Sediment Management Work Group

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Quality Control Aspects of Active Cap Materials & Placement at East Branch Grand Calumet River: Evaluation of Sorption Characteristics of AquaGate+Organoclay™ Coated Materials

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AquaBlok Composite Particle System

Background

The specification and design for the East Branch of the Grand Calumet River (EBGCR) project called for an active cap consisting of organoclay materials having certain minimum specified sorptive properties (partition coefficients – K_d values) for two target dissolved phase PAH contaminants. To construct the active cap J.F. Brennan selected AquaGate+Organoclay™ (AG+OC), manufactured by AquaBlok, as the active capping product and placed the materials with their proprietary spreader barge system. AquaBlok provided quality control data on the as-manufactured/shipped product and Natural Resource Technology (NRT) performed monitoring and quality control during subaqueous installation of the cap materials. After installation of the active layer, NRT provided samples of recovered, as-placed cap materials to AquaBlok. AquaBlok subsequently engaged SAO Environmental Consulting to oversee laboratory sorption testing to evaluate the relative sorption characteristics of both manufactured and as-placed product samples.

Challenge

Effective design and implementation of active caps is acknowledged to have great potential to reduce risks and costs as a remedy for contaminated sediment remediation. However, design and implementation is still considered to be new in the industry. As a result, cumulative factors of safety are applied to multiple variables which can result in increased active cap thickness or the application of significant quantities of expensive treatment materials.

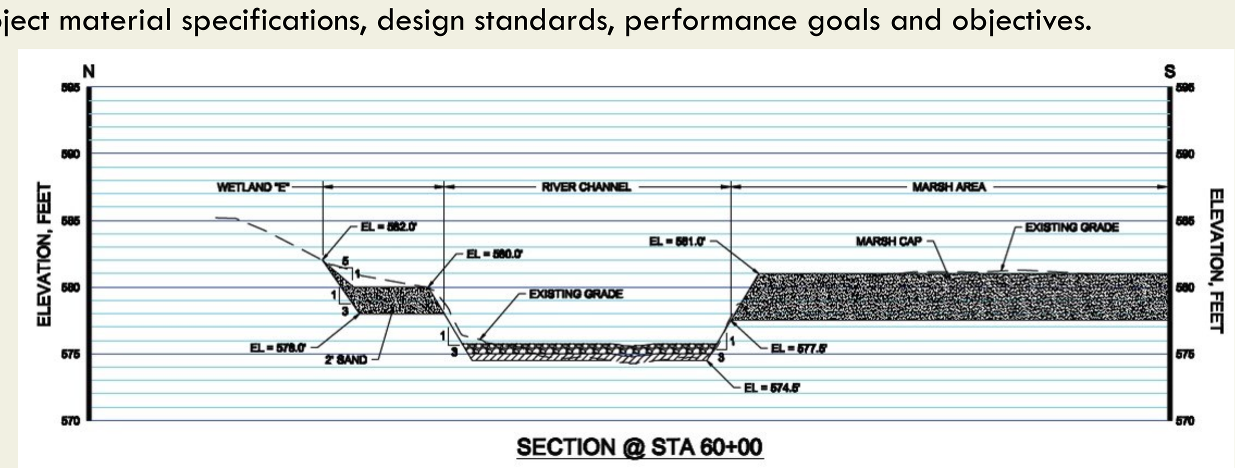
Modeling has been utilized to determine targeted cap thickness, including specific treatment amendment loading. Key assumptions incorporated into models include, uniform distribution of treatment amendments, and appropriate residence or contact time to address advective flow of contaminated sediment pore water or ebullition.

If we can demonstrate and verify that key modeling assumptions can be implemented in a full-scale installation of an active cap, this will provide greater confidence that design objectives will be met, resulting in significantly lower project costs.

Approaches/Objectives

This presentation will provide an overview of placement and on-site quality control activities surrounding placement of the EBGCR active cap. In addition, the approach, methodology and results for laboratory sorption testing of the active capping product will also be provided. The objective of the additional laboratory-based work in this study is to determine possible detrimental impacts that either the AquaGate manufacturing process (incorporating CETCO's organoclay powder material into a coated particle) or the act of placing the product in the river may have had on the organoclay sorption capability for either separate-phase contamination (oil) and/or dissolved-phase contaminants (selected PAH compounds, including naphthalene; phenanthrene; pyrene and benzo(a)pyrene).

Data to be presented demonstrate that use of the AquaGate+Organoclay approach for delivering active-treatment materials to the sediments provides a result that supports the modeling assumptions incorporated into the EBGCR remedial design. It can be concluded that such an approach provides for full-scale application of active capping materials and construction methods which allows verification of both the quantity and post-placement material properties relative to project material specifications, design standards, performance goals and objectives.



Quality Assurance vs. Quality Control

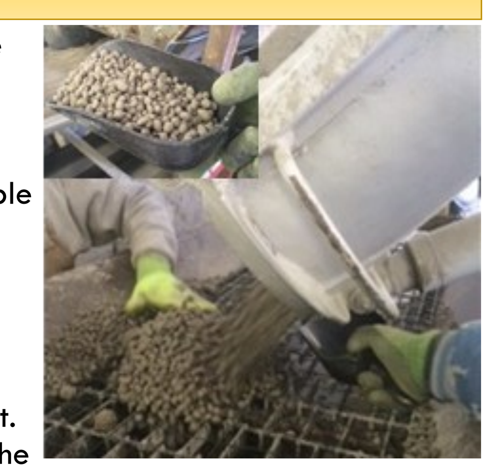
ISO 9000:2015 differentiates between Quality Assurance and Quality Control. Quality Assurance focuses on providing confidence that quality requirements will be fulfilled, while Quality Control focuses on fulfilling quality requirements. Quality Assurance activities are determined before work begins and these activities are performed while the work is in progress. Quality Control activities are performed after the work has been completed.

Raw Materials/Manufacturing—Project Quality Assurance

AquaBlok employs multiple different processes in order to ensure a quality finished product. The following are methods that were utilized in order to maintain a high level of control over the raw materials entering the batch process.

- Batch Sheets — All AquaBlok products are produced in a batch recipe process. This allows a significant level of control when it comes to batch inputs. All inputs to each batch are documented.
- Weighing Bulk Bags — All bulk bags of organoclay are pre-weighed and checked, on a certified scale, prior to use in production. This ensures that the weights recorded on the batch sheets are accurate.
- Aggregate Gradation — The aggregate added into each batch is weighed on a certified scale prior to addition into the manufacturing process. This certified weight is then recorded on the batch sheet.

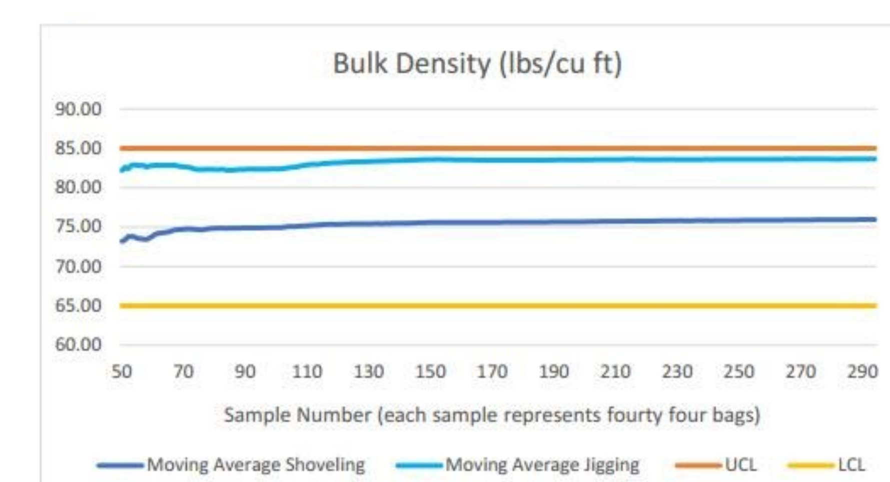
Raw Materials/Manufacturing—Project Quality Control

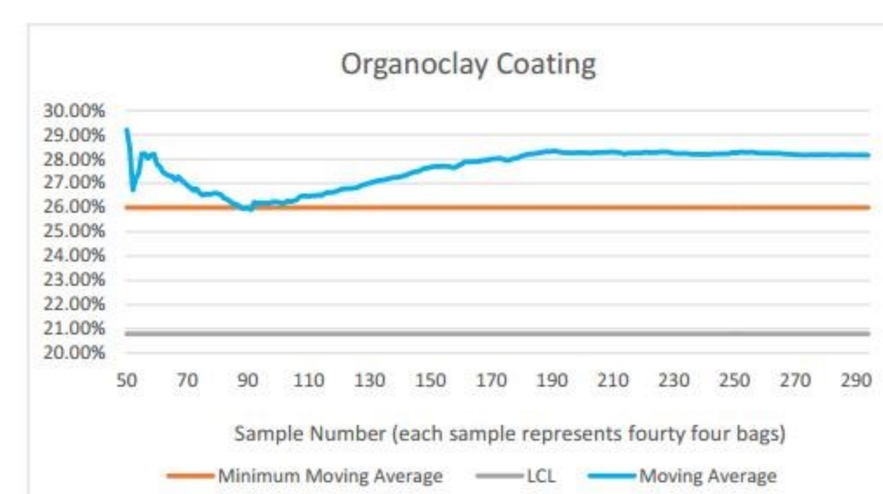


AquaBlok performed the following test methods on the finished product. The finished product did not leave the plant until the associated quality control sample had passed all quality control measures. If a sample does not pass any of the quality control tests, then the material associated is re-processed and re-tested to ensure that the quality metrics were met.

- Sampling AquaGate+Organoclay (AQBTM D 75) — This was intended to provide a representative sample of finished AG+OC product for further analysis and testing.
- Bulk Density (AQBTM C 29) — The project required a Bulk Density of 75lb/cu ft. +/- 10 lb/cu ft.
- Sieve Analysis (AQBTM C 136) — The requirement in the project specification was to use AASHTO #8 Aggregate
- Moisture Content, Oven Drying (AQBTM D2216) — In order to obtain an accurate measurement of the coating weight on the composite AG+OC particle, it is necessary to remove and measure moisture content.
- Material Coating Analysis (AQBTM AB100) — The material coating analysis is performed to determine the average weight of coating material on the AG+OC composite particle as a percentage of total particle weight. This is considered to be the measurement that will determine if percent coating by weight has been achieved.
- Material Scrape Test (AQBTM AB101) — The scrape test was conducted to determine the amount of organoclay that still remains on the sample after the Material Coating Analysis has been concluded. The results of the scrape test determine, on average, an adjustment factor to account for organoclay residuals remaining on aggregate particles subjected to the Material Coating Analysis.

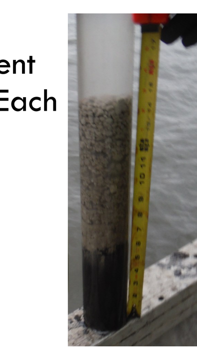
The project required a minimum moving average of 26% organoclay with a minimum of 20.8% on any given sample. The Final Moving Average Organoclay Content was 28.15% +/- 0.256% with a 99% Confidence Level.





Post-Construction Cap Confirmation Sampling—Project Quality Assurance

- Placement of the capping materials and quality assurance during construction was performed by JF Brennan. A belt scale was utilized in order to determine the quantity/thickness of capping material placed by the spreader barge.
- Immediately following placement, construction quality control activities were performed by NRT. The reach was divided into 87 sampling grids located every 100 linear feet along the centerline of the river. Within each sample grid five cores and five bucket samples were obtained (for a total of 870 placement/construction quality control checks). These sample locations were determined using a random number generator.



- Of the above samples, NRT retrieved bucket samples from nine different locations which were used for post-placement quality control activities. Each bucket sample retrieved was a duplicate (second bucket) from the same location as the randomly generated bucket samples.
- The duplicate bucket sample was transported to AquaBlok for Post-Construction Cap Confirmation Sampling – Project Quality Control as described in detail below.

Post-Construction Cap Confirmation Sampling—Project Quality Control

- As detailed above, Post-Construction Project Quality Assurance Activities included the recovery of sample buckets containing as-placed capping materials (AquaGate+Organoclay).
- Material that was placed as part of the field capping portion was provided by NRT for analysis of the relative efficacy of the active organoclay component as compared to the project specifications (to sorb targeted contaminants).
- Bucket samples provided by NRT were processed by AquaBlok in order to separate the dry powdered organoclay component. This material became the as-placed powdered organoclay sample utilized in further testing as detailed below.
- In addition to the as-placed organoclay sample, AquaBlok included two additional samples for comparison. Blind testing was performed on all three of the following samples.
  - **As-Received** powdered organoclay, supplied by CETCO and used in the production of the AquaGate+Organoclay product.
  - **As-Produced** powdered organoclay, removed from representative samples taken during the product manufacturing process.
  - **As-Placed** powdered organoclay, removed from material placed in the river during project capping.
- To evaluate NAPL sorption, the three samples were sent to CETCO's lab for oil sorption testing (see Figure 1). This test indicated minimal variation of sorption capacity, with all materials meeting an assumed 50% - 100% NAPL sorption capacity.

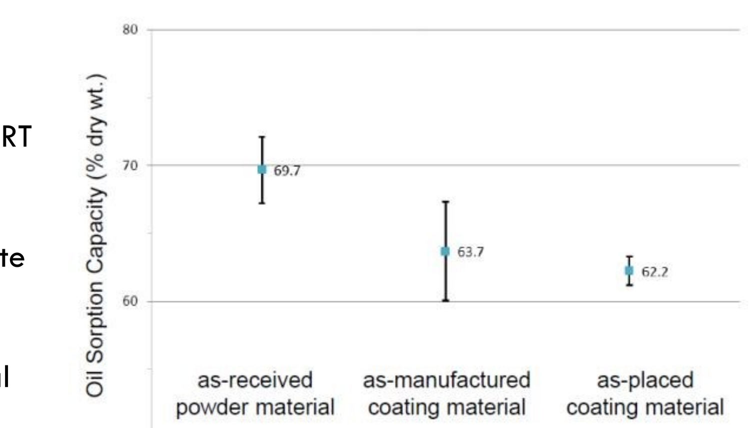


Figure 1. Oil sorption capacity (% dry wt.) for the different EBGCR organoclay materials. Error bars represent the 95% confidence interval (CI) around respective mean values; n=4 for each material type.

Bucket sample of placed material — as received.

- Similar blind testing was performed to evaluate dissolved-phase PAH sorption for project-specific contaminants, phenanthrene and pyrene. Additional testing was performed for naphthalene and benzo(a)pyrene. This sorption testing (determination of partition coefficients) was performed by Texas Tech University, under the guidance of Danny Reible.
- Testing indicated that partition coefficients met or exceeded the values called out in the project specifications. As shown in Figure 2, no substantial differences existed between the samples.

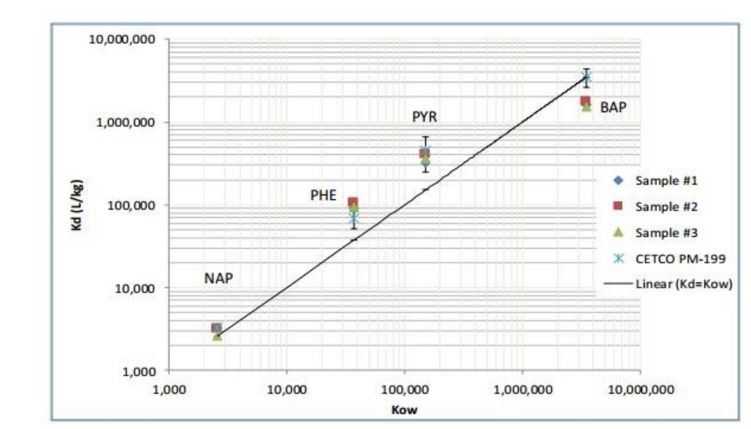
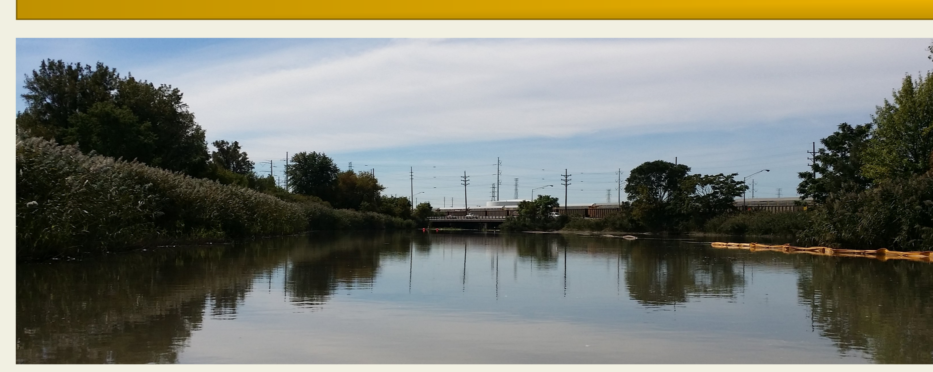


Figure 2. Estimated mean partition coefficient (K_d) values as a function of PAH Kow for the three AquaGate+Organoclay products, plus comparison to values for the CETCO PM-199 organoclay. The Kd=Kow line is also shown for reference.

Results/Findings/Summary



Scenic View completed project.

Data presented demonstrates that the project's approach for delivering active-treatment materials to the sediments provides several significant advantages, as follows:

1. Ability to confirm the <u>quantity</u> of high-value amendment material (organoclay coating weight) being supplied and placed.
2. Confirmation of material properties such as bulk density (<u>determines layer thickness</u>), which is critical to demonstrate that this key design parameter is met.
3. Verification of <u>uniform distribution</u> of active-treatment materials is achieved through the thickness of the capping layer.
4. Enables ability to perform post-placement confirmation of active-treatment material testing of <u>adsorption capacity</u> (partition coefficient) that meets the specification.
5. Modeling <u>output can be confirmed</u> through comparison of input/assumptions to post-placement physical and material property data.
6. Results can support modeling assumptions and be used to <u>reduce costs associated with excessive factors of safety</u> due to lack of certainty of achievement of a design/specification as well as the ability to provide post-placement verification.

It can be concluded that the approach enabled full-scale application of active capping materials and construction methods that allow for verification of both the quantity and post-placement material properties relative to project material specifications and design standards, to meet performance goals and objectives.

Acknowledgements:

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Aquagate+ organoclay™

Permeable Materials for In-Situ Treatment & Remediation Applications

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