CASE STUDY

Evaluation of Short-Term Risks Resulting from Dredge-Induced Resuspension and Deposition in the Buffalo River and Buffalo Ship Canal

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The Buffalo River Background

- Flows from the east and discharges into Lake Erie near the head of the Niagara River
- A Great Lakes Area of Concern

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Site Characteristics

- Buffalo River (lower 5.5 miles)
  - Slow-moving river (~0.1 m/s)
  - Small watershed with flashy responses
  - High suspended sediment load at high flows
- Ship Canal
  - Short (1.5 miles), dead-end, man-made canal
  - Virtually no watershed
  - Water exchange driven by fluctuating Lake Erie water elevation
  - Very low velocity (~0.002 m/s)
  - Low suspended sediment load

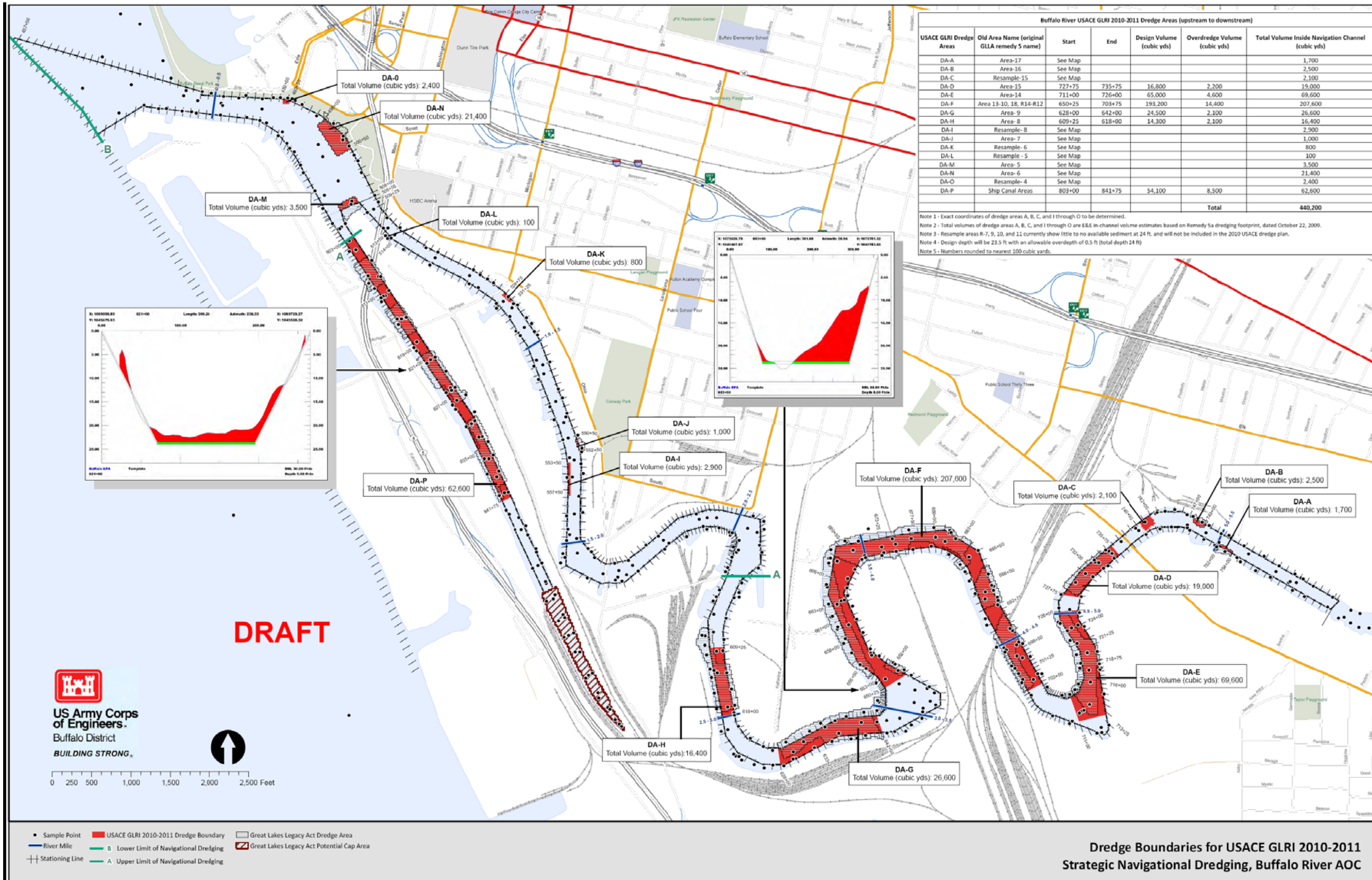
Project Background

- Support Remediation of Buffalo AOC under the Great Lakes Restoration Initiative by the USACE Buffalo District
- Dredge the Federal Navigation Channel to Authorized Depth of 22 ft with 2 ft of Overdredging in the delineated AOC
- 337,600 CY in Buffalo River including overdpeth
- 62,600 CY in Ship Channel including overdepth

Project Background

- COCs consist mainly of PCBs, PAHs, Lead, Mercury and Copper
- Bucket dredging utilized due to distance to the CDF
- Additional environmental dredging is planned for areas outside and below the channel

16 DMUs Divided into 45 Subunits



Buffalo River USACE GLRI 2010-2011 Dredge Areas (upstream to downstream)

USACE GLRI Dredge Areas	Old Area Name (original GLLA remedy 5 name)	Start	End	Design Volume (cubic yds)	Overdredge Volume (cubic yds)	Total Volume Inside Navigation Channel (cubic yds)
DA-A	Area-17	See Map				1,700
DA-B	Area-16	See Map				2,500
DA-C	Resample-15	See Map				2,100
DA-D	Area-15	727+75	735+75	16,800	2,200	19,000
DA-E	Area-14	711+00	726+00	65,000	4,600	69,600
DA-F	Area 13-10, 18, R14-R12	650+25	703+75	193,200	14,400	207,600
DA-G	Area- 9	628+00	642+00	24,500	2,100	26,600
DA-H	Area- 8	609+25	618+00	14,300	2,100	16,400
DA-I	Resample- 8	See Map				2,900
DA-J	Area- 7	See Map				1,000
DA-K	Resample- 6	See Map				800
DA-L	Resample - 5	See Map				100
DA-M	Area- 5	See Map				3,500
DA-N	Area- 6	See Map				21,400
DA-O	Resample- 4	See Map				2,400
DA-P	Ship Canal Areas	803+00	841+75	54,100	8,500	62,600
					Total	440,200

Note 1 - Exact coordinates of dredge areas A, B, C, and I through O to be determined.
Note 2 - Total volumes of dredge areas A, B, C, and I through O are E&E in-channel volume estimates based on Remedy 5a dredging footprint, dated October 22, 2009.
Note 3 - Resample areas R-7, 9, 10, and 11 currently show little to no available sediment at 24 ft. and will not be included in the 2010 USACE dredge plan.
Note 4 - Design depth will be 23.5 ft with an allowable overdepth of 0.5 ft (total depth 24 ft)
Note 5 - Numbers rounded to nearest 100 cubic yards.

Problem

Measured contaminant concentrations in pre-dredging sediment sampling led to concerns over:

- Dissolved concentrations in the water column resulting from release of contaminants during sediment resuspended during dredging
- Particulate associated contaminants settling in channel
- Deposition of sediments with particulate associated contaminants outside the channel

ERDC Study Objective

1. Determine the short-term environmental risks associated with suspended sediment and contaminants resulting from dredging the Buffalo River and Buffalo Ship Canal pursuant to Section 401 of the Clean Water Act
2. Determine the short-term environmental risk associated with the deposition of the dredge-induced plume outside of dredging areas
3. Determine controls to mitigate any unacceptable risks from resuspension impacts on water quality and sediment quality
4. Evaluate the feasibility of barge overflow to improve economic loads in light of risks predicted to result from resuspension

Risk Evaluation

- Short-term environmental risk in the water column
  - Model sediment resuspension and contaminant concentrations as a function of distance from the dredging operation
  - Compare model results to risk-based water quality criteria
- Short-term risk to sediment–dwelling organisms outside the dredging area
  - Model contaminant concentrations associated with settled solids outside the dredging area
  - Compare to preliminary sediment remediation goals (PRGs)
- Deposition in-channel is considered dredging residuals, modeled using RECOVERY under a parallel effort
- The Buffalo River and Buffalo Ship Canal (Dredging Reach DA-P) were modeled separately due to the significantly different flow regimes

Modeling Approach: Dredging Resuspension Rates

- Choose a conservative, “upper bound” resuspension rate
- Use ERDC tools to calculate a resuspension rate based on available
  - ➢ Grain size distribution data
  - ➢ In-situ sediment density
  - ➢ Assumed dredge operational characteristics
  - ➢ Assumed dredge production
- Model both resuspension rates as “user defined input” in DREDGE and carry results through post-processors
- Evaluate results, assess the need for controls

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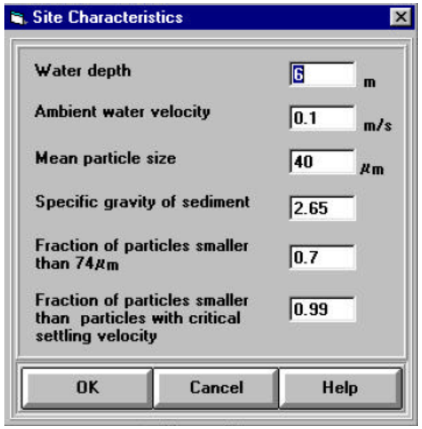
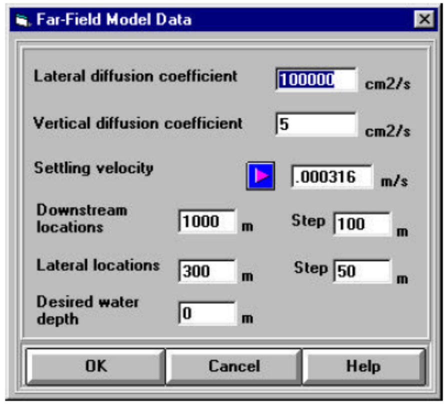
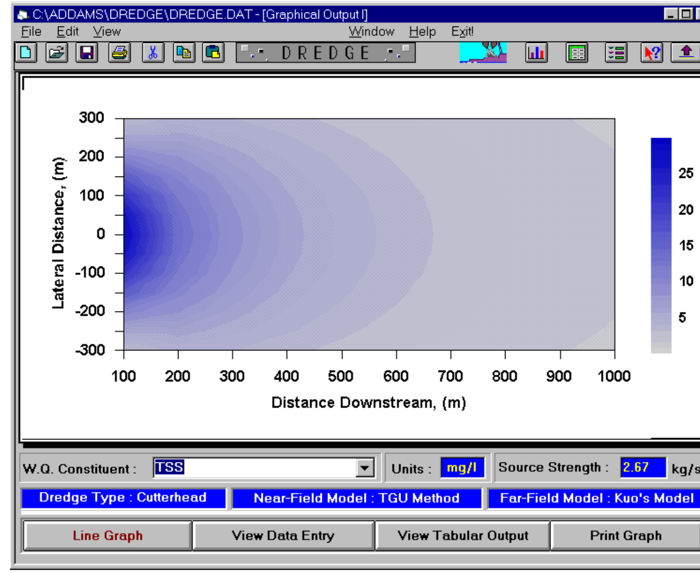
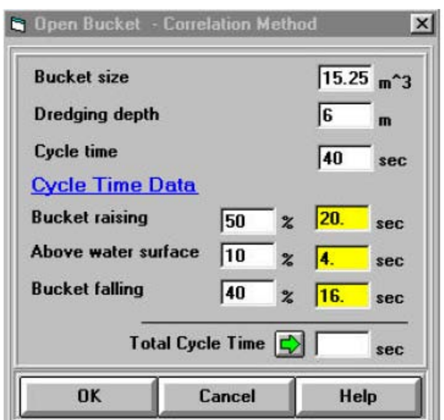
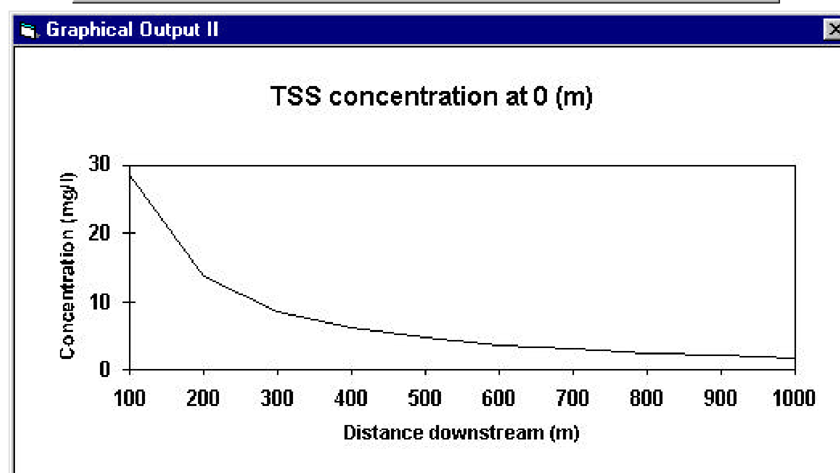
Modeling With DREDGE











Utilizing DREDGE Model Output for Dissolved Phase Concentrations and Deposition Masses

- The DREDGE Model does not
  - ➢ Predict dissolved phase contaminant concentrations
  - ➢ Compute masses or thicknesses of deposited sediment
  - ➢ Account for a channelized waterway
- All of these limitations needed to be addressed for the Buffalo River Project
- A suite of post-processing spreadsheets was written to accept DREDGE Model output and account for the limitations above

DREDGE Model Post-Processor Deposition Modeling

- A loss rate scenario is run twice
  - Once with no settling ($v_s = 0$)
  - Once with a settling velocity representative of the dredged material
- Comparison of the two plumes gives the change in suspended sediment mass at a distance (i.e. unit deposition)
- Couple with duration of dredging at a DMU to obtain mass deposited
- Use assumed dry density of deposited sediment to obtain depositional thickness

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DREDGE Model Post-Processor Contaminant Modeling

1. The bulk sediment contaminant concentration, C_s was input into dredge
2. The non-settling plume generated by DREDGE give the total contaminant concentration at distance, C_t
3. Results for the settling plume generated by DREDGE are exported to the post-processor, where a fraction dissolved, f_d, if computed
4. f_d is multiplied by C_t in the non-settling plume (2.) to obtain the dissolved contaminant concentration throughout the waterbody, C_d

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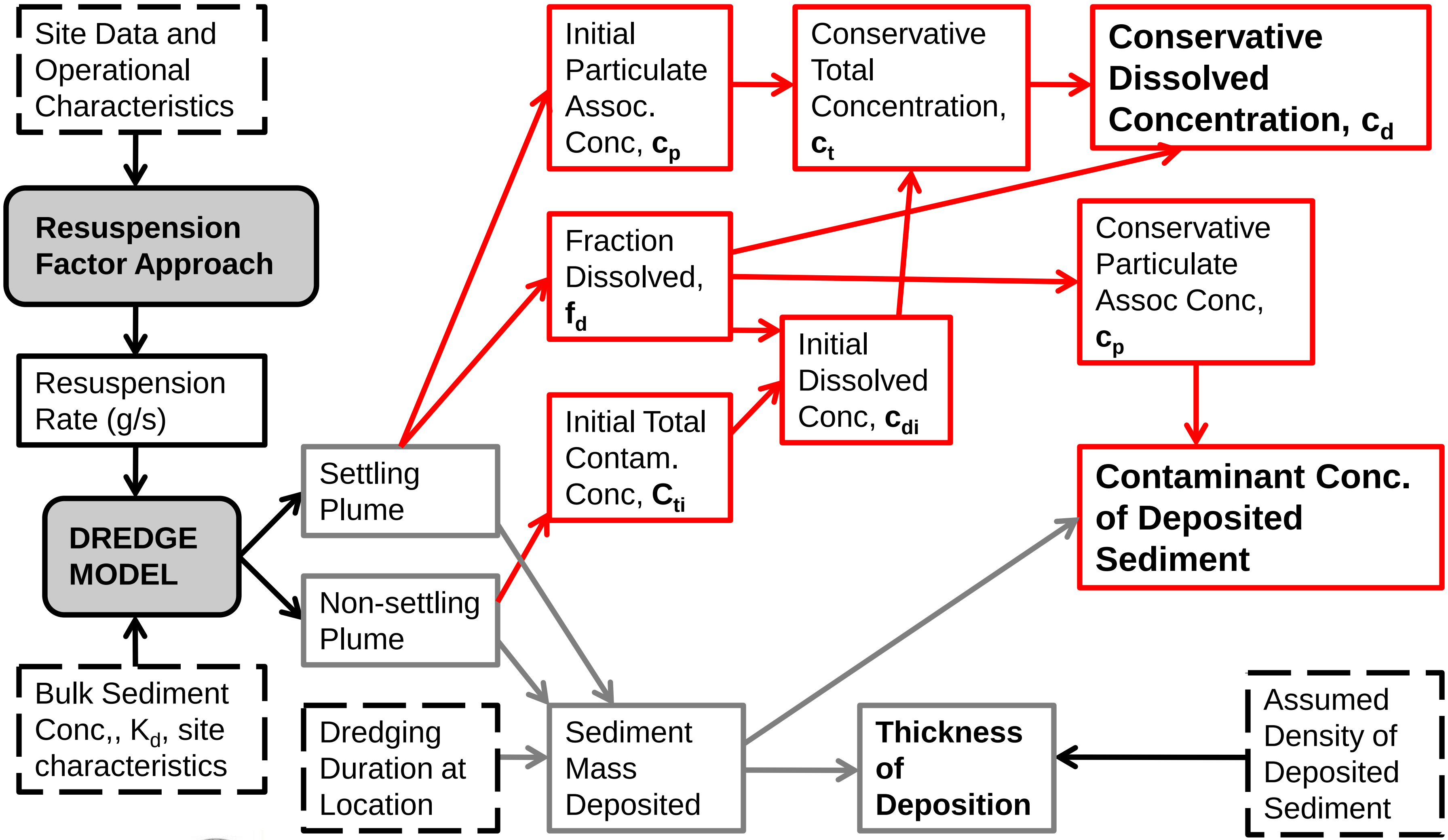
DREDGE Model Post-Processor Contaminant Modeling

5. It is assumed that the total contaminant concentrations, C_t, reported by DREDGE at distance are particulate associated, C_p
6. These conservative C_d and C_p concentrations were added together to compute a new, conservative total contaminant concentrations, C_t
7. f_d was then reapplied to the repartition and compute the final C_d and C_p distributions that were used in water quality and deposition evaluations

Contaminant Modeling

- Dissolved contaminant concentrations are exported and compared to screening criteria
- The mass of sediment deposited at a given distance and the mass of contaminant deposited at the same distance are exported to compute the contaminant concentration of deposited sediment in mg/kg, then compared to screening criteria

Modeling Flowchart



Model Inputs: Resuspension Rates

- 1% loss rate chosen for upper bound resuspension rate, based on typical assumptions regarding all parameters that are thought to influence resuspension for mechanical dredges in the absence of site-specific information
- 0.08% loss rate was calculated using the Hayes et al. (2007) Resuspension Factor Method. The lower calculated value is a result of the low liquidity/high compaction/high cohesion of Buffalo River sediments
- For both loss rates, a conservative production rate of 6000 cy/day was assumed
- Modeling of a sediment loss rate that incorporates barge overflow was to be performed if evaluation of the upper bound of dredging resuspension did not pose unacceptable risk

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Model Inputs: Organics Partitioning

- Partitioning coefficients developed from elutriate testing
  - More conservative than using pore water due to inclusion of colloidal fraction
  - More representative of monitoring protocols
- Release of dissolved organic carbon (DOC) included in the sediment resuspension and contaminant plume modeling

Model Inputs: Metals Partitioning

- The site-specific partitioning coefficients for the metallic constituents were developed from modified elutriate test results
  - Coefficients assumed that the metals will be released in an oxic environment, increasing the metal solubility and availability.
  - This produced conservative predictions for metal concentrations in the water column, while limiting the concentrations predicted in the residuals.
- Metals assumptions are justified by
  - dissolved contaminants in the water column driving short-term risk due to bioavailability
  - risk associated with dredging residuals was performed as a separate task using RECOVERY Model analysis using conservative sediment concentrations

Buffalo River Water Quality Analysis

- Based on the screening of contaminants performed for disposal of the sediment in a CDF, eight COCs were identified for further modeling:
  - Copper
  - Lead
  - Mercury
  - Benzo(a)anthracene
  - Fluorene
  - Phenanthrene
  - Total PAHs
  - Total PCBs
- Modified elutriate results for the eight constituents exceeded the National Recommended Water Quality Criteria Criterion Maximum Concentrations (CMCs) or NYS Water Quality Standards & Guidance for Fish Survival

Buffalo River Water Quality Analysis: Approach

- For short term risk worst case estimate, maximum area average concentrations measured for dredge units in the Buffalo River and Buffalo Ship Canal were used at both resuspension rates
- These dissolved concentration results were used to predict dissolved concentrations resulting from the dredging of each individual dredging area by linearly scaling the area average sediment concentrations
- The contaminant contribution from dissolved organic carbon in the sediment pore water was added to the results of the water quality analysis to determine a total dissolved concentration
- Two distances were considered for exceedances of CMCs, 150 m and 500 m.

Parameters for DREDGE Model and Post-Processor

Model:	
Parameter	**Assumption**
1	Steady State, Depth Averaged, Line Source for Sediment Release
2	Ambient Current = 0.1 m/s Buffalo River, 0.002 m/s Buffalo Ship Channel
3	Water Depth = 7 m
4	River Width = 80 m
5	15 cy Dredge Bucket
6	Bucket 80% full after sediment capture
6	6000 cy/day Dredge Production
7	70 second Dredge Cycle Time
8	Worst Case Sediment Contaminant Concentrations for the River and Side Channel (DA-P)
	were used to calculate Concentrations at the Mixing Zone Boundry
9	Characteristic Particle Size of 10um used to calculate Stokes settling (0.000079 m/s), based
	on aggregate (floc) size in fine-grained sediment beds comprised of approximately 25% clay
10	Equilibrium Contaminant Partitioning
11	Sediment In-Situ Dry Density = 1337 kg/m^3
12	Sediment percent fines = 95%
13	Waterway Lateral Diffusivity = 42 cm^2/s for Buffalo River, 0.84 cm2/s for Buffalo Ship Channel
14	For 1% Loss (1.641 kg/s), assume liquidity index =1.82, open navigation bucket,
	and bucket ascent and descent velocities of 1.6 and 1.2 m/s, respectively
15	For 0.08% Loss (0.131 kg/s), calculated a liquidity index of 1.37, assumed bucket ascent
	and descent velocities of 0.7 and 0.6 m/s, respectively
16	Pore Water DOC Concentration = 60 mg/L
17	Sediment volume lost @ 1% loss rate = 2 L/s; @ 0.08% loss rate, 0.13 L/s

Buffalo Ship Canal Water Quality Analysis: Approach

A similar analysis was conducted for the Buffalo Ship Canal except that

- The analysis was done on a daily basis due to the extremely low velocities in the canal
- The ambient velocity was estimated to be 0.002 m/sec and bidirectional, leading to a calculated lateral diffusivity of 0.84 cm^2/sec
- The mass release rates were different due to a different ambient velocity (0.673 kg/sec and 0.054 kg/sec for loss rates of 1% and 0.08%, respectively)

Buffalo River Post Processor Dissolved Contaminant Results: Copper

In Meters	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510
-36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000201
-30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.000803
-28	0	0	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.001808	0.003013
-26	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.002209	0.004017	0.006829	0.010846
-24	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.00241	0.005021	0.009038	0.015063	0.023298	0.034545
-22	0	0	0	0	0	0	0	0.000201	0.001004	0.002611	0.005825	0.011448	0.020285	0.033139	0.050611	0.073102	0.101013
-20	0	0	0	0	0	0	0.000603	0.002008	0.005825	0.013457	0.02631	0.045791	0.073303	0.109045	0.153818	0.207418	0.269238
-18	0	0	0	0	0.000201	0.001004	0.00462	0.013457	0.03113	0.060451	0.103423	0.161046	0.233513	0.320414	0.420333	0.531856	0.653368
-16	0	0	0	0.000201	0.002008	0.010243	0.031532	0.073102	0.139564	0.232911	0.35212	0.495358	0.658988	0.839174	1.032285	1.234696	1.443389
-14	0	0	0.000201	0.003615	0.022093	0.073905	0.172891	0.323827	0.523641	0.765034	1.03851	1.334387	1.644212	1.960952	2.2788	2.593363	2.901461
-12	0	0	0.005021	0.046795	0.174497	0.412716	0.754218	1.174288	1.645454	2.142756	2.647133	3.144614	3.626074	4.085415	4.519347	4.925982	5.305409
-10	0	0.004017	0.091576	0.414523	0.999079	1.76524	2.618135	3.486114	4.32459	5.10899	5.828191	6.479025	7.063236	7.584498	8.047799	8.458667	8.82219
-8	0.000402	0.14619	0.990073	2.465427	4.151371	5.773734	7.217878	8.45544	9.49536	10.36022	11.07527	11.66436	12.14833	12.5447	12.86831	13.13099	13.34315
-6	0.093584	2.345148	6.263437	9.789349	12.46755	14.40153	15.77403	16.73886	17.40989	17.86779	18.1702	18.35763	18.45988	18.49803	18.48796	18.44149	18.36759
-4	4.914796	16.72463	22.97774	25.82036	27.0188	27.39988	27.35754	27.09031	26.70395	26.25707	25.78294	25.30091	24.82255	24.35461	23.90051	23.46236	23.04094
-2	49.93222	52.31394	48.97899	45.53323	42.54878	40.02067	37.86935	36.01907	34.40999	32.99579	31.74104	30.61876	29.60721	28.68951	27.85239	27.08448	26.37704
0	102.1554	75.22415	62.56336	54.78722	49.37892	45.33234	42.15485	39.57264	37.41963	35.58793	34.00461	32.61792	31.38999	30.29253	29.30394	28.40726	27.58888
2	49.93222	52.31394	48.97899	45.53323	42.54878	40.02067	37.86935	36.01907	34.40999	32.99579	31.74104	30.61876	29.60721	28.68951	27.85239	27.08448	26.37704
4	4.914796	16.72463	22.97774	25.82036	27.0188	27.39988	27.35754	27.09031	26.70395	26.25707	25.78294	25.30091	24.82255	24.35461	23.90051	23.46236	23.04094
6	0.093584	2.345148	6.263437	9.789349	12.46755	14.40153	15.77403	16.73886	17.40989	17.86779	18.1702	18.35763	18.45988	18.49803	18.48796	18.44149	18.36759
8	0.000402	0.14619	0.990073	2.465427	4.151371	5.773734	7.217878	8.45544	9.49536	10.36022	11.07527	11.66436	12.14833	12.5447	12.86831	13.13099	13.34315
10	0	0.004017	0.091576	0.414523	0.999079	1.76524	2.618135	3.486114	4.32459	5.10899	5.828191	6.479025	7.063236	7.584498	8.047799	8.458667	8.82219
12	0	0	0.005021	0.046795	0.174497	0.412716	0.754218	1.174288	1.645454	2.142756	2.647133	3.144614	3.626074	4.085415	4.519347	4.925982	5.305409
14	0	0	0.000201	0.003615	0.022093	0.073905	0.172891	0.323827	0.523641	0.765034	1.03851	1.334387	1.644212	1.960952	2.2788	2.593363	2.901461
16	0	0	0	0.000201	0.002008	0.010243	0.031532	0.073102	0.139564	0.232911	0.35212	0.495358	0.658988	0.839174	1.032285	1.234696	1.443389
18	0	0	0	0	0.000201	0.001004	0.00462	0.013457	0.03113	0.060451	0.103423	0.161046	0.233513	0.320414	0.420333	0.531856	0.653368
20	0	0	0	0	0	0	0.000603	0.002008	0.005825	0.013457	0.02631	0.045791	0.073303	0.109045	0.153818	0.207418	0.269238
22	0	0	0	0	0	0	0	0.000201	0.001004	0.002611	0.005825	0.011448	0.020285	0.033139	0.050611	0.073102	0.101013
24	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.00241	0.005021	0.009038	0.015063	0.023298	0.034545
26	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.002209	0.004017	0.006829	0.010846
28	0	0	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.001004	0.001808	0.003013
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000201	0.000402	0.000803
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000201
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- 1% Loss
- Results from centerline concen-tration used for screening
- Copper Criteria 18 ug/L

Buffalo Ship Channel Post Processor Dissolved Contaminant Results: Copper

In Meters	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510
-36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000469
-32	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000376	0.000845	0.001784
-30	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000376	0.000845	0.001972	0.004038	0.007512
-28	0	0	0	0	0	0	0	0	0	9.39E-05	0.000282	0.000751	0.001972	0.004507	0.009202	0.016995	0.0292
-26	0	0	0	0	0	0	0	0	9.39E-05	0.000563	0.00169	0.004601	0.010423	0.020938	0.038307	0.064872	0.102976
-24	0	0	0	0	0	0	0	0.000282	0.001127	0.003944	0.010516	0.023943	0.047788	0.086365	0.143698	0.223987	0.330669
-22	0	0	0	0	0	9.39E-05	0.000469	0.002441	0.008826	0.024224	0.055297	0.109449	0.19463	0.31782	0.484743	0.699851	0.965674
-20	0	0	0	0	9.39E-05	0.000845	0.005071	0.019718	0.055954	0.12812	0.25126	0.438652	0.700362	1.042763	1.468165	1.975678	2.561716
-18	0	0	0	9.39E-05	0.001315	0.010329	0.044032	0.129713	0.298492	0.577983	0.9873	1.535804	2.223343	3.042622	3.981051	5.023127	6.151877
-16	0	0	0	0.00169	0.019624	0.097435	0.30223	0.699203	1.33212	2.215764	3.340577	4.67994	6.198017	7.855849	9.615334	11.44214	13.30588
-14	0	0	0.001502	0.033988	0.212335	0.707277	1.647606	3.07161	4.939643	7.167257	9.655321	12.30894	15.04659	17.8028	20.52809	23.18619	25.75219
-12	0	0.000469	0.047881	0.447469	1.663037	3.90384	7.058269	10.85546	15.00923	19.2853	23.5167	27.59531	31.45759	35.07083	38.42282	41.51432	44.3539
-10	0	0.039433	0.875807	3.919662	9.272258	16.0016	23.151	30.10181	36.54374	42.36112	47.54151	52.12052	56.15261	59.69645	62.8084	65.53993	67.93701
-8	0.003474	1.395112	9.192508	21.85489	34.99879	46.53455	56.06235	63.79597	70.07255	75.1967	79.40886	82.89119	85.781	88.1831	90.17898	91.83339	93.19879
-6	0.893877	20.92817	49.86901	70.8717	84.43629	93.33394	99.43844	103.8245	107.0954	109.5953	111.5272	113.0177	114.1509	114.9876	115.5744	115.9493	116.1446
-4	41.16652	105.6805	126.7609	133.6704	135.9303	136.5963	136.7479	136.7598	136.7358	136.6794	136.5644	136.3638	136.0593	135.6433	135.1168	134.4875	133.7667
-2	199.9873	197.0436	185.9364	176.1382	168.5741	163.0373	159.0939	156.3037	154.2907	152.7625	151.5073	150.3809	149.2922	148.1882	147.0423	145.8451	144.5979
0	258.8244	227.0616	205.4669	190.1226	179.2333	171.5945	166.284	162.5825	159.9431	157.9657	156.3703	154.9709	153.6506	152.3413	151.0076	149.6354	148.2231
2	199.9873	197.0436	185.9364	176.1382	168.5741	163.0373	159.0939	156.3037	154.2907	152.7625	151.5073	150.3809	149.2922	148.1882	147.0423	145.8451	144.5979
4	41.16652	105.6805	126.7609	133.6704	135.9303	136.5963	136.7479	136.7598	136.7358	136.6794	136.5644	136.3638	136.0593	135.6433	135.1168	134.4875	133.7667
6	0.893877	20.92817	49.86901	70.8717	84.43629	93.33394	99.43844	103.8245	107.0954	109.5953	111.5272	113.0177	114.1509	114.9876	115.5744	115.9493	116.1446
8	0.003474	1.395112	9.192508	21.85489	34.99879	46.53455	56.06235	63.79597	70.07255	75.1967	79.40886	82.89119	85.781	88.1831	90.17898	91.83339	93.19879
10	0	0.039433	0.875807	3.919662	9.272258	16.0016	23.151	30.10181	36.54374	42.36112	47.54151	52.12052	56.15261	59.69645	62.8084	65.53993	67.93701
12	0	0.000469	0.047881	0.447469	1.663037	3.90384	7.058269	10.85546	15.00923	19.2853	23.5167	27.59531	31.45759	35.07083	38.42282	41.51432	44.3539
14	0	0	0.001502	0.033988	0.212335	0.707277	1.647606	3.07161	4.939643	7.167257	9.655321	12.30894	15.04659	17.8028	20.52809	23.18619	25.75219
16	0	0	0	0.00169	0.019624	0.097435	0.30223	0.699203	1.33212	2.215764	3.340577	4.67994	6.198017	7.855849	9.615334	11.44214	13.30588
18	0	0	0	9.39E-05	0.001315	0.010329	0.044032	0.129713	0.298492	0.577983	0.9873	1.535804	2.223343	3.042622	3.981051	5.023127	6.151877
20	0	0	0	0	9.39E-05	0.000845	0.005071	0.019718	0.055954	0.12812	0.25126	0.438652	0.700362	1.042763	1.468165	1.975678	2.561716
22	0	0	0	0	0	9.39E-05	0.000469	0.002441	0.008826	0.024224	0.055297	0.109449	0.19463	0.31782	0.484743	0.699851	0.965674
24	0	0	0	0	0	0	0	0.000282	0.001127	0.003944	0.010516	0.023943	0.047788	0.086365	0.143698	0.223987	0.330669
26	0	0	0	0	0	0	0	0	9.39E-05	0.000563	0.00169	0.004601	0.010423	0.020938	0.038307	0.064872	0.102976
28	0	0	0	0	0	0	0	0	0	9.39E-05	0.000282	0.000751	0.001972	0.004507	0.009202	0.016995	0.0292
30	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000376	0.000845	0.001972	0.004038	0.007512
32	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000376	0.000845	0.001784
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000469
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- 1% Loss
- Copper Criteria 18 ug/L

Buffalo Ship Channel Post Processor Dissolved Contaminant Results: Copper

In Meters	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510
-36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188
-30	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000282	0.000563
-28	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000376	0.000751	0.001315	0.002347
-26	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000376	0.000845	0.00169	0.003099	0.005164	0.008263
-24	0	0	0	0	0	0	0	0	9.39E-05	0.000282	0.000845	0.001878	0.00385	0.006855	0.011455	0.017934	0.026384
-22	0	0	0	0	0	0	0	0.000188	0.000657	0.001972	0.004413	0.008732	0.015587	0.025351	0.038776	0.055955	0.077262
-20	0	0	0	0	0	9.39E-05	0.000376	0.001596	0.004507	0.010235	0.020093	0.035021	0.056048	0.083456	0.117708	0.158615	0.205983
-18	0	0	0	0	9.39E-05	0.000845	0.003474	0.010329	0.023849	0.046192	0.079044	0.123149	0.178685	0.244987	0.321385	0.406742	0.499642
-16	0	0	0	9.39E-05	0.001596	0.007793	0.02413	0.055954	0.10682	0.178118	0.269353	0.378805	0.503822	0.641469	0.78901	0.943618	1.102851
-14	0	0	9.39E-05	0.002723	0.016995	0.05661	0.132245	0.247594	0.400417	0.584811	0.793577	1.019444	1.255832	1.497398	1.73976	1.979481	2.214073
-12	0	0	0.00385	0.035771	0.133463	0.315623	0.576427	0.897192	1.256439	1.635362	2.019398	2.397996	2.764098	3.113276	3.442873	3.751887	4.039867
-10	0	0.003193	0.070126	0.317023	0.763397	1.347441	1.996416	2.655785	3.291848	3.88622	4.430822	4.923501	5.365586	5.759954	6.110584	6.421572	6.696779
-8	0.000282	0.111886	0.756495	1.879957	3.158247	4.383641	5.471473	6.402106	7.183759	7.833939	8.372043	8.816021	9.181343	9.481139	9.726377	9.926096	10.08762
-6	0.071535	1.788811	4.751712	7.389905	9.378891	10.81055	11.8274	12.54555	13.04887	13.39638	13.62963	13.77801	13.86292	13.89973	13.90022	13.87288	13.82425
-4	3.73954	12.52696	17.0474	19.07322	19.93157	20.21924	20.2123	20.0474	19.79672	19.50001	19.1805	18.85171	18.52205	18.19648	17.87816	17.56881	17.26953
-2	36.18956	37.52356	35.13406	32.76481	30.74669	29.0496	27.6076	26.36469	25.27865	24.31833	23.46041	22.68741	21.98588	21.3451	20.75676	20.214	19.7112
0	70.29768	52.54401	44.11647	38.94903	35.36238	32.67844	30.56536	28.84002	27.39231	26.15196	25.07163	24.11827	23.26787	22.50257	21.8087	21.17552	20.59463
2	36.18956	37.52356	35.13406	32.76481	30.74669	29.0496	27.6076	26.36469	25.27865	24.31833	23.46041	22.68741	21.98588	21.3451	20.75676	20.214	19.7112
4	3.73954	12.52696	17.0474	19.07322	19.93157	20.21924	20.2123	20.0474	19.79672	19.50001	19.1805	18.85171	18.52205	18.19648	17.87816	17.56881	17.26953
6	0.071535	1.788811	4.751712	7.389905	9.378891	10.81055	11.8274	12.54555	13.04887	13.39638	13.62963	13.77801	13.86292	13.89973	13.90022	13.87288	13.82425
8	0.000282	0.111886	0.756495	1.879957	3.158247	4.383641	5.471473	6.402106	7.183759	7.833939	8.372043	8.816021	9.181343	9.481139	9.726377	9.926096	10.08762
10	0	0.003193	0.070126	0.317023	0.763397	1.347441	1.996416	2.655785	3.291848	3.88622	4.430822	4.923501	5.365586	5.759954	6.110584	6.421572	6.696779
12	0	0	0.00385	0.035771	0.133463	0.315623	0.576427	0.897192	1.256439	1.635362	2.019398	2.397996	2.764098	3.113276	3.442873	3.751887	4.039867
14	0	0	9.39E-05	0.002723	0.016995	0.05661	0.132245	0.247594	0.400417	0.584811	0.793577	1.019444	1.255832	1.497398	1.73976	1.979481	2.214073
16	0	0	0	9.39E-05	0.001596	0.007793	0.02413	0.055954	0.10682	0.178118	0.269353	0.378805	0.503822	0.641469	0.78901	0.943618	1.102851
18	0	0	0	0	9.39E-05	0.000845	0.003474	0.010329	0.023849	0.046192	0.079044	0.123149	0.178685	0.244987	0.321385	0.406742	0.499642
20	0	0	0	0	0	9.39E-05	0.000376	0.001596	0.004507	0.010235	0.020093	0.035021	0.056048	0.083456	0.117708	0.158615	0.205983
22	0	0	0	0	0	0	0	0.000188	0.000657	0.001972	0.004413	0.008732	0.015587	0.025351	0.038776	0.055955	0.077262
24	0	0	0	0	0	0	0	0	9.39E-05	0.000282	0.000845	0.001878	0.00385	0.006855	0.011455	0.017934	0.026384
26	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000376	0.000845	0.00169	0.003099	0.005164	0.008263
28	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000376	0.000751	0.001315	0.002347
30	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188	0.000282	0.000563
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9.39E-05	0.000188
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- 0.08% Loss
- Copper Criteria 18 ug/L

Water Quality Results at 150 m from Dredging

Contaminant	Copper, mg/kg		Lead, mg/kg		Mercury, mg/kg		PCB, Total, mg/kg O.C.		PAH, Total, mg/kg O.C.		Fluorene, mg/kg O.C.		Phenanthrene, mg/kg O.C.		Benz(a)anthracene, mg/kg O.C.	
Buffalo River Maximum Sediment Concentration (BR-MAX C)	200.85		245.65		3.90		53.00		2500.00		260.00		550.00		110.00	
Buffalo Ship Channel (DA-P) Maximum Sediment Concentration (BSC-MAX C)	93.90		112.83		1.25		10.45		779.80		16.72		70.08		59.69	
Concentrations in ug/L	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss
Criteria or Screening Value	**13**		**63**		**1.4**		**2**		**25**		**4.8**		**45**		**0.23**	
BR-MAX C	**49.40**	4.24	57.50	5.16	0.91	8.19E-02	2.64E-04	2.18E-03	**151.12**	**41.68**	1.47	1.18	0.43	0.40	2.18E-03	2.18E-03
BSC-MAX C	**179.23**	**35.36**	**147.40**	38.73	**1.70**	4.46E-01	1.59E-05	2.07E-03	**42.28**	**34.50**	0.15	0.14	0.29	0.28	2.07E-03	2.07E-03
DA-A	10.16	0.87	7.30	0.66	0.01	1.30E-03	2.98E-06	2.47E-05	13.90	3.83	0.01	0.01	0.01	0.01	1.33E-03	1.33E-03
DA-B	0.00	0.00	7.49	0.67	0.02	2.01E-03	2.76E-05	2.29E-04	11.91	3.29	0.03	0.02	0.01	0.01	1.02E-03	1.02E-03
DA-C																
DA-D1	**17.94**	1.54	16.00	1.44	0.06	4.94E-03	1.62E-05	1.34E-04	**33.26**	9.17	0.07	0.05	0.04	0.03	2.80E-03	2.79E-03
DA-D2	**13.43**	1.15	11.08	0.99	0.03	2.67E-03	9.52E-06	7.89E-05	12.69	3.50	0.03	0.02	0.01	0.01	1.01E-03	1.01E-03
DA-E1	**19.24**	1.65	12.57	1.13	0.04	3.21E-03	1.37E-05	1.14E-04	14.01	3.86	0.02	0.02	0.02	0.02	1.37E-03	1.37E-03
DA-E2	10.72	0.92	8.29	0.74	0.02	1.41E-03	3.23E-06	2.68E-05	10.88	3.00	0.01	0.01	0.01	0.01	6.56E-04	6.54E-04
DA-E3	7.22	0.62	5.98	0.54	0.02	1.35E-03	2.73E-06	2.26E-05	6.89	1.90	0.01	0.00	0.01	0.01	6.84E-04	6.83E-04
DA-E4	**17.09**	1.47	18.73	1.68	0.07	6.28E-03	2.57E-05	2.13E-04	**119.27**	**32.89**	0.54	0.44	0.17	0.15	8.01E-03	7.99E-03
DA-E5	**49.40**	4.24	22.82	2.05	0.05	4.32E-03	8.37E-06	6.94E-05	20.91	5.77	0.06	0.04	0.02	0.02	1.65E-03	1.65E-03
DA-E6	9.41	0.81	6.99	0.63	0.02	1.45E-03	4.04E-06	3.35E-05	5.82	1.61	0.02	0.01	0.01	0.00	4.70E-04	4.69E-04
DA-F1	12.92	1.11	11.54	1.04	0.06	5.51E-03	1.50E-05	1.24E-04	12.91	3.56	0.02	0.02	0.01	0.01	1.20E-03	1.20E-03
DA-F10	**18.64**	1.60	21.00	1.88	0.04	3.22E-03	2.83E-05	2.35E-04	**35.04**	9.66	0.06	0.05	0.05	0.04	3.49E-03	3.48E-03
DA-F11	11.73	1.01	38.95	3.50	0.11	9.78E-03	1.25E-04	1.04E-03	**51.09**	14.09	0.12	0.09	0.09	0.08	5.30E-03	5.29E-03
DA-F12	6.55	0.56	5.37	0.48	0.02	1.51E-03	3.38E-06	2.80E-05	8.51	2.35	0.01	0.01	0.01	0.01	8.49E-04	8.46E-04
DA-F13	**18.75**	1.61	33.04	2.96	0.16	1.40E-02	1.16E-05	9.63E-05	**43.47**	11.99	0.17	0.14	0.07	0.06	4.40E-03	4.39E-03
DA-F14	**14.03**	1.20	9.41	0.84	0.01	1.28E-03	7.91E-06	6.56E-05	15.94	4.40	0.03	0.03	0.02	0.02	1.33E-03	1.32E-03
DA-F15	**30.17**	2.59	21.52	1.93	0.10	9.18E-03	2.31E-05	1.92E-04	**45.78**	12.63	0.09	0.07	0.04	0.04	4.06E-03	4.05E-03
DA-F16	11.81	1.01	12.38	1.11	0.03	2.76E-03	7.83E-06	6.49E-05	8.64	2.38	0.02	0.01	0.01	0.01	8.57E-04	8.55E-04
DA-F17	**19.58**	1.68	14.18	1.27	0.04	3.20E-03	1.92E-05	1.59E-04	21.40	5.90	0.03	0.03	0.03	0.02	2.03E-03	2.03E-03
DA-F2	**42.83**	3.67	15.39	1.38	0.04	3.23E-03	2.43E-05	2.02E-04	16.93	4.67	0.02	0.02	0.02	0.02	1.64E-03	1.64E-03
DA-F3	10.40	0.89	9.44	0.85	0.01	1.14E-03	6.69E-06	5.55E-05	9.97	2.75	0.01	0.01	0.01	0.01	7.42E-04	7.40E-04
DA-F4	11.51	0.99	12.80	1.15	0.03	2.97E-03	2.57E-05	2.13E-04	24.75	6.83	0.05	0.04	0.03	0.03	2.66E-03	2.65E-03
DA-F5	**29.76**	2.55	4.54	0.41	0.01	1.26E-03	0.00E+00	0.00E+00	0.40	0.11	0.00	0.00	0.00	0.00	6.37E-05	6.35E-05
DA-F6	**39.85**	3.42	23.97	2.15	0.20	1.83E-02	4.39E-05	3.64E-04	**37.02**	10.21	0.07	0.06	0.06	0.06	2.38E-03	2.37E-03
DA-F7	9.53	0.82	8.86	0.80	0.03	2.31E-03	1.14E-05	9.45E-05	14.05	3.88	0.02	0.02	0.02	0.01	1.28E-03	1.28E-03
DA-F8	**36.40**	3.12	13.25	1.19	0.04	3.68E-03	2.18E-05	1.81E-04	21.90	6.04	0.03	0.02	0.03	0.03	2.34E-03	2.33E-03
DA-F9	**23.20**	1.99	34.35	3.08	0.19	1.68E-02	4.97E-05	4.12E-04	**48.55**	13.39	0.12	0.10	0.08	0.07	4.70E-03	4.68E-03
DA-G1	9.41	0.81	9.44	0.85	0.03	2.38E-03	1.29E-05	1.07E-04	16.00	4.41	0.04	0.03	0.02	0.02	1.47E-03	1.47E-03
DA-G2	8.94	0.77	14.33	1.29	0.07	5.97E-03	1.22E-05	1.01E-04	**31.12**	8.58	0.10	0.08	0.05	0.05	3.97E-03	3.96E-03
DA-G3	7.40	0.64	7.84	0.70	0.03	2.81E-03	1.24E-05	1.02E-04	**56.21**	15.50	0.21	0.17	0.04	0.04	7.26E-03	7.24E-03
DA-H1	10.70	0.92	13.83	1.24	0.04	3.32E-03	5.82E-05	4.82E-04	21.13	5.83	0.07	0.06	0.03	0.02	1.85E-03	1.84E-03
DA-H2	**13.34**	1.14	14.46	1.30	0.03	3.00E-03	5.35E-05	4.44E-04	16.42	4.53	0.03	0.02	0.02	0.02	1.52E-03	1.52E-03
DA-I	**14.46**	1.24	18.76	1.68	0.07	5.90E-03	2.19E-05	1.82E-04	**62.12**	17.13	0.07	0.06	0.08	0.08	6.69E-03	6.67E-03
DA-J	**22.41**	1.92	26.26	2.36	0.31	2.80E-02	6.28E-05	5.20E-04	**51.41**	14.18	0.16	0.12	0.07	0.07	4.69E-03	4.68E-03
DA-K	**41.48**	3.56	57.50	5.16	0.65	5.79E-02	1.89E-04	1.57E-03	**59.96**	16.54	0.29	0.23	0.12	0.11	4.97E-03	4.96E-03
DA-L	**37.87**	3.25	47.99	4.31	0.91	8.19E-02	1.49E-05	1.24E-04	**151.12**	**41.68**	1.47	1.18	0.43	0.40	1.05E-02	1.04E-02
DA-M	**18.40**	1.58	13.75	1.23	0.06	5.53E-03	2.91E-05	2.41E-04	19.86	5.48	0.06	0.05	0.02	0.02	1.67E-03	1.67E-03
DA-N	**20.69**	1.77	49.98	4.48	0.18	1.65E-02	2.85E-05	2.36E-04	**28.70**	7.92	0.05	0.04	0.05	0.05	3.66E-03	3.65E-03
DA-O	**28.53**	2.45	31.83	2.86	0.77	6.93E-02	2.63E-04	2.18E-03	**72.54**	20.01	0.28	0.22	0.15	0.14	7.04E-03	7.02E-03
DA-P1	**95.25**	**18.79**	**123.82**	32.54	0.40	1.06E-01	1.23E-05	1.60E-03	20.12	16.41	0.05	0.00	0.15	0.00	3.76E-03	1.99E-06
DA-P2	**179.23**	**35.36**	**147.40**	38.73	**1.70**	4.46E-01	1.59E-05	2.07E-03	**34.64**	**28.26**	0.11	0.00	0.22	0.00	6.66E-03	3.54E-06
DA-P3	**87.24**	**17.21**	**65.22**	17.14	0.35	9.20E-02	8.31E-06	1.08E-03	21.06	17.18	0.08	0.00	0.18	0.00	5.95E-03	3.15E-06
DA-P4	**144.82**	**28.57**	**115.74**	30.41	0.87	2.28E-01	1.04E-05	1.35E-03	24.03	19.61	0.07	0.00	0.12	0.00	4.79E-03	2.54E-06
DA-P5	**111.80**	**22.06**	**123.12**	32.35	1.16	3.05E-01	9.59E-06	1.25E-03	**42.28**	**34.50**	0.15	0.00	0.29	0.00	8.08E-03	4.28E-06

Parameter	Units	Buffalo River	Buffalo Ship Canal
1 % Loss Rate	kg/s	1.64	0.67
0.08 % Loss Rate	kg/s	0.13	0.054
TSS @ 150 m 1% Loss	mg/L	263.47	**2316**
TSS @ 150 m 0.08% Loss	mg/L	20.80	184.95

Water Quality Results at 500 m from Dredging

Contaminant	Copper, mg/kg		Lead, mg/kg		Mercury, mg/kg		PCB, Total, mg/kg O.C.		PAH, Total, mg/kg O.C.		Fluorene, mg/kg O.C.		Phenanthrene, mg/kg O.C.		Benz(a)anthracene, mg/kg O.C.	
Buffalo River Maximum Sediment Concentration (BR-MAX C)	200.85		245.65		3.90		53.00		2500.00		260.00		550.00		110.00	
Buffalo Ship Channel (DA-P) Maximum Sediment Concentration (BSC-MAX C)	93.90		112.83		1.25		10.45		779.80		16.72		70.08		59.69	
Concentrations in ug/L	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss	1% Loss	0.08% Loss
Criteria or Screening Value	13		63		1.4		2		25		4.8		45		0.23	
BR-MAX C	**27.60**	2.30	32.79	2.81	0.52	4.46E-02	6.52E-05	6.52E-05	**125.25**	24.92	1.43	0.98	0.43	0.36	8.34E-03	8.29E-03
BSC-MAX C	**148.22**	**20.59**	**130.13**	23.62	**1.50**	2.72E-01	1.59E-05	1.59E-05	**34.95**	**29.89**	0.14	0.11	0.28	0.25	8.08E-03	8.04E-03
DA-A	5.67	0.47	4.16	0.36	0.01	7.09E-04	7.34E-07	7.31E-07	11.52	2.29	0.01	0.01	0.01	0.01	1.06E-03	1.05E-03
DA-B	0.00	0.00	4.27	0.37	0.01	1.09E-03	6.80E-06	6.77E-06	9.87	1.96	0.03	0.02	0.01	0.01	8.14E-04	8.08E-04
DA-C																
DA-D1	10.02	0.84	9.13	0.78	0.03	2.69E-03	3.99E-06	3.97E-06	**27.56**	5.49	0.07	0.05	0.04	0.03	2.23E-03	2.22E-03
DA-D2	7.50	0.63	6.32	0.54	0.02	1.45E-03	2.34E-06	2.33E-06	10.52	2.09	0.02	0.02	0.01	0.01	8.07E-04	8.02E-04
DA-E1	10.75	0.90	7.17	0.61	0.02	1.75E-03	3.38E-06	3.37E-06	11.61	2.31	0.02	0.02	0.02	0.01	1.09E-03	1.09E-03
DA-E2	5.99	0.50	4.73	0.40	0.01	7.66E-04	7.95E-07	7.92E-07	9.02	1.79	0.01	0.01	0.01	0.01	5.23E-04	5.20E-04
DA-E3	4.03	0.34	3.41	0.29	0.01	7.36E-04	6.73E-07	6.70E-07	5.71	1.14	0.01	0.00	0.01	0.01	5.46E-04	5.42E-04
DA-E4	9.55	0.80	10.68	0.91	0.04	3.42E-03	6.33E-06	6.30E-06	**98.84**	19.67	0.53	0.36	0.17	0.14	6.39E-03	6.35E-03
DA-E5	**27.60**	2.30	13.01	1.11	0.03	2.35E-03	2.06E-06	2.05E-06	17.33	3.45	0.05	0.04	0.02	0.02	1.32E-03	1.31E-03
DA-E6	5.26	0.44	3.99	0.34	0.01	7.87E-04	9.95E-07	9.91E-07	4.82	0.96	0.02	0.01	0.01	0.00	3.75E-04	3.72E-04
DA-F1	7.22	0.60	6.58	0.56	0.04	3.00E-03	3.69E-06	3.67E-06	10.70	2.13	0.02	0.02	0.01	0.01	9.59E-04	9.52E-04
DA-F10	10.41	0.87	11.98	1.03	0.02	1.75E-03	6.98E-06	6.94E-06	**29.04**	5.78	0.06	0.04	0.05	0.04	2.78E-03	2.76E-03
DA-F11	6.55	0.55	22.21	1.90	0.06	5.32E-03	3.08E-05	3.07E-05	**42.34**	8.43	0.11	0.08	0.09	0.07	4.23E-03	4.20E-03
DA-F12	3.66	0.31	3.06	0.26	0.01	8.22E-04	8.31E-07	8.28E-07	7.05	1.40	0.01	0.01	0.01	0.01	6.77E-04	6.72E-04
DA-F13	10.47	0.87	18.84	1.61	0.09	7.60E-03	2.86E-06	2.85E-06	**36.02**	7.17	0.17	0.11	0.07	0.06	3.51E-03	3.48E-03
DA-F14	7.84	0.65	5.37	0.46	0.01	6.98E-04	1.95E-06	1.94E-06	13.21	2.63	0.03	0.02	0.02	0.02	1.06E-03	1.05E-03
DA-F15	**16.86**	1.41	12.27	1.05	0.06	5.00E-03	5.69E-06	5.67E-06	**37.94**	7.55	0.09	0.06	0.04	0.03	3.24E-03	3.22E-03
DA-F16	6.60	0.55	7.06	0.60	0.02	1.50E-03	1.93E-06	1.92E-06	7.16	1.43	0.02	0.01	0.01	0.01	6.83E-04	6.79E-04
DA-F17	10.94	0.91	8.09	0.69	0.02	1.74E-03	4.73E-06	4.70E-06	17.74	3.53	0.03	0.02	0.03	0.02	1.62E-03	1.61E-03
DA-F2	**23.93**	2.00	8.78	0.75	0.02	1.76E-03	6.00E-06	5.97E-06	14.03	2.79	0.02	0.02	0.02	0.02	1.31E-03	1.30E-03
DA-F3	5.81	0.48	5.38	0.46	0.01	6.21E-04	1.65E-06	1.64E-06	8.26	1.64	0.01	0.01	0.01	0.01	5.91E-04	5.87E-04
DA-F4	6.43	0.54	7.30	0.63	0.02	1.62E-03	6.33E-06	6.30E-06	20.51	4.08	0.05	0.04	0.03	0.02	2.12E-03	2.11E-03
DA-F5	**16.62**	1.39	2.59	0.22	0.01	6.86E-04	0.00E+00	0.00E+00	0.33	0.07	0.00	0.00	0.00	0.00	5.08E-05	5.05E-05
DA-F6	**22.26**	1.86	13.67	1.17	0.12	9.94E-03	1.08E-05	1.08E-05	**30.68**	6.11	0.07	0.05	0.06	0.05	1.89E-03	1.88E-03
DA-F7	5.32	0.44	5.06	0.43	0.01	1.26E-03	2.81E-06	2.80E-06	11.65	2.32	0.02	0.01	0.01	0.01	1.02E-03	1.01E-03
DA-F8	**20.33**	1.70	7.56	0.65	0.02	2.00E-03	5.38E-06	5.35E-06	18.15	3.61	0.03	0.02	0.03	0.02	1.86E-03	1.85E-03
DA-F9	12.96	1.08	19.59	1.68	0.11	9.12E-03	1.22E-05	1.22E-05	**40.24**	8.01	0.12	0.08	0.07	0.06	3.74E-03	3.72E-03
DA-G1	5.26	0.44	5.38	0.46	0.02	1.29E-03	3.17E-06	3.15E-06	13.26	2.64	0.04	0.03	0.02	0.02	1.17E-03	1.17E-03
DA-G2	4.99	0.42	8.17	0.70	0.04	3.25E-03	3.02E-06	3.00E-06	**25.80**	5.13	0.10	0.07	0.05	0.05	3.17E-03	3.15E-03
DA-G3	4.14	0.35	4.47	0.38	0.02	1.53E-03	3.04E-06	3.03E-06	**46.58**	9.27	0.21	0.14	0.04	0.04	5.79E-03	5.75E-03
DA-H1	5.98	0.50	7.89	0.68	0.02	1.81E-03	1.43E-05	1.43E-05	17.51	3.48	0.07	0.05	0.03	0.02	1.47E-03	1.46E-03
DA-H2	7.45	0.62	8.24	0.71	0.02	1.63E-03	1.32E-05	1.31E-05	13.61	2.71	0.03	0.02	0.02	0.02	1.21E-03	1.21E-03
DA-I	8.08	0.67	10.70	0.92	0.04	3.21E-03	5.40E-06	5.38E-06	**51.48**	10.25	0.07	0.05	0.08	0.07	5.33E-03	5.30E-03
DA-J	12.52	1.04	14.98	1.28	0.18	1.53E-02	1.55E-05	1.54E-05	**42.61**	8.48	0.15	0.10	0.07	0.06	3.74E-03	3.72E-03
DA-K	**23.17**	1.93	32.79	2.81	0.37	3.15E-02	4.66E-05	4.64E-05	**49.70**	9.89	0.28	0.19	0.12	0.10	3.97E-03	3.94E-03
DA-L	**21.16**	1.76	27.36	2.34	0.52	4.46E-02	3.67E-06	3.65E-06	**125.25**	24.92	1.43	0.98	0.43	0.36	8.34E-03	8.29E-03
DA-M	10.28	0.86	7.84	0.67	0.04	3.01E-03	7.17E-06	7.14E-06	16.46	3.28	0.06	0.04	0.02	0.02	1.33E-03	1.33E-03
DA-N	11.56	0.96	28.50	2.44	0.10	8.95E-03	7.02E-06	6.99E-06	23.79	4.73	0.05	0.03	0.05	0.04	2.92E-03	2.90E-03
DA-O	**15.94**	1.33	18.15	1.55	0.44	3.77E-02	6.49E-05	6.46E-05	**60.12**	11.96	0.27	0.19	0.15	0.12	5.61E-03	5.57E-03
DA-P1	**78.77**	10.94	**109.32**	19.85	0.36	6.49E-02	1.23E-05	1.14E-05	16.63	14.22	0.05	0.04	0.15	0.13	3.76E-03	3.74E-03
DA-P2	**148.22**	**20.59**	**130.13**	23.62	**1.50**	2.72E-01	1.59E-05	1.47E-05	**28.63**	24.49	0.10	0.08	0.22	0.19	6.67E-03	6.63E-03
DA-P3	**72.15**	10.02	57.58	10.45	0.31	5.61E-02	8.32E-06	7.68E-06	17.41	14.89	0.08	0.06	0.18	0.16	5.95E-03	5.92E-03
DA-P4	**119.76**	**16.64**	**102.19**	18.55	0.76	1.39E-01	1.04E-05	9.61E-06	19.87	16.99	0.06	0.05	0.12	0.11	4.79E-03	4.77E-03
DA-P5	**92.46**	12.85	**108.70**	19.73	1.02	1.86E-01	9.60E-06	8.87E-06	**34.95**	**29.89**	0.14	0.11	0.28	0.25	8.08E-03	8.04E-03

Parameter	Units	Buffalo River	Buffalo Ship Canal
1 % Loss Rate	kg/s	1.64	0.67
0.08 % Loss Rate	kg/s	0.13	0.054
TSS @ 500 m 1% Loss	mg/L	136.40	176.08
TSS @ 500 m 0.08% Loss	mg/L	10.89	14.06

Water Quality Analysis

- Buffalo River
  - ➢ Exceedances were predicted only for copper at the higher resuspension loss rate of 1%.
  - ➢ No exceedances of the CMCs or NYS fish survival standards for fluorene, phenanthrene, benz(a)anthracene, or Total PCBs at either resuspension loss rate
- Buffalo Ship Canal
  - ➢ Exceedances for metals at higher loss rate
  - ➢ No exceedances of the CMCs or NYS standards for fish survival for fluorene, phenanthrene, benz(a)anthracene, or Total PCBs were predicted in the at either resuspension loss rate.

Buffalo River Water Quality Results: Discussion of Copper Exceedances

- Predicted dissolved copper concentrations
  - met the CMC for both distances at all dredging subunits in the Buffalo River at a loss rate of 0.08%
  - exceeded the CMC for a number of subunits for both distances at a loss rate of 1%.
- The maximum loss rate without an exceedance of the copper criteria in the Buffalo River is
  - about 0.25% for a distance of 150 m
  - about 0.45% for a distance of 500 m.

Buffalo Ship Canal Water Quality Results: Discussion of Copper Exceedances

- Predicted dissolved copper concentrations exceeded the water quality criteria at all dredging subunits for a 1% loss rate for both distances.
- At a loss rate of 0.08%,
  - Exceedance at at all five subunits at150-m
  - Exceedance at two of the five subunits at 500-m
- At a loss rate of 0.08% the productivity rate would need to be reduced to
  - Below 3700 cy/day for a 500-m distance
  - Below 2200 cy/day for a 150-m distance

Water Quality Results
Discussion of Lead Exceedances

- In the Buffalo River, no exceedances of the CMC were predicted.
- In the Buffalo Ship Canal, no exceedances of the CMC were predicted at a loss rate of 0.08%, but exceedances were predicted from all subunits at a loss rate of 1%.

Water Quality Results
Discussion of Mercury Exceedances

- In the Buffalo River, no exceedances of the CMC were predicted at either loss rate
- In the Buffalo Ship Canal, an exceedance of the CMC was predicted from one of the five subunits at a 1% loss rate

Water Quality Results
Discussion of Total PAH Exceedances

- Exceedances of the acute toxicity screening value for total PAHs were similar in frequency and magnitude as the exceedances for copper
- In the Buffalo River predicted dissolved total PAHs concentrations
  - met the screening value for acute toxicity at the 500-m distance for all dredging subunits at a loss rate of 0.08%
  - exceeded the ac150-m distance for two dredging subunits.
  - ute toxicity screening values at the

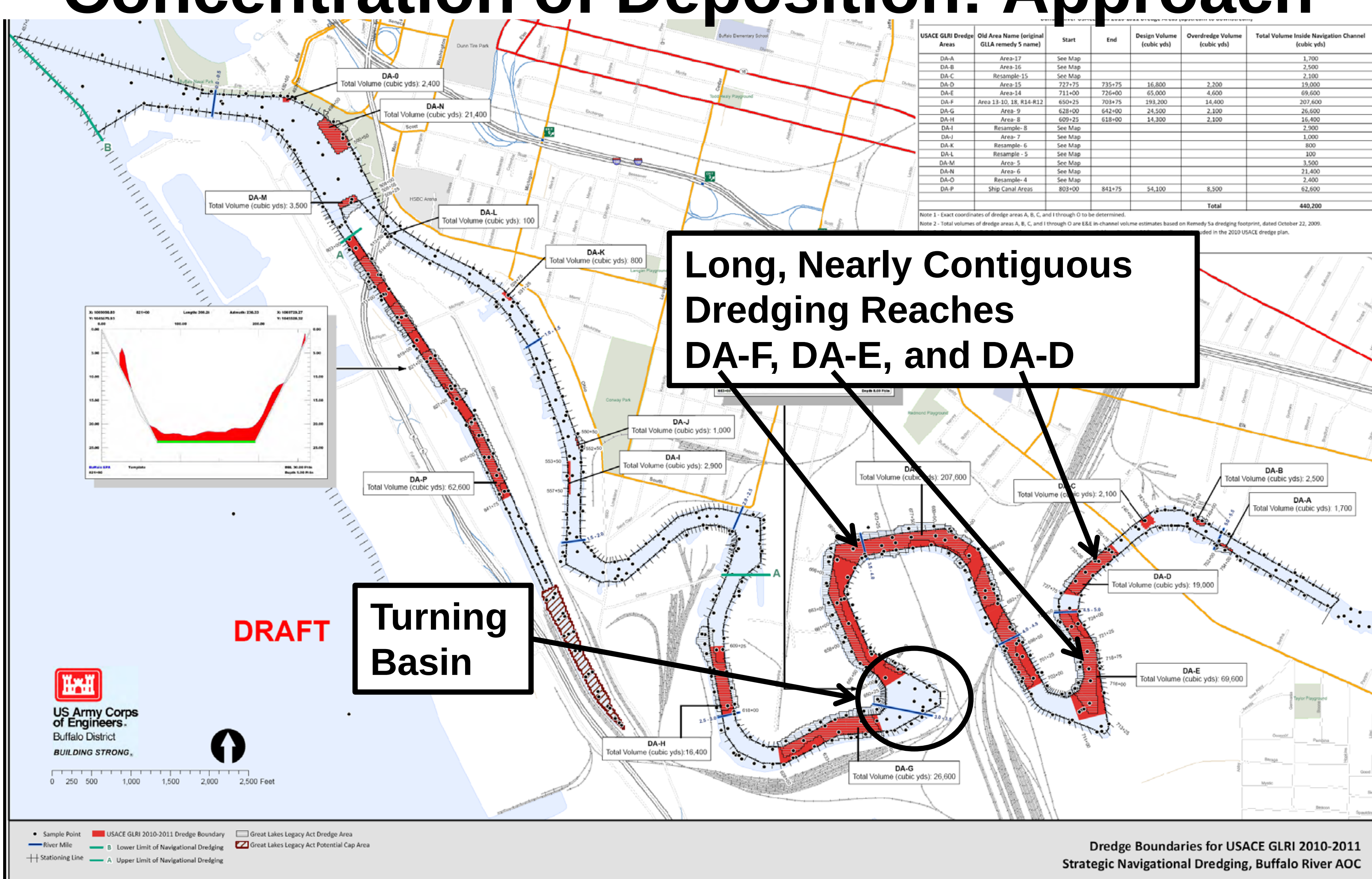
Water Quality Results
Discussion of Total PAH Exceedances

- In the Buffalo Ship Canal the predicted dissolved total PAHs concentrations
  - Exceeded the screening value for acute toxicity at the 150-m distance for two of the five dredging subunits at a loss rate of 0.08%
  - Exceeded the acute toxicity screening value at the 500-m distance for only one dredging subunit
- At 1% Loss, predicted dissolved total PAHs concentrations exceeded the acute toxicity screening value for a number of subunits in both Buffalo Rive and Buffalo Ship Canal

Prediction of Thickness and Contaminant Concentration of Deposition: Approach

- An area downstream of the longest contiguous stretch of dredging reaches was chosen to evaluate resuspension generated residuals outside the dredging units
- The site selected for deposition evaluation was a turning basin directly downstream of dredging reach DA-F
  - This location is expected to receive significant deposition from the dredging of reaches DA-D, DA-E, and DA-F
  - This analysis provides a worst case estimate for the amount of solids deposited at a location outside the dredging area

Prediction of Thickness and Contaminant Concentration of Deposition: Approach



USACE GLRI Dredge Areas	Old Area Name (original GLLA remedy 5 name)	Start	End	Design Volume (cubic yds)	Overdredge Volume (cubic yds)	Total Volume Inside Navigation Channel (cubic yds)
DA-A	Area-17	See Map				1,700
DA-B	Area-16	See Map				2,500
DA-C	Resample-15	See Map				2,100
DA-D	Area-15	727+75	735+75	16,800	2,200	19,000
DA-E	Area-14	711+00	726+00	65,000	4,600	69,600
DA-F	Area 13-10, 18, R14-R12	650+25	703+75	193,200	14,400	207,600
DA-G	Area- 9	628+00	642+00	24,500	2,100	26,600
DA-H	Area- 8	609+25	618+00	14,300	2,100	16,400
DA-I	Resample- 8	See Map				2,900
DA-J	Area- 7	See Map				1,000
DA-K	Resample- 6	See Map				800
DA-L	Resample - 5	See Map				100
DA-M	Area- 5	See Map				3,500
DA-N	Area- 6	See Map				21,400
DA-O	Resample- 4	See Map				2,400
DA-P	Ship Canal Areas	803+00	841+75	54,100	8,500	62,600
					Total	**440,200**

Note 1 - Exact coordinates of dredge areas A, B, C, and I through O to be determined.

Note 2 - Total volumes of dredge areas A, B, C, and I through O are E&E in-channel volume estimates based on Remedy 5a dredging footprint, dated October 22, 2009.

Prediction of Thickness and Contaminant Concentration of Deposition: Approach

Volume-weighted average for contaminant throughout Buffalo River dredging reaches was used

- Maximum sediment contaminant concentrations is of interest to water quality analyses due to the short-term risks posed by the dredge plume, but
- Sediments deposited downstream can have a different contaminant concentration than the resuspended sediment due to stripping by the water column during transport

Prediction of Thickness and Contaminant Concentration of Deposition: Approach

- To model residuals due to upstream dredging operations
  - the river was “straightened” from dredging reach DA-D to the end of DA-F (the location of interest for deposition) so that it could be incorporated into the DREDGE model and its post-processors.
  - The midpoints of the dredging sub-units were determined along the longitudinal axis of the river relative to the upstream extent of DA-D1.
  - Since dredging is to occur from bank to bank throughout this section of the river, deposition was laterally distributed
- For sake of conservative screening, a 1% loss rate and production of 6000 cy/day were assumed for modeling.

Prediction of Thickness and Contaminant Concentration of Deposition

- The production assumption averaged to approximately two dredging days (22.8 hrs) per dredging sub-unit.
- The Dredge model source was placed in the upstream-most sub-unit, DA-D1, and simulated 22.8 hours of resuspension, transport, and deposition of TSS and associated contaminants.
- The source of the model was then repositioned downstream around the midpoint of the next dredging sub-unit, and again simulated the effects of 22.8 hrs of dredging.

Prediction of Thickness and Contaminant Concentration of Deposition

- This process was conducted a total of 25 times as the dredging source moved from DA-D1 to DA-F17
- The sediment and contaminant mass at every location in this modeling sub-domain was stored to calculate an overall average contaminant concentration in the dredging residuals

Prediction of Thickness and Contaminant Concentration of Deposition

- The mass of deposition was converted to a thickness by using an assumed dry bulk density of 300 kg/m^3, characteristic of recently settled fine-grained solids.
- A similar analysis was performed in the Buffalo Ship Canal adjacent to dredging reach DA-P. Five sub-units were used for modeling with an average dredging duration of 25 hours.

Plume Movement Through Buffalo River

Paste Anchor		30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870
-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-72	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-69	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-66	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-63	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-60	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-57	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-54	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-51	-							-	-	-	-	-	-	-	-	-	-	-	-	82.90	185.29	384.84	644.79	1,007.84	1,414.34	1,855.77	2,340.16	2,766.90	3,191.35	3,616.71
-48	-							-	-	-	-	-	-	-	-	-	31.54	106.07	269.46	568.47	1,014.44	1,577.98	2,242.04	2,964.01	3,664.76	4,385.60	5,028.49	5,596.55	6,131.49	6,581.92
-45	-							-	-	-	-	-	-	-	44.24	176.15	502.18	1,095.62	2,003.98	3,161.58	4,444.23	5,817.07	7,147.32	8,493.54	9,714.39	#######	#######	#######	#######	#######
-42	-							-	-	-	-	-	49.64	247.13	826.84	2,013.37	3,793.09	6,057.08	8,601.27	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-39	-							-	-	-	40.15	260.75	1,189.50	3,276.71	6,601.66	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-36	-							-	14.65	174.24	1,284.73	4,542.47	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-33	-							46.70	810.68	4,947.02	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-30	-	-	-	-	-	-	169.15	3,090.62	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-27	-	-	-	-	-	451.05	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-24	-	-	-	-	837.96	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-21	-	-	-	808.71	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-18	-	-	109.48	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-15	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-12	-	4,965.03	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-9	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-6	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-3	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
0	-	[illegible]	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
3	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
6	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
9	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
12	-	4,965.03	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
15	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
18	-	-	109.48	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
21	-	-	-	808.71	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
24	-	-	-	-	837.96	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
27	-	-	-	-	-	451.05	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
30	-	-	-	-	-	-	169.15	3,090.62	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
33	-	-	-	-	-	-	-	46.70	810.68	4,947.02	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
36	-	-	-	-	-	-	-	-	14.65	174.24	1,284.73	4,542.47	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
39	-	-	-	-	-	-	-	-	-	-	40.15	260.75	1,189.50	3,276.71	6,601.66	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
42	-	-	-	-	-	-	-	-	-	-	-	-	49.64	247.13	826.84	2,013.37	3,793.09	6,057.08	8,601.27	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44.24	176.15	502.18	1,095.62	2,003.98	3,161.58	4,444.23	5,817.07	7,147.32	8,493.54	9,714.39	#######	#######	#######	#######	#######
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.54	106.07	269.46	568.47	1,014.44	1,577.98	2,242.04	2,964.01	3,664.76	4,385.60	5,028.49	5,596.55	6,131.49	6,581.92
51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82.90	185.29	384.84	644.79	1,007.84	1,414.34	1,855.77	2,340.16	2,766.90	3,191.35	3,616.71
54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Coordinates in meters
X_{inc} = 30 m
Y_{inc} = 3 m

Plume Movement Through Buffalo River

Paste Anchor						30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750
-75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82.90	185.29	384.84	644.79	1,007.84	1,414.34	1,855.77
-48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.54	106.07	269.46	568.47	1,014.44	1,577.98	2,242.04	2,964.01	3,664.76	4,385.60
-45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44.24	176.15	502.18	1,095.62	2,003.98	3,161.58	4,444.23	5,817.07	7,147.32	8,493.54	9,714.39	#######
-42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49.64	247.13	826.84	2,013.37	3,793.09	6,057.08	8,601.27	#######	#######	#######	#######	#######	#######	#######
-39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.15	260.75	1,189.50	3,276.71	6,601.66	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-36	-	-	-	-	-	-	-	-	-	-	-	-	14.65	174.24	1,284.73	4,542.47	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-33	-	-	-	-	-	-	-	-	-	-	-	46.70	810.68	4,947.02	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-30	-	-	-	-	-	-	-	-	-	-	169.15	3,090.62	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-27	-	-	-	-	-	-	-	-	-	451.05	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-24	-	-	-	-	-	-	-	-	837.96	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-21	-	-	-	-	-	-	-	808.71	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-18	-	-	-	-	-	-	109.48	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-15	-	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-12	-	-	-	-	-	4,965.03	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-9	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-6	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
-3	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
0	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
3	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
6	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
9	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
12	-	-	-	-	-	4,965.03	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
15	-	-	-	-	-	-	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
18	-	-	-	-	-	-	109.48	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
21	-	-	-	-	-	-	-	808.71	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
24	-	-	-	-	-	-	-	-	837.96	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
27	-	-	-	-	-	-	-	-	-	451.05	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
30	-	-	-	-	-	-	-	-	-	-	169.15	3,090.62	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
33	-	-	-	-	-	-	-	-	-	-	-	46.70	810.68	4,947.02	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
36	-	-	-	-	-	-	-	-	-	-	-	-	14.65	174.24	1,284.73	4,542.47	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40.15	260.75	1,189.50	3,276.71	6,601.66	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######	#######
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	49.64	247.13	826.84	2,013.37	3,793.09	6,057.08	8,601.27	#######	#######	#######	#######	#######	#######	#######
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44.24	176.15	502.18	1,095.62	2,003.98	3,161.58	4,444.23	5,817.07	7,147.32	8,493.54	9,714.39	#######
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.54	106.07	269.46	568.47	1,014.44	1,577.98	2,242.04	2,964.01	3,664.76	4,385.60
51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82.90	185.29	384.84	644.79	1,007.84	1,414.34	1,855.77
54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Plume Movement Through Buffalo River

DepositionPlumes.exe

Deposition Modeling Results

- In the Buffalo River
  - Approximately 1.4 cm of deposition was evenly distributed across a width of 80 meters adjacent to the longest stretch of dredging for a loss rate of 1%
  - only 0.11 cm of deposition would be expected at a loss rate of 0.08%.
- In the Buffalo Ship Canal,
  - the maximum depth of deposition outside of the dredging unit was 0.70 cm at a loss rate of 1% and
  - 0.06 cm at a loss rate of 0.08%.

Deposition Modeling Results

- No predicted exceedance of available sediment PRGs for Lead, Mercury, Total PAHs and Total PCBs (PRGs do not exist for the other CoCs) in either waterway
- Probable Effect Concentrations (PECs) used to screen the other four COCs, no exceedances were predicted in either waterway

Buffalo River Residuals at 1% Loss

Parameter	Units	Screening Value	Avg. Bulk Sediment Conc	Residual Conc Outside Dredging Reach DA-F
TSS Deposition for 1% Loss @ 300 g/L Residual Density	cm			1.37
Concentration of Copper in Residuals	mg/kg sed	149.0	75.70	1.49
Concentration of Lead in Residuals	mg/kg sed	90.0	73.76	2.74
Concentration of Mercury in Residuals	mg/kg sed	0.44	0.28	0.01
Concentration of Benz(a)anthracene in Residuals	mg/kg sed	1.05	0.627	0.626
Concentration of Fluorene in Residuals	mg/kg sed	0.54	0.299	0.263
Concentration of Phenanthrene in Residuals	mg/kg sed	1.17	1.115	1.052
Concentration of Total PAHs in Residuals	mg/kg sed	16.00	10.708	3.995
Concentration of PCBs in Residuals	mg/kg sed	0.20	0.036	0.036

Buffalo Ship Canal at 0.08% Loss (adjusted for downtime)

Parameter	Units	Screening Value	Avg. Bulk Sediment Conc	Residual Conc Outside Dredging Reach DA-P
TSS Deposition for 0.08% Loss Averaged over 1 Dredging Day @ 300 g/L Residual Density	cm			.056
Concentration of Copper in Residuals	mg/kg sed	149.0	65.10	4.7
Concentration of Lead in Residuals	mg/kg sed	90.0	86.86	10.25
Concentration of Mercury in Residuals	mg/kg sed	0.44	0.66	0.078
Concentration of Benz(a)anthracene in Residuals	mg/kg sed	1.05	1.07	1.07
Concentration of Fluorene in Residuals	mg/kg sed	0.54	0.25	0.23
Concentration of Phenanthrene in Residuals	mg/kg sed	1.17	1.15	1.09
Concentration of Total PAHs in Residuals	mg/kg sed	16.00	12.75	9.09
Concentration of PCBs in Residuals	mg/kg sed	0.20	0.04	0.04

Buffalo Ship Canal at 1.0% Loss (adjusted for downtime)

Parameter	Units	Screening Value	Avg. Bulk Sediment Conc	Residual Conc Outside Dredging Reach DA-P
TSS Deposition for 1% Loss Averaged over 1 Dredging Day @ 300 g/L Residual Density	cm			.70
Concentration of Copper in Residuals	mg/kg sed	149.0	65.10	27.7
Concentration of Lead in Residuals	mg/kg sed	90.0	86.86	46.3
Concentration of Mercury in Residuals	mg/kg sed	0.44	0.66	.035
Concentration of Benz(a)anthracene in Residuals	mg/kg sed	1.05	1.07	1.07
Concentration of Fluorene in Residuals	mg/kg sed	0.54	0.25	0.25
Concentration of Phenanthrene in Residuals	mg/kg sed	1.17	1.15	1.14
Concentration of Total PAHs in Residuals	mg/kg sed	16.00	12.75	11.78
Concentration of PCBs in Residuals	mg/kg sed	0.20	0.04	0.04

Need for Controls: Buffalo River

- The principal concern for contaminant release in the Buffalo River is the release of copper and total PAHs associated with resuspension at a rate above about 0.2%.
- Additional concern from release of total PAHs above 0.1%, predominantly from dredging subunits E-4 and L where exceedances of the screening value were observed at the 150-m distance
- Slower production rates should be considered in these two dredging subunits

Need for Controls: Buffalo River

- The anticipated loss is about 0.1% without residual losses based on the cohesiveness and liquidity of the sediments, thus there is some margin of safety for nearly all of the dredging subunits in the Buffalo River.
- Consequently, no need for controls in the dredging if care is taken to minimize the disturbance of the sediment bed by
  - Minimizing the number of lifts used to achieve the desired channel depth
  - Limiting traffic over the site and upstream units during active dredging
- Barge overflow should be avoided, but the bucket could be drained at the surface to reduce the water transferred to the barge.
- Draining would increase the contaminant release slightly, but this increase would be offset by the reduction of productivity (increase in cycle time), which would serve to reduce the resuspension rate in kg/sec and the deterioration of the water quality

Need for Controls: Buffalo Ship Canal

- The principal concern is also the release of copper and total PAHs associated with resuspension
- Based on the partitioning information from the modified elutriate tests
  - Unlikely that the CMC for copper can be met without controls within a 500-m distance
  - To a lesser degree, unlikely that total PAHs screening value can be met without controls within a 500-m distance
- Under the best of conditions, productivity should be restricted to about 3000 cy per day
- Minimize the disturbance of the sediment bed by
  - Minimizing the number of lifts used to achieve the desired channel depth
  - Limiting traffic over the site and upstream units during active dredging

Need for Controls: Buffalo Ship Canal

- Barge overflow and bucket draining should be avoided because limited flow does not provide transport or dilution
- A dredging elutriate test could be performed to verify the copper partitioning characteristics
- Use of silt curtains would reduce the spread of suspended solids, but would not significantly reduce the release of dissolved copper or total PAHs because both contaminants are expected to be more than 90% dissolved
- Control of TSS spreading is not needed because the expected residuals outside of the dredging areas are expected to be less than a few millimeters thick and have a contaminant concentration below the PRGs and the PECs.

Summary and Conclusions

- Three tools developed under DOER program used to
  - ➢ Resuspension Factor Approach to estimate suspended sediment loss rates resulting from dredging operations
  - ➢ Input of loss rates into the DREDGE Model for passive plume transport and decay
  - ➢ Manipulation of DREDGE Model outputs using post-processors to estimate
    - – Dissolved contaminant concentrations at distance
    - – Thickness and contaminant concentration of residuals
- Residuals output can be coupled with the USACE Recovery model, however RECOVERY modeling was done in parallel with short-term assessments due to time constraints on this project

Results of ERDC Study

- Water Quality and NEPA Certification were successfully secured by Buffalo District
- Dredging to initiate this summer
- Monitoring will be conducted to verify our analysis during dredging and placement
- The same analysis is currently being applied to contaminated sediments outside the navigation channel that are to be dredged for remediation under GLLA
- As with previous work, our analysis will be used for CWA and NEPA Permitting, and evaluation of controls