Milwaukee Harbor (Jones Island) Confined Disposal Facility-Dredged Material Disposal Facility Beneficial Use Evaluation

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Introduction

Figure 1. *Site Location Map*

A field investigation was performed at the Milwaukee Harbor (Jones Island) Confined Disposal Facility-Dredged Material Disposal Facility (CDF-DMDF) to identify the potential for the beneficial reuse of historically placed dredged material in the CDF-DMDF. The CDF-DMDF is owned by the City of Milwaukee – Port of Milwaukee (Port of Milwaukee) and operated and maintained by the U.S. Army Corps of Engineers (USACE). An in-lake facility attached to land, the facility is located at the south end of the Milwaukee Harbor in Milwaukee, Wisconsin, as shown on **Figure 1**, and is within the Milwaukee Estuary Area of Concern (AOC).

The CDF-DMDF facility has a constructed capacity of 510,000 cubic yards (cy) and is expected to receive 30,000 cy of sediment every other year. Potential reuse of this material could create additional capacity within the CDF-DMDF for dredged sediments from Milwaukee Harbor Federal Navigation Project and non-federal projects within Milwaukee Harbor. The initial step in this process is the collection of core samples of the placed dredged material within the CDF-DMDF to determine its physical and chemical composition. Foth Infrastructure & Environment, LLC (Foth) performed this field investigation in March 2018 of behalf of the Port of Milwaukee and We Energies.

Field Sampling Activities

Field sampling activities were performed by Foth and their subcontracted driller, Coleman Engineering Company (Coleman).

Sampled core locations are shown on **Figure 2**.

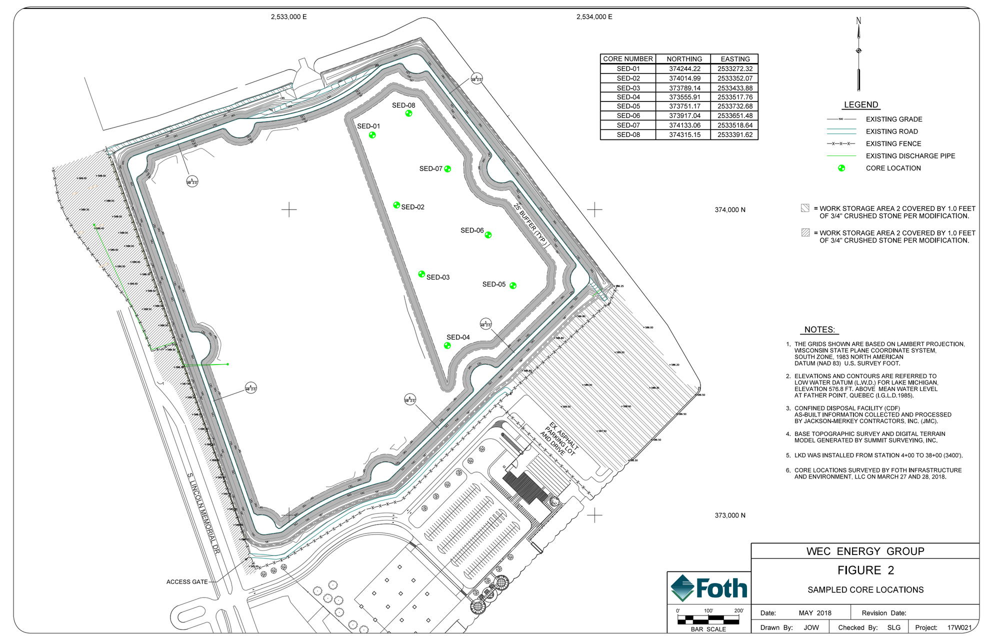


Figure 2. *Sampled Core Locations*

Table 1 summarizes general sediment core information including horizontal coordinates, elevation of the top of sediment at the time of borehole completion and sample recovery efficiency.

The direct push technology (DPT) drill rig was mounted onto a 26-foot long pontoon boat. Cores were advanced using either MC-7 (3 inch outer diameter) or MC-5 (2 inch outer diameter) DPT. Core tubes were advanced in 5-foot intervals to a target depth of 20 feet or to refusal, if encountered shallower than 20 feet. Recovered cores were capped and sealed in an upright position for transport to the core processing area, where the top core cap was removed and free water was drained by drilling a hole in the side of the tube, just above the sediment/water interface. Each core was then laid horizontal and cut open lengthwise, recovery measured, photographed, and sediments visually characterized and processed for analytical and geotechnical samples.

Summary of 2018 Sediment Core Information
Milwaukee Harbor CDF-DMDF
Milwaukee, Wisconsin

Date Logged	Borehole ID	Northing (ft)	Easting (ft)	Mudline Elevation (ftmsl)	Depth (ft)	Overall Sample Recovery (%)
3/27/18	SED-01	374244.22	2533272.32	586.65	20.0	70.0
3/28/18	SED-02	374014.99	2533352.07	586.70	20.0	86.0
3/28/18	SED-03	373789.14	2533433.88	586.56	20.0	82.0
3/27/18	SED-04	373555.91	2533517.76	586.63	18.2	78.0
3/27/18	SED-05	373751.17	2533732.68	587.03	16.5	76.0
3/28/18	SED-06	373917.04	2533651.48	586.61	20.0	85.0
3/28/18	SED-07	374133.06	2533518.64	586.66	20.0	76.0
3/27/18	SED-08	374315.15	2533391.62	586.96	14.2	70.0

ft = feet
ftmsl = feet mean sea level
Core locations surveyed by Foth Infrastructure & Environment, LLC on March 27 and 28, 2018.
Elevations are referred to low water datum (LWD) for Lake Michigan. Elevation 576.8 feet above mean level (ftmsl) at Father Point, Quebec (IGLD 1985).

Prepared by: RJM7
Checked by: SLG

Table 1. *Summary of 2018 Sediment Core Information*

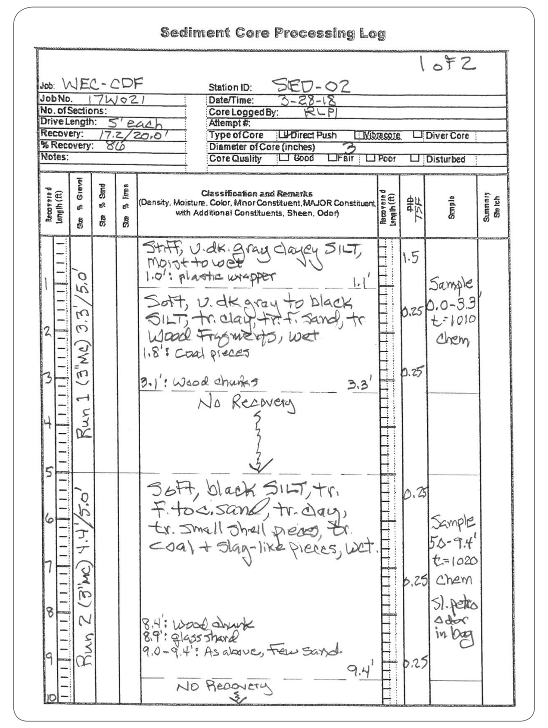
Investigation Results

Sediments were typically characterized as dark gray silt with varying clay and sand content. Trace plant and shell fragments were frequently observed. Examples of the **photographic logs** of the sediment cores are presented to the right, along with an example **boring log**. The boring logs note major lithologic changes and intervals from which analytical and geotechnical samples were collected. Each sand bearing soil fraction was homogenized and placed into the appropriate sampling containers. If the boring lacked sand bearing fractions, each recovered portion of each core tube was homogenized, processed and containerized for analysis for spatial representation.

Sediment cores were sampled and analyzed for the following parameters at TestAmerica Laboratories, Inc., in Chicago, Illinois.

- Polynuclear aromatic hydrocarbons (PAH)-19
- Total Metals
- Resource Conservation Recovery Act (RCRA) Metals
- Hexavalent Chromium
- Reactive Phenol
- Polychlorinated biphenyl (PCB)-Aroclors
- Total organic carbon (TOC)
- Pesticides and Herbicides
- Total Phosphorus
- Total Nitrogen

Sample Photographic Log



Sample Boring Log

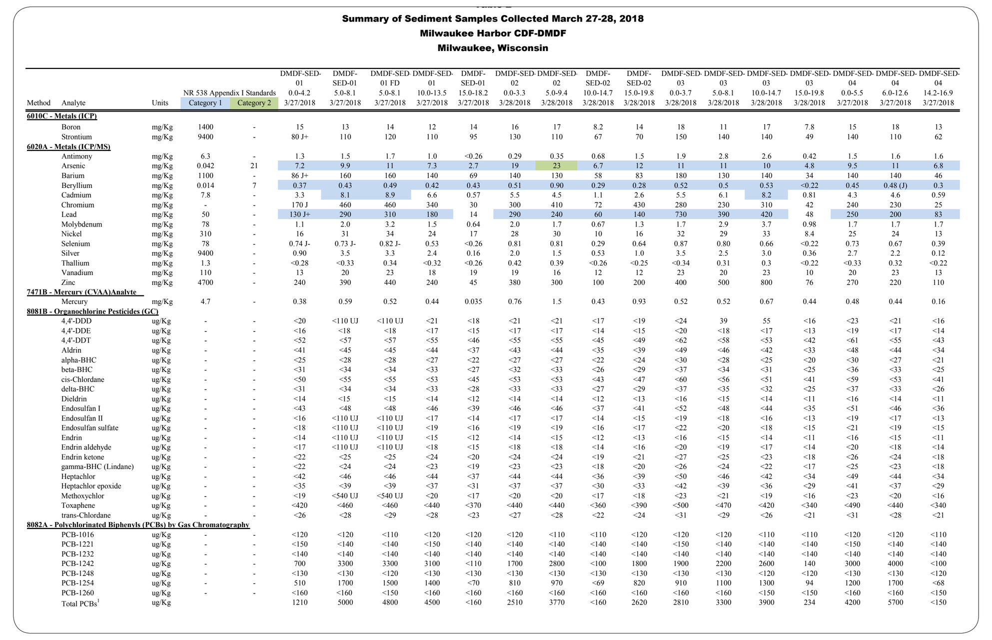


Table 2. *Summary of Sediment Samples Collected March 27-28, 2018*

The analytical samples and validated results are presented in **Table 2**. Based on the data verification and validation process, the analytical results were considered representative of site conditions and usable for the intended purposes.

In general, the metals tested for were frequently detected throughout all depths at all locations with the exceptions of hexavalent chromium and thallium, which were infrequently detected. Metals have been identified within the AOC as contaminants potentially of concern (WDNR, 2017).

With the exception of detections of dichlorodiphenyldichloroethane (4-4'-DDD) in SED-03, SED-06, and qualified estimated detections in SED-07 samples, pesticides and herbicides were not detected. Concentrations of 4-4'-DDD ranged from 20 micrograms per kilogram (µg/kg) to 74 µg/kg.

Two PCB Aroclors (PCB-1242 and PCB-1254) were commonly detected at all locations at depths. The total PCBs ranged from a minimum of 0.2 mg/kg to a maximum of 5.9 mg/kg.

Phenolics were predominantly non-detect, with SED-01 and SED-04 having the highest detected concentrations at 1.0 mg/kg and 1.1 mg/kg, respectively. Total organic carbon content of the sediment was typically high, ranging from 36,000 mg/kg (3.6%) to 200,000 mg/kg (20%).

Summary of Geotechnical Sediment Samples Collected March 27-28, 2018
Milwaukee Harbor CDF-DMDF
Milwaukee, Wisconsin

ASTM No.				D6913/D7928					D4318				D2216	D2487
				Grain Size Analysis					Atterberg Limits					
Date Sampled	Core ID	Sample ID	Sample Interval (ft)	%Gravel	%Sand	%Silt	%Clay	%Fines <#200	Liquid Limit[1]	Liquid Limit[2]	Plastic Limit	Plasticity Index	Water Content (%)	U.S.C.S.
3/27/18	SED-01	SED-01-0.0'-4.2'	0.0'-4.2'	2.6	26.5	35.8	35.1	70.9	66	52	32	34	50.9	CH
3/28/18	SED-02	SED-02-10.3'-14.7'	10.3'-14.7'	1.3	79.6	11.2	7.9	19.1	--	--	--	--	30.9	SM
3/28/18	SED-03	SED-03-15.0'-19.8'	15.0'-19.8'	1.2	86.1	--	--	12.7	--	--	--	--	23.1	SM
3/27/18	SED-04	SED-01-14.2'-16.9'	14.2'-16.9'	25.9	61.1	8.6	4.4	13.0	--	--	--	--	18.0	SM
3/27/18	SED-05	SED-05-3.4'-7.4'	3.4'-7.4'	0.4	30.9	49.6	19.1	68.7	67	50	32	34	62.8	OH
3/28/18	SED-06	SED-06-0.3'-1.0'	0.3'-1.0'	5.6	80.0	--	--	14.4	--	--	--	--	24.8	SM
3/28/18	SED-07	SED-07-0.0'-2.7'	0.0'-2.7'	0.0	12.8	65.6	21.6	87.2	69	55	34	35	60.4	CH
3/27/18	SED-08	SED-08-5.2'-6.1'	5.2'-6.1'	0.0	4.3	72.1	23.6	95.7	62	38	24	38	50.4	OH

[1] Liquid limit before oven drying.
[2] Liquid limit after oven drying.
-- = Hydrometer test not performed.
ft = feet; ID = identification; CH = fat clay; SM = silty sand or silty sand with gravel; OH = organic clay; U.S.C.S. = Unified Soil Classification System

Prepared by: RLP1
Checked by: HLV

Table 3. *Summary of Geotechnical Sediment Samples Collected March 27-28, 2018*

The geotechnical results are presented in **Table 3**. Samples submitted for geotechnical analyses were biased toward the coarse grained fraction, where present. The percentage of fines passing the number 200 sieve ranged from 12.7% in SED-03 to 95.7% in SED-08. Fine grained samples submitted for analysis ranged from high plasticity organic clays (OH) to high plasticity fat clays (CH). Coarse grained samples were classified as silty sand (SM) and silty sand with gravel (SM). Four of the 8 samples analyzed had Atterberg limits measured. The plasticity index ranged from 34 to 38 and liquid limits ranged 62% to 69%. Moisture contents were highly variable, ranging from 18% in SED-04 to almost 63% in SED-05.

Beneficial Use Evaluation

Although the material is not in the defined group of industrial byproducts under Wisconsin Administrative Code (Wis. Admin. Code) Ch. NR 538.03(4), sediment chemistry was evaluated relative to the standards outlined in *Guidance for the Beneficial Use of Industrial Byproducts* and NR 538 for comparison purposes. Use of the dredged material as an industrial byproduct would require special approval from the WDNR under Wis. Admin. Code NR 538.

Total elemental analysis of the samples was performed and results were compared to Category 1 and 2 standards of Wis. Admin. Code NR 538 because Categories 1-2 represent potentially high volume uses that could easily account for the volume of material present in the CDF-DMDF. A comparison to Category 3 or 4 standards would require additional analysis of samples using the ASTM D3987-85 water leach test. However, most uses in Categories 1-3 are better suited to coarser grained materials.

Green shading on **Table 2** represents exceedance of Category 2 standards, and blue shading represents exceedance of Category 1 standards as defined in the guidance document. Benzo(a)pyrene exceeded its Category 2 standard of 4,400 µg/kg throughout the investigation footprint area, as shown on a three-dimensional (3D) rendering presented on **Figure 3**. Red shading on Figure 3 depicts concentrations above

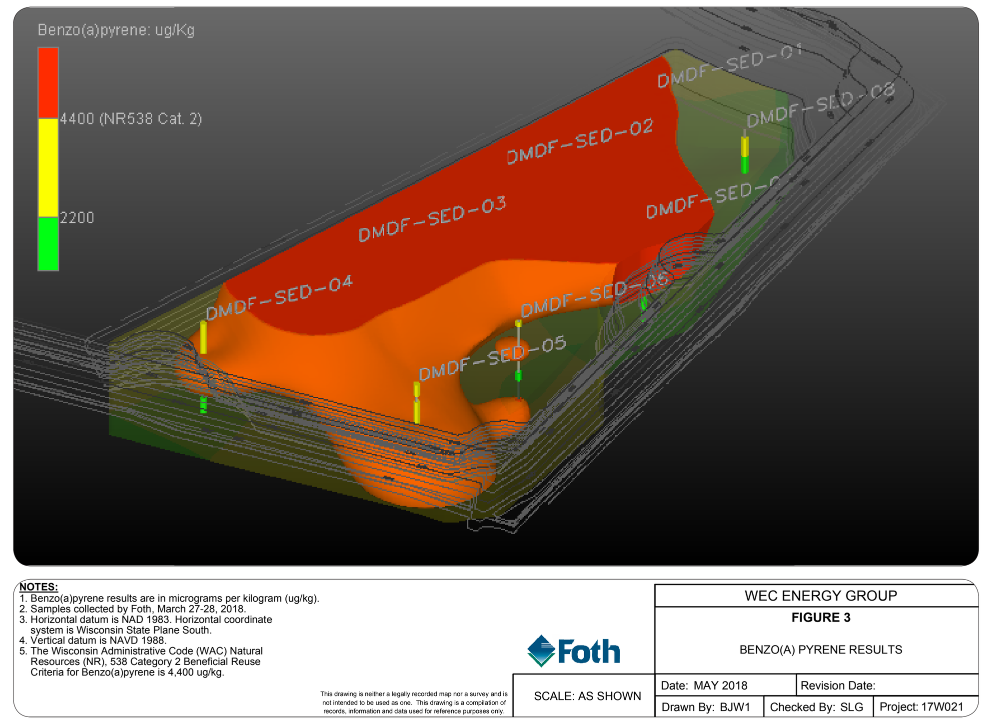


Figure 3. *Benzoa(A) Pyrene Results*

Category 2 standards and yellow represents 50% of the standard. The transparency of the yellow in the block diagram makes a portion of the red shading appear orange. Although there is not a criterion for total PCBs (tPCBs), tPCBs exceed 1 mg/kg, a common remedial action goal for contaminated soil and sediment projects in the Great Lakes region, throughout the investigation footprint area. **Figure 4** presents the 3D distribution of tPCB concentrations. Red shading represents concentrations greater than and equal to 1,000 µg/kg. Yellow shading represents concentrations equal to 500 µg/kg. **Figure 5** presents a rendering of all parameter Category 2 exceedences within the CDF-DMDF based on the 2018 investigation results.

The geotechnical properties of the placed materials were evaluated for potential reuse as engineered fill or non-structural fill (e.g., habitat restoration material). **Figure 6** presents a 3D rendering of coarse-grained material (retained on #200 sieve) and fine-grained material (passes #200 sieve). Most of the coarse-grained material, within the investigation footprint area, is at or near the lakebed elevation, near the base of the CDF, well below several feet of previously disposed dredged material. There is a shallower occurrence of coarse-grained material near the surface at location SED-07. The lateral extent of the shallow occurrence of this sand is limited because it was not identified in the adjacent borings. Fine-grained material is readily available and accessible near the surface. However, due to the characteristically high plasticity index, liquid limit, and moisture contents of the fine-grained material, amendment with a stabilization agent of some type (e.g., lime, cement, fly ash) to improve strength would be

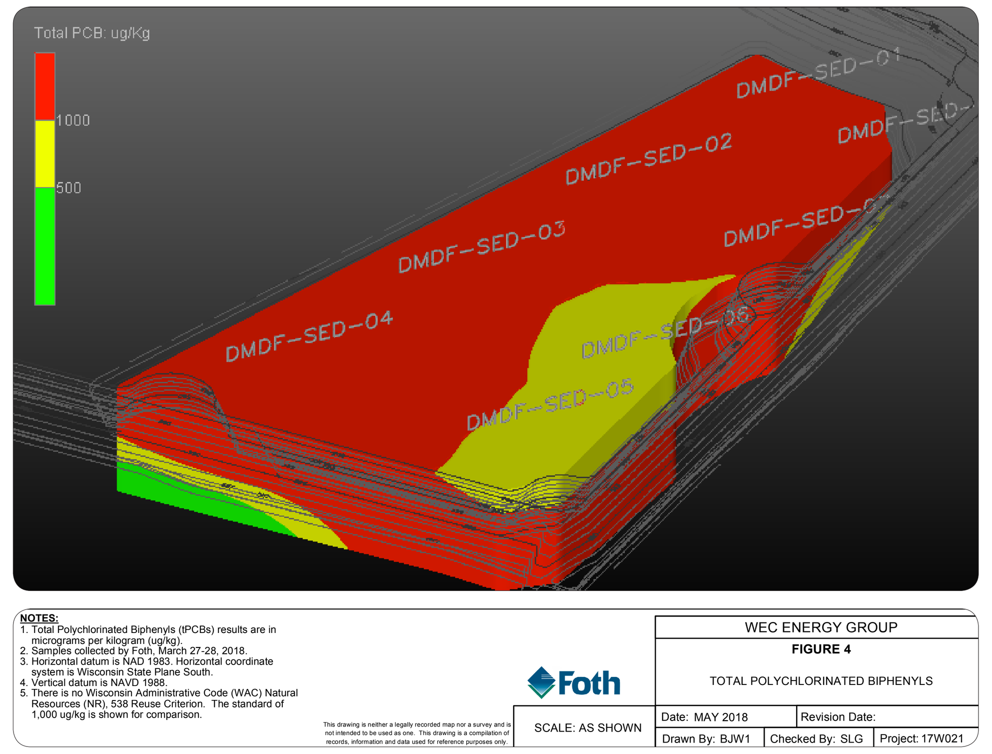


Figure 4. *Total Polychlorinated Biphenyls*

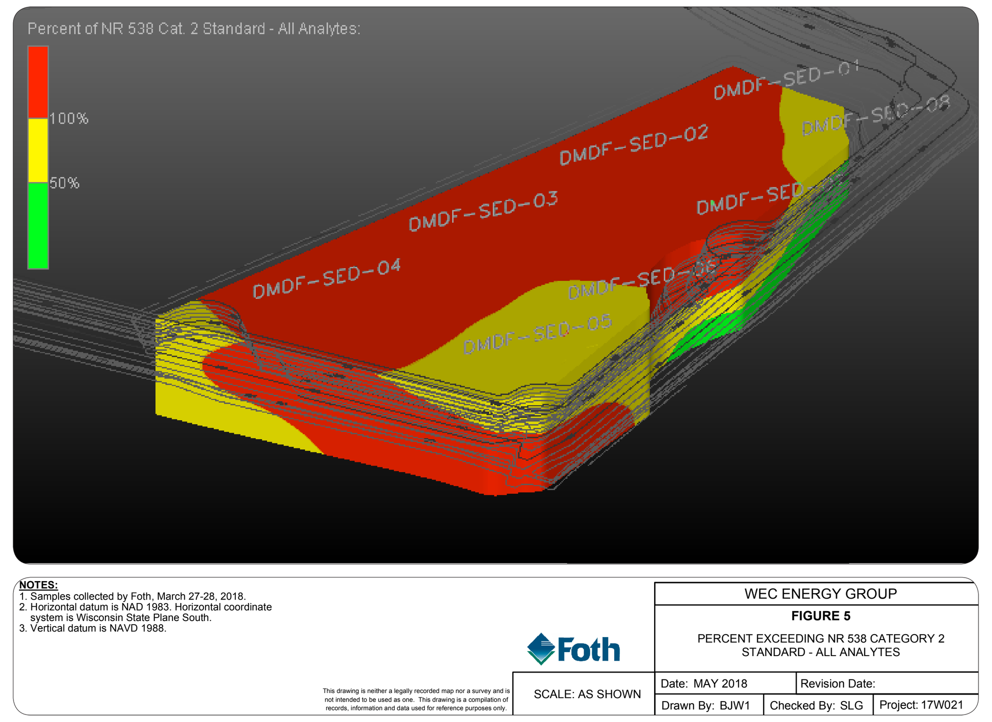


Figure 5. *Percent Exceeding NR 538 Category 2 Standard - All Analytes*

necessary to make it potentially usable for engineered fill. In general, even if sediment chemistry was not an issue, the high plasticity of the material makes it less desirable as use for habitat restoration backfill or marsh construction fill, in spite of the high organic content. Thus, amending the material to make it physically or chemically acceptable for Categories 3-4 uses would add costs, which would reduce the cost-effectiveness of reusing the material. Although the permeability of the fine-grained material was not tested, presumably it is low. Depending on special landfill permits, the fine-grained material may have use as daily cover at a landfill for Category 5 usage. However, an economic analysis would be required to demonstrate whether or not the cost of removal, transport, and tippage fees outweighed the economic benefit of CDF capacity increase.

In summary, due to the highly organic and fine-grained nature of the sediments, the wide-spread distribution of benzo(a)pyrene above Wis. Admin. Code NR 538 Category 2 standards and the prevalence of tPCBs at concentrations greater than 1 mg/kg, the potential for off-site beneficial re-use of these materials is not feasible other than the potential for daily cover at a landfill (Category 5 usage) and even then is not cost effective.

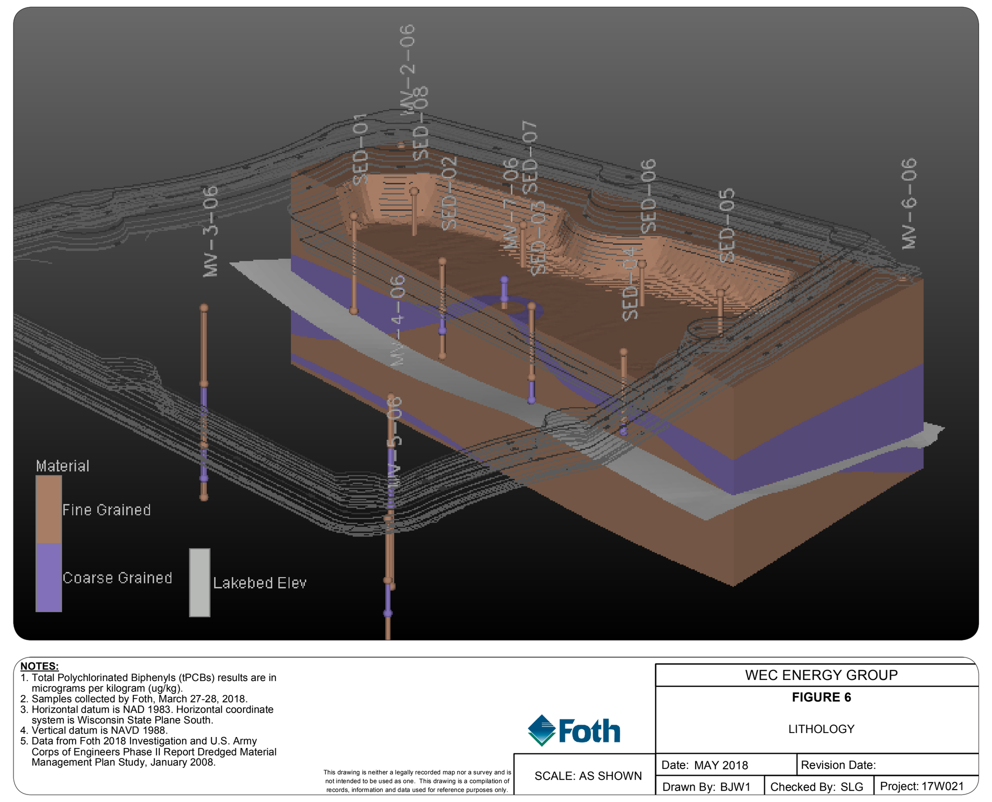


Figure 6. *Lithology*

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