INFRASTRUCTURE ALTERNATIVES, INC.

THE IMPACT OF TREATABILITY STUDIES ON FULL-SCALE PROJECTS

Presented by Connor McNeely

CLEAN WATER SOLUTIONS

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TREATABILITY STUDIES

- Site-specific remediation investigations
  - Past project experience only so helpful
- Typically used for environmental dredging projects
- Means for evaluation and optimization in a laboratory settling

TREATABILITY STUDIES

- Improves remediation strategy prior to field implementation
- Provides scale-up information on performance variables
- Minimizes risk & increases confidence
- Saves time and money

TREATABILITY STUDIES

- Typically 2-4 years prior to full-scale implementation
- Somewhat seasonally dependent
- Sometimes multiple studies performed years or decades apart
- Sometimes performed for existing systems as technical evaluation

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SAMPLE COLLECTION

- Site sediment and surface water samples collected from one or multiple locations
- Sample locations determined by sediment variability and volume to be dredged
  - Pre-investigation very helpful
  - Roughly 1 sample location per 20,000 CY
  - Typically less variability with surface water
- Important to collect range of samples

SAMPLE COLLECTION

- Sample volume determined by treatability scope
- Sediment collection method
  - Cores ideal
  - Ponar “grab” sampler, sludge judge, bucket-and-rope usable for softer, uniform material
  - Boat, excavator, frozen water surface

SAMPLE CONTAINER & TRANSPORT

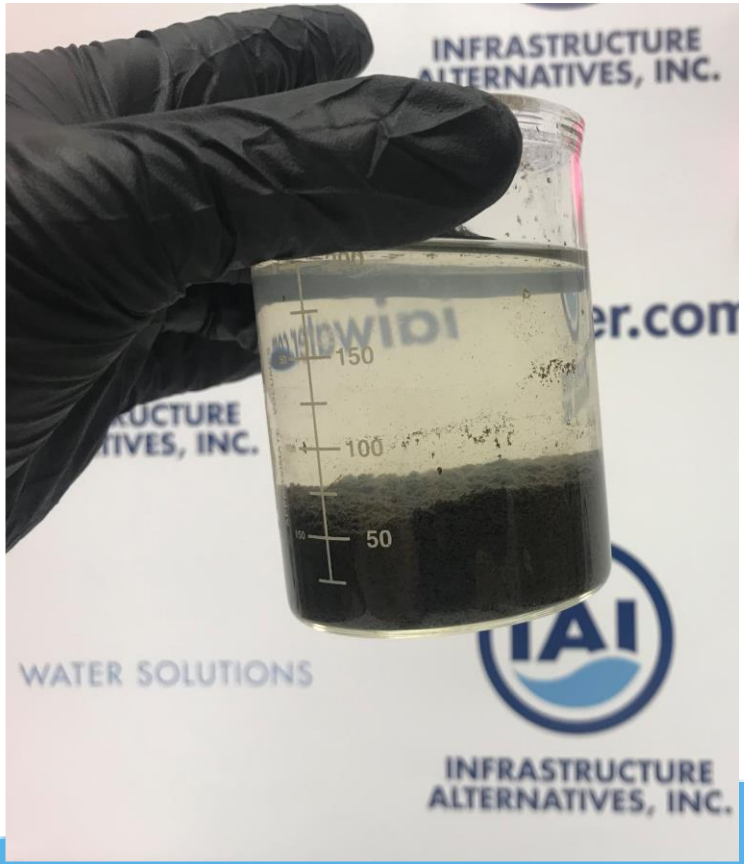
- Container type dependent on sample volume, receiving ability
  - 5-gal buckets typical
  - 55-gal drums or 275-gal totes
- Shipping considerations
  - Leaking buckets often flagged, gasketed lids necessary
  - Mishaps less likely with priority, weekday, or private shipping

IN-SITU CHARACTERIZATION

- Bulk homogenization for best representation
- Mixing observations such as color, odor, consistency
- Solids content
- Bulk density
- Particle size distribution
- Chemical analysis

DEWATERING PRODUCT SELECTION

- Typical dredge slurry 8-12% solids content
- Treatment product evaluation via jar testing
  - Products varying in charge, structure, molecular weight
  - Qualities such as floc size, floc strength, water clarity
  - Dosage rate



DEWATERING PRODUCT SELECTION

- Some objectivity from Rapid Dewatering Tests (RDTs)
  - Water release rate as direct comparison

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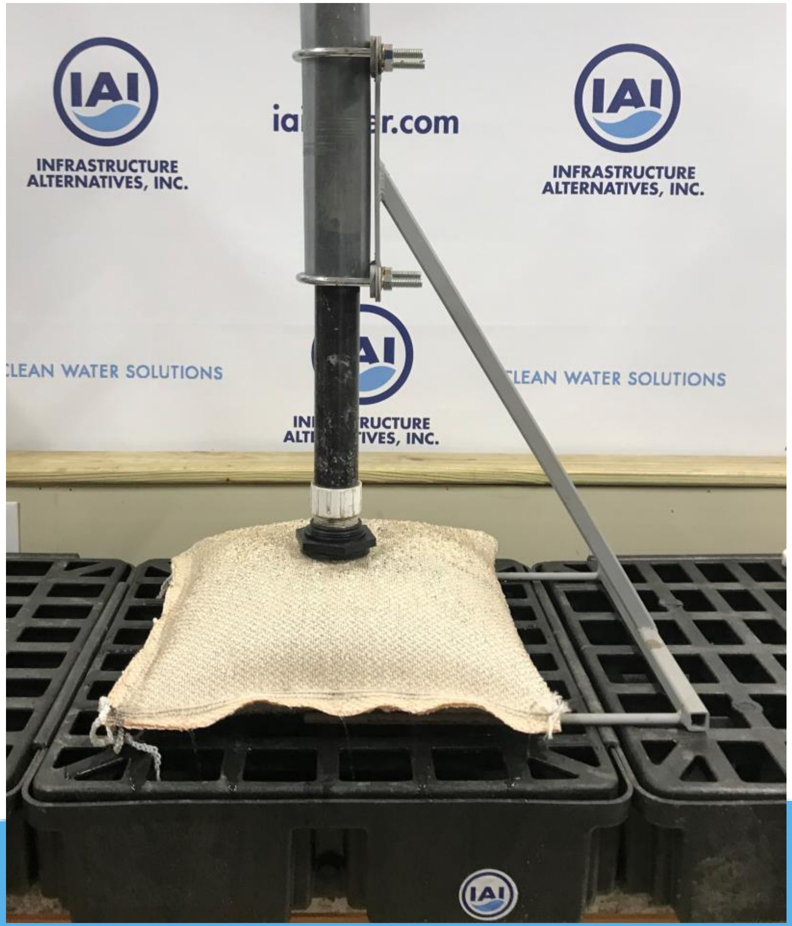
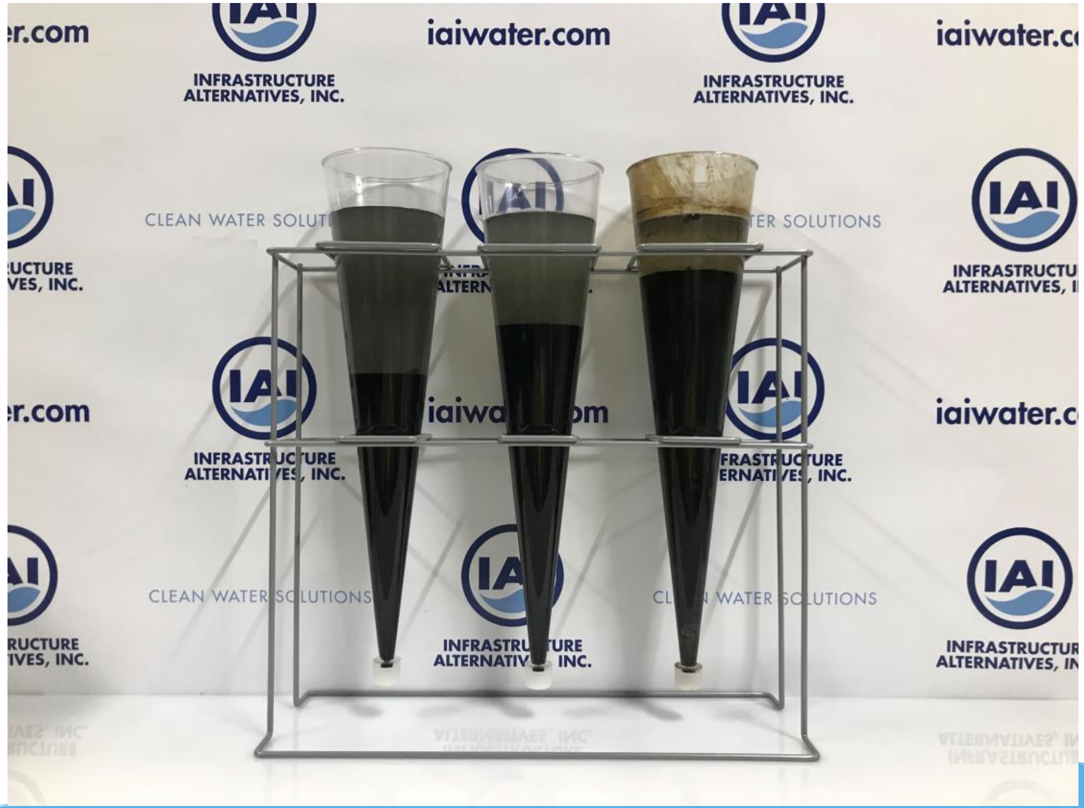
GEOTEXTILE TUBE DEWATERING TEST

- Conditioned slurry into pillow-sized geotextile tube
- Filtrate collection and analysis
- Dewatered material testing
  - Chemical analyses
  - Solids content over time
  - Consolidation estimates
  - Paint filter test, compression strength test



DREDGED MATERIAL MANAGEMENT TEST

- Settling test, with and without chemical settling aid
  - Zone settling – shorter term
  - Compression settling – longer term
  - Supernatant collection
    - Water treatment testing



MECHANICAL DEWATERING TESTS

- Belt filter press
  - Pressure zones simulated – gravity drainage, low pressure, high pressure
- Plate and frame press
  - Various filtration pressures and time intervals simulated
- Material amendment/stabilization

WATER TREATMENT TESTING

- Project specific information important
  - Discharge limits
  - Pre-approved treatment chemicals
- Collection and analysis between each treatment process very useful
- Influent and effluent most valuable data points

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WATER TREATMENT TESTING

- Generating water for testing
  - WTP influent source?
  - Must have contamination
- Sufficient volume for testing and analytical sampling
  - Duplicate sampling or repeat testing sometimes necessary
  - Excess volume never a bad thing

WATER TREATMENT TESTING

- Clarification and precipitation
  - Jar testing to determine effectiveness and dosage range
  - Mechanical stirring in phases to simulate settling pond
  - Bulk clarification and precipitation

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WATER TREATMENT TESTING

- Filtration simulation
  - Pumped through pressurized columns loaded with various filter media
  - Filter paper or bag filter as alternative
    - 25-micron (nominal) good substitute for multimedia
    - 1-micron (nominal) for extra polishing

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WATER TREATMENT TESTING

- Adsorption media simulation
  - Pumped through pressurized columns loaded with various adsorption media
  - Granular activated carbon, ion exchange, organoclay
    - Lead-lag arrangement typical in field
  - Flow rate, media volume, contact time very important
    - Constant head pressure, effluent valve adjustments

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TREATABILITY CASE STUDY #1

- Great Lakes Area of Concern site
- Mechanical or hydraulic dredging? TBD
- Water treatment and discharge back to water body
- Metals, other inorganics, PAHs, VOCs among contaminants of concern
    - Ion exchange?
    - Multiple multimedia steps?

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TREATABILITY CASE STUDY #1

- Approach
- Testing split into two pathways
  - Mechanical dredging
    - Modified elutriate test
    - Water treatment testing
  - Hydraulic dredging
    - Geotextile tube dewatering test
    - Water treatment testing

MODIFIED ELUTRIATE TEST

- Approx. 110 gal. of 150 g/L slurry into open tote
  - Vigorously agitated for 5 min.
  - Aerated for 60 min.
  - Allowed to settle for 24 hr.
  - Decanted supernatant = WTP influent

GEOTEXTILE TUBE DEWATERING TEST

- Dewatering products screened for multiple sample locations
  - Regimen that best treated all sample locations selected
- Selected regimen applied to approx. 60 gal. of 10% solids content slurry
  - Conditioned slurry into geotextile tubes
  - Geotextile tube filtrate = WTP influent

WATER TREATMENT TESTING

- WTP influent
  - MET supernatant
  - GTDT filtrate
- Clarification & precipitation
  - ferric chloride
  - pH adjustment

WATER TREATMENT TESTING

- Multimedia filter #1
  - Filter sand
  - Anthracite
  - 5.6 gpm/sf^2
- Multimedia filter #2
  - Filter sand
  - Garnet
  - 5.6 gpm/ft^2

WATER TREATMENT TESTING

- Lead GAC
  - 4.5 min EBCT
- Lag GAC
  - 4.5 min EBCT
- Ion exchange
  - 22 Bv/h

ANALYTICAL SAMPLING

- Samples collected throughout each pathway
- Sample set collected after each unit process
  - WTP influent
  - Clarification effluent
  - Precipitation effluent
  - Multimedia filter #1 effluent
  - Multimedia filter #2 effluent
  - Lead GAC effluent
  - Lag GAC effluent
  - Ion exchange effluent

ANALYTICAL SAMPLING

- Sample set – approx. 1 gal
  - Metals – total and dissolved
  - Low level mercury
  - Other inorganics
  - PAHs
  - VOCs

ANALYTICAL DATA

NOTE: Highlighted cells are values > effluent limit

		Step	1	2	3	4	5	6	7	8
		pH	10.08	10.33	3.84	5.21	6.06	8.51	8.48	10.39
Parameter	Units	Limit	Influent	Clarification Eff	Precipitation Eff	MMF 1 Eff	MMF 2 Eff	GAC 1 Eff	GAC 2 Eff	IX 1 Eff
Arsenic, Dissolved	µg/L		5.14	7.59	< 1.00	< 1.00	< 1.00	1.44	2.13	1.94
Arsenic, Total	µg/L	350	5.39	9.79	2.26	1.07	< 1.00	1.25	2.22	1.90
Cadmium, Dissolved	µg/L		0.200	< 0.200	0.655	0.860	< 0.200	< 0.200	< 0.200	< 0.200
Cadmium, Total	µg/L	5	< 0.200	1.49	0.656	0.864	< 0.200	< 0.200	< 0.200	< 0.200
Chromium, Total	µg/L		3.71	7.74	15.1	2.51	< 1.00	2.25	< 1.00	< 1.00
Chromium, Trivalent	µg/L	1776	3.71	7.74	15.1	2.51	< 1.00	2.25	< 1.00	< 1.00
Chromium, Hexavalent	µg/L	19	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Copper, Dissolved	µg/L		2.00	4.56	29.8	23.6	8.99	<1.00	<1.00	<1.00
Copper, Total	µg/L	17	29	29	22.1	26.3	12.4	1.57	1.84	1.87
Cyanide	µg/L	5.9	5.3	3.8	4.5	< 2.00	< 2.00	< 2.00	< 2.00	< 2.00
Iron, Dissolved	µg/L		227	223	4730	3580	< 100	< 100	< 100	< 100
Iron, Total	µg/L	2800	4740	18100	16400	7810	443	< 100	< 100	< 100
Lead, Dissolved	µg/L		< 1.00	< 1.00	36.9	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Lead, Total	µg/L	3.9	82.4	181	48.5	2.34	< 1.00	< 1.00	< 1.00	< 1.00
Mercury, Low-Level	µg/L	0.0013	0.51	0.53	0.05	0.038	0.037	0.0014	< 0.0005	< 0.0005
Nickel, Dissolved	µg/L		< 1.00	1.1	11.9	16.6	5.51	1.39	1.4	< 1.00
Nickel, Total	µg/L	500	4.01	7.77	12	16.3	5.81	1.42	1.4	< 1.00
Zinc, Dissolved	µg/L		56.3	4.64	147	403	110	44	23.9	3.38
Zinc, Total	µg/L	107	142	380	142	409	152	1008	15.5	6.72
Benzene	µg/L	4487	< 5.00	2.04	1.74	0.76	0.8	< 0.500	< 0.500	< 0.500
m,p-Xylene	µg/L		< 10.0	1.71	1.16	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
o-Xylene	µg/L		< 5.00	0.91	0.71	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Xylenes, Total	µg/L		3.11	2.62	1.87	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Ethylbenzene	µg/L		< 5.00	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500
Toluene	µg/L		1.28	0.97	0.81	0.58	0.59	< 0.500	< 0.500	< 0.500
BTEX, Total	µg/L	1400	< 30.0	5.63	4.42	< 3.00	< 3.00	< 3.00	< 3.00	< 3.00
Acenaphthene	µg/L	58	< 2.00	< 2.00	< 2.00	< 0.400	0.22	< 0.200	< 0.200	< 0.200
Anthracene	µg/L	0.39	< 2.00	< 2.00	< 2.00	< 0.400	< 0.200	< 0.200	< 0.200	< 0.200
Benzo(a)pyrene	µg/L	0.66	2.00	< 2.00	< 2.00	< 0.400	< 0.200	< 0.0400	< 0.0400	< 0.0400
Fluoranthene	µg/L	4.2	16.0	6.6	3.5	0.75	< 0.200	< 0.200	< 0.200	< 0.200
Naphthalene	µg/L	462	640	9.9	5.5	4.6	4.1	< 0.200	< 0.200	< 0.200
Phenanthrene	µg/L	39	21.0	< 2.00	< 2.00	< 0.400	< 0.200	< 0.200	< 0.200	< 0.200

CASE STUDY #1 FINDINGS

- Geotextile tube dewatering very effective for contamination removal
- Some redundancy shown with multiple multimedia steps
- Samples found to be discharge compliant prior to lag GAC and ion exchange

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CASE STUDY #1 - FULL SCALE

- Dredge slurry 4,000 gpm to geotextile tubes for dewatering
- 4,000 gpm water treatment plant
- Discharge compliance maintained throughout
- Only one multimedia step utilized
    - Cost and space saving
- No ion exchange utilized
    - Highly cost and time saving

TREATABILITY CASE STUDY #2

- Great Lakes Area of Concern site
- Hydraulic dredging, thickening to geotextile tubes
- Filtrate treatment and discharge back to water body
- Oils, greases, NAPLs, metals among contaminants of concern
    - Organoclay?
    - Ion exchange?
    - High VOCs exposure?

TREATABILITY CASE STUDY #2

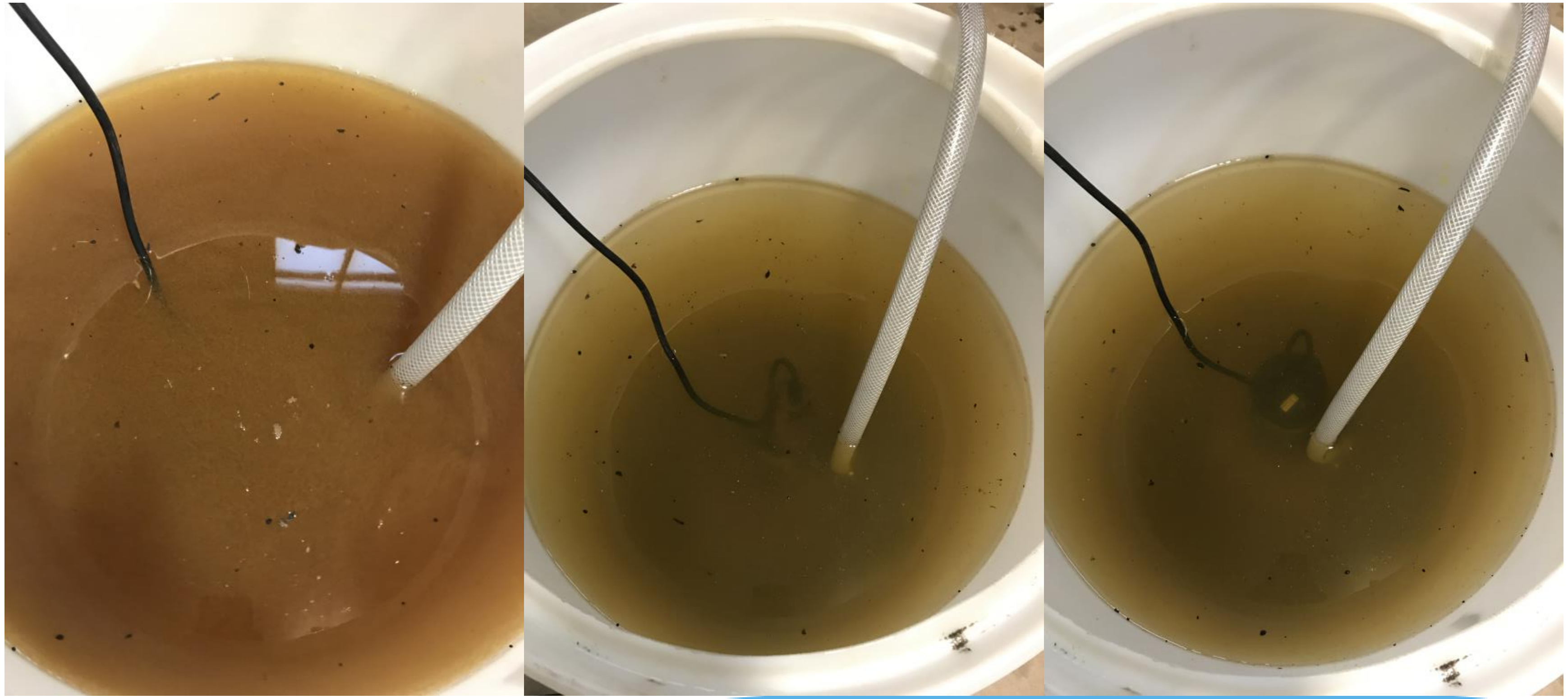
- Approach
  - Geotextile tube dewatering tests
  - Water treatment
    - Composite influent sources
  - Atmospheric testing during key steps

GEOTEXTILE TUBE DEWATERING TEST

- Dewatering products screened for multiple sample locations
  - Regimen that best treated all sample locations selected
- Selected regimen applied to approx. 30 gal. of 10% solids content slurry
- Thickening process simulated
  - Supernatant decanted
  - Thickened solids into geotextile tubes

WATER TREATMENT TESTING

- WTP influent
  - Thickener supernatant
  - Geotextile tube filtrate
- Clarification
  - Ferric chloride



WATER TREATMENT TESTING

- Multimedia filter
  - Filter sand
  - Anthracite
  - 5.6 gpm/ft^2
- Organoclay
  - 4.5 min. EBCT
- Lead GAC and lag GAC
  - 4.5 min. EBCT each

AQUEOUS ANALYTICAL SAMPLING

- Sample set collected after each unit process
  - Unconditioned slurry
  - WTP influent
  - Clarification effluent
  - Multimedia filter effluent
  - Organoclay effluent
  - Lead GAC effluent
  - Lag GAC effluent

AQUEOUS ANALYTICAL SAMPLING

- Sample set – approx. 1.5 gal
  - Heavy metals
    - Low level mercury
  - PAHs
  - Oil and Grease
  - Total petroleum hydrocarbons
    - Gas range (C6-C10)
    - Diesel range (C10-C28)
    - Oil range (C28-C36)

SOLIDS ANALYTICAL SAMPLING

- Sample collection points
  - Thickened solids
  - Geotextile tube dewatered material
- Sample set – approx. 20 oz
  - Particle size distribution
  - Heavy metals
  - PCBs
  - PAHs
  - Total petroleum hydrocarbons

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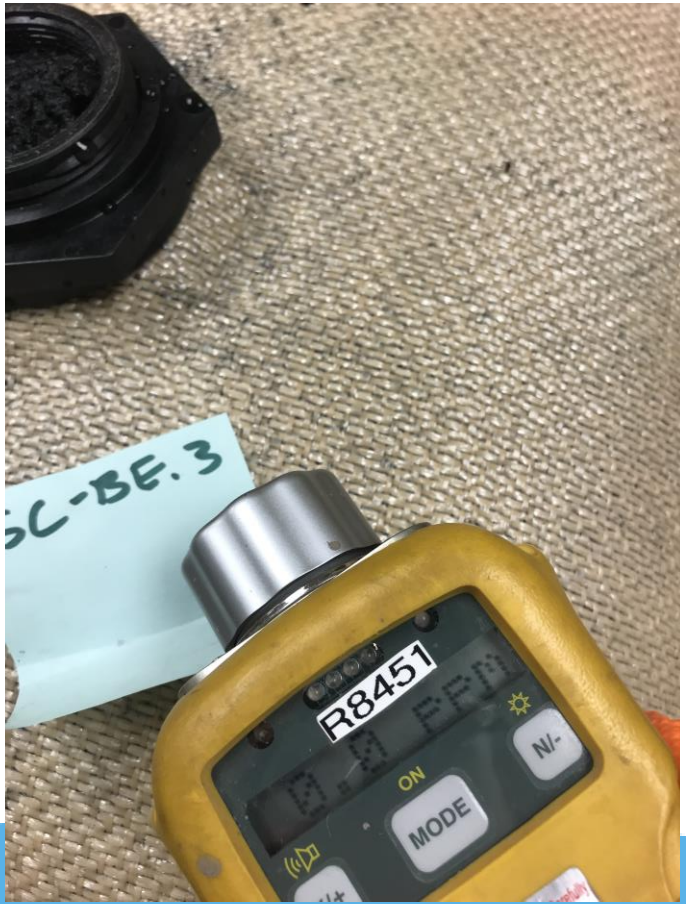
AIR MONITORING

- Photoionization detector (PID) used
- VOCs exposure monitored during key steps
  - Opening of sediment containers
  - Mixing of sediment and surface water
  - Slurry conditioning and thickening
  - Geotextile tube dewatering



CASE STUDY #2 FINDINGS

- VOCs exposure below limits
  - Geotextile tube operations safe
- Oil and grease non-detect after organoclay
  - Organoclay necessary for full scale
- Heavy metals highly associated with solids
  - Ion exchange not needed

CASE STUDY #2 FINDINGS

- PAHs and PCBs tended to remain with sediment
- Petroleum hydrocarbons aqueous affinity higher than anticipated
  - More lower MW compounds = better solubility
  - Gas and diesel range in organoclay effluent but not in lead GAC effluent
- PAHs largely removed by settling and filtration
  - Backwash cycles likely high in PAHs

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TREATABILITY CASE STUDY #3

- Great Lakes Area of Concern site
- Hydraulic and/or mechanical dredging
  - Water treatment and discharge back to waterbody
- High variance in sediment characteristics
- Mercury of great concern
  - Specialty mercury treatment chemical necessary?

TREATABILITY CASE STUDY #3

- Approach
  - 5 sample locations tested individually
  - Geotextile tube dewatering tests
  - Water treatment testing
  - Whole Effluent Toxicity (WET) testing
    - Discharge approval for water treatment chemical additives

GEOTEXTILE TUBE DEWATERING TESTS

- Dewatering products screened for multiple sample locations
  - Regimen that best treated all sample locations selected
- Selected regimen applied to approx. 36 gal. of 10% solids content slurry, per location
  - Conditioned slurry into geotextile tubes
  - Geotextile tube filtrate = WTP influent

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WATER TREATMENT TESTING

- Jar testing of coagulants for dosage evaluation
  - Aluminum sulfate, ferric sulfate, ferric chloride, specialty mercury-targeting reagent (SMTR)
- Screening of various coagulants and combinations to determine effectiveness
  - Coagulant alone
  - Coagulant + SMTR
  - Coagulant +SMTR + pH adjustment

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WATER TREATMENT TESTING

- Bulk clarification based on coagulant screening
- Simulated multimedia filtration utilizing 25-micron paper filter
- Bag filtration utilizing 1-micron bag filter
- Lead and lag GAC adsorption utilizing pressurized media columns
  - 4.5 min EBCT for each

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CASE STUDY #3 FINDINGS

- Mercury removal to lower than 1.3 ng/L feasible
- Specialty mercury-targeting reagent shown to be beneficial

Initial Clarification Screening	Total Hg (ng/L)	Dissolved Hg (ng/L)	pH
GTDT Filtrate	1800	1700	12.42
Aluminum Sulfate 200 ppm	1300	900	12.37
Ferric Sulfate 200 ppm	1200	1100	12.32
Ferric Chloride 50 ppm	900	870	12.25
Aluminum Sulfate 200 ppm + 1 ppm SMTR	1100	900	12.33
Ferric Sulfate 200 ppm + 1 ppm SMTR	1000	880	12.31
Ferric Chloride 50 ppm + 1 ppm SMTR	870	850	12.25

Additional Clarification Screening	Total Hg (ng/L)	Dissolved Hg (ng/L)	pH
Ferric Chloride 50 ppm	115	53	8.88
Ferric Chloride 50 ppm, 1 ppm SMTR	120	50	8.79
Ferric Chloride 100 ppm	870	850	12.24
Ferric Chloride 100 ppm	88	61	9.01
Ferric Chloride 100 ppm, 10 ppm SMTR	920	900	12.18
Ferric Chloride 100 ppm, 10 ppm SMTR	50	22	8.76
Ferric Chloride 100 ppm, 20 ppm SMTR (pH 9) used for Bulk Clarification of GTDT filtrate			

Water Treatment Testing	Total Hg (ng/L)	Dissolved Hg (ng/L)
Bulk Clarification Effluent	130	6.9
Multimedia Filter Effluent	7.8	1.6
Bag Filter Effluent	4	1.3
GAC Effluent	0.25	0.22

QUESTIONS?

Connor McNeely,
Project Manager
Infrastructure Alternatives, Inc.
Mobile: 616.916.1160
Office: 616.866.1600 ext. 28
E-mail: cmcneely@iaiwater.com