



# Monterey Dam Impoundment Sediment Report

**SUBMITTED TO**

City of Janesville

Wisconsin Department of Natural Resources

**PREPARED BY**

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**December 22, 2015**

## Introduction

The City of Janesville is currently considering whether to repair the Monterey Dam on the Rock River or remove it. To better inform this decision, the City contracted Inter-Fluve to assess the quantity and quality of the sediment stored in the Monterey Dam impoundment. The primary objective of the sediment characterization is to understand requirements for sediment management if the dam is removed.

The dam was constructed in approximately 1855. It consists of a 190 ft spillway with a flume that is perpendicular to the flow of the river and a 185 ft spillway that is parallel to the flow. The 3500 square mile watershed is approximately 75% agricultural lands, and the remaining area is mixed urban land, wetlands, and forests. Upstream of the project area, the Rock River flows through a mix of towns and agricultural areas. Potential sources of pollutants include agricultural runoff, stormwater discharges, treated municipal, industrial wastewater discharges, and legacy contamination. Additionally, General Motors produced automobiles at a facility immediately adjacent to the impoundment between 1918 and 2009.

## Sediment Volume Assessment

### METHODS

Inter-Fluve used single beam sonar to collect bathymetry data within the impoundment. In addition, survey grade GPS was utilized to survey elevations along transects within the impoundment (Appendix A, Sheet 2). Spring Brook, which enters the Rock River at Jeffris Park (Dawson Ball Park) was also surveyed. At each surveyed location along a transect, a graduated rod was pushed through the soft sediment material to the point where the surveyor felt a substantial change in resistance. This point is referred to as the refusal depth. In locations where the pre-dam channel likely existed, gravel and cobble was encountered at refusal depth. In locations that were likely floodplain areas prior to dam construction, a firm compact layer was encountered. The surveyor calculated the depth of sediment at each location using the graduations along the rod. Topographic surfaces based on the surveyed reservoir bed and the depth of refusal measurements were then compared to determine the volume of sediment stored in the reservoir.

### RESULTS

Sediment thickness within the impoundment range from 0 (gravel/cobble bed with little to no fine sediment cover) to 9 ft, but the majority of the area surveyed, nearly 70%, had sediment thickness of less than 2 ft. The main channel bed primarily includes gravel and cobbles with deposits of loose gravel and medium to coarse sand that are generally less than 2 ft thick. The portion of the area outside of the main channel, which is shown by the dotted line in Figure 1 (also in Appendix A, Sheet 1), contains 2 to 9 ft of deposited fine sand, silts, and organic material. Upstream of the exhibit extent, to the Janesville Central Dam, the bed was primarily cobbles and boulders with small, localized areas of minor sand cover. The refusal elevations in the large bay just upstream of the Monterey Dam, on the north side of the channel, are not much higher than the refusal elevations within the main channel. These similar refusal depths suggest the embayment area was likely excavated at some point, perhaps to provide fill

for the park immediately to the west. Therefore, the refusal depths in that area do not likely represent a pre-dam floodplain. Based on the collected data, the estimated total volume of accumulated unconsolidated material in the impoundment is approximately 245,000 cy. We also estimate that approximately 7000 – 10,000 cy of additional material is stored along Spring Brook. The volumes of material within different areas of the impoundment are summarized in Appendix A, Sheet 3.

In considering the potential impact of sediment and potential contaminants adhered to the sediment, it is important to understand the fate of the material in the event that the dam is removed with the sediment in place. The portion of the total sediment that is within the active and activated channel would become mobile following dam removal and would be transported downstream. We estimated this portion by extending a corridor through the impoundment that follows the low points along the delineated pre-dam channel bed, which is 300 ft wide at the base, and slopes up to meet existing ground at a slope of ~2:1. These channel dimensions approximate the channel shape in the unimpounded, upstream and downstream reaches of the Rock River and provide a rough estimate of the anticipated channel dimensions through the impoundment following dam removal. Final channel dimensions will be refined through hydraulic modeling if dam removal design is pursued. The volume of estimated mobile material within this expected active channel, as well as the anticipated sediment released from Spring Brook, amounts to approximately 85,000 cy. The remainder of the material is expected to remain in place and be stabilized by vegetation if the dam is removed, unless sediment quality and (or) future land use necessitates removal.

## Sediment Contamination

In general, dams act as sediment traps. The reduced energy in the impoundment not only limits transport of coarse sediment, but it also creates areas where fine material, including silt, clay, and organics, can fall out of suspension. Pollutants often adsorb to fine material, so contaminant concentrations may be elevated in dam impoundments where these sediments accumulate. In order to assess the magnitude and distribution of any sediment contamination in the Monterey Dam Impoundment, sediment samples were collected at ten locations, including nine within the impoundment and two control points, upstream and downstream of the impoundment, respectively (Figures 1 and 2). The samples were analyzed for a range of inorganic (e.g., metals) and organic (e.g., PCBs, VOCs, PAHs) pollutants as well as physical characteristics.

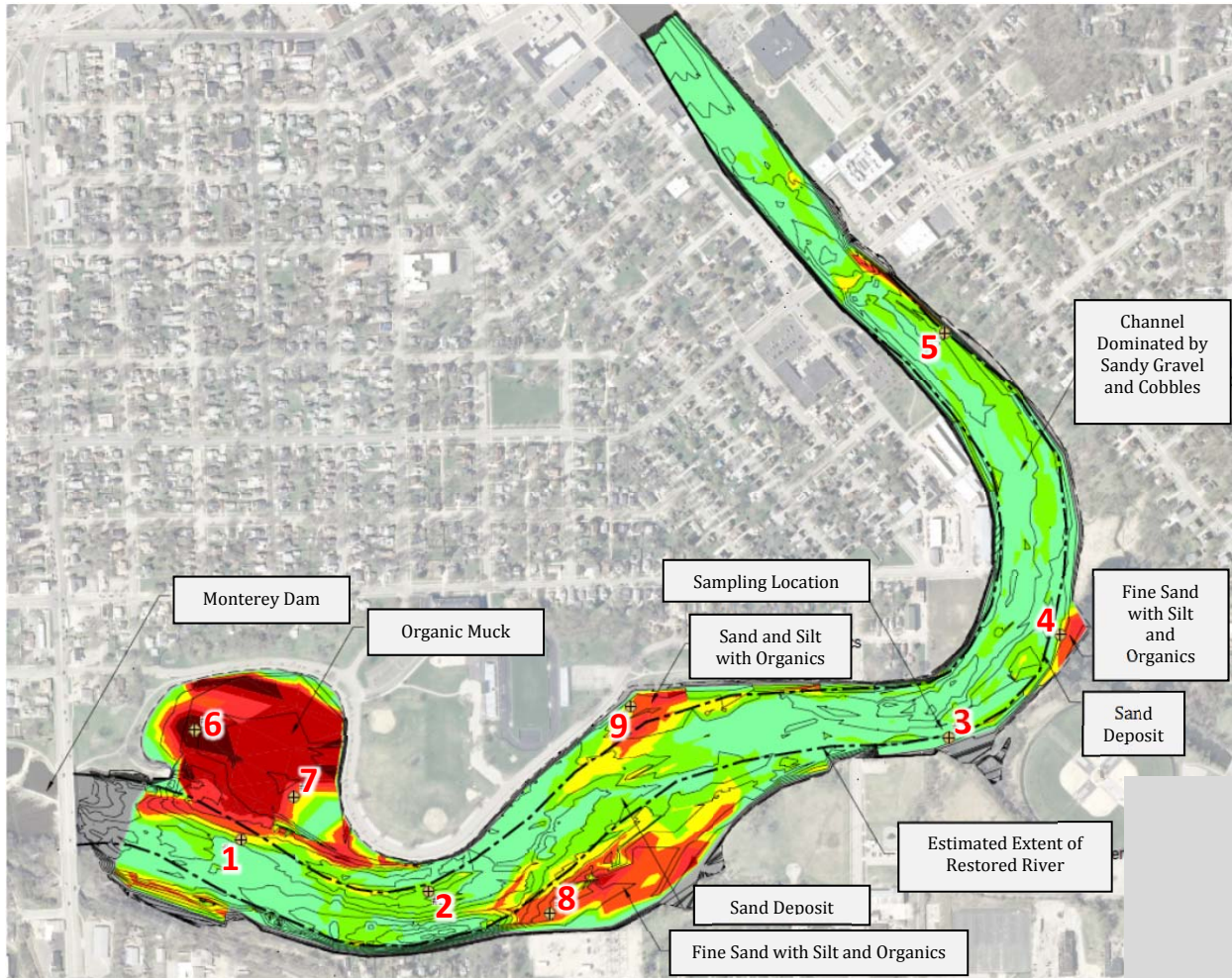
### SAMPLING LOCATIONS

#### Control Samples

In addition to samples within the impoundment, we collected and analyzed one sample from upstream of the impoundment and one sample from downstream. The upstream sample provided a guide for assessing background level of pollutants transported through the Rock River and into the impoundment, and was located approximately 400 ft upstream of E Memorial Dr (County Hwy A). The downstream sample allowed for a comparison of existing conditions to potential pollutant releases from within the impoundment and was located approximately 850 ft downstream of the Hwy 51 bridge. Both samples

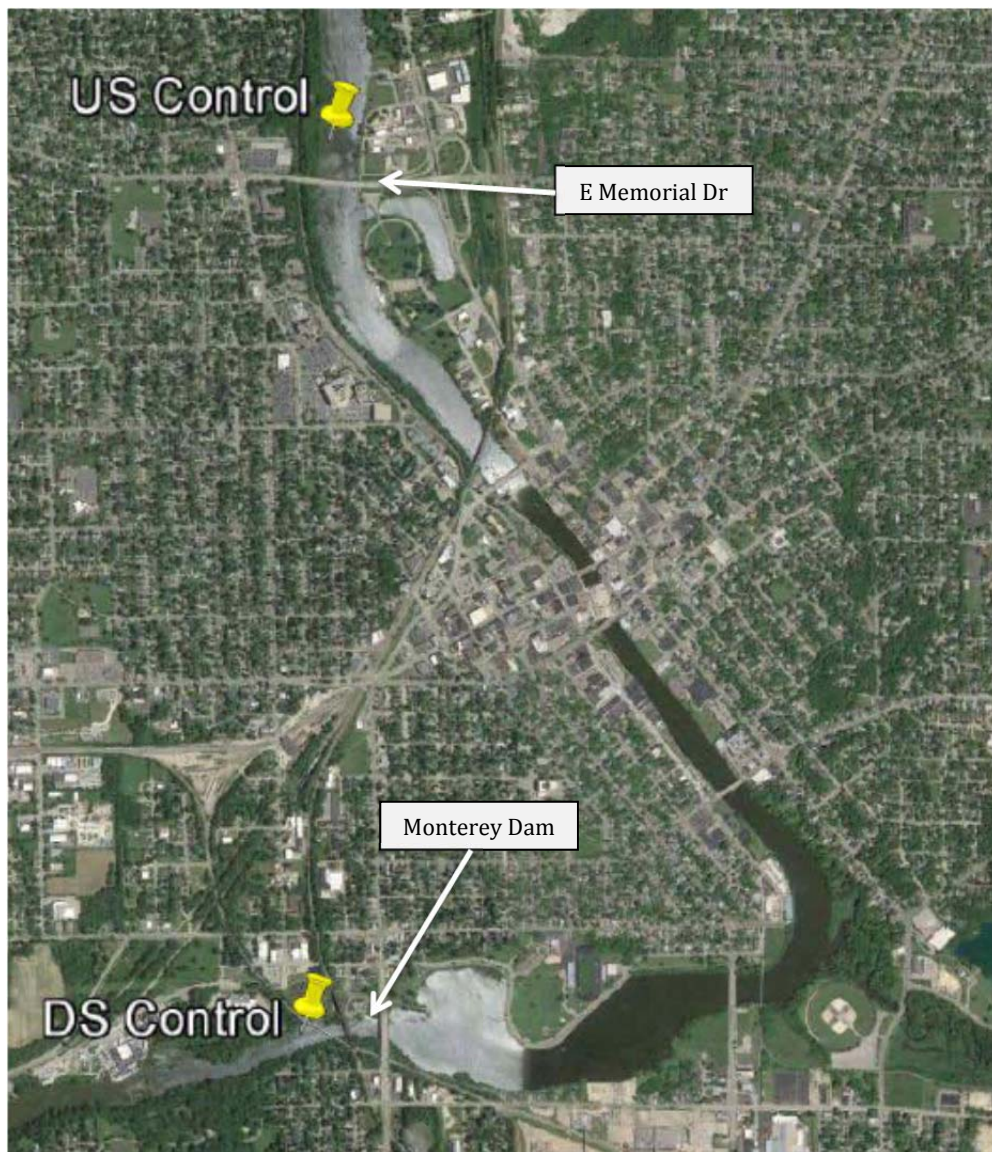


were taken from depositional areas within the river that appeared to contain a significant fraction of fines (Figure 2).



**Figure 1. Topography/bathymetry and sediment thicknesses and types for the Monterey Dam Impoundment. Sediment sampling locations are marked with red labels and yellow markers. For more details, see Appendix A, Sheet 1).**





**Figure 2. Control sample locations upstream and downstream of the Monterey Impoundment.**

### **Active Channel Samples**

Sample locations 1, 2, 3, and 5 were located along the main channel, from about 500 ft upstream of the dam and Highway 51 bridge (Site 1) to 250 feet downstream of the Racine Street Bridge (Figure 1). We would expect sediments within this area to be fully mobile once the dam is removed. Of these, three samples (sites 1, 3, and 5) were comprised primarily of coarse material (< 5% passed the No. 200 Sieve; see Table 2) and therefore, were not analyzed for the full suite of pollutant parameters, in accordance with the sampling plan. Fine sediment is likely primarily transported in suspension through the main channel and passed downstream. Sample 2 was collected in somewhat finer sediment overall, but the sample still contained less than 5% fines. Regardless, it was analyzed for contaminants due to its proximity to the General Motors plant and concern that pollutants originating on that site may be transported into the main channel near that location. Sample Site 4 was located at the Spring Brook

confluence and also reflects material that is expected to mobilize if the dam is removed. The portion of material that passed the No. 200 Sieve for Sample 4 was 6.9% (Table 2), and therefore, it was tested for the full suite of parameters.

### **Backwater Samples**

Samples 6, 7, 8, and 9 were collected in lower energy areas of the impoundment, where sediment transport would not be expected if the dam is removed (Figure 1). The samples included mostly sand, fine sediment, and organic material, with fines (< .075 mm; Sieve 200) comprising between 5 and 16% of the material (Table 2). Samples 6 and 7 were collected in the embayment on the north side of the channel, and Sample 8 was collected in sediments adjacent to the General Motors facility on the south side of the channel. Sample 9 was collected in a depositional area on the north side of the impoundment upstream of the General Motors facility. The material in these samples included more than 5% fines (Table 2), so the full suite of proposed analyses was run for each sample.

### **METHODS**

Sampling and handling methods were consistent with protocols and methods presented in Inter-Fluve's "Sediment Sampling for Dam Removal Projects" (Appendix C) and Wisconsin Administrative Code NR 347.06. Samples were collected with a 3 inch – diameter push corer, and included vertical, continuous lengths of sediment. For the main channel samples, we encountered refusal at depths of less than 1 ft, but elsewhere, samples included the upper 3-6 ft of material. At Sites 6, 7, and 8, samples were split based on sediment depth in order to differentiate contamination at the surface from contamination at depth. Splitting the samples in this manner allows us to assess contamination of the sediment that would likely be exposed if the dam is removed. The upper 6 inches of material at location 8 was considerably sandier than the material found below it. No stratification at greater depths was visually apparent, so the sample was divided into the first 6 inches of looser surface material (A), then the next 1.5 ft (B), and the final, lower 2 ft (C). Samples 6 and 7 did not show visual evidence of stratification. We broke the samples into subsamples by collecting the top 6 inches as subsample A, the next 1.5 ft as subsample B and the 2-3 ft below that as subsample C. Upon retrieval, each sediment sample was thoroughly mixed using stainless steel buckets and mixing tools, placed in containers supplied by the laboratory, and stored on ice until they reached the laboratory.

Each sample was analyzed by CT Laboratories (Baraboo, WI) for a specific set of metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polycyclic aromatic hydrocarbons (PAHs), oil and grease, and physical character. Analyses were conducted using standard laboratory methods (Table 1). Several of the PAHs are also included in the VOC and SVOC groups, so several of the PAHs were analyzed multiple times using the different methods shown in table 1. Differences between these results may reflect heterogeneity in the sample and/or volatilization of contaminants during sample mixing and bottling. Samples were well mixed in the field prior to separation into different sample bottles, but it is likely that the mixing did not completely homogenize the sample.

Table 1. Analytical Parameters and Methods

Category	Specific Parameters	Laboratory Method
Metals	As, Cd, Cr, Cu, Pb, Ni, Zn Hg	EPA 6010C EPA 7471B
Organics	PCBs PAHs SVOCs VOCs Oil and Grease	EPA 8082A EPA 8310 EPA 8270D EPA 8260C EPA 9071B
Physical	Particle size (sieve) %TOC	ASTM C136-84A L-Kahn/9060A

PCB – polychlorinated biphenyls  
 VOC – Volatile Organic Compound  
 SVOC – Semi-Volatile Organic Compound  
 PAH-Polycyclic Aromatic Hydrocarbon  
 TOC – Total Organic Carbon

### CONTAMINANT CONCENTRATIONS

Several state and federal laws and regulations exist to protect aquatic wildlife and humans that may come into direct or indirect contact with the pollutants in rivers. Aquatic wildlife, such as fish and macroinvertebrates, and humans can experience chronic and/or acute toxicity from direct contact with sediments in the water column or bed sediment. River sediments left exposed after dam removal or dredging can also pose risk of exposure. Direct contact to sediment pollutants by people may be possible depending on future landuse, burrowing animals may be exposed to contaminants, and runoff and infiltration can move both sediment-adsorbed and leached contaminants into groundwater and the river.

We compared analytical results to three sets of published thresholds – the screening level guidelines summarized by Wisconsin Department of Natural Resources (WDNR, 2002), the thresholds described in state regulations included in NR 661 regarding Toxicity Characteristic Leaching Process (TCLP) test results that define hazardous waste, and EPA’s Regional Screening Level thresholds. TCLP analysis has not been conducted, but using the rough guidelines that the leaching process used in the test dilutes the concentration by a factor of twenty, we have preliminarily compared test results to values that reflect 20 times the TCLP limits associated with hazardous waste.

The WDNR screening levels included the Threshold Effects Concentration (TEC), the Midpoint Effects Concentration (MEC) and the Probable Effects Concentration (PEC). Concentrations of contaminants below the TEC are expected to have no impact on benthic aquatic organisms. Concentrations of contaminants above the PEC are considered likely to have adverse impacts on benthic aquatic organisms. The MEC simply allows a quick indication of whether the contaminant concentration is closer to the PEC or the TEC. WDNR staff has indicated that for industrial rivers, such as the Rock River near Janesville, exceedances of the TEC values are common. Therefore, in considering sediment management requirements if the Monterey Dam is removed, the MEC and/or PEC are the appropriate guidelines for determining where active sediment management (i.e., sediment removal) would be required. Toxicity of



organic pollutants to benthic aquatic organisms is affected by the amount of organic carbon in the sediment. Therefore, the guidelines require normalizing the pollutant concentration to 1% total organic carbon (TOC) by dividing the total concentration of pollutant in the soil by the %TOC.

The USEPA Regional Screen Level concentrations (RSLs) are based on risk to human health. USEPA publishes two sets of guidelines that are relevant to soil quality – one for soil quality in residential land uses and one for industrial land uses. The different levels are based on assumptions of exposure to soil in each of these land uses, where exposure is assumed to be much more frequent in residential areas than in industrial areas. In a dam removal scenario, a portion of the area currently flooded by the impoundment will be exposed and become upland and subject to some types of land use. However, given that the area will likely remain within the floodplain, these areas will not likely be suitable for development as either residential or industrial use. However, if the areas become park spaces or are otherwise accessible by people, these RSLs are relevant.

The sediment quality data for the Monterey Dam impoundment, suggests that while exceedances of several of the guideline values occur within the main channel sediment and most of the margin areas, the sediment quality near sample location #8 is notably poorer than any other location, and sediment in this location will require removal or isolation. These results are summarized in the following sections and all results are included in the tables in Appendix B. Appendix B includes the detection limits for those parameters that were not detected. Detection limits varied between individual samples due to three factors – amount of sample used during extract preparation, percent solids in the sample, and dilution factor necessary. Each of these factors is accounted for as the instrument detection limit of a prepared extract is translated to a concentration of contaminant in the sample in terms of milligrams of contaminant per kilogram of dry sample.

**Sediment Size**

The results of the grain size analysis for all samples is shown in Table 2

Table 2 – Results of Grain Size Analysis  
Percent of Sample Passing Through Sieve

Sieve	Mesh Size (mm)	Sample										
		CTRL DS	CTRL US	#1	#2	#3	#4	#5	#6	#7	#8	#9
#4	4.75	84.8	86.9	99.1	80.4	78	99.9	95.1	93.5	99.8	68.9	98.6
#20	0.85	61.6	64.3	91.6	54.1	52.7	66.2	83.1	44.2	48.3	33.9	93.8
#40	0.425	30.6	39.3	44	32.2	40.5	39.9	72.2	31.6	36.7	23.5	79.8
#60	0.25	3.6	12.8	2.4	10.6	21.5	18.9	44.3	23.9	29.8	17.5	47.3
#80	0.18	0.89	6	0.73	5.6	10.8	13.4	17.8	19.6	25.6	14.5	15.6
#100	0.15	0.64	4.8	0.61	4.5	8.5	11.8	11	17.8	23.8	12.6	8.4
#200	0.075	0.3	3	0.41	2.1	3.3	6.9	3.4	11.6	14.6	5.7	1.4
#230	0.063	0.25	2.7	0.37	1.5	2.6	5.5	2.6	9.7	11.3	2	1

**Upstream and Downstream Control Sediments (Sample Locations US Control and DS Control)**

The samples collected at the control locations, were relatively coarse; the upstream sample contained 2% fines (< No. 200 sieve) and the downstream sample contained only 0.3% fines. Because most of the contaminants of concern bind to fines, contamination was expected to be particularly low for the downstream sample. However, the control samples did contain elevated concentrations of a few contaminants.

- Metals – The TEC for lead was exceeded in the upstream control sample.
- PCBs – All PCBs were below detection limits in both the upstream and downstream controls.
- PAHs – The TEC was exceeded for several of the PAHs in both the upstream and downstream controls.
- Human contact guidelines – Because these sample locations are under water, neither Residential nor Industrial land uses are possible in these locations. However, even at these control locations exceedances of the RSLs were found. The Residential RSL for arsenic was exceeded in both samples. At the upstream control, the Residential RSL was exceeded for five of the PAHs, and for one of these five, the Industrial RSL was exceeded. At the downstream control, Residential RSL was exceeded for three PAHs, and for one of these three, the Industrial RSL was also exceeded.

**Main Channel and Tributary Sediments (Sample Locations 1 – 5)**

The samples collected along the main channel, including the Spring Brook confluence, were coarse and relatively, but not completely, clean. The bed in these areas is primarily gravel, cobble, and sand, but samples were collected in areas that had larger deposits of smaller material. The samples contained less than 5% fines, at locations 1, 3 and 5. Because most of the contaminants of concern bind to fines, contamination was expected to be minimal. Additionally, most of the finer materials along the bed surface, and their associated contaminants, are likely mobile during high flows under existing conditions, so existing fine material was likely transported into these locations, either from upstream or from the channel margin areas, fairly recently. Sample 4 contained 6.9% fines, so it was fully analyzed for contaminants. Sample 2 was analyzed for the full suite of parameters due to its proximity to the GM site and relatively high sediment thickness in that location.

- Metals – Neither sample contained metals that exceeded TEC values.
- PCBs – All PCBs in both samples were below the detection limit.
- PAHs - Several PAHs were present at concentrations that exceeded the TEC values but concentrations were generally comparable to those found in the upstream and downstream control samples.
- Human contact guidelines – As with the control samples, these sample locations are under water, so neither Residential nor Industrial land uses are possible in these locations and exposure to them is likely much lower than the assumed exposure for the upland uses, but because people do come into contact with the river sediment, they are worth noting. Sample 2

exceeded the Residential RSL for arsenic and Sample 4 exceeded the Industrial RSL for arsenic. In Sample 2, the Residential RSL was exceeded for three of the PAHs, and for one of those PAHs, the Industrial RSL was also exceeded. In Sample 4, the Residential RSL was exceeded for three of the PAHs, but no Industrial RSLs were exceeded.

### **North Bay**

The samples collected in the north bay of the impoundment included more than 10% fines and a greater amount of organics than the main channel and background samples. As described previously, the samples collected at locations 6 and 7 in the north bay were broken into sub-samples by vertical location – subsample A consisted of material from the bed surface to 6 inches below the surface; subsample B was collected from 6 inches below the surface to 24 inches below the surface, and subsample C was collected between 24 inches below the surface to 4-5 feet below the surface. The samples contained elevated levels of a few metals and organics.

- Metals – Sample 6A (depth 0-6 in) and 6B (depth 6-24 in) contained lead at concentrations greater than the TEC but lower than the upstream control. Sample 7A (depth 0-6 in) was found to contain cadmium at concentration greater than the TEC. All stratifications of Sample 7 contained mercury at concentrations greater than the TEC.
- PCBs – All PCBs in all samples were below the detection limits.
- PAHs - Many of the PAHs were detected at concentrations greater than the TEC. Additionally, Acenaphthene and Phenanthrene were found to be greater than the MEC for Sample 6B. Pyrene was found to be higher than the PEC for Samples 6A and 6B and higher than the MEC for Samples 6C, 7A and 7C.
- Human contact guidelines –The Industrial RSL for arsenic was exceeded in all of the subsamples collected at sites 6 and 7. A total of five different PAHs were present in concentrations that exceeded the Residential RSL in at least one sample within the north bay. The Industrial RSL was exceeded in at least one of the subsamples at site 6 for four of the PAHs and in the subsamples at site 7 for one of the PAHs.
- In general the middle layer (depth of 6 to 24 inches below the bed surface) was found to be more contaminated at location 6. The top layer (depth of 0 to 6 inches below the bed surface) had higher contaminant concentrations at location 7.

### **Adjacent to General Motors Facility (Sample Site 8)**

Sample location 8, adjacent to the General Motors facility, was sampled on two different days in approximately the same location. The first day, a composite of the entire depth of material was collected (Sample 8). On a second day, three different samples were collected to reflect vertical variability as described previously, similar to sites 6 and 7. Sample 8A was the sample collected from 0-6 inches below the bed surface, 8B was collected from 6-24 inches below the bed surface, and sample 8C was collected at a depth of 24-48 inches below the bed surface. The samples contained more fines (15%) in the lower portion of the sample than in the upper layer (4%). Organic material concentrations were a



little lower than those in the embayment samples, but at least 3 times the values for the main channel. The sediment had a distinct odor, and its proximity to the industrial area lead to suspicion that contamination levels might be higher at this location. Sample analysis confirmed this.

- Metals - Chromium, lead, and mercury concentrations exceeded both the PEC and 20 times the TCLP limits for at least some layers. The PEC was exceeded for zinc and cadmium as well. The MEC for copper was exceeded in Sample 8B, and all other metals tested were found in excess of the TEC for at least one subsample.
- PCBs – Most PCBs were below detection limits, but Aroclor 1254 was found in Samples 8A and 8B at a concentration that exceeds the TEC concentration for total PCBs.
- PAHs – Of the 17 PAHs analyzed, 11 were found at concentrations that exceeded the PEC, and 2 were found between the MEC and PEC, and 3 were found between the MEC and the TEC in at least one sample.
- Other organics – In addition to the PAHs, a couple of other organic compounds were found at high concentrations in subsample 8B. 1,2-Dichlorobenzene was present at a concentration that exceeded the PEC, and the Dibenzofuran concentration exceeded the MEC.
- Human contact guidelines – Industrial RSL concentrations for arsenic and lead were exceeded at all depth stratifications for site 8. The Residential RSL for mercury was exceeded in the middle subsample and the composited sample at a nearby location contained mercury at a concentration that exceeded the Industrial RSL. The Aroclor-1254 Residential RSL was exceeded in the upper and middle layers. Seven PAHs were found in at least one of the subsamples at concentrations exceeding the Residential RSL, and of those seven, five were also found to exceed the Industrial RSLs.
- In general, Sample 8B (depth of 6 – 24 inches below the bed surface) contained higher concentrations of contaminants.

### **Other Channel Margin Sites (Sample 9)**

The sample collected at Site 9 was sandier overall than the other sites, but contained relatively little fines. Only 1.4% of the sediment passed through the No.200 Sieve. The %TOC was lower in Sample 9 than any other. At only 0.609% TOC, normalizing to 1% TOC resulted in higher concentrations of organic pollutants than the uncorrected values.

- Metals – No exceedances of the WDNR aquatic benthic organism thresholds were detected.
- PCBs – All PCBs in all samples were below the detection limits.
- PAHs - With the correction for TOC the PEC concentrations were exceeded for four of the PAHs, the MEC was exceeded for three of them, and only the TEC was exceeded for four others.
- Human contact concerns - As with nearly all other sites, arsenic was found at a concentration that exceeded the Industrial RSL. Residential RSLs were exceeded for four PAHs, and of these four, one was found at a concentration that exceeded the Industrial RSL.

## Sediment Management

### Active versus Passive Sediment Management

Passive restoration of a stream entails removing the major impediment to natural river function, in this case the dam, and allowing the river to restore itself over time. The channel within the impoundment freely adjusts its slope and form via incision, widening, and meandering, while the resulting eroded sediment flushes downstream unimpeded. These adjustments continue until the channel develops a form appropriate for the flows and sediment regime imposed on it. The exposed sediment that is not flushed downstream becomes floodplain and the existing seedbank in those soils contributes vegetation to stabilize the surface. The advantage to this approach is the low cost, as it requires little work in the impoundment to control sediment or develop more natural channel characteristics. Low cost comes at the expense of time, as the river will evolve through a process of erosion and migration that may require decades following dam removal. It can also have a negative short term impact on downstream reaches if large volumes of sediment, including any mobilized contaminated materials, are delivered to reaches downstream of the dam.

Under an active sediment management scenario, at least some of the sediment within the impoundment would be mechanically removed and channel form and adjustment would be controlled via design and construction. Active management may also include capping or excavation and replacement of sediment along the channel margins that are expected to become floodplain areas if these sediments are highly contaminated. Active restoration results in reduced sediment load to the downstream river reaches, immediately stable channel form, and a higher degree of ecological function in a shorter time. These advantages are realized at a higher capital expense of the project.

### Proposed Sediment Management

Given the high contaminant concentrations reflected by Sample 8, the sediment in this area should be removed. Additional sampling may be conducted to precisely delineate the boundary of the required sediment removal. Removal of this material is necessary regardless of whether or not the dam is removed.

The existing channel through the impoundment is fairly well established and the upstream dam controls incoming sediment. The channel would likely widen and possibly shift slightly to occupy the area predicted by the DOR and bathymetry survey analysis (Figure 1; Appendix A, Sheet 1). Sediment in this area is relatively coarse and uncontaminated, and would likely result in little long term impact downstream. Because the existing active channel has the capacity to convey most of the flow when the dam is removed, sediment along the channel margin, such as within the embayment, along the inside of bends, etc., would likely be left in place. The sediment would revegetate over time, which would stabilize the sediments in those locations. Because this sediment would be stabilized in place, we propose leaving all of the material other than that removed from the Sample 8 area. However, given that several human contact guideline concentrations are exceeded in these areas, placing a cap of clean material on top of the soils may be necessary if the areas are developed as park spaces or are otherwise accessible to people.

On December 2, 2015, City of Janesville, WDNR, and Inter-Fluve staff met to discuss the results of the Monterey Dam sediment study and the implications for dam removal. WDNR staff indicated that addressing the contamination near the GM facility would be the responsibility of GM. WDNR staff agreed that due to the relatively small quantity, coarse nature, and low contamination level of sediment within the channel, no removal of material within the active channel would be required if dam removal is pursued. They also agreed that the sediment that would become floodplain and would be stabilized by vegetation could remain in place pending confirmation that the material did not pose a risk to human health.

## SUMMARY

The sediments impounded by Monterey Dam vary from sandy gravel and cobble along an established main channel to sand with silt and organics in the low energy channel margin areas. The channel margins include a large embayment just upstream of the dam, and an area adjacent to an inactive General Motors Facility. Sediment samples were collected at representative locations along the main channel and within the channel margins, and were analyzed for physical characteristics, metals, PCB, VOC, SVOC, and PAH contamination. Although main channel sediments contained concentrations of a few PAHs that exceeded guideline concentrations, they were relatively clean, and some of the contaminated sediment is likely being transported downstream under existing conditions. Sediment in the embayment contained high concentrations of lead and mercury, as well as elevated concentrations of several organics. Adjacent to the GM facility, the highest concentrations of most contaminants were found. Several metals exceeded guideline concentrations by orders of magnitude. One of the PCBs was well above guideline concentrations. Most of the PAHs were found at concentrations that exceed concentrations that are harmful to aquatic life, and several were found at concentrations unsafe for regular human exposure.

The presence of an established channel with a coarse bed in the impoundment makes passive sediment management along the main channel of the Rock River a viable option if the Monterey Dam is to be removed. The only sediment that must be removed from the impoundment is the material adjacent to the GM facility. Because GM will be responsible for this material, there should not be any expense to the city for sediment removal in conjunction with dam removal. However, if new floodplain areas are developed as park space or other land uses that allow human exposure to soils at levels similar to the exposure level that is the basis of the USEPA Regional Screening Level guidelines, expense associated with bringing clean fill to the site to cap the existing soil should be included in the budget for dam removal and river enhancement.

## References

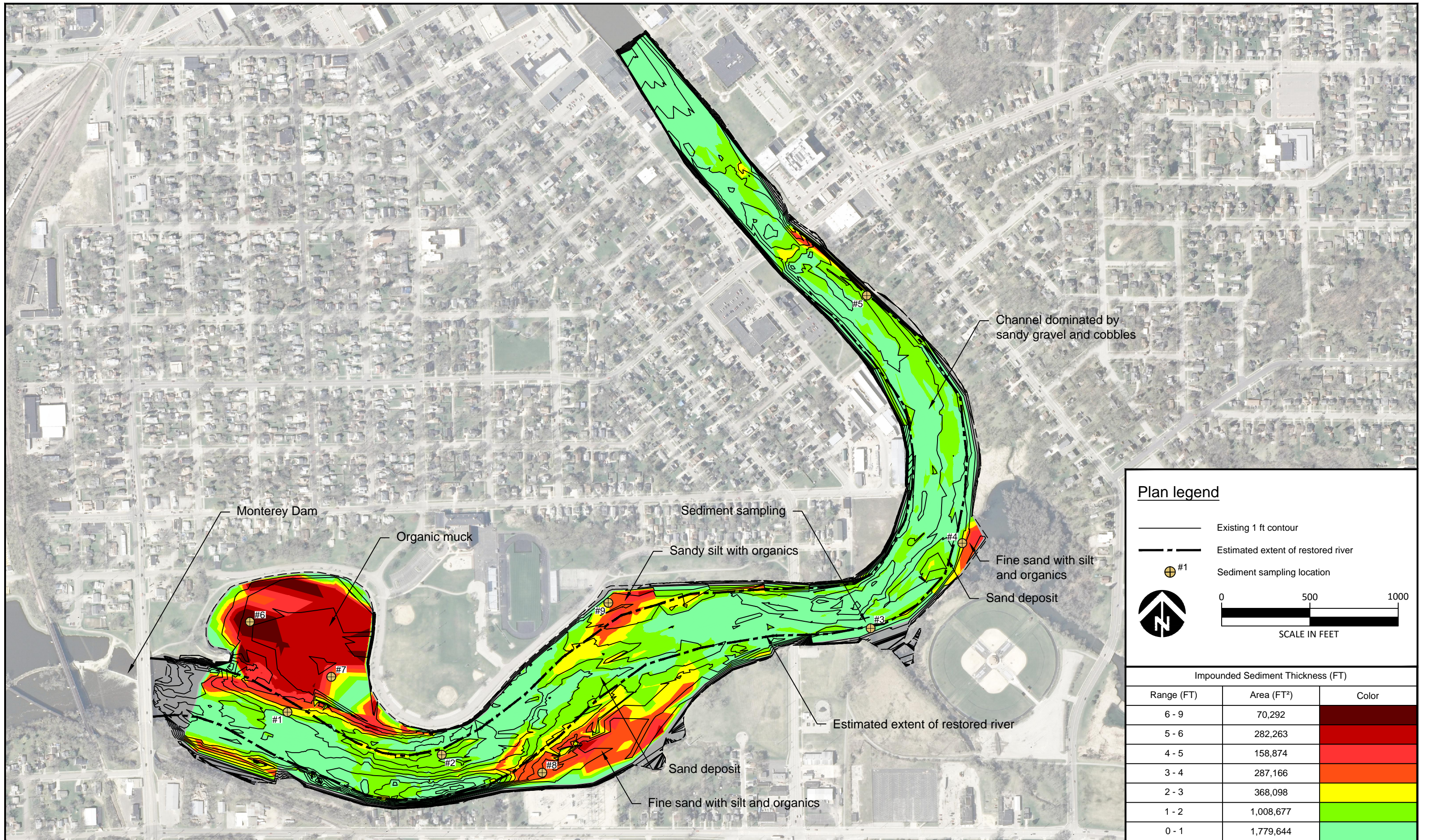
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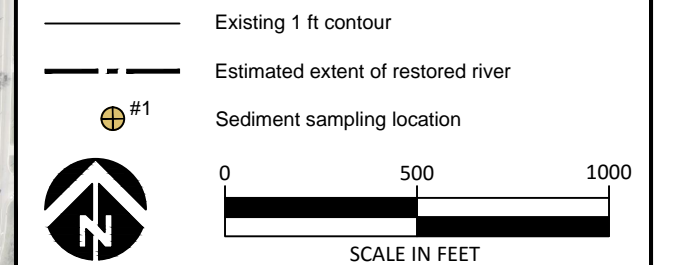


## Appendix A – Monterey Dam Impoundment Sediment Quantity and Sample Locations





### Plan legend



Impounded Sediment Thickness (FT)		
Range (FT)	Area (FT <sup>2</sup> )	Color
6 - 9	70,292	
5 - 6	282,263	
4 - 5	158,874	
3 - 4	287,166	
2 - 3	368,098	
1 - 2	1,008,677	
0 - 1	1,779,644	



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## Monterey Dam Sediment Analysis

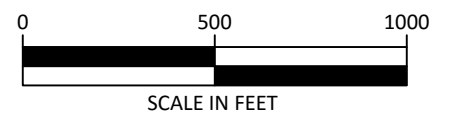
Sediment Analysis Exhibit  
December 9, 2015





**Plan legend**

- Existing 1 ft contour
- Depth of refusal data location



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Madison, WI 53703  
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# Monterey Dam Sediment Analysis



## Depth of Refusal - Transect Locations

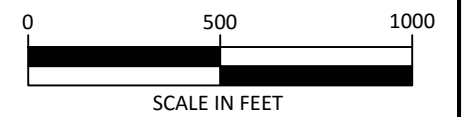
December 9, 2015





**Plan legend**








-  Existing 1 ft contour
-  Sediment Removal Area



**Sediment Volumes**

Name	Area	Volume
	(Sq. Ft.)	(Cu. Yd.)
C 1	313,638	13,237
C 2	621,153	31,500
C 3	944,790	28,788
RR 1	693,455	106,688
RR 2	243,533	12,068
RL 1	150,886	5,600
RL 2	397,707	38,119
RL 3	96,743	2,963
RL 4	40,199	3,685
RL 5	40,667	597

**Impounded Sediment Thickness (FT)**

Range (FT)	Area (FT <sup>2</sup> )	Color
6 - 9	70,292	
5 - 6	282,263	
4 - 5	158,874	
3 - 4	287,166	
2 - 3	368,098	
1 - 2	1,008,677	
0 - 1	1,779,644	



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**Monterey Dam Sediment Analysis**  
 Sediment Removal Exhibit  
 December 9, 2015



## Appendix B – Sediment Quality Results



Monterey Dam Impoundment Sediment Sampling Results  
Organic Contaminant Results Normalized to 1% TOC and Compared to WI CBSQLs

Constituent	CSA	Units	Method	Guidelines				Samples														
				WI CBSQL (TEC)	WI CBSQL (MEC)	WI CBSQL (PEC)	TCLP limits *20	CTRL DS#1	CTRL US#1	#2	#4	#6A	#6B	#6C	#7A	#7B	#7C	#8	#8A	#8B	#8C	#9
				Sample depth range (inches below bed surface):							0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 48		0 - 6	6 - 24	24 - 48		
<b>Metals</b>																						
Arsenic	7440-38-2	mg/kg	EPA 6010C	9.8	21.4	33	100	0.99	1.3	1.4	3	4.7	9.1	6.9	5.2	5.8	6.4	8.8	9.2	13	15.8	1.9
Cadmium	7440-43-9	mg/kg	EPA 6010C	0.99	3	5	20	0.19	0.35	0.31	0.096	0.69	0.8	0.29	1	0.98	0.48	1.5	2.6	5.4	2	0.34
Chromium	7440-47-3	mg/kg	EPA 6010C	43	76.5	110	100	5.1	5.6	7.5	11.7	23.1	21.2	17.6	20	19.3	15.5	34.1	157	240	26.7	6.5
Copper	7440-50-8	mg/kg	EPA 6010C	32	91	150		2.4	5.2	4.9	6.5	25.9	23.9	17.2	21.4	21.3	16.2	59.8	66.4	123	90.7	7.3
Lead	7439-92-1	mg/kg	EPA 6010C	36	83	130	100	25.9	75.7	4.8	18.8	56.3	42.2	26.3	33	32.2	25.8	560	1880	1960	935	27.8
Nickel	7440-02-0	mg/kg	EPA 6010C	23	36	49		2.2	3.6	2.7	4.4	10.5	14.3	10.2	9.9	11.3	9.2	8.2	26.2	28.9	9.9	3.1
Zinc	7440-66-6	mg/kg	EPA 6010C	120	290	460		11.3	29.1	22.3	35.2	106	95.9	66.6	91.4	85	59.2	460	557	1210	657	34.6
Mercury	7439-97-6	mg/kg	EPA 7471B	0.18	0.64	1.1	4	0.0046	0.012	0.034	0.054	0.15	0.18	0.046	0.29	0.2	0.44	56.7	0.19	20.3	0.41	0.05
<b>PCBs Normalized to 1% TOC</b>																						
Aroclor-1016	12674-11-2	mg/kg	EPA 8082A					0.037	0.012	0.029	0.022	0.012	0.010	0.005	0.011	0.007	0.009	0.010	0.007	0.006	0.005	0.048
Aroclor-1221	11104-28-2	mg/kg	EPA 8082A					0.031	0.010	0.025	0.019	0.010	0.009	0.005	0.009	0.006	0.007	0.009	0.006	0.005	0.004	0.041
Aroclor-1232	11141-16-5	mg/kg	EPA 8082A					0.035	0.011	0.027	0.020	0.011	0.010	0.005	0.010	0.007	0.008	0.010	0.007	0.005	0.004	0.044
Aroclor-1242	53469-21-9	mg/kg	EPA 8082A					0.034	0.011	0.026	0.020	0.011	0.009	0.005	0.010	0.007	0.008	0.009	0.007	0.005	0.004	0.043
Aroclor-1248	12672-29-6	mg/kg	EPA 8082A					0.028	0.009	0.022	0.016	0.009	0.008	0.004	0.008	0.005	0.006	0.008	0.005	0.004	0.003	0.036
Aroclor-1254	11097-69-1	mg/kg	EPA 8082A					0.022	0.007	0.018	0.013	0.007	0.006	0.003	0.007	0.004	0.005	0.006	0.111	0.079	0.003	0.028
Aroclor-1260	11096-82-5	mg/kg	EPA 8082A					0.021	0.006	0.016	0.012	0.007	0.006	0.003	0.006	0.004	0.005	0.005	0.004	0.003	0.003	0.026
Total PCBs	1336-36-3	mg/kg	EPA 8082A	0.06	0.368	0.676													0.111	0.079		
<b>VOCs Normalized to 1% TOC</b>																						
1,2,4-Trichlorobenzene (also SVOC)	120-82-1	mg/kg	EPA 8260C	0.008	0.013	0.018		0.031	0.03	0.034	0.031	0.08	0.055	0.12	0.054	0.053	0.053	0.043	0.031	0.039	0.05	0.033
1,2-Dichlorobenzene (also SVOC)	95-50-1	mg/kg	EPA 8260C	0.023		0.023		0.036	0.035	0.039	0.037	0.093	0.064	0.14	0.063	0.062	0.062	0.05	0.036	0.0691	0.058	0.038
1,4-Dichlorobenzene (also SVOC)	106-46-7	mg/kg	EPA 8260C	0.031	0.0605	0.9	150	0.028	0.028	0.031	0.029	0.073	0.051	0.11	0.05	0.049	0.048	0.039	0.028	0.035	0.045	0.03
Benzene	71-43-2	mg/kg	EPA 8260C	0.057	0.083	0.11		0.021	0.007	0.016	0.011	0.007	0.005	0.006	0.005	0.004	0.005	0.006	0.004	0.003	0.003	0.025
Naphthalene (PAH)	91-20-3	mg/kg	EPA 8260C	0.176	0.369	0.561		0.050	0.017	0.040	0.028	0.016	0.013	0.015	0.013	0.010	0.012	0.077	0.115	0.107	0.007	0.061
o-Xylene	95-47-6	mg/kg	EPA 8260C	0.025	0.0375	0.05		0.022	0.007	0.018	0.013	0.007	0.006	0.006	0.006	0.004	0.005	0.011	0.009	0.007	0.003	0.026
Toluene	108-88-3	mg/kg	EPA 8260C	0.89	1.345	1.8		0.047	0.016	0.036	0.027	0.015	0.012	0.014	0.012	0.009	0.011	0.020	0.009	0.008	0.006	0.056
<b>SVOCs Normalized to 1% TOC</b>																						
1,2,4-Trichlorobenzene	120-82-1	mg/kg	EPA 8270D	0.008	0.013	0.018		0.029	0.009	0.024	0.017	0.009	0.008	0.004	0.008	0.006	0.007	0.081	0.057	0.047	0.037	0.038
1,2-Dichlorobenzene	95-50-1	mg/kg	EPA 8270D	0.023		0.023		0.031	0.010	0.025	0.019	0.010	0.009	0.005	0.009	0.006	0.007	0.087	0.063	0.049	0.040	0.041
1,4-Dichlorobenzene	106-46-7	mg/kg	EPA 8270D	0.031	0.0605	0.9	150	0.029	0.009	0.024	0.017	0.009	0.008	0.004	0.008	0.006	0.007	0.081	0.057	0.047	0.037	0.038
2,4-Dimethylphenol	105-67-9	mg/kg	EPA 8270D	0.29		0.29		0.054	0.018	0.044	0.033	0.018	0.016	0.008	0.016	0.011	0.013	0.153	0.108	0.087	0.070	0.071
2-Methylnaphthalene (also PAH)	91-57-6	mg/kg	EPA 8270D	0.0202	0.111	0.201		0.038	0.012	0.031	0.023	0.013	0.011	0.006	0.011	0.008	0.009	0.434	0.230	0.714	0.351	0.049
2-Methylphenol	95-48-7	mg/kg	EPA 8270D	6.7		6.7		0.022	0.007	0.018	0.013	0.007	0.006	0.003	0.007	0.004	0.005	0.061	0.043	0.035	0.028	0.028
Acenaphthene (also PAH)	83-32-9	mg/kg	EPA 8270D	0.0067	0.048	0.089		0.031	0.010	0.039	0.019	0.031	0.074	0.013	0.009	0.006	0.008	0.087	0.234	1.024	0.065	0.041
Acenaphthylene (PAH)	208-96-8	mg/kg	EPA 8270D	0.0059	0.067	0.128		0.028	0.007	0.018	0.013	0.009	0.008	0.003	0.021	0.007	0.006	0.061	0.043	0.035	0.028	0.028
Anthracene (PAH)	120-12-7	mg/kg	EPA 8270D	0.0572	0.451	0.845		0.097	0.021	0.109	0.029	0.074	0.207	0.034	0.038	0.022	0.024	0.208	0.584	2.222	0.077	0.081
Benzo(a)anthracene (PAH)	56-55-3	mg/kg	EPA 8270D	0.108	0.579	1.05		0.322	0.083	0.247	0.098	0.227	0.458	0.074	0.124	0.054	0.092	0.529	0.932	3.042	0.223	0.286
Benzo(a)pyrene (PAH)	50-32-8	mg/kg	EPA 8270D	0.15	0.8	1.45		0.314	0.105	0.259	0.149	0.191	0.430	0.078	0.153	0.062	0.101	0.474	1.068	3.242	0.164	0.363
Benzo(b)fluoranthene (PAH)	205-99-2	mg/kg	EPA 8270D	0.027	6.82	13.4		0.426	0.176	0.342	0.237	0.352	0.563	0.109	0.205	0.094	0.142	0.613	1.575	4.335	0.211	0.521
Benzo(g,h,i)perylene (PAH)	191-24-2	mg/kg	EPA 8270D	0.17	1.685	3.2		0.117	0.056	0.176	0.115	0.160	0.228	0.041	0.083	0.032	0.049	0.271	0.652	1.791	0.095	0.191
Benzo(k)fluoranthene (PAH)	207-08-9	mg/kg	EPA 8270D	0.24	6.82	13.4		0.156	0.056	0.132	0.080	0.134	0.219	0.029	0.067	0.031	0.051	0.280	0.425	1.213	0.071	0.179
Benzyl alcohol	100-51-6	mg/kg	EPA 8270D	0.57	0.65	0.73		0.054	0.018	0.044	0.033	0.018	0.016	0.008	0.016	0.011	0.013	0.153	0.108	0.087	0.070	0.071
Chrysene (PAH)	218-01-9	mg/kg	EPA 8270D	0.166	0.728	1.29		0.313	0.108	0.257	0.141	0.247	0.437	0.083	0.139	0.064	0.112	0.636	1.074	3.060	0.367	0.306
Dibenzo(a,h)anthracene (PAH)	53-70-3	mg/kg	EPA 8270D	0.033	0.084	0.135		0.054	0.018	0.044	0.033	0.065	0.074	0.014	0.021	0.011	0.013	0.153	0.173	0.169	0.070	0.071
Dibenzofuran	132-64-9	mg/kg	EPA 8270D	0.15	0.365	0.58		0.028	0.009	0.027	0.016	0.009	0.017	0.004	0.008	0.005	0.006	0.075	0.111	0.532	0.042	0.036
Diethylphthalate	84-66-2	mg/kg	EPA 8270D	0.61	0.855	1.1		0.022	0.007	0.018	0.013	0.007	0.006	0.003	0.007	0.004	0.005	0.061	0.043	0.035	0.028	0.028
Dimethylphthalate	131-11-3	mg/kg	EPA 8270D	0.53		0.53		0.023	0.008	0.019	0.014	0.008	0.007	0.003	0.007	0.005	0.006	0.066	0.046	0.038	0.030	0.031
Di-n-butylphthalate	84-74-2	mg/kg	EPA 8270D	2.2	9.6	17		0.023	0.008	0.019	0.014	0.015	0.020	0.003	0.024	0.024	0.006	0.332	0.196	0.386	0.253	0.031
Di-n-octylphthalate	117-84-0	mg/kg	EPA 8270D	0.58	22.79	45		0.029	0.009	0.024	0.017	0.009	0.008	0.004	0.019	0.006	0.007	0.081	0.057	0.112	0.037	0.038

Constituent	CSA	Units	Method	Guidelines				Samples														
				WI CBSQL (TEC)	WI CBSQL (MEC)	WI CBSQL (PEC)	TCLP limits *20	CTRL DS#1	CTRL US#1	#2	#4	#6A	#6B	#6C	#7A	#7B	#7C	#8	#8A	#8B	#8C	#9
				Sample depth range (inches below bed surface):							0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 48		0 - 6	6 - 24	24 - 48		
Fluoranthene (PAH)	206-44-0	mg/kg	EPA 8270D	0.423	1.327	2.23		0.722	0.256	0.614	0.273	0.562	0.957	0.185	0.240	0.131	0.224	1.139	2.499	6.922	0.395	0.581
Fluorene (PAH)	86-73-7	mg/kg	EPA 8270D	0.0774	0.307	0.536		0.031	0.011	0.064	0.019	0.026	0.074	0.012	0.011	0.007	0.009	0.177	0.313	1.335	0.098	0.041
Indeno(1,2,3-cd)pyrene (PAH)	193-39-5	mg/kg	EPA 8270D	0.2	1.7	3.2		0.115	0.056	0.151	0.099	0.147	0.212	0.036	0.077	0.030	0.044	0.227	0.610	1.758	0.094	0.188
Naphthalene (PAH)	91-20-3	mg/kg	EPA 8270D	0.176	0.369	0.561		0.031	0.010	0.025	0.019	0.010	0.009	0.005	0.009	0.006	0.007	0.207	0.110	0.311	0.205	0.041
Pentachlorophenol	87-86-5	mg/kg	EPA 8270D	0.15	0.175	0.2	2000	0.038	0.012	0.031	0.023	0.013	0.011	0.006	0.011	0.008	0.009	0.107	0.077	0.062	0.049	0.049
Phenanthrene (PAH)	85-01-8	mg/kg	EPA 8270D	0.204	0.687	1.17		0.421	0.126	0.514	0.134	0.302	0.697	0.142	0.113	0.074	0.121	1.066	2.006	6.812	0.459	0.247
Phenol	108-95-2	mg/kg	EPA 8270D	4.2	8.1	12		0.046	0.015	0.036	0.027	0.015	0.013	0.007	0.013	0.009	0.011	0.127	0.091	0.073	0.059	0.059
Pyrene (PAH)	129-00-0	mg/kg	EPA 8270D	0.195	0.858	1.52		0.375	0.369	0.468	0.273	2.39	3.58	1.33	1.07	0.712	0.876	3.2	6.83	29.9	3.36	0.31
<b>PAHs Normalized to 1% TOC</b>																						
2-Methylnaphthalene	91-57-6	mg/kg	EPA 8310	0.0202	0.111	0.201		0.050	0.078	0.780	0.593	0.161	1.398	0.720	0.146	0.097	0.118	2.775	1.937	2.350	1.200	1.283
Acenaphthene	83-32-9	mg/kg	EPA 8310	0.0067	0.048	0.089		0.072	0.118	1.145	0.813	0.233	2.022	1.037	0.211	0.141	0.170	4.046	2.821	2.186	1.801	1.809
Acenaphthylene	208-96-8	mg/kg	EPA 8310	0.0059	0.067	0.128		0.065	0.103	1.020	0.764	0.215	1.828	0.931	0.190	0.127	0.153	3.468	2.536	2.004	1.561	1.645
Anthracene	120-12-7	mg/kg	EPA 8310	0.0572	0.451	0.845		0.019	0.061	0.291	0.220	0.059	0.516	0.265	0.097	0.039	0.043	1.012	0.866	2.532	0.468	0.477
Benzo(a)anthracene	56-55-3	mg/kg	EPA 8310	0.108	0.579	1.05		0.050	0.107	0.061	0.424	0.095	0.437	0.070	0.149	0.072	0.071	0.491	1.333	3.661	0.282	1.074
Benzo(a)pyrene	50-32-8	mg/kg	EPA 8310	0.15	0.8	1.45		0.058	0.153	0.049	0.122	0.144	0.374	0.053	0.154	0.083	0.073	0.318	1.385	3.515	0.236	1.365
Benzo(b)fluoranthene	205-99-2	mg/kg	EPA 8310	0.24	6.82	13.4		0.074	0.129	0.058	0.107	0.157	0.462	0.061	0.133	0.077	0.077	0.205	1.362	3.352	0.092	1.360
Benzo(g,h,i)perylene	191-24-2	mg/kg	EPA 8310	0.17	1.685	3.2		0.075	0.263	0.114	0.089	0.144	0.385	0.106	0.130	0.049	0.057	0.405	0.835	1.913	0.180	1.240
Benzo(k)fluoranthene	207-08-9	mg/kg	EPA 8310	0.24	6.82	13.4		0.028	0.070	0.041	0.037	0.065	0.171	0.037	0.008	0.033	0.029	0.145	0.533	1.464	0.134	0.592
Chrysene	218-01-9	mg/kg	EPA 8310	0.166	0.728	1.29		0.052	0.130	0.146	0.106	0.117	0.353	0.138	0.175	0.084	0.075	1.358	1.239	3.443	0.809	1.227
Dibenzo(a,h)anthracene	53-70-3	mg/kg	EPA 8310	0.033	0.084	0.135		0.015	0.038	0.229	0.171	0.048	0.409	0.212	0.044	0.029	0.035	0.809	0.570	0.583	0.372	0.378
Fluoranthene	206-44-0	mg/kg	EPA 8310	0.423	1.327	2.23		0.201	0.389	0.157	0.262	0.286	1.200	0.214	0.353	0.219	0.234	0.685	3.846	8.597	0.357	3.487
Fluorene	86-73-7	mg/kg	EPA 8310	0.0774	0.307	0.536		0.037	0.085	0.229	0.171	0.048	0.409	0.212	0.078	0.046	0.066	0.809	0.786	2.823	0.372	0.530
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	EPA 8310	0.2	1.7	3.2		0.066	0.144	0.114	0.089	0.023	0.275	0.106	0.120	0.061	0.050	0.405	1.125	3.169	0.180	1.155
Naphthalene	91-20-3	mg/kg	EPA 8310	0.176	0.369	0.561		0.031	0.049	0.489	0.374	0.102	0.882	0.455	0.092	0.062	0.075	1.734	1.225	0.984	0.792	0.806
Phenanthrene	85-01-8	mg/kg	EPA 8310	0.204	0.687	1.17		0.084	0.233	0.102	0.155	0.129	0.903	0.168	0.259	0.057	0.157	1.032	2.667	9.654	0.425	2.023
Pyrene	129-00-0	mg/kg	EPA 8310	0.195	0.858	1.52		0.239	0.358	0.114	0.179	0.215	0.847	0.142	0.312	0.203	0.211	1.176	4.217	11.548	0.564	4.211
<b>Other</b>																						
Oil and Grease	OILGREASE	mg/kg	EPA 9071B					350	1530	361	911	4250	1920	1930	2880	2150	1160	14100	6030	24500	36500	816
Solids, Percent	SOLID	%	EPA 8000C					79.9	82.6	71.3	74.4	29.9	41.4	39.6	40.5	43.8	47.4	56.6	79.3	62.2	51.7	68.6
Total Organic Carbon	TOC	mg/kg	L-Kahn/9060A					6810	20400	9610	12300	55900	46500	94500	45900	63000	48300	34600	35100	54900	83300	6080
TOC		%						0.681	2.04	0.961	1.23	5.59	4.65	9.45	4.59	6.3	4.83	3.46	3.51	5.49	8.33	0.608

NOTES

WI-Wisconsin DNR. 2002.Consensus-Based Sediment Quality Guidelines. Recommendations for Use and Applications. Interim Guidance. WT-732. 35pp.  
[http://dnr.wi.gov/topic/brownfields/documents/cbsqg\\_interim\\_final.pdf](http://dnr.wi.gov/topic/brownfields/documents/cbsqg_interim_final.pdf)

000	Below Limit of Detection (detection limit shown in bold)
000	Result Exceeds WI Sediment Quality Guidelines - TEC
000	Result Exceeds WI Sediment Quality Guidelines - MEC
000	Result Exceeds WI Sediment Quality Guidelines - PEC
000	Result Exceeds WI Sediment Quality Guidelines - TCLP*20

Monterey Dam Impoundment Sediment Sampling Results  
Compared to USEPA Regional Screening Levels (RSLs)

Constituent	CSA	Units	Method	Screening Levels		Samples														
				EPA RSL (Resident)	EPA RSL (Indust)	CTRL DS#1	CTRL US #1	#2	#4	#6A	S #6B	#6C	#7A	#7B	#7C	#8	#8A	#8B	#8C	#9
				Sample depth range (inches below bed surface):				0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 48		0 - 6	6 - 24	24 - 48			
<b>Metals</b>																				
Arsenic	7440-38-2	mg/kg	EPA 6010C	0.39	1.65	0.99	1.3	1.4	3	4.7	9.1	6.9	5.2	5.8	6.4	8.8	9.2	13	15.8	1.9
Cadmium	7440-43-9	mg/kg	EPA 6010C	70	80	0.19	0.35	0.31	0.096	0.69	0.8	0.29	1	0.98	0.48	1.5	2.6	5.4	2	0.34
Chromium	7440-47-3	mg/kg	EPA 6010C	-	-	5.1	5.6	7.5	11.7	23.1	21.2	17.6	20	19.3	15.5	34.1	157	240	26.7	6.5
Copper	7440-50-8	mg/kg	EPA 6010C	3,100	41,000	2.4	5.2	4.9	6.5	25.9	23.9	17.2	21.4	21.3	16.2	59.8	66.4	123	90.7	7.3
Lead	7439-92-1	mg/kg	EPA 6010C	400	800	25.9	75.7	4.8	18.8	56.3	42.2	26.3	33	32.2	25.8	560	1880	1960	935	27.8
Nickel	7440-02-0	mg/kg	EPA 6010C	1,500	20,000	2.2	3.6	2.7	4.4	10.5	14.3	10.2	9.9	11.3	9.2	8.2	26.2	28.9	9.9	3.1
Zinc	7440-66-6	mg/kg	EPA 6010C	23,000	310,000	11.3	29.1	22.3	35.2	106	95.9	66.6	91.4	85	59.2	460	557	1210	657	34.6
Mercury	7439-97-6	mg/kg	EPA 7471B	10	43	0.0046	0.012	0.034	0.054	0.15	0.18	0.046	0.29	0.2	0.44	56.7	0.19	20.3	0.41	0.05
<b>PCBs</b>																				
Aroclor-1016	12674-11-2	mg/kg	EPA 8082A			0.025	0.024	0.028	0.027	0.067	0.048	0.05	0.049	0.045	0.042	0.035	0.025	0.032	0.039	0.029
Aroclor-1221	11104-28-2	mg/kg	EPA 8082A			0.021	0.021	0.024	0.023	0.057	0.041	0.043	0.042	0.039	0.036	0.03	0.021	0.027	0.033	0.025
Aroclor-1232	11141-16-5	mg/kg	EPA 8082A			0.024	0.023	0.026	0.025	0.063	0.046	0.048	0.047	0.043	0.04	0.033	0.024	0.03	0.037	0.027
Aroclor-1242	53469-21-9	mg/kg	EPA 8082A			0.023	0.022	0.025	0.024	0.06	0.043	0.045	0.045	0.041	0.038	0.031	0.023	0.029	0.035	0.026
Aroclor-1248	12672-29-6	mg/kg	EPA 8082A			0.019	0.018	0.021	0.02	0.05	0.036	0.038	0.037	0.034	0.031	0.026	0.019	0.024	0.029	0.022
Aroclor-1254	11097-69-1	mg/kg	EPA 8082A	0.22	0.74	0.015	0.015	0.017	0.016	0.04	0.029	0.03	0.03	0.027	0.025	0.021	0.389	0.436	0.023	0.017
Aroclor-1260	11096-82-5	mg/kg	EPA 8082A			0.014	0.013	0.015	0.015	0.037	0.026	0.028	0.027	0.025	0.023	0.019	0.014	0.018	0.021	0.016
Total PCBs	1336-36-3	mg/kg	EPA 8082A													0.389	0.436			
<b>VOCs</b>																				
1,2,4-Trichlorobenzene (also SVOC)	120-82-1	mg/kg	EPA 8260C	22	99	0.031	0.03	0.034	0.031	0.08	0.055	0.12	0.054	0.053	0.053	0.043	0.031	0.039	0.05	0.033
1,2-Dichlorobenzene (also SVOC)	95-50-1	mg/kg	EPA 8260C	1,900	9,800	0.036	0.035	0.039	0.037	0.093	0.064	0.14	0.063	0.062	0.062	0.05	0.036	0.0691	0.058	0.038
1,4-Dichlorobenzene (also SVOC)	106-46-7	mg/kg	EPA 8260C	2.4	12	0.028	0.028	0.031	0.029	0.073	0.051	0.11	0.05	0.049	0.048	0.039	0.028	0.035	0.045	0.03
Benzene	71-43-2	mg/kg	EPA 8260C	1.1	5.4	0.014	0.014	0.015	0.014	0.037	0.025	0.055	0.025	0.024	0.024	0.02	0.014	0.018	0.023	0.015
Naphthalene (PAH)	91-20-3	mg/kg	EPA 8260C	3.6	18	0.034	0.034	0.038	0.035	0.09	0.062	0.14	0.061	0.06	0.059	0.268	0.402	0.587	0.056	0.037
o-Xylene	95-47-6	mg/kg	EPA 8260C	690	3,000	0.015	0.015	0.017	0.016	0.04	0.028	0.06	0.027	0.027	0.026	0.037	0.0326	0.0375	0.025	0.016
Toluene	108-88-3	mg/kg	EPA 8260C	5,000	45,000	0.032	0.032	0.035	0.033	0.083	0.057	0.13	0.057	0.056	0.055	0.069	0.032	0.043	0.052	0.034
<b>SVOCs</b>																				
1,2,4-Trichlorobenzene	120-82-1	mg/kg	EPA 8270D	22	99	0.02	0.019	0.023	0.021	0.053	0.039	0.04	0.039	0.037	0.033	0.28	0.2	0.26	0.31	0.023
1,2-Dichlorobenzene	95-50-1	mg/kg	EPA 8270D	1,900	9,800	0.021	0.021	0.024	0.023	0.057	0.041	0.043	0.042	0.039	0.036	0.3	0.22	0.27	0.33	0.025
1,4-Dichlorobenzene	106-46-7	mg/kg	EPA 8270D	2.4	12	0.02	0.019	0.023	0.021	0.053	0.039	0.04	0.039	0.037	0.033	0.28	0.2	0.26	0.31	0.023
2,4-Dimethylphenol	105-67-9	mg/kg	EPA 8270D	1200	12000	0.037	0.036	0.042	0.04	0.1	0.073	0.076	0.074	0.069	0.063	0.53	0.38	0.48	0.58	0.043
2-Methylnaphthalene (also PAH)	91-57-6	mg/kg	EPA 8270D			0.026	0.025	0.03	0.028	0.07	0.051	0.053	0.052	0.048	0.044	1.5	0.807	3.92	2.92	0.03
2-Methylphenol	95-48-7	mg/kg	EPA 8270D	-	-	0.015	0.014	0.017	0.016	0.04	0.029	0.03	0.03	0.028	0.025	0.21	0.15	0.19	0.23	0.017
Acenaphthene (also PAH)	83-32-9	mg/kg	EPA 8270D	3,400	33,000	0.021	0.021	0.0374	0.023	0.174	0.346	0.125	0.042	0.039	0.0381	0.3	0.82	5.62	0.538	0.025
Acenaphthylene (PAH)	208-96-8	mg/kg	EPA 8270D			0.0193	0.014	0.017	0.016	0.0503	0.0391	0.03	0.0967	0.0426	0.0268	0.21	0.15	0.19	0.23	0.017
Anthracene (PAH)	120-12-7	mg/kg	EPA 8270D	17,000	170,000	0.0658	0.0428	0.105	0.0359	0.415	0.964	0.323	0.175	0.138	0.116	0.72	2.05	12.2	0.641	0.0493
Benzo(a)anthracene (PAH)	56-55-3	mg/kg	EPA 8270D	0.15	2.1	0.219	0.17	0.237	0.12	1.27	2.13	0.702	0.57	0.338	0.446	1.83	3.27	16.7	1.86	0.174
Benzo(a)pyrene (PAH)	50-32-8	mg/kg	EPA 8270D	0.015	0.21	0.214	0.215	0.249	0.183	1.07	2	0.733	0.704	0.393	0.487	1.64	3.75	17.8	1.37	0.221
Benzo(b)fluoranthene (PAH)	205-99-2	mg/kg	EPA 8270D	0.15	2.1	0.29	0.359	0.329	0.292	1.97	2.62	1.03	0.942	0.591	0.687	2.12	5.53	23.8	1.76	0.317
Benzo(g,h,i)perylene (PAH)	191-24-2	mg/kg	EPA 8270D			0.08	0.114	0.169	0.141	0.893	1.06	0.384	0.38	0.203	0.239	0.939	2.29	9.83	0.788	0.116
Benzo(k)fluoranthene (PAH)	207-08-9	mg/kg	EPA 8270D	1.5	21	0.106	0.114	0.127	0.0986	0.75	1.02	0.273	0.308	0.196	0.246	0.969	1.49	6.66	0.594	0.109
Benzyl alcohol	100-51-6	mg/kg	EPA 8270D	6,100	62,000	0.037	0.036	0.042	0.04	0.1	0.073	0.076	0.074	0.069	0.063	0.53	0.38	0.48	0.58	0.043
Chrysene (PAH)	218-01-9	mg/kg	EPA 8270D	15	210	0.213	0.221	0.247	0.174	1.38	2.03	0.78	0.639	0.406	0.542	2.2	3.77	16.8	3.06	0.186
Dibenzo(a,h)anthracene (PAH)	53-70-3	mg/kg	EPA 8270D	0.015	0.21	0.037	0.036	0.042	0.04	0.365	0.346	0.134	0.0974	0.069	0.064	0.53	0.606	0.928	0.58	0.043



Constituent	CSA	Units	Method	Screening Levels		Samples														
				EPA RSL (Resident)	EPA RSL (Indust)	CTRL DS#1	CTRL US #1	#2	#4	#6A	S #6B	#6C	#7A	#7B	#7C	#8	#8A	#8B	#8C	#9
				Sample depth range (inches below bed surface):				0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 48		0 - 6	6 - 24	24 - 48			
Dibenzofuran	132-64-9	mg/kg	EPA 8270D			<b>0.019</b>	<b>0.018</b>	0.0255	<b>0.02</b>	<b>0.05</b>	0.0777	<b>0.038</b>	<b>0.037</b>	<b>0.034</b>	<b>0.031</b>	<b>0.26</b>	0.39	2.92	0.346	<b>0.022</b>
Diethylphthalate	84-66-2	mg/kg	EPA 8270D	<b>49,000</b>	<b>490,000</b>	<b>0.015</b>	<b>0.014</b>	<b>0.017</b>	<b>0.016</b>	<b>0.04</b>	<b>0.029</b>	<b>0.03</b>	<b>0.03</b>	<b>0.028</b>	<b>0.025</b>	<b>0.21</b>	<b>0.15</b>	<b>0.19</b>	<b>0.23</b>	<b>0.017</b>
Dimethylphthalate	131-11-3	mg/kg	EPA 8270D			<b>0.016</b>	<b>0.016</b>	<b>0.018</b>	<b>0.017</b>	<b>0.043</b>	<b>0.032</b>	<b>0.033</b>	<b>0.032</b>	<b>0.03</b>	<b>0.027</b>	<b>0.23</b>	<b>0.16</b>	<b>0.21</b>	<b>0.25</b>	<b>0.019</b>
Di-n-butylphthalate	84-74-2	mg/kg	EPA 8270D	<b>6,100</b>	<b>62,000</b>	<b>0.016</b>	<b>0.016</b>	<b>0.018</b>	<b>0.017</b>	0.0819	0.0927	<b>0.033</b>	0.112	0.151	<b>0.027</b>	1.15	0.688	2.12	2.11	<b>0.019</b>
Di-n-octylphthalate	117-84-0	mg/kg	EPA 8270D			<b>0.02</b>	<b>0.019</b>	<b>0.023</b>	<b>0.021</b>	<b>0.053</b>	<b>0.039</b>	<b>0.04</b>	0.0863	<b>0.037</b>	<b>0.033</b>	<b>0.28</b>	<b>0.2</b>	0.617	<b>0.31</b>	<b>0.023</b>
Fluoranthene (PAH)	206-44-0	mg/kg	EPA 8270D	<b>2,300</b>	<b>22,000</b>	0.492	0.522	0.59	0.336	3.14	4.45	1.75	1.1	0.824	1.08	3.94	8.77	38	3.29	0.353
Fluorene (PAH)	86-73-7	mg/kg	EPA 8270D	<b>2,300</b>	<b>22,000</b>	<b>0.021</b>	0.0225	0.0612	<b>0.023</b>	0.146	0.342	0.11	0.0521	0.0422	0.0427	0.611	1.1	7.33	0.816	<b>0.025</b>
Indeno(1,2,3-cd)pyrene (PAH)	193-39-5	mg/kg	EPA 8270D	<b>0.15</b>	<b>2.1</b>	0.0786	0.115	0.145	0.122	<b>0.822</b>	<b>0.986</b>	<b>0.339</b>	<b>0.355</b>	<b>0.191</b>	<b>0.212</b>	<b>0.787</b>	<b>2.14</b>	<b>9.65</b>	<b>0.78</b>	0.114
Naphthalene (PAH)	91-20-3	mg/kg	EPA 8270D	<b>3.6</b>	<b>18</b>	<b>0.021</b>	<b>0.021</b>	<b>0.024</b>	<b>0.023</b>	<b>0.057</b>	<b>0.041</b>	<b>0.043</b>	<b>0.042</b>	<b>0.039</b>	<b>0.036</b>	0.717	0.387	1.71	1.71	<b>0.025</b>
Pentachlorophenol	87-86-5	mg/kg	EPA 8270D	<b>0.89</b>	<b>2.7</b>	<b>0.026</b>	<b>0.025</b>	<b>0.03</b>	<b>0.028</b>	<b>0.07</b>	<b>0.051</b>	<b>0.053</b>	<b>0.052</b>	<b>0.048</b>	<b>0.044</b>	<b>0.37</b>	<b>0.27</b>	<b>0.34</b>	<b>0.41</b>	<b>0.03</b>
Phenanthrene (PAH)	85-01-8	mg/kg	EPA 8270D			0.287	0.257	0.494	0.165	1.69	3.24	1.34	0.517	0.468	0.586	3.69	7.04	37.4	3.82	0.15
Phenol	108-95-2	mg/kg	EPA 8270D	<b>18,000</b>	<b>180,000</b>	<b>0.031</b>	<b>0.03</b>	<b>0.035</b>	<b>0.033</b>	<b>0.083</b>	<b>0.061</b>	<b>0.063</b>	<b>0.061</b>	<b>0.057</b>	<b>0.052</b>	<b>0.44</b>	<b>0.32</b>	<b>0.4</b>	<b>0.49</b>	<b>0.036</b>
Pyrene (PAH)	129-00-0	mg/kg	EPA 8270D	<b>1,700</b>	<b>17,000</b>	0.375	0.369	0.468	0.273	2.39	3.58	1.33	1.07	0.712	0.876	3.2	6.83	29.9	3.36	0.31
<b>PAHs</b>																				
2-Methylnaphthalene	91-57-6	mg/kg	EPA 8310			<b>0.034</b>	<b>0.16</b>	<b>0.75</b>	<b>0.73</b>	<b>0.9</b>	<b>6.5</b>	<b>6.8</b>	<b>0.67</b>	<b>0.61</b>	<b>0.57</b>	<b>9.6</b>	<b>6.8</b>	12.9	<b>10</b>	<b>0.78</b>
Acenaphthene	83-32-9	mg/kg	EPA 8310	<b>3,400</b>	<b>33,000</b>	<b>0.049</b>	<b>0.24</b>	<b>1.1</b>	<b>1</b>	<b>1.3</b>	<b>9.4</b>	<b>9.8</b>	<b>0.97</b>	<b>0.89</b>	<b>0.82</b>	<b>14</b>	<b>9.9</b>	<b>12</b>	<b>15</b>	<b>1.1</b>
Acenaphthylene	208-96-8	mg/kg	EPA 8310			<b>0.044</b>	<b>0.21</b>	<b>0.98</b>	<b>0.94</b>	<b>1.2</b>	<b>8.5</b>	<b>8.8</b>	<b>0.87</b>	<b>0.8</b>	<b>0.74</b>	<b>12</b>	<b>8.9</b>	<b>11</b>	<b>13</b>	<b>1</b>
Anthracene	120-12-7	mg/kg	EPA 8310	<b>17,000</b>	<b>170,000</b>	0.0131	0.124	<b>0.28</b>	<b>0.27</b>	<b>0.33</b>	<b>2.4</b>	<b>2.5</b>	0.447	0.243	<b>0.21</b>	<b>3.5</b>	3.04	13.9	<b>3.9</b>	<b>0.29</b>
Benzo(a)anthracene	56-55-3	mg/kg	EPA 8310	<b>0.15</b>	<b>2.1</b>	0.0338	0.218	0.0586	0.521	0.53	2.03	0.657	0.682	0.455	0.345	1.7	4.68	20.1	2.35	0.653
Benzo(a)pyrene	50-32-8	mg/kg	EPA 8310	<b>0.015</b>	<b>0.21</b>	0.0395	0.312	<b>0.047</b>	0.15	0.806	1.74	0.505	0.707	0.523	0.351	1.1	4.86	19.3	1.97	0.83
Benzo(b)fluoranthene	205-99-2	mg/kg	EPA 8310	<b>0.15</b>	<b>2.1</b>	0.0506	0.263	<b>0.056</b>	0.132	0.876	2.15	0.581	0.61	0.487	0.37	<b>0.71</b>	4.78	18.4	<b>0.77</b>	0.827
Benzo(g,h,i)perylene	191-24-2	mg/kg	EPA 8310			0.0508	0.537	<b>0.11</b>	<b>0.11</b>	0.806	1.79	<b>1</b>	0.596	0.307	0.275	<b>1.4</b>	2.93	10.5	<b>1.5</b>	0.754
Benzo(k)fluoranthene	207-08-9	mg/kg	EPA 8310	<b>1.5</b>	<b>21</b>	0.019	0.142	<b>0.039</b>	0.0457	0.363	0.797	<b>0.35</b>	<b>0.035</b>	0.209	0.142	<b>0.5</b>	1.87	8.04	1.12	0.36
Chrysene	218-01-9	mg/kg	EPA 8310	<b>15</b>	<b>210</b>	0.0355	0.266	<b>0.14</b>	<b>0.13</b>	0.653	1.64	<b>1.3</b>	0.804	0.53	0.364	4.7	4.35	18.9	6.74	0.746
Dibenzo(a,h)anthracene	53-70-3	mg/kg	EPA 8310	<b>0.015</b>	<b>0.21</b>	<b>0.01</b>	0.0766	<b>0.22</b>	<b>0.21</b>	<b>0.27</b>	<b>1.9</b>	<b>2</b>	<b>0.2</b>	<b>0.18</b>	<b>0.17</b>	<b>2.8</b>	<b>2</b>	3.2	<b>3.1</b>	<b>0.23</b>
Fluoranthene	206-44-0	mg/kg	EPA 8310	<b>2,300</b>	<b>22,000</b>	0.137	0.794	0.151	0.322	1.6	5.58	2.02	1.62	1.38	1.13	2.37	13.5	47.2	2.97	2.12
Fluorene	86-73-7	mg/kg	EPA 8310	<b>2,300</b>	<b>22,000</b>	0.025	0.173	<b>0.22</b>	<b>0.21</b>	<b>0.27</b>	<b>1.9</b>	<b>2</b>	0.36	0.291	0.321	<b>2.8</b>	2.76	15.5	<b>3.1</b>	0.322
Indeno(1,2,3-cd)pyrene	193-39-5	mg/kg	EPA 8310	<b>0.15</b>	<b>2.1</b>	0.045	0.293	<b>0.11</b>	<b>0.11</b>	<b>0.13</b>	1.28	<b>1</b>	0.551	0.387	0.241	<b>1.4</b>	3.95	17.4	<b>1.5</b>	0.702
Naphthalene	91-20-3	mg/kg	EPA 8310	<b>3.6</b>	<b>18</b>	<b>0.021</b>	<b>0.1</b>	<b>0.47</b>	<b>0.46</b>	<b>0.57</b>	<b>4.1</b>	<b>4.3</b>	<b>0.42</b>	<b>0.39</b>	<b>0.36</b>	<b>6</b>	<b>4.3</b>	<b>5.4</b>	<b>6.6</b>	<b>0.49</b>
Phenanthrene	85-01-8	mg/kg	EPA 8310			0.0571	0.476	0.0976	0.191	0.72	4.2	1.59	1.19	0.357	0.759	3.57	9.36	53	3.54	1.23
Pyrene	129-00-0	mg/kg	EPA 8310	<b>1,700</b>	<b>17,000</b>	0.163	0.73	<b>0.11</b>	0.22	1.2	3.94	1.34	1.43	1.28	1.02	4.07	14.8	63.4	4.7	2.56
<b>Other</b>																				
Oil and Grease	OILGREASE	mg/kg	EPA 9071B			350	1530	361	911	4250	1920	1930	2880	2150	1160	14100	6030	24500	36500	816
Solids, Percent	SOLID	%	EPA 8000C			79.9	82.6	71.3	74.4	29.9	41.4	39.6	40.5	43.8	47.4	56.6	79.3	62.2	51.7	68.6
Total Organic Carbon	TOC	mg/kg	L-Kahn/9060A			6810	20400	9610	12300	55900	46500	94500	45900	63000	48300	34600	35100	54900	83300	6080
TOC		%				0.681	2.04	0.961	1.23	5.59	4.65	9.45	4.59	6.3	4.83	3.46	3.51	5.49	8.33	0.608

NOTES

\*\*\*EPA- Region 3 (Mid-Atlantic) Screening Values from multiple sources - <http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm>

<b>000</b>	<b>Below Limit of Detection (detection limit shown in bold)</b>
000	Result Exceeds Residential Regional Screening Level
000	Result Exceeds Industrial Regional Screening Level

## Appendix C – Inter-Fluve Sediment Sampling Protocols



# **Sediment Sampling for Dam Removal Projects**

General sample collection guidelines for contaminant testing

**April 25, 2007**



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This document is intended as a general guideline for sampling sediment deposited upstream of dams in relation to Inter-Fluve projects involving dam removal or modification, where testing of potential contaminants is required.

These guidelines are taken largely from the State of Wisconsin sampling guidelines and are generally in accordance with standard protocols as presented in US- EPA-823-B-01-002, 2001, *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analysis: Technical Manual*. Refer to the EPA manual for a more detailed discussion of study plans, collection, and processing of samples. Individual projects and states may have specific requirements, and individual laboratories may have alternative instructions for data collection.

This document covers sampling procedures, and does not address sampling experimental design. For more detailed guidance in designing statistically robust sampling plans, consult the US EPA and the local state environmental agency.

## **Part 1: General Sediment Sampling Procedure**

### **1. Scope**

1.1. This section describes general procedures for sediment sampling and the use of common sediment sampling equipment. Study goals may require additional or alternate equipment or procedures other than those discussed herein. Any procedure changes should be based on sound scientific and practical reasons and should ultimately help further the goals of the study without the loss of quality assurance and control.

### **2. Equipment and Supplies**

2.1. Below is a suggested list of equipment needed for most sediment sampling efforts. This list suggests equipment that may be necessary for your project and should not be considered exhaustive. Equipment that is specific to a specialized type of sampling may be included only in the section describing the particular type of sampling.

#### 2.2. Equipment Checklist

- Boat, anchor, motor, gas tank, tow vehicle
- Life jackets
- Protective clothing: boots, waders, gloves, rain gear, etc.
- First aid kit
- Mobile phone
- Maps: road and site maps
- Compass and measuring equipment
- Electronic location device (Loran or GPS)
- Field notebook and field sheets
- Waterproof pens and pencils
- Field measurement equipment (temperature, dissolved oxygen, etc.)
- Sample containers
- Sample labeling tape or paper and permanent marker
- Sediment pole for measuring depth
- Coring device and dredge or grab with adequate rope and extension poles (grab is backup for corer in sandy sediments), including extension poles.
- Slide hammer for corer
- Pliers, wrenches, etc. for adjusting equipment
- Mixing bowl and spoon
- Cleaning (decontamination) supplies (non-ionic detergent, tub, brushes, etc.)
- Wash bottles
- Ice chest and ice for cooling samples
- Extra rope

### 2.3. Equipment suitability for chemical analysis:

- 2.3.1. All equipment or sample containers that will come into contact with a sediment sample for chemical analysis should be constructed of materials that will not affect the concentration of contaminants in the sediment sample. In general, sediment samples to be analyzed for metals should not touch metallic surfaces (other than stainless steel), and samples for organic analysis should not contact materials that can react with organic substances. The level of care that needs to be taken with the materials used will depend on the level and types of contaminants associated with the sediment and the quality assurance needs and study goals.
- 2.3.2. For **organic analysis**, equipment and containers should be constructed of: *glass, teflon, polycarbonate, nylon, aluminum, galvanized steel, stainless steel or porcelain*. *Acrylic* core tubes are also acceptable for almost all sampling needs.
- 2.3.3. For **inorganic analysis**, equipment and sample containers should be constructed of: *glass, teflon, polyethylene polycarbonate, stainless steel or acrylic*.

## 3. **Basic Sediment Sampling Procedures**

### 3.1. Preparation

- 3.1.1. **Sampling Plan** - Sampling strategy decisions and sampling locations should be made well before going into the field, and should be designed to collect quality data that will best answer the questions or meet the goals of the study or monitoring program. Reconnaissance level or statistically robust screening level plans should be in place prior to field work. Decisions should be made ahead of time about sample location, number of replicates at each site (sampling strategy), and what chemical analyses to be performed on the samples. This will help ensure that appropriate and quality samples are collected.
- 3.1.2. **Safety** - All field staff should be aware of and fully understand the possible physical and chemical safety hazards posed by any site. Precautions should be taken to prevent exposure to contaminated sediments.
- 3.1.3. **Equipment** - Make all the preparations necessary to obtain suitable collecting equipment, protective clothing, vehicle and boat. Test and calibrate any equipment according to manufacturer's instructions. Record in the field notebook information about the instrument tests and calibrations including: dates, results and person testing the equipment. It may help to label sample containers for each site prior to sampling.

3.1.4. Cleaning Equipment - All equipment should be cleaned *before going into the field and between sites and samples* to prevent contaminating sediment samples. Equipment should be washed with clean scrub brushes using a non-phosphate detergent that leaves no residue when rinsed such as Alconox powdered or Liqui-nox liquid detergent (Liqui-nox is the EPA standard detergent for sampling apparatus). To properly clean equipment, wash apparatus thoroughly with detergent, then rinse 5-6 times with tap water and 3 times with deionized/distilled water if available. Rinse the apparatus with site water before taking the first sediment sample.

3.1.5. Field Observations - Take turbidity or Secchi readings first if possible, before the sediment is suspended by other sampling procedures. Record all field measurements and observations.

### 3.2. General Procedures in the Field

3.2.1. Turn on any equipment that needs to warm up (like a DO meter) first or before reaching the site.

3.2.2. Make sure all equipment is clean and ready to use.

3.2.3. When working from a boat, two or three anchors or spuds driven into the sediment in shallow water will help stabilize boat in breezy, open water conditions.

3.2.4. Each grab or core attempt, whether for a composite sample or replicates, should be taken from undisturbed sediment at the site. Avoid disturbing sediments with a boat motor or by walking on the site. Approach sites from downstream to avoid suspending sediment into the water column over the site.

3.2.5. Have container ready to accept entire sample quickly upon retrieval.

3.2.6. Label every sample container with a permanent marker on labeling tape on the side of the jar or wherever the label will not come off accidentally. Information on the label should include: **Sample #, replicate #, date, collector name** and **analysis type** (organic, inorganic).

3.2.7. Record all site information in a field notebook or on fieldsheets before leaving site. Information usually includes: field measurements, time and date, persons collecting samples, number and types of samples taken including field blanks, etc., labels assigned to each sample, and any general observations. Keep records of all samples, how they were labeled and any blanks or controls that are submitted for analysis.



### 3.3. Collecting Composite Samples

- 3.3.1. Composite samples are generally used to estimate the average concentration of the individual samples that make up the composite. Multiple grabs or cores for a composite sample should be taken from a relatively homogeneous sediment deposit (i.e., all grabs should be of similar sand/silt content). In some cases, composite samples are needed to generate sufficient sample volume for all analyses. It is best to know the rough boundaries of the sediment deposit or "site" before sampling.
- 3.3.2. Place each grab or core into a single mixing bowl (made of suitable material), remove any large objects such as sticks, leaves or stones, etc. and stir thoroughly with a spoon to homogenize. A single grab or core should be mixed at least two minutes. Multiple grab or core samples should be mixed five minutes or longer if necessary.
- 3.3.3. Fill sample jars with the sediment mixture by placing one spoonful sequentially into each jar until the jars are full (see section on sample containers). This sub-sampling system assures that each sample container contains a sample as similar as possible to the other containers.

### 3.4. Collecting Replicate Samples

- 3.4.1. Replicate samples can be obtained at different stages of the sampling for different purposes depending on the objectives of the study. A study plan should describe where and how much replication is necessary. The procedures described here are for collecting distinct field replicate samples where the object is to determine the variability within a deposit and compare one field site to another.
- 3.4.2. When collecting replicate samples to statistically compare sediment deposits, sample sites within each deposit should be randomly located for statistical comparisons to be valid.
- 3.4.3. Be sure each sample is taken from an undisturbed area of sediment
- 3.4.4. If the replicate samples are fairly similar, the equipment need only be rinsed with site water between samples. But, if the replicates are not similar, and some contain significantly more fines than others, then the core tube or dredge may need to be washed with a non-ionic detergent (see equipment) and rinsed in between samples to prevent cross-contamination and to keep replicate samples independent for valid statistical analysis of the data. Use a tub of water in the boat to wash equipment to prevent getting detergent in the site water while sampling.

#### 4. Procedures for Core and Grab Sampling Devices

4.1. Sediment samples are most commonly collected using a coring device, dredge or grab sampler. The type of collecting equipment chosen will depend on sediment texture, site location (depth and current velocity), analyses to be performed and study goals. See **References** for more detailed discussion of the pros and cons of various sampling devices.

#### 4.2. Piston Corer

##### 4.2.1. Preparation and Scope

4.2.1.1. A corer allows excellent quantitative and qualitative sampling to a specified sediment depth with little disturbance of the sediment water interface. Samples can be separated or stratified by depth or color/texture to analyze distinct layers of sediment, although the sediment along the side of the core may smear as the core penetrates, slightly distorting the stratification of the sediment.

4.2.1.2. A corer may not be able to penetrate and/or retain very sandy substrates. Coring in high clay-content sediments where grabs won't work is possible if the water is not too deep, but may be difficult with a push corer and may require the use of a slide hammer or vibrating corer.

4.2.1.3. A large bore corer will provide a larger volume of sediment per attempt. This is important if discreet sample replicates are desired, and enough sample must be collected for a specific analysis or test. Even with the large bore core tube, samples may need to be combined to obtain enough sediment volume for the required analyses and/or tests.

4.2.1.4. A hand-operated, 3 inch diameter core sampler with an optional piston and extensions for deeper water can be effectively used in soft sediments with some silt/clay content in water up to ~30 ft deep. Core samplers may not be able to penetrate or retain very sandy sediments.

##### 4.2.2. Collection Procedure

4.2.2.1. This procedure can be used for a push corer with or without a piston. A piston may not be necessary in high clay sediments. Disregard directions for use of the piston if piston will not be used.

4.2.2.2. Assemble the corer. Adjust the piston (the nut on the bottom adjusts piston diameter) so that it fits snugly. If the piston is too loose, it will not stay in place until the corer

reaches the sediment. If too tight, the piston will not move sufficiently when the corer is being pushed into the sediment, and compaction of the sediment core may occur.

- 4.2.2.3. Position the piston at the bottom of the core tube (open end), with the rope attached and threaded through the core head.
- 4.2.2.4. With the piston in place, let the core tube fill with water from the top, then lower the corer slowly and vertically to the sediment. If the piston falls out the bottom or moves up the core tube before reaching the sediment, tighten piston slightly and try again.
- 4.2.2.5. With the bottom edge of the corer and the piston in contact with the sediment in a vertical position, push the core tube into the sediment while maintaining some tension on the piston rope. The piston should remain at the sediment surface while the core tube moves into the sediment. In difficult sediments, it may be necessary to actually pull on the rope as the corer is pushed into the sediment. The object however is to maintain the piston in a fixed position at the sediment-water interface without compacting the sediment.
- 4.2.2.6. In hard or clay sediments where it is difficult to push the corer into the sediment by hand, a slide hammer designed specifically for the core sampler should be used. Do not pound on the core head or extension tubes with a hammer or anything else as this could break or damage the core head or other parts, and is generally less effective than the slide hammer.
- 4.2.2.7. After core is pushed to desired depth, pull up the corer slowly while maintaining the position of the piston by holding the piston rope in place. Even with the piston, some sediment may be lost from the bottom of the corer if the sediment is sandy. To help prevent sample loss, bring the corer into a horizontal position as it reaches the surface. A plug can also be inserted into the bottom of the sampler before removal from the water.
- 4.2.2.8. Place the corer on the work surface (boat or ice) over the receiving container. The sediment core can be extruded from the top or bottom of the core tube, depending on the purpose of the sample and study goals. Generally, cores collected for macroinvertebrate work should be extruded out the bottom, and cores collected for chemical analysis should be extruded out the top of the core tube if only part of the segment is needed to reduce contamination of the sample segment from other layers.

4.2.2.9. To extrude through the bottom, remove the sampler head, insert a pole through the top and push down on the piston eyebolt. Extrude the core into a waste container until the desired length of core remains, then extrude the remaining sediment into the sample container. To extrude through the top, remove the sampler head and place an extrusion pole and rubber plug at the bottom of the sampler and push sediment out through the top slowly. A premarked acrylic or polycarbonate (clear) core tube is helpful for measuring core lengths.

### 4.3. Grab Samplers

#### 4.3.1. Preparation and Scope

4.3.1.1. Grab samplers rely on their own weight and gravity to penetrate the sediment as well as the leverage from the closing of the jaws. For this reason, they are not as efficient in water flowing over one meter per second. They normally take a discreet "bite" of sediment to a fairly consistent and measurable depth. Grabs often cause a shock wave upon descent which may disturb very fine sediment at the sediment-water interface.

4.3.1.2. Many grabs and dredges such as the petite Ponar and Ekman dredge can be used. These two can be hand operated from a suitably sized boat, preferably flat-bottomed. The Ponar is better suited to sampling hard or sandy sediments because of the greater ability to penetrate. The Ekman is more suited to sampling in soft sediments in low flow waters. Neither grab will effectively sample hard clays where a coring device or shovel such as a sharpshooter spade can be used.

4.3.1.3. Have a sample tub ready to receive sediment that is large enough to receive the entire contents of the sampler.

4.3.1.4. Understand and be careful of the closing mechanism and moving parts on a sampler.

#### 4.3.2. Collection Procedure

4.3.2.1. Set closing mechanism and lower grab slowly to substrate, being careful to avoid a shock wave caused by too rapid of a descent near the sediment.

4.3.2.2. Initiate closure mechanism of grab. This is usually a messenger sent down the rope or a sharp pull on the rope.

4.3.2.3. When it feels like the grab has closed and contains sediment, raise grab at a steady rate and immediately position over large bucket. If jaws are not completely closed due to obstructions, discard entire grab contents away from sampling area and try again.

Make sure to move the sampling site at least several feet away from the previous attempt(s) to avoid sampling a disturbed area.

4.3.2.4. If the study dictates careful sampling for metals analysis, the middle portion of the sample not touching the metal grab can be collected with a teflon or plastic spoon, and the rest of the sample discarded.

4.3.2.5. Empty entire contents of grab into mixing bowl if sample needs to be mixed.

4.3.2.6. Place appropriate volume of sediment into sample container.

#### 4.3.3. Quality Control Measures

4.3.3.1. Sediment samples should be collected from the reference or control sites first when possible to reduce the chances of cross-contamination from other sites.

4.3.3.2. All samples in a study should be handled identically, including using the same sampling equipment, stirring times, etc.

4.3.3.3. When collecting samples for chemical or toxicity tests, take appropriate measures to prevent contamination from other sources such as vehicle and boat motor exhaust or associated contaminants and other contaminated sites. The person operating the boat motor should either not handle sediment samples or make sure to put on clean gloves to prevent contamination from the motor.

## 5. References

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Management.

## **Part 2: Collecting and Processing Samples for Chemical and Physical Analysis**

### **1. Scope**

- 1.1. Quality data can only be obtained from environmental samples that are properly collected, preserved and promptly shipped to the laboratory for analysis. The procedures involved in this process include: 1) collecting the samples using appropriate sampling techniques; 2) selecting proper sample containers; 3) preserving the samples immediately after collection either chemically or by cooling to 4°C, whichever is appropriate; 4) clearly identifying the samples and completing the corresponding laboratory sheets; and 5) carefully packaging and promptly shipping the samples to the laboratory for analysis.
- 1.2. Sediments for organic and inorganic chemical analyses are most often collected using grab, dredge or core methods. The chosen method should target the goals of the study plan and complement any other biological tests that may be conducted at the site or with sediments from the site. Samples slated for different types of physical and chemical analysis may need to be collected and handled in slightly different ways. The level of precautions that must be taken to prevent contamination of samples will depend on the type of analysis to be performed and the study objectives.

### **2. Equipment**

- 2.1. Sample Containers - Samples for organic analysis and inorganic (metals) analysis must be in separate containers. Containers are prepared by and should be obtained from the laboratory doing the analyses. General guidelines are as follows:
  - 2.2. Sample Containers for Inorganic Analysis
    - 2.2.1. Sediment samples should be submitted to the laboratory in a container appropriate for the analyses requested.
    - 2.2.2. Metals - Samples that require metals analyses should be submitted either in 250 mL "metals" bottles or a glass quart mason jar with teflon lid. One 250 mL "metals" bottle (same as for water) provides enough sample to perform all of the routine metals analyses and solids analyses.
    - 2.2.3. Nutrients - Samples that require nitrogen, phosphorus and solids analyses should be submitted in 250 mL "nutrient" bottles or a glass quart mason jar with teflon lid.

2.2.4. Oil & Grease - Samples for Oil & Grease are analyzed by the inorganic section and must be in a glass quart jar with a teflon lined lid. Fill jar 3/4 full or more. Separate containers for metals or nutrients are not necessary if the glass quart jar is used.

2.2.5. Additional information can be obtained from:

East Coast

Tim Byrne  
GeoLabs, Inc.  
Sales Director/  
Environmental Scientist  
45 Johnson Lane  
Braintree, MA 02184  
P 1-781-848-7844  
F 1-781-848-7811  
C 1-781-420-1178

2.3. Sample Containers for Organic Analysis

2.3.1. Soil and sediment samples should be submitted to the laboratory in a container appropriate for the analyses requested.

2.3.2. Organics (PCBs, PAHs, etc.) - Samples for all regular organics analysis should be contained in glass quart jars with teflon lined lids. Jars should be 3/4 full or more. If analyzing for semi- or volatile organics fill jar completely so no air space exists.

2.3.3. Volatile Organic Carbon (VOC) and Gasoline Range Organics (GRO) - A 60 milliliter glass vial with a septum top should be used for soil and sediment samples that are to be analyzed for VOC and GRO. The laboratory will provide three pre-weighed sample vials for each sample site. The vials should be filled with sediment to the "Fill to here---" label (approx. 25g) found on the side of each vial. A water and methanol "trip blank" will be included in each sample mailer.

2.3.4. Diesel Range Organics (DRO) - A 60 milliliter glass vial should be used for soil samples that are to be analyzed for DRO. The laboratory will provide three preweighed sample vials for each sample site. The vials should be filled with soil to the "Fill to here---" label (approx. 25g) found on the side of each vial.

2.4. Samples for Bioassays and Chemical and Physical analyses

2.4.1. If chemical and/or physical analyses are required on sediment samples also slated for toxicity or bioaccumulation tests, the lab can perform the sediment homogenization and fill

sample jars for the chemical analyses from the same sediment that will be used for the bioassays. The testing lab should be contacted for information on appropriate sample containers and procedures.

## 2.5. Samples for Particle size analysis

2.5.1. Quart-size plastic bags (from the store) can be used for particle size samples. **Double bag** the sample and fill 1/2-3/4 full. Label **both** bags in permanent marker with Sample #, date and collector's name. Particle size analysis is usually contracted for every chemical analysis sample, but be sure to clarify this testing with the lab and collect sediment for this analysis.

## 2.6. Quality Control of Sample Containers

2.6.1. Quality control audits should be conducted for chemical analysis to verify that they are free from contaminants. These audits are performed before any bottles are approved for use. Because of the considerable effort expended in assuring the quality of sample bottles, it is important that they be used only for the parameters specified on the label.

2.6.2. To make sure appropriate procedures are used to prevent contamination, quality control information should be obtained from analysis laboratories when the contract for service is generated.

## 3. Cleaning Sediment Collection Equipment

3.1. The following steps for cleaning new or used sediment sampling equipment and containers are recommended by EPA (1994):

3.1.1. Soak 15 min in tap water, and scrub with detergent.

3.1.2. Rinse twice with tap water.

3.1.3. Rinse once with fresh, dilute (10% V:V) hydrochloric or nitric acid. To prepare a 10% solution of acid, add 10 ml of concentrated acid to 90 ml of deionized water.

3.1.4. Rinse twice with deionized water.

3.1.5. Rinse once with full-strength, pesticide-grade acetone (use a fume hood or canopy).

3.1.6. Rinse three times with deionized water.

3.1.7. Rinse field collection equipment with site water immediately before use. Lab equipment should be rinsed with test dilution water immediately before use in a test.

3.1.8. Clean equipment can be protected from contamination during transport (i.e., exhaust, pickup beds, boat motors, etc.) by wrapping in aluminum foil.

3.1.9. Quality control procedures to be followed at the sites should be written down for all field staff.

#### 4. **Sample Preservation**

4.1. All sediment samples for chemical analysis should be preserved as soon as possible after collection by cooling to and **maintaining** a temperature of  $\sim 4^{\circ}\text{C}$  (ice cold) by putting samples on ice in a cooler.

4.2. Keep samples shaded from sunlight to prevent breakdown of chemicals by UV light.

4.3. Ice packs should be included in each sample kit designed for VOC, GRO and DRO analysis, although samples should first be cooled to  $4^{\circ}\text{C}$  on ice. Plastic bottles can also be filled with water, frozen, and placed in the shipping container. Samples should be pre-chilled if these cooling materials are used for shipping.

4.4. For soil or sediment samples to be analyzed for GRO, it may be required to add 25 ml of premeasured methanol to two of the sample vials at the time of collection. (Vials of methanol should be provided by the lab) A third vial is used for determining moisture of the sample.

4.5. For soil samples to be analyzed for VOCs, the collector should consult the laboratory and the individual program needs for the appropriate preservation requirements which may include methanol preservation.

4.6. Contact the contracted laboratory for additional preservative requirements for specific parameter requests.

#### 5. **Packaging and Shipping**

##### 5.1. Cooling Samples

5.1.1. When cooling is required during shipping, the samples should be pre-cooled in an ice chest, and later placed in a field pack with a suitable quantity of ice or "Blue Ice". Ice should not be placed in the field pack loose. It should be securely sealed in a heavy plastic bag to prevent leakage during shipment. DO NOT USE metals bottles, nutrient bottles, or bottles designated for specific tests as ice containers.

##### 5.2. Packing Samples

- 5.2.1. Properly packaging sediment samples for shipping is important for maintaining sample quality and safety of persons contacting the samples.
- 5.2.2. After collection, check each sample to make sure the container lid is securely closed and the sample is properly preserved. The exterior of each sample container should be wiped clean with a wet cloth.
- 5.2.3. Check all samples for secure, correct and complete labels that match the accompanying lab sheets (see below).
- 5.2.4. A whirl-pak or ziploc plastic bag should be used to protect the laboratory sheets from moisture damage during shipment. Dividers, included in the packs, help protect the sample bottles during shipment and should be used whenever possible. When sealing the field packs, secure all four sides of the lid by wrapping with reinforced tape. The tape should be completely wrapped around the pack to make sure that the lid is secure. When more than one field pack is needed to ship various sample portions from a single sampling site, tape the field packs together. This will prevent sample sorting errors and will allow the lab to match the bottles with the correct laboratory sheets.
- 5.2.5. A cooler lined with a polyethylene bag can be used instead of the foam pack if necessary, but be sure to pack sample jars to avoid breakage during shipping and handling.

### 5.3. Laboratory Sheets

- 5.3.1. Different laboratories may have their own lab sheets that should accompany all samples. Generally, lab sheets should include:
  - Sample identification
  - Sample description
  - Sampling program
  - Name and address of the person to whom the report should be sent
  - Last name of the sample collector
  - Field information
  - Tests (parameters) requested
- 5.3.2. The laboratory sheet is an important link between the laboratory and field personnel. The laboratory relies on the sheet to obtain the information necessary to prepare and analyze the sample properly.



#### 5.4. Shipping Samples

- 5.4.1. If storage time limitations are recommended for the sample parameters, coordinate with the laboratory before collecting samples to let them know the sampling schedule.
- 5.4.2. Alert the receiving laboratory of any samples that are known or believed to contain high levels of specific contaminants, including an estimated concentration if possible. This can be done either over the phone before the samples arrive or with an enclosed written warning. The advanced notice allows the lab to handle highly contaminated samples in a way to prevent human exposure as well as cross-contamination of samples in the lab. Additionally, the lab will be able to process and analyze the samples more quickly if they know before analysis that the contaminant concentration is high.
- 5.4.3. Samples should be shipped with an "overnight" mail service or personally delivered to the laboratory for temporary storage so that the samples arrive before all of the ice melts in the shipping container. Monday, Tuesday or Wednesday are the best days to ship samples to assure they do not sit in a mail room with no refrigeration over the weekend. Even "overnight mail" can take longer than 24 hours, so Thursdays can be risky. DO NOT send samples on Fridays unless you have made previous arrangements with the lab.

#### 5.5. Shipping Safety

- 5.5.1. If a sample bottle seal is questionable and no additional bottles are available, place the entire bottle in a whirl-pak (250 mL bottles only). This will contain the sample and prevent any preservative from contaminating other samples in the field pack.
- 5.5.2. The outside of the sample containers should be completely free of contaminated material before the samples are shipped. If this is not possible, the laboratory should be made aware of these samples before shipment.
- 5.5.3. If the submitter believes a sample contains a Department of Transportation (DOT) regulated material or hazardous material, refer to individual state shipping guidelines for hazardous materials.

#### 6. References

- Baudo, R., Giesy, J., and H. Muntau, (Eds.). 1990. *Sediments: Chemistry and Toxicity of In-Place Pollutants*. Lewis Publishers, Boca Raton, FL.
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*Adapted from State of Wisconsin Sediment Sampling Guidelines*