Appendix H:

Sediment Quality Analysis

In July and August of 2015, the US Army Corps of Engineers (USACE), St. Paul District completed two sediment surveys of Boulanger Bend in lower pool 2 of the Upper Mississippi River (river miles 821-818). The purpose of the 2015 sediment surveys were to characterize the physical and chemical properties of the sediment for the Lower Pool 2 Channel Management Study: Boulanger Bend to Lock and Dam No. 2. The sample locations were randomly selected inside the footprint of the preferred alternative: The widening of the Boulanger Bend navigational channel and the placement of training structures outside of the channel (Figure 1). Below is a detailed description of the 2015 survey, including: sampling locations, depths, sampling methods, chemical and physical analyses, results and discussion.

2015 SURVEY

Sampling:

For the July survey, district staff drilled four boreholes and collected one composite sample per borehole. Two boreholes were located at the upstream section of the main channel dredge cut (boreholes 15-60M and 15-61M) and the other two boreholes were located inside the proposed upstream training structure (boreholes 15-58M and 15-59M). The composite samples were taken from roughly the upper 4 feet of surficial sediment for 15-60M and 15-61M and about the top two feet for 15-58M and 15-59M.

In early August 2015, 10 composite samples were collected from six new boreholes (four in the main channel cut and two inside the downstream training structure. The four main channel boreholes (15-67M, 15-69M, 15-71M and 15-72M) accounted for 8 composite samples, two samples from each hole (roughly split between a five foot upper sample and a 3 foot lower sample). The remaining two samples were from two boreholes inside the downstream training structure (15-68M and 15-70M), consisting of a single surficial 2.5 foot composite sample from each location.

A record of the boring depths and description of the material encountered are detailed in the boring logs shown in Figure 2.

All of the sediment samples from the July and August surveys were immediately processed after collection and sent on ice to ARDL, Inc., Mt Vernon, IL for physical and chemical analyses to determine grain size and contamination.

Analyses:

Metals, PCBs, pesticides, PAHs, cyanide, total organic carbon, percent moisture, percent solids, percent total volatile solids, selected inorganics and grain-size analyses were performed by ARDL, Inc. for each of the 14 composite samples plus 2 split QA/QC samples.

Results and Discussion:

The results of the grain size analyses showed that the sediment samples had a wide range of silt content. In general, finer material was found in samples that were: 1) inside the training structures, 2) further out from the channel centerline and 3) for the boreholes with multiple composite samples, the lower stratum samples were finer than their corresponding upper stratum samples. The samples with the least amount of silt was found in the furthest upstream boreholes, 15-60M and 15-61M. Table 1 shows the percentage of material that passed through the #200 sieve for each sample and their total organic carbon content (TOC). The role of sediment in chemical pollution is tied both to the particle size of sediment, and to the amount of particulate organic carbon associated with the sediment. Silt content is important, because finer material has more surface area for binding with contaminants, but as TOC increases, the affinity between the sediment and the contaminants also increases. As a result, greater TOC concentrations reduces the biological availability of many of the persistent, bioaccumulating and toxic organic contaminants, especially chlorinated compounds.

Table 1. Silt and Total Organic Carbon Composition of Composite Sediment Samples.

Sample ID	Percent of material passed through the #200 sieve	Total Organic Carbon mg/kg
P2-15-59M/1	97.2	14000
P2-15-58M/1	87.8	19000
P2/15-68M/1	81.6	19000
P2/15-71M/2	79.7	30000
P2/15-69M/2	77.3	27000
P2/15-70M/1	76.5	25000
P2/15-69M/1	75.5	35000
P2/15-71M/1	41.6	18000
P2/15-67M/2	32.1	12000
P2/15-72M/2	18.6	7000
P2/15-67M/1	17.7	6000
P2/15-72M/1	10.9	5400
P2-15-60M/1	3.9	1200
P2-15-61M/1	2.9	990

To ascertain the possible toxicity of the samples to the benthic environment, the chemical results were compared to the Minnesota Pollution Control Agency's (MPCA) sediment quality targets (SQTs) for the protection of sediment-dwelling organisms in Minnesota and the MPCA's Soil Reference Values (SRVs) that are used for upland placement suitability (Table 2). The SQTs consist of level I guidance for a high level of protection for benthic invertebrates and level II guidance for the moderate level of protection for benthic invertebrates.

The three furthest upstream main channel dredge cut boreholes (15-60M,15-61M and 15-72M) were mostly sand, but 15-60M had a SQT I exceedance of acenaphthylene, 15-61M had SQT I exceedances of acenaphthylene, acenaphthene and benzo(a) anthracene and the upper subsample of 15-72M had exceedances of acenaphthylene, benzo(a) anthracene, pyrene and benzo(a)pyrene. However, all of these exceedances were only minimally above the SQT I guidelines.

15-71M was the one sample collected in the middle portion of the dredge cut. This borehole was mainly composed of finer material. The high silt percentage in 15-71M is probably due to it being on the outside edge of the channel dredge cut where fines tend to buildup. In both the upper ~ 5 feet and the lower ~ 2.5 feet of the surficial sediment there were exceedances of several SQT I guidelines. 15-71M/1 had exceedances of acenaphthylene, acenaphthene, benzo(a) anthracene and benzo(a)pyrene. 15-71M/2 had SQT I exceedances of acenaphthylene and cadmium.

The next downstream channel borehole is 15-69M. The silt percentage of the material found in both stratums of 15-69M were similar to the lower stratum of 15-71M at around 75%. SQT I exceedances found in 15-69M includes: acenaphthylene and cadmium in 15-69M/1 and acenaphthylene, acenaphthene and cadmium in 15-69M/2.

The furthest downstream borehole in the channel dredge cut was 15-67M. 15-67M had SQT I exceedances in just in the lower stratum that included acenaphthylene and acenaphthene.

Of the four boreholes (15-58M, 15-59M 15-68M and 15-70M) located in the two training structures, 15-70M was the most concerning. The other three had several SQT I exceedances, but 15-70M had SQT II exceedances for acenaphthylene and pyrene and recreational SRV exceedances for benzo(a)pyrene and cadmium.

The recommended future action related to sediment quality for this study is to engage the MPCA to determine if the results of the 2015 surveys are acceptable to continue pursuing the preferred alternative. And specifically, does the results of the existing testing allow the construction of training structures on sediment containing levels of pollutants above SQT II and SRVs and are there any issues with widening the main channel, which has some sediment with minimal SQT I exceedances.

References for Sediment Quality

Crane, J.L. and S. Hennes. 2007. Guidance for the use and application of sediment quality targets for the protection of sediment-dwelling organisms in Minnesota. Minnesota Pollution Control Agency, St. Paul, MN. MPCA Doc. No. tdr-gl-04. (http://www.pca.state.mn.us/index.php/view-document.html?gid=9163)

Crane, J.L., D.D. MacDonald, C.G. Ingersoll, D.E. Smorong, R.A. Lindskoog, C.G. Severn, T.A. Berger, and L.J. Field. 2002. Evaluation of numerical sediment quality targets for the St. Louis River Area of Concern. Arch. Environ. Contam. Toxicol. 43:1-10

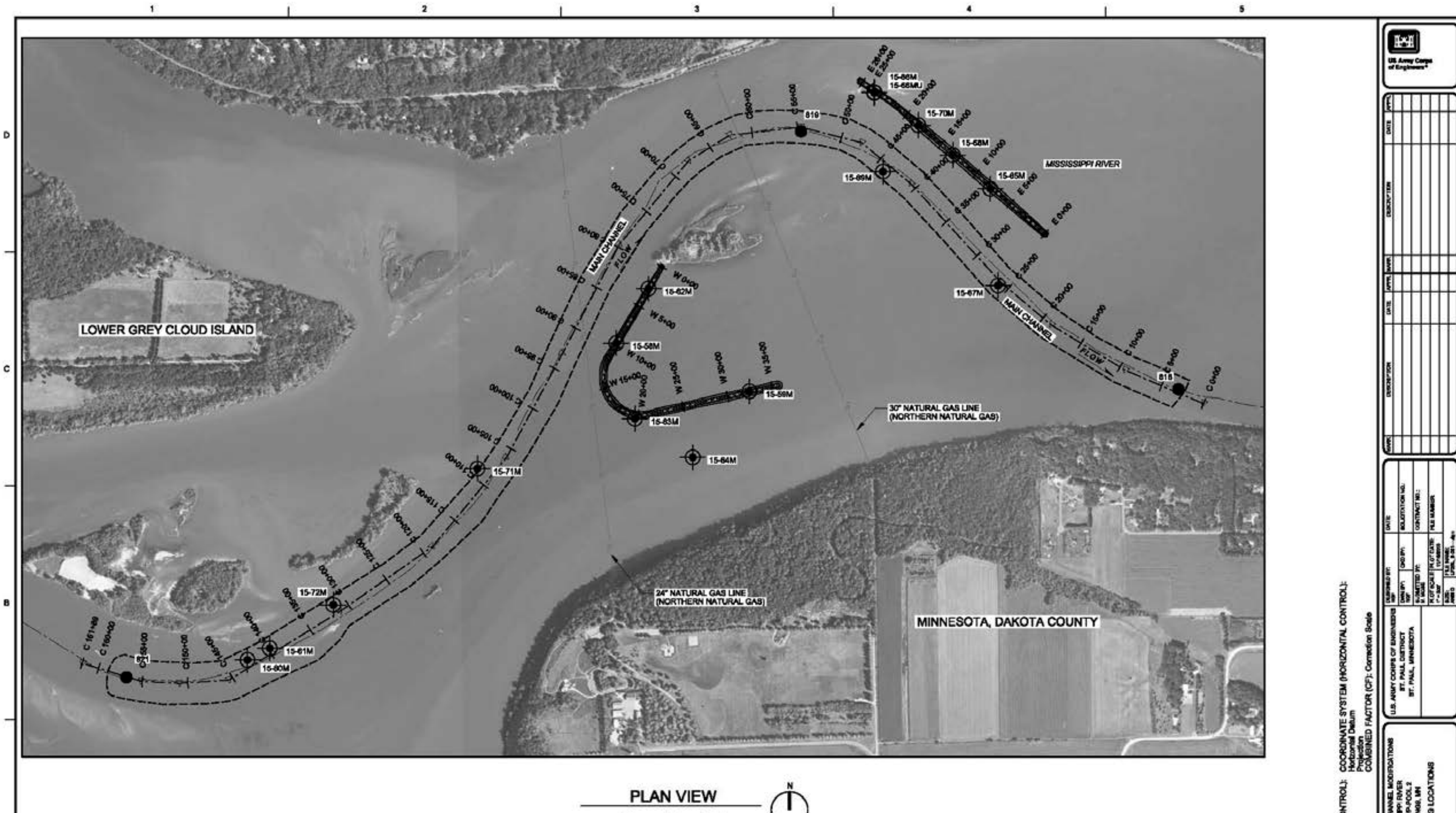
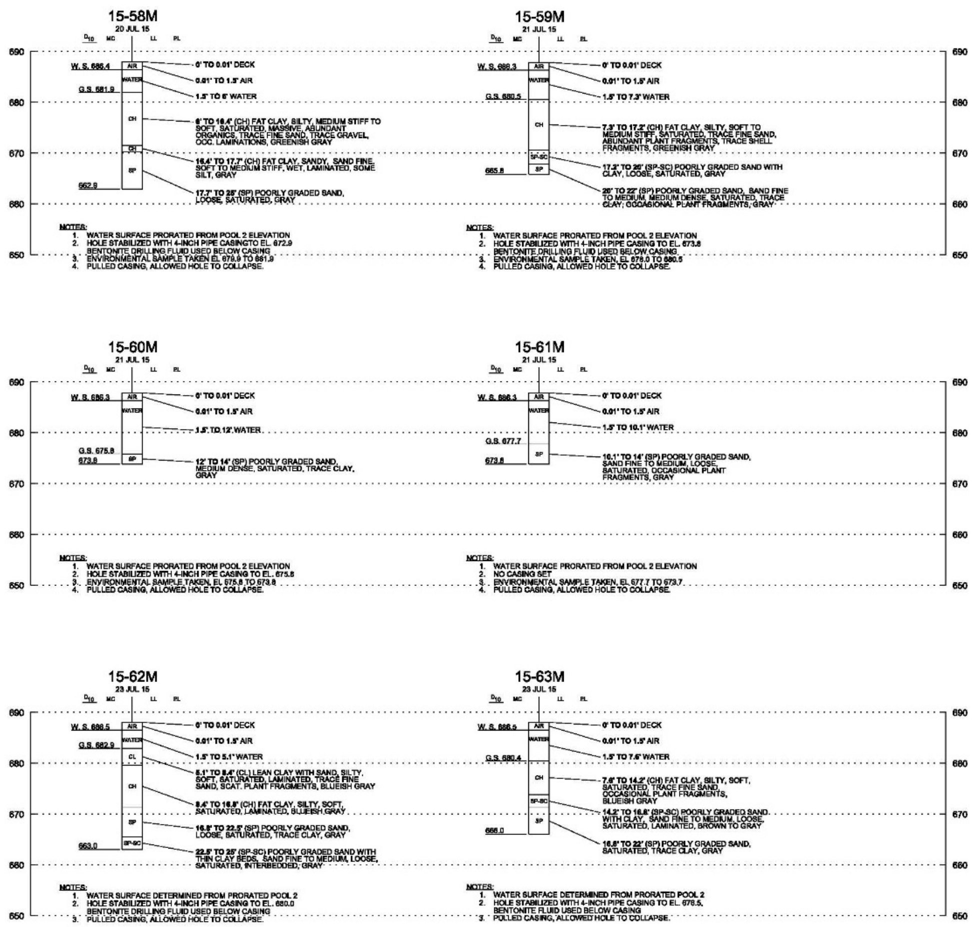


Figure 1. Map of Boulanger Bend, Lower Pool 2 Boreholes for Preferred Alternative - Main Channel Widening and Training Structures.

Figure 2. Boring Log

Boreholes for Preferred Alternative - Main Channel Widening and Training Structures.



GENERAL BORING LEGEND

84-1M	YEAR OF BORING-BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
1 MAY 1984	DATE OF BORING
W.S. 1026.7	WATER SURFACE ELEVATION ON DAY OF BORING
G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND - SILT MIXTURES
SC	CLAYEY SANDS, SAND - CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER
PT	THAN 50 PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
1	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 726.7	WATER LEVEL ON DATE OF BORING
700.1	ELEVATION AT BOTTOM OF BORING
(238.56)	ELEVATION IN METERS

GENERAL BORING NOTES

1. GENERAL: THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE SHOWN BELOW THE BORING STAFF.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING STAFF.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12-INCHES. STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST (SPT) USING A 1... X 2-INCH SAMPLER, 3#8 X 2-INCH SAMPLER, 140 LB. HAMMER, AND A 30-INCH DROP. FOR NON-STANDARD BLOW COUNTS SAMPLER SIZE, HAMMER WEIGHT, AND HEIGHT OF DROP ARE AS SHOWN.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT OF THE BORING STAFF.
6. RQD: ROCK QUALITY DESIGNATION (RQD) IS SHOWN TO THE LEFT OF THE PERCENT RECOVERY COLUMN. RQD IS THE PERCENT RECOVERY CONSISTING OF UNBROKEN PIECES LONGER THAN 4-INCHES.
7. % RECOVERY: PERCENT CORE RECOVERY IS SHOWN TO THE LEFT OF THE BORING STAFF. PERCENT RECOVERY IS LENGTH OF CORE RECOVERED/LENGTH OF CORE CUT X 100. UNLESS SPECIFIED OTHERWISE, ALL CORE IS 4-INCH DIAMETER.
8. ELEVATIONS REFERENCED TO N.G.V.D. 1929 ADJ. UNLESS SPECIFIED OTHERWISE.
9. THE BORINGS SHOW SUMMARIES OF INFORMATION RECORDED ON THE ORIGINAL FIELD LOGS. THESE LOGS ARE AVAILABLE FOR INSPECTION AT THE ST. PAUL DISTRICT OFFICE. ARRANGEMENTS TO INSPECT LOGS CAN BE MADE BY CALLING (651) 290-5599.

ELEVATION DATUM (VERTICAL CONTROL): NAVD 88 GEOID

COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD 83 (2007)

COMBINED FACTOR (CF):

U.S. ARMY CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL, MINNESOTA

BOULANGER BEND CHANNEL MODIFICATIONS
MISSISSIPPI RIVER
UMR-MVP-POOL 2
HASTINGS, MN

BORINGS LOGS NOTES AND LEGEND 15-58M TO 15-63M

Sheet ID B-200

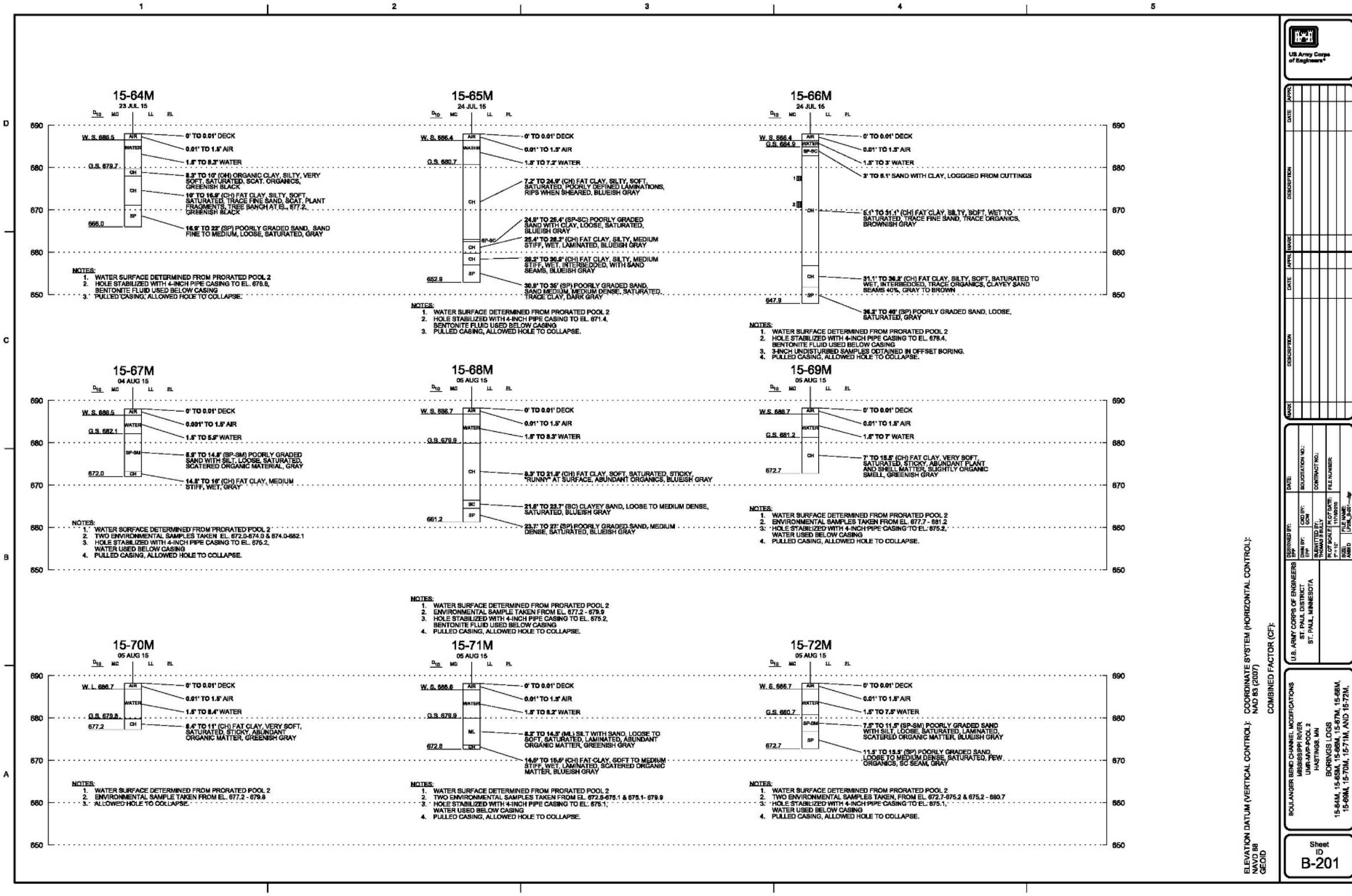

15-64M
23 JUL 15
W. S. 686.5
G.S. 679.7
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 8.3' WATER
8.3' TO 10' (OH) ORGANIC CLAY, SILTY, VERY SOFT, SATURATED, SCAT. ORGANICS, GREENISH BLACK
10' TO 16.9' (CH) FAT CLAY, SILTY, SOFT, SATURATED, TRACE FINE SAND, SCAT. PLANT FRAGMENTS, TREE BANCH AT EL. 677.2, GREENISH BLACK
16.9' TO 22' (SP) POORLY GRADED SAND, SAND FINE TO MEDIUM, LOOSE, SATURATED, GRAY
666.0
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 676.8, BENTONITE FLUID USED BELOW CASING
3. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-65M
24 JUL 15
W. S. 686.4
G.S. 680.7
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 7.2' WATER
7.2' TO 24.9' (CH) FAT CLAY, SILTY, SOFT, SATURATED, POORLY DEFINED LAMINATIONS, RIPS WHEN SHEARED, BLUEISH GRAY
24.9' TO 25.4' (SP-SC) POORLY GRADED SAND WITH CLAY, LOOSE, SATURATED, BLUEISH GRAY
25.4' TO 28.2' (CH) FAT CLAY, SILTY, MEDIUM STIFF, WET, LAMINATED, BLUEISH GRAY
28.2' TO 30.9' (CH) FAT CLAY, SILTY, MEDIUM STIFF, WET, INTERBEDDED, WITH SAND SEAMS, BLUEISH GRAY
30.9' TO 35' (SP) POORLY GRADED SAND, SAND MEDIUM, MEDIUM DENSE, SATURATED, TRACE CLAY, DARK GRAY
652.9
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 671.4, BENTONITE FLUID USED BELOW CASING
3. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-66M
24 JUL 15
W. S. 686.4
G.S. 684.9
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 3' WATER
3' TO 5.1' SAND WITH CLAY, LOGGGED FROM CUTTINGS
5.1' TO 31.1' (CH) FAT CLAY, SILTY, SOFT, WET TO SATURATED, TRACE FINE SAND, TRACE ORGANICS, BROWNISH GRAY
31.1' TO 36.2' (CH) FAT CLAY, SILTY, SOFT, SATURATED TO WET, INTERBEDDED, TRACE ORGANICS, CLAYEY SAND SEAMS 40%, GRAY TO BROWN
36.2' TO 40' (SP) POORLY GRADED SAND, LOOSE, SATURATED, GRAY
647.9
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 678.4, BENTONITE FLUID USED BELOW CASING
3. 3-INCH UNDISTURBED SAMPLES ODTAINED IN OFFSET BORING.
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-67M
04 AUG 15
W. S. 686.5
G.S. 682.1
0' TO 0.01' DECK
0.001' TO 1.5' AIR
1.5' TO 5.9' WATER
5.9' TO 14.8' (SP-SM) POORLY GRADED SAND WITH SILT, LOOSE, SATURATED, SCATERED ORGANIC MATERIAL, GRAY
14.8' TO 16' (CH) FAT CLAY, MEDIUM STIFF, WET, GRAY
672.0
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. TWO ENVIRONMENTAL SAMPLES TAKEN EL. 672.0-674.0 & 674.0-682.1
3. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 676.2, WATER USED BELOW CASING
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-68M
05 AUG 15
W. S. 686.7
G.S. 679.9
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 8.3' WATER
8.3' TO 21.8' (CH) FAT CLAY, SOFT, SATURATED, STICKY, "RUNNY" AT SURFACE, ABUNDANT ORGANICS, BLUEISH GRAY
21.8' TO 23.7' (SC) CLAYEY SAND, LOOSE TO MEDIUM DENSE, SATURATED, BLUEISH GRAY
23.7' TO 27' (SP) POORLY GRADED SAND, MEDIUM DENSE, SATURATED, BLUEISH GRAY
661.2
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. ENVIRONMENTAL SAMPLE TAKEN FROM EL. 677.2 - 679.9
3. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 675.2, BENTONITE FLUID USED BELOW CASING
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-69M
05 AUG 15
W.S. 686.7
G.S. 681.2
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 7' WATER
7' TO 15.5' (CH) FAT CLAY, VERY SOFT, SATURATED, STICKY, ABUNDANT PLANT AND SHELL MATTER, SLIGHTLY ORGANIC SMELL, GREENISH GRAY
672.7
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. ENVIRONMENTAL SAMPLES TAKEN FROM EL. 677.7 - 681.2
3. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 675.2, WATER USED BELOW CASING
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-70M
05 AUG 15
W. L. 686.7
G.S. 679.8
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 8.4' WATER
8.4' TO 11' (CH) FAT CLAY, VERY SOFT, SATURATED, STICKY, ABUNDANT ORGANIC MATTER, GREENISH GRAY
677.2
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. ENVIRONMENTAL SAMPLE TAKEN FROM EL. 677.2 - 679.8
3. ALLOWED HOLE TO COLLAPSE.
15-71M
05 AUG 15
W. S. 686.6
G.S. 679.9
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 8.2' WATER
8.2' TO 14.5' (ML) SILT WITH SAND, LOOSE TO SOFT, SATURATED, LAMINATED, ABUNDANT ORGANIC MATTER, GREENISH GRAY
14.5' TO 15.5' (CH) FAT CLAY, SOFT TO MEDIUM STIFF, WET, LAMINATED, SCATERED ORGANIC MATTER, BLUEISH GRAY
672.6
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. TWO ENVIRONMENTAL SAMPLES TAKEN FROM EL. 672.6-675.1 & 675.1- 679.9
3. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 675.1, WATER USED BELOW CASING
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
15-72M
05 AUG 15
W. S. 686.7
G.S. 680.7
0' TO 0.01' DECK
0.01' TO 1.5' AIR
1.5' TO 7.5' WATER
7.5' TO 11.5' (SP-SM) POORLY GRADED SAND WITH SILT, LOOSE, SATURATED, LAMINATED, SCATERED ORGANIC MATTER, BLUEISH GRAY
11.5' TO 15.5' (SP) POORLY GRADED SAND, LOOSE TO MEDIUM DENSE, SATURATED, FEW ORGANICS, SC SEAM, GRAY
672.7
NOTES:
1. WATER SURFACE DETERMINED FROM PRORATED POOL 2
2. TWO ENVIRONMENTAL SAMPLES TAKEN, FROM EL. 672.7-675.2 & 675.2 - 680.7
3. HOLE STABILIZED WITH 4-INCH PIPE CASING TO EL. 675.1, WATER USED BELOW CASING
4. PULLED CASING, ALLOWED HOLE TO COLLAPSE.
ELEVATION DATUM (VERTICAL CONTROL): NAVD 88 GEOID
COORDINATE SYSTEM (HORIZONTAL CONTROL): NAD 83 (2007)
COMBINED FACTOR (CF):
US Army Corps of Engineers
U.S. ARMY CORPS OF ENGINEERS ST. PAUL DISTRICT ST. PAUL, MINNESOTA
Sheet ID B-201

Table 2. Analytical results and MPCA sediment guidelines

SEDIMENT Data	Units		Parameter	MPCA SQT I	MPCA SQT II	MPCA Res/Rec Soil Reference Value (SRV)	MPCA Comm/Ind Soil Reference Value (SRV)	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut	Boulanger Cut
Pool								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sediment Surface Elev					Table 2. Results of Sediment Anayses			682.1	682.1	split 67M/1	679.9	split 68/M								681.9	680.5	675.8	677.7
													681.2	681.2	679.8	679.9	679.9	680.7	680.7				
Top of Sample Elev								682.1	675	682.1	679.9	679.9	681.2	675.2	679.8	679.9	675.1	680.7	675.2	681.9	680.5	675.8	677.7
Bottom of Sample Elev								675	672	675	677.2	677.2	675.2	672.7	677.2	675.1	672.6	675.2	672.7	679.9	678	673.8	673.7
Lab								ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC	ADRL, INC
Lab ID								008050-01	008050-02	008050-03	008050-04	008050-05	008050-06	008050-07	008050-08	008050-09	008050-10	008050-11	008050-12	008043-01	008043-02	008043-03	008043-04
Corps ID								P2/15-67M/1	P2/15-67M/2	P2/15-67M/3	P2/15-68M/1	P2/15-68M/2	P2/15-69M/1	P2/15-69M/2	P2/15-70M/1	P2/15-71M/1	P2/15-71 M/2	P2/15-72M/1	P2/15-72M/2	P2-15-58M/1	P2-15-59M/1	P2-15-60M/1	P2-15-61M/1
Date Collected								8/4/2015	8/4/2015	8/4/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	8/5/2015	7/20/2015	7/21/2015	7/21/2015	7/21/2015
	ug/kg		Acenaphthylene	5.9	130			5.65	9.29	2.22 J	93.9	90.9	8.9	8.7	285	9.36	10.9 J	19.3	3.41 J	ND	ND	9.25	11.5
	ug/kg		Acenaphthene	6.7	89	1300000	19000000	2.87 J	11. 7	1.67 J	31.1	14	6.35 J	22.1	70	7	6.45 J	4.23	1.78 J	ND	ND	2.34 J	7.37
	ug/kg		Anthracene	57	850	6500000	97000000	8.13	21.9	7.93	228	85.7	21. 2	26	247	17.7	14	41. 0	5.03	ND	ND	25.7	43.6
	ug/kg		Fluoranthene	420	2200	510000	6700000	75.9	167	73.6	980	459	196	177	1320	212	172	190	57	1.52 J	1.02 J	128	171
	ug/kg		Pyrene	200	1500	44000		71.3	157	64.1	1380	564	176	176	1580	191	155	215	54.1	1.55 J	1. 28 J	143	187
	ug/kg		Benzo(a) anthracene	110	1100			39.8	92	35.3	713	390	101	83.8	1060	111	82.2	155	26.8	ND	1.13 J	78.6	113
	ug/kg		Benzo(b)fluoranthene					65.3	140	59	821	466	191	178	1400	219	175	203	58.1	1.61 J	1.82 J	97.9	144
	ug/kg		Benzo(k)fluoranthene					16.8	43.9	18	226	154	49.3	53.5	421	62.3	49.6	63.8	18	ND	ND	28.9	44.3
	ug/kg		Benzo(a)pyrene	150	1500	1000 ***	14000***	45.8	100	38.I	829	457	103	89.6	1150	122	97.9	177	31.1	ND	ND	80.5	115
	ug/kg		Benzo(g,h,i)perylene					29	48.6	19.8	524	176	34.7	27.7	523	30.4	56.8	36.4	10.3	ND	ND	28.3	38.2
	ug/kg		Hexachlorobenzene					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		Chlordane trans isomer					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Organics	ug/kg		Chlordane cis isomer	3.2*	18*	7000 *	75000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		P, P' -DDE	3.2	31	13000	70000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		O, P' -DDD					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.64
	ug/kg		Dieldrin	1.9	62	110	1500	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		O, P'-DDE					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		O, P' -DDT					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		P, P' -DDD	4.9	28	19000	100000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		P, P' -DDT	4.2	63	7300	86000	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		PCB 1016					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		PCB 1248					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		PCB 1254					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		PCB 1260					ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	ug/kg		Total PCBs	60	680	620	8200	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	mg/kg		Arsenic	9.8	33	9	9	1.5	2.5	1. 7	3	2.9	5.4	2.3	2.2	ND	2.3	0.68	ND	2.8	3.9	ND	ND
	mg/kg		Cadmium	0.99	5	1.6	23	0.69	0.75	0.47	1.4	1. 3	1.4	1.4	1. 7	0.77	1. 3	0.4	0.51	1.3	1.4	0.27	0.26
	mg/kg		Chromium	43	110	23000	100000	7.3	10.3	7.4	20.7	19.4	19.6	19.8	22.2	11.1	18.9	5.6	8.1	18.2	19	8.6	4.9
	mg/kg		Copper	32	150	2200	33000	3.8	6.9	3.7	15.5	16.8	15.7	17.8	22.5	8	16.7	2.2	4.2	13.6	14.1	1.6	1. 8
Metals	mg/kg		Lead	36	130	300	700	3.4	21.2	3.5	13.8	17.4	10.1	10.5	34	5.8	11.2	2.8	3.9	6.8	7.3	1. 5	2
	mg/kg		Manganese			2100	21000	240	504	222	859	668	1230	1420	629	485	1090	176	358	1150	701	141	131
	mg/kg		Mercury	0.18	1.1	3.1 **	3.1	ND	ND	ND	0.16	0.21	ND	0.13	0.54	ND	ND	ND	ND	ND	ND	ND	ND
	mg/kg		Nickel	23	49	170	2600	5.9	8	5.6	16.2	14.9	16.4	15.9	14. 8	8.9	15	4.6	5.7	19.1	19.5	4.9	3.6
	mg/kg		Zinc	120	460	4600	70000	21.3	35.3	25	66.1	73.4	75.1	73.6	113	37.1	72 .3	15.9	22.7	72 .1	80.8	11.4	14.3
	mg/kg		Chromium (VI)			11	57	ND	2.2	ND	5.4	2.7	6.6	4.6	3.4	ND	5	ND	ND	5.7	3.5	ND	ND
	mg/kg		Ammonia Nitrogen					36.1	184	34.8	154	173	488	508	326	445	200	72 .1	165	110	98	12.4	18.4
	mg/kg		Cyanide, Total			13	190	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	%		Moisture					22.3	26.3	21.4	32.9	32.8	48.5	44	40.6	31.5	44.4	22.3	23.3	33.1	33.5	20.5	22.1
	mg/kg		Phenol					ND	ND	ND	ND	ND	ND	ND	ND	ND	84	ND	ND	ND	ND	ND	ND
Inorganics	mg/kg		Phosphorus					377	181	317	687	524	749	633	632	502	634	336	341	480	505	284	235
	%		Solids, Percent					77.7	73.7	78.6	67.1	67.2	51.5	56	59.4	68.5	55.6	77.7	76.7	66.9	66.5	79.5	77.9
	%		Solids,Total Volatile					ND	1. 5	ND	2.8	2.9	3.2	3.4	3.1	1.6	2.8	ND	ND	2.4	2.4	4.2	ND
	mg/kg		Total Kjeldahl Nitrogen					508	697	259	1400	1500	2340	2420	2170	903	2140	137	458	1280	1200	99.6	ND
	mg/kg		Total Organic Carbon					6000	12000	6500	19000	19000	35000	27000	25000	18000	30000	5400	7000	19000	14000	1200	990
		coarse	4					100	100	100	100	100	100	100	99.9	100	100	100	100	100	100	99.9	99.9
			10					100	100	100	100	99.9	100	100	99.8	100	99.9	100	100	100	100	99.5	99.8
PARTICLE SIZE % FINER	SAND	medium	20					99.7	99.9	99.6	99.9	99.7	99.9	99.4	99.8	99.9	99.9	99.9	99.8	99.9	99.9	94.2	97.8
			40					99	99.8	98.6	99.6	99.2	99.7	98.6	99.7	99.7	99.8	98.7	96.7	99.6	99.3	72	89.7
		fine	60					97	99.4	95.8	99	98.1	99	97.1	99.3	99.2	99.4	91	86.4	97.1	98.8	43	66.3
			140					25.9	45.2	24.3	88.5	82.4	82.6	81.3	85.7	59.3	87.4	17	25.2	90	98.3	4.6	4
	SILT	clay	200					17.7	32.1	15.6	81.6	75.3	75.5	77.3	76.5	41.6	79.7	10.9	18.6	87.8	97.2	3.9	2.9

* Chlordane
** Mercury (inorganic)
*** Benzo[a]pyrene (BaP equivalents)

Level I SQT – Chemical concentrations which will provide a high level of protection for benthic invertebrates.

Level II SQT – Chemical concentration which will provide a moderate level of protection for benthic invertebrates.

2015 draft MPCA Res/Rec Soil Reference Value (SRV)

J - Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the mass spectral data indicate the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than zero.