Advanced Sediment Washing for Decontamination of New York/New Jersey Harbor Dredged Materials

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I. The Contaminated Sediment Issue

One of the greatest drivers for maintaining access to America's intermodal ports and related infrastructure redevelopment efforts over the next several years will be the control and treatment of contaminated sediments dredged from our nations waterways. More than 400 million cubic yards (CY) of sediments are dredged annually from U.S. waterways, and each year, close to 60 million CY of this material is disposed of in the ocean. The need to protect our environment against undesirable effects from contaminated sediment dredging and disposal practices is gaining increased attention from the public and government.

I. Regional Focus: New York / New Jersey Harbor Region

In the New York / New Jersey Harbor Region, the effect of contaminated sediments on dredging operations can be costly. The Port is responsible for over 180,000 jobs in the region, and $26 billion in revenue. This area is considered to be the richest consumer market in the United States, and 85% of the freight that moves through this Port remains in the region. The ships that call at this Port require a minimum depth of 12 to 14 meters (40 to 45 feet) for navigation. The natural, undredged depth of the NY/NJ Harbor is 5.8 meters (19 feet), which requires that 3 to 5 million m^3 (4 to 7 million cy) of sediment be removed for safe navigation. Estimates from the U.S. Army Corps of Engineers indicate that 75% of this material is contaminated. To impede dredging is to add undesirable costs to freight movements. Therefore, disposal options for this material have been developed in response to the termination of the dredged material ocean disposal site, the former Mud Dump Site. The options include utilizing less contaminated materials for landfill capping, providing redevelopment of Brownfield properties, and the construction of confined disposal facilities within the Harbor. The more contaminated material, which was ineligible for other remedial alternatives, is the focus of this project.

1 Public / Private Partnership

Congress mandated the development of procedures suitable for the decontamination of sediments in the Port under the Water Resources Development Act (WRDA) of 1992 (Section 405C) and 1996 (Section 226). The WRDA Program is the responsibility of the U.S. Environmental Protection Agency (EPA) – Region 2 and the U.S. Army Corps of Engineers (USACE) – New York District, with the U.S. Department of Energy (DOE) – Brookhaven National Laboratory (BNL) acting as the Technical Project Manager. BioGenesis[sm] Sediment Washing technology is one of the technologies being demonstrated under the review of the members of this team.

The mission of this WRDA project is to prove one or more decontamination technologies commercially viable at full scale. For the purposes of the NY/NJ Harbor, full scale is defined as 500,000 cubic yard capacity per year. This is a segment of the overall material, and suggests that the technologies be a part of an overall solution, and can be integrated into the planning of dredging activities within the region.

The demonstration of the BioGenesis[sm] Advanced Sediment Washing technology is an integrated treatment train approach to sediment decontamination for NY/NJ Harbor dredged materials. BioGenesis Enterprises, Inc. has teamed with Roy F. Weston, Inc., to implement the technology for this project. Federal funding from the WRDA legislation provides assistance to this Pilot Operation, and to the commercialization process, while the private sector will provide the capital needed for actual facility construction and operation. Further operations of the large scale facility will be funded by the State of New Jersey, Maritime Resources Decontamination Project, which will provide and fund the demonstration of the technology from 30,000 to 150,000 cubic yards of material.

IV. Technology Development to Application: Corporate Team Identities

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BioGenesis Enterprises, Inc.

This technology development company, started in 1989, has been developing environmentally safe specialty chemicals and successfully bringing them to commercial markets in various use categories. These products include fire suppressants, odor neutralizers, cleaning compounds, and a chemical breakthrough in production enhancement for the oil refining industry. Thus BioGenesis entered the soil washing arena with a significant advantage: experience with chemical development, production, and implementation. The chemicals that would aid in the physical removal of contaminants from soils effectively, efficiently, and economically were a progression from the chemicals manufactured by the company from the late 1980's. BioGenesis continues to develop private label chemicals, as well as supply its own brands to its distributors nationally. The Company is headquartered in Oak Creek, WI, and has operations in Springfield, VA.

Roy F. Weston, Inc.

BioGenesis has joined with Roy F. Weston, Inc. (Weston) for the technology demonstration and commercial implementation. Weston is a leading infrastructure redevelopment services firm with more than 40 years of experience. The company's services include consulting, engineering, construction and operations, and extensive ports services, including property redevelopment. Headquartered in West Chester, Pennsylvania, the company has 60 offices throughout the United States and international operations in Europe, Latin America and Asia. Weston provides to the project the engineering, construction, and operational skills needed to move the technology into the commercial marketplace.

V. BioGenesis[sm] Soil and Sediment Washing: Early Technology Development

Developed originally for contaminated soils treatment, the technological advances made by BioGenesis to clean sediment from NY/NJ Harbor have been extraordinary. A successful project

using the soil washing equipment and chemicals produced by BioGenesis at a refinery site in Minnesota also served as a demonstration for the USEPA SITE Program, which determined the removal rates of contaminants to be between 80-90%. To improve upon typical soil washing for fine-grained materials, the Company developed a new piece of equipment, to provide the contact of chemical to contaminant and the physical collision necessary to achieve removal results from materials under 38 microns. In combination with the BioGenesis chemicals, this equipment and the principals behind it have proved to USEPA, US Army Corps and the Dept of Energy, Brookhaven National Laboratory that this is an effective way of decontaminating sediment. The material from NY/NJ Harbor can be over 90% comprised of materials under 38 microns, and several federally-funded bench scale studies have proved the system effective on materials taken from various Harbor sites.

V. The Demonstration Project

The demonstration project consists of three phases: Pilot Operations, Full Scale Plant Design & Construction, and Full Scale Operations. During Phase 1, Pilot Operations, scale-up engineering data has been obtained, treated material has been produced for beneficial reuse testing, and process effectiveness is revalidated. In Phase 2, Full Scale Plant Construction, full scale equipment will be procured and the full scale plant will be constructed based on the results of Phase 1. In Phase 3, Full Scale Operations, the full scale plant will be used to treat 30,000 to 150,000 cy of sediment. This paper documents the Pilot Operations, which, at the time of this writing, had just been completed.

The operations of this phase of the project were specifically designed to secure the following information and data; technical validation, sediment volume throughput, upscale design, production of clean material, and system economics. With the information obtained in this phase, the technology is currently being designed for its next phase of operations, at full scale.

Planning

The Pilot Operations Phase included the following planning steps :
Site Agreements
Site Plan (equipment arrangements)
Work Plan/Sampling and Analysis Plan/HASP
PFD/Mass Balance
Process and Instrumentation Diagram
Electrical Single Line Drawing
Mechanical Plans
State Permits
Local Permits

Pilot Operations:

Material Handling Preparation

Seven hundred (700) cy of contaminated sediment was supplied by the US Army Corps of Engineers, dredged from a site in Newark Bay. SK Services (East) L.C. screened the sediment to less than ¼", and removed the oversize material. The sediment was transported in tank trucks to the operations site, where it was stored in closed mixing tanks.

Pre-processing and Core Processing

At the operations site, runs of the core BioGenesis process were performed with contaminated sediment in order to determine the correct chemical addition rates and equipment settings. Sampling was performed throughout the process to evaluate the chemical mixtures and equipment layout being used. The major objectives of the Core Processing Task were to determine optimum chemical feed rates, process effectiveness under varying conditions, obtain process design information for scale-up, determine and quantify residual management, and produce treated sediment for further testing.

The core equipment used included the pre-processor, to which BioGenesis[tm] cleaning chemicals were added. This provided removal of the outer layer of contamination adhered to the sediment particles. The next step involved aeration where lighter organics were removed from the slurry through skimming. Next, the sediment collision chamber removed the innermost component of the contamination through a powerful impact technology within the unit. At this point, the contaminants were removed from the solids to the water phase.

Cavitation / Oxidation

This step provided destruction of the organic contaminants through addition of an oxidant in combination with a cavitation process.

Liquid-Solid Separation

Liquid-solid separation was successfully performed using pilot scale hydrocyclone and centrifuge equipment. The system yielded cleaned sediment at approximately 65% solids, which is considered to be the appropriate moisture for blending to make manufactured soil. Samples of sediment that were treated by the core BioGenesis process have been shipped to selected vendors to obtain additional performance information that may be integrated into the scale-up design.

Water Treatment

Metals contained in the water phase will precipitate out at this point in the system. For the Pilot Operations wastewater was disposed of at a POTW.

During Pilot Operations, wastewater was bench tested to determine the most cost effective treatment considering the level of organic and inorganic contaminants and suspended solids for implementation at full scale. At full scale, the waste water will be treated and, to the maximum extent, recycled into the core processing system or alternatively used in the manufacture of various beneficial reuse products. Based on those results, which will vary because the input feed sediment, its contamination type and level, and process variables, the water will either be recycled to the system, used in the manufacture of soil product, or disposed offsite. These results are being incorporated into the full scale design.

Manufactured Topsoil

Dewatered and decontaminated solids were used to create various types of material for further beneficial reuse evaluation. This was done by mixing the sediment with amending materials (peat moss, cellulose waste, vermiculite, pearlite, and BioGenesis SeaSoil? organic material) to produce test quantities of various soil products, such as

- Manufactured soil - High-end growth use (i.e. potting soil)
- Manufactured soil - Low-end growth use (i.e. top soil)
- Nonstructural fill material (daily/intermediate landfill cover)

The BioGenesis WRDA project prepared the material at the pilot processing site from which, under the separate EPA Region 2 Beneficial Reuse Project, the products will be trucked to the manufactured soil test site or shipped for laboratory testing.

VII. The Beneficial Use Products

This component of the project is important to the overall economics of the process, because it can provide a benefit back to the bottom line, enabling a potential reduction in cost for treatment of contaminated sediment. This is a distinction not shared by most other sediment disposal options.

As part of the approach to cleaned sediment as a resource, it is necessary to provide an understanding of the markets available for decontaminated sediment blended with amendments, or "manufactured topsoil" and an estimate of the value of this product.

Material Production

Following the Sediment Decontamination Demonstration Program, a field demonstration was performed to evaluate blending characteristics of cleaned sediment with various amendments. The field demonstration program is being conducted on sediment that was decontaminated during the final week of operations of the Sediment Decontamination Demonstration Project (approximately 50 cyds of treated, dewatered sediment from 100 cyds of raw untreated sediment). A formulation is currently being developed using raw materials readily available within the vicinity of the site to make a topsoil product (i.e., topsoil for ornamental landscaping, etc.).The decontaminated sediment is being mixed with raw materials to create approximately 100 to 200 cyds of manufactured soils.

Verification

Bench-scale studies are being conducted to design and test a horticultural planting medium, which incorporates the cleaned dredged material with conventional soil amendments. Specific end-product prototype media are currently being evaluated under the Market Evaluation. At this time, the products are assumed to be landscape planting, turf establishment, and container usage (i.e. potted plants). Physical testing (grain size analysis, density, moisture content, etc) of the manufactured soil is being conducted to evaluate the blending process.

The overall approach to the bench-scale study is to develop mixture ratios for physical, chemical and growth testing to evaluate the effect of decontaminated sediment in the varying amounts on the end product. Lettuce plants will be grown in the test mixtures and observed for symptoms of toxicity. The resulting foliage will be tested for uptake of heavy metals, and organics. Lettuce was the choice for growth tests, because standard growth protocols are available. Additionally, growth rates, visual observations, foliar analysis ranges for nutrients and heavy metals are also available. Physical, chemical, and nutritional analysis of the mixtures will be conducted. The test plant will provide base level viability data and plant uptake data within the time constraints

of the study. This is to ensure a high quality product, and support expected product performance levels.

Markets

As part of the Beneficial Use Evaluation, potential markets for soil products are being identified to ensure an acceptable output for the manufactured topsoil. In order for the State of New Jersey to issue an Alternative Use Determination for the manufactured soil, BioGenesis/Weston will need to provide a demonstration of the chemical and physical appropriateness of the material for the product as well as an ability to move the end product.

The data generated from the market survey will be used to determine the economic applicability of the manufactured topsoil product to the existing regional topsoil market. It will provide an economic as well as volumetric assessment of the markets for the manufactured topsoil products and fill products, regionally and nationally. At the conclusion of the market evaluation, there will exist a database for each of the products, which includes the estimates of the volume of product markets, the value of that market, and a group of clients that are currently purchasing similar product. The production of a topsoil material as output from a full scale facility with a production rate of 500,000 cy per year is estimated to be well within the volumes of the current regional wholesale market for comparable product.

VIII. Conclusion

The Pilot Operations that ran from January to March of 1999 were successful in generating the information and data necessary to take the process to full scale. Currently the system is being designed for its full scale operations, to enable capacity of 275,000 cubic yards per year. Construction is scheduled to begin in the Summer of 1999.

The contaminated material into a clean resource concept is a reality. The manufactured topsoil distribution networks are being established, and wholesale clients are being identified for bulk sale arrangements.

By 2000, the public/private teammates will have successfully completed the mission of bringing a technology from bench scale to full scale. BioGenesis/Weston have planned by 2001 to provide the NY/NJ Harbor region with a commercial decontamination component able to treat contaminated sediments at 500,000 cy/yr to add to its disposal options for sediments.