AD-A118 762 ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS F/G 13/2
DREDGED MATERIAL RESEARCH. NOTES, NEWS, REVIEWS, ETC. VOLUME D---ETC(U)
AUG 82 H H ALLEN, J W WEBB

UNCLASSIFIED NL

1 OF 1
AD
A118762

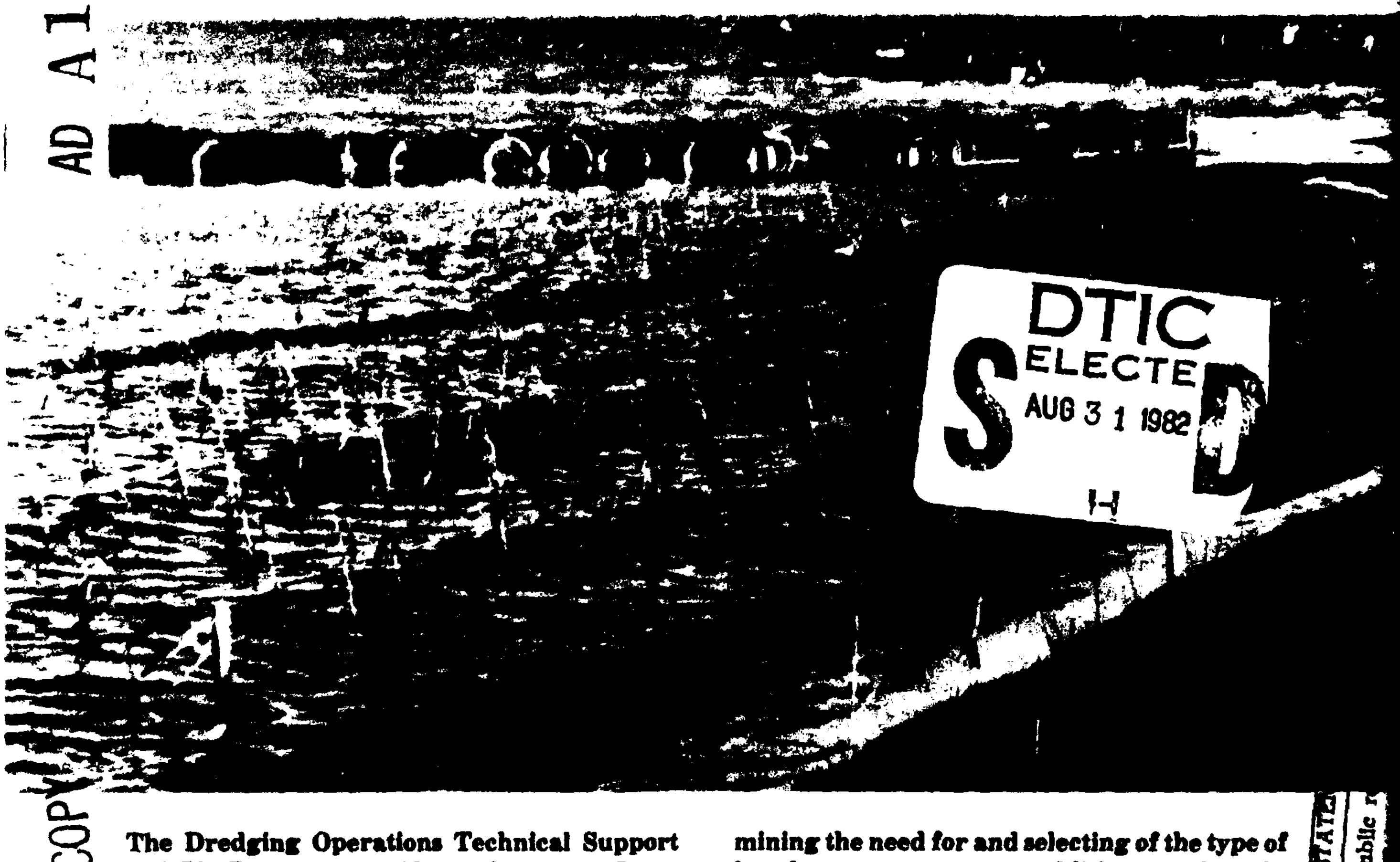
END
DATE
FILMED
9-82
DTIC

DREDGED MATERIAL RESEARCH

US Army Corps of Engineers

VOL D-82-3
Aug 1982

NOTES • NEWS • REVIEWS etc



The Dredging Operations Technical Support (DOTS) Program provides assistance to Corps elements in solving site-specific problems associated with the environmental effects of dredging and dredged material disposal. An example of DOTS activities is the technical assistance and other support given the Mobile District in determining the need for and selecting of the type of breakwater to protect establishment of a saltmarsh to provide erosion control in a wind-driven wave climate. The photo above shows a floating tire breakwater on the left and a fixed breakwater in the right background. Details of the project are given in the following article.

INFLUENCE OF BREAKWATERS ON ARTIFICIAL SALTWATER MARSH ESTABLISHMENT

*Hollis H. Allen and James W. Webb**

The U. S. Army Engineer Waterways Experiment Station (WES) conducted a study to test the feasibility of artificially establishing saltmarsh on dredged material in a high-energy wind-driven wave climate. The U. S. Army Corps of Engineers District, Mobile, sponsored the study because they planned to plant saltmarsh grass along a dike on one side of a dredged material disposal island in Mobile Bay. Technical assistance and other support were provided through DOTS. The District planned to use the marsh grass primarily for erosion control on the dike, a practice demonstrated by numerous investigators. They also hoped that the saltmarsh would serve as wildlife habitat.

The District considered whether or not marsh grass transplants could be established in the high wave-energy environment without protection. Wind fetches around the site range between 4.8 and 6.4 km, which could severely limit marsh establishment by producing waves that would wash out the transplants. According to marsh-establishment criteria discussed by Knutson et al. (1981), the wind fetch at this site plus other factors such as degree of slope and sediment size indicated a marsh-establishment success probability of about 50 percent.

The alternatives were to plant marsh grass without protection or to erect some type of wave-stilling device and plant behind it. Various types of wave-stilling devices were considered for possible use in this situation. Allen et al. (1978) discussed a sandbag dike used in Galveston Bay, Texas, to protect newly planted marsh grass from waves. Webb and Dodd (1978) evaluated two wave-stilling devices for new marsh transplant protection, also in Galveston Bay. One consisted of hay bales between wire mesh and the other consisted of tires on cables attached to posts.

The WES and the District considered two breakwaters, a floating tire breakwater (FTB) and a fixed breakwater. Costs and labor requirements for both breakwaters seemed too high. This led to the decision to conduct a small-scale demonstration study where marsh grasses were planted without protection on a portion of the planting site. Later, marsh grasses were planted behind an FTB and a fixed breakwater to evaluate their effectiveness in protecting plants from waves.

STUDY SITES

The study sites were located on the northwest side of Theodore Disposal Island, which is almost in the center of Mobile Bay, Alabama (Figure 1). Theodore Disposal Island is a three-sided island consisting of dredged material dikes on all sides with water in the center that will eventually be displaced by dredged material. The dikes are a nonhomogenous mixture of coarse- and fine-grained sand, silt, and clay; clay is the predominant type of substrate. The northwest dike was only 2-3 months old and mostly unvegetated when the study began.

Water salinities near the study sites range from a low of 7 ppt in the spring to a high of 29 ppt in the late summer with an average salinity of about 18 ppt. Tides are generally diurnal with a mean tidal range in the bay of about 45 cm and an extreme,

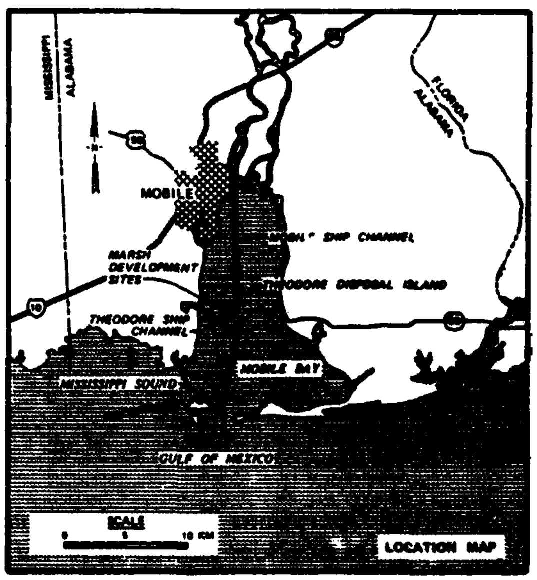


Figure 1. Location of study sites on Theodore Disposal Island

*Allen, an Ecologist, is assigned to the Wetland and Terrestrial Habitat Group of the Environmental Resources Division, Environmental Laboratory. Webb, Department of Marine Biology at Texas A&M University at Galveston, is working in the same organization under an Inter-governmental Personnel Act Agreement.

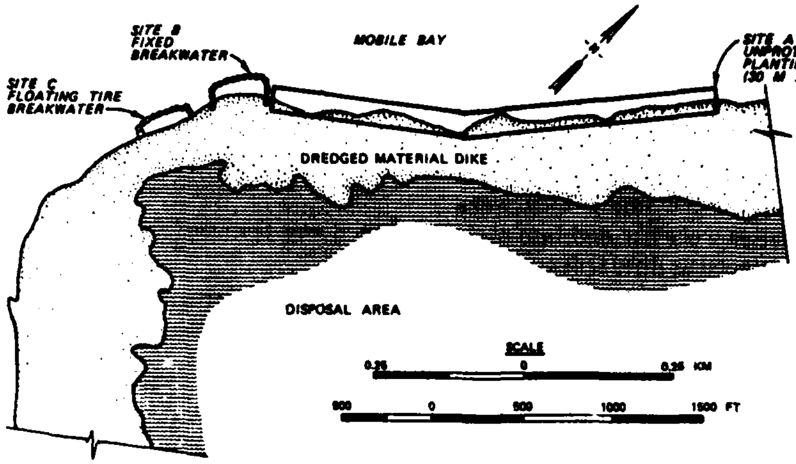


Figure 2. Location of three marsh development sites on part of northwest dike

except during storms, of about 80 cm. Waves along the shoreline of the research area are characterized as short-period wind-generated waves ranging in period from 1 to 3 seconds and generally not exceeding 1 m in height.

MATERIALS AND METHODS

Saltmarsh transplants (sprigs of *Spartina alterniflora*) were dug from a nearby location in Mobile Bay and planted at three sites on Theodore Disposal Island (Figure 2). Transplants were placed in about a 0.45-m tidal zone below +0.52 m mean low water, which was considered to be the mean high water level. They were planted over a slope distance of 20-30 m on a 1V:30H slope at two times during 1981: 4-13 May and 10-22 August.

First Planting Period

During the first planting period, marsh plants were transplanted on 1.55 ha, 1.4 ha at Site A and 0.15 ha at Site B. Both sites were unprotected (without a breakwater) at that time. Site A was planted on a larger area to be observed qualitatively while Site B was for quantitative observations consisting of periodic plant survival and density measurements.

Site A, because of its large size, was planted using a tractor pulling two mechanical transplanters (Figure 3). The tractor facilitated planting in soft sediments because of its high flotation attributes. Site B was planted by hand. The plants at Site A were placed on 0.5-m centers and were fertilized by placing 28.3 g of 18-6-12 slow-release fertilizer in each planting hole. The plants at Site B received various fertilizer and spacing treatments as described later.

Second Planting Period

The second planting period was required because nearly all of the plants in the unprotected sites washed out. Sites B and C, each 0.15 ha in size, were laid out with breakwaters to protect the plants from wave action. A fixed breakwater was located at Site B and an FTB at Site C (Figure 2).

The expedient fixed breakwater was made from wooden posts with metal planks bolted to them and rubber tires strapped to the planks. The FTB,

Figure 3. Tractor with two mechanical transplanters used in planting S. alterniflora sprigs

modified from the Goodyear design described by Gifford et al. (1977), consisted of a series of modules where 20 tires were bound together in a module. The modules floated with the tires vertical in the water, supported by polyurethane sprayed into each tire crown.*

Because Sites B and C were small, they were planted by hand. The sites were divided into plots where the plants were placed at different spacings and received different fertilizer treatments. Four 5- by 20-m plots were planted at each site in the same tidal elevation zone used for the first planting. The plots were used for four random treatments that were replicated three times: (1) 0.5-m spacing, fertilized; (2) 1.0-m spacing, fertilized; (3) 0.5-m spacing, unfertilized; and (4) 1.0-m spacing, unfertilized. Fertilizer treatments were the same as that described previously for Site A.

Sampling Scheme

Sites A and B were monitored 8-11 June, one month after the first planting, and Sites B and C were monitored 18-19 October, two months after the second planting. Both plant survival and density measurements were taken by counting all plants in each 5- by 20-m plot. If plants showed any green on their leaves or stems, they were counted as alive.

RESULTS

During the first observation period, the unprotected plants at Sites A and B were almost completely washed out. No more than 10 percent of the plants remained at Site A. The density of the remaining plants was greater in a small cove and on a large flat within Site A than on straight shoreline segments or beachheads.

Before a breakwater was installed at Site B, only 4.0 percent of the transplants survived one month after planting. Transplants placed behind breakwaters at Sites B and C in August were inspected in October and showed a marked contrast in plant survival and density between breakwater types and with no breakwater (Table 1). A significant statistical difference was found where Site C with the FTB had more than twice the plant survival (55.7%) as Site B with the fixed breakwater (24.3%). Similarly, Site C had nearly four times as many plants (459.2 plants/100m²) as Site B (119.3 plants/100m²).

Table 1

INFLUENCE OF STUDY VARIABLES ON SURVIVAL AND DENSITY OF TRANSPLANTED *S. ALTERNIFLORA*

Variable	*Percent Survival*	*Density of Plants (No./100 m²)*
Type of wave protection*		
FTB	55.7_A	459.2_A
Fixed breakwater	24.3_B	119.3_B
No breakwater	4.0_C	—
Fertilizer treatment**		
Fertilized	26.1	247.1
No fertilizer	29.9	331.4
Spacing of transplants†		
1.0 m	34.3	188.3_A
0.5 m	21.8	390.3_B

*Percent survival behind each type of protection was significantly different at $P<0.0001$ level of significance as determined by analysis of variance F-test. Density of transplants behind each type of protection was significantly different at $P<0.0036$ level of significance as determined by analysis of variance F-test. Different letter subscripts indicate significant differences as tested by Duncan's Multiple Range Test at $P<0.05$

**Differences between means were not statistically significant.

†Difference in density due to spacing was significant at $P<0.10$ as indicated by different letter subscripts.

The effects of fertilizer treatments were not significantly different when analyzed for Sites B and C. Average percent survival and density values are given in Table 1.

Not surprisingly, the effects of spacing plants on 0.5- and 1.0-m centers were significantly different for plant densities when analyzed for Sites B and C (Table 1). Percent survival for th 0.5-m spacing, somewhat lower than for the 1-m spacing, was an apparent anomaly.

DISCUSSIONS AND CONCLUSIONS

Plant Stability With and Without Breakwater Protection

The decision to plant marsh grass without wave protection was based on the 50-percent success probability mentioned earlier. Rather than plant a tremendously large area and risk failure, only a small demonstrational area (Sites A and B) was planted without protection from a breakwater.

*Donald Davidson of the WES Hydraulics Laboratory provided technical advice on the design and construction of the FTB.

Plants remained in place only in two areas on Site A: a small cove and a large extended flat. In the cove, plants were protected by the wave-damping effect of the shoreline configuration. On the large flat, there was a more gentle slope with a higher percentage of plants being in a shallower zone than on other parts of Site A. The wave energy on this flat was less because of the energy dissipation on the long shallow slope. This demonstration indicated that specific areas along the shoreline needed protection.

After two breakwaters were installed and the sites were planted behind them, there was a dramatic difference in plant stability than before a breakwater was used. Both breakwater areas had considerably more plants present than those with no protection. The FTB was more effective for attenuating waves and protecting plants than the fixed breakwater (Figures 4 and 5). The FTB damped waves regardless of tidal conditions, whereas waves went under the planks of the fixed breakwater when tides were low. Also, waves tended to rebuild after they hit the fixed breakwater. After two months, the fixed breakwater began deteriorating. The metal parts such as guy wires and planks were badly corroded. Tires were missing because the rubberized nylon straps holding them rubbed on the metal planks and separated.

The FTB cost $126 per linear metre, slightly less than twice that of the expedient fixed breakwater,

Figure 4. View of FTB attenuating waves

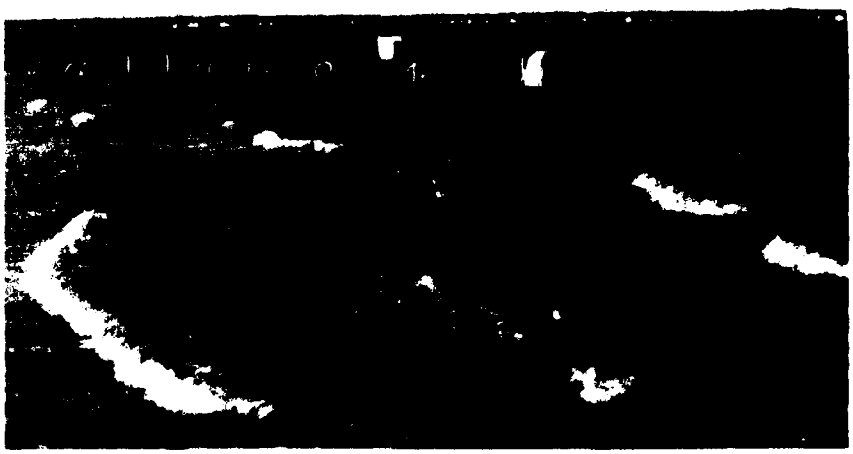


Figure 5. View of fixed breakwater and accompanying wave action

which cost $67 per linear metre.* Yet, the FTB resulted in over twice the plant survival and nearly four times the plant density of the fixed breakwater. The price of the FTB may seem high, but the FTB coupled with marsh grass is estimated to be 2-3 times cheaper than structural means of controlling erosion on this island, such as riprap. Another advantage the FTB has over structural means of protection is that it can be disassembled into sections and floated off for building marsh elsewhere. NOTE: An FTB should be positioned where it will always float regardless of tides. If the tires have no holes punched in the bottom and the FTB touches bottom, they will fill with sediment, eventually causing the whole breakwater to be covered with sediment.

We concluded that an FTB may be of considerable aid to persons attempting to establish saltmarsh grasses in high wave-energy areas for erosion control or habitat development purposes.

Fertilizer Treatments

Plants in fertilized and unfertilized plots showed no statistical differences in plant survival and density. This is consistent with reports from other investigators (Garbisch et al. 1975 and Webb et al. 1978), who found no significant differences in plant performance values between fertilized and unfertilized *S. alterniflora* at exposed sites. Garbisch et al. (1975) attributed this lack of difference to a coarse-textured substrate and extensive wave stress. On less exposed sites with finer textured substrates, they noted an 860 percent increase in net aerial productivity relative to unfertilized transplants after just 10 days. This leads one to suspect that for high-wave-energy sites like the ones reported here, fertilizer is moved around by wave action or is leached through the substrate.

Spacing Treatments

The two spacing treatments, 0.5 and 1.0 m, were significantly different in terms of plant density, but the 0.5-m spacing produced lower densities than expected. If all plants had remained, one would expect at least 4 times as many 0.5-m-spaced plants as 1.0-m plants. However, 0.5-m-spaced plants were only 52 percent more predominant than 1.0-m-spaced plants. This may suggest that for about a fourth the time and cost, one could plant 1.0-m-spaced plants and realize half the number of plants as 0.5-m-spaced plants. This, in turn, may indicate that 1.0-m-spacing may be an optimum plant spacing for the cost involved.

*Costs were somewhat deflated for both breakwaters. For the fixed breakwater, the metal planks were obtained free from Government surplus. There was no charge for a tug and barge used to transport tires to the site.

LONG-TERM STUDIES

Under DOTS long-term monitoring efforts, data are being collected to provide a basis for establishing the requirements for breakwaters needed to protect planted areas. Guidance will be provided on the effectiveness of various types of breakwaters and also on the need for temporary or permanent facilities. Theodore Disposal Island has been selected as one of the long-term monitoring sites.

LITERATURE CITED

Allen, H. H., E. J. Clairain, Jr., R. J. Diaz, A. W. Ford, L. J. Hunt, B. R. Wells. 1978. "Habitat Development Field Investigations, Bolivar Peninsula, Marsh and Upland Habitat Development Site, Galveston Bay, Texas, Summary Report," Technical Report D-78-15, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

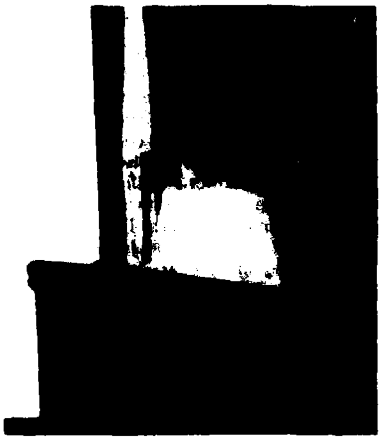
Garbisch, E. W., Jr., P. B. Woller, and R. J. McCallum. 1975. "Saltmarsh Establishment and Development," TM-52, U. S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va.

Gifford, C. A., J. A. Fisher, and T. L. Walton, Jr. 1977. "Floating Tire Breakwaters," SUSF-SF-77-002, Florida Sea Grant Program, University of Florida, Gainesville, Fla.

Knutson, P. L., Ford, J. C., Inskeep, M. C., and Oyler, J. 1981. "National Survey of Planted Salt Marshes (Vegetation Stabilization and Wave Stress)," *The Journal of the Society of Wetland Scientists*, 1:129-156.

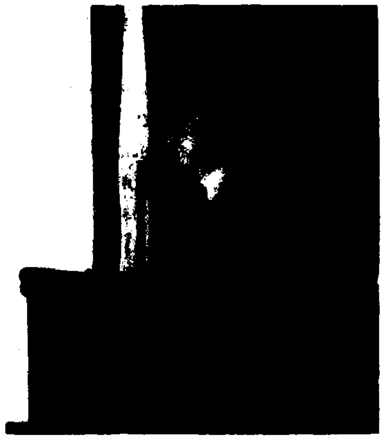
Webb, J. W., and J. D. Dodd. 1978. "Shoreline Plant Establishment and Use of a Wave-Stilling Device," M.R. 78-1, U. S. Army, Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, Va.

Webb, J. W., J. D. Dodd, B. W. Cain, W. R. Leavens, L. R. Hossman, C. Lindau, R. R. Stickney, and H. Williamson. 1978. "Habitat Development Field Investigations, Bolivar Peninsula Marsh and Upland Habitat Development Site, Appendix D: Propagation of Vascular Plants and Post-Propagation Monitoring of Botanical, Soil, Aquatic Biota, and Wildlife Resources," Technical Report D-78-15, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.



Ms. Leslie Carothers
EPA Deputy Regional Administrator

Mr. Donald J. Ehreth
Acting Director, EPA Office of Environmental Processes and Effects Research



Dr. Tudor Davies
Director, EPA Environmental Research Laboratory

COL C. E. Edgar III
Commander, U. S. Army Engineer Division, New England

Mr. Jesse A. Pfeiffer
Office, Chief of Engineers, Directorate of Research and Development

COL Tilford C. Creel
Commander and Director U. S. Army Engineer Waterways Experiment Station

INTERAGENCY MEETING — Plans for the Corps/EPA Field Verification Program (FVP) Studies proposed for Black Rock Harbor, Bridgeport, Connecticut, were recently presented at the EPA Environmental Research Laboratory (ERLN), Narragansett, RI. The photos show Corps/EPA officials who participated in the meeting. A description of the FVP was given in the last edition of this bulletin.

The meeting was hosted by Dr. Davies. COL Edgar welcomed the attendees on behalf of the Corps and outlined benefits of the program to the entire Nation as well as to the New England Division. Ms. Carothers expressed the support of EPA Region I for the work. Mr. Pfeiffer reviewed events leading to the initiation of the FVP, while Mr. Ehreth reviewed EPA's role in the research. COL Creel and Dr. Davies introduced their respective staff members, who in turn provided detailed technical briefings on various aspects of the study at Black Rock. Similar briefings will be held periodically in order to maintain lines of communications with all interested groups, agencies, and individuals.

NEW PUBLICATIONS

The Hydraulics Laboratory of the WES has compiled and published the first installment of "Dredging—An Annotated Bibliography on Dredging Operations, Equipment, and Processes." The bibliography is in loose-leaf format and will be supplemented by periodic installments. Installment 1 contains 646 annotated references; subsequent installments will be of comparable size. A limited number of copies of Installment 1, complete with loose-leaf binders, are available from the address given below:

Commander and Director
U.S. Army Engineer Waterways Experiment Station
ATTN: Hydraulics Laboratory (Richardson)
P. O. Box 631, Vicksburg, Mississippi 39180

* * * * *

The proceedings of the 6th U.S./Japan Experts Meeting on Management of Bottom Sediments Containing Toxic Substances have been published. Papers presented at the meeting were listed in Vol D-81-1, the June 1981 edition of this bulletin. Copies of the proceedings are available from the following address:

Commander and Director
U.S. Army Engineer Waterways Experiment Station
ATTN: WESEV
P. O. Box 631, Vicksburg, Mississippi 39180

This bulletin is published in accordance with AR 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It was published during the conduct of the Corps of Engineers' nationwide Dredged Material Research Program (DMRP) to disseminate program results rapidly and widely to Corps District and Division offices, as well as other Federal agencies, state agencies, universities, research institutes, and individuals. The DMRP was completed in March 1978, but the bulletin will be published under the Corps' Dredging Operations Technical Support (DOTS) program as part of the program mission to continue information dissemination and to assist in implementation of DMRP results. The bulletin will be issued on an irregular basis as dictated by the quantity and importance of information available for publication. Contributions of news, notes, reviews, or any other type of information are solicited from all sources and will be considered for publication as long as they are relevant to the DOTS theme of providing definitive information on the environmental impact of dredging and dredged material disposal operations and the development of technically satisfactory, environmentally compatible, and economically feasible dredging alternatives, including consideration of dredged material as a manageable resource. Special emphasis is placed on material relating to application of research results or technology to specific project needs. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: Mr. C. C. Calhoun, Jr., U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180, or call AC 601/634-3428 (FTS 542-3428).

TILFORD C. CREEL
Colonel, Corps of Engineers
Commander and Director

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION
CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG, MISSISSIPPI 39180
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300
WESAR

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD-314
FIRST CLASS

ME

8