



ENVIRONMENTAL DREDGING

Lower Duwamish Waterway

Enhanced Natural Recovery/Activated Carbon Pilot Study



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Mr. Craig Vogt
c/o Western Dredging Association
WEDA Environmental Commission

via: craig@craigvogt.com

Mr. Vogt:

Pacific Pile & Marine (PPM) is pleased to nominate the Lower Duwamish Waterway Enhanced Natural Recovery/Activated Carbon Pilot Study Project for the WEDA 2017 Environmental Excellence Award for an Environmental Dredging Project. While this project did not involve the direct removal of contaminated materials, its purpose was environmental enhancement and remediation through an innovative capping technique.

This project represents an important step in the Region's advancement of mitigation measures and could serve as a major design consideration for the planned cleanup of the Duwamish Waterway as well as future cleanups.

Representatives from PPM are registered and plan to attend the 2017 Dredging Summit & Expo in Vancouver, BC. Members of the construction team will be in attendance and are committed to presenting a formal presentation or poster and answering questions regarding the Project, if selected.

Please find attached the nomination. Should you have any questions or require additional information, please contact us at (206) 331-3873 or by email at kustaa@pacificpile.com.

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ENVIRONMENTAL DREDGING: LOWER DUWAMISH WATERWAY ENHANCED NATURAL RECOVERY/ACTIVATED CARBON PILOT STUDY

SUMMARY

The Lower Duwamish Waterway Superfund Site is a 5 mile section of the Duwamish River that flows into Elliott Bay in Seattle, Washington. More than 100 years of heavy industrial use left the waterway contaminated with toxic chemicals from many contributing sources including commercial operations along its banks; stormwater pipes; and runoff from upland activities, streets, and roads. 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. The site was added to USEPA's National Priorities List (NPL) in 2001.

In 2014, USEPA announced a cleanup plan for the Duwamish. The Record of Decision (ROD) was intended to reduce the risks 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 \$342 Million.

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 November 2016, the LDWG, with King County as the lead, contracted Pacific Pile & Marine (PPM) to conduct an Enhanced Natural Recovery Activated Carbon pilot study.

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. The goal of the study is to determine 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.

The study will compare the effectiveness of ENR with added AC (ENR+AC) with that of ENR without added AC in three (3) areas (called "plots") within the Lower Duwamish Waterway. These plots are referred to as the (1) Intertidal Plot, (2) Subtidal Plot, (3) and Scour Plot. For the purposes of this project, ENR involved the placement of a thin layer of clean material (sand or gravelly sand) over subtidal or intertidal sediments and ENR+AC involved the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments.

The project is noteworthy when compared to standard remediation work because it is a pilot study to determine the effectiveness of ENR+AC in reducing PCB bioavailability. The ultimate goal of the study is 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 MEMBERS

Owner	The Lower Duwamish Waterway Group (made up of King County, the Port of Seattle, the City of Seattle, and The Boeing Company)	
Project Lead	King County	
Engineers	AMEC Foster Wheeler - (WEDA member) Dalton, Olmsted & Fuglevand, Inc (DOF) - (WEDA member)	
Stakeholders	US Environmental Protection Agency US Army Corps of Engineers Washington Department of Ecology Muckleshoot Indian Tribe Squamish Tribe US Fish and Wildlife Service Washington Department of Wildlife	
Contractors	Prime (nominating entity)	Pacific Pile & Marine - (WEDA member)
	Subcontractors	TerraSond Limited - Hydrographic Survey - (WEDA member) CalPortland - Aggregate Supplier

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.

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. If the results of the study prove to be successful, this application could be used in 48 acres of the overall Duwamish River cleanup. The Duwamish River hosts a myriad of uses such as public recreation, fishing, shipping, industry, and wildlife habitat. In a larger sense, if successful, this method could be applied at other cleanup projects where environmental capping is the selected remedial action.

UNIQUE CHALLENGES

The project was inherently unique being a pilot program, with in-kind challenges. These challenges were overcome and the work successfully executed. For the purpose of this submission, a short list is detailed below.

GRANULARLY ACTIVATED CARBON

The project was designed with a 4-percent 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.

Granular Activated Carbon has material 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 percent requirement provided a challenge in eliminating potentials for AC loss during the production, handling, and placement of the material. The production concerns centered around the aggregate supplier's ability to uniformly mix in the required AC percentage with each barge load of ENR material. Additionally, there was a concern additional handling of the ENR+AC material once it was loaded on the material barge would cause segregation of the AC from the ENR.

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. There was a risk of substantial winnowing of AC from the ENR during placement.

UNIFORMITY OF COVERAGE

The ENR and ENR+AC materials needed to achieve a minimum thickness of 4 to 6 inches over the subplot area. The project had a total target thickness of 6 to 9 inches over a minimum of 80% of the area and 100% of area 4 inches or more in thickness. The maximum thickness was not to exceed 12 inches.

COORDINATION WITH WATERWAY USERS

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

MITIGATION MEASURES

The nature of the pilot program required several conventional means and methods commonly utilized in dredging or capping operations to be significantly heightened to meet the environmental challenges.

GRANULARLY ACTIVATED CARBON

Although Granularly Activated Carbon 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 required the blended material (ENR+AC) be loaded onto a water-tight barge and be pre-soaked by flooding the barge with water from the Duwamish River for a minimum of 12 hours prior to placement. The blended material was then required to be kept saturated at all times before placement. The intent of the pre-soaking was 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.

UNIFORMITY OF COVERAGE

A fixed-arm excavator equipped with a sealed 3- to 6-cubic-yard clamshell bucket was prescribed for placement of ENR and ENR+AC materials. PPM utilized a Hitachi 1200-6 hydraulic excavator equipped with RTK-GPS. In order to achieve the minimum 4" thickness and hit the 6-9" overall target thickness, the material was placed in two 4.5" lifts with an offset bucket pattern.

ENGINEERING WITH NATURE

ENR and ENR+AC layers were engineered to be placed on sediments in plots that represent three habitat types: (1) Subtidal, (2) Intertidal, and (3) a subtidal area that may be influenced by propeller wash, 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.

INNOVATION

LEADERSHIP

This project demonstrated leadership by taking steps beyond "conventional" environmental cleanups that led to a number of successful outcomes. Instead of pursuing the "lowest cost" approach, the LDWG chose to pursue new technologies to not only mitigate the target areas, but to do so with modern methods that have the potential to significantly reduce the adverse impacts during construction. Implementation of this strategy resulted in the virtual elimination of cross contaminants and formation of post-dredging contaminated sediment layers. The project team, including contracting agency, engineers, contractor, and key stakeholders actively worked together.

Multiple agencies and stakeholders were engaged early in the process. Prior to development of work plans, all stakeholders met to understand each parties' interests and concerns with the pilot study. This meeting allowed for open communication between all parties so expectations could be understood prior to the determination of means and methods that would be incorporated into work plans. Daily meetings were held on-site prior to placement activities beginning. Every worker from the contractor's team (operator especially), the Owner's representative, the Engineer's representative, and the Stakeholder's representative attend the meeting. This allowed for detailed discussion of the previous day's results, work being performed that day, and worked planned for the next three days. These meetings allowed for constant input and feedback from all parties in how work was progressing.

The contract between the Owner and the Prime Contractor was structured on a daily rate. Each day of work the contractor was paid a flat rate. The use of a daily flat rate allowed for adjustments to methods, procedures, and approaches to the work as issues arose.

NEW METHODS, TECHNOLOGIES, APPROACHES

The pilot program's specifications had several notable requirements that required creative approaches.

Pre-Soaking: The requirement for the pre-soaking 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-inches over the material. The water level was then to be maintained during placement to ensure continuous saturation of the AC.

Material Thickness: one requirement was for the material to be placed in 9-inch target thickness. PPM placed the material in two (2) 4.5-inch lifts with an offset bucket pattern to achieve. The clamshell bucket selected for this project was a 5-cubic yard 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-ft. This volume and thickness was out of tolerance with the project specifications. One option would be for the operator to only fill the bucket partially however that would not result in a consistent and controlled full ratio especially with the material being underwater in the barge. PPM determined the most practical solution was 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.

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

Pre-Determined Bucket Grids: 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.

Spud Anchor Tracking: 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.

ECONOMIC BENEFITS

COST-EFFECTIVE METHODS, PROCEDURES, OR PRACTICES

If the pilot study is able to prove Activated Carbon's ability to reduce PCB bioavailability the material could be used in more applications potentially saving costs compared to more expensive conventional dredging and capping methods. If the ENR+AC out performs ENR then it will provide greater protection the communities and people who use the Duwamish waterway.

The Puget Sound area, and Pacific Northwest in large, has a rich tradition of aquatic-reliant commerce. Restoring the Lower Duwamish Waterway to a cleaner condition results in numerous socio-economic benefits for the local community, neighboring businesses, and recreational waterway users, including tribal and other commercial fishers that rely on the waterway and its historic salmon run.

TRANSFERABILITY

The pilot study has the potential to serve as a model for sustained recovery of contaminated sites. The use of the pre-determined bucket locations, controlled placement above mudline, and the two distinct material lifts helped assist with uniform placement. The use of the bucket grids, while slow in production did ensure consistent and stable placing of the material. The pre-soaking of the ENR+AC appeared to help the winnowing of the AC. Operations were modified to allow for the material to be flooded with water but not under the water level based on observations maintaining the material in a submerged state was not required to achieve the desired operational success. This gave the operator better control of his fill factor and bucket loading speeds. Spud anchor tracking is another technology that proved to be useful during the project. It could have benefit on projects where spudding through the cap is not allowed or in areas that may have sensitive ecological systems that cannot be disturbed.

OUTREACH AND EDUCATION

The project was covered by local media outlets. Public inquiries were directed through King County and regular updates were posted to the County's website and an information video released on the County's YouTube channel. Project stakeholders were engaged early in the process through meetings held to inform interested parties about project updates and garner feedback and local knowledge for incorporation into the planning of the work. Members of the engineering and construction team intend to submit papers and present on various aspects of the project.

