Volume II

Final
Basis of Design Report

Lower Fox River and Green Bay Site

Brown, Outagamie, and Winnebago Counties, Wisconsin

Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

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Shaw® Shaw Environmental, Inc.
ANCHOR ENVIRONMENTAL, L.L.C.

APPENDIX A
TECHNICAL MEMORANDA AND CALCULATIONS

BASIS OF DESIGN REPORT

LOWER FOX RIVER AND GREEN BAY SITE
BROWN, OUTAGAMIE, AND WINNEBAGO COUNTIES, WISCONSIN

Prepared by:
Shaw Environmental & Infrastructure, Inc.
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Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

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Attachment A –

Correction of Geotechnical Properties for Core Compaction

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	**CALC NO.** 1	**SHEET** 1 of 2
SUBJECT: Correction of Geotechnical Properties for Core Compaction		

Purpose: Correct the geotechnical properties to account for sampling-induced core compaction

Given: Geotechnical samples were collected during the 2004/2005 RD investigations using a vibracore. The process of vibracore typically tends to compact the sample relative to in situ conditions.

Assumptions: Core compaction results from the expulsion of pore water. Therefore, core compaction affects only the volume of water and total volume of a sample. Mass of solids is conserved. Saturation is assumed to be 100% for subaqueous sediment.

1.) Convert each moisture content measurement to compaction-correct value

dry density, corrected = dry density * R

$$\frac{(\gamma_w)(G_s)}{1+(S)(w^*)(G_s)} = \frac{(\gamma_w)(G_s)(R)}{1+(S)(w)(G_s)}$$ (Das 1994)

Where:
w = uncorrected moisture content (as sampled); [%]
w^* = corrected moisture content; [%]
R = percent recovery of core; defined as recovery depth/penetration depth, [%]
G_s = specific gravity
γ_w= unit weight of water; [62.4 pcf]
S= saturation; [assumed to be 100%]

Rearranging:

$$1+(w^*)(G_s) = \frac{1}{R} + \frac{(w)(G_s)}{R}$$

$$w^* = \frac{w}{R} + \left(\frac{1}{G_s}\right)\left(\frac{1}{R} - 1\right)$$

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE

ANCHOR ENVIRONMENTAL, L.L.C.

DESIGNER:	P. LaRosa	**DATE:**	1/6/06	**CALC. NO.:**	1	**REV.NO.:**	0
PROJECT:	Lower Fox River Remedial Design			**CHECKED BY:**	J. Verduin	**CHECKED DATE:**	1/7/06
SUBJECT:	Geotechnical Properties						

2.) Use the compaction correct moisture content data to calculate compaction corrected percent solids for each sample

$$\%solids^* = \frac{1}{1 + w^*}$$

Where:
% Solids* = compaction corrected percent solids; [%]
w^* = corrected moisture content; [%]

3.) Use the compaction correct moisture content data to calculate compaction corrected bulk and dry density values for each sample

$$\gamma_d = \frac{(\gamma_w)(G_s)}{1 + (S)(w^*)(G_s)}$$

$$\gamma_b = (1 + w^*)\gamma_d$$ (Das 1994)

Where:
γ_b= bulk density of sediment; [pcf]
γ_d= dry density of solids; [pcf]
S= saturation; [assumed to be 100%]
w^* = corrected moisture content; [%]
G_s = specific gravity
γ_w= unit weight of water; [62.4 pcf]

4.) Compute weighted average percent solids and dry density of sediments targeted for dredging under ROD or Optimized Remedy

A weighted average approach was used to calculate the percent solids and dry density of the sediments targeted for dredging. The corrected depth of each sample was compared to the target dredge depth to determine if the sample was collected within the target dredge prism. The Thiessen polygons were then used to determine the relative area that each sample represents within the river. Therefore a sample collected within a large polygon area targeted for dredging was weighted more heavily in the average than a sample representing only a small area. See "Sediment Processing Calculations" in Appendix A for additional details of the methods used to evaluate the characteristics of the in situ sediment.

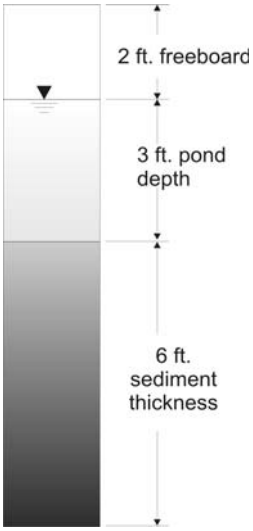
Attachment B –
Sizing of NR 213 Basin for ROD Remedy

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	**CALC NO.**	**SHEET** 1 of 5
SUBJECT: Sizing of NR 213 Basin for ROD Remedy		

An analysis of the sizing of the NR213 Settling Basin for the ROD remedy has been conducted. This analysis has been conducted with comparison of a preliminary analysis for the ROD Remedy made by Mike Palermo Consulting (memo dated 4/11/05). For the conditions expected for dredging, sand removal, settling, and dewatering, a total of four (4), equal-volume settling basins (cells) are planned. The size of each settling cell is selected to have the capacity to handle the hydraulic loadings and the storage requirements in a given year.

The sizing of each cell is based on the following configuration at the end of the loading cycle:



Sediment storage will likely control the sizing of the cells. Additional dewatering after the loading period will reduce the sediment thickness and the pond depth will also be reduced to promote dewatering.

Based on the assumptions of the analysis and details described below, <u>the minimum cell area is 68 Ac</u>. The required storage volume, without consideration of side slopes, is 653,000 cy (405 Ac-ft.). With 6 ft. sediment thickness, 3 ft. pond depth and 2 ft. freeboard, the minimum cell volume is 742 Ac-ft. Four, equal-volume cells would occupy a footprint of at least 272 Ac plus the area required for side slopes and other operational requirements.

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE
1	Updated percent solids estimates for ROD Remedy	GRE	JOS1	2/13/06	2/13/06

The following notes and Table 1 are provided as additional detail for the preliminary analysis.

1. Dredging rates are the very similar to those presented by Mike Palermo Consulting (memo dated 4/11/05, used for BODR planning discussions). However, the number of active dredging days per year has been reduced from 180 days to 154 days.
2. The ROD Remedy is based on hydraulic dredging of OU2, OU3 and OU4, over a 10-year period. Dredged sediment will be desanded (OU3 and OU4 only), but the bulk of the sediment and dredge flow will be delivered to the NR 213 Settling Basin via a specially designed sediment transfer pipeline.
3. Sizing is based on parameters for OU4 dredging (2 dredges at 48% efficiency), which is most critical in terms of flow and loading of the NR213 Basin. OU3 dredging will be conducted with only one dredge at 50% efficiency, so the flow rates will be approximately one-half of the rates for OU4.
4. In situ properties have been modified. Based on an analysis of sediment areas that are planned to be dredged, the specific gravity is expected to be 2.43 and the in situ percent solids is expected to be 35.5%.
5. Dredge concentration (percentage of in situ volume compared to the dredge stream volume) is assumed to be 14%. Although this is identical to the conditions assumed by Mike Palermo Consulting, the differences in the *in situ* conditions lead to a lower percent solids in the dredge stream (6.1% vs. 7.3%).
6. ROD Remedy assumes sand removal from dredge stream. This reduces the solids loading and volumetric flow delivered to the NR213 Basin. The specific gravity of the desanded sediment also is reduced. The pipeline flow is expected to be 70,700 cy/d with 4.6% solids during OU4 dredging.
7. The assumed percent solids for bulk sediments in storage is 31.2%. This value is less than the 35.2% solids expected under the parameters used by Mike Palermo Consulting (on the basis of settling results and the SETTLE model), but is consistent with percent solids levels that could be deduced from the column settling tests at settling times of 11d or more.
8. Actual percent solids in the NR 213 Basin near the end of the loading period is expected to be at least 35% or higher, since several months of consolidation time is available. Dewatering to 37.3% solids leads to a 20% reduction in sediment storage volume. Dewatering to 41.3% solids leads to a 30% reduction in sediment storage volume.
9. After loading cycle is complete, sediment will remain in the dewatering cell for approximately two more years to dewater passively to 50% solids. Once dewatered to 50% solids, sediments would be removed from the basin and hauled by truck to one or more project-approved landfills.

10. The hydraulic efficiency of the basin was assumed to be 50%. The hydraulic efficiency is dependent on the geometry of the basin. Achieving favorable hydraulic performance is promoted by desanding, but will likely require additional planning, updated process calculations, and in-field measures to maintain flow uniformity and an even depth profile of the settled sediment. Although most of the sediment is expected to settle within the basins, additional water treatment processes are expected to follow sedimentation and additional removal of suspended solids may be needed to achieve effluent with low TSS.
11. For all cases considered here, the pipeline flow in any given dredging day is assumed to be maintained at a constant rate, even when the dredge is not operating. Some reduction in flow will likely be possible. Similarly, the sediment loading to the NR 213 basin is expected to be minor during the inactive dredging periods, but full flow from the pipeline is assumed to be delivered to the NR 213 basin. Some reduction of hydraulic loading from the pipeline to the basin during low solids loadings will also be possible if a bypass to water treatment was allowed.
12. Hydraulic residence time in the pond is 2.3 d and settling is expected to operate with an effective overflow rate of 0.65 ft./d. Further modifications to the design, such as reducing the sediment thickness, increasing the footprint area, or modifying the loadings from the pipeline would increase the hydraulic residence time and decrease the overflow rate. This would generally improve settling conditions and effluent quality.

The sequencing of four cells within the NR 213 Basin is planned as a simple, serial plan (see below). Beginning year one, at least two cells would be available. Each cell will follow a four-year staging plan. The plan allows for one year of sediment loading (fill stage F), two years for dewatering (DW), and one year for load-out to trucks for hauling dewatered sediment to the landfill (load-out stage LO).

NR 213 Basin Sequencing Plan for ROD Remedy

Project Year	OU dredged	Flow (gpm)	Cell and Sequencing			
			1	2	3	4
1	2,3	5000	F			
2	3	5000	DW	F		
3	3,4	10,000	DW	DW	F	
4	4	10,000	LO	DW	DW	F
5	4	10,000	F	LO	DW	DW
6	4	10,000	DW	F	LO	DW
7	4	10,000	DW	DW	F	LO
8	4	10,000	LO	DW	DW	F
9	4	10,000	F	LO	DW	DW
10	4	10,000	DW	F	LO	DW
11	4	10,000	DW	DW	F	LO
12			LO	DW	DW	
12				LO	DW	
13					LO	

F = Fill stage
DW = passive dewatering stage
LO = Load-out for landfill disposal stage

There are several attributes of the plan that suggest a conservative plan in terms of cell capacity and dewatering:

1. Cells are sized conservatively. Initial settling over loading cycle to 31.2% solids provides adequate capacity. However, a greater degree of dewatering over the one-year period of loading is expected. As mentioned above, dewatering to 37.3% solids leads to a 20% reduction in the stored sediment volume.

2. Sizing of cells is based on loading rates that will be effective during dredging of sediment from OU4. Over the first two years of the project for the ROD Remedy, OU2 and OU3 will be addressed with only one dredge, so the flow rate is generally half that expected for OU4. Cells 1 and 2 are twice as big as needed to address OU2 and OU3 in the first two years. These cells will, therefore, have additional storage capacity in the first three years of operation.

3. For the first three years, at least one additional cell will be freely available for loading as a contingency measure for poor settling performance, problems requiring maintenance in the cell that is actively in the fill stage, or other problems. For subsequent years, it is reasonable to expect that dewatering in other cells will provide a significant overflow storage capacity - if there are problems with the cell undergoing an active fill stage.

4. Dewatering periods of 2 years is likely adequate. If dewatering occurs at a faster rate, greater flexibility in operations will be provided.

5. A pond depth of 3 ft. over the settled sediment can be drained after the cell is loaded (at the end of a fill stage). This provides some short-term, emergency overflow capacity.

While future stages of design may reduce the level of redundancy in storage and overflow capacity, it will likely be very important to allow conservative sizing of the basins so that high flow rates from the dredge and pipeline operations can be maintained.

DESIGNER: GRE **DATE:** 8/01/05 **CALC. NO.:** **REV.NO.:** 1

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** JOS1 **CHECKED DATE:** 2/13/06

SUBJECT: Sizing of NR 213 Basin for ROD Remedy

Table 1. Process variables, parameters, and calculated quantities for preliminary sizing of NR213 Basin for ROD Remedy.

Process variable or parameter	Units	Mike Palermo Consulting, 4/11/05 memo		ROD Remedy, BODR
		5 ft. sediment thickness, 180d of dredging per year at 50% efficiency	6 ft. sediment thickness, 180d of dredging per year at 50% efficiency	6 ft. sediment thickness, 154d of dredging per year at 48% efficiency
dredge efficiency		**50%**	**50%**	**48%**
number of dredges		**2**	**2**	**2**
hourly removal rate per dredge	cy/h	**208.07**	**208.07**	**208**
dredging days per year	d	**180**	**180**	**154**
daily removal rate	cy/d	4994	4994	4792
in situ volume removed per year	cy	898,862	898,862	738,017
Specific Gravity		**2.47**	**2.47**	**2.43**
Percent Solids, in situ		**41%**	**41%**	**35.5%**
dredge, percent vol. as in situ		**14%**	**14%**	**14%**
percent solids in dredge during dredging		7.26%	7.26%	6.06%
total dredge flow	cy/d	35669	35669	34231
total dredge flow (during dredging)	gpm	10,006	10,006	10,002
Mass removal of sand				**25%**
Water content of sand (removed with sand)				**0.20**
Dry tons of sand removed per year	ton			69,747
Reduction in total dredge flow	cy/d			310
Reduction in total dredge flow (during dredging)	gpm			91
Pipeline flow (during dredging)	gpm	10006	10006	9912
Percent flow maintained when dredge is off		**100%**	**100%**	**100%**
Pipeline flow (daily average)	gpm	10006	10006	9912
Pipeline flow (daily average)	cy/d	71338	71338	70668
Pipeline percent solids (during dredging)		7.26%	7.26%	4.63%
Specific gravity, adjusted for sand removal		2.47	2.47	**2.36**
bulking factor for storage, in situ vol. basis		**1.22**	**1.22**	0.88
bulking factor for storage, pipeline vol. basis		0.171	0.171	0.125
percent solids in storage		35.2%	35.2%	**31.2%**
sed. volume at end of filling	cy	1,096,612	1,096,612	652,950
Fill limit, sediment thickness	ft.	**5.0**	**6.0**	**6.0**
Ponding depth	ft.	**3.0**	**3.0**	**3.0**
Free board	ft.	**2.0**	**2.0**	**2.0**
Percent of pipeline flow to basin when dredge is off		**100%**	**100%**	**100%**
Basin Flow (daily average)	cy/d	71338	71338	70668
volume with ponding depth	cy	1,754,579	1,644,918	979,425
Days to fill volume, initial	d	25	23	14
Total volume (with pond and freeboard)	Ac-ft	1359	1246	742
Area required, w/o side slopes	Ac	136	113	67.5
Hydraulic efficiency of basin		**44%**	**44%**	**50%**
Volume of pond, filled	cy	657,967	548,306	326,475
Hyd. Residence Time in Pond	d	4.1	3.4	2.3
Overflow rate (cu. ft. per day per sq. ft.)	ft./d	0.33	0.39	0.65

Attachment C –
Sizing of Dewatering Landfill for Optimized Remedy

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	CALC NO.	SHEET 1 of 9
SUBJECT: Sizing of Dewatering Landfill for Optimized Remedy		

SUMMARY

These notes summarize the preliminary sizing of the dewatering landfill. The sizing is based on the following design concepts and assumptions:

1. The dewatering landfill will receive mechanically dredged sediments from OU2 and OU3 by truck, and hydraulically dredged and desanded sediment from OU3 and OU4 via pipeline. Only non-TSCA sediments will be received. Dewatering landfill will provide for adequate storage of sediment, allow for loading by truck and pipeline flows, provide adequate area for settling/compression of sediment, provide outflow hydraulic structures to handle clarified water, and will provide containment and monitoring measures for long-term disposal of the sediments.

2. The landfill liner will consist of a composite geosynthetic membrane liner, and will be designed and operated to meet requirements of the current Wisc. Admin. Code NR500 for solid waste disposal facilities. During operation, the landfill will operate like a lagoon or confined disposal facility (CDF). Effluent will be pumped to a water treatment facility prior to discharge.

3. Details of *in situ* volumes, average removal rates, and other process details are summarized by OU in Table 1. Table 1 is useful primarily for the description of total volumes and weights. Total *in situ* volume addressed is 3,486,000 cy, with more than 93% of the volume coming from OU4.

4. Total, dewatered sediment volume for disposal is 1,472,000 cy and wet tonnage is 1,737,000 tons after settling and consolidation to 50% solids. However, sizing of dewatering landfill will be based on hydraulic loadings and short-term storage conditions for sediment at 20-40% solids.

5. Scheduling of sediment dredging and estimated volumes and tonnages delivered to the landfill are summarized in Table 2. First year of operation will address mechanically dredged and trucked sediment from OU2 and OU3, and the beginning of hydraulically dredged and desanded sediment from OU3 and OU4 (delivered by pipeline). Subsequent years (2-8) will address the remaining sediment in OU4.

6. Hydraulic loading is highest for OU3 and OU4 (see Table 2) in years 2 through 8 (daily average flow roughly 5000 gpm). This assumes that pipeline flow rate in any given dredge day is maintained

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE
1	Optimized Remedy Volumes, % solids in situ	GRE	JOS1	2/14/06	2/14/06

Foth & Van Dyke

even when dredge is not operating. This also assumes full delivery of pipeline flow to the dewatering landfill, even when the dredge is off.

7. Process calculations are not presented here in detail, although processing conventions and equations are addressed in the BODR appendix notes on process calculations. Details of rates, total quantities, and other process parameters are identified in the tables below (Tables 1-3). Table 3 is used to describe hydraulic and sediment loadings during peak years of operation.

8. Although most of the sediment will be captured by sedimentation within the dewatering landfill, some fine particles may pass the dewatering landfill and will need to be removed by post-sedimentation water treatment processes. For this reason, the sizing of the dewatering landfill will be based primarily on sediment storage capacity for some intermediate dewatering condition.

Based on the design concept and assumptions, a preliminary estimate for the required sediment settling area is 36 acres (see Table 3). This area is based on annual storage requirements for a 7.0 ft. thick lift thickness at 30% solids. For hydraulic loading conditions for OU4, a 6.0 ft. ponding depth and a 50% hydraulic efficiency, the hydraulic residence time would be 4.9 days and the overflow rate would be 0.61 ft./d.

Although the 36 acre area may be divided into two or more cells, the entire 36 acre area will be needed for each year of dredging, to provide for the expected loadings of water and sediment. Additional area (and storage volume) will likely be required for operational logistics at the landfill, and as a contingency measure to provide continuous operation of the pipeline. This will be addressed in subsequent design stages.

A simplified, conservative estimate for the peak fill height of sediment would be 49 ft. (based on 30% solids and a total sediment volume of 2,847,000 cy). For 50% solids (1,472,000 cy), the fill height over 36 acres would be approx. 25 ft. Actual sediment fill height is estimated to be between 25 and 49 ft., but will depend on the configuration of side slopes, internal drainage layers, and the effective settling and consolidation of the sediment. Annual, internal drainage and cover layers will affect overall fill height and design capacity, and will be addressed in subsequent design stages.

Comparison to Confined Disposal Facility (CDF) from Detailed Evaluation of Alternative (DEA) report.

The sizing details provided here (Table 3) also includes a comparison to NR 500 Dewatering Landfill addressed in the DEA report (Table 7-2 in the DEA report). The concept of the CDF is different than a dewatering landfill. However, it is useful to use the DEA analysis for comparison with regard to capacity and sedimentation parameters. The main details provided in the DEA report are:

6,500,000 *in situ* CY removed over 8.0 years, with 180 dredging days per year

A total storage volume of 11.3 million cy, with an adjustment factor of 1.2 to accommodate "intermediate drainage layers between successive years of waste placement".

37.1% solids *in situ* for OU3 and 33.8% solids for OU4.

Flow rate to the CDF is (up to) 4100 gpm.

SETTLE analysis yielded annual storage requirement of 1.2 million cy. With a maximum fill thickness of 40 ft., this yielded a wetted area of 176 acres.

Some simplifying assumptions were made to match the dredge flow rate of 4109 gpm and storage volume. To obtained the specified removal over 8.0 years and the specified dredge flow rate of 4100 gpm, the dredge(s) would operate at 209 cy/h at an efficiency of 90%, with 7.0% solids in the dredge stream. These calculations were based on an *in situ* percent solids value for OU3 and OU4 of 34.0% and a specific gravity of 2.4.

To yield the annual storage volume of 1.2 million cy, the settled solids in annual storage would be at 25% solids. To get the wetted area of 176 acres for this volume, the average sediment thickness would be 4.2 ft. The effective overflow rate, assuming a 50% hydraulic efficiency, would be 0.10 ft./d.

The preliminary design for the BODR Optimized Remedy is different in several ways:

- After desanding, the daily pipeline flow is 14% lower than the DEA and the percent solids in the pipeline is also lower (4.1% compared to 7.0% in the DEA).
- The days of active dredge operation per year is expected to be 154 d, versus 180 d in DEA.
- The expected percent solids in annual storage is expected to be near 30% solids, compared to 25% solids in the DEA. Justification for the higher sediment concentration will be discussed below.
- The sediment fill thickness is set to 7.0 ft. (compared to 4.2 ft. in DEA) to provide greater storage per unit area, while also providing a satisfactory overflow rate (0.61 ft./d compared to 0.10 ft./d for DEA).
- The area required is 36 acres, compared to 176 acre in the DEA.

- Likewise, the overall sediment capacity is 2,895,000 cy (30% solids), compared to 11,300,000 cy in the DEA (25% solids with safety factor of 1.2).
- The overflow rate (flow rate per unit area) for the dewatering landfill is six times higher than the DEA. This will tend to produce post-sedimentation water with a higher total suspended solids concentration (TSS). However, post-sedimentation water treatment will be required and additional TSS removal will be accomplished within these processes.

The main reasons for a much smaller size compared to the DEA is the reduced in situ volume, the expectation for greater sediment dewatering in the fill area, the higher overflow rate, and a lower rate of loading solids and water to the fill.

The DEA analysis was based primarily on sedimentation, and did not address the long-term dewatering and consolidation of the stored sediment (25% solids conserved over loading period). For the dewatering landfill concept of the Optimized Remedy, further analysis of consolidation and sedimentation processes are needed to refine the dewatering targets and overflow rate estimates needed for storage requirements. Preliminary considerations for dewatering targets are addressed below.

Short term and long term dewatering

When the wet, dredged sediment is loaded to the landfill, the percent solids concentration is typically less than 10% for hydraulically-dredge sediment, and less than 35% solids for mechanically-dredged sediment. Over a short-term period of several days, the sediment is expected to compress to 25-35% solids. This rate may be demonstrated in a column settling test. More complete, long-term dewatering requires compression and consolidation of the sediment. Under passive conditions, long-term dewatering may require times of several months or more. This compression and consolidation will depend on stress levels (overburden) and consolidation properties. Large-strain consolidation theory, lab consolidation results, and other resources may be used to refine consolidation estimates for long-term dewatering as part of subsequent design basis. Additional dewatering by desiccation can also be significant. However, desiccation between dredging seasons may be limited by colder temperatures and snow pack.

For low stress levels and wet conditions, it is reasonable to expect that the sediment will settle and consolidate to a density similar to *in situ* densities. Over the long term, favorable consolidation properties, and dry weather conditions, it is reasonable to expect densities that are considerably higher.

Justification for percent solids selected for dewatered sediment

Over the loading period in any given year, the percent solids may be expected to settle to a density near the in situ density (for 32.1% solids and Gs equal to 2.41 , the bulk (wet) density is 77 pcf), so short-term percent solids will likely be in the range of 25-35% solids. Over a period of several years after loading, the increased effective stresses caused by overburden would result in continued

consolidation, especially if adequate drainage layers are provided.

Solids balance calculations performed on recently conducted settling column tests from OU4 (Shaw Group) showed that settled sediment had percent solids concentrations ranging from 24-31% solids after 1 day, and 29-37% solids after 11 days. Given that the time to fill the basin is 21 days and the hydraulic residence time is 4.9 d, it is reasonable to assume that short-term dewatering would result in a solids concentration near 30%. As the sediment will, on average, spend more than 75 operating days in the landfill during the yearly loading cycle, it is reasonable to assume that the sediment solids concentration may be 35% or higher (on average) near the end of the annual filling period.

One difference is that the settling tests used to support the 30% and 35% solids estimates were not desanded prior to the settling test. Additional work may be needed to make a correction for sand quantities or to perform additional settling tests on desanded sediment.

Long-term dewatering is expected to produce sediments at 50% solids. It is difficult to confirm this value without consideration of effective stresses and consolidation parameters of the sediment materials. However, short-term mechanical dewatering (hydraulic press) has been shown to produce sediment at 55% solids or higher (Deposit N and SMU 56/57 demonstrations for the Lower Fox River Project). While the stress levels from the press will not be matched by field conditions in the dewatering landfill, the much longer period of dewatering may be expected to yield sediments at 50% solids. This will have to be verified, probably through analysis of consolidation tests, for subsequent design stages.

In addition, after the hydraulic loading of the landfill is completed for a dredging season, the supernatant can be decanted and the some sediments may desiccate, leading to further drying. This may result in higher in-field densities. As mentioned above, winter conditions will limit desiccation.

Given these issues, it is reasonable to expect that long-term dewatering will yield sediment with 50% solids. Further work will be required to support this estimate. However, landfill sizing based on an intermediate dewatering level of 30% solids is likely conservative.

Additional steps needed to refine sizing and design of dewatering landfill

The estimates provided here serve as a preliminary estimate for sizing of the NR 500 Dewatering Landfill. Several of the remaining steps to refine for the next stage of design will include the following

- Refine the estimates for volumes, hydraulic loadings, and staging of the dewatering project. For example, the number of dredging days in a week were not considered, although a 5d per week operation would generally reduce the weekly-average flows and loading rates by 29%. A 6 day per week operation would reduce weekly-average flows and loading rates by 14%.
- Refine estimates of sedimentation for desanded sediment in order to assure that the basin

overflow rate is acceptable, considering the solids loadings to post-sedimentation water treatment processes.

- Refine and support estimates for short-term and long-term sediment dewatering targets, preferably in terms of percent solids. This may require additional testing of project sediments, such as column tests and consolidation tests on desanded materials.
- With consolidation and rate of dewatering supporting information, develop a dynamic model for dewatering that estimates the fill volumes over the life-cycle of the landfill. The model would be based on mass balance modeling over a daily time cycle, and used to integrate the dewatering and loading conditions to simulate the loading of the landfill and water treatment rates over the period of operation. This information is very useful for design.
- Provide additional detail on the storage concepts used for the dewatering landfill, providing details on earthwork, liner/cover systems, grades, stormwater management, drainage layers and piping configurations, influent and effluent hydraulic design, landfill side slopes, and design elements dealing with closure (such as final cover), long-term monitoring, and restoration.
- Provide a more detailed description of contingency measures for issues such as variable sedimentation during loading, storage limitations during storm events, and sediment management issues related to uneven sediment deposition in the fill areas. Specific contingency measures relating to the operation of the pipeline and water treatment operations, in particular, are likely to be very important to operational constraints at the dewatering landfill.
- Evaluate constructability issues such as liner construction and sequencing given seasonal limitations.
- Evaluate operational issues such as separate basins, sequencing of operations, and short and long-term consolidation characteristics.
- Analyze the cost-performance sensitivity of key design parameters so that more optimal storage conditions might be considered.

The consideration of these and other factors would be addressed in subsequent stages of the design process and documented in future design documents.

This note addresses the preliminary sizing of a dewatering landfill for the BODR Optimized Remedy. Other dredging, dewatering, and disposal options are being considered. Further evaluation of all alternatives is not likely, as some will be ruled-out due to considerations of cost-effectiveness and other implementability factors. Although there may be changes in the concepts for disposal, several of the steps to refine the design for the dewatering landfill will be applicable to other dewatering and disposal options.

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Table 1. Process variables, parameters, and calculated quantities for preliminary sizing of Dewatering Landfill for Optimized Remedy.

parameter	units	BODR Optimized Remedy - Dewatering Landfill					Comments
		OU2	OU3a	OU3b	OU4	Total	
Total Volume, *in situ*	CY	**24,000**	**6,000**	**198,000**	**3,458,000**	3,686,000	Includes TSCA volume
TSCA Volume, *in situ*	CY				**200,000**	200,000	Handled separately (see appropriate worksheet)
Non-TSCA Volume, *in situ*	CY	24,000	6,000	198,000	3,258,000	3,486,000	
Percent Solids, *in situ*	%	**30.2**	**30.2**	**30.2**	**32.1**	32.0	see "Process Calc Notes"
Specific Gravity, Gs		**2.41**	**2.41**	**2.41**	**2.41**	2.41	based on evaluation of samples within Optimized Remedy
Water content, *in situ (w =Ww/Ws)*		2.31	2.31	2.31	2.12	2.13	consistent with percent solids
Bulk (wet) density, *in situ*	pcf	75.8	75.8	75.8	76.8	76.8	assumes saturated conditions, OU3-4 from prism averages
Dry density, *in situ*	pcf	22.9	22.9	22.9	24.7	24.5	assumes saturated conditions
Dry weight	tons	7,416	1,854	61,182	1,084,711	1,155,164	
Wet weight	tons	24,556	6,139	202,591	3,379,163	3,612,449	
Dredge, percent solids	% by wt.	**25**	**25**	5.0	5.4	5.37	OU2 and nearshore OU3 Mechanically Dredged, OU3-4 hydraulically dredged. Although 10% solids is stated for OU3 and OU4, lower percent solids is consistent with one-dredge flow rate of 5000 gpm
Dredge, in situ volume concentration	% by vol.	80%	80%	**14.0%**	**14.0%**	14.1%	Percentage of total volume produced by dredge that is occupied by in situ sediment (total) volume. Calculated from *in situ* % solids, dredge % solids, and Gs
Average in-situ production per hour, per dredge	CY/h	**98**	**98**	**208**	**208**	206	
Number of dredges operating		**1**	**1**	**1**	**1**	**1**	
Dredge efficiency (% of day operating)	%	**50%**	**50%**	**64%**	**64%**	63.7%	Multiply by 24 hours to get hours of operation per day.
Dredge, *in situ* removal rate	CY/d	1176	1176	3195	3195	3148	
Dredge days required	days	20.4	5.1	62.0	1019.8	1107	
Dredge flow produced	gpm	413	413	5001	5001	4918	Calculated from bulking factor and removal rate. Assumes 24 h/d operation
Desanding, percent sand removed by dry weight	%	**0**	**0**	**25.0**	**25.0**	24.8	See "Desanding" worksheet
Sand porosity (as reported for beneficial reuse)		**0.43**	**0.43**	**0.43**	**0.43**		
Sand Volume for Beneficial Reuse	CY	0	0	12,021	213,116	225,136	Assumes Gs = 2.65
Dry weight of sand removed	tons	0	0	15,296	271,178	286,473	
Water content of drained sand		**0.20**	**0.20**	**0.20**	**0.20**	0.20	
total volume removed from dredge stream	CY	0	0	10,483	185,858	196,341	
Pumpage to dewatering, after desanding	gpm	413	413	4964	4961	4879	
Percentage of desanded flow when dredge is off		**0%**	**0%**	**100%**	**100%**	99%	Percentage of pumpage rate to dewatering/disposal area when dredge is down.
Specific Gravity, desanded stream		2.41	2.41	2.34	2.34	2.34	adjusts specific gravity to account for sand removal
Dewatering Method		**passive**	**passive**	**passive**	**passive**	**passive**	
Dewatered percent solids, short-term	%	**30**	**30**	**30**	**30**	30	
Wet tons, short term	tons	24,720	6,180	152,956	2,711,778	2,895,634	
Volume of short-term dewatered material	CY	24,194	6,049	150,385	2,666,193	2,846,821	assumes saturation
Dewatered percent solids, long-term	%	**50**	**50**	**50**	**50**	50	
Wet tons, long term	tons	14,832	3,708	91,774	1,627,067	1,737,381	
Volume of long-term dewatered material	CY	12,456	3,114	77,756	1,378,549	1,471,876	assumes saturation
Wet tons per in situ CY	tons/CY	0.62	0.62	0.46	0.50	0.50	
Water Treatment Loading	gpm	121	121	4,788	4,772	4,683	daily average, matched to daily dredge rate, and based on long-term dewatering targets
Total water	million gal	3.56	0.89	427	7,007	7,439	

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Table 2. Preliminary loading sequence for dewatering landfill, with expected delivery rates and volumes.

									Conditions for 30% solids				Conditions for 50% solids			
Project Year	Dredging Days	OU dredged	*in situ* Removal Rate (cy/d)	Method of Delivery to Landfill	% Solids as Delivered to Landfill	Gs	Dry tons per day	Cumulative Dry Tons	Bulk Density (t/cy)	Added Volume (CY/d)	Cumulative Volume (CY)	Daily Average Water Flow (gpm)	Bulk Density (t/cy)	Added Volume (CY/d)	Cumulative Volume (CY)	Daily Average Water Flow (gpm)
1	20.4	2	1176	truck	25%	2.41	363	7,413	1.022	1186	24,185	40	1.191	610	12,451	121
1	5.1	3	1176	truck	25%	2.41	363	9,266	1.022	1186	30,231	40	1.191	610	15,564	121
1	62.0	3	3195	pipeline	5.4%	2.34	740	55,174	1.017	2427	180,678	4624	1.180	1255	93,349	4788
1	66.5	4	3195	pipeline	5.4%	2.34	798	108,228	1.017	2615	354,544	4595	1.180	1352	183,243	4772
2	154	4	3195	pipeline	5.4%	2.34	798	231,089	1.017	2615	757,181	4595	1.180	1352	391,418	4772
3	154	4	3195	pipeline	5.4%	2.34	798	353,951	1.017	2615	1,159,819	4595	1.180	1352	599,593	4772
4	154	4	3195	pipeline	5.4%	2.34	798	476,812	1.017	2615	1,562,456	4595	1.180	1352	807,768	4772
5	154	4	3195	pipeline	5.4%	2.34	798	599,674	1.017	2615	1,965,094	4595	1.180	1352	1,015,942	4772
6	154	4	3195	pipeline	5.4%	2.34	798	722,535	1.017	2615	2,367,731	4595	1.180	1352	1,224,117	4772
7	154	4	3195	pipeline	5.4%	2.34	798	845,397	1.017	2615	2,770,369	4595	1.180	1352	1,432,292	4772
8	29	4	3195	pipeline	5.4%	2.34	798	868,773	1.017	2615	2,846,975	4595	1.180	1352	1,471,899	4772

Notes:
1. Percent solids is based on mechanical dredging of OU2 and nearshore sediments in OU3, and hydraulic dredging with 25% (by dry wt.) desanding of OU3 and OU4 sediments.
2. For desanded sediment, specific gravity (Gs) is adjusted from *in situ* value.
3. Bulk density is calculated with assumption of 100% saturation.
   Bulk density (tons/cy) = (unit weight of water) / {(% solids/100%)(1/Gs+100%/(%solids)-1)}.
4. Water flow rates are for water treatment and are estimated from instantaneous dewatering to target % solids (30% or 50%).

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Table 3. Preliminary sizing of dewatering landfill for BODR Optimized Remedy, compared to estimated conditions for Detailed Evaluation of Alternatives (DEA).

Process variable or parameter	Units	Optimized Remedy, BODR 7 ft. sediment thickness added per year, 154d of dredging per year at 64% efficiency	DEA 5 ft. sediment thickness added per year, 180d of dredging per year at 4512 cy/d
dredge efficiency		**64%**	**90%**
number of dredges		**1**	**1**
hourly removal rate per dredge	cy/h	**208**	209
dredging days per year	d	**154**	**180**
daily removal rate	cy/d	3195	4514
in situ volume removed per year	cy	492,012	812,500
Specific Gravity		**2.41**	**2.40**
Percent Solids, in situ		**32.1%**	**34.0%**
dredge, percent vol. as in situ		**14.0%**	**17.2%**
percent solids in dredge during dredging		5.36%	7.00%
total dredge flow	cy/d	22821	26244
total dredge flow (during dredging)	gpm	5,001	4,090
Mass removal of sand		**25.0%**	**0.0%**
Water content of sand (removed with sand)		**0.20**	**0.20**
Dry tons of sand removed per year	ton	40,952	-
Reduction in total dredge flow	cy/d	182	-
Reduction in total dredge flow (during dredging)	gpm	40	0
Pipeline flow (during dredging)	gpm	4961	4090
Percent flow maintained when dredge is off		**100%**	**100%**
Pipeline flow (daily average)	gpm	4961	4090
Pipeline flow (daily average)	cy/d	35372	29159
Pipeline percent solids (during dredging)		4.09%	7.00%
Specific gravity, adjusted for sand removal		**2.34**	**2.40**
bulking factor for storage, in situ vol. basis		0.82	1.45
bulking factor for storage, pipeline vol. basis		0.115	0.249
percent solids in storage		**30.0%**	**25.0%**
sed. volume at end of filling	cy	402,624	1,177,365
Fill limit, sediment thickness	ft.	**7.0**	**4.15**
Ponding depth	ft.	**6.0**	**1.5**
Free board	ft.	**2.0**	**2.0**
Percent of pipeline flow to basin when dredge is off		**100%**	**100%**
Basin Flow (daily average)	cy/d	35372	29159
volume with ponding depth	cy	747,731	1,602,918
Days to fill volume, initial	d	21	55
Total volume (with pond and freeboard)	Ac-ft	535	1345
Area required, w/o side slopes	Ac	35.7	176
Hydraulic efficiency of basin		**50%**	**50%**
Volume of pond, filled	cy	345,107	425,554
Hyd. Residence Time in Pond	d	4.9	7.3
Overflow rate (cu. ft. per day per sq. ft.)	ft./d	0.61	0.10

Attachment D –
Sediment Process Calculations

The main elements of sediment process modeling are:

1. *in situ* characteristics (volume, % solids, specific gravity and other quantities)
2. dredge production rates (*in situ* removal rate, % solids, dredge pumpage)
3. coarse-stream separation, or desanding
4. dewatering
5. lime amendment (if needed)
6. water treatment
7. load-out

1. Characteristics of *in situ* sediment

It is important to have a consistent parameter set for *in situ* properties. The key properties are the volume, % solids by weight (or gravimetric water content, w), and specific gravity. Common assumption is 100% saturation ($S_r = 1$). Key relationships are:

% solids *P* and water content *w*:

$$P = \frac{100\%}{1+w} \qquad (1)$$

Dry density:

$$\gamma_d = \frac{\gamma_w}{\frac{1}{G_s} + \frac{w}{S_r}} = \frac{0.8424\, t/cy}{\frac{1}{G_s} + \frac{w}{(1)}} \qquad (2)$$

Bulk (wet) density:

$$\gamma = \frac{\gamma_w (1+w)}{\frac{1}{G_s} + \frac{w}{S_r}} = \gamma_d (1+w) \qquad (3)$$

The unit weight of water, γ_w, is expressed as 0.8424 tons per cu. yard. This is equivalent to 62.4 pcf (with conversions of 27 cu. ft./cy and 2000 lbs./ton).

Often, sediment geotechnical data are summarized by simple averages. For example, a set of water contents may be averaged, another set of specific gravity values are averaged, and another set of bulk densities are averaged. The problem is that the set of average values may not be internally consistent and may lead to inaccurate estimates of the aggregate property from the set of samples. The best estimates for the aggregate average percent solids, water content, and other properties match what would be obtained if the *in situ* volume is recorded and the appropriate portions of the samples were

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NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE
1	Correction to sand removal volume, SRE, and vols.	GRE	JOS1	DMR	1/29/06
2	Adjustment to water rates, text on pumpage	GRE	JOS1	DMR	1/29/06
3	Add lime section, update examples, provide load-out section.	GRE	JOS1	DMR	2/28/06

actually blended and homogenized (without any gain/loss of sediment or water).

The appropriate in situ properties can be internally consistent if good estimates are obtained for the total volume, percent solids and specific gravity (and saturation ratio, if the sediment is not expected to be fully saturated).

The best estimate for the aggregate percent solids is found by dividing the sum of dry weights by the sum of wet weights of all sub-volumes from which there is a representative sample

$$Percent\ Solids, P = \frac{total\ dry\ weight}{total\ wet\ weight} = \frac{\gamma_w \sum \frac{V_i}{1/G_{s,i} + w_i / S_r}}{\gamma_w \sum \frac{V_i (1 + w_i)}{1/G_{s,i} + w_i / S_r}} \tag{4}$$

Assuming saturation and equal sub-volumes V_i, the aggregate percent solids simplifies to:

$$Percent\ Solids, P = \frac{\sum \frac{1}{1/G_{s,i} + w_i}}{\sum \frac{(1 + w_i)}{1/G_{s,i} + w_i}} \tag{5}$$

It can be shown that this aggregate average percent solids estimate (Eqn. 5) is consistent with the numerical average of the bulk (wet) density.

Although the aggregate average specific gravity can be found as:

$$Specific\ Gravity, G_s = \frac{\sum \frac{V_i}{1/G_{s,i} + w_i / S_r}}{\sum \frac{V_i}{1 + w_i G_{s,i} / S_r}} \tag{6}$$

G_s is rarely determined for all samples, actual variation in specific gravity is typically minor, and a suitable value is often the numerical average.

Once the aggregate average specific gravity and percent solids are determined, equations 1 – 3 can be used to determine the consistent values for bulk and dry densities and water content.

Example. A simple example set for individual percent solids values is {20%, 40%, 45%, 50%, and 70%}, with corresponding water contents of {4.00, 1.50, 1.22, 1.00, and 0.429}. All samples are assumed saturated. The numerical average for percent solids *P* is 45.0% and the numerical average water content *w* is 1.63. Note that the water content associated with *P* of 45.0% is 1.22 (equation 1), so the numerical averages for *P* and *w* are not internally consistent. The aggregate average *P* is 47.2% (equation 5) assuming an average specific gravity of 2.50. The associated water content *w* is 1.12.

In the above example, the numerical average value for percent solids was low by 4.6% (relative difference between 45.0% and 47.2%), but the associated dry density would be low by 6.4%. If the numerical average percent solids was used, water treatment volumes and dewatered sediment load-out tonnages to the landfill would be underestimated by 6.4% - just from this effect.

So, when averaging individual percent solids values, it is important to consider that:

- numerical averages tend to underestimate the appropriate aggregate average percent solids
- weighted averages for percent solids should have weighting coefficients that reflect the volume and bulk density of the impacted sediment associated with the samples.
- sediment areas with higher percent solids concentrations have a higher density and have a greater effect on the overall percent solids than sediment areas with lower values of percent solids.

The parameter sets for percent solids, water content, specific gravity, bulk and dry density are presented in Table 1. Although numerical average quantities are presented, the best estimates for percent solids and the associated, internally consistent parameter set (also presented) are based on the numerical averages for bulk density and specific gravity. It is important to note that these estimates were obtained given equal volume weighting to each sample value. A more detailed analysis of the spatial distribution of sediment density may be conducted to refine these estimates.

Summary of calculation steps for *in situ* properties:

a. Estimate average specific gravity, from numerical average or Eqn. 6.
b. Estimate aggregate average percent solids (Eqn. 4 or Eqn. 5).
c. Calculate water content consistent with percent solids value (see Eqn. 1).
d. Calculate dry and bulk density values that are consistent with other parameters (Eqns. 2 and 3).
e. Using volume estimate, multiply volume by dry density to obtain total dry tons of sediment.
f. Using volume estimate, multiply volume by bulk (wet) density to obtain total wet tons of sediment. Value for bulk density should compare favorably with the numerical average value for bulk density.

Finally, the internally consistent *in situ* parameter set is maintained on the spreadsheet and used in subsequent processing calculations.

2. Dredge production rates

Dredge production rates are set by the type of dredges used, properties of the sediment deposits (depth, thickness, density), the size of pumps and transfer lines to a barge or dewatering facility, the hours of operation (hours per day, days per week), and the number of dredges.

For the process calculations presented here, we will assume dredging conditions that are consistent with the ROD remedy for OU4-5 (two 12″ hydraulic dredges with an hourly removal rate HRR of 208 *in*

situ cy/h per dredge during active operation). We will also assume that the dredge flow brings in excess water to the extent that the portion of the dredge flow occupied by the in situ sediment (dredge concentration, or DC) is 14% of the total volumetric flow. In addition, we will assume that the dredge efficiency (DE), expressed as the percentage of the day that dredging is active, is 48% (11.52 h per day).

The daily removal rate (DRR) is determined as

$$DRR = \left(\frac{HRR\,(cy/h)}{1\,dredge}\right)(number\ of\ dredges)\left(\frac{24\,h}{d}\right)\left(\frac{DE\,(\%)}{100\%}\right) \qquad (7)$$

For the assumed values, DRR = (208 cy/h) (2) (24/d) (48% / 100%) = 4792 *in situ* cy/d. The number of dredge days required is determined from the total *in situ* volume sediment to be removed, divided by the DRR. For only one dredge in operation with the same settings (ROD remedy, OU2-3), the DRR = 2396 in situ cy/d.

The dredge flow (DF) is the actual pumpage (gpm) during operation of the dredges, determined as

$$DF\ (gpm) = \frac{\left(\frac{HRR\,(cy/h)}{1\,dredge}\right)(number\ of\ dredges)\left(\frac{1\,h}{60\,\min.}\right)\left(\frac{201.97\,gal.}{cy}\right)}{\left(\frac{DC\,(\%\,vol.)}{100\%}\right)} \qquad (8)$$

For the dredge hourly removal rate of 208 cy/h and the dredge concentration (DC) of 14% by volume (as *in situ* sediment volume), two dredges, the dredge flow during operation (DF) is 10,002 gpm. For only one dredge in operation with the same settings (ROD remedy, OU 2-3), the DF = 5,001 gpm.

The dredge concentration (DC) can be found from a mass balance on dry solids processed by the dredge. DC is related to the ratio of the dry density in the dredge to the dry density *in situ*:

$$DC\,(\%) = \frac{V_{in\,situ}}{V_{dredged}}(100\%) = \frac{\gamma_{d\ dredge}}{\gamma_{d\ in\,situ}}(100\%) = \frac{\left(1/G_s + \frac{100\%}{P_{in\,situ}} - 1\right)}{\left(1/G_s + \frac{100\%}{P_{dredge}} - 1\right)}(100\%) \qquad (9)$$

For saturated media, Gs = 2.43,and *in situ* percent solids ($P_{in\ situ}$) of 35.5%, the percent solids in the dredge (P_{dredge}) would be 6.1% (by wt.) for a dredge concentration (DC) of 14% (by vol.). While the

dredging contractor may specify that 10% solids can be handled by the dredge, the other settings during operation would lead to 6.1% solids on average. For one dredge in operation and in situ percent solids of 32.8% (OU2-3, ROD remedy), the percent solids in the dredge (P_{dredge}) would be 5.5% (by wt.) for a dredge concentration (DC) of 14% (by vol.).

3. Desanding

It may be fruitful to remove coarse-grained sediment prior to pipeline transport or sediment dewatering. Table 1 shows that roughly 45% of the sediment (by dry weight) is sand or gravel, and roughly 10% of the sediment is gravel and course sand. The Sand Washing Report (Shaw Group, 5/8/2005) showed test results on sand removal, floatation and attrition scrubbing to removal PCBs from the coarse fraction. In general, removal was excellent for sediment that would not pass the #100 sieve, but removal from finer sands was more difficult.

On the basis of gradation and washing results, it appears that sand removal efficiency (SRE) of 20-25% (by dry wt.) may be achievable. If sufficiently clean with respect to environmental contaminants such as PCBs, the washed sand could then be used beneficially.

The total dry weight of sediment is determined by the dry density and the volume of *in situ* sediment. For OU4-5 and the ROD remedy *in situ* sediments, the dry density is 28.0 pcf (0.378 t/cy) and the non-TSCA volume is 6,552,000 cy. The dry tonnage = (0.378 t/cy) (6,552,000 cy) = 2,477,000 tons.

Sand removal SRE of 25% applied to the dry tonnage would yield roughly 619,000 dry tons of sand and gravel (M_{sand}). The volume of sand solids ($V_{sand\ solids}$) is found by the dry weight of sand and the specific gravity. The volume of the sand generated for reuse is estimated from the following equation:

$$V_{sand,reuse} = \frac{V_{sand\ solids}}{1-n} = \frac{M_{sand}}{(1-n)\gamma_w G_{s,sand}} \qquad (10)$$

where n is the porosity of sand (assumed as 0.43, loose sand) and $G_{s,sand}$ is the specific gravity of sand (2.65). For OU4 and the ROD remedy, the volume of the sand for reuse is 487,000 cy. For the ROD remedy and OU3, 25% SRE is also applied, and roughly 48,000 cy is removed. For OU3 and OU4, roughly 535,000 cy of sand would be generated for beneficial reuse (value rounded to 3 sig. figs.). After sand drainage, a residual water content (w_{sand}) of 0.20 is assumed for the sand, and the remainder of the drained water is combined with the dredge stream.

Pumpage to the pipeline or dewatering, or the desanded dredge flow (DSDF), is determined by the incoming dredge flow (DF) and the volume of sand removed as a volumetric portion in the dredge:

$$DSDF\ (gpm) = DF\ (gpm)\left[1 - \frac{V_{removed}}{\left(\dfrac{V_{in\,situ}}{DC(\%)/100\%}\right)}\right] \tag{11}$$

The volume of sand removed ($V_{removed}$) depends on the mass of sand removed, and also considered the volume of residual water left in the sand:

$$V_{removed} = \frac{M_{sand}}{\gamma_w}\left(\frac{1}{G_{s,sand}} + w_{sand}\right) \tag{12}$$

For ROD Remedy for OU4 ($G_{s,sand}$ = 2.65, w_{sand} = 0.20, M_{sand} = 619,000 t), the volume removed from the dredge stream is 424,000 cy. Applying Equation 11 with a dredge flow (DF) of 10,000 gpm, the *in situ* volume of 6,552,000 cy, and dredge concentration of 14%, the desanded dredge flow (DSDF) is reduced from the dredge flow (DF) by just 0.9% to 9912 gpm.

Sand removal will affect the specific gravity of the desanded sediment. Conserving the overall mass and volume in a mixture, the specific gravity of the desanded sediment can be determined as:

$$G_{s,desanded} = \frac{1 - SRE(\%)/100\%}{\left(\dfrac{1}{G_s} - \dfrac{SRE(\%)/100\%}{G_{s,sand}}\right)} \tag{13}$$

where SRE is the sand removal efficiency (25.0% by wt.), Gs is the bulk specific gravity prior to desanding (2.43) and $G_{s,sand}$ is the specific gravity of sand (2.65). With these inputs, the specific gravity of the desanded sediment is adjusted to 2.36.

Further details of process calculations for the ROD Remedy are shown in Table 3 and Table 4. Further details of process calculations for the Optimized Remedy are shown in Table 5.

4. Dewatering

For this stage of dewatering calculations, only total volumes and tonnages for dewatered sediment are calculated. Also, volumes are calculated with the assumption that the sediment remains fully saturated.

The method for calculation of volumes and mass is to first account for the total, dry tons of sediment that will be delivered to the dewatering process (presses, dewatering landfill or settling basin)

$$M_{s,desanded} = (1 - SRE(\%)/100\%)(\gamma_d \; V_{in\,situ}) \qquad (14)$$

For OU4-5 ROD remedy, the dry tonnage of desanded material is 1,858,000 tons. The wet tonnage of dewatered sediment can be found by simply dividing the dry tonnage by the percent solids expected in the dewatering area. For short-term dewatering, 25% solids appears to be achievable (see Table 2). The total wet weight for OU4 ROD remedy would be 7,430,000 tons at 25% solids. Using the corrected specific gravity and the formula for bulk (wet) density (see Equation 3), the volume is 7,548,000 cy.

For long-term dewatering, 42.8% solids is likely achievable. For the OU4 ROD remedy and the same method used to calculate quantities for the 25% solids point, the wet weight is 4,340,000 tons and the saturated volume is 3,880,000 cy.

Lime amendment may be needed to reach 50% solids (see below).

Additional work is needed to refine the scheduling of loading, storage, dewatering, and load-out of dewatered sediment (if applicable).

5. Lime amendment

Long-term dewatering of the sediment may not achieve dewatering targets, so lime amendment or other sediment dewatering or amendment techniques may be needed. Lime amendment (as quicklime) at 5% of the wet weight of sediment is suggested as an appropriate amendment to reach the 50% solids goal.

An empirical, stoichiometric model for lime amendment assumes 0.32 tons of water consumed by reaction and 0.20 tons of water is entrained in solids for every ton of quicklime added. Evaporative losses may account for an additional increase of approx. 2% in the final percent solids. For example, if the stoichiometric loss of water and formation of new solids leads to 48% solids, evaporation is assumed to raise the percent solids to 50%. The specific gravity of reacted lime solids is assumed to be 2.50.

The empirical model was compared to a lime amendment pilot demonstration project (see Montgomery Watson, “Basis of Design Report, Sediment Removal Demonstration Project Sediment Management Unit 56/57, Fox River, Green Bay, Wisconsin, May 1998.). Model results for final percent solids (with lime amendment) are compared with the pilot study results, and the comparison is shown in Figure 1. Future work may be needed to refine mixing strategies and amendment amounts.

According to the empirical model and for a passive dewatering endpoint of 42.8% solids, 5% quicklime (by wet weight) is expected to be needed to reach 50% solids. For OU4-5and the ROD remedy, the wet weight at 42.8% solids is 4,340,000 tons. At 5% addition, 217,000 tons of quicklime would be added. After the lime has cured, the dry weight would increase from the original dry weight by the amount of the lime addition plus the amount of water converted to lime solids (1.52 times the lime addition). For OU4-5 and the ROD remedy, the dry weight after curing would be 2,187,000 tons. Water consumed by the reaction (0.52 times the lime addition) would be roughly 113,000 tons. Factoring in the amount of new

solids formed and water lost to reaction, the new wet weight would be 4,557,000 tons and percent solids would be at 48%. The specific gravity of the treated sediment solids would increase slightly to 2.38.

During and after curing, but prior to load-out, additional water is expected to be lost to evaporation. According to the model, this loss should result in a shift in percent solids from 48% to 50%.

6. Water treatment

Water treatment volumes are determined from the overall water balance. The volume of sand removed ($V_{removed}$, Equation 12) and the final volume of dewatered sediment are subtracted from the total volume produced by the dredge (V_{dredge} see Eqn 9). The average daily rate (gpm) is computed by dividing the volume by the number of dredge days and applying conversion factors (201.97 gal./cy and 1440 min. per day).

Consideration is also made for the pumpage of water during inactive dredging periods. For OU4 ROD remedy, there were two major assumptions that have a large impact on water treatment quantities and influent quality:

- For every active dredging day, the pipeline flows are assumed to be maintained at a constant rate, even when the dredge is not actively producing solids. Some flow will need to be maintained in the pipeline to prevent sedimentation, however, the flow rate during inactive dredging periods may be reduced somewhat.

- For every active dredging day, 100% of the pipeline flow is assumed to be delivered to the passive dewatering cells. In actuality, when solids have been purged from the pipeline after active dredging periods, the flow will likely be diverted directly to water treatment rather than loading the dewatering cells.

Because the OU4 ROD remedy assumes that the pipeline flow will be maintained at a constant rate, the expected water treatment loading is 9590 gpm. For the ROD remedy and conditions for OU2 (no desanding, 1 dredge in operation), the expected water treatment loading is 4808 pgm. For the ROD remedy and conditions for OU2-3 (one dredge in operation), the expected water treatment loading is 4810 gpm.

7. Load-out

Load-out process calculations refer mainly to the wet weight and volume of the dewatered sediment and the rate at which that material is transported. The final wet weight prior to load-out is found from the percent solids (P_f) and the dry weight (wet weight = dry weight / P_f). Alternatively, if a wet weight (W_i) at some intermediate value of percent solids (P_i) is known, the final wet weight (W_f) can be determined from a simple ratio:

$$W_f = W_i \left(\frac{P_i}{P_f} \right). \tag{15}$$

This ratio assumes the dry weight of sediment is conserved.

For OU4-5 and the ROD remedy, the wet tonnage of desanded material at 42.8% solids is 4,340,000 tons. Equation 15 could be used to estimate the wet weight of sediment dewatered to 50% solids without amendment (4,340,000 * (42.8/50.0) = 3,715,000 tons). Using the corrected specific gravity (2.36) and the formula for bulk (wet) density (see Equation 3), the volume is 3,139,000 cy.

For OU4-5 and the ROD remedy, the wet weight of lime-treated sediment at 48% solids would be 4,557,000 tons. If evaporation leads to sediment at 50% solids prior to load-out the load-out tonnage would decrease to 4,375,000 tons (wet).

Load-out volumes are determined from the calculated, bulk density (Eqn. 3) and the wet weight.

$$V_f = \frac{W_f}{\gamma} = \frac{W_f \left(\frac{1}{G_s} + \frac{w}{S_r} \right)}{\gamma_w (1 + w)} \tag{16}$$

For 50% solids, the moisture content (w) is 1.00 (see Eqn. 1). Assuming complete saturation is achieved, possibly from compaction, S_r = 1.0 (this may underestimate volumes slightly). The specific gravity of lime-treated OU4-5 ROD remedy sediment is expected to be 2.38, and the saturated, bulk density is expected to be 1.187 tons per CY). The load-out volume is expected to be 3,685,000 CY.

Load-out rates are determined by the days and hours per day that load-out will be achieved. The load-out rate should not exceed the allowable load-out rates that are set by transportation limitations (such as trucks per day). These and other important processing issues, such as management of staging area, optimization, and space requirements for storage are not addressed here.

Table 1. Parameter Set of *in situ* Sediment Conditions Expected for OU2-5, ROD Remedy and Optimized Remedy

Parameter		Units	ROD Remedy	Optimized Remedy	Note	Comments
Percent Solids, *in situ*						
	OU2-3	%	32.8	30.2	1	Corrected for core compaction
	OU4-5	%	35.5	32.1	1	Corrected for core compaction
	OU2-5	%	35.3	32.0	1	Corrected for core compaction
Gradation,	**(OU2-5)**					
	Gravel/Sand	%	46	43.4	2	
	Sand	%	43.8	42.1	2	
	Gravel to med. Sand	%	11.6	10.2	2	ranges from 0 - 50%, ignores fine sand
	Silt/Clay	%	53.9	56.6	2	
Organic Content, average		%	16.8	11.2	2	
Specific Gravity, Gs			2.43	2.41	3	
Dry Density (OU2-5)		pcf	27.8	24.5	1	Corrected for core compaction
Moisture Content (OU2-5)			1.83	2.13	3	
Bulk Density (OU2-5)		pcf	78.7	76.7	3	Corrected for core compaction

Notes:

1. Average quantities for percent solids and dry density provided by P. Larosa, Anchro Environmental, Jan. 6, 2006. Sample geotechnical results were corrected for core compaction (see calculation sheet "Geotechnical Properties" in Appendix A). Percent solids averages determined from weighted averages (see Eq. 4) for the associated dredge prisms and a specified dredge undercut. Complete saturation was assumed for *in situ* conditions.
2. Gradation and organic content values are rough estimates, not rigorous averages for the associated dredge cuts.
3. Calculated from percent solids and/or dry density so that the geotechnical parameters are internally consistent.

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Table 2. Summary of Column Settling Test Results

5% slurry	Starting Conditions					Column State after 1 day settling					Column State after 11 days settling					
	reported composite % solids (%)	added wet sediment weight (kg)	dry solids (kg)	added water weight (kg)	% solids by weight (%)	interface height after 1 day (in.)	avg. TSS in suspension (mg/L)	dry solids, sludge zone (kg)	volume, sludge zone (L)	% solids, sludge zone (%)	interface height after 11 days (in.)	avg. TSS in suspension (mg/L)	TSS at top sampling port (mg/L)	dry solids, sludge zone (kg)	volume, sludge zone (L)	% solids, sludge zone (%)
CST-300	39.62	7.71	3.05	53.38	5.3%	10.88	2360	2.93	8.96	27.4%	9.25	328	7	3.04	7.62	32.3%
CST-400a	36.7	8.32	3.05	53.76	5.2%	12	3453	2.87	9.88	24.8%	10.25	1079	115	2.99	8.44	29.4%
CST-400b	43.07	7.09	3.05	53.99	5.3%	11.75	1340	2.98	9.67	26.1%	9.5	278	43	3.04	7.82	31.7%
CST-501	49.89	6.12	3.05	54.96	5.3%	9.6	797	3.01	7.90	31.2%	7.75	281	95	3.04	6.38	37.3%

12 % slurry	Starting Conditions					Column State after 1 day settling					Column State after 11 days settling					
	reported composite % solids (%)	added wet sediment weight (kg)	dry solids (kg)	added water weight (kg)	% solids by weight (%)	interface height after 1 day (in.)	avg. TSS in suspension (mg/L)	dry solids, sludge zone (kg)	volume, sludge zone (L)	% solids, sludge zone (%)	interface height after 11 days (in.)	avg. TSS in suspension (mg/L)	TSS at top sampling port (mg/L)	dry solids, sludge zone (kg)	volume, sludge zone (L)	% solids, sludge zone (%)
CST-300	39.62	19.22	7.61	44.24	13.6%	32.75	2088	7.54	26.96	24.0%	24.5	1460	132	7.55	20.17	30.7%
CST-400a	36.7	20.75	7.62	42.71	13.6%	32.63	1798	7.55	26.86	24.1%	25.25	404	134	7.60	20.79	30.1%
CST-400b	43.07	17.68	7.61	45.78	13.6%	28.75	1900	7.54	23.67	26.9%	22.88	327	94	7.60	18.84	32.7%

Note:

1. Testing conducted by Shaw Environmental, Inc., Paul Leer's group.
2. Column diameter 8.0 in. and height 6.4 ft. (76.8 in.).
3. In all cases, supernatant was turbid and sediment interface height was difficult to interpret.
4. Sludge zone is zone of settled and thickened solids, and reported values represent average condition from the bottom of the column to the interface height. Percent solids value for sludge zone is based on an assumed specific gravity of 2.40.

Table 3. Detailed Summary of Process Calculations for OU2-5 ROD Remedy

parameter	units	BODR - ROD Remedy				
		OU2	OU3	OU2-3	OU4-5	OU2 - OU5
Total Volume, *in situ*	CY	81,000	716,000	797,000	6,762,000	7,559,000
TSCA Volume, *in situ*	CY				210,000	210,000
Non-TSCA Volume, *in situ*	CY	81,000	716,000	797,000	6,552,000	7,349,000
Percent Solids, *in situ*	%	32.8	32.8	32.8	35.5	35.2
Specific Gravity, Gs		2.43	2.43	2.43	2.43	2.43
Water content, *in situ (w =Ww/Ws)*		2.05	2.05	2.05	1.82	1.8
Bulk (wet) density, *in situ*	pcf	77.3	77.3	77.3	78.9	78.7
Dry density, *in situ*	pcf	25.4	25.4	25.4	28.0	27.7
Dry weight	tons	27,734	245,156	272,890	2,476,820	2,749,710
Wet weight	tons	84,555	747,427	831,983	6,976,957	7,808,940
Dredge, percent solids	% by wt.	5.5	5.5	5.51	6.1	6.0
Dredge, in situ volume concentration	% by vol.	14.0%	14.0%	14.0%	14.0%	14.0%
Average in-situ production per hour, per dredge	CY/h	208	208	208	208	188
Number of dredges operating		1	1	1	2	2
Dredge efficiency (% of day operating)	%	48.0%	48.0%	48.0%	48.0%	48.0%
Dredge, *in situ* removal rate	CY/d	2396	2396	2396	4792	4323
Dredge days required	days	34	299	333	1367	1,700
Dredge flow produced	gpm	5001	5001	5001	10002	9024
Desanding, percent sand removed by dry weight	%	0	25	22.5	25	24.7
Sand porosity (as reported for beneficial reuse)		0.43	0.43		0.43	
Sand Volume for Beneficial Reuse	CY	0	48,166	48,166	486,626	534,792
Dry weight of sand removed	tons	0	61,289	61,289	619,205	680,494
Water content of drained sand		0.20	0.20	0.20	0.20	0.20
total volume removed from dredge stream	CY	0	42,006	42,006	424,387	466,392
Pumpage to dewatering, after desanding	gpm	5001	4960	4964	9912	8944
Percentage of desanded flow when dredge is off		100%	100%	100%	100%	100%
Specific Gravity, desanded stream		2.43	2.36	2.37	2.36	2.37
Dewatering Method		passive	passive		passive	passive
Dewatered percent solids, short-term	%	25	25	25	27	27
Wet tons, short term	tons	110,937	735,468	846,405	6,880,055	7,726,460
Volume of short-term dewatered material	CY	112,317	747,104	859,421	6,894,641	7,754,062
Dewatered percent solids, long-term	%	42.8	42.8	42.8	42.8	42.8
Wet tons, long term	tons	64,799	429,596	494,395	4,340,222	4,834,617
Volume of long-term dewatered material	CY	57,548	384,008	441,556	3,879,644	4,321,200
Wet tons per in situ CY	tons/CY	0.80	0.60	0.62	0.66	0.66
Water Treatment Loading	gpm	4,762	4,780	4,778	9,514	8,587
Total water	million gal	232	2,057	2,289	18,730	21,018

Note: Minor deviations from text and other presentations are likely results of rounding.

Table 4. Summary of Lime Amendment Process Calculations for OU2-5 ROD Remedy

	OU2	OU3	OU2-3	OU4-5	OU2 - OU5
Dewatering in Contained Area	Lime	Lime	Lime	Lime	Lime
percent solids, dewatered	42.8%	42.8%	42.8%	42.8%	42.8%
water content, dewatered	1.34	1.34	1.34	1.34	1.34
dry density, dewatered (BDT/cy)	0.482	0.479	0.479	0.479	0.479
Total Volume, dewatered (cy)	57,548	384,008	441,556	3,879,644	4,321,200
Total Wet tonnage, dewatered (tons)	64,799	429,596	494,395	4,340,222	4,834,617
bone dry tons (tons)	27,734	183,867	211,601	1,857,615	2,069,216
Lime Amendment					
Quick lime added (% of wet weight)	5.0%	5.0%	5.0%	5.0%	5.0%
Added quicklime (tons)	3,240	21,480	24,720	217,011	241,731
Dry weight with reacted lime (BDT)	32,659	216,516	249,175	2,187,472	2,436,647
Water consumed by lime (tons)	1685	11169	12854	112846	125700
Wet weight, 7d after lime (tons)	68,039	451,076	519,115	4,557,233	5,076,348
Percent solids, 7d after lime (%)	48.0%	48.0%	48.0%	48.0%	48.0%
Specific Gravity, 7d after lime	2.44	2.38	2.39	2.38	2.39
Additional water lost by evaporation (ton)	2,722	18,043	20,765	182,289	203,054
Wet weight, after evaporation (ton)	65,318	433,033	498,351	4,374,943	4,873,294
Percent solids, after evaporation	50.0%	50.0%	50.0%	50.0%	50.0%
Bulk density, (wet tons/cy)	1.20	1.19	1.19	1.19	1.19
Load-out					
Total wet weight (tons)	65,318	433,033	498,351	4,374,943	4,873,294
Total volume, saturated (cy)	54,654	364,790	419,446	3,685,488	4,104,934

Note: Minor deviations from text and other presentations are likely results of rounding.

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Table 5. Detailed Summary of Process Calculations for OU2-5 Optimized Remedy

parameter	units	BODR Optimized Remedy - Dewatering Landfill					BODR - Optimized, Plate-Frame				
		OU2	OU3a	OU3b	OU4	Total	OU2	OU3a	OU3b	OU4	Total
Total Volume, *in situ*	CY	15,000	15,000	229,000	3,312,000	3,571,000	15,000	15,000	229,000	3,312,000	3,571,000
TSCA Volume, *in situ*	CY				200,000	200,000				200,000	200,000
Non-TSCA Volume, *in situ*	CY	15,000	15,000	229,000	3,112,000	3,371,000	15,000	15,000	229,000	3,112,000	3,371,000
Percent Solids, *in situ*	%	30.2	30.2	30.2	32.1	32.0	30.2	30.2	30.2	32.1	32.0
Specific Gravity, Gs		2.41	2.41	2.41	2.41	2.41	2.41	2.41	2.41	2.41	2.41
Water content, *in situ (w=Ww/Ws)*		2.31	2.31	2.31	2.12	2.13	2.31	2.31	2.31	2.12	2.13
Bulk (wet) density, *in situ*	pcf	75.8	75.8	75.8	76.8	76.7	75.8	75.8	75.8	76.8	76.7
Dry density, *in situ*	pcf	22.9	22.9	22.9	24.7	24.5	22.9	22.9	22.9	24.7	24.5
Dry weight	tons	4,635	4,635	70,761	1,036,102	1,116,134	4,635	4,635	70,761	1,036,102	1,116,134
Wet weight	tons	15,348	15,348	234,309	3,227,733	3,492,738	15,348	15,348	234,309	3,227,733	3,492,738
Dredge, percent solids	% by wt.	25	25	5.0	5.4	5.37	25	25	5.0	5.4	5.37
Dredge, in situ volume concentration	% by vol.	80%	80%	14.0%	14.0%	14.1%	80%	80%	14.0%	14.0%	14.1%
Average in-situ production per hour, per dredge	CY/h	98	98	208	208	206	98	98	208	208	206
Number of dredges operating		1	1	1	1	1	1	1	1	1	1
Dredge efficiency (% of day operating)	%	50%	50%	64%	64%	63.7%	50%	50%	64%	64%	63.7%
Dredge, *in situ* removal rate	CY/d	1176	1176	3195	3195	3147	1176	1176	3195	3195	3147
Dredge days required	days	12.8	12.8	71.7	974.1	1071	13	13	72	974	1071
Dredge flow produced	gpm	413	413	5001	5001	4915	413	413	5001	5001	4915
Desanding, percent sand removed by dry weight	%	0	0	25.0	25.0	24.9	0	25	25.0	25.0	25.0
Sand porosity (as reported for beneficial reuse)		0.43	0.43	0.43	0.43		0.43	0.43	0.43	0.43	
Sand Volume for Beneficial Reuse	CY	0	0	13,903	203,565	217,468	0	911	13,903	203,565	218,379
Dry weight of sand removed	tons	0	0	17,690	259,026	276,716	0	1,159	17,690	259,026	277,875
Water content of drained sand		0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
total volume removed from dredge stream	CY	0	0	12,125	177,529	189,654	0	794	12,125	177,529	190,448
Pumpage to dewatering, after desanding	gpm	413	413	4964	4961	4876	413	396	4964	4961	4876
Percentage of desanded flow when dredge is off		0%	0%	100%	100%	99%	0%	0%	100%	100%	99%
Specific Gravity, desanded stream		2.41	2.41	2.34	2.34	2.34	2.41	2.34	2.34	2.34	2.34
Dewatering Method		passive	passive	passive	passive	passive	press	press	press	press	press
Dewatered percent solids, short-term	%	30	30	30	30	30	55	55	55	55	55
Wet tons, short term	tons	15,450	15,450	176,904	2,590,256	2,798,060	8,427	6,320	96,493	1,412,867	1,524,108
Volume of short-term dewatered material	CY	15,121	15,121	173,930	2,546,714	2,750,886	6,785	5,140	78,476	1,149,053	1,239,454
Dewatered percent solids, long-term	%	50	50	50	50	50	55	55	55	55	55
Wet tons, long term	tons	9,270	9,270	106,142	1,554,154	1,678,836	8,427	6,320	96,493	1,412,867	1,524,108
Volume of long-term dewatered material	CY	7,785	7,785	89,930	1,316,773	1,422,273	6,785	5,140	78,476	1,149,053	1,239,454
Wet tons per in situ CY	tons/CY	0.62	0.62	0.46	0.50	0.50	0.56	0.42	0.42	0.45	0.45
Water Treatment Loading	gpm	121	121	4,788	4,772	4,680	132	141	4,811	4,796	4,704
Total water	million gal	2.22	2.22	494	6,693	7,192	2.42	2.60	497	6,727	7,228

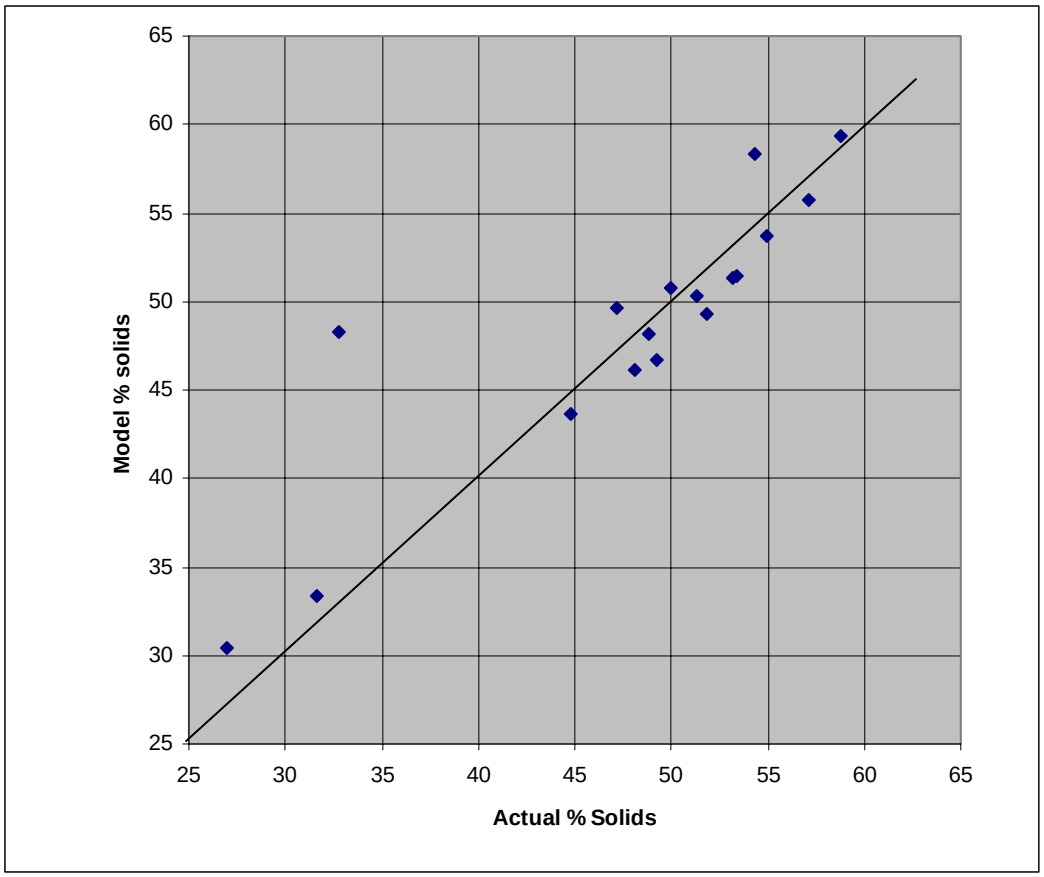

Figure 1. Agreement of percent solids outcomes between lime amendment model and actual percent solids results from 1998 pilot project of lime amendment to SMU 56/57 sediment. (Experimental Data Source: Montgomery Watson. "Basis of Design Report, Sediment Removal Demonstration Project Sediment Management Unit 56/57, Fox River, Green Bay, Wisconsin, May 1998.

Attachment E
Stability of Cut and Cap Slopes

ANCHOR ENVIRONMENTAL, L.L.C.

Memorandum

To: Basis of Design Report File

From: John Laplante, Paul LaRosa, and John Verduin

cc: George Hicks (Shaw), Paul Montney, Chip Hilarides, Richard Moser, (Georgia Pacific) Roger McCready (NCR), John Heyde (Sidley)

Date: February 14, 2006

Re: Dredged Cut and Capped Slope Stability

This memorandum provides details and background on the dredge cut slope and cap stability analyses. The analyses described herein were performed during development of the Basis of Design for the Fox River.

Details of the slope stability analyses performed for the design of dredge cut slopes are provided below using data generated during the 2004 and 2005 Remedial Design (RD) geotechnical investigation program (Shaw/Anchor 2004 and 2005). Three (3) horizontal to 1 vertical (3H:1V) slopes were selected for the dredge prism design based on review of vane shear and triaxial strength data collected as part of the RD and previous investigations. These data indicate that a 3H:1V slope will have a factor of safety of at least 1.3 for the vast majority of the data reviewed. Slopes cut at 3H:1V are expected to remain stable throughout construction.

Moreover, under the ROD Remedy (and areas handled in a similar fashion under the Optimized Remedy), any long-term sloughing of adjacent slopes is expected to involve clean material (less than 1 ppm PCBs), since the dredge prism in these areas was designed to remove the deepest contamination between adjacent cuts. Slight adjustment of the slopes is expected in some areas over time due to the dynamic nature of hydrodynamic conditions. However, adjustments in these dredge slopes will not expose contaminated sediments in the future.

Based on detailed stability analyses outlined below, capped areas are predicted to be stable on existing slopes as steep as 2.75H:1V, as generally discussed in Appendix H. While the cap will be stable on these steeper slopes, only one very localized section of the capped area has a slope of this angle. The vast majority of capped areas proposed under the Optimized Remedy have slopes of 10H:1V or flatter.

STABILITY OF DREDGE CUT SLOPES

For purposes of the Basis of Design Report (BODR), the stability of cut slopes was evaluated for a range of slope angles and a range of cut depths. For purely cohesive sediments, the stability of the cut is a function of the height of the cut. For sediments with appreciable sand, the stability is also a function of the slope angle.

Lambe and Whitman (1969) present methods to evaluate the stability of slopes using infinite slope theory, for both cohesive and granular materials. These methods were used to compute the factor of safety for slopes based on the existing site strength data, which includes the following:

- Vane Shear Test (VST) data collected in 2004 and 2005
- Laboratory Unconsolidated Undrained (UU) shear strength test data collected by the Johnson Company as well as the Shaw/Anchor team
- Laboratory Consolidated Undrained (CU) shear strength test data collected by the Shaw/Anchor team

Using the methods presented by Lambe and Whitman, a graph was prepared to show the required sediment shear strength for a given slope, and a given depth of cut, at a selected factor of safety. Figure 1 presents these curves, which are linear plots of cut depth vs. required shear strength, for slopes of 3H:1V, 4H:1V, 5H:1V and 10H:1V, assuming a factor of safety of 1.3 for these slopes.

Also plotted on Figure 1 are the available laboratory UU and CU shear strength data from the sources listed above. The UU data are plotted as discrete shear strengths for each undisturbed sample, at the depth from which the sample was collected. The CU data are plotted as strength versus depth, using the cohesion and friction angle measured during the laboratory CU test on each sample.

Evaluations made using the VST shear strength data (corrected based on plasticity index after Bjerrum, 1972) indicate that more than 95 percent of the time, a factor of safety of 1.3 or better is achieved using a 3H:1V cut slope. Most importantly, the CU data, which are among the highest quality of the tests, all show adequate strength to achieve the target factor of safety.

The preliminary limit equilibrium slope stability analyses demonstrate that the Lambe and Whitman methods provide a conservative estimate of the strength required to achieve the target factor of safety. More detailed computer modeling limit equilibrium analyses will be performed during later stages of design (30 or 60 Percent Design).

Based on this evaluation, the 3H:1V cut slope was selected for design. This represents the slope that the Contractor will be required to achieve, and will likely be the basis for measurement of pay volumes during construction.

STABILITY OF CAPS ON SLOPES

To evaluate the stability of caps on slopes, areas of interest were identified in the river, and a representative section was selected that included a steep slope and capping as part of the remedy. The selected section, 112+00, is located in OU 4. The east bank of the river in this area has an average slope of 4.7H:1V, with localized steeper areas up to 2.75H:1V, and a proposed cap thickness of 13 inches.

Slide 5.0 is a two-dimensional slope stability analysis software, complete with sensitivity, probabilistic and back analysis capabilities. The Slide software offers various vertical slice limit equilibrium methods (Bishop, Janbu, Spencer, Corps of Engineers #1 and #2, and more) for stability modeling. Slope stability evaluations are conducted by inputting the geometry and subsurface stratigraphy of an existing or proposed slope as well as various parameters describing the sediment and water conditions (sediment and water densities, cohesion, friction angle, soil model, groundwater/surface water elevations, etc.). The software output includes graphical solutions of the factor of safety associated with various failure surfaces and well as numerous other tabular and graphical outputs useful for data analyses.

In situ sediment properties for the slope stability evaluations were obtained from laboratory measurements on samples collected during the 2004 and 2005 pre-design sampling and analysis program. In addition, physical properties of the capping materials were estimated based on the nature of the cap materials proposed (sand and gravel) and the method of cap placement (mechanical clamshell). The following input assumptions were used in the model:

- Cap unit weight = 120 pcf (this is a conservative value; the unit weight will likely be lower), friction angle = 32 degrees and cohesion = 0 psf.

- Sediment unit weight= 92 pcf, friction angle = 0, and cohesion varying as a function of depth from 50 to 750 psf, based on results of the vane shear and laboratory strength testing.

Both circular and non-circular surfaces were evaluated, and the software performed a search for the critical (i.e. lowest factor of safety) slip surface. Generalized Limit Equilibrium and Spencer methods were used to compute the factor of safety.

Based on the results of the static stability analysis, caps on slopes similar to the conditions modeled for river section 112+00 (average slope of 4.7H:1V, with localized steeper areas up to 2.75H:1V) are expected to have a static factor of safety of 1.3 or better, which meets the criteria presented by Hammer and Blackburn (1977) for the long term stability condition. Results of the static slope stability evaluation are presented on Figure 2. Future phases of the design will include evaluation of the slope stability during seismic events.

Appropriate construction techniques will be required to ensure proper cap placement thereby limiting the potential for slope stability failures during or shortly after construction. This will involve the placement of materials in a "bottom up" fashion, whereby materials are first placed at the toe of a slope and construction produces towards to top of slope. In this way, cap materials will be continually placed against a firm toe support and are not allowed to slump towards the base.

REFERENCES

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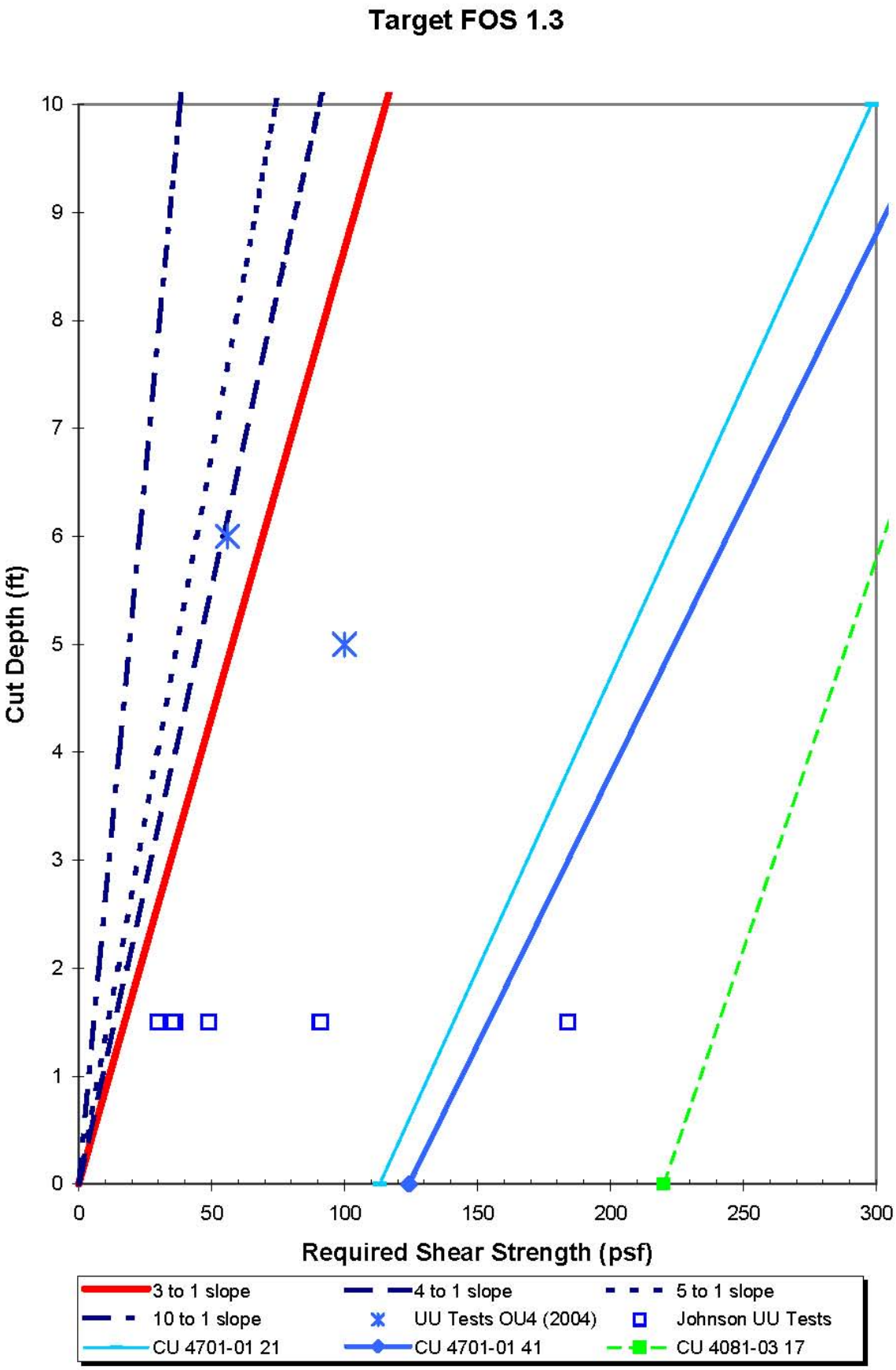
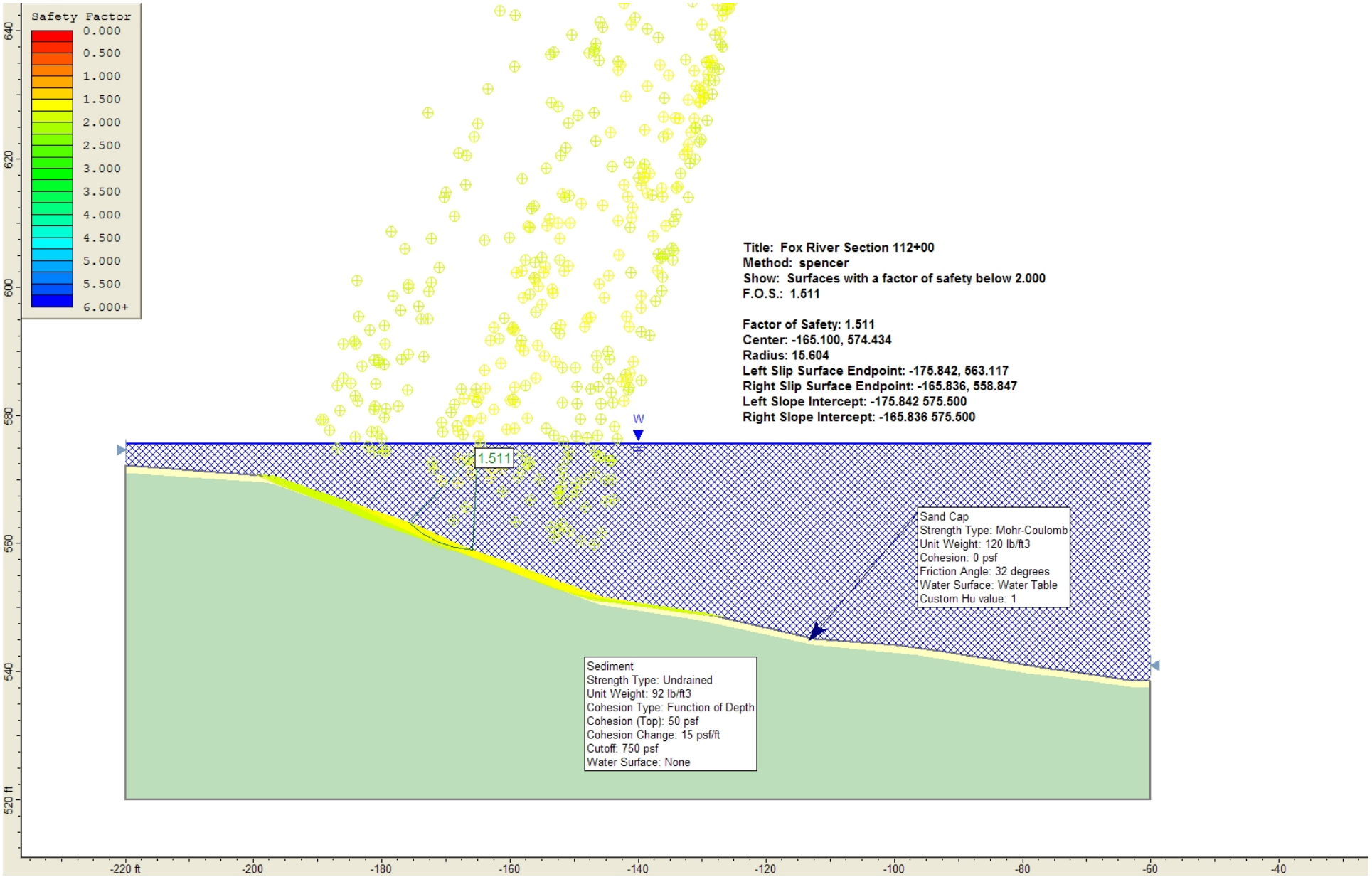


Figure 1
Selection of Cut Slope Angle
Fox River

ANCHOR ENVIRONMENTAL, L.L.C.



ANCHOR ENVIRONMENTAL, L.L.C.

Shaw

Figure 2
Cap Slope Stability
Lower Fox River

Attachment F –
PCB Content of the Dewatered Silts and Clays

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	CALC NO.	SHEET 1 of 1
SUBJECT: PCB Content of the Dewatered Silts and Clays		

Purpose: To determine the effect of desanding on the PCB content of the separated and dewatered silts and clays.

Reference: None.

Given: Conservation of mass

PCB Content (mg/kg dry weight basis, dwb) of the In-Place Sediment = (PCB Content of the Desanded (>100 Mesh) Material (mg/kg dwb) * Fraction of Material >100 mesh) + PCB Content of the Dewatered Silts and Clay (<100 Mesh) Material (mg/kg dwb) * Fraction of Material <100 Mesh)

Given: Fraction of the Material equal the percentage of the total solids divided by 100%

Assumed: Desanded material is 35% of the total solids; Silts and clays will comprise 65% (100%-35%) of the total solids

Assumed PCB content (mg/kg dwb) of the desanded material is less than 1 mg/kg dwb; 1 mg/kg will be used in the calculation

Therefore, The PCB Content (mg/kg dwb) of the Dewatered Silts and Clays (>100 Mesh) would be:

PCB Content of the Dewatered Silts and Clay (<100 mesh) (mg/kg dwb) =[PCB Content (mg/kg dwb) of the In-Place Sediment - (PCB Content of the Desanded (>100 Mesh) Material (mg/kg dwb) * Fraction of Material >100 mesh)]/ Fraction of Material <100 Mesh)

PCB Content of the In-Place Sediment (mg/kg dwb)	PCB Content of the Desanded Material (mg/kg dwb)	Fraction of the Desanded Material	PCB Content of the Dewatered Silts and Clays (mg/kg dwb)	Fraction of the Dewatered Silts and Clays
5.0	1.0	0.35	7.2	0.65
10.0	1.0	0.35	14.9	0.65

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE

APPENDIX B

MINERGY COST COMPARISON

BASIS OF DESIGN REPORT

LOWER FOX RIVER AND GREEN BAY SITE
BROWN, OUTAGAMIE, AND WINNEBAGO COUNTIES, WISCONSIN

Prepared by:
Shaw Environmental & Infrastructure, Inc.
Anchor Environmental, LLC
Foth & Van Dyke
Limno-Tech

Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

List of Attachments

Attachment A Minergy Cost Comparison Memo
Attachment B Minergy Design Basis

Attachment A –

Minergy Cost Comparison Memo

Shaw Environmental
& Infrastructure, Inc.

Memo

To: Sediment Treatment Work Group

Lower Fox River Remedial Design, OUs 2 - 5

From: George L. Hicks and Dr. Paul Lear (Shaw)

CC: Walter Kunicki; Bruce Baker

Date: May 12, 2005

Re: Cost Comparison of Minergy GFT Technology with Landfill Disposal

Introduction

The Glass Furnace Technology (GFT), developed by Minergy Corporation, has been proposed for the vitrification of the Fox River sediment material. The GFT has been tested on a pilot-scale for the melter and bench scale for the dryers as part of an EPA Superfund Innovative Technology Evaluation (SITE) demonstration in August of 2001. A commercial scale GFT facility is under design by Minergy. The Sediment Treatment Work Group has been tasked with evaluating the feasibility and cost-effectiveness of GFT as part of the OU2-5 remedial design.

On March 18, 2005, Minergy provided (Attachment A) the capital and "all inclusive" operating estimates for vitrification facilities that addressed eight "large-quantity" scenarios submitted by the respondents' Remedial Design Team. The eight primary scenarios were as follows:

1.) Processing 4,600,000 CY @ 50% Solids (Mechanical Dewatering) --- Over a Ten Year Timeframe

2.) Processing 4,600,000 CY @ 50% Solids (Mechanical Dewatering) --- Over a Fifteen Year Timeframe

3.) Processing 4,600,000 CY @ 35% Solids (Passive Dewatering) --- Over a Ten Year Timeframe

4.) Processing 4,600,000 CY @ 35% Solids (Passive Dewatering) --- Over a Fifteen Year Timeframe

5.) Processing 7,100,000 CY @ 50% Solids (Mechanical Dewatering) --- Over a Ten Year Timeframe

6.) Processing 7,100,000 CY @ 50% Solids (Mechanical Dewatering) --- Over a Fifteen Year Timeframe

7.) Processing 7,100,000 CY @ 35% Solids (Passive Dewatering) --- Over a Ten Year Timeframe

8.) Processing 7,100,000 CY @ 35% Solids (Passive Dewatering) --- Over a Fifteen Year Timeframe

Note: The draft quantities above represent the ROD Remedy for dredging only (7.6 million cubic yards) and a potential Contingent Remedy, which includes areas remediated with capping (4.6 million cubic yards). The 10 year – timeframe represents the ROD Remedy projection for the remedial action. The 15 year – timeframe was provided for informational purposes --- due to a potential lack of storage space during the "off season". Any changes to the ROD Remedy would require some form of administrative action.

The estimates provide by Minergy were subject to the following assumptions and clarifications;

- The capital estimates are for an all inclusive vitrification plant including receiving, drying, melting, heat recovery, oxygen, air quality control systems, wastewater treatment and sediment storage.
- Capital estimate includes design, engineering, buildings, foundations (assuming nothing extraordinary), utility interconnections, construction, construction management, equipment procurement, start up and contingency (10%).
- For the passive dewatering options, Minergy backed out the Remedial Design Team's assumption of 20% lime by weight and added back in only the lime necessary for fluxing purposes (included in O&M estimate). Minergy assumed the material could be passed over the fence without having to pass the paint filter test as the only logical place for this facility would be located adjacent to the dewatering activity.
- Permitting assumes use of CERCLA permit bar with substantive requirements no more stringent than presented in the Permitting Feasibility report.
- Included in the annual O&M estimate is a line item for an O&M contract. Included in this line item are staffing (wages and fringe) and annual maintenance budget to fully operate the facility.
- No financing costs have been included.

Changes in some of these assumptions would affect the cost estimates for the GFT project. For example, if permitting requirements were more stringent than presented in the Permitting Feasibility report, this would increase the cost of GFT. In addition, because no cost of financing was included in the operating estimates, the cost of financing would have to be added to these estimates in order to obtain a "fully-loaded" cost estimate. Finally, as the Work Group has discussed at previous meetings, the Remedial Design Team has expressed concerns that additional components would need to be added to Minergy's GFT concept in order to overcome certain technical challenges or uncertainties that come with conducting a "Serial No. 1" project. Despite these concerns, the Remedial Design Team has not included any cost for addressing these concerns in the cost estimates. Thus, these cost estimates represent "best case" estimates.

As a separate concept, in addition to the cost estimates for these large quantity facilities, Minergy has provided cost estimates for a smaller-quantity facility based on the assumption that a facility could be located next to their currently operating Neenah, Wisconsin plant. The estimates for this "co-located" facility were based on a 50 glass ton per day unit (375,000 tons of dewatered sediment processed over a ten year timeframe) and a 100 glass ton per day unit (640,000 tons of dewatered sediment processed over a ten year timeframe). The two co-located facility estimates are included as Attachment B.

Purpose

The purpose of this task was to review and evaluate vitirfication technology costs for the eight large-quantity scenarios and compare those costs to currently-available costs for upland disposal.

Evaluation Results

Shaw took the cost estimates supplied for the eight scenarios and extended the annual O & M costs for the life cycle of the plant (10 or 15 years respectively) and added the capital cost. We then divided this total cost by the proposed number of years of operation and used the appropriate cubic yard to ton conversion rate to determine a per ton vitrification cost. The results are illustrated in Table 1.

Table 1				
Vitrification Costs*				
	Scenario	**Per CY Price**	**CY/Ton Conversion Factor**	**Per Ton Price**
(1)	4,600,000 CY @ 50% Solids/10 Years	$50.82	1.12	$58.44
(2)	4,600,000 CY @ 50% Solids/15 Years	$49.89	1.12	$55.99
(3)	4,600,000 CY @ 35% Solids/10 Years	$75.73	1.06	$80.27
(4)	4,600,000 CY @ 35% Solids/15 Years	$72.00	1.06	$76.32
(5)	7,100,000 CY @ 50% Solids/10 Years	$47.71	1.12	$53.43
(6)	7,100,000 CY @ 50% Solids/15 Years	$45.32	1.12	$50.83
(7)	7,100,000 CY @ 35% Solids/10 Years	$71.47	1.06	$75.76
(8)	7,100,000 CY @ 35% Solids/15 Years	$67.34	1.06	$71.38

*Note: As discussed above, this “vitrification cost” does not address the excluded costs of financing, transportation from the dewatering facility to the Minergy facility (even if located side by side there would be some form of transportation) or technical concerns not easily quantifiable to dollars.

In comparison, the Remedial Design Team has obtained quotes from landfill facilities for transportation and disposal of mechanically dewatered material at $35 per ton, and disposal of passively dewatered material at $45 per ton. Compared to these landfill costs, the cost of vitrification from Table 1 for the eight large-quantity scenarios is between 30 and 60 percent more expensive.

Summary and Next Steps

Based on this comparison, the “large-quantity” vitrification concept is substantially more expensive for the OU2-5 project than landfill disposal of sediment. This is true over a range of sediment volume, timeframe, and percent solids assumptions.

The Remedial Design Team is still reviewing the smaller-quantity, co-located facility option (50 or 100 glass ton per day). While the Remedial Design Team does not expect that this option would be cost-effective for most sediment, it may be cost-effective for treatment of TSCA material. Provided Minergy is interested in pursuing the concept of the smaller-quantity, co-located facility, which would have to be TSCA-permitted, the Remedial Design Team will continue to evaluate this option during cost estimating exercises for the “Basis of Design Report”.

Attachment A

Vitrification Capital and O&M for OU2-5

4,600,000 cy/ 50% TS / 10 years / Mechanical Dewatering					
Capital estimate (installed):	$70,670,355				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	775,842	mmBtu	$7.25	$/mmBtu	$5,627,184
Annual lime consumption	20,963	tons	$65.00	$/ton	$1,362,575
Annual electric consumption	40,439	MWH	$49.00	$/MWH	$1,981,503
Cooling water	85	MG	$1,600	$/MG	$135,241
Minergy O&M contract					$7,203,000
Total Annual O&M					$16,309,503

4,600,000 cy/ 50% TS / 15 years / Mechanical Dewatering					
Capital estimate (installed):	$48,860,000				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	516,652	mmBtu	$7.25	$/mmBtu	$3,747,278
Annual lime consumption	13,960	tons	$65.00	$/ton	$907,372
Annual electric consumption	26,929	MWH	$49.00	$/MWH	$1,319,531
Cooling water	94	MG	$1,600	$/MG	$150,210
Minergy O&M Contract					$5,949,000
Total Annual O&M					$12,073,391

4,600,000 cy / 35% TS / 10 years / Passive Dewatering					
Capital estimate (installed):	$112,150,730				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	1,334,322	mmBtu	$7.25	$/mmBtu	$9,677,837
Annual lime consumption	22,903	tons	$65.00	$/ton	$1,488,696
Annual electric consumption	53,643	MWH	$49.00	$/MWH	$2,628,492
Cooling water	148	MG	$1,600	$/MG	$236,802
Minergy O&M Contract					$9,589,000
Total Annual O&M					$23,620,827

4,600,000 cy / 35% TS / 15 years / Passive Dewatering					
Capital estimate (installed):	$76,615,909				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	890,310	mmBtu	$7.25	$/mmBtu	$6,457,415
Annual lime consumption	15,282	tons	$65.00	$/ton	$993,314
Annual electric consumption	35,792	MWH	$49.00	$/MWH	$1,753,828
Cooling water	140	MG	$1,600	$/MG	$223,850
Minergy O&M Contract					$7,545,000
Total Annual O&M					$16,973,407

7,100,000 cy / 50% TS / 10 years / Mechanical Dewatering					
Capital estimate (installed):	$106,012,974				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	1,195,730	mmBtu	$7.25	$/mmBtu	$8,672,631
Annual lime consumption	32,308	tons	$65.00	$/ton	$2,100,004
Annual electric consumption	62,324	MWH	$49.00	$/MWH	$3,053,897
Cooling water	130	MG	$1,600	$/MG	$208,433
Minergy O&M Contract					$9,235,000
Total Annual O&M					$23,269,965

7,100,000 cy/ 50% TS / 15 years / Mechanical Dewatering					
Capital estimate (installed):	$72,416,534				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	796,577	mmBtu	$7.25	$/mmBtu	$5,777,577
Annual lime consumption	21,523	tons	$65.00	$/ton	$1,398,991
Annual electric consumption	41,520	MWH	$49.00	$/MWH	$2,034,460
Cooling water	87	MG	$1,600	$/MG	$138,855
Minergy O&M Contract					$7,304,000
Total Annual O&M					$16,653,883

7,100,000 cy/ 35% TS / 10 years / Passive Dewatering					
Capital estimate (installed):	$170,166,560				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	1,941,686	mmBtu	$7.25	$/mmBtu	$14,083,051
Annual lime consumption	35,348	tons	$65.00	$/ton	$2,297,623
Annual electric consumption	82,791	MWH	$49.00	$/MWH	$4,056,759
Cooling water	228	MG	$1,600	$/MG	$365,475
Minergy O&M Contract					$12,924,000
Total Annual O&M					$33,726,908

7,100,000 cy / 35% TS / 15 years / Passive Dewatering					
Capital estimate (installed):	$115,198,536				
	Annual Consumption		**Unit Cost**		**Annual Total**
Natural gas	1,372,402	mmBtu	$7.25	$/mmBtu	$9,954,031
Annual lime consumption	23,557	tons	$65.00	$/ton	$1,531,182
Annual electric consumption	55,174	MWH	$49.00	$/MWH	$2,703,506
Cooling water	152	MG	$1,600	$/MG	$243,560
Minergy O&M Contract					$9,764,000
Total Annual O&M					$24,196,279

Attachment B –

Minergy Design Basis

Attachment B

CONFIDENTIAL – For Discussion Purposes Only **Draft 3/16/05**

Design Basis
For
Treatment of PCB Contaminated Sediment

PROCESSING LOCATION: Adjacent to Minergy's Neenah facility**.** By locating the facility adjacent to the Minergy Neenah facility, cost savings realized through taking advantage of existing resources such as steam, electric power, sewer, water, compressed air, plant operators and maintenance services infrastructure. Savings realized through both reduced capital and annual operation & maintenance costs.

DAILY PROCESSING CAPACITY: 50 glass tons/day

ANNUAL CAPACITY: 17,500 glass tons/year operating 350 days/year. Equivalent to 17,500 bone dry tons of sediment or approximately 37,500 tons of dewatered sediment at an average 50% dry solids content.

PROCESSING DURATION: 10 years for a total of approximately 375,000 tons of dewatered sediment at an average 50% dry solids content.

TECHNOLOGY: Indirect steam heated sediment dryer
Steam energy provided by Minergy-Neenah
Oxy-fuel fired melter
Bulk liquid oxygen delivery and storage
PLC integrated with Neenah plant operations
Off-site storage

SEDIMENT QUALITY: 45 to 55% dry solids content and screened

PROCESSING COSTS: Processing fee in a range of $76 to $124 per wet ton of sediment dependant on final detailed basis of design and commercial terms and conditions. Due to the smaller size (lower capital costs) of the facility and innovate nature of the sediment treatment, outside funding may be available. External funding can drive the processing costs down to or potentially below the cost range discussed above.

DESIGN BASIS
FOR
TREATMENT OF PCB CONTAMINATED SEDIMENT

PROCESSING LOCATION: Adjacent to Minergy's Neenah facility**.** By locating the facility adjacent to the Minergy Neenah facility, cost savings realized through taking advantage of existing resources such as steam, electric power, sewer, water, compressed air, plant operators and maintenance services infrastructure. Savings realized through both reduced capital and annual operation & maintenance costs.

DAILY PROCESSING CAPACITY: 100 glass tons/day

ANNUAL CAPACITY: 32,000 glass tons/year operating 320 days/year. Equivalent to 32,000 bone dry tons of sediment or approximately 64,000 tons of dewatered sediment at an average 50% dry solids content.

PROCESSING DURATION: 10 years for a total of approximately 640,000 tons of dewatered sediment at an average 50% dry solids content.

TECHNOLOGY:
Indirect steam heated sediment dryer
Steam energy provided by Minergy-Neenah
Oxy-fuel fired melter
Bulk liquid oxygen delivery and storage
PLC integrated with Neenah plant operations
Off-site storage

SEDIMENT QUALITY: 45 to 55% dry solids content and screened.

PROCESSING COSTS: Processing fee in a range of $65 to $98 per wet ton of sediment dependant on final detailed basis of design and commercial terms and conditions. Due to the smaller size (lower capital costs) of the facility and innovate nature of the sediment treatment, outside funding may be available. External funding can drive the processing costs down to or potentially below the cost range discussed above.

APPENDIX C

DESANDING TREATABILITY TESTING REPORT

BASIS OF DESIGN REPORT

LOWER FOX RIVER AND GREEN BAY SITE
BROWN, OUTAGAMIE, AND WINNEBAGO COUNTIES, WISCONSIN

Prepared by:
Shaw Environmental & Infrastructure, Inc.
Anchor Environmental, LLC
Foth & Van Dyke
Limno-Tech

Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

List of Attachments

Attachment A Desanding Treatability Testing Report

Attachment A –

Desanding Treatability Testing Report

Shaw Environmental & Infrastructure, Inc.

TREATABILITY TESTING REPORT FOR THE SEPARATION OF SAND FRACTIONS FROM THE PCB-CONTAMINATED FOX RIVER SEDIMENTS

Prepared By:

Shaw E&I Technology Applications Laboratories
Knoxville, TN

Paul R. Lear
Director, Technology Applications

May 8, 2005
Shaw Project 108876

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1.0 INTRODUCTION

1.1 PROJECT HISTORY

The Operable Units (OUs) 2 through 5 of the Lower Fox River and Green Bay Site contain PCB-contaminated sediments. The remedial design for OUs 2 through 5 includes the hydraulic dredging of some or all of these contaminated sediments. Desanding of the dredged slurry is being considered, either to separate a non-contaminated sand fraction or to separate the sand to reduce wear on the pipeline transporting the dredged slurry.

1.2 REMEDIAL TECHNOLOGY DESCRIPTION

The desanding methodology tested utilizes a combination of physical separation processes to separate the PCB contaminated fine particles from the clean sand particles. A combination of physical separation technologies, particle size classification and attrition scrubbing, were incorporated to separate the PCB-impacted fine fractions from the clean sands.

This treatability study was conducted to evaluate specific technologies for the physical separation of PCB contaminated soils from clean sands and soils. The goal of the physical separation is to separate the media into two fractions:

- Residual PCB-contaminated soil fractions, and
- "Clean" Sand.

"Clean" sand was considered to have total PCB concentrations less than 1,000 µg/kg.

2.0 TREATABILITY STUDY APPROACH

2.1 TEST OBJECTIVES AND RATIONALE

The objective of the desanding/treatability testing is to determine whether a "clean" sand fraction can be obtained by desanding with or without attrition scrubbing (high speed, high shear abrasive mixing).

2.2 EXPERIMENTAL DESIGN AND PROCEDURES

2.2.1 Treatability Study Samples

Sediments were sampled at various locations along the Fox River during the summer of 2004 as part of a delineation study. Selected sediment samples from OUs 3, 4, and 5, representing eight different composite samples, were shipped to Shaw's Technology Development Laboratory in Knoxville, Tennessee. Samples were received on November 30, 2004. Upon receipt, each sample was logged in and given an individual sample number. All samples designated for a particular composite were combined and homogenized, producing the eight composite samples. Aliquots from each composite sample were removed for other testing. The sand washing treatability testing was performed using 2.5 kg of the remaining sample material for each composite. Testing was not performed on sediments from Composites 301 and 302 due to a shortage of sample material.

The 2.5 kg of each composite sample were thoroughly individually homogenized in a Hobart Planetary mixer and divided into 2-equal sub- samples designated A and B. Portions of each sub-sample were submitted to En Chem in Green Bay, Wisconsin for PCB analysis.

2.2.2 Sample Characterization

Portions of each sub-sample (A & B) were analyzed for the parameters listed in Table 2-1. The PCB analysis was performed by En Chem (a division of Pace Analytical) in Green Bay, Wisconsin, as was all of the PCB analyses for this treatability study.

Table 2-1. Parameters for Characterization of the Fox River Sediments

Parameter	Methodology
Solids Content	ASTM Method D2216
PCBs	Fox River Method

2.2.3 Desanding With Organic Flotation and Attrition Scrubbing

For the Desanding Test with Organic Flotation and Attrition Scrubbing testing (Figure 2-1), 1,100 g of the A-portion of each composite sample was washed through a 200 mesh sieve (0.0029 inch). The material passing through the sieve was collected. The collected slurry was flocculated using a ferrous sulfate solution and centrifuged to separate the liquid and solid fractions. Then the solids were air dried and weighed. An aliquot of the dried fines from each composite sample was analyzed for bulk density and total PCBs.

Because there was visible organic "muck" along with the sand remaining on the 200 mesh sieve, the material that remained on the 200 mesh sieve was washed several times with water in order to float the organic material away from the sand. The organics and water decanted from the sands were centrifuged. The organic material was air dried and weighed. An aliquot of the dried organic material from each composite sample was analyzed for bulk density and total PCBs.

The remaining sand material for each composite sample was mixed with water to approximately 50 % solids content and attrition-scrubbed to remove humic and clay particles adhering to the surface of the sand with abrasion. After attrition scrubbing, the sands were washed through a series of sieves (No. 4, 10 mesh, 20 mesh, 40 mesh, 100 mesh and 200 mesh) to separate the sand into various fractions and to remove any separated fine particles. The material collected on each sieve was washed twice with tap water to remove entrained fines. The material on each sieve was then air-dried and weighed. For sand fractions containing more than 10 g of air-dried material, an aliquot of the dried sand fraction was analyzed for bulk density and total PCBs.

2.2.4 Desanding Without Attrition Scrubbing

Desanding without organic flotation and attrition scrubbing (Figure 2-2) was performed on 1,100 g of the B-portion of each composite sample. Each B-portion was washed through a series of sieves (No. 4, 10 mesh, 20 mesh, 40 mesh, 100 mesh and 200 mesh). The material on each sieve was washed twice with tap water to remove entrained fines, air-dried, and weighed. For sand fractions containing more than 10 g of air-dried material, an aliquot of the dried sand fraction was analyzed for bulk density and total PCBs.

Figure 2-1. Process Flow Diagram for Desanding with Organic Flotation and Attrition Scrubbing Testing

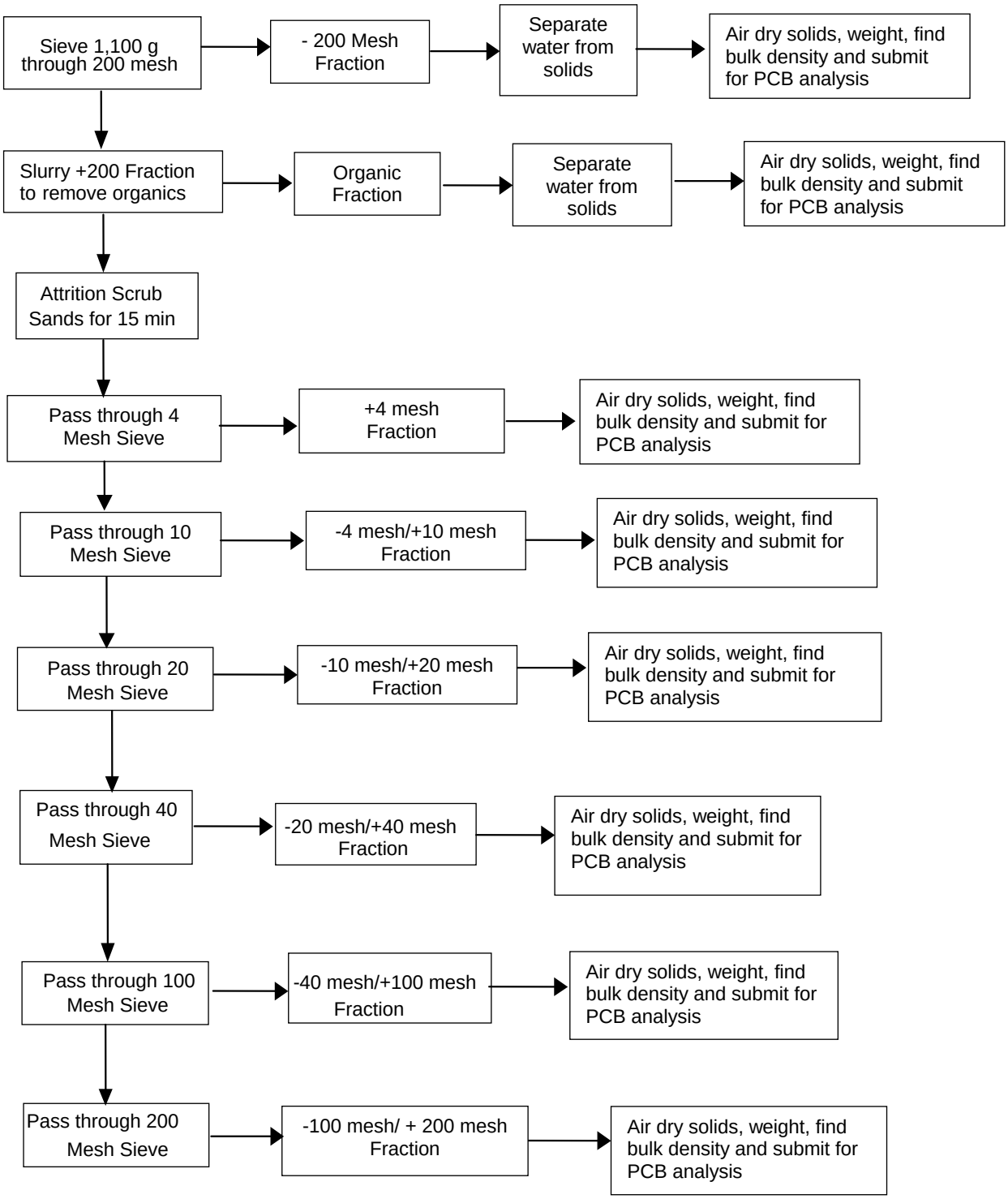
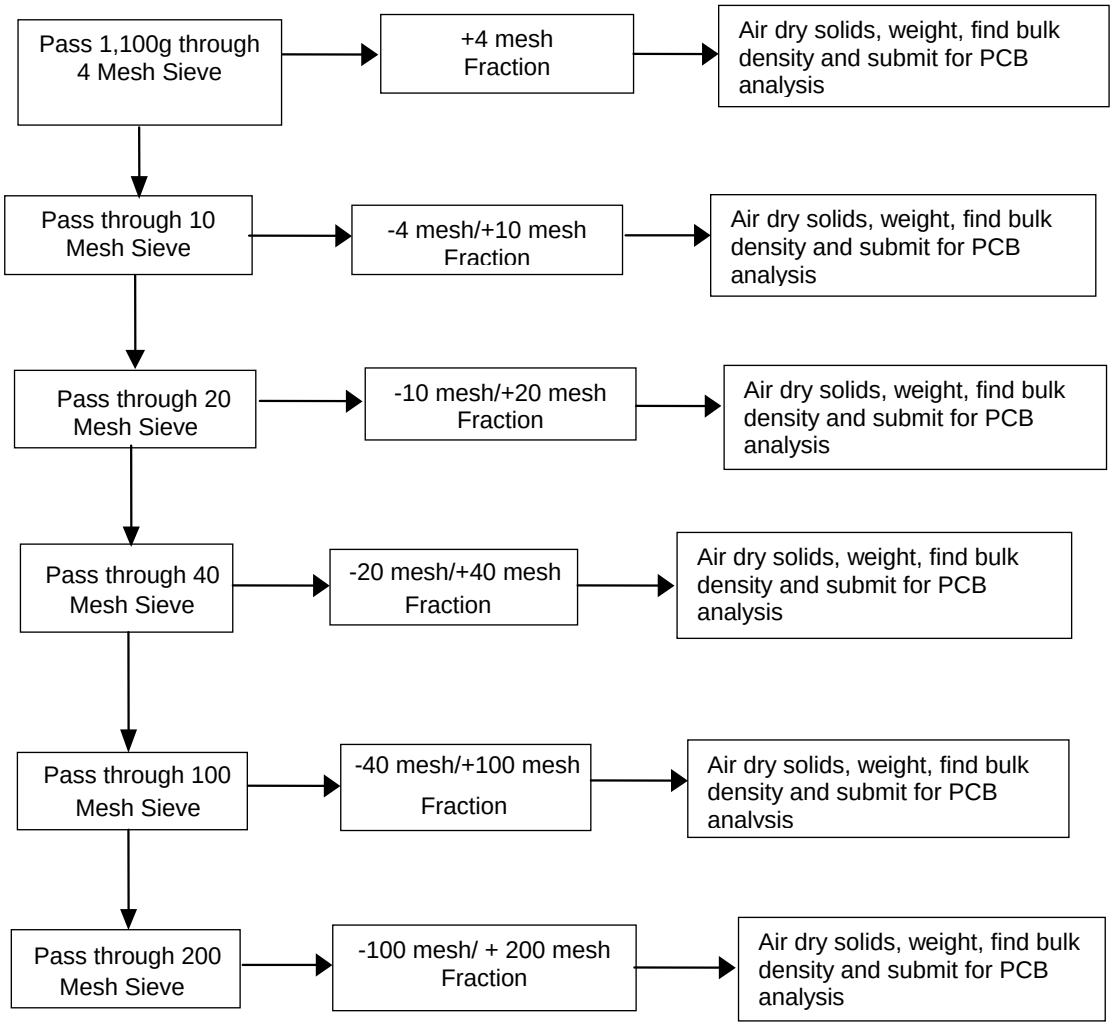


Figure 2-2. Process Flow Diagram for Desanding without Organic Flotation and Attrition Scrubbing Testing



2.3 EQUIPMENT AND MATERIALS

2.3.1 Equipment

The equipment for the treatability testing included, but was not limited to,

- Hobart Kitchenaid 4-quart mixer
- Denver Equipment Attrition Scrubber
- Laboratory centrifuge
- 4 mesh, 10 mesh, 20 mesh 40 mesh, 100 mesh, and 200 mesh sieves
- 2000 ml glass beakers
- assorted glass jars
- 250 ml centrifuge bottles
- metal spatulas

2.3.2 Materials

The reagents utilized for flocculation and dewatering was technical grade ferrous sulfate.

3.0 RESULTS AND DISCUSSION

The results for the treatability study are discussed below. The subsections generally follow the subsections of Section 2.2, *Experimental Design and Procedures*, above.

3.1 SAMPLE CHARACTERIZATION

The results from the sample characterization are summarized in Table 3-1.

Table 3-1. Characterization Results for the Fox River Sediment Samples

Composite Sample	Total PCB (µg/kg)	Solids Content (%)
303A	3,400	52.6
303B	3,500	52.6
401A	50,000	31.4
401B	48,000	31.4
402A	12,000	42.0
402B	12,000	42.0
403A	12,000	43.6
403B	12,000	43.6
404A	11,000	42.6
404B	12,000	42.6
501A	2,800	49.9
501B	2,000	49.9

3.2 DESANDING WITH ORGANIC FLOTATION AND ATTRITION SCRUBBING

Table 3-2 and Figure 3-1 contains percent of total air-dried material in each sieved fraction for the desanded, organic floated, and attrition scrubbed A-portions of each sediment composite sample. Table 3-3 contains the bulk densities for each of the air-dried sieve fractions, and Table 3-4 contains the total PCB concentration for each of the air-dried sieve fractions.

Table 3-2. Weight of Sieved Fractions Following Desanding, Organic Flotation, and Attrition Scrubbing

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Percent of Total Air-Dried Material					
+4 mesh	>0.187 in.	3.35	0.04	<0.04	0.26	2.23	<0.04
-4 mesh /+10 mesh	<0.187 >0.0787 in.	3.10	0.26	0.05	0.38	0.84	0.05
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	28.64	0.36	0.16	0.17	1.45	0.10
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	7.39	1.44	2.50	13.28	4.92	0.12
-40 mesh/+100	<0.0165 >0.0059 in.	12.37	6.84	14.29	12.40	14.12	37.44
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	2.42	2.53	6.48	2.16	3.55	7.56
-200 mesh	<0.0029 in.	33.20	72.13	61.38	53.67	55.30	42.35
+200 mesh organics	>0.0029 in. organics	9.53	16.40	15.13	17.67	17.58	12.38

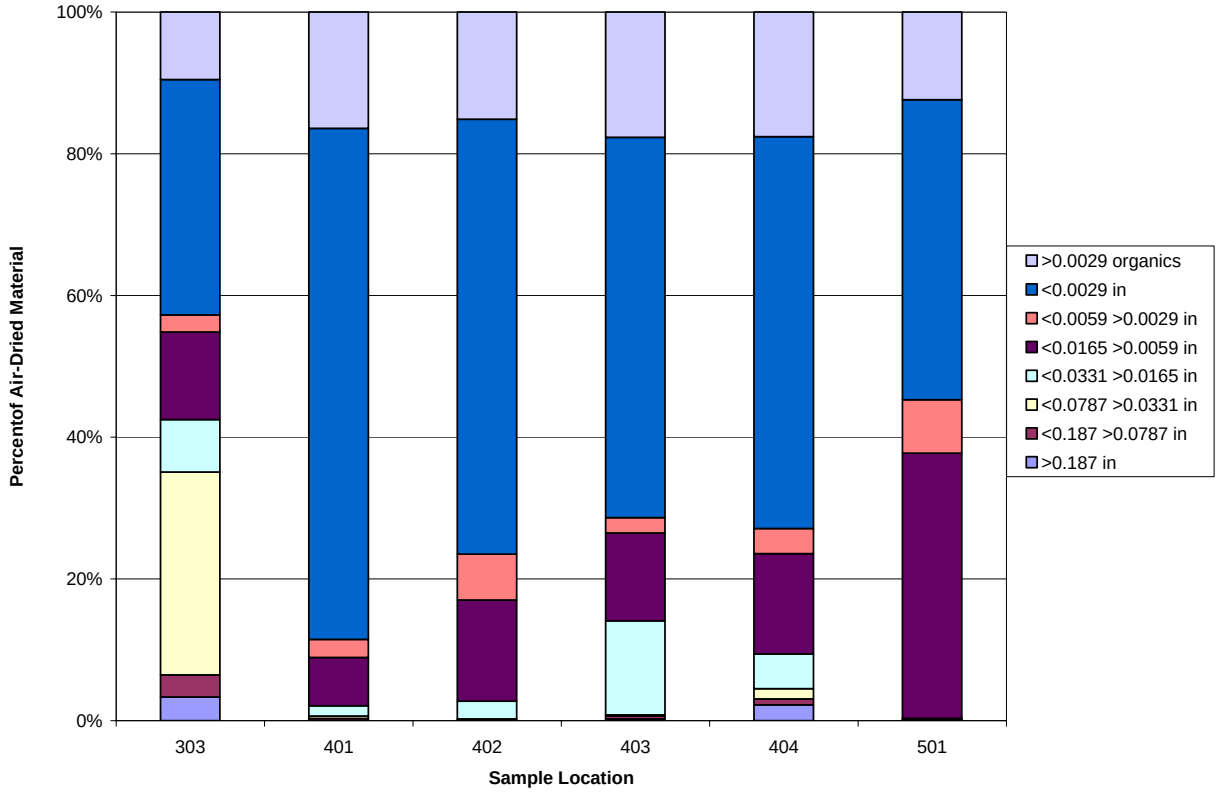


Figure 3-1. Particle Size Fractionation Following Desanding, Organics Flotation, and Attrition Scrubbing

Table 3-3. Bulk Densities of the Sand Fractions Following Desanding, Organic Flotation, and Attrition Scrubbing

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Dry Bulk Density (lb/ft^3)					
+4 mesh	>0.187 in.	--[1]	--	--	--	--	--
-4 mesh /+10 mesh	<0.187 >0.0787 in.	66.0	--	--	--	--	--
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	104.6	--	--	62.4	56.2	--
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	101.3	--	101.1	103.2	104.9	--
-40 mesh/+100	<0.0165 >0.0059 in.	100.4	99.4	97.8	101.9	96.3	94.4
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	84.8	91.9	94.5	90.5	67.7	93.8
-200 mesh	<0.0029 in.	54.2	56.8	60.2	56.7	58.9	58.9
+200 mesh organics	>0.0029 in. organics	35.7	28.8	36.0	36.1	42.3	46.3

[1] Double dashes (--) means that there was insufficient sample for analysis

Table 3-4. PCB Concentrations in Sand Fractions Following Desanding, Organic Flotation, and Attrition Scrubbing

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Total PCB (µg/kg)					
+4 mesh	>0.187 in.	29	--[1]	--	--	250	--
-4 mesh /+10 mesh	<0.187 >0.0787 in.	<27	--	--	--	--	--
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	<27	--	--	--	--	--
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	<27	--	<28	42	170	--
-40 mesh/+100	<0.0165 >0.0059 in.	<27	530	41	77	220	66
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	140	--	100	140	1,900	45
-200 mesh	<0.0029 in.	9,600	42,000	17,000	17,000	19,000	4,000
+200 mesh organics	>0.0029 in. organics	14,000	85,000	22,000	19,000	20,000	5,000

[1] Double dashes (--) means that there was insufficient sample for analysis

3.3 DESANDING WITHOUT ORGANIC FLOTATION AND ATTRITION SCRUBBING

Table 3-5 and Figure 3-2 contains the percent of total air-dried material in each sieve fraction for the desanded B-portion of the composite samples. Table 3-6 contains the bulk densities for each of the air-dried sieve fractions and Table 3-7 contains the total PCB concentration for each of the air-dried sieve sample fractions.

Table 3-5. Weight of Sieved Fractions Following Desanding

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Percent of Total Material					
+4 mesh	>0.187 in.	14.56	0.50	0.28	0.48	6.35	0.06
-4 mesh /+10 mesh	<0.187 >0.0787 in.	5.78	1.20	0.48	0.73	2.25	0.19
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	5.44	1.42	0.81	3.19	2.93	0.34
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	12.99	3.33	1.19	4.04	3.68	1.25
-40 mesh/+100	<0.0165 >0.0059 in.	29.57	11.85	14.33	23.26	20.75	25.07
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	3.66	8.97	16.33	12.26	8.15	27.58
-200 mesh	<0.0029 in.	28.00	72.73	66.58	56.04	55.89	45.53

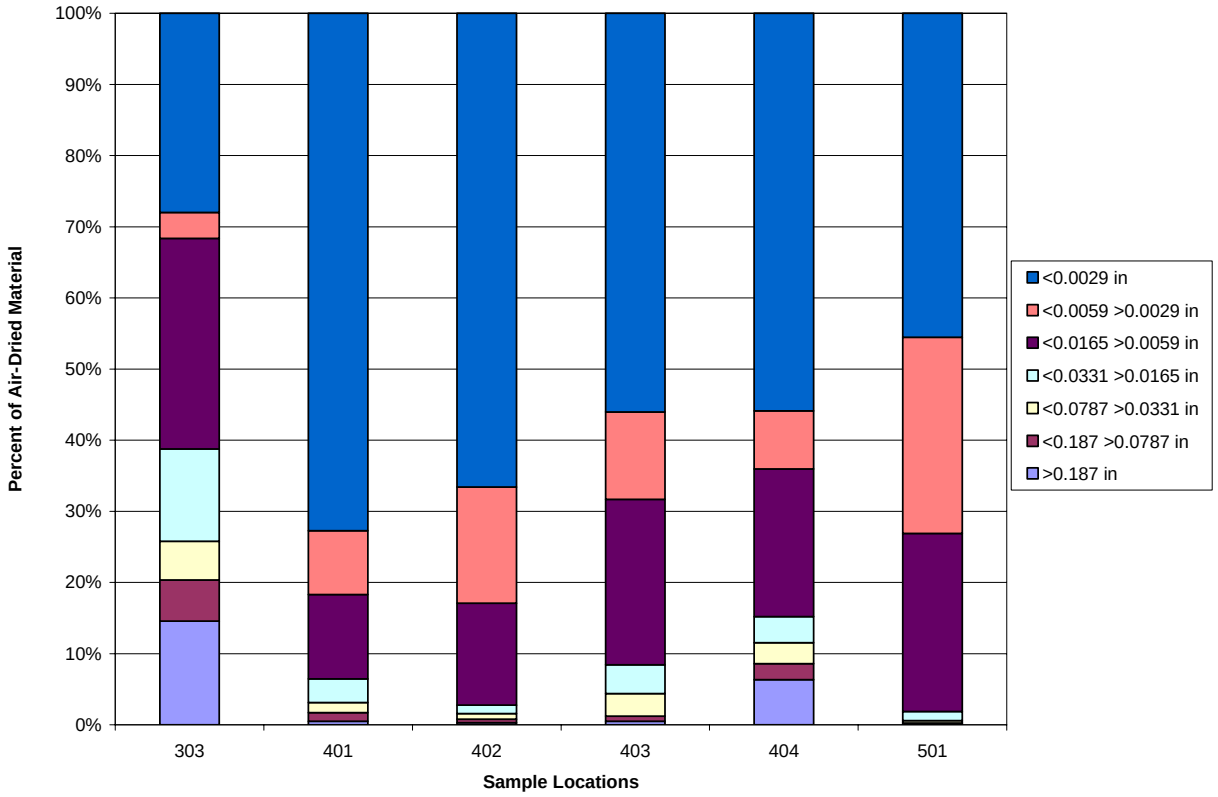


Figure 3-2. Particle Size Fractionation Following Desanding

Table 3-6. Bulk Densities of Sand Fractions Following Desanding

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Dry Bulk Density (lb/ft^3)					
+4 mesh	>0.187 in.	--[1]	--	--	--	--	--
-4 mesh /+10 mesh	<0.187 >0.0787 in.	102.8	--	--	--	20.4	--
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	71.1	--	--	32.6	43.8	--
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	79.8	30.0	--	48.7	49.8	--
-40 mesh/+100	<0.0165 >0.0059 in.	81.7	46.7	60.1	65.8	59.2	71.1
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	67.8	43.6	70.4	57.8	50.6	74.2

[1] Double dashes (--) means that there was insufficient sample for analysis

Table 3-7. PCB Concentrations of Sand Fractions Following Desanding

Composite Sample		303	401	402	403	404	501
Sieve Mesh	Size Fraction	Total PCB (µg/kg)					
+4 mesh	>0.187 in.	81	--[1]	--	--	2,100	--
-4 mesh /+10 mesh	<0.187 >0.0787 in.	490	--	--	--	4,800	--
-10 mesh/+20 mesh	<0.0787 >0.0331 in.	950	--	--	12,000	7,800	--
-20 mesh/+40 mesh	<0.0331 >0.0165 in.	790	73,000	--	6,900	7,400	--
-40 mesh/+100	<0.0165 >0.0059 in.	1,100	27,000	4,800	3,200	4,300	1,100
-100 mesh/ +200 mesh	<0.0059 >0.0029 in.	5,000	35,000	5,400	5,800	9,000	810

[1] Double dashes (--) means that there was insufficient sample for analysis

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CHARACTERIZATION

Characterization data shows that the Fox River sediment composites contained relatively high amounts of PCBs. Concentrations ranged from 2,400 µg/kg in the composite from Sample Location 501 to 49,000 µg/kg in the composite from Sample Location 401. The PCB concentrations between the A- and B- portions of each composite sample were relatively similar (with 2% relative percent difference [RPD]) for all of the Sample Locations except Sample Location 501 where the PCB concentrations (2,000 and 2,800 µg/kg) had a RPD of 17%.

The solids content of the composite sediment samples ranged from 31.4 percent to 51.6 percent, indicating that the sediment materials contained high amounts of water.

4.2 DESANDING WITH ORGANIC FLOTATION AND ATTRITION SCRUBBING

The data in Table 3-2 and Table 3-4 indicates that the fine fractions (-200 mesh or 0.0029 in.) and the organic fractions larger than 200 mesh (0.0029 in.) comprise not only a majority of the air dried sediment mass but also the highest concentrations of PCBs.

The sediment from Sample Location 303 had the lowest mass of combined fines and organic fractions of all of the sediments tested. Together the fines and the organics greater than 200 mesh (0.0029 in.) comprised of 42.7 % of the total air-dried sediment mass, and had PCB concentrations of 9, 600 and 14, 000 µg/kg, respectively. All of the sand fractions for Sample Location 303 had total PCB concentrations of ≤29 µg/kg, with the exception of the -100 mesh/+200 mesh (<0.0059 >0.0029 in.) fraction which had a total PCB concentration of 104 µg/kg.

The sediment from Sample Location 401 had the highest combined mass of fines and organics which comprised of 88.5 % of the total air-dried sediment. The fines had a total PCB concentration of 42,000 µg/kg, and the organics had a total PCB concentration of 85,000 µg/kg. The -40 mesh/+100 mesh (<0.0165 >0.0059 in.) sand fraction comprised 6.8% of the total air-dried sediment and had a total PCB concentration of 530 µg/kg which is far less than the performance goal of 2,000 µg/kg. Most of the remaining sand fractions could not be analyzed due to insufficient sample.

Sediment samples from Sample Locations 402, 403, and 404 where fairly similar to one another. All had combined fine and organic fractions of about 73% (ranging from 71.3 to 76.5%). The fine fractions all contained from 17, 000 to 19,000 µg/kg total PCB and the organic fractions from 19,000 to 22,000 µg/kg total PCBs. The sand fractions for all three composite samples had total PCB concentrations of less than 260 µg/kg, with the exception of the -100 mesh/+200 mesh (<0.0059 >0.0029 in.) fraction from Sample Location 404 which had a total PCB concentration of 1,900 µg/kg. Even though this concentration exceeds “clean” criteria of 1,000 µg/kg, the -100 mesh/+200 mesh (<0.0059 >0.0029 in.) fraction only made up 13% of the air-dried mass of the

sand fractions from Sample Location 404 and therefore when blended with the other sand fractions would not cause the total sand fraction to exceed 1,000 mg/kg PCBs.

The sediment from Sample Location 501 also had the majority of the total PCBs concentrated in the combined fine and organic fractions. Just over half of the air-dried material (54.7%) in this composite sample was fines and organics. These fractions contained 4,000 and 5,000 µg/kg of total PCB respectively. Only the -40 mesh/+100 mesh (<0.0165 >0.0059 in.) and the -100 mesh/+200 mesh (<0.0059 >0.0029 in.) had sufficient sample for analysis. The PCB concentrations in these fractions were 66 µg/kg and 45 µg/kg, respectively.

Based on these results in Tables 3-2 and 3-4, desanding, flotation of organics, and attrition scrubbing of the Fox River sediments is likely to produce "clean" sand (+200 mesh or 0.0029 in.) material. This "clean" sand could potentially be beneficially re-used. If able to meet particle size distribution and/or hydraulic conductivity requirements for construction of landfill soil layers, this material could also potentially be used for the project's sediment disposal facility construction (e.g., interim cover, drainage and venting layers), or at other local landfill sites.

4.3 DESANDING WITHOUT ORGANIC FLOTATION AND ATTRITION SCRUBBING

The particle size distribution data in Table 3-5 for the desanded sediment materials is similar to the particle size distributions from the sediment materials which were desanded, organic floated, and attrition scrubbed (Table 3.2). The differences appear to have come from agglomerates that were broken up during the attrition scrubbing and which could not be broken up with washing alone. This is most apparent in the sediment from Sample Location 303 which had 14.6% of the total air-dried material in the greater than 4 mesh (0.0187 in.) fraction after desanding, but only 3.35% of the total air-dried material was found in this fraction after desanding, organic flotation, and attrition scrubbing. Consequently, while the -10mesh/+20 mesh fraction (<0.0787 > 0.0331 in.) from the desanding of the Sample Location 303 composite contained 5.4% of the air-dried material, the same fraction comprised 28.6% of the total air-dried material after desanding, organic flotation, and attrition scrubbing. These differences are consistent with the break up of agglomerates into their respective individual particles.

The PCB data in Table 3-7 which shows consistently higher PCB concentrations in the sand fractions (+200 mesh or 0.0029 in.) for desanded sediment materials as opposed to those sediment materials which were desanded, organic floated, and attrition scrubbed (Table 3-4). For the Sample Location 303 sediment, the sand fractions had total PCB concentrations of 81, 490, 950, 790, 1,100, and 5,000 µg/kg, respectively. In the attrition scrubbed sample, these same fractions had total PCB concentrations of 29, <27, <27, <27, <27, and 140 µg/kg respectively. The high total PCB concentration in the sand fractions following desanding only of the sediment materials suggests that desanding alone will not separate contaminated fines and organics from the sand particles comprising the sand fraction.

While the sand fraction produced by the desanding of the sediment materials from Sample Locations 303 and 501 would likely have less than 1,000 µg/kg PCBs, the sand fraction produced by desanding of the sediment material from Sample Locations with higher PCB

contamination would have greater than 1,000 µg/kg PCBs. The results found in Table 3-5 and Table 3-7 indicated that sand washing alone would not effectively separate "clean" sands from PCB contaminated sediments.

4.4 RECOMMENDATIONS

Based on the results of the treatability testing on the PCB-contaminated sediments from the Fox River, physical separation technologies, specifically desanding with organic flotation and attrition scrubbing can be employed to separate "clean" sand (+200 mesh or 0.0029 in.) from residual PCB-contaminated fractions. Using this technology, roughly 30 percent of the sediment solids will be separated as "clean" sand, having a PCB concentration less than 1,000 µg/kg and may be available for beneficial reuse.

According to the laboratory testing the most effective separation of "clean sands" from the PCB contaminated Fox River sediments is to first separate greater than 200 mesh material from the rest of the dredged slurry. This can be accomplished by screening or hydrocycloning. The organics can be floated away from the sands by traditional flotation technologies (e.g., DAF). Fine particles attached to the surfaces of the sand can be liberated by attrition scrubbing and separated by screening or hydrocycloning.

Appendix A – Analytical Reports

APPENDIX D

CONTINGENT REMEDY EVALUATIONS

BASIS OF DESIGN REPORT

LOWER FOX RIVER AND GREEN BAY SITE
BROWN, OUTAGAMIE, AND WINNEBAGO COUNTIES, WISCONSIN

Prepared by:
Shaw Environmental & Infrastructure, Inc.
Anchor Environmental, LLC
Foth & Van Dyke
Limno-Tech

Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

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Introduction – Contingent Remedy Design Evaluations

As discussed in Section 5 of the BODR, in situ capping is a remedial option utilized in combination with dredging to design the Optimized Remedy. In an effort to evaluate the potential extent of capping in the river, a preliminary contingent remedy design was developed (using 2004 RD data) assuming that capping were to be implemented alone (i.e., without consideration of the other Optimized Remedy concepts [e.g. dredge and cap]). This preliminary contingent remedy design was then used to focus supplemental RD sampling in 2005 to collect the necessary data to further evaluate and design the Optimized Remedy components. This Appendix details this preliminary capping evaluation, while the main text of the BODR in Section 5 presents the refinements of the preliminary capping evaluations to design the blended Optimized Remedy. This Appendix is organized into four main sections as generally described below

D.1. Initial Identification of Prospective Capping Areas – This section describes the identification of prospective capping areas in accordance with the exclusionary criteria set forth in the ROD for the contingent remedy.

D.2. Cap Design Criteria – This section presents the technical cap design used in the preliminary contingent remedy evaluations and subsequent Optimized Remedy cap design.

D.3. Comparative Evaluation: ROD and Contingent Remedies – This section presents a comparative evaluation of the ROD Remedy and preliminary contingent remedy using the nine NCP evaluation criteria.

D.4. Cap Design – Optimized Remedy- This section presents the details of the Optimized Remedy cap design (as described in Section 5 of the BODR) building on the preliminary contingent remedy evaluations and using the cap design criteria presented in Sections D.1 and D.2, respectively.

D.1 Initial Identification of Prospective Capping Areas

In general, potential areas for capping were initially identified using "preliminary exclusionary criteria" defined below, which were subsequently modified as appropriate for the Optimized Remedy, based on a more detailed location-by-location evaluation, as discussed in Section 5 of the BODR. These preliminary exclusionary criteria provide general limitations on the use of capping as follows:

- No capping within the spatial boundaries of the federally-authorized navigation channel.
- No capping of sediment designated as potentially subject to TSCA disposal requirements, according to Addendum No. 3 of the Agency Approved Work Plan (Shaw/Anchor 2004a).
- No capping in areas that do not have sufficient load-bearing capacity.
- No capping in areas where the existing slope is greater than 2H:1V.
- No capping in shallow-water areas (bottom elevations that would result in a final cap surface elevation of greater than -3 feet below chart datum [see below]) without prior dredging to allow for cap placement.

Each of the preliminary criteria is discussed further below.

D.1.1 Reauthorized Navigation Channel

As discussed in Section 2 of the BODR, portions of the federally-authorized channel are currently maintained by dredging, performed by the USACE, between the mouth of the river at Green Bay and the Fort Howard turning basin (denoted OU 4B), including only a portion of the federally authorized channel width in this area. Upstream of the turning basin, in OU 4A, the federally authorized channel is currently in "caretaker" status and is not actively maintained. The reauthorization of this portion of the channel has been incorporated into and approved by the House as part of the 2005 WRDA Bill (S.7281), and Senate approval is pending.

The ROD states that capping will not be permitted within the spatial boundaries of the federal navigation channel, which has been defined by Congress in both the horizontal and vertical (i.e., depth) dimensions and in practice includes appropriate offsets to account for horizontal and vertical control accuracy. However, the requirements for exclusion of capping within the federal channel as stated in the ROD can be interpreted

[1] The OU 4A channel reauthorization was incorporated into the 2005 WRDA bill as follows:
Sec. 3103. "Green Bay Harbor Project, Green Bay, Wisconsin. That portion of the inner harbor of the Federal navigation channel of the Green Bay Harbor Project, authorized by The Act of June 23, 1886, beginning at Station 190+00 to Station 378+00 is authorized to a width of 75 feet and a depth of 6 feet effective with the enactment of this Act."

in various ways. Two alternative definitions of the boundary of the navigation channel were considered in this preliminary evaluation and are summarized below:

1. The Response Agencies have noted that the ROD is currently interpreted as preventing capping anywhere within the footprint of the authorized navigation channel regardless of depth. Under this interpretation, capping below the authorized navigation depth would not be permitted.

2. The ROD could be interpreted as allowing capping below the authorized depth of the navigation channel, consistent with approved designs at other similar CERCLA capping projects in federal navigation channels, which includes definition of the channel in the x, y, and z dimensions such that the navigation channel has a vertical boundary at the authorized depth. Under this interpretation, capping could be proposed where the top of the cap would be sufficiently below the authorized depth to ensure that the cap would not be disturbed. The Participating Companies acknowledge that this interpretation may require an ESD or ROD Amendment and recommend that this revised interpretation be included as part of the appropriate documentation that would be prepared to incorporate capping as part of the contingent remedy for OUs 2 to 5 of the Lower Fox River, considering the substantial and disproportionate costs that would be associated with using the first interpretation, with little or no benefit in environmental protection (see Section 5.2 of the BODR).

The second of the two interpretations discussed above was carried forward for the purposes of the preliminary capping evaluations, and has also been integrated into the Optimized Remedy (see Section 5 of the BODR). Furthermore, capping of sediments exceeding the 1 ppm RAL may be proposed outside of the authorized channel (targeted for reauthorization in OU 4A to 75 feet wide under the 2005 WRDA bill), incorporating a 10-foot horizontal offset from the authorized horizontal boundary. Assuming a change in the interpretation of ROD criteria as suggested above, capping could also be proposed within the horizontal boundaries of the navigation channel, but below the authorized depth, incorporating a 2-foot vertical offset below the bottom of the reauthorized channel. The 2-foot vertical offset is a buffer that has often been required at other similar CERCLA capping projects performed in federal navigation channels (e.g., Thea Foss

Waterway in Tacoma, Washington), and is defined as the vertical interval below the authorized depth of the federal navigation channel and the top of the completed cap. This vertical offset, which has been developed by the Corps based on considerations of normal dredging accuracy and overdepth allowances, provides a factor of safety to protect the surface of the cap from potential damage during future maintenance dredging activities.

D.1.2 Infrastructure and Utilities

As part of the CERCLA RD Design Work Plan, and in support of the 2004 RD sampling effort, information was compiled on all known utility crossings in the Lower Fox River including natural gas, petroleum, and water pipelines, overhead power transmission lines, and telephone cables as discussed in Section 2 of the BODR. The majority of these crossings are located in OU 4B, downstream of the Fort Howard turning basin.

In areas where contaminated sediments exceeding the RAL are identified in proximity to utility crossings, capping may be desirable since temporary or permanent relocation of the utilities in support of a dredging remedy may not be feasible or practicable. Thus, capping may be required in some of these areas based on a consideration of implementability issues. In addition to the utility crossings, there are six bridges (railroad and automobile) that cross the Lower Fox River in OU 4.

A long-term monitoring and maintenance plan will also be developed for caps to address future modifications or disturbance resulting from utility repair work in prospective capping areas.

D.1.3 Sediments Potentially Subject to TSCA Disposal Requirements

The ROD states that caps will not be placed in areas where PCB concentrations in contiguous sediment zones (i.e., accounting for small-scale spatial variability of sediment concentrations) exceed the Toxic Substances Control Act (TSCA) disposal criterion of 50 ppm. Results of the 2004 and 2005 pre-design sampling effort were used to develop a preliminary delineation of the extent of sediment PCB concentrations within OUs 2 through 5 that exceed 50 ppm.

Delineation of the areal extent and thickness of sediments potentially subject to TSCA disposal requirements was based on a Thiessen polygon analysis of the pre-design investigation data. This analysis averaged small-scale variability between sequential

core section samples, as described in Section 2.4 of the BODR. Based on this analysis, relatively few of the sampling stations in OU 4 and none of the sampling stations in OUs 2, 3, or 5 contained sediments that are potentially subject to TSCA disposal requirements (see Figure 2-24 of the BODR). The Thiessen polygon analyses were used to identify possible cap exclusion areas based on an initial application of the 50 ppm criterion.

Sediments potentially subject to TSCA disposal requirements are located in the following five areas:

- Southwest corner of OU 4A
- Upper end of De Pere Turning Basin
- Southwest of Ft. Howard Turning Basin, adjacent to SMU 56/57
- Northwest of Fort Howard Turning Basin
- Relatively small, discontinuous, and thin zones within the OU 4A abandoned navigation channel

Although PCB concentrations above 50 ppm were detected in one location in OU 2 and a few scattered locations in OU 4B, no other contiguous areas that exceed 50 ppm PCBs, and thus potentially subject to TSCA disposal requirements as described in BODR Section 2.4, have been identified outside of the areas listed above.

D.1.4 Geotechnical Stability Analysis

An in situ cap must be constructable and stable on top of the existing sediments in both the short term (during and immediately following construction) and long term (post-construction). Two forms of stability were evaluated for the preliminary cap design: sediment-bearing capacity and slope stability. The existing sediments that will support the in situ cap must have sufficient internal strength (bearing capacity) to prevent local shear failures. In addition, sediments on slopes will need to be of sufficient strength to provide slope stability under the weight of the cap.

For the purpose of the initial delineation of prospective capping areas, preliminary geotechnical bearing capacity analyses were completed as described in BODR Sections 2 and 5. Based on the initial results of this evaluation, a maximum differential cap thickness during placement of 10 to 12 inches was predicted. To ensure the stability of caps on existing slopes, a slope angle of 2H:1V was used as part of the preliminary

exclusionary criteria and developed by considering existing strength data. This slope angle was used to screen out areas that would likely be determined (in a more detailed location-by-location practicability analysis) as too steep to cap in a cost-effective way. Section 5 of the BODR presents a more detailed discussion of the bearing capacity and slope stability analyses.

D.1.5 Post-Cap Water Depth

As defined in Sections 10.1 and 13.4 of the ROD, caps will not be placed "in shallow-water areas (bottom elevations that would result in a cap surface at elevation greater than -3 feet chart datum) without prior dredging to allow for cap placement." The minimum required water depth of 3 feet was selected in consideration of the following general factors:

- To prevent damage to an in situ cap from ice scour and wind/wave forces;
- To allow recreational vessel traffic; and
- To discourage the promotion of undesirable fish (e.g., carp) habitat.

It should be noted that the refinements to the preliminary cap design for the Optimized Remedy presented in Section 5 of the BODR include assessments of the potential benefits of covering relatively shallow, thin, low-level PCB deposits (i.e., marginally above 1 ppm), with a relatively thin layer of material.

The ROD did not specifically address the baseline water elevation for determining post-construction water depths. The selection of baseline water elevations for OUs 2, 3, and 4 to be used in design evaluations of the use of capping under the Optimized Remedy is summarized below and is addressed in further detail in Attachment A.

In general, there are two design components to the water depth criterion considered in the cap design evaluation:

1. A design component to ensure long-term cap stability under a range of potential erosion forces; and
2. A "beneficial use" component that addresses potential shallowing of water depths with respect to navigation requirements, as well as changes in habitat function elements.

The vertical datum used for OU 3 capping evaluations was based on a review of key characteristics of the De Pere Dam. This included the crest of the De Pere Dam (587.31 feet [IGLD 1985]) as shown on construction drawings (Corps 1972). The crest elevation also approximately corresponds with the NOAA low water datum of 587.4 feet IGLD 1985. The De Pere dam crest elevation shown on the 1972 construction drawings was confirmed through comparison of recent conditions surveys of the dam (Corps 1999). For the purposes of the contingent remedy evaluations, a reference low water surface elevation of 587.3 feet (IGLD 1985) was used in OU 3, corresponding with a maximum top of cap elevation in OU 3 of 584.3 feet (IGLD 1985).

As discussed above, the ROD did not specifically address the baseline water elevation for determining post-construction water depths. Therefore, a thorough review of available stage data was conducted in order to set a reference low water surface elevation for cap design evaluation purposes, including the beneficial use component discussed above (see Attachment A).

The beneficial use evaluation considered short-term water level fluctuations resulting from seiche events, which have been measured at the NOAA gaging station located at the mouth of the Lower Fox River in Green Bay. From the cumulative frequency distribution of the vertical elevation data, a conservative low-water elevation of 576.5 feet was selected as the design baseline water elevation for OU 4. This elevation corresponds to a 1 percent frequency event. That is, the OU 4 water surface elevation is greater than 576.5 feet for more than 99 percent of the boating season.

Table D-1 summarizes the baseline water elevations selected for use in the contingent remedy evaluation, based on the findings presented in Attachment A.

Table D-1 – Summary of Baseline Water Elevations

Operable Unit	Baseline Water Elevation Dynamic Height (IGLD85)	Basis for Selection
OU 2	593.5 feet	NOAA Low Water Datum above Little Kaukauna Dam
OU 3	587.3 feet	Crest of De Pere Dam (and NOAA Low Water Datum)
OU 4	576.5 feet	Lower 1% occurrence frequency of hourly data from NOAA gage at Green Bay (adjusted for long-term data record through 1953)

Section 10.1 of the ROD also stated that cap design should include the consideration of potential changes in Lake Michigan water levels, which would in turn affect levels within Green Bay and the Lower Fox River. Due to the presence of the De Pere Dam, these long-term lake variations would only affect OU 4 and not OU 3. The analysis presented in Attachment A explicitly considers the extent of those potential drops in water level, which have followed a cyclical pattern of extended periods (1-2 years) of low water occurring approximately every 30 years, as observed on the hydrograph of the Lake Michigan-Huron basin (1918 – 2003) presented in Attachment A. Based on statistical analysis of the long-term Lake Michigan-Huron hydrograph, the contingent remedy does not require an additional consideration of long-term lake elevation declines. The baseline elevation of 576.5 feet IGLD 85 (without hydraulic correction) was conservatively set at the lower 1 percent frequency of occurrence based on hourly data collected at the NOAA gage at Green Bay, adjusted for long-term data record through 1953. Therefore, initial capping areas were identified to provide a minimum three-foot depth below the baseline water elevation to the top of the cap, as stated in Table D-1. In addition, Optimized Remedy evaluations of potential beneficial use "impacts" associated with capping, as described in Section 5 of the BODR, also considered net changes in elevations within Operable Units, relative to existing conditions.

Assuming the minimum post-cap water depths and baseline elevations discussed above, capping areas within OUs 3 and 4 were initially identified using a cap thickness ranging from approximately 13 to 16 inches, depending on armor requirements, based on the results of the preliminary cap design modeling presented in Section 5 of the BODR. This 13- to 16-inch cap thickness includes placement of a minimum of 6 inches of sand

(mixing and chemical isolation layers), overlain by a minimum of 4 inches of sand or gravel (armor/bioturbation layer). Based on initial design analyses of cap placement and verification options, caps would likely be placed using a mechanical clamshell bucket. Contractor placement tolerance, given the mechanical placement method coupled with anticipated water depths of 5 to 25+ feet, ranges between 0 to 6 inches with the average around 3 inches (Verduin et al 2001). Therefore, the preliminary cap evaluation assumed 3 inches of additional material for sand and/or gravel layers (6-inches in those areas requiring both sand and gravel to account for the two different layers), resulting in a total placed thickness ranging from approximately 13 to 16 inches.

D.1.6 Potential Capping Areas

Based on the preliminary exclusionary criteria outlined above, potential capping areas identified in OUs 3, 4A and 4B are depicted on Figures D-1, D-2, and D-3 respectively. Table D-2 presents a preliminary summary of prospective capping areas.

Table D-2
Estimated Contingent Remedy Capping Areas
(preliminary estimates without dredge-and-cap combinations)

Operable Unit	Sediments > 1 ppm PCBs Area	Potential Capping Areas	Remaining Dredging Areas
	(acres)	(acres)	(acres)
OU 3	176	126	50
OU 4A	616	264	352
OU 4B	324	124	200
Total	1,116	514	602

As discussed above, the initial identification of capping areas did not consider potential dredge-and-cap scenarios. This is true for areas where a portion of the contaminated sediments were initially excluded due to water depth limitations and could potentially be dredged to a depth that would accommodate a sediment cap. Section 5 of the BODR includes further evaluations of the dredge-and-cap component, along with other design elements of the Optimized Remedy.

D.2 Cap Design Criteria

This section presents the design criteria that were used to develop a cap design as part of the preliminary contingent remedy design for the Lower Fox River. Section 5 of the BODR presents refinements to this design based on location specific information used in the development of the Optimized Remedy.

Detailed guidance for in situ capping as a remedial alternative for contaminated sediment has been developed by the Corps and EPA. The documents *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (EPA 2005a), *Guidance for Subaqueous Dredged Material Capping* (Palermo et al. 1998a), and *Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. 1998b) provide detailed procedures for site and sediment characterization, cap design, cap placement operations, and monitoring for subaqueous capping. These guidance documents, specifically Palermo et al. (1998b), provide the technical basis for the preliminary design of the in situ cap on the Lower Fox River. As such, the caps are designed to be protective of human health and the environment.

Figure D-4 presents a flow chart showing the major steps in designing the thickness of a protective cap. Figure D-5 presents the preliminary cap sections proposed for OUs 3 and 4, based on the 2004 pre-design investigation data. This preliminary design was used to focus supplemental data collection in 2005 to support the Optimized Remedy discussed in Section 5 of the BODR. The thickness design of the preliminary in situ cap includes consideration of the following five components:

- Chemical isolation of contaminants (Ti)
- Bioturbation (Tb)
- Consolidation (Tc)
- Erosion (Te)
- Operational considerations (i.e., gas generation, placement inaccuracies, and other pertinent processes) (T_o)

As part of this preliminary contingent remedy design, an appropriate thickness of cap was determined individually for each component based on site-specific design parameters. The individual component thicknesses contribute to a total cap thickness

that satisfies all design components as shown in Equation D-1 below. Individual components of the cap are evaluated further in Section 5 of the BODR based on location specific conditions as part of the Optimized Remedy.

$$T = T_i + T_b + T_c + T_e + T_o \qquad \text{[Equation D-1]}$$

As noted below, the erosion component and the bioturbation component may be a concurrent thickness and not independent thickness requirement. That is, a set thickness of an armor layer can serve to resist erosion as well as accommodate bioturbation. In addition to designing the cap thickness, the following other factors were considered in the initial conceptual design of the contingent capping remedy:

- Geotechnical stability
- Ebullition

The design of the capping remedy is an iterative process balancing the requirements of the various components of design. The general design sequence involves first evaluating a preliminary isolation thickness and armor gradation. The consolidation of underlying sediments is then evaluated for the preliminary isolation and armor thickness. Next, consolidation results are fed back into another round of isolation thickness modeling and armor design. This design sequence may go through several iterations before arriving at an appropriate cap design satisfying all of the design component requirements. This section presents the initial steps in this design sequence, while Section 5 of the BODR presents the results of multiple iterations to develop the Optimized Remedy.

In some situations, cap designs in the Lower Fox River may also be considered to provide environmental benefits over and above cleanup requirements, including:

- Possible cap enhancements to improve performance
- Water depth to optimize desirable fish species and to avoid carp or other undesirable species
- Substrate type to ensure stable, well-sorted substrate for spawning and secondary production by aquatic insects
- Water velocity to optimize the needs of desirable fish species

- Potential for submerged aquatic vegetation

Optimization of environmental benefits are discussed further in the BODR.

D.2.1 Chemical Isolation of Contaminants and Bioturbation

Design of an effective chemical isolation layer for an in situ cap includes consideration of the movement of contaminants by advection (flow of porewater), molecular diffusion (across a concentration gradient), and sorptive transport (movement of solid particles with contaminants attached). For the purpose of developing preliminary cap design consistent with ROD requirements, a series of preliminary calculations were undertaken to evaluate the characteristics of the chemical isolation component of a subaqueous cap necessary to appropriately contain PCBs in OUs 3 and 4. Section 5 of the BODR addresses refinements to these cap specifications to address location-specific habitat, shear stress, and consolidation characteristics associated with the Optimized Remedy.

The transient model described in Appendix B of the *ARCS Program Guidance for In Situ Subaqueous Capping of Contaminated Sediments* (Palermo et al. 1988b) was used to estimate contaminant flux through the chemical isolation layer and the time to achieve steady state chemical flux conditions in the isolation layer of the cap. In addition, the steady state model of Reible et al. (2004) was used to estimate chemical concentrations in the surficial (bioturbation) sediment layers of the cap once steady state conditions are achieved. For this preliminary evaluation, the following assumptions were applied:

- A sediment PCB concentration of 49 ppm immediately below the cap;
- The armoring layer was conservatively assumed to not provide any chemical isolation component;
- No net sedimentation was assumed on the surface of the cap, even though net sedimentation rates ranging from 1 to 2 cm/yr are typical of the prospective capping area, as reported in the Lower Fox River Remedial investigation/Feasibility Study (RI/FS) [Retec (2002] (Given the net depositional characteristics of much of the Lower Fox River, finer-grained sediment will likely accumulate over time within the interstices of the sand/gravel armor layer. Section 5 of the BODR addresses the use of the hydrodynamic model to simulate the post-remedy conditions including both dredging and capping.);

- The bioturbation layer (and by the assumption above, the entire armoring layer) was conservatively assumed to achieve a steady state total organic carbon (TOC) content equivalent to existing conditions in OUs 3 and 4, including the influence of historical discharges (since controlled) of organic-rich paper mill effluents. During the 2004 RD sampling, surface sediment TOC in OUs 3 and 4 ranged from 0.5 to 9 percent (lower 5% and upper 95% values, respectively), averaging 4 percent (Shaw/Anchor 2004b and 2006a). The range of surface sediment values was input into the steady-state model with a Monte Carlo sensitivity analysis of this model input parameter. For comparison, the average value of newly-deposited sediments from recent sediment trap data collected by Eadie et al. (1991) was 2 percent;
- The bottom 3 inches of the designed chemical isolation layer was assumed to be compromised by intermixing with underlying sediment during placement (see discussion below);
- The underlying sediment was assumed to maintain the maximum estimated porewater PCB concentration for all time without degradation or depletion due to transport into the cap;
- Conservative estimates of groundwater seepage rates into the river were employed (see below);
- Conservative estimates of other model parameters (e.g., PCB sorption coefficient, bioturbation, and benthic boundary layer mass transfer coefficients) were employed.

The transient model described in detail in Palermo et al. (1998b) can be used to estimate transient chemical concentrations in the chemical isolation layer and time to steady state flux through this layer. The chemical isolation layer, however, does not represent a point of exposure as long as the bioturbation and armoring layers overlay this zone.

Palermo et al. (1998b) also discusses an approach to estimating concentrations in the various layers of a cap using balance between fluxes in and out of the chemical isolation or bioturbation layers. As described in the ROD, the point of compliance for post-construction monitoring of chemical isolation effectiveness will be the biologically active zone of the cap (upper 10 cm [4 inches] of the placed cap). The 1 ppm RAL and the 10 cm point of compliance are consistent with those for the dredging-only remedy as presented in the ROD. The steady-state model was employed to predict the chemical

concentrations in the bioturbation layer under steady-state conditions. Depending on the armoring requirements for a specific cap location, the point of compliance may be within the sand or gravel layer.

Based on data collected during the RI/FS of the Lower Fox River, as discussed in the ROD, along with a review of bioturbation depths from other similar freshwater sediment systems, the potential bioturbation depth at the site is expected to be limited to the upper few centimeters. The EPA/Corps cap design guidance document (Palermo et al. 1998a) presents the results of a survey of bioturbation depths specific to the Great lakes region, suggesting that bioturbation in a sand cap would be limited to the top 5 to 10 cm (2 to 4 inches). A more recent Corps Technical Note focusing on the estimation of bioturbation profiles, depths, and process rates relative to cap design confirms that biologic activity is mostly concentrated in the surficial zone of the sediment column, extending to a maximum depth of approximately 10 cm (Clark et al. 2001). The EPA/Corps survey also noted that the presence of a gravel armoring layer would inhibit the colonization of deep burrowing organisms. Thus, cap design for the Lower Fox River presented herein considered the erosion protection layer component (T_e) of the cap sufficient for both physical isolation and bioturbation (T_b).

For the purposes of developing an initial cap design for this evaluation, the steady-state model was used to calculate the steady-state PCB concentration (i.e., following long-term chemical "breakthrough") in the overlying armoring layer assuming that this layer provides no chemical isolation. The concentration in the relatively mixed bioturbation layer was thus calculated as a balance between the flux from the underlying chemical isolation layer and the flux leaving the bioturbation layer (characterized by a mass transfer coefficient, k_{bio}) and the overlying benthic boundary layer in the overlying water (characterized by a mass transfer coefficient, k_{bl}). Considering that groundwater seepage and transport of contaminants may potentially occur independently of these processes, the predicted porewater concentration in the bioturbation layer (C_{bio}) is related to the flux out of the chemical isolation layer by:

$$C_{bio} = Flux\left[\frac{1}{k_{bio}R_f + U} + \frac{1}{k_{bl} + U}\right] \qquad \text{[Equation D-2]}$$

where the various terms in the equation are as defined in Table D-3 along with the input parameter values used.

The solid concentration in the bioturbation layer (W_{bio}), which can then be compared to the RAL of 1 ppm PCBs, is given by:

$$W_{bio} = K_d C_{bio} \qquad \text{[Equation D-3]}$$

where K_d is an effective partition coefficient appropriate for the bioturbation layer.

Table D-3
Input Parameters for Cap Chemical Isolation Steady State Model

Symbol	Value	Units	Comments
L_{eff}	8	cm	Effective cap thickness for isolation layer
Ø	0.4	unitless	Porosity of cap sediments (typical value for placed sand)
SG	2.5	g/cm^3	Specific gravity of particles of cap sand
P_b	1.5	g/cm^3	Bulk sediment density of cap sediments calculated as P_b = (1-Ø)*SG (per page B24 Palermo et al. 1998b)
K_{oc}	500,000	L/kg OC	Organic carbon partitioning coefficient (most conservative value from PCLT and RI/FS)
f_{oc}	0.001	fraction	Cap fraction Total Organic Carbon (TOC) content of cap material (typical value shown for quarry sand)
$f_{oc\ (bio\ layer)}$	0.01 – 0.22	fraction	Fraction TOC of bioturbation layer (Monte Carlo analysis for 0.1-22% TOC from site data– See Appendix A))
K_d	500	L/kg	Cap adsorption distribution coefficient $K_d = K_{oc}*f_{oc}$
R_f	1876	unitless	Retardation factor calculated as Rf = ((P_b * K_d)/ Ø)+1
A	0.8	cm	Dispersitivity calculated as 10% of L_{eff}
H	0 - 0.22	ft/ft	Hydraulic gradient (Monte Carlo analysis for values from 0 to 0.22 from regional values– See Appendix A)
K	23.1	cm/yr	Hydraulic conductivity (average post cap value from seepage induced consolidation tests on OU3 samples)
U	0.01 - 5.07	cm/yr	Darcy velocity (calculated as U = ki)
V	0.02 - 12.7	cm/yr	Cap seepage velocity calculated as v = U/Ø
D_o	190	cm^2/yr	Molecular diffusion of chemical in water (value shown max. of RAIS[1] database and DiToro 2001)
D	140 - 150	cm^2/yr	Diffusion/dispersion combined coefficient calculated as D = (a*v)+(Do/$Ø^{-1/3}$)
C_o	1.12E-03	mg/L	Porewater concurrent of underlying sediments (max. calculated value in both OUs)
$k_{bio\ (particle)}$	1	cm/yr	Bioturbation mixing coefficient for particle, based on Toms (1995)
$k_{bio\ (water)}$	100	cm/yr	Bioturbation mixing coefficient for water, based on Toms (1995)
k_{bl}	1	cm/hr	Benthic boundary layer coefficient, based on Thibodeaux et al. (2001)

1 RAIS – Risk Assessment Information System (http://risk.lsd.ornl.gov/) [DOE 2004]

The transient model was used to understand the time it would take to achieve the steady state conditions calculated by the steady state model. The transient model was employed exactly as defined in Palermo et al. 1998b. Per that guidance, Table D-4 shows the input parameters for that model. Attachment B to this appendix provides a more detailed presentation of contaminant transport and isolation thickness modeling assumptions for both models.

Table D-4
Input Parameters for Cap Chemical Isolation Transient Model

Symbol	Value	Units	Comments
L_{eff}	8	cm	Effective cap thickness for isolation layer
Øc	0.4	unitless	Porosity of cap sediments (typical value for placed sand)
Øs	0.78	unitless	Porosity of underlying sediments (calculated from average water contents and post cap consolidation)
SG	2.5	g/cm^3	Specific gravity of particles of cap sand
P_b	1.5	g/cm^3	Bulk sediment density of cap sediments calculated as P_b = (1-Øc)*SG (per page B24 Palermo et al. 1998b)
K_{oc}	500,000	L/kg OC	Organic carbon partitioning coefficient (most conservative value from PCLT and RI/FS)
f_{oc}	0.001	fraction	Cap fraction Total Organic Carbon (TOC) content (typical value shown for quarry sand)
K_d	500	L/kg	Cap adsorption distribution coefficient $K_d = K_{oc}*f_{oc}$
R_f	750	unitless	Retardation factor calculated per Eq. B3 of Palermo et al. 1998b)
a	0.8	Cm	Dispersitivity calculated as 10% of L_{eff}
i	0.22	ft/ft	Hydraulic gradient (maximum of regional values)
k	23.1	cm/yr	Hydraulic conductivity (average post cap value from seepage induced consolidation tests on OU3 samples)
v	6.50	cm/yr	Sediment seepage velocity calculated as v = ki/Øs
D_o	190	cm^2/yr	Molecular diffusion of chemical in water (value shown max. of RAIS[1] database and DiToro 2001)
D_{eff}	56	cm^2/yr	Effective diffusion through cap (per equation on page B25 of Palermo et al. 1998b)
D	61	cm^2/yr	Diffusion/dispersion combined coefficient calculated as $D = a*U+D_{eff}$ (per page B28 of Palermo et al. 1998b).
C_o	1.12E-03	mg/L	Porewater concurrent of underlying sediments (max. calculated value in both OUs)

1 RAIS – Risk Assessment Information System (http://risk.lsd.ornl.gov/) [DOE 2004]

For both models, the cap characteristics were determined from the preliminary design and was assumed to have an effective isolation layer of 8 cm consisting of sand with a porosity of 0.4 and specific gravity (of sand particles) of 2.5.

For both models, conservative (low) Kd values (for cap partitioning) were calculated based on the lowest Koc value (500,000 L/kg) determined from Pancake Column Leach Test (PCLT) data available for OU 3 and OU 4, as well as literature values as summarized in the Lower Fox River Remedial Investigation/Feasibility Study (RI/FS). As shown in Tables D-3 and D-4, Kd is a function of organic carbon content of the cap sand, which was assumed to be very low (0.1% TOC), consistent with a quarry or similar sand source.

For the steady state model, as discussed above, a Monte Carlo analysis of the long-term steady-state organic carbon content of the bioturbation layer (incorporating deposition and mixing of newly deposited sediments) was performed with TOC values ranging from 0.1 to 22 percent, from measurements of organic carbon of the existing sediments in OUs 3 and OU 4 (Shaw/Anchor 2004b and 2006a). However, future sediment deposits are expected to contain less TOC than previously deposited sediments given the changes in regional industrial discharges to the river. Attachment B provides a more detailed presentation of contaminant transport and isolation thickness modeling assumptions including presentation of the TOC data used in the analyses.

Regional groundwater modeling conducted by the USGS (1997) suggests that advective flow into the Lower Fox River from the relatively shallow groundwater system is likely, particularly at shallow water depths along the shoreline. However, largely due to the presence of a low permeability (approximately 10^{-6} to 10^{-7} cm/s) contiguous clay aquitard layer present beneath the river bed, relatively low groundwater seepage velocities have been calculated for the river channel.

For the purpose of determining a protective design specification for the cap isolation zone, results of available regional vertical hydraulic gradient measurements in the Lower Fox River valley and in other regional drainages were reviewed and compiled, conservatively excluding downward gradient measurements (see Attachment B). The maximum gradient from this review (0.22 ft/ft) was used in the transient model. For the steady state model, similar to surface sediment TOC analyses discussed above, a Monte Carlo analysis of upward hydraulic gradients was performed with upward hydraulic gradients ranging from 0.001 to 0.22 ft/ft, which represents the range (5th and 95th percentiles) of regional measurements. By comparison, USGS (1997) groundwater

modeling of the Lower Fox River estimated a reasonable worst-case seepage conditions into the river, based on a MODFLOW computer simulation of the aquifer system assuming minimal withdrawal of deeper groundwater (potentially resulting in greater groundwater discharge into the river) of approximately 0.37 ft/ft, which is conservative relative to the range of available regional gradient measurements. For both models, the gradient was used to obtain groundwater seepage velocities through the cap, which were calculated from the hydraulic conductivity and porosity of consolidated sediments underlying the cap (obtained from seepage induced consolidation tests (SICT) simulating capped conditions) per equations shown in Tables D-3 and D-4. The resulting seepage velocities ranged from 0.02 to 12.7 cm/yr.

It should be noted that consistent inputs were used between the two models wherever possible. However, the methods of calculating some intermediate variables vary between the two models. Most notable among these are the equations to estimate the retardation factor, which is obtained through different formulations in the two models. The formulation shown in Table D-3 is estimated to be the most accurate for the assumed conditions of the steady state model. However, the formulation shown in Table D-4 is specifically called for in the guidance for the transient model, and thus was not altered. Similarly, the methods of calculating the combined cap diffusion/dispersion factor varies between the two models, but because the transient formulation is set forth in guidance it was not altered for this effort.

In addition to advective flow resulting from upward groundwater gradients, cap-induced consolidation of existing soft sediment may also contribute to the advective flux of porewater into the overlying cap. This cap-induced consolidation will also result in a decreased permeability and porosity of the existing contaminated sediments underlying the cap. Data from seepage-induced consolidation testing from the 2004 pre-design investigations were used to evaluate the effects of cap-induced consolidation on the design of the chemical isolation thickness, as discussed in Section D.2.2. The results of additional SICT testing of samples collected during the 2005 pre-design investigations will be incorporated during later phases of design.

Transient model results indicate that approximately 920 years would be would be required to achieve near steady state fluxes through a nominal 3-inch-thick (8 cm)

chemical isolation component of the cap over existing sediments with a concentration of 49 ppm when the maximum regional value for hydraulic gradient was used to estimate seepage velocity. This is the primary output for the transient model. An estimate of the chemical concentration in the bioturbation layer under steady state conditions was obtained using the steady state model.

The results of the steady state model indicate that once steady state conditions are achieved with a 3-inch isolation layer thickness, there is greater than a 99 percent probability that sediment PCB concentrations in the overlying bioturbation zone would be maintained (in perpetuity) below the 1 ppm RAL. This analysis considers the full range of potential bioturbation layer TOC contents from river sediment data and regional groundwater gradients. Note that the underlying cap isolation layer is not subject to bioturbation and is isolated from organic carbon deposition at the sediment-water interface. Thus, the cap isolation layer would never achieve these organic carbon contents or associated chemical concentrations. As the relevant remediation goal for the Lower Fox River is the 1 ppm RAL defined in the ROD, the preliminary contaminant transport modeling results outlined above suggests that a nominal 3-inch-thick chemical isolation zone will be protective in OUs 3 and 4.

Long-term depletion and/or degradation of PCBs in the underlying sediment, as well as substitution of more typical values in place of the conservative assumptions listed above (e.g., consideration of over-placement allowances, seepage velocity, K_{oc}, long-term sedimentation, etc.), would cause the actual PCB concentration in the bioturbation layer to be considerably lower than these preliminary model predictions. In addition, the use of PCB concentrations just below TSCA levels (49 ppm) in the chemical isolation modeling is also conservative for the majority of prospective capping areas considered for the contingent remedy evaluation and for the Optimized Remedy (see Section 5 of the BODR). In conclusion, a conceptual cap design in OUs 3 and 4 comprised of a minimum chemical isolation thickness of 3 inches (0.25 feet) of sand overlain by the armoring/bioturbation layer, along with additional over-placement allowances (see Figure D-5) would meet or exceed the performance goals of the ROD dredging-only remedy.

D.2.2 Consolidation

The consolidation component of the cap design is intended to evaluate both internal cap consolidation (i.e., consolidation of the capping materials themselves) as well as cap-induced consolidation of the in situ sediments that will support the cap. Materials to be used in the Lower Fox River caps will likely be granular (sand and gravel). Internal cap consolidation in this case will be "elastic" and will occur almost instantly during construction. Therefore, long-term considerations are not necessary to account for internal cap consolidation and an additional consolidation thickness is unnecessary (T_c = 0 in).

However, since the existing river-bottom sediments are fine-grained in nature, some degree of cap-induced settlement is expected over time. Porewater expelled from the contaminated layer during consolidation will be directed up into the more permeable cap layer placed above. Since the dissipating porewater can contribute to contaminant flux through the cap, the amount of consolidation has been estimated. In addition, consolidation of the existing sediments underlying the cap will cause a reduction in permeability and porosity of the contaminated sediments.

In order to evaluate the magnitude and time rate of the cap-induced consolidation, several samples were collected for SICT evaluation as part of the 2004 and 2005 pre-design investigations (Note: the results of the SICT on samples collected during 2005 were not available at the time of this writing and will be incorporated during later stages of design). The SICT is a specialized consolidation test for very soft sediments, through which five dimensionless parameters are determined that describe the consolidation characteristics as a function of void ratio, stress, and permeability. The SICT method was used based on improved accuracy in prediction of consolidation behavior as compared to a standard (odometer) consolidation test, especially in the low stress range.

The relationships obtained from the SICT were then used to estimate the amount of cap-induced consolidation for a nominal 13- or 16-inch-thick placed cap, as presented in Table D-5. Furthermore, the post-cap permeability and porosity of the sediments were estimated from the relationship between void ratio and the stress level equivalent to the proposed cap thickness. Post-consolidation permeability and porosity of the existing sediments were used in the contaminant transport modeling to determine the chemical isolation thickness, as discussed in Section D.2.1.

Table D-5
Summary of Predicted Cap-Induced Consolidation

Sample Number	Thickness of Deposit (ft)	Predicted Settlement (inches)	
		13-inch Cap	16-inch Cap
OU3			
3018-02	3	5	5
3044-02	4	8	9
3056-02	4	7	8
3067-02	2	6	6
OU 3 Average	3.3	6	7
OU4			
4020-12	2.5	5	5
4030-04	6.5	9	10
4042-02	3	6	7
4046-04	7.5	10	11
OU 4 Average	4.9	8	8
OU 3 and 4 Average	4.0	7	7

Predictions based on results of seepage-induced consolidation

The impacts on design of the porewater advection have been evaluated and accounted for as part of the chemical isolation component, as discussed in Section D.2.1. However, this preliminary contingent remedy cap design did not consider consolidation settlement with respect to post-cap water depth as part of the initial selection of potential capping areas.

D.2.3 Erosion-Stability of Cap Materials in Response to Potential Scour Forces

The erosion protection component serves as resistance to external forces from disturbing the in situ contaminated sediments being capped as well as to the cap itself. Several potential forms of erosion have been evaluated in the preliminary contingent remedy cap design including the following:

- Hydrodynamic flows (including seiches);
- Ice scour;
- Wind-induced waves; and
- Vessel-induced propeller wash.

Each of these erosional forces is discussed in further detail below.

D.2.3.1 Hydrodynamic Flows

Hydrodynamic flows present the largest potential for erosion of an in situ cap in the Lower Fox River. As discussed in Section 2 of the BODR, the USGS and Sea Engineering Inc. (SEI) recently completed a study of the hydrodynamics in OUs 3 and 4 under various flow conditions. SEI used the field data collected by USGS to develop and calibrate a 2-dimensional hydrodynamic model to predict bottom shear stresses in both OU 3 and OU 4. The SEI reports for OUs 3 and 4 are provided in Attachment C of this Appendix.

The original SEI hydrodynamic models for OUs 3 and 4 were refined to address agency comments on the model, and to incorporate post-cap bathymetric conditions. These refinements also included further evaluation of the coefficient of friction in OUs 3 and 4 based on the aggregate shear stress measurements (LTI 2005a, Attachment C). Shear stress predictions for preliminary design conditions were made based on the new function, and allowed direct evaluation of uncertainties in model predictions to determine a factor of safety to develop appropriate cap armor specifications.

Following final calibration and refinement, the models for OUs 3 and 4 were used to predict velocity and bottom shear stress for a design level flow event (24,200 cfs [685 m^3/s]) with a recurrence interval of 100 years. The predictive modeling was performed using initial estimates of the bathymetry of the river following construction of the preliminary contingent caps, as generally depicted in Figures D-1 through D-3). Section D.3 of this Appendix and Section 5 of the BODR addresses the results of the hydrodynamic modeling of bathymetric conditions representing the complete Optimized Remedy design, including integrated capping and dredging. Because increased water depth and decreased river flow velocities resulting from dredging were not considered in this preliminary analysis, shear stress modeling results presented herein result in a conservative (overprotective) design of the erosion protection layer, particularly in OU 4 where considerable dredging is anticipated.

Initial predictive hydrodynamic modeling in OU 4 was performed assuming that the 100-year flood condition occurred concurrent with a relatively large (4.3-foot-high [2.2-foot amplitude]) seiche event at the mouth of the river. Additionally, the East River was assumed to concurrently discharge at rate of 10 percent of the De Pere Dam flow rate during the flood simulations.

Figures D-6 through D-8 present the predicted shear stresses corresponding to the 100-year flow event assuming installation of the preliminary contingent caps in OUs 3, 4A, and 4B, respectively. The model predicted minimal increases in shear stresses throughout OUs 3 and 4 with the addition of the capping materials. The maximum bottom shear stress predicted for the preliminary OU 3 capping areas is approximately 50 dynes/cm^2, and occurs in the narrow downstream portion above the De Pere Dam. The maximum predicted shear stress within preliminary capping areas in OU 4 is approximately 30 dynes/cm^2.

Correlations using the Shields dimensionless critical shear stress parameter, τ_{*c}, were used to relate the predicted shear stress under the design flow event to a stable grain size (Attachment C). The Shields critical shear stress parameter is defined mathematically as follows (Shields 1936):

$$\tau_{*c} = \frac{\tau_c}{(\gamma_s - \gamma)D_{50}} \qquad \text{[Equation D-4]}$$

where:

τ_c = critical shear stress (threshold of motion) pounds per square foot (psf)
γ_s = specific weight of the sediment (Gs x ◎) per cubic foot (pcf)
γ = specific weight of the water (62.4 pcf)
Gs = specific gravity of sediment (dimensionless)
D50 = median grain size (feet)

Shields conducted flume experiments on initiation of motion and bedload transport of sediment with median sizes ranging from 0.014 to 0.13 inches (0.36 mm to 3.4 mm) (Shields 1936). Through dimensional analysis and the combination of previous investigations, Shields presented a plot of dimensionless critical shear stress versus a dimensionless Reynolds number or critical boundary Reynolds number. This graphical representation, commonly known as the Shields diagram, is still widely used to determine a general relationship for incipient motion. Rouse (1939) fitted a mean curve to the zone of these data points, above which particles are considered to be in motion, and showed that at higher values of the Reynolds number (i.e., coarse sediments/larger grain sizes, and/or fully turbulent flow) the critical shear stress parameter approaches a constant value of 0.060. Since then, others have proposed more conservative values for

the critical shear stress parameter ranging from 0.039 by Laursen (1963) to 0.045 by Yalin and Karahan (1979).

Rearranging Equation D-4 to solve for sediment size and substituting a sediment-specific gravity of 2.65 and a conservative critical shear stress parameter of 0.039 yields the relationship shown in Equation D-5. This relationship is consistent with the results of experimental investigations of channel erosion conducted by the Highway Research Board (1970), which is commonly used to determine sediment sizes required for stable hydraulic channel design. Equation D-5 was used to determine the median grain size (D_{50}) for erosion protection that would be stable under the a bottom shear stress of 100 dynes/cm^2 (i.e., design shear stress):

$$D_{50} = \frac{\tau}{4} \qquad \text{[Equation D-5]}$$

where:

D_{50} = median stone size (feet)
τ = predicted shear stress (psf)
4 = coefficient representing Gs = 2.65 and τ_{*c} = 0.039 (pcf)

In addition, an appropriate factor of safety was included in the preliminary stable particle size calculation shown based on a review of the available hydrodynamic data for OUs 3 and 4. Site data (Attachment C) were used to estimate the average coefficient of friction in the Lower Fox River, and the uncertainty in the coefficient of friction estimate contributes to uncertainty in predicted shear stress, since shear stress is proportional to the coefficient of friction. Based on analysis of the available shear stress data (Attachment C), most of the scatter in local estimates of the coefficient of friction is attributable to variability in measurement. The resultant uncertainty in the mean coefficient of friction for a given depth was less than +/- 15 percent, based on the sample size and variability of the underlying data. Thus, if all of the data variability was attributable to measurement uncertainties, a 15 percent increase in modeled shear stress estimates could be applied to determine stable cap material specifications. However, conservatively assuming that all of the measured data uncertainty represented real variations in local hydrodynamic conditions, the resultant increase in shear stress estimates could approach 100 percent (i.e., a factor of safety of 2). Of 106 local friction

coefficient measurements made by USGS in OUs 3 and 4, all but one (i.e., 105 measurements) was within a range of twice the average friction coefficient used by SEI in its modeling. For the purpose of this initial analysis, a preliminary, conservative (overprotective) factor of safety of 2 was applied to the OU 3 and OU 4 shear stress estimates to determine stable particle size for the cap armor layer, as outlined above.

Given the shear stress of 50 dynes/cm^2 selected for preliminary contingent remedy cap design and factor of safety of 2, a median particle size of approximately 0.62 inches would be required for the cap armor layer in some areas of OUs 3 and 4. This armor stone size is conservative (overprotective) for the majority of the capping areas, since most of the area will be subjected to shear stresses significantly lower than 50 dynes/cm^2. For areas where the predicted upper-bound shear stress is below approximately 15 dynes/cm^2 (30 dynes/cm^2 with a factor of safety of 2), a sand specification similar to that required for the chemical isolation layer (see above) will provide the necessary erosion protection under the 100-year design flow event.

Based on the recommendations provided by EPA/Corps Cap Design Guidance (Palermo et al. 1998a), the erosion layer should have a minimum thickness of 1.5 D_{50} (1.5 x 0.62 in = 1 in). Such armor thickness requirements are less than the 4-inch (10-cm) bioturbation depth. Thus, for the purpose of the preliminary contingent remedy design, a 4-inch combined armor/bioturbation thickness was assumed. The requirements for erosion resistance based on the preliminary hydrodynamic modeling are summarized in Table D-6. Additional refinements of the armoring requirements for the complete Optimized Remedy are presented in Section D.3.

Table D-6
Erosion Resistance Requirements

Bottom Shear Stress, τ (dynes/cm^2) [a]	Stable Median Grain Size, D_{50} (in) [b]	Required Thickness (inches) [c]
τ <15	0.19	4
15 ≤ τ <50	0.62	4

Notes:
a. Predicted by hydrodynamic model
b. Stable grain size calculation includes factor of safety of 2.
c. 1.5 D_{50} or 4 inches, for bioturbation, whichever is greater

D.2.3.2 Ice Scour

One source of potential cap damage within the Lower Fox River is scour resulting from direct ice contact or from increased flow velocity caused by channel restriction from the collection of frazil ice. Frazil ice is a group of individual ice crystals suspended in water that form in super-cooled (slightly below 0°C), turbulent water. As the water velocity slows and the turbulence decreases, the frazil ice rises to the water surface and can form a deposit and restrict flow under a relatively flat ice cover formed over the calm section of the river. Frazil ice typically forms in rapids sections of rivers where there is turbulent mixing.

Frankenstein (2003) and Ashton (2005) conducted separate evaluations of the characteristics of ice formation on the Lower Fox River and the potential for these formations to create conditions favorable for ice-related scour of the river bottom (including capping materials). Both researchers completed a review of available historical climate data, conducted a site visit, and conducted personal interviews with local individuals with significant experience on the river.

Observations during the site visits did not identify any visual signs of ice-related damage to shoreline vegetation or structures indicating that significant ice-jams do not occur within OUs 3 and 4 of the river. The fact that local residents routinely leave their private docks in the river during the winter months is further evidence that ice jams do not occur on the river.

In addition to the site visits conducted , a review of the USACE's historical database of ice jams indicates that since 1958 (the beginning of the period of record) ice jams have only been reported upstream of OU 3, the closest of which occurred in Kaukauna, WI (Corps 2005).

Ashton (2005) evaluated the likelihood of frazil ice formation and the potential for "anchor ice" based on a review of historical climate data and river flow velocities since both temperature and velocity control the type of ice formation (See Attachment D for full report). Ashton concluded that during typical winter flows (5,000 cfs or less), the ice cover would form rapidly over the majority of the Site and be characterized by a "skim ice run" with little frazil ice at the surface. During high winter flows (approximately 10,000 cfs or greater), the ice cover over the majority of the Site would form from a

layered slush and skim ice accumulation with little or no entrainment of frazil ice into the flow beneath the ice.

Ashton also identified the following two areas of rapids, where the water surface could be free of ice cover due to high flow velocity and frazil ice could potentially form.

- Immediately downstream of the Little Rapids Dam – 2,000 feet long and 900 feet wide
- Immediately downstream of the De Pere Dam – 1,000 feet long and 600 feet wide.

Assuming conservative extreme conditions, Ashton calculated that the frazil ice formed at the Little Rapids dam could be deposited a maximum of approximately 1.6 miles downstream of the dam. Using similar assumptions, the maximum potential area of deposition of frazil ice downstream of the De Pere dam was estimate to be less than 1,400 feet.

Anchor ice could potentially be formed within the two rapids sections listed above (downstream of the dams), but is not expected to exceed a foot in thickness. Ashton notes that generally speaking, a sediment thickness of 1/20 (i.e., 0.6 inches) of the thickness of the anchor ice formation could potentially be entrained by the anchor ice deposit if the sediment had enough cohesion to support the sediment beneath the ice-sediment interface. However, given the granular (non-cohesive) nature of the proposed Fox River cap material, anchor ice is not expected to be a significant mode of sediment transport.

However, no prospective capping areas have been proposed within the rapids portions of OUs 3 and 4 that have a likelihood of forming frazil ice (and therefore anchor ice) or within the potential zone of frazil ice deposition [1.6 miles downstream of the Little Rapids Dam or 1,400 feet downstream of the De Pere dam] (Ashton 2005, Frankenstein 2003).

Ashton also estimated that a maximum of 17.5 to 24.5 inches of ice is expected to form at the Site for an average year and 23.4 to 32.8 inches during an extreme winter. Therefore, as discussed above, caps should be limited to areas where the post-remedy water depth

would be 3 feet or more. Additional evaluations of ice impacts were evaluated as part of the Optimized Remedy design following this preliminary cap design and are presented in Section D.4.

D.2.3.3 Wind Wave-Induced Currents

As part of the preliminary cap design for the contingent remedy, bottom shear stresses resulting from waves generated by an extreme wind event were evaluated to ensure the protectiveness of the cap armor layer. This section discusses the interaction of wind waves with hydrodynamic flows, including an evaluation of the combined effects on bottom shear stress. A summary of the wind wave evaluation conducted for the site is then presented based on conclusions of the evaluation of combined effects. Section D.3 presents refinements to these evaluations based on the design of the Optimized Remedy.

Interaction of Wind Waves and Hydrodynamic Flows. Wind wave effects were modeled at conservatively low water levels because shear stresses due to wind waves are greatest in shallow water. Under high-flow conditions, water depth would be greater, reducing wind wave effects. In addition, simulated shear stresses due to currents are greatest in the deepest portions of the river (greater than 5 feet), while the simulated effects of wind waves are greatest in the shallowest areas (less than 5 feet). For these reasons, their effects have been presented above as independent design considerations.

However, it should be noted that the hydrodynamic flow modeling discussed above implicitly includes wind wave effects, consistent with the strong winds noted by SEI and USGS personnel during 2004 field surveys of current velocities. Wind waves create a near bed boundary layer due to the orbital water velocities under the wave. The wave boundary layer interacts with the current boundary layer to increase apparent bottom roughness and coefficient of friction during wind events. The variability in 2004 estimates of the coefficient of friction in OU3 and OU4 is due in part to variations in ambient wind waves experienced at the various stations and 2004 survey dates. The 100 percent factor of safety applied to simulated high-flow shear stresses captures this range of estimated coefficients of friction, effectively allowing for a range of wind wave conditions similar to those experienced during the field study.

Wind Wave Modeling. Limno-Tech, Inc. (LTI) utilized a nearshore spectral wind wave model (Simulating Waves Nearshore [SWAN] software) for OUs 3 and 4 to simulate wind-generated waves for various meteorological conditions (LTI 2005b, see Attachment E). SWAN uses an energy balance equation to represent the progression of the wave spectrum and accounts for the following processes: wave propagation in time and space; shoaling and refraction due to current and depth, diffraction, and opposing currents; transmission through, blockage by, or reflection against obstacles; wind-generated waves; whitecapping; bottom friction; depth-induced wave breaking; wave-wave interactions; and wave-induced setup.

The maximum bottom shear stresses associated with the wind-generated waves predicted by the SWAN model were calculated by the Grant-Madsen method, which is dependent upon depth, wave height, peak wave period, and bed roughness. With the exception of bed roughness, all parameters were generated in SWAN based on initial input conditions. (Bed roughness was estimated as 0.002 m [SEI 2005].) For this study, model inputs included a rectilinear bathymetry grid representing the site area and prevailing wind conditions. A pool elevation of 587.3 feet IGLD 85, corresponding to the NOAA low water datum and the crest of the De Pere dam was used for modeling within OU 3. Similarly, a pool elevation of 577.5 feet IGLD 85, corresponding to the NOAA low water datum was used for preliminary modeling in OU 4.

Section D.3 discusses the refinement of the wind wave modeling to include the bathymetry for the Optimized Remedy as well as a pool elevation in OU 4 of 576.5 ft IGLD 85, corresponding to the lower 1 percent occurrence frequency of measured water elevations since 1953, as discussed above and shown on Table D-1.

Based on wind data from the NOAA weather station at the City of Green Bay, four extreme wind scenarios representative of the prevailing wind conditions along the main fetch of OU 3 and OU 4 were simulated and are listed below in Tables D-7 and D-8, respectively.

Table D-7
Maximum Shear Stresses for Extreme Wind Events in OU 3

Wind Scenario	Proposed Cap Area	Maximum Shear Stress (dynes/cm^2)
SSW 37.3 mph	center	17.29
	southwest	15.70
	north	15.40
SW 37.3 mph	center	17.29
	southwest	15.70
	North	14.22
NE 37.3 mph	center	13.71
	southwest	14.72
	North	11.37
NNE 31.1 mph	center	12.12
	southwest	11.85
	North	11.00

Table D-8
Maximum Shear Stresses for Extreme Wind Events in OU 4

Wind Scenario	Proposed Cap Area	Maximum Shear Stress (dynes/cm2)
SSW 37.3 mph	south OU 4A	17.75
	north OU 4A	29.00
	west bank OU 4B	18.87
	east bank OU 4B	24.49
SW 37.3 mph	south OU 4A	20.91
	north OU 4A	27.28
	west bank OU 4B	16.32
	east bank OU 4B	23.24
NE 37.3 mph	south OU 4A	19.13
	north OU 4A	14.79
	west bank OU 4B	23.46
	east bank OU 4B	20.46
NNE 31.1 mph	south OU 4A	15.56
	north OU 4A	11.62
	west bank OU 4B	23.46
	east bank OU 4B	16.51

The model results showed increases in shear stresses above existing conditions within prospective capping areas, especially along the center of OU 3 and in areas with shallower water depths in OUs 3 and 4. The maximum shear stresses predicted for these preliminary capping regions under the four wind conditions are summarized in Tables D-7 and D-8. However, these predicted shear stresses are the maximum for each

capping area; the vast majority of the area (more than 99 percent) covered by the prospective caps show much lower values. Table D-9 lists the percentage of total cap area for ranges of predicted shear stress values for the four simulated wind scenarios.

Table D-9
Comparison of Shear Stress Distribution for Prospective Cap Areas

Wind Scenario	Shear Stress (dynes/cm2)	Area in OU 3 (% of Total)	Area in OU 4 (% of Total)
SSW 37.3 mph	0 to 10	92.74	99.49
	10 to 15	6.56	0.36
	15 to 20	0.71	0.13
	>20	0.00	0.03
SW 37.3 mph	0 to 10	92.88	99.54
	10 to 15	6.28	0.31
	15 to 20	0.84	0.11
	>20	0.00	0.04
NE 37.3 mph	0 to 10	93.67	99.73
	10 to 15	6.33	0.20
	15 to 20	0.00	0.04
	>20	0.00	0.03
NNE 31.1 mph	0 to 10	97.33	99.82
	10 to 15	2.67	0.13
	15 to 20	0.00	0.04
	>20	0.00	0.02

The maximum predicted shear stresses from the wind waves in OUs 3 and 4 are significantly less than the maximum shear stress of 50 dynes/cm^2 predicted for the 100-year flow event, confirming that hydrodynamic flows represent the greatest potential for erosion of the cap armor layer as discussed above. Therefore, the 100-year design flow event is the controlling factor with respect to the erosion protection component of the preliminary contingent remedy in situ cap design.

D.2.3.4 Propeller Wash

The propeller jet of a maneuvering vessel has the potential to impact the cap surface and may cause erosion of capping materials if they are not sized appropriately. Propeller wash in prospective capping areas may include recreational and/or commercial vessels and tugs, depending on the specific location within the Lower Fox River. Propeller wash velocities from vessels will likely be localized, of short duration, and infrequent. The propeller wash from recreational vessels and most passing commercial vessels will

likely result in minor modifications to a cap surface, but will rarely impact the overall performance of a cap. However, the propeller was from a vessel during a maneuvering operation (e.g. berthing with bow thruster or tug assist) can cause significant erosion of bottom sediments if an appropriate armor stone is not in place to resist the propeller-induced bottom velocities.

Private vessels that use the site range from motorized family boats, race boats and personal watercraft (i.e., jet skis). Many of these vessels are relatively small and are transported to the site via trailer and launched at one of several boat launches. There are several marinas located in OU 4. Several of these marinas provide moorage for relatively large pleasure boats that primarily navigate through the OU 4 channel as a means to accessing Green Bay and Lake Michigan. These large vessels and others typically respect the No-Wake Zone, that exists throughout the majority of OU 4B. The OU 4B navigation channel is also used for commercial activities including numerous deep-draft, bulk carriers (primarily cement and coal) vessels. A private tour company, Foxy Lady Cruises, operates the *Foxy Lady*, a 65-ft long, 340-HP yacht at a typical cruising speed of 8 mph. The *Foxy Lady* operates mostly in OU 4 and remains within the navigation channel. It also operates upstream of the De Pere Dam in OU 3. There are up to four cruises per day during peak season.

In addition to the *Foxy Lady*, the site is also traversed daily by McMullen and Pitz Construction Company. McMullen and Pitz operate three different tug boats on the river (*Mary Jane, Gopher, and Badger*) and is apparently the only tug company to navigate in the upper portions of the river. These tugs typically remain in the navigation channel, but often moor at private docks along the river banks.

Design Vessels

Discussions with tug operators and the *Foxy Lady* representatives indicate that their vessels normally navigate in the deeper portion of the river. The tugs use an average of approximately 25 percent of their horsepower (HP) and the Foxy Lady applies 75 percent at its typical cruising speed of 8 mph. Out of the three tug vessels that McMullen and Pitz operate at the site, the *Gopher* is the most powerful one, and was selected for this analysis. Although accurate data on private vessels is often difficult to acquire, discussions with marina owners indicate that recreation vessels operating on

the Fox River range from small (16-ft-long, 50 horsepower) single-screw fishing boats to water ski boats (18 to 20-foot-long single or twin engine, up to 250 HP) to large (50-foot-long, up to 600 HP) twin engine pleasure yacht. However, as discussed above, these larger yachts typically navigate only within the deep OU 4B federal channel at low speeds as they transit to Green Bay.

Communication with the Vice President of Operations of Lake Carriers' Association revealed that commercial vessels frequent the OU 4B Navigation Channel, ranging in engine power from 4,000 to 12,000-hp. For analysis, it was assumed that these large commercial vessels would apply 10 percent of their horsepower, which is representative of typical commercial vessel activity in the Lower Fox River. This does not account for the short-term increases in power applied for turning vessels.

Characteristics of the different vessels considered in this analysis are presented in Table D-10. It was assumed that an average high-end recreational boat would be equipped with either one 300-HP engine ("single-screw") or two 125-HP engines ("twin screw"). In addition, analyses were conducted for 4,000 and 12,000-hp commercial vessels as well as 500 and 600-hp recreational vessels with two engines operating in the OU 4B navigation channel only. It was assumed that all other vessels would navigate in shallow water as well as in deeper water throughout OUs 3 and 4, and would use 25 to 100 percent of their horsepower, depending on water depth.

Table D-10
Design Vessels Characteristics

Vessel Name	Ducted Propeller [Y/N]	Prop Diameter [ft]	Prop. Shaft Depth [ft]	No. of Screws	Total Vessel HP
Bulk Carrier 1	N	16	18	1	1200
Bulk Carrier 2	N	12	18	1	4000
Foxy Lady	N	1.5	3.5	2	340
Gopher	N	2.5	1.33	1	200
Recreational Boat 1	N	1.4	2	2	250
Recreational Boat 2	N	1.4	2	1	300
Recreational Boat 3	N	1.4	2	2	500
Recreational Boat 4	N	1.4	2	2	600

Propwash Modeling Theory

The currently available predictive models for propeller-induced bottom velocities are based on jet flow for a stationary jet and were developed more than 30 years ago without significant revisions since. Hence, the models are not directly applicable to many scenarios encountered in the field, including small moving vessels. Therefore the design team conducted a Propwash Field Study in October 2005 using bottom-mounted current meters to measure actual bottom velocities of maneuvering and passing vessels in the Fox River. The results and analysis of this study are discussed further in the Propwash Field Study section below. The remainder of this section presents the preliminary propwash evaluation using the available predictive methods, which will be revisited in the 30 Percent Design submittal based on data collected during the field study.

The rotation of a vessel's propeller produces an underwater jet, commonly called propeller wash. The bottom water velocities caused by propellers were predicted using the spreadsheet model PROPWASH, based on the equations developed by Blaauw and van de Kaa (1978) and Verhey (1983). For a defined water depth, bottom velocities at various distances behind the propeller were computed.

This approach is also recommended in Appendix A of the EPA/Corps guidance document *Guidance for In-Situ Capping of Contaminated Sediments* (Palermo et al. 1998b). This model requires specific input regarding vessel characteristics (e.g., propeller diameter, depth of shaft, and shaft horsepower) and has been used for several cap designs approved by state and federal agencies.

The model predicts the maximum bottom velocity and associated grain size required to resist the long-term, steady state propeller wash from vessels for a given depth and distance behind the propeller. It is important to note that these analyses are conservative for the case of a moving vessel as they are solely based on slowly maneuvering vessels (i.e., vessel speed of zero). However, in reality, the propeller wash force is transient in nature since the vessels typically are operating at some speed, which acts to significantly reduce the duration and magnitude of the propeller wash acting on the river bottom. Verhey (1983) conducted research on the effects of vessel speed on

resulting bottom velocities from a propeller jet behind a conventional inland vessel. Table D-11 below summarizes these results.

Table D-11
Propeller Wash Bottom Velocities at Different Vessel Speeds

Vessel Speed		Bottom Velocity		% of Bottom Velocity for speed = 0
[m/s]	[mph]	[m/s]	[ft/s]	
0	0	2.75	9.02	-
1	2.23	2.10	6.89	76%
2	4.47	1.45	4.76	53%

In addition, the stable stone size equation for propeller wash developed by Blaauw et al. (1984) incorporates a coefficient, C_3, to describe the degree of sediment transport allowed, which is a site-specific parameter based on the acceptability of particle rearrangement. Data from Maynord (1984) and (Palermo et al. 1998b) suggests that C_3 equal to 0.55 is appropriate in harbor areas where repeated (or consistent directional) attack is expected and no transport/movement can be tolerated. In contrast, C_3 equal to 0.70 is reported as sufficient for general channel protection where infrequent attack (or random directional attack) is expected and thus, small transport is allowed such that normal river flow conditions or other random attacks will serve to reposition a localized perturbation of bottom sediment. For the BODR, the latter scenario was employed (C_3 = 0.70) since these analyses were conducted for general channel protection where less frequent attack from vessel operation (i.e., non-localized scour effects) is expected.

Effects of the jet produced by propeller wash can also be described in terms of depth of scour caused by slowly maneuvering ships. Maximum scour depths were computed for a defined grain size as a function of water depth and duration of scour, based on the empirical relationships developed by Hamill (1988). A spreadsheet was used to determine these empirical relationships among initial velocity, tip clearance, propeller diameter, sediment size and time in order to compute scour depth at different locations for a given grain size.

Maximum Predicted Bottom Velocity

OU 3 and OU 4A. The PROPWASH model was first run for each vessel type operating throughout OUs 3 and 4A in water depths ranging from 6.5 to 25 feet. The model was run for the *Foxy Lady* assuming the operator applies up to 50 percent of the total horsepower in shallow water (depth less than 10 ft) and up to 75 percent in deeper water, and for the tug boat *Gopher*, assuming that the operator uses up to 25 percent of total horsepower, as noted by their operators. For private recreational vessels, the analysis was conducted for boats with either two 125 HP or one 300 HP engines. (For boats with two engines, design velocities were obtained by multiplying velocities for one engine by $\sqrt{2}$ [Schokking 2002]). It was assumed that private (recreational) vessels use 25 percent of their horsepower in shallow water (depth less than 10 feet), and 100 percent of their horsepower in deeper water. Results are presented in Table D-12. The PROPWASH spreadsheet results are presented in Attachment F.

Table D-12
Propeller-Induced Bottom Velocities for a Stationary Vessel in OUs 3 and 4A

Vessel	Power Applied	Depth for Maximum Bottom Velocity [ft]	Maximum Bottom Velocity [ft/s]
Foxy Lady	75%	10	1.9
Foxy Lady *	50%	6.5	3.6
Gopher	25%	6.5	1.5
Recreational Boat 2 (300 Hp)	100%	10	1.4
Recreational Boat 2 (300 Hp)	25%	6.5	1.6
Recreational Boat 1 (250 Hp)	100%	10	1.5
Recreational Boat 1 (250 Hp)	25%	6.5	1.7

* Design vessel selected for analysis

Based on these results, the *Foxy Lady* was selected as the design vessel for OUs 3 and 4A.

OU 4B. The PROPWASH model was also run for each vessel type operating in the OU 4B Federal Navigation Channel where water depths range from 22 to 26 feet. Similar to the previous analysis, the model was run for the tug boat *Gopher* assuming operation at both 25 and 50 percent of total horsepower. Analyses were also conducted for the *Foxy Lady* and private recreational vessels with twin 125, 500 and 600 HP engines. In contrast to OUs 3 and 4A, it was assumed that the *Foxy Lady* and the private recreational vessels use up to 50 and 25 percent of their horsepower, respectively, due to the No-Wake Zone

restrictions in OU 4B. In addition, preliminary analyses were conducted for 4,000 and 12,000-hp commercial vessels applying 10 percent of total engine power and for a reconfigured channel water depth of 26 feet (2 feet below the authorized depth). These results are summarized in Table D-13, with Bulk Carrier 1 (12,000 HP) selected as the design vessel for OU 4B. The PROPWASH spreadsheet results are presented in Attachment F.

Table D-13
Propeller-Induced Bottom Velocities for a Stationary Vessel in OU 4B Federal Navigation Channel

Vessel	Power Applied	Depth for Maximum Bottom Velocity [ft]	Maximum Bottom Velocity (ft/s)
Bulk Carrier 1 (12,000 Hp)*	10%	26	4.1
Bulk Carrier 2 (4,000 Hp)	10%	26	3.2
Foxy Lady	25%	22	0.46
Gopher	50%	22	0.46
Gopher	25%	22	0.37
Recreational Boat 4 (600 Hp)	25%	22	0.51
Recreational Boat 3 (500 Hp)	25%	22	0.48
Recreational Boat 1 (250 Hp)	25%	22	0.38

* Design vessel selected for analysis

Stable Sediment Size

As discussed above, the predicted bottom velocity from a propeller jet of a stationary vessel decreases significantly as the operating speed of a vessel increases. Furthermore, the currently available predictive models for propeller-induced bottom velocities of a moving ship are not considered accurate for the conditions in the Fox River. Therefore as previously mentioned, the design team conducted a field study in October 2005 using bottom-mounted current meters to measure actual bottom velocities of maneuvering and passing vessels in the Fox River, which are further discussed below.

Since field measurements were not available during the initial phase of this design effort, the data presented by Verhey (1983) in Table D-11 were used to develop preliminary estimates of the effects of vessel speed. These data indicate that the bottom velocity for a ship traveling at speeds exceeding 4.5 mph will be at most 50 percent of

the bottom velocity predicted for stationary conditions. Therefore for this preliminary estimate, the bottom velocities used to determine stable sediment size for the design vessels, *Foxy Lady* and Bulk Carrier 1, are assumed to represent 50 percent of the maximum bottom velocities predicted for zero vessel speed as shown in Tables D-12 and D-13. This corresponds to bottom velocities of 1.8 ft/s for the *Foxy Lady* and 2.0 ft/s for Bulk Carrier 1. Because the Bulk Carrier 1 vessel is expected to operate regularly within the OU 4 B channel and the Fort Howard turning basin, stable sediment size was also determined for the maximum bottom velocity of 4.1 ft/s predicted for this vessel at stationary/slowly maneuvering speeds and presented above in Table D-13.

The maximum sediment size required to resist erosion from the propeller wash of the *Foxy Lady* traveling at its typical speed of 8 mph is approximately 1.5 inches and a sediment size of 2 inches would be sufficient to resist erosion from the Bulk Carrier 1 (12,000 HP) operating in the OU 4B channel at 5 mph. For a stationary/slowly maneuvering Bulk Carrier 1 within the turning basin, a sediment size of 8 inches is required to withstand the anticipated erosional forces. These results are summarized in Table D-14.

Table D-14
Stable Sediment Size to Resist Propeller Wash For Design Vessels

Reach	Design Vessel	Power Applied	Vessel Speed (mph)	Max Predicted Bottom Velocity Underway (ft/s)	Stable Sediment Size (in)	Sediment Type
OU 3	*Foxy Lady*	50%	8	1.8	1.5	Coarse Gravel
OU 4A	*Foxy Lady*	50%	8	1.8	1.5	Coarse Gravel
OU 4B	Bulk Carrier 1 (12000 Hp)	10%	5	2.0	2.0	Coarse Gravel
OU 4B	Bulk Carrier 1 (12000 Hp)	10%	0	4.1	8.0	Cobbles

Based on these results and those from the analysis of other erosional forces (waves and currents) discussed above, a preliminary median particle size (D_{50}) of 1.5 inches was selected as a cap armor layer to resist erosion from propeller wash and the 100-year design flow event in OUs 3 and 4A. A median particle size ranging between 6 and 9 inches, corresponding to quarry spall stone, has been selected as the preliminary cap armor layer to resist erosion from the large commercial vessels operating within the OU 4B Federal Navigation Channel.

The design conditions representative of the site may be outside of the applicable range associated with the methods available and used to determine propeller wash effects. Therefore, field studies discussed above were used to obtain/measure site-specific vessel characteristics and corresponding effects of propeller wash. Armor layer design was revisited following the field studies and is discussed below.

Scour Depth

As discussed above, cap design calculations performed for the BODR also evaluated the depth of scour to further describe the potential effects of the propeller wash velocity field on cap armor materials. The depth of scour was computed for the *Foxy Lady* based on the specifications of this vessel operating in water depths ranging from 6.5 to 26 ft as summarized in Table D-15. Depth of scour was calculated for durations of scour ranging from 30 sec to 5 min based on the equations developed by Hamill (1988) and the 1.5-inch defined sediment size. Maximum depths of scour occurred at the shallowest water depth of 6.5 ft and varied from 0.56 (t = 30 sec) to 1.24 inches (t = 5 min). A 1-min duration was identified as a conservative assumption for this vessel operating in the Lower Fox River, which corresponds to a maximum scour depth less than 1 inch.

Table D-15
Summary of Scour Depth Predictions

Reach	Design Vessel	Power Applied	Assumed Duration of Propwash	Max Predicted Depth of Scour (inches)
OU 3	*Foxy Lady*	75%	1 min	0.74
OU 4A	*Foxy Lady*	75%	1 min	0.74

D.2.4 Operational Considerations

Due to the nature of in-water construction, variability in the thickness of capping material placed is inherent in all capping operations. To account for placement inaccuracy and mixing, an additional cap thickness component (T_o) is added to the design to ensure that the entire capping area is covered by the minimum thickness required to meet the design objectives. The additional thickness (referred to as the operational over-placement) is dependent on the type of equipment used, the anticipated range of operator skills, the nature of the material, and the site conditions.

Given site conditions in the Lower Fox River, the anticipated cap placement method is likely to be by mechanical clamshell. Based on other similar capping project experience, and on considerations of likely contractor incentives to limit, as practicable, the amount of excess thickness, the over-placement amount is expected to vary between 0 to 6 inches with an average of less than 3 inches. Therefore, for costing and subsequent engineering evaluations an additional 3 inches of cap material and 3 inches of gravel armor material have been assumed. It is important to note that this over-placement thickness is not required for protectiveness.

In accordance with workgroup discussions, specification language will be developed as part of future design submittals for cap placement identifying a "target thickness" of material to be placed. This target thickness will be the sum of the required thicknesses for chemical isolation, bioturbation, erosion, and consolidation as well as the over-placement allowance(s). Possible specification language for caps constructed in areas requiring a 3-inch chemical isolation zone and overlying erosion protection layer (preliminary cap design presented above and in Figure D-5) may be as follows:

"*Contractor shall target placement of 13 inches of cap materials (16 inches for an armored cap) such that an average of 13 inches of sand is placed (16 inches for an armored cap including a minimum of 4 inches of armor material). The minimum cap thickness shall not be less than 10 inches (13 inches for an armored cap). The maximum thickness may not exceed 16 inches (22 inches for an armored cap) for payment. However, removal of material will not be required if the water depth limitations are met. Further, for averaging purposes, areas exceeding 16 inches (22 inches for an armored cap) will use a value of 16 inches (22 inches for an armored cap) rather than the actual thickness if greater than 16 inches (or 22 inches for an armored cap).*"

Placement accuracies relative to the target thickness and the thickness required for protectiveness will be monitored during construction via continuous bathymetric surveying and direct measurement through core sampling to ensure cap placement to the limits and extents provided by the design.

Given the soft consistency of the existing sediments in the Lower Fox River, some amount of mixing of cap material with the underlying contaminated sediments is possible. Recent experience has shown that minimal mixing can be achieved with appropriate placement equipment and techniques (see Table D-17; Verduin et al 2001;

Verduin and Lynch 2005). Given the assumed mechanical placement method, and considering water depths and existing sediment strength measured in OUs 3 and 4, less than 3 inches of mixing would be anticipated. The mixed portion of the cap is not considered to contribute to the chemical isolation thickness (T_i) of the cap (see Figure D-5).

Construction sequencing will be appropriately staged to avoid recontamination as a result of remedial activities. The current assumption is that dredging would begin in OU 3 followed by capping in OU 3 and concurrent dredging in OU 4. Following dredging within the upstream portion of OU 4, capping would follow with an appropriate buffer distance between the capping and dredging operations.

D.2.5 Geotechnical Stability Considerations

D.2.5.1 Bearing Capacity of Sediment

As cap material is placed on the surface of soft sediment, it results in an unbalanced load wherever there are variations in cap thickness. The unbalanced load is usually most prominent along the edge of the cap where the difference is equal to the height of the lift. This unbalanced load effect at the edge of the cap is mitigated to a certain degree because the cap will tend to be tapered as the material falls at its natural angle of repose. In addition to effects at the edge of the cap, an imbalance can also occur in the interior of a cap if a variation in lift thickness occurs during placement. Figure D-9 illustrates the concepts of uneven cap load.

Appendix C of the *ARCS Program* "*Guidance for In Situ Subaqueous Capping of Contaminated Sediments*" (Palermo et al. 1998b) describes a method of assessing stability of a cap placed on soft sediment. The method is based on the bearing capacity theory applied to a shallow foundation on a subgrade. Cap stability for this site was analyzed in accordance with this method (referenced as the deterministic approach herein).

The ARCS guidance manual states that a safety factor of 3 is typical for a bearing capacity analysis (Palermo et al. 1998b). Traditionally with foundation design, this safety factor is appropriate because it limits potentially damaging settlement that could impact a structure. However, during cap placement with incremental layer placement, a lower safety factor could be acceptable. To better address foundation stability under a cap, a probabilistic analysis of cap bearing failure was completed that incorporates the

uncertainty of the sediment strength and cap weight. The traditional foundation bearing capacity analysis was performed, but instead of using a rigid safety factor we predicted the probability of no failure. This approach is also useful when the shear strength properties vary significantly and the average value varies from the highest and lowest values.

The critical cap height differential was evaluated using three different methods, which are detailed below:

- Deterministic evaluation
- Probabilistic evaluation
- Comparison to past similar capping projects

Theoretically, there is a critical cap height difference (h), as defined in Figure D-9, that will induce a differential load sufficient to cause failure of the subgrade. When this occurs, the cap material can become intermixed with contaminated sediment. The intent of this analysis is to determine the critical height difference and to evaluate if this critical height is reasonable given typical cap construction techniques.

Deterministic Evaluation

The existing sediments that will support the in situ cap must have sufficient internal strength (bearing capacity) to prevent local shear failures. To evaluate the short-term condition, the bearing capacity of the sediments was calculated using the Terzaghi equations (Lambe and Whitman 1969, Equation 32.1) with undrained shear strengths measured by in situ vane shear testing , laboratory Torvane testing, and laboratory unconsolidated undrained (UU) triaxial testing.

$$q_{ult} = N_c * S_u \qquad \text{[Equation D-6]}$$

where:

q_{ult} = ultimate bearing capacity of sediment (psf)

N_c = Bearing capacity factor (dimensionless)

= 5.14 for continuous strip footing (Terzaghi and Peck 1967)

S_u = undrained shear strength from vane shear test (psf)

= c = sediment cohesion from UU triaxial test (psf)

As shown above, the undrained shear strength, S_u, is equal to the sediment cohesion, c, obtained from the UU triaxial test, where the internal angle of friction, ϕ, is zero because the failure occurs too rapidly for the sediment to drain.

During the 2004 and 2005 pre-design sampling of OUs 3 and 4, the undrained shear strength within the prospective capping area was measured at one-, two-, and three-foot depths using a field vane shear device. In the upper one-foot-interval, 105 tests within OU 3 and OU 4 were completed, and the measured shear strength was ranged from approximately 15 to nearly 193 pounds per square foot [psf] (10th and 90th percentile values, respectively) with an average of approximately 50 psf. The range of measured shear strengths was higher in the next two depth intervals at 2 and 3 feet below the sediment surface (average of 82 psf and 102 psf, respectively). In addition, the minimum measured shear strength from the UU triaxial testing was 80 psf. For the deterministic evaluation the average (50 psf) and 10th percentile (15 psf) measured strength values were used:

q_{ult} = 5.14 x 15 psf = 77 psf

q_{ult} = 5.14 x 50 psf = 257 psf

A factor of safety of 3 was then applied to the ultimate bearing capacity to calculate an allowable bearing capacity ($q_{allowable}$):

$$q_{allowable} = \frac{q_{ult}}{\text{Factor of Safety}} \qquad \text{[Equation D-7]}$$

$$q_{allowable} = \frac{77\ \text{psf}}{3} = 25.7\ \text{psf} \quad \text{and}$$

$$q_{allowable} = \frac{257\ \text{psf}}{3} = 86\ \text{psf}$$

A maximum safe lift thickness (or variation in lift thickness) that could be supported by the in situ sediments without causing internal shear failure was then calculated for the allowable bearing capacity calculated above using the following equation:

$$\text{Lift Thickness} = \frac{q_{\text{allowable}}}{\gamma'} \qquad \text{[Equation D-8]}$$

where:

γ' = buoyant unit weight of capping material (pcf)

$\gamma' = \gamma - \gamma_w$

γ = total unit weight of capping material (pcf)

γ_w = unit weight of water (62.4 pcf)

γ' = 115 pcf - 62.4 pcf = 56.2 pcf

$$\text{Lift Thickness} = \frac{25.7\ \text{psf}}{56.2\ \text{pcf}} = 0.46\ \text{feet} \approx 6\ \text{inches} \quad \text{and}$$

$$\text{Lift Thickness} = \frac{86\ \text{psf}}{56.2\ \text{pcf}} = 1.5\ \text{feet} \approx 18\ \text{inches}$$

The analyses above, which utilize a conservative safety factor, indicate lift thicknesses of 6 to 18 inches can be placed across the site with minimal chance of bearing capacity failure.

Probabilistic Evaluation

The same formula described above in the deterministic evaluation was used for the probabilistic evaluation. However, the variability of the sediment strength and the cap weight was accounted for with the probabilistic evaluation. With this approach, the results indicate the likelihood that bearing capacity failure would occur, rather than using a safety factor. This method accounts for the entire range of observed shear

strengths that the deterministic approach cannot consider. The probabilistic approach used the @Risk software to perform a Monte Carlo simulation considering the different input uncertainties. The cumulative distribution of undrained strength data was used, for example, in assigning a statistical uncertainty to this parameter. The potential variability of the cap buoyant unit weight was also accounted for by assuming a mean value of 43 pounds per cubic foot (pcf), a normal distribution and a coefficient of variation of 4 percent (Harr 1987; Table 1.8.1).

The probabilistic approach determined that a 10- to 12--inch cap differential corresponds to a 95 percent probability of success. This means that if the cap differential ("h" in Figure D-9) were 10 to 12 inches, 95 percent of the time the cap would not cause a bearing capacity failure into the underlying sediment.

Comparison to Past Similar Capping Projects

The evaluation summarized above compares favorably with empirical evidence of successful cap placement on much softer sediments, based on a review of case histories for previously completed capping projects, which represents a "reality check" on this concept of potential cap failure. As shown in Table D-16, subaqueous caps have been successfully placed at other project sites across the country where measured shear strengths have been as low as 3 psf, but often range around 10 to 20 psf. Even in these examples, post-cap cores have shown a distinct cap/sediment interface, with no intermixing between the cap and the sediments, which indicates that bearing capacity type failure has not occurred during capping.

Table D-16
Summary of Previously Completed Capping Projects

Project	Moisture Content	Percent Solids	Atterberg Limits		Undrained Shear Strength in psf	Water depth in feet	Cap Design	Method of Placement	Observations
			LL[1]	PI[2]					
KPC Ward Cove Sediment Remediation Ketchikan, AK [3]	Avg 415%	Avg 19%			3 to 100	40 to 120	6" to 12" of clean, fine to medium sand	Rehandling with bucket	Clear cap/sediment boundary
LA Corps Aquatic Capping Project Dredge Material Placement Los Angeles Harbor, CA [4]	140 to 183% Avg 161%	35 to 41% Avg 38%	53 to 76 Avg 66	22 to 41 Avg 33	7.5 to 13 Avg 11	60	Placed 2.5 to 3.0 feet of LARE material	Stagnant bottom dump barge.	Mudwaves created in some locations; other areas performed as anticipated
LA Corps Aquatic Capping Project Cap Material Placement Los Angeles Harbor, CA [4]	98 to 134% Avg 111%	43 to 51% Avg 47%	38 to 51 Avg 44	7 to 20 Avg 13	5 to 22 Avg 11	52	5 feet of fine to medium sand	Bottom dump barge moving and rehandling with bucket	Post dredge cores indicate little mixing of the cap and underlying contaminated sediment
Matsushima Bay Japan [5]	200 to 375% Avg 275%	21 to 33% Avg 27%	160 to 175 Avg 170	115 to 130 Avg 125	5 to 35	10	12" fine sand cap	Unknown	Successful
Soda Lake Capping Casper, WY [6]	161 to 455% Avg 200%	18 to 38% Avg 33%	91 to 155	>50	< 280	0.5 to 12	3 foot cap of medium clean sand	Hydraulic with surface diffuser barge	Clear cap/sediment boundary
PPG Barberton Project Barberton, OH [7]	7 to 287% Avg 199%	26 to 94% Avg 37%	35 to 93 Avg 76	16 to 55 Avg 38	9 to 76 Avg 21	4 to 6	1 foot of clean sand	Hydraulic with surface diffuser barge	Clear cap/sediment boundary
Hiroshima Bay Sediments Japan [5]	80 to 100% Avg 88%	50 to 56% Avg 53%	60 to 75 Avg 68	22 to 38 Avg 31	20 to 85	65 to 70	12" to 20" sand cap	Unknown	Successful
Lake Biwa Japan [5]	95 to 150% Avg 125%	40 to 51% Avg 44%	70 to 135 Avg 105	40 to 70 Avg 55	20 to 190	5	8" medium sand cap	Unknown	Successful
Georgia Pacific Log Pond Bellingham, WA [8]	97 to 175% Avg 142%	36 to 51% Avg 41%	65 to 175 Avg 105	36 to 79 Avg 61	65 to 277 Avg 144	3 to 15	6" to 8' fine to medium sand cap	Rehandling with bucket	Clear cap/sediment boundary
West Waterway CAD Seattle, WA [9]	Avg 91%	Avg 52%	Avg 73	Avg 39	Not measured	55 to 65	2 foot uniformly-graded sand cap	Bottom dump barge	Clear cap/sediment boundary

Notes:
[1] LL = liquid limit
[2] PL – plasticity index (LL minus the plastic limit)

References:
[3] Hartman Consulting (2000)
[4] Verduin et al. (2002)
[5] Palermo et al. (1998b)
[6] Houck et al. (2001)
[7] Anchor (2003)
[8] Verduin et al. (2001)
[9] Sumeri (1996)

D.2.5.2 Slope Stability

To evaluate the stability of caps on slopes, areas of interest were identified in the river, and a representative section was selected that included a steep slope, and capping as part of the remedy. The selected section, 112+00, is located in OU 4. The east bank of the river in this area has an average slope of 4.7H:1V, with localized steeper areas up to 2.75H:1V, and a cap thickness of 13 inches.

Slide 5.0 is a comprehensive slope stability analysis software, complete with sensitivity, probabilistic and back analysis capabilities. The Slide software offers various vertical slice limit equilibrium methods (Bishop, Janbu, Spencer, Corps of Engineers #1 and #2, and more) for stability modeling. Slope stability evaluations are conducted by inputting the geometry and subsurface stratigraphy of an existing or proposed slope as well as various parameters describing the sediment and water conditions (sediment and water densities, cohesion, friction angle, soil model, groundwater/surface water elevations, etc.). The software output includes graphical solutions of the factor of safety associated with various failure surfaces and well as numerous other tabular and graphical output useful for data analyses.

In situ sediment properties for the slope stability evaluations were obtained from laboratory measurements on samples collected during the 2004 and 2005 pre-design sampling and analysis program. In addition, physical properties of the capping materials were estimated based on the nature of the cap materials proposed (sand and gravel) and the method of cap placement (mechanical clamshell). The following input assumptions were used in the model:

- Cap unit weight = 120 pcf, friction angle = 32 degrees and cohesion = 0 psf.
- Sediment unit weight= 92 pcf, friction angle = 0, and cohesion varying as a function of depth from 50 to 750 psf, based on results of the vane shear and laboratory strength testing.

Both circular and non-circular surfaces were checked, and the software performed a search for the critical (i.e lowest factor of safety) slip surface. Generalized Limit Equilibrium and Spencer methods were used to compute the factor of safety.

Based on the results of the stability analysis, caps on slopes are expected to have a static factor of safety of 1.3 or better, which meets the criteria presented by Hammer and Blackburn (1977) for the long term stability condition.

Appropriate construction techniques will be required to ensure proper cap placement thereby limiting the potential for slope stability failures during or shortly after construction. This will involve the placement of materials in a "bottom up" fashion, whereby materials are first placed at the toe of a slope and construction produces towards to top of slope. In this way, cap materials will be continually placed against a firm toe support and are not allowed to slump towards the base.

D.2.5.3 Cap Punch Through Analysis

A typical cap section was evaluated to determine the factor of safety against punch through, under the walking load of human foot traffic. This analysis used to punch through bearing capacity methods described by Das (1999).

For this evaluation, human foot traffic was modeled as the load applied by a 200-pound individual standing on one foot. The surface area of the load was assumed to be applied over a width of 4 inches, and a length of 10 inches, resulting in a net load of 720 psf to the cap under these conditions (assuming no benefit from potential buoyancy effects, which would reduce the applied load).

A 13-inch-thick cap section was evaluated assuming complete saturation, and the following strength parameters for the cap and the underlying sediment:

- Cap friction angle = 32 degrees; cohesion = 0 psf.
- Sediment friction angle = 0 degrees; cohesion = 50 psf.

Under the loading scenario evaluated, the factor of safety against punching shear is 1.5, which is considered acceptable.

D.2.6 Ebullition Considerations

The Lower Fox River has been characterized as having significant methane sediment content (GAS/SAIC 1996). Sub-bottom profiles of sediments revealed subsurface

accumulations of methane in many areas of the river. Methane releases have also been observed during sediment sampling, and were seen during recent dredging demonstration projects at SMU 56/57 and in OU 1 (Retec Group, Inc. 2003). However, such releases were not observed during the 2004 pre-design sampling in OUs 2 through 5. Gas generation and movement have the potential to impact contaminant transport through a cap. This process was not explicitly considered in the capping model discussed in Section 3.1 and is therefore evaluated below.

Mineralization of sedimentary organic matter by bacteria generates gases such as methane (CH_4), nitrogen (N_2), carbon dioxide (CO_2) and other trace gases. Denitrifying bacteria produce N_2, methanogenesis results in CH_4, and CO_2 results from fermentation and sulfate reduction processes in sediments. These gases tend to migrate out of sediments into overlying water and are vented to the atmosphere.

A cap interferes with gas generation and migration in a number of ways. The cap effectively isolates contaminants in the underlying sediments but also isolates that sediment from fresh organic matter that drives gas generation. In sediments that contain significant amounts of labile organic matter, such as sewage sludges, gas generation could continue for a long time. Sediments in which organic cycling is expected to be driven by decaying vegetation, however, are likely to exhibit significantly reduced gas generation within a few seasons after placement of a cap. The most labile organic carbon has a half-life on the order of weeks whereas the remaining reactive organic carbon is generally considered to have a half-life on the order of a year.

During the transient period when gas generation continues at significant rates, several gas-related transport processes could potentially compromise the performance of a cap. These include:

- Direct transport of volatile contaminants within the gas phase;
- Direct transport of semi-volatile compounds attracted to the interface of the gas bubbles;
- Indirect transport of liquid phase contaminants due to migration in the wake or on the surface of the bubble; and

- Indirect transport due to secondary porosity generated by passage of the gas bubbles.

Transport by any of the first three mechanisms requires a significant mass of contaminant to be present in the mobilized phase. The PCBs of interest in the Lower Fox River are relatively non-volatile except from water which contains only a small fraction of the PCB mass. The sorption of the PCBs onto the interface of the bubbles does increase the mobile mass but an order-of-magnitude analysis suggests that other mechanisms of facilitated transport, such as colloidal transport of PCBs, is far greater. The importance of the third mechanism appears to be strongly related to the presence of NAPL as the only liquid phase that carries significant PCB mass. Only when NAPL is present in sediments, which is not the case for the Fox River, has gas bubble movement been convincingly linked to contaminant migration. Finally, indirect transport due to the formation of secondary porosity generated by the passage of gas bubbles could be important in cohesive media that is unlikely to collapse the generated secondary porosity. Granular capping materials such as those proposed for the Fox River, however, will not support any gas voids and will tend to collapse upon passage of the gas bubble. The relatively limited effects of gas bubbles combined with the transient behavior of gas generation for capped sediments in which gas generation is the result of the degradation of natural organic matter suggests that gas is of little concern relative to capping in the Lower Fox River.

D.2.7 Summary of Cap Design Components

As discussed at the beginning of Section 3, there are five main thickness components to the cap design, each of which are discussed above. The following is a summary of the preliminary design for each component:

1. Chemical isolation component, T_i = 6 inches (including 3 inches of assumed mixing into underlying sediments)

2. Bioturbation component, T_b = 0 inch (4 inches of bioturbation protection is included as part of the erosion protection component discussed below)

3. Consolidation component, T_c = 0 inch (internal cap consolidation is negligible; chemical flux resulting from the average 7-inch consolidation of in situ sediments is covered in the chemical isolation component thickness discussed above)

4. Erosion protection component, T_e = 4 inches (including bioturbation component)

5. Operational component, T_o = 3 inches on average per layer (6 inches total for sand cap with gravel armor)

Using Equation D-1 from Section D.2, target cap thickness was calculated. Given the soft sediment characteristics in OUs 3 and 4, an average 7 inches of sediment consolidation is expected below a 16-inch layer of placed material, although this consolidation was not considered for this preliminary cap design with respect to the required post-cap water depth requirements.

D.3 Comparative Evaluation: ROD and Contingent Remedies

This section compares the contingent capping remedy (as described in Sections D.1 and D.2) with the ROD Remedy, using the nine evaluation criteria set forth in the National Contingency Plan (40 C.F.R. Part 300). Since a capping remedy was previously shown in the ROD to meet each of the individual criteria, this evaluation consists of a comparative analysis focusing upon the relative performance of the contingent remedy and the ROD Remedy under each criterion.

In order to compare the ROD and contingent remedies, the volumes and areas associated with dredging and capping for each remedy were determined within OUs 2 through 5 as discussed above. Table D-2 presents a summary of the areas of dredging and capping for the ROD and contingent remedies

D.3.1 Threshold Criteria

Overall Protection of Human Health and the Environment

The contingent remedy is expected to provide at least the same level of human health and environmental protection as the ROD remedy. The contingent remedy has been designed to provide permanent chemical isolation and prevent future exposure to confined subsurface sediments. The technical design framework discussed in Sections D.1. and D.2 was developed based on the USACE guidance (Palermo et al. 1998a) and

White Paper 6B (Palermo et al. 2002) to provide this level of protectiveness. This comparison is consistent with Sections 11.1.1 and 11.2.1 of the ROD, which concluded that capping and dredging alternatives will achieve acceptable fish tissue concentrations and protective levels in sediment for ecological receptors within similar time frames. In addition, the ROD concluded that both alternatives will provide similar reductions in PCB loading to downstream areas. Given that the contingent remedy could be completed in less time than the ROD Remedy (see discussion in Short-Term Effectiveness section for discussion of project duration), the contingent remedy can be expected to reduce ecological receptor tissue concentrations and loading to downstream areas sooner than the ROD Remedy.

Furthermore, the long-term monitoring, management, and contingency response requirements associated with the specific cap design are included as integral parts of the contingent remedy design (and associated cost estimate) to ensure continued protectiveness.

Experience at a range of similar CERCLA dredging projects has shown that residual sediment contamination can be expected as a result of dredging. Estimation of the degree and extent of residual contamination is an important step in predicting post-dredge sediment concentrations, which are addressed in Section 3.6. In a qualitative comparison, experience has shown that residual chemical contamination following capping is significantly less than that following dredging. Therefore, with respect to mitigation or avoidance of residual contamination, capping is more protective of human health and the environment than dredging.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

As discussed in Section 11.1.1 of the ROD, there are several ARARs associated with removal that will be applicable to both the ROD Remedy and the contingent remedy. These ARARs are therefore not addressed in this comparative evaluation.

The ROD and contingent remedy must comply with substantive provisions of local, state, and federal laws and regulations including the following:

- Wisconsin State requirements (WI Statutes Chapter 30);
- U.S. federal regulations (Rivers and Harbors Act of 1899, 22 CFR 403); and
- Chapter 116 of the Wisconsin Administrative Code.

As discussed in the ROD, the ROD and contingent capping remedy provisions readily comply with WI Statutes Chapter 30 and the federal Rivers and Harbors Act of 1899, 22 CFR 403, as the remedial designs for the ROD and contingent remedies were developed to assure compliance with the ARARs. Under Chapter 116 of the Wisconsin Administrative Code, the remedies must not adversely alter the 100-year flood plain for the river. Largely because dredging volumes equal or exceed capping volumes, the 100-year flood plain in OUs 3 and 4 is not expected to be adversely impacted by the contingent remedy.

D.3.2 Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Both the ROD and contingent remedies provide long-term effectiveness through the removal and containment of contaminated sediments. Both remedies also require some degree of institutional controls (i.e., fish consumption advisories until the remedial action objectives are met).

The cap designs for the contingent remedy provide protective and reliable chemical isolation and ensure that erosion will not occur even if a river flow event with a 100-year recurrence interval occurs as discussed in Section D.2.3. In addition, other erosive forces (e.g., wind waves, propeller wash, ice scour) were also evaluated in Section D.2.3 and the caps were designed to withstand these forces over the long term.

To ensure the adequacy and reliability of controls for an in situ cap, similar to controls normally included with upland landfill confinement options as described in the ROD, a long-term monitoring, maintenance, and contingency response plan, including institutional controls and repair (as needed) of damaged capping areas, will be developed for the contingent remedy, as discussed above. A long-term cap monitoring plan will include both physical integrity monitoring (bathymetry surveys and core sampling) as well as chemical analyses of surface sediments and/or cores collected from within the capping areas to assess contaminant mobility through the cap. Specific

institutional controls necessary to ensure long-term cap integrity will be developed during later stages of design.

Natural recovery modeling, as reported in the RI/FS, suggests that residual sediment contamination that may remain on the post-dredge (or post-cap) surface will be expected to decline at an accelerated rate following implementation of either remedy, as a result of overall sediment resuspension controls and ongoing sedimentation processes. Monitoring of surface sediment recovery within dredging areas could be implemented to verify such natural recovery expectations. Detailed monitoring plans will be necessary for both alternatives and will be developed as a collaborative Workgroup process during subsequent stages of RD.

Reduction of Toxicity, Mobility, or Volume through Treatment

As discussed in the Lower Fox River RI/FS and ROD, both the ROD and contingent remedies utilize permanent solutions to the maximum extent possible. Significant volumes of PCB-contaminated sediments and PCB mass will be removed from the river under either remedy. Although a smaller volume of PCB-contaminated sediment will be removed from the river under the contingent remedy, the remaining sediments will be appropriately isolated from the environment to eliminate the potential for migration.

Both the ROD Remedy and contingent remedy would permanently remove large sediment volumes and accompanying PCB mass from OUs 2 to 5. These volumes of removed sediment would be effectively contained in an upland engineered landfill where PCB would be isolated from the environment. Similarly, the use of in situ capping as part of the contingent remedy would isolate PCB contaminants from ecological receptors and reduce the mobility of PCBs sequestered beneath the cap. However, neither of these remedial technologies satisfies the statutory preference for treatment (e.g., see Section 11.2.2 of the OU 3 to 5 ROD). Given the large volumes of material involved, treatment was identified in the RODs as likely not cost-effective. This was verified during development of this BODR (see Appendix E of the BODR).

Short-Term Effectiveness

The OU 3 to 5 ROD discusses that short-term effectiveness relates to the length of time needed to implement an alternative, and the risks the alternative poses during implementation. The following in-water construction durations were estimated based on the extent of dredging and capping for the ROD and contingent remedies and on assumed production rates for each activity:

- ROD Remedy: 10 years
- Contingent Remedy: 6 years

It should be noted that these durations include only the in-water construction portion of the project. Pre-construction activities such as permitting and construction of a new dedicated landfill would extend these project durations by at least 2 years. In addition, technical uncertainties related to the use of multiple dredges operating concurrently with a single pipeline for transport (as discussed in under the Implementability criteria) could lead to a considerable increase in project duration, as discussed in Section 6 of the BODR.

The contingent remedy is estimated to require 40 percent less time to implement than the ROD Remedy, and presents fewer contingencies that could extend the duration of remedy implementation. Based on these estimated durations, potential impacts on the environment and human health (of the workers and community) during remedial construction will be less for the contingent remedy than for the ROD Remedy, and the contingent remedy will achieve protectiveness more rapidly than the ROD Remedy.

Resuspension of contaminated sediment during construction (both dredging and capping) is anticipated. However, monitoring data available from other similar projects indicates that resuspension during capping operations can be minimized depending on placement techniques employed. Two investigations conducted by USEPA's National Risk Management Research Laboratory (NRMRL) measured the release of in situ contaminated sediments during cap placement at Boston Harbor, MA and Eagle Harbor, WA (EPA 2005b). The results of both investigations indicated that resuspension occurred during the initial run(s), and progressively decreased and dissipated with each subsequent run. (Elevated releases were observed for the first lift only in Boston Harbor

and for the first three lifts at Eagle Harbor due to the more aggressive placement technique for the latter case.)

The results suggest that resuspension during cap placement may be minimized by placing cap materials in several lifts, such that the initial lift involves minimal disturbance (i.e., low energy) methods followed by more aggressive techniques for subsequent lifts. Therefore, the contingent remedy should result in substantially fewer short-term impacts than the ROD Remedy with respect to potential resuspension and deposition of PCBs and subsequent sediment residuals.

The time needed to achieve protection with the contingent remedy will likely be less than that of the ROD Remedy, given the lesser degree of anticipated residual management necessary following careful cap placement.

Implementability

Both dredging and capping are implementable on the Lower Fox River. Both technologies have been implemented successfully on many other remedial projects. The majority of the services, materials, and equipment are expected to be readily available in the project vicinity. However, although the use of multiple dredges pumping to a shore-side surge system feeding a single pipeline for transport was determined to be technically feasible by the Workgroup, this type of operation has never been implemented on a scale proposed for this project. Therefore, the estimated project durations discussed above are dependent on the effectiveness and efficiency of the multiple dredge system.

As discussed in Section D.1.2, capping is likely more easily implemented than dredging in some portions of the river, including areas surrounding infrastructure and submerged utilities, because dredging in the vicinity of infrastructure and submerged utilities could adversely affect their structural integrity. Furthermore, dredging of contaminated sediments at the base of shoreline slopes in some areas is impracticable without adversely impacting the stability of the shoreline.

Due to the large volume of sediment requiring disposal under the ROD Remedy, and given the limited availability of local landfill capacity, the lower upland disposal volume

associated with the contingent remedy likely makes this option more implementable than the dredging-only ROD Remedy. For this BODR, it was assumed that a new dedicated NR 213 settling basin and NR 500 landfill will be constructed for either the ROD Remedy or contingent remedy options, as presented in the ROD. .

Cost

For the purposes of this comparative evaluation, a comprehensive cost estimate was developed for both the dredging-only and contingent capping remedies, including capital costs, annual operation and maintenance (O&M) costs, and long-term monitoring. Long-term cap monitoring was assumed to include focused monitoring within the first 30 year period following construction to verify the performance of the design and anticipated natural recovery processes, with follow-on monitoring, contingency response to specific events of potential concern (e.g., 50-year floods), as defined as part of remedial design. All costs were assumed to be present day (2005) values to provide a clear comparison of the actual costs.

The cost estimates have been advanced to approximately a 10 percent design level for both remedy options at a similar level of detail. The dredging remedy cost estimate was updated from the estimate presented in the ROD to incorporate the latest developments, including optimized assumptions related to multiple dredges, and mechanical dredging of sediments potential subject to TSCA disposal requirements. The results of the Boldt Oversight Team's evaluations have been incorporated where appropriate into these cost comparisons.

The costs of cleanup passes and the handling of residual contamination have been intentionally excluded from this evaluation. Including such costs would be expected to increase the difference between the ROD Remedy and the contingent remedy. These factors will be considered in later stages of the design.

Approximately 4.2 million cy would be dredged under both the ROD Remedy and contingent remedies and is therefore referred to as the "baseline volume." The remaining 2.9 million cy would either be dredged under the ROD Remedy or capped under the contingent remedy. It should be noted that the volumes discussed herein do

not include any allowance for "second pass" dredging or backfill/cover placement to manage post-dredging residuals.

The estimated cost for dredging the baseline volume of 4.2 million cy is approximately $405 million under both the ROD and contingent remedies. The estimated incremental cost to dredge the remaining 2.9 million cy (including consideration of economies of scale associated with the larger dredging project) is approximately $128 million, compared to the estimated $40.5 million of incremental costs to cap that remaining volume. The contingent capping remedy would cost about $88 million less than the ROD Remedy to address the same sediments. Thus, the contingent capping remedy would be approximately 70 percent less costly than the ROD Remedy to address the sediments that are potentially subject to either capping or dredging under the ROD criteria. Expressed in other terms, dredging the 2.9 million cy under the ROD Remedy is approximately 3.2 times more expensive than capping the same 2.9 million cy under the contingent remedy.

D.3.3 Modifying Criteria

Agency Acceptance

For capping to be implemented under the contingent remedy, approval from EPA and WDNR will be necessary; both through an ESD or ROD Amendment process, and through approval of subsequent detailed remedial design documents. Active agency participation in the contingent remedy workgroup is occurring to ensure early resolution of agency concerns.

Community Acceptance

The level of community acceptance of the contingent remedy will be gauged through public comments received as part of the ESD or ROD Amendment process.

D.4 Cap Design: Optimized Remedy

In accordance with the Optimized Remedy design objectives presented in Section 5 of the BODR, in situ containment of PCB contaminated sediments is an integral component of the Optimized Remedy. Sections D.1 and D.2 presented a preliminary evaluation and design of a cap, in accordance with the provisions for the contingent remedy described in the ROD, that would be protective of human health and the environmental by effectively containing sediments with PCB concentrations up to 49.9 ppm. This section expands that preliminary cap design by presenting refined cap designs for the Optimized Remedy tailored to the various site conditions present within the rive while minimizing impacts to navigation, recreation, and habitat and maximizing long-term stability and permanence of the caps. In many areas of the river, this is accomplished by a combination of dredging and capping, while in other areas capping alone will provide a protective remedy. The remainder of this Appendix presents the details of caps that would be utilized for the Optimized Remedy.

D.4.1 Summary of Cap Design Components

As discussed above, the design thickness of an in situ cap is based on consideration of five major components, including the following:

- Chemical isolation of contaminants;
- Bioturbation;
- Consolidation;
- Erosion; and
- Operational considerations.

In addition, there are numerous other considerations related to the selection of potential capping areas within the Fox River, as discussed above, including the following:

- Federal navigation channel;
- Infrastructure and utilities;
- Distribution of sediments potential subject to TSCA disposal requirements;
- Geotechnical stability of existing sediments and cap materials;
- Ebullition;

- Habitat (post-cap water depths); and
- River hydrodynamics (post-remedy flood plains).

Given the variation in site conditions within the river and considerations listed above, several cap designs were developed for implementation under the Optimized Remedy as summarized in Table D-17 and presented on Figures D-10 and D-11. This section presents the design for the Optimized Remedy cap, based on the EPA/USACE design guidance (Palermo et al. 1998b) as described in Section D.2. In general the preliminary design criteria presented in Sections D.1 and D.2 were also used in identifying cap areas for the Optimized Remedy, except as refined below.

Table D-17
Summary of Optimized Remedy Cap and Cover Designs

Cap Description	Minimum Post-Remedy Water Depth (ft)	PCB Concentration in 0 to 1.5-ft Interval	Comments
13-inch Sand/Gravel Cap	3 feet	< 10 ppm	Used in low concentration areas where mixing zone of clean sand provides necessary chemical isolation.
16-inch Sand/Gravel Cap	3 feet	10-50 ppm	Used in areas where 3 inches of uncompromised chemical isolation layer is necessary for protection. Note that in one location, where PCBs slightly exceed 50 ppm, a thicker chemical isolation layer will be required resulting in a 20-inch-thick cap.
33-inch Sand/Quarry Spall Cap	3 feet	10-100 ppm	Used in OU 4B navigation channel only where large cargo ships may potentially develop relatively high propwash forces.
Cover (6-inch)	N/A	<1 ppm except single 6-inch sample with 1-2 ppm or Dredge Residuals	Used to cover low risk areas or post-dredge residuals.

Note: Cap thicknesses above refer to the "target" thickness.

D.4.1.1 Refined Hydrodynamic Analyses

As discussed in Section D.2, the results of the preliminary hydrodynamic modeling from the contingent remedy evaluations were used to refine the Optimized Remedy cap designs to ensure long-term stability and protectiveness of the Optimized Remedy caps.

SEI performed additional hydrodynamic modeling using the detailed 2-dimensional hydrodynamic model to predict bottom shear stresses within OU s 3 and 4 during a design level flow event (24,200 cfs [685 m^3/s]) with a recurrence interval of 100 years. This refined modeling incorporated the post-construction bathymetry created by the Optimized Remedy including both dredge and cap areas.

Figures D-12 and D-13 show the maximum predicted shear stresses in OU 3 corresponding to the reasonable worst-case hydrodynamic design condition (i.e., simultaneous 100-year flows, historical low water levels, and maximum seiche amplitude) under the existing bathymetry conditions and under the Optimized Remedy bathymetric condition, respectively. Figures D-14 and 15 present similar predictions of shear stress under existing bathymetry conditions and post-Optimized Remedy bathymetry conditions, respectively, for OU 4. Relative to existing conditions, the hydrodynamic model predicted only minor changes in shear stresses throughout OUs 3 and 4 resulting from the Optimized Remedy. The maximum bottom shear stress predicted within the OU 3 capping areas is approximately 50 dynes/cm^2, and occurs in the narrow downstream portion above the De Pere Dam. The maximum predicted shear stress within OU 4 capping areas is approximately 80 to 90 dynes/cm^2, for relatively small zones within the OU 4B navigation channel. Based on these predictions, a conservative maximum bottom shear stress of 100 dynes/cm^2 was selected for design.

The design-level shear stress of 100 dynes/cm^2 was correlated to a stable median grain size (D_{50}) of 1.5-inches (i.e., gravel; see Figure D-10), based on the approach described by Shields (1936) and including a conservative factor of safety of 2 based on a review of the available shear stress data scatter (see Attachment C). Since the armor layer will serve as both erosion and bioturbation protection a minimum thickness of 4 inches of 1.5-inch armor will be required to satisfy both requirements for caps outside of the OU 4 B federal navigation channel, as discussed in Section D.3 and summarized in Table D-6 . Within the OU 4B channel, larger armor stone may be necessary to resist potential worst-case propwash, as discussed above.

D.4.1.2 Refined Ice Scour Analysis

As discussed in Section D.3.2, initial identification of potential capping areas consistent with the contingent remedy of the ROD included an evaluation of potential impacts to the caps from ice scour. Further evaluations as part of the Optimized Remedy design included a statistical analysis of maximum ice thickness and low water elevation to evaluate potential worst-case combined conditions. As discussed in Attachment D of this Appendix, this statistical analysis included a Monte Carlo analysis of worst-case conditions resulting from the combined conditions of maximum ice thickness (99th percentile; 1 percent probability of exceedance) and low water elevations (100-yr event). The results of this Monte Carlo indicate that under these combined worst-case conditions, the elevation of the bottom of the ice formation is expected to be at elevation 584.9 and 573.6 ft IGLD85 for OUs 3 and 4, respectively. As discussed in Section 5 of the BODR, all engineered caps were design to have a maximum top elevation of 584.3 and 573.5 ft IGLD85 in OUs 3 and 4, respectively.

D.4.1.3 Refined Propeller Wash Analyses

As previously mentioned, the design team conducted field studies in October 2005 for both stationary and moving vessels that typically traverse the Fox River. For the purposes of the BODR, an preliminary evaluation of the filed study results was performed to corroborate the empirical model results presented in Section D.2.3.4. As such, the measured velocity data was used to estimate potential reasonable worst-case sediment cover or cap scour depths resulting from the propeller jet from a moving, single propeller vessel. Note that results from the stationary vessel tests will be evaluated in later stages of design (e.g., to further calibrate propeller wash models as part of the 30 Percent Design submittal).

In general, the moving vessel field trials consisted of 4 trial runs conducted for each test scenario (e.g., specified vessel type, speed, pitch, and rpm) in accordance with the Agency-accepted Propwash Field Study Plan (Shaw/Anchor 2005a). The tests were conducted at a single fixed location with a water depth of 5.2 ft. Velocity magnitude and direction were recorded by an acoustic Doppler current profiler (ADCP) for each trial run at 0.33 ft depth intervals (from 1 to 4 ft

below the water surface) and 1-second intervals from 0 to 60 seconds. A total of 19 different test scenarios were conducted: 2 using a dual-propeller vessel, 11 using a 220-hp single propeller vessel, and 6 using a jet-ski. Preliminary moving vessel data and plots are included in the "Propwash Field Study Results and Preliminary Scour Analysis for Moving Vessel Tests" memorandum dated December 6, 2005 (Shaw/Anchor 2005b), which is included as Attachment F of this Appendix.

Hamill (1988) developed an equation to estimate maximum scour depth over time for various propeller and sediment characteristics. Based on Hamill's relationship, maximum scour depths were estimated for the peak bottom velocity reading from each trial run and the corresponding time intervals observed in the field (i.e., 2 to 5 seconds), and applied to the two sediment grain sizes representing the cap armor layer and the cover sand material. As presented in Attachment F, the peak near bottom velocities ranged from 1.0 to 6.5 ft/s; the corresponding maximum scour depths of less than 1 inch were predicted for the gravel cap armor layer and less than 1 foot for the sand cover material for a passing vessel with a 5-second duration of peak velocity.

Additional scour depth analyses were conducted based on a statistical evaluation of the velocity data from the single, propeller moving vessel trials and for various grain sizes anticipated for use as covers and caps s part of the Optimized Remedy for OUs 2-5 of the Lower Fox River. These analyses and results are discussed in further detail in the "Preliminary Velocity Frequency and Scour Analyses for Moving Vessels" memorandum dated December 22, 2005 and included as Attachment F (Shaw/Anchor 2005c).

This statistical analysis included development of the cumulative frequency of occurrence for a given velocity by compiling and sorting all velocity measurements within the time span indicating propeller wash effects for each trial (including the entire range of depths from surface to near-bottom). Maximum depths of scour expected for either a potential sand cover (D_{50} = 0.02 in [0.5 mm]) or cap armor layer (D_{50} = 1.5 in [38.1 mm]) were calculated using Hamill's relationship for velocities with 50, 90 and 99% frequencies and are

summarized in the table below. The time for maximum scour depth for a given bottom velocity was determined as the maximum time interval over which velocity readings were equal to or greater than the given velocity for any field test.

Table D-18
Maximum Scour Depths Expected for Potential Sand Covers and Caps

Cumulative Frequency of Occurrence [%]	Probability of Exceedance [%]	V_o [ft/s]	V_b [ft/s]	t_{max} [s]	Sand Cover ε_{max} [in]	Cap Armor (D_{50} = 1.5 in) ε_{max} [in]	Arrmor [a] (D_{50} = 2 in) ε_{max} [in]
50%	50%	5.6	0.72	15.0	0.008	0.003	0.002
90%	10%	13.0	1.69	4.0	0.022	0.001	0.001
99%	1%	30.4	3.95	3.0	0.74	0.020	0.016

a. Note: armor stone size of 2 inches presented to illustrate sensitivity analysis only. The proposed cap armor layer for the Optimized Remedy is 1.5 inches.

Potential reasonable worst-case sediment cover or cap scour depths resulting from the action of a propeller jet from a moving, single propeller vessel, based on the measured velocity data obtained during the trials are minimal as shown above. The maximum scour depth is less than one inch even for a sand cover subjected to a bottom velocity of approximately 4 ft/s, which is expected to be exceeded only 1% of the time (i.e., 99% of the time the velocity will be 4 ft/s or less).

These estimates demonstrate that the preliminary armor design of the cap proposed for the Optimized Remedy will provide effective resistance to propwash from moving vessels under the conditions evaluated during the October 2005 Field Study.

D.4.1.4 Refined Wind Wave Analysis

Similar to the refined hydrodynamic modeling discussed above, LTI refined the wind wave modeling for the Optimized Remedy in OUs 3 and 4 using the SWAN software to simulate wind-generated waves for the 4 significant wind events discussed in Section D.3 (LTI 2005c, see Attachment E). Tables D-19 and D-20 present the results of this refined analysis. Table D-20 lists the percentage of total cap area for ranges of predicted shear stress values for the four simulated

wind scenarios. These results indicate a similar conclusion to the preliminary analyses presented in Section D.2. The maximum predicted shear stresses from the wind waves in OUs 3 and 4 (less than 15 dynes/cm^2) were significantly less than the maximum predicted shear stresses discussed above during the reasonable worst-case hydrodynamic condition, confirming that wind-wave forces are less of a concern for cap design.

Table D-19
Maximum Shear Stresses for Extreme Wind Events in OU 3

Wind Scenario	Remedy Description	Area (m^2)	Maximum shear stress (dynes/cm^2)	Average shear stress (dynes/cm^2)
SSW 37.3 mph	Cover < 3' water depth	102896	6.30	3.80
	Cover > 3' water depth	614818	7.85	1.93
	Dredge to 1 ppm	244668	5.32	0.92
	Engineered Cap	162114	6.71	1.04
	PCBs < 1 ppm	2377228	9.56	1.41
SW 37.3 mph	Cover < 3' water depth	102896	5.83	3.12
	Cover > 3' water depth	614818	7.32	1.83
	Dredge to 1 ppm	244668	5.08	0.81
	Engineered Cap	162114	7.01	1.00
	PCBs < 1 ppm	2377228	9.33	1.29
NE 37.3 mph	Cover < 3' water depth	102896	6.33	4.48
	Cover > 3' water depth	614818	6.44	1.80
	Dredge to 1 ppm	244668	7.79	1.11
	Engineered Cap	162114	6.27	0.85
	PCBs < 1 ppm	2377228	8.38	1.60
NNE 31.1 mph	Cover < 3' water depth	102896	5.78	3.78
	Cover > 3' water depth	614818	5.92	1.51
	Dredge to 1 ppm	244668	6.20	0.93
	Engineered Cap	162114	6.19	0.74
	PCBs < 1 ppm	2377228	7.30	1.36

Table D-20
Maximum Shear Stresses for Extreme Wind Events in OU 4

Wind Scenario	Remedy Description	Area (m^2)	Maximum shear stress ($dynes/cm^2$)	Average shear stress ($dynes/cm^2$)
SSW 37.3 mph	Cover < 3' water depth	161213	7.39	2.69
	Cover > 3' water depth	782726	9.20	0.88
	Dredge & Engineered Cap	376897	6.32	0.81
	Dredge to 1 ppm	1623628	7.39	1.33
	Engineered Cap	207183	6.74	1.29
	PCBs < 1 ppm	1396577	9.20	1.82
	Staging Facility Fill	173	2.88	0.74
SW 37.3 mph	Cover < 3' water depth	161213	7.54	2.67
	Cover > 3' water depth	782726	8.18	0.89
	Dredge & Engineered Cap	376897	5.98	0.78
	Dredge to 1 ppm	1623628	7.54	1.23
	Engineered Cap	207183	6.56	1.32
	PCBs < 1 ppm	1396577	7.54	1.90
	Staging Facility Fill	173	2.34	0.60
NE 37.3 mph	Cover < 3' water depth	161213	7.99	2.85
	Cover > 3' water depth	782726	10.17	1.02
	Dredge & Engineered Cap	376897	7.65	0.93
	Dredge to 1 ppm	1623628	9.67	1.65
	Engineered Cap	207183	7.22	1.50
	PCBs < 1 ppm	1396577	10.17	2.01
	Staging Facility Fill	173	0.87	0.23
NNE 31.1 mph	Cover < 3' water depth	161213	7.81	2.51
	Cover > 3' water depth	782726	8.39	0.78
	Dredge & Engineered Cap	376897	5.92	0.67
	Dredge to 1 ppm	1623628	8.39	1.28
	Engineered Cap	207183	5.88	1.19
	PCBs < 1 ppm	1396577	8.17	1.75
	Staging Facility Fill	173	1.00	0.27

Table D-21
Comparison of Shear Stress Distribution for Prospective Cap Areas

Wind Scenario	Remedy Description	Shear Stress (dynes/cm^2)	Area in OU3 (% Total)	Area in OU4 (% Total)
SSW 37.3 mph	Cover < 3' depth	0-3	11.20%	44.59%
		3-6	87.88%	54.26%
		6-9	0.92%	1.14%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	81.56%	91.74%
		3-6	17.51%	8.16%
		6-9	0.93%	0.07%
		>9	0.00%	0.02%
	Engineered Cap	0-3	86.86%	81.47%
		3-6	12.64%	17.41%
		6-9	0.49%	1.12%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	94.85%
		3-6		5.01%
		6-9		0.14%
		>9		0.00%
SW 37.3 mph	Cover < 3' depth	0-3	41.95%	44.82%
		3-6	58.05%	53.64%
		6-9	0.00%	1.54%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	83.28%	91.32%
		3-6	15.95%	8.58%
		6-9	0.77%	0.10%
		>9	0.00%	0.00%
	Engineered Cap	0-3	87.88%	80.66%
		3-6	11.38%	18.03%
		6-9	0.74%	1.31%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	95.99%
		3-6		4.01%
		6-9		0.00%
		>9		0.00%
NE 37.3 mph	Cover < 3' depth	0-3	4.02%	42.80%
		3-6	94.03%	55.95%
		6-9	1.95%	1.24%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	81.45%	86.97%
		3-6	18.24%	12.30%
		6-9	0.32%	0.66%
		>9	0.00%	0.07%
	Engineered Cap	0-3	88.55%	77.52%
		3-6	11.20%	20.03%
		6-9	0.25%	2.45%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	93.30%
		3-6		6.43%
		6-9		0.27%
		>9		0.00%
NNE 31.1 mph	Cover < 3' depth	0-3	12.77%	51.35%
		3-6	87.23%	48.02%
		6-9	0.00%	0.63%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	87.15%	93.22%
		3-6	12.85%	6.43%
		6-9	0.00%	0.35%
		>9	0.00%	0.00%
	Engineered Cap	0-3	90.97%	83.20%
		3-6	8.78%	16.80%
		6-9	0.25%	0.00%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	97.38%
		3-6		2.62%
		6-9		0.00%
		>9		0.00%

D.4.2 Horizontal Extent of Capping under Optimized Remedy

Figures D-16 and D-17 present the horizontal extent of the capping, dredging/capping, and sand cover under the Optimized Remedy in OUs 2/3 and 4/5, respectively. Table D-22 presents a summary of the area associated with the proposed caps for the Optimized Remedy.

Table D-22
Estimated Optimized Remedy Capping Areas

Operable Unit	6-inch Cover	Dredge and Cap	Engineered Cap
	(acres)	(acres)	(acres)
OU 2	--	--	--
OU 3	138	--	84
OU 4/5	75	90	210
Total	213	90	294

D.4.3 Summary of Optimized Remedy Cap Design Thicknesses

D.4.3.1 13-Inch Sand/Gravel Cap

Sand caps with gravel armor with a target thickness of 13 inches will be placed in areas where PCB concentrations of the upper 1.5 feet of sediment do not exceed 10 ppm. In addition, within the exception of nearshore caps (see Section 5 of the BODR), areas identified for 13-inch caps would have a post-cap water depths of at least 3 feet to avoid ice scour, avoid undesirable shallow-water habitat, and allow recreational vessel traffic more than 99.9 percent of the boating season (see Section D.1.5).

Chemical Isolation (T_i). Chemical isolation modeling using the transient and steady state models discussed in Section D.2.1 and summarized in Attachment B, indicate that a 3-inch thick layer of sand mixed with the underlying existing sediments is sufficient to limit PCB concentrations in the overlying bioturbation zone to less than 1 ppm once the near steady state conditions are achieved (which the transient model predicts would not occur for at least 900 years; see above). These results are summarized in Table D-23.

Bioturbation (T_b). The bioturbation zone for a cap in the Lower Fox River was predicted to be 4 inch-thick or less based on the guidance described for the preliminary cap design presented in Section D.2.1. This cap component thickness for bioturbation protection will be included as part of the erosion protection layer as discussed below.

Consolidation (T_c). As discussed in Section D.2.2, consolidation of the sand and gravel cap materials themselves would occur immediately (i.e. during construction). However, the underlying fine-grained sediments are expected to consolidate under the weight of the cap as discussed above.

Erosion Resistance (T_e). The grain size of the armor layer necessary to resist erosion is estimated to be a fine to coarse gravel with a median stone size (D_{50}) of approximately 1.5 inches based on the erosion analyses presented in Sections D.2.3 and D.4.1, which includes consideration of the following:

- Design hydrodynamic flow: 100-year recurrence interval with 4.33 foot (measured peak to trough) seiche);
- Wind-generated waves;
- Propeller-induced bottom velocity from passing vessels;
- Ice scour

The minimum required thickness of the gravel erosion layer is estimated to be approximately 3 inches (2 x D_{50}) in accordance with the Corps design guidance (Palermo et al 1998b). However, as discussed in Section D.2, the erosion protection layer will serve as both the physical isolation component and the bioturbation (T_b) component. Therefore, the layer would be 4 inches thick, corresponding to the required thickness to prevent bioturbating organism from reaching the underlying chemical isolation layer.

Operational Considerations (T_o). To account for inaccuracies during placement and potential mixing of the cap material with underlying sediments, an additional cap thickness component (T_o) has been added to the design to ensure that the entire capping area is covered by the minimum thickness required to meet the design objectives. As discussed in Section D.2.4, the over-placement amount is expected to vary between 0 to 6 inches per material type (sand and

gravel) with an average of less than 3 inches per material type (average 6 inches for a sand and gravel cap).

Total Cap Thickness (T). The total target cap thickness based on the component thicknesses outlined above and summarized in Table D-23 is 13 inches.

D.4.3.2 16-Inch Sand/Gravel Cap

Sand caps with gravel armor with a target thickness of 16 inches would be placed in areas where PCB concentrations of the upper 3 feet of sediment are between 10 and 50 ppm. In addition, areas identified for 16-inch caps would have a post-cap water depth of at least 3 feet to avoid ice scour, avoid undesirable shallow-water habitat, and allow recreational vessel traffic more than 99.9 percent of the boating season (see Section D.1..5).

Chemical Isolation (T_i). Chemical isolation modeling using the transient and steady state models discussed in Section D.2.1 and summarized in Attachment B, indicate that a 6-inch thick layer of sand, up to 3 inches of which could potentially mix with the underlying sediment, would be sufficient to limit PCB concentrations in the overlying bioturbation zone to less than 1 ppm once the near steady state conditions are achieved. It should be noted that the chemical isolation modeling of this cap conservatively assumes that the potential mixing zone (3 inches) does not provide any chemical isolation These results are summarized in Table D-23.

Bioturbation (T_b). The bioturbation zone for a cap in the Lower Fox River was predicted to be 4 inch-thick or less based on the guidance described for the preliminary cap design presented in Section D.2.1. This cap component thickness for bioturbation protection will be included as part of the erosion protection layer as discussed below.

Consolidation (T_c). As discussed in Section D.2.2, consolidation of the sand and gravel cap materials themselves would occur immediately (i.e. during construction). However, the underlying fine-grained sediments are expected to consolidate under the weight of the cap as discussed above.

Erosion Resistance (T_e). The grain size of the armor layer necessary to resist erosion is estimated to be a fine to coarse gravel with a median stone size (D_{50}) of approximately 1.5 inches based on the erosion analyses presented in Section D.2.3, which includes consideration of the following:

- Design hydrodynamic flow: 100-year recurrence interval with 4.33 foot (measured peak to trough) seiche);
- Wind-generated waves;
- Propeller-induced bottom velocity from passing vessels;
- Ice scour

The minimum required thickness for a gravel erosion layer with a median stone size of 1.5 inches is approximately 3 inches (2 x D_{50}) in accordance with the Corps design guidance (Palermo et al 1998b). However, as discussed above, the erosion protection layer will serve as both the physical isolation component and the bioturbation (T_b) component. Therefore, the layer would be 4 inches thick, corresponding to the required thickness to prevent bioturbating organism from reaching the underlying chemical isolation layer.

Operational Considerations (T_o). To account for inaccuracies during placement and potential mixing of the cap material with underlying sediments, an additional cap thickness component (T_o) has been added to the design to ensure that the entire capping area is covered by the minimum thickness required to meet the design objectives. As discussed in Section D.2.4, the over-placement amount is expected to vary between 0 to 6 inches per material type (sand and gravel) with an average of less than 3 inches per material type (average 6 inches for a sand and gravel cap).

Total Cap Thickness (T). The total target cap thickness based on the component thicknesses outlined above and summarized in Table D-23 is 16 inches.

D.4.3.3 33-Inch Sand/Quarry Spall Cap

Sand caps with quarry spall armor with a target thickness of 33 inches would be placed in limited areas of the river including the following:

- In the OU 4B federal navigation channel where propeller wash velocities could potentially be significant from the maneuvering of large, deep-draft cargo vessels.

- In areas where dredging could not be performed without adversely impacting the stability of the shoreline and remaining (subsurface) PCB concentrations in these areas may approach approximately 100 ppm. These areas are limited to two small shoreline sections near the former SMU 56/57 demonstration project.

Chemical Isolation (T_i). Chemical isolation modeling using the transient and steady state models discussed in Section D.2.1 and summarized in Attachment B, indicate that a 8-inch-thick layer of sand would provide chemical isolation to limit PCB concentrations in the overlying bioturbation zone to less than 1 ppm for underlying sediment with PCB concentrations up to 100 ppm. Furthermore, within the OU 4B navigation channel, where PCB concentrations are less than 50 ppm, but propwash is the significant erosive force, the 12 inches of sand will provide the necessary chemical isolation as well as bedding/filter layer to separate the overlying armor stone from the underlying fine-grained sediment. Similar to the cap designs presented above, it was assumed that up to 3 inches of the sand isolation layer would potentially mix with the underlying sediment and would not provide any chemical isolation (a conservative assumption).

Due to the possibility of relatively high propeller wash forces in the OU 4B channel, an 18-inch-thick layer of quarry spall armoring would be used in these areas. These results are summarized in Table D-23.

Bioturbation (T_b). The bioturbation zone for a cap in the Lower Fox River was predicted to be 4 inch-thick or less based on the guidance described for the preliminary cap design presented in Section D.2.1. This cap component thickness for bioturbation protection will be included as part of the erosion protection layer as discussed below.

Consolidation (T_c). As discussed in Section D.2.2, consolidation of the granular cap materials themselves would occur immediately (i.e. during construction).

However, the underlying fine-grained sediments are expected to consolidate under the weight of the cap.

Erosion Resistance (T_e). As discussed above, a larger armor stone is necessary for these caps to either resist the propwash of the large vessels operating in the OU 4 B navigation channel. The grain size of the armor layer would be quarry spalls with a stone size between 6 and 9 inches as discussed in Section D.2.3.

Operational Considerations (T_o). To account for inaccuracies during placement and potential mixing of the cap material with underlying sediments, an additional cap thickness component (T_o) has been added to the design to ensure that the entire capping area is covered by the minimum thickness required to meet the design objectives. As discussed in Section D.2.4, the over-placement amount is expected to vary between 0 to 6 inches for sand and gravel layers with an average of less than 3 inches per material type. For the quarry spall layer, the over-placement amount is expected to vary between 0 and 12 inches with an average of 6 inches.

Total Cap Thickness (T). The total target cap thickness based on the component thicknesses outlined above and summarized in Table D-23 is 33 inches.

D.4.3.4 6-Inch Sand Cover

In accordance with the ROD, 6-inch sand covers would be placed as a residuals management technique in areas where confirmatory samples indicated that surface concentrations exceed the 1 ppm RAL following dredging. In addition, 6-inch sand covers would be placed in areas where existing conditions are similar to that of post-dredge residuals, where contaminated sediments present a relatively low risk, generally defined for this purpose as those areas with a PCB mass per unit area of 3 grams/m^2 or less.

The results of the transient and steady state chemical isolation models discussed in Section D.2.1 indicate that a thin layer (less than 3 inches thick) of sand mixed with the relatively low concentration underlying sediments is sufficient to maintain chemical concentrations below the 1 ppm RAL in perpetuity within the surficial bioturbation zone (upper 10 cm). To ensure that a minimum of 3-inches

of material is placed, a target thickness of 6 inches would be specified for 6-inch covers.

Unlike the other cap designs presented above, the use of 6-inch sand covers will not be limited to areas with a post-remedy water depth of 3 feet. In addition, since the 3-inch zone of potential mixing provides the necessary protection 6-inch covers have not been designed to remain completely undisturbed in perpetuity. Furthermore, an erosion/bioturbation component is not included in the 6-inch cover design since it is not intended to be an engineered cap. However, similar to the engineered caps discussed above, an operational thickness averaging 3 inches was assumed for the 6-inch cover to ensure that the minimum 3 inches necessary for chemical isolation is placed.

Table D-23
Summary of Optimized Remedy Cap Component Thicknesses

Optimized Remedy Cap Description	Component Thickness (inches)				Total Cap Thickness (inches)		
	Chemical Isolation T_i [a]	Bioturbation/ Erosion T_e/T_b	Consolidation T_c	Operational T_o [b]	Minimum	Target	Maximum
13-inch Sand/Gravel Cap	3	4	0	0 to 12 (avg. 6)	7	13	19
16-inch Sand/Gravel Cap	6	4	0	0 to 12 (avg. 6)	10	16	22
33-inch Sand/Quarry Spall Cap	12 [c]	12	0	0 to 18 (avg. 9)	24	33	42

a. Includes 3 inches of potential mixing with existing underlying sediment
b. Includes over-placement allowance with each layer (sand and gravel)
c. The isolation thickness in this case is determined by the necessary thickness of the filter layer to support overlying quarry spall materials; only an 8-inch chemical isolation thickness is needed to provide permanent containment of underlying PCB concentrations up to 100 ppm (see text).

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List of Attachments

Attachment A	Baseline Water Evaluation Memo 6-15-05
Attachment B	Chemical Isolation Calculation Sheets Lower Fox River – Reible Steady State Model 7-5-05 Lower Fox River – Transient Model OU4-5 5-4-05
Attachment C	Final Hydrodynamic Design Memo Hydrodynamic Flow Calculation Sheets Lower Fox River – Hydrodynamic Report Final OU3 Lower Fox River – Hydrodynamic Report Final OU4 Uncertainty Memo-SEI Hydrodynamic Model Support
Attachment D	Lower Fox River Ice Memo 2-01-06 Ice Scour Report 7-11-05
Attachment E	Windwave Model 2-18-05 Windwave Model 8-02-05
Attachment F	Prop Wash Calculation Sheets Prop Wash Field Study Report-Moving Vessel Preliminary Moving Vessel Current Data and Plots (Attachment B of 12-06-05 Memo)

APPENDIX D – ATTACHMENT A

Attachment A –

Baseline Water Evaluation Memo 6-15-05

Memorandum

To: Jim Hahnenberg (EPA)
Greg Hill, Jim Killian (WDNR)

From: Paul LaRosa, Clay Patmont, John Laplante, John Verduin (Anchor)
John Wolfe (LTI)
George Hicks (Shaw)

cc: Paul Montney, Chip Hilarides, Richard Moser, Al Toma (Georgia Pacific)
Roger McCready (NCR)
John Heyde (Sidley)
Steve Jawetz (Beveridge and Diamond)
Steve Jaeger (WDNR)
Rich Johnson (Boldt)
Rick Fox, Rich Weber (NRT)

Date: June 15, 2005

Re: Baseline Water Elevation for Contingent Remedy Evaluations

1 INTRODUCTION

As defined in Sections 10.1 and 13.4 of the Record of Decision (ROD) for Operable Units (OUs) 2 through 5 of the Lower Fox River (WDNR and EPA 2003), in situ capping associated with application of the Contingent Remedy will not be performed "in shallow-water areas (bottom elevations that would result in a cap surface at elevation greater than -3 feet chart datum) without prior dredging to allow for cap placement." As discussed in Contingent Remedy Workgroup meetings, the minimum required water depth of 3 feet was selected by WDNR and EPA in consideration of the following general factors:

- To prevent damage to an in situ cap from ice scour and wind/wave forces
- To allow recreational vessel traffic
- To discourage the promotion of undesirable fish (e.g., carp) habitat

The ROD did not specifically address the baseline water elevation for determining post-construction water depths. This memorandum presents the basis for selecting the baseline

elevation for OUs 2, 3, and 4 to be used in design evaluations of the Contingent Remedy and the Optimized Contingent Remedy.

There are two design components to the water depth criterion that will need to be considered in the evaluation of the Contingent Remedy including:

1. A design component to ensure long-term cap stability under a range of potential erosion forces, as discussed in more detail in the Contingent Remedy Evaluation Memorandum; and
2. A "beneficial use" component that addresses potential shallowing of water depths with respect to navigation requirements, as well as changes in habitat function elements. Note that evaluations of potential beneficial use "impacts" associated with capping will also consider net changes in elevations within Operable Units, relative to existing conditions. These evaluations will be discussed in more detail in the Basis of Design Report.

2 OU 2

The baseline water elevation to be used in the Contingent Remedy evaluations will be the NOAA low water datum of 593.5 International Great Lakes Datum 1985 (IGLD 85) (Dynamic Height with no hydraulic corrector) above the Little Kaukauna Dam separating OUs 2 and 3 (NOAA 2002).

3 OU 3

The baseline water elevation to be used for OU 3 capping evaluations was based on a review of key characteristics of the DePere Dam. This included the crest of the DePere Dam (587.31 feet [IGLD 85]) as shown on construction drawings (Corps 1972). The crest elevation also approximately corresponds with the NOAA low water datum of 587.4 feet (IGLD 85). The DePere dam crest elevation shown on the 1972 construction drawings was confirmed through comparison of recent conditions surveys of the dam (Corps 1999). For the purposes of the Contingent Remedy design evaluations, a reference low water surface elevation of 587.3 feet (IGLD 85) will be used.

4 OU 4

As discussed above, the ROD did not specifically address the baseline water elevation for determining post-construction water depths. Therefore, WDNR and EPA initially clarified that the reference elevation/datum to be used for the Contingent Remedy design evaluations in OU 4 would be the IGLD 1985 low water datum for Green Bay, which is defined by National Oceanic and Atmospheric Administration (NOAA) as 577.5 feet (WDNR 2004; NOAA 2002). However, a review of the historical stage data for Green Bay (NOAA gaging stations 9087078 and 9087079) revealed that water elevations below the NOAA low water datum (577.5 ft IGLD 85) have been periodically observed since 1953 (the period of available data). In consideration of this information, the Contingent Remedy Workgroup recommended that a more thorough review of available stage data was warranted prior to setting a reference low water surface elevation for cap design evaluation purposes, particularly relative to the beneficial use component.

The available stage data from the NOAA Green Bay stations include the following:

- Monthly minimum, maximum, and mean water elevation: 1953-Present
- Daily mean water elevation: 1970-Present
- Hourly water elevation: 1970-Present
- Six-minute water elevations: 1997-Present

Given the frequency and duration of seiche events in Green Bay and OU 4 of the Fox River (period of approximately 11 hours), the 6-minute and hourly data captures water level minima caused by these seiche events. However, these minima are not as apparent in the daily and monthly mean data due to the averaging over multiple seiche periods (Figure 1). On the other end of the timescale, the six-minute water elevation data were limited because they do not exist for the period before 1997. Therefore, the analysis of an appropriate low-water datum focused on the daily, hourly, and six-minute water elevation data.

4.1 Hydraulic Correction of IGLD 85 Vertical Datum

Previous discussions of a low-water datum for OU4 have focused on the NOAA IGLD 85 vertical datum. The water elevation data reported for the NOAA station in Green Bay is referenced to this IGLD 85 vertical datum with a hydraulic corrector of 0.374 feet applied to the dynamic height, in accordance with paragraph 36 of "Establishment of International

Great Lakes Datum (1985)" (The Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, 1995). Equation 1 and Table 1 below provide the relationship between the dynamic height and IGLD 85:

Dynamic Height – Hydraulic Corrector (0.374 ft) = IGLD 85 (Equation1)

Table 1 - Conversion from IGLD 85 to NAVD 88

Designation	North Latitude	West Longitude	Gravity NAVD 88 Height		Dynamic Height	IGLD 85 Height	Hydraulic Corrector
			(gals)	(meters)	(meters)	(meters)	(meters)
NOAA Low Water	44 35 8.10000	87 59 38.90000	980.49770	176.1565	176.1359	176.0220	0.114

However, by definition in paragraph 39 of the referenced document: "The water surfaces of all connecting channels and other rivers on the Great Lakes are considered to be sloping surfaces. Therefore, their Hydraulic Corrector is zero." So for the Fox River, the hydraulic corrector is zero by definition, regardless of hydraulic effects of the adjacent water bodies on the water surface elevations. Therefore the Fox River elevation data is simply the "dynamic height".

Since the project datum for the Fox River has been set as IGLD 85 <u>without</u> the hydraulic corrector (i.e., "dynamic height"), the NOAA gaging station data must be adjusted by removing the hydraulic corrector. In other words, for the purpose of the OU 4 cap design evaluation, all of the NOAA gaging station data were increased by 0.114 meters (0.347 feet) for comparison with river elevation data.

4.2 Beneficial Use Component

The beneficial use component of the water depth criterion relates post-cap water depths to navigation requirements, as well as to changes in habitat function elements. Included in the beneficial use evaluation is a consideration of short-term water level fluctuations resulting from seiche events, which are monitored in the hourly water level measurement record. While 6-minute water elevation data are also available, it should be noted that these data are much less extensive than the hourly dataset. The Design Team evaluated the use of 6-minute data and determined that its use would not significantly increase the resolution of

the dataset, but would dramatically complicate the computational procedure. Therefore, the hourly data set was selected for use in the design evaluation.

Figure 2 presents the frequency distribution of available hourly measurements of water elevation from the Green Bay NOAA station between 1970 and 2005. Prior to 1970 only measurements of the monthly mean water elevation were reported at the Green Bay station. Therefore, this record of hourly measurement data does not include the extended period of relatively low water between late 1963 and early 1965. To account for this period of low water, the cumulative frequency distribution of hourly measurements for 1970 to 2005 was adjusted based on a comparison between the 1953 to 2005 and 1970 to 2005 cumulative frequency distributions of the monthly mean measurements, as presented in Figure 1. This comparison indicates that there is a difference of approximately 0.65 feet at the 1 percent frequency between the two data sets of monthly means (Table 2).

Table 2 – Summary of Cumulative Frequency Distributions for Monthly Data
(all elevation data in feet IGLD 85)

Frequency	Elev. with Hydraulic Corrector (0.114 m)		Delta: (1970 to 2005) - (1953 to 2005)
	1953 to 2005	1970 to 2005	
1%	576.08	576.73	0.65

Using this comparison, and for a conservative 1 percent frequency event (see below), the period of record of the hourly data (1970 to 2005) can be extrapolated to include the data between 1953 and 1970 by applying a difference of 0.65 feet to the hourly water elevation data from 1970-2005.

Since the beneficial use component of water elevation is generally related to public use of the river, it is appropriate to evaluate the historical data on a seasonal basis. The Fox River typically freezes over between December and February such that navigation depth requirements are not applicable during this period. Conversely, the river is used extensively by watercraft during the remainder of the year (March through November).

Figure 2 shows the distribution of the vertical elevation data (1970-2005), stratified into March-November and December-February. In particular, Figure 2 shows that the March-November elevation is below 577.15 feet (dynamic height) only one percent of the time. This represents a conservative low-water elevation. As described above, this elevation was

then extrapolated to reflect 1953-1970 data by subtracting 0.65 feet. This extrapolation results in a design baseline water elevation for OU 4 of the Lower Fox River of 576.5 feet (dynamic height). Note that this elevation occurs approximately 1 percent of the seasonal time period in which boating may occur (9 months). That is, the OU 4 water surface elevation is greater than 576.5 feet (dynamic height) for more than 99 percent of the boating season.

5 SUMMARY

Table 3 summarizes the baseline water elevations selected for use in the Contingent Remedy design evaluation, based on the findings presented in this memorandum. Consistent with the ROD, an exclusionary criterion will be applied for the Contingent Remedy such that capping is not considered in areas in which the bottom elevation is less than three feet below the baseline water elevation for the applicable OU. (The ROD stated that, in OU 4 only, a four-foot depth below the IGLD 85 low-water datum should be applied to account for potential long-term changes in water level. The analysis in this memorandum explicitly considers the extent of those potential drops in water level and, based on these results, Respondents will design the Contingent Remedy to leave a three-foot depth below the baseline water elevation to the top of the cap, as stated in Table 3.) As discussed above, evaluations of potential beneficial use "impacts" associated with capping will also consider net changes in elevations within Operable Units, relative to existing conditions. These evaluations will be discussed in more detail in the Basis of Design Report.

Table 3 – Summary Baseline Water Elevations

Operable Unit	Baseline Water Elevation Dynamic Height (IGLD85 w/o Hydr. Corr.)	Basis for Selection
OU 2	593.5 feet	NOAA Low Water Datum above Little Kaukauna Dam
OU 3	587.3 feet	Crest of DePere Dam (and NOAA Low Water Datum)
OU 4 (Beneficial Use Evaluations)	576.5 feet	Lower 1% occurrence frequency of hourly data from NOAA gage at Green Bay (adjusted for long-term data record through 1953)

6 REFERENCES

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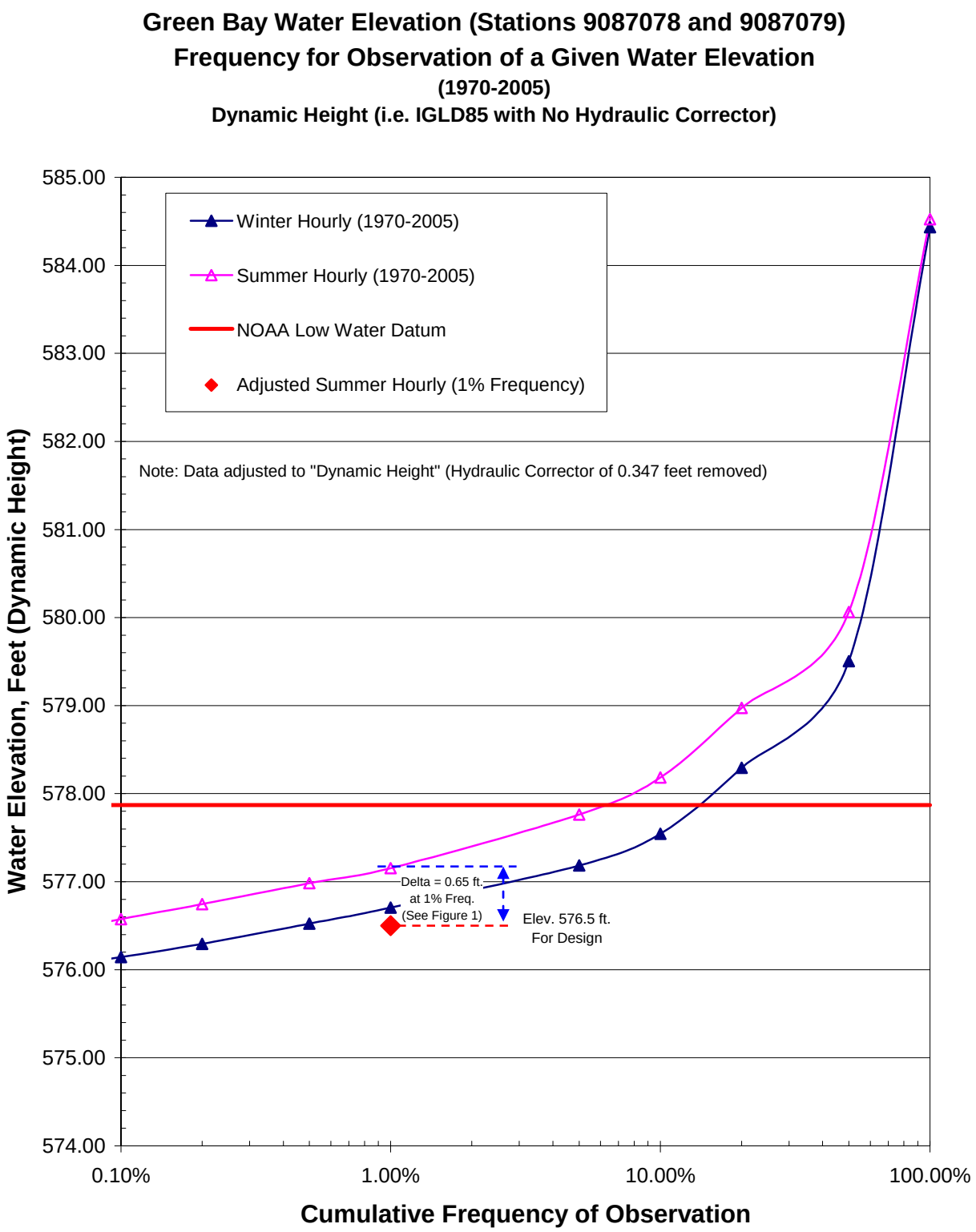

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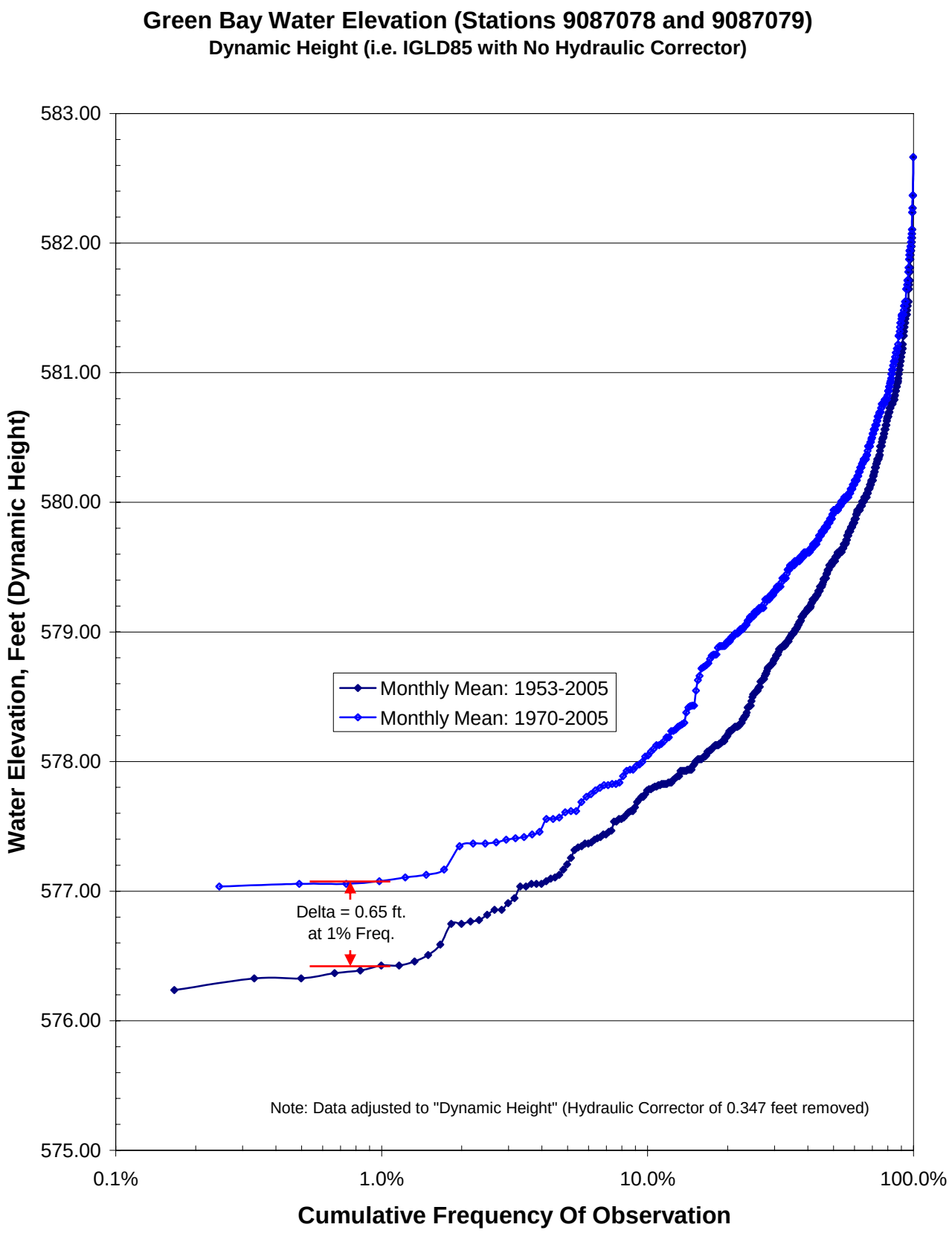
Figure 2
Green Bay Water Levels - Hourly Frequency Distribution
Lower Fox River



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Green Bay Water Levels - Monthly Frequency Distribution
Lower Fox River

APPENDIX D – ATTACHMENT B

Attachment B –

Chemical Isolation Calculation Sheets

Attachment B – Chemical Isolation Calculation Sheets

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	**CALC NO.**	**SHEET** 1 of 6
SUBJECT: Chemical Isolation of Contaminants and Bioturbation		

Purpose: To determine cap thickness requirements necessary for chemical containment and bioturbation.

Reference: *Guidance for In situ Subaqueous Capping of Contaminated Sediment*, Appendix B: Model for Chemical Containment by a Cap by D. Rieble et al., Louisiana State University, Baton Rouge, Louisiana

Given: Governing Equations for Cap Chemical Isolation Steady State Model

Predicted Porewater Concentration in the Bioturbation Layer

$$C_{bio} = Flux\left[\frac{1}{k_{bio}R_f + U} + \frac{1}{k_{bl} + U}\right]$$

Solid Concentration in the Bioturbation Layer

$$W_{bio} = K_d C_{bio}$$

INITIAL CAP DESIGN

Input Parameters for Cap Chemical Isolation Steady State Model

C_{bio}	=	porewater concentration in bioturbation layer		[mg/L]
L_{eff}	=	effective cap thickness for isolation layer	8	[cm]
K_{oc}	=	organic partitioning coefficient (most conservative value from PCLT and RI/FS)	500,000	[L/kg OC]
f_{oc}	=	cap fraction Total Organic Carbon (TOC) content of cap material (typical value for quarry sand)	0.001	[-]

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE

$f_{oc(biolater)}$	=	fraction TOC of bioturbation layer (Monte Carlo analysis for 0.1-22% TOC from site data)	0.01 - 0.22	[-]
K_d	=	cap adsorption distribution coefficient, $K_d = K_{oc}*f_{oc}$	500	[L/kg]
$k_{bio(particle)}$	=	bioturbation mixing coefficient for particle (Toms 1995)	1	[cm/yr]
$k_{bio(water)}$		bioturbation mixing coefficient for water (Toms 1995)	100	[cm/yr]
k_{bl}	=	benthic boundary layer coefficient (Thibodeaux et al. 2001)	1	[cm/hr]
R_f	=	retardation factor, $Rf = ((P_b * K_d)/ Ø)+1$ (Eq. B3 of Palermo et al. 1998b)	1876	[-]
P_b	=	bulk sediment density of cap sediments, $P_b = (1-Ø)*SG$	1.5	[g/cm^3]
Ø	=	porosity of cap sediments (typical value for placed sand)	0.4	[-]
SG	=	specific gravity of particles of cap sand	2.5	[g/cm^3]
U	=	Darcy velocity, U = ki	0.01 - 5.07	[cm/yr]
k	=	hydraulic conductivity (average post cap value from seepage induced consolidation tests on OU 3 samples)	23.1	[cm/yr]
i	=	hydraulic gradient (Monte Carlo analysis from regional values)	0 - 0.22	[ft/ft]
v	=	cap seepage induced velocity, $v = U/Ø$	0.02 - 12.7	[cm/yr]
D_o	=	molecular diffusion of chemical in water (value shown max. of RAIS database and DiToro 2001)	190	[cm^2/yr]
D	=	diffusion/dispersion combined coefficient, $D = (a*v)+(Do/Ø^{-1/3})$	140 - 150	[cm^2/yr]
C_o	=	porewater concurrent of underlying sediments (max calculated value in OUs 3 and 4)	1.12E-0.3	[mg/L]
W_{bio}	=	solid concentration in bioturbation layer		[mg/kg]

Governing Equation for Cap Chemical Isolation Transient Model

Predicted Penetration of Contaminant into the Cap and Breakthrough Time (time to steady state)

$$C_{pw}(L_{eff},t) = \frac{C_o}{2}\left[erfc\left(\frac{R_f L_{eff} - Ut}{2\sqrt{R_f Dt}}\right) + \exp\left(\frac{UL_{eff}}{D}\right) erfc\left(\frac{R_f L_{eff} + Ut}{2\sqrt{R_f Dt}}\right)\right]$$

DESIGNER: C. Stivers **DATE:** 8-8-05 **CALC. NO.:** _____ **REV.NO.:** _____

CHECKED BY: CRP **CHECKED DATE:** 8-8-05

PROJECT: Lower Fox River Remedial Design

SUBJECT:

Input Parameters for Cap Chemical Isolation Transient Model

C_{pw}	=	contaminant concentration in the porewater		[mg/L]
L_{eff}	=	effective cap thickness for isolation layer	8	[cm]
K_{oc}	=	organic partitioning coefficient (most conservative value from PCLT and RI/FS)	500,000	[L/kg OC]
f_{oc}	=	cap fraction Total Organic Carbon (TOC) content of cap material (typical value for quarry sand)	0.001	[-]
$f_{oc(biolater)}$	=	fraction TOC of bioturbation layer (Monte Carlo analysis for 0.1-22% TOC from site data)	0.01 - 0.22	[-]
K_d	=	cap adsorption distribution coefficient, $K_d = K_{oc}*f_{oc}$	500	[L/kg]
$k_{bio(particle)}$	=	bioturbation mixing coefficient for particle (Toms 1995)	1	[cm/yr]
$k_{bio(water)}$		bioturbation mixing coefficient for water (Toms 1995)	100	[cm/yr]
k_{bl}	=	benthic boundary layer coefficient (Thibodeaux et al. 2001)	1	[cm/hr]
R_f	=	retardation factor, $Rf = ((P_b * K_d)/ Ø)+1$	750	[-]
a	=	dispersivity, 10% of L_{eff}	0.8	[cm]
P_b	=	bulk sediment density of cap sediments, $P_b = (1-Ø)*SG$	1.5	[g/cm^3]
Øc	=	porosity of cap sediments (typical value for placed sand)	0.4	[-]
Øs	=	porosity of underlying sediments (calculated from average water contents and post cap consolidation)	0.78	[-]
SG	=	specific gravity of particles of cap sand	2.5	[g/cm^3]
k	=	hydraulic conductivity (average post cap value from seepage induced consolidation tests on OU 3 samples)	23.1	[cm/yr]
i	=	hydraulic gradient (max of regional values)	0.22	[ft/ft]
v	=	sediment seepage velocity, v = ki/Øs	0.02 - 12.7	[cm/yr]
D_o	=	molecular diffusion of chemical in water (value shown max. of RAIS database and DiToro 2001)	190	[cm^2/yr]
D_{eff}	=	effective diffusion through cap	56	[cm^2/yr]
D	=	diffusion/dispersion combined coefficient, $D = a*U+D_{eff}$	61	[cm^2/yr]
C_o	=	porewater concurrent of underlying sediments (max calculated value in OUs 3 and 4)	1.12E-0.3	[mg/L]
t	=	time to steady state	10 - 920	[yrs]

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				REV.NO.:	
PROJECT:	Lower Fox River Remedial Design	CHECKED BY:	CRP	CHECKED DATE:	8-8-05
SUBJECT:					

Initial Cap Design Results:

Transient Model:

L_{eff}	chemical isolation component cap thickness	8	[cm]
	existing sediment concentration	49	[mg/kg]
t	time to achieve near steady state contaminant flux through chemical isolation component of cap	920	[yrs]
C_{pw}	contaminant concentration in the porewater	8.12E-04	[mg/L]

Steady State Model:

L_{eff}	chemical isolation component cap thickness	8	[cm]
C_{bio}	sediment PCB concentration in bioturbation layer at steady state	< 1	[mg/kg]
	probability of maintaining < 1 ppm in bioturbation layer (in perpetuity)	99	[%]

OPTIMIZED REMEDY CAP DESIGNS

Input Parameters for Cap Chemical Isolation Steady State Model

		16-Inch Sand/Gravel Caps	33-Inch Sand/Quarry Spall Caps	
L_{eff}	=	8	15	[cm]
K_{oc}	=	500,000	500,000	[L/kg OC]
f_{oc}	=	0.001	0.001	[-]
$f_{oc(biolater)}$	=	0.01 - 0.22	0.01 - 0.22	[-]
K_d	=	500	500	[L/kg]
$k_{bio(particle)}$	=	1	1	[cm/yr]
$k_{bio(water)}$		100	100	[cm/yr]
k_{bl}	=	1	1	[cm/hr]
R_f	=	1876	1876	[-]
P_b	=	1.5	1.5	[g/cm^3]
Ø	=	0.4	0.4	[-]
SG	=	2.5	2.5	[g/cm^3]

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PROJECT: Lower Fox River Remedial Design **CHECKED BY:** CRP **CHECKED DATE:** 8-8-05

SUBJECT: _____

U	=	0.01 - 5.07	0.01 - 5.07	[cm/yr]
k	=	23.1	23.1	[cm/yr]
i	=	0 - 0.22	0 - 0.22	[ft/ft]
v	=	0.02 – 12.7	0.02 – 12.7	[cm/yr]
D_o	=	190	190	[cm²/yr]
D	=	140 - 150	140 - 150	[cm²/yr]
C_o	=	1.12E-0.3	1.12E-0.3	[mg/L]

Input Parameters for Cap Chemical Isolation Transient Model

		16-Inch Sand/Gravel Caps	**33-Inch Sand/Quarry Spall Caps**	
L_{eff}	=	8	15	[cm]
K_{oc}	=	500,000	500,000	[L/kg OC]
f_{oc}	=	0.001	0.001	[-]
$f_{oc(biolater)}$	=	0.01 - 0.22	0.01 - 0.22	[-]
K_d	=	500	500	[L/kg]
$k_{bio(particle)}$	=			[cm/yr]
		1	1	
$k_{bio(water)}$		100	100	[cm/yr]
k_{bl}	=	1	1	[cm/hr]
R_f	=	750	750	[-]
a	=	0.8	0.8	[cm]
P_b	=	1.5	1.5	[g/cm³]
Øc	=	0.4	0.4	[-]
Øs	=	0.78	0.78	[-]
SG	=	2.5	2.5	[g/cm³]
k	=	23.1	23.1	[cm/yr]
i	=	0.22	0.22	[ft/ft]
v	=	0.02 – 12.7	0.02 – 12.7	[cm/yr]

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CHECKED BY: CRP **CHECKED DATE:** 8-8-05

PROJECT: Lower Fox River Remedial Design

SUBJECT:

D_o	=	190	190	[cm²/yr]
D_{eff}	=	56	56	[cm²/yr]
D	=	61	61	[cm²/yr]

Optimized Remedy Cap Designs Results:

Cap Description	Chemical Isolation Component Thickness [inches]	Time to Reach Steady State [years]	Probability of Maintaining <1 ppm in Bioturbation Layer (in perpetuity)
16-inch Sand/Gravel Cap with 50 ppm underlying PCB concentration	6 inches sand (incl. 3 in. sand mixed with underlying sediment)	288	99%
33-inch Sand/Quarry Spall Cap with 100 ppm underlying PCB concentration	9 inches sand (inc. 3 in. sand mixed with underlying sediment)	1102	99%

Attachment B -

Lower Fox River – Reible Steady State Model 7-05-05

Lower Fox River
Remedial Design
Chemical Isolation Component Steady State Cap Model

OU3/OU4

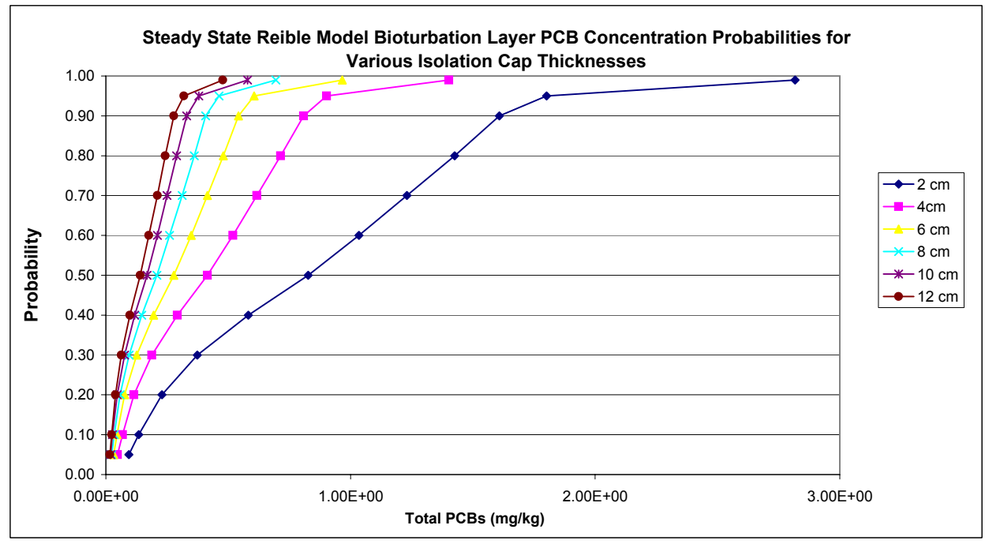
kbio (particle) cm/yr	1
kbl cm/hr	1
kbio (water) cm/yr	100

Variable	ρ_b	ε or (n)	v	U	C_o	a	Vb	Dw	Hp	D'	foc	Koc	K_d	L_{eff}	R_f	t_{50}	λ	u	SS Rxn	Peclet Number	Approximate Time to Steady Conditions	foc (bio layer)	Maximum of Diffusive or Advective Flux	Reactive Flux	Sediment Concentration (C_{bio}) at Steady State
				Variable										Variable								Variable			
	Bulk density of cap material (1-ε)*ρs	Porosity	Pore water Velocity (U/ε)	Darcy Velocity (or v*ε)	Initial pore water concentration	Dispersivity (10% L_{eff})	Organic Compd LeBas Molar Volume	Molecular diffusion coefficient	Hindrance Parameter ($\varepsilon^{-1/3}$)	Diffusion/dispersion coefficient	Fraction of organic carbon in cap material	Organic carbon partition coeff for organics	Observed partition coefficient for CB (organics=foc*Koc)	Effective Chemical Isolation Layer Thickness	Retardation Factor 1+(ρ_b*K_d/ε)	Half Life	Reaction Term (=ln2/t_{50})	$\sqrt{v^2+4\lambda D}$				Fraction of organic carbon in bioturbation layer (sensitivity analysis)			
	g/cm^3		cm/yr	cm/yr	mg/L		cm3/mol	cm^2/yr		cm^2/yr		mL/g	L/kg	cm		day	yr^{-1}		/cm		years		mg/cm2/yr	mg/cm2/yr	mg/kg
							Est.																		
PCB's	1.50	0.4	0.1	0.02	1.12E-03	0.8000	250	1.90E+02	1.4	140	0.1%	500,000	500	8	1876	0	0.0	0.1	0	0.0	320.6	0.020	7.84E-06	NC	0.1011
PCB's	1.50	0.4	0.1	0.02	1.12E-03	0.8000	250	1.90E+02	1.4	140	0.1%	500,000	500	8	1876	0	0.0	0.1	0	0.0	320.6	0.100	7.84E-06	NC	0.51
PCB's	1.50	0.4	12.5	5.0	1.12E-03	0.8000	250	1.90E+02	1.4	150	0.1%	500,000	500	8	1876	0	0.0	12.5	0	0.7	299.3	0.020	8.40E-06	NC	0.11
PCB's	1.50	0.4	12.5	5.0	1.12E-03	0.8000	250	1.90E+02	1.4	150	0.1%	500,000	500	8	1876	0	0.0	12.5	0	0.7	299.3	0.100	8.40E-06	NC	0.54
PCB's	1.50	0.4	31.8	12.7	1.12E-03	0.8000	250	1.90E+02	1.4	165	0.1%	500,000	500	8	1876	0	0.0	31.8	0	1.5	472.7	0.020	1.42E-05	NC	0.18
PCB's	1.50	0.4	31.8	12.7	1.12E-03	0.8000	250	1.90E+02	1.4	165	0.1%	500,000	500	8	1876	0	0.0	31.8	0	1.5	472.7	0.100	1.42E-05	NC	0.91

0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.95	0.99
C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile	C_{bio} Percentile

Non-Formula Copied Values

9.42E-02	1.34E-01	2.29E-01	3.74E-01	5.82E-01	8.27E-01	1.03E+00	1.23E+00	1.43E+00	1.61E+00	1.80E+00	2.82E+00
4.80E-02	6.79E-02	1.15E-01	1.88E-01	2.92E-01	4.15E-01	5.20E-01	6.17E-01	7.15E-01	8.09E-01	9.02E-01	1.40E+00
3.18E-02	4.53E-02	7.65E-02	1.25E-01	1.95E-01	2.78E-01	3.49E-01	4.15E-01	4.80E-01	5.42E-01	6.06E-01	9.66E-01
2.40E-02	3.39E-02	5.80E-02	9.46E-02	1.47E-01	2.08E-01	2.61E-01	3.12E-01	3.61E-01	4.08E-01	4.63E-01	6.95E-01
1.92E-02	2.72E-02	4.64E-02	7.60E-02	1.18E-01	1.68E-01	2.10E-01	2.50E-01	2.89E-01	3.30E-01	3.80E-01	5.79E-01
1.63E-02	2.33E-02	3.94E-02	6.31E-02	9.77E-02	1.40E-01	1.75E-01	2.10E-01	2.42E-01	2.77E-01	3.19E-01	4.78E-01



Attachment B -

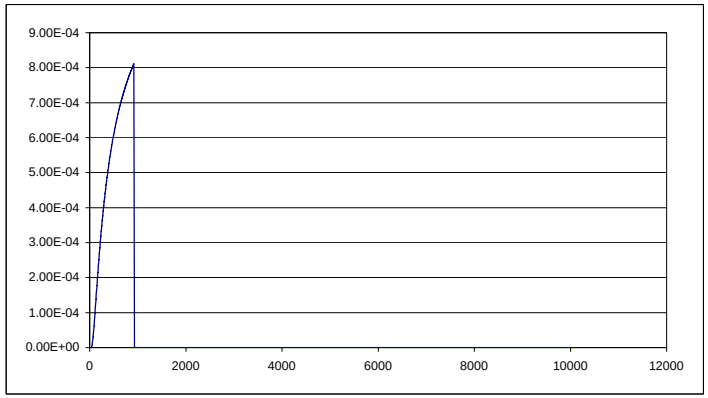
Lower Fox River – Transient Model OU4 5-04-05

Lower Fox River
Remedial Design
Chemical Isolation Component Transient Cap Model

Inputs **PCBs**

Symbol	Value	Units	Comments	
ø	0.4	unitless	See Table H-4	
SG	2.5	g/cm3	See Table H-4	
P_b	1.50	g/cm3	See Table H-4	
K_{oc}	500,000	L/kgOC	See Table H-4	
f_{oc}	0.001	fraction	See Table H-4	
K_d	500	L/kg	See Table H-4	
R_f	750	unitless	See Table H-4	
L_{eff}	8	cm	See Table H-4	
v	6.5	cm/yr	See Table H-4	
D_o	190	cm2/yr	See Table H-4	
D_{eff}	56	cm2/yr	See Table H-4	
D	61	cm2/yr	See Table H-4	
C_o	1.121E-03	mg/L	See Table H-4	
TS	10	years	See Table H-4	
Criteria	1.7E-07	mg/L	See Table H-4	
Sol	0.27	mg/L	Solubility maximum for comparative purposes (from RAIS for Aroclor 1242)	

Solubility Max	0.27	mg/L	using Aroclor 1016 only from RAIS
	0.277	mg/L	using Aroclor 1242 only from RAIS



Model Calculation and Results

Years Time (t)	Fac1	EF	Fac2	Comb	mg/L Conc. (Cpw)
10	5.78E-10	2.34E+00	2.42E-10	1.14E-09	6.42E-13
20	1.47E-05	2.34E+00	6.03E-06	2.88E-05	1.61E-08
30	4.67E-04	2.34E+00	1.88E-04	9.08E-04	5.09E-07
40	2.73E-03	2.34E+00	1.08E-03	5.27E-03	2.95E-06
50	8.06E-03	2.34E+00	3.15E-03	1.54E-02	8.64E-06
60	1.68E-02	2.34E+00	6.46E-03	3.19E-02	1.79E-05
70	2.87E-02	2.34E+00	1.09E-02	5.41E-02	3.03E-05
80	4.31E-02	2.34E+00	1.61E-02	8.08E-02	4.53E-05
90	5.95E-02	2.34E+00	2.19E-02	1.11E-01	6.21E-05
100	7.73E-02	2.34E+00	2.81E-02	1.43E-01	8.02E-05
110	9.62E-02	2.34E+00	3.45E-02	1.77E-01	9.92E-05
120	1.16E-01	2.34E+00	4.10E-02	2.12E-01	1.19E-04
130	1.35E-01	2.34E+00	4.75E-02	2.47E-01	1.38E-04
140	1.56E-01	2.34E+00	5.39E-02	2.81E-01	1.58E-04
150	1.76E-01	2.34E+00	6.01E-02	3.16E-01	1.77E-04
160	1.95E-01	2.34E+00	6.62E-02	3.50E-01	1.96E-04
170	2.15E-01	2.34E+00	7.20E-02	3.84E-01	2.15E-04
180	2.35E-01	2.34E+00	7.77E-02	4.16E-01	2.33E-04
190	2.54E-01	2.34E+00	8.31E-02	4.48E-01	2.51E-04
200	2.72E-01	2.34E+00	8.84E-02	4.79E-01	2.69E-04
210	2.91E-01	2.34E+00	9.34E-02	5.09E-01	2.86E-04
220	3.09E-01	2.34E+00	9.82E-02	5.39E-01	3.02E-04
230	3.27E-01	2.34E+00	1.03E-01	5.67E-01	3.18E-04
240	3.44E-01	2.34E+00	1.07E-01	5.95E-01	3.33E-04
250	3.61E-01	2.34E+00	1.11E-01	6.21E-01	3.48E-04
260	3.77E-01	2.34E+00	1.15E-01	6.47E-01	3.63E-04
270	3.94E-01	2.34E+00	1.19E-01	6.73E-01	3.77E-04
280	4.09E-01	2.34E+00	1.23E-01	6.97E-01	3.91E-04
290	4.25E-01	2.34E+00	1.26E-01	7.21E-01	4.04E-04
300	4.40E-01	2.34E+00	1.30E-01	7.43E-01	4.17E-04
310	4.55E-01	2.34E+00	1.33E-01	7.66E-01	4.29E-04
320	4.69E-01	2.34E+00	1.36E-01	7.87E-01	4.41E-04

Model Calculation and Results

Years Time (t)	Fac1	EF	Fac2	Comb	mg/L Conc. (Cpw)
330	4.83E-01	2.34E+00	1.39E-01	8.08E-01	4.53E-04
340	4.97E-01	2.34E+00	1.42E-01	8.29E-01	4.64E-04
350	5.11E-01	2.34E+00	1.44E-01	8.48E-01	4.75E-04
360	5.24E-01	2.34E+00	1.47E-01	8.67E-01	4.86E-04
370	5.37E-01	2.34E+00	1.49E-01	8.86E-01	4.97E-04
380	5.50E-01	2.34E+00	1.51E-01	9.04E-01	5.07E-04
390	5.62E-01	2.34E+00	1.54E-01	9.22E-01	5.17E-04
400	5.74E-01	2.34E+00	1.56E-01	9.39E-01	5.26E-04
410	5.86E-01	2.34E+00	1.58E-01	9.55E-01	5.36E-04
420	5.98E-01	2.34E+00	1.60E-01	9.72E-01	5.45E-04
430	6.10E-01	2.34E+00	1.62E-01	9.87E-01	5.53E-04
440	6.21E-01	2.34E+00	1.63E-01	1.00E+00	5.62E-04
450	6.32E-01	2.34E+00	1.65E-01	1.02E+00	5.70E-04
460	6.43E-01	2.34E+00	1.66E-01	1.03E+00	5.79E-04
470	6.54E-01	2.34E+00	1.68E-01	1.05E+00	5.87E-04
480	6.64E-01	2.34E+00	1.69E-01	1.06E+00	5.94E-04
490	6.74E-01	2.34E+00	1.71E-01	1.07E+00	6.02E-04
500	6.85E-01	2.34E+00	1.72E-01	1.09E+00	6.09E-04
510	6.94E-01	2.34E+00	1.73E-01	1.10E+00	6.17E-04
520	7.04E-01	2.34E+00	1.75E-01	1.11E+00	6.24E-04
530	7.14E-01	2.34E+00	1.76E-01	1.12E+00	6.30E-04
540	7.23E-01	2.34E+00	1.77E-01	1.14E+00	6.37E-04
550	7.33E-01	2.34E+00	1.78E-01	1.15E+00	6.44E-04
560	7.42E-01	2.34E+00	1.79E-01	1.16E+00	6.50E-04
570	7.51E-01	2.34E+00	1.80E-01	1.17E+00	6.56E-04
580	7.60E-01	2.34E+00	1.81E-01	1.18E+00	6.62E-04
590	7.68E-01	2.34E+00	1.81E-01	1.19E+00	6.68E-04
600	7.77E-01	2.34E+00	1.82E-01	1.20E+00	6.74E-04
610	7.85E-01	2.34E+00	1.83E-01	1.21E+00	6.80E-04
620	7.94E-01	2.34E+00	1.84E-01	1.22E+00	6.86E-04
630	8.02E-01	2.34E+00	1.84E-01	1.23E+00	6.91E-04
640	8.10E-01	2.34E+00	1.85E-01	1.24E+00	6.97E-04
650	8.18E-01	2.34E+00	1.86E-01	1.25E+00	7.02E-04
660	8.26E-01	2.34E+00	1.86E-01	1.26E+00	7.07E-04
670	8.34E-01	2.34E+00	1.87E-01	1.27E+00	7.12E-04
680	8.41E-01	2.34E+00	1.87E-01	1.28E+00	7.17E-04
690	8.49E-01	2.34E+00	1.88E-01	1.29E+00	7.22E-04
700	8.56E-01	2.34E+00	1.88E-01	1.30E+00	7.27E-04
710	8.64E-01	2.34E+00	1.89E-01	1.30E+00	7.31E-04
720	8.71E-01	2.34E+00	1.89E-01	1.31E+00	7.36E-04
730	8.78E-01	2.34E+00	1.89E-01	1.32E+00	7.40E-04
740	8.85E-01	2.34E+00	1.90E-01	1.33E+00	7.45E-04
750	8.92E-01	2.34E+00	1.90E-01	1.34E+00	7.49E-04
760	8.99E-01	2.34E+00	1.90E-01	1.34E+00	7.53E-04
770	9.06E-01	2.34E+00	1.91E-01	1.35E+00	7.57E-04
780	9.12E-01	2.34E+00	1.91E-01	1.36E+00	7.61E-04
790	9.19E-01	2.34E+00	1.91E-01	1.37E+00	7.65E-04
800	9.25E-01	2.34E+00	1.91E-01	1.37E+00	7.69E-04
810	9.32E-01	2.34E+00	1.91E-01	1.38E+00	7.73E-04
820	9.38E-01	2.34E+00	1.92E-01	1.39E+00	7.77E-04
830	9.44E-01	2.34E+00	1.92E-01	1.39E+00	7.81E-04
840	9.51E-01	2.34E+00	1.92E-01	1.40E+00	7.84E-04
850	9.57E-01	2.34E+00	1.92E-01	1.41E+00	7.88E-04
860	9.63E-01	2.34E+00	1.92E-01	1.41E+00	7.92E-04
870	9.69E-01	2.34E+00	1.92E-01	1.42E+00	7.95E-04
880	9.75E-01	2.34E+00	1.92E-01	1.42E+00	7.98E-04
890	9.81E-01	2.34E+00	1.92E-01	1.43E+00	8.02E-04
900	9.87E-01	2.34E+00	1.92E-01	1.44E+00	8.05E-04
910	9.92E-01	2.34E+00	1.92E-01	1.44E+00	8.08E-04
920	9.98E-01	2.34E+00	1.92E-01	1.45E+00	8.12E-04

APPENDIX D – ATTACHMENT C

Attachment C –

Final Hydrodynamic Design Memo

Sea Engineering, Inc.
200 Washington St. Suite 210
Santa Cruz, CA 95060
Voice: 831.421.0871
Fax: 831.421.0875

To: Clay Patmont

From: Craig Jones

CC: Paul LaRosa, George Hicks, John Wolfe

Date: August 3, 2005

Re: Lower Fox River – Reaches 3 and 4 Hydrodynamic Results - Revised

---

Hydrodynamic Simulations

Two-dimensional hydrodynamic models of Reaches (OUs) 3 and 4 of the Lower Fox River have been developed and validated by Sea Engineering, Inc. (SEI) using hydrodynamic field data collected by the USGS (SEI, 2004 and 2005). SEI and Limno-Tech Inc. (LTI) have subsequently conducted an evaluation of the both hydrodynamic models. As part of the evaluation, LTI utilized the field measured shear stress data to develop a function for the coefficient of friction for Reaches 3 and 4 of the Lower Fox River. The updated function is:

$$c_f = 0.00333/(1-1.94e^{-1.29h}) \qquad (1)$$

where h is the water depth at the location of interest. The function's derivation is detailed in a separate memo issued by LTI. Using this function to predict bottom shear stress as a function of velocity, simulations were conducted on both reaches of the river to examine pre- and post-cap installation and removal action under extreme conditions. The following sections outline the simulations and results for both reaches of the river.

Reach 3 Cap Design Simulations

Using the validated model described above, a 100-year simulation was conducted on Reach 3 of the Lower Fox River to approximate hydrodynamic design conditions. Two different simulations were conducted for 100-year event:

1.) Present Reach 3 bathymetry
2.) Post-remediation Reach 3 bathymetry

The initial water level applied in the model for each of these cases was 587.27 ft IGLD 85. The model computes the additional water level gradient (η) required to produce the flow through the river.

Figures 1 and 2 show plots of maximum shear stress (dynes/cm^2) for both cases. The maximum shear stress occurs just below the Little Rapids Dam. No significant change due to alteration of the bathymetry is seen in the upstream region of the river. Areas in the narrow downstream region of the river were most affected by the remediation, but the shear stress changes are on the order of 10% or less at most locations. Overall, no significant change in shear stress is seen due to the remediation of the river.

It should be noted here that the accuracy of the single beam bathymetry used to generate the model is on the order of 15 cm; therefore, the evaluation of water level changes encountered on Reach 3 during the 100-year simulations (< 2 cm) was not conducted.

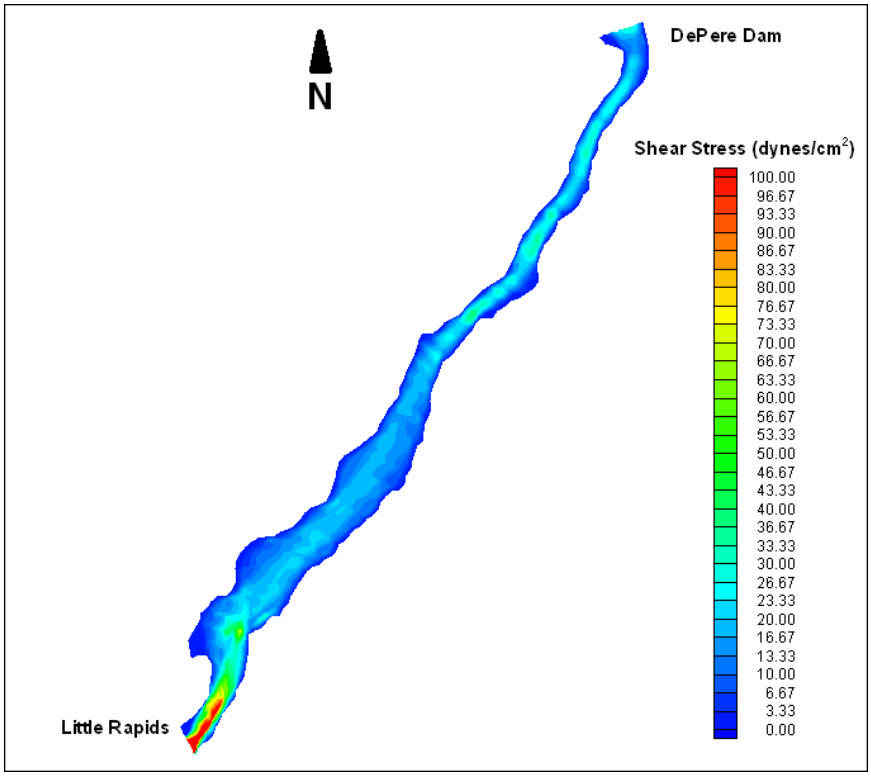


Figure 1. 100-year flow event shear stresses on Reach 3 with present bathymetry.

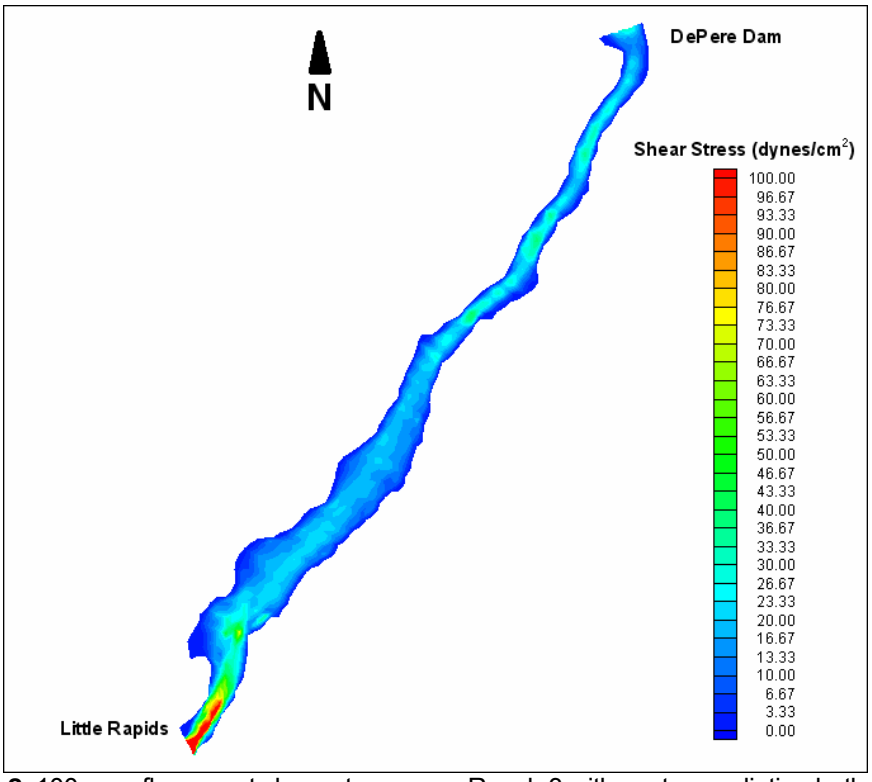


Figure 2. 100-year flow event shear stresses on Reach 3 with post-remediation bathymetry.

Reach 4 Cap Design Simulations

A 100-year flow simulation was conducted on Reach 4 of the Lower Fox River to approximate design conditions. Two different simulations were conducted for the 100-year event:

1.) Present Reach 4 bathymetry
2.) Post-remediation Reach 4 bathymetry

The initial water level applied in the model for each of these cases was 576.5 ft IGLD 85. A 132 cm high seiche with an 11 hour period was applied at the mouth of the river to approximate an extreme seiche event during the design flow conditions. Additionally, the East River was assumed to be flowing at 10% of the DePere Dam flow rate during the simulations. Figures 4 and 5 show plots of maximum shear stress (dynes/cm^2) for both cases. Note that these figures are not to scale.

The figures both show a single time period in the seiche motion when the river velocities and shear stresses were at their highest. The maximum shear stress of 125 dynes/cm^2 with the present bathymetry occurs in the downstream deep channel of the river. The model results showed a minimal shear stress change to 122 dynes/cm^2 with the inclusion of the post-remediation bathymetry. Much of the river shows a decrease in shear stress due to the removal of material in many of the deep channel regions on the river. Maximum and minimum water level changes are controlled by seiche motion in Green Bay. Due to the transient nature of these water levels they are not included as snapshot plots here. The shear stresses (dynes/cm^2) and water levels (cm) are included electronically in an attachment to this memo.

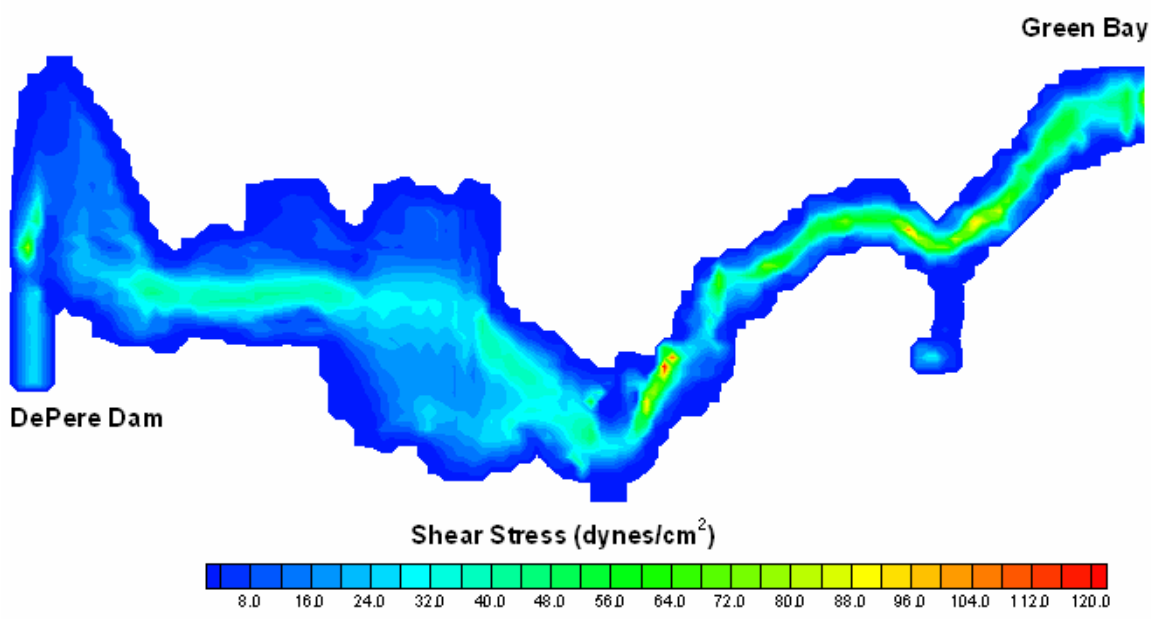


Figure 4. Snapshot of the maximum shear stress during a 100-year flow event and seiche on Reach 4 with present bathymetry.

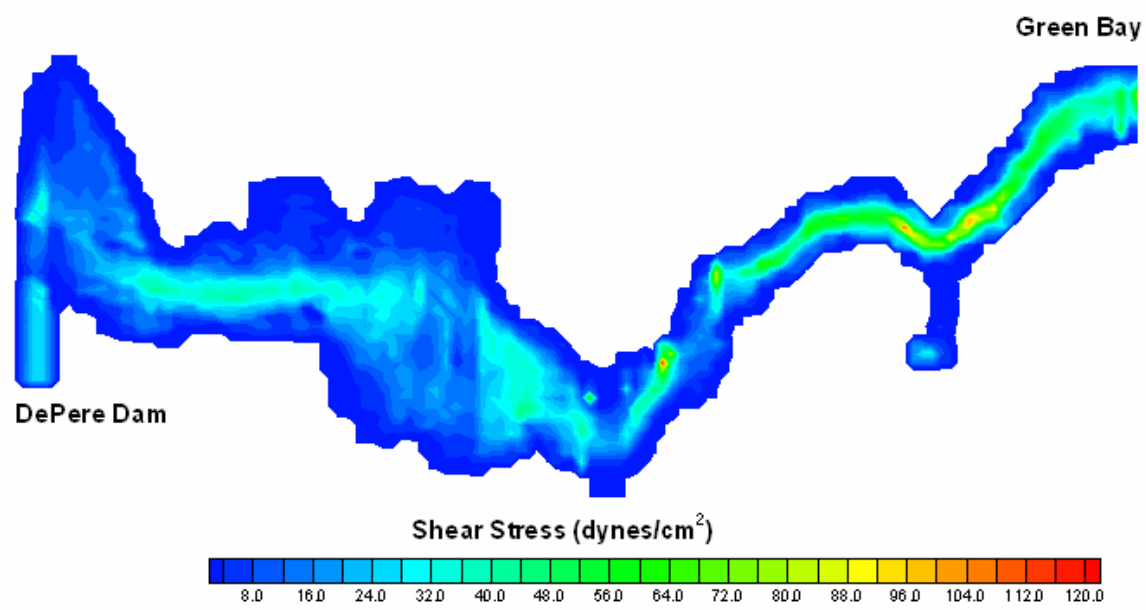


Figure 5. Snapshot of the maximum shear stress during a 100-year flow event and seiche on Reach 4 with post-remediation bathymetry.

Attachment C –

Hydrodynamic Flow Calculation Sheets

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	**CALC NO.**	**SHEET** 1 of 2
SUBJECT: Hydrodynamic Flows		

Purpose: To determine rip-rap/armor size necessary to prevent erosion of cap due to shear stress predicted for design (100-yr) flow event

Reference: Shields A 1936. Application of similarity principles and turbulence research to bed-load movement. Mitteilunger der Preussischen Versuchsanstalt f˙ur Wasserbau und Schiffbau 26: 5–24.

Given: Shields' Critcal Shear Stress Equation, (Shields 1936)

$$\tau_{*ct} = \frac{\tau_C}{(\gamma_s - \gamma)D_{50}}$$

$\tau_{*c\backslash\backslash\backslash}$	=	Shields critical shear stress parameter, 0.039 - 0.060 [Shields (1936), Rouse (1939), Laursen (1963), Yalin and Karahan (1979)]	[-]
τ_c	=	critical shear stress (threshold of motion)	[lb/ft^2]
γ_s	=	specific weight of sediment, (G_s x γ)	[lb/ft^3]
γ	=	specific weight of water, 62.4	[lb/ft^3]
G_s	=	specific gravity of sediment, 2.65	[-]
D_{50}	=	median grain size	[ft]

Substituting most conservative value of $\tau_{*c\backslash\backslash\backslash}$ = 0.039 into Shields' Equation yields:

$$D_{50} = \frac{\tau}{4}$$

$\tau_{\backslash\backslash\backslash}$	=	predicted shear stress (maximum for design 100-yr flow event)	[lb/ft^2]
4	=	(2.65 * 62.4 - 62.4) * 0.039	[lb/ft^3]

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE

Shaw ANCHOR ENVIRONMENTAL, L.L.C.

DESIGNER: _____ **DATE:** _____ **CALC. NO.:** _____ **REV.NO.:** _____

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** _____ **CHECKED DATE:** _____

SUBJECT: _____

τ [dynes/cm^2]	τ [lb/ft^2]	D_{50} [in]	FS [-]	D_{50} [in]	Sediment Type
100	0.209	0.627	2	1.25	Coarse Gravel

Note: 1.5 inches is used for the design

Minimum Layer Thickness - EPA/Corps Cap Design Guidance (Palermo et al. 1998a)

$1.5D_{50}$

= 1.5 x 1.5 in = 2.25 in

Summary of Erosion Resistance Requirements

Bottom Shear Stress, τ [dynes/cm^2] [a]	**Stable Median Grain Size, D_{50} [in]** [b]	**Required Thickness [inches]** [c]
τ < 100	1.5	4

Notes:
a. Predicted by hydrodynamic model
b. Stable grain size calculation includes factor of safety of 2.
c. 1.5 D_{50} or 4 inches, for bioturbation, whichever is greater

Attachment C -

Lower Fox River – Hydrodynamic Report Final OU 3

Hydrodynamic Field Measurement and Modeling Analysis of the Lower Fox River

REACH 3

Prepared for:

THE JOHNSON COMPANY, INC.
100 State Street, Suite 600
Montpelier, Vermont, USA 05602

Prepared by:

Sea Engineering Inc.
200 Washington Street, Suite 210
Santa Cruz, CA 95060

January, 2005

Executive Summary

As part of the Lower Fox River Hydrodynamic, Geotechnical, and Chemical Partitioning Study, the USGS and Sea Engineering, Inc. (SEI) conducted a hydrodynamic study of the Lower Fox River from Little Rapids to the DePere Dam in order to evaluate the stability of a possible engineered sediment cap. The USGS conducted a field survey which included the measurement of vertical velocity profiles at 33 locations along 8 transects from Little Rapids to the DePere Dam. The purpose of these measurements was to provide velocity profiles for the calculation of shear stress and bottom roughness. The measurement event was conducted in October 2004 and was a moderate flow case (248 m^3/s). Shear stresses calculated from the vertical velocity profile data for the event ranged from 0.24 to 2.87 dynes/cm^2.

Concurrent with the field events, SEI developed a 2-dimensional hydrodynamic model of Reach 3 (Operable Unit 3) of the Lower Fox River. Measured flows were applied as a boundary condition at the Little Rapids Dam to simulate the measurement event. The measured vertical velocity profile data were compared to the model results on a point-by-point basis. The final validated model results showed good agreement between modeled and measured vertically averaged velocities (correlation coefficient of 0.87). Four different approaches to developing an appropriate coefficient of friction value were evaluated. Of the four approaches evaluated, a law of the wall formulation and a constant c_f value of 0.003 were found to produce the highest correlations (0.057) between modeled shear stresses and those calculated from the vertical velocity profiles. Although the shear stress correlations for the different c_f values are relatively low (0.53 – 0.57), the scatter is due to the natural variability in the measured values of c_f. This scatter will be bounded with confidence intervals and the c_f values potentially refined before any values are used in cap design.

10-year and 100-year recurrence flows were predictively simulated with the validated hydrodynamic model. A 66 percent increase in the maximum predicted shear stress was observed in the model runs from the 10-year to 100-year flows. Shear stress plots can be found for the 10-year flow in Figure 6.2 on page 27 and for the 100-year flow in Figure 6.4 on page 28.

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1.0 Introduction

The Lower Fox River Hydrodynamic, Geotechnical, and Chemical Partitioning Study (Study) was conducted to provide supplemental data and analysis for Operable Unit 4 (OU4) of the Lower Fox River (the River) to support the appropriate remedy selection for OU4.. As an extension of the Study, Operable Unit 3 (OU3) was subsequently investigated. OU3, otherwise known as Reach 3, is the river segment from Little Rapids, also referred to as Little Kaukauna, to the DePere Dam (Figure 1.1).

The Wisconsin Department of Natural Resources has determined that the Lower Fox River requires remedial action to address unacceptable human health and ecological risk due to sediment contamination. The unacceptable risks result from PCB contamination of the sediments and the transport of these contaminants to human and animal receptors through the food chain.

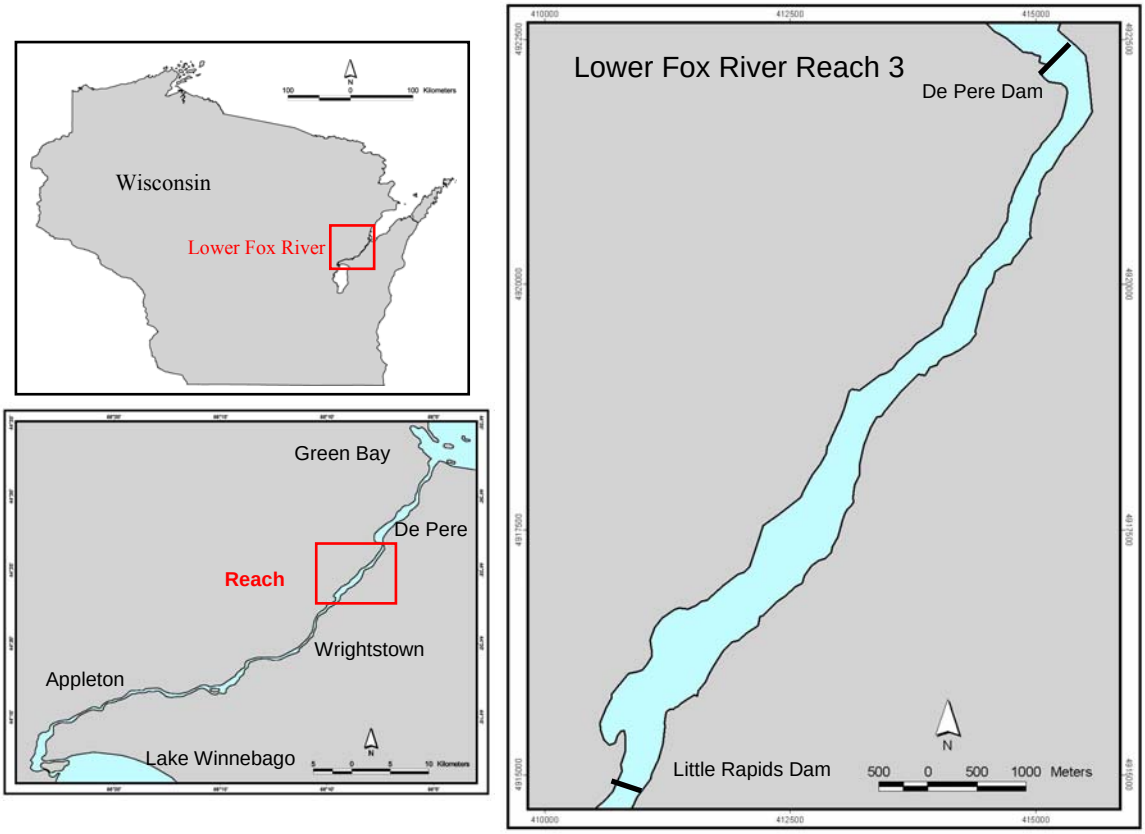

Figure 1.1 Map of Reach 3 of the Lower Fox River

This Study has been developed, and the work is being performed, as a collaboration among: the United States Geological Survey (USGS), Middleton, Wisconsin; Sea Engineering, Inc. (SEI), Santa Cruz, California; and, The Johnson Company, Montpelier, Vermont.

The following elements from the Reach 4 study were applied to Reach 3:

1) Hydrodynamic data collection in Reach 3 by Acoustic Doppler Current Profiler (ADCP)
2) Hydrodynamic modeling in Reach 3

This report covers the completion of the Study for Reach 3.

1.1 Lower Fox River Description

The Lower Fox River is a 56 km long river flowing from Lake Winnebago in the south to Green Bay in the north (Figure 1.1). The focus of this study is Reach 3 of the River from Little Rapids to DePere. The distance from Little Rapids to DePere is approximately 14 km. Figure 1.2 shows the bathymetry contours of Reach 3 as determined from the most recent single-beam hydrographic survey (WDNR, 2004). All depths are measured relative to the IGLD 85 low water datum of 587.27 feet. Depths range from less than 1 meter in the shallow nearshore regions to more than 6 meters in the deeper downstream channels where the river narrows.

There are no significant tributaries into this reach of the River. The flow over the dam at Little Rapids is primarily regulated by outflows from Lake Winnebago at the dams in Neenah and Menasha. Outflows from Lake Winnebago are regulated according to the Linde Plan. This plan aims to provide water usage for hydropower and navigation, while preserving or enhancing fish, wildlife, wetland habitat, and water quality in the River and the Lake Winnebago Pool. The Linde Plan requires maintenance of a constant lake level during the navigation season and whenever ice is forming or breaking up. A minimum summer flow is mandated, along with winter flow constraints (U.S. Army Corps of Engineers, 2004).

Flow rates at Wrightstown (upstream of Reach 3 – see Figure 1.1) have been recorded continuously since 1917, providing a long term data set for determination of flow recurrence intervals as shown in Table 1.1. Flow rates during a typical year vary from 30 to 280 m^3/s. High flow events are generally caused by opening of the dams or large storms. The highest flow rate on record is approximately 650 m^3/s and corresponds to a 50 year recurrence interval. Two flow rates greater than 600 m^3/s have been recorded since 1917 (http://waterdata.usgs.gov/wi/nwis/rt). Seiche motion in Green Bay, which can significantly modify flows in Reach 4, does not affect flow in Reach 3 due to the discontinuity at the DePere Dam, which works to maintain a steady water level in Reach 3 and prevent seiche motion from reaching Reach 3.

Table 1.1 Summary of Lower Fox River Flow Rates at Wrightstown (Krug, et al., 1992)

Recurrence Interval (years)	Flow (m^3/s)	Flow (cfs)
2	360	12,700
5	481	17,000
10	544	19,200
25	612	21,600
50	651	23,000
100	685	24,200

A USGS side-looking Doppler velocity meter was sited upstream of the DePere Dam for this project to provide a real-time record of flow and velocity. The location of this station

is marked as "USGS Sontek" in Figure 1.2. This velocity meter is a Sontek Argonaut SL 500 kHz side-looking Doppler velocity meter. The side-looking Doppler unit uses two acoustic beams to estimate the two-dimensional water velocity (X,Y) at a point in time. The beams travel a maximum of about 60m into the River from the location on the south bank. The total River width at this point in the River is about 240 m. The cross-sectional average flow velocity and discharge are calculated from a relationship between the side-looking Doppler velocity meter, cross-sectional velocity measurements made with a boat-mounted Acoustic Doppler Current Profiler (ADCP), and knowledge of the River cross section at that location.

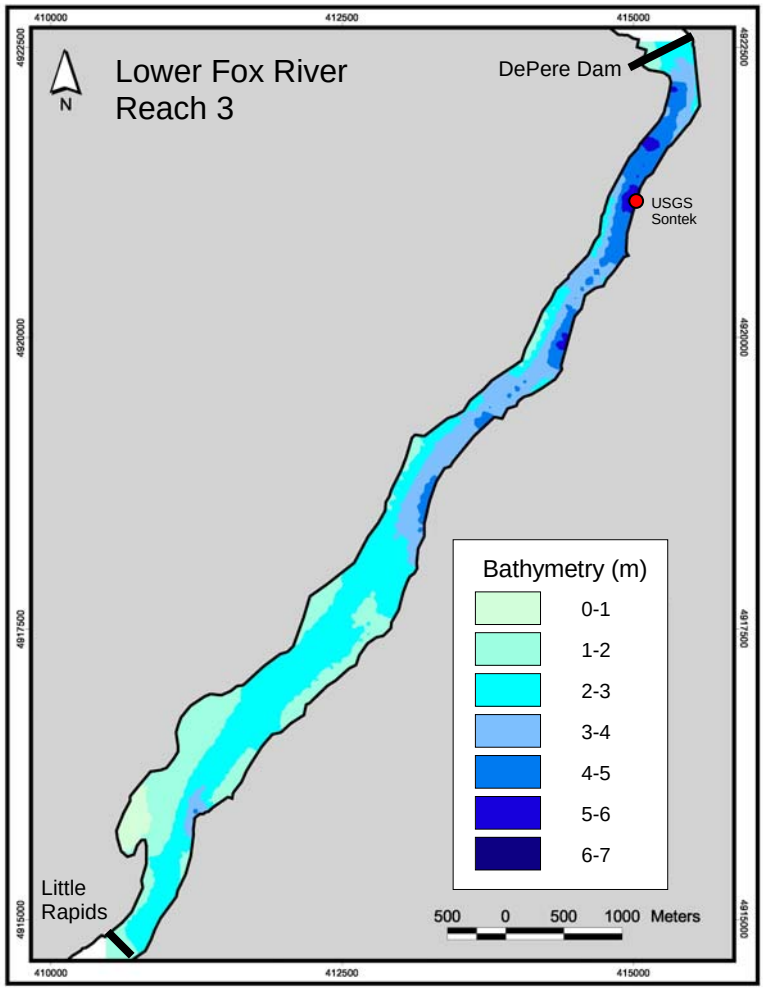

Figure 1.2 Bathymetric contours of Reach 3 in meters.

1.2 Background

The Fox River Group (FRG), Wisconsin Department of Natural Resources (DNR), and independent academic institutions have undertaken past efforts to use numerical models to predict the hydrodynamic behavior of the River. One of the first detailed modeling efforts of the River occurred when the two-dimensional hydrodynamic and sediment transport model SEDZL was applied by researchers at the University of California, Santa Barbara to Reach 4 of the River (Gailani et al., 1991). Although this model reproduced suspended sediment concentrations and generally observed patterns of flow in the river, no hydrodynamic measurements were used to validate the model results.

The Upper Fox River Model (UFRM) was used to evaluate river hydrodynamics from Lake Winnebago to De Pere including Reach 3 (WDNR, 2000a). This model was a one-dimensional flow model that did not include any high resolution modeling of velocities. As a follow on to this work, a more sophisticated two-dimensional ECOMSED model was developed for this portion of the River (WDNR, 2000a). This second generation model was called UFRHydro. The UFRHydro model utilized 27 grid points downstream from Little Rapids to the DePere Dam and up to 10 grid points in the cross stream to describe the flow. The measured flow rates at the various dams along the River were compared with the model results to provide verification of the model. There were no discrete velocity measurements available during this study to provide more detailed hydrodynamic model verification. The UFRHydro was compared with the UFRM to investigate discrepancies between modeling frameworks (WDNR, 2000a). The findings of this study showed that the UFRM may over predict dispersion rates and velocities when compared to the higher resolution UFRHydro model. The UFRHydro model was also used to study sediment transport in the River (WDNR, 2000b).

1.3 Hydrodynamic Modeling Approach

The goals of this study are twofold. The first goal is to develop a validated hydrodynamic model of Reach 3 of the River using detailed velocity profile measurements. The second goal is to utilize the validated model to predict shear stresses throughout Reach 3 so that a cap stability analysis can be conducted under design flow conditions. The approach developed to achieve these goals has been split into three phases:

- **Data Collection and Analysis**
    - Collect and analyze vertical profiles to calculate shear stresses and coefficients of friction
- **Model Development and Verification**
    - Develop model runs for data collection events
    - Refine model based on measured velocities to minimize error
- **Predictive Model Runs**

- Conduct model runs under design flow conditions for cap stability analysis using pre-cap installation bathymetry

Each of these phases is detailed in this report.

2.0 Data Collection

The following section outlines the general procedures used for, and results obtained from, the USGS hydrodynamic data collection efforts.

2.1 Hydrodynamic Field Measurements

The data collection involved a single field deployment on Reach 3 of the River with the primary goal of measuring vertical velocity profiles along eight transects. The USGS collected velocity profile data using a boat mounted ADCP (Figure 2.1). Approximately three stationary vertical velocity profiles were collected along each transect.

Figure 2.1. The USGS used a downward looking Acoustic Doppler Current Profiler (ADCP) anchored at various stations to collect vertical velocity profiles. The ADCP can be seen here attached to the side of the study vessel.

For this study, vertical velocity profiles were measured by taking the following steps at each observation point:

1. Handheld GPS devices manufactured by Garmin International were used to navigate a USGS vessel to pre-selected points of interest.
2. The vessel was steered bow into the wind or current.
3. Three anchors were set to hold the vessel in place: two in the upstream or upwind direction, and one in the downstream or downwind direction.
4. A depth finder was used to estimate the water depth at the current location.
5. The RDI ADCP (see Section 2.2 for a description) was lowered into the water on the end of an adjustable 10-foot aluminum rod.
6. The 10-foot rod was adjusted to allow the ADCP signal to completely reach the stream bottom. With 255 one-centimeter bins (and thus 2.55 meters of range), a common depth setting was 0.18 meters below the water surface. For areas with depths greater than 2.55 meters, the rod was lowered accordingly so that complete signal penetration was achieved.
7. The configuration of the ADCP unit was checked.
8. Vertical velocity profile data were collected until at least 300 good ensembles had been collected. Each measurement "ensemble" produces a complete, independent velocity profile using all four acoustic beams.
9. Data were recorded and the vessel was relocated to the next location.

2.2 Equipment Description

An RD Instruments 1200 MHz Workhorse Rio Grande Acoustic Doppler Current Profiler (ADCP) was used to make the water velocity profile measurements (http://www.rdinstruments.com/).

This ADCP uses four separate acoustic beams to obtain two separate measurements of the water velocity: one in the horizontal and one in the vertical orientations. For each velocity estimate within the velocity profile, the ADCP calculated an "error velocity" as well, based on the difference between the two separate vertical velocity component estimates. The error velocity term provides a way to determine whether there are significant in-homogeneities in flow, as well as providing a check on the functioning of the equipment (RD Instruments, 1996). The "error velocity" term is used in software post-processing steps to reject velocity data that appear to have been collected during transient periods of highly variable flow. These velocities are rejected in the field and were not included in the analysis presented here.

The ADCP unit may be operated using a number of "modes". Each operating mode refers to a specific set of manufacturer-developed signal processing algorithms and parameters. Operating modes are generally fine-tuned to a specific range of environmental conditions.

RD Instruments Workhorse Rio Grande Water Mode 11 was the preferred mode of operation for the vertical velocity profiles measured in this study. The recommended applications for this mode include:

1. High resolution, shallow water profiling in slow moving rivers, streams and estuaries.
2. Boundary layer measurements.

The recommended limits and requirements for Mode 11 operation were ideal for Reach 3 of the River. These requirements include:

1. Shallow water (4m max. at 1200KHz)
2. Low flow velocity (< 1 m/s)
3. Small depth cell size (minimum 1 cm)
4. Low standard deviation of velocity measurement.

2.3 Measurement Event

This section provides a description of the October 2004 measurement event. Figure 2.2 shows the river flow measured by USGS at Wrightstown and Appleton from October 17th through the 30th. Wrightstown is approximately 9 km upstream of Little Rapids Dam and Appleton is approximately 29 km upstream. The ADCP was used on discrete transects to measure the instantaneous flow rate in Reach 3 between October 25th and 27th and these values are also shown on Figure 2.2. Using these discrete flow rate measurements, the flow vs. velocity relationship was developed by the USGS for the Sontek on Reach 3. The flow rates determined from the Sontek are also shown on Figure 2.2.

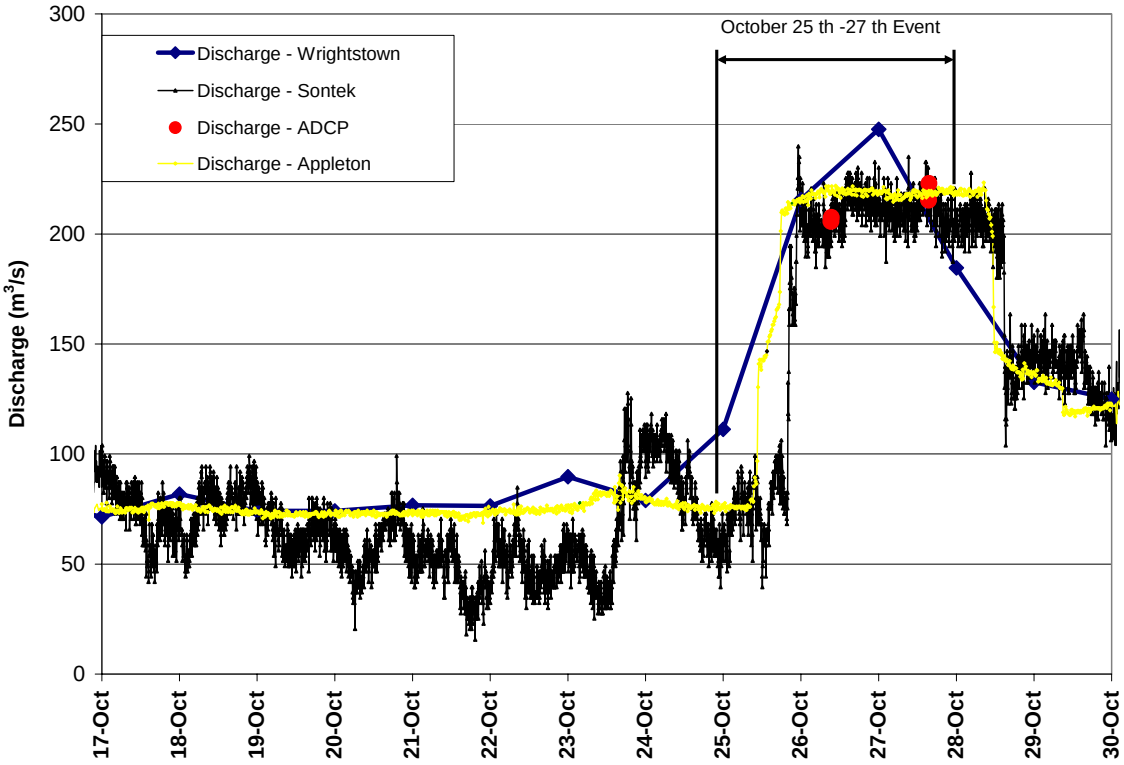

Figure 2.2. Flow rates in m^3/s at Wrightstown and Appleton and measured in Reach 3 from the ADCP and Sontek from October 17th – 30th, 2004.

The October 2004 measurement event took place during a controlled release from Lake Winnebago. Daily averaged flow rates at Wrightstown ranged from 111 to 248 m^3/s for the period from October 25 through October 30, 2004. Figure 2.2 shows the rapid increase in flow rate following the controlled release (by the U.S. Army Corps of Engineers) from the dams at Neenah and Menasha that began on October 26th. Figure 2.3 shows the velocity data from the USGS Sontek velocity meter just above the DePere Dam between October 25th and 27th. Figure 2.4 presents a map of all measurement locations. Data for thirty-three vertical profiles were collected during this measurement period. Note that duplicate profiles were measured at eight of the twenty-five locations shown on Figure 2.4.

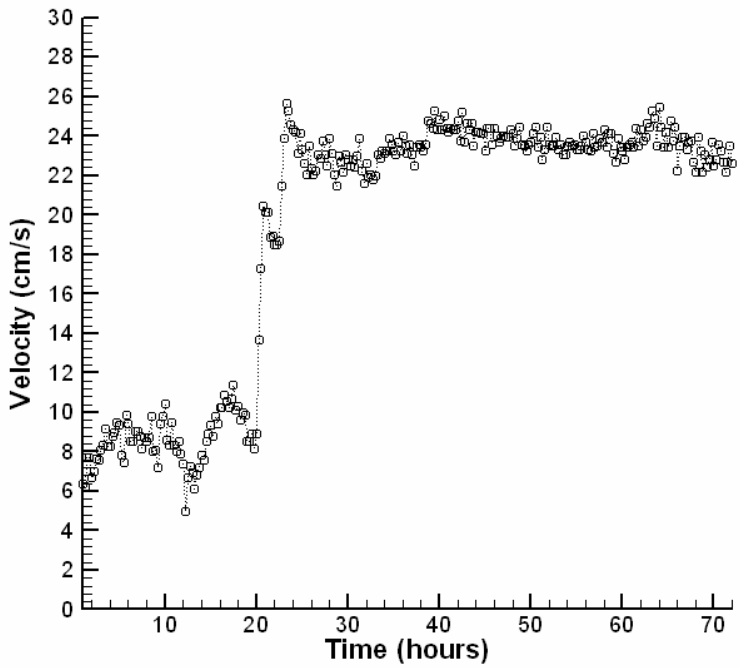

Figure 2.3 Average of vertical and horizontal current velocities at 15 minute intervals at the Reach 3 Sontek location during the October 2004. Timing begins at 00:00 hrs on October 25th, 2003.

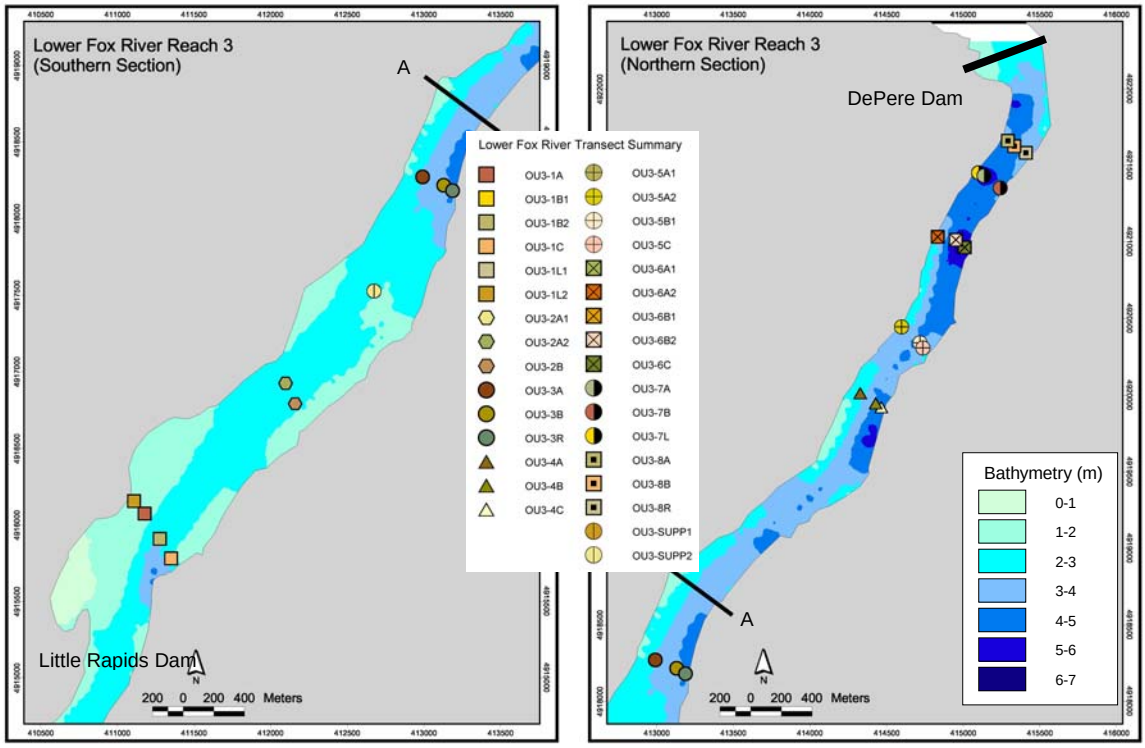

Figure 2.4 Vertical profile locations during the October 2004 event.

3.0 Data Analysis

The vertical velocity profiles were analyzed to determine the bottom shear stress and bottom roughness for the various locations and flow regimes in the River. An idealized vertical velocity profile is shown in Figure 3.1. This represents fully developed turbulent flow in a downstream direction. The profile shown is termed a logarithmic velocity profile or the law of the wall. The velocity profile can be plotted using Equation 3.1.

$$u = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_o}\right) \tag{3.1}$$

where u is the current velocity (cm/s) at height z above the sediment bed (cm), κ is the von Karman constant, z_o is the bed roughness or zero velocity level (cm), and u_* is the bed shear velocity (cm/s) which is equal to the square root of the bed shear stress (τ, dynes/cm^2) over the fluid density (ρ, g/cm^2) or $\sqrt{\tau / \rho}$.

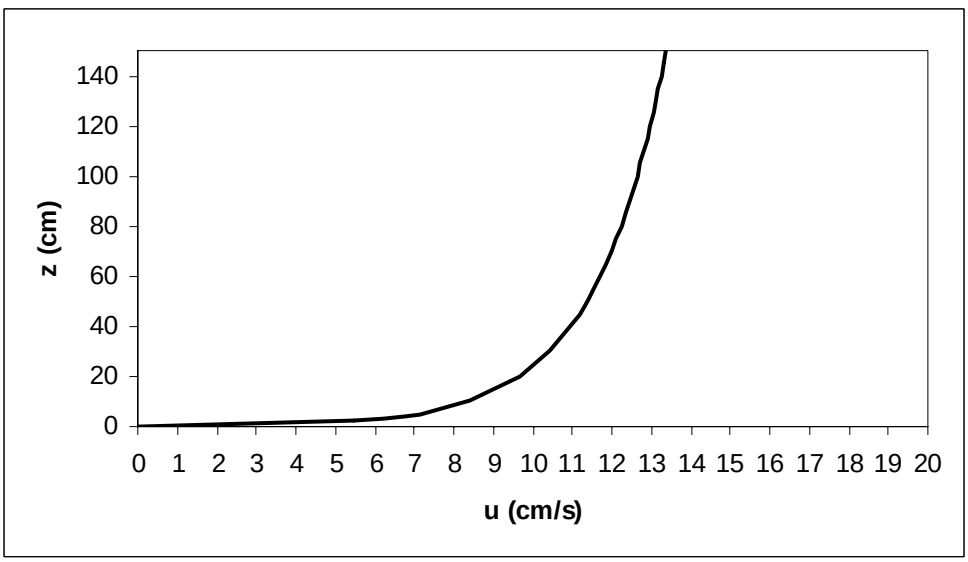

Figure 3.1 Idealized vertical velocity profile

Once vertical velocity profiles were obtained with the ADCP, the bottom shear stress and bed roughness at each location and flow rate can be determined by fitting Equation 3.1 to the data collected in the field. Equation 3.2 (written for *z* in terms of *u*) and Figure 3.2 show how the law of the wall relationship described above may be plotted on a logarithmic scale. When Equation 3.2 is fit to field data, the z-intercept is equivalent to z_o and the slope is equivalent to the von Karman constant over the shear velocity (κ/u_*).

$$\ln(z) = \frac{\kappa}{u_*} u + \ln(z_o) \tag{3.2}$$

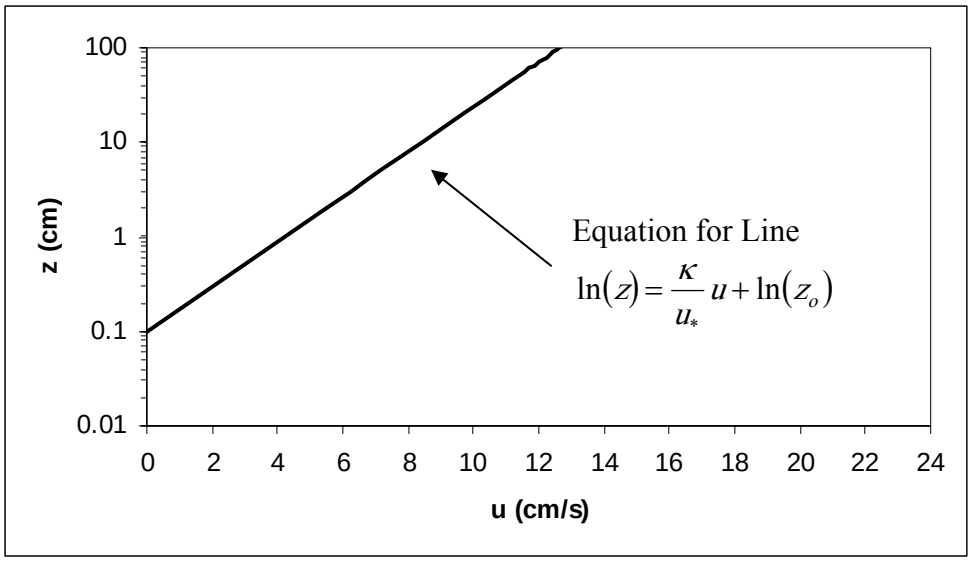

Figure 3.2 Sample logarithmic velocity profile plotted on a semi-log graph

Table 3.1 presents the z_o and bottom shear stress calculations from the October 2004 field measurement event. These values are obtained through a log-linear curve fit of the measured vertical velocity profile using Equation 3.2.

The "wall" region for river flows can be practically defined to encompass the range from less than or equal to about 20 percent of the water depth from the river bottom. Above 20 percent of the water depth, the velocity is not substantially impacted by the shear stresses on the sediment bed (Gonzalez, et al., 1996). The law of the wall has been identified as inherently valid only within the wall region; therefore, only data points in the lower 20 percent of the water depth are considered to conform to the relationship defined by the logarithmic velocity profile (the law of the wall) in this analysis. Further, data from the bottom 10 percent of the water depth were also not considered in this analysis due to the inherent data scatter resulting from the data collection method (boat-based with the associated instrument movement) and the variability of the bottom surface. For these reasons, only data points falling between 10 and 20 percent of the water depth from the river bottom were used in the calculation of z_o and bottom shear stress.

If the correlation coefficient of the logarithmic fit to the measured velocity was 0.9 or greater, those data were considered valid for shear stress and z_o calculations. Only data considered valid for these calculations (32 of the 33 profiles measured) are shown on Table 3.1. Calculated shear stresses for all events ranged from 0.24 to 2.87 dynes/cm^2.

Table 3.1 additionally shows a calculated coefficient of friction, c_f. This coefficient was investigated for modeling applications and will be discussed in the following sections. The coefficient is calculated as:

$$c_f = \frac{\tau}{\rho u^2} \tag{3.3}$$

where u is the vertically averaged fluid velocity.

Table 3.1 October measurement event – Calculated values from valid data (97 percent of data collected were considered valid)

Measurement Location	Water Depth (m)	Vertically Averaged Velocity (cm/s)	Shear Stress, τ (dynes/cm^2)	z_0 (m)	Coefficient of Friction c_f
OU3-1L1	2.23	12.5	0.89	0.0020	0.0056
OU3-1L2	2.23	12.2	1.70	0.0092	0.0114
OU3-1A	1.65	11.3	0.53	0.0010	0.0041
OU3-1B1	4.08	24.5	1.95	0.0007	0.0032
OU3-1B2	4.08	23.8	2.60	0.0024	0.0046
OU3-1C	1.52	10.5	1.03	0.0066	0.0092
OU3-2B	2.38	17.6	1.38	0.0018	0.0045
OU3-2A1	3.29	19.9	1.68	0.0016	0.0042
OU3-2A2	3.29	21.5	2.87	0.0046	0.0062
OU3-3A	3.66	21.2	1.38	0.0006	0.0031
OU3-3B	3.66	19.6	1.48	0.0014	0.0038
OU3-3R	2.50	22.0	1.36	0.0004	0.0028
OU3-8B	5.55	24.4	1.45	0.0002	0.0024
OU3-8A	5.61	22.2	1.89	0.0013	0.0038
OU3-7L	3.44	14.7	0.35	0.0000	0.0016
OU3-7A	5.76	17.8	1.81	0.0045	0.0057
OU3-7B	3.05	12.5	1.00	0.0044	0.0063
OU3-6C	3.63	22.6	0.81	0.0000	0.0016
OU3-6B1	6.80	26.1	2.54	0.0026	0.0037
OU3-6B2	6.80	26.5	2.36	0.0013	0.0034
OU3-6A1	1.80	10.1	0.62	0.0031	0.0060
OU3-6A2	1.80	10.2	0.47	0.0022	0.0045
OU3-5B1	4.91	19.0	1.08	0.0003	0.0030
OU3-5B1-Dup	4.91	19.5	1.39	0.0012	0.0036
OU3-5C	2.01	9.0	0.24	0.0004	0.0029
OU3-5A1	2.62	13.5	0.60	0.0012	0.0033
OU3-5A2	2.62	12.2	0.57	0.0020	0.0038
OU3-4C	3.20	24.9	2.45	0.0015	0.0039
OU3-4B	5.79	24.4	1.24	0.0001	0.0021
OU3-4A	2.50	18.9	1.30	0.0012	0.0036
OU3-SUPP1	2.10	15.9	1.53	0.0035	0.0060
OU3-SUPP2	2.10	16.4	0.89	0.0007	0.0033

4.0 Hydrodynamic Model

The following section outlines the theoretical and numerical formulations of the hydrodynamic model used on Reach 3 of the Lower Fox River.

4.1 General Model Formulation and Assumptions

Three-dimensional, time-dependent hydrodynamic models of currents in surface waters are more general and, at least in principle, more accurate than both two-dimensional and one-dimensional time-dependent models. Because of this, much effort has been expended on the development of three-dimensional models. However, in practice, three-dimensional models consume large amounts of development and computer time.

In contrast to three-dimensional models, two-dimensional (vertically-integrated or vertically-averaged), time-dependent models consume much less development and computer time and are much easier to understand and use. In addition, they are quite often as accurate as three-dimensional models. This is especially true for relatively shallow waters which are well-mixed vertically and where density stratification is therefore not significant. In these cases, two-dimensional models are quite accurate for predicting currents and also are well–accepted for predicting the transport of sediments and contaminants (e.g., Ziegler, 2002).

The validity of two-dimensional models is more general than this. This has been demonstrated by Wang, et al. (1995) who used several numerical models to investigate the transport and fate of sediments in Green Bay for a range of conditions. In this investigation, the following models were used and compared: a) a three-dimensional transport model with no vertical stratification present; b) a three-dimensional model with strong vertical temperature stratification present; and c) a two-dimensional (vertically-integrated) model. The predictions of sediment transport by all three models were remarkably similar and, for all practical purposes, were identical. The reasons for this are a combination of the following: 1) shear stresses due to both wave action and currents are much greater in shallow waters; and 2) in shallow waters, vertical stratification is greatly reduced due to strong vertical mixing. The result is that sediment transport is more dominant in nearshore, shallow waters where it can be well approximated by a vertically-integrated model. In off-shore, deeper waters, sediment transport is much less dominant and, because of this, does not have to be approximated as accurately to still obtain a good prediction of river-wide transport.

For these reasons, a two-dimensional (vertically integrated), time-dependent model of currents, SEDZL, will be used here as a basis for the model. No three-dimensional structure is anticipated in the shallow uni-directional flow environment of Reach 3.

The vertically integrated hydrodynamic equations used in SEDZL are (Ziegler and Lick, 1986)

$$\frac{\partial \eta}{\partial t}+\frac{\partial U}{\partial x}+\frac{\partial V}{\partial y}=0 \tag{4.1}$$

$$\frac{\partial U}{\partial t}+gh\frac{\partial \eta}{\partial x}=\tau_x^w-\tau_x^b+A_H\left(\frac{\partial^2 U}{\partial x^2}+\frac{\partial^2 U}{\partial y^2}\right)-\frac{\partial(U^2/h)}{\partial x}-\frac{\partial(UV/h)}{\partial y} \tag{4.2}$$

$$\frac{\partial V}{\partial t}+gh\frac{\partial \eta}{\partial y}=\tau_y^w-\tau_y^b+A_H\left(\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial y^2}\right)-\frac{\partial(UV/h)}{\partial x}-\frac{\partial(V^2/h)}{\partial y} \tag{4.3}$$

where g is the acceleration due to gravity, $h = h_o + \eta$ is the total water depth, $h_o(x, y)$ is the equilibrium water depth, $\eta(x, y)$ is the surface displacement from equilibrium, and U and V are vertically integrated velocities defined by

$$U=\int_{-h_o}^{\eta} \mathrm{u}\, dz \tag{4.4}$$

$$V=\int_{-h_o}^{\eta} \mathrm{v}\, dz \tag{4.5}$$

where u and v are the velocities in the x and y directions, respectively, and z is the vertical coordinate. The bottom stress is represented by τ^b whose components are given by

$$\tau_x^b=\mathrm{c_f}\, q\frac{U}{h} \tag{4.6}$$

$$\tau_y^b=\mathrm{c_f}\, q\frac{V}{h} \tag{4.7}$$

where q is the velocity magnitude and $\mathrm{c_f}$ is a bottom shear stress friction factor (coefficient of friction) typically calculated using a log-layer distribution of velocity. The calculation of $\mathrm{c_f}$ in Reach 3 is detailed in the next section. The surface wind stress, τ^w, is included for generality in the formulation but is assumed to be zero in the present calculations.

The value of the eddy viscosity, A_H, is chosen as the minimum value required for numerical stability; it is therefore dependent on local grid size. A volume integral method is used to derive finite difference equations from the governing equations presented here. The resulting finite difference equations are second-order accurate, explicit, and conservative. Additionally, these equations have been transformed into a more general curvilinear coordinate system so that more accurate grids may be generated.

The curvilinear SEDZL model is detailed in Cardenas et al. (1995). Stability and boundary condition concerns for this numerical formulation are discussed in more detail in Zeigler and Lick (1986).

4.2 Bottom Shear Stress

The bottom shear stress in the hydrodynamic model is calculated from the vertically averaged velocity through Equations 4.6 and 4.7. According to the logarithmic law (Equation 3.1), c_f can be calculated from an ideal logarithmic velocity (i.e., the law of the wall) by

$$c_f = \frac{\kappa^2}{\left(\ln \frac{h}{2z_o}\right)^2} \tag{4.8}$$

where κ is the von Karman constant (0.42), and z_o is the zero velocity level. As the zero velocity level increases or as the depth of water decreases, c_f increases. In general modeling applications, z_o is related to grain size and ripple or dune features on the sediment bed surface (van Rijn, 1993). z_o can also be directly measured through the velocity profile as shown in the previous section. Determination of z_o for the Reach 3 model is discussed in the following section.

5.0 Fox River Model

This section outlines the setup of the SEDZL hydrodynamic model for Reach 3 of the River. Additionally, the specification of boundary conditions, model refinement, and comparison with the field measurements is presented.

5.1 Model Setup and Boundary Conditions

The SEDZL two-dimensional vertically averaged hydrodynamic model was utilized to model the flow in Reach 3. A curvilinear grid was selected due to the sinuous path the river takes from Little Rapids Dam to the DePere Dam. This type of shoreline is well suited to description by a curvilinear grid. The final grid is shown in Figure 5.1. The grid has 111 elements in the downstream directions and 10 elements in the cross stream direction. The water depths at each node were defined from bathymetry generated in 2004, and provided to SEI for incorporation into the model. All water depths are measured from the IGLD 85 datum of 587.27 feet. The depth measurement nearest to the center of each grid node was used to define the depth for that node.

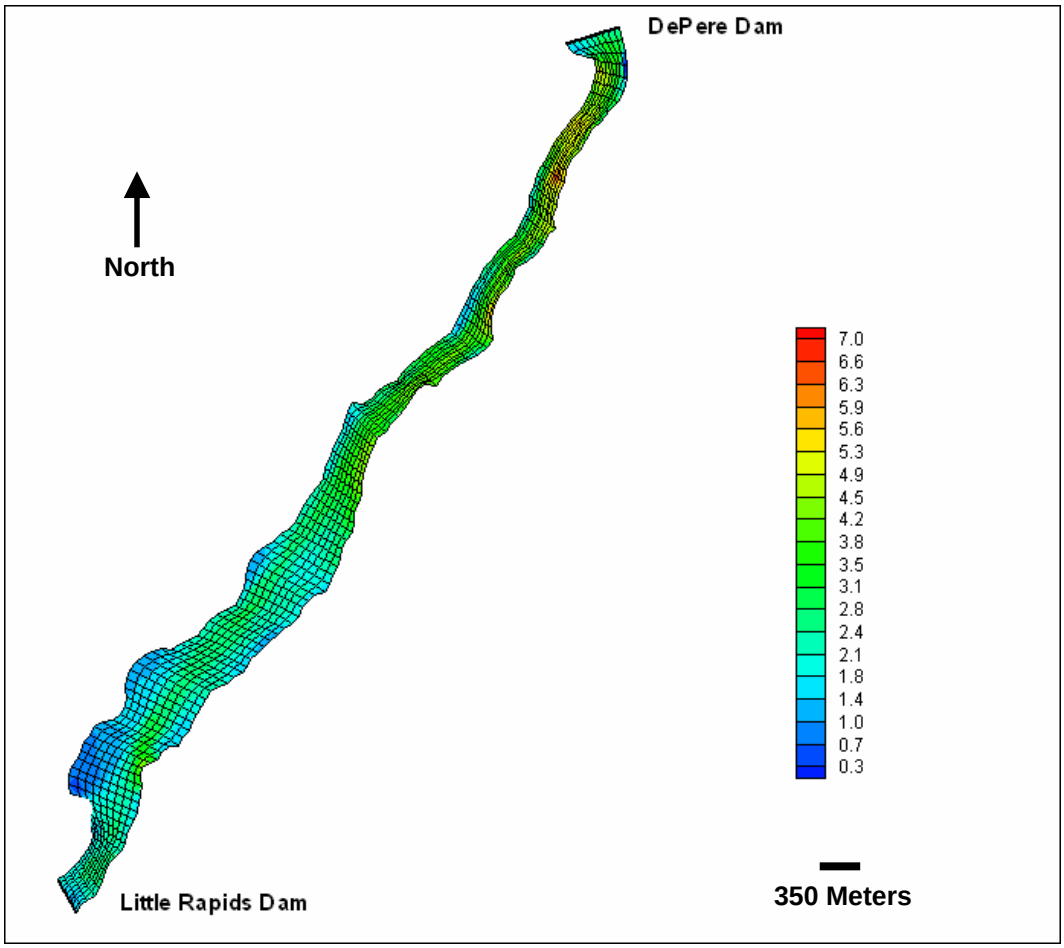

Figure 5.1 Reach 3 model grid and bathymetry contours in meters.

The predominant flow into Reach 3 of the River is from the Dam at Little Rapids. Flow contributions due to runoff and other smaller tributaries were considered to be negligible. Therefore, the only flow boundary specified for the model was the Little River Dam. The USGS Sontek deployed during October, 2004 provides the only direct continuous measurement of flow rate on Reach 3. Figure 2.2 shows a comparison of the daily averaged flow rates at Wrightstown and the flow rates at Appleton with the flow rates determined from the Sontek (see Figure 1.1 for approximate locations of Wrightsville and Appleton relative to Reach 3). The Wrightstown flow rates can be seen to miss the rapid rise and fall of the flow while the Appleton data can be seen to lead the Sontek data in the flow rise by up to 12 hours. Since the flow variation during this time period is so rapid, the USGS Sontek flow rates were used as the upstream boundary condition at the Little Rapids Dam.

Seiche motion does not propagate beyond the DePere Dam and is excluded from these calculations. Additionally, level loggers deployed at the upstream and downstream portions of Reach 3 did not show a level difference beyond the instrument error (0.1 ft, personnel communication with Steve Westenbroek, USGS). Therefore, the downstream boundary at DePere dam was left as an open boundary.

5.2 Model Refinement

The hydrodynamic model was set up with appropriate boundary flow rates and water levels as described above. The modeling period started at 00:00 hours on October 25, the day prior to the first measurement, to allow at least 24 hours for model start-up. Start-up effects typically occur in hydrodynamic models as the model starts from a zero flow initial condition and ramps flow up to the desired level. The start-up can result in oscillations in the model solution that take some time to dampen out.
Modeled velocities were extracted at the same times and locations as during the measurement events for comparison.

The primary measurements available for model refinement and validation are the velocities. Although shear stress maps are the goal of the modeling effort, comparisons must be made with directly measured data instead of calculated quantities. For this reason, the vertically averaged velocity values were compared to evaluated model performance based on that same parameter.

The initial model predicted the continuous velocity measurements at the USGS Sontek velocity meter to within 20 percent of measured values. Plots of these results are shown in the following sections. This gave confidence that the boundary conditions were correctly specified and that the large scale flow patterns in the River were being reproduced correctly. The next step was the comparison of point measurements of velocities for the October 2004 measurement event. The initial comparison of the velocities in the River showed a high correlation coefficient (R) between modeled and measured velocities of 0.87. This high correlation gives confidence in the boundary conditions and grid utilized in the model.

The bottom shear stress balances the downstream momentum of flow in a river. This balance of forces plays a significant role in the velocity magnitudes throughout the River. Thus, the shear stresses from the measurements need to be compared with those modeled to ensure that the flow patterns and magnitudes are accurate. As stated earlier, the calculation of shear stress in the model is dependent upon the coefficient of friction, c_f; therefore, a comparison of measured versus modeled results was performed using various methods to estimate c_f. According to the law of the wall, c_f is dependent upon water depth and z_o (Equation 4.8). c_f was also determined for the measured shear stresses and is shown in Table 3.1. Figure 5.3 shows a plot of the coefficient of friction as a function of water depth.

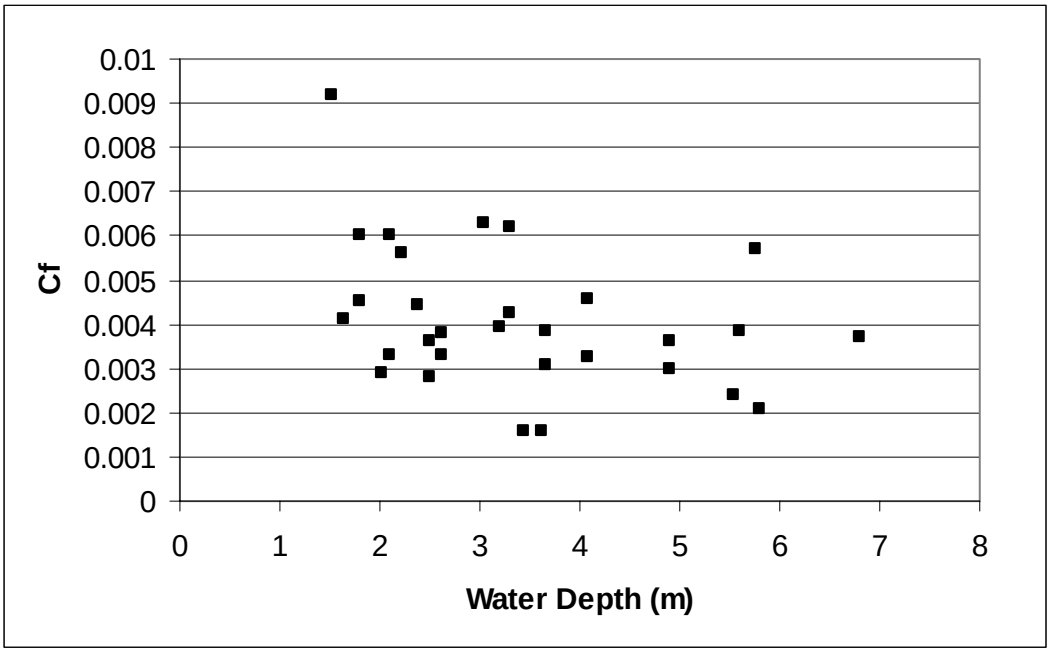

Figure 5.3 Coefficient of Friction (c_f) values determined from measurements as a function of water depth.

Since there is not sufficient information to develop a map of z_o for the entire model domain, it was initially assumed that c_f is a function of depth alone and that z_o is roughly constant. The law of the wall (Equation 4.8) can then be applied to the data with z_o equal to the average from the measurements ($z_o = 0.002$ m), which is shown in Figure 5.4. The correlation coefficient of the law of the wall to the data was only 0.43. It is clear from Figure 5.4 that the law of the wall model greatly under-predicts the c_f in shallow water areas less than 2 m deep. Some idea of z_o variation in the River would be required for an accurate law of the wall prediction, but unfortunately no correlation of z_o to any parameter was seen in the data.

A regression of the data was conducted, and it was found that a logistic function most accurately reproduced the behavior throughout the range of depths. The correlation coefficient for the logistic model to the data is 0.46. The logistic function is shown in

Equation 5.1 and in Figure 5.4. For application in the model, the function was limited to the shallowest water depth measured (1.5 m). This represents the limit of the measured data.

$$c_f = \frac{0.0037}{1 - 6.6\exp(-1.65\,h)} \tag{5.1}$$

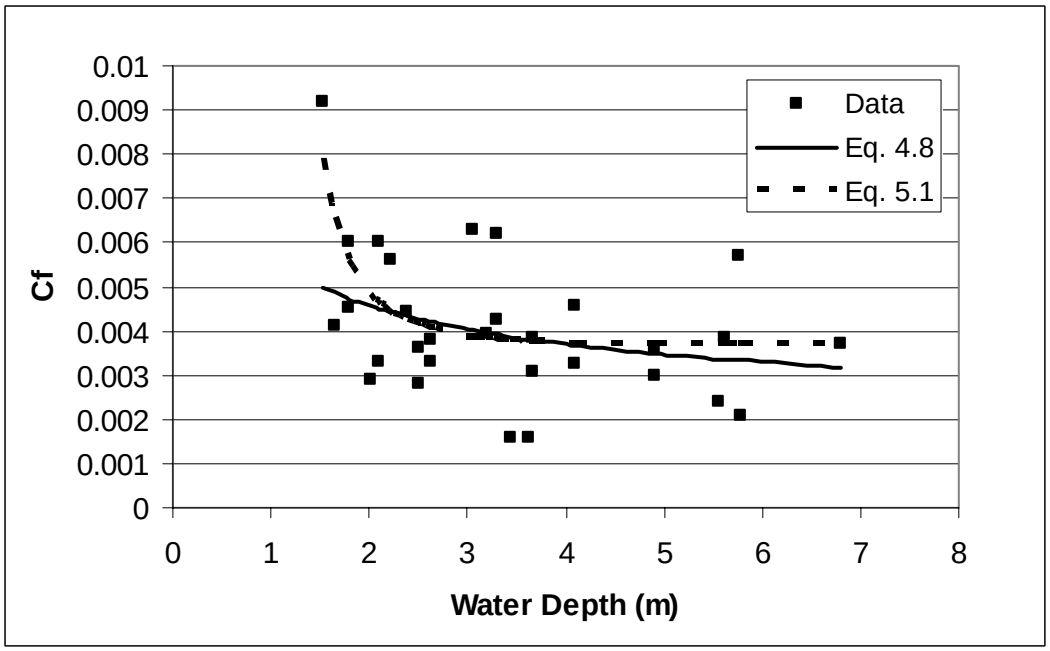

Figure 5.4 Two models applied for the calculation of c_f .

5.3 Model Validation

The depth and c_f model refinements were applied to the model for the October 2004 measurement event. To investigate model sensitivity and to obtain the most accurate model of shear stress, four different methods for determining c_f were investigated. These methods were: 1) the law of the wall (Eq. 4.8); 2) the best fit of the data (Eq. 5.1); 3) the average c_f of 0.0042; and 4) an assumed c_f of 0.003. Table 5.3 presents a summary of correlation coefficients for vertical average velocity and shear stress for all four methods.

Of the four approaches evaluated, the law of the wall formulation and an assumed c_f value of 0.003 were found to produce the highest correlations (0.57) between modeled shear stresses and those calculated from the vertical velocity profiles. Figures 5.5 and 5.6 present the velocity and shear stress comparisons for the hydrodynamic model using the law of the wall to calculate the coefficient of friction. Although the shear stress correlations for the different c_f values are relatively low (0.53 – 0.57), the scatter is due to the natural variability in the measured values of c_f. This scatter will be bounded with

confidence intervals and the c_f values potentially refined before any values are used in cap design.

Table 5.3 Correlation coefficients for velocity and shear stress comparisons for different coefficient of frictions.

Coefficient of Friction	Velocity	Shear Stress
Eq. 4.8	**0.87**	**0.57**
Eq. 5.1	0.87	0.53
0.0042 (Average of Measurements)	0.87	0.56
0.003 (assumed)	**0.87**	**0.57**

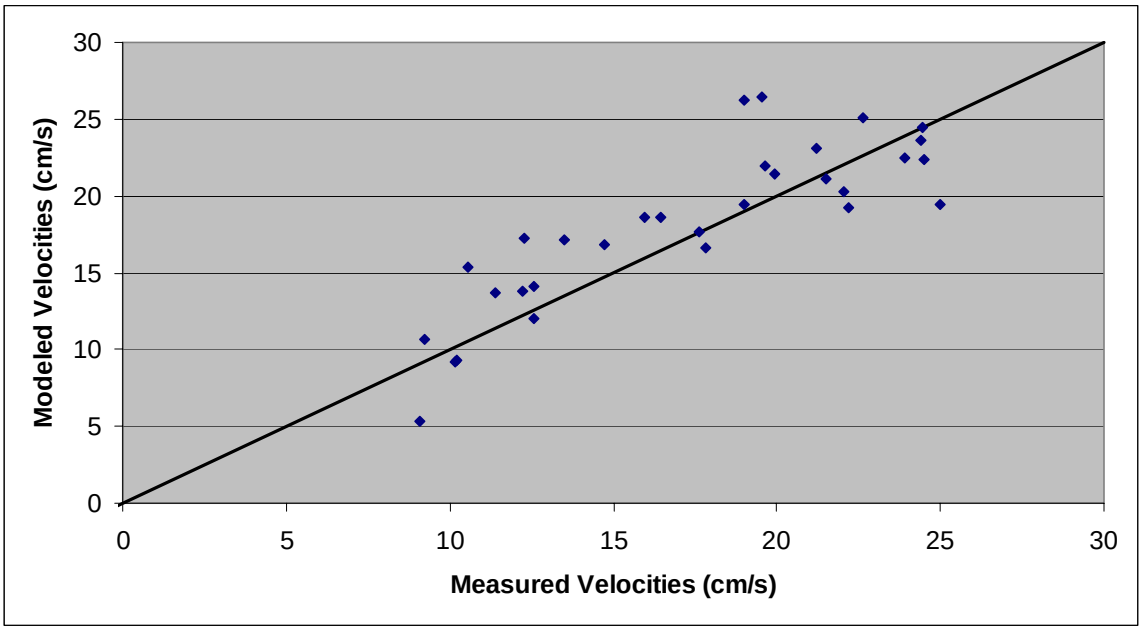

Figure 5.5 Comparison of measured and modeled vertically averaged velocities. The line represents a 1 to 1 slope.

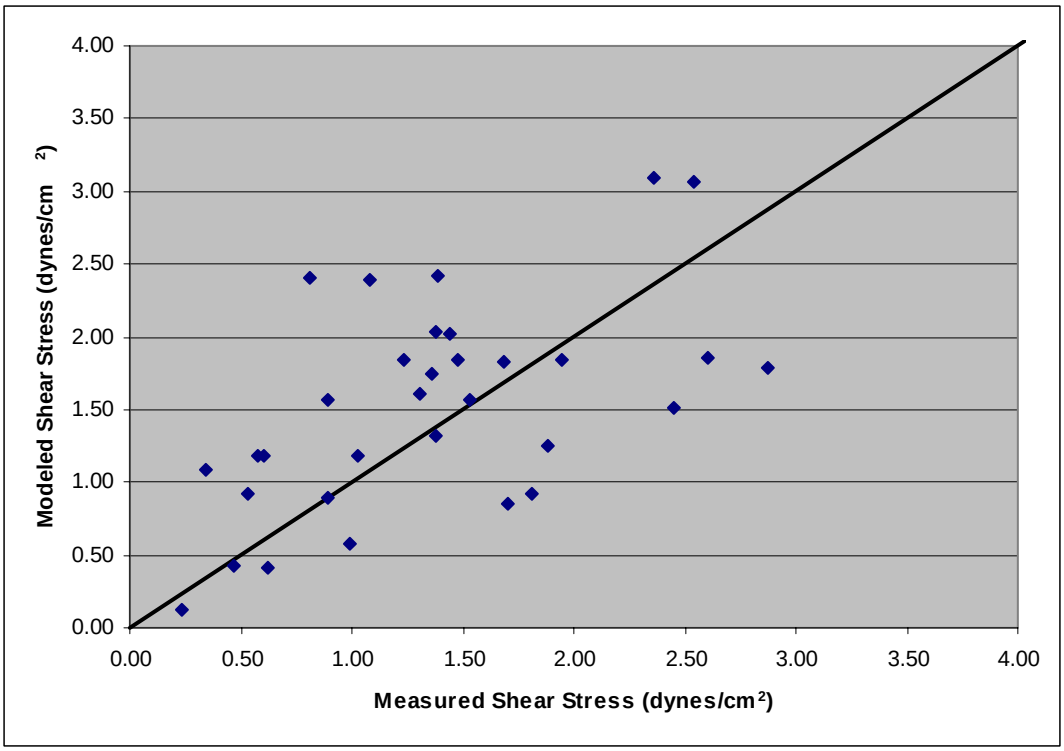

Figure 5.6 Comparison of measured and modeled shear stresses. The line represents a 1 to 1 slope.

The model run for the October 2004 measurement event covers the period from October 25th through October 27th of 2004. Figure 5.7 shows the measured data compared with modeling results for the USGS Sontek velocity meter. The model shows excellent agreement with the data. Figures 5.8 and 5.9 show modeled velocity and shear stress plots for the period with the maximum upstream flow. The maximum shear stress modeled during the flow was 27 dynes/cm2 and occurred immediately downstream of the Little Rapids dam. This is where the flow over the dam develops into the main river channel which yields expected high shear stresses. The shear stress rapidly drops with distance away from the dam. The maximum downstream shear stress in the narrow northern portion of the river is 5 dynes/cm2.

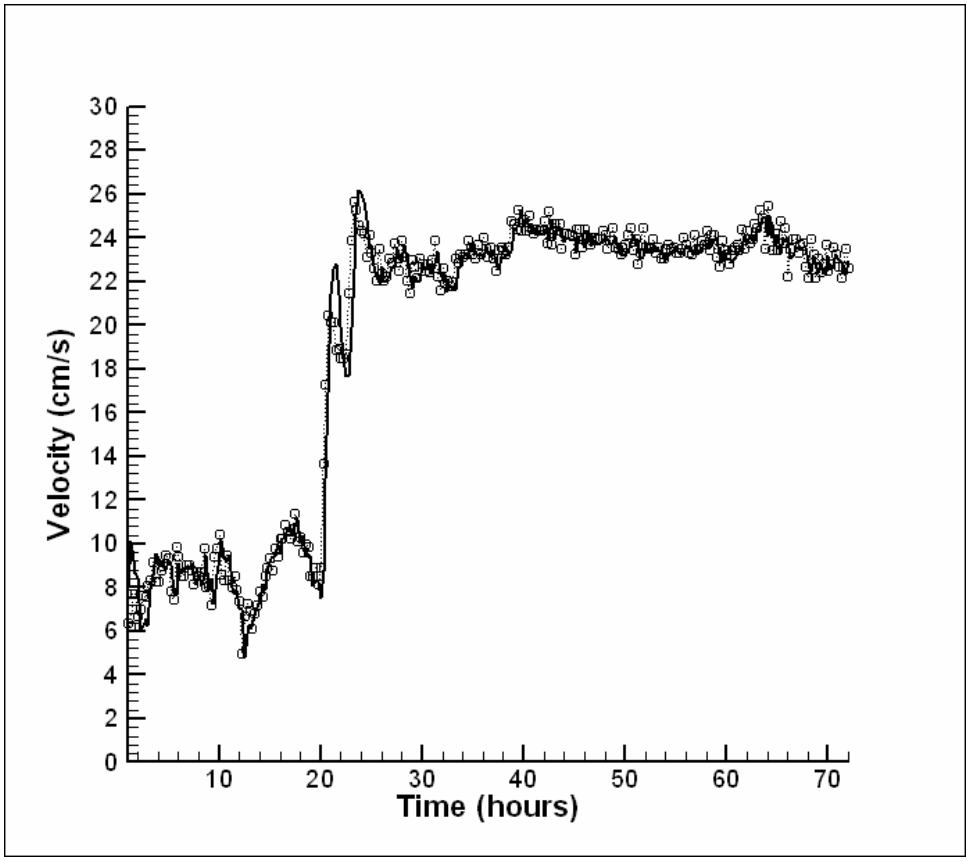

Figure 5.7 Modeled and measured velocities from the USGS Sontek velocity meter. Model results are shown with a solid line.

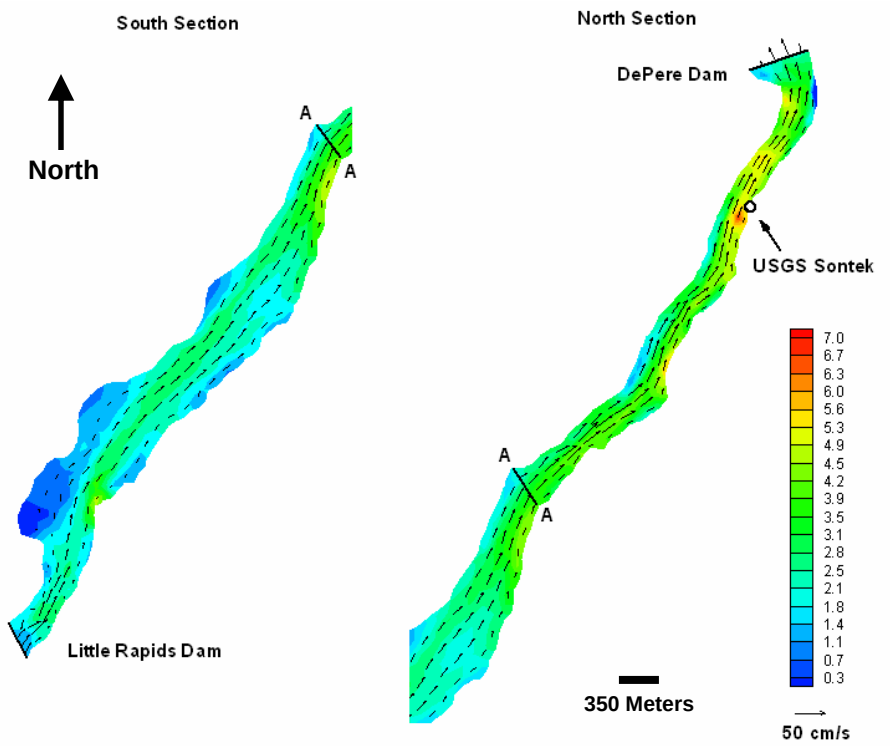

Figure 5.8 Modeled velocity vectors and bathymetry contours (meters) during the maximum flow for the October 2004 event.

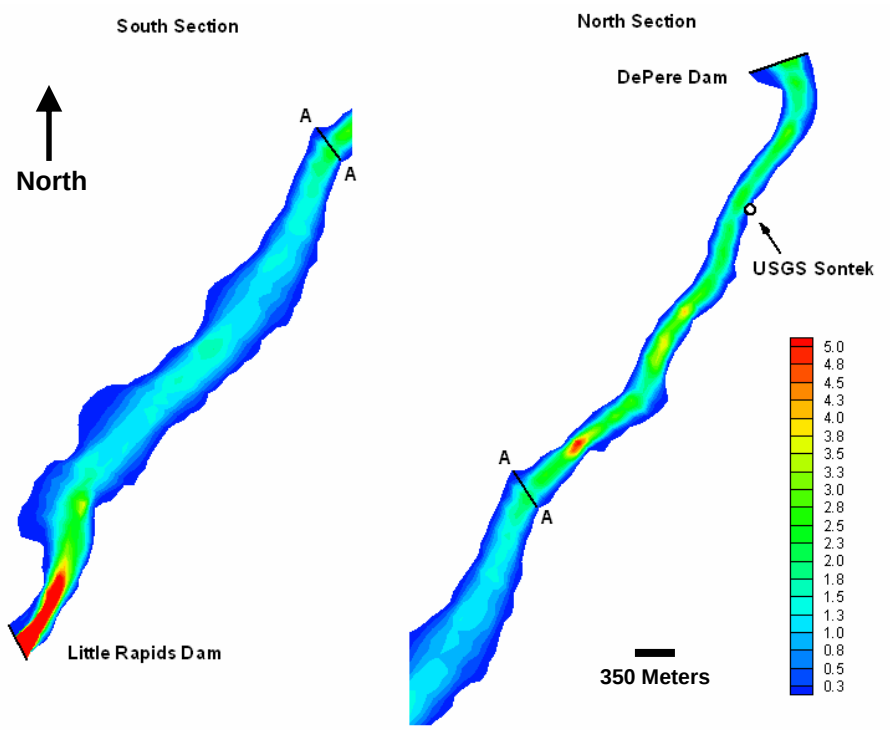

Figure 5.9 Modeled shear stress contours (dynes/cm^2) during the maximum flow for the October 2004 event.

6.0 Predictive Model Runs

The following section outlines predictive model runs that were designed to investigate shear stress levels in Reach 3 during design flow conditions. The law of the wall was used to calculate the coefficient of friction in the predictive modeling efforts. The results of the model runs are presented with a brief discussion of the major features.

6.1 Model Setup and Boundary Conditions

Two predictive model runs were conducted for studying cap stability. A 10-year recurring flow of 544 m^3/s and a 100-year recurring flow of 685 m^3/s were modeled in order to investigate shear stress levels during a high flow and an extreme flow event. The flow rates were applied at the Little Rapids Dam for a period of four days so that any start-up effects were avoided. The initial water level for these cases was set to the low water datum for Reach 3 (587.27 feet IGLD 1985). No other changes were made to the validated model presented in the previous section.

6.2 Results and Discussion

10-year Event

The 10-year flow model produced shear stress patterns consistent with the validation results. Figure 6.1 shows a plot of the maximum velocities throughout Reach 3 during a 10-year flow event. The maximum velocity is approximately 230 cm/s. Figure 6.2 shows a plot of maximum shear stresses during a 10-year flow event. The maximum shear stress at any point in Reach 3 is approximately 160 dynes/cm^2, located directly downstream of the Little Rapids Dam. The maximum shear stress rapidly drops to $1/10^{th}$ of the maximum value 500 m downstream of the dam. The maximum shear stress in the downstream narrow portion of the river is approximately 30 dynes/cm^2.

100-year Event

The 100-year flow model produced shear stress patterns consistent with the validation results. Figure 6.3 shows a plot of the maximum velocities throughout Reach 3 during a 100-year flow event. The maximum velocity is approximately 298 cm/s. Figure 6.4 shows a plot of maximum shear stresses during a 100-year flow event. The maximum shear stress at any point in Reach 3 is approximately 266 dynes/cm^2, located directly downstream of the Little Rapids Dam. The maximum shear stress rapidly drops to $1/10^{th}$ of the maximum value 500 m downstream of the dam. The maximum shear stress in the downstream narrow portion of the river is approximately 50 dynes/cm^2.

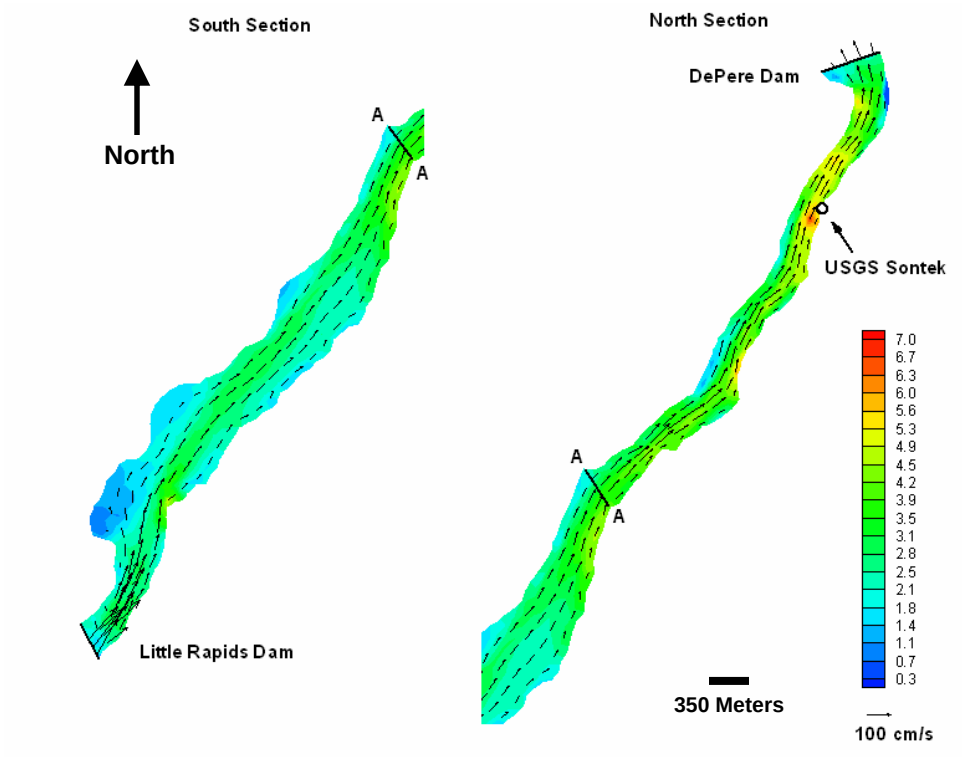

Figure 6.1 Maximum velocity vectors and bathymetry contours (m) for the 10-year flow event.

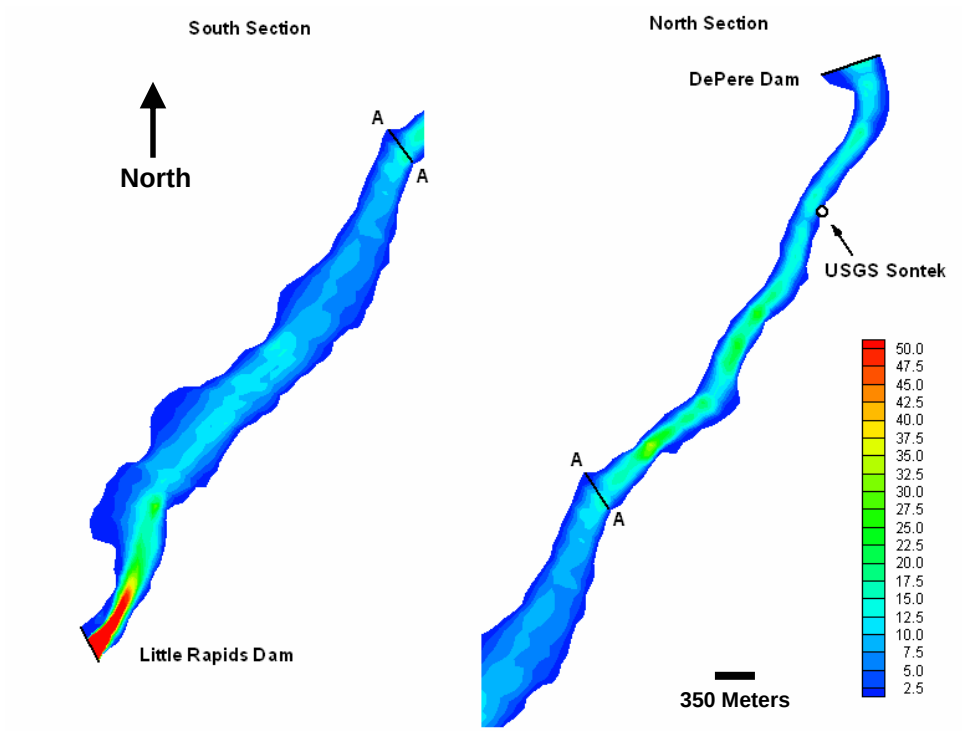

Figure 6.2 Maximum shear stress contours (dynes/cm^2) for the 10-year flow event.

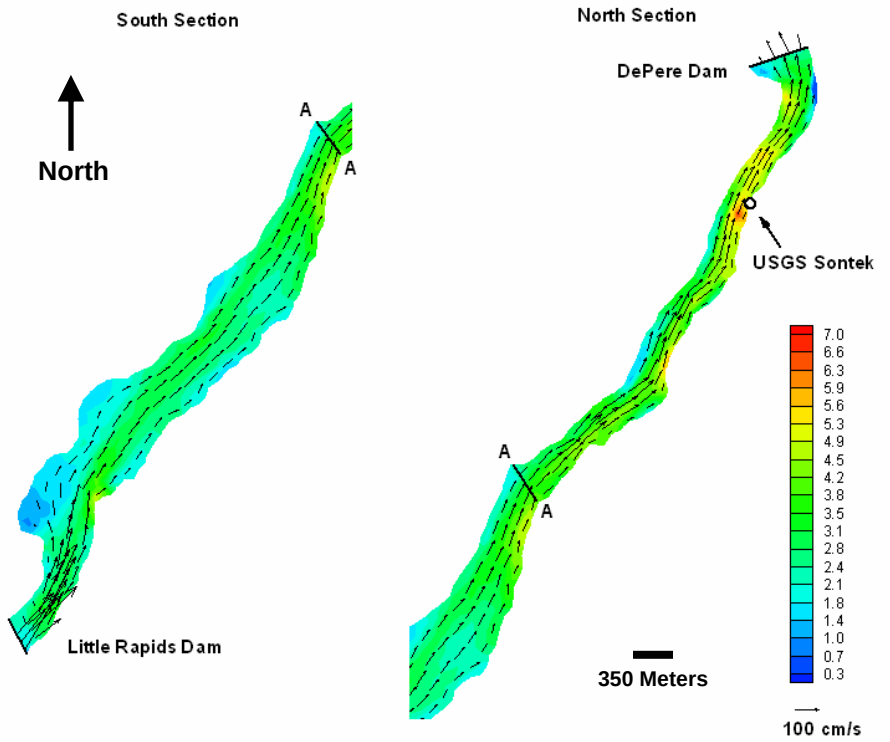

Figure 6.3 Maximum velocity vectors and bathymetry contours (m) for the 100-year flow event.

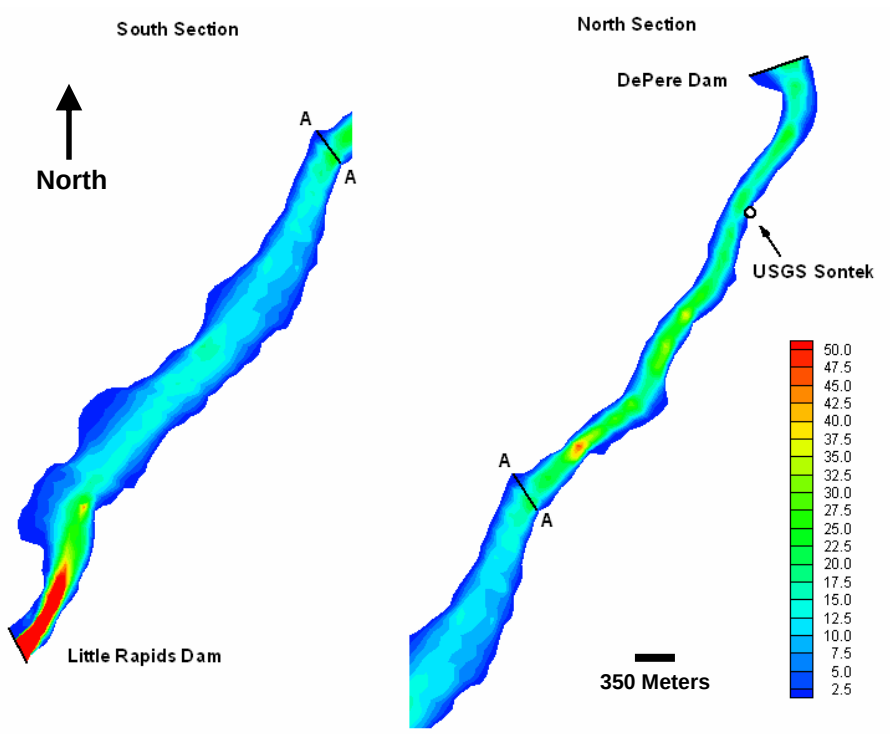

Figure 6.4 Maximum shear stress contours (dynes/cm^2) for the 100-year flow event.

7.0 Summary and Recommendations

The goals of this study were to develop a validated hydrodynamic model of Reach 3 of the Lower Fox River using detailed velocity profile measurements and to utilize the validated model to predict shear stresses so that a cap stability analysis can be conducted under design flow conditions. The USGS conducted all data collection efforts and provided 33 velocity profiles during a single measurement event in October 2004. These data allowed the calculation of shear stresses throughout Reach 3. This information, combined with continuous velocity measurements by a USGS Sontek velocity meter, allowed for the development and refinement of a 2-dimensional hydrodynamic model of Reach 3. The model was shown to reproduce ADCP measured velocities with a correlation coefficient of 0.87.

To investigate model sensitivity and to obtain the most accurate model of shear stress, four different methods for determining c_f were investigated. These methods were: 1) the law of the wall (Eq. 4.8); 2) the best fit of the data (Eq. 5.1); 3) the average c_f of 0.0042; and 4) an assumed c_f of 0.003. Of the four approaches evaluated, the law of the wall formulation and a constant c_f value of 0.003 were found to produce the highest correlations (0.057) between modeled shear stresses and those calculated from the vertical velocity profiles. Although the shear stress correlations for the different c_f values are relatively low (0.53 – 0.57), the scatter is due to the natural variability in the measured values of c_f. This scatter will be bounded with confidence intervals and the c_f values potentially refined before any values are used in cap design.

Some idea of z_o variation in the River would be required for more accurate shear stress predictions prediction, but unfortunately no correlation of z_o to any parameter was seen in the data. Therefore, the value of c_f giving the highest shear stress correlation was selected for predictive simulations. Further refinement of the c_f values will be conducted before the model predictive model is utilized for design purposes, but as seen in Table 5.3, the velocity predictions are insensitive to changes in c_f and remain valid.

10- year and 100-year recurrence flows were predicatively simulated with the validated hydrodynamic model. A 66 percent increase in shear stress was observed in the model runs from the 10-year to 100-year flows. The highest shear stress values were directly below the dam at Little Rapids. Since the dam effectively acts as a flow constriction, the highest velocities are expected directly below this location. It should be noted that the shear stress drops by over half of the maximum value 150 m downstream of the dam.

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Attachment C –

Lower Fox River – Hydrodynamic Report Final OU 4

Hydrodynamic Field Measurement and Modeling Analysis of the Lower Fox River

REACH 4

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Executive Summary

As part of the Lower Fox River Hydrodynamic, Geotechnical, and Chemical Partitioning Study, the USGS and Sea Engineering, Inc. (SEI) conducted a hydrodynamic study of the Lower Fox River from the DePere Dam to Green Bay in order to study the stability of a possible engineered sediment cap. The USGS conducted four field surveys which included the measurement of vertical velocity profiles at up to 30 locations along the river from DePere Dam to Green Bay. The purpose of these measurements was to provide velocity profiles for the calculation of shear stress and bottom roughness. The measurement events encompassed the following flow periods on the river: a low-flow period (100 m^3/s) dominated by seiche motion in Green Bay, two moderate flow cases (200-300 m^3/s), and a high flow case (400 – 450 m^3/s). Calculated shear stresses for all events ranged from 0.1 to 13.8 dynes/cm^2.

Concurrent with the field events, SEI developed a 2-dimensional hydrodynamic model of Reach 4 of the Lower Fox River. Measured flows were applied as a boundary condition at the DePere Dam and measured water levels were applied as a boundary condition at Green Bay in the model to simulate each measurement event. The measured vertical velocity profile data were compared to the model results on a point-by-point basis for each event. The final validated model results showed good agreement between modeled and measured velocities (correlation coefficients of 0.80 and greater).

Two predictive model runs were conducted for studying cap stability. A 10-year recurring flow of 544 m^3/s and a 100-year recurring flow of 685 m^3/s were modeled in order to investigate shear stress levels during a high flow and an extreme flow. Additionally, a relatively large seiche height of 40 cm with a period of 13 hours was applied at the Green Bay boundary to investigate the effects of a seiche during these high flows. Figure 6.2 on page 44 shows a plot of maximum shear stresses during a 10-year flow event. The maximum shear stress at any point in Reach 4 is 95 dynes/cm^2, located at approximately 400 m downstream from the East River in the central channel. Figure 6.4 on page 45 shows a plot of maximum shear stresses during a 100-year flow event. The maximum shear stress at any point in Reach 4 is 120 dynes/cm^2 located at approximately 400 m downstream from the East River in the central channel. It is important to note that these maximum shear stresses are in a localized area in the downstream portion of the river and are not representative of the shear stresses throughout most of the river. Additionally, the maximum shear stress location is not in an area of proposed sediment capping. Overall, a 30 percent increase in shear stress was observed in the model runs from the 10-year to 100-year flows. Seiche motion included in the predictive model runs caused an approximately10 percent variation in shear stress levels during both predictive runs.

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1.0 Introduction

The Lower Fox River Hydrodynamic, Geotechnical, and Chemical Partitioning Study (Study) was conducted to provide supplemental data and analysis to support the appropriate remedy selection for the Lower Fox River (the river) Operable Unit OU 4. OU4, otherwise known as Reach 4, is the river segment from DePere Dam to Green Bay (Figure 1.1).

Wisconsin Department of Natural Resources has determined that the Lower Fox River requires remedial action to address unacceptable human health and ecological risk due to sediment contamination. The unacceptable risks result from PCB contamination of the sediments and the transport of these contaminants to human and animal receptors through the food chain.

This Study has been developed, and the work is being performed, as a collaboration among: the United States Geological Survey (USGS), Middleton, Wisconsin; Sea Engineering, Inc., Santa Cruz, California; and, The Johnson Company, Montpelier, Vermont. Martin Johnson, Nani Bhowmik, and James Knox have also participated in the development of this program and served as expert reviewers.

The Study elements are:

1) Hydrodynamic data collection in Reach 4 by Acoustic Doppler Current Profiler (ADCP)
2) Hydrodynamic modeling in Reach 4
3) Sediment coring in Reach 4 and geotechnical analyses
4) Sediment geotechnical measurements in Reach 4 and chemical partitioning analyses

This report covers the completion of elements 1 and 2 on Reach 4. The results of elements 3 and 4 were presented in an earlier separate report (USGS, Sea Engineering, and The Johnson Company, 2004).

1.1 Lower Fox River Description

The Lower Fox River is a 56 km long river flowing from Lake Winnebago in the south to Green Bay in the north (Figure 1.1). The focus in this study is Reach 4 of the Lower Fox River from DePere Dam to Green Bay. The distance from the DePere Dam to Green Bay is approximately 11 km. A bathymetric map of this portion of the river (Figure 1.2) shows the upstream region of Reach 4 to be fairly wide (over ½ km in some regions) with shallow pools in the nearshore regions as little as 1 m in depth. Maintenance dredging in the center channel areas has created a channel of up to 5 meters in depth in the upstream region. The bottom sediments in the nearshore region are generally silty (D_{50} of 10 to 100 μm), whereas the center channel regions have been observed to be generally in the fine sand range (D_{50} of 100 to 300 μm) (The Johnson Company, 2004; McNeil et al., 1996; Xu, 1991).

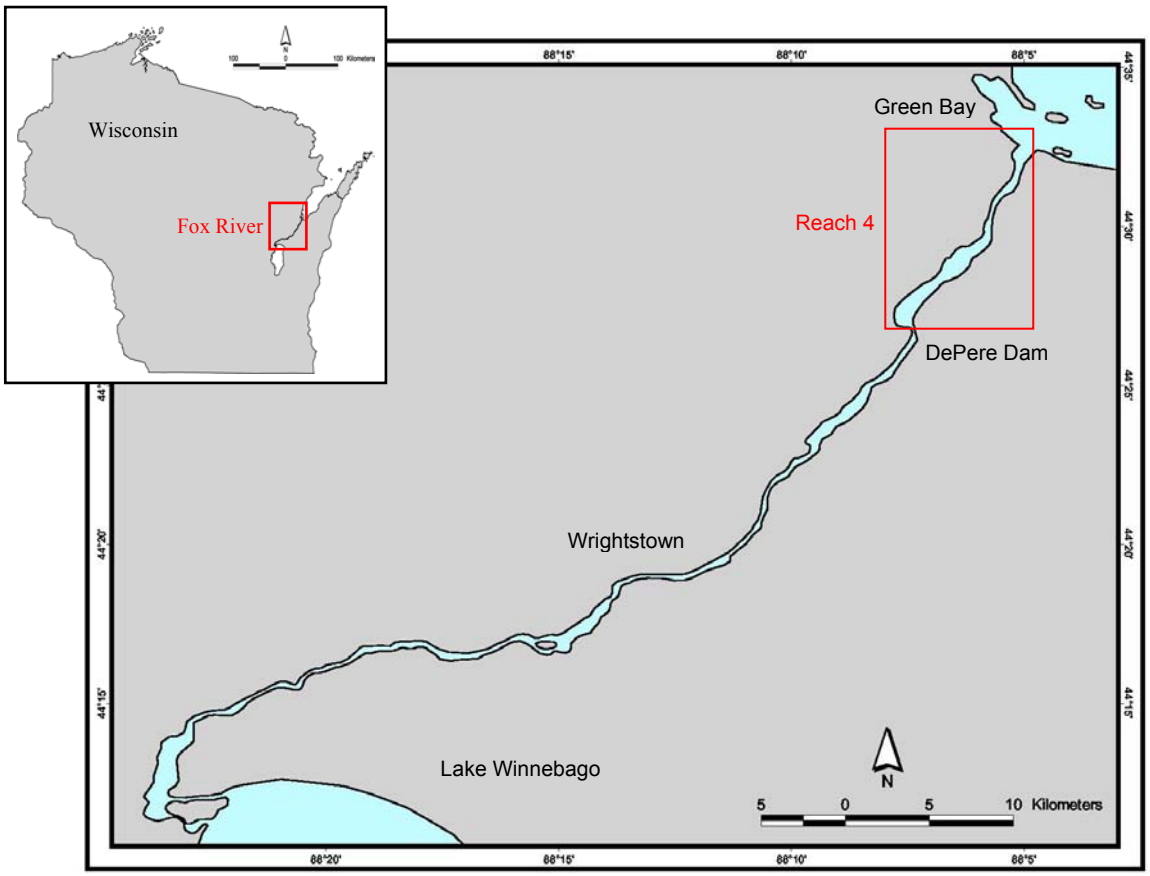

Figure 1.1 Map of the Lower Fox River

Reach 4 narrows significantly downstream of the Fort Howard Turning Basin and remains narrow and deep until Green Bay. The only significant tributary into this portion of the Lower Fox is the East River. The flow into Reach 4 is primarily over DePere Dam with the East river adding minimal flow (on the order of 10 percent) in the downstream portion. The flow over DePere Dam is primarily regulated by outflows from Lake Winnebago at the dams in Neenah and Menasha.

Outflows from Lake Winnebago are regulated according to a document known as the Linde Plan. This plan aims to provide water usage for hydropower and navigation, while preserving or enhancing fish, wildlife, wetland habitat, and water quality in the Lower Fox River and the Lake Winnebago Pool. The plan requires maintenance of a constant lake level during the navigation season and whenever ice is forming or breaking up. A minimum summer flow is mandated, along with winter flow constraints (U.S. Army Corps of Engineers, 2004).

Flow rates at Wrightstown have been recorded continuously since 1917, providing a long term data set for determination of flow recurrence intervals as shown in Table 1 (http://waterdata.usgs.gov/wi/nwis/rt; WDNR, 2000). Flow rates during a typical year vary from 30 to 280 m^3/s. High flow events are generally caused by opening of the dams or large storms. The highest flow rate on record is approximately 650 m^3/s and

corresponds to a 50 year recurrence interval. Two flow rates greater than 600 m^3/s have been recorded since 1917. Additionally, seiche motion in Green Bay has been shown to play a significant role in direction of flow in Reach 4 (comm. with Peter Hughes, USGS; Gailani et al., 1991).

A USGS stage gauge and a side-looking Doppler velocity meter are sited at the mouth of the river and provide a real-time record of flow, stage, and velocity at the mouth. The location is named Oil Tank Depot and marked in Figure 1.2.

The side-looking Doppler unit is a Sontek Argonaut SL 500 kHz side-looking Doppler velocity meter. The side-looking Doppler unit uses two acoustic beams to estimate the two-dimensional water velocity (X,Y) at a point in time. The beams travel a maximum of about 60m into the river from the Oil Tank Depot on the north bank of the river. The total river width at this point in the river is about 160m. The cross-sectional average flow velocity and discharge are calculated from a relationship between the side-looking Doppler velocity and numerous individual field discharge measurements made with a boat-mounted Acoustic Doppler Current Profiler (ADCP). Multiplying the velocity value by a factor of 0.8935 yields the average cross-sectional velocity, based on the current stage-area relationship for the site.

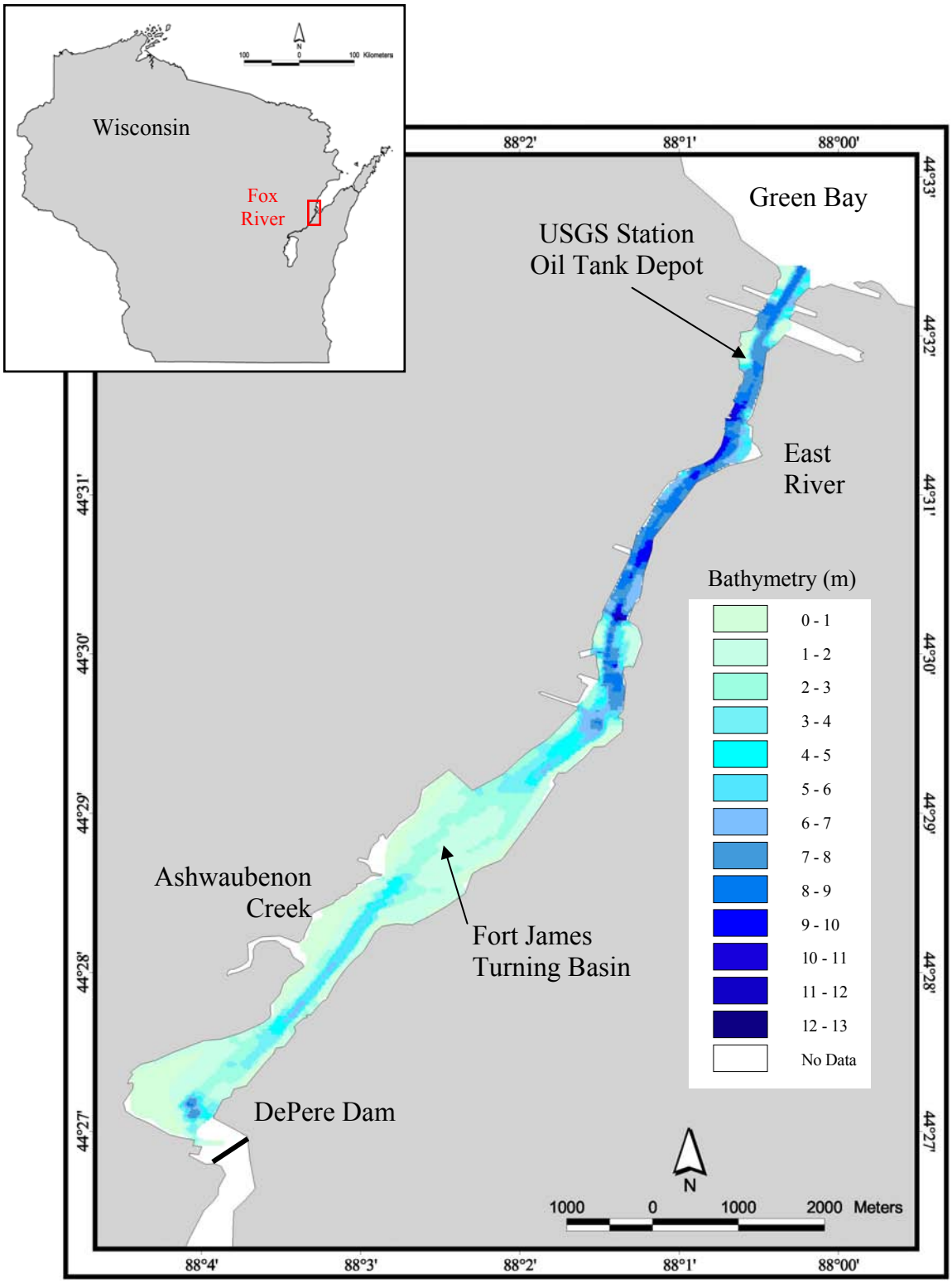

Figure 1.2 Reach 4 of the Lower Fox River including bathymetry.

Table 1.1 Summary of Lower Fox River Flow Rates at Wrightstown (Krug, et al., 1991)

Recurrence Interval (years)	Flow (m^3/s)	Flow (cfs)
2	360	12,700
5	481	17,000
10	544	19,200
25	612	21,600
50	651	23,000
100	685	24,200

1.2 Background

The Fox River Group (FRG), Wisconsin Department of Natural Resources (DNR), and independent academic institutions have undertaken past efforts to use numerical models to predict the hydrodynamic behavior of the Lower Fox River. One of the first detailed modeling efforts of the Lower Fox River was when the two-dimensional hydrodynamic and sediment transport model SEDZL was applied by researchers at the University of California, Santa Barbara (Gailani et al., 1991). Although this model reproduced suspended sediment concentrations and generally observed patterns of flow in the river, no hydrodynamic measurements were used to validate the model results. Following onto these efforts, Velleux and Endicott (1994) developed a mass balance model of the river which included a simplified hydrodynamic analysis of the river. This model was a one-dimensional description of flow in and out of different reaches of the river, but did not provide a detailed description of the hydrodynamic within each mass balance segment of the river. In 2000, Baird and Associates completed the application of the ECOM-siz-SEDZL model to Reach 4 of the river as part of a joint DNR and FRG effort (WDNR, 2000). The side-looking Doppler velocity meter in place at the Oil Tank Depot at the mouth of Reach 4 was used to validate model velocities at this location. The model produced generally good agreement with the data, but the validation only represented one point in a narrow relatively uniform depth region of the river and provided no measure of shear stress. The models listed here do not encompass all of the modeling efforts completed on the river, but are intended to represent the milestones in the sophistication of model application and validation.

1.3 Hydrodynamic Modeling Approach

The goals of this study are twofold. The first goal is to develop an extensively validated hydrodynamic model of Reach 4 of the Lower Fox River using detailed velocity profile measurements. The second goal is to utilize the validated model to predict shear stresses throughout Reach 4 so that a cap stability analysis can be conducted under design flow conditions. The approach developed to achieve these goals has been split into three phases:

- **Data Collection and Analysis**
    - Collect and analyze vertical profiles to calculate shear stresses and coefficients of friction
- **Model Development and Verification**
    - Develop model runs for data collection events
    - Refine model based on measured velocities to minimize error
- **Predictive Model Runs**
    - Conduct model runs for cap stability analysis under design flow conditions

Each of these phases is detailed in this report.

2.0 Data Collection

The following section outlines the general procedures used for and results obtained from the USGS hydrodynamic data collection efforts.

2.1 Hydrodynamic Field Measurements

The data collection involved four separate field deployments on Reach 4 of the river with the primary goal of measuring vertical velocity profiles along eight transects. The USGS collected velocity profile data using a boat mounted ADCP (Figure 2.1). Approximately three stationary vertical velocity profiles were collected along each transect.

Figure 2.1. The USGS used a downward looking Acoustic Doppler Current Profiler (ADCP) anchored at various stations to collect vertical velocity profiles. The ADCP can be seen here attached to side of the study vessel.

For this study, vertical velocity profiles were measured by taking the following steps at each observation point:

1. Handheld GPS devices manufactured by Garmin International were used to navigate a USGS vessel to pre-selected points of interest.
2. The vessel was steered bow into the wind or current.
3. Three anchors were set to hold the vessel in place: two in the upstream or upwind direction, and one in the downstream or downwind direction.
4. A depth finder was used to estimate the water depth at the current location.
5. The RDI ADCP (see Section 2.2 for a description) was lowered into the water on the end of an adjustable 10-foot aluminum rod.
6. The 10-foot rod was adjusted to allow the ADCP signal to completely reach the stream bottom. With 255 one-centimeter bins (and thus 2.55 meters of range), a common depth setting was 0.18 meters below the water surface. For areas with depths greater than 2.55 meters, the rod was lowered accordingly so that complete signal penetration was achieved.
7. The configuration of the ADCP unit was checked.
8. Vertical velocity profile data were collected until at least 300 good ensembles had been collected. Each measurement "ensemble" produces a complete, independent velocity profile using all four acoustic beams.
9. Data were recorded and the vessel was relocated to the next location.

2.2 Equipment Description

An RD Instruments 1200 MHz Workhorse Rio Grande Acoustic Doppler Current Profiler (ADCP) was used to make the water velocity profile measurements (http://www.rdinstruments.com/).

The ADCP employed for this work uses four separate acoustic beams to obtain two separate measurements of the water velocity: one in the horizontal and one in the vertical orientations. For each velocity estimate within the velocity profile, the ADCP calculated an "error velocity" as well, based on the difference between the two separate vertical velocity component estimates. The error velocity term provides a way to determine whether there are significant in-homogeneities in flow, as well as providing a check on the functioning of the equipment (RD Instruments, 1996). The "error velocity" term is used in software post-processing steps to reject velocity data that appear to have been collected during transient periods of highly variable flow. These velocities are rejected in the field and were not included in the analysis presented here.

The ADCP unit may be operated using a number of "modes". Each operating mode refers to a specific set of manufacturer-developed signal processing algorithms and parameters. Operating modes are generally fine-tuned to a specific range of environmental conditions.

RD Instruments Workhorse Rio Grande Water Mode 11 was the preferred mode of operation for the Lower Fox River vertical velocity profiles. The recommended applications for this mode include:

1. High resolution, shallow water profiling in slow moving rivers, streams and estuaries.
2. Boundary layer measurements.

The recommended limits and requirements for Mode 11 operation were ideal for Reach 4 of the Lower Fox River. These requirements include:

1. Shallow water (4m max. at 1200KHz)
2. Low flow velocity (< 1 m/s)
3. Small depth cell size (minimum 1 cm)
4. Low standard deviation of velocity measurement.

2.3 Measurement Events

The following sections provide a description of the four measurement events. Figure 2.2 shows the river flow at Wrightstown since May 2003 labeling all of the flow events.

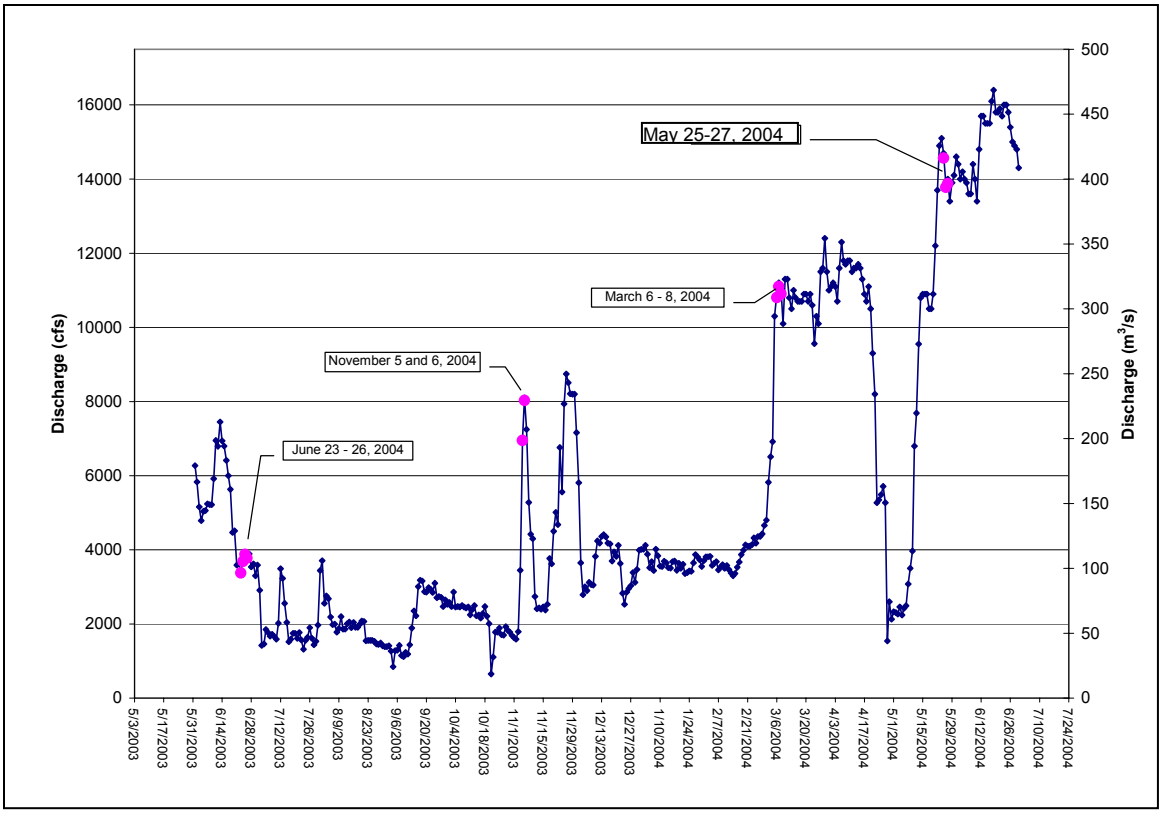

Figure 2.2. Flow rates in cfs and m^3/s at Wrightstown from May 2003 to July 2004. Labels represent the four measurement events.

June 2003

The June 2003 measurement event was characterized by relatively low flow over the DePere Dam combined with upriver winds which resulted in the river flow being dominated by seiche motion from Green Bay into Reach 4. Flow reversals were observed throughout Reach 4 during the June 2003 measurements event (comm. with Peter Hughes, USGS). Daily averaged flow rates at Wrightstown ranged from 96 to110 m^3/s for this period. Figure 2.2 shows the relative low flow of the river during this measurement event. Figure 2.3 shows detailed water level and current velocity data from the USGS water level gauge and side-looking Doppler velocity meter at the Oil Tank Depot near the mouth to Green Bay. The station is USGS 040851385 and illustrates the measurement event beginning on June 22, 2003. The zero water level corresponds to the IGLD 1985 vertical datum of 577.5 ft. Figure 2.4 presents flow rate measurements at Wrightstown during the June 2003 event. Figure 2.5 presents a map of all measurement locations. Data for twenty three vertical profiles were collected during this measurement period.

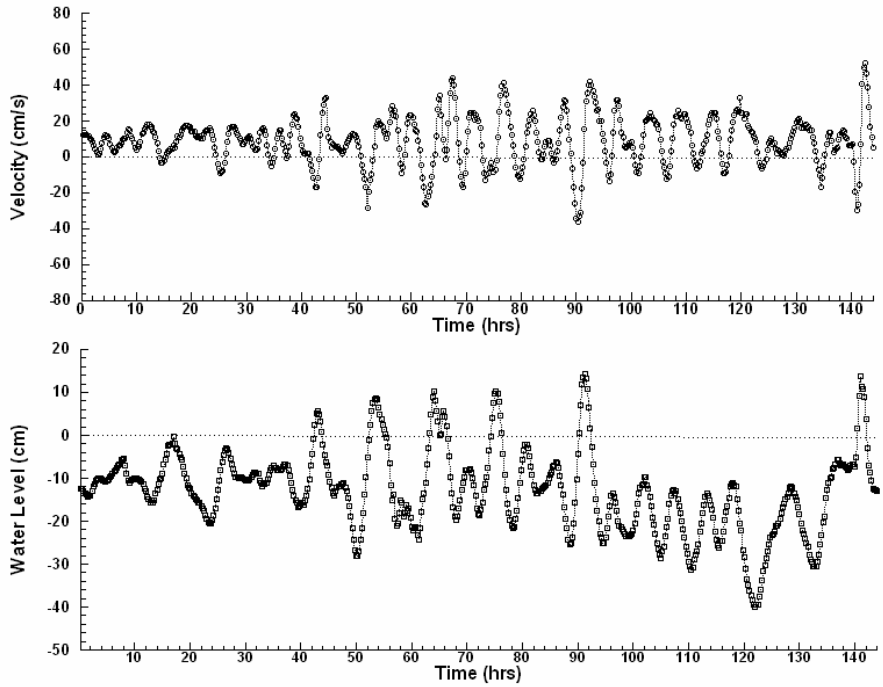

Figure 2.3 Water level and current velocity at the Oil Tank Depot station during the June 2003 low flow event. Timing begins at 00:00 hrs on June 22, 2003.

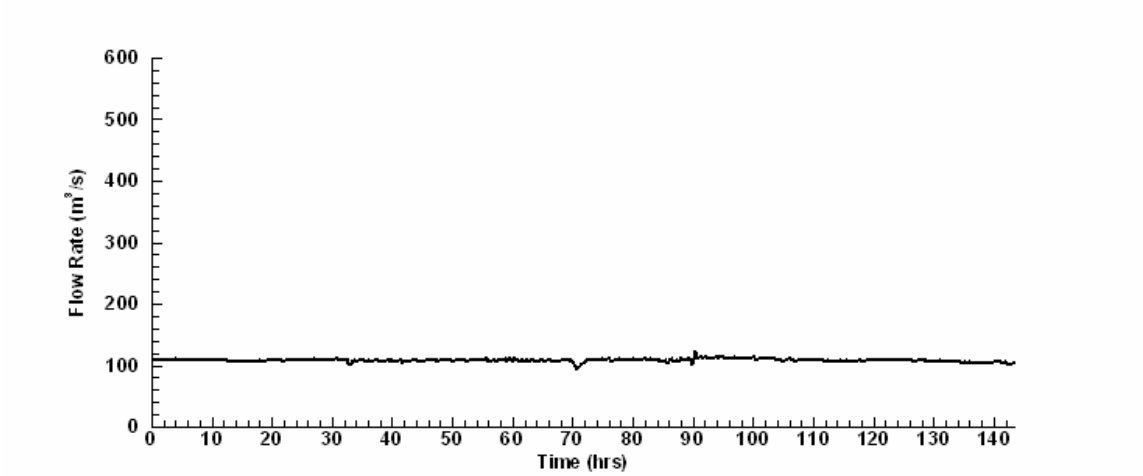

Figure 2.4 Flow rate measurements at Wrightstown for the June 2003 event. Timing begins at 00:00 hrs on June 22, 2003.

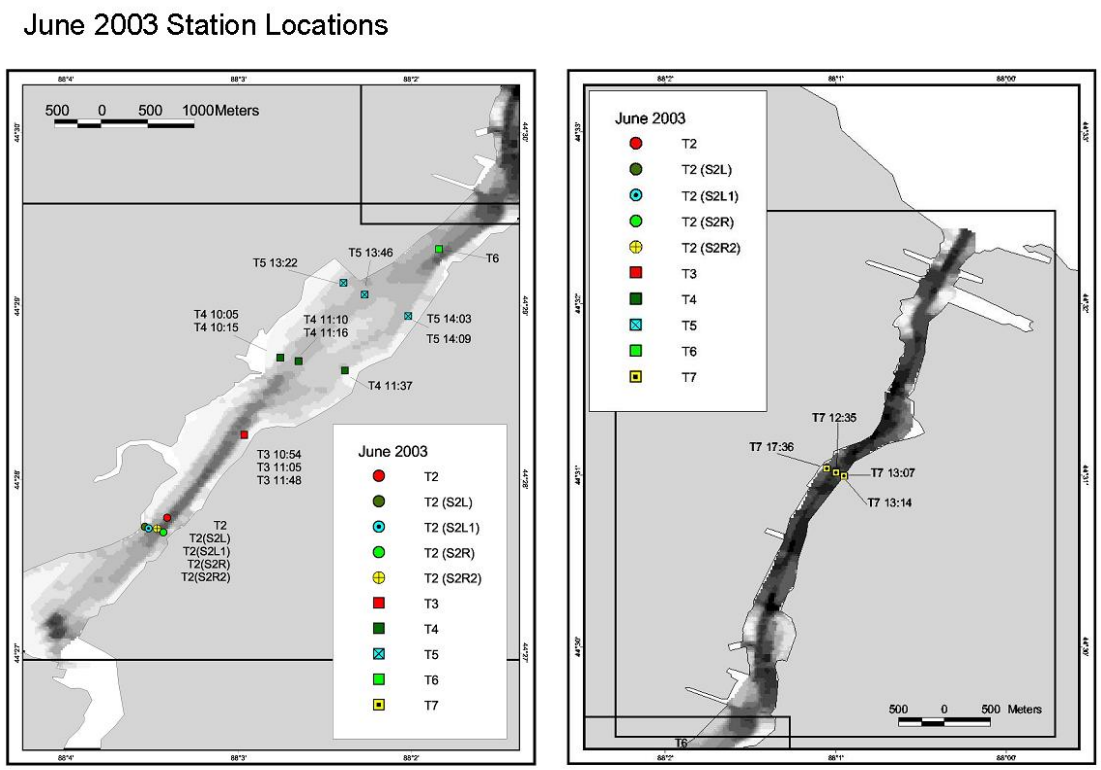

Figure 2.5 Vertical profile locations during the June 2003 event.

November 2003

The November 2003 measurement event was characterized by moderate flow over the DePere Dam resulting in downstream dominated flow with flow reversals occurring periodically due to seiche motion in Green Bay. Daily averaged flow rates at Wrightstown ranged from 97 to 229 m^3/s for this period. Figure 2.2 shows the flow during this measurement event, and Figure 2.6 shows detailed water level and current velocity data from the USGS Oil Tank Depot station during the same measurement period. Figure 2.7 presents flow rate measurements at Wrightstown during the November 2003 event. Figure 2.8 presents a map of all measurement locations. Data for twenty seven vertical profiles were collected during this measurement period.

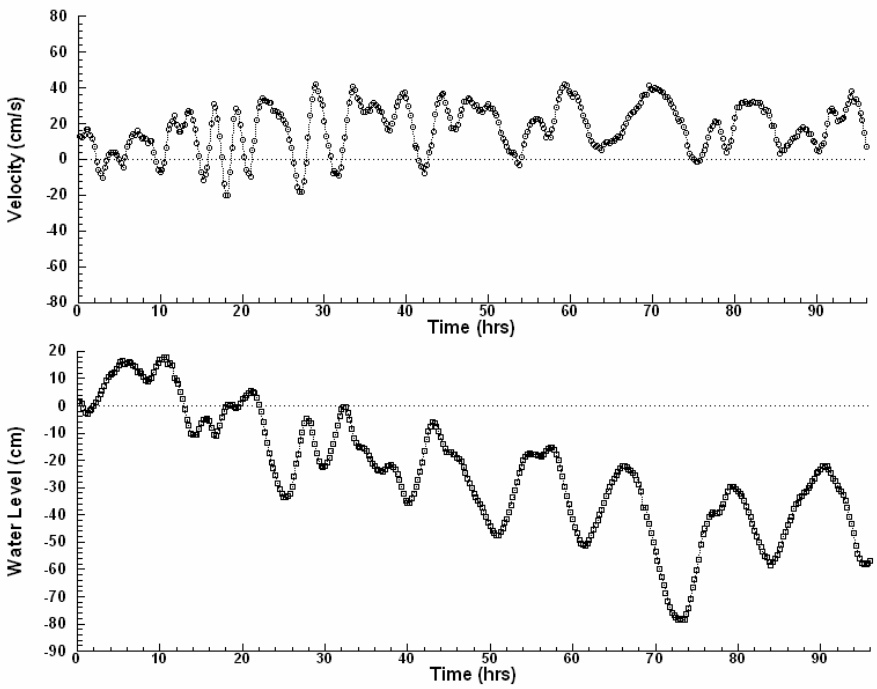

Figure 2.6 Water level and current velocity at the Oil Tank Depot station during the November 2003 moderate flow event. Timing begins at 00:00 hrs on November 4, 2003.

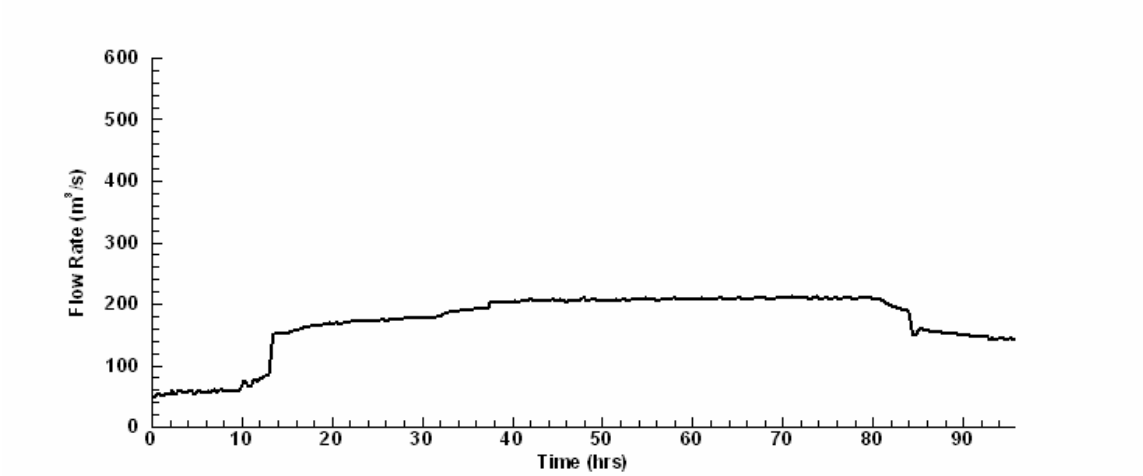

Figure 2.7 Flow rate measurements at Wrightstown for the November 2003 event. Timing begins at 00:00 hrs on November 4, 2003.

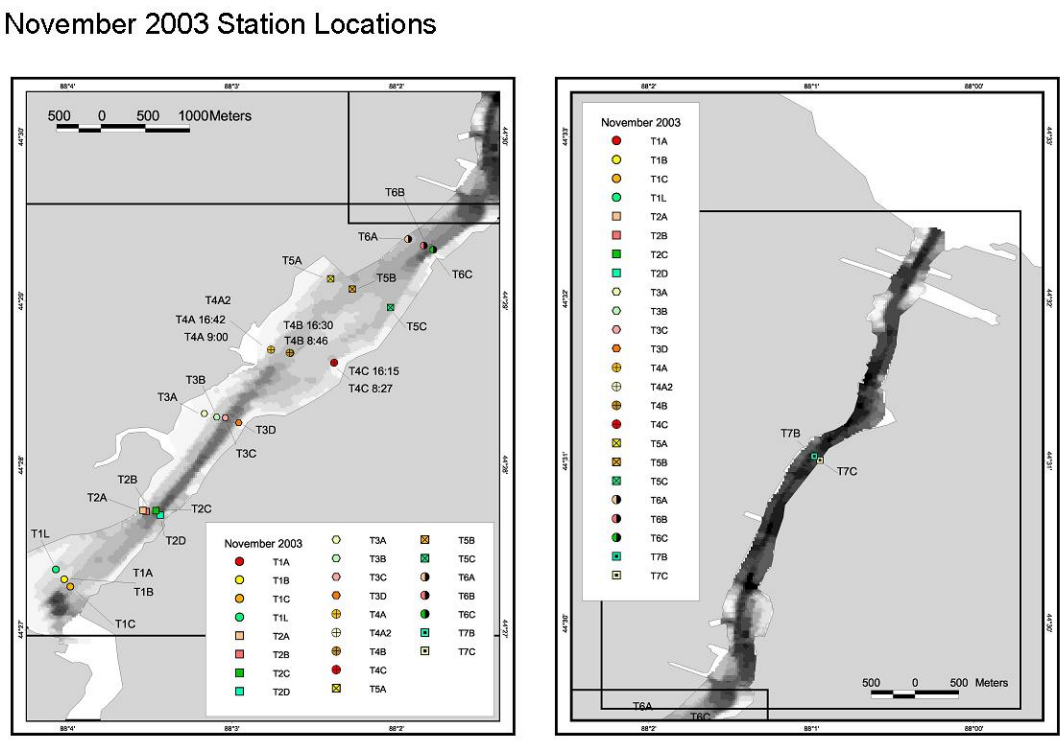

Figure 2.8 Vertical profile locations during the November 2003 field event.

March 2004

The March 2004 measurement event was characterized by moderate flow over the DePere Dam resulting in downstream dominated flow. Daily averaged flow rates at Wrightstown ranged from 291 to 317 m^3/s for this period. Figure 2.2 shows the relative moderate flow of the river during this measurement event, and Figure 2.9 shows detailed water level and current velocity data from the USGS Oil Tank Depot station during the same measurement period. Figure 2.10 presents flow rate measurements at Wrightstown during the March 2004 event. Figure 2.11 presents a map of all measurement locations. Data for twenty seven vertical profiles were collected during this measurement period.

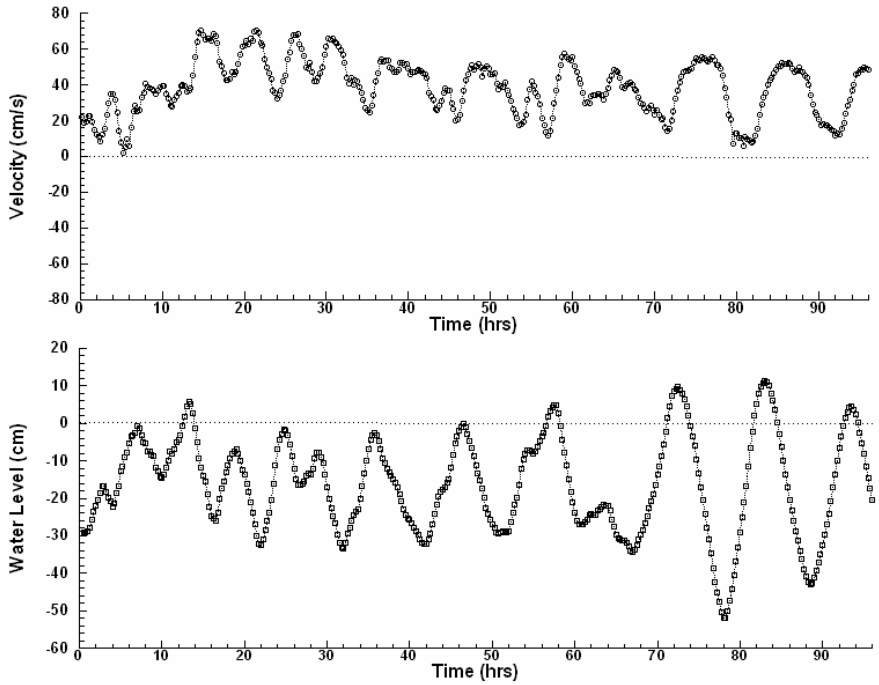

Figure 2.9 Water level and current velocity at the Oil Tank Depot station during the March 2004 moderate flow event. Timing begins at 00:00 hrs on March 5, 2004.

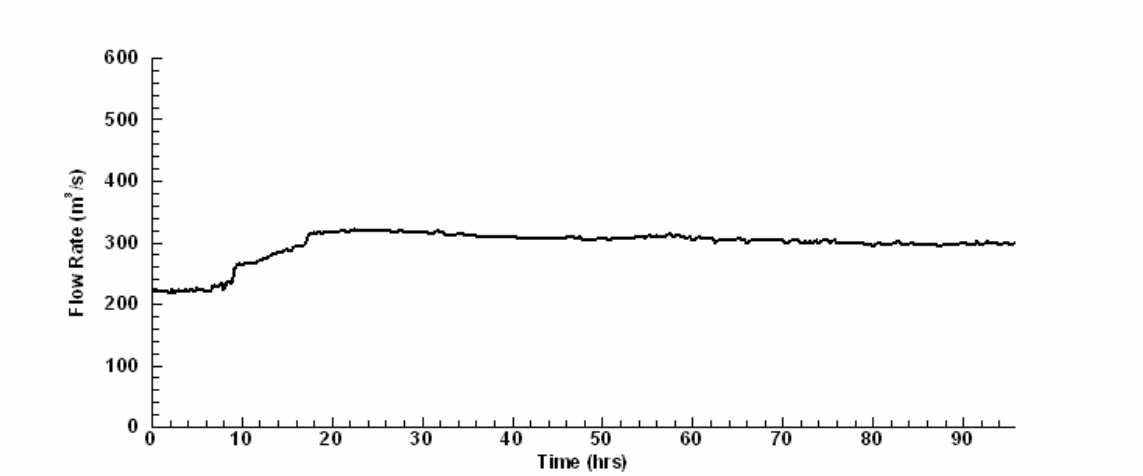

Figure 2.10 Flow rate measurements at Wrightstown for the March 2004 event. Timing begins at 00:00 hrs on March 5, 2004.

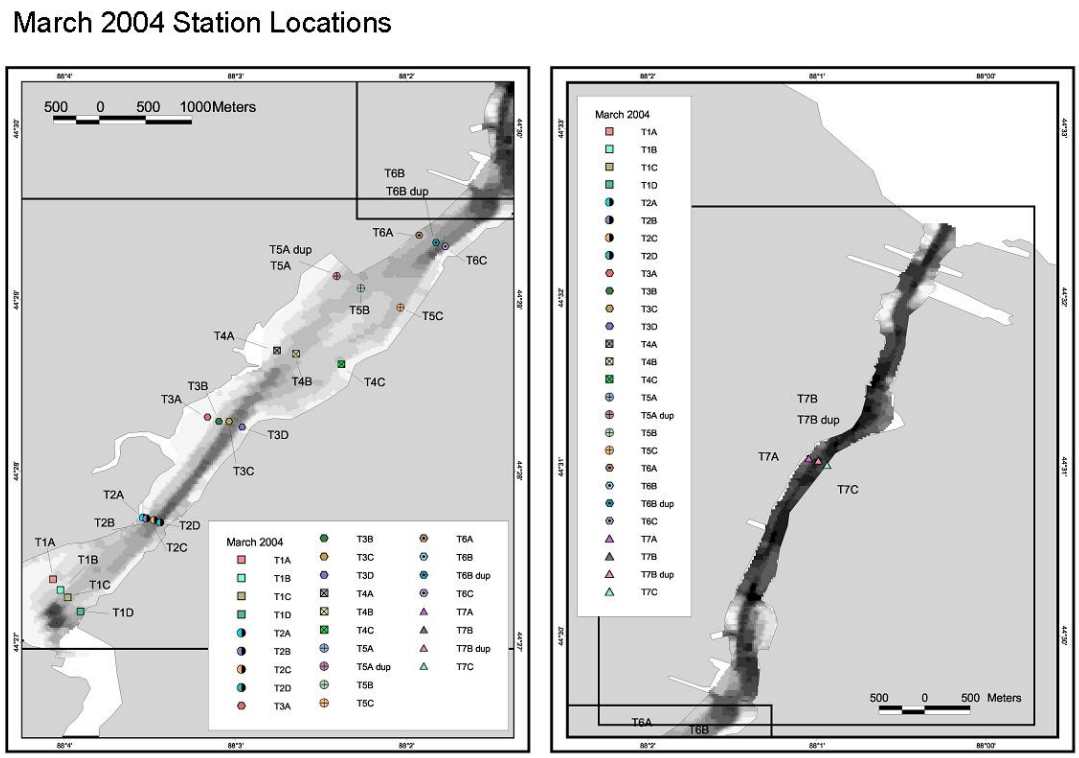

Figure 2.11 Vertical profile locations during the March 2004 field event.

May 2004

The May 2004 measurement event was characterized by high flow over the DePere Dam resulting in strong downstream flow approaching a five-year flow event. Daily averaged flow rates at Wrightstown ranged from 425 to 442 m^3/s for this period. Figure 2.2 shows the relative high flow of the river during this measurement event, and Figure 2.12 shows detailed water level and current velocity data from the USGS Oil Tank Depot station during the same measurement period. Figure 2.13 presents flow rate measurements at Wrightstown during the May 2004 event. Figure 2.14 presents a map of all measurement locations. Data for twenty nine vertical profiles were collected during this measurement period.

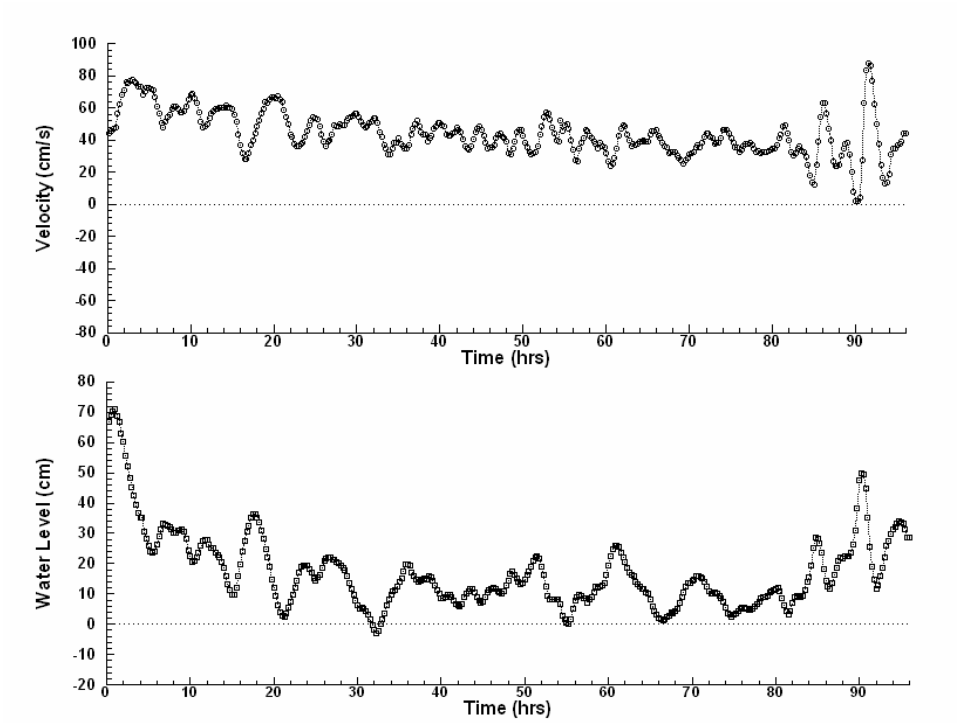

Figure 2.12 Water level and current velocity at the Oil Tank Depot station during the May 2004 moderate flow event. Timing begins at 00:00 hrs on May 24, 2004.

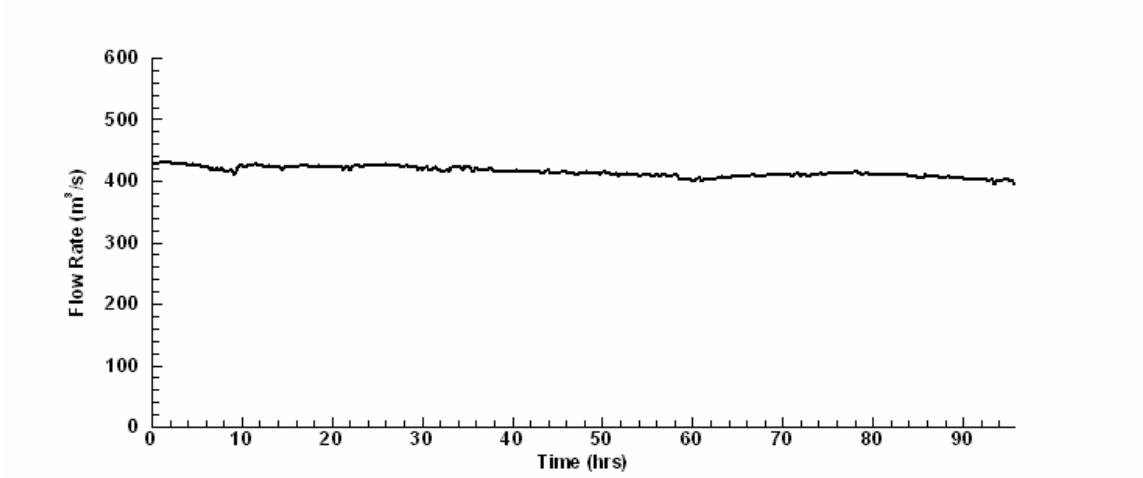

Figure 2.13 Flow rate measurements at Wrightstown for the May 2004 event. Timing begins at 00:00 hrs on May 24, 2004.

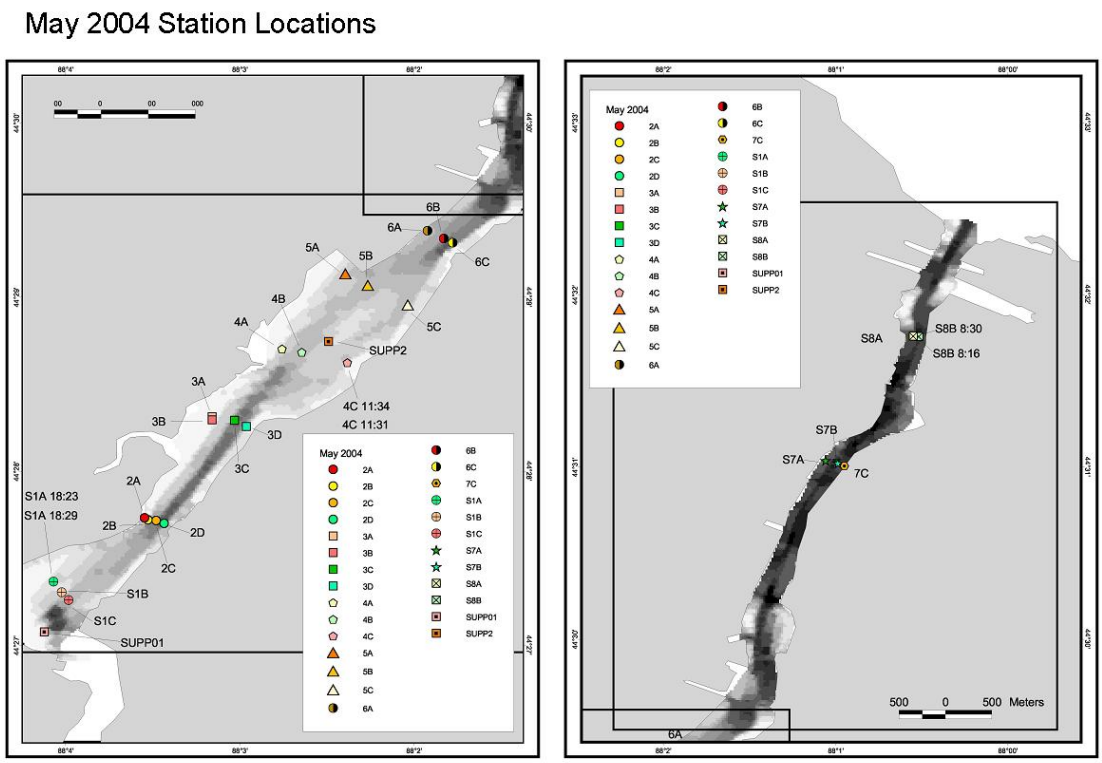

Figure 2.14 Vertical profile locations during the May 2004 field event.

3.0 Data Analysis

The vertical velocity profiles along transects were analyzed to determine the bottom shear stress and bottom roughness for the various locations and flow regimes in the river. An idealized vertical velocity profile is shown in Figure 3.1. This represents fully developed turbulent flow in a downstream direction. The profile shown is termed a logarithmic velocity profile. The velocity profile can be plotted using Equation 3.1.

$$u = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_o}\right) \tag{3.1}$$

where u is the current velocity (cm/s) at height z above the sediment bed (cm), κ is the von Karman constant, z_o is the bed roughness or zero velocity level (cm), and u_* is the bed shear velocity (cm/s) which is equal to the square root of the bed shear stress (τ, dynes/cm^2) over the fluid density (ρ, g/cm^2) or $\sqrt{\tau / \rho}$.

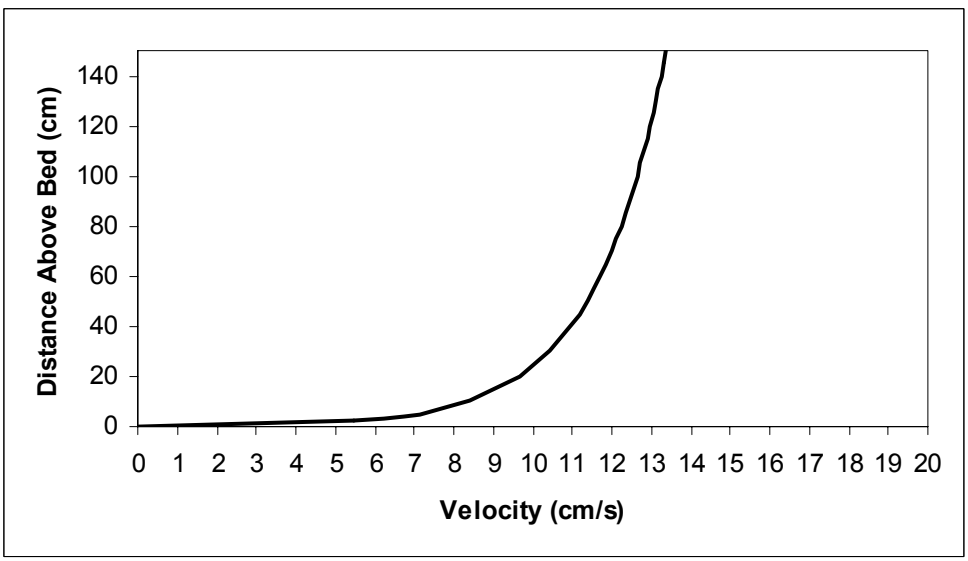

Figure 3.1 Idealized vertical velocity profile

Once vertical velocity profiles were obtained with the ADCP, the bottom shear stress and bed roughness at each location and flow rate can be determined by fitting Equation 3.1 to the data collected in the field. Equation 3.2 and Figure 3.2 show how the data from above may be plotted linearly on a logarithmic scale. When the line of Equation 3.2 is fit to the data, the z-intercept is equivalent to z_o and the slope is equivalent to the von Karman constant over the shear velocity (κ/u_*).

$$\ln(z) = \frac{\kappa}{u_*} u + \ln(z_o) \tag{3.2}$$

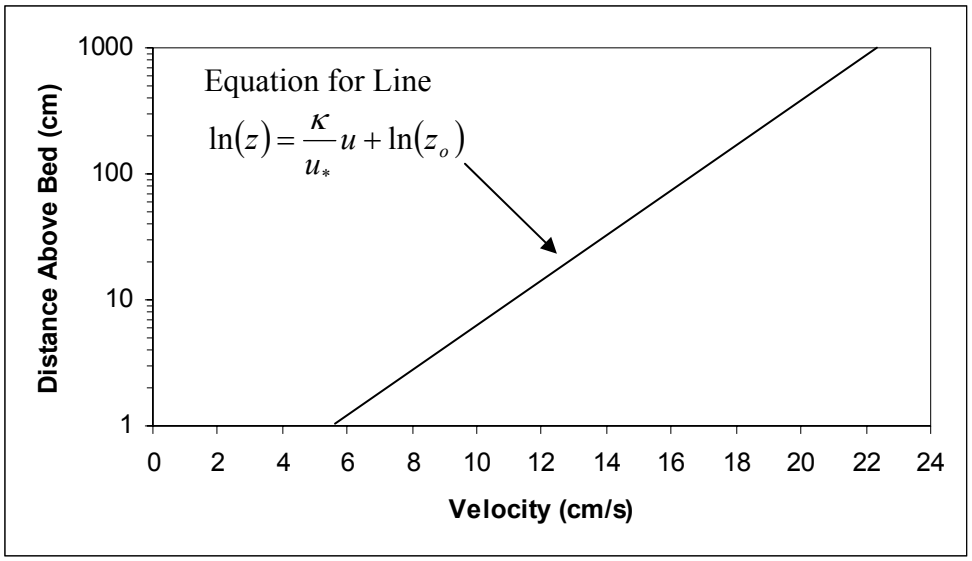

Figure 3.2 Sample logarithmic velocity profile plotted on a semi-log graph

Tables 3.1 through 3.4 present z_o and bottom shear stress calculations from the four field measurement events. These values are obtained through a log-linear curve fit of the measured vertical velocity profile using Equation 3.2.

Data points between 10 and 20 percent of the depth from the bottom were used to calculate the shear stress. The "wall" region for river flows is defined by some to encompass the range from less than or equal to 10 percent to 20 percent of the depth from the river bottom. The law of the wall has been identified as inherently valid only within the wall region, although it is commonly assumed that the law of the wall applies to the entire water column depth of uniform, steady river flows (Gonzalez, and others, 1996). For this reason, only data points falling between 10 and 20 percent of the depth from the river bottom were used.

If the correlation coefficient was 0.8 or greater that data was considered valid for shear stress and z_o calculations. Only data valid for these calculations are show in the tables below. Shear stresses for all events ranged from 0.1 to 13.8 dynes/cm^2.

The tables additionally show a calculated coefficient of friction, c_f. This coefficient was investigated for modeling applications and will be discussed in the following sections. The coefficient is calculated as:

$$c_f = \frac{\tau}{\rho u^2}$$

where u is the vertically averaged fluid velocity.

Table 3.1 June 2003 measurement event - 44 percent of data collected were valid for shear stress calculation.

Sample Location	Depth (m)	Average Velocity (cm/s)	z_o (cm)	Shear Stress (dynes/cm^2)	c_f
T2 (S2L)	1.3	18.3	0.0089	3.2	0.0095
T2 (S2L1)	3.0	20.1	0.0044	1.7	0.0042
T2 (S2R2)	6.3	19.2	0.0063	1.9	0.0051
T3	1.5	7.6	0.0035	0.4	0.0062
T7	4.9	9.8	0.0289	1.1	0.0117
T4	1.4	11.9	0.0031	0.9	0.0062
T4	1.3	12.2	0.0035	1.1	0.0071
T4	2.5	16.5	0.0007	0.7	0.0026
T4	2.5	15.2	0.0007	0.6	0.0027
T4	1.5	13.4	0.0007	0.6	0.0032

Table 3.2 November 2003 measurement event - 85 percent of data collected were valid for shear stress calculation.

Sample Location	Depth (m)	Average Velocity (cm/s)	z_o (cm)	Shear Stress (dynes/cm^2)	c_f
T1L	0.8	11.3	0.0027	1.2	0.0092
T1A	1.3	21.7	0.0003	1.5	0.0033
T1B	1.3	32.3	0.0001	2.7	0.0026
T1C	4.4	35.1	0.0001	2.4	0.0020
T2D	3.5	25.6	0.0000	1.0	0.0016
T2C	6.3	37.8	0.0006	3.6	0.0025
T2B	2.9	18.6	0.0019	1.4	0.0042
T2A	1.1	12.2	0.0066	1.8	0.0122
T3A	0.6	7.3	0.0070	1.2	0.0219
T3B	1.5	18.3	0.0024	1.8	0.0054
T3C	5.0	35.4	0.0006	3.6	0.0029
T3D	1.2	14.6	0.0004	0.7	0.0034
T4C	1.1	18.6	0.0016	2.1	0.0060
T4B	2.5	34.2	0.0002	2.7	0.0023
T4C	1.3	13.1	0.0047	1.5	0.0087
T4B	2.6	24.7	0.0003	1.5	0.0025
T5C	2.2	18.6	0.0005	0.9	0.0028
T5B	2.5	27.5	0.0001	1.4	0.0019
T5A	1.2	13.7	0.0003	0.6	0.0032
T6C	4.7	31.4	0.0016	3.8	0.0039
T6B	3.9	34.5	0.0026	5.3	0.0045
T6A	1.5	22.3	0.0018	2.6	0.0053
T7C	4.6	14.6	0.0017	0.7	0.0035

Table 3.3 March 2004 measurement event - 63 percent of data collected were valid for shear stress calculation.

Sample Location	Depth (m)	Average Velocity (cm/s)	z_o (cm)	Shear Stress (dynes/cm^2)	c_f
T1A	1.5	31.6	0.00105	4.1	0.0041
T1B	1.5	33.0	0.00001	1.5	0.0013
T1C	4.4	37.3	0.00001	1.4	0.0010
T2A	1.0	25.0	0.00005	1.3	0.0021
T2B	2.8	39.0	0.00019	3.3	0.0022
T2C	6.1	54.9	0.00385	13.0	0.0043
T2D	4.9	38.1	0.00109	4.9	0.0034
T3B	1.4	24.1	0.00033	1.8	0.0031
T3D	1.4	21.7	0.00173	2.6	0.0055
T4B	2.6	46.4	0.00068	6.3	0.0030
T5B	2.7	17.7	0.00006	0.5	0.0015
T5C	2.2	14.0	0.00218	1.0	0.0049
T6A	2.0	21.0	0.00218	1.9	0.0043
T6B dup	4.4	27.1	0.00001	0.9	0.0012
T6C	5.0	24.4	0.00143	2.0	0.0034
T7A	5.3	37.8	0.00004	2.4	0.0017
T7C	5.5	19.8	0.00016	0.8	0.0022

Table 3.4 May 2004 measurement event - 67 percent of data collected were valid for shear stress calculation.

Sample Location	Depth (m)	Average Velocity (cm/s)	z_o (cm)	Shear Stress (dynes/cm2)	c_f
S1B	1.6	43.4	0.0029	11.2	0.0059
S1A	1.6	36.6	0.0004	4.1	0.0031
S1A	1.6	37.8	0.0024	8.1	0.0059
3A	1.0	15.4	0.0004	1.0	0.0041
3B	1.8	34.1	0.0004	3.2	0.0028
3C	5.4	50.6	0.0004	6.7	0.0026
3D	1.9	21.4	0.0006	1.4	0.0031
4C	1.8	17.9	0.0041	2.0	0.0062
4B	3.1	38.1	0.0033	8.4	0.0058
4A	1.8	16.0	0.0058	1.9	0.0074
5A	1.7	12.3	0.0043	1.0	0.0067
5B	3.1	34.8	0.0002	2.8	0.0023
5C	2.5	24.2	0.0008	1.8	0.0031
6C	5.4	29.6	0.0015	3.3	0.0037
6B	4.5	36.9	0.0000	2.1	0.0016
6A	2.1	25.3	0.0017	2.6	0.0041
2D	4.8	43.9	0.0002	4.2	0.0022
2C	6.5	51.9	0.0005	7.1	0.0026
2B	2.4	43.3	0.0001	3.4	0.0018
2A	1.5	36.2	0.0004	4.0	0.0031
S8B	8.3	38.4	0.0000	2.0	0.0014
S8A	8.1	51.4	0.0053	13.8	0.0052
S7A	6.2	9.9	0.0001	0.1	0.0015
7C	5.8	35.5	0.0009	4.1	0.0033

4.0 Hydrodynamic Model

The following section outlines the theoretical and numerical formulations of the hydrodynamic model used on Reach 4 of the Lower Fox River.

4.1 General Model Formulation and Assumptions

Three-dimensional, time-dependent hydrodynamic models of currents in surface waters are more general and, at least in principle, more accurate than both two-dimensional and one-dimensional, time-dependent models. Because of this, much effort has been expended on the development of three-dimensional models. However, in practice, three-dimensional models consume large amounts of development and computer time.

In contrast to three-dimensional models, two-dimensional (vertically-integrated or vertically-averaged), time-dependent models consume much less development and computer time and are much easier to understand and use. In addition, they are quite often as accurate as three-dimensional models. This is especially true for relatively shallow waters which are well-mixed vertically and where density stratification is therefore not significant. In these cases, two-dimensional models are quite accurate for predicting currents and also are well–accepted for predicting the transport of sediments and contaminants (e.g., Ziegler, 2002).

In reality, the validity of two-dimensional models is more general than this. This has been demonstrated by Wang, et al. (1995) who used numerical models to investigate the transport and fate of sediments in Green Bay for a range of conditions. In this investigation, they used (a) a three-dimensional transport model with no vertical stratification present, (b) a three-dimensional model with strong vertical temperature stratification present, and (c) a two-dimensional (vertically-integrated) model. The predictions of sediment transport and fate by all three models were remarkably similar and, for all practical purposes, were identical. The reasons for this are: 1) shear stresses due to both wave action and currents cause much larger stresses in shallow waters; and 2) in shallow waters, vertical stratification is greatly reduced due to strong vertical mixing and vertical currents. The result is that sediment concentrations and transport are largest in nearshore, shallow waters where sediment transport can be well approximated by a vertically-integrated model. In off-shore waters, these quantities are much smaller and, because of this, do not have to be approximated as accurately.

For these reasons, a two-dimensional (vertically integrated), time-dependent model of currents, SEDZL, will be used here as a basis for the model. Although it is possible that some three-dimensional velocity structure is present in Reach 4 of Lower Fox River, the USGS velocity profiles taken throughout the river during a wide range of flow conditions gave no indicators of a bidirectional flow. Bidirectional flow would the primary sign of three-dimensional flow structure in the river.

The vertically integrated hydrodynamic equations used in SEDZL are (Ziegler and Lick, 1986)

$$\frac{\partial \eta}{\partial t} + \frac{\partial U}{\partial x} + \frac{\partial V}{\partial y} = 0 \tag{4.1}$$

$$\frac{\partial U}{\partial t} + gh\frac{\partial \eta}{\partial x} = \tau_x^w - \tau_x^b + A_H\left(\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2}\right) - \frac{\partial (U^2/h)}{\partial x} - \frac{\partial (UV/h)}{\partial y} \tag{4.2}$$

$$\frac{\partial V}{\partial t} + gh\frac{\partial \eta}{\partial y} = \tau_y^w - \tau_y^b + A_H\left(\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2}\right) - \frac{\partial (UV/h)}{\partial x} - \frac{\partial (V^2/h)}{\partial y} \tag{4.3}$$

where g is the acceleration due to gravity, $h = h_o + \eta$ is the total water depth, $h_o(x, y)$ is the equilibrium water depth, $\eta(x, y)$ is the surface displacement from equilibrium, and U and V are vertically integrated velocities defined by

$$U = \int_{-h_o}^{\eta} u\, dz \tag{4.4}$$

$$V = \int_{-h_o}^{\eta} v\, dz \tag{4.5}$$

where u and v are the velocities in the x and y directions, respectively, and z is the vertical coordinate. The bottom stress is represented by τ^b whose components are given by

$$\tau_x^b = c_f\, q\frac{U}{h} \tag{4.6}$$

$$\tau_y^b = c_f\, q\frac{V}{h} \tag{4.7}$$

where q is the velocity magnitude and c_f is a bottom shear stress friction factor typically calculated using a log-layer distribution of velocity. The calculation of c_f in Reach 4 is detailed in the next section. The surface wind stress is τ^w; it is included for generality in the formulation, but is assumed to be zero in the present calculations.

The value of the eddy viscosity, A_H, is chosen as the minimum value required for numerical stability; it is therefore dependent on local grid size. A volume integral method is used to derive finite difference equations from the governing equations presented here. The resulting finite difference equations are second-order accurate, explicit, and conservative. Stability and boundary condition concerns for this numerical formulation are discussed in more detail in Zeigler and Lick (1986).

4.2 Bottom Shear Stress

The bottom stress in the hydrodynamic model is calculated from the vertically averaged velocity in the hydrodynamic model through Equations 4.6 and 4.7. According to the logarithmic law (Equation 3.1) c_f can be calculated from an ideal logarithmic velocity (i.e. the law of the wall) by

$$c_f = \frac{\kappa^2}{\left(\ln \frac{h}{2z_o}\right)^2} \tag{4.8}$$

where κ is the von Karman constant (0.42), z_o is the zero velocity level. As the zero velocity level increases or as the depth of water decreases, c_f increases. In general modeling applications, z_o is related to grain size and ripple or dune features on the sediment bed surface (van Rijn, 1993). z_o can also be directly measured through the velocity profile as shown in the previous sections. Determination of z_o for the Reach 4 model will be discussed in the following sections.

5.0 Fox River Model

This section outlines the setup of the SEDZL hydrodynamic model for Reach 4 of the Lower Fox River. Additionally, the specification of boundary conditions, model refinement, and comparison with the field measurements is presented.

5.1 Model Setup and Boundary Conditions

The SEDZL two-dimensional vertically averaged hydrodynamic model was utilized to model the flow in Reach 4. A rectangular grid was selected for the model as opposed to a curvilinear grid. The rectangular grid was selected due to the rapid changes in width along the length of the river. These rapid changes in width can create large grid gradients in curvilinear models that can be avoided through a fine resolution rectangular grid. A 30 m by 90 m rectangular grid was generated to describe Reach 4 (Figure 5.1). The water depths at each node were defined from bathymetry generated by The Johnson Company from sounding data collected by Ocean Surveys, Inc. in 1998 (OSI,1998), and provided to Sea Engineering for incorporation into the model. The depth measurement nearest to the center of each grid node was used to define the depth for that node since the resolution of the bathymetry was greater than the 30 m by 90 m grid.

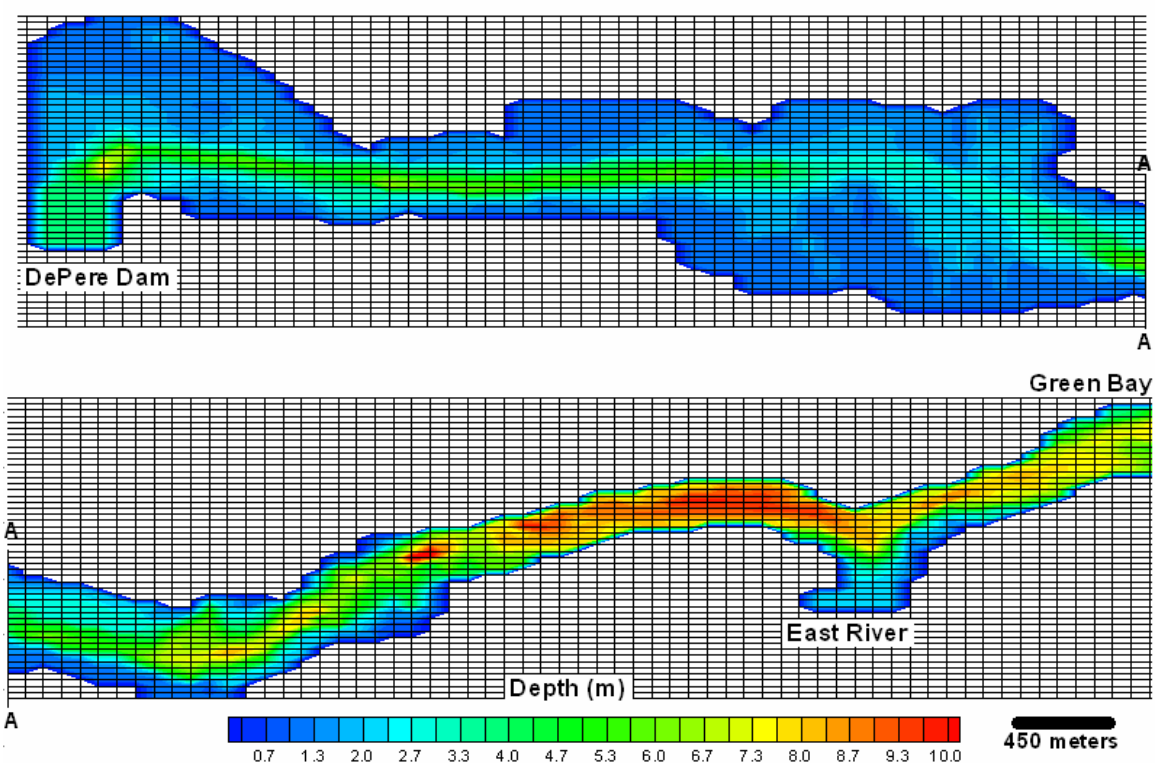

Figure 5.1 Reach 4 model grid (30 m by 90 m) and bathymetry.

The predominant flow into this portion of the river is from the DePere Dam. Approximately 10 percent of any given flow at the DePere Dam concurrently flows in through the East River, but only impacts the extreme downstream portion of the river (Gailani et al., 1991). The flow through the East River was neglected as part of this study due to its small contribution to only the downstream portions of the river. Additionally, the regions below the East River are not being considered for sediment capping. Flow contributions due to runoff and other smaller tributaries were also considered to be negligible. Therefore, the inlet boundary condition specified for the model was the DePere Dam. Historic flow records show a strong correlation (R > 0.95) between the flow over the DePere Dam and the flow measurements at Wrightstown (Figure 5.2). Daily averaged flow rates at Wrightstown were used to specify the upstream boundary conditions for the validation cases since data at the DePere Dam is no longer recorded.

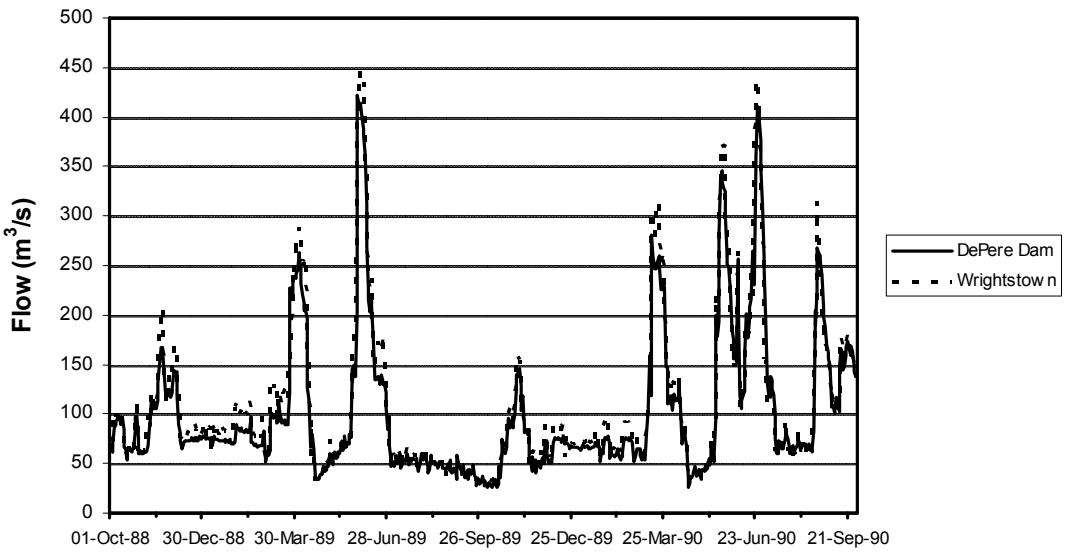

Figure 5.2 Comparison of flow rates at DePere Dam and Wrightstown

Seiche motion in Green Bay can have a significant affect on the flow in Reach 4 by driving flow reversal when the seiche amplitude is large enough (See Figures 2.3 and 2.5). The USGS gauge at the Oil Tank Depot at Green Bay was used to specify water levels at the mouth of the river. Figures 2.3, 2.5, 2.7, and 2.9 show water level measurements at the mouth for all four measurement events. These records were used to specify the model boundary.

5.2 Model Refinement

The hydrodynamic model was set up with appropriate boundary flow rates and water levels for each of the four measurement events. The modeling period started at 0000 hours the day prior to the first measurement for each event to allow at least 24 hours for model start-up. Start-up effects typically occur in hydrodynamic models as the model

starts from a zero flow initial condition and ramps flow up to the desired level. The start-up can result in oscillations in the model solution that take some time to dampen out. Modeled velocities were extracted at the same times and locations as during the measurement events for comparison.

The primary measurements available for model refinement and validation are the velocities. Although shear stress maps are the goal of the modeling effort, comparisons must be made with directly measured data instead of calculated quantities. For this reason, the vertically averaged velocity values were compared to evaluated model performance based on that same parameter.

The initial model predicted the continuous velocity measurements at the Oil Tank Depot side-looking Doppler velocity meter to within 20 percent of measured values including flow reversals. Plots of these results are shown in the following sections. This gave confidence that the boundary conditions were correctly specified and that the large scale flow patterns in the river were being reproduced correctly. The next step was the comparison of point measurements of velocities throughout each modeled event. The initial comparison of the velocities in the upstream half of the river showed an average agreement within 30 percent between measured and modeled velocities. But the downstream portion of the river model tended to over predict the measured velocities by as much as 150 percent.

Upon examination of the model grid, depths selected as representative of the grid elements in some areas were found to be shallower than the actual average depths as measured by the ADCP profiles. This is because the center of each grid element for the model was selected from the nearest point from the bathymetry survey data. The selected depth at some locations was not representative of the average depth across the 30 m by 90 m grid element. Modeled depths were examined at locations where measured depths from the ADCP profiles were available. Adjustments were made at locations where the model depths over a grid node did not agree with depths obtained from the ADCP measurements.

The bottom shear stress balances the downstream momentum of flow in a river. This balance of forces plays a significant role in the velocity magnitudes throughout the river. Thus, the shear stresses from the measurements need to be compared with those modeled for accuracy to ensure that the flow patterns and magnitudes are accurate. As stated earlier, the calculation of shear stress in the model is dependent upon the coefficient of friction, c_f; therefore, the comparison of measured versus modeled results was done with the c_f. According to the law of the wall c_f is dependent upon depth and z_o (Equation 4.8). c_f was also determined for the shear stresses calculated from the measurement events and is shown in the Tables 3.1 through 3.4. Figure 5.3 shows a plot of the coefficient of friction as a function of depth.

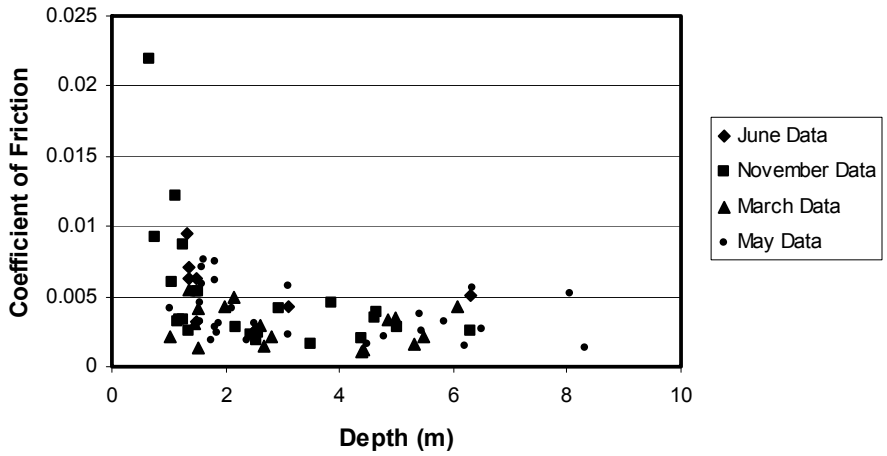

Figure 5.3 c_f values determined from measurements as a function of depth.

Since there is not sufficient information to develop a map of z_o for the entire model domain, it was initially assumed that c_f is a function of depth alone and that z_o is roughly constant. The law of the wall (Equation 4.8) can then be applied to the data with z_o equal to the average from the measurements ($z_o = 0.003$ m) and is shown in Figure 5.4. The correlation coefficient of the law of the wall to the data was only 0.55. It is clear from Figure 5.4 that the law of the wall model greatly under predicts the c_f in shallow water areas less than 2 m deep. Some idea of z_o variation in the river would be required for an accurate law of the wall prediction, but unfortunately no correlation of z_o to any parameter was seen in the data. Since large portions of the river are less than 2 m of depth, it was necessary to develop another function to accurately determine the c_f in these areas.

A regression of the data was conducted, and it was found that a logistic function most accurately reproduced the behavior throughout the range of depths. The correlation coefficient for the logistic model to the data is 0.77. The logistic function is shown in Equation 5.1 and in Figure 5.4. For application in the model, c_f was limited to less than the maximum value of 0.15 for a 0.75 m water depth. This represents the limit of the measured data.

$$c_f = \frac{0.004}{1 - 1.9\exp(-1.28\,h)} \tag{5.1}$$

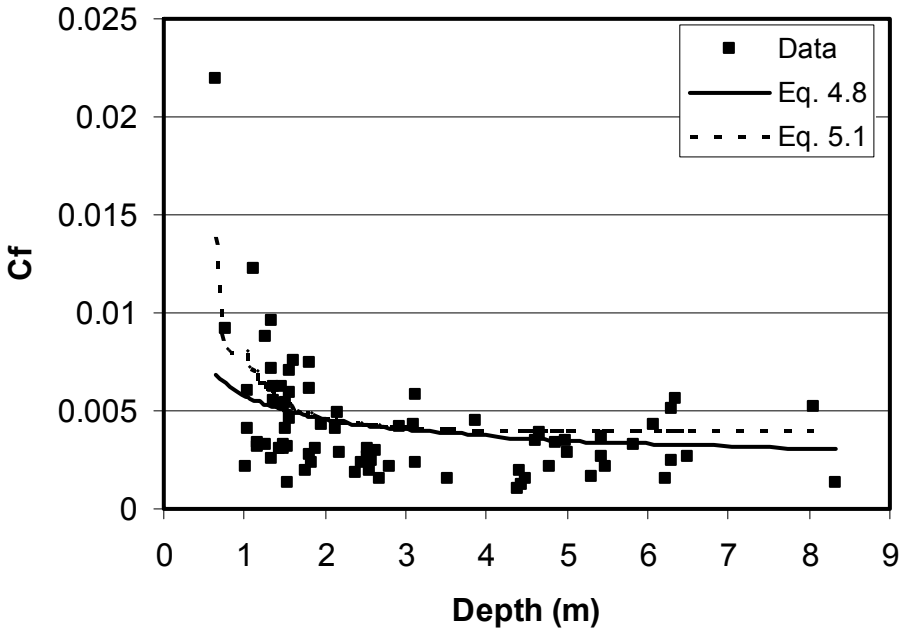

Figure 5.4 Two models applied for the calculation of c_f .

5.3 Model Validation

The depth and c_f model refinements were applied to the model for the four measurement events. The modeled and measured vertically averaged velocity comparisons showed a correlation coefficient of 0.7 or greater for each individual event. The May event, the measurement events used for model validation, had a correlation coefficient of 0.89 which was the highest of all four events. Figure 5.5 shows a plot of modeled versus measured velocities. The furthest outliers generally occurred during periods of rapid flow variation or upstream flow at the mouth. No loss of correlation is observed as flow rates over the DePere Dam increased.

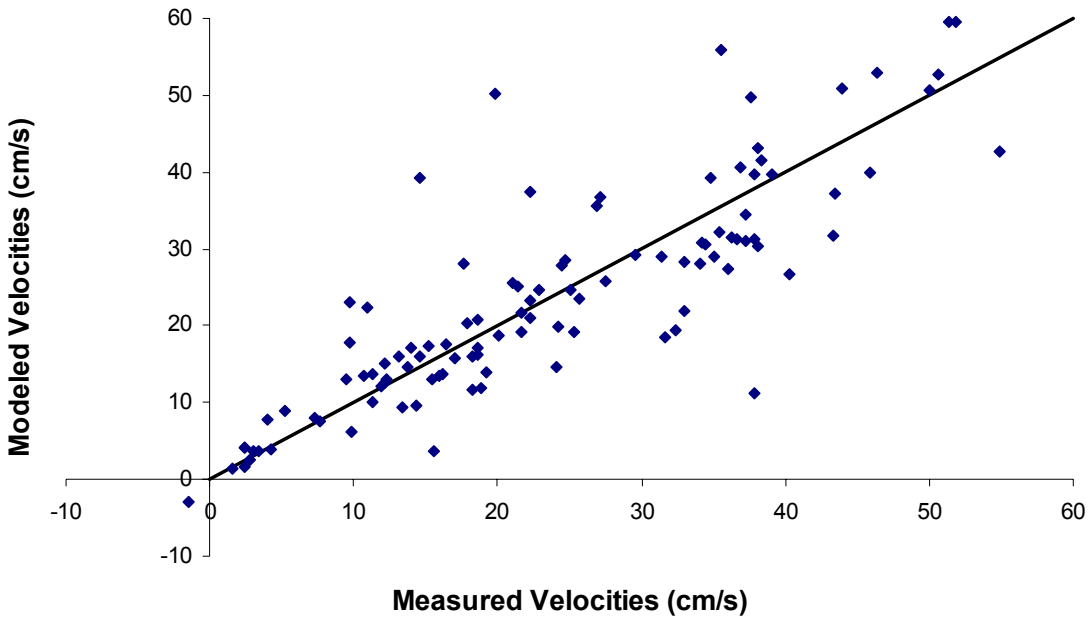

Figure 5.5 Comparison of measured and modeled vertically averaged velocities for all field measurement events. The line represents a 1 to 1 slope.

June Event

The model run for the June 2003 measurement event covers the period from June 23rd through June 27th of 2003. Figure 5.6 shows the measured data compared with modeling results for the USGS Oil Tank Depot water level gauge and side-looking Doppler velocity meter. The model shows excellent agreement with the data as well as accurately reproducing the flow reversals due to seiche motion. Figures 5.7 and 5.8 show velocity and shear stress plots for the maximum upstream flow due to seiche effect during the measurement event. The maximum shear stress modeled during the maximum upstream flow was 6 dynes/cm^2 and occurred approximately 400 m downstream of the East River in the center channel. Figures 5.9 and 5.10 show velocity and shear stress plots for the maximum downstream flow during the measurement event. The maximum shear stress modeled during the maximum downstream flow was 30 dynes/cm^2 and occurred approximately 400 m downstream of the East River in the center channel. This location is a localized deep channel that the flow accelerates through creating a localized high shear. Because the high shear is only in a small region, the shear stress contours in Figure 5.8 and following shear stress plots encompass shear stress limits more representative of Reach 4.

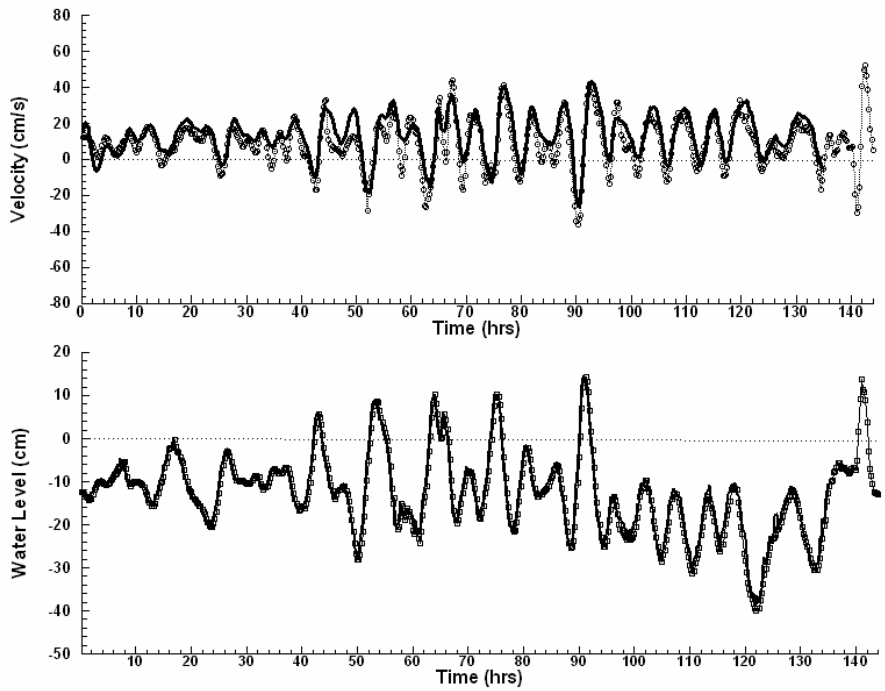

Figure 5.6 Modeled and measured velocities and water levels from the USGS Oil Tank Depot site for the June 2003 event. Model results are shown with a solid line.

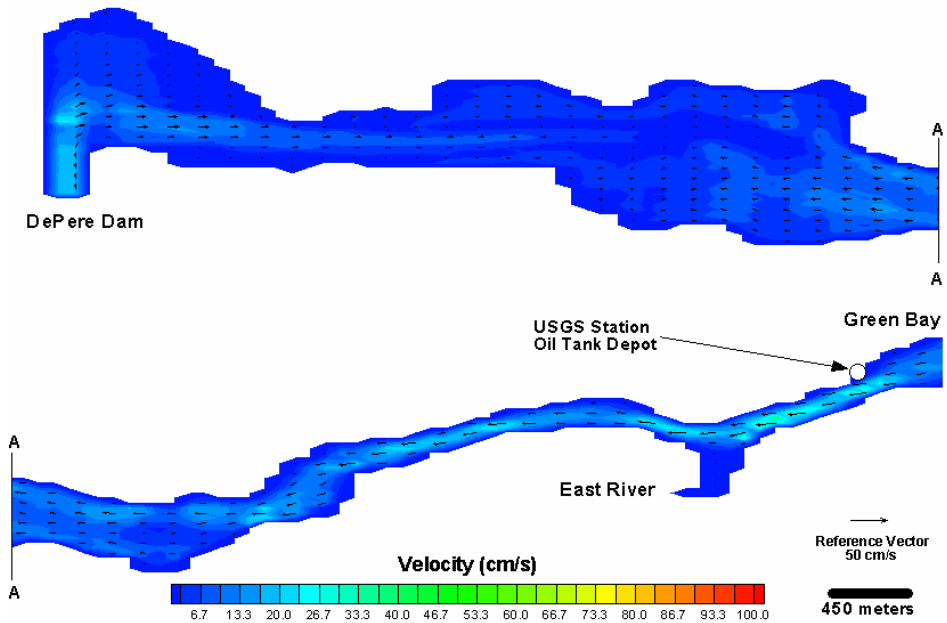

Figure 5.7 Modeled velocity vectors and contours during the maximum upstream flow for the June 2003 event.

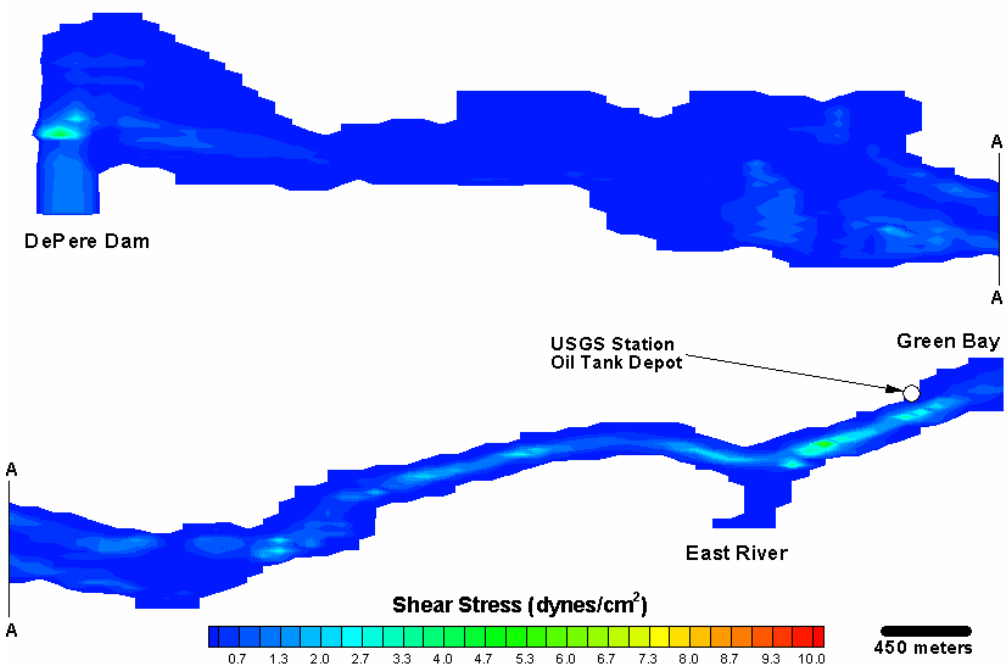

Figure 5.8 Modeled shear stress contours during the maximum upstream flow for the June 2003 event.

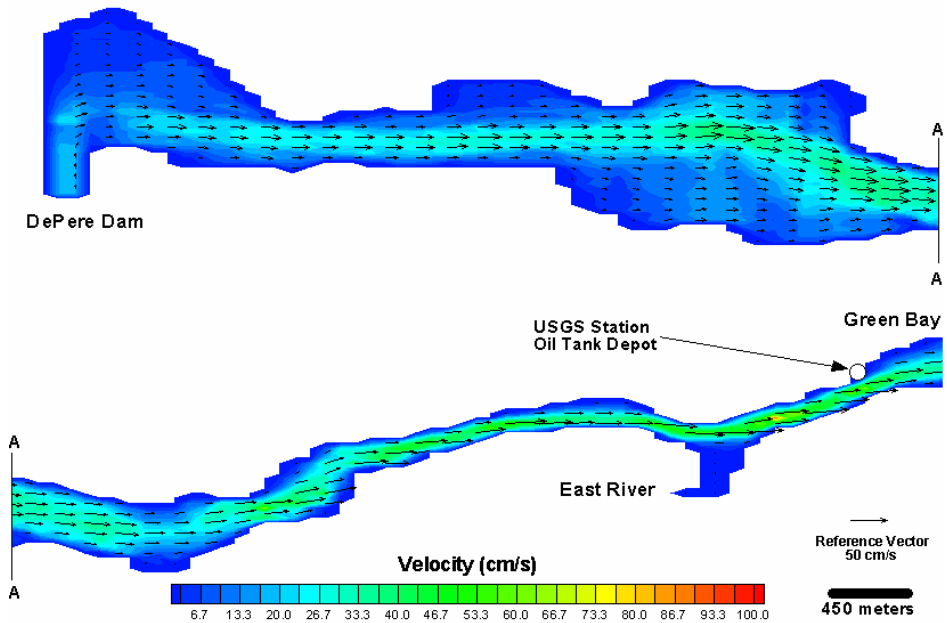

Figure 5.9 Modeled velocity vectors and contours during the maximum downstream flow for the June 2003 event.

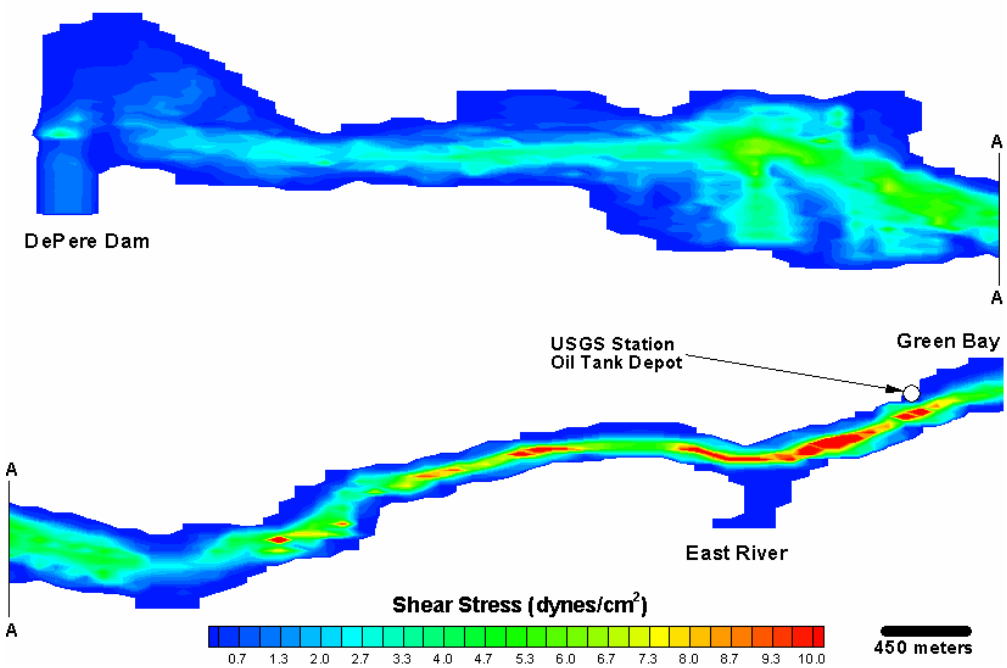

Figure 5.10 Modeled shear stress contours during the maximum downstream flow for the June 2003 event.

November Event

The model run for the November 2003 measurement event covers the period from November 4th through November 7th of 2003. Figure 5.11 shows the measured data compared with modeling results for the USGS Oil Tank Depot water level gauge and side-looking Doppler velocity meter. The model shows excellent agreement with the data as well as accurately reproducing the flow reversals due to seiche motion. Figures 5.12 and 5.13 show velocity and shear stress plots for the maximum downstream flow during the measurement event. The maximum shear stress was 40 dynes/cm^2 and occurred approximately 400 m downstream of the East River in the center channel.

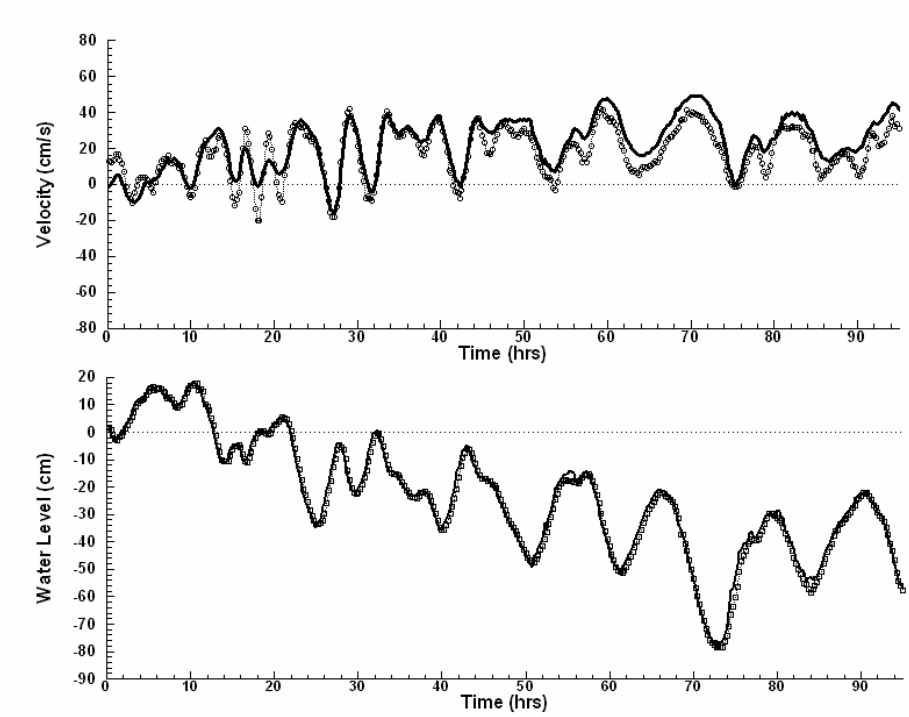

Figure 5.11 Modeled and measured velocities and water levels from the USGS Oil Tank Depot site for the November 2003 event. Model results are shown with a solid line.

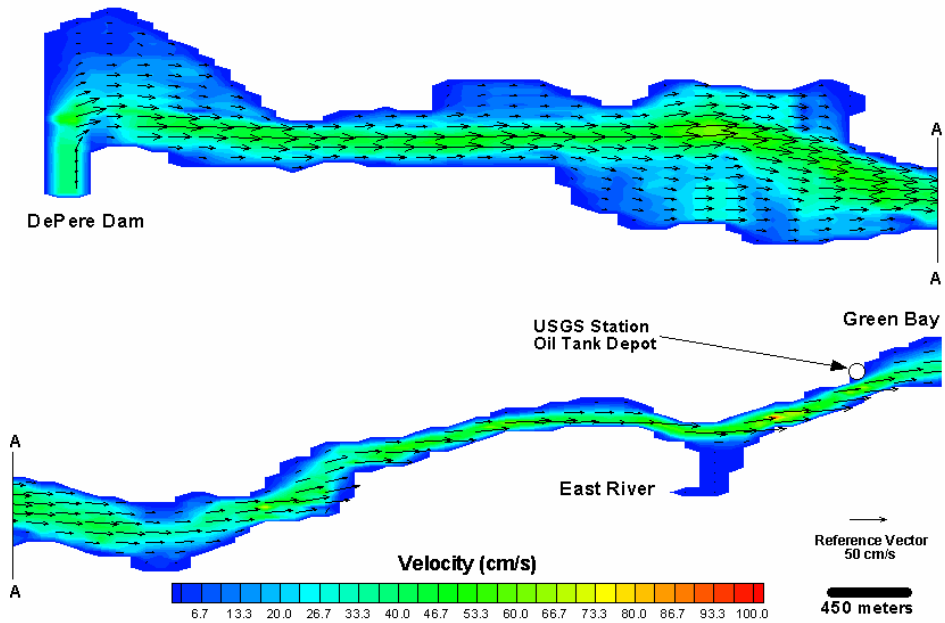

Figure 5.12 Modeled velocity vectors and contours during the maximum downstream flow for the November 2003 event.

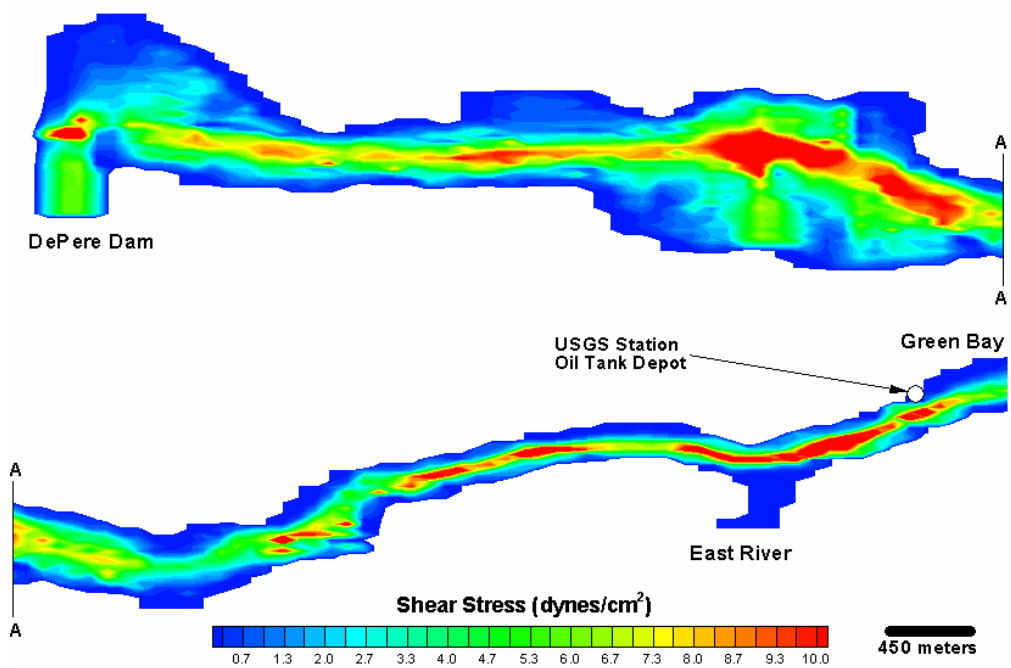

Figure 5.13 Modeled shear stress contours during the maximum downstream flow for the November 2003 event.

March Event

The model run for the March 2004 measurement event covers the period from March 5th through March 8th of 2004. Figure 5.14 shows the measured data compared with modeling results for the USGS Oil Tank Depot water level gauge and side-looking Doppler velocity meter. The model shows excellent agreement with the data as well as accurately reproducing the flow patterns due to seiche motion. Figures 5.15 and 5.16 show velocity and shear stress plots for the maximum downstream flow during the measurement event. The maximum shear stress was 50 dynes/cm^2 and occurred approximately 400 m downstream of the East River in the center channel.

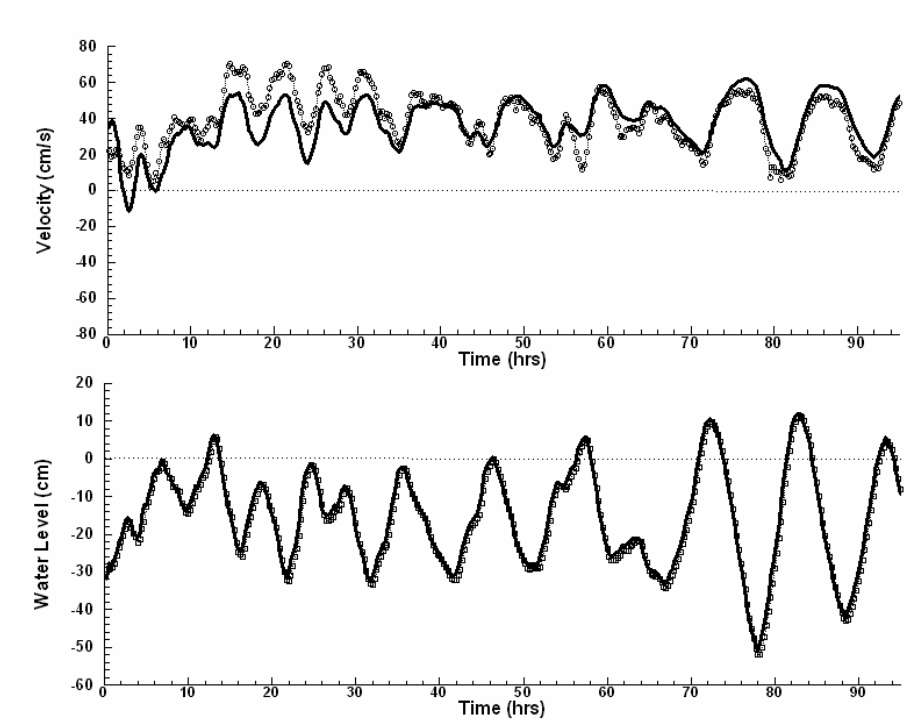

Figure 5.14 Modeled and measured velocities and water levels from the USGS Oil Tank Depot site for the March 2004 event. Model results are shown with a solid line.

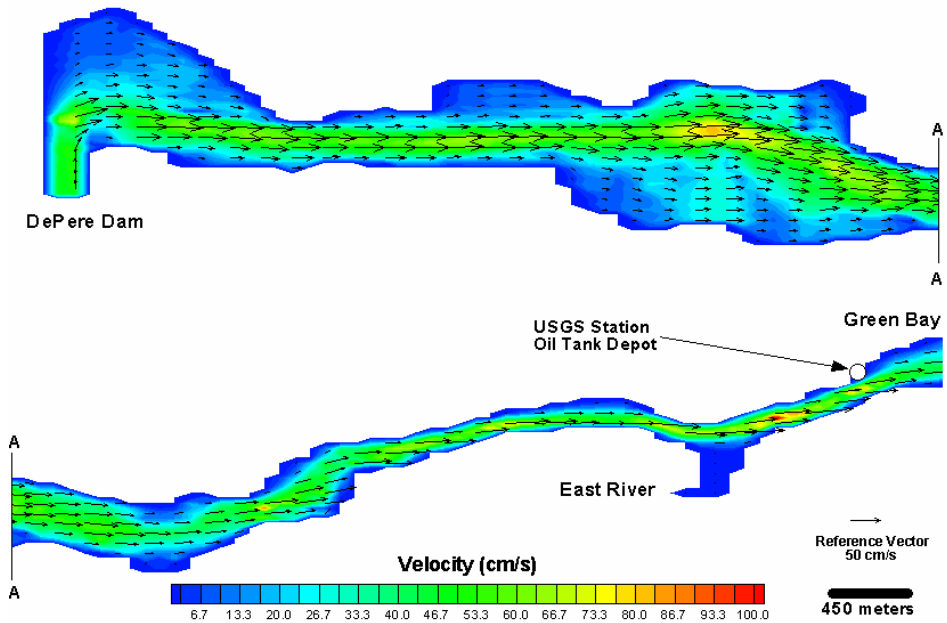

Figure 5.15 Modeled velocity vectors and contours during the maximum downstream flow for the March 2004 event.

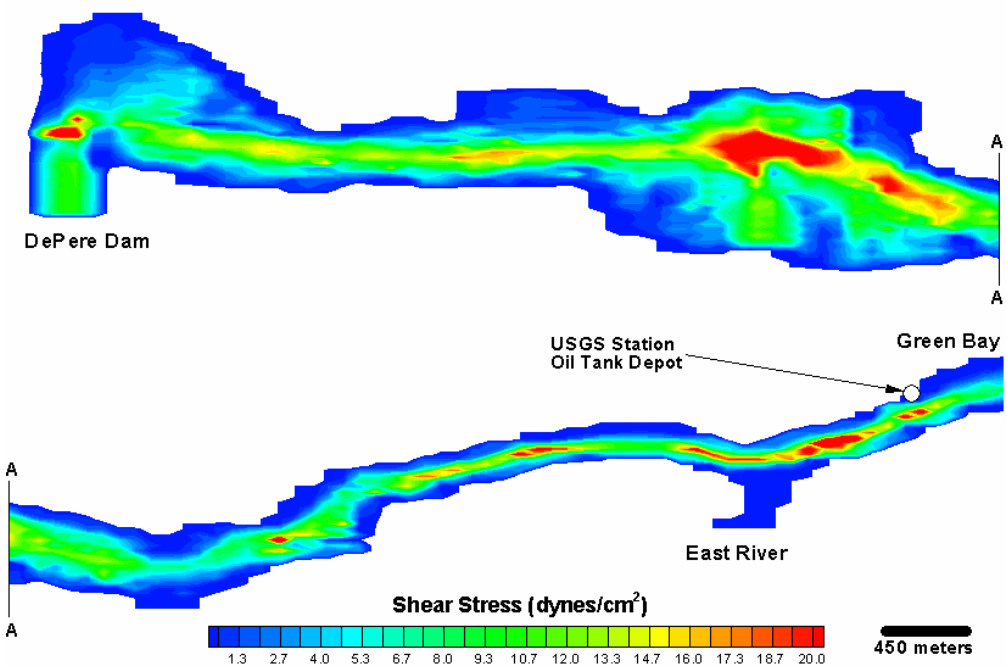

Figure 5.16 Modeled shear stress contours during the maximum downstream flow for the March 2004 event.

May Event

The model run for the May 2004 measurement event covers the period from May 24th through May 27th of 2004. This event was modeled without any additional model refinement so that it could be used as a verification case. Figure 5.17 shows the measured data compared with modeling results for the USGS Oil Tank Depot water level gauge and side-looking Doppler velocity meter. The model shows good agreement with the data as well as accurately reproducing the flow patterns due to seiche motion. Although the model tends to over predict velocities at the Oil Tank Depot gauging station, the error is relatively small (correlation coefficient = 0.87) and has not warranted further investigation. Figures 5.18 and 5.19 show velocity and shear stress plots for the maximum downstream flow during the measurement event. The maximum shear stress was 70 dynes/cm^2 and occurred approximately 400 m downstream of the East River in the center channel.

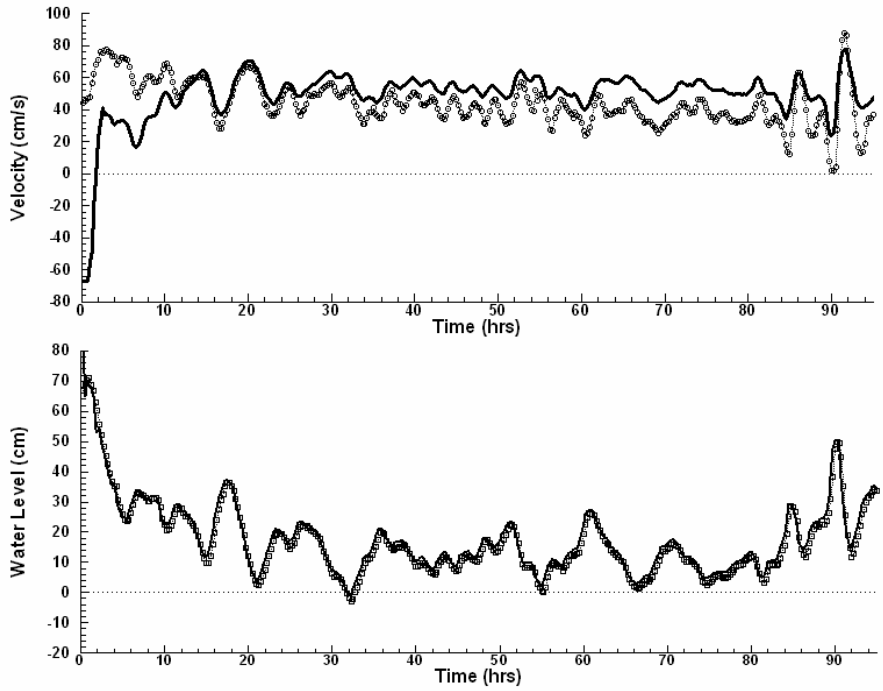

Figure 5.17 Modeled and measured velocities and water levels from the USGS Oil Tank Depot site for the May 2004 event. Model results are shown with a solid line.

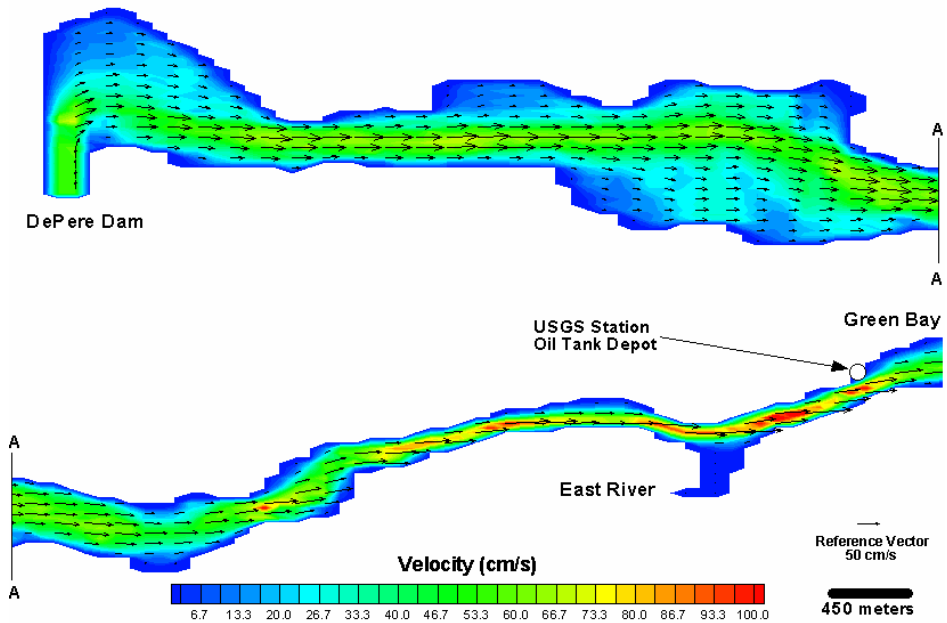

Figure 5.18 Modeled velocity vectors and contours during the maximum downstream flow for the May 2004 event.

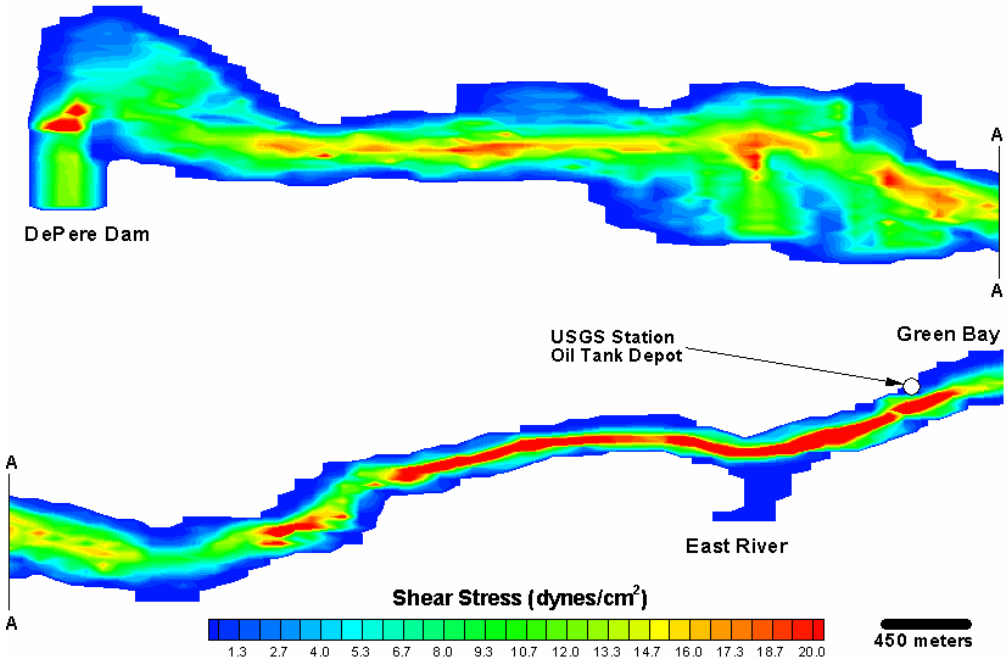

Figure 5.19 Modeled shear stress contours during the maximum downstream flow for the May 2004 event.

The four verification cases showed generally good agreement with modeled and measured velocities at both the discrete locations measured with the ADCP and the continuous measurements made at the USGS Oil Tank Depot Station. Furthermore, the May 2004 measurement event was conducted after all model refinements presented here had been completed. The May event was simulated in a purely predictive mode with no model modification. The good agreement between modeled and measured results for the May event verifies the applicability of this model to high flow events on the river.

6.0 Predictive Model Runs

The following section outlines predictive model runs that were designed to investigate shear stress levels throughout the river during design flow conditions. The results of the model runs are presented with a brief discussion of the major features.

6.1 Model Setup and Boundary Conditions

Two predictive model runs were conducted for studying cap stability. A 10-year recurring flow of 544 m^3/s and a 100-year recurring flow of 685 m^3/s were modeled in order to investigate shear stress levels during a high flow and an extreme flow. The flow rates were applied at the DePere Dam for a period of four days so that any start-up effects were avoided.

Additionally, a relatively large seiche height of 40 cm with a period of 13 hours was applied at the Green Bay boundary to investigate the effects of a seiche during these high flows. This seiche height and period was selected from the highest water levels and period measured during the 4 events. The initial water level for these cases was set to the NOAA Great Lakes Datum (i.e. zero as shown on previous plots of water level). No other changes were made to the validated model presented in the previous section.

6.2 Results and Discussion

10-year Event

The 10-year flow model produced shear stress patterns consistent with the validation results. The seiche motion in Green Bay only produced a 10 percent variation in the model-predicted velocities at the mouth of the river during a 10-year flow event. Figure 6.1 shows a plot of the maximum velocities throughout Reach 4 during a 10-year flow event. The maximum velocity is approximately 160 cm/s. Figure 6.2 shows a plot of maximum shear stresses during a 10-year flow event. The maximum shear stress at any point in Reach 4 is 95 dynes/cm^2, again located at approximately 400 m downstream from the East River in the central channel. The highest modeled shear stresses (e.g., over 50 dynes/cm^2) are all located in the downstream half of the river in the deepest narrowest regions. In the upstream half of the river (i.e., above Fort Howard), the maximum shear stress during a 10-year flow event was 50 dynes/cm^2. The average shear stress in the upstream portion of the river is approximately half of the average shear stress in the downstream portion of the river.

100-year Event

The 100-year flow model again produced shear stress patterns consistent with the validation results. The seiche motion in Green Bay only produced a 10 percent variation in the model-predicted velocities at the mouth of the river during a 100-year flow event. Figure 6.3 shows a plot of the maximum predicted velocities throughout Reach 4 during a 100-year flow event. The maximum velocity is approximately 180 cm/s. Figure 6.4

shows a plot of maximum shear stresses during a 100-year flow event. The maximum shear stress at any point in Reach 4 is 120 dynes/cm^2 located at approximately 400 m downstream from the East River in the central channel. Shear stresses over 40 dynes/cm^2 are seen in much of the central deep channel in Reach 4, particularly in the lower portions of the Reach, and also in the location of the former turning basin just downstream of DePere Dam. The maximum modeled shear stress in the upstream portion of Reach 4 (i.e., above Fort Howard) is 60 dynes/cm^2. Overall the increase in shear stress from the 10-year event is approximately 30 percent. The average shear stress in the upstream portion of the river is approximately half of the average shear stress in the downstream portion of the river.

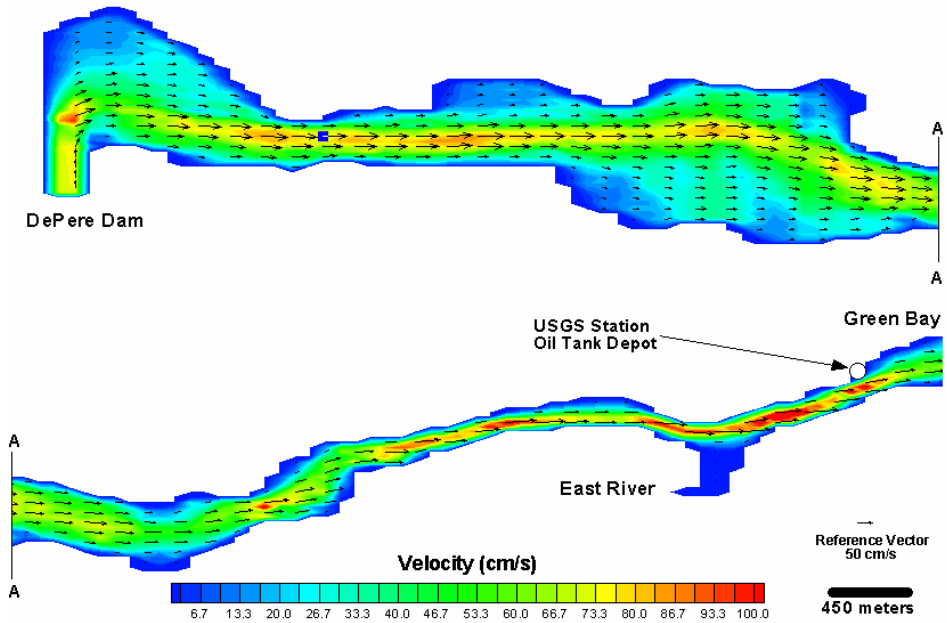

Figure 6.1 Maximum velocity vectors and contours for the 10-year flow event.

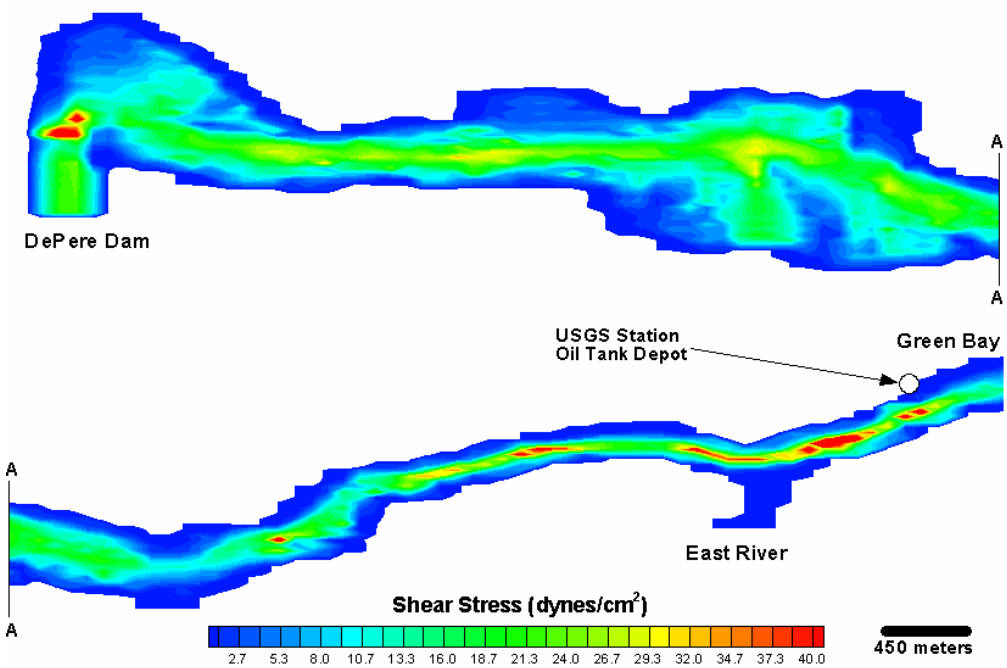

Figure 6.2 Maximum shear stress contours for the 10-year flow event.

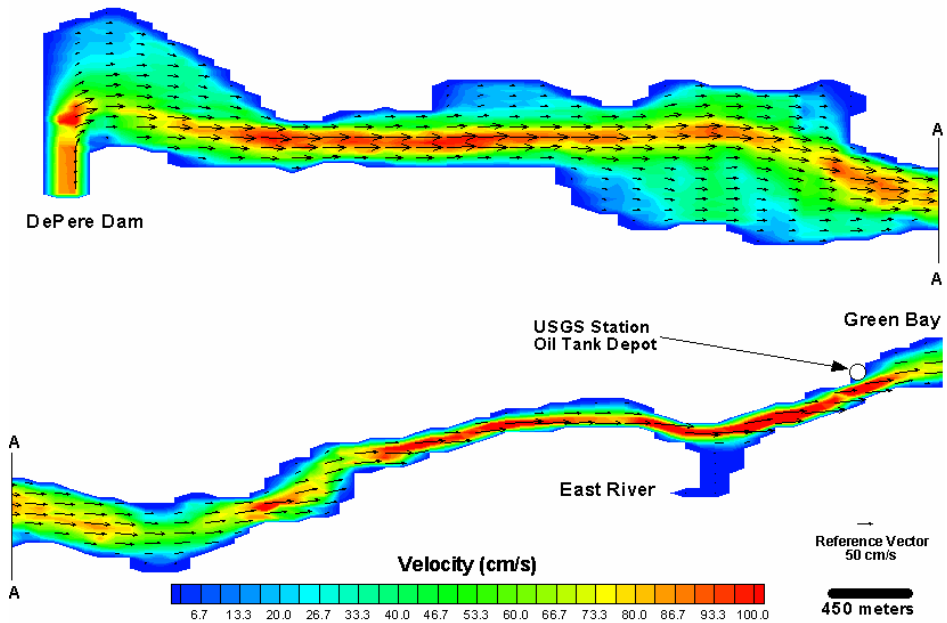

Figure 6.3 Maximum velocity vectors and contours for the 100-year flow event.

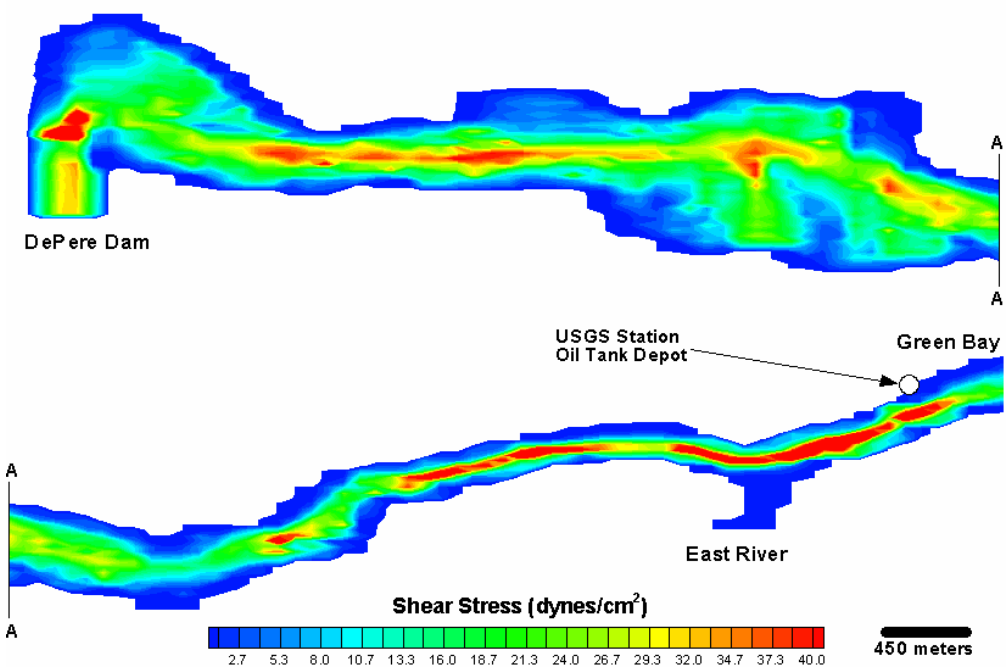

Figure 6.4 Maximum shear stress contours for the 100-year flow event.

7.0 Summary and Recommendations

The goals of this study were to develop an extensively validated hydrodynamic model of Reach 4 of the Lower Fox River using detailed velocity profile measurements and to utilize the validated model to predict shear stresses so that a cap stability analysis can be conducted under design flow conditions. The USGS conducted all data collection efforts and provided more than 100 total velocity profiles over 4 measurement events. These data allowed the calculation of shear stresses throughout Reach 4. This information, combined with continuous velocity measurements at the mouth of the Fox River by a USGS side-looking Doppler velocity meter, allowed for the development and refinement of a 2-dimensional hydrodynamic model of Reach 4. The model was shown to reproduce measured velocities with a correlation coefficient of 0.7 or better for each individual measurement event. No loss of correlation between measurement events and model results was observed as flow rates over the DePere Dam increased.

A logistic function of c_f was developed from the measured data to calculate c_f as a function of depth in the model. A logistic function of depth only was used instead of the standard law of the wall formulation due to the inability of the law of the wall formulation to predict c_f values below 2 m of water depth. Some idea of z_o variation in the river would be required for an accurate law of the wall prediction, but unfortunately no correlation of z_o to any parameter was seen in the data. The logistic approach yielded a hydrodynamic model which accurately predicted velocities and shear stresses throughout the river.

10- year and 100-year recurrence flows were predicatively simulated with the validated hydrodynamic model. An approximately 30 percent increase in shear stress was observed in the model runs from the 10-year to 100-year flows. Relatively large seiche motion included in the predictive model runs caused an approximately10 percent variation in shear stress levels during both predictive runs.

It is recommended that the effects of seiche motion be studied in more detail. By examining the entire water level record over time and space, the attenuation of the seiche through Reach 4 can be quantified. Although the seiche motion does not have a significant affect on design conditions as shown in the effort here, the attenuation of the seiche would be of interest in the general study of river hydrology. Additionally, the effects of long-term lake level changes were not investigated as a part of this study. Long-term levels can be directly incorporated as a downstream boundary condition and be evaluated in future studies.

Flow input from the East River was not included in this study since the focus on cap stability analysis and data collection was initially in the upstream portions of Reach 4. Previous modeling work has assumed that the East River input is approximately 10 percent of the flow over the DePere Dam (Gailani et al., 1991). It is anticipated that this would result in an approximate increase of 10 percent in the velocities below the East River. A more rigorous analysis of actual flow input from the East River can be

conducted so that these flows can be incorporated into the model if necessary for future cap stability analysis in the downstream portions of Reach 4.

Any final cap design evaluation should also include design bathymetry (i.e., post-cap placement) in the model as cap installation may affect the flow of the river in shallow regions. Additionally, although it is unlikely that large enough surface areas exist to produce sustained wind driven currents, wind driven waves in wide portions of the river may impact shallow shoreline regions during sustained high winds. These effects could be incorporated into the existing model for further cap stability evaluation.

8.0 References

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Attachment C –

Uncertainty Memo - SEI Hydrodynamic Model Support

Limno-Tech, Inc.
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Memorandum

DATE: January 20, 2005
PROJECT: **FOXSH 5**

TO: **Craig Jones**
Sea Engineering

FROM: **JohnWolfe**
CC: George Hicks, Clay Patmont

SUBJECT: **Recommended Approach to Account for Uncertainty, in Hydrodynamic Model Support to OU3/4 Remedial Design**

The purpose of this memorandum is to propose estimated coefficients of friction and uncertainty bounds for event shear stress estimates for Operable Units (OUs) 3 and 4 of the Lower Fox River. Shear stress estimates are planned using the hydrodynamic model that SEA Engineering, Inc. (SEI, 2004 and 2005) has developed for Johnson and Company, Inc, to support remedial design. We recommend that the hydrodynamic modeling make use of a logistic coefficient of friction function, presented below, which was estimated using combined measurements from OU3 and OU4. We also recommend that remedial design engineers add a 15% safety factor to event shear stress predictions produced by the model using this function, to account for data uncertainty.

<u>The Coefficient of Friction</u>
The focus of this memo is on estimation of the coefficient of friction (c_f), based on SEI's recent field measurements, and on establishing an upper bound of predicted values that is consistent with those field measurements. This range of c_f estimates dictates the range of shear stress estimates, because shear stress is proportional to c_f , according to the equation

$$\tau = c_f \rho u^2, \qquad (1)$$

where τ is shear stress, ρ is fluid density, and u is vertically averaged fluid velocity.

<u>Estimates of the Coefficient of Friction for OU3 and OU4</u>
SEI's report on its hydrodynamic modeling of OU4 (SEI, 2004) tabulated estimates of c_f at various water depths and locations for four different flow events, based on field measurements of vertical velocity profiles. These measurements are shown in Figure 1. For use in modeling, SEI developed a functional relationship between water depth and c_f. A logistic function (Eq. 5-1 in that report) was presented as a best fit to the local c_f estimates for OU4. Much of the difference between individual measured values and the best-fitting curve was attributed to measurement variability.

For OU3 modeling, one field measurement event was conducted, providing c_f measurements for multiple locations. Figure 1 shows that the trend in OU3 measurements with water depth was generally consistent with the trend in OU4 measurements. This suggests that it is appropriate to pool the data from OU3 and OU4 to estimate a single relationship between c_f and depth. Pooling of the data increases the size

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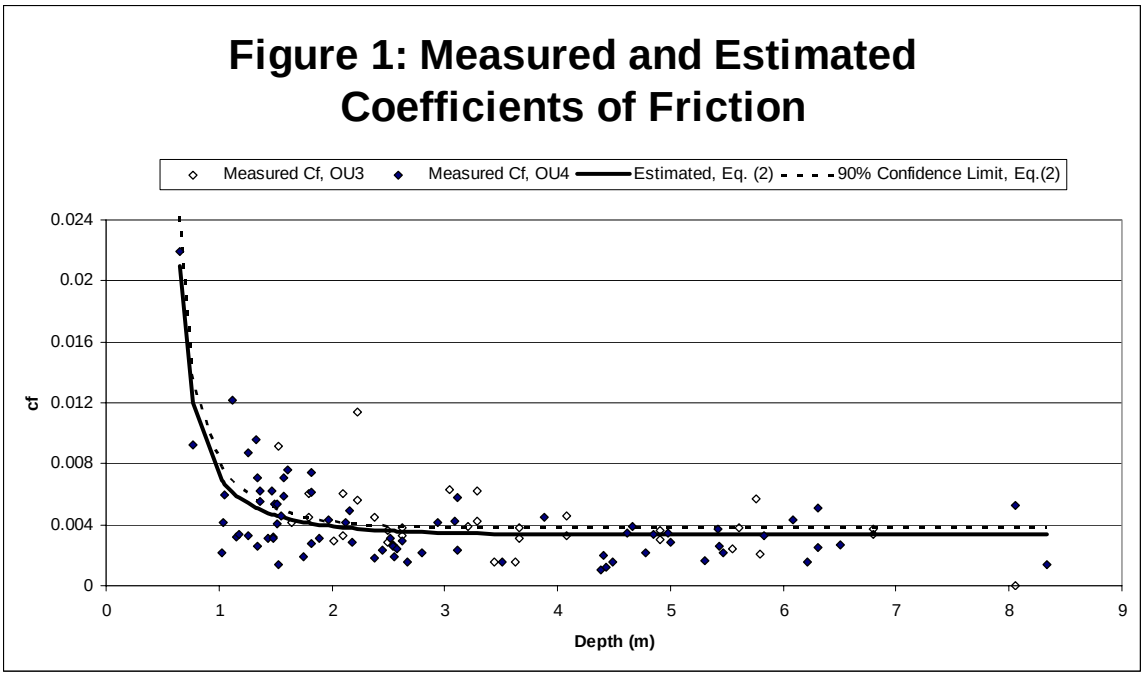
of the dataset available to estimate the function relating c_f to depth, which is of particular benefit for OU3 where fewer c_f measurements were made. Pooling also makes it possible to use a consistent set of hydrodynamic modeling parameters across OU3 and OU4. A statistical test of the appropriateness of pooling across OU3 and OU4 is presented below.

The following logistic function was estimated, using the pooled OU3 and OU4 measurements, minimizing the sum of squared residuals using a nonlinear optimization routine.

$$c_f = 0.00333/(1-1.94e^{-1.29h}). \qquad (2)$$

This function is shown in Figure 1, and fits the combined dataset well. Confidence limits of the mean c_f estimate for each depth were generated in the course of fitting Eq.(2). The estimated 90% upper confidence limit of the mean c_f for each depth is also shown in Figure 1.



To test the appropriateness of pooling the measurements from OU3 and OU4, an F test was constructed. The null hypothesis is that c_f measurements are related to depth in the same way in OU3 as in OU4. The test statistic was based on the change in goodness of fit of Eq. (2), when it was estimated with and without OU3 measurements included. The result:

$$F(32,71) = 1.14 \quad (\alpha = 32\%) \qquad (3)$$

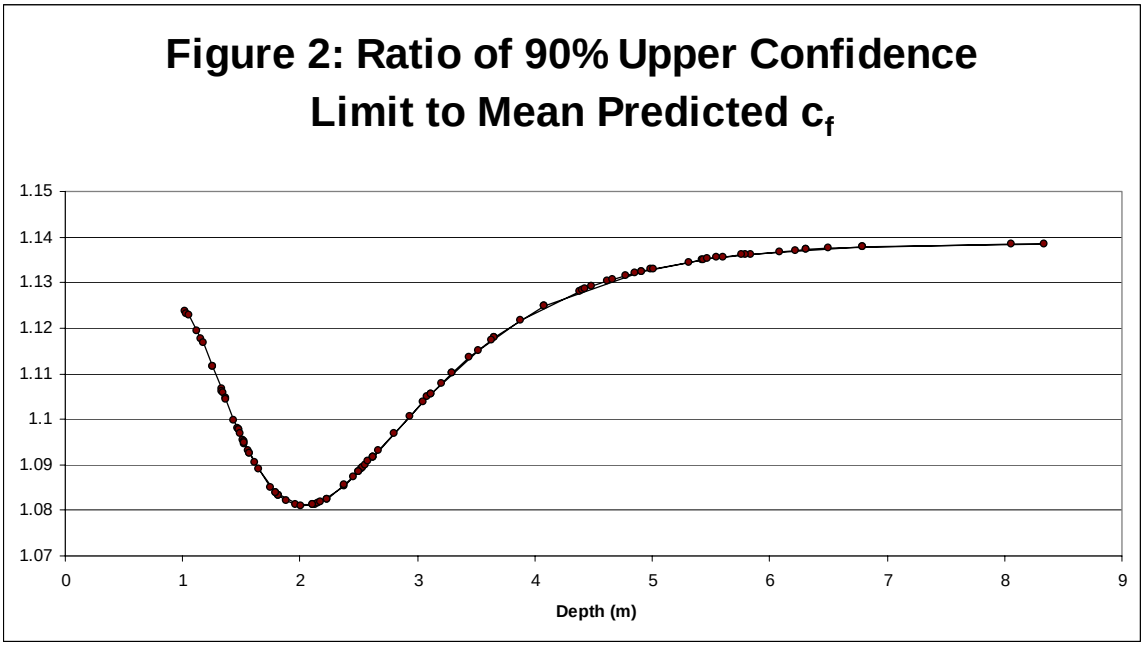
indicates that the fit of the OU3 measurements to Eq. (2) is sufficiently good that the null hypothesis cannot be rejected at conventional confidence levels. The available data are not sufficient to distinguish OU3 from OU4, despite some differences in the character of

these two reaches, so that OU3 and OU4 measurements may be treated as a common dataset. This avoids conducting a separate analysis with the more limited OU3 dataset.

Safety Factor for Shear Stress Estimates

Figure 2 plots the ratio of the upper 90% confidence limit to the mean value predicted by Eq. (2). It shows that the ratio approaches about 1.14 at the greatest depths, and is smallest at about 2m of depth, reflecting the general richness of data in this depth neighborhood. In our judgment, the coefficient of friction cannot be reliably estimated by the method outlined in this memo at depths less than 1 m, where there were only two measurements.

Variability in c_f implies variability in shear stress, because of their proportional relationship as shown in equation (1) above. To account for data variability in remedial design, it would be protective to add a 15% safety factor to predicted shear stresses, based on the results shown in Figure 2. At depths less than 5 m, a smaller safety factor may suffice, as Figure 2 shows. However, we recommend caution in using model simulations of shear stress, calculated by this method, for remedial design depths of 1 m or less.



References:

Sea Engineering, Inc. 2004. Hydrodynamic Field Measurement and Modeling Analysis of the Lower Fox River. Draft, September.

Sea Engineering, Inc. 2005. Hydrodynamic Field Measurement and Modeling Analysis of the Lower Fox River, Reach 3. Draft, January.

APPENDIX D – ATTACHMENT D

Attachment D –

Lower Fox River Ice Memo 2-1-06

Anchor Environmental, L.L.C.
1423 3rd Avenue, Suite 300
Seattle, Washington 98101
Phone 206.287.9130
Fax 206.287.9131

Memorandum

To: File - Fox River

From: John Laplante, PE, Anchor Environmental, L.L.C.

CC: Clay Patmont and Paul LaRosa, Anchor Environmental
George Hicks, Shaw E&I

Date: February 1, 2006

Re: Probabilistic Bottom of Ice Elevation - Fox River

This memorandum presents the results of and procedures used to compute a probabilistic estimate of bottom of ice elevation for the Fox River.

1 BACKGROUND

The following data sources and references were used to predict the bottom of ice elevation for OU3 and OU4:

- 1-hour and monthly average water level data from Fox River gauging station: 1970 to present
- Monthly average water level data from Fox River gauging station: 1953 to present
- Daily temperature data from Austin Straubel Airport Station 14898: 1949 to present
- Baseline Water Elevation Memorandum dated June 15, 2005 (Anchor/Shaw 2005)
- Effects of Ice on Sediments in Fox River near Green Bay dated July 10, 2005 (Ashton 2005)

The bottom of ice elevation was computed by taking the river stage elevation and subtracting the ice thickness. As described in Anchor/Shaw (2005), the river stage elevation varies in OU4 based on the water elevation in Green Bay, the flow over the DePere dam, and short term seiche effects. The river stage elevation in OU3 is based on the crest elevation of the DePere dam. Monthly mean river stage data in Green Bay indicates that there was an extended period of relatively low water between late 1963 and early 1965. However, the record of 1-hour measurement data does not include this time period. Therefore, to account for this period of low water, the cumulative frequency distribution of hourly measurements for 1970 to 2005 was

adjusted based on a comparison between the 1953 to 2005 and 1970 to 2005 cumulative frequency distributions of the monthly mean measurements. Using this comparison, a correction factor was developed to adjust the hourly data to include the period of low water as discussed below.

Ice thickness is a function of the cooling degree days, and can be computed according to the relationship provided by Ashton (2005):

$$h_i = C\sqrt{S_f}$$

where:

h_i = ice thickness in inches

C = coefficient related to snow cover (0.5 to 0.7 for Green Bay)

S_f = freezing degree days

Predicted ice thickness on the Fox River will vary depending on the amount of cooling and snow cover for a given winter.

The probabilistic bottom of ice elevation was computed by using the distribution of river stage elevation as described above, combined with the distribution of freezing degree days (as obtained from daily temperature data measured at the Austin Straubel Airport from 1949 to the present) to predict ice thickness per the equation above. The probabilistic estimate was obtained using a Monte Carlo analysis as available in the @RISK software package for Microsoft Excel.

2 METHODS

The following methodology was used to develop the data distributions for water level and freezing degree days used in the @RISK analysis:

1. For OU4, use 1-hour water elevation data from the Fox River gauging station (1970 to present). Add 0.374 feet to account for the hydraulic corrector, as described in Anchor/Shaw (2005) For OU3, use the DePere dam elevation (587.3 ft IGLD 85). .
2. Fit a curve to both monthly (1970 to present) and monthly (1953 to present) water level data sets presented in Anchor/Shaw (2005) to develop a long-term correction equation

that can be applied to the hourly data to account for historic period of low water not included in the hourly data record. Figure 1 presents the fitted curves and equations for each data set.

3. Create a long-term correction equation by subtracting the two equations shown on Figure 1. This correction will be applied to the 1-hour data set. The correction is as follows:

$$\Delta y = -46.355x^5 + 114.642x^4 - 99.558x^3 + 35.388x^2 - 4.837x + 0.7$$

where:

Δy = correction factor for water elevation

x = frequency interval for water elevation

4. Correct OU4 1-hour data for historic low water using the equation presented above.
5. Compute cumulative freezing degree days for each season using Green Bay meteorological data (daily average temperature), assuming that winter days warmer than 32º F do not decrease the cumulative total of freezing degree days in that season. Ignoring days where the daily average temperature is greater than 32º F results in a conservative calculation of freezing degree days. Prepare frequency distribution of cumulative freezing degree days over 50-year record of temperature data.
6. Provide @RISK with corrected frequency distribution for 1-hour water level per Steps 1-4, frequency distribution for freezing degree days per Step 5, and uniform distribution for ice thickness coefficient "*a*." Compute ice bottom elevation distribution in @RISK using equation from Ashton (2005).

3 RESULTS AND CONCLUSIONS

Table 1 presents the results of the ice thickness evaluation:

Table 1 – Bottom of Ice Elevation Frequency of Occurrence Fox River

Frequency of Occurrence	OU4 Elevation for Bottom of Ice[1]	OU3 Elevation for Bottom of Ice[1]
0.1%	573.1	584.6
1%	573.9	584.7
5%	574.7	584.9
10%	575.1	585.0

1. Datum IGLD85 feet (dynamic) without hydraulic corrector

The analyses presented in this memorandum are based on an approximate 50-year record of data for water level and freezing degree days. Statistical analyses have not been performed to extrapolate these data to predict a recurrence interval for a 100-year ice level – however the lower end frequencies of occurrence presented in Table 1 could be considered analogous to the bottom of ice elevation that might be expected to occur for these rare events.

4 REFERENCES

Anchor/Shaw 2005. *Baseline Water elevation for Contingent Remedy Evaluations*, memorandum to J. Hahnenberg (EPA), Greg Hill and Jim Killian (WDNR) dated June 15, 2005.

Ashton 2005. *Effects of Ice on Sediments in Fox River near Green Bay Wisconsin*, by George D. Ashton, PhD, DRAFT, dated July 10, 2005.

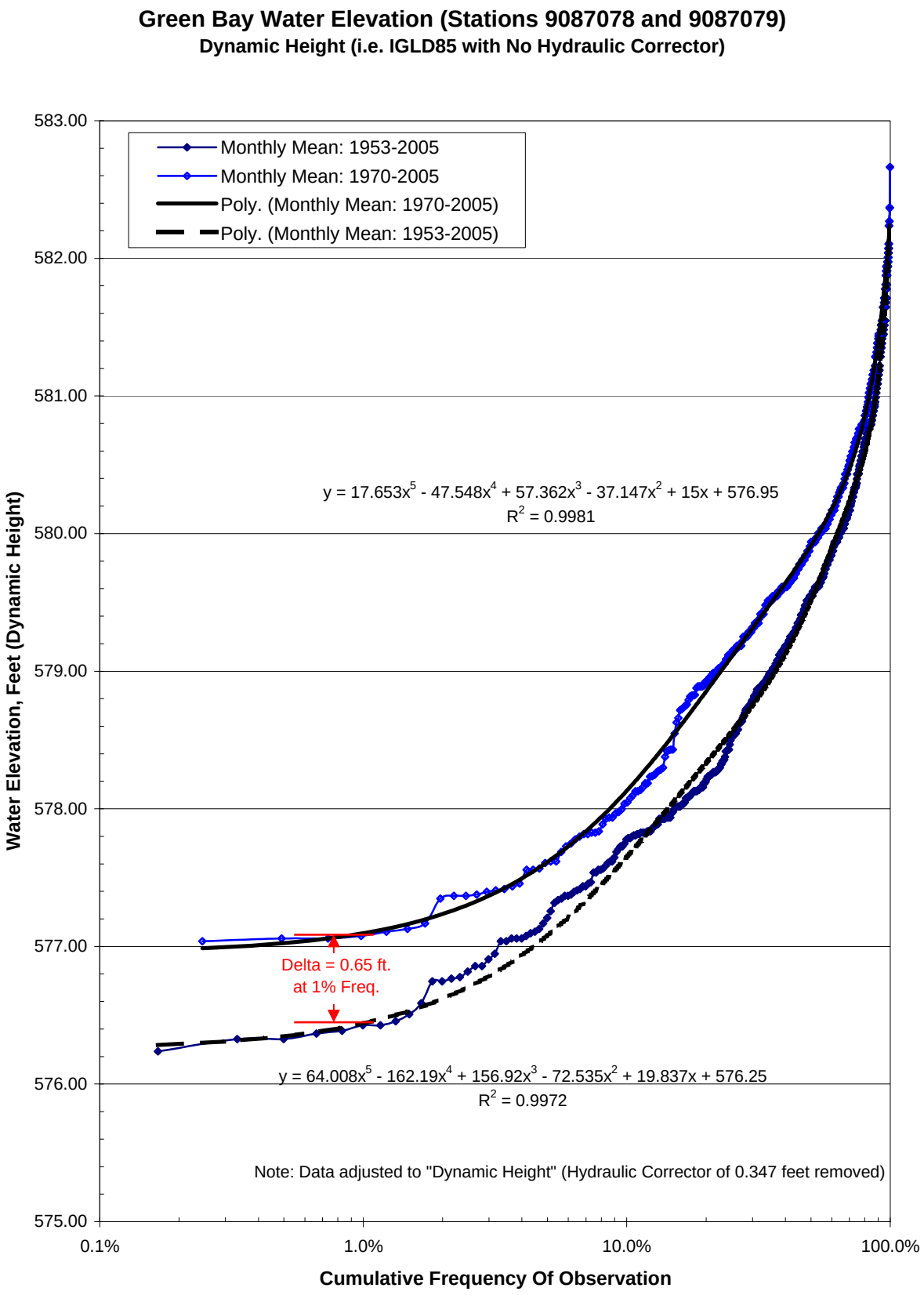


Figure 1
Correction of OU4 Water Level Data
Fox River

ANCHOR ENVIRONMENTAL, L.L.C.

Attachment D –

Ice Scour Report 7-11-05

EFFECTS OF ICE ON SEDIMENTS IN FOX RIVER NEAR GREEN BAY, WISCONSIN

By

George D. Ashton, PhD
86 Bank Street
Lebanon, NH 03766

DRAFT – 10 JULY 2005

SUMMARY OF FINDINGS

No evidence was found of ice jamming associated with breakup of the ice cover on the lower Fox River near Green Bay, WI. There were anecdotal accounts of frazil accumulations just downstream of Little Kaukauna Dam. There will be some frazil production and accumulation during very cold periods. These are not expected to pose a hazard to sediment remediation measures planned. In very shallow regions there is a possibility of very minor entrainment of sediment associated with the ice cover freezing to the bed.

BACKGROUND

As part of the effort to remediate sediments in the lower Fox River extending from Little Kaukauna lock and dam to the mouth at Green Bay, there was concern as to the possible effects of ice on sediments and the remediation measures planned. This report discusses the nature of the ice cover at the site and associated processes that could conceivably interact with the sediments or the capping of those sediments. The conclusions below are based on review of data of stream flows and winter temperatures for the site, on a site visit including interviews with personnel with experience at the site, on published literature dealing with ice and sediments, and on some 35 years of personal experience examining river and lake ice behavior.

The formation of ice in rivers is complex. Nevertheless approximate calculations are made to assess the general behavior of ice at the site to evaluate any possible interactions with sediments.

LOWER FOX RIVER NEAR GREEN BAY, WI

The lower Fox River extends from the outlet of Lake Winnebago to its mouth at Green Bay. The flow from Lake Winnebago is dominated by measures taken to control the water level in Lake Winnebago. This includes a winter drawdown beginning in mid-October and extending until the end of February with the intent of providing storage for later runoff into Lake Winnebago. When the drawdown target is achieved the stage is held constant until the ice cover in the Lake Winnebago pool breaks up. The stage in

Lake Winnebago is then increased beginning about mid-April to provide a navigation stage. More detail on the operating schedules and objectives are contained in USACE (1994).

There are a number of low head dams, some with hydropower facilities, in this reach but the storage capacity in the lower Fox River is minimal and, as a consequence, the dams and hydroelectric facilities operate as "run-of-river" controls; i.e., the flows released from Lake Winnebago continue to the mouth of the Fox River with little change. There is awareness of possible ice problems downstream of Lake Winnebago contained in the operational strategy and to "help prevent frazil ice development, experience has shown that flows must be limited to about 4,000 cfs (113 cms) when the air temperature falls below 25 degrees Fahrenheit, until such time as a complete ice cover has developed on the river." (USACE 1994). Examination of the detailed flow records at the USGS gaging station at Green Bay, WI showed that, at least since 1994, that strategy has been implemented with flows during the freezeup period no greater than 5,000 cfs.

There are two reaches of concern in this report. The upper reach extends from Little Kaukauna Dam downstream to the dam at De Pere, WI. The lower reach extends from De Pere to the mouth of the Fox River into Green Bay at Green Bay, WI. These will be referred to in this report as the "upper reach" and the "lower reach".

The upper reach has a relatively narrow width of about 900 feet for a distance of about 0.5 miles at the upper end of the reach, then widens to about 2000 feet for a distance of about 2.0 miles, then narrows to about 800-1000 feet for a distance of about 2.6 miles to the dam at De Pere. Operable Unit 3 is in this reach. The maximum depth is about 7 to 9 feet in the upper half of this reach then gradually deepens to about 15 feet in the narrower reach extending to the dam at De Pere. At about 2.0 miles downstream of Little Kaukauna dam is a potential capping area with a sand armor envisioned. The lower 2.6 miles is an area of potential capping where a gravel armor is envisioned.

The lower reach has a 2500 ft wide area of shallow water just downstream of the dam at De Pere, but with a deep area 800 feet wide and 1400 feet long opposite Voyager Park. The river then narrows to 800 ft about 1 mile downstream of the dam after which it again widens to about 2500 to 3000 ft, then narrows to about 1400 ft about 0.5 miles upstream of the Fox River Railroad bridge. From the dam downstream to the narrow section upstream of the railroad bridge there is a central channel shown as 5 ½ feet deep and about 250 feet wide on the navigation charts. From the Fox River Railroad bridge to the mouth into Green Bay the river is narrow and quite deep with channel depths of the order of 20 to 23 feet and 300 to 400 feet wide. There are extensive areas in this lower reach of potential capping areas.

SITE VISIT

A visit was made to the site on 29-30 June 2005. On the morning of 29 June the writer, together with George Hicks of Shaw Environment & Infrastructure, Inc., traveled the river from downstream of the sewage treatment plant (located about 1 mile below the De Pere lock and dam), through the lock at De Pere and upstream to just below the lock at Little Kaukauna Dam. Observations were made of vegetation and structures along the shores with the objective of detecting any damage due to ice effects. None was observed. The river downstream of the sewage treatment plant was examined at various points from the shoreline and as far as the mouth of the river into Green Bay. Much of this section of the river has industrial plants along the shore. Again, there was no evidence of ice damage.

The afternoon of 29 June and the morning of 30 June, a number of people with experience on the river during winter were contacted either by direct visit or by telephone. Briefly, the following observations were related:

Sewage Treatment Plant (west side of river about 1 mile downstream of the dam at De Pere), Mike Kersten, Manager. He described ice formation as initially composed of skim ice. No jams have been observed in his experience of about 15 years. In some years the river does not completely freeze over. Melt out is not associated with any large ice movement events. There is some ice fishing on the ice cover directly adjacent to Voyager Park (on the east side of the river) and a region of ice adjacent to the shore line there often remains in place after the rest of the river has become ice free. There was rip rap shore protection observed during the previous day at the plant site (and at many other places along the river). Here it was composed of stone estimated about 18 to 24 inches size and was placed about 15 years ago. No replacement has been necessary to this rip rap.

International Paper – Tilmany Paper – telephone conversation with Tom Piette, Utilities Manager. Plant is located on west side of river adjacent to dam at De Pere. He related that there was a problem with clogging of the 14 inch diameter intake pipe to the plant last winter (2004-2005 winter) but it was the first occurrence in 14 years. He has observed some ice passing over the dam at De Pere but described it as minor (an ice sheet or two). Typically the river becomes ice covered in mid-December and melting begins in February to sometimes March. He associated the clogging of the intake to low flows in the Fox River.

Little Kaukauna Dam – USACE office. Met with Dave Haefs and Joe Kalies who operate the dams on the lower Fox River. They remembered a jam on the Fox River near Appleton about 4 years ago and characterized it as “small”. They also described an ice jam upstream of the Little Kaukauna Dam that held back water for a few hours. They described the ice season as mid-December to late March. During very cold periods they often get ice buildup on the gates and top of the overflow spillways and manually break it up.

Hank Koch (of Foth & Van Dyke civil engineering firm, but an avid fisherman and guide) telephone conversation. He described the ice season as mid-December to the

end of March but with melt out often occurring prior to the end of March down the central channel region. He believes the ice has been as thick as 20 inches where people ice fish at Voyager Park. He prepares to "be ready to fish for large walleyes" well before the end of March and as early as the end of February. He described the ice cover as highly variable and treacherous to be on since it varies in thickness. He contrasted the ice of the lower Fox River as much less complete and thick relative to other rivers in Wisconsin.

CLIMATE AND HYDRAULICS

The Fox River near Green Bay, WI is characterized by a quite cold winter with from as few as 8 to as many as 50 days during which the daily minimum air temperature is below 0°F with a long term average of 24.3 days. Mean monthly temperatures (period 1971-2000) at Green Bay, WI are

December	January	February	March
21.2°F	15.6°F	20.5°F	31.3°F

The long term average mean air temperature (average of daily high and lows) decreases to 32°F in late November and increases to 32°F about the last week of March. In terms of freezing degree days (1 freezing degree day is 1°F below 32°F for a day), this means the average freezing degree days accumulated December thru March is 1230 °F – days (684 °C-days). This latter value is useful to estimate the maximum ice thickness to be expected at the end of the winter. An examination of longer term records showed that there have been a few years when it was very cold relative to this long term average; notably in the last 50 years, both 1976 and 1978 experienced very cold winters and the estimated accumulated freezing degree day totals for those winters were about 2200 °F – days (1222 °C – days).

The hydraulics at the site is variable but, as pointed out above, considerably controlled upstream in association with control of the water levels in Lake Winnebago. Average monthly stream flows as measured at the oil tank depot at Green bay, WI as measured by the USGS for the period 1988- 2003 are

December	January	February	March
4328 cfs	3798 cfs	3777 cfs	5843 cfs

These are fairly constant flows for a river this far north and are due to the control at the outlet of Lake Winnebago. However, there are excursions of the flow that are quite a bit higher. The daily discharge records at the USGS station at the oil tank depot at Green Bay, WI were examined for the period 15 December to 31 March for the years of record from the winter of 1988-89 through the winter of 2003-2004 and the peak flows during

that period extracted. The highest ranked peak flows are shown in Table 1 together with the air temperatures experienced before, during and after the peak flow.

TABLE 1

Highest Peak Flows December 15 to 31 March, Period 1988-2004

Winter	Peak flow (cfs)	Date	Air Temperatures		
			Before	During	After
2003-04	16600	4 Mar	Warm*	Warm	Cool**
1997-98	16000	31 Mar	Very Warm	Warm	Very Warm
1996-97	14900	26 Mar	Warm	Warm	Very Warm
1989-90	14900	13 Mar	?	?	?
1992-93	14800	14 Dec	Cool	Warm	Cold***
1990-91	12000	27 Mar	Warm	Warm	Cool
1988-89	11600	24 Mar	?	?	?
1991-92	11000	11 Dec	Warm	Cool	Cool
1993-94	9800	18 Feb	Warm	Warm	Cold
2001-02	8200	8 Mar	Warm	Warm	Warm

* Warm – average daily air temperatures above 32 °F
** Cool – average daily air temperatures below 32 °F but above 15 °F
***Cold – average daily air temperatures near 0 °F
Note: At the time of writing detailed air temperatures had not been obtained for the years 1988-1990.

While a more detailed statistical analysis was not performed, it is clear that about one year in five it is expected that a flow as high as 16,000 cfs may be expected during this period. We also note that the highest "mid-winter" flow, i.e., one occurring between 1 January and 28 February is the fifth highest ranking flow of 14800 cfs on 14 December 1992, during a period of above freezing air temperatures, but followed by cold air temperatures when the flow had decreased to less than 9000 cfs. This may be compared to the design flows associated with the project. For recurrence intervals of 5, 10, and 25 years those flows are, respectively, 17,000, 19,200, and 21,600 cfs. There are two main

effects of high flows during the winter associated with ice effects in rivers. First, the severity in terms of thickness of ice jams that may form are related to the discharge, and second, high flows tend to delay or prevent a full ice cover from forming thus providing more open surface for frazil production during very cold periods. As noted above, there is no evidence that ice jams form in the reaches under consideration, so that effect is not applicable. To determine whether the high flows were associated with large potential for frazil formation, the air temperatures just prior, during, and after the peak flows occurred were examined with the results shown in Table 1 above. In only two of the peak flow cases among the ten highest ranked peak flows were the air temperatures "Cold" soon after the occurrence of the peak flows. These were the peak flows of 14 December 1992 when daily low air temperatures were near 0 °F and 18 February 1994 when there was a daily low air temperature of -5 °F soon after the peak flow occurrence.

FLOW VELOCITIES

Using the results of hydrodynamic modeling done previously for the site for a design flow of 685 cms (24,000 cfs), the estimated flow velocities at mid-channel for three different flows were determined for representative reaches beginning somewhat downstream of Little Kaukauna Dam and extending to the mouth of the Fox River into Green Bay. The flows chosen for examination were a typical freezeup flow of 5,000 cfs, a high winter flow of 10,000 cfs, and an extreme winter flow of 16,000 cfs. The results are presented in Table 2:

Table 2

Summary of maximum mid-channel velocities for different reaches

Reach	Typical Freezeup Flow (5000 cfs)	High Winter Flow (10,000 cfs)	Extreme Winter Flow (16,000 cfs)
Downstream of Little Kaukauna Dam to mid-reach	0.5 fps	1.0 fps	1.7 fps
Lower half of upper Reach	0.8 fps	1.7 fps	2.7 fps
Upper half of lower reach (Downstream of dam at De Pere)	0.6 fps	1.3 fps	2.1 fps
Lower half of lower reach to mouth of East River	0.9 fps	1.8 fps	2.8 fps
Below mouth of East			

River – narrow section	1.1 fps	2.2 fps	3.4 fps

FORMATION OF FRAZIL, ANCHOR ICE, AND SURFACE ICE COVER

In very large lakes, and most rivers subject to very cold temperatures, frazil ice can form and be carried to great depths (Frazil is ice in very small crystals formed in supercooled flow (slightly below 0ºC). In fast flowing rivers, frazil can be distributed through the depth of the flow and attach itself to the bottom sediments. In this form it is termed "anchor" ice. Upon warming slightly or when the buoyancy exceeds the adhesion at the bed, it can rise and sometimes bring a quantity of sediment to which it had adhered. There is considerable experience in assessing the nature and intensity of frazil formation based on mean water velocity and this is well represented by a diagram originated by Matousek (1984) and presented with some addition and simplification by Ashton (1988). From 0 to about 0.2 m/s (0.6 fps) the initial ice formation is in the form of thin sheets on the surface and little frazil formation. From about 0.2 m/s (0.6 fps) to about 0.7 m/s (2.3 fps) a "skim ice run" occurs, again, with little frazil formation. From about 0.7 m/s (2.3 fps) to about 0.95 m/s (3.1 fps) the frazil forms a "layered frazil and slush run" with the ice confined to the near surface of the water. Above about 0.95 m/s (3.1 fps) a "well mixed frazil run" occurs with frazil transported to some or the entire depth of flow. It is this last type of formation that can lead to anchor ice formation on the bed. There is some effect on these boundaries of types of ice formation due to the intensity of cooling with higher cooling rates tending to shift the types of ice formation somewhat towards the more severe types. At about 2 fps and below, the frazil formation is able to accumulate into an initial ice cover and, once stationary, will continue to thicken by thermal growth. Thus frazil produced in high velocity reaches is carried downstream until a lower velocity reach is present at which it forms a solid cover. Further arrival of frazil may be carried under the ice cover and either be further transported beneath the ice cover or deposit out (upwards) beneath the ice cover. In some cases such accumulations may form very thick "hanging dams". As the deposit thickens, the diminished cross section causes velocities to increase beneath the accumulation. The critical velocity beneath which frazil deposits out from the flow is about 2.0 fps based on observations of frazil deposits in rivers and is consistent with numerical models that use that value as the critical velocity, and with laboratory experiments. Once deposited, the frazil develops some cohesion between particles and, as a consequence, the critical value for erosion is generally taken to be slightly higher and about 2.3 fps.

To summarize, it is expected that there will be frazil formation when the water surface does not have an intact ice cover. This corresponds to regions where the surface velocity is 2 fps or greater. There will be a possibility of anchor ice formation in regions where the flow velocity is greater than about 3 fps.

OCCURRENCE OF FRAZIL, ANCHOR ICE, AND SURFACE ICE COVER AT SITE

With the above guidance, it is possible to describe the nature of ice formation at the site associated with the different flows shown in Table 2.

For typical freezeup flows of 5000 cfs, the average velocities in all reaches are 1.1 fps or less. We thus expect the ice cover to form rapidly and be characterized by a skim ice run of frazil at the surface. The only exceptions to this are the short reaches just downstream of the two dams and these will be treated separately below.

For a high winter flow of 10,000 cfs, the velocities are below 2 fps in all reaches except the very downstream reach below the mouth of the East River. There the ice cover will be formed from layered slush and skim ice accumulation. Thus even at fairly high winter flows we expect an orderly formation of the ice cover with little or no entrainment of ice into the flow beneath.

For an extreme winter flow of 16,000 cfs the velocities exceed 2 fps and should this flow occur when there is not yet an ice cover, there would be a "layered frazil and slush run" that would eventually accumulate to form a rough ice cover. Should such a flow occur in mid-winter when there is already an ice cover present, we would expect rapid melting of the ice cover since such flows are associated with warm air temperatures. There is some slight possibility of limited surface ice jamming, but both the limited supply of ice available from upstream and the nature of the river geometry makes such jams, should they occur, of limited thickness. This is consistent with the lack of observations or evidence of jamming at the site.

There are two exceptions to this general behavior, both occurring just downstream of the two dams.

The production of frazil in a fast flowing open area through a winter period may be estimated from the cumulative degree-days of freezing. A simple heat balance between the production of frazil and the heat loss to the atmosphere results in

$$\rho \lambda h_f = H_{wa} (T_m - T_a) t$$

where ρ is the density of solid ice, λ is the heat of fusion of ice, h_f is the thickness of ice produced over time t when exposed to an air temperature T_a relative to the freezing point T_m. The value of ρ is accurately known at 916 kilograms per cubic meter, and λ is accurately known at 334,000 Joules per kilogram. Hwa is a heat transfer coefficient between the water surface and the air above. It varies with wind speed with higher wind speeds yielding higher heat transfer rates. Hwa typically varies from 10 Watts per square meter per °C under still air conditions and is about 30 Watts per square meter per °C for moderately windy conditions. Here we will use a more typical average value of 20 Watts per square meter per °C. The product $(T_m - T_a) t$ is the degree-days of freezing. At Green Bay the average cumulative degree-days of freezing December through March is

684 °C – days. Inserting these values into the above equation results in a potential thickness of solid ice production per unit area of 3.84 meters (about 12.5 feet) per unit area of open water surface exposed throughout the winter. The daily temperature records at Green Bay, WI from 1991 to 2005 were examined to find periods of extended consecutive very cold days, since such periods are more directly related to the production of frazil that may be of concern than are the total seasonal cumulative degree-days of freezing. The coldest period found was from 19 December 1998 to 15 January 1999. There were 677 freezing °F –days (376 °C –days) accumulated during this period, so use of the average seasonal accumulation of 684 °C -days is considered conservative in terms of estimating maximum ice production.

Deposition of frazil downstream of the rapids reach below Little Kaukauna Dam

Downstream of the Little Kaukauna Dam is a relatively shallow area estimated at about 2000 feet long and about 900 feet wide where the velocities are fairly high and the flow could be described as a rapids. This area will remain open at higher flows and the open surface and shallow depths will enable significant frazil production and accumulation. (NOTE: The frazil formation described above that occurs just downstream of Little Kaukauna Dam has also been described by Den Hartog in the CRREL Ice Jam Data Base (see references) and in a report by Frankenstein (2003).)

The rapids reach is about 2000 feet long and 900 feet wide. Thus the resulting potential frazil production is a volume of 832,000 cubic yards of solid ice. When deposited the frazil has porosity of the order of 0.5 so the total bulk volume of frazil potentially produced is estimated to be almost 1.6 million cubic yards.

The frazil produced in the rapids reach will be deposited in the very shallow reaches of the rapids and be carried downstream. While the deposits and accumulation in the shallow areas are the cause of the flooding described by Den Hartog in the CRREL Ice Jam Data Base, that accumulation is confined to the immediate region of the rapids. The frazil may also be carried downstream to deeper reaches with an ice cover and, just as sediment deposits out in slower velocity reaches, so does the frazil deposit (upwards) beneath the downstream ice cover. It does this rather quickly and accumulates in thickness until the resulting diminished flow area beneath the deposit has increased the velocity to about 2 fps, at which point the frazil is carried further downstream until the velocity again decreases. The process may be visualized as an extending (upside down) delta. The upstream sections will accumulate first and the deposit will gradually extend itself downstream. It is possible to do a time – stepping simulation of this deposition process but for present purposes we simply calculated the flow volume beginning at 1 mile downstream. It is relatively constant in that reach with a volume per mile of about 2,000,000 cubic yards per mile. Thus the frazil production of 1,600,000 cubic yards (bulk volume) can be contained in a deposit occupying only about 1.6 miles below Little Kaukauna Dam if it fills half the flow volume (and thus increasing the flow velocity to 2 fps for a flow of 10,000 cfs). We thus expect the majority of the thick frazil deposits to be in the upper half of the upstream reach, even under the rather conservative extreme

conditions used in these calculations. There is one “potential capping area” of Operable Unit 3 located in this section about 1.5 miles downstream of Little Kaukauna Dam on the west side of the river in a fairly shallow area. While there is thus a possibility of some frazil accumulation there, the sand armor capping is not considered to be at risk for the reasons outlined below.

The same limiting velocity beneath which frazil deposits out from the flow also means that bottom sediments whose critical erosion velocity is above that, will not be scoured by the flow. It is probably prudent to use the critical velocity for those considerations as the somewhat higher value associated with erosion of frazil (2.3 fps) since there clearly could be cases where increasing flows will take some time to erode the frazil deposit.

Deposition of frazil downstream of the dam at De Pere

Downstream of the dam at De Pere there will be an open water area since it takes a certain amount of time and distance for frazil to be produced and form an ice cover. The colder the air temperature, the shorter the distance of open water. A reasonably conservative (large) estimate at usual flows is that the open water would be the width of the flow of about 1000 feet and some 600 feet long. Following the same calculations as used above we would expect the total thickness of solid ice produced to be 12.5 feet over the season thus yielding a total production of about 278,000 cubic yards of solid ice and 555,000 cubic yards of bulk frazil volume. The flow area just downstream of the dam at De Pere immediately deepens and widens so the deposition will occur rapidly. The effective cross section area of the flow, disregarding the shallow areas on the west side of the river where there will be little frazil transported because of the low velocities, is about 800 feet wide and 20 feet deep and about 1400 feet long. It is expected that even this large amount of frazil can almost be accommodated by deposition in the region of the river containing the deep area of width about 800 feet and length of 1400 feet using the 2 fps criterion for critical velocity of deposition at a flow of 10,000 cfs. The portion of the flow diverted to the shallow areas on the west side is even more diminished by the presence of the ice cover that will form there and will tend to concentrate the flows in the deeper areas. We thus expect little deposition of frazil in that shallow area and no effect on the sediments in that region.

ANCHOR ICE FORMATION

Anchor ice is frazil ice that has been carried to the bottom of a stream or river and attaches to the bottom material (and, after initial covering, to itself). Once attached, the crystals may subsequently grow quite a bit larger than those seen in the bulk flow. It is most readily observed in shallow mountain streams and may build up to considerable thicknesses, but it also occurs in deep rivers and in lakes where the mixing arises from wind and wave action.

As pointed out above, the only location where there are high enough velocities and anchor ice is expected to form is in the rapids downstream of Little Kaukauna Dam. No doubt anchor ice contributed to the large buildup of frazil ice in that portion of the river that led to minor local flooding and frazil damming in 1986.

Occasionally anchor ice has been known to entrain the sediment to which it is attached into the flow when the ice releases from the bottom. The writer has seen small-fist-sized rocks in floating ice covers that undoubtedly were the result of such a process but when seen, these have been widely dispersed and represent only insignificant transport. The magnitude of such sediment transport may be appreciated by a simple hydrostatic force balance. The buoyant upward force of the ice mass is $(\rho_w - \rho_i)(1 - p)\, h_i$ where ρ_w is the density of water, ρ_i is the density of solid ice, p is the porosity and h_i is the thickness of the anchor ice accumulation. The resisting downward force is $(\rho_w - \rho_s)(1 - p)\, h_s$ where ρ_s is the density of the sediments and h_s is the thickness of sediment which is in equilibrium with the attached ice mass. Assuming similar porosities and a specific gravity of the sediment particles of 2.67 (silica) the ratio of h_i to h_s is (2.67-1.0)/(1.0 – 0.916) = 19.9. In short, the thickness of sediment possibly entrained by an anchor ice deposit is 1/20 the thickness of the deposit. This assumes, of course, that the sediment has enough cohesion to support the sediment beneath the ice-sediment interface. This author doubts that anchor ice deposits ever exceed about a foot or so in thickness at the site, and in any case, are confined to the rapids area just downstream of Little Kaukauna Dam.

FREEZING TO BOTTOM IN SHALLOW WATER

In shallow water regions of the site there are areas where the water is quite shallow. We are concerned here with those regions where the water is shallower than the maximum thickness of ice that can form over the winter. In such areas, the freezing process may continue into the bed beneath, and upon rise of the water level with increasing discharge, the soil frozen to the bottom of the ice cover may be lifted and transported with the ice cover. This would apply, of course, to regions where the ice cover is sufficiently buoyant to overcome the weight of the sediment frozen to the bottom. After breakup of rivers, ice pieces with a thin layer of sediment on the bottom are often seen. It is believed that this is a very minor sediment transport mechanism and probably offset by sedimentation in such shallow areas during the remainder of the year.

The maximum thickness of ice that might be expected at the site is given by a modified Stefan equation of the form $h_i = C\, S_f^{1/2}$ where, if h_i is given in inches and S_f is the degree days of freezing in °F – days, then C is typically about 0.5 to 0.7 for slow flowing rivers and protected still waters. For the average S_f of 684 °C days (= 1230 °F – days), this results in a thickness of 17.5 to 24.5 inches. For the extreme winters with an accumulated degree days of freezing of 2200 °F – days, this results in a thickness of 23.4 to 32.8 inches, although these thicknesses would only be attained in protected areas with little or no flow velocity. Thus the mechanism described above is applicable to regions where the water depth is 2 1/2 feet or less.

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APPENDIX D – ATTACHMENT E

Attachment E -

Windwave Model 2-18-05

Limno-Tech, Inc.
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Memorandum

DATE: February 18, 2005
PROJECT: **FOXSH**

TO: **John Wolfe**

FROM: **Dan Rucinski**
CC: file

SUBJECT: **Lower Fox River Wind Wave Model (OU3 and OU4)**

INTRODUCTION

LTI has developed a nearshore spectral wind wave model for Operable Units 3 (OU3) and 4 (OU4) of the Lower Fox River, WI using the SWAN (Simulating WAves Nearshore) modeling software (Booij 1999, SWAN 2004). The model is intended to simulate wind-driven waves in the river for several meteorological conditions. This memorandum presents a summary of the model development, and conclusions based on model output.

MODEL DEVELOPMENT

Model Configuration

SWAN requires several simulation specifications and model inputs. Simulation options selected for this study include: Cartesian coordinate system, rectilinear grid configuration, bottom friction dissipation estimated by default JONSWAP function (Hasselman et al. 1973), and triad wave-wave interactions. Model inputs include rectilinear bathymetry grid expressed as water depth from simulated uniform standing pool elevation.

Spatial Representation

The OU3 reach of the Lower Fox River is represented by a regular, rectilinear grid orientated 35 degrees clockwise from true north. Grid cells are approximately 20m x 20m, with 480 cells along the x-axis, and 175 cells along the y-axis. This configuration results in approximately 8,900 “wet” cells, or cells which have >50% of the surface covered by water. A subset of the grid is shown in Figure 1 to demonstrate the resolution of the grid.

The grid representing the OU4 reach of the Lower Fox River is orientated 27 degrees clockwise from true north. Grid cells are approximately 20m x 20m, with 580 cells along the x-axis, and 93 cells along the y-axis, corresponding to approximately 13,800 “wet” cells. A subset of the grid is shown in Figure 2 to demonstrate the resolution of the grid.

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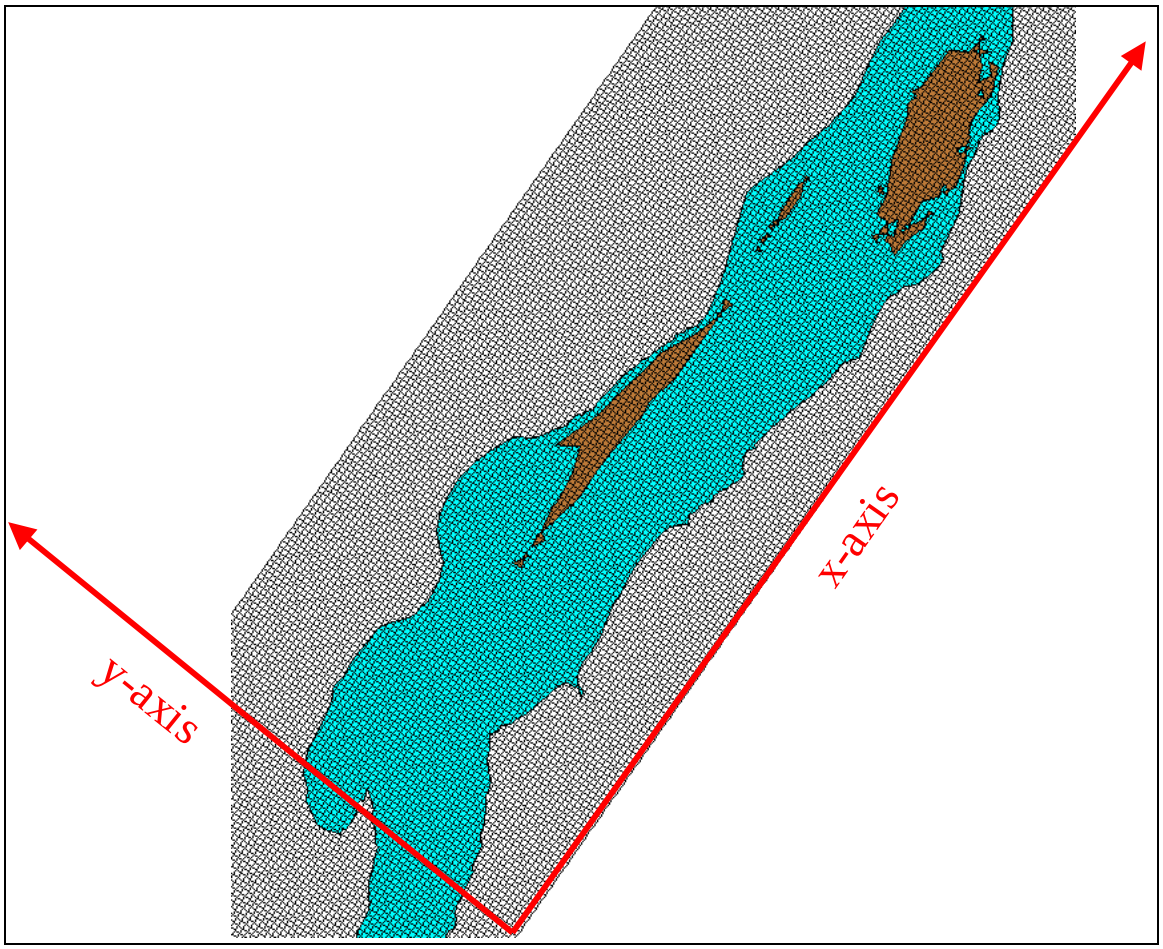

Figure 1. Subset of model grid representation of Lower Fox River (OU3) w/ proposed sediment capping.

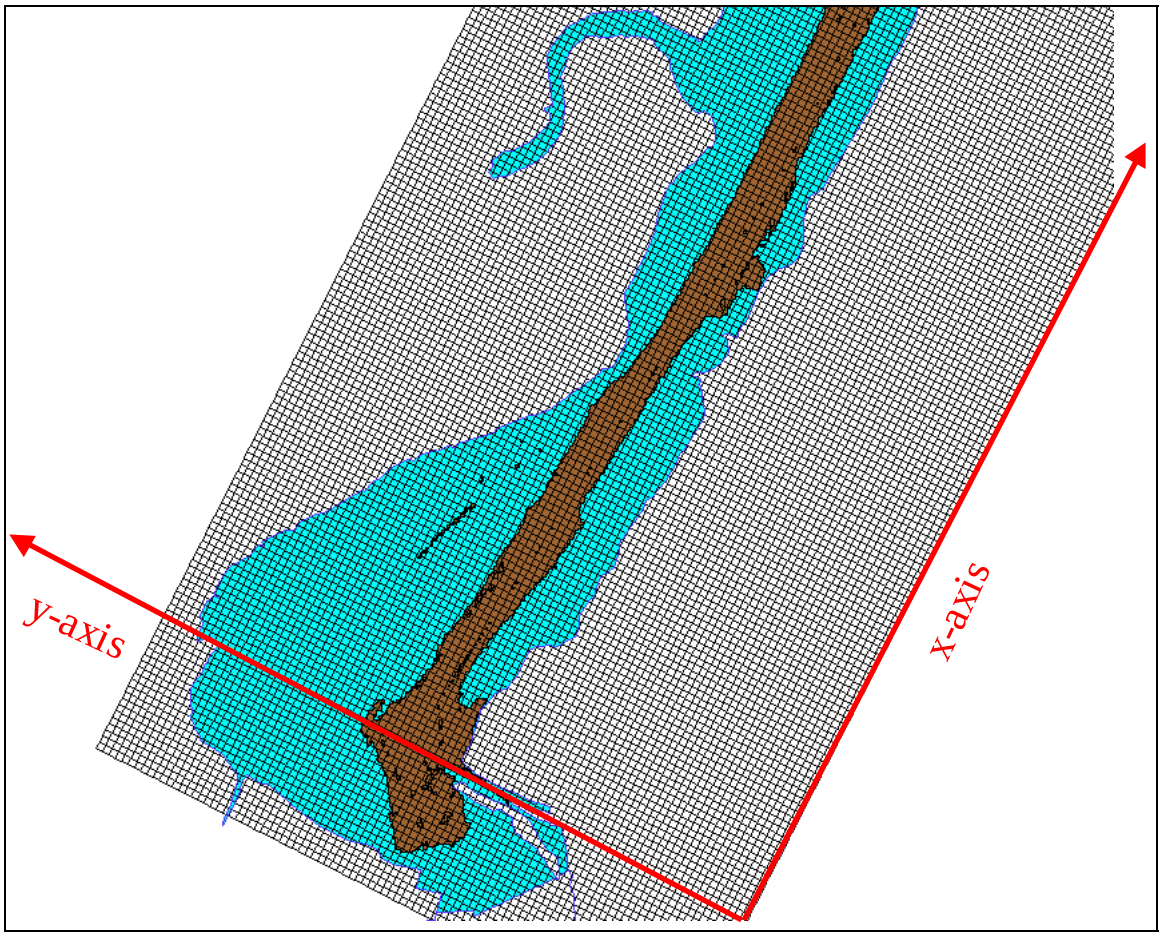

Figure 2. Subset of model grid representation of Lower Fox River (OU4) w/ proposed sediment capping.

Simulated Events

Several extreme events were simulated by varying the wind speed and direction and assuming an extreme low water level for the reach. In each simulation a steady and sustained wind was assumed, with the given velocity and direction. Historical records of dam operations at the Corps of Engineers DePere Dam (downstream extent of OU3) indicate a range of standing pool elevation between 586.31 ft and 588.81 ft (IGLD 85) is maintained. The lower bound of this range (586.31 ft) was used as a conservative estimate of standing pool elevation for the OU3 simulations. Anchor Environmental provided a low water level of 577.5 ft (IGLD 85) for OU4 simulations. Water depth is assumed to be based on the simulated water surface, and bathymetry provided by Anchor Environmental, including assumed conceptual sediment caps. Figures 3 and 4 show the water depths specified for OU3 and OU4 simulations, respectively.

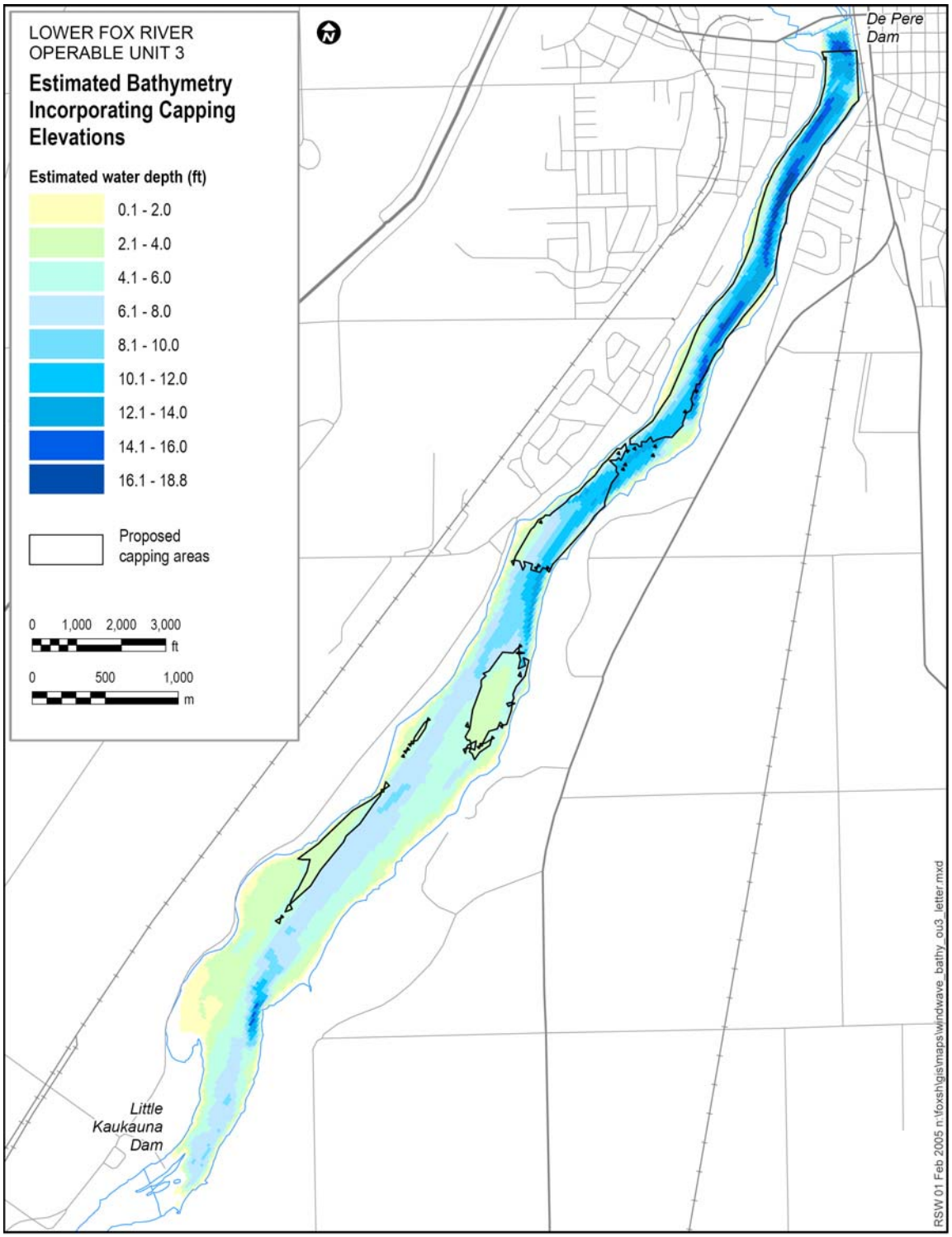

Figure 3. Lower Fox River (OU3) bathymetry.

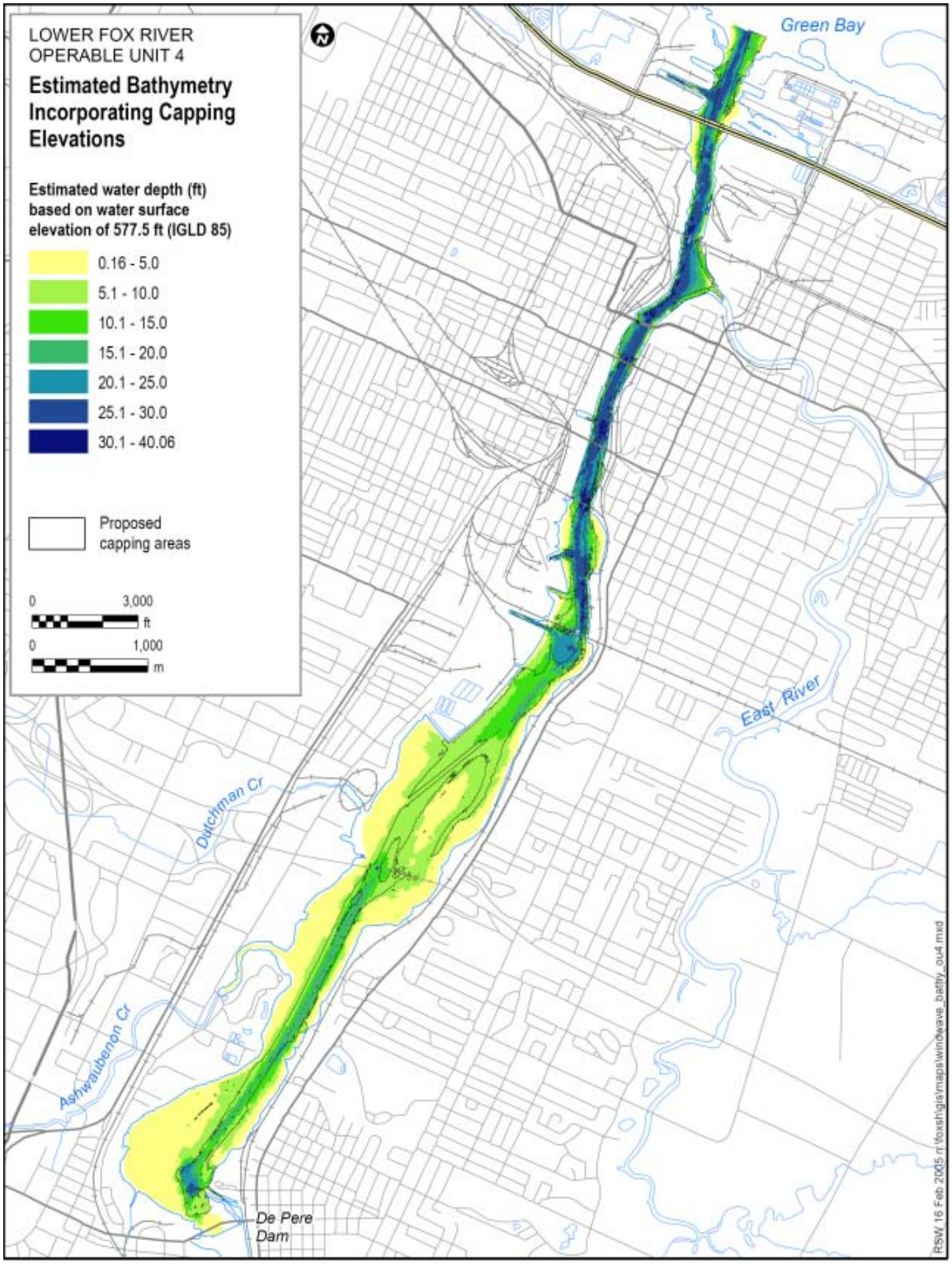

Figure 4. Lower Fox River (OU4) bathymetry.

Analysis of wind data from the NOAA weather station at the City of Green Bay shows prevailing winds out of the southwest and west. The distribution of wind observations by direction is shown in Figure 5, adapted from Appendix C of the Lower Fox River and Green Bay Remedial Investigation Report (ThermoRetec, 2001). The data indicate that winds are from the southwest about 12% of the time and from the west about 11% of the time. Four wind scenarios were chosen for simulation, representing dominant prevailing winds and winds along the main fetch of the OU3 and OU4 reaches of the Lower Fox River, which is oriented downstream from SW to NE. Figure 6 shows the distributions of wind speeds in each of these four directions (ThermoRetec, 2001). The wind speeds selected for each scenario represent upper bound velocities in each direction as shown in Appendix C. These scenarios include: a) 60 km/hr (37 mph) from SSW, b) 60 km/hr (37 mph) from SW, c) 60 km/hr (37 mph) from NE, d) and 50 km/hr (31 mph) from NNE.

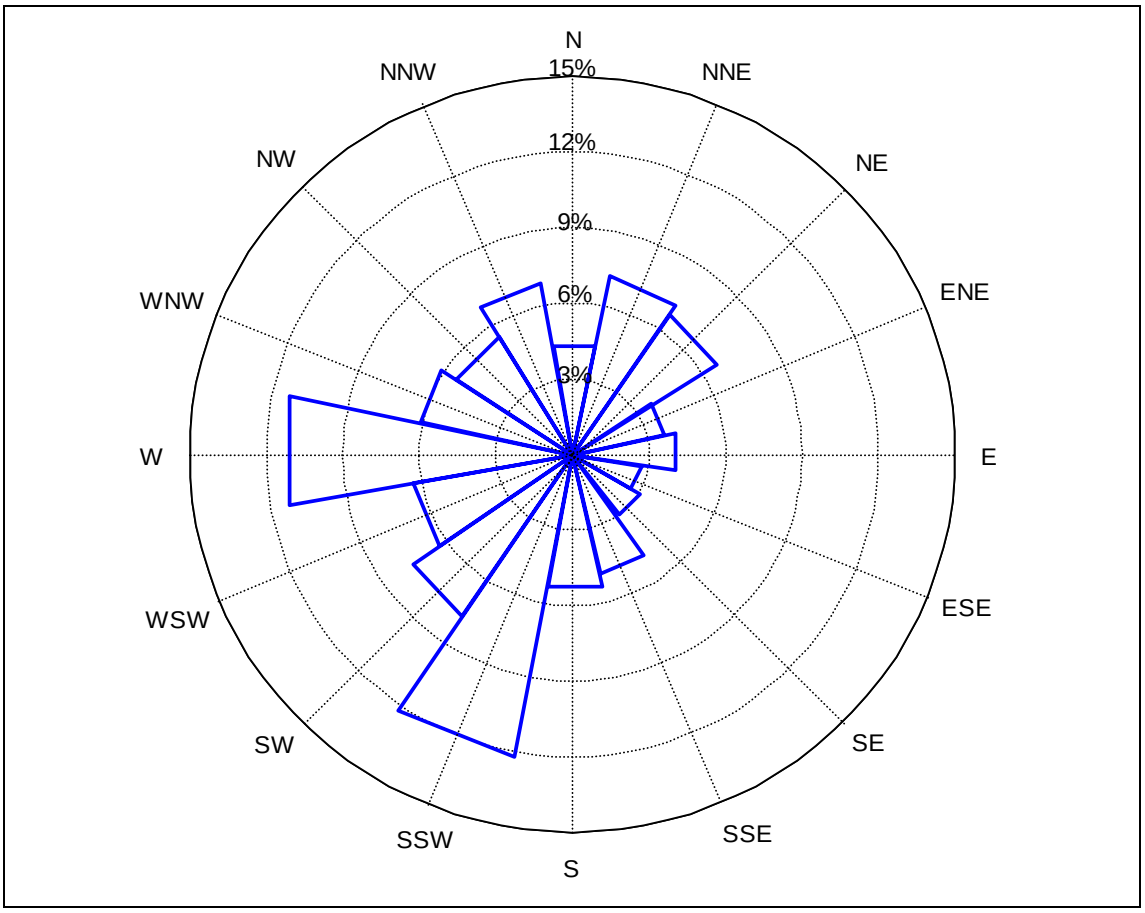

Figure 5. Distribution of wind events by direction, Green Bay, WI.

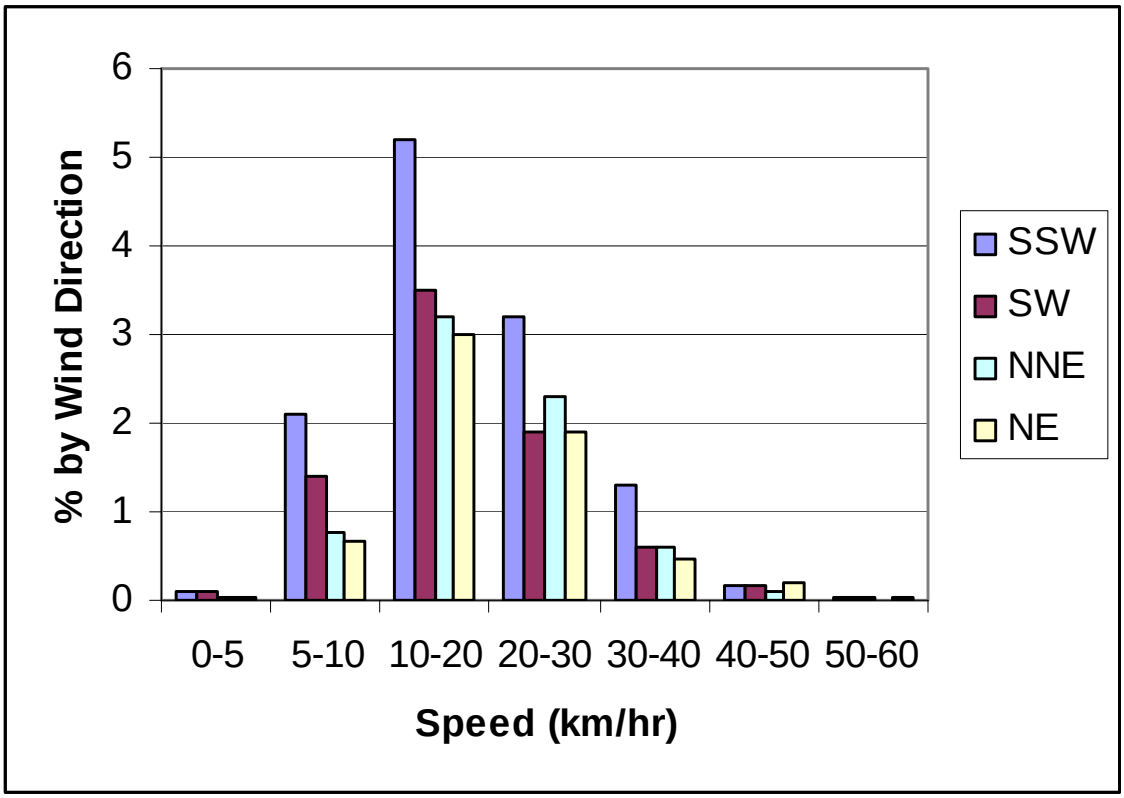

Figure 6. Distribution of wind speeds, by direction, Green Bay, WI

RESULTS AND DISCUSSION

Large wind-driven waves play an important role in inducing shore erosion and bottom shear stress. Wave heights tend to be greatest near the shore opposite of the source direction of wind; i.e., downwind. Bottom shear stress is calculated by the Grant-Madsen method, which is a function of depth, wave height, peak wave period, and bed roughness. All parameters are generated in SWAN, except bed roughness, which was estimated as 0.002 m (SEI 2005). Shear stress tends to be greatest near intersections of shallow depth (Figures 2, 3) and high waves.

Operable Unit 3

Model output (shear stress) is shown for each of the four wind scenarios for OU3: 37-mph from SSW (Figure 7), 37-mph from SW (Figure 8), 37-mph from NE (Figure 9), and 31-mph from NNE (Figure 10).

All four simulated wind conditions produce elevated shear stresses along the east and west banks of the river, as well as near the proposed sediment cap near the center of the reach. These stresses are primarily due to shallow depth in the local areas. The southwestern portion of OU3 (near Little Kaukauna Dam) is impacted by high waves in

two of the four simulated events and is relatively shallow. Winds from the SSW (Figure 7) and SW (Figure 8) produce significantly lower shear stresses in the southwestern portion of OU3 than winds from the NE (Figure 9) and NNE (Figure 10). Winds out of the NE and NNE produce higher stresses in this area due to the long fetch along the river allowing for high waves. The scenarios where winds are out of the SW and SSW produce less shear stress in the shallow southwestern portion of the river, as local wave height is less extreme.

Shear stress tends to be elevated in areas where sediment caps are proposed, especially in areas of shallower water depths. This is most apparent near the proposed cap in the center of the reach. The bed elevation is higher here than the surrounding areas, resulting in a local zone of higher shear stress. The proposed cap area near the southwestern area of the reach has a similar shear stress response to shallow depth. The elongated sediment cap near the northern portion of the reach is less impacted by wind waves, as water depths are generally higher in this area; however, the southern most tip of this cap section is relatively shallow, resulting in maximum shear stress predictions for the "north" cap that are similar to the other capped areas. The maximum predicted shear stress for the three major capped areas under the four simulated extreme wind events is summarized in Table 1.

Table 1: Maximum Predicted Shear Stress in Proposed Cap Areas for OU3.

Wind Scenario	Cap Area	Max Shear Stress (dynes/cm^2)
SSW 37.3 mph	center	17.29
	southwest	15.70
	north	15.40
SW 37.3 mph	center	17.29
	southwest	15.70
	north	14.22
NE 37.3 mph	center	13.71
	southwest	14.72
	north	11.37
NNE 31.1 mph	center	12.12
	southwest	11.85
	north	11.00

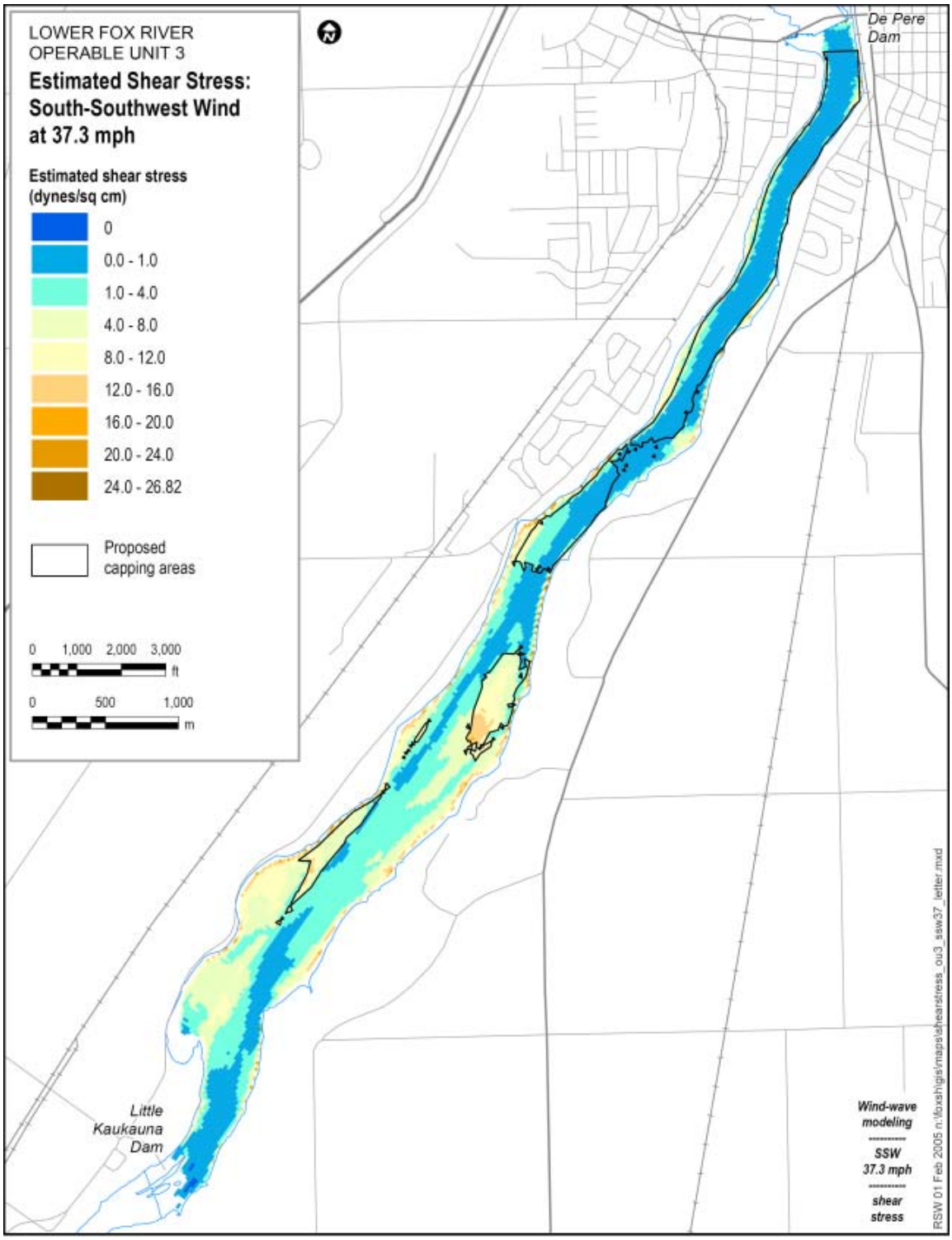

Figure 7. Wind wave induced shear stress in OU3, 37-mph SSW wind.

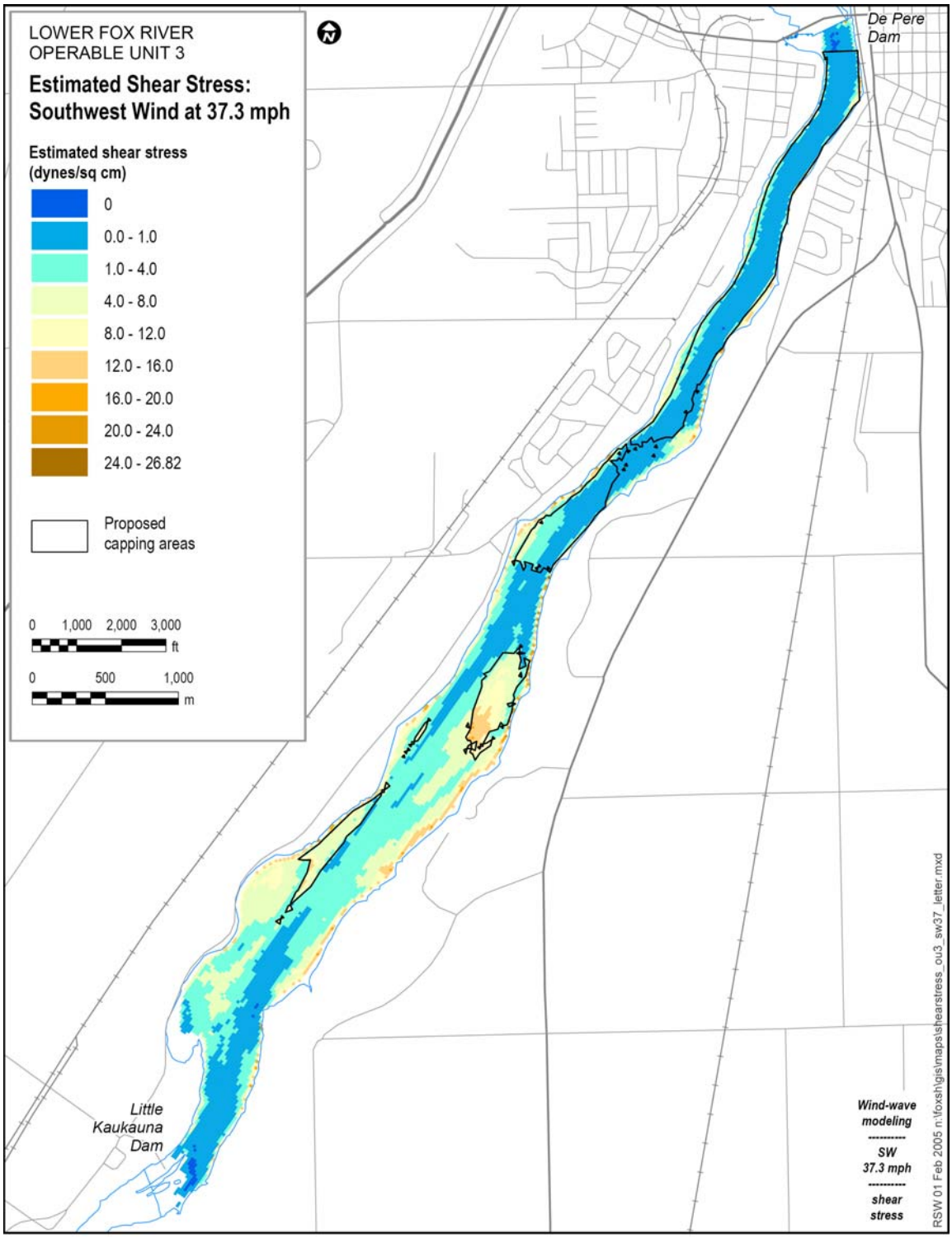

Figure 8. Wind wave induced shear stress in OU3, 37-mph SW wind.

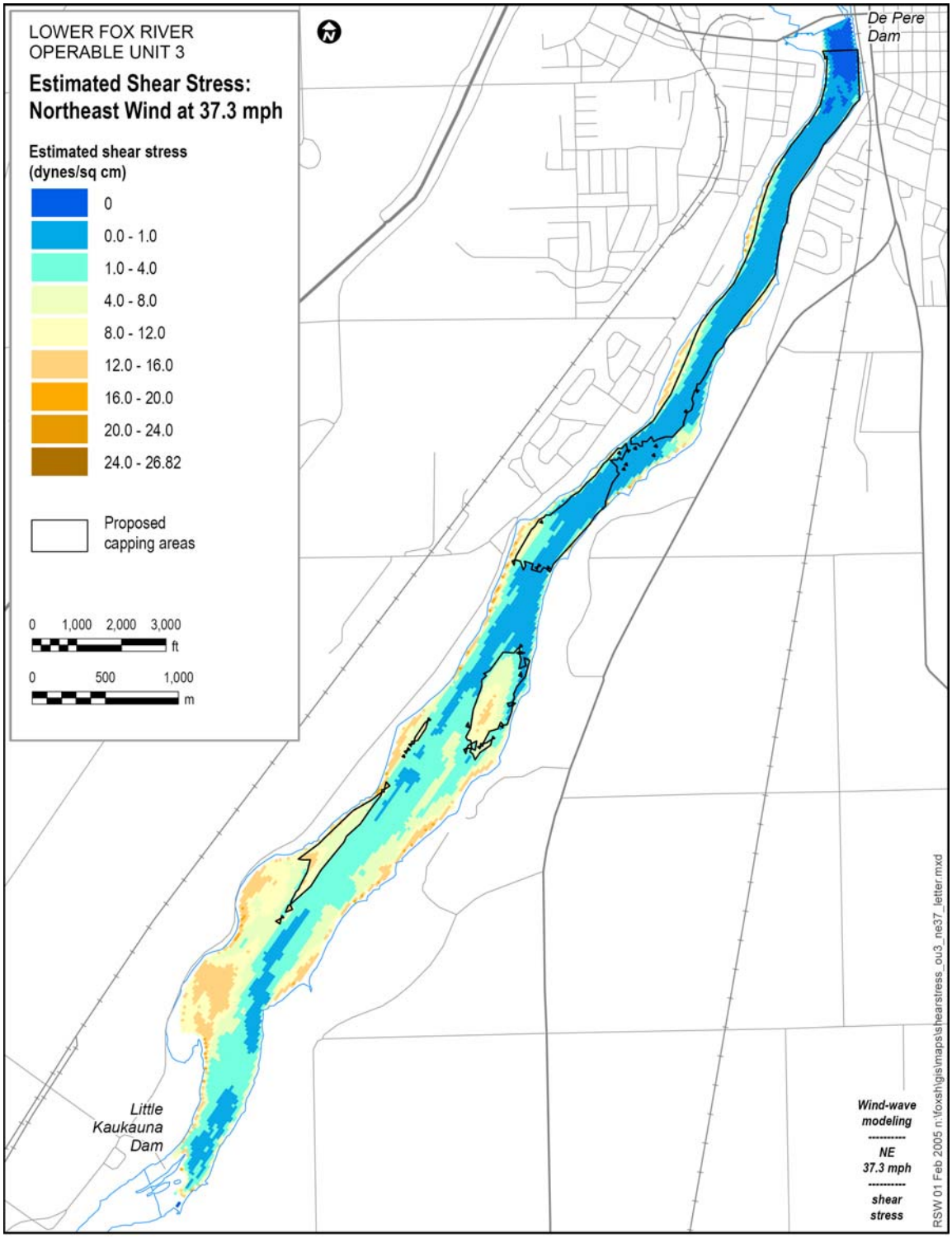

Figure 9. Wind wave induced shear stress in OU3, 37-mph NE wind.

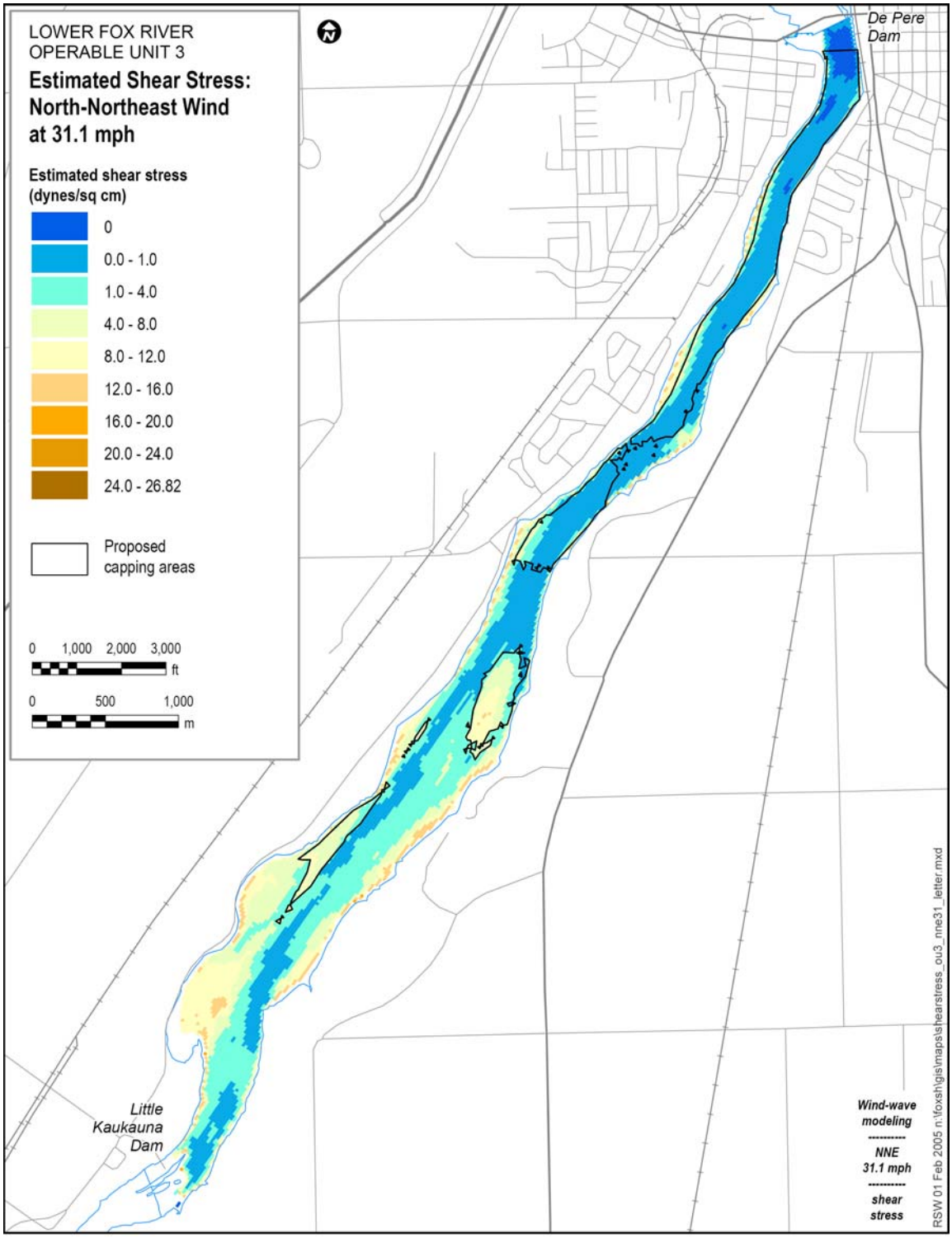

Figure 10. Wind wave induced shear stress in OU3, 31-mph NNE wind.

Operable Unit 4

Model output (shear stress) is shown for each of the four wind scenarios for OU4: 37-mph from SSW (Figure 11), 37-mph from SW (Figure 12), 37-mph from NE (Figure 13), and 31-mph from NNE (Figure 14).

All four simulated wind conditions result in relatively low shear stress in the main channel of OU4, particularly in OU4b. This is due to the greater depths in the channelized portion of the reach. Simulated winds from SW (Figure 11) and SSW (Figure 12) produce relatively low shear stress values near the wider OU4a portion of the river, while winds from the NE (Figure 13) and NNE Figure 14) show higher shear stresses in this area. The high shear stresses predicted for the NE and NNE scenarios are due to the combination of shallow depths and long fetch distance along the main channel.

The proposed cap areas for OU4 are generally less sensitive to shear stress from wind-driven waves than cap areas proposed for OU3. The proposed cap areas for OU4a are generally along the main channel, where depths are greater and thus the effects of waves are attenuated. However, small portions of proposed caps in both OU4a and OU4b are located where water is shallower. These areas generally result in predicted shear stress values (Table 2) that are greater than any estimated for OU3 (Table 1). However, it should be noted that the vast majority of the area (>99%) covered by the proposed caps show much lower values (Figures 11-14). Table 3 lists the percentage of total cap area for ranges of predicted shear stress values for the four simulated wind scenarios.

Table 2: Maximum Predicted Shear Stress in Proposed Cap Areas for OU4.

Wind Scenario	Cap Area	Max Shear Stress (dynes/cm^2)
SSW 37.3 mph	south OU4a	17.75
	north OU4a	29.00
	westbank OU4b	18.87
	eastbank OU4b	24.49
SW 37.3 mph	south OU4a	20.91
	north OU4a	27.28
	westbank OU4b	16.32
	eastbank OU4b	23.24
NE 37.3 mph	south OU4a	19.13
	north OU4a	14.79
	westbank OU4b	23.46
	eastbank OU4b	20.46
NNE 31.1 mph	south OU4a	15.56
	north OU4a	11.62
	westbank OU4b	23.46
	eastbank OU4b	16.51

Table 3: Comparison of Shear Stress Distribution for Proposed Cap Areas.

Wind Scenario	Shear Stress (dynes/cm^2)	Area in OU3 (% of Total)	Area in OU4 (% of Total)
SSW 37.3 mph	0-10	92.74%	99.49%
	10-15	6.56%	0.36%
	15-20	0.71%	0.13%
	>20	0.00%	0.03%
SW 37.3 mph	0-10	92.88%	99.54%
	10-15	6.28%	0.31%
	15-20	0.84%	0.11%
	>20	0.00%	0.04%
NE 37.3 mph	0-10	93.67%	99.73%
	10-15	6.33%	0.20%
	15-20	0.00%	0.04%
	>20	0.00%	0.03%
NNE 31.1 mph	0-10	97.33%	99.82%
	10-15	2.67%	0.13%
	15-20	0.00%	0.04%
	>20	0.00%	0.02%

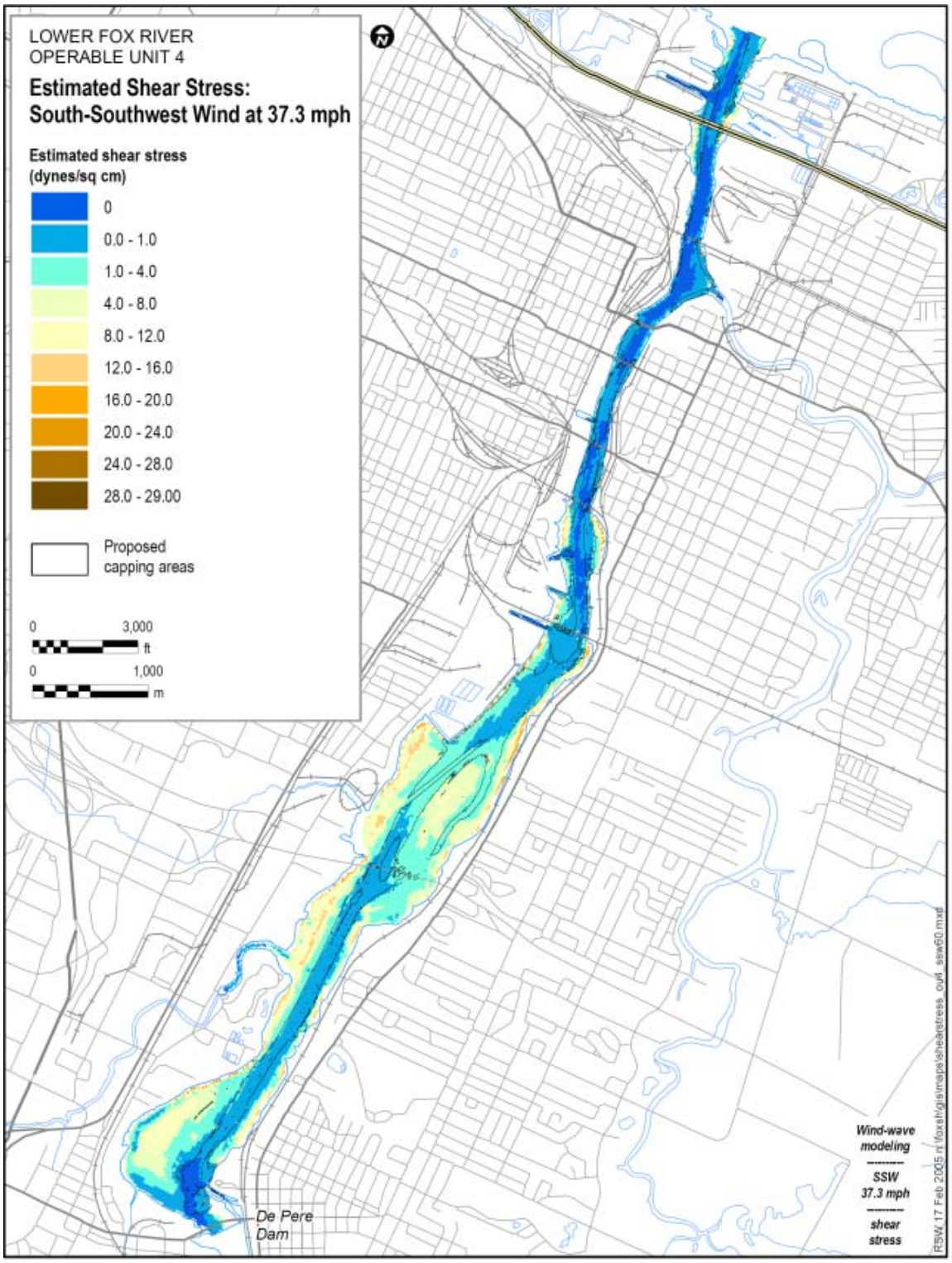

Figure 11. Wind wave induced shear stress in OU4, 37-mph SSW wind.

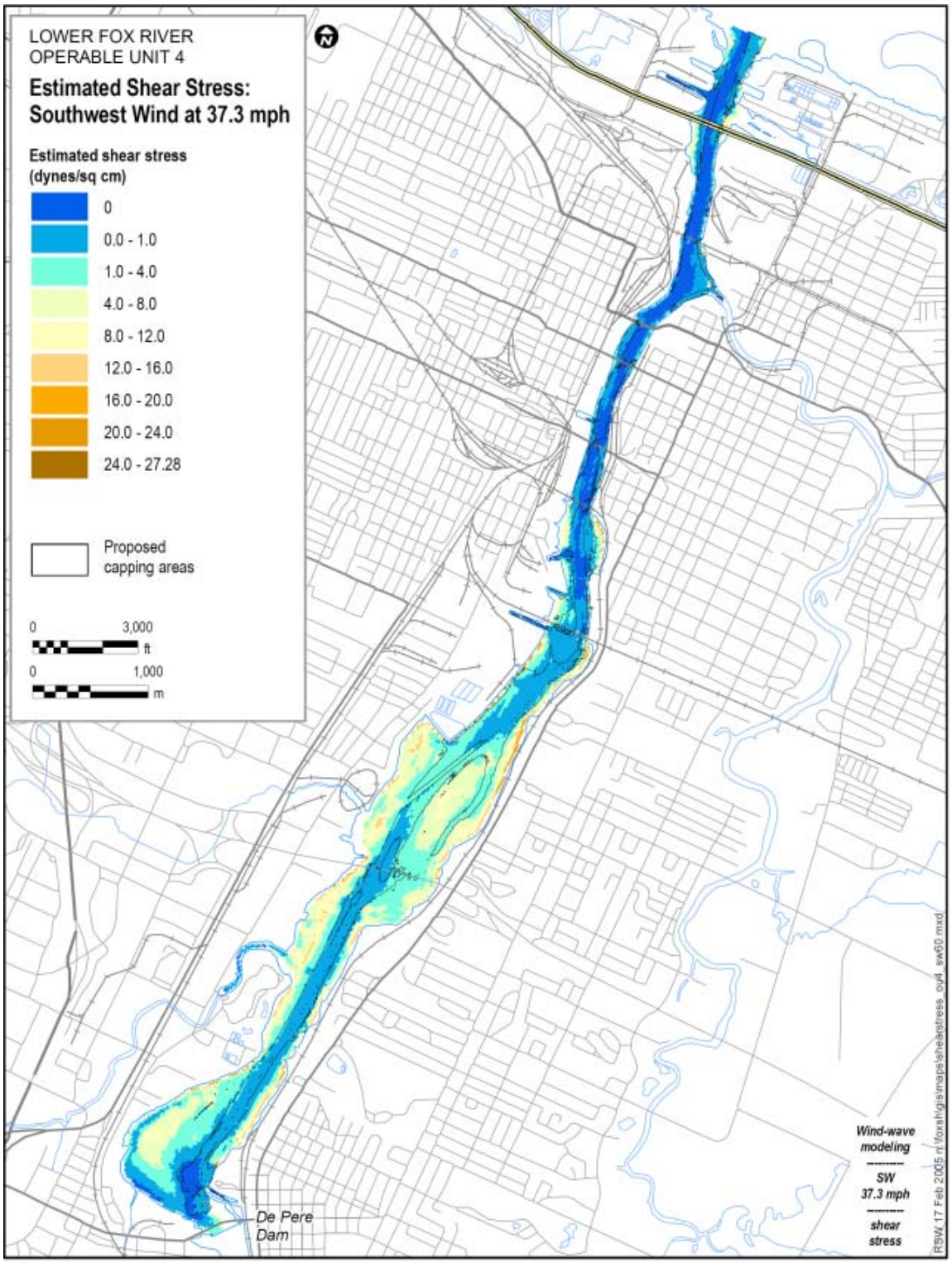

Figure 12. Wind wave induced shear stress in OU4, 37-mph SW wind.

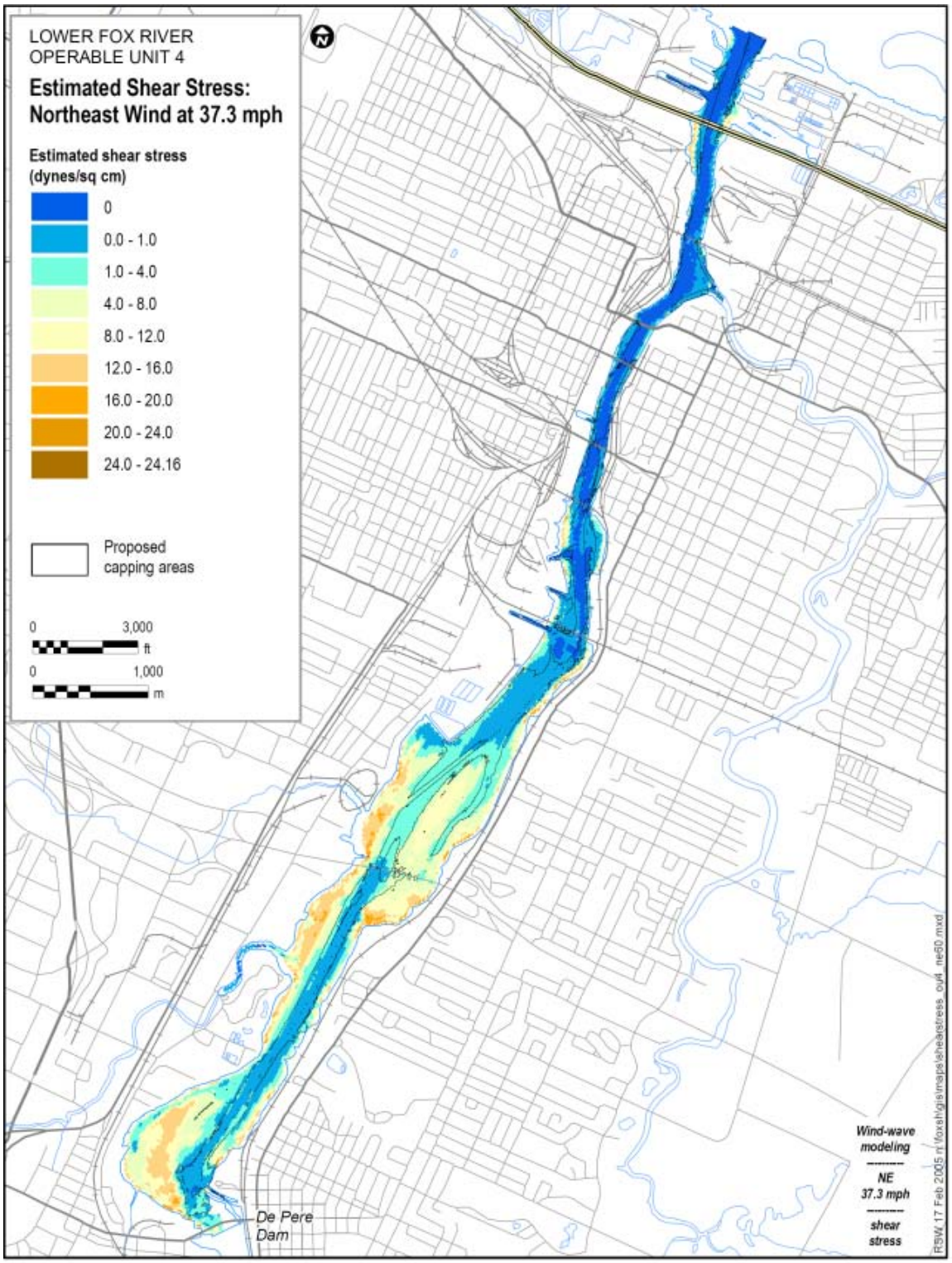

Figure 13. Wind wave induced shear stress in OU4, 37-mph NE wind.

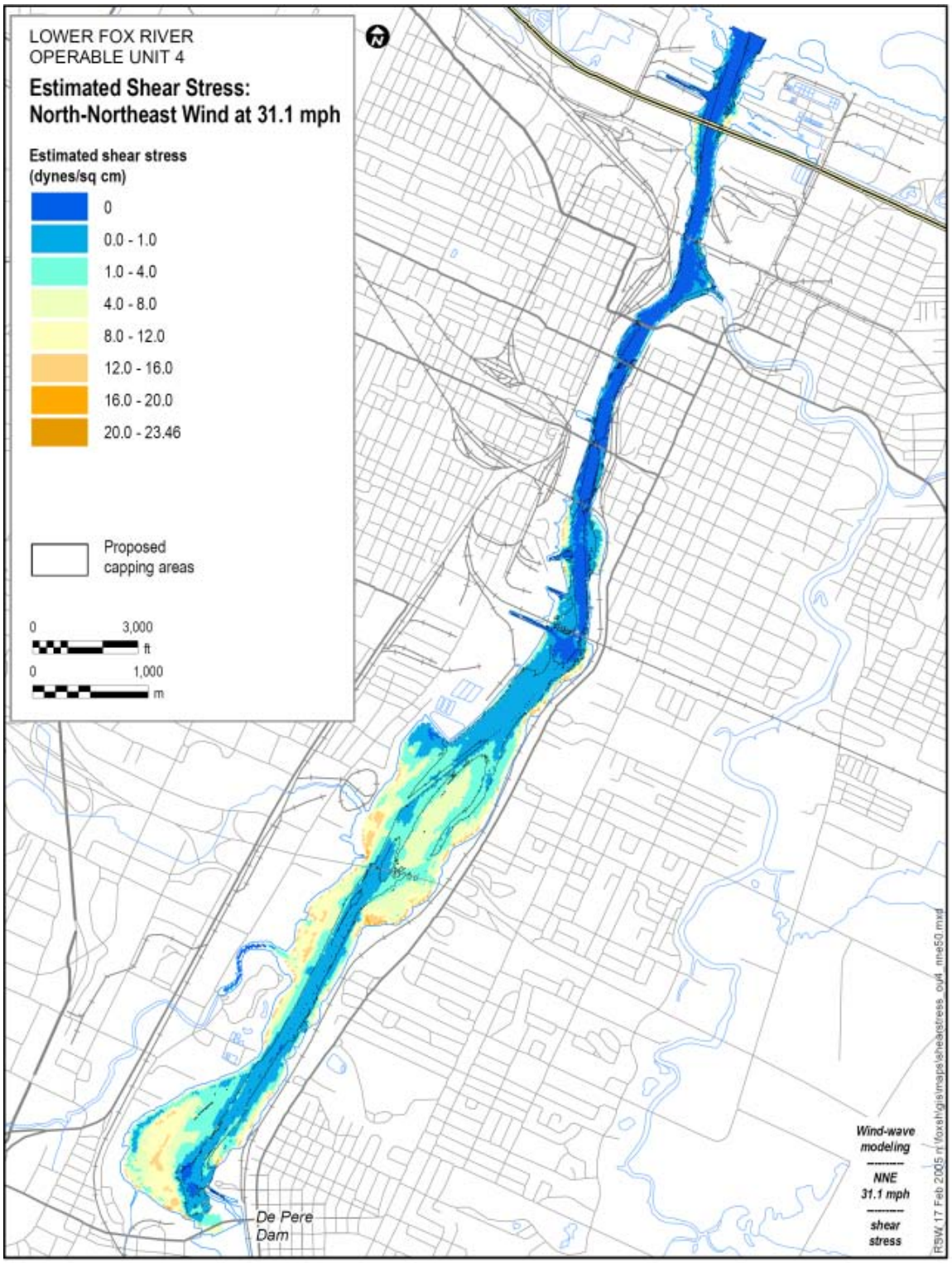

Figure 14. Wind wave induced shear stress in OU4, 31-mph NNE wind.

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Attachment E -

Windwave Model 8-02-05

Limno-Tech, Inc.
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Memorandum

DATE: August 2, 2005
PROJECT: **FOXSH**

TO: **John Wolfe**

FROM: **Dan Rucinski**
CC: file

SUBJECT: **Lower Fox River Wind Wave Model (OU3 and OU4)**

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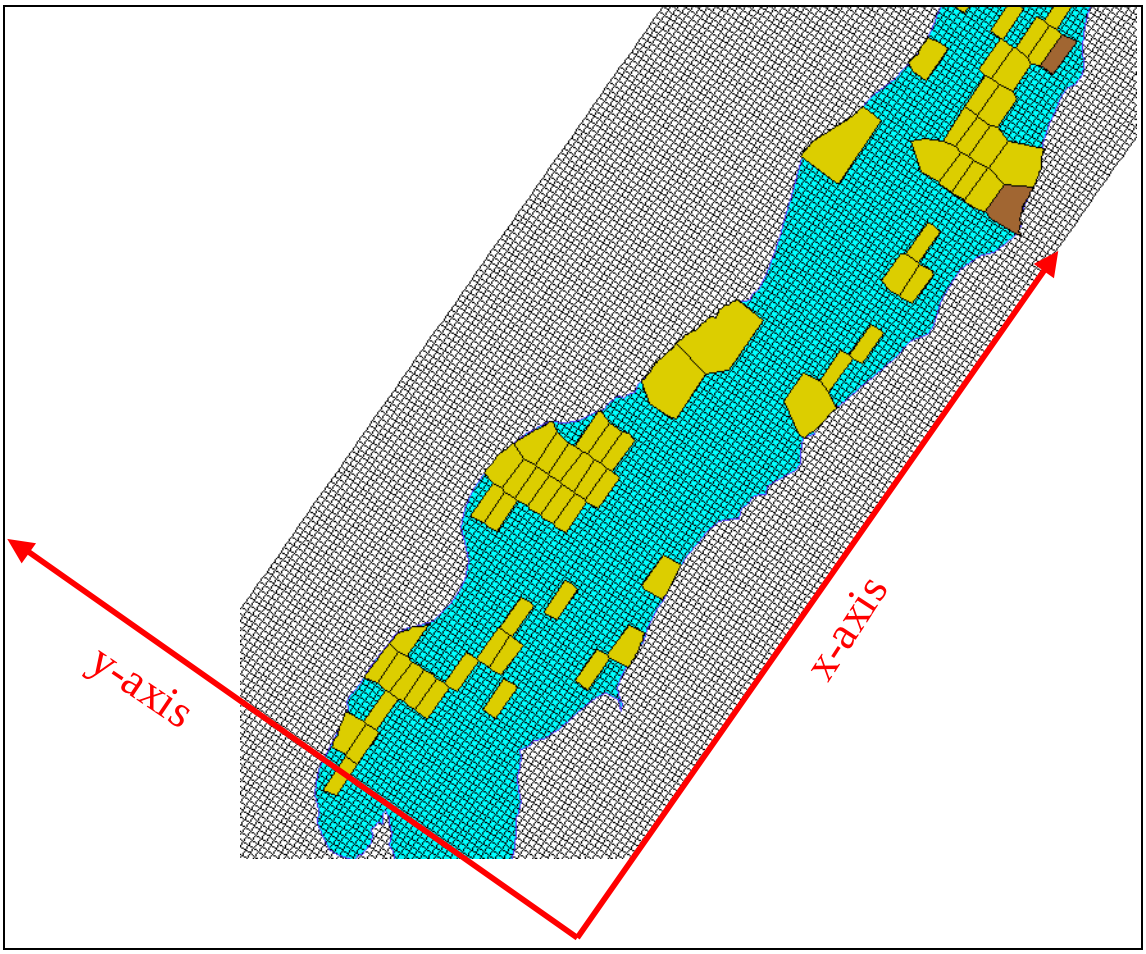

Figure 1. Subset of model grid representation of Lower Fox River (OU3) w/ proposed sediment capping (brown) and cover (yellow).

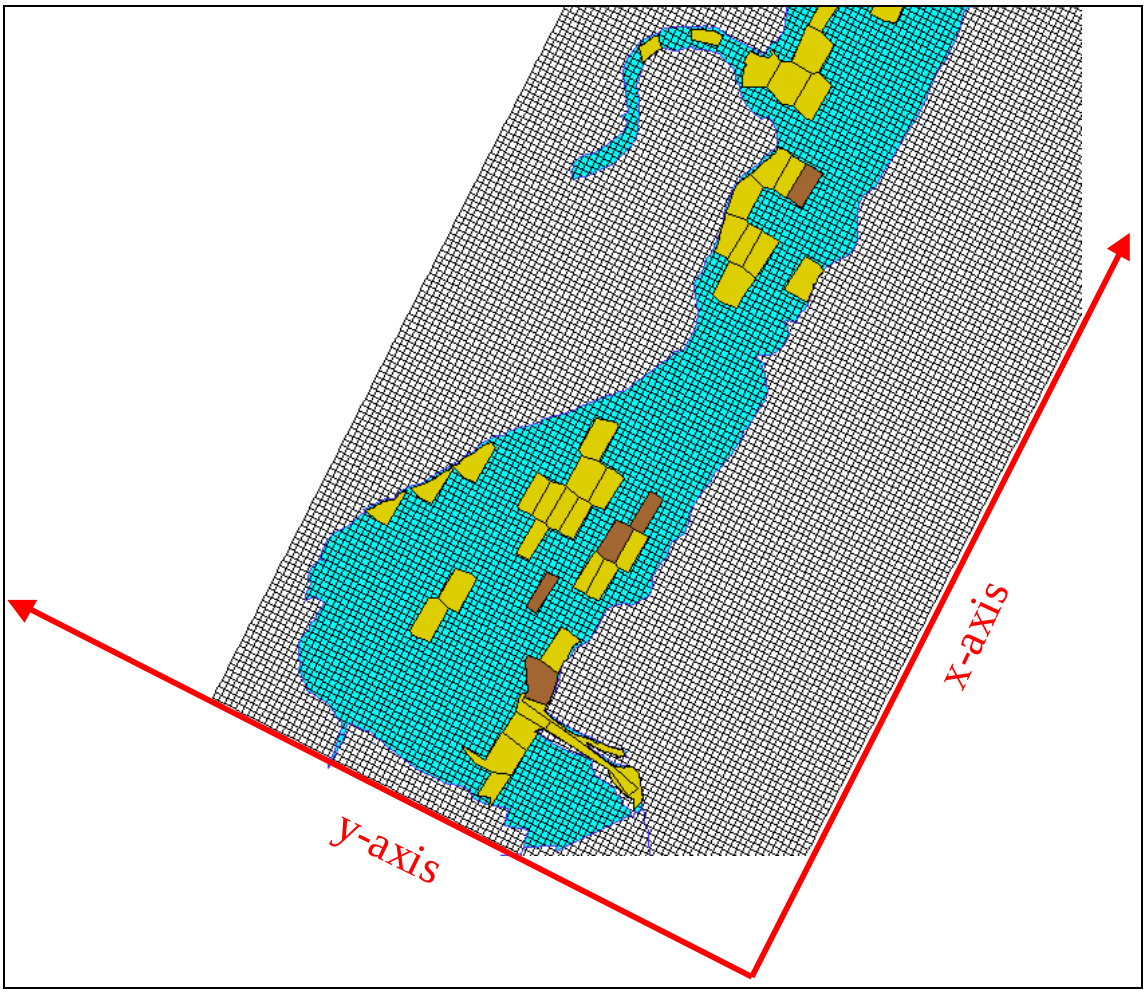

Figure 2. Subset of model grid representation of Lower Fox River (OU4) w/ proposed sediment capping (brown) and cover (yellow).

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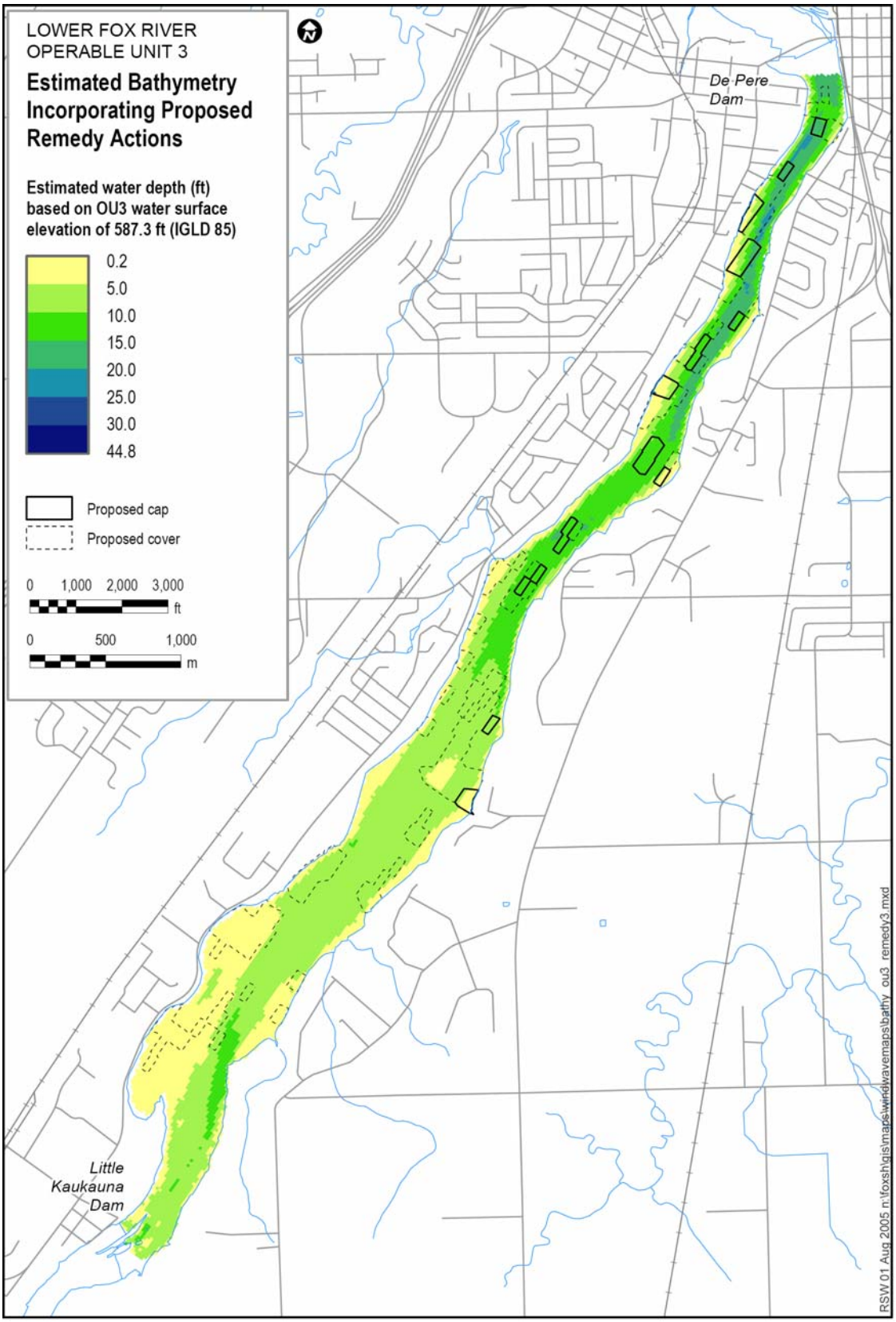

Figure 3. Lower Fox River (OU3) bathymetry.

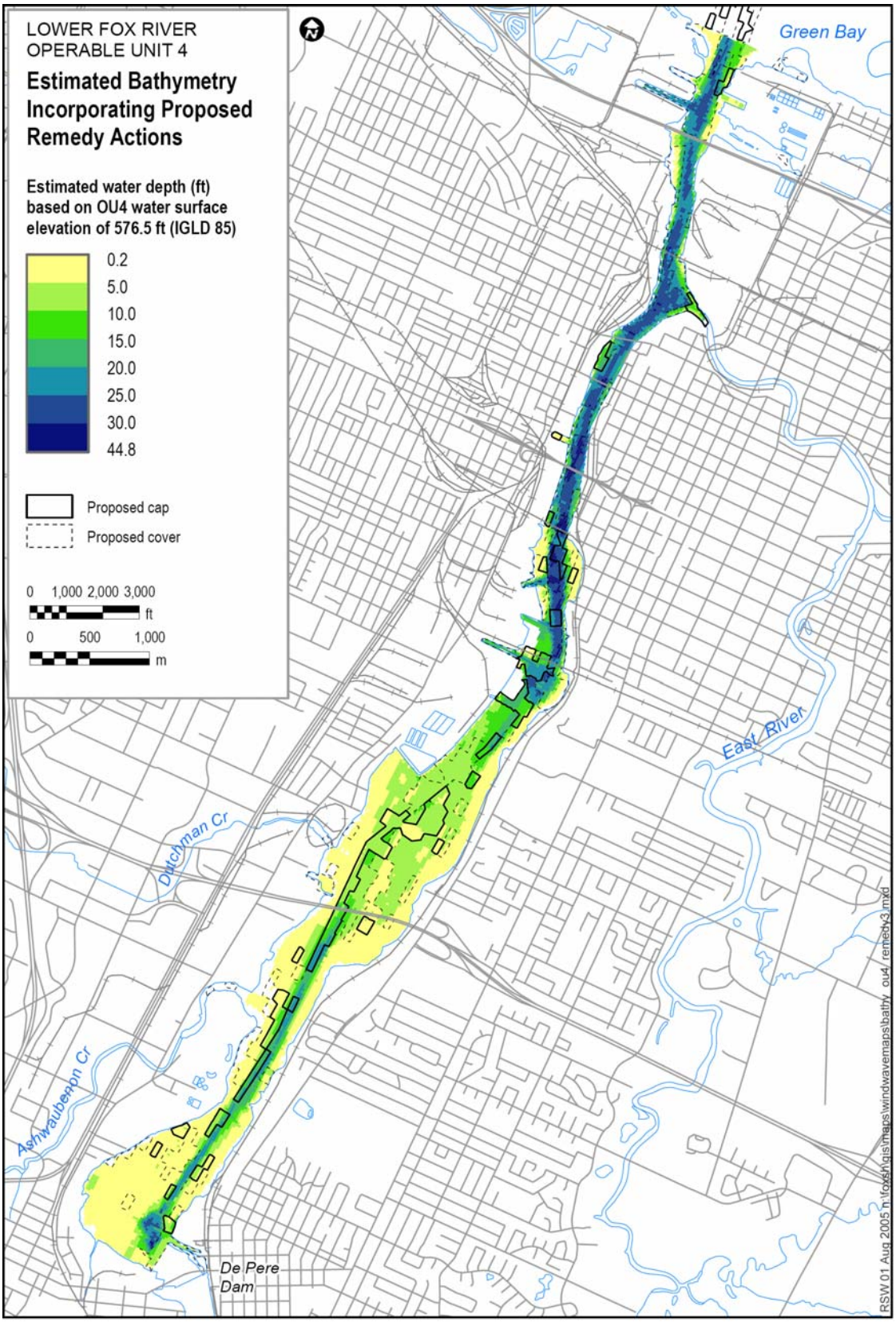

Figure 4. Lower Fox River (OU4) bathymetry.

Analysis of wind data from the NOAA weather station at the City of Green Bay shows prevailing winds out of the southwest and west. The distribution of wind observations by direction is shown in Figure 5, adapted from Appendix C of the Lower Fox River and Green Bay Remedial Investigation Report (ThermoRetec, 2001). The data indicate that winds are from the southwest about 12% of the time and from the west about 11% of the time. Four wind scenarios were chosen for simulation, representing dominant prevailing winds and winds along the main fetch of the OU3 and OU4 reaches of the Lower Fox River, which is oriented downstream from SW to NE. Figure 6 shows the distributions of wind speeds in each of these four directions (ThermoRetec, 2001). The wind speeds selected for each scenario represent upper bound velocities in each direction as shown in Appendix C. These scenarios include: a) 60 km/hr (37 mph) from SSW, b) 60 km/hr (37 mph) from SW, c) 60 km/hr (37 mph) from NE, d) and 50 km/hr (31 mph) from NNE.

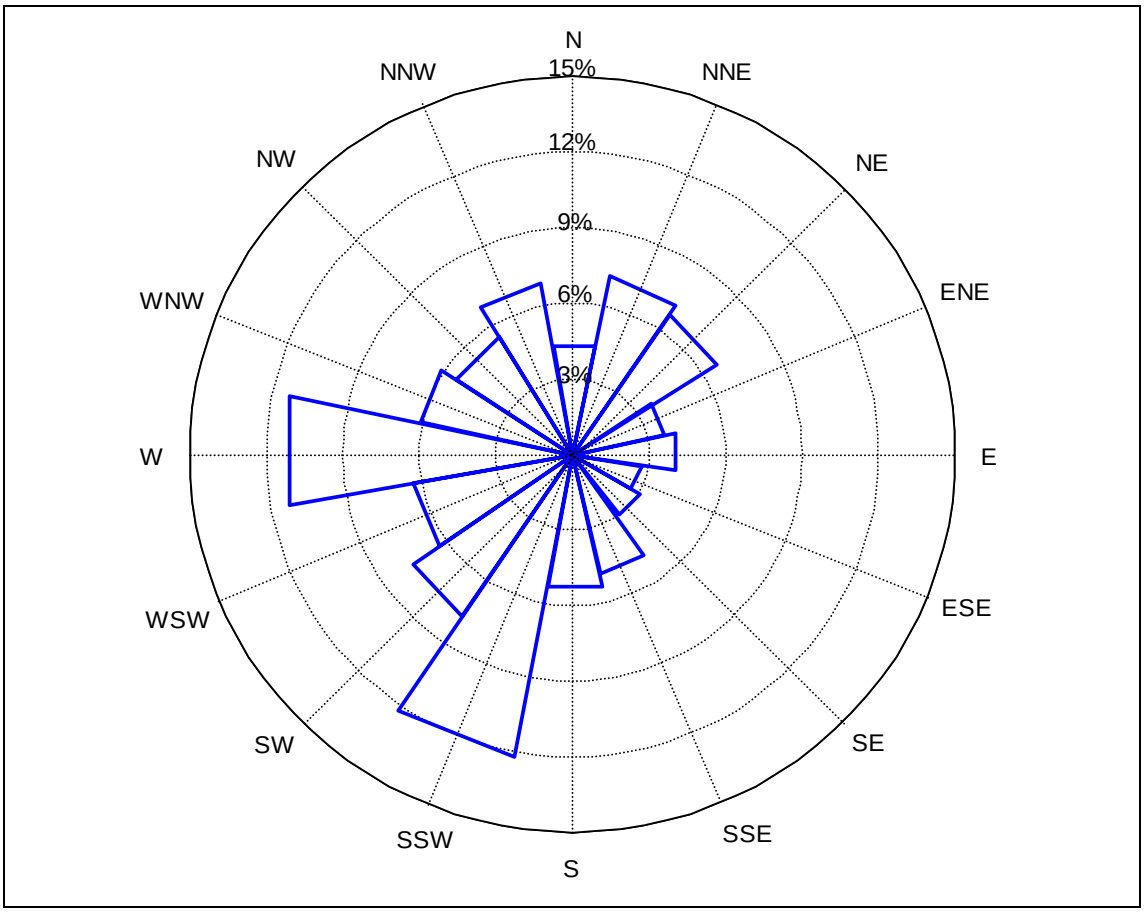

Figure 5. Distribution of wind events by direction, Green Bay, WI.

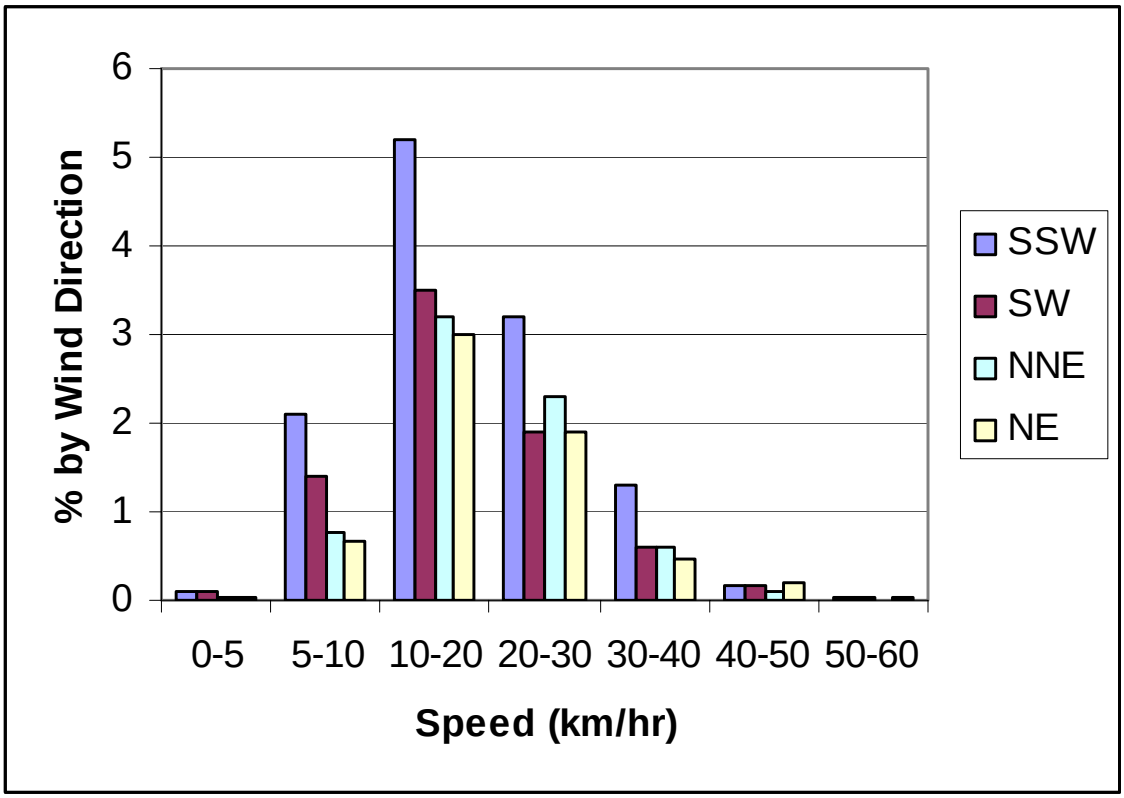

Figure 6. Distribution of wind speeds, by direction, Green Bay, WI

RESULTS AND DISCUSSION

Large wind-driven waves play an important role in inducing shore erosion and bottom shear stress. Wave heights tend to be greatest near the shore opposite of the source direction of wind; i.e., downwind. Bottom shear stress is calculated by the Grant-Madsen method, which is a function of depth, wave height, peak wave period, and bed roughness. All parameters are generated in SWAN, except bed roughness, which was estimated as 0.0003 m from surface sediment data collected during 2000 (LTI, 2002). Shear stress tends to be greatest near intersections of shallow depth (Figures 2, 3) and high waves.

Operable Unit 3

Model output (shear stress) is shown for each of the four wind scenarios for OU3: 37-mph from SSW (Figure 7), 37-mph from SW (Figure 8), 37-mph from NE (Figure 9), and 31-mph from NNE (Figure 10).

All four simulated wind conditions produce elevated shear stresses (> 5 dynes/cm^2) along the east and west banks of the river. These stresses are primarily due to shallow depth in the local areas. The southwestern portion of OU3 (near Little Kaukauna Dam) is impacted by high waves in two of the four simulated events and is relatively shallow.

Winds from the SSW (Figure 7) and SW (Figure 8) produce significantly lower shear stresses in the southwestern portion of OU3 than winds from the NE (Figure9). Winds out of the NE produce higher stresses in this area due to the long fetch along the river allowing for high waves. The scenarios where winds are out of the SW and SSW produce less shear stress in the shallow southwestern portion of the river, as local wave height is less extreme.

For each wind scenario, the maximum predicted shear stress occurs in areas with PCB concentrations < 1 ppm. These maximum values are less than 10 dynes/cm^2 for each wind scenario. Maximum predicted shear stresses for engineered caps are 7.01 dynes/cm^2 or less for the four wind scenarios, and the maximum predicted shear stresses for areas of cover are 7.85 dynes/cm^2 or less. The maximum and average predicted shear stress for the remedy areas under the four simulated extreme wind events are summarized in Table 1.

Table 1: Predicted Shear Stress in Proposed Cap Areas for OU3.

Wind Scenario	Remedy Description	Area (m^2)	Maximum shear stress (dynes/cm^2)	Average shear stress (dynes/cm^2)
SSW 37.3 mph	Cover < 3' water depth	102896	6.30	3.80
	Cover > 3' water depth	614818	7.85	1.93
	Dredge to 1 ppm	244668	5.32	0.92
	Engineered Cap	162114	6.71	1.04
	PCBs < 1 ppm	2377228	9.56	1.41
SW 37.3 mph	Cover < 3' water depth	102896	5.83	3.12
	Cover > 3' water depth	614818	7.32	1.83
	Dredge to 1 ppm	244668	5.08	0.81
	Engineered Cap	162114	7.01	1.00
	PCBs < 1 ppm	2377228	9.33	1.29
NE 37.3 mph	Cover < 3' water depth	102896	6.33	4.48
	Cover > 3' water depth	614818	6.44	1.80
	Dredge to 1 ppm	244668	7.79	1.11
	Engineered Cap	162114	6.27	0.85
	PCBs < 1 ppm	2377228	8.38	1.60
NNE 31.1 mph	Cover < 3' water depth	102896	5.78	3.78
	Cover > 3' water depth	614818	5.92	1.51
	Dredge to 1 ppm	244668	6.20	0.93
	Engineered Cap	162114	6.19	0.74
	PCBs < 1 ppm	2377228	7.30	1.36

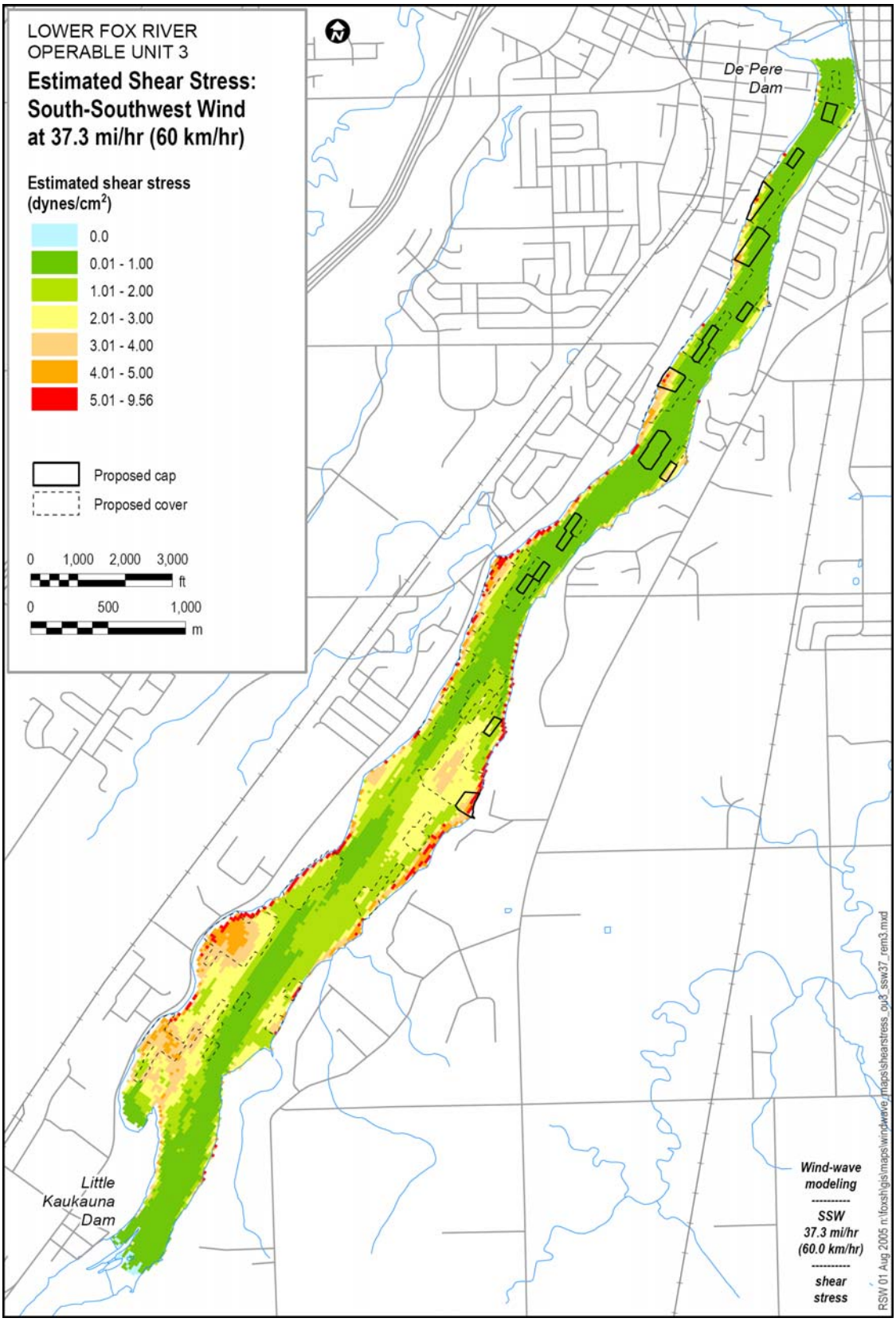

Figure 7. Wind wave induced shear stress in OU3, 37-mph SSW wind.

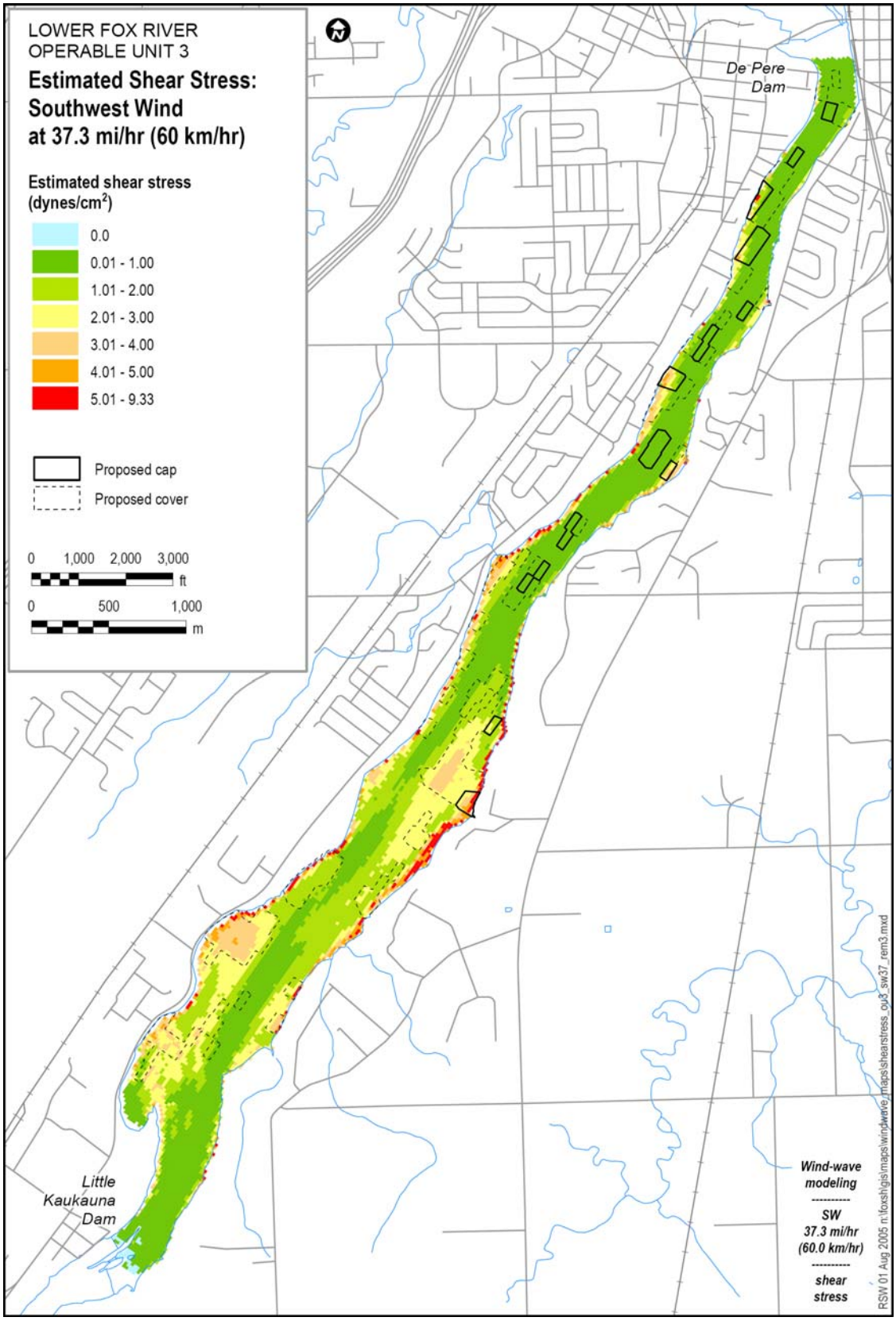

Figure 8. Wind wave induced shear stress in OU3, 37-mph SW wind.

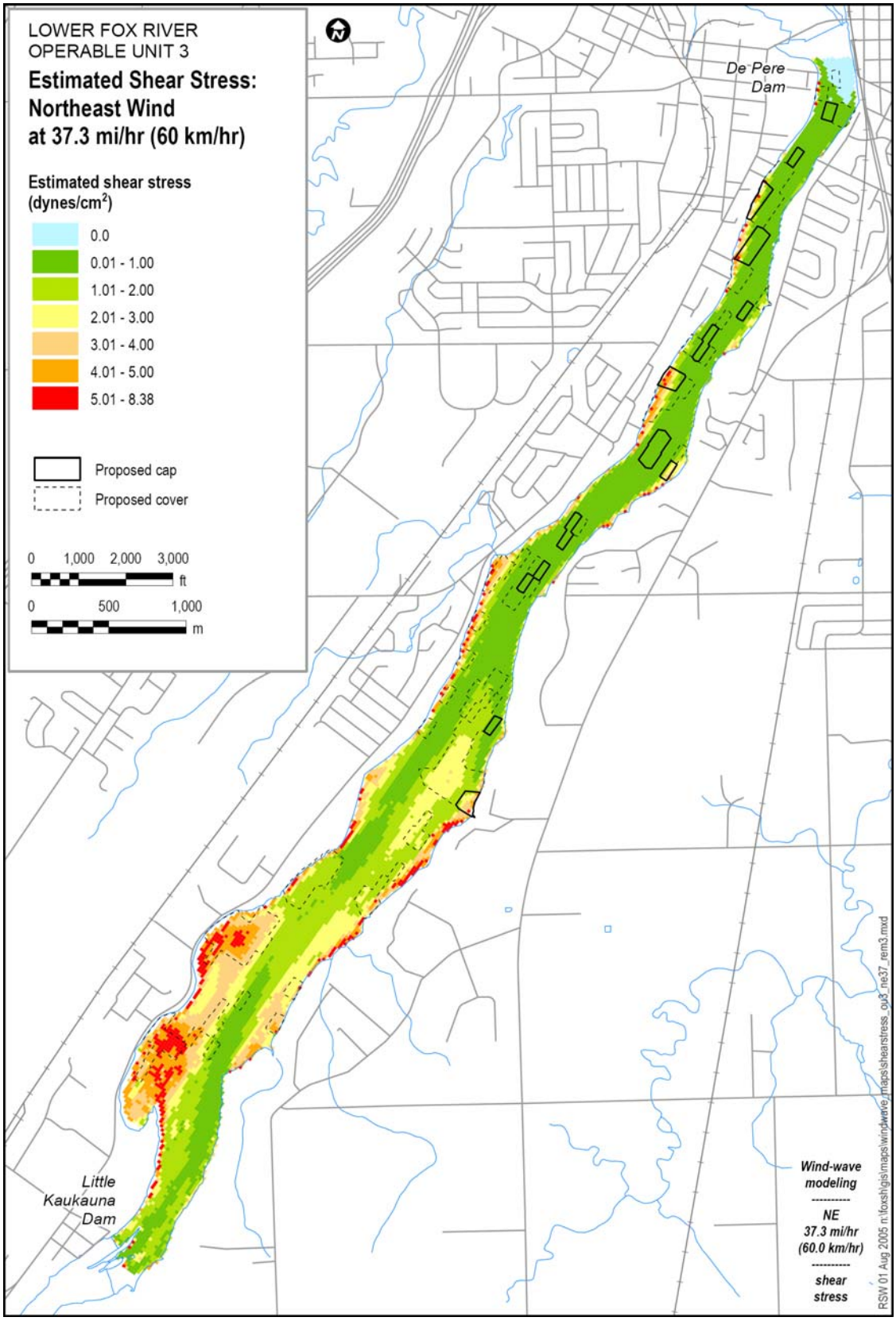

Figure 9. Wind wave induced shear stress in OU3, 37-mph NE wind.

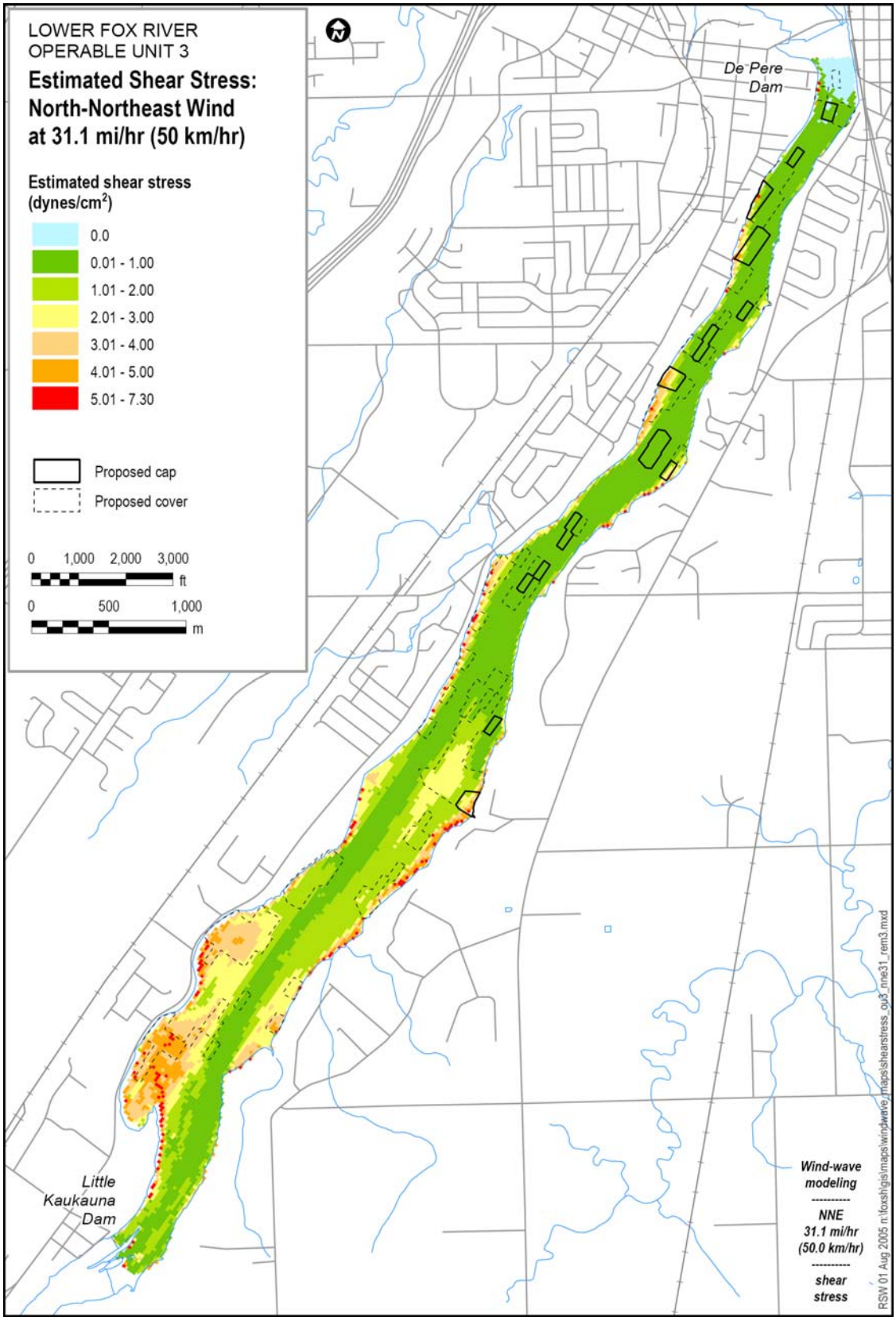

Figure 10. Wind wave induced shear stress in OU3, 31-mph NNE wind.

Operable Unit 4

Model output (shear stress) is shown for each of the four wind scenarios for OU4: 37-mph from SSW (Figure 11), 37-mph from SW (Figure 12), 37-mph from NE (Figure 13), and 31-mph from NNE (Figure 14).

All four simulated wind conditions result in relatively low shear stress in the main channel of OU4, particularly in OU4b. This is due to the greater depths in the channelized portion of the reach. The scenarios show somewhat higher shear stresses in near-shore portions of OU4a, due to the combination of shallow depths and long fetch distance along the main channel. Figures 11 and 12 show that the effects of SSW and SW winds on shear stress are greatest along the east bank of OU4, whereas Figure 13 shows that shear stresses along the west bank are affected more by NE winds.

Maximum shear stresses in OU4 under the four wind scenarios (Table 2) range up to 10.17 dynes/cm^2 for areas where concentrations are below the action level of 1 ppm, and less than or equal to this maximum shear stress for all other remedial areas. Table 2 shows that maximum OU4 shear stresses range up to 7.65 dynes/cm^2 for capped areas and up to 10.17 dynes/cm^2 for areas of cover, under the four wind scenarios. Table 3 presents the distribution of simulated shear stresses for each scenario and category of caps and covers in OU3 and OU4. Table 3 shows that shear stresses greater than 6 dynes/cm^2 are predicted for less than 3% of remedial area for each combination of remedy and wind scenario.

Table 2: Maximum Predicted Shear Stress in Proposed Remedy Areas for OU4.

Wind Scenario	Remedy Description	Area (m^2)	Maximum shear stress ($dynes/cm^2$)	Average shear stress ($dynes/cm^2$)
SSW 37.3 mph	Cover < 3' water depth	161213	7.39	2.69
	Cover > 3' water depth	782726	9.20	0.88
	Dredge & Engineered Cap	376897	6.32	0.81
	Dredge to 1 ppm	1623628	7.39	1.33
	Engineered Cap	207183	6.74	1.29
	PCBs < 1 ppm	1396577	9.20	1.82
	Staging Facility Fill	173	2.88	0.74
SW 37.3 mph	Cover < 3' water depth	161213	7.54	2.67
	Cover > 3' water depth	782726	8.18	0.89
	Dredge & Engineered Cap	376897	5.98	0.78
	Dredge to 1 ppm	1623628	7.54	1.23
	Engineered Cap	207183	6.56	1.32
	PCBs < 1 ppm	1396577	7.54	1.90
	Staging Facility Fill	173	2.34	0.60
NE 37.3 mph	Cover < 3' water depth	161213	7.99	2.85
	Cover > 3' water depth	782726	10.17	1.02
	Dredge & Engineered Cap	376897	7.65	0.93
	Dredge to 1 ppm	1623628	9.67	1.65
	Engineered Cap	207183	7.22	1.50
	PCBs < 1 ppm	1396577	10.17	2.01
	Staging Facility Fill	173	0.87	0.23
NNE 31.1 mph	Cover < 3' water depth	161213	7.81	2.51
	Cover > 3' water depth	782726	8.39	0.78
	Dredge & Engineered Cap	376897	5.92	0.67
	Dredge to 1 ppm	1623628	8.39	1.28
	Engineered Cap	207183	5.88	1.19
	PCBs < 1 ppm	1396577	8.17	1.75
	Staging Facility Fill	173	1.00	0.27

Table 3: Comparison of Shear Stress Distribution for Proposed Remedy Areas.

Wind Scenario	Remedy Description	Shear Stress (dynes/cm^2)	Area in OU3 (% Total)	Area in OU4 (% Total)
SSW 37.3 mph	Cover < 3' depth	0-3	11.20%	44.59%
		3-6	87.88%	54.26%
		6-9	0.92%	1.14%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	81.56%	91.74%
		3-6	17.51%	8.16%
		6-9	0.93%	0.07%
		>9	0.00%	0.02%
	Engineered Cap	0-3	86.86%	81.47%
		3-6	12.64%	17.41%
		6-9	0.49%	1.12%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	94.85%
		3-6		5.01%
		6-9		0.14%
		>9		0.00%
SW 37.3 mph	Cover < 3' depth	0-3	41.95%	44.82%
		3-6	58.05%	53.64%
		6-9	0.00%	1.54%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	83.28%	91.32%
		3-6	15.95%	8.58%
		6-9	0.77%	0.10%
		>9	0.00%	0.00%
	Engineered Cap	0-3	87.88%	80.66%
		3-6	11.38%	18.03%
		6-9	0.74%	1.31%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	95.99%
		3-6		4.01%
		6-9		0.00%
		>9		0.00%
NE 37.3 mph	Cover < 3' depth	0-3	4.02%	42.80%
		3-6	94.03%	55.95%
		6-9	1.95%	1.24%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	81.45%	86.97%
		3-6	18.24%	12.30%
		6-9	0.32%	0.66%
		>9	0.00%	0.07%
	Engineered Cap	0-3	88.55%	77.52%
		3-6	11.20%	20.03%
		6-9	0.25%	2.45%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	93.30%
		3-6		6.43%
		6-9		0.27%
		>9		0.00%
NNE 31.1 mph	Cover < 3' depth	0-3	12.77%	51.35%
		3-6	87.23%	48.02%
		6-9	0.00%	0.63%
		>9	0.00%	0.00%
	Cover > 3' depth	0-3	87.15%	93.22%
		3-6	12.85%	6.43%
		6-9	0.00%	0.35%
		>9	0.00%	0.00%
	Engineered Cap	0-3	90.97%	83.20%
		3-6	8.78%	16.80%
		6-9	0.25%	0.00%
		>9	0.00%	0.00%
	Dredge and Engineered Cap	0-3	NA	97.38%
		3-6		2.62%
		6-9		0.00%
		>9		0.00%

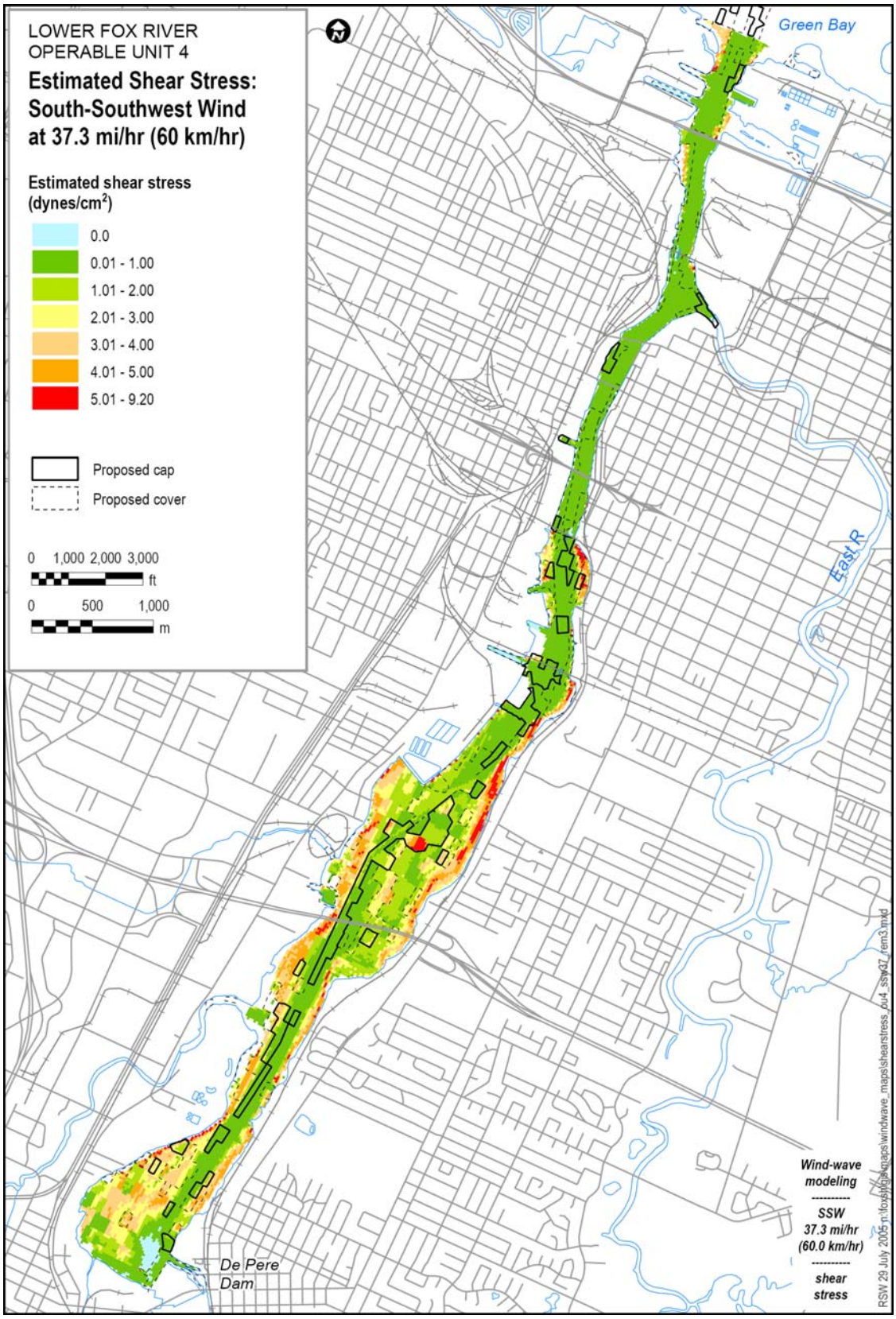

Figure 11. Wind wave induced shear stress in OU4, 37-mph SSW wind.

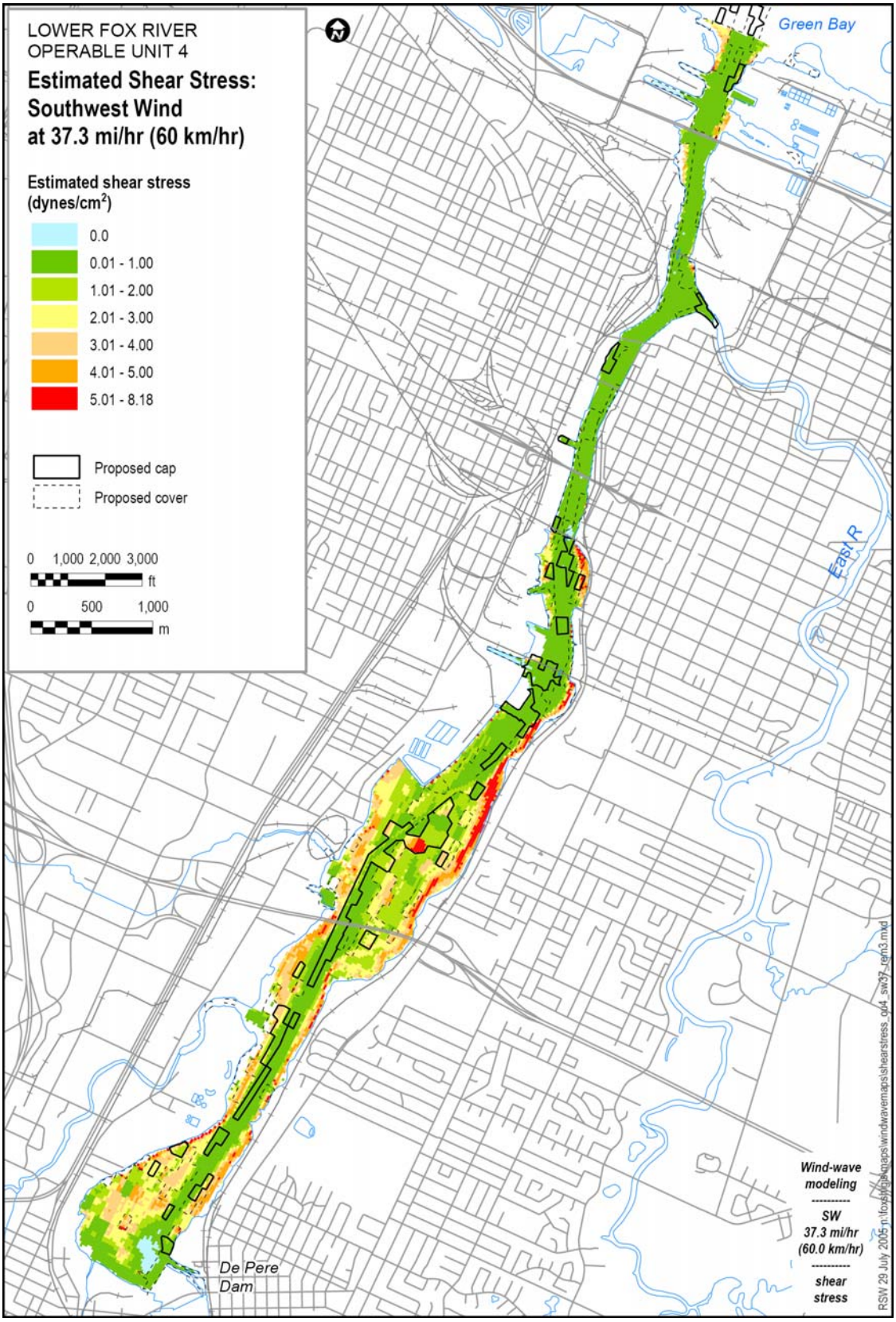

Figure 12. Wind wave induced shear stress in OU4, 37-mph SW wind.

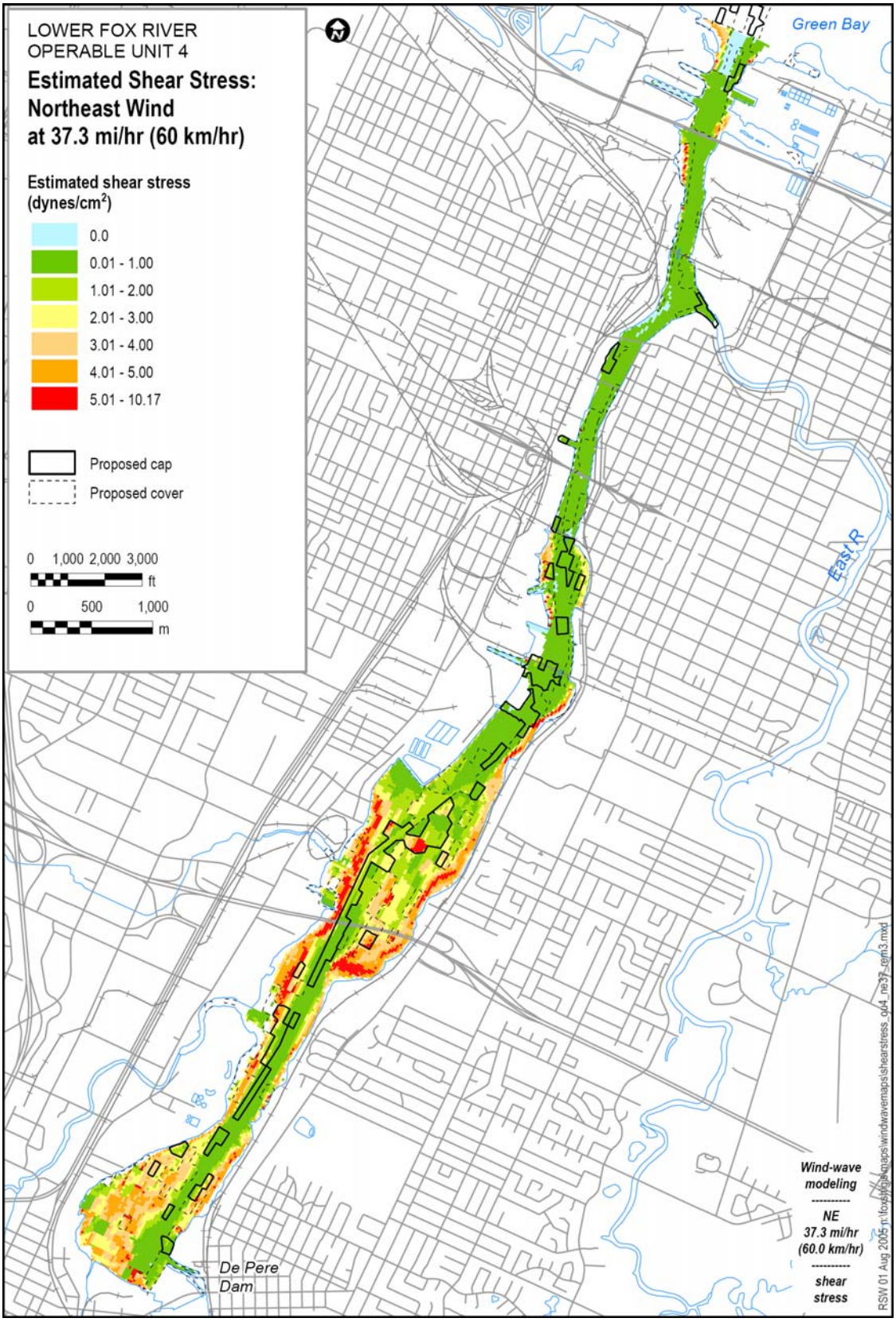

Figure 13. Wind wave induced shear stress in OU4, 37-mph NE wind.

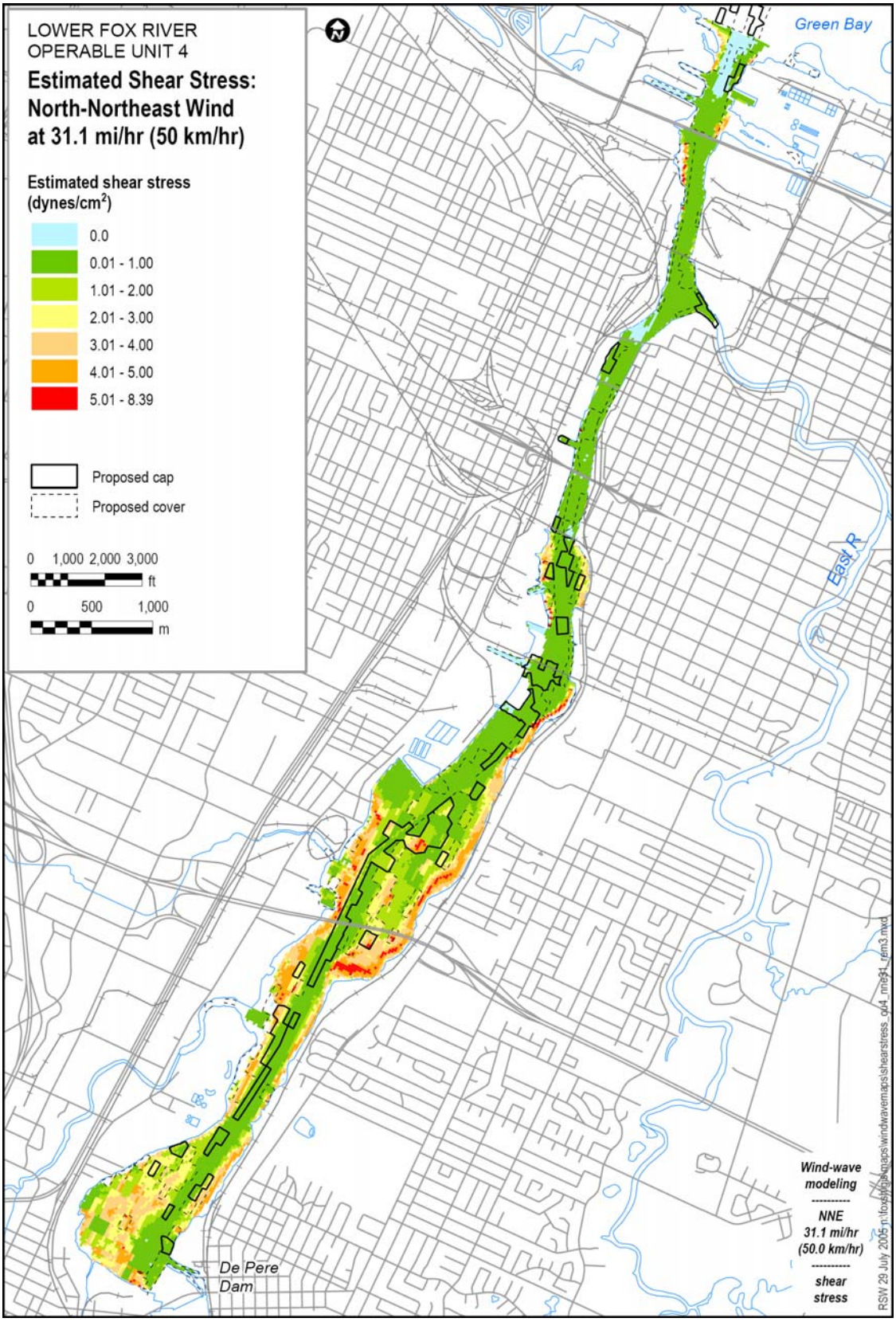

Figure 14. Wind wave induced shear stress in OU4, 31-mph NNE wind.

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APPENDIX D – ATTACHMENT F

Attachment F -

Prop Wash Calculation Sheets

CALCULATION COVER SHEET

PROJECT: Lower Fox River Remedial Design	**CALC NO.**	**SHEET** 1 of 9
SUBJECT: Propeller Wash		

Purpose: To determine rip-rap/armor size necessary to prevent erosion of cap due to propeller wash of maneuvering vessels.

Reference: *Guidance for In situ Subaqueous Capping of Contaminated Sediment*, Appendix A: Armor Layer Design by S. Maynord, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi

Given: Equation 3, Maximum Bottom Velocity in the Propeller Wash of a Maneuvering Vessel

$$V_{b(\max)} = C_1 U_o D_o / H_p$$

$V_{b(\max)}$	=	maximum bottom velocity	[ft/s]
C_1	=	0.22 for non-ducted propeller	[-]
	=	0.30 for ducted propeller	
U_o	=	jet velocity exiting propeller	[ft/s]
D_o	=	$0.71 D_p$ for non-ducted propeller	[ft]
	=	D_p for ducted propeller	
D_p	=	propeller diameter	[ft]
H_p	=	Distance from propeller shaft to channel bottom	[ft]

Equation 4, Jet Velocity exiting a propeller

$$U_o = C_2 \left(\frac{P_d}{D_p^2} \right)^{1/3}$$

P_d	=	Applied engine/propeller power	[hp]
C_2	=	9.72 for non-ducted propellers	[-]
	=	7.68 for ducted propellers	[-]

RECORD OF REVISIONS

NO.	REASON FOR REVISION	BY	CHECKED	APPROVED/ ACCEPTED	DATE

Shaw ANCHOR ENVIRONMENTAL, L.L.C.

DESIGNER: _____ **DATE:** _____ **CALC. NO.:** _____ **REV.NO.:** _____

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** _____ **CHECKED DATE:** _____

SUBJECT: _____

Equation 5, Stone Size for Propeller Wash

$$V_{b(\max)} = C_3 \left(g \Delta D_{50} \right)^{1/2}$$

C_3	=	0.55 for no movement allowed (repeated attack)	[-]
	=	0.70 for small transport (infrequent attack)	[-]
Δ	=	$(\gamma_s - \gamma_w)/\gamma_w$ = 1.65	[-]
γ_s	=	unit weight of stone = 165	[lb/ft^3]
γ_w	=	unit weight of water = 62.4	[lb/ft^3]
D_{50}	=	stone size	[ft]

VESSEL: Bulk Carrier 1 (1-12000HP engine)

Propeller Type	=	non-ducted	
D_p	=	16	[ft]
D_o	=	11.36	[ft]
Propeller Shaft Depth	=	16	[ft]
Power/engine	=	12000	[hp]
Power/propeller	=	12000	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 4B Federal Navigation Channel (maneuvering/stationary vessel)

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
10%	1200	26	10	16.3	4.1	7.7	Cobbles

DESIGNER: _____ **DATE:** _____ **CALC. NO.:** _____ **REV.NO.:** _____

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** _____ **CHECKED DATE:** _____

SUBJECT: _____

Maximum Bottom Velocity in the Propeller Wash of a Vessel Underway - Verhey (1983)

Ship Speed V_s [m/s]	Ship Speed V_s [mph]	$V_{b(\max)}$ [m/s]	$V_{b(\max)}$ [ft/s]	% Decrease in $V_{b(\max)}$ $\frac{V_{b(\max)}}{V_{b(\max)}(V_s = 0)}$
0	0	2.75	9.02	1
1	2.2	2.10	6.89	0.76
2	4.5	1.45	4.76	0.53

Therefore, for a given water depth, the bottom velocity for a vessel underway traveling at a speed greater than 4.5 mph, is at most 50% of the maximum bottom velocity for a maneuvering (i.e., stationary) ship.

Adjust maximum bottom velocity for a vessel underway:

$50\% * V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
2.0	1.9	Coarse Gravel

VESSEL: Bulk Carrier 2 (1-4000 HP engine)

Propeller Type	=	non-ducted	
D_p	=	12	[ft]
D_o	=	8.52	[ft]
Propeller Shaft Depth	=	18	[ft]
Power/engine	=	4000	[hp]
Power/propeller	=	4000	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
10%	400	26	8	13.7	3.2	4.7	Cobbles

DESIGNER: _____ **DATE:** _____ **CALC. NO.:** _____ **REV.NO.:** _____

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** _____ **CHECKED DATE:** _____

SUBJECT: _____

VESSEL: *Foxy Lady (2-340HP engines)*

Propeller Type	=	non-ducted	
D_p	=	1.5	[ft]
D_o	=	1.07	[ft]
Propeller Shaft Depth	=	3.5	[ft]
Power/engine	=	340	[hp]
Power/propeller	=	170	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 3 and OU 4A

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
50%	85	6.5	3.0	32.6	3.6	6.0	Cobbles
50%	85	7	3.5	32.6	3.1	4.4	Cobbles
50%	85	8	4.5	32.6	2.4	2.7	Very Coarse Gravel
75%	127.5	10	6.5	37.3	1.9	1.7	Coarse Gravel
75%	127.5	16.5	13.0	37.3	0.95	0.42	Fine Gravel
75%	127.5	22	18.5	37.3	0.67	0.21	Fine Gravel
75%	127.5	26	22.5	37.3	0.55	0.14	Coarse Sand

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	42.5	22	18.5	25.9	0.46	0.10	Coarse Sand
25%	42.5	26	22.5	25.9	0.38	0.07	Medium Sand

Adjust maximum bottom velocity for a vessel underway:

$50\% * V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
1.8	1.5	Coarse Gravel

DESIGNER: _____ **DATE:** _____ **CALC. NO.:** _____ **REV.NO.:** _____

PROJECT: Lower Fox River Remedial Design **CHECKED BY:** _____ **CHECKED DATE:** _____

SUBJECT: _____

Maximum depth of scour - Hamill (1988)

$$\varepsilon_{\max} = 45.04\Gamma^{-6.98}\left[\ln(t)\right]^{\Gamma}$$

$\varepsilon_{\max}$	=	maximum depth of scour	[mm]
Γ	=	experimental coefficient $= 4.1135\left[\frac{C}{D_{50}}\right]^{0.742}\left[\frac{D_P}{D_{50}}\right]^{-0.522} F_o$	[-]
C	=	tip clearance $= d_{water} - \left(d_{shaft} + \frac{D_p}{2}\right)$	[mm]
F_o	=	Froude Number $= \frac{V_o}{\sqrt{gD_{50}(\gamma_s - \gamma_w)/\gamma_w}}$	[-]
t	=	duration of scour	[sec]

Design conditions for depth of scour analysis:

D_{50}	=	1.5 in (38.1mm)
P_d	=	127.5 hp (75% of 170 hp)
U_o	=	37.3 ft/s

				Depth of Scour, $\varepsilon_{\max}$ [in]					
Water depth [ft]	F_o [-]	C [mm]	Γ [-]	t = 30 s [0.5 min]	t = 60 s [1 min]	t = 120 s [2 min]	t = 180 s [3 min]	t = 240 s [4 min]	t = 300 s [5 min]
6.5	14.5	686	1.55	0.56	0.74	0.95	1.07	1.17	1.24
7	14.5	838	1.80	0.27	0.37	0.49	0.57	0.63	0.68
8	14.5	1143	2.26	0.09	0.14	0.21	0.25	0.28	0.31
10	14.5	1753	3.11	0.03	0.05	0.08	0.11	0.13	0.15

VESSEL: *Gopher (1-200HP engine)*

Propeller Type	=	non-ducted	
D_p	=	2.5	[ft]
D_o	=	1.78	[ft]
Propeller Shaft Depth	=	1.33	[ft]

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Power/engine	=	200	[hp]
Power/propeller	=	200	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 3 and OU 4A

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	50	6.5	5.2	19.4	1.5	1.0	Coarse Gravel
25%	50	7	5.7	19.4	1.3	0.83	Coarse Gravel
25%	50	8	6.7	19.4	1.1	0.60	Fine Gravel
25%	50	10	8.7	19.4	0.88	0.35	Fine Gravel
25%	50	16.5	15.2	19.4	0.50	0.12	Coarse Sand
25%	50	22	20.7	19.4	0.37	0.06	Medium Sand
25%	50	26	24.7	19.4	0.31	0.04	Medium Sand

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	50	22	20.7	19.4	0.37	0.06	Medium Sand
25%	50	26	24.7	19.4	0.31	0.04	Medium Sand
50%	100	22	20.7	24.5	0.46	0.10	Coarse Sand
50%	100	26	24.7	24.5	0.39	0.07	Medium Sand

VESSEL: Recreational Boat 1 (2-125HP engines)

Propeller Type	=	non-ducted	
D_p	=	1.4	[ft]
D_o	=	0.99	[ft]
Propeller Shaft Depth	=	2	[ft]
Power/engine	=	125	[hp]
Power/propeller	=	125	[hp]

C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 3 and OU 4A

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	50	6.5	4.5	24.5	1.7	1.3	Coarse Gravel
25%	50	7	5.0	24.5	1.5	1.1	Coarse Gravel
25%	50	8	6.0	24.5	1.3	0.74	Coarse Gravel
25%	50	10	8.0	24.5	0.95	0.41	Fine Gravel
25%	50	16.5	14.5	24.5	0.52	0.13	Coarse Sand
25%	50	22	20.0	24.5	0.38	0.07	Medium Sand
25%	50	26	24.0	24.5	0.32	0.05	Medium Sand
100%	125	10	8.0	38.8	1.5	1.0	Coarse Gravel
100%	125	16.5	14.5	38.8	0.83	0.32	Fine Gravel
100%	125	22	20.0	38.8	0.60	0.17	Coarse Sand
100%	125	26	24.0	38.8	0.50	0.12	Coarse Sand

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	50	22	20.0	24.5	0.38	0.07	Medium Sand
25%	50	26	24.0	24.5	0.32	0.05	Medium Sand

VESSEL: Recreational Boat 2 (1-300HP engine)

Propeller Type	=	non-ducted	
D_p	=	1.4	[ft]
D_o	=	0.99	[ft]
Propeller Shaft Depth	=	2	[ft]
Power/engine	=	300	[hp]
Power/propeller	=	300	[hp]
C_1	=	0.22	[-]

C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 3 and OU 4A

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	75	6.5	4.5	32.8	1.6	1.2	Very Coarse Gravel
25%	75	7	5.0	32.8	1.4	0.95	Coarse Gravel
25%	75	8	6.0	32.8	1.2	0.66	Coarse Gravel
25%	75	10	8.0	32.8	0.90	0.37	Coarse Gravel
25%	75	16.5	14.5	32.8	0.49	0.11	Fine Gravel
25%	75	22	20.0	32.8	0.36	0.06	Coarse Sand
25%	75	26	24.0	32.8	0.30	0.04	Coarse Sand
100%	125	10	8.0	52.0	1.4	0.93	Coarse Gravel
100%	125	16.5	14.5	52.0	0.78	0.28	Fine Gravel
100%	125	22	20.0	52.0	0.57	0.15	Coarse Sand
100%	125	26	24.0	52.0	0.47	0.10	Coarse Sand

VESSEL: Recreational Boat 3 (2-250HP engines)

Propeller Type	=	non-ducted	
D_p	=	1.4	[ft]
D_o	=	0.99	[ft]
Propeller Shaft Depth	=	2	[ft]
Power/engine	=	250	[hp]
Power/propeller	=	250	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

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SUBJECT: _____

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	62.5	22	20.0	30.8	0.48	0.11	Coarse Sand
25%	62.5	26	24.0	30.8	0.40	0.07	Medium Sand

VESSEL: Recreational Boat 4 (2-300HP engines)

Propeller Type	=	non-ducted	
D_p	=	1.4	[ft]
D_o	=	0.99	[ft]
Propeller Shaft Depth	=	2	[ft]
Power/engine	=	300	[hp]
Power/propeller	=	300	[hp]
C_1	=	0.22	[-]
C_2	=	9.72	[-]
C_3	=	0.70	[-]

OU 4B Federal Navigation Channel

% Power Applied	P_d [hp]	Water depth [ft]	H_p [ft]	U_o [ft/s]	$V_{b(\max)}$ [ft/s]	D_{50} [in]	Sediment Type
25%	75	22	20.0	32.8	0.51	0.12	Coarse Sand
25%	75	26	24.0	32.8	0.42	0.08	Coarse Sand

Attachment F -

Prop Wash Field Study Report – Moving Vessel Memo

Memorandum

To: Jim Hahnenberg (EPA)
Greg Hill (WDNR)

From: Clay Patmont, Paul LaRosa, Regina Williams, Tom Wang (Anchor)
George Hicks (Shaw)

cc: Paul Montney, Chip Hilarides, Richard Moser, Al Toma (Georgia Pacific)
Roger McCready (NCR)
John Heyde (Sidley)
Steve Jawetz (Beveridge and Diamond)
Mike Palermo (Palermo Consulting)
Rich Johnson (Boldt)
Rick Fox, Rich Weber (NRT)
Tim Harrington (HE&C)

Date: December 6, 2005

Re: Propwash Field Study Results and Preliminary Scour Analysis for Moving Vessel Tests

This memorandum presents results obtained during the Propwash Field Study conducted in October 2005 for moving vessels. This memorandum also presents preliminary calculations of potential reasonable worst-case sediment cover or cap scour depths resulting from the action of a propeller jet from a moving, single propeller vessel, based on the measured velocity data obtained during the trials. Included with this memo are the following:

- Attachment A: Moving Vessel Trial Log, which summarizes the test scenarios conducted; and
- Attachment B: Preliminary Moving Vessel Current Data and Plots, which is a compilation of velocity measurements collected for each moving vessel trial.

It should be noted that the propwash field studies also included stationary vessel tests, the results of which will be used in later stages of design (e.g., to further calibrate propeller wash models as part of the 30% Design submittal). The results of these stationary vessel tests are not evaluated in this memorandum.

In general, the moving vessel field trials consisted of 4 trial runs conducted for each test scenario (e.g., specified vessel type, speed, pitch, and rpm) in accordance with the Agency accepted Propwash Field Study Plan (Shaw/Anchor 2005). The tests were conducted at a single

fixed location with a water depth of 5.2 ft. Velocity magnitude and direction were recorded by an acoustic Doppler current profiler (ADCP) for each trial run at 0.33 ft depth intervals (from 1 to 4 ft below the water surface) and 1-second intervals from 0 to 60 seconds. For each test scenario, 4 velocity profiles were plotted (one for each trial run) showing a time series of measured velocity at 1.0, 2.3, and 4-ft depths below the water surface. A total of 19 different test scenarios were conducted: 2 using a dual-propeller vessel, 11 using a single propeller vessel, and 6 using a jet-ski. This information is included in Attachment B, the Preliminary Moving Vessel Current Data and Plots.

Typically, estimates of maximum bottom velocities are required for analyses relating to scour of bed material. Therefore for these preliminary analyses, the maximum velocity reading for each trial run was extracted from the velocity profiles for the 4-ft depth below the water surface, since this represents the near-bottom velocity (approximately 1.25 feet above the river bottom). The average peak velocity for each test scenario was calculated by taking the average of the peak velocities determined for each from each of the four trial runs. These peak velocities are summarized in Table 1. Note that Tests 1 and 2 were performed using a dual propeller vessel, but a full range of operating conditions was not tested in the field due to time constraints. Therefore, the results of Tests 1 and 2 are not included in this preliminary data evaluation. The highlighted and bold values represent overall peak velocity and average peak velocity for a given test, respectively. For example, in Test 3 the overall peak velocity measured was 1.23 ft/s from Run 4 and the average of the measured peak velocities is 1.12 ft/s considering Runs 1 through 4.

The jet produced by a vessel propeller may result in scour of bed material. In general, erosion resulting from propeller wash is time dependent and often occurs in localized areas. Quantifying/predicting these effects is often difficult as the process is sensitive to vessel and sediment properties, and is time-dependent. Hamill (1988) conducted laboratory studies of scour patterns produced by scale propellers to generate equations describing rate of propeller scour development. Experimental results revealed that the amount of scour is primarily a function of jet velocity, propeller tip clearance, and sediment size. It was also determined that the depth of maximum scour was proportional to the natural log of time. Based on this relationship and relating empirical coefficients to propeller and sediment characteristics, Hamill developed the following equation to estimate maximum scour depth over time:

$$\varepsilon_{\max} = 45.04\Gamma^{-6.98}\left[LN(t)\right]^{\Gamma}$$

where:

$\varepsilon_{\max}$ = maximum scour depth, mm

t = time, s

$$\Gamma = 4.1135\left|\frac{C}{D_{50}}\right|^{0.742}\left|\frac{D_p}{D_{50}}\right|^{-0.522} F_o^{-0.682}$$

C = bed tip clearance, mm

D_{50} = median bed grain size, mm

D_p = propeller diameter, mm

F_o = densimetric Froude number

$$= \frac{V_o}{\sqrt{gD_{50}\cdot[(\rho_s-\rho)/\rho]}}$$

V_o = propeller jet efflux velocity, mm/s

ρ = density of water, 1000 kg/m^3

ρ_s = sediment density, 2650 kg/m^3 (assuming specific gravity of 2.65)

g = acceleration of gravity, 9.81 m/s^2

Blaauw and van de Kaa (1978) developed the following relationship to estimate maximum near-near-bottom velocity based on propeller jet efflux velocity measurements:

$$V_{b,\max} = C\left(\frac{D_p}{H_p}\right)V_o$$

where:

C = 0.30 for open wheels or non-ducted propellers

H_p = distance from propeller shaft to channel bottom, mm

Since maximum near-bottom velocities were measured and thus are known values, Blaauw and van de Kaa's relationship was used to back-calculate the corresponding propeller jet efflux velocities to use in Hamill equations. Subsequently, Hamill's relationship was used to estimate scour depths for observed time intervals for two prospective sediment cap and cover grain size specifications:

D_{50} = 1.5 in [38.1 mm] cap armor layer (7-inch-thick layer under Optimized Remedy design)

D_{50} = 0.5 mm, sand cover [0.02 in, medium sand] (6-inch-thick layer under Optimized Remedy design)

Appling the Hamill model, potential scour depths using peak velocity readings were evaluated for Tests 3 through 13 (which used the *Monterey*, a single propeller, 220-hp vessel).. These scour depth values were estimated based on the corresponding time intervals observed in the field, and applied to the two sediment grain sizes representing the cap armor layer and the cover sand material as summarized in Table 1. The propwash field study results indicate that peak near-bottom velocities impact a given point on the bottom for a duration of approximately 2 to 5 seconds. As shown in Table 1, maximum scour depths of less than 1 inch are predicted for the gravel cap armor layer and less than 1 foot for the sand cover material for a passing vessel with a 5 second duration of peak velocity.

These predictions indicate that the preliminary armor design of the cap proposed for the Optimized Remedy will provide effective resistance to propwash from moving vessels under the conditions evaluated during the October 2005 Field Study. Furthermore, the results also indicate that the assumptions for cover mixing analysis discussed in the technical Workgroups (i.e., reasonable worst-case mixing of cover materials up to a depth of 1.5 feet) is conservative. These mixing depths may be refined during later phases of the design. as additional analyses are performed.

Table 1 – Peak Near-Bottom Velocities Measured in Field Study and Predicted Scour For Moving Vessels

TEST NO.	TEST CONDITIONS			RUN	TIME INTERVAL [s]	PEAK CONDITIONS		Predicted Scour Depths, εmax [in]	
	VESSEL	PITCH/ SPEED	RPM			Mag [ft/s]	Dir [deg]	Cap (D_{50}=1.5 in)	Cover (D_{50}=0.02 in)
3	Single-Prop	Up	2900	1	5	1.05	36.6	0.0	0.0
				2	5	1.20	21.1	0.0	0.0
				3	5	1.02	69.8	0.0	0.0
				4	5	1.23	10.2	0.0	0.0
				AVG	**5**	**1.12**	**34.43**	0.0	0.0
4	Single-Prop	Neutral	1300	1	5	1.46	145	0.0	0.0
				2	5	1.44	121.8	0.0	0.0
				3	5	1.27	94.1	0.0	0.0
				4	5	1.17	213.4	0.0	0.0
				AVG	**5**	**1.34**	**143.58**	0.0	0.0
5	Single-Prop	Up	1300	1	3	1.42	76.1	0.0	0.0
				2	3	2.71	58.8	0.0	0.2
				3	3	1.70	25	0.0	0.0
				4	4	5.39	113.5	0.1	4.5
				AVG	**3.25**	**2.81**	**68.35**	0.0	0.3
6	Single-Prop	Up 10	1300	1	4	3.58	98.7	0.0	0.7
				2	4	2.57	95.4	0.0	0.2
				3	4	1.62	284.3	0.0	0.0
				4	4	6.35	80.5	0.3	9.4
				AVG	**4**	**3.53**	**139.73**	0.0	0.7
7	Single-Prop	Down 2	2000	1	4	2.02	84.8	0.0	0.1
				2	4	4.74	0.8	0.1	2.6
				3	4	2.53	46.8	0.0	0.2
				4	4	6.35	80.5	0.3	9.4
				AVG	**4**	**3.91**	**53.23**	0.0	1.1
8	Single-Prop	Up 15	2000	1	5	2.58	36.5	0.0	0.2
				2	5	2.54	30.1	0.0	0.2
				3	5	6.52	11.7	0.4	10.6
				4	5	2.84	84.2	0.0	0.3
				AVG	**5**	**3.62**	**40.63**	0.0	0.8
9	Single-Prop	Down 2	Full Throttle Startup	1	4	3.99	99.7	0.0	1.2
				2	4	2.39	56.8	0.0	0.1
				3	4	4.35	32.3	0.0	1.7
				4	4	3.28	110.7	0.0	0.5
				AVG	**4**	**3.50**	**74.88**	0.0	0.7
10	Single-Prop	Up 15	Full Throttle Startup	1	4	4.87	54.2	0.1	2.9
				2	4	2.64	34	0.0	0.2
				3	4	2.35	66.4	0.0	0.1

TEST NO.	TEST CONDITIONS			RUN	TIME INTERVAL [s]	PEAK CONDITIONS		Predicted Scour Depths, εmax [in]	
	VESSEL	PITCH/ SPEED	RPM			Mag [ft/s]	Dir [deg]	Cap (D_{50}=1.5 in)	Cover (D_{50}=0.02 in)
				4	4	2.77	57.3	0.0	0.2
				AVG	**4**	**3.16**	**52.98**	0.0	0.4
11	Single-Prop	Down 2	50% Throttle Startup	1	3	1.56	87	0.0	0.0
				2	3	1.62	59.4	0.0	0.0
				3	3	1.04	281.8	0.0	0.0
				4	3	1.73	170.9	0.0	0.0
				AVG	**3**	**1.49**	**149.78**	0.0	0.0
12	Single-Prop	Down 2	25% Throttle Startup	1	4	1.20	122.3	0.0	0.0
				2	4	3.03	258.7	0.0	0.4
				3	4	2.44	177.5	0.0	0.1
				4	4	2.27	268.3	0.0	0.1
				AVG	**4**	**2.24**	**206.70**	0.0	0.1
13	Single-Prop	Down 2	100% Throttle Startup	1	4	2.60	269	0.0	0.2
				2	4	3.70	193	0.0	0.9
				3	4	2.96	259.1	0.0	0.3
				4	4	3.50	281.6	0.0	0.7
				AVG	**4**	**3.19**	**250.68**	0.0	0.5
14	Jetski	35 mph	5000	1	3	0.60	272.2	0.0	0.0
				2	3	0.85	301.3	0.0	0.0
				3	3	0.88	282.9	0.0	0.0
				4	3	0.97	353.8	0.0	0.0
				AVG	**3**	**0.83**	**302.55**	0.0	0.0
15	Jetski	8 mph	3000	1	2	1.44	100.9	0.0	0.0
				2	2	1.25	47.3	0.0	0.0
				3	2	0.83	66.7	0.0	0.0
				4	2	1.28	60.7	0.0	0.0
				AVG	**2**	**1.20**	**68.90**	0.0	0.0
16	Jetski	12 mph	4000	1	2	1.01	69.4	0.0	0.0
				2	2	0.78	62.1	0.0	0.0
				3	2	0.88	113.8	0.0	0.0
				4	2	0.81	83.8	0.0	0.0
				AVG	**2**	**0.87**	**82.28**	0.0	0.0
17	Jetski		Full Throttle Startup	1	2	0.87	80.6	0.0	0.0
				2	2	0.91	182	0.0	0.0
				3	2	0.87	103.1	0.0	0.0
				4	2	1.19	75.3	0.0	0.0
				AVG	**2**	**0.96**	**110.25**	0.0	0.0
18	Jetski		50% Throttle Startup	1	2	0.85	107	0.0	0.0
				2	3	0.76	72.6	0.0	0.0
				3	2	1.20	89.5	0.0	0.0

TEST NO.	TEST CONDITIONS			RUN	TIME INTERVAL [s]	PEAK CONDITIONS		Predicted Scour Depths, εmax [in]	
	VESSEL	PITCH/ SPEED	RPM			Mag [ft/s]	Dir [deg]	Cap (D_{50}=1.5 in)	Cover (D_{50}=0.02 in)
				4	2	1.02	69.4	0.0	0.0
				AVG	**2.25**	**0.96**	**84.63**	0.0	0.0
19	Jetski		25% Throttle Startup	1	3	0.95	85.6	0.0	0.0
				2	3	0.84	59.2	0.0	0.0
				3	3	0.85	72	0.0	0.0
				4	2	1.08	93.1	0.0	0.0
				AVG	**2.75**	**0.93**	**77.48**	0.0	0.0

ATTACHMENT A

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Formula	10/24/2005	12:45	OU4A	5.2	22	3000 rpm	0	
Formula	10/24/2005	12:48	OU4A	5.2	22	3000 rpm	0	small wake
Formula	10/24/2005	12:53	OU4A	5.2	22	3000 rpm	0	
Formula	10/24/2005	12:58	OU4A	5.2	22	3000 rpm	0	
Formula	10/24/2005	1:02	OU4A	5.2	22	3000 rpm	0	
Formula	10/24/2005	1:31	OU4A	5.2	5	1500 rpm	0	
Formula	10/24/2005	1:36	OU4A	5.2	5	1500 rpm	0	
Formula	10/24/2005	1:39	OU4A	5.2	5	1500 rpm	0	
Formula	10/24/2005	1:43	OU4A	5.2	5	1500 rpm	0	
Formula	10/24/2005	1:46	OU4A	5.2	5	1500 rpm	0	
Monterey	10/24/2005	4:14	OU4A	5.2	25	2900 rpm	-9.5	No velocity increase noted by OSI
Monterey	10/24/2005	4:16	OU4A	5.2	25	2900 rpm	-9.5	No velocity increase noted by OSI
Monterey	10/24/2005	4:20	OU4A	5.2	25	2900 rpm	-9.5	No velocity increase noted by OSI
Monterey	10/24/2005	4:23	OU4A	5.2	25	2900 rpm	-9.5	No velocity increase noted by OSI

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Monterey	10/24/2005	4:26	OU4A	5.2	25	2900 rpm	-10	No velocity increase noted by OSI
Monterey	10/24/2005	4:29	OU4A	5.2	>5	1300 rpm	-10	Test to see if ADCP is working = yes
Monterey	10/24/2005	4:32	OU4A	5.2	>5	1300 rpm	-10	
Monterey	10/24/2005	4:34	OU4A	5.2	<5	1300 rpm	-10	
Monterey	10/24/2005	4:38	OU4A	5.2	<5	1300 rpm	-10	
Monterey	10/24/2005	4:41	OU4A	5.2	<5	1300 rpm	-10	
Monterey	10/25/2005	9:22	OU4A	5.2	<5	1300 rpm	-9.5	sunny 40 degrees calm
Monterey	10/25/2005	9:25	OU4A	5.2	<5	1300 rpm	-9.5	
Monterey	10/25/2005	9:27	OU4A	5.2	<5	1300 rpm	-9.5	
Monterey	10/25/2005	9:31	OU4A	5.2	<5	1300 rpm	-9.5	
Monterey	10/25/2005	9:33	OU4A	5.2	<5	1300 rpm	-8	
Monterey	10/25/2005	9:36	OU4A	5.2	<5	1300 rpm	-8	
Monterey	10/25/2005	9:39	OU4A	5.2	<5	1300 rpm	-8	
Monterey	10/25/2005	9:41	OU4A	5.2	<5	1300 rpm	-8	
Monterey	10/25/2005	9:44	OU4A	5.2	<5	1300 rpm	-8	

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Monterey	10/25/2005	9:49	OU4A	5.2	<5	2000 rpm	-11	Trim all the way down
Monterey	10/25/2005	9:51	OU4A	5.2	<5	2000 rpm	-11	
Monterey	10/25/2005	9:53	OU4A	5.2	<5	2000 rpm	-11	Photo taken of wake
Monterey	10/25/2005	9:57	OU4A	5.2	<5	2000 rpm	-11	
Monterey	10/25/2005	10:00	OU4A	5.2	<5	2000 rpm	-11	Trim all the way down
Monterey	10/25/2005	10:02	OU4A	5.2	<5	2000 rpm	-11	
Monterey	10/25/2005	10:06	OU4A	5.2	<5	2000 rpm	-7	
Monterey	10/25/2005	10:08	OU4A	5.2	<5	2000 rpm	-7	
Monterey	10/25/2005	10:11	OU4A	5.2	<5	2000 rpm	-7	
Monterey	10/25/2005	10:14	OU4A	5.2	<5	2000 rpm	-7	
Monterey	10/25/2005	10:22	OU4A	5.2	start up	100%	-11	Trim all the way down - start up conditions
Monterey	10/25/2005	10:25	OU4A	5.2	start up	100%	-11	10' beyond sensor at start
Monterey	10/25/2005	10:27	OU4A	5.2	start up	100%	-11	10' beyond sensor at start
Monterey	10/25/2005	10:30	OU4A	5.2	start up	100%	-11	10' beyond sensor at start
Monterey	10/25/2005	10:33	OU4A	5.2	start up	100%	-11	10' beyond sensor at start

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Monterey	10/25/2005	10:35	OU4A	5.2	start up	100%	-7	start up @10' beyond sensor
Monterey	10/25/2005	10:39	OU4A	5.2	start up	100%	-7	start up @10' beyond sensor
Monterey	10/25/2005	10:41	OU4A	5.2	start up	100%	-7	start up @10' beyond sensor
Monterey	10/25/2005	10:43	OU4A	5.2	start up	100%	-7	start up @10' beyond sensor
Monterey	10/25/2005	10:46	OU4A	5.2	start up	100%	-7	start up @10' beyond sensor
Monterey	10/25/2005	10:50	OU4A	5.2	start up	50%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	10:53	OU4A	5.2	start up	50%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	10:55	OU4A	5.2	start up	50%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:02	OU4A	5.2	start up	50%	-11	reversed direction (North) into wind; Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:03	OU4A	5.2	start up	50%	-11	drifting off center of buoys; Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:05	OU4A	5.2	start up	50%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:07	OU4A	5.2	start up	25%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:08	OU4A	5.2	start up	25%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:11	OU4A	5.2	start up	25%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:12	OU4A	5.2	start up	25%	-11	Trim all down - startup @ 10' beyond sensor
Monterey	10/25/2005	11:16	OU4A	5.2	start up	25%	-11	Trim all down - startup @ 10' beyond sensor

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Monterey	10/25/2005	11:21	OU4A	5.2	start up	100%	-11	startup with bow over sensor
Monterey	10/25/2005	11:25	OU4A	5.2	start up	100%	-11	startup with bow over sensor
Monterey	10/25/2005	11:29	OU4A	5.2	start up	100%	-11	startup with bow over sensor
Monterey	10/25/2005	11:31	OU4A	5.2	start up	100%	-11	startup with bow over sensor
Monterey	10/25/2005	11:33	OU4A	5.2	start up	100%	-11	startup with bow over sensor
Jet Ski	10/25/2005	12:55		5.2	35	5000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	35	5000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	35	5000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	35	5000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	35	5000 rpm	N/A	upstream travel
Jet Ski	10/25/2005	1:00		5.2	10	3000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	10	3000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	10	3000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	10	3000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2	10	3000 rpm	N/A	upstream travel

Fox River Propwash Field Study : Trial Log - Moving Vessel Trials

Vessel	Date	Time	Location	Actual Conditions Measured				Comments (ADCP File Name)
				Water Depth (ft)	Vessel Speed (knots)	Vessel throttle (%)	Approx. Angle of Prop (deg. above horz.)[a]	
Jet Ski	10/25/2005	1:08		5.2		4000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2		4000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2		4000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2		4000 rpm	N/A	upstream travel
Jet Ski	10/25/2005			5.2		4000 rpm	N/A	upstream travel
Jet Ski	10/25/2005	1:18		5.2	8000	100%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	8000	100%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	8000	100%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	8000	100%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	8000	100%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005	1:29		5.2	6000-6500	50%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	6000-6500	50%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	6000-6500	50%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	6000-6500	50%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005			5.2	6000-6500	50%	N/A	startup w/ bow over sensor
Jet Ski	10/25/2005	1:39		5.2	5000-5400	25%	N/A	

a. Angle of propeller estimated based on vessel trim gauge, Captain's knowledge of total trim range, and actual measurements of trim in dry dock.

ATTACHMENT B

Preliminary Moving Vessel Data
Test One

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 12:47:49		168	330.4	51	343	125	102	161	20.3	87	12	90	58.6	152	9.5	132	349.5	31	317.6	49	81.9
1	10/24/2005 12:47:50		176	98.8	194	97.4	36	38.2	81	294.7	125	349	126	38.9	70	215.1	98	356.5	114	331.2	108	348.8
2	10/24/2005 12:47:51		41	98.3	96	71.8	92	109	122	358.6	141	292.6	29	90	122	319.7	18	343.6	61	296.1	95	152.4
3	10/24/2005 12:47:52		105	153.9	92	201	150	131.2	110	354.2	100	46.6	87	78	218	93.2	113	105.4	94	101.1	96	154.8
4	10/24/2005 12:47:53		69	6.6	110	221.7	51	306.2	15	262.4	167	44.5	67	137.4	42	73.3	71	196.4	56	322.3	93	263.8
5	10/24/2005 12:47:54		123	9.8	201	332.2	102	78.1	125	82.6	94	228.9	121	211.5	166	281.9	96	354.6	95	352.7	201	352
6	10/24/2005 12:47:55		107	43.1	131	65.2	63	276.3	128	257.8	42	84.6	129	56.7	162	92.5	87	161.1	38	41.8	101	43
7	10/24/2005 12:47:56		101	283.8	146	337.5	33	48.7	229	339	88	83.4	42	182.7	166	132.3	104	171.7	172	113.6	23	124.4
8	10/24/2005 12:47:57		160	49.3	90	30.9	144	322.3	126	65.1	42	26.6	221	244.2	263	68.1	539	79.2				
9	10/24/2005 12:47:58		55	89	125	80.8					515	62.7	847	46.7								
10	10/24/2005 12:47:59						405	65.8	918	68.3	966	47.1	717	43	589	33.5	376	94.1	136	98.9	370	63
11	10/24/2005 12:48:00		496	89.7	784	35.6	772	47.8	982	42.9	1458	48.1	1396	47.9	957	60.5	856	58.9	425	39.9	468	38.6
12	10/24/2005 12:48:01		764	39.7	888	33.3	849	45	1016	22.7	1095	21.5	769	42.6	703	39.7	435	61	243	26.4	237	11.5
13	10/24/2005 12:48:02		290	58.8	204	45.8	259	47.2	349	39.8	494	46.8	330	57.8	338	60.8	445	119.3	355	77.3	26	81.3
14	10/24/2005 12:48:03		219	62.5	356	66	310	93.7	236	65.7	203	62.8	155	349.6	316	10.2	331	356.7	244	30.6	519	20.5
15	10/24/2005 12:48:04		54	331	275	13.2	392	22	444	51	285	67	296	73.3	161	35.4	246	26.6	326	347.8	387	2.7
16	10/24/2005 12:48:05		431	25.6	311	42.7	335	10.3	251	53.9	449	67.8	640	64	686	21.7	543	1.1	641	2.4	582	338.7
17	10/24/2005 12:48:06		287	42.2	108	96.9	63	101.8	234	96.6	251	42.9	279	41.5	455	28	325	20.7	340	34.4	281	6.1
18	10/24/2005 12:48:07		330	20	337	32.5	358	41.5	392	59.5	395	28.6	351	40.1	193	13.8	223	37.3	233	335.4	348	321.6
19	10/24/2005 12:48:08		268	32.2	239	24	257	19.8	396	16.6	520	42.5	449	52.7	261	50.1	131	37.2	210	284.4	316	358.7
20	10/24/2005 12:48:09		219	10.3	286	341.4	343	50.9	490	35.1	368	7.6	280	358.6	291	4.3	90	19.4	161	37.4	182	44.8
21	10/24/2005 12:48:10		112	78.2	163	74.7	234	42.2	219	88.4	381	45.5	552	43.1	421	76.8	447	82.4	287	87	267	72.8
22	10/24/2005 12:48:11		121	2.4	386	36.4	510	58.3	436	61.5	468	51.4	578	54.1	581	59.6	305	24.6	225	59.8	420	64
23	10/24/2005 12:48:12		529	49.7	511	49.5	454	49.9	303	88.5	289	73.3	353	75.6	390	94	428	99.3	426	67.9	336	91.4
24	10/24/2005 12:48:13		340	55	386	38.3	325	69.1	325	92.3	254	85.3	171	85	129	92.7	258	76.8	293	80.8	187	113
25	10/24/2005 12:48:14		162	51	312	62.3	218	62.1	329	60.1	104	106.2	307	102	242	65.9	92	91.2	169	38	110	313.9
26	10/24/2005 12:48:15		141	51	168	43.1	223	93.9	308	75.7	362	84	359	77.9	332	95.4	356	91.9	359	71.2	229	50
27	10/24/2005 12:48:16		141	68.7	200	54.6	240	85	245	108.6	349	110.1	288	116.6	219	119.8	231	96.7	330	79.5	394	61.7
28	10/24/2005 12:48:17		224	155.2	230	107.2	271	101.1	174	112.6	284	133.1	82	120	301	120.7	210	128.6	192	48.6	267	29.6
29	10/24/2005 12:48:18		152	164	194	149.7	157	192.9	157	105.9	125	147.1	277	178.1	157	124.1	45	84.9	108	58.7	193	62.5
30	10/24/2005 12:48:19		204	117.4	154	191.2	94	149.3	187	158.7	93	105.5	84	74.1	117	46.4	85	64.3	130	136.2	90	143.1
31	10/24/2005 12:48:20		233	111.9	164	129	159	193.9	23	17.7	98	232.4	247	249.1	162	252.3	59	237.4	86	90.7	129	113.2
32	10/24/2005 12:48:21		284	39.9	190	45.9	218	37.6	74	51.6	87	51.5	26	229.6	141	130.7	129	82.9	171	93	259	96.9
33	10/24/2005 12:48:22		274	46.2	251	32.5	188	39.4	230	38.8	86	45	266	46.8	87	319.2	116	136.4	152	126.4	256	145.2
34	10/24/2005 12:48:23		171	12.2	257	64.9	149	50.4	309	47.4	179	26.6	110	77.4	126	17.6	38	129.6	50	38.5	67	112.8
35	10/24/2005 12:48:24		171	65.1	194	62	179	139.1	203	48.8	302	356.2	85	28.7	118	346.8	54	7.4	90	158.6	180	107.1
36	10/24/2005 12:48:25		272	61.7	211	31.8	233	1	241	5	82	341.6	147	298	67	301.6	197	265.9	208	63.7	159	119.3
37	10/24/2005 12:48:26		206	50.5	193	40	255	12.5	224	19	184	13.2	204	352.9	25	313.4	87	131.7	200	69.8	173	47.6
38	10/24/2005 12:48:28		117	26.3	226	34.9	140	14	141	34.6	199	39.7	204	42.6	110	10.5	145	358.4	169	347	95	356.4
39	10/24/2005 12:48:29		240	136.3	82	19.3	69	190	233	27.1	160	19.7	177	16.4	71	351.1	223	19.1	189	354.2	152	324.1
40	10/24/2005 12:48:30		69	304.4	71	283.8	217	350.2	131	359.1	210	355.3	256	355.3	87	53.9	202	36.8	211	21.1	268	28.1
41	10/24/2005 12:48:31		226	49.1	80	108.2	150	313.4	134	50.1	30	250.3	56	338	62	60.1	129	93.5	115	61.4	209	36.8
42	10/24/2005 12:48:32		68	309.1	150	338.1	144	252.6	244	0	175	6.6	211	32.8	141	9	182	328.2	158	24	150	31.4
43	10/24/2005 12:48:33		540	48.2	45	35.1	192	12.7	126	33.3	228	66.8	125	46.6	122	332.2	278	49.7	247	50.8	269	45.3
44	10/24/2005 12:48:34		194	345.7	84	52.7	112	339.1	165	343.1	101	358.3	43	38.5	31	19	326	77.6	258	62.5	204	50.8
45	10/24/2005 12:48:35		95	33.9	115	18.3	137	327.8	221	4.2	54	40.5	74	43.9	118	39.5	272	63.8	151	163	137	171.6
46	10/24/2005 12:48:36		77	90	93	136.3	45	140.4	51	329.4	22	71.6	138	328	160	52.6	119	352.8	118	351.7	67	15.5
47	10/24/2005 12:48:37		136	338.4	152	61.8	63	23.3	158	80.5	12	350.5	218	87.6	103	58.9	199	51.1	280	86.5	220	12.9
48	10/24/2005 12:48:38		300	50	271	38.9	204	35.2	210	59.6	196	39.2	113	84.9	110	30.1	107	343.1	158	50.7	107	54.1
49	10/24/2005 12:48:39		180	290.1	96	74.2	91	21.2	278	73.3	301	68.4	175	65.3	139	115.6	156	143.4	88	204.8	149	128.2
50	10/24/2005 12:48:40		292	52.2	106	37.3	329	60.5	405	66.9	204	80.7	170	38.1	258	80	107	47.7	57	70.6	65	100.6
51	10/24/2005 12:48:41		177	43.6	235	42.2	79	0.7	132	36.3	343	35.9	298	69.8	92	93.1	53	79.1	46	31.6	230	9.5
52	10/24/2005 12:48:42		227	66	196	86.5	321	52.8	191	79.2	140	88.8	297	71.3	364	102.1	133	90.4	68	355.8	243	85.3
53	10/24/2005 12:48:43		153	85.9	172	87	126	36	44	271.3	42	171.9	43	326.3	308	59.4	240	64.8	198	96.4	44	24.2
54	10/24/2005 12:48:44		141	16.9	150	43.9	53	291.2	38	321.3	91	103.3	152	77.1	105	77.9	144	93.2	193	66.2	160	72.1
55	10/24/2005 12:48:45		54	143.3	41	185.6	144	46.7	57	322.1	77	77.2	141	9	160	29.1	152	53.8	66	53	39	82.7
56	10/24/2005 12:48:46		164	311.1	164	76.6	138	245.1	162	187.4	84	81.8	95	64.5	110	31.7	115	89.5	68	184.2	132	93.5
57	10/24/2005 12:48:47		94	144.1	61	122.9	82	120.6	41	108.4	66	114.2	31	239.3	36	57.7	96	115.2	106	8.1	152	61.2
58	10/24/2005 12:48:48		147	25.3	84	2	129	332.2	66	357.4	156	129.5	136	118.4	107	73.8	136	2.1	136	94.6	220	53.1
59	10/24/2005 12:48:49		115	30.8	58	80	127	6.8	35	31	105	16.5	207	32.8	115	14.6	193	0.9	248	17.6	163	34.5
60	10/24/2005 12:48:50		175	70.3	52	41.1	42	30.3	85	344.3	206	58.3	40	57.1	104	65.6	76	31	119	112.7	136	325.5

Preliminary Moving Vessel Data
Test One

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 2		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 12:54:18		43	23.6	81	39	85	352.5	86	334.6	93	2.5	47	1.2	141	112	139	90	48	46.7	162	28
1	10/24/2005 12:54:19		86	224.1	204	36.4	75	348.4	158	172	161	171.8	79	159.3	34	19	35	334.9	18	353.7	83	13.2
2	10/24/2005 12:54:20		82	355.8	184	326.3	140	131.8	107	314.6	213	11.1	87	53.9	169	31.4	135	69.1	170	109.3	45	56
3	10/24/2005 12:54:21		79	306.7	154	82.6	66	12.2	33	328.7	99	297.6	146	98.3	67	93.4	165	85.5	21	230.9	107	117.8
4	10/24/2005 12:54:22		74	12.5	110	21.4	43	40.3	54	21.8	89	25.4	7	81.9	117	94.9	79	296.2	216	269.5	25	258.2
5	10/24/2005 12:54:23		82	295.3	34	61.9	53	104.3	46	322.1	125	69	35	98.1	80	344.7	43	41.2	44	166.9	98	343.4
6	10/24/2005 12:54:24		149	313.1	105	358.4	133	345.7	194	304.9	176	326.1	32	352.9	75	351.5	153	72.2	222	128.8	157	165.6
7	10/24/2005 12:54:25		63	225.6	71	282.3	162	354.7	123	147.6	104	126.8	52	164.4	153	43.9	127	262.3	92	15.7	42	126.3
8	10/24/2005 12:54:26		136	78.1	70	285.8	137	204.1	67	297.7	86	162.4	166	152.8	79	22.3	184	84.7	38	303.3	191	244.5
9	10/24/2005 12:54:27		228	357	77	321.3	155	279.6	96	292.6	214	334.5	274	323.2	134	271.3	143	299.8	173	281.7	240	279.6
10	10/24/2005 12:54:28		196	64	94	111.1	243	128.7	257	75.1	400	51.8										
11	10/24/2005 12:54:29		54	3.2	325	350.4																
12	10/24/2005 12:54:30		384	146.5	170	135.7					530	5.7	800	22.8	583	17.7					214	124.1
13	10/24/2005 12:54:31		550	331.2					127	100	263	94.4	246	67.3	794	1.4	309	48.7	291	337.8	396	195.4
14	10/24/2005 12:54:32		245	68.2			305	16.4	395	97	402	68.5	930	40.2	881	46	953	42.1	621	53	300	51.6
15	10/24/2005 12:54:33		264	72.8	130	339.3	253	12.3	911	14			1302	8.8	470	12.5	313	60.5	470	109	245	32.7
16	10/24/2005 12:54:34		379	58.5	318	13.3	106	339.5	326	211.4	193	204.2	379	139.3	452	111.6	716	110.9	602	103.8	298	73.6
17	10/24/2005 12:54:35		255	338.6	159	5.4	179	72.5	364	59.1	421	30.5	293	40.4	116	44.3	468	110.3	429	41.5	249	112.4
18	10/24/2005 12:54:36		172	274.7	120	207.2	147	119.4	304	133.4	561	55.4	614	53.3	560	50.5					507	101.5
19	10/24/2005 12:54:37		163	341	160	346.2	143	331.6	175	87.7	459	118.9	294	87.7	465	41.5			330	120.8	414	125.6
20	10/24/2005 12:54:38		98	42.9	337	37.4	183	108.8	239	57.6	335	136.1	340	164.3			155	104.2	345	74.5	422	100.6
21	10/24/2005 12:54:39		128	76.4	150	49.3	391	92.6	269	89.6	281	75.6	275	80.2	286	99.1	368	101.6	309	88	588	100.9
22	10/24/2005 12:54:40		326	55.5	195	111.3	83	105.4	312	269.3	113	169.8	202	165.3	170	53.9	522	93.5	374	81.2	338	64.4
23	10/24/2005 12:54:41		242	39.8	124	68.8	215	125.2	354	124.6	327	118.7	169	162.7	168	103.5	99	39.7	367	30.5	263	83.2
24	10/24/2005 12:54:42		218	120	186	148.2	68	48.6	25	80.9	100	125.6	140	88.8	128	139.7	193	98.6	283	132.1	237	113.3
25	10/24/2005 12:54:43				77	40.8	118	221.9	234	144.7	227	168.5	58	183.9	122	144.4	109	106.4	186	135.2	230	131.1
26	10/24/2005 12:54:44		119	71.9	263	78.8	225	107.9	83	135	43	215.5	53	217.3	153	177.8	25	166	247	109.2	130	92.6
27	10/24/2005 12:54:45		88	291.9	105	316.9	173	286.8	144	275.6	79	270.7	125	344.7	132	316.8	90	1.3	233	15.7	110	22.4
28	10/24/2005 12:54:46		97	281.3	61	330.5	70	215.7	191	44.6	82	12.7	81	30.4	132	109.9	38	195.1	89	332.6	131	8.8
29	10/24/2005 12:54:47		194	16.2	155	91.1	168	35.3	302	38.3	114	16.4	244	14.5	219	307	106	107.6	130	82.1	89	105.6
30	10/24/2005 12:54:48		94	93	52	48.9	117	46	268	149	127	107.4	98	27.3	211	309.4	174	330.8	70	265.1	34	225
31	10/24/2005 12:54:49		234	54.5	143	3.2	87	86.1	92	112.4	181	102.1	271	53.8	150	88.1	98	24.7	137	253	127	139.2
32	10/24/2005 12:54:50		207	62.1	30	289.7	133	59.2	213	91.9	194	57.6	289	87.4	98	127.1	64	120.2	166	132.3	222	158.1
33	10/24/2005 12:54:51		273	79.7	247	110.9	352	82.5	236	80.5	155	97.8	241	100.5	153	127.5	333	101.1	159	104.6	189	162.4
34	10/24/2005 12:54:52		220	59.7	195	45.4	200	93.7	196	74.6	250	52.8	133	101.3	230	106.2	230	126	161	71.9	284	111.5
35	10/24/2005 12:54:53		192	61.7	162	352.2	245	57.2	49	114	295	87.5	143	42.2	53	322.7	136	206.8	148	102.5	251	70.9
36	10/24/2005 12:54:54		142	54.2	32	73.8	26	17.7	99	50.3	129	23.2	246	58.4	72	59.2	282	115.2	283	86.8	304	80.4
37	10/24/2005 12:54:55		153	100.9	154	73	220	35	138	63.2	153	357.8	136	353.7	124	345.1	30	222.3	168	114.6	200	84.3
38	10/24/2005 12:54:56		81	136.5	188	350.2	254	8.8	219	60.7	177	33.2	30	50.4	139	73.3	223	104	296	72.7	195	67.7
39	10/24/2005 12:54:57		182	52.4	296	38.4	169	107.9	272	81.3	295	74.9	109	17.6	67	339.1	103	47.8	165	40.3	151	52
40	10/24/2005 12:54:58		81	43.5	113	73	237	56.5	140	27.1	191	27.1	208	51.3	134	39.5	271	68.6	306	77.4	309	67.9
41	10/24/2005 12:54:59		80	35.9	255	49.9	273	50.7	203	21.1	314	25.9	238	21	109	52.8	243	43	276	77	88	130.4
42	10/24/2005 12:55:00		98	44.2	189	69.3	170	40.7	182	85.3	222	54.7	210	39.2	218	40	227	110.7	254	67.1	85	76.5
43	10/24/2005 12:55:01		142	64.2	101	114.5	131	65.2	144	70.9	213	348.9	231	36	92	337.6	195	62.8	86	65.2	235	37.4
44	10/24/2005 12:55:02		212	102.5	220	89.2	61	105.2	80	60.9	129	34.9	22	65.8	233	61.8	174	25.1	291	59.5	202	80.9
45	10/24/2005 12:55:03		202	54.3	220	85	168	105.2	212	88.6	236	71.7	152	51.4	124	57.8	100	35.6	161	56.1	111	42.4
46	10/24/2005 12:55:04		140	102.8	244	80.6	269	105.9	227	90.3	239	65.8	228	78.6	197	122.6	108	82.5	130	71.1	214	56.2
47	10/24/2005 12:55:05		184	73.2	135	87	138	80	204	84.1	117	119.6	127	131.5	44	82.2	176	145.7	89	130.5	201	121.8
48	10/24/2005 12:55:06		84	56.7	172	91.3	249	75.8	162	61.5	114	53.9	133	334.6	187	43.9	217	30.1	65	5.3	89	201.1
49	10/24/2005 12:55:07		208	98	229	106.2	226	43.7	209	74.4	287	70.7	150	357.7	13	318	119	359	92	22.4	165	172.4
50	10/24/2005 12:55:08		249	90.2	272	105.1	84	126.3	91	132.3	220	75.3	220	58.4	200	57	132	109.5	48	29.7	122	44
51	10/24/2005 12:55:09		111	146.7	207	79.7	274	90.2	176	50.1	158	59.5	226	79.8	209	24.9	198	18.5	186	346.9	146	352.5
52	10/24/2005 12:55:10		272	82.8	202	84	132	3.5	275	57.8	374	69.8	279	79.7	122	118.5	100	112.2	18	90	109	50.6
53	10/24/2005 12:55:11		284	92.8	236	104	249	94.4	303	49.7	284	43.4	244	106.4	99	49.9	237	43.5	207	60.8	172	77.6
54	10/24/2005 12:55:12		265	49.4	302	71.7	257	53.2	280	57.1	401	77.5	258	63.8	158	26.2	239	2.4	308	50.8	55	24.7
55	10/24/2005 12:55:13		168	34.8	223	45.5	165	64.5	290	71.1	267	46.2	289	78.8	290	94.7	208	28.2	214	81.1	47	326.3
56	10/24/2005 12:55:15		79	79.1	123	69.5	227	19.6	193	36.2	213	22.6	256	40.7	83	19.1	54	195.1	177	12.4	73	82.1
57	10/24/2005 12:55:16		25	318.2	112	92.6	120	63.2	231	38.2	261	52.5	267	58.2	178	59.5	362	21.4	230	6.8	200	60.6
58	10/24/2005 12:55:17		100	42.6	114	88.5	112	41.4	294	65.7	403	72.8	312	61.7	101	45.4	85	61.3	208	3.9	231	47.6
59	10/24/2005 12:55:18		70	107.4	47	17.3	142	24	249	36.7	220	51.5	77	81	61	338.9	126	39.9	153	54.5	69	31.4
60	10/24/2005 12:55:19		79	63.8	91	5	51	349.8	34	306.5	100	56	128	9.9	118	95.4	225	109.2	295	95.1	143	87.2

Preliminary Moving Vessel Data
Test One

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 12:58:50		91	45.4	95	31.2	136	61.9	95	69.7	305	57.3	238	75.9	163	136.5	171	133.6	40	352.9	265	41.6
1	10/24/2005 12:58:51		105	188.2	80	58.3	174	34.2	163	44.3	17	319.8	48	56	134	315.3	93	91.2	106	151.7	50	111
2	10/24/2005 12:58:52		94	8.6	55	64.4	45	281.6	64	23.8	51	83.3	169	95.1	154	79.9	127	96.8	203	49.8	151	78.5
3	10/24/2005 12:58:53		166	317.9	60	357.1	124	34.8	69	290.3	226	328.8	16	3.6	79	297.9	168	319.6	75	35.2	94	343.3
4	10/24/2005 12:58:54		93	11.8	18	3.2	82	300.6	71	293.3	51	218.7	41	346	182	15.9	56	73.5	89	93.9	129	92.2
5	10/24/2005 12:58:55		148	9.3	15	233.1	146	306.1	106	267.8	50	151.4	78	26.6	105	46.2	115	33.7	195	344.3	88	11.8
6	10/24/2005 12:58:56		178	263.9	64	59.8	44	325.2	85	299.6	48	16.9	34	19	48	80.3	45	106.8	53	42.7	58	297.9
7	10/24/2005 12:58:57		139	8.2	77	164.2	92	295.2	55	82.7	64	91.8	84	343.5	158	26.7	201	31.6	206	51.9	183	98.5
8	10/24/2005 12:58:58		100	45.4	51	43.4	92	243.4	29	352.1	104	270.6	22	39.5	36	110.9	77	50.8	114	236.4	89	116.6
9	10/24/2005 12:58:59		95	74.1	64	43.7	214	92.4	52	30	85	51.2	236	47.7	228	28.8	284	38.8	297	76.9	142	71.1
10	10/24/2005 12:59:00		119	265.7	129	344.7	199	294.4	153	330.6	230	313.8	227	330.7	208	318.9	402	333.4	587	305.4	346	331
11	10/24/2005 12:59:01		138	52.1	26	300.6	190	82.7	429	133.6									391	152.5		
12	10/24/2005 12:59:02		152	297.9	240	4.1									612	58.8	373	58.1	129	20.4	53	35.8
13	10/24/2005 12:59:03				227	68.1	268	56.5			836	17.9	312	340.5	426	330.3	181	349.2	148	30.4	211	134.6
14	10/24/2005 12:59:04		216	141.6	682	162.2	313	30.1	1178	353.1			544	137.2	411	122.4			334	94.6	218	92.9
15	10/24/2005 12:59:05		326	187.6	390	136.7	402	98.9	196	38.8	309	47.6	259	87.1			640	85			582	88.2
16	10/24/2005 12:59:06				222	145.8	188	167.1	393	120.7	418	71.9	487	92.4								
17	10/24/2005 12:59:07		135	156.9	222	72.5	172	104.8	173	336.5	57	230.7	112	302.3	558	40.7					515	122.8
18	10/24/2005 12:59:08				280	121	258	101.9	136	206.8	141	278.1	67	39.6	141	100.2					464	124.8
19	10/24/2005 12:59:09		186	148.2	53	332.9	189	265.7	260	244.7	263	188.7	327	148.1	628	156.3			422	113.6	273	91.5
20	10/24/2005 12:59:10		72	50.1	36	356.8	91	140.4	14	50.7	136	36	146	17.1	14	236.3	233	75.3	379	27.6	213	77
21	10/24/2005 12:59:11				136	38.7	173	45.5	157	65.1	334	70.6	305	72.5	168	111.7	176	124.3	206	83.6	560	51.3
22	10/24/2005 12:59:12				279	17.7	347	26.7	249	24.9	510	41	407	16.6	247	13.6	242	47.7	267	79.9	305	76.7
23	10/24/2005 12:59:13		82	340	161	34.4	374	38.4	350	21.3	236	47.1	212	23.7	169	47.9	225	85.7	301	78.5	371	73.2
24	10/24/2005 12:59:14		269	26.3	296	53.5	242	58	227	59.6	241	20.2	245	25.6	321	29.3	283	53	377	35.5	483	86.1
25	10/24/2005 12:59:15		294	29.1	218	14.4	90	24.9	168	29.6	325	48.6	590	74.8	324	78.4	66	93.5	54	330.1	129	3.5
26	10/24/2005 12:59:16		30	344.6	169	63.3	128	51.3	224	49.7	245	53.1	282	64.6	319	71.2	418	79.3	314	73.4	198	112.9
27	10/24/2005 12:59:17		114	253.2	99	216.8	32	56.3	75	82.3	195	92.6	172	88	172	72.4	78	249.7	33	96.9	27	39
28	10/24/2005 12:59:18		169	127.5	111	87.4	98	95.9	134	8.1	72	172.8	170	132.1	8	293.2	173	59.4	290	94.4	209	72.8
29	10/24/2005 12:59:19		158	97.6	145	59.7	103	85	73	141.7	189	218.6	320	124.3	259	106.8	317	53.6	314	71	303	64.2
30	10/24/2005 12:59:20		83	76.1	202	153.2	75	162.1	213	161.7	148	103.3	119	117	241	96.9	83	68.1	163	72.5	84	35.8
31	10/24/2005 12:59:21		77	132.4	109	67.9	126	112.3	243	134.7	105	97.7	59	56.9	222	355.3	152	69.2	214	108.5	225	63.7
32	10/24/2005 12:59:22		24	67.8	134	82.7	204	8.2	132	49.3	312	31.7	117	61.5	211	53.1	305	71.9	265	69.2	297	73.4
33	10/24/2005 12:59:23		274	71.7	207	42.6	315	32.8	365	38.4	306	49.2	266	29.3	161	15.8	356	70.1	250	91.8	128	105.9
34	10/24/2005 12:59:24		257	50.9	406	30	313	35.5	390	46.6	327	63.1	350	73.9	284	83.9	342	76.1	168	50.8	117	74.2
35	10/24/2005 12:59:25		38	351	307	23.2	210	30.4	222	9.6	208	48.5	327	39	261	38	436	65.3	251	66.8	237	107.4
36	10/24/2005 12:59:26		54	84.7	45	114.9	234	358	310	357	238	3.9	200	41.3	186	65.9	334	68	313	94	161	61.4
37	10/24/2005 12:59:27		167	75.8	17	301	67	242.3	229	352.5	436	25.1	335	45.2	333	50	259	66.8	249	105.2	34	341
38	10/24/2005 12:59:28		164	353.4	53	24.6	64	210.2	16	291.8	63	255.3	137	284.9	208	307.4	148	286.8	75	25.2	83	105.4
39	10/24/2005 12:59:29		110	64.8	128	171	144	153.1	166	134.3	110	206.3	64	236.6	153	295.1	140	326.1	65	124.9	195	87.1
40	10/24/2005 12:59:30		164	335.5	19	58	109	19.8	218	175.3	48	195.8	132	93.5	41	161.6	113	218.2	56	227.2	109	102.8
41	10/24/2005 12:59:31		91	83	175	116.4	102	21.3	136	134.7	189	139.5	175	131.5	214	145.5	201	151.1	164	138.7	116	82.1
42	10/24/2005 12:59:32		189	39	268	53.9	101	32.9	286	44.1	360	20.5	213	68.2	175	71.7	222	80.4	148	128.4	252	83.4
43	10/24/2005 12:59:33		122	38	106	37.7	54	98.6	180	61.9	286	62.3	384	42.3	288	54.8	311	29.3	170	52.2	220	63.2
44	10/24/2005 12:59:34		84	357.3	104	45.4	122	26.4	126	103.3	201	90.9	203	76.9	314	75	265	20.3	291	43.7	246	61.6
45	10/24/2005 12:59:35		224	86.2	248	79.1	325	66.8	104	34.5	339	43.8	383	59.2	326	44.1	289	61.5	364	72.6	198	67.4
46	10/24/2005 12:59:36		208	42.7	120	37.9	289	34.1	144	66.6	222	66.9	229	47.8	277	51	212	99	110	117	23	2.5
47	10/24/2005 12:59:37		60	129	202	102.9	173	72.2	175	49.9	172	52.1	300	38.4	339	31.6	93	1.8	97	69.5	191	55.6
48	10/24/2005 12:59:38		80	215.3	144	47.8	267	63.2	148	50.5	162	40.5	95	43.3	83	40.6	134	81.9	93	95.5	154	113.4
49	10/24/2005 12:59:39		245	45.5	140	17.9	216	59	196	32.1	231	68.7	132	67.7	127	126.3	82	92.1	150	47.2	108	95.3
50	10/24/2005 12:59:40		205	57.2	401	50.5	173	15.8	27	96.3	110	85.8	54	93.2	118	103.7	224	111.2	224	101.1	116	87.5
51	10/24/2005 12:59:42		282	44.3	264	35.6	134	36.8	109	35.3	200	53.1	174	57.7	207	78.3	210	121.6	175	103.2	208	74.7
52	10/24/2005 12:59:43		165	40.6	204	53.4	92	347.5	154	113.7	190	22	179	79.4	217	23.6	151	34.7	45	73.2	117	108.4
53	10/24/2005 12:59:44		115	30.4	175	34.1	150	42.8	164	58.7	136	80.7	107	26.6	162	41.5	212	86.2	92	45	38	66.8
54	10/24/2005 12:59:45		115	88	113	359.5	156	295.4	230	300.9	173	31.3	88	74.9	10	216.9	61	208.2	74	74.3	117	67.8
55	10/24/2005 12:59:46		182	60.1	188	85.4	201	87.7	168	18	90	29.1	14	81.9	140	104	91	98.2	136	74.2	63	123.9
56	10/24/2005 12:59:47		96	47.5	260	21.9	287	61.5	90	338.6	138	268.8	191	332.9	44	228.7	39	270	152	64.3	89	113.1
57	10/24/2005 12:59:48		139	108	91	140.4	101	83.2	161	63.1	160	353.2	121	50	180	51.1	109	87.9	216	88.7	184	97.5
58	10/24/2005 12:59:49		143	43.9	202	36.1	118	108.3	241	12.2	277	49.5	326	68.6	237	61.3	201	83.2	129	69	204	80.1
59	10/24/2005 12:59:50		188	28.2	92	5	159	56.3	288	50.2	182	26.1	305	9.8	261	8.2	135	27.3	115	54.2	79	58.9
60	10/24/2005 12:59:51		112	80.2	148	76	199	65	317	73.7	244	48.8	161	33.6	124	33.2	75	122.4	97	5.3	16	240.3

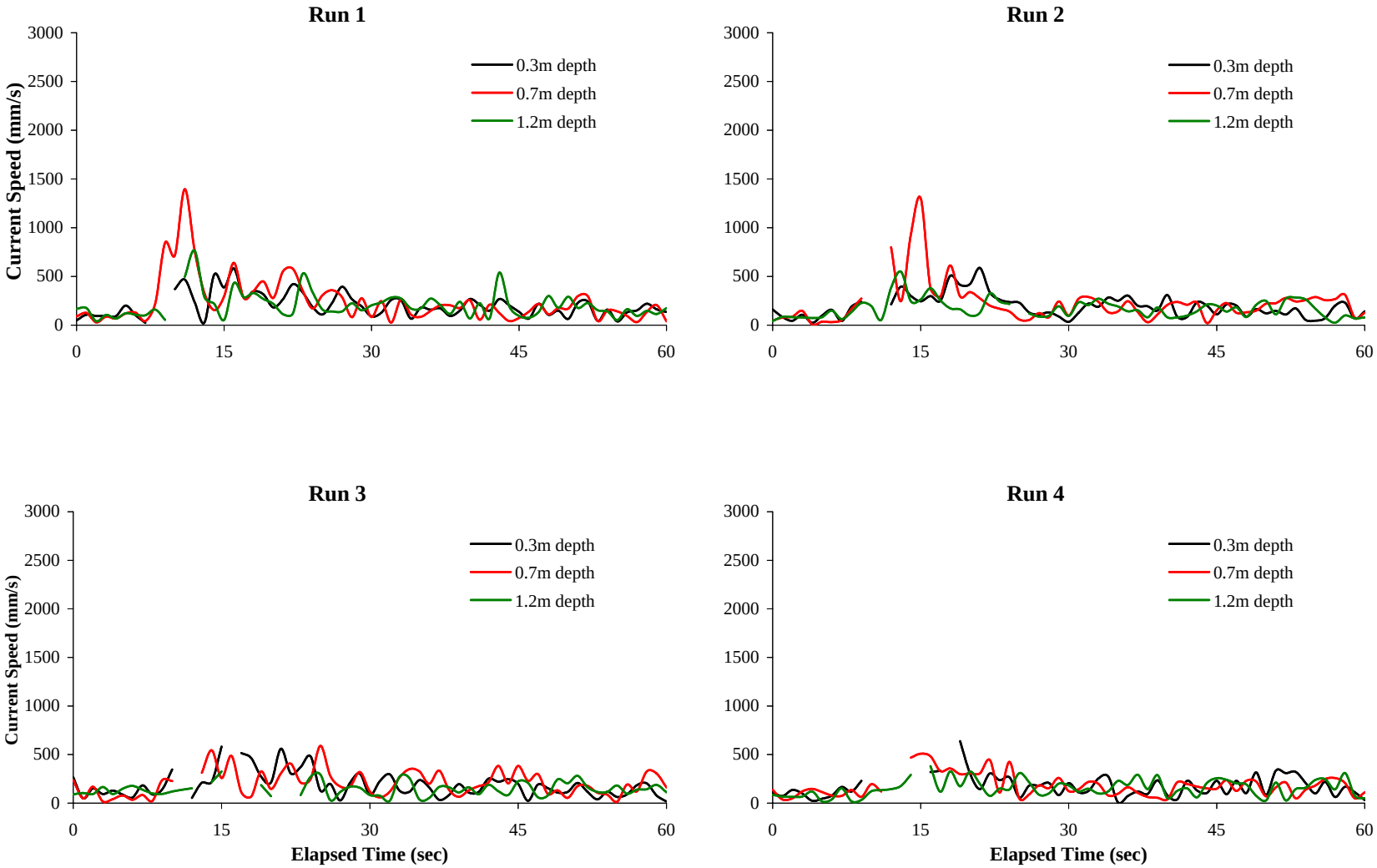
Preliminary Moving Vessel Data
Test One

Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 13:02:37		85	14.4	73	355.3	90	76.6	134	60.6	143	45.6	137	300.3	86	55.9	175	64.6	77	92.2	110	144.3
1	10/24/2005 13:02:38		68	147	128	10.8	44	58.1	65	58.3	1	0	37	51.6	80	101.6	156	4.4	175	330.5	73	270
2	10/24/2005 13:02:39		65	288.7	31	63.4	51	117.1	190	45.9	163	73.6	49	274.7	33	28.9	54	54.8	186	16.9	136	55.1
3	10/24/2005 13:02:40		68	346.4	88	37.1	107	229.9	107	338.7	83	80.3	121	102.4	255	64.7	121	47.3	57	68.4	99	76.5
4	10/24/2005 13:02:41		119	120.2	91	89.4	51	354.4	107	72.1	123	28.6	147	104.1	152	178.5	211	162.1	57	217.9	24	45
5	10/24/2005 13:02:42		18	189.5	39	352.7	162	331.2	61	55	15	36.9	114	29.5	125	47.6	176	43.4	97	67.7	45	141.3
6	10/24/2005 13:02:43		38	42.9	86	209.2	127	314.4	133	29.9	67	234.2	78	131.9	88	200.7	93	87.5	31	103.1	77	78
7	10/24/2005 13:02:44		151	33.4	107	12.5	155	351.8	70	73.4	206	30.7	74	156.9	43	192.1	117	351.2	67	14.7	167	3.8
8	10/24/2005 13:02:45		18	47.3	132	324.9	60	40.9	83	145.3	67	22.8	135	100.6	97	1.2	180	343.9	74	328.9	119	297.4
9	10/24/2005 13:02:46		33	128.9	72	97.2	19	32	201	51.9	118	89.5	64	98.1	192	67.3	79	70	146	76.2	230	78.7
10	10/24/2005 13:02:47		123	329.7	102	55.4	31	33.2	275	85.8	162	79.7	195	116.6	237	144.4	230	241.1				
11	10/24/2005 13:02:48		134	115.2	119	176.2	152	91.1	133	128	194	117	119	140.4	182	323.5	311	326	113	248.2	515	340.9
12	10/24/2005 13:02:49		144	60.9	242	98.8	157	56.4	289	146.4	82	35										
13	10/24/2005 13:02:50		177	99.8	96	50.5	161	41.2													172	148.1
14	10/24/2005 13:02:51		291	333.4	176	87.7	181	52.2	181	69.3	204	112.4	469	23.3	370	5						
15	10/24/2005 13:02:52				389	71.9	514	29.4	304	45.8			509	129.4	381	126.6	399	113.9				
16	10/24/2005 13:02:53		381	303.2	130	28.5	252	67.8	484	60.9	291	92.4	483	53.6	394	123.1					320	135
17	10/24/2005 13:02:54		117	129.4	215	141	338	177.5	622	155.6	308	100.9	330	117.3	165	84.4	364	102.5			333	178.6
18	10/24/2005 13:02:55		327	69	41	145.9	221	168.8	298	216	209	134.2	358	122.1	557	110.2	471	114.4	356	104.3		
19	10/24/2005 13:02:56		173	86	123	71.6	195	132.5	397	125.6	441	136.1	299	121.7	291	108.4	422	103.6	492	89.5	638	90
20	10/24/2005 13:02:57		326	96	211	85.9	53	69.2	202	60.3	368	78.4	307	68	372	86.1	400	70.3	335	98.9	307	52.5
21	10/24/2005 13:02:58		198	78.6	197	53.2	244	105.2	111	166.5	251	67.7	307	98.8	231	75.5	336	145.8	126	338.5	145	28.5
22	10/24/2005 13:02:59		74	83	50	115	230	118.4	284	108.7	372	130	446	107.5	299	85.6	237	108.2	226	98.7	305	28
23	10/24/2005 13:03:00		150	76.5	182	114	162	236.3	198	174.2	242	129.1	108	208.2	138	54.7	329	94.2	270	108.1	237	50.8
24	10/24/2005 13:03:01		142	345.3	345	39.2	240	23	202	48.4	75	338.2	425	357.3	212	20.4	220	42.6	18	116.6	266	356.8
25	10/24/2005 13:03:02		310	38.1	283	8.5	190	6	129	277.1	7	171.9	46	154	120	10.6	233	355.8	77	256.5	58	200.3
26	10/24/2005 13:03:03		214	337.8			129	42.8	8	219.8	111	7.8	90	353.6	273	10.6	158	2.2	196	331.6	180	307.3
27	10/24/2005 13:03:04		87	341.1	50	292.4	30	19.7	72	7.2	197	20.8	183	11.4	96	303.5	160	244.4	152	250	180	209.3
28	10/24/2005 13:03:05		100	124.8	104	55.5	160	150.4	86	186.7	109	290.4	154	287.7	206	252.4	140	208.6	284	257.4	207	203.3
29	10/24/2005 13:03:06		201	138.2	143	87.2	218	140.4	108	106.8	24	145	260	297.3	74	270	213	208	228	229.6	83	195.4
30	10/24/2005 13:03:07		181	53.3	218	83.9	55	79.5	194	194.6	8	82.9	124	240.5	146	217.2	99	219.7	121	183.3	206	133.2
31	10/24/2005 13:03:08		120	76	211	12.3	179	74.8	155	39.2	57	225	143	238.4	142	227.9	130	354.2	195	19.8	112	275.1
32	10/24/2005 13:03:09		149	3.8	161	57.2	186	15.3	194	326.6	158	255.7	218	256.7	122	189.9	53	66.8	162	346.8	125	347.1
33	10/24/2005 13:03:10		99	357.7	168	12	131	4.8	274	331.9	287	321.1	200	298.6	174	324.8	69	327.5	141	32.2	253	42.9
34	10/24/2005 13:03:11		121	22.8	147	40.9	478	357.1	97	21	79	327.9	79	321.7	101	313.8	108	338.9	118	91.5	275	68.9
35	10/24/2005 13:03:12		230	31.7	294	44.4	207	18.3	21	35.2	175	31.7	98	194.2	47	114.9	60	91	112	126	7	81.9
36	10/24/2005 13:03:13		187	84.2	319	40.9	228	78.1	140	116.2	21	230.9	163	3.2	106	90.5	93	150.4	114	107.3	73	82.9
37	10/24/2005 13:03:14		293	36.1	308	64.8	191	82.8	410	67.2	176	57.3	106	60.5	174	95	169	49.1	105	51.2	119	325.6
38	10/24/2005 13:03:15		145	18.1	72	60.9	203	49.4	211	127.1	129	97.6	63	344.4	132	27.9	207	53.9	184	7.8	95	104
39	10/24/2005 13:03:16		289	40.9	194	36.6	162	46.3	104	74.4	153	84.7	55	82.7	303	16.9	250	28.4	315	34.4	235	77.4
40	10/24/2005 13:03:17		51	155.5	25	279.1	172	79.9	156	70.9	139	70.3	38	63.4	157	105.5	111	65.5	250	47.1	81	87.9
41	10/24/2005 13:03:18		127	142	84	60.1	72	86	54	143.3	102	118.1	215	83.3	182	91.3	192	143.5	149	140.4	38	344.9
42	10/24/2005 13:03:19		153	149.7	122	80.1	154	67.9	58	37.3	69	126.7	196	97.3	256	98.1	201	99.5	178	82.2	230	91.7
43	10/24/2005 13:03:20		59	297.4	126	61	217	118.6	23	301	208	63.7	171	21.6	80	39.4	68	118.8	54	172.6	130	34.7
44	10/24/2005 13:03:21		207	93.6	221	93.4	204	77.3	88	113.4	258	106	152	122.6	129	158.6	14	303.7	134	80.1	105	3.8
45	10/24/2005 13:03:22		257	111.2	201	121.2	95	105.2	292	54.2	237	110.3	148	98.1	134	87.4	96	351	207	38.1	230	18.5
46	10/24/2005 13:03:23		240	71.6	260	85.1	234	58.8	199	71.6	219	47.4	236	45.7	70	76.8	48	194.6	107	135.8	92	183.7
47	10/24/2005 13:03:24		204	82.7	244	88.1	123	52.9	76	114.9	170	54.8	125	41.4	100	314.6	39	262.7	107	332.2	230	9.5
48	10/24/2005 13:03:25		192	93.3	228	98.8	37	79	146	68.3	211	79.6	229	117.9	152	111.7	76	83.2	145	146.9	103	351.6
49	10/24/2005 13:03:26		75	145.3	238	114.6	282	87.6	97	88.8	101	74.4	223	103.2	228	125.4	135	44.1	124	105.9	316	166.6
50	10/24/2005 13:03:27		27	68.2	139	137	132	102.2	137	97.5	214	92.4	70	129.8	233	114.9	235	146.8	83	25.6	84	117.8
51	10/24/2005 13:03:28		212	71.3	239	102.3	53	185.4	132	108.2	138	101.3	162	87.9	109	41.3	163	111.5	159	48.3	335	119.6
52	10/24/2005 13:03:29		27	353.7	235	54.3	60	107.5	42	298.4	153	67.3	213	14.4	236	50.2	156	39	308	49.2	309	53.9
53	10/24/2005 13:03:30		145	104.8	80	108.9	239	137.5	101	175.5	56	113.3	50	180	119	128.9	180	63.3	256	122.4	322	96.2
54	10/24/2005 13:03:31		160	52.3	110	142.4	44	21.3	32	82.9	70	74.2	137	43.2	277	76.9	137	65.9	177	97.4	207	101.4
55	10/24/2005 13:03:32		239	97.9	160	79.5	75	36.9	156	70.2	86	100	181	74.3	171	76.5	273	63.7	199	86.3	101	38.6
56	10/24/2005 13:03:33		246	73.3	237	64.5	235	67.8	238	63.3	379	73	249	61.7	275	74.4	234	95.6	299	58.4	219	103.7
57	10/24/2005 13:03:34		141	12.7	105	65.9	262	24.8	201	14.4	97	118.4	258	91.8	96	73.6	40	200.2	160	152	63	147.3
58	10/24/2005 13:03:35		311	119.3	246	114.8	198	71.5	255	53.4	172	49.5	208	116.9	256	90	319	92.2	27	92.1	168	74.8
59	10/24/2005 13:03:36		75	21.1	123	56.6	96	47.1	187	50.2	139	59.2	50	50.6	54	147.8	165	127.6	184	159	112	129.2
60	10/24/2005 13:03:37		51	82.2	70	94.9	136	38.7	260	51.4	196	43.6	112	68.5	145	27.4	87	123.7	147	76.6	31	191.3

Fox River Propwash Study - Moving Vessel Trials

Test #1: Dual-Prop Vessel - 3000 RPM - Neutral Pitch

October 24, 2005



Lower Fox River Moving Vessel Trials
Test Two

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 1		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 13:33:30		73	165.8	114	97.1	117	98.8	44	78.2	103	64.2	94	77.7	148	81.4	136	64.4	234	50.2	179	48.4
1	10/24/2005 13:33:31		120	358.6	48	304	168	120.4	131	97	156	50.7	51	85.5	72	105.4	139	346.7	105	10.5	117	48.8
2	10/24/2005 13:33:32		43	257.9	113	35.2	156	45.3	142	134.1	115	42.9	42	343.3	84	78.3	24	125	70	117.3	40	198.9
3	10/24/2005 13:33:33		101	343.4	107	52.6	41	8.3	45	88.7	50	271.1	77	17.3	130	101.6	174	102.6	80	219.4	52	315
4	10/24/2005 13:33:34		35	198.4	105	242.2	92	1.9	89	4.5	124	7.9	33	27.3	105	36.1	51	28.1	92	152.9	44	259.5
5	10/24/2005 13:33:35		41	98.3	217	278.8	130	214.7	87	123.3	70	91.6	99	81.3	174	83.1	35	13.2	82	218.6	13	132
6	10/24/2005 13:33:36		52	34	97	19.9	220	84.5	188	69.4	119	100.6	109	336.7	170	17.1	52	122.5	133	133.2	178	29.3
7	10/24/2005 13:33:37		19	312.9	84	155.3	56	247.1	107	246.8	165	163.8	70	279.9	46	330.1	98	109	59	173.2	105	2.2
8	10/24/2005 13:33:38		51	27.1	208	176.4	103	253.1	84	195.9	23	43.3	184	303.3	71	354.4	46	36.1	167	104.2	150	126.9
9	10/24/2005 13:33:39		175	133.6	117	168.7	75	161.3	60	220.3	116	358	87	104	16	291.8	98	298.7	155	283.4	100	105.7
10	10/24/2005 13:33:40		92	272.5	41	263	98	262.9	66	298.9	175	176.7	80	185	103	311.1	205	317.4	33	203.4	31	119.1
11	10/24/2005 13:33:41		122	57.3	40	310	31	326.8	33	268.3	146	230.3	66	261.3	227	289	269	283.5	828	262.9	1024	243.3
12	10/24/2005 13:33:42		255	47.1	302	59.5	294	53	287	39.1	352	38.9	334	54.1					3298	250		
13	10/24/2005 13:33:43		490	70.5	493	42.9	736	98.4	853	76.4	578	80.3			493	351.5						
14	10/24/2005 13:33:44												1099	161	643	178.3						
15	10/24/2005 13:33:45		1102	32.2	1585	50.1	1585	51.6	1496	72	1245	62.6	1290	25.7	397	100.6	256	76.9	201	142.9	664	178
16	10/24/2005 13:33:46		1293	72.9	1112	69.5	1379	72.1	1525	75.1	1250	89.8	897	72.7	794	65.7	430	136.1	608	177.2	676	159.5
17	10/24/2005 13:33:47		1204	57	837	67.1	460	57.5	1222	13.5	371	24.6	353	24.8	646	342.6	358	279.3	279	116.8	319	97
18	10/24/2005 13:33:48		805	48.6	851	45.4	485	58.6	260	75.7	267	41.5	450	56.9	582	82.5	205	301.4	345	233.5	494	229.6
19	10/24/2005 13:33:49		524	63.3	361	46.6	528	4.2	542	52	715	70.4	642	81.7	605	71.7	662	82	180	103.5	207	78.9
20	10/24/2005 13:33:50		739	65.7	613	73.2	492	69.8	555	78.2	425	97.8	334	125.5	614	131	673	121	598	95.9	481	121
21	10/24/2005 13:33:51		536	69.4	282	75.2	390	56.2	569	53.9	543	69.1	451	102.4	556	122.9	683	137.6	587	137.3	536	102.9
22	10/24/2005 13:33:52		665	44.7	436	24.7	528	19.9	519	40.1	459	49.9	411	88	447	86.9	570	122.8	475	122.7	468	126
23	10/24/2005 13:33:53		618	19.4	316	15	313	357.3	293	320.1	162	327.6	451	163.3	354	98.5	434	138.5	451	145.4	307	166.2
24	10/24/2005 13:33:54		470	39.8	344	15.9	326	323.9	90	306	112	223.2	211	164.6	155	174.8	323	174	423	168.3	521	150
25	10/24/2005 13:33:55		354	47.3	354	355.6	155	5.9	157	304.9	144	75.1	260	145.6	302	153.9	212	209.1	364	182.4	307	111.2
26	10/24/2005 13:33:56		207	16.6	184	323.4	292	332.9	134	31.6	360	87.9	432	82	374	74.2	457	71.2	176	51.4	56	210.3
27	10/24/2005 13:33:57		164	348	267	335.6	531	9.4	614	6.3	393	15.7	102	35.9	279	47.6	270	47.9	223	48.8	57	5
28	10/24/2005 13:33:58		401	46.9	334	27.9	353	41.6	288	59.3	453	70.1	535	72.4	650	61.1	610	82.4	359	81.4	284	36.3
29	10/24/2005 13:33:59		288	65.1	240	59.5	336	77.3	184	74.2	233	82.8	262	75.9	263	80.8	432	99.2	162	40.8	67	105.5
30	10/24/2005 13:34:00		167	58.7	268	61.2	181	77.3	232	102.2	131	53.4	135	134.7	150	11.9	313	335.5	221	287.9	123	319.3
31	10/24/2005 13:34:01		305	92.3	125	29.9	131	99.7	173	84	143	31.6	204	79.2	30	93.8	134	329.6	98	346.4	139	226.5
32	10/24/2005 13:34:02		111	75.3	253	33.9	183	58.7	214	48.8	247	63	82	80.9	25	306.9	207	192.8	133	274.7	136	253.8
33	10/24/2005 13:34:03		375	45.2	270	70.8	212	60.1	244	66.3	110	25.9	298	67.7	281	61.1	180	33	86	5.3	35	10
34	10/24/2005 13:34:04		304	71.4	484	45.3	246	54.8	344	101.6	253	79.8	369	88.1	154	189.7	230	98.2	164	119.2	113	194.9
35	10/24/2005 13:34:05		412	80.1	405	70.9	261	98.2	427	78.2	278	74.4	278	83.4	125	44.7	199	82.2	114	174.4	23	136.7
36	10/24/2005 13:34:06		462	96.1	508	76.6	585	76.9	316	60.6	381	113.9	249	131.1	162	186.4	244	117.6	228	139.3	95	116.8
37	10/24/2005 13:34:07		310	97.8	266	87.6	229	74.3	394	111.4	215	108.4	229	151.9	185	158.4	196	141.4	96	94.8	192	89.1
38	10/24/2005 13:34:08		215	111.3	206	106.3	292	71.8	366	81.4	314	86.7	228	125	294	146.1	212	127.1	287	124.6	149	131.5
39	10/24/2005 13:34:09		288	69	310	83	325	98.1	213	108.3	412	71.6	375	88.6	436	84.5	331	86.2	348	78.2	242	66.4
40	10/24/2005 13:34:10		149	27.1	242	96.2	281	59.1	263	71.6	322	53.2	216	83.9	316	80	65	43.8	56	51.5	96	116
41	10/24/2005 13:34:11		215	68.2	447	62.3	402	79.5	436	74.3	121	97.1	191	47.1	189	104.7	227	142.9	118	192.3	103	181.1
42	10/24/2005 13:34:12		322	75.4	428	78.3	431	84	378	83	211	77.9	168	104.9	297	116.8	253	132.4	284	235.8	83	267.2
43	10/24/2005 13:34:13		323	62.1	496	65.1	270	95.5	291	121.8	164	98.1	267	128.2	214	167.1	121	177.2	258	206.8	89	226.8
44	10/24/2005 13:34:14		139	120.8	320	137.5	337	132.8	244	114.2	273	127.4	346	131.7	217	152.8	293	141.9	140	94.1	120	67.5
45	10/24/2005 13:34:15		105	216.9	168	143.9	235	122.7	207	103.1	232	125.2	313	134.4	145	68.6	190	6.3	147	62	215	101.3
46	10/24/2005 13:34:16		123	353	253	53.4	258	82.4	262	131.3	322	129.1	256	165	201	118.2	332	88.8	106	75.8	55	39.1
47	10/24/2005 13:34:17		155	74.3	206	46	150	82.7	210	89.7	263	167	273	134.4	344	112.5	283	127.4	132	113.7	93	243.7
48	10/24/2005 13:34:18		161	111.5	178	129.3	369	120.8	381	120.3	287	125.1	235	126.5	224	89.7	206	45.4	50	35.3	209	291
49	10/24/2005 13:34:19		152	85.5	96	145.2	126	101	137	91.7	183	67.8	94	121.5	92	158.4	77	38.7	128	73.3	78	31.8
50	10/24/2005 13:34:20		123	123	180	77.5	153	127.8	100	67	249	65.1	383	100.1	322	105.7	223	90.8	272	61.6	150	95
51	10/24/2005 13:34:21		199	73.4	314	57.5	141	89.2	152	70	224	75.5	193	39.1	107	85.7	65	50.6	91	132.3	61	115.3
52	10/24/2005 13:34:22		246	94.2	334	107.9	307	85.7	361	57	309	49.5	298	57.8	207	115.5	172	51.9	126	75.3	90	90
53	10/24/2005 13:34:23		50	103.8	147	100.6	82	35.6	45	150.6	253	70.6	107	66.8	232	93.2	63	151.4	58	62.1	47	45.9
54	10/24/2005 13:34:24		123	48.9	381	45.3	236	79.5	223	93.3	372	105.4	236	86.8	161	107.8	93	76.3	44	61.7	115	62.1
55	10/24/2005 13:34:25		195	64.5	204	23.7	114	26.6	198	78.9	252	76.7	171	103.1	157	89.6	161	57.4	211	68	148	136.4
56	10/24/2005 13:34:26		170	46.4	182	45.2	152	59	248	54.2	184	38.6	150	82.7	133	43.8	46	102.5	160	358.2	63	147.3
57	10/24/2005 13:34:27		375	60.1	224	17.7	266	61.7	301	72.2	133	107.1	271	108.7	155	48.4	274	38.6	329	43.9	283	76.1
58	10/24/2005 13:34:28		336	72.5	214	60	231	42.7	194	69.8	107	114.2	149	83.8	87	223.6	128	95.8	217	22.8	46	137.6
59	10/24/2005 13:34:29		179	96.1	388	93.5	309	88	129	40.6	5	68.2	153	44.7	114	14.3	169	43.8	191	114.1	154	35.2
60	10/24/2005 13:34:30		216	120.6	188	104.2	198	92.3	75	152.1	127	94.5	167	120.3	129	114.2	80	129.9	156	115.9	107	45.8

Lower Fox River Moving Vessel Trials
Test Two

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 13:37:27		126	352.7	80	355.7	89	352.9	95	51	162	1.8	94	350.2	81	352.9	78	240.2	105	0	152	16.8
1	10/24/2005 13:37:28		97	115	51	45	146	27.3	29	84.1	124	28.4	84	98.9	37	69.6	86	38.9	110	24.2	69	8.4
2	10/24/2005 13:37:29		79	89.3	69	81.6	161	83.2	119	325.6	84	300.8	66	313.8	164	354	163	3.2	107	2.7	114	90
3	10/24/2005 13:37:30		54	33.7	109	16.4	32	56.3	39	284.7	108	338.9	113	278.6	119	359	96	349.7	99	74.8	163	49
4	10/24/2005 13:37:31		251	3.4	196	330.9	355	322.7	266	333.6	311	307.7	233	334	262	288.7	400	301.3	419	291.1	828	265.3
5	10/24/2005 13:37:32		169	34.9	233	98.1	213	108.9	330	84.1	313	44	173	84.7			1125	246.3	2499	255.8	2779	260.5
6	10/24/2005 13:37:33		503	89.7	568	106.7	514	94	537	117	922	86.6					2878	268.1				
7	10/24/2005 13:37:34						1694	91.6	1524	98.1												
8	10/24/2005 13:37:35		806	53.4	1680	83.6	2205	87.7	2140	89.7	1886	95.1	1404	97.9	1126	67.5	1259	60.3			1021	80.4
9	10/24/2005 13:37:36		306	185.1	334	121.8	954	66.1	1090	66.8	1361	74.1	1361	85.1	1336	83.3	1055	67.4	903	71.7	105	71
10	10/24/2005 13:37:37		496	48.1	597	50.2	819	53.7	1236	87	1103	82.2	1337	82.5	1398	87.2	1208	90.9	899	102.3	632	106.6
11	10/24/2005 13:37:38		154	79.9	173	342.8	193	63.2	287	34.9	429	74.7	419	54.4	557	20.3	485	37.5	640	33.9	771	32.8
12	10/24/2005 13:37:39		300	309.6	179	309.6	571	330.7	353	2.1	531	26.8	395	54.4	538	48.5	806	11.3	619	349.3	700	338
13	10/24/2005 13:37:40		183	60.5	292	68.7	331	102.4	396	19.9	352	26.7	428	351.9	415	359.4	603	342.6	538	347.3	440	335.9
14	10/24/2005 13:37:41		332	14.1	656	62.4	285	31.5	339	65.6	494	21	543	10.2	400	7.5	567	334.6	405	317	406	320.6
15	10/24/2005 13:37:42		149	326.7	136	334.4	227	335	243	344	240	33.6	149	349.1	394	313	764	322.7	249	346.7	469	327.2
16	10/24/2005 13:37:43		98	130.9	82	95.6	188	15.7	223	359	141	26.6	82	41.1	184	350	320	317.5	506	338.6	496	349.3
17	10/24/2005 13:37:44		164	55	131	29.7	93	237.3	23	350.1	194	36	264	74.6	208	14.5	236	29.5	150	354.6	414	16.3
18	10/24/2005 13:37:45		79	65.4	243	71.8	239	103.3	272	100.2	505	81.7	268	46.7	171	21.6	133	255.7	312	241.9	446	273.1
19	10/24/2005 13:37:46		373	84.6	271	109.2	349	91.6	474	72.2	301	59.4	489	77.2	234	76.4	203	49.2	110	246.9	392	301.9
20	10/24/2005 13:37:47		219	104.5	366	84.5	366	106	370	76.7	222	105.2	256	98.3	266	72.7	268	163.1	328	167.1	102	99
21	10/24/2005 13:37:48		405	71	367	68.1	269	52.2	318	80.4	315	78.1	454	76.1	422	91.8	221	65.1	112	86.4	173	132
22	10/24/2005 13:37:50		120	188.1	249	185.1	103	154.2	89	80.3	194	87.3	389	107.2	209	95.5	193	108.4	185	137.4	221	95.7
23	10/24/2005 13:37:51		68	335.7	275	242	219	225.9	87	264.1	115	97	139	90	320	45.5	137	103.1	191	56.7	147	45
24	10/24/2005 13:37:52		186	253.4	193	192.9	130	144.4	107	253.8	66	234.9	144	113.4	286	170.5	386	166.8	328	167.1	301	163.2
25	10/24/2005 13:37:53		152	347.1	156	44.5	336	30.6	109	61.6	43	102.1	125	288.7	164	175.1	217	131.8	312	148.5	397	172.8
26	10/24/2005 13:37:54		178	53.5	190	10	120	20.6	208	30.6	196	62.4	193	81.4	164	182.4	140	203.6	230	204.1	364	195
27	10/24/2005 13:37:55		325	7.8	139	42.4	188	50	112	81.3	198	34.1	197	268	60	153.4	112	198.3	99	205.8	264	230.8
28	10/24/2005 13:37:56		234	38.9	340	4.9	72	26.2	140	49.4	39	334.1	167	259.3	225	276.1	120	253.1	206	226.8	182	225.9
29	10/24/2005 13:37:57		111	141.6	143	230.1	46	159.6	188	62.1	74	66.9	64	2.7	79	343.2	71	4.8	242	161.9	274	169.7
30	10/24/2005 13:37:58		152	68.3	99	42.5	41	180	147	45	152	37.8	185	136.5	166	132.1	93	186.8	170	139.3	235	107.4
31	10/24/2005 13:37:59		98	109.7	174	80.4	222	87.2	146	96.7	207	109.5	116	171.1	78	174.1	45	100.3	56	65.7	8	209.7
32	10/24/2005 13:38:00		51	159.4	54	327.8	232	76.6	435	31.6	178	43.9	34	90	63	153.4	192	177.6	68	160.2	142	205.5
33	10/24/2005 13:38:01		108	321.8	49	200.3	146	76.5	312	106.8	105	183.3	177	171.9	184	182.2	237	97	66	197.6	126	239.6
34	10/24/2005 13:38:02		142	43	128	63	69	320.3	17	59	163	55.5	201	141.7	98	125	152	69.5	49	30.8	113	289.1
35	10/24/2005 13:38:03		104	98.8	205	151.1	112	60.4	49	31.8	98	12.9	32	172.9	104	84.5	125	75.6	32	41.2	24	233.6
36	10/24/2005 13:38:04		234	150	113	117.5	195	132.3	75	148	106	28	53	173.5	184	342.6	120	342	117	304.2	36	11.3
37	10/24/2005 13:38:05		137	93.8	220	74.4	70	172.6	209	96	75	59.7	141	33.5	76	280.6	94	294.4	155	331.4	114	4
38	10/24/2005 13:38:06		198	45	88	37.6	90	102.2	198	120.1	72	184.8	170	342.8	152	303.2	89	292.5	72	356	116	322.3
39	10/24/2005 13:38:07		118	152.8	200	75.5	80	137.5	235	71.4	95	161.6	112	243.4	155	209.9	199	7.2	135	293.5	114	7.1
40	10/24/2005 13:38:08		173	105.7	270	120.9	246	102.7	196	86.2	137	36.4	138	117.1	166	46.5	110	294.7	293	335.4	42	321.8
41	10/24/2005 13:38:09		96	359.4	54	328.7	64	51.3	145	40.8	256	21.3	153	172.9	179	212.4	49	246	110	329.5	144	355.2
42	10/24/2005 13:38:10		61	58.4	238	31.1	176	307.8	107	137.7	93	124.9	231	342.6	166	258.1	99	239	157	272.6	98	304.2
43	10/24/2005 13:38:11		152	67.6	92	252.3	112	294.7	135	41.4	56	277.1	73	316.7	82	203.1	29	337.8	109	320.2	177	60.5
44	10/24/2005 13:38:12		58	263.1	147	155.5	88	3.9	97	207.6	215	326	102	261	114	109.6	173	335.1	25	113.5	182	178.7
45	10/24/2005 13:38:13		165	21	93	9.3	75	35.2	54	81.4	145	348.1	136	269.2	158	23.5	67	312	27	21.8	97	35.3
46	10/24/2005 13:38:14		177	344.2	115	7.5	26	292.6	55	257.5	59	80.2	62	195.8	105	262.3	132	183.9	83	54.8	103	11.2
47	10/24/2005 13:38:15		171	230	128	326.4	175	338.9	94	274.3	85	342.8	83	267.9	180	313.9	21	140.9	110	63.7	143	77.9
48	10/24/2005 13:38:16		195	69.2	187	58.4	46	49.4	64	267.3	204	303.4	53	289.8	107	263.5	49	209.2	42	173.2	136	133.2
49	10/24/2005 13:38:17		103	334.7	128	78.3	157	109.7	132	281.4	92	281.9	93	307.6	88	315	174	325.3	118	24	166	44.8
50	10/24/2005 13:38:18		263	69.5	159	35.8	215	46.1	139	40.3	177	356.1	223	1.5	124	6.5	87	78	162	25.1	148	63.6
51	10/24/2005 13:38:19		124	86.8	86	282.1	164	34.6	242	19.6	226	343.6	20	57.1	88	34.4	91	108.6	84	104.5	111	52.7
52	10/24/2005 13:38:20		151	65.8	89	40.5	210	27.8	229	53	65	276.1	88	209.2	153	5.3	226	9.7	131	59.7	113	257.2
53	10/24/2005 13:38:21		65	85.6	194	55.1	164	34.6	101	35.7	136	337.6	132	356.1	203	0.8	202	29.4	58	348.1	61	284.3
54	10/24/2005 13:38:22		57	37.9	155	328.2	163	323	64	137.5	64	82.9	250	40.1	224	80.5	216	71.6	128	328.4	16	341.6
55	10/24/2005 13:38:23		163	47.2	158	14.7	66	11.3	91	132.3	83	291.3	193	65.6	97	145.5	150	133.9	88	201.3	99	1.7
56	10/24/2005 13:38:24		111	321.6	115	112.5	53	5.4	73	99.5	7	261.9	99	73.6	77	12	158	267.1	48	308.3	22	33.7
57	10/24/2005 13:38:25		66	201.5	129	34.6	130	72.1	92	66.2	125	24.5	67	342.6	79	133.5	160	160.7	42	308.2	25	63.4
58	10/24/2005 13:38:26		119	340.8	119	338.4	48	49.3	175	211.7	103	291.1	124	145.2	28	25.6	75	246.5	144	251.8	42	192.4
59	10/24/2005 13:38:27		121	104.8	51	141.3	93	218	105	6	86	222.6	190	166.9	84	167.6	80	145.1	172	146.1	188	87
60	10/24/2005 13:38:28		48	2.4	151	23	19	101.9	48	20.7	80	127.9	45	136.8	21	297.8	138	98.3	56	114.3	76	311.8

Lower Fox River Moving Vessel Trials
Test Two

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 13:40:37		124	165.5	80	70.2	19	71.6	111	32.8	95	74.8	56	141.5	57	161.6	118	245.4	27	45	54	0
1	10/24/2005 13:40:38		143	88.8	68	128.4	105	316.2	102	357.2	153	309.4	78	1.5	45	275.1	141	35.5	112	45.4	62	32.4
2	10/24/2005 13:40:39		81	33.9	120	327.9	188	336.8	194	326.1	171	273	80	271.4	125	268.6	98	251.6	135	321.9	134	297.1
3	10/24/2005 13:40:40		171	256.9	141	334.3	72	97.2	161	152.6	123	55.9	22	180	59	23.1	169	15.1	29	22.2	115	343.8
4	10/24/2005 13:40:41		10	354.3	178	9.7	85	122	112	6.7	62	9.3	135	216.9	119	172.8	23	7.4	45	222.3	71	297.6
5	10/24/2005 13:40:42		43	245.2	70	272.5	92	343.5	93	157.3	82	56.5	59	162.2	83	316	112	53.3	77	18.2	155	341.9
6	10/24/2005 13:40:43		105	306.9	15	151.7	212	60.1	117	353.6	87	290.1	53	225.8	66	162.4	97	31.6	60	294.4	86	59.3
7	10/24/2005 13:40:44		54	307.5	135	301.7	112	316.8	203	290.8	129	294.8	271	296.9	335	297.8	351	300.7	483	265.2	448	250.7
8	10/24/2005 13:40:45		90	38.3	118	22	252	73.9	314	40.2	273	77.3	286	67.4	322	37.9	896	114.4	1241	235.6		
9	10/24/2005 13:40:46		434	78.4	376	85	498	80.8	562	68.9	680	80.7	680	70	1353	100.1	2975	256.1				
10	10/24/2005 13:40:47		103	217.1	100	251.4	83	250.9	237	52.4	733	30.3					427	209.3				
11	10/24/2005 13:40:48		106	3.2	81	248.2	324	166.4	483	13	998	51.9	819	66.5	623	99.2	141	154.3	171	233.8	786	249.4
12	10/24/2005 13:40:49		181	11.8	633	51.7	819	46.4	565	39.5	607	35.5	799	70.2	567	12.5	323	184.8	255	268.4	365	280.1
13	10/24/2005 13:40:50		405	201.4	643	135.1	973	53.5	837	83.3	720	90.1	561	100.7	460	91.7	1074	140.5	1064	155.5	68	339.4
14	10/24/2005 13:40:51		526	204	509	179.1	93	296.8	153	314.2	246	302.7	297	287.8	356	305.5	254	317.1	169	314.8	115	185
15	10/24/2005 13:40:52		323	175.7	137	23.6	172	196.5	345	102.9	187	92.8	151	36.9	171	32.9	304	52.3	305	57.5	505	74.5
16	10/24/2005 13:40:53		181	96	343	90.2	266	35.8	198	60.3	426	21.9	690	35.9	600	36.5	588	52.5	375	50.8	246	351.8
17	10/24/2005 13:40:54		174	52.5	193	119.2	153	140.6	176	28.9	195	25.5	448	33.7	444	12.9	260	76.2	324	54.8	320	50.3
18	10/24/2005 13:40:55		244	36.7	92	5	259	95.1	298	20.9	149	58.8	80	0.7	152	37.2	117	100.3	188	131.6	281	72
19	10/24/2005 13:40:56		59	74.3	161	308.7	159	52.4	252	69	295	79.3	294	85.5	223	78.9	171	60.9	78	85.6	205	98.4
20	10/24/2005 13:40:57		165	352.7	355	26.3	114	41.1	274	47.2	571	57.1	541	89.9	558	67.2	428	100.9	424	109.1	329	146.3
21	10/24/2005 13:40:58		287	341.1	127	0.5	304	76.1	440	57.1	243	76.7	391	85.3	486	80.1	273	65.5	232	80.6	190	84.3
22	10/24/2005 13:40:59		361	39.7	208	49.5	256	50.4	178	43.6	195	71.8	383	56.4	255	60.4	562	36.2	477	34.7	489	82.6
23	10/24/2005 13:41:00		129	41.2	368	39.3	296	61.1	118	13.7	182	60.3	357	16.6	290	35.6	536	63.4	585	66.8	576	69.6
24	10/24/2005 13:41:01		280	81.4	186	108.1	84	26.9	160	19	417	23.6	417	44.1	359	37.8	411	58.6	327	25	473	39.9
25	10/24/2005 13:41:02		301	66.5	197	67.6	86	69.7	126	11.9	59	30.5	69	79.2	134	74.4	295	35.5	300	24.2	368	10
26	10/24/2005 13:41:03		161	67.7	319	59.1	213	108.9	94	144.1	122	165.3	126	349.5	111	54.2	195	80	146	53.9	227	71.2
27	10/24/2005 13:41:04		230	89.8	211	40.2	222	85.6	64	343.6	103	188.4	168	225	281	206.7	141	129.8	102	69.2	122	240.5
28	10/24/2005 13:41:05		91	33.3	110	38.7	315	13.9	246	49.4	119	35.4	169	86.6	198	89.4	191	62.9	239	34.6	263	32.1
29	10/24/2005 13:41:06		39	14.7	57	103.1	140	66.9	159	7.6	167	4.1	357	0.2	232	18.4	244	28.9	290	62.7	377	67
30	10/24/2005 13:41:07		110	344.7	191	128.6	113	66.6	79	89.3	259	64.1	214	36.1	261	14.6	416	39.2	396	42.5	315	46.7
31	10/24/2005 13:41:08		104	358.3	187	326.3	170	226.2	235	280.8	87	292.4	141	7.7	229	45	255	40.9	364	53.8	214	68.1
32	10/24/2005 13:41:09		196	295.7	155	277	90	328.6	172	313.3	99	47.5	181	34.7	139	17.7	87	54.8	303	65.9	363	69
33	10/24/2005 13:41:10		212	4.3	219	67.2	131	5.3	217	292.2	197	12	98	6.5	84	85.9	144	77.6	266	93.2	356	80.5
34	10/24/2005 13:41:11		335	18.7	220	15	103	344.2	153	44.7	170	46.7	78	115.9	148	106.8	134	78.8	401	95.9	371	97
35	10/24/2005 13:41:12		232	66.1	199	63.8	181	35.4	241	88.8	282	92.2	221	102.8	367	94.5	380	72.5	404	82	280	101.3
36	10/24/2005 13:41:13		215	29.9	242	51	320	52.2	178	65.7	69	67.9	24	125	98	318.7	82	74.4	193	63.2	188	111.2
37	10/24/2005 13:41:14		114	36.5	221	60.4	239	65.6	137	66.4	151	98.4	277	123.1	62	211.1	100	119.9	211	105.7	295	102.9
38	10/24/2005 13:41:15		162	46.3	233	65.4	205	65.6	238	106.8	178	88.7	125	65.9	296	107.9	237	128.7	224	112.6	212	102.5
39	10/24/2005 13:41:16		201	49	201	40.4	56	50.1	70	353.5	48	303	65	187	191	176.1	39	108	107	199.6	224	174.1
40	10/24/2005 13:41:17		245	87	155	122.4	223	76.3	72	110.5	145	76.4	329	147.4	294	154	302	151.1	212	154.9	178	142.5
41	10/24/2005 13:41:18		179	88.7	153	88.5	213	108	211	123.8	173	228	85	167.8	147	148.4	186	136.1	230	163.3	187	117.8
42	10/24/2005 13:41:19		226	144.6	84	153.7	202	139.8	122	141.3	139	71.6	21	48.8	155	171.8	160	182.1	243	165	194	153
43	10/24/2005 13:41:20		30	336.8	74	341.1	75	144.2	182	182.2	240	150	170	204.3	196	167	247	140.3	277	133	307	125
44	10/24/2005 13:41:21		23	43.3	39	84.1	20	239.5	108	222	109	182.6	163	213.2	212	244.6	192	190.5	146	164.5	380	169.5
45	10/24/2005 13:41:22		77	220.3	73	75.8	79	238.9	122	113.2	117	45.7	160	69.5	161	134.2	73	113.4	145	96.3	144	76
46	10/24/2005 13:41:23		30	273.8	89	166.3	158	236.1	131	191.5	163	175.1	171	193.9	143	119.2	29	144.7	156	141	141	71.8
47	10/24/2005 13:41:24		31	315	189	79.3	32	298.2	69	137.3	119	189.2	141	147.4	175	34.5	110	96.3	173	76	275	42.5
48	10/24/2005 13:41:25		107	233.8	115	176	105	56.6	132	357.8	34	73.1	205	160.6	179	99.7	121	110.8	21	90	195	48.5
49	10/24/2005 13:41:26		116	310.1	2	90	101	5.1	142	127.3	173	357.4	100	88.3	295	109.2	247	135.2	45	178.7	144	80.8
50	10/24/2005 13:41:27		98	112.9	37	83.8	70	351.8	166	49.4	161	138.3	96	92.4	100	135	180	87.1	200	90.6	207	113.6
51	10/24/2005 13:41:28		149	85.8	215	324.5	188	22.9	283	357.2	214	20	95	148.3	100	82.5	145	90	185	61.9	123	74.4
52	10/24/2005 13:41:29		163	76.9	223	54.7	100	35.3	215	61.6	63	51.5	135	56.2	45	88.7	170	72.9	97	58.1	26	4.4
53	10/24/2005 13:41:30		121	44.7	220	90.8	144	113.7	234	79.2	151	53.4	261	44.5	233	53.7	291	62.1	222	32.7	135	37.5
54	10/24/2005 13:41:31		88	82.8	207	104	68	102.8	176	88	107	358.9	86	69.7	117	236.9	63	347.1	160	27.5	88	225
55	10/24/2005 13:41:32		90	48.2	127	130.8	64	53.3	233	28.2	187	22.6	200	28.1	236	43.6	58	88	189	110.4	218	59.7
56	10/24/2005 13:41:33		147	107.8	181	79.8	205	88.6	151	57.2	132	49.9	269	22.3	94	75.8	80	91.4	104	98.8	127	26.2
57	10/24/2005 13:41:34		206	71.9	93	88.8	184	72.6	131	90	73	25.2	153	63.9	153	37.3	128	100.8	112	83.3	25	306.9
58	10/24/2005 13:41:35		38	319.2	171	100.5	61	143.7	153	81	19	93	28	111	174	53.7	142	83.5	229	41.8	121	64.1
59	10/24/2005 13:41:36		81	132.5	121	345.6	94	0	55	25.6	329	336.6	154	56.1	15	203.2	72	33	66	105.7	132	8.7
60	10/24/2005 13:41:37		67	31.6	49	84.2	72	100.4	293	77	144	9.2	224	45.5	47	330.7	65	29.3	106	104.8	161	120.7

Lower Fox River Moving Vessel Trials
Test Two

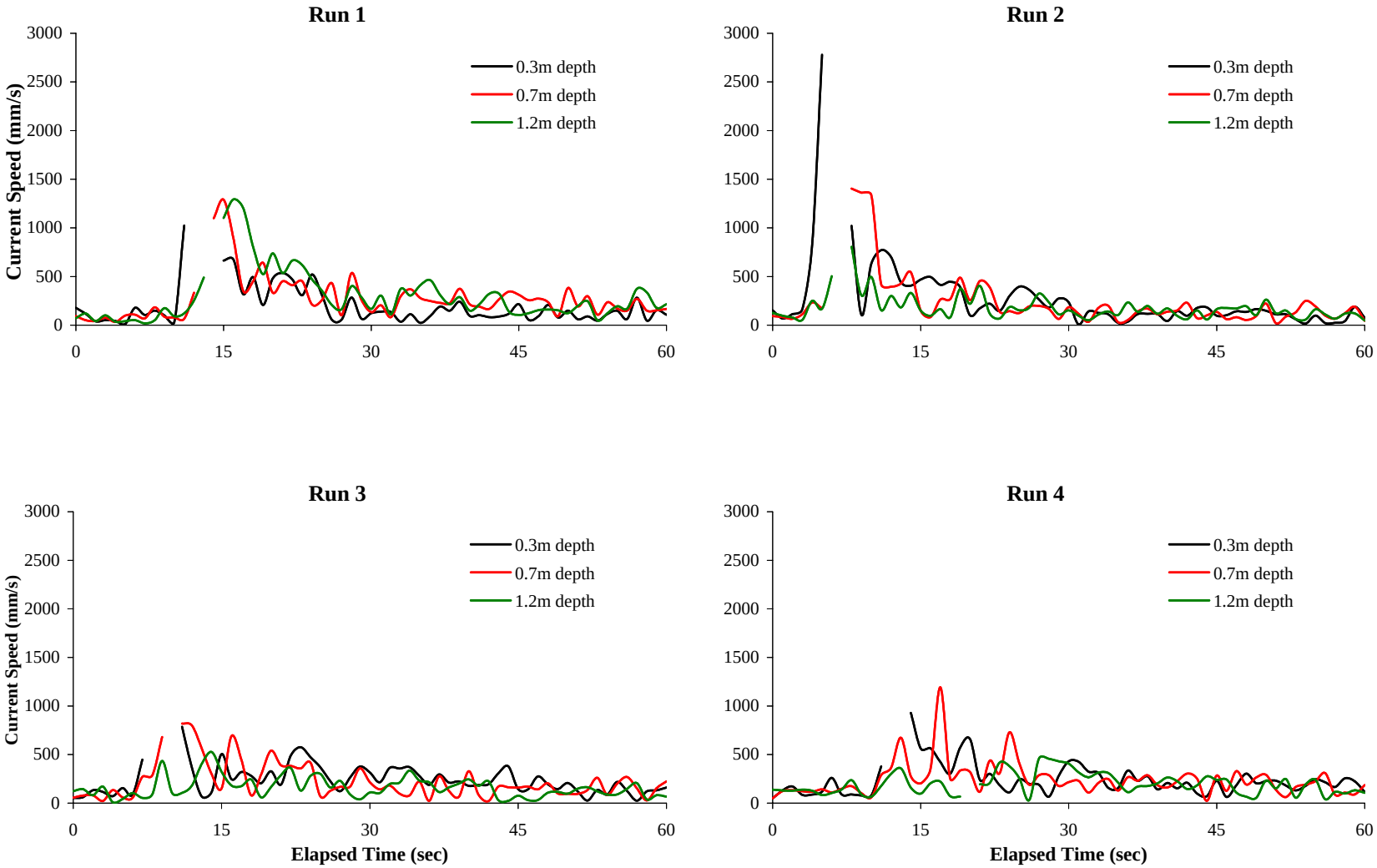
Run 4

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
0	10/24/2005 13:43:49	139	43	88	342.8	120	48	80	8.6	55	115.6	50	135.8	162	85.8	62	83.6	93	316.3	48	87.6
1	10/24/2005 13:43:50	130	49.1	168	10.6	143	76.3	29	174.1	127	131.5	124	68.2	129	91.3	225	38.1	149	346.1	131	46.5
2	10/24/2005 13:43:51	128	16.3	53	103	180	28.8	134	79.3	140	34.5	134	20.5	77	107.5	133	164.3	132	69.6	172	50.7
3	10/24/2005 13:43:52	139	19.3	51	326.9	97	43.7	135	41.7	74	24.8	123	64.5	284	73.9	89	107.6	27	81.6	85	60.4
4	10/24/2005 13:43:53	128	67.4	133	328.2	176	25.5	110	90.5	74	61.7	117	34.2	197	82.1	125	56.4	183	356.2	88	58.5
5	10/24/2005 13:43:54	83	318.4	63	301.4	111	180.5	76	174.7	180	34.6	141	29.3	56	73.5	127	82.8	114	133.9	118	41.6
6	10/24/2005 13:43:55	104	159.8	107	335.1	45	348.4	87	21.6	200	27.3	110	72.1	200	47.6	202	4.6	245	13.5	260	56.4
7	10/24/2005 13:43:56	140	2.9	58	230.6	104	26.3	63	325.3	129	345.2	148	25.5	26	351.3	104	295.1	95	330.2	89	197.6
8	10/24/2005 13:43:57	237	65.3	150	78.8	90	12.2	138	16.5	221	41.7	175	30.2	36	203	5	78.7	37	150.6	89	75.7
9	10/24/2005 13:43:58	90	321.7	116	329.9	78	213.5	223	127.2	66	93.5	102	351	193	125.1	69	92.5	169	142	78	130.8
10	10/24/2005 13:43:59	66	319.3	36	285.9	54	31.3	86	21.2	216	36	59	343.1	85	292.9	17	346.8	81	19.6	80	215.9
11	10/24/2005 13:44:00	177	304.9	98	326.6	38	265.5	99	344.8	312	335.8	289	331.7	62	4.6	118	345.7	275	284.9	378	228.6
12	10/24/2005 13:44:01	301	63.5	375	35.7	463	69.1	310	56.6	431	60	364	49.6	413	41.4	809	96.3	2435	198		
13	10/24/2005 13:44:02	358	94.2	449	120.2	619	98.8	661	99.7	696	96.2	674	108.9	788	122.9						
14	10/24/2005 13:44:03	159	194.9	118	322.5	148	271.5	102	196.5	185	231.1	275	237.6	441	178.3			631	217.3	929	221.9
15	10/24/2005 13:44:04	97	263.5	83	169.6	291	73.8	72	308.8	275	140.8	204	155.3	535	130.8	521	166.5	467	176.9	562	260
16	10/24/2005 13:44:05	203	142.8	80	199.8	682	133.1	315	155.5	335	53.1	350	50.2	292	99.8	309	256.5	193	147.5	565	242.2
17	10/24/2005 13:44:06	221	31.3	115	44.6	162	105.8	235	109.9	392	77.5	1194	20.7	747	24.8	659	142	427	188.1	423	159.1
18	10/24/2005 13:44:07	72	324.1			180	238.2	229	146.9	69	51.5	252	114.3	540	112	309	121.4	432	191.8	302	233.6
19	10/24/2005 13:44:08	68	27.3	349	72.5	354	92.9	432	126.7	544	140.4	335	119.1	614	101.1	534	125.9	521	146.2	570	179.4
20	10/24/2005 13:44:09			89	178.1	216	140.6	352	149.8	481	144.7	321	127.4	361	140.6	551	113.2	78	198	660	197.4
21	10/24/2005 13:44:10	194	117	183	109.8	253	141.3	335	145.7	149	181.9	117	94.4	294	100.6	371	89.7	1098	89.9	239	63.6
22	10/24/2005 13:44:11	208	151.6	39	126.6	306	136.1	387	148.9	603	143.4	437	134.4	529	115.1	360	108.6	506	100.9	303	92.5
23	10/24/2005 13:44:12	418	114.7	627	122.8	575	112.6	356	121.9	342	105.1	308	130	305	122.7	237	134.1	196	164.9	184	150.4
24	10/24/2005 13:44:13	380	107.9	282	87.2	377	92.3	235	103.3	420	112.5	730	106.1	372	125.9	433	142.2	402	149.2	112	158
25	10/24/2005 13:44:14	254	55.9	384	66	364	81.8	462	106.4	316	97.5	408	74.5	563	64.9	442	70.9	246	42.5	246	186.8
26	10/24/2005 13:44:15	30	88.1	347	125	528	103	450	107.5	412	134.1	190	88.5	165	123.9	242	124.2	208	153.4	199	181.7
27	10/24/2005 13:44:16	461	88	411	108	291	85.3	303	58.5	310	102.3	288	125.4	191	108	289	61.2	314	91.6	188	79.9
28	10/24/2005 13:44:17	457	104.2	520	101.1	435	107	259	84.2	269	88.5	288	67.3	320	40.1	328	69.1	294	76.6	66	345.1
29	10/24/2005 13:44:18	431	120	532	102	417	109	144	117.8	145	104.4	176	114.1	317	133.7	234	102.8	193	91.8	282	88.2
30	10/24/2005 13:44:19	407	105	388	94.6	382	101.8	159	75.4	168	117.3	216	107.5	295	23.2	213	21.5	376	26	431	49
31	10/24/2005 13:44:20	318	43.7	334	81.7	301	87.7	250	112.1	226	31.4	229	31.8	267	81	516	53.5	451	49	426	48.4
32	10/24/2005 13:44:21	267	83.3	325	68.2	216	14.2	69	336.8	200	48	109	81.6	92	47.6	50	103.8	114	85	325	113.4
33	10/24/2005 13:44:23	313	111.3	291	79.9	214	29.1	147	15.4	315	76.4	207	68.1	130	84.7	274	96.9	219	111.8	312	143.4
34	10/24/2005 13:44:24	311	71.2	202	114.9	206	167.7	104	107.4	332	45.9	249	61.5	212	103.4	195	91.8	136	114.3	158	56.6
35	10/24/2005 13:44:25	212	63.1	81	96.4	230	101.8	347	80.2	190	66.1	129	69.2	134	96.4	92	48.5	198	41.9	156	62.1
36	10/24/2005 13:44:26	113	99.7	134	90.9	99	64.2	140	54.3	216	42.2	267	46.4	257	25.4	402	32.2	529	27.5	335	37.5
37	10/24/2005 13:44:27	170	80.2	193	26.4	261	44.2	289	38.8	309	23.2	231	23.8	289	51.2	361	56.5	232	52.2	231	39.6
38	10/24/2005 13:44:28	176	43.8	123	13.1	207	53.2	359	34.7	177	1.3	287	26.7	332	26.6	363	33.8	316	48.1	277	32.6
39	10/24/2005 13:44:29	204	87.5	144	9.6	86	286.1	66	71.6	235	66.4	185	358.1	216	21.2	260	25	319	53.9	142	45.3
40	10/24/2005 13:44:30	264	132.7	217	132.4	196	96.1	141	85.5	100	46.2	161	23.9	156	54.9	160	76.7	148	50.5	207	78.9
41	10/24/2005 13:44:31	226	54.2	166	46.2	191	59.4	123	66.6	147	54.1	225	59.9	226	88	134	42.3	108	81.5	153	26.4
42	10/24/2005 13:44:32	146	344.1	120	352.3	143	46.1	216	82.5	257	49.7	304	30	263	68.1	219	72.1	221	49.8	210	38.2
43	10/24/2005 13:44:33	183	47	210	47.5	297	40.2	116	85.6	234	73.1	253	69.1	276	53.3	222	29.7	110	345.2	99	40.5
44	10/24/2005 13:44:34	277	22.5	131	44.1	121	134	157	36.2	247	54.7	23	46.7	214	70.3	237	108	115	119.7	71	117.6
45	10/24/2005 13:44:35	239	33.6	263	42.1	273	63.7	262	79.5	285	77.9	284	98.7	277	83	257	98.1	339	68.4	229	53
46	10/24/2005 13:44:36	243	75	398	74.4	221	82.2	274	72.2	282	97.1	126	100.1	187	93.1	301	77.1	143	105.8	63	20.4
47	10/24/2005 13:44:37	109	91.1	200	19.2	162	85.4	217	39.2	260	65.9	330	73.1	273	123.3	355	120.5	245	83.2	184	70.3
48	10/24/2005 13:44:38	66	102.3	119	92.4	59	82.1	82	152.5	66	160.5	191	100.8	230	24.4	278	59.7	289	46.4	304	51.3
49	10/24/2005 13:44:39	54	153.4	148	349.9	201	41.2	123	49.6	135	113.1	264	56.4	162	49.5	201	62.8	200	39.3	205	15.9
50	10/24/2005 13:44:40	232	109.4	185	104.4	266	123.8	216	92.7	329	93.1	292	71.2	109	98.9	186	81	158	20.4	227	48.4
51	10/24/2005 13:44:41	153	65.3	241	104.9	90	99.6	206	120.9	246	76.6	138	102.1	111	116.1	71	103.1	120	6.7	231	359.8
52	10/24/2005 13:44:42	249	88.4	157	72.1	216	79.3	290	107.4	141	141	62	104.9	154	111.7	80	66.3	74	3.9	182	40.3
53	10/24/2005 13:44:43	55	34.6	115	134.3	168	90.7	25	83.2	118	271.5	166	95.9	125	75.6	19	101.9	73	119.7	131	13.2
54	10/24/2005 13:44:44	193	118.2	174	83.1	85	82.5	128	13.6	125	18.1	191	62.6	315	77.7	344	45.4	298	65.2	177	73.9
55	10/24/2005 13:44:45	241	67.8	119	54.6	219	51.3	245	103.2	232	87.5	226	20.8	345	32.1	325	48.9	259	72.7	245	50.1
56	10/24/2005 13:44:46	40	69.8	170	39.5	181	65.8	193	105.6	249	37	309	29.7	129	20.8	165	40.6	144	61.3	214	42.7
57	10/24/2005 13:44:47	115	103.6	76	110.8	62	76	135	329.3	61	14.3	86	100.8	128	341.3	121	21.9	240	31	166	47.2
58	10/24/2005 13:44:48	99	91.7	45	136.8	145	105.6	61	99.5	84	292.3	109	355.8	147	14.6	139	44.1	197	40.9	256	37
59	10/24/2005 13:44:49	132	127.3	103	6.2	116	124.1	72	206.2	149	144.3	90	42.7	221	113.4	109	84.2	213	32.3	224	83.6
60	10/24/2005 13:44:50	106	334.9	122	292.6	91	221.4	34	88.3	102	63.7	186	35.8	126	78.6	166	125.4	271	111.9	115	125.1

Fox River Propwash Study - Moving Vessel Trials

Test #2: Dual-Prop Vessel - 1500 RPM - Neutral Pitch

October 24, 2005



Lower Fox River Moving Vessel Trials
Test Three

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:14:34		325	52.6	196	343.7	165	272.4	48	230	105	359.5	157	41.9	178	116	120	80.9	291	132.6	123	303.7
1	10/24/2005 16:14:35		130	302.1	102	125.9	503	66.3	153	67.3	188	156.8	94	48.5	208	44.6	59	62.6	239	128	146	36.1
2	10/24/2005 16:14:36		156	353.7	245	72.9	233	89.3	126	68.1	115	45	109	79.9	218	353.7	175	50.6	57	164.7	155	138.4
3	10/24/2005 16:14:37		221	355.1	105	13.8	69	112.9	236	31.7	91	52.1	84	104.5	219	317.8	135	34.2	123	357.7	111	121.4
4	10/24/2005 16:14:38		46	49.4	276	72.3	471	85.5	343	70.8	270	59.5	183	65.1	98	142.4	220	63.2	350	64.2	91	336
5	10/24/2005 16:14:39		182	38.8	44	280.5	158	62.5	125	22.1	149	315.3	170	14.3	145	105.6	116	270	120	147.2	90	183.8
6	10/24/2005 16:14:40		278	0.4	242	98.8	22	0	181	341.3	129	159	69	25.8	210	165.6	329	87.2	322	338.3	281	29.2
7	10/24/2005 16:14:41		35	139.6	145	128.8	72	313.9	178	7.8	240	358.6	173	80	138	16.9	294	34.6	165	46.7	92	40.1
8	10/24/2005 16:14:42		47	103.4	191	115.1	129	34.6	62	121.1	69	350	243	38.7	169	349.8	123	74.9	40	110.2	153	176.6
9	10/24/2005 16:14:43		238	84.2	163	43.8	141	190.6	104	36.8	182	24	279	65.2	71	185.6	227	105.9	145	124.9	29	3.9
10	10/24/2005 16:14:44		58	6.9	155	142.3	123	314.3	152	354	311	52.2	296	8.7	186	26.4	52	54.5	130	89.6	70	72.6
11	10/24/2005 16:14:45		62	3.7	156	128.8	108	52.9	189	89.4	246	120.3	171	113.7	265	165.1	201	140	148	127.3	247	221.6
12	10/24/2005 16:14:46		243	125.5	136	87.1	136	68.5	10	78.7	37	130.6	165	10.5	246	335.2	339	359.8	289	351	330	327.4
13	10/24/2005 16:14:47		97	161.4	57	75.7	150	145	79	20.7	152	217.8	238	111	388	84.5	342	95.4	135	70.1	201	124.9
14	10/24/2005 16:14:48		98	242.7	40	16.1	212	63.4	203	24.4	206	38.1	72	303	154	100.9	168	46.4	261	70.7	93	105.5
15	10/24/2005 16:14:49		200	48.2	163	124	290	133.3	40	290.2	222	155.3	280	236.1	49	205.5	291	49.3	39	68.7	67	166.2
16	10/24/2005 16:14:50		38	48.2	149	93.5	134	43.2	78	106.3	215	11	157	43.5	79	169.1	66	191.3	157	272.9	82	319.5
17	10/24/2005 16:14:51		139	22.3	229	271.5	167	1.4	89	11.1	44	189.2	150	316.1	266	53.6	334	38.6	154	356.3	288	85.6
18	10/24/2005 16:14:52		104	37.2	168	135.2	69	156.8	349	64.2	188	18.6	158	47	231	75.2	61	6.5				
19	10/24/2005 16:14:53		82	90	52	128	280	93.3	263	56.6	277	68.4	2	26.6	71	79.5						
20	10/24/2005 16:14:54		174	71.3	235	221	125	102	146	2.7	140	180.8	98	43.3	350	2.1						
21	10/24/2005 16:14:55		24	184.8	85	64	243	24.8	150	63.9	272	359.6	215	58.3	270	190.4						
22	10/24/2005 16:14:56		241	252.4	122	358.6	288	57.2	39	68.7	80	260.7	115	204.8	223	205.2	285	165.6	111	162.2	50	163.7
23	10/24/2005 16:14:57		235	60.4	104	338.6	87	152.5	121	184.3	244	87	275	40.9							136	311.4
24	10/24/2005 16:14:58		135	41.4	95	28.2	139	143.5	176	150.4	275	88.1	74	55.5	233	11.9	170	224.8	568	213.3	524	335.4
25	10/24/2005 16:14:59		117	90	147	55.2	146	88	243	114.3	129	124.9	205	68.8	443	104.3	251	80.3	261	64.3	282	71
26	10/24/2005 16:15:00		107	30.9	127	38.3	237	333.4	314	32.5	166	271.4	165	29.4	295	13.7	260	53.9	335	67.9	272	100.4
27	10/24/2005 16:15:01		106	72.4	101	17.9	202	335.7							462	3.6	229	7.8	268	355.1	102	39
28	10/24/2005 16:15:02		74	186.2	84	123.3	105	306.1	176	259.5									249	5.5	446	20.1
29	10/24/2005 16:15:03		141	351.9	49	261.7	187	52	279	98.9	188	32.6	251	9.7	413	359.4					108	100.2
30	10/24/2005 16:15:04		320	36.6	252	89.8	131	93.5	39	62.8	196	29.7	103	45.4	22	185.2	95	115.5	124	129.1	214	249.2
31	10/24/2005 16:15:05		41	204.7	72	109.4	39	24	112	299.6	208	46.9	254	73.1	89	26	105	21.7			75	185.3
32	10/24/2005 16:15:06		174	103.6	400	58.7	368	60.5	117	43.6	217	40.9	319	86.8	268	145.8	90	266.2			122	108.1
33	10/24/2005 16:15:07		224	14.5	95	263.9	119	285.1	60	169.4	144	82	267	93.2	187	135.4	209	74.8	164	32.5	66	263.9
34	10/24/2005 16:15:08		86	358	214	248.6	160	147.8	280	110.2	195	103.6	101	317.8	78	280.3	576	74.7	162	57.6	151	96.8
35	10/24/2005 16:15:09		133	82.2	59	156	187	114.9	333	90.9	27	39	191	86.1	215	24.8	264	65.2	198	32	257	44.1
36	10/24/2005 16:15:10		19	351	145	102.8	101	217	378	52.9					478	70.8	313	67.3	292	116.8	273	31.1
37	10/24/2005 16:15:11		79	232.7	189	69.6	241	54.1	248	42.9	262	124.4							647	62.7	368	53.5
38	10/24/2005 16:15:12		317	72.9	578	182.1	298	32.9	169	135.2	557	118.3	30	60	378	130.4	276	106.4	368	47.4	266	52.8
39	10/24/2005 16:15:13		137	62.1	370	79.7	289	92.8	378	111.3	209	94.1	279	137	218	61.8	328	87.4	247	95.6	485	30.9
40	10/24/2005 16:15:14		26	0	48	117.1	260	110.9	226	354.7	165	40.8	138	240.1	313	69.3	303	51.2	374	68.5	298	28
41	10/24/2005 16:15:15		249	57.7	513	96.7	92	187.5	26	283.5	85	103.5	44	59.9	270	4.3	32	311.2	100	32.7	181	89.4
42	10/24/2005 16:15:16		279	103	357	106.3	234	113.9	405	142.9	144	190.8	68	61.9	291	71.8	231	87	229	81.7	279	37.7
43	10/24/2005 16:15:17		68	151.9	107	247.5	235	137.1	256	97	44	88.7	348	83.4	374	90.2	296	67.3	220	279.4	228	24.9
44	10/24/2005 16:15:18		162	72.8	235	156.7	246	98.2	239	172.1	275	148.7	78	44	224	67.1	126	104.7	165	68.3	189	133.1
45	10/24/2005 16:15:19		209	90.8	131	91.3	260	142.5	318	90.9	325	73.4	160	160.3	197	157	165	98	296	64	246	9.3
46	10/24/2005 16:15:20		73	115.2	126	86.4	11	100.3	198	95.5	299	198.3	153	94.5	250	28.2	309	50	120	79.9	144	94.4
47	10/24/2005 16:15:21		215	264.4	72	175.2	130	249.8	245	159	137	108.3	40	317	93	38.5	114	19.6	177	322.8	213	80
48	10/24/2005 16:15:22		141	127.2	110	80.6	115	140.6	98	75.8	258	73.5	195	149.9	204	80.4	383	57.5	255	335.1	64	89.1
49	10/24/2005 16:15:23		176	183.9	107	69.2	127	351.9	244	66.4	175	161.7	89	1.3	193	78.3	22	236.3	122	68.9	117	102.8
50	10/24/2005 16:15:24		127	340.1	224	332.9	88	13.1	238	55.4	106	93.8	308	109.7	248	72.1	62	339.2	255	309.1	189	23.4
51	10/24/2005 16:15:25		101	271.7	73	243.1	152	44.7	398	86.7	278	65.6	243	22.8	248	114.1	64	336.2	249	16.1	174	59.6
52	10/24/2005 16:15:26		196	47.7	132	4.3	164	111.9	212	131	92	158.4	312	79.8	420	58.9	249	3.2	204	356.4	310	13.2
53	10/24/2005 16:15:27		88	185.8	41	350.1	128	6.7	146	223.9	234	122.3	372	39.3	118	117.2	63	273.6	100	95.1	234	62.8
54	10/24/2005 16:15:28		165	39.1	132	37.3	112	34.8	176	58.5	249	126.2	194	51.9	499	23.2	149	51.8	282	106.1	277	66.4
55	10/24/2005 16:15:29		183	315.2	175	23.9	156	286.3	94	352	86	183.3	210	206.6	90	324.9	167	342.5	192	319.4	274	309.7
56	10/24/2005 16:15:30		104	144	156	39.3	86	339.7	196	74	259	116.4	88	52	285	4.6	176	3.9	81	70.4	214	9.4
57	10/24/2005 16:15:31		161	54.8	225	105	170	87.3	279	30.6	128	15.9	142	278.1	229	161.2	202	97.4	197	55.3	323	67
58	10/24/2005 16:15:32		151	85.5	285	124	182	94.7	139	249.3	84	197.4	159	88.9	189	79.9	281	57.5	255	145.4	64	62.2
59	10/24/2005 16:15:33		183	44.3	131	33.8	426	98	343	108.3	191	108.6	83	126.2	76	63.4	117	18.4	334	39.7	171	190.1
60	10/24/2005 16:15:34		144	295.5	68	318.6	117	117	251	217.6	119	27.6	112	12.9	87	234.3	209	92.2	235	132.2	290	75.8

Lower Fox River Moving Vessel Trials
Test Three

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:18:03		280	31	84	34.8	31	120.7	152	85.5	234	169.2	164	128.1	302	50.5	27	79.5	162	237.6	169	78
1	10/24/2005 16:18:05		268	26.6	265	70.6	160	64.4	110	79	242	109	157	153.6	134	159	109	2.6	388	26	178	41.6
2	10/24/2005 16:18:06		198	20.1	181	191.5	165	176.9	138	98.8	142	6.9	115	15.1	152	94.1	251	47.4	138	35	129	45.9
3	10/24/2005 16:18:07		104	209.3	83	226.9	240	58.8	335	358.1	75	56.9	173	93.6	123	52.3	298	33.6	272	11.4	275	23.1
4	10/24/2005 16:18:08		162	180.7	254	340.7	105	101	285	334.7	241	9.3	196	119.1	169	87.3	65	77.5	39	210.5	119	235.2
5	10/24/2005 16:18:09		119	200.7	133	23.1	126	24.3	166	37.1	135	96.8	200	58.1	273	58.4	181	65.8	182	23.6	205	67.1
6	10/24/2005 16:18:10		189	39.4	139	22	96	193.3	159	76.1	299	74.3	269	75.6	305	32.8	82	127.6	138	29.5	192	71.8
7	10/24/2005 16:18:11		281	41.4	177	323.5	134	149.6	213	108.9	407	42.7	54	169.3	337	45.8	322	47.4	187	162	204	74.9
8	10/24/2005 16:18:12		155	84.1	99	107	84	97.5	105	152.7	140	32.4	84	39.2	87	43.6	246	36.1	209	12.2	203	17.5
9	10/24/2005 16:18:13		112	151.1	23	102.8	282	143.2	159	81.7	115	52.4	391	71.3	253	5.7	151	9.9	182	73.4	198	32.4
10	10/24/2005 16:18:14		178	217.7	163	99.9	120	45.3	306	352.5	212	4.6	354	41	360	5.4	306	310.6	244	1.9	458	39.4
11	10/24/2005 16:18:15		41	41.1	266	156.2	78	139.2	289	167.4	470	125.4	475	119.1	349	118.6	659	131.9	629	142.2	888	149.9
12	10/24/2005 16:18:16		243	57.4	111	34	102	304.2	36	80.3	56	51.5	113	320.4	26	69.4	90	109.4	64	12.7	238	17.1
13	10/24/2005 16:18:17		178	34.7	35	45	208	92.8	399	64.9	108	27	249	50.7	122	18.6	307	343.2	265	46.1	100	312.2
14	10/24/2005 16:18:18		160	27.2	207	91.4	115	43.6	172	34.3	29	36.5	331	44.8	86	114.8	129	111.4	121	55.1	201	72.6
15	10/24/2005 16:18:19		149	296.2	90	0.6	69	138.5	203	81.5	111	106.8	305	41	125	121.9	85	97.5	182	113.3	118	68.2
16	10/24/2005 16:18:20		107	158.7	60	79.4	209	49.8	293	62.1	210	48.1	391	35.3	246	24.5	129	24.8	139	25.6	110	160.4
17	10/24/2005 16:18:21		152	121.3	297	54.4	263	25.4	141	52.8	108	22.8	178	63.6	164	110	261	85.2	0	0		
18	10/24/2005 16:18:22		156	128.8	148	155.7	187	60.1	194	79.6	79	270	249	43	141	223	40	56.3	140	220.4	163	227
19	10/24/2005 16:18:23		81	164.9	245	109	390	43	76	17.7	145	121.2	247	119.9	141	96.1	65	86.5	258	94.9	234	129.6
20	10/24/2005 16:18:24		89	17	41	74.6	78	118.2	37	119.4	215	57.3	160	46	123	82.1	8	346	427	12.9	289	121.3
21	10/24/2005 16:18:25		199	58.1	164	9.5	117	144.4	133	102.2	193	188.6	93	286.3	56	102.3	126	299	133	69.2	477	70.7
22	10/24/2005 16:18:26		120	233.8	203	3.4	156	57.3	161	81.4	133	165.7	84	56.7	154	69.4	190	49.7	230	63.1	321	37
23	10/24/2005 16:18:27		28	27.5	219	28.1	213	23.6	142	26.7	30	39.6	223	349.6	183	112.8	174	26.7	256	4	225	23.8
24	10/24/2005 16:18:28		184	239.7	201	321.3	53	56.6	71	17.2	81	353.6	171	54.5	116	83.1	194	67.5	303	175.6	81	151.8
25	10/24/2005 16:18:29		367	21.1	182	61.7	89	112.5	83	109.1	56	349.7	175	88.4	139	95.8	240	41.3	268	18.2	364	341.4
26	10/24/2005 16:18:30		253	103.3	155	94.4	190	95.1	149	6.6	141	250.5	139	92.5	370	3.9	217	315.9	310	40.7	454	13.8
27	10/24/2005 16:18:31		212	345.5	136	89.2	102	126.2	73	188.7	168	15.9	149	287.9	172	17.9	425	311.8	457	304.2	179	87.4
28	10/24/2005 16:18:32		67	5.1	145	268	163	219.3	90	93.8	121	108.3	166	104.6	157	88.5	312	97.4	363	48	246	40
29	10/24/2005 16:18:33		143	33.6	90	162.6	118	80.7	190	40.7	45	93.8	100	26.8	109	192.1	146	191.8	195	332.9	228	83.7
30	10/24/2005 16:18:34		109	301.1	129	340	48	241.3	160	62.5	64	126.7	176	99.1	71	53.6	101	69	64	334.2	19	291.3
31	10/24/2005 16:18:35		71	248.5	92	232.5	104	25.1	343	41.9	20	78.7	209	75.3	207	341.4	98	29.2	33	136.2	187	258.9
32	10/24/2005 16:18:36		95	345.4	91	15.3	144	73.1	167	289.2	40	355.7	328	52	289	90.4	305	82.3	340	112.3	187	296.3
33	10/24/2005 16:18:37		73	96.3	100	40.5	249	96.5	146	31.3	163	58.3	100	55.2	348	58.9	217	90.3	97	27.6	316	97.6
34	10/24/2005 16:18:38		4	315	76	95.3	156	30.8	102	63.9	240	69	164	148.4	252	104.7	177	92.6	272	168.8	213	67.6
35	10/24/2005 16:18:39		210	128.6	290	70.9	94	66.2	11	79.7	357	45.6	158	122.6	235	40	292	52	136	23.9	180	309.4
36	10/24/2005 16:18:40		218	160.2	250	62.6	183	86.2	98	65.8	160	88.9	330	97.1	254	73.3	358	42.7	105	358.9	230	177
37	10/24/2005 16:18:41		131	107.3	210	109.2	151	157.8	178	49.3	297	2.5	164	340.3	29	257.9	187	16.5	258	349.7	256	66.2
38	10/24/2005 16:18:42		42	25.3	162	72.8	476	64	294	94.1	315	321.8	214	330.6	415	293.6	274	95.2	268	24.7	304	59.8
39	10/24/2005 16:18:43		140	21.4	132	309.5	58	35.9	230	322.4	43	80.5	115	349.5	233	347.1	144	41.6	273	24.9	349	41.4
40	10/24/2005 16:18:44		79	53.3	171	40.5	135	65.5	167	339.3	280	55.6	314	14.7	352	338.8	359	37.6	269	23.2	356	35.7
41	10/24/2005 16:18:45		170	188.8	214	175.2	200	165.5	150	346.9	155	325.3	116	101.4	185	109.2	240	52.3	300	37.3	367	69.2
42	10/24/2005 16:18:46		244	60.6	212	140.4	79	154.4	121	283.9	109	72.4	63	96.3	180	273.8	171	52.6	447	8	232	49
43	10/24/2005 16:18:47		215	101.3	67	349.7	42	73.3	296	80.1	135	31.7	377	21.5	50	121.2	218	5.8	216	49.1	206	70.2
44	10/24/2005 16:18:48		155	190.4	192	117.9	321	71.1	385	53.5	141	13.9	232	0	216	2.9	203	12.8	144	0.8	110	13.7
45	10/24/2005 16:18:49		284	92.4	161	68.1	232	36.8	443	21	147	131.7	249	56.3	253	8.9	120	73.1	323	353.1	211	325
46	10/24/2005 16:18:50		201	43.4	576	21.4	180	341.6	178	93.2	204	70.5	272	10.6	59	40.2	218	40	295	40.3	154	62.9
47	10/24/2005 16:18:51		143	358.4	259	48.3	237	1	340	20.5	343	39	205	116.7	225	96.9	184	166.5	238	56.8	190	94.2
48	10/24/2005 16:18:52		155	66.1	257	84.4	307	170	58	80	115	346.9	139	313.8	234	73.7	243	61.7	144	82.8	57	131.5
49	10/24/2005 16:18:53		269	3.4	106	232.3	133	31.8	129	323.2	156	273.7	170	205.4	190	351.2	183	46.8	249	76.3	183	56.1
50	10/24/2005 16:18:54		134	134.7	140	155.1	200	61.3	202	14.7	107	30.9	116	55.9	279	60.3	131	65.6	326	56.5	195	29.9
51	10/24/2005 16:18:55		211	45.6	200	7.8	242	70.2	160	356.1	57	347.9	111	27.3	131	26.2	148	95.8	249	26.3	193	131.6
52	10/24/2005 16:18:56		179	75.4	110	125.4	172	46.2	238	123.2	33	79.4	117	108.4	32	38.7	118	119	201	157.8	156	272.9
53	10/24/2005 16:18:57		185	101.9	170	136	137	65.5	115	93	285	110.5	310	122.9	215	152.6	286	106.2	184	30.1	360	79.1
54	10/24/2005 16:18:58		145	229.5	297	137.9	120	84.7	130	78	430	80.1	380	85.3	246	81.6	477	49.4	298	79.9	32	28.2
55	10/24/2005 16:18:59		292	16.5	294	25.8	393	52.3	238	45.9	301	56.4	272	94.2	200	64.8	252	79.7	185	114.2	193	133.5
56	10/24/2005 16:19:00		159	24.5	230	55.8	126	56.3	525	26.1	107	45.4	262	71.8	76	68.5	141	64.9	273	42.5	160	117.2
57	10/24/2005 16:19:01		195	15.2	217	66	338	37.9	204	78.7	147	95.5	216	47.8	289	74.8	147	68.5	210	81.3	371	55.9
58	10/24/2005 16:19:02		220	106.9	143	179.6	120	79.9	114	107.3	96	308.7	118	139.1	99	286.4	187	122.8	101	66	96	30.6
59	10/24/2005 16:19:03		89	91.3	217	32.6	255	97.9	203	49.2	259	41.7	200	69.5	283	49.4	83	95.5	244	60.5	311	353.4
60	10/24/2005 16:19:04		179	100.9	135	82.8	137	112.3	202	90	95	19.8	410	73.7	111	90	194	234.4	85	79.9	343	72.4

Lower Fox River Moving Vessel Trials
Test Three

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 3		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:21:26		109	31.5	97	330.3	171	88.7	85	90	166	24.6	332	141.9	156	131.9	184	295.7	168	269.3	123	155.5
1	10/24/2005 16:21:27		158	12	197	49.5	223	45.9	35	202.1	89	311.4	111	9.9	364	57.1	97	234.7	288	90	187	56.3
2	10/24/2005 16:21:28		211	294	181	217.8	100	46.6	148	67.4	98	304.7	232	172.8	244	129.7	218	85.8	211	44.2	327	83.2
3	10/24/2005 16:21:29		115	273	120	230.7	95	107.1	133	335.9	73	114.1	49	15.5	96	62.6	226	67.1	154	58.3	262	70.1
4	10/24/2005 16:21:30		38	334.8	98	1.8	329	36.1	111	355.9	160	74.7	130	97.9	220	72.6	98	80.1	151	152.4	52	52
5	10/24/2005 16:21:31		281	319.6	132	17.6	184	33	149	355.8	159	192.7	87	56.7	155	16.1	187	71	96	56.5	213	43.7
6	10/24/2005 16:21:32		129	42.5	252	64.9	186	107.9	326	91.6	250	85.6	167	46.5	83	140.4	141	15.2	107	103	182	91.9
7	10/24/2005 16:21:33		174	354.7	162	345.7	213	327.3	241	31.8	268	73.7	246	91.6	212	44.6	183	12.3	284	39.9	133	23.9
8	10/24/2005 16:21:34		162	43.2	208	62.8	105	296.6	117	308.7	30	151.7	141	43.9	167	3.8	284	15.9	292	40.6	82	152.5
9	10/24/2005 16:21:35		120	44.7	240	73.1	128	28.4	73	48.9	232	121.4	54	119.9	185	118.8	375	52.2	160	39.7	129	73.4
10	10/24/2005 16:21:36		258	325.6	177	346	41	80.1	120	133.7	247	51.4	248	23.8	197	53.2	333	345.8	254	10	417	41.3
11	10/24/2005 16:21:37		205	111.4	334	156.1	241	165.1	253	132.6	276	126	572	130.2	499	132.8	456	109.1	710	130.7	643	146
12	10/24/2005 16:21:38		123	88.6	224	39.4	225	46.8	329	41.3	343	17.3	388	338.2	290	32.8	271	4.4	327	343.7	470	358.9
13	10/24/2005 16:21:39		190	45.6	62	326.8	86	315.5	224	70.7	121	345.2	43	193.4	295	17	168	104.4	243	135.7	51	114.5
14	10/24/2005 16:21:40		129	210.4	50	169.6	207	14	178	123.3	244	95.6	115	122.6	163	315						
15	10/24/2005 16:21:41		123	349.2	117	194.4	148	48	281	14.6	237	34.5	23	110								
16	10/24/2005 16:21:42		16	183.6	148	344.4	305	53.4	50	15.2	173	79.3	125	9.7	68	117.3						
17	10/24/2005 16:21:43		115	201	171	69.8	203	129.4	115	331.4	167	148.2			124	80.2	112	15.5				
18	10/24/2005 16:21:44		310	69.8	95	22.8	36	140.6	129	15.3	204	147.8	200	38.3	224	6.1	62	60.9	323	95.1		
19	10/24/2005 16:21:45		133	31.2	143	137.8	120	64.9	189	78.4	624	88.7	292	111.3	352	79	168	132.8	242	186.4		
20	10/24/2005 16:21:46		149	22.4	136	202.4	55	40.6	248	85.6			198	56.6	163	212.7	168	117.3	99	308.8	315	187.8
21	10/24/2005 16:21:47		160	73.3	83	332.8	335	51.9					200	54.2	38	113.2	206	338.7	199	338.5	95	292.2
22	10/24/2005 16:21:48		166	178.3	384	5.5	252	67.1	459	32.1	243	23	243	24	350	0.5	77	59.4	343	26.6	355	353
23	10/24/2005 16:21:49				220	73.1	363	43.3	118	288.3	105	352.3	162	162.3	87	106.8	95	34.7	365	59.6	469	31.7
24	10/24/2005 16:21:50		150	6.1	123	266.3	207	260	29	123.7	187	142.2	275	92.9	276	86.9	155	94.4	126	91.4	395	38.7
25	10/24/2005 16:21:51		267	309.5	175	335	116	149.9	157	282.2	89	189	390	157.1	163	17.9	235	59.6	347	20.1	189	90.3
26	10/24/2005 16:21:52		47	333.4	82	350.2	247	12.2	210	80.1	298	79.4	347	84.2	97	58.4	326	67.4	240	84.3	271	80.4
27	10/24/2005 16:21:53		96	42.5	329	2.1	73	216.1	156	172.3	294	95.3	264	90.2	89	163	69	109.5	436	38.8	386	16.9
28	10/24/2005 16:21:54		218	307.2	327	126.4	45	11.6	118	90	70	123.9	318	82.6	309	67.3	284	71.3	338	10.9	161	115.4
29	10/24/2005 16:21:55		46	225.9	318	79.5	196	85.9	262	100.8	313	59.5	81	277.8	283	123.6	190	92.7	47	94.9	119	296.6
30	10/24/2005 16:21:56		128	89.1	84	120.8	172	79.6	262	95.5	176	91.3	285	91.4	309	38.9	399	43	311	69.9	287	83.4
31	10/24/2005 16:21:57		154	50	106	48.1	204	49	175	49.6	175	95.6	324	44	615	137.2	429	29.9	256	50.5	216	51.4
32	10/24/2005 16:21:58		102	155.2	174	133.6	121	120.8	107	327.2	331	60.3	249	53	360	73.4	410	51.7	457	39.7	351	56.4
33	10/24/2005 16:21:59		9	305.5	116	78.1	160	152.5	132	43.8	101	31.6	277	72.3	348	64.8	234	39.5	313	59.5	344	76.6
34	10/24/2005 16:22:00		159	314.2	74	53.7	301	2.9	122	150.5	174	12.9	59	340	214	61.9	107	68.7	271	88.7	275	84.6
35	10/24/2005 16:22:01		13	108.4	158	62.5	198	74.8	36	37.2	228	82.7	213	118	103	88.3	136	70.6	164	86.5	388	90.9
36	10/24/2005 16:22:02		116	291.3	25	315	170	87	123	241.8	132	23.7	150	100	227	106.6	287	63.1	223	122	253	80.9
37	10/24/2005 16:22:03		9	180	132	65	74	67.9	181	143.8	57	339.3	297	93.7	266	113.5	114	49.6	20	351.5	213	65.6
38	10/24/2005 16:22:04		105	222.7	79	202.3	92	13.1	102	4.5	236	65.7	130	349.8	285	7.4	312	51.3	63	124.7	123	64.9
39	10/24/2005 16:22:05		161	132.2	244	119.4	230	93.5	34	169.7	80	290.5	183	337.8	254	11.8	107	50.7	393	38.7	166	97.3
40	10/24/2005 16:22:06		238	57.5	113	292.5	62	107.9	240	9.3	211	45.6	192	91.2	363	58.6	211	104	358	79.9	349	59
41	10/24/2005 16:22:07		152	72.4	79	38.3	97	127.5	344	82.8	233	62.4	288	82.4	190	69.7	447	63.3	91	41	316	60.6
42	10/24/2005 16:22:08		58	324.1	218	331.2	167	81.7	117	110.4	251	88.2	404	48.3	380	56.5	169	96.8	247	54.9	207	71.7
43	10/24/2005 16:22:09		127	306.7	144	73.1	154	117.1	73	80.5	63	76.2	220	130.2	199	98.7	189	58	244	71.1	129	97.6
44	10/24/2005 16:22:10		190	206.6	548	103.5	70	155.6	131	73.6	290	93	64	339	102	83.2	273	60.3	398	41.3	155	66.1
45	10/24/2005 16:22:11		273	355.6	160	182.1	116	238.8	297	100.9	245	111.8	299	91.7	185	82.5	497	58.1	334	76.5	177	104.4
46	10/24/2005 16:22:12		107	218.6	151	344.7	186	169.8	56	100.3	187	133.1	107	191.8	153	49.8	234	24.5	381	92.6	259	88
47	10/24/2005 16:22:13		188	286.4	117	34.2	67	169.7	208	160.1	353	165.2	40	299.7	214	128.7	159	106.8	360	110.5	153	102.5
48	10/24/2005 16:22:14		174	339.5	149	111.6	92	34.4	94	107.3	63	186.3	199	79.9	371	72	249	59.1	67	97.8	315	36.5
49	10/24/2005 16:22:15		93	235.5	166	16.1	193	73.4	195	15.2	102	9.6	194	230.6	239	122.4	161	65.3	87	80.1	78	21.9
50	10/24/2005 16:22:16		142	76.9	220	107.7	38	81	204	84.7	307	68.6	203	107.8	222	24.1	177	3.6	216	352	255	49.1
51	10/24/2005 16:22:18		157	50.4	120	326.6	260	56.3	122	112.6	176	36.2	310	5.2	169	338.5	138	32.9	71	51.8	38	65.4
52	10/24/2005 16:22:19		192	249.3	157	21.3	104	193.4	165	149.9	48	13.2	175	35.7	68	185.9	56	171.7	160	176.4	170	341.1
53	10/24/2005 16:22:20		150	161.3	272	114.3	171	0	156	69	211	350.7	314	344.3	140	29.5	96	297.9	144	226.1	112	95.1
54	10/24/2005 16:22:21		187	33.4	92	69.6	152	13.7	106	26.3	98	15.5	129	66.8	26	164.4	156	342.8	275	81.6	58	302.3
55	10/24/2005 16:22:22		145	49.5	340	53.4	56	349.7	153	42.9	144	94.4	133	93	410	90.4	450	65.1	216	349.6	116	92.5
56	10/24/2005 16:22:23		139	106.3	217	131.6	262	89.1	136	136.2	118	109.8	106	116.3	192	3.9	202	57.1	123	75.9	402	107.4
57	10/24/2005 16:22:24		49	132.5	185	227	78	166.7	153	56.2	79	112.3	110	358.4	225	92	174	65.5	102	86.1	209	229.1
58	10/24/2005 16:22:25		209	47.9	15	19.7	145	304.6	155	4.1	93	92.5	74	225	171	358	52	48.1	108	115.9	246	123.6
59	10/24/2005 16:22:26		67	232.3	162	326.6	168	269.3	112	299.3	184	347.8	318	11.6	170	47.4	105	168.5	203	49	168	355.5
60	10/24/2005 16:22:27		131	36	86	314.1	25	45	278	7.4	139	321.7	123	330.7	170	88.7	100	82	154	59.6	291	91.4

Lower Fox River Moving Vessel Trials
Test Three

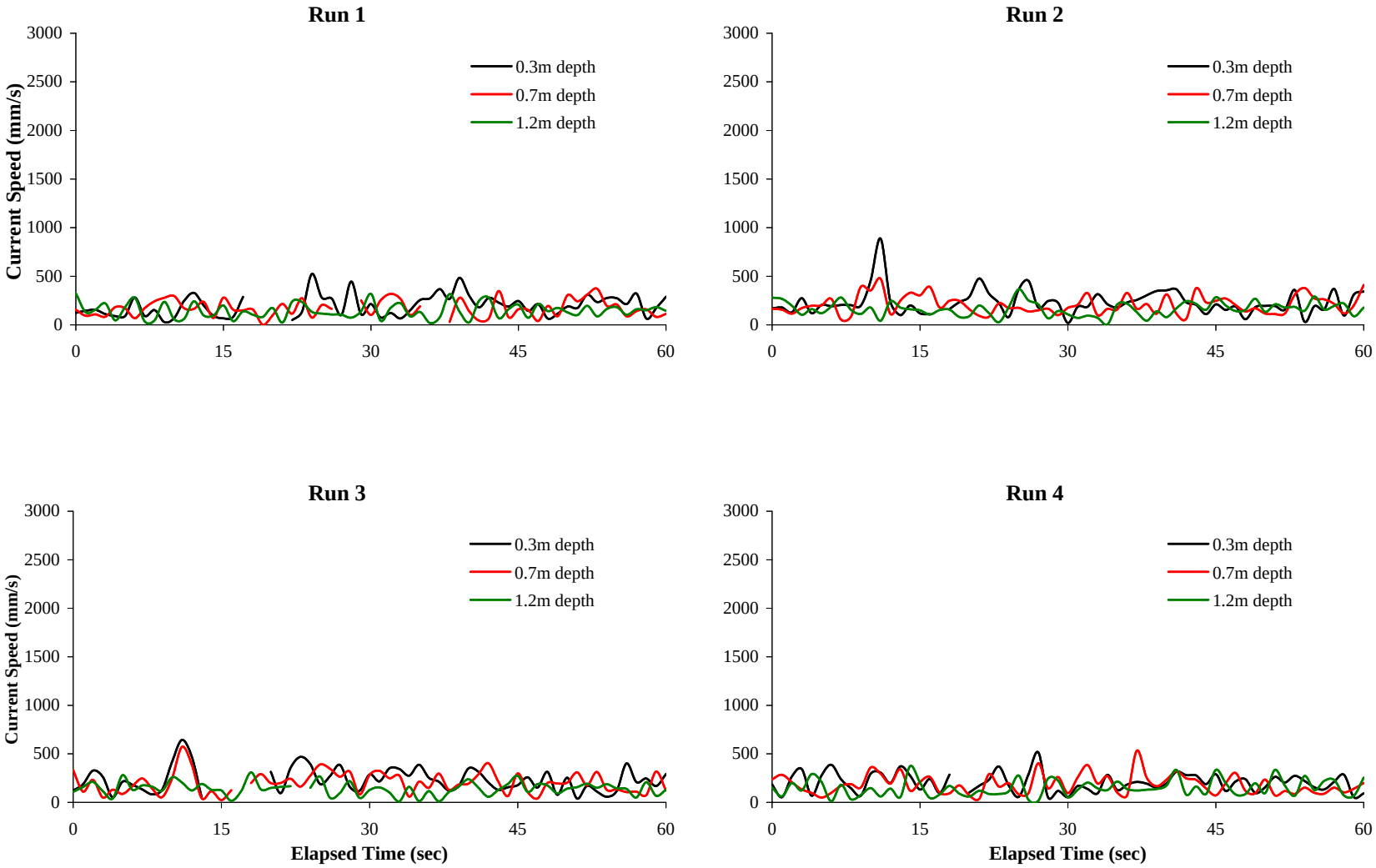
Run 4

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3		
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3		
0	10/24/2005 16:24:15	153	298.4	102	39	97	321.7	219	46.3	232	3.7	236	92.4	228	104.7	55	159.9	116	283.4	184	13.5		
1	10/24/2005 16:24:16	62	6.4	111	114.5	267	13.7	54	58.7	82	5.6	285	80.1	235	138.1	190	104.9	53	290.8	53	172.5		
2	10/24/2005 16:24:17	200	65.7	129	41.9	21	8.1	118	56.7	48	4.8	207	320.3	170	19.9	128	72.7	164	296.9	265	27.1		
3	10/24/2005 16:24:18	123	32	208	95.8	161	74.2	53	329.6	166	15.7	133	54.5	166	10.4	289	347	65	15.1	344	56		
4	10/24/2005 16:24:19	291	355.5	161	48	89	78.9	157	142.8	29	20.3	97	246.9	227	110.7	168	105.2	131	194.6	69	92.5		
5	10/24/2005 16:24:20	210	79.6	130	33.1	57	137.9	30	126.9	80	19.8	49	270	159	81.7	156	135.3	182	60.8	275	30.6		
6	10/24/2005 16:24:21	11	254.7	34	65.7	222	137.9	147	155.5	103	73.1	97	91.8	52	102.2	211	74.9	269	45.6	388	70.9		
7	10/24/2005 16:24:22	182	129.2	77	12.8	150	89.6	387	131.8	277	89.6	170	308.6	150	161.7	143	59.7	213	32.1	238	25.2		
8	10/24/2005 16:24:23	31	97.4	88	32.4	139	56.8	141	76.5	106	3.2	188	121.1	77	140.8	250	100.4	176	66.2	146	59.9		
9	10/24/2005 16:24:24	76	132.9	261	68.9	271	111	169	180.7	98	312.1	153	309.7	85	352.5	36	176.8	60	34.8	68	292.4		
10	10/24/2005 16:24:25	147	343	154	322.9	166	65.4	280	92.7	180	88.7	359	64.8	198	347.4	99	10.5	342	47.1	295	76.1		
11	10/24/2005 16:24:26	60	350.4	219	32.7	339	74.8	260	114.6	264	90	296	141.6	271	41.4	105	356.7	320	319.9	306	339.9		
12	10/24/2005 16:24:27	142	138.1	333	120.3	70	52	149	143.4	190	115.2	193	65.8	330	51.9	86	82	62	72.1	200	322.3		
13	10/24/2005 16:24:28	53	255.7	184	117.8	274	109.2	359	94.9	230	99.5	341	122.3	263	80.6	303	95.7	349	117.1	371	151.4		
14	10/24/2005 16:24:29	374	10.2	58	130.8	130	118.5	173	106.8	137	102.6	119	322.2	123	55.9	36	294.4	134	36.8	273	11.4		
15	10/24/2005 16:24:30	204	98.2	280	82.2	203	124.6	73	75.8	90	150.6	211	98.2	65	40	55	80.5	396	77.8	132	96.5		
16	10/24/2005 16:24:31	46	353.8	228	123.9	94	149.3	32	299.7	153	118.6	263	110.7	222	64.4	148	338.6	360	76	240	352.3		
17	10/24/2005 16:24:32	81	217.4	213	92.2	181	45.9	128	130.6	170	169.5	100	178.3	236	136.2	83	68.7	22	248.2	97	281.9		
18	10/24/2005 16:24:33	169	59.8	246	63.2	163	299.4	66	59.9	94	4.9	94	16.7	230	38.5	350	119.4	195	61.2	286	87.8		
19	10/24/2005 16:24:34	90	144	62	349.8	111	127.3	144	129.1	243	10.7	174	27	92	91.2	61	45	236	41.4				
20	10/24/2005 16:24:35	60	314.3	201	48.2	77	174.8	40	278.5	21	115.3	72	41	89	103.7	80	55.7	144	126.6	102	96.2		
21	10/24/2005 16:24:36	120	181.4	140	90	126	56.3	195	53.1	267	84	36	80.3	263	50.6	248	58.2	314	49.8	171	35		
22	10/24/2005 16:24:38	86	183.3	91	76.7	185	349.7	221	13.8	78	87.1	292	79	196	60.7	282	147.4	114	41.1	234	92.7		
23	10/24/2005 16:24:39	86	125.5	165	171.3	202	84.9	108	98.5	176	15.9	162	86.5	147	59.8	226	90.5	231	27	370	339.3		
24	10/24/2005 16:24:40	114	307.2	100	132.6	121	325.8	149	295.9	143	69.2	198	96.1	277	105.3	201	14.4	223	30.7	172	324.9		
25	10/24/2005 16:24:41	277	41.3	351	113.5	207	56	241	11.3	154	51.6	84	80.4	227	24.8	251	0	74	80.7	57	130.1		
26	10/24/2005 16:24:42	28	261.9	164	61.6	319	56.3	432	3.3	181	36.9	94	74.6	146	31.8	205	23.3	361	359.8	288	73.9		
27	10/24/2005 16:24:43	17	90	176	31.5	46	134.1	77	294.6	242	339.9	403	345.9	33	310	170	8.8	171	71.2	515	264.9		
28	10/24/2005 16:24:44	246	335	94	276.1	186	61.1	224	88.7	123	349.7	145	339.8	20	345.3	228	50.5	87	358.7	49	106.6		
29	10/24/2005 16:24:45	224	44.5	70	355.1	255	42.6	264	5.6	283	88.4	261	64.6	122	279.9	54	21.8	93	207.4	118	1.9		
30	10/24/2005 16:24:46	54	101.7	170	343.6	141	64.9	169	141	360	144.3	95	46.3	320	75.1	78	134.5	106	87.3	54	101.7		
31	10/24/2005 16:24:47	129	289	214	60.7	82	157.8	89	285.6	91	125.6	259	60.7	203	89.2	301	46.9	90	53.1	169	355.6		
32	10/24/2005 16:24:48	204	313	69	325.6	113	158.7	63	9.2	42	19.3	385	52.6	199	29.1	203	6.2	196	314.8	138	345.4		
33	10/24/2005 16:24:49	145	318.9	195	356.8	56	218.5	174	139	270	118.1	194	92.4	332	2.2	145	2.4	116	202.4	92	89.4		
34	10/24/2005 16:24:50	127	321.7	140	40.6	130	349.4	343	75.2	217	114.4	271	65.8	244	318.5	109	191.1	131	101	283	144.1		
35	10/24/2005 16:24:51	215	2.1	74	12.5	87	158.4	108	104.4	195	139.4	101	136.2	244	208.9	183	177.8	223	44.5	127	70.7		
36	10/24/2005 16:24:52	138	70.5	189	195.7	113	44.3	46	169.9	331	174.1	70	252.6	143	267.6	205	185.6	138	85.9	183	93.4		
37	10/24/2005 16:24:53	122	1.4	98	354.1	109	66.7	277	357.5	314	16.5	533	161.1	133	72.9	211	138.5	308	113.7	211	246		
38	10/24/2005 16:24:54	131	348.1	139	7.4	470	64	214	10.2	353	64.2	253	5.9	394	74	325	80.1	427	39.6	192	154.8		
39	10/24/2005 16:24:55	138	4.6	167	70.8	308	323.1	136	78.5	220	96.8	166	28.1	273	64.8	337	92.7	239	42	152	56.8		
40	10/24/2005 16:24:56	173	353.4	162	219	257	22.9	253	3.4	319	68.5	234	57.2	393	22.1	420	39.6	209	35.4	196	46.4		
41	10/24/2005 16:24:57	336	35.9	80	78.4	176	55.4	141	98.6	249	79.6	320	92.7	112	50.8	430	11.9	337	38.5	315	60.8		
42	10/24/2005 16:24:58	78	87.8	141	85.5	204	75.2	186	68.8	315	131.8	248	126	234	152	186	51.3	138	318.8	281	274.7		
43	10/24/2005 16:24:59	163	54.7	71	137.3	202	56.7	157	32.8	113	80.3	232	73.7	97	0	66	321.7	351	13.3	278	24.9		
44	10/24/2005 16:25:00	85	25.1	80	92.9	156	279.2	52	342.3	129	66.2	145	43	63	83.7	305	354.2	108	133.9	188	21.2		
45	10/24/2005 16:25:01	336	38.8	95	15.9	260	44.2	285	5.6	147	349.4	72	37.7	227	93.3	177	115.4	237	42.8	290	36.9		
46	10/24/2005 16:25:02	201	91.7	250	95.7	218	132.8	394	126.2	185	36.4	196	13.9	344	343.1	135	14.1	329	342.3	117	167.2		
47	10/24/2005 16:25:03	82	67.2	240	77.2	193	92.1	217	44.8	195	28.1	304	89.1	23	205.5	43	20.6	145	161.4	215	351.5		
48	10/24/2005 16:25:04	85	96	342	128.7	113	90.5	155	343.1	45	183.8	120	30.6	304	66.3	77	309.2	30	136.3	239	47.7		
49	10/24/2005 16:25:05	196	53.3	166	72.9	175	113.6	28	317.9	215	64.4	94	30.7	166	85.9	54	129	241	133	97	102.5		
50	10/24/2005 16:25:06	95	33.4	102	335.7	93	98	134	66.3	130	91.8	235	69	46	349.9	70	322	81	20.9	155	80.4		
51	10/24/2005 16:25:07	336	25.3	86	21.2	204	294	157	11	135	122.3	72	130.5	175	89.7	274	48.9	33	32.7	263	92.4		
52	10/24/2005 16:25:08	173	46.6	263	92.6	369	56.1	70	111	164	31.6	117	218.4	117	27	129	46.6	31	29.1	205	84.7		
53	10/24/2005 16:25:09	67	273.4	242	103.6	233	58.5	174	171.7	66	194.9	87	292.4	199	63.7	208	86.1	304	37.2	274	32.2		
54	10/24/2005 16:25:10	272	52.3	114	23.9	188	36.6	138	39.7	166	198.2	151	188.4	56	97.1	127	49.2	215	352.5	220	58.2		
55	10/24/2005 16:25:11	126	7.3	132	45.6	342	338.9	61	133.7	218	352.4	98	260.1	113	52.9	319	86.6	126	76.2	156	70.5		
56	10/24/2005 16:25:12	222	82.2	189	60.6	208	99.1	154	157.9	250	53.1	90	104.8	376	60.2	180	71.6	50	260.7	134	84.8		
57	10/24/2005 16:25:13	233	56.4	265	68.1	30	178.1	94	65.4	137	277.1	151	302	144	8.4	27	309	183	59.5	212	35.4		
58	10/24/2005 16:25:14	71	278.1	64	131.9	89	50	190	102.4	231	71	103	179.4	135	166.7	44	123	184	120.3	285	23.8		
59	10/24/2005 16:25:15	67	64.2	115	68.6	49	47.5	126	52.4	339	61.5	140	101.1	38	317.1	141	21.3	190	44.1	53	11.9		
60	10/24/2005 16:25:16	254	112.4	154	183.7	240	134	173	145.6	194	128.5	199	48.9	125	359.1	154	137.4	177	116.9	92	22.4		

Fox River Propwash Study - Moving Vessel Trials

Test #3: Single-Prop Vessel - 2900 RPM - Pitch Up

October 24, 2005



Lower Fox River Moving Vessel Trials
Test Four

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 1		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:29:57		101	186.8	98	53.7	272	86.6	208	74.4	169	55.1	176	29.2	281	88.2	237	58.7	138	13	166	20.1
1	10/24/2005 16:29:58		114	55.8	62	199.9	161	161.6	225	65.3	143	305.6	106	34.6	198	114.8	173	108.9	134	34	87	134.5
2	10/24/2005 16:29:59		39	95.9	147	3.5	121	58.1	243	76.9	62	19.9	143	355.6	245	35.4	254	18.6	168	44	152	326
3	10/24/2005 16:30:00		340	32.1	196	28	69	116.6	68	77.2	34	74.7	266	66.7	278	80.5	184	76.8	9	200.6	246	74.7
4	10/24/2005 16:30:01		200	266.3	175	73	332	71.6	237	15.4	98	35	269	59.1	288	68.9	82	32.5	121	351.5	81	7.8
5	10/24/2005 16:30:02		132	169.5	123	130	68	29.2	216	51	70	327.2	66	201.5	147	13.4	118	7.3	150	325	50	74.8
6	10/24/2005 16:30:03		116	80.5	241	106.9	14	347.9	129	302.3	125	57.7	104	224.6	122	26.4	214	78.4	260	79.6	125	39.2
7	10/24/2005 16:30:04		175	341.7	346	16.8	339	37	78	154.1	178	95.5	168	79	31	307.2	290	65.8	246	52.9	185	50.3
8	10/24/2005 16:30:05		48	322.7	119	67.8	138	52.6	54	248.2	30	162.8	12	170.5	264	26.3	135	71	156	33.5	149	56.2
9	10/24/2005 16:30:06		150	131.2	205	22.7	135	124.7	121	246.2	224	221	298	135.1	127	94.1	132	43.5	169	9.9	74	280.1
10	10/24/2005 16:30:07		143	97.6	110	29.4	174	304.7	145	20.2	8	166	95	169.6	0	0	243	357.9	261	354.1	414	35
11	10/24/2005 16:30:08		224	269.2	134	349.7	144	43.9	109	315	93	285.5	47	78.9	219	306.5	125	265.9	117	239.3	292	331.8
12	10/24/2005 16:30:09		270	41.8	250	17	299	2.9	325	15.7	293	30.1	188	16	427	35.8	220	35.2	381	30.8		
13	10/24/2005 16:30:10		259	52.4	250	62.9	396	80.1	439	67.6	513	89	584	89.6	469	74.8	356	63.7	1013	99.1	798	214.8
14	10/24/2005 16:30:11		262	114.6	163	27.8	96	97.8	252	167.4	286	159.1	454	177.1	215	146.8	104	131.5	299	180.6		
15	10/24/2005 16:30:12		184	116.4											226	9.2	368	96.7	275	56		
16	10/24/2005 16:30:13		48	71.9			776	11.6	624	350.2			375	83	270	40.3	1285	75.1	300	66.9	361	102.6
17	10/24/2005 16:30:14		249	141.5	560	41.2	349	45	340	41.4	701	89.4	483	129	415	55.3	538	46	261	75.6	496	79.7
18	10/24/2005 16:30:15		444	145			313	67.7	682	64.8	692	48	695	26.7	489	85.1	494	76.2	617	72.9	873	66.8
19	10/24/2005 16:30:16		227	86.7	373	84.2	160	35.9	774	3.6	659	57.9	718	72.2	560	86.5	434	123	533	146.5	609	156.2
20	10/24/2005 16:30:17		152	94.5	256	96	403	86.3	481	89.6	547	81.8	729	39.4	718	67.2	410	109.4	737	118.5	766	108.4
21	10/24/2005 16:30:18		92	58.4	387	122.7	388	97.3	641	81.9	530	78.4	658	68.5	613	66.9	564	91.8	651	83.6	713	82
22	10/24/2005 16:30:19		171	67.6	338	106.5	280	89.2	195	100	238	75.7	180	40.5	320	74.2	222	89	112	20.4	327	66.2
23	10/24/2005 16:30:20		93	93.1	319	103.8	299	75.1	428	63.1	261	92.2	189	333.6	229	84.7	352	63.1	400	50.3	633	66.4
24	10/24/2005 16:30:21		218	208.8	112	102.4	338	53.5	355	92.1	325	73.2	116	62.3	410	15.3	524	355.3	433	8.8	162	46.3
25	10/24/2005 16:30:22		183	109.1	402	90.4	494	105.8	279	145.5	286	130.9	205	86.6	269	110.7	452	92.2	331	86	407	84.2
26	10/24/2005 16:30:23		293	82.9	310	113.3	325	181.1	222	227.6	142	198.9	127	202.1	256	89.1	289	57.7	204	66.6	254	49.5
27	10/24/2005 16:30:24		118	57.1	76	45	117	91	206	68.9	62	194.9	89	326	61	255.7	138	133.5	139	289.7	161	62.2
28	10/24/2005 16:30:25		388	137.9	125	153.4	193	97.1	221	34.5	228	42.2	75	331.4	193	245.2	49	135.8	193	4.2	196	7.3
29	10/24/2005 16:30:26		321	69.8	158	131.7	195	60.8	132	351.7	211	51.7	460	73.2	247	103.6	293	64.3	497	60.6	359	68.4
30	10/24/2005 16:30:27		269	318.8	298	314.7	294	324.3	270	4.5	221	29.6	356	12.5	357	26.6	443	36.1	452	39.3	547	43.7
31	10/24/2005 16:30:28		285	56.8	126	107.1	115	43.9	404	14.5	525	44.2	539	22.2	539	30	352	70.2	279	33	219	25.7
32	10/24/2005 16:30:29		199	27.9	296	359.8	428	31.5	319	48.2	358	7.2	248	32.5	495	43.4	410	35.2	332	76.9	148	53
33	10/24/2005 16:30:30		282	46.9	356	30	311	40.4	80	13.7	445	354.1	337	34.7	264	84.6	404	48.3	458	20.3	87	16.8
34	10/24/2005 16:30:31		298	6.9	120	34.1	101	325.1	121	320	87	336.4	131	44.1	26	307.3	100	112.2	280	27.4	231	56.3
35	10/24/2005 16:30:32		140	242.3	290	199.3	73	231.7	227	320.6	275	328.2	214	290	182	299.2	414	326.9	288	339.7	205	353.6
36	10/24/2005 16:30:33		243	249	34	202.8	74	268.5	24	175.2	232	6.4	309	332.9	269	21.8	269	93.8	416	63.6	305	71.4
37	10/24/2005 16:30:34		215	328.5	316	306.3	107	308.2	260	51.1	114	11.1	193	11.1	43	350.5	233	44.3	353	36.1	383	31.7
38	10/24/2005 16:30:35		170	114.6	61	8.5	360	12.7	408	20.2	373	18.1	681	4.2	333	15.9	359	8.3	256	31.3	391	18.8
39	10/24/2005 16:30:36		208	23.9	142	50.1	306	19.1	399	21.5	521	13.8	320	355.9	480	15.8	367	5.6	321	7.3	238	21.5
40	10/24/2005 16:30:37		140	3.3	122	31.2	240	310.4	230	315.9	460	330.4	166	14	408	32.8	109	309.1	126	277.7	337	8.7
41	10/24/2005 16:30:38		71	10.5	130	301.5	408	344.6	433	351.6	269	330.6	223	349.6	265	36.6	250	358.6	325	14.6	396	21.5
42	10/24/2005 16:30:39		142	325.3	107	308.6	211	2.7	311	351.7	306	334.6	364	334.6	200	346.7	231	351.5	393	26	156	43.2
43	10/24/2005 16:30:40		292	356.1	193	315.6	159	340.9	54	350.4	199	86	323	325.2	387	354.4	275	41.2	25	21.4	185	52.7
44	10/24/2005 16:30:41		112	9.8	56	75.5	364	344.1	158	3.6	244	358.6	235	279.3	185	330.9	233	329.2	117	294.8	216	30
45	10/24/2005 16:30:42		230	21.1	220	324.8	209	321.6	221	291.5	310	305.3	244	323.3	402	4.1	281	339.6	44	52.4	170	273
46	10/24/2005 16:30:43		160	50.3	132	348.2	266	345.2	148	247.8	151	314.2	97	213.7	129	1.8	220	345.3	91	19.8	382	32.5
47	10/24/2005 16:30:44		107	307.4	162	70.9	223	36	106	266.8	338	331.9	170	259.2	36	24.4	321	80.3	148	72.3	357	26.6
48	10/24/2005 16:30:45		102	114.8	201	62.2	105	346.2	84	76.3	169	71.8	132	80.8	59	174.2	125	355.4	193	9.6	63	36
49	10/24/2005 16:30:46		26	240.5	62	353.6	107	0.5	144	297.8	92	336.2	245	357	609	22.8	393	38.2	156	49.2	284	350.3
50	10/24/2005 16:30:47		93	120.4	166	8.3	99	256.5	290	77.1	301	62.1	296	26.7	253	7.5	156	8.9	354	351.9	209	341.6
51	10/24/2005 16:30:48		155	68.9	154	96.7	178	27	223	358.7	311	353.9	284	8.9	363	359.2	311	356.7	316	15.4	315	7.8
52	10/24/2005 16:30:49		181	73.3	299	24.3	399	45.6	191	38.2	280	59.8	154	119.6	132	127.9	252	41.1	174	38.9	449	23.4
53	10/24/2005 16:30:50		131	290.5	159	145.5	88	0.7	90	256.6	144	274	80	13	80	32.7	105	333.9	79	16.1	163	274.2
54	10/24/2005 16:30:51		75	321	187	8.3	162	35.9	263	16.8	105	86.7	56	70.3	71	278.9	156	167.8	193	48.4	128	314.7
55	10/24/2005 16:30:52		127	144.3	295	94.3	260	90	318	94.1	314	37.5	221	26.6	279	29.7	358	25.1	152	21.7	179	356.5
56	10/24/2005 16:30:53		168	301.1	295	138	199	115.9	189	77.8	122	54.4	282	30.7	245	45.8	398	19.8	195	359.1	7	90
57	10/24/2005 16:30:54		190	193.1	189	133.1	225	321.9	114	196.8	33	125.1	48	113.4	157	112.5	188	8.3	148	278.1	290	335.6
58	10/24/2005 16:30:55		77	115.2	292	342.1	250	36.2	105	46.5	219	41.9	47	149	175	66.1	163	83	366	52.2	316	67.5
59	10/24/2005 16:30:56		103	22.3	344	349	70	80.9	146	141.1	55	156.3	217	78.6	76	69.2	51	283.5	160	132	102	230.2
60	10/24/2005 16:30:57		264	74.9	136	5.5	233	70.2	192	351	144	79.6	130	318.4	201	302.4	173	66.1	136	70.6	316	344.4

Lower Fox River Moving Vessel Trials
Test Four

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:33:19		198	4	142	326.8	244	52.7	334	71.1	147	349.8	259	58.1	228	113.2	234	65	278	345.4	240	27.8
1	10/24/2005 16:33:20		162	42.2	95	125.5	63	79.9	86	27.8	44	107.2	266	144.6	76	1.5	44	105.9	204	84.4	341	138.7
2	10/24/2005 16:33:21		183	86.2	156	142.8	61	79.6	68	168.2	201	38.9	63	86.4	322	106.8	175	87.1	140	58.1	59	100.7
3	10/24/2005 16:33:22		145	325.7	137	17	182	6.3	190	91.8	192	52	222	53.8	336	89	278	150.5	36	231.8	227	93.3
4	10/24/2005 16:33:23		56	143.7	75	47.2	115	356.5	88	160.1	81	65	280	70.8	131	136.5	156	132.4	45	279	112	313.5
5	10/24/2005 16:33:24		118	68	129	82.4	124	45.3	205	120.4	88	82.8	191	242.6	136	12.3	33	127.6	102	195.9	82	50.9
6	10/24/2005 16:33:25		369	51.3	49	284	233	349.8	99	18.3	67	184.3	279	85.3	346	80.2	152	1.9	131	26.4	30	331.7
7	10/24/2005 16:33:26		136	125.4	74	41.7	142	342.8	158	47.8	244	50.6	338	47.9	118	99.8	54	192.8	82	320.9	97	13.2
8	10/24/2005 16:33:27		26	30.6	208	88.1	47	233.6	142	299.6	195	246.1	173	349.7	49	35	161	124.9	275	27.5	117	297
9	10/24/2005 16:33:28		134	79.7	166	73.5	187	353.6	193	144.9	140	288.3	273	7.4	166	125.2	146	322	267	23.6	248	43
10	10/24/2005 16:33:29		93	175.1	171	36.9	97	56	91	64.6	71	50.7	41	235.9	76	55.7	162	141	83	32.2	360	80.4
11	10/24/2005 16:33:30		276	11.5	218	322.7	73	245.9	126	4.1	176	94.9	211	284.3	64	9.9	420	274.8	168	238.1	251	260.8
12	10/24/2005 16:33:31		388	43.2	315	37.4	353	33.3	429	17	300	70.1	311	61.2	287	76.7	372	25	400	90.3	1017	105.4
13	10/24/2005 16:33:32		207	85.8	126	55.3	418	43.2	372	82.9	206	70.7	370	72.9	175	107	197	141.8	743	92.9	667	157.2
14	10/24/2005 16:33:33		71	7.3	129	54.5	139	125.1	82	169.5	56	269	131	315.9	103	350.5	224	159.4	55	64.4	372	135.9
15	10/24/2005 16:33:34		250	73	283	73	190	123.2	139	47	192	44.4	150	301.4	170	31.5	331	11.7	421	2.7	459	305.9
16	10/24/2005 16:33:35		429	99.4	351	116.6	254	135.8	264	117.7	339	56.2	435	131.8	556	126.8	393	148.9	840	164.8	91	222.8
17	10/24/2005 16:33:36		163	54.5	265	99.4	232	51.6	315	77.7	235	92.4	93	6.8	220	185.2	458	348.9	474	336.9	543	358
18	10/24/2005 16:33:37		84	32.4	72	125.4	236	9.7	257	43.4	604	28.8	576	59	487	5.4	494	349.4	738	12.2	469	347.8
19	10/24/2005 16:33:38		198	52.8	258	124.1	270	132	214	50.1	819	68.7	999	54.5	488	65.2	157	97.3	74	210.7	220	193.2
20	10/24/2005 16:33:39		162	106.5	214	53.9	266	71.6					607	343.1	114	123.6	142	54.7	341	53.1	268	8.4
21	10/24/2005 16:33:40		364	101.7	90	36.9	143	101.3	204	73.8			168	12.7	116	288.1	204	220.4	166	19.3	190	223.7
22	10/24/2005 16:33:41		232	12.4	300	76.3	449	58	235	120.9	341	201.3	174	152	586	204.3	550	217.5	348	215.1	18	279.5
23	10/24/2005 16:33:42		144	88.8	184	56.7	103	61.7	111	14.7	281	143	280	139.8	552	197.2	213	195.5	145	191.5	107	81.9
24	10/24/2005 16:33:43		173	54.2	147	3.1	247	12.4	503	45.4	180	86.8	424	338.1	258	1.8	128	40.3	349	102.9	591	102.1
25	10/24/2005 16:33:44		327	75.5	292	14.5	286	15.6	132	22.7	327	351.4	176	107.2	377	11	153	101.7	160	173.9	397	118.6
26	10/24/2005 16:33:45		254	329.5	188	12.3	249	29.9	190	23.2	53	356.8	172	324	141	342.2	458	121.6	372	127.8	345	86.2
27	10/24/2005 16:33:46		136	21.1	216	27.5	373	0.9	199	356.8	161	38.7	112	262.8	452	270.6	223	128.6	326	185.3	448	136.5
28	10/24/2005 16:33:47		21	244.7	118	60.6	256	28.5	452	56	195	103.7	85	109.9	304	143.2	199	133.4	251	84.7	327	81.5
29	10/24/2005 16:33:48		62	317.6	70	289.2	224	68.8	169	7.8	92	45.9	185	88.1	281	64.5	282	55	269	82.5	519	99.5
30	10/24/2005 16:33:49		99	25	167	148.7	40	46	231	65.2	169	103.7	270	40.6	288	105.7	183	109.8	214	150.6	387	132.1
31	10/24/2005 16:33:50		25	126.9	253	97.3	258	105.8	213	103.6	165	120.6	521	83.5	215	54.5	358	97.1	191	87.6	285	101.5
32	10/24/2005 16:33:51		440	121.8	277	101.2	232	128.4	324	88.9	229	55.3	438	110.9	132	50.5	110	102.6	208	196.8	137	311.5
33	10/24/2005 16:33:52		128	62.6	76	355.5	232	140.1	371	133.8	322	122.7	88	327	210	115.3	206	160.7	278	137.9	256	184.9
34	10/24/2005 16:33:53		135	151.7	354	142	94	96.1	56	204.3	48	170.3	258	101.4	132	68.3	206	144.5	376	160.6	171	181.3
35	10/24/2005 16:33:54		201	98.9	131	49	254	74.7	319	131.8	111	107.8	347	86.4	264	117.5	179	129.6	196	142.9	79	104.7
36	10/24/2005 16:33:55		21	95.4	116	40.4	332	107	280	60.1	332	114.2	331	92.8	133	162.1	164	113	212	122.5	287	341.9
37	10/24/2005 16:33:56		210	123.9	136	92.1	345	117.2	264	62.3	275	68.5	139	80.1	298	132.7	328	122.7	47	240.7	218	339.6
38	10/24/2005 16:33:57		91	120.2	142	116.4	355	105.8	75	324.8	335	354	151	108.2	240	98.6	241	113.7	132	128.5	250	273.9
39	10/24/2005 16:33:58		247	173	114	61.2	416	93.6	416	109.7	166	145.8	295	152.1	119	108.6	91	173.7	202	143.9	55	33.1
40	10/24/2005 16:33:59		225	68.7	238	140.6	122	97.1	217	79.9	349	152	212	168.3	59	162.2	75	76.9	21	135	121	103.3
41	10/24/2005 16:34:00		190	80.6	209	112.8	243	144	272	134.7	277	77.3	258	97.3	220	96.5	220	69.3	356	166.2	167	148.7
42	10/24/2005 16:34:01		127	128	293	55.3	293	51.6	413	116.8	211	105.9	143	91.2	116	82.6	10	78.7	36	78.7	265	103.8
43	10/24/2005 16:34:02		20	78.7	179	132.5	169	104.8	100	135.8	356	86	290	91.2	85	122.9	160	118.8	127	122.4	343	221.8
44	10/24/2005 16:34:03		196	337.5	261	52	88	47.8	73	61.3	174	114.1	51	139.8	34	292.8	236	168.7	293	145.7	309	169.7
45	10/24/2005 16:34:04		33	79.4	126	91.8	128	8.1	216	121.2	87	88.7	72	215.9	23	221.4	120	133.7	145	178	57	259.9
46	10/24/2005 16:34:05		66	226.2	181	162.7	283	89.2	233	76.1	76	122.6	207	183.3	191	133.3	67	120.4	166	149.3	95	297.6
47	10/24/2005 16:34:06		131	100.1	283	32.5	128	72.3	117	108.4	38	302	188	281	146	197.1	165	170.9	293	171.8	187	258.9
48	10/24/2005 16:34:07		91	238.1	371	120.1	336	52	195	47.7	156	45.3	68	225	149	254	252	217.4	151	254.2	306	255.2
49	10/24/2005 16:34:08		146	106.7	148	169.1	121	167.6	160	143.6	153	134.7	350	87.4	12	155.6	51	4.5	176	247.7	133	270.4
50	10/24/2005 16:34:09		335	105	152	300.4	190	305.4	266	4.7	105	101.5	86	291.2	38	160.1	114	2	204	287.7	192	235.4
51	10/24/2005 16:34:10		285	70.7	222	66.1	143	349.6	184	72.9	160	114.8	209	71.9	118	49.5	160	150.4	119	52.2	113	229.3
52	10/24/2005 16:34:11		48	110.7	40	216.9	169	61.8	94	31.5	89	123.5	95	154.5	107	102.4	60	114.8	157	40.9	205	166.4
53	10/24/2005 16:34:12		182	26.8	149	67.1	218	349.7	150	20.2	198	64.2	235	25.5	175	319.6	127	61.2	227	350.4	47	53.6
54	10/24/2005 16:34:13		188	65.9	167	109.2	150	35.8	295	70	279	46.9	176	290.6	189	33.1	210	69.3	106	62	231	178.3
55	10/24/2005 16:34:14		122	92.3	335	64.2	162	53.3	71	305.3	44	61.7	55	171.6	65	124.9	102	105.4	72	5.6	170	156.8
56	10/24/2005 16:34:15		156	61.6	212	102.3	69	155.3	196	55.2	239	60.1	83	136.9	174	102.3	180	87.8	61	169.6	95	203
57	10/24/2005 16:34:16		196	26	377	110.8	301	75.6	198	67.7	62	156.3	15	199.7	133	105.3	49	78.2	92	126.1	110	200.3
58	10/24/2005 16:34:17		101	69.8	196	86.2	194	107.1	59	152.6	135	90.8	113	95.6	254	62.5	264	61.7	223	108	78	75.1
59	10/24/2005 16:34:18		285	121.2	272	38.4	60	145.2	93	199.4	218	105.4	265	35	384	63.6	150	87.3	156	95.2	211	95.2
60	10/24/2005 16:34:19		208	60.6	131	357.8	72	300.1	121	43.3	391	10.4	256	104.7	101	59.6	79	303.7	108	42.4	171	48.6

Lower Fox River Moving Vessel Trials
Test Four

Run 3																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/24/2005 16:35:12		47	94.9	146	127.2	126	55.3	144	67.9	185	83.5	415	93	122	97.5	294	50.5	126	19.4	292	47.9
1	10/24/2005 16:35:13		115	24.6	194	86.8	63	153.4	149	130.1	172	187.7	44	162.8	284	131	126	55.3	196	2.6	152	41
2	10/24/2005 16:35:14		183	37.7	99	49.5	48	350.3	36	88.4	166	101.1	59	40.2	151	100.3	175	43.6	157	122.8	213	62.6
3	10/24/2005 16:35:15		14	155.2	14	39.3	152	113.7	41	164.6	109	0.5	246	27.4	194	21.4	81	62.2	162	63.3	169	82.2
4	10/24/2005 16:35:16		261	68.6	323	34.1	149	56.7	271	66.9	143	258.3	237	58.5	309	2.4	255	27.1	329	48.1	24	325
5	10/24/2005 16:35:17		344	101.6	262	72.2	211	44.6	215	64	173	132.4	221	93.9	176	80.2	269	38.1	124	66.1	182	38.3
6	10/24/2005 16:35:18		171	71.6	71	315.6	379	62	261	75.4	355	69.2	216	70.6	303	31.2	211	43.8	209	67.2	325	50.4
7	10/24/2005 16:35:19		147	123.9	371	94.9	172	79.9	45	84.9	175	43.2	73	6.3	107	45.4	246	74.9	318	72.1	345	100.9
8	10/24/2005 16:35:20		205	99.3	164	333.6	108	3.2	141	24.4	83	338.1	163	355.1	147	96.6	93	355.7	112	339.1	157	27.7
9	10/24/2005 16:35:21		253	103	241	61.2	296	41.2	213	70.5	247	120.7	142	313.6	85	5.4	260	69.5	207	44	190	67.1
10	10/24/2005 16:35:22		108	325.1	154	41.6	125	150.4	138	49.1	204	26.8	321	338.2	157	356.4	157	90.7	164	72.6	143	95.6
11	10/24/2005 16:35:24		309	58.4	162	17.2	322	27.2	335	7.9	72	353.7	197	354.2	147	5.9	275	345.7	357	328.3	264	320.5
12	10/24/2005 16:35:25		366	45	496	37.6	310	58.5	322	44.9	413	34.2	500	63	545	56	432	57.2	465	61.2	428	36.5
13	10/24/2005 16:35:26		388	94.1	267	93.9	163	169.7	329	72.1	348	80.1	270	92.3	268	85.1	453	92.7	488	89.4	541	117.2
14	10/24/2005 16:35:27		152	119.6	243	96.1	102	153.7	69	57.5	110	134.3	189	112.8	109	79.9	121	192.9	149	96.2	56	83.9
15	10/24/2005 16:35:28		39	297.2	104	309.2	199	66.7	50	32.7	104	98.8	131	66.6	88	79.6	140	168	155	332.8	192	331.7
16	10/24/2005 16:35:29		91	52.1	73	50	226	101	191	115.5	81	104.2	307	114.1	137	96.3	135	8.1	127	20.3	121	357.2
17	10/24/2005 16:35:30		221	35.4	156	25.4	88	165.5	168	54.4	60	203.6	150	55.9	95	223.3	120	110.6	106	68.5	245	46.5
18	10/24/2005 16:35:31		70	109.2	218	58.9	242	56.6	242	1.4	45	262.4	72	51.2	156	67	51	262.2	8	270	200	343.5
19	10/24/2005 16:35:32		154	305.2	275	69.8	105	37.6	206	48.7	261	359.3	172	68.2	313	77.3	196	14.5	247	37.6	251	18.4
20	10/24/2005 16:35:33		128	89.1	140	343	156	352.6	98	13.6	277	34.3	222	95.4	199	3.7	243	345	280	356.5	270	34.7
21	10/24/2005 16:35:34		152	17.2	109	41.3	64	104.5	340	349.3	153	335.6	234	302.9	56	141.5	215	32.7	101	65.5	167	97.2
22	10/24/2005 16:35:35		27	351.6	106	185.4	129	25.8	201	32.8	136	174.1	430	122.7	99	115	145	308.8	40	138	183	227.7
23	10/24/2005 16:35:36		242	27.3	24	80.5	102	356.6	117	20.4	67	98.6	194	52.5	343	55.3	242	112.1	324	114.4	228	271.3
24	10/24/2005 16:35:37		163	61.1	112	39.5	66	331.1	11	169.7	125	41.4	229	356.3	6	0	128	177.3	243	15.5	369	74
25	10/24/2005 16:35:38		159	112.2	147	318	245	355.5	188	92.7	88	140.5	70	247.4	224	313.2	410	1.1	173	28.6	348	25.3
26	10/24/2005 16:35:39		143	90.4	130	102.9	168	116.1	334	0.5	82	336.3	258	55.9	112	103.4	158	53	401	351.5	311	332.4
27	10/24/2005 16:35:40		241	9.3	370	70.2	205	63.3	118	28.3	236	154.1	261	110.4	317	49.5	177	61	174	87.7	97	282.5
28	10/24/2005 16:35:41		277	45.3	129	120.7	95	135.9	513	63	350	102.7	289	65.2	155	312.6	142	27.6	293	55.7	224	288.5
29	10/24/2005 16:35:42		86	93.3	309	33	158	93.6	132	121	322	66.8	212	84.3	158	7.3	239	52	130	8.9	29	90
30	10/24/2005 16:35:43		311	67.1	341	83.3	507	61.2	129	39.4	265	9.1	278	6	224	53.3	191	42	78	349.7	281	339.6
31	10/24/2005 16:35:44		71	91.6	202	112.8	215	86.8	46	3.7	134	90.9	270	87.7	190	45	73	90	92	261.9	73	228.9
32	10/24/2005 16:35:45		248	45.8	269	11.4	253	105.9	329	103.2	156	94.4	211	348.3	149	325.1	35	270	178	287	179	80
33	10/24/2005 16:35:46		141	34	296	35.8	206	65.1	232	131.2	29	52	185	283.1	153	271.9	227	237.6	137	235.4	107	96.5
34	10/24/2005 16:35:47		153	340.5	238	132.8	132	127.9	185	295.3	55	310.6	220	40.2	484	118	204	63.8	262	220.8	239	234.2
35	10/24/2005 16:35:48		177	1.3	83	136.9	15	66.8	118	87.6	103	57.7	192	281.4	254	38.4	62	126.5	137	95.9	47	309.8
36	10/24/2005 16:35:49		328	96.3	243	78.8	259	70.9	97	195.6	53	79.1	118	53.6	332	92.1	118	158	174	114.1	293	59.9
37	10/24/2005 16:35:50		195	13.6	193	52.6	198	124.9	330	64.7	232	84.8	229	82.2	53	325.7	48	54.3	58	197.2	286	247.6
38	10/24/2005 16:35:51		169	83.2	75	152.1	112	125.5	137	138.5	64	67	66	39.5	231	82.8	100	157.8	93	180.6	115	88
39	10/24/2005 16:35:52		119	34.4	193	92.7	225	78.4	81	125.5	171	231.2	168	86.3	132	31.4	154	231.1	233	33.6	29	65.2
40	10/24/2005 16:35:53		153	48.2	126	52.4	188	53.9	313	104.6	155	139.7	128	192.2	113	248.2	134	176.2	184	167.5	185	348.8
41	10/24/2005 16:35:54		175	341.7	321	103.5	90	8.9	154	56.1	36	342.1	92	358.8	38	184.5	163	220	129	88.2	83	163.1
42	10/24/2005 16:35:55		191	353.7	352	49.6	177	45.7	73	273.9	70	265.1	171	261.6	249	292.1	108	265.2	58	239.9	123	113
43	10/24/2005 16:35:56		81	65	229	17	317	45	174	35.2	205	166.8	19	145.5	159	22.2	175	45.2	258	356.2	52	120
44	10/24/2005 16:35:57		174	17.4	89	354.9	27	126	116	76.6	71	213.5	141	35.5	125	314	167	85.2	115	53.8	80	274.3
45	10/24/2005 16:35:58		153	120.6	312	33	239	72.5	291	79.9	318	82.8	73	41.1	101	117.1	208	61.6	100	42.6	124	44.7
46	10/24/2005 16:35:59		112	3.6	188	39.4	185	346.3	76	5.3	263	79.9	225	98.2	275	51.3	92	147	125	16.3	107	357.3
47	10/24/2005 16:36:00		121	299.7	173	88	305	99.6	143	90.4	193	7.8	43	91.3	247	110.3	161	69.7	196	28.3	295	336
48	10/24/2005 16:36:01		208	86.7	312	94.4	110	106.3	252	18.3	297	18.1	60	235.8	85	193.5	162	100.3	125	145.8	208	31.2
49	10/24/2005 16:36:02		69	63.4	144	351.6	206	66.2	117	120.7	209	71	133	327.6	159	92.2	140	61.8	46	169.9	107	224.2
50	10/24/2005 16:36:03		178	356.5	194	40.8	112	66.4	324	16.7	251	40.8	50	5.7	60	129	131	115.8	134	47.1	149	151
51	10/24/2005 16:36:04		181	22	300	36.9	272	8.5	383	54	436	59.1	193	70.3	277	97.5	121	159.8	67	122.7	110	276.8
52	10/24/2005 16:36:05		311	31.6	298	2.1	137	46.5	218	70.4	118	101.7	158	45.8	165	29.8	215	1.9	129	97.1	86	246.7
53	10/24/2005 16:36:06		63	238.6	174	143.2	35	255.2	68	164.7	65	100.6	266	90.2	235	79.9	107	91.1	0	0	59	41.6
54	10/24/2005 16:36:07		119	307.2	111	202.2	58	3	57	210.6	29	77.9	69	337.9	111	273.1	185	356.6	27	303.1	136	295.8
55	10/24/2005 16:36:08		133	249.8	196	282.1	117	0	194	272.4	166	56.8	231	57	148	333.6	170	338.6	166	38.4	132	10.9
56	10/24/2005 16:36:09		206	93.6	98	178.2	94	153.4	255	134.2	149	45.3	256	60.7	52	296.1	208	123.2	133	79.6	187	76
57	10/24/2005 16:36:10		243	84.6	296	93.3	229	55.3	225	18.4	219	92.1	234	60.6	120	48.4	239	22.6	127	2.3	189	315.6
58	10/24/2005 16:36:11		277	37.8	249	39.8	274	84.1	143	54.4	225	58.4	324	43.5	295	358.3	303	14.1	420	42.7	163	87.5
59	10/24/2005 16:36:12		259	88.2	30	203.2	92	185.6	151	193.4	68	169.8	109	155.1	119	28.5	238	52.8	228	25.8	311	30.8
60	10/24/2005 16:36:13		157	64.4	166	11.9	203	56.5	124	349.3	282	49	116	350	95	43.3	177	355.5	275	35.4	173	87

Lower Fox River Moving Vessel Trials
Test Four

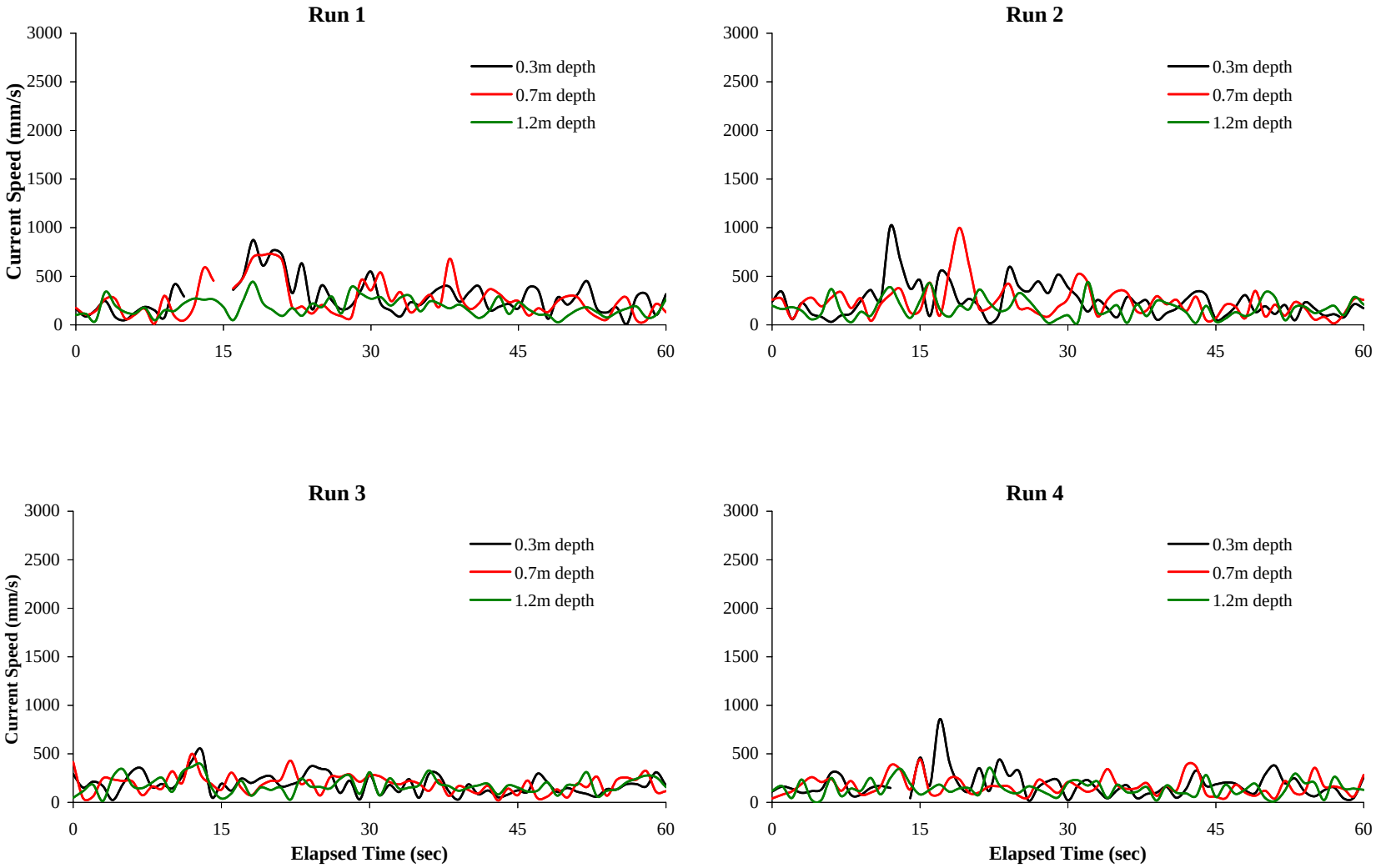
Run 4

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3		
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3		
0	10/24/2005 16:41:34	119	240.2	109	94.2	200	46.4	160	101.5	154	137.4	40	208.5	33	328.7	112	193.4	53	18.8	112	4.1		
1	10/24/2005 16:41:35	168	51.3	226	39.3	153	31.6	21	148.6	199	121.2	79	302.1	219	330.7	201	81.7	177	120.9	162	271.4		
2	10/24/2005 16:41:36	44	69.9	81	124.5	144	155.4	151	68.7	186	333.2	113	65.5	264	40.1	103	42.2	127	82.3	140	34.3		
3	10/24/2005 16:41:37	235	36.5	87	122.8	89	45.9	116	92.5	219	35.4	191	120.2	154	88.9	169	76.6	187	120.5	98	56.6		
4	10/24/2005 16:41:38	26	324.5	109	88.4	143	51.5	218	61	85	295.7	260	28.4	113	310.7	162	109.4	50	169.6	116	92.5		
5	10/24/2005 16:41:39	26	357.8	143	37.6	209	94.9	291	51.8	187	99.6	209	25.8	57	34.2	80	237.7	202	91.7	134	64.4		
6	10/24/2005 16:41:40	251	341.4	170	23.2	148	141	136	70.6	361	48.4	242	77.6	277	65.2	213	23	265	55.8	304	47.1		
7	10/24/2005 16:41:41	65	25.4	185	51.1	107	324.5	269	121.8	78	29.2	120	72.5	179	80	103	117.8	124	11.7	281	10.9		
8	10/24/2005 16:41:42	142	50.1	231	91.5	258	64.5	162	83.6	213	39.1	220	3.4	146	320.3	169	63	57	90	77	242.1		
9	10/24/2005 16:41:43	119	74.9	81	333.7	126	30.4	156	36.1	124	30.1	83	310.6	177	282.1	209	306.7	239	345.7	79	348.3		
10	10/24/2005 16:41:44	252	59.5	126	92.7	144	67.5	44	322.4	237	22	100	1.7	76	61.8	122	305.6	154	322.4	148	125.6		
11	10/24/2005 16:41:45	83	130.6	175	290.1	288	318.1	258	51.8	58	313.6	167	3.8	119	252.3	292	309.6	66	302	169	103		
12	10/24/2005 16:41:46	252	26.4	156	23	295	28.7	326	11	293	48	381	26.6	257	338.8	351	13.3	347	20.8	148	5.4		
13	10/24/2005 16:41:47	347	62	392	56	327	24.6	259	93.8	353	79.7	335	102.6	368	87.8	296	88.1	297	119				
14	10/24/2005 16:41:48	193	98	122	243.2	70	170.1	236	102.2	67	80.5	132	19.5	147	239.4	251	185.9	233	142.7	43	257.9		
15	10/24/2005 16:41:49	81	95.6	107	126.2	232	73.7	272	36.3	276	24	444	54.2	267	66.8	187	74.5	443	4.9	460	349.7		
16	10/24/2005 16:41:50	130	193.3	25	291.4	326	131.8	152	121	156	120	98	77.1	248	67.7	402	121.8	149	88.5	173	192		
17	10/24/2005 16:41:51	183	193.3	62	356.3	154	104.3	237	58.5	127	65.3	87	47.3	70	70	317	112.3	344	145.3	856	162.7		
18	10/24/2005 16:41:52	109	22.1	39	101.9	39	256.7	86	259.2	124	137.3	247	66.3	326	79.2	215	48.2	288	197.6	409	171.7		
19	10/24/2005 16:41:53	144	80.4	10	180	55	319.4	258	85.6	169	121	238	71.9	41	173	183	193	42	186.8	173	156.8		
20	10/24/2005 16:41:54	146	6.3	129	46.9	100	176	330	171.5	10	168.7	96	137.1	74	349.1	65	133.8	207	154.8	116	101.4		
21	10/24/2005 16:41:55	80	210.7	143	266.4	35	47.3	86	336.1	83	5.5	103	169.9	100	96.3	96	127.3	154	185.2	354	194.2		
22	10/24/2005 16:41:57	356	213.4	251	185	21	334.7	146	123.8	188	304.4	163	149.8	123	85.8	76	93.8	77	41.3	116	271.5		
23	10/24/2005 16:41:58	186	102.4	40	278.5	116	86.5	43	343.7	28	16.5	165	224	138	112.7	151	103.8	169	153	440	156.9		
24	10/24/2005 16:41:59	109	205.6	150	231.8	74	226.6	193	84.3	246	120.5	163	98.5	94	152.9	197	190.5	343	140.9	273	150.3		
25	10/24/2005 16:42:00	97	152.9	90	172.3	68	73.7	46	2.5	87	5.9	69	98.4	100	157.8	182	179.7	163	180.7	326	206.8		
26	10/24/2005 16:42:01	165	104	161	37.4	224	35.4	201	49.2	150	77.7	52	308	123	177.7	212	59.5	108	22.3	19	288.4		
27	10/24/2005 16:42:02	132	96.5	244	125.8	110	73.1	158	107.6	188	66.2	233	92.5	94	67.5	85	145	53	191.9	156	109.8		
28	10/24/2005 16:42:03	84	339.8	232	61.1	48	144.3	123	73	59	125.3	166	162.4	209	46.7	67	126.5	287	105.2	218	128.3		
29	10/24/2005 16:42:04	51	251.6	84	97.5	102	137.4	168	168.7	264	111.1	97	119.7	407	199.7	215	107.3	90	230	227	9.1		
30	10/24/2005 16:42:05	204	319.6	64	350.1	100	25.5	37	229.4	86	329.8	210	270.8	58	149.9	246	155.5	125	25.5	20	191.3		
31	10/24/2005 16:42:06	228	191.1	138	342.2	74	111.4	211	115	158	30	164	13.8	131	358.7	173	356.7	153	18.3	172	11		
32	10/24/2005 16:42:07	173	279.3	229	27.6	251	29.8	129	356.5	41	348.7	108	52.2	326	38.8	295	357.5	123	353	229	281.1		
33	10/24/2005 16:42:08	216	139.5	63	79.9	112	91	122	67.8	178	90.3	166	296.1	118	158.6	196	265	83	272.1	131	239.7		
34	10/24/2005 16:42:09	45	266.2	175	61.2	311	144.8	77	129.7	219	96	344	74.1	143	82.4	93	59.6	204	42.2	41	194		
35	10/24/2005 16:42:10	181	262	189	51.2	290	58.7	197	261.5	123	155.5	176	113.1	122	175.8	97	349.3	46	232.1	126	278.2		
36	10/24/2005 16:42:11	105	265.6	73	92.4	277	35	105	288.3	125	34.2	139	61.2	176	4.2	155	129.2	345	100.4	176	132.9		
37	10/24/2005 16:42:12	108	93.2	94	343.3	106	56.9	103	228.6	48	204.4	147	42.8	323	61.8	183	174.4	132	153	43	170.5		
38	10/24/2005 16:42:13	158	63.8	73	94.7	83	0	175	10.9	63	40.5	200	146.6	204	84.1	218	53	95	146.1	86	320.2		
39	10/24/2005 16:42:14	18	19.4	126	6.4	203	355.5	90	198	77	203.9	67	221.3	177	108.4	119	75.4	138	20.8	100	288.1		
40	10/24/2005 16:42:15	174	86.1	20	78.7	215	51.4	112	356.9	71	349.5	169	161	294	80	150	17.8	124	44.3	159	335		
41	10/24/2005 16:42:16	100	169.6	37	198.9	31	222.4	115	231.3	81	24	123	104.1	276	81.3	42	206.6	246	50.1	47	197.3		
42	10/24/2005 16:42:17	92	150.1	1	0	168	48.1	175	110.1	156	98.5	384	15.3	70	64.5	115	30.4	283	313.3	142	6.5		
43	10/24/2005 16:42:18	65	150.7	272	69.1	182	80.8	47	20	97	357	369	79.1	113	77.7	241	141.7	146	34.1	329	351.8		
44	10/24/2005 16:42:19	282	101.5	141	83.9	132	19	213	73.1	169	80.1	85	134	174	36.6	93	88.2	314	104.7	171	42.6		
45	10/24/2005 16:42:20	55	349.5	158	77.6	139	26.9	160	67.1	164	2.1	59	255.3	66	336.9	367	355	52	27.6	185	230.7		
46	10/24/2005 16:42:21	183	348.6	174	73.3	326	100.2	270	75.9	391	85.7	42	169	57	101.1	252	344.1	159	64.7	205	263		
47	10/24/2005 16:42:22	86	275.3	89	15	118	311.9	120	86.7	166	169.6	182	183.1	177	177.7	293	350.8	136	298.6	193	22.6		
48	10/24/2005 16:42:23	133	243.2	26	186.6	29	170.2	343	87	103	68.9	99	142	191	84.9	160	308.7	135	305.3	123	11.2		
49	10/24/2005 16:42:24	193	26.4	186	57.9	162	74.9	125	68.4	138	327.7	69	133.2	160	71.5	166	174.5	214	336.1	96	279.6		
50	10/24/2005 16:42:25	45	198	244	5.6	106	56.9	94	25.8	201	13.6	120	250.5	231	80	259	58.4	272	320.5	288	333.4		
51	10/24/2005 16:42:26	13	208.6	122	144	96	103.3	128	49.4	204	276.7	39	78.1	245	69.7	164	48.9	55	183.1	380	10.8		
52	10/24/2005 16:42:27	121	106.3	110	354.8	197	119.6	61	225	145	154.3	220	128.5	288	132.6	51	130.2	82	313	196	140.8		
53	10/24/2005 16:42:28	296	234.9	196	78.5	222	103	72	46.1	170	10.5	95	122.5	145	207.1	169	95.8	128	145.2	247	2.3		
54	10/24/2005 16:42:29	200	234.2	40	20.2	61	33.7	69	22.9	41	101.3	109	181.1	340	159.5	69	149.3	250	311.9	112	159.1		
55	10/24/2005 16:42:30	204	83.8	201	194.7	68	17.9	149	113.8	89	192.3	356	152.4	304	145.7	213	92.4	178	331.4	62	325.5		
56	10/24/2005 16:42:31	24	150.3	131	47.8	179	177.4	294	117.8	39	106.6	163	134	223	259.9	113	131.4	23	145.6	125	68.4		
57	10/24/2005 16:42:32	262	287.1	84	113.2	167	6.9	112	159.6	134	113.7	165	40.3	299	92.5	46	286.5	52	230.5	154	259.9		
58	10/24/2005 16:42:33	141	330.7	105	275.4	54	102.8	44	325.2	114	106.8	135	104.1	143	109.2	199	278.4	122	169.1	38	234.6		
59	10/24/2005 16:42:34	142	132.1	119	186.8	295	173.6	188	193.2	78	77.4	60	51.8	219	218	130	193.4	63	283.8	48	195.8		
60	10/24/2005 16:42:35	129	221.9	296	232.5	33	54.9	93	314.6	103	193.5	283	172.7	70	2.5	133	174.8	255	339.8	258	341		

Fox River Propwash Study - Moving Vessel Trials

Test #4: Single-Prop Vessel - 1300 RPM - Neutral Pitch

October 24, 2005



Lower Fox River Moving Vessel Trials
Test Five

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:22:40		160	128.7	69	45	97	25.8	45	81	143	96	257	82.2	132	64	194	92.7			116	337.6
1	10/25/2005 09:22:41		99	38	129	86.5	84	73.5	138	107.3	156	95.5	122	351.1	62	74.2	43	324.5	118	76.3	138	100.4
2	10/25/2005 09:22:42		150	127.7	69	125.5	72	65.6	110	51.3	121	34.6	119	68.4	127	57.6	53	134.2	167	229.4	91	176.2
3	10/25/2005 09:22:43		82	83	50	341.2	38	164.9	17	32.7	55	274.2	47	353.9	113	58	200	11.5	185	206	21	169.2
4	10/25/2005 09:22:44		78	80.4	138	239.5	119	358.1	96	98.4	134	64.8	89	54.2	39	280.4	119	80.8			94	75.2
5	10/25/2005 09:22:45		108	85.2	90	118.6	42	111	53	97.5	115	102.6	141	175.9	126	229.5	45	2.5			131	129.7
6	10/25/2005 09:22:46		202	51.8	167	105.6	169	77	118	89	100	49.5	26	305.5	83	17.6	189	44.8			41	211
7	10/25/2005 09:22:47		83	46.5	91	341.4	42	256.3	186	114.5	136	272.1	68	295.4	80	120.7	172	79.9			72	71.3
8	10/25/2005 09:22:48		65	71	124	312.1	76	352.4	113	329.6	76	348.5	87	215.2	143	52.4	108	257.1	51	37.8	49	263
9	10/25/2005 09:22:49		152	130.2	129	156.8	117	213.8	110	46.1	38	26.6	60	346.4	63	236.1	102	21.3	149	133.4	52	129.5
10	10/25/2005 09:22:50		143	56.4	14	77.9	134	184.7	93	177.5	286	268.8	25	101.3	66	294.2	8	284	142	205.5	43	140.7
11	10/25/2005 09:22:51		18	273.2	187	226.5	159	178.6	140	194.4	209	224.4	156	229.2	342	237.1	296	226	219	270.5	60	225.7
12	10/25/2005 09:22:52		235	61.8	242	92.8	164	100.9	153	52.5	121	70.2	216	54.6					2358	237.9		
13	10/25/2005 09:22:53		254	72.1	305	82.3	419	46.1	358	52.5	384	68.9			2010	245.9	2384	250.6				
14	10/25/2005 09:22:54		63	338.7	120	320.1	314	342.2	425	318.2	398	285.4	695	292.7			1093	216.5	1319	209.7	1961	246.8
15	10/25/2005 09:22:55		250	6.9	223	305	139	335.8	308	303.2			500	263.5	149	133.4	600	192.2	501	223.7	1141	328.7
16	10/25/2005 09:22:56		272	303.2			692	318.3	511	318.2	643	14.6	666	346.6	469	7.7			1006	153.9	240	198
17	10/25/2005 09:22:57		249	311.6	95	276.1	48	300.3	228	43.9	380	7	704	359.7	370	354.7	194	334.4	464	182.3	339	263.6
18	10/25/2005 09:22:58		84	9.6	330	290	285	28.1	237	11.2	391	28.3	316	8.6	440	35.4	415	347.9	329	297.3	829	261.6
19	10/25/2005 09:22:59				204	324	361	19.2	438	3.7	511	349.6	596	38.4	415	12.4	411	356.5	479	340.7	677	323.5
20	10/25/2005 09:23:00				350	13.6	127	350.5	279	127.3	914	45	554	3.8	653	51.9	407	37	405	355.8	467	342
21	10/25/2005 09:23:01				70	357.5	119	305.4	129	233.8	298	30	411	20.1	481	46.3	476	26	357	39.7	630	20
22	10/25/2005 09:23:02		163	30.2	300	348.7	191	358.2	103	351.6	425	5.3	444	38.8	366	35.6	230	69.4	488	98	509	38.7
23	10/25/2005 09:23:03		362	51.7	181	354.3	506	7.2	491	10.9	415	337.5	373	2.3	292	306.8	88	44.1	136	61	591	41.6
24	10/25/2005 09:23:04		192	79.5	111	343.2	240	321.6	393	328.9	342	350.9	285	302.7	341	330.9	306	342.5	92	320.3	405	45.5
25	10/25/2005 09:23:05		133	203.1	319	12.5	590	359.8	252	24.1	198	3.5	212	0.8	277	1.9	156	26.2	478	144.2	94	39.8
26	10/25/2005 09:23:06		96	336.1	176	53.1	182	48.8	148	96.6	290	49.3	325	17.4	152	1.1	115	45.4	170	40.5	90	170.4
27	10/25/2005 09:23:07		182	56.4	107	17.4	198	37.4	271	83.8	478	86.3	387	71.3	416	61.6	402	68.4	325	106.6	32	146.3
28	10/25/2005 09:23:08		433	76.1	306	35.1	55	54.6	202	112.4	307	129.9	290	105.4	312	103.1	388	96.1	448	113.7	268	84
29	10/25/2005 09:23:09		199	69.7	189	75.3	301	128.7	251	89.1	213	104.1	369	107.7	322	95	283	115.1	267	84.8	96	138.8
30	10/25/2005 09:23:10		37	117.3	175	64.6	103	84.5	57	113.9	190	121.8	226	89.7	408	87.9	313	75.2	292	51.1	240	45.8
31	10/25/2005 09:23:11		380	67.4	178	128.2	101	93.4	127	51.1	70	2.5	211	77.9	178	121.9	1	45	470	350.9	99	40.9
32	10/25/2005 09:23:12		273	76.9	244	80.8	267	75.2	184	101.9	162	86.5	181	133.7	286	114.1	313	77.3	369	61.4	232	48
33	10/25/2005 09:23:13		115	47.1	104	102.8	193	92.7	218	98.7	185	78.8	308	85	234	94.4	192	67.3	291	54.1	330	47.5
34	10/25/2005 09:23:14		72	159.5	181	109.3	237	99	280	116.1	189	68.9	143	66.5	289	84.3	351	103.2	250	62.3	181	47.7
35	10/25/2005 09:23:15		174	58.9	144	30.5	194	72.3	244	116.3	212	112.2	343	97.2	318	99.8	221	92.1	307	112.4	115	91.5
36	10/25/2005 09:23:16		140	51.7	147	75	83	36.2	148	142.7	242	95	117	126	92	118	106	97.6	22	123.7	32	158.2
37	10/25/2005 09:23:17		138	29.5	142	13.8	162	51.8	114	102.7	130	130.9	214	242.7	186	109.5	173	43.4	247	40.9	136	140.1
38	10/25/2005 09:23:18		258	48	197	9	146	23.4	28	249	449	146.2	69	58.6	70	97.4	86	70.3	389	121.8	319	90.4
39	10/25/2005 09:23:19		179	15.9	292	341.6	111	359.5	8	240.3	88	109.9	124	95.6	154	56.9	281	75.6	164	46	155	128.7
40	10/25/2005 09:23:20		204	3.1	200	335.7	128	31.6	118	116.8	156	4.4	79	48.1	120	90.5	198	47	206	32.9	237	72.6
41	10/25/2005 09:23:21		236	42.4	78	110.3	182	2.5	217	13.8	156	32.2	76	40.2	131	30.9	108	359.5	327	1.4	279	72.3
42	10/25/2005 09:23:22		140	20.5	215	37.5	164	18.1	129	67.6	179	63.1	77	91.5	90	36	144	54.9	188	44.6	165	54.1
43	10/25/2005 09:23:23		110	31.2	148	37.3	108	46.5	128	64	21	50.9	151	30.6	95	84.6	27	145.7	75	122.4	181	232.6
44	10/25/2005 09:23:24		126	333	202	50.2	218	34.9	169	83.9	179	54.1	60	53.1	126	19	179	28.4	242	52	256	39.6
45	10/25/2005 09:23:25		65	282.5	182	337.1	110	43.2	86	277.4	119	29.8	169	13.7	95	37.7	64	57.8	211	162.3	74	93.9
46	10/25/2005 09:23:26		362	0.5	308	332.9	243	5.9	120	12.5	135	340.1	56	58.9	187	58.8	97	34	127	46.9	274	71.3
47	10/25/2005 09:23:27		238	64.6	197	46	250	21.3	265	354.2	191	5.1	294	346.8	41	324	112	115.9	237	82	210	69.4
48	10/25/2005 09:23:28		308	22.7	218	325.7	261	356.9	318	334.3	107	348.2	193	54.9	118	108.3	40	198.9	151	307.2	186	308.5
49	10/25/2005 09:23:29		58	223.6	210	342.3	180	330.7	91	321.2	68	348.2	207	63.9	32	191	79	149.5	196	104.8	128	81.5
50	10/25/2005 09:23:30		58	93	111	69.4	308	344.2	179	8.4	23	164.7	50	319	165	50.9	170	36.4	173	58	224	74.7
51	10/25/2005 09:23:31		171	21.9	234	35.8	163	337.7	173	21.7	106	73.6	58	235.5	117	47.1	241	66	176	81.5	105	4.9
52	10/25/2005 09:23:32		49	334.5	55	33.1	188	292.5	346	312.1	93	0	62	43.7	145	58	112	330.7	86	79.2	129	96.2
53	10/25/2005 09:23:33		168	66.2	161	51.6	202	44	185	345.3	146	48.9	219	26	187	13.3	193	39.5	172	55.7	126	1.8
54	10/25/2005 09:23:34		45	65.1	113	41	157	24.1	150	353.9	183	351.8	208	350.6	223	28.4	134	350.5	253	335.8	213	55.7
55	10/25/2005 09:23:35		109	169.4	41	291.5	187	317.6	157	339.5	195	349	192	47.1	167	21	72	27.3	120	349.9	75	276.1
56	10/25/2005 09:23:36		282	70.3	105	119	162	25.9	144	356.4	66	48.1	78	50.2	134	73.5	112	25.4	68	9.3	84	30.8
57	10/25/2005 09:23:37		72	27.3	59	120.5	45	44.1	89	33.5	64	356.4	239	54.7	118	44.7	136	345.6	183	77	128	38
58	10/25/2005 09:23:38		199	52.6	154	42.6	165	18.3	25	94.6	30	327.4	217	40.1	182	2.5	58	26.6	185	129.5	196	54.1
59	10/25/2005 09:23:39		74	182.3	114	338.4	85	14.4	167	6.2	91	353.7	118	37.5	300	62.6	328	84.8	82	85.1	130	13.8
60	10/25/2005 09:23:40		62	263.6	201	129.1	100	106.8	140	83.8	174	159.2	52	14.6	105	46.2	200	48.4	101	53	144	53.8

Lower Fox River Moving Vessel Trials
Test Five

Run 2

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
0	10/25/2005 09:25:44	114	43.9	21	253.3	76	4.5	118	343.7	147	29.7	192	26.6	105	88.4	84	303.3	148	32.3	48	175.2
1	10/25/2005 09:25:45	32	169	51	333.4	40	119.7	55	4.2	147	52.7	89	26.6	71	73.6	123	355.4			129	70.6
2	10/25/2005 09:25:46	185	19.9	183	77	252	52.6	140	26.7	194	81.7	201	49.6	66	28.9	139	16.3			75	202.8
3	10/25/2005 09:25:47	51	49.8	46	206	160	7.2	216	36.7	163	71.8	254	3.8	163	29.4	88	128			100	200.4
4	10/25/2005 09:25:48	177	14	80	17.5	127	57.6	178	83.9	104	139.7	169	5.1	185	94	78	72	109	195.9	92	91.9
5	10/25/2005 09:25:49	120	47.7	102	88.3	87	64.9	112	44.6	123	73.5	170	65.4	28	71.6	69	45			128	76.9
6	10/25/2005 09:25:50	210	114.1	176	32	112	46.8	132	341	70	295.5	43	282.1	145	97.9	340	46.7			157	87.4
7	10/25/2005 09:25:51	206	25.9	111	321.6	85	308.8	116	65	100	28.6	161	30.5	89	71.8	154	117.4			136	48
8	10/25/2005 09:25:52	147	35.3	302	50.1	193	46.5	207	14.2	137	30.7	128	40.6	83	82.4	217	64			57	144.3
9	10/25/2005 09:25:53	39	87.1	171	41.2	87	309.9	31	132.4	95	65.9	13	296.6	237	69.3	227	32.2			222	74.3
10	10/25/2005 09:25:54	46	16.5	115	20.3	127	327.6	110	333.4	128	15.5	49	64.5	108	8	131	67.5			109	103.8
11	10/25/2005 09:25:55	107	29	203	16.3	244	322	142	329.5	188	306.1	153	274.9	127	300.8	293	281.6	196	288.4	260	46.2
12	10/25/2005 09:25:56	383	43.7	390	42.2	462	51.6	441	52.7	407	40.8	514	42.9	2507	260.7						
13	10/25/2005 09:25:57	326	70.1	368	50.3	474	51.8	349	80.4	594	25.2										
14	10/25/2005 09:25:58	110	136.8	255	162.9	21	194	326	180.7	262	210	410	221	1078	272.3	1009	243.8	638	281		
15	10/25/2005 09:25:59	826	58.8	431	30	299	97.3	175	182.9	523	249.3	634	251.2	473	231.4						
16	10/25/2005 09:26:00	422	60.6	637	122.2	476	176.1	525	176.6	1704	255	1566	172.1	535	223.6	512	244.7	613	325.8		
17	10/25/2005 09:26:01	400	120.3	878	92.8	990	91.2	1046	111.1	477	119	194	183.8	173	244.6	405	255.7	318	311.8	267	11.4
18	10/25/2005 09:26:02	724	146.7	346	135.1	463	122.6	667	183.4	257	232.4	133	217.4	252	183	197	170.1	230	246.1	244	344.5
19	10/25/2005 09:26:03	460	149.1	553	162.1	196	156.2	268	117.3	416	112.6	488	72.8	481	96.2	117	51.6	875	165	74	66.9
20	10/25/2005 09:26:04	471	66.8	469	51.1	494	81.5	443	91.2	503	105.3	341	101.5	397	87.4	500	89.8	761	147.1	412	45.4
21	10/25/2005 09:26:05	269	69.7	413	59.9	423	61.3	252	42.4	233	148.5	235	79.7	211	9.8	185	71.8			330	41.6
22	10/25/2005 09:26:06	134	347.9	114	323.9	71	92.4	57	130.1	270	0.6	248	30.3	225	61.3	341	21.5	389	21.6	543	25
23	10/25/2005 09:26:07	181	39.2	336	43.2	304	33.6	258	40.1	167	35	115	21	273	35.1	111	22.2	336	112.1	504	43.4
24	10/25/2005 09:26:08	263	341.4	295	63.4	263	62.2	343	88.5	358	103.9	355	89.7	328	89.1	277	41.6	225	23	330	356.2
25	10/25/2005 09:26:10	355	26.4	442	47.8	324	61.6	125	82.6	235	57	322	97.7	434	79.5	407	60.5	403	108.2	479	48.9
26	10/25/2005 09:26:11	130	85.2	380	75.2	609	88.1	420	78.6	397	82.6	459	55.9	385	47.3	397	65.4	264	78.6	408	52.4
27	10/25/2005 09:26:12	141	89.2	238	80.1	433	76.3	514	68.7	628	90.7	474	81.6	473	79.6	543	81.1	355	38.4	229	18.6
28	10/25/2005 09:26:13	403	80.9	431	82.3	430	91.3	394	82.9	642	82.8	408	93.1	450	62.1	269	81.7	261	75.6	285	50
29	10/25/2005 09:26:14	421	66.8	426	89.5	149	73.6	193	121.6	364	92.2	232	88.5	138	60.1	113	69.3	380	37.6	393	58.5
30	10/25/2005 09:26:15	169	94.4	144	122.3	314	88.9	447	71	271	118	223	66.4	306	74.8	281	37	498	41.1	395	40.2
31	10/25/2005 09:26:16	273	88.3	312	86.1	442	82.5	315	92.5	293	80.4	416	72.5	217	73.1	133	336.1	147	13.8	258	21.1
32	10/25/2005 09:26:17	398	83.7	279	74.6	383	71.3	510	84.4	385	70.4	290	77.3	282	58.8	301	58.3	218	18.2	190	43.9
33	10/25/2005 09:26:18	306	96	351	88	451	74.7	392	82.2	448	98.3	410	101.1	165	101.9	110	52.4	156	347	146	344.1
34	10/25/2005 09:26:19	294	91.2	190	104.9	311	87.6	217	95.6	226	74.1	123	68.6	129	252.4	120	231.4	77	330.4	227	32.8
35	10/25/2005 09:26:20	360	92.7	188	98.6	286	73.5	257	103.5	198	37.6	243	61.5	57	238.5	51	80.9	98	353.5	68	72.1
36	10/25/2005 09:26:21	220	122.2	329	128.3	317	130.1	272	101.2	157	115.6	251	127.9	69	215.5	254	324.6	158	297.1	104	4.9
37	10/25/2005 09:26:22	261	71.9	199	57.1	242	95.2	332	54.9	230	62.5	265	60.3	93	297.7	87	256.8	179	346.4	209	331.3
38	10/25/2005 09:26:23	186	40.6	239	50.8	251	66	104	54.8	168	66.5	216	85.7	63	160.4	123	335.9	71	154.2	166	290.4
39	10/25/2005 09:26:24	287	22.5	222	43.5	322	56.9	261	63.8	342	81.6	226	77.2	212	133.9	246	41.5	32	12.7	140	3.7
40	10/25/2005 09:26:25	224	103.2	112	90	185	85	229	71.4	264	106.3	285	86	229	156.3	121	181.9	84	189.6	59	212.6
41	10/25/2005 09:26:26	31	76.9	112	49.3	98	99.9	134	109.1	116	110.6	316	99.6	243	124.6	165	50.2	127	58.2	198	200.1
42	10/25/2005 09:26:27	204	65.3	83	81.7	104	66.1	28	310.6	180	87.5	275	78.9	213	116.4	129	105.3	123	334.1	174	254
43	10/25/2005 09:26:28	49	76	79	48.1	56	53.7	201	119.9	194	94.4	154	139.5	200	138	92	25.2	153	104.8	498	64.9
44	10/25/2005 09:26:29	139	14.1	48	146	149	95.8	217	131.6	153	87.4	118	74.8	161	107	121	102	151	347	164	302.5
45	10/25/2005 09:26:30	194	107.1	271	56.6	33	38.9	101	50.6	135	188.1	84	136.4	182	115.7	89	81.6	327	13.1	124	31.1
46	10/25/2005 09:26:31	77	95.2	217	62.3	118	64.3	111	83.3	180	87.5	93	112.7	207	80.8	136	95.9	168	52.7	226	26
47	10/25/2005 09:26:32	174	67	176	75.5	98	40.9	273	66.7	252	87.7	264	78	148	108.6	181	82.4	260	44.4	206	59.1
48	10/25/2005 09:26:33	99	54.9	146	90.4	139	108.8	314	48.1	307	69.4	246	61.4	155	19.3	122	45	189	27.1	123	58
49	10/25/2005 09:26:34	222	21.1	73	12.7	56	208.9	128	122.2	32	118.2	125	3.2	224	39.4	213	41	176	36.2	171	47.1
50	10/25/2005 09:26:35	39	70.6	35	137.3	240	63.2	163	65	131	16.4	234	23.4	224	59.1	185	54.7	195	123.3	183	101.7
51	10/25/2005 09:26:36	90	354.9	135	319.5	137	273.8	138	32	84	4.1	181	74.3	268	119.7	175	51.5	251	111.8	267	93.4
52	10/25/2005 09:26:37	108	84.1	111	175.9	93	16.9	195	22.6	192	80.1	256	102.2	227	76.2	186	56.7	145	31.2	147	68
53	10/25/2005 09:26:38	93	83.2	159	60.2	108	140.3	233	73.8	12	311.6	100	77.3	78	90.7	124	35.5	67	20.1	214	55.3
54	10/25/2005 09:26:39	144	57.7	17	305.5	128	62.6	246	47.1	291	57.6	171	49.5	207	23.1	151	49.6	157	77.8	124	103
55	10/25/2005 09:26:40	87	80.1	110	102	43	50.7	51	114.1	162	63.3	191	83.1	128	66.4	135	111.8	202	99.4	90	85.6
56	10/25/2005 09:26:41	94	24.6	79	77.6	95	16.5	136	11.5	98	22.1	82	80.2	50	1.1	84	40.7	175	45.5	198	90.9
57	10/25/2005 09:26:42	204	67.6	73	255.8	65	103.4	140	46.2	82	36	124	140.3	135	55.3	161	44.2	178	41.1	242	57.5
58	10/25/2005 09:26:43	145	13.6	28	73.5	29	63.4	138	1.2	130	34.1	156	281.8	199	48.5	257	71.4	168	0.3	55	49.4
59	10/25/2005 09:26:44	282	40	119	39.6	59	340	130	29.5	63	0	35	225	63	189.2	187	87.9	197	134.4	201	73.5
60	10/25/2005 09:26:45	90	91.9	148	134.5	96	357	127	42.5	189	355.4	203	16.3	25	301.8	112	11.3	238	116.5	142	66.3

Lower Fox River Moving Vessel Trials
Test Five

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:28:31		119	21.6	84	47.9	66	22.3	162	76.4	105	74.5	35	18.4	109	121.5	252	56.3			28	284.5
1	10/25/2005 09:28:32		110	332.5	129	323.5	9	212	61	146.3	123	97.5	147	120.8	119	87.1	323	124.3	76	147.4	36	172.1
2	10/25/2005 09:28:33		191	57.8	143	57.9	158	51.2	222	50.7	75	74.5	163	85.1	7	90	27	66.3	69	176.7	128	98.1
3	10/25/2005 09:28:34		75	87.7	84	101.7	57	71.6	99	50.7	128	260.1	87	283.2	155	90.4	97	76.3	165	1.4	79	204
4	10/25/2005 09:28:35		136	260.7	3	225	125	71.3	153	61.6	135	210.7	104	32	79	270.7	140	89.6			77	50.3
5	10/25/2005 09:28:36		201	78	255	80.8	80	164.1	108	25.9	49	92.3	83	121.2	69	55.6	152	209.9	79	175.7	64	135.6
6	10/25/2005 09:28:37		98	80.6	189	87.6	155	42.1	51	1.1	63	38.5	122	71.9	63	356.4	35	341.6	136	144.6	182	81.2
7	10/25/2005 09:28:38		142	22.8	58	93.9	114	109.6	112	123.7	51	223.4	34	344.7	103	23.3	185	119.9	105	334.7	70	8.2
8	10/25/2005 09:28:39		102	45.8	141	85.5	167	7.2	102	51.3	193	54.3	81	313.5	65	89.1	113	42.5	124	120.1	97	51.7
9	10/25/2005 09:28:40		176	1.6	112	62.3	83	45	43	38.5	38	222.9	212	0.3	11	123.7	129	72	62	75.1	21	41.2
10	10/25/2005 09:28:41		121	147.1	92	23	126	354.1	101	40.2	70	25.5	75	122.4	80	67.9	142	118.2	149	56.2	137	89.2
11	10/25/2005 09:28:42		41	17.1	72	208.4	121	267.6	220	239.9	108	279.6	178	268.4	57	200.7	113	248.7			227	71
12	10/25/2005 09:28:43		184	44.6	154	86.7	211	44.6	353	35.7	306	54			2345	260.6	1909	265.3				
13	10/25/2005 09:28:44		233	69.2	225	58.4	121	18.7	54	286.1			2343	263.6								
14	10/25/2005 09:28:45				1854	238.4					1121	259.6	1793	262.4	1814	269.5	899	233.3	2001	288.2	1494	288.2
15	10/25/2005 09:28:46		497	136.4	1584	164.2	1794	159.3	228	133.2	1199	335.5							235	47.4	120	48.7
16	10/25/2005 09:28:47		212	64.6	391	140.2	520	9.9	395	308.7	418	332.5	490	303	428	13	504	64	579	147.2	351	317.5
17	10/25/2005 09:28:48		205	345.6	467	92.3	169	74.2	641	82.7	964	60.8	1016	55.1	1041	59.5	859	39.6	383	62.5	617	310.3
18	10/25/2005 09:28:49		308	335.3	250	309.5	467	22.6	645	33.1	670	43.7	754	24.6	808	31.2	526	13.7	118	100.3	451	324.5
19	10/25/2005 09:28:50		518	25	752	355.3	654	4.6	427	30.8	326	42.3	548	59.8	627	40.5	564	43.6	678	137.5	582	69.8
20	10/25/2005 09:28:51		395	354.5	293	17.1	535	27.6	230	2.7	180	103.8	149	51	611	29.7	398	30			462	352.5
21	10/25/2005 09:28:52		259	39.8	176	53.8	235	24.2	121	100.5	274	86.4	423	40.4	345	22.5	232	359.5	301	97.8	331	20
22	10/25/2005 09:28:53		238	46.7	220	46.3	325	35	303	86.4	42	34.4	89	180	166	24.2	381	33.4	286	125.9	153	36
23	10/25/2005 09:28:54		248	54.8	400	61.5	231	49.2	66	89.1	71	94	161	358.6	359	56.4	409	66.4	319	169	230	347.5
24	10/25/2005 09:28:55		224	24.5	94	310.7	234	84.1	210	57.4	593	344	431	327.9	354	8.6	395	42.9	281	46	209	59.1
25	10/25/2005 09:28:56		269	106.2	255	118.6	163	115	203	103.7	153	49.8	245	74.8	309	58.1	433	61.4	467	71.6	526	44.7
26	10/25/2005 09:28:57		109	106.6	225	98.7	78	53.9	83	274.1	91	63.2	383	61.1	312	80.2	429	103.2	442	65.5	521	51.9
27	10/25/2005 09:28:58		151	128	88	141.4	233	116	349	81.4	308	89.6	367	47.2	262	50.4	503	100.9	497	100.5	373	57
28	10/25/2005 09:28:59		228	83.7	220	128.9	97	88.2	123	71	93	38	128	43.4	138	70.5	223	128.6	73	120.4	273	63.9
29	10/25/2005 09:29:00		175	85.4	140	126.3	308	47.2	197	59.8	101	14.9	29	319.2	82	8.4	99	166.5	296	199.1	117	59.3
30	10/25/2005 09:29:01		99	133.4	390	91.3	393	63	181	66.8	256	53.3	88	60.8	195	107	239	45.7	158	68.5	102	353.8
31	10/25/2005 09:29:02		268	127	246	117.8	478	73.7	447	71.5	361	52.3	353	68.2	303	78.4	257	66.1	257	70.4	154	260.3
32	10/25/2005 09:29:03		225	71.6	252	80.4	321	83	213	58.3	145	57.1	294	86.7	343	76.9	366	58.9	148	73.5	182	79.2
33	10/25/2005 09:29:04		224	98.2	307	113.6	213	75.9	305	99.2	235	95.6	238	113	286	108.8	352	67.3	264	73.7	320	56
34	10/25/2005 09:29:05		217	110.2	214	105.1	156	30.3	245	91.6	316	73.9	239	88.8	353	90.6	337	97	380	66.4	156	44.2
35	10/25/2005 09:29:06		203	145.4	76	89.2	39	90	134	100.7	147	102.1	239	90.2	410	65.4	232	70.4	245	32.3	199	46.4
36	10/25/2005 09:29:07		205	180.6	240	206.2	252	134	225	183.8	212	137.7	176	123.9	232	76.6	233	136.2	331	126.3	259	73.4
37	10/25/2005 09:29:08		147	210.2	105	207.3	166	83.1	77	106.6	128	56.4	264	98.1	293	55.3	168	30.4	221	342.9	116	68.3
38	10/25/2005 09:29:09		109	219.1	11	15.3	19	108.4	157	16.2	135	145.8	201	100	194	85.3	78	9.6	145	60.6	92	33.5
39	10/25/2005 09:29:10		107	160.9	154	88.5	330	84.3	132	38.5	310	19	129	53.5	218	68.1	238	96.3	175	318	179	45.7
40	10/25/2005 09:29:11		246	94	194	107.1	233	77.9	160	92.9	184	16.5	327	30.1	143	83.6	210	88.4	257	83.3	274	57.2
41	10/25/2005 09:29:12		354	110.5	187	115.6	177	119.5	68	57	259	58.3	261	37.5	135	75.5	196	114.1	176	106.2	423	89.2
42	10/25/2005 09:29:13		128	94.5	164	110.3	198	115.4	116	53.4	151	90.4	166	63.6	242	46.7	361	66.1	313	80.1	293	71.9
43	10/25/2005 09:29:14		169	138.1	273	116.3	100	128.9	26	100.9	132	35.7	284	75.3	151	73	227	85.4	171	70.9	106	92.2
44	10/25/2005 09:29:15		337	157.9	127	171.4	54	79.3	144	71.3	121	73.2	66	108.4	310	89.8	109	97.4	178	78.3	274	77.3
45	10/25/2005 09:29:16		221	179.7	245	151.8	49	219.2	183	75.7	119	47.7	199	76.9	130	74.8	248	89.5	178	65	162	40.3
46	10/25/2005 09:29:17		161	219.7	121	188.5	132	170.8	95	145.3	93	73.1	160	68.4	86	203.9	10	246	204	310.6	148	81
47	10/25/2005 09:29:18		178	148.5	172	209.5	183	336.5	267	294.1	194	348.4	162	47.8	226	20.8	134	339.4	367	5.9	233	61.6
48	10/25/2005 09:29:19		134	48.3	130	43.1	133	108.4	156	128.8	34	83.3	142	58.2	137	83.7	163	134.5	175	28.3	94	32.8
49	10/25/2005 09:29:20		73	52.2	133	32.7	206	13.2	44	267.4	110	16.3	138	30.1	231	29.6	162	12.5	248	59.2	109	91.6
50	10/25/2005 09:29:21		226	357.5	265	10.4	130	27.9	150	356.6	209	33.1	35	8.1	246	4.4	280	12.6	171	35.5	57	10.1
51	10/25/2005 09:29:22		245	61.8	108	58.2	220	77.4	101	12.5	96	82.2	180	27.1	121	325.1	86	306.5	223	6.2	96	317.1
52	10/25/2005 09:29:23		298	345.2	199	320.7	235	27.1	114	54.6	107	124.7	59	53.9	107	291.3	118	349.3	102	72.3	141	28.9
53	10/25/2005 09:29:24		173	1.3	238	330.3	106	9.8	250	351	113	100.2	182	60.1	86	54.5	149	56.7	152	74	293	64.9
54	10/25/2005 09:29:25		98	287.1	53	10.9	177	325.6	115	319.9	87	312.7	108	2.7	100	270.6	170	237.7	81	2.8	189	111.1
55	10/25/2005 09:29:26		123	96.1	44	320.5	126	297.4	62	32.4	143	17.9	115	349	42	358.6	128	155	168	156.9	51	77.6
56	10/25/2005 09:29:27		92	23	103	321.7	103	286.3	211	348.5	67	30.4	125	240.8	71	90	155	83	131	37.6	153	345.2
57	10/25/2005 09:29:28		77	274.5	57	130.1	43	1.3	111	351.2	18	337.6	49	212.4	183	45.7	80	54.1	210	27.2	119	108.1
58	10/25/2005 09:29:29		109	322.1	134	51.3	46	287.7	76	285.3	90	320.8	59	38.8	100	54.4	64	85.5	142	270.4	180	71.2
59	10/25/2005 09:29:30		169	125.9	183	105.9	115	33.3	221	3.1	154	355.9	78	44	115	302.2	190	164.1	47	248.9	65	42.5
60	10/25/2005 09:29:31		78	69.7	122	36	115	83	121	16.3	128	44.1	202	23.3	77	17.5	47	13.4	243	41.8	84	346.3

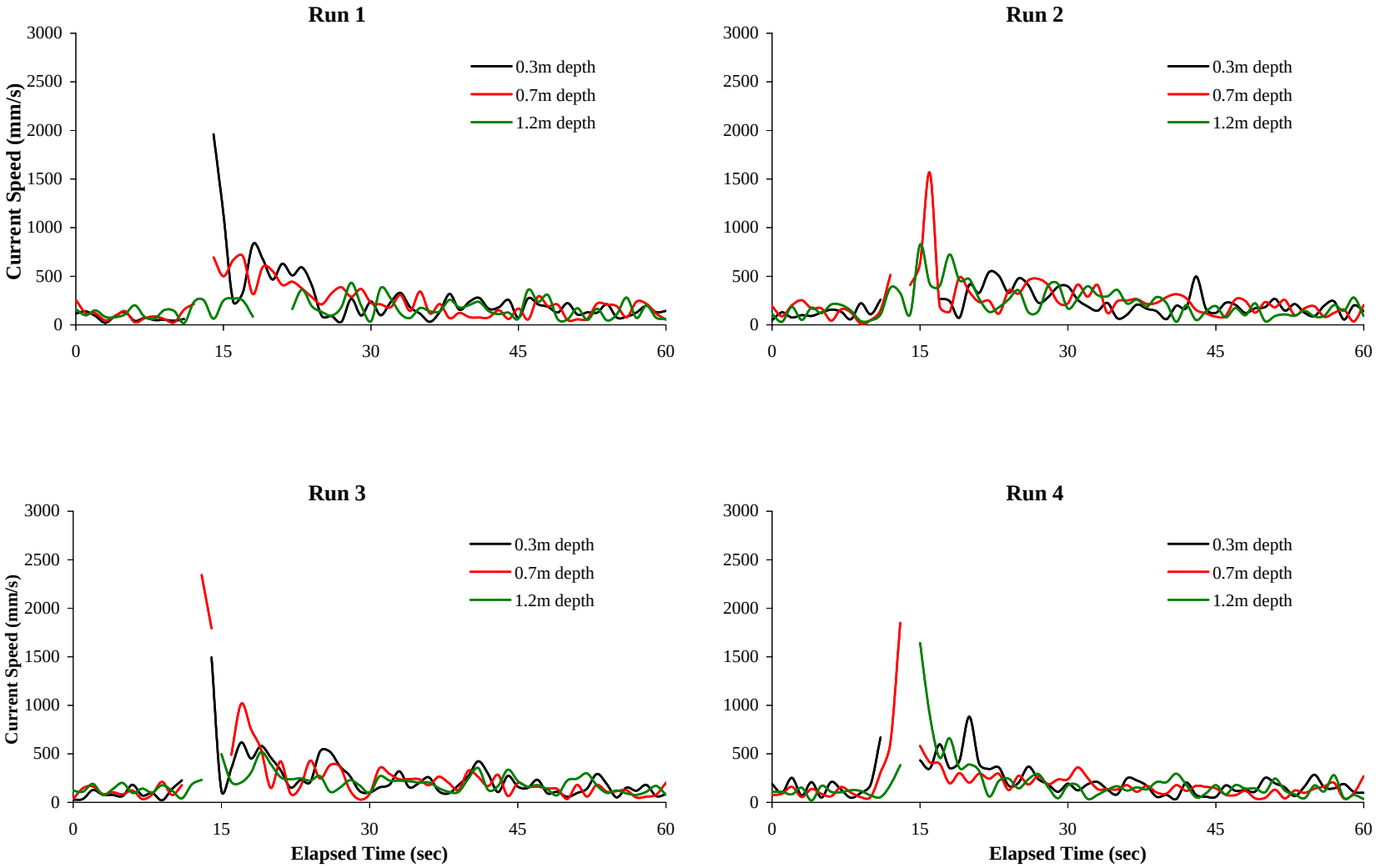
Lower Fox River Moving Vessel Trials
Test Five

Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:31:44		109	81.1	207	24	179	353.6	47	43.3	89	332.6	75	350	97	16.8	31	350.8	35	156.4	189	38.8
1	10/25/2005 09:31:45		109	348.9	282	58.8	220	84.8	112	51.5	89	169.7	90	141.7	53	321.2	56	289.7	170	105.3	98	82.9
2	10/25/2005 09:31:46		83	311.6	43	2.7	85	54.1	12	0	109	130.1	161	125.7	44	54.2	104	33.2	124	154.3	253	227.4
3	10/25/2005 09:31:47		151	43.7	79	9.5	29	157.8	113	357	61	225	55	283.8	126	99.6	58	155.6	25	0	70	157.4
4	10/25/2005 09:31:48		18	308.2	123	63.9	60	24.4	46	119.9	49	14.3	139	21.6	199	95.5	11	225	111	177.4	209	134.8
5	10/25/2005 09:31:49		171	79.2	68	89.2	57	305.1	131	278.3	85	235	88	42.2	31	101.3	131	99.2	177	56.8	49	147.6
6	10/25/2005 09:31:50		108	181.6	62	39.8	150	299.1	103	353.3	85	24.4	63	32.7	52	63.9	223	122.2	71	64.2	211	87.8
7	10/25/2005 09:31:51		104	27.6	115	88.5	74	59.3	42	141.8	80	194.6	158	290.4	100	214	108	196.8	85	116	131	94.8
8	10/25/2005 09:31:52		125	34.6	69	53.3	48	183.6	87	45.5	77	18.9	100	161.4	22	114.2	75	193.1	242	36.8	47	116.6
9	10/25/2005 09:31:53		117	335.8	77	6.8	50	320.6	202	45.6	77	3.7	54	1.1	124	144.5	96	222	157	215.4	98	61.9
10	10/25/2005 09:31:54		72	153.8	168	73.4	84	311.1	203	27.3	41	48.9	56	179	21	188.1	177	168.2	89	60.3	185	84.1
11	10/25/2005 09:31:55		53	301.9	115	319.2	48	247.8	188	310.9	218	297.6	309	305.8	107	326.5	1337	257.6	1627	292.3	669	259.9
12	10/25/2005 09:31:56		182	63.6	163	44	276	33.2	303	30.1	389	34.1	616	38	2414	265.1						
13	10/25/2005 09:31:57		384	66.4	384	76.9	61	74.8	560	44.3			1850	268.5	2357	266.2			3379	261.6	2477	286.3
14	10/25/2005 09:31:58																		1329	223.4		
15	10/25/2005 09:31:59		1643	113.5	1808	101.5	1697	109.6	1209	102.3	1170	112.1	581	131.4	273	37.7	802	58.7			433	50.1
16	10/25/2005 09:32:00		900	90.1	805	59.6	1067	68.5	969	75.1	571	91.5	414	232.9	486	38.1	503	66.3	163	323	349	4.8
17	10/25/2005 09:32:01		459	133.3	210	74.2	487	6	1418	320.4	546	279	398	263.1	307	325.2	336	338	493	286.9	598	301.8
18	10/25/2005 09:32:02		662	91	769	90.5	698	78.5	482	41.5	186	12.8	197	51.8	120	20.6	202	43.2	531	10.9	355	323.4
19	10/25/2005 09:32:03		355	82.4	563	54.2	374	100.2	326	85.8	17	245	301	194.6	72	322.3	238	20.4	517	1.4	428	302.7
20	10/25/2005 09:32:04		390	40.1	482	26.1	498	41.7	398	46.6	49	194.3	202	317.2	44	55.2	613	65.8	527	26.2	882	31.7
21	10/25/2005 09:32:05		325	77	416	59.1	535	12.7	382	23.3	534	95.8	295	75.5	283	72.7	288	104.7			397	359.6
22	10/25/2005 09:32:06		61	116.1	144	86.8	269	97.9	137	197	23	307.9	243	81	163	67.2	145	190.8	84	270	344	5
23	10/25/2005 09:32:07		222	108.1	352	137	117	121	333	160.5	82	90.7	294	64.2	132	51.5	208	4.7	137	356.2	359	20.1
24	10/25/2005 09:32:08		243	107	137	94.2	420	201.4	305	189.2	122	191.3	127	39.2	150	83.5	143	73	90	43.6	171	320.7
25	10/25/2005 09:32:09		144	213.4	245	166.5	158	166.8	171	232.6	421	219.7	275	218.2	255	189.2	165	356.5	183	6	205	334.6
26	10/25/2005 09:32:10		239	149.6	211	174.6	91	29.7	133	60.1	140	130.6	183	200.1	175	173.4	42	213.3	90	307.8	368	51.5
27	10/25/2005 09:32:11		291	121.2	370	148.4	233	99.6	73	43.3	312	162.5	270	134.7	83	199.1	102	214.2	59	324.7	239	28.7
28	10/25/2005 09:32:12		157	63.6	144	147.2	131	98.8	41	43	105	175.6	185	112.5	264	89.3	54	21.8	113	99.1	186	41.9
29	10/25/2005 09:32:13		42	218.2	209	141.2	422	103.1	322	113.6	358	128	237	117.1	449	110.2	398	98.8	230	85.8	108	41.2
30	10/25/2005 09:32:14		176	74.9	122	63.6	280	88	168	39.2	280	93.7	238	69	419	122.4	417	136.8	300	132.3	192	67.7
31	10/25/2005 09:32:15		174	97.9	176	128.3	250	93.4	150	126.9	108	80.4	360	84.3	387	64.8	343	55	157	93.6	124	63.2
32	10/25/2005 09:32:16		36	148.5	46	141.1	192	204	173	106.1	181	97.3	251	66.3	247	58.6	203	27.3	111	67.1	187	87.6
33	10/25/2005 09:32:17		77	24.6	98	150	279	157.7	165	148.1	199	134	138	99.6	110	85.8	107	88.9	261	82.1	211	70
34	10/25/2005 09:32:18		131	94.4	135	149.3	147	93.9	121	174.8	163	166.1	138	150.1	54	189.6	169	146.1	218	86.3	131	15
35	10/25/2005 09:32:19		167	126.7	152	167.9	74	23.1	25	71.6	133	187.3	132	138.1	113	119.7	166	118	51	158	83	134
36	10/25/2005 09:32:20		121	147.5	268	119.1	209	129.8	50	86.6	142	173.9	177	135.2	307	141.3	229	89.7	73	102.7	247	75.2
37	10/25/2005 09:32:21		155	119.9	268	112.8	101	91.1	101	96.8	118	30.5	108	98.5	105	42.7	184	33	149	282.4	226	5.8
38	10/25/2005 09:32:22		133	42.6	141	99	146	102.7	345	63.7	85	107.8	170	126.1	125	86.8	81	123.9	92	5.6	170	52.4
39	10/25/2005 09:32:23		210	123.5	176	112.8	139	137	153	107.5	149	107.2	102	27.3	90	120.9	85	311.2	67	57.7	56	69
40	10/25/2005 09:32:24		208	87.8	191	79.2	173	129.8	123	123.7	130	145.7	91	116.8	137	67.7	98	96.5	274	123.2	77	130.8
41	10/25/2005 09:32:25		296	67.2	216	118.8	235	138.4	222	122.3	395	101.7	178	95.5	167	72.5	232	48.3	247	59.1	34	348
42	10/25/2005 09:32:26		181	65.6	236	89.3	220	106.9	238	120	205	120.4	118	86.6	108	76.6	176	92	89	57.9	203	95.7
43	10/25/2005 09:32:27		51	20.6	228	71.1	233	82.6	218	85.3	294	97	171	139	281	116.7	165	146.9	72	29.1	77	60.4
44	10/25/2005 09:32:28		94	35.9	163	134	265	87.6	206	128.7	382	134.8	160	125.6	213	133.7	120	63.9	47	70	58	307.3
45	10/25/2005 09:32:29		178	156.5	201	127.3	31	119.1	108	358.9	251	128.1	144	111.9	218	110.9	65	155.4	83	217.1	57	286.2
46	10/25/2005 09:32:30		83	120.3	190	144.6	230	134.1	211	144.7	224	114.5	78	90.7	135	162.4	116	172.6	129	61.2	174	79.1
47	10/25/2005 09:32:31		179	149	171	160.9	142	132.4	112	131.4	178	93.5	74	133.4	63	191	137	113.6	109	173.7	118	94.4
48	10/25/2005 09:32:32		141	119.8	55	112.4	99	108.8	99	47.5	176	86.7	118	121.8	126	149.6	115	118.6	85	119.6	126	52.4
49	10/25/2005 09:32:33		143	110.1	267	68.7	39	34.5	113	105.9	53	78.1	41	157.2	105	159.3	112	205.9	64	143.3	112	33
50	10/25/2005 09:32:34		104	119.3	158	121.6	82	165.1	86	94	164	119.5	47	106.1	49	151.9	308	112.5	273	102.3	253	91.6
51	10/25/2005 09:32:35		245	125.2	107	124	74	154.5	103	188.4	97	184.1	131	106.4	179	124	265	104.2	168	70.2	196	51.2
52	10/25/2005 09:32:36		121	96.7	296	99	88	110.7	164	116.1	208	118.2	41	279.9	85	155.6	162	109.1	117	7.9	154	74.5
53	10/25/2005 09:32:37		82	160	80	45.5	120	148.3	121	143	123	148.2	122	109.2	172	159.2	57	86	75	22.8	64	138.8
54	10/25/2005 09:32:38		42	135	117	124.2	56	92	163	134.8	125	60.8	98	131.3	83	176.6	59	229.8	67	79.7	165	62.7
55	10/25/2005 09:32:39		174	55	164	59.5	15	61.7	85	120.5	72	137.2	141	123.1	105	169.5	38	138.2	210	216.1	284	95.7
56	10/25/2005 09:32:40		113	70.3	129	61.2	145	95.9	33	185.2	44	143.4	164	141	112	106.7	169	117.9	74	169.1	155	55
57	10/25/2005 09:32:41		281	109.5	97	23.7	64	120.2	221	133.2	227	115.3	202	143.6	170	119.3	67	197.4	120	167.5	144	68.8
58	10/25/2005 09:32:42		46	40.6	107	74.3	103	11.7	118	80.2	260	119	40	182.9	34	88.3	70	240.2	74	314.5	190	82.7
59	10/25/2005 09:32:43		75	57.6	127	17.4	177	82.6	114	140.7	76	253.2	95	47.6	55	310.6	89	219.6	29	200.3	107	305.5
60	10/25/2005 09:32:44		35	140.8	274	92.5	179	96.1	197	46.2	33	148.7	270	326.3	114	102.7	90	16.8	149	58.4	97	95.3

Fox River Propwash Study - Moving Vessel Trials

Test #5: Single-Prop Vessel - 1300 RPM - Pitch Up 5

October 25, 2005



Lower Fox River Moving Vessel Trials
Test Six

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 1		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:34:32		63	311.8	64	2.7	149	344.8	124	97.4	79	92.2	61	344.8	170	58.9	124	55.2	180	45	127	39.2
1	10/25/2005 09:34:33		82	213.5	163	355.4	217	82.6	143	45	149	276.9	139	301.7	125	31.3	242	49.5	140	17	109	285.4
2	10/25/2005 09:34:34		21	292.8	138	320.3	58	32.3	47	41.5	135	11.1	103	75.4	153	82.9	220	115.6	155	64.4	177	49.6
3	10/25/2005 09:34:35		130	76.7	98	95.9	87	94.6	80	349.2	57	40.1	179	108.2	120	151.7	133	59.2	86	225.5	82	331.6
4	10/25/2005 09:34:36		81	252	100	185.7	120	255.5	18	343.6	61	217.1	74	184.6	132	110.4	159	115	80	156.3	61	104.3
5	10/25/2005 09:34:37		90	57.7	95	39.9	114	50.3	90	30.9	81	45	121	52.4	191	48.8	142	332.4	115	51.7	76	32.6
6	10/25/2005 09:34:38		136	62.3	72	72.3	43	320.7	128	43.4	99	33	79	353.4	178	74.3	237	58.5	149	144.8	82	229.9
7	10/25/2005 09:34:39		29	174.1	23	39.8	86	98	134	80.1	29	22.2	46	177.5	145	337.3	11	333.4	38	35.4	165	67.5
8	10/25/2005 09:34:40		107	356.3	8	315	28	173.9	291	79.7	80	326.7	108	78.8	78	40.8	188	56.1	156	30.8	204	53.2
9	10/25/2005 09:34:41		168	341.2	98	340.3	100	196.8	78	224	73	153.1	44	50.5	126	282.8	105	255	15	151.7	47	1.2
10	10/25/2005 09:34:42		172	203.3	115	238.1	120	271	113	182.5	27	231	130	173.8	151	206.4	486	285.9			76	31
11	10/25/2005 09:34:43		65	101.5	198	54.9	321	76.7	157	66.4	502	62.6	254	86.8	2220	259.1	2382	246.4			558	64.2
12	10/25/2005 09:34:44		210	48.3	368	64.1	353	66.8	450	100.9			2271	238.1	2546	243.5						
13	10/25/2005 09:34:45		608	352.8	337	347.5	1773	108.9							556	351.9					1531	263
14	10/25/2005 09:34:46		1090	98.7	1480	116.5	1076	133.6	974	107.8	1655	92.5	1333	92.1	1295	99.5			1555	82.1	665	93.1
15	10/25/2005 09:34:47		515	61.6	1195	83.1	1124	77	967	57.5	809	51.3	652	70.2	762	88	706	100.8			358	56.4
16	10/25/2005 09:34:48		626	100.6	676	119.4	550	125.6	806	149.9	576	140.6	422	126.6	591	174.4	533	145.9	487	122.5	531	47.7
17	10/25/2005 09:34:49		520	105.3	783	122.3	837	133.7	684	150.1	442	161.4	485	141	661	127.4	519	100.2	758	75.1	436	44.6
18	10/25/2005 09:34:50		331	127.9	361	118.6	427	132.4	277	144.7	193	239.4	114	220	338	289.7	302	278.4	219	284.3	373	5.4
19	10/25/2005 09:34:51		358	111.6	225	122.3	230	147.6	126	232.4	222	280.4	137	352.5	134	298.1	234	192.6	411	53.1	711	41.2
20	10/25/2005 09:34:52		133	114.4	229	73	474	141.2	281	143.1	359	135.7	296	202.8	434	80.3	308	132	406	54.4	492	24.4
21	10/25/2005 09:34:53		93	161.8	130	135.6	162	84.3	288	131.9	324	145.8	254	146.2	84	43.6	127	46.3	226	62.3	454	31.8
22	10/25/2005 09:34:54		203	353.8	109	49.9	293	121.9	162	151.2	160	177.9	122	183.3	81	31.9	159	53.7	222	39.5	382	31.5
23	10/25/2005 09:34:55		82	2.8	33	46.2	63	141.5	166	134.3	250	93.7	162	138.7	198	76	316	121.5	193	64.9	134	2.1
24	10/25/2005 09:34:56		61	25.3	184	16.8	175	342	117	38.4	83	43.1	103	253.7	228	8.3	132	28.5	393	68.8	343	32.3
25	10/25/2005 09:34:57		81	36.4	136	331.9	260	336.9	193	315.6	152	121	122	103.2	388	71.8	342	65.3	120	3.8	220	39.8
26	10/25/2005 09:34:58		44	211.2	114	276.6	54	220.5	74	7	103	50.1	147	92.7	220	91.6	283	78.8	392	68.7	238	70.7
27	10/25/2005 09:34:59		55	211.7	76	209.9	150	215.8	143	188.9	70	109.2	282	109.7	154	94.5	272	71.4	274	62.6	124	46
28	10/25/2005 09:35:00		19	186	202	323.6	278	258.6	206	303.5	38	358.5	19	297.9	102	80.4	28	340.9	86	328.3	185	33.5
29	10/25/2005 09:35:01		68	162.9	81	144.5	110	227.6	50	128.5	120	78.5	246	54.1	90	4.4	109	85.3	125	34.6	173	62.8
30	10/25/2005 09:35:03		91	116.8	188	96.1	125	119.2	171	123.8	222	70.5	136	107.1	92	333.4	129	13	103	54.5	103	71.9
31	10/25/2005 09:35:04		39	82.7	200	93.4	243	77.6	349	109.9	248	90.2	169	94.1	129	249.6	144	345.5	115	67.5	101	120.4
32	10/25/2005 09:35:05		125	89.5	171	99.7	181	72.3	181	58.3	111	44.6	69	276.6	111	171.7	146	328.7	27	342.9	108	64.1
33	10/25/2005 09:35:06		247	88.4	160	93.6	109	145.4	262	66.7	171	54.7	151	124.2	148	150.8	63	177.3	89	179.4	46	321.1
34	10/25/2005 09:35:07		54	127.5	145	71.1	93	65.1	129	80.6	198	94.6	193	160	264	138.8	178	145.3	133	153.2	53	22.2
35	10/25/2005 09:35:08		70	79.3	126	116.4	65	46.2	90	301.4	79	173.4	24	250.8	194	123.4	231	135.2	223	84.9	29	146.3
36	10/25/2005 09:35:09		124	83	112	158.5	64	99.9	84	163.3	210	180.5	116	175.1	56	202.9	214	95.1	60	16.3	61	78.7
37	10/25/2005 09:35:10		320	269.8	98	355.9	48	299.7	112	144	154	173.3	227	211.1	147	182.7	156	123.8	175	103.6	163	51.7
38	10/25/2005 09:35:11		32	147.8	32	111.8	283	138.4	181	149.9	191	185.4	131	115.4	93	266.9	124	218.8	101	101.4	133	334.6
39	10/25/2005 09:35:12		35	203.6	93	206.8	237	162.6	130	198.4	222	130.8	167	133.1	52	137.4	123	208	127	188.6	66	56.8
40	10/25/2005 09:35:13		167	135.5	252	82.3	110	88.4	251	100.3	107	113.7	186	85.7	174	93.9	173	74.9	165	82	14	355.9
41	10/25/2005 09:35:14		71	16.4	149	95.4	206	74.6	157	79.3	83	27.2	107	123.5	77	181.5	72	196.2	106	29.5	102	56.6
42	10/25/2005 09:35:15		190	96.6	156	60.8	184	48.8	156	76.7	211	69.2	101	119.1	70	206.2	131	67.5	190	14	213	359.2
43	10/25/2005 09:35:16		191	83.4	149	13.9	188	52.3	163	109.3	175	45.7	207	106.6	124	120.5	11	10.3	94	342	85	349.9
44	10/25/2005 09:35:17		199	1.7	143	82	103	35.5	301	30.6	322	12.4	183	3.8	142	39.3	120	34.5	96	127	194	42.9
45	10/25/2005 09:35:18		57	45	103	93.9	52	106.7	9	63.4	205	54.5	121	109.3	135	74.1	212	62.7	76	22.5	122	63.2
46	10/25/2005 09:35:19		182	199.6	136	122.4	49	162.3	6	9.5	76	115.6	28	55.2	120	29.3	137	20.9	139	32.1	67	81.4
47	10/25/2005 09:35:20		96	259.7	100	239.3	88	207.7	76	223.9	57	100.1	94	83.3	95	289	67	34.6	126	40.2	176	33
48	10/25/2005 09:35:21		71	244.9	13	118.6	198	28.6	33	340.5	84	355.9	235	56.6	42	295.3	174	358	127	8.1	69	137.3
49	10/25/2005 09:35:22		23	131.4	203	108.1	10	156	89	323.3	134	304	92	348.1	107	333.9	160	352.5	142	4.9	66	58
50	10/25/2005 09:35:23		130	31.5	159	56	124	50.5	119	88.6	64	31	89	9.7	154	46.8	57	93	61	155.9	152	76.3
51	10/25/2005 09:35:24		119	57	131	111.9	113	1	103	357.8	97	341.9	54	16.1	151	19.8	100	345.5	127	113.7	76	119.9
52	10/25/2005 09:35:25		200	22.3	67	141.1	72	335.6	112	16.7	172	99.4	168	44.8	160	25.1	161	62.3	89	73	99	95.8
53	10/25/2005 09:35:26		217	56.5	81	82.2	119	19.2	132	37.3	37	47.2	188	97.7	133	112.1	274	70.8	187	77	265	59.4
54	10/25/2005 09:35:27		120	19.9	193	75.9	110	137.9	126	86.4	90	55.4	88	138.7	94	141.1	116	75.5	215	62.6	181	66.3
55	10/25/2005 09:35:28		106	7.6	127	340.1	106	28.3	82	344.4	7	123.7	168	109.5	112	193.9	57	114.8	27	107.1	108	53.7
56	10/25/2005 09:35:29		47	36.4	170	44.8	134	67.2	97	185.3	66	197.6	168	91	83	66.5	56	261.7	137	161.7	66	189.6
57	10/25/2005 09:35:30		169	65.9	52	160.9	66	225	64	189.9	49	147.6	88	89.3	131	102.8	149	190	59	208.3	46	127.9
58	10/25/2005 09:35:31		198	80.1	162	139.5	104	72.6	70	4.1	73	89.2	114	138.2	127	85	67	142.3	35	123.2	127	107
59	10/25/2005 09:35:32		161	63.4	170	55.3	220	23.1	85	339.4	26	240.5	107	135.4	218	182.6	92	116.6	84	191	107	336.8
60	10/25/2005 09:35:33		151	146.6	48	259.2	171	273.7	109	327.3	65	205.4	50	245	60	84.3	121	110.2	13	278.7	73	128.3

Lower Fox River Moving Vessel Trials
Test Six

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 2		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:36:56		131	4.4	117	106.4	45	113.7	114	115.9	23	118.8	39	46	140	50.5	39	140.2	244	163.1	82	130.1
1	10/25/2005 09:36:57		106	357.3	135	291.8	151	337	69	66	138	182.9	34	229.8	78	166.7	140	53.1	87	31.3	164	73
2	10/25/2005 09:36:58		50	23.5	171	85	131	43.5	60	65.6	188	128.9	98	94.7	55	331.6	108	79.3	100	328.5	42	6.8
3	10/25/2005 09:36:59		126	82.3	61	11.3	113	137.1	100	57.3	111	307.3	46	21.6	32	126.2	51	135	29	308	100	36.9
4	10/25/2005 09:37:00		171	53.1	50	78.5	68	93.4	100	27.3	94	25.8	75	3.1	201	92.8	93	44.1	155	98.9	185	83.5
5	10/25/2005 09:37:01		265	18.2	30	160.3	61	56.3	72	92.4	161	136.8	132	131.9	122	143.3	108	93.7	98	46.2	222	64.4
6	10/25/2005 09:37:02		60	350.4	84	77.6	80	45.5	87	54.8	112	327.4	9	69.4	64	262.9	170	340.4	143	56.4	133	287.5
7	10/25/2005 09:37:03		56	116.6	77	50.3	83	37.1	82	339.4	118	251.3	69	323.3	99	263.6	155	59	187	146.1	90	95.7
8	10/25/2005 09:37:04		121	152.4	142	63.3	78	101.9	60	320.4	124	247.2	199	179.7	117	308	80	89.3	30	250.3	41	245.3
9	10/25/2005 09:37:05		168	329.6	93	330.9	108	355.8	96	88.2	88	242.9	163	292	82	199.3	65	43.8	107	50.7	99	91.2
10	10/25/2005 09:37:06		42	236.7	9	180	79	264.2	164	246.7	173	299.1	67	220.1	156	234.7	207	285.1			142	64.5
11	10/25/2005 09:37:07		154	45.5	122	20.7	132	40.7	168	54.7	266	41.3			2177	261.5	1802	261				
12	10/25/2005 09:37:09		289	65	265	47.6	125	290.2	275	34.6	2049	266.9	2099	264.7								
13	10/25/2005 09:37:10				1422	73.6																
14	10/25/2005 09:37:11		799	115.9	1112	109.8	855	119.4	2139	84.7	2556	63.8	2547	66.1							717	53.3
15	10/25/2005 09:37:12		267	98.2	677	128.8	390	112.8	323	66.3	921	64.2	476	14.9	573	8.2	1147	357.1	497	327.8	517	27.1
16	10/25/2005 09:37:13		598	31	774	43.2	656	52.2	653	39.9	588	32.5	636	23.7	473	10.7	728	350.2	605	350.6	758	10.7
17	10/25/2005 09:37:14		782	95.4	668	91.5	469	91.5	597	77.8	657	66.6	711	78.2	715	58.7	758	49.8	647	27.5	708	20.3
18	10/25/2005 09:37:15		250	153.9	571	150.3	504	135.2	137	122.2	288	74.3	129	38.7	560	76.7	512	45.3	488	49.7	606	23
19	10/25/2005 09:37:16		284	102.6	317	173.8	535	160.8	479	151.2	240	96	374	80	501	50.3	556	117.3	231	42.9	531	25.1
20	10/25/2005 09:37:17		361	69.8	222	104.1	293	178.6	337	144.7	303	115.8	536	84.9	466	74.7	499	71.1	444	350.9	511	29.4
21	10/25/2005 09:37:18		186	156.9	68	339.4	102	117.6	254	76.1	49	220.9	266	91.5	205	105.6	380	29.3	264	31	577	41.5
22	10/25/2005 09:37:19		132	227.1	39	129.8	262	105.9	418	70.7	132	106.8	256	106.6	417	127.9	360	134.7	375	26.6	515	20.6
23	10/25/2005 09:37:20		252	74.1	307	110.2	258	124.2	230	125.6	266	121	176	114.1	307	54.4	233	87.3	482	75.1	116	82.6
24	10/25/2005 09:37:21		213	120.2	221	66	214	98.6	477	114.7	325	101.2	265	99.8	467	72	509	75.2	321	82.1	428	67.2
25	10/25/2005 09:37:22		68	80.7	100	76.7	144	116.7	119	151.9	136	68.9	327	64.5	249	68.1	160	50.1	199	27.9	202	60.3
26	10/25/2005 09:37:23		35	173.5	72	155.6	104	133.1	239	308.9	222	263.8	112	230.1	158	44.5	203	70.4	214	84.1	138	87.5
27	10/25/2005 09:37:24				157	183.3	227	138	140	156.9	215	133.5	59	40.2	221	72.1	331	29.9	259	109.4	224	105.3
28	10/25/2005 09:37:25		162	204	305	193.7	186	191.8	116	258.6	97	261.7	175	0.3	69	136.8	260	45.2	210	59.4	174	110.5
29	10/25/2005 09:37:26		133	208.3	100	201.2	319	234.6	185	284.1	42	288	73	116.9	138	189.6	90	173	64	18.2	168	70.5
30	10/25/2005 09:37:27		128	174.6	90	151.4	141	260.2	194	214.3	174	239.1	79	109.1	181	141.5	317	142.4	265	123.8	239	220.4
31	10/25/2005 09:37:28		122	269.5	130	72.1	87	253.2	123	221.7	80	137.5	220	102.6	180	50.2	160	58.3	177	70.8	148	183.9
32	10/25/2005 09:37:29		160	155.7			87	249.1	58	303.7	13	241.4	13	347	250	75.4	266	61.2	146	54.8	44	195.9
33	10/25/2005 09:37:30		65	251	180	68.4	175	196.3	188	247.5	70	209.1	85	56.5	21	295.3	15	78.7	81	118.2	132	235.8
34	10/25/2005 09:37:31		69	35.5	125	187.8	69	193.4	78	168.1	25	168.2	233	48.3	140	115.8	134	125.6	64	86.4	33	271.7
35	10/25/2005 09:37:32		96	81.6	145	5.2	41	247.2	39	75.3	154	150.9	106	116.8	62	194.9	82	102.7	258	83.3	19	132.9
36	10/25/2005 09:37:33		148	54.6	170	57.7	168	80.8	16	206.6	291	145.7	102	125.9	144	101.6	53	11.9	192	355.8	284	44.4
37	10/25/2005 09:37:34		64	142.6	22	243.4	38	49.2	26	218.7	148	104.9	89	140.4	251	104.8	199	104.9	322	78.6	329	57.3
38	10/25/2005 09:37:35		58	72.8	100	8.6	91	312.3	216	8.2	220	122.4	148	140.2	114	126.8	103	33.1	137	62.1	82	350.2
39	10/25/2005 09:37:36		208	40.1	175	8.9	97	65.6	227	34.6	74	10.1	50	12.7	204	30.3	207	69.9	293	44.6	134	56.9
40	10/25/2005 09:37:37		69	189.2	83	55.7	118	319.8	96	351	119	332.4	112	73.3	135	356.6	151	67	284	17.2	202	72.5
41	10/25/2005 09:37:38		82	53.4	59	232.5	30	74.6	98	44.6	208	13	30	15.4	132	29.5	158	43.2	124	20.3	48	51.7
42	10/25/2005 09:37:39		63	318.2	85	273.4	102	200	165	55.2	301	41.4	310	15.9	223	57.8	199	39.3	170	32.3	241	49.7
43	10/25/2005 09:37:40		145	109.7	98	142.1	68	204.3	27	188.4	125	91.8	205	41.8	61	51.6	116	53	57	263	186	22.8
44	10/25/2005 09:37:41		134	54.4	53	82.5	233	52.7	122	36.7	96	48	173	1	121	357.2	73	70.1	96	105.8	63	308
45	10/25/2005 09:37:42		71	130.4	27	162.9	137	121.3	99	66.8	8	309.8	49	329.2	135	26.9	135	72.8	128	84.6	116	6.9
46	10/25/2005 09:37:43		118	105.2	100	119.4	156	74	216	18.6	184	10.3	269	23.4	220	39.1	111	91.5	76	0	70	122.1
47	10/25/2005 09:37:44		53	60.5	97	51.2	149	83.8	108	58.7	184	20.4	156	33.8	120	14	150	29.5	71	57.7	138	41.2
48	10/25/2005 09:37:45		90	75.2	93	58.2	226	16.2	71	321.8	171	13.5	187	41.1	191	93	238	45	182	50.4	142	76.9
49	10/25/2005 09:37:46		168	149.9	136	51.9	188	46.7	175	105.9	92	275	168	64.7	31	86.3	115	118.6	91	41.4	172	55.2
50	10/25/2005 09:37:47		87	20.1	134	33.5	117	49.5	243	68.5	127	359.1	247	60.6	157	68.3	92	60.6	181	49	70	14
51	10/25/2005 09:37:48		52	355.6	87	76.8	110	351.6	69	37.4	164	70.5	98	52.9	86	182.7	158	358.5	76	25.6	113	63.2
52	10/25/2005 09:37:49		57	120.6	234	132.4	240	101.8	72	75.6	29	121	114	288	49	57.6	115	218.3	71	94	93	138.9
53	10/25/2005 09:37:50		178	89	45	333.4	80	109.8	76	64.1	100	78.5	161	356.1	238	309.7	29	174.1	86	183.3	169	76.6
54	10/25/2005 09:37:51		63	179.1	67	136.8	117	76.7	104	13.4	85	74.3	272	22.7	38	346.3	141	319.9	132	31.6	146	73.3
55	10/25/2005 09:37:52		69	18.7	76	84.7	57	53.5	216	32.1	68	55.1	57	112.5	81	65	212	335.5	143	32.7	261	45.5
56	10/25/2005 09:37:53		126	36	144	102	102	116.1	128	4.9	85	23.6	20	98.5	94	342	88	56.1	150	311.2	284	44.7
57	10/25/2005 09:37:54		21	25.3	84	291	175	44.3	141	99.8	86	61.7	213	74.5	47	241.8	148	155.7	100	332.7	69	318.5
58	10/25/2005 09:37:55		86	235.4	154	67.4	74	125.6	39	142.3	109	92.6	90	290.3	86	105.5	38	132.9	83	28.1	26	232.7
59	10/25/2005 09:37:56		155	261.5	42	21	41	166	138	91.2	50	266.6	57	344.7	106	109.8	93	90	136	251.6	106	67.8
60	10/25/2005 09:37:57		67	27.7	44	84.8	169	163.8	63	115.3	188	53.9	59	37.5	119	53.9	147	17.4	147	353	183	64.4

Lower Fox River Moving Vessel Trials
Test Six

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:39:37		74	160.3	80	141.6	102	117.6	69	92.5	75	148	138	25.8	88	78.8	252	83.2	28	2	78	204.9
1	10/25/2005 09:39:38		65	191.5	132	194	94	160.8	84	127.3	52	1.1	179	55.2	75	17.9	72	136.1	151	317.7	104	344.9
2	10/25/2005 09:39:39		115	59.6	104	15.6	175	76.8	129	94.4	125	46	35	345.2	28	47.9	54	337.2	87	282.6	10	240.9
3	10/25/2005 09:39:40		79	168.3	145	139.5	151	107	151	104.2	212	67.8	62	342.1	120	42.3	187	4.6	71	231.8	120	104.5
4	10/25/2005 09:39:41		12	346	123	59.7	104	136.9	92	98.7	149	80.3	182	271.9	49	49.1	163	106	75	191.6	97	208.9
5	10/25/2005 09:39:42		135	304.2	112	202	42	288	31	104.9	49	49.1	89	101.7	220	80.1	109	36.8	29	110.3	196	34.2
6	10/25/2005 09:39:43		68	62.7	100	84.3	164	251.9	55	164.2	135	117.3	214	101.3	55	39.1	47	141.9	167	278.6	158	65.4
7	10/25/2005 09:39:44		54	317.2	135	260.6	91	155.4	116	112.4	242	82.6	199	46.8	165	102.9	91	179.4	55	146	53	160.2
8	10/25/2005 09:39:45		159	81.7	20	126.9	86	95.3	107	199.1	67	151.5	100	125.3	54	99.6	183	125.4	45	123.3	33	72.1
9	10/25/2005 09:39:46		119	85.2	91	105.9	159	106	75	61.4	60	78.5	152	270.4	128	73.3	161	348.9	62	333	152	16.4
10	10/25/2005 09:39:47		84	107.4	33	328.7	158	172.7	114	216.1	105	190.5	105	139.6	69	66	140	138.5	77	121.2	28	196.5
11	10/25/2005 09:39:48		104	285.6	108	298.2	158	295.1	92	302.1	171	268.3	162	278.5	352	289.8	727	261.3	1698	268.6	1633	259.6
12	10/25/2005 09:39:49		210	76.5	220	71.5	214	69.2	256	38	247	19.4	477	18.7			2633	279.4				
13	10/25/2005 09:39:50		333	80.1	403	50.3	311	38.9	131	54	508	9.2			2499	261.5			3862	269.8		
14	10/25/2005 09:39:51		159	115.3	48	82.9	447	129.6	122	154.3	504	305.4	798	264.1	1269	266.8					892	294.9
15	10/25/2005 09:39:52		495	284.3	398	255.2	705	238.6	1176	255	188	275.8	357	223.1	563	251.2					274	216.2
16	10/25/2005 09:39:53		111	110.6	269	189.2	314	231.9	546	192.4	565	196	776	182.1	803	168.3			411	271.3	434	325.5
17	10/25/2005 09:39:54		219	56.7	275	160.2	320	118.2	228	129.8	485	165.3	739	145.3	585	173.6	547	161.5	217	100.6	221	327.7
18	10/25/2005 09:39:55		146	162.1	437	134.4	296	178.6	422	161.8	902	149.8	592	127	563	107.8	485	107.4	553	71.9	350	9
19	10/25/2005 09:39:56		148	184.3	430	104.1	316	181.6	407	195.2	460	145.3	243	132.5	674	123.4	559	109.3	101	89.4	190	1.2
20	10/25/2005 09:39:57		222	113.9	417	126.1	554	191.6	545	131.1	389	159.7	270	139.1	454	136.8	484	126.7	105	344	409	339.8
21	10/25/2005 09:39:58		277	85	310	136	238	191.4	318	117.7	188	156.2	236	160	263	107.3	287	66.1	557	66.3	298	18
22	10/25/2005 09:39:59		118	128.8	337	234.8	192	152.8	329	156.7	315	128.2	314	176.2	93	181.8	16	14.9	522	85.4	322	23.6
23	10/25/2005 09:40:00		191	152.2	414	114.3	164	163.7	292	147.2	174	118.2	281	126.9	95	35.2	286	21.4	736	71.4	360	25.4
24	10/25/2005 09:40:01		18	286.4	136	168.1	223	157	285	155.5	176	113.5	241	133	93	5.5	168	351.8	67	42	200	57.7
25	10/25/2005 09:40:02		171	258.9	131	231.2	84	165.5	40	140	177	258.2	66	167.8	31	103.1	286	14.4	322	33.3	227	0.8
26	10/25/2005 09:40:03		41	175.8	100	68.3	95	335.1	136	124.5	302	68.2	279	155.2	278	140.2	198	41.7	297	36.4	274	348.9
27	10/25/2005 09:40:04		39	1.5	127	46.9	343	49.4	52	7.7	198	40.9	371	64.5	279	90	93	42.8	179	62.4	155	323.6
28	10/25/2005 09:40:05		124	102.6	108	23.5	138	40.9	235	75.7	219	64.8	115	46.1	240	102.8	385	22	284	357.2	203	344.2
29	10/25/2005 09:40:06		102	115.6	121	66.6	83	67.4	263	58.7	250	33.6	35	323.1	238	54.9	84	86.6	380	2.9	276	343.3
30	10/25/2005 09:40:07		66	356.5	192	95.4	121	220.7	241	0	177	56	177	40.9	169	61.3	177	105.1	159	31.9	178	26
31	10/25/2005 09:40:08		143	56.1	96	110.1	9	180	137	92.9	144	61.8	240	63.8	213	29.8	162	81.5	119	302	83	46.5
32	10/25/2005 09:40:09		179	127.1	130	103.3	175	59.8	47	131.5	265	53.4	145	16.1	180	17.1	50	72.6	93	322.4	206	322.9
33	10/25/2005 09:40:10		172	319	175	246.8	147	108.7	86	70.9	165	52.2	242	27	183	32.7	123	322.9	123	227.6	81	29.7
34	10/25/2005 09:40:11		55	71.9	197	148.9	33	228.7	97	159.5	133	52.4	136	65.3	169	20.5	48	56	43	123.7	32	174.6
35	10/25/2005 09:40:12		173	195.1	188	81.1	214	95.4	176	117	143	149.9	67	30.4	92	79.3	51	350.9	225	244.2	92	148.7
36	10/25/2005 09:40:13		79	137	31	123.2	186	62.1	377	102.6	51	119.6	61	125	59	34	94	5.5	16	345.1	32	306.2
37	10/25/2005 09:40:14		123	195.5	135	275.5	108	81.5	112	77.6	188	89.4	136	63.4	103	96.2	152	41.8	138	5.4	149	39.3
38	10/25/2005 09:40:15		39	117.2	88	191.2	230	179.3	76	121	150	343.7	26	2.2	18	141.8	104	333.2	95	147.5	22	190.3
39	10/25/2005 09:40:16		66	205	222	26.2	55	129.8	138	127.4	77	96.8	98	40	71	116.9	97	93.5	104	85.1	111	1
40	10/25/2005 09:40:17		126	90	171	140.9	210	128.6	226	110	65	77.5	139	114.2	189	30.2	69	68.7	10	11.3	83	267.9
41	10/25/2005 09:40:18		224	85.4	133	87.8	160	112.4	103	112.8	209	83.1	149	38.2	252	45.6	104	77.8	111	9.9	167	247.1
42	10/25/2005 09:40:19		129	121.3	184	89.4	256	92.9	263	100.1	181	55.6	169	41.4	360	58.7	209	89.7	95	220.7	204	201.5
43	10/25/2005 09:40:20		115	65.4	157	96.2	92	32.1	118	359.5	202	356.9	207	65.8	117	48.1	44	48.7	282	89.8	177	91
44	10/25/2005 09:40:21		140	64.5	113	114.1	123	123	103	5.5	193	343.7	54	105.1	203	38.8	136	63.8	151	34.2	96	19.6
45	10/25/2005 09:40:22		97	101.3	169	112.3	160	65.7	59	75.3	146	69.9	210	46	226	60.8	148	91.2	147	93.9	117	44.3
46	10/25/2005 09:40:23		43	309.3	181	116.3	68	118.1	101	349.7	221	58.7	131	54.6	37	93.1	156	90.4	94	126.7	96	134.2
47	10/25/2005 09:40:24		133	89.6	141	123.5	192	96	337	111.9	135	114.1	94	158.9	69	108.7	107	81.4	60	94.8	41	17.1
48	10/25/2005 09:40:25		89	86.1	216	85.5	199	256	24	294.4	115	82	132	16.8	149	27.1	159	340.9	121	303.2	92	56.1
49	10/25/2005 09:40:26		204	33.6	266	39.5	172	56.9	261	41.3	160	112.9	127	62.2	6	189.5	163	351.9	116	15.5	129	77
50	10/25/2005 09:40:27		101	17.4	291	87	60	64.3	198	21.4	212	67.5	112	81.8	142	36.7	2	0	135	74.9	80	77
51	10/25/2005 09:40:28		102	29.3	101	330.4	84	127.3	88	76.9	255	28.1	129	342.4	29	33.7	195	64.9	167	74.4	109	112.1
52	10/25/2005 09:40:29		108	64.1	75	49.9	200	359.7	95	28.2	117	60.8	180	67.4	272	60.5	209	104.1	81	104.2	204	83.8
53	10/25/2005 09:40:30		101	338	64	212.2	227	35.3	74	46.1	165	42.3	230	50.3	123	65.5	340	154.2	92	138.5	91	79.2
54	10/25/2005 09:40:31		65	220	58	182	250	10.8	28	19.1	129	335.8	163	40.5	171	335.1	198	268	121	53	115	54.2
55	10/25/2005 09:40:32		55	225	129	111.8	138	352.1	49	56.6	64	17.3	84	326.7	71	70.3	207	113.3	60	317	152	201.2
56	10/25/2005 09:40:33		70	50.2	164	148.7	152	59.2	125	60.4	150	74.9	69	18.7	76	24.2	152	168.2	128	147.8	163	195
57	10/25/2005 09:40:34		99	245.5	34	55.8	265	61.1	177	82.5	113	33.4	49	104	58	46.4	123	299.7	37	220.6	24	22.2
58	10/25/2005 09:40:35		40	301.7	52	109.1	114	42.5	115	56	113	328	41	1.4	33	21.2	149	218.7	191	188.7	115	130.8
59	10/25/2005 09:40:36		136	338.5	127	5.9	121	72.2	40	101.6	34	238.2	154	358.1	108	342.2	105	104.3	92	237	45	297.7
60	10/25/2005 09:40:37		112	172.8	101	57.1	30	55.8	36	75.6	175	353.1	86	5.3	69	129.7	28	83.9	53	231.8	47	355.1

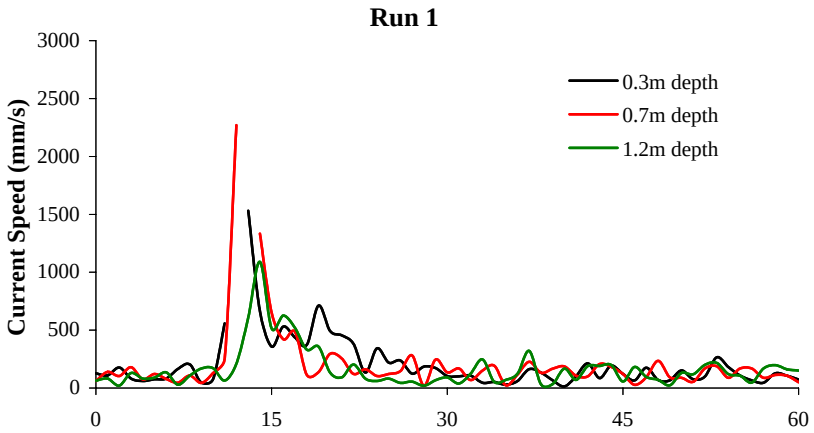
Lower Fox River Moving Vessel Trials
Test Six

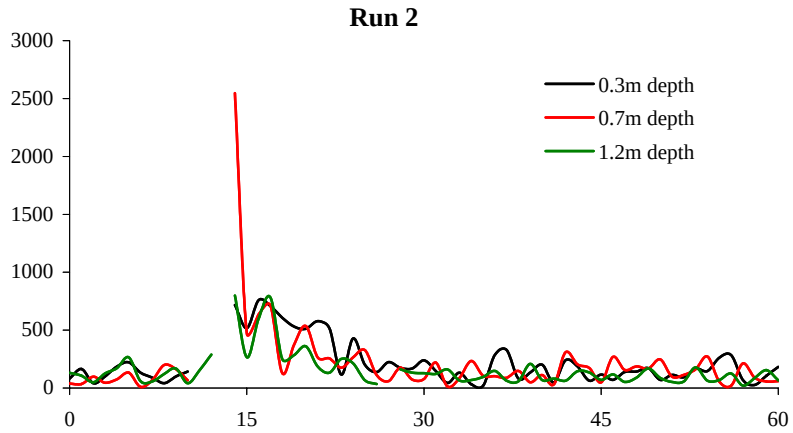
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 4		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:42:06		154	97.4	97	90.6	35	98.1	149	81.1	63	292.5	36	226.1	30	101.7	194	161	110	123.1	246	57.3
1	10/25/2005 09:42:07		49	118.1	142	318.1	64	298.2	41	15.8	110	316.5	165	131.8	79	182.2	76	335.1	88	254.9	161	304.9
2	10/25/2005 09:42:08		48	31.4	68	61.2	64	54.6	105	59.8	57	42.1	71	67.8	120	138.7	88	21.3	40	20.7	134	261.4
3	10/25/2005 09:42:09		75	122.4	25	323.1	85	349.1	96	341.2	30	46.3	82	61.6	62	273.7	72	218.8	136	99.7	110	40.2
4	10/25/2005 09:42:10		70	185.7	38	74.9	141	67.1	187	55.5	76	22.5	53	72.6	93	354.5	102	324.6	113	332.5	122	27.8
5	10/25/2005 09:42:11		58	49.2	24	112.2	61	59.2	176	88.7	174	75.3	85	144.1	24	213	213	224.4	84	148.2	70	135.6
6	10/25/2005 09:42:12		119	129.2	120	99.1	74	0.8	25	78.2	56	115.2	45	330.6	47	38.1	226	328.2	74	239.3	52	100
7	10/25/2005 09:42:13		72	42.2	81	97.1	104	105.1	65	98	29	52	87	22.2	77	18.9	89	316.8	128	258.3	166	87.6
8	10/25/2005 09:42:14		61	116.1	110	235.7	130	113	115	17.7	83	63.4	145	348.8	120	204.6	79	151.2	95	53.1	121	32.9
9	10/25/2005 09:42:15		98	334	82	202.8	107	335.6	26	105.6	200	69.8	122	4.7	163	80.5	69	356.7	82	47	163	8.5
10	10/25/2005 09:42:16		82	352.3	104	63.7	89	103.7	73	56.1	67	318	64	347.3	131	252.3	203	314	39	271.5	172	245.7
11	10/25/2005 09:42:17		101	151.7	92	120.7	105	212.9	85	302	42	75	123	356.7	206	280.7	140	172.6	187	199.4	48	90
12	10/25/2005 09:42:18		115	91.5	18	303.7	102	27.6	75	13.1	191	24.1	222	325.5	2126	255.5	2115	258.5				
13	10/25/2005 09:42:19		264	56.7	191	53.1	325	47.9	439	43.1			2380	264.5								
14	10/25/2005 09:42:20												491	219.1	811	280.8			2478	259.5	1864	255.4
15	10/25/2005 09:42:21		1936	80.5	1221	88.1			877	140.1							1516	232.6			857	284.5
16	10/25/2005 09:42:22		708	117.4	578	97.5	873	139.6	535	143.5	963	167.8	1069	195.1	1097	213.2	945	227.1	85	160.1	144	165.5
17	10/25/2005 09:42:23		569	137	589	177.8	789	198.2	864	156.6	524	183.3	499	196.3	318	266.2	725	164.5	163	238.1	246	303.9
18	10/25/2005 09:42:24		293	75.4	457	185.1	1073	189.2	838	176	466	203.1	335	328.2	564	334.1	190	234.2	155	186.3	170	57.2
19	10/25/2005 09:42:25		155	6.7	259	185.3	572	144.2	693	160.7	476	171.2	287	236.4	310	126.6	560	110.9	266	174.4	66	75.1
20	10/25/2005 09:42:26		217	55.1	290	145.8	292	124.4	336	150.6	242	205.2	228	290.8	793	359.1	375	108.2	129	101.7	292	268.8
21	10/25/2005 09:42:27		66	148	157	202	435	220.8	626	204.4	458	214.3	53	239.6	367	228.8	398	163.5	98	58.7	84	290.2
22	10/25/2005 09:42:28		116	311.1	93	170.1	326	211.2	350	241.2	486	224.2	231	205.3	331	185.7	121	66.6	259	58.6	314	66.7
23	10/25/2005 09:42:29		130	250.2	117	180.5	171	294.5	408	222.9	267	235.8	297	239.9	276	260.2	274	126	125	359.1	170	50.2
24	10/25/2005 09:42:30		136	102.3	232	174.8	139	267.9	149	186.6	213	174.9	277	229.8	228	224.5	248	176.8	82	318	268	71.3
25	10/25/2005 09:42:31		38	100.7	165	53.6	219	114	27	243.4	176	219.5	331	181.9	383	195.1	381	182.7	303	100.8	168	91.7
26	10/25/2005 09:42:32		180	36	122	18.6	227	98.1	158	144	222	173.3	93	168.2	137	221.5	301	198.2	36	62	77	77.2
27	10/25/2005 09:42:33		180	18.1	88	45.5	256	176.6	192	189.6	309	177.6	210	148.8	171	166.1	72	149.2	138	220	77	125.5
28	10/25/2005 09:42:34		104	31.2	107	81.9	334	89.7	145	160.7	408	146	426	147.3	245	87.7	59	158.2	45	354.9	147	87.7
29	10/25/2005 09:42:35		264	74	156	93.3	144	150.1	175	112.2	269	106.6	202	144.7	162	172.6	51	277.8	37	4.6	43	308.5
30	10/25/2005 09:42:36		167	102.1	287	70.7	224	80.2	177	110.5	113	95.6	215	142.2	162	175.4	174	143.2	23	149	90	347.2
31	10/25/2005 09:42:37		202	78	257	98.9	198	84.8	309	108.9	142	108.9	90	108.8	147	187.8	201	164.4	20	49.1	127	32.8
32	10/25/2005 09:42:38		194	147.2	371	86.9	171	108.4	166	119.2	114	75.2	120	67.9	52	108.1	72	133.9	96	41.2	262	18.5
33	10/25/2005 09:42:39		189	141	199	92.6	449	98.6	76	88.5	140	115.5	178	131.6	62	186.4	186	15.3	176	35.3	170	356
34	10/25/2005 09:42:40		163	91.8	135	134.1	154	82.6	165	144.4	215	175.2	224	180	254	193.7	147	238.9	71	24	20	26.6
35	10/25/2005 09:42:41		219	215.5	387	150.1	177	115.8	260	134.4	48	139.3	145	184.7	95	266.4	55	264.8	318	272.3	188	290.3
36	10/25/2005 09:42:42				131	39.7	130	152.1	13	184.4	164	18.9	151	219.1	97	59.7	78	18.7	128	305.4	154	329.9
37	10/25/2005 09:42:43		168	95.1	187	40.4	143	235	225	149.9	119	115.5	79	185.8	237	167.3	142	300.5	188	272.7	89	212.1
38	10/25/2005 09:42:44		187	105.2	171	78.9	234	61.1	126	185	190	129.9	210	179.5	143	169.1	97	104.9	118	60	121	20.2
39	10/25/2005 09:42:45		147	318.3	87	118.9	133	49.9	49	30.8	51	198.4	122	273.8	31	168.7	177	235.1	124	126.1	88	286.6
40	10/25/2005 09:42:46		137	74.3	144	105.3	65	195.1	117	180.5	172	130.7	94	75.8	41	279.9	141	190.6	27	74.9	110	103.7
41	10/25/2005 09:42:47		163	68.8	33	135	85	326.5	81	157.5	200	185.5	45	167.2	71	270.8	60	122.1	103	105.3	29	337.8
42	10/25/2005 09:42:48		90	50.8	109	95.8	121	74.1	48	56	123	246.6	119	253.4	82	269.3	82	175.8	94	149.3	140	182
43	10/25/2005 09:42:49		278	88.1	193	107.5	81	149.6	41	344.2	125	109.6	186	104.3	145	199.3	258	106.5	149	93.8	168	71.6
44	10/25/2005 09:42:50		139	130.9	228	198.9	176	154.7	111	113.3	190	99.4	203	106	183	177.2	266	153.9	138	85	187	39.6
45	10/25/2005 09:42:51		231	94.2	361	98.4	143	144.6	89	117.4	154	82.6	167	148.2	111	202.2	113	218.9	136	131.4	96	165.5
46	10/25/2005 09:42:52		77	65.4	99	81.9	224	133.5	85	199.9	82	99.1	88	31.5	107	112	94	79.5	30	178.1	22	206.6
47	10/25/2005 09:42:53		252	127.9	241	138.4	258	133	231	134.5	47	211	150	116.1	57	4	62	220.4	100	245.7	62	185.5
48	10/25/2005 09:42:54		151	136.9	178	104.3	206	145.3	195	115.1	168	62.7	125	92.7	128	3.6	90	308.7	58	89	48	331.3
49	10/25/2005 09:42:55		180	109.8	260	118.7	295	115.5	208	142.8	153	54.5	188	67.8	123	73	185	18.9	97	141.7	56	52.3
50	10/25/2005 09:42:56		152	131.5	144	192.9	173	182.3	239	137.7	137	101.4	183	70.6	127	105	168	132.8	155	79.6	141	358.4
51	10/25/2005 09:42:57		181	158.7	224	125.7	185	154.4	105	115.3	166	156.2	79	56.9	60	105.4	125	120.9	148	43.6	181	41.2
52	10/25/2005 09:42:58		123	192.2	110	128	212	146.8	180	222.3	30	207.4	124	139.9	126	234	96	81	29	153.4	21	295.3
53	10/25/2005 09:42:59		175	134.1	18	206.6	158	127	131	231.2	90	168.4	119	139.1	40	67.9	72	23	189	52.5	148	65.7
54	10/25/2005 09:43:00		47	293.8	65	197.9	73	108.4	119	145.6	193	173.2	213	118.2	184	90	141	83.1	39	53.4	86	336.7
55	10/25/2005 09:43:01		118	89	130	93.5	148	147.2	60	201.4	116	103.4	121	109.3	104	76.1	109	326.6	133	103	26	337.4
56	10/25/2005 09:43:02		90	171.1	54	126	14	265.9	86	83.3	151	109.8	226	44.8	54	132.8	163	130.5	82	61.6	55	312.1
57	10/25/2005 09:43:03		55	79.5	55	304.6	77	340.4	229	82.2	70	44.4	89	34	145	100.8	222	84.3	159	96.5	188	36.6
58	10/25/2005 09:43:04		24	357.6	157	0.7	93	325.5	79	47.6	33	74.3	125	64.9	65	36.9	190	11.5	120	205.7	115	119.2
59	10/25/2005 09:43:05		199	25	130	7.9	79	56.3	119	76.9	117	228.8	59	41.6	37	341.1	59	80.2	101	143.5	40	108.9
60	10/25/2005 09:43:06		127	308.9	124	49.2	95	98.5	148	52.1	102	137.4	165	74.9	38	357	148	96.2	49	162.3	111	138.7

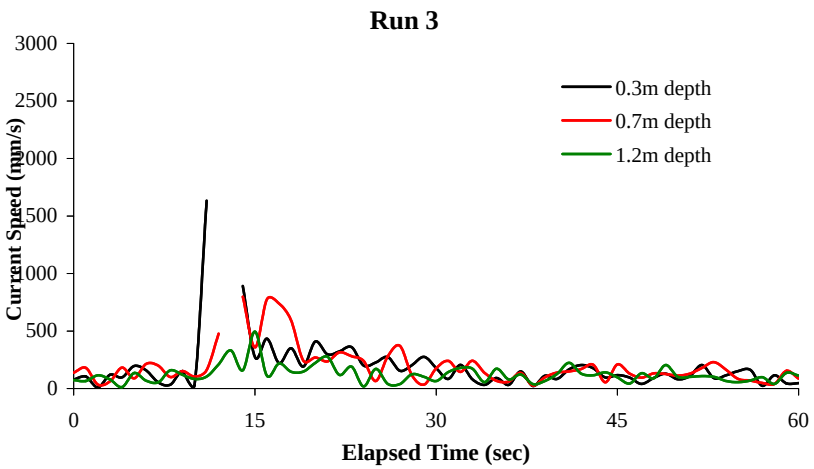
Fox River Propwash Study - Moving Vessel Trials

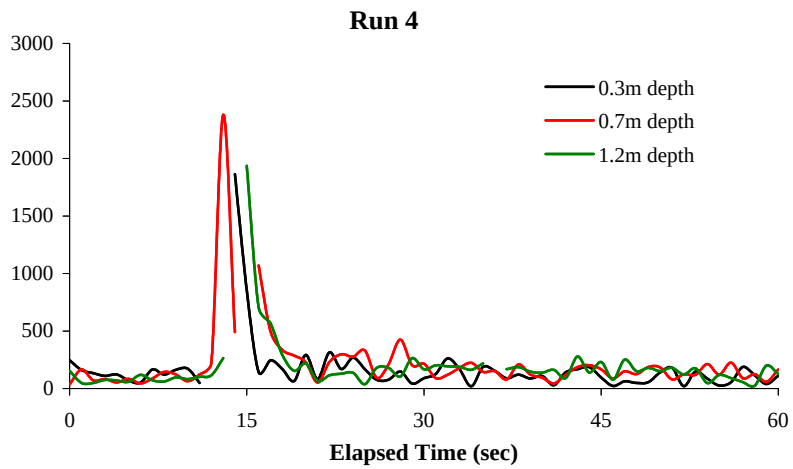
Test #6: Single-Prop Vessel - 1300 RPM - Pitch Up 10

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Seven

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:49:46		80	154.1	117	208.5	88	272.6	162	259.3	115	292.5	163	244.2	20	258.7	67	69.1	124	135.7	72	118
1	10/25/2005 09:49:47		268	272.8	41	342.9	111	290.6	82	264.4	187	269.1	121	247.2	65	214.4	82	295.9			40	259.8
2	10/25/2005 09:49:48		143	253.7	348	269.7	313	258	353	269.7	332	260.1	409	236	2418	252.2	2576	253.9				
3	10/25/2005 09:49:49		625	51.3	639	46.1	610	49.8			2994	244.9	2995	244.2							407	87.2
4	10/25/2005 09:49:50		824	347.3	378	354.8			162	21	661	333.2										
5	10/25/2005 09:49:51																				243	266
6	10/25/2005 09:49:52						399	71.9											504	354.2	353	54.5
7	10/25/2005 09:49:53				282	359.8			244	41.7	384	0.7	688	61.9	579	57.2			887	354.6	832	40.9
8	10/25/2005 09:49:54		388	322	297	317.6	187	307.6	287	345.5	292	46	251	55.9	235	59.3	184	30.7	301	350.8	504	4.6
9	10/25/2005 09:49:55		313	325.3	432	352.2	666	350.5	505	339.1	447	346.4	294	328.9	207	333.6	154	352.9	457	348.2	434	335.8
10	10/25/2005 09:49:56		503	353.5	487	339.3	719	301.5	488	348.4	476	336.5	352	9.3	181	20.7	417	351.3	421	347.5	425	11.7
11	10/25/2005 09:49:57		616	84.8	930	79.7			237	358.1	246	54.2	318	74.9	320	94.3	151	136.6				
12	10/25/2005 09:49:58		530	18	506	21.2	400	350.7	399	291.3	643	73.4	852	78.8	900	85.4			542	49.9	334	1.5
13	10/25/2005 09:49:59		284	4	399	331.6	590	278.4	667	260.3	377	285.7	353	282.8	287	266.4	271	288.7	368	1.7	547	4.3
14	10/25/2005 09:50:00		167	75.8	774	78.1	804	76.8	774	70.3	530	48.4	278	5.8	354	319.5	291	310.5	121	275.2		
15	10/25/2005 09:50:01		128	33.2	153	57.6	449	80.8	390	78	556	75.6	657	67.9	607	71.7			578	29.3	528	317.9
16	10/25/2005 09:50:02		338	56.2	492	47.6	644	59.4	439	82	283	118.5	241	142.4	618	91.6			266	90.4		
17	10/25/2005 09:50:03		231	44.3	368	45.5	426	71.8	454	32.8	339	70	627	95.6	245	110.6			289	253.5	196	355.9
18	10/25/2005 09:50:04		156	66.6	804	83.1	324	89.3	264	84.4	503	88.6	710	77.1	321	93.9			210	66.5	345	8.3
19	10/25/2005 09:50:05		360	107.5	352	82.5	362	64.8	467	83	647	78.3	513	87.9	70	59	422	99.4	291	94.9		
20	10/25/2005 09:50:06		256	59.7	526	75.4	383	84.6	475	89.6	716	81.7	468	96.7	455	105.4			670	62.7	193	353.8
21	10/25/2005 09:50:07		135	359.6	368	292.7	370	280.9	57	322.1	160	104.8	290	66.6	56	17.8			154	27.1	256	324.7
22	10/25/2005 09:50:08		160	354.6	168	305.3	263	288.2	278	288.7	169	319.1	216	297.3	420	57.6	99	95.2	135	27.9	54	0
23	10/25/2005 09:50:09		134	354.8	321	37	240	357.4	166	327.6	117	33.1	241	289.4	78	287			41	34.1	68	79.8
24	10/25/2005 09:50:10		364	17.1	219	291.4	47	91.2	275	20.4	118	35.7	193	260.7	382	138.9	340	180.2	207	233.5	61	98.5
25	10/25/2005 09:50:11		140	242.3	132	63	110	37.6	216	78	254	14.6	404	82.6	52	106.7	150	80.4	97	219.6	288	84.6
26	10/25/2005 09:50:12		105	236.3	79	74.6	145	58.5	110	23.1			117	48.8	253	67.9					153	87.8
27	10/25/2005 09:50:13		181	47.7	552	267.2	462	268.9	271	282.6	201	278.9	184	256.8	84	235.2	219	278.1	61	207.4	143	217.9
28	10/25/2005 09:50:14		276	10.5	326	273.3	675	275.6	530	270	661	278.8	402	273.6	323	319.9			145	54.6	101	31.6
29	10/25/2005 09:50:16		421	66.6	68	69.4	140	53.7	350	255.3	305	274.7	201	249	129	224.1	311	187.6	225	177.7		
30	10/25/2005 09:50:17		293	8.6	314	292.5			286	306.9	269	334.2	222	353.8	312	292.5			301	55.4	153	17.1
31	10/25/2005 09:50:18		111	105.7	310	82.8			246	39.7	380	92.7	269	102.2	38	324.6	101	197.9				
32	10/25/2005 09:50:19		261	60.4	352	73.3	358	67.3					184	67.6	135	292.6	200	340.1	115	5	151	357
33	10/25/2005 09:50:20		364	95	271	107	375	98.1			239	59.6	127	92.7	122	271.4	85	305.4	295	284.3	264	269.3
34	10/25/2005 09:50:21		603	87.1	509	86.6			433	96.1	634	73.6	184	109	46	37.1	182	221.7	27	328.7	109	290.4
35	10/25/2005 09:50:22		382	106.3	343	100.8			573	76.1	338	77.2	439	78.2	363	98.9	15	148.4			207	17.7
36	10/25/2005 09:50:23		252	105	220	83.7	231	86.3			143	132.7			116	148.8	267	52.9	136	288	180	31.6
37	10/25/2005 09:50:24		299	45.9	267	24.6	224	64	211	314.6	158	258.7			149	35.7	51	34.6	111	80.1	162	341.2
38	10/25/2005 09:50:25		354	55.6	331	61.7	349	31.6	440	49.8	56	4.1			162	267.9	154	166.1	53	68.8	61	256.7
39	10/25/2005 09:50:26		134	309.5	101	354.3	156	8.9	271	292.8	175	203.9	233	27.7	100	22.2	173	239.4	116	83.6	50	129.4
40	10/25/2005 09:50:27		121	113.8	211	122.6	238	273.9	392	279.5	139	350.1	48	280.8	84	105.2	207	65.4	44	62.9	127	70.7
41	10/25/2005 09:50:28		242	87.4	198	307	257	286.7	532	261.7	473	269.4			21	50.9	23	87.5	231	82.3	22	277.8
42	10/25/2005 09:50:29		117	67.4	64	223.1	86	323.5	235	209.3	359	255	283	275.7	208	359.4			52	248.4	54	87.9
43	10/25/2005 09:50:30		159	25.8	73	105.2	253	276.8	214	305.1	272	331.5	153	333.9	82	105.6			173	328	114	338.9
44	10/25/2005 09:50:31		157	28.5	177	86.4	73	41.1	79	172	92	341.6	142	319	247	15			98	18.4	123	330.7
45	10/25/2005 09:50:32		267	55.2	169	65.1	154	70.3	136	21.5	136	7.6	118	295	115	339.7	309	277.4	119	6.8	165	12.9
46	10/25/2005 09:50:33		191	354.9	8	150.3	207	46.2	163	73.6	170	327.2	264	303.3	182	20.6			93	11.2	99	325.7
47	10/25/2005 09:50:34		212	46.9	116	70.3	197	262.7	178	20.4	335	50.9	218	320.8	132	340.1	52	138.9	157	323.3	139	26.9
48	10/25/2005 09:50:35		132	331.5	68	103.6	145	286.1	103	190.1	152	60.1	84	175.2	110	336.5	291	29.2			181	77.6
49	10/25/2005 09:50:36		119	62.6	339	78.1	236	58	93	34	122	329.4	72	322.3	83	201.3	54	275.3	200	69.5	111	25.6
50	10/25/2005 09:50:37		122	156.8	161	78.6	417	86.1	217	86.3	155	23.9	95	314.6	101	46.2	216	35.4	274	242.4	28	278.1
51	10/25/2005 09:50:38		224	76	389	74.2	265	90	119	66.7	109	327.8	226	57.1	99	68.6	255	270	257	294.4	179	60.6
52	10/25/2005 09:50:39		465	94.6	198	102.6	218	82.1	23	118.8	115	98.5	158	42.2	103	318.6			47	270	85	267.3
53	10/25/2005 09:50:40		315	92.7	371	86.8	206	80.2	232	51.6	215	28.6	288	54.8	115	348.5			116	173.1	182	315.7
54	10/25/2005 09:50:41		165	111.3	241	67.6	112	353.8	203	75.4	125	38.2	39	120.5	234	275.4			213	71.4	110	308
55	10/25/2005 09:50:42		135	67.4	189	316.1	141	45.6	107	116.1	150	352	232	311.3	30	331.7			40	29.7	83	341.1
56	10/25/2005 09:50:43		274	72.2	241	80.9	57	76.7	48	29.7	162	255.4	180	285.8	80	46.5	67	225.6	119	228.4	73	8.7
57	10/25/2005 09:50:44		141	99	369	70.9	234	21.1	216	54.6	141	24.4	165	280.1	241	269	114	289.4	122	51	89	311.4
58	10/25/2005 09:50:45		172	60	258	54	247	57.4	212	63.3	102	3.4	162	276.7	81	282.1			105	270.5	51	325.4
59	10/25/2005 09:50:46		423	57.4	360	44.9	205	40.1	166	16.8	166	349.2	166	293.5	207	21			45	310.5	81	49
60	10/25/2005 09:50:47		46	31.6	194	43.3	90	318.2	63	142.8	268	303.6	165	358.6	101	44.6			184	274.4	42	114.1

Lower Fox River Moving Vessel Trials
Test Seven

Run 2

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
0	10/25/2005 09:57:48	57	88	186	111.7	218	92.4	224	70.7	78	98.1	77	280.4	62	172.5			66	41.9	129	4.9
1	10/25/2005 09:57:49	102	39	74	53.3	282	67.4	69	10	175	24.4	24	332.4	84	317.4			90	304.6		
2	10/25/2005 09:57:50	33	130	192	71.8	219	72.1	60	141	156	16.8	385	58.5	143	15.4			48	277.1		
3	10/25/2005 09:57:51	235	93.4	187	77.3	315	81.4	294	98.4	72	45	74	318.3	75	30.3			131	89.6		
4	10/25/2005 09:57:52	117	254.7	120	96.7	45	57.7	122	72.9	56	248	115	260	122	39.7			123	251		
5	10/25/2005 09:57:53	268	138.3	96	87.6	153	352.1	263	357.2	44	315	39	72	172	287.3			114	75.8		
6	10/25/2005 09:57:54	22	65.8	200	112.3	113	20.7	79	53.3	139	3.7	94	297.9	121	95.2			75	127.9		
7	10/25/2005 09:57:55	99	109.5	34	61.9	126	275.9	68	356.6	184	37.9	111	99.3	129	315.9			236	250.7		
8	10/25/2005 09:57:56	191	287.7	140	267.5	216	260.7	115	278	157	282.5	246	241.4	86	313.6	146	14.3	104	216.4		
9	10/25/2005 09:57:57	54	226.5	261	298.3	62	150.1	74	329.3	192	18.8	179	350	115	324.9	114	204.3	139	96.6		
10	10/25/2005 09:57:58	85	340.1	110	12.6	93	112.7	39	31.2	51	341.6	165	74.9	197	236.1	108	244.9	146	322.5		
11	10/25/2005 09:57:59	109	247.9	121	240.9	24	155.6	58	267	181	305.1	194	256	200	282.7	433	244.1	318	247.2	128	18.7
12	10/25/2005 09:58:00	210	96	203	83.8	31	350.8	82	260.9	120	222.6	514	131.4	2587	240.6	3517	242.7				
13	10/25/2005 09:58:01	799	41.3	905	44.5	1035	43.1	1184	45.2												
14	10/25/2005 09:58:02	201	37.3	86	8	335	233.1	262	240.2	233	321.5	217	210.5	906	224.7			717	276.6	1479	251
15	10/25/2005 09:58:03	280	322.7	378	296.4	327	357.2	114	181.5	162	323.6			292	244.2	380	346.6	139	219.4	199	280.7
16	10/25/2005 09:58:04	1446	0.8	713	39.4	363	302.5	401	4.6	589	327.8							169	229.1	254	60.8
17	10/25/2005 09:58:05	561	302.9	394	345.3	274	352.9	315	301	588	289.3	341	296.5	273	329.1			175	49.6	54	36
18	10/25/2005 09:58:06	290	3.4	577	3.4	397	350.1	845	286.8	591	249.3	910	251.2	535	243.3					107	332.7
19	10/25/2005 09:58:07	562	63.3	303	45.4	483	72	419	97.4	50	40.1	240	311.1							272	3.8
20	10/25/2005 09:58:08	297	73.2	157	346	253	328.9	513	295.7	209	211.1	376	252.2	508	264.4						
21	10/25/2005 09:58:09	513	76.4	538	20.5	494	11.1	355	355.3	216	358.4	163	37.8	120	43	400	341	291	335.5	394	338.4
22	10/25/2005 09:58:10	672	19.8	248	42.1	215	142.2	308	128.8	344	122.9	358	164.6	283	101.2			47	272.4	141	339.3
23	10/25/2005 09:58:11	96	150	512	170.8	300	237.4	306	71.5	163	242.7	254	190.2	295	188.6	302	164.8	44	6.5	176	60.7
24	10/25/2005 09:58:12	189	353.9	28	198.4	142	324.7	368	8.1	332	267.4	230	149.8	84	126.7	224	167.6	651	41.7	391	2.2
25	10/25/2005 09:58:13	525	324.9	462	344.4	262	11	30	197.2	223	284.8	65	2.6	121	347.1	189	271.2	315	354.7	314	25.1
26	10/25/2005 09:58:14	447	4.8	190	353.1			248	74.6	110	49.1	289	86.6	227	115			484	24	394	26.2
27	10/25/2005 09:58:15	542	93.5	653	78.2	150	56.4	145	314.7	187	43.5	584	106.4	198	242.7	240	106.7	238	49.4	47	38.1
28	10/25/2005 09:58:16	692	96.4			374	115.8	421	258.9	116	64.5	225	201.7	354	119.5			592	78.4	205	51.3
29	10/25/2005 09:58:17	443	92.8	748	59.2	96	85.2	490	262.5	296	274.1	340	262.6	222	353	155	106.1	243	95.2	68	281.8
30	10/25/2005 09:58:18	267	71.4	241	106.6			223	227.4	164	294.5	201	265.4	116	186.4			276	40.9	187	20.4
31	10/25/2005 09:58:19	45	82.4	84	106.7	88	295.7	17	66.4	126	291.5	150	74.9	95	260.3			201	8	201	61.5
32	10/25/2005 09:58:20	357	271.3	303	260.7	229	115.3	285	105.9	225	108.4	139	116	441	63.3	210	331	187	313.9	145	21.8
33	10/25/2005 09:58:21	44	123	208	254.7	48	168	140	115.5	369	83.5	309	90	526	62.2	254	34.1	65	73.8	244	19.4
34	10/25/2005 09:58:22	108	238.2	152	138.2	206	73.3	99	173.6	261	282	269	116.8	146	224.7	162	347.5	159	302.7	177	324.9
35	10/25/2005 09:58:23	200	257.9	163	216.5	195	185.6	204	93.4	169	39.7	88	332.9	93	76.3	244	27.3	255	0.9	410	3.6
36	10/25/2005 09:58:24	132	253.2	49	258.2	43	82.1	170	120.3	261	169.9	244	256.8	208	49.5	280	48.9	99	141.2	237	61.8
37	10/25/2005 09:58:25	240	303.6	105	36.9	223	279	277	267.9	369	286.7	378	281	156	270.7	249	309.6	268	351.8	365	38.3
38	10/25/2005 09:58:26	106	348.1	299	322.3	322	282.6	119	274.3	467	276.9	532	276.4	273	259	275	350	184	36.4	176	46.6
39	10/25/2005 09:58:27	101	282	160	282.6	130	257.6	296	286.7	508	293.1	663	293	155	328.2	307	340.6	299	355.6	186	27.3
40	10/25/2005 09:58:28	136	27.5	88	114.2	280	31	265	35	356	300.7	292	307.3	132	31.4	203	44	42	34.4	140	109.6
41	10/25/2005 09:58:29	94	50.6	136	303.9	139	276.2	59	297	387	275.2	319	266	214	337.2	519	20	185	355	134	68
42	10/25/2005 09:58:30	56	100.3	213	273	28	253.5	245	259.2	65	283.4	23	336.8	71	36.4			135	53.7	145	25
43	10/25/2005 09:58:31	84	29.9	237	260.3	174	284	159	271.8	152	56.8	75	262.3	124	238.9			78	64.1	216	101.8
44	10/25/2005 09:58:32	161	27.7	120	297.8	207	37.8	172	46.7	124	84.9	193	38.9	318	278.1			47	45	44	221.3
45	10/25/2005 09:58:33	244	295.2	43	338.2	117	41.2	276	69	111	166.5	175	50.1	279	74	294	187.2	167	284.2	69	322.6
46	10/25/2005 09:58:34	102	331.2	154	235.1	213	192.2	347	49.2	112	339.6	144	310.8	121	70.7	98	207.3	53	321.8	130	12
47	10/25/2005 09:58:35	21	43	143	225.6	407	278.3	173	319.7	128	318.8	70	248.2	228	56.4	248	249	92	242	112	83.8
48	10/25/2005 09:58:36	161	26.9	135	272.5	218	315.2	151	46.3	192	74	142	138.7	299	93.6	46	66.8	115	205.2	92	164.3
49	10/25/2005 09:58:37	213	99.2	225	15	73	326.1	226	94.6	170	201	176	144.2	419	87.7	324	154.6	88	84.8	59	89
50	10/25/2005 09:58:38	105	15.5	120	132.3	169	287.6	229	241	183	200.8	139	246.2	418	78.4	299	126.3	63	79	106	40.8
51	10/25/2005 09:58:39	199	5.2	115	84	218	215.3	153	209.4	96	189	114	167.8	230	118.8			133	79.2	180	71.9
52	10/25/2005 09:58:40	128	92.7	173	94	118	84.1	460	93.5	151	156.7	286	210	258	142.6			96	162.3	229	95.3
53	10/25/2005 09:58:41	119	80.8	308	124.4	218	134.6	135	114.1	389	134.6	368	193.4	239	142.1	93	85.7	46	96.2	207	70.5
54	10/25/2005 09:58:42	152	23.2	97	177.6	244	138.8	298	105.6	285	151.5	190	122.8	350	173.1			103	273.9	105	162.8
55	10/25/2005 09:58:43	96	11.4	138	87.5	276	94.6	396	102.8	143	182.4	398	239	199	205.3			155	158.4	127	98.6
56	10/25/2005 09:58:44	170	4.7	119	328.5	79	303.1	156	224.7	337	262	248	220.6	242	183.1	116	59.5	152	76.7	50	113.5
57	10/25/2005 09:58:45	187	332.6	247	9.5	82	74.4	370	229.9	155	198.4	31	166.9	92	113	188	143.9	129	176.9	88	111.9
58	10/25/2005 09:58:46	179	23.4	77	70.4	390	249.6	329	232.8	160	93.2	116	224.3	102	161.7	185	90.3	220	233.1	143	125.4
59	10/25/2005 09:58:47	176	29.3	92	109	548	273.8	275	294.7	22	300.1	97	36.6	105	226.9	209	110.8	174	172.1	245	133.8
60	10/25/2005 09:58:48	228	29.4	94	353.9	463	266.4	201	240.5	390	256.6	123	256.9	65	164.9			120	110.6	244	77.7

Lower Fox River Moving Vessel Trials
Test Seven

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:00:47		182	67.4	130	229.4	191	256	124	39.5	103	285.3	105	302.2	227	72.3			89	27.4	37	240.6
1	10/25/2005 10:00:48		162	58.4	108	220.9	87	206	164	160.3	94	232.8	49	272.3	27	357.9	47	58	233	281.1	58	264.1
2	10/25/2005 10:00:49		119	108.6	142	204.9	60	129.6	99	158.1	170	45.2	244	38.2	44	345.7			43	7.9	106	327.4
3	10/25/2005 10:00:50		130	110.7	180	254.6	110	41.7	183	32.7	116	43.6	104	278.3	145	305.8	117	218.7	36	74.1	81	150.3
4	10/25/2005 10:00:51		102	130.2	40	299.7	122	152.2	81	222.5	116	205	187	261.7	144	242.7	61	251.9	204	55.6	187	243.7
5	10/25/2005 10:00:52		174	100.3	262	244.4	117	198.4	178	216.1	22	339.1	128	49.1	77	30.6	178	299.3	46	176.3	168	265.5
6	10/25/2005 10:00:53		155	103.1	88	314.5	98	242.7	49	78.2	34	190.3	119	294.8	104	318.5	81	317	40	150.3	80	167
7	10/25/2005 10:00:54		338	76	198	35.9	70	25.5	80	344.1	85	337.9	174	306.3	102	18.3			110	274.7	60	51
8	10/25/2005 10:00:55		228	98.3	59	79.3	89	334	56	5.1	110	242.3	82	292.2	223	273.1			311	248.1	94	133.7
9	10/25/2005 10:00:56		75	73.7	143	223.9	104	265.6	110	332.5	101	290.2	142	299.6	168	304.8	316	249.6	167	273.1	108	262
10	10/25/2005 10:00:57		138	73.5	148	232.1	141	280.2	153	183	86	197	357	266.5	126	357.3	49	182.3	82	62.5	37	292.4
11	10/25/2005 10:00:58		299	228	205	166.8	112	88	121	217.2	270	205	402	209.8					3084	247	3082	247.4
12	10/25/2005 10:00:59		770	46.8	782	41.9	858	52.2	853	41.8	1510	242.9	2837	246.6								
13	10/25/2005 10:01:01		102	14.7	154	278.6	550	260	90	312.7	125	56.4	353	255.1	605	238.9			949	269.1	922	278.4
14	10/25/2005 10:01:02		100	326.8	91	74.7	140	350.5	353	277.2	773	272.2	354	329.6	400	266.7			350	288.3	422	315.7
15	10/25/2005 10:01:03		221	6.2			400	298.5	297	29.9	508	51	503	33.3					48	290.7	19	55.5
16	10/25/2005 10:01:04		361	41.7	383	0	369	3.7	111	83.3	613	356.4	645	347.5							148	353.4
17	10/25/2005 10:01:05		482	26.6	338	19	143	352.8	196	348.5	99	322	197	293.7	330	285.3	473	300.4	87	9.2	175	22.2
18	10/25/2005 10:01:06		268	359.6	575	334.5	770	335.5			746	260.5	263	261.9	151	20.6			322	318.1	193	288.7
19	10/25/2005 10:01:07		60	157.3	262	313.9	449	318.7	636	309.4			269	263.4	545	243.8	336	256.4	199	311.9	171	11.8
20	10/25/2005 10:01:08		277	315.6	414	294.2	319	309.5	535	308.1	387	308	303	51.7	196	318.5			283	31.7	306	16.3
21	10/25/2005 10:01:09		320	306.5	238	288.6	269	265.3	615	284.3	488	281.1	328	266.7	265	282.2	170	291.4	403	301.4	368	351.9
22	10/25/2005 10:01:10		141	280.6	311	243.7	109	259.4	365	272.8	576	286.9	449	287.1	279	297.8	168	268.6	190	330.7	311	16.6
23	10/25/2005 10:01:11		178	325.1			573	264.8	156	276.6	334	296.9			151	39.4			541	78.3	196	56.5
24	10/25/2005 10:01:12		110	49.1	450	24.6	439	274.2	750	291.3	698	283.8	476	261.3	257	242.1			228	43.2	141	78.5
25	10/25/2005 10:01:13		273	2.1	249	88.8	258	79.5	376	279.8	295	275.6	451	293.9	309	44.6			152	275.7	90	84.9
26	10/25/2005 10:01:14		173	128.2	209	146.9			204	306.4	220	295.6	128	323	252	329.5	501	274.8	181	313.7	262	29
27	10/25/2005 10:01:15		201	195.9			107	204.4	116	141	83	109.1	233	310.1	530	302.8			171	309.5	178	43.9
28	10/25/2005 10:01:16		90	240	113	202.5			135	297.9	115	267.5	153	240.3	184	172.8	115	31.9	109	0.5	290	15
29	10/25/2005 10:01:17		147	200.6	43	127.4			267	284.6	144	271.6	186	237.1	261	273.7	227	18.5	264	305.6	304	337
30	10/25/2005 10:01:18		45	133.2			315	52.5	121	120.2	231	293.8	257	274.5	217	335.2	267	338.9	64	320.1	156	39.5
31	10/25/2005 10:01:19		209	357	296	44.2	318	58.9	81	16.4	107	334.6	284	268.4	314	269.8	276	269.6	93	297.7	154	22.9
32	10/25/2005 10:01:20		240	83.3	263	85	36	131.6	44	125.8	145	342.7	120	281	150	313.9			164	12.7	101	54.3
33	10/25/2005 10:01:21		364	42.8	282	93	40	124.9	291	233.1	201	258.8	147	289.9	360	292			187	5.5	273	61.4
34	10/25/2005 10:01:22		83	340.3	170	135	262	219.9	292	243.3	497	250.4	464	267.4	223	315.7	74	240	47	68.9	182	22.6
35	10/25/2005 10:01:23		97	113.7	103	172.7	444	196.8	243	211	399	252.1	301	265.8	153	324.3			215	76.8	253	66
36	10/25/2005 10:01:24		93	99.3	272	206.8	374	232.1	451	247.9	227	225.9	323	257.1	97	190.1			126	289.4	186	357.5
37	10/25/2005 10:01:25		118	57.1	160	215.6	143	209.8	225	274.3	229	237.3	283	239	93	189.3			126	90	182	68.1
38	10/25/2005 10:01:26		136	95.9	357	233.3	131	218.2	163	209.9	89	200.5	266	259.6	314	52.3			212	230.2	132	213.6
39	10/25/2005 10:01:27		110	136.5	283	181.6	178	184.8	383	70.8	55	186.2	57	137.1	256	106.1			33	57.3	224	186.9
40	10/25/2005 10:01:28		177	94.9	126	161	198	222.5	265	127.5	217	193.8	225	79.5	150	94.2			11	318.8	62	352.5
41	10/25/2005 10:01:29		407	91.8	353	113.7	352	253	60	169.4	316	139.1	329	178.3	114	172.4			78	185.9	129	159
42	10/25/2005 10:01:30		319	86.4	110	334.6	274	23.2	85	345	297	68.3	149	139.4	77	122.9			131	306.6	121	334.5
43	10/25/2005 10:01:31		258	94.2	255	280.9	148	111.4	133	113.1	245	158.7	133	173.1	343	227.4	341	237.2	189	207.1	189	263
44	10/25/2005 10:01:32		202	120.6	227	198.5	341	118.6	317	107.2	233	126.1	124	156.7	118	324.3			68	106.3	99	239
45	10/25/2005 10:01:33		354	163.1	251	132.4	240	179	433	122.8	539	96.1	553	95.2	241	211.8			79	278	114	293.2
46	10/25/2005 10:01:34		287	167.1	184	170.9	243	97.3	380	151.1	330	126.9	357	105.7	143	75.4			45	308.7	83	288.2
47	10/25/2005 10:01:35		225	90.8	222	142.3	399	130.6	385	116.4	490	102.7	503	83.5	285	59.4			48	7.1	42	59.7
48	10/25/2005 10:01:36		172	52.1	202	68.8	268	102.7	380	120.5	479	139.7	173	162.5	124	259.3			24	175.2	107	78.2
49	10/25/2005 10:01:37		227	88.5	402	102.8	281	96.7	322	181.4	220	200.5	146	145	251	130.8			231	236.1	97	222.9
50	10/25/2005 10:01:38		202	102.3	497	78.4	391	96.2	247	144.1	170	179.7	361	136.2	60	104.5			368	249.3	51	333.4
51	10/25/2005 10:01:39		366	69.9	108	231	127	240.8	33	105.7	434	248.8	292	270.2	187	146.3			15	216.9	89	115.4
52	10/25/2005 10:01:40		367	79.8	282	74.4	92	83.7	207	245.2	537	245	345	239.1	133	136.8			152	205.4	129	258.3
53	10/25/2005 10:01:41		277	34.3	168	286.3	164	64.7	175	205	326	243	93	232	172	165.6			212	229.4	69	204
54	10/25/2005 10:01:42		313	46.7	325	62.5	329	56.6	167	254.7	239	264.7	218	116.1	178	250.6			277	236.9	27	141
55	10/25/2005 10:01:43		453	102	387	83.3	320	77.5	167	67.1	91	65.4	87	99.2	201	275.7	413	233.3	72	169.6	75	187.7
56	10/25/2005 10:01:44		318	44.1	156	47.8	408	57.2	181	14	179	325	49	52.4	111	188.8			158	148.2	96	197.5
57	10/25/2005 10:01:45		232	70.9	73	325	223	45.2	274	44.4	72	113	93	132.8	189	94.9			69	239.7	177	195.1
58	10/25/2005 10:01:46		235	49.7	209	315.2	244	336.6	176	349.5	266	29.7	130	318.4	147	347			135	184.2	174	293.8
59	10/25/2005 10:01:47		251	72.4	182	337.4	219	339.4	331	55.8	240	19.5	212	299.9	148	239.6			134	175.3	121	81.9
60	10/25/2005 10:01:48		129	19	133	32.1	126	1.8	96	47.1	188	79.6	129	48.8	138	261.2	244	48.2	160	248.4	267	203.6

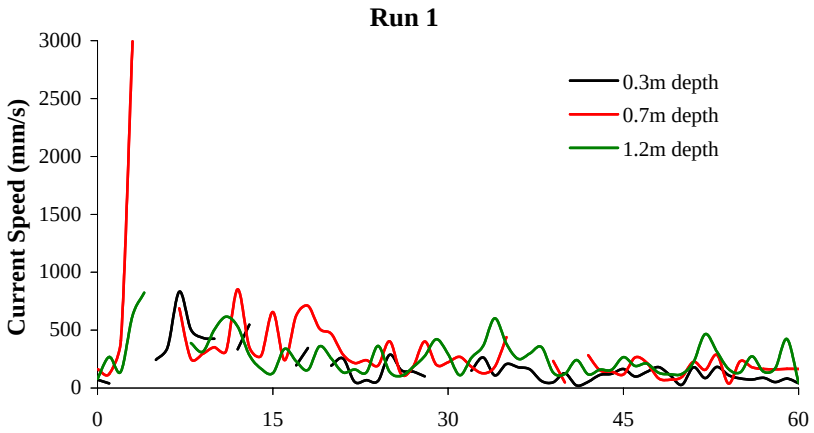
Lower Fox River Moving Vessel Trials
Test Seven

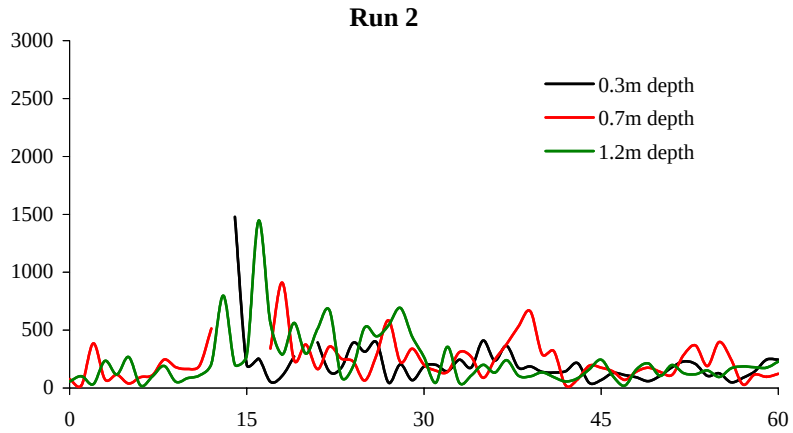
Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 09:42:06		154	97.4	97	90.6	35	98.1	149	81.1	63	292.5	36	226.1	30	101.7	194	161	110	123.1	246	57.3
1	10/25/2005 09:42:07		49	118.1	142	318.1	64	298.2	41	15.8	110	316.5	165	131.8	79	182.2	76	335.1	88	254.9	161	304.9
2	10/25/2005 09:42:08		48	31.4	68	61.2	64	54.6	105	59.8	57	42.1	71	67.8	120	138.7	88	21.3	40	20.7	134	261.4
3	10/25/2005 09:42:09		75	122.4	25	323.1	85	349.1	96	341.2	30	46.3	82	61.6	62	273.7	72	218.8	136	99.7	110	40.2
4	10/25/2005 09:42:10		70	185.7	38	74.9	141	67.1	187	55.5	76	22.5	53	72.6	93	354.5	102	324.6	113	332.5	122	27.8
5	10/25/2005 09:42:11		58	49.2	24	112.2	61	59.2	176	88.7	174	75.3	85	144.1	24	213	213	224.4	84	148.2	70	135.6
6	10/25/2005 09:42:12		119	129.2	120	99.1	74	0.8	25	78.2	56	115.2	45	330.6	47	38.1	226	328.2	74	239.3	52	100
7	10/25/2005 09:42:13		72	42.2	81	97.1	104	105.1	65	98	29	52	87	22.2	77	18.9	89	316.8	128	258.3	166	87.6
8	10/25/2005 09:42:14		61	116.1	110	235.7	130	113	115	17.7	83	63.4	145	348.8	120	204.6	79	151.2	95	53.1	121	32.9
9	10/25/2005 09:42:15		98	334	82	202.8	107	335.6	26	105.6	200	69.8	122	4.7	163	80.5	69	356.7	82	47	163	8.5
10	10/25/2005 09:42:16		82	352.3	104	63.7	89	103.7	73	56.1	67	318	64	347.3	131	252.3	203	314	39	271.5	172	245.7
11	10/25/2005 09:42:17		101	151.7	92	120.7	105	212.9	85	302	42	75	123	356.7	206	280.7	140	172.6	187	199.4	48	90
12	10/25/2005 09:42:18		115	91.5	18	303.7	102	27.6	75	13.1	191	24.1	222	325.5	2126	255.5	2115	258.5				
13	10/25/2005 09:42:19		264	56.7	191	53.1	325	47.9	439	43.1			2380	264.5								
14	10/25/2005 09:42:20												491	219.1	811	280.8			2478	259.5	1864	255.4
15	10/25/2005 09:42:21		1936	80.5	1221	88.1			877	140.1							1516	232.6			857	284.5
16	10/25/2005 09:42:22		708	117.4	578	97.5	873	139.6	535	143.5	963	167.8	1069	195.1	1097	213.2	945	227.1	85	160.1	144	165.5
17	10/25/2005 09:42:23		569	137	589	177.8	789	198.2	864	156.6	524	183.3	499	196.3	318	266.2	725	164.5	163	238.1	246	303.9
18	10/25/2005 09:42:24		293	75.4	457	185.1	1073	189.2	838	176	466	203.1	335	328.2	564	334.1	190	234.2	155	186.3	170	57.2
19	10/25/2005 09:42:25		155	6.7	259	185.3	572	144.2	693	160.7	476	171.2	287	236.4	310	126.6	560	110.9	266	174.4	66	75.1
20	10/25/2005 09:42:26		217	55.1	290	145.8	292	124.4	336	150.6	242	205.2	228	290.8	793	359.1	375	108.2	129	101.7	292	268.8
21	10/25/2005 09:42:27		66	148	157	202	435	220.8	626	204.4	458	214.3	53	239.6	367	228.8	398	163.5	98	58.7	84	290.2
22	10/25/2005 09:42:28		116	311.1	93	170.1	326	211.2	350	241.2	486	224.2	231	205.3	331	185.7	121	66.6	259	58.6	314	66.7
23	10/25/2005 09:42:29		130	250.2	117	180.5	171	294.5	408	222.9	267	235.8	297	239.9	276	260.2	274	126	125	359.1	170	50.2
24	10/25/2005 09:42:30		136	102.3	232	174.8	139	267.9	149	186.6	213	174.9	277	229.8	228	224.5	248	176.8	82	318	268	71.3
25	10/25/2005 09:42:31		38	100.7	165	53.6	219	114	27	243.4	176	219.5	331	181.9	383	195.1	381	182.7	303	100.8	168	91.7
26	10/25/2005 09:42:32		180	36	122	18.6	227	98.1	158	144	222	173.3	93	168.2	137	221.5	301	198.2	36	62	77	77.2
27	10/25/2005 09:42:33		180	18.1	88	45.5	256	176.6	192	189.6	309	177.6	210	148.8	171	166.1	72	149.2	138	220	77	125.5
28	10/25/2005 09:42:34		104	31.2	107	81.9	334	89.7	145	160.7	408	146	426	147.3	245	87.7	59	158.2	45	354.9	147	87.7
29	10/25/2005 09:42:35		264	74	156	93.3	144	150.1	175	112.2	269	106.6	202	144.7	162	172.6	51	277.8	37	4.6	43	308.5
30	10/25/2005 09:42:36		167	102.1	287	70.7	224	80.2	177	110.5	113	95.6	215	142.2	162	175.4	174	143.2	23	149	90	347.2
31	10/25/2005 09:42:37		202	78	257	98.9	198	84.8	309	108.9	142	108.9	90	108.8	147	187.8	201	164.4	20	49.1	127	32.8
32	10/25/2005 09:42:38		194	147.2	371	86.9	171	108.4	166	119.2	114	75.2	120	67.9	52	108.1	72	133.9	96	41.2	262	18.5
33	10/25/2005 09:42:39		189	141	199	92.6	449	98.6	76	88.5	140	115.5	178	131.6	62	186.4	186	15.3	176	35.3	170	356
34	10/25/2005 09:42:40		163	91.8	135	134.1	154	82.6	165	144.4	215	175.2	224	180	254	193.7	147	238.9	71	24	20	26.6
35	10/25/2005 09:42:41		219	215.5	387	150.1	177	115.8	260	134.4	48	139.3	145	184.7	95	266.4	55	264.8	318	272.3	188	290.3
36	10/25/2005 09:42:42				131	39.7	130	152.1	13	184.4	164	18.9	151	219.1	97	59.7	78	18.7	128	305.4	154	329.9
37	10/25/2005 09:42:43		168	95.1	187	40.4	143	235	225	149.9	119	115.5	79	185.8	237	167.3	142	300.5	188	272.7	89	212.1
38	10/25/2005 09:42:44		187	105.2	171	78.9	234	61.1	126	185	190	129.9	210	179.5	143	169.1	97	104.9	118	60	121	20.2
39	10/25/2005 09:42:45		147	318.3	87	118.9	133	49.9	49	30.8	51	198.4	122	273.8	31	168.7	177	235.1	124	126.1	88	286.6
40	10/25/2005 09:42:46		137	74.3	144	105.3	65	195.1	117	180.5	172	130.7	94	75.8	41	279.9	141	190.6	27	74.9	110	103.7
41	10/25/2005 09:42:47		163	68.8	33	135	85	326.5	81	157.5	200	185.5	45	167.2	71	270.8	60	122.1	103	105.3	29	337.8
42	10/25/2005 09:42:48		90	50.8	109	95.8	121	74.1	48	56	123	246.6	119	253.4	82	269.3	82	175.8	94	149.3	140	182
43	10/25/2005 09:42:49		278	88.1	193	107.5	81	149.6	41	344.2	125	109.6	186	104.3	145	199.3	258	106.5	149	93.8	168	71.6
44	10/25/2005 09:42:50		139	130.9	228	198.9	176	154.7	111	113.3	190	99.4	203	106	183	177.2	266	153.9	138	85	187	39.6
45	10/25/2005 09:42:51		231	94.2	361	98.4	143	144.6	89	117.4	154	82.6	167	148.2	111	202.2	113	218.9	136	131.4	96	165.5
46	10/25/2005 09:42:52		77	65.4	99	81.9	224	133.5	85	199.9	82	99.1	88	31.5	107	112	94	79.5	30	178.1	22	206.6
47	10/25/2005 09:42:53		252	127.9	241	138.4	258	133	231	134.5	47	211	150	116.1	57	4	62	220.4	100	245.7	62	185.5
48	10/25/2005 09:42:54		151	136.9	178	104.3	206	145.3	195	115.1	168	62.7	125	92.7	128	3.6	90	308.7	58	89	48	331.3
49	10/25/2005 09:42:55		180	109.8	260	118.7	295	115.5	208	142.8	153	54.5	188	67.8	123	73	185	18.9	97	141.7	56	52.3
50	10/25/2005 09:42:56		152	131.5	144	192.9	173	182.3	239	137.7	137	101.4	183	70.6	127	105	168	132.8	155	79.6	141	358.4
51	10/25/2005 09:42:57		181	158.7	224	125.7	185	154.4	105	115.3	166	156.2	79	56.9	60	105.4	125	120.9	148	43.6	181	41.2
52	10/25/2005 09:42:58		123	192.2	110	128	212	146.8	180	222.3	30	207.4	124	139.9	126	234	96	81	29	153.4	21	295.3
53	10/25/2005 09:42:59		175	134.1	18	206.6	158	127	131	231.2	90	168.4	119	139.1	40	67.9	72	23	189	52.5	148	65.7
54	10/25/2005 09:43:00		47	293.8	65	197.9	73	108.4	119	145.6	193	173.2	213	118.2	184	90	141	83.1	39	53.4	86	336.7
55	10/25/2005 09:43:01		118	89	130	93.5	148	147.2	60	201.4	116	103.4	121	109.3	104	76.1	109	326.6	133	103	26	337.4
56	10/25/2005 09:43:02		90	171.1	54	126	14	265.9	86	83.3	151	109.8	226	44.8	54	132.8	163	130.5	82	61.6	55	312.1
57	10/25/2005 09:43:03		55	79.5	55	304.6	77	340.4	229	82.2	70	44.4	89	34	145	100.8	222	84.3	159	96.5	188	36.6
58	10/25/2005 09:43:04		24	357.6	157	0.7	93	325.5	79	47.6	33	74.3	125	64.9	65	36.9	190	11.5	120	205.7	115	119.2
59	10/25/2005 09:43:05		199	25	130	7.9	79	56.3	119	76.9	117	228.8	59	41.6	37	341.1	59	80.2	101	143.5	40	108.9
60	10/25/2005 09:43:06		127	308.9	124	49.2	95	98.5	148	52.1	102	137.4	165	74.9	38	357	148	96.2	49	162.3	111	138.7

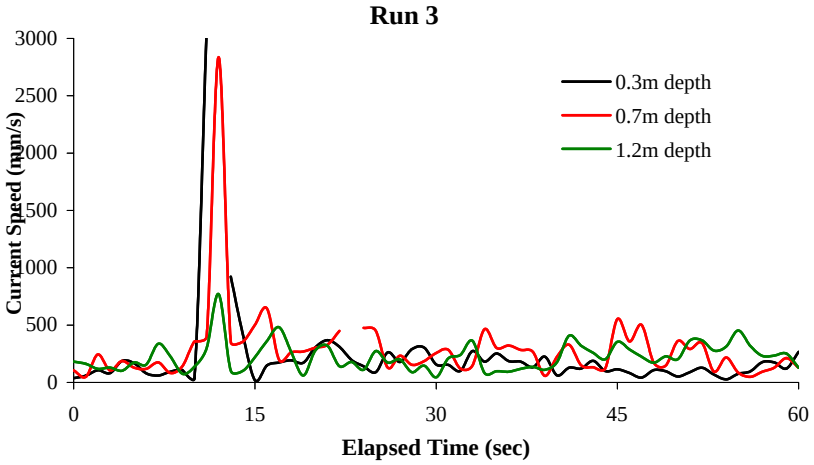
Fox River Propwash Study - Moving Vessel Trials

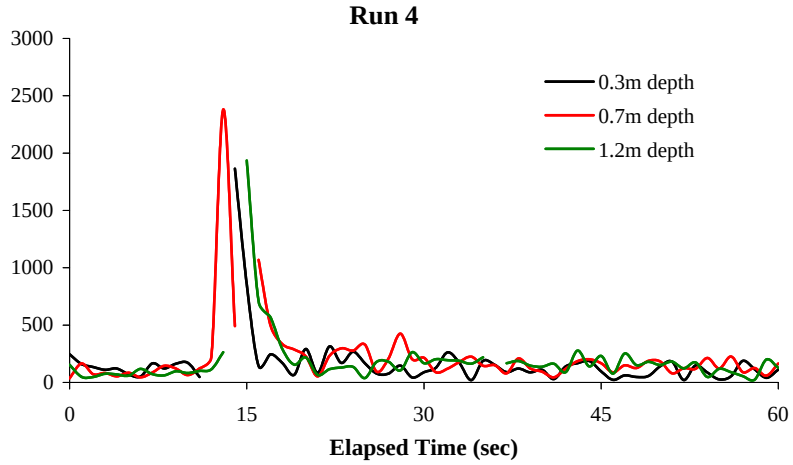
Test #7: Single-Prop Vessel - 2000 RPM - Pitch Down2

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Eight

Run 1

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:06:27		55	260.5	96	253.6	30	49	105	50.4	167	328.2	63	43.1	96	351	29	356.1	56	108.8	55	47.9
1	10/25/2005 10:06:28		73	281.9	160	299.9	93	247.3	65	94.4	60	20.6	90	305.1	188	283.8	150	271.1	225	243.9	89	56
2	10/25/2005 10:06:29		68	334.6	52	311.9	38	41.8	39	277.3	44	297.1	126	1.4	62	197	137	191.4	157	213.3	41	217.1
3	10/25/2005 10:06:30		188	272.1	11	10.3	97	283.2	15	254.1	46	233.9	124	307.1	78	317.1	60	179	15	306.9	70	184.1
4	10/25/2005 10:06:31		198	207.3	122	254.8	77	14.2	137	267.1	152	191.4	116	269.5	142	70.7	95	83.3	133	165.2	154	88.5
5	10/25/2005 10:06:32		138	270	178	281.7	182	272.8	88	264.2	238	304.2	168	66.5	41	175.8	55	291.4	32	235.3	131	325
6	10/25/2005 10:06:33		68	251	101	343.9	45	195.6	52	266.7	38	45	105	46.9	51	257.6	143	249.9	110	273.6	94	247.5
7	10/25/2005 10:06:34		249	266.3	168	355.2	152	303.2	118	287.2	69	323.3	150	291.1	105	323.9	113	152.1	150	243.1	82	15.6
8	10/25/2005 10:06:35		91	296	120	246.4	158	291.5	89	289	31	26.6	69	262.5	35	250	79	194.7	24	253.1	194	156.6
9	10/25/2005 10:06:36		134	214	152	275.3	103	269.4	100	294.8	192	279.6	193	267.6	138	251.4	92	206.6	245	266	89	11.1
10	10/25/2005 10:06:37		177	260.2	286	230	286	256.3	170	195.7	146	299.9	229	266	273	266	394	274.8	362	286.4	290	261.9
11	10/25/2005 10:06:38		95	41.6	147	63.3	254	42.6	227	69.9	395	138.7	1930	244.7	3052	247	2882	248.5	479	93.5	251	310.5
12	10/25/2005 10:06:39		786	36.5	1157	33.9	1042	21.7														
13	10/25/2005 10:06:40						855	310.1											803	246.5	286	272
14	10/25/2005 10:06:41				392	36.3			738	3.8											347	1
15	10/25/2005 10:06:42				579	88.8	885	77.9	32	82.9	607	88.9	642	90.4	547	16.4	839	61.9	454	76.4	561	34
16	10/25/2005 10:06:43		425	55.3	404	57.7	553	62.6	427	62.7	433	60.5	366	61.3	368	20.5	196	57.5	220	9.4	222	43.5
17	10/25/2005 10:06:44		415	20.6	475	38.5	621	40.5	551	22.2			329	337.3	408	292	131	25.8	293	18.7	466	24.6
18	10/25/2005 10:06:45		187	40.4	184	35.5	439	36.1	409	325.1	560	337	791	317.2	433	296	421	284.6	229	296.7	346	18
19	10/25/2005 10:06:46		324	349	475	14.6	600	358.4	510	313.2	685	299.9	650	332.6	635	333.2	526	346.3	437	1	557	19.6
20	10/25/2005 10:06:47		240	56.9	170	329.7	369	299.7	402	300.1	627	317.7	577	339.5	740	333.8	648	339.8	747	9.6	982	26.4
21	10/25/2005 10:06:48		242	75.2	253	73.5	77	52.4	211	184.6	237	61.8	420	23.3	264	9.4	326	356	552	349.5	694	13.4
22	10/25/2005 10:06:49		525	67.6	438	83.6	131	98.8	260	37.4	623	111.8	580	69.1	819	69.2	630	102.1	831	64	531	67.6
23	10/25/2005 10:06:50		423	60.9	591	81.2	815	66.2	937	62	523	37.9	448	49.4	290	47.5	346	109.6	468	45.9	434	30.2
24	10/25/2005 10:06:51		233	10.9	105	327.1	289	75.8	432	74.5	525	61.9	212	55.8	348	59	314	46.5	29	26.6	320	59.6
25	10/25/2005 10:06:52		414	52.4	209	34.3	231	45.7	326	45.9	463	56.6	253	49	290	335.4	199	311.5	216	14.7	326	60.4
26	10/25/2005 10:06:53		349	54.2	252	49.2	201	20.1	258	52.7	162	138.2	107	337.5	388	352.3	300	352.9	255	46.1	215	34.6
27	10/25/2005 10:06:54		424	42	459	54.8	303	28.8	259	5.1	177	57.2	291	44.2	294	22.8	337	39.8	392	63.2	496	30.6
28	10/25/2005 10:06:55		518	82.3	465	37.5	417	41.4	663	41.9	355	56.5	263	32.1	298	41.2	343	352.1	418	21.8	381	31.1
29	10/25/2005 10:06:56		197	78	409	105.2	600	85.2	661	70.1	437	15.4	461	356.8	475	349.6	190	347.2	245	359.8	225	28.4
30	10/25/2005 10:06:57		291	82.7	140	105.3	275	93.6	230	58.5	339	24.8	261	359.1	245	10.8	483	2.9	410	13	377	48.4
31	10/25/2005 10:06:58		49	160.8	209	157.8	172	77.6	82	51.4	194	49.4	186	3.1	201	352.8	224	22	186	30	327	32
32	10/25/2005 10:06:59		219	104.5	175	145.5	308	135.9	163	99.9	212	74.4	375	38.4	115	26.8	506	3.6	285	64.4	329	59.5
33	10/25/2005 10:07:00		346	93.5	213	103.3	127	94.5	200	91.4	216	57.3	126	50.1	90	32.3	124	26.8	177	156.8	209	114.2
34	10/25/2005 10:07:01		64	39.9	156	272.9	165	297.3	202	328	230	346.7	144	38.8	325	44.4	314	52.1	390	57	404	63.2
35	10/25/2005 10:07:02		206	64.4	224	63.2	102	36.2	229	353	202	354.6	247	8.1	70	78.5	194	54.7	375	64.3	274	60.4
36	10/25/2005 10:07:03		67	315.6	95	284.6	146	273.5	87	279.2	222	319.9	117	353.1	159	29.5	37	156.2	221	100.7	205	65.8
37	10/25/2005 10:07:04		141	334.9	73	35	94	117.1	103	58.9	99	90.6	80	308.9	37	36.3	272	139.3	342	72.1	332	98.3
38	10/25/2005 10:07:05		170	6.7	204	32	273	6.9	92	294.3	114	321	155	278.2	167	249	51	102.4	134	323.2	157	19
39	10/25/2005 10:07:06		229	48.4	101	14.9	120	341.6	263	348.8	124	29.5	171	68.1	314	71.4	224	54.5	112	36.7	198	59.3
40	10/25/2005 10:07:07		169	322.5	346	339.5	340	319.3	73	303.3	289	14.6	247	1.9	31	82.6	162	331.7	132	342.4	89	6.5
41	10/25/2005 10:07:08		171	344	253	357.5	149	346.4	102	56.2	168	49.1	81	44.5	202	54.7	505	17.8	270	317.3	312	64.7
42	10/25/2005 10:07:09		315	12.8	252	2.5	246	334.7	115	43.6	79	22.3	40	318	92	13.9	303	35.7	300	52.6	174	23.8
43	10/25/2005 10:07:10		156	56.2	201	57.8	85	353.2	74	57.2	77	275.2	101	3.4	182	63.9	160	68.4	326	51.5	323	86.4
44	10/25/2005 10:07:11		110	123.1	164	65.2	51	38.7	147	323.6	158	324.3	173	52.3	163	65	264	72.1	208	210.4	126	29.4
45	10/25/2005 10:07:12		190	66.8	200	18.7	154	36.8	96	32.7	176	16.5	271	76.3	239	127.7	86	47.4	62	43.7	161	50.8
46	10/25/2005 10:07:13		230	40.1	162	49.5	192	36.8	228	5.3	127	320.4	112	82.3	249	81.2	245	65.4	136	59.5	135	22.2
47	10/25/2005 10:07:14		258	88.4	89	82.9	139	75	73	141.7	110	160.4	38	54.6	158	75	366	125.4	107	260.3	88	47.8
48	10/25/2005 10:07:15		433	108.7	275	100.7	161	51.6	80	124.3	141	55.1	24	163.1	119	29.1	267	66.9	63	302.7	111	341.6
49	10/25/2005 10:07:16		249	71.3	352	73.7	202	67	178	149.7	121	247.1	90	275.1	64	95.4	119	90	119	277.2	140	59.6
50	10/25/2005 10:07:17		128	37.4	177	124.9	129	103	119	84.2	139	63.1	56	75.5	111	130.3	118	5.4	116	34.8	90	105.4
51	10/25/2005 10:07:18		188	99.5	139	106.7	78	65.1	159	116.1	200	77.9	167	125	175	119.1	132	64.4	199	74.6	125	131.7
52	10/25/2005 10:07:19		57	76.7	78	235.5	159	63.9	75	47.2	183	28.8	67	42.6	188	325	147	16.6	139	119.7	169	139.3
53	10/25/2005 10:07:20		17	100	97	348.1	164	335.9	173	342.2	176	355.4	384	341.5	283	349.2	230	6.5	271	77.4	130	6.2
54	10/25/2005 10:07:21		193	262.2	187	343.5	170	333.4	56	337.1	295	331.7	162	320	170	321.9	92	38.9	121	274.7	123	124.7
55	10/25/2005 10:07:22		59	163.4	133	329.8	439	316	366	299.4	361	284.8	116	285	125	60.1	97	109.9	373	106	145	87.2
56	10/25/2005 10:07:23		95	319.3	219	315.4	203	284.9	145	281.5	231	299.6	125	300.9	93	48.1	89	94.5	101	189.6	210	196
57	10/25/2005 10:07:24		286	272.2	164	271.4	117	209.6	171	289.8	279	316.3	239	338.7	107	65.6	273	90.4	346	87.7	74	193.3
58	10/25/2005 10:07:25		250	262.4	135	324.3	176	311.1	270	306.9	179	293.7	218	337.7	114	54.6	118	146	279	92.1	218	86
59	10/25/2005 10:07:26		317	278.5	293	289.1	375	295.9	483	302.8	389	319.6	235	337.7	263	29.6	478	3.7	108	334.1	94	99.8
60	10/25/2005 10:07:27		148	15.3	103	332.9	236	322.1	322	330.3	462	334	303	341.9	187	19.4	175	24.7	213	304.3	138	356.3

Lower Fox River Moving Vessel Trials
Test Eight

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:09:02		109	48.7	59	340	158	262	202	219.6	118	251.7	65	302.5	130	146.9	159	159.7	70	86.7	129	67.2
1	10/25/2005 10:09:03		39	119.2	54	286.1	37	64.1	89	151.7	70	147.9	56	179	115	113.7	108	28.2	144	119.9	112	213.7
2	10/25/2005 10:09:04		55	249.9	92	209.4	127	276.8	33	162.1	109	267.4	96	249.3	211	164.6	139	150.7	38	137.1	204	90.3
3	10/25/2005 10:09:05		91	46.8	82	232.4	126	300.4	133	257.4	77	171.8	106	175.7	223	97.2	178	173.6	161	167.8	109	162.4
4	10/25/2005 10:09:06		28	90	82	189.1	137	185.9	113	164.1	148	178.8	89	161	48	203.4	190	203.9	159	240.2	98	155.8
5	10/25/2005 10:09:07		179	125.5	223	176.9	130	180.4	131	233.4	138	262.9	135	272.5	107	61	70	125.1	48	178.8	109	129.1
6	10/25/2005 10:09:08		101	107.4	23	203.2	152	209.1	138	261.7	98	206.6	95	261.5	84	180.7	84	137.9	69	226.2	133	49.3
7	10/25/2005 10:09:09		100	356	57	267	332	216.7	180	185.1	270	199.4	144	166.3	163	126	64	135	137	105.3	12	85.2
8	10/25/2005 10:09:10		100	151.9	68	61.9	109	145.9	142	188.5	68	129.1	137	132	171	56.2	78	182.9	62	211.1	27	243.4
9	10/25/2005 10:09:11		86	224.5	70	248.2	181	200	208	188.3	200	188.3	202	134.8	190	145.3	193	169.9	130	151.5	140	173.8
10	10/25/2005 10:09:12		157	250.3	283	208.7	262	251.3	241	238.2	280	218.8	376	219.7	457	231.2	404	230.3	746	225.8	423	225
11	10/25/2005 10:09:13		393	85.8	391	89	430	86.5	424	86.6	609	111.3			3120	246.9	2248	243.5	316	106.9	289	80.2
12	10/25/2005 10:09:14		775	30.1	859	30.2	957	26.3			1254	5	1611	347								
13	10/25/2005 10:09:15		149	266.5	219	247.4	192	270.3	368	271.1	444	222	694	206.8	2015	248.3	1386	243.3	1714	279	1400	270.2
14	10/25/2005 10:09:16		191	7.5	241	49.7	202	81.5	263	60.9	1334	274.6	1631	268.2	895	295.3			517	295.8	314	318.2
15	10/25/2005 10:09:17		263	10.5	428	3.9	504	332.1			579	266.2	394	250.4	411	258.8			109	96.9	111	258.1
16	10/25/2005 10:09:18		763	329.9	1126	348.2	1044	358.1	1038	346.9	539	342.2	137	295.4	290	312.5			366	9.6	537	4.6
17	10/25/2005 10:09:19		506	9	495	15.8	771	20	750	11.8	551	8.5	609	34.2	543	16.3	939	359.1	658	7.1	439	10.4
18	10/25/2005 10:09:20		92	7.5	188	338.1	344	2.8	279	352.6	614	24.9	722	36	449	308.6	937	336.6	684	337.9	968	15
19	10/25/2005 10:09:21		65	17	228	46.8	157	3.3	611	337.4	467	352.5	782	21.7	556	15.2	809	355.5	469	330.1	677	7.8
20	10/25/2005 10:09:22		164	329.7	319	327.6	245	336.7	260	353.8	311	69.9	273	11.4					420	23	405	23.4
21	10/25/2005 10:09:23		345	67.9	93	52.4	155	32	379	91.5	470	95.5	399	95.9	377	134.2	672	0.1	757	36.4	396	358.6
22	10/25/2005 10:09:24		520	101.9	517	91.9	358	45.7	537	80.3	657	105.1	521	100.2	540	83.4	793	108.2	935	56	387	39.1
23	10/25/2005 10:09:25		463	98.1	480	97.5	328	94.2	174	28.2	227	4.3	384	132.7	144	333.6	331	349	475	35.5	398	50.1
24	10/25/2005 10:09:26		210	6.6	209	67.7	225	95.4	76	26.6	260	318.6	263	3.7	523	1.5	421	29.1	599	50.2	366	37.8
25	10/25/2005 10:09:27		209	18.7	411	340.4	301	343.2	263	345.5	145	307.7	46	12.5	178	9	362	40.3	488	67.7	293	56
26	10/25/2005 10:09:28		480	106.5	135	156.9	147	252.2	475	296.9	193	251.3	78	197	42	40.2	129	39	406	65.7	296	50.6
27	10/25/2005 10:09:29		207	36.1	256	337.7	246	333.4	113	305.2	195	286.7	178	290.4	81	178.6	217	27.7			260	12.9
28	10/25/2005 10:09:30		327	39.3	144	18.2	248	351.6	77	335.4	228	313.9	196	277.6	269	296.8	515	326.6	333	284.8	173	3.6
29	10/25/2005 10:09:31		563	110.8	589	105.8	326	80.7	42	289.3	303	304.8	200	314.8	172	349.9	256	307	75	316.1	330	38.6
30	10/25/2005 10:09:32		278	91	329	60.9	285	23.6	157	17.4	61	62.6	87	357.4	101	268.9	183	285.6	202	287.9	345	58.2
31	10/25/2005 10:09:33		235	78	288	70.1	224	109.6	115	93.5	74	354.6	217	14.7	168	340.2	490	8.7	208	265.6	233	85.1
32	10/25/2005 10:09:34		391	100	259	74.3	168	39.7	265	19.2	96	16.9	130	12.9	24	345.4	259	300.3	152	301.8	134	24.7
33	10/25/2005 10:09:35		85	17.8	117	8.3	282	346.3	222	333.2	242	5.5	94	12.9	78	38.2	203	16	143	6.8	360	32.1
34	10/25/2005 10:09:36		198	324.5	182	19.5	126	10.5	184	27.1	222	35.3	224	84.1	103	6.7	297	337	151	355.5	180	66
35	10/25/2005 10:09:37		174	63.4	132	71	184	75.5	164	59.7	164	347	190	12.1	216	21.5	455	7.2	237	31.2	290	50.9
36	10/25/2005 10:09:38		301	91	324	93.2	220	76.3	88	354.8	369	30.7	343	24.6	309	25.7	142	88.8	102	38.2	348	66.7
37	10/25/2005 10:09:39		321	82.3	181	37.8	116	96.9	319	60.9	258	38.4	339	45.4	303	352	96	64.8	147	66.4	150	49.1
38	10/25/2005 10:09:40		290	72.3	99	105.9	108	138.8	62	91.8	239	70	279	64.7	178	61.1	187	69.6	142	68.5	236	81.5
39	10/25/2005 10:09:41		239	297.6	153	265.1	221	304.7	35	256.8	211	106.2	223	76.3	294	60.9	329	82.3	244	72.4	256	39.5
40	10/25/2005 10:09:42		334	339.1	223	341.7	288	339.2	184	316.8	222	118.2	231	117.9	305	97.9	68	121.1	284	77.2	324	95.5
41	10/25/2005 10:09:43		153	45.3	199	19.3	233	358	184	16.8	217	347.8	183	28.7	149	61.2	166	77.5	110	76.3	76	335.8
42	10/25/2005 10:09:44		46	195.3	167	41.6	177	37.6	142	102.6	52	80	187	71.3	114	51.4	485	167.9	177	201.9	155	109.3
43	10/25/2005 10:09:45		82	295.3	200	38.7	118	56.4	141	54.8	62	184.6	74	167.5	123	60.7	84	108.6	166	90	163	161.5
44	10/25/2005 10:09:46		94	41.5	256	26.2	409	47.2	361	52.4	465	60.1	274	46.9	148	54.1	227	62.4	366	89.5	416	89
45	10/25/2005 10:09:47		182	21.2	283	359.6	333	32.4	284	36	154	31.2	194	33.4	282	41.5	145	76.4	114	75.8	104	103.4
46	10/25/2005 10:09:48		214	315.9	230	337	257	40.3	373	37.5	251	67.7	215	72.4	220	17.7	278	105.9	258	95.1	286	75.2
47	10/25/2005 10:09:49		242	60.6	21	320.9	24	192.3	134	47.7	305	101.7	240	91.2	151	128.8	313	97.5	272	90.8	188	148.3
48	10/25/2005 10:09:50		123	44.3	105	42.3	119	42.3	222	23.1	229	81.4	172	89.7	130	48.4	173	75.6	188	117.5	290	98.9
49	10/25/2005 10:09:51		250	15.3	112	333.4	126	339.1	76	338.5	144	83.6	132	50.9	233	104.7	248	99.5	390	85.6	115	123.3
50	10/25/2005 10:09:52		114	345.2	157	322.8	144	323.2	158	324.3	148	343.2	177	94.2	258	83.8	164	45.5	132	44.7	126	92.7
51	10/25/2005 10:09:53		165	76.3	135	19.9	284	19.3	199	338.2	64	23	107	76	210	107.1	234	142.1	269	113.9	231	136.8
52	10/25/2005 10:09:54		242	86.7	231	353	281	315.7	297	304.7	210	325.5	199	22.4	242	14.8	285	151.7	123	129.4	207	125.8
53	10/25/2005 10:09:55		107	55.7	165	15.8	275	326.4	190	307.5	82	106.2	37	99.2	217	96.1	103	79.9	42	123.3	52	143.6
54	10/25/2005 10:09:56		243	21.7	241	359.5	232	338	221	327.7	121	310	168	285.9	52	3.3	138	75.8	118	160.2	191	181.5
55	10/25/2005 10:09:57		149	22.9	213	10.3	110	2.1	145	265.7	59	313.6	29	254.1	100	46.6	89	41.8	70	88.4	113	116.8
56	10/25/2005 10:09:58		206	26.6	82	23.1	164	293	78	183.7	139	258.8	63	128.5	152	81.3	203	33.5	81	44	116	79.1
57	10/25/2005 10:09:59		35	45	51	43.4	104	276.6	7	153.4	87	56.7	140	59.6	187	43.9	186	114.8	100	213.2	65	45
58	10/25/2005 10:10:00		99	358.8	235	10.5	112	40.7	2	116.6	210	80.4	94	41.5	94	62.9	125	1.4	152	202.4	116	69.8
59	10/25/2005 10:10:01		139	357.5	96	295.2	166	317.9	190	345.7	98	337.1	302	54.3	251	55	175	65	46	137.6	63	191.8
60	10/25/2005 10:10:02		82	219.5	104	302	188	286	145	317	136	28.6	171	17	228	21.1	128	70.4	51	55.4	142	105.1

Lower Fox River Moving Vessel Trials
Test Eight

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:11:47		170	328.7	120	56.6	81	7.1	112	4.1	188	47.8	154	92.2	33	307.6	153	216.5	187	80.4	138	119
1	10/25/2005 10:11:48		105	324.7	44	69.9	73	157.3	84	15.9	204	27.1	127	338.7	85	267.3	181	203	104	77.8	53	324.2
2	10/25/2005 10:11:49		196	0.3	98	348.2	172	347.9	88	24.8	145	86.4	27	109.8	65	220.6	87	57.2	64	249.9	107	310.1
3	10/25/2005 10:11:50		105	55.9	159	279.8	118	322.9	84	223.6	92	217.5	102	306.2	179	312.1	137	293.2	276	247.4	90	176.8
4	10/25/2005 10:11:51		74	315.5	117	318.1	103	280.7	111	309.1	201	294.7	129	306.8	151	217.2	209	227.1	187	216.3	126	229.8
5	10/25/2005 10:11:52		40	315	56	7.1	117	343.1	109	328.9	148	316.4	62	248.4	92	242.9	126	358.6	144	263.2	67	197.4
6	10/25/2005 10:11:53		125	273.2	47	286.1	177	220.9	112	106.7	43	337	34	148.2	88	269.3	101	159.8	91	119.7	84	126.7
7	10/25/2005 10:11:54		16	322.4	111	155	55	270	68	131.4	42	233.7	56	57.4	60	4.8	272	318.6	142	295.5	61	147.1
8	10/25/2005 10:11:55		90	122.8	97	64.2	45	72	67	348	173	163.6	83	53.8	26	234.5	228	1.8	28	229.4	37	304.1
9	10/25/2005 10:11:56		69	234.5	82	236.9	143	159.2	138	181.7	118	271.5	129	259.3	50	237.3	103	311.9	94	270.6	176	240.4
10	10/25/2005 10:11:57		194	244.6	253	252.3	232	265.3	204	232	401	221.6	280	240.2	262	250.1	292	249.1			283	229.7
11	10/25/2005 10:11:58		211	77.7	203	89.7	292	150.4	180	108.4	494	160.7	848	205.5	2947	239.4	2920	242.7			512	77.7
12	10/25/2005 10:11:59		1023	42.1	1237	30.3																
13	10/25/2005 10:12:00		714	303.8	1074	282.4	643	292.1														
14	10/25/2005 10:12:01		1987	11.7	1814	358.1	1513	15.2											92	83.7	184	52.9
15	10/25/2005 10:12:02		830	349.6	700	347	847	24.7	497	8.6	484	351.1	520	349.7	397	346			179	28.4	294	30.5
16	10/25/2005 10:12:03		288	33.5	379	53.9	573	290	576	305.7	504	323.7	598	282.5	280	290.2	446	319.8	268	332.7	320	354.8
17	10/25/2005 10:12:04		561	26	993	357.6	742	12.9	518	23.9	243	31	354	35.3	576	60.4	574	20.7	416	4.3	642	29.1
18	10/25/2005 10:12:05		671	355	505	320.8	306	12.6	330	56.5	161	109.2	86	35.5	428	358.4	270	39.9	429	43.8	616	48.3
19	10/25/2005 10:12:06		250	350.1	299	335.7	255	322.3	602	324	679	335.8	948	339.4	519	329.3	587	352.2	604	353.8	741	14.3
20	10/25/2005 10:12:07		333	87.1	130	78.9	165	40.1	310	28.3	449	0.3	494	349.6	699	0.5	991	335	848	1.6	898	24.1
21	10/25/2005 10:12:08		403	67.8	473	97	456	112.4	325	116.5	261	66	260	2.6	407	352.9	80	315.5	862	16.4	765	4.4
22	10/25/2005 10:12:09		644	79.7	410	79.5	423	90.3	378	74.3	356	48.4	406	24.3	684	37.2	485	65.7	717	16.8	839	22
23	10/25/2005 10:12:10		159	22.5	436	20.3	214	84.4	211	60.2	261	49	470	29.2	453	40.6	421	96.8	976	61.5	584	23.6
24	10/25/2005 10:12:11		177	9.8	398	345.3	449	345.4	317	329.2	524	283.6	342	68.2	148	56.3	569	136.4	815	63	526	42.8
25	10/25/2005 10:12:12		173	155.1	212	264.9	260	317.2	367	352.2	124	329.5	247	339.9	376	31.3	449	103.5	245	93.8	468	66.3
26	10/25/2005 10:12:13		90	4.4	172	188.7	234	295.8	269	331.2	186	354.1	330	30.4	322	12.7	313	75.2	568	79.4	92	39.2
27	10/25/2005 10:12:15		170	89.7	105	79	302	71.4	339	76.9	220	82.9	54	164.9	119	10.6	316	44.9	303	56.6	304	82.8
28	10/25/2005 10:12:16		314	75.3	487	67.2	432	68.5	141	87.6	190	92.4	279	149.1	119	207	246	152.4	177	134.8	162	78.3
29	10/25/2005 10:12:17		464	85.2	421	72.7	494	86.4	339	80.5	336	87.6	354	93.4	289	129.2	305	117.3	178	110.4	234	73.9
30	10/25/2005 10:12:18		107	82.5	88	75.5	232	99.4	458	84.2	541	94.9	359	94.9	245	105.6	269	98.8	548	83.8	222	73.8
31	10/25/2005 10:12:19		398	74.3	370	103.4	342	65.8	522	65.2	386	78.6	277	67.5	352	54.8	370	74	333	71.5	291	97.9
32	10/25/2005 10:12:20		259	3.1	426	31.6	356	53	444	68.5	598	61.4	360	39.3	342	76.3	330	26.4	258	104.6	209	152.9
33	10/25/2005 10:12:21		311	51	380	36.4	433	36.3	616	34.8	605	35.2	506	16.8	524	62.8	393	86.9	522	90.7	147	100.2
34	10/25/2005 10:12:22		362	92.5	407	75.2	651	52.2	790	63	908	54.2	741	42.3	222	13.8			417	79.9	226	117.9
35	10/25/2005 10:12:23		324	88.9	319	69.2	404	64.8	415	54.3	447	42.4	322	50.9	186	73.1	252	132.7	346	82.5	93	193
36	10/25/2005 10:12:24		213	64.4	199	39.7	342	45.7	193	27.8	240	34.8	113	80.3	124	147.2	90	50.8	42	229.8	46	257.5
37	10/25/2005 10:12:25		120	57.9	193	53	228	69.5	156	39.8	156	100.4	66	205	68	210	83	142.9	253	165.1	154	148.3
38	10/25/2005 10:12:26		148	86.9	140	85.1	277	86.7	155	17.3	162	27.2	83	322.9	82	0.7	133	304.3	113	222.1	53	219.7
39	10/25/2005 10:12:27		252	90.7	251	102.7	126	140.1	81	45	215	27.4	109	251.2	198	218	411	199.8	347	221.5	234	173.9
40	10/25/2005 10:12:28		499	61.9	225	64.7	159	79.1	218	63.9	239	4.6	253	356.1	67	290.1	150	306.9	182	245	150	228.2
41	10/25/2005 10:12:29		298	69.2	142	104.2	129	143.2	334	96.9	276	127	176	162.5	182	179.1	481	134.7	314	116.9	183	186.6
42	10/25/2005 10:12:30		161	54.8	266	88.9	289	63.5	490	95.9	440	110.2	284	116.6	372	96.8	185	153.3	106	249.5	128	118
43	10/25/2005 10:12:31		312	78.9	298	112.9	252	135.3	309	129.1	374	110.7	498	97.4	373	102.5	307	94.7	184	282.9	111	5.1
44	10/25/2005 10:12:32		376	58.7	232	58.9	375	106.6	415	95.7	404	59	234	83.6	292	81.3	261	94.2	134	61.9	24	55
45	10/25/2005 10:12:33		335	80.7	216	68.3	229	55.3	229	85.5	39	122.5	79	127.3	225	84.9	105	128.1	60	294.8	53	56.6
46	10/25/2005 10:12:34		234	59.5	268	69.3	165	73.8	334	68.4	232	42.6	201	100	202	40	40	143.1	61	5.6	203	32.8
47	10/25/2005 10:12:35		464	38.2	265	32.4	289	5.4	81	52.6	42	30.3	146	140.8	89	61.7	182	334	142	349.9	60	344.6
48	10/25/2005 10:12:36		262	73.8	238	81.1	175	83.1	179	88.1	127	243.8	33	141.1	98	341.6	201	109.8	300	98.4	143	80.7
49	10/25/2005 10:12:37		208	49.1	64	81	104	47.7	312	44.6	184	62.2	150	26.9	161	68.5	303	348.9	107	139.2	39	94.4
50	10/25/2005 10:12:38		268	57.2	309	54.2	398	55.2	318	78.4	233	66.7	78	65.1	111	69.9	203	113.2	205	166.4	176	153.3
51	10/25/2005 10:12:39		471	59.2	287	60.8	390	75.3	400	79.1	187	34.1	150	33.6	193	77.4	81	41	71	196.4	107	81.9
52	10/25/2005 10:12:40		359	57.5	328	76.4	301	92.1	257	62.6	326	25.8	103	9.5	193	116.8	230	37.8	93	142.9	178	109.7
53	10/25/2005 10:12:41		192	48.6	382	89.1	242	84.8	215	80.9	184	87.2	218	102.4	205	166.4	182	130.1	83	222.6	89	178.1
54	10/25/2005 10:12:42		72	65.2	96	52.7	277	79	135	74.9	72	39.4	59	12.6	38	297.9	176	51	133	96.1	92	144.2
55	10/25/2005 10:12:43		180	66	91	75.4	107	73.1	167	101.4	166	39.4	62	349.8	43	47.8	222	177.4	73	195.2	369	158.7
56	10/25/2005 10:12:44		155	87.8	32	161.6	71	119.4	53	47.3	44	238.1	35	98.1	124	223.7	207	255.2	118	248.6	54	234.8
57	10/25/2005 10:12:45		134	4.7	81	332.8	145	311.4	110	249.7	113	190.7	116	186	48	219	133	194.3	192	105.4	181	121.2
58	10/25/2005 10:12:46		120	76.5	68	133.8	248	269.1	166	304.9	49	35	143	353.2	107	260.9	295	149.7	256	87.1	134	84
59	10/25/2005 10:12:47		166	133	113	270	120	278.6	114	316.1	144	319.2	90	357.5	98	201.6	144	348.4	71	194.6	127	149.2
60	10/25/2005 10:12:48		122	336.8	252	297.2	249	276.7	112	294.3	36	38.2	17	283.2	169	15.4	75	333.8	153	242.8	267	85.3

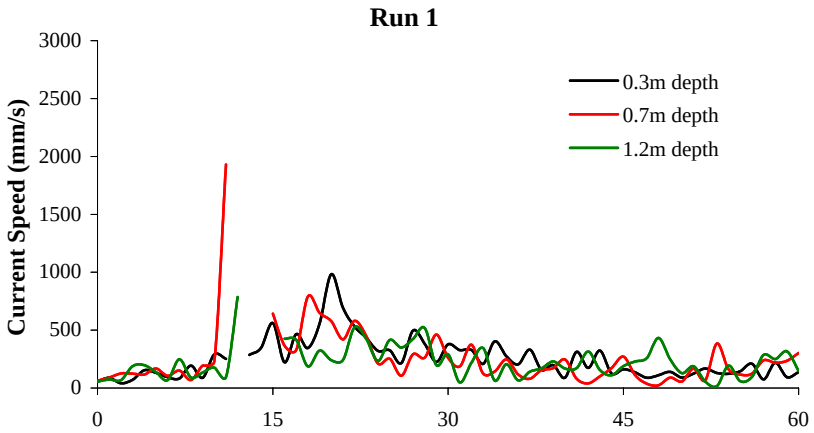
Lower Fox River Moving Vessel Trials
Test Eight

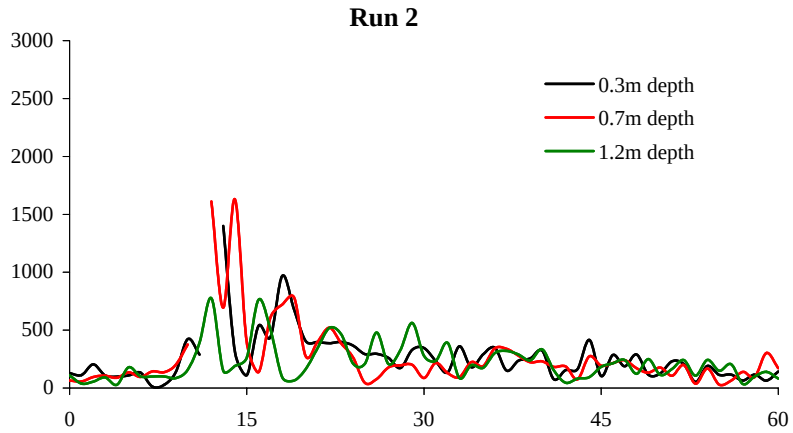
Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:14:35		155	75.4	90	73.8	197	90	65	109.8	101	354.9	212	342.7	49	40.9	200	155.5	68	45	94	290
1	10/25/2005 10:14:36		145	116.6	217	100.4	35	341.6	61	359.1	64	267.3	40	145.1	102	5.6	115	184	46	38.9	133	170.9
2	10/25/2005 10:14:37		83	151.3	172	90.7	103	69.4	145	334.3	144	352	110	271.6	204	61.7	133	31.2	70	289.2	137	191.4
3	10/25/2005 10:14:38		105	145.1	74	96.2	45	104	146	22.2	109	190.6	56	51.5	139	292.5	178	198.6	65	200.7	128	248.9
4	10/25/2005 10:14:39		93	11.8	97	9.5	96	54.3	66	77.8	130	315.6	76	12.2	119	300.9	92	310.6	82	303.1	71	242.4
5	10/25/2005 10:14:40		46	347.5	97	320.4	115	340.8	84	351.8	117	348.2	52	34	144	334.5	22	159.1	154	258.4	118	45.3
6	10/25/2005 10:14:41		27	74.9	27	58.7	22	177.4	53	341.2	52	328.5	205	246.4	77	201.3	162	150.7	97	178.2	46	263.8
7	10/25/2005 10:14:42		101	333.4	161	297	62	273.7	48	261.5	181	301.9	72	159.5	106	347.4	97	304.5	286	221	225	244.2
8	10/25/2005 10:14:43		55	34	28	45	27	74.9	173	324.7	194	302.1	117	237.3	51	99.1	275	176.9	119	220.9	101	242.2
9	10/25/2005 10:14:44		51	341.6	47	296.6	63	274.5	113	222.1	43	296	57	200.7	81	213.9	153	258.3	202	240.3	186	260.7
10	10/25/2005 10:14:45		90	271.3	73	199.2	85	243.4	144	215.7	67	330.4	131	259.5	84	288.6	66	228.1	71	252.8	52	100
11	10/25/2005 10:14:46		80	288.2	93	237.7	155	267.8	202	266.3	300	222.3	493	212.9	471	230.2	1019	219.6	765	229.3	1200	235.9
12	10/25/2005 10:14:47		614	71	431	76	370	67.6	481	82.8	1371	105	3122	243.4	3034	246.9			561	121.1	522	121.3
13	10/25/2005 10:14:48		668	36.4	847	17	790	15.7			1672	351.1	1251	16.9								
14	10/25/2005 10:14:49		471	320.9	575	299	558	294.2	256	277.4	218	318.7			195	353.5	696	299.3	920	266.9	686	269.2
15	10/25/2005 10:14:50		602	308.9	842	314.9	564	286.3	528	307.6	697	326.2	476	340.2					56	295.2	233	340.7
16	10/25/2005 10:14:51		670	14.3	644	21.7	835	2.1	482	2	221	94.7	223	201	853	55.7	231	45.9	238	36.6	385	57.6
17	10/25/2005 10:14:52		821	312.2	823	337.1	627	5.7	750	21.8	740	45.9	565	9.3	596	4.8	694	2.1			377	19.2
18	10/25/2005 10:14:53		353	55.7	568	55.7	458	60.6	208	22.6	422	22.9	717	4.2	561	29.3	742	13.2	514	21.5	496	25.4
19	10/25/2005 10:14:54		865	84.2	578	97.1	455	89	243	92.4	319	45.1	277	38.1	583	327.7	646	343.1	550	336.3	492	12.3
20	10/25/2005 10:14:55		714	89.5	583	87.1	563	79.8	556	84.6	733	88.7	767	86.7	824	68.3			736	12.1	776	29.5
21	10/25/2005 10:14:56		499	69.5	500	79.7	722	85.2	624	90.4	519	63.3	568	62.9	355	63.9	421	32.8	358	355.4	560	36.6
22	10/25/2005 10:14:57		612	80.9	809	91.7	720	93.5	375	90.9	432	72.6	635	57.5	326	26.3	406	354.1	567	3.8	735	12.6
23	10/25/2005 10:14:58		632	81.4	489	97.9	43	173.4	134	357.4	158	55.6	338	71.7	74	178.5	185	44.3	378	7	721	21
24	10/25/2005 10:14:59		346	17	359	358.6	265	3.7	79	57.9	261	75.8	186	79.5	144	29.9	124	118.8	168	10.3	558	47.5
25	10/25/2005 10:15:00		313	30.1	307	17.4	349	87	381	92.4	332	80.3	334	89	466	55.5	490	116.1	1046	79.4	382	58.9
26	10/25/2005 10:15:01		443	24.4	316	8.6	273	344.1	112	36	55	354.8	235	64.5	467	104.4	322	113.5	574	70.1	478	68.6
27	10/25/2005 10:15:02		306	62.8	364	50.6	293	54.3	105	78.5	287	84.8	305	80.9	809	93.3	732	51.5	586	75.2	362	55.3
28	10/25/2005 10:15:03		399	48.2	443	62.3	375	75	179	94.8	223	68.7	346	64.8	168	93.7	105	101.5	412	67	263	70.3
29	10/25/2005 10:15:04		497	108.2	443	112.6	463	103.6	292	78.7	263	83.2	309	69.9	94	67.5	165	123.1	139	197.5	128	121.6
30	10/25/2005 10:15:05		467	68.7	555	75	513	88.5	395	81.8	335	66.6	180	104.1	388	91	651	70.3	500	76.2	343	107
31	10/25/2005 10:15:06		140	73.4	92	310.6	66	239.2	322	119.4	493	119	524	107	224	136.3	191	124.5	52	225.8	91	346
32	10/25/2005 10:15:07		157	74.9	345	107.7	173	110.3	32	18.4	281	93.9	419	119.3	276	137.1	378	117.6	457	73.1	398	67.1
33	10/25/2005 10:15:08		394	85.5	266	72	303	104.1	222	77.8	503	86.7	523	85.7	622	91	464	59	181	88.1	340	73.3
34	10/25/2005 10:15:09		194	108.9	282	79.4	284	103.3	190	76	420	42.6	642	66.7	393	72.1	361	71.6	143	61.1	240	89.3
35	10/25/2005 10:15:10		550	119.8	531	118.1	438	95.5	441	86.2	394	49.8	507	34.5	466	41.7	414	11.4	143	296.6	173	21.4
36	10/25/2005 10:15:11		298	69.4	320	74.2	475	91.7	380	62.2	466	42.5	501	41.7	531	28.8	826	358.5	332	9.7	313	44.5
37	10/25/2005 10:15:12		273	97.2	327	100.2	365	90	147	46.7	93	94.9	108	18.9	76	13.7	274	55.3	89	70.3	254	74
38	10/25/2005 10:15:13		423	70.2	413	54.8	436	53.4	314	71.2	237	71.6	298	65.2	171	50.7	64	306.2	132	110.4	256	135
39	10/25/2005 10:15:14		599	53.9	564	44	501	56.8	359	34.7	358	52.8	285	50	318	39.1	76	41.8	217	115.1	207	116.4
40	10/25/2005 10:15:15		377	54.6	475	36.4	383	58	479	32.2	464	41	299	60.5	315	63.8	462	127.2	340	122.4	262	142.4
41	10/25/2005 10:15:16		195	36.2	324	72.4	345	55.6	266	38.3	444	40.9	595	29.7	398	45.5	480	55	464	63.7	398	37.8
42	10/25/2005 10:15:17		302	74.9	83	40.6	257	60.9	260	77.4	236	74.3	385	71.4	303	76.2	286	83.8	321	73	257	102.8
43	10/25/2005 10:15:18		236	68.1	282	49.8	233	29	277	46.9	211	44.4	305	94.1	254	68.3	161	131.2	126	91.8	255	75.5
44	10/25/2005 10:15:19		156	87.4	210	124.5	113	132.1	154	94.9	235	89.3	176	111	280	122.2	365	142.8	181	126.9	232	112.8
45	10/25/2005 10:15:20		89	53.6	150	137.7	189	109.8	256	67.2	295	63.2	120	71.6	48	90	88	45.9	67	55.4	157	74.9
46	10/25/2005 10:15:21		243	94.3	190	107.8	99	177.1	71	163.6	28	328	183	101.7	199	144.8	391	136.6	305	111.8	80	102.3
47	10/25/2005 10:15:22		127	141.4	310	135.3	189	138.6	210	131.7	129	94.4	204	65.7	318	83	186	73.4	45	90	74	112.4
48	10/25/2005 10:15:23		60	55.2	150	145	215	143.5	246	116.4	125	92.3	160	74.1	67	132	329	149.7	208	142.8	114	104.8
49	10/25/2005 10:15:24		327	79.8	205	77.3	233	139.9	237	121	230	159.4	133	174.8	166	144.8	330	165.1	65	146.3	123	116.6
50	10/25/2005 10:15:25		330	85.3	355	109	400	103.1	299	85	108	189	116	216.6	178	141.4	186	161.5	212	210.3	97	140.4
51	10/25/2005 10:15:26		334	97.1	459	97.9	354	63.9	174	114.8	104	357.8	23	39.8	40	198.9	176	227.5	181	178.7	86	162.4
52	10/25/2005 10:15:27		386	71.3	316	49.4	113	70.9	66	23.1	44	320.5	118	253.3	106	171.9	137	185.9	237	143.2	151	164.7
53	10/25/2005 10:15:28		11	296.6	34	76.4	96	122.7	71	72.8	96	256.7	111	168.6	139	177.5	358	187.9	157	218	76	223.4
54	10/25/2005 10:15:29		180	181	52	122.5	155	194.9	70	62.7	223	101.7	182	177.5	135	149.8	110	196.3	83	127.1	172	156.4
55	10/25/2005 10:15:30		178	175.2	160	81.7	205	48.6	55	326.9	132	221.6	139	301.2	124	183.2	261	196.2	134	200.6	98	161.6
56	10/25/2005 10:15:31		190	98.8	189	128.3	282	150.4	185	113	133	111.6	18	146.3	56	211.1	54	331	164	118.7	184	141.2
57	10/25/2005 10:15:32		162	90	187	117.8	103	172.7	99	176	112	103.4	133	152.3	166	126.2	102	123.4	327	139.3	278	153.3
58	10/25/2005 10:15:33		141	165.2	118	144.7	83	185.5	200	92.6	189	150.2	357	138.6	240	158.2	218	143.4	96	251.8	44	357.4
59	10/25/2005 10:15:34		242	85.3	130	69.3	60	96.7	121	243	90	156.3	137	136.5	179	123.2	319	152	260	140	146	161.2
60	10/25/2005 10:15:35		270	91.5	112	153	118	84.6	84	160.5	50	166.2	89	135	187	122.8	112	207	200	138.2	152	127.2

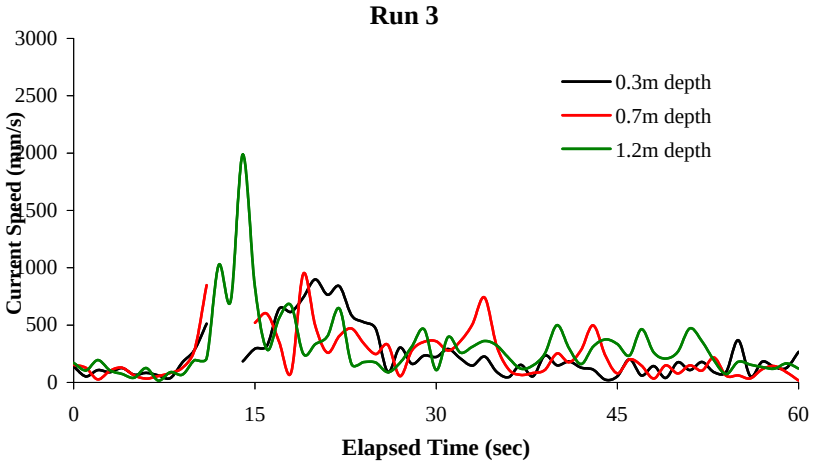
Fox River Propwash Study - Moving Vessel Trials

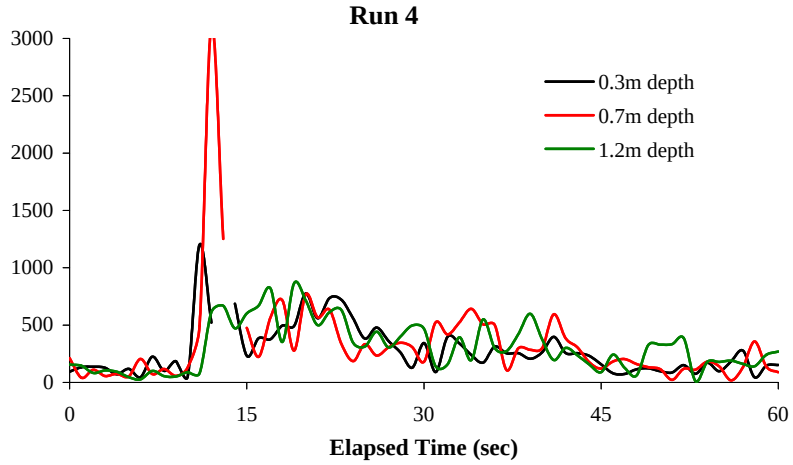
Test #8: Single-Prop Vessel - 2000 RPM - Pitch Up 15

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Nine

Run 1																								
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:25:35		229	71.2	91	102.1	143	75.9	121	99.5	192	104.2	170	67.8	202	39.4	344	232.8	537	222.1		
1	10/25/2005 10:25:36		153	84.4	267	96	144	111.2	63	92.7	208	148.4	143	124.5					516	221.4		
2	10/25/2005 10:25:37		158	108.8	67	37.7	188	78.3	170	81.5	85	61.9	131	129.4			441	247.2	454	222.9	722	249.2
3	10/25/2005 10:25:38		238	103.1	194	96.8	298	103.2	132	132.9	174	74.4	105	10.5			187	149.9	309	245.8	392	261.6
4	10/25/2005 10:25:39		120	102.5	226	38.7	55	41.3	196	48.9	135	85.3	83	353.8	229	281.6	246	312.4	207	286	411	267.9
5	10/25/2005 10:25:40		141	76.1	226	87	147	13	127	31.2	227	350.9	178	14.7	205	294.2			487	277.9	245	310.5
6	10/25/2005 10:25:41		68	25.1	186	38.9	183	322.6	161	333	161	350.7	151	352.4	428	262.6	246	269.1	334	263.6	308	267.4
7	10/25/2005 10:25:42		161	117	92	6.9	141	54.5	158	44.2	36	99.5	107	20.8	196	324.1	210	351.5	336	272.9	67	258
8	10/25/2005 10:25:43		93	67.9	92	111.6	78	124.5	36	249.1	80	334.7	213	48.8	44	162.8	228	266.7	261	230	300	232.7
9	10/25/2005 10:25:44		104	60.7	62	72.1	107	24.9	102	28.1	42	58.6	78	351.9	85	352.5	342	338	188	277.4	179	213.9
10	10/25/2005 10:25:45		165	92.4	249	105.4	164	124.1	79	44	134	47.7	101	122.4	97	1.2	70	250	85	252.2	72	153.4
11	10/25/2005 10:25:46		83	256.8	36	203	109	32.7	84	22.3	117	51.6	133	49.9	117	164.2	227	170.4	86	311.2	27	100.5
12	10/25/2005 10:25:47		133	16.7	94	310.3	71	17.9	30	11.7	18	163.6	63	121.4	165	113.9	46	344.7	104	240	16	299.7
13	10/25/2005 10:25:48		202	48	262	82.5	176	164.9	149	103.6	94	99.2	42	126.3	173	95.3	188	115.9	139	55.9	98	64.7
14	10/25/2005 10:25:49		145	103.2	29	157.8	111	107.8	73	228.9	157	287.9	89	258.9	32	213.7	103	297.8	131	263	157	300.7
15	10/25/2005 10:25:50		282	354.7	537	288.3			322	207.1	342	308.6	459	325.9	471	335.6			58	289.1	207	50.3
16	10/25/2005 10:25:51		1215	99.7	1239	92	1091	102.2	755	84.4	670	70.6	711	69.8	511	88.3	733	106.9	311	67.3	429	32.7
17	10/25/2005 10:25:52		601	63	846	81.1	545	54.8	601	37.8	292	59.7	225	63.1	305	78.7	365	74.1	320	34.3	254	28.5
18	10/25/2005 10:25:53		498	82	272	52.3	511	44.6	491	68.2	353	73.9	367	67.4	221	59.8	506	119.8	91	336	198	8.4
19	10/25/2005 10:25:54		346	339.5	494	311.5	102	79.2	203	136.4	144	34.8	224	46.6	498	68.9	318	72.4	223	29	214	304.1
20	10/25/2005 10:25:55		341	342.4	550	333.3	425	356.2	277	33.1	166	58	175	60.2	178	108	433	128.9	53	31.9	160	345.2
21	10/25/2005 10:25:56		424	335.3	437	10.7	795	358.3	188	61.8	710	245.1	111	8.8	267	305.5			72	254.6	120	106.9
22	10/25/2005 10:25:57		517	343.1	607	2	523	33.9	278	330.2	324	321.9	532	280.7	444	283.4	358	194.9			301	110.2
23	10/25/2005 10:25:58		311	342.4	325	333.7	581	302.6	426	309.4	503	317.7	593	341.2	583	300.9	1080	342	597	25.6	389	53
24	10/25/2005 10:25:59		54	15.1	297	259.7	381	257.9	278	285.6	315	304.4	95	29.8	803	63.7	333	77.3	463	19.2	744	14
25	10/25/2005 10:26:00		302	322.7	521	321.2	358	304.8	376	316.5	304	301.5	214	316.3	444	311.1	73	153.1	582	77.7	285	38.9
26	10/25/2005 10:26:01				163	320.7	96	324.3	302	330.6	188	312.6	206	289	233	244.6	199	240.5	116	61.7	282	10
27	10/25/2005 10:26:02				305	354	162	20.6	319	315.1	294	300.7	322	298.6	306	323.8	106	125.8	43	41.2	270	40.3
28	10/25/2005 10:26:03		396	115.9	208	93.9	169	358.3	101	339	467	316.4	638	310.1	366	316	421	343.8	392	25.8	391	35
29	10/25/2005 10:26:04		385	102.7	535	140.5	117	122.5	107	294.2	376	335.1	778	324.2	694	336.4	993	344.5	307	340.6	397	10.2
30	10/25/2005 10:26:05		360	108.8	364	143.6	160	95.7	363	337.3	300	319.7	347	305.2	298	341.4	590	332	504	316	439	5.2
31	10/25/2005 10:26:06		147	127.3	258	341.9	147	348.2	355	336.6	494	322.6	519	322.9	450	335.4	128	310.6	90	57.2	173	10
32	10/25/2005 10:26:07		142	95.3	42	205.3	82	115.9	78	310.8	236	294	315	305.7	307	293	236	297.2	143	288.3	102	55.8
33	10/25/2005 10:26:08		44	71.6	33	41.3	198	244.2	40	187.1	244	255.3	598	307.7	337	283.4	459	313.5	332	309.7	223	346.5
34	10/25/2005 10:26:09		205	71.8	56	352.9	289	283.8	120	316	131	285.1	418	313	423	295.4	553	316.8	417	286.4	259	306.8
35	10/25/2005 10:26:10		242	26.8	100	79.6	64	209	217	213.2	321	309.1	162	294	458	313	478	331.9	129	301.7	142	33.2
36	10/25/2005 10:26:11		201	99.5	114	348.4	67	130.1	25	267.7	332	304.3	328	291.1	214	350.8	214	289.4	257	284	190	11.5
37	10/25/2005 10:26:12		100	21.7	16	284	103	99.5	68	315	73	337.3	360	347	417	335.2	466	323	212	307.1	92	5
38	10/25/2005 10:26:13		228	357.2	32	18.4	119	336.2	235	337.2	143	290.8	270	314.7	272	286.9	405	320	396	286	255	351.6
39	10/25/2005 10:26:14		61	232.9	131	338.9	213	332	106	344.6	215	5.9	82	339.4	255	259.4	371	327	280	40.1	261	351.4
40	10/25/2005 10:26:15		100	27.3	193	34	180	17.4	69	279.2	131	320.6	190	336.8	259	345.5	362	325.7	203	318.8	161	315.5
41	10/25/2005 10:26:16		169	71	282	46.3	133	80	114	20.5	119	4.3	110	318.3	167	318.7	259	306.8	292	287.1	182	346
42	10/25/2005 10:26:17		69	22.9	170	68.3	125	79	59	26.1	129	38.7	169	16.5	199	333.7	225	356.4	275	294	271	1.7
43	10/25/2005 10:26:18		93	34.5	157	31.2	185	85	153	69.7	90	63.7	84	38.2	135	16.3	119	342.3	143	357.6	130	31.5
44	10/25/2005 10:26:19		211	55.6	255	92	187	89.1	305	82.9	135	32.9	252	45	286	1	73	314.4	241	348.7	170	2.7
45	10/25/2005 10:26:20		304	83.4	216	110.3	222	38.8	189	36.4	11	100.3	239	83.8	31	26.6	113	99.1	131	4.4	167	31.3
46	10/25/2005 10:26:21		219	88.2	264	87.8	218	58.7	320	89.3	261	58.1	214	39.9	155	64.8	72	51.2	17	180	24	57
47	10/25/2005 10:26:22		117	63	239	31.8	310	55	281	92	262	55.1	127	65.3	208	7.5	155	16.5	132	312.5	82	7
48	10/25/2005 10:26:23		144	66.6	177	74.9	279	79.5	161	42.5	112	58.9	267	47	140	55.5	282	104.2	64	3.6	248	42.4
49	10/25/2005 10:26:24		128	48.5	232	70.6	232	63.3	361	59.2	259	70.9	218	52.7	295	41.6	117	23.1	37	101	71	22.2
50	10/25/2005 10:26:25		225	55	319	71.9	236	56.2	334	33.9	206	45.4	284	27.3	249	20.7	348	21	76	326.3	96	6.6
51	10/25/2005 10:26:26		224	59.1	356	62.7	299	73.1	201	54.7	237	76.1	135	58.7	208	60.4	252	17.8	172	44.8	37	198.9
52	10/25/2005 10:26:27		356	56	292	57.3	316	80.7	150	78.1	246	48.1	218	58.1	170	311.7	223	353	197	93.5	59	330.4
53	10/25/2005 10:26:28		173	94	350	82	268	77.1	235	53.5	140	30	122	43.7	190	50.5	255	80.3	142	60	53	42.7
54	10/25/2005 10:26:29		138	60.5	162	40.5	219	34.6	159	66.3	202	63.2	253	85	115	63.2	135	34.4	115	257.4	83	69.6
55	10/25/2005 10:26:30		155	28.6	153	55.9	192	64.1	146	54.5	229	42.2	110	21.9	127	37.3	159	24.5	68	313.8	70	201
56	10/25/2005 10:26:31		153	45.3	113	22.5	97	50.4	156	63.3	218	0	205	31.8	144	5.6	146	81.3	81	104.4	39	302.5
57	10/25/2005 10:26:32		182	28.3	332	70.3	248	18.6	166	50.4	219	27.5	277	58	313	42.9	74	100.9	260	61.6	295	353.8
58	10/25/2005 10:26:33		209	21.3	247	100.3	206	77.4	207	18.3	291	46.1	245	33.4	309	36.8	152	38.6	180	251.6	51	97.8
59	10/25/2005 10:26:34		246	70.8	334	58.2	339	74.2	220	79.3	263	41.8	231	27.3	181	351.1	113	33.4	69	138	13	265.6
60	10/25/2005 10:26:35		146	59.6	196	78.5	78	41.9	128	38.7	162	349.3	125	30.3	344	57.1	33	111.2	132	34.5	108	11.7

Lower Fox River Moving Vessel Trials
Test Nine

Run 2

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
0	10/25/2005 10:28:18	169	64.3	106	21.5	102	62.4	103	22.3	149	1.9			423	250.7					103	176.7
1	10/25/2005 10:28:19	155	351.1	124	52.9	52	326	109	16.4	151	328.8	99	28.9	371	231.5						
2	10/25/2005 10:28:20	203	358.6	205	346.8	51	274.5	56	317.2	16	60.3	143	255	313	254.8						
3	10/25/2005 10:28:21	9	229.4	136	351.6	209	337.2	168	280.6			397	272.9	403	254.9	690	276.3	239	272.4	166	333.1
4	10/25/2005 10:28:22	211	40.8	408	292.2	194	303.2	233	299.3	323	264.5	105	149	383	301.1	349	273.5	315	275.5	189	237.7
5	10/25/2005 10:28:23	61	7.6	147	261	423	273.7	197	257.1	433	244.4	82	194	210	349	235	178.3	348	127.1	430	188.3
6	10/25/2005 10:28:24	104	0	137	300.7	299	266.2	189	255.9			292	274.3	375	352.5	174	152.7	250	198.9	231	201.6
7	10/25/2005 10:28:25	260	358.9	308	297.5	261	256.3	305	288.1	325	321.5	130	246.4	12	166	244	320.8	125	77.1	70	194
8	10/25/2005 10:28:26	216	314.8	220	303.1	83	302.2	154	286.2	345	315	136	295.2	194	270.6	52	11.1	102	258.7	250	288.7
9	10/25/2005 10:28:27	33	271.7	186	320.2	277	303.3	170	253.3	147	277.8	230	268.3	41	182.8	35	36.9	127	9.5	171	340.5
10	10/25/2005 10:28:28	179	279.3	113	322.2	290	285.6	74	277	21	280.8	47	292.7	158	352	84	20.2	56	343.5	201	297.2
11	10/25/2005 10:28:29	131	38.8	100	247	53	247.8	172	300.7	103	307.5	191	303.7	136	357.1	145	28.3	137	42.3	147	5.5
12	10/25/2005 10:28:30	192	36.5	108	330.1	58	43.6	114	66.1	169	74.6	28	145.2	72	240.9	122	332.2	234	348.9	186	322.6
13	10/25/2005 10:28:31	413	340.8	315	3.1	166	339.6	18	38.2	140	288.7	46	297.1	191	354.9	51	323.8	411	0.3	387	28.9
14	10/25/2005 10:28:32																			407	22.2
15	10/25/2005 10:28:33																				
16	10/25/2005 10:28:34					709	162.3														
17	10/25/2005 10:28:35	442	269.9	394	323.2	341	326.4	569	30.4	395	329.6	355	359.5	144	52.3	222	58.5	228	334.6	357	28.3
18	10/25/2005 10:28:36	556	61.1	483	35.1	292	14.9	320	277.4	416	47.6	212	243.3	144	350	352	291.8	399	311.2	511	343.5
19	10/25/2005 10:28:37	562	62	486	51.7	534	38.5	247	13.8	110	37.6	190	275.1	204	225.6	292	193.1	182	209.2	353	338.7
20	10/25/2005 10:28:38	728	56.8	731	55.9	700	32.5	209	43.1	612	339.8	363	356.8	117	0	178	53	214	6.2	238	47
21	10/25/2005 10:28:39	311	63.8	471	44	586	41.3	628	45.4	519	18.2	462	43.3	268	65.1	397	94.6	442	0.6	532	11.9
22	10/25/2005 10:28:40	339	333.4	438	44.4	446	52.9	334	48.8	395	42.5	459	43.1	441	43.8	414	40.4	565	39.2	563	24.7
23	10/25/2005 10:28:41	695	38.6					388	27.8	419	36.2	545	18.6	730	13.3	695	1.3	290	30.5	520	35.7
24	10/25/2005 10:28:42	383	37.9	518	15.5	456	48.7	72	333.8	349	45.7	570	25.6	600	30.9	500	63.8	479	60.2	338	34.9
25	10/25/2005 10:28:43	336	48	582	28.1	628	4.7	679	5.8	505	345.1	502	355.8	604	22.6	690	15.2	434	16.7	515	27.9
26	10/25/2005 10:28:44	664	356	549	343.3	560	349.6	374	340.6	154	354.8	130	45	168	168	336	142.1	295	92.9	72	343.8
27	10/25/2005 10:28:45	221	15.7	304	56.7	303	41.1	362	46.6	350	40.2	132	19.9	292	132.8	323	104	249	115.7	553	92.4
28	10/25/2005 10:28:46	380	38.8	399	43.6	538	48.3	623	37	417	76.1	127	77.7	220	116.1	494	132.5	539	82.3	272	120
29	10/25/2005 10:28:47	383	32.5	270	55.5	309	62.7	428	58.1	496	77.1	500	88.2	289	125.7	313	152.2	221	122	295	122
30	10/25/2005 10:28:48	195	18.8	308	19.7	391	34.6	439	65.1	635	82.6	513	91.1	380	119.8	765	152.9	364	138.6	283	135.3
31	10/25/2005 10:28:49	441	52.9	530	100.9	449	109.8	447	92.6	643	115.6	471	105.6	339	129.4	278	88.4	379	90.9	191	120.9
32	10/25/2005 10:28:50	350	104.4	270	125.5	309	102.9	363	129.5	292	139.6	430	122.1	481	113	549	138	359	105.4	165	150.2
33	10/25/2005 10:28:51	376	53.9	309	71.3	151	122.3	332	107	297	110.5	232	150	361	115.4	387	116.2	206	189.5	287	89
34	10/25/2005 10:28:52	442	47.8	357	52.2	389	87	323	115.5	353	131.7	224	126.7	233	108.7	202	126.8	233	135.5	282	95.5
35	10/25/2005 10:28:53	442	52.2	363	57.8	359	60.3	264	19	180	140	286	113.5	192	122.9	98	86.5	403	90.3	310	64.6
36	10/25/2005 10:28:54	400	40	381	61.8	471	80.8	593	79.7	341	81.7	278	76.7	359	82.8	244	91.9	519	87.6	232	109.1
37	10/25/2005 10:28:55	400	58.4	282	64.3	230	93	396	148.5	309	156.6	133	125.2	244	108.9	313	107.9	456	99.1	217	99
38	10/25/2005 10:28:56	185	80.7	178	100.7	175	114.4	110	156.5	217	152.8	230	145.3	294	138.2	392	125	332	195.4	188	111.2
39	10/25/2005 10:28:57	298	92.3	406	92.8	279	86.9	273	143.3	324	135.3	347	142.1	258	136.1	338	158.1	197	194.7	165	173.7
40	10/25/2005 10:28:58	183	130.1	412	41	310	82.4	138	135.3	171	140.9	79	159.3	238	128.4	301	135.4	480	105.9	225	74
41	10/25/2005 10:28:59	149	356.5	218	26.4	275	83.3	393	79	215	129.9	282	151.6	223	136.1	445	153.3	331	151.9	269	149.9
42	10/25/2005 10:29:00	200	8.3	258	46.9	267	113.6	182	152.4	151	126.9	122	114.2	134	141.3	232	160.3	236	138.6	158	137
43	10/25/2005 10:29:01	164	41.8	174	32.8	72	32.6	255	117.1	93	132.8	70	153.8	155	226.8	173	159.4	166	201.6	254	180.2
44	10/25/2005 10:29:02	333	15.2	73	15.9	158	82.7	147	46.7	121	100.5	202	89.1	341	150.9			212	124.4	238	120.9
45	10/25/2005 10:29:03	396	32.4	227	16.1	340	56.9	267	76.3	205	69.2	213	126	69	143.3	122	168.7	126	191	35	132.7
46	10/25/2005 10:29:04	98	44.6	234	6.9	232	45.7	263	43.8	204	64.7	268	113	243	140.7	258	125.5	210	110.7	94	63.4
47	10/25/2005 10:29:05	277	92.9	213	343.6	143	3.2	148	80.3	184	96.2	139	79.3	209	148.5	321	148.2	290	111.4	278	132.8
48	10/25/2005 10:29:06	223	18.6	119	1.9	170	5.4	30	46.3	30	78.3	149	120.2	310	106.5	246	136	254	116.5	266	151.5
49	10/25/2005 10:29:07	297	9.5	179	357.4	56	2	114	20.5	23	182.5	170	131.2	421	106.8	393	152.3	107	124.3	217	133.3
50	10/25/2005 10:29:08	163	92.5	147	45	129	332.2	27	28.4	154	26.2	189	93.9	95	129.9			255	128.9	192	120
51	10/25/2005 10:29:09			178	12	130	67	118	69.7	17	324.5	56	164.5	220	140.2	213	77.8			82	102
52	10/25/2005 10:29:10	163	97.4	77	71.8	338	80.6	169	131.6	5	90	54	164.9	119	119.1	313	138.4	277	111.4	176	153.3
53	10/25/2005 10:29:11	157	310.6	67	79.7	154	122.2	321	101.5	93	21.3	48	164.2	163	165.8			138	105.9	78	122.5
54	10/25/2005 10:29:12	94	35.9	210	51.4	124	352.6	257	38.5	136	62.5	6	270	55	58.3			198	69	94	64.8
55	10/25/2005 10:29:13	126	57.9	118	95.4	128	70.4	121	53	106	285.4	43	30.7	239	57.6			74	182.3	224	115.1
56	10/25/2005 10:29:14	192	25.6	99	35.9	158	30.8	97	108.1	88	52.9	82	39.5	240	70.8			151	201.8	231	169.8
57	10/25/2005 10:29:15	131	41	83	68.7	194	45.4	275	56	198	55.3	65	40	80	120.7			132	163.2	117	138.8
58	10/25/2005 10:29:16	202	14.9	26	92.2	96	47.5	199	55	111	46.8	112	29.6	109	156.3			113	190.2	152	133.7
59	10/25/2005 10:29:17	93	86.9	95	106.5	145	36.3	251	37.1	49	66	164	126.8	118	55			44	120.1	99	76
60	10/25/2005 10:29:18	76	136.1	83	85.9	224	39.9	99	57.8	122	42	122	178.6	73	67.3					98	56.6

Lower Fox River Moving Vessel Trials
Test Nine

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:30:32		77	41.3	89	130	207	78.9	292	154.8	60	87.1	190	57.5	231	74.9			177	156.8	231	175
1	10/25/2005 10:30:33		142	353.9	67	341.8	163	87.5	15	53.1	143	94	100	63.9	269	33.3			201	144.7	150	175
2	10/25/2005 10:30:34		69	22.9	60	319.7	58	62.1	138	99.6	39	235.5	58	69.7	47	71.6			177	186.5	127	221.5
3	10/25/2005 10:30:35		89	9	38	240.1	99	173.6	227	140.4	160	74.7	153	66.5	191	10						
4	10/25/2005 10:30:36		87	2	78	278.1	96	49.7	148	38.4	158	24.3	81	342.7	382	9.3			81	336		
5	10/25/2005 10:30:37		147	298.5	37	304.1	69	268.3	79	64.4	64	331.8	47	48.5	91	78.6	160	215.1	789	279.4	237	345.6
6	10/25/2005 10:30:38		132	84.3	110	128.7	67	354	68	131.4	150	356.2	151	50.1	109	101.1			114	271.5		
7	10/25/2005 10:30:39		124	11.1	37	302.8	59	20.9	83	94.1	173	33.7	219	342.2	110	330.6			134	236.9	104	305.2
8	10/25/2005 10:30:40		59	264.2	62	154.3	96	20.1	155	1.1	51	348.7	87	209.5	89	341.8	257	276.5			46	351.2
9	10/25/2005 10:30:41		114	13.7	31	132.4	98	104.7	63	342.4	142	51.8	67	339.9	40	218.9	113	317.1	342	329.5	116	340.3
10	10/25/2005 10:30:42		143	23	139	19.7	168	332.7	102	55.4	211	241.7	87	113	75	75.4	107	218.9	158	316.5	40	347
11	10/25/2005 10:30:43		88	62.3	52	30	22	333.4	110	84.2	53	213.4	155	310.8	79	348.3	76	267.7	247	301.4	68	269.2
12	10/25/2005 10:30:44		114	33.6	122	41	127	80.5	72	27.3	208	148.4	158	27.5	48	76.8	47	268.8	46	307.1	118	282.7
13	10/25/2005 10:30:45		131	55.2	110	38.3	201	68.1	212	80	245	73.4	322	49.8	56	12.3	319	60.1	111	23.8	279	38.3
14	10/25/2005 10:30:46																		115	92.5	202	158.5
15	10/25/2005 10:30:47																					
16	10/25/2005 10:30:48		1326	32.3	1551	26	1029	35.3			487	16.7							624	20.4		
17	10/25/2005 10:30:49		792	81.5	777	82	1066	80.3	1099	74.2	577	83.6	378	76.7	418	72	402	59.2	371	61.8	332	42.9
18	10/25/2005 10:30:50		380	322	667	331.2	440	351.1	157	347.9	345	309.6	262	298.5	425	293.9	339	340.7	267	336.4	389	14.1
19	10/25/2005 10:30:51		1144	6.5	612	24.9	551	10.5	624	21.8	622	9.1	553	355.6	669	351.2	581	345.7	546	359.3	455	2.3
20	10/25/2005 10:30:52		522	71.8	226	50.7	541	4.8	622	0.6	517	9.2	622	29	560	25.6						
21	10/25/2005 10:30:53		148	10.1	338	343.5	352	336.7	89	2.6	258	354.4	273	348.8	608	58.2	545	96.6	452	25.5	619	54.5
22	10/25/2005 10:30:54		452	324.9	599	28.2	516	301.3	653	290	407	271.5	245	344.8	223	51.2	268	167.9	316	345.5	514	37.7
23	10/25/2005 10:30:55		139	71.6	336	58.9	303	74.1	1027	72.5	607	130.4	216	21.7	281	118.2	629	126.4	1098	64	476	21.6
24	10/25/2005 10:30:56		319	106.2	386	102.1	448	106.3	369	109.1	337	58	132	32	151	91.9	217	149.5	424	287.6	437	7.6
25	10/25/2005 10:30:57		740	102.3	863	95.3	789	114.1	689	99.3	602	82.3	312	60.6	176	79.8	259	314.1	295	295.7	261	309.6
26	10/25/2005 10:30:58		621	99.7	719	112.1	692	121.8	602	115.2	382	103.3	275	111.3	248	107.6	84	72.6	380	358.3	414	3.9
27	10/25/2005 10:30:59		408	101.2	315	137.2	410	142.9	489	150.2	343	119.6	402	123.2	304	113.4	195	75.5	214	308.4	210	4.7
28	10/25/2005 10:31:00		226	101	357	118.3	430	151.6	333	133.9	302	132.2	138	153.8	383	101.6	146	189.8	209	45.2	151	350.5
29	10/25/2005 10:31:01		280	129.9	201	118.5	314	143.4	310	161.4	156	146	285	100.5	356	52.9	285	31.3	150	37.7	71	356
30	10/25/2005 10:31:02		253	85.5	208	118.8	241	96.9	444	128.1	413	118.6	353	127.7	317	114.4	421	104	187	45.6	321	61.1
31	10/25/2005 10:31:03		306	37.4	283	47	140	14.9	179	107.5	362	110.2	387	109.6	386	94.5	516	97.1	629	74.3	263	60.1
32	10/25/2005 10:31:04		365	57.7	291	50.4	335	54.5	356	73.3	308	112.6	254	127.8	294	126.7	462	131.1	241	61.2	261	15.6
33	10/25/2005 10:31:05		292	104.3	370	67.7	319	88.4	226	127.3	305	105	236	117.5	399	120.5	412	129.9	514	67.6	179	48.8
34	10/25/2005 10:31:06		453	74.4	365	93.6	240	108.2	193	93.3	227	86	176	55	204	76.4	154	131.8	388	93.3	233	49
35	10/25/2005 10:31:07		132	45	155	143.1	291	111.2	200	131.6	205	103	246	105.6	290	97.3	420	113.4	261	79.6	151	56.6
36	10/25/2005 10:31:08		90	77.8	98	123.4	136	200.2	135	117.3	180	86.5	204	95.3	281	131	361	131.4	132	88.7	450	33.9
37	10/25/2005 10:31:09		366	59.4	213	88.1	139	109.7	67	78.9	67	159.1	236	84.4	320	113.2	431	108.1	103	75.4	116	78.1
38	10/25/2005 10:31:10		265	36.9	346	36.8	305	14.6	72	65.2	9	77.5	205	138.4	71	87.6	199	64.5	468	79.7	301	48.4
39	10/25/2005 10:31:11		282	21	187	26.3	96	39.5	127	7.7	283	52	252	56.8	358	75.5	450	86.2	590	76.5	244	70.6
40	10/25/2005 10:31:12		444	40.1	181	21.7	274	42.8	149	46.6	252	24.8	242	81	253	107	394	68.8	187	118.8	348	60.4
41	10/25/2005 10:31:13		174	9.2	184	19.3	167	13.9	177	54.9	197	54.7	121	62	124	53.5	239	71.5	20	78.7	145	115.7
42	10/25/2005 10:31:14		86	5.3	111	30.3	81	339.8	195	95.6	146	114.6	62	119.1	245	108.6	377	119.6	309	132.9	147	131.7
43	10/25/2005 10:31:15		108	348.3	105	82.3	47	282.3	49	151.9	25	116.6	207	127.8	247	90.7	526	142.3	502	100.6	252	111.2
44	10/25/2005 10:31:16		190	99.1	75	3.1	109	320.9	119	59.1	26	122.5	331	90.9	189	67.9	506	122.5	505	91.8	187	107.8
45	10/25/2005 10:31:17		135	12.4	133	40.7	86	17	105	327.1	104	40.3	240	103.7	245	117.7	427	127	611	87	283	102.9
46	10/25/2005 10:31:18		306	78.1	144	105.7	129	137.5	362	246.4	80	169.2	274	119.7	231	100.2	419	121.3	381	82.9	148	81.4
47	10/25/2005 10:31:19		206	87.2	126	166.7	88	103.9	28	69	103	24.6	260	48	96	25.2	198	71.7	144	119.1	83	153.4
48	10/25/2005 10:31:20		193	82.8	193	67.8	271	61.8	97	51.2	179	118.7	37	181.5	63	165.3	159	129.9	249	125.9	118	131.9
49	10/25/2005 10:31:21		36	104.4	88	65.8	160	66.8	123	55.9	113	111.8	147	110.6	204	109.5	257	127.7	477	76.7	220	106.1
50	10/25/2005 10:31:22		54	77.2	144	10.8	132	51.1	83	128.7	99	192.2	85	119	67	86.6	84	11.7	195	95.6	64	67
51	10/25/2005 10:31:23		107	142.6	248	128.9	126	52.4	105	326.3	111	74.3	216	103.1	102	89.4	244	147.2	135	68.2	134	60.6
52	10/25/2005 10:31:24		199	28.5	187	13	181	136.3	52	138.9	138	100.4	116	91	430	132.7	160	91.8	274	85	112	83.3
53	10/25/2005 10:31:25		279	45.9	96	58.6	166	161.8	31	326.8	244	110.9	191	89.1	187	104.9			142	116.4	133	120.2
54	10/25/2005 10:31:26		84	23.2	75	39	33	107.9	89	74.4	202	98.5	152	141.9	109	106.6	400	172.4	330	102.3	229	122.7
55	10/25/2005 10:31:27		119	61.9	215	17	211	66.8	217	68.6	130	124.1	281	152.4	150	161	174	128.7	221	128.7	167	155.6
56	10/25/2005 10:31:28		183	48.1	181	100.5	223	129	68	90.8	74	102.5	205	109.9	22	180	13	243.4	147	84.9	129	156.2
57	10/25/2005 10:31:29		124	98.3	69	78.4	153	90	104	51.3	125	112.7	121	161.3	265	145.8	144	207.8	155	103.1	201	147.6
58	10/25/2005 10:31:30		86	53	32	77.3	156	32.7	158	56.6	112	358	227	99.6	35	158.5	70	164.2	93	162.5	93	127.6
59	10/25/2005 10:31:31		164	77	119	52.8	60	57.9	163	94.6	144	44.2	241	101.7	68	107.1	195	177.9	95	194	125	220.5
60	10/25/2005 10:31:32		158	79	16	76	92	11.9	131	92.6	134	1.7	39	166.7	153	77.5	25	68.6	158	250.1	129	147.1

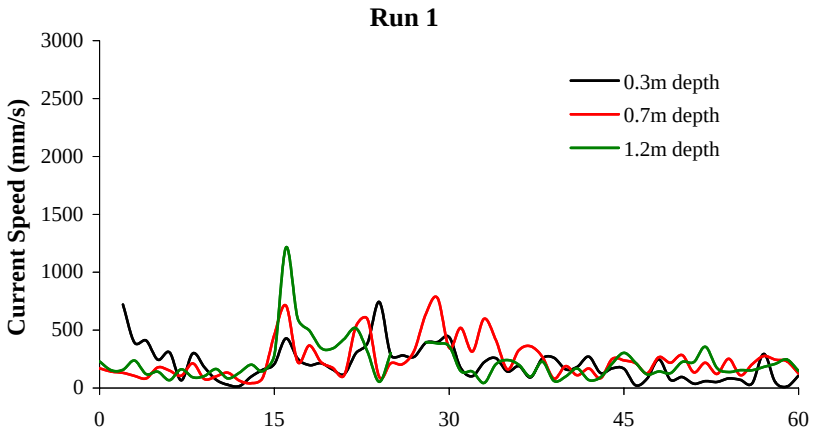
Lower Fox River Moving Vessel Trials
Test Nine

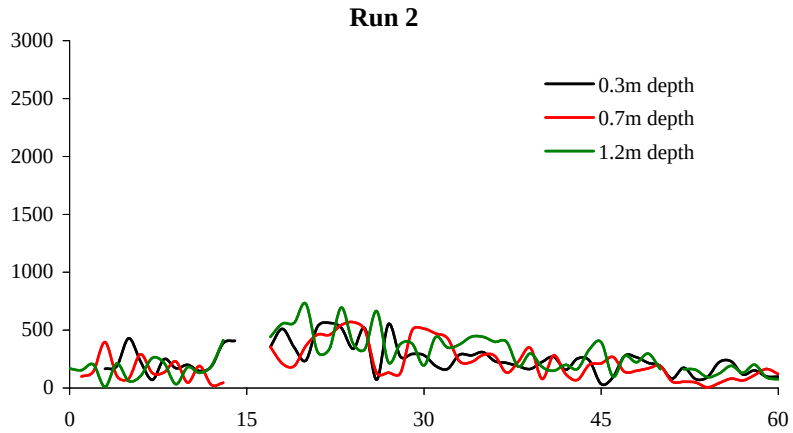
Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:33:46		91	67.4	106	62.5	132	134.7	207	113.3	264	136.7	311	127.7	248	146.5	193	127	177	135.9	606	243.9
1	10/25/2005 10:33:47		157	78.6	272	90.4	298	99.5	370	82.7	282	96.7	213	65.2	241	132			1042	247.4	767	224.3
2	10/25/2005 10:33:48		87	51	267	70.8	146	105.1	319	94.5	381	58.3	227	82.2			651	249	846	227.6		
3	10/25/2005 10:33:49		215	79.8	196	80.6	99	83.6	328	38.3	226	99.9	297	94.8			648	245.2	719	243.9		
4	10/25/2005 10:33:50		284	86.6	140	73	213	78.4	355	68	239	57.6	194	15	122	152.2	647	247.3	768	253.3		
5	10/25/2005 10:33:51		156	22.3	305	76.1	121	61.3	87	3.3	179	38.2	312	19.7			154	215.8	301	290.2		
6	10/25/2005 10:33:52		142	120.5	59	196.6	61	99.5	191	72	153	83.2	388	348.9			562	175.5	475	197.9	417	182.2
7	10/25/2005 10:33:53		89	48.2	103	307.1	71	214.1	106	161.9	102	65.7	115	157	244	287.2			69	117.7	288	266.6
8	10/25/2005 10:33:54		154	38.7	97	3	7	135	63	115.3	256	93.8	229	29.6	267	6.5	587	328.9	420	330.7	346	344.9
9	10/25/2005 10:33:55		44	107.2	67	89.1	105	314.6	69	138	33	185.2	79	298.8	190	313.9	48	307.3	249	305.4	162	18.8
10	10/25/2005 10:33:56		214	81.4	100	4	77	344.9	130	350.7	204	151.5	179	131.2	235	98.1	193	152.2	141	327.4	183	321.9
11	10/25/2005 10:33:57		165	66.8	83	144.8	56	103.5	88	193.9	94	116.6	230	142.2	221	204	124	226.3	129	297.8	309	287.1
12	10/25/2005 10:33:58		298	84.8	78	128.8	137	150.3	216	97.5	141	75.2	105	62.7	281	107.9	216	152.5	244	49.3	180	47.7
13	10/25/2005 10:33:59		286	65.9	261	73.5	235	86.8	35	323.1	60	295.7	47	206.6	57	300.6	195	139	144	17.4	91	54.4
14	10/25/2005 10:34:01		188	106.7	230	261.8	387	241.6	382	235.8	231	244.3	382	245	50	311	386	282.3	529	295.9	298	310.8
15	10/25/2005 10:34:02		971	93.6	1089	105.2	1205	102	1121	96.9	774	96.9	907	94.9	747	97.7	720	97.3	509	72.1	465	79.2
16	10/25/2005 10:34:03		999	110.7	1111	108	942	101.2	888	89	699	84.2	513	82	434	93.2	344	83.3	440	93	485	82.7
17	10/25/2005 10:34:04		475	110.6	539	142.7	593	147.3	553	147.2	586	117.8	459	119.9	348	123.6	269	132	211	114.6	248	76.2
18	10/25/2005 10:34:05		542	52.5	637	297.6	461	299.2	154	190.9	328	157	173	168	160	131.5	198	79.3	120	29.3	187	3.7
19	10/25/2005 10:34:06		761	84.1	657	77.3	565	79.1	623	71.4	270	56.3	295	57.3	367	62.4	286	48.5	322	27.8	301	39.5
20	10/25/2005 10:34:07		682	53.9	479	73.6	148	127.3	489	143.8	113	220.3	111	196.2	92	125.2	310	88	293	273.1	214	44.6
21	10/25/2005 10:34:08		222	55.5	851	87.4	611	69.9	399	62.9	391	52.4	413	88.3	408	115.7	346	113.9	424	46.5	423	35.8
22	10/25/2005 10:34:09		69	86.7	96	187.2	95	74.1	124	327.8	191	73.9	97	38.3	116	322.7	389	88.1	471	79.4	412	67.3
23	10/25/2005 10:34:10		161	10.4	253	16.1	259	12.7	373	331.9	281	345.6	361	56.7	588	57	675	21.5	390	46.5	234	82.4
24	10/25/2005 10:34:11		190	0	254	327.7	251	47.3	448	61	373	68.3	431	104.4	355	138	421	149.4	166	93.8	132	71
25	10/25/2005 10:34:12		350	80.1	356	61.5	366	89.8	592	90.9	697	117	624	118.8	917	119	566	82	760	79.8	345	79.6
26	10/25/2005 10:34:13		427	92.1	624	108.9	747	108.2	761	114.9	836	109	612	102.8	388	106.5	434	99.7	458	100.5	51	115.6
27	10/25/2005 10:34:14		283	96.7	385	85.5	301	99.6	277	120.6	528	118	487	93.2	659	81.2	338	73.3	95	121.7	273	110.4
28	10/25/2005 10:34:15		104	213.2	90	161.2	114	161.1	250	95	130	154	30	227.7	308	100.3	515	121.6	463	97.7	491	92.6
29	10/25/2005 10:34:16		471	117.4	360	98.6	194	94.4	218	99.8	378	95.6	420	95.9	420	94	338	98.3	309	128.8	261	115.2
30	10/25/2005 10:34:17		354	124.4	259	96.9	327	78.3	234	94.2	242	98.6	351	90	342	77.8	443	355.9	406	72.1	305	71.1
31	10/25/2005 10:34:18		299	83.9	365	87.5	296	65.3	226	113.5	290	74.8	359	74.1	299	58.5	137	104.3	319	103.4	242	102.1
32	10/25/2005 10:34:19		85	70.7	220	67	251	95.3	403	108.5	405	85	271	87.7	327	73.1	210	101.8	507	113.4	401	103.6
33	10/25/2005 10:34:20		223	60.7	188	60.7	346	59.6	474	59.4	388	68.7	390	90.7	378	94.4	391	96.9	540	89.8	395	101.1
34	10/25/2005 10:34:21		321	35.4	339	64.3	366	69.9	323	82.5	343	55.3	460	78.7	400	79.6	439	79	349	63.4	400	73.9
35	10/25/2005 10:34:22		133	38.6	157	59.8	135	55.3	156	57	39	160.6	119	70.8	329	43.2	478	48.8	331	89.8	479	81.2
36	10/25/2005 10:34:23		159	36.8	53	51.2	110	24.7	75	344.5	84	72.6	287	17.6	370	52	323	49	358	114.3	589	99.4
37	10/25/2005 10:34:24		213	337	227	357.2	130	358.7	316	4	297	42	288	90.4	619	94.5	514	112.3	450	125.3	425	120.7
38	10/25/2005 10:34:25		374	59.5	286	69.5	327	74.2	246	117.3	384	81.9	537	89	371	90.2	446	122	326	110.3	288	144.8
39	10/25/2005 10:34:26		228	82.7	419	73.6	339	75.6	336	91.9	464	94.1	459	90.6	335	98.1	513	90.9	438	81.9	360	53.7
40	10/25/2005 10:34:27		253	56.1	260	68.6	299	81.4	314	83.2	256	73.9	169	74.2	224	148.2	149	111.6	302	81.2	346	96
41	10/25/2005 10:34:28		281	59.7	357	71.7	250	87.9	185	107.9	337	129.6	162	106.1	273	109.5	213	102.7	252	53.2	245	43.7
42	10/25/2005 10:34:29		268	62.7	232	82.1	375	84.3	115	104	213	109.2	305	106.4	339	128.7	230	110.3	136	123.3	172	90.7
43	10/25/2005 10:34:30		232	121.4	246	120.2	200	90.6	160	78.8	137	107.4	189	183.3	137	98.4	232	94	221	142.9	196	88
44	10/25/2005 10:34:31		216	90.3	159	94.3	146	64.5	117	75.1	140	106.6	156	112.6	194	112.1	368	140.1	217	47.4	239	85.4
45	10/25/2005 10:34:32		304	48.9	334	73.1	295	62.7	213	39.7	278	103.7	27	141	80	85.7	146	122.7	90	50	396	53.9
46	10/25/2005 10:34:33		295	67.5	154	60.4	243	87.2	224	32.4	215	53.7	124	78.9	206	69.3	203	90.6	223	53.7	202	72.1
47	10/25/2005 10:34:34		310	74.7	248	60.9	267	80.3	327	97.2	381	58.7	242	86	205	138.8	70	134.4	34	42.6	125	71.3
48	10/25/2005 10:34:35		250	96.7	209	81.5	306	102.4	347	111.8	172	119.2	171	66.3	212	76.6	202	94.3	72	244.5	56	351.7
49	10/25/2005 10:34:36		347	79	368	96.1	256	41.8	217	68.9	184	73.5	215	91.1	238	80.8	326	108.6	80	55.1	173	90.7
50	10/25/2005 10:34:37		250	108.1	262	60	343	60.9	315	74	344	39.7	262	57.6	282	46.6	320	91.4	126	64	148	93.9
51	10/25/2005 10:34:38		241	71.1	281	84.1	313	62.8	151	40.4	129	356	140	23.6	283	108.9	262	77.9	149	6.9	214	45
52	10/25/2005 10:34:39		313	37.1	346	36.2	256	76.2	190	74.4	186	15.9	187	63.7	249	78.9	369	46.5	244	70.6	60	91
53	10/25/2005 10:34:40		135	37.8	155	62.8	157	121.2	165	19.4	175	84.4	210	99.3	103	128.3	232	63.7	229	109.1	158	105.8
54	10/25/2005 10:34:41		165	109.9	158	73.9	261	49	126	51.8	231	94.7	209	117.1	103	41.9	59	296.1	142	93.2	141	127.5
55	10/25/2005 10:34:42		126	69.6	276	72.9	228	79.4	402	34	234	101.1	179	56.1	444	76.2	237	68.2	375	85.6	102	103.1
56	10/25/2005 10:34:43		193	55.2	206	74.8	283	68.2	272	102.8	275	101.1	318	64.5	213	24.4	169	40.9	95	243.7	29	24.8
57	10/25/2005 10:34:44		62	60.9	167	68.5	305	73	435	94.7	208	103.9	133	94.7	173	149	315	128.4	177	118.3	179	222.5
58	10/25/2005 10:34:45		83	29.7	130	85.6	136	102.3	176	98.8	170	70.8	222	120.3	234	89.8	294	43.2	287	89.2	178	160.3
59	10/25/2005 10:34:46		240	41.3	200	66.1	138	25.8	76	94.5	183	53.4	212	31.9	181	104	392	134.9	153	153.3	45	218.7
60	10/25/2005 10:34:47		330	42.8	236	42.6	196	56.9	157	46	41	354.4	172	184	36	32.3	85	173.2	47	22.7	67	43.2

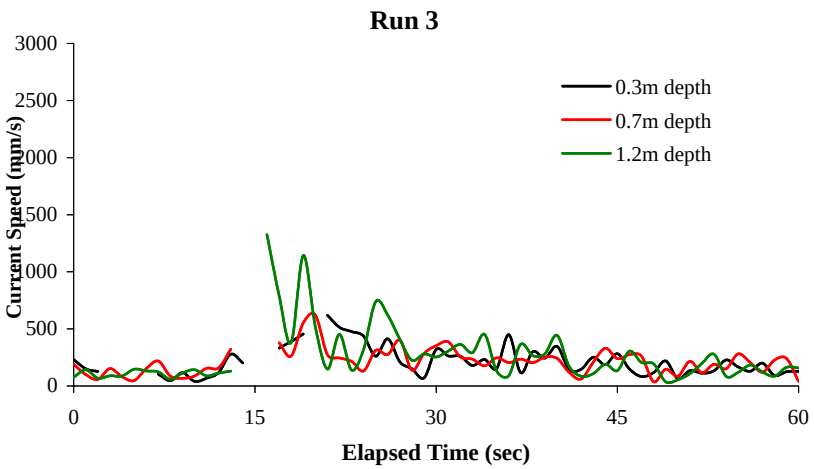
Fox River Propwash Study - Moving Vessel Trials

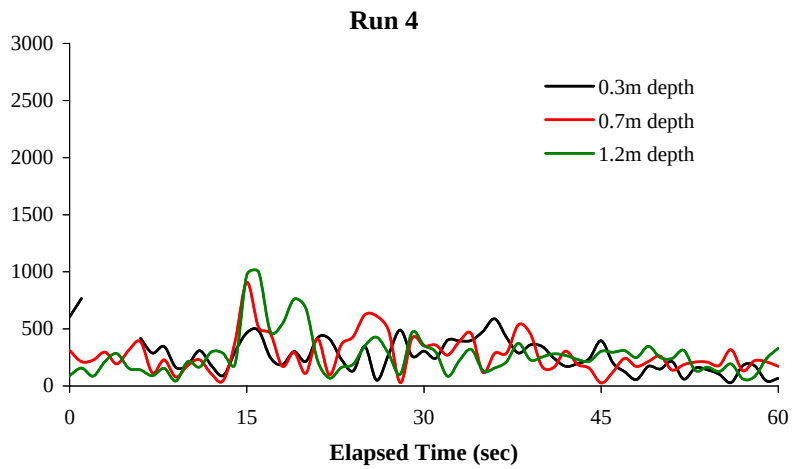
Test #9: Single-Prop Vessel - Full Throttle Startup - Pitch Down 2

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Ten

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 1		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:36:34		6	80.5	110	151.1	145	13.9	206	243.4	129	192.1	14	282.1	256	120.8	316	169	78	150.8		
1	10/25/2005 10:36:35		207	95	179	99.7	260	64.5	129	45.3	110	83.2	106	118.7	54	54	216	116.1				
2	10/25/2005 10:36:36		222	42.1	47	255.1	114	141	66	43.8	67	156.1	207	200.1	33	232.4	82	256			68	0
3	10/25/2005 10:36:37																					
4	10/25/2005 10:36:38		335	66.4	279	69.2	219	76.5	278	73.7	211	81.3	193	46	136	84.9	317	66.3	70	0.8	311	60.6
5	10/25/2005 10:36:39		291	181.8	449	218.6	581	181.1	299	169.4	582	147.5	487	142.8	371	134.5	95	134.1	279	80.1	410	65.2
6	10/25/2005 10:36:40		1484	54.2	1398	55.6	1216	68.2	573	83.6	517	94	567	93.9	466	81	620	75.5	743	71.6	761	50.7
7	10/25/2005 10:36:41		616	130.4	925	128.1	872	132	498	107.6	732	78.1	348	77.7	560	64.1	519	77.2	599	64.9	689	57.6
8	10/25/2005 10:36:42		1249	90.3	1082	109.2	1189	113.8	868	111.9	569	76.6	636	86.3	492	111.1	662	129.4	1244	78.9	703	60.4
9	10/25/2005 10:36:43		418	110.7	520	96.5	677	108.5	789	102.5	719	105	742	106.7	561	87.3	638	118.8	376	88.6	646	55.5
10	10/25/2005 10:36:44		430	90.8	267	96.2	385	136.3	312	88	465	134.6	801	117.6	723	117.9	730	124	1121	67.9	948	44.4
11	10/25/2005 10:36:45		766	50.3	914	44	778	62.3	438	41.3	507	65.8	445	117.3	508	100.3	703	97.7	1451	78.4	772	72.1
12	10/25/2005 10:36:46		552	60.6	537	50.9	556	51.3	281	64.5	192	65.7	224	115.7	340	147.6	663	133.9	1496	82.4	832	62.4
13	10/25/2005 10:36:47		367	39.8	444	31.1	477	38.2	451	32	448	32.4	261	36.1	421	68.4			322	71.9	459	50.8
14	10/25/2005 10:36:48		496	54.5	259	64.9	209	70.2	129	151.8	213	183.5	327	323.6	21	328.6	280	100.9	236	90.7	195	92.1
15	10/25/2005 10:36:49				199	68.5	334	83.5	217	110.5	155	160	232	183.7	151	276.8	144	150.4	121	143	77	143.4
16	10/25/2005 10:36:50		209	80.9	155	70.4	260	102.9	308	144.2	380	173.3	159	195.7	383	159.7	228	204.3	172	230.2	289	198.7
17	10/25/2005 10:36:51		352	1	44	58.1	61	103.3	199	194	176	197.5	272	221.4	205	181.4	234	163.9	130	121.5	274	121.3
18	10/25/2005 10:36:52				145	332.9	51	194.9	174	268	269	299.9	152	256.3	219	239.2	129	230	190	205.2	165	85.1
19	10/25/2005 10:36:53		217	320.8	163	112.3	64	290.1	185	188.7	15	53.1	64	243	84	213.9			116	91.5	205	84.4
20	10/25/2005 10:36:54		179	65.3	330	176.7	124	49.9	51	52.2	127	280.9	152	14.5	230	19.1	219	5.2	158	311.2	123	91.4
21	10/25/2005 10:36:55		206	21.7	158	64.6	232	34.6	334	14.9	296	33.7	340	32.4	346	43	160	27.5	243	138.8	240	57.4
22	10/25/2005 10:36:56		236	44.7	327	36.6	229	348.2	131	8.3	208	357.5	70	24.4	243	67.8	327	96.3	83	54.8	198	29.3
23	10/25/2005 10:36:57		238	23	167	338.5	164	231.9	411	16.1	232	36.2	487	77.6	179	84.5	181	355.6	23	17.7	40	10.2
24	10/25/2005 10:36:58		150	43.9	211	44.6	131	341.3	130	106.5	152	90.4	116	79.1	89	199	105	78.5	85	151	70	8.2
25	10/25/2005 10:36:59		91	93.8	37	104	118	73.7	138	103.8	217	84.4	252	111.2	144	157.2	151	140.1	73	199.2	141	61.6
26	10/25/2005 10:37:00		273	20.8	194	47.9	177	63.4	224	18.5	81	3.5	66	27	147	104.1	466	146.1	133	202.5	121	170.5
27	10/25/2005 10:37:01		129	42.5	164	55.9	312	47.7	137	90.4	103	7.8	149	357.3	277	67.3	331	109	220	109.7	26	231.3
28	10/25/2005 10:37:02		253	26.6	244	40	294	21.8	89	140	110	111.2	173	119.4	243	114	317	113.7	282	75.4	92	0
29	10/25/2005 10:37:03		137	34.3	161	59.5	99	86.5	139	69.7	238	51	358	82	387	52.2	522	29.9	243	42.8	221	57
30	10/25/2005 10:37:04		72	319	177	69.1	295	87.7	244	70.1	348	40.5	251	82	199	117.9	247	49.6	133	80.9	128	56.8
31	10/25/2005 10:37:05		295	32.4	294	28.5	270	71.6	362	47.8	352	47.9	162	34.2	221	31.7	76	40.2	172	92	226	98.4
32	10/25/2005 10:37:06		142	28.5	182	330.8	147	7.8	171	0.7	251	72.4	264	62.9	227	156.4	129	352.9	87	278.6	93	266.9
33	10/25/2005 10:37:07		106	15.9	217	47.8	205	355	167	358.3	186	31.8	164	43.5	325	19.4	391	347.1	39	270	111	188.8
34	10/25/2005 10:37:08		151	346.2	133	89.6	112	64.6	130	39.1	76	247.5	153	115.2	160	102.6	134	129.3	157	304.6	155	87.8
35	10/25/2005 10:37:09		58	215.9	77	130.8	107	153.9	143	239.9	69	318	181	48.4	328	88.6	207	127.8	120	6.7	112	69.6
36	10/25/2005 10:37:10		205	98.4	50	190.4	176	143.1	145	179.2	43	236.3	116	280.4	117	285.3	234	317.4	85	347.1	108	168.3
37	10/25/2005 10:37:11		227	72.3	299	96.5	213	109.2	208	137.3	80	143.1	133	164.3	223	182.1			16	194	179	88.4
38	10/25/2005 10:37:12		134	104.7	155	106.1	170	81.9	146	139.4	234	268.3	220	230.9	274	134.1	349	152	107	210.4	44	133.2
39	10/25/2005 10:37:13		159	87.5	122	126	96	80.4	122	175.8	362	232	197	205.3	141	46.1	226	172.9	33	164.3	177	106.8
40	10/25/2005 10:37:14		56	180	17	211	96	261	131	191.5	230	151.4	303	172.2	233	126.1	284	131.1	122	156.4	137	146.3
41	10/25/2005 10:37:15		43	127.4	177	72.9	216	101.8	197	111.1	218	107.6	225	168.7	132	48.7	185	117	276	116.9	256	141.8
42	10/25/2005 10:37:16		166	144.6	294	95.3	320	128.9	345	132.5	315	121.6	189	141.9	186	171.7	143	149.3	220	121.6	163	71.8
43	10/25/2005 10:37:17		34	127.9	95	173.3	161	144.3	147	118	209	156.9	333	136.6	291	136.7	255	125.7	190	107.1	75	165.4
44	10/25/2005 10:37:18		69	68.7	139	103.3	215	135.4	166	127.1	107	137.7	17	86.6	173	181.7	253	128.1	139	100.7	111	78.1
45	10/25/2005 10:37:19		108	78.3	203	156.5	86	171.3	198	162	130	165.7	173	86.7	302	135.9	149	134.2	87	211.3	75	319.9
46	10/25/2005 10:37:20		88	0	194	171.4	226	160	498	156.7	261	126.4	120	103.5	138	95.4	104	156.1	263	64.3	142	72.3
47	10/25/2005 10:37:21		119	335.2	124	84.4	204	159.6	197	110.2	225	186.9	260	139.8	229	141	115	3	50	11.5	38	267
48	10/25/2005 10:37:22		138	77.5	147	105.8	166	156.5	189	171.5	271	143.3	257	143.7	81	186.3	63	65.5	58	130.8	29	206.6
49	10/25/2005 10:37:23		222	82	169	112.3	28	75.5	28	12.5	134	153.4	61	180	101	249.8	82	208.4	107	212.8	78	130.8
50	10/25/2005 10:37:24		71	230.7	175	101.6	119	87.1	238	153.3	135	148.9	184	175	175	214.8	118	176.6	86	215.5		
51	10/25/2005 10:37:25		184	116.4	98	112.1	55	84.8	196	101.5	157	117.4	97	160.1	22	320.5	211	174.3	191	223.3	129	134.1
52	10/25/2005 10:37:26		160	112.4	109	204.9	62	144.8	204	152.3	140	131.8	281	159.8	60	162.5	72	23.7	62	127.8	173	169.3
53	10/25/2005 10:37:27		68	93.4	142	86	223	131	52	171.1	160	190.5	25	313.4	143	25.7	24	204.4	41	128	178	223.6
54	10/25/2005 10:37:28		119	185.8	61	232.9	161	173.9	261	141.4	215	155.6	258	173.3	99	191.7	88	78.8	79	175.7	125	137.6
55	10/25/2005 10:37:29		133	217	139	281.2	133	244.2	93	186.2	225	156.4	202	162.5	229	162	246	153.6	225	213.2	238	193.6
56	10/25/2005 10:37:30		74	300.7	70	250.8	202	192.6	66	190.5	62	199.9	230	113.9	114	149.4	45	66.3	353	95.2	92	248.4
57	10/25/2005 10:37:31		55	181	63	173.7	418	266.6	14	129.3	180	205.3	141	154.3	91	240.3	239	174.2	89	129.1	140	223.3
58	10/25/2005 10:37:32		65	162.1	79	123.1	98	179.4	120	183.8	187	152.2	181	174.6	144	179.6	240	136.2	22	320.5	161	212.6
59	10/25/2005 10:37:33		269	245.9	139	167.6	33	62.7	178	158.6	281	120.3	203	109.9	146	106.7	38	357	206	262.7	95	239.7
60	10/25/2005 10:37:34		179	75.1	126	140.5	7	326.3	73	135.6	166	214.2	109	166.2	200	198.7	257	223.9	153	147.2	143	135

Lower Fox River Moving Vessel Trials
Test Ten

Run 2																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:39:43		114	75.8	46	124.4	64	149	88	179.3	153	179.6	215	166.8	255	183.8	616	218.1	270	209.5	646	231.9
1	10/25/2005 10:39:44		220	79	145	66.8	105	121.4	111	137.6	118	87.1	171	118.2	236	193			825	218.9	268	240.9
2	10/25/2005 10:39:45		163	68.5	175	75.8	90	138.2	126	138.9	165	114.7					810	238.8				
3	10/25/2005 10:39:46		78	21.9	66	288.4	61	10.4	69	117.7	32	60.3										
4	10/25/2005 10:39:47		196	71.3	198	119.7	245	146.6	76	168.7	72	336.3			720	241.7						
5	10/25/2005 10:39:48		151	89.2	52	208.5	45	306.9	83	174.5	218	51.7			706	247.1						
6	10/25/2005 10:39:49		277	117.3	198	104.3	94	71.4	97	114.4					511	245.5			543	245.9	235	224.8
7	10/25/2005 10:39:50		169	117.2	38	201.8	153	259.4	332	244.7	341	213.3			843	218.3	507	249.6	538	201.6	302	199.9
8	10/25/2005 10:39:51		188	61.8	101	164.4	309	234.8	186	242.5	346	249.7			669	208.2	519	210.3	365	155.8	340	221.9
9	10/25/2005 10:39:52		176	96.8	77	168.8	144	309.3	389	266.2	159	72.8	228	133.2	732	242.2	712	249.6	554	255.3	459	250.3
10	10/25/2005 10:39:53		81	83.7	176	3.9	140	306.3	356	177.4	203	251.7	136	259.4	416	279.3	360	260.4	201	319.2	128	284.5
11	10/25/2005 10:39:54		157	4.8	15	312.3	224	122.8	77	57.8	177	78.2	149	227.7	276	264.8	263	273.5	381	264.4	342	286.5
12	10/25/2005 10:39:55		324	83.6	457	77.8	244	49	271	16.3	109	346.7	348	236.3	181	222.8	196	258.8			182	199.6
13	10/25/2005 10:39:56		97	247.7	507	42.5					263	268.7	476	270.1	329	253.4					160	357.5
14	10/25/2005 10:39:57		756	27.3			419	16.7														
15	10/25/2005 10:39:58		805	34	593	56.3			279	86.3	494	52			556	52						
16	10/25/2005 10:39:59		153	298.4	344	237.2	268	263.8	62	328.1	259	12	176	84.8	47	108.4	132	321.7	79	148.9	97	165.1
17	10/25/2005 10:40:00		670	83.8	780	86.2	859	85.8	686	97.1	613	122.1	378	149.2	427	138.6	342	132.3	397	121.6	244	102.3
18	10/25/2005 10:40:01		800	131.8	782	125.4	975	128.1	693	150.8	683	135.9	611	149	411	146.9	484	147.1	170	191.2	97	48.8
19	10/25/2005 10:40:02		439	75.6	562	125.6	548	119.7	463	123.6	492	136.2	552	119.3	536	107	393	106.7	167	87.6	449	34
20	10/25/2005 10:40:03		548	69.7	471	121.7	430	94.9	496	115.8	282	154.2	370	109.1	316	119.4	416	70	576	76.8	536	53.7
21	10/25/2005 10:40:04		485	139.6	219	130	315	60.1	617	66.8	440	80	305	200.2	535	116.7	871	100.4	1091	68	408	55
22	10/25/2005 10:40:05		167	350.7	4	326.3	145	41.9	580	80.9	664	100.3	549	128.5	702	105	670	91.5	917	81.3	427	51.9
23	10/25/2005 10:40:06		310	154.2	252	128.9	452	132.7	478	145.6	429	94.8	667	104.3	560	121.1	646	126.2	623	96.9	301	55.1
24	10/25/2005 10:40:07		361	174	376	152.8	287	187	273	219.6	292	177.3	380	186	489	114.9	657	128.1	436	30.9	619	49
25	10/25/2005 10:40:08		427	149.9	377	189	486	186.1	634	143.2	549	191.6	655	170.9	500	181.9	361	158.2	693	92	478	93.7
26	10/25/2005 10:40:09		289	173.8	321	186.6	256	176.9	391	180.3	254	170.5	435	167.9	431	181.7	391	162.1	94	152.1	170	120
27	10/25/2005 10:40:10		179	138.6	283	159.5	341	177.8	206	198.3	376	176.8	487	197.3	525	186.9	302	153.7	90	167.8	137	131.7
28	10/25/2005 10:40:11				488	169.8	369	220.4	406	227.9	365	177.2	504	191.9	496	201.4	280	195.3	434	198.1	270	126.1
29	10/25/2005 10:40:12		239	123	264	170.9	445	179	360	193.1	333	197.1	366	171.2	342	154.6	336	142.1	235	147.3	203	138.8
30	10/25/2005 10:40:13		98	134.2	238	194.9	453	260.7	557	205.1	325	190.7	243	148.3	241	117.9	293	120.1	617	90	257	180
31	10/25/2005 10:40:14		175	202.5	299	97.5	197	151.2	283	136.4	242	150.3	273	158.5	238	117.5	212	116.7	249	90.7	252	208.4
32	10/25/2005 10:40:15				129	46.3	105	59.8	191	228	263	120.4	306	137.9	298	132.4	282	102.5	183	171.2	230	175.3
33	10/25/2005 10:40:16		198	113.8			204	121.6	188	186.1			210	147.1	289	159.3	151	134.7	249	183.9	270	158.5
34	10/25/2005 10:40:17		159	100.1			106	105.9	134	186			211	194.3	192	139.7	104	180			102	141
35	10/25/2005 10:40:18		323	156.8			118	120.5	230	87.3			177	125.1	246	159.3	138	152	140	137.9	163	115.8
36	10/25/2005 10:40:19		200	97.2	125	139.5	131	103.2					120	140.7	120	12.1	130	145.7	156	102.6	218	88.7
37	10/25/2005 10:40:20		194	71.9			146	147.6	164	162.7			177	99.8	185	102.8	224	140.6	62	166.9	265	124.2
38	10/25/2005 10:40:21		136	66.6	105	114.1	209	85.1					137	144.8	75	142.1	136	201.1	145	133.6	282	123.4
39	10/25/2005 10:40:22		37	312.8	90	35.5	242	34.2					84	239.2	152	239.6	69	233.8	104	208	142	98.9
40	10/25/2005 10:40:23		171	355.3	128	351.5	207	46.2			166	73.5	145	142	123	137.6	165	177.2	147	112.9	182	26.8
41	10/25/2005 10:40:24		154	12.8	58	76	50	2.3	100	56	75	184.6	131	50.3	215	92.1	253	69.6	261	106.7	52	75.4
42	10/25/2005 10:40:25		144	73.5	60	3.8	188	147.4			115	47.8	124	101.7	164	91	214	148.8	259	109.4	172	91
43	10/25/2005 10:40:26		191	100.8	30	78.3			47	71.6	147	136.7	183	180.3	214	112.2	104	120	103	76	154	90
44	10/25/2005 10:40:27		75	313.9	277	98.1	341	337.9	48	38.3	151	227.7	2	270	144	222.5	181	231.3	71	131.6	151	98.4
45	10/25/2005 10:40:28		137	186.7	186	143.3	183	197.1	38	273	16	111.8	72	317.2	55	304.6	183	236.1	69	249.7	200	30.3
46	10/25/2005 10:40:29		92	175	27	167	210	157.3	196	149.6	220	219.1	122	229.7	117	241.9	294	184.3	47	244.5	159	291.7
47	10/25/2005 10:40:30		94	151.5	162	216.2	65	209.3	128	159.4	224	187.7	228	197.9	196	175.6	268	179.8	89	100.3	142	87.2
48	10/25/2005 10:40:31		141	108.2	93	264.5	146	241.9	113	271.5	262	200.6	196	216.7	188	198.3	222	170.9	111	156.7	88	107.8
49	10/25/2005 10:40:32		109	281.6	123	338.5	55	230.9	94	198.6	122	197.1	165	219.6	77	174.1	108	188	124	193	110	254.7
50	10/25/2005 10:40:34		64	212.2	34	210.4	114	281.6	224	183.1	38	245.4	228	245.3	88	271.3	78	356.3	74	186.2	104	143.6
51	10/25/2005 10:40:35		157	40.6	116	55.9	238	56.6	53	79.1	58	42.2	167	223.5	193	291.9	107	223.1	181	269.1	80	173.5
52	10/25/2005 10:40:36		203	4.8	329	39	149	66.2	109	79.9	178	164	57	34.2	143	15.4	78	299.8	60	144.5	159	51.6
53	10/25/2005 10:40:37		197	58.1	104	55.5	247	63.5	178	127.7	204	170.7	134	339.4	145	236.9	54	237.8	58	307.3	134	85.7
54	10/25/2005 10:40:38		161	51.3	256	44.1	231	12.8	154	34.9	108	343.9	204	146.8	17	61.9	207	186.6	47	111.1	112	58.9
55	10/25/2005 10:40:39		191	55.2	232	19.6	268	339.5	166	343.5	130	335	171	41.4	163	134.8	121	50	245	94.7	54	215.2
56	10/25/2005 10:40:40		159	53.2	165	43.8	222	28.9	182	10.1	254	54.4	134	88.7	112	103.9	18	83.7	55	70.9	110	123.8
57	10/25/2005 10:40:41		85	12.9	97	15.6	196	57.5	148	56.3	157	358.9	22	267.4	197	181.2	286	163.3	14	65.2	95	136.7
58	10/25/2005 10:40:42		277	8.9	266	351.4	243	2.6	182	3.8	55	323.1	93	54.6	181	161	293	140.4	42	186.8	77	90.7
59	10/25/2005 10:40:43		383	28.2	214	29.1	240	12.8	405	24	110	62.5	64	42.5	56	185.1	381	123.4	184	112.7	111	125.1
60	10/25/2005 10:40:44		222	34.5	191	30.6	238	28.6	156	29.5	70	44.4	225	64.7	177	150.3	96	168.6	71	184	42	43.1

Lower Fox River Moving Vessel Trials
Test Ten

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:44:11		134	169.3	228	222.9	37	254.5	65	60.7	187	210.8	157	139.4	107	242.2	71	95.6	184	243.6	82	236.9
1	10/25/2005 10:44:12		260	120.2	154	130	44	157.5	44	121.9	96	178.8	130	209.5	602	243.7	1208	205.3	1307	259.4	840	255.5
2	10/25/2005 10:44:13		87	7.9	51	130.2	146	107.9	117	150.8	185	131.7			889	208.2	302	241.7	476	243		
3	10/25/2005 10:44:14		106	104.7	159	207.4	64	205	48	327					957	256.4						
4	10/25/2005 10:44:15		255	68.2	41	111.5	21	2.7	158	90.7					885	255.3						
5	10/25/2005 10:44:16		272	90.2	144	102.4	101	91.1	180	121.8												
6	10/25/2005 10:44:17		199	72.1	83	283.2	116	53.4	216	33.7			252	353.2								
7	10/25/2005 10:44:18		177	131.3	178	207	137	102.2	229	142.6	126	132.4	110	221.7					808	264.1		
8	10/25/2005 10:44:19		142	135.9	130	244	124	177.7	182	183.1	182	165	155	187			177	220.2	98	265.3	237	304.7
9	10/25/2005 10:44:20		229	117.8	184	295.7	164	238.4	230	203.3	181	185.1	208	127	159	110.3	490	201.5	432	254	280	246.9
10	10/25/2005 10:44:21		170	74.7	61	184.7	121	98.1	169	173.9	180	112.6	171	175.3	361	181	713	233.8	266	248	641	224.8
11	10/25/2005 10:44:22		91	105.9	51	307.1	66	113.1	279	86.5	240	145.2			157	230.4	212	60.1	492	126.6	289	222.8
12	10/25/2005 10:44:23		132	336.3	56	356.9	77	29.6	110	357.9	73	29.7			108	33	65	54.4	191	60.5	160	292.1
13	10/25/2005 10:44:24				139	313.5	185	319.2	111	335	272	302.7	149	299	115	334.3	51	29.6	81	167.2	177	299.9
14	10/25/2005 10:44:25		388	279.5	753	297.6	952	310.8			475	319.3	214	303.2	355	286.7	157	325.9	235	88.8	177	205.8
15	10/25/2005 10:44:26		214	226.1	326	270.9	316	266.2	526	256.6	303	267	212	307.7	177	264.2	147	316.1	46	229.4	291	241.9
16	10/25/2005 10:44:27		155	348.5	236	173.7	91	8.8	240	283	496	312.5	228	290.3	141	66.5			309	245.8	290	287.9
17	10/25/2005 10:44:28		61	131			230	338.9	123	264.9	54	341.6	262	303.1	117	320.9			390	230.9	107	190.3
18	10/25/2005 10:44:29						255	314.7	147	273.1	143	246.5	270	325.3	85	2	245	212.7	348	219.3	166	279.7
19	10/25/2005 10:44:30		16	145.3			318	272	325	249.4	341	280.1	77	15.1	220	295.9	289	259.4	167	196.7	207	155.8
20	10/25/2005 10:44:31		353	81.7	110	90					190	236.4	276	249.2	72	203	59	239.5			87	295.1
21	10/25/2005 10:44:32		354	136.3	884	72.1	699	72.4					167	231.1	81	230	69	185.8	164	216.6	257	229.4
22	10/25/2005 10:44:33		304	133.1	306	100.7	600	52.9					338	347.9			184	176.3	216	230.6	171	245.5
23	10/25/2005 10:44:34		716	66.4	544	45.1	355	58					357	160.6			411	164.8	99	269.4	118	235
24	10/25/2005 10:44:35		336	12.5	460	30.7	528	36.6	325	349					251	186.4	15	301.6	284	283.6	73	16.7
25	10/25/2005 10:44:36		331	24.5	303	34.5	327	348.9	263	335.3			322	236.9	103	213.5	163	344.7	146	26	21	337.2
26	10/25/2005 10:44:37		174	55.8					156	243.3			241	190.8	140	155.5	318	260.8	148	26.6	30	17.2
27	10/25/2005 10:44:38				175	118.6			287	213.6			552	262.3	198	209	160	2.5	200	310.9	117	274.4
28	10/25/2005 10:44:39						413	210.7	550	204.4			415	239.1	405	171.9			89	56.5	46	277.4
29	10/25/2005 10:44:40		208	186.3	383	186.4	184	234.1	382	243.2	345	171.8			104	230.5	386	229.3	99	8.1	165	335.3
30	10/25/2005 10:44:41		110	209.4	482	164					207	186.4	210	249.3	174	273.3	123	43.7	54	257.2	108	239.9
31	10/25/2005 10:44:42		91	235.8	224	171.5	328	197.2	109	182.6			200	262	450	337.4	419	335.3			47	34.7
32	10/25/2005 10:44:43		118	282.7			213	173	450	248.6	312	252.3									109	153.2
33	10/25/2005 10:44:44		168	256.2	105	261.3	228	213	353	230.2	199	228.9									25	313.4
34	10/25/2005 10:44:45		137	209.7	335	45.2	118	258.3			143	281.7			96	231.3			113	13.3		
35	10/25/2005 10:44:47		178	112.8	0	0	261	125.8	126	211	198	239							67	95.1	143	74.2
36	10/25/2005 10:44:48		173	109.3	332	62.6	24	282.3					111	356.9	175	69.6	129	97.6	114	324.6	41	313
37	10/25/2005 10:44:49		397	84.8	278	83	383	94.5			196	38.8	140	237.2					116	31.2	101	329.6
38	10/25/2005 10:44:50		368	77.6	527	75.9	310	61.9			161	309.2	75	249.6	110	108.6			63	107.6	178	249.9
39	10/25/2005 10:44:51		580	76.9	603	78.4	212	47.5	182	264.9	202	296.4	129	252.4			236	245.5	52	5.5	249	265.8
40	10/25/2005 10:44:52		282	63.9	351	93.1			178	309.3	21	43			182	209.7	135	130.8	63	134.4	197	225.6
41	10/25/2005 10:44:53		85	202.1	177	329.8	76	247.5	71	214.1					87	194			347	242	184	213.9
42	10/25/2005 10:44:54		162	92.1	32	0	48	204.4	60	115.7	311	93.7	184	174.7					218	210.3	252	236.5
43	10/25/2005 10:44:55		30	297.4	30	172.4	191	348.8			124	61.2	169	227.2	223	234.1	236	270.2	124	279.3	242	248.2
44	10/25/2005 10:44:56		221	276	142	322.2	59	241.7			160	214.3	96	249.3	50	321.5	73	183.1	121	279	59	314.3
45	10/25/2005 10:44:57		87	221.7	66	315	174	152.7	270	151.9	291	230.6	112	223.5	374	139.2	176	90	144	232.3	85	263.2
46	10/25/2005 10:44:58		117	222.6	242	197.1	187	229.3	16	299.7	25	258.2	186	90.3	79	350.5	134	244.4	132	236.4	141	265.9
47	10/25/2005 10:44:59		97	290.5	295	272.1	130	187.1	201	260.3	78	251.3	312	234.3	153	246.1	66	318.1	137	241.8	28	255.5
48	10/25/2005 10:45:00		229	248.2	369	195.2	243	260.5	117	179.5	144	138.4	95	216	113	134.3	108	42	74	183.1	40	20.7
49	10/25/2005 10:45:01		98	204.2	84	353.1	28	239.7	146	17.6	139	146.8	182	37.6	176	83.2	152	115.7	221	160.4	84	224.5
50	10/25/2005 10:45:02		215	231.4	229	180.8	117	185.9	126	200.4	91	189.5	102	244.9	142	87.6	57	302	51	255.1	166	246.2
51	10/25/2005 10:45:03		275	279	56	270	161	173.2	97	76.3	78	170.4	65	242.7	108	175.8	210	198.9	106	202.2	161	208.2
52	10/25/2005 10:45:04		233	201.6	112	210	225	262.8	42	191	126	252.9	149	196.7	139	117.5	279	146	88	91.3	204	192.5
53	10/25/2005 10:45:05		40	342.5	58	214.5	91	181.9	139	154	96	218.7	141	117.8	114	103.2			37	115.9	213	256.4
54	10/25/2005 10:45:06		111	155.5	146	157.5	142	164.5	132	196.2	148	230.2	85	285.7	121	79.5	110	277.8	72	33	204	275.3
55	10/25/2005 10:45:07		46	349.9	248	261.6	11	158.2	139	209.7	129	227.2	43	239.3	48	130.7	129	150.6	119	262.8	11	338.2
56	10/25/2005 10:45:08		176	246.6	55	246.3	122	203.6	112	207.7	74	108.2	200	105.6	190	167.6	186	161.9	152	69.5	84	351.1
57	10/25/2005 10:45:09		222	231.9	182	195.6	102	183.4	92	229.4	99	223.4	148	192.9	221	164.3	83	217.7	294	260.4	112	242.3
58	10/25/2005 10:45:10		360	81.5	158	43.2	204	155.1	231	56.7	69	99.2	72	140.1	157	175.2	265	164.2	267	193.7	84	249.8
59	10/25/2005 10:45:11		183	90.9	237	150.7	220	99.7	26	229.6	225	138.4	224	164.2	134	196.5			85	212.6	71	48.4
60	10/25/2005 10:45:12		117	225.3	39	246	77	204.6	72	194.4	59	68.2	17	10	167	25.5	34	28.1	117	352.1	81	252

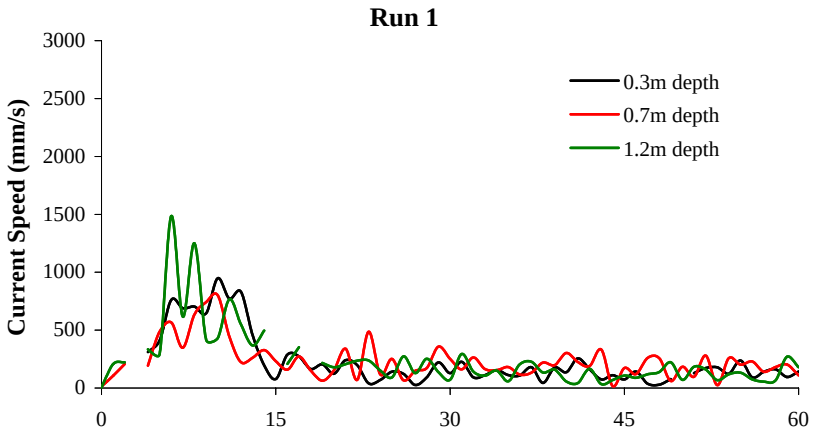
Lower Fox River Moving Vessel Trials
Test Ten

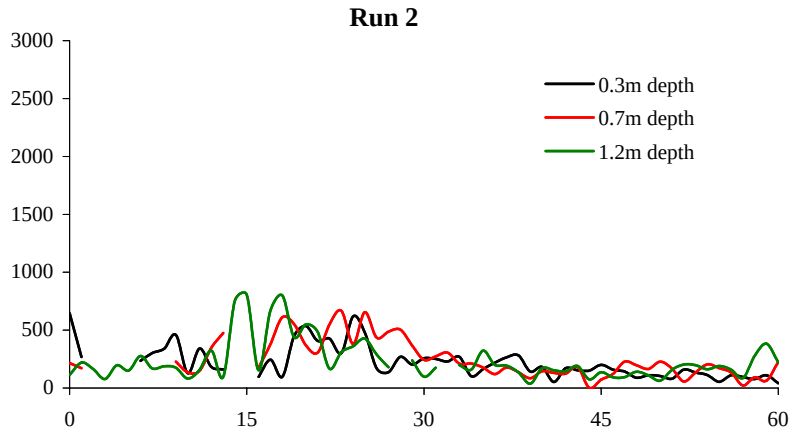
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 4		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:46:30		228	97.3	68	132.6	23	151.2	46	116	120	1.9	124	14.5			845	238.2				
1	10/25/2005 10:46:31		102	65.2	160	262.8	92	6.3	41	178.6	93	344.5			871	227.4						
2	10/25/2005 10:46:32		130	312.5	179	84.2	184	144.8	98	145.8												
3	10/25/2005 10:46:33		164	104.5	50	251.2	51	156.9	50	259.6												
4	10/25/2005 10:46:34		188	90.6	151	249.4	713	258.9	935	257.4	602	265.2			259	256.1					37	143.7
5	10/25/2005 10:46:35		51	130.2	47	46.7	116	19.7	251	119.1	133	77.8	244	56.7	571	324.1	1048	216.7	1109	254	745	249.5
6	10/25/2005 10:46:36		61	22	221	295.4	58	345	188	108.2	184	211	77	153.8	509	180.7	710	186.8				
7	10/25/2005 10:46:37		74	216.7	178	304.2	351	262.3	38	102.2	90	40.9			141	213.7	291	56.9	192	241.7	446	211.3
8	10/25/2005 10:46:38		64	247	280	312	343	286.3	139	179.6	83	41.6			457	309.7	167	341.1	66	263.9	292	211.6
9	10/25/2005 10:46:39		120	100.6	181	266.8	23	7.4	220	191.8	68	31.8	143	261.1			173	92.6	64	36.2	112	254.5
10	10/25/2005 10:46:40		135	193.7	183	303.2	37	136.1	47	316.7	84	116.3	204	99.3	153	137.7	237	16.9			84	120.8
11	10/25/2005 10:46:41		125	75.6	120	359.5	76	9.8	205	90.6	84	26.3	138	72.7	150	47.7					150	64.3
12	10/25/2005 10:46:42		168	345.1	237	355.9	237	309.2	340	293.8	378	270.6	164	260.5	107	38.2			142	15.9	171	226.9
13	10/25/2005 10:46:43		244	327	467	276.8	369	256.5	437	242.3	519	204.5	611	193.6	472	177.1	281	194.2				
14	10/25/2005 10:46:44		78	303.5	333	142.4	257	18.6	485	154.6	399	108.8	261	146.6	90	126.9	233	171.9	131	159.5	204	51.2
15	10/25/2005 10:46:45		232	67.4	81	109.6	546	206.8	627	218.2	413	221.8	240	215.3	350	237.9	270	228	322	254.9	237	274.4
16	10/25/2005 10:46:46		358	173.3	821	217	1545	182.4	935	191.3	1895	172	927	177.8	785	194.7	708	198.8	447	211.4		
17	10/25/2005 10:46:47		244	357	400	10.1	1188	333.8	112	218.1	99	181.7	155	165.4	674	241.8	1298	170.6	427	195.9	131	314.1
18	10/25/2005 10:46:48		390	143.5	175	121.7	129	167	492	233.6	53	124.3	119	143.9	261	55.5	170	281.5	106	339	442	59.8
19	10/25/2005 10:46:49		527	135.1	508	152.4	401	157.1	577	201.1	593	239.9	270	265.1	455	242.3	455	231.2	348	266	238	15.3
20	10/25/2005 10:46:50		298	141.4	114	172.4	160	159.9	181	145.6	462	219.5	468	192.3	452	191.6	254	237.9	314	36.8	623	22.1
21	10/25/2005 10:46:51		359	47.8	496	60.4	578	57.9	700	31	348	49.3	41	324	264	160.7	296	111.6	221	79.6	461	42.9
22	10/25/2005 10:46:53		844	57.3	824	54.1	659	37.5	618	42.8	737	28.2	754	36	461	52.5	636	88.6	1065	71.4	683	68.1
23	10/25/2005 10:46:54		346	88.5	314	62.9	413	44.8	313	81	549	98.4	600	85	404	97.2	455	102.7	405	78.7	539	67
24	10/25/2005 10:46:55		352	47.3	268	33.6	357	46.6	520	44.1	768	89.3	514	80.3	564	80	594	71.5	299	28.8	311	67.1
25	10/25/2005 10:46:56		825	45.7	805	58	728	46.5	825	55.8	790	87.4	762	88	456	96.8	303	109.3	708	87.6	383	80.8
26	10/25/2005 10:46:57		398	50.1	411	65.4	420	61.7	419	67	335	83.5	139	132.4	429	88.8	728	111.7	1052	88.6	429	73.8
27	10/25/2005 10:46:58		370	111.4	470	83.9	457	68.5	289	65.9	354	102.5	316	98.7	192	132.3	323	114.9	325	108.8	272	78.8
28	10/25/2005 10:46:59		265	130.4	238	133.6	350	181.6	354	177.9	310	135.9	271	124.3	231	106.3	163	172.6	176	139.2	61	172.4
29	10/25/2005 10:47:00		472	106.5	704	113.4	389	112.5	247	125.6	413	126	384	98.5	134	89.1	240	112	162	68.2	238	80.1
30	10/25/2005 10:47:01		752	107.4	684	87.4	523	95	375	110.1	370	107.8	430	77.1	489	90	475	78.8	398	81	338	84.2
31	10/25/2005 10:47:02		169	66.3	148	124.2	356	63.5	314	93.8	390	101.8	377	86.2	500	77.8	450	79.4	349	100.1	386	104.3
32	10/25/2005 10:47:03		290	178.4	316	187.3	373	187.9	463	154	154	143.7	316	93.6	267	101	139	73.7	70	44.4	436	83.2
33	10/25/2005 10:47:04		397	186.5	363	172.9	374	171.5	495	143.5	314	171	268	136.7	345	98.2	550	57.2	86	334.6	527	55.4
34	10/25/2005 10:47:05		443	160.7	290	164.6	418	157.4	194	171.1	182	144.4	296	118.6	408	102	290	47.9	410	70.8	327	24.9
35	10/25/2005 10:47:06		260	105.4	339	115	221	132.8	246	108.9	301	136.6	305	117.5	147	125.9	191	109.6	45	236	130	84.7
36	10/25/2005 10:47:07		416	117	389	135.6	496	139.4	433	151.7	248	108.1	319	135.9	353	137.8	361	129.2	535	85	194	106.8
37	10/25/2005 10:47:08		439	136.8	499	122.5	558	127.6	583	116.2	438	122.4	358	139.9	232	168.1	241	154.7	118	141.2	238	72.6
38	10/25/2005 10:47:09		141	121.1	179	153.4	135	177.5	378	117.7	361	147	432	163.6	293	134.7	182	171.8	150	146.9	346	217.6
39	10/25/2005 10:47:10		18	45	108	136.1	72	298	140	173.4	316	160.4	520	169.6	142	171.5	211	156	133	130.4	249	133
40	10/25/2005 10:47:11		130	128.1	154	155.4	233	207.6	364	184.4	448	186.8	297	157.7	213	131.2	168	153.4	193	195.6	196	132.7
41	10/25/2005 10:47:12		156	122.7	287	154.4	241	162.1	277	157.3	280	162.5	292	133.2	344	152.8	342	100.6	205	77.3	139	40.9
42	10/25/2005 10:47:13		223	141.4	280	132.4	258	162.4	323	158	308	176.6	305	149.1	300	155.1	361	113.4	304	78	138	49.1
43	10/25/2005 10:47:14		262	140.9	120	136	268	184.3	157	195.5	337	186	344	171.8	91	72.8	250	80.6	269	59.9	124	325.5
44	10/25/2005 10:47:15		158	178.2	209	155.4	171	164.7	319	185.8	392	189.1	476	174.2	439	140.2	338	138.7	131	82.5	76	110.8
45	10/25/2005 10:47:16		99	126.8	322	199.1	293	158.8	361	175.2	307	183.9	393	197.2	221	147.7	188	164.9	196	90.3	82	233.4
46	10/25/2005 10:47:17		100	65.2	76	164.7	137	214.6	264	198.3	428	148.3	440	137.8	374	126.8	160	162.1	118	138.1	90	207.7
47	10/25/2005 10:47:18		130	99.3	102	121.8	155	162.4	293	158	455	161	352	178.2	369	159.6	303	133.9	195	137.7	261	232.5
48	10/25/2005 10:47:19		119	107.1	122	178.1	210	153.4	335	158.6	241	144.8	302	177	294	159.5	492	159.5	107	178.9	103	152.2
49	10/25/2005 10:47:20		218	128.9	264	131.5	302	131.5			255	147	315	150.9	318	156.3	224	136.3	167	171	108	180
50	10/25/2005 10:47:21		216	167.7	214	145.9	302	163.4	349	193.1	385	193.5	116	171.1	222	160	268	108	110	90	190	58.6
51	10/25/2005 10:47:22		199	207	104	210	94	286.7			236	157.9	194	159.5	233	156.5	198	140.5	311	101.7	160	202.4
52	10/25/2005 10:47:23		75	131.8	177	191.8	139	190.7	307	181.1	293	170.4	484	191.6	303	153.9	228	142.5	182	153.2	212	100.9
53	10/25/2005 10:47:24		423	214.7	112	109.9			118	86.6	303	179.6	253	182.3	352	208.9	152	141.4	83	124.3	28	154.4
54	10/25/2005 10:47:25		293	68.3	162	201.3	292	182	171	165.8	246	180.9	269	145.6	310	186.5	135	189.8	133	184.7	139	259.3
55	10/25/2005 10:47:26		542	104.3	186	194.9	130	147.5			140	142	269	187.3	283	191.8	317	168.7	211	181.1	135	232.5
56	10/25/2005 10:47:27		250	95.7	163	215.3			118	193.2	201	159.6	210	105.2	262	183.7	129	192.5	272	130.4	195	222.7
57	10/25/2005 10:47:28		236	195	257	192.8	264	194.7	282	145.4	229	146.9	198	154.6	214	180.5	251	180.9	192	135	226	276.9
58	10/25/2005 10:47:29		18	229.4			138	180	200	182	341	186.6	302	176.6	301	207.5	306	206.6	247	226.5	204	193.3
59	10/25/2005 10:47:30		30	11.7			378	133.5	366	164.1	362	169.8	340	181.3	203	201.1	285	175.4	186	219.1	123	221.7
60	10/25/2005 10:47:31		212	66.9			157	123.3	142	248.1	281	202.2	204	197.1	70	179.2	149	232.4	340	231.2	167	251.5

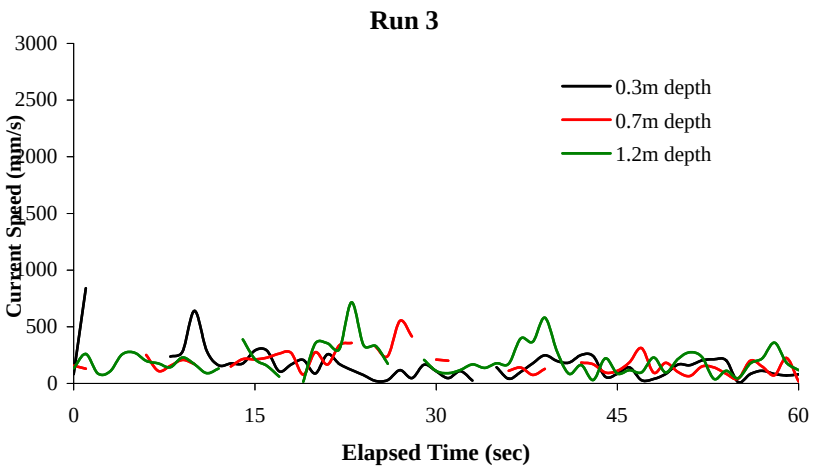
Fox River Propwash Study - Moving Vessel Trials

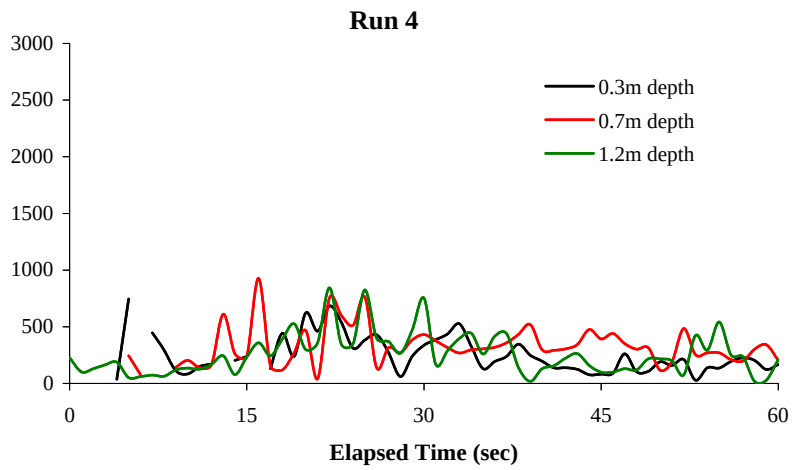
Test #10: Single-Prop Vessel - Full Throttle Startup -Pitch Up 15

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Eleven

Run 1

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
0	10/25/2005 10:50:37	137	101.8	82	129.1	106	104.7	99	16.4	123	342.5	89	181.9			939	247.6	902.8	239.1		
1	10/25/2005 10:50:38	112	280.3	164	105.2	95	207.6	132	277.8	62	53.5					874	238.7	874.1	238.7		
2	10/25/2005 10:50:39	95	15.9	123	330.3	87	352.1	22	223.2												
3	10/25/2005 10:50:40	198	31.8	27	34.3	101	47.8	83	90.7												
4	10/25/2005 10:50:41	14	339	43	18.9	218	4.2	374	326.9			81	329.6					947.8	218.6	994	259.7
5	10/25/2005 10:50:42	170	107.2	172	110	210	89.5	203	12.3	394	45.9	285	33.4							205	242.1
6	10/25/2005 10:50:43	33	176.5	142	103.8	307	135.8	152	114.9	273	161.4	386	73.3	536	36.3					153	95.6
7	10/25/2005 10:50:44	253	25.8	255	185.2	184	147.4	170	188.1	253	177.5	112	178.5	103	124.8	105	92.2	72.62	221.4	227	242.4
8	10/25/2005 10:50:45	101	107.9	73	146.1	159	164.6	155	182.6	157	156.7	241	164.6	59	120.5			133.1	57.26	141	223.9
9	10/25/2005 10:50:46	144	121.4	66	153	58	95.9	122	174.8	110	284.2	92	237.9	168	193.5					31	80.8
10	10/25/2005 10:50:47	139	153.4	41	207.8	119	186.3	38	140.4	59	253.4	123	238.2	320	130.8	141	107.3	108.7	121.6	88	145.2
11	10/25/2005 10:50:48	68	144	84	48.4	121	131.3	147	187.4	173	162.8	183	181.9	167	150.5	179	33.2	76.22	38.07	30	187.6
12	10/25/2005 10:50:49	152	102.1	237	108	174	174.7	217	185.3	142	146.8	22	69.1	189	114.4	108	17.3	81.95	40.3	77	73.4
13	10/25/2005 10:50:50	27	162.9	117	177.6	217	151.9	57	253.8	17	155	143	183.6	130	130.9	128	342.3	128.1	342.3		
14	10/25/2005 10:50:51	47	330.7	78	113.3	310	202.2	252	195.9	126	11	90	236.8	140	189.1	173	275	163.4	45.74	217	224.8
15	10/25/2005 10:50:52	36	250.6	26	218.7	129	110.8	82	127.6	79	87.8	22	302.3	110	345.2	147	312	137.8	294.9	142	277.3
16	10/25/2005 10:50:53	74	33.5	152	104.5			178	259.3	185	270.3	202	218.2	182	174.3	124	70.3	124.3	70.25		
17	10/25/2005 10:50:54	85	259.1	64	17.3	170	346.7	83	190.4	79	311.4	156	202.6	264	110.8	215	209.2	215.3	209.2		
18	10/25/2005 10:50:55	126	12.8	130	325.7	59	286.6	192	329.3	62	60.1	202	166.5	220	142.8	78	247.4	236.3	214		
19	10/25/2005 10:50:56	195	287	160	358.6	104	336.1	343	183.7	49	24	74	51.6	153	136.6	103	190.1	102.6	190.1		
20	10/25/2005 10:50:57	95	252.9	30	132.3	84	259.8	115	317.8	125	83.6	65	342.1	112	82.3	251	262.5	485.5	214.9		
21	10/25/2005 10:50:58	29	69.7	114	35.4	62	317			92	298	146	267.3	42	214.4	89	228.2	50.01	271.1		
22	10/25/2005 10:50:59	75	93.8	83	40.6	172	267	76	22.5	121	347.6	127	40.2	53	321.8	88	246.6	66.52	268.7	61	301.6
23	10/25/2005 10:51:00	113	202.9	56	208.9	112	54	89	99	158	338.1	67	328.4	53	68.8	51	284.9	24.02	267.6	15	176.2
24	10/25/2005 10:51:01			85	160.1	117	164.2	123	197	74	161.8	224	251	133	214.9	115	327.4	52.65	288.3	74	210.7
25	10/25/2005 10:51:02			100	94	123	115.1	250	151.6	42	0	125	287.3	117	294.8	58	235.5	84.22	240.1	110	242.5
26	10/25/2005 10:51:03					184	50.1	69	144.5	44	21.3	116	30.1	54	186.3	147	153.8	249.4	254.2		
27	10/25/2005 10:51:04	133	19.8			160	100.5	7	0	79	143.3	171	4.7	124	314.7	146	260.2	146.2	260.2		
28	10/25/2005 10:51:05	178	92.3	127	79.6			82	43	165	290.6	300	261.8	125	258.4	64	268.2	367.6	229.9		
29	10/25/2005 10:51:06	476	87	310	82.6			238	249	231	324.5	306	275.4	34	263.3	204	283.9	142.1	264.6	114	228.2
30	10/25/2005 10:51:07	93	32.3	48	88.8	133	42.6			381	246.7	134	270.4	204	217.8	50	233.1	31.48	79.94	110	68.1
31	10/25/2005 10:51:08	133	103.5	68	138.6	58	89	50	95.7	63	234	191	199.9	27	280.5	146	297.8	113.3	193.8	54	353.7
32	10/25/2005 10:51:09	121	260	158	115.9	220	154.1	100	281	104	218	66	286.8	67	132.6	120	3.3	91.71	288.4	191	251.1
33	10/25/2005 10:51:10	219	11.6	57	143.5	75	141.5	13	193	417	269.9	113	302.7	117	312.9	72	261.2	83.73	262.5	31	253.3
34	10/25/2005 10:51:11	124	335.3	156	3.3	143	354.4	95	351.5	28	268	254	216.2	141	289.1	136	180.8	91.84	54.75	184	268.4
35	10/25/2005 10:51:12	167	341.5	178	320.7	58	38			124	316.3	228	130.5	69	103.4	115	134.3	38.48	294.6	55	317.9
36	10/25/2005 10:51:13	378	27.9	236	356.8	111	307	161	100.4	241	54.8	114	199.4	102	359.4	219	61.7	200.6	68.04	188	53.9
37	10/25/2005 10:51:14	397	16.4	392	2.6	199	349.6	176	44.8	276	137.6	126	68.1	117	279.9	209	21.3	161	0.712	146	330.4
38	10/25/2005 10:51:15	284	21.2	299	11.9	289	335.9	128	328.4	48	20.7	173	249.4	150	203.1					61	247.7
39	10/25/2005 10:51:16	306	54.9	131	15.9	334	356.2	187	348.3	95	82.7	88	343.4	85	305.4	225	74.8	136.4	31.36	174	355.7
40	10/25/2005 10:51:17	137	40.6	152	34.5	28	317.9	110	353.7	64	349.2	73	109.9	83	73.1			212.8	54.37	83	18.9
41	10/25/2005 10:51:18	109	26.1	244	29.7	49	0	107	319.2	96	310.3	53	240.5	35	208.7					204	270
42	10/25/2005 10:51:20	288	7.4	310	11.9	237	14.9	109	49.9	93	341.2	37	197.4	18	243.4	127	276.8	83.88	275.5	41	271.4
43	10/25/2005 10:51:21	184	298.2	225	331.8	70	302.1	104	98.3	102	21.8	120	53.8	110	270	100	242.7	83.01	238.8	66	233
44	10/25/2005 10:51:22	309	23.1	207	357.5	221	51.3	174	59.3	264	338.7	111	339.9	137	130.6	230	332	208.6	348.7	208	7.2
45	10/25/2005 10:51:23	186	17.9	257	62.4	188	74.6	204	43	142	48.1	144	346.7	107	342.1			350.3	236.2	27	265.8
46	10/25/2005 10:51:24	257	331.4	202	344.2	171	19.1	94	89.4	149	64.6	89	86.8	135	156.5			115.7	235.2	153	238.6
47	10/25/2005 10:51:25	240	327.2	242	16.6	22	262.2	101	69.8	95	100.4	98	85.3	24	347.7			122.2	208.9	31	268.2
48	10/25/2005 10:51:26	186	283.7	48	318.4	69	104.2	20	81.5	52	139.6	41	284	28	92	338	80.3	172.6	223.1	76	229.8
49	10/25/2005 10:51:27	143	279.7	127	313.4	78	81.1	145	332	74	46.1	122	305	57	101.1			87.8	217.1	118	263.2
50	10/25/2005 10:51:28	168	286.6	116	168	84	246.8	196	268	179	304	94	318.9	146	248.3	224	186.4	197.4	210.3	210	235.9
51	10/25/2005 10:51:29	68	58.2	28	149.7	88	342.2	94	104.8	19	93	87	140.6			406	345.3	96.43	130.8	42	210.3
52	10/25/2005 10:51:30	121	304.2	77	273	78	263.3	162	301.1	152	296.6	75	323.1	92	325.6	63	145.3	142.8	225	281	237.8
53	10/25/2005 10:51:31	90	290.3	136	272.5	178	307.3	132	297.9	73	265.3	136	152.3	312	174.1	203	229.8	91.27	237.5	33	1.7
54	10/25/2005 10:51:32	81	39	91	266.9	63	154.7	39	297.2	92	358.1	105	224.6	137	180.8	222	122.1	144.5	62.37	86	45
55	10/25/2005 10:51:33	181	321	203	338	53	81.3	83	44	59	207.4	73	301.5			65	97	49.21	42.12	81	0.7
56	10/25/2005 10:51:34	180	338.1	129	290.8	150	54.2	34	78	9	282.5	52	95.5	29	107.8					43	293.6
57	10/25/2005 10:51:35	230	304.7	37	27.3	40	90	70	291	57	22.5	26	24.6	113	231.1	164	252.2	114.5	345.8	83	342.4
58	10/25/2005 10:51:36	116	283	49	205.5	17	203.6	119	61.5	68	334.9	44	58.1	50	291	207	113.3	248.9	135.3	44	204.2
59	10/25/2005 10:51:37	148	271.5	185	293.9	20	339.8	40	73.9	134	338.6	147	308.4	288	311.5					201	76.8
60	10/25/2005 10:51:38	186	318.5	111	14	46	163.5	139	209.3	44	214.8	215	253.8	7	98.1	128	32	108.4	20.53	94	4.9

Lower Fox River Moving Vessel Trials
Test Eleven

Run 2																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:53:16		84	99.6	78	330.8	76	280.6	160	93.2	53	98.7	87	352.7	16	3.6	147	266.5	205.4	258.1	266	253.4
1	10/25/2005 10:53:17		97	102.5	134	125.6	173	158.3	162	164.2	73	203.4	303	162.7	347	177.5	403	210.3	587.5	219.1	779	223.6
2	10/25/2005 10:53:18		201	94.6	209	111	180	85.9	167	80.4	207	104.8	212	61.5							482	240
3	10/25/2005 10:53:19		115	66.3	134	53.8	255	96.1	333	69.1	214	94.6	300	138.9			951	239.1	952.6	233.6		
4	10/25/2005 10:53:20		167	87.6	230	57.4	188	98	167	59	93	79.4					1040	240.9	1040	240.9		
5	10/25/2005 10:53:21		179	81.3	121	242.4	279	99.1	163	83.7	204	76.6					723	238.6	326.4	185.3	530	225.1
6	10/25/2005 10:53:22		15	118.3	99	235.7	71	151.3	180	116.7	245	140.1	540	166.4			168	234.4	189.5	301.8	548	340.2
7	10/25/2005 10:53:23		165	141.4	169	275.8	95	231	129	164.7	252	207.9			866	170.2	560	164.2	1259	169.2	620	230.6
8	10/25/2005 10:53:24		128	80.5	50	118.6	133	187.3	134	225.9	377	118.9	725	166.7			384	174.8	856.1	171.2	451	191.9
9	10/25/2005 10:53:25		116	200.6	199	229.3	117	201.1	394	159	506	173.3	408	203.1	273	175.2	410	215.7	314.4	261.6	139	246.7
10	10/25/2005 10:53:26				151	249.4	360	225.8	513	216.4	387	252.7	315	205	263	201.7	260	218.3	267.6	241.7	314	260.8
11	10/25/2005 10:53:27				337	237.5	510	217.3	427	211	65	187	165	78.1	384	163.7	281	162.8	297.7	212.5	217	213.2
12	10/25/2005 10:53:28		372	245.2	336	227	561	229.9	422	257.1	118	229.5	194	159.5	170	159.6	263	141.2	216.1	145	104	265.6
13	10/25/2005 10:53:29		254	250.4	429	256.8	358	242.6	291	238.5	152	190.2	253	165.1	256	147.6	289	306.8	22.14	161.6	34	306.5
14	10/25/2005 10:53:30		448	261	422	278.6	269	270.4	407	255	190	218.4	211	255.7	37	247.6	192	145.4	172.7	61.65	185	280
15	10/25/2005 10:53:31		154	246.6	286	258.5	312	237.6	122	271.9	205	311.6	74	247.9	93	307.6	202	237.3	211.1	265.5	262	286.8
16	10/25/2005 10:53:32		287	212.2	227	232.2	149	203.8	132	245.4	279	305.2	450	295.1	628	279.4	462	261	336.9	222.4	116	231.6
17	10/25/2005 10:53:33		286	240.7	306	231	256	236	154	213.4	386	188.6	472	217.4	501	217.5	492	217.3	762.2	214.5	265	267.4
18	10/25/2005 10:53:34		168	191.6			303	221	423	203.8	848	224.7	400	195.9	475	223.6	727	226.7	539.6	226	374	242.8
19	10/25/2005 10:53:35		339	200.2	372	222.4	642	231.3	737	232.9	644	217.7	471	215.7	634	217.5	364	190.8	116.1	198.6	62	273.7
20	10/25/2005 10:53:36		139	177.5	175	249.6	324	181.2	499	182.5	441	201.3	591	208.5	397	144.7	126	217	114.3	105.7	221	50.7
21	10/25/2005 10:53:37		368	1.7	35	227.3	75	170.8	318	216.2	418	190.5	523	225.9	675	237.7	479	230.4	162.1	263.3	271	10
22	10/25/2005 10:53:38		229	63.2	189	354.8	212	201.6	245	213.4	343	152.5	442	213.5	377	227	116	209.9	274.4	133.8	306	26.6
23	10/25/2005 10:53:40		158	54.5	279	9.5	67	106.5	87	97.9	291	230.3	277	237.4	185	239.1	282	232.9	263.5	221.6	233	64
24	10/25/2005 10:53:41		158	357.8	305	318.8	303	31.5	34	358.3	473	228.4	102	129.8	260	174.5	218	164.6	128.4	147.2	81	94.2
25	10/25/2005 10:53:42		129	160.6	107	96.5	175	182	207	190	81	294.7	114	81.4	92	88.1	141	71.4	352.8	286.6		
26	10/25/2005 10:53:43		151	206.4	258	164.7	218	194.1	316	253.3	277	237.5	149	96.9	121	142.8	87	35.7	435.8	121.4	183	120.5
27	10/25/2005 10:53:44		149	245.8	148	286.5	194	243	304	214	505	162.8	407	153.3	379	208.9	337	176.3	246.6	236.2	326	94
28	10/25/2005 10:53:45		158	274	145	234	155	230.2	188	155.8	362	128.8	435	160.2	497	171	477	182.4	209.5	191.8	136	90
29	10/25/2005 10:53:46		123	74.9	116	178.5	207	168.9	41	195.8	121	124.6	353	168.2	302	161.9	454	178.6	376.1	181.1	127	88.2
30	10/25/2005 10:53:47		281	246.5	232	217.7	330	118.8	402	181.4	285	196.1	258	144.5	427	210.9	545	191.7	223.9	188.3	102	26.8
31	10/25/2005 10:53:48		20	130.9	231	189.2	104	193.9	193	184.8	345	148.9	218	192.7	164	194.1	312	216.1	71.61	305.9	118	242.1
32	10/25/2005 10:53:49		266	104.1	153	134.2	267	226.8	186	238.2	283	209.2	291	185.5	177	190.7	295	236.9	240.5	231.4	149	31.6
33	10/25/2005 10:53:50		495	59.4	158	54.5	219	178.4	131	139	239	143	156	99.2	54	175.8	219	206.6	217.6	231	76	196
34	10/25/2005 10:53:51		417	44.3	216	45.7	196	107.5	109	73.6	214	123.4	139	137.6	166	87.2	88	227.8	114.5	192.1	103	253.7
35	10/25/2005 10:53:52		201	64.3	149	76.1	130	99.3	170	190.8	121	139.7	149	207.6	192	148.6	338	141.6	156.5	169.7	311	248.3
36	10/25/2005 10:53:53		263	60.1	324	70.5	261	98.6	108	78.8	142	180.8	128	238.4	81	249.8	188	178.2	59.06	331.7	113	180
37	10/25/2005 10:53:54		248	56.7	489	81.8	458	93.3	289	55.9	30	82.4	197	212.8	217	199.7	94	105.4	244.1	146.7	123	197.5
38	10/25/2005 10:53:55		77	81	175	124.1	183	125.4	188	138.2	240	148.3	295	128.7	284	203.2	153	205.9	94.02	231.9	216	256.6
39	10/25/2005 10:53:56		236	204.8	51	296.6	104	51.3	307	93.2	241	124.3	316	201.9	242	189	162	195.1	175.9	218.3	284	251.5
40	10/25/2005 10:53:57		52	306.4	268	265.5	223	257.6	135	192.8	291	160.3	284	204.1	216	239.8	372	273.7	210.5	280.4	236	310
41	10/25/2005 10:53:58		205	284.4	293	246.2	397	240.1	406	215.7	304	188.1	251	212	163	230.5	236	221.7	247.3	198.1	102	338.7
42	10/25/2005 10:53:59		179	208	355	200.6	359	213.5	265	242.6	231	221.5	90	198.8	157	161.8	267	259	413	240.1	141	244.9
43	10/25/2005 10:54:00		249	76.3	88	232.9	148	245.2	85	266	318	199.9	237	176.6	258	243.3	254	216.5	270.3	218.8	287	220.9
44	10/25/2005 10:54:01		304	193.5	291	213.4	230	230.8	263	235.2	214	284.9	123	184.2	198	235.9	196	203.4	212.2	209	230	213.8
45	10/25/2005 10:54:02		139	184.5	209	170.4	158	152.1	159	263.9	422	199	214	245.7	110	226.5	323	212.4	171.9	190.6	128	120.6
46	10/25/2005 10:54:03		122	126	117	207.4	374	227.3	150	234.5	104	232	42	268.6	246	253.7	264	235.3	121.2	236.4	49	217.6
47	10/25/2005 10:54:04		84	195.9	214	273.7			204	315.2	41	223	141	171.4	168	64.7	117	60.8	43.97	287.2	285	248.6
48	10/25/2005 10:54:05		161	256.7	226	232.9	176	262.8	184	225	180	328.2	134	177.9			70	169.3	140.4	235	260	249.3
49	10/25/2005 10:54:06		349	244.4	213	223.7	191	305.4	92	323.4	37	132.8	188	204.5	188	201.5	64	217.4	108.1	177.3	185	218.4
50	10/25/2005 10:54:07		51	255.1	228	243.1	90	255.2	328	165.7	71	98.9	102	123.4	209	182.2					103	217.9
51	10/25/2005 10:54:08		182	252.4	101	307.8	172	230.7			92	261.3	100	121.5	260	183.5	223	223.7	240.9	239.7	275	252.6
52	10/25/2005 10:54:09		196	213.4	186	251.2	182	274.1	305	298.6	153	205.1	418	153.4			199	220.7	111.9	212.4	39	165.3
53	10/25/2005 10:54:10		177	146	117	241.9	196	265.3	134	285.2	179	164.8	224	124.8	247	215.6	226	127.3	106.1	136.9	39	242.8
54	10/25/2005 10:54:11		89	273.2	161	234.8	140	268.4	38	310.8	115	316.8	221	144.6	224	142.3	149	190.4	130.4	221.3	153	251.3
55	10/25/2005 10:54:12		113	253.5	173	223.4	97	222.9	202	217.2	67	202.8	134	154.4	117	213.8	284	171.1	169.4	170.3	55	166.2
56	10/25/2005 10:54:13		171	282.2	179	266.2	108	272.7	241	246	288	282.2	357	195.4	114	209.5	46	175	102.2	253.5	200	266.6
57	10/25/2005 10:54:14		220	237.2	197	273.5	118	267.6	55	300.8	148	240.5			144	222.8	107	183.7	123.2	209.7	157	227.1
58	10/25/2005 10:54:15		89	261.6	166	263.8	311	262.6	165	261.6	190	321.2	72	46.1	61	114.1					183	262.4
59	10/25/2005 10:54:16		182	266.9	243	257.4	52	271.1	39	202.6	107	191.3	280	179.8	267	213.1	201	122.8	88.7	113.2	39	351.3
60	10/25/2005 10:54:17		199	237.8	115	225.4	140	249.1	177	160.1	59	150.4	236	70.7			316	121.9	84.04	146.4	177	278.8

Lower Fox River Moving Vessel Trials
Test Eleven

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 10:56:04		80	71.1	23	154.5	92	67.6	44	323.4	108	247										
1	10/25/2005 10:56:05		87	195.9	81	139	74	28.3	103	34.3	88	317.3										
2	10/25/2005 10:56:06		68	165.6	51	258.7	40	287.5	48	124												
3	10/25/2005 10:56:07		34	287.4	41	39.1	127	110.7	187	148.1	360	42			110	78	502	319.8	395.3	287.5	454	251.4
4	10/25/2005 10:56:08		109	265.3	73	187.1	96	324.3	102	107	211	109.1	212	148.7	421	176.6			477.9	215.7	512	258.1
5	10/25/2005 10:56:09		112	178	93	227.2	154	218.7	169	347	163	162.1	132	124.2	536	82	313	2.9	49.16	355.3	120	122.1
6	10/25/2005 10:56:10		63	101.8	26	327.5	71	180	98	61.3	122	107.1	292	147	357	120.7	595	170.3	595.5	170.3		
7	10/25/2005 10:56:11		185	344.3	195	295.1	74	250.3	80	246.3	559	99.2	101	105.6	227	153	70	147.9	19.1	137.1	33	340.5
8	10/25/2005 10:56:12		144	260.4	114	233.5	154	228.2	241	205.3	249	167.7	271	179.2	216	193.7	75	287	114.9	243.7	183	227.2
9	10/25/2005 10:56:13		65	13.4	64	19.3	65	353	122	82	150	63.9	80	40.4	375	266.9	169	264.2	118.6	281.9	92	315.9
10	10/25/2005 10:56:14		138	343.5	57	13.1	104	3.3	88	199.3	159	66.3	161	321.3	140	319					230	248.8
11	10/25/2005 10:56:15		96	298.7	101	347.5	180	310.5	119	331.9	141	292	210	156.1	196	267.1					82	205.3
12	10/25/2005 10:56:16		123	320.6	115	28.1	239	2.6	99	300.2	65	342.1	104	1.7	431	282.3	502	290.5	209.2	234.3	226	235.8
13	10/25/2005 10:56:17		59	274.8	304	290	179	289.2	133	339.8	76	60.7	123	344.5	130	291.2	51	251.6	8.062	97.13	85	12.9
14	10/25/2005 10:56:18		152	204	142	238.6	82	149	494	76.8	489	158.5	158	190.2	251	83.1	205	241.2	73.02	271.2	108	18.4
15	10/25/2005 10:56:19		258	298.9	225	9	97	313.7	454	240.9	433	269.5			438	318.4	402	328.6	287.9	343.5	214	12.2
16	10/25/2005 10:56:20		103	356.1	189	15.7	243	20.2	358	342.1	319	252.3	400	230.9							35	168.4
17	10/25/2005 10:56:21		153	343.3	111	180			114	260.4	249	216.5	616	242.6	486	235.7	369	234.9	262.2	241.8	76	303.7
18	10/25/2005 10:56:22		151	216.6	141	315.6	247	260.2	382	259.9	135	164.5	242	196.8	389	230.6	700	315.6	420	315	485	256
19	10/25/2005 10:56:23		251	100.8	50	83.2	219	343	265	265.2	287	124.2	216	163.8	86	196.1					149	247.6
20	10/25/2005 10:56:24		223	225.2	376	254.1	141	271.2					15	90	383	283.6	370	308	484.4	314.6	134	213.1
21	10/25/2005 10:56:25		317	281.8	328	284.7			514	348.8	16	169.4	56	143.7	340	264.8	330	253.1	198.1	240.8	102	197.2
22	10/25/2005 10:56:26		205	302.8	236	275.8	135	326.2			566	175.3	521	182.8	395	180.7	561	175.4	302.1	186.7	123	250.5
23	10/25/2005 10:56:27		145	343.6	151	260.1	134	218.9			273	309.5	150	214.4	286	209.5	234	196.7	173.6	175.4	155	142.1
24	10/25/2005 10:56:28		206	276.4	9	238	173	44.5	273	178.7	60	90	131	186.6	265	271.3	195	213.9	187.3	222.1	183	230.8
25	10/25/2005 10:56:29		81	131	78	195.6	298	160.4	56	37.1	176	231.2	244	219.7	127	220.2	70	13.2	43.42	125.2	130	155
26	10/25/2005 10:56:30		140	194	158	217	22	32.3	96	242.1	307	205.1	144	182.4	295	220.9	201	194.1	353.6	345.3	103	216.3
27	10/25/2005 10:56:31		93	149	367	187.2	483	137.2	229	180.3	129	175.1	233	174.8	200	249.2	218	247.7	228.5	317	108	264.7
28	10/25/2005 10:56:32		64	249.9			286	121	138	124	299	92.1	107	208.5	111	207.3	88	329.9	25.93	250.9	93	183.1
29	10/25/2005 10:56:33		234	203.2	227	197.2	30	151.7	168	170.4	75	114.5	98	115.3	207	253.1	153	324.3	68.12	273.4	125	202.1
30	10/25/2005 10:56:34		213	163.1	102	337.5	195	153.4	270	110.4	212	133.3	224	135.5	156	160.5	39	62.8	72.03	61.83	105	61.5
31	10/25/2005 10:56:35		74	164.3			468	99.3	158	190.2	87	112.4	46	116	211	280.4	156	266.7	131.7	173.9	102	88.3
32	10/25/2005 10:56:36		120	42.6	253	185	158	66.2	145	216	171	127.4	40	188.5	202	66.6	75	107.9	219.3	168.7	66	179.1
33	10/25/2005 10:56:37		161	194.4	190	218	118	117.2	168	179.7	148	192.5	216	229.3	171	209	89	242.6	128.5	274.9	82	225
34	10/25/2005 10:56:38		140	153.8	51	26.6	10	73.3	70	291	143	179.6	188	155.2	214	156	29	93.9	22.47	237.7	59	259.3
35	10/25/2005 10:56:39		156	212.5	53	104.3	97	180	68	334.6	104	25.1	143	106.3	169	147.3	181	161.7	194.3	211.3	17	3.4
36	10/25/2005 10:56:40				149	171.9	186	119.3	289	109.4	147	232.7	299	169.6	187	156.3	98	118.7	73.49	140.2	66	173.1
37	10/25/2005 10:56:41		83	26.6	43	203.6	220	147.8	132	197.6	210	143.1	93	188.7	161	175.4	11	48.8	298.3	207.3	77	210.6
38	10/25/2005 10:56:42		173	137.3	121	150.9	163	74.7	92	137.6	124	123.8	189	194.1	175	201.7	241	197.2	220.9	192.1	203	186.2
39	10/25/2005 10:56:43		147	216.7	26	155.4	64	112.1	134	104.7	105	164	66	166	119	184.8	109	278.4	101.2	249.8	119	223.6
40	10/25/2005 10:56:44		172	233.5	113	180.5	170	157.9	83	230.4	175	144.3	80	99.3	65	126.9	213	343.1	34.71	191.6	117	82.1
41	10/25/2005 10:56:45		128	177.8	180	216.9	32	191	238	186.5	76	160.9	81	143.6	207	190.9	258	200.4	211.1	198.2	164	194.8
42	10/25/2005 10:56:46		181	155.1	214	119.7	203	126.2	132	135.9	254	292.7	287	197.6	144	219.3	133	232.6	152	225.5	172	220.1
43	10/25/2005 10:56:47		121	79.5	183	129	286	116.4	99	82.4	142	143.6	409	86.4	29	172.1	147	217.8	108.8	200.4	89	171
44	10/25/2005 10:56:48		120	45.3	84	126.3	74	304.5	177	165.3	193	108.4			51	150.9	178	119.6	117.4	139.7	91	181.9
45	10/25/2005 10:56:49		66	2.6	72	124.8	25	85.4	107	150.8	183	130.1	147	120.2	225	196	222	198.9	177.4	188.4	142	171.9
46	10/25/2005 10:56:50		80	12.3	126	80.4	174	55	102	56.2	320	96.1	177	107.1	61	52.9	82	116.9	187.9	197.7	74	190.1
47	10/25/2005 10:56:51		302	94.2	131	40.4	249	82.6	47	216.4	134	162.6	197	237.4	166	314.3	83	166.1	132.5	149.4	187	142
48	10/25/2005 10:56:52		175	102.8	397	123.6	323	108.6	202	119.7	162	114					143	134.4	100.9	103.8	107	61
49	10/25/2005 10:56:53		231	113.5	64	152.2	231	143.6	190	127.7	72	160.6	56	64.8			223	252.2	92.01	217.5	67	216.5
50	10/25/2005 10:56:54		228	124.8	170	159.3	142	179.2	72	136.1	187	2.4	107	125.9			185	23.2	133.8	191.6	158	138.3
51	10/25/2005 10:56:55		56	209.7	84	258.3	196	197.5	200	259	134	68	72	311.6			173	137.1	146.4	156.2	141	180
52	10/25/2005 10:56:56		223	83.3	145	173.3	45	180	121	108.7			33	241.1	39	70.6					68	194.4
53	10/25/2005 10:56:57		145	113.2	196	111.9	96	131.6	103	152.9			184	170.9	121	187.1					198	257.2
54	10/25/2005 10:56:58		107	107.4	94	97.4	206	132.4	237	249.7	72	309.9									109	219.1
55	10/25/2005 10:56:59		280	116.7	247	108.4	244	124.5	168	140.1	212	188.7									92	304.4
56	10/25/2005 10:57:00		205	58.8	188	106.4	232	136.4	59	152.6	84	199.5					295	296	132.8	308.1	66	58
57	10/25/2005 10:57:01		244	151.9	322	124.6	408	136.7	279	106.2			145	151.5	155	204.7					53	170.2
58	10/25/2005 10:57:02		266	123	353	124.3	355	120.5	275	119.4	392	128.7	210	174.5	270	186.4	464	249	269.5	248.7	45	190.3
59	10/25/2005 10:57:03		179	128.7	195	122	264	131.5	459	110.8			371	137.6	222	115.6					115	217.6
60	10/25/2005 10:57:04		123	154.1	227	130.7	349	136.7	255	72.2	144	74.3	222	82	130	27.6					96	232.2

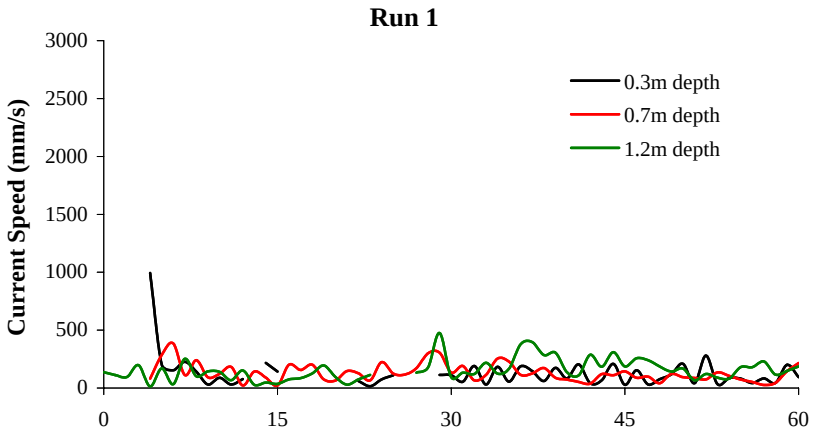
Lower Fox River Moving Vessel Trials
Test Eleven

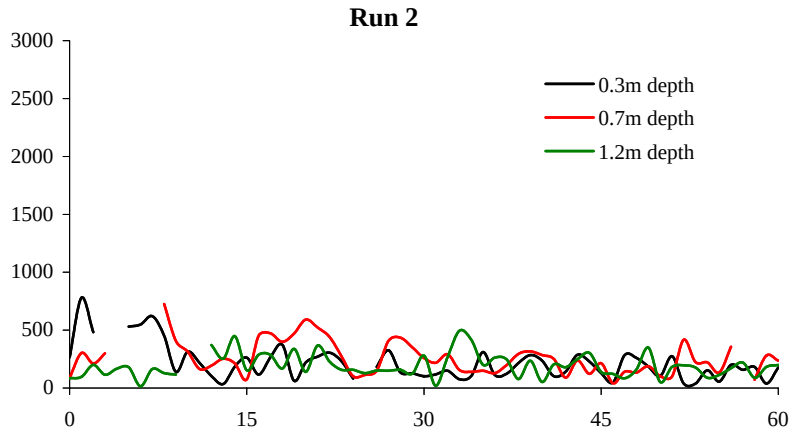
Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:02:15		33	230	163	214.3	52	308	93	90	58	351	88	246.6	239	176.6	150	201.1	159.8	230.3	202	251.6
1	10/25/2005 11:02:16		73	280.2	119	248.4	162	326.3	33	95.2	21	182.7	49	356.5	96	9.6	40	7.1	20.4	281.3	55	234.6
2	10/25/2005 11:02:17		132	4.3	104	239.5	71	195.6	211	50.6	122	136.7	231	88.5	74	44.5	5	53.1	37	89.23	70	91.6
3	10/25/2005 11:02:18		83	279.7	172	36	274	351.8	44	320.5	91	17.8	108	353.6	457	248.3	463	234.2	463.5	234.2		
4	10/25/2005 11:02:19		16	82.9	54	272.1	64	25	119	258.4					332	212.6						
5	10/25/2005 11:02:20		48	130	215	272.9	164	300.8	98	84.1			348	231.4	387	225.1						
6	10/25/2005 11:02:21		74	212.8	253	226	247	174.4	89	197.6												
7	10/25/2005 11:02:22		173	291.7	109	194.9	89	171	49	183.5												
8	10/25/2005 11:02:23		176	208.2	226	253.6	91	188.8	157	173.4												
9	10/25/2005 11:02:24				462	183.5	377	176.7			173	166.6										
10	10/25/2005 11:02:25		528	170.9	327	139.1	209	163.6	186	157.3	426	169.6	337	173.9	231	166.5					283	101.2
11	10/25/2005 11:02:26		201	86.9	200	164.4	228	150.3	308	152.4	191	155.9	394	198.5	347	157.6	185	110.2	253.3	109.4	323	185.3
12	10/25/2005 11:02:27		319	206.4	177	272.6	389	169.6					257	203.6	100	137.4	446	154.5	539	149.2	354	126.7
13	10/25/2005 11:02:28		252	155.4	236	163.8	183	99.8	356	289	106	88.4	167	101	460	133.7	549	113.4	559	137	572	16.9
14	10/25/2005 11:02:29		186	182.5	72	206.6	228	165.2	105	204.1	288	165.3	277	158.4	500	122.3	648	101	770.8	130.7	454	81.6
15	10/25/2005 11:02:30		94	158.1	145	122	103	246.7	236	136.7			708	159.2	725	137.8	663	122.3	418.6	142.5	288	274.2
16	10/25/2005 11:02:31		244	176.5	187	179.1	132	149					478	168.2	598	146.3	746	132.9	1429	159.7		
17	10/25/2005 11:02:32		230	171	195	161.8	242	182.4	170	159.6	151	168.2	301	140.5	432	122.1	594	158.1	593.7	158.1		
18	10/25/2005 11:02:34		253	149.4	143	158.6	113	172.9	255	163.1	155	207.7	200	126.9	501	109.1					322	300.2
19	10/25/2005 11:02:35		71	137.3	86	149.8	205	139.6	479	141.4	252	165.7	331	137.2	300	157.9	234	178.8	131	244.2	96	177.6
20	10/25/2005 11:02:36		257	138.9	210	151	191	194.5	146	88.4	174	177	101	229.4	226	236.2	197	267.7	124.2	247.8	160	163.3
21	10/25/2005 11:02:37		147	134.4	215	161.8	217	175	238	172.3	235	145.6	93	142	203	228.8	159	189	117.6	215.3	116	252.5
22	10/25/2005 11:02:38		44	228.7	169	195.4	238	173.2			76	152.8	64	178.2	273	105.3					134	233.5
23	10/25/2005 11:02:39		412	110	156	101.5	166	142.9	375	169.9			186	162.8							163	214.3
24	10/25/2005 11:02:40				136	191.1	154	222.4	151	162.6	155	164.6	264	172.2	154	218.7					161	231.3
25	10/25/2005 11:02:41		450	231.9			262	231.2	169	184.4	86	143.5	195	240.8	176	204.8					87	247.8
26	10/25/2005 11:02:42						291	253.6	189	227.4	211	187.4	181	176.5	193	189.3	86	10.7	63.45	12.28	41	15.8
27	10/25/2005 11:02:43						183	193	352	249.9	196	194.8	244	219.5	216	163.1	285	159.3	155.2	165.1	39	212.5
28	10/25/2005 11:02:44						89	171.6	157	202	211	168.3	312	144.5	250	165.6	253	221	144	198.6	110	137.9
29	10/25/2005 11:02:45				101	246	181	236.5	158	188	130	209.5	220	149.9	207	156.7	240	187.7	156.1	192.4	76	207.6
30	10/25/2005 11:02:46		160	193.8	146	209.6	201	180.3	99	138.3	124	205.3	85	186.8	174	167.7	122	268.6	41.5	233.8	72	129.9
31	10/25/2005 11:02:47				183	210.2	140	222.7	194	197.1	257	192.6	263	153.3	154	156.3	288	179.2	163.4	191.7	77	245.4
32	10/25/2005 11:02:48				256	170.8	301	165.6	276	186	244	194.5	154	187.1	82	156.9	19	207.9	9.962	162.5	15	97.6
33	10/25/2005 11:02:49				102	164.1	106	160.2	212	132.7	224	137.7	237	132.4	211	142.7	126	198	97.6	196.7	69	194.2
34	10/25/2005 11:02:50		67	122.7			285	203.1	174	205.1	126	182.7	139	187.4	132	196.8	172	156	171.9	156		
35	10/25/2005 11:02:51						124	192.1	194	188.6	145	176.1	31	277.4	80	257.7	150	164.1	74.14	176.5	32	262.9
36	10/25/2005 11:02:52						157	164.9	251	180.5	156	147.8	106	100.4	77	99.7	150	144.5	92.86	208.6	181	256.9
37	10/25/2005 11:02:53		193	193.5			225	195	91	167.9	186	233.7	154	164.5	230	97.5	111	166	85.77	172.3	62	183.7
38	10/25/2005 11:02:54		84	263.9	16	187.1			85	139.8	125	169.4	124	93.2	106	180	57	148.5	68.35	191.4	102	213.8
39	10/25/2005 11:02:55		66	268.3	194	123.2	83	200.4	191	244.6	206	130.5	166	137.4	157	177.1	162	238.4	123.3	232.2	87	220.8
40	10/25/2005 11:02:56		98	132.1	248	218.3	210	169.6	158	172.7	300	122.7	226	144.9	153	194	254	239.2	194.1	243	136	250.2
41	10/25/2005 11:02:57		81	208.8	114	162.2	69	171.6	63	346.2			19	32	142	38.2	309	73.4	206.1	74.38	104	77.2
42	10/25/2005 11:02:58		234	237.4	36	298	4	296.6	110	157.6	145	183.9	105	70	86	159.7	307	90.4	169.6	102.6	76	161.6
43	10/25/2005 11:02:59		150	233.7	63	142.8	122	77.7	63	90.9	113	117.5	337	181.4	253	160.1	145	214.6	152.4	237.5	181	255.6
44	10/25/2005 11:03:00		136	210.9	150	147.3	178	174.8	122	191.9	208	150	123	155.9	181	51.3	173	209.1	168.8	227	181	244.1
45	10/25/2005 11:03:01		83	102.5	301	138.6	252	117.2	181	113.7	185	97.5	109	101.6							157	233.6
46	10/25/2005 11:03:02		87	182.6	80	190	215	168.7	219	140	11	131.2	462	146	144	226.1	98	58.7	75.29	39.61	66	10.5
47	10/25/2005 11:03:03		165	147.4	71	102.3	140	173.4	51	93.4	249	6.5			381	164.2	277	246.6	173.6	253.6	80	278.6
48	10/25/2005 11:03:04		112	225.4	30	137.7	177	206.6	77	218.7							293	216.7	203.2	233.1	150	266.6
49	10/25/2005 11:03:05		100	217.7	116	148.4	102	171.6	126	70	206	90.6									99	258.9
50	10/25/2005 11:03:06		120	230.7	100	188	130	164.4	211	135.4	213	95.9	226	138.8							142	270.4
51	10/25/2005 11:03:07		118	182.9	202	174.6	71	119.4	125	89.5	127	152.4	295	103.3							115	236
52	10/25/2005 11:03:08		94	246.7	116	148.8	82	138.9	154	102			255	109.5	77	270.7	173	93.6	144.6	106.1	168	159.1
53	10/25/2005 11:03:09		115	197.7	112	136.5	152	125.4	117	203.7			425	119.5	266	117.8	269	127.8	95.46	171.9	188	262.6
54	10/25/2005 11:03:10		75	178.5	158	125.2	177	95.8	122	77.2			224	129	279	152	211	219	293.3	232.3	384	239.5
55	10/25/2005 11:03:11		100	196.8	137	144.2	40	124.9			285	173.7	211	80.2	179	117.3	106	105.9	80.22	258.1	259	269.1
56	10/25/2005 11:03:12		148	177.7	89	155.4	177	181.9	50	263.2	52	102.2	92	168.1	139	219.4	119	163.9	75.31	188.4	65	237.5
57	10/25/2005 11:03:13		74	169.1	20	212.9	51	80.9	257	101.9	118	356.1	91	297.4	103	37.5	212	236.8	124.8	226.5	56	184.1
58	10/25/2005 11:03:14		53	158.8	96	122.7	146	155.7	111	111	111	92.1	111	221.7	76	198.4	275	198.4	229.5	205.6	87	199.5
59	10/25/2005 11:03:15		71	312.7	167	122.6	445	234.1	5	53.1	108	237	166	270.7	135	260.2					19	0
60	10/25/2005 11:03:16		108	217.8	211	267.3					183	238.7	106	261.9	170	139.3	159	181.4	99.74	192.2	52	226.5

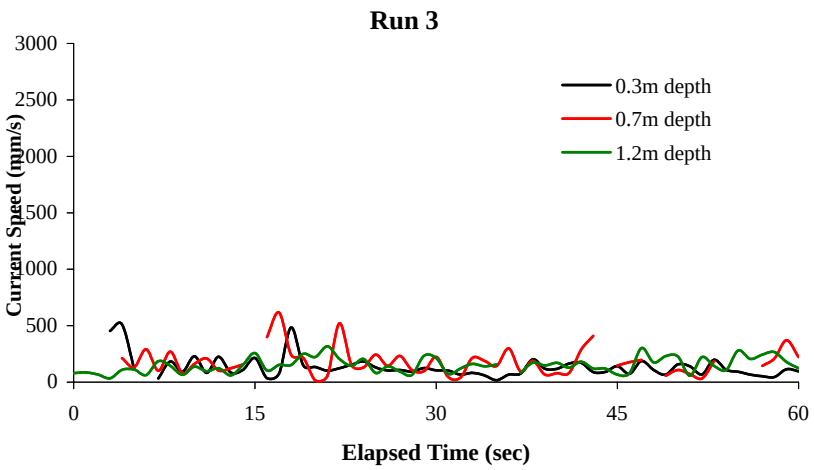
Fox River Propwash Study - Moving Vessel Trials

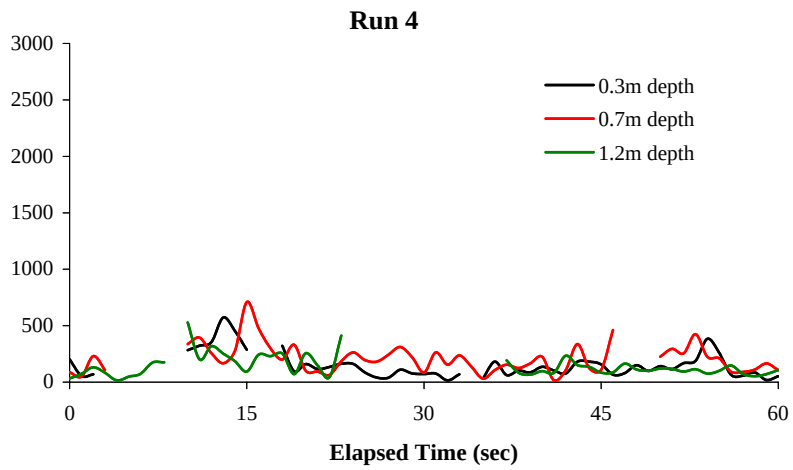
Test #11: Single-Prop Vessel - 50% Throttle Startup -Pitch Down 2

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Twelve

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:05:36		208	140.7	154	185.6	30	205.7	56	352.9	33	62.7	188	135	187	168.3	72	54.1	100.9	99.7	160	118.3
1	10/25/2005 11:05:37		74	191.8	199	130.7	143	115.3	42	114.1	189	126.8	235	109.4	133	119.6	121	116.6	85.91	118.5	51	123.1
2	10/25/2005 11:05:38		144	150.4	150	64.3	90	136.4	34	171.6	129	117.2	222	105.7	201	96.6	56	149.7	55.57	149.7		
3	10/25/2005 11:05:39		134	68.6	132	71	141	110.7	178	275.8	237	309	43	196.3	175	60.5	161	204.7	353.3	97.81	584	80.4
4	10/25/2005 11:05:40		139	134.1	150	246	127	289.9	295	185.6			669	246	513	242.4	83	16.9	82.57	16.9		
5	10/25/2005 11:05:41		110	43.2	19	15.5	164	319.2	74	272.3	389	187.4	266	222.9	303	227.9						
6	10/25/2005 11:05:42		26	204.6	149	305.2	119	280.2	136	212.4	124	214.5										
7	10/25/2005 11:05:43		4	206.6	30	7.6	154	252.3	184	210.7	134	187.7					239	188.4	238.6	188.4		
8	10/25/2005 11:05:44		112	133.5	203	91.4	127	162.6	330	213.9	61	173.5	84	217.3					199.2	103.1	242	222.7
9	10/25/2005 11:05:45		283	125.7	181	183.2	148	188.1	209	139.5	138	238	279	167	158	203.8					387	248.8
10	10/25/2005 11:05:46		367	122.3	265	115.5	88	188.5	238	178.1	205	167	148	194	467	176.9					243	132.5
11	10/25/2005 11:05:47		188	127	274	134.9	437	139.8	99	111.9	504	199.5	609	211.6	451	175.6	375	204.1	731	211.7		
12	10/25/2005 11:05:48		338	171.5	238	41.3	220	135.2	188	145.4	235	125.7	151	178.1	255	147.3						
13	10/25/2005 11:05:49		112	178.5	196	169.7	158	153.3	267	175.5	173	207.9	251	147.2	148	188.2					130	128.5
14	10/25/2005 11:05:50		95	268.2	234	127	246	145.1	174	182.6	150	127.7	124	169.3	89	114	286	157.4	286	157.4		
15	10/25/2005 11:05:51		179	173.6	104	175.1	330	234.4	188	124.4	270	130.3	121	247.2			419	175.3	419.4	175.3		
16	10/25/2005 11:05:52		179	210.1	53	52.7	158	146.1	192	107.3	270	85.3	124	161.7	160	177.5						
17	10/25/2005 11:05:53		212	146.5	156	94	108	148.2	143	135.6	76	344	71	164.4	167	188.3	281	154.1	163.5	114.8	209	56.3
18	10/25/2005 11:05:54		143	66.5	227	122.4	40	284.4	194	216.4	272	198.4	236	178.3	253	271.6					89	107
19	10/25/2005 11:05:55		155	37.9	47	155.1	69	226.8	148	229.7	157	209	35	103.2								
20	10/25/2005 11:05:56				75	36.9	141	57.8	199	146.9	183	148.7	319	202.7	121	157.2	225	107.6	225.5	107.6		
21	10/25/2005 11:05:57		75	242.1	222	139.9	78	332.4	97	193.2	211	210.2	140	205.3								
22	10/25/2005 11:05:58		102	180.6	106	111.5	120	69	103	134.6	50	257.3	81	98.5							72	77.9
23	10/25/2005 11:05:59		94	307.2	95	98.5	172	118.8	224	77.1	101	194.3	148	170.3	301	148.3	230	74.1	95.35	58.73	68	301.8
24	10/25/2005 11:06:00				129	137.2	51	65.9			203	183.7	109	172.1	241	218.6	72	257.1	41.25	263.7	14	300.3
25	10/25/2005 11:06:01				180	166.8	161	235.6	81	165.6	27	162.9	122	182.8	267	220.4	238	191.9	204.6	205.9	187	223.9
26	10/25/2005 11:06:02				236	156.5	127	132.5	68	90	109	159.6	90	69.7	251	217.2					88	241.4
27	10/25/2005 11:06:03				90	90	57	145.8	130	166.2	124	97.9	228	173.5	194	178.2					204	247.6
28	10/25/2005 11:06:04		52	211.5			247	182.1	111	266.9	128	347.8	58	232	120	199.5					107	138.4
29	10/25/2005 11:06:05		109	217.2			142	113.1	35	184.9	48	125.7	160	160.3								
30	10/25/2005 11:06:06		173	199.9			117	140.9	72	166.3	131	158.1	103	178.3			84	0				
31	10/25/2005 11:06:07		154	216.3	283	246.9			129	185.4	192	202.7	139	191.6	71	88.4	95	170.9	98.72	194.7	117	213.8
32	10/25/2005 11:06:08		118	221.9	280	253.4			142	28.2	127	156.3	160	214.3	137	165.1						
33	10/25/2005 11:06:09		70	87.5	139	201.6			223	96.2	234	202.4	132	177.4	99	180.6	544	66.6	543.7	66.59		
34	10/25/2005 11:06:10		79	357.1	107	164.3			47	170.1	158	136	163	230.7	185	174.4	102	198.3	115.7	223.4	145	240.8
35	10/25/2005 11:06:11		22	294.2	145	130.3	292	205.2	145	72.8	57	189.1	70	194.8	161	182.5	211	126.3	211	126.3		
36	10/25/2005 11:06:12		38	108.4	112	281.8			129	151.8	104	204.4			87	168	139	225.3	139.3	225.3		
37	10/25/2005 11:06:13		128	159.4	188	267.3			16	129.8	93	181.2	125	171.7	143	150.8	80	247.9	99.72	68.84		
38	10/25/2005 11:06:14		125	31.3			206	166.8	135	164.5	108	115.9	170	256	142	207.6	173	94.7	34.89	244.5	236	266.1
39	10/25/2005 11:06:15		146	185.9	231	89.8	114	203.2	393	165.6	48	185.9	112	218.5	90	241.4	150	192.3	85.04	181.7	35	130.4
40	10/25/2005 11:06:16		63	79.9	232	196.8	185	134.8	128	147.8	97	165.1	128	75.1	59	43.6	103	190.1	83.44	241.7	131	279.7
41	10/25/2005 11:06:17		53	154.4	208	267.5	125	222.1	143	116.6	129	157.2	196	112.8	100	99.7	142	120	79.24	109.9	31	56.8
42	10/25/2005 11:06:18		100	257.3	69	208.4			66	134.4	92	83.7	133	142.4	158	193.5	121	166.1	102.5	165	84	163.5
43	10/25/2005 11:06:19		183	306.1	35	98.1	302	212.7	142	122.3	182	153.9	186	153.2	16	150.3	75	131.8	143.4	219.9	294	234.7
44	10/25/2005 11:06:20		174	304.2	96	279	27	214.3	129	162.4	119	142.8	245	192	225	161.9	100	173.7	80.69	183.9	66	199.5
45	10/25/2005 11:06:21		60	18.4			114	88.5	205	95.9	156	214.3	142	140.1	35	139.6	125	151.4	120.7	201.9	188	232.8
46	10/25/2005 11:06:22		110	159.3	165	215.6	91	214.7	192	99.3	90	174.9	165	169.5	170	198.1	166	216.2	166	216.2		
47	10/25/2005 11:06:23		82	182.8	239	183.6	196	160	175	138	138	176.7	137	200.6	42	117.2	134	114.7	134.2	114.7		
48	10/25/2005 11:06:24		45	72	153	219.9	159	119.8	158	118.7	83	196.9	85	186.8	161	205.3	174	168.8	174.3	168.8		
49	10/25/2005 11:06:25		136	86.2	136	206.2	129	161	121	107.2	258	103.7	190	106.2	120	127.5	89	207.4	54.34	206.8	20	204
50	10/25/2005 11:06:26		249	153.7	104	174.5	184	149.3	119	122.6	272	121.9	348	110.5	55	153	201	211.8	134.6	207.9	70	196.6
51	10/25/2005 11:06:27		4	153.4	116	119.4	190	127.5	178	203.1	142	74.1	128	117	104	98.3	75	180.8	99.62	199.3	130	209.9
52	10/25/2005 11:06:28		181	121.2	149	47.2	182	113.6	47	309.8	126	157.1	73	165	157	150.7	161	138.8	137.6	178.1	182	212.2
53	10/25/2005 11:06:29		194	138.8	128	145.2	92	55.6	60	155.2	122	132.7	82	157.2	138	195.1	137	242.1	115.8	213.6	129	183.1
54	10/25/2005 11:06:30		61	128.4	195	41.9	59	344.3	167	205.2	138	150.1	114	150.1	88	142.9	53	239.6	54.72	257.9	61	273.8
55	10/25/2005 11:06:31		197	91.7	175	131.5	12	31	60	60	69	156	236	143.3	262	205.3	191	187.5	152.9	197.9	123	214.1
56	10/25/2005 11:06:32		375	87.1	214	113.1	65	166.6	41	77.3	114	137.5	271	176.8	146	129.5	94	138	179.6	200.7	327	215.5
57	10/25/2005 11:06:33		145	101.9	241	68.3	233	99.1	231	95.2	253	138	138	118	160	149.6	223	345.2	133.1	37.21	218	91.1
58	10/25/2005 11:06:34		135	145.6	74	106.5	183	122.5	123	144.2	40	67.9	123	293	42	148.6	185	55.8	185	55.79		
59	10/25/2005 11:06:35		317	107.8	218	134.3	81	207.8	155	145.5	58	111.3	159	147.6	247	160.6	127	276.3	38.21	222.9	102	133.4
60	10/25/2005 11:06:36		237	92.4	84	134.5	164	150	71	161.8	86	246.1	42	278.1	162	180	82	146.9	38.58	176.3	41	258.7

Lower Fox River Moving Vessel Trials
Test Twelve

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:09:16		138	147.1	174	87.4	175	150.5	52	257.8	84	219.2	89	116	70	103.2	72	35.4	106	69	157	83.8
1	10/25/2005 11:09:17		33	317.5	127	169.1			92	201	64	313.1	77	312.4	102	137.4	134	173.6	66.45	193.9	47	274.9
2	10/25/2005 11:09:18		73	74.8	77	195.1	197	312.5	116	176.1	118	142.9	46	178.8	46	163.5	195	268.8	169.8	288.5	207	228.9
3	10/25/2005 11:09:19		147	316.7	96	338.5	81	163.6	99	233.6	132	227.8	199	153.2	237	215.2	190	222.4	105.8	196.5	93	132.8
4	10/25/2005 11:09:20		104	313.8	134	162.6	87	82.1	67	164.5	113	222.1	124	169.8	170	183.4	151	90.4	96.56	92.08	42	98.1
5	10/25/2005 11:09:21		36	6.3	73	21.7	90	248.6	117	155.8	76	209.3	77	78.8	232	62.6	122	122.3	147.1	101.8	185	88.5
6	10/25/2005 11:09:22		46	164.7			74	104	158	270.7	231	277.2	243	246			687	90	687	89.92		
7	10/25/2005 11:09:23						121	67.7	395	240.8	287	339										
8	10/25/2005 11:09:24				143	195.4	97	204.4	113	198.6												
9	10/25/2005 11:09:25				143	193.7	83	110.4	219	209.5					250	253.5						
10	10/25/2005 11:09:26				251	259.5			124	217.1												
11	10/25/2005 11:09:27																					
12	10/25/2005 11:09:28																					
13	10/25/2005 11:09:29																				322	234.1
14	10/25/2005 11:09:30		554	200.7			464	233.5	363	234.1	317	263.5	531	267.2	320	221.3						
15	10/25/2005 11:09:31		339	109.1	247	171.6	55	136.5	119	114.4			240	2.4	136	347.3	285	329.7	35.11	324.3	215	151.4
16	10/25/2005 11:09:32		924	258.7	827	240.9	274	238.1	343	263	310	279.1	268	246.7	177	278.1					308	249.1
17	10/25/2005 11:09:33		157	117.7	166	140.6	112	237.4	280	92	300	231	345	185.1	122	228.3					54	287.1
18	10/25/2005 11:09:34				116	186.9	346	207.2														
19	10/25/2005 11:09:35		140	69.5	391	190.6	262	187.5	353	184.7	401	175	196	198.7					1145	183		
20	10/25/2005 11:09:36				200	180.9	213	185.7	287	196.8	161	188.6	124	161.1	176	145						
21	10/25/2005 11:09:37				308	211.7	333	165	343	174.5	398	195.7	224	185.1	156	202.6	364	213	361.7	224.7	375	236.1
22	10/25/2005 11:09:38		155	170.7	200	197.4	278	163.7	233	183.2	286	174.8			198	179.4	162	184.2	95.56	200.5	58	252.8
23	10/25/2005 11:09:39				320	210.4	230	173	240	158.5	167	229.1	143	197.9	236	149.7	260	146.3	308.2	210	90	170.4
24	10/25/2005 11:09:40		213	231.7	277	258.1	193	237.5	32	163.8	179	227.5	261	157	117	134.3	236	130.4	26.57	109.8	23	133.3
25	10/25/2005 11:09:41		349	268.4			189	253.4	41	62.2	95	184.8	190	190.9	77	331.4	106	162.9	184.3	104.5	326	88.4
26	10/25/2005 11:09:42						242	221.5	151	155.8	159	183.6	129	216.5							23	110
27	10/25/2005 11:09:43										397	108.3	302	218.7							90	172.3
28	10/25/2005 11:09:44		118	136	342	223.7							233	249.6	176	219.5	162	102.8	233	217.9	127	146.6
29	10/25/2005 11:09:45		315	195.1	529	232.8							346	232.2	213	180.3	180	164.9	165	173.6	154	183.7
30	10/25/2005 11:09:46		305	220.2	256	123.7			113	251.9			380	231.2	337	198.3	191	186.3	203.9	166.2	237	150.2
31	10/25/2005 11:09:47		254	223.2			141	140.5			422	183.7	227	224.1	227	193.8	55	201.4	101.4	106.9	214	92.1
32	10/25/2005 11:09:48		111	228.3			84	239.2			113	209.7	122	233.7	80	129.9	106	116.3	98.3	150.4	124	179.1
33	10/25/2005 11:09:49		405	251.4	347	197.3	123	238	272	211.2	238	229.1	160	238.8	313	240.3	169	219	103.2	171.1	156	117.9
34	10/25/2005 11:09:50		308	154.6					221	205.2	281	185.1	293	201	124	182.3	255	186.3	210.6	196	176	210.1
35	10/25/2005 11:09:51		66	195.9	72	338.1			16	201.8	322	222.1	140	222.1	201	215.9	84	266.6	39.54	103.2	162	94.6
36	10/25/2005 11:09:52		150	217.4					220	247.3	219	226.3	109	235.9	209	224.8	187	203.3	149.3	193	119	176.6
37	10/25/2005 11:09:53		223	172.8	180	221.4			208	262	110	200.3	193	215.9	112	263.8	146	197.9	141.3	205.6	139	213.6
38	10/25/2005 11:09:54				245	104.9	270	168.5	24	135	75	176.2	118	164.3	49	201.4	177	93.2	95.4	130.5	118	195.7
39	10/25/2005 11:09:55				241	262.6	89	93.2	124	142.9	156	275.5	176	244.5	113	272.5	97	237.6	72.89	211	73	174.5
40	10/25/2005 11:09:56		416	238.3	216	224.3	191	73.6	153	141.1	196	205.4	177	216.5	141	133.6	106	115.8	98.32	142	112	166.6
41	10/25/2005 11:09:57		71	225	215	190.2			128	117.4	64	355.5	90	249.1	123	228.6	22	206.6	90.2	183.8	160	180.7
42	10/25/2005 11:09:58		203	163.4			217	44.1	230	83	190	244.1	245	230.8	108	170.4	48	282	22.94	20.41	71	62.4
43	10/25/2005 11:09:59		383	260.4					95	181.8	113	270.5	165	233.9	75	212	124	58.5	43.44	78.04	51	204.1
44	10/25/2005 11:10:00		40	132	170	150			121	180.9	195	210.5	76	200.8	114	191.1	129	171.6	72.58	189.9	46	251.2
45	10/25/2005 11:10:01		144	302.3	370	261.8	80	202.7					243	225.8	238	201.9	186	147.9	137.1	143	90	132.7
46	10/25/2005 11:10:02		98	281.8	477	246.4	225	248.1	161	276.4			117	201.1	228	187.3	56	99.3	29.83	309.6	111	295
47	10/25/2005 11:10:03		268	240.9	256	235.5	38	41.8			260	156.7	147	237.5	130	191.1	210	174.5	141.4	160.2	95	126.9
48	10/25/2005 11:10:04		248	194	140	224.4	120	157.9					243	240.2	108	230.3	209	175.6	179.7	175.1	151	174.3
49	10/25/2005 11:10:05		216	234.2	250	213.4	147	203.6	100	3.4			255	241.7	116	203.5	99	254.8	83.33	251.5	68	246.5
50	10/25/2005 11:10:06		306	180.9	267	200.4	118	177.1	359	172			271	209.4	122	192.3	193	129.3	92.78	145.5	54	234.8
51	10/25/2005 11:10:07		33	162.1	204	265.8	197	208.1					254	243.8	61	194.3	117	231.6	74.22	215.4	48	172.9
52	10/25/2005 11:10:08		128	299	84	246.2	162	265.8			79	239.5	179	218.9	56	214.8	255	139.9	136.9	145.3	31	194.9
53	10/25/2005 11:10:09		251	273	136	266.2	150	190.8	180	114	462	236.7	231	240.7	187	218	113	175.4	76.8	216.8	101	264.3
54	10/25/2005 11:10:10		396	227.7	311	228.8	182	193	32	196.2			50	196.3	84	210.8	120	191	92.52	178.8	72	158.1
55	10/25/2005 11:10:11		236	190.7	39	199.4	55	153.9	140	174.2	150	318.8	3	225	143	198.3	88	201.3	100	218.3	119	230.8
56	10/25/2005 11:10:12		93	81.3	34	91.7	101	75.1	117	203.7	79	157	97	260	139	243.4	97	301.1	33.24	248.8	77	164.2
57	10/25/2005 11:10:13		26	149.4					38	205.2	73	205.2	149	163.3	100	161.4	272	229.2	130.9	213.6	73	123.3
58	10/25/2005 11:10:14		153	298.6	291	266.9	208	257.5	57	163.8	73	254.8	118	162.8	50	220.1	181	67.3	75.96	73.95	35	216.9
59	10/25/2005 11:10:15		35	121					52	300	175	139.6	216	178.4	236	173.7	151	212.3	144.5	201.9	143	190.9
60	10/25/2005 11:10:16		20	72.5	105	252.3	190	40.3	38	230.4	115	157.5	52	181.1	149	181.9	99	144.1	79.34	147.6	60	153.4

Lower Fox River Moving Vessel Trials
Test Twelve

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:11:07		153	125.1	111	56.7	140	90.8	135	160.5	43	88.7	34	126.5	117	42.9	57	63.9	123.1	163.5	424	77.5
1	10/25/2005 11:11:08		85	163.7	95	209	232	231	18	19.4	375	266.3										
2	10/25/2005 11:11:09		167	141.8	175	179.3	159	196.4	136	231.3	282	245.3										
3	10/25/2005 11:11:10		128	132.2	141	240.2	176	210.1	191	223.3	376	244.1										
4	10/25/2005 11:11:11		128	148	92	130.6	98	330.8	61	210.3	211	227.3			242	195.6	184	176.6	184.3	176.6		
5	10/25/2005 11:11:13		39	181.5	84	167.6	165	233.1	217	265.5	268	239	281	201.3					232.2	214.6		
6	10/25/2005 11:11:14		235	152.7	46	216.1	64	216.7	168	171.4	176	212	200	203.6								
7	10/25/2005 11:11:15		91	95	32	21.8	35	198.4	133	200.8	114	192.7									288	255.5
8	10/25/2005 11:11:16		193	330.8	181	345.6	71	244.9	67	212.7	150	190.3	194	143.2	99	137.5					342	246
9	10/25/2005 11:11:17		125	124.6	153	146.2									113	149.6					84	242.2
10	10/25/2005 11:11:18		744	177.5	523	195	223	236	309	178.7	291	197.8	232	216.4	707	219.6	684	217.6	457.3	220.3	233	228
11	10/25/2005 11:11:19		497	168.7	524	195.3	384	165.5	92	171.3	243	172.4	231	181.5	309	191	168	225.5	168.3	225.5		
12	10/25/2005 11:11:20		379	207.2	557	187.1	460	165.9	607	116.6	375	137.8	327	162	411	188.5	317	161.8	182.6	159	51	141.3
13	10/25/2005 11:11:21		212	192			535	181.9	379	167.2	435	162.4	293	155							214	116.1
14	10/25/2005 11:11:22		477	202.2					470	153.8	326	162.3	208	180.3	104	142.8	195	155.8	195.2	155.8		
15	10/25/2005 11:11:23		318	169.7	425	194.9	213	139.2	179	200	239	223	253	186.8	361	183						
16	10/25/2005 11:11:24		452	109.9	203	148.9	112	128.5	204	189.9	375	184.6	369	226.1								
17	10/25/2005 11:11:25		195	98.3	87	182	316	76.1	169	121			254	130.5								
18	10/25/2005 11:11:26		170	172.2	218	156.5	240	119.4	164	144.7	202	147.1	349	155.6							172	130.1
19	10/25/2005 11:11:27		352	108.9	203	129.4	389	122.7	112	115.4	208	152.6										
20	10/25/2005 11:11:28		110	133.2	168	167.6			295	204.8	199	239.6									131	216
21	10/25/2005 11:11:29		63	127.2	181	159.7	231	204	146	133.6	205	113.3	336	82.1	189	148.4	476	167	312.3	165.3	149	159.6
22	10/25/2005 11:11:30		142	157.2	170	179.7			172	150			235	149.3	477	169.3	331	156.5	177.3	153.4	30	117.4
23	10/25/2005 11:11:31		69	155.3	172	150.8	311	136.7	230	150												
24	10/25/2005 11:11:32		73	81.3	59	138.4			256	135.9											121	245.1
25	10/25/2005 11:11:33		279	113.4	164	118	91	139.5			228	125										
26	10/25/2005 11:11:34		184	103.5	299	94	146	77.8	82	85.1	177	183.9									124	11.1
27	10/25/2005 11:11:35		203	142.6	206	155.7	388	102.6	172	131	89	213.5									151	203.3
28	10/25/2005 11:11:36		295	92.7	280	141.7	515	97.6	92	96.3	181	188.3	207	154.2								
29	10/25/2005 11:11:37		257	93.1	197	150.4	240	134.8	149	123.8	264	167.5	167	123	240	215.1					117	189.4
30	10/25/2005 11:11:38		223	133.4	84	206.3	256	99.4	196	130.9	73	136.7	214	144.3	186	177.2	244	184	158.2	190.6	79	211.1
31	10/25/2005 11:11:39		166	143.3	90	171.1	132	106.8	228	111.4	110	190	103	123.1	203	127	187	134.4	137.4	143.9	95	162.9
32	10/25/2005 11:11:40		220	140.2	224	191.3	306	121.9	115	67	218	189.5	185	130.8	101	137.8	121	193.3	107.2	201.9	96	212.7
33	10/25/2005 11:11:41		103	87.2	81	138.5	269	91.5	143	83.2	66	207	135	199	218	163.2	104	220.3	93.81	211.5	87	200.9
34	10/25/2005 11:11:42		194	161.7	196	127.1	243	76.7	187	98.3	82	137	215	193.7	148	154.3	212	186	138.2	201	90	238.6
35	10/25/2005 11:11:43		109	112.6	159	184.3	273	100.1	173	140.4	235	155.9	153	145.7	136	226.8	118	125	105.6	117.7	95	108.4
36	10/25/2005 11:11:44		239	128	190	186	324	141.6	232	112	185	150.3	234	137.6	240	118.4	228	125	145.4	132.6	71	157.8
37	10/25/2005 11:11:45		146	122.2	140	167.2	314	118	169	109.4	172	189	206	155.3	161	217.9	295	134	196.4	132.8	98	129.2
38	10/25/2005 11:11:46		379	132.8	227	178.7	331	128	146	162.1	125	194.8	198	110.4	84	146.7	112	118.2	52.65	175.6	105	240.3
39	10/25/2005 11:11:47		219	130.7	79	224	443	108.3	110	191.5	245	190.6	232	119.8	275	157.8	195	187.4	135.4	175.3	90	148.6
40	10/25/2005 11:11:48		196	126.9	322	149.8	441	113.7	201	144.3	235	154	126	112.9	246	149.2	139	94.1	127.1	127	157	155.9
41	10/25/2005 11:11:49		220	138.5	141	127.2	272	110	225	152.8	114	155.7	120	192.1	149	171.5	27	124.3	62.62	242.4	140	252.1
42	10/25/2005 11:11:50		141	108.2	119	184.8	331	129.1	207	150.1	76	41.3	177	105.4	185	145.4	160	147	129.8	151	101	157.2
43	10/25/2005 11:11:51		271	120.8	317	73.7	266	82	207	159.6	273	198.2	229	149.5	187	106.8	176	145	119.5	165.2	96	204.7
44	10/25/2005 11:11:52		270	114.5	338	90.7	197	155.8	152	107.6	232	152	124	126.8	135	138.3	104	122	36.28	101.9	43	337
45	10/25/2005 11:11:53		89	80.3	91	138.6	149	118.8	300	116.6	96	102	29	220.8	164	177.2	53	16.4	63.53	208.2	179	204.7
46	10/25/2005 11:11:54		130	158.8	204	132.6	151	101.5	158	77.2	231	133.8	61	136.3	214	169.2	80	115.9	77.86	148.7	98	174.8
47	10/25/2005 11:11:55		41	265.8	91	191.4	143	92	174	130.1	263	229.9	106	182.7	153	206.4	45	271.3	11.54	287.7	24	75.4
48	10/25/2005 11:11:56		149	132.3	287	202.7	122	237.7	161	234.8	460	240.9	380	258.9	194	237	274	225.7	176.5	213.9	102	180.6
49	10/25/2005 11:11:57		199	127.4	208	257.2	227	174.2	344	223.8	501	242.3	360	234.3	455	244.3	265	218.7	178.1	208.1	107	181.1
50	10/25/2005 11:11:58		171	158.7	124	179.1	150	92.3	68	140.9	190	222	306	171.9	227	147.2	94	136.3	101.1	154.2	116	168.6
51	10/25/2005 11:11:59		85	90.7	269	206	170	135	194	128.5	308	236.1	104	195.6	94	122.8	151	164.7	126.4	160.3	102	153.9
52	10/25/2005 11:12:00		275	246.4	233	217.9	272	93.8	106	150.1	371	247	394	231.6	249	226.3	54	236.3	39.8	206.9	42	167.6
53	10/25/2005 11:12:01		166	230.6	231	261	140	95.8	162	214.2	474	248.1	173	213.4	262	249.4	155	204.7	113.1	210	73	221.1
54	10/25/2005 11:12:02		118	217.1	178	198	205	86.4	160	212.5	247	232.1	251	213.3	159	220.9	69	252.3	66.57	214.3	89	185.8
55	10/25/2005 11:12:03		100	149.3	231	205.9	153	86.3	75	196.3	190	262.7	149	239.8	396	252.1	83	197.6	78.48	167.1	95	141
56	10/25/2005 11:12:04		88	30.6	230	225.9	133	97.8	171	132.4	241	238.2	209	234.9	325	226.4	214	222.7	142.6	231.1	80	254.1
57	10/25/2005 11:12:05		160	135	118	223.3	248	86.8	195	101.5	275	209.9	254	227.4	421	227.9	201	236.4	183.5	235.1	167	233.5
58	10/25/2005 11:12:06		106	145.4	149	241	264	129.2	92	143.4	262	220.4	297	217.6	259	228.3	314	252.2	183	247.8	58	223.6
59	10/25/2005 11:12:07		239	120.6	140	282	111	48.7	109	32.7	289	252.1	290	228.2	276	260	109	244.4	65.12	218.5	58	162.8
60	10/25/2005 11:12:08		139	76.3	74	359.2	244	99.2	108	129.7	265	224.2	184	245	144	223	285	195.1	188.9	185.6	108	159.9

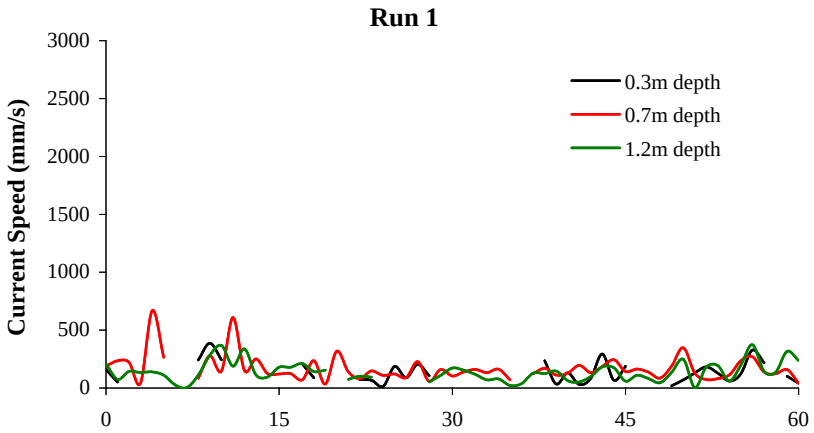
Lower Fox River Moving Vessel Trials
Test Twelve

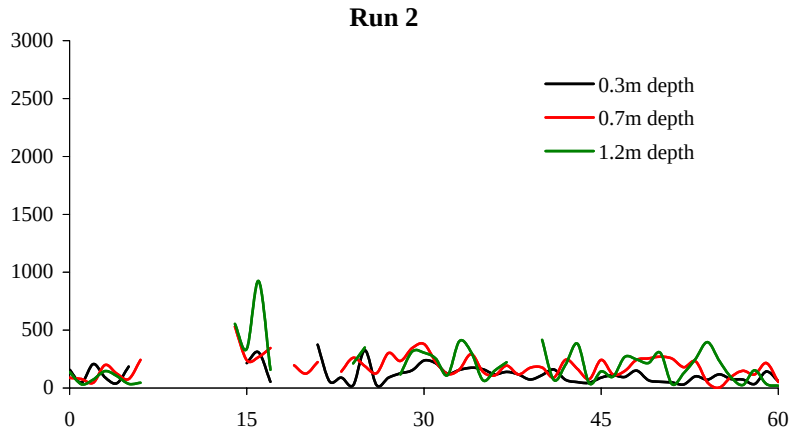
Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:16:43		275	246.7	106	266.2	149	271.2	348	258.7	204	242.3	310	233.6	119	183.8	147	259.5	72.94	253.7	15	160.3
1	10/25/2005 11:16:44		211	247.1	116	266.5	232	267.8	351	265.4	137	285.3	228	235.2	201	239.5	280	241	183.3	231.5	101	204.5
2	10/25/2005 11:16:45		64	296.2	219	197.9	224	260.5	273	254.3	182	239.6	347	256.7	64	225	115	321.7	69.03	262.9	126	211.7
3	10/25/2005 11:16:46		157	207.7	304	235.7	260	244.2	278	242.1	246	206.6	277	240.4	145	126.3	112	110.9	82.13	138	82	176.5
4	10/25/2005 11:16:47		182	241.7	303	256.2	306	232	435	227.1	206	238.3	259	232.7	257	151.6	180	181.9	721.7	356.1		
5	10/25/2005 11:16:48		134	233.8	202	228.8	348	237.3	501	254.9	409	249.8	347	236.8					793.8	70.88	837	72.7
6	10/25/2005 11:16:49		204	268.6	348	269.3	390	234.6	493	257.9	342	274.4	140	291.4			846	66.9	845.9	66.89		
7	10/25/2005 11:16:50		137	238.4	279	261.8	389	256.5	327	253.3	242	265.3					795	81.5	794.7	81.53		
8	10/25/2005 11:16:51		272	268.3	153	247.3	87	217.5	159	73.5	228	118.2									235	106
9	10/25/2005 11:16:52		202	219.6	227	243.3	293	239.9	226	245.1	139	149.2	611	87.8			874	127.7	439.1	80.43	1003	85.3
10	10/25/2005 11:16:53		802	280.6	767	317.9	984	307.8	560	322			1317	93.8	224	99	335	76.5	443.4	82.94	555	86.8
11	10/25/2005 11:16:54																					
12	10/25/2005 11:16:55																					
13	10/25/2005 11:16:56		749	253.8	632	248.2	354	257.5	239	286	265	277.2	293	267.8	493	239.5					124	144.5
14	10/25/2005 11:16:57		711	248.7	313	222.7	374	346.9	76	139.8	252	258.6	284	216.8	242	215.6	290	274.6	226.2	275.8	279	247.2
15	10/25/2005 11:16:58		140	234.6	360	170.3	425	218.9	9	90	304	312.5	53	312.7	99	183.5	135	236.8	320.3	254.1	309	251.1
16	10/25/2005 11:16:59		226	263.7	375	240.1	349	210.1	377	209.4	573	184.9	375	200.8	364	169.2	205	138.4	458.8	156.9	341	236.4
17	10/25/2005 11:17:00		347	238.2	415	270.7	335	244.5	418	223.5	469	193.8	479	179.5	515	161.7	471	179.4	431.3	178	206	251.7
18	10/25/2005 11:17:01		692	268.3	756	273.2	659	271.7	526	250.1	590	227.4	402	219	413	181.8	451	197.1	646.2	181.5	114	153.9
19	10/25/2005 11:17:02		414	246.7	383	224	614	249.7	400	250	520	280.2	302	14.4	302	335.3	60	129.6	237.8	107.4	490	78.2
20	10/25/2005 11:17:03		508	261.2	487	244	428	219.8	513	182	363	254.7	205	264.4	231	285.1	89	249.5	160.7	141.1	269	69.5
21	10/25/2005 11:17:04		167	189.3	215	196.5	294	193.8	238	244.1	389	204.8	625	261.2	444	269.4	246	277.9	66.47	225	503	69.5
22	10/25/2005 11:17:05		228	201.4	86	287.6	222	282.2	253	247.5	335	270.3	342	264.6	263	265.4	187	230.4	158.6	216.8	285	59.7
23	10/25/2005 11:17:06		11	311.2	29	339.7	191	297.1	438	283.1	397	303.6	290	315	198	60.3	120	96.2	297.1	82.46	479	79
24	10/25/2005 11:17:07		181	175.2	214	257.8	155	293.2	402	297.1	308	287.4	186	329.3	208	20.3	289	135.4	108.5	157.2	226	85.4
25	10/25/2005 11:17:08		210	209.4	199	167.8	137	285.7	208	339.1	93	325.5	339	11.6	263	15.9	187	84.8	209.7	161.7	219	216.7
26	10/25/2005 11:17:09		111	166.5	220	164.4	258	151.5	138	118	286	347.3	248	51.2	563	138.4	300	125.2	397.4	164.5	648	246
27	10/25/2005 11:17:10		159	201.1	272	155.9	101	112.8	53	7.5	378	41.5	61	349.6	169	8.8	19	68.7	152.1	152.6	203	139.4
28	10/25/2005 11:17:11		216	151.2	151	118.4	194	65.9	140	347.2	180	326.6	230	308.1	331	330.5	90	327.7	147.3	176.5	100	185.8
29	10/25/2005 11:17:12		118	91	172	50.7	204	66	44	78.2	414	347.7			27	225	45	311.4	134	179.6	220	217.8
30	10/25/2005 11:17:13		244	57.7	350	120.2	378	79.5	122	75.3	112	349.7	58	18.1	45	5.1	148	355.7	250.9	203	142	194.2
31	10/25/2005 11:17:14		99	271.2	315	86.7	248	101.2	228	127.9	292	113	318	139.3	182	133.7	86	162.4	558.5	199.3	225	102.9
32	10/25/2005 11:17:15		193	140	157	143.6	115	212.6	436	143.4	117	8.3	199	152.8	232	181.7	216	172	262.4	223.9	431	219.6
33	10/25/2005 11:17:16		262	116.6	511	152.2	72	102.9	331	155.4	186	160.2	459	106.3	239	161.2	143	176.8	131.8	217.9	92	183.7
34	10/25/2005 11:17:17		70	204.4	44	124.8	100	119.4	160	165.5	257	190.5	258	193	230	173.5	259	161.8	287.1	181.4	164	194.5
35	10/25/2005 11:17:18		85	103.5	95	126.9	42	34.4	141	190.6	146	171.3	147	162.2	158	115.1	92	235.6	106.2	255.8	63	180.9
36	10/25/2005 11:17:19		137	219.4	133	324.2	169	10.9	96	157.4	290	173.3	144	184.8	158	230.1	166	206.9	249.6	213.6	144	255.5
37	10/25/2005 11:17:20		262	175.6	303	189.9	222	201.7	211	197.9	294	197.6	385	214	165	173	132	193.6	248	180.9	139	170.5
38	10/25/2005 11:17:21		162	238.7			26	107.7	98	119.5	311	197.8	247	193.4	121	166.7	60	96.7	250.9	206.8	143	271.6
39	10/25/2005 11:17:22		78	124.1	319	254.5			84	273.4	133	144.2	206	199	139	219.8	116	218.4	123.5	185.1	97	177
40	10/25/2005 11:17:23		94	88.2			31	312.4	113	196.5	135	206.4	176	149.6	143	178.4	165	236.6	129.1	196.2	156	206.7
41	10/25/2005 11:17:24		136	239.1	188	50			137	241.2	95	168.5	251	198.8	194	291.8	34	271.7	207.2	195.1	148	150
42	10/25/2005 11:17:25		86	287			12	104	97	221.2	107	170.3	268	189	270	298.7	61	143.7	36.06	183.2	92	118
43	10/25/2005 11:17:26		102	256.4			147	231.3	301	275.9	196	235.4	135	209.8	254	31.6	63	100.1	260.4	155.5	39	72
44	10/25/2005 11:17:27		101	265.5	225	234.4	346	185.3	187	225.9	150	190.3	137	249.4	113	213.4	141	206	53.6	194	68	229.8
45	10/25/2005 11:17:28		212	304.4	153	264.4			134	120.4	128	199.6	108	219.7	75	315	192	238.6	79.45	229.6	43	94
46	10/25/2005 11:17:29		262	274.2	110	312.1			114	246.1	104	164.9	284	160	151	232.8	106	210.7	43.06	164.5	77	84.1
47	10/25/2005 11:17:30		338	261.2	183	285.6			114	190.6	113	222.5	72	102.1	125	182.3	183	226.5	182.6	236.6	188	246.4
48	10/25/2005 11:17:31		257	289.6	349	299.1	346	271	87	176.7	187	272.1	103	154.7	107	124.7	62	330.9	49.93	327.3	38	321.3
49	10/25/2005 11:17:32		286	278.8	306	275.6	175	273.9	174	190.9	75	176.9	166	151.1	158	181.8	209	123.5	122.3	115.4	48	78
50	10/25/2005 11:17:33		249	241	224	208.9	131	303.2	209	149.5	123	228.6	245	184.9	120	174.7	191	164.2	142.1	172.9	99	189.8
51	10/25/2005 11:17:34		195	200.8	201	190	120	5.8	62	40.4	99	180.6	226	235.3	99	169.5	156	115.4	155.1	99.46	166	84.5
52	10/25/2005 11:17:35		109	239.7	103	287.6	96	139.7	92	303	11	232.1	67	232.3	93	206.8	109	129.4	75.14	163.4	85	208.7
53	10/25/2005 11:17:36		80	359.3	48	248.2	120	291.4	109	258.4	144	215.7	125	136	156	141	198	71.7	100.7	75.62	14	149.7
54	10/25/2005 11:17:37		121	279.5	108	356.3	125	302.9	108	254.4	52	150	284	177	122	168.1	48	166.8	45.54	171.2	43	176
55	10/25/2005 11:17:38		291	226.8	121	189.1	278	293.3	330	226.5	120	198.4	197	229.7	193	151.2	94	120.1	38.92	222.9	134	265.7
56	10/25/2005 11:17:39		305	241.4	47	271.2	26	72.3	143	191.7	135	163.2	181	182.5	113	161.9	201	92.6	55.17	133.5	138	241
57	10/25/2005 11:17:40		209	186	121	210.8	117	9.4	146	205.2	104	271.1	216	250.2	211	174	187	171.1	92.76	168.8	8	66.8
58	10/25/2005 11:17:41		230	224.5	302	207.8	143	172	132	164.2	206	252.4	32	53.8	121	188.5	238	223.5	170.6	216.3	109	200.4
59	10/25/2005 11:17:42		84	171.8	35	207.3	62	248.4	95	209.8	197	168	240	156.6	142	192.6	128	157	107.8	145.2	94	128.9
60	10/25/2005 11:17:43		139	162.9	182	139.5	125	186.9	88	352.8	126	87.3	82	94.2	108	201.1	134	106	75.8	171.7	156	223.4

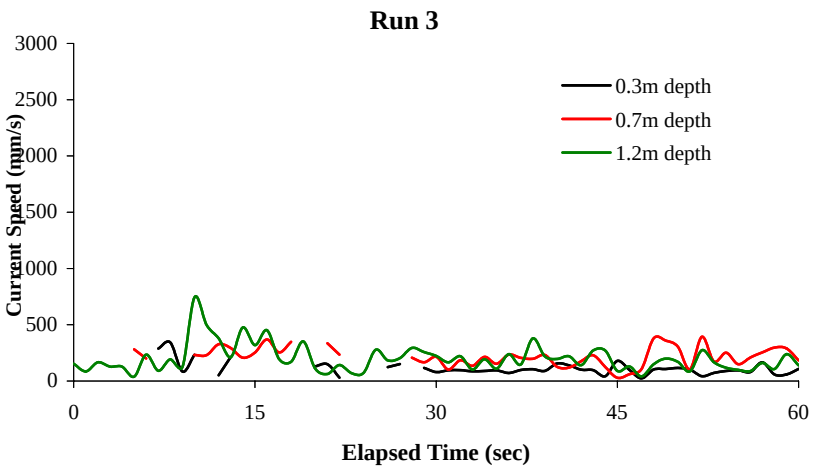
Fox River Propwash Study - Moving Vessel Trials

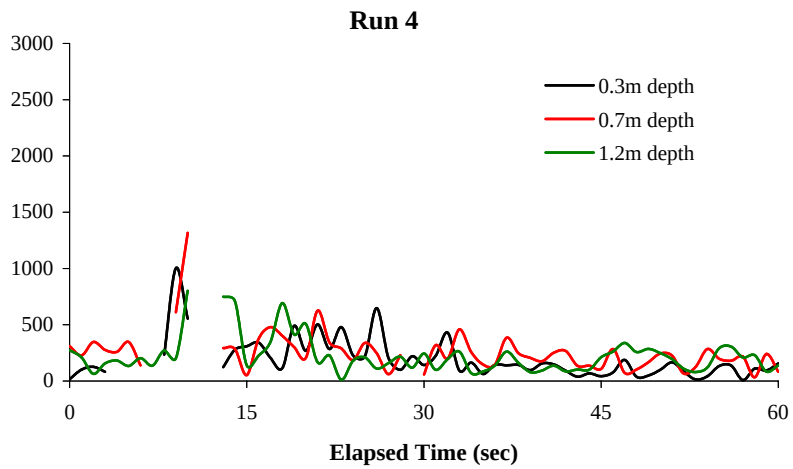
Test #12: Single-Prop Vessel - 25% Throttle Startup -Pitch Down 2

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Thirteen

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:22:20		165	87.6	76	301.6	140	7.4	173	351.7	114	283.7	130	270.9	90	259.8	33	48.7	63.05	92.27	105	105
1	10/25/2005 11:22:21		54	74.9	70	236.1	33	195.7	44	169.5	2	0	202	6.8	96	1.8	75	339.6	123	181.4	67	202
2	10/25/2005 11:22:22		145	48.9	58	95.9	140	8.2	145	302	19	212	75	138.2	159	212.7	35	55.4	199.4	226.2	157	215.9
3	10/25/2005 11:22:23		15	246.8	98	205.3	148	205.7	53	284.3	144	308.8	12	94.8	96	189.6	53	193	229.4	206.1	13	198.4
4	10/25/2005 11:22:24		96	91.2	89	214	113	171.4	36	287.9	195	299.5	11	41.2	69	279.2	229	239.6	277.6	318.2	97	257.5
5	10/25/2005 11:22:25		45	338	148	348.3	88	143.8	80	202.1	26	300.6	98	96.5	101	295.8	74	203.8	39.92	247.9	58	170
6	10/25/2005 11:22:26		82	358.6	51	114.5	79	89.3	54	40.5	81	260.1	129	269.1	21	286.7	26	119.5	26.93	148.7	33	171.4
7	10/25/2005 11:22:27		125	75.2	77	113.6	69	208.4	141	237.8	149	291.7	202	338.8	23	25.5	107	316.9	34.01	245.7	107	174.1
8	10/25/2005 11:22:28		79	47	19	21.3	87	337.8	69	233.3	47	283.4	23	167.2	26	342.3	150	85.4	79.34	98.33	36	168.7
9	10/25/2005 11:22:29		122	128.4	41	84.4	71	138.4	72	10.4	77	52.4	91	190.1	85	57.1	95	86.4	13.15	98.75	37	133.9
10	10/25/2005 11:22:30		18	146.3	91	41	100	63.9	272	42.9	158	75	310	82.4	700	101.5			4618	168.2		
11	10/25/2005 11:22:31																					
12	10/25/2005 11:22:32																					
13	10/25/2005 11:22:33				684	224	724	205.3	862	255												
14	10/25/2005 11:22:34		611	250.1	784	258.7	689	264.7	640	260.7	513	236.7	569	244.6	475	244.6	485	270.5	531	270.2	420	280.6
15	10/25/2005 11:22:35		769	233.1	1132	222.5	1042	237.8	773	261	951	254.1	815	242.6	687	248.9	524	239.5	605.5	243.7	438	256.9
16	10/25/2005 11:22:36		793	269	914	255.4	941	244	1176	243.2	1296	247.6	934	253.1	468	261.9	526	261.7	447.3	255.5	487	260.2
17	10/25/2005 11:22:37		324	294.3	620	291.4	614	295.1	574	281.3	480	286.3	722	299.8	705	309.5	433	293.1	259.6	350.5	256	2.7
18	10/25/2005 11:22:38		465	240.2	541	263.2	639	296	522	262.5	670	223	1015	208.7	836	232	535	244.4	87.56	193.9	85	277.5
19	10/25/2005 11:22:39		150	238.1	153	296.1	87	236.3	286	207.3	521	208.3	481	191	406	212.1	467	219.6	349.4	215.9	260	274.2
20	10/25/2005 11:22:41		486	219.2	418	251.3	495	213.8	399	205.1	594	165.9	464	189.8	447	202.8	452	183.2	249.6	256.8	520	253.5
21	10/25/2005 11:22:42		328	194.7	317	239.1	432	226.6	465	213.6	478	179.4	498	163.9	602	157.7	575	154.5	289	179.6	116	95.5
22	10/25/2005 11:22:43		300	214.5	350	189.2	450	199.3	902	173.5	852	185.5	613	186.2	863	172.7	479	203.6	255.2	251.5	11	264.8
23	10/25/2005 11:22:44		469	224.6	453	208.3	342	197.9	614	228.7	992	222.7	411	198	341	161.9	305	217.1	250.6	217.1	312	250.8
24	10/25/2005 11:22:45		292	229.2	214	206.7	306	219	480	232.8	484	246	15	101.3	132	211	251	246.3	216.9	187.7	42	358.6
25	10/25/2005 11:22:46				180	186.1	227	212.6	150	191.5	374	217.4			286	220.3	295	212.6	380.1	268.6	269	265.3
26	10/25/2005 11:22:47		206	219.5	434	237.9	351	250.5	466	240	556	285.7	507	276.6	509	275.4	310	285.5	227.2	249.7	69	133.2
27	10/25/2005 11:22:48		355	263.7	326	283.8	401	255.9	443	269.5	408	281.9	323	286	297	265.2	266	300	86.83	308.5	152	105.7
28	10/25/2005 11:22:49		109	243.2	280	241.4	388	255.7	313	276.4	361	279.9	487	284.9	413	309.4	268	336.2	210.6	342.6	83	151.9
29	10/25/2005 11:22:50		137	100.9	125	169.4	195	261.2	248	257.4	295	204.2	272	267.9	350	300.4	216	320.3	141.6	259	121	237.5
30	10/25/2005 11:22:51		129	216.2	220	257.1	316	210.4	297	230.2	362	225.7	286	240.2	344	255.2	417	256.7	11.18	280.3	59	73.1
31	10/25/2005 11:22:52		220	159.5	347	167.2	292	201.3	178	199	381	179.2	335	218.1	211	237.2	245	270.5	77.82	205.9	130	248.8
32	10/25/2005 11:22:53		303	240.3	220	219.1	419	213	507	203.2	440	196.2	437	199.2	205	237.9	135	290.3	228	0.251	61	77.8
33	10/25/2005 11:22:54		243	181.7	239	161.5	447	166.2	261	194	278	203.3	129	188.9	34	166.4	229	108.4	185.4	116.1	147	128.1
34	10/25/2005 11:22:55		165	205.5	290	171.3	380	226.4	303	248.5	219	236.2	187	138.5	101	190.9	30	84.3	406.6	154.5	51	264.4
35	10/25/2005 11:22:56		150	247.2	216	209.1	330	199.6	357	221.8	322	240.7	285	218.3	62	284	153	75.2	343.7	174.3	79	116.2
36	10/25/2005 11:22:57		307	238.8	272	249.3	106	212.6	244	211.1	153	190.9	67	339.9	87	64	198	87.1	175	67.32	177	45
37	10/25/2005 11:22:58		89	216.7	299	163.5	226	211.4	263	160.3	182	150.8	93	161.2	192	183.3	153	222.9	50.82	293.8	153	4.1
38	10/25/2005 11:22:59		142	207.6	287	242.6	168	173.2	143	212.7	179	143.4	309	115.5	133	85.3	343	84.1	290.4	123.2	195	69.6
39	10/25/2005 11:23:00		203	236.2	234	236.9	212	159.3	273	120.3	167	73.6	303	99.9	166	137.2	156	22.3	197.9	97.84	100	352
40	10/25/2005 11:23:01		223	228.5	179	221.2	159	194.6	90	308.7	161	92.1	116	64.5	163	95.3	150	66.3	234.7	109.7	72	23
41	10/25/2005 11:23:02		110	257.4	111	241.3	141	269.2	168	263.5	139	146.4	81	105.1	100	349	103	148.9	132.2	44.08	248	45.7
42	10/25/2005 11:23:03		160	210.9	129	202.8	246	171.8	60	174.3	208	114.5	93	128	256	100.3	302	88.1	416.6	138.7	274	67.7
43	10/25/2005 11:23:04		16	176.4	29	142	90	95.7	85	171.9	112	277.2	33	122.7	119	131.6	279	136.6	101.8	45.8	146	82.1
44	10/25/2005 11:23:05		142	188.5	119	188.2	152	134.2	114	188.1	51	113.1	218	117.9	301	93.2	130	49.7	61.4	16.07	42	188.1
45	10/25/2005 11:23:06		175	172.1	115	80	132	115	72	59.9	155	97	266	90.6	302	90.2	231	77.2	60.41	250.7	57	192.1
46	10/25/2005 11:23:07		52	228.1	109	87.4	95	167.3	49	266.5	184	115.7	166	98.3	136	90.8	151	43.7	129.6	144.1	179	190.6
47	10/25/2005 11:23:08		76	143.6	68	185.9	30	15.4	121	54.1	220	59.1	126	85	110	51.3	105	98.7	63.16	23.32	105	94.9
48	10/25/2005 11:23:09		131	89.6	17	260	267	2.1	105	341	157	38.5	30	222.3	219	1.3	134	47.4	47.17	274.9	132	71.4
49	10/25/2005 11:23:10		15	317.7	69	26.6	44	84.8	13	67.4	170	355.6	45	62.3	180	5.7	83	359.3	87.66	122.4	179	57.1
50	10/25/2005 11:23:11		21	81.9	62	201.6	166	307.1	145	243.8	24	82.9	131	51.2	76	130.2	157	71.4	111.9	108.8	116	329.5
51	10/25/2005 11:23:12		41	45	55	112.4	103	167	222	254.8	53	62	39	39.8	30	129.6	108	168.3	182	242.9	233	267.3
52	10/25/2005 11:23:13		81	185.6	21	238.6	124	165.5	33	280.6	52	177.8	52	75.4	114	243.4	94	137.2	85.71	352.6	65	325.6
53	10/25/2005 11:23:14		143	93.6	139	102.8	80	90	132	263.9	90	230.8	104	357.2	43	193.4	91	104	27.23	262.6	143	276
54	10/25/2005 11:23:15		28	188.1	149	152.1	65	157.4	103	223	153	171.3	167	125.5	98	220	137	277.5	250.1	254.5	124	216.1
55	10/25/2005 11:23:16		91	134.1	146	107.9	103	214.8	122	112.2	155	94.1	147	124.4	153	127.8	122	347.7	115.4	340.8	41	247.2
56	10/25/2005 11:23:17		120	130.6	230	99.3	50	134.2	118	138.8	177	140	206	116.6	24	355.2	35	355.1	39.25	55.91	69	82.5
57	10/25/2005 11:23:18		92	162.3	129	138.8	304	144.2	75	116.2	139	134.7	60	124.8	78	107	32	81.1	21.84	285.9	16	243.4
58	10/25/2005 11:23:19		67	116.6	95	196.5			80	192.3	228	190.9	46	40.6	38	319.2	94	61.5	5.099	101.3	53	334.4
59	10/25/2005 11:23:20		31	93.7	197	115.9	45	281.6	51	25.6	80	265.7	110	199.1	38	144.6	40	75.6	81.84	231.4	93	138.9
60	10/25/2005 11:23:21		52	40.4	85	122.9	345	147.9	120	227.4	76	297.2	97	234.2	45	164.4	3	161.6	112.9	292.9	13	222

Lower Fox River Moving Vessel Trials
Test Thirteen

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:29:24		114	111.6	127	122.4	80	162.5	154	198.2	175	215.2	59	251.3	138	215	102	66.2	90.14	19.44	33	155
1	10/25/2005 11:29:25		352	85.3	114	106.8	19	90	52	225.8	197	119.2	26	90	162	253.1	45	146	145.8	206.9	6	161.6
2	10/25/2005 11:29:26		228	131.4	174	111.3	139	177.9	135	69.7	72	137.2	194	96.8	149	112.1	31	80.8	155	53.13	85	92.7
3	10/25/2005 11:29:27		65	133.8	86	70.9	187	256.4	68	260.7	39	98.7	124	98.8	84	238.2	117	213.1	201.3	141.3	99	210.2
4	10/25/2005 11:29:28		69	226.2	97	303.7	12	270	106	115.6	160	101.9	94	112.5	125	94.6	39	97.3	34.06	229.8	99	246.8
5	10/25/2005 11:29:29		281	67.8	118	138.4	113	94.6	113	215.2	95	77.3	68	123	56	81.7	73	108.4	138	66.96	33	307.6
6	10/25/2005 11:29:30		129	29.1	66	116.2	120	147.9	138	103	100	195.7	76	95.3	40	317	96	141.3	185.1	155.9	106	120.7
7	10/25/2005 11:29:31		132	86.5	158	146.9	58	105.9	92	181.9	114	164.3	34	34.2	57	196.2	46	142.9	40.08	93.58	61	58.4
8	10/25/2005 11:29:32		77	122.9	109	25.6	88	182	4	90	102	163.5	114	105.3	23	37.9	47	35.4	30.04	177.1	101	193.8
9	10/25/2005 11:29:33		120	74.6	177	105.8	159	87.5	45	125.1	117	127.4	74	157.6	98	150.8	104	334.9	70.72	133.9	79	95.1
10	10/25/2005 11:29:34		134	109.1	174	118	32	84.6	197	269.4	69	306.7	50	354.3	135	238.7	40	51.1	142.8	241.1	128	217
11	10/25/2005 11:29:35		211	91.4	127	53.3	129	104.8	89	127.3	68	175.8	47	128.1	84	25.3	129	66.6	462.2	1.736	36	263.7
12	10/25/2005 11:29:36		299	79	114	103.7	133	54.8	159	109.5	22	30.1	148	96.6	299	125.6	696	90.9	1406	86.29	2119	84.8
13	10/25/2005 11:29:37				949	279.5			468	152.1												
14	10/25/2005 11:29:38		1127	193																		
15	10/25/2005 11:29:39		729	245.4	654	223.2			219	235.6												
16	10/25/2005 11:29:40		472	198.1	315	69.4	80	344.7	415	293	310	234.1	305	209.3	214	200.6	193	274.5	74.73	102.4	241	280
17	10/25/2005 11:29:41		389	253.3	494	303.9	489	298.5	316	291.7	403	320.9	195	187.1	295	204.7	43	51.5	71.85	351.2	308	309.2
18	10/25/2005 11:29:42		286	297.5	388	343.2	576	317.5	515	297.9	383	241	459	260.7	322	258.9	122	82.5	53.23	334.4	315	349.9
19	10/25/2005 11:29:43		300	263.9	695	271.2	704	259.1	598	260.1	485	286	467	256.5	704	262.7	803	267.2	448.2	252.7	165	293.9
20	10/25/2005 11:29:44		308	249.7	534	240	577	236.3	885	233.4	987	233.6	1069	236.7	904	245.8	700	245.4	749.8	217.4	111	273.1
21	10/25/2005 11:29:45		566	213	820	214.8	734	207.8	661	215.6	752	271.8	813	278.5	778	277.4	498	265.5	443.8	252.8	450	293.3
22	10/25/2005 11:29:46		260	183.8	588	203.3	422	183.9	317	218.6	613	249.3	667	251.6	697	251.4	455	260.8	542.1	211.3	494	268.5
23	10/25/2005 11:29:47		498	182.8	294	211.4	252	189.6	304	242.6	483	256.5	439	267.4	562	258	513	266.4	467.5	272.6	356	295.3
24	10/25/2005 11:29:48		481	216.2	419	255.2	292	242.2	303	244.8	294	253	145	252.7	425	202.8	524	205.2	255.4	183.1	270	300.5
25	10/25/2005 11:29:49		313	220.2	260	232.5	265	220.6	249	217.3	46	193.7	144	187.2	288	228.5	279	196.9	274.7	332.2	190	326.1
26	10/25/2005 11:29:50		239	222.1	424	199.1	223	236.2	237	283.2	115	192.1	263	158.6	237	211.9	304	234.8	555.2	298.3	420	265.2
27	10/25/2005 11:29:51		270	276.8	201	246	322	261.4	273	250.1	25	205.6	192	273.9	238	241.6	281	250.9	371.8	245.4	490	260.4
28	10/25/2005 11:29:52		181	229.3	142	265.6	263	240.4	384	253.2	276	225.9	260	189.5	75	199.4	136	266.2	300.1	244.1	114	283.2
29	10/25/2005 11:29:53		354	269.2	189	256.6	56	208.9	74	173	107	195.7	137	182.9	20	284.7	25	158.6	72.44	186.3	145	223
30	10/25/2005 11:29:54		132	240.9	451	212	310	205.2	174	181.6	155	236.3	232	233.8	230	166.9	188	130.9	87.28	18.02	36	298
31	10/25/2005 11:29:55		428	210	299	251.9	289	212	180	188.6	296	188.7	168	234.7	58	107.2	51	83.3	323.1	208.5	48	291.8
32	10/25/2005 11:29:56		194	199.6	166	246.2	59	156	112	70.8	88	133.6	108	203.5	228	141.4	251	160	65.3	62.65	36	347.1
33	10/25/2005 11:29:57		341	163.1	28	288.4	118	197.2	56	84.9	64	215.4	105	171.3	212	151.3	222	181	370.8	222.8	197	219
34	10/25/2005 11:29:58		66	155.8	217	126.6	92	80	53	285.4	242	334.5	41	281.3	97	166.3	43	77.9	62.37	192	191	268.2
35	10/25/2005 11:29:59		87	246.4	52	342.3	114	292.7	119	318.4	241	313	177	208.3	183	89.4	191	72.6	262.6	335	131	334.2
36	10/25/2005 11:30:00		77	297.9	238	262.8	27	293.7	160	310.7	101	292	137	217.3	447	230.9	189	253.1	362.2	258.5	244	245.8
37	10/25/2005 11:30:01		199	262.2	277	239.2	299	265.8	272	274.6	128	271.3	285	238.8	294	251.1	385	243.3	244.8	252.9	198	276.1
38	10/25/2005 11:30:02		331	221.9	502	207.3	288	218.9	91	263.7	99	254.1	308	227	323	231.8	190	230.8	20.62	309.1	144	352.4
39	10/25/2005 11:30:03		209	192.2	170	224.5	161	244.7	178	243.3	280	218.9	462	245.7	334	237	277	239.9	165.3	235.3	105	224.2
40	10/25/2005 11:30:04		150	262	151	208.1	217	217.7	239	260.9	212	238.1	220	237.8	125	232.1	111	241.3	56.82	331.6	9	234.5
41	10/25/2005 11:30:05		162	238.9	248	231.2	245	278.7	323	267.5	377	285.4	351	293	320	270.2	181	239.5	162.1	263.3	69	287.7
42	10/25/2005 11:30:06		197	251.9	209	239.9	162	260.1	370	262.9	261	216.9	145	250.7	115	283.6	145	268.4	289	254.1	191	270.6
43	10/25/2005 11:30:07		379	253.1	373	263.8	277	246.4	222	258.3	277	254.9	363	266	417	282.2	262	263.4	285.7	225.6	55	306.9
44	10/25/2005 11:30:08		181	263	198	252.9	236	248.9	213	277	167	243	185	270.9	238	246.8	128	252.7	170.7	175	134	204.3
45	10/25/2005 11:30:09		74	246.2	94	269.4	235	260.9	194	311.2	112	230.1	185	216.4	308	226.8	266	221.8	205.4	228.2	211	230.6
46	10/25/2005 11:30:10		211	103.4	108	76.6	35	284.8	112	219.5	181	261.7	145	259.2	135	287.2	135	218.4	122.2	356.7	154	46.6
47	10/25/2005 11:30:11		25	58.2	132	115	68	142.1	51	209.6	176	288.8	46	220.6	241	210.9	142	116.4	75.8	121	186	76.3
48	10/25/2005 11:30:12		45	114.9	185	126.2	53	93.2	100	225.4	110	300.5	114	308.6	133	329.2	64	170.1	152.1	328.7	130	316.9
49	10/25/2005 11:30:13		144	121.4	153	24.7	27	48	75	208.6	98	224.2	61	332.6	99	89.4	97	140.9	262.7	193.9	65	313.8
50	10/25/2005 11:30:14		165	35.1	134	354	8	7.1	162	313.2	28	309.3	103	204.1	128	185.8	271	167.4	482.8	158.1	107	57.2
51	10/25/2005 11:30:15		97	285.6	135	289.9	24	277.1	62	348.9	17	211	24	209.7	121	219	180	191.6	190.4	162.9	94	40.7
52	10/25/2005 11:30:16		165	343.1	103	240.2	152	211.3	83	149.7	87	134.5	40	141.1	78	230.2	138	209	134.5	218.7	254	263.9
53	10/25/2005 11:30:17		154	274.5	115	334.8	109	258.9	67	308.9	90	176.8	71	179.2	133	246.5	32	20.1	298.7	333.8	70	36.9
54	10/25/2005 11:30:18		151	276.5	38	114.6	171	237.1	136	252.5	91	157.4	182	226.6	136	173.7	143	244.3	87.32	249.9	22	35.8
55	10/25/2005 11:30:19		116	3.9	57	63	76	151.8	103	90	101	179.4	116	120.1	104	94.4	51	23.1	233.1	331.6	73	85.3
56	10/25/2005 11:30:20		271	277.9	58	232	98	167.7	77	225.5	154	232.4	191	166.7	43	56.3	84	175.2	159	179.6	100	227.8
57	10/25/2005 11:30:21		244	270	61	286.1	90	61.4	129	15.8	126	172.3	157	112.1	22	206.6	207	140.1	77.16	198.9	95	171.5
58	10/25/2005 11:30:22		229	74.6	188	82.6	202	108.8	97	100.7	202	119.7	219	96.3	133	104.8	192	63.4	368.9	38.17	288	72.2
59	10/25/2005 11:30:23		96	88.8	102	89.4	146	55	55	100.5	98	235.8	80	62.5	30	352.4	131	70.9	340.5	31.92	71	53.6
60	10/25/2005 11:30:24		23	28.8	50	49	150	308.2	40	331.5	112	178	223	104.8	364	78.3	286	13.9	273.4	78.61	145	43

Lower Fox River Moving Vessel Trials
Test Thirteen

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:32:06		145	18.4	24	170.5	62	233.5	95	227.6	71	253.6	60	272.9	116	242.3	157	238.5	151.1	165	87	227.3
1	10/25/2005 11:32:07		97	71.4	38	105.1	22	285.9	61	84.4	118	118.3	144	135.3	84	128.2	21	27.8	26	292.6	58	271
2	10/25/2005 11:32:08		94	58	56	98.3	62	143.5	38	340.1	59	78.3	20	49.1	24	165.4	89	175.5	120.1	14.96	84	124.8
3	10/25/2005 11:32:09		66	180.9	160	123.3	164	116.1	162	108	110	196.3	290	159.4	149	72.8	55	188.4	102	271.7	229	254
4	10/25/2005 11:32:10		40	167	63	38	183	168	74	72.8	111	166.5	25	43.4	86	296.3	50	356.6	122.1	267.2	140	226.2
5	10/25/2005 11:32:11		152	63.8	69	200.3	139	17.7	77	145.1	40	88.6	64	203	104	1.1	22	103.4	109.3	8.945	66	205
6	10/25/2005 11:32:12		63	122.7	69	223.2	149	128.5	122	128	67	247.2	167	218.9	40	293.4	56	90	248.6	194.2	118	251.3
7	10/25/2005 11:32:13		199	71.6	79	293	79	354.2	39	122.5	167	152.2	67	261.4	140	66.4	86	110.3	186.6	4.611	72	256.3
8	10/25/2005 11:32:14		135	98.5	74	120.7	121	189.1	143	171.1	30	45	94	91.2	58	325.5	63	322	21.71	165.3	105	151.5
9	10/25/2005 11:32:15		188	78	154	75.7	52	22.6	114	171.9	115	244.3	142	213.2	89	305.8	60	178.1	119.4	117.4	117	156.9
10	10/25/2005 11:32:16		57	139.9	112	253.3	126	200	166	200.8	210	240.9	69	125.5	89	184.5	18	209.4	146.4	226.4	268	227.3
11	10/25/2005 11:32:17		144	43	122	44	189	54.5	194	58.3	172	73.5	174	36.3	904	95.2	1564	105.3	3711	85.63		
12	10/25/2005 11:32:18																					
13	10/25/2005 11:32:19																					
14	10/25/2005 11:32:20		1041	286.6	980	283.5																
15	10/25/2005 11:32:21		903	241.8	666	236.7	386	201.1	527	193.8	425	227.9	368	230.1	188	251.7	79	106.1	115.1	198.7	158	211.8
16	10/25/2005 11:32:22		562	206.4	390	206.2	278	209.5	200	201.1	204	307.4	244	244	207	43.6	102	95.6	215	105.7	248	23.3
17	10/25/2005 11:32:23		342	252.8	441	266.5	531	262.5	497	272.2	722	277.6	638	267.5	499	279.1	472	305.1	461.2	336.2	691	315.3
18	10/25/2005 11:32:24		903	259.1	879	258.3	1102	262.9	1099	259.5	952	262.2	869	265.8	609	243.6	472	263.4	394.3	238.2	510	307.8
19	10/25/2005 11:32:25		371	248.1	529	238.7	623	250.9	446	239.7	554	278.8	622	250.7	425	244	386	230.2	552	219.5	1021	263.4
20	10/25/2005 11:32:26		601	239.5	571	248.9	612	231.2	595	213.7	636	208.7	493	211.4	268	200.1	573	206.7	588.2	195.8	304	244.7
21	10/25/2005 11:32:27		454	237.2	491	237.2	668	214.1	568	216.6	375	187.5	193	247.2	397	205	507	211.2	601	174.3	127	270.5
22	10/25/2005 11:32:28		290	151.4	257	225.5	392	259.1	453	270.6	67	305.3	329	155	379	153.7	500	182.6	580.2	193.6	60	60
23	10/25/2005 11:32:29		301	115.2	122	180.9	191	119.5	141	135.6	173	356.7	258	21.1	89	112.5	299	180.4	578.5	157.6	501	68.1
24	10/25/2005 11:32:30		106	68.5	80	185.7	208	113.5	134	47.7	171	102.8	106	79.1	181	139.3	448	178.1	183.3	176.6	221	265.3
25	10/25/2005 11:32:31		238	237.5	62	137.6	179	357.1	184	356.3	50	341.2	155	270.4	263	258.6	111	196.8	155.4	158.9	182	269.4
26	10/25/2005 11:32:32		384	306.1	183	305.4	268	288.2	333	255.9	303	255.9	269	280.1	213	300.2	371	279.9	328.6	210.5	142	101
27	10/25/2005 11:32:33		675	264.7	586	246.1	553	249	530	231.7	434	240.8	384	224.3	179	243.4	139	288.8	240	233.1	89	194.3
28	10/25/2005 11:32:34		469	266.2	509	273.6	517	276.1	494	309.3	336	278.6	372	281	311	279.6	178	20.4	227.1	313	124	304.8
29	10/25/2005 11:32:35		185	271.5	160	232.1	381	280.1	512	296.2	461	310.3	434	316.8	473	311	549	320.8	305.8	322.3	340	29.4
30	10/25/2005 11:32:36		452	235.8	219	248.3	304	256.1	335	273.1	537	270.7	547	282.5	453	285.1	479	285.5	460.8	299.5	350	284.7
31	10/25/2005 11:32:37		456	231.1	393	209	248	220.8	223	266.9	252	288.3	334	275.7	411	264.8	364	256.7	510.9	319.8	33	14
32	10/25/2005 11:32:38		416	230.5	349	230.3	259	231.9	315	229.9	230	247.5	400	256.6	258	239	172	283.5	545.6	285.4	225	295.8
33	10/25/2005 11:32:39		238	184.8	441	193.6	374	232.6	254	224.2	327	228.5	360	264.7	337	244.9	259	270	392.8	295	294	257
34	10/25/2005 11:32:40		302	223	370	219.1	408	226.3	408	226.3	192	242.8	349	289.1	406	297.8	375	281.5	284	297.5	109	327.8
35	10/25/2005 11:32:41		315	209.5	372	200.6	310	219.4	315	244.8	151	228	181	262.4	286	246.7	112	256.6	296.3	225.4	296	270.6
36	10/25/2005 11:32:42		194	220.2	250	205.8	322	181.2	239	212.9	202	278.5	75	209.6	176	238	153	264.4	159.4	274	116	82.1
37	10/25/2005 11:32:43		325	223.1	226	196.2	149	249.6	148	234.4	123	238	162	224.7	276	253.3	253	271.1	255.1	181.6	20	2.9
38	10/25/2005 11:32:44		264	219.8	161	231.6	168	272.4	125	223	238	223.6	222	246.3	437	255.4	313	281.2	199.7	260.5	194	279.5
39	10/25/2005 11:32:45		185	220	163	203.9	107	207.8	260	223.6	130	261.6	196	273.5	231	275.7	159	286.5	382.7	245.8	370	248.1
40	10/25/2005 11:32:46		234	245.3	315	237.6	180	226.1	143	252.5	157	229.1	200	257.6	121	304.6	214	285.1	177.2	229.1	101	98.5
41	10/25/2005 11:32:47		211	235.3	292	219.3	197	198.6	146	294.3	94	9.2	137	203.2	209	239.1	356	297.6	222.9	260.7	207	286.2
42	10/25/2005 11:32:48		128	161.3	57	125.1	118	236.4	99	245.5	66	127.6	49	278.3	189	294.7	299	298.1	329.4	193	114	261.9
43	10/25/2005 11:32:49		190	187.9	27	126	111	282.5	140	246.9	110	235	147	283.8	131	244.6	243	266.9	43.05	272.7	41	272.8
44	10/25/2005 11:32:50		218	136.9	209	144.9	211	147.4	333	179.3	345	198.2	280	217.9	262	200.8	370	232.4	447.8	233.1	163	224.5
45	10/25/2005 11:32:51		240	143.8	235	134.3	217	150.5	267	173.1	260	194.7	327	218.6	48	279.7	25	229.9	234	179	46	102.5
46	10/25/2005 11:32:52		144	144.3	294	158.9	322	145.6	437	158.1	303	176	302	195	241	217.6	201	249	285	199.9	43	307.4
47	10/25/2005 11:32:53		175	134.8	256	150.5	104	92.8	243	166.4	370	161.2	248	180.2	195	217.5	109	252.4	181.7	275.1	235	205.5
48	10/25/2005 11:32:54		189	189.5	518	171.8	251	156.8	179	137.9	178	166	255	173.9	308	207.2	259	165.7	220.5	196.9	91	77.3
49	10/25/2005 11:32:55		119	151.9	100	124.8	262	92.6	164	123.8	163	207	285	171.7	205	177.8	291	110.5	53.71	155.8	205	58.2
50	10/25/2005 11:32:56		116	188.9	123	85.4	167	111.8	68	179.2	143	129	184	163.6	289	133.5	212	192.3	198	179.7	69	234.5
51	10/25/2005 11:32:57		40	237.1	140	194.9	14	94.1	184	203.6	222	208.5	243	180.2	135	144.7	94	163.9	51.74	48.92	63	32.7
52	10/25/2005 11:32:58		56	69	250	22.4	92	346.1	250	182.1	210	205.1	131	255.4	120	217.5	263	204.7	279.5	209.6	129	221.2
53	10/25/2005 11:32:59		86	84.7	112	107.6	203	197.5	204	183.4	66	180	232	62.6	65	14.3	113	108.1	107.4	327.9	19	195.5
54	10/25/2005 11:33:00		157	109.7	215	259.5	215	235.8	73	86.9	33	190.6	106	28	81	37	99	357.1	64.85	63.43	172	80.6
55	10/25/2005 11:33:01		147	162.2	100	118.6	175	200.4	220	227.4	71	197.9	49	336	93	1.8	167	123.8	108.5	325.1	178	275.5
56	10/25/2005 11:33:02		321	359.3	179	124	213	168.6	183	174.4	207	166.6	123	176.7	139	165.5	58	205.7	91.78	168.7	89	201.1
57	10/25/2005 11:33:03		240	190.1					185	196.3	120	188.1	89	135	224	69.4	184	152.9	71.7	140.1	70	225.6
58	10/25/2005 11:33:04		238	133.1			144	234.3	45	176.2	168	109.8	253	117.6	143	104.1	43	69.4	85.44	196.3	101	195.6
59	10/25/2005 11:33:05		251	129.5			66	256.8	85	157.9	28	242.5	123	3.7	121	339.8	27	96.3	299.5	191.9	181	183.5
60	10/25/2005 11:33:06		440	153.4			260	245.2	167	289.6	117	200.4	112	81.8	87	64.9	99	40.5	171.3	154.8	133	97.8

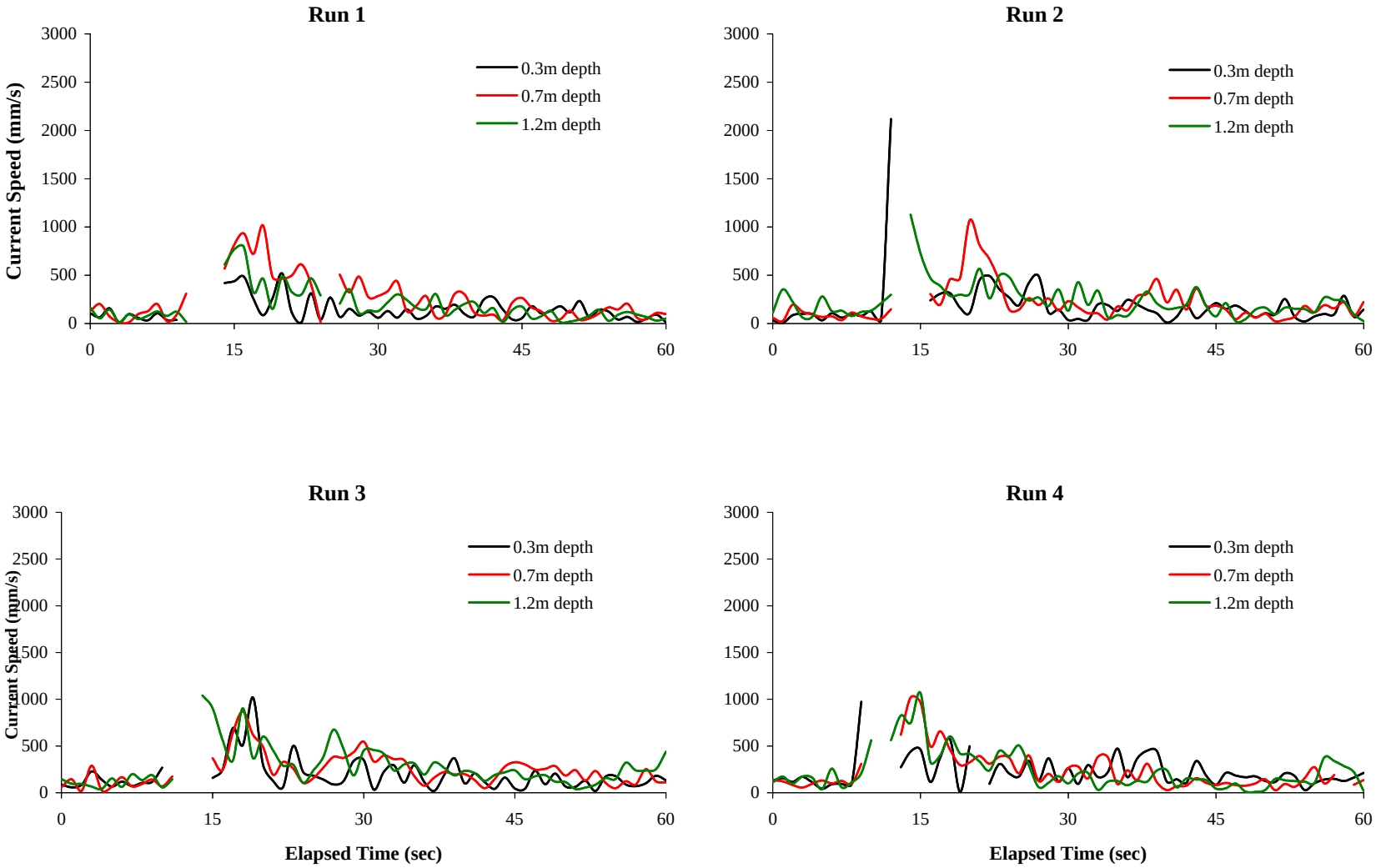
Lower Fox River Moving Vessel Trials
Test Thirteen

Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 11:34:26		111	104.7	67	68	94	118.5	123	71.6	161	165.3	133	125.5	57	170.9	90	126	194.8	189.8	130	133.1
1	10/25/2005 11:34:27		172	272	197	43.2	67	56.5	159	108.3	133	114.4	123	179.5	121	171	106	147.4	234	89.51	157	161.4
2	10/25/2005 11:34:28		97	121.1	81	20.2	117	118.1	64	120.2	99	109.5	83	206.6	67	147.7	107	254.3	155.4	338.9	115	248.1
3	10/25/2005 11:34:29		173	91.7	252	105.2	133	205.8	126	173.2	179	155.3	55	317.9	51	165.1	154	154.3	187.4	206.3	170	179
4	10/25/2005 11:34:30		162	123.7	161	95	64	275.4	192	223.7	68	242.7	95	190.4	160	215.9	116	240.6	71.59	282.1	113	233.6
5	10/25/2005 11:34:31		37	183.1	332	86.2	178	94.2	115	188	116	88	131	90	194	146.6	139	188.7	81.3	175.1	43	125.5
6	10/25/2005 11:34:32		259	91.5	227	63.5	80	354.3	142	199.7	106	169.1	100	143.1	142	297.3	236	272.2	113.9	226.1	91	99.5
7	10/25/2005 11:34:33		57	17.5	175	81.8	159	111.7	68	279.3	120	213.8	127	154.8	83	197.6	53	272.2	31.89	131.2	96	52.7
8	10/25/2005 11:34:34		112	68.5	210	44	135	125.9	147	138.6	132	115	95	105.2	127	161.7	66	106.8	177.3	14.04	93	98.7
9	10/25/2005 11:34:35		210	48.3	190	63.7	115	73.3	132	53.3	239	57	310	60.2	152	65.5	69	357.5	262.2	238.2	974	84.6
10	10/25/2005 11:34:36		561	284																		
11	10/25/2005 11:34:37																					
12	10/25/2005 11:34:38		563	290.9	1040	277.9																
13	10/25/2005 11:34:39		827	320.8	508	297.7	805	270.9	819	268.1	594	259.2	621	267.8	358	246.8	414	281.3	253.7	278.4	272	323.7
14	10/25/2005 11:34:40		747	271.3	1136	263.5	1332	260.8	1459	257.8	1271	267.3	1019	265.8	1044	254	785	258.8	600.1	259	439	253.2
15	10/25/2005 11:34:41		1068	281.6	1028	273.1	714	278.9	1243	281.3	1346	274.1	965	281.8	679	253.2	627	255.3	469.5	274.6	462	274.3
16	10/25/2005 11:34:42		328	357.2	527	276.8	650	290.4	588	283.7	345	258.1	497	225.1	397	198.7	386	205	279.9	256.4	116	325.9
17	10/25/2005 11:34:43		399	214.3	805	237.4	727	238.3	407	252.4	534	228.6	658	215	370	231	123	116.6	201.9	219	375	315.4
18	10/25/2005 11:34:44		604	258.4	649	251.5	815	224.2	668	221.7	227	202.3	459	145.9	339	163	178	186.4	230.9	219.6	570	293.9
19	10/25/2005 11:34:45		421	275.3	268	252.6	238	255.1	198	188.7	313	128.1	297	122.8	327	139.3	432	159.1	291.7	155.3	10	106.7
20	10/25/2005 11:34:46		417	242.8	240	247.7	99	267.1	352	143.6	314	144.3	325	164.6	316	209	356	204.6	339.3	202.7	498	335.3
21	10/25/2005 11:34:47		332	241.2	312	259.1	118	299	187	332.3	289	180	393	187.9	385	205.9	230	211.1	230.2	211.1		
22	10/25/2005 11:34:48		238	268.6	321	268.2	278	227.5	240	218.7	322	194.6	309	194.8	292	170.3	137	182.1	113.1	170.3	96	153.4
23	10/25/2005 11:34:49		448	235.6	412	255	341	221.1	337	201.2	305	192.5	386	196.2	310	200.2	93	352.6	414.6	193	307	105.9
24	10/25/2005 11:34:50		392	271	441	259	482	247.8	330	274.9	149	170.3	374	143.4	475	211	524	207	304.1	226.2	206	282.9
25	10/25/2005 11:34:51		506	270.6	358	251.1	290	264.1	154	241.8	236	247.6	208	115.6	589	178	282	216.8	352.6	204.5	173	276.6
26	10/25/2005 11:34:52		294	255	278	239	285	248.2	263	264.3	325	192.5	399	192.9	444	170.8	181	203.2	193.7	229.8	339	287.5
27	10/25/2005 11:34:53		60	100.6	53	285.4	129	299.1	154	259.9	100	295.5	124	162.1	90	230	375	196.4	204.9	308.7	133	255.7
28	10/25/2005 11:34:54		107	170.9	180	18.8	158	274	223	274.1	299	290.6	202	332.5	227	325.8	246	279.1	387.5	272.8	368	251
29	10/25/2005 11:34:55		177	130.4	185	144.2	132	222.5	188	276.7	191	235.6	119	271.9	81	12.1	102	4.5	170	33.97	118	25.7
30	10/25/2005 11:34:56		100	183.4	55	261.6	230	247.6	237	228.9	60	295.7	264	270.9	185	276.8	274	294.8	353.3	296.6	261	300.9
31	10/25/2005 11:34:57		206	104	74	109.7	162	140	52	340.9	221	247.1	281	275.7	225	242.8	221	269	217.2	288.5	94	330.7
32	10/25/2005 11:34:58		213	327.3	83	294.1	88	189.8	183	137.9	64	0.9	153	313.9	321	253.4	199	244.3	222.6	280.4	295	298.7
33	10/25/2005 11:34:59		31	292.5	88	316.8	45	147.7	54	181.1	121	237.1	383	269.7	160	265.3	215	243.2	207.2	276.1	169	237.8
34	10/25/2005 11:35:00		117	344.7	74	43.4	87	164.7	365	259.4	219	252.7	383	273.3	211	271.9	309	258.8	250.3	253.5	217	262.6
35	10/25/2005 11:35:01		125	82.6	121	160.7	148	152.6	324	179.8	84	288	93	272.5	350	260.1	205	245.6	77.41	275.9	473	244.6
36	10/25/2005 11:35:02		80	124.3	165	154.5			33	318.7	50	6.8	240	250.3	220	206.8	83	217.1	254.3	230.4	167	278.6
37	10/25/2005 11:35:03		127	336.3	30	3.8	145	253.9	135	225.9	163	262.3	137	259.9	191	212.2	263	245.5	345.5	253.3	365	223.4
38	10/25/2005 11:35:04		118	115.7	120	149	115	122.6	159	146	181	194.4	311	251.9	249	243.5	281	242.7	354	262.5	449	233.7
39	10/25/2005 11:35:05		239	96.7	101	40.2	86	317.8	132	220.7	92	173.1	113	21.3	86	299.2	295	266.1	284.8	276.5	447	253.9
40	10/25/2005 11:35:06		241	62.8	24	257.7	95	218.2	144	211.9	44	344.1	28	154.4	271	258.7	204	264.4	134.5	304.4	120	167.5
41	10/25/2005 11:35:07		58	192.8	92	251.6	200	282.4	98	315.8	88	194.5	68	336.5	251	285.7	190	252.9	247.2	264.4	144	248.1
42	10/25/2005 11:35:08		152	103.7	16	10.6	86	287.6	41	355.8	75	256.1	75	59.7	25	338.6	157	154.3	247.9	342.1	107	143.8
43	10/25/2005 11:35:09		141	164.8	72	172	186	334.1	62	302.4	209	328.5	156	274.4	330	271.7	411	257.6	258.6	266.2	339	243.9
44	10/25/2005 11:35:10		136	205.8	29	159.7	55	208.4	96	274.8	128	295	105	289	198	269.4	237	268.5	143.1	13.74	184	241.1
45	10/25/2005 11:35:11		44	158.7	133	262.2	124	243.6	35	247.9	150	109.9	82	279.1	220	273.9	274	244.7	163	221	85	278.8
46	10/25/2005 11:35:12		49	140.8	41	216	171	159.4	30	86.2	111	198.9	105	314.6	130	241.1	180	240.3	147.9	227.5	212	255.5
47	10/25/2005 11:35:13		98	195.5	197	162.9	128	158.9	70	301	64	228.1	81	339.8	154	236.4	120	240	64.56	163.8	184	248.3
48	10/25/2005 11:35:14		13	26.6	117	185.4	46	233.9	75	5.3	84	174.6	76	306.4	190	252.5	139	314.4	256.8	223.3	165	307.8
49	10/25/2005 11:35:15		8	113.2	94	222	79	146.3	104	105.1	51	254.1	100	215.6	143	178	116	296.1	204.2	177.2	176	236.1
50	10/25/2005 11:35:16		30	41	115	196.2	230	248.3	199	168.1	74	41.2	144	214.2	217	246.6	110	155.3	55.08	273.1	125	262.2
51	10/25/2005 11:35:17		148	58.2	117	115.9	173	116.1	104	188.8	134	224.7	27	70.2	60	220.9	106	55	82.61	96.95	115	15.6
52	10/25/2005 11:35:18		133	111.6	105	85.6	101	214.5	139	286.7	18	106.4	94	107.3	137	104.3	41	15.4	240.7	171.4	208	257.5
53	10/25/2005 11:35:19		124	302.8	20	90	49	135.8	103	2.2	88	28.6	63	39.2	84	55.2	122	337.8	88.77	14.35	179	15.9
54	10/25/2005 11:35:20		119	359.5	31	129.8	152	75.5	146	61.9	51	117.1	155	61.9	54	54	73	24.1	125.9	321.1	28	198.4
55	10/25/2005 11:35:21		106	82.9	98	352.4	182	73.4	130	56.3	46	310.6	274	328.1	249	316.6	110	350	292.6	16.89	102	333.7
56	10/25/2005 11:35:22		378	14.7	187	125.2	207	151.7	126	107.1	224	115.1	100	74.3	76	91.5			109.6	116.6	141	189
57	10/25/2005 11:35:23		340	139.9	153	158.5	73	109.9	70	69	141	29.8	190	28.3			203	37	137	335.9	148	44.2
58	10/25/2005 11:35:24		286	102.9	89	184.5	63	142.8	74	4.6	52	346.8			237	23.1	71	10.5	201.4	15.55	125	47
59	10/25/2005 11:35:25		221	148.9	128	135.3	184	170.9	82	143.4	150	72.2	86	99.4	112	24.7	193	261.7	179.4	30.85	162	229.7
60	10/25/2005 11:35:26		19	6	29	77.9	135	133.5	221	123.8	195	62.9	136	35.4	117	288	79	250.9	197.4	204.2	213	254.2

Fox River Propwash Study - Moving Vessel Trials

Test #13: Single-Prop Vessel - 100% Throttle Startup -Pitch Down 2

October 25, 2005



Lower Fox River Moving Vessel Trials
Test Fourteen

Run 1																									
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 12:54:25		114	203.9	46	57.3	25	180	103	14.6	108	329.9	63	299.4	119	88.6	138	124.4	48.45	313.7	234	308.2
1	10/25/2005 12:54:26		37	99.2	220	102.1	159	37.1	154	318.7	117	122.5	176	63.7	83	282.5	27	169.5	202.9	97.93	37	86.9
2	10/25/2005 12:54:27		145	358.8	242	85.5	98	327.1	148	65.7	85	62.8	80	73.4	124	120.5	125	113.5	93.3	118.5	63	128.5
3	10/25/2005 12:54:28		105	302.2	199	116.8	34	25.8	22	313.2	99	83.6	40	312	78	270	202	95.4	139.3	190.3	141	334.9
4	10/25/2005 12:54:29		148	46.4	239	127	117	113.7	130	4	93	304.5	33	207.3	182	310.3			127.6	318.8	61	329.2
5	10/25/2005 12:54:30		23	180	276	24.2	234	65	168	193.8	154	165.7	68	91.7	238	244.1			77.16	312.4	104	67.9
6	10/25/2005 12:54:31		137	163.4	130	87.4	105	96.6	22	352.2	54	143.3	78	141.8	193	243.8			92.09	214.4	174	254.4
7	10/25/2005 12:54:32		114	17.8	207	24	244	49	275	340.6	152	14.5	204	84.7					337.4	52.59	254	50.1
8	10/25/2005 12:54:33		127	309.6	107	130.8	188	134.6	79	133	126	340	34	5	231	138.2			80.65	340.4	131	21.9
9	10/25/2005 12:54:34		69	295.8	49	100.6	145	340.7	89	189	128	184.9	142	173.5			80	338.9	105.6	71.22	89	113.1
10	10/25/2005 12:54:35		163	63	104	36	62	75.1	152	71.2	77	227.6	46	109.2	312	350.2	189	353.6	185.3	320	10	204
11	10/25/2005 12:54:36		160	325.4	144	11.6	121	325.1	123	147	58	208.8	73	114.1	155	124.2	212	354.3	148.3	40.35	106	36.5
12	10/25/2005 12:54:37		113	157.7	190	35.8	105	117.3	53	160.2	81	46.5	285	113.6	247	63.8	281	9.4	259.1	1.548	191	39
13	10/25/2005 12:54:38		96	137.1	65	86.5	39	129.8	136	193.6	62	341.3	152	240.9	40	357.1	147	133.3	84.38	148.6	93	30.4
14	10/25/2005 12:54:39		74	263	117	132.6	163	42	33	3.5	24	65.6	94	138.5			319	343.6	203.2	140.6	43	346.6
15	10/25/2005 12:54:40		65	203.4	140	9.1	224	27.1	39	11.9	92	190.7	161	258.9	127	336.9	146	73.3	153.3	40.24	87	71.1
16	10/25/2005 12:54:41		59	142.5	78	45	121	322.4	106	13.6	117	243.7			171	51.2	40	56.3	187.8	18.63	55	241.6
17	10/25/2005 12:54:42		43	139.7	237	71.3	114	86.5	146	54.5	163	282.8			188	111.5	183	90.3	201.5	93.98	123	334.5
18	10/25/2005 12:54:43		51	321.3	82	121	110	343.7	35	14.8	62	237.6	156	273.7			83	139.4	47.17	291.1	55	108.1
19	10/25/2005 12:54:44		69	166.6	119	29.1	109	359.5	115	89.5	42	178.6	102	46.6			48	124	101.6	208.8	233	14.2
20	10/25/2005 12:54:45		95	11	130	111.6	103	134.6	280	138.2	147	241.2	44	86.1			173	78.7	15.3	168.7	26	242.4
21	10/25/2005 12:54:46		13	308.7	183	127	98	153.4	107	153.9	49	165.7	104	316.9	160	7.5	272	5.3	181.7	55.09	48	1.2
22	10/25/2005 12:54:47		34	24.3	208	55.8	169	327.8	87	106.8	236	106	133	61.3	201	65.9	102	141	122	49.65	226	350.8
23	10/25/2005 12:54:48		65	336.6	160	59.9	103	21.1	86	210.2	112	231.5	73	210.4	137	284.9	106	208	73.68	277.8	84	135.5
24	10/25/2005 12:54:49		124	326.2	91	66	204	38.8	83	75.3	128	264.6	80	76.3	203	353.8	251	10.5	292.8	35.97	237	28.7
25	10/25/2005 12:54:50		182	272.2	104	274.4	239	63.6	134	83.6	200	165.2	68	180.8	63	81.7	238	160.3	67.36	174	35	157.9
26	10/25/2005 12:54:51		112	192.4	213	61.2	256	80.3	133	96.1	275	86.7	171	72	133	100	113	90	73.82	331.7	122	28.5
27	10/25/2005 12:54:52		40	42	119	60.2	282	57.2	175	348.4	86	108.2	228	81.9	189	97	70	354.3	102.4	282.4	148	83.4
28	10/25/2005 12:54:53		97	242.4	186	120.3	132	45.3	71	343.6			133	71.6	108	83.6	57	175	127.7	9.462	126	50.1
29	10/25/2005 12:54:54		34	115.8	196	59.6	177	77.3	9	108.4			356	61.5	168	13	94	8.6	188.3	96.71	273	37.7
30	10/25/2005 12:54:55		68	196.3	230	28.6	234	74.4	159	10.1	211	48.8			147	311.4	190	318	230.3	287.2	121	282.4
31	10/25/2005 12:54:56		76	270	147	115.9	59	244.7	86	325.4	61	123.7			310	332.1	106	352.4	87.1	12.6	77	6.8
32	10/25/2005 12:54:57		61	334.7	141	56.5	22	7.8	45	225	257	175.3	137	234.2	78	142.3	101	36.5	137.1	327.8	25	191.8
33	10/25/2005 12:54:58		49	140.8	100	78.5	150	345.3	76	245.8	106	263.5	120	265.7	22	35.8			128	295	220	22.7
34	10/25/2005 12:54:59		63	310.5	152	354.7	112	355.4	150	322.1	68	90	74	66.2	14	114.8			137.9	70.51	94	61.5
35	10/25/2005 12:55:00		123	288.4	101	18.4	42	31.4	104	200.2	42	145.6	186	211.8					84.31	337.7	18	77.5
36	10/25/2005 12:55:01		87	309.4	106	356.2	188	49.1	169	58.6	20	69.8	20	315	196	88.5	207	327.8	130.1	7.507	210	24.1
37	10/25/2005 12:55:02		116	283.9	150	352	121	20.2	110	313.2	51	101.3	122	72.3	120	344.6			107.6	290.1	83	351.7
38	10/25/2005 12:55:03		79	70.9	141	85.9	124	61.6	114	100.6	102	108.8	112	45.7	164	311.1	330	2.4	137.1	39.38	270	99.4
39	10/25/2005 12:55:04		37	74.5	124	5.6	75	124.7	34	225	89	233.6	216	88.4	271	28.5			108.9	128.7	55	137.9
40	10/25/2005 12:55:05		105	270.5	196	28.7	132	44.4	49	93.5	96	122.2	228	41.8	295	5.2	53	337.8	37.34	277.7	156	343.2
41	10/25/2005 12:55:06		51	65.5	156	42.9	125	331.4	140	13.2	85	41.2	79	306.3			255	335.9	195.5	38.98	349	44.5
42	10/25/2005 12:55:07		96	271.2	143	37.9	219	19.5	85	270	86	107	101	47	366	9.3	157	91.5	94.43	84.53	127	87.3
43	10/25/2005 12:55:08		115	250.8	192	114.3	141	131.8	65	182.6	134	82.3	88	241.4					38.63	248.7	128	188.5
44	10/25/2005 12:55:09		49	303.4	133	48.7	144	31	52	34	103	27.8	112	36.7			203	6.5	138.8	51.73	206	30.3
45	10/25/2005 12:55:10		117	350.6	85	162.2	45	18	49	87.7	21	160.7	40	312	330	91.7	110	299.4	95.52	59.14	45	2.5
46	10/25/2005 12:55:11		93	183.1	197	33.9	142	33.8	162	70.6	47	113.8	78	218.8	136	86.2	113	84.9	34.18	200.6	83	78.8
47	10/25/2005 12:55:12		124	332.6	96	55.2	25	11.8	123	279.4	87	83.4	52	156.4	119	61.5	135	121.7	113.3	159.3	97	125.8
48	10/25/2005 12:55:13		92	60.1	211	60.5	193	110.3	67	20.1	49	64.5	121	87.2	217	207.4	116	85.6	179.7	73.18	191	106.7
49	10/25/2005 12:55:14		32	11	153	104	31	326.8	66	315.6	57	137.9	197	225.6	93	152.3	54	63.4	68.62	108.7	79	92.2
50	10/25/2005 12:55:15		177	295.1	110	43.2	103	67.2	73	298.7	31	236.8	58	308.7	211	27.4	144	28.2	169.4	352.5	218	3.2
51	10/25/2005 12:55:16		85	56.5	147	69.4	31	51.6	128	98.1	59	333.9	95	74.8	381	62.8	138	74.1	132.8	260.5	99	28.4
52	10/25/2005 12:55:17		54	45	198	72.4	31	358.2	190	323.6	50	287.4	125	262.2	25	16.3	105	349.5	145.7	78.92	122	117.4
53	10/25/2005 12:55:18		35	25.1	133	65.6	136	95.5	82	204.4	71	37.5	181	96.3	129	108.6	108	123	165	323.1	71	16.4
54	10/25/2005 12:55:19		11	52.1	198	76.9	75	125.2	111	346	6	315	90	72.6	241	78.3	333	15.7	52.7	33.39	117	36.7
55	10/25/2005 12:55:20		85	205.7	193	84.1	189	357	83	58.8	44	115.4	23	31	24	128.3	152	174	128.9	350.2	154	308.1
56	10/25/2005 12:55:21		175	1.6	139	65.8	198	34.5	177	44.3	46	200.4	78	92.9	179	56.1			124.7	346.1	136	354.1
57	10/25/2005 12:55:22		162	262.6	209	85.1	118	95.9	135	139.8	80	100	163	81.2	68	188.5	87	7.9	113.5	211.3	251	37.1
58	10/25/2005 12:55:23		60	333.4	145	142.6	81	81.5	67	124.6	164	73.7	27	21.8	159	85.7	194	0.9	264.4	37.78	135	22.2
59	10/25/2005 12:55:24		25	113.5	128	44.7	64	65.9	46	49.4	82	120	136	78.5	155	91.5	24	51.7	245.8	34.72	60	21.4
60	10/25/2005 12:55:26		168	343.1	154	68.6	90	35.1	130	312.2	111	127.7	68	150	59	313.6	124	337.2	257.5	100.7	48	187.1

Lower Fox River Moving Vessel Trials
Test Fourteen

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 12:55:37		50	5.7	122	101.9	50	234.7	45	149.5	66	166.8	98	159.7	93	121			70.33	240.2	104	327.5
1	10/25/2005 12:55:38		113	273.5	99	1.7	105	56.6	77	336.1	136	355.4	109	320.2	138	13.4	189	15.9	189.3	15.95		
2	10/25/2005 12:55:39		62	168	203	120.5	130	103.3	92	207.1	225	163.2	150	172.7	33	72.1					102	238.7
3	10/25/2005 12:55:40		204	244.8	94	51.9	216	59.6	149	63.3	52	172.3	12	194	162	156					156	14.8
4	10/25/2005 12:55:41		177	18.7	98	99.4	53	152	27	79.5	105	197.7	140	118.2							225	23.3
5	10/25/2005 12:55:42		84	165.5	48	183.6	148	133.1	143	51.5	24	82.9	325	69.7					269.1	293.9	298	55.7
6	10/25/2005 12:55:43		28	226.5	149	119.8	162	99.9	129	50.4	50	57.3	115	53.1					166.2	134.8	229	63.8
7	10/25/2005 12:55:44		205	291.8	99	333.7	25	71.6	77	140.3	83	206.6	120	202.1					192.8	335.2	58	322
8	10/25/2005 12:55:45		93	44.6	122	90.5	83	106.9	29	93.9	111	90	95	104			164	271	204	295.6	183	64.4
9	10/25/2005 12:55:46		86	282.1	127	15.6	129	28.8	63	59.3	74	131.2	231	256.2			204	24.3	165	39.96	144	62.4
10	10/25/2005 12:55:47		53	321.8	191	40.1	174	11.2	225	49.9	186	22.8	66	67.7	120	15.4					244	55
11	10/25/2005 12:55:48		89	169.7	167	69.7	145	38.8	93	13.7	237	57	167	0.3	98	64.5			86.28	45.94	105	124.9
12	10/25/2005 12:55:49		57	157.5	16	60.3	109	4.7	173	62.8	60	268.1	51	43.4					110.3	38.74	126	81.4
13	10/25/2005 12:55:50		142	297.6	185	24.2	94	294.4	18	170.5	61	259.6	49	163.4					213.8	126.4	109	309.1
14	10/25/2005 12:55:51		94	325.8	56	13.5	85	58.9	133	23.5	120	224.7	56	51.5	55	95.2			193.9	122.8	208	34.2
15	10/25/2005 12:55:52		103	143.7	85	159.4	108	346.6	59	178.1	77	140.8	34	178.3			226	314.3	162.6	107.5	199	350.2
16	10/25/2005 12:55:53		21	8.1	145	72.8	73	36.1	103	74.2	156	356	170	50.5	151	253.8	68	115.1	345.1	131.4	173	50.2
17	10/25/2005 12:55:54		118	100.3	118	71.3	132	354.3	178	256.4	128	299.6	70	53.1			123	96.5	387.3	137.8	273	74.5
18	10/25/2005 12:55:55		260	301.3	122	36.7	118	66	111	50.9	91	54.4	17	302.7			194	91.5	265.2	20.76	170	69
19	10/25/2005 12:55:56		30	39.6	93	359.4	87	15.9	103	29.8	30	160.3	112	119.6	261	94.6	162	130	31.24	39.81	149	92.3
20	10/25/2005 12:55:57		130	258.9	68	31.1	71	18.2	159	2.2	68	245.7	27	61.6	235	138.4			138.6	316.2	118	13.7
21	10/25/2005 12:55:58		231	55.8	112	13.4	133	18	33	32.7	56	99.3	94	254.6	138	58			30.08	21.45	193	69.4
22	10/25/2005 12:55:59		112	297.7	226	9.7	159	46.8	86	91.3	210	168.7	72	99.6	125	54.1			41.62	144.8	129	60.9
23	10/25/2005 12:56:00		117	61.9	161	104.7	92	115.7	76	172.4	93	68.7	126	89.5	96	35.7			47.1	266.3	111	133.2
24	10/25/2005 12:56:01		116	182	100	118.1	34	348	166	34.2	60	87.1	142	9.7	229	194.6			90.26	9.567	87	351.4
25	10/25/2005 12:56:02		105	306.1	68	328.2	107	55.7	13	251.6	58	114.4	80	310.4	62	114.9	452	275.7	48.66	170.5	117	47.1
26	10/25/2005 12:56:03		19	254.5	193	59.2	161	71.6	110	130.9	64	295.8	121	163.2	188	113.6	243	240.2	70.52	161.8	243	189.2
27	10/25/2005 12:56:04		6	315	219	73.8	88	109.3	63	23.3	150	19.5	21	29.1			166	359	78.24	321.2	97	11.3
28	10/25/2005 12:56:05		40	75.6	156	86	130	95.8	93	48.1	21	313			110	277.3	57	0	155.9	287.2	44	41.3
29	10/25/2005 12:56:06		142	10.1	168	52.2	63	27.4	132	150.5	108	57	112	132.1	76	142.5	63	37.2	74.25	225.5	155	55.8
30	10/25/2005 12:56:07		102	340.5	267	85.1	160	104.5	108	60.1	132	97	205	136.2	126	151.6			43.93	191.8	32	115.8
31	10/25/2005 12:56:08		101	246.7	143	108.8	244	46.5	163	91.1	151	32.3	96	348	188	61.4			187.3	30.12	235	51
32	10/25/2005 12:56:09		68	301.8	112	58.9	110	31.2	97	140.9	137	316.2	75	26.9			176	333	175.4	27.88	96	72.3
33	10/25/2005 12:56:10		58	312.2	142	128.4	65	126.9	97	103.2	158	15.8	86	247.3	178	26.4	98	328.7	93.09	267.5	177	338.1
34	10/25/2005 12:56:11		59	242.6	181	103.4	197	65.4	216	23.5	137	98.8	23	85			243	61.2	129.8	78	176	71.8
35	10/25/2005 12:56:12		18	337.6	162	44.2	128	28.6	155	262.2	138	217	75	13.1	42	276.8	272	15.1	100.4	260.3	178	29.6
36	10/25/2005 12:56:13		16	341.6	98	82.9	170	86.3	44	74.1	136	155.3	186	156.6	177	98.8	181	236.7	69.32	296.6	74	32.8
37	10/25/2005 12:56:14		105	272.2	82	20.6	54	6.3	49	83	20	323.1	82	67.2	326	352.6			211	82.1	359	35
38	10/25/2005 12:56:15		149	320.7	177	55.1	133	38	175	28.8	51	135	103	120.3	55	331.6	405	85.9	91.78	101.3	89	335.4
39	10/25/2005 12:56:16		80	257.7	127	111.7	114	172.4	181	211.9	93	199.4	140	145.5					94.87	237.5	71	270.8
40	10/25/2005 12:56:17		122	9.5	261	53.1	197	46.8	109	78.4	43	77.9	132	44.1	500	64.4	191	136.7	90.09	81.06	140	324.6
41	10/25/2005 12:56:18		99	152.9	94	343.3	55	156.3	35	219.2	48	267.6	137	0.8	122	36.3	153	64.4	127	358.6	134	227.1
42	10/25/2005 12:56:19		89	299.7	143	13.4	118	69.1	128	98.5	144	350.4	197	9.4	149	306.8	122	331.1	54.12	297.5	224	66.9
43	10/25/2005 12:56:20		25	130.1	167	89	62	72.1	21	278.1	55	258.5	110	112.4	115	81	111	179	260.9	134.2	66	344.1
44	10/25/2005 12:56:21		17	139.8	124	134.7	209	79	39	75.3	75	219.6	170	333.4	182	284.3	98	60.8	36.14	345.6	216	0.5
45	10/25/2005 12:56:22		42	234.8	237	77.1	98	44.2	70	21	143	268	89	190.3	89	100.3	297	137.5	192.4	226.3	42	108
46	10/25/2005 12:56:23		132	202.3	169	97.1	27	164.9	19	55.5	189	255.9	82	205.3	33	171.4			60.22	215.5	122	230.7
47	10/25/2005 12:56:24		111	163.2	40	78.4	124	17.9	29	319.2	162	328.7	111	85.4	65	334.6	153	8.7	79.32	146.3	161	43.7
48	10/25/2005 12:56:25		141	297.8	46	286.5	113	207.9	102	344.6	212	201.3	131	186.6	111	123.3	194	161.1	103.6	229.7	167	220.9
49	10/25/2005 12:56:26		161	296.1	118	3.9	108	71.7	16	37.6	164	344.8	224	343.9	189	330.9	231	353.3	112.3	13.91	274	4.2
50	10/25/2005 12:56:27		77	264.8	190	46.5	54	200.4	30	114	127	258.7	75	328	178	38.6	327	292.6	69.29	20.27	48	310.7
51	10/25/2005 12:56:28		122	40.3	125	127.5	204	136	63	130.5	174	246.7	97	42.1	171	254.4	54	20.4	114.5	124	103	87.8
52	10/25/2005 12:56:29		52	276.6	22	100.3	89	347.7	65	14.3	104	213.2	117	33.1	450	77.3	52	21.6	314.6	20.85	277	39
53	10/25/2005 12:56:30		85	274.7	36	303.7	88	88	48	76.8	147	112	10	24	88	93.3	36	110.9	271.5	116.9	140	114.5
54	10/25/2005 12:56:31		195	111.3	163	40	121	2.4	84	79	43	39.3	131	270.4	114	351.4	88	11.2	35.79	41.04	138	12.5
55	10/25/2005 12:56:32		65	263	144	39.3	109	118	84	307.3	81	204.7	55	267.9	61	35	65	248.2	50.8	100.2	151	24.7
56	10/25/2005 12:56:33		150	78.1	269	47.1	42	274.1	9	186.3	179	183.8	123	131.4	96	88.2	129	113.2	138.6	110.3	153	105.6
57	10/25/2005 12:56:34		67	177.4	188	67.5	67	89.1	197	41.3	127	51.4	134	312.3	188	0.6	268	4.7	77.34	310.3	81	77.9
58	10/25/2005 12:56:35		101	356.6	254	61.8	213	108.9	248	94.4	146	35	77	29.6			126	127.6	138.6	133.8	171	53.3
59	10/25/2005 12:56:36		127	31.4	137	90	65	73	101	112	28	14.5	171	153.6			150	100	213.8	97.52	80	79.2
60	10/25/2005 12:56:37		55	246.3	127	55.9	208	40.7	37	47.2	108	332.5	159	251.7	144	180.4	136	225	93.54	353.9	248	5.1

Lower Fox River Moving Vessel Trials
Test Fourteen

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 3		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 12:56:40		124	331.6	122	27.4	144	16.9	73	90	69	80	92	126.6			146	37.2	90.03	12.18	246	44
1	10/25/2005 12:56:41		164	289.2	182	87.2	40	32.9	82	253.8	74	117.3	97	331.1	316	149.4	72	171.2	93.72	320.2	92	18.4
2	10/25/2005 12:56:42		76	111.5	232	110.2	105	140.4	168	92.7	85	69.4	63	101	126	175.5	178	187.4	183.8	233.6	100	102.7
3	10/25/2005 12:56:43		88	210.1	314	73.7	143	132.2	141	13.9	136	56.4	156	106	64	352.8	363	67.7	49.03	11.77	233	44.5
4	10/25/2005 12:56:44		165	337.6	258	98	110	116.3	169	286.2	149	3.8	103	39.9	115	83	167	33	251.8	55.68	250	49.1
5	10/25/2005 12:56:45		98	159.7	192	114.7	95	67	57	116.1	137	63.6	38	122	159	110.6	209	137.9	16.64	57.26	139	65.3
6	10/25/2005 12:56:46		25	21.4	118	4.4	128	27	78	298.2	98	13.6	74	60	32	79	155	335.6	238.1	91.2	221	44.8
7	10/25/2005 12:56:47		79	328.9	16	137.5	160	49	22	10.3	169	68.5	103	344.7	166	60.8	87	23	143.7	298.7	166	13.2
8	10/25/2005 12:56:48		35	178.4	161	90.7	66	153.8	72	221	131	217.2	117	317.4	279	273.3	10	253.3	78.64	239.8	147	238.9
9	10/25/2005 12:56:49		136	190.6	191	109.3	165	135.2	55	126.9	41	341.6	218	10.3	157	341.4	178	123.8	531.7	66.62		
10	10/25/2005 12:56:50		166	208.1	144	152.7	181	173	289	196.5	252	180.5	209	166.7	225	178.7					1482	172
11	10/25/2005 12:56:51		57	47.1	244	19.2	152	118.8	72	52.3	145	58.3	73	5.5	231	351.3					308	45.9
12	10/25/2005 12:56:52		64	6.2	107	88.4	53	350.2	189	155.3	174	184.6	100	343.2								
13	10/25/2005 12:56:53		56	224.3	178	43.2	160	75.9	68	328.2	77	87.8	61	218.4	70	334.5					287	74.7
14	10/25/2005 12:56:54		50	125.3	90	52.2	82	98.4	63	242.6	65	263	203	164.2					133.6	191.2	210	108.9
15	10/25/2005 12:56:55		86	108.2	26	195.6	68	266.6	65	273.5	200	11.8	205	24.8					294.4	37.69	639	25.7
16	10/25/2005 12:56:56		139	277.8	11	303.7	63	17.6	119	124.8	47	178.8	136	265.4			106	356.2	150.3	117.8	270	351.5
17	10/25/2005 12:56:57		98	345.8	60	15.4	128	90	124	144.5	93	146.8	81	162			222	111.9	491	111.8	289	86.8
18	10/25/2005 12:56:58		82	240.9	208	65.9	40	60.3	25	177.7	128	155	154	115.7					74.85	202.8	213	72.2
19	10/25/2005 12:56:59		63	111.3	77	87.8	44	121.9	40	124.9	40	57.1	123	212.4			37	216.3	50.25	328.8	53	283
20	10/25/2005 12:57:00		66	287.6	115	82.5	121	58.5	11	344.7	226	334.3	274	322.7	145	141.7	172	71.7	191.9	98.09	259	75.5
21	10/25/2005 12:57:01		198	285.9	64	161.8	67	357.4	86	126.5	198	158.1			314	105.7	377	123.1	183.4	93.75	238	101.6
22	10/25/2005 12:57:02		111	161.1	81	172.2	152	179.6	100	126.9	106	285.9			73	15.2	112	212.3	141.9	170.7	150	123.1
23	10/25/2005 12:57:03		29	270	28	140.7	101	62.9	82	60			362	24.3	42	111	119	128.5	200.1	74.64	263	51.6
24	10/25/2005 12:57:04		51	151.9	155	68.7	54	151	113	54.3			65	78.5	100	22.4	129	336.2	192.3	13.53	187	21.6
25	10/25/2005 12:57:05		59	227.1	63	145.3	11	201.8	219	205.4			143	316.7	114	28.8	72	339.5	193.8	31.07	336	65.2
26	10/25/2005 12:57:06		96	201.5	149	44.7	113	103.3	164	108.1			203	359.7	201	21	125	351.3	117.3	57.53	268	52.7
27	10/25/2005 12:57:07		87	234.8	173	135	30	136.3	73	246.6	426	206.8	32	33.7	72	222.2	139	201	116	225.7	40	113.4
28	10/25/2005 12:57:08		114	18	130	80.2	91	105.9	49	194.3	97	70.1	25	315	200	11.5	118	95.4	232.3	65.86	344	69.6
29	10/25/2005 12:57:09		179	291.3	19	58	38	28.6	62	290.8	72	120.8					89	114.6	43.86	46.85	232	77
30	10/25/2005 12:57:10		56	217.1	202	107.3	47	171.3	52	135	70	129.8	257	342.3			89	2.6	116.2	21.71	71	16.4
31	10/25/2005 12:57:11		193	222.5	135	123.8	133	130.4	141	211.7	85	148.9	101	236.3			54	121.3	148.2	144.1	147	94.3
32	10/25/2005 12:57:12		169	190.6	12	340	141	130.7	85	200.8	35	248.5	213	341.1	137	86.7	122	39.3	90.6	127.4	86	128.9
33	10/25/2005 12:57:13		106	216.5	126	219.9	53	315.8	104	50.5	30	331.7	50	218.5	134	244.8	123	234.6	63.01	270.9	106	314.2
34	10/25/2005 12:57:14		72	19.4	147	33.4	335	74.4	57	153.9	315	180.5	139	350.5	88	88.7	29	144.7	126.8	240.2	115	96
35	10/25/2005 12:57:15		103	10.1	205	60.4	159	64.2	81	94.9	108	39.7	209	99.1	231	98	197	129	67.07	177.4	169	92
36	10/25/2005 12:57:16		210	340.3	32	290.1	147	288.2	65	39.4	114	20.5	108	53.7	99	123	45	200.9	71.18	65.96	48	200.7
37	10/25/2005 12:57:17		121	186.2	64	115	154	319	109	332.7	121	342.8	43	218.5	58	135	92	300.7	282.5	20.29	201	50.4
38	10/25/2005 12:57:18		43	83.4	49	63.4	74	167.5	207	316.2	39	301.2	19	312.9	98	205.3	110	143.9	92.66	299.1	126	88.6
39	10/25/2005 12:57:19		69	318	100	355.4	128	344.1	160	121.7	148	57.2	96	329.4	39	41.9	358	79.4	100.4	56.78	159	73.5
40	10/25/2005 12:57:20		49	305	107	38.6	89	31.7	66	39.5	79	296.2	146	352.5	95	0.6	42	236.7	83.66	292.1	148	305.6
41	10/25/2005 12:57:21		74	79.9	203	94.5	94	131.5	89	288.2	65	197.9	142	143.9	83	38.7	75	21.8	68.48	28.81	209	54
42	10/25/2005 12:57:22		108	326.8	195	42.7	16	284.9	62	311.7	47	16.1	115	250.1	184	238.8	184	120.1	38.21	132.9	195	80.9
43	10/25/2005 12:57:23		233	350.1	93	55.1	96	110.1	153	19	144	99.6	212	125.4	107	342.6			349.3	45.46	214	45.4
44	10/25/2005 12:57:24		114	47.5	44	54.2	124	55.2	117	62.6	81	107.3	47	245.1	101	4.5	87	340.5	98.98	330.3	282	59.1
45	10/25/2005 12:57:25		140	194.9	150	145	177	158.1	150	109	90	6.4	168	138.6	26	57.5	377	58.1	87.86	41.31	76	29.9
46	10/25/2005 12:57:26		108	51.8	188	41.8	124	107.4	242	120.3	253	105.6	66	38.3			45	273.8	171.4	82.63	233	88.8
47	10/25/2005 12:57:27		178	219.3	90	355.6	135	318.6	182	273.1	105	316.5	32	14.5			42	4.1	130.3	340.7	74	31.8
48	10/25/2005 12:57:28		219	124.8	280	102.6	139	111.6	108	36.3	91	106.6	134	117.1			144	191.6	109.4	216.5	160	216.9
49	10/25/2005 12:57:29		43	84.7	282	99.6	173	76.6	76	142.5	39	357.1	60	304.2			91	68	112.6	52.21	121	48.7
50	10/25/2005 12:57:30		269	282.9	48	343.1	54	126.7	65	85.6	122	226.3	146	164.1	565	245.7	337	351	108.2	160.6	76	22.5
51	10/25/2005 12:57:31		70	38.7	238	43	48	266.4	73	305	102	102.4	104	226.2	194	70.1	107	180.5	133.6	348.8	138	65.1
52	10/25/2005 12:57:33		124	327.8	170	75.3	64	90	143	342.5	81	48.5	79	341.6	130	36.3	94	212.8	32.56	190.6	156	47.1
53	10/25/2005 12:57:33		232	117.4	151	49.6	189	43.9	124	35.5	78	149.2	106	173.5			121	174.3	36.12	48.37	115	63.7
54	10/25/2005 12:57:34		119	301.5	46	302.7	88	62.9	140	22.7	125	51.8	82	25.3	167	201.8	107	257.6	184.7	295.3	188	308.5
55	10/25/2005 12:57:36		125	216.9	86	77.3	147	122	97	104.3	93	357.5	110	45	142	53.9	76	164.7	136.8	35.78	220	51.1
56	10/25/2005 12:57:36		43	309.3	8	140.2	25	21.4	61	88.1	202	80	60	141	72	164.6	84	197.4	113.5	84.44	183	49
57	10/25/2005 12:57:37		204	169	137	110	141	0	144	37.7	145	198.9	89	253.6	101	250.8	174	161.9	108.9	51.34	90	3.8
58	10/25/2005 12:57:38		99	352.4	151	63.3	79	28.8	23	322.1	50	42.6	238	118.9	140	149	204	358.3	39.2	322.3	59	336
59	10/25/2005 12:57:39		206	327.1	232	17.6	49	312.5	73	149.6	71	143	275	138.2	115	307.6	152	97.5	143.9	263.6	6	251.6
60	10/25/2005 12:57:40		44	350.8	106	25.6	68	337.6	33	8.6	73	123.3	27	252.9	200	317	185	34.2	72.45	296.2	134	49.5

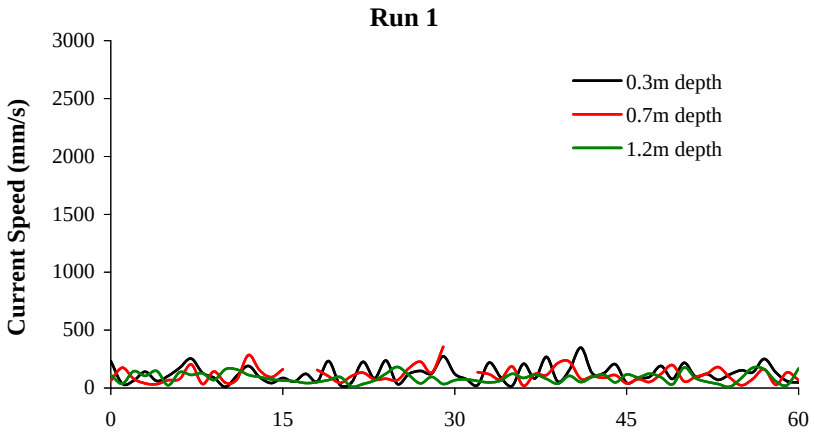
Lower Fox River Moving Vessel Trials
Test Fourteen

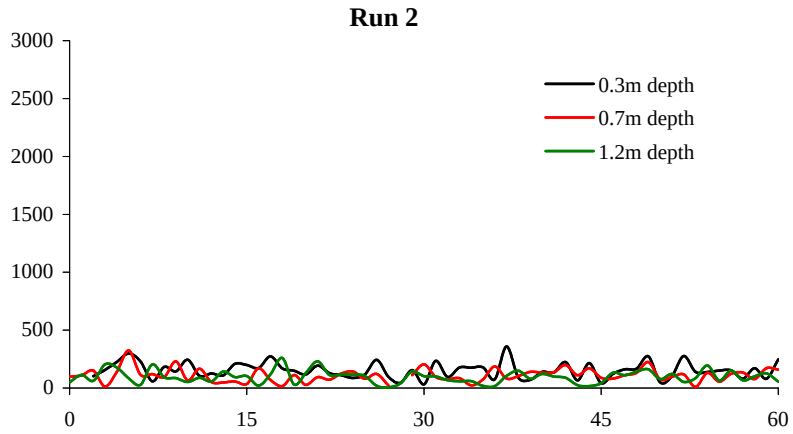
Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 12:57:50		157	226	81	133.5	114	244.6	71	174.4	57	61.6	137	64.9	334	337.7	178	48.2	42.15	247.7	122	207.4
1	10/25/2005 12:57:51		69	16.9	297	66.2	70	32.8	76	23.2	212	55.6	105	51.9	134	82.7	208	15.3	82.23	13.36	139	52.3
2	10/25/2005 12:57:52		67	27.7	190	100.6	153	74.4	147	255	20	180	111	16.2	161	338.9	125	70.8	65.31	25.39	226	65.1
3	10/25/2005 12:57:53		60	1	175	57.1	117	75.1	100	38.9	29	7.9	61	112.3	149	68.3	25	253.7	44.01	271.3	103	87.8
4	10/25/2005 12:57:54		125	95	151	45.8	48	27.1	149	265.4	115	194	111	54.2	111	167	44	189.2	66.76	286.5	86	276
5	10/25/2005 12:57:55		25	281.3	137	88.7	56	325.2	123	266.3	82	337.8	93	333.2	44	131.3	184	6.5	162	339.8	196	13.5
6	10/25/2005 12:57:56		138	50.3	84	58.2	85	64.3	66	28.9	119	3.8	166	79.9	176	19	48	30.3	105.5	350.2	333	30.3
7	10/25/2005 12:57:57		70	26.2	169	108.6	202	70.3	36	326.3	93	175.7	21	299.1	137	131.7	103	266.7	164.5	239.7	128	32.2
8	10/25/2005 12:57:58		182	66	161	61	93	59	54	40.5	56	152.5	108	105.6	42	47.9	128	30	43.42	75.32	49	80.5
9	10/25/2005 12:57:59		72	311	58	345	94	61.2	30	252.8	228	9.6	186	345.7	114	30.6	30	233.1	73.41	114.1	147	21.1
10	10/25/2005 12:58:00		102	212.6	111	60.9	28	0	95	327.5	67	189.5	116	72.5	103	6.7	118	356.1	117.8	203.5	76	33.7
11	10/25/2005 12:58:01		208	296.6	79	24.6	36	228.4	29	82.1	100	103.9	139	68.4	89	109	197	349.5	114.2	177	77	298.9
12	10/25/2005 12:58:02		94	273	92	63.4	46	27.1	86	45.5	17	305.5	18	229.4	167	29.5	57	198.4	97.67	190.6	94	118.5
13	10/25/2005 12:58:03		118	196.7	139	114.7	87	95.9	105	294.9	110	117	52	247.4	31	24.9					826	271.4
14	10/25/2005 12:58:04		110	229.1	66	96.9	240	205.2	63	212.7	77	253.4	117	107.4							406	321.1
15	10/25/2005 12:58:05		101	69	113	139.3	166	287.9	154	242.6	64	275.4	138	195.5	258	343.1					36	268.4
16	10/25/2005 12:58:06		297	353.8	117	35.6	137	46.5	128	115.4	113	67.5	54	36	71	90			61.13	285.2	326	24.8
17	10/25/2005 12:58:07		194	70.4	113	99.7	128	201.1	46	217.9	106	278.1	124	167.4	96	84.6			31.91	32.2	254	332.3
18	10/25/2005 12:58:08		88	232.4	113	52.9	134	354	88	274.5	83	247.4	166	347.5					83.24	28.72	180	42.5
19	10/25/2005 12:58:09		125	232.1	129	161	82	49.5	48	343.1	47	240.7	171	159.4	38	47.1					334	83.8
20	10/25/2005 12:58:10		196	248.4	68	331.9	63	270	103	214.8	60	276.7	108	137.3	89	161.8			253.3	130.4	167	316.5
21	10/25/2005 12:58:11		182	239.2	103	131.4	82	159.4	47	137.6	62	21.6	119	334.7					36.06	86.82	147	349.8
22	10/25/2005 12:58:12		77	232.4	81	223	115	24.1	66	126.3	38	215.4	99	149	63	240.6			526.7	84.22	157	43.5
23	10/25/2005 12:58:13		130	309.7	100	99.7	234	142	109	144	230	143.5	84	156.8	102	20	260	286.3	37.12	4.635	304	345.5
24	10/25/2005 12:58:14		130	262.1	38	56.7	114	293.9	151	295.9	38	230.4	379	341.4	150	328.6	322	335.2	267.9	240	68	294.3
25	10/25/2005 12:58:15		42	340.7	97	13.2	155	49.2	33	111.2	68	355.8	335	320.7	163	136	197	217.6	41.76	196.7	245	116.7
26	10/25/2005 12:58:16		91	227.7	204	92	261	97	67	143.5	79	48.1	188	325.2	59	231.2	15	258.7	72.92	47.78	103	58.5
27	10/25/2005 12:58:17		195	323.5	95	39	220	78.2	184	55.6	256	5.6	66	223.2	116	70.3			185	84.1	252	46.1
28	10/25/2005 12:58:18		286	295.5	46	97.4	236	97.1	88	172.1	240	276.7	29	126.5	208	104.8			214.4	101.6	191	57.4
29	10/25/2005 12:58:19		80	87.1	114	108.9	93	154.5	154	132.6	81	83.7	82	121.6	113	182.5	16	296.6	185.1	83.8	326	35.9
30	10/25/2005 12:58:20		174	205.1	107	38.2	123	114.5	114	75.8	116	267	43	266	61	230.3	322	188	159.5	131.2	216	99.9
31	10/25/2005 12:58:21		79	22.3	146	19.5	213	2.7	206	351.6	142	74.9	71	49.6	251	311.4	93	35.4	233.4	108	293	40.4
32	10/25/2005 12:58:22		51	259.8	138	61.4	199	62.8	109	77.2	45	336.3	51	73	188	16	73	65.9	34	151.9	232	86.3
33	10/25/2005 12:58:23		113	283.3	68	39.1	63	24.5	173	45.9	143	94.8	148	13.3	170	44	26	27.6	19.03	273	179	118
34	10/25/2005 12:58:24		145	31.2	229	57.8	82	99.1	138	151	229	55.1	161	78.2	338	76.8	201	262.3	73.76	347.5	101	68
35	10/25/2005 12:58:25		98	293.4	133	212.4	124	240.5	239	152	153	74.1	73	110.9	221	168	101	176.6	162.4	332.5	186	43.9
36	10/25/2005 12:58:26		79	283.2	194	96.8	155	87	151	74.2	250	66.2	35	143.1	289	230.8	231	145.1	99.46	77.22	206	23.5
37	10/25/2005 12:58:27		59	70.3	205	10.7	48	131.6	139	51.4	101	68.5	91	62.6	132	350.4	128	32	184.2	325.6	213	25.8
38	10/25/2005 12:58:28		84	184.1	102	112.5	88	93.3	110	132.8	125	357.7	130	337.4	67	283			60.54	59.2	231	64.7
39	10/25/2005 12:58:29		64	136.9	79	131.4	15	82.4	119	111.6	148	44.2	83	180	125	9.7			114.9	338.6	122	356.7
40	10/25/2005 12:58:30		70	319	140	342.1	94	58.5	155	89.3	105	228.9	76	206.6	37	312.8	150	157.2	90.52	135.9	60	17.5
41	10/25/2005 12:58:31		108	138	136	39.3	56	109.7	120	76	105	279.9	230	162	36	320.6	121	22.9	231.4	61.33	298	51.6
42	10/25/2005 12:58:32		106	236.2	91	321.2	119	63.4	51	109.5	69	99.2	120	203.6	91	240.3	135	335.5	51.01	88.88	162	31.6
43	10/25/2005 12:58:33		57	49.3	214	81.7	93	117.4	128	84.6	65	207.3	156	299.2	60	309	197	1.5	157.2	9.522	28	265.9
44	10/25/2005 12:58:34		81	324.5	120	40.6	35	184.9	66	323.7	69	165	224	222.8	62	132.4	131	164.1	120.9	226	65	141.9
45	10/25/2005 12:58:35		64	92.7	73	19.9	80	345.4	120	358.1	149	82.7	57	166.7	14	36	168	355.2	53.71	209	115	61.4
46	10/25/2005 12:58:36		51	114.5	91	120.2	184	185	63	149.3	77	162.5	20	206.6	39	104.7	246	120.3	151.8	144.1	165	52.2
47	10/25/2005 12:58:37		139	265	209	73	65	116.6	175	51	206	52.3	104	123.2	43	266	136	170.3	55.07	60.64	56	161.2
48	10/25/2005 12:58:38		54	136.5	126	54.7	60	338.6	173	120.1	75	142.1	69	323.8	31	305.8	169	357	73.88	230.5	409	65.3
49	10/25/2005 12:58:39		165	86.5	269	97.3	60	34.2	40	88.6	28	12.5	159	131.7	54	191.7	141	259.4	97.72	197.9	42	25.3
50	10/25/2005 12:58:40		114	232.8	111	244.4	30	248.6	278	357.3	43	334	62	226.3	82	155.6	98	110.8	45.61	52.13	47	39.8
51	10/25/2005 12:58:41		64	337.9	117	93.4	79	111.7	36	183.2	125	49.2	159	59.4	108	318.8	233	107.7	177.8	81.92	131	82.1
52	10/25/2005 12:58:42		100	280.4	22	324.2	26	81.3	34	59.6	153	238.9	120	81.9	70	152	73	22.7	68.03	1.685	110	74.2
53	10/25/2005 12:58:43		189	342.7	269	42	123	25.9	33	186.9	221	221.7	33	65	120	181.4	97	137.9	122.8	102.2	294	49.3
54	10/25/2005 12:58:44		15	132.3	187	59.5	139	34.7	69	222	55	159.9	106	5.4	88	312.2			118	16.75	54	92.1
55	10/25/2005 12:58:45		60	271.9	32	352.9	84	68.3	59	13.8	94	173.9	110	254.7	30	240	108	350.4	96.57	195.6	70	108.4
56	10/25/2005 12:58:46		120	299.6	139	24.2	163	5.6	61	23.2	27	116.6	232	219.2	50	213.7	247	195	55.95	298.9	101	127.3
57	10/25/2005 12:58:47		93	228.9	142	5.7	123	317.6	19	55.5	84	40.2	93	275.5	76	204.9	4	346	30.46	66.8	259	55.2
58	10/25/2005 12:58:48		81	112.5	75	349.3	83	165.3	88	47.3	33	131.3	159	71.3	170	73.9	159	115	244.5	60.6	109	64.4
59	10/25/2005 12:58:49		57	9.1	91	55.3	24	36.4	103	127.9	35	194.8	101	94	233	350.6	40	277.1	26.17	226.5	56	10.3
60	10/25/2005 12:58:50		43	203	123	326.3	86	24.8	280	241.1	176	190.5	41	171.7	298	143.3			37.58	295.2	182	53.5

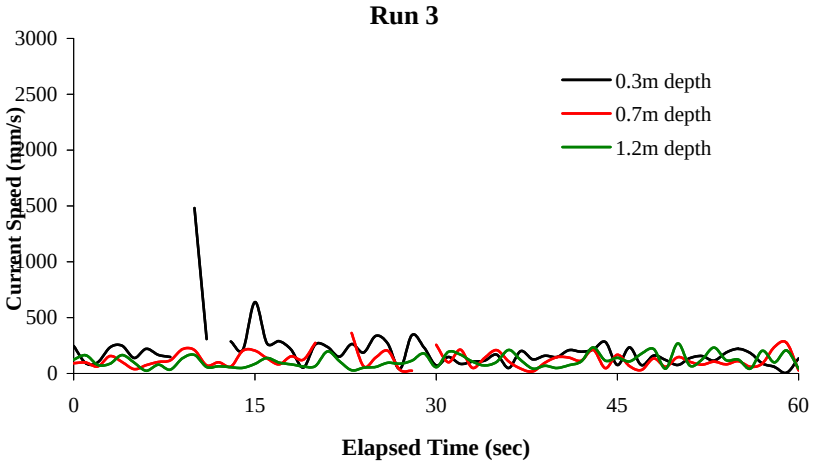
Fox River Propwash Study - Moving Vessel Trials

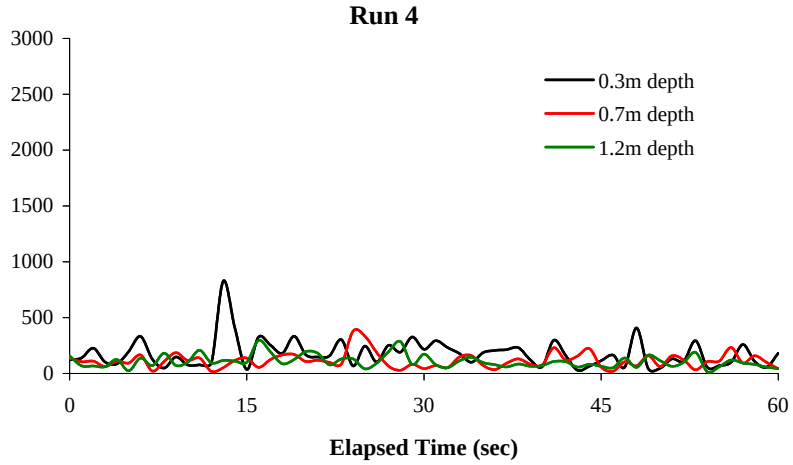
Test #14: Jetski - 5000 RPM - 35 MPH

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Fifteen

Run 1		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:00:25		183	97.9	156	66.6	172	26.6	106	356.2	93	137.6	75	102.4	42	180	167	92.1	95.13	102.1	93	198.2
1	10/25/2005 13:00:26		67	259.7	76	111.5	77	38.7	66	348.7	61	74.8	91	33.3	100	118.1	194	21.1	74.85	337.2		
2	10/25/2005 13:00:27		125	270	71	141.8	181	284	194	279.5	344	315.2	314	318.7	284	304.5	371	305	600.2	338.4		
3	10/25/2005 13:00:28		438	100.9	329	102.3	265	110.1	476	107.5	626	131.6			446	135.3			1868	149.2	648	59.7
4	10/25/2005 13:00:29		208	145.2	166	92.4	81	218	96	197.7											324	108.5
5	10/25/2005 13:00:30		292	53.5	235	69.1	230	90.5	220	109.9	261	76.9							1154	79.22	749	50.4
6	10/25/2005 13:00:31		259	90	192	96	102	73	79	170.5	55	352.7					484	110.7	257	132	218	49.1
7	10/25/2005 13:00:32		115	225.4	40	136	53	286.4	56	29.7	53	129.7					66	115	52.67	19.98	129	349.3
8	10/25/2005 13:00:33		97	24.4	27	56.9	169	103.7	86	315.5	130	128.1					48	283.2	138.8	170.9	411	26.4
9	10/25/2005 13:00:34		164	174.4	138	16.9	187	28.8	73	38.3	92	48.5	278	120.7			237	65.8	304.6	13.67	383	35.8
10	10/25/2005 13:00:35		54	99.6	38	151.4	145	246.1	69	310.9	43	33.7	79	40.9			180	283.5	128.5	309.6	142	349.5
11	10/25/2005 13:00:36				89	271.3	70	39.8	81	47	79	23	86	273.3					235.1	29.29	276	35.4
12	10/25/2005 13:00:37				191	162.3	178	81.6	129	20.8	133	335.2	183	183.1			239	295.8	120.4	265.2	93	325.1
13	10/25/2005 13:00:38				65	327.5	40	10.2	129	342.4	7	254.1	175	29.5			113	256.2	146.3	298.1	137	285.7
14	10/25/2005 13:00:39				178	37.5	196	65	146	41.1	23	217.9	198	17.6			35	213.2	27.59	313.5	112	35.5
15	10/25/2005 13:00:40		56	109.7	179	80	127	77.3	234	45.2	164	84.7	165	172.4			190	312.2	121.8	330.5	165	329.4
16	10/25/2005 13:00:41		90	162.6	150	334.8	92	154.8	187	354.2	76	320.9	97	153.7			216	288.6	103.1	341.9	242	352.4
17	10/25/2005 13:00:42		153	107.5	184	83.1	95	17.9	79	129.3	14	102.1	16	68.2			35	293.6	80.71	33.89	144	337.9
18	10/25/2005 13:00:43		242	101.2	79	59.5	205	23.9	137	61.2	46	143.9			140	147.6	99	173	180.9	70.96	66	336.9
19	10/25/2005 13:00:44		105	84.6	51	126.2	27	252.9	39	181.5	164	131.8	47	278.7	227	79.1	206	65.3	132.8	39.81	105	22.4
20	10/25/2005 13:00:45		60	229.7	46	111.6	211	43.7	106	12.6	102	70.5	88	109.3	280	258	209	213.7	160.4	172.5	94	125
21	10/25/2005 13:00:46		115	117.5	139	26.6	192	26.3	113	55	206	9	150	90	80	89.3	205	0.8	79.93	46.52	60	26.6
22	10/25/2005 13:00:47		111	322.7	53	298	103	41.4	194	316.3	169	262.9	267	325.5	343	77	75	305.2	137.1	339.1	134	301.9
23	10/25/2005 13:00:48		122	7.5	116	10.9	139	76.7	143	53	133	126.4	32	79	13	331.4	67	229.9	67.03	1.71	103	8.9
24	10/25/2005 13:00:49		335	22.7	120	53.1	36	51.8	52	109.1	82	95.6			167	7.2	94	282.9	144.3	290.7	119	70.3
25	10/25/2005 13:00:50				203	109.6	69	92.5	77	50.3	126	81.8	136	53.4	87	66.4	109	20.9	152.3	97.54	165	51.4
26	10/25/2005 13:00:51		135	206.9	130	75.3	175	100.2	144	4.8	105	82.9	311	1.3			111	156	57.01	158.4	137	53.6
27	10/25/2005 13:00:52		118	40.5	61	17.2	126	75.7	123	120.7	152	110			214	245.7	220	271.8	43.93	131.3	100	125.3
28	10/25/2005 13:00:53		43	315.9	116	87.5	224	62.9	124	156.7	70	18.4	71	261.1	154	60.4	99	350.2	26.93	328.7	134	343.6
29	10/25/2005 13:00:54		104	76.6	24	182.4	68	25.4	59	25.3	268	135.2			144	88.4	153	30.6	102.6	283	111	314.6
30	10/25/2005 13:00:55		102	49	216	30.4	211	45.6	61	284.3	280	30			98	68.4	170	75.3	213.5	70.29	92	36.1
31	10/25/2005 13:00:56		155	38.2	92	143.9	38	139.2	123	189.8	198	323.8	60	288.4			151	87.7	77.62	194.9	33	324.9
32	10/25/2005 13:00:57		70	358.4	91	88.1	89	73.6	148	40.9	136	68.9	370	331.2	97	9.5	124	62.6	67.08	116.6	184	90.6
33	10/25/2005 13:00:58		31	121.6	99	81.3	145	319.5	36	239.9	90	310	294	301.4	113	292.3	69	61.6	145.9	24.28	147	27.1
34	10/25/2005 13:00:59		95	279.7	168	44.8	121	72.6	11	296.6	78	82.6			113	314.3	183	21.8	174.6	290.1	171	72.3
35	10/25/2005 13:01:00		174	77.4	40	237.1	120	108	94	352	63	11.8	69	175	134	102.9	166	67.8	15.65	26.57	60	38.2
36	10/25/2005 13:01:01		44	71.6	129	64.8	182	113.3	93	122.3	103	127.5	14	175.9	189	111.4	14	129.3	134	347.9	314	53.2
37	10/25/2005 13:01:02		7	56.3	160	88.2	279	107.7	152	60.4	49	111.4	116	74.5	45	192.8	63	30.7	109	88.95	108	322.9
38	10/25/2005 13:01:03		33	237.3	107	30.9	97	73.2	220	275.2	46	339.6	204	46	162	54.1	106	59.3	94.49	39.42	160	69.1
39	10/25/2005 13:01:04		131	1.7	172	71.4	147	119.4	94	74.6	297	168.7	133	98.2	111	49	240	26.8	59.09	66.04	147	48
40	10/25/2005 13:01:05		100	7.5	58	254.1	30	201.4	177	66.3	148	353.4	88	29.2	79	39.3	129	84.6	127.7	350.5	185	25.6
41	10/25/2005 13:01:06		180	30	180	276.1	54	262.6	274	356.7	120	349.4	135	278.5	190	285.3	50	234.7	130	233.1	82	308.6
42	10/25/2005 13:01:07		167	24	240	50.1	173	333.6	51	322.9	126	342	189	49.9	116	19.1	59	300.5	112.1	15.52	143	32.5
43	10/25/2005 13:01:08		90	341.2			60	355.2	153	181.9	322	302.3	180	277.3	170	27.3	60	12.4	193.2	78.05	138	10.8
44	10/25/2005 13:01:09		147	118.8	167	317.4	85	278.1	103	335.4	173	257.3	123	231.9	79	25.6	76	329	141.4	278.1	151	111.8
45	10/25/2005 13:01:10		63	7.4	174	62.3	87	335.5	259	349.3	104	144	58	156.5	6	141.3	74	93.1	43.19	95.31	79	172
46	10/25/2005 13:01:11		70	218.7	54	215.2	41	341.6	52	22.6	174	199.5	262	246.4	64	293.8	105	333.4	182.2	53.26	112	32.6
47	10/25/2005 13:01:12		126	76.2	327	87.7	105	59	141	351.4	56	64.8	28	173.9	85	61	44	59.9	154.3	42.9	168	79.7
48	10/25/2005 13:01:13		179	93.8	123	155.5	37	57.2	113	27.5	230	340.1	159	13.1	81	302.9			72.69	277.9	148	92.7
49	10/25/2005 13:01:14		339	134.4	168	115	77	122.2	97	86.5	15	70.3	79	62.8	67	325.4	94	349.5	153.4	334.1	321	61.4
50	10/25/2005 13:01:15		276	7.7	59	44.3	136	257.7	129	74.2	174	308.2	185	21.9	38	38.7	22	13.4	51.31	213.1	53	18.8
51	10/25/2005 13:01:16		90	72	91	91.9	40	200.2	93	44.6	297	9.5	129	27.2	149	57.1	150	116.9	44.55	9.039	110	45
52	10/25/2005 13:01:17		203	66.2	147	131.7	171	69.4	118	55			128	199.1	68	79.8	81	1.4	72.01	62.72	153	85.5
53	10/25/2005 13:01:18		103	289.3	41	127.1	40	25.3	100	124.8	168	282	30	358.1	41	335.3	83	143.8	79.4	95.78	54	98.6
54	10/25/2005 13:01:19		134	39.5	120	91.4	78	104	96	80.4	110	159.3	57	23.9	88	287.8	269	163.6	47.52	188.5	88	165.5
55	10/25/2005 13:01:20		33	48.7	139	63.4	151	102.2	87	115.1	180	340.9	136	7.6	108	170.4	256	353.3	90.02	268.7	104	17.4
56	10/25/2005 13:01:21		93	200.8	146	107.9	54	93.2	39	50.2	12	55	51	77.6	57	130.1	190	4.8	56.75	255.7	133	233.6
57	10/25/2005 13:01:22		69	12.6	104	109.7	200	125.8	148	185.4	81	22.5	109	9.5	189	136.1	140	119.1	161.3	316.5	254	56.1
58	10/25/2005 13:01:23		33	298.9	97	106.2	181	22	123	47.6	69	326.3	166	86.6	234	125.6	94	110	113.5	202.3	143	29.2
59	10/25/2005 13:01:24		58	38.7	130	38.5	131	335.2	106	99.2	101	53.5	144	38.5	175	100.2	156	338.2	61.29	95.62	277	67.2
60	10/25/2005 13:01:25		102	15.4	108	67.2	105	109.5	42	120.3	23	316.7	126	292.5	122	38.4	87	268.7	138.2	202.1	75	232.1

Lower Fox River Moving Vessel Trials
Test Fifteen

Run 2																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:01:45		75	342.1	141	22.9	99	76.5	85	231.7	163	225.2	83	276.2	110	152.3	183	149.5	105.1	272.2	204	194.4
1	10/25/2005 13:01:46		187	333	182	36.3	101	52.2	62	50.2	104	64.4	46	17.7	76	121.6	221	45.5	92.14	273.1	120	50.1
2	10/25/2005 13:01:47		116	310.4	179	3.2	175	26.1	119	13.1	165	56.6	65	346.6	72	4.8	114	322.8	50.77	327.9	267	31.1
3	10/25/2005 13:01:48		137	172.5	230	98	54	88.9	7	135	108	226.1	112	238.9	139	223	44	346.9	47.51	220.7	71	250.3
4	10/25/2005 13:01:49		82	74.4	118	29	273	6.5	63	64.7	91	323	182	352.8	80	317.5	223	348.3	246	252	67	309.6
5	10/25/2005 13:01:50		75	129	152	1.1	128	92.7	75	350	87	161.1	135	147.1	162	150.4	190	180.6	129.6	185.3	33	122.7
6	10/25/2005 13:01:51		55	355.8	144	35.1	197	59.5	157	64.7	141	358.8	76	276	32	73.8	50	102.7	179.7	226.4	134	53.2
7	10/25/2005 13:01:52		53	51.8	233	92.5	47	260.1	138	87.1	174	9.2	25	161.6	191	278.4	167	11	36.77	225	328	57.8
8	10/25/2005 13:01:53		56	10.3	197	28.8	289	59.9	139	306.2	57	337.5	64	7.1	81	274.9	132	324.9	371.2	358	130	357.4
9	10/25/2005 13:01:54		354	106.1	305	97.7	308	118.7	270	91.3	307	118.6	523	107.8	501	57.6	474	72.1	577.5	75.87	878	88.9
10	10/25/2005 13:01:55		207	148.8	121	90.5	203	324.8	148	91.9			180	124.6	323	305.4	547	301.6	851.7	303.7	1157	304.6
11	10/25/2005 13:01:56		177	133.2	409	78.6			507	187.6	578	150.1					288	151.8	183.9	43.68	420	49.1
12	10/25/2005 13:01:57		64	115	63	167.1					418	196.4	314	203.3	187	281.1	631	199.4	339.1	209.9	518	71.9
13	10/25/2005 13:01:59		214	69.4	300	92.1	298	134	173	129.6	211	130.8	396	122.9	355	146.7	482	159.2	1140	71.44	926	52.6
14	10/25/2005 13:02:00		31	273.7	86	307	126	222.4	149	207.6	173	227.6	380	193.6	352	221.7	460	254.5	586.6	208.4	145	56.9
15	10/25/2005 13:02:01		74	45	178	148.5	313	88.4	233	115.9	234	137.6	198	184	231	243.8	252	148.6	229.1	51.38	672	44.9
16	10/25/2005 13:02:02		85	122	50	90	86	291.8	228	306.3	67	200.9	70	38	228	215.2	291	297.9	467.2	271.8	312	52.3
17	10/25/2005 13:02:03		103	119.8	132	96.5	50	91.1	228	14.2	265	341.8	184	301.2	104	266.7	152	263.6	316.7	23.25	646	30.1
18	10/25/2005 13:02:04		97	82.9	311	107.2	119	105.5	175	38.5	106	159	297	295.7	147	287.8	98	249.7	63.01	216	258	55.3
19	10/25/2005 13:02:05		183	78.3	183	13.3	142	11.4	152	23.2	253	0	387	359.4	249	352.6			311.2	355	330	356
20	10/25/2005 13:02:06		128	48.5	198	84.5	171	72.6	107	134.2	141	143.9	259	146.8	137	11.8	69	180.8	211.2	32.03	250	49.5
21	10/25/2005 13:02:07		51	295.6	109	12.8	72	111.2	121	358.1	73	47.8	39	166.7	329	335.8			176.2	305.8	383	355.1
22	10/25/2005 13:02:08		59	221.6	292	75.1	183	156.8	142	124.7	80	302.7	14	4.1	226	90			50.01	281.5	119	59.1
23	10/25/2005 13:02:09		113	22.5	229	103.9	84	52.7	32	304.7	26	119.5	174	313.6	56	121.1			199.7	33.77	249	350.5
24	10/25/2005 13:02:10		233	101.1	55	267.9	122	99.9	135	48	30	129.6	148	64.3	145	304.9	355	78.6	257.1	38.21	176	26.3
25	10/25/2005 13:02:11		67	191.1	226	91.5	106	344.1	284	14.9	25	168.7	102	107.7	448	54.3	282	77.1	345.9	55.48	267	13.7
26	10/25/2005 13:02:12		54	251.6	97	98.9	76	131.3	264	48.2			236	38.8	410	58.7	274	63.8	141.4	75.67	3	45
27	10/25/2005 13:02:13		45	333.4	106	48.1	201	71.7	52	23.6	167	58.2	139	78.8	448	68.2	186	95.3	183.5	321.2	26	51.3
28	10/25/2005 13:02:14		381	47.3	183	64.4	227	97.1	130	265.6	67	224.4	122	103.8	125	54.4	28	263.9	272	359.6	258	87.1
29	10/25/2005 13:02:15		34	26.6	60	181	139	334.4	154	294.6	123	272.8	90	277.7	83	36.2	108	258.3	192.6	355.5	156	33.5
30	10/25/2005 13:02:16		110	81.6	153	150.6	45	351	69	48.5	88	109.3	96	91.2	62	247.2	244	145	139.1	88.35	64	129.9
31	10/25/2005 13:02:17		60	97.7	252	72.4	60	206.6	114	48.2	118	22.4	125	73.3	132	182.2	244	298.1	137.4	41.46	229	25.7
32	10/25/2005 13:02:18		230	94	30	129.6	74	301.8	36	91.6	24	325	85	134	121	93.3	202	82.6	63.51	116.2	229	53.2
33	10/25/2005 13:02:19		65	343	152	56.8	159	342.5	320	22.6	48	37.3	58	304.5	207	6.6	28	85.9	83.49	96.19	123	349.2
34	10/25/2005 13:02:20		130	54.1	64	133.7	71	87.6	169	78	162	46.3	34	324.5	65	167.5	164	141.2	52.89	164.6	128	356
35	10/25/2005 13:02:21		223	44.6	65	69.3	126	82.3	164	12.3	40	293.4	30	180	130	246	54	132	171.5	246.3	64	69.9
36	10/25/2005 13:02:22		84	36.7			76	29.3	126	175.9	76	50.9	214	358.7	151	290.1	121	30.2	158.8	20.26	107	43.9
37	10/25/2005 13:02:23		208	49.3	126	63	79	5.1	200	356	83	55.7	128	105.9	161	75.6	212	88.9	173.1	81.03	267	94.9
38	10/25/2005 13:02:24		212	253.3	78	269.3	41	344.6	42	252	102	319.8	150	21.1	103	349.3	236	51.7	192.4	3.576	247	3.2
39	10/25/2005 13:02:25		20	267.1	170	35.7	87	325.8	36	50.6	115	27.5	95	172.1	48	130.7	35	86.7	215.4	31.33	243	359.1
40	10/25/2005 13:02:26		110	35	276	60.3	113	308.2	135	236.8	144	233.2	223	150.7	148	217.9	110	272.6	142.3	56.76	147	51.3
41	10/25/2005 13:02:27		61	95.6	167	323.3	91	118.3	108	15.6	35	45	131	96.1	192	348.9	42	102.4	126.2	33.69	86	5.3
42	10/25/2005 13:02:28		156	34.3	243	54.9	95	137.6	430	32.4	241	67.3	221	44.1	156	51.5	188	44.1	213.5	38.53	158	22.3
43	10/25/2005 13:02:29		108	103.4	180	80.1	90	97.7	161	177.2	151	70.6	41	88.6	72	148.1	262	134.7	129.3	129.4	163	121.9
44	10/25/2005 13:02:30		81	29.4	21	104	118	152.8			153	278.3	79	283.9	59	71.3	212	28.5	177.3	29.02	195	29.5
45	10/25/2005 13:02:31		192	77.3	171	57	163	79.7			125	252.3	160	53.1	193	8.3	169	28.2	62.1	345.1	321	37
46	10/25/2005 13:02:32		59	156.9	132	25.6			85	333.4	136	159.3	69	114.7	85	32	132	36.7	161.9	225.8	110	152.3
47	10/25/2005 13:02:33		155	88.9	62	56.8	200	30	63	25.3	34	100.3	68	80.7	189	3.6	76	328.4	94.37	49.73	183	55
48	10/25/2005 13:02:34		101	92.3	107	76	135	44.1	154	31.2	262	15.3	257	11.9	91	311.9	209	75.9	204.6	21.8	405	33.4
49	10/25/2005 13:02:35		198	48.3	122	224.7	59	258.3	259	241.7	85	154.9	80	39.4	140	180.8	108	177.3	103.8	169.4	114	200
50	10/25/2005 13:02:36		32	36.2	137	113.2	212	101.2	107	135.4	92	331.5	88	39.5	176	69	3	71.6	143.8	346.7	267	63.2
51	10/25/2005 13:02:37		91	21.2	174	104	122	98.5	46	124.4	76	356.2	80	44.5	92	248.2	93	84.5	137.4	150.8	206	48.3
52	10/25/2005 13:02:38		132	72.8	160	67.6	125	176.8	25	126.9	76	334.1	155	190.4	182	225.9	71	198.9	116.5	299.9	92	151.5
53	10/25/2005 13:02:39		211	79.6	72	120.1	30	64.3	90	156.3	147	181.6	46	167.5	52	139.6	153	44.5	45.65	61.19	35	137.3
54	10/25/2005 13:02:40		55	42.1	70	16.6	217	79.6	105	96	166	150	101	131.8	69	246.8	96	349.7	25.46	315	177	39.3
55	10/25/2005 13:02:41		70	122.1	74	352.2	44	27.1	70	63.8	57	153	90	205.7	69	227.3	139	352.2	58.31	59.04	171	8.4
56	10/25/2005 13:02:42		187	96.7	172	59.3	147	14.6	166	28.4	181	116.3	56	253.5	126	317.6	131	334.2	130.2	284.7	203	25.7
57	10/25/2005 13:02:43		146	120.1	232	50.4	173	20.6	35	130.4	75	146.9	109	176.3	254	5.2	160	59.9	216.9	33.91	192	46.9
58	10/25/2005 13:02:44		133	101.7	148	118.6	132	268.7	110	20.3	208	351.4	177	171.2	102	182.8	118	282.3	112.2	248	113	217.5
59	10/25/2005 13:02:45		96	99.6	101	221	48	349.2	87	15.9	125	55.4	129	167.9	94	9.8	143	29.2	232.4	36.43	302	21.4
60	10/25/2005 13:02:46		247	56.1	119	61.3	186	348.5	161	340.8	68	330.8	246	3.3	213	332.4	231	313.4	283.4	281.2	128	54.8

Lower Fox River Moving Vessel Trials
Test Fifteen

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 3		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:03:09		180	53.8	192	59.7	212	348.3	39	131.9	253	35.8	59	41.6	73	61.3	158	27.1	135.6	105	147	10.5
1	10/25/2005 13:03:10		120	117.8	128	88.7	73	89.2	164	249.7	44	69.9	185	38.9	90	124.6	57	137.9	49.48	14.04	94	131.5
2	10/25/2005 13:03:11		241	74.6	162	74.2	29	330.8	7	8.1	101	329.1	25	166	113	22.9	118	349.7	111.3	199.4	284	66.8
3	10/25/2005 13:03:12		67	37.7	83	120.3	100	282.1	147	286.2	144	40.2	279	39.3	175	81.1	184	11.6	226.9	258	274	32.9
4	10/25/2005 13:03:13		224	134.8	83	95.5	89	121.7	117	354.1	99	241.1	62	293.7	98	60	151	69.9	82.29	295.9	288	26.1
5	10/25/2005 13:03:14		105	136.9	74	272.3	142	95.3	76	250.9	191	253.8	26	83.4	135	63.1	182	142.1	118.4	326.7	80	325.7
6	10/25/2005 13:03:15		224	34.6	139	89.2	160	154.9	174	156.2	25	130.1	107	103	230	90.7	194	358.2	166.2	66.98	83	103.9
7	10/25/2005 13:03:16		91	83	86	197.6	51	77.6	184	132.4	70	39.8	145	1.2	95	278.5	180	355.9	75.11	86.95	58	198.1
8	10/25/2005 13:03:17		92	45.9	146	73.7	138	351.2	169	245.9	182	243.2	210	314.4	127	352.8	65	86.5	150	343.7	29	252.2
9	10/25/2005 13:03:18		145	109.8	153	51.1	67	131.3	129	50.6	163	13.5	85	68.6	87	52.5	259	96	59.21	85.16	448	55.3
10	10/25/2005 13:03:19		105	25.3	192	329	114	345.8	161	307.4	138	291.2	190	4.5	289	310.4	118	320.5	146.7	318.9	176	317.8
11	10/25/2005 13:03:20		183	72.9	300	58.9	161	91.4	223	77.3	266	89.8	266	48.8	230	16.4	34	206.6	218.6	34.56	221	342.1
12	10/25/2005 13:03:21		178	103.6	18	220.6	30	313.7	83	248.1	143	270.4	105	190.5	95	276.1	395	355.5	349	317.7	478	284.5
13	10/25/2005 13:03:22		109	134.3	218	134.8	95	69.7	134	150.9			457	120.8			228	322.8	64.5	330.3	52	149
14	10/25/2005 13:03:23		97	268.2	89	143.6	164	175.8	108	209.4	411	241.5	450	242.4	857	207.8	719	227.4	603.5	239.3	257	272.7
15	10/25/2005 13:03:24		136	143	183	176.2	98	152.1	475	122.5	255	54.7	613	81.3	58	171	154	187.4	350.7	75.81	679	58.2
16	10/25/2005 13:03:25		178	206.4	93	186.8	414	194.8	206	191.2	336	177.4			600	206.9	677	187	668.4	138	646	85
17	10/25/2005 13:03:26		154	96	105	134.6	219	40	31	56.8	49	210.8			161	153	523	142.5	448.8	70.88	728	56.9
18	10/25/2005 13:03:27		113	78.3	121	91.9	52	10			203	146.2	101	173.7	152	66	190	38.4	676.1	40.38	939	28.7
19	10/25/2005 13:03:28		17	35.5	124	25.3	85	230.3	81	227	282	238.3	92	242	244	337.1	304	334.4	569.4	336	569	25.5
20	10/25/2005 13:03:29		168	74.8	142	73.2	186	123.6			277	236.5	91	208.3	178	180	350	150.4	43.01	35.54	14	36
21	10/25/2005 13:03:30		44	58.8	89	313.2	33	225	110	157.6	76	0.8			288	356.2	157	354.1	327.2	9.146	424	14.8
22	10/25/2005 13:03:31		184	78.4	80	55.7	125	81.7	254	130.8	63	122.7	125	153.8			133	354.8	245.1	58.52	350	34.4
23	10/25/2005 13:03:32		131	326.8	88	342.2	84	136.4	45	220.5	90	253.2	148	283.3			533	323.9	253.2	239.9	212	340.7
24	10/25/2005 13:03:33		79	26.2	133	42	110	353.7	203	43.6	115	353	210	95.5	136	45	129	15.8	309.1	62.03	158	89.3
25	10/25/2005 13:03:34		107	34.7	207	229.9	73	345.8	47	352.7	12	215	93	46.3	97	317.9	47	252.7	219.2	289.2	112	26.6
26	10/25/2005 13:03:35		155	79.2	126	78.1	16	315	82	107.8	223	94.4	231	86.3	150	68.9	126	83.2	7.81	320.2	152	60.4
27	10/25/2005 13:03:36		163	34.8	79	7.3	127	261.9	34	239.6	141	305.2	95	121.7	134	286.5	109	79.9	262.5	26.47	363	23
28	10/25/2005 13:03:37		232	39.4	77	115.2	91	116.8	192	137.3	68	94.2	253	93.2	237	153.7	138	98.8	131	26.76	180	61.2
29	10/25/2005 13:03:38		112	51.2	117	86.6	176	70.4	117	317.1	31	303.2	20	323.1	143	297.1	177	266.4	62.18	332.2	174	352.8
30	10/25/2005 13:03:39		122	44	215	73.8	94	82.6	58	72.8	207	28.3	62	58.1	131	277	134	177.9	73.01	180.8	167	100.7
31	10/25/2005 13:03:40		156	74.7	95	162.1	170	121.1	35	13.2	135	27.3	123	27.6	35	21.5	179	212.9	79.4	95.78	185	61.2
32	10/25/2005 13:03:41		26	339.4	88	46.8	248	101.6	192	89.4	60	116.6	236	334.6	51	198.4	307	121.7	173.6	48.5	169	94.1
33	10/25/2005 13:03:42		133	78.3	13	288.4	164	74.8	184	102.5	324	81.5	237	40.2	92	53.9	427	107.3	282.7	62.17	191	69.2
34	10/25/2005 13:03:43		203	85.2	181	96.3	113	348.8	233	354.1	78	52.8	163	27.8	86	329.8	121	65.6	12.04	85.24	81	356.5
35	10/25/2005 13:03:44		162	185.7	105	31.4	144	14.9	138	10.4	9	18.4	120	283	183	30.2			226.4	64.91	277	68.4
36	10/25/2005 13:03:45		133	38.6	179	89.4	172	142.1	124	221.4	45	77.2	73	11.9	138	4.1	86	100	34.01	358.3	122	40.3
37	10/25/2005 13:03:46		164	15.9	170	75	153	39.4	166	41.1	220	346.1	268	67.4	102	46.6	106	72.9	133.8	28.1	332	48.3
38	10/25/2005 13:03:47		253	66.7	189	95.2	31	321.6	41	11.3	51	15.9	197	129	138	144.5	185	67.5	178.1	61.85	294	60.5
39	10/25/2005 13:03:48		67	75.3	292	62.9	161	44.5	40	71.1	142	358	71	36.4	186	62.1	104	48.5	170.1	15.34	350	39.8
40	10/25/2005 13:03:49		142	30.9	105	110	117	123.1	107	162.1	56	105.5	120	64.9	170	355.6	198	128.8	120.3	128.6	223	49.2
41	10/25/2005 13:03:50		28	22.9	104	88.9	100	77.9	106	96.5	90	140	177	319.4	120	208.3	31	317.6	55.79	284.5	201	4.3
42	10/25/2005 13:03:51		138	44.7	102	70	61	351.5	62	52.2	71	53.6	118	15.7	219	67.8	160	28	161.4	63.12	249	62.5
43	10/25/2005 13:03:52		176	80.2	89	136.8	148	66	81	94.9	80	111.1	76	90	30	270	125	317.6	57.28	134.3	55	359
44	10/25/2005 13:03:53		76	346.3	131	63.2	98	355.3	150	100.3	54	117.5	168	72.3	190	38	250	160.8	205.9	299.1	59	182.9
45	10/25/2005 13:03:54		111	203.3	92	14.5	119	153.6	56	88	140	79.7	71	27.6	146	28.1	75	153.8	65.03	88.24	104	46.2
46	10/25/2005 13:03:55		65	54.4	52	302.5	83	289.7	169	338.5	74	120	63	134.4	102	179.4	132	205.6	32.98	256	98	67.9
47	10/25/2005 13:03:56		112	191.8	67	339.1	106	293.9	66	3.5	75	21.8	183	82.4	157	73.8	110	354.2	185.9	330	195	35.8
48	10/25/2005 13:03:57		138	68.3	174	22.6	149	350.7	144	349.6	66	247.7	97	333.2	23	121	83	30.3	82.87	278.3	142	8.1
49	10/25/2005 13:03:58		186	339.5	72	5.6	111	343.2	103	276.2	123	27.2	159	25.8	121	193.3	174	321.8	125	320.2	140	356.7
50	10/25/2005 13:03:59		252	30.5	167	59.7	88	50.5	115	168.5	154	47.9	110	15.3	206	139.7	80	54.7	123.7	96.03	77	51.3
51	10/25/2005 13:04:00		234	38.6	40	98.5	39	140.2	45	42.3	35	146.8	161	303.6	207	352.8	102	78.7	23.32	59.04	108	228.4
52	10/25/2005 13:04:01		146	133.9	146	10.7	61	260.5	33	257.7	111	5.1	21	223	127	121.4	192	356.1	88.07	282.5	148	54.4
53	10/25/2005 13:04:02		116	44.3	218	51.3	200	57	14	12.1	27	13	52	110.2	57	319.3	62	41.1	112.6	19.72	339	48.6
54	10/25/2005 13:04:03		90	82.3	152	127.2	172	353	131	5.7	155	73.5	257	60.8	108	37.8	100	183.4	94.89	151	161	72.7
55	10/25/2005 13:04:05		236	126.9	134	87.4	241	78.7	88	117.1	121	118	142	94.4	170	77.1	159	53.4	208.1	99.96	158	96.5
56	10/25/2005 13:04:06		86	359.3	61	149.7	83	35.2	66	266.5	99	159.4	187	47.6	233	27.7	196	48.5	150.1	32.21	195	46.5
57	10/25/2005 13:04:07		168	80	220	27.4	109	83.1	70	0	94	130.3	162	64.1	155	44.2	195	57.8	115.4	72.35	346	77
58	10/25/2005 13:04:08		163	125.5	53	156.8	26	17.7	109	101.6	66	44.4	40	63.4	182	66.7	200	91.4	130.9	83.42	108	81.5
59	10/25/2005 13:04:09		94	15.4	202	133	66	216.3	30	50.4	136	115.2	101	55.5	253	156	218	268.4	92.7	156.5	123	253
60	10/25/2005 13:04:10		74	171.4	134	133.8	181	92.5	309	58.4	131	118.3	15	262.4	119	203.3	212	328.5	69.64	302.1	101	72.6

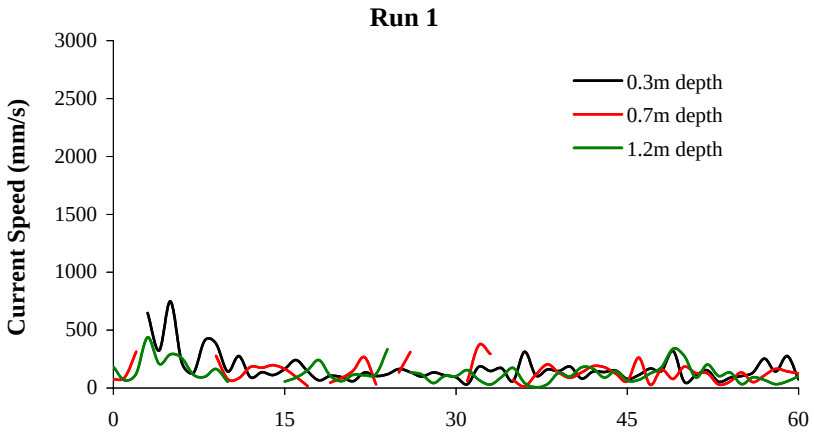
Lower Fox River Moving Vessel Trials
Test Fifteen

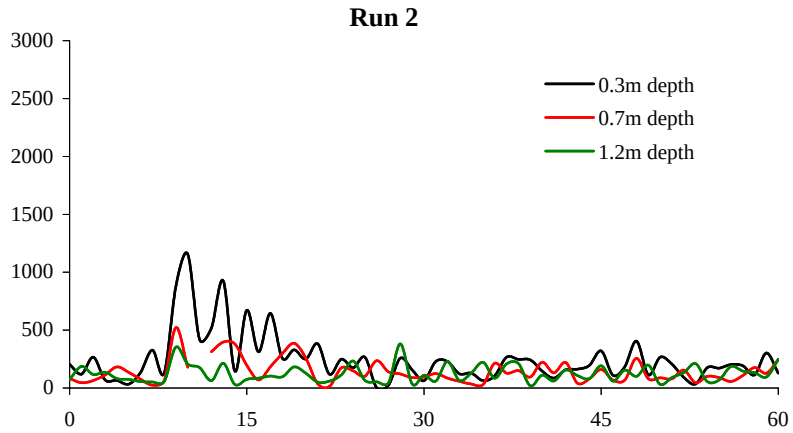
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 4		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:06:12		141	114.4	47	108.4	220	84.3	128	141.3	127	288.9	120	318.4	101	43.8	59	51.2	65.19	221.3	170	43.8
1	10/25/2005 13:06:13		145	41.1	193	42.1	201	104.1	119	344.9	87	267.4	97	201.3	44	96.5	112	101.8	95.71	190.8	193	70.6
2	10/25/2005 13:06:14		150	29.5	234	47.6	207	35.4	137	331.8	26	305.5	137	338.1	178	75			69.31	136.2	309	40.8
3	10/25/2005 13:06:15		187	74.8	40	336.6	132	7	120	288	64	100.8	106	354.6	117	11.8	97	65	57.63	218.7	118	77.3
4	10/25/2005 13:06:16		260	49.7	86	60.2	51	119.1	122	84.3	85	110.6	103	99.5	137	100.5	89	48.2	79.61	26.89	194	54.8
5	10/25/2005 13:06:17		149	78.4	82	48	112	79.2	29	270	73	326.1	57	80.9	67	249.1	96	7.2	79.62	11.59	120	13.5
6	10/25/2005 13:06:18		175	27.1	173	47.8	223	2.6	111	275.1	80	101.6	121	327.5	70	173.5	61	113.2	106.9	301.6	108	71.6
7	10/25/2005 13:06:19		55	186.2	88	43.2	172	48.5	150	35.8	42	316.9	162	332	50	70.1	49	29.2	96.57	291.3	107	260.3
8	10/25/2005 13:06:20		121	57.5	101	66.7	156	147.8	74	352.2	85	223.1	20	11.3	67	13.8	64	87.3	74.55	83.07	173	354.7
9	10/25/2005 13:06:21		169	87	143	73	201	67.5	142	35.8	157	208.2	113	164.6	50	190.4	135	218.4	163.6	306.8	120	4.3
10	10/25/2005 13:06:22		225	59.8	156	21.5	69	320.3	233	58.4	152	99.8	46	57.3	113	108.1	97	218.8	139	270.8	362	4.6
11	10/25/2005 13:06:23		105	142.4	141	23.5	147	339.2	151	352	254	57.6	205	25.1	50	140.6	131	90	117.9	10.26	302	21.4
12	10/25/2005 13:06:24		389	60.7	325	83.8	267	95.8	235	88.8	338	83.5	312	90.7					224.9	63.32	136	95.1
13	10/25/2005 13:06:25		155	99.6	133	225	20	116.6	85	223.1	118	276.8	243	259.8			554	225.1	260.7	240.1	685	290.2
14	10/25/2005 13:06:26		184	69.3	257	104.6	239	82.1	130	106.5	260	155.4							451.2	275.7	676	325.1
15	10/25/2005 13:06:27		54	27.5	241	146.5	87	198	78	277.4	151	149.9	119	128.5			321	186.4	207.2	272.8		
16	10/25/2005 13:06:28		211	89.7	189	66.3	216	89.7	289	113.6			346	206.3	749	99.5	283	78.8	697.2	40.52	780	32.9
17	10/25/2005 13:06:29		124	158.8	135	209.8	63	223.1	21	174.6	386	187.8	147	193.4	505	250.5	398	252	493.4	301.7	482	24.7
18	10/25/2005 13:06:30		272	86.6	192	38	152	58.7	100	24.3	164	114.1	138	86.3	332	92.4	326	112.2	208.8	34.07	756	34.6
19	10/25/2005 13:06:31		147	103.8	92	31.6	123	78.8	148	204.3	120	207.8	148	165.5			178	111.8	237.7	46.36	153	48.7
20	10/25/2005 13:06:32		139	70.3	123	14.1	134	53.8	100	218.1	142	76.6	338	147.6	258	153.2	161	92.1	366.7	59.52	443	44.5
21	10/25/2005 13:06:33		91	64.6	84	86.6	41	344.2	66	53	74	121.1	130	331.5	64	157	45	133.2	82.02	1.397	314	37.7
22	10/25/2005 13:06:34		256	65	239	63.6	154	352.9	38	277.5	73	60.6	157	210.7	192	204.7	62	148.1	172.9	338.6	161	24.2
23	10/25/2005 13:06:35		25	49.9	133	68.4	84	61.6	271	345.7	340	10.5	242	328.7	263	17.5	270	50.1	69.97	211	188	55.6
24	10/25/2005 13:06:36		146	69.1	60	341.6	264	355.2	77	78.8	338	331.9	206	344.6	67	269.1	222	288.1	76.24	175.5	183	93.4
25	10/25/2005 13:06:37		125	340.8	150	19.5	38	317.1	110	324.3	230	344.3	305	321.9	179	322.5	138	60.1	153.6	53.2	138	58
26	10/25/2005 13:06:38		205	23.3	109	88.9	91	341.4	135	9.4	174	61.5	121	95.7			153	45	91.41	79.92	248	62.9
27	10/25/2005 13:06:39		135	78	102	105.4	97	315.4			80	225.5	97	299.7	100	99.7	73	295.2	130.5	346.7	84	307.3
28	10/25/2005 13:06:40		168	29.9	44	273.9	171	47.8	116	8.9	109	328.9	175	279.2	220	327.8			77.83	339.7	187	34.5
29	10/25/2005 13:06:41		16	346	115	151.9	90	238.6	76	332.8	113	281.2	87	328.1	140	337.3	241	288.9	27.89	255.5	214	44.8
30	10/25/2005 13:06:42		12	180	87	296	183	338.2	94	263.3	155	320	406	358.6	150	39.9	112	279.2	87.46	38.97	314	37.9
31	10/25/2005 13:06:43		100	68.3	41	105.4	143	66.5	368	328.7			121	357.6	110	120.5	98	24.2	190.1	1.809	81	7.8
32	10/25/2005 13:06:44		128	21.1	20	156	142	47.9	181	312.3	88	37.6	57	23.9	85	51.2	217	65.4	360.7	48.71	328	13
33	10/25/2005 13:06:45		223	65.4	192	43.7	38	287	122	80.5			103	344.2	104	50.5	147	116.7	193.8	43.33	353	37.9
34	10/25/2005 13:06:46		122	68.9	129	64.8	214	68.6	181	357.5	117	155.2	68	330.8	34	232.1	82	33.1	151.6	138.7	136	46.2
35	10/25/2005 13:06:47		47	332.4	83	117.2	168	75.1	81	148.7	73	289.9	32	81.1	216	80.9	312	6.4	177.8	13.33	183	110.8
36	10/25/2005 13:06:48		201	53.1	95	71.6	92	27.1	159	335.9	97	33.2	68	293.5	94	117.9	273	42.3	382.2	42.46	375	43.7
37	10/25/2005 13:06:49		132	189.2	95	97.9	40	290.2	150	353.9	192	31.1	216	92.4	88	59.9	161	100	131.5	68.12	138	40.3
38	10/25/2005 13:06:50		165	213.4	104	0.6	20	32.9	98	294.2	103	144.9	80	324.1	123	10.8	28	159	154.7	351.5	160	52.1
39	10/25/2005 13:06:51		111	68.3	122	113.6	132	108.2	210	72.9	124	208.8	63	221.8	36	281.3	110	306.1	109	348.9	29	38
40	10/25/2005 13:06:52		178	102	91	64	44	50.5	306	224.3	90	246.3	124	20.3	392	59.6	142	79.9	224.7	69.15	325	59.2
41	10/25/2005 13:06:53		79	73.9	109	109.9	51	90	41	194	96	81.6	124	97	252	77.4	185	75.6	267.8	76.17	225	85.4
42	10/25/2005 13:06:54		185	100.3	135	66.5	98	85.9	124	14.5	149	52.4	95	71	78	8.9	204	22.2	296	60.66	139	39.4
43	10/25/2005 13:06:55		210	60	97	23.7	200	4.9	155	128.2	86	332.2	136	302.4	99	1.7	197	95.2	137.5	66.42	357	42
44	10/25/2005 13:06:56		191	83.7	64	289.3	93	34.5	71	217.5	78	261.9	253	51.4	256	39.8	235	42.2	189	54.04	119	26.4
45	10/25/2005 13:06:57		137	41.7	124	34.5	91	337.4			87	62	281	77.7	270	58	149	88.1	145	91.19	107	107.4
46	10/25/2005 13:06:58		72	121.9	117	79.2	104	94.9	319	49.7	48	100.8	254	104.1	69	88.3	165	109.4	142.7	62.9	72	54.1
47	10/25/2005 13:06:59		55	129.8	125	49.2	99	159.4	47	258.9	57	3	107	67.5	133	37	64	29	111.6	59.3	160	39.9
48	10/25/2005 13:07:00		36	123.7	61	177.2	140	128.3	48	102	164	178.3	186	177.8	93	130.2	95	121.7	53.31	23.2	166	59.3
49	10/25/2005 13:07:01		167	83.1	35	221.5	134	343.5	143	341.7	145	10.3	125	28.6	135	75.5	192	71.8	200.6	122.6	211	76
50	10/25/2005 13:07:02		114	1.5	149	51	137	69.4	150	74.6	137	38.2	180	55.9	194	27	79	44	234	65.52	125	100.6
51	10/25/2005 13:07:03		84	122.4	75	115.2	122	120.6	109	39.8	36	33.7	121	12.9	202	73.6	115	131.8	94.02	119.3	120	127.5
52	10/25/2005 13:07:04		67	40.8	150	39.3	172	12.1	113	26.8	90	91.9	121	50	233	57.8	192	332.4	58.14	40.82	118	349.3
53	10/25/2005 13:07:05		232	74.5	127	118.2	180	38	73	99.5	74	90.8	78	96.7	72	45	98	80.6	146.1	49.44	82	65.6
54	10/25/2005 13:07:06		107	64.6	166	30.4	131	30.3	102	135.8	61	151.8	96	212.2	130	143.7	214	180.8	64.88	204.6	55	95.2
55	10/25/2005 13:07:07		46	13.7	246	27.6	32	299.7	59	32.6	302	38	59	52.5	142	31.8			189.4	302.9	225	359.7
56	10/25/2005 13:07:08		278	20	142	90	98	69.7	199	59.2	124	74.6	170	73.3	124	23.3	193	127.2	135.8	46.79	204	55.4
57	10/25/2005 13:07:09		273	111.5	73	58.5	280	88.8	174	71.6	22	84.8	175	129	19	126.3	306	158.1	110.2	176.4	53	305.8
58	10/25/2005 13:07:10		27	234	144	315.3	103	60.5	92	4.4	211	90.8	245	39.2	319	63.8	66	38.3	118.2	38.13	172	77.6
59	10/25/2005 13:07:11		66	83.9	53	353.5	66	72.4	125	36.9	264	31.7	188	40.9	60	125.5	235	67.8	65.39	203.4	126	225
60	10/25/2005 13:07:12		187	91.2	106	59.3	162	104.3	112	45	56	352.9	83	80.3	48	51.7	76	46.6	92.27	175.6	125	4.6

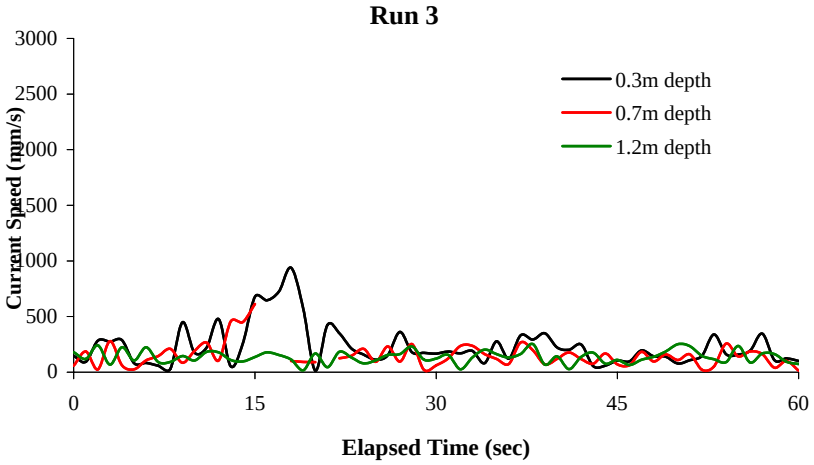
Fox River Propwash Study - Moving Vessel Trials

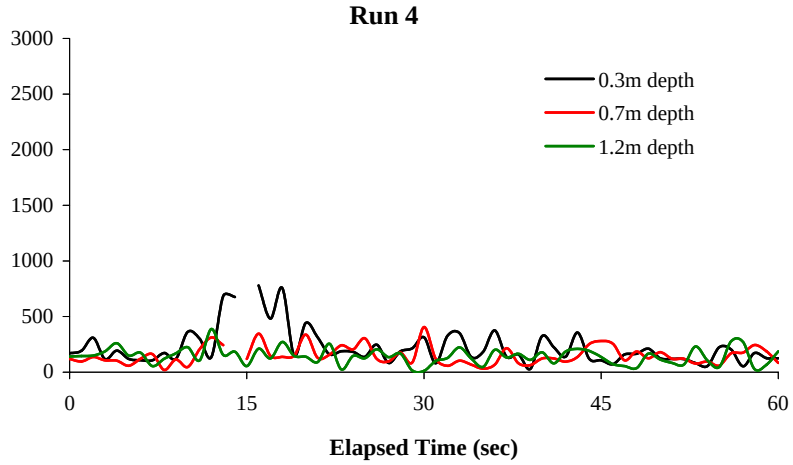
Test #15: Jetski - 3000 RPM - 8 MPH

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Sixteen

Run 1																								
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:11:08		55	16.8	98	254.7	130	201.6	37	341.1	102	2.8	109	315.7	38	81	159	170.2	88.57	173.5	130	107.9
1	10/25/2005 13:11:09		166	127.1	33	3.5	145	126	55	139.4	159	321.9	166	90.3	105	110	92	98.7	154.3	256.5	59	331.7
2	10/25/2005 13:11:10		85	53.1	119	135.7	129	19.4	61	62.6	160	32.5	31	341	91	85.6	278	123.9	44.78	23.7	57	319.3
3	10/25/2005 13:11:11		175	92.9	54	94.2	43	87.3	45	56.7	234	89	227	66.4	132	357.4	183	21.8	147.1	16.59	278	26
4	10/25/2005 13:11:12		107	63.4	156	36.1	135	64	147	1.6	101	21	70	31	151	23.8	153	317.1	43.29	83.37	111	67.1
5	10/25/2005 13:11:13		150	87.7	102	3.4	135	39	231	22.9	160	62	149	36.8	108	22.3	101	91.1	55.04	267.9	225	42.8
6	10/25/2005 13:11:14		64	46.3	156	36.9	193	83.8	135	54.3	200	71.3	134	4.3	156	45.3	126	160.6	329.5	77.74	72	125.9
7	10/25/2005 13:11:15		140	82.6	264	87.2	113	38.2	97	104.9	37	260.8	239	62.4	266	18.2	246	112	7.616	113.2	127	42.1
8	10/25/2005 13:11:16		241	160.1	188	87.6	79	127.3	66	129.5	86	272	113	92.5	72	118.4	148	130.1	111.5	264.3	101	32.9
9	10/25/2005 13:11:17		210	51	75	0	171	100.1	76	15.3	161	63.4	111	142.3	103	97.3	64	131.9	73.16	21.66	68	58.9
10	10/25/2005 13:11:18		196	107.2	111	114	107	61	222	68.9	235	105.6	132	138.7	167	88.6	106	144.2	181.7	294	114	25.4
11	10/25/2005 13:11:19		115	139.2	168	106.9	287	74.8	162	113.2	217	142.1	93	131.9	240	58.6	101	79.7	342.2	71.25	197	73.8
12	10/25/2005 13:11:20		209	74.8	13	81.3	86	29.8	131	105.5	220	67.5	75	36.9	223	331.6	202	358	220.7	341.6	254	328.7
13	10/25/2005 13:11:21		74	146.5	58	18.1	9	130.6	16	299.7	140	316.7	157	0.7	185	53.6	120	152.8	209.8	207.5	1177	338.7
14	10/25/2005 13:11:22		138	52.6	51	353.3	156	121.3	49	134.2	77	83.2	104	120.5	178	136.1			261.9	119	433	4.4
15	10/25/2005 13:11:23		72	82.8	154	64.3	60	18.4	143	293.9	66	68.5	70	65.6	102	26.1			137.6	159.6	81	121.3
16	10/25/2005 13:11:24		167	53.7	176	116	77	161.8	88	90.7	10	163.3	221	74.5	311	19.1			398	75.89	115	80.5
17	10/25/2005 13:11:25		178	88.1	194	130	300	50.4	219	1.3	238	328.3	159	345.4	55	2.1	264	352.2	484.1	74.3	96	27.9
18	10/25/2005 13:11:26		76	71.6	77	151.1	345	87	89	53.3	86	140.2	124	355.8	162	349			44.1	86.1	151	52
19	10/25/2005 13:11:27		190	82.7	57	79.9	77	211.2	35	242.7	40	288.9	124	323.5	65	0	32	264.6	39.45	329.5	212	58.1
20	10/25/2005 13:11:28		267	73	146	53.9	78	13.3	112	93.6	92	30.7	99	344.8	31	284.9	235	26.2	102.5	354.4	56	39.9
21	10/25/2005 13:11:29		138	70.1	163	23.1	210	317.7	132	63.4	38	6	85	257.8			79	157.7	89.44	79.7	135	90
22	10/25/2005 13:11:30		206	60.7	71	93.2	431	71.1	88	34.8	94	54.1	138	162.7	193	128.1	243	64.2	202.4	47	141	39
23	10/25/2005 13:11:31		114	67.9	200	55.6	156	66.6	65	338.2	129	334.2	97	90	20	206.6	204	71.1	116.4	19.06	386	56.1
24	10/25/2005 13:11:32		122	76.8	171	1	93	322.4	159	24.1	73	122.2	255	103.2	260	170.2	176	125	78.1	272.9	220	15.8
25	10/25/2005 13:11:33		167	56.2	149	106	444	347.2	109	333.2	95	162.9	102	338.7	87	113	73	258.1	76.28	55.68	111	45.4
26	10/25/2005 13:11:34		170	63.4	117	356.6	60	356.2	107	141.1	88	145.2	208	259.5	77	279			264.8	94.55	404	68.1
27	10/25/2005 13:11:35		82	99.1	61	111.1	91	102.7	51	331.9	14	257.9	329	164.9	202	98.5			107	48.41	108	82.5
28	10/25/2005 13:11:36		257	84	180	58.4	87	192	109	107.1	139	278.2	211	125.6	167	50.1			313.2	52.65	348	45
29	10/25/2005 13:11:37		248	61.9	102	87.2	311	122.7	150	14.7	93	160.6	140	92.9					170.3	74.33	67	55.4
30	10/25/2005 13:11:38		210	95.2	138	50.3	24	125	117	122.1	211	105.4	136	97.2	236	106.2			163	23.89	122	50.3
31	10/25/2005 13:11:39		308	69.4	126	74.3	53	51.2	86	2.7	41	330.9	56	72.2	133	234.8	175	359.3	70.21	342.6	127	15
32	10/25/2005 13:11:40		197	76.2	108	88.9	128	63	107	109.6	190	42.7	41	39.1	120	35.5	119	1	127.9	26.97	244	48.5
33	10/25/2005 13:11:41		187	118.1	97	131.2	94	228.5	100	341.9	360	1.8	74	277	105	29.7	158	98.7	140.2	60.51	132	86.5
34	10/25/2005 13:11:42		119	99.7	61	43.7	59	17.8	83	304.3	164	67	86	55.9	121	58.5	84	35.8	34.93	346.8	214	38.2
35	10/25/2005 13:11:43		191	83.1	125	27.2	131	300.3	71	5.6	163	161	177	106.8	69	116.6	115	65.2	153.2	29.74	328	51.7
36	10/25/2005 13:11:44		119	40.9	176	26.3	114	149.4	60	183.8	103	69.4			155	123.7	146	107.6	191.4	79.16	192	49.7
37	10/25/2005 13:11:45		140	60.5	141	64.3	255	65.6	207	40.7	265	88.1	60	97.7	91	16.6	162	21.8	100.3	99.18	222	112.5
38	10/25/2005 13:11:46		260	65	291	81.9	120	43.7	112	301.8	112	239.3	74	42.8	104	36.8	468	355.7	244.3	267	178	40.2
39	10/25/2005 13:11:47		179	85.2	59	47.7	100	35.6	25	170.9	119	203.3	50	266.6	69	313.2	208	152	174.4	97.25	288	105.7
40	10/25/2005 13:11:48		91	109.8	26	38.7	237	58.7	137	66.3	125	36.9	137	37.9	144	341.8	101	35.7	84.5	69.21	130	27.9
41	10/25/2005 13:11:49		129	6.2	133	33.7	118	80.7	158	101.7	211	113.2	161	256.7	131	79.9	77	107.5	153	131.8	91	179.4
42	10/25/2005 13:11:50		166	90	105	83.4	117	43.6	50	348.5	91	77.3	102	11.3	216	40.5	109	45	85	64.94	226	55.3
43	10/25/2005 13:11:51		159	89.6	180	34.6	170	56	212	42.7	195	147.8	115	245.4	86	358.7	125	147.1	56.09	348.7	143	54.6
44	10/25/2005 13:11:52		177	89	209	63.9	205	12.7	241	343.1	75	145.3	119	288.6	118	47.8	121	30.4	120.6	290.4	183	55.3
45	10/25/2005 13:11:53		56	74.5	131	52.4	254	354.1	28	102.5	86	200.3	228	252.7	64	157	87	192.6	150.4	259.7	142	92.8
46	10/25/2005 13:11:54		140	71.3	182	59.6	142	117.6	54	135.7	89	336.9	69	163.1			55	152	80.92	130	173	88
47	10/25/2005 13:11:55		16	116.6	109	5.2	172	45.7	92	120.7	173	59.4	145	262.9	210	151.2	88	347.5	91.79	60.64	161	72.2
48	10/25/2005 13:11:56		60	82.3	203	44	170	61.6	169	109.7	68	5.9	70	242.7	76	150.1	177	357.1	65.97	284	82	43
49	10/25/2005 13:11:57		6	128.7	92	86.3	78	111.9	178	89.7	188	170.2	32	46.3	117	99.9	161	128.7	124.4	85.39	194	69.1
50	10/25/2005 13:11:58		115	131.8	220	50.7	211	53.1	210	352.1	260	323.7	121	72.6	83	348.1	275	116.3	105.5	347.4	265	43.3
51	10/25/2005 13:11:59		49	9.5	99	78.3	123	278.4	111	23.8	121	66.6	118	32.2	110	31.2	110	69.3	160.3	40.45	79	16.8
52	10/25/2005 13:12:00		213	95.4	176	41.3	88	42.7	151	34.7	127	12.3	134	16.9	131	38.2	153	103.6	45.65	208.8	177	47.7
53	10/25/2005 13:12:01		135	91.7	72	354.4	129	3.1	161	55.9	150	28.3	134	9.5	241	98.8	172	70.3	93.64	19.98	109	66.3
54	10/25/2005 13:12:02		111	73.2	28	6.1	110	87.9	38	242.1	84	261.8	91	160.2	185	120.2	131	54.6	111.2	41.72	13	321.3
55	10/25/2005 13:12:03		138	80.8	152	68.3	120	122.1	107	110.3	115	169.5	86	60.2	102	74.6	273	11.6	196.7	47.06	132	76.4
56	10/25/2005 13:12:04		157	60.2	20	45	159	31.1	114	41.1	112	20.9	174	83.7	113	110.2			223.2	87.43	258	77
57	10/25/2005 13:12:05		243	33.4	101	359.4	71	303.5	231	309.9	81	232	162	92.5	124	99.8	100	224.6	110.5	9.377	247	55.2
58	10/25/2005 13:12:06		228	88.2	162	78.6	151	45.5	109	107.1	92	168.7	64	256.4	145	57.4	86	336.1	166.8	332.5	133	7.3
59	10/25/2005 13:12:07		61	120.8	90	29.1	128	40.6	171	91.3	105	4.4	141	80.6	63	26.6	224	87.4	146.7	56.96	180	69.9
60	10/25/2005 13:12:08		63	36	46	349.9	302	78.5	47	128.1	160	58.8	125	63.8	92	351.9	208	35.2	235.2	29.84	348	43.6

Lower Fox River Moving Vessel Trials
Test Sixteen

Run 2		Depth (m)	1.2		1.2		1.1		1.1		1.0		1.0		0.9		0.9		0.8		0.8		0.7		0.7		0.6		0.6		0.5		0.5		0.4		0.4		0.3		0.3	
		Range from ADCP (m)	0.4		0.4		0.5		0.5		0.6		0.6		0.7		0.7		0.8		0.8		0.9		0.9		1		1		1.1		1.1		1.2		1.2		1.3		1.3	
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:12:28		210	82.1	92	87.5	107	129.3	134	112	145	335.9	184	87.5	96	88.8	322	144.7	111.4	184.6	99	168.9																		
1	10/25/2005 13:12:29		97	50.4	148	55.5	78	52.8	37	102.5	73	305	103	131.4	87	84.1	208	147.4	89.82	78.44	168	76.5																		
2	10/25/2005 13:12:30		183	43	80	110.5	65	86.5	111	356.4	86	314.5	89	41.4	152	16.4	111	102.5	169.6	61.47	262	54.3																		
3	10/25/2005 13:12:31		194	30.7	82	296.9	120	118.9	23	85	39	145.5	155	180.7	80	20.5	156	23.8	81.34	200.9	183	133																		
4	10/25/2005 13:12:32		55	143.1	56	163.5	164	66.3	169	223.8	150	90.8	83	178.6	165	33.4	198	52.4	149.2	44.73	114	27.2																		
5	10/25/2005 13:12:33		231	108.9	95	46.3	147	45.6	138	94.1	48	141	132	325.5	263	342.3			123.1	335.5	287	36.6																		
6	10/25/2005 13:12:34		155	70.7	162	51.5	179	20.3	118	304.6	99	186.4	55	196.8	96	12	45	330.6	53.94	79.32	60	117.8																		
7	10/25/2005 13:12:35		134	73.1	158	40.1	24	92.4	190	268.8	143	280.4	63	193.8	41	230.9			81.22	350.1	110	66.9																		
8	10/25/2005 13:12:36		92	158.2	125	125.6	181	104.7	119	104.2	111	35.1	69	42	145	14.8	88	335.8	142.7	31.24	326	58.8																		
9	10/25/2005 13:12:37		59	143.3	159	88.2	109	74.6	80	111.1	99	319.5	82	90	51	128.7	274	143.2	439.2	63.2	174	65.5																		
10	10/25/2005 13:12:38		40	243.4	18	310.6	134	73.1	171	150.1	162	235	61	334.7	59	237.4	325	340.8	593.2	339.1	861	338.4																		
11	10/25/2005 13:12:39		122	107.1	128	56.2	223	108.3	192	57.6	189	345	112	19.2	274	140.3	119	55.6	118.7	55.64																				
12	10/25/2005 13:12:40		90	35.1	209	82.3	123	84.4	104	232	139	40.9	167	91.7	156	94.4	334	165.3	30.44	132.3	285	351.9																		
13	10/25/2005 13:12:41		84	164.1	186	77.9	143	121.6	37	349	79	130.9	110	115.9	142	180.8					750	80.8																		
14	10/25/2005 13:12:42		118	85.6	103	97.3	92	134.1	84	48.4	32	200.1	42	43.1			109	79.4	309.6	122.2	770	92.8																		
15	10/25/2005 13:12:43		164	84.4	76	8.3	59	27	159	263.5	145	40.3	93	84.5			179	114.7	270.2	84.69	633	100.9																		
16	10/25/2005 13:12:45		86	315.9	192	83.1	85	81.2	75	8.5	191	350.6	317	356.6	247	60.9	240	120.3	308.2	122.1	455	78.8																		
17	10/25/2005 13:12:46		154	68.6	32	114.1	76	319.8	153	265.5	69	94.1	149	129.6			221	306.4	145	270.8	237	23.6																		
18	10/25/2005 13:12:47		135	73.7	208	130.1	81	120.4	49	157.1	73	101.9	142	350.3					406	90.71	365	72.5																		
19	10/25/2005 13:12:48		185	78.1	137	52.7	67	342.6	95	73.5	204	75.8	138	129.7			326	59.8	266.6	60.07	426	68.4																		
20	10/25/2005 13:12:49		227	95.3	172	75.2	34	137.4	54	357.9	106	238.1	102	161.2	19	161.6	253	295	248.5	8.097	226	39.6																		
21	10/25/2005 13:12:50		129	85.6	217	100.6	55	100.5	174	252.6			95	332.4	38	355.5			217.3	109.4	30	156																		
22	10/25/2005 13:12:51		97	31.6	95	117.6	167	111	137	103.9	106	356.8	117	144.4	182	81.8			118.5	78.31	306	76.8																		
23	10/25/2005 13:12:52		94	88.2	229	64.3	116	33	127	54.3			143	107.9	226	91.8			178	64.73	380	59.5																		
24	10/25/2005 13:12:53		59	35.3	226	65.4	128	124.8	130	73.5	185	53.6	172	166.2			137	77.8	110.1	151.8	272	150.2																		
25	10/25/2005 13:12:54		122	76.2	84	16.7	183	43.9	78	127.2	159	26.9	221	305.8					97.69	157.1	203	130.2																		
26	10/25/2005 13:12:55		73	62.4	58	25.7	86	69.7	74	82.2	104	36.4					84	271.4	87.97	81.5	260	48.9																		
27	10/25/2005 13:12:56		210	327.4	212	104.5	83	91.4	101	80.4	37	64.1	199	25.9			60	348.5	167	17.78	172	19																		
28	10/25/2005 13:12:57		178	79.6	220	107.2	119	107.1	62	325.5	114	6.6	51	281.3			238	76.9	207.4	96.65	252	87.7																		
29	10/25/2005 13:12:58		70	213.9	69	37.4	47	60.7	48	54.3	85	125	110	70.4			250	123.2	102.7	121.1	85	120.5																		
30	10/25/2005 13:12:59		150	127.7	232	88	34	71	222	31	175	87.4	62	217.8			117	31	87.92	123.9	42	331.6																		
31	10/25/2005 13:13:00		109	68.4	146	103.8	231	17.9	139	337.1	11	123.7	99	31.8			112	333	232.1	25.79	235	29																		
32	10/25/2005 13:13:01		158	75.7	90	72	201	340.6	91	321.2	88	329.9	322	344.7					196.4	353.3	332	12.9																		
33	10/25/2005 13:13:02		107	114.2	128	72.3	139	64.4	161	81.4	189	81.8	122	127.3	197	348.9			174.4	86.05	431	65.6																		
34	10/25/2005 13:13:03		102	80.4	145	124.3	95	77.9	107	22.5	118	273.4	128	32	97	163.2			131.8	22.29	82	113.7																		
35	10/25/2005 13:13:04		36	194.4	129	77	98	129.2	54	351.4	179	0	19	124.5	52	334.9			41.23	140.9	76	316.1																		
36	10/25/2005 13:13:05		71	44.4	123	41.1	30	334.3	85	76.5	137	87.5	188	82.6	142	168.6			94.19	356.3	74	7.8																		
37	10/25/2005 13:13:06		115	76	168	49.6	32	330.3	108	50.3	84	8.9	128	48.5	107	314.6			281.2	291.3	73	58.5																		
38	10/25/2005 13:13:07		157	98.8	198	70.6	86	70.9	104	29.3	127	18.9	12	125	168	54.4	75	322.1	419.6	42.78	172	49.3																		
39	10/25/2005 13:13:08		136	97.6	223	79.6	156	71.7	155	74.6	145	325.4	72	1.6			123	64.9	222.8	59.52	150	54.2																		
40	10/25/2005 13:13:09		139	65.3	232	68.5	14	234	119	45	11	270	113	23.4			254	33.3	227.7	25.21	175	43.8																		
41	10/25/2005 13:13:10		176	44.8	212	18.7	27	26.6	110	123.1	144	167.6	130	53.7			84	349.8	191.5	20.8	245	33.4																		
42	10/25/2005 13:13:11		203	28	135	57.4	125	24.5	98	329.2	538	158.6	62	284.9	60	231	123	295.9	163.1	329.8	51	102.4																		
43	10/25/2005 13:13:12		98	93.5	251	156	57	109.4	112	94.1	49	30.8	112	126.7	145	268.4	131	232.4	200.6	41.16	266	87.6																		
44	10/25/2005 13:13:13		75	74.5	87	109.5	120	11	72	321.2	67	47.4	107	15.2	55	214.6	119	241.3	65.76	298.1	179	40.9																		
45	10/25/2005 13:13:14		86	90.7	93	26.8	55	210.8	15	82.4	104	39.9	69	60.5	46	10.1	75	137.2	77.65	352.6	103	66.7																		
46	10/25/2005 13:13:15		111	26.1	106	50	78	88.5	52	103.2			134	72.2	156	77.4	70	334.5	36.24	140.6	179	75.1																		
47	10/25/2005 13:13:16		56	70.3	94	112.5	140	76	119	338.8	76	81.7	60	48.4	157	9.2	54	194	64.51	341	111	62																		
48	10/25/2005 13:13:17		93	63.2	26	110.6	68	255.6	151	39.6	84	68.3	170	18.1	526	83.9	256	64.3	127.5	73.13	177	102.1																		
49	10/25/2005 13:13:18		46	73.5	55	200.1	47	351.3	91	96.3	53	355.7	253	144	259	91.1			61.4	253.9	109	67.9																		
50	10/25/2005 13:13:19		238	62.1	124	113.7	89	102.3	29	354.1	84	283.7	77	234.5	49	31.8			147.3	111.5	42	169																		
51	10/25/2005 13:13:20		45	81	113	45.7	90	342	63	44.4	83	27.2	119	80.3	73	317.8			62.24	226.3	186	95.9																		
52	10/25/2005 13:13:21		91	104	120	53.1	93	47.6	58	336.5	94	32			28	4.1	79	201.7	87.42	324.3	166	20.1																		
53	10/25/2005 13:13:22		123	48.9	80	344.7	81	29.7	92	293.8	105	307.6	176	267.4	219	324.3	224	214.3	125.2	251.9	52	214																		
54	10/25/2005 13:13:23		121	54.1	175	43.4	68	34.9	176	31.5	63	0	76	6.8	156	322.5	74	143.7	210	45.96	300	72.3																		
55	10/25/2005 13:13:24		98	122.6	169	96.5	68	95.9	15	137.7	144	317.2	143	99.3	179	250.8	71	357.6	37.12	94.64	71	231.8																		
56	10/25/2005 13:13:25		107	25.4	231	66.5	151	105.8	103	127.1	103	154.7	60	49.7	183	88.7	191	151.1	43.01	234.5	198	37.4																		
57	10/25/2005 13:13:26		65	58.3	139	31.7	80	43.5	53	340.2	95	276.1	137	218.5	109	19.3	291	180.2	46.04	214.4	112	55.2																		
58	10/25/2005 13:13:27		187	61.7	156	16.8	117	70	127	351.9	72	296.2	30	101.7	524	359.2			59.08	56.04	51	80.9																		
59	10/25/2005 13:13:28		170	28.8	84	13.7	182	53.5	133	307	32	306.2	58	111.3	181	184.8			285.3	321.4	97	10.1																		
60	10/25/2005 13:13:29		218	27	140	42.1	50	101.5	143	105.8	120	179.5	66	23.1	117	332.6	103	168.3	127.5	151.4	150	268.5																		

Lower Fox River Moving Vessel Trials
Test Sixteen

Run 3		Depth (m)	1.2		1.2		1.1		1.1		1.0		1.0		0.9		0.9		0.8		0.8		0.7		0.7		0.6		0.6		0.5		0.5		0.4		0.4		0.3		0.3	
		Range from ADCP (m)	0.4		0.4		0.5		0.5		0.6		0.6		0.7		0.7		0.8		0.8		0.9		0.9		1		1		1.1		1.1		1.2		1.2		1.3		1.3	
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:13:45		104	78.9	50	105.2	122	193.2	102	110	173	127.5	183	145	88	213	161	249.7	59.48	106.6	23	77.2																		
1	10/25/2005 13:13:46		130	171.6	104	20.2	55	62	92	218.9	129	82	136	56.7	80	206.6	82	304.1	115	244.8	159	173.1																		
2	10/25/2005 13:13:47		57	54.9	51	87.8	147	28	183	61.3	65	341.3	95	65.1	107	307.4	176	343.1	55.15	337.6	166	35.4																		
3	10/25/2005 13:13:48		116	285.5	121	50.4	208	66.8	146	113	18	310.6	32	123.7	235	107	182	132.1	39.81	191.6	102	17.7																		
4	10/25/2005 13:13:49		91	74	61	208.2	74	190.9	24	289.2	35	304.6	117	65.8	198	305.1	44	211.2	87.36	105.9	112	42.1																		
5	10/25/2005 13:13:50		80	344.7	135	335.9	47	342.7	67	100.3	193	91.5	154	69.1	77	71.1	173	357.7	148.9	337.9	207	26.4																		
6	10/25/2005 13:13:51		142	32.9	159	60.7	103	77	34	328.2	113	68.7	57	23.9	83	250.9	95	295.5	136.5	219.1	112	336.9																		
7	10/25/2005 13:13:52		170	98.5	61	62.6	147	63.3	36	298	66	347.7	142	29.4	217	219.9	104	244.4	156.8	122	96	168.6																		
8	10/25/2005 13:13:53		137	80.7	150	60.4	40	69.3	115	54.9	166	47.7	115	116.3	324	70.5	188	216.1	169.9	50.97	160	57																		
9	10/25/2005 13:13:54		147	87.7	166	74.3	67	43.2	61	307.1	49	343.4	232	358.5	139	322.3	209	198.4	145.5	336.1	169	15.4																		
10	10/25/2005 13:13:55		137	344.7	152	114	28	59.7	59	128.8	250	216.9	164	145.4	146	95.5	174	97.2	135.4	144.3	82	183.5																		
11	10/25/2005 13:13:56		205	50.3	170	107.5	176	56.1	18	49.4	81	6.3	139	15.8	144	347.1	181	329.7	333.1	358.5	515	8.1																		
12	10/25/2005 13:13:57		160	103	103	60.9	102	141.3	78	155.7	68	330.8	229	105.7	168	207.3					1138	318.4																		
13	10/25/2005 13:13:58		92	103.9	130	155	71	135	179	153.1	30	187.6	137	133.2	291	154.3					191	339.2																		
14	10/25/2005 13:13:59		206	111.3	109	358.9	56	107.8	118	150.6	15	227.7	42	166.3	79	100.9	230	34.4	260.1	18.96	305	7.4																		
15	10/25/2005 13:14:00		64	78.3	185	36	176	27.7	35	270	195	296.4			265	20.8	188	42	181.2	25.15	131	40																		
16	10/25/2005 13:14:01		22	24.2	11	116.6	19	207.9	88	98.5	144	104.5	415	200.7	80	38.9	151	6.1	219.5	280.2	155	355.9																		
17	10/25/2005 13:14:02		88	43.6	103	116.6	52	233.6	136	151.9	150	122.7	119	43	110	156.9	290	348.1	108.2	31.78	219	50																		
18	10/25/2005 13:14:03		91	100.8	154	128.1	26	110.6	121	138.7	116	93	98	318.7	237	19.5	270	319.8	36.88	12.53	166	353.4																		
19	10/25/2005 13:14:04		49	35	30	140.4	20	40.9	88	251.4	139	240.3	68	112.4	70	359.2	101	290.2	33.11	205	222	53.6																		
20	10/25/2005 13:14:05		114	66.1	174	43.1	284	112.1	154	103.5			118	108.3	98	127.9	146	244	114.8	106.7	221	81.4																		
21	10/25/2005 13:14:06		111	52.7	187	75.4	115	123.7	51	307.1	129	200.8	127	335.3	133	79.6	338	66.6	145.2	19.31	285	53.6																		
22	10/25/2005 13:14:07		151	61.1	95	201.7	126	95.5	23	23.2	145	224.2	112	349.2	93	253.7			84.29	41.63	283	65.8																		
23	10/25/2005 13:14:08		178	22.4	281	91.8	223	135.9	52	196.7	450	65.3	105	122.2	194	79	221	105.5	174	45.47	208	65.3																		
24	10/25/2005 13:14:09		71	72.1	27	201.8	160	283.3	117	196.9	72	230.6	112	299.6	119	331.5	186	14.3	259	89.56	155	91.1																		
25	10/25/2005 13:14:10		168	53.5	205	63.3	173	80.4	136	263.2	61	271.9	68	189.3	124	300.5	145	74.4	199.4	83.09	80	51.6																		
26	10/25/2005 13:14:11		126	107.1	204	48.2	91	90	74	341.8	123	41.1			141	118.9	193	8.6	53.23	205.6	162	62.5																		
27	10/25/2005 13:14:12		147	36.7	127	113.1	163	103.1	149	88.8	61	97.6	452	162.2	126	19.4	201	82.3	229.2	65.78	327	101.7																		
28	10/25/2005 13:14:13		55	85.8	167	44.5	34	35.5	111	152	213	99.7			241	39.1	302	8.6	242	52.89	327	51.2																		
29	10/25/2005 13:14:14		34	188.4	82	84.4	42	139.8	54	94.2	81	209.4	163	348.3			210	345.4	225.8	26.57	183	351.2																		
30	10/25/2005 13:14:15		162	80.1	113	79.3	181	36.7	306	314.6	117	59	79	58.9	117	32.7	79	111.4	183.5	38.81	167	35.5																		
31	10/25/2005 13:14:16		152	78.2	219	49.8	511	133.3	102	16.5	12	340	110	76.8	44	205.4	192	307.6	45.65	28.81	219	139.3																		
32	10/25/2005 13:14:17		142	89.6	100	135.8	74	89.2			136	229.2	53	175.7	191	180.3	94	352	199	106.3	246	123.2																		
33	10/25/2005 13:14:18		119	94.3	70	147.2	68	162.1	181	52.9	206	68	153	85.5	135	14.1	179	104.6	27.8	52.31	249	52.7																		
34	10/25/2005 13:14:19		94	132	100	144.7	76	47.7	132	17.2	220	261.9	208	26.2	189	53.6	101	67.2	182.5	46.78	359	24.9																		
35	10/25/2005 13:14:20		187	90.3	181	100.5	144	70.1	161	167.1	166	166.8	55	56	315	275.1	161	29	276.8	37.37	352	16																		
36	10/25/2005 13:14:21		154	103.9	43	5.3	31	320.2	75	54.2	134	111.4	65	130	322	248.9	65	55.6	107.2	176.3	217	40.1																		
37	10/25/2005 13:14:22		202	77.1	16	352.9	77	29.6	157	18.9			71	73.6	75	108.7	127	79.1	300	98.05	379	79.7																		
38	10/25/2005 13:14:23		268	113.8	113	92.5	90	113.7	147	65.9	34	79.7	133	147.9	41	105.4	77	348.8	100.7	139	289	104.6																		
39	10/25/2005 13:14:24		78	108.7	128	28.6	60	257.6	83	15.4	103	82.2	143	66.1	138	95.8	184	104.5	225.3	78.74	274	30.5																		
40	10/25/2005 13:14:25		89	55.1	192	61.3	75	263.1	139	287.5	89	301.7	130	239.5	189	82.1	142	87.6	138	110.8	193	110																		
41	10/25/2005 13:14:26		132	128.3	163	76.1	345	59.3	15	11.3	197	307.8	145	134.7	221	104.2	139	37.1	128.7	315	432	36.6																		
42	10/25/2005 13:14:27		198	81.9	155	90.7	55	270	62	325.5	65	71	51	116.6	81	55.5	173	342.5	61.4	52.94	234	35.6																		
43	10/25/2005 13:14:28		182	81.2	64	143.8	108	88.9			185	333.7	126	350.4	131	58.1	103	43.8	17.8	321.8	150	77.7																		
44	10/25/2005 13:14:29		135	84.9	81	109.6	102	8.4			36	52.8	55	149.2	48	90	76	51.9	163.8	98.43	161	101.8																		
45	10/25/2005 13:14:30		59	42.9	70	98.2	258	23.1	34	301.8	70	71.6	134	85.7	214	129.1	78	87.8	69.63	282.4	162	76																		
46	10/25/2005 13:14:31		82	174.4	194	41.7	197	319.7	23	59	81	317.5	256	234.1	95	153.7	158	195.8	204	77.26	61	95.6																		
47	10/25/2005 13:14:32		146	45	107	347	108	126.3	73	316.7	51	265.5	75	43.9	78	101.9	130	324.7	84.17	66.18	242	98.3																		
48	10/25/2005 13:14:33		107	65.8	181	21	112	125.5			131	118.7	191	167.3	41	52.9	200	188	25.61	128.7	138	93.3																		
49	10/25/2005 13:14:34		92	86.9	192	28.6	74	22.1	366	116.6	86	42.2	84	4.8	247	3.5	16	76	163.5	47.73	75	358.5																		
50	10/25/2005 13:14:35		47	258.9	170	88.3	155	159.2	59	34	167	336	167	61.4	164	213.3	55	38.3	133.1	32.74	113	61.4																		
51	10/25/2005 13:14:36		167	82.8	9	90	164	144.7	126	61	223	49	336	344.8	87	95.9	165	283.7	194.4	304.1	154	20.6																		
52	10/25/2005 13:14:37		134	70.9	93	350.1	106	92.2	34	349.7	153	50.1	140	149	52	292.6	77	55.1	172	55.66	209	27.7																		
53	10/25/2005 13:14:38		132	46.5	196	13.9	167	81.7	118	94.4	146	272.4	56	122.6	198	342.4	31	58.4	47.89	61.29	280	45																		
54	10/25/2005 13:14:39		205	70.3	238	30.3	89	87.4	219	98.1	177	67.4	10	150.9	84	68.3	269	51.9	144.2	77.99	208	60																		
55	10/25/2005 13:14:40		98	24.2	173	46.6	147	48.6	64	143.3	120	229.4	400	79.2	187	83	255	70.5	138.2	62.88	276	35																		
56	10/25/2005 13:14:41		88	359.3	162	65.5	40	88.6	138	252.7	134	156.3	269	78.6	270	71.9	306	91.9	224.6	69.95	175	72																		
57	10/25/2005 13:14:42		73	37.8	262	60.2	193	59.4	62	223.7	24	53.6	81	71.3	121	60.3	93	29.1	182	41.66	209	55.3																		
58	10/25/2005 13:14:43		86	315.9	83	57.8	127	80.5	82	189.8	58	85.1	100	349.6	207	38.5	144	106.5	123.2	38.08	113	44.3																		
59	10/25/2005 13:14:44		139	29.3	140	40.6			89	84.9	151	91.5	209	79.5	144	210.8	140	34.3	127.4	36.06	185	41.7																		
60	10/25/2005 13:14:45		186	61.4	149	79.6	120	11.5	233	324.6	164	104.1	179	73.5	105	320.4	103	42.2	43.83	55.22	98	43.8																		

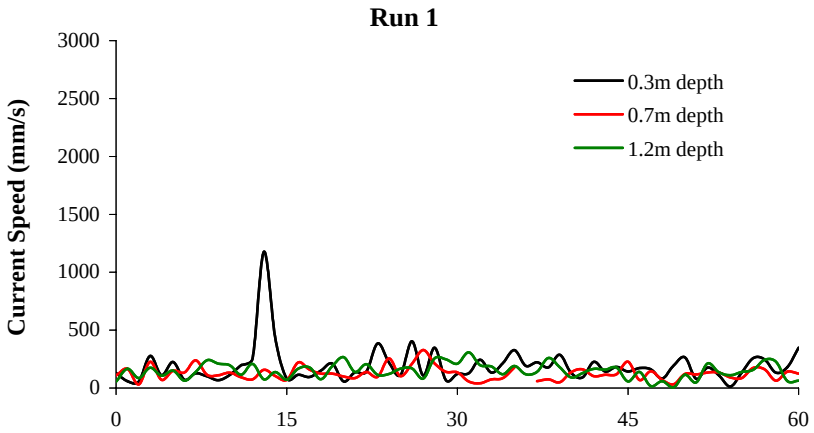
Lower Fox River Moving Vessel Trials
Test Sixteen

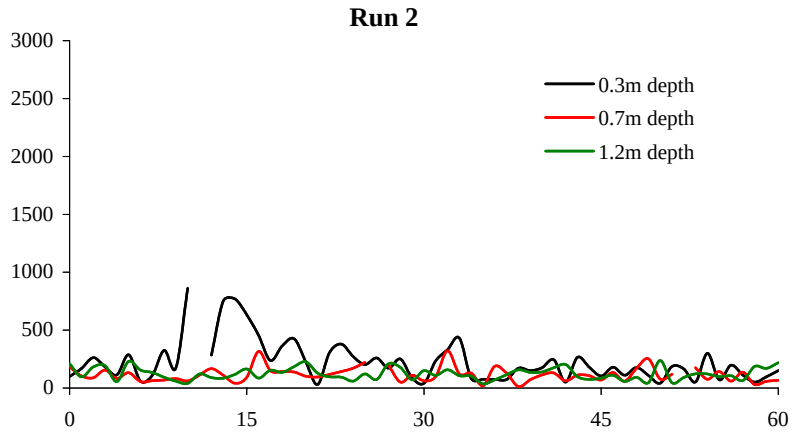
Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:15:08		100	357.7	139	43	191	64.9	102	1.1	299	3.5	42	234.8	52	193.2	182	0	12.17	80.54	162	69
1	10/25/2005 13:15:09		113	83.4	237	75.1	123	73.9	65	39.4	83	345.3	88	38	116	235.2	243	285.5	71.17	340.3	215	64.6
2	10/25/2005 13:15:10		149	63.8	119	129.6	51	100.2	6	9.5	280	56.4	171	48.3	115	82	327	350.1	287.8	238.4	71	356.8
3	10/25/2005 13:15:11		71	151.3	130	102.4	113	149.6	218	121.9	224	69.4	140	86.3	50	262	130	179.6	46.65	211	65	176.5
4	10/25/2005 13:15:12		227	85.7	118	111.4	76	333.4	88	52.4	45	160.3	68	52.8	178	80.3			73.01	283.5	82	330
5	10/25/2005 13:15:13		94	55	25	270	59	11.7	175	1.6	181	289.3	63	255.3	82	166.6	129	175.1	173	282.3	145	32
6	10/25/2005 13:15:14		204	74.7	193	82.2	40	97.1	106	249.5	57	256.7	14	339	194	98.3	206	85.8	186.8	31.65	219	50.6
7	10/25/2005 13:15:15		71	84.4	162	90.7	147	105.4	56	235.2	127	298.8	95	74.1	163	135.5	60	240	210.6	52.91	260	46.7
8	10/25/2005 13:15:16		182	40.1	94	284.8	138	60.1	38	107	120	276.7	72	150.9	203	53	69	95.8	98.08	200.3	111	261.2
9	10/25/2005 13:15:17		75	26.9	191	72.6	162	27.2	142	199.7	32	41.2	64	53.3	4	270	69	137.3	87.6	288.6	121	77.6
10	10/25/2005 13:15:18		157	74.1	299	68.6	147	106.2	36	352.1	206	321.5	24	167.7	110	39.5	123	71	127.2	286.4	21	81.9
11	10/25/2005 13:15:19		97	66.3	134	138.9	70	221	133	352.7	168	62.7	254	0.5	101	34.9	264	21.8	486.3	3.36	727	356.8
12	10/25/2005 13:15:20		127	24.1	124	104	194	76.3	81	56.1	107	104	66	133.8	92	156.2					930	326.9
13	10/25/2005 13:15:21		149	132.8	110	121.9	78	92.2	62	121.1	210	109.7	281	158.5					946.8	71.34	781	11.5
14	10/25/2005 13:15:22		147	58.4	144	108.2	81	294	89	176.8	20	32.9	125	121.3			267	70.1	263.9	67.03	157	15.1
15	10/25/2005 13:15:23		133	48.7	62	327.6	19	145.5	64	344.7	86	289.7	111	326			185	64.7	116.4	331.2	155	2.2
16	10/25/2005 13:15:24		137	41.5	91	31.9	67	128.9	56	322.3	30	11.7	118	112.4	211	129			104	157.4	85	332.5
17	10/25/2005 13:15:25		47	83.9	117	127.4	61	11.3	79	75.3	157	77.5	113	282.3	64	9.9	164	40.3	46.1	114.3	119	355.7
18	10/25/2005 13:15:26		179	107.5	76	208.2	150	30.5	98	39.2	208	205.7	128	280.3	111	74.3	361	12.2	139.9	320.5	170	6.4
19	10/25/2005 13:15:27		234	35.8	190	46.9	40	33.7	38	52.5			262	21	106	28			216	0.796	213	17.2
20	10/25/2005 13:15:28		93	28.2	14	265.9	68	194.4			75	157.2	93	112.7	191	106.2	100	69.6	71.57	105.4	273	50.2
21	10/25/2005 13:15:29		92	356.9	98	330.8	39	305.7			101	217	168	179.7	111	156.2	59	174.2	77.01	142.4	193	112.8
22	10/25/2005 13:15:30		140	144.3	336	91.2	89	72.4			110	243.7	137	158.7	121	263.3	55	8.4	133.1	32.74	377	37.8
23	10/25/2005 13:15:31		192	52.4	132	114.6	16	284.9	161	251.9	371	184.9	47	78.9	99	168.9	75	70.6	68.59	45.59	114	65
24	10/25/2005 13:15:32		107	29.2	196	113.8	44	232.4	185	187.5	263	232.9	158	143.5	98	230	72	47.2	75.03	91.53	187	78.9
25	10/25/2005 13:15:33		72	94.8	96	131.6	67	122.7	127	174.6	139	216.5			69	66.8	99	227.5	91.71	18.43	135	89.6
26	10/25/2005 13:15:34		104	109.1	83	83.8	63	99.2	41	4.2	123	225			77	189.7	125	161.3	60.11	44.33	136	71.2
27	10/25/2005 13:15:35		64	89.1	149	80.7	244	67.1	19	21.3	123	64.5			88	5.8	133	35.5	175.3	27.15	264	62
28	10/25/2005 13:15:36		81	66	137	20.6	84	136.4	170	118.8					189	12.2	141	60.7	143.8	51.78	246	41.9
29	10/25/2005 13:15:37		199	131.9	174	111.6	86	296.3			72	338.8	176	73.5	255	36.2	91	43.2	81.22	52	261	66.3
30	10/25/2005 13:15:38		98	95.9	175	133.6	103	137	47	33.7	78	356.3	302	18.6	292	32.8	228	55	199.6	80.77	320	62.5
31	10/25/2005 13:15:39		10	101.3	51	102.4	129	319.4	117	90	91	30.2	72	12.1	123	62.4	237	63.8	174.6	4.927	231	38.5
32	10/25/2005 13:15:40		77	40.8	39	62.8	62	158.4	216	286.2	132	225.9	54	274.2	137	275	52	25.1	99.76	42.97	267	25.8
33	10/25/2005 13:15:41		187	132.4	174	107.7	177	11.1	99	213	54	287.1	121	14.8	192	45	233	125.7	115.3	43.95	195	52.7
34	10/25/2005 13:15:42		71	60.6	76	105.3	158	148.7	240	185.5	443	231.5	209	57.7	213	106.1			239.9	84.98	291	81.5
35	10/25/2005 13:15:43		180	47.7	24	255.4	88	191.2			217	256.2	80	18.2	27	180	57	174	159.8	66	101	37.3
36	10/25/2005 13:15:44		84	69.8	126	64	225	44.3	135	124.7	141	246.2			61	181.9	2	296.6	251.1	72.14	256	53.1
37	10/25/2005 13:15:45		53	341.2	85	147.1	135	112.2			282	224.6			207	88.9	38	328	91.79	7.512	5	258.7
38	10/25/2005 13:15:46		27	126	76	180.8	245	173.9	26	15.6	184	260					102	61.2	29.83	283.6	118	301.8
39	10/25/2005 13:15:47		60	60.9	88	47.3	254	157.1	106	289.3	121	254.7	211	252.1			124	19.3	272.5	38.59	172	51.6
40	10/25/2005 13:15:48		186	90.3	198	66.5	71	66.7	137	140	92	57	78	170.4	91	199.2	2	206.6	93.92	108.6	109	36.5
41	10/25/2005 13:15:49		154	289.4	106	61.7	78	151.8	397	240.7	79	319.1	325	330.5	68	244.6	271	292.8	93.41	291.3	163	52.5
42	10/25/2005 13:15:50		248	83.8	77	90.7	102	65.2	109	65.1			60	15.4	172	89.7	143	80.3	175	83.77	359	86.6
43	10/25/2005 13:15:51		110	158.8	206	77.7	93	87.5	285	33	176	54.7	187	248	185	328.3	129	330.3	196	312.7	172	14.8
44	10/25/2005 13:15:52		110	135.7	132	107.2	139	107.5	113	160.3	148	237.7	69	59.7	64	106.4	252	149.8	88.77	104.3	297	130.1
45	10/25/2005 13:15:53		81	82.9	142	141.8	158	161.2	65	109			127	223.7	116	246.1	188	334.1	157	26.89	214	23.9
46	10/25/2005 13:15:54		101	84.9	55	40.6	25	168.2	143	258.7			72	168.8	75	129.6	24	94.8	199.8	67.03	161	62.3
47	10/25/2005 13:15:55		169	71.8	111	155	158	159.6	85	89.3			64	351	153	339	47	70	83.22	4.135	223	15.3
48	10/25/2005 13:15:56		42	6.8	76	119.3	109	100.6	47	213.7	15	121.6	76	125.4	68	115.4	50	55.7	81.86	295.3	271	47.2
49	10/25/2005 13:15:57		213	110.3	36	48.4	60	167.6	90	54	117	101.8	172	346.9	157	6.2	255	43.6	68.6	59.32	80	62.5
50	10/25/2005 13:15:58		57	175	125	20.2	30	166.4	94	267	237	196.7	182	186.6	138	5.4	205	20.3	75.96	286	120	44
51	10/25/2005 13:15:59		63	81.7	62	97.5	144	85.2	223	182.6	157	183.6	140	58.5	149	67.6	183	87.5	136.5	61.56	222	102.5
52	10/25/2005 13:16:00		43	1.3	47	71.6	148	112.6	51	282.4	63	355.5	118	2.4	140	257.6	205	331.2	99.28	26.31	131	353.9
53	10/25/2005 13:16:01		89	154.9	213	166.2	40	53.1	129	44.4	170	46.4	169	92.7	279	75.5	102	3.9	105.9	56.16	56	155.7
54	10/25/2005 13:16:02		89	55.1	178	59.7	160	60.1	82	190.5	28	320.7	44	262.2	120	137.7	298	113.6	35.23	83.48	119	50.1
55	10/25/2005 13:16:03		123	152.8	126	83.6	9	32	84	97.5	60	160.7			85	72.2	175	83.8	58.26	219.4	30	111.4
56	10/25/2005 13:16:04		192	70.5	122	126	63	161.6	50	95.7	88	223.6	242	165.4	92	44.1	328	76.8	38.64	100.4	90	77.8
57	10/25/2005 13:16:05		179	40	110	41.7	43	277.9	1	0	26	166.5	73	205.9	110	103.2	87	143.4	144.8	34.02	130	60.5
58	10/25/2005 13:16:06		67	125.8	89	148.3	53	203.2	108	127.8	141	186.5	100	155.2	166	91.4	227	90.3	82.04	80.88	214	187.3
59	10/25/2005 13:16:07		113	139	106	94.9	78	112.6	166	134.8	75	349.3	52	70.9	47	54.6	94	114.6	80.16	33.29	98	45.8
60	10/25/2005 13:16:08		163	127.3	74	87.7	216	60.6	179	85.2	65	150.7	131	106.9	61	150.5	116	20.8	13.04	327.5	7	344.1

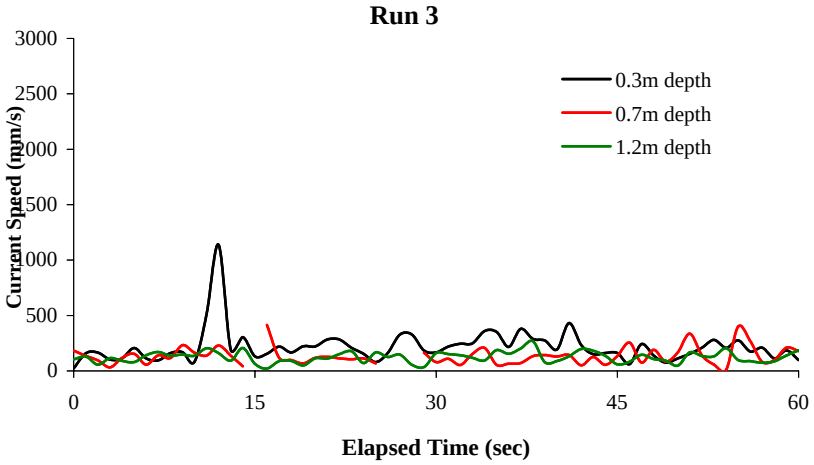
Fox River Propwash Study - Moving Vessel Trials

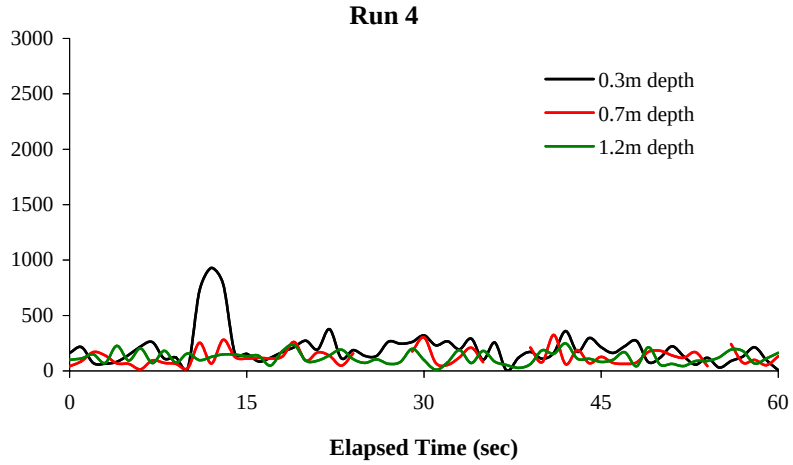
Test #16: Jetski - 4000 RPM - 12 MPH

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Seventeen

Run 1																								
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:20:58		134	81.4	103	95	80	97.9	23	205.5	115	109.9	35	11.6	73	280.2	61	20.2	181.7	82.09	167	31.3
1	10/25/2005 13:20:59		41	19.7	242	60.3	27	33.1	75	122	76	106	123	5.6	105	39.6	149	29.8	144	63.61	206	15.2
2	10/25/2005 13:21:00		149	98.1	185	101.9	219	114.2	103	65.4	46	37.9	139	345	90	110.9	238	174.9	76.21	198	114	323.5
3	10/25/2005 13:21:01		132	51.7	194	87.3	88	57.6	219	108.9	92	84.4	80	59.3	127	60.2			329.8	65.46	45	53.1
4	10/25/2005 13:21:02		114	27.7	292	83.7	91	86.2	61	46.3	127	54.3	97	74.4	101	41.8			170.4	224.3	17	144.5
5	10/25/2005 13:21:03		56	44.3	75	78.4	42	208.4	123	47	101	249	61	11.3	80	331.5	117	343.1	77.2	286.6	108	344.9
6	10/25/2005 13:21:04		102	155.2	105	119.7	149	222.6	318	270.4	163	176.8	31	157.5	97	34	121	52.4	99.72	248.8	33	81.4
7	10/25/2005 13:21:05		103	68.9	136	21.6	157	39.6	100	52.3	64	355.5	76	123.7	61	355.3	79	66	91.68	26.57	110	63
8	10/25/2005 13:21:06		56	128.5	81	21.8	65	62.7	161	121.8	89	44.1	118	215.7	8	23.2	86	63.7	78.19	291	180	66.7
9	10/25/2005 13:21:07		102	102.4	61	9.5	72	0.8	120	81.9	202	32.9	139	47.6	40	10.2	158	185.8	311.7	262.4	158	36
10	10/25/2005 13:21:08		131	106.4	123	134.3	168	116.6	141	202.6	59	53.9	162	208.5	254	120.3	116	202.4	187.3	125.2	46	155.7
11	10/25/2005 13:21:10		84	344.1	103	47.4	18	315	148	225.8	85	352.5			86	90	165	265.1	189.3	69.27	264	297.1
12	10/25/2005 13:21:11		155	147.6	147	88.8	139	162.9	131	173.9	78	35.1	112	16	241	108.4	506	212.1	228.6	277.8	524	339.5
13	10/25/2005 13:21:12		191	149.4	104	189.4	203	183.7	275	186.3	200	320.7	327	189			190	161.6	368.8	233.4	540	32
14	10/25/2005 13:21:13		265	80.6	105	85.1	62	181.8	144	182	50	146.3			358	125.7	410	121.6	518.5	98.32	931	69.2
15	10/25/2005 13:21:14		96	81	76	127	37	133.9	132	100.5	109	130.1			341	137.4	414	151.9	270.3	84.48	381	53.8
16	10/25/2005 13:21:15		97	144.7	145	107.2	76	110.8	120	43	126	354.5			222	104.3	527	108.2	867.5	85.64	599	82.4
17	10/25/2005 13:21:16		148	117.8	42	128.2	242	91.4	125	63.4	62	81.6	204	27.1	489	54.5	280	32.9	307.6	32.66	485	41.2
18	10/25/2005 13:21:17		126	95	38	161.6	107	146.5	43	100.8	22	13.4	21	52.6	195	107	195	39.4	325.2	6.71	535	19.9
19	10/25/2005 13:21:18		215	55.1	169	94.4	168	101	78	86.3	168	166.2			125	47	312	19.7	386.7	41.65	511	16.8
20	10/25/2005 13:21:19		61	58.4	149	117.6	127	109.3	60	162.5	147	114.5			155	88.9	259	14.1	126.8	327.6	258	26.5
21	10/25/2005 13:21:20		125	104.8	216	87.9	189	157.6	59	355.2			63	8.3	73	87.6	413	148.5	155.3	17.62	209	39.2
22	10/25/2005 13:21:21		93	131.9	116	145.5	60	91.9	76	303.7			186	4	82	325.9	696	338.9	261.7	6.582	278	22.4
23	10/25/2005 13:21:22		169	33.7	130	78.9	127	45.6	219	143.9	90	245.7	154	127.6			47	48.5	257.6	62.74	281	50.8
24	10/25/2005 13:21:23		184	79.1	86	37.4	54	73.9	115	232.4	147	281	37	209.4			152	347.1	205.4	61.81	203	30.9
25	10/25/2005 13:21:24		161	0.7	145	63.8	159	74.3	122	136.7	41	36	153	250.1			259	61.8	227.3	78.84	306	61.7
26	10/25/2005 13:21:25		123	93.7	79	93.6	62	173.6	50	321.5	113	47.5			35	356.7	298	10.6	68.77	40.87	258	56.6
27	10/25/2005 13:21:26		188	55.4	212	45.8	68	11.8	35	43.8	230	123.5			200	4.3	144	24.6	302.2	47.55	241	42.3
28	10/25/2005 13:21:27		72	79.6	131	12.3	224	86.7	102	143.8			217	100.4	263	64.5	268	61.9	451.5	79.54	296	79.5
29	10/25/2005 13:21:28		44	121.9	86	131.2	158	30	36	93.2	108	18.3	133	32.7			135	107.6	294.4	51.07	292	38.8
30	10/25/2005 13:21:29		95	342.9	148	3.1	143	39.6	63	183.6	112	164	59	239.5	121	90.9	376	24	211	69.76	228	58.3
31	10/25/2005 13:21:30		100	96.3	88	104.5	54	65.8	190	106.5	11	201.8			210	86.2	134	100.3	126	73.87	234	44.8
32	10/25/2005 13:21:31		65	34.4	108	68.9	86	37.9	170	34.4					153	69.3	70	45.6	192.9	61.18	92	356.3
33	10/25/2005 13:21:32		93	75.7	111	163.2	117	108	151	152.4					100	124.8	175	179.3	172.7	126.4	219	97.9
34	10/25/2005 13:21:33		22	338.2	196	83.3	17	61.9	33	84.8	59	78.3			120	301			146.2	9.849	224	358.5
35	10/25/2005 13:21:34		34	109	140	142.6	111	135.4	43	134.1	51	225			208	76.4	117	358.5	83.38	22.57	57	359
36	10/25/2005 13:21:35		219	101.9	236	113.5	276	87.9	238	128.4	304	105.3	242	101.9	195	64.9	311	86.7	353.1	90.97	557	74.3
37	10/25/2005 13:21:36		115	130.8	168	55.6	51	63.4	121	256.7			159	173.1	167	63.3	96	76.7	189.4	3.935	223	347.3
38	10/25/2005 13:21:37		110	21.2	95	39.9	105	88.9			169	164.6			89	80.3	181	74.7	188.7	54.71	280	46.7
39	10/25/2005 13:21:38		101	117.1	152	113.2	136	98.9	76	25.9	83	297.2			107	79.7	336	85.6	232	106	327	105.3
40	10/25/2005 13:21:39		65	234.4	140	145.2	15	42.3	91	142.1	233	327.6			98	13.6	64	343.6	167.2	329.4	362	347.7
41	10/25/2005 13:21:40		211	24.6	150	55.9	98	84.8	116	187.9	140	355.9	42	121.4	160	19	174	76.4	357.6	61.07	282	50.6
42	10/25/2005 13:21:41		193	138.1	112	52.6	164	93.1	47	202.7	103	308.3	68	74.7	96	75.5	177	93.6	266.1	51.41	288	57.2
43	10/25/2005 13:21:42		154	10.9	140	333.3	28	32	85	308.3	38	137.1	95	312.4	153	333.3	276	351.9	87.64	343.4	145	16.4
44	10/25/2005 13:21:43		80	53.1	140	33	100	133.8	124	225.3	221	85.3	164	192.3	65	129.4	205	297.6	178.5	62.29	224	70.2
45	10/25/2005 13:21:44		118	30.5	182	58.9	117	85.6	190	109.4			74	92.3	126	92.7	178	192.3	132.2	252.4	155	77.7
46	10/25/2005 13:21:45		80	21.1	102	62.4	132	51.1	31	273.7			54	296.6	63	22.5	258	147.4	174	20.52	126	55
47	10/25/2005 13:21:46		59	16.6	105	228.1	193	130.4	115	152.1					201	194.7	320	173.2	145.2	19.31	319	38.9
48	10/25/2005 13:21:47		188	73.6	202	95.4	296	107.1	52	175.6	189	172.4			228	44.1	237	52.9	295.6	52.98	314	70.3
49	10/25/2005 13:21:48		233	25.5	187	78.3	148	110.5	103	168.3	139	341			160	358.6	124	101.7	59.68	31.29	132	52.7
50	10/25/2005 13:21:49		103	32.3	72	1.6	62	110.8	163	3.9	36	320.6	84	148.2	91	145.8	79	31.5	138.1	32.88	165	41.3
51	10/25/2005 13:21:50		166	16.8	161	37.4	56	293.3	205	261	511	143.2	104	111.4	178	17.3			160.3	326.7	289	19.2
52	10/25/2005 13:21:51		74	127.3	45	82.4	111	24.5	154	63.4	89	103.6	216	41.4	85	102.9	156	118.7	161.9	62.01	274	74.5
53	10/25/2005 13:21:52		174	60.3	238	27.2	157	25.3	128	61.6	149	200.4	67	124.6	77	304.9	86	2.7	203.6	30.72	120	61.7
54	10/25/2005 13:21:53		144	82	59	59.5	118	55.4	73	34.3	135	45.9	147	56.6	264	22.7	200	37.5	205	60.81	134	72.2
55	10/25/2005 13:21:54		163	84	178	92.6	321	150.9	185	111.9	247	85.4	254	122.9	190	72.9			234.7	49.32	328	49.3
56	10/25/2005 13:21:55		90	72.6	220	69.5	15	273.8	55	263.8	33	287.9	111	48.7	192	91.2	180	30	226.4	36.92	252	73.9
57	10/25/2005 13:21:56		168	32.8	129	0.4	144	273.6	233	202.5	155	7.4	166	55.8	106	59.3	231	194.5	231.1	240.4	14	45
58	10/25/2005 13:21:57		157	62.3	142	11.4	275	222.2	10	286.7	241	77.1	175	98.2	178	125.8			28.3	122	108	26.3
59	10/25/2005 13:21:58		109	337.4	223	243.7	47	111.1	103	70.2	147	38.1	178	83.9	146	168.9	83	44.5	156.9	349	330	62.3
60	10/25/2005 13:21:59		50	348.5	112	270	85	249.2	183	7.6	173	56.6	171	56.7	100	22.2	89	64.6	299.9	43.38	351	60.4

Lower Fox River Moving Vessel Trials
Test Seventeen

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:22:48		117	42.9	12	14	44	292.5	91	353	89	34	153	125.1	37	25.9	15	289.7	94.87	55.3	62	294.9
1	10/25/2005 13:22:49		83	353.8	180	77.1	79	73.2	76	100.6	180	65.7	134	38.3	139	78.4	123	52.6	171.7	72.73	205	7.9
2	10/25/2005 13:22:50		144	15.3	160	59.9	234	65.2	242	90.2	232	82.1	275	39.5	132	65.4	161	85.7	117.4	81.18	83	61.9
3	10/25/2005 13:22:51		101	6.8	139	47.9	104	72.6	65	14.3	19	32	62	98.4	222	17.9	47	333.4	93.19	56.82	78	130.8
4	10/25/2005 13:22:52		76	333.4	108	54.4	66	114.2	211	68.9	142	144.2	121	118	61	230.3	52	228.9	107.9	339.4	141	334
5	10/25/2005 13:22:53		130	7.9	39	94.4	77	2.2	120	45	95	95.4	49	266.5	52	278.9	165	7.6	36.25	155.6	294	42.7
6	10/25/2005 13:22:54		63	104.7	188	20.3	108	354.1	62	21.6	142	103.1	174	87.7	85	77.8	256	139	185.8	75.66	137	135
7	10/25/2005 13:22:55		175	42.9	209	83.7	55	129.8	73	78.1	135	62.7	202	334.8	80	78.4	193	354.1	153.9	6.34	172	340
8	10/25/2005 13:22:56		199	123.9	175	52.2	35	14.8	28	315	119	163.4	199	172.5	36	19.4	184	158.6	60.64	193.3	55	97.3
9	10/25/2005 13:22:57		165	34.4	200	7.8	84	99.6	95	56.6	66	345.1	118	35	85	112.1	121	39.6	149	286.4	194	64
10	10/25/2005 13:22:58		161	21.1	165	32.3	210	55.5	138	82.1	22	18.4	25	158.6	204	76.4	93	85.7	109	89.74	125	92.7
11	10/25/2005 13:22:59		119	96.3	193	48.8	137	54.2	131	62.9	90	53.1	156	35.6	126	24.9	226	10.5	45.8	233.9	250	159.4
12	10/25/2005 13:23:00		92	66.2	103	115.8	193	121.6	30	140.4	120	128.2	40	243.4	136	10.6	173	99.6	319.9	352.3		
13	10/25/2005 13:23:01		155	106.9	160	34.3	23	92.5	129	92.7	62	175.4	347	154					529.6	234.8	195	298.8
14	10/25/2005 13:23:02		134	124.6	69	126.2	43	201.8	101	177.7	136	182.9	139	208.8	342	199.5	317	193.9	361.7	349.4	1021	356.8
15	10/25/2005 13:23:03		90	18	79	106.1	77	132.4	33	115	68	37.2	191	161.4	347	112.9					539	89.8
16	10/25/2005 13:23:04		186	100.8	247	111.6	113	83.4	72	113.7	110	176.4	237	64.7	377	75.3					728	68
17	10/25/2005 13:23:05		163	132.8	61	120.8	231	49.6	80	50.1	238	160.1	77	136.6					303.2	32.75	901	43
18	10/25/2005 13:23:06		77	353.2	51	62.9	137	35.8	132	138.7	98	55	120	211.7	128	115	168	131.9	108.2	13.91	598	61.2
19	10/25/2005 13:23:07		220	59.9	107	31.6	172	70.3	84	209.3	249	286.3	28	280.1	208	73.5	289	98.7	229.7	94.49	221	76.9
20	10/25/2005 13:23:08		158	37	135	53.1	145	352.9	28	169.9	64	245	191	227.5	231	125.1	141	96.5	365.7	46.44	343	55.8
21	10/25/2005 13:23:09		160	56.2	130	41.9	76	84	14	265.9	319	341			292	356.7	132	43.2	337.5	24.13	343	46.5
22	10/25/2005 13:23:10		105	62.7	133	65.2	163	26.3	81	159.8			99	356	163	91.8	241	86.7	163.7	76.22	294	54.8
23	10/25/2005 13:23:11		67	102	33	130	94	46.3	53	75.7	219	356.3			184	16.4	162	122.9	212.2	66.09	262	38.8
24	10/25/2005 13:23:12		111	78.6	167	78.2	96	64	348	88.4			183	312.3	201	102.9	367	44.2	264.4	34.83	427	47
25	10/25/2005 13:23:13		88	93.9	179	48.6	197	13.2	68	81.5	139	2.9			436	47	380	88.9	394.4	73.95	304	78.6
26	10/25/2005 13:23:14		70	76	104	152.4	119	116.4	76	12.9	324	39.7			235	0.2	140	26.7	198	5.797	329	41.8
27	10/25/2005 13:23:15		214	125.7	132	106.8	185	68.7	100	290.4	245	236.8	82	36.6	189	13.7	244	36.7	308.3	45.79	273	38.5
28	10/25/2005 13:23:16		84	49.8	163	58.1	64	205.8					245	5.6	173	16.8	242	96.4	363.7	29.67	436	32.9
29	10/25/2005 13:23:17		80	92.1	76	301	134	20.1			132	243	110	323.9	166	138.4	350	132.9	132.1	97.39	90	106.8
30	10/25/2005 13:23:18		62	209.1	44	239.9	30	115.7			53	2.2	384	43	34	290.6	160	43.5	323.7	68.43	250	96.9
31	10/25/2005 13:23:19		144	92	183	44.8	197	68.9					350	141	81	319			292	90.78	203	75.5
32	10/25/2005 13:23:20		93	101.8	144	80	442	72.9	197	98.7			284	71.1	201	39.6	177	17.4	231.7	64.98	159	23.3
33	10/25/2005 13:23:21		164	55	180	111.6	49	237.6	78	235.9	91	341.4	145	19.8	211	60.5	115	57.4	128.8	19.98	183	43
34	10/25/2005 13:23:22		241	89.8	220	97.3	62	200.8	168	304.8	219	132.4	170	55.6	86	14.8	153	251.7	156.3	9.944	228	14.7
35	10/25/2005 13:23:23		137	69.4	133	52.6	71	20.7	78	39.8	123	122.4	50	59.8	336	11.5	267	36.3	77.08	67.09	354	51.5
36	10/25/2005 13:23:24		62	37.8	143	56.1	62	58.1	10	29.1			81	80.8	255	165.3	178	145.3	185.7	85.06	166	92.1
37	10/25/2005 13:23:25		167	51.6	219	88.7	180	149.3	50	31.2			129	85.6	152	49.8	198	55.3	237.8	60.52	416	38.6
38	10/25/2005 13:23:26		151	75	104	129.5	75	139.3	35	22.1			62	226.3	38	26.6	167	172.8	85.07	342.2	209	30.1
39	10/25/2005 13:23:27		66	200.4	148	39	92	1.9	88	11.2	109	171.1	176	49.6	263	6.8	225	153.7	178.5	48.18	151	43.1
40	10/25/2005 13:23:28		98	300.8	79	33.7	279	3.1	212	31.3	32	290.1			123	165.4	113	318.6	108	1.591	141	11.5
41	10/25/2005 13:23:29		123	83.9	97	26.8	101	99.1	72	218.8	90	29.4	140	126.9	194	95.6	62	29.1	181	53.76	258	67.9
42	10/25/2005 13:23:31		179	88.1	142	99.7	125	23.1	144	212.3	76	124.3	117	332.6	356	337.7	104	75.6	203.7	76.37	112	108.8
43	10/25/2005 13:23:32		81	102.1	71	54.7	136	50.9	127	125.1	106	99.2	39	327.5	68	34.2	92	68.4	73.93	23.1	326	49.2
44	10/25/2005 13:23:33		115	53.1	123	91.4	101	81.5	71	333.1			47	33.7	113	2	188	137.2	90.05	60.02	158	102.4
45	10/25/2005 13:23:34		61	76.7	37	23.8	27	193	88	9.8	129	85.6	160	92.5	94	350.2	60	24.8	158.7	38.6	166	43.3
46	10/25/2005 13:23:35		130	35.9	65	261.1	110	45	47	6.1	69	42	245	129.5	351	305.4	90	322.2	187	69.34	182	45.9
47	10/25/2005 13:23:36		274	49.7	243	26.7	145	26.6	103	196.9	110	330.6	157	73.8	84	85.9	72	265.2	114.6	9.545	224	6.9
48	10/25/2005 13:23:37		97	71.4	159	95.8	105	111.2	33	185.2	21	180	91	326.7	160	342.9	125	78.4	216.9	68.64	324	48.1
49	10/25/2005 13:23:38		51	52.9	113	70.3	35	137.3	86	325.9	173	40.3	187	42.4	238	319.6	277	159.9	157.5	107.7	229	53.9
50	10/25/2005 13:23:39		158	74.6	116	12.5	129	52.2	184	178.1	111	43.9			102	341.2	267	139	186.6	114.4	290	124.6
51	10/25/2005 13:23:40		204	71.7	80	71.1	122	44.7	96	94.8	265	352.6	179	332	87	0.7	116	125.9	264.7	83.49	61	118.2
52	10/25/2005 13:23:41		98	97.6	232	334.4	23	99.9	231	53.6	354	329.1	153	7.9	233	14.2	176	27.4	203.1	70.14	151	14.6
53	10/25/2005 13:23:42		219	32.9	196	38.2	103	62.2	56	74.5	223	24.6	127	54.9	156	70.5	104	94.4	249.2	112.7	239	92.6
54	10/25/2005 13:23:43		253	73.7	30	78.3	88	17.8	127	260	204	3.9	126	11.4	178	77	104	98.3	300.2	8.427	223	48.5
55	10/25/2005 13:23:44		210	358.1	131	70.9	57	116.1	151	21	161	69.7	32	1.8	162	59.2	97	40	156	90.73	140	118
56	10/25/2005 13:23:45		126	97.3	211	99.6	41	72.9	89	263.5	67	78	86	174.7			53	174.6	114	137.5	293	96.1
57	10/25/2005 13:23:46		222	93.1	113	95.1	75	57.6	68	24.3	55	135	76	350.9	130	214.1	225	183.3	127.5	85.05	241	89.5
58	10/25/2005 13:23:47		278	95.8	182	103	118	68	156	87.1	99	117.1			231	301	57	99.1	81.25	76.48	140	69.5
59	10/25/2005 13:23:48		135	129	148	173.4	172	226.7	132	89.1	61	71	197	98.7	72	72.3	121	22.8	34.13	84.96	10	150.9
60	10/25/2005 13:23:49		200	71.9	80	293.7	126	46.9	93	116.8	133	57.6	72	247	29	128			130.6	56.55	199	47.6

Lower Fox River Moving Vessel Trials
Test Seventeen

Run 3		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:25:04		226	58.2	191	37.1	239	54.2	47	355.1	130	325.7	92	204.3	93	234.6	330	22.1	140.2	128.3	113	168.3
1	10/25/2005 13:25:05		193	15.3	185	52.7	99	55.7	132	39.1	203	71.7	162	19.4	33	40			91.29	317.2	197	24.9
2	10/25/2005 13:25:06		129	40.6	214	77.6	138	85.4	36	144.1	47	93.7	123	84.9	159	63.1	192	158.9	259.9	80.03	193	40.8
3	10/25/2005 13:25:07		106	31.1	94	77.1	129	118.2	38	355.5	54	317.2	58	164.1	86	96			103.7	50.48	220	341.2
4	10/25/2005 13:25:08		32	16.2	121	83.3	77	118.9	73	164.1	170	37.6	176	49.6	127	226.9	157	215.4	30.07	176.2	186	348.5
5	10/25/2005 13:25:09		44	105.9	74	61	112	90	124	86.3	102	133.4	93	77.6	83	241.3			128.7	129	22	116.6
6	10/25/2005 13:25:10		100	325.2	59	54.7	112	106	69	9.2	159	31.9	116	96	60	32.1	143	206.2	150.6	79.29	153	328.9
7	10/25/2005 13:25:11		87	78.7	97	261.7	113	33.8	166	103.2	124	232.9	56	299.7	80	102.3			8.246	256	110	271
8	10/25/2005 13:25:12		168	29.2	120	100.6	124	340.3	188	353.3	187	25.1	24	67.8	35	0	70	336.4	103.2	16.33	125	44
9	10/25/2005 13:25:13		136	344.2	203	48.6	72	61.6	135	32.9	104	81.2	156	149.2	147	80.2			17.09	339.4	158	43
10	10/25/2005 13:25:14		141	73.1	121	108.3	47	3.7	54	346	167	7.9	117	329	228	359.7	163	327	44.01	338.7	56	103.5
11	10/25/2005 13:25:15		112	180.5	42	108	152	157.6	109	115.6	144	117.6	135	179.2	262	133.6			23.6	323.6	63	144
12	10/25/2005 13:25:16		104	140.5	57	296.1	141	81	66	18.4	87	51	136	44.7	211	72.9			346.5	235.3	598	328.9
13	10/25/2005 13:25:17		107	100.8	140	69.1	52	352.3	110	147.6	69	118.4	142	41.3			342	1.8	266.1	356.1	195	346
14	10/25/2005 13:25:18		208	158.6	135	96	144	71.3	46	154	61	27.4									118	60.6
15	10/25/2005 13:25:19		44	95.2	72	161.3	46	249.6	49	167.1	96	263.4	70	359.2							250	25.3
16	10/25/2005 13:25:20		214	143.6	340	121	209	111.6	144	109.9	270	134.4					400	117.8	289.6	93.56	646	84
17	10/25/2005 13:25:21		118	138.8	60	173.3	62	64.3	87	284.7	149	331.5	185	291.9			412	7	714.9	8.527	301	41.9
18	10/25/2005 13:25:22		114	49.6	252	101.7	143	94.4	236	92.7							462	149.2	315	101.2	488	66.1
19	10/25/2005 13:25:23		217	67.2	66	127.6	58	338.7	132	332.1									315.8	312.2	289	24.7
20	10/25/2005 13:25:24		155	83	198	86.8	212	108.4	75	145.9	612	147.4					85	345	9.487	251.6	459	41
21	10/25/2005 13:25:25		7	326.3	295	84.2	150	85.8	96	47.1			255	62.2			280	37.4	394.3	59.01	287	47.7
22	10/25/2005 13:25:26		150	63.4	156	70.5	162	336.8			276	75.3	152	83.6	202	38.6	283	31.6	258.5	78.17	305	57.7
23	10/25/2005 13:25:27		72	54.6	73	103.5			186	36.3	54	42	225	77.9			63	62.6	157	302.8	185	341.8
24	10/25/2005 13:25:28		189	98.8	180	98.3	96	212.2			46	19.2	95	75.4			132	15.4	326.1	60.21	329	58.1
25	10/25/2005 13:25:29		98	114	103	121.1	149	23.3	202	320.4	126	322.4	138	104.2	222	27			276.5	28.05	340	37.2
26	10/25/2005 13:25:30		83	43.5			220	68.7	150	219.9			126	29	363	50	203	107.8	341.3	62.61	328	67.2
27	10/25/2005 13:25:31		91	141.2	93	62.3	191	58.1	85	215.9	290	132.1			246	82.3	190	52.5	53.6	81.42	149	57.1
28	10/25/2005 13:25:32		221	42.1	258	83.1	38	27.9			98	194.2	244	333.4	310	50.8	522	61.8	268.3	73.32	156	52.8
29	10/25/2005 13:25:33		113	78.8	132	63.4	271	57.4	245	146.3	73	132.2			227	26.7	308	61.3	412.1	88.47	233	66
30	10/25/2005 13:25:34		99	70.5	177	74.9	138	91.7	97	132.9	276	101.5	270	63.2	487	94.6			442.2	60.01	461	66.3
31	10/25/2005 13:25:35		69	19.5	24	24.4	76	317.1	182	282.1	134	65.7	161	7.1	297	330.8	67	22	142.7	8.868	281	39.5
32	10/25/2005 13:25:37		64	108.2	259	81.8	127	141.1	106	115.8	385	92.1	159	102.7	93	38.5	281	70.2	405.4	83.77	416	109.1
33	10/25/2005 13:25:38		120	65.4	119	90	77	118.9	146	308.6	275	356.9	79	100.9	113	126.4	84	68.3	132.6	23.09	61	41
34	10/25/2005 13:25:39		98	56.6	272	35.3	225	79.7					114	196.4	81	38	149	65.5	89.05	91.93	194	25.6
35	10/25/2005 13:25:40		162	61.7	200	79	179	87.4	79	260.5			115	147.8	54	177.9	92	116.6	376	105.1	248	108.8
36	10/25/2005 13:25:41		142	115.8	299	78.4	141	96.1	58	171	320	174.6	208	120	215	121.7	432	144	188.5	68.2	282	95.5
37	10/25/2005 13:25:42		155	30.7	144	102	217	123.5	52	187.7	261	45.2	300	344.7	185	13.7			94.64	38.57	234	40.5
38	10/25/2005 13:25:43		78	82.6	69	353.4	217	142.1	148	15.6	310	71.7	138	270.4	183	55.4			203.3	48.39	231	65.4
39	10/25/2005 13:25:44		145	21.1	256	86.4			170	292.8	182	112.9	73	79	228	59.2	211	21.7	98.41	64.74	331	57.7
40	10/25/2005 13:25:45		107	19.6	177	61.7	53	145.7	94	334.2	58	100.9	47	345.1	81	345.6	183	351.2	138.5	341	51	114.1
41	10/25/2005 13:25:46		36	48.4	63	128.5	100	36.9	230	96.5			112	44.6	240	29.2	219	105.6	177.1	63.87	113	65.5
42	10/25/2005 13:25:47		99	18.3	71	286.4	88	24.2	164	69.2			395	301.8	159	308.6	74	308.4	135.2	7.651	187	238.1
43	10/25/2005 13:25:48		227	20.9	189	51.2	53	258.1	115	75.4			142	29.4	145	46.4	271	97	139.8	96.16	396	78.3
44	10/25/2005 13:25:49		68	306	16	304.7	144	145.8	103	62.9			201	62.8	186	61.4	243	44	277.3	87.31	281	81.2
45	10/25/2005 13:25:50		265	103.1	209	98	169	117.5	147	152.4	178	120.5	116	359.5	83	50.4	165	52.2	229.1	56.03	333	96.5
46	10/25/2005 13:25:51		17	159.4	130	130.6	107	79.2	82	44	284	75.3	311	19.5	186	68.3	175	4.2	60.75	302.9	126	41.1
47	10/25/2005 13:25:52		165	69	220	48.3	135	75.5	186	87.2	396	69.5	160	253.3	35	53.1	125	41.7	37.59	61.39	196	2.6
48	10/25/2005 13:25:53		190	168.5	181	113.4	296	142	190	155.7	248	105.9	394	122	223	143.7	322	144.3	256	106.1	332	126.4
49	10/25/2005 13:25:54		49	60.8	196	89.1	99	123.9	115	86	64	61	103	87.8	57	17.5	108	52.9	195.7	97.63	153	89.3
50	10/25/2005 13:25:55		94	342.7	87	198	101	30.9	142	21.5	138	110.8	73	68.3	59	15.7	233	88	129	162.4	199	103.3
51	10/25/2005 13:25:56		64	67	163	43.5	218	88.4	146	50			212	74.6			277	71.9	229.8	130.4	296	124.8
52	10/25/2005 13:25:57		195	33.7	170	37.3	136	348.9	167	178.6	186	358.8	18	303.7	139	188.2	124	89.1	52.78	318.5	156	299.5
53	10/25/2005 13:25:58		72	42.2	246	97	228	104.2	47	73.9	295	292.6	165	259.9			55	289.1	53.91	49.51	166	352
54	10/25/2005 13:25:59		85	117.5	244	61.9	160	94.7	65	83	141	175.9	186	39.3	31	135	114	108	116.2	87.04	229	66.9
55	10/25/2005 13:26:00		170	29.3	69	45	133	65.2	132	1.7	294	118.4	227	73.9	133	134.4	182	167.9	192.1	75.53	290	126.3
56	10/25/2005 13:26:01		89	54.2	74	115.5	186	103.4	73	38.9	170	25.4	124	17.9	135	344.1	63	57.3	207.7	31.01	327	37.3
57	10/25/2005 13:26:02		118	48.1	297	73.4	33	40	147	54.1	122	50.3			217	65.2	153	44.7	270.9	23.73	262	3.1
58	10/25/2005 13:26:03		179	347.4	147	76.2	181	100.2	127	105	104	31.2	159	67.5	82	141.4	83	180	266.7	125.5	212	62.1
59	10/25/2005 13:26:04		179	113.7	138	101.7	202	119.4	111	171.7	225	131.8	186	125.1	298	190.3	177	129.3	140.6	113.5	212	111.9
60	10/25/2005 13:26:05		19	288.4	179	104.9	90	49.1	135	49.2	68	28.8	74	113.8	73	53.9	612	341.9	165.1	342	152	12.9

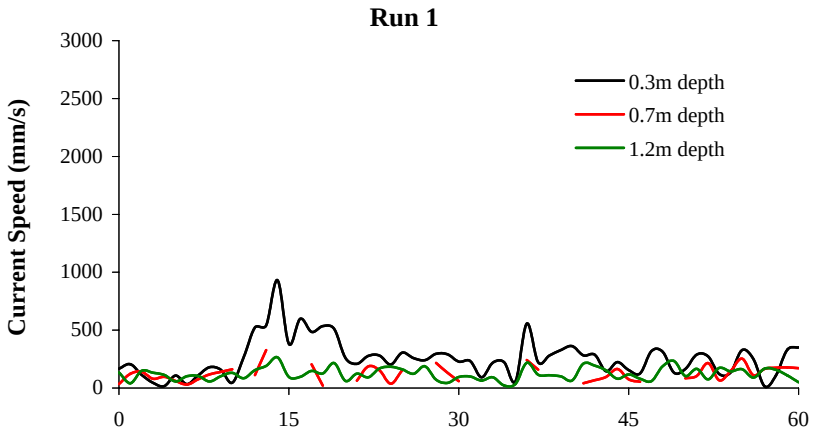
Lower Fox River Moving Vessel Trials
Test Seventeen

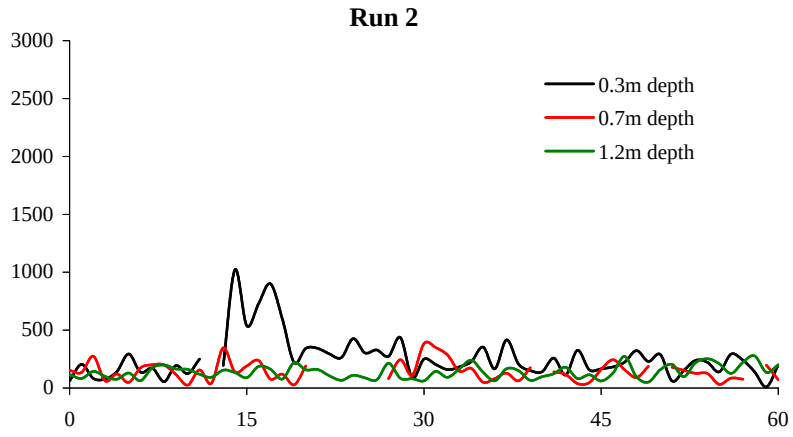
Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:27:19		149	30.7	143	86.8	151	40.4	158	44.5	77	49.7	131	349.5	104	30	138	297.7	43.32	288.9	120	26.1
1	10/25/2005 13:27:20		130	97.5	84	78.3	149	97.7	135	99.8	68	139.8	27	124.3	147	84.9	70	130.3	67.21	43.19	214	43.7
2	10/25/2005 13:27:21		75	93.8	108	75.6	85	38.3	147	290.3	217	286.9	132	301	89	342.4	142	231.6	164.2	294.8	79	31.5
3	10/25/2005 13:27:22		171	47.4	151	66.7	159	94.3	83	86.6	129	36.5	173	123	303	85.8	208	29.6	86.68	348.7	102	23.8
4	10/25/2005 13:27:23		75	67.2	184	55.2	24	4.8	121	83.8	118	41.2	140	339.5	75	0	97	161.4	27.02	51.01	60	236.6
5	10/25/2005 13:27:24		104	9.4	160	64.9	85	145.6	158	304.4	57	319.9	163	17.9	69	68.7	100	36.9	127.5	65.44	287	43.3
6	10/25/2005 13:27:25		294	91.9	238	92.6	322	72.6	149	74	44	97.8	152	71.6	28	81.9	75	141.5	12.21	145	119	40.2
7	10/25/2005 13:27:26		120	53.1	190	19.4	84	29.9	85	321.2	82	184.2	6	329	135	275.5	380	276.3	100.3	299.9	187	349.2
8	10/25/2005 13:27:27		115	69.7	236	57.8	222	39.9	137	18.3	120	339	131	30.3	32	204.1			135.6	56.43	137	33.1
9	10/25/2005 13:27:28		243	85	325	76.6	239	100.1	264	124.7	116	51	18	319.4	159	141.6	200	195.4	62.13	56.82	199	319.9
10	10/25/2005 13:27:29		27	124.3	151	42.3	166	78.1	39	288	238	151.9									467	213.4
11	10/25/2005 13:27:30		79	189.5	104	53.2	152	73.2	39	168.1					139	233.8	301	229.6	243.3	244.7		
12	10/25/2005 13:27:31		217	103.1	212	154.6	134	114.7	156	185.2									590.8	97.29	619	69.1
13	10/25/2005 13:27:32		180	115.3	169	72.1	110	104.2	163	58.3	224	162.1	148	147.2			633	109.3	652.1	71.12	1086	52.4
14	10/25/2005 13:27:33		53	92.2	126	98.2	88	286.6	104	69.1	107	100.3	50	56.3			562	123.7	651.9	66.11	816	55
15	10/25/2005 13:27:34		119	51.1	231	43.2	128	38	97	19.9	70	47.9							195.2	2.643	500	59.8
16	10/25/2005 13:27:35		167	56.2	150	87.3	41	109.7	39	322.3							190	314.8	236.1	8.525	391	31.6
17	10/25/2005 13:27:36		208	82.3	151	96.1	249	72.4	208	359.4	177	19.8			53	19.8					302	54.8
18	10/25/2005 13:27:37		195	106.4	146	46.1	105	97.1	162	128.2			95	231	99	171.3	112	24.7	278.8	335.6	256	51.8
19	10/25/2005 13:27:38		149	81.1	107	54.1	97	124.5	234	326.5	120	295.1	222	57.9	340	316.8	99	350.7	179.9	331.4	297	22.8
20	10/25/2005 13:27:39		155	86.3	84	43.6	109	6.9	132	0			154	84.8	113	153.2	364	135.8	392.2	78.98	336	85.4
21	10/25/2005 13:27:40		158	82	189	98.5	52	346.8	318	290.3			267	285.7	163	351.2	153	292.7	143.1	38.47	159	23
22	10/25/2005 13:27:41		104	96.1	140	99.9	157	62.8	106	87.3			131	129.7	149	28.8	264	51.6	352.5	87.07	292	87.3
23	10/25/2005 13:27:43		109	22.6	163	103.4	123	25.1	162	21.3					278	67.4	234	61.5	336.8	52.72	244	35.8
24	10/25/2005 13:27:43		175	131.5	148	133.6	169	89	48	339.3					128	53	259	2.9	246.8	37.43	280	8
25	10/25/2005 13:27:44		65	58.3	25	0	45	296.6	57	47.9	97	320.9			198	12.3	118	97.8	294	10.58	164	46.5
26	10/25/2005 13:27:46		75	108.7	1	0	131	236.2	63	245.5	139	258.4	0	0			195	2.9	65.76	81.25	78	348.1
27	10/25/2005 13:27:46		149	83.1	78	0.7			134	24.3	126	69.6			47	96.1	116	357	144.3	22.83	178	19.7
28	10/25/2005 13:27:47		246	86.7	195	53.8	29	102.1			179	43.4			136	128.7	144	129.1	106.8	292	214	90.8
29	10/25/2005 13:27:48		122	56	69	47.3									244	342.1	68	63.8	164.6	16.23	197	65.4
30	10/25/2005 13:27:49		151	70.7	155	88.5									166	71.8	104	78.9	142.6	40.17	168	78.4
31	10/25/2005 13:27:51		47	226.7	58	31	147	99.4	226	99.7					57	122	106	45	366.8	77.4	80	67.9
32	10/25/2005 13:27:51		241	96.2	75	109.4	66	110.4	60	36.9					63	145.3	135	162.4	43.84	135	140	25.8
33	10/25/2005 13:27:52		205	40.4	181	72.7	149	89.6	79	136.5			194	146.1	108	93.7	99	7	41.59	27.18	181	70.3
34	10/25/2005 13:27:54		46	341.2	28	18.4	202	50.6	15	156.8	64	122.9			48	56	118	97.3	239.1	46.69	225	65.6
35	10/25/2005 13:27:54		175	66.8	97	95.9	97	53.8	149	85.8	145	124	89	29.7			19	154.8	56.08	68.01	163	75
36	10/25/2005 13:27:55		104	17.4	148	61.7	64	88.2	162	75.4	242	39	95	36.9	167	20.7	95	66.4	155.4	52.32	215	43.5
37	10/25/2005 13:27:57		244	31.9	234	59.7	199	97.8	145	57.4	107	14			279	304.5	177	355.5	74.22	346	127	22.1
38	10/25/2005 13:27:58		146	78.9	228	47.1	145	37.4	46	341.2	223	74.9			336	352.5	135	94.2	112.6	318.2	319	31.5
39	10/25/2005 13:27:59		133	61.7	297	18.4	145	156.4	130	281.1	172	62.7	396	82	193	15.9	235	28.2	93.68	286.1	126	57.3
40	10/25/2005 13:28:00		157	124.1	213	37.6	97	96.5	108	21.8	60	30	132	68.3	148	136.9	206	162.2	144.5	28.52	160	100.8
41	10/25/2005 13:28:01		199	50.1	61	25.3	65	77.5	56	109.7	107	357.3	131	53.4	146	172.1			219	89.74	251	9.2
42	10/25/2005 13:28:02		100	27.3	91	32.5	11	285.3	44	180	237	143.4	225	97.2	106	86.2	69	128.5	197.8	73.86	216	65.3
43	10/25/2005 13:28:03		226	92.3	54	53.3	165	70.6	99	214.3	67	94.3	28	120.3	201	172.3	63	9.2	110.3	351.1	137	37.9
44	10/25/2005 13:28:04		108	130.9	119	49.1	101	29.1	71	147.7	31	106.7	107	22.5	114	40	116	100.4	185	49.16	318	71.3
45	10/25/2005 13:28:05		193	14.4	195	118.5	107	110.3	290	95.1	302	95.7	337	52.7	253	91.8	236	68.1	218.9	100.8	263	93.5
46	10/25/2005 13:28:06		64	202.1	126	76.7	37	202.4	149	340.3	70	340	118	61.7	96	38.7	53	28	109	359.5	57	333.9
47	10/25/2005 13:28:07		228	76.3	51	32.1	94	57.2	199	17	185	148	197	123.6	113	122.7	239	107.3	117.1	82.15	200	81.1
48	10/25/2005 13:28:08		36	276.3	140	47.9	172	61.9	269	100.5	259	79.8	211	53.1	76	50.9	71	157.8	19.31	338.7	236	9.5
49	10/25/2005 13:28:09		22	13.4	62	123.2	67	154.2	113	62.1	217	37.1	42	283.7	109	136.5	163	130	218.5	71.32	296	39.7
50	10/25/2005 13:28:10		222	249.1	149	111.6	130	49.4	162	172.9	413	143.5	378	81.9	131	72.7	305	115.6	242.8	79.8	228	83.5
51	10/25/2005 13:28:11		363	75.3	89	26.6	155	69.2	148	117.4	164	309.8	173	12	155	13.4	141	73.1	270.4	71.23	193	52.8
52	10/25/2005 13:28:12		199	87.4	113	53.6	238	111.4	183	42.6	72	75.6			141	53.9	164	332	182.8	18.83	142	302.3
53	10/25/2005 13:28:13		293	71.7	168	309.9	165	354.8	9	0	319	102.1	128	165.1	112	78.2	177	117.6	118.7	57.38	410	81.4
54	10/25/2005 13:28:14		198	71.7	64	344.7	145	108.6	121	184.3			72	70.6	139	72.3	245	23.1	195.3	81.16	259	69.5
55	10/25/2005 13:28:15		123	296.6	112	110.4	60	101.5	56	52.9			21	16.7	242	83.8	233	69.4	265.2	27.14	271	14.3
56	10/25/2005 13:28:16		339	52.8	176	48.9	75	347.6	19	141.3			142	78.2	97	177	103	148.5	97.86	68.42	155	77.7
57	10/25/2005 13:28:17		248	51.4	177	343.6	122	58.4	88	69.3	51	94.5	124	93.7	208	77	217	192.8	29.83	13.57	117	78.7
58	10/25/2005 13:28:18		54	238.7	229	6.5	170	51.4	105	291.2	48	38.3	49	33.4	86	57.8	146	122.4	118.9	19.65	187	61.7
59	10/25/2005 13:28:19		171	69.8	50	61.4	60	120	177	85.1	170	57.7	10	73.3	123	97	48	84.1	134.3	309.3	127	39.2
60	10/25/2005 13:28:20		202	145.7	128	37	83	320.4	145	342.8			388	87.2	87	118	124	103	117.4	45	289	54

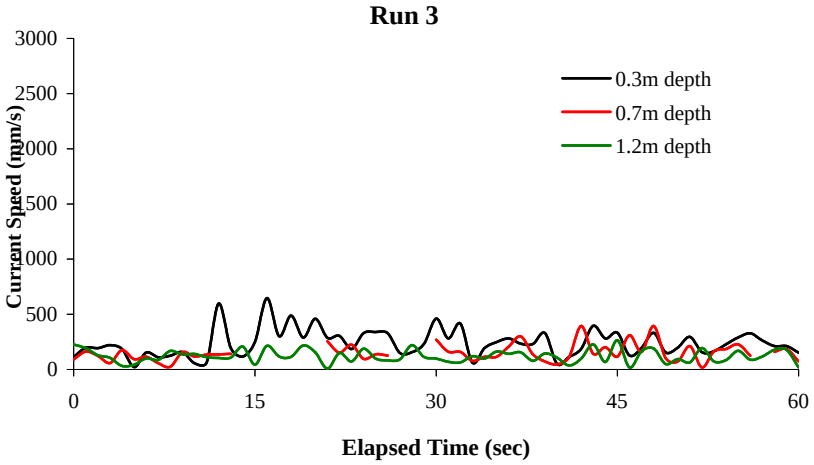
Fox River Propwash Study - Moving Vessel Trials

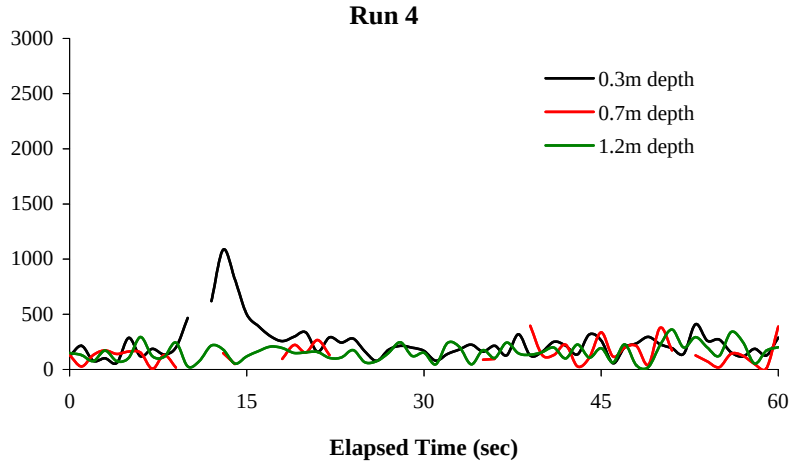
Test #17: Jetski - Full Throttle Startup

October 25, 2005









Lower Fox River Moving Vessel Trials
Test Eighteen

		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
Run 1		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:29:52		176	69.4	97	68.7	159	71.7	179	116.1	80	86.4	81	163.6	88	122.4	75	333.1	200.4	53.93	106	358.4
1	10/25/2005 13:29:53		107	29.2	29	189.8	30	160.3	31	273.7	47	321.9	57	234.3	127	357.3	95	187.9	99.98	98.05	70	17.4
2	10/25/2005 13:29:54		193	145.6	23	25.5	145	84.1	52	223.5	78	115.9	42	111	33	77.7	122	137	79.38	70.88	34	163.1
3	10/25/2005 13:29:55		62	346	48	329.7	80	330.9	82	88.6	39	44	33	242.7	60	60.9			79.63	82.79	75	101.6
4	10/25/2005 13:29:56		102	108.3	184	41.2	127	320.8	130	340.7	100	44.6	147	13.8	117	334.7			158.1	267.8	48	54.3
5	10/25/2005 13:29:57		64	91.8	132	68.3	18	289.4	13	118.6	69	41.5	107	130.1	92	358.1	174	193.6	276.6	262.1	51	45
6	10/25/2005 13:29:58		142	108.1	60	118.7	65	78.5	108	73.9	108	77.8	105	131.9	256	113.3			266.2	92.37	21	119.1
7	10/25/2005 13:29:59		81	48	248	64	153	30.3	21	311.2	28	227.9	128	32	96	108.2			43.66	339.9	90	300
8	10/25/2005 13:30:00		72	86	83	47.4	102	33.8	148	299.2	104	357.2	74	88.5	205	354.1	254	303.4	125.6	252.9	132	68.7
9	10/25/2005 13:30:01		138	50	52	17.7	159	34.5	240	39.3	265	357	96	14.5	307	43.2	84	323.3	46.32	32.66	314	14.2
10	10/25/2005 13:30:02		89	97.1	280	57.8	260	81.4	81	72	91	77.9	134	69.4					32.65	207.3	69	11.6
11	10/25/2005 13:30:04		118	163.3	124	100.2	70	115.5	141	220.7	26	240.5	67	35.3	117	89.5			150.3	99.96	44	306.6
12	10/25/2005 13:30:05		97	123.2	82	17.8	15	233.1	96	34.4	35	34.6	174	185.3	48	343.1					126	313.7
13	10/25/2005 13:30:06		177	87.1	163	44	296	38.4	197	339.5	188	122.2										
14	10/25/2005 13:30:07		78	272.2	93	158.7	154	125.2	142	116.7							354	151.5	211.6	82.94	441	34.7
15	10/25/2005 13:30:08		152	68	71	94.8	56	174.9					602	188.9	403	152	260	90.2	794.1	61.98	729	42.6
16	10/25/2005 13:30:09		123	107	148	84.6	169	153.3	114	148.7	225	179.7			293	123.1	384	138.2	267	68.24	540	26.4
17	10/25/2005 13:30:10		259	88.7	190	111	101	92.8	35	27.3	205	98.1					277	144.5	501.7	58.12	521	41.6
18	10/25/2005 13:30:11		124	50.9	186	68.5	241	86.9	182	130.3	180	118.8	435	122.9					227	354.7	632	35.9
19	10/25/2005 13:30:12		250	49.5	313	63.6	104	97.7	135	146.2	147	7	128	130.9							222	26.4
20	10/25/2005 13:30:13		101	134.6	194	59.6	64	113	141	129.2	149	110.9			246	62.9	322	28.8	285.1	33.41	473	24.7
21	10/25/2005 13:30:14		79	75.3	139	10.7	115	57.4	101	67.2	98	108.4	131	291.1			194	32.4	329.5	41.19	210	71.7
22	10/25/2005 13:30:15		35	14.8	184	70.7	139	100.7	288	3.6									182.1	25.02	320	52.7
23	10/25/2005 13:30:16		249	87.5	141	42.4	70	303.9	113	278.6							357	44.7	332.3	60.43	310	55.6
24	10/25/2005 13:30:17		130	16.5	86	17	175	354.1	134	315.6	84	103			52	177.8	94	91.8	127.9	347.8	135	59.3
25	10/25/2005 13:30:18		102	38.7	265	13.1	128	23.6	94	352.6					128	24	175	6.2	271.9	47.98	250	108.2
26	10/25/2005 13:30:19		212	56.9	178	55.8	145	23.2	171	33.8	59	193.8			161	309.7	147	95.1	132.3	47.14	246	20.4
27	10/25/2005 13:30:20		145	140.6	143	30.7	201	51.7	184	19	102	109.5			16	76	93	33.2	216.3	342.2	205	42.2
28	10/25/2005 13:30:21		127	63.2	149	70	58	71.9	173	13.4	146	64			208	25.6	129	211.3	221.4	71.57	305	75.8
29	10/25/2005 13:30:22		105	74	163	66.4	110	113.5	192	164	6	180	59	343.4			87	54.3	231.8	52.54	173	38.7
30	10/25/2005 13:30:23		70	83.5	89	66	159	4.7	122	87.2	81	89.3					211	2.7	79.4	31.09	97	37.5
31	10/25/2005 13:30:24		190	83.4	193	78.6	126	71	128	38	136	138			305	333.1	144	154.5	183.3	325.4	120	16.5
32	10/25/2005 13:30:25		98	58.7	161	62.2	149	96.9	159	134.2	33	14			145	17.2	114	19.4	135.2	68.75	127	58.2
33	10/25/2005 13:30:26		136	356.2	168	103.5	181	120.5	32	53.8	78	60.8	203	235.4	228	356	49	329.2	251	39.02	141	76.5
34	10/25/2005 13:30:27		153	73.7	133	97.8	68	342.9	66	10.5	173	53.5	255	77.1	148	356.1	102	32.6	92.36	70.39	154	51.3
35	10/25/2005 13:30:28		99	174.8	140	80.9	240	27.3	73	100.2	53	62			110	83.2	171	38.8	276.8	62.69	142	60.6
36	10/25/2005 13:30:29		91	65.4	82	348	23	200	152	109.6	83	13.9	223	139.5	98	84.8	305	97.5	51.55	108.1	96	47.5
37	10/25/2005 13:30:30		59	53.9	55	65.3	113	102.8	134	191.6	52	8.9	112	160.1	173	356.7	118	54.3	100.9	72.1	233	75.1
38	10/25/2005 13:30:31		188	25.2	21	157.2	169	259.8	115	299.2	75	146.9	232	163.4	250	67.4	133	357	78.92	337.7	104	23.1
39	10/25/2005 13:30:32		154	93	128	0.9	44	74.1	35	28.7	44	57	78	29.8	114	56.4	96	6.6	84.38	301.4	230	65
40	10/25/2005 13:30:33		113	108.6	104	62	52	18.1	51	218.7	208	249.5	64	285.3	199	64.3	125	285.3	85.48	241.3	55	225
41	10/25/2005 13:30:34		85	91.3	49	104	83	272.8	111	73.2	97	62.9			272	84.1	123	110.9	93.38	43.26	82	42
42	10/25/2005 13:30:35		163	133.3	187	73.5	275	56.1	106	244.4	182	130.1	12	80.5	19	276	109	289.3	173	90.99	169	93.7
43	10/25/2005 13:30:36		81	97.8	190	244.1	167	300.3	158	358.2	277	164.7	56	126.3	162	88.2			112.7	26.34	194	61.7
44	10/25/2005 13:30:37		158	99.1	118	55.4	74	202.1	123	356.3	330	15.1	65	106.2	171	157.6	62	135.7	146.8	65.88	160	72.6
45	10/25/2005 13:30:38		139	85	65	94.4	123	20.5	128	43.4	176	233.3	122	83.4	33	86.5	165	333.4	51.4	37.09	64	41.2
46	10/25/2005 13:30:39		77	341.8	129	46.3	89	251	126	98.2	53	158.8	142	145.6	17	139.8	85	16.3	39.92	112.1	137	86.7
47	10/25/2005 13:30:40		202	98.8	54	58.7	66	61.9	174	16.4	147	51.6	137	2.5	199	62.8	41	41.1	171.7	26.27	187	55.9
48	10/25/2005 13:30:41		137	71.7	179	44.8	90	286.8	35	291.5	16	142.4	100	38.1	214	161.5	67	75.3	73.01	306.1	163	33.5
49	10/25/2005 13:30:42		20	278.5	70	47.9	235	78.5	104	18.4	87	27.5			103	15.3	90	91.9	62.61	63.43	116	186.9
50	10/25/2005 13:30:43		92	188.1	127	80	37	145.9	57	318.5	189	72.1	164	48	194	30	240	12.2	59.51	114.8	173	68.3
51	10/25/2005 13:30:44		121	104.8	40	299.7	145	236.5	22	111.8	29	342.2	193	171.7	28	136.5	200	102.4	220	55.37	260	56.4
52	10/25/2005 13:30:45		187	24.6	344	16.9	236	334.4	81	21.8	148	39.5	47	150.7	181	86.5	301	66.3	131.9	27.54	103	18.1
53	10/25/2005 13:30:46		40	78.4	146	349.8	163	169.7	88	285.1	72	235.2	177	153.9	322	71.7	214	112.2	157.7	46.28	113	49.3
54	10/25/2005 13:30:47		92	69	78	56.5	235	260.2	71	104.6	51	322.2	581	54	146	0	173	162.5	140.1	313.3	221	20.4
55	10/25/2005 13:30:48		163	79	277	49.2	107	79.7			52	61.5	110	61.1	112	347.6	95	151	121.2	81.94	144	63.3
56	10/25/2005 13:30:49		103	47	38	303.3	83	114.1			71	223.3	124	148.5	102	162.3	133	94.7	133.8	64.78	21	272.7
57	10/25/2005 13:30:50		129	105.3	231	49.6	126	107.1			104	115.1			52	46.5	155	91.5	25.24	56.31	115	47.8
58	10/25/2005 13:30:51		81	20.9	122	9.5	217	37.9	393	351.1	135	357.9	20	30.5	156	44.5	40	349.8	55.9	280.3	221	73.2
59	10/25/2005 13:30:52		115	123.3	73	90	383	163.6	82	6.3			109	73.4	161	35.4	142	109.3	121	90.95	85	61.9
60	10/25/2005 13:30:53		174	76.4	51	48.2	266	143.6	78	6.7			89	122.6	87	69.1	84	251.4	29.27	82.15	121	100.9

Lower Fox River Moving Vessel Trials
Test Eighteen

Run 2		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:31:20		114	70.4	55	309.1	233	73.8	166	51.3	211	341.7	24	126.4	54	182.1	31	123.2	33.96	103.6	33	40
1	10/25/2005 13:31:21		150	85.4	136	101	117	78.2	49	268.8	281	141.5	35	33.2	155	109.6	84	342.6	68.96	240.5	102	18.3
2	10/25/2005 13:31:22		161	73.8	59	78.3	142	90.4	175	107.6	214	68.6	140	35.4	103	62.9	156	65.4	113.7	29.49	114	72.2
3	10/25/2005 13:31:23		43	161.1	226	99.9	268	24.3	207	5	171	161.2	86	75.8	76	72.3	27	318	89.94	311.8	169	339.2
4	10/25/2005 13:31:24		231	72.6	209	119.3	164	107	93	159.8	43	94	26	141.3	201	69	90	142.2	151.8	78.99	217	66
5	10/25/2005 13:31:25		200	34.8	206	58.7	61	233.7	144	262.8	97	201	215	58.5	157	108.2	137	85	104	271.7	151	5
6	10/25/2005 13:31:26		72	71.3	69	19.5	210	102.1	36	3.2	63	54	125	94.1	70	329	208	112.4	85.09	2.694	119	95.8
7	10/25/2005 13:31:27		51	52.2	354	125.9	108	200.6	40	319.1	85	189.5	35	143.1	11	349.7	213	111.5	91.07	58.93	71	60.6
8	10/25/2005 13:31:28		171	315.9	252	35.3	30	246.8	56	309.9	97	161.4	89	266.8	51	23.1	224	155.2	85	151.9	80	9.3
9	10/25/2005 13:31:29		114	139.6	78	192.6	133	77.4	180	84.3	168	138.6	135	241.7	193	247.8	79	199.1	103.1	98.37	97	115
10	10/25/2005 13:31:30		155	82.6	241	143.6	184	142.5	181	248.3	157	46.5	68	36	57	19.4	69	39.7	166.4	33.98	134	320.5
11	10/25/2005 13:31:31		252	56.5	190	24.3	143	51.5	178	60	101	41.8	98	69.7	307	52.7	241	191	79.23	355.7	229	11.1
12	10/25/2005 13:31:32		192	57.6	112	43.2	87	80.8	96	2.4	9	130.6	80	36.9	106	41.9			163.5	58.25	214	40.3
13	10/25/2005 13:31:33		125	73.7	153	150.3	185	146.9	203	126.2	105	112.4	332	75.7	57	45	98	180.6	150.1	29.98	136	21.6
14	10/25/2005 13:31:34		73	37.8	48	1.2	112	142.6	116	26.6	154	64.6	254	359.3	329	342.7			78.77	20.05	721	319.6
15	10/25/2005 13:31:35		127	163.6	42	226.9	82	160			252	224.5	312	183.7	606	223.5	389	202.3	293.9	131.7	588	93
16	10/25/2005 13:31:36		102	84.4	122	131	118	144.7			152	185.7	392	169.7	527	219.4			399.4	115.7	898	65.7
17	10/25/2005 13:31:37		202	94.3	246	95.1	72	121.9	65	254.9	125	259.9	158	356	612	74.6			876.5	70.26	916	45.4
18	10/25/2005 13:31:38		149	42.6	131	93.5	69	111.3	102	285.4	234	75.9	236	52.7	55	48.7			644.2	65.03	508	60.5
19	10/25/2005 13:31:39		159	142.9	202	84.6	275	107.1	21	27.8	198	214.9	262	139	167	128.9			447.4	74.44	440	70.3
20	10/25/2005 13:31:40		94	76.4	126	101.4	170	77.8	225	3.8	99	117.6	186	261	172	253.8	236	89	286.5	43.44	675	30.8
21	10/25/2005 13:31:41		79	60.5	264	107.6	240	77.8	140	114.5	167	101	204	51.8	457	58.6	346	67.6	497.4	71.24	324	47
22	10/25/2005 13:31:42		154	155.1	90	30.9	80	76.3	39	327.5	107	157.5	56	157.1	137	75.1	221	33	384.7	45.84	268	18
23	10/25/2005 13:31:43		178	43.9	182	102.7	109	94.2	48	171.5	135	327.7			264	16.7	314	12.9	314.7	51.71	374	72.9
24	10/25/2005 13:31:44		111	86.9	145	96.3	69	75.8	41	239	174	52	104	322.8	76	291.5	279	47	234	338.7	299	33.5
25	10/25/2005 13:31:45		87	126.6	174	117.3	51	83.3	47	6.1	141	193.5	204	113.7	242	41.7	283	30.4	90.27	94.45	275	42
26	10/25/2005 13:31:46		201	113.8	145	71.1	232	23.1	74	309.5			37	62.7	127	27.2	314	48.4	311.3	38.08	140	34.5
27	10/25/2005 13:31:47		159	70.2	119	63	120	21	112	90	208	161	128	19.1	219	11.6	236	63	285.6	70.99	384	57.4
28	10/25/2005 13:31:48		125	357.7	181	48.8	125	348	127	92.7	255	135.3	119	60.9	383	8.9	201	84.9	247.8	39.92	351	38.9
29	10/25/2005 13:31:49		193	58.1	161	69.7	158	236.6	174	279.2	73	356.9			60	27.8	77	247.8	88.84	191.7	102	342.8
30	10/25/2005 13:31:50		240	77.8	238	85.2	76	62.8	213	162.5	82	355.1			237	152.4	241	120.9	92.59	117.7	265	103.3
31	10/25/2005 13:31:51		67	22	91	36.5	144	33.7	141	257.3	111	156	142	222.1	35	16.4	167	321.6	301.6	28.52	243	35.8
32	10/25/2005 13:31:52		38	15.1	174	28.5	90	140.8	64	250.7	118	283.7			260	150.3	162	16.5	160.6	52.84	306	68
33	10/25/2005 13:31:53		54	356.8	210	29.7	194	54	123	25.1					34	55.8	223	79.4	29.15	30.96	274	61.7
34	10/25/2005 13:31:54		40	87.1	84	73.5	30	124.2	100	43.4			111	252.2	58	8	120	349.4	260.6	6.389	140	21.8
35	10/25/2005 13:31:55		87	8.6	65	14.3	249	29	116	301.6			163	200.4	59	131.6			260	59.49	163	52.7
36	10/25/2005 13:31:56		106	40.4	98	62.1	49	174.2	24	194.6			79	272.2			50	328.8	129.4	4.433	176	4.9
37	10/25/2005 13:31:57		228	93.8	99	57	102	62.4	67	169.7			152	18.4	145	95.2	91	278.8	73.36	27.61	170	44.5
38	10/25/2005 13:31:58		117	112.6	209	43.6	57	49.3	29	76			145	270			287	33.5	191.4	353.1	200	4
39	10/25/2005 13:31:59		153	70.1	81	66	151	80.8	123	239.7	133	92.6	238	129.7	285	83.3	216	91.3	110.9	62.05	49	167.1
40	10/25/2005 13:32:00		124	45.3	169	71.4	15	191.3	81	245.3	84	122.4			99	321.2	329	302.3	207.5	11.96	354	48.6
41	10/25/2005 13:32:01		108	60.6	151	56.3	155	76.6	45	149.5	142	83.9	172	117.3	22	2.6	182	83.4	255.2	102.7	346	89.2
42	10/25/2005 13:32:02		99	31	54	36	67	89.1	31	33.2	57	349.9	241	260.2	270	60.5	181	86.5	150.7	35.27	240	21
43	10/25/2005 13:32:03		69	29.5	21	8.1	200	359.1	190	38.8	90	354.3	185	60.3	215	23.8	79	290	61.55	317	33	347.7
44	10/25/2005 13:32:04		103	79.9	102	82.1	146	104.3	187	29.9	79	90.7	166	150.8	65	235.6	110	324.3	115	229.9	28	196.5
45	10/25/2005 13:32:05		63	345.3	124	349.8	128	29.6	68	116.2	71	195.6	117	302.1	124	82.6	70	234.9	96.03	98.38	110	352.2
46	10/25/2005 13:32:06		239	97.7	192	101.4	84	63.7	126	33.1	56	127.1	200	102.1	74	174.6	187	172.3	82.29	334.1	134	84.8
47	10/25/2005 13:32:07		122	71.4	209	67.8	155	72.7	304	145.1	239	61.8	37	6.2					78	67.38	36	116.6
48	10/25/2005 13:32:08		107	97.5	154	91.9	234	37.7	104	195.1	162	244.4	168	61.9	210	352.3	200	47.2	139.8	70.79	329	78.6
49	10/25/2005 13:32:09		215	67.3	109	55.9	159	96.9	27	338.2	531	72.9	172	41	181	41.9	174	0.7	69.26	17.65	208	83.4
50	10/25/2005 13:32:10		130	99.3	175	64.6	49	12.9	83	316	79	306.3	132	18.6	99	47.5	147	110.6	106.8	43.86	265	359.6
51	10/25/2005 13:32:11		116	135.7	113	109.1	58	125.9	97	351.1	227	296.5	107	329.6	282	10.6	217	93.4	295.6	44.73	293	344.8
52	10/25/2005 13:32:12		72	36.6	169	27.5	83	127.7	81	249.8	149	40.1	62	39.8	154	27.1	330	8.2	240.5	57.57	190	338.4
53	10/25/2005 13:32:13		114	132.5	154	116.6	91	79.9	68	346.4	327	65.1	122	99.9	131	270.4			145.8	75.3	205	97.6
54	10/25/2005 13:32:14		49	122.4	119	88.6	19	214.5	37	35	20	278.5	55	206.1	294	183.9	101	27.8	88.05	358	73	294.1
55	10/25/2005 13:32:15		255	55.6	66	61.1	121	73.7	70	12.4	31	161	106	8.7	92	338.2			115.2	306.2	97	258.1
56	10/25/2005 13:32:16		141	116.6	187	86.9	159	68.6	91	23.2	25	56.3	104	74.4	117	13.3	378	333.3	142.9	350.7	47	2.4
57	10/25/2005 13:32:17		93	294.9	79	133.5	110	51.3	89	168.3	92	86.3	107	36.7	246	316	232	20.9	205.9	54.69	137	43.2
58	10/25/2005 13:32:18		98	73.4	250	78.2	80	61.5	144	338.1	68	116.9	119	47.7	63	62.6			186.2	42.17	236	3.6
59	10/25/2005 13:32:19		272	87.5	41	59	68	72.9	76	25.9	108	62.5	366	75.4	77	359.3			104.7	44.23	185	355
60	10/25/2005 13:32:20		151	57.5	218	69.3	126	131.1	23	61.2	218	355.3	144	0.4	162	4.2	92	333.4	201.6	36.53	50	95.7

Lower Fox River Moving Vessel Trials
Test Eighteen

Run 3		Depth (m)	1.2		1.2		1.1		1.1		1.0		1.0		0.9		0.9		0.8		0.8		0.7		0.7		0.6		0.6		0.5		0.5		0.4		0.4		0.3		0.3	
		Range from ADCP (m)	0.4		0.4		0.5		0.5		0.6		0.6		0.7		0.7		0.8		0.8		0.9		0.9		1		1		1.1		1.1		1.2		1.2		1.3		1.3	
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:32:59		84	328.2	130	7.9	60	17.5	51	80.9	198	115.1	205	32.8	40	310	112	83.8	40.72	65.32	284	60.7																				
1	10/25/2005 13:33:00		45	57.7	52	242.4	123	300.3	121	90	149	14.4	160	91.8	61	258.7	56	342.2	126.2	33.69	86	62.2																				
2	10/25/2005 13:33:01		223	67	65	93.5	92	111.8	82	273.5	123	50	60	47	90	76.6	106	14.7	160.6	46.77	79	320.7																				
3	10/25/2005 13:33:02		47	340	159	84.9	64	119	93	27.7	124	183.2	94	352	80	230.1	144	311.6	76.49	25.56	107	314.6																				
4	10/25/2005 13:33:03		40	229.1	75	103.9	154	11.6	95	357	38	144.6	85	51.7	112	101.3	86	37.4	109.1	26.1	238	60																				
5	10/25/2005 13:33:04		79	11.7	243	44.5	131	7.5	115	65.9	181	104	264	141	83	122.2	87	163.2	115.2	87.01	268	66																				
6	10/25/2005 13:33:05		180	1.6	209	55.9	75	73	68	86.6	30	273.8	142	65.4	217	67.6	352	139.2	408.7	76.27	194	70.4																				
7	10/25/2005 13:33:06		118	24	199	69.7	125	119.9	85	95.4	102	160.5	90	29.1	85	59.5			116.9	246.3	209	77.3																				
8	10/25/2005 13:33:07		194	7.7	169	13.7	108	82.5	156	345.2	44	292.5	106	58.1	279	58.9	422	45.3	29.41	144.7	56	79.7																				
9	10/25/2005 13:33:08		48	190.8	129	96.7	97	275.3	94	338.1	129	230.4	99	22.7	48	345.4	200	187.8	101.2	69.78	57	143.5																				
10	10/25/2005 13:33:09		74	26.6	113	78.3	110	28.2	41	217.1	130	0	131	174.3	107	231.8	148	152.7	48.55	327.6	70	40.3																				
11	10/25/2005 13:33:10		154	6.3	64	100.8	122	10.4	160	350.3	90	53.1	27	195.1	108	93.2	152	311.3	65.3	320	287	37.5																				
12	10/25/2005 13:33:11		122	106.7	57	122.9	134	189	157	142	207	138.9	264	127	224	113.9	108	82.5	167	213	319	259.7																				
13	10/25/2005 13:33:12		14	306	91	49	124	106.8	110	351.1	90	35.5	89	108.2	31	301.6			99.62	54.4	845	342.9																				
14	10/25/2005 13:33:13		120	114	206	135.8	76	135.5	110	180	116	60.6	122	117.4			525	91.6	212.2	70.46																						
15	10/25/2005 13:33:14		365	89.5	128	87.8	59	347.4	168	101.3	195	99.8					421	161.3	593.3	114.7	860	60																				
16	10/25/2005 13:33:15		101	137.8	85	117.2	196	191.2	63	173.7	168	135					368	107.2	541	224.3	841	38.3																				
17	10/25/2005 13:33:16		128	51.3	137	70.8	61	94.7	187	107.5	184	106.5	249	150.3			408	121.3	809.8	49.96	1061	40.5																				
18	10/25/2005 13:33:17		233	68.6	219	63.7	71	13.8	62	133	56	307.7	41	158.5			38	93	267.3	75.7	502	37																				
19	10/25/2005 13:33:18		74	81.4	187	90.9	269	79.3	122	23.2	104	3.3					318	81.5	424.9	55.45	510	25.2																				
20	10/25/2005 13:33:19		205	85.2	42	136.9	26	339.4	194	51.7	208	157.1			229	32.2			233	26.78	298	31.3																				
21	10/25/2005 13:33:20		106	151.3	136	43.8	162	55.8	146	118.7	88	140.5	154	95.2	232	1.7	302	349.3	80.75	352.2	215	42																				
22	10/25/2005 13:33:21		86	115.4	48	139.3	70	75.2	131	351.2			58	351	166	83.4			221.8	16.23	149	61.5																				
23	10/25/2005 13:33:22		58	68.7	166	71.8	57	18.4	86	104.8	69	284.2	96	228.4	122	304	228	183.8	52.15	355.6	30	216.9																				
24	10/25/2005 13:33:23		178	49.8	212	71.6	98	325	126	4.1	111	26.1	123	27.2					329.2	62.11	267	40.3																				
25	10/25/2005 13:33:24		182	89.7	162	77.9	168	76.5	42	149.7	92	355.6			153	339.8	257	166	90.38	24.86	176	23.1																				
26	10/25/2005 13:33:25		59	3.9	132	34.2	23	265	178	344			40	275.7	258	354	307	354.6	164.3	21.41	170	26.1																				
27	10/25/2005 13:33:26		84	100.2	67	356.6	80	32.7	66	171.3	338	178.3	212	124.2	208	91.1	73	250.8	216.9	22.78	370	77.1																				
28	10/25/2005 13:33:27		164	55.9	126	328.3	75	298.6	74	272.3	112	353.3	155	129.2	56	52.3	79	42.4	32.45	56.31	302	56.9																				
29	10/25/2005 13:33:28		117	86.6	112	16.7	42	99.7	56	104.5	64	129.9			191	79.5	52	352.3	63.95	333	155	52.6																				
30	10/25/2005 13:33:29		146	26.4	172	355	141	93.2	91	239.5	89	270	128	215.2	114	339.5	156	58.3	191	30.86	120	30																				
31	10/25/2005 13:33:30		67	132	60	172.3	134	136.8	117	214.9	86	118.3	45	264.9	122	147.3			124.4	151.2	63	192.9																				
32	10/25/2005 13:33:31		124	85.4	76	96	97	101.9	33	132.5	59	27.4	140	160	44	110.1	282	64.6	102	24.3	164	53.7																				
33	10/25/2005 13:33:32		17	10	111	104	214	134.4	270	347.4	174	25.2	32	308.7	182	127.9	77	41.3	76.48	62.76	148	85.4																				
34	10/25/2005 13:33:33		156	72.5	32	133.7	123	31.4	69	66.8	318	46	223	350.5	220	6	262	345.2	192.9	5.651	333	354.8																				
35	10/25/2005 13:33:34		162	86.8	204	68.7	167	142	209	108.7			99	97	220	89.2	391	51.4	283.8	74.89	385	39																				
36	10/25/2005 13:33:35		69	351.6	83	116.6	15	250.3	123	127.7			99	323.2	155	273.7	202	303.3	166.4	318.2	209	353.1																				
37	10/25/2005 13:33:36		209	91.9	132	121	102	118.8	375	345.5	78	343.7	162	294.5	203	47.2	178	30	138.9	30.26	267	62.3																				
38	10/25/2005 13:33:37		64	91.8	64	107.3	27	83.7	156	154.6	59	52.5	95	195.2	50	195.2	252	8	229.5	54.58	286	84.6																				
39	10/25/2005 13:33:38		147	94.3	148	38.4	57	90	211	45.4	118	17.2	48	251.9	130	321.5	183	309.4	256.5	8.067	366	0																				
40	10/25/2005 13:33:39		244	75.5	93	120.4	96	30	182	111.9	109	133.5	422	109.9	192	99	201	114.7	326	104.2	411	109																				
41	10/25/2005 13:33:40		123	344.5	165	329.9	88	11.2	91	265	131	310			335	339	132	329	258.8	8.443	222	351.7																				
42	10/25/2005 13:33:41		106	37	151	54.7	18	141.8	87	50.1	40	140	29	110.3	312	36.8	165	37.4	177.4	71.26	315	76.8																				
43	10/25/2005 13:33:42		273	87.3	130	70.7	163	64.5	52	331.5	104	210.5	169	295.7	206	318.3	256	347.4	97.31	22.35	233	46.7																				
44	10/25/2005 13:33:43		241	88.8	159	50.9	110	359.5	89	48.6	83	139.4			230	282	216	320.6	91.42	250.2	49	285.5																				
45	10/25/2005 13:33:44		87	222.7	171	125	5	291.8	77	151.1	146	97.5	159	144.7	195	110.8	231	100	275.3	110.4	327	115.2																				
46	10/25/2005 13:33:45		140	62.3	44	62.9	45	149.5	142	353.1	44	91.3	260	300	138	335.1	173	318.3	345	359.7	423	11.2																				
47	10/25/2005 13:33:46		93	78.8	137	49.4	194	20.5	57	42.9	85	10.9	45	138.6	170	248.3	144	147.7	303	180.2	176	219.2																				
48	10/25/2005 13:33:47		160	117.2	191	51.6	177	102.1	89	162.4	224	85.9	337	88.8	213	81.9	192	63.7	185	123.1	284	75.7																				
49	10/25/2005 13:33:48		68	148.2	36	105.9	85	208.1	53	230.3	254	3.6	310	338	223	348.6	306	310.5	201.2	324.1	317	332																				
50	10/25/2005 13:33:49		168	140.1	188	115.9	124	359.5	59	44.3	155	4.4	61	12.2	9	153.4	156	108	122.3	124.3	310	28.7																				
51	10/25/2005 13:33:50		131	189.7	77	87	179	218	192	71.2	122	16.7	21	58.6	100	42.2	128	48.5	360.7	80.75	376	50.9																				
52	10/25/2005 13:33:51		63	56.1	89	113.1	187	79.8	175	291.1	228	344.5	169	316.7	89	11.7	106	113.9	87.05	312.7	111	351.2																				
53	10/25/2005 13:33:52		246	128.1	86	74.5	100	193.3	92	51.1	94	300.1	76	164.7	159	231.1	9	333.4	123.2	105.1	57	47.9																				
54	10/25/2005 13:33:53		76	42.3	107	49.2	116	62.3	37	176.9	175	353.1	173	50.9	171	30.9	202	67.6	88.36	5.194	158	50.7																				
55	10/25/2005 13:33:54		97	46.3	177	73.3	174	229.2	18	132.7	217	285.8	167	333	345	66.6	147	113.6	94.35	194.1	142	150.9																				
56	10/25/2005 13:33:55		62	247.2	210	89.5	119	356.2	103	348.3	25	66.5	91	46.8	79	263.4	199	5.8	320.9	33.69	140	339.1																				
57	10/25/2005 13:33:56		91	222.3	139	289.3	33	295	79	70.9			88	212.4	203	357.7	157	317.1	149.3	253.3	286	38																				
58	10/25/2005 13:33:57		137	111.3	110	242.5	21	25.3	132	356.5			154	109.4	228	112.2	376	131.4	249.6	109.7	300	95.2																				
59	10/25/2005 13:33:58		187	355.7	218	52.8	163	24.7	157	325.1	155	140.2	46	132.4	127	7.2	165	10.1	187.5	7.352	288	17																				
60	10/25/2005 13:33:59		179	108.2	146	48.3	44	149.9	201	22.5	126	298	146	291.3	78	265.6	146	293.8	40	233.1	214	324.9																				

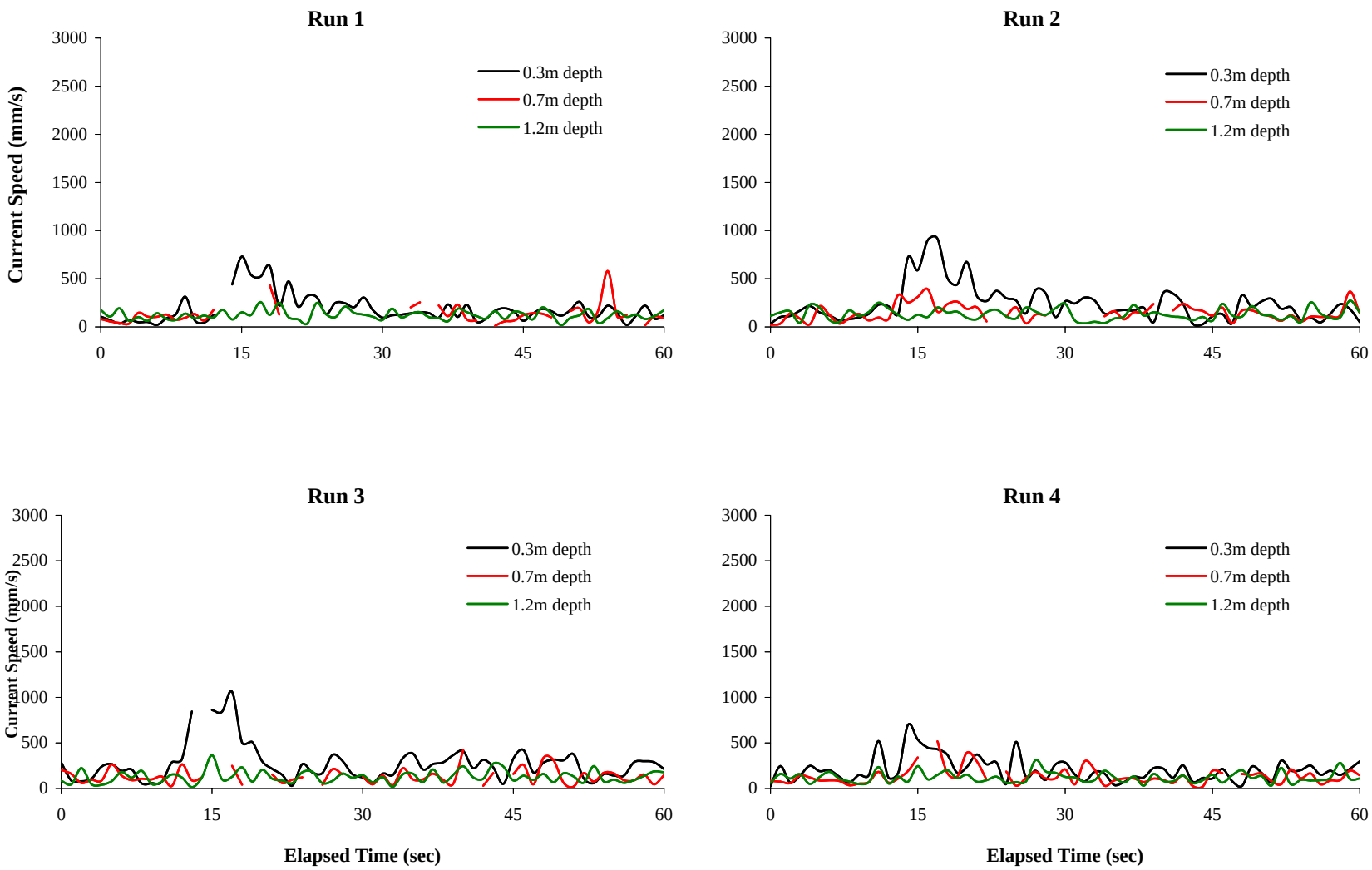
Lower Fox River Moving Vessel Trials
Test Eighteen

Run 4		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:36:20		62	58.9	213	95.9	71	30.5	182	343.8	225	107.9	83	49.4	191	25.8	77	15.1	105.5	68.3	25	83.2
1	10/25/2005 13:36:21		159	48.3	145	44.2	11	146.3	50	303.7	65	98	75	43.9	99	13.5			32.28	106.2	246	11
2	10/25/2005 13:36:22		110	40.9	90	53.1	54	32.2	124	128.8	72	68.8	59	97.9	149	57.6	385	192.7	111.2	48.28	64	15.3
3	10/25/2005 13:36:23		157	66.7	148	96.6	136	109.8	23	121	40	73.9	143	14.1	93	2.5	90	180.6	96.69	10.73	140	70.4
4	10/25/2005 13:36:24		49	94.7	77	54	129	331.2	66	59.9	96	333.4	122	102.8	63	14.7	71	223.3	160	358.6	249	5.3
5	10/25/2005 13:36:25		126	51.1	225	64.1	70	51.3	151	167.8	13	45	86	53	139	346.3	134	173.6	63.13	266.4	190	84
6	10/25/2005 13:36:26		182	37.2	102	83.8	86	153.1	148	115.2	52	277.7	89	21.7	96	32.2	93	39.3	110.1	65.3	201	40
7	10/25/2005 13:36:27		107	55.3	162	84.7	151	56.3	198	111.6	75	179.2	82	181.4	46	254.7	137	197.9	185.9	150	129	15.8
8	10/25/2005 13:36:28		77	153.1	201	65.6	216	45.9	94	215	26	182.2	35	96.5	122	137.3	121	147.1	47.27	186.1	62	144.8
9	10/25/2005 13:36:29		50	148.8	114	100.6	13	103	150	216.3	74	43.9	52	109.1	46	182.5	142	11.4	49.34	17.7	147	281.4
10	10/25/2005 13:36:30		67	72.6	128	91.8	29	164.1	37	12.5	42	5.4	69	357.5	283	58.9	186	38.7	62.77	67.52	143	56.4
11	10/25/2005 13:36:31		235	122.1	201	106.5	117	87.1	60	231	96	168.6	183	158.9	714	143.5	443	96.6	346.7	74.44	520	127.1
12	10/25/2005 13:36:32		54	51	101	42.2	103	173.8	67	284.7	54	146.3	64	122.2	128	155	128	343.7	57.7	205.7	121	35.9
13	10/25/2005 13:36:33		130	14.7	76	44.5	50	53.1	138	220	88	306.2	110	31.2	207	19.2					172	100.7
14	10/25/2005 13:36:34		74	227.7	77	78	108	187.5	178	223.2	131	265.6	192	347.7	10	233.1	133	211.2	306.9	335.1	697	344.3
15	10/25/2005 13:36:35		245	121	202	113.9	132	190.5	29	164.1	178	152.3	341	166.8							536	29.4
16	10/25/2005 13:36:36		101	143.5	103	138.1	122	114.7	92	148.4	181	183.5			227	122.8	761	158.1	556.5	99.41	449	23.8
17	10/25/2005 13:36:37		149	107.9	139	84.2	148	134.2	71	358.4	255	149.9	518	225.8	680	79.8	409	111.5	383.6	50.5	430	30.9
18	10/25/2005 13:36:38		200	62.9	224	81	159	71.7	118	68	141	44.1	170	39.5	117	115.3	234	116.7	285	59.66	369	39.5
19	10/25/2005 13:36:39		114	70.4	16	284	87	125.7	303	234.9	143	49.8	129	11.1	195	281.3	219	292.2	158.9	303.2	173	29.8
20	10/25/2005 13:36:40		152	47.4	333	13.4	91	22	341	52.2	155	348.8	393	333.7	448	349.4	219	72.1	273.4	67.19	236	56.6
21	10/25/2005 13:36:41		75	158.2	18	289.4	115	95					299	276.5	469	318.5	78	18.7	262.1	27.25	373	34.4
22	10/25/2005 13:36:42		90	128.3	196	344.3	215	111.8			144	317.8	95	260.9	55	104.8	205	136.6	200	89.71	265	16.9
23	10/25/2005 13:36:43		130	73.5	181	350.5	150	260.8	159	262.4	151	236.6			105	339.3			239.8	46.52	286	41.3
24	10/25/2005 13:36:44		61	97.6	151	166.6	102	338.7	196	212.1			186	216.9	30	118.3	53	124.3	227.2	2.27	50	131.7
25	10/25/2005 13:36:45		70	81.8	117	77.6	109	95.8	164	90.3			31	296.6	201	72.3	335	56.3	264.5	43.77	512	34.5
26	10/25/2005 13:36:46		76	74.7	107	101.3	62	99.3	285	103			112	168.7	94	74.6	92	78.7	51.48	97.82	130	68.4
27	10/25/2005 13:36:47		312	69.4	285	84.8	241	90.7	138	36.5			182	86.9	361	1.6	105	90.5	340.1	59.82	195	60.8
28	10/25/2005 13:36:48		188	88.2	177	135.2	148	73.2	190	123.6			111	64.4	101	107.4	298	112.7	168.6	85.24	94	2.4
29	10/25/2005 13:36:49		173	47.3	65	109.8	89	195.6	105	331	271	29.6	109	98.4	135	46.5	151	24.2	185.5	22.83	263	18.8
30	10/25/2005 13:36:51		127	76.8	110	76.3	100	72.5	193	108.7	233	43.6	209	69.8	386	72	304	94.5	325.6	64.54	285	33
31	10/25/2005 13:36:52		120	16.9	81	35.5	80	252.5			157	315	45	358.7	99	358.3	223	53	179.9	48.15	153	46.6
32	10/25/2005 13:36:53		71	156	19	58	146	114.6			113	160.9	300	3.6	140	81.8	217	338.1	98.06	11.77	78	85.6
33	10/25/2005 13:36:54		92	15.1	162	30.8	56	64.8			104	75.6	207	348.3	201	37.7	304	353.8	245.1	25.62	183	16.2
34	10/25/2005 13:36:55		194	91.2	148	69.5	88	74.9	208	180			30	78.3	17	10	143	267.6	59.81	249.4	163	63.4
35	10/25/2005 13:36:56		123	33.7	61	57.1	149	10.4					88	313.2	65	182.6	165	89.3	184.4	53.38	38	183
36	10/25/2005 13:36:57		65	73	87	174.7	54	190.7	130	54.7	182	70.5	110	133.2	147	172.6	246	158.8	129.4	4.433	70	13.2
37	10/25/2005 13:36:58		132	96.5	190	73.8	181	120.5	39	104.7			110	38.7	90	345.8	174	35	39.32	262.7	129	100.3
38	10/25/2005 13:36:59		30	189.5	64	24.1	25	260.9	93	353.2			70	237.2	97	326.3	94	308.1	160.1	67.6	122	51.3
39	10/25/2005 13:37:00		160	114	41	111.5	260	104.3	16	165.1			108	121.3	126	146.3	126	92.7	180	60.73	223	35.9
40	10/25/2005 13:37:01		82	44	151	38.8	224	76	164	6			93	77	154	10.1	41	341.6	161.2	43.99	218	57.8
41	10/25/2005 13:37:02		79	84.2	37	113.8	127	140.4	62	104.9			59	4.8	138	40	95	96.1	199.9	51.3	118	50.5
42	10/25/2005 13:37:03		142	202.4	108	91.6	154	65.4	60	231	116	267.5	143	1.6	148	17.3	150	36.9	232.2	28	254	35.1
43	10/25/2005 13:37:04		57	52.1	44	325.2	95	60.2	101	8.5	50	333.9	27	31.3	59	203.1	175	135.7	44.05	39.47	73	161.6
44	10/25/2005 13:37:05		89	55.1	194	101.6	83	79.6	65	173.9	178	330.4	21	324.8	43	95.3	149	120.7	66.48	136.2	115	86
45	10/25/2005 13:37:06		151	45	182	55.5	7	333.4	206	168.5	187	178.2	195	231.2	143	96	116	291.3	30.41	350.5	109	34.6
46	10/25/2005 13:37:07		65	17	102	94.5	235	52.6	145	33.5	70	11.5	168	286.3	83	101.2	261	74.7	225.8	68.43	215	58.7
47	10/25/2005 13:37:08		144	64.9	195	70.8	206	354.4	87	356.1	412	55.6			192	357	286	12.3	237.8	32.29	82	66.9
48	10/25/2005 13:37:09		200	110.8	179	110.3	118	131.9	179	127.5	240	17.2	159	265.3	79	259.1	79	301.5	250.1	298.4	27	338.2
49	10/25/2005 13:37:10		114	16.4	49	357.7	58	232	113	122	169	313.3	151	33.4	117	18	91	109.2	209.2	32.7	239	9.4
50	10/25/2005 13:37:11		136	62.3	189	14.1	82	126.6	62	133.7	217	270	164	288.9	79	7.3	12	31	159.5	7.927	171	25.2
51	10/25/2005 13:37:12		30	76.4	74	64.5	208	57.1	75	263.9			84	299.9	193	66.8	263	39.1	149	90.77	67	56.5
52	10/25/2005 13:37:13		227	34.6	291	36.8	140	3.3	142	339.8	199	13.1	45	349.7	102	61.2	220	14.2	184.4	105.1	306	22.9
53	10/25/2005 13:37:14		44	52.4	106	63.7	130	62.4	87	11.3	112	27.7	208	41.9	231	54.3	185	100.9	42.45	133.1	197	31.1
54	10/25/2005 13:37:15		94	64.2	231	125.1	160	339.2	126	275.9	88	22.8	113	37.8	180	52.2	39	196.6	62.27	60.14	202	10.9
55	10/25/2005 13:37:16		87	21.6	220	30.3	173	359.7	58	300.1	88	86.7	165	20.2	62	60.9	159	35	183.6	33	251	10.8
56	10/25/2005 13:37:17		90	181.9	199	78.1	177	83.2	100	210.7	76	279.8	45	358.7	51	85.5	18	343.6	213.8	95.1	151	93.8
57	10/25/2005 13:37:18		117	299.6	20	30.5	50	139.9			82	290	87	306.6	6	211	164	153.9	202.7	38.79	194	28.9
58	10/25/2005 13:37:19		281	69.8	216	106.4	199	152.4	136	242.5	258	358.9	90	24.9	26	2.2	161	95	64.82	51.89	147	93.9
59	10/25/2005 13:37:20		105	97.1	205	80.2	104	39.9	63	145.3			196	70	119	83.2	82	148.4	113.6	83.94	216	75.8
60	10/25/2005 13:37:21		109	138.7	10	174.3	134	28.5	134	52.9	100	41.3	145	58.5	171	54.7	178	350.3	145	359.2	298	29.3

Fox River Propwash Study - Moving Vessel Trials

Test #18: Jetski - 50% Throttle Startup

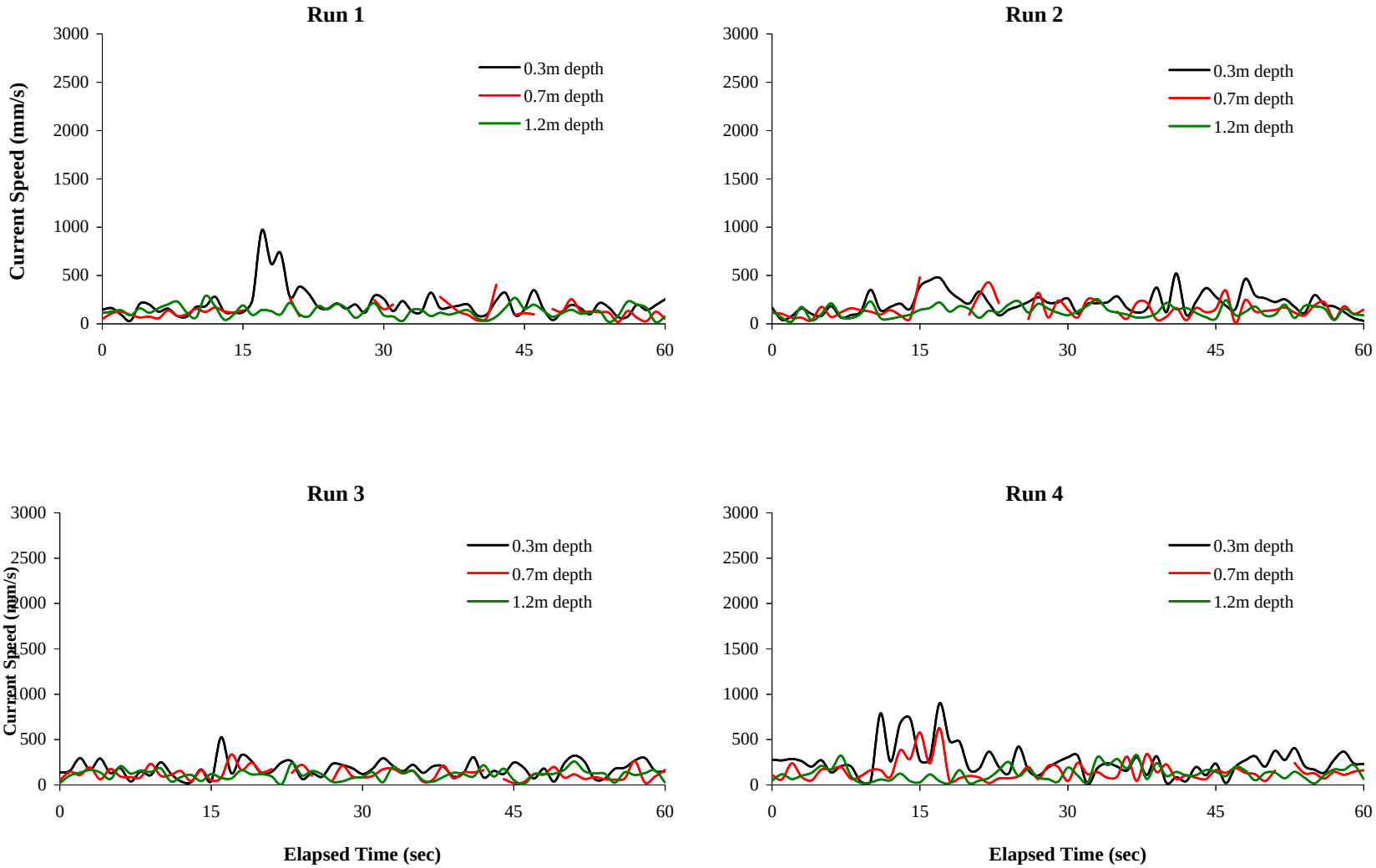
October 25, 2005



Fox River Propwash Study - Moving Vessel Trials

Test #19: Jetski - 25% Throttle Startup

October 25, 2005



Lower Fox River Moving Vessel Trials
Test Nineteen

Run 1																								
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:40:36		113	27.9	218	65.3	106	337.8	87	242.5	99	83.6	49	44.2	22	5.2	108	167.8	60.03	88.09	147	41.4
1	10/25/2005 13:40:37		126	52.4	152	43.1	177	10.1	117	23.7	18	3.2	109	140.6	83	74.6					163	46.2
2	10/25/2005 13:40:38		141	124.6	201	95.1	166	113.5	73	356.1	166	348.1	125	325.8	190	332.1	50	230.6	4.123	256	96	21.5
3	10/25/2005 13:40:39		88	127.1	126	56.7	139	34.7	28	18.4	86	255.8	94	358.8	6	231.3					32	0
4	10/25/2005 13:40:40		160	40.4	46	347.5	78	18	207	337.3	60	340.7	66	104	99	52.8					208	357
5	10/25/2005 13:40:41		115	42.9	79	47.6	123	140.6	118	57.1	99	72.3	75	36.9	186	30.7	80	222.5	76.04	338	200	359.1
6	10/25/2005 13:40:42		163	71.8	141	60.2	56	102.3	42	72	94	104.2	58	92	45	123.3			304.4	259.2	127	342.6
7	10/25/2005 13:40:43		202	92	183	55	97	73.8	183	24.9	182	57.4	138	35.5	156	33.5					158	15.4
8	10/25/2005 13:40:44		231	132.2	172	133.3	128	50.1	236	359.5	180	30.4	82	64.7	56	315.7					80	140.6
9	10/25/2005 13:40:45		118	46.7	78	97.4	144	15.3	88	111.3	73	344.1	101	43	104	87.2			13.34	167	75	29.6
10	10/25/2005 13:40:46		66	63	44	164.1	62	310.4	140	289.6	199	328.5	155	319.4	35	85.1	97	230.4	95.72	32.2	175	341.4
11	10/25/2005 13:40:47		289	85.6	178	63.3	275	78.9	113	66.6	154	65.4	123	55.3	229	91					183	34.7
12	10/25/2005 13:40:48		184	83.8	217	75.8	159	53.2	149	91.5	56	86.9	170	94	302	73.7					280	151.4
13	10/25/2005 13:40:49		43	28.9	92	22.4	240	75.3	117	171.2	93	225	129	274	178	95.8					124	155.3
14	10/25/2005 13:40:50		96	95.4	196	90.6	91	39.6	70	327.9	66	112.3	119	63	267	32.6					118	119.4
15	10/25/2005 13:40:51		191	124.8	174	119.2	163	80.5	106	83.5	96	358.2	140	78.9							121	84.8
16	10/25/2005 13:40:52		91	88.1	218	107.9	57	94	162	181.8					839	167.2	695	155.7	273.9	137.5	244	20.1
17	10/25/2005 13:40:53		144	135.3	182	150.1	179	115.8	163	201.5					248	186	342	107	1588	70.2	968	38.3
18	10/25/2005 13:40:54		131	96.6	128	125.2	49	206.6	147	113.6					170	81.9	358	101.1	1042	64.22	622	52.3
19	10/25/2005 13:40:55		97	69	286	70.4	179	352	155	353.3	159	301.9			267	13.7	128	23.6	449.2	46.71	734	14.6
20	10/25/2005 13:40:56		219	112.2	172	88.7	150	150.9	113	114.1	199	18.4	266	52					609.1	56.86	280	15.7
21	10/25/2005 13:40:57		99	99.3	55	31.7	127	131.5	109	63.9	255	52	80	45.5			345	49.7	709.3	39.8	386	29.6
22	10/25/2005 13:40:58		78	175.6	109	83.7	212	94.1	45	146	36	178.4			40	336.6			117.4	336.9	312	350.2
23	10/25/2005 13:40:59		184	23.8	75	63.1	141	93.7	120	66.4	106	69.5	267	50.2			67	35.8	352.2	43.62	175	37.6
24	10/25/2005 13:41:00		151	98	269	91.3	21	247.2	22	313.2	149	129			85	31.1	110	102.6	142.4	48.7	156	38.8
25	10/25/2005 13:41:01		206	97	191	98.4	21	166	166	170.7			260	118.2	73	128.3	221	141.1	91.09	17.24	211	52.9
26	10/25/2005 13:41:02		163	97.4	88	54.7	106	84	158	306	220	67.5			68	123	192	114.7	129.1	59.26	158	48.3
27	10/25/2005 13:41:04		62	83.6	42	306.3	31	24.9			135	31.7			58	33.7	89	279	88.55	333.1	200	15.4
28	10/25/2005 13:41:05		137	115.4	45	223.2	86	102.1							124	295.7	124	9.8	229.5	48.18	115	350.5
29	10/25/2005 13:41:06		214	53.2	74	159.4	78	100.3	104	153.7			246	244.8	34	253.1	183	59.5	90.03	347.8	290	13.6
30	10/25/2005 13:41:07		88	228.7	33	96.9	22	108.4					150	13.1	144	359.6	278	18.7	148.5	12.45	259	31.1
31	10/25/2005 13:41:08		76	323.6	76	296.6	10	330.9			152	112.4	200	46.4	55	304.6	141	316.7	31.89	311.2	133	35.5
32	10/25/2005 13:41:09		29	77.9	138	75.3	39	88.5	129	220.6	153	77.1					113	45.7	125.6	17.14	236	38.6
33	10/25/2005 13:41:10		143	49.3	126	36.6	100	93.4	61	58.4	131	101			179	193.3	151	55.3	219.1	77.61	131	337.5
34	10/25/2005 13:41:11		144	109.9	40	303.7	118	110.9	124	114.7	145	68.6	83	271.4	143	236.4	177	161.9	16.12	299.7	124	1.4
35	10/25/2005 13:41:12		80	51.1	218	45.7	172	95	72	16.2	236	47.9			225	85.4	320	23.8	368.6	62.18	324	55.8
36	10/25/2005 13:41:13		115	171	198	102.3	169	58.3	71	143.6	78	40.8	279	267.3	117	17.4	225	36	268.6	9.427	165	14.7
37	10/25/2005 13:41:14		95	135.4	281	56.8	185	70.4	81	105.8	260	54.5	202	127.6			137	47.1	101.5	50.19	172	35.1
38	10/25/2005 13:41:15		122	102.8	98	47.5	201	37.1	35	31	179	24.8	125	55.8			348	45	160.2	53.63	188	66.4
39	10/25/2005 13:41:16		142	62.7	100	89.4	102	91.7	64	29	138	327.1	91	290.6	58	37.3	167	88.6	182.5	56.4	201	55.8
40	10/25/2005 13:41:17		57	28.4	124	84.4	74	112.4	173	91.3	38	215.4	36	204.4	286	235.7	85	357.3	157	88.91	87	49.7
41	10/25/2005 13:41:18		32	251.6	98	27.9	60	36.9	164	95.3			66	14.9	85	59.5	130	51.9	66.13	20.35	100	56
42	10/25/2005 13:41:19		76	105.3	179	79.4	187	73.9	15	203.2			406	47.2	145	49.7	200	26.7	140.7	39.23	243	78.6
43	10/25/2005 13:41:20		169	130.2	188	92.1	40	40	142	7.3	171	57.9			59	110	262	85	223.6	94.36	319	61.7
44	10/25/2005 13:41:21		270	96.8	275	97.3	119	97.2	88	359.3			93	111.3	207	152.1	256	355.7	229.5	41.82	90	53.1
45	10/25/2005 13:41:22		156	62.4	38	28.6	102	30.6	149	53.2	17	315	112	359.5	308	36.9	93	101.2	90.76	341.4	150	63.1
46	10/25/2005 13:41:23		199	52.6	176	12.1	213	51.5	49	346	150	33.6	98	57.9	211	73.2			256.2	49.91	350	61.1
47	10/25/2005 13:41:24		138	91.7	125	38.5	157	127.2	97	81.7	61	190.4			173	290.6	61	315	204.6	47.97	159	124.5
48	10/25/2005 13:41:25		75	69.6	147	51.9	90	112.9	13	85.6	251	83.1	153	133.4	221	209.8	224	229.7	252.1	47.89	40	223
49	10/25/2005 13:41:26		111	121	68	205.4	169	28.2	91	167.9	153	59.7	127	49.2	80	323.1			41.77	349	123	113.4
50	10/25/2005 13:41:27		145	71.6	92	72.3	135	117.9	27	162.9	159	98.7	256	66.5	216	348.2	168	129.5	173.3	43.83	196	69.7
51	10/25/2005 13:41:28		105	354	116	78	86	100.8	43	345.3	75	154.8	130	87.4	47	55.3	139	89.2	13.93	249	160	47.5
52	10/25/2005 13:41:29		117	62.6	147	53.3	134	318.3	60	150.9	156	334.1	128	68.4	141	96.1	228	137.5	115.3	141.3	100	83.1
53	10/25/2005 13:41:30		131	49.6	75	78.4	82	19.3	149	255.6			120	99.6	27	214.3	192	65.7	222.7	69.78	215	39.3
54	10/25/2005 13:41:31		19	222.9	228	70.8	43	196.3	103	327.2	146	79.8	115	133.9	77	84.1	105	71.7	198.3	34.73	169	28.2
55	10/25/2005 13:41:32		85	117.2	94	42	169	53.4	151	236.3	69	330.5	20	258.7	49	4.7	161	341.9	29.7	225	69	143.8
56	10/25/2005 13:41:33		231	335.2	94	323.6	244	287.9			98	264.1	133	70.2	93	54.6	202	306.4	122.4	216	75	299.6
57	10/25/2005 13:41:34		199	42.8	238	100.4	182	55.1			314	67.5	64	136.3	70	153.8	198	87.4	99.08	267.7	197	11.1
58	10/25/2005 13:41:35		167	130.4	162	122.4	87	29.5			115	76	28	207.5	92	125.8	121	5.2	178.1	57.38	143	198.3
59	10/25/2005 13:41:36		16	104.9	106	103.1	83	335	301	213.5	48	152.9	125	12.5	181	8	215	19.9	129	7.125	194	55.1
60	10/25/2005 13:41:37		76	172.4	39	322.3	65	186.1	37	273.1	72	111.9	52	58.5	208	58.8	323	111.4	221.7	13.03	254	39.3

Lower Fox River Moving Vessel Trials
Test Nineteen

Run 2

Elapsed Time (sec)	Time (CDT)	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
	Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3		
	Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3		
0	10/25/2005 13:42:06	134	48.9	306	55.8	134	154.4	70	325.4	15	301.6	113	0.5	333	10	24	175.2	77.79	314	167	18.9		
1	10/25/2005 13:42:07	63	115.3	134	85.3	56	88	118	326.7	123	90.9	103	150.2	170	343.3	46	232.1	197	12.91	41	78.7		
2	10/25/2005 13:42:08	23	151.2	145	102.3	157	91.1	193	58.8	66	342.4	62	129.1	127	62.8	315	119.5	206.6	63.56	82	284.9		
3	10/25/2005 13:42:09	176	45.7	74	107.2	120	80.4	157	46	82	56.5	62	102	160	148	243	104.8	107.5	9.638	159	347.3		
4	10/25/2005 13:42:10	37	55	192	1.5	122	352	159	256.6	126	110	36	243.4	96	105.8	248	76.2	133.5	29.64	104	15.6		
5	10/25/2005 13:42:11	101	27.8	154	22.9	139	350.5	142	240.6	130	275.3	175	65.3	74	298.3	123	25.1	126.4	13.27	81	7.1		
6	10/25/2005 13:42:12	212	100	127	116.2	111	64.4	132	66.7	128	123.8	72	98	348	2	119	358.6	175.8	25.25	182	48.8		
7	10/25/2005 13:42:13	75	65.5	140	109.2	111	306.6	159	262	109	346.7	120	162	150	317.7	231	259.8	155.3	325.5	65	303.7		
8	10/25/2005 13:42:14	59	156	228	48.6	86	131.7	118	256.3	92	286.5	162	114.4	28	14.5	122	219	102.6	47.76	91	47.7		
9	10/25/2005 13:42:15	105	107.2	47	358.8	41	52.9	25	310.1	114	346.8	141	319.9	81	350.1	116	330.6	99.25	266	127	3.2		
10	10/25/2005 13:42:16	232	70.3	203	83.8	44	79.5	129	34.6	206	16.3	127	26.8	137	116.9	81	97.8	383.5	67.78	352	22.3		
11	10/25/2005 13:42:17	59	45	254	107.2	217	91.6	26	234.5	25	296.6	97	267.6	58	104			61.03	271.9	139	309.2		
12	10/25/2005 13:42:18	52	159.8	203	132.4	104	139.7	78	40.8	28	282.5	142	114.6	139	6.2			57.58	110.3	175	311.5		
13	10/25/2005 13:42:19	74	333.4	112	52.6	69	107.7	35	345.2	49	330.8	89	3.9	171	340.2			68.25	230.9	209	308.8		
14	10/25/2005 13:42:20	95	45	151	57.2	16	135	168	342.6	60	140.4	52	291.6	361	309.4	319	193.8	122.6	221.4	153	325.7		
15	10/25/2005 13:42:21	144	257.6	123	62.8	143	54.6	59	33.1	161	113.4	481	350.3	508	101.8					384	78.7		
16	10/25/2005 13:42:22	164	42.3	55	111.4	174	148.4	180	144.3	371	140.4			188	71.1	531	95.1	137.2	87.08	451	37.1		
17	10/25/2005 13:42:23	221	146.8	180	107.4	184	110.4	181	110.7	162	85.4			193	103.2	167	105.3	305.8	74.05	477	63.6		
18	10/25/2005 13:42:24	127	89.1	180	98.9	132	107.6	90	155.7	247	92.8					324	156	117	359	340	39		
19	10/25/2005 13:42:25	182	88.7	89	115.4	153	123.3	196	111.2	42	245.9			142	114.9	57	109.4	663.8	72.47	259	59.6		
20	10/25/2005 13:42:26	153	86.3	77	95.2	102	150.7	89	159.5	123	213.7	96	123.5	148	245.2	102	262.1	227.9	39.84	210	52.7		
21	10/25/2005 13:42:27	62	131.7	174	64	107	57.2	40	198.9	379	83.9	299	159.4	18	60.6	351	344.8	397.9	336.9	335	359.3		
22	10/25/2005 13:42:28	135	54.7	207	64.5	46	342.3	118	293.5			428	142.8	177	96.5	381	105.8	192.4	52.18	212	40.2		
23	10/25/2005 13:42:29	119	126.5	151	18.6	194	234.8	114	266	230	245.6	216	241.8	260	162.5	436	156.6	317.6	250.3	88	22.8		
24	10/25/2005 13:42:30	202	100.3	128	46.6	158	358.9	211	169.9							189	110.4	25.3	288.4	146	40.6		
25	10/25/2005 13:42:31	235	58.4	224	102.6	76	320.9							112	103.4			199.6	36.24	182	26.8		
26	10/25/2005 13:42:32	117	92.9	93	161.8	156	124			242	90.7	51	142.9	112	354.9	272	17.3	254.1	47.71	226	19.9		
27	10/25/2005 13:42:33	209	119.5	119	103.6	232	109.4	201	46.2	330	69	321	78.3					94.64	353.3	277	33.2		
28	10/25/2005 13:42:34	156	103	58	84.1	124	343.2	142	358.8	148	37.9	67	224.4	86	221.2	144	326.3	186.3	328.6	219	330.5		
29	10/25/2005 13:42:35	115	62.1	125	55.4	95	67.2	56	317.2	54	322.5	240	8.1					71.02	57.65	224	30.9		
30	10/25/2005 13:42:36	90	5.7	253	347	149	322.9	121	103.3	265	28.4	147	5.9	80	333.1	230	90	207.7	23.85	263	36.2		
31	10/25/2005 13:42:37	130	23.6	148	135	60	123.4	27	219	78	271.5	67	319.2			5	306.9	56.08	176.9	105	81.8		
32	10/25/2005 13:42:38	188	50.4	238	45.9	83	37.7	85	273.4	126	49.8	254	75.9	206	75.7	102	35.4	94.11	42.85	207	46		
33	10/25/2005 13:42:39	256	59.2	61	319	64	145.8	153	134.7	42	134	238	56.3	144	350.4	58	62.1	202.5	48.2	214	36.8		
34	10/25/2005 13:42:40	147	121.6	186	151.8	19	251.6	109	70.1	128	97.2			179	51.6	209	172	102.4	84.96	223	94.4		
35	10/25/2005 13:42:41	116	71.9	147	8.2	86	108.2	86	46.9	154	15	126	33.1	179	73.8	72	354.4	177.1	87.74	285	60.1		
36	10/25/2005 13:42:42	97	289.2	199	319.9	117	275.4	65	263	81	7.1	53	45.8	143	1.6	106	215	162.9	48.48	164	15.9		
37	10/25/2005 13:42:43	65	121.7	109	35.3	39	242.8	67	36.5	101	41.4	219	53.9	72	211.9			105.4	33.39	118	63.9		
38	10/25/2005 13:42:44	71	182.4	121	89.5	182	119.9	102	65.7	65	60.7	220	33.3	129	103			238.8	209.9	155	66.1		
39	10/25/2005 13:42:45	111	171.2	114	151.2	59	262.1	93	211.8	94	322.8	44	6.5	110	352.2	127	267.7	193.2	272.4	376	289.9		
40	10/25/2005 13:42:46	217	352.6	59	101.7	123	52.9	67	75.3	142	76.6	74	122.8	57	49.3	237	60.9	197.9	75.96	122	89.1		
41	10/25/2005 13:42:47	151	56.3	243	115.8	166	106.5	163	112.3	104	125.2	165	53.9	187	78.3			326.1	88.59	522	79.9		
42	10/25/2005 13:42:48	165	2.1	73	141.7	88	183.9	82	32.5	188	94.6	38	62.1	193	354.1			81.39	5.641	94	30.1		
43	10/25/2005 13:42:49	113	345.6	59	54.7	289	35.3	143	6	94	357	164	6.6	59	293.1	148	276.2	246.4	35.75	230	322.6		
44	10/25/2005 13:42:50	69	59.7	240	57.8	248	47	47	268.8	100	18.6	120	48	192	347.7	257	67.8	324	83.62	370	92.9		
45	10/25/2005 13:42:51	53	125.8	242	10.9	100	359.4	183	338.9	115	38	156	8.1	72	102.1	165	67.9	158.6	68.94	281	90.4		
46	10/25/2005 13:42:52	245	27.7	127	56.6	94	242.9	46	330.1	116	344.1	346	310.3	179	302.7	224	325.4	204.6	42.03	189	341.5		
47	10/25/2005 13:42:53	90	70.6	264	31.7	126	79.9	71	81.9	121	182.8	9	35.5	72	354.4	111	92.6	162.8	117	153	74.4		
48	10/25/2005 13:42:54	125	99.7	265	106.7	202	143.9	115	152.5	140	101.1	247	101.7	181	66.3	212	103.1	189.6	112.6	466	97		
49	10/25/2005 13:42:55	180	127.6	90	45.5	72	70.6	39	109.4	134	15.2	127	42.5	169	45.2	253	98.6	120.1	12.99	294	77.6		
50	10/25/2005 13:42:56	85	102.2	79	246	138	340.5	86	286.1	161	329	134	336.3	102	348.1	161	226.5	168.6	297.2	266	293.3		
51	10/25/2005 13:42:57	95	339.7	37	77.5	66	4.3	124	43.7	139	341.6	144	24.6	79	30.5	65	262	67.98	206.2	225	311.8		
52	10/25/2005 13:42:58	199	79.6	198	118	200	8.6	20	206.6	33	312.5	170	272.7	55	236.9	292	89.4	295.2	117	254	77.7		
53	10/25/2005 13:42:59	61	79.6	61	59.2	201	95.1	165	78.1	126	22.3	116	75	48	248.2			262.5	57.76	176	92.9		
54	10/25/2005 13:43:00	187	46.3	115	60.8	80	91.4	68	54	44	154.6	87	339.9	213	340.2			87.93	252.8	114	43.9		
55	10/25/2005 13:43:01	180	44.3	134	87.4	52	81.1	24	36.4	108	281.7	190	25.6	365	351.5			114.5	345.8	297	346		
56	10/25/2005 13:43:02	159	358.9	110	79.5	88	44.5	55	101.5	116	46.4	225	97.7	107	339.7			91.01	89.37	198	81		
57	10/25/2005 13:43:03	40	49.1	50	303.7	72	42.2	85	44	189	54.7	48	20.7	98	40			137.5	76.97	179	79.1		
58	10/25/2005 13:43:04	153	87	117	132.9	200	60.6	171	53.8	276	80.8	181	29.4	181	57.2			117.6	72.18	124	26.4		
59	10/25/2005 13:43:05	101	30.9	74	20.6	95	36.9	60	354.3	412	329	104	108.4	131	75.4	244	241.3	150.5	262	59	21.8		
60	10/25/2005 13:43:06	88	23.4	225	20.3	203	297.6	119	335.6	135	10.6	146	328.2	199	12.2	144	324.9	168.4	305.6	30	21.4		

Lower Fox River Moving Vessel Trials
Test Nineteen

Run 3																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:43:39		20	182.9	81	101.4	198	76.6	55	112.4	77	90	51	33.1	144	28.7			114.6	316.4	137	346.5
1	10/25/2005 13:43:40		105	88.9	184	79.4	55	102.5	128	94.9	84	353.9	144	344.3	98	211.3			88.57	115.4	158	41.2
2	10/25/2005 13:43:41		135	58.9	203	29.2	345	0.3	178	46.8	117	41.9	109	84.2	197	250.1			153	335.3	297	3.7
3	10/25/2005 13:43:42		165	103.7	232	77.8	138	75.3	143	54.6	74	31.8	193	87.3	83	199.1	124	151.2	123.1	163.5	167	50.1
4	10/25/2005 13:43:43		138	88.3	76	154.1	229	74.8	69	45	108	298.2	62	243	58	265.1	83	118.1	30.61	308.4	292	67.7
5	10/25/2005 13:43:44		65	85.6	69	141.5	115	101	26	85.6	76	203.2	175	223.6	27	296.6	151	168.9	105.8	49.99	131	314.7
6	10/25/2005 13:43:45		208	351.2	121	37.6	166	43.8	141	97.3	105	41.9	94	343.3	113	14.4	59	277.9	55.71	339	184	352.5
7	10/25/2005 13:43:46		125	27.6	111	110.6	121	99	74	153.4	40	190.2	87	33.7	64	71.8	89	214	110	169	38	32
8	10/25/2005 13:43:47		161	52.1	98	99.9	237	44.8	97	108.6	195	327.1	84	335.3	60	22.7			49.25	84.17	146	116.4
9	10/25/2005 13:43:48		143	6.8	70	85.9	11	37.9	63	101	56	163.5	232	334.4	149	117.1	122	126.7	88.2	266.1	107	14
10	10/25/2005 13:43:49		184	47.6	32	341.6	211	1.6	146	15.1	51	30.6	101	131	102	17.7	165	205.2	104	46.95	250	27.4
11	10/25/2005 13:43:50		38	163	105	80.1	113	42.9	76	187.6	210	324.1	110	7.8	199	355.4	154	189.7	99.46	279.8	125	0.5
12	10/25/2005 13:43:51		87	72	24	131.6	79	137	205	153.1	69	146.3	153	183.4	170	82.6	244	122.1	198.1	137	40	220
13	10/25/2005 13:43:52		112	88.5	40	194.4	65	34.4	75	319.3	187	19	43	151.1	93	45.4	79	303.7	128.7	107.2	29	284
14	10/25/2005 13:43:53		43	20.6	90	38.7	53	70.2	126	156.1	115	40.8	162	36.2	118	341.3	124	358.2	206.3	303.5	171	351.9
15	10/25/2005 13:43:54		121	208.7	177	93.6	59	312.3	188	331.1	165	262	50	256.2	45	313.2	311	161.4	172.8	157.4	42	125.2
16	10/25/2005 13:43:55		76	45	223	69.5	180	121.8	69	219.7	112	94.1	83	202.6	241	93.8	77	355.5	265.1	78.8	527	87.2
17	10/25/2005 13:43:56		72	301.9	35	334.9	86	173.3	187	204.4			337	211.9	275	204.5	120	210.6	319.8	247.8	128	80.1
18	10/25/2005 13:43:57		162	160.6	192	119	142	134.7	189	202.8			167	220.4	258	151.5	149	183.1	138.6	43.83	330	11
19	10/25/2005 13:43:58		117	92.9	161	127.9	256	137.8			46	134.1	245	199.3	75	144.2	165	49.4	349.5	50.57	264	26.1
20	10/25/2005 13:43:59		119	185.3	104	101.1	133	147.6	251	109.6	258	85.6	142	132.4	113	209.7	128	86	322	67.74	127	64.8
21	10/25/2005 13:44:00		94	59.9	137	102.2	135	138.9			81	177.9	173	125.3	80	159.5	259	125.6	121.8	33.95	145	80.9
22	10/25/2005 13:44:01		7	351.9	34	247.2	248	213.3	244	281.8	142	210.5			164	55.9	137	25.1	221	21.22	249	31.5
23	10/25/2005 13:44:02		243	102.4	182	44.3	94	233.6	37	9.2	90	276.4	134	134.4	259	61.2	196	72.8	291	75.68	259	92
24	10/25/2005 13:44:03		104	342.6	82	217.6	104	340.3	330	308.1	76	274.5	222	168.3			175	359	57.72	14.04	67	275.1
25	10/25/2005 13:44:04		155	5.6	135	51.6	47	193.4	181	311.6	42	316	103	119.5	311	117.1			271.9	26.66	128	13.6
26	10/25/2005 13:44:05		116	304.1	66	226.8	6	80.5	126	0.5	78	193.3							260.9	279.9	90	9.6
27	10/25/2005 13:44:06		35	230.8	106	223.5	96	318.8	97	276.5	130	329.5	40	161.1	31	88.2	153	304.6	117.4	314.3	231	347.8
28	10/25/2005 13:44:07		40	50	30	101.7	90	45.5	78	243.4	15	101.3	210	41.5	365	330.3	232	87.5	222.2	53.23	219	16.7
29	10/25/2005 13:44:08		77	188.2	78	78.1	89	163	243	4.5	92	1.9	96	291.5	129	46.6	28	98.1	130	69.75	184	92.2
30	10/25/2005 13:44:09		87	30.4	73	306.1	84	21.7	164	113.7	106	155.4	84	284.5	140	54.3	222	68.9	146.8	24.12	121	350.9
31	10/25/2005 13:44:10		142	23.7	121	49	38	140.4	202	337	265	357.2	99	52.8	60	1	69	26.6	61.98	349.8	180	37.8
32	10/25/2005 13:44:11		30	109.7	187	85.4	142	9.7	153	351.3	121	327.5	172	68.2	173	30.6	201	358	207.7	33.61	294	42.4
33	10/25/2005 13:44:12		197	76.2	192	99.9	17	76.8	130	294.6	108	293.5	179	327.1	112	76.6	98	65.8	214.8	352.5	213	359.2
34	10/25/2005 13:44:13		135	204.5	10	286.7	236	123.8	65	108.7	74	30.7	126	71.6	182	120.6	281	108.7	32.25	82.87	151	141.2
35	10/25/2005 13:44:14		157	50.9	138	106.5	98	307.1	324	275.7	206	359.2	154	37.6	172	227.1	241	325	160.6	347.8	223	9.3
36	10/25/2005 13:44:15		50	57.3	90	34.6	175	22.2	202	347.7	175	278.2	36	93.2	60	19.3	199	308.9	121.2	16.79	134	358.3
37	10/25/2005 13:44:16		37	157.6	91	243.2	120	98.1	53	79.1	124	320.5	60	303.4	83	180	115	169	141	60.71	206	54.1
38	10/25/2005 13:44:17		89	184.5	66	63	198	22.9	9	161.6	230	264	214	310.5	194	327.2	191	30.2	213	11.1	205	12.7
39	10/25/2005 13:44:18		134	43.8	118	17.8	150	261.5	116	225	128	59.4	73	243.1	60	325.8	94	280.5	41.77	222.1	93	73.1
40	10/25/2005 13:44:19		120	29.3	199	104.2	115	71.7	58	310.8	190	316.1	140	26.2	107	350.9	94	81.4	152.3	41.54	130	67.4
41	10/25/2005 13:44:20		91	20.6	261	2	179	1.3	193	29.7	77	273	139	339.7	252	43.9	44	353.5	189.9	346.9	306	0.4
42	10/25/2005 13:44:21		218	100.3	104	125.2	232	140.6	61	253.9	186	261.3	164	308.8	104	50.1	33	41.3	78.03	88.53	82	10.5
43	10/25/2005 13:44:22		93	106.9	88	123.9	113	152.1	41	119.1	158	85.7			144	71.8	187	51.3	198.6	63.05	154	75.7
44	10/25/2005 13:44:23		179	47.9	75	19.4	63	90.9	53	7.5	163	359.6	65	1.8	191	11.2	224	26.6	230.5	24.34	120	32.1
45	10/25/2005 13:44:24		54	44.3	260	96.2	176	298.2	392	262.2	9	108.4	21	240.9	199	22.8	150	342.5	167.6	45.24	248	15.9
46	10/25/2005 13:44:25		9	26.6	174	130.6	96	143	108	126.3	39	250.6	31	270	142	314.1	135	48.3	107.6	48.01	189	14.7
47	10/25/2005 13:44:26		116	39	28	282.5	100	73.7	99	11.1	41	0	122	27.4	130	214.7	87	251.1	149.6	53.97	70	103.2
48	10/25/2005 13:44:27		121	78.6	91	44.1	70	106.6	145	148.8	43	18.9	115	5.5	76	312.3	43	349.2	169.3	54.62	181	62.7
49	10/25/2005 13:44:28		124	94.2	171	118.2	128	133.4	103	355	102	319.8	198	250.6	73	214.3	45	267.5	80.02	88.57	37	27.3
50	10/25/2005 13:44:29		166	22.2	126	78.5	132	62.1	96	355.2	141	213.1	81	165.6	193	142.4	45	33.3	43.01	35.54	239	57
51	10/25/2005 13:44:30		259	72	294	78.8	117	102.4	56	71.2	82	260.9	118	114	237	97.8	107	76	237.5	59.66	324	68.8
52	10/25/2005 13:44:31		151	53.4	116	115	73	272.4	28	201	51	117.1	66	177.4	65	83	281	149.1	149.6	175	257	1.6
53	10/25/2005 13:44:32		127	75.4	99	173	89	140.9	54	357.9	219	71.9	87	104	238	123.2	64	212.2	113.1	195.4	67	184.3
54	10/25/2005 13:44:33		125	83.6	154	30.1	152	309.1	278	15	36	342.1	64	346.4	140	215.4	279	164.8	57.56	352	68	12.8
55	10/25/2005 13:44:34		24	330.3	93	0	8	309.8	145	34	125	253.7	59	18.7	193	260.1	194	127.9	142.1	7.275	176	356.4
56	10/25/2005 13:44:35		142	21.9	84	77	64	219.9	74	325.5	73	262.1	74	88.5	130	31.5	115	136.8	133.4	79.2	191	108.9
57	10/25/2005 13:44:36		109	49.5	60	325.8	88	73.4	81	174.4	73	156.6	262	90.9	140	97	247	209.4	53.41	51.84	270	104.8
58	10/25/2005 13:44:37		131	12.8	62	343	126	43.7	47	80.1	131	87.4	25	270	201	85.7	222	22.2	50.7	75.14	297	59.2
59	10/25/2005 13:44:38		160	339.5	203	61.8	67	56.5	203	272.3	56	355.9	92	241.5	196	155.3	230	67.6	130.7	50.59	156	63.3
60	10/25/2005 13:44:39		27	342.9	58	195	134	63.8	126	334.7	155	69.2	167	79.6	118	82.2	207	312.1	160	71.79	150	43.4

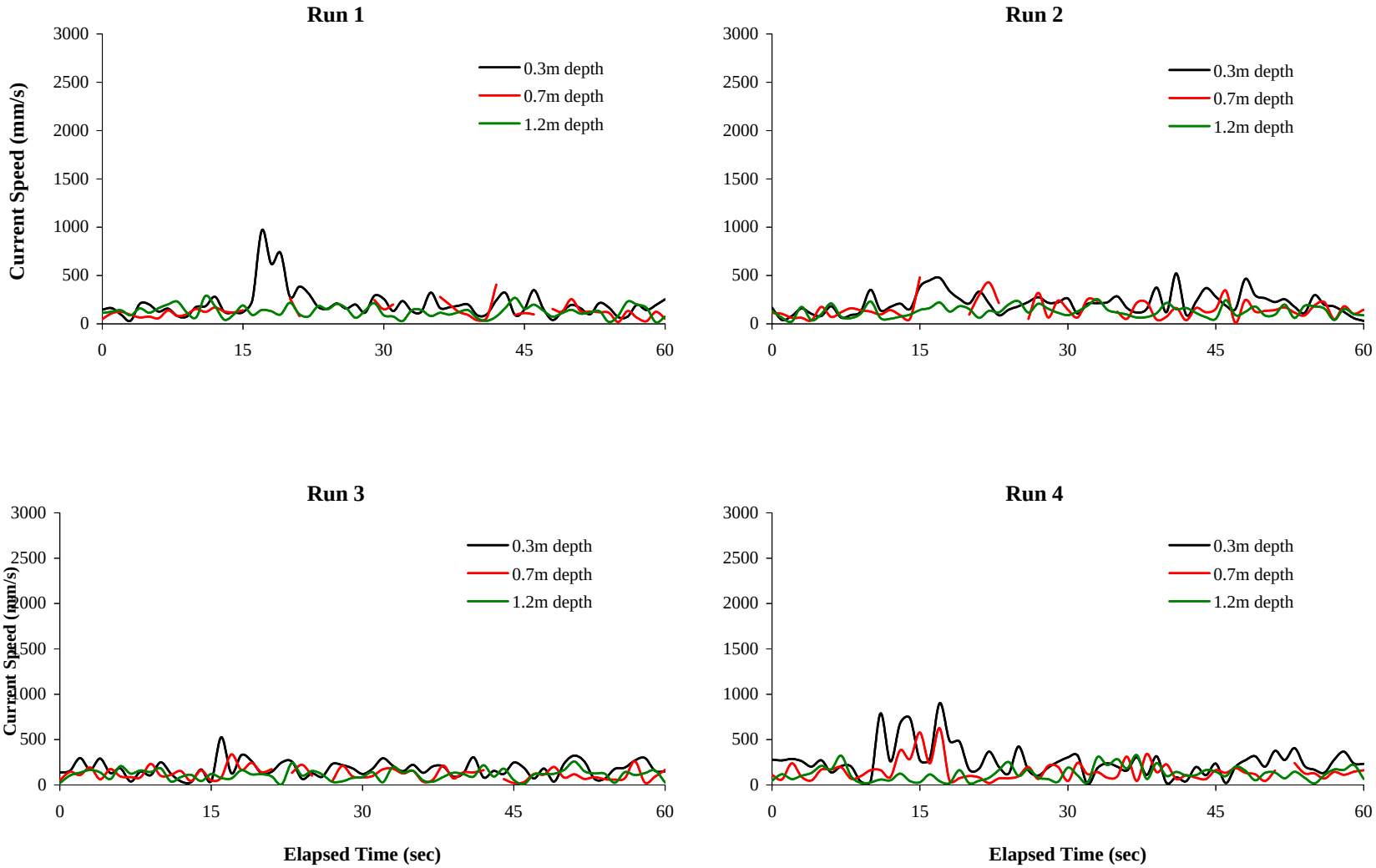
Lower Fox River Moving Vessel Trials
Test Nineteen

Run 4																							
		Depth (m)	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
		Range from ADCP (m)	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1	1	1.1	1.1	1.2	1.2	1.3	1.3
Elapsed Time (sec)	Time (CDT)		Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg	Mag mm/s	Dir deg
0	10/25/2005 13:45:02		49	42.5	58	52.7	121	6.2	112	334.1	41	27.8	111	14	119	262.3	389	276.3	130.1	333	280	304.7
1	10/25/2005 13:45:03		118	34	39	54.3	97	23.7	88	83.4	44	52.4	61	92.8	141	314.7	101	10.9	193	349.9	271	1.7
2	10/25/2005 13:45:04		65	290.7	105	320.4	144	12.9	227	340.7	116	11.9	239	39.7	131	6.6	96	341.8	41.23	292.8	287	23.6
3	10/25/2005 13:45:05		101	265.5	122	38.7	86	39.8	78	119.2	200	30	91	315.4	168	90.3	181	357.2	181.4	68.67	264	27.1
4	10/25/2005 13:45:06		132	48.4	158	37	66	24.2	101	43	182	37.6	50	155	230	56	140	41.8	193.9	55.08	201	71.5
5	10/25/2005 13:45:07		211	45.4	138	50	163	59.8	198	129.2	215	86	169	98.8	141	83.9	419	63.8	231.4	68.98	273	49
6	10/25/2005 13:45:08		172	47.1	38	6	91	62.6	67	77	172	67.8	170	82.6	116	66.1	146	3.5	41.59	332.8	139	7
7	10/25/2005 13:45:09		324	87.3	147	60.3	178	35.8	141	35.2	187	30.5	196	60.7	163	25	166	353.4	126.3	310.5	207	55.6
8	10/25/2005 13:45:10		98	98.2	87	86.1	165	31.4	140	108.3	104	333.7	69	17.7	163	352.3	155	301.8	162.7	13.87	204	0.3
9	10/25/2005 13:45:11		22	313.2	101	154.7	124	101.1	161	80	45	150.6	97	75.7	125	159.8	330	325.2	106.1	348.6	38	15.1
10	10/25/2005 13:45:12		28	227.9	96	210.9	125	90.5	207	297.1	72	344.6	164	289.2	24	119.7	85	309.3	86.16	21.8	41	285.4
11	10/25/2005 13:45:13		61	94.7	36	110.9	179	331.6	44	54.2	136	3.4	164	344.4	51	60.9	254	175.7	270.6	340.1	789	345.1
12	10/25/2005 13:45:14		52	165.4	62	160.1	62	194.9	81	113.4	59	134.3	87	58.7	444	148.9	391	146.7	498.9	95.06	259	50.6
13	10/25/2005 13:45:16		125	92.7	110	222.4	170	193.3	189	146.9	222	188.8	383	146.9	353	132.2	791	125.4	1137	76.06	683	54.7
14	10/25/2005 13:45:17		42	130.2	87	150.5	136	226.8	183	146.8	180	121.6	287	161.1	180	120.7	370	81.5	512.1	50.03	734	34.8
15	10/25/2005 13:45:18		30	227.7	95	145.3	94	201.9	90	125.1	301	120.1	578	127.3	284	87.6	378	86.2	883.8	72.96	273	51.7
16	10/25/2005 13:45:19		117	82.1	64	188.1	159	106.5	115	64.3	107	124	239	79.9	151	68.2	143	116.6	188.9	81.78	289	18.7
17	10/25/2005 13:45:20		41	347.3	132	241.9	124	293.9	13	274.4	153	82.1	626	60.1	129	49.4	299	65.7	292.9	58.97	903	20.8
18	10/25/2005 13:45:21		20	220.9	124	209.5	49	279.5	85	259.1	241	337.3	47	73.9	176	285.1	162	36.2	329.9	4.172	487	9.2
19	10/25/2005 13:45:22		163	316.2	129	316.3	104	94.4	169	145.1	145	150.3	75	323.1	125	356.3	327	358.2	358.5	44.66	478	26.7
20	10/25/2005 13:45:23		19	264	14	339	90	255.2	40	146.3	70	358.4	99	0.6	284	291.2	383	334.5	93.23	337.3	169	341.4
21	10/25/2005 13:45:24		47	151.8	88	308	122	337.8	192	340.8	260	282	82	2.1			312	335.8	154.6	307.9	180	4.5
22	10/25/2005 13:45:25		78	354.1	65	320.6	45	108	96	102	138	318.2	21	19.3	153	356.6	52	329	178	1.287	368	359.7
23	10/25/2005 13:45:26		165	341.7	106	40	32	138.8	98	107.1	192	62.4	72	42.8	37	317.2	94	248.1	56.64	317.9	200	14.5
24	10/25/2005 13:45:27		253	3.4	134	338.6	130	357.4	156	25.9	133	30.8	73	294.1	181	65.8	100	314.6	276.8	58.89	127	53.9
25	10/25/2005 13:45:28		99	237	98	143.7	72	92.4	73	231.1	165	23.6	97	75.1	100	113.5	266	25.1	335.4	53.61	424	76.2
26	10/25/2005 13:45:29		173	79.7	108	81	99	133.4	129	24.8	226	29.2	198	18.3	447	319	55	247.6	355.7	59.04	164	48.7
27	10/25/2005 13:45:30		81	80.8	103	58.9	70	112.6	38	291.8	220	166.6	66	164.1			50	198.8	57.08	267	104	23.1
28	10/25/2005 13:45:31		65	344.9	186	302.5	91	47.7	134	22.8	245	64.6	211	51.6	221	44.1	213	313.7	195.5	349.1	191	351.6
29	10/25/2005 13:45:32		35	90	98	25.5	47	331.8	37	271.5	66	65	199	318.9	277	307.1	188	319.1	191.2	347.9	256	358.7
30	10/25/2005 13:45:33		191	59.4	234	113.9	167	103.5	206	355.5	199	100.7	44	58.1	274	6.1	353	49.9	378.5	47.03	305	49
31	10/25/2005 13:45:34		104	83.4	179	119.4	247	99.8	94	78.9	222	86.9	245	31.5	133	348.3	203	7.4	241.2	46.85	324	53.4
32	10/25/2005 13:45:35		27	213.1	105	51.6	128	70.4	33	194	68	80.7	119	38.9	98	206.6	54	260.4	113.5	328.7	8	270
33	10/25/2005 13:45:36		307	73.2	127	83.7	206	64.4	115	18.7	99	223.4	143	153.8	182	63.9	260	79.8	182.6	65.4	186	13.4
34	10/25/2005 13:45:37		220	112.7	91	74.7	94	78.3	121	339.2	172	127.2	79	270.7	166	335.8	145	351.6	200.7	38.53	238	337
35	10/25/2005 13:45:38		286	47.6	192	33.1	200	96	30	151.7	84	156.8	94	30.1	133	81.3	148	74.7	116.8	24.81	201	79.1
36	10/25/2005 13:45:39		182	102.7	55	344.2	100	137	116	83.1	155	356.7	312	60.9	139	7	114	129.3	194.5	44.79	159	61.8
37	10/25/2005 13:45:40		329	93.1	41	164.6	235	83.1	112	50.8	256	49.3	44	124.8	107	324.1	54	322.5	179.6	322.2	305	322.2
38	10/25/2005 13:45:41		66	36.3	43	107.6	357	79.8	133	77.8	109	35.3	342	14.9	52	73.3	231	176.3	253.6	138.5	111	24
39	10/25/2005 13:45:42		241	104.7	56	71.2	141	67.1	84	15.9	102	163	141	345.2	249	79.6	161	54.6	259.7	102	317	86.2
40	10/25/2005 13:45:43		98	124.7	107	29	75	108.7	158	13.5	25	121.8	226	58.6	100	74.3	125	151.8	36.4	232.8	22	74.1
41	10/25/2005 13:45:44		144	16.9	145	86.1	240	154.3	134	173.6	152	42.1	66	348.7	77	15.1	57	3	161.4	3.909	85	356
42	10/25/2005 13:45:45		104	80	151	67.4			142	43	50	309.4	107	108.6	43	307.4	148	152.7	50.25	58.84	41	77.3
43	10/25/2005 13:45:46		109	19.9	159	55.5	208	28.2	122	17.7	109	14.9	79	198.4	218	302.8	120	231.8	122.2	190.9	199	20.3
44	10/25/2005 13:45:47		165	188.7	155	152.3	131	114.8	119	186.8	51	15.9	65	293.4	38	68.2	59	127.5	111.3	40.99	108	114.7
45	10/25/2005 13:45:48		145	357.2	170	74.7	177	80.6	125	113.5	27	13	164	144.2	69	20.3	46	76.3	143	80.34	236	86.8
46	10/25/2005 13:45:49		97	77.5	106	31.1	36	146.3	77	130.3	171	330.9	134	47.4	97	152.4	53	132.7	55.23	84.81	21	334.7
47	10/25/2005 13:45:50		202	72.1	49	32.4	67	39.6	61	103.3	143	266.8	185	33.1	127	303.4	315	2.4	187.4	315.2	198	330.1
48	10/25/2005 13:45:51		158	82.4	147	60.6	183	66.5	213	124.7	200	356	134	68.6	85	107.8	140	47.9	86.05	51.13	273	54.4
49	10/25/2005 13:45:52		51	85.5	119	6.3	30	313.7	141	98.1	62	153	118	127.1	148	33.2	232	79.6	153.6	15.48	317	77.6
50	10/25/2005 13:45:53		134	53.8	144	163.1	211	36.7	73	254.1	171	216.7	44	345.7	79	313	347	327.2	191	25.76	202	343
51	10/25/2005 13:45:54		137	74.7	136	85.8	164	45.5	72	98.8	81	269.3	159	264.9	47	87.6	160	221.5	118.4	283.7	377	358.8
52	10/25/2005 13:45:55		73	329.6	28	347.5	23	149	187	68	128	82.8			82	78	229	14.9	200.8	63.69	276	71.4
53	10/25/2005 13:45:56		145	58.3	186	81.3	67	113.9	133	100	272	350.7	241	105.9	207	89.2	315	60.5	352.2	97.67	407	33.8
54	10/25/2005 13:45:57		81	145.5	76	25.6	89	76.4	216	13.1	109	9.5	128	49.1	43	4	89	280.3	214	0.268	210	331
55	10/25/2005 13:45:58		16	227.5	187	133.9	39	101.9	148	109.3	51	288.4	128	325.8	51	318.2	68	303	164.3	308.8	168	316.4
56	10/25/2005 13:45:59		107	88.4	151	165.4	136	108.8	105	191	32	326.3	71	42.7	246	32.5	147	21.1	203.5	25.94	136	62.3
57	10/25/2005 13:46:00		171	106.3	66	136.2	34	118.1	71	143.6	127	273.2	144	73.8	104	50.5	268	90.4	324.5	80.42	278	79.9
58	10/25/2005 13:46:01		167	149.4	171	135	51	205.6	148	176.9	147	97	112	249.1	220	119.1	254	353.9	106.2	93.78	368	88.4
59	10/25/2005 13:46:02		221	70.4	144	26.9	268	78.8	29	290.3	140	34.3	145	341.1	172	346.5	244	154.3	70.94	21.5	237	351.3
60	10/25/2005 13:46:03		66	102.2	190	86.1	191	134.6	106	62.5	75	7.7	162	298.8	222	296.4	139	300.3	119	326.3	233	326.7

Fox River Propwash Study - Moving Vessel Trials

Test #19: Jetski - 25% Throttle Startup

October 25, 2005



Attachment F -

Prop Wash Frequency Scour Memo

Memorandum

To: Jim Hahnenberg (EPA)
Greg Hill (WDNR)

From: Clay Patmont, Paul LaRosa, Regina Williams, Tom Wang (Anchor)
George Hicks (Shaw)

cc: Paul Montney, Chip Hilarides, Richard Moser, Al Toma (Georgia Pacific)
Roger McCready (NCR)
John Heyde (Sidley)
Steve Jawetz (Beveridge and Diamond)
Mike Palermo (Palermo Consulting)
Rich Johnson (Boldt)
Rick Fox, Rich Weber (NRT)
Tim Harrington (HE&C)

Date: December 22, 2005

Re: Preliminary Velocity Frequency and Scour Analyses for Moving Vessel Tests

This memorandum presents a statistical evaluation of the range of water velocities measured in the propeller jet of a moving, single propeller vessel during the Fox River Propwash Field Study conducted in October 2005. This memorandum also presents estimations of potential scour depths resulting from the measured velocity data for materials with various grain sizes anticipated for use as covers and caps as part of the Optimized Remedy for OUs 2-5 of the Lower Fox River.

The velocity measurements obtained during the moving vessel trials were tabulated and plotted for each test trial as discussed in the "Propwash Field Study Results and Preliminary Scour Analysis for Moving Vessel Tests" memorandum dated December 6, 2005. Generally, the plots reveal elevated velocity readings within a discrete time span ranging from 24 to 40 seconds or 34 seconds on average. All velocity measurements within the time span indicating propeller wash effects for each trial (including the entire range of depths from surface to near-bottom) were extracted and compiled into a larger data. Once propeller wash related velocities were compiled, the data set was sorted from lowest to highest velocity to determine the cumulative

frequency of occurrence for a given velocity reading. Attachment A presents a plot of the cumulative frequency of occurrence versus velocity measurements from the single-propeller, moving vessel trials.

Based on this information, the depth of scour was estimated for a given velocity of a known frequency using the relationship developed by Hamill (1988) and explained in the December 6, 2005 memorandum. Since maximum near-bottom velocities (V_b) were measured and thus are known values, the corresponding propeller jet efflux velocities (V_o) were back-calculated to use in the Hamill equations, as discussed in December 6, 2005 memo:

$$\varepsilon_{\max} = 45.04\Gamma^{-6.98}\left[LN(t)\right]^{\Gamma}$$

where:

$\varepsilon_{\max}$ = maximum scour depth, mm
t = time, s

$$\Gamma = 4.1135\left|\frac{C}{D_{50}}\right|^{0.742}\left|\frac{D_p}{D_{50}}\right|^{-0.522} F_o^{-0.682}$$

C = bed tip clearance, mm
D_{50} = median bed grain size, mm
D_p = propeller diameter, mm
F_o = densimetric Froude number

$$= \frac{V_o}{\sqrt{gD_{50}\cdot\left[(\rho_s-\rho)/\rho\right]}}$$

V_o = propeller jet efflux velocity, mm/s
ρ = density of water, 1000 kg/m^3
ρ_s = sediment density, 2650 kg/m^3 (assuming specific gravity of 2.65)
g = acceleration of gravity, 9.81 m/s^2

The relationship presented above is time-dependent and thus requires an estimate of the time during which maximum scour depth occurs. Through careful evaluation of the raw velocity data, the time for maximum scour depth for a given bottom velocity was determined as the maximum time interval over which velocity readings were equal to or greater than the given velocity for any field test. For example, from the cumulative frequency analysis the velocity

associated with the 99th percentile is 3.95 ft/s (1205 mm/s). Within the trials for which this velocity value was measured, the maximum time interval where the velocity readings were equal to or greater than 3.95 ft/s was 3 seconds. Therefore, the time used in the Hamill equation to estimate the maximum depth of scour for a bottom velocity of 3.95 ft/s with a 1% probability of exceedance (99% of measurements were below this value) was 3 seconds.

The maximum depths of scour expected for either a potential sand cover (D_{50} = 0.02 in [0.5 mm]) or cap armor layer (D_{50} = 1.5 in [38.1 mm]) have been calculated for velocities with 50, 90 and 99% frequencies and are summarized in the table below. Note also that an additional cap armor layer size of 2 in [50.8 mm] was evaluated to provide a sensitivity analysis of scour with respect to grain size.

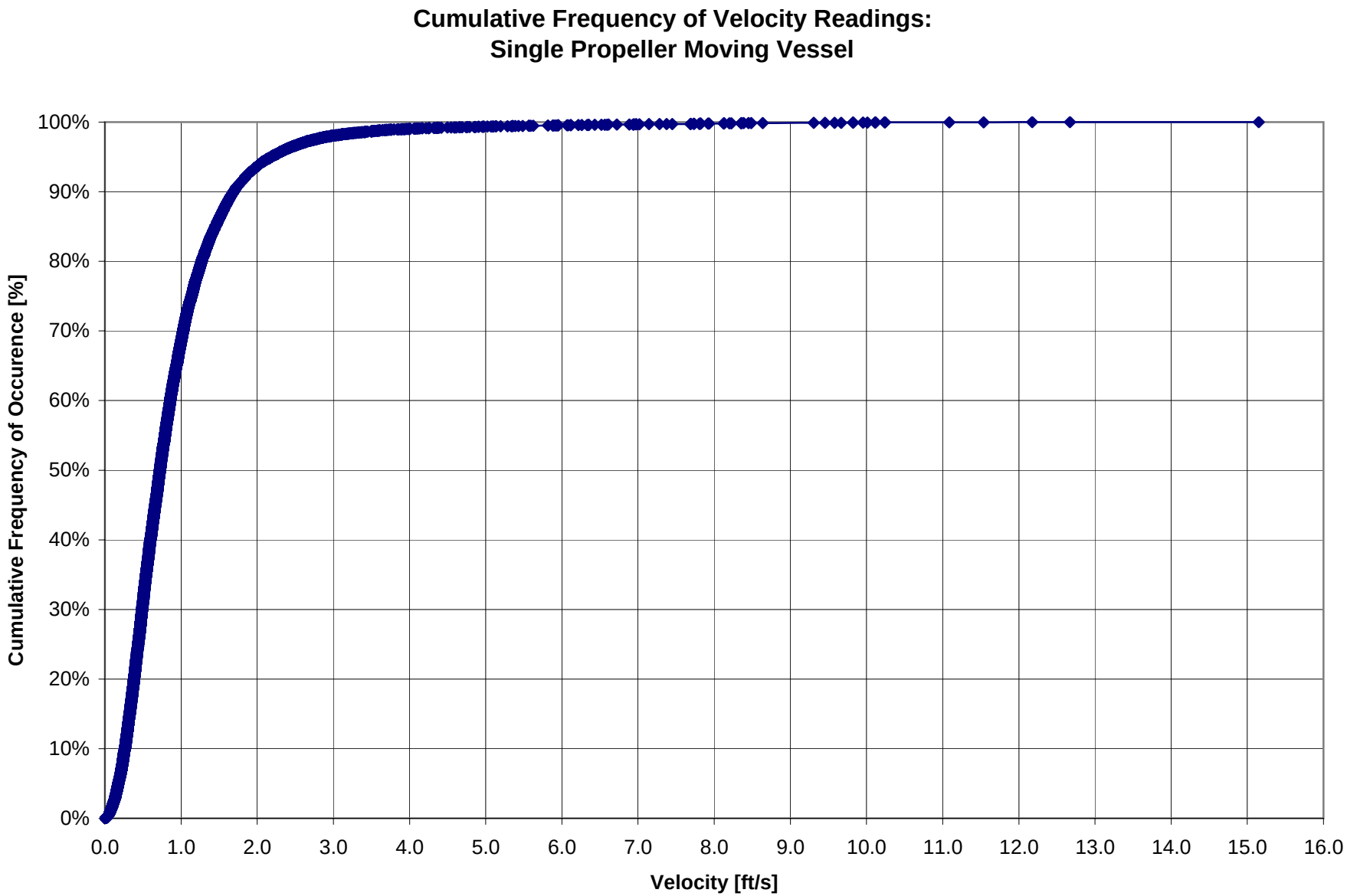
Cumulative Frequency of Occurrence [%]	Probability of Exceedance [%]	V_o [ft/s]	V_b [ft/s]	t_{max} [s]	Sand Cover ε_{max} [in]	Cap Armor (D_{50} = 1.5 in) ε_{max} [in]	Arrmor [a] (D_{50} = 2 in) ε_{max} [in]
50%	50%	5.6	0.72	15.0	0.008	0.003	0.002
90%	10%	13.0	1.69	4.0	0.022	0.001	0.001
99%	1%	30.4	3.95	3.0	0.74	0.020	0.016

a. Note: armor stone size of 2 inches presented to illustrate sensitivity analysis only. The proposed cap armor layer for the Optimized Remedy is 1.5 inches.

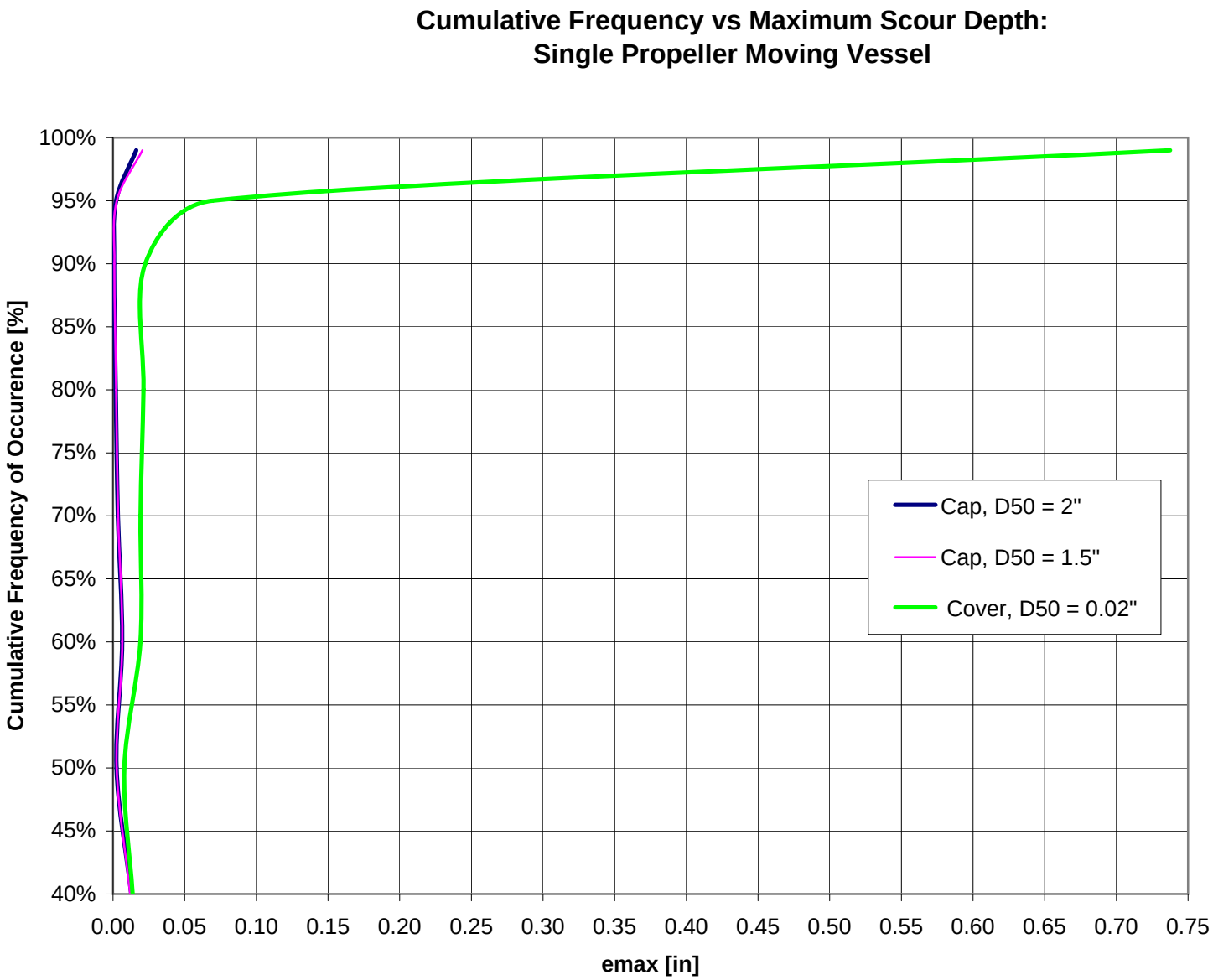
In the table above, the column entitled 'Cumulative Frequency of Occurrence' denotes the percentage of measurements that were equal to or less than a given velocity value; thus, the 'Probability of Exceedance' column refers to the percentage of measurements that were greater than the given velocity value (i.e., 1 - Cumulative Frequency of Occurrence).

Potential reasonable worst-case sediment cover or cap scour depths resulting from the action of a propeller jet from a moving, single propeller vessel, based on the measured velocity data obtained during the trials are minimal as shown above. The maximum scour depth is less than one inch even for a sand cover subjected to a bottom velocity of approximately 4 ft/s, which is expected to be exceeded only 1% of the time (i.e., 99% of the time the velocity will be 4 ft/s or less). Attachment B shows a plot of maximum scour depths expected for various velocity frequencies for each of the three grain sizes analyzed above.

ATTACHMENT A


Cumulative Frequency of Velocity Readings:
Single Propeller Moving Vessel
Cumulative Frequency of Occurence [%]
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
Velocity [ft/s]

ATTACHMENT B


Cumulative Frequency vs Maximum Scour Depth:
Single Propeller Moving Vessel
Cumulative Frequency of Occurence [%]
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
0.75
emax [in]
Cap, D50 = 2"
Cap, D50 = 1.5"
Cover, D50 = 0.02"

Attachment D -

Figures

Attachment D

List of Figures

D-1 Preliminary Contingent Capping Areas - OU 3

D-2 Preliminary Contingent Capping Areas - OU 4A

D-3 Preliminary Contingent Capping Areas - OU 4B

D-4 In Situ Cap Design Flow Chart

D-5 Preliminary Cap Design Schematic

D-6 Preliminary Capping Areas and Shear Stress - OU 3

D-7 Preliminary Capping Areas and Shear Stress - OU 4A

D-8 Preliminary Capping Areas and Shear Stress - OU 4B

D-9 Conceptual Schematic of Cap Height

D-10 Optimized Remedy Cap Design Schematics

D-11 Optimized Remedy Cap Design Schematics

D-12 Predicted Shear Stress for Existing Conditions - OU 3

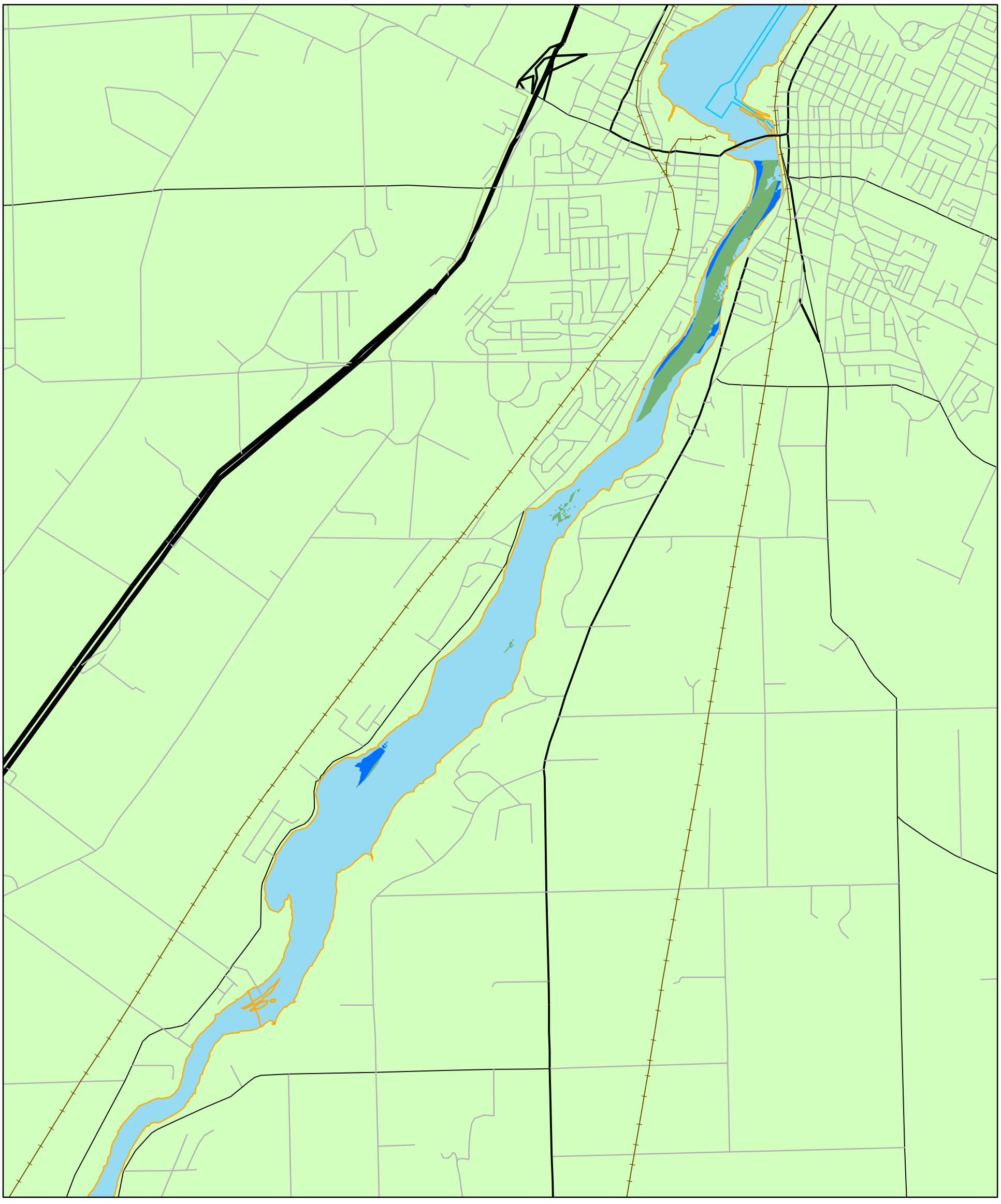
D-13 Predicted Shear Stress for Post-Optimized Remedy Conditions - OU 3

D-14 Predicted Shear Stress for Existing Conditions - OU 4

D-15 Predicted Shear Stress for Post-Optimized Remedy Conditions - OU 4

D-16 Horizontal Extent of Caps and Sand Covers for the Optimized Remedy - OU 4

D-17 Horizontal Extent of Caps and Sand Covers for the Optimized Remedy - OU 4



Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor

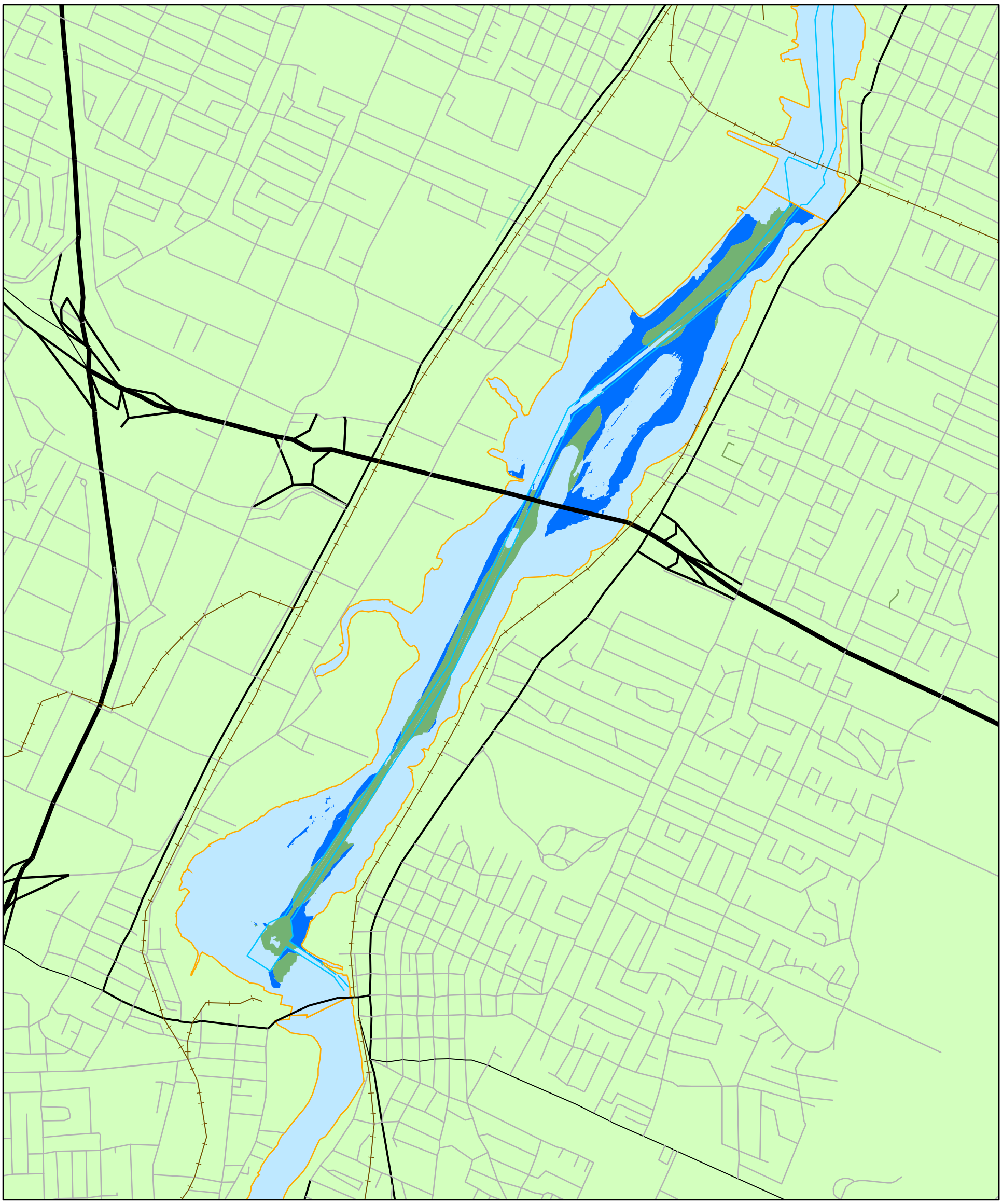
N

Figure D-1
Preliminary Sediment Capping Areas
Operable Unit 3
Gravel Armor - > 15 dynes/cm^2
Sand Armor - < 15 dynes/cm^2

3,000 0 3,000 Feet

ANCHOR ENVIRONMENTAL, L.L.C.

Shaw®



Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor
- Federal Navigation Channel

N

Figure D-2
Preliminary Sediment Capping Areas
Operable Unit 4A
Capping Within Federal Navigation Channel
Gravel Armor - > 15 dynes/cm^2
Sand Armor - < 15 dynes/cm^2

2,000 0 2,000 Feet

ANCHOR ENVIRONMENTAL, L.L.C.

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Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor
- Federal Navigation Channel

N

Figure D-3
Preliminary Sediment Capping Areas
Operable Unit 4B
Gravel Armor - > 15 dynes/cm^2
Sand Armor - < 15 dynes/cm^2

2,000 0 2,000 Feet

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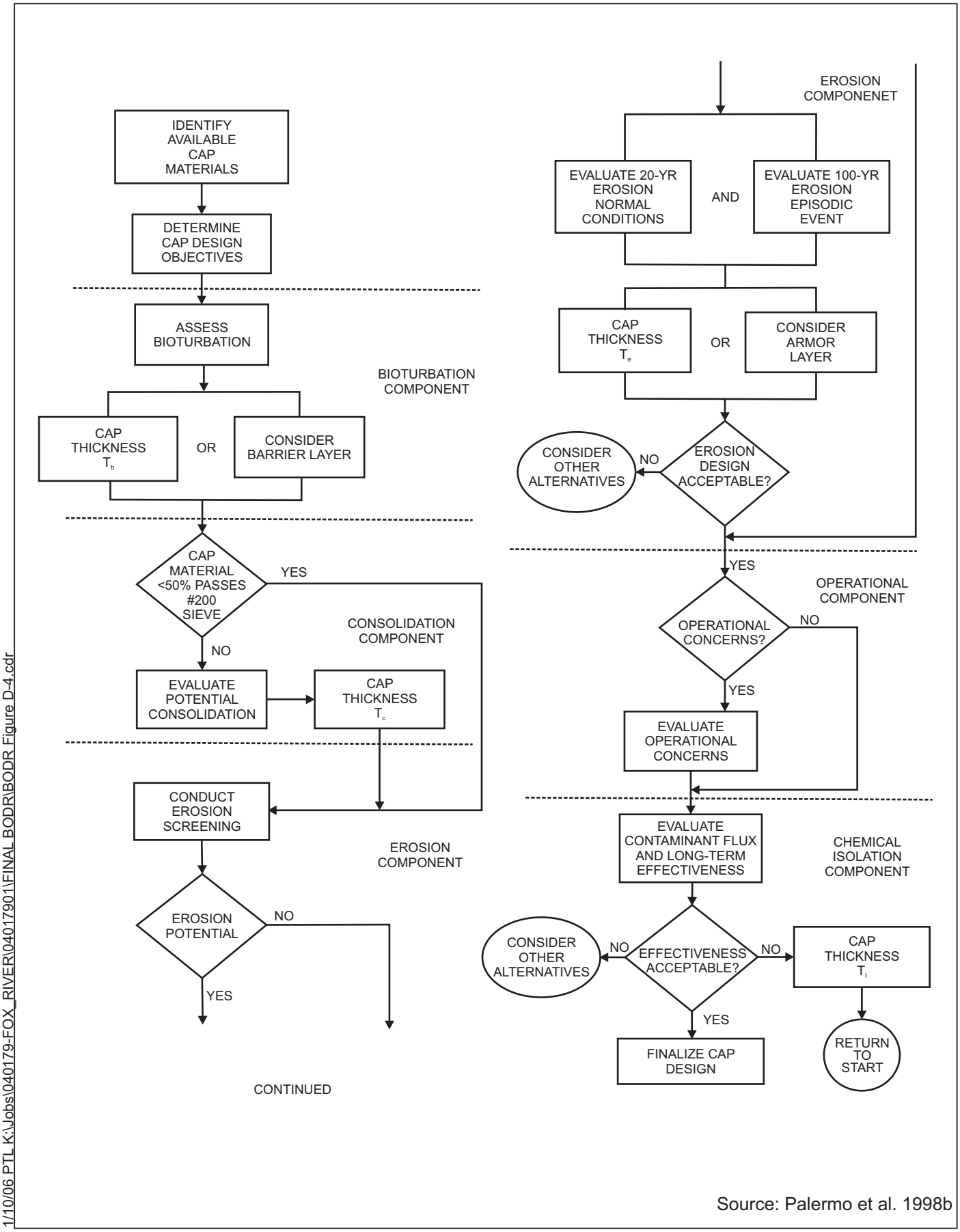
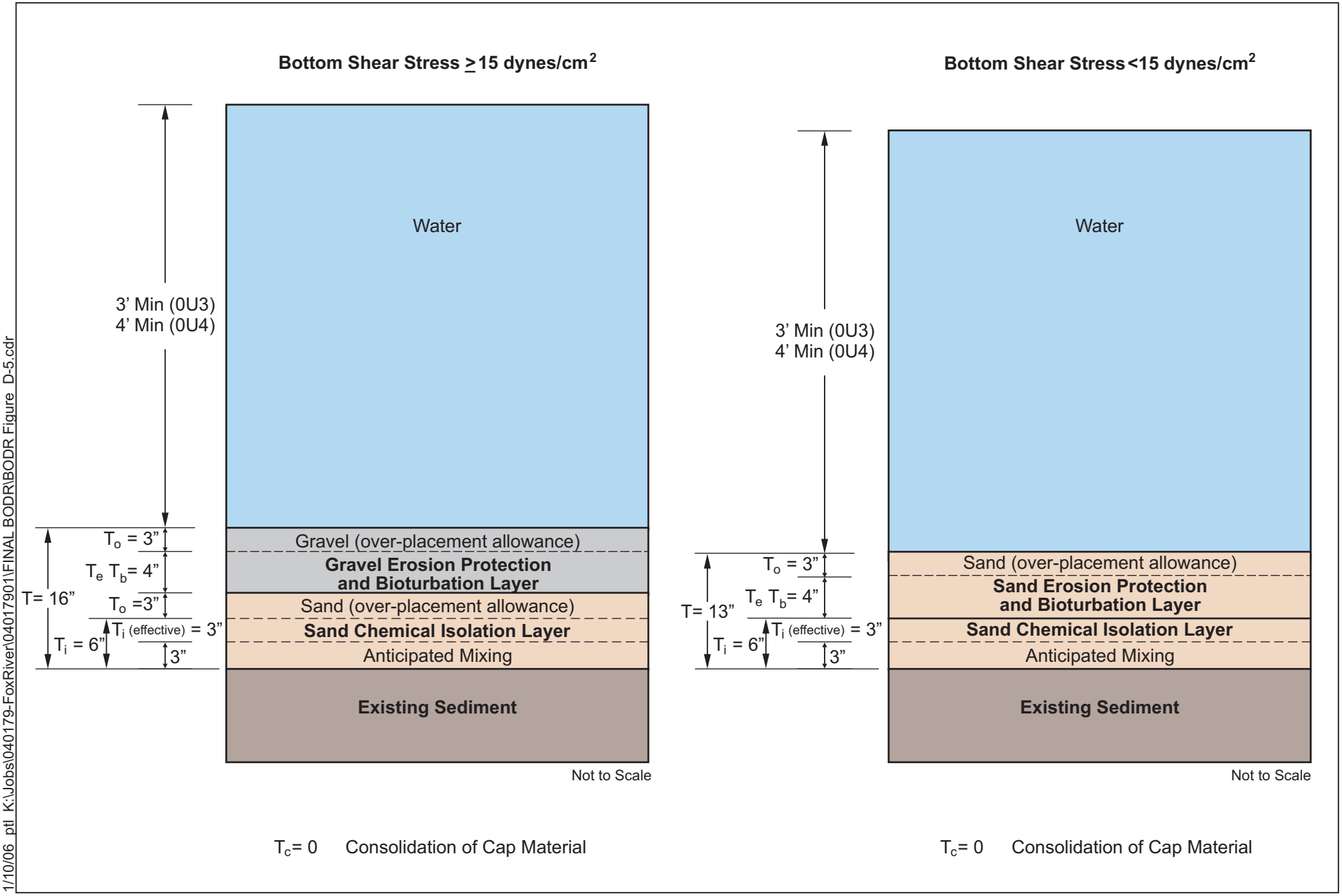


Source: Palermo et al. 1998b

1/10/06 PTL K:\Jobs\040179-FOX_RIVER\04017901\FINAL BODR\BODR Figure D-4.cdr

Figure D-4
In Situ Cap Design Flow Chart
Lower Fox River



1/10/06 ptl K:\Jobs\040179-FoxRiver\04017901\FINAL BODR\BODR Figure D-5.cdr

ANCHOR ENVIRONMENTAL, L.L.C.

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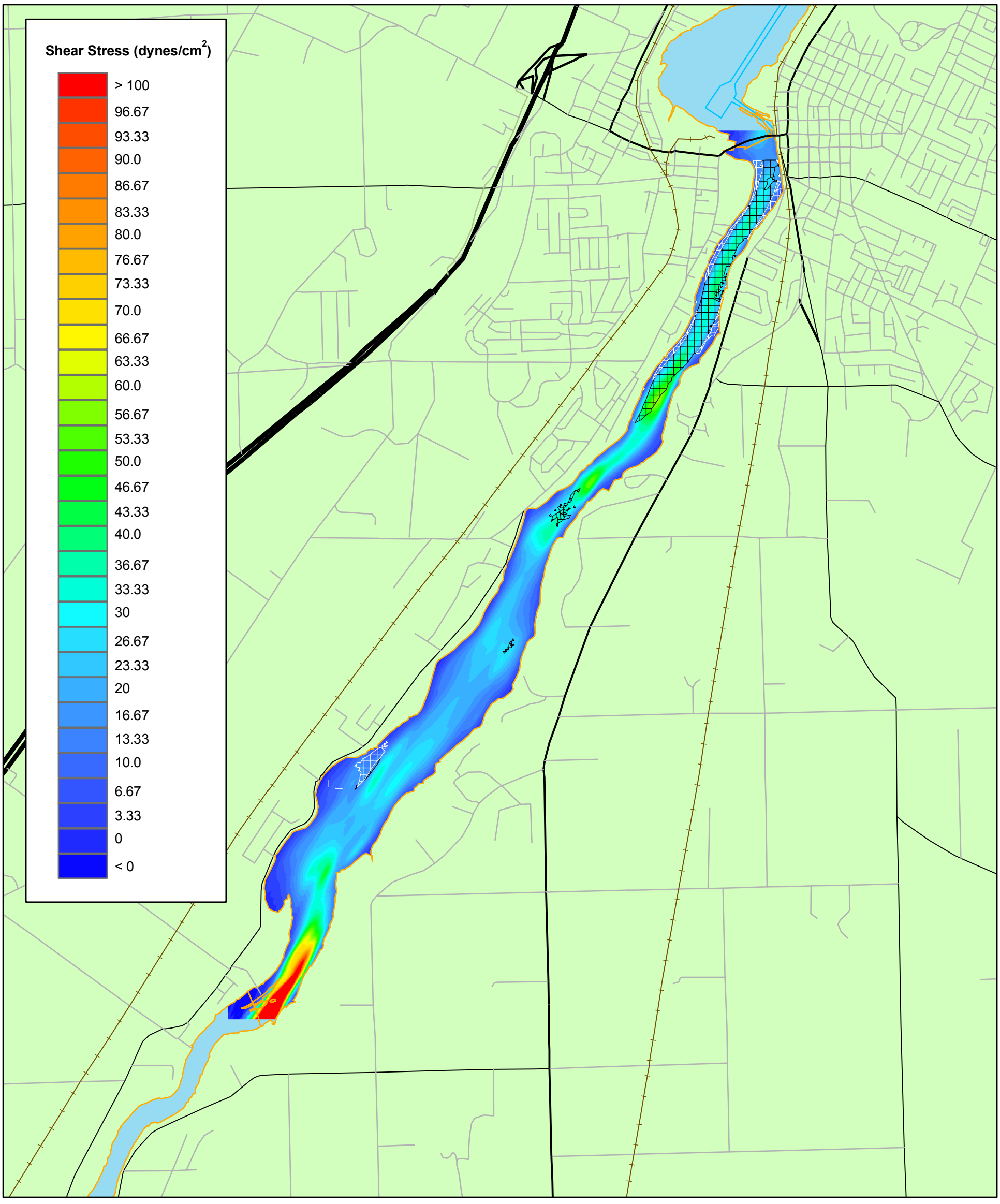
Figure D-5
Preliminary Cap Design Schematic
Lower Fox River



Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor

N

Figure D-6
Preliminary Sediment Capping Areas and Shear Stress (100-yr Event, Post-Capping)
Operable Unit 3
1 ppm RAL

3,000 0 3,000 Feet

ANCHOR ENVIRONMENTAL, L.L.C.

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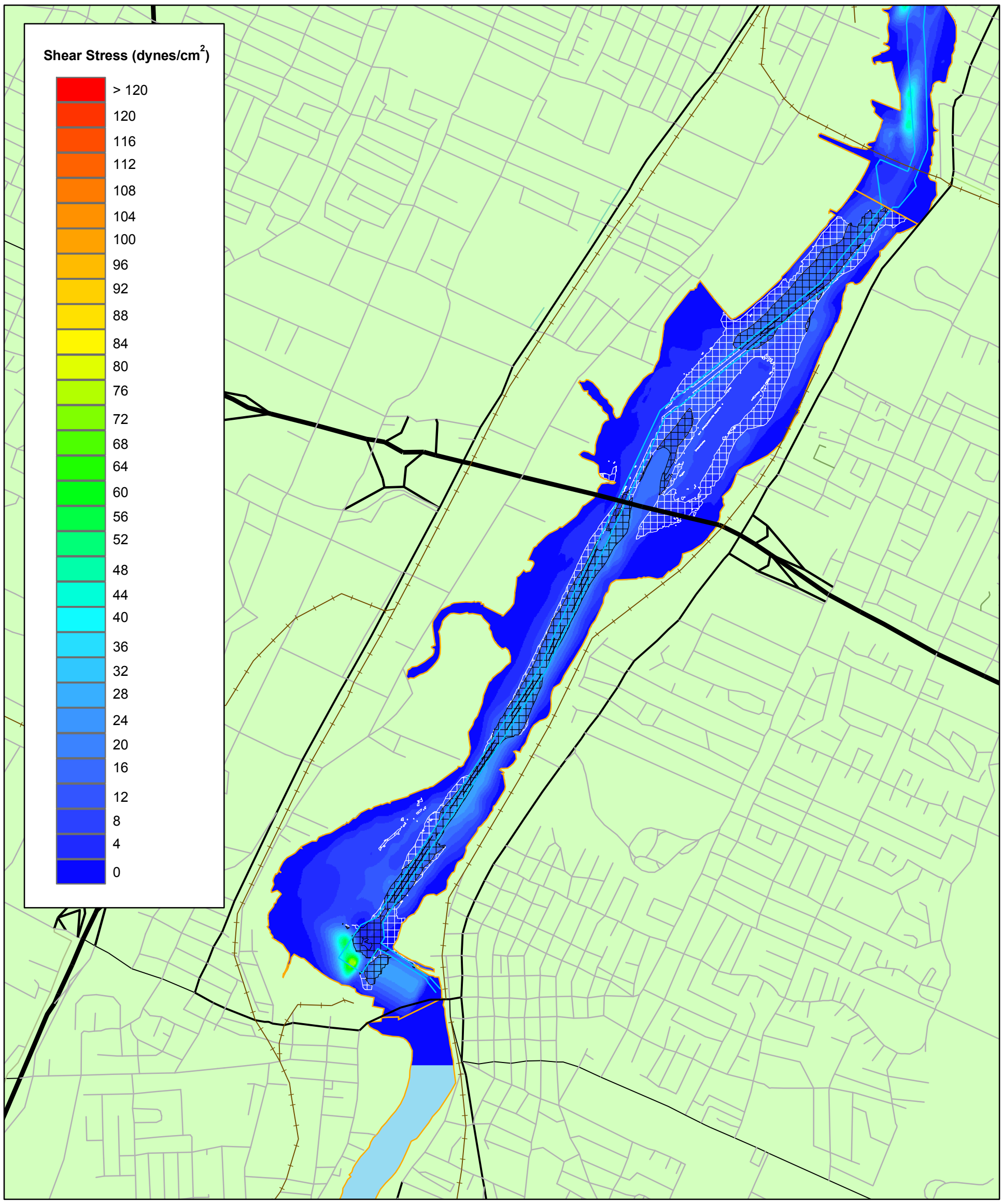

Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor

N

Figure D-7
Preliminary Sediment Capping Areas and Shear Stress (100-yr Event, Post-Capping)
Operable Unit 4A
1 ppm RAL

2,000 0 2,000 Feet

ANCHOR ENVIRONMENTAL, L.L.C.

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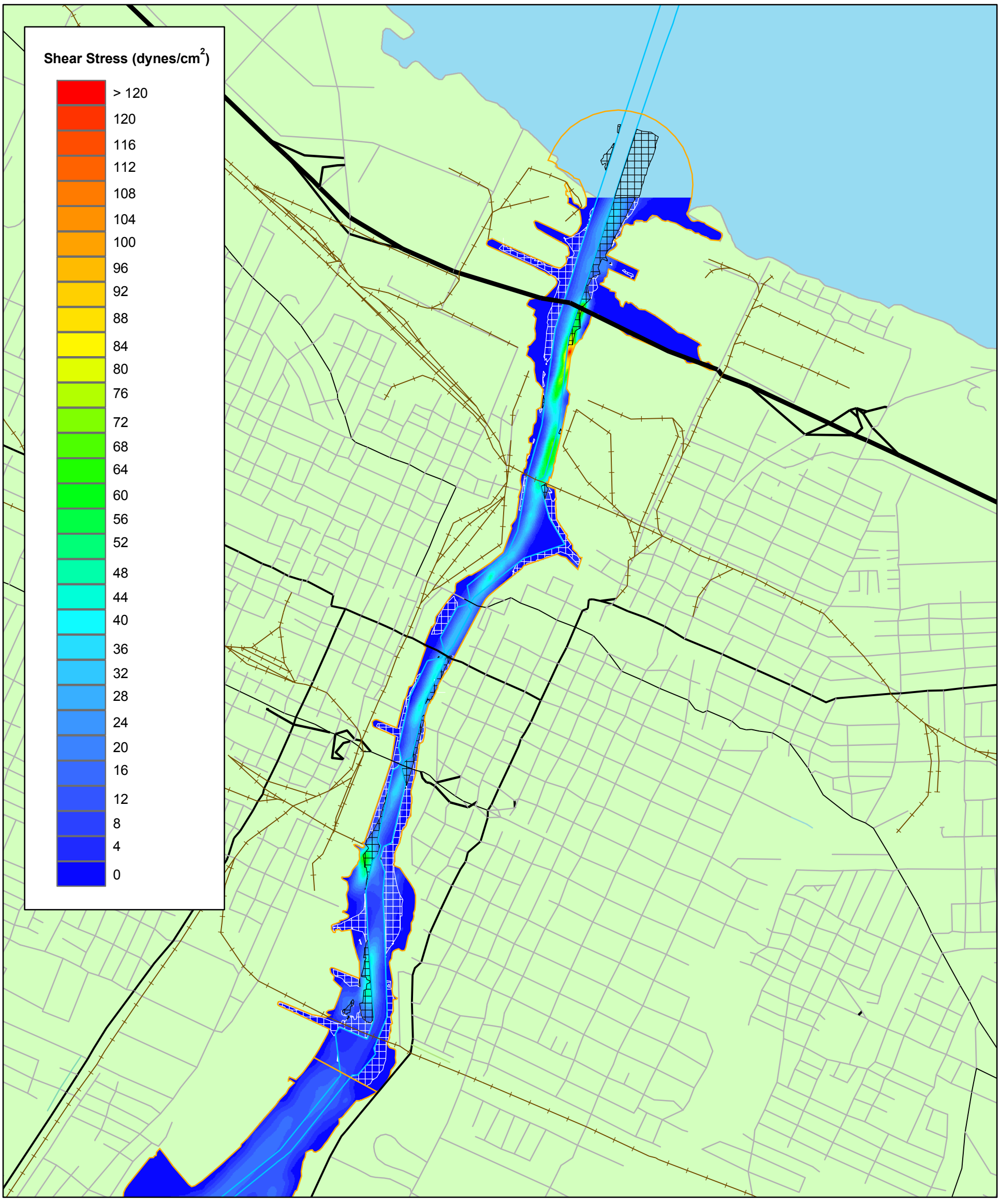

Legend

- Potential Capping Areas - Gravel Armor
- Potential Capping Areas - Sand Armor

N

Figure D-8
Preliminary Sediment Capping Areas and Shear Stress (100-yr Event, Post-Capping)
Operable Unit 4B
1 ppm RAL

2,000 0 2,000 Feet

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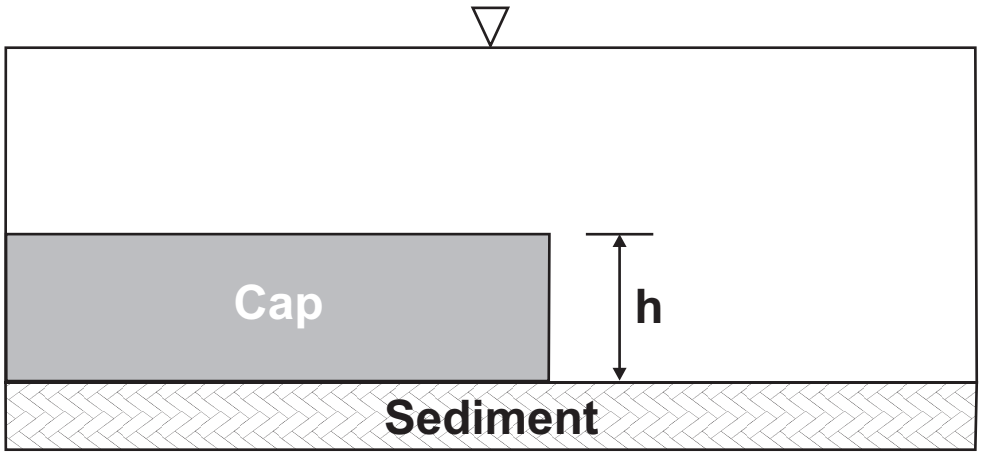
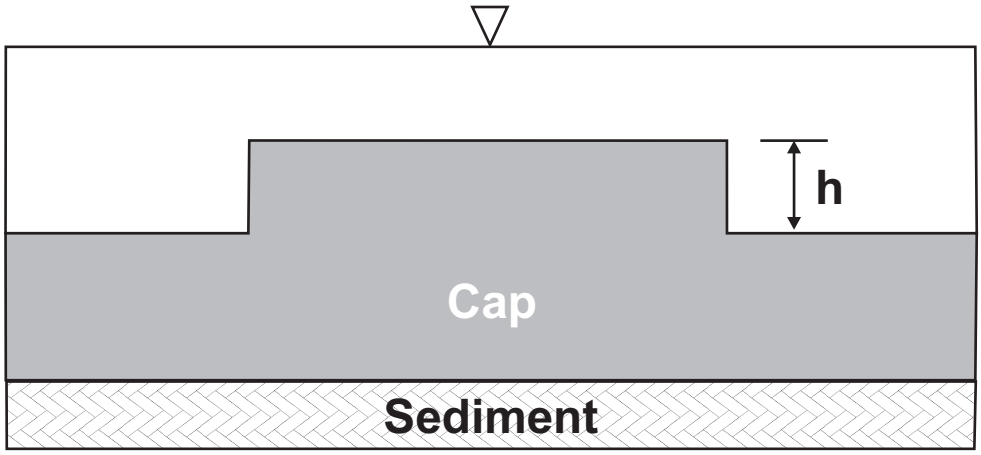


A. Cap thickness variation at edge of cap (initial lift)

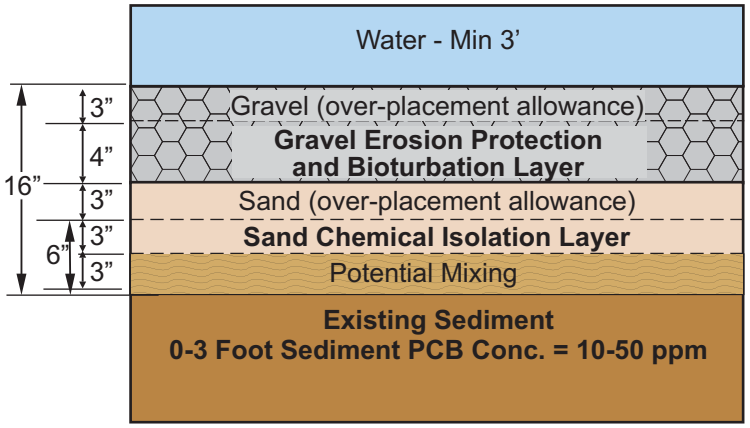


B. Cap thickness variation (subsequent lifts)

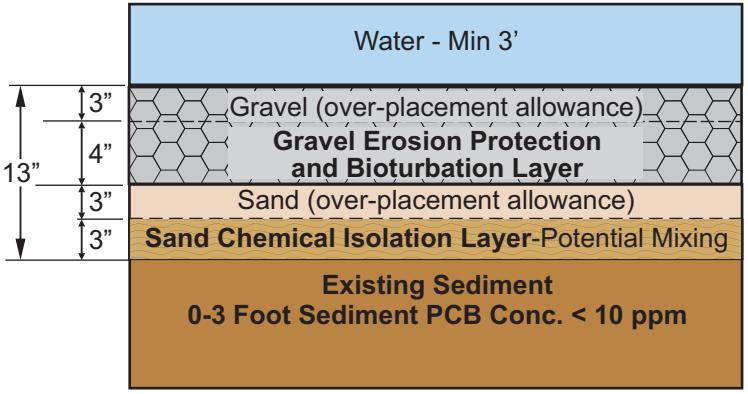
1/10/06 PTL K:\Jobs\040179-FOX_RIVER\04017901\FINAL BODR\BODR Figure D-9.cdr

Figure D-9
Conceptual Schematic of Cap Height
Lower Fox River

16-Inch Gravel Armored Cap



13-Inch Gravel Armored Cap



Note: Cap thicknesses shown are "Target" thicknesses to be specified in the contract

Not to Scale

8/1/05 ptl K:\Jobs\040179-FoxRiver\04017901\BODR\Optimized Remedy Cap Design.cdr

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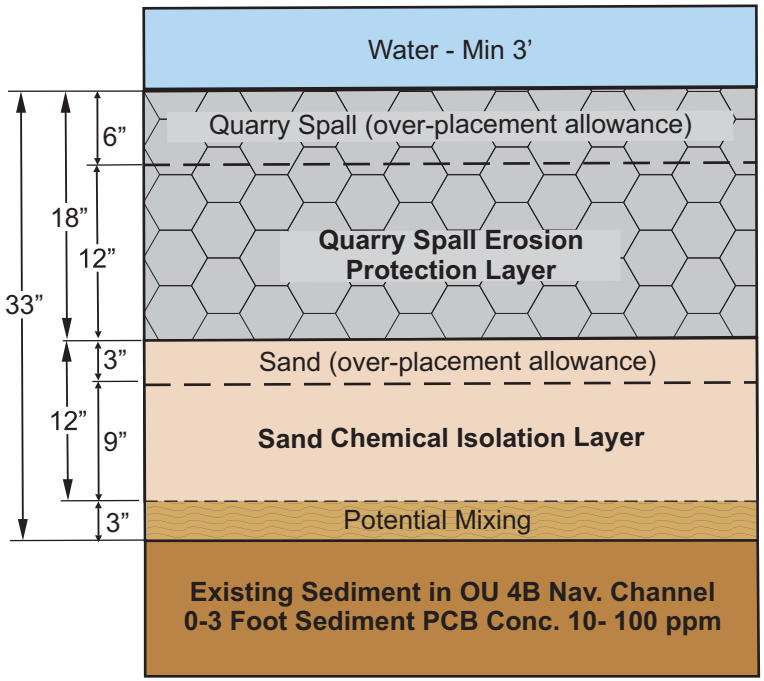
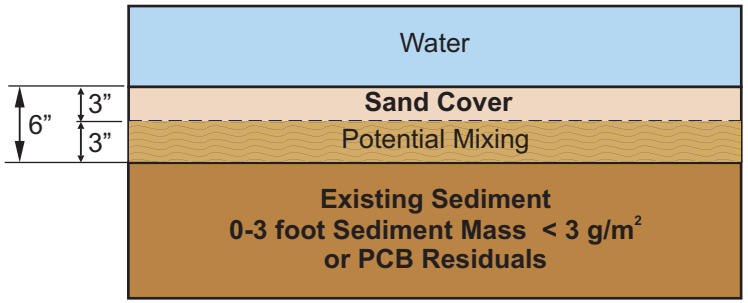
Figure D-10
Optimized Remedy Cap Design Schematic
Lower Fox River

33-Inch Quarry Spall Armored Cap



6-Inch Cover



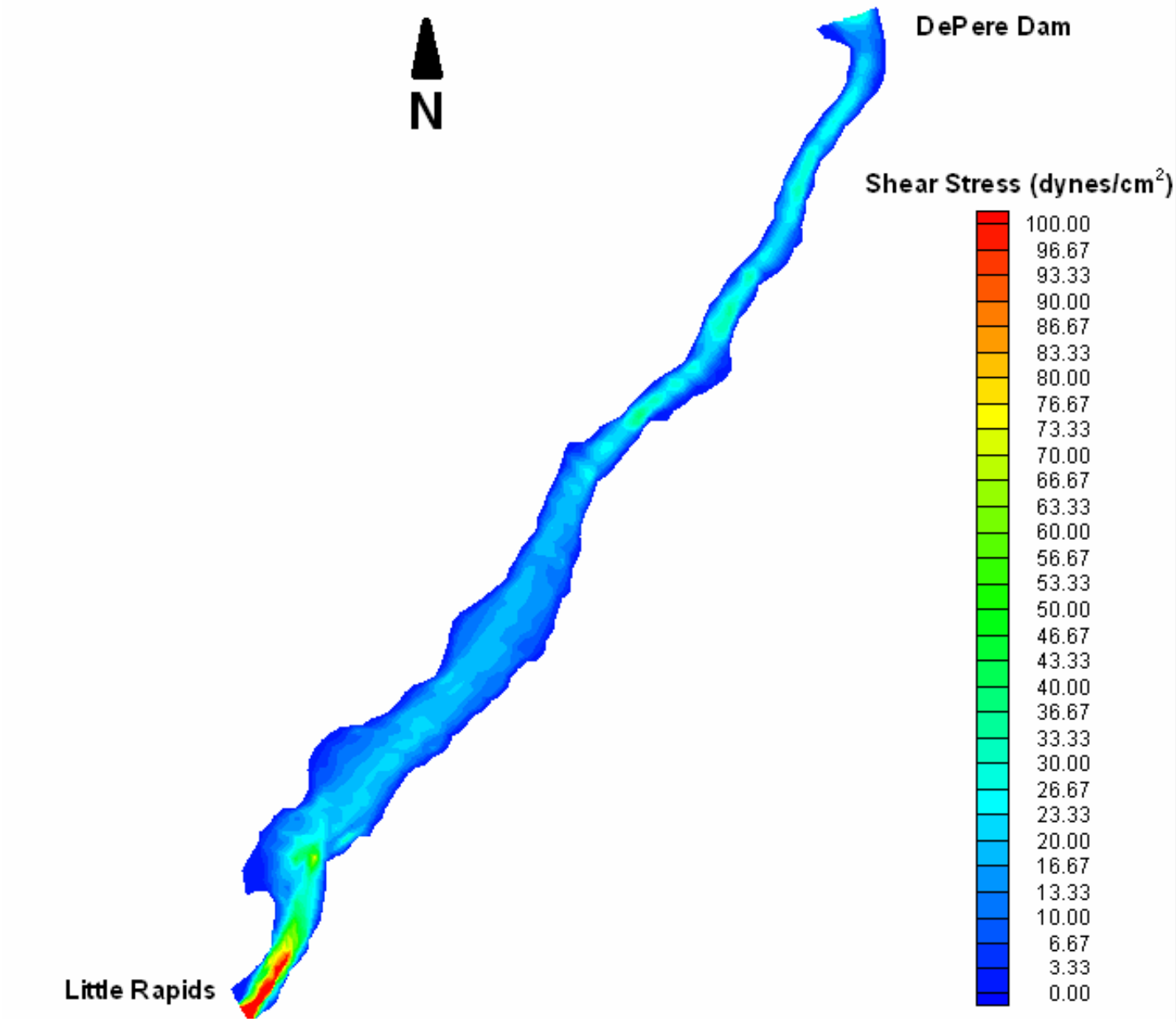
Note: Cap thicknesses shown are "Target" thicknesses to be specified in the contract

Not to Scale

6/23/05 ptl K:\Jobs\040179-FoxRiver\04017901\Optimized Remedy Cap Design.cdr

ANCHOR ENVIRONMENTAL, L.L.C. Shaw

Figure D-11
Optimized Remedy Cap Design Schematic
Lower Fox River



ANCHOR ENVIRONMENTAL, L.L.C. Shaw

Figure D-12
Predicted Shear Stress for 100-Year Flow - OU 3 Existing Conditions
Lower Fox River

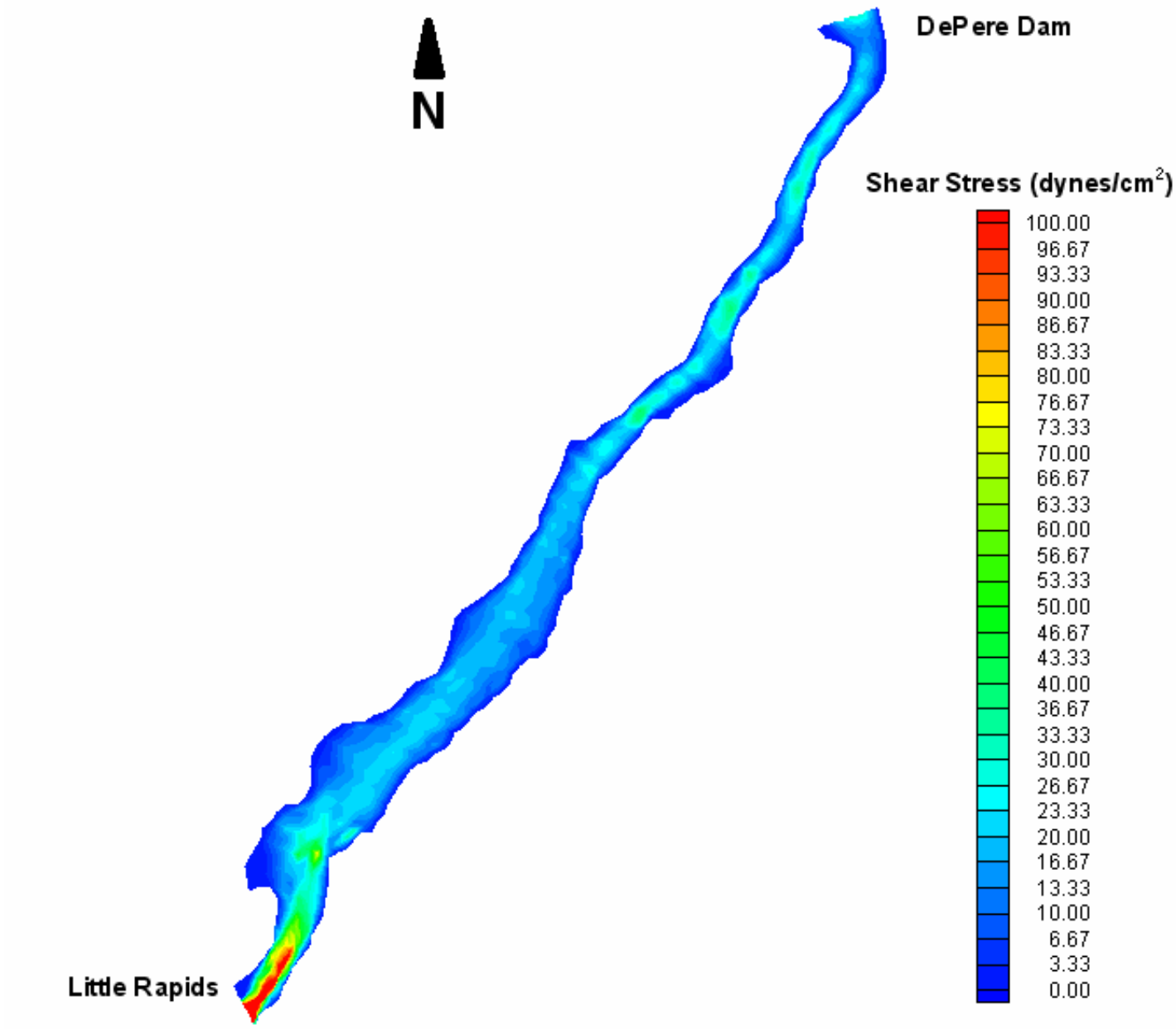


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Figure D-13
Predicted Shear Stress for 100-Year Flow - OU 3 Optimized Remedy
Lower Fox River

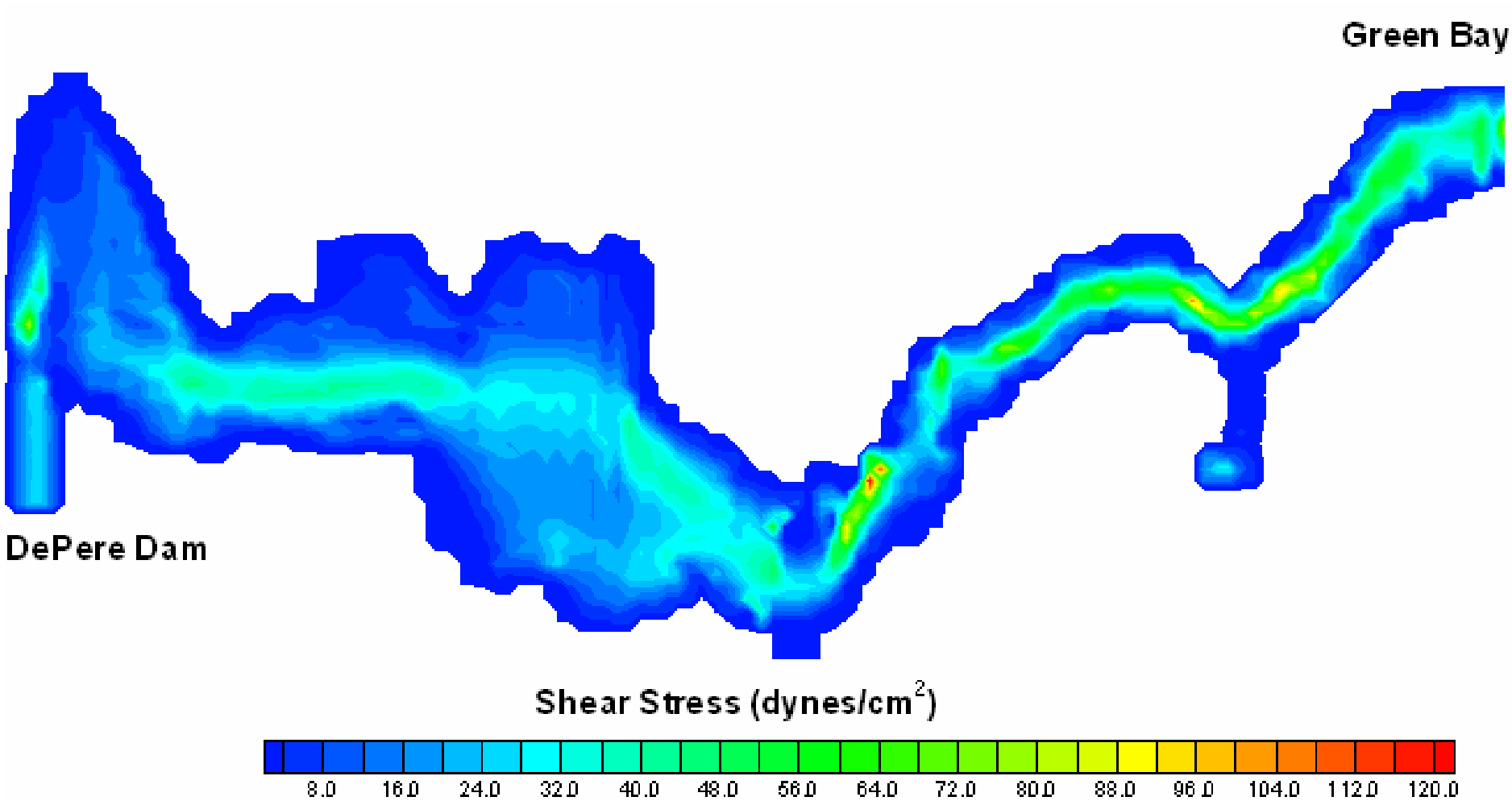

Figure D-14
Predicted Shear Stress for 100-Year Flow and Seiche - OU 4 Existing Conditions
Lower Fox River

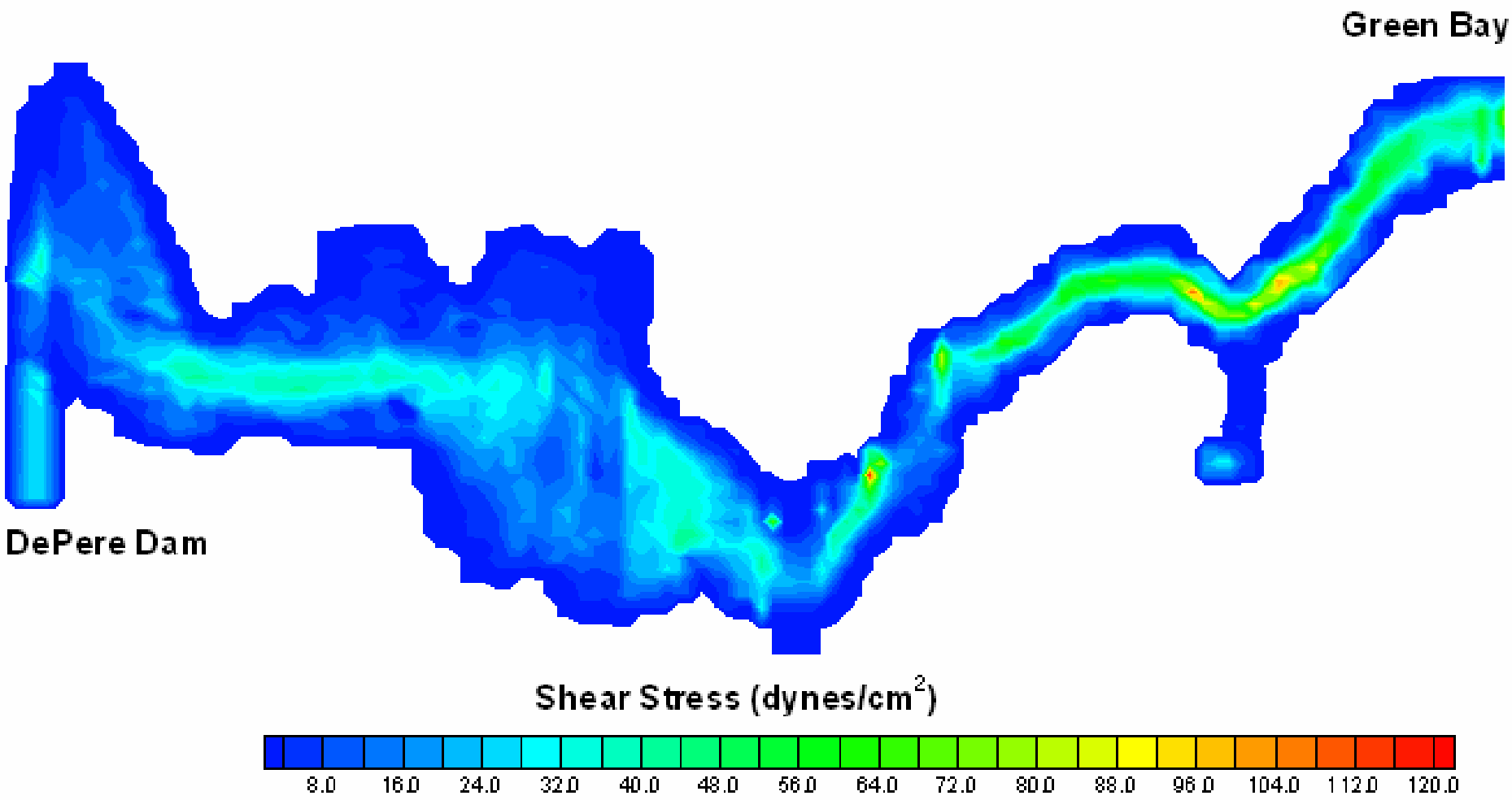

Figure D-15
Predicted Shear Stress for 100-Year Flow and Seiche - OU 4 Optimized Remedy Conditions
Lower Fox River

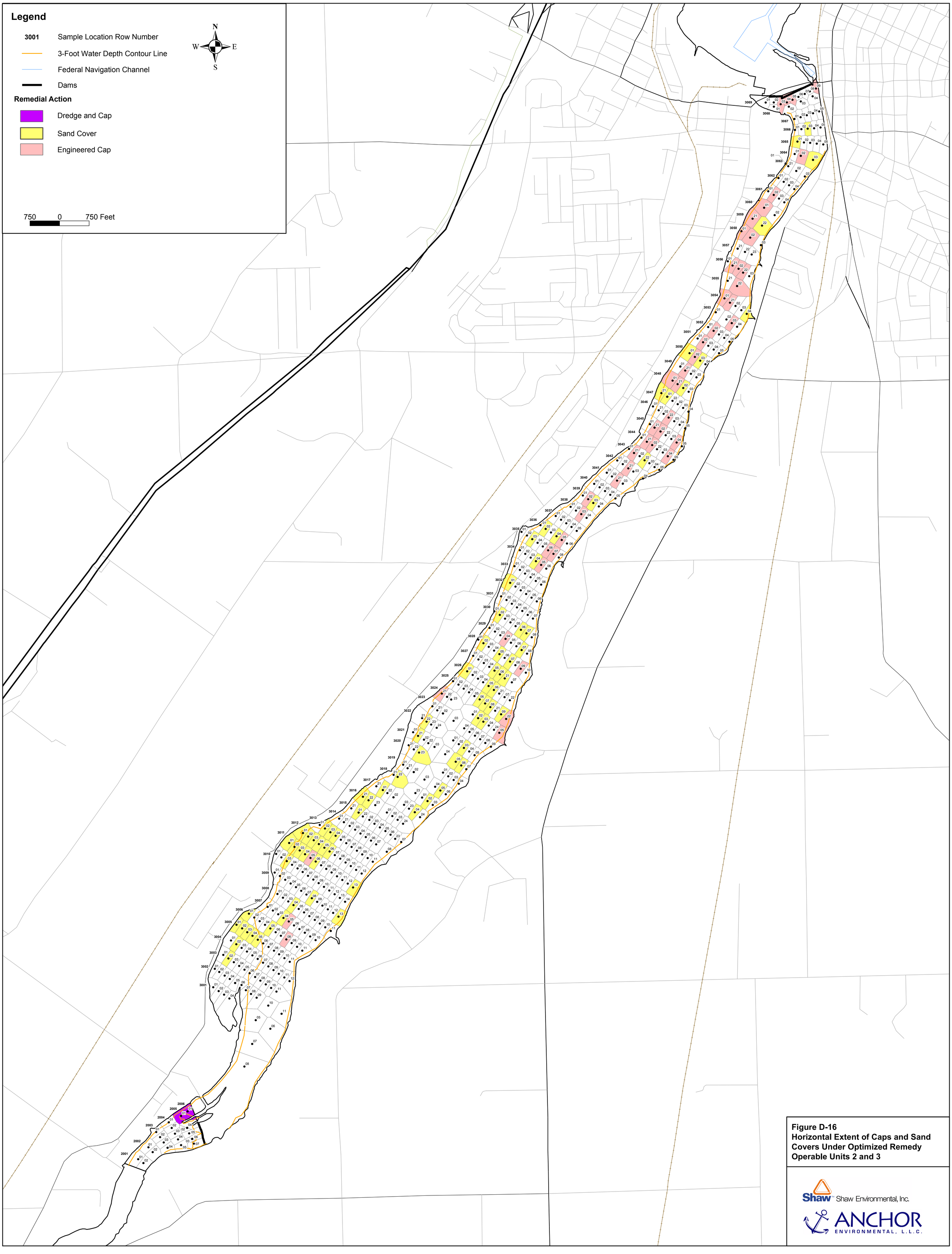

Figure D-16
Horizontal Extent of Caps and Sand Covers Under Optimized Remedy Operable Units 2 and 3

Shaw Environmental, Inc.

ANCHOR ENVIRONMENTAL, L.L.C.

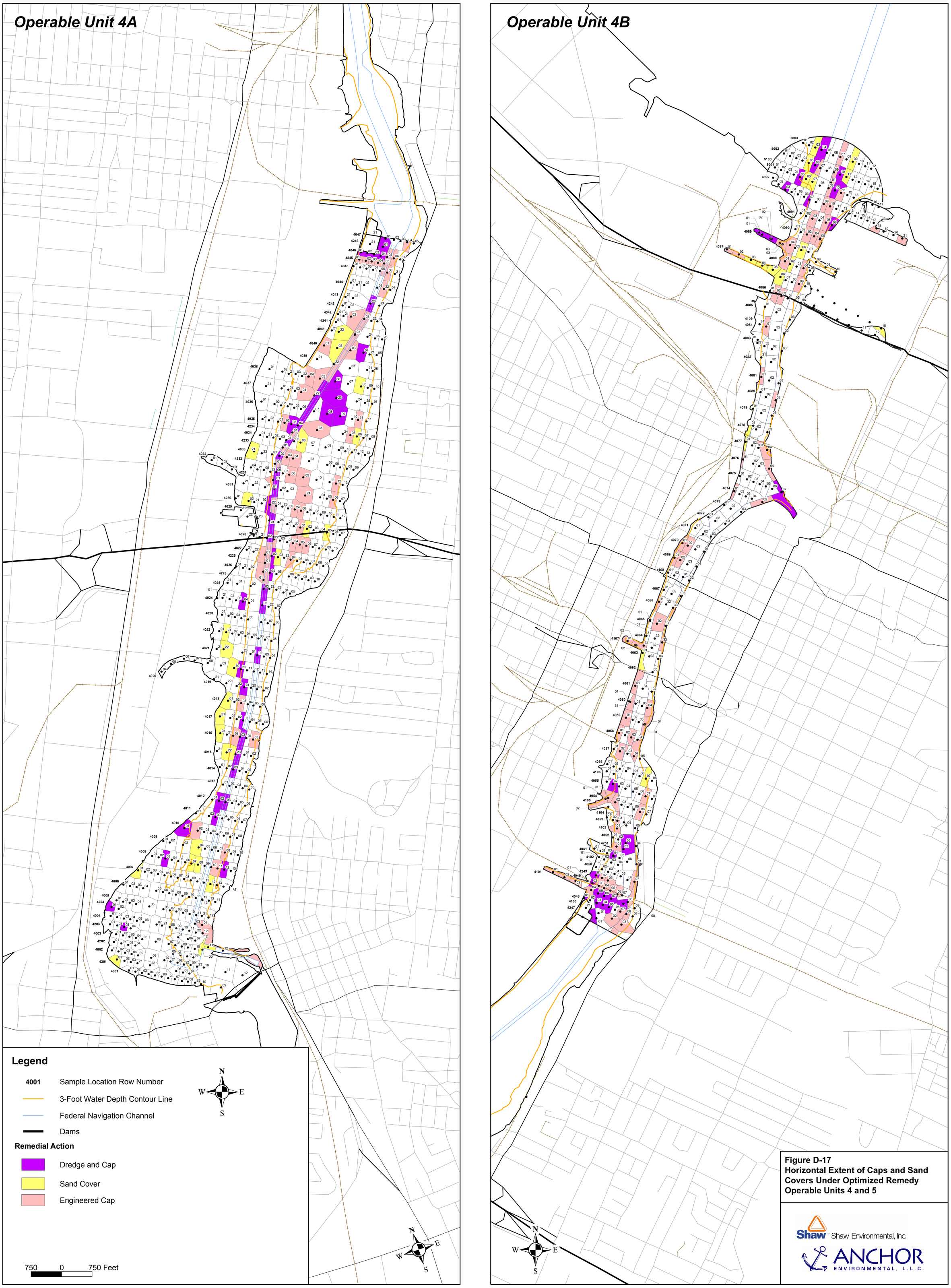

Figure D-17
Horizontal Extent of Caps and Sand Covers Under Optimized Remedy Operable Units 4 and 5

Shaw Environmental, Inc.
ANCHOR ENVIRONMENTAL, L.L.C.

APPENDIX E
FINAL BASIS OF DESIGN REPORT COMMENT TABLE

LOWER FOX RIVER AND GREEN BAY SITE
BROWN, OUTAGAMIE, AND WINNEBAGO COUNTIES, WISCONSIN

Prepared by:
Shaw Environmental & Infrastructure, Inc.
Anchor Environmental, LLC
Foth & Van Dyke
Limno-Tech

Prepared for:
Fort James Operating Company, Inc.
NCR Corporation

For Submittal to:
Wisconsin Department of Natural Resources
U.S. Environmental Protection Agency

June 16, 2006

APPENDIX E
Final Basis of Design Report Comment Table

Comment No.	March 31, 2006 Agencies/Boldt Oversight Team Comments to the OU 2-5 Final BODR	April 11, 2006 Workgroup Resolution	Respondent/Design Team Outline of Responses and Changes
1	1. We discussed the need for basic decision tree logic for several design and implementation processes, i.e., how to decide whether to dredge, re-dredge, cap, or dredge and cap. A decision tree on how to assess dredge residuals vs. inventory is also being developed. There are also a number of sections in the BODR that provide new data and information to help evaluate and define scope, and measure success. The Agencies and Oversight Team have not come to agreement with the Respondents on the approach to these decisions to the extent they are presented in the BODR document. These details will need to be further developed and clarified in the next phase of design. Any related specific logic/criteria included in the BODR should be described as examples representative of design developed so far or should be taken out. More specific comments are provided later in this document.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team recognizes that the Respondents and Agencies have not completed a final framework for addressing dredge residuals. The OT April 18, 2006 memorandum " *Monitoring and Management of Dredging Residuals for Lower Fox River* " will be discussed in subsequent workgroup meetings. For the 30 Percent Design submittal, the RD Team and OT will collaboratively develop a decision tree for addressing dredge residuals.
2	2. We did not find discussion in the approach to cap design on the intent to include a cap indicator layer in channels or other recreation areas where maintenance dredging may occur. This needs to be addressed.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The Optimized Remedy cap design in the OU 4B channel includes a quarry spall armoring layer that would be clearly distinguished from maintenance dredged sediment. A similar indicator layer is not necessary in the OU 4A channel given the "caretaker" status of this historical channel. Existing institutional controls (e.g., 401 Water Quality Certification requirements) will further ensure the future integrity of engineered caps (e.g., in berthing and marina areas).
3	3. In general the document may overstate the potential limit of landfill space available. The document should be updated to clarify limits due to permitting vs. actual space limitations/availability (for example, see page 9, section 1, 4th bullet).	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Disposal capacity will be evaluated in more detail in future remedial design stages. Given the large disposal volumes involved for both the ROD and Optimized Remedies, the RD Team believes that potential limits on landfill space are a very real concern.
4	4. We recognize the dredge/cap/cover zones as presented in the BODR are based on updated information. We also noted that new updates in this version include changes such as more extensive dredging or capping in some areas, while eliminating dredging or capping in others. Similarly the net deepening or shallowing in the different OUs has changed from previous iterations. Based on the geostatistical working group process the Respondents and Agencies have agreed that the remedial footprint (vertical and horizontal) is defined by the 50% LOS estimate of the 1-ppm concentration line. The optimized remedy mosaics do not completely cover the lateral extent of the modeled 1-ppm footprint. It is expected that the actual dredge prisms developed in design stages will be adjusted so that the entire 1-ppm footprint is included in the optimized remedy footprint. The Agencies recognize that there may be specific areas within the 1-ppm footprint that may not be amenable to remedial actions. These areas should be specifically identified and discussed on a case-by-case basis during subsequent design stages.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The RD Team agrees that the Optimized Remedy is designed to remediate the entire lateral extent of the modeled 1-ppm footprint, excluding isolated areas where remediation is technically infeasible. The RD Team will continue to refine the limits of dredging, capping, and other remedial actions during future stages of the design.
5	5. The Agencies expect that any aspect of the design presented in the BODR is subject to further Agency review and approval during the 30% & 60% & 90% detail design phases. Some examples of design improvements that may develop include refinements to the model and dredge prism design, incorporating 2005 core data results, specific contractor operation means & methods to achieve the remedy described in the BODR, confirmation sampling and evaluation of meeting RAL/SWAC requirements, proposed enhancements based on additional field experience, etc. More specific comments are provided later in this document.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The RD Team has responded to more specific comments later in the document. In general, the RD Team agrees that some issues discussed in the BODR will require further refinement later in design. However, in response to certain comments, the RD Team has noted where decisions have already been made in workgroup meetings that the RD Team does not believe need to be revisited.
6	6. Page 2, last bullet: This section says there is limited landfill disposal capacity in Wisconsin. This is likely true in every state, and the statement could be omitted without changing the point being made.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The general region-wide limitation on disposal capacity is noted. Given the large volumes involved, potential limits on landfill space are a very real concern. The fact that other states also have limited capacity underscores this concern.
7	7. Table ES-1, page 7: The document should be updated throughout to add the acreage of the TSCA dredging, non-TSCA dredging, and caps and covers, relative to the total wetted acreage of the project area in OU2-5, and that of the 1-ppm footprint. The percentage of total PCB mass removed under the Optimized Remedy is compared to the mass removed under the ROD remedy (75%). These quantities should be more appropriately compared throughout the document to the total PCB in-situ mass in the respective river sections.	The workgroup agreed that the RD Team could provide this information separately, and that no change is necessary in the BODR. Several clarifications have been made to the BODR text to improve the clarity of the mass removal comparisons.	Requested additional tables have been provided to the Agencies, and clarification text added to the BODR. Future design deliverables will compare the mass removed to the total PCB mass in the respective river sections.
8	8. Table ES-1, page 7: The weight of sediment for disposal on the optimized remedy dropped by 40% (3,051,000 to 1,815,00 tons). The weight for ROD remedy dropped by 15% (6,599,000 to 5,604,000). Is this the result of the in-place solids content being adjusted down for both alternates?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The change in dredge and disposal quantities from the Draft BODR is due in large part to the revision of the in situ solids content based on compaction correction of the physical property data. Other adjustments in quantities for the Optimized Remedy are the result of minor adjustments to the remedial actions in various areas.
9	9. Section 1, page 2: The summary would do better to emphasize this as a “dredging” project.	Revisions have been made to the executive summary to emphasize this point.	In addition to the revisions made to the Final BODR, future discussions of the Optimized Remedy will emphasize the considerable amount of dredging included in the remedy.
10	10. Section 1, page 5: The argument for complexity/uncertainty for the ROD Remedy regarding operating two dredges to a surge tank is not compelling and would better be left out. To provide a more balanced evaluation, there are other issues not discussed in favor of the ROD remedy, such as the extent of post remediation monitoring needed for cap maintenance for the Optimized Remedy. Other points made are more convincing in favor of the Optimized Remedy.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The specific language in the BODR was discussed in prior workgroup meetings and then provided to the Agencies in December 2005, and no responses were received. As discussed in earlier workgroup meetings, the Design Team believes there is clearly more complexity associated with operating two dredges into a single surge tank.

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11	11. Section 1.6.1, page 7, last bullet and Section 1.6.2, page 10, first bullet: Monitored natural recovery (MNR) is listed as an option for post-dredge residuals management. This carries throughout the document. The ROD does not presently list MNR as an option for residuals management; only re-dredging, placement of sand cover, or no action if the SWAC is achieved. MNR would need to be approved in a ROD Amendment.	Reference to MNR as a stand-alone residual management option has been removed from the final BODR. Any ROD Amendment should provide for adaptive management, including possible consideration of the use of MNR.	Given the new information available on dredge residuals, various residuals management options will be considered in more detail in future stages of RD. The text of the BODR discusses a general adaptive management framework that will be informed by the results of post-dredge sampling and analysis data.
12	12. Section 1.6.2, page 8, 3rd bullet: Quantify what is "at or near the RAL"?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Additional details regarding the concentrations referred to in this summary section are provided in other sections of the BODR, including Section 5.
13	13. Section 2.2.1, page 18: Does the percentage of residential land use in Table 2-1a (29.2%) include OU5 (Green Bay)? OU5 has a substantially higher residential land use than portions of the river.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The percentages presented in Table 2-1a pertain only to the Fox River and not Green Bay
14	14. Section 2.2.2.4, page 24, last bullet: The text refers to the SMU 56/57 demonstration project in the context of a 2001 Foth & Van Dyke Report. Based on this reference, the report summarizes dredging activities in 2000. The BODR refers to the year 2000 dredging in SMU 56/57 as the demonstration project, when the demonstration project dredging was performed in 1999, and a subsequent removal action was performed in 2000.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The RD Team acknowledges the difference between the SMU 56/57 demonstration project conducted in 1999 and the subsequent removal action performed in 2000. Discussions of the SMU 56/57 project in future design documents will clarify this distinction.
15	15. Section 2.2.4, page 25: The text refers to near-surface fractured bedrock immediately beneath contaminated sediment, even in OU4. Other than immediately downstream of the De Pere dam in the high flow energy environment, where little or no sediment was found to exist, we are not aware of shallow bedrock beneath PCB-contaminated sediment that might impact dredging operations. More specifics on details will need to be addressed in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As discussed in the Sand Cover Design memo (dated 1-31-06), bedrock or other hard-bottom conditions were encountered in numerous locations within the river. Additional details regarding the locations of bedrock or hard-bottom conditions will be provided in more detailed design submittals.
16	16. Section 2.2.5.2, page 31: The text refers to a range of average plasticity index results of 35 to 41%, yet Table 2-7 indicates the range is 36 to 43%.	Text has been clarified in the Final BODR.	The range of values presented in Table 2-7 (36 to 43%) is correct. The text has been revised.
17	17. Section 2.2.5.3, Table 2-8, page 32: We recognize that the summary of all data does not apply to the later calculations for the production volumes and weights of the dredge prism material only. However, this table still has the water content, which is measured and then used to calculate the percent solids, showing that they do not correlate with each other. This is because the average percent solids should be calculated directly from the water content average and not from an average of percent solids taken as the average of each individual converted water content. This will not yield the same answer because of the inversion of 1+water content. See Chart 1 -comment #106 "Averaging Example." If this same method is used for the dredge prism areas, the percent solids used in the design could be higher than actual values. This issue should be addressed in the later stages of the design process.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue was discussed at the November 9, 2005 Workgroup meeting. It should be noted that the percent solids value used for design is a vertically- and laterally-weighted average as discussed in Appendix A. The Workgroup concluded this method was consistent with OU 1 and appropriate for design. See response to comment 2-4 of the Agencies/OT comments on the Draft BODR.
18	18. Section 2.2.5.3, page 32: The text indicates that sediment moisture content test results were compaction corrected. An example of this calculation is requested to help determine whether it is appropriate to apply a "correction" to a measured value using ASTM standard laboratory methods.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Attachment A of Appendix A of the Final BODR provides the basis for the compaction correction used to adjust measured geotechnical properties to account for coring-induced compaction. This methodology is consistent with the Agency-approved RD Work Plan and SAP/QAPP and was discussed with the Workgroup during a conference call prior to submittal of the Final BODR.
19	19. Section 2.2.5.4, page 32: The text indicates that dry and wet bulk densities were computed using moisture content and specific gravity test results, with summaries listed in Table 2-9. Using the referenced moisture content results in Table 2-8 and the specific gravity results in Table 2-10, we computed dry densities 20 to 30% lower than those shown in Table 2-9. Further, using the dry and wet densities listed in Table 2-9, we back-calculated moisture contents 24 to 37% lower than the values listed in Table 2-8. This needs clarification/ correction.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Similar to the response to Comment No.17, the difference in values noted by the reviewer is a result of using averaged values in computations rather than using discrete data and averaging at the end of the computations. Appendix B of the RD data report, provided as a supplemental to the Final BODR, contains the full data set that was used in the RD Team computations.
20	20. Section 2.3.1.1, page 37: Section on Thiessen Polygons. The Agencies expected that that the BODR would also include maps of surface and/or maximum concentration based on a kriging analysis in addition to the Theissen polygons, which are not amenable for comparison with the lateral FIK dredge footprint. The mathematical bias is not a valid justification for using the Thiessen polygons alone. While not a serious problem for estimating the 50% LOS, it would be useful to have a comparison of the lateral footprint based on FIK vs. ordinary kriging of the maximum concentration. We agree that using Thiessen polygons to display locations of higher concentration (i.e., TSCA) material and help identify physical discontinuities is a reasonable approach, since the smoothing affects of kriging will tend to understate the extreme values.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The use of Thiessen polygon figures in the BODR was discussed and agreed to during prior Workgroup meetings. The acreages of the remediation footprints determined using FIK, ordinary/indicator kriging, and Thiessen polygons have already been compared in prior Workgroup submittals (see Geostats Technical Memo dated 4/18/05) and the results of the various methods were in excellent agreement, especially in OU 4 (within 5 percent). Based on these prior submittals and discussions, FIK was chosen as the preferred geostatistical method to support remedial design, and further comparisons with inferior methods are not necessary. Nevertheless, certain types of concentration-based maps may be useful in future design work, for example to help inform the post-construction confirmation sampling plan.
21	21. Section 2.3.1.4, page 39: Optimum level of significance. The BODR argues that the 50% LOS provides the best balance of performance and reliability. From the Agencies perspective a better characterization is that, while the 50% LOS will be used to delineate the dredge prisms, false negative rates and model bias will be reduced when interpolated depth of contamination is modified to include over dredging and other engineering constraints, and through confirmation sampling.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The RD Team agrees that the use of allowable overdredging provides an additional reason to select the 50% LOS for dredge plan delineation. Future design submittals will include the requested clarification regarding the use and application of the 50% LOS.
22	22. Section 2.3.2, page 44: The text indicates the average dry density of sediment based on 2004/2005 data is approximately 0.45 g/cm3. This equates to 28 lb/ft3, which is believable based on experience. However, referring back to Table 2-9, which summarized density results calculated from moisture content and specific gravity results, this table indicates the average density in OU3 and OU4 is about 46 lb/ft3, which equates to 0.74 g/cm3. This further substantiates our questions about the results in Table 2-9.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The 0.45 g/cc density referred to in the text is representative of the "soft" sediments containing PCB concentrations > 1 ppm targeted for dredging as opposed to Table 2-9 with presents results representative of all sediments sampled in the river, including sediments below the RAL.

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23	23. Section 2.3.2, page 44: The BODR needs to include confidence limits on the estimated mass and volume of PCB contamination. This should be included in table 2-14.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This is a new request from the Oversight Team, which can be addressed during subsequent stages of design.
24	24. Section 2.3.2, page 44: How much uncertainty results from assumptions necessary to "de-compress" core samples? Does this explain the differences in mass estimates, and do we have any reason to prefer one over the other?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The assumptions for compaction correction are consistent with the Agency-approved RD Work Plan and SAP/QAPP. The table presented in the BODR was developed to address uncertainties associated with density and "decompression" assumptions. Further analysis of this issue may be performed during more detailed remedial design.
25	25. Section 2.3.2, page 44: Based on the discussion presented, there may be mitigating factors playing a role in the change in estimated mass relative to the ROD. There may be an increase in extent of contamination but with a mitigating decrease in PCB concentration within this larger volume of material. The net being a reduction in total mass. This suggests that mass estimates may be sensitive to assumptions underlying core de-compaction.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Further analysis of this issue may be performed during more detailed remedial design.
26	26. Section 2.3.4.1, page 46: This section should point out that deposition within former thalwegs will be characterized more completely with data collected in 2005 within the navigation channel.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The 2005 data will be incorporated in the geostatistical model as part of the 30% Design submittal.
27	27. Section 2.3.4.2, page 46: The document should clarify that deeply buried PCB deposits have overlying sediments exceeding the 1.0-ppm RAL. These sediments are not buried by clean sediments. These would be more accurately depicted as thick deposits (over 13 foot deep) that may not be fully removed under the optimized ROD.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The text and figures referenced in this section note that deeply buried PCB deposits have overlying sediments exceeding the 1.0-ppm RAL. Future design documents will also make this clear.
28	28. Section 2.4.2, page 49: Thiessen polygons were used to delineate TSCA material after vertically compositing sediment samples above and below each TSCA exceedance. The Thiessen approach is not reliable for delineating deposits, and probably does not accurately reflect boundaries of TSCA material. The Respondents should consider the cost benefit of increased sampling to delineate TSCA material vs. the cost of disposal of non-TSCA material falsely identified through the Thiessen approach.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The use of Thiessen polygons to delineate TSCA sediments was previously discussed with TSCA program staff, and Thiessen polygons provide certain advantages over kriging in localized, high-concentration areas. As the commenter suggests, the RD Team has considered the cost-benefit of increased sampling to reduce uncertainty, and the RD Team concluded that additional sampling control was needed in certain key areas (e.g., Phase 1 area in OU 4). This sampling was performed in 2005, and these new data will be included in the 30% Design submittal.
29	29. Section 2.5.2, page 50: Since it is possible PCB inventory will be left behind after dredging in some areas, a paragraph discussing re-dredging passes for inventory removal vs. residual removal should be included.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	In prior workgroup discussions, this issue has been deferred to later design stages.
30	30. Section 3.3.3, page 74, 3rd paragraph: The statement "Example cross sections presented in Figure 3-5 indicate that the ROD Remedy preliminary dredge plan will frequently remove sediments vertically to a 0.3 or 0.4 level of significance" is not supported and should be taken out. Details will be developed in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This statement is supported by the example dredge plan cross sections presented in the BODR. However, the RD Team recognizes that additional workgroup discussion of this issue may need to occur, and the RD Team agrees the later stages of design will include additional details on the relationship between the dredge prism and the levels of significance other than the 0.5 LOS.
31	31. Section 3.6.3.5, page 86: DRET Tests – The discussion on DRET test applied for evaluation of potential water quality impacts due to dredging is appropriate. One technical comment -the text (p. 89) implies that the DRET TSS concentrations are representative of the TSS conditions at the point of dredging. The TSS in the extracted DRET samples are not necessarily representative of TSS at the point of dredging since these concentrations would depend on a number of factors not represented in the DRET. The purpose of DRET is to determine the contaminant partitioning between dissolved and particulate fractions in resuspended sediment using a sample representative of the general conditions at the point of dredging. Any prediction of total contaminant concentrations downstream must rely on both DRET results and a model of TSS source strength and subsequent dispersion (such as the DREDGE model). The DREDGE model was applied in the BODR evaluation for assumed sediment losses of 1% and 3% and therefore the results for downstream TSS should be a conservative estimate.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Future design documents will further clarify the use of data from the DRET test and DREDGE model to inform remedial design.
32	32. Section 3.6, page 91: The statement that 20% by weight of the dredge prism material is clay by weight as shown by the project grain size information is not true. The grain size information provided by the Respondents for the dredge prism material shows that there is very little clay fraction. The review team would suspect that this statement includes all grain size information for the site that would incorporate samples from the hard clay till underlying parts of the work area. Percent clay by weight in the sediment within the dredge prisms is less than 10% by weight as shown by the summary of grain size analysis tabulated by the Respondents.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	83 discrete samples that were collected within the ROD Remedy dredge prism were tested for grain size analysis. On average, the analyses showed that 20.1% by weight of the sediment consists of clay-sized particles. The full data set is available for review in Appendix B of the RD Data report, provided as a supplement to the Final BODR.
33	33. Section 3.6.4.2, page 94: Post-Dredge Residual Expectations – The proposed range of 2 to 8% of the dredged mass for the expected mass of dredge-induced residuals is based on a number of field data sets. This range seems reasonable as a starting point for areas with a single production cut. Areas with multiple production cuts would have a high total dredged mass, but the residuals should be approximated by considering the mass removed in the last production cut.	The RD Team will verify the range of representative residuals estimates with the OT (specifically M. Palermo). The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The residuals data developed to date are based on sampling data collected at other comparable sediment cleanup sites after a series of production cuts were acomplished, and following confirmation that the design elevations were achieved. The range of 2 to 8% residuals represents the ratio of the post-dredge residual mass remaining within the dredge cut area, divided by the total mass of material dredged (i.e., including all production cuts and the final cleanup pass). Thus, the 2 to 8% range provides a reasonable estimate of post-dredge residuals anticipated in OUs 3 and 4. This issue will be reviewed and refined as necessary during future phases of RD.

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34	34. Section 3.6.4.2, page 95: While the projects referenced may provide some interesting information, they do not necessarily relate well to the variety of conditions on the Fox River system. Their value in drawing conclusions for this project is not clearly presented or supported.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As summarized in the response to comment #33 above, the data referened in the BODR provides the most accurate estimates of post-dredge residuals anticipated in OUs 3 & 4, and in fact includes data collected from the OU 2 and OU 4 pilot projects. A preliminary review of recent (2005) data collected in OU 1 further confirms the representativeness of these data. This issue will be reviewed and refined as necessary during future phases of RD.
35	35. Section 4.1.1, page 109: The statement is made that the nine booster pumps are sized to pump the sand and silt gradation of the sediment in the dredge management units. Yet the paragraph prior to the discussion of the boosters indicates that the sand will be removed before the slurry is pumped to the NR 213 facility. The sizing and the complexity of the long pipeline booster system is overstated, since removal of the sand and larger particle will make pumping easier and the risk of plugging the pipeline less.	The wording of the BODR text has been revised to remove the conflicting statement.	The pump configurations have been based on the assumption that the sand-sized particles would be removed from the slurry prior to pumping to the landfill.
36	36. Section 4.1.1.1, page 111: In paragraph 4, it references that the addition of an amendment to the sediment could increase the ROD remedy estimated cost by as much as $220 million. The following outlines our interpretation of cost of the sediment amendment.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See responses to Comment No. 36.b.
36	a. It is stated that 5% lime by weight may have to be added to the NR213 settled sediment prior to transport to the NR500 landfill (on the assumption that it would only have a solids content of 43% after 2-years of dewatering).	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
36	b. Table ES-1 indicates 5,604,000 tons at 50% solids. That would equate to 6,516,000 tons at 43% solids. Lime added at 5% by weight would require the purchase and mixing of 325,800 tons of lime. With lime cost of $65/ton and an allowance of $10/ton for the mixing operation, the additional cost is $86,000,000.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Please note that the dewatered tons presented in Table ES-1 represent the likely scenario of passive dewatering to 42.8% followed by 5% lime amendment. As referenced in Section 4.1, Table 4-1 provides a more complete summary of the sediment process calculations including the estimated tonnages for both scenarios of dewatering with lime amendment and dewatering to 50% solids without lime amendment. Attachment D of Appendix A provides the detailed calculations of the sediment processing quantities including the lime amendment. Based on these calculations, the estimated quantity of lime is 241,731 tons. The cost calculations leading to the potential $220 million increase are consistent with the DEA , which assumed $25 per ton for the mixing of lime with the sediment, and the experience of the RD Team for similar amendment applications. The RD Team believes this is a reasonable unit cost for lime addition/mixing under the ROD Remedy.
36	c. The weight increase over the Table ES-1 assumption would be half of 5,604,000, plus the weight of lime divided by 50% solids, bringing the total for disposal to 6,255,000 tons, or an increase of 651,000 tons over the Table ES-1 value. At $35/ton, this would add another $22,000,000 for trucking and disposal.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See response to Comment No. 36.b.
36	d. Total incremental cost for addition of lime, in our opinion, is approximately $100,000,000. Please help us understand the BODR's incremental cost of $220,000,000.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See response to Comment No. 36.b.
37	37. Section 4.1.2.4, page 117 last paragraph, bullet 1: OU1 had about eight ports for 1/3 the flow. Is there a hydraulic jet design issue and a recreational craft issue?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The design of the discharge pipes will be further evaluated during later stages of the RD.
38	38. Section 4.2.1, page 123, end of middle paragraph: The evaluation of economic viability for processing TSCA material has not been finalized.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team believes it is correct to say that vitrification is not economically viable as a treatment method for TSCA sediment, for two reasons. First, the Phase 1 remedy, involving 26,000 cy of TSCA sediment, will be complete in 2007, before a vitrification facility could be built. The remaining TSCA sediment would not justify vitrification economically. Second, we understand the existing Minergy facility is scheduled to close in September 2006. The plans for vitrification rely on the co-location with this facility.
39	39. Section 4, Table 4-6: The top of the table refers to acute, but does not reference chronic values. Chronic values should be added, or the color coding at the bottom should be keyed to acute values. The table implies that only the Enforcement Standard is exceeded for some of the chemicals – this is not true.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The discussion of PCLT results will address both acute and chronic water quality criteria in future design submittals. Because it is assumed that underdrain leachate water may be discharged back to the Lower Fox River commingled with over-the-weir dredging elutriate water, the PCLT results will be evaluated using the acute and chronic dilution factors developed in Section 4.1.2.4. Subsequent evaluations will clearly indicate which results are above water quality criteria, groundwater enforcement standards, or both.
40	40. Section 4.3.6, page 131: This section (Cat Island Re-use), has limited benefit compared to the potential to introduce public concern during review.	This discussion has been removed from the final BODR.	Upon further review of this issue, Respondents agree with the Agencies that this option has limited benefit compared to the potential for public concerns.
41	41. Table 5-1: There are two Table 5-1 on the CD. One is imbedded in the text and the other is in the folder titled "Final BODR Tables". Should the one in the folder be 5-2?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The version of Table 5-1 included in the folder should not be used. The correct version is embedded in the text.
42	42. Section 5.1, page 142: Design criteria – Sediment removal -A general statement is made that the overall sequence of dredging will be high-to-low and upstream-to-downstream to avoid recontamination. The sequencing of capping and sand covers should also be incorporated into the overall operations sequence. All dredging for a given segment of the project should be complete before sand covers and caps are placed. As a general rule, no capping or cover placement should be on-going downstream of on-going or planned dredging operations.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Future stages of the RD will include additional evaluation of the project sequencing.

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43	43. Section 5.1, page 143: "Water treatment" – Bag filters need to also be described as part of the process.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The details of this issue will be addressed as part of subsequent design submittals.
44	44. Section 5.1.1, page 144, 1 st bullet: Evaluation of what is considered available inventory and what is reasonable to dredge will require further evaluation as part of detail design. A six-foot limit on depth, for example, is not appropriate as a general rule.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue will be reviewed as part of future RD.
45	45. Section 5.1.1, page 144, 2 nd bullet, last few lines: We have not shown that a six-inch cover can reliably achieve risk based performance objectives. This again will require further evaluation in the detail design phase.	The wording of the BODR text in Section 5.1.1 has been revised as agreed to reflect the preliminary status of the evaluation.	The protectiveness of six-inch covers will be evaluated in more detail in future design phases.
46	46. Section 5.1.1, page 145, 1 st bullet: The remediation of the high concentration area described must be included in the scope of this BODR to whatever extent it is not finished in Phase 1.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue will be reviewed as part of future RD.
47	47. Section 5.1.1, page 145, 2 nd bullet: As the described approach requires further congressional approval, the BODR should describe the planned remediation if this approval is not received.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Reauthorization of OU 4A continues to be included as part of the WRDA bill, which should be voted on soon. In the unlikely event that the WRDA bill is not voted on during RD, the design can be modified in these areas.
48	48. Section 5.1.2, page 148, 4 th paragraph: Define "relatively low risk", "low risk", "marginally above 1-ppm RAL".	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The details of the sediments suitable for sand cover under the Optimized Remedy are discussed in Section 5.4.
49	49. Section 5.2.1, page 154, 1 st bullet: The text states that near-surface sediments (defined as upper three feet) above 1-ppm PCBs were targeted for dredging, unless preliminary evaluations indicated shoreline instability, to be further evaluated in remedial design. Removal of three feet of sediment may not cause significant shoreline instability, and must be carefully reviewed during detail design.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Further stages of the RD will include a case-by-case review of the stability of dredge cuts.
50	50. Section 5.2.2, page 156: The text refers to compaction corrections made to the geotechnical properties in Table 5-1 for sediments targeted for dredging under the Optimized Remedy. Similar to a comment in Section 2, explain the procedures for compaction corrections of laboratory test results. The results in Table 5-1 seem more reasonable compared to geotechnical properties described in Section 2 for all sediment test results.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Attachment A of Appendix A of the Final BODR provides the basis for the compaction correction used to adjust measured geotechnical properties to account for coring-induced compaction. This methodology is accordance with the Agency-approved RD Work Plan and SAP/QAPP.
51	51. Section 5.3, page 166, second bullet: The text refers to Appendix D for analysis of the field prop wash study completed in October 2005. Further analyses of the fixed vessel portion of the field study is needed in comparison to results of the moving vessel portion of the field study. How results will be incorporated into the cap design will also require follow-up in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The propwash data will be further analyzed as part of future RD.
52	52. Section 5.3.1, page 167, 1 st paragraph, Operational Considerations: The characterization of part of the cap thickness as "over-placement allowance" does not clearly represent the intent. Future design details will develop specification language to ensure target cap placement thickness is achieved over 95% (or other agreed on percentage) of area as demonstrated by follow-up testing. This is actually addressed better later in the document and could be eliminated here to avoid confusion.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As the comment points out, later sections of the BODR already provide the requested clarification. In addition, the RD Team agrees with the commenter that the construction specifications will be developed during subsequent design with appropriate language for cap "target thickness".
53	53. Section 5.3.1, page 166: Vessel-induced prop wash – The final BODR appropriately describes the status of prop wash evaluations to date. But this is the one component of cap design remaining that may potentially change the cap designs and/or areas to be capped in the detail design phase. The interpretation of the field study results must be carefully considered for the proposed cap areas in shallow water, subject to recreational vessel and Jet Ski traffic.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The propwash data will be further analyzed as part of future RD.
54	54. Section 5.3.2, page 167, 1 st bullet: Again, for purposes of the BODR, the proposed design needs to also address the approach considering not receiving the channel reauthorization referenced.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See response to Comment No. 47.
55	55. Section 5.3.3, Table 5.5, page 170: add maximum PCB concentration under cap.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The second column of Table 5-5 defines the maximum PCB concentration within the top 1.5 feet of sediment, which the November 8 Workgroup concluded was the appropriate concentration that will govern the cap design.
56	56. Section 5.3.3, page 170: The right margin on Table 5-5 has text cut off.	Final BODR includes a corrected table.	The table has been corrected in the Final BODR
57	57. Section 5.3.4, page 171, 5 th bullet: This paragraph indicates capping will be performed over two 12-hour shifts per day in OU4. Is nighttime capping work practical given the precise controls necessary to ensure proper location and thickness? Will noise and lights be a nuisance to residents?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As discussed in response to Comment No. 3-24 on the Draft BODR, this issue will be reviewed and addressed during later stages of the design.
58	58. Section 5.3.4, page 171: In paragraph 3, it references that "conservatively" a 10% loss factor was added to the granular materials for losses expected during the capping operation. With materials being handled possibly three or four times prior to final placement, it is our opinion that a 15% loss factor could be added to the quantities.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Based on experience with similar placement techniques on similar projects, The RD team considers a 10 percent loss rate adequate for the BODR. This will be evaluated further in future design stages.
58	a. In the ROD Remedy under Task Items II.5.3 & II.5.4, the impact would be an additional estimated cost of $450,000.		
58	b. In the Optimized Remedy under Task Items II.5.1, II.5.2, II.5.3 & II.5.4, the impact would be an additional estimated cost of $ 725,000.		

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59	59. Section 5.4, page 173, 1st paragraph: Information presented for dredge volumes should be adjusted to be consistent with the same numbers presented elsewhere in the document. A clarification that no greater PCB concentrations are under the surface deposits. Also in Table 5-6, list percentage of total PCB mass in OU2-5, not just percentage of ROD PCB mass.	The inconsistencies in dredge volumes has been corrected in the Final BODR. No other changes to the BODR are necessary.	With respect to the clarification of PCB concentrations in cover only areas, the reference paragraph and the preceding 3 bullets note that covers were only designed in areas with a maximum 6-inch sampled interval with PCB concentrations between 1 and 2 ppm. No other sampled intervals were above the 1 ppm RAL.
60	60. Section 5.4, page 173: The right margin on Table 5-6 may have text cut off. Is the column of "acres" in this table the total wetted surface in OU3-5, or just the total 1-ppm boundary? The column should be labeled accordingly.	The Final BODR includes a corrected column label and updated values.	The column titled "acres" presents the areas of each remedial action under the Optimized Remedy.
61	61. Section 5.5.1, page 174: The statement "Within OU3, the Optimized Remedy includes an approximate balance of dredge and cap/cover volumes, such that there is no net change in the total area at various water depths (Figure 5-14)" is contradicted by the statement in Section 5.5.4, page 175 of "In OU3, the volume of material to be removed under the Optimized Remedy (approximately 204,000 cy) is slightly less than the proposed cap and cover volume (approximately 260,000 cy, excluding cap consolidation, which will reduce the net placement volume) indicating that the river will be marginally constricted as a result of the Optimized Remedy (see Figure 5-14)."	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The slight imbalance in dredge and cap quantities will be offset by cap-induced consolidation which is predicted to average approximately 6 to 7 inches for a 13 to 16-inch cap in OU 3, based on the results of seepage-induced consolidation testing conducted as part of the RD. Cap consolidation and dredge/cap volume balances will be evaluated in more detail in future design phases.
62	62. Section 5.6, Table 5-7 & 5-8, page 177-178: This section provides new data and information not covered in previous workgroup discussions without new supporting documentation. As such, the information should be characterized as preliminary and subject to further refinement/review in detail design or taken out of the BODR document for later development.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Tables 5-7 and 5-8 are similar to those previously presented in the "Sand Cover Protectiveness and Dredge Residual Management Considerations" memo dated 1/6/06. In addition, SWAC calculations will be evaluated in more detail in future design phases.
63	63. Section 5.6, page 176: SWAC -Residuals terminology – The second paragraph uses the terminology "mass release" to describe an assumed mass of dredge-generated residual sediments. This terminology is generally associated with sediment resuspension, not residuals, and is therefore potentially confusing. This points to the need to develop generally accepted terms.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team believes that the terminology is appropriate and consistent with terminology used in other dredging projects, but the RD Team is open to any proposed changes in terminology that would make future documents clearer.
64	64. Section 5.6, Tables 5-7 and 5-8, page 177: SWAC – The values for anticipated post-cover concentrations in dredged areas are apparently still based on the "1/17th algorithm" proposed earlier by the Respondents for identifying sand-cover only areas. There is not agreement on this approach and further evaluation will be required in the detail design phase. This should be clarified.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team recognizes that the Agencies have not settled on an approved approach to calculating values for post-cover concentrations. The BODR discussion is consistent with the "baseline" case developed during prior Workgroup meetings. Other SWAC calculations methodologies are discussed in a memo titled "SWAC Sensitivity Analysis" dated 3/17/06. Future design phases will address this issue in more detail.
65	65. Section 5.6, Tables 5-7 and 5-8, page 177: SWAC – In order to evaluate the SWAC either in these tables or possibly in an additional table we need to see a detailed breakout by OU of the area (acres) of each type of remedial situation and corresponding estimated post remedial surface average.	The workgroup agreed that the RD Team could provide this information separately and that no change is necessary in the BODR.	The RD Team has prepared a summary table as requested.
65	a. Dredged only, dredged and capped, sand cover only, capped only, no action and any other situations should be identified. Additionally, for each of these situations the estimated mean surface concentration that applies to each of these areas should be reported. Where feasible, this should include approximate confidence limits as well. Finally, the overall SWAC estimate should also include an estimate of precision. The sensitivity analysis reported quantifies potential biases in the SWAC estimate, but the precision of these estimates remains unknown. It is possible that sampling error is a larger component than bias due to varying assumptions. Is the SWAC estimate good to 10%, 50% order of magnitude?	The workgroup agreed that the RD Team could provide this information separately and that no change is necessary in the BODR.	The RD Team has prepared a summary table as requested.
65	b. In this accounting of areas, one of the most important components for judging the potential to meet the SWAC is the proportion of total area within each OU that will not be remediated and the estimated surface concentration within these unremediated areas. This information needs to be clearly communicated so that we can understand the reliability of the reported SWAC estimates.	The workgroup agreed that the RD Team could provide this information separately and that no change is necessary in the BODR.	The RD Team has prepared a summary table as requested.
66	66. Section 5.6.1, page 178: Dredge Residual and Undredged Inventory Management – MNR in dredged areas – The option of considering MNR as a process in dredged areas for purposes of meeting the SWAC requires that the SWAC be calculated based on sampling in the mid-to long-term. Would these sand cover areas not be monitored again in the mid-to long-term?	Reference to MNR as a stand-alone residual management option has been removed from the final BODR.	The RD Team believes that it is possible to develop methodologies that will allow consideration of the effect of enhanced sedimentation rates as a dredge residual management option.
67	67. Section 5.6.1, page 179: Under the heading of Residual Covers and Engineering Caps, it says, "In those areas where sand covers may not be sufficiently protective, but where the permanent stability and performance of engineered caps can be assured, and where further dredging would not be expected to provide additional PCB mass removal or risk reduction, the Optimized Remedy includes engineered caps, consistent with the contingent remedy provisions of the ROD." Where are these areas in which engineered caps are proposed for residuals management? Are they now known/predicted, or will this be a response action to be determined following dredging of specific areas? If now known/predicted, were these areas classified as "a dredging area, a dredge and cap area, or an engineered cap area" when the remediation areas were classified and grouped, like in Table ES-1 and Table 5-5?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The areas requiring residuals management and the actual management technique will be identified based on post-dredging confirmation sampling results. On the figures in the BODR, areas were not identified as "capping" or "dredging and capping" areas unless those remediation approaches were selected as the initial remedy for those areas.
68	68. Section 5.8.3, page 184: Shouldn't this include an "amendment admixture" discussion?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The option for passive dewatering and amendment admixture was not considered viable at the shore side staging area and therefore was not carried forward in the evaluation.

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69	69. Section 5.8.3, page 184: The text of this section is the same as the draft, and still lacks clarity and congruence with the referenced figures. Further, we are still not in agreement on the relative assessment of operating efficiency presented as affects productivity and cost estimates for the different options considered. This will require refinement and follow-up in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue will be addressed as part of future RD.
70	70. Section 5.8.3, Figure 5-22, page 184, Mass Balance, reference:	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Figure 5-22 will be revised accordingly during subsequent phases of design
70	a. The mass balance starts out with a summary that states the process is operating 18-hours per day. Since the dredge is only running 16-hours per day is this correct?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The final 5,000 GPM (3,200 CY/day) mass-balance is based on 5,000 GPM of flow from the dredge at an average "effective" operational period of 16 hours/24 hour day @ 100% productivity duty. This rate and loading was used for initial sizing and design of sediment unit processing operations and modules. It is anticipated that actual dredge productivity (starting, stopping, repositioning, in/out of sediment banks, etc.) will equate to more of an 18 hr/day operational schedule for the sediment processing system, but with 16 hours of effective flow. This issue will be addressed further during subsequent design phases.
70	b. Is the grain size distribution being used treated as a percent by volume or dry weight? The grain size by dry weight distributions referenced on this figure do not match with the values given on the average sediment property summaries provided by the Respondents that are on the basis of percent by dry weight.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The grain size distribution given in Figure 5.22 is by dry weight. This issue will be addressed further during subsequent design phases.
70	c. The number of truck loads per day in each size range indicates that the first two cuts >3/8 inch and 3/8 inch to 100 micron are being trucked from the site at 30 tons per load. The two smaller fractions are leaving at 20 tons per load. Will 30 tons really be a legal load in Wisconsin or should the number of truckloads per day increase by 15 trucks?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	All truck loads should be based upon 20 tons. This issue will be addressed further during subsequent design phases.
70	d. The weight of the solids from the smallest size fraction <45 micron is low. If the lightest fraction is 30% of the total dry weight of 69 tons per hour (3200 cubic yards per day, times 1.08 tons per yard, divided by 16-hours, times 32% dry solids), then the dry tons reporting to the <45 micron cut will be 21 tons, plus some efficiency loss from the previous separation step so say around 23 tons. If this 23 dry tons is at 50% solids after the filter press operation, then the disposal weight would be 46 tons/hour not the 27 tons/hour shown on the mass balance.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The weight of in-place dry sediment solids dredged per day is 1,210 tons/day (3,200 cy/day * 1.08 tons/cy * 35% solids content). The -45 micron solids represent 27% of the to dry weight of the solids (since the -45 micron organics (3% of the total dry solids) were removed during the screening). Therefore, the -45 micron solids are 326.6 tons per day (1,210 tons per day *27%). The -45 micron solids and the 18.5 tons per day of quicklime added during dewatering make up the solids in the filter cake. Since the filter cake is at 55% solids, 627 tons/day of filter cake will be produced ([326.6 +18.5]/55%). Over the 18 hour day of production, that translates to 34.8 tons/hour of filter cake. This issue will be addressed further during subsequent design phases.
70	e. The mass balance performed by the review team is included as Chart 2 -comment #107, and shows that the total tons per hour are in good agreement, but with nearly ½ of the total weight to disposal from the <45 micron cut. The differences should be resolved during the detail design, including if the cost of equipment and operations for the dewatering should be adjusted upward.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Differences between the mass balances are mainly due to different assumed particle size distributions and different assumptions in the solids contents of the various fractions generated from the processing. Overall, the RD Team's mass balance suggests that 75.1 tph of wet - 100 micron material (including additives) would be disposed of off-site, while the OT mass balance suggests that 74 tph of similar material would be disposed of off-site. The RD Team's mass balance suggests that 42 tph of +100 mesh material would be recycled, while the Agency/OT's mass balance suggests that 27 tph of +100 mesh material would be recycled. These differences will be resolved during the detailed design.
71	71. Section 5.8.3, page 184: The middle paragraph states "Plate and frame mechanical filter presses were chosen in order to process the sediment into a 'filter cake solid' that meets landfill specifications of 50 to 55% solids (by weight), with a compressive strength of at least 0.4 tons per square foot." Are there bench test results available, which suggest that 50 to 55% solids will achieve a compressive strength of 0.4 tons per square foot? A landfill will likely not specify a minimum percent solids for the dewatered sediment; it only has to be classified as a solid waste (i.e., pass paint filter testing) for purposes of disposal, and a percent solids less than 50% will probably pass the paint filter test. However, percent solids and compressive strength may be used by the landfill as a guideline to determine whether the dewatered sediment is "workable," which likely will affect the landfill tipping fee, and thus the project cost.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The 50 to 55% solids achieved by the presses is based on experience on the Fox River and other sites with similar sediment properties. The dewatered percent solids and associated strength required for landfill disposal is based on discussions with local landfills with consideration of "workability" of the sediment within the landfill. This issue will be addressed further as part for future RD.
72	72. Section 5.8.4, page 184-185:		
72.1	a. As noted with the draft version of the BODR, one surge tank (150,000 gallon) is referenced, whereas the drawing (Figure 5-24) shows 2 -250,000 gallon tanks. Therefore, still does not agree with Figure 5-24.	The BODR has been revised to reflect two 250,000 gallon tanks.	The reference to two 250,000 gallon tanks is correct.
72.2	b. The text indicates bag filters follow carbon filters, whereas in Figure 5-24, the bag filters precede the carbon filters. Please clarify.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	These differences will be resolved during the detailed design.
73	73. Section 5.8.4, page 184-185: As requested for the draft BODR version, please provide a table showing unit process design criteria for each unit process proposed for the water treatment plant.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As discussed during the April 11 Workgroup meeting, Equipment Data Sheets that provide detailed design criteria will be provided as part of the 30% Design submittal.

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74	74. Section 5.8.7.2, page 190: The text indicates the costs for a possible dewatering landfill are similar to mechanical dewatering and truck transport to the Onyx Hickory Meadows landfill (therefore, the Onyx landfill costs were used in the Section 8 cost estimate). Where are the cost details of the dewatering landfill to substantiate this statement?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	For the purposes of the BODR, the RD Team developed an internal cost estimate for the dewatering landfill, based primarily on the information presented in the Detailed Evaluation of Alternatives Report. The RD Team will provide the Agencies with further cost details and supporting information in future design submittals, to the extent the dewatering landfill remains a design option.
75	75. Section 5.9, page 191: In paragraph 4, first bullet point states, "reduce the volume of uncontaminated (less than 1-ppm PCBs) sediment . . ." Is the use of 'uncontaminated' in this sentence correct? If it contains PCBs, it's contaminated.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Use of the term "uncontaminated" in this context erroneously referred to sediments with less than 1 ppm PCBs. Future design deliverables will use different terminology.
76	76. Section 5.9.1, page 192, 2nd paragraph: Again the information presented here on reduced SWAC provides new data and information not covered in previous workgroup discussions without new supporting documentation. As such, the information should be characterized as preliminary, and subject to further refinement/review in detail design, or taken out of the BODR document for later development.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See response to Comment No. 62
77	77. Section 5.9.2, page 196, bullet on ROD Remedy timeline: We do not agree that two-dredge operation vs. one will impact length of schedule significantly, based on OU1 experience with three dredges.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue was been discussed at several workgroup meetings. The workgroup concluded that the BODR should present the ROD Remedy time schedule as a range, with the low end of the range representing no delays and the high end representing the potential technical and "administrative" delays. In addition, while the BODR presents this range, the BODR's comparative evaluation of the ROD and Optimized Remedies is based only on the low end of the ROD Remedy schedule range. The RD Team continues to believe that presentation of the full range is appropriate. In response to the comment's reference to the OU1 project, the RD Team does not feel that the comparison to the OU 1 dredging project is an appropriate indicator of the potential technical difficulties associated with two 5,000 gpm dredges pumping to a single shore-side surge tank and then through 18 miles of pipeline. In sum, it appears that the RD Team and the Agencies agree that the Optimized Remedy can be completed in a shorter time than the ROD Remedy, although there appears to be some disagreement over some of the details of that comparison.
78	78. Section 5.9.2, pages 198, 199 and 200: All of the bullet points on these pages present delay times that could happen with the ROD Remedy due to "uncertainties". If you add all of these up, these "uncertainties" could add 4 to 19 years onto the duration of the ROD Remedy. Uncertainties are evident in either solution and should be presented more accurately as such.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This section presents "uncertainties" for both remedies. The RD Team believes that the uncertainties associated with the ROD Remedy have the potential to delay that remedy more significantly than the uncertainties associated with the Optimized Remedy might. See also the response to comment 77.
79	79. Section 5.9.4, page 201: Should acknowledge here, for example, that the Optimized Remedy requires long term monitoring after construction, in addition to PCB monitoring for water/fish.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Both the ROD and Optimized Remedies will require long-term monitoring of engineered caps constructed where dredging can not be completed, although the magnitude of cap monitoring would be larger for the Optimized Remedy than for the ROD Remedy. Future design phases will address this issue in more detail.
80	80. Section 6.0, page 205: Is beneficial re-use no longer critical part of site work impacting schedule?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Sand removed as part of the dredge material sand separation process may be beneficially reused on-site as backfill at the Shell Property staging area for both the ROD and Optimized Remedies. Given that the necessary quantity of sand will not be available for reuse at the start of the project, it is anticipated that temporary floating docks or borrow material will be necessary during the initial stages of construction. The costs for such have been included in the project cost estimates. This issue will be address further during more detailed remedial design.
81	81. Section 6.0, page 205: Construction Schedule and Sequencing -This section provides some detail on sequencing of operations, but no mention is made of the upstream-to-downstream sequencing of dredging, or the sequencing of capping to follow dredging to avoid recontamination. This should be addressed in more detail.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The specific sequence of activities will be developed during subsequent phases of design. However, in general the work will be sequenced from upstream to downstream with capping following dredging. The exception to this will be the Phase I project in OU 4A, which is anticipated to be completed prior to the start of the larger remediation project.
82	82. Section 6.1, page 205, 1st bullet: Is the proposed SMU different from the SMUs previously defined by WDNR? If so, suggest changing the former to dredge management units (DMUs) as in OU1. This concept will be a detail design follow up topic.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Future design documents will use the DMU terminology.
83	83. Section 6.1, page 205, 1 st bullet: The last sentence says "At a minimum, a post-construction survey would be completed near the end of each construction season to determine progress." It is the Agencies' expectation that QA completion surveys would be performed much more often than once per construction season. Weekly or bi-weekly is more reasonable.	The BODR has been revised to note that contractor progress surveys will be required, in addition to the post-construction surveys previously discussed.	The RD Team contemplates that, in addition to the post-construction surveys described in the quoted passage, the dredging contractor would also be required to complete frequent progress surveys.
84	84. Section 6.2, page 209, 3 rd and 4th bullets, and Section 6.3, page 211, 5 th and 6th bullets: Why are placement rates different for capping of shoreline areas vs. placement of sand covers for post-dredge residuals management?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The placement rates are different due to the expected reduced production rates on slopes and in shallow water.
85	85. Section 6.3, page 212: How/when do you install caps and then how/when do you monitor by OU regarding OU2 through OU3 through OU4A, OU4B? We agreed this would be detailed in the next detail design phase and should acknowledge that point.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team agrees that further development of sequencing will be addressed during later stages of the RD.
86	86. Section 7, pages 213-233: There needs to be some acknowledgement of potential nuisance due to lighting. This has been an issue at other sites and we made this comment to the first draft of the BODR.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	See response to Comment No. 57

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87	87. Section 7.2, page 214: Construction Water Quality Monitoring – Use of elutriate tests is mentioned as a reliable indicator for other chemicals of concern. And the statement is made that if the TSS limit of 80mg/l is met, effects of other constituents would not be expected. Although appropriate, there is no analysis of the DRET data to support these statements, and such an assessment should be included in detail design. Water quality standards will also need to be addressed.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	A more thorough analysis of the elutriate test data relative to suspended sediment concentrations as well as other water quality parameters will be provided in subsequent detailed design documents.
88	88. Section 7.2.2, page 214: The text indicates that, "Prior to construction, water quality monitoring will be performed to establish ambient water quality conditions, and to develop a quantitative correlation between turbidity levels and TSS concentrations in the Lower Fox River." The Agencies recommend the turbidity-TSS monitoring correlations established in OU1 also be considered, and further, that monitoring initially be conducted continuously until it can be established that no problems are occurring.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the water quality monitoring program will be developed during later stages of the RD.
89	89. Section 7.4, page 217: Post-Dredge Sediment Confirmation Sampling – As outlined in previous comments, while the information presented is a good step forward in developing a possible approach to sampling, the discussion should be revised to describe it as a conceptual model and example of how the subject could be approached. The Agencies will have significant input on the process, and expect this will require further development and review in the detail design process.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team appreciates the comment and agrees that the BODR approach is illustrative, as the details of the confirmation sampling monitoring program will be developed during later stages of the RD.
90	90. Section 7.4, page 217, 1st bullet: No action is listed as a possible post-dredge response action if the 1-ppm RAL is not achieved. Per the ROD, this is only an acceptable response if the SWAC is attained. The second bullet lists MNR as a possible response action. Similar to an earlier comment, MNR is not included in the current ROD for this type of consideration, and MNR would have to be approved via a ROD amendment or ESD.	Reference to MNR as a stand-alone residual management option has been removed from the final BODR.	See response to Comments No. 11 and 66.
91	91. Section 7.4.1, page 218, 3rd bullet: Indicates that confirmation sampling of dredge residual cover areas will include "initial" sampling to confirm proper placement of 6-inch sand covers. What is meant by "initial?" An acceptable confirmation sampling plan for residual sand covers will be determined and approved at the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the confirmation sampling monitoring program will be developed during later stages of the RD.
92	92. Section 7.4.1.1, page 219: The first paragraph indicates that, "surface sediment (top 10 cm) confirmation samples will be collected within and immediately adjacent to the dredged areas." How will these samples be collected? The second paragraph indicates that "For the purpose of costing this BODR (Section 8) it was assumed that the level of effort for confirmation sampling will be approximately 20 percent of the surface sampling locations collected during the 2004-2005 RD investigation." The 20% level is too low. In this same paragraph, it states that, "In areas where surface sediment concentrations are significantly higher than predicted residuals concentrations, 'short cores' (e.g., manually deployed 12-to 24-inch piston cores) will be obtained to determine whether undredged inventory may be present below the residuals layer." Cores longer than four inches should be taken for all samples to avoid a second sampling effort, with the recovered portion below four inches archived for future analysis, depending on the results of the first analysis. An acceptable confirmation sampling plan will be determined and	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the confirmation sampling monitoring program will be developed during later stages of the RD.
93	93. Section 7.4.2, page 220-221, last 2 bullets: This section should clarify that initially, chemical analyses of the cover material will be required to determine the relationship with the existing surficial PCB concentration to the resultant PCB concentration in the sand cover material.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. The first paragraph of Section 7.4.2 discusses the anticipated use of chemical sampling in combination with physical monitoring during initial stages of construction to verify the anticipated degree of mixing during cover placement. This issue will be addressed further as part of the 60 Percent Design submittal.
94	94. Section 7.5.1.1, page 222: What is meant by "a limited number of cores will be collected after cap construction to verify cap thickness and correlate with bathymetric surveys"? Consolidation of the soft sediment under the cap may render bathymetric surveys an inaccurate predictor of cap thickness such that cores would be the normal means for verifying cap thickness. In the first bullet, as noted, the word "majority" will be determined and approved in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the confirmation sampling monitoring program will be developed during later stages of the RD.
95	95. Section 7.5.2.1, page 224, Bank Caps: Monitoring during low water conditions should be defined better. For example, is this "annual" low water and not when water levels for the lake and river hit a certain low level?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the confirmation sampling monitoring program will be developed during later stages of the RD.
96	96. Section 7.5.2.1, page 224: Physical Integrity of Sediment Caps – In the paragraph at the top of the page, significant storm events should be added to the list of events which would trigger additional monitoring.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. Section 5.7 describes the use of significant storm events as a trigger for additional cap monitoring. This issue will be addressed further as part of the 60 Percent Design submittal.
97	97. Section 7.5.2.1, page 224: Physical Integrity of Sediment Caps – The text mentions a USACE definition of erosion that corresponds to approximately one-half the proposed cap thickness. This statement is likely derived from an entry in Table 7 of WES Technical Report DOER-1, Guidance for Subaqueous Dredged Material Capping (Palermo et al 1998). This table is a sample tiered monitoring program for a dredged material capping project. The table entries mention a cap thickness reduction threshold of 0.5 feet for consideration of management options (0.5 feet is approximately half the proposed Fox River cap thickness of 13 inches). There are several reasons that this table entry should not have been cited in the BODR as an applicable definition of erosion for the Fox River caps:		
97.1	a. First, TR DOER-1 is a guidance document for Dredged Material Capping, not Remediation Capping. The conditions for contaminated dredged material capping would generally include lower levels of contamination as compared to remediation projects, consideration of capping in the context of open water placement of contaminated dredged material, and generally less precise cap thickness determinations and placement operations.		
97.2	b. Second, the table is intended as a sample monitoring program to illustrate the concept of monitoring tiers, and is not intended as a guide on threshold criteria to be applied to any specific project.		

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97.3	c. Third, the concept of erosion threshold as mentioned in the table is within the context of a design with planned erosion, i.e., for a dredged material capping project, the design may anticipate erosion over time with the intention of "nourishing" the cap with more clean dredged material from navigation projects over time. The Fox River caps are intended to be erosion-resistant, and in fact, are designed as armored caps to prevent any erosion of the isolation layers of the cap.	Final BODR text has been modified to remove the reference to the USACE definitions of the trigger for additional action due to cap erosion. The specific triggers will be quantified during later stages of design.	Cap monitoring programs will be further addressed as part of the 60% Design submittal.
97.4	d. Fourth, and most importantly, as commented earlier for the draft BODR, "A value of 6 inches is proposed here as a definition of the condition of cap erosion. With 13 to 16 inch caps as target thicknesses, this value accounts for almost half of the desired cap thickness. If 6 inches of cap is eroded, the effectiveness of the cap may well be compromised. Also, the proposed management action for an initial monitoring result of 6 inches erosion is "no action if chemical analytical results are acceptable." Considering the nature of this project and the relatively thin isolation cap target thicknesses, the value of six inches of thickness reduction is simply not acceptable as a threshold. We recommend three inches of cap layer reduction as the definition cap erosion. For erosion of zero to three inches, the initial thickness of cap should be considered along with the chemical data in deciding if no action is appropriate. If greater than three inches of cap thickness is confirmed as lost to erosion, the appropriate management response is repair of the cap and/or armoring with coarser material. And, it should be noted that with physical loss of cap material, the fact that chemical results are initially acceptable may		
98	98. Section 7.5.2.1, page 224: The text indicates that, "survey data will be collected along the same transects from year to year to ensure comparable data are collected." Although we agree with this statement, bathymetric surveys will also need to be performed between a yet-to-be-determined number of transect locations to check broader areal extent of cap and cover stability	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the long-term monitoring program will be developed during later stages of the RD.
99	99. Section 7.5.2.2, page 225: The text indicates "Surface sediment sampling in the capped area will be completed during Years 1, 4, and 9 following completion of the remedial action." The text further states "The purpose of the surface sediment samples is to monitor for chemical breakthrough of the cap." The cap was designed to prevent or minimize the potential for chemical breakthrough. In fact, page 18 of Appendix D indicates that approximately 920 years would be required to achieve steady state fluxes through a nominal three-inch thick chemical isolation component of the cap. Therefore, chemical monitoring beyond nine years would seem to be warranted. On page 226, the text indicates that approximately ten cores will be routinely collected extending through the cap and into underlying sediments to serve as sentinels for cap performance. We are uncertain whether ten cores are adequate, and whether one can collect a representative core of an engineered cap containing a protective armor layer. An acceptable confirmation sampling plan will be determined and approved in the detail design phase. Also on page 226, the text indicates a possible response action if sediment cores indicate cap breakthrough includes "increasing th	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the long-term monitoring program will be developed during later stages of the RD. Note that several prior CERCLA sediment capping projects have determined that data collection through Year 9 has been sufficient to demonstrate long-term cap performance (i.e., well beyond 9 years).
100	100. Section 7.6.3.2, page 230-231, 2nd paragraph: Discontinuing fish tissue monitoring when specific remediation goals have been met is discussed. Details for this approach have not been agreed on with the Agencies relative to the DQOs or decision criteria for Long Term Monitoring because the Respondents are deferring this plan to the detail design phase. This paragraph should be revised or removed.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The RD Team acknowledges that the details for this approach have not been resolved with the Agencies. This issue is scheduled to be addressed as part of the 60 Percent Design submittal.
101	101. Section 8.0, page 234 and page 244: Estimate accuracy discussion.		
101.1	a. In paragraph two on page 234, the BODR states the estimates do not include escalation or contingencies. It also notes that the cost estimates have been advanced to approximately a 30% design level.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.2	b. Based on our review, the Final BODR estimate is past the order of magnitude and approaching a feasibility cost study level. This would reflect an estimate accuracy level of +/-20% to 25%, which, in turn, would relate to a 30% design level.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.3	c. In paragraph 2 on page 244, the BODR states that, due to the conservative nature and assumptions made for the Optimized Remedy, an overall project contingency is not considered appropriate for the Optimized Remedy. In determining level of accuracy, the project estimate typically includes a contingency allowance and addresses escalation. These should be included for the following reasons:	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.3	i. An initial contingency here would represent an allowance for scope we expect to be required and included for the project but that is not detailed at this time. We recommend that at least a 10% contingency be added to all estimates before evaluating overall estimate accuracy. At that point, depending on the further assessment of overall accuracy, an additional contingency may be allocated to address unknowns in support of an appropriation of funds request.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The framework for cost estimating has been the topic of numerous workgroup meetings. The Workgroup concluded that adding a overall project contingency would reduce the usefulness of the project cost estimates for this report, which are primarily provided as a comparison between the ROD and Optimized Remedies.
101.3	ii. For escalation, note, for example, the current estimate is based on 2005 values for labor, materials and equipment. In this area, we have been experiencing 3% to 5% escalation annually over the past couple of years.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted. In order to provide the most accurate comparison of ROD and Optimized Remedy costs, the Workgroup previously concluded that present day costs were appropriate for most project elements with the exception of long-term monitoring and maintenance. Future design stages will consider escalation for planning purposes.
101.4	d. Some general comments for both the ROD Remedy and the Optimized Remedy:		
101.41	i. The variance that could be experienced with the dredging quantities and the capping quantities should fall within the overall level of accuracy for the project.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.

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101.42	ii. The production efficiencies continue to be discussed. The Oversight Team has previously commented production efficiencies of the dredging and sediment dewatering operations. We are closer to understanding the assumptions and reasons that went into developing these units. However, there is still some discussion that needs to occur as the project design continues. This probably affects the Optimized Remedy more so than the ROD Remedy.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	The process efficiencies will be further evaluated during later stages of the RD.
101.43	iii. An overall look at the unit cost on a dollar per cubic yard basis for the remediation process needs to be done. Understanding the "economy of scale" discussion, historical costs for comparison and discussion have not been produced.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This issue was discussed at the November 9, 2005 workgroup meeting. After an internal review of historical projects, the RD Team concluded that there are no projects similar enough to the Fox River to provide a useful comparison.
101.5	e. In regards to the ROD Remedy, there are a couple of factors that could drive the accuracy outside of that range.		
101.51	i. If an amendment is required to be added to the sediment for disposal at the landfill, the Oversight Team estimates an additional cost to the project of at least $100 million could be experienced. (Current BODR estimate for this is $220 million)	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.52	ii. The level of design for the cross-country pipeline, the surge tank and NR213/NR500 landfills are very preliminary.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.53	iii. Transportation and disposal costs have the potential for fluctuation depending on oil prices and landfill capacities.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.6	f. In regards to the Optimized Remedy, there are fewer factors that could drive the accuracy outside of the range discussed above. However, the following could have some definite impacts:		
101.61	i. The sediment dewatering system is still in preliminary design. There continues to be concerns regarding the process flow, and what equipment and quantities of equipment will be required. However, additional costs were addressed in the current estimate based on previous input.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.62	ii. The current mass balance for the process flow needs to be finalized.		This will be addressed during later stages of the design.
101.63	iii. Transportation and disposal costs have the potential for fluctuation depending on oil prices and landfill capacity.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
101.7	g. Summarizing Level of Accuracy. Based on the current level of documentation and information, the Oversight Team believes that the Optimized Remedy will always be the evaluated lower cost option. Other cost variables that may impact the estimate, will impact both the ROD Remedy and the Optimized Remedy equally in relative terms.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Comment noted.
102	102. Section 8.2.1.3, page 240, 3 rd and 7th bullets: For the ROD cost estimate, the third bullet states that "Post-dredge surface sediment confirmation sampling and analysis was assumed to be required at the same frequency as RD investigations (approximately one core per 1.6 acres and composited as described in Section 7)." This is a reasonable assumption for the BODR, however, as noted earlier for Section 7.4.1.1 (page 219), the second paragraph indicates that "For the purpose of costing this BODR (Section 8) it was assumed that the level of effort for confirmation sampling will be approximately 20 percent of the surface sampling locations collected during the 2004-2005 RD investigation." The seventh bullet indicates "Cap maintenance was conservatively assumed to be required over 5 percent of the area at four events in the future (2, 5, 10, and 30 years after construction)." An acceptable cap monitoring and maintenance plan will be determined and approved in the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the long-term monitoring program will be developed during later stages of the RD.
103	103. Section 8.3.1.3, page 243, 3 rd bullet: For the Optimized Remedy, the text indicates, "Maintenance of the capped areas was assumed to occur at 2, 5, 10, and 50 years after construction." Again, an acceptable cap monitoring and maintenance plan will be determined and approved during the detail design phase.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As set forth in the AOC, the details of the long-term monitoring program will be developed during later stages of the RD.
104	104. Reference Preliminary Construction Cost Estimate for the Optimized Remedy.		
104.1	a. Reference the WWTP Capital & Installation Cost Estimate. It appears there were no adjustments made to this estimate from Draft BODR (note estimate was $2,366,500). In our opinion this estimate is still low.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This will be addressed during later stages of the design.
104.2	b. Reference the WWTP Annual Operating Costs. It appears that there were no adjustments made to this estimate from the Draft BODR (note estimate was $450,430). In our opinion this estimate is still low.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	This will be addressed during later stages of the design.
104.3	c. Reference Estimate Worksheet II.2.1. The overhead and profit adjustment of 18% does not appear to have been applied to the estimated grand total of $24,594,764. In the previous BODR draft version the 18% was applied to the estimated grand total. Please explain the change in philosophy.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As discussed in previous Workgroup meetings and noted in the "comments" column of the referenced worksheet, the 18% overhead and profit were not applied to the landfill disposal costs since this is not appropriate. This does not represent a change in methodology since the draft BODR.
104.4	d. Reference Estimate Worksheets II.5.1, II.5.2, II.5.3 and II.5.4. Please review the quantities for the granular materials. These appear to reference back to the Capping Area Worksheet included in the Engineer's Cost Estimate Backup Worksheets.	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	Quantities in II.5.1 and II.5.2 inadvertently also include the quantities from II.5.3 and II.5.4. Correction of this double-counting will translate into an approximately $1M savings to the Optimized Remedy. Adjustments will be made during later stages of the design.
104.41	i. Estimate Worksheet II.5.1: Mechanical Capping OU3. The quantities used for granular materials appear to include the quantity associated with the shoreline capping for OU3 (Sand @ 16,398 tons & gravel @ 12,754 tons). Is this doubled up with those granular material quantities in II.5.3 for OU3?		
104.42	ii. Estimate Worksheet II.5.2: Mechanical Capping OU4. The quantities used for granular materials appears to include the quantity associated with the shoreline capping for OU4 (Sand @ 60,375 tons & gravel @ 46,958 tons). Is this doubled up with those granular material quantities in II.5.3 for OU4?		
104.43	iii. Estimate Worksheet II.5.3: Mechanical Capping for Shoreline Areas OU4. It appears that the granular material capping quantities are correct. However, it appears these quantities are also included in II.5.2.		

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104.44	iv. Estimate Worksheet II.5.3: Mechanical Capping for Shoreline Areas OU3. It appears that the granular material capping quantities are correct. However, it appears these quantities are also included in II.5.1.		Optimized Remedy. Adjustments will be made during later stages of the design.
105	105. Reference Preliminary Construction Cost Estimate for the ROD Remedy.		
105.1	a. Reference Estimate Worksheet I.1.3. The unit cost for purchase of the 12-inch dredge, 12-inch booster on barge, small tug and 20-foot workboat are different than the unit costs used in the Optimized Remedy. Shouldn't both the ROD and Optimized Remedy be using the same Unit Cost for these items?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As detailed on the "Equipment Purchase Costs" worksheet for the ROD and Optimized Remedy developed by the Boldt OT and the RD Team, the dredge and booster costs include the following: capital cost of the equipment; hull, P&I, liability, pollution insurance; replacement of major parts; and finance charges. Since the duration of the ROD Remedy is longer than the Optimized Remedy, the costs for some of those items are larger and are therefore reflected in the lump sum costs used on worksheet I.1.3.
105.2	b. Reference Estimate Worksheet IV.2. The hourly rates for personnel remained the same yet the unit cost was reduced from previous draft BODR. Please explain why this was changed?	The workgroup agreed that no change is necessary for the Final BODR. See RD Team response to comment.	As discussed in Section 8.2.1.3 and 8.2.1.4 of the Final BODR, labor costs for tasks completed by the Owner's consultants were treated differently than contractor labor. As such overhead and profit and labor taxes are built in to the labor rates.