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HABITAT DEVELOPMENT FIELD INVESTIGATIONS, BOLIVAR PENINSULA MARSH AND UPLAND HABITAT DEVELOPMENT SITE, GALVESTON BAY, TEXAS

APPENDIX A: BASELINE INVENTORY OF WATER QUALITY, SEDIMENT QUALITY, AND HYDRODYNAMICS

by

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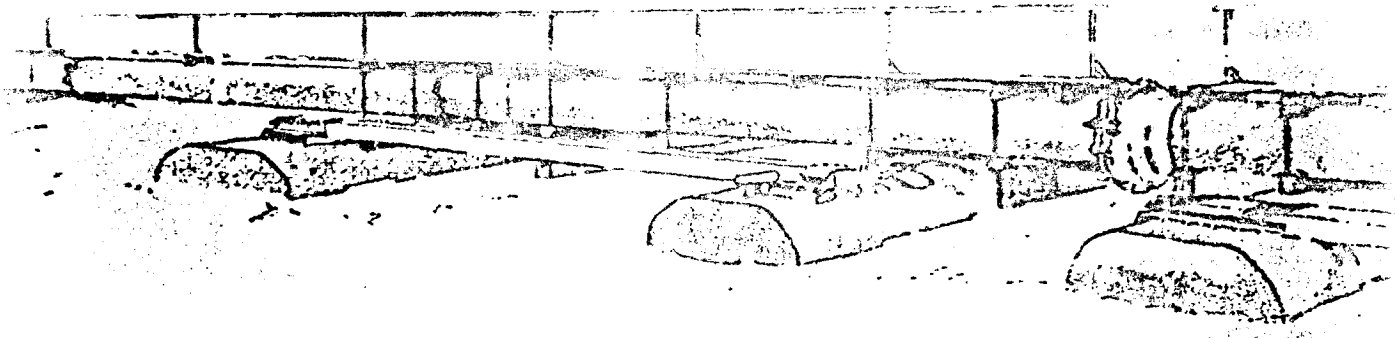

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HABITAT DEVELOPMENT FIELD INVESTIGATIONS, BOLIVAR PENINSULA
MARSH AND UPLAND HABITAT DEVELOPMENT SITE
GALVESTON BAY, TEXAS

Appendix A: Baseline Inventory [illegible] Quality, and Hydrodynamics

Appendix B: Baseline Inventory of Terrestrial Flora, Fauna, and Sediment Chemistry

Appendix C: Baseline Inventory of Aquatic Biota

Appendix D: Propagation of Vascular Plants and Postpropagation Monitoring of Botanical, Soil, Aquatic Biota, and Wildlife Resources

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Water and sediment quality and hydrodynamics in Galveston Bay at Bolivar Peninsula, Texas, were inventoried in connection with a proposed experimental marsh and upland habitat development project using dredged material.

Results of field studies at the site and a review of historical data considering various field parameters and nutrient, metal, insecticide, and herbicide concentrations in the water and sediments are presented; studies of tide and current conditions related to [illegible]

20. ABSTRACT (Continued)

The water and sediments were found to be free of levels of metals or organic pollutants likely to adversely influence the experimental habitat development. Nutrient concentrations were low and dissolved oxygen values high. The site was influenced by small short-period waves that scour the sediments on the site. Water stages were between 0.85 and -0.37 m (National Geodetic Vertical Datum) 98 percent of the time and were strongly influenced by seasonal wind conditions. Winds from the northwest at 16 to 23 km/hr may lower the water stage as much as 0.30 m. Currents flowed in southwesterly and northeasterly directions with an average velocity of 21 cm/sec during usual tide and wind conditions.

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This report presents water quality, sediment quality, and hydrodynamic information collected by the U. S. Geological Survey during April, May, June, and August 1975, along with a review of selected historical data. The information was collected for use by the U. S. Army Corps of Engineers in evaluating environmental conditions at a proposed marsh and upland habitat development site on Bolivar Peninsula in Galveston Bay, Texas. The low concentrations of nitrogen and phosphorus species, the low biochemical oxygen demand (BOD), the low concentrations of heavy metals, the near absence of insecticide and herbicide residues, and the high [illegible] saturation indicated that conditions at the test site were favorable for salt-marsh plant and animal growth.

Water velocities at the test site exceeded 30 cm/sec during one storm period but were less than 21 cm/sec during usual wind and tidal conditions. Water stages for 13 years of record were between 0.85 and -0.37 m (National Geodetic Vertical Datum) during 98 percent of the time. The mean water stage from October 1973 to September 1975 was 0.32 m.

The climate at the test site was described by data collected at the Galveston airport. The mean monthly air temperatures for 1940-60 were 12.3° to 28.8°C, and the mean annual temperature was 21.2°C. The mean monthly rainfall was 72.1 to 151.9 mm. The mean annual rainfall was 1160.8 mm.

Wind speeds greater than 21 km/hr, which occurred 45 percent of the days each year, caused changes in the water stages. West and northwest winds caused the greatest stage change for the least wind. Winds of 24 to 32 km/hr from any direction caused stage changes between 0.15 and 0.30 m, but southeast winds greater than 32 km/hr were required to cause more than an 0.30-

Preface

Data presented in this report were collected under Interagency Agreement Nos. WESKF 75-95 and 76-59 dated 25 March 1975 and 18 November 1975, between the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, and the U. S. Geological Survey (USGS), Austin, Texas. The agreements were sponsored by the Office, Chief of Engineers, U. S. Army, under the Dredged Material Research Program (DMRP) which was managed by the Environmental Laboratory (EL), formerly the Environmental Effects Laboratory, WES.

Field collections and observations, sample analyses, and initial data reduction were conducted under the supervision of Mr. D. C. Hahl, Chief, Texas Bays and Estuaries Project, USGS, and transmitted to the Environmental Laboratory as an open-file report, "Data on Water Quality and Hydrodynamics at the Bolivar Wetland - Habitat Development Site, Galveston, Texas." Hydrologic aspects of the open-file report are contained herein as amplified and revised by Mr. Ellis J. Clairain, Jr., Fisheries Biologist, EL [illegible] and revisions of text and tabular materials for publication were made by Mr. John D. Lunz, Marine Biologist, EL, and Dr. John W. Simmons, Biologist, EL. The editorial supervisor was Ms. Dorothy P. Booth.

The agreement was monitored by Mr. Lunz and coordinated by Dr. John Byrne, Site Coordinator, EL.

The project was under the general supervision of Dr. H. K. Smith, Project Manager, Habitat Development Project; Dr. C. J. Kirby, Chief, Environmental Resources Division; and Dr. John Harrison, Chief, EL.

Commanders and Directors of WES during the preparation and publication of this report were COL G. H. Hilt, CE, and COL J. L. Cannon, CE. Technical Director was Dr. [illegible]

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HABITAT DEVELOPMENT FIELD INVESTIGATIONS
BOLIVAR PENINSULA MARSH AND UPLAND
HABITAT DEVELOPMENT SITE
GALVESTON BAY, TEXAS

APPENDIX A: BASELINE INVENTORY OF WATER QUALITY, SEDIMENT QUALITY, AND HYDRODYNAMICS

Introduction

1. This report presents water quality, sediment quality, water stage, and water velocity and direction data collected by the U. S. Geological Survey (USGS) in response to a 30 January 1975 request from the U. S. Army Engineer Waterways Experiment Station (WES) to participate in a study of environmental conditions at the Bolivar Peninsula habitat development site (Figure 1).

2. The Bolivar Peninsula test site is located near lat. 29°25'N and long. 94°44'W about 20.1 km northeast of the Galveston, Texas, airport. The test site is in the Galveston Bay reach of the Trinity-San Jacinto Estuary about 6.4 km from the western end of Bolivar Peninsula.

3. The objective of the program is to develop a marsh and upland habitat complex using dredged material from the Intracoastal Waterway as a substrate. The dredged material will be protected by a dike. The objective of the work by the USGS was to document the water and sediment quality and hydrodynamic conditions at the proposed project location.

4. To achi[illegible] the USGS scheduled hydrologic studies prior to and during development of the site. In the conduct of these studies, the USGS arranged:

- a. To review and summarize climatic data for the nearest weather station.
- b. To collect water quality and sediment quality data at the test site and to perform a literature search to ascertain the applicability of historical data.
- c. To establish a water stage recorder at the test site or determine historical water stages by correlation of

the test site data with data from a nearby long-term water stage recorder and evaluate changes in water stage due to wind velocities.

d. To measure water velocities and directions at the test site during extreme conditions.

5. The work proposal and sampling sites (Figure 2) were agreed upon by USGS and WES representatives, and work began in April 1975. By June 1975, a water stage recorder was installed; three water quality surveys were completed; water velocities were measured; and historical water quality, climatological, and water stage data were obtained. In September 1975, a [illegible] plans by the Corps of Engineers caused discontinuance of all work by the USGS except operation of the water stage recorder.

Climate

6. The test site is on the bayward side of a 3.2-km-wide barrier peninsula along the Gulf of Mexico. The following data, taken from "Climatography of the United States" (U. S. Weather Bureau 1965), indicate the mild climate of the area.

7. Mean monthly air temperatures at the Galveston airport for 21 years of record (1940-60) ranged from a high of 28.8°C to a low of 12.3°C. The mean annual temperature was 21.2°C. Air temperature for 10 years of record (1951-60) was 32.2°C or more on an average of 35 times a year and was 0°C or less on an average of only 2 times a year. The extreme temperatures recorded in Galveston during 1951-60 were 36.7°C and -7.8°C.

8. Mean monthly rainfall at Galveston airport for 21 years of record (1940-60) ranged from a high of 151.9 mm to a low of 72.1 mm. The mean annual rai[illegible] Rainfall for 10 years of record (1951-60) w[illegible] more on an average of 23 days a year and for 7 years of record (1954-60) was 2.5 mm or less on an average of 52 days a year.

9. Frequency of wind occurrence and mean wind velocity data based on 87,690 hourly observations during the 10-year period 1951-60 (U. S. Weather Bureau 1962) for the Galveston airport are summarized in Table 1. These data show that winds occur on an average of 99 percent of the days each year and that the mean daily wind speed exceeds 21 km/hr 45 percent of the days each year.

10. The selection of the two periods shown in Table 1 is based on predominant wind directions. From March through August, wind is from the south quadrant 69 percent of the days; from September through February, wind is from the northeast quadrant 46 percent of the days.

Water and Sediment Quality

11. Water and sediment quality at the proposed site were determined by considering both historical data from the area and an analysis of water and sedimen[illegible] by the USGS during this project.

Historical data

12. As part of its Galveston Bay project, the Texas Water Quality Board (TWQB) conducted an extensive sampling program in the bay from July 1968 to September 1971. Samples were collected monthly from 15 to 39 stations, at 2- or 3-hour intervals during five 24-hour periods. The data collected during this period and related material are presented in a publication by Huston (1971). The TWQB site 29, located at the Hanna Reef tide gage shown in Figure 1, was sampled 27 times during the TWQB study. Review of the data from site 29 and TWQB data from other sites in Galveston Bay indicates that water quality was nearly uniform in the area of the bay between Bolivar Peninsula and Hanna Reef; therefore, data from site 29 can be considered representative of conditions at the test site from July 1968 to September 1971.

Data collection and analysis during this project

13. During April, May, June, and August 1975, in situ measurements of dissolved oxygen (DO), pH, specific conductance, and temperature were made, and laboratory analyses for nutrients, major constituents, metals,

insecticides, herbicides, and radiochemicals were performed. Specific parameters and procedures for both field collection/analysis and laboratory analysis are presented in Table 2.

14. Table 3 is a comparison of water quality data for samples collected at a depth of 0.3 m from July 1968 to September 1971 by the TWQB at site 29 and of similar data for samples collected at depths of 0.3 up to 4.9 m from April to August 1975 by the USGS at the Bolivar Peninsula test site. All of the water and sediment data collected for this project by the USGS are presented in Tables 4-10.

15. Data collected by the USGS show that the differences in chemical and physical characteristics between water in the bay and water in the Intracoastal Waterway are minor except for the dissolved oxygen concentration, which averaged about 0.5 mg/ℓ less in the Intracoastal Waterway.

16. Turbidity at the test site is a direct function of wave energy. On 14 May 1975, after 2000 hours, northerly winds increased to about 32 km/hr. Th[illegible] through the night until a predawn lessening of the wind reduced the wave heights. Through 16 May 1975, winds continued at speeds greater than 24 km/hr and the turbidity remained high. Southerly winds during the April, June, and August 1975 sampling periods were less than 24 km/hr, and the resultant turbidities were much less than in May.

17. The concentrations of nitrogen species were low, but phosphorus concentrations ranged from 0.06 to 0.35 mg/ℓ. Biochemical oxygen demand (BOD) did not exceed 2.7 mg/ℓ, indicating that a deficiency of dissolved oxygen would not occur.

18. Analyses for minor elements and pesticides showed that the concentrations of these constituents were low; most of them were too low for the analytical methods to detect. Results of an analysis for lead, mercury, and zinc based on samples collected in 1972 about 91 m from line 610, site 40 (Galveston District 1975), showed concentrations

of the same order of magnitude as those collected by the USGS in 1975 (USGS 1976).

19. The low concentrations of nitrogen and phosphorus species, the low BOD, the low concentrations of heavy metals, the absence of insecticide and herbicide residues, and the high dissolved oxygen saturation indicate that the Bolivar Peninsula test site is nearly free of pollutants; therefore, marsh development at the site should not be adversely affected by water quality.

Water Velocities and Directions

20. Water velocities and directions were measured hourly at line 640, site 40, [illegible] 14 May until 0100 hours on 16 May 1975. Surface wind [illegible] sampling period were from the north at 24 to 32 km/hr. Measurements were repeated at this site during the period from 1300 hours on 25 June until 1200 hours on 26 June 1975. During the June sampling period, winds were from the southeast and moderate. Observations were also made on line 620, site 40, during the same periods in May and June. However, these measurements were obtained only when the water depth allowed boat access to the site. The data for both sampling periods are presented in Tables 11 and 12.

21. Water velocities and directions at line 640, site 40, differed significantly between May and June (Figure 3). In May, with the strong northerly wind predominant, water movement was to the southwest 80 percent of the time, and [illegible] velocity averaged 24.4 cm/sec. Northeasterly water movement only occurred 20 percent of the time, and water velocity averaged 21.0 cm/sec.

22. During the June sampling period, when moderate winds were from the southeast, flow at line 640, site 40, was to the southwest 38 percent of the time, and velocity averaged only about half (13.6 cm/sec) of that observed in May. Flow to the northeast, however, occurred 62 percent of the time with an average velocity of 12.5 cm/sec.

23. At line 620, site 40, close to the proposed habitat development project dike, only 7 observations were made in May and 19 in June 1975. May current measurements, made during the strong northerly wind, are presented in Figure 4. The average current velocity during the sampling period was 14.8 cm/sec, and all flow was in a southwesterly direction.

24. In June, with the moderate southeasterly winds, current velocity averaged 7.7 cm/sec for the 39 percent of the time that flow was to the southwest. [illegible] 61 percent of the time, average current velocity was 10.0 cm/sec, and flow was to the northeast (Figure 4).

25. In summary, observations made during this study show that currents flow parallel to the proposed site in Galveston Bay regardless of the tide or wind condition. Water velocities and directions are influenced by both wind and tide. Effects of northeast winds blowing water out of the bay are negated by incoming tides during short periods of large stage differences between the gulf and the bay. Velocity difference during a tide cycle or between different tide cycles is a function of head differences if wind can be ignored. Antecedent wind and water stages have a marked effect on velocities. Nearshore current speeds were lower than offshore current speeds during both sampling periods.

Water Stages

26. A water stage recorder was installed at the test site on 16 May 1975. Datum of the gage was set to that of the U. S. Army Corps of Engineers [illegible] + 43.9 at 1.786 m National Geodetic Vertical Datum (NGVD) as determined in 1975. By using a water level datum transfer based on 39 days of nonstorm record, it was determined that the datum of the gage at Hanna Reef must be raised by 0.378 m to agree with the NGVD elevation for BM 2960 + 43.9.

The following discus[illegible] based on the datum of BM 2960 + 43.9.

27. The range in water stage for the period January 1962 through September 1975 at Hanna Reef was 1.28 to -1.07 m. However, during about 98 percent of that period, water stages were between 0.85 and -0.37 m; during more than 50 percent of the period, water stages were between 0.70 and -0.21 m.

28. A few storms occurred during the period of common record between the gages at Hanna Reef and the test site. This common record indicates that water stages are the same at both places when water is being blown into the bay, but that water stages are different when water is being blown o[illegible] tides driven by northerly winds overrun the land, and during [illegible] storms, the overrun persists for most of the storm period and appears to cause stages as much as 0.05 m higher at the test site than those at Hanna Reef.

29. The wake from oceangoing vessels causes significant wave action at the site. These waves are 0.3 m or more in height; they occur in groups; and they roll [illegible] the shore with surflike action. These groups of waves, even though [illegible] at irregular intervals, probably will have an undetermined effect on the test site.

30. Review of the data suggests that historical records for the gage at Hanna Reef represent water stages at the test site most of the time. The mean water stage at Hanna Reef, adjusted to the datum of BM 2960 + 43.9, for the 24 months from October 1973 through September 1975 is 0.317 m. An illustration of application of the historical water stage data to the elevation specifications of the proposed habitat development project is presented by Figure 5.

Deviations of Water Stages

31. Deviations in [illegible] from symmetrical tidal fluctuations are usually cau[illegible] data for 1974 (National Oceanic and Atmospheric Administration 1974) were obtained from the

Galveston office of the National Weather Service, tabulated, and reduced, and tide charts for Galveston Bay at the Hanna Reef tide gage were obtained from the Galveston District. For periods of wind greater than 23 km/hr during 197[illegible], the daily mean wind velocities and directions were selected from the N[illegible] Service data; corresponding deviations in tide stage [illegible] charts were noted. These paired events were grouped first by wind direction and second by wind velocity. The data were then sorted by the magnitude of the change in stage. The results are given in Table 13.

32. The greatest deviations from mean water stage occur [illegible] winds from the west and [illegible] than westerly wind, may either decrease the water stage when [illegible] with an ebbing tide or increase the water stage by action with the flooding tide. Northwesterly winds tend to push water out of the bay or retard water entering the bay. Winds off the Gulf of Mexico from the south, southeast, and southwest all tend to increase the mean water stage by moving water into or holding water in the bay. For the period of record in 1974, wind conditions from the southeast were most common, and velocities often exceeded 32 km/hr raising water stages by 0.3 m. Less common winds from the southwest had similar effects at more moderate velocities of 24 to 32 km/hr.

33. Different antecedent wind velocities and the coincidence of peak winds with high or low tides alter the magnitude of the recorded changes in stage. Although [illegible] conditions were not examined, the data in Table 13 [illegible] ities have unique effects on water stages. The magnitude and frequency of deviation from usual tidal stages and the time of year that the deviations should occur can be inferred by a combination of the information contained in Tables 1 and 13.

34. Winter wind conditions favor a lower mean water stage than spring and summer conditions. September to February wind conditions during the 10-year period of record (1951-60) were characterized by dominant winds (condition based on percent frequency of occurrence)

varying between those that tend to increase water stages and those that decrease water stages. Strongest average wind velocities occur in winter from the north, northeast, and northwest, conditions that favor greatest downward deviations in water stage. By comparison with winter wind conditions, spring and summer winds predominantly come from southerly directions and tend to increase the mean water stage.

Conclusions and Recommendations

35. Water quality and sediment quality parameters are favorable for the establishment and growth of salt-marsh plants and animals. Phosphorus and nitrogen species were present in low concentrations as were heavy metals. Additionally, herbicide and insecticide residues were absent, BOD was low, and dissolved oxygen saturation was high.

36. Current velocities exceeded 30 cm/sec only during one storm period and were less than 21 cm/sec during usual wind and tide conditions. Water stages for 98 percent of the period January 1963-September 1975 were 0.85 to -0.37 m, and the mean water stage for the period October 1973-September 1975 was 0.317 m.

37. The historical climate information for 1940-60 indicated mean monthly temperatures of 12.3° to 28.8°C and a mean annual temperature of 21.2°C. The mean monthly rainfall was 72.1 to 151.9 mm, and the mean annual rainfall was 1160.8 mm.

38. Wind velocities greater than 21 km/hr occurred 45 percent of the days each year and caused changes in the water stage. West and northwesterly winds caused the greatest stage change for the least wind. Winds of 24 to 32 km/hr from any direction caused stage changes of 0.15 to 0.30 m, but southeasterly winds had to be greater than 32 km/hr to cause [illegible] change.

39. The test site is an environment characterized by high wave energy. Development of a gulf coast salt marsh would be facilitated by the absence of water and sediment pollutants but would require protection from the wave actions and water stage fluctuations, as well as selection of species adaptable to this energy regime.

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Table 1

Frequency and Mean [illegible] Winds, Galveston Airport, 1951-1960*

Wind Direction	September-February				March-August			
	Mean Daily Wind Speed km/hr	Percent of Days with Wind	Percent of Days with Wind 20.9-38.6 km/hr	Percent of Days with Wind >38.6 km/hr	Mean Daily Wind Speed km/hr	Percent of Days with Wind	Percent of Days with Wind 20.9-38.6 km/hr	Percent of Days with Wind > km/hr
North	24.5	15.6	8.2	1.5	20.9	6.4	3.0	0
Northeast	22.0	15.0	7.0	0.8	19.5	6.4	2.7	0
East	20.1	15.2	6.3	0.4	19.3	9.5	4.5	0
Southeast	18.0	21.1	6.8	0.1	19.5	26.0	12.0	0
South	18.5	15.2	5.3	0.1	20.3	32.2	15.3	0
Southwest	18.3	5.6	2.0	0.2	18.2	10.7	4.5	0
West	16.7	3.9	1.1	0.1	17.1	3.6	0.8	0
Northwest	22.0	7.2	3.4	0.7	20.1	4.3	1.5	0
	Calm	1.2	--	--	Calm	0.9	--	--
Total	--	100.0	40.1	3.9	--	100.0	44.3	[illegible]
Average	20.0	--	--	--	19.4	--	--	--

* Adapted from U. S. Geological Survey open-file report.

Table 2

Water and Sediment Quality Parameters and Procedures

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
SiO_2	Water	Drawn from submerged in situ analysis or [illegible] manifold	Atomic absorption	Brown et al. (1974)
NO_3	Water (total)	"	Brucine (spectrophotometric, manual)	"
NH_3	Water (total)	"	Diazotization (spectrophotometric, manual)	"
NO_2	Water (total)	"	Distillation (spectrophotometric, manual)	"
Total P	Water (total)	"	Phosphomolybdate (spectrophotometric, manual)	"
BOD	Water (total)	"	Manometric	"
Ca	Water	"	Atomic absorption	"
Mg	Water	"	Atomic absorption	"
Na	Water	"	Atomic absorption	"
K	Water	"	Atomic absorption	"
HCO_3	Water	"	Manual calculation	"
SO_4	Water	"	Thorin (spectrophotometric, manual)	"

(Continued)

(Sheet 1 of

Table 2 (Continued)

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
Cl (Chloride)	Water	Drawn from submerged in situ analysis probe holding manifold	Mohr (Titrimetric, manual)	Brown et al. (1974)
Total dissolved solids	Water	"	Manual calculation	"
Al (aluminum)	Water	"	Ferron-orthophenanthroline (spectrophotometric, manual)	"
As	Water	"	Silver-diethyldithiocarbamate (spectrophotometric, manual)	"
	Sediment	Ponar grab	Silver-diethyldithiocarbamate (spectrophotometric, manual)	"
Cd	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"
Cr	Water	Drawn from manifold	Atomic absorption	"
Co	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"
Cu	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"

(Continued)

Table 2 (Continued)

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
CN	Sediment	Ponar grab	Pyridine-pyrazolone (spectrophotometric, manual)	Brown et al. (1974)
Fe	Water	Drawn from manifold	Atomic absorption	"
Pb	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"
Li	Water	Drawn from manifold	Atomic absorption	"
Mn	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"
Hg	Water	Drawn from manifold	Atomic absorption	USGS (1976)
	Sediment	Ponar grab	Atomic absorption	USGS (1976)
Ni	Water	Drawn from manifold	Atomic absorption	Brown et al. (1974)
Sr	Water	Drawn from manifold	Atomic absorption	"
Zn	Water	Drawn from manifold	Atomic absorption	"
	Sediment	Ponar grab	Atomic absorption	"
Aldrin	Water (total)	Drawn from manifold	Gas chromatography	Goerlitz and Brown (1972)
	Sediment	Ponar grab	Gas chromatography	"
Chlordane	Water (total)	Drawn from manifold	Gas chromatography	"
	Sediment	Ponar grab	Gas chromatography	"

(Continued)

(Sheet 3

Table 2 (Continued)

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
DDD	Water (total)	Drawn from manifold	Gas chromatography	Goerlitz and Brown (1972)
	Sediment	Ponar grab	"	"
DDE	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
DDT	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Dieldrin	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Endrin	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Heptachlor	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Heptachlor-epoxide	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Lindane	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Parathion	Water (total)	Drawn from manifold	"	"
Methyl parathion	Water (total)	Drawn from manifold	"	"

(Continued)

(Sheet 4 of

Table 2 (Continued)

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
Malathion	Water (total)	Drawn from manifold	Gas chromatography	Goerlitz and Brown (1972)
Diazinon	Water (total)	Drawn from manifold	"	"
PCB	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
2,4-D	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
2,4,5-T	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Silvex	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Toxaphene	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Ethion	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Methyl-trithion	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar grab	"	"
Trithion	Water (total)	Drawn from manifold	"	"
	Sediment	Ponar [illegible]	"	"

(Continued)

(Sheet 5

Table 12 (Concluded)

Parameter	Sample Type	Collection/In Situ Analysis	Method of Analysis	Reference
Organic Carbon	Water	Drawn from manifold	Infrared analysis	Goerlitz and Brown (1972)
	Suspended	Drawn from manifold	"	"
	Total	Drawn from manifold	"	"
RA-226	Water	Drawn from manifold	"	"
U	Water	Drawn from manifold	"	"
Gross α (U-NAT)	Water	Drawn from manifold	"	"
	Suspended	Drawn from manifold	"	"
Gross β (SR 90/Y 90)	Water	Drawn from manifold	"	"
	Suspended	Drawn from manifold	"	"
Gross β (CS-137)	Water	Drawn from manifold	"	"
	Suspended	Drawn from manifold	"	"
Filterable residue	Water (total)	Drawn from manifold	"	"
Nonfilterable residue	Water (total	Drawn from manifold	"	"

(Sheet

Table 3

Comparison of Water Quality Data Collected Near Hanna Reef With That Collected Near Bolivar Peninsula Test Site

Parameter	Hanna Reef Site 29 Data**	Bolivar Peninsula Test Site Data**	Mean Value at Surface+ For All Sampling Sites
Organic nitrogen, mg/ℓ			
Maximum	1.3	--	--
Minimum	0.4	--	
Mean ($\bar{x}$)	0.7	--	
Total nitrate, mg/ℓ			
Maximum	0.2	0.0	0
Minimum	<0.05	0.0	0
Mean ($\bar{x}$)	0.1	--	0
Ammonia nitrogen, mg/ℓ			
Maximum	1.3	0.13	
Minimum	0.0	0.00	0.01
Mean ($\bar{x}$)	0.06	--	0.02
Total nitrite, mg/ℓ			
Maximum	0.05	0.01	
Minimum	<0.005	0.00	0.005
Mean ($\bar{x}$)	0.01	--	0.003
Total phosphorus, mg/ℓ			
Maximum	0.63	0.35	
Minimum	0.06	0.06	0.18
Mean ($\bar{x}$)	0.28	--	0.19

(Continued)

Table 3 (Continued)

Parameter	Hanna Reef Site 29 Data*	Bolivar Peninsula Test Site Data**	Mean Value at Surface+ For All Sampling Sites
Dissolved organic carbon, mg/ℓ			
Maximum	--	15	
Minimum	--	5.0	6.5
Mean ($\bar{x}$)	--	--	7.5
Suspended organic carbon, mg/ℓ			
Maximum	--	1.4	
Minimum	--	0.6	0.9
Mean ($\bar{x}$)		--	1.0
Dissolved oxygen, mg/ℓ			
Maximum	11.1	10.1	
Minimum	5.4	5.6	8.6
Mean ($\bar{x}$)	8.0	--	8.2
BOD, mg/ℓ			
Maximum	4	2.7	
Minimum	0	0.5	1.4
Mean ($\bar{x}$)	2	--	1.7
Total coliform, MPN/100 ml			
Maximum	200	--	
Minimum	<2	--	
Mean ($\bar{x}$)	15	--	
Fecal coliform, MPN/100 ml			
Maximum	23	--	
Minimum	<2	--	
Mean ($\bar{x}$)	[illegible]	--	

(Continued)

(Sheet 2 of 3)

Table 3 (Concluded)

Parameter	Hanna Reef Site 29 Data*	Bolivar Peninsula Test Site Data**	Mean Value at Surface+ For All Sampling Sites
Specific conductance, μmhos			
Maximum	37,600	30,000	
Minimum	7,400	11,000	14,655.2
Mean ($\bar{x}$)	22,300	--	14,755.6
Turbidity, JTU			
Maximum	--	275	
Minimum	--	5	69.1
Mean ($\bar{x}$)	--	--	97.9
Temperature, °C			
Maximum	[illegible]	29.0	
Minimum		23.3	26.4
Mean ($\bar{x}$)	20.3	--	26.1

((Sheet 3 of 3))

Note: It should be remembered that the Hanna Reef Site 29 data were collected monthly over a period exceeding 3 years (Huston 1971), and that the Bolivar Peninsula test site data were collected by the USGS during 4 months of a single year (1975).

*Based on samples collected from a depth of 0.3 m.

**Based on samples collected from a depth of 0.3 m and other depths up to 4.9 m.

+Surface samples are those collected from a depth of 0.3 m.

Table 4

Bolivar Peninsula Test Site Data; Field Determinations*

Date of Collection	Time	Site	Depth (m)	Specific Conductance (µmhos) (Field)	Temperature (°C)	pH	Dissolved Oxygen (mg/ℓ)	Percent Saturation	Turbidity (JTU)	Transpa: Secc: Dis: (cm
					Line 610					
Apr 25, 75	1500	40	0.3	18000	24.7	8.2	8.8	111	10	--
			1.5	18000	24.6	8.2	8.7	110	5	--
			3.0	19000	23.9	8.2	8.2	102	10	--
			4.9	19000	23.9	8.1	8.1	101	10	--
Jun 24, 75	1245	40	0.3	16000	27.2	8.3	7.9	103	25	62
			1.5	16000	27.2	8.2	7.5	97	25	--
			3.0	18000	27.2	8.2	6.9	91	25	--
			4.9	18000	27.2	8.2	7.0	92	60	--
Aug 06, 75	1040	40	0.3	23000	28.8	--	7.2	100	10	81
			1.5	23000	28.0	--	5.6	77	20	--
			3.0	30000	23.2	--	6.0	86	15	--
			4.6	30000	28.0	--	5.9	84	15	--
					Line 620					
Apr 25, 75	1430	40	0.3	19000	26.7	8.4	9.3	122	15	--
			0.6	19000	26.6	8.4	9.3	122	30	--
Jun 24, 75	1400	40	0.3	17000	26.6	8.3	9.2	121	50	45
			0.6	17000	[illegible]	8.3	8.8	116	50	--

(Continued)

* Taken from U. S. Geological Survey open-file report.

(Sheet 1 o

Table 4 (Continued)

Date of Collection	Time	Site	Depth (m)	Specific Conductance (µmhos) (Field)	Temperature (°C)	pH	Dissolved Oxygen (mg/ℓ)	Percent Saturation	Turbidity (JTU)	Transparency Secchi Disk (cm)
					Line 620 Continued					
Aug 06, 75	1245	40	0.5	17000	29.0	--	8.7	119	--	--
					Line 630					
Apr 25, 75	1415	40	0.3	19000	25.3	8.4	9.5	122	10	--
			1.1	19000	25.2	8.4	9.5	120	10	--
Jun 24, 75	1345	40	0.3	16000	26.9	8.3	8.7	114	25	55
			1.2	17000	26.7	8.3	8.1	107	40	--
Aug 05, 75	1230	40	0.3	18000	28.5	--	8.0	108	15	--
			1.1	25000	28.0	--	7.0	97	20	--
					Line 640					
Apr 25, 75	1330	40	0.3	18000	24.9	8.4	9.3	118	10	--
			0.9	18000	24.7	8.4	9.3	118	10	--
			1.4	18000	24.6	8.4	9.1	115	10	--
May 14, 75	1425	40	0.3	13000	27.7	--	9.1	118	55	--
			1.2	13000	27.0	--	9.3	119	70	--
May 14, 75	1500	40	0.3	14000	27.9	--	9.1	120	40	--
			1.2	14000	26.8	--	8.8	113	85	--
May 14, 75	1600	40	0.3	13000	28.2	--	9.6	126	35	--
			1.4	15000	26.5	--	8.9	114	80	--

(Continued)

(Sheet 2

Table 4 (Continued)

Date of Collection	Time	Site	Depth (m)	Specific Conductance (μmhos) (Field)	Temperature (°C)	pH	Dissolved Oxygen (mg/ℓ)	Percent Saturation	Turbidity (JTU)	Transpa Secc Disk (cm)
				Line 640 Continued						
May 14, 75	1700	40	0.3	13000	28.3	--	10.1	133	30	--
			1.4	15000	26.6	--	7.2	94	60	--
May 14, 75	1805	40	0.3	14000	27.8	--	10.0	132	30	--
			1.4	[illegible]	26.5	--	7.4	95	50	--
May 14, 75	1900	40	0.3	[illegible]			9.8	127	30	--
			1.4	17000	26.4	--	7.2	94	60	--
May 14, 75	2000	40	0.3	14000	27.3	--	9.3	121	50	--
			1.4	15000	26.5	--	7.6	97	50	--
May 14, 75	2230	40	0.6	12000	26.8	8.2	8.[illegible]	114	--	--
			1.4	12000	26.8	8.1	8.7	112	120	--
May 14, 75	2400	40	0.6	12000	26.3	8.3	8.3	105	--	--
			1.2	12000	26.3	8.2	8.2	104	170	--
May 15, 75	0105	40	1.1	11000	25.5	8.1	8.2	101	190	--
May 15, 75	0205	40	1.1	12000	25.0	8.3	7.9	98	230	--
May 15, 75	0305	40	1.1	12000	24.7	8.2	7.9	98	180	--
May 15, 75	0410	40	1.0	12000	24.4	8.2	7.9	96	170	--
May 15, 75	0505	40	1.0	12000	24.0	7.9	7.9	96	180	--
May 15, 75	0610	40	1.1	12000	23.8	8.2	7.9	96	170	--
May 15, 75	0710	40	1.2	11000	23.4	8.2	7.8	93	180	--

(Continued)

(Sheet 3 o

Table 4 (Continued)

Date of Collection	Time	Site	Depth (m)	Specific Conductance (µmhos) (25°C)	Temperature (°C)	pH	Dissolved Oxygen (mg/ℓ)	Percent Saturation	Turbidity (JTU)	Fra. S
				Line 640 Continued						
May 15, 75	0810	40	1.1	11000	23.7	8.3	7.6	90	130	
May 15, 75	0930	40	0.3	12000	24.3	8.4	7.7	94	140	
			1.2	12000	23.9	8.0	7.9	96	240	
May 15, 75	1000	40	0.3	12000	24.5	8.4	7.6	93	130	
			1.2	12000	24.4	8.2	7.7	94	260	
May 15, 75	1100	40	0.3	12000	24.4	--	7.8	95	120	
			1.2	12000	24.5	--	7.9	96	200	
May 15, 75	1200	40	0.3	12000	24.8	--	7.9	98	105	
			1.2	12000	24.9	--	8.0	99	200	
May 15, 75	1300	40	0.3	12000	25.2	--	8.1	100	80	
			1.2	12000	25.4	--	8.2	102	100	
May 15, 75	1400	40	0.3	12000	25.4	--	8.5	106	100	
			1.2	12000	25.7	--	8.5	106	95	
May 15, 75	1500	40	0.3	12000	25.1	--	8.4	104	115	
			1.4	12000	25.1	--	8.6	106	150	
May 15, 75	1600	40	0.[illegible]	[illegible]	[illegible]	--	8.4	105	150	
			1.[illegible]	[illegible]	[illegible]	--	8.8	109	2[illegible]	
May 15, 75	1700	40	0.3	11000	25.7	--	8.0	99	210	
			1.2	11000	25.7	--	8.3	102	275	

(Continued)

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Table 4 (Concluded)

Date of Collection	Time	Site	Depth (m)	Conductance (µmhos) (Field)	Temperature (°C)	pH	Dissolved Oxygen (mg/ℓ)	Percent Saturation	Turbidity (JTU)	Transparency Secchi Depth (m)
				Line 640 Continued						
May 15, 75	1800	40	0.3	11000	25.4	--	8.2	101	190	-
			1.2	11000	25.5	--	8.3	102	270	-
May 15, 75	1900	40	0.3	11000	25.2	--	8.1	99	200	-
			1.2	11000	25.3	--	8.5	105	200	-
May 15, 75	2010	40	0.6	11000	24.9	--	8.1	99	--	-
			1.3	11000	24.8	--	8.2	100	200	-
May 15, 75	2110	40	0.6	11000	24.6	--	8.0	98	--	
			1.3	11000	24.5	--	8.1	98	240	-
May 15, 75	2210	40	0.6	11000	24.4	--	7.9	96	--	-
			1.2	12000	24.2	--	7.9	96	180	-
May 15, 75	2300	40	0.6	12000	24.0	--	7.9	96	--	-
			1.2	12000	23.8	--	7.9	96	200	-
May 15, 75	2400	40	0.6	13000	23.6	--	7.9	95	--	-
			1.1	13000	23.5	--	7.9	95	150	-
May 16, 75	0100	40	0.6	12000	23.4	--	7.8	94	--	-
			1.1	12000	23.3	--	7.9	95	130	-
Jun 24, 75	1320	40	0.3	16000	26.9	8.3	8.5	112	25	-
			1.4	19000	27.3	8.2	6.8	91	60	-
Aug 06, 75	1215	40	0.3	21000	28.4	--	7.4	101	20	-
			1.2	28000	28.4	--	6.3	89	20	-

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Table 5

Bolivar Peninsula Test Site Data; Nutrients and Other Environmental Characteristics*

Date of Collect[illegible]	[illegible]	Site	Depth (m)	Dissolved Silica (SiO_2) (mg/l)	Total Nitrate (N) (mg/l)	Ammonia Nitrogen (N) (mg/l)	Total Nitrite (N) (mg/l)	Dissolved Phosphorus Ortho (P) (mg/l)	Total Phosphorus (P) (mg/l)	Biochemical Oxygen Demand (BOD) (mg/l)	Che Ox Dr ((m
						Line 610					
Apr 25, 7[illegible]	[illegible]	40	0.3	2.2	0.0	0.00	0.00	--	0.06	2.3	-
			4.9	[illegible]			0.00	--	0.08	2.3	-
Jun 24, 7[illegible]	[illegible]	40	0.3	[illegible]	[illegible]	[illegible]	[illegible]	--	0.15	1.2	-
			4.9	2.4	0.0	0.07	0.01	--	0.19	1.0	-
Aug 06, 7[illegible]	[illegible]	40	0.3	--	0.0	0.01	0.01	--	0.27		
			4.6	4.4	0.0	0.01	0.01	--	0.27	1.4	-
						Line 620					
Apr 25, 7[illegible]	[illegible]	40	0.6	1.9	0.0	0.01	0.00	--	0.08	2.5	-
Jun 24, 75	[illegible]	40	0.5	2.5	0.0	0.01	0.01	--	0.18	1.1	-
Aug 06, 75	[illegible]	40	0.5	5.4	0.0	0.01	0.00	--	0.28	2.1	-
						Line 630					
Apr 25, 75	1515	40	1.1	2.2	0.0	0.00	0.00	--	0.07	2.1	-
Jun 24, 75	[illegible]	40	0.3	2.5	0.0	0.01	0.01	--	0.17	0.6	-
Aug 06, 75	1230	40	1.1	--	0.0	0.03	0.00	--	0.35	--	
						Line 640					
Apr 25, 75	1330	40	0.3	2.1	0.0	0.01	0.00	--	0.09	2.4	-
			1.4	2.1	0.0	0.01	0.00	--	0.10	2.3	-
Jun 24, 75	1320	40	0.3	2.6	0.0	0.01	0.01	--	0.17	0.9	-
			1.4	2.5	0.0	0.13	0.00	--	0.22	0.5	-
Aug 06, 75	1215	40	0.3	--	0.0	0.01	0.00	--	0.27	--	-
			1.2	4.6	0.0	0.01	0.00	--	0.31	2.7	-

* Taken fr[illegible] U. S. Geological Survey open-f[illegible]le report.

Table 6

[illegible] Peninsula Test Site Data: Major Constituents*

	Site	Depth (m)	Dissolved Calcium (Ca) (mg/l)	Dissolved Magnesium (Mg) (mg/l)	Dissolved Sodium (Na) (mg/l)	Dissolved Potassium (K) (mg/l)	Bicarbonate (HCO_3) (mg/l)	Dissolved Sulfate (SO_4) (mg/l)	Dissolved Chloride (Cl) (mg/l)	Dissolved Solids (Sum of Constituents) (mg/l)
					Line 610					
[illegible]	40	0.3	150.[illegible]	390.0	[illegible]	[illegible]	117	850	[illegible]	11000
		4.9	150.[illegible]	400.0	3400	140	114	870	6[illegible]	11100
[illegible]	40	0.3	140.[illegible]	350.0	3100	120	115	760	[illegible]	9930
		4.9	160.[illegible]	[illegible]20.0	3600	180	115	860	6200	11500
[illegible]	40	0.3	--	--	--	--	--	--	--	--
		4.6	290.0	750.0	6600	260	138	1500	[illegible]	20500
					Line 620					
[illegible]	40	0.4	160.[illegible]	410.0	3600	140	119	860	6[illegible]	11700
[illegible]	40	0.3	150.[illegible]	380.0	3300	140	103	930	[illegible]	10500
Aug [illegible]	40	0.5	150.0	360.0	3200	130	128	740	[illegible]	10300
					Line 630					
Apr [illegible]	40	1.1	160.0	410.0	3500	140	117	870	6200	11400
Jun [illegible]	40	0.3	140.0	350.0	3100	130	111	790	5500	10100
Aug [illegible]	40	1.1	--	--	--	--	--	--	--	--
					Line 640					
Ap[illegible]	40	0.3	150.[illegible]	[illegible]	[illegible]	140	119	[illegible]	6200	11200
		1.4	[illegible]			[illegible]	119	[illegible]	[illegible]	10900
Ma[illegible]	40	1.2	[illegible]			--	--	--	--	--
Ma[illegible]	40	0.6	--	--	--	--	--	--	--	--
	40	0.3	140.[illegible]	420.0	3100	130	111	[illegible]	[illegible]	10100
		1.4	160.[illegible]	360.0	3600	150	117	930	6100	11700
Au[illegible]	40	0.[illegible]	--	--	[illegible]	--	--	--	--	--
		1.2	250.0	740.0	[illegible]	250	135	1600	11000	19800

* [illegible] S. Geological Survey open file report.

Table 7

Bolivar Pe[illegible] Selected Ions Analyses*

Col[illegible]	Site	Depth (m)	Dissolved Aluminum (Al) (µg/l)	Dissolved Arsenic (As) (µg/l)	Total Arsenic (As) (µg/l)	Bottom Deposit Arsenic (As) (µg/g)	Dissol[illegible] Cadmium (Cd) ([illegible])	[illegible] Cadmium (Cd) ([illegible])	Bo[illegible] Ca[illegible] ([illegible]
				Line 610					
Apr [illegible]	40	0.3	10	0	--	--	0	--	
		4.9	10	0	--	2	0	--	<1
Jun [illegible]	40	0.3	20	1	--	--	0	--	
		4.9	20	1	--	--	0	--	
				Line 620					
[illegible]	40	0.6	10	1	--	1	0	--	<1
Jun 2[illegible]	40	0.3	20	1	--	--	0	--	
				Line 630					
Apr 2[illegible]	[illegible]0	1.1	10	1	--	1	0	--	<1
Jun 2[illegible]	[illegible]	0.3	[illegible]	2	--	--	0	--	
				Line 640					
Apr 2[illegible]	40	0.3	0	1	--	--	0	--	
		1.4	10	1	--	1	0	--	<1
Jun 24, [illegible]	40	0.3	6	1	--	--	0	--	
		1.4	20	1	--	--	0	--	

(Continued)

* Tab[illegible] S. Geological Survey open-file report.

(Sheet 1 o

Table 7 (Continued)

Col	[illegible]	Depth (m)	Dissolved Chromium (Cr) (µg/l)	Total Chromium (Cr) (µg/l)	Dissolved Cobalt (Co) (µg/l)	Total Cobalt (Co) (µg/l)	Bottom Deposit Cobalt (Co) (µg/g)	Di[illegible] C[illegible] ([illegible]	Total Copper (Cu) (µg/l)	P[illegible] D[illegible] C[illegible] ([illegible]
					Line 610					
Ap[illegible]	[illegible]0	0.3	0	--	0	--	--	[illegible]	--	
		4.9	0	--	0	--	<10.0	[illegible]	--	
Jun[illegible]	[illegible]0	0.3	0	--	0	--	--	[illegible]	--	
		4.9	0	--	0	--	--	[illegible]	--	
					Line 620					
Apr[illegible]	[illegible]0	0.6	0	--	0	--	<10.0	[illegible]	--	
Jun[illegible]	[illegible]0	0.3	0	--	0	--	--	[illegible]	--	
Apr[illegible]	40	1.1	0	--	0	--	<10.0	2.0	--	
Jun[illegible]	40	0.3	0	--	0	--	--	4.0	--	
					Line 640					
Apr[illegible]	40	0.3	0	--	0	--	--	[illegible]	--	
		1.4	0	--	0	--	<10.0	[illegible]	--	
Jun[illegible]	40	0.3	0	--	0	--	--	[illegible]	--	
		1.4	0	--	0	--	--	[illegible]	--	

(Continued)

(Sheet 2

Table 7 (Continued)

Site	Depth (m)	Dissolved Cyanide (CN) (mg/ℓ)	Bottom Deposit Cyanide (CN) (mg/kg)	Dissolved Iron (Fe) (mg/ℓ)	Total Iron (Fe) (mg/ℓ)	Bottom Deposit Iron (Fe) (mg/kg)	Total Lead (Pb) (mg/ℓ)
			Line 610				
40	0.3	--	--	40	--	--	--
	4.9	--	0.0	40	--	--	--
40	0.3	--	--	40	--	--	--
	4.9	--	--	40	--	--	--
			Line 6[illegible]0				
40	0.6	--	0.0	50	--	--	--
40	0.3	--	--	40	--	--	--
			Line 630				
40	1.1	--	0.0	50	--	--	--
40	0.3	--	--	40	--	--	--
			Line 640				
40	0.3			40	--	--	--
	1.4			[illegible]	--	--	--
40	0.3	--	--	40	--	--	--
	1.4	--	--	40	--	--	

(Continued)

(Sheet

Site	Depth (m)	Dissolved Lithium (Li) (µg/ℓ)	Dissolved Manganese (Mn) (µg/ℓ)	Total Manganese (Mn) (µg/ℓ)	Bottom Deposit Manganese (Mn) (µg/g)	Dissolved Mercury (Hg) (µg/ℓ)	Total Mercury [illegible]	Dissolved Nickle (Ni) (µg/ℓ)
				Line 610				
40	0.3	60	10	--	--	0.3	--	0
	4.9	50	10	--	140	0.1	--	1
40	0.3	50	10	--	--	0.0	--	0
	4.9	60	10	--	--	0.0	--	0
				Line 620				
40	0.6	50	10	--	50	0.1	--	4
40	0.3	60	10	--	--	0.0	--	0
				Line 630				
40	1.1	50	10	--	70	0.1	--	1
40	0.3	50	10	--	--	0.0	--	1
				Line 640				
40	0.3	50	10	--	--	0.2	--	0
	1.4	50	10	--	80	0.1	--	1
40	0.3	50	10	--	--	0.0	--	0
	1.4	60	10	--	--	0.0	--	1

(Sheet

Table 7 (Concluded)

	Site	Depth (m)	Dissolved Zinc (Zn) (µg/l)	Total Zinc (Zn) (µg/l)	Bottom Deposit Zinc (Zn) (µg/g)
			Line 610		
[illegible]	40	0.3	80	--	--
		4.9	[illegible]	--	20.0
[illegible]	40	0.3	110	--	--
		4.9	110	--	--
			Line 620		
A[illegible]	40	0.6	40	--	<10.0
J[illegible]	40	0.3	60	--	--
			Line 630		
A[illegible]	40	1.1	60	--	<10.0
J[illegible]	40	0.3	110	--	--
			Line 640		
A[illegible]	40	0.3	40	--	--
		1.4	40	--	<10.0
J[illegible]	40	0.3	30	--	--
		1.4	80	--	--

Sheet 5

Depth (m)	Total Aldrin (ng/l)	Bottom Deposit Aldrin (ng/kg)	Total Chlordane (ng/l)	Bottom Deposit Chlordane (ng/kg)		Bo (ng
			Line 610			
0.3	0.00	--	0.0	--		-
4.9	0.00	0.0	0.0	0.0		0
0.3	0.00	--	0.0	--		-
4.9	0.00	--	0.0	--		-
4.6	--	0.0	--	0.0	--	0
			Line 620			
0.6	0.00	--	0.0	--		-
0.3	0.00	--	0.0	--		-
0.5	--	0.0	--	0.0	--	0
			Line 630			
0.3	0.00	--	0.0	--	0.4	-
1.1	--	0.0	--	0.0	--	0
0.3	0.00	--	0.0	--	0.00	
			Line 640			
0.3	0.00	--	0.0	--	0.[illegible]	-
1.4	0.00	0.0	0.0	0.0	0.[illegible]	0
0.3	0.00	--	0.0	--	0.[illegible]	-
1.4	0.00	--	0.0	--	0.[illegible]	-
1.2	--	0.0	--	0.0	--	0

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Table 8 (Continued)

Date of Collection	Time	Site	Depth (m)	Total DDT (µg/ℓ)	Bottom Deposit DDT (µg/kg)	Total Dieldrin (µg/ℓ)	Bottom Deposit Dieldrin (µg/kg)	Total Endrin (µg/ℓ)	Bottom Deposit Endrin (µg/kg)	Total Heptachlor (µg/ℓ)	Bottom Deposit Heptachlor (µg/kg)
						Line 610					
Apr 25, 75	1500	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
			4.9	0.00	0.0	0.00	0.1	0.00	0.0	0.00	
Jun 24, 75	1245	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
			4.9	0.00	—	0.00	—	0.00	—	0.00	
Aug 06, 75	1040	40	4.6	—	0.0	—	0.0	—	0.0	—	
						Line 620					
Apr 25, 75	1430	40	0.6	0.00	—	0.00	—	0.00	—	0.00	
Jun 24, 75	1400	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
Aug 06, 75	1243	40	0.5	—	0.0	—	0.0	—	0.0	—	
						Line 630					
Apr 25, 75	1415	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
			1.1	—	0.0	—	0.0	—	0.0	—	
Jun 24, 75	1345	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
						Line 640					
Apr 25, 75	1330	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
			1.4	0.00	0.0	0.00	0.0	0.00	0.0	0.00	
Jun 24, 75	1320	40	0.3	0.00	—	0.00	—	0.00	—	0.00	
			1.4	0.00	—	0.00	—	0.00	—	0.00	
Aug 05, 75	1215	40	1.2	—	0.0	—	0.0	—	0.0	—	

(Continued)

(Sheet 2

Table 8 (Continued)

Date of Collection	Time	Site	Depth (m)	Total Heptachlor Epoxide (µg/ℓ)	Bottom Deposit Heptachlor Epoxide (µg/kg)	Total Lindane (µg/ℓ)	Bottom Deposit Lindane (µg/kg)	Total Parathion (µg/ℓ)	Total Methyl Parathion (µg/ℓ)	Total Malathion (µg/ℓ)	Tot Diaz (µg/
					Line 610						
Apr 25, 75	1500	40	0.3	0.00	--	0.00	—	0.00	0.00	0.00	0.0
			4.9	0.00	0.0	0.00	—	0.00	0.00	0.00	0.0
Jun 24, 75	1245	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
			4.9	0.00	—	0.00	—	0.00	0.00	0.00	0.0
Aug 06, 75	1040	40	4.6	—	0.0	—	0.0	—	—	—	—
					Line 620						
Apr 25, 75	1430	40	0.6	0.00	—	0.00	—	0.00	0.00	0.00	0.0
Jun 24, 75	1400	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
Aug 06, 75	1245	40	0.5	—	0.0	—	0.0	—	—	—	—
					Line 630						
Apr 25, 75	1415	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
			1.1	—	0.0	—	0.0	—	—	—	—
Jun 24, 75	1345	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
					Line 640						
Apr 25, 75	1330	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
			1.4	0.00	0.0	0.00	—	0.00	0.00	0.00	0.0
Jun 24, 75	1320	40	0.3	0.00	—	0.00	—	0.00	0.00	0.00	0.0
			1.4	0.00	—	0.00	—	0.00	0.00	0.00	0.0
Aug 06, 75	1215	40	1.2	—	0.0	—	0.0	—	—	—	—

(Continued)

(Sheet 3 of

Table 8 (Continued)

Date of Collection	Time	Site	Depth (m)	Total PCB (µg/ℓ)	Bottom Deposit PCB (µg/kg)	Total 2,4-D (µg/ℓ)	Bottom Deposit 2,4-D (µg/kg)	Total 2,4,5-T (µg/ℓ)	Bottom Deposit 2,4,5-T (µg/kg)	Total Silvex (µg/ℓ)	Bottom Deposit Silvex (µg/kg)
					Line 610						
Apr 25, 75	1500	40	0.3	0.0	—	0.00	—	0.00	—	0.00	
			4.9	0.0	—	0.00	0.0	0.00	0.0	0.00	
Jun 24, 75	1245	40	0.3	0.0	—	0.01	—	0.01	—	0.00	
			4.9	0.0	—	0.01	—	0.01	—	0.00	
Aug 06, 75	1040	40	0.3	—	—	0.02	—	0.01	—	0.00	
			4.6	—	0.0	—	—	—	—	—	
					Line 620						
Apr 25, 75	1430	40	0.6	0.0	—	0.00	—	0.00	—	0.00	
Jun 24, 75	1400	40	0.3	0.0	—	0.00	—	0.00	—	0.00	
Aug 06, 75	1245	40	0.3	—	0.0	0.02	—	0.00	—	0.00	
					Line 630						
Apr 25, 75	1415	40	0.3	0.0	—	0.00	—	0.00	—	0.00	
			1.1	—	0.0	—	0.0	—	0.0	—	
Jun 24, 75	1345	40	0.3	0.0	—	0.01	—	0.01	—	0.00	
			1.2	—	—	0.01	—	0.00	—	0.00	
					Line 640						
Apr 25, 75	1330	40	0.3	0.0	—	0.00	—	0.00	—	0.00	
			1.4	0.0	—	0.00	0.0	0.00	0.0	0.00	
Jun 24, 75	1325	40	0.3	0.0	—	0.00	—	0.01	—	0.00	
			1.4	0.0	—	0.01	—	0.01	—	0.00	
Aug 06, 75	1215	40	0.3	—	—	0.02	—	0.01	—	0.00	
			1.2	—	0.0	—	—	—	—	—	

(Continued)

(Sheet 4

Table 3 (Concluded)

Date of Collection	Time	Site	Depth (m)	Total Toxaphene (µg/ℓ)	Bottom Deposit Toxaphene (µg/kg)	Total Ethion (µg/ℓ)	Bottom Deposit Ethion (µg/kg)	Total Methyl Trithion (µg/ℓ)	Bottom Deposit Methyl Trithion (µg/kg)	Total Trithion (µg/ℓ)	Bott Depo Trit (µg/
					Line 610						
Apr 25, 75	1500	40	0.3	0.0	—	—	—	—	—	—	—
			4.9	0.0	0.0	—	—	—	—	—	—
Jun 24, 75	1245	40	0.3	0.0	—	—	—	—	—	—	—
			4.9	0.0	—	—	—	—	—	—	—
Aug 06, 75	1040	40	4.6	—	0.0	—	—	—	—	—	—
					Line 620						
Apr 25, 75	1430	40	0.6	0.0	—	—	—	—	—	—	—
Jun 24, 75	1400	40	0.3	0.0	—	—	—	—	—	—	—
Aug 06, 75	1245	40	0.5	—	0.0	—	—	—	—	—	—
					Line 630						
Apr 25, 75	1415	40	0.3	0.0	—	—	—	—	—	—	—
			1.1	—	0.0	—	—	—	—	—	—
Jun 24, 75	1345	40	0.3	0.0	—	—	—	—	—	—	—
					Line 640						
Apr 25, 75	1330	40	0.3	0.0	—	—	—	—	—	—	—
			1.4	0.0	0.0	—	—	—	—	—	—
Jun 24, 75	1320	40	0.3	0.0	—	—	—	—	—	—	—
			1.4	0.0	—	—	—	—	—	—	—
Aug 06, 75	1215	40	1.2	—	0.0	—	—	—	—	—	—

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Table 9

Bolivar Peninsula Test Site Data; Organic Carbon Analyses*

Date of Collection	Time	Site	Depth m	Dissolved Organic Carbon mg/ℓ	Suspended Organic Carbon mg/ℓ	Total Organic Carbon mg/ℓ
			Line 610			
Apr 25, 75	1500	40	0.3	5.9	1.2	7.1
			4.9	7.3	1.1	8.4
Jun 24, 75	1245	40	0.3	—	—	9.4
			4.9	—	—	6.8
Aug 6, 75	1040	40	0.3	7.0	0.6	7.6
			4.6	5.8	0.8	6.6
			Line 620			
Apr 25, 75	1430	40	0.6	5.0	1.4	6.4
Jun 24, 75	1400	40	0.3	—	—	6.2
Aug 6, 75	1245	40	0.5	7.0	0.7	7.7
			Line 630			
Apr 25, 75	1415	40	1.1	5.9	1.3	7.2
Jun 24, 75	1345	40	0.3	—	—	9.8
Aug 6, 75	1230	40	1.1	15	1.0	16
			Line 640			
Apr 25, 75	1330	40	0.3	6.4	1.3	7.7
			1.4	8.8	—	—
Jun 24, 75	1320	40	0.3	—	—	12
			1.4	—	—	11
Aug 6, 75	1215	40	0.3	6.8	0.6	7.4
			1.2	9.0	0.7	9.7

* Taken from U. S. Geological Survey open-file report.

Table 10

Bolivar Peninsula Test Site Data; Radiochemical Analyses*

Collection	Time	Site	Depth m	Dissolved RA-226, Radon Method pc/ℓ	Dissolved Uranium (U) μg/ℓ	Dissolved Gross Alpha as U-NAT μg/ℓ	Dissolved Gross Beta as SR 90/Y 90 pc/ℓ	Dissolved Gross Beta as CS-137 pc/ℓ
					Line 610			
Apr 25, 75	1500	40	4.9	0.18	1.1	<95	85	110
					Line 640			
Apr 25, 75	1330	40	1.4	0.18	1.2	<97	130	170

Collection	Time	Site	Depth m	Total Filterable Residue mg/ℓ	Suspended Gross Alpha as U-NAT μg/ℓ	Suspended Gross Beta as SR 90/Y 90 pc/ℓ	Suspended Gross Beta Nonfilterable CS-137 pc/ℓ	Total Non-filterable Residue mg/ℓ
					Line 610			
Apr 25, 75	1500	40	4.9	113,000	0.9	0.6	0.7	15
					Line 640			
Apr 25, 75	1330	40	1.4	13,000	2.0	1.6	1.8	14

* Taken from U. S. Geological Survey open-file report.

Table 11

Current Velocity and Gage Height Observations at Bolivar Peninsula Test Site, 14-16 May 1975*

Line 620, Site 40

Date	Hour	Average Velocity cm/sec	Gage Height cm
May 14	1405	12.19 SW*	58.22
	1510	17.98 SW	59.74
	1600	17.98 SW	59.74
	1710	7.92 SW	55.17
	1800	10.97 SW	56.69
	1900	13.11 SW	56.69
	2005	23.47 SW	55.71
	2100	--	--
	2200	--	--
	2300	--	--
	2400	--	--

Line 640, Site 40

Date	Hour	Average Velocity cm/sec	Gage Height cm	Date	Hour	Average Velocity cm/sec	Gage Height cm
May 14	1425	16.15 SW	56.69	May 15	0800	3.05 NE	21.64
	1500	17.98 SW	56.69		0930	25.91 NE	27.74
	1610	20.12 SW	58.22		1000	27.43 NE	30.78
	1700	15.54 SW	55.71		1100	21.95 NE	35.36
	1805	12.19 SW	56.69		1200	21.03 NE	38.40
	1900	12.19 SW	56.69		1300	20.73 SW	36.88
	2000	23.16 SW	55.71		1400	18.29 SW	38.40
	2100	--	53.64		1500	23.16 NE	42.98
	2200	27.74 SW	58.22		1600	24.69 NE	39.93
	2300	27.74 SW	38.40		1700	27.43 SW	41.45
	2400	30.78 SW	30.78		1800	22.55 SW	39.93
15	0100	29.56 SW	27.74		1900	29.87 SW	38.40
	0200	24.99 SW	21.64		2000	30.78 SW	38.40
	0300	22.25 SW	15.54		2100	38.10 SW	33.83
	0400	27.12 SW	9.45		2200	32.00 SW	30.78
	0500	25.60 SW	7.92		2300	32.92 SW	26.21
	0600	24.38 SW	7.92		2400	25.91 SW	18.59
	0700	20.42 SW	12.50	16	0100	28.35 SW	12.50

* SW--flow southwesterly; NE--flow northeasterly.

Table 12

Current Velocity and Gage Height Observations at Bolivar Peninsula Test Site, 25-26 June 1975*

Line 620, Site 40				Line 640, Site 40			
Date	Hour	Average Velocity cm/sec	Gage Height cm	Date	Hour	Average Velocity cm/sec	Gage Height cm
Jun	1315	10.06 NE*	62.79	Jun	1300	14.02 NE	62.79
25	1400	12.50 NE	64.31	25	1405	11.28 NE	64.31
	1505	7.62 NE	64.31		1500	9.14 NE	64.31
	1605	8.53 SW	61.26		1600	11.58 NE	61.26
	1710	8.23 SW	58.22		1700	13.41 NE	59.74
	1800	7.92 SW	53.64		1805	17.37 SW	52.12
	1945	9.75 SW	47.55		1920	15.85 SW	50.60
	2000	—	—		2000	19.81 SW	47.55
	2100	8.53 SW	41.45		2100	15.24 SW	41.45
	2200	7.92 SW	33.83		2210	14.02 SW	33.83
	2310	2.74 SW	29.26		2300	16.15 SW	29.26
	2400	0.00	26.21		—	—	—
26	—	—	—	26	0010	12.80 SW	24.69
	0100	—	—		0100	5.79 SW	23.16
	0200	—	—		0200	5.49 SW	21.64
	0300	—	—		0300	4.27 NE	23.16
	0400	—	—		0400	6.77 NE	24.69
	0510	11.58 NE	30.78		0500	15.85 NE	30.70
	0610	7.92 NE	35.36		0600	19.81 NE	35.36
	0705	5.49 NE	46.02		0700	19.51 NE	46.02
	0810	10.58 NE	42.98		0800	18.29 NE	42.98
	0900	10.36 NE	52.12		0905	14.02 NE	52.12
	1005	10.67 NE	49.07		1000	12.19 NE	49.07
	1100	10.67 NE	52.12		1105	9.75 NE	52.12
	1205	12.19 NE	50.60		1200	8.23 NE	50.60

* SW--flow southwesterly; NE--flow northeasterly.

Table 13

Deviations from Mean Water Stage Due to Wind
[illegible] at Hanna Reef, 1974*

Wind velocity km/hr	Deviation, m							
	North	Northeast	East	Southeast	South	Southwest	West	North
16-23	0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.15-0.30	0.15-[illegible]
24-32	0.15-0.30	0.15-0.30	—	0.15	<0.15	0.30	0.15-0.30	-
>32	—	—	—	0.15-0.30	—	—	0.30-0.45	-
Direction of stage change	down	down	either	up	up	up	either	down
Days Compared	17	17	11	45	26	2	3	1

* Adapted from U. S. Geological Survey open-file report.

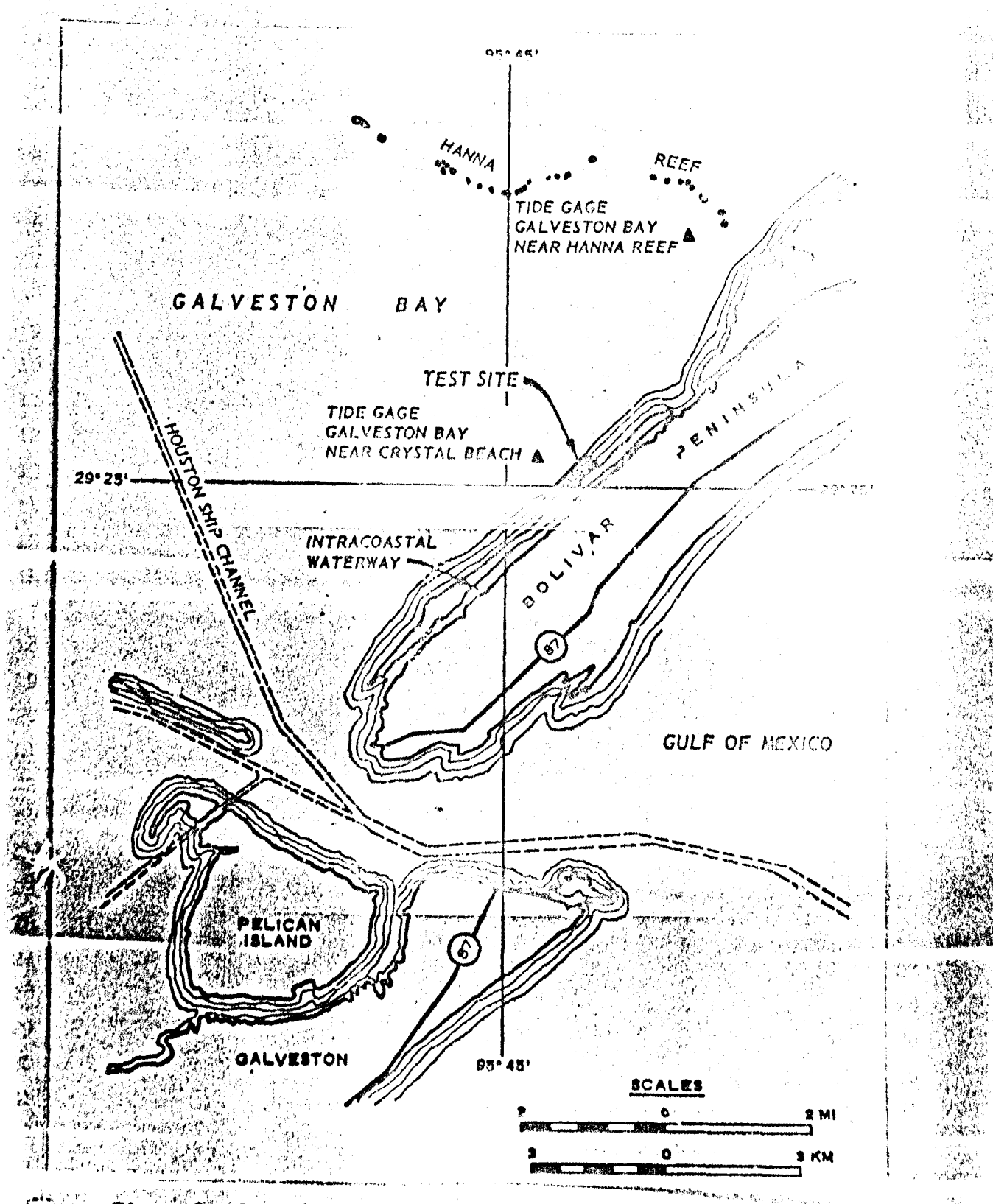


Figure 1. Location of the Bolivar Peninsula test site (taken from the U. S. Geological Survey open-file report)

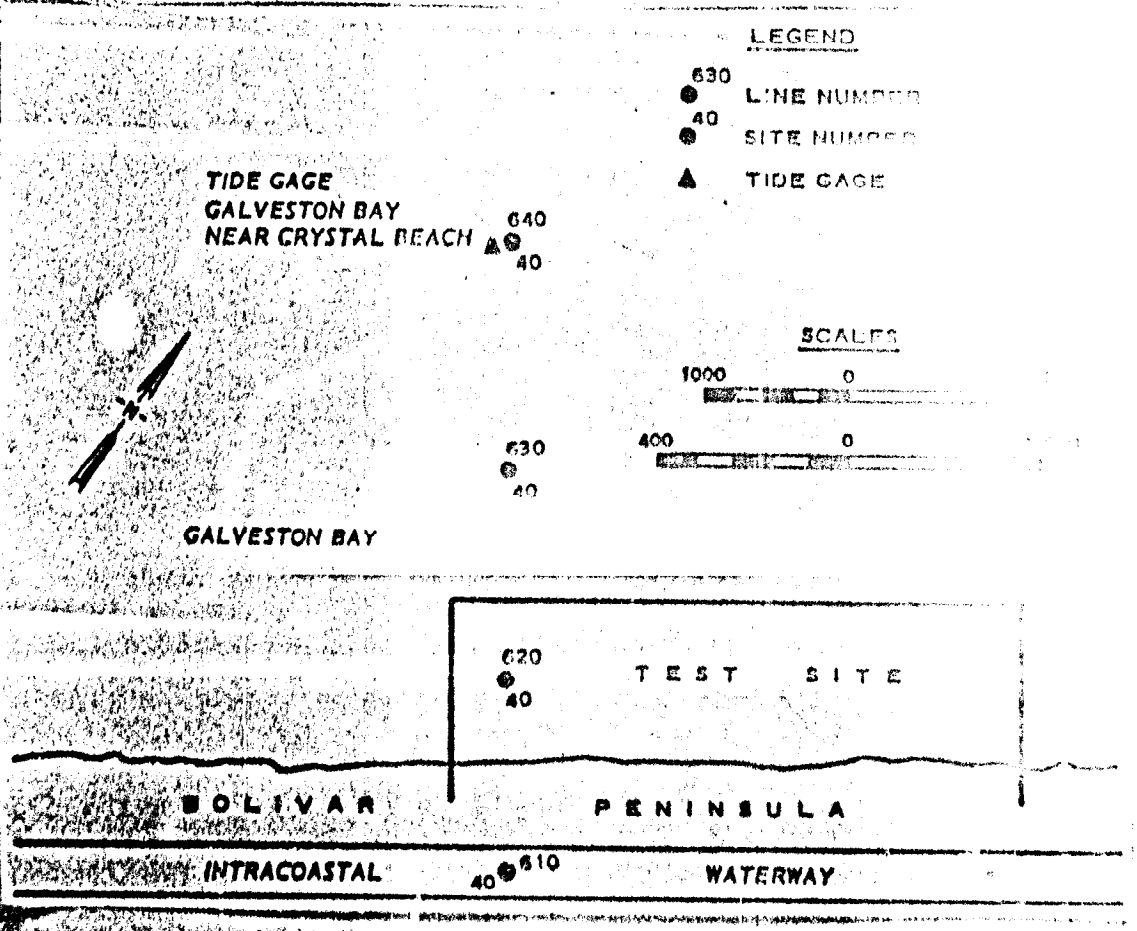
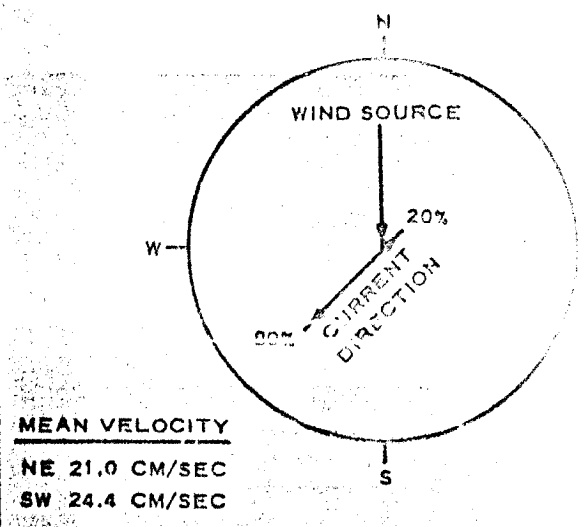
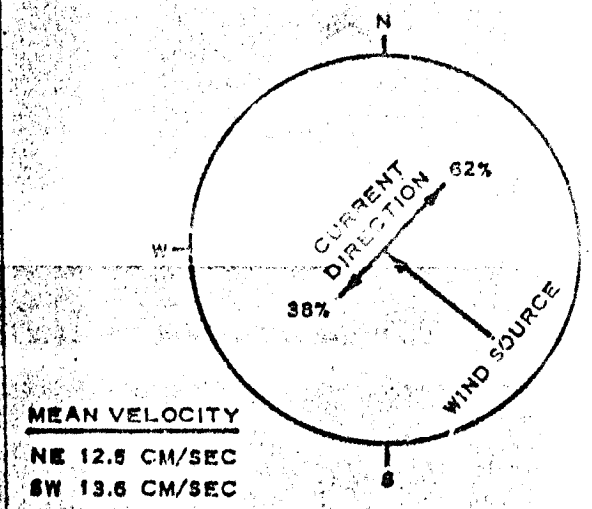


Figure 2. Sampling locations at the Bolivar Peninsula test site (taken from the U. S. Geological Survey open-file report)

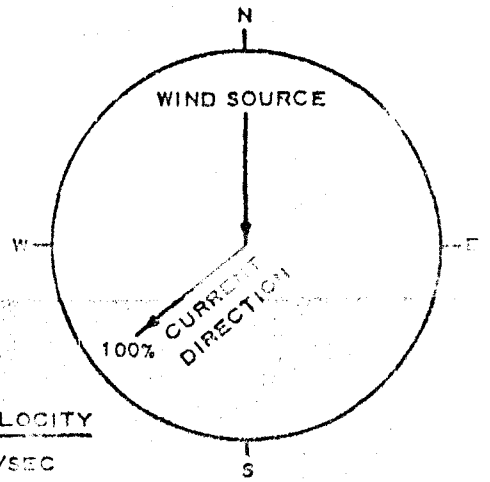


MAY 1975



JUNE 1975

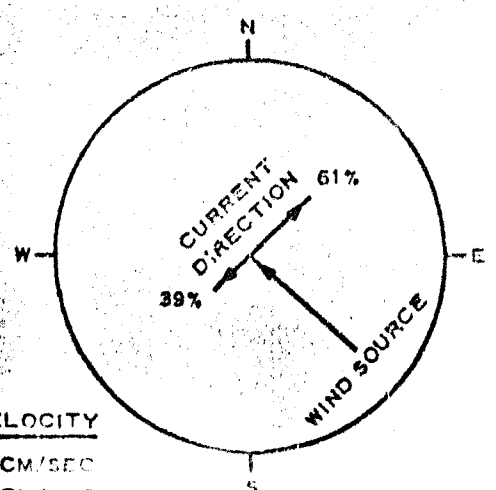
Figure 3. Comparison of water velocities and directions at line 640, site 40 (offshore)



MEAN VELOCITY

14.8 CM/SEC

MAY 1975



MEAN VELOCITY

NE 10.0 CM/SEC

SW 7.7 CM/SEC

JUNE 1975

Figure 4. Comparison of water velocities and directions at line 620, site 40 (nearshore)

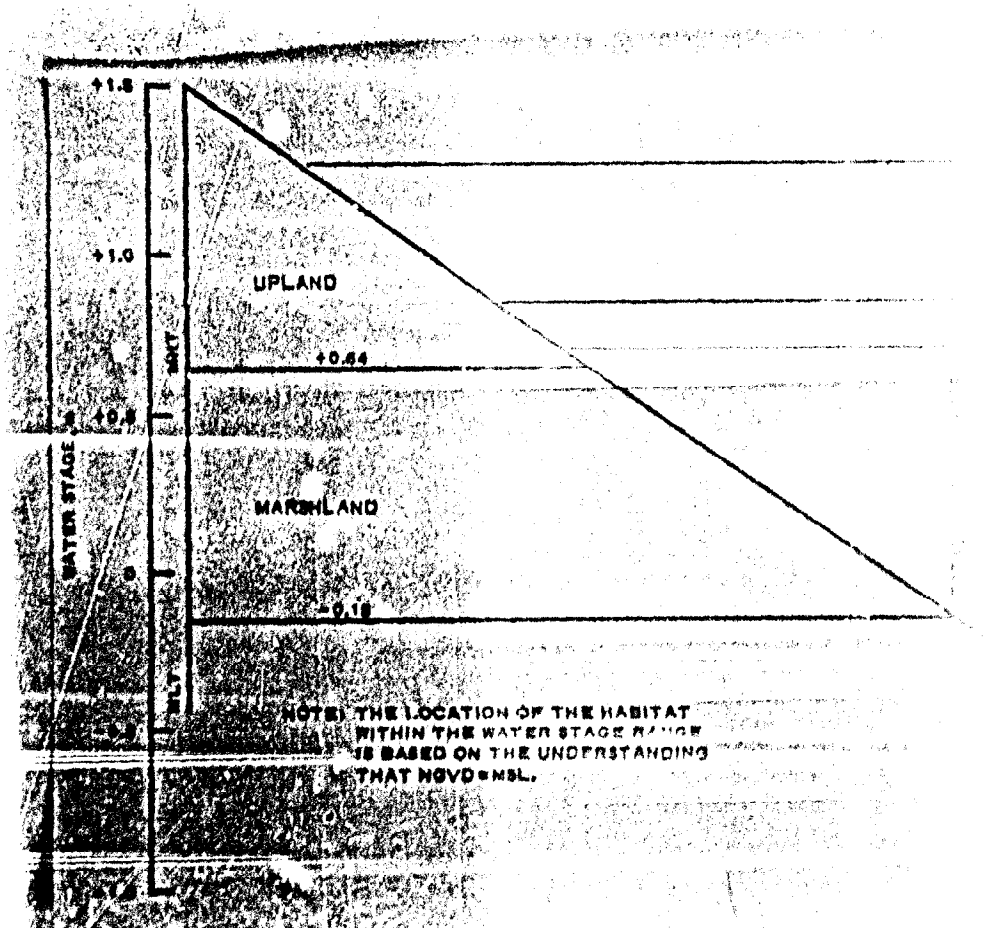


Figure [illegible] Proposed habitat location in the historical [illegible]

In accordance with letter from [illegible]
22 July 1977, Subject: Facsimile [illegible]
Laboratory Technical Publications, [illegible]
card in Library of Congress MARC [illegible]
below.

Lunz, John D
Habitat development field investigations [illegible]
marsh and upland habitat development [illegible];
Appendix A: Baseline inventory of [illegible]
ity, and hydro[illegible]
John W. Simmers, [illegible]
Station ; Springfield, Va. : available from [illegible]
Information Service, 1978.
14, [37] p. : ill. ; 27 cm. (Technical [illegible]
Engineer Waterways Experiment Station ; [illegible]
Prepared for Office, Chief of Engineers, U.S. [illegible]
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TA7.W34 no.D-78-15 Appendix A