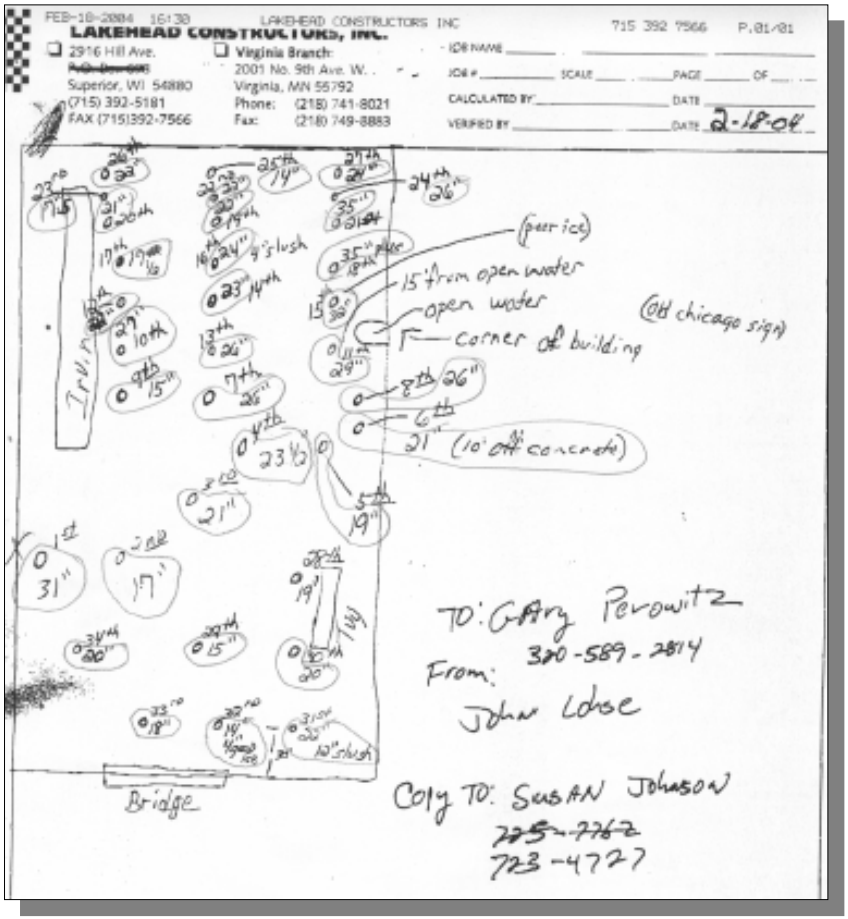
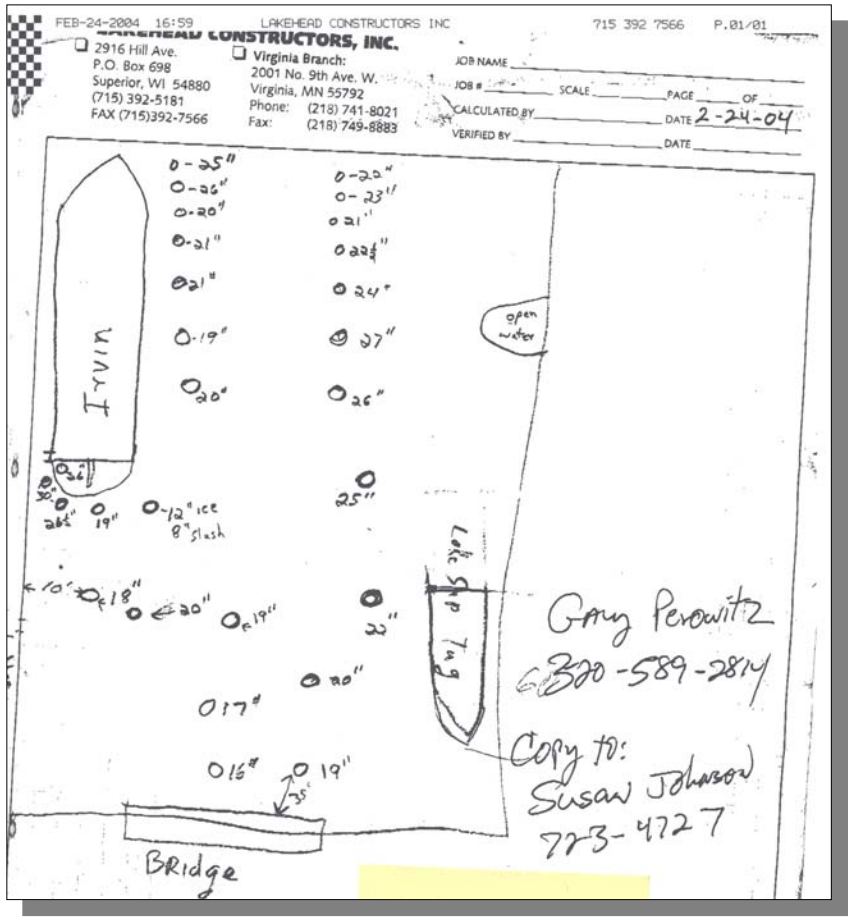
APPENDIX A: Data

1. Ice soundings taken prior to field investigation.

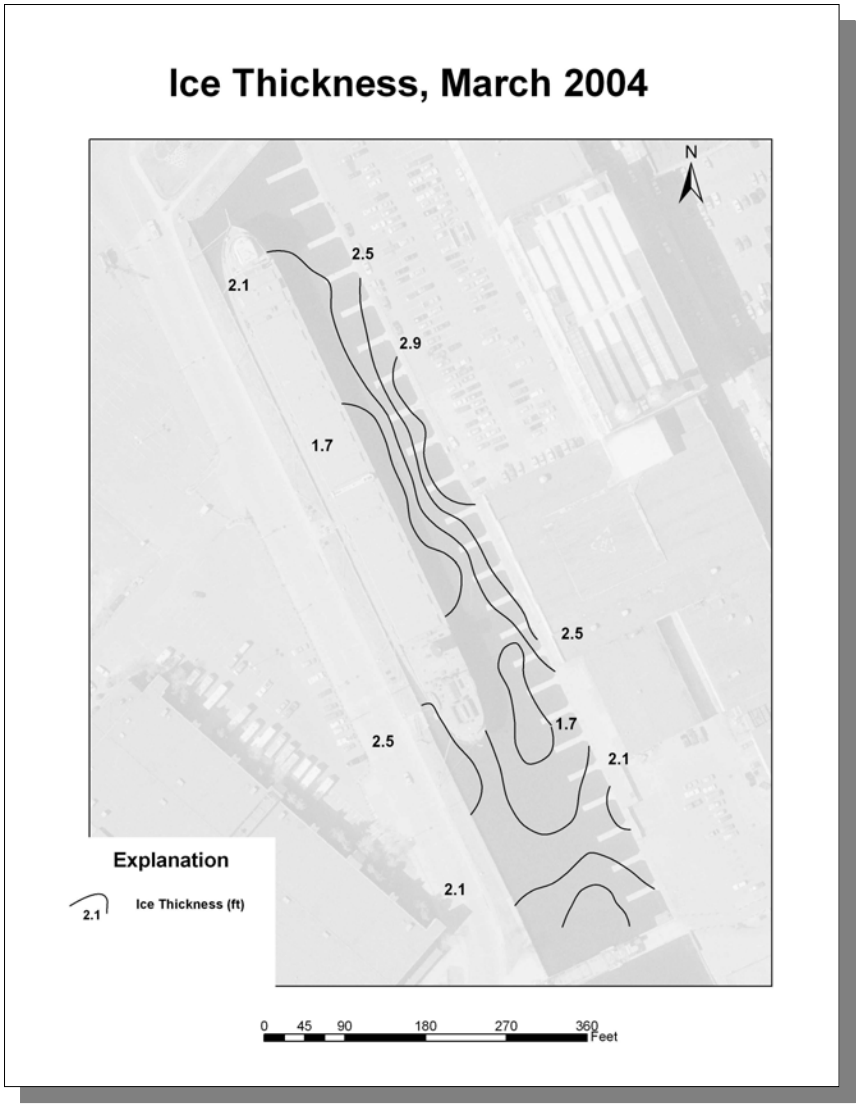
2/18/2004

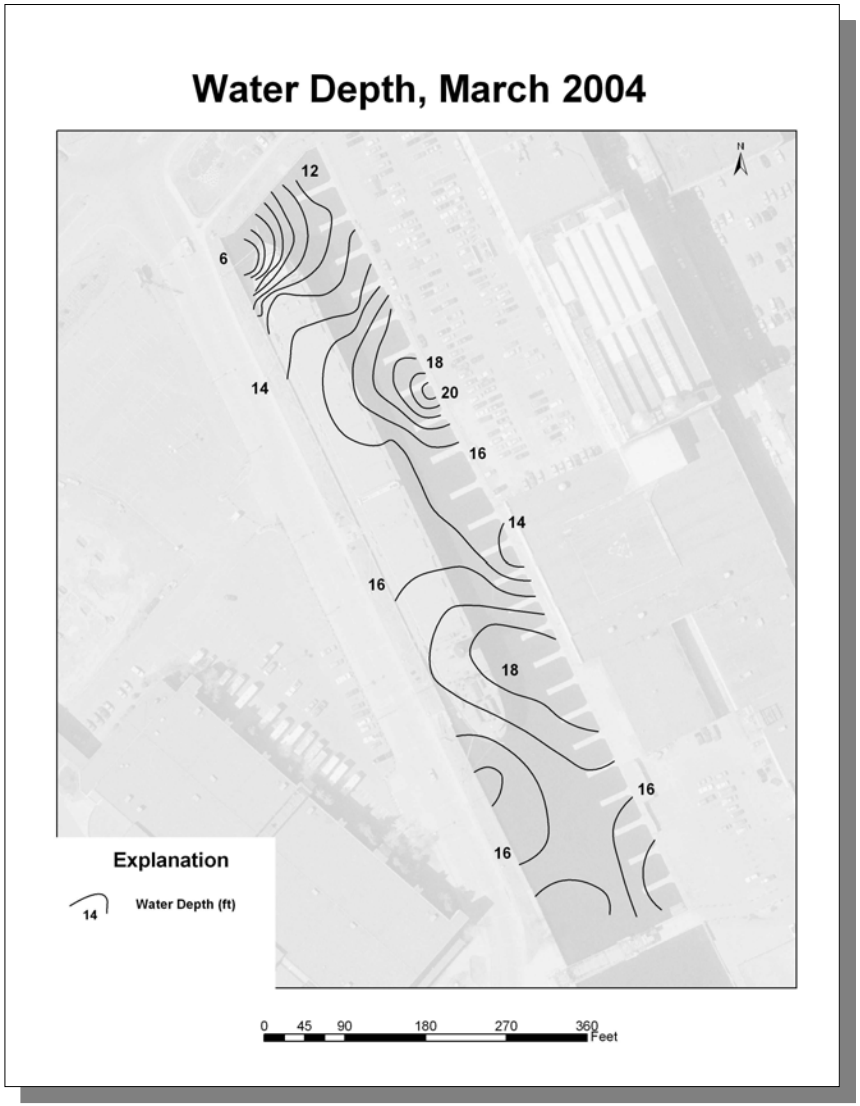


2/24/2004



2. Ice Thickness & Depth to Sediment





3. Various Tables

TABLE A 1:
Cartesian Coordinates for LIF Probe Points and Sediment Samples Collected from Minnesota Slip, March 2004. Geopositioning method used to collect coordinates: GPS; Geopositioning Datum, NAD83. Coordinates presented in UTM, Zone 15.

Sample ID	Sampling Technique	UTM_E	UTM_N
1	LIF	568958	5181305
2	LIF	568947	5181328
3	LIF & Sediment	568931	5181353
4	LIF	568963	5181338
5	LIF	568980	5181347
6	LIF	568950	5181366
7	LIF	568966	5181375
8	LIF	568974	5181313
9	LIF	568992	5181319
10	LIF & Sediment	569004	5181291
11	LIF	568986	5181285
12	LIF	568971	5181278
13	LIF	568939	5181396
14	LIF & Sediment	568924	5181422
15	LIF	568909	5181453
16	LIF	568895	5181476
17	LIF	568885	5181500
18	LIF & Sediment	568877	5181516
19	LIF	568861	5181505
20	LIF	568864	5181492
21	LIF	568887	5181524
22	LIF	568877	5181527
23	LIF & Sediment	568899	5181511
24	LIF	568914	5181483
25	LIF	568935	5181426
26	LIF	568953	5181400
27	LIF & Sediment	568926	5181457
28	LIF & Sediment	568904	5181412
29	LIF & Sediment	568874	5181466

TABLE A 2: Laboratory Analytical Parameters	
Minnesota Slip Analytical Parameters March 2004	
Metals	**Polycyclic Aromatic Hydrocarbons (PAHs)**
Arsenic	Acenaphthene
Barium	Acenaphthylene
Boron	Anthracene
Cadmium	Benzo (a) anthracene
Chromium	Benzo (a) pyrene
Lead	Benzo (b) fluoranthene
Mercury	Benzo (ghi) perylene
Silver	Benzo (k) fluoranthene
Zinc	Chrysene
Selenium	Dibenzo (a,h) anthracene
	7, 12-Dimethylbenz (a) anthracene
Miscellaneous	Fluoranthene
Polychlorinated biphenyls (PCB)	Fluorene
Diesel Range Organics (DRO)	Indeno (1,2,3-cd) pyrene
Total Solids (%)	2-Methyl-naphthalene
Total Organic Carbon (TOC)	Naphthalene
Moisture Content	Phenanthrene
	Pyrene

TABLE A 3: Metals Concentrations

Laboratory Results- Metals
MN Slip- West Central Environmental Consultants

Sample Location	Sample Name	DRO (ppm)	**Arsenic** (ppm)	Barium (ppm)	Boron (ppm)	**Cadmium** (ppm)	**Chromium** (ppm)	**Lead** (ppm)	**Mercury** (ppm)	Silver (ppm)	**Zinc** (ppm)	Total Solids (%)	Selenium (ppm)	TOC (ppm)	**PCB** (ppm)
	WC-TH3 (8' heave)	130*	5**	92	<50	<2	22.4	459	0.6	<4	478	43	1.7**	42500	<0.04#
3	WC-TH3 (6-7')	26*	1.2**	13.1	<25	<2	3.6	47	<0.2	<4	73.5	80	<0.4**	<2000	<0.04#
	WC-TH10 (1-3')	11*	1.5**	24.9	<50	<2	11.2	87.9	<0.2	<4	83.2	87	<0.4**	10900	<0.04#
10	WC-TH10 (6-8')	<10	0.6**	6.3	25	<2	2.1	<7	<0.2	<4	7.8	81	<0.4**	<2000	<0.04#
	WC-TH14 (2-4')	57*	1.7**	49.2	<25	<2	10.8	90.6	0.3	<4	110	72	<0.4**	15700	<0.04#
	WC-TH14 (6-8')	160*	1**	10.4	<25	<2	5	8.2	<0.2	<4	14	70	<0.5**	3770	<0.04#
14	WC-TH14 (10-12')	<10	0.9**	13.6	<25	<2	5.6	10.3	<0.2	<4	17.4	80	<0.4**	9130	<0.04#
	WC-TH18 (0-4')	31*	3.2**	145	<75	3.6	40.8	320	0.4	<4	0.4	56	<0.4**	16800	<0.04#
18	WC-TH18 (4-8')	58*	3.8	150	<50	<2	25.2	220	3.3	<4	366	63	0.5 ^	36400	<0.04#
23	WC-TH23 (4-8')	230*	4.3	162	<50	2.5	26.9	544	1.6	<4	559	56	0.4 ^	49900	<0.04#
	WC-TH27 (3-5')	17*	1.5	33.8	<50	<2	22	67.2	<0.2	<4	94.7	72	<0.2	4960	<0.04#
27	WC-TH27 (6-7')	<10*	0.8	13	<25	<2	4.8	<7	<0.2	<4	11.8	67	<0.2 ^	17500	<0.04#
	WC-TH28 (5' heave)	210*	1.8	62.1	<25	<2	8.8	108	0.4	<4	105	68	0.3 ^	40300	<0.04#
	WC-TH28 (6-9') !	46*	1	53.4	<25	<2	7.1	66.2	<0.2	<4	76.1	79	<0.2 ^	2860	<0.04#
28	WC-TH49 (6-9') !	48*	1.4	40.8	<25	<2	6.14	52.5	0.2	<4	59.3	79	<0.2 ^	4420	<0.04#
	WC-TH29 (6-8')	10*	0.7	20	<25	<2	4.8	22	<0.2	<4	49.2	77	<0.2 ^	<2000	<0.04#
	WC-TH29 (9' heave)	<10	0.8	9.5	<25	<2	3.6	<7	<0.2	<4	14	80	<0.2 ^	<2000	<0.04#
29	WC-TH29 (11')	<10	0.6	6.69	<25	<2	4.5	<7	<0.2	<4	15.2	79	<0.2 ^	<2000	<0.04#
Waste	WC-Comp.Waste	<10	1.2 $	21.7	<15	<2.5	5.3	22	<0.2	<2.5	40.1	76	<0.3	3300	<0.04#
	Level 1 SQT	*150*	*9.8*			*0.99*	*43*	*36*	*0.18*		*120*				*60*
	Level II SQT	*1,200*	*33*			*5.0*	*110*	*130*	*1.1*		*460*				*680*

** Heavy hydrocarbon compounds detected outside the DRO window*
*** Matrix spike not within control limits selenium-69%, arsenic-63%*
! Duplicate Samples
 # PCBs were not detected in any of the samples. The laboratory's reporting limit varied between 0.02 and 0.04 ppm for the various PCBs.
Please refer to the laboratory report for exact reporting limit values.
$ Arsenic was detected in the method blank at 0.0021 ppm
All analytical results presented as dry weight concentrations

TABLE A 4: PAH Concentrations
Laboratory Results- PAH - MN Slip- West Central Environmental Consultants
All results- ppm

Sample Location	Sample	**Total**	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benzo (a) anthracene	Benzo (a) pyrene	Benzo (b) fluoranthene	Benzo (ghi) perylene	Benzo (k) fluoranthene	Chrysene	Dibenzo (a,h) anthracene
3	WC-TH3 (8' heave)	21.38	**0.548**	<0.034	**0.888**	**1.583**	**1.330**	**1.302**	**0.556**	**1.155**	**1.736**	**0.127**
	WC-TH3 (6-7')	4.86	**0.140**	<0.034	**0.193**	**0.318**	**0.267**	**0.195**	**0.159**	**0.198**	**0.360**	<0.09
10	WC-TH10 (1-3')	19.27	**0.264**	<0.034	**0.797**	**1.704**	**1.366**	**1.462**	**0.476**	**1.500**	**1.697**	**0.123**
	WC-TH10 (6-8')	0.00	<0.036	<0.034	<0.032	<0.031	<0.038	<0.035	<0.03	<0.031	<0.034	<0.09
14	WC-TH14 (2-4')	269.95	**8.961**	<0.034 *	**13.19**	**19.09**	**14.12**	**11.17**	**7.154**	**11.64**	**19.49**	**1.867**
	WC-TH14 (6-8')	67.63	**2.398**	**0.051**	**3.064**	**4.748**	**3.847**	**3.635**	**1.588**	**2.232**	**4.872**	**0.435**
	WC-TH14 (10-12')	0.61	<0.036	<0.034	<0.032	**0.056**	**0.050**	**0.036**	<0.09	**0.046**	**0.060**	<0.09
18	WC-TH18 (0-4')	14.44	**0.251**	<0.034	**0.560**	**1.087**	**0.900**	**1.049**	**0.491**	**0.825**	**1.243**	**0.147**
	WC-TH18 (4-8')	19.98	**0.333**	<0.034	**0.678**	**1.622**	**1.350**	**1.199**	**0.644**	**1.175**	**1.815**	**0.158**
23	WC-TH23 (4-8')	45.17	**1.151**	<0.17 #	**1.901**	**3.272**	**2.302**	**1.755**	**1.281**	**2.228**	**3.526**	<0.45 #
27	WC-TH27 (3-5')	8.78	**0.181**	<0.034	**0.347**	**0.676**	**0.552**	**0.479**	**0.245**	**0.541**	**0.736**	<0.09
	WC-TH27 (6-7')	0.00	<0.036	<0.034	<0.032	<0.031	<0.038	<0.035	<0.09	<0.031	<0.034	<0.09
28	WC-TH28 (5' heave)	56.36	**1.404**	**0.106**	**1.895**	**4.169**	**3.497**	**3.456**	**1.564**	**3.165**	**4.554**	**0.380**
	WC-TH28 (6-9') !	32.00	**0.699**	<0.034	**1.123**	**2.383**	**2.030**	**2.085**	**0.924**	**1.920**	**2.726**	**0.247**
	WC-TH49 (6-9') !	14.50	**0.273**	<0.034	**0.445**	**1.102**	**0.912**	**0.878**	**0.508**	**1.033**	**1.249**	<0.09
29	WC-TH29 (6-8')	1.25	<0.036	<0.034	**0.071**	**0.100**	**0.081**	**0.058**	<0.09	**0.062**	**0.105**	<0.09
	WC-TH29 (9' heave)	1.25	<0.036	<0.034	**0.044**	**0.101**	**0.077**	**0.061**	<0.09	**0.103**	**0.121**	<0.09
	WC-TH29 (11')	0.00	<0.036	<0.034	<0.032	<0.031	<0.038	<0.035	<0.09	<0.031	<0.034	<0.09
Waste	WC-Comp.Waste	5.82	**0.144**	<0.034	**0.184**	**0.405**	**0.331**	**0.296**	**0.182**	**0.321**	**0.475**	<0.09
	Level 1 SQT	*1.6*	*0.0067*	*0.0059*	*0.057*	*0.110*	*0.150*				*0.170*	*0.033*
	Level II SQT	*23*	*0.089*	*0.130*	*0.850*	*1.100*	*1.500*				*1.300*	*0.140*

! Duplicate sample
 # Elevated "less than result" due to sample matrix
** Elevated "less than result" due to sample concentration*
Bolded values are individual PAH compounds above the reporting limit
All analytical results presented as dry weight concentrations

TABLE A 4: PAH Concentrations (Continued)
Laboratory Results- PAH - MN Slip- West Central Environmental Consultants
All results- ppm

Sample Location	Sample	7, 12-Dimethylbenz (a) anthracene	Fluoran-thene	Fluorene	Indeno (1,2,3-cd) pyrene	2-Methyl-naphthalene	Naph-thalene	Phenan-threne	Pyrene		
3	WC-TH3 (8' heave)	<0.045	**2.78**	**0.673**	**0.510**	**0.217**	**0.291**	**3.596**	**4.090**		
	WC-TH3 (6-7')	<0.045	**0.694**	**0.154**	**0.144**	**0.088**	**0.078**	**0.890**	**0.981**		
10	WC-TH10 (1-3')	<0.045	**2.912**	**0.330**	**0.504**	**0.250**	**0.260**	**2.132**	**3.489**		
	WC-TH10 (6-8')	<0.045	<0.04	<0.036	<0.08	<0.04	<0.033	<0.035	<0.03		
14	WC-TH14 (2-4')	<0.45 *	**36.43**	**10.52**	**7.861**	**4.727**	**10.64**	**47.92**	**45.17**		
	WC-TH14 (6-8')	<0.045	**7.108**	**2.782**	**1.581**	**0.867**	**1.264**	**14.81**	**12.35**		
	WC-TH14 (10-12')	<0.045	**0.094**	<0.036	<0.08	<0.04	<0.033	0.116	0.153		
18	WC-TH18 (0-4')	<0.045	**1.798**	**0.383**	**0.453**	**0.117**	**0.128**	**2.007**	**3.003**		
	WC-TH18 (4-8')	<0.045	**3.000**	**0.436**	**0.679**	**0.150**	**0.245**	**2.562**	**3.931**		
23	WC-TH23 (4-8')	<0.225 #	**6.525**	**1.438**	**1.301**	**0.490**	**1.021**	**8.510**	**8.473**		
27	WC-TH27 (3-5')	<0.045	**1.176**	**0.250**	**0.274**	**0.071**	**0.122**	**1.386**	**1.748**		
	WC-TH27 (6-7')	<0.045	<0.04	<0.036	<0.08	<0.04	<0.033	<0.035	<0.03		
28	WC-TH28 (5' heave)	<0.045	**7.347**	**1.504**	**1.607**	**0.568**	**0.892**	**9.067**	**11.18**		
	WC-TH28 (6-9') !	<0.045	**4.471**	**0.821**	**0.945**	**0.237**	**0.309**	**4.794**	**6.289**		
	WC-TH49 (6-9') !	<0.045	**1.856**	**0.315**	**0.461**	**0.152**	**0.189**	**2.037**	**3.089**		
29	WC-TH29 (6-8')	<0.045	**0.200**	**0.039**	<0.08	<0.04	<0.033	0.262	0.270		
	WC-TH29 (9' heave)	<0.045	**0.257**	<0.036	<0.08	<0.04	<0.033	0.216	0.274		
	WC-TH29 (11')	<0.045	<0.04	<0.036	<0.08	<0.04	<0.033	<0.035	<0.03		
Waste	WC-Comp.Waste	<0.045	**0.839**	**0.145**	**0.167**	**0.086**	**0.094**	**0.963**	**1.184**		
	Level 1 SQT		0.420	0.077		0.020	0.180	0.200	0.200		
	Level II SQT		2.200	0.540		0.200	0.560	1.200	1.500		

! Duplicate sample
 # Elevated "less than result" due to sample matrix
** Elevated "less than result" due to sample concentration*
Bolded values are individual PAH compounds above the reporting limit
All analytical results presented as dry weight concentrations

TABLE A 5: Copy of Table 14 from "Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment", Crane *et al.* 2000.

Table 14. Recommended Level I and Level II Sediment Quality Targets for the Protection of Sediment-dwelling Organisms

Chemical	Aquatic Life		
	Level I SQT	Level II SQT	Source†
Metals (in mg/kg DW)			
Arsenic§	9.8	33	MacDonald *et al.* (2000a)
Cadmium*§	0.99	5.0	MacDonald *et al.* (2000a)
Chromium§	43	110	MacDonald *et al.* (2000a)
Copper*§	32	150	MacDonald *et al.* (2000a)
Lead*§	36	130	MacDonald *et al.* (2000a)
Mercury	0.18	1.1	MacDonald *et al.* (2000a)
Nickel§	23	49	MacDonald *et al.* (2000a)
Zinc*§	120	460	MacDonald *et al.* (2000a)
PAHs (in µg/kg DW)			
2-Methylnaphthalene	20	200	CCME (1999)
Acenaphthene	6.7	89	CCME (1999)
Acenaphthylene	5.9	130	CCME (1999)
Anthracene*	57	850	MacDonald *et al.* (2000a)
Fluorene	77	540	MacDonald *et al.* (2000a)
Naphthalene*§	180	560	MacDonald *et al.* (2000a)
Phenanthrene*§	200	1200	MacDonald *et al.* (2000a)
Benz(a)anthracene*§	110	1100	MacDonald *et al.* (2000a)
Benzo(a)pyrene*§	150	1500	MacDonald *et al.* (2000a)
Chrysene*§	170	1300	MacDonald *et al.* (2000a)
Dibenz(a,h)anthracene	33	140	MacDonald *et al.* (2000a); CCME (1999)
Fluoranthene*	420	2200	MacDonald *et al.* (2000a)
Pyrene*§	200	1500	MacDonald *et al.* (2000a)
Total PAHs*§	1600	23000	MacDonald *et al.* (2000a)
PCBs (in µg/kg DW)			
Total PCBs*§	60	680	MacDonald *et al.* (2000a)
Pesticides (in µg/kg DW)			
Chlordane*	3.2	18	MacDonald *et al.* (2000a)
Dieldrin*	1.9	62	MacDonald *et al.* (2000a)
Sum DDD*	4.9	28	MacDonald *et al.* (2000a)

TABLE A 5, continued.

Table 14. Continued

Chemical	Aquatic Life		
	Level I SQT	Level II SQT	Source[†]
Pesticides (continued)			
Sum DDE*[§]	3.2	31	MacDonald *et al.* (2000a)
Sum DDT*	4.2	63	MacDonald *et al.* (2000a)
Total DDT*	5.3	570	MacDonald *et al.* (2000a)
Endrin	2.2	210	MacDonald *et al.* (2000a)
Heptachlor epoxide*	2.5	16	MacDonald *et al.* (2000a)
Lindane (gamma-BHC)	2.4	5	MacDonald *et al.* (2000a)
Toxaphene	0.1	32	NYSDEC (1999)[¥]
Mean PEC-Q	0.1	0.6	USEPA 2000a

SQT = sediment quality target; TEQ = toxic equivalent; PEC-Q = probable effect concentration quotient.
[†] Some SQT values were rounded to two significant figures from the original source.
* Reliable consensus-based TEC values that were adopted as Level I SQTs [i.e., predictive ability ≥75% and ≥20 samples below the TEC (MacDonald *et al.* 2000a)].
[§] Reliable consensus-based PEC values that were adopted as Level II SQTs [i.e., predictive ability ≥75% and ≥20 samples predicted to be toxic (MacDonald *et al.* 2000a)].
[¥] originally based on µg/g OC; assumed TOC = 1%.

TABLE A 6: Grain Size Analysis for Sample 14, 6 – 8 foot depth.

Sample ID: 14, 6 - 8 foot deep			
Starting Mass (g)		31.3	
Dry Mass (g)		26.9	
Sieve Mass (g)		23.1	
Moisture Content (%)		14.1	
	Sieve#	Weight (g)	Weight (%)
	4	0	0
	10	0.1	0.4
	18	0.3	1.1
	35	0.4	1.5
	60	3.6	13.3
	120	17.3	64.1
	200	1.5	5.6
	Fines	3.8	14.1
Sum		27	100
Sieve Loss		-0.1	-0.4

TABLE A 7: Grain Size Analysis for Sample 18, 4 – 8 foot depth.

Sample ID: 18, 4 - 8 foot deep			
Starting Mass (g)		92.3	
Dry Mass (g)		68.6	
Sieve Mass (g)		33.0	
Moisture Content (%)		25.7	
	Sieve#	Weight (g)	Weight (%)
	4	1.8	2.6
	10	1.7	2.5
	18	0.8	1.2
	35	0.6	0.9
	60	3.9	5.7
	120	20.2	29.7
	200	3.4	5.0
	Fines	35.6	52.4
	Sum	68	100
	Sieve Loss	0.8	2.4

TABLE A 8: Copy of Table 16 from "Sediment Remediation Scoping Project in Minnesota Slip, Duluth Harbor", Crane *et al.* 2002.

Table 16. Mean PEC-Q Values for Sediment Samples Collected from Minnesota Slip

Site Location	Core Section (cm)	Mean PEC-Q
98-MNS-02	0-5	1.6
98-MNS-03	0-5	1.3
98-MNS-04	0-5	0.66
MNS-99-01	0-5	0.72
MNS-99-02	0-5	0.68
MNS-99-03	0-5	0.71
MNS-99-04	0-5	1.1
MNS-99-05	0-5	0.75
MNS-99-06	0-5	0.76
98-MNS-02	0-15	1.8
98-MNS-03	0-15	0.86
MNS-99-01	0-15	0.73
MNS-99-02	0-15	1.0
MNS-99-03	0-15	0.97
MNS-99-04 (mean)	0-15	1.1
MNS-99-07	0-15	0.31
MNS-99-08	0-15	0.96
MNS-99-09	0-15	1.1
MNS-99-10	0-15	0.93
MNS-99-11	0-15	0.15
MNS-99-12	0-15	1.6
MNS-99-13 (mean)	0-15	1.3
MNS-99-14	0-15	0.98
MNS-99-15	0-15	0.97
MNS-99-16	0-15	0.82
MNS-99-17	0-15	1.2
MNS-99-18	0-15	0.97
98-MNS-02	15-30	1.3
98-MNS-03	15-30	1.6
MNS-99-01	15-30	1.5
MNS-99-02	15-28	0.86
MNS-99-03	15-30	1.7
MNS-99-04 (mean)	15-30	1.2
MNS-99-07	15-30	1.4
MNS-99-08	15-30	1.9

TABLE A 8, continued.

Table 16. Continued

Site Location	Core Section (cm)	Mean PEC-Q
MNS-99-09	15-30	2.2
MNS-99-10	15-30	1.9
MNS-99-11	15-30	0.26
MNS-99-12	15-30	1.3
MNS-99-13	15-30	1.8
MNS-99-13R	15-30	3.8
MNS-99-14	15-30	2.4
MNS-99-15	15-30	1.3
MNS-99-16	15-30	0.97
MNS-99-17	15-30	1.5
MNS-99-18	15-30	1.5
98-MNS-02	30-45	3.5
98-MNS-03	30-45	2.2
MNS-99-01	30-45	0.73
MNS-99-03	30-45	2.2
MNS-99-04	30-45	2.4
MNS-99-04R	30-45	1.3
MNS-99-07	30-45	0.35
MNS-99-08	30-45	2.2
MNS-99-09	30-45	1.4
MNS-99-10	30-45	1.5
MNS-99-11	30-45	0.62
MNS-99-13 (mean)	30-45	1.4
MNS-99-14	30-45	12.9
MNS-99-15	30-45	1.8
MNS-99-16	30-45	0.35
MNS-99-17	30-45	1.9
MNS-99-18	30-45	2.4
MNS-99-01	45-60	0.28
MNS-99-03	45-60	2.9
MNS-99-04 (mean)	45-60	9.4
MNS-99-09	45-58	1.7
MNS-99-13 (mean)	45-60	1.5
MNS-99-14	45-60	0.96
MNS-99-15	45-60	3.0
MNS-99-16	45-58	0.21
MNS-99-17	45-60	3.1

TABLE A 9: Field LIF and Laboratory Analytical Results.

Sample ID	Depth (ft)	LIF % Response	Total PAH (ppm)
18a	0-4'	1.8	14.4
18b	4-8'	3.9	20.0
23a	4-8'	5	45.2
29a	6-8'	2	1.2
29b	9' heave	0.8	1.3
29c	11'	0.4	0.0
27a	3-5'	0.9	8.8
27b	6-7'	0.7	0.0
10a	1-3'	1.8	19.3
10b	6-8'	0.3	0.0
3a	6-7'	8.2	4.9
3b	8' heave	1.2	21.4
14a	2-4'	4.2	270.0
14b	6-8'	8.1	67.6
14c	10-12'	1.1	0.6
28a	5' heave	1.9	56.4
28b	6-9'	5.7	32.0

4. Figures

FIGURE A 1: Comparison of US Steel and Minnesota Slip Contaminants of Concern.