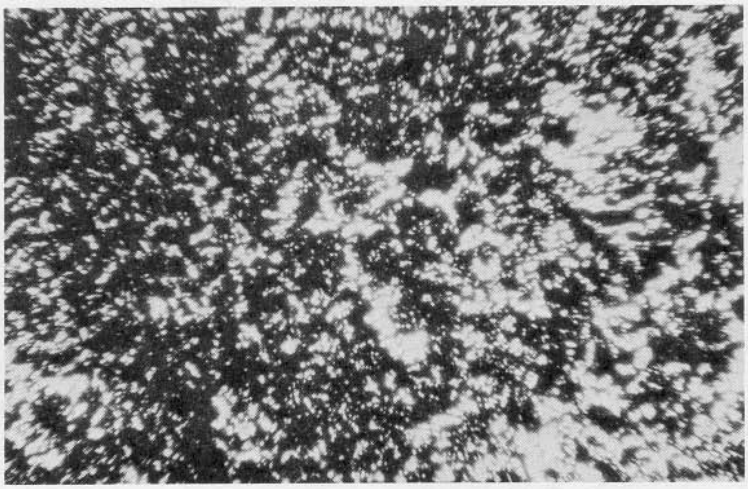
TABLE B.—*Sieve analyses of Maumee River test boring samples*—Continued

Sample number	U.S. sieve series (percent passing)								ϕm	So	Water depth (ft)	Bottom penetration (ft)
	⅜ in	4	8	16	30	50	100	200				
MR-12-1	100.00	98.66	94.67	82.50	47.85	7.23	0.82	0.50	0.7	1.6	11.7	0.0-0.5
MR-12-2	100.00	79.05	61.76	46.41	29.71	13.09	3.32	0.94	-0.7	3.1	11.7	4.5-5.0
MR-12-3	100.00	56.97	29.81	20.13	12.80	5.86	3.58	2.34	-2.2	--	11.7	7.0-8.0
MR-13-1	100.00	47.24	33.97	27.50	20.39	10.60	2.55	0.58	-2.7	--	17.7	0.0-0.5
MR-13-2	100.00	90.48	81.32	72.25	58.83	29.61	4.66	1.06	0.8	2.5	17.7	1.0-1.7
MR-13-3	100.00	74.67	57.41	44.80	32.47	10.16	1.25	0.34	-0.8	2.6	17.7	6.0-6.4
MR-14-1	100.00	91.65	73.95	57.00	38.02	9.93	1.79	0.20	0.2	2.5	7.6	0.0-0.5
MR-15-1	100.00	98.27	97.09	96.33	95.62	49.63	1.56	0.12	1.7	1.2	8.1	0.0-0.5
MR-15-4	100.00	73.45	61.18	49.28	33.71	14.04	3.45	0.49	-0.3	3.3	8.1	7.5-8.0
MR-16-1	100.00	92.46	76.12	61.21	36.18	11.41	2.86	0.41	0.2	2.1	6.4	0.0-0.5
MR-17-1	100.00	73.86	59.98	53.27	46.32	26.14	5.96	0.75	0.2	4.1	6.1	0.0-0.5
MR-18-1	100.00	60.50	45.22	37.06	30.43	18.95	7.50	1.51	-1.8	4.2	4.3	0.0-0.5
MR-18-2	100.00	75.41	58.06	42.32	30.39	17.09	4.96	0.62	-1.0	3.6	4.3	0.5-1.0
MR-19-1	100.00	94.47	87.79	80.97	65.08	17.16	3.04	0.89	1.2	1.6	6.6	0.0-0.5
MR-20-1	100.00	29.48	12.51	8.82	6.55	3.57	1.29	0.32	--	--	3.7	0.0-0.5
MR-21-1	100.00	64.17	53.55	50.38	47.80	32.94	6.69	1.21	0.4	2.0	6.5	0.0-0.5
MR-21-2	100.00	92.92	68.50	28.62	4.36	0.86	0.06	--	-0.8	2.0	6.5	5.5-5.7
MR-22-2	100.00	87.55	73.74	60.16	42.46	25.05	4.40	0.40	1.8	1.4	8.2	2.8-5.3
MR-23-1	100.00	95.11	90.77	88.80	85.97	74.17	31.52	2.22	2.3	1.5	8.4	0.0-0.5
MR-23-2	100.00	81.52	66.58	55.97	41.06	19.99	5.86	0.54	1.8	1.2	8.4	3.1-3.5
MR-23-3	100.00	100.00	99.55	98.96	97.48	91.08	21.52	2.09	2.6	1.1	8.4	3.5-3.9
MR-23-4	100.00	85.85	74.40	66.91	54.87	34.32	9.21	1.09	1.1	3.1	8.4	3.9-4.2
MR-23-6	100.00	100.00	99.64	95.59	75.62	33.08	7.13	0.63	1.5	1.5	8.4	8.3-8.5
MR-24-1	100.00	64.08	47.17	38.50	29.29	11.19	3.05	0.39	-1.7	3.5	8.7	0.0-0.5
MR-24-2	100.00	87.03	68.91	51.94	35.95	17.10	4.03	0.29	0.3	2.7	8.7	2.8-3.1
MR-25-1	100.00	86.20	69.03	56.70	47.67	26.94	4.70	2.27	1.5	4.0	5.6	0.0-0.5
MR-25-2	100.00	93.07	79.55	60.91	42.80	18.92	4.26	0.51	0.3	2.4	5.6	5.9-6.2
MR-25-4	100.00	92.64	83.79	76.75	68.12	44.24	9.02	1.23	2.5	2.2	5.6	10.9-11.2
MR-26-1	100.00	95.07	91.60	87.32	74.79	21.49	1.25	0.11	1.5	2.8	10.8	0.0-0.5
MR-26-2	100.00	94.40	91.00	88.24	80.63	33.51	3.40	0.43	1.4	1.4	10.8	6.0-6.7
MR-26-3	100.00	71.81	41.23	33.14	27.12	18.73	3.93	0.42	-1.9	3.3	10.8	11.0-11.5
MR-27-1	100.00	53.29	31.68	25.69	21.59	14.84	5.98	1.13	-2.4	0.0	9.9	0.0-0.5
MR-27-2	100.00	92.68	82.79	74.02	55.04	22.70	4.18	0.71	0.9	2.1	9.9	7.0-9.0
MR-28-1	100.00	100.00	99.59	98.80	96.70	89.51	76.97	18.15	3.3	1.3	10.5	0.0-0.5
MR-28-2	100.00	98.95	97.28	92.76	80.46	41.14	7.15	0.83	1.6	1.6	10.5	6.3-8.3
MR-28-3	100.00	79.34	58.91	45.63	31.94	11.32	2.35	0.34	-0.8	1.7	10.5	11.3-11.5
MR-30-2	100.00	86.31	76.02	66.58	50.75	13.54	3.43	0.56	0.7	2.5	13.8	3.0-4.0
MR-30-3	100.00	96.43	75.26	54.90	34.76	9.67	1.98	0.26	0.0	2.2	13.8	8.0-8.3


QUARRY "A"
5,000
10,000
20,000
30,000
60,000
80,000
100,000
100,000
100,000
B's Portion of the Market
MARKET LOSS
QUARRY "D"
QUARRY "B"
QUARRY "B'"
10
9
8
7
6
5
4
3
2
1
0
4 miles
QUARRY "C"


QUARRY "A"
QUARRY "D"
Haul Road
QUARRY "B"
4 miles
QUARRY "B'"
QUARRY "C"

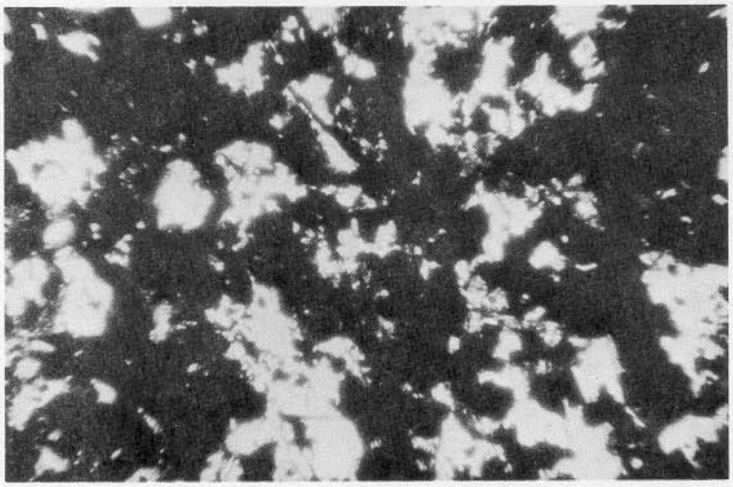

MARKET CONSUMPTION
TONS
200,000
100,000
TRANSPORTATION COST CURVE AT B'
TRANSPORTATION COST CURVE AT B
20 cents
70
60
50
40
30
20
10
TRANSPORTATION COST, CENTS/TON
10
9
8
7
6
5
4
3
2
1
0
1
2
3
4
"B"
"B'"
MILES



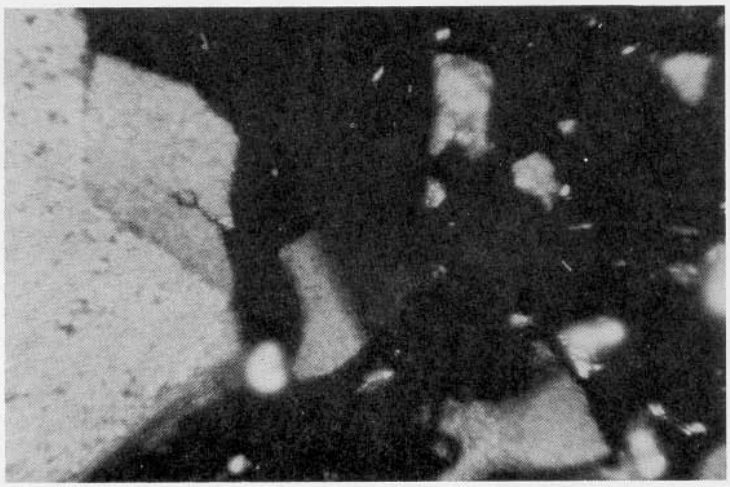
0.1 MM

SCALE
(All Samples)

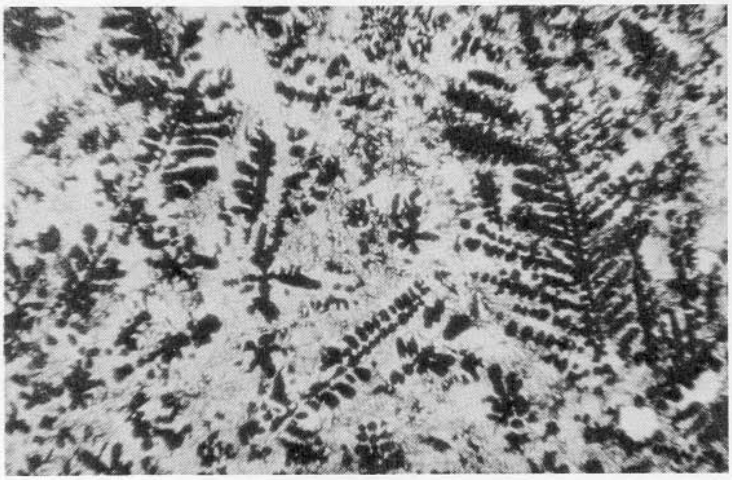
Slag #1



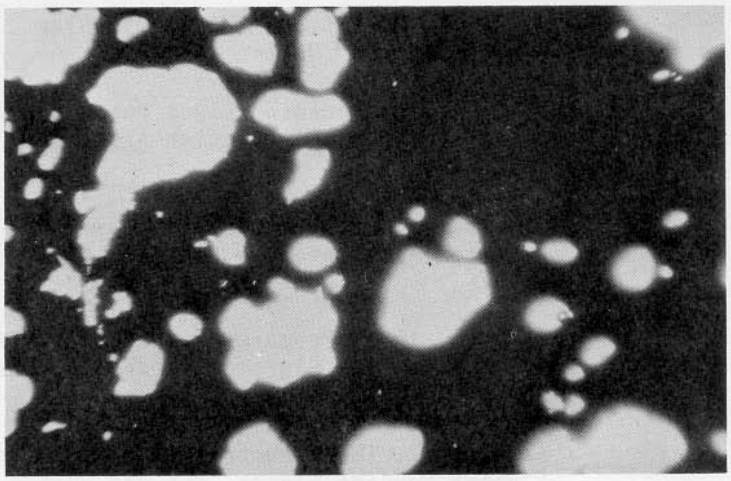
Slag #2



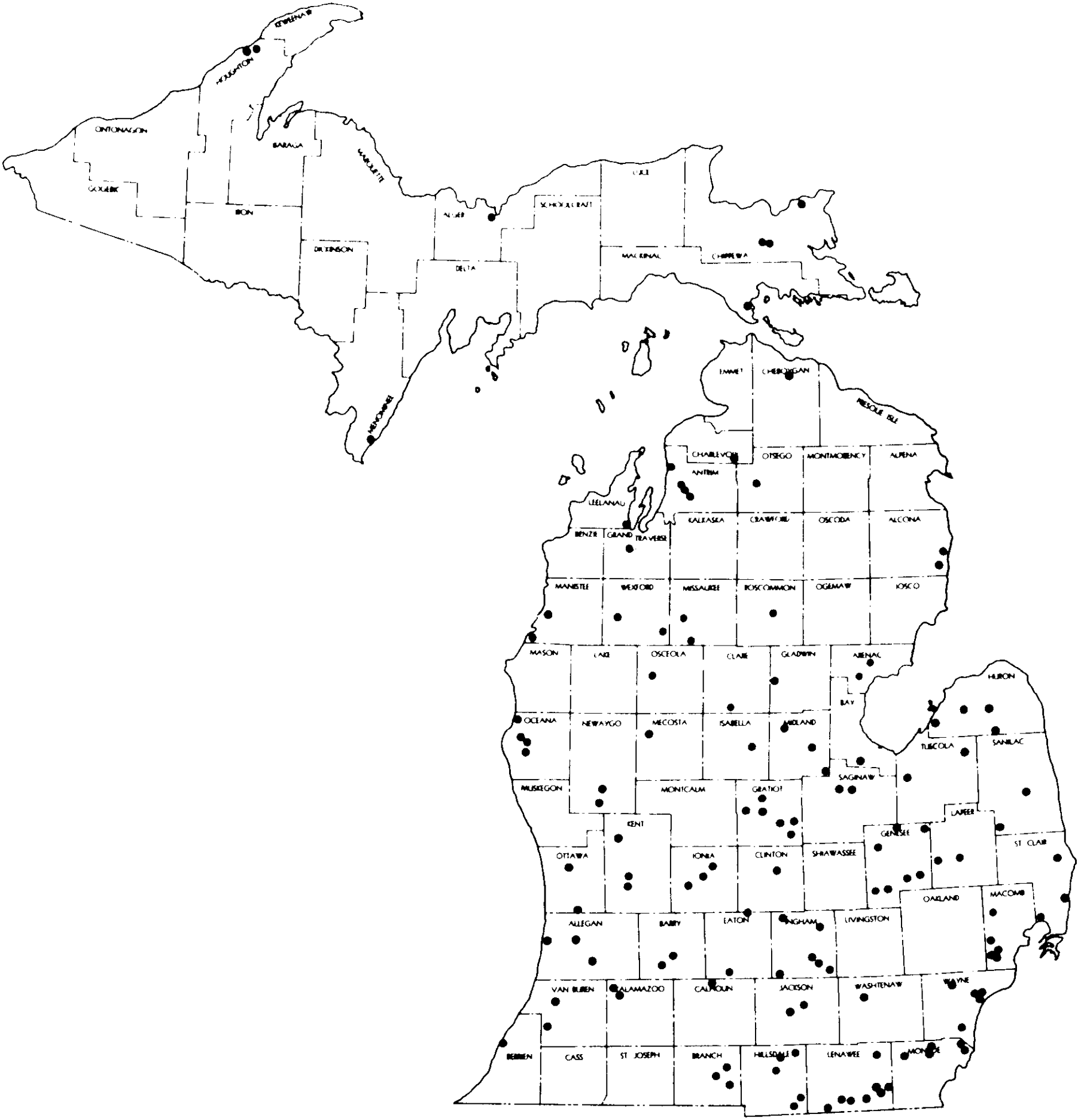
Slag #3



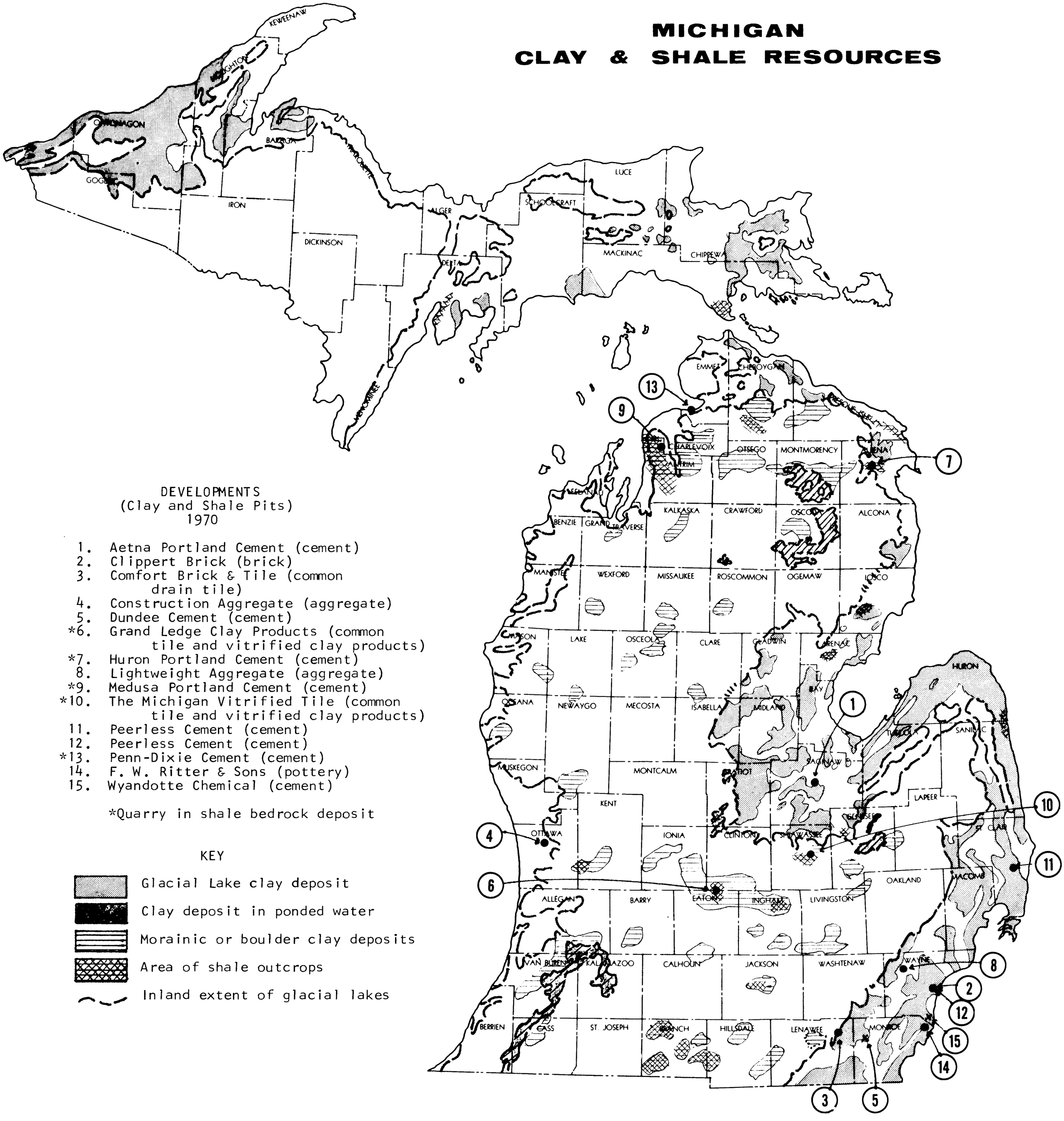
Slag #4



Slag #5


KEWEENAW
HOUGHTON
ONTONAGON
BARAGA
MARQUETTE
GOGEBIC
IRON
ALGER
SCHOOLCRAFT
LUCE
DICKINSON
DELTA
MACKINAC
CHIPPEWA
MENOMINEE
EMMET
CHEBOYGAN
PRESQUE ISLE
CHARLEVOIX
OTSEGO
MONTMORENCY
ALPENA
ANTRIM
LEELANAU
KALKASKA
CRAWFORD
OSCODA
ALCONA
BENZIE
GRAND TRAVERSE
MANISTEE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
MASON
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
HURON
BAY
OCEANA
NEWAYGO
MECOSTA
ISABELLA
MIDLAND
TUSCOLA
SANILAC
SAGINAW
MUSKEGON
MONTCALM
GRATIOT
LAPEER
KENT
GENESEE
ST CLAIR
OTTAWA
IONIA
CLINTON
SHIAWASSEE
OAKLAND
MACOMB
ALLEGAN
BARRY
EATON
INGHAM
LIVINGSTON
VAN BUREN
KALAMAZOO
CALHOUN
JACKSON
WASHTENAW
WAYNE
BERRIEN
CASS
ST JOSEPH
BRANCH
HILLSDALE
LENAWEE
MONROE

MICHIGAN
CLAY & SHALE RESOURCES



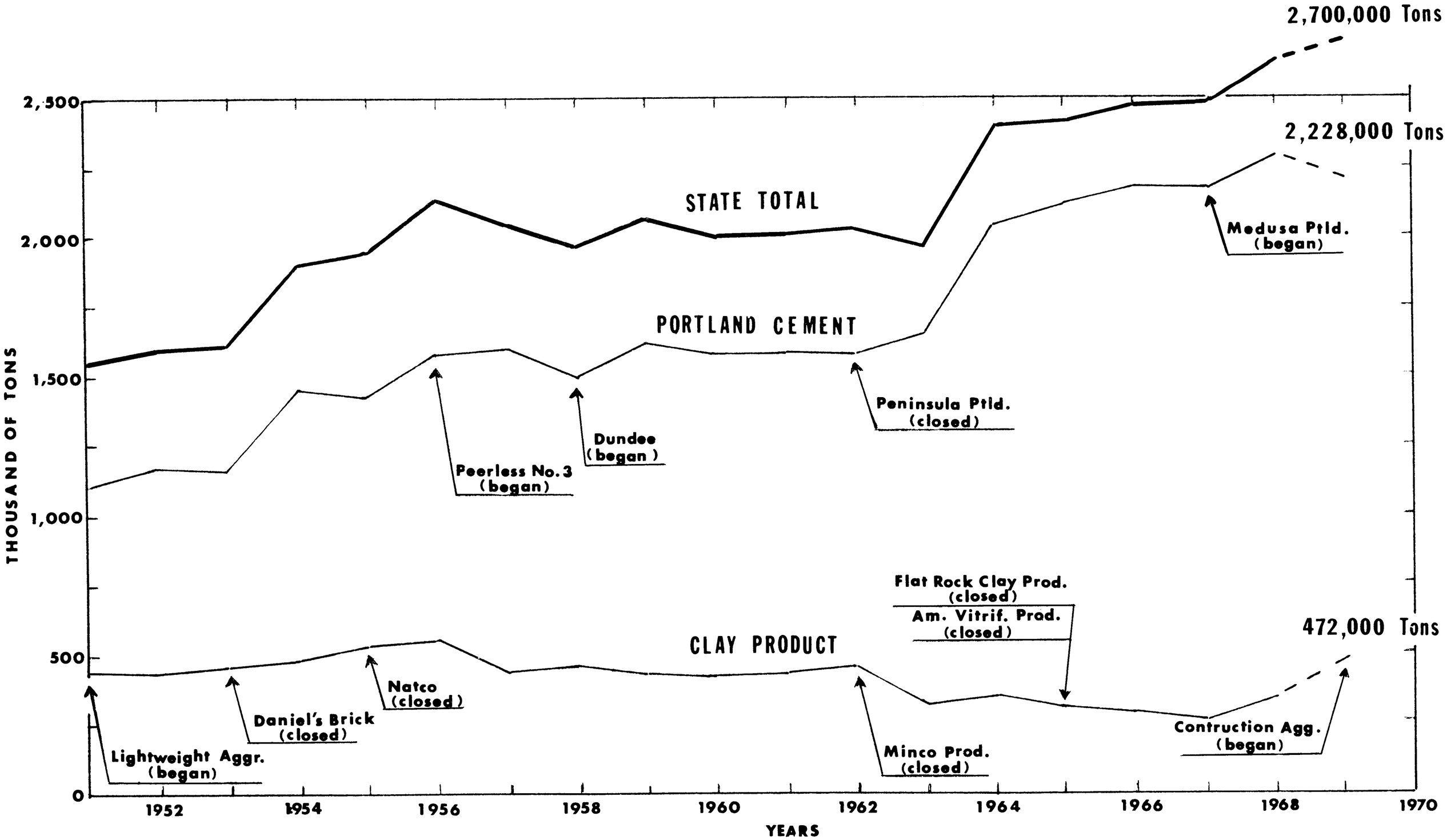
DEVELOPMENTS
(Clay and Shale Pits)
1970

1. Aetna Portland Cement (cement)
2. Clippert Brick (brick)
3. Comfort Brick & Tile (common drain tile)
4. Construction Aggregate (aggregate)
5. Dundee Cement (cement)
*6. Grand Ledge Clay Products (common tile and vitrified clay products)
*7. Huron Portland Cement (cement)
8. Lightweight Aggregate (aggregate)
*9. Medusa Portland Cement (cement)
*10. The Michigan Vitrified Tile (common tile and vitrified clay products)
11. Peerless Cement (cement)
12. Peerless Cement (cement)
*13. Penn-Dixie Cement (cement)
14. F. W. Ritter & Sons (pottery)
15. Wyandotte Chemical (cement)

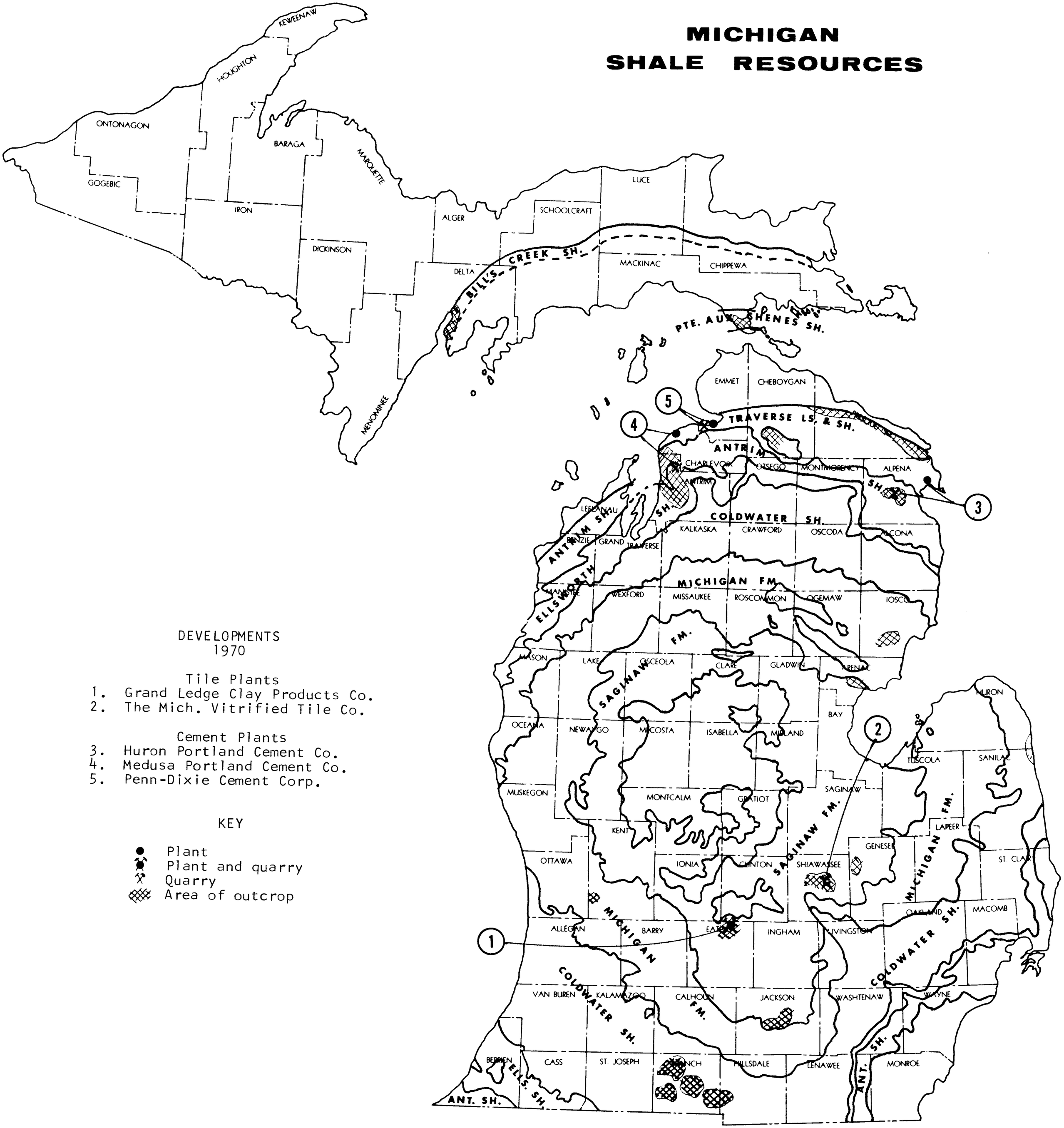
*Quarry in shale bedrock deposit

KEY

- Glacial Lake clay deposit
- Clay deposit in ponded water
- Morainic or boulder clay deposits
- Area of shale outcrops
- Inland extent of glacial lakes


2,700,000 Tons
2,228,000 Tons
472,000 Tons
STATE TOTAL
PORTLAND CEMENT
CLAY PRODUCT
Medusa Ptld. (began)
Peninsula Ptld. (closed)
Dundee (began)
Peerless No. 3 (began)
Flat Rock Clay Prod. (closed)
Am. Vitrif. Prod. (closed)
Natco (closed)
Daniel's Brick (closed)
Lightweight Aggr. (began)
Minco Prod. (closed)
Contruction Agg. (began)
THOUSAND OF TONS
2,500
2,000
1,500
1,000
500
0
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
YEARS

MICHIGAN SHALE RESOURCES



DEVELOPMENTS
1970

Tile Plants

1. Grand Ledge Clay Products Co.
2. The Mich. Vitrified Tile Co.

Cement Plants

3. Huron Portland Cement Co.
4. Medusa Portland Cement Co.
5. Penn-Dixie Cement Corp.

KEY

- Plant
- Plant and quarry
- Quarry
- Area of outcrop

STRATIGRAPHIC SUCCESSION IN MICHIGAN

PALEOZOIC THROUGH RECENT

MICHIGAN DEPARTMENT OF CONSERVATION

Ralph A. MacMullan, Director

GEOLOGICAL SURVEY

Gerald E. Eddy, State Geologist

ACKNOWLEDGEMENT. Compiled with the counsel of colleagues in this department, the U. S. Geological Survey, Michigan's universities, other state Geological Surveys, and geologists within Michigan's oil and gas industry. Dr. Aureal T. Cross, Department of Geology, Michigan State University, identified rocks of Mesozoic age and suggested provisional age assignments.

GEOLOGIC NAMES COMMITTEE

Garland D. Ells, Chairman, Robert W. Kelley, Secretary, Harry J. Hardenberg, L. David Johnson, Harry O. Sorensen

SHALE RESOURCE (present and former uses)

X TILE, brick

X Brick

X Brick, cement

X CEMENT, brick

X CEMENT

X Brick

X CEMENT

X Cement

X Brick

X

X Brick

(x) shale bed locally exposed or near surface to be of potential value for ceramic products and cement use

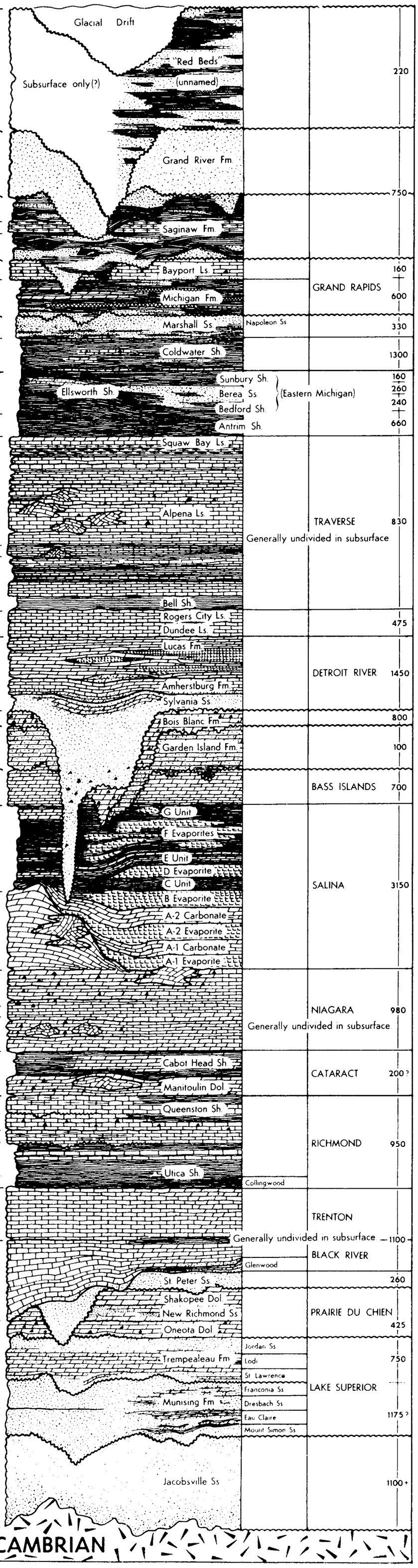
PLEISTOCENE NOMENCLATURE

ERA	SYSTEM	SERIES	STAGE	
CENOZOIC	QUATERNARY	RECENT		
		PLEISTOCENE	Wisconsin Glaciation	Valders Stade
				Two Creeks Interstade
				Mankato Stade (Pt. Huron?)
				Cary Stade
				Tazewell Stade
			Sangamon Interglaciation	
			Illinoian Glaciation	

OUTCROP NOMENCLATURE

GEOLOGIC TIME: ERA	PERIOD	EPOCH	TIME-STRATIGRAPHIC: SYSTEM	SERIES	ROCK-STRATIGRAPHIC: GROUP	FORMATION	MEMBER
MESOZOIC	JURASSIC	LATE	JURASSIC	KIMERIDGIAN			
PALEOZOIC	PENNSYLVANIAN	LATE	PENNSYLVANIAN	CONEMAUGH		Grand River Fm.	Ionia, Eaton, and Woodville Sandstones
		EARLY		POTTSVILLE		Saginaw Fm.	Verne Ls.
	MISSISSIPPIAN	LATE	MISSISSIPPIAN	MERAMECIAN	GRAND RAPIDS	Bayport Ls.	
						Michigan Fm.	
		EARLY		OSAGIAN		Marshall Ss.	Napoleon Ss.
				KINDERHOOKIAN		Coldwater Sh.	
	MISSISSIPPIAN-DEVONIAN		Unassigned				
	DEVONIAN	LATE				Ellsworth Sh. (Western Michigan)	
				CHAUTAUQUAN		Antrim Sh.	
				SENECAN		Squaw Bay Ls.	
		MIDDLE		ERIAN	TRAVERSE	Thunder Bay Ls.	
						Potter Farm Fm.	
						Norway Point Fm.	
						Four Mile Dam Fm.	
						Alpena Ls.	
						Newton Creek Ls.	
						Genshaw Fm.	Killians
						Ferron Point Fm.	
						Rockport Quarry Ls.	
						Bell Sh.	
						Rogers City Ls.	
						Dundee Ls.	
				ULSTERIAN	DETROIT RIVER	Anderdon Fm.	
						Lucas Fm.	
						Amherstburg Fm.	
						Sylvania Ss.	
						Bois Blanc Fm.	
		EARLY				Garden Island Fm.	
	SILURIAN	LATE		CAYUGAN	BASS ISLANDS	Raisin River Dol.	
						Put-in-Bay Dol.	
					SALINA	St. Ignace Dol. (Northern Peninsula)	
						Pte. aux Chenes Sh.	
		MIDDLE		NIAGARAN		Engadine Dol.	
					MANISTIQUE	Cordell Dol.	
						Schoolcraft Dol.	
					BURNT BLUFF	Hendricks Dol.	Fiborn Ls.
						Byron Dol.	
						Lime Island Dol.	
		EARLY		ALEXANDRIAN	CATARACT	Cabot Head Sh.	
						Manitoulin Dol.	
	ORDOVICIAN	LATE		CINCINNATIAN	RICHMOND	Big Hill Fm.	
						Stonington Fm.	Ogontz; Bay de Noc
						Bill's Creek Sh.	Collingwood
		MIDDLE		MOHAWKIAN	TRENTON	Groos Quarry Fm.	
						Chandler Falls Fm.	
					BLACK RIVER	Bony Falls Fm.	
		EARLY		CHAZYAN			
				CANADIAN	PRAIRIE DU CHIEN	Oneota Dol.	
	CAMBRIAN	LATE		ST. CROIXAN	LAKE SUPERIOR	Trempealeau Fm.	Jordan Ss.; Lodi; St. Lawrence
						Munising Fm.	Miner's Castle Ss.; Chapel Rock Ss.
		MIDDLE				Jacobsville Ss.	
		EARLY					

SUBSURFACE NOMENCLATURE



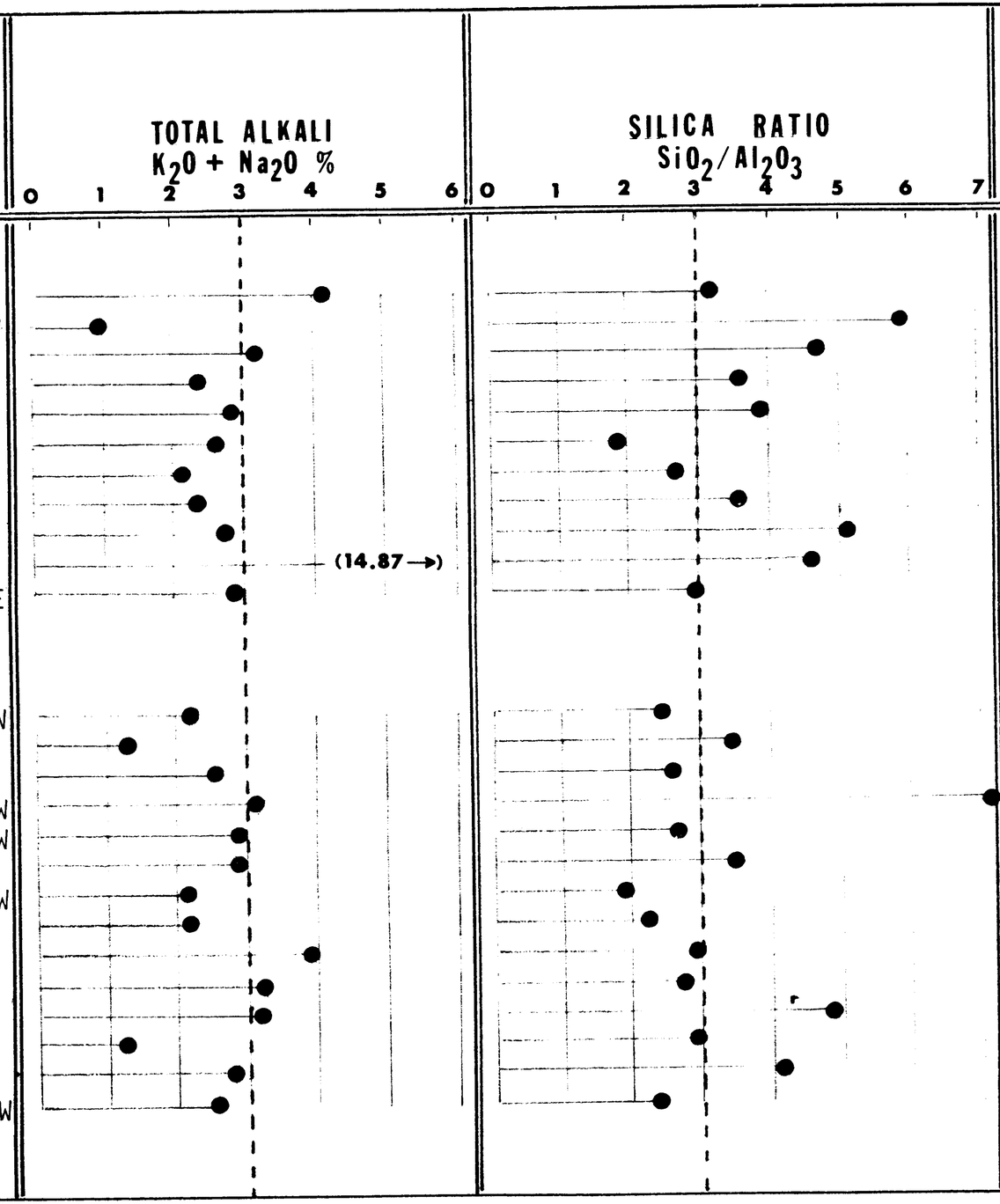
GEOLOGIC NAMES COMPILATIONS: Harry O. Sorensen, Cambrian and Ordovician, Robert W. Kelley, Early and Middle Silurian, Garland D. Ells, Late Silurian through Detroit River Group of Devonian age, Harry J. Hardenberg, Dundee Limestone through Traverse Group of Devonian age, L. David Johnson, Antrim Shale through the Pennsylvanian System, F. Wells Terwilliger, glacial geology of the Cenozoic.

TABLE 1

COUNTY	CONE NO. 010 08 06 04 02 1 3 5 7 9 11 13	Nearest Town	SEC	T	R
SURFACE CLAYS					
1 Allegan		Allegan	32	2N	13W
2 Baraga			31	51N	34W
3 Livingston		Howell	23	2N	4E
4 Macomb		Utica	4	1N	12E
5 Mackinac		Gould City	28	42N	11W
6 Monroe		Azalia	25	5S	6E
7 Monroe		Rockwood	21	5S	10E
8 St. Clair		Avoca	5-8	7N	15E
9 St. Clair		New Baltimore	7	3N	15E
10 Tuscola		Cass City	4	13N	11E
11 Wayne		Flat Rock	30	4S	10E
SHALE BEDS					
PENNSYLVANIAN PERIOD					
Saginaw Shale					
12 Bay		Auburn	30	14N	4E
13 Eaton		Grand Ledge	3	4N	4W
14 Ingham		Williamston	1	3N	1E
15 Jackson		Jackson	11	2S	1W
16 Shiawassee		Corunna	23	7N	3E
MISSISSIPPIAN PERIOD					
Michigan Shale					
17 Kent(1)		Grand Rapids	3	6N	12W
Coldwater Shale					
18 Branch		Coldwater	32	6S	6W
19 Huron		White Rock	32	15N	16E
DEVONIAN PERIOD					
Ellsworth Shale					
20 Antrim		Ellsworth	23	32N	8W
Antrim Shale					
21 Alpena		Alpena	30	31N	7E
22 Antrim		Chestonia	17	31N	6W
23 Charlevoix		Boyne City	25	33N	6W
24 Cheboygan		Indian River	1	34N	3W
25 Emmet		Walloon Lake	36	34N	6W
Traverse Gp. (Potter Farm Fm)					
26 Alpena		Alpena	33	31N	8E
Traverse Gp. (Gravel Pt-"Upper Blue Sh")					
27 Charlevoix		Charlevoix	28	34N	8W
Traverse Gp. (Bell Shale)					
28 Presque Isle		Rogers City	30	35N	5E
ORDOVICIAN PERIOD					
Richmond (Bill's Creek Shale)					
29 Delta		Stonington	11	39N	22W

KEY

Soft — Hard — Vitrified — Overburden or melt



COUNTY	SEC. TWP. RGE.	Common Brick	Drain Tile	Bldg. Tile	Pottery	Cement	REMARKS
BOULDER CLAY							
Allegan	9-10, T1N, R12W						upper 10'
Benzie	30, T26N, R15W						boulder clay
Calhoun	SE 7, T1S, R6W					X	blue clay
Clare	SE 24, T17N, R5W						red clay 12-17' thick
Ingham	NW 14, T4N, R2W	X					blue clay
Ionia	SW 25, T7N, R7W		X		X		upper 20' red clay
Ionia	SW 25, T7N, R7W		X		X		underclay 50-75' blue clay
Isabella	2, T14N, R9W		X				12' of blue clay under 3' gravel
Isabella	30, T15N, R5W						boulder clay
Lenawee	SE 24, T6S, R3E						PRE-WISC. TILL (under 12' cover)
Manistee	11, T24N, R16E						red glacial clay
LAKE CLAY							
Leelanaw	28, T28N, R11W	X					blue clay
Lenawee	NW 14, T8S, R3E	X	X				red clay, 12-15' deep
Macomb	4, T1N, R12E	X					blue and red clay 10-12' deep
Manistee	10, T24N, R16W						blue clay, upper 8'
Manistee	36, T23N, R16W	X	X				blue clay
Monroe	23, T5S, R6E						blue clay, below 12'
Muskegon	SE 14, T12N, R15W	X					blue clay, lower 6'
Oakland	36, T2N, R9E	X		X			blue plastic clay
St. Clair	1, T4N, R16E	X					red clay
St. Clair	SW 18, T4N, R17E	X					plastic gray clay, upper 5'
St. Clair	7, T3N, R15E	X					upper 3' red burning clay
Van Buren	21, T3S, R16W	X	X				upper 6'
Wayne	30, T4S, R10E		X				upper 3'
Wexford	7, T22N, R11W	X					Harrietta clay deposit