IEc

Sauget Industrial Corridor Sites Natural Resource Damage Assessment:

Field Sampling and Data Report

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prepared for:

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CHAPTER 1 | SUMMARY OF 2018 FIELD SAMPLING AND ANALYSIS

FIELD SAMPLING EFFORT

On August 7-10, 2018, Industrial Economics, Incorporated (IEc) and subcontractor EcoAnalysts conducted field sampling for the purpose of sediment and benthic invertebrate collection and analysis within the Sauget Industrial Corridor Sites (SIC Sites) (Exhibit 1). As detailed in the Sampling and Analysis Plan (SAP; IEc 2018), we conducted targeted sampling within identified SIC Sites, adjacent locations within Areas 1 and 2 that are not defined SIC Sites, and reference locations. The field team visited 11 discrete study locations within the study area and two reference area locations (Exhibit 2) to collect sediment for chemical analysis and benthic macroinvertebrates for enumeration and identification as well as tissue chemical analysis (Exhibit 3). These data are intended to support the SIC natural resource damage assessment (NRDA). Specifically, the study design aimed to fill temporal and geographic information gaps related to the nature, magnitude, and extent of hazardous substances and associated natural resource injuries within SIC aquatic habitats. Specific objectives of this field sampling included (IEc 2018):

- Determine the concentrations of hazardous substances in sediments from previously sampled and under-sampled locations in the study area.
- Determine the concentrations of hazardous substances in benthic macroinvertebrate tissues from the study area.
- Determine if hazardous substances occur in sediment at concentrations sufficient to injure natural resources in the study area.
- Determine if community structure and/or tissue contaminant concentrations in benthic macroinvertebrates collected from SIC Sites differ significantly from benthic macroinvertebrates collected at reference locations.
- Determine whether additional sampling may be required to evaluate the nature, magnitude, and extent of aquatic injuries within the SIC.

In addition to the sediment and benthic macroinvertebrate sampling led by IEc and EcoAnalysts, U.S. Fish and Wildlife (FWS) personnel conducted bat acoustic surveys within the SIC from spring to fall 2018. Results from the acoustic data analysis to evaluate which bat species are present and whether bats are feeding within the SIC are reported under separate cover.

EXHIBIT 1 MAP OF SAUGET INDUSTRIAL CORRIDOR SITES

EXHIBIT 2 LOCATION AND NUMBER OF SAMPLES PROPOSED IN SAP (DEVIATIONS FROM PLAN NOTED IN PARENTHESIS)

STUDY or REFERENCE	LOCATION	SEDIMENT SAMPLE NUMBER[1]	DUPLICATE SEDIMENT SAMPLE NUMBER	INVERTEBRATE SAMPLE NUMBER[2]
Study Area	Site P[3]	2 (0)	0	0
	Site Q	3	1	2
	Dead Creek Segment B	1	0	0
	Dead Creek Segment C	1	0	1
	Dead Creek Segment D	1	0	1
	Dead Creek Segment E	1	0	1
	Dead Creek Segment F	2	0	1
	Outflow of Dead Creek	1	0	0
	Borrow Pit Lake (BPL)	4	1	2
	North of CS-F (between Dead Creek and BPL)	1	0	0
	Field adjacent to BPL	4	0	0
Reference	Site 1	1	1	1
	Site 2	2	0	1
TOTAL		**24 (22)**	**3**	**10**

Notes.

1. Each sediment sample enumerated here was collected at a distinct sampling location. Where indicated, a duplicate sample was collected at the same sampling location for quality control purposes.
2. Invertebrates were collected for enumeration and identification, but not for chemical analysis due to insufficient tissue mass.
3. The two samples proposed for Site P were not collected due to the lack of aquatic habitat.

EXHIBIT 3 PAIRED SEDIMENT AND INVERTEBRATE SAMPLES

STUDY or REFERENCE	LOCATION NAME	SEDIMENT LOCATION NAME (SAMPLE ID)	INVERTEBRATE LOCATION NAME
Study Area	Site P	--	--
	Site Q	Site Q Sediment 1 (SED22) Site Q Sediment 1-Dup (SED23)	Site Q Invert 1
		Site Q Sediment 2 (SED24)	--
		Site Q Sediment 3 (SED25)	Site Q Invert 2
	Dead Creek Segment B	Site M Sediment (SED03)	--
	Dead Creek Segment C	CS-C Sediment (SED04)	CS-C Invert
	Dead Creek Segment D	CS-D Sediment (SED15)	CS-D Invert
	Dead Creek Segment E	CS-E Sediment (SED16)	CS-E Invert
	Dead Creek Segment F	CS-F Sediment 1 (SED01)	--
		CS-F Sediment 2 (SED18)	CS-F Invert
	Outflow of Dead Creek	Outfall Sediment (SED17)	--
	Borrow Pit Lake (BPL)	BPL Sediment 1 (SED09)	--
		BPL Sediment 2 (SED21)	BPL Invert 1
		BPL Sediment 3 (SED19) BPL Sediment 3-Dup (SED20)	--
		BPL Sediment 4 (SED10)	BPL Invert 2
	North of CS-F	Adjacent to CS-F (SED02)	--
	Field adjacent to BPL	Ag Field Sediment 1 (SED07)	--

STUDY or REFERENCE	LOCATION NAME	SEDIMENT LOCATION NAME (SAMPLE ID)	INVERTEBRATE LOCATION NAME
		Ag Field Sediment 2 (SED06)	
		Ag Field Sediment 3 (SED05)	
		Adjacent to BPL (SED08)	
Reference	Site 1	REF 1 Sediment (SED11) REF 1 Sediment-Dup (SED12)	REF 1 Invert
	Site 2	REF 2 Sediment 1 (SED14)	REF 2 Invert
		REF 2 Sediment 2 (SED13)	--

ADAPTIVE MANAGEMENT DURING FIELD SAMPLING

During the field sampling, the field sampling team identified two distinct challenges and followed the adaptive management procedure identified in the SAP (IEc 2018). The following section summarizes the challenges and our revised approach to completing the field sampling effort.

The main challenge the field team encountered was collecting sufficient macroinvertebrate tissue mass. Our first invertebrate collection occurred at Dead Creek Segment C on August 7, 2018. As directed in the SAP, we collected, composited, and sieved three grab samples and began processing the sample in the field. The sample contained a large amount of vegetative material and pebbles. Processing this single invertebrate sample took more time than originally planned, and we were unable to isolate the invertebrates from the remaining organic material. The next day, we processed a second invertebrate sample consisting of five sediment grabs from Borrow Pit Lake. This sample had less organic matter to isolate and remove, but sorting the recognizable invertebrates took more than two hours and yielded approximately three grams of tissue. In the SAP, we had estimated that 100 grams of tissue per sample was required to analyze the composited tissue sample for the chosen suite of analytes. Thus, the time necessary to process the amount of tissue necessary for chemical analysis was prohibitive. To address this issue, we sought to understand whether the sampling locations were depauperate compared to reference locations, or whether all locations (including reference areas) contained insufficient tissue mass for chemical analysis. On the third day of sampling, we began by collecting an invertebrate sample at one of the two reference locations. Again, we were unable to collect the required tissue mass at the reference location, only finding a small number of red worms (affirmatively identified as *Limnodrilus hoffmeisteri* in the subsequent taxonomic analysis).

Thus, the field team concluded that all sampling locations likely contained insufficient invertebrate mass for chemical analysis. After an adaptive management discussion among the Field Team Leader, Project Manager, QA Manager, and FWS, we implemented an updated approach to collect invertebrates for taxonomic identification and enumeration but not chemical analysis. In addition, to better understand and quantify injuries to aquatic resources within the SIC, the project management team proposed to consider future laboratory-based macroinvertebrate toxicity testing based on the outcome of the sediment chemistry results.

The second challenge the field team encountered was environmental conditions which differed from expectations based on orthophotos and SIC-specific documents. Specifically, the wetland habitat expected at Site P was not present. No standing water or sediment was found during reconnaissance and therefore we did not collect the two planned sediment samples from Site P. Similarly, we relocated several samples based on access issues (e.g., distance from vehicle access points and/or impassible vegetation) but always within the same general location to maintain integrity with the original sampling plan and maximize the objective to fill data gaps (Exhibits 4 and 5).

EXHIBIT 4 MAP OF SAMPLED LOCATIONS (SIC SITES)

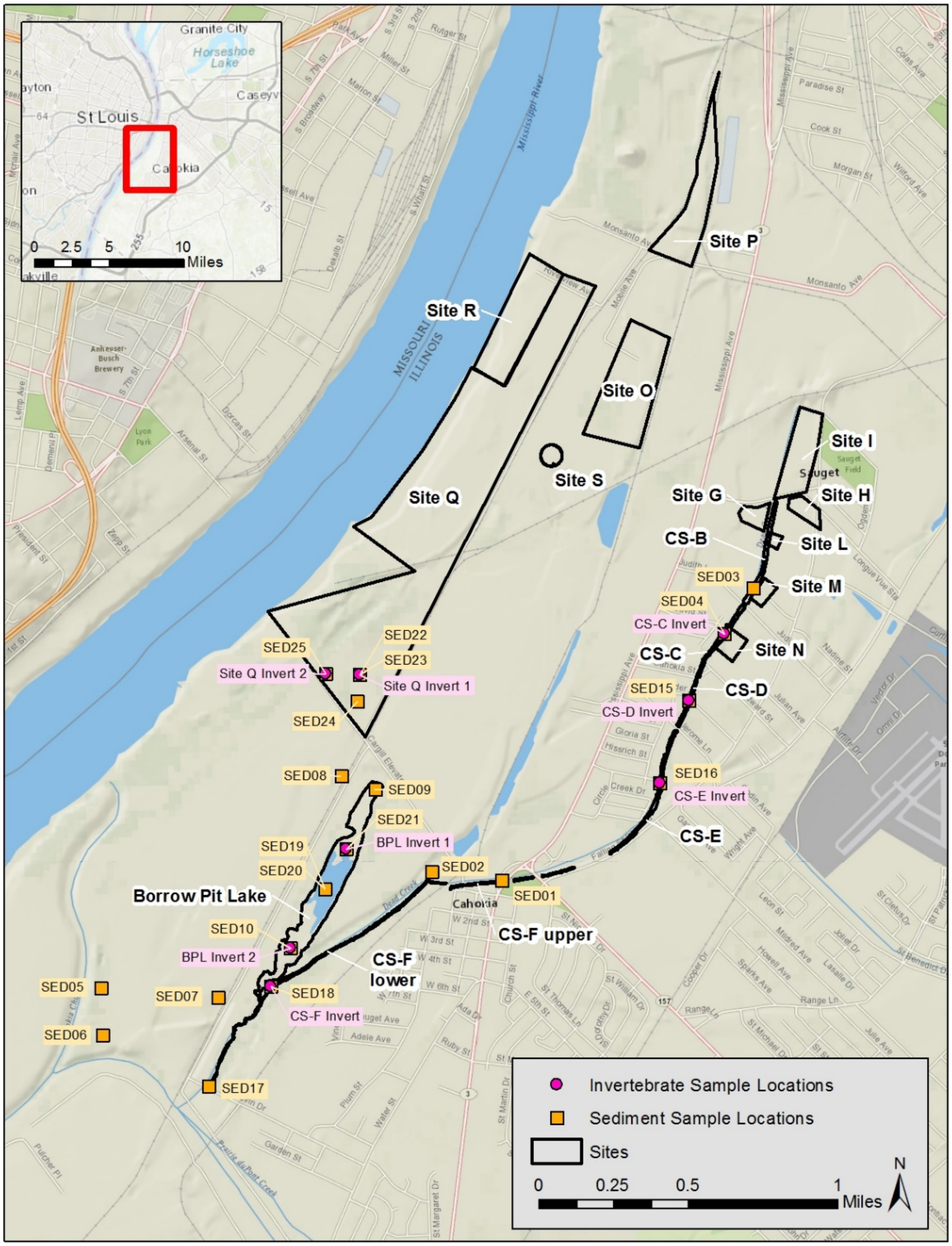
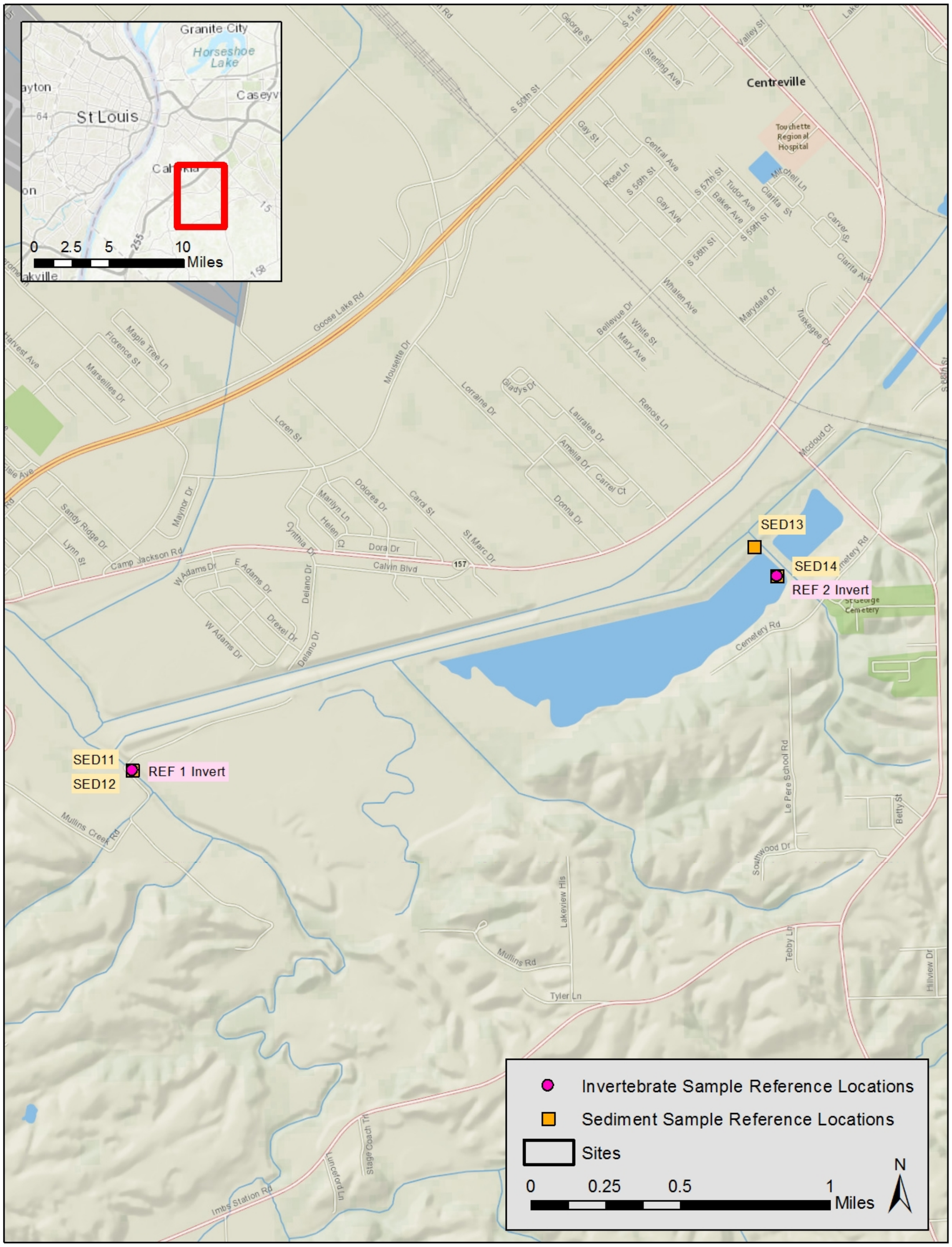


EXHIBIT 5 MAP OF SAMPLED LOCATIONS (REFERENCE)



SEDIMENT AND INVERTEBRATE SAMPLE ANALYSIS

INVERTEBRATE SAMPLE ANALYSIS

EcoAnalysts conducted the analysis of benthic invertebrate samples, including enumeration of invertebrates in each sample, identification down to the lowest taxonomic group, and analysis of richness, diversity, and other related biological indices. Results are presented in Chapter 2 and in the electronic data deliverable (Attachment 1).

SEDIMENT SAMPLE CHEMICAL ANALYSIS

FWS contracted directly with U.S. Government-approved laboratories to conduct the chemical analysis of sediment samples. The FWS Analytical Control Facility provided data quality assurance and quality control for the data generated from the laboratory sample analysis. Inorganic analytes (metals) were analyzed by Research Triangle Institute (RTI). IEc received the electronic data file in May 2019. Organic analytes (PCBs, PAHs, dioxins, furans, and alkanes) were analyzed by ALS Global. IEc received the electronic data files for organic analytes in May and August 2019. IEc reviewed all data files for completeness and accuracy.

Upon review of the PCB congener data, IEc became aware that only a subset of PCB congeners was measured, and the dataset did not contain an estimate of Total PCBs for each sample. Through FWS, IEc communicated with the laboratory and obtained results for Aroclor PCB mixtures in August 2019, which had been analyzed by the laboratory but were not part of the data file. We reviewed both the Aroclor data and the partial PCB congener data, and used each to estimate two separate Total PCB concentrations per sample (i.e., by summing the detected PCBs and Aroclor values, respectively; see text boxes below). Based on these methods, several sampled locations had Total PCB concentrations in between the threshold and probable effects thresholds for Total PCBs as defined in MacDonald et al. 2000. IEc consulted FWS and developed a plan to reanalyze

Calculation of Total PCBs

Polychlorinated biphenyls (PCBs) are hazardous substances as defined in CERCLA § 101(14) and consist of a group of 209 individual compounds, known as congeners. IEc used the HRMS/HRGC data to determine the percent difference compared to the partial PCB congener data. We then estimated an average percent difference for all samples with HRMS/HRGC data. For samples without high resolution data, the Total PCB estimate (derived from partial congener data) was adjusted by the average percent difference to arrive at an adjusted Total PCB value that more accurately represents all 209 congeners (reported in Chapter 2). Non-detected analytes were treated as zeros.

Calculation of Total PAHs

Polycyclic aromatic hydrocarbons (PAHs) are one of the major groups of hydrocarbon compounds. As part of this study, over 30 PAH compounds were analyzed for each sediment sample. For this report, IEc calculated Total PAH estimates based on the results from the 13 specific PAHs used to develop effects thresholds (discussed in Chapter 2) for each sediment sample. Non-detected analytes were treated as zeros.

the sediment sample remnants using a high-resolution method that identifies all 209 PCB congeners (including some congeners that co-elute).

Thirteen samples were analyzed by ALS Global using EPA Method 1668C, high-resolution mass spectrometry and high-resolution gas chromatography (HRMS/HRGC). IEc received the electronic data file in June 2020, and reviewed the file for completeness and accuracy. For each sample with both HRMS/HRGC results and partial congener results, IEc summed all PCB congeners for each set of results, treating non-detected analytes as zeros, to derive two estimates of Total PCBs. IEc then calculated a mean percent difference between the two Total PCB estimates (Exhibit 6) and used it as an adjustment factor to calculate Total PCBs for the remaining samples. Results are presented in Chapter 2 and in the electronic data deliverable (Attachment 2).

EXHIBIT 6 CALCULATION OF MEAN PERCENT DIFFERENCE IN PARTIAL CONGENER AND HRMS/HRGC METHODS FOR ESTIMATING PCBS

SAMPLE ID	TOTAL PCBS: PARTIAL CONGENERS (MG/KG)	TOTAL PCBS: HRMS/HRGC (MG/KG)	PERCENT DIFFERENCE[1,2]
SED01	0.19	0.35	0.82
SED02	3.91	4.14	0.06
SED03	0.34	0.64	0.87
SED04	0.11	0.23	0.98
SED07	0.50	0.11	-0.79
SED10	0.02	0.07	1.82
SED15	0.25	0.45	0.76
SED16	0.53	1.01	0.90
SED18	0.06	0.14	1.19
SED19	0.03	0.06	1.02
SED20	0.03	0.07	1.66
SED23	9.02	10.50	0.16
SED25	0.15	0.39	1.53
		Mean	**0.845**

Notes.

1. The percent difference was calculated by subtracting the partial congener concentration from the HRMS/HRGC concentration, then dividing by the partial congener concentration.
2. For each sample not listed in this table, the Total PCB concentration was calculated by multiplying the partial congener concentration by (1 + mean percent difference).

INVERTEBRATE SAMPLE ANALYSIS RESULTS

Macroinvertebrate samples collected in the field were analyzed in laboratories for standard benthic community metrics. Here, we summarize those analytical results and highlight location-specific trends, where applicable. The electronic data deliverable with raw information and calculated community metrics is included as Attachment 1.

Water quality parameters including conductivity, dissolved oxygen (DO), pH, and temperature are summarized for each sampled location in Exhibit 7, which also includes a study-area and reference-area mean for each parameter. Several portions of Dead Creek (CS-D, CS-E), as well as portions of the agricultural field and interstitial area between Dead Creek CS-F and Borrow Pit Lake, have DO concentrations equal to or less than 1 mg/L, while reference areas range from 6.58 to 7.28 mg/L.

Biological metrics are presented in Exhibit 8, including species richness, EPT (Ephemeroptera, Plecoptera, and Tricoptera) richness,[1] Shannon-Weaver diversity index, and Simpson's evenness (another type of diversity index). Portions of Dead Creek and Borrow Pit Lake have species richness ranging from two to nine, while reference areas range from 14 to 19. Seven of the 10 sampled locations (including the reference areas) had an EPT richness of zero.

Depictions of the number of organisms per taxonomic order and the organisms per functional group are shown in Exhibits 9 and 10, respectively. One sample collected in Borrow Pit Lake contained the greatest number of individuals, the majority of which were Nematodes. Certain study locations had fewer identified benthic invertebrate individuals (e.g., Dead Creek CS-E, CS-F, and the second Borrow Pit Lake sample), while other study areas had more diversity in terms of the number of taxonomic orders represented. Benthic invertebrates in Borrow Pit Lake are almost exclusively predators, compared with a mix of gatherers, filterers, and other types in the other study areas (Exhibit 10).

[1] EPT richness measures the individuals in three orders that are generally less tolerant of water pollution.

EXHIBIT 7 WATER QUALITY PARAMETERS

STUDY or REFERENCE AREA	CONDUCTIVITY (µS/CM)	DISSOLVED OXYGEN (MG/L)	PH	TEMP (°C)
Site Q Sed 1/Invert 1	0.43	9.81	8.92	27.86
Site Q Sed 2	0.49	6.97	8.56	28.62
Site Q Sed 3/Invert 2	0.54	8.49	8.84	29.73
Site M Sed	0.22	5.77	7.90	28.44
Dead Creek CS-C Sed/Invert	0.19	4.95	7.75	28.12
Dead Creek CS-D Sed/Invert	0.23	0.42	6.63	24.72
Dead Creek CS-E Sed/Invert	0.21	0.74	6.80	25.02
Dead Creek CS-F Sed 1	0.11	4.83	7.32	24.65
Dead Creek CS-F Sed 2/Invert	0.68	3.30	7.68	23.82
Outfall Sed	0.68	12.73	7.93	27.68
BPL Sed 1	0.66	6.72	7.39	28.89
BPL Sed 2/Invert 1	0.77	4.60	7.29	24.97
BPL Sed 3	0.73	5.47	7.87	25.79
BPL Sed 4/Invert 2	0.45	2.08	9.51	36.14
Ag Field Sed 1	0.14	0.69	6.96	28.19
Ag Field Sed 2	0.14	2.61	7.23	26.74
Ag Field Sed 3	0.45	3.30	7.75	27.54
Adjacent to CS-F (No-Site Sed 1)	0.14	4.88	7.35	24.96
Adjacent to BPL (No-Site Sed 2)	0.92	1.01	9.40	35.79
Study Area Mean	***0.43***	***4.70***	***7.85***	***27.77***

STUDY or REFERENCE AREA	CONDUCTIVITY (µS/CM)	DISSOLVED OXYGEN (MG/L)	PH	TEMP (°C)
Ref Site 1 Sed/Invert	0.45	6.58	7.69	22.91
Ref Site 2 Sed 1/Invert	0.37	7.01	9.01	30.74
Ref Site 2 Sed 2	0.36	7.28	9.01	30.76
Reference Site Mean	***0.39***	***6.96***	***8.57***	***28.14***

EXHIBIT 8 BIOLOGICAL METRICS

STUDY or REFERENCE AREA	SPECIES RICHNESS	EPT RICHNESS	DIVERSITY: SHANNON-WEAVER H' (log 10)	EVENNESS: SIMPSON'S HETEROGENEITY
Site Q Invert 1	18	1	1.04	0.89
Site Q Invert 2	16	2	1.03	0.89
Dead Creek CS-C Invert	19	1	1.03	0.88
Dead Creek CS-D Invert	9	0	0.46	0.48
Dead Creek CS-E Invert	4	0	0.49	0.67
Dead Creek CS-F Invert	9	0	0.75	0.76
BPL Invert 1	2	0	0.30	0.67
BPL Invert 2	4	0	0.14	0.15
Ref 1 Invert	19	0	0.99	0.84
Ref 2 Invert	14	0	0.58	0.58

EXHIBIT 9 ORGANISMS PER ORDER

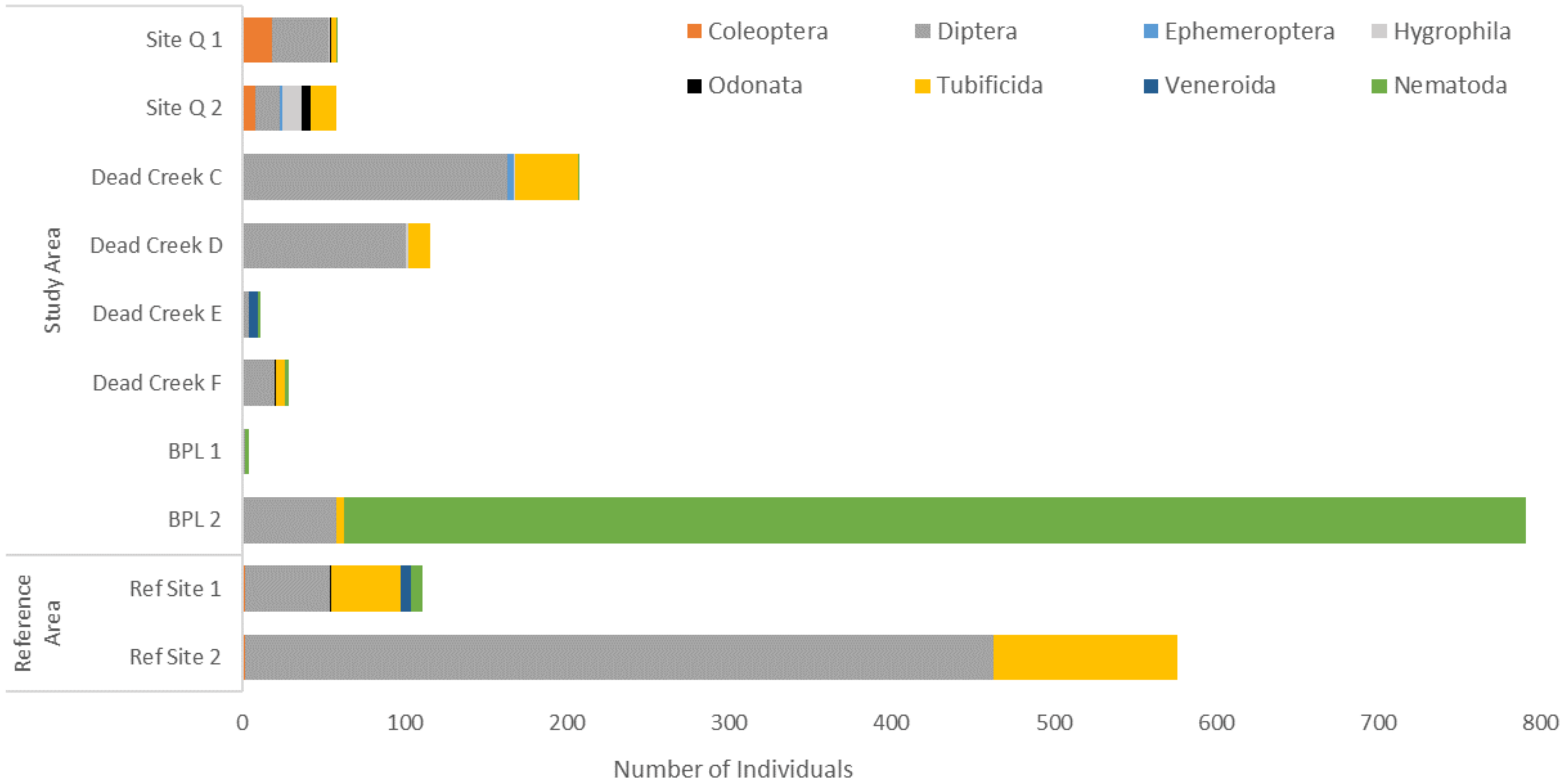
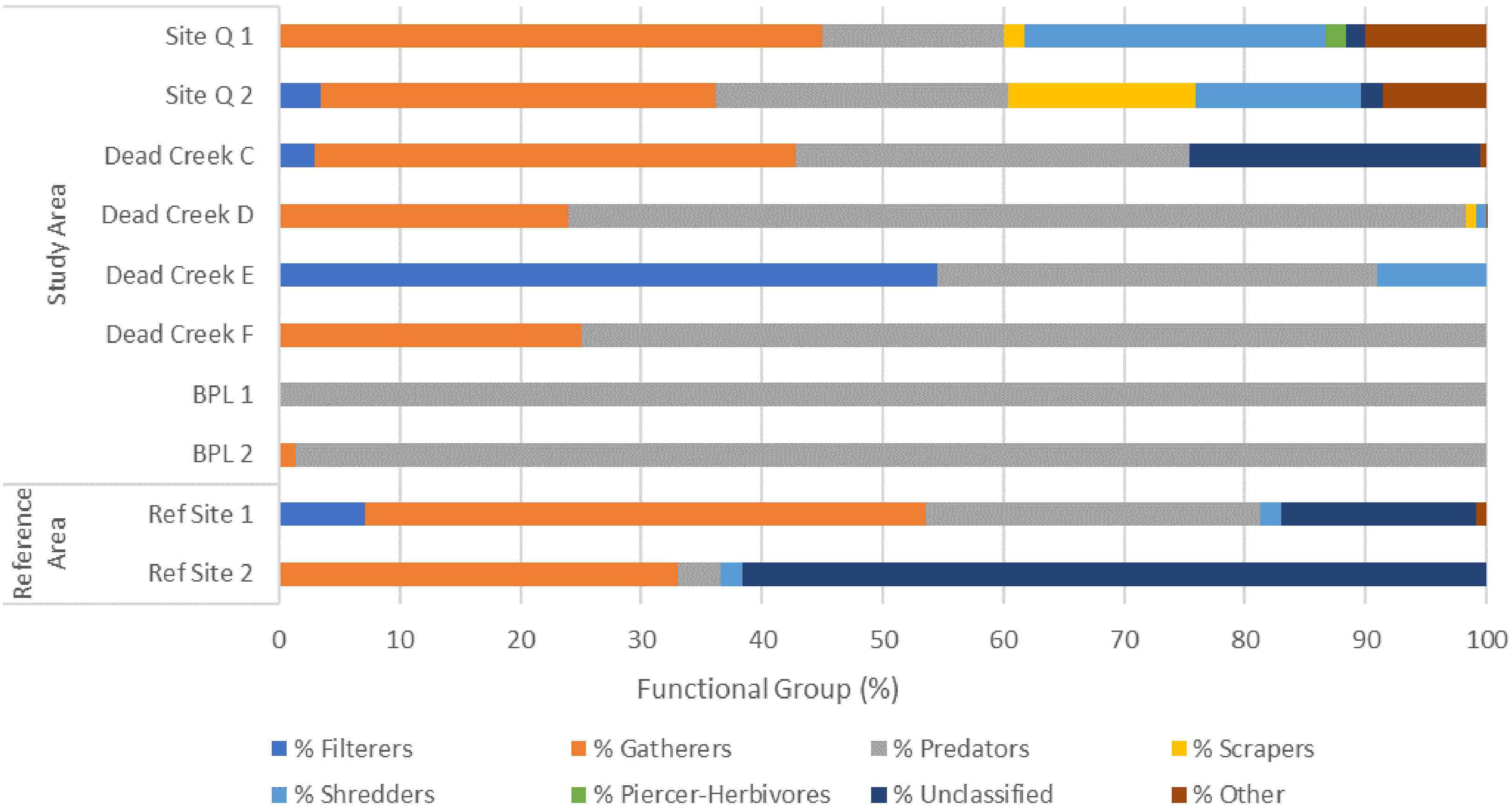


EXHIBIT 10 ORGANISMS PER FUNCTIONAL GROUP



SEDIMENT SAMPLE CHEMICAL ANALYSIS RESULTS

Sediment samples collected in the field were analyzed in laboratories for a suite of chemical analytes. The analytical results are compared to appropriate, readily available adverse effects thresholds to provide context for location-specific concentrations relative to concentrations indicative of injury to benthic organisms (Exhibit 11).

Reference location concentrations of inorganic (Exhibit 12) and organic analytes (Exhibit 13) are lower than threshold values for all analytes except manganese (exceeds in one of four samples). This evidence supports the inference that the chosen reference locations are representative of background concentrations for the Sauget region.

Concentrations of metals are elevated relative to thresholds in portions of Dead Creek, Borrow Pit Lake, and the interstitial locations within the study area that are not part of any defined SIC Site (e.g., the connecting area between Dead Creek CS-F and Borrow Pit Lake). At Site Q, only one inorganic threshold exceedance is apparent for zinc. However, Site Q has some of the highest Total PCB concentrations measured in the study area, exceeding the probable effect concentration at multiple sample locations (MacDonald et al. 2000). The connecting area between Dead Creek CS-F and Borrow Pit Lake (SED02) also has some of the highest Total PCB, Total PAH, and 2,3,7,8-TCDD (dioxin) concentrations, exceeding the thresholds listed in Exhibit 11. Dead Creek exceeded the Total PAH threshold in multiple locations. The analyzed pesticides, insecticides, and phthalate compounds were largely not detected in sediment samples, with only one exceedance of dieldrin (pesticide) in Dead Creek CS-D.

EXHIBIT 11 CHEMICAL THRESHOLDS RELEVANT TO BENTHIC ORGANISMS

ANALYTE	THRESHOLD EFFECTS LEVEL (PPM)	PROBABLE EFFECTS LEVEL (PPM)
Arsenic	9.79[1]	33[2]
Cadmium	0.99[1]	4.98[2]
Chromium	43.4[1]	111[2]
Copper	31.6[1]	149[2]
Iron	20,000[3]	40,000[4]
Lead	35.8[1]	128[2]
Manganese	460[3]	1,100[4]
Mercury	0.18[1]	1.06[2]
Nickel	22.7[1]	48.6[2]
Zinc	121[1]	459[2]
1,2-Dicholorobenzene	0.34[5]	--
2,3,7,8-TCDD	2.5E-6[6]	2.5E-5[7]
Anthracene	0.0572[1]	0.845[2]
Benzo(a)anthracene	0.108[1]	1.05[2]
Benzo(a)pyrene	0.15[1]	1.45[2]
Bis(2-ethylhexyl)phthalate	0.182[8]	--
Chrysene	0.166[1]	1.29[2]
Dibenz(a,h)anthracene	0.033[1]	--
Dieldrin	0.0019[1]	0.0618[2]
Endrin	0.00222[1]	0.207[2]

ANALYTE	THRESHOLD EFFECTS LEVEL (PPM)	PROBABLE EFFECTS LEVEL (PPM)
Fluoranthene	0.423[1]	2.23[2]
Fluorene	0.0774[1]	0.536[2]
Gamma BHC (Lindane)	0.00237[1]	0.00499[2]
Heptachlor Epoxide	0.00247[1]	0.016[2]
Naphthalene	0.176[1]	0.561[2]
Phenanthrene	0.204[1]	1.17[2]
Pyrene	0.195[1]	1.52[2]
Total PAH	1.61[1]	22.8[2]
Total PCB	0.0598[1]	0.676[2]

Notes.

1. Threshold Effect Concentration (TEC; MacDonald et al. 2000): The concentration below which adverse effects are not expected to occur.
2. Probable Effect Concentration (PEC; MacDonald et al. 2000): The concentration above which harmful effects are expected to occur frequently.
3. Lowest Effect Level (LEL; Persaud et al. 1993): The level at which actual ecotoxic effects become apparent; the concentration which 95% of species can tolerate.
4. Severe Effect Level (SEL; Persaud et al. 1993): The concentration at which most benthic organisms could potentially be eliminated; the concentration which 95% of species cannot tolerate.
5. Sediment Quality Benchmark (SQB; Jones et al. 1997): The EPA sediment quality benchmark based EPA Tier II Chronic value (Region IV 1996), assuming one percent total organic carbon.
6. Low Risk Level (LRL; EPA 1993): The highest concentration that is unlikely to cause significant effects to sensitive organisms. Derived from no-effects thresholds for reproductive effects in sensitive species.
7. High Risk Level (HRL; EPA 1993): The lowest concentration that is likely to cause severe effects. Derived from doses expected to cause 50 to 100 percent mortality in embryos and young of sensitive species.
8. Threshold Effect Level (TEL; Jones et al. 1997): Upper limit of the range of concentrations dominated by no effects. The geometric mean of the 15th percentile concentration in the effects data set and the 50th percentile concentration in the no effects data set.

EXHIBIT 12 EXCEEDANCE OF THRESHOLDS (INORGANICS)

SAMPLE ID[1,2]	ARSENIC	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	MANGANESE	MERCURY	NICKEL	ZINC
TYPE OF THRESHOLD	TEC/PEC	TEC/PEC	TEC/PEC	TEC/PEC	LEL/SEL	TEC/PEC	LEL/SEL	TEC/PEC	TEC/PEC	TEC/PEC
Site Q — SED22	nd[3]	0.677	13.2	13.2	10200	18.7	210	0.0617	8.55	75.9
Site Q — SED23	nd	0.977	15.4	15.6	10900	23	213	0.0727	10	88
Site Q — SED24	nd	0.95	19.9	21.9	16100	28.6	396	0.0906	12.8	127
Site Q — SED25	nd	0.235	8.97	8.58	8430	12.2	230	0.0271	7.61	55.3
Site M — SED03	nd	nd	10.8	50.8	9210	0.0412	255	0.0862	0.00476	381
Site M — SED03-D	0.891	1.12	13.2	65.4	9300	15.3	299	0.026	26.6	387
Dead Creek C — SED04	1.64	8.17	28.2	132	12300	54.4	112	0.165	143	1620
Dead Creek D — SED15	3.15	10.3	25.7	156	12300	45.1	172	0.19	87.4	1630
Dead Creek E — SED16	3.25	7.07	24.4	122	12000	60	165	0.529	60.9	921
Dead Creek F — SED01	1.25	2.69	14.5	42.3	8300	60.1	99.8	0.23	23.9	529
Dead Creek F — SED18	4.77	5.98	15.4	51.7	16400	33	299	0.288	74.3	712
Outfall — SED17	0.872	0.122	11.5	9.77	10100	9.07	339	0.0475	10	46.5
Borrow Pit Lake — SED09	24.4	0.694	23.4	16.7	57200	25.7	854	0.113	28.3	202
Borrow Pit Lake — SED10	2.26	1.41	23.6	36.8	33100	28.7	1060	0.19	32.6	285

SAMPLE ID[1,2]	ARSENIC	CADMIUM	CHROMIUM	COPPER	IRON	LEAD	MANGANESE	MERCURY	NICKEL	ZINC
TYPE OF THRESHOLD	TEC/PEC	TEC/PEC	TEC/PEC	TEC/PEC	LEL/SEL	TEC/PEC	LEL/SEL	TEC/PEC	TEC/PEC	TEC/PEC
Borrow Pit Lake — SED19	6.96	1.43	29.3	40.1	43000	40.9	1640	0.153	45.1	322
Borrow Pit Lake — SED20	4.9	1.21	25.6	34.4	38600	33.4	1220	0.162	38.8	278
Borrow Pit Lake — SED21	2.75	0.681	17.3	19.1	28600	23.5	655	0.112	31.7	213
Adjacent to CS-F — SED02	6.01	8.29	105	481	23100	272	362	0.803	395	3440
No-Site — SED02-D	5.74	7.96	103	458	22200	268	350	0.15	391	3430
Ag Field — SED05	1.28	0.0341	9.62	7.55	8890	6.61	259	0.0199	8.84	41.2
Ag Field — SED06	nd	0.462	22.8	22.1	19600	23.6	503	0.091	16.2	128
Ag Field— SED07	0.85	0.61	21	20.3	19100	46.5	522	0.0973	16.1	147
Adjacent to BPL — SED08	1.84	0.354	19.6	18.2	18900	41.5	501	0.0742	16.6	99.4
Ref. Site 1 — SED11	0.677	0.018	15.2	11.1	12700	10.1	489	0.0347	10.7	47.7
Ref. Site 1 — SED12	0.52	0.0289	16.4	12.2	12800	13.1	429	0.0441	10.8	52.7
Ref. Site 2 — SED13	1.4	0.0758	6.96	4.45	5970	4.96	202	0.0417	5.7	28.7
Ref. Site 2 — SED14	0.554	0.0853	8.08	6.59	6950	5.79	272	0.035	7.03	29.2

Notes.

1. Gray shading indicates an exceedance of the threshold effect concentration/level; red indicates an exceedance of the probable effect concentration/level (Exhibit 11).
2. All units are mg/kg (parts per million (ppm)).
3. The analyte was not detected.

EXHIBIT 13 EXCEEDANCE OF THRESHOLDS (ORGANICS)

SAMPLE ID[1,2]	TOTAL PAH[3]	TOTAL PCB[4]	1,2-DICHLORO-BENZENE	2,3,7,8-TCDD	BIS(2-ETHYLHEXYL) PHTHALATE	DIELDRIN	ENDRIN	GAMMA BHC	HEPTACHLOR EPOXIDE
TYPE OF THRESHOLD	TEC/PEC	TEC/PEC	SQB	LRL/HRL	TEL	TEC/PEC	TEC/PEC	TEC/PEC	TEC/PEC
Site Q — SED22	0.383	13.8*	nd[5]^	nd	nd^	0.00039	nd	nd	nd
Site Q — SED23	0.237	10.5	nd^	1.69E-06	nd^	0.00059	nd	nd	nd
Site Q — SED24	0.675	2.85*	nd^	1.74E-06	nd^	0.00029	nd	nd	nd
Site Q — SED25	0.806	0.39	nd^	nd	nd^	nd	nd	nd	nd
Site M — SED03	0.303	0.64	nd^	2.99E-06	nd^	nd	nd	nd	nd
Dead Creek C — SED04	0.236	0.23	nd^	1.76E-06	nd^	nd	nd	nd	nd
Dead Creek D — SED15	1.962	0.45	nd^	2.44E-06	nd^	0.0021	nd	nd	nd
Dead Creek E — SED16	6.828	1.01	nd^	7.21E-06	nd^	nd	nd	nd	nd
Dead Creek F — SED01	37.3	0.35	nd[3]^	4.43E-06	nd^	nd	nd	nd	nd
Dead Creek F — SED18	0.333	0.14	nd^	6.23E-06	nd^	nd	nd	nd	nd
Outfall — SED17	0.216	0.002*	nd^	nd	nd^	nd	nd	nd	nd
Borrow Pit Lake — SED09	0.32	0.028*	nd^	nd	nd^	nd	nd	nd	nd
Borrow Pit Lake — SED10	0.437	0.069	nd^	1.20E-06	nd^	nd	nd	nd	nd
Borrow Pit Lake — SED19	0.37	0.063	nd^	1.55E-06	nd^	nd	nd	nd	nd
Borrow Pit Lake — SED20	0.381	0.071	nd^	1.17E-06	nd^	nd	nd	nd	nd

SAMPLE ID[1,2]	TOTAL PAH[3]	TOTAL PCB[4]	1,2-DICHLORO-BENZENE	2,3,7,8-TCDD	BIS(2-ETHYLHEXYL) PHTHALATE	DIELDRIN	ENDRIN	GAMMA BHC	HEPTACHLOR EPOXIDE
TYPE OF THRESHOLD	TEC/PEC	TEC/PEC	SQB	LRL/HRL	TEL	TEC/PEC	TEC/PEC	TEC/PEC	TEC/PEC
Borrow Pit Lake — SED21	0.26	0.023*	nd^	nd	nd^	nd	nd	nd	nd
Adjacent to CS-F — SED02	1.908	4.14	nd^	1.29E-05	nd^	0.0012	nd	nd	nd
Ag Field — SED05	nd	nd*	nd^	nd	nd^	nd	nd	nd	nd
Ag Field — SED06	0.299	0.053*	nd^	nd	nd^	nd	nd	nd	nd
Ag Field— SED07	0.519	0.11	nd^	1.04E-06	nd^	nd	nd	nd	nd
Adjacent to BPL — SED08	0.258	0.036*	nd^	nd	nd^	0.00067	nd	nd	nd
Ref. Site 1 — SED11	0.256	0.004*	nd^	nd	nd^	0.00021	nd	nd	nd
Ref. Site 1 — SED12	0.129	nd*	nd^	nd	nd^	nd	nd	nd	nd
Ref. Site 2 — SED13	0.174	nd*	nd^	1.08E-06	nd^	nd	nd	nd	nd
Ref. Site 2 — SED14	0.274	0.012*	nd^	nd	nd^	nd	nd	nd	nd

Notes.

1. Gray shading indicates an exceedance of the threshold effect concentration/level; red indicates an exceedance of the probable effect concentration/level (Exhibit 11).
2. All units are mg/kg (parts per million (ppm)).
3. Total PAHs include acenaphthylene, acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene. Total PAHs were calculated by summing detected PAH compounds for each sample. Non-detects were treated as zero.
4. Total PCBs were calculated by two methods, depending on available data (Exhibit 6). Samples *not* analyzed by HRMS are indicated with an asterisk (*).
5. The analyte was not detected. Instances where the analyte’s detection limit exceeded the threshold provided in Exhibit 11 are indicated with a caret symbol (^).

CHAPTER 3 | SUMMARY

The sediment field sampling program and collection of benthic invertebrates for enumeration and identification was successfully completed in August 2018. The chemical analysis of sediment samples and analysis of benthic community metrics such as richness and diversity fill temporal and spatial data gaps for the SIC Sites.[2] Briefly, we summarize several key results from the chemical and biological analyses:

- **Reference Locations.** The reference locations chosen for this study have low concentrations of hazardous substances and are likely representative of background conditions in the Sauget region.
- **PCB Analysis.** The re-analysis of sediment samples by HRMS/HRGC analysis confirmed that 10 sediment samples were correctly quantified at values between the threshold and probable effect concentration thresholds, and confirmed the existence of very high concentrations of PCBs (~10.5 mg/kg) at Site Q.
- **Elevated Contaminants.** Metals, Total PAHs, and Total PCBs are elevated at multiple SIC Sites, including Dead Creek and Borrow Pit Lake. One pesticide, dieldrin, exceeds the threshold effect concentration at Dead Creek Segment D.
    - The sampled locations that are not within any specific SIC Site are elevated for certain compounds. For example, the connecting area between Dead Creek CS-F and Borrow Pit Lake (SED02) has some of the highest concentrations of Total PCBs and Total PAHs.
    - The highest concentrations of Total PCBs were quantified at samples from Site Q (10.5 – 13.8 mg/kg), far exceeding the probable effect concentration (0.676 mg/kg from MacDonald et al. 2000).
- **Not Detected Contaminants.** Several contaminants, including the pesticides, insecticides, and phthalate compounds reported in Exhibit 12 do not appear to be present within the study area at levels above threshold values indicative of injury to benthic invertebrates.
- **Water Quality.** Low dissolved oxygen is present in portions of Dead Creek and Borrow Pit Lake.

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[2] Additional sampling and/or laboratory analysis may be implemented at a later date in order to better characterize the contaminant levels in benthic invertebrates, which in this study were not found in sufficient quantities to analyze for contaminant chemistry.

- **Community Metrics.** Overall, the number of individuals and functional groups varied across sampling locations. Certain study locations had notably fewer individuals (e.g., Dead Creek CS-E, CS-F; and Borrow Pit Lake 1) relative to other locations. Further, benthic invertebrate samples collected within Borrow Pit Lake indicate a prevalence of nematodes and the presence of fewer functional groups.

REFERENCES

Industrial Economics, Inc. 2018. Sampling and Analysis Plan for the Sauget Industrial Corridor Sites NRDA. Sediment and Benthic Invertebrate Field Sampling. Prepared for U.S. Fish and Wildlife Service. August.

Jones, D.S., G.W. Suter II, and R.N. Hull. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. Prepared for U.S. Department of Energy. ES/ER/TM-95/R4. November.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39:20-31.

Persaud, D., R., Jaagumagi, and A. Hayton. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.

U.S. Environmental Protection Agency (EPA). 1993. Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-b-dioxin Risks to Aquatic Life and Associated Wildlife. EPA/600/R-93/055. March.