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COMPILATION OF LONGSHORE CURRENT DATA

by

Cyril J. Galvin and Richard A. Nelson

U.S. ARMY

COASTAL ENGINEERING RESEARCH CENTER

ABSTRACT

This paper is a compilation of published longshore current data available from North American sources as of January 1966. The data comprise 352 separate observations; of these 225 were obtained from four laboratory studies and 127 from four field studies. Each observation includes (at least) measured longshore current velocity, in feet per second; wave direction; a wave height, in feet; wave period, in seconds; and beach slope. Values of breaker height and breaker angle were computed for those observations lacking measured values. Longshore current velocity is usually less than 2 feet per second under both field and laboratory conditions. The maximum velocity observation from the field is 5.5 feet per second; from the laboratory 3.8 feet per second.

FOREWORD

Coastal engineers are examining longshore currents with increasing interest in the hope of predicting longshore current velocity from measurable characteristics of the waves and, eventually, the littoral transport rates that result from the flow of the currents. This compilation brings the available data together in a format that will be convenient to researchers. However, additional data are still needed, especially data accompanied by statistics of their variability and by a description of experimental procedure. Others working on this problem are invited to send copies of their published longshore current observations to CERC.

The paper was prepared by Cyril J. Galvin, Jr., Oceanographer, Research Division, U. S. Army Coastal Engineering Research Center, and Richard A. Nelson, graduate student, Department of Civil Engineering, Massachusetts Institute of Technology, assisted by J. D. Waggoner of the National Bureau of Standards.

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NOTE: Comments on this publication are invited. Discussion will be published in the next issue of the CERC Bulletin.

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ILLUSTRATIONS

COMPILATION OF LONGSHORE CURRENT DATA

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Cyril J. Galvin, Jr. and Richard A. Nelson
Research Division
U. S. Army Coastal Engineering Research Center

1. Introduction

The principal goal of longshore current studies has been the prediction of longshore current velocity from measurable characteristics of the waves generating these currents. In order to test theoretical predictions of velocity or to calculate empirical predictions of velocity, data are necessary. Some data have been obtained and published in scattered journals. To make this data conveniently available, this article reprints, in standardized form, eight previously published sets of longshore current data, including four sets of field measurements (Putnam, Munk, and Traylor, 1949; Inman and Quinn, 1951; Moore and Scholl, 1961; Galvin and Savage, 1966)* and four sets of laboratory measurements (Putnam, Munk, and Traylor, 1949; Saville, 1950, Brebner and Kamphuis, 1963; Galvin and Eagleson, 1965). These data are presented in tables following the list of references.

These eight sets of data, obtained under varying conditions using differing experimental procedures, are not equally reliable. The purpose of this paper is to merely list the data in convenient format and to briefly describe how they were obtained as a background to the review and evaluation given by Galvin (1967). Because the available data cannot be easily evaluated, a secondary purpose of this paper is to suggest the full publication of experimental procedure and statistics indicating the reliability of the data obtained by future research.

2. Variables Listed

The eight sets of data, listed in the table, contain a total of 352 observations. A longshore current observation, for the purpose of this report, is the approximately simultaneous measurement of five variables: a mean longshore current velocity (VMEAS), in feet per second, the direction of the wave at breaking (THETAB) in degrees, the period of the breaking wave (TB) in seconds, the height of the breaking wave (HB) in feet, and the beach slope (SLOPE) dimensionless. These variables are defined in Figure 1. Other measurements in the table include mean water depth at the breaking point (DB) in feet, given with Putnam, Munk, and Traylor's laboratory data, the direction of the wave (THETAO) in degrees, and the height of the wave in deep water (HO) in feet, as computed by Saville and Brebner and Kamphuis for their laboratory data, and the horizontal distance from the breaking position to the stillwater line on the beach (BVAL) in feet,

* Parenthetical notations refer to LITERATURE CITED on page 8.

measured in the experiments of Galvin and Eagleson. In some of the eight studies additional information was obtained, and this is discussed in the description of each investigation given in paragraph 4.

In the tables, laboratory data are listed first, followed by field data, each in chronological order. The compilation of data in the tables is reasonably complete, but other published studies may exist, especially in foreign literature. Other unpublished data are known to exist (Johnson, 1953, and Harrison and Krumbein, 1964), and field data obtained at Nags Head, North Carolina, by the Coastal Studies Institute of Louisiana State University (Sonu and McCloy, 1966).

The first column of the table is an identification number (ID) consisting of the initials of the investigators (as PMT), the letter L or F to indicate laboratory or field studies, and a number identifying the observation within the particular set of data. The last column of the table, labeled COUNT, is an identification number running from 1 to 352.

3. Difficulties in Measuring

Wave direction (THETAB) is the variable most difficult to measure with necessary accuracy. Visual field estimates are probably least reliable (Galvin and Savage, 1966) and even vertical photographs must have accurate horizontal control. The possibility of relative error increases markedly as THETAB decreases.

Longshore current velocity measurements (VMEAS) are more reliable than angle measurements, but this variable must be measured carefully because of the unsteadiness typical of field examples (Putnam, Munk, and Traylor, 1949) and the non-uniformity typical of laboratory examples (Brebner and Kamphuis, 1963; Galvin and Eagleson, 1965).

Wave height at breaking (HB) can be measured with reasonable accuracy, but care must be taken that measured values are representative. The wave gage must be fixed offshore of the mean breaking point and those waves which break before reaching the gage must be eliminated from the averages. Other problems arise because waves in nature have a finite crest length and are almost always subject to refraction effects; and on laboratory beaches, reflection causes partial standing waves which locally distort wave heights.

Wave period and beach slope can be measured within desirable accuracy under laboratory conditions. Under favorable conditions, wave period can be measured reasonably consistently in the field, either from oscillographs of the water surface or by visual observation. Well-controlled sounding from a pier permits accurate measurement of beach shape from which a slope may be defined. Similar sounding is necessary for laboratory sand beaches.

4. Descriptions of Investigations

The following paragraphs describe the peculiarities of each set of data, in the order that they are listed in the tables, based on

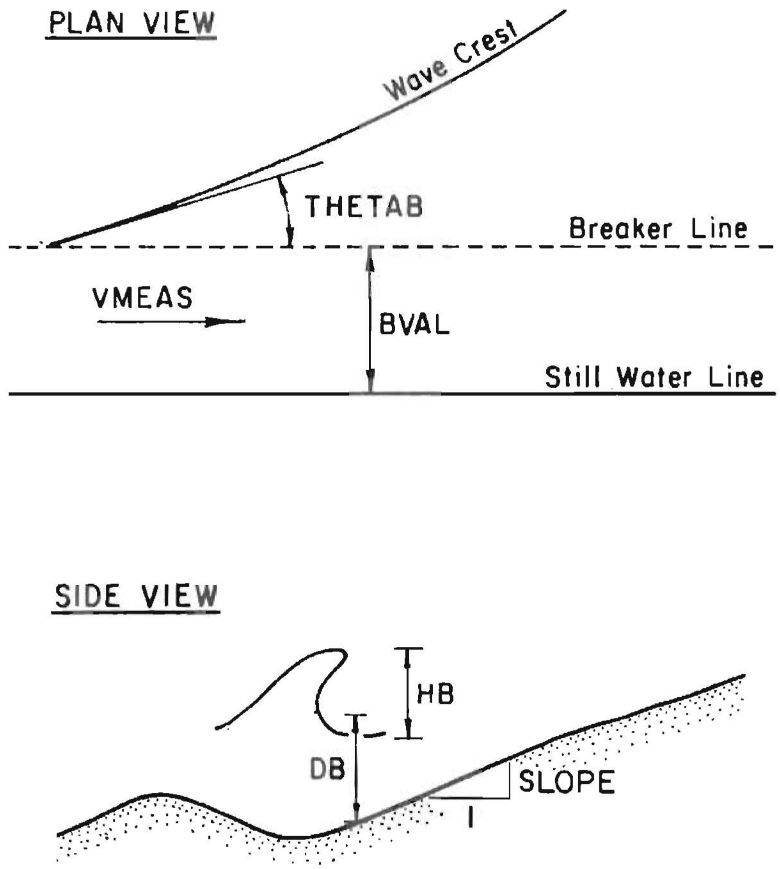

FIGURE 1. DEFINITION OF LONGSHORE CURRENT VARIABLES

information obtained from the papers of the respective authors.

a. Putnam, Munk, and Traylor Laboratory Observations (COUNT 1-37)

At the University of California at Berkeley, longshore current velocity was measured by timing the travel of potassium permanganate ($KMnO_4$) dye on the central 10-foot section of a 39-foot (?) test beach. The breaker angle was obtained from vertical photographs, and wave height was measured by electric point gages.

A fixed, artificially roughened, plane beach was used in these experiments. For numbers 1 through 14, the beach surface was roughened by bonding natural sand to it. For numbers 15 through 28, the beach was covered with sheet metal or smooth cement. For numbers 29 through 37, the beach was covered with 1/4-inch gravel bonded with a thin grout.

b. Saville Laboratory Observations (COUNT 38-46)

At the University of California at Berkeley, additional longshore current data were obtained during a study of sand transport. The travel of $KMnO_4$ dye along a 10-foot segment of the 60-foot beach was timed to obtain velocity. Wave heights offshore were measured with point gages. Offshore of the surf zone, the beach was concrete, and inshore it was 0.3 mm sand. The slope listed in the table (0.10) is that of the concrete, but the slope in the surf zone may have been lower.

Breaker angle (THETAB) and breaker height (HB) were not measured, but the theoretical values in deep water (THETAO and HO) were computed from small-amplitude wave theory. THETAB and HB were computed in this study for the table using refraction graphs (Johnson, O'Brien, and Isaacs, 1948) and (Le Mehaute, 1961). The zero value of VMEAS in observation number 46 (SAVL 9) is for a run in which little net longshore current was observed.

c. Brebner and Kamphuis Laboratory Observations (COUNT 47-187)

These data were obtained from a model study at Queens University, Kingston, Ontario, Canada. THETAB and HB were not measured, so the values listed in the table were also computed by using refraction graphs as for Saville's data. Velocity was measured by timing the travel of an immiscible, neutral-density fluid along the beach between 15 and 20 feet from the upstream wall. The concrete beach was at least 30 feet long and roughened by indentations spaced on one-inch centers. Offshore wave heights (not in table) were measured with an electric point gage.

d. Galvin and Eagleson Laboratory Observations (COUNT 188-225)

At the Massachusetts Institute of Technology, Hydrodynamics Laboratory, wooden floats and a current meter were used to measure longshore current velocity. The listed velocity is that observed at 18 feet from the upstream wall but considerable additional data are available on the two-dimensional velocity distribution in the surf zone, as well as the distribution of setup over the whole beach. The overall beach was 30 feet long, of which 20 feet made up the test section. Most values of THETAB are the average of twenty measurements with a protractor. Wave height was measured with a parallel-wire resistance gage.

All blanks in the table for the data of Galvin and Eagleson indicate that the quantity was not measured.

e. Putnam, Munk, and Traylor Field Observations (COUNT 226-243)

At Oceanside, California, velocity was measured using weighted floats and fluorescein dye. Additional data was obtained showing the unsteadiness of the current. THETAB was measured with a compass from a pier or from photographs taken from a blimp. Slope was obtained by sounding from a pier. Observations 238 and 242 were obtained during a 22-knot following wind approximately parallel to the shore.

f. Inman and Quinn Field Observations (COUNT 244-276)

Velocity was measured at the water surface and at the bottom of the surf zone by timing the travel of floating kelp and weighted, tethered soccer balls. The velocities given by Inman and Quinn are already the averages of measurements made at 15 stations spaced at about 300-foot intervals at Torrey Pines and Pacific Beach (near La Jolla), California. Their statistics show that the standard deviations often exceed the mean velocity. In table 6, the velocity listed is the average of the bottom and surface velocities whenever both are given. HB was estimated by an observer on the beach. More than half of the values of THETAB were measured with a transit sighting bar. Zeros in the table mean that the variables, averaged over the 15 stations, had approximately zero magnitude.

g. Moore and Scholl Field Observations (COUNT 277-347)

Daily measurements were made during the summer of 1960 at Ogoturuk Beach, Alaska. THETAB was measured to the nearest 5° by compass, HB was estimated to the nearest tenth of a meter, and VMEAS in cm/sec with dye. Moore and Scholl's data, given originally in the metric system, are presented here in English units to conform with the other studies. SLOPE was not measured during the study and the value listed under SLOPE is a nominal one taken from a profile in their paper. The gravel beaches in this area produce steeper slopes than the sand beaches in the other field studies. Zeros listed in the table are measured values.

During observations numbered 285, 287, 295, 300, 302, and 322, the direction of the longshore current flow was opposite the direction from which the waves approached (indicated by minus signs on the velocity in the table).

h. Galvin and Savage Field Observations (COUNT 348-352)

At Nags Head, North Carolina, velocity was measured by timing the travel of balloons filled with freshwater. Most values of THETAB were obtained by compass but some were also obtained by measuring the speed of the plunge point of the breaker or by crude triangulation. Wave height (HB) was measured visually or from oscillographs of the water surface. SLOPE was the average slope between the mean water line and a point 6 feet below mean water level. Other data include histograms showing the distribution of some of the measured variables from this CERC field project at Nags Head. THETAB in observation 352 is a single measurement at a time of changing wave conditions. VMEAS in observation 351 was small but not actually zero. Wind speed was high during nearly all the Nags Head measurements.

5. Discussion of Data

The data in the tables and the foregoing descriptions indicate differences among the sets of data. Among the laboratory studies, some differences are in the magnitude of the variables tested. For example, the laboratory conditions of Putnam, Munk, and Traylor are for conditions producing high values of VMEAS and THETAB. Of the 225 laboratory observations in the listing, six observations in the data of Putnam, Munk, and Traylor account for the six highest velocities (2.2 to 3.8 ft/sec) and the six highest breaker angles (39° to 38°). No value of THETAB in their laboratory experiments was less than 10°, but all of Saville's data, and most of the measurements of Galvin and Eagleson were for conditions producing THETAB less than 10°.

There are also differences in the variables which the investigators chose to measure. In the laboratory experiments of Saville and of Brebner and Kamphuis, THETAB and HB were not measured, but THETAO and HO were computed from offshore measurements instead. As explained in paragraph 4, the values of THETAB and HB for these two studies were newly computed for this paper; thus they will vary more regularly, yet they may be less accurate than actual measurement.

The experimental conditions of the laboratory tests also differ considerably. No two of the basins were alike in size and layout, and Saville's measurements were the only ones made on a deformable sand beach.

Large differences among the data from the field studies are also evident. The data of Inman and Quinn, although they provide useful statistics on variability, cannot be readily compared with other field measurements because their data are spatial averages along the beach. The data of Moore and Scholl are for lower waves, steeper beaches, and weaker currents than the other field studies. The few observations in the Nags Head study are accompanied by documented uncertainties, many of which were probably present in the other studies as well. Putnam, Munk, and Traylor velocities and Nags Head velocities are, on the average, significantly higher than in the other studies.

Viewed as a whole, the difference in magnitude between the laboratory and field data is greatest in wave height, and less for wave period and beach slope. Surprisingly, there is little difference between the average magnitudes of the field and laboratory measurements of THETAB and VMEAS, despite the fact that wave heights differ by nearly two orders of magnitude.

Accurate measurement of longshore currents in the field and laboratory are still needed, particularly measurements of currents produced by conditions intermediate between laboratory and ocean wave conditions. The nonuniformity and unsteadiness of longshore currents should be studied under controlled laboratory conditions, including how they are affected by variations in the geometry of the laboratory basin. In future studies, more effort should be made to document the reliability of the experimental procedure and the variability of the data.

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TABLE I

LABORATORY DATA BY PUTNAM, MUNK, AND TRAYLOR

ID		HB FT	TB SEC	THETAB DEGREE'	SLOPE -	VMEAS FPS	DB FT	COUNT
PMTL	1	0.47	1.00	18.3	0.066	0.78	0.75	1
PMTL	2	0.32	1.06	13.8	0.066	0.64	0.44	2
PMTL	3	0.40	1.14	14.6	0.066	0.82	0.56	3
PMTL	4	0.31	1.15	12.6	0.066	0.68	0.41	4
PMTL	5	0.30	1.25	11.7	0.066	0.76	0.39	5
PMTL	6	0.32	1.32	11.7	0.066	0.75	0.40	6
PMTL	7	0.29	1.40	10.9	0.066	0.64	0.37	7
PMTL	8	0.16	1.90	17.6	0.144	0.75	0.24	8
PMTL	9	0.15	2.13	17.2	0.144	0.66	0.23	9
PMTL	10	0.15	2.22	17.3	0.144	0.50	0.24	10
PMTL	11	0.28	0.72	18.2	0.241	1.33	0.48	11
PMTL	12	0.35	0.92	16.5	0.241	1.27	0.52	12
PMTL	13	0.22	1.14	10.4	0.241	0.53	0.28	13
PMTL	14	0.22	1.22	10.6	0.241	0.69	0.27	14
PMTL	15	0.24	0.99	28.0	0.100	1.68	0.32	15
PMTL	16	0.22	1.32	22.8	0.100	1.45	0.27	16
PMTL	17	0.16	1.63	18.8	0.100	0.96	0.23	17
PMTL	18	0.16	1.98	18.4	0.100	0.76	0.22	18
PMTL	19	0.28	0.83	56.6	0.139	2.46	0.43	19
PMTL	20	0.23	0.91	45.3	0.139	2.31	0.33	20
PMTL	21	0.22	1.00	38.8	0.139	2.22	0.29	21
PMTL	22	0.20	1.12	33.2	0.139	1.93	0.24	22
PMTL	23	0.20	1.35	31.1	0.139	1.52	0.25	23
PMTL	24	0.34	0.80	57.5	0.260	3.78	0.62	24
PMTL	25	0.29	0.90	52.5	0.260	3.34	0.43	25
PMTL	26	0.28	0.98	47.2	0.260	3.00	0.41	26
PMTL	27	0.20	1.23	32.5	0.260	1.91	0.26	27
PMTL	28	0.22	1.27	31.9	0.260	1.76	0.23	28
PMTL	29	0.26	0.95	30.1	0.098	1.03	0.36	29
PMTL	30	0.21	1.33	21.4	0.098	0.46	0.27	30
PMTL	31	0.16	1.67	18.0	0.098	0.20	0.20	31
PMTL	32	0.12	1.99	16.4	0.098	0.15	0.19	32
PMTL	33	0.33	1.08	30.4	0.143	1.32	0.47	33
PMTL	34	0.29	1.36	24.6	0.143	0.63	0.38	34
PMTL	35	0.20	1.58	19.3	0.143	0.36	0.27	35
PMTL	36	0.20	1.91	18.4	0.143	0.32	0.26	36
PMTL	37	0.22	2.32	19.1	0.143	0.18	0.30	37

TABLE 2

LABORATORY DATA BY SAVILLE

ID	HB FT	HO FT	TB SEC	THETAB DEGREE	THETAO DEGREE	SLOPE	VMEAS FPS	COUNT
SAVL 1	0.147	0.146	0.71	7.7	10.0	0.10	0.32	38
SAVL 2	0.138	0.129	0.85	6.7	10.2	0.10	0.27	39
SAVL 3	0.132	0.116	0.94	6.3	10.5	0.10	0.25	40
SAVL 4	0.130	0.110	1.00	5.6	10.8	0.10	0.21	41
SAVL 5	0.171	0.169	0.74	7.2	10.0	0.10	0.40	42
SAVL 6	0.154	0.147	0.85	6.7	10.2	0.10	0.32	43
SAVL 7	0.144	0.126	0.99	5.6	10.7	0.10	0.24	44
SAVL 8	0.137	0.106	1.17	5.2	11.4	0.10	0.07	45
SAVL 9	0.127	0.082	1.50	4.7	13.1	0.10	0.00	46

TABLE 3

LABORATORY DATA BY BREBNER AND KAMPHUIS

ID		HB FT	HO FT	TB SEC	THETAB DEGREE	THETAO DEGREE	SLOPE	VMEAS FPS	COUNT
BKL	1	0.092	0.075	1.13	7.0	21.9	0.10	0.44	47
BKL	2	0.097	0.089	1.00	7.5	20.9	0.10	0.47	48
BKL	3	0.110	0.112	0.87	9.0	20.3	0.10	0.67	49
BKL	4	0.118	0.124	0.78	10.0	20.1	0.10	0.82	50
BKL	5	0.118	0.106	1.13	7.5	21.9	0.10	0.49	51
BKL	6	0.138	0.129	1.00	8.0	20.9	0.10	0.67	52
BKL	7	0.153	0.157	0.87	10.0	20.3	0.10	0.83	53
BKL	8	0.159	0.172	0.78	12.0	20.1	0.10	0.99	54
BKL	9	0.157	0.151	1.13	9.0	21.9	0.10	0.63	55
BKL	10	0.159	0.167	1.00	9.5	20.9	0.10	0.80	56
BKL	11	0.200	0.207	0.87	12.0	20.3	0.10	0.96	57
BKL	12	0.203	0.212	0.78	13.0	20.1	0.10	1.07	58
BKL	13	0.177	0.174	1.13	9.0	21.9	0.10	0.63	59
BKL	14	0.220	0.211	1.00	11.0	20.9	0.10	0.88	60
BKL	15	0.228	0.242	0.87	12.5	20.3	0.10	1.04	61
BKL	16	0.231	0.257	0.78	14.0	20.1	0.10	1.16	62
BKL	17	0.092	0.076	1.13	10.0	33.1	0.10	0.60	63
BKL	18	0.112	0.089	1.00	11.0	31.4	0.10	0.81	64
BKL	19	0.110	0.113	0.87	13.0	30.5	0.10	0.84	65
BKL	20	0.118	0.125	0.78	15.0	30.1	0.10	0.91	66
BKL	21	0.118	0.107	1.13	11.0	33.1	0.10	0.83	67
BKL	22	0.133	0.130	1.00	12.5	31.4	0.10	0.97	68
BKL	23	0.153	0.158	0.87	15.0	30.5	0.10	1.04	69
BKL	24	0.159	0.172	0.78	17.0	30.1	0.10	1.14	70
BKL	25	0.170	0.153	1.13	13.0	33.1	0.10	0.94	71
BKL	26	0.158	0.168	1.00	14.0	31.4	0.10	1.12	72
BKL	27	0.200	0.208	0.87	17.0	30.5	0.10	1.25	73
BKL	28	0.194	0.212	0.78	18.0	30.1	0.10	1.32	74
BKL	29	0.184	0.176	1.13	13.0	33.1	0.10	1.07	75
BKL	30	0.204	0.212	1.00	16.0	31.4	0.10	1.25	76
BKL	31	0.231	0.244	0.87	18.0	30.5	0.10	1.29	77
BKL	32	0.234	0.258	0.78	21.0	30.1	0.10	1.32	78
BKL	33	0.085	0.077	1.13	12.0	44.5	0.10	0.70	79
BKL	34	0.097	0.090	1.00	14.0	42.1	0.10	0.83	80
BKL	35	0.110	0.113	0.87	17.0	40.7	0.10	0.88	81
BKL	36	0.112	0.125	0.78	18.0	40.2	0.10	1.05	82
BKL	37	0.118	0.109	1.13	14.0	44.5	0.10	0.91	83
BKL	38	0.133	0.131	1.00	16.0	42.1	0.10	0.96	84
BKL	39	0.141	0.158	0.87	18.0	40.7	0.10	1.10	85
BKL	40	0.147	0.172	0.78	21.0	40.2	0.10	1.22	86
BKL	41	0.151	0.156	1.13	17.0	44.5	0.10	1.08	87
BKL	42	0.153	0.170	1.00	18.0	42.1	0.10	1.18	88
BKL	43	0.176	0.209	0.87	22.0	40.7	0.10	1.36	89
BKL	44	0.187	0.213	0.78	24.0	40.2	0.10	1.53	90
BKL	45	0.177	0.179	1.13	17.0	44.5	0.10	1.21	91

TABLE 3 (Continued)

ID	HB FT	HO FT	TB SEC	THETAB DEGREE	THETAO DEGREE	SLOPE	VMEAS FPS	COUNT
BKL 46	0.189	0.214	1.00	19.0	42.1	0.10	1.34	92
BKL 47	0.204	0.243	0.87	23.0	40.7	0.10	1.48	93
BKL 48	0.085	0.077	1.13	12.0	44.5	0.10	0.66	94
BKL 49	0.097	0.090	1.00	14.0	42.1	0.10	0.74	95
BKL 50	0.110	0.113	0.87	17.0	40.7	0.10	0.90	96
BKL 51	0.112	0.125	0.78	18.0	40.2	0.10	1.03	97
BKL 52	0.118	0.109	1.13	14.0	44.5	0.10	0.85	98
BKL 53	0.133	0.131	1.00	16.0	42.1	0.10	0.95	99
BKL 54	0.141	0.158	0.87	18.0	40.7	0.10	1.10	100
BKL 55	0.147	0.172	0.78	21.0	40.2	0.10	1.26	101
BKL 56	0.151	0.156	1.13	17.0	44.5	0.10	1.03	102
BKL 57	0.153	0.170	1.00	18.0	42.1	0.10	1.14	103
BKL 58	0.176	0.209	0.87	22.0	40.7	0.10	1.35	104
BKL 59	0.187	0.213	0.78	24.0	40.2	0.10	1.56	105
BKL 60	0.177	0.179	1.13	17.0	44.5	0.10	1.09	106
BKL 61	0.189	0.214	1.00	19.0	42.1	0.10	1.29	107
BKL 62	0.204	0.243	0.87	23.0	40.7	0.10	1.42	108
BKL 63	0.085	0.081	1.13	14.0	56.7	0.10	0.61	109
BKL 64	0.097	0.092	1.00	17.0	53.1	0.10	0.75	110
BKL 65	0.104	0.113	0.87	19.0	51.0	0.10	0.89	111
BKL 66	0.109	0.125	0.78	22.0	50.3	0.10	1.06	112
BKL 67	0.118	0.113	1.13	16.0	56.7	0.10	1.02	113
BKL 68	0.123	0.133	1.00	19.0	53.1	0.10	0.97	114
BKL 69	0.137	0.159	0.87	22.0	51.0	0.10	1.13	115
BKL 70	0.147	0.172	0.78	26.0	50.3	0.10	1.35	116
BKL 71	0.157	0.163	1.13	19.0	56.7	0.10	1.06	117
BKL 72	0.153	0.173	1.00	21.0	53.1	0.10	1.19	118
BKL 73	0.184	0.209	0.87	26.0	51.0	0.10	1.43	119
BKL 74	0.178	0.213	0.78	28.0	50.3	0.10	1.52	120
BKL 75	0.177	0.187	1.13	20.0	56.7	0.10	1.29	121
BKL 76	0.184	0.218	1.00	23.0	53.1	0.10	1.43	122
BKL 77	0.208	0.246	0.87	27.0	51.0	0.10	1.73	123
BKL 78	0.215	0.258	0.78	32.0	50.3	0.10	1.79	124
BKL 79	0.085	0.092	1.13	16.0	70.9	0.10	0.74	125
BKL 80	0.092	0.096	1.00	18.0	64.7	0.10	0.83	126
BKL 81	0.104	0.115	0.87	22.0	61.5	0.10	0.87	127
BKL 82	0.103	0.125	0.78	24.0	60.5	0.10	0.99	128
BKL 83	0.112	0.130	1.13	19.0	70.9	0.10	0.86	129
BKL 84	0.112	0.139	1.00	21.0	64.7	0.10	1.01	130
BKL 85	0.129	0.161	0.87	25.0	61.5	0.10	1.10	131
BKL 86	0.140	0.173	0.78	28.0	60.5	0.10	1.25	132
BKL 87	0.138	0.186	1.13	21.0	70.9	0.10	1.03	133
BKL 88	0.143	0.180	1.00	23.0	64.7	0.10	1.15	134
BKL 89	0.172	0.212	0.87	28.0	61.5	0.10	1.28	135
BKL 90	0.169	0.214	0.78	31.0	60.5	0.10	1.48	136
BKL 91	0.151	0.214	1.13	22.0	70.9	0.10	1.12	137
BKL 92	0.179	0.227	1.00	26.0	64.7	0.10	1.27	138
BKL 93	0.192	0.248	0.87	30.0	61.5	0.10	1.42	139

TABLE 3 (Continued)

ID		HB FT	HO FT	TB SEC	THETAB DEGREE	THETAO DEGREE	SLOPE	VMEAS FPS	COUNT
BKL	94	0.203	0.259	0.78	35.0	60.5	0.10	1.66	140
BKL	95	0.092	0.075	1.13	7.0	21.9	0.05	0.49	141
BKL	96	0.097	0.089	1.00	7.5	20.9	0.05	0.56	142
BKL	97	0.110	0.112	0.87	9.0	20.3	0.05	0.62	143
BKL	98	0.118	0.124	0.78	10.0	20.1	0.05	0.68	144
BKL	99	0.118	0.106	1.13	7.5	21.9	0.05	0.66	145
BKL	100	0.138	0.129	1.00	8.0	20.9	0.05	0.61	146
BKL	101	0.153	0.157	0.87	10.0	20.3	0.05	0.67	147
BKL	102	0.159	0.172	0.78	12.0	20.1	0.05	0.69	148
BKL	103	0.157	0.151	1.13	9.0	21.9	0.05	0.71	149
BKL	104	0.159	0.167	1.00	9.5	20.9	0.05	0.73	150
BKL	105	0.200	0.207	0.87	12.0	20.3	0.05	0.80	151
BKL	106	0.203	0.212	0.78	13.0	20.1	0.05	0.81	152
BKL	107	0.177	0.174	1.13	9.0	21.9	0.05	0.84	153
BKL	108	0.220	0.211	1.00	11.0	20.9	0.05	0.80	154
BKL	109	0.228	0.242	0.87	12.5	20.3	0.05	0.82	155
BKL	110	0.231	0.257	0.78	14.0	20.1	0.05	0.84	156
BKL	111	0.092	0.076	1.13	10.0	33.1	0.05	0.63	157
BKL	112	0.112	0.089	1.00	11.0	31.4	0.05	0.61	158
BKL	113	0.110	0.113	0.87	13.0	30.5	0.15	0.65	159
BKL	114	0.118	0.125	0.78	15.0	30.1	0.05	0.64	160
BKL	115	0.118	0.107	1.13	11.0	33.1	0.05	0.76	161
BKL	116	0.133	0.130	1.00	12.5	31.4	0.05	0.68	162
BKL	117	0.153	0.158	0.87	15.0	30.5	0.05	0.76	163
BKL	118	0.159	0.172	0.78	17.0	30.1	0.05	0.78	164
BKL	119	0.170	0.153	1.13	13.0	33.1	0.05	0.86	165
BKL	120	0.158	0.168	1.00	14.0	31.4	0.05	0.78	166
BKL	121	0.200	0.208	0.87	17.0	30.5	0.05	0.90	167
BKL	122	0.194	0.212	0.78	18.0	30.1	0.05	0.90	168
BKL	123	0.184	0.176	1.13	13.0	33.1	0.05	0.96	169
BKL	124	0.204	0.212	1.00	16.0	31.4	0.05	0.92	170
BKL	125	0.231	0.244	0.87	18.0	30.5	0.05	0.98	171
BKL	126	0.234	0.258	0.78	21.0	30.1	0.05	1.03	172
BKL	127	0.085	0.077	1.13	12.0	44.5	0.05	0.66	173
BKL	128	0.097	0.090	1.00	14.0	42.1	0.05	0.80	174
BKL	129	0.110	0.113	0.87	17.0	40.7	0.05	0.68	175
BKL	130	0.112	0.125	0.78	18.0	40.2	0.05	0.83	176
BKL	131	0.118	0.109	1.13	14.0	44.5	0.05	0.79	177
BKL	132	0.133	0.131	1.00	16.0	42.1	0.05	0.89	178
BKL	133	0.141	0.158	0.87	18.0	40.7	0.05	1.00	179
BKL	134	0.147	0.172	0.78	21.0	40.2	0.05	1.07	180
BKL	135	0.151	0.156	1.13	17.0	44.5	0.05	0.87	181
BKL	136	0.153	0.170	1.00	18.0	42.1	0.05	1.07	182
BKL	137	0.176	0.209	0.87	22.0	40.7	0.05	1.04	183
BKL	138	0.187	0.213	0.78	24.0	40.2	0.05	1.12	184
BKL	139	0.177	0.179	1.13	17.0	44.5	0.05	1.06	185
BKL	140	0.189	0.214	1.00	19.0	42.1	0.05	1.07	186
BKL	141	0.204	0.243	0.87	23.0	40.7	0.05	1.15	187

TABLE 4

LABORATORY DATA BY GALVIN AND EAGLESON

ID	HB FT	TB SEC	THETAB DEGREE	SLOPE	BVAL FT	VMEAS FPS	COUNT
GEL 1	----	1.00	5.4	0.109	0.83	1.62	188
GEL 2	0.21	1.12	5.1	0.109	0.82	1.53	189
GEL 3	0.14	1.25	3.3	0.109	0.68	1.33	190
GEL 4	0.19	1.37	2.3	0.109	0.53	1.24	191
GEL 5	----	1.50	3.7	0.109	0.52	1.17	192
GEL 6	0.03	1.25	2.6	0.109	0.34	0.62	193
GEL 7	0.12	1.25	3.1	0.109	0.50	0.87	194
GEL 8	0.17	1.25	3.8	0.109	0.67	1.21	195
GEL 9	0.17	1.25	3.7	0.109	0.71	1.07	196
GEL 10	0.19	1.25	4.0	0.109	0.84	1.44	197
GEL 11	0.07	1.50	1.1	0.109	0.21	0.76	198
GEL 12	0.09	1.00	2.9	0.109	0.45	0.98	199
GEL 13	0.18	0.90	---	0.109	1.81	----	200
GEL 14	0.17	1.00	14.1	0.109	1.76	1.52	201
GEL 15	0.19	1.12	12.1	0.109	1.60	1.51	202
GEL 16	0.19	1.25	10.1	0.109	1.61	1.44	203
GEL 17	0.19	1.37	9.2	0.109	1.42	1.13	204
GEL 18	0.16	1.50	6.9	0.109	1.23	1.04	205
GEL 19	0.09	1.25	6.1	0.109	0.56	0.68	206
GEL 20	0.13	1.25	6.6	0.109	0.96	0.85	207
GEL 21	0.15	1.25	8.6	0.109	1.23	1.11	208
GEL 22	0.17	1.25	9.8	0.109	1.49	1.33	209
GEL 23	0.17	1.25	11.0	0.109	1.77	1.55	210
GEL 24	0.11	1.50	3.7	0.109	----	0.77	211
GEL 25	0.11	1.00	9.7	0.109	----	0.94	212
GEL 26	0.18	1.00	28.0	0.109	2.15	1.40	213
GEL 27	----	1.12	21.8	0.109	1.89	1.15	214
GEL 28	0.19	1.25	18.6	0.109	1.91	1.22	215
GEL 29	----	1.37	15.7	0.109	1.81	1.32	216
GEL 30	0.10	1.50	8.6	0.109	0.91	0.91	217
GEL 31	0.16	1.25	13.3	0.109	0.65	0.69	218
GEL 32	0.13	1.25	14.3	0.109	1.20	0.83	219
GEL 33	0.16	1.25	19.6	0.109	1.57	1.19	220
GEL 34	----	1.25	19.6	0.109	1.88	1.27	221
GEL 35	----	1.25	22.5	0.109	1.96	1.29	222
GEL 36	----	1.50	6.0	0.109	0.18	0.57	223
GEL 37	----	1.00	20.1	0.109	1.46	0.88	224
GEL 38	----	1.00	18.9	0.109	----	1.11	225

TABLE 5

FIELD DATA BY PUTNAM, MUNK, AND TRAYLOR

ID	HB FT	TB SEC	THETAB DEGREE	SLOPE	VMEAS FPS	COUNT
PMTF 1	5.0	10.0	15.0	0.016	2.5	226
PMTF 2	5.5	9.0	12.0	0.020	2.2	227
PMTF 3	7.0	9.0	15.0	0.023	3.0	228
PMTF 4	6.0	7.0	7.5	0.017	1.8	229
PMTF 5	5.0	10.0	10.0	0.031	3.6	230
PMTF 6	8.0	10.0	10.0	0.022	2.8	231
PMTF 7	8.0	10.0	10.0	0.023	2.3	232
PMTF 8	6.5	12.0	10.0	0.020	2.4	233
PMTF 9	4.5	12.0	10.0	0.020	2.4	234
PMTF 10	4.5	12.0	10.0	0.019	2.7	235
PMTF 11	4.5	12.0	10.0	0.019	2.1	236
PMTF 12	6.5	15.0	5.0	0.016	1.7	237
PMTF 13	8.0	7.0	17.5	0.022	5.2	238
PMTF 14	5.0	8.0	10.0	0.030	3.3	239
PMTF 15	8.5	8.0	12.0	0.020	2.5	240
PMTF 16	5.0	15.0	5.0	0.026	2.4	241
PMTF 17	9.0	8.0	15.0	0.019	5.5	242
PMTF 18	9.0	8.0	15.0	0.019	3.9	243

TABLE 6

FIELD DATA BY INMAN AND QUINN

ID		HB FT	TB SEC	THETAB DEGREE	SLOPE	VMEAS FPS	COUNT
IQF	1	2.8	15.0	6.5	0.027	0.38	244
IQF	2	3.1	8.5	1.5	0.027	0.04	245
IQF	3	3.7	8.0	4.0	0.027	0.22	246
IQF	4	3.6	14.0	0.	0.027	0.04	247
IQF	5	4.9	8.0	5.0	0.027	0.84	248
IQF	6	3.8	7.0	5.0	0.027	0.21	249
IQF	7	3.4	12.5	0.	0.027	0.55	250
IQF	8	2.6	8.0	0.	0.035	0.04	251
IQF	9	3.0	9.5	1.0	0.035	0.01	252
IQF	10	2.7	10.0	0.	0.035	0.15	253
IQF	11	3.5	13.5	0.	0.035	0.09	254
IQF	12	4.9	13.0	0.	0.035	0.21	255
IQF	13	2.9	10.0	0.	0.035	0.50	256
IQF	14	4.6	12.0	0.	0.035	0.88	257
IQF	15	3.7	8.0	0.	0.028	0.20	258
IQF	16	5.1	12.0	6.0	0.027	0.29	259
IQF	17	4.7	14.0	7.0	0.027	0.53	260
IQF	18	4.5	15.0	4.0	0.027	0.70	261
IQF	19	4.8	12.0	4.0	0.027	1.19	262
IQF	20	4.2	12.0	4.5	0.027	0.40	263
IQF	21	2.0	12.0	4.0	0.027	0.36	264
IQF	22	1.7	8.0	7.0	0.027	0.23	265
IQF	23	2.9	15.0	5.0	0.027	0.56	266
IQF	24	1.6	6.0	5.0	0.027	0.11	267
IQF	25	6.2	14.0	5.0	0.014	0.54	268
IQF	26	3.1	16.0	7.0	0.014	0.62	269
IQF	27	4.5	12.0	3.0	0.014	0.49	270
IQF	28	3.5	14.0	4.0	0.014	0.17	271
IQF	29	2.7	16.0	3.5	0.014	0.13	272
IQF	30	4.7	13.0	7.0	0.014	1.37	273
IQF	31	2.6	11.5	2.0	0.014	0.04	274
IQF	32	2.0	14.5	4.0	0.014	0.11	275
IQF	33	1.8	12.0	2.5	0.014	0.06	276

TABLE 7

FIELD DATA BY MOORE AND SCHOLL

ID		HB FT	TB SEC	THETAB DEGREE	SLOPE	VMEAS FPS	COUNT
MSF	1	0.66	2.5	35	0.2	0.16	277
MSF	2	0.66	2.7	25	0.2	0.	278
MSF	3	0.98	2.6	40	0.2	0.	279
MSF	4	0.66	2.6	5	0.2	0.29	280
MSF	5	0.66	3.3	5	0.2	0.26	281
MSF	6	1.97	5.0	5	0.2	0.66	282
MSF	7	1.64	4.8	5	0.2	0.49	283
MSF	8	1.31	4.3	10	0.2	0.36	284
MSF	9	1.64	4.0	20	0.2	-0.13	285
MSF	10	0.66	2.7	35	0.2	0.66	286
MSF	11	0.33	3.5	5	0.2	0.49	287
MSF	12	0.66	5.5	10	0.2	0.16	288
MSF	13	0.98	3.5	5	0.2	0.10	289
MSF	14	4.59	6.0	5	0.2	0.75	290
MSF	15	0.98	4.0	5	0.2	0.03	291
MSF	16	0.33	6.5	0	0.2	0.	292
MSF	17	0.33	5.0	0	0.2	0.16	293
MSF	18	0.33	7.1	5	0.2	0.10	294
MSF	19	0.66	4.5	10	0.2	-0.07	295
MSF	20	0.33	4.5	0	0.2	0.	296
MSF	21	0.33	5.5	5	0.2	0.36	297
MSF	22	0.33	4.3	5	0.2	0.	298
MSF	23	0.98	4.1	15	0.2	0.20	299
MSF	24	1.31	4.4	25	0.2	-0.82	300
MSF	25	0.98	4.4	20	0.2	0.20	301
MSF	26	0.66	4.4	10	0.2	-0.07	302
MSF	27	3.94	4.4	5	0.2	0.95	303
MSF	28	4.59	5.8	5	0.2	0.26	304
MSF	29	3.61	5.5	-0	0.2	-0.	305
MSF	30	1.97	5.5	-0	0.2	0.13	306
MSF	31	0.66	5.0	-0	0.2	0.03	307
MSF	32	0.66	7.5	-0	0.2	0.13	308
MSF	33	0.33	7.0	-0	0.2	0.16	309
MSF	34	0.33	7.1	-0	0.2	0.	310
MSF	35	0.33	5.5	-0	0.2	0.	311
MSF	36	0.33	5.3	5	0.2	0.10	312
MSF	37	0.33	5.3	-0	0.2	-0.	313
MSF	38	0.33	5.0	5	0.2	0.26	314
MSF	39	0.33	6.0	15	0.2	-0.	315
MSF	40	0.66	2.5	20	0.2	0.20	316
MSF	41	1.64	3.5	5	0.2	0.16	317
MSF	42	5.90	5.5	0	0.2	0.52	318
MSF	43	2.96	5.0	5	0.2	0.95	319
MSF	44	1.64	7.0	20	0.2	0.92	320

TABLE 7 (Continued)

ID		HB FT	TB SEC	THETAB DEGREE	SLOPE	VMEAS FPS	COUNT
MSF	45	2.62	6.0	25	0.2	1.38	321
MSF	46	0.66	7.0	15	0.2	-0.10	322
MSF	47	0.33	5.0	-0	0.2	-0.	323
MSF	48	0.33	6.0	5	0.2	0.33	324
MSF	49	0.66	4.5	5	0.2	-0.	325
MSF	50	0.98	2.5	5	0.2	0.46	326
MSF	51	0.98	4.4	-0	0.2	0.16	327
MSF	52	1.64	3.3	10	0.2	0.69	328
MSF	53	0.66	4.0	-0	0.2	-0.	329
MSF	54	0.98	4.0	30	0.2	0.10	330
MSF	55	2.96	4.5	20	0.2	0.49	331
MSF	56	1.97	5.0	45	0.2	1.25	332
MSF	57	0.66	1.0	-0	0.2	0.16	333
MSF	58	1.97	4.0	20	0.2	0.98	334
MSF	59	1.97	3.9	30	0.2	1.21	335
MSF	60	3.94	5.0	20	0.2	0.75	336
MSF	61	4.92	4.0	10	0.2	1.18	337
MSF	62	1.97	4.0	45	0.2	1.41	338
MSF	63	0.98	4.6	10	0.2	0.10	339
MSF	64	5.91	4.0	30	0.2	1.21	340
MSF	65	2.96	1.0	20	0.2	0.49	341
MSF	66	2.96	2.3	20	0.2	0.16	342
MSF	67	3.94	4.0	20	0.2	0.75	343
MSF	68	5.91	4.2	10	0.2	0.98	344
MSF	69	0.98	3.6	20	0.2	0.07	345
MSF	70	2.96	4.0	20	0.2	0.33	346
MSF	71	5.91	3.6	30	0.2	0.98	347

TABLE 8

FIELD OBSERVATIONS BY GALVIN AND SAVAGE

ID		HB FT	TB SEC	THETAB DEGREE	SLOPE	VMEAS FPS	COUNT
GSF	1	2.0	5.2	19.5	0.030	2.42	348
GSF	2	3.2	9.9	19.0	0.026	4.33	349
GSF	3	1.8	5.9	11.0	0.029	1.96	350
GSF	4	1.5	8.8	3.2	0.027	0.	351
GSF	5	8.0	12.3	12.0	0.026	1.27	352

U. S. ARMY COASTAL ENGRG RESEARCH CENTER, CE
WASHINGTON, D. C.

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2. Littoral Processes
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