Reducing Costs and Improving the Industry: Goals of the Dredging Research Program of the United States

Ivan L. Sheall

Navy Research and Development Liaison Officer
Commander and Director
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180-6199, USA

ABSTRACT

The following is an overview of the U.S. Army Corps of Engineers Dredging Research Program conducted at the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. The article consists of background information, the managerial structure and the specific work units of the Dredging Research Program.

ADDITIONAL INDEX WORDS: Disposal sites, dredged material placement, dredge plant equipment, dredging operations, dredging technology transfer, navigational dredging.

INTRODUCTION

The ebb and flow of time brings a variety of changes to the coastal arena where the battles for keeping open the paths for commercial traffic are fought. Rivers flow deep and swift, carrying more than just water on their unrelenting journey toward the sea. Particles of sediment carried down from the mountains of their birth or carved from the sides of their banks are deposited in the widening channels during their march to the sea. Through wide, slow moving estuaries, the remaining material flows to the sea to be deposited at the mouths of great rivers, forming fertile deltas, or carried past the coast to join other material already being carried by the subsurface rivers of the world’s oceans. These submarine rivers deposit their material in the bottom of ocean channels and along the coast, blocking the mouths of harbors. The rivers, estuaries, ocean channels, and harbors form a vital system for the transportation of commerce. In order for this vital system to retain its future usefulness, the results of this passage of time must be fought (Figure 1). Dredging the parts of this system to a specific depth and maintaining that depth in order for commercial traffic to use the system is essential.

The U.S. Army Corps of Engineers annually spends upwards of $400 million dredging the waterways of the United States in order to keep them open for commercial traffic. An additional $200 million per year for the next decade is programmed for new dredging operations as existing ports and channels are improved to meet the goals of the Water Resources Development Act of 1986.

This massive effort is necessary since private industry daily uses the more than 25,000 miles of navigable rivers and channels to transport commercial products within the U.S. and to other countries. Waterborne transport is the most cost- and energy-efficient means of shipping bulk cargoes of raw materials, agricultural products and finished products. The commercial traffic through our harbors and ports annually amount to two billion tons and has an impact on roughly 20 percent of all jobs in the United States.

Since early in the nineteenth century the nation has depended directly on the Corps of Engineers to meet its dredging requirements. Today private industry, through Corps-managed contracts, is the major role player in keeping the waterways open and the commercial traffic flowing.
traffic flowing smoothly through the watery byways of the nation.

**DREDGING RESEARCH PROGRAM**

In order to keep abreast of the latest worldwide developments and to seek improvements in the dredging process, both economically and technically, the Dredging Research Program (DRP) was initiated by the Corps of Engineers in 1988 for a period of seven years. The DRP’s primary mission is to reduce the cost of dredging operations through more effective management and technical methods without increasing the potential risk to the environment or lessening the quality of Corps’ projects. The DRP is managed by the Coastal Engineering Research Center at the Waterways Experiment Station in Vicksburg, Mississippi. Review and guidance is provided by several Technical Monitors from the Headquarters of the Corps of Engineers and a Field Review Group consisting of technical experts from throughout the field offices of the Corps of Engineers. The group meets semi-annually to review progress of the program and to provide guidance on the future direction of the program.

The DRP coordinates research on various aspects of dredging operations. To more effectively manage this effort, the research program was separated into five technical problem areas (Figure 2). These five technical problem areas are: Analysis of Dredged Material Placed in Open Water; Material Properties Related to Navigation and Dredging; Dredge Plant Equipment and System Processes; Vessel Positioning, Surveying Controls and Dredge Monitoring Systems; and Management of Dredging Operations. The results from these technical problem areas are distributed to Corps of Engineers’
field offices and industry through a proactive and innovative technology transfer program.

ANALYSIS OF DREDGED MATERIAL PLACED IN OPEN WATER

The Analysis of Dredged Material Placed in Open Water technical problem area studies the behavior of dredged material in open water as it interacts with the hydrodynamic forces present both during and after placement. Modeling these forces and their effect on placed material assists in determining the ultimate resting site of the dredged material. These models are a vital factor in avoiding potential environmental impacts and improving the probability of material remaining at the site where it was originally placed, thus reducing the quantity and expense of required maintenance dredging. This research includes developing better methods for calculating boundary layer properties at submerged disposal areas and developing long- and short-term prediction models for the fate of disposed dredged materials. In addition, field data gathered to be used as input for the prediction models and calculating methods developed from this research are leading to improved site monitoring techniques (Figure 3). The specific research topics being investigated in this technical problem area are:

- Calculation of Boundary Layer Properties (Non-cohesive and Cohesive Sediments)
- Measurement of Entrainment and Transport (Non-cohesive and cohesive Sediments)
- Numerical Simulation Techniques for Evaluating Short-Term Fate and Stability of Dredged Material Disposed in Open Water
- Numerical Simulation Techniques for Evaluating Long-Term Fate and Stability of Dredged Material Disposed in Open Water
Field Techniques and Data Analysis to Assess Open Water Disposal

MATERIAL PROPERTIES RELATED TO NAVIGATION AND DREDGING

The Material Properties Related to Navigation and Dredging technical problem area conducts research in improving the understanding of the physical properties of materials that are involved in the dredging process. By using the results of the research from this technical problem area, field personnel can determine whether a channel actually needs dredging or whether the physical conditions present are showing a false bottom and dredging is not really required. Field personnel will also be able to make more informed decisions in selecting the correct type of dredge for the material to be dredged. This research includes developing instrumentation and their accompanying operating procedures for rapidly and inexpensively surveying fluid mud properties, defining the practical navigable depth of channels in fine grain sediments, improving the instrumentation used in analyzing the properties of consolidated sediments, and establishing dredging soil and rock descriptions (Figure 4). The specific research topics being investigated in this technical problem area include:

- Measurements and Definition of Navigable Depth in Fluff and Fluid Mud
- Rapid Measurement of Properties of Consolidated Sediments
- Descriptors for Bottom Sediments to be Dredged
- Descriptors for Rock Material to be Dredged
DREDGE PLANT EQUIPMENT AND SYSTEM PROCESSES

The Dredge Plant Equipment and System Processes technical problem area conducts research in improving the equipment and processes used in dredging. Improvements in dredging equipment efficiency in such equipment as dragheads in various types of dredged material are being investigated. Improved sand bypass systems are being studied to decrease the downtime as a result of ingestion of debris. Cost reduction in nearshore or beach placement is being studied by looking at direct pumpout onto the beach and nearshore placement of material which uses the natural forces present to place material on the beach. This research includes developing improvements to such equipment as sand bypass eductors, increasing the dredge payload for fine-grain sediments, and improving the equipment used in the near or onshore placement of material (Figure 5).

The specific research topics being investigated in this technical problem area include:

- Improved Draghead Design
- Improved Eductors for Sand Bypassing
- Increased Dredge Payload for Fine Grain Sediments
- Dredging Equipment for Nearshore/Onshore Placement

VESSEL POSITIONING, SURVEY CONTROL AND DREDGE MONITORING SYSTEMS

The Vessel Positioning, Survey Control and Dredge Monitoring Systems technical problem area conducts research in developing efficient systems to precisely locate dredges and to monitor dredging performance. Reduction in money spent needlessly because dredging vessels were out of position and dredging in the wrong location or cutting deeper than necessary is the goal...
of much of the research in this problem area. Other work being done in this area is improving the measurement of the amount of material actually being dredged to ensure that the government is receiving its money's worth. This research includes developing a real time system for estimating project site water level variations caused by tides in offshore open water, a three-dimensional positioning system for dredging and hydrographic surveying operations using the Global Positioning System, and an unmanned system for monitoring and reporting the performance of dredges (Figure 6). Production meter performance in various situations is also being evaluated. The specific research topics being investigated in this technical problem area include:

- Integrated Vertical Control and Seastate System
- Horizontal/Vertical Positioning System
- Utilizing the GPS Satellite Constellation
- Production Meter Technology
- Silent Inspector

**MANAGEMENT OF DREDGING OPERATIONS**

The Management of Dredging Operations technical problem area is dedicated to the
improvement of the management practices used by the Corps of Engineers in carrying out its dredging responsibilities. This technical problem area is developing methods for providing better information to field personnel in order to make more timely, efficient, and economical decisions throughout the duration of a dredging project. This research includes developing a model of dredging project activities to be used in evaluating the effects of decisions and project changes, developing guidance for optimizing the use of open water sites, and improving dredging cost estimating techniques. This technical problem area is also responsible for incorporating state-of-the-art technology into existing dredging manuals. The specific research topics being investigated in this technical problem area include:

- Open Water Placement Site Planning, Design and Management
- Dredging Manuals
- Analysis of Dredging Cost Estimating Techniques

**DREDGING TECHNOLOGY TRANSFER**

The effective use of technology transfer ensures that the transmittal of research results to the ultimate users is timely. A prime component of the dredging program, technology transfer will be practiced throughout the life of the DRP. The magnitude of this effort and the diversity of the activities involved in the DRP will only increase the need for technology transfer during the latter half of the program, with the emphasis being placed on distributing user-ready end products. The technology trans-
The Dredging Research Program is aggressively pursuing its objective of maximum technology dissemination of the information developed from the research of the DRP through several different media. These different media include a newsletter, technical notes, reports, manuals, computer programs, videos, workshops, training courses, meetings, and other appropriate methods.

**DRP REDUCES COSTS**

The Dredging Research Program is a far-reaching and aggressive program that is utilizing the experience and expertise gained from the Corps’ long involvement in dredging to make improvements in dredging technology and management practices. In view of its primary goal of reducing costs, the DRP is bringing the latest equipment and innovative management systems to the nation’s dredging effort with the view of improving technical and economical efficiencies.

The effort to keep the nation’s waterways open and free for commercial traffic is a struggle against the effects of the droughts of summer and the floods of spring, an ongoing struggle that is vital to keeping the nation’s economy healthy and growing. This never-ending effort to keep one of the nation’s more important resources viable is being facilitated through the research and efforts of the DRP.

For more information on the DRP, please contact Mr. Clark McNair, Program Manager or Ms. Carolyn Holmes, Assistant Program Manager at the DRP Program Manager Office:

Coastal Engineering Research Center
Waterways Experiment Station
ATTN: CEWES-CP-D
3909 Halls Ferry Road
Vicksburg, MS 39180-6199, USA

**ACKNOWLEDGEMENTS**

Information presented was obtained from research conducted under the Dredging Research Program of the United States Corps of Engineers. Permission was granted by the Chief of Engineers to publish this information.

ZUSAMMENFASSUNG


RESUME

Ce papier passe en revue le programme de recherche sur les dragages de l’US Army Corps of Engineer Waterway à la station expérimentale de Vicksburg, MS. L’article comporte une information générale, la structure de la direction et les unités spécifiques de travaux du programme de recherche sur les dragages.—Catherine Bousquet-Bressolier, Géomorphologie EPHE, Montrouge, France.