MIAMI RIVER DREDGING FOR SUSTAINABILITY OF A UNIQUE RIVERINE ENVIRONMENT AND AN IMPORTANT MARINE INDUSTRY

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ABSTRACT

The Miami River is a 5.5 mile long narrow shipping corridor in the heart of Miami, Florida with substantial maritime traffic that stretches from the Miami Airport to the environmentally sensitive Bay of Biscayne. The banks are lined with a mix of commercial facilities with working docks, industrial centers, residential areas and public parks. The navigational channel, which varies in width from 100 to 150 feet, was constructed in the 1930's and has not been dredged since its inception. Sediments, some of which are contaminated but not classified as hazardous waste, have built up resulting in a shallow channel that impedes navigational traffic, and has constrained economic development along the banks of the river pending cleanup of the river.

This paper summarizes the efforts of the community, working with the U.S. Army Corps of Engineers (USACE) and the Local, State, and Federal Environmental Agencies involved, and the private sector, in bringing about a project that promises to restore the Miami River, revive it as a public destination and attraction, and to promote it's destiny as a principal focus of trade and commerce with the Caribbean. A key element to the success of this initiative is the dredging and sediment disposal project. This project was awarded in early 2004 by the USACE to Joint Venture partners Weston Solutions, Inc. and Bean Environmental LLC. Details of the operations approach are provided.

Keywords: Dredged Material; Sediment Handling; Contaminated Sediments; Ecosystem Restoration; Endangered Species

INTRODUCTION

In the 1960s, a movement to restore the Miami River, long plagued by a reduced navigation channel, pollution and sedimentation issues, took wing and through the 1970s, state and local civic and political leaders undertook studies to document the neglect of the river. Through the 1980s, a Miami River Coordinating Committee took shape as a central clearinghouse for information on the river and later evolved into the Miami River Study Commission. In January 1998, the Miami River Study Commission issued a "call to action" urging a forceful, community-wide effort to restore the Miami River's designated 15-foot deep federal navigable channel, while cleaning up the river to bring it to its full potential as a working river in an attractive urban corridor.

The Miami River Commission was formed shortly thereafter, and soon started to fulfill its mission, managing to unite disparate and often conflicting voices to act with common cause to restore the river, revive it as a public destination and attraction, and promote its destination as a principal focus of trade and commerce with the Caribbean. Central to the plan was dredging of the river to allow more efficient commerce and to remove the pollutants that had accumulated through the years. Joint Venture partners Weston Solutions, Inc. and Bean Environmental LLC (Weston/Bean) were awarded the contract to dredge the river early in 2004 by the U.S. Army Corps of Engineers. The project is expected to last two to five years, depending on the availability of funding.

The Project consists of dredging approximately 721,000 cubic yards of sediment from the river. The contract has two primary components consisting of 599,000 cubic yards in the Federal channel and 122,000 cubic yards of Non-Federal channel, which is the area from the Federal channel to each bank. The material will be dried and processed at two sites along the river and then hauled to nearby landfills.

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Maintenance dredging is expected to boost international trade with over 100 Caribbean ports of call that rely heavily on the river's port, and to further economic development along the corridor, Dredging will also improve the health of the river for all marine life and downstream ecosystems. The project has the full support from the State of Florida, Miami Dade County, Corps of Engineers, City of Miami, maritime industry, near communities, and environmental groups.

PROJECT SITE AND HISTORY

From the time of the first Indian settlements, evidenced by the recently discovered 2,000 year old "Miami Circle," the community that became Miami formed on the banks of the Miami River (River). The earliest tribes lived, worshipped and traded by its rushing waters, which at that time were brimming with sea life. Missionaries, soldiers and settlers followed. The City of Miami was founded at the river's mouth and grew up along the river. Over time, the river became the lifeblood of Miami's growth and trade.

Today the 5.5 mile long narrow shipping corridor with substantial maritime traffic stretches from the Miami Airport to the environmentally sensitive Bay of Biscayne. The River's banks are lined with a mix of commercial facilities with working docks, industrial centers, residential areas and public parks. The navigational channel which varies in width from 100 to 150 feet was constructed in the 1930's and has never been dredged. Sediments have built up resulting in a shallow channel that impedes navigation traffic.

Pollution has been a great concern for a century. Although no longer a problem, untreated sewage was the greatest culprit from the beginning. The county planned and grappled with a comprehensive treatment system and unveiled a plan in 1925, but it was immediately thwarted by the land speculation collapse of 1925-27, the great hurricane of 1926, the Great Depression, and World War II. Other environmental problems impacting the river over the years included salt water intrusions, and chemical and oil seepage,

In 1990, the United States Army Corps of Engineers (USACE) recommended maintenance dredging of the federal navigation channel as the build-up of sediments restricted ship navigation. The Miami River had become the fourth largest port in the State of Florida with 24 shipping terminals certified by the United States Coast Guard as compliant with the Federal Maritime Security Act, providing international trade with over 100 Caribbean ports of call. For decades, the accumulated sediment reduced the designated 15-foot deep federal navigable channel to approximately 11-12-feet deep. For decades, the Miami River's shipping vessels have been restricted to only 50% of the cargo capacity and could only traverse the River during high tide. It was recognized that the Miami River had several long standing recreational boat yards which had the expertise and infrastructure to service Mega-Yachts. Mega-Yacht access was also limited by the shallow depth of the River, providing another reason for strong local support for dredging the River. It was widely known that everyday vessel traffic over the years had caused many tons of contaminated sediments in the river to stir into the water column and flow into Biscayne Bay. Dredging was considered the only way to remove the sediments from the water basin. However, dredging did not get under way immediately because of environmental concerns. Dredged materials are normally disposed of in the ocean. However, the United States Environmental Protection Agency (US EPA) ruled the Miami River sediments do not meet ocean disposal criteria and must be disposed in an upland site, greatly increasing the cost of dredging and disposal.

The sediments are contaminated primarily from stormwater drainage systems that empty into the river from over 69 square miles of urban and industrialized areas. The sediments are contaminated with traces of heavy metals, sewage, and petroleum products, and are migrating into and degrading Biscayne Bay.

SOLUTIONS SOUGHT

In January 1998, a Miami River Study Commission was established and issued a "call to action," urging a forceful, community-wide effort to clean up the river and bring it to its full potential as a working river in an attractive urban corridor. The State of Florida established the Miami River Commission shortly thereafter, and it managed to unite disparate and often conflicting voices along the river to act with a common cause to restore the river, revive it as a public destination and attraction, and promote its destiny as a principal focus of trade and commerce with the Caribbean.

The Miami River Commission has 18 members, including elected officials, business leaders, environmentalists, neighborhood and civic leaders, involved and knowledgeable on River issues. The Commission has the responsibility to unite all governmental agencies, businesses and residents to speak with one voice on River issues to develop coordinated plans, priorities, programs, projects and budgets that will substantially improve the river environment. The Commission is to act as the River's principle advocate and watchdog to ensure that River projects are funded and implemented in a proper and timely manner. The Miami River Commission, in a published statement, has established the following projects as the "top priorities" to substantially improve the River and its surrounding environment:

Dredging **-** The members of the Miami River Commission, and the project sponsors, believe that dredging will provide the following benefits:

- The River will be environmentally restored and prevent further degradation to Biscayne Bay
- The shipping industry will expand as ships will be less dependent on high tide sailings and could transit at most times of the day and night. This will increase the estimated $4 billion dollars of goods now being transported via the River and improve the economy
- The River infrastructure will be in place to maximize trade opportunities with numerous shallow draft ports of the Caribbean should political events increase trade opportunities; for example, the Caribbean Basin Initiative.
- The dredging project will be a catalyst for explosive economic development of under-utilized properties along the River and in the adjacent neighborhoods.
- Benefits to the State, County and City include: enhancement of the environmental quality of the River and downstream areas of Biscayne Bay, improvement of brownfields redevelopment programs, expansion of commerce and international trade, and better utilization of empowerment zones.
- Dredging or "cleaning" of the River will improve the livability of River communities by enhancing river walks, greenways, and parks for citizens and tourists.
- Dredging will eliminate the classification of the river as a "cesspool" by the two Grand Jury reports and bring about a revitalization of this distressed urban waterfront area similar to other major cities like Baltimore, Jacksonville and Washington, DC
- Dredging will increase jobs. The trade journal "Florida Shipper" notes that one small coastal freighter carrying 100 containers creates 77 jobs (indirect and direct) on shore. River dredging will allow the average river freighter to increase their cargo capacity from 160 containers to 240 containers. In 1998 alone, over 4000 cargo vessels called on the Miami River.

Miami River Greenway – The *Miami River Greenway Action Plan* was adopted in 2001 by the Miami River Commission, City of Miami and Miami-Dad County. The Plan is currently being implemented in partnership with the Trust for Public Land, City of Miami, Miami-Dade County, Florida Department of Transportation and private developers. The principal Greenway is designed as a 20-foot wide riverwalk downtown and an "on road" facility in the west, to proceed around marine industrial businesses. The Greenway will connect the multicultural neighborhoods bordering the River to the River itself and its eight public parks. The riverwalk is planned to become a destination landscape with entertainment attractions such as riverside cafes, fresh fish markets, restaurants, nightclubs, retail shops, etc. Several sections of the Miami River Greenway are already under construction.

Miami River Corridor Plan and Urban Infill Planning Initiative – After creating the Miami River Commission in 1998, the Florida Legislature passed the Miami River Improvement Act, recommending that the City of Miami, Miami-Dade County, and the Miami River Commission create a holistic strategic plan for all Miami River improvement initiatives. Under a Joint Planning Agreement, a two year, 42 public hearing planning process lead to the creation of the now award-winning Miami River Corridor Urban Infill Plan, which was adopted by the Miami River Commission in September, 2002. Since its adoption in 2002, half of the Plan's "Implementation Steps" (31 of 62 Implementation Steps) have been brought to fruition, particularly the Miami River Commission's top priority step, the Miami River Maintenance Dredging Project.

RFP Requirements

In the long awaited RFP, the USACE Jacksonville District specified a "Best Value Procurement," with selection based on best technical approach, past performance, and price. They also specified that they intended to issue options for the Federal channel concurrently with the options for the adjacent non-Federal areas to allow each acceptance area to be dredged in a single operation.

The contractor also was to coordinate with state and local agencies to accommodate dredging under and near drawbridges to minimize peak traffic impacts and obtain permits for hauling materials along public roads. The contractor was responsible for acquiring all applicable permits including the Florida Department of Environmental Protection's (FDEP's) Environmental Resource Permit (ERP).

The RFP also recognized the following project requirements:

- Prevent dredging within 10 ft of existing waterfront structures, including those encroaching into the design channel
- USACE's interpretation of the dredging permits was given in the plan views on the Contract Drawings.
- The contractor also was not to dredge "massive, monolithic rock," preventing the contractor from reaching grade in some areas.
- Material to be dredged included debris, sands, silts, clays, and gravel overlying soft to moderately hard limestone rock. Overflow or spillout from water and the dredged materials barged was allowed only during loading for the purposes of obtaining an economic load, not during transport to the unloading site. All dredged material, including debris, could be temporarily stored at the dock site, provided that dredged sediment is contained and covered and runoff and/or decontaminated water is handled according to all applicable permit requirements.
- All water discharged back into the river must meet FDEP ERP requirements.

All work must be performed with minimal impact to environmental resources, with special attention to the endangered manatee. All applicable federal, state and local permits must apply to work performed under the contract. The contractor is also responsible for bringing any encounters with cultural or historic artifacts to USACE's attention.

JOINT VENTURE TEAM APPROACH

Weston Solutions, Inc. and Bean Environmental, LLC, after following the proposed project separately for four years while assessing all of the technical and environmental challenges involved, formed a Joint Venture known as Weston/Bean JV (JV) to eliminate redundant management and the potential for competing agendas and multiple project management systems in a Prime-Sub relationship.

The Weston/Bean JV plan manages the project by integrating the dredging and processing together, not separating them into distinct phases or assigning responsibility to different companies, in order to minimize the disposal product and to reduce project costs. The JV partners felt strongly that USACE would benefit from the JV's knowledge of the project as a result of both team members jointly following the project's evolution and the decision to undertake additional sampling and testing in 2002 to supplement data supplied by the USACE.

The JV's quest to obtain a comprehensive understanding of the issues began in 1999 with a presentation on the dredged material management and treatment options to the Miami River Commission. In the years following, the JV team regularly attended Miami River Commission Dredging Work Group meetings and other public events in the area having to do with the river. All this effort resulted in a clear understanding of the issues involved and became the background for preparation of a successful response to the RFP.

In summary, the Weston/Bean JV believes that the ultimate success of the project requires a unified teaming approach to maximize results while dredging the River in a safe, environmentally sound, and economical manner. The decision to form the JV on this important project was driven by the following considerations:

- The JV structure precludes each of these possibilities by creating one team with a focused goal.
- The management and execution of this project requires the merging of two specialized skills, dredging and environmentally responsible materials processing, handling and disposal to functionally address the project scope. The combined capabilities of the JV fully satisfy these requirements.
- Materials handling considerations must be overseen by the management of the prime entity.

- Access to the best and most qualified personnel in the organization based solely on their experience and skills as they apply to this project. The JV, a legally binding agreement, gives USACE this assurance.

PROJECT OPERATIONS

Project operations consist of four sub-elements –

1. Dredging,
2. Handling and Disposal of Material,
3. Traffic Control (land and marine), and
4. Environmental Protection and Permits.

The method of operation was designed by the team to provide flexibility to allow a synergy between dredging and materials processing and handling. The following describes the JV's understanding and method of accomplishing the four sub-elements.

Dredging

Preliminary Planning and Project Design

As previously mentioned, Weston/Bean JV began preliminary planning for the Miami River project four years before the RFP was issued. The planning was necessary to design the dredging and sediment processing systems that would result in the best value for the government. The first step in the planning was the review of existing documentation, including the Dredge Material Management Plan, the Environmental Impact Statement, and previous studies and reports.

USACE took 52 core samples in 1992 and 2000 in order to characterize the sediments in situ. USACE performed grain size analysis, visual descriptions, certain specific gravity readings, and settling tests, the results of which were published in the RFP. The JV obtained the results to develop the preferred dredging, processing, and disposal plan well in advance of the RFP.

The contractor is paid by in-place volume, measured in cubic yards. However, the largest cost item is transport and disposal, measured in tons. The conversion of final disposal tons back into in situ cubic yards presented a major risk. To minimize risk to both the government and the JV, additional sediment sampling and testing and a detailed hydrographic survey was performed by the JV in June and November 2002, to supplement and/or confirm the previous USACE sampling events, including grain size, in situ density, in situ dry matter content, organic content, chemical constituency, and stabilization and mechanical dewatering characteristics.

Concurrent with the sampling campaign, the JV undertook a hydrographic survey to verify the existing depths. The JV utilized a 26 foot survey vessel for the survey, outfitted with Trimble DGPS and an Odom Echotrak dual-frequency transducer/fathometer. The purpose of the survey was to verify the published USACE survey and to look for gross differences in the bottom elevations. With a few exceptions, the surveys compared reasonably well to each other. Therefore, the JV verified the in situ *template* volumes by using the USACE survey.

The JV considered two feasible dredging methods for this project – mechanical dredging and hydraulic dredging. Mechanical dredging was chosen over hydraulic dredging for several reasons, including the following:

- A mechanical dredge handles debris well. The JV expected substantial trash and debris in the channel, a condition that would greatly limit the running time and production of a hydraulic dredge since the pump and cutter would require constant cleaning. In addition, it would create elevated turbidity when the dredge was shut down.
- There are logistical difficulties in placing the long lines needed to pump to the staging area as the hydraulic dredge progresses to the southeast, in addition to the measures needed to protect the pipeline.

In many areas there is very limited (if any) space to place a line outside the channel, and a submerged pipe would likely create a safety and navigational hazard in the narrow river.

- In order to pump the long distances required for much of the project with a hydraulic dredge, a booster pump is required in the line which would present additional noise, land lease and environmental control issues as well as possible production impacts.
- Additional time would be required to move a hydraulic dredge for ship traffic in this particular channel because of its narrow width and congestion. The floating line would often need to be broken and secured out of the channel and the swing anchors would need to be drawn up and brought in to avoid a larger ship catching an anchor wire. When dredging with a mechanical dredge on a spud barge, moving is a relatively straightforward matter of raising the spuds and towing out of the channel.
- Much of the Miami River template includes rock above grade as per the wash probes included in the contract drawings. A mechanical dredge will dig to refusal only. Dredging with a hydraulic dredge in areas where the rock bottom encroaches into the channel could cause damage to the cutterhead and/or the dredge, again resulting in downtime and elevated turbidity.
- Mechanical dredging with barge transport would result in a minimal addition of water when compared to hydraulic dredging and pipeline transport.

Mechanical dredge types include conventional cable-rig clamshell bucket dredges and hydraulic excavators. There are advantages and disadvantages to both dredge types, depending on the specific project requirements. The JV proposed hydraulic excavator for the following reasons:

- Excavators are more precise than cable rigs (cranes) because the digging arm is fixed rather than suspended by wires; there is no pendulum motion or swinging of the bucket. The operator has more control and can dredge precisely in the horizontal and vertical planes with the correct positioning system. This is especially important when dredging within 10 ft of the existing structures.
- Excavators given a sufficient boom/stick configuration can partially dig beneath many of the bridges on the river while minimizing the amount of time that the bridge must be opened. Using a crane would require that the bridge be open for the entire dredging quantity.
- Cycle times are generally faster for excavators than for similar sized conventional cranes.
- Excavators are generally safer than cranes. With excavators, there are no hoist or boom wires to break or part, an excavator cannot be “two-blocked” nor have its boom dropped, etc. The operator has more control over the bucket with an excavator than with cable rigs.
- Excavators can utilize either conventional backhoe buckets or clamshell buckets, giving more options for excavation, whereas cable rigs cannot.
- Excavators have break-out (shear) force if necessary although not required for this project unless large impediments were to be removed at USACE’s request.
- Excavators have a lower vertical profile on the digging arm than does a crane boom of similar capacity.

<u>Selection of Dredge Utilized on Project</u>

The dredge chosen to perform the Miami River project is the Barredor del Rio (model Hitachi EX 800). The following table contains information regarding the technical specifications and capabilities of the Barredor del Rio dredge.

Figure 1. Dredge Barredor del Rio.

Table 1. General information for Dredge Barredor del Rio

Identification of the Dredge	Barredor del Rio, Hitachi EX 800 fix mounted to jack-up spud barge
Associated booster-pump/pipeline equipment including size	Not applicable
Dimensions of the dredge including draft and freeboard	Barge 100 feet long by 40 feet wide by 7 feet deep Standard boom 27.8 feet, sticks of 11.1 feet and 14.5 feet Draft: 4 feet (average) floating, varies when jacked up Freeboard: 3 feet floating, varies when jacked up
Positioning Equipment (vessel and dredge-head/arm apparatus)	Vessel horizontal position: Trimble 4000 differential GPS, Sperry MK 1 digital gyrocompass. Dredge arm/bucket control: Bean's proprietary Crane Monitoring System (CMS).
Size of suction and discharge lines	Not applicable
Primary horsepower of excavator	Isuzu BB-6WG1T, 450 HP
Photographs of the dredge	See above
Bucket types/sizes	HPG Clamshell, 4.5 CY capacity Conventional bucket, 5.5 CY heavy duty capacity Conventional bucket, 7.0 CY light duty capacity
Coast Guard certification	Documented vessel, certificate attached
ABS Certification	None
Associated scow barges	Big 100 (1,500 CY); AGS 1101 (!,500 CY); ZT 201 (1,500 CY)
Last major maintenance, scheduled future maintenance	Built 2004, next future maintenance is scheduled for October 2005
Present Location	Miami, FL
Breakout force	77,000 lbf (with 14.5' stick)
Dredge depths	Digging envelopes attached
Mooring system	Three each 50 foot long jack up spuds; two each positioning spuds forward, port and starboard; one walking spud aft.

Dredging Operations Overview

As shown in this aerial photograph of the Miami River (Figure 2), the area to be dredged in the Miami River is space-restricted in many areas.

Figure 2. Aerial map of Miami River.

<u>Dredged Material Transport Method Selection: Barge Transport (Tug and Barge) vs. Hydraulic Transport (Pumping)</u>

Once material is dredged, it is transported to the Dockside Processing Site. Figure 3 shows an overview of the Dockside Processing Site. The JV considered two feasible transport methods: barge transport and hydraulic transport. With barge transport, the dredge is always productive since debris is handled at the offloading site, not at the dredge. Using barge transport, all materials are loaded including debris into an open top sealed hopper barge. A tug then pushes the barge to the Dockside Processing Site for debris separation and offloading of sediment.

With hydraulic transport, the dredged material is loaded into a pump unit for pumping directly to the staging area. However, there are disadvantages to hydraulic transfer at the dredge:

- Substantial debris is expected in the river. As a result, the dredge would incur downtime when separating debris from the grizzly, loading debris onto a debris barge and performing other ancillary activities. Production would suffer as a result.
- If debris is separated at the dredge, it would require that a debris barge be alongside the dredge, further increasing the width of the equipment spread on the narrow river (where there is not sufficient width).
- Hydraulic transport would require slurry lines from the dredge to the processing site. As with hydraulic dredging, there would be difficulties with placing the slurry lines, moving the dredge, and protecting the slurry lines.
- Hydraulic transport would eventually require a booster in the line, which would impact logistical, noise and production concerns.
- Hydraulic transport would require substantial amounts of water to be added to the material to pump the material the long distances necessary, which would increase processing time and costs.

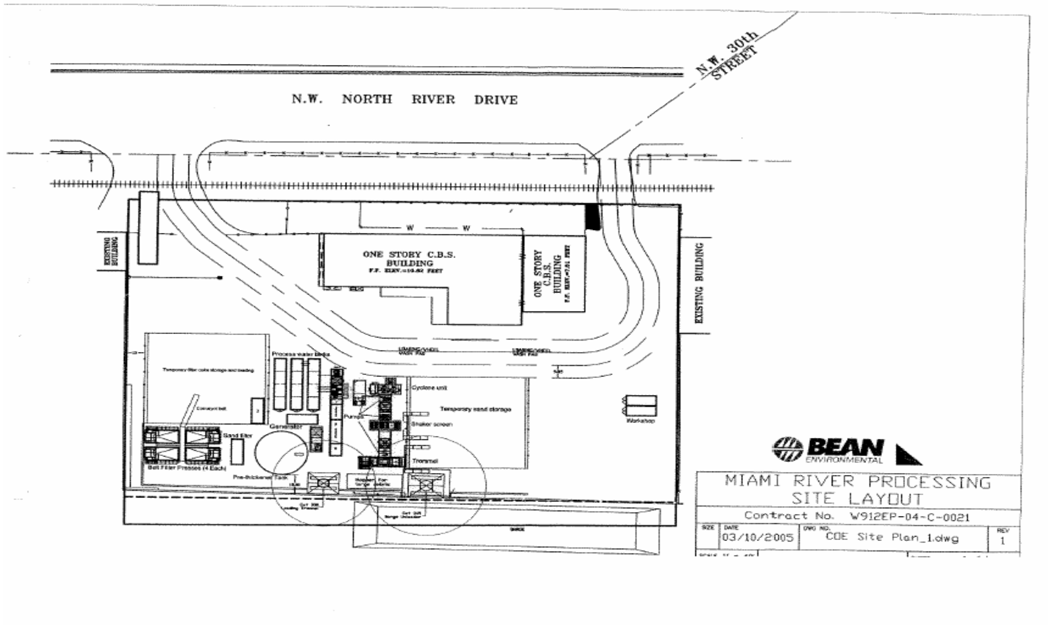

Figure 3. Dockside Processing Facility

Operations Planning

The JV is committed to executing the Miami River Project in a safe and efficient manner while maintaining ongoing commercial operations long the rive by utilizing suitable, proven equipment and experienced personnel in order to accomplish the work as per the contract drawings and specifications.

Our first order of preparatory work was to establish and/or verify the existing control on the project and to establish the horizontal and vertical dredging limits. The JV performed a thorough site survey well in advance of work. The site survey included a check of existing monuments given in the contract drawings and specifications, and a subsequent check of the existing tide gauges 1 through 6. Once the base control was established, the JV set a series of both electronic and visual tide gauges along the channel for visual references during work.

Concurrently, the JV located the limits of the existing structures along the river. Since the dredge template is dictated in large part by the 10 ft offset from the structures, it was necessary to establish the structure limits well in advance of the start of work. The survey was used to develop the final dredge templates in coordination with USACE. All surveying was performed under the supervision of a licensed professional surveyor and mapper (PSM) in the state of Florida.

All of the template and pre-dredge surface information gathered during the survey work was loaded into our dredge positioning system. The JV uses Bean's proprietary CMS software for dredging control. The CMS utilizes either RTK or Differential GPS signals, gyrocompass inputs, angle, and rotation sensors on the excavator to show the location of the bucket in the project coordinates and in real time. The JV enters the final dredging templates and the actual dredging surface from the pre-dredge survey of record. The operator views a monitor in the cab that displays the dredge, the dredge template, and the pre-dredge survey in both plan and profile view. As the operator takes a bucket, the plan and profile views update his progress so he knows the remainder left to dredge in any particular spot. The vertical component is shown as an elevation in the project datum, meaning the operator does not need to continuously correct for tide.

In addition, the CMS logs the cut location and elevation in digital format as the bucket closes. The JV will record the location of each bucket during the project. Our ability to record the X, Y and Z position of each bucket will assist in the final acceptance of each area, particularly when we encounter rock above grade.

The JV expects most of the Miami River Project will be dredged with a closed hydraulic clamshell bucket. The JV prefers a clamshell bucket over a conventional “backhoe” bucket on this project for several reasons:

- Better ability to handle debris
- Less spillage, improving water quality
- More control with 360-degree rotor to position the bucket in any orientation
- Better ability to dredge over an irregular surface such as limestone, as no breakout force is needed

The JV also has available the proprietary Horizontal Profiling Grab (HPG) bucket for use in areas when turbidity becomes an issue. For example, Acceptance Sections 14 and 15 are near the mouth of the river which empties into Biscayne Bay. The mixing zone is at the mouth of the river, and the outgoing current can be quite strong here. The HPG was specifically designed for environmental dredging projects where precision and water quality are major concerns.

The JV works the dredge for two 12 hour sifts per day, 7 days a week. The crews consist of certified operators, mates, engineers, and deckhands. All of the crew is properly trained and certified in their respective positions. Support staff includes endangered species monitors on each shift, a project engineer, and hydrographic surveyors.

Due to the highly congested nature and narrow width of the upper reaches of the Miami River (above 27th Avenue) there is insufficient width to accommodate the dredging plant and ships. Therefore it is necessary to temporarily relocate many of the ships that are moored along the river.

The JV maintains flexibility in the dredging sequence such that the dredge remains productive and the working ships are minimally impacted. In order to minimize interruptions to dredging and shipping, the JV is prepared to relocate the dredge multiple times within one or more acceptance sections. It is unlikely that the dredge will be able to work continuously within an acceptance section, although every attempt will be made to do so.

HANDLING AND DISPOSAL OF MATERIAL

The Weston/Bean JV responded to the RFP by proposing a comprehensive technical approach to efficiently process and dispose of sediments dredged from the Miami River, deploying a combination of the following materials handling methods.

- **Oversize separation** – The first separation is oversize material (> 1 ft) followed by screening to < 3”, 1” and ¼”.
- **Sand Separation/Mechanical Dewatering**: The JV’s primary mass reduction process consists of passing dredged sediment through sand separation and belt filter presses to produce washed sand and a dewatered “cake” for disposal.
- **Direct Loading**: Trucking suitable dredged sediment and debris directly from a Dockside Processing Site to the disposal facility.
- **Gravity Draining and Solidification**: Staging wet sediments at a staging area on drainage pads for air drying and gravity dewatering, combined with mixing a pozzolanic material (i.e., Portland cement) when necessary to achieve landfill acceptance criteria.

The JV’s comprehensive approach allows the flexibility to address all of the variables that could impact the project. The three materials handling and disposal methods selected enable the JV to address the irregular nature of the Miami River sediments to deliver the most efficient, best value approach for each bargeload of material offloaded.

Primary features of this comprehensive approach include:

- The capability to direct dredged sediments through multiple processing channels, ensuring the JV is always able to process the sediment at the rate it is delivered from the dredging operation.
- Reducing the material mass for disposal to achieve lower disposal costs.
- The flexibility to use a combination of processing methods to optimize throughput.

The JV began developing this comprehensive processing and disposal strategy by collecting 21 additional in situ samples from strategic locations along the Miami River, comparing them with samples collected by USACE Jacksonville District, and conducting a comprehensive program of treatability testing in their in-house and equipment manufacturer's laboratories in order to evaluate sediment characteristics and processing alternatives.

Based on the combined JV and USACE data review and treatability testing, Weston/Bean developed four sediment classifications for Miami River sediments (Table 2).

The JV anticipates each acceptance area of the river will contain varying combinations of the above sediment categories. Weston/Bean will use these sediment categories to determine the parameters for the sand separation/mechanical dewatering system to ensure that the processed material passes the paint filter test required for acceptance at the disposal facility.

Category 1 material consists mostly of sand, some of which could be ready for direct loading to a final disposal facility. Categories 2 and 3 materials contain lower sand content, requiring either sand separation/mechanical dewatering or gravity dewatering/solidification before disposal. Category 4 material has the lowest solids content and will require sand separation/mechanical dewatering to achieve appropriate mass reduction for economical final disposal.

The JV anticipates each acceptance will contain varying combinations of these sediment categories.

Table 2. Categories for Miami River Sediment

Category	1	2	3	4
In situ bulk density (ton/cy)	1.34-1.43	1.12-1.37	1.21-1.27	1.12-1.23
Solids (%)	64-67	51-60	50-56	42-48
Organic Matter (%)	2.5-6.6	5.1-10.2	6.9-8.8	10.7-14.1
Sand (> 200 mesh, %)	71.5-83.6	58.5-67.2	35-61.8	34.1-43.1
Fines (<200 mesh, %)	16.1-18.5	32.8-41.5	32.8-65	56.9-65.9
Sediment volume percentage	25	24.5	24.5	26

Note: The volumes presented in Table 2 are based on Weston/Bean's laboratory data and reflect the range of sediment characteristics the JV anticipates encountering within a given sediment category.

Implementing a Comprehensive Approach

The JV is performing all of the direct loading and sand separation/mechanical dewatering operations on a 1.8 acre Dockside Processing Site. In addition, the JV is using a portion of the former Jai Alai parking lot for conducting gravity drainage activities and staging operations throughout the project. This parking lot is located near the Dockside Site and was made available by the non-federal sponsor for use as a staging area.

Operations at the Dockside Processing Site include:

- Barge staging and offloading
- Oversize debris separation
- Large debris screening
- Small debris screening and washing
- Sand separation and washing
- Fines conditioning and dewatering
- Water management
- Dewatered debris, sand, and filter cake staging
- Truck loading and manifesting

Operations at the Jai Alai Staging Area include:

- Staging roll-off containers of unknowns and hard-to-dispose of debris dredged from the river while awaiting final disposal approval
- Staging dump trucks and trailers in preparation for material transport from the JV's processing site(s).
- Gravity draining of materials to maximize the solids content of materials transported for disposal.

DOCKSIDE FACILITY OPERATIONS

Barge Offloading

Dredged sediments are transported to the dockside processing facility in hopper barges where they are moored along approximately 400 ft of available berthing space. Once the barge docks at the Dockside Processing Site, the Processing Manager determines the most appropriate course of action to efficiently and economically prepare the dredged material for disposal. This may include direct loading material onto trucks or transferring it to the sand separation/dewatering operation. An excavator equipped with a clam bucket is used to offload dredged sediment arriving at the Dockside Processing Site.

Dredged Sediment Processing

The Mobile Plant was specifically designed and constructed for processing mineral waste materials, including contaminated soil and contaminated dredged sediment. This is accomplished by means of coarse particle screening, washing, and mechanical dewatering of the remaining fines fraction. The mobile plant is designed for a water based volume reduction process, using particle size and density separation.

Plant Capacity and Throughput

The mobile plant (Figure 4) is designed to handle up to 140 tons per hour of wet sediment including debris, coarse particles, sand, silt/clay, and moisture. In a typical sediment treatment project, the throughput of the mobile plant will be limited by either the sand separation phase or by the mechanical de-watering phase. The sand separation phase is normally limited by the capacity of the hydrocyclones at approximately 110 tons of dry solids, which includes all sand and silt/clay particles present in the material after oversize materials are separated.

Figure 4. Mobile dredged sediment processing plant.

The capacity of the dewatering phase is determined by the number of belt filter presses used. The average capacity range of a 2-meter belt filter press can range up to 17 tons of dry solids per hour, which includes only the silt/clay particles. Filter cake output ranges from 10 to 20 tons of 'wet' filter cake per hour with 40-50% solids content.

Process Steps

The Mobile Plant process is based on a series of interrelated processes, each to be considered as separate plant modules but connected to each other by an automated plant control system. The plant consists of the following steps:

- A stationary grizzly for separation of very large debris
- A rotating sieve drum (trommel) for separation and washing of large debris and coarse fraction;
- Vibrating shaker (scalping) screen module for sieving medium to coarse fraction;
- Sand separation module, using hydro cyclones and a counter current washer, followed by a vibrating sand de-watering screen;
- Pre-thickener / clarifier module, for separating silt/clay fraction from the process water;
- Mechanical dewatering of silt/clay fraction, using one or more belt filter presses;
- Water treatment module, for discharge of excess process water;
- Automation module, for control and steering of all modules

The different modules are engineered as standardized skid mounted and containerized equipment, including screening and separation units, a polymer dosing unit, plant automation and control equipment (Figure 5). The plant can be assembled in different configurations, depending on the optimal site lay out.

Screening Module

The sediment processing plant is equipped with two sieve/scalping steps, with carefully chosen screen diameters. These process steps are important, to reduce downtime that can be caused by pumps, valves and pipes, to maximize mass reduction, and if possible, produce material for beneficial use.

The dredged sediment is loaded into the plant by using a hydraulic excavator.

Figure 5. Screening stage equipment.

The plant and equipment used for the screening stage include:

- Hydraulic excavator, Cat 345 or comparable;
- Grizzly screen for large debris approximately;
- Hydraulic excavator, Cat 330 or comparable;
- Wash- and sieve drum (trommel) for screening;
- Ultra heavy duty slurry pump
- Scalping screen;

Vibrating Grizzly Screen

The contaminated sediment is offloaded from the barge with a Cat 345 MH (material handler) equipped with a clamshell bucket onto a grizzly screen. The large debris is washed with process water and discharged into a compartment. The sediment and coarse material is collected in a hopper underneath the grizzly screen. A second excavator loads the material from the hopper into the rotating wash and sieving drum (trommel) as described below.

Rotating Wash- Sieving drum (trommel)

The trommel (Figure 6) utilizes a rotating and washing action to separate debris or rock from the dredged material. The separated material is cleaned as much as possible using pressurized process water which is injected through nozzles inside the trommel. The sediment fraction is collected in a slurry tank directly underneath the trommel unit. From this tank it is pumped to the next screening step using a heavy duty pump.

Figure 6. Rotating wash-sieving drum (trommel).

Shaker screen

The material that passes the trommel is pumped onto a shaker screen (Figure 7) for separation of medium size material. The material is washed with process water provided by nozzles on the screen deck. The remaining small material is collected in the second slurry tank underneath the shaker screen. The separated debris is temporarily stockpiled on the Dockside facility until it can be transported for disposal.

Figure 7. Shaker screen.

Sand separation module

After screening, the remaining slurry will consist of primarily sand and silt sized particles. The slurry is pumped from the second slurry tank using ultra heavy duty pump to a state-of- the-art sand separation module (Figure 8) consisting of high capacity, durable hydrocyclones, a counter current washer and a sand dewatering screen. The counter current washer is used to polish the separated sand, directly after the separation process. Separated and polished sand particles are de-watered with a large sand de-watering screen. The separated fines are collected in a sump (sludge tank) for feed to the thickener.

Figure 8. Sand separation module.

The hydro-cyclones (sand separators-Figure 9) are specially constructed for maximum recovery of sand fraction and separation of mineral materials. The separators are rubber lined to reduce wear and tear. The geometry of the separators is designed to handle high solid concentration.

Figure 9. Hydrocyclones for sand separation.

Using the special regulator in the separator underflow it is possible to vary the cut point. In order to guarantee an optimum sand separation, the flow and density of the slurry in the cyclone feed and the inlet pressure of the hydro-cyclones are continuously measured.

The counter current washer is used as a polishing step for the sand fraction. The counter current washer is placed in the process after the hydro cyclones, and normally forms an integrated step in the sand separation module. However, the use of the counter current washer is optional, depending on soil and contaminant characteristics.

The separated sand is temporarily stockpiled at the Dockside facility. The sand is then hauled to the Jai Alai facility for further drainage and analytical testing.

Pre-thickening / Mechanical Dewatering Module

Pre-thickening

The remaining sediment particles (silt/clay), referred to as the fines, are dewatered. The dewatering system consists of polymer dosing, a pre-thickener tank and mechanical dewatering (Belt Filter Presses).

Fines separated in the hydrocyclone overflow and are collected in a sludge tank and are then pumped (Figure 10) to the pre-thickener tank. The density of the fines collected in the sludge tank, the flow rate to the thickener is measured constantly. Based on the density and flow measurements, the automation module calculates the exact amount of polymer that needs to be added before discharge to the pre-thickener tank.

Figure 10. Pump for pre-thickening.

By using a pre-thickener, we are able to minimize the number of belt filter presses required and achieve maximum dry solids content in the filter cake after mechanical dewatering. At the same time the presence of a pre-thickener tank minimizes down-time because it also functions as a holding tank. Clean water is separated in this of the process so it can be re-used in our closed loop system.

The mobile plant is built with a specially developed pre-thickening computer monitoring system including flow/density measurement in order to realize an optimum pre-thickening process and to minimize the polymer consumption. Polymer is automatically prepared in a containerized polymer diluting, aging, and dosing unit. Polymer diluting, aging and dosing to the sludge is a fully automated system and is an integrated part of the complete mobile sediment processing system.

Mechanical Dewatering

Mechanical de-watering is achieved using one or more belt filter presses (Figure 11). Depending on project specific demands, the belt filter presses can be exchanged for other types of dewatering equipment such as plate and frame presses or decanter centrifuges. On the Miami River project we use four belt filter presses.

The pre-thickened fines are pumped to belt filter presses. Belt filter press capacity and filter cake solid/moisture content depends on sediment characteristics. For Miami River, the cake solid content is typically between 45 to 50%. The resulting filter cake is stockpiled with a conveyor belt for transport to landfill disposal. Filtrate from the gravity and pressure sections of the belt filter presses is pumped to the water treatment section of the plant.

Figure 11. Belt presses.

Process water treatment

The system of separation and dewatering is a closed loop system where the water is re-used as much as possible. Depending on the amount of water in the dredged sediment, a certain amount of surplus water has to be treated and discharged back into the river. In several stages of the plant, process water is applied to dilute the sediment and to wash coarse material and debris. When dredged sediment is processed, surplus water is also added to the system.

Figure 12. Water treatment facility.

All sludge flows, including process water, flow to the pre-thickener tank. The underflow (settled sludge) of the pre-thickener tank is pumped to the belt filter presses. The overflow of the pre-thickener tank is stored in a process water tank for re-use in the process as needed.

Surplus water is pumped to the water treatment facility, which consists of a sand filtration unit. The plant is equipped with an in-line total solid measurement device installed in the process water tank to monitor plant effluent.

Electrical installation and automation

At Miami River, the plant is powered by a generator, and all processes are monitored and controlled from a central command unit (CCU) as shown in Figure 13. The process operators overlook and control the entire process from the CCU. The process is followed on monitors and interfered from the switchboards.

Figure 13. Central command unit.

All electrical wiring between plant units is installed using prefabricated steel cable bridges (Figure 14). For safety reasons during maintenance and repairs every electric motor is equipped with separate on and off switches, and the plant is also equipped with a number off emergency switches.

Figure 14. Prefabricated steel cable bridge.

In order to regulate and control the process, most of the electric motors are frequency regulated. The critical pump flows are measured using in-line flow meters. All of this data is monitored and regulated by a PLC in the central command unit. The process operator can monitor and adjust the process on a monitor screen.

Maintenance and spare parts

To minimize plant down-time the plant is equipped with a spare parts container (Figure 15). In this container most spare parts are stored. The plant superintendent is keeping spare part storage up-to-date and is responsible for sufficient spare parts. The plant is also equipped with a workshop container. This container is equipped with the most important tools. The mobile plant is controlled by a computer. A list of production hours and maintenance intervals of the plant components are automatically produced. Preventive maintenance is scheduled accordingly.

Figure 15. Spare parts container.

Testing: Samples are collected from loaded barges and the various unit processes to determine sediment and product characteristics in the lab. This enables the JV to allocate resources to the appropriate processing methods and minimize/optimize material processing before transporting material off-site for disposal. In order to determine key process variables, samples are subjected to sieve analysis, density tests, and belt-press simulators at our on-site laboratory to quantify the water content, density, sand and fines content, and the required polymer dosages.

TRAFFIC CONTROL – MARINE

The Weston/Bean JV appreciates the need to work safely in the Miami River in cooperation with the established shipping concerns in the area. In some areas of the river, it is necessary to relocate the entire dredging operation in order to allow ships to pass. The river is so narrow in parts that simply moving to the edge of the channel does not sufficiently reduce the risk of collision. For proper coordination the JV has established clear lines of communication with the shipping companies and local pilots prior to the start of work and has identified areas to relocate the dredging operations to, if necessary, during a ship passage.

In order to facilitate effective and safe communication, the JV has established Captain Beau Payne, president of P&L Towing, as the full time river traffic coordinator on the project. P&L Towing also performs barge handling and towing for this project. P&L Towing performs approximately 75% of all ship movements along the Miami River and is in daily communication with those who use the river for commerce. The JV met with Captain Payne several times in preparation for this project and together developed a plan for dealing with ship traffic in the safest most efficient manner possible. P&L Towing develops weekly schedules of ship movements along the Miami River. P&L Towing communicates with all ship operators along the river, including the ships they do not pilot, in order to develop a complete schedule of *all* ship movements on the river. Each week the JV receives a ship movement schedule that encompasses every vessel along the river for the coming week.

Communication is the key to minimizing shipping and dredging delays. The JV monitors VHF Channels 7, 9, 13 and 16 as necessary in order to maintain communications with the ships and pilot tugs. In addition, the JV distributes phone numbers of the dredge, the assist tugs and the JV Operations Manager to the several marine groups in Miami so that shippers have a second option of communication.

The JV developed a dredging schedule with graphic displays on aerial photographs of the proposed order of work. The schedule is updated on a by-weekly basis for distribution to affected businesses as work progresses. Therefore, the shippers always know as accurately as possible where the dredge will be working in order to limit impacts to their schedules and the JV's.

Work is planned according to the ship movements, dredging the open docks within the dredge area between ship arrivals. The JV maintains open docks where the dredges and support equipment can be temporarily stored during ship movements as necessary. In addition, five areas other areas that have sufficient space to temporarily spud down the dredge outside of the channel limits, in the event that no docks are available or the dredge cannot pass. Because of the ship traffic and narrow width of the channel, particularly in Acceptance Areas 1, 2 and 3, it is necessary to shift the dredge frequently during work. For example, there are areas with ships docked directly across from one another which will not provide sufficient width for the dredge and barge. Therefore, instead of sequentially dredging along the acceptance section, it will be necessary to temporarily relocate to a station that provides enough channel width to work safely. These movements will be planned as part of the weekly traffic coordination meeting and distributed to USACE and all users of the river.

In addition to scheduling for marine traffic, a plan had to be devised to deal with the opening and closing of 13 bridges when dredging is scheduled beneath them. By utilizing a hydraulic excavator on the project, it will be possible to dredge beneath portions of many of the bridges without the bridge being opened. Some bridges (most notably NW5th Street) must be opened during dredging to safely work without damaging the structure.

TRAFFIC CONTROL – LAND

The management and control of land traffic is a critical component for the disposal of the dredged material for the Miami River project. As mentioned earlier, the dredging material processing sites are located at the Jai Alai parking lot (Jai Alai Staging Area), and at the Dockside Processing Site. Both of these sites are located in heavily industrialized and congested areas.

Weston/Bean JV produces approximately 2,500 tons per day of dewatered sediment and debris which requires transport by trucks from either one or both sites to a Waste Management landfill. The successful execution of the Miami River project depends largely upon a well-planned and well-executed land traffic management plan that is built on the following:

- Advance planning prior to start of work
- Designated truck hauling routes
- Type and size of truck fleet
- Signage and flagmen
- Manifests/bills of lading

In preparation for selecting the proposed land management plan, regulatory and community agencies such as Florida Department of Transportation (FDOT), City of Miami and Miami-Dade County were first contacted to ensure utilization of the most appropriate and efficient routes to move truck and vehicular traffic.

Trucking of the processed material originates from either the Dockside Processing Site or the Jai Alai Staging Area, with most of the material destined for Waste Management's Central Landfill in Pompano Beach. Depending on the traffic and other considerations, Waste Management provides disposal space at two other landfills – Medley landfill in Dade County and Okeechobee Landfill in Okeechobee if needed.

Trucks associated with the project will be traveling routes accustomed to heavy truck traffic. Notwithstanding, trucking operations present a risk for an accident or for spillage of dredged material onto public roadways which could be a possible risk to the community and to public safety. Accordingly, the Weston/Bean JV requires the following actions from the trucking firms:

- All trucks used on the Miami River project have sealed truck beds in order to prevent leakage from the truck
- Prior to leaving the site, all trucks are checked to insure that dripping and carryover onto public roadways does not occur

- Trucks are equipped with appropriate mufflers and air quality equipment so that no appreciable impact to noise or air quality is anticipated
- Weston/Bean JV has a spill response plan that includes emergency contact information and named local response subcontractors with specialized equipment such as vacuum trucks/vactors, roll-off equipment, etc., strategically located along the primary truck routes. It is critical that the JV be able to respond as quickly as possible to any incident or accident.

ENVIRONMENTAL PROTECTION

The primary environmental concerns for the Miami River project include:

- Water quality – Turbidity, Dissolved Oxygen, Lead, Arsenic, Copper
- Endangered Species – Manatees
- Submerged Resources – Archeological Resources
- Air Quality – Noise, odor, birds, emissions

Water Quality

Often a major environmental concern with dredging is turbidity. With mechanical dredging turbidity can be increased through inappropriate equipment and operation by methods such as overfilling the bucket, dredging with an open bucket, raising a bucket that is not fully closed, or "sweeping" the cut with the bucket as a check on grade.

On Miami River, the JV controls turbidity to the maximum extent possible through a controlled dredging process that incorporates proper equipment, techniques, and operational controls.

In order to prevent overfilling the bucket, we control the depth of each dredge pass to fill the bucket being used at the time. To insure that dredging environmental concerns are addressed, the JV utilizes the Bean Crane Management System software. Target excavation depth and position are programmed into the CMS at depth intervals of 1.2 ft and the excavator digs at these levels until grade or hard bottom is reached. The parameters of the CMS on board the dredge are changed so changing grades or buckets during work does not present difficulties or impacts to production. The system incorporates a bucket closure sensor into the CMS so that the operator will know if the bucket if fully closed before raising the bucket to the surface. If the operator closes on a piece of debris, he has the option of raising it to the surface if it is a large item, or opening the bucket and attempting another grab.

If water quality requirements dictate, the JV utilizes its proprietary HPG environmental bucket to dredge the sediments. The HPG was specially designed to minimize turbidity and create a level bottom after dredging. Because the bucket is designed with D-seals around the perimeter, the HPG is completely sealed when closed. The top of the bucket has six vents that open and close as the bucket opens and closes allowing trapped water to escape and prevent material from squeezing out from the sides.

Endangered Species

Since manatees frequent the Miami River, the JV employs qualified and approved endangered species observers 24 hours per day while dredging is underway. The JV does not operate any equipment within 50 feet of a manatee and ceases operations until the manatee is clear of the area as certified by the endangered species observer. We also employ adequate lighting at night so that manatees can easily be identified. All tugs, crewboats, survey boats, etc. are operated on "idle/no wake" speeds at all times.

Archeological Resources

The JV is utilizing the help of a local archeological firm to help us monitor for archeological resources that are dredged. Since we are screening at the dockside facility, reject from the screens is monitored and interesting objects found are placed aside for identification and logging if necessary.

Air Quality

During the JV's sediment sampling campaign of November 2002, two samples were noted that had a relatively strong sulfur odor which is common on many dredging projects. Due to the proximity to private residences in many parts of the river, the JV maintains an organic odor neutralizer on board the dredge. If a particular reach of the river contains material with an odor strong enough to be offensive, the JV can spray the odor neutralizer around the barge as needed to control the odor.

The JV periodically monitors noise levels to insure that the City of Miami noise ordinance that limits noise levels to 79 dBA at night at the edge of a private residence property line is not being exceeded. Should noise become an issue, noise abatement devices will be installed on the machinery to mitigate the noise concerns.

SUMMARY

The need for dredging and the ultimate handling and disposal of the sediments are always a challenge. When contaminated sediments are involved, more often than not, projects don't materialize because of environmental concerns and the lack of public confidence that dredging can be accomplished so that environmental and cultural values can be sustained.

Everything leading up to award of the Miami River Dredging Project has demonstrated that local, state, and federal agencies can work together in defining a project that will provide economic benefits in the hopes of sustaining and enhancing the environment. All involved spent over a decade working together to overcome environmental and funding concerns. This led to a request for proposals from the contracting community to provide a best value approach for meeting all needs. Although the Miami River Dredging Project is still in it's early construction stages, what has been demonstrated to-date is that it's vital, to be successful, to have commitment and teamwork on the part of all stakeholders- to move forward.

From the viewpoint of the Weston/Bean JV, it was essential to get involved early in the process to really understand in the project goals and technical requirements. This was necessary to accomplish dredging, processing and disposal in a manner satisfactory to the community, the private sector, the sponsor, and the USACE.

ACKNOWLEDGEMENTS

The executive director of the Miami River Commission was asked to comment on the draft of this paper and made several very constructive comments on the history leading up to the award of the contract to proceed with dredging. He also requested that the following be acknowledged for making a very difficult and challenging project come to fruition: United States Congress, especially the Dade Delegation under the leadership of Congresswoman Ros-Lehtinen, former Congresswoman Carrie Meek, former Senator Bob Graham, the late former Senator Claude Pepper, the Florida Legislature under the leadership of Governor Bush, and the Dade Delegation, the City of Miami, Miami-Dade County under the leadership of Commissioner Bruno Barreiro, the Florida Inland Navigation District, the Miami River Marine Group under the leadership of Dr. Fran Bohnsack, and the South Florida Water Management District under the leadership of Irela Baque.