WORK PLAN

FOR

WORK ASSIGNMENT NO. 0-270

CENTERDALE MANOR SITE

September 17, 2002

0270-DWP-091702

WORK PLAN
CENTERDALE MANOR SITE

Prepared for
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (U.S. EPA)/
ENVIRONMENTAL RESPONSE TEAM CENTER (ERTC)

Date:	September 17, 2002
Contract No:	68-C99-223
Assignment No.:	0-270

Approval:

REAC Task Leader	(signature) (FOR GROSSMAN)	**Date:** 17/SEPT/2002
REAC Group Leader (Cost Model Review)	(signature) (Acting)	**Date:** 17 Sept. 02
REAC Program Manager	(signature)	**Date:** 9/18/02

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0270-DWP-091702

Work Assignment Number:	**0-270**
Work Assignment Title:	**Centerdale Manor Site**
Work Assignment Manager:	**Mark Sprenger**
Lockheed Martin REAC Task Leader:	**Scott Grossman**
Duration:	**August 16, 2001 to May 31, 2004**
Contract Number	**68-C99-223**
Site ID:	**016P**

INTRODUCTION

Purpose. Under this Work Assignment (WA) REAC personnel will provide on-site geophysical support to the United States Environmental Protection Agency / Environmental Response Team Center (U.S. EPA/ERTC) and U.S. EPA Region I at the Centerdale Manor Site. Geophysical data will be collected over water to map sediment thickness in two river impoundments. A sediment-core sampling plan will be written and implemented for dioxin/furan analysis.

Background. The Centerdale Manor site is located in North Providence, Rhode Island. The area being investigated under this WA will consist of the Allendale and the Lymansville Impoundments on the Woonasquatucket River. The impoundments are downstream and south of the Centerdale Manor Apartments (Figure 1).

Prior to 1936, the properties were occupied by Centerdale Worsted Mills, a woolens mill. Atlantic Chemical Company began operating on the properties around 1943. Atlantic Chemical Company changed its name in 1953 to Metro-Atlantic, Inc. and continued to operate until the early 1970s. New England Container Company, Inc. operated an incinerator-based drum reconditioning facility on a portion of the site from 1952 until 1971. A major fire in 1972 destroyed most of the structures at the site. Subsequently, apartment buildings were constructed on the site; the apartment buildings opened in 1977.

In November 1981, a Notice of Violation and Order was issued by the Rhode Island Department of Environmental Management (RIDEM) to the property owners for violations of the State Hazardous Waste Management Act. This order required that the property owners immediately identify all hazardous material on-site and dispose of all hazardous wastes off-site. The response of the property owners to the order is unknown. In February 1982, according to RIDEM records, approximately 400 drums were excavated from the site. Chemical residue was analyzed from approximately 30 drums. The empty drums were crushed and sent to a solid waste facility and at least eight drums containing hazardous material were manifested as hazardous waste. RIDEM required that soil samples be collected in the area of the building footprint prior to the construction of the Centerdale Manor Apartments. As a result of the sampling analysis, approximately 6,000 cubic yards of soil were excavated and disposed of as non-hazardous solid waste. The Centerdale Manor Apartments were opened in 1983.

Dioxins were first identified in 1996 in fish collected from the Woonasquatucket River. Since that time, the U.S. EPA has documented elevated levels of several contaminants in soil, sediment, and surface water at the site. The contaminants included dioxins, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals.

In January 1999 the U.S. EPA initiated a time-critical removal action that included sampling and the installation of fencing and interim soil caps. The U.S. EPA began initial remedial investigation (RI) activities at the site in August 1999; a pilot tree study was completed in spring 2000. Additional site evaluations for ecological risk assessment (ERA) and a human fish consumption survey are currently on-going. From the autumn of 2000 through the summer of 2001, the U.S. EPA also conducted a source area investigation including the installation of groundwater monitoring wells, collecting surface and down hole geophysical data and collecting and analyzing soil and groundwater. A final report with recommended long-term response action is expected in late 2002.

The U.S. EPA started a non time-critical removal action in February 2000 when the Agency signed an Approval Memorandum initiating the performance of two Engineering Evaluation/Cost Analyses (EE/CAs). The two EE/CAs were later combined into one, resulting in an EE/CA report issued in September 2000 recommending the restoration of the Allendale Dam and the removal of dioxin-impacted soil and flood plain sediment from the residential and adjacent recreational-use properties. Following a 60-day public comment period, EPA issued an action memorandum on January 18, 2001 that approved the removal action plan. The initial phase of the non time-critical removal action plan involved the reconstruction of the Allendale Dam; rebuilding of the dam began in the summer of 2001 and was completed in February, 2002.

Scope of Work. The ERTC has been requested by a U.S. EPA Region I On-Scene Coordinator (OSC) to perform a field investigation to map the sediment deposits of the Allendale and Lymansville Impoundments for further evaluation by the Region. Response Engineering and Analytical Contract (REAC) personnel will conduct this investigation using the technical approach described below. The U.S. EPA Region I OSC may provide subcontractors to perform tasks that cannot be done by REAC personnel within the time frame requested by the U.S. EPA or to perform tasks to achieve a lower overall cost.

General Assumptions.

- Access to the site will be provided by the U.S. EPA Region I OSC.
- Aerial photographs will be provided to REAC personnel by the U.S. EPA.
- REAC personnel will not perform any laboratory analyses.
- Logistical support for this WA will be provided by U.S. EPA Region I.
- The level of effort required to perform the geophysical surveys can not be accurately estimated due to unknown site conditions. Two geophysical methods are proposed but if either does not provide useful data, one or both methods will be discontinued. Survey parameters may need to be refined if the planned density or rate of acquisition does not provide sufficient data quality. A conservative estimate of 20 working days will be required to complete the geophysical surveys.
- REAC personnel will design and implement a sampling plan to collect sediment cores. The sampling plan will be developed based on sediment bed thicknesses obtained from the geophysical survey data. Based on the sampling plan, REAC personnel will provide the Work Assignment Manager (WAM) with a revised budget estimate. A WA amendment may be required.

- REAC personnel may perform the sediment coring phase. However, a subcontractor may be used if lower costs can be achieved or if completing the work within the schedule requested by the U.S. EPA is not possible. Subcontracting will be the responsibility of the U. S. EPA Region I OSC.

TECHNICAL APPROACH

Task 1. Over the Water Geophysical Surveys. Geophysical surveys will be performed from a low-draft, pontoon-type boat which will be rented locally. Two geophysical methods will be used: ground penetrating radar (GPR) imaging and acoustic sub-bottom profiling. Both methods will be used concurrently. The methods operate using similar principles but respond to different physical properties. The resultant data are therefore expected to be complimentary. Either of these methodologies may be refined or discontinued based on the data generated on-site.

GPR data will be collected with a GSSI SIR 2000 console and a 200 megahertz (MHz) antennae. The time interval and gain settings will be determined based on the on-site conditions. The instrument responds to changes in ground conductivity and dielectric constants. Pulses of radar energy are reflected by significant contrasts in these properties with depth. Sediment strata or perhaps even a layer of flocculent at the bottom of the water column may cause a reflection. However, the penetration depth is highly variable with this method. For over water geophysical surveys, limiting factors include the depth of the water, the conductivity of the water, and amount of clay-rich sediments. The GPR instrument will likely provide useful information that the acoustic sub-bottom profiler cannot provide.

Acoustic sub-bottom profiling will be performed using an instrument such as the Datasonics CHIRP II. This type of instrument responds to changes in acoustic velocity in the sediments. This method is expected to provide good quality images of the sediment bed thickness. However, it may not be able to penetrate deep enough especially in areas of coarse sand or gravel. The acoustic sub-bottom profiler will likely provide useful information that the GPR instrument cannot provide.

Bathymetric data will be compiled from the results of both methods. Some manual measurements of water depth will also be made for confirmation. A section of steel reinforcing bar will be used to indicate the approximate thickness of soft sediment. These sub-bottom probing data may be useful to calibrate the geophysical data displays.

Navigation during the survey will be achieved using a Trimble™ PRO XRS differential Global Positioning System (GPS) receiver and specialized computer software. The computer software was developed for side-scan sonar survey so it is ideally suited for the marine navigation required for this WA. The line spacing will be 25 feet but may be changed based on field conditions, or to increase or decrease survey resolution as necessary. The lines will be oriented east-west and/or perpendicular to the water flow direction. Control lines will also be surveyed parallel to the water flow direction with a anticipated line spacing of 100 feet.

The survey velocity will be approximately 1 mile per hour. However, due to survey logistics, weather, and unknown site factors, it is estimated that about 2 miles can be surveyed during a full day of production. About 8 miles of survey lines are estimated in the Allendale Impoundment and about 16 miles of survey lines are estimated in the Lymansville Impoundment. (Time will be required for adjusting survey parameters and to mobilize and demobilize the survey gear each day.)

The results of the surveys will be made available to the WAM as soon as possible following the surveys. Preliminary draft maps of bathymetry, sediment thickness, and cross-sections will be compiled while in the field. All data will be provided to the U.S. EPA in digital format so it can be incorporated in a site GIS database.

Task 2. Sediment Sampling. REAC personnel (or a U.S. EPA Region I subcontracted team) will collect 30 sediment cores from the Allendale and Lymansville Impoundments. The sediment cores will be located using the results from the geophysical surveys. Sampling will be conducted using a portable and light weight vibracore unit to allow the collection of undisturbed cores from 10 to 30 feet in length. A high frequency, low amplitude vibration that is generated and transferred from the vibracore head down through the core tube. The vibrational energy liquefies the sediment enabling the core tube to penetrate into the sediment. A trap at the end of the tube holds the sediment inside the tube when it is withdrawn. Samples from the sediment cores will be transferred to the U.S. EPA Region I for all chemical analyses.

Sampling Equipment Decontamination

The following procedure will be employed to decontaminate non-dedicated sampling equipment prior and subsequent to sampling location:

1 physical removal
2 non-phosphate detergent wash [Liquinox]
3 potable water rinse
4 acetone rinse
5 air dry
6 distilled/deionized water rinse
7 air dry

Standard Operating Procedures

Sample collection, documentation, packaging, and shipment will be conducted per the following U.S. EPA/ERT and REAC standard operating procedures (SOPs):

- SOP #2001, *General Field Sampling Guidelines*
- SOP #2002, *Sample Documentation*
- SOP #2005, *Quality Assurance/Quality Control Samples*
- SOP #2006, *Sampling Equipment Decontamination*
- SOP #2016, *Sediment Sampling*
- SOP #4001, *Logbook Documentation*
- SOP #4005, *Chain of Custody Procedures*

In addition to guidance provided by the site Health and Safety Plan (HASP) and the site Health and Safety Coordinator (SHSC), the following SOPs will apply to site health and safety:

- SOP #3001, REAC *Health and Safety Program Policy and Implementation*
- SOP #3010, REAC *Personal Safety/Protective Equipment*
- SOP #3012, REAC *Health and Safety Guidelines for Activities at Hazardous Waste Sites*
- Draft SOP #3022, *Boat Safety*
- Draft SOP #3023, *Boat Operation*

Waste Disposal All investigation-derived waste (IDW) will remain on-site and will be handled in accordance with the procedures outlined in U.S. EPA documents and according to the site's existing IDW disposal procedures.

STAFFING PLAN AND SCHEDULE

Staffing Plan. The REAC Task Leader will maintain contact with the U.S. EPA/ERTC WAM to provide information on the technical and financial progress of this project. This communication will commence with the issuance of the WA. Activities will be summarized in appropriate format for inclusion in REAC monthly reports.

The WA for this project was received on August 5, 2002. The Work Plan (WP) was initiated within 30 days after receiving the WA. The project will be completed by May 31, 2004.

The REAC Task Leader/Quality Control (QC) Coordinator is the primary point of contact with the U.S. EPA WAM. The Task Leader is responsible for the development and completion of the WP, WA team organization, and supervision of all WA tasks, including reports and deliverables. In addition, the QC Coordinator is responsible for ensuring field adherence to the WP and recording any deviations from the WP.

The following REAC field sampling personnel will work on this WA:

Personnel	Responsibility	Level
Physical Scientist	Task Leader/QC Coordinator	P2
Geophysicist	Field Geophysical Survey and Data Interpretation	P3
Technician/Geologist	Field Sampler	T3/P2
Technician	Field Sampler	T3

The REAC Quality Assurance Officer, the Health and Safety Officer, the Operations Section Leader, and the Program Manager are responsible for auditing and guiding the WA team, reviewing/auditing the deliverables and proposing corrective action, if necessary, for nonconformity to the WP or the HASP.

Vendor Services. Vendor service costs have not been included in the cost estimate. If vendor services are required, a revised cost estimate will be submitted.

Schedule of Activities. The anticipated scheduled of activities is as follows:

Item	Date
WP	September 17, 2002
Final Geophysical Report	January 10, 2003
Sampling Plan (Sediment Core Sampling)	February 14, 2003
Revised WP (if required)	February 14, 2003
Trip Report	June 27, 2003

This schedule assumes the following 5 trips:

Trip #1 Geophysical Survey of Allendale Impoundment (Late September/Early October 2002)
- Number of days 10
- Number of personnel 2

Trip #2 Geophysical Survey of Lymansville Impoundment (Late October/Early November 2002)
- Number of days 10
- Number of personnel 2

Trip #3 Site Visit in Preparation for Vibracoring, if Applicable (March 2003)
- Number of days 3
- Number of personnel 2

Trip #4 Vibracoring at Allendale Impoundment, if Applicable (April/May 2003)
- Number of days 5
- Number of personnel trip 3

Trip #5 Vibracoring at Lymansville Impoundment if Applicable (April/May 2003)
- Number of days 5
- Number of personnel trip 3

COST PROJECTION

The estimated costs (including labor, travel, equipment and sub-contractor services) to complete this project are given in the attached cost summary.

Photodocumentation, computer graphics and support, report preparation, and purchasing support are required in order to accomplish the objectives of this WA and are included in the cost estimate.

QUALITY ASSURANCE ATTACHMENT

Field monitoring equipment will be calibrated and used as per the manufacturers' instructions and recommendations. All calibration data will be documented in site log books.

Documentation of site activities and observations will be in the form of field logbooks and the appropriate field data sheets completed with information to sufficiently describe the site and any conditions which may have a bearing on the final data interpretation.

All WA deliverables will receive an internal peer review prior to release, as per guidelines established in REAC Administrative Procedures (AP) #22, *Peer Review of REAC Deliverables*.

Measuring Sediments *In Situ*

Biot Theory is Key to Determining Engineering Properties; Test Process Yields Synthetic Seismogram: Acoustical Response Of Seafloor

By Richard G. McGee
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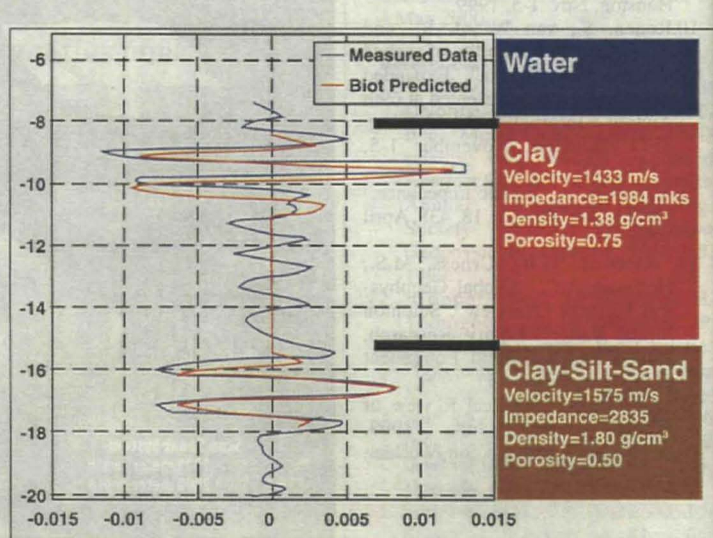
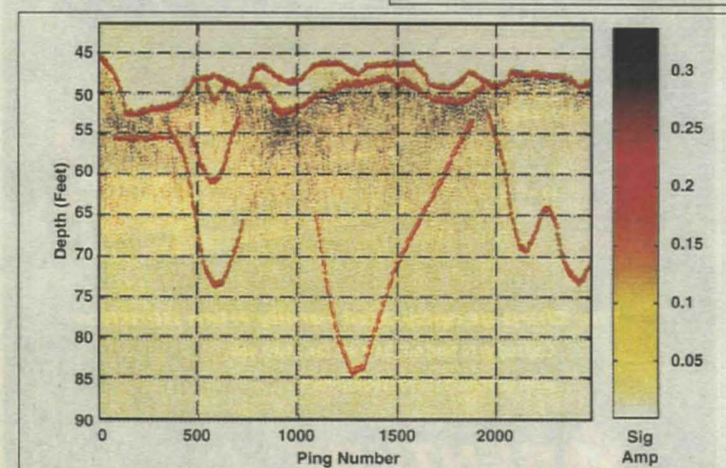
Kirkland, Washington
Jeffrey M. Cox
Evans-Hamilton Inc.
Seattle, Washington
and
Dr. Paul R. Ogushwitz
PRO Scientific Consulting
Hackettstown, New Jersey

Surveyors who measure underwater sediments hope to obtain information about stratigraphy, composition, and detailed physical properties. Traditionally, acoustic subbottom profile surveys have yielded the stratigraphic information, and the sediment descriptions have been obtained by correlating the stratigraphy with strategically placed sediment cores.



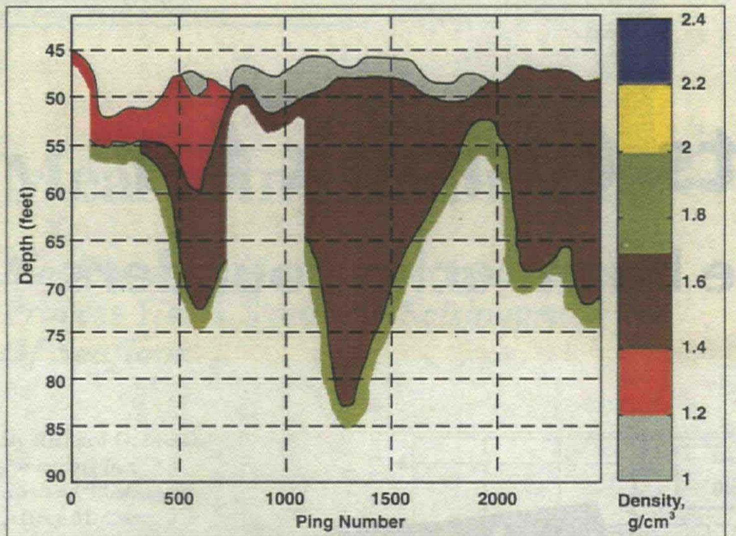


Seismograms, (top, right) consisting of composited vertical traces taken from the reflection data near core locations, were simulated using synthetic seismograms.

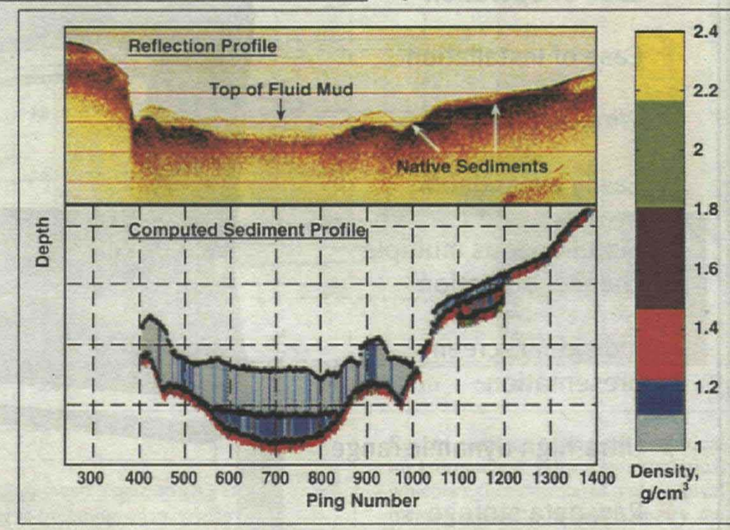
EHI applied the Biot method (above) to 7-kHz acoustic reflection data obtained in the channel.

Recent methods reduce the acoustical measurements to a few statistics, which are then correlated with archival measurements to broadly classify the composition of the sediments. Statistical methods, however, do not provide the detailed engineering properties (including density, porosity, grain size, and elastic moduli) that are often desired as the end product of a survey. Moreover, statistical methods rely on compilations of data worldwide and do not always faithfully characterize the conditions at the local site of interest.

This paper presents a straightforward, well-tested deterministic technique, which does not suffer from the limitations of the statistical methods. Just as in the earlier methods, we conduct acoustical reflection surveys and collect subbottom profiles, and we correlate the acoustic data with core samples obtained locally, thereby



are using the Biot theory, but the way we are using it. We start with a computer program developed at PRO Scientific Consulting and modified under funding provided by Evans-Hamilton (EHI). The code assumes a multilayered seafloor, which is being insonified at normal incidence. For assumed frequencies and assumed properties of the layers, the code uses Biot theory to estimate the sound speed and absorption of each layer, determines relevant physical properties of the layers, and produces a synthetic seismogram representing the acoustical response of a seafloor with the assumed structure and properties. The results are compared to the actual measurements, and the bottom properties in the model are modified until the synthetic seismogram matches the actual measurements within some specified tolerance.



After calibration, the data (above) were fully analyzed and sediment property maps of the channel were prepared.

The District expressed special interest in our maps (top) of the highly fluidized muds accumulating within the channel, because fluid muds may be an impediment to navigation

obtaining stratigraphic and compositional information. Beyond that, however, we use proven analytical techniques to determine the quantitative physical properties of the sediments for all data along the survey, providing a continuous, complete sediment description. Our fundamental analytical tool is Biot theory.

The Biot Theory

The Biot theory was developed to explain the physics of porous materials that are fluid-saturated[1]. The theory turns out to be an excellent descriptor of the acoustical behavior of sediments. The applicability of the Biot theory has been demonstrated for the entire suite of sedimentary materials, from surficial materials with porosities as high as 100 percent to well consolidated materials with porosities as low as one percent[2,3].

The Biot theory predicts that sound speed and attenuation in sediments depend on the frequency of the signal, on the density and elastic properties of the sediment grains and pore fluid, and on bulk properties of the material including porosity, mean grain size, permeability, elasticity, and effective stress. In total, there are 13 physical parameters in the model.

It has been argued that the theory is not useful because too much information has to be known. In response, it is important to note three things. First, some of the parameters (e.g., fluid densities and elastic properties) are well known and available in the literature. Second, some parameters are dependent on others and are easy to constrain. Third and most important, Biot-based estimates of acoustical properties are particularly sensitive to just a few of the parameters (particularly porosity), while the remaining parameters have a much smaller effect on the acoustic response. The most sensitive parameters are precisely those of interest to the engineering community.

Modeling

What's different here is not that we

The process is repeated for each seismic trace where core information exists, developing the attenuation and wave speed coefficients for the entire site. We then analyze every seismic trace (i.e., all locations) automatically using ancillary software. In this way, a 3-D map of the entire survey area is developed. The map presents the interpreted sediment properties as a function of position and subbottom depth.

The above method is an example of "forward modeling". Software to determine sediment properties by

Original includes color coding.

"We have successfully used the technique to develop site characterizations in regard to beach nourishment, navigation dredging, dredge disposal monitoring, navigable depth, lake sediments, environmental assessments, sediment contamination, and general marine sediment investigations."

"inverse modeling" of acoustical measurements using Biot theory is being validated.

To obtain usable, unambiguous results with our method, we use physical measurements from some of the core samples to constrain the initial model. As a way of testing the validity of the method, we predict the physical properties of sediments in nearby parts of the survey area and compare them with core samples that have not already been used. Predictions of the engineering properties of the sediments in the nearby areas have been uniformly excellent.

We use the code before, during, and after the survey. Before conducting the survey, we use the code along with archival information to predict the acoustical response of the area. From that, we develop a preliminary experimental design, establishing frequencies, sound power levels, and other experimental settings that will optimize the survey results. During the survey, we use the code in conjunction with acoustic calibration of the measurement instrumentation to confirm that we are collecting reproducible acoustic data and to monitor specific geoacoustic properties such as impedance.

While in the field, we use the theory to test the measurements for measurement error and to watch for unanticipated survey results. After the survey, we use the code to analyze all measured data to determine engineering properties of the surficial and subbottom sediment.

Since 1997, we have applied the Biot method to surveys in many locations following comprehensive field calibration protocols[1]. The results have been reproducible within each survey area. The overall approach appears to yield accurate estimates of the engineering properties of sediments.

Example: Mobile Ship Channel

The Corps of Engineers Mobile District office requested EHI, provide assistance in determining the physical properties of sediments in the Mobile Bay ship channel in support of planning for future channel maintenance and deepening operations. EHI applied the Biot method to 7-kHz acoustic reflection data obtained in the channel.

Sediment core data provided by the District were used to develop constraints on the initial model. Seismograms, consisting of composited vertical traces taken from the reflection data near core locations, were simulated using synthetic seismograms. After calibration, the data were fully analyzed and sediment property maps of the channel were prepared.

We mapped the density and sediment type to an average depth of 8 meters below the existing channel bottom for the entire 32-mile length of the Mobile ship channel. The analysis revealed a broad range of sediment types, including unconsolidated fine-grained sediments ("fluid muds"), fat clays, silty sands, and poorly graded fine-medium sands. The District expressed special interest in our maps of the highly fluidized muds accumulating within the channel, because fluid muds may be an impediment to navigation.

The sediment property interpretation for the fluid mud survey revealed a layer of gassy native clays and sands defining the dredge prism underlying the fluid mud throughout the Mobile Bay ship channel. The fluid mud was characterized as gas free with densities between 1.08 and 1.20 gram/cubic-centimeters, porosities greater than 90 percent, and minimal elastic modulii. Typically, these sediments begin accumulating within the channel soon after dredging has been completed.

Conclusion

This paper describes geoacoustic modeling and data inversion tools that quantitatively assess *in situ* sediment characteristics by correlating measured acoustic responses with actual and predicted sediment properties. We have successfully used the technique to develop site characterizations in regard to beach nourishment, navigation dredging, dredge disposal monitoring, navigable depth, lake sediments, environmental assessments, sediment contamination, and general marine sediment investigations.

References

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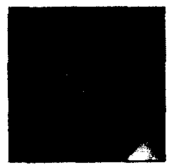
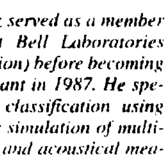


Richard G. McGee is a senior engineer specializing in the development and application of applied geophysical methods for the characterization of aquatic environments. He is heavily involved in sediment classification for dredging and remediation projects. He recently joined the Kirkland office of Parametrix Inc.



Jeffrey M. Cox is President of Evans-Hamilton and a senior oceanographer in the EHI Seattle office. He specializes in the collection and interpretation of physical oceanographic data for understanding design and operational conditions for coastal and offshore structures as well as the transport of pollutants within coastal marine systems.

Dr. Paul R. Ogushwitz served as a member of technical staff at Bell Laboratories (Ocean Systems Division) before becoming a geophysical consultant in 1987. He specializes in sediment classification using Biot theory, computer simulation of multibeam echo sounding, and acoustical measurement of bedload transport in rivers and surf zones.