

World DREDGING

Mining & Construction

Vol. 51, Nos. 1/2 - 5/17

DB Heidi-Renee owned and operated by
JE McAmis Inc. (Chico, California)
dredging the Skipanon River with
their new 14.5 yd³ Cable Arm
Environmental Clamshell bucket
for USACE Portland District's
2016 Oregon Coast Clamshell
Maintenance Dredging project.

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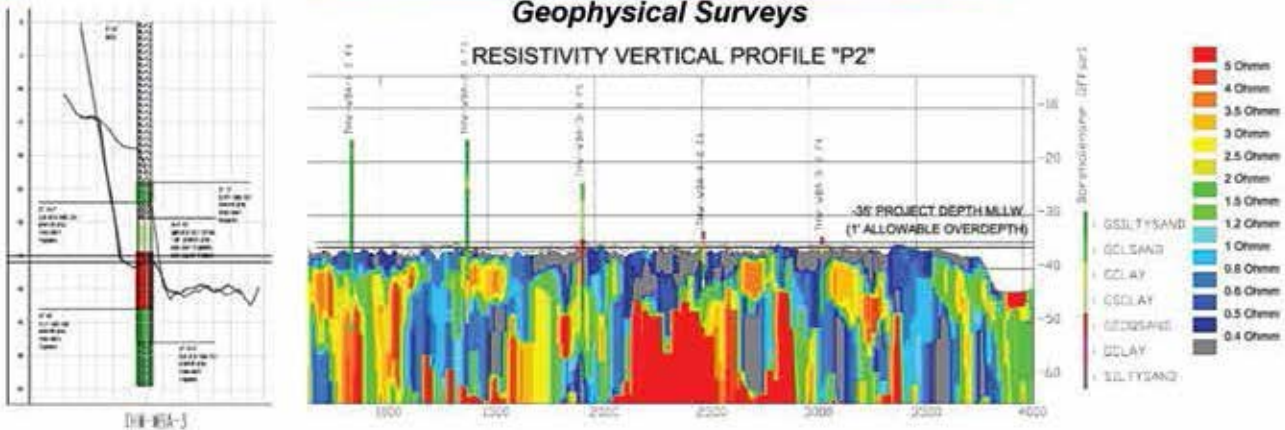
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Editor / Publisher

Steve Richardson
E: wdmcsteve@aol.com

Head Office

PO Box 17479, Irvine, CA 92623-7479, USA; T: (714) 451 - 2228,
F: (657) 227 - 9383, E: worlddredging@aol.com, www.worlddredging.com

International Correspondent

Kurt A. Richardson

Foreign Technical Editor

Dieter Giersch E: GierschConsult@gmx.de
Gluckstadt, Germany

Contributing Editor

Baer Charlton baer@charltonproductions.com
Portland, Oregon, USA

European Office

D. Mark Carter, Manager
South Place, Derby Road,
Haslemere, Surrey GU27 1BP, England / U.K.
T/F: +44 (1428) 64-2208, E: dworlddredging@outlook.com

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BOARD OF INDUSTRY ADVISORS...

The individual names and affiliations of the Board of Industry Advisors are not responsible for the content of WORLD DREDGING Mining & Construction magazine. The purpose of the Board is to provide current communication with the dredging industry.

COVER: DB Heidi-Renee owned and operated by JE McAmis Inc. (Chico, California) dredging the Skipanon River with their new 14.5 yd³ Cable Arm Environmental Clamshell bucket for USACE Portland District's 2016 Oregon Coast Clamshell Maintenance Dredging project.

J.E. McAmis performns
Marina del Rey Harbor
Maintenance Dredging &
Dockweiler Beach Enhancement
Los Angeles County, California



Dredging contractor J.E. McAmis of Chico California won the US\$ 2,696,000, 385,000 yd³ Marina del Rey Harbor Maintenance Dredging, Los Angeles County, California Project awarded by the US Army Corps of Engineers (USACE) Los Angeles District. The goal of the project, which began December 11, 2016 and finished March 20, 2017, was to dredge Areas 4 and 5 of the Harbor Entrance Channel to -20 / -22 MLLW (110,000 yd³) and dredge 130,000 yd³ in Area 6 Advanced Maintenance Area to -28 / -30 MLLW. In-Water disposal of dredged material at Dockweiler Beach Near Shore Placement Site. An optional amount 145,000 yd³ was awarded for Area 6 Advanced Maintenance.

The dredged material was deposited a few miles south at Dockweiler Beach which was the Near Shore Placement Site for Beach Enhancement / Shoreline Restoration.

J.E. McAmis' equipment on the project consisted of : Dredge Heidi Renee / 10 yd³ conventional clamshell bucket, Dump Scow Sand Island / 1700 yd³ Split Hull Dump Scow, Campbell Towing's Tug Norton Bay / 1600 hp Ocean Tug, Survey 1 / Single Beam Survey Boat conducting progress surveys at Dredge and Disposal sites.

Los Angeles District, US Army Corps of Engineers' Project Manager - Navigation Section, Jeffrey C. Cole stated, "...the Corps allowed for on beach or near shore placement in the MDR dredging project. This provides for flexibility and allows for the greatest amount of potential bidders. The contractor with the lowest bid has the option to use near shore or on shore placement or both. "

Near shore beach enhancement consisted of placing sand as near shore as practical within limits of permitted boundary. Disposal Site was split into three lanes so that the tug could optimize placement during times in which weather allowed nearest shore placement. Weekly single

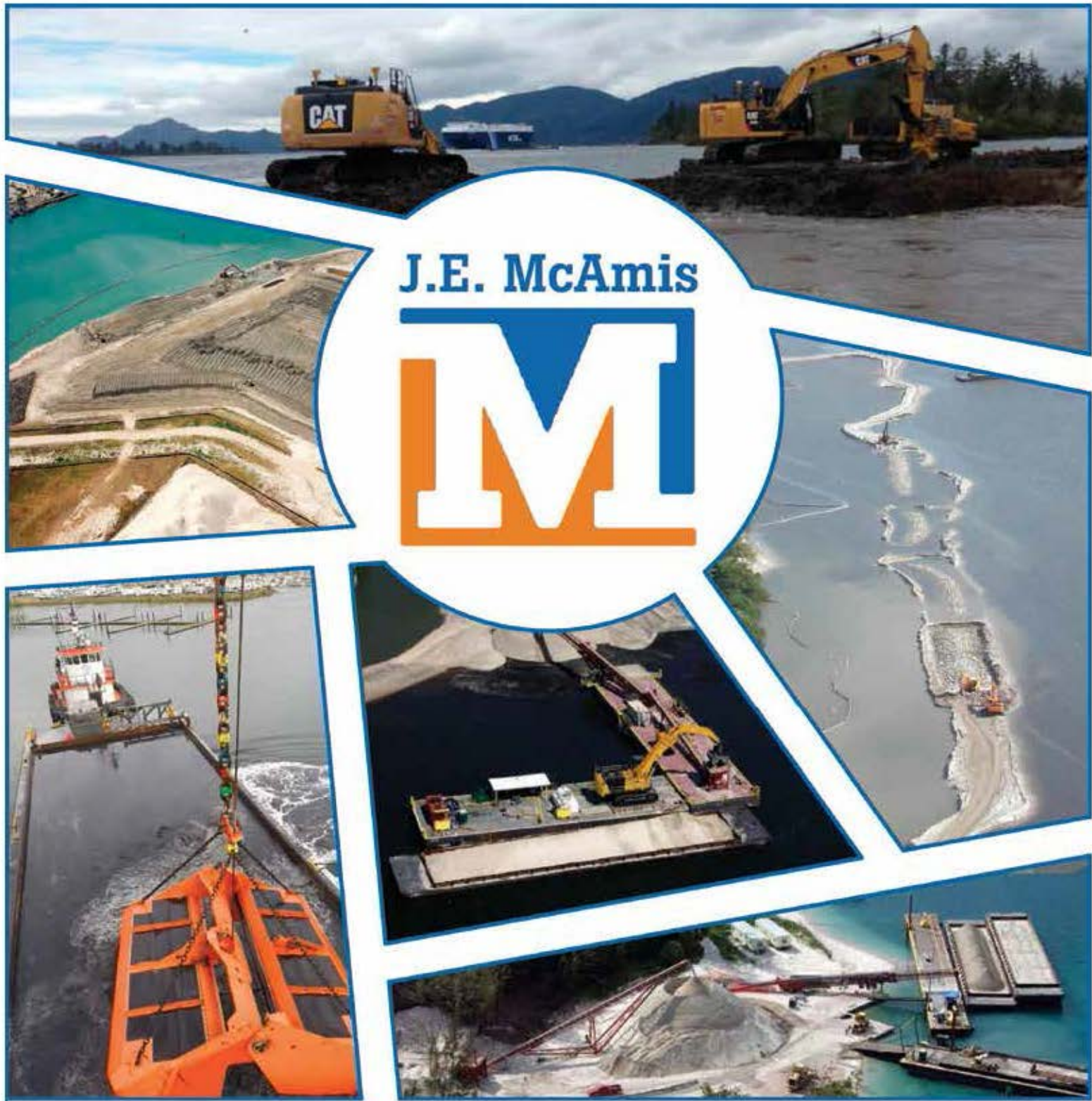
beam hydrographic surveys updated the tugs' Rose Point Navigation computer software to ensure proper placement without barge grounding and over placement.

Maintenance dredging of Marina Del Rey

The Near Shore Disposal site was broken into (3), 300' wide lanes. The nearest shore lane was disposed on high tides with minimal swell.

Weekly hydrographic surveys would dictate





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Marina del Rey Harbor
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Los Angeles County, California

(Continued)

In - Water disposal of dredged material at Dockweiler Beach Near Shore Placement Site.

disposal placement to avoid grounding and proper placement. Weather conditions and high periods of swell would change the dynamics of the site and move the nearest shore placement material to the beach as designed by the USACE LA District.

The project consisted of 3 Acceptance Areas, Area's 4 and 5 were approximately 400' x 500' areas of the entrance channel into the harbor with a minimum dredge elevation of -20 MLLW and a maximum dredge depth of -22 MLLW. Area 6 was a 600' x 500' area of Advanced Maintenance with a dredge depth of -28 MLLW minimum and -30 maximum.

Dredge depths ranged from -13 in Areas 4 and 5 to + 4 in Area 6. The project was designed to clear the shoaling into the harbor, dredge the Advance Maintenance Area 6 (275,000 yd³) to help keep the harbor channel clean of infill material.

J.E. McAmis had dredged the site successfully in 2006.

The project ran seven days a week, 24 hours per day. Shifts on the dredge were 00:00 to 12:00 / 12:00 to 00:00. Tug crew was six hours on six hours off. Personnel consisted of the following : two Operators, two Deck Engineers, two Deckhands, Site Safety and Health Officer (SSHO) and Project Superintendent with four men on the Tug crew.



The project experienced only 12 days of down-time for weather and a 10 day holiday shutdown from December 23 through January 2.

The end of the Environmental Work Window was April 15 which the project complied with well in advance completing March 20.

The project was monitored by USACE LA District, LA County Beaches and Harbors. LA County Sheriff Department, US Coast Guard (USCG). Pi Environmental, LLC. performed water quality monitoring. Sediment sampling was done by CTE, Inc., (eight) sediment samples total. Hydrographic multi-beam surveys required for progress payments were conducted by Northwest Hydro Inc.

The project clients were very happy with the performance and quality of workmanship. Locals welcomed the dredge operations without any complaints.

Project Manager Darrell Jamieson also said, "I would walk nightly on the North Jetty and speak with the locals who would ask great questions and express interest in the operations, all in a positive manner."

About J.E. McAmis, Inc.

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J.E. McAmis is a Service-Disabled Veteran-Owned, HUBZone certified contractor.

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(See ad on pg. 7) ○



Project Manager Darrell Jamieson

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Salt Marsh Restoration through Beneficial Reuse of Dredge Material

Due to rising sea levels many of Rhode Island's salt marshes, including the marshes in Ninigret Pond, are beginning to drown in place, becoming mud flats or open water. Why is this a problem? Salt marshes perform many important functions, such as storm protection for communities along our shorelines and habitat for a variety of wildlife.

To save one of these valuable resources, the Rhode Island Coastal Resources Management Council (CRMC) and its partners designed a project that beneficially reused sediment dredged from the Ninigret Pond breach way channel to build up the elevation of an adjacent marshland. The long-term objective of the project is to preserve the function of the existing salt marsh by making it more resilient to rising sea levels and storm events. An additional goal is to slow the entry of sediment into the pond to maintain a deeper breach way channel between the Atlantic Ocean and Ninigret Pond.

To reach their goals the CRMC contracted J.F. Brennan Company Inc. (Brennan), an environmental services and marine construction firm that specializes in waterway remediation and habitat restoration. Brennan's job was to dredge two sedimentation basins within the breach way channel and beneficially reuse the dredged material to enhance an adjacent marsh as well as re-nourish a nearby beach.

Brennan utilized two 8-inch



Two 8 inch Dredges



Project Area



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Salt Marsh Restoration through Beneficial Reuse of Dredge Material

from pg. 11



Amphibious excavator working the discharge.

hydraulic dredges to complete both phases of the two-phased project. For the first phase, dredge pipelines were snaked through the breach way channel and into the marsh area. Dredged material was then deposited in several locations at varying thicknesses to meet the final design contours and elevations. As the material exited the pipeline in the desired locations, Brennan utilized one of its customized amphibious excavators to spread the sediment. This excavator has an extremely low

ground pressure, so it was ideal to move across the soft marsh without the need for any temporary access roads. Brennan then used a low-pressure bulldozer for the final grading and contouring.

Once Brennan finished restoring the marsh elevation, they reconfigured the dredge pipelines and added a booster pump. Sand from the breach way was then pumped nearly one mile and discharged along the shoreline in an inter tidal area located to the east of the breach way. This material was spread using an excavator and low-pressure bulldozer as part of a re-nourishment project for the Charlestown Town Beach.

The next step for the newly restored marsh will be to monitor its reestablishment. Over time, salt marsh grasses will begin to recolonize the



8 inch dredge

newly covered areas. One of the partners of the project, Save The Bay, will work with CRMC to plant a portion of the restored area to “jump start” the natural recolonization process. Many of the plants will come from native seeds collected in Rhode Island with the help of the New England Wildflower Society. If all goes according to plan, healthy salt marsh grasses will again cover the restored marsh. www.jfbrennan.com (See ad on pg. 11) ○

Bradford Fish Ladder Bank Erosion Repairs – 2017

Will Jones and Michael Eakin, Marine Industrial Construction

In early 2017, this repair occurred at Bonneville Lock and Dam at Bradford Ladder. The objective of the repair was to minimize on-going shoreline erosion adjacent to this primary fish ladders. The project required rebuilding a revetment on the north shore of Bradford Island under the B Branch.

Bonneville Dam is a major hydroelectric facility on the Columbia River at River Mile 145. The dam is managed and operated by the U.S. Army Corps of Engineers, Portland District (Corps). The dam has three fish ladders to support major fisheries. In 2016, close to 700,000 adult Chinook salmon as well as Coho, Steelhead, Sockeye, Lamprey and Shad passed through Bonneville Fish ladders. The Bradford fish ladder has two entrances: one near the original powerhouse on the Oregon side of the River (A Branch) and one under the main spillway (B Branch). The shoreline below the B Branch fish ladder was found to have major erosion directly below the fish ladder. This erosion had the potential to adversely affect the B Branch Fish Ladder.

The Bradford Island Fish ladder was completed in 1938. Historical repairs in the local vicinity occurred shortly after



Figure 1. Map of the Project Area

Continued on pg. 18



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CLEANING UP THE DUWAMISH

Long reach Hitachi 1200 excavator placing granularly activated carbon (GAC) in the Duwamish Waterway – Photo courtesy of Pacific Pile & Marine

BACKGROUND

The Duwamish River is the name of the lower 12 miles (19 km) of Washington State's Green River. The industrialized estuary, known as the Duwamish Waterway, is a major shipping route serving commercial and industrial operations for containerized cargo, marina operations, concrete/metal/aeronautical manufacturing, fishing, and food processing. Although the Waterway is viewed primarily as an economic sector, it is bordered by several residential neighborhoods and used for recreational purposes.

The Lower Duwamish Waterway is a 5.5 mile section of the River that flows into Elliott Bay in Seattle, WA. In 2001, the U.S. Environmental Protection Agency (USEPA) added the site to the National Priorities List (NPL) or Superfund after more than 100 years of heavy industrial use left the waterway contaminated with toxic chemicals. Pollution in the river sediments includes polychlorinated biphenyls (PCBs), dioxins/furans, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and arsenic. Many of these chemicals remain in the environment for a long time and have risen to unsafe levels in resident fish and shellfish. In 2002 the Washington State Department of Ecology (DOE) listed the site under the authority of the Washington Model Toxics Control Act (MTCA).

Despite the industrialization of the Waterway, it remains a vital habitat for countless species of fish and other wildlife, many of which contain an unhealthy amount of contaminants as a result. Fish, other than salmon, and shellfish found in the river have been classified as unfit for human consumption.

Over the past few decades years, public agencies and volunteer organizations have worked to restore inter tidal and sub tidal habitat to the river. The concentrations of sediment contamination vary, but many areas exceed the Washington Sediment Management Standards and/or regional Dredged Material Management Program criteria.

ENHANCED NATURAL RECOVERY

Enhanced Natural Recovery (ENR) is the process of covering contaminated sediments (river mud) with a thin layer of sand to speed up the process of natural recovery – the natural deposition of cleaner sediments to cover contaminated sediments. For the purposes of this project, ENR involved the placement of a thin layer of clean material (sand or gravelly sand) over sub tidal or inter tidal sediments and ENR+AC involved the placement of a thin layer of clean material augmented with AC with the goal of determining whether adding activated carbon to the sand layer can reduce PCB bioavailability (the amount of PCBs that can be taken up by fish and other living things in the river) in sediment as part of ENR.

In 2014, USEPA announced a cleanup plan for the Duwamish. The Record of Decision (ROD) was intended to reduce the ecological risk to people's health and the environment from toxic chemicals in the river. The plan includes details of the cleanup of about 177 acres in the waterway. Cleanup will involve dredging, capping, and natural sedimentation at an estimated cost of US\$ 342M.

The Lower Duwamish Waterway Group (LDWG), which is made up of King County, the Port of Seattle, the City of Seattle, and The Boeing Company is conducting important work to advance the design of USEPA's plan. In 2016, the LDWG, with King County as the lead, contracted with Pacific Pile & Marine (PPM) to



Long reach Hitachi 1200 excavator placing granularly activated carbon (GAC) in the Duwamish Waterway – Photo courtesy of Pacific Pile & Marine

conduct an Enhanced Natural Recovery Activated Carbon pilot study.

ACTIVATED CARBON PILOT STUDY

The purpose of the study is to compare the effectiveness of ENR with added AC (ENR+AC) with that of ENR without added AC. ENR and ENR+AC layers were engineered to be placed on sediments in plots that represent three habitat types: (1) Sub tidal, (2) Inter tidal, and (3) a sub tidal area that may be influenced by propeller wash, which is referred to as the "Scour Plot." Because the goal of the pilot study is to evaluate the performance of ENR augmented with AC as compared with that of ENR alone, the pilot study was evaluated side-by-side subplots. This study is particularly noteworthy when compared to conventional capping because the effectiveness of ENR+AC in reducing PCB bioavailability has the potential to influence remediation options for Superfund sites such as the Lower Duwamish Waterway and Portland Harbor.

The main goals of the study are to:

- (1) Verify ENR+AC can be successfully applied in the Lower Duwamish Waterway by monitoring physical placement success (uniformity of coverage and percentage of carbon in a placed layer);
- (2) Evaluate the performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations;
- (3) Assess potential impacts on the benthic community in ENR+AC compared to ENR alone;
- (4) Assess changes in bioavailability of PCBs in ENR+AC compared to ENR alone; (5) Assess the stability of ENR+AC in scour areas (such as berthing areas).

PROJECT TEAM

The study is being commissioned by the Lower Duwamish Waterway Group made up of King County, the Port of Seattle, the City of Seattle, and The Boeing Company. The Project Lead was King County. Engineers on the project included Amec Foster Wheeler and Dalton, Olmsted & Fuglevand, Inc.


Major Stakeholders included the USEPA, U.S. Army Corps of Engineers, DOE, Muckleshoot Indian Tribe, Suquamish Tribe, U.S. Fish and Wildlife Service, and Washington Department of Fish and Wildlife. PPM was the General Contractor. Hydrographic survey support was provided by TerraSond Limited.

ENVIRONMENTAL BENEFITS


The project is designed to improve long-term sediment and water quality by employing a technique that reduces contaminant concentrations in sediments. The direct environmental benefit of the remedial action is to restore several plots within the waterway to jump-start the natural process of recovery and improving the aquatic habitat for resident wildlife such as benthic invertebrates and fish. These chemicals can accumulate in their tissue. This poses an elevated health risk through ingestion. By removing these toxic chemicals in the sediment, it reduces the risk. Cleaning up this industrial corridor will improve conditions for local residents and provide a variety of economic benefits for the local community for the myriad of users.

The overall environmental and economic benefit of this project will be determined by the effectiveness of the pilot study in reducing concentrations of sediment contamination and long-term protectiveness in combination with limiting short-term adverse effects to water quality during construction.


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Long reach Hitachi 1200 excavator placing granularly activated carbon (GAC) in the Duwamish Waterway – Photo courtesy of Pacific Pile & Marine

CLEANING UP THE DUWAMISH

Continued

If the results of the study prove to be successful, this application could prove beneficial for the 48 acres of the overall Duwamish River cleanup.

PROJECT CHALLENGES

Although Granularly Activated Carbon (GAC) has been used in several remediation projects, this project had very prescribed procedures of the storage and placement of the GAC that have not been previously utilized. The project was designed with a 4% Activated Carbon (AC) concentration based on the dry weight of GAC and ENR material. The concentration was based on previous studies which were designed to decrease bioavailability of PCBs without impacting benthic communities. GAC material has distinct properties including a low specific gravity and a high void ratio that make placement of AC blended with sand or other aggregates more complex than placement of sand and gravel materials alone.

The 4% requirement provided a challenge in eliminating potentials for AC loss during the production, handling, and placement of the

material. This required the blended material (ENR+AC) be loaded onto a water-tight barge and be presoaked by flooding the barge with Duwamish River water for a minimum of 12 hours before material placement. The blended material was then required to be kept saturated at all times before placement.

The intent of the presoaking is to wet the AC particles and reduce the amount of air in the AC pore spaces, and thus reduce the difference in density between the AC and the ENR material. With the project being a pilot program and situated within an active waterway there were several challenges to the execution of the work. The ENR and ENR+AC materials needed to achieve a minimum thickness of 4" to 6" over the subplot area. The project had a total target thickness of 6" to 9" over a minimum of 80% of the area and 100% of area 4" or more in thickness. The maximum thickness was not to exceed 12".

The Duwamish River is a busy waterway serving several cargo, manufacturing, and industrial terminals. In the west waterway alone there are an average of 500 vessels movements a month. Two of the plot locations were located in the direct traffic lines for several maritime businesses.

There were production concerns including the uniformity of mix required to get the AC %age with each barge load of ENR material and handling of the ENR+AC material once it was loaded on the material barge. It was feared that additional handling could cause segregation of the AC from the ENR, or create substantial winnowing of AC from the ENR during placement. The AC has a specific gravity similar to that of water and could be resuspended and sorted from the heavier sand and gravel ENR materials during placement.

INNOVATIVE APPROACHES

A fixed-arm excavator equipped with a sealed clamshell bucket was used for placement of ENR and ENR+AC materials to achieve the minimum 4" thickness. The clamshell bucket selected for this project was a 5-yd³ Young Environmental bucket. When the bucket is opened in a static position it will place material in a cosine wave with the average material thickness being 1.7". This volume and thickness was out of tolerance with the project specifications. PPM determined the best solution would be to weld internal plates in the bucket to restrict volume and modify the placement geometry. PPM performed several dry tests at their equipment facility to figure out what configuration of plates placed the optimal thickness and geometry. To achieve the targeted 6-9" overall thickness, material was ultimately placed in two 4.5" lifts with an offset bucket pattern.

In addition to the material thickness, it was also required that the bucket be opened 2' from existing mudline. This approach would allow for a more uniform placement of material as it fell through the water column. The use of a RTK GPS machine control was used however a bucket open-close sensor was also installed on the bucket. The sensor was used as a Quality Assurance measure to allow the Engineer to verify the bucket was not opened prior to achieving the 2' target above mudline.

Typically in a capping project the operator will place the buckets in a fan pattern using Dredgepack to mark the buckets as they place them. It is at the operator's discretion where the buckets are placed and how much overlap. Due to the extreme emphasis on uniformity of coverage bucket grids set to the bucket's dimension were developed, set within the plot boundaries, and loaded into the Dredgepack software. The operator would then line up each bucket to the required bucket location. The only way to achieve the border of the bucket to the bucket grid was to install a bucket rotation sensor so the exact position of the bucket was transmitted to the operator via Dredgepack. This process was gradual and tedious as not only did the bucket have to fit precisely within the bucket grid but the bucket also need to be positioned at the 2' above mudline target zone.

The requirement for the pre-soaking the material, although not a new concept, was much more prescribed on this project. Bin barges were welded and sealed in order to hold water. The material was loaded onto the barge via conveyor in windrows. Once the barge was on-site it was flooded with water until the water was 1-2" over the material. The water level was then to be maintained during placement to ensure continuous saturation of the AC.

Another technology applied to the project was the ability to real-time track the location of the spud anchors. The tracking was done in order to avoid accidentally spudding down in previously capped areas that would damage the ENR materials. It was also used to identify where the spuds had been placed prior to capping in order to target those areas for additional ENR material placement.

BY THE NUMBERS

- 1,341 tons of ENR Sand placed in one plot ;
- 1,389 tons of ENR Sand + 58 tons of Activated Carbon placed in two plots ;
- 2,540 tons of Gravelly Sand placed in two plots;
- 2,274 tons of Gravelly Sand + 95 tons of Activated Carbon placed in two plots ;
- 3,293 distinct buckets of material placed throughout entire project;
- 183 spud anchor holes in the plot footprints that needed to be filled.

GENERAL CONTRACTOR

PPM is a heavy civil and marine infrastructure contractor that provides construction and logistics solutions to clients in need of environmental remediation, over-water structures, shoring, demolition, specialty foundations, and heavy lift services (to name a few) in the Western United States. PPM recently formed PPM Civil Constructors as a division of PPM to offer those same services to Western Canada. PPM has an extensive fleet of equipment including barges up to 15,000 ton capacity, cranes up to 600 tons capacity marine 450 tons upland, and mid to large-sized excavators with a reach of up to 60-ft. PPM is a Union-shop averaging between 80 and 100 employees. www.PacificPile.com (See ad on pg. 27) ○

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Bradford Fish Ladder Bank Erosion Repairs – 2017

from pg. 13

flood related erosion events in 1948 and 1964. In contrast, more recent erosion in 2011 may have been related to modifications of the spillway in 2001 affecting hydraulics patterns as opposed to extreme flooding. Erosion in the affected area could undermine the fish-way, risk damage to the structure and ultimately, fish passage at key times during the year. The 2012 repair was limited in scope to deal with the immediate concerns of operating the fish-way and providing foundation support. The limited repair consisted of concrete placement under the ladder and placed rip-rap materials with some additional grouting above the waterline. A long term solution was deferred pending a major rehabilitation of the Bonneville Project.

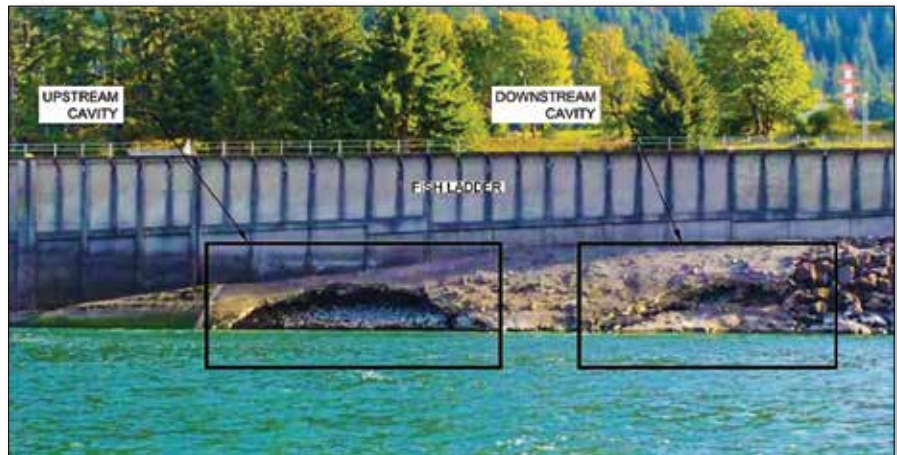


Figure 2. Erosion areas (Corps of Engineers Photo)

This 2016-2017 Repair is not a part of the planned major rehabilitation but was designed for the hydraulics of an extreme flood (Annual Chance Exceedance (ACE) of 1%) and models were used to account for any changes in the hydraulics from 2001. This repair is presumed to have an indefinite service life similar to the other rock structures in the spillway.

Problem

The Corps evaluated the erosion in the summer of 2016 and determined that the grout had failed and the rip-rap and underlying material had eroded away. The Corps designed a new revetment, which incorporated many additional design factors including:

- Significantly larger sized rip-rap (D50=3,000 lbs) than used in 2012. Also the rip-rap sizing accounted for slope which was never included in previous designs (1948 and 1964) and not available in practice until after the Corps completed the research in the late 1980s.
- Thicker layer of rip-rap than used in 2012 (Minimum 7.5 versus 3 to 6 feet) ;
- Lower resulting slopes for improved stability (previous repairs were to slopes of 1.5:1 to 2:1 and new repairs were all 2:1 Slope) ; and
- Base contract included an additional berm at the toe of the slope for extra stability resting on the bedrock spillway.

An option existed for excavating a traditional key at the toe of the slope, however, the bedrock spillway was harder than specified in the contract and therefore the option was not executed. The erosion present (as seen in the above photos) shows large cavities under the grouted rip-rap in front of the ladder.

The rock specified for the project ranged from 938 to 15,000-pound rip-rap with an average rock diameter of roughly 39"



Figure 3. Dredge with support tug and 2 loads of rock

and good gradation and quality. Many of the specifics from the historical repairs, especially those completed in 1951, probably in response to 1948 erosion event were unknown due to lost documents. Therefore, some of the rock from the historical repairs was excavated and replaced to provide a fully engineered structure from top to bottom and is expected to withstand a design flood event.

Contract

The contract had numerous components including obtaining rock (11,700 tons), marine transport, demolition of eroded grout, excavation, and placement of rip-rap and all supporting engineering, safety and related work.

Safety was important on the project since it is under a spillway in a boat-restricted zone with cold water and high flows. The contractor was Marine Industrial Construction (MIC) of Wilsonville, Oregon.

Marine Industrial Construction is a specialized Oregon based marine construction company with a fleet of tugs, barges, dredges and shore-based mining and construction equipment. MIC was the primary contractor for this project. The MIC Team consisted of its crew, LKE (rock supply and demolition),

Continued on pg. 25

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19



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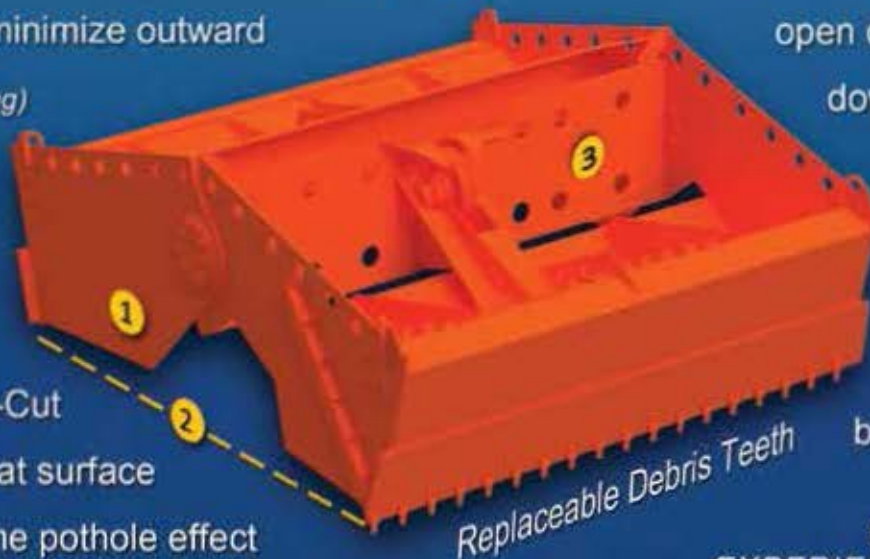
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A near Level-Cut produces a flat surface opposed to the pothole effect which can create a pool of contamination.

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Cable Arm

Designed to tackle the 4 Rs of environmental dredging (Resuspension

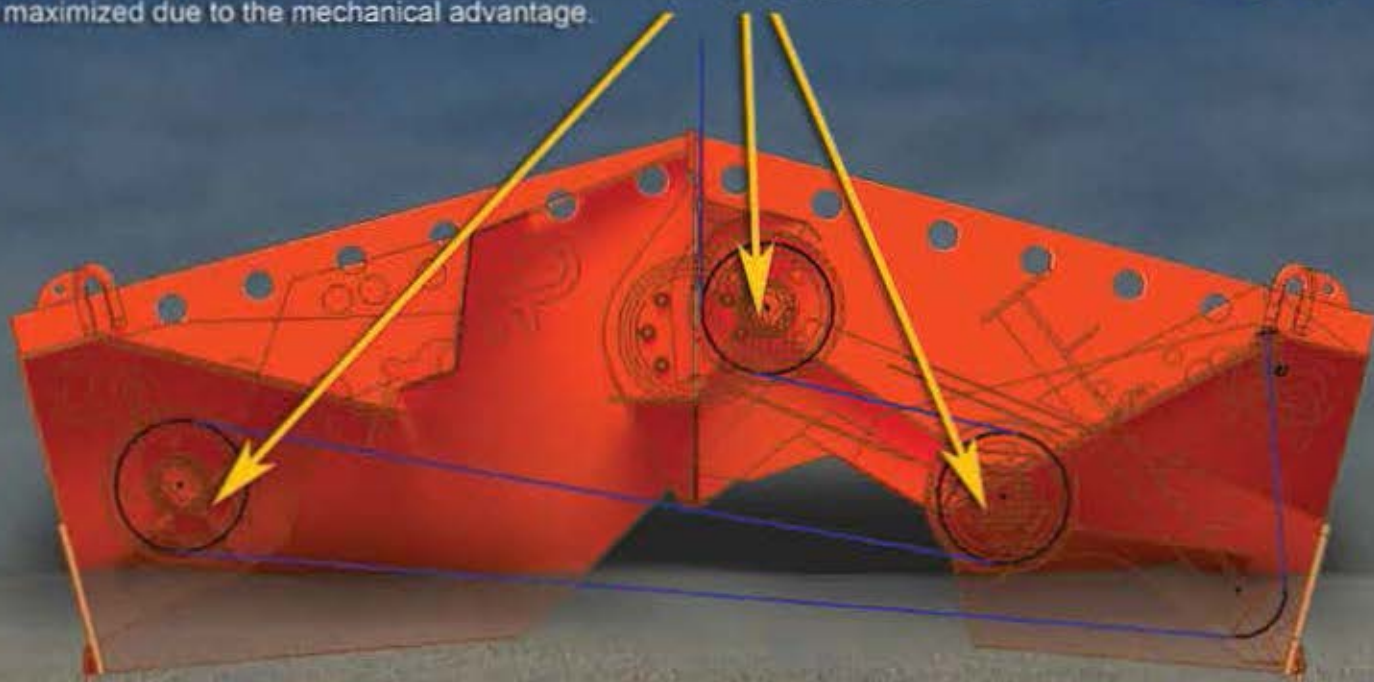
Resuspension

When dredging, sediments are loosened, stirred, and dispersed into the water column. These sediments then resettle overtop the freshly dredged area and downstream when a current is present. The Cable Arm Environmental clamshell features an open center and venting system to allow the bucket to descend without water pressure buildup beneath it. The bucket is designed with overlapping side plates to prevent sediment from pushing out the sides, and to seal in the material. Rubber flaps and the material's low center of mass also help seal and enclose the sediment to prevent washout during ascension.

Release

Pollutants are absorbed into and adsorbed onto pore water and sediment material. Once disturbed and re-suspended, those trapped pollutants can be released. It is, therefore, imperative that dredging operations minimize the resuspension of contaminated sediment. Another unique feature of the Cable Arm Environmental clamshell is the angle of its cutting edge. The 150° cutting angle allows the bucket to scoop the material with minimal disturbance. Optional debris teeth combined with maximum cutting edge forces ensure each bite makes it to grade, without material spillage, and leaves a near flat surface.

The unique design of the Cable Arm Environmental clamshell provides the bucket with key environmental features designed to minimize the 4 Rs. The clamshell's closing line is guided by either 2 or 3 sheaves to apply its closing forces. When adding the 3rd sheave (see image below), the force along the cutting edge is maximized due to the mechanical advantage.



WATCH VIDEO:
<http://www.cablearm.com/Buckets/Enviro.html>

A LOOK INSIDE THE BUCKET

n, Release, Residual, and Risk) and specializing in shallow cut sediment removal.

Residual

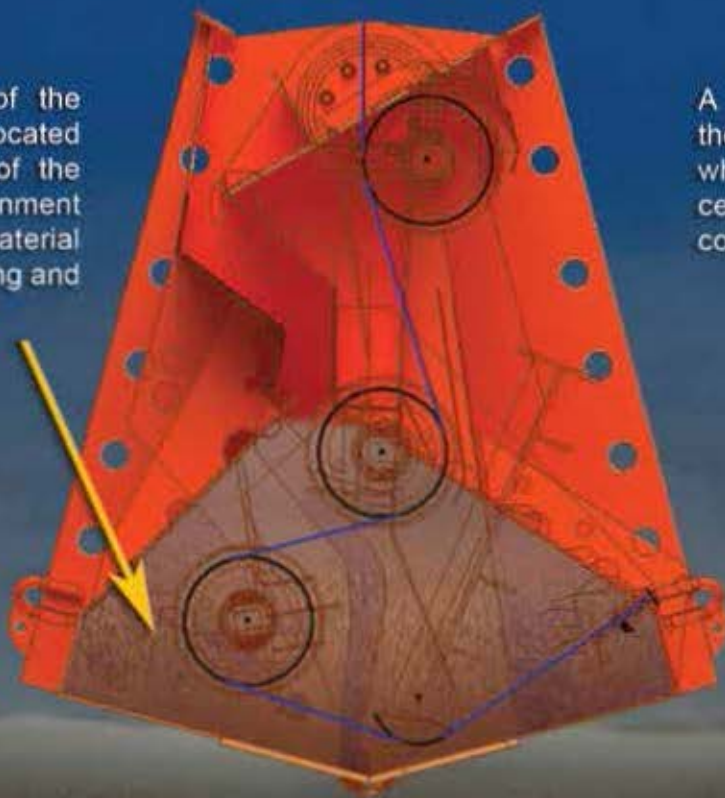
Ideally, all contaminated material will have been removed during the dredging operation. Of course, nature hardly ever provides ideal dredging conditions. That is why it is important to have a versatile, yet job specific, customized bucket. With over 25 years of experience, Cable Arm continues to be the leader in environmental clamshell innovations.

Risk

All change comes with risks. When those risks include our water, food, and health, it is vital that not only the best plan is implemented, but that the best equipment is utilized. The bucket should be part of the solution, not the problem. When equipping a dredge with a Cable Arm Environmental clamshell, the reward outweighs the risk.

Approximately $\frac{3}{4}$ of the material's mass is located below the center of the bucket's containment area to minimize material washout while closing and ascending.

A 150° cutting edge allows the bucket to "scoop" material which lowers the materials center of mass within the containment area.



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Cable Arm

DEBRIS BUCKET

Separate and Remove Debris from Sediment to allow smooth removal dredging operations

PRE-DREDGING

Navigational model with dual sided grizzly bars

***footprint shown in 19 ft X 20 ft

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**patent & patent pending

Bradford Fish Ladder Bank Erosion Repairs – 2017

from pg. 18

NW Hydrographics (surveying and mapping) and JT Marine (barge loading and access).

Equipment needed to be marine based and able to work effectively in a small project area (which is about 200 feet long by 150 feet wide.) Deployed equipment included tugs, barges and dredges. Specific major equipment on site included a tug (the Duchess B, a 1400 Horsepower triple screw tug), a barge mounted crane (a 100 ton clamshell crane with 80 foot boom mounted on a 100 foot by 36 foot barge with generators, warping lines and 60 foot spuds for position), a barge mounted excavator (a 80,000 pound machine) mounted on a 150 foot barge, and equipment and a safety boat (a 21 aluminum foot Thunder Jet with two motors).

The contract required a continuous supply of material and had no space to stockpile at the site. MIC used six (6) of its deck barges (each with roughly 1000 ton capacities) to transport rocks to the site on a just-in-time delivery schedule. The winds and seas during the project were significant and required lighter loading of the barges to have more free board (up to 2 feet). Barges were mostly loaded to 650 tons and moved on site with 1800 HP deep draft tug. The tugboat Rene transported most of the rock. The tow duration averaged 12-hours from Vancouver to Bonneville Dam, with a return trip of roughly 8 hours.



Figure 4. Mobilizing equipment up the Columbia River



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Bradford Fish Ladder Bank Erosion Repairs – 2017

Continued

Contract Complexity

The contract was complicated by a narrow time window, the lock closure for upstream access, the need to spill water (dam releases) because of excess flows, high winds, and several snow and ice events. These conditions impacted the rock delivery, access to the site, and the work schedule.

The project also included some challenging logistics on supplying rock. Detailed requirements included specific size gradation, testing (drop tests, limited fracturing, and density), angularity and other components. The Rip-rap was mined at the Munsen Quarry in The Dalles, Oregon, which is above Bonneville Dam.

There is no shore-side access for material loading or stockpiling. The navigation locks at the dam were closed during the project, so rock needed to be transported by truck roughly 90 miles to Vancouver, Washington (the nearest downstream loading site) where the barges were loaded and then pushed 40 miles upstream to the project site.



Figure 5. Dredge and Excavator working on demolition

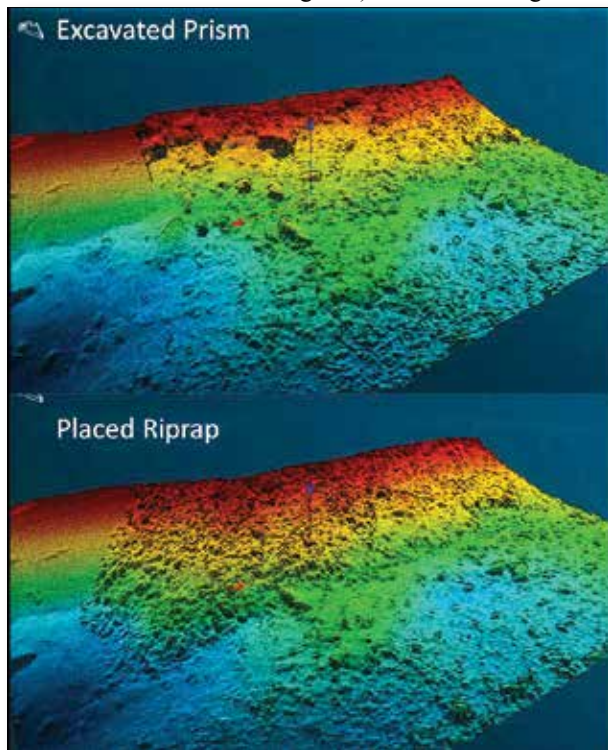


Figure 6. Draft 3D images of Excavated and Final placement

(originally specified as having an unconfined compressive strength of 6,000 psi) was hammered into smaller pieces that were subsequently excavated and stored on barges.

Excavation

The excavation and dredging was completed with a barge mounted clamshell dredge. A Bucyrus Erie 71B crane is mounted on a 100' x 36' x 7' barge. The 100-ton duty crane has a maximum allowable load of 65,000 lbs. at a radius of 25 feet, and 24,200 lbs. at 40 feet. The dredge has 60 foot I beam spuds for positioning with and warping lines for barge positioning. A 3 yd³ ESCO clamshell bucket with teeth was used to remove the material and place it on barges for recycling.

Schedule

The in-water-work window was very short to minimize potential impacts to fish populations. The work window was from January 12 to February 28. The time window created one of the largest challenges for the project. The tight schedule was further impacted by severe winter weather (ice, snow, wind, seas, road closures, etc.). January 2017 had more snow and ice than previous years with an average January temperature of 29 degrees and over 4.5 inches of precipitation (primarily in snow and ice storms). The MIC crew in conjunction with the Corps staff worked all possible time windows available by staying on the vessel and obtaining local lodging to maximize access to the project area.

Spillage of water from the dam also affected the work window. Bonneville Dam is a run of river dam and does not have storage ability. The work is directly below the spillway and no work can be performed when water is being spilled due to safety. The Columbia River flow conditions required the Dam to spill on 14 of 28 days in February. MIC was required to stop all work for each spill. Daily coordination meeting occurred (except for Sundays) with final Spill notices given about 3 hours in advance.

Demolition

The demolition was successfully completed using a barge-mounted excavator equipped with a vibratory hammer. The grout

Placing Rip Rap

Each Rock was placed in the prism individually using an ESCO 3 yd³ clamshell bucket with teeth. Placements were marked using boom tip GPS and WinOPS dredging software. Areas were assessed to match target depth using line markings and a gage monitoring the river level. A Trimble Geo 7 with a range finder was used to check position off the fish ladder and dam. It was critical to evaluate where each rock was in the prism to ensure proper depth and slope.

The rip-rap was placed by working from downstream locations to upstream starting at the toe of the material and stacking material to the top of bank. Rocks sizes were evaluated by the operator to ensure interlock. Smaller rock was sprinkled into the mix to ensure tight connections in the rock network. The specifications required placement for maximum interlock and every attempt was made, however placement under water often resulted in a stone being rolled into position. Corps indicated this affect is accounted for in design by using a larger minimum layer thickness below the water line.

Quality Control

Detailed quality control and quality assurance was completed by the contractor and the Corps. This included constant grade checks and verifying the depth of exaction and fill, detailed tracking tonnage from barge displacement, field surveying and mapping with lasers and high precision Trimble Global Position Systems (GPS), tracking dredging and placement with multiple Raven differential GPS systems (installed on crane boom tip and on dredge).


In addition, a BlueView image sonar was used to review underwater activities, and five multi-beam surveys were completed. Detailed analysis were completed of the survey data, dredge logs and design data in CAD (AutoCAD and Civil 3D) and GIS software (ArcGIS).

Restored Shore Line


Restoring the bank was critical for the success of the project. The improved design should provide a significantly stronger revetment and protect the Bradford Island Fish Ladder. The project was completed just as the adult fish passage season began March 1st- November 30th. Spillway operations for juvenile fish passage are from April 10th through August 31st.







Figure 7. Rene, Duchess, Excavator Barge, Dredge and Rock Barge off project area (viewing from Bonneville Dam) ○

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Work begins on developing an innovative fueling process in the Atlantic arch

S/F SamuelLNG Project, lead by French Dragages Ports (DP), is the first phase of the Global Project 'Towards a Blue Atlantic Arch by 2025'. The overall project aims to improve the sustainability of marine traffic through the use of marine Liquefied Natural Gas (LNG) as an environmentally-friendly, and cost-effective, alternative to conventional ship fuels for small vessels.

According to the 'Third IMO Greenhouse Gas Study 2014', maritime transport emits around 1,000M tons of CO₂ annually and is responsible for about 2.5% of global greenhouse gas emissions. Shipping emissions are predicted to increase by between 50% and 250% by 2050 – depending on future economic and energy developments – and something clearly needs to be done. Such increases

are not compatible with the internationally agreed goal of keeping the global temperature increase below 2°C, compared to pre-industrial levels. The current goals require worldwide emissions to be at least halved, from 1990 levels, by 2050.

Subsequently, the IMO's Marine Environment Protection Committee (MEPC) has agreed that implementation of a 0.5% global sulphur cap on marine fuel will be brought forward to 2020, from the originally proposed date of 2025. The S/F SamuelLNG Project will contribute to this by helping to achieve the objectives of two key EU Directives: Directive 2014/94/EU on the sustainability of the European maritime transport and Directive 2012/33/EU on reduction in the sulphur content of marine fuels.

As the regulations around shipping emissions become more stringent LNG is expected to become increasingly important as an alternative fuel. As a result, the number of LNG-fueled ships being commissioned is growing and at present the supply infrastructure required to service them is limited. The outcomes of the S/F SamuelLNG Project will help to address the increasing need for an innovative and sustainable fueling process in the Atlantic arch.

Key activities

Over the next three years, the S/F SamuelLNG Project will cover the following key activities:

- LNG bunkering studies including: a risk assessment in the port of Nantes Saint-Nazarene, a mobile bunkering unit in the Port of Gijon, and a floating device in the Port of Vigo (in conjunction with each of the port's partners) ;
- LNG retrofit of DP's Samuel de Champlain - an 8,500 m³ Trailing Suction Hopper (TH) Dredge - from Marine Gas Oil to a dual-source fuel engine system ;
- Environmental Impact Assessment studies in the Ports of Rouen, Le Havre and Nantes Saint-Nazarene ;
- The training of staff involved in LNG operations in the Ports of Nantes Saint-Nazarene and Rouen ;
- Dissemination of the results to the maritime community by CEDA.



DP's Samuel de Champlain - an 8,500 m³ Trailing Suction Hopper (TH) Dredge



Port of Gijon

Stage 1: Setting up an innovative fueling process in the Atlantic arch

The first stages of the project, which will lead to the development and deployment of the LNG distribution infrastructure in the Atlantic arch, are underway. Activities include a risk assessment on marine LNG handling in the Port of Nantes/Saint-Nazarene, and detailed pre-design studies which will result in designs for an LNG mobile device in the Port of Gijon and a floating LNG storage device in the Port of Vigo.

Risk assessment study: Initial assessments have suggested that the 'trucks-to-ship' method is, at this stage, the best for LNG bunkering activity in the Port of Nantes/Saint-Nazarene and on the Loire estuary. The Port is leading the study which aims

to fully assess the risks and establish the rules for authorizing this bunkering procedure, plus those for 'barge-to-ship' and 'ship-to-ship' refueling scenarios. The assessment consists of hazard identification studies for the different sites to highlight the risks of LNG bunkering operations involving one or more LNG tankers; and the impact of bunkering on port operations and surrounding facilities, in terms of health and safety, and operational and environmental risks. It is also looking at the safety barriers and additional measures that will be needed to avoid any identified risks.

Bunkering and pre-design study in the Port of Gijon: This study evaluates the potential infrastructure required for ports with low LNG demand and will propose a design for a corresponding flexible, or mobile, bunkering system that will be appropriate for small vessels. The Port of Gijon is working on the study with engineering and design consultants, Ghenova, and energy supply company, Energias de Portugal. They will analyze the bunkering options including synergy between bunkering in maritime transport, and refueling in road transport, to optimize investment conditions, and identify appropriate locations. The study will also define appropriate safety and administrative conditions of the LNG bunkering service, and recommend a business model for it. Finally, a flexible/mobile LNG bunkering system will be designed specifically to deal with the low LNG demand during the initial deployment period.

Design of floating LNG storage device in the Port of Vigo: The Port of Vigo is leading a study to develop a prototype design for a floating storage and supply unit that will cater mainly for LNG but potentially also handle CNG and MDO. They are working with engineering and design companies, Inova and Ghenova, and short sea shipping company, Suardiaz, to determine the key parameters including LNG storage capacities, inclusion of other fuels, propulsion methods and modular capacity of the storage device. The engineering design will also examine the feasibility of installing a ploy-generation system in the projected unit, which will enable the supply of electricity and heat to vessels while at port (Cold Ironing Function of the barge). As part of that, the necessary logistics and technical on-board equipment for the cold ironing function will also be studied. Finally, a scale model will be developed and rigorously tested in a storm tank... along with the robustness of the project itself.

As the studies develop the lead partners will share the results as appropriate. A conference is planned for June, in the Port of Vigo, to exchange knowledge and the initial learnings from the project and details are available from the Port.

About the project management team

The SamueLNG Project is coordinated by Dragages Ports (DP) and supported by a consortium of 12 partners, from along the Atlantic Arch, representing France, Spain and the Netherlands. DP is an economic interest group which ensures fleet management for dredging in the main French Ports of Dunkirk, Le Havre, Rouen, Nantes Saint-Nazarene, La Rochelle, and Bordeaux. Part-owned by French authorities and French port authorities, it was established to optimize the costs of dredging. As part of that DP is involved in improving maritime access to ports – particularly in the TEN-T Atlantic corridor. The partners working alongside DP on the S/F SamueLNG Project are:

- ♦ 5 public port authorities: Nantes Saint-Nazarene (GPMNSN), Le Havre (GPMH), Rouen (GPMR), Port Authority of Gijon (APG), Port Authority of Vigo (APV) ;
- ♦ 2 ship engineering and design companies: Inova, Ghenova;
- ♦ 2 energy supply companies: Energias de Portugal (EDP), Gas Natural Fenosa (GNF) ;
- ♦ A short sea shipping company: Suardiaz (VN) ;
- ♦ An international dredging association: CEDA (Central Dredging Assn.). ○

As the regulations around shipping emissions become more stringent LNG is expected to become increasingly important as an alternative fuel. As a result, the number of LNG-fueled ships being commissioned is growing and at present the supply infrastructure required to service them is limited. The outcomes of the S/F SamueLNG Project will help to address the increasing need for an innovative and sustainable fueling process in the Atlantic arch.

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Managing and optimizing production from a dredge requires continuous monitoring of pipeline pressure, vacuum and slurry velocity. The operating conditions are

extremely harsh and any sensing components in contact with the abrasive slurry can be damaged. But dredge operators need accurate real-time flow information to properly manage production so equipment manufacturers have been seeking innovative monitoring solutions.

Cornerstone Industries of Otley, Iowa (IA) provide automation controls for the dredging industry. To improve dredge operation efficiency they searched for suitable flow measurement technologies and identified the Greyline DFM 5.1 Doppler Flow Meter as an ideal instrument to monitor slurry velocity. The Greyline flow meters work with non-contacting, clamp-on ultrasonic sensors that do not require cutting the pipe and are not affected by the abrasive slurry.

In 2009 Cornerstone began supplying Greyline Doppler Flow Meters to dredging equipment OEM's and evaluated their performance and reliability. Working with the manufacturer CDW Custom Dredge Works of Topeka Kansas (KS), Greyline Doppler Flow Meters were installed on CDW's line of popular Cutterhead dredges and sold throughout the United States and worldwide. Before Greyline Doppler flow meters were deployed, CDW used pressure gages in the discharge line and vacuum gages on the suction side of the pump. By comparing pressure and vacuum readings they were able to get a crude indication of flow rate and slurry density but were never satisfied with accuracy and overall efficiency of the dredge production.

With a Greyline DFM 5.1 Doppler Flow Meter installed the dredge operator can monitor the actual flow rate in the discharge pipe. If flow velocity slows down the operator allows more water into the suction side to decrease the slurry density and increase the flow rate. If the flow velocity is too fast the operator increases the slurry density by reducing water intake. Production conditions vary from site to site but the dredge operator will typically maintain flow velocity between 11 and 17



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ft/sec in steel pipes 8 to 24 inch diameter. Costs are directly related to the time the dredge is in operation, so obtaining the highest density slurry at the highest possible velocity dramatically improves efficiency and profitability.

CDW Custom Dredge Works mount a Greyline clamp-on Doppler sensor on the dredge discharge pipe at least 6 to 8 feet from the pump or elbows. The ultrasonic sensor is connected to an electronics display enclosure that is mounted inside the dredge operator's cab. With the flow rate continuously visible the operator can troubleshoot pipe plugging and adjust the intake pipe winches so that optimum water/sand mixture is maintained for best production.

CDW Custom Dredge Works' DJ Jones said, " The Greyline flow meter is great piece of equipment ! "



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Detroit District's Cat Island project shows early signs of success

The Detroit District's dredge material disposal facility on Cat Island is proving to be an environmental success as wildlife begins to return to the area.

Since 2014, just one year into the project, over 385,000 yd³ of clean dredged material from the Green Bay Harbor (outer), Wisconsin (WI) has been placed on Cat Island in an effort to restore terrestrial habitat and wetland in the former Pete lake Marsh area.

According to Wisconsin Fish and Wildlife Service's biologist, Betsy Galbraith, because of the placed material some habitats have already been restored for fish and wildlife. More than 30 species of Great Lakes shorebirds have been spotted around Cat Island to include: state threatened and endangered birds such as the piping plover and several species of terns. Federally threatened and endangered species have also been seen to include: the rufa red knot and whooping crane.



*Male piping plover nesting with chick fledged this summer at Cat Island.
Photo courtesy of Tom Presthy.*

"The fact that we are just at the beginning of this restoration project and wildlife are already returning to use this area is a great sign," says Josh Martinez, a Wisconsin Department of Natural Resources (DNR), Green Bay-based wildlife biologist working on the restoration project. "We're happy to be part of this partnership and know there will be many more great wildlife successes to come."

One of Cat Islands' greatest successes, this past summer, was the nesting of the piping plover for the first time in 75 years. Since being listed as endangered in 1986, conservationists have worked tirelessly to save this bird.

"Piping plovers are the most endangered species in the Great Lakes," explains Charlie Wooley, U.S. Fish and Wildlife Service Midwest deputy regional director. "It's been an honor in my career to see this remarkable bird come back from the brink of extinction. It reflects the hard work of many and is just another example of successful fish and wildlife restoration efforts across the Great Lakes."

According to Jon Imbrunone, project manager for the U.S. Army Corps of Engineers, Detroit District, "continuous coordination and communication with the Cat Island Advisory Committee (CIAC), Wisconsin DNR and the U.S. Fish and Wildlife Service have been key in every aspect of this project to include the success of the piping plover."

"The Service and the Corps worked closely this season to protect the nesting plovers. Our shared goals contributed to three chicks successfully fledging from the nest. This is significant when you consider there were only 75 nests in the Great Lakes this summer" said Betsy Galbraith, biologist for the Wisconsin Fish and Wildlife Service.

The Corps planned to dredge the Outer Green Bay Harbor and place approximately 400,000 yd³ of clean material onto Cat Island by the end of December 2016.

"It is amazing to see the benefits of this project come to life, I am proud of our partnerships and team who have made this possible and look forward to the future of Cat Island for many years as this project continues," said Lt. Col. Dennis Sugrue, district engineer, U.S. Army Corps of Engineers, Detroit District.

Dissipated in the 1960s, Cat Island consisted of three islands located west of the mouth of the Fox River in Green Bay. Over the next 20 - 30 years, Cat Island will be restored with the placement of clean dredged material from the Green Bay (outer) navigation channel. Cat Island reconstruction will restore and protect 274 acres of terrestrial habitat and 1,400 acres of wetland.

From more information please visit the U.S. Army Corps of Engineers, Detroit District Web site: <http://www.lre.usace.army.mil/>

Contact:

Erica Mitchell, 313-226-6750;

Erica.A.Mitchell@usace.army.mil

U.S. ARMY CORPS OF ENGINEERS – DETROIT DISTRICT

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*Aerial photo of Cat Island after first year of clean dredge material was placed on the West Island.
Photo courtesy of U.S. Army Corps of Engineers, Detroit District. ○*



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Innovative Near-shore Berm Placement Techniques at Vilano Beach, FL and Application of the Sediment Mobility Tool

Brian C. McFall¹, Katherine E. Brutsché¹, Jase D. Ousley^{2,1†}, Coraggio K. Maglio^{3,1†}, Jason A. Engle⁴

USACE ¹Engineer Research and Development Center, ²Portland District, ³Galveston District, ⁴Jacksonville District

†Formerly at second affiliation.

Placing dredged sediment in the near-shore region as a berm or a mound is common regional sediment management practice. The objectives of near-shore berms are to reduce the energy dissipated on the shoreline by altering the hydrodynamic conditions and to add material to the existing profile. The natural winnowing of the finer sediment from the near-shore berm can occur and during times of accretion the coarser sediment provides a sediment source for the active beach profile. Near-shore berms with high relief may dissipate wave energy by inducing breaking.

Waves broken over the berm must reform and progress towards shore with less energy. To improve the understanding of the near-shore berm sediment transport and beach response, a near-shore berm project was studied in Vilano Beach, Florida.

Beginning in late July 2015, 150,000 yd³ of dredged sediment from St. Augustine Inlet and the Atlantic Intracoastal Waterway was placed in the near-shore of Vilano Beach, Florida as shown in Figure 1. Two 1,000 ft. long berm shapes were constructed by the U.S. Army Corps of Engineers (USACE) split hull hopper dredge

Murden to study the shape effects on the morphologic evolution of the near-shore berms and adjacent shoreline. The northern berm was constructed as an elongated bar, while the southern berm was constructed as a mound shape, with sediment concentrated in the center and tapering off to either end.

The placement plan is shown with colored vessel heading lines in Figure 2, with actual placement locations shown as colored circles. The dredge was instructed to “nose in” along the placement line, and then split the hopper to place the sediment as shallow as possible given the tide. In order to lessen the dredge draft for shallower placement, the hopper was not filled to capacity during dredging.

To construct the northern berm, the dredge was instructed to begin with a placement on the most northern line and to make subsequent placements on each line of the same color moving south, then repeat for the next color. Once a placement was made on each of the lines for the northern berm, the process was repeated two more times for a total of three placements per line. A similar pattern was instructed for the southern berm with a north to south order per placement line color, but additional placement lines were added to the center of the berm to concentrate sediment in a mound shape. Only two placements per line were made on the southern berm. The berms were constructed in depths of 5-12 ft.

The sedimentological and morphological evolution of the near-shore berms and adjacent shoreline were monitored with cross-shore sediment samples, topographic and bathymetric surveys, the Radar Inlet Observing System (RIOS), and camera arrays mounted to balconies of adjacent private beach houses with the cooperation of the Vilano Beach Homeowner’s Association. Time lapse photographs from one of the balcony mounted cameras of the *Murden* placing material in the near-shore and the waves breaking over the newly placed sediment are shown in Figure 3.

The near-shore berms were designed with the assistance of the Sediment Mobility Tool (SMT). The SMT is a scoping level tool to support coastal

planners and engineers identify near-shore areas well suited for the placement of dredged sediment, and is available to the public through a Web application on the USACE Navigation Portal (<http://navigation.usace.army.mil>).

The SMT transforms Wave Information Study (WIS) hind-casts to the proposed near-shore placement site and estimates the depth of closure, frequency that placed sediment will be mobilized, cross-shore sediment migration direction, and creates a wave rose to estimate the axis of wave dominate sediment transport.

Additional details about the sediment mobility and depth of closure calculations used in the SMT can be found in McFall et al. (2016) and Brutsché et al. (2016), respectively. The SMT Web application, which uses 10 years WIS hind-casts (1 January 1990 – 1 January 2000), was applied to this near-shore placement site with a depth of 10 ft. and median sediment grain size of 0.33 mm. The transformed zero-moment wave



Figure 1. Near-shore berm project location at Vilano Beach, FL, north of St. Augustine Inlet, with the permitted dredging and near-shore placement areas shown. The near-shore berm placement in this study occurred in two sections of the larger box shown here.



Figure 2. Two near-shore berms were designed: northern berm as an elongated bar and the southern berm as mound shaped. The colored lines are the vessel heading line for placement and the circles show the actual hopper placement locations. The dredge was instructed to place the sediment as close to the shoreline as possible given the tide.



Figure 3. a) The USACE hopper dredge *Murden* placing sediment in the near-shore, and b) the waves breaking over the newly placed material.

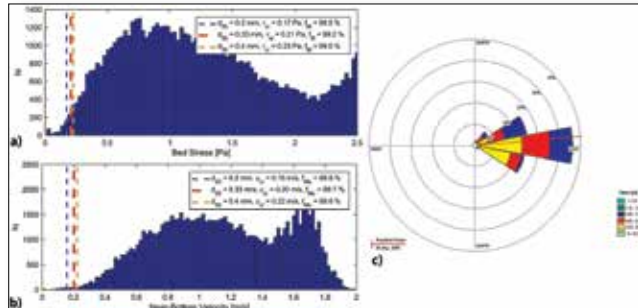


Figure 4. Results of the Sediment Mobility Tool (SMT): a) Histograms of the bed shear stress using linear wave theory and b) near-bottom velocity using nonlinear stream function wave theory, and the c) wave rose at the near-shore placement site. Vertical dashed lines in the histograms note the critical threshold to mobilize sediment of the specific size noted in the legend.

water (MHHW) tidal datum in Figure 5.

The net long-shore transport during the monitoring was predominately southern. A mild shoreline accretion was observed on the lee side of the bar shaped northern berm, while a more peaked shoreline cusp was observed on the lee side of the mound shaped southern berm. These results substantiate the use of near-shore berms as a beneficial use of dredged sediment to protect the shoreline and keep the sediment in the littoral system. Additionally, this project provides a successful example of the applicability of the Sediment Mobility Tool on an open coastline. The study of this project will continue by modeling the morphological evolution of the near-shore berms and beach with the robust Coastal Modeling System to compare with the results of the Sediment Mobility Tool.

Acknowledgements

This study was funded through the USACE Regional Sediment Management (RSM) program, Coastal Inlet Research Program (CIRP), Dredging Operations and Environmental Research (DOER) program, and the USACE - Jacksonville District. The cooperation of the crew of the USACE dredge *Murden* and the Vilano Beach Homeowner's Association is graciously acknowledged.

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height was estimated to mobilize the sediment 99-100% of the time and move the sediment onshore 100% of the time. The wave rose shows a resultant vector close to shore normal. The SMT histograms and wave rose are shown in Figure 4. These results indicate the Vilano Beach near-shore is a good site to place dredged sediment as the median grain size is estimated to be mobilized often and move landward.

Topographic and bathymetric surveys of the region are used to understand the morphological changes of the beach due to the near-shore berms. The shoreline accretion on the lee side of the near-shore berms is clearly shown

in the shoreline change between the preconstruction survey and the survey four months after construction using mean high-high

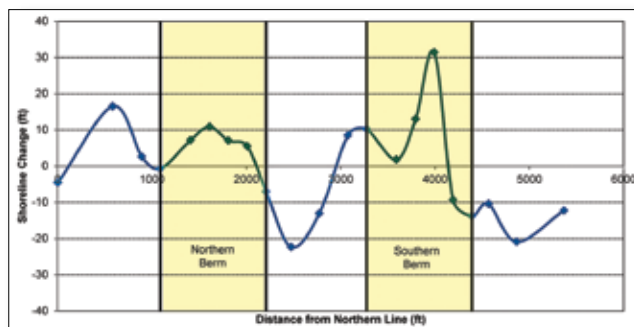


Figure 5. Vilano Beach shoreline change using the MHHW tidal datum between preconstruction and four months after construction. Note the positive shoreline change on the lee side of the near-shore berms.

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Comparing Drone Technology to Conventional Methods for Beach Monitoring Surveys

Christian Stallings, CP, Research & Development Manager, McKim & Creed, Inc.

There's a buzz in the air.....literally. It's coming from an unmanned aerial system (UAS), more commonly referred to as a drone. By now you've probably heard it.

The residents of Wrightsville Beach, North Carolina heard it last spring when two national firms came together to test the efficacy of using UAS to collect data for beach monitoring surveys.

The POC Premise

According to NOAA, shorelines constitute less than 10% of total land area in the U.S. but are home to 39% of the nation's population. Nearly 130M people live in communities that depend on accurate, cost-effective beach monitoring surveys to maintain healthy coastlines.

Coastal communities prepare for a land-falling storm event year round. Most municipalities that have oceanfront assets have a beach management



McKim & Creed and Esri conducted a proof of concept (POC) to test the accuracy, efficiency, cost effectiveness and environmental efficacy of using low-cost, commercial unmanned aerial systems (UAS) for beach monitoring surveys. Here, McKim & Creed's Christian Stallings, CP, (yellow vest) explains the UAS technology to representatives from local, state and federal agencies, as well as

plan, which is required for communities that have or are seeking federal funds to help maintain their beaches. Included in the plans are beach monitoring surveys. These are performed twice per year to capture current, existing conditions of the beach. Comparing the surveys helps engineers analyze the beach's performance in terms of erosion and accretion, and plan and predict maintenance and renourishment events. In the case of a storm event where significant loss of beach occurs, these surveys can be used to help secure emergency funding for restoration.

Data is typically collected using terrestrial LiDAR, aerial

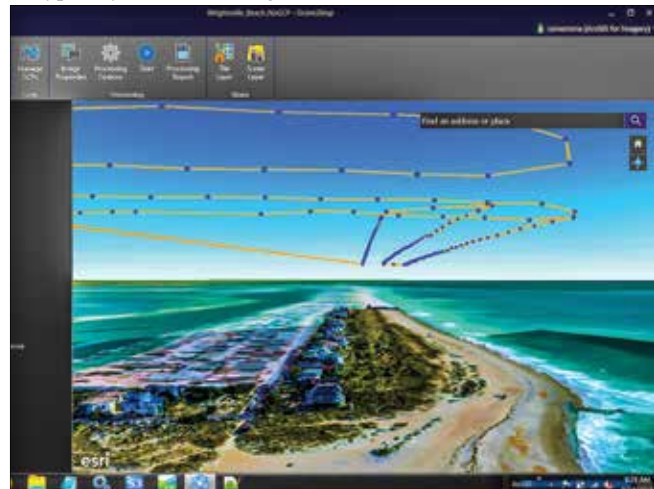


McKim & Creed field crews collected blind checkpoints at the site to independently verify the accuracy of the UAS data.

LiDAR, and/or conventional surveying technologies.

On May 16, 2016 during National Hurricane Preparedness Week, national engineering, surveying and planning firm McKim & Creed, Inc., headquartered in Raleigh, North Carolina, teamed with Redlands, California-based Esri, the world's largest geographical information systems (GIS) company. The two companies performed a proof of concept (POC) to determine if UAS technology could provide coastal communities with a faster, more cost-effective, and more environmentally friendly way to produce beach monitoring surveys.

Representatives from local, state and federal agencies, as well as UNC Wilmington, Audubon Society and NC Land Trust, were onsite to observe the test flights and data collection. The processed data and results of the study were presented to the observers the following day.



The data was processed in Esri's Drone2Map software. Blue dots represent the location each image was taken and the 3D model is laid over existing imagery.

The Site

The test site for the UAS POC covered approximately 100 acres along Wrightsville Beach, North Carolina and included two rock jetties.

This area is prone to erosion and is surveyed regularly to accurately measure and map the erosion and determine the urgency of beach renourishment programs. Such erosion can cause costly property damage and disturb environmentally sensitive shore bird nesting areas.

The Technology

The POC showcased Esri's Drone2Map software, which processes imagery collected by UAS into an accurate, usable dataset that can be seamlessly imported into Esri's GIS mapping platform. McKim & Creed, which was operating under FAA Section 333 and has a long history of performing coastal surveys using conventional methodologies, performed the UAS data acquisition. This included filing a flight plan with the FAA, setting ground control, working with the local municipality to help secure the test areas during the data collection, and flying the site.



The test site included two rock jetties. The inset is the 3D model produced from the UAS data, and the background image is a photo of the jetty taken by the drone.

McKim & Creed conducted four data-collection flights. Two flights were flown with the 3DR Solo UAS equipped with a Sony R10C camera with 16-mm prime lens (operating altitude of 400 ft. above ground level [AGL], 1.21 inches ground sampling distance [GSD]). To compare the accuracy of various drone cameras, one flight was flown using a Solo/GoPro Hero 4 Black edition setup (400 ft. AGL 2.44 inch GSD), and another was flown with a Phantom 4 (200 ft. AGL 1.01 inch GSD). The same day, a federal agency used terrestrial LiDAR to collect data in the same area.

To verify accuracy, McKim & Creed field crews surveyed 14 targets on the beach using virtual reference station (VRS) double occupancies, and collected 22 blind check shots in random locations. Esri processed the data using its Drone2Map software, and compared it with data collected via aerial LiDAR, terrestrial LiDAR and conventional surveying on the basis of accuracy, cost, delivery time and environmental efficacy.

The Results

The data comparison showed that, in the correct environmental conditions such as open beaches or moderately vegetated berms and basins, UAS outperforms conventional services by producing a more detailed digital

	CONVENTIONAL SURVEY	TERRESTRIAL LiDAR	AERIAL LiDAR
ACCURACY	UAS is within 4 cm on control points	UAS is within 2 cm of LiDAR specifications	UAS is within 2 cm of LiDAR specifications
COST	UAS is 30% less expensive for competitive project	UAS is 15% less expensive for competitive project	UAS is 60% less expensive for competitive project
TIME	UAS captures greater detail in less time	Similar mobilization & coverage, faster collection & processing	Similar mobilization & coverage, faster collection & processing
ENVIRONMENT	Onsite naturalists confirmed that bird nesting habitats were not disturbed when using UAS.		
OVERALL	the POC indicated that UAS outperforms conventional technology by producing a more detailed digital elevation model at a 60 percent savings in time and cost. It's resource conservation at its finest.		

The UAS data was compared with data collected of the same site via terrestrial LiDAR, aerial LiDAR and conventional surveying. Overall, the POC indicated that UAS, a highly accurate, non-invasive technology, outperforms conventional technology by producing a more detailed digital elevation model at a 60% savings in time and cost. Just as importantly, it does not disturb wildlife and bird habitats.



The POC team in a photo taken by the drone. The UAS proof of concept was named the "2017 Grand Conceptor" engineering excellence award winner by the North Carolina Chapter of the American Council of Engineering Companies. The Grand Conceptor is highest award given in the engineering excellence awards program.

elevation model (DEM) more quickly and at a lower cost. Specifically, the 3D results provided an accuracy of 2.5 cm (about one inch), which far surpassed the conventional accuracy of approximately 6.5 inches. With UAS the McKim & Creed/Esri team was able to provide a detailed elevation model with 3D points every few inches, rather than a more traditional map showing cross sections every few hundred feet. Overall, the team estimated that UAS provided up to a 60% savings in time and cost when compared to conventional techniques for beach monitoring surveys. UAS also required fewer people, offered greater safety to crews, provided higher accuracy, produced a faster deliverable, and did not disturb bird nesting or other coastal wildlife habitats.

The data that was collected was used to create a profile of Wrightsville Beach's pre-hurricane season condition,

About McKim & Creed

McKim & Creed is an employee-owned engineering, surveying and planning firm with nearly 400 staff members in offices throughout the U.S., including North Carolina, Florida, Virginia, Georgia, Texas, and Pennsylvania. McKim & Creed specializes in civil, environmental, mechanical, electrical, plumbing, and structural engineering; industrial design-build services; airborne and mobile LiDAR/scanning; unmanned aerial systems; subsurface utility engineering; and hydrographic and conventional surveying services for the energy, transportation, federal, land development, water and building markets. The firm was recently ranked the #1 surveying and mapping firm in the U.S. by ENR Southeast magazine. For more information about McKim & Creed, visit www.mckimcreed.com.

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Detroit District views dredged material as resources, not waste

1st Lt. Erica Mitchell



Placement of dredged material in near shore beach nourishment site in Muskegon Harbor, Mich. This material is dredged from the entrance channel of the Muskegon outer harbor (U.S. Army Corps of Engineers, Detroit District photo).

Lt. Col. Dennis Sugrue, district engineer, Detroit District. “We need to view it as a resource and projects throughout the Great Lakes have already demonstrated how it can benefit coastal resilience, fish and bird habitat and a range of other crucial needs.”

Most prominent among beneficial uses of dredged material is beach nourishment. Beach nourishment is a low cost, beneficial option for operation and maintenance dredging projects in the district. Many of the district’s harbors provide clean, sandy material from the navigation channels; which is then transferred to nearby beaches in order to diminish the effects of erosive wind, waves and weather. St. Joseph Harbor, is a



U.S. Army Corps of Engineers, Detroit District employees walk across the shoal feature of 21st Ave West Embayment in Duluth Harbor (U.S. Army Corps of Engineers, Detroit District photo).

West locations, more than 600,000 yd³ of dredged material has been placed and its success has contributed greatly to the start of placement at the 40th Avenue location this year. The goal of placing material at the sites’ focuses on improving aquatic habitat diversity and restoring aquatic ecosystem function that was altered since the late 1800’s when pollutants settled into the soil reducing and damaging wildlife habitat.

Prior to the Corps authority to construct confined disposal facilities in 1970, material was mainly deposited in deep water sites. Since then, several projects were developed to also utilize dredged material for island creation and enhancement such as the Cat Island project in Green Bay, Wis. Cat Island has been among one of the most effective beneficial use of dredged material projects for the district. Since the material placement

Last year, the U.S. Army Corps of Engineers, Detroit District dredged over 1.8M yd³ within the Great Lakes federal channels, and of that more than 60 % of dredged material was used beneficially.

Dredged material use is classified as beneficial when it is used as a resource, not a waste. Successful ways the Detroit District has used and continues to facilitate the beneficial use of dredged material include: beach nourishment, habitat development, island creation and construction and industrial use. The dredged material comes from normal Corps dredging operations of the federal navigation projects and must be dredged and disposed of in the least cost, environmentally acceptable and engineeringly feasible manner.

“The days of treating dredged material as ‘waste’ are behind us” said



Dredged material placement south of the south pier at St. Joseph Harbor, Mich. Material is dredged from the entrance channel for placement in the near shore beach nourishment site (U.S. Army Corps of Engineers, Detroit District photo).

classic example of a beach nourishment project. Last year, the district placed over 26,000 yd³ of clean dredged material on the beach.

Habitat development, a type of beneficial use that is sometimes overlooked, is the development and restoration of aquatic wildlife habitats or nesting meadows in upland disposal areas. The district has had success with placing suitable dredged material within 21st Avenue West and 40th Avenue West embayments in Duluth Harbor supporting aquatic habitat restoration initiatives within near the Duluth-Superior Harbor in Minn. /Wis. Since the pilot program began in 2013, at the 21st Avenue



Shown 21st Ave West Embayment with two shoal features that are currently sticking out of the water. The vast majority of the 600,000 yd³ of dredged material placed in this area is underwater (U.S. Army Corps of Engineers, Detroit District photo).

activities began in 2014, almost 750,000 yd³ of material have been placed into the facility to begin restoring the islands that were washed away in the 1960s by high water levels, waves and ice. The Cat Island chain consisted of three islands located west of the mouth of the Fox River in Green Bay.

In the next 20-30 years, the Cat Island chain will be rebuilt with the placement of clean dredged material from the Green Bay (outer) navigation channel. The Cat Island Dredged Material Placement Site will reestablish and protect 274 acres of terrestrial habitat and



Hydraulic discharge pipe placing dredged material at Detroit District's Cat Island project in Green Bay, Wis. (U.S. Army Corps of Engineers, Detroit District photo).



Aerial photo of the Cat Island project in Green Bay, Wis. showing sand and vegetation that was placed in 2014 (U.S. Army Corps of Engineers, Detroit District photo).

1,400 acres of wetland. The newly restored islands help coastal marsh areas, underwater plants, and various fish and wildlife species thrive.

"The Corps must always deal with dredged material that results from annual maintenance dredging in the least cost and environmentally acceptable manner," said Dave Wright, operations chief, Detroit District. "It is a win-win situation when we are able to place material in a manner that meets these requirements and also ultimately supports other efforts such as environmental habitat restoration or facilitates use of the material for other construction purposes."

There is also a growing interest in the reuse of dredged material as construction material for various purposes such as parking lot construction, roadway construction or landfill cover. Local sponsors for several of the district's confined disposal facilities have been pursuing the mining of suitable material from these facilities for construction or industrial use. As an example, to extend the capacity of Erie Pier, a confined disposal facility (CDF) in the Duluth-Superior Harbor, the local community developed a project where dredged material is rinsed with on-site water to wash away fine materials leaving clean sand, which can be removed and used for various construction and industrial applications. Erie Pier CDF in Duluth, operated and maintained by the Corps, is approximately 82 acres with the capacity of holding 2.5M yd³ of dredged material. Because Erie Pier is almost full, the Corps, the Seaway Port Authority of Duluth, as well as the city of the Duluth strive to find ways to use dredged material in order to keep the CDF available for continued use when necessary.

The Detroit District looks to the future for more projects that can benefit from dredged material whether it's beach nourishment, habitat development, island creation and construction or industrial use.

For more information on dredging on the Great Lakes or beneficial uses of dredge material, please visit: <http://www.lre.usace.army.mil/Missions/Great-Lakes-Navigation/> ○



Clean sand that has been hydraulically separated at the Erie Pier CDF and is now ready for beneficial reuse for construction and industrial use (U.S. Army Corps of Engineers, Detroit District photo).

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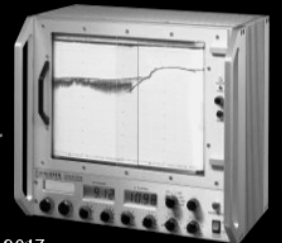
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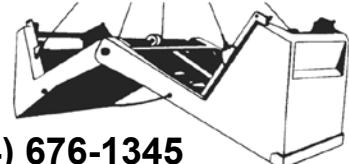
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