Modeling and Construction Overview for Passaic RM 10.9 Active Cap

Battelle
The Business of Innovation

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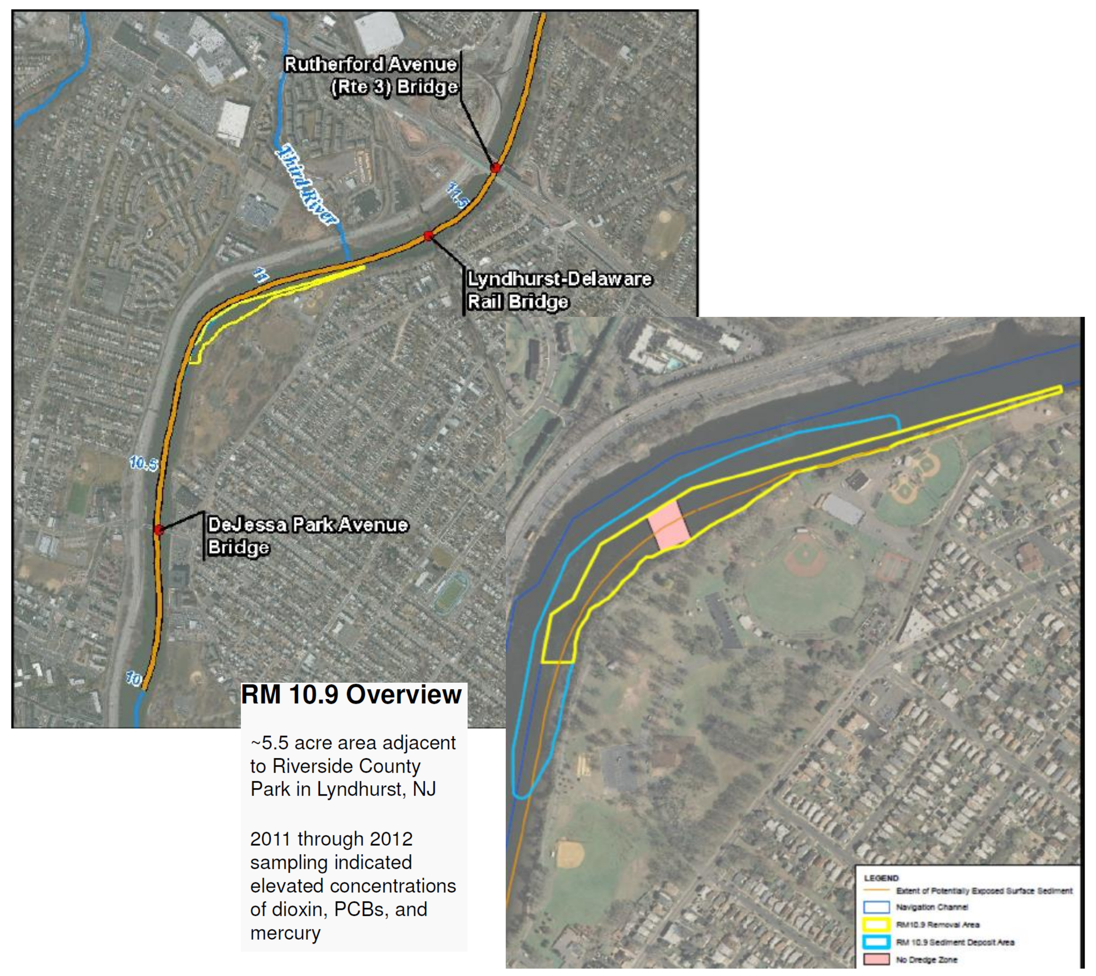
INTRODUCTION AND PROJECT OVERVIEW

The Lower Passaic River is a highly contaminated urban river that has been the subject of numerous investigations for more than 30 years. In June 2012, a group of potentially responsible parties signed an agreement with USEPA Region 2 to remove contaminated sediment from a mudflat at River Mile 10.9, adjacent to Riverside Park in Lyndhurst, New Jersey. This area was identified during remedial investigation within the Lower Passaic River Study Area. A removal action was developed to address the contaminated sediment. The design included removal of approximately 15,000 cubic yards of impacted sediment from the river followed by the placement of 5.5 acres of an amended cap in the dredge area. The specification and design for the amended cap was determined based on modeling that indicated a loading requirement for activated carbon mixed with a sand/aggregate layer.



POST-DREDGE CAP CONCEPT & DESIGN

Cap Modeling & Design Approach

Following dredging/removal activities, it was necessary to restore the river bottom to its previous elevation and provide protection for the underlying cap materials. Since it was known that residual contamination would be present following dredging, it was determined that the use of an "Active" Cap would be appropriate to sequester and minimize upward migration of contaminants. The general concept behind the use of an active cap is shown in the graphic to the right. The essential concept is that adsorptive treatment or 'active' materials must be uniformly distributed and placed (through the water) to form a permeable layer that will allow pore water to move upward through the sediment without becoming a transport mechanism for underlying residual contamination.

General Concept - Permeable Active Cap:

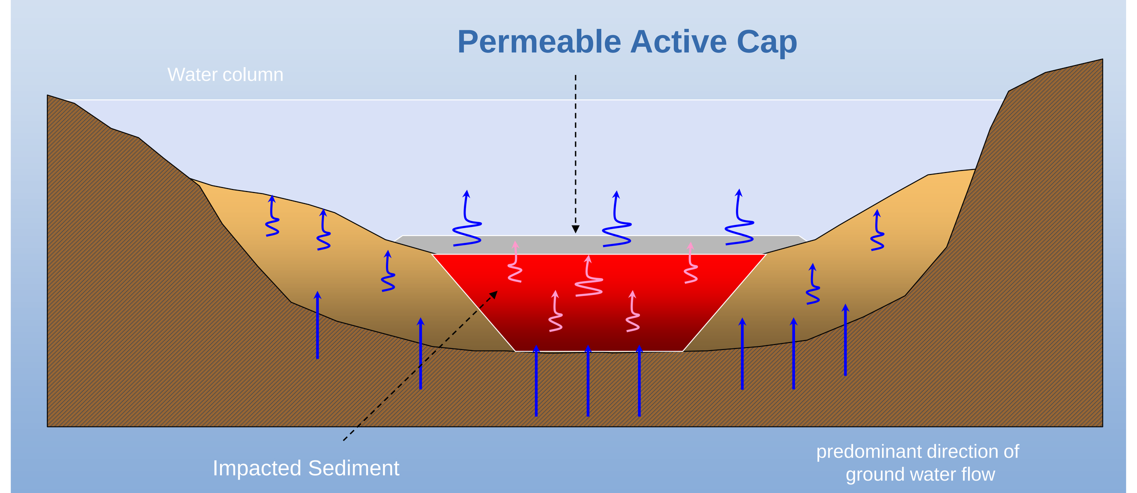
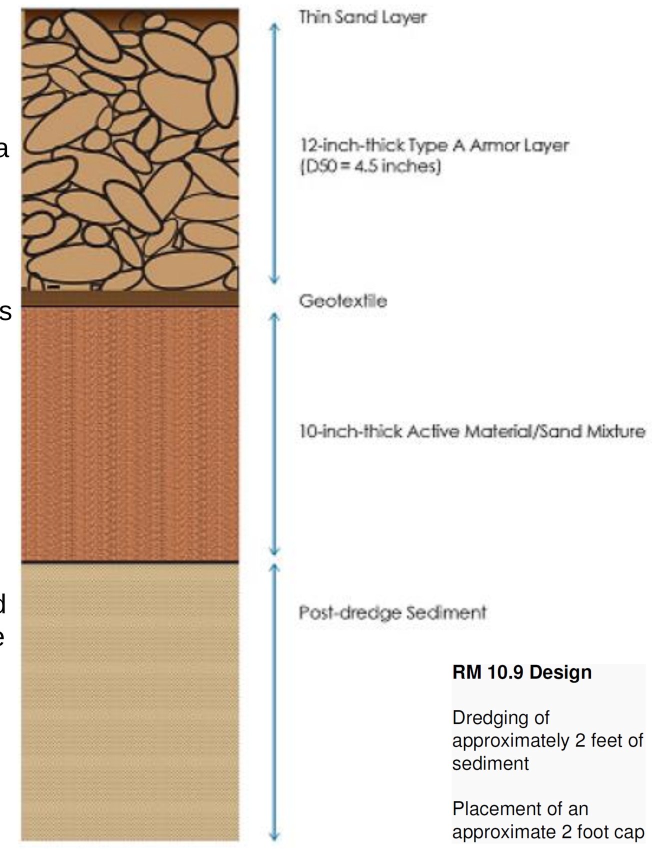


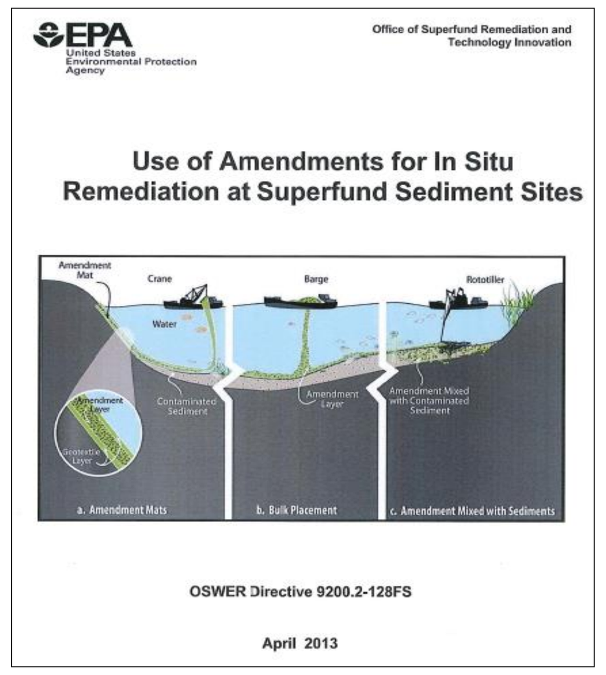
Figure 1: Graphic of Conventional Permeable Active Capping Layer

The numerical model CapSim was used to predict the potential transport of select chemicals of potential concern (COPC) through the cap layers. Four COPC groups were: dioxins/furans (2,3,7,8-TCDD), total PCBs (PCB-52), PAHs (represented by phenanthrene), and mercury. The average pore water concentrations for each COPC, based on composites generated from sediments collected from high concentration biased locations were used in the model simulations. Groundwater flux at four locations through the sediments in the RM 10.9 Removal Area were obtained with ultrasonic seepage (UltraSeep) meters and the average seepage rate was used in the CapSim modeling to determine the active layer thickness. CapSim model was run with site-specific data (pore water concentrations and groundwater flux) to predict breakthrough (as required by New Jersey Surface Water Quality Standards) of more than 100 years.

The modeling was used to determine both the appropriate adsorptive materials as well as the quantity of material necessary. A range of scenarios were modeled, primarily for a thin layer application of a treatment material, followed by a sand layer of significant thickness. During the initial modeling activities, a thickness and application rate of activated carbon was determined to provide the desired time of sequestration, based on an assumption of an unlimited source of contamination. However, subsequent modeling using an assumption of a mixed sand layer provided a more robust result at a lower loading or content of activated carbon. Based on this modeling output, it was determined that improved active layer performance and significant cost savings could be realized by mixing an activated carbon containing material with the sand in a 10-inch thick layer. The final cap design is shown in the graphic to the right.



AMENDMENT MATERIALS AND APPLICATION APROACH


EPA United States Environmental Protection Agency

Office of Superfund Remediation and Technology Innovation

Use of Amendments for In Situ Remediation at Superfund Sediment Sites

OSWER Directive 9200.2-128FS

April 2013

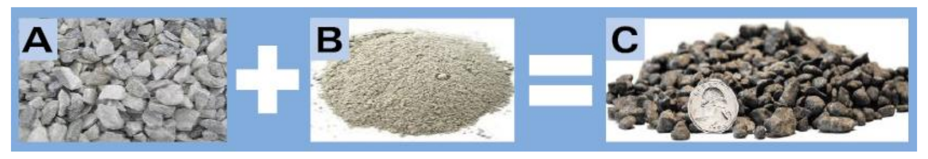
Acceptance & Use of Amendment Materials:

The EPA has recognized that the use of amendments to reduce bioavailability of contaminants by sorption or promote the degradation of the contaminants is a viable option for in situ sediment remediation[1]. While it is still considered an innovative technology, it has been demonstrated at full-scale application to improve the risk reduction and cost-effectiveness of remedies at sediment sites. Amended caps have shown that reduced thickness can improve performance over traditional caps in a range of ways, such as improved resistance to erosional events and reduced advective transport of COCs by ebullition, NAPL, or groundwater flow. Amendments applied directly to the contaminated sediment may be particularly useful in areas where MNR, caps, or dredging are not likely to be effective in reducing risks. A primary advantage to use of amendment materials is risk of remedy reduction from more invasive remediation approaches.

New design tools available in the industry, such as modeling and treatability studies can relatively quickly and cost-effectively determine the relative advantages or benefits of utilizing amendment materials as an alternative to other more conventional contaminated sediment remediation remedies.

AMEDMENT MATERIAL SELECTION

AquaGATE+



AquaGate+ - A permeable treatment material containing a "Reagent" that will perform similar to a filtration bed – allowing water to flow, while removing or minimizing contaminant transport by absorption, adsorption, fixation, or precipitation (depending on the amendment or treatment material employed. This material acts as the "gate" in PRB or funnel and gate type designs.

AquaGate+PAC™ (Powdered Activated Carbon) is a patented, composite-aggregate technology resembling small stones typically comprised of a dense aggregate core, clay or clay-sized materials, polymers, and fine-grained activated carbon additives. AquaGate+PAC serves as a delivery mechanism to reliably place reactive capping materials into aquatic environments.

AquaGATE+

INSTALLATION

The ability to handle and place capping and treatment materials through the water can be an important factor in reducing installation related costs such as the need for water treatment. It is important that materials are rugged and will withstand packaging, transportation and multiple handling steps prior to final placement. If two materials are to be mixed prior to placement, it is important that the materials are of similar bulk density and particle size so the drop velocity of the mixed materials will result in a uniform distribution on the sediment surface.

The AquaGate+PAC materials were delivered in 2,500lb bulk supersacks with a nominal 10% Powder Activated Carbon coating material in an approximate 3/8" particle size. This allowed for uniform mixing and distribution of the desired quantity of amendment material in a single lift.

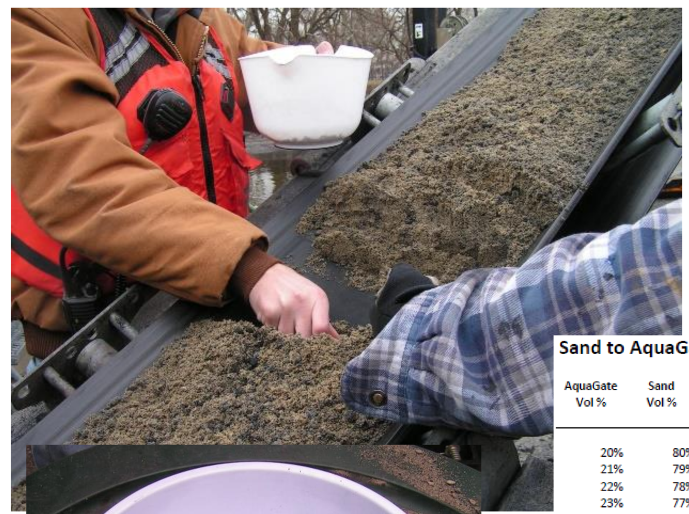
A wide range of installation/application equipment can be used to place thin layers of capping materials. the equipment used to install the active cap mixture was a Telebelt (shown above at right). This is an articulated, telescoping belt placement system that has the capability to place lifts of material with a high degree of accuracy. The operator controls three key parameters during installation; belt feed rate, swing of the mast (articulation) and the length of the mast (telescope).

Mixing of the sand and AquaGate+PAC is performed in a two hopper feed system, as shown in the center photo to the right. The two hoppers feed continuously onto a belt that places material in a mixing hopper – shown in the bottom right photo. The mixing hopper then feeds material to the conveyor used to feed the Telebelt placement equipment. This approach enables the Telebelt operator to continuously place capping material – making this a highly productive placement or installation approach. The installation contractor reported placement rates ranging from 10,000 to 30,000 SF per day, depending on the need to move the barge or other factors.

INSTALLATION & QUALITY CONTROL

As noted below, the Telebelt receives material from the dual hopper feed system via a belt and interim mixing hopper. The top photo on the right shows the upper portion of the transfer belt where the samples of material were taken, as follows:

Subsequent to mixing, the mix ratio was verified using a simple technique, which did not interrupt the placement for a long period of time. To accomplish this, both belt systems were temporarily shut-down while members of the team sampled material from an approximate 12-inch length of the belt, as shown in the photo to the right. After the sample was collected the sand and AquaGate components were separated using a simple screen and each material was weighed. As shown in the below right photo, the AquaGate+PAC component of the mix was able to be segregated and weighed to verify that the quantity, by weight, of the cap material included the target amendment to meet the meet the specification.



To improve control, placement is monitored with a computer system that essentially allows the operator to "paint" a target area at a uniform rate, collecting data on placement rate, based on feed rate and belt speed. This combination provides the operator with a significant amount of control over both the thickness of the layer, based on application rate (lb/SF of material from the belt). The photo to the right shows the control system used by the operator to track placement.

Sand to AquaGate Comparison Chart

AquaGate Vol %	Sand Vol %	AquaGate Wt % 80 lb/cu ft	Sand Wt % 90 lb/cu ft	Mix Ratio Sand to AquaGate
20%	80%	18%	82%	4.50
21%	79%	19%	81%	4.23
22%	78%	20%	80%	3.99
23%	77%	21%	79%	3.77
24%	76%	22%	78%	3.56
25%	75%	23%	77%	3.38
26%	74%	24%	76%	3.20
27%	73%	25%	75%	3.04
28%	72%	26%	74%	2.89
29%	71%	27%	73%	2.75
30%	70%	28%	72%	2.63
31%	69%	29%	71%	2.50
32%	68%	29%	71%	2.39
33%	67%	30%	70%	2.28
34%	66%	31%	69%	2.18
35%	65%	32%	68%	2.09
36%	64%	33%	67%	2.00
37%	63%	34%	66%	1.92
38%	62%	35%	65%	1.84
39%	61%	36%	64%	1.76
40%	60%	37%	63%	1.69

CONCLUSIONS

As noted in the introduction, the design for the project was based on modeling data that assumed a uniform distribution of activated carbon within a 10-inch thick reactive cap. Therefore, it was important that the QA/QC activities demonstrate that the above equipment was able to accomplish this objective. Based on this, the focus was placed on verification of both layer thickness and distribution of the AquaGate as the primary quality assurance/control measurements following the installation process

Although the production records provide a direct measurement and means to calculate and verify material placement, verification of layer thickness was also evaluated through core sampling of the as-placed active cap. Twelve (12) samples were taken over the installation area to provide a statistically valid demonstration of the physical layer thickness. The highly consistent measurements from these core samples provide direct evidence that a uniform thickness was achieved during installation of the active layer.

This project demonstrated the successful placement of a sand and AquaGate+PAC 10% mixture and placement to provide a uniform 10-inch thick cap layer. Ongoing monitoring activities are anticipated to provide a positive result supporting the modeling assumptions.

Final Cap Photos:

– Left (North)

- Right (South)

REFERENCES

1. EPA Office of Superfund Remediation and Technology Innovation. "Use of Amendments for In Situ Remediation at Superfund Sediment Sites", April 2013
2. Lampert, D.J. and Reible, D.D. 2008. "An Analytical Modeling Approach for Evaluation of Capping of Contaminated Sediments," Soil & Sediment Contamination.
3. EPA CAG Meeting – Removal Action Update - June 12, 2014

AquaGATE+

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