Field Testing Advanced Remedial Dredging and Sediment Transport Technologies at the New Bedford Harbor Superfund Site

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Abstract: The ongoing remedial design for sediment dredging and disposal at the New Bedford Harbor Superfund site will be based on prior site characterization and pilot dredging and disposal studies. From these it has been learned that selection of the dredging technology must address needs for accurate dredging, high production, and minimal resuspension and spill of sediments during dredging. Also, for successful completion of the project it is important to dredge and transport sediments minimizing water addition to the waste stream and to dredge efficiently in debris laden and shallow water depth areas.

To develop current information on the capabilities of state-of-the art dredging equipment and verify the performance of the equipment a detailed technology evaluation was performed. New Bedford specific screening criteria were used in the technology evaluation. Two types of dredge systems were selected from the technology screening. It was decided to perform an on-site pilot dredging study of one of the dredge systems to monitor and verify dredging performance. The Pre-Design Field Test (PDFT) included monitoring of the dredging for performance parameters and environmental affects. Monitoring was conducted for dredge production, solids concentration of dredge slurry, dredging accuracy, sediment resuspension and transport (water quality), air emissions from dredging and disposal, and confirmation of clean-up goals.

Introduction

The New Bedford Harbor Superfund Site is contaminated with polychlorinated biphenyls (PCBs), heavy metals and other chemicals. Remediation of the site will be conducted in accordance with the EPA Record of Decision dated September 25, 1998 and will require the use of state-of-the-art dredge technology, dredging techniques, and material handling systems to remove and process contaminated sediments prior to final disposal.

In 1999, Foster Wheeler working with the USACE performed preliminary and detailed evaluations of current, available dredge technologies to meet the specific requirements of the full scale remediation project. From review and discussion of these evaluations with USACE and the EPA, it was decided to perform a Pre-Design Field Test (PDFT) of dredging systems that show potential for application on the New Bedford full scale cleanup, to acquire performance values for use in the final remediation design, and to select the final dredge system(s) to be used on the full scale cleanup.

Dredge Technology Selection

The report "Dredge Technology Review", was completed by Foster Wheeler under USACE Contract No. DACW33-94-D-0002 – NE TERC. The report provides an assessment of potential dredging technologies that can address a set of specific criteria that have been identified in previous studies and actual dredging efforts at the site. These include the following:

- Maximize solids content and thereby reduce water volume and water treatment
- Minimize re-suspension of contaminated marine sediments while dredging
- Dredge in shallow water depths (1 to 4 feet) and intertidal areas
- Perform precision dredging to minimize overdredging
- Dredge in sediment having significant debris
- Attain relatively high production rates; and
- Minimize or eliminate odors and polychlorinated biphenyl (PCB) volatilization

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Over sixty (60+) dredge technologies available in the United States and internationally were screened for application on the New Bedford Harbor project in the report, nine (9) of which were suggested for further evaluation in the report. It was concluded that dredging technology used for environmental remediation has changed substantially since completion of both prior dredging events at New Bedford Harbor, the Pilot Dredging Study in 1988-1989 and the Hot Spot Dredging event in 1995.

The nine (9) technologies were further screened and evaluated against the project criteria in a subsequent report titled “Evaluation of Dredging Technologies – Phase 2”. Based on the findings of this study, the dredge technologies having the highest probability for success in meeting the New Bedford Harbor project constraints were proposed for further investigation by site demonstration or meetings with technology representatives. These technologies included the following:

- Bean Technical Excavation Corporation (Bean TEC) *Bonacavor*
- Normrock Industries *Amphibex*
- Ellicott International Series 370 Hydraulic Cutterhead Dredge

The Ellicott 370 hydraulic cutterhead dredge was used during both the Pilot and Hot Spot dredging events, and to date, provided the best all around performance results in the site. Substantial testing and data collection was performed and documented regarding the dredge’s performance.

The Normrock Industries *Amphibex* was concluded to represent an applicable type of "amphibious" dredge technology for the full scale cleanup in intertidal areas, but was not demonstrated in the PDFT as the dredge was constructed on a foreign (Canadian) built hull, and not permitted to operate in U.S. navigable waters under the Jones Act.

The PDFT therefore focused on the Bean type environmental hydraulic excavator for testing in the New Bedford Upper Harbor. Coordination between Bean Environmental LLC (BELLC), and Foster Wheeler was initiated in early 2000, for participation in development and demonstration of a Bean type environmental hydraulic excavator, suited to work within the parameters of the Upper Harbor site. This dredge system would be a variant of the original Bean type environmental hydraulic excavator *Bonacavor*, used successfully on the Bayou Bonfouca Superfund project.

Bean Environmental Test Dredge

Bean Environmental LLC mobilized and demonstrated a hybrid dredge (mechanical excavation / hydraulic transport), which incorporated the innovative environmental dredging systems described below.

<u>Horizontal Profiling Grab (HPG)</u>

One goal of the PDFT was to test mechanical dredging methods on the New Bedford Harbor site. It was theorized that excavation using a clamshell bucket could provide optimum dredging production, debris management, and dredging accuracy for the New Bedford Harbor site specific conditions. The clamshell bucket selected for use with the BELLC dredge tested during the PDFT was a 4.5 cy Horizontal Profiling Grab Bucket (HPG). The HPG was developed by Royal Boskalis Westminster n.v., BELLC’s European partner firm. The HPG bucket is designed to excavate thin, level layers of material with high accuracy causing minimal spill, turbidity, and removal of underlying “clean” material. A Caterpillar 375LC hydraulic excavator (backhoe) was used to operate the HPG bucket. The 375LC was equipped with a centimeter level accuracy Real Time Kinematic (RTK) DGPS and a Crane Monitoring System (CMS).

<u>Crane Monitoring System (CMS)</u>

The CMS is an on-board electronic sensor system that provides the crane operator precise control of the bucket while dredging, both in the horizontal and vertical planes. The CMS combines signals from the excavator boom, stick, and bucket hinges, signals from the swing of the excavator, the horizontal and vertical position of the RTK antenna, and the list, trim and orientation of the barge. These signals are assimilated in a computer that displays the entire dredge system in a graphical format, in combination with the digital pre-dredge hydrographic survey and the design dredge prism.

Slurry Processing Unit (SPU)

A key component of the Bean dredge *Bonacavor* that was desired to be tested for application on the New Bedford Harbor Cleanup was the Bean patented Slurry Processing Unit (SPU) with automated control unit. The SPU system is a hydraulic slurry transport system that delivers high percent solids concentrations, by introducing controlled amounts of water to mechanically dredged material. The in-situ material conditions dictate the theoretical maximum achievable slurry density (i.e. it is not possible to achieve solids concentrations that are higher than that of the in-situ material).

Recirculation System

Efforts were made by Foster Wheeler, the USACE and Bean Environmental personnel to develop a system that would serve to further minimize the volume of discharge water to be managed on the full-scale project. A water recirculation system was theorized and included for testing in the PDFT. The recirculation system involved the pumping of decant water from the CDF with a self priming 8-inch diesel driven pump, via an 8-inch diameter 3,000 foot fused high density polyethylene (HDPE) pipeline, back to the dredge for use as make up water, creating a closed loop system.

Dredge Performance Tests

The BELLC dredge and support systems were mobilized to the project site in late July 2000, and underwent a series of performance tests. A 100-foot x 400-foot dredge area located in the New Bedford Upper Harbor approximately 3,700 feet north of the Coggeshall Street Bridge, was designated for the PDFT. The area, was centered on relatively high levels (over 3,000 parts per million) of PCB contamination and transitioned across varying depth, debris, sediment type, and contaminant zones. The depths within the dredge area ranged from roughly -5.0 to 0.0 feet MLLW, with depth of cuts ranging from 1 to 4 feet. Sediments dredged were hydraulically transported by the SPU system via the discharge pipeline to the Sawyer Street CDF, approximately 3,000 feet to the south.

The PDFT Monitoring Team consisted of representatives from the USACE, EPA, Foster Wheeler, BELLC, ENSR International, URS, Kevric and CR Environmental.

Dredge Production

Dredge production monitoring was performed over the course of dredge operations in the PDFT to obtain representative production rates over the design test area. BELLC and Foster Wheeler collected production data using a number of electronic data collectors for the dredge systems, including flow meters, production meters, Crane Monitoring System (CMS), and slurry processing unit. The dredge production monitoring program yielded dredge production rates in the 50-60 cy/hour range, based on a 10 hour operating day, including delays. It is reasonable to assume that improvements in the areas of debris handling, dredge advance, and overall dredge efficiency could be made for the full-scale project that could bring the average dredge production rate to 75 cy/hour or greater.

Solids Concentration of Dredge Slurry

Average solids concentration values recorded by the SPU system over sustained dredging periods ranged from 13.3% to 16.3% solids by weight. These concentrations were achieved in areas having in situ sediments with average solids concentrations of 32% to 43% solids by weight. The solids concentration values attained by the BELLC dredge were impacted by debris, and could be improved with inclusion of a more efficient debris separation system(s) on a full-scale project.

Also of significance was the successful demonstration of the discharge water recirculation system. The recirculation system created a closed loop system, whereby the only water added to the dredge process was that entrained in the dredge bucket. This water addition amounts to on the order of 30% to 40% of the in situ volume. The water recycled back to the dredge was used as make up water for the SPU system, as jet water for debris management, or directed back to the hopper, from the discharge line, to increase the solids concentration of the dredge slurry.

Dredging Accuracy

Excellent results were achieved by the BELLC test dredge and HPG bucket overall, with the project dredging accuracy goal of less than 6 inches in the vertical plane and less than 2.0 feet in the horizontal plane attained. The CMS, coupled with the RTK system provides bucket positioning in the x, y, and z planes within two inches. Practically however, due to operational limitations, movement of the barge, crane and bucket, and the accuracy limitations in surveys, the realized dredging accuracy during the PDFT was on the order of 4 inches in the vertical plane, and 1.0 foot in the horizontal plane.

PCB Removal Efficiency

Comparison of pre- and post-dredge PCB concentrations in the sediment indicate that the dredging technology used for the PDFT is very efficient and therefore has a high probability of being able to achieve sediment PCB clean-up goals established for Upper New Bedford Harbor. In comparing PCB concentrations before and after dredging to calculate overall PCB removal efficiency of the dredge, the results indicate that approximately 97% of the PCB mass was removed within the dredging boundaries.

Water Quality Monitoring

A water quality monitoring program for the PDFT was conducted. The actual dredging process appeared to have a limited impact on the water column, with support activities (tugboat and barge movements) having a much greater impact on water quality than the dredging. It was also ascertained by the water quality monitoring program that normal fluctuations in water quality occur in the Upper Harbor related to changing environmental conditions that appear similar or greater in scale than the overall impacts related to the dredging operation.

Air Sampling

Flux chamber samples and ambient air samples were collected during the PDFT. Results show that emission flux measurements are generally highest in association with well-mixed sediment and water slurries in the CDF. Dredging activities, including at the point of dredging and on the dredge, are relatively small sources of PCB emissions in comparison with the CDF because of their lower flux measurements and limited surface area.

Conclusions

The PDFT was conducted August 10-August 18, 2000, and yielded dredge performance and environmental monitoring results that significantly improved on the prior performance demonstrations at the Upper Harbor Site. The study results, summarized in the Final Pre-Design Field Test Evaluation Report, provide the basis upon which the final dredging and dredged material conveyance plan can be engineered for the New Bedford Harbor Full Scale Cleanup.