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SECTION 404(b)(1) EVALUATION
MAINTENANCE DREDGING OF THE
9-FOOT CHANNEL NAVIGATION PROJECT

ILLINOIS WATERWAY
RIVER MILES 80.2 - 303.4

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US Army Corps
of Engineers ®
Rock Island District

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ILLINOIS WATERWAY
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SECTION 1 - PROJECT DESCRIPTION

I. LOCATION

A Final Environmental Impact Statement (FEIS) was prepared in 1975 for Operation and Maintenance of the Illinois Waterway (IWW) 9-Foot Channel Navigation Project (Project). The Statement of Findings for the FEIS (now referred to as the Record of Decision) was signed by the Director of Civil Works on November 18, 1975. The Project is located on the between River Miles (RM) 80.2 and 303.4. Dredging is required at numerous, but unpredictable, locations in this reach of the waterway.

II. GENERAL DESCRIPTION

In order to maintain the Project, maintenance dredging will be performed at locations where needed in the reach of the IWW within the U.S. Army Corps of Engineers (Corps), Rock Island District (District). The District's portion of the IWW extends approximately 223 river miles from the junction of the Calumet-Sag Channel to approximately 9 river miles downstream from Beardstown, Illinois. The Corps' operation and maintenance of the present navigation system was initiated when Congress passed the River and Harbor Act of 1927. Congress has appropriated funds for District operation and maintenance work of this segment of the waterway since 1927.

The Project from RM 80.2 to 303.4 consists of 7 locks and dams. Upstream of each dam and extending to the next dam is a slackwater navigation pool. Wing dams, closing dams, and revetment works are other physical structures that are normally integral parts of an inland waterway navigation project. These types of structures are not prevalent on the IWW, but when present, may require routine physical maintenance. Annual dredging is required at various locations in the main channel to assure a 9-foot depth.

Annual maintenance dredging of the Project is normally performed at 10 to 15 sites of the 67 individual reaches between RM 80.2 and 303.4. Over the last 10 years, the annual volume of dredged material ranged from approximately 71,000 cubic yards (CY) to 583,000 CY. Due to the large sediment load and continually changing flows, specific dredging locations and quantities to be dredged vary from year to year and cannot be determined sufficiently in advance to perform individual Clean

Water Act 404(b)(1) Evaluations. Long-term permits provide the District the flexibility to rapidly respond to channel maintenance need while complying with the Clean Water Act. Long-term channel maintenance 404 permits are unique in that they are issued for a 3- to 10-year period for entire reaches of the IWW. Long-term 404 permits allow for the historic (previously used) placement sites as long as these sites are acceptable to the State and Federal natural resource and regulatory agency representatives.

The District has been preparing Clean Water Act Section 404(b)(1) Evaluations for the Project at 5-year intervals. The District indicated in the 404(b)(1) Statement of Findings (SOF) signed by the District Engineer in 2009, the intent to pursue a 10-year period of authorization when the next 404(b)(1) was prepared. With completion of the 404 studies, which investigated the direct effects of dredge material placement on resources and the array of existing Dredge Material Management Plans, the District is proposing a 10-year period of authorization.

Dredged material is removed from the navigation channel by either hydraulic or mechanical methods. Hydraulic dredging is performed by a cutterhead dredge, which discharges material to the placement site via a floating pipeline. Mechanical dredging is performed by a clamshell dredge or excavator, which loads material onto barges for transport to approved placement sites. In general, material from RM 80.2 to 260.0 is removed by a hydraulic cutterhead dredge, while material from RM 260.0 to 303.4 is removed by a mechanical dredge. A recent review of sediment grain size analyses seems to indicate that most sediments in the river navigation channel are primarily sandy with intermittent stretches of fine-grained material. Dredging depth is normally limited to 11 feet below flat pool elevation.

Prior to the placement of any dredged material, representatives of the District and the IWW On-Site Inspection Team (IWW OSIT) meet to determine the preferred placement site for the material. State and Federal natural resource and regulatory agency representatives participate in the IWW OSIT. At the end of each dredging season, the IWW OSIT inspects each placement site and makes recommendations to the District for future dredging events. In addition, the IWW OSIT chairman prepares a Post-Disposal Evaluation Report and submits this information to each involved State and Federal agency for review.

The IWW OSIT was formed during the Great River Environmental Action Team (GREAT) studies and consists of State and Federal natural resource and regulatory agency representatives, as well as the Corps. The GREAT was authorized by Congress in the Water Resources Development Act (WRDA) of 1976. The purpose of the GREAT was to develop a total river resource management plan for the entire Upper Mississippi River System and, in particular, to resolve inter-agency disputes relative to the Corps channel maintenance activities.

III. HISTORIC DREDGING ACTIVITY

Table 1 lists historic dredging locations in the IWW and summarizes the dredging activity that has occurred at these sites during the 33-year period from 1980-2013. Frequency of dredging is determined by the number of dredging events required during the 33-year time period (i.e., 4 events ÷ 33 years = 12.1 percent)**.** Sites with dredging frequencies greater than 20 percent are often referred to as "chronic" sites since they require frequent monitoring and/or dredging to prevent shoaling. If applicable, the historic bank placement (left or right descending bank) area(s) are also presented for each dredging location. Maps of the placement sites associated with the historic dredging locations can be found in Appendix C.

IV. COORDINATION WITH OTHER FEDERAL AND STATE AGENCIES

The following is a list of principal Federal and state agencies with whom the dredging operations are being coordinated:

- U.S. Coast Guard Eighth District, St. Louis, MO
- U.S. Environmental Protection Agency (EPA), Region V, Chicago, IL
- U.S. Department of the Interior, Fish and Wildlife Service (FWS, Rock Island, IL)
- Illinois EPA, Springfield, IL
- Illinois Dept of Natural Resources (DNR), Office of Realty and Planning, Springfield, IL
- Illinois Dept of Natural Resources (DNR), Office of Water Resources, Springfield IL
- Illinois Dept of Agriculture, Springfield, IL
- Illinois Natural History Survey, Havana, IL

V. AUTHORITY AND PURPOSE

The Rock Island District has been assigned responsibility to maintain a 9-foot navigation channel on the IWW between the La Grange Lock and Dam and the junction of the Calumet-Sag Channel and the Chicago Sanitary and Ship Canal [CS&SC (RM 80.2-303.4)] as provided by the River and Harbor Act of 1927. This Act provides for the maintenance of a channel not less than 9 feet in depth. The District also is responsible for operating and maintaining the Calumet-Sag Channel (RM 303.4-327.0) and CS&SC (RM 303.4-325.6). These portions of the waterway are not addressed in this document.

VI. THE 404 STUDIES

The 404 Studies on the Mississippi River and IWW investigated the direct effects of dredged material placement on measurable metrics/resources that helped assess the effects of dredge placement on these resources. Metrics/resources selected were: terrestrial vegetation, aquatic macroinvertebrates, freshwater mussels, fish, and turtles. Sediment transport analysis and construction of a physical model of a highly dredged reach in Pool 18 Upper Mississippi River (UMR) were also done to investigate migration of dredge material off-site. Field studies were conducted throughout the District, with vegetation, macroinvertebrates, and fish being studied in both the IWW and UMR. The 2009 Final 404 Studies report is included as Appendix C of this package.

Table 1. Summary of Dredging Locations - Rock Island District IWW – 1980-2013

Pool	Dredge Cut	River Mile	Frequency of Dredging	Avg Volume(CY) Per Job (1,000s)	Avg Volume(CY) Per Year (1,000s)	Last Year Dredged	Historic Bank Placement
LaGrange	Above LaGrange Lock	80.0 - 81.0	9%	4.0	0.4	1992	Left
LaGrange	Brigg's Landing	83.7 - 84.4	6%	20.7	1.3	2009	Left
LaGrange	Bar Island	84.5 - 86.1	3%	20.7	0.6	2007	Right
LaGrange	Grape Island	86.2 - 87.5	18%	34.4	6.3	2010	Right, Upland
LaGrange	Beardstown	87.5 - 89.5	55%	24.8	13.5	2011	Right, Upland
LaGrange	Anderson Lake	109.0 - 109.7	15%	20.8	3.2	2012	Right
LaGrange	Grand Island	109.7 - 110.6	3%	19.6	0.6	1990	Right
LaGrange	Otter Creek	110.6 - 112.4	3%	75.2	2.3	2012	Right
LaGrange	Grand Island Head	112.4 - 114.0	15%	18.1	2.7	2009	Right
LaGrange	Matanzas Bay	114.0 - 116.0	12%	15.3	1.9	2009	Left
LaGrange	Devil's Elbow	116.2 - 117.2	21%	39.5	8.4	2011	Left
LaGrange	Quiver Island	120.0 - 123.0	15%	35.2	5.3	2001	Right
LaGrange	Senate Island	132.0 - 135.0	33%	48.5	16.2	2010	Left, Upland
LaGrange	Duck Island	135.0 - 136.0	27%	30.2	8.2	2010	Left, Upland
LaGrange	Copperas Creek	136.0 - 137.5	39%	22.4	8.8	2012	Left, Right, Upland
LaGrange	Lancaster Landing	142.0 - 145.0	24%	35.5	8.6	2011	Left, Right
LaGrange	Kingston Mines	145.0 - 146.7	64%	34.9	22.2	2011	Left, Right, Upland
LaGrange	Mackinaw River	146.7 - 148.0	106%	52.8	55.9	2013	Left, Right, Upland
LaGrange	LaMarsh Creek/Pekin Bend	148.0 - 153.1	41%	20.3	8.4	2012	Left, Upland
LaGrange	Lick Creek	153.1 - 156.6	27%	41.9	11.4	2013	Left
LaGrange	Below Peoria Lock	156.6 - 157.7	6%	55.6	3.4	1991	Left and Right
Peoria	Peoria Boat Yard	164.0 - 164.5	6%	7.4	0.4	2013	Upland
Peoria	Blue Creek/Rome Light	173.0 - 178.0	3%	12.7	0.4	2003	Left
Peoria	Senachwine Creek	180.8 - 181.8	9%	0.6	0.1	2008	Right
Peoria	Henry	193.3 - 196.3	6%	2.0	0.1	2003	Left
Peoria	Illinois Power	212.0 - 213.7	3%	14.0	0.4	2009	Left and Right
Peoria	Clark Island	214.5 - 215.7	41%	17.0	7.0	2013	Right
Peoria	Spring Valley	215.9 - 218.4	24%	15.6	3.8	2009	Right

Table 1. Summary of Dredging Locations - Rock Island District IWW – 1980-2013

Pool	Dredge Cut	River Mile	Frequency of Dredging	Avg Volume(CY) Per Job (1,000s)	Avg Volume(CY) Per Year (1,000s)	Last Year Dredged	Historic Bank Placement
Peoria	Spring Creek/Huse Slough	218.5 - 221.1	15%	37.2	5.6	2009	Right
Peoria	LaSalle Bend	225.4 - 225.7	3%	8.6	0.3	1991	Left and Right
Peoria	Vermillion River	226.0 - 226.9	6%	7.8	0.5	2009	Right
Peoria	Deer Park Light	227.7 - 228.5	9%	20.6	1.9	2000	Right
Peoria	Below Starved Rock Lock	230.2 - 230.8	91%	6.6	6.0	2012	Upland
Starved Rock	Above Starved Rock Lock	231.2 - 232.5	36%	4.8	1.8	2012	Upland
Starved Rock	Bulls Island	240.5 - 241.5	79%	13.4	10.6	2013	Right, Upland
Starved Rock	Milliken Creek	242.8 - 242.2	6%	6.7	0.4	2010	Left, Right, Upland
Starved Rock	Below Marseilles Lock	244.0 - 244.5	27%	4.2	1.1	2011	Upland
Marseilles	Marseilles Canal	244.7 - 247.0	33%	6.3	2.1	2008	Upland
Marseilles	Ballards Is/KickapooCreek	248.5 - 248.9	3%	0.1	0.0	2006	Upland
Marseilles	Johnson Is/Kickapoo Creek	249.7 - 250.0	6%	3.2	0.2	2007	Upland
Marseilles	Springbrook Light	251.4 - 251.5	3%	1.0	0.0	1981	Right
Marseilles	Seneca	253.3 - 253.6	3%	2.0	0.1	1981	Right
Marseilles	Grist Island	258.6 - 259.3	27%	9.0	2.4	2010	Right
Marseilles	Sugar Island	260.0 - 261.0	3%	2.0	0.1	1980	Right
Marseilles	Aux Sable	268.0 – 268.0	3%	1.6	0.0	2013	Upland
Marseilles	Below Dresden Island Lock	270.8 - 271.4	45%	9.6	4.4	2011	Left, Upland
Dresden Is	Above Dresden Island Lock	271.5 - 272.0	27%	3.7	1.0	2012	Upland
Dresden Is	Bonnel Bend	273.7 - 274.3	3%	4.0	0.1	1980	Left and Right
Dresden Is	Grant Creek Cut Off	274.4 - 274.9	3%	5.0	0.2	1980	Left and Right
Dresden Is	DuPage River	277.2 - 277.5	3%	2.0	0.1	1980	Left
Dresden Is	Treats Island	278.8 - 279.5	18%	2.4	0.4	2007	Upland
Dresden Is	Hunting Lodge Bend	281.1 - 281.6	3%	1.0	0.0	1983	Upland
Dresden Is	Below Brandon Road Lock	285.2 - 285.8	30%	3.2	1.0	2007	Upland
Brandon Rd	Above Brandon Road Lock	286.0 - 286.3	6%	0.3	0.0	2004	Upland
Brandon Rd	Below Lockport Lock	290.0 - 291.0	24%	0.1	0.0	2007	Upland

VII. GENERAL DESCRIPTION OF DREDGED MATERIAL

Dredging is required at numerous locations in the IWW; hence, the composition of dredged material often varies with location. In general, the upper portion of the IWW (RM 231-303.4) consists primarily of coarse materials (sand, gravel, rock cobble) while those encountered in the downriver portion (RM 80.2-230) consist of sand with varying amounts of fine materials (i.e., silt and clay). A detailed grain size analysis of dredged material is covered in Section 2.

The total volume of dredged material removed annually from the IWW can vary significantly from year to year. This variability is primarily attributable to natural river fluctuations, periodic flood/drought events, and tributary inputs, which affect the water depth and bedload. Tributary streams of the waterway, carrying sediments from upland erosion, are the primary contributors to the river's bedload and subsequently dictate the annual need for dredging.

VIII. DESCRIPTION OF THE PROPOSED PLACEMENT SITES

Dredged material has typically been placed along the shoreline adjacent to dredging sites or loaded onto barges for later placement in approved floodplain or upland/contained placement sites.

Discharge/placement sites vary significantly in size. Sites used for a single placement may cover only a single acre. Some sites, located in chronic dredging locations, have been used repeatedly for many years and occupy several acres.

Potential dredged material placement sites include:

Shoreline Placement: Material is deposited along the shoreline.

Thalweg Placement: Material is deposited into deep portions of the river channel, where it incorporates with the bedload. Thalweg placement is not a viable option along the IWW due to relatively slow hydrologic conditions.

Floodplain Placement: Dredged material is deposited on the floodplain in bottomland forests, industrial sites, and agricultural fields. Deposition of dredged material in bottomland forests is typically limited to a depth of 4 feet based upon IWW OSIT recommendations. Experience has shown that sand deposition on trees greater than 4 feet deep tends to increase tree mortality. There is little or no erosion from these sites because surrounding trees prevent high water velocities, even during spring flooding. Agricultural or industrial sites are often protected by levees and are therefore rarely exposed to the erosive annual flood events.

Beneficial Use Sites: Dredge material can be used in a manner that would be beneficial to society and the natural environment. Material is placed in a location for direct benefit or into stockpile locations for later use. Dredge material can be used for beach nourishment, erosion control, habitat creation, or by beneficial users (e.g., city, county, or State road crews, or independent contractors). The potential for beneficial use will vary greatly, depending upon the particular dredging location. Placement sites with beneficial use are preferred since dredged

material can either provide benefits to the environment or is used by those people and entities desiring it; extending the life of placement sites.

Upland or Contained Placement: Material is placed within a protected natural or manmade site designed to prevent the runoff or re-deposition of dredged material. Upland or contained placement sites are considered the most durable since dredged material is not exposed to the erosive forces of high water events.

Temporary Placement: Material is deposited in or alongside the main channel at temporary storage sites for later re-handling of material to more distant placement sites. This method is rarely used along the IWW due to the small configuration of this river and channel.

Hydraulic cutterhead dredging usually occurs during the summer and fall from approximately June through November. Mechanical dredging could occur any time throughout the year. The duration of placement at any one particular site ranges from 1 or 2 days to a week or more. A summary of dredging placement between 1993 and 2013 can be found in Figure 1 and Table 2.

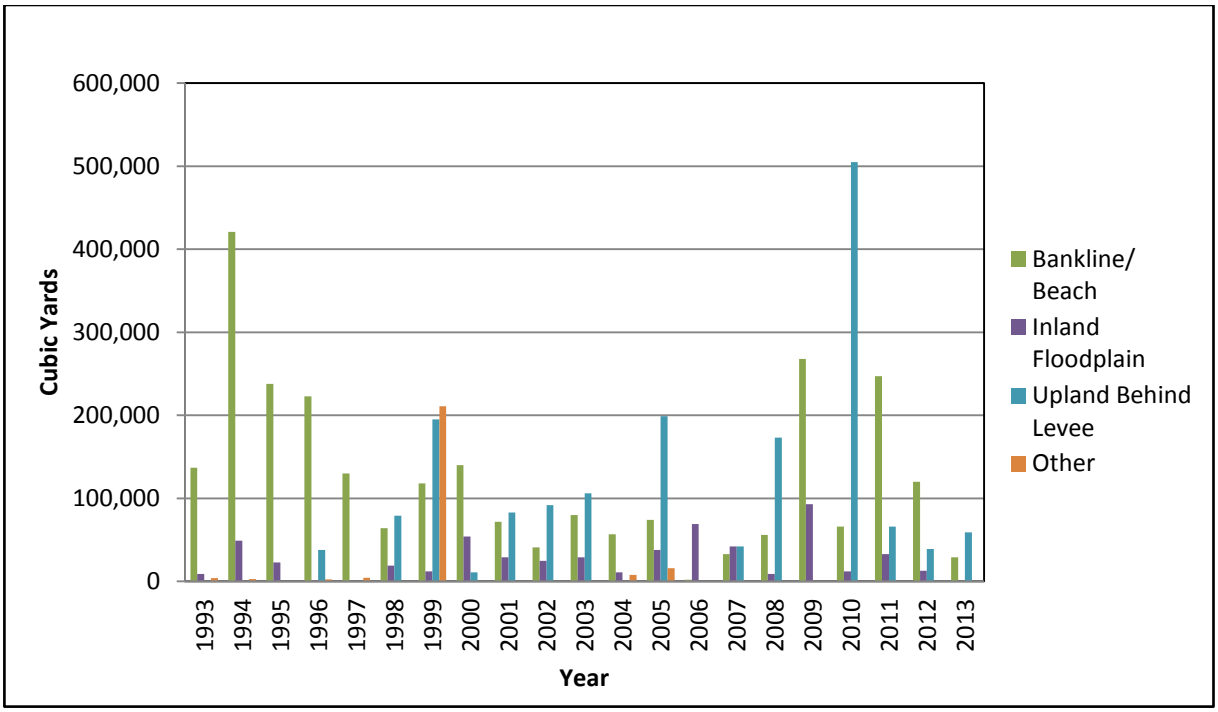

Figure 1. Summary of Placement Between 1993 and 2013

Table 2. Placement Types Used (by CY and by % total annual volume) Rock Island District, IWW – 1993-2013

Year	Thalweg/ Open Water	Bankline/ Beach	Inland Floodplain	Upland Behind Levee	Other	Annual Totals
		29,000		59,000		88,000
2013		33%		67%		
		120,000	13,000	39,000		172,000
2012		70%	8%	23%		
		247,000	33,000	66,000		346,000
2011		71%	10%	19%		
		66,000	12,000	505,000		583,000
2010		11%	2%	87%		
		268,000	93,000			361,000
2009		74%	26%			
		56,000	9,000	173,000		238,000
2008		24%	4%	73%		
		33,000	42,000	42,000		117,000
2007		28%	36%	36%		
		2,000	69,000			71,000
2006		3%	97%			
		74,000	38,000	199,000	16,000	327,000
2005		23%	12%	61%	5%	
		57,000	11,000		8,000	76,000
2004		75%	14%		11%	
		80,000	29,000	106,000		215,000
2003		37%	13%	49%		
		41,000	25,000	92,000		158,000
2002		26%	16%	58%		
		72,000	29,000	83,000		184,000
2001		39%	16%	53%		
		140,000	54,000	11,000		205,000
2000		68%	26%	7%		
		118,000	12,000	195,000	211,000	536,000
1999		22%	2%	36%	39%	
		64,000	19,000	79,000	300	162,300
1998		39%	12%	49%	0%	
		130,000			4,500	134,500
1997		97%			3%	
		223,000	1,000	38,000	2,500	264,500
1996		84%	0%	14%	1%	
		238,000	23,000			261,000
1995		91%	9%			
		421,000	49,000		3,000	473,000
1994		89%	10%		1%	
		137,000	9,000		4,000	150,000
1993		91%	6%		3%	

IX. DESCRIPTION OF DREDGING METHOD

Typically, the material between RM 80.2 to 260.0 is removed from the channel by a hydraulic contract dredge having a pump discharge diameter of 14-16 inches. Such a dredge can pump as much as 300 CY/hr as far as 5,000 feet and up to 2,000 feet inland. The dredge *Dubuque*, from the St. Paul District, or a contract dredge, *America*, from St. Louis District, have also been used in the past during emergencies or for Dredged Material Management Plan (DMMP) actions. They are equipped with a 12- to 24-inch-diameter pump discharge, respectively. The dredged material between RM 260.0 and 304.3 is typically mechanically dredged with Corps' equipment and crews. Mechanical dredging can and does take place anywhere within the District. In most instances, material placement is on the bankline or in relatively close upland areas.

SECTION 2 - FACTUAL DETERMINATIONS

I. PHYSICAL SUBSTRATE DETERMINATION

Prior to most dredging events in the IWW, the District collects 2-inch-diameter sediment core samples at approximately 0.1 to 0.3 river mile intervals within the proposed dredge cut. Depending on substrate type, the penetration of the core sampler may range from 0.3 to 4 feet in depth. Immediately after collection, samples are homogenized and visually classified. A subsample is returned to the laboratory for grain size analysis, which includes the determination of the percent by weight of the material that passes through a #230 sieve (0.062 mm) or commencing in November 2007, a #200 sieve (0.075 mm). Between 1983 and 2013, a total of 2,056 core samples were analyzed from proposed IWW dredge cuts (Table 3). Unlike the Mississippi River, grain size of IWW dredged material is highly variable, and fine materials (< 0.062 or <0.075 mm) are often encountered in the navigation channel. Sites where fine materials exceed 20 percent often require additional testing (see paragraph II. B, *Predicting Water Quality Impacts*).

II. WATER QUALITY PARAMETERS

From 1983 through 1993, the District routinely tested water quality at IWW sites having a dredging frequency greater than or equal to once every 10 years. Pre-dredging elutriate tests were performed on samples collected from these sites to determine if water quality would be affected by the resuspension of material contained within the dredged material. Since 1993, annual pre-dredging testing has been limited to those sites where dredging was to be performed within that calendar year.

From the early 1980s through 1994, the District monitored water quality during hydraulic dredging events on the IWW. This monitoring was discontinued in 1995 following the adoption of a site-specific rule governing hydraulic dredging with bankline placement.

A. Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Placement Site. Testing and previous dredging experience have shown localized increases in suspended particulates and turbidity levels due to the removal and placement of dredged material. The action of the mechanical bucket and cutterhead disturbs sediments near the river bottom, causing elevated levels immediately downstream. Shoreline placement of dredged material may also result in elevated levels due to material being carried in the return water.

B. Predicting Water Quality Impacts. The results from monitoring performed during dredging in the early 1980s through 1994 indicated that occasionally elevated levels of ammonia and selected heavy metals were present in the return water. However, given a relatively small mixing zone, elevated values quickly returned to ambient concentrations. Based on the results of this monitoring and special studies performed during the 1980's designed to aid in the development of a mathematical model capable of predicting the area of the river that would be affected by dredging activity, the District requested that the Illinois Pollution Control Board (IPCB) adopt a site-specific rule governing dredging on the IWW. The proposed rule was adopted by the IPCB in 1994 and is applicable to the bankline placement of material resulting from main channel hydraulic maintenance dredging performed by the District between RM 80.2 and 291.0. Entitled *Bankline Placement along the Illinois Waterway/River*, 35 Ill. Adm. Code, 303.400 calls for pre-dredging sediment sampling to determine grain size at all dredging locations. When primarily coarse-grained material (sand, gravel and cobble) is present, bankline placement of dredged material is permitted. If 10 percent or more of the core samples from a proposed dredge cut exceed 20 percent fine material (< 0.062 or <0.075 mm), then an elutriate test is performed. Information from the grain size analysis and elutriate test are input into a computer model (SSTFATE) to determine the size of a "*temporary area of allowed dilution*" required to comply with applicable water quality standards. If the size of the "*temporary area of allowed dilution*" is within prescribed limits, bankline placement is permitted. Since 1994, the "*temporary area of allowed dilution*" determined by SSTFATE has always been within the prescribed limits.

C. Contaminant Determinations. Pre-dredging chemical testing was reduced significantly with the adoption of the IPCB site-specific dredging rule in 1994. Since this time, chemical testing has consisted primarily of performing an elutriate analysis for ammonia nitrogen when predominantly fine-grained sediments are encountered. Occasionally, bulk sediment analyses for metals and polychlorinated biphenyl (PCBs) have also been performed in an effort to address the concerns of potential beneficial users that the material may be contaminated. The results from samples collected for this purpose between 2000 and 2007 are found in Table 4. The 30 samples consisted of both fine- and coarse-grained sediments and were collected over a nearly 200-mile length of the IWW.

Included in the table for comparison purposes are the consensus-based Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) sediment quality guidelines, respectively, according to MacDonald et al. (2000).[1] The TEC values are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected. The PEC values are intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms are expected to occur frequently. No samples had heavy metal concentrations exceeding

[1] MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. *Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems.* Archives of Environmental Contamination and Toxicology 39:20-31.

the respective PEC. Samples from several sites composed primarily of fine-grained material, collected from within and upstream of Peoria Lake, exceeded the PEC for polycyclic aromatic hydrocarbon and PCBs.

D. Actions Taken to Minimize Impacts. Placement sites and methods (within capabilities of existing equipment) are coordinated with the IWW OSIT (US FWS; US EPA; IL EPA; IL DNR; Illinois Natural History Survey; and Illinois Department of Agriculture).

The 404 studies were a series of 19 scientific studies designed to evaluate the effects of District channel maintenance activities on the impacts of dredged material placement in aquatic and terrestrial habitats of the UMR System. Specific measurement metrics used in this evaluation include: sediment transport, vegetation, macroinvertebrates, freshwater mussels, fish, and turtles. The findings from these studies were evaluated by a multi-agency 404 Study Team, a subcommittee of the Fish and Wildlife Interagency Committee (FWIC), and used to develop criteria for selecting future dredged material placement sites. The 404 Studies Final Report can be found in Appendix C.

Table 3. Summary of Results from Grain Size Analysis from IWW Dredge Cuts Between 1983 and 2013

				% Passing #230 or #200 Sieve		
Pool	**Dredge Cut**	**River Miles**	**Number of Samples**	**Maximum**	**Average**	**Standard Deviation**
La Grange	Briggs Landing	83.7-84.1	8	3.6	1.7	0.88
La Grange	Bar Island	85.4-86.9	6	4.9	2.4	1.92
La Grange	Grape Island	86.3-87.2	17	1.8	0.7	0.44
La Grange	Beardstown	87.5-89.3	41	13.4	1.7	2.38
La Grange	Grand Island	105.6-106.9	5	8.6	5.1	2.79
La Grange	Holmes	108.1-108.3	3	7.0	4.4	2.65
La Grange	Anderson Lake	109.0-109.4	23	23.6	5.8	5.51
La Grange	Grand Island	109.8-110.5	19	42.6	12.9	12.07
La Grange	Otter Creek	110.9-112.2	22	48.3	7.0	11.80
La Grange	Grand Island	112.8-113.8	28	24.2	6.0	6.53
La Grange	Matanzas Bay	115.0-116.0	18	21.9	3.4	5.76
La Grange	Devil’s Elbow	116.1-117.3	47	38.2	4.0	7.52
La Grange	Quiver Island	120.0-123.0	107	99.8	62.3	21.25
La Grange	Senate Island	132.0-135.0	88	26.1	7.3	6.16
La Grange	Duck Island	135.1-135.9	34	81.0	8.0	15.82
La Grange	Copperas	136.0-137.5	108	78.4	14.3	18.35
La Grange	Coon Hollow	140.9-141.4	14	62.5	14.5	16.66
La Grange	Lancaster Light	141.5-141.9	13	25.6	11.1	6.27
La Grange	Lancaster	142.1-144.8	85	76.9	13.1	18.36
La Grange	Kingston	145.0-146.7	124	73.1	6.8	10.86
La Grange	Mackinaw	146.8-148.0	135	77.6	7.1	14.59
La Grange	La Marsh	148.1-152.0	132	93.2	17.7	24.33
La Grange	Lick Creek	154.0-156.6	120	68.6	9.9	13.41
La Grange	Peoria Lock,	156.7-157.6	49	92.2	32.7	35.46

Table 3. Summary of Results from Grain Size Analysis from IWW Dredge Cuts Between 1983 and 2013

				% Passing #230 or #200 Sieve		
Pool	**Dredge Cut**	**River Miles**	**Number of Samples**	**Maximum**	**Average**	**Standard Deviation**
Peoria	Peoria Lock,	157.9-158.1	35	85.7	16.2	23.55
Peoria	Kickapoo	159.0-159.9	5	1.0	0.6	0.26
Peoria	Peoria	161.0-163.0	88	97.0	27.0	34.60
Peoria	Peoria Lake	171.5-173.0	10	99.6	85.1	27.84
Peoria	Senachwine	180.8-181.8	56	72.8	9.3	16.67
Peoria	Clark Island	214.5-215.7	56	77.8	3.1	10.25
Peoria	Spring Valley	215.9-218.4	72	4.0	1.1	0.75
Peoria	Spring	218.5-220.6	101	96.8	8.9	21.76
Peoria	La Salle Bend	225.3-225.8	12	3.3	1.3	1.09
Peoria	Vermillion	226.2-227.2	14	5.7	1.7	2.00
Peoria	Deer Park	227.3-228.5	38	2.4	0.5	0.42
Peoria	Plum Island	229.1-229.9	9	9.1	3.4	2.91
Peoria	Starved Rock	230.2-230.9	28	3.5	1.3	0.95
Starved Rock	Bulls Island	240.2-241.6	114	17.9	1.0	1.78
Starved Rock	Milliken Creek	242.4-243.0	7	0.4	0.2	0.13
Marseilles	Marseilles	244.0-244.7	18	48.9	8.8	12.82
Marseilles	Marseilles	244.8-247.0	45	65.9	19.5	16.69
Marseilles	Grist Island	258.6-258.9	21	1.4	0.7	0.32
Marseilles	Dresden Island	270.7-271.3	40	74.5	14.6	17.18
Dresden Island	Treats Island	279.1-279.4	5	1.8	1	0.57
Dresden Island	Brandon Road	285.2-285.8	17	1.7	0.7	0.53
Brandon Road	Brandon Road	286.0-286.3	8	93.4	73.8	17.40
Brandon Road	Lockport Lock,	290.1-290.9	11	3.1	1.1	0.73
Total	**IWW**	**83.7-290.9**	**2056**	**99.8**	**12.9**	**22.54**

Table 4. Bulk Sediment Analysis Results from IWW Sites Compared to Sediment Quality Guidelines

	Parameter	Units	ILR-86.9	ILR-88.1	ILR-89.0	ILR-171.5	ILR-171.9	ILR-172.0	ILR-172.3	ILR-172.3^	ILR-172.5	ILR-172.7	ILR-181.5	ILR-181.8	ILR-230.7L	ILR-230.8L
Metals	Arsenic, Total	mg/kg	<5	<5	<5	<10	<10	11.3	<10	<10	11	<10	<12	<12	<10	<10
	Cadmium, Total	mg/kg	na	na	na	<5	<5	na	<5	5.1	na	<5	na	na	2.1	<1
	Chromium, Total	mg/kg	2.3	4.4	6.3	35.2	50.4	56.1	54.9	53.4	51.5	30.8	5.5	5.0	7.7	5.3
	Copper, Total	mg/kg	1.5	4.6	4.7	37.5	41.4	47.6	49.2	45.8	42.6	33.7	1.3	2.3	22.6	3.6
	Lead, Total	mg/kg	<5	6.5	6.3	44.2	59.0	67.8	66.2	64.6	55.2	38.5	<5.8	7.4	83.1	7.6
	Mercury, Total	mg/kg	<0.1	<0.1	<0.1	0.7	0.3	0.6	0.39	0.39	0.45	0.28	<0.12	<0.12	<0.1	<0.1
	Zinc, Total	mg/kg	11.1	21.5	25.4	202	263	310	286	287	270	177	15.7	19.3	51.7	30.5
	Moisture	%	na	na	na	na	na	na	na	na	na	na	na	na	28	23
PNAs	Acenaphthene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	nd	nd
	Acenaphthylene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	nd	nd
	Anthracene	mg/kg	na	na	na	<0.1	0.13	na	0.15	0.12	na	<0.1	na	na	nd	nd
	Benzo(a)anthracene	mg/kg	na	na	na	0.31	0.43	na	0.44	0.30	na	<0.1	na	na	0.79	nd
	Benzo(a)pyrene	mg/kg	na	na	na	0.40	0.48	na	0.66	0.48	na	0.51	na	na	0.62	nd
	Benzo(b)fluoranthene	mg/kg	na	na	na	0.32	0.40	na	0.42	0.31	na	0.42	na	na	nd	nd
	Benzo(ghi)perylene	mg/kg	na	na	na	0.27	0.31	na	0.39	0.34	na	0.35	na	na	nd	nd
	Benzo(k)fluoranthene	mg/kg	na	na	na	0.37	0.35	na	0.49	0.28	na	0.35	na	na	nd	nd
	Chloronaphthalene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	nd	nd
	Chrysene	mg/kg	na	na	na	0.43	0.69	na	0.64	0.46	na	0.46	na	na	0.92	nd
	Dibenzo(a,h)anthracene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	nd	nd
	Flouranthene	mg/kg	na	na	na	0.43	0.78	na	0.70	0.48	na	0.41	na	na	1.57	nd
	Fluorene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	nd	nd
	Indeno(1,2,3-cd)pyrene	mg/kg	na	na	na	0.22	0.23	na	0.29	0.28	na	0.32	na	na	nd	nd
	Methylnapthalene (2)	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	0.6	nd
	Naphthalene	mg/kg	na	na	na	<0.1	<0.1	na	<0.1	<0.1	na	<0.1	na	na	0.57	nd
	Phenanthrene	mg/kg	na	na	na	0.15	0.23	na	0.25	0.22	na	0.17	na	na	1.52	nd
	Pyrene	mg/kg	na	na	na	0.68	1.26	na	1.05	0.78	na	0.63	na	na	1.62	nd
PCBs	PCB (AR1016)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	0.1	nd
	PCB (AR1221)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	PCB (AR1232)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	PCB (AR1242)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	PCB (AR1248)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	PCB (AR1254)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	PCB (AR1260)	mg/kg	na	na	na	na	na	na	nd		na	na	na	na	nd	nd
	Total PCB's*	**mg/kg**	**na**	**na**	**na**	**<0.1**	**<0.1**	**0.043**	**0.1**	**0.12**	**0.066**	**<0.1**	**<0.25**	**<0.25**	**0.1**	**nd**

"*" Indicates only total PCBs were analyzed prior to 2002
"^" Indicates results from a field duplicate sample
"nd" Indicates this parameter was not detected
"na" Indicates this parameter was not analyzed
"TEC" Indicates Theshold Effects Concentration
"PEC" Indicates Probably Effects Concentration

																Consensus-based	
ILR-240.7R	**ILR-258.6**	**ILR-258.6R^**	**ILR-258.8**	**ILR-258.9R**	**IL-271.0L**	**IL-271.1L**	**ILR-285.3**	**ILR-285.3R***	**ILR-285.3R^**	**ILR-285.4**	**ILR-285.5L**	**ILR-285.5L^**	**ILR-285.5R**	**ILR-285.7L**	**ILR-285.7R**	**TEC**	**PEC**
<10	<12	<10	<12	<10	<10	<10	<18	<10	<10	<13	14	<10	<10	<10	<10	9.79	33
<1	na	<1	na	<1	<1	<1	na	<1	1.1	na	<1	2.5	<1	1.3	1.1	0.99	4.98
6.2	6.5	5.3	7.6	8.5	11.1	11.0	32.0	16.1	21.8	20.0	21.9	25.7	15.8	20.7	31.6	43.4	111
10.4	<1.2	1.9	<1.2	2.2	13.7	12	31.5	9.9	12.8	22.5	22.4	50.3	18.1	13.9	15.6	31.6	149
6.8	8.1	6.2	7.7	8.9	15.5	12.3	73	38.4	48.5	59	60.5	189	56.3	124	29.6	35.8	128
<0.2	<0.12	<0.1	<0.12	<0.1	<0.2	<0.2	<0.18	0.1	<0.1	<0.13	0.22	0.1	0.1	<0.1	<0.1	0.18	1.06
27.3	28.4	21.9	36	44.4	58.7	59.2	260	77.1	85.6	180	156	135	88	115	130	121	459
16	na	18	na	17	15	19	na	22	22	na	67	47	21	8.3	13	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	1.36	nd	na	4.54	3.58	nd	0.26	0.55	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	1.35	na	5.64	2.56	1.62	0.33	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	2.59	2.95	na	43.3	8.3	4.06	1.32	1.42	0.0572	0.845
nd	na	nd	na	nd	*nd*	1.13	na	10.2	11.5	na	100	26.6	21.2	3.16	6.53	0.108	1.050
nd	na	nd	na	nd	0.32	1.79	na	11.7	11.8	na	120	22.2	21.6	3.25	5.65	0.15	1.450
nd	na	nd	na	nd	0.29	1.57	na	10.6	10.5	na	135	27.9	20.8	2.97	4.96	-	-
nd	na	nd	na	nd	*nd*	0.76	na	8.65	7.49	na	50.4	7.3	15.1	1	1.79	-	-
nd	na	nd	na	nd	*nd*	1.64	na	10	8.68	na	90.9	16	19	2.75	4.55	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	1.56	na	10.8	10.2	na	115	26.8	23	2.94	4.96	0.166	1.290
nd	na	nd	na	nd	*nd*	*nd*	na	1.52	1.5	na	11.7	3.47	2.77	0.44	0.69	0.033	-
nd	na	nd	na	nd	0.29	1.32	na	14.7	21	na	155	27.8	27.8	5.84	11.9	0.423	2.230
nd	na	nd	na	nd	*nd*	*nd*	na	2.27	nd	na	4.7	3.32	nd	0.29	nd	0.0774	0.536
nd	na	nd	na	nd	*nd*	*nd*	na	6.09	5.6	na	48.4	12.8	nd	0.32	2.67	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	3.64	3.51	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	1.47	nd	na	9.91	4.56	2.48	0.28	0.64	0.176	0.561
nd	na	nd	na	nd	*nd*	0.57	na	5.15	7.92	na	28.9	15.2	4.92	2.14	3.72	0.204	1.170
nd	na	nd	na	nd	0.33	1.41	na	nd	17	na	130	30.8	25.4	4.7	9.01	0.195	1.520
nd	na	nd	na	nd	*nd*	*nd*	na	0.19	0.36	na	*nd*	1.15	0.35	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	nd	nd	nd	nd	-	-
nd	na	nd	na	nd	*nd*	*nd*	na	nd	nd	na	*nd*	0.24	nd	nd	nd	-	-
nd	**<0.25**	**nd**	**<0.25**	**nd**	**nd**	**nd**	**1.1**	**0.19**	**0.36**	**6.4**	**nd**	**1.39**	**0.35**	**nd**	**nd**	**0.0598**	**0.676**

III. AQUATIC ECOSYSTEM AND ORGANISM DETERMINATIONS

A. Effects on Plankton. Planktonic organisms may be impacted as a result of current pattern and water velocity changes. The overall planktonic community structure should remain relatively the same following placement of dredged material.

B. Effects on Benthos. Where aquatic or shoreline placement is recommended, there are likely to be varying degrees of impact on benthos, primarily unionid mussels. A systemic mussel survey of the IWW highlighted the precarious nature of mussels inhabiting the river. After an absence of several decades, mussels are once again colonizing parts of the upper IWW (RM 210-272). A total of 11 species of mussels were collected from the upper river; however, many species were represented by only a few individuals. In the lower and middle river, species abundance and diversity show signs of continued decline. Species extirpations and re-introductions appear to be occurring at the same rate, with no net loss in total mussel species (23 species) during the last 30 years. However, the persistence of re-introduced species is at best tenuous, since most are still only represented by a few individuals. Only 21 possible mussel beds were identified in the entire IWW, and 55 percent of these were located in Alton Reach (Whitney et al., 1999[2]).

> **Mussels.** The mussel studies represented the most systemic approach of all the 404 Studies from reconnaissance to specific studies. These mussel studies were conduction primarily between 1998 and 2005. Mussels exhibited a patchy distribution, forming beds, consequently, one expects high variability for any single study. These studies were no exception but despite high variability results showed trends that allow for generalized conclusions. The studies indicated that because the thalweg typically has high shear stress it is unlikely to support a sustainable population of mussels. Therefore one recommendation from this study is that in areas where mussels are common, placement of material in the thalweg is a low-risk option for these species. Channel border areas were found to provide more suitable habitat as indicated by mussel abundance although distribution was, as expected, very patchy. Some data from these studies suggest that mussel assemblages in placement sites were as abundant and diverse as adjacent non-placement sites; differences in catch rates did not differ statistically from non-placement sites; and mussel assemblage compositions at placement sites were relatively similar to non-placement sites. Any thalweg placement should be done carefully in order to minimize the potential for accidental placement in channel border areas.
>
> The sand-on-sand placement philosophy was supported with regards to mussels because these species, overall, appear poorly adapted to the shifting sand habitats that occur in repetitive dredge cut and placement areas. Sessile organisms such as mussels can, potentially, be adversely affected by placement. The use of existing placement sites, which are already disturbed, or sites that do not possess favorable conditions for mussels, such as the thalweg, greatly reduce the risk of negatively impacting mussels.

[2] Whitney, S. D., K. D. Blodgett, and R. E. Sparks. 1999. *A Comprehensive Mussel Survey of the Illinois River, 1993-95*. Illinois Natural History Survey, Aquatic Ecology Technical Report. 239 pp.

The Marseilles Dam was damaged during an incident during April 2013 when seven barges broke loose from a tow during historic flooding on the Illinois River. To allow for emergency repairs, a partial drawdown of the Marseilles Pool was performed. A multi-agency mussel recovery and sampling effort was put together to gather mussel information in Marseilles Pool during the drawdown. The two-day recovery and sampling effort collected 23 different species. The results of this effort would indicate a possible increase in mussel diversity within Marseilles Pool from recent decades.

Macroinvertebrates. The results of the 404 Studies indicated that macroinvertebrate abundance and diversity varies widely on both temporal and spatial scales. It is impossible to make definitive conclusions regarding the effects of dredge placement based on the macroinvertebrate data because different methods were used on the UMR and IWW and methods inappropriate to site conditions were initially used on the IWW. Even after implementation of appropriate methods it is still difficult to make statistically valid conclusions because of the extreme variability of the results. There was a trend of historic dredged material placement sites having higher abundances of macroinvertebrates than reference sites on both the UMR and IWW, as long as the last placement of dredged material was at least 1 year prior to sampling. After placement, the IWW placement site continued to have higher abundances whereas the abundances dropped to similar reference levels on the Mississippi placement site. The ecological significance of this is unknown but changes in abundance were less than an order of magnitude, which given the natural variability and patchy distribution of macroinvertebrates may be ecologically negligible. The effect of sampling methods strongly suggests that future work involving invertebrates requires careful a priori assessment of habitat conditions to tailor sampling methods. The variability within pre- and post- placement sites also suggests that multiple year assessments will be required to gather scientifically valid results. However, these data do suggest that dredged material placed along historic bankline placement sites does adversely impact the resident macroinvertebrate community for at least 1 year post placement. These data also suggest that all placement sites studied have recovered. One bankline study site (Hogback UMR) “recovered” to the point of having more macroinvertebrates than the control site that never received dredged material (Long Island, UMR), even though the sample was taken only 15 months after the previous placement event. It is not anticipated that continued use of historic UMR and IWW historic bankline placement sites would have a significant impact on resident macroinvertebrates at the placement site, the pool, or the UMR.

C. Effects on Nekton. The 404 Studies indicated that negative short-term (< 3 years) impacts upon fish diversity and richness immediately following dredged material placement are modest. Changes are greatest immediately following dredged material placement when a shift in substrate type changes the macroinvertebrate community and the fish community that feeds upon them. These changes are minor when the existing substrate type matches the characteristics of the dredged material. Fisheries communities in areas with sand substrate appear to be more resilient to channel maintenance dredged material placement that those with non-sand substrate. The impacts to the fishery from dredged material placement can be minimized by re-using placement sites with sand substrate.

D. Effects on Aquatic Food Web. No significant adverse impacts are anticipated.

E. Effects on Special Aquatic Sites

1. Sanctuaries and Refuges. Coordination with the proper agencies will be accomplished if the District proposes dredged material placement on Federal or State lands that may comprise a part of a conservation or refuge area.

2. Wetlands. None of the historic placement sites covered in this 404(b)(1) Evaluation are considered jurisdictional/regulated wetlands because they lack one or more of the three wetland identification criteria.

3. Mudflats and Vegetated Shallows. These sites are not used as placement sites.

F. Federal Threatened and Endangered Species. There are 11 listed threatened and endangered species, one proposed endangered species, and 2 candidate species listed for counties occurring along the IWW corridor (Appendix B). The Indiana bat (*Myotis sodalis*), decurrent false aster (*Boltonia decurrens*), eastern prairie fringed orchid (*Platanthera leucophaea*), prairie bush clover (*Lespedeza leptostachya*), piping plover (*Charadrius melodus*), Hine's emerald dragonfly (*Somatochlora hineana)*, leafy prairie clover (*Dalea foliosa*), Mead's milkweed (*Asclepias meadii*), sheepnose mussel (*Plethobasus cyphyus*), snuffbox (*Epioblasma triquetra*), and lakeside daisy (*Hymenoxis herbacea*) are listed as threatened or endangered. The northern long-eared bat (*Myotis septentrionalis*) is currently proposed as endangered. The eastern massasauga (*Sistrurus catenatus*) and rattlesnake-master borer moth (*Papaipema eryngii*) are currently listed as candidate species. Based on the county location along the river corridor where the species occurs, the habitat needs of the species, the dredging season, and typical dredge and placement practices, the only species perceived to be potentially affected by dredging operations is the decurrent false aster. Potential impacts to other species such as the bats and mussels are likely to be more easily identified and avoided. Each proposed dredging operation will be coordinated with the U.S. Fish and Wildlife Service concerning endangered species impacts on a case-by-case basis. Therefore, no adverse effect on any federally listed threatened or endangered species that might jeopardize the continued existence of the species is anticipated.

G. Other Wildlife. In 1985, the District contracted with Environmental Science and Engineering, Inc.[3] (ESE) to conduct a wildlife survey (i.e., mammals, reptiles, and amphibians) of six dredged material placement sites in Pool 18 UMR (ESE 1985). This study found no significant difference between dredged material placement sites and floodplain forest areas with respect to usage by mammals. Most reptiles and amphibians (i.e., snakes, turtles, and toads) were more abundant at dredged material placement sites. Apparent positive effects on terrestrial communities of dredged material placement in the floodplain forest include the creation of additional edge habitat, turtle nesting areas, and toad habitat. The dredged material placement sites may also provide high ground for small mammals during periods of high water. The ESE 1985 study's results were validated by another study on impacts to turtles at dredge placement sites in Pool 13 UMR (Lambrecht and

[3] ESE, 1985. Natural Resource Survey of Fauna Inhabiting Dredged Material Disposal Sites in Pool 18 of the Mississippi River. Final Report submitted to the Rock Island District, U.S. Army Corps of Engineers. 55 pp.

Stumme, 2006)[4]. In the Lambrecht and Stumme 2006, study, turtle hatching success, lower nest predation, and a greater relative abundance of two turtle species were greater on dredged material placement sites than on non-dredged material placement sites. The effects of dredged material placement on wildlife have been extensively studied on the UMR. These UMR findings are applicable to the IWW as well. While dredged material placement may have short-term negative impacts to breeding areas for frogs, toads, and turtles depending on the timing of placement, the long-term effects of beach nourishment and the additional edge habitat and would have a net positive impact to turtle nesting habitat in addition to no net impact to other terrestrial animals.

H. Determination of Cumulative Impacts. Since 1996, State and Federal resource agencies expressed concern that the District was not adequately assessing the cumulative impacts to aquatic resources resulting from terrestrial and aquatic dredged material placement. As a result, the District commenced a collaborative natural resource data collection effort directed at developing the comprehensive 404 Studies. The Impact Analysis Team, consisting of members from the State and Federal resource agencies and representatives from the District, was formed to oversee the development and implementation of the 404 Studies. Consequently, individual studies were implemented to evaluate the impact of dredged material placement on the following categories: (1) mussels, (2) macroinvertebrates, (3) fish, (4) terrestrial vegetation, and (5) sediment transport. The 2009 Final 404 Studies report is included in Appendix C of this package. At this time, no other studies evaluating impacts from dredged material placement utilizing historic placement sites have been planned or scheduled.

I. Actions to Minimize Impacts. The IWW OSIT recommends placement sites that minimize impacts to fish and wildlife. In addition, for higher frequency, higher volume sites, DMMPs are being developed with long-term alternatives to minimize impacts. Additionally, beneficial uses are aggressively pursued.

The 404 studies were a series of 19 scientific studies designed to evaluate the effects of District channel maintenance activities on the impacts of dredged material placement in aquatic and terrestrial habitats of the UMR System. Specific measurement metrics used in this evaluation include: sediment transport, vegetation, macroinvertebrates, freshwater mussels, fish, and turtles. The findings from these studies can be found in the 404 Studies Final Report in Appendix C.

IV. POTENTIAL EFFECTS ON HUMAN USE

The IWW provides many benefits to humans besides the commercial transportation of their commodities. Such benefits may include municipal, industrial, and private water supply; recreational and commercial fisheries; water-related recreation; agricultural irrigation; sightseeing; etc. Dredging activity in the IWW will not adversely affect the recreational, industrial, or municipal uses of the waterway.

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[4] Lambrecht, Kirk W. and Stephen Stumne. 2006. Evaluation of Turtle Nesting Success of Dredged Material Placement Areas in Pool 13 of the Upper Mississippi River System. Prepared Under Contract for U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL, by MACTEC Engineering and Consulting, Inc., Maryland Heights, MO. 40pp.

V. HISTORIC PROPERTIES

The District; the Illinois, Iowa, Missouri, and Wisconsin State Historic Preservation Officers (SHPOs); and the Advisory Council on Historic Preservation (Council) have signed Programmatic Agreements (PAs) regarding implementation of dredged material placement for the IWW RM 80.0 to 327.0. These PAs are appropriate for addressing historic property concerns for dredged material placement promulgated by the National Historic Preservation Act (NHPA), as amended and its implementing regulation 36 CFR Part 800: "Protection of Historic Properties."

These PAs are entitled:

- *Programmatic Agreement Among the Rock Island District of the U.S. Army Corps of Engineers, the Advisory Council on Historic Preservation, and the Illinois State Historic Preservation Officer, the Iowa State Historic Preservation Officer, the Missouri State Historic Preservation Officer and the Wisconsin State Historic Preservation Regarding Implementation of the Short-Term Dredged Material Placement*

- *Programmatic Agreement Among the Rock Island District of the U.S. Army Corps of Engineers, the Advisory Council on Historic Preservation, and the Illinois State Historic Preservation Officer, the Iowa State Historic Preservation Officer, the Missouri State Historic Preservation Officer and the Wisconsin State Historic Preservation Regarding Implementation of the Long-Term Dredged Material Placement.*

As stipulated in Section X of both PAs, the District has provided the SHPOs with periodic review of all projects, titles of the documents which contain the Agreement, historic properties identified, determinations of effect, avoidance procedures, level of investigations(s) and/or mitigation(s) conducted with the titles of all project reports related to such investigations(s) and/or mitigation(s) which have been completed. The District received comment from the Menominee Indian Tribe of Wisconsin at Keshena, Wisconsin; the Citizen Potawatomi Nation at Shawnee, Oklahoma; and the Delaware Tribe of Western Oklahoma at Anadarko, Oklahoma. The District met the immediate requests of these Tribes and included them on the lists generated by the District for the Dredged Material Management Plan reports.

By letter dated October 7, 1999, the District contacted the SHPOs and approximately 70 Tribes or Tribal Historic Preservation Officers (THPOs) regarding the PAs and the dredged programs. Allowing for tribal review and comment contributes to fulfilling obligations as set forth in the NHPA (PL 89-665), as amended; the National Environmental Policy Act of 1969 (PL 91-190); Executive Order (EO) 11593 for the "Protection and Enhancement of the Cultural Environment" (Federal Register, May 13, 1971); the Archaeological and Historical Preservation Act of 1974 (PL 93-291); the ACHP "Regulations for the Protection of Historic and Cultural Properties" (36 CFR Part 800); and the applicable National Park Service and Corps regulations.

In conjunction with compliance, consultation, and coordination completed for all proposed dredging and dredged material placement activities with the appropriate State and tribal officials, the District conducts an archival search for historic properties following the "Policy and Procedures for the Conduct of Underwater Historic Resource Surveys for Maintenance Dredging and Disposal Activities" (DGL-89-01, March 1989). The District also queries the most recent Illinois Geographic

Information Systems site file database for historic properties within those areas potentially affected by the historic dredge cut and dredged material placement alternatives. The Corps PA assures that the District will comply with the NHPA. If any construction activities and ancillary actions result in the discovery of, or potentially affect significant historic properties, the District would discontinue the undertaking and resume coordination with the SHPOs, tribes, agencies, and other consulting parties. All consulting parties must be aware that the specific locations of historic and archaeological properties are subject to protection through nondisclosure under Section 304 of the National Historic Preservation Act. All maps subject to public review/access shall not contain any information on archeological sites. This information is not to be released to the general public in order to protect the resources at the sites.

If human remains, funerary objects, sacred objects, or objects of cultural patrimony are encountered or collected, the District will comply with all provisions outlined in the appropriate State acts, statutes, guidance, provisions, etc., and any decisions regarding the treatment of human remains will be made recognizing the rights of lineal descendants, Tribes, and other Native American Indians and under consultation with the SHPO/THPO(s) and the other consulting parties, designated Tribal Coordinator, and/or other appropriate legal authority for future and expedient disposition or curation. When finds of human remains, funerary objects, sacred objects, or objects of cultural patrimony are encountered or collected from Federal lands or federally recognized tribal lands, the District will coordinate with the appropriate federally recognized Native American Tribes, pursuant to the Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. § 3001 *et seq*.) and its implementing regulations (43 CFR Part 10).

SECTION 404(b)(1) EVALUATION
MAINTENANCE DREDGING OF THE
9-FOOT CHANNEL NAVIGATION PROJECT

ILLINOIS WATERWAY
RIVER MILES 80.2 - 303.4

SECTION 3 - FINDINGS OF COMPLIANCE OR NONCOMPLIANCE WITH THE RESTRICTIONS ON PLACEMENT

1. Continued use of IWW historic dredged material placement sites within the Rock Island District would not cause significant adverse impacts to any resources category (e.g. mussels, fisheries, macroinvertebrates, vegetation, or turtles) either directly, indirectly, or cumulatively.

2. No significant adaptation of the Clean Water Act Section 404(b)(1) Guidelines was made relative to this evaluation.

3. Alternative placement sites considered in this evaluation are: (a) shoreline placement; (b) floodplain placement; (c) beneficial use sites; and (d) upland/contained placement. Beneficial use sites are the preferred placement location since these sites may be used again after material is removed. Because of poor road access and equipment limitations, there are few dredging locations where beneficial use is possible. When beneficial use is not possible, coordination is accomplished with the proper State and Federal agencies to determine which available site will be the most economical, operationally feasible, and environmentally acceptable.

4. Pre-dredging water quality testing for ambient water, elutriate, and sediment samples concerning selected parameters from sites having a high dredging frequency have been performed by the Corps of Engineers periodically since 1983. Ambient water samples for copper, ammonia, and mercury have exceeded state standards from time to time. Elutriate samples for copper, lead, zinc, arsenic, nickel, cadmium, barium, ammonia, and mercury periodically show elevated concentrations. Sediment contaminants detected with regularity parallel those seen in elutriate test results. In addition, turbidity will be increased in the immediate vicinity of the discharge and the dredge cutterhead or mechanical bucket. With the exception of the lack of conformity listed above, overall water quality tests have shown that most dredging operations are compliant with State standards and that Federal guidelines are being met. The increased trend of utilizing upland/contained sites for dredged material placement will continue to result in positive impacts on the water quality of the IWW.

5. The placement operation will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

6. Use of placement sites will not threaten the continued existence of any Federal or State threatened or endangered species. Coordination will be initiated with Federal and State resource agencies on a site-by-site basis.

Encl 1

Findings of Compliance or Noncompliance
With the Restrictions on Placement

7. The use of placement sites along the Illinois Waterway is not anticipated to result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values are not foreseen.

8. At this time, no other studies evaluating impacts from dredged material placement utilizing historic placement sites have been planned or scheduled.

9. The proper Federal and State agencies and appropriate reviewers will be informed of prospective dredging and placement sites in order to determine what dredging and placement procedures (within existing equipment capabilities) and sites will be the most economical, operationally feasible and environmentally acceptable and to assure compliance with applicable statutes, standards, and regulations. This coordination includes the multi-agency On-Site Inspection Team that visits prospective dredging and placement sites and recommends which dredging and placement procedures will result in the least overall impacts.

10. On the basis of the Clean Water Act Section 404(b)(1) Guidelines, the proposed placement sites for the discharge of dredged material are specified as complying with the inclusion of appropriate and practical conditions to minimize adverse effects on the aquatic ecosystem.

9-7-14
Date

Mark J. Deschenes
Colonel, US Army
Commander & District Engineer

SECTION 404(b)(1) EVALUATION
MAINTENANCE DREDGING OF THE 9-FOOT CHANNEL NAVIGATION PROJECT

ILLINOIS WATERWAY
RIVER MILES 80.2 - 303.4

APPENDIX A

FEDERALLY LISTED ENDANGERED, THREATENED, AND CANDIDATE SPECIES FOR COUNTIES OCCURRING ALONG THE IWW CORRIDOR

Appendix A. Table of Federally Listed, Proposed, and Candidate Species for Counties Occurring Along the IWW Corridor in the Rock Island District

			County															
Common Name	**Scientific Name**	**Status**	**Cook**	**DuPage**	**Will**	**Grundy**	**LaSalle**	**Putnam**	**Bureau**	**Marshall**	**Peoria**	**Woodford**	**Tazewell**	**Fulton**	**Mason**	**Schuyler**	**Brown**	**Cass**
Indiana bat	*Myotis sodalis*	Endangered				X	X	X	X	X	X	X	X	X	X	X	X	X
decurrent false aster	*Boltonia decurrens*	Threatened					X	X	X	X	X	X	X	X	X	X	X	X
eastern prairie fringed orchid	*Platanthera leucophaea*	Threatened	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
northern long-eared bat	*Myotis septentrionalis*	Proposed as Endangered	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
prairie bush clover	*Lespedeza leptostachya*	Threatened	X	X														X
piping plover	*Charadrius melodus*	Endangered	X															
eastern massasauga	*Sistrurus catenatus*	Candidate	X	X	X													
Hine's emerald dragonfly	*Somatochlora hineana*	Endangered	X	X	X													
rattlesnake-master borer moth	*Papaipema eryngii*	Candidate	X		X	X												
leafy prairie-clover	*Dalea foliosa*	Endangered	X	X	X													
Mead's Milkweed	*Asclepias meadii*	Threatened	X	X	X													
sheepnose mussel	*Plethobasus cyphyus*	Endangered			X													
snuffbox	*Epioblasma triquetra*	Endangered			X													
lakeside daisy	*Hymenopsis herbacea*	Threatened			X								X					

SECTION 404(b)(1) EVALUATION
MAINTENANCE DREDGING OF THE
9-FOOT CHANNEL NAVIGATION PROJECT

ILLINOIS WATERWAY
RIVER MILES 80.2 - 303.4

APPENDIX B

MAPS

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 79.8 TO 82.7
Page Number: 1
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 82.7 TO 86.1
Page Number: 2
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet

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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 83.6 TO 89.4
Page Number: 3
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 108.6 TO 111.6
Page Number: 4
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 111.5 TO 114.9
Page Number: 5
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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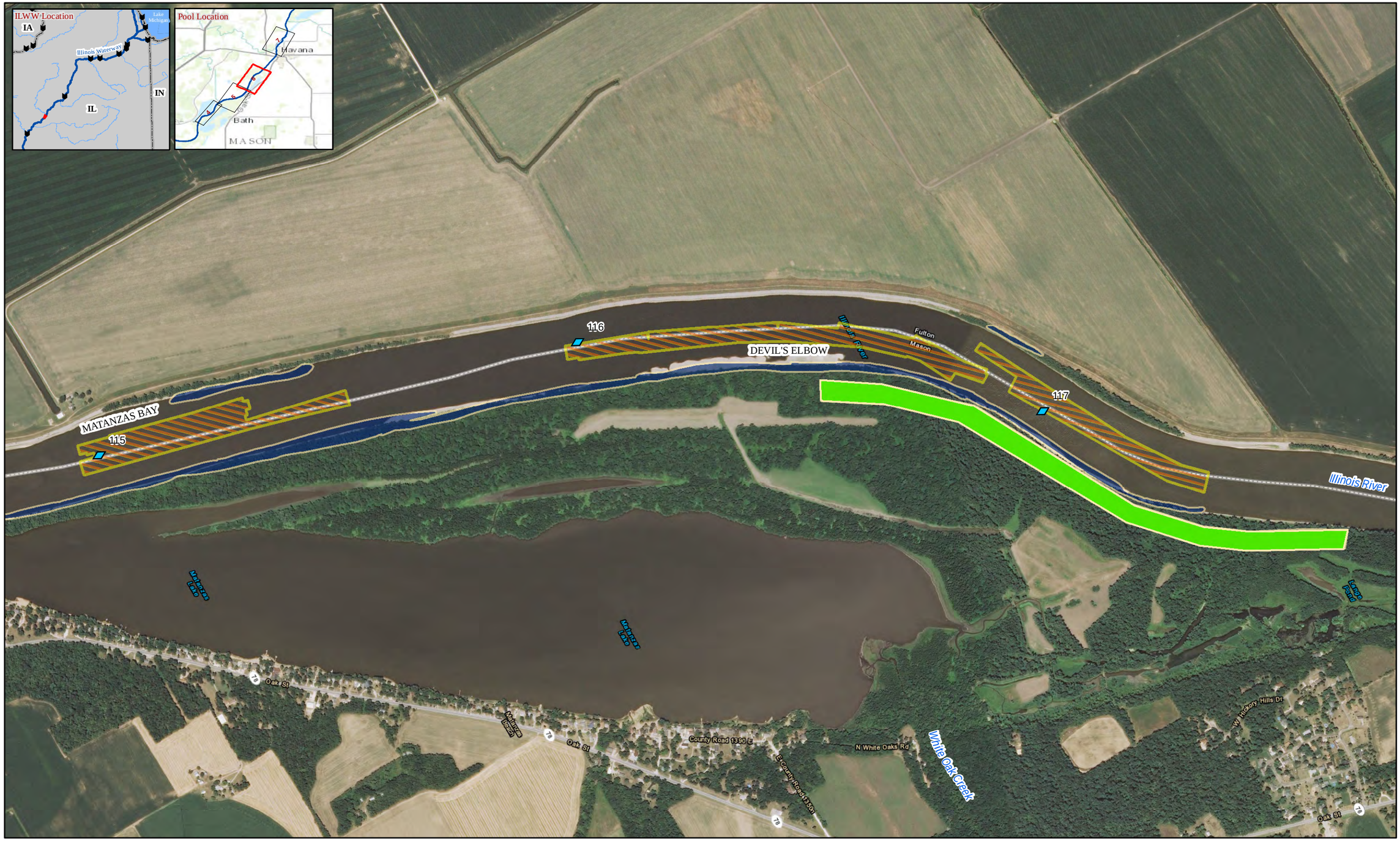
U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles



Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 114.9 TO 117.8
Page Number: 6
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 120.8 TO 123.8
Page Number: 7
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 132.8 TO 135.9
Page Number: 8
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 136.0 TO 139.0
Page Number: 9
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 141.9 TO 144.8
Page Number: 10
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

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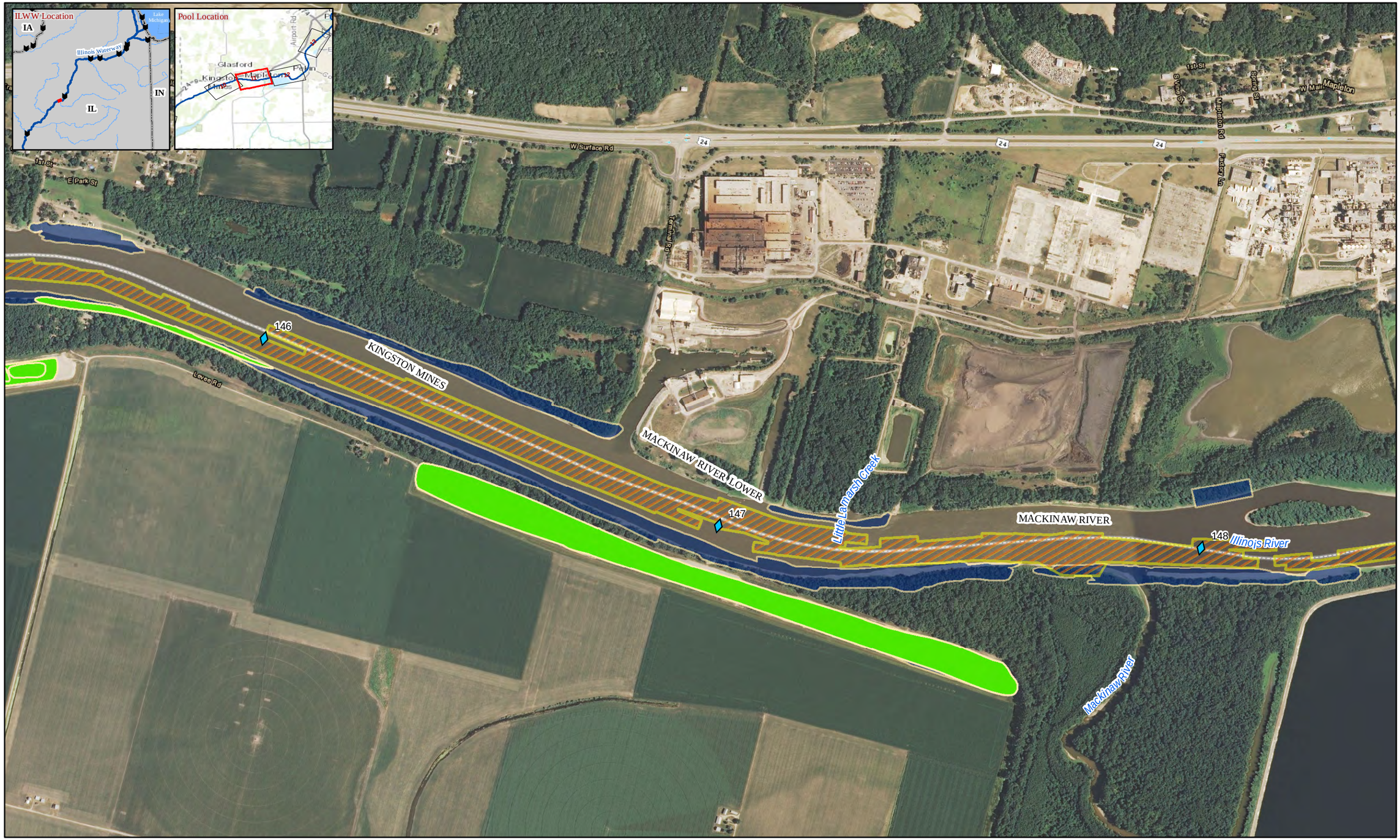

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 144.8 TO 147.7
Page Number: 11
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 147.7 TO 151.0
Page Number: 12
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: LaGrange
River Miles: 154.1 TO 157.1
Page Number: 13
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 163.0 TO 166.1
Page Number: 14
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet

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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 170.9 TO 173.8
Page Number: 15
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 181.5 TO 184.4
Page Number: 16
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 195.7 TO 198.9
Page Number: 17
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

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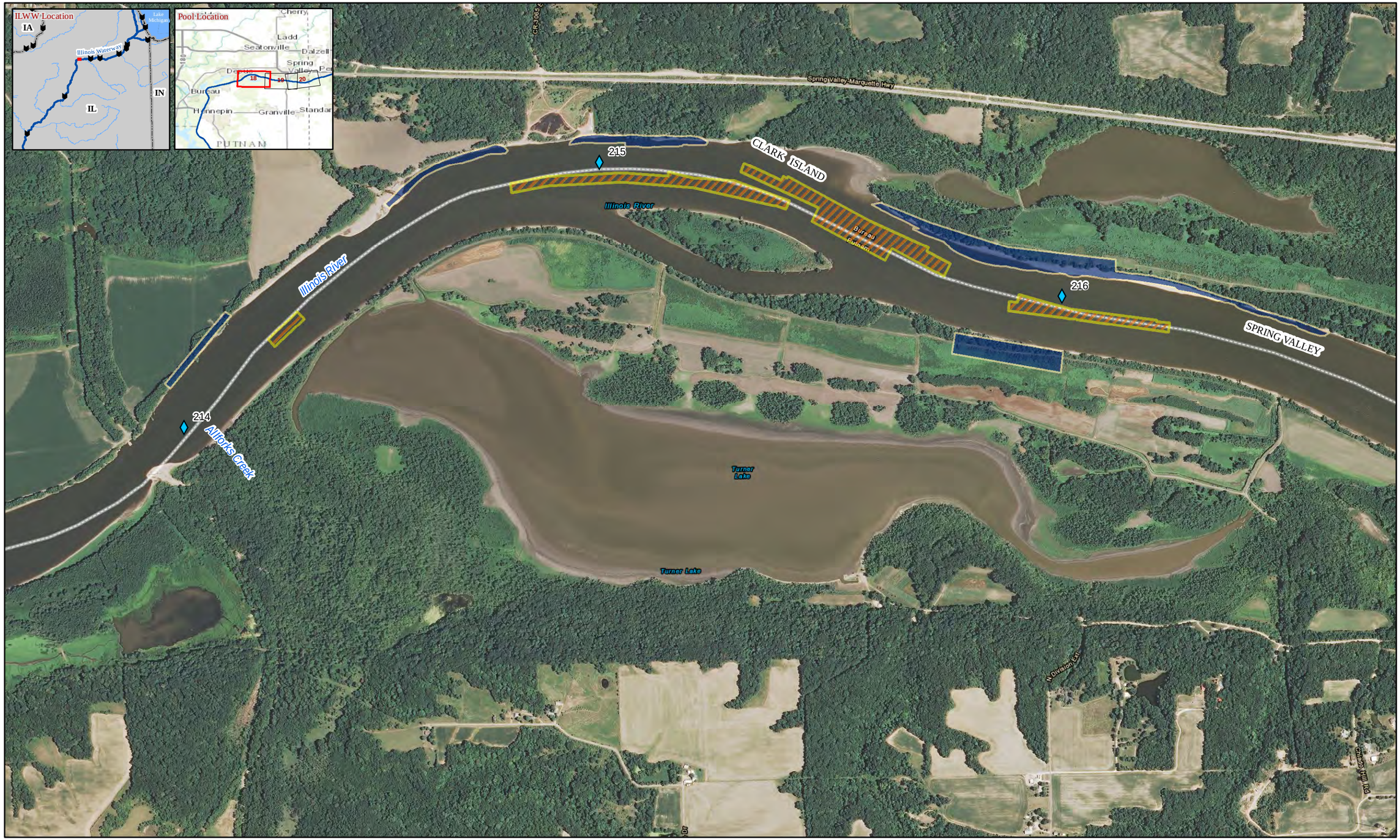

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 213.5 TO 216.7
Page Number: 18
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 216.8 TO 219.6
Page Number: 19
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 219.6 TO 222.6
Page Number: 20
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

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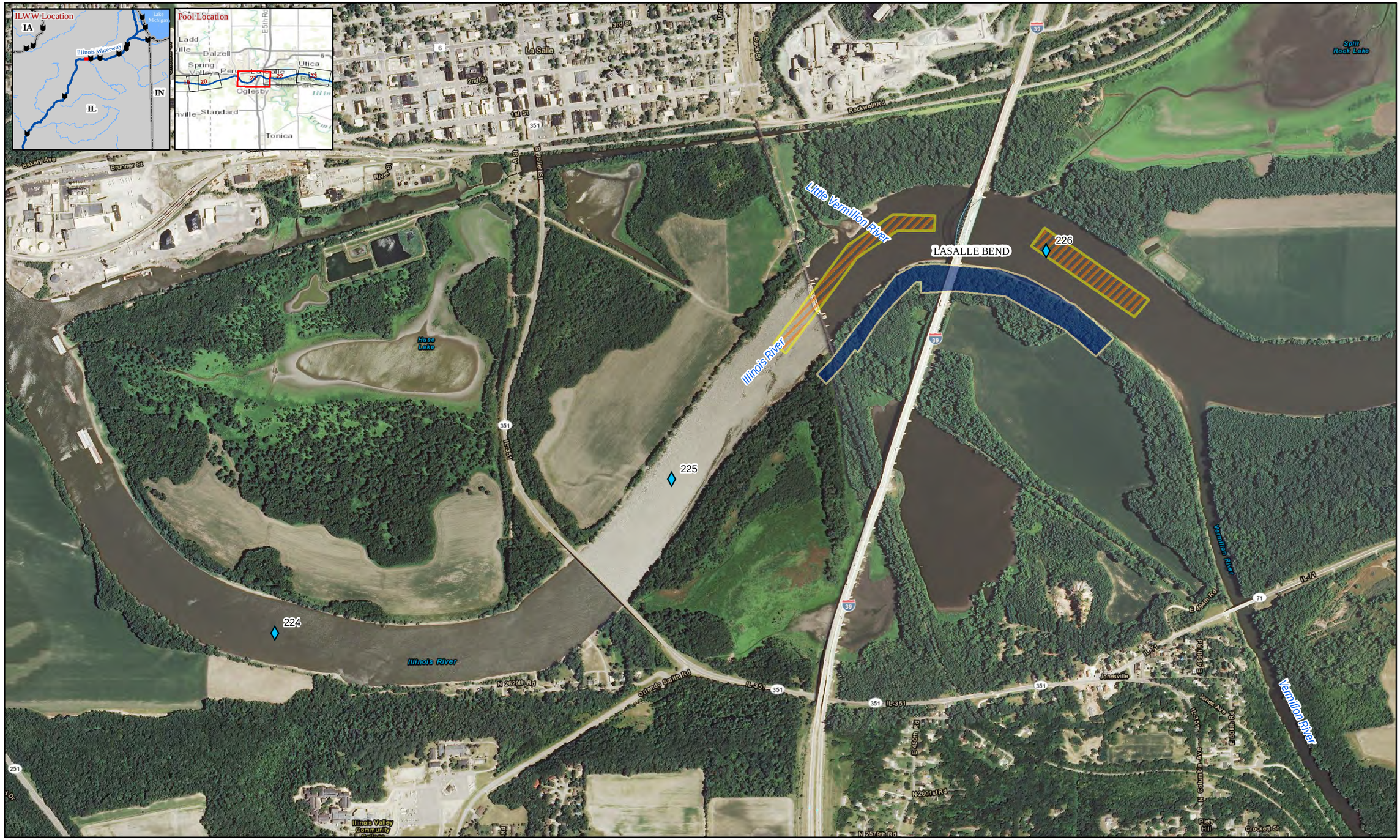

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 222.6 TO 226.4
Page Number: 21
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

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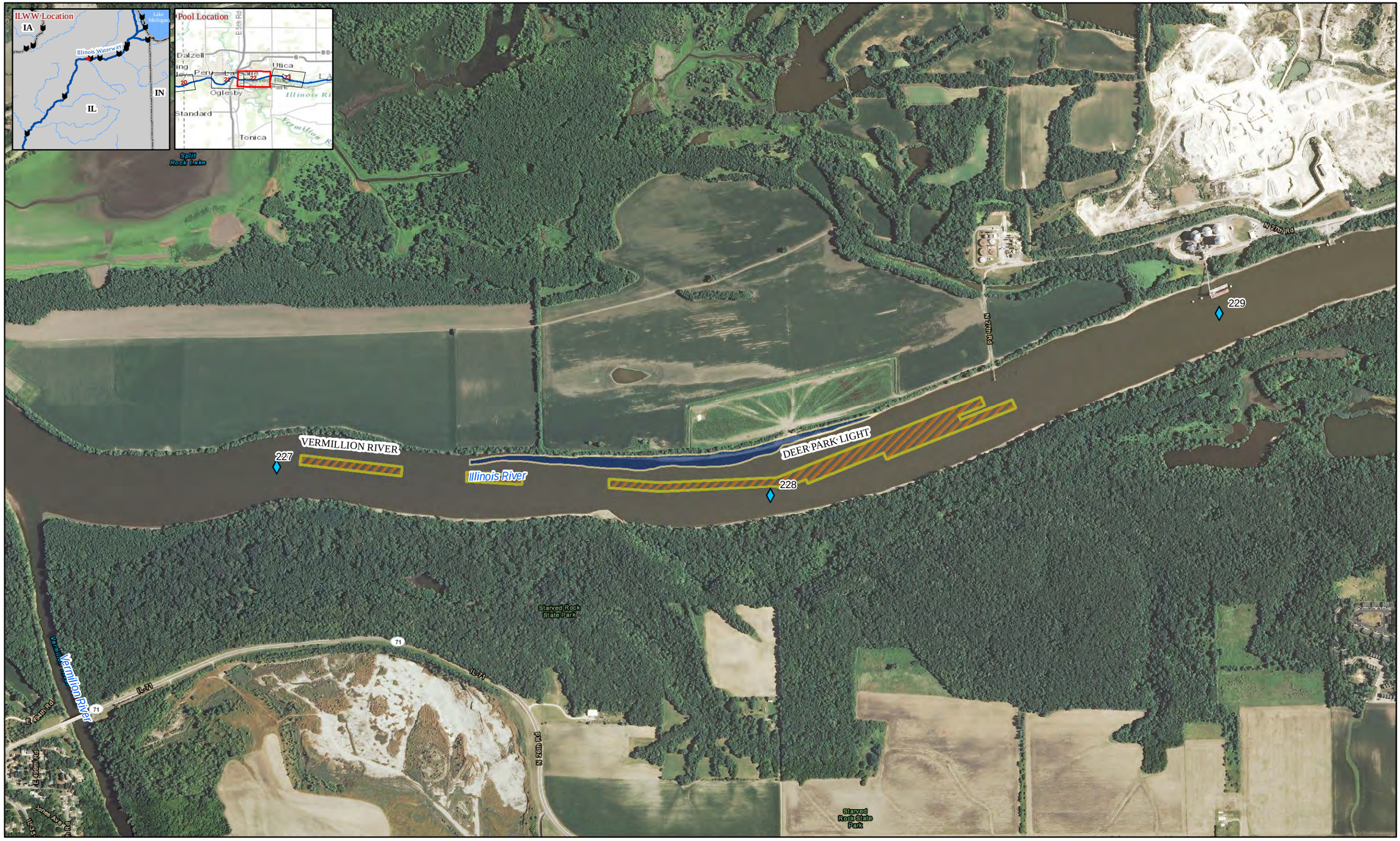

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Peoria
River Miles: 226.3 TO 229.4
Page Number: 22
Coordinate System: NAD 1983 StatePlane Illinois West FIPS 1202 Feet
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U.S. Army Corps of Engineers
Rock Island District

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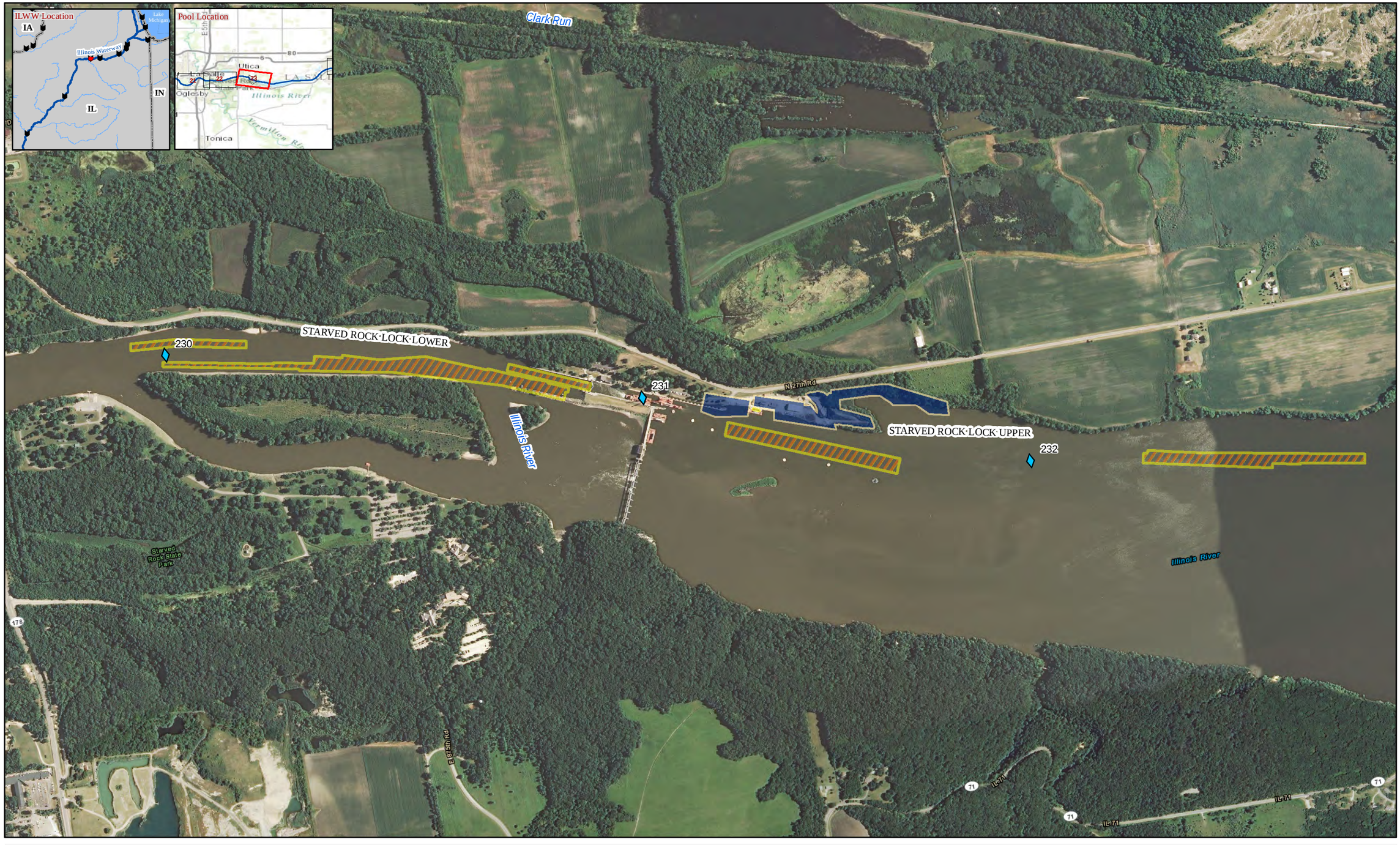

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Starved Rock L&D
River Miles: 229.4 TO 232.6
Page Number: 23
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
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U.S. Army Corps of Engineers
Rock Island District

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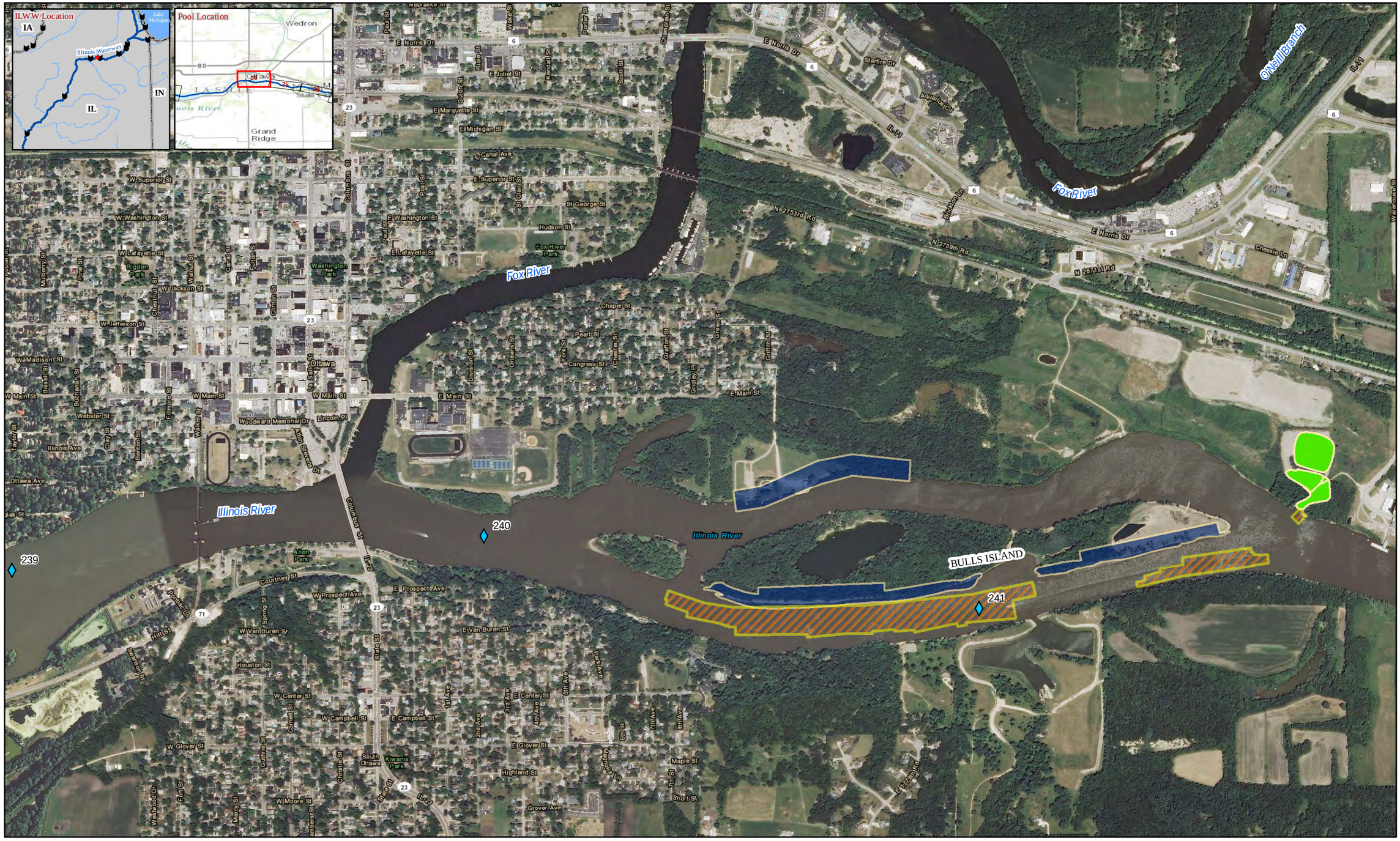

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Starved Rock
River Miles: 239.0 TO 241.9
Page Number: 24
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Marseilles L&D
River Miles: 242.0 TO 247.9
Page Number: 25
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

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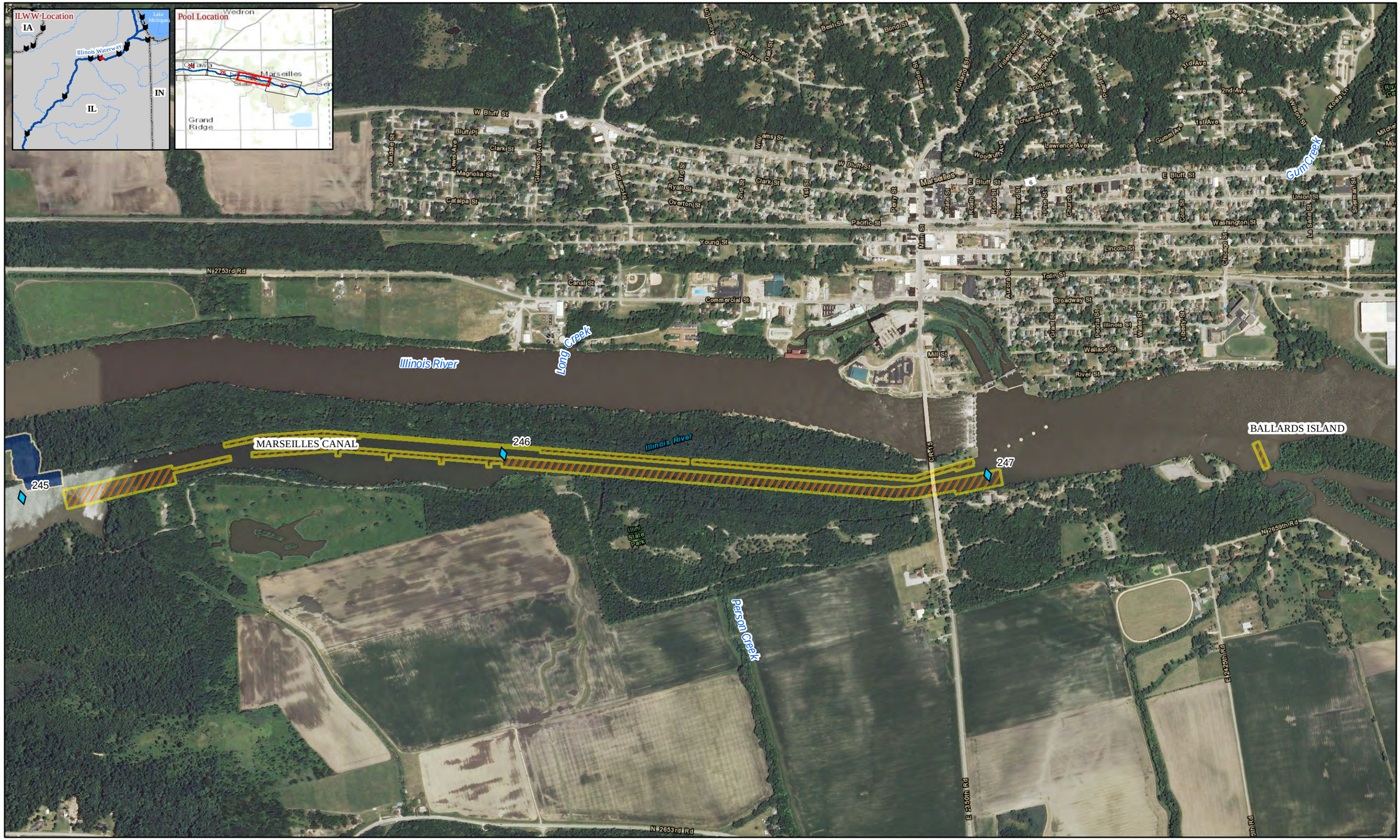

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Marseilles
River Miles: 245.0 TO 247.9
Page Number: 26
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

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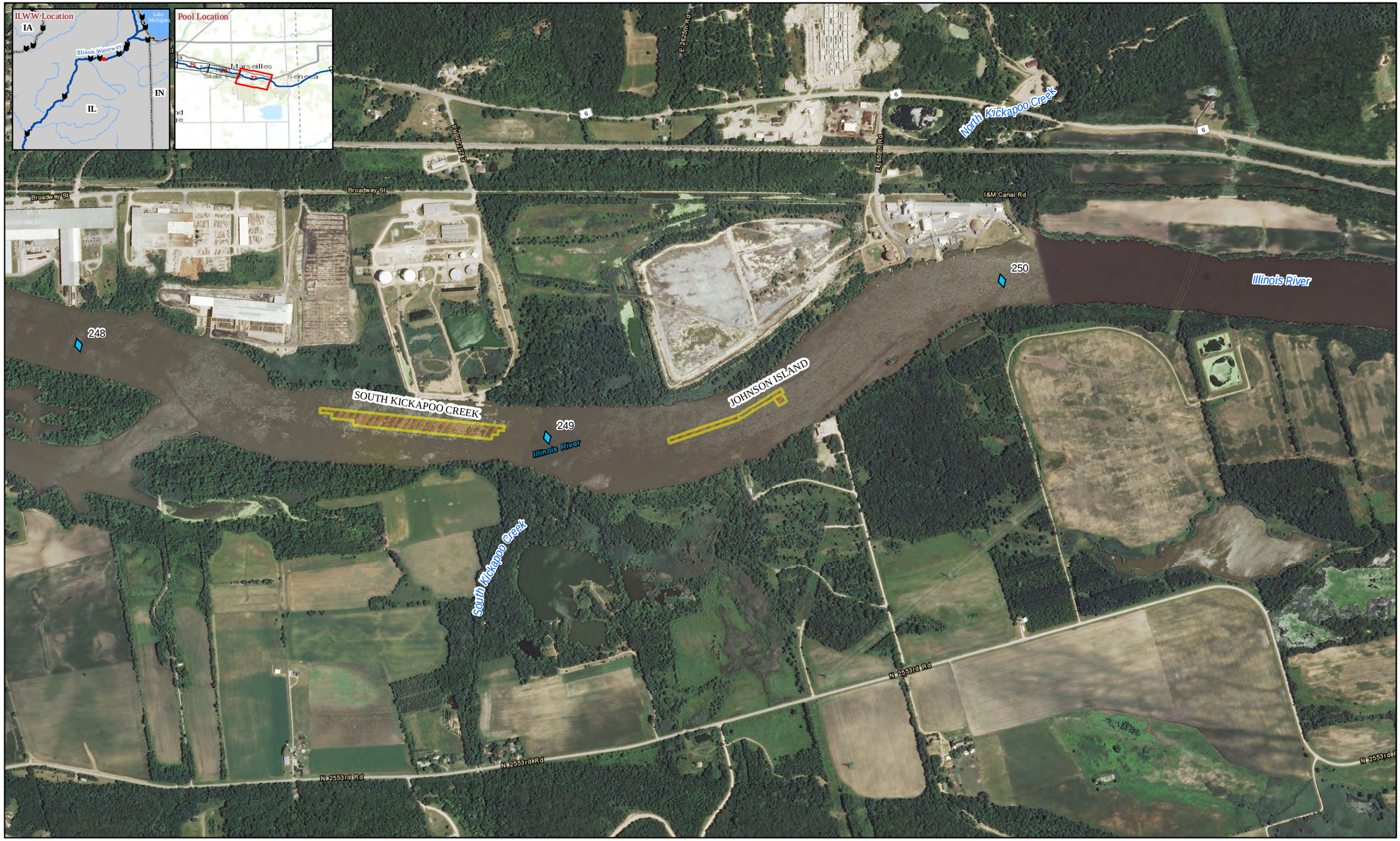

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Marseilles
River Miles: 247.8 TO 250.8
Page Number: 27
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
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U.S. Army Corps of Engineers
Rock Island District

N

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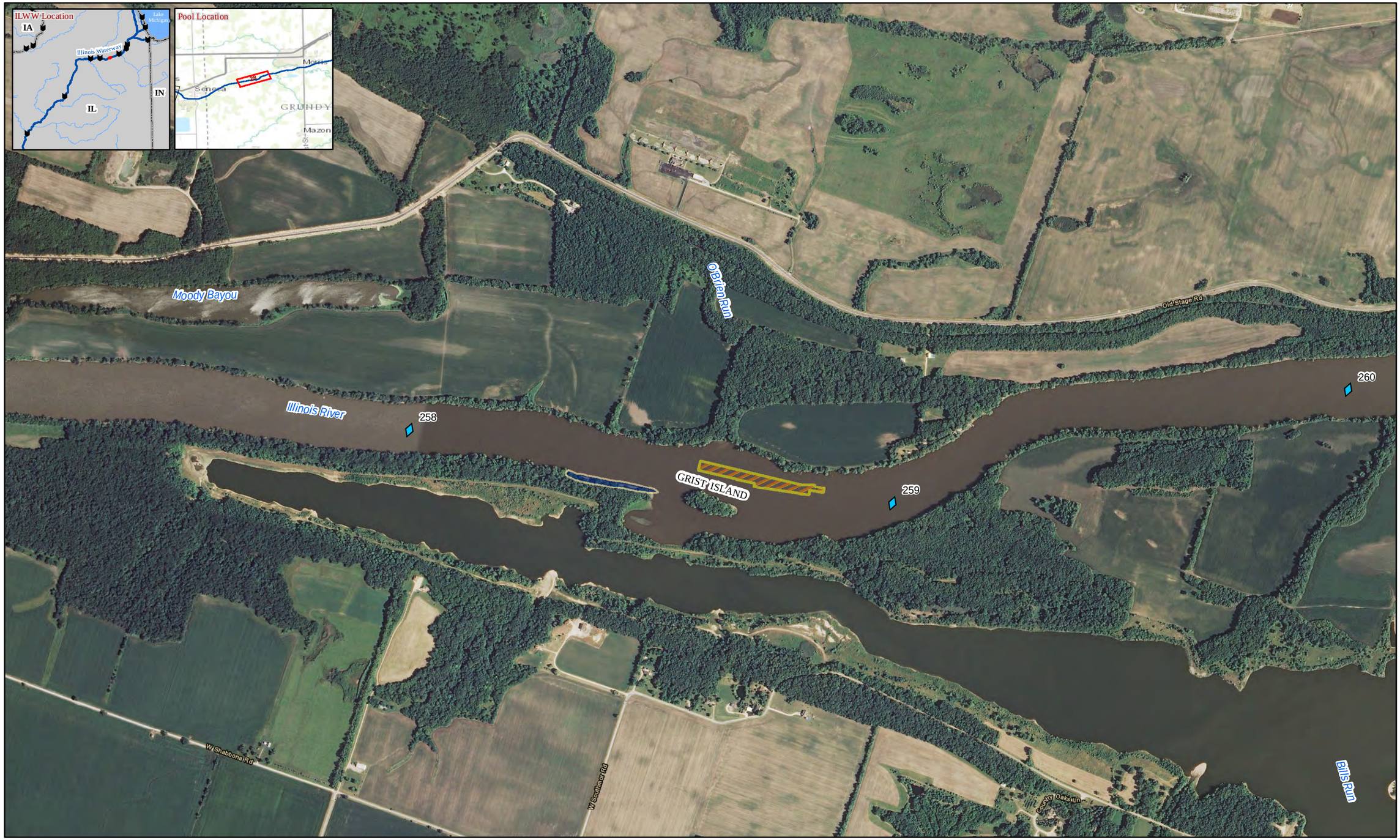

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Marseilles
River Miles: 257.2 TO 260.1
Page Number: 28
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
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U.S. Army Corps of Engineers
Rock Island District

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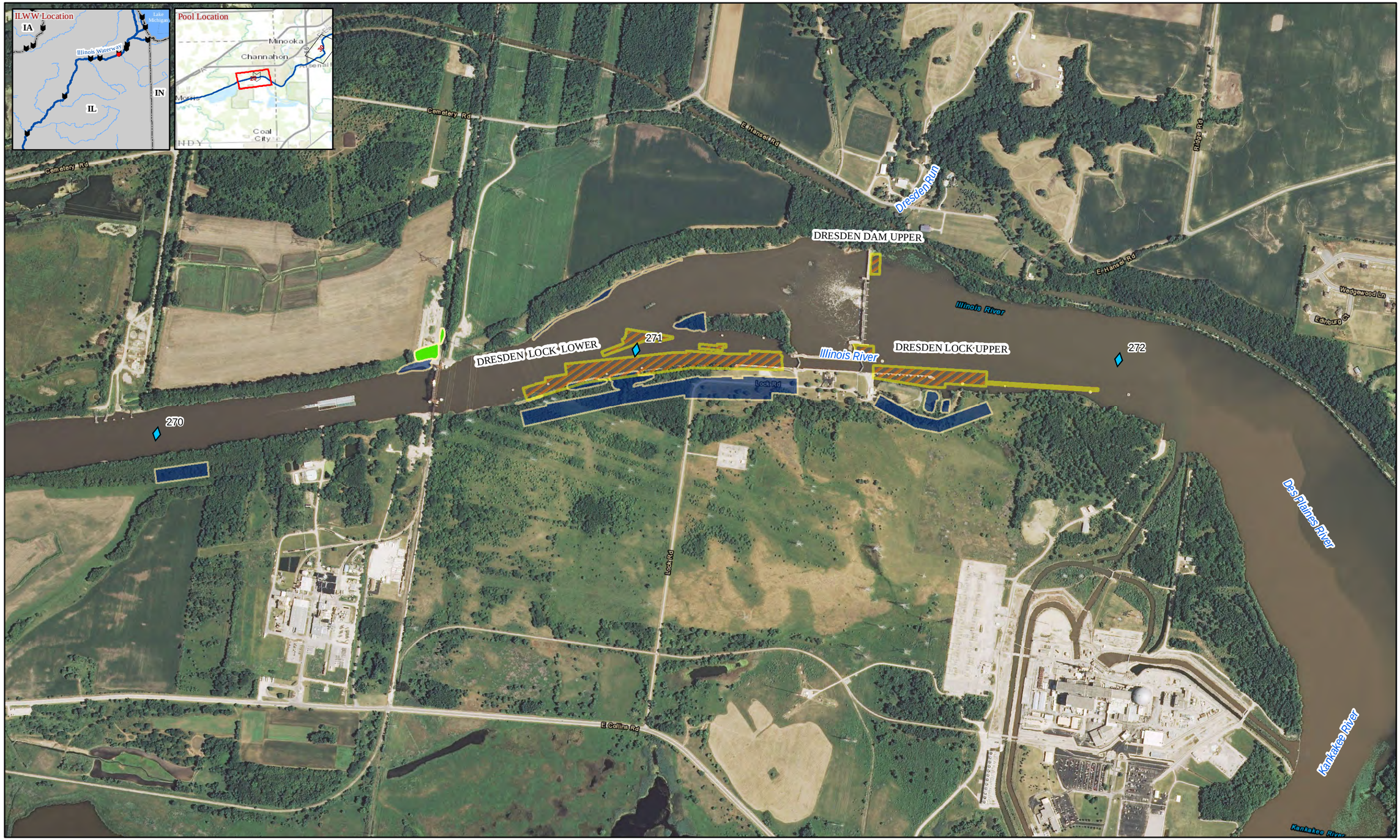

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Dresden L&D
River Miles: 268.8 TO 271.8
Page Number: 29
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

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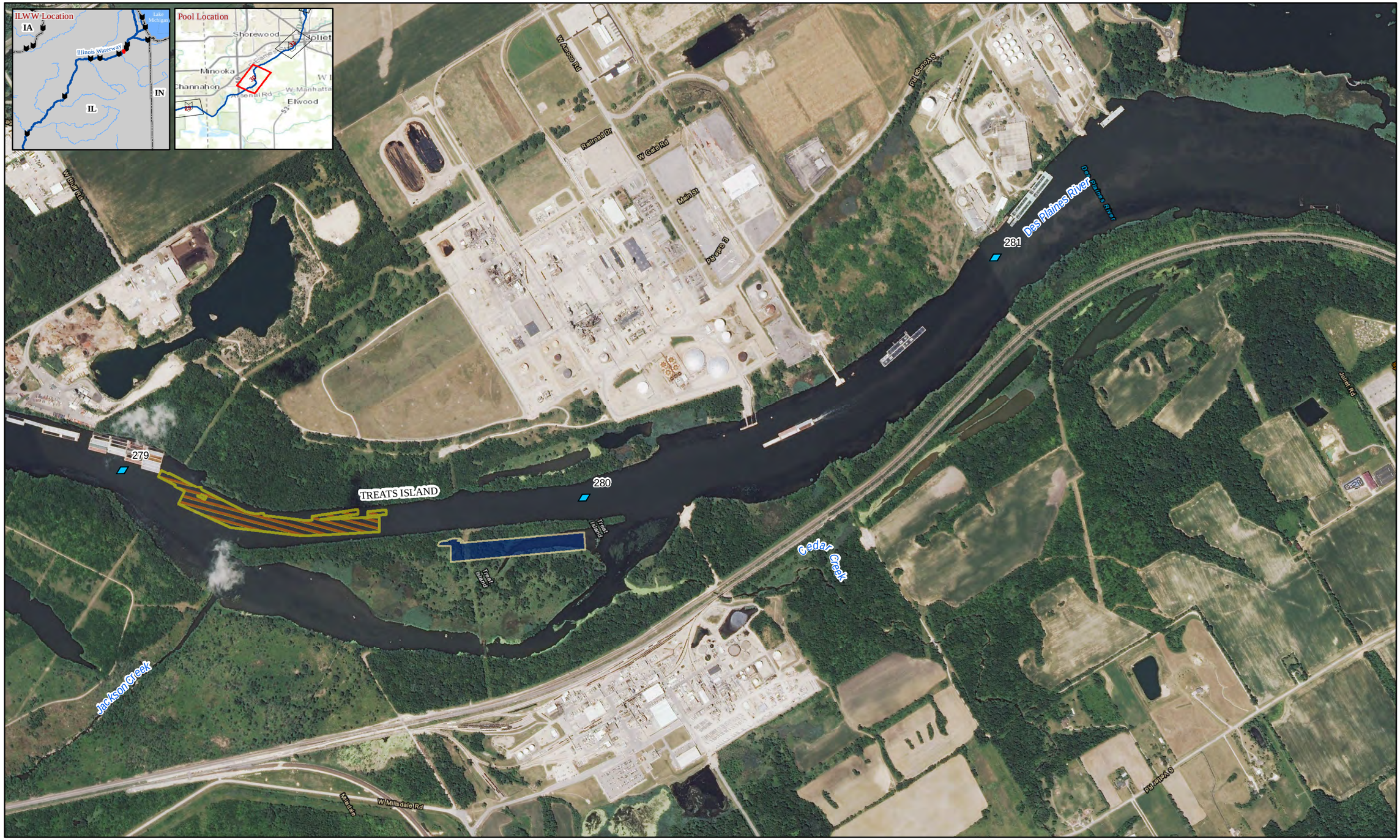

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Dresden
River Miles: 278.7 TO 281.9
Page Number: 30
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Brandon Road L&D
River Miles: 284.8 TO 288.0
Page Number: 31
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

Legend

- River Mile
- Historic Dredge Location
- Historic Placement Location
- Upland Historic Placement Location

Pool Location: Lockport L&D
River Miles: 290.7 TO 293.6
Page Number: 32
Coordinate System: NAD 1983 StatePlane Illinois East FIPS 1201 Feet
Path: T:\OD-T Shared\Hayes\2013_Maps\404Permit\MVRDredgingAndPlacement.mxd

U.S. Army Corps of Engineers
Rock Island District

N

0 0.25 0.5 1 Miles

SECTION 404(b)(1) EVALUATION
MAINTENANCE DREDGING OF THE
9-FOOT CHANNEL NAVIGATION PROJECT

ILLINOIS WATERWAY
RIVER MILES 80.2 - 303.4

APPENDIX C

THE 404 STUDIES FINAL REPORT

THE 404 STUDIES

SUMMARY ASSESSMENT OF DREDGED MATERIAL PLACEMENT ALONG THE UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY

FINAL REPORT

March 2009

US Army Corps
of Engineers ®
Rock Island District

PREFACE

The work reported herein was conducted for the U.S. Army Corps of Engineers Rock Island District's (District) Channel Maintenance Program under Section 404(b)(1) of the Clean Water Act (33 U.S.C. 1344). The information in this report was developed for consideration in the review process for channel maintenance dredged material placement permits on previously used (historic) dredged material placement sites within the District.

This report was produced by the 404 Study Team, a subgroup of the Fish and Wildlife Interagency Committee for the River Resources Coordinating Team. Agencies that participated in the 404 Study Team included the District; the U.S. Fish and Wildlife Service; the Iowa Department of Natural Resources; the Missouri Department of Conservation; the Illinois Department of Natural Resources; and the Illinois Natural History Survey.

This report and these studies were funded by the District through the Operations Division's Channel Maintenance Program.

THE 404 STUDIES

SUMMARY ASSESSMENT OF DREDGED MATERIAL PLACEMENT ALONG THE UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY

FINAL REPORT

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THE 404 STUDIES

SUMMARY ASSESSMENT OF DREDGED MATERIAL PLACEMENT ALONG THE UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY

FINAL REPORT

I. INTRODUCTION

This report summarizes a series of 19 scientific studies (404 Studies) designed to evaluate the impacts of U.S. Army Corps of Engineers, Rock Island District (District) channel maintenance activities of dredged material placement in aquatic and terrestrial habitats of the Upper Mississippi River (UMR) System. Specific measurement metrics used in this evaluation include: sediment transport, vegetation, macroinvertebrates, freshwater mussels, fish, and turtles. The findings from these studies were evaluated by a multi-agency 404 Study Team, a subcommittee of the Fish and Wildlife Interagency Committee (FWIC), and used to develop criteria for selecting future dredged material placement sites. For purposes of clarity, conclusions and recommendations based on the 404 Studies are referenced "study" or "studies"; while conclusions and recommendations resulting from this report reference "this report."

The 404 Studies get their name from the Federal Water Pollution Control Act of 1972 (Clean Water Act) which regulates maintenance dredging and the placement of dredged or fill material. Section 404 of the Clean Water Act requires a permit before dredged or fill material may be discharged into waters of the United States, including the UMR and the Illinois Waterway (IWW). The basic requirement of the 404 permit program is that no discharge of dredged or fill material is permitted if: 1) a practicable alternative exists that is less damaging to the aquatic environment or 2) the nation's waters would be significantly degraded. The member agencies of the FWIC, acting independently, intended to use the 404 Studies to help answer recurring questions that arise in the process of issuing long-term channel maintenance permits.

Pursuant to the Clean Water Act, the U.S. Army Corps of Engineers is the issuing agency for all 404 permits nationwide. Each District is required to go through the formal 404 evaluation process (i.e. issuance of a Public Notices and compilation of 404(b)(1) Evaluations) for its own dredged material placement actions. Long-term channel maintenance 404 permits are unique in that they are issued for a 3- to 10-year period for entire reaches of the UMR and IWW within the District. Long-term 404 permits allow for the use of historic (previously used) placement sites as long as these sites are acceptable to the State and Federal natural resource and regulatory agency representatives. Long-term permits provide the District the flexibility to rapidly respond to channel maintenance needs while complying with the Clean Water Act.

Dredging Background

The UMR passes between 1.6 and 19.1 million cubic yards (between 2 and 24 million tons) of sediment per year through the District (USACE 2000a). Most of this sediment is sand and most passes unnoticed as bedload, yet there are areas where sediment chronically accumulates, creating shoals which block the navigation channel. Dredging and hydraulic records show that shoaling reoccurs in

areas where slow currents occur, causing excessive sediment deposition. Slow currents typically arise at channel crossings, point bars on river bends, side channel splits, and tributary mouths. River bends present another channel maintenance challenge because currents travel slower on the inside portion of the bends and faster on outside portion of the bends which causes sedimentation and erosion processes, respectively. In free-flowing rivers, this process leads to meandering and oxbow formation; in "trained" rivers such as the UMR-IWW, it can lead to blockages in the navigation channel. Tributary mouths present dredging challenges when higher gradient tributaries that have greater hydraulic power, flow into slower flowing mainstem rivers causing heavy gravel and sand to deposit.

Typically, the District removes excessive sedimentation within the navigation channel via hydraulic dredging. Hydraulic dredges (figure 1) are large, specialized machines that rotate a cutterhead through river substrates and pump them through a pipe in a slurry of water to a placement site (figure 2). Mechanical dredging is done when hydraulic dredging is not practical because of high percentages of rocky or cobble material or if small volumes need to be dredged or material must be transported greater than 1 mile. Mechanical dredging uses backhoes or cranes, to scoop material from the river bottom; material is then loaded onto a barge for transport to a placement site. While hydraulic dredging is less expensive per unit of material moved and more expedient, mechanical dredging, because of its use of barges rather than pipelines, allows material to be transported greater distances.

Figure 1. Hydraulic dredges (bottom left) turn a cutterhead (bottom right) through sediments which are suctioned up by a pump on the barge and through a pipeline (top right) to a desired placement site, such as this beneficial use site in an urban area (top left).

Figure 2. Hydraulic dredges discharge a slurry of sand, mud, and water onto placement sites. These sites may be more than a mile from the dredge cut given sufficient pipe and sometimes booster pumps.

The District has traditionally placed dredged material along the shoreline, channel borders, on islands, or in bottomland hardwood forests adjacent to dredge cut sites. Dredged material has also been placed in thalwegs (deep parts of the main channel), behind levees, and in confined placement areas (figure 3). In the early 1980s, the Great River Environmental Action Team (GREAT) recommended considerations for changes in dredged material placement, including long-term site development and the reduction of floodplain impacts, with the goal to place more material out of the river system. The U.S. Army Corps of Engineer guidance in 1988 required the Corps to develop long-term (greater than 10 years) management strategies for their channel or harbor maintenance programs. New regulations in 2000 (ER 1105-2-100) updated this requirement for long-term site development to greater than 20 years. The District strives for long-term capacities of greater than 40 years whenever possible. The District is nearing completion of these Dredged Material Management Plans (DMMPs) for each of its chronic dredge cuts. Beneficial use stockpile sites have been created near some dredge cuts for later removal by public and private individuals for road sanding, construction, and other uses (figure 1, top left). Agencies also seek opportunities to use dredged material for habitat creation (e.g., islands). However, sand supply greatly exceeds the demand from beneficial users. River engineers are also working to keep sand moving through channels by constructing and improving regulating structures (such as wingdams or closing dams) that direct the flow of water causing scour the river bed. Where possible, engineers work with biologists to design and construct structures that can also increase fish habitat by providing refugia or subsequent creation of scour holes which provide deep water habitat. Greater emphasis is also being placed on removing the material entirely from the floodway (e.g. behind levees). Removing material from the floodway helps avoid sensitive habitats and minimizes potential impacts to flood heights (figure 3).

Figure 3. Confined placement sites are located away from environmentally sensitive sites to less sensitive areas such as former crop fields or industrial sites.

Historic Placement Activities. The District placed material on nearly 3,960 acres (<0.6 percent) of the UMR floodplain from 1939-1998 with the majority (~3600 acres) of placement occurring before 1990. From 1990 through 1998 only 330 (<0.1 percent) of the UMR floodplain has been used (USACE 2003). Most of the floodplain area used for dredged material was either open water or wet floodplain forest (table 1). The open water classification includes all non-vegetated aquatic areas. The classification is very general and could include aquatic areas from the shoreline to the middle of the river. This could include main-channel border and main-channel habitats.

Sand/mud, agricultural, scrub/shrub, as well as developed lands have all been used; although for these other land types, less than 1 percent of the total UMR floodplain area has been used. The exception to this is mud/sand lands. When practical, the District has historically operated its placement practices on the principle of "like on like" – the placement of sand on top of sand is less environmentally harmful than placing such material on a dissimilar type of substrate. These principles are found in Clean Water Act Section 404(b)(1) Guidelines, Subpart H. Because the majority of dredged material is comprised of sand, the higher amount of sand/mud land cover used is expected.

Historical placement records for the IWW are less reliable than for the UMR for several reasons (USACE 2003). However, similar trends in land use cover between the UMR and the IWW are seen with the majority of placement occurring in open water and wet floodplain forest followed by wet meadow and sand/mud. Shoreline placement sites can be popular recreational use sites, and some sites near urban areas are often very high use areas. Boaters and campers can be found on placement sites throughout the District. The Corps does not maintain beaches, but the public and cooperating agencies have been seeking opportunities where the Corps' mission and recreational interests coincide.

Table 1. Summary of 1989 Habitat Conditions Resulting From Rock Island District Dredged Material Placement Activities from 1939-1989 for Pools 11-24 of the UMR

HNA Land Use/Land Cover Types	HNA Land Cover in Dredged Material Placement Areas (acres)	Total Habitat Type in UMR (HNA) (acres)	Total Cover
Agriculture	13.0	274,446.9	0.0%
Developed	165.7	36,290.8	0.5%
Floating-Leaved Aquatic	3.0	12,123.3	0.0%
Grassland	3.8	1,070.2	0.4%
Mesic Bottomland	9.3	11,141.6	0.1%
No Photo Coverage	0.0	162,773.8	0.0%
Open Water	1,896.6	128,104.7	1.5%
Populus Community	19.4	1,309.2	1.5%
Salix Community	40.1	2,160.6	1.9%
Sand/Mud	160.3	984.7	16.3%
Scrub/Shrub	112.2	21,680.3	0.5%
Seasonally Flooded Emergent Perennial	3.5	1,873.0	0.2%
Semi-permanently Flooded Emergent Annual	0.0	68.7	0.0%
Semi-permanently Flooded Emergent Perennial	11.1	10,058.1	0.1%
Submersed Aquatic Bed	45.5	15,799.2	0.3%
Wet Floodplain Forest	1,061.7	97,417.2	1.1%
Wet Meadow	85.3	16,780.3	0.5%
Total	**3,630.4**	**794,082.6**	**0.5%**

Future Placement Activities. For the UMR, the District's 40-year projections (from 2000) for future placement indicate the habitat types that will be most used for dredged material placement will be open water, followed by agricultural and scrub/shrub (figure 4). The open water classification includes all non-vegetated aquatic area. The classification is very general and could include aquatic areas from the shoreline to the middle of the river. This could include main-channel border and main-channel habitats. The forecast for the IWW is reach-specific (figures 5 and 6), but open water, agricultural, and woody terrestrial are projected to be most used.

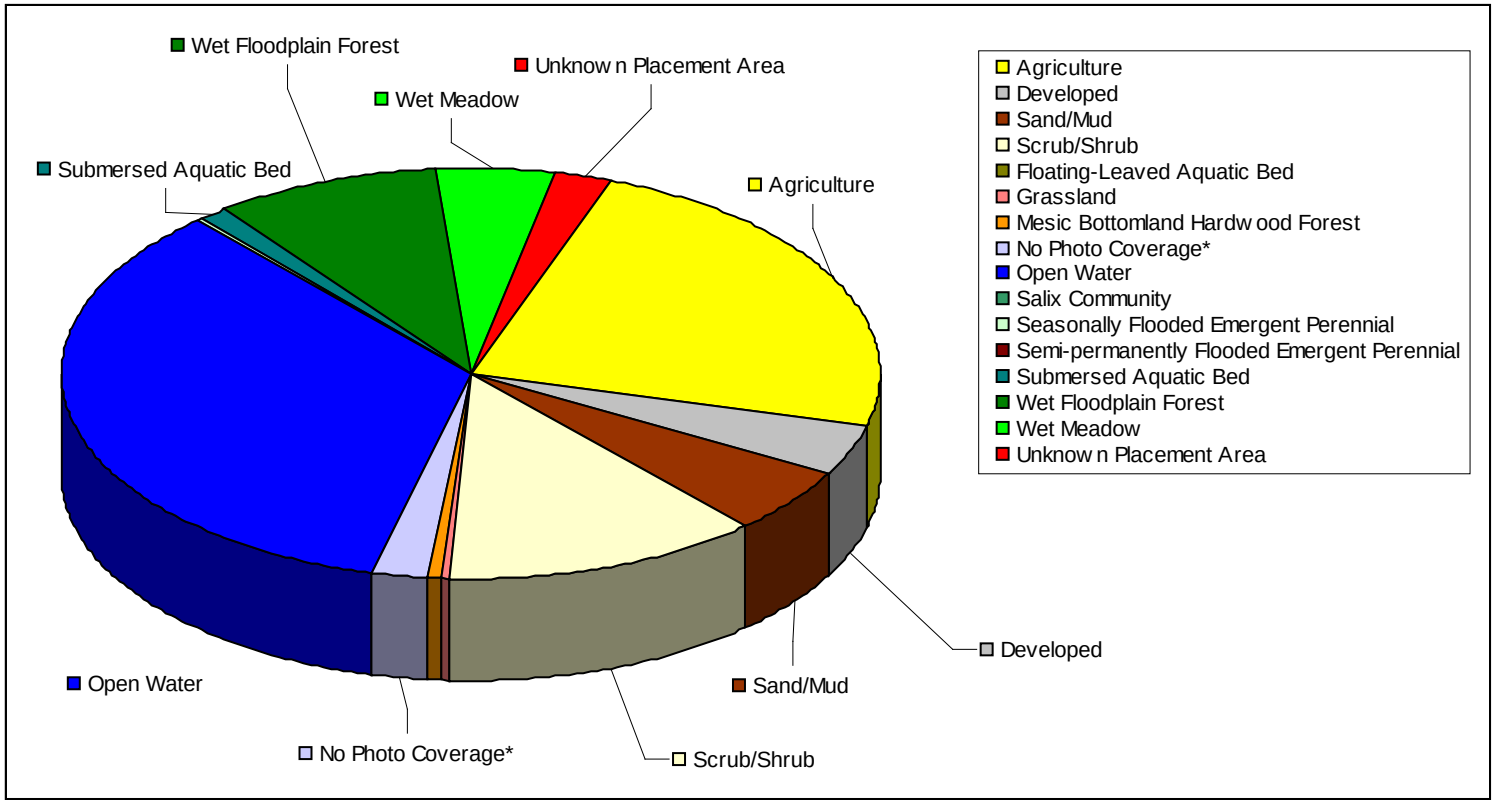

Figure 4. 40-Year Projection Summary of the Relative Aerial Coverage of Projected Dredged Material Placements, by Habitat Type, for Areas of **Pools 11 - 24 of the UMR** for 2000 – 2040

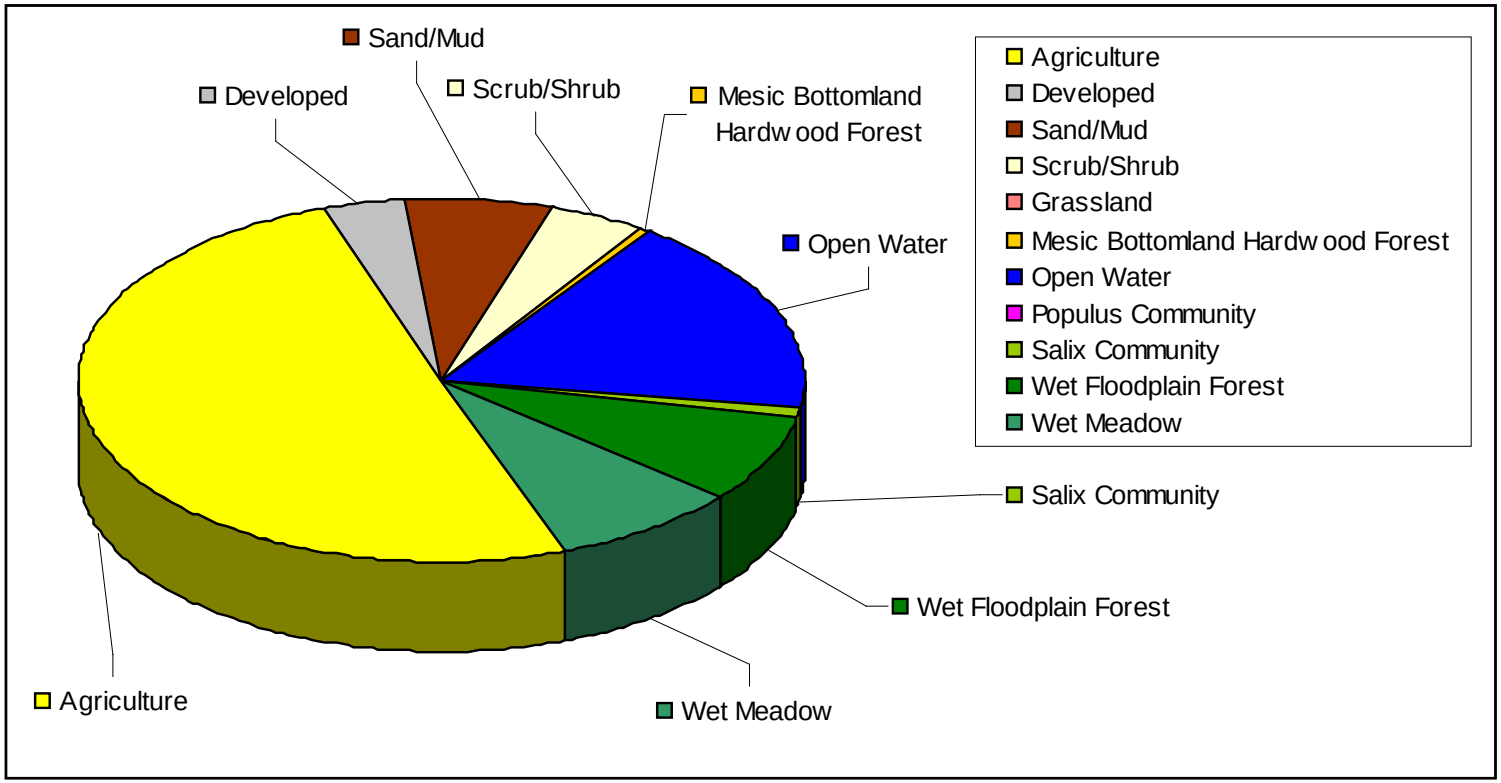

Figure 5. 40-Year Projection Summary of the Relative Aerial Coverage of Projected Dredged Material Placements, by Habitat Type, for Areas of **Peoria and La Grange Pools of the IWW** for 2000 – 2040

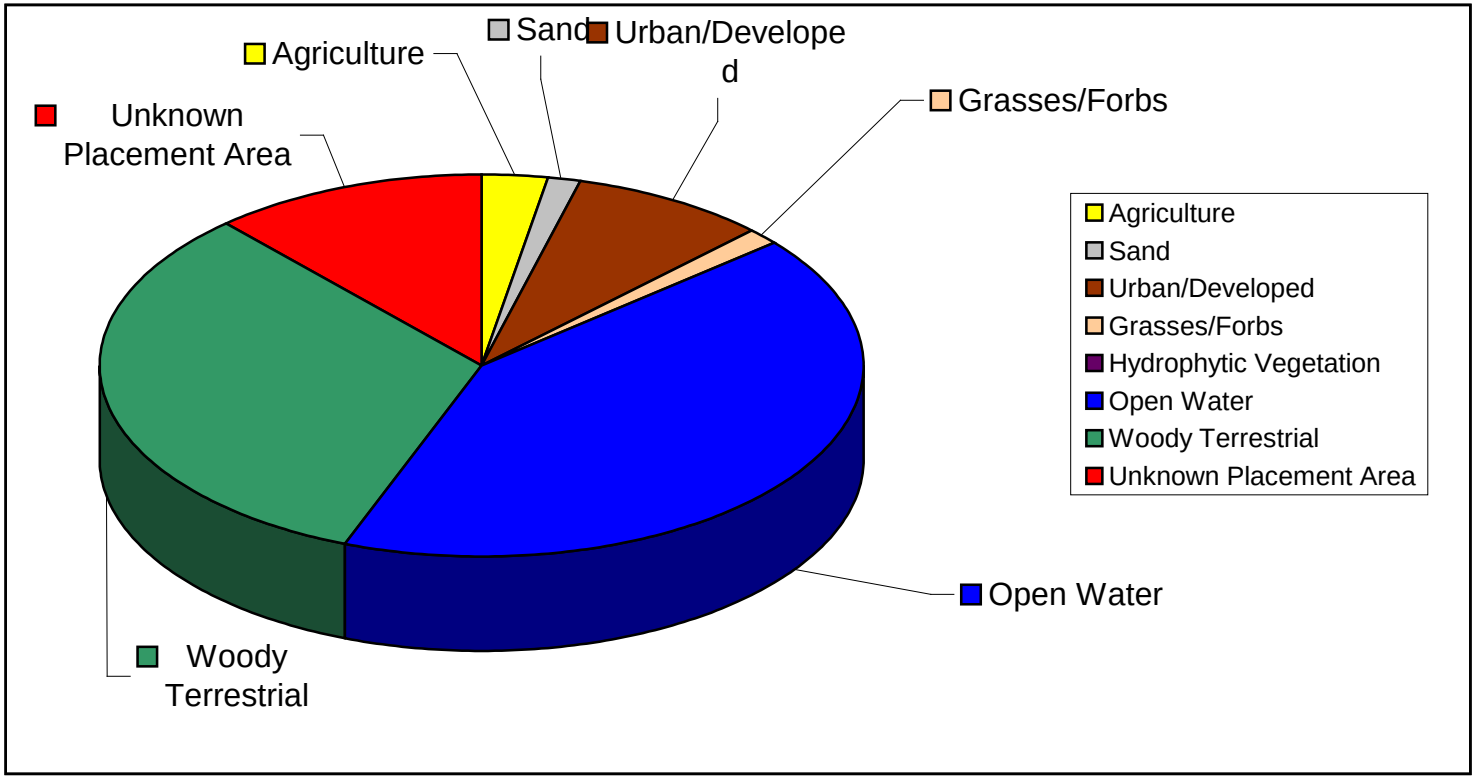

Figure 6. 40-Year Projection Summary of the Relative Aerial Coverage of Projected Dredged Material Placements, by Habitat Type, for Areas of **Dresden, Marseilles and Starved Rock Pools of the IWW** for 2000 -2040

II. THE 404 STUDIES

The 404 Studies investigated the direct effects of dredged material placement on measurable metrics/resources to help assess the effects of dredge placement on these resources. Metrics/resources selected were: terrestrial vegetation, aquatic macroinvertebrates, freshwater mussels, fish, and turtles. Sediment transport analysis and construction of a physical model of a highly dredged reach in Pool 18 were also done to investigate migration of dredge material off-site. Field studies were conducted throughout the District (figure 7), with vegetation, macroinvertebrates, and fish being studied in both the IWW and UMR.

A. SEDIMENT TRANSPORT COMPONENT

Objectives. Sediment transport was investigated to better understand environmental impacts associated with the migration of dredged material from a highly erosive bankline placement site (UMR, Camp Island RM 418-420). This eroded sand has the potential to move into secondary channels and backwaters and contribute to increased sedimentation and habitat degradation. The 404 Study Team proposed a set of three studies to address this concern. Multi-dimensional numerical modeling (figure 8), physical micromodeling, and prototype sediment tracking (i.e., dyed sand) were selected for the studies. Similar results from each independent study technique served to verify overall conclusions as multiple lines of evidence.

Methods. In May 2001, 80,000 pounds of sand were tagged with fluorescent dye and mixed with dredged material at a dredging event from the Benton Island dredge cut in UMR Pool 18. Dredged material was placed on the bankline of Camp Island, a historical placement site which had been used several times but showed little sign of previous use due to rapid erosion of material from the site. Camp Island was specifically chosen for the study due to its unusually rapid rate of erosion of material from the bankline, thereby representing a worse case scenario. Material that eroded from the placement site was tracked by collecting 358 bed material samples from downstream locations. All samples were visually inspected and classified based on physical characteristics. Each sample was also analyzed for the presence of dyed sand using an ultraviolet light. Prior to analysis, samples were washed through a series of sieves to remove fine-grained material which interfered with the analysis. Records were kept of the mass of material lost through washing as a further measure of the physical composition of each sample. Several quality assurance/quality control measures were implemented to understand overall study limitations and attempt to quantify detection limits.

Results. Results indicated that most dyed sand was found in samples taken immediately adjacent to the placement site (figure 9). However, lesser amounts of dyed sand were also found in off-channel areas and the navigation channel. Approximately one quarter of all samples collected contained over 20 percent fine-grained material, which is indicative of depositional areas. Approximately one quarter of the samples containing dyed sand also contained over 20 percent fine grained material, indicating that sand from the placement site moved into depositional areas, at least temporarily. Despite the fact that the amount of dyed sand used was small relative to the amount of bed material transported by the UMR, and that each sample analyzed represented a large area, tagged sand was found as far as 1 mile from the placement site. Some samples containing dyed sand were collected more than a year following placement.

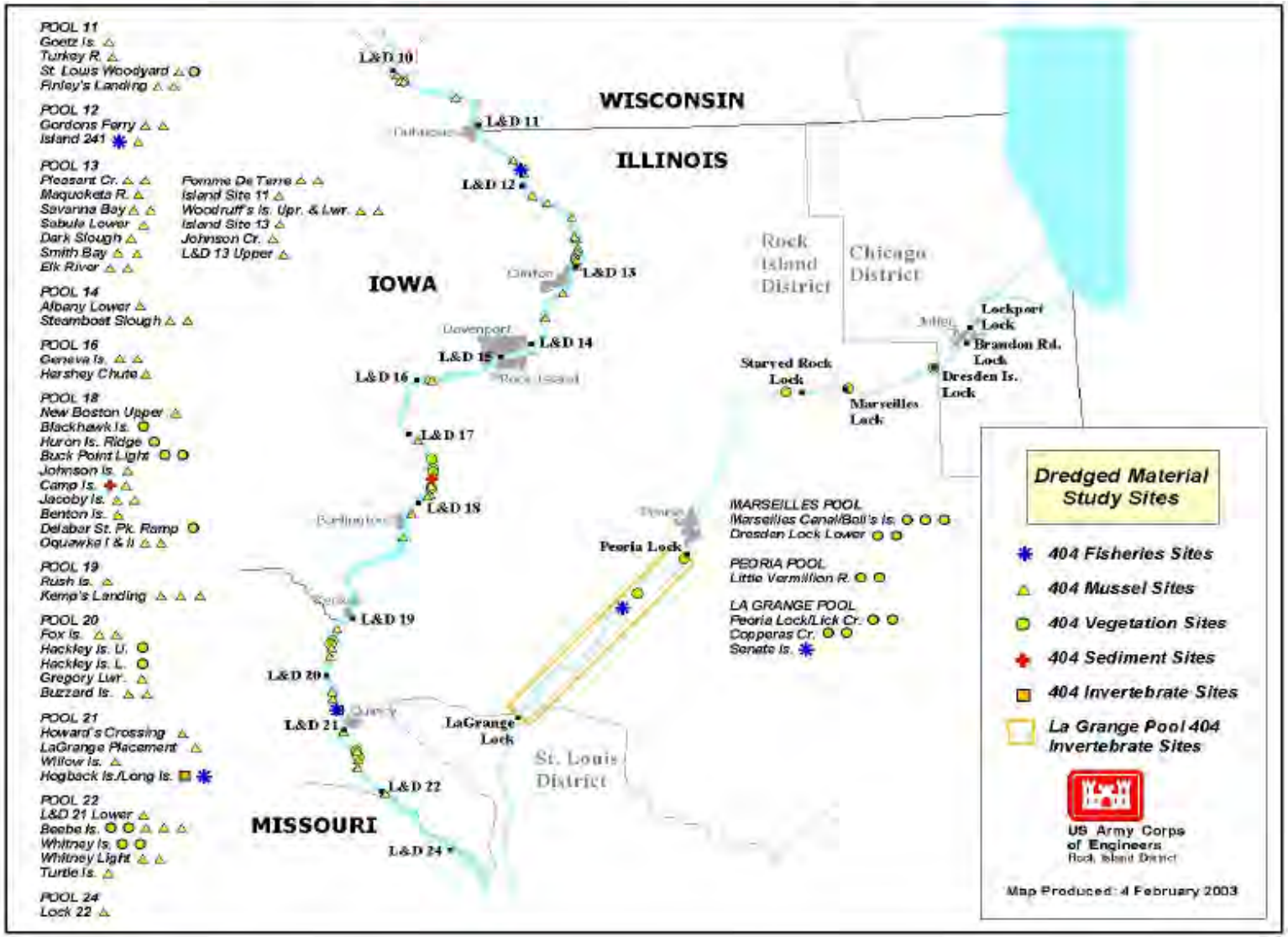

Figure 7. Dredged Material Sites for all Components of the 404 Studies, 1998 – 2005

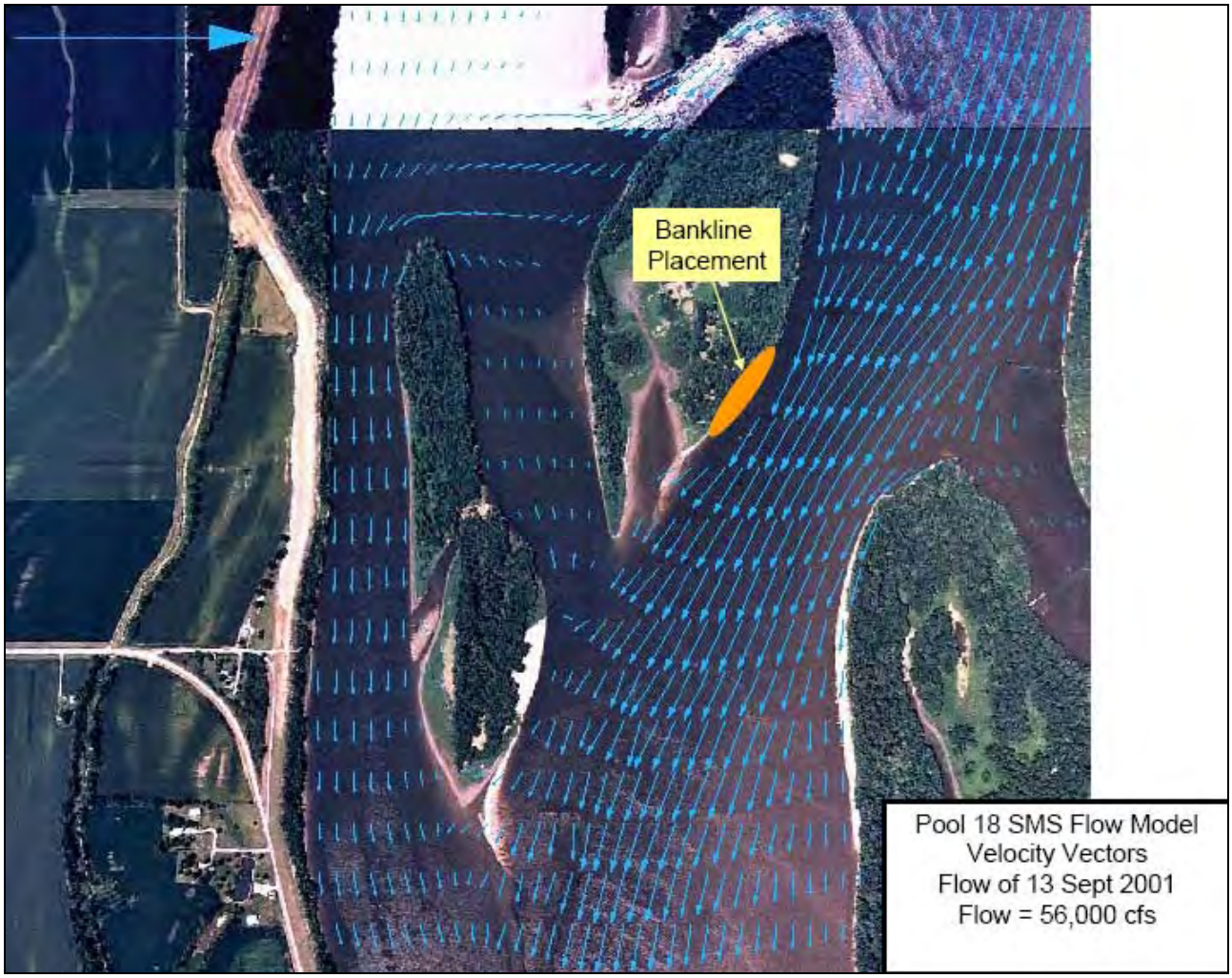

Figure 8. Hydraulic model output displays relative current velocity and direction. Note flow lines backing into secondary channel in the center of the image; these were the sediment transport issues of concern to fisheries managers.

Figure 9. Cumulative Results of Analysis for Dyed Sand Grains From All Sampling Events

Results from this study were also compared to the numerical model, and the locations where dyed sand was found agreed well with numerical simulations in the area near the placement site. Attempts to match micromodel simulations of sand deposition distant from the placement site were not successful. This may have resulted from sampling limitations which prevented intensive sampling over the large area downstream from the placement site.

Conclusions and Recommendations. Dyed sand tracking and hydraulic modeling confirm that sediment transport from the shoreline upstream for a short distance into a side channel can occur. This particular flow pattern at the tip of Jacoby Island is a localized phenomenon. It can occur in side channels which experience greater head loss than the main channel, causing lower water levels than the main channel. This can cause water and sediment from the main channel to move upstream for short distances, towards the side channel having lower water levels. The sediment transport studies were not entirely conclusive because relatively few samples were examined compared to the large area where material from the placement site could potentially move. It is likely that some areas which contained dyed sand were not sampled intensively enough to detect the dyed material. Another limitation was the inability to determine if material which erodes from the placement site and deposits down current/down slope stays at those locations or is re-suspended and eventually moves. These deficiencies could be addressed by sampling over a longer period of time, but that would be expensive and yield low power to detect change. Finally, hydraulic conditions are site specific and factors causing sediment transport at the Camp Island placement site may be different at other placement sites. It would be very costly to conduct similar tracer studies at other locations.

A practical approach to address these limitations may be to predict how dredged material moves from placement sites through model studies, in combination with limited field verification. This study suggests that because migration of dredged material back into the river occurs, river velocity, localized flow patterns, material characteristics and proximity of the placement site to the navigation channel will influence how placed material migrates. In addition, since the UMR and IWW move such tremendous quantities of bedload, material which migrates from a placement site quickly becomes incorporated into and indistinguishable from this massive bedload.

B. VEGETATION COMPONENT

Objectives. Plant communities are distributed within the environment in relation to other plant communities and according to a wide range of environmental conditions. For example, variations in soil texture, chemical and nutrient composition, depth and timing of material placement, degree of flooding, and distance to the water table are some of the factors that influence plant communities. Examples of these communities in relative order by moisture/water levels include: submersed and floating leaved aquatic vegetation, emergent aquatic vegetation, marsh, sedge meadow, shrub/scrub, willow, cottonwood, floodplain forest (silver maple, elm, green ash, etc.), lowland forest (northern pecan, pin oak, swamp white oak, etc.), upland forest (white oak, basswood, sugar maple, etc.), and sand prairie. The 404 Vegetation Studies were undertaken to understand the soil/sediment factors influencing plant succession on dredged material placement sites.

In 1996 and 1997, nearly 100 historic placement sites throughout the District were reviewed by the 404 Team for consideration as vegetation study areas. Site characteristics were extremely varied. In many areas, material placement depths were shallow; however, other areas had as much as 16 feet of

material. Plant communities developed in all placement areas, but there was great variability in their species composition. The 404 Study Team agreed that an in-depth investigation was in order, and in 1999 a study plan was developed (Rosburg 2003). This study investigated the effect of placement on vegetation in both the UMR and the IWW (figure 10) including sites of varying age, depth of placement, and geography.

Figure 10. Vegetation Sampling Along Transects Crossing Dredged Material Placement Sites

Vegetation development on placement sites can be greatly affected by soil treatments. Given this assumption, two primary objectives were developed. The first objective was to evaluate soil development on sites that had been used for placement. The second was to establish trends regarding the effect of dredged material placement on floodplain vegetation, and in particular, establish which characteristics of the dredged material substrates (i.e., soil type, soil depth, time since placement, etc.) may be correlated with impacts to woody and herbaceous vegetation. Information collected was analyzed to identify the importance of these various factors in determining the effects of material placement on existing plant communities and the kinds of plant communities that would develop on similar sites in the future.

Methods. The approach was to observe and compare existing soil and vegetation on both natural floodplain habitats (reference sites) and a variety of placement sites that represent a range of ages, depths, and locations. Transects were established that crossed the dredge material placement sites at their maximum depth and varied in length according to the size of the placement site. Reference transects were established on natural floodplain habitat/reference sites adjacent to the placement sites. Field data collection encompassed the following primary tasks:

1) plant species composition and structure of vegetation communities.
2) soil texture, soil pH, organic content, and soil nutrients.
3) elevation and slope.

The topographic and elevation data obtained in task 3 provided an indirect assessment of the material placement depth and flooding regime for soil and plant community samples. Additional important environmental variables specific to each study site were the amount of time since placement and biogeography (represented by latitude and longitude).

Univariate statistics, regressions, correlations, and diversity and community similarity measurements were compiled and compared between the reference and placement sites. Multivariate ordination techniques were used to identify vegetation gradients and illustrate the pattern of variation in species composition among and within transects, as well as to characterize how environmental factors are correlated with species composition.

Results. This study indicates the amount of time since dredged material placement is less of a factor on vegetation community development than environmental factors such as flooding, siltation, and soil development. Paired sample comparisons showed that placement had a substantial effect on the environment, both in terms of changing the flooding regime as well as changing soil characteristics. Flooding frequency and intensity was greater on the UMR than on the IWW. Within the IWW, flooding frequency and intensity is greater at downstream locations than at upstream locations. As expected, the placement of dredged material at a site decreases the frequency and duration of inundation at that site. Flood events of nearly all inundation periods occurred more frequently on the reference sites than on the placement sites. Incidental with this is a greater cumulative depth of water on the reference than the placement sites. Most soil/sediment factors were significantly different at placement sites than reference sites. Dredge material consisted mainly of various sizes of sand dredged from the navigation channel of the UMR and IWW. Consequently, placement sites had decreasing silt and clay texture and lower nutrient and organic matter content as the amount of sand increased (table 2).

Table 2. Comparisons of Soil/Sediment Factors Between Reference (R) and Placement (P) Transects (100 M) Among All Sites

	0-15 cm		**15-30 cm**		**30-60 cm**	
Soil Variable	**R**	**P**	**R**	**P**	**R**	**P**
PO3 ppm	64	40	44	39	41.5	27
Ca ppm	4,260	2,700	3,850	2,160	3,420	2,090
Mg ppm	504	262	508	204	484	191
K ppm	113	85	92	55	79	44
SO4 ppm	43	19	29	14	26	15
Zn ppm	10	6	9	5	7	3
Fe ppm	92	47	86	44	72	41
Mn ppm	9	7	9	5	10	5
Cu ppm	2	1	2	1	2	1
NO3 ppm	51	38	27	16	16	10
% organic	4	2	3	1	2	1
% sand	27	65	33	71	40	72
% silt	52	25	45	20	40	19
% clay	21	10	22	9	20	9

In some cases, the plant community changed dramatically, and in others, the placement communities were well within the range of variation expected for floodplain communities. The placement of dredged material only significantly changed about half of the sites; the other half exhibited some minor vegetation change (fluctuation) but remained compositionally similar to floodplain forest vegetation. Portions of all placement sites, and indeed some entire transects, are essentially unchanged from the possible variants of natural floodplain forests. The initial community and depth of placement were the strongest determinants of the differences. The largest overall change was the establishment of sand flora communities. Placement effects were least dynamic on small trees and most dynamic on the herbaceous layer. Placement sites favor the establishment of stress tolerant plant species (S-selected), native or exotic. Wetland or hydric species status was reduced at all placement sites compared to reference sites.

Conclusions and Recommendations. Specific hydrological, topographical, biogeographical, and historical factors were identified as important factors affecting soil fertility, soil texture, and plant population size and diversity. Environmental factors have the most impact on soils and vegetation, (such as increasing elevation, and changing flood/inundation frequency, flood depth, and longitude) followed by increasing placement depth and time since placement. This held true for both reference and placement sites. Hydrology is a major factor in affecting vegetation because of its large variation over the study area. Flooding was extremely variable on both the UMR and IWW floodplains. Consequently, with respect to inundation, placement cannot create more variation than already exists naturally on the UMR and IWW floodplains. Placement, does however, decrease the frequency and duration of flooding/inundation as evidenced by flood events occurring more frequently on reference than placement sites. Accompanying this is a greater cumulative depth of water (about four times) on the reference sites than on the placement sites. Inundation differences between reference and placement on the IWW was less frequently observed than on the UMR, perhaps because the IWW exhibited less flooding than the UMR.

The channel maintenance community will need to continue weighing the environmental effects of placing a greater depth of dredged material over a small area versus the same volume of dredged material spread to a lesser depth but over a greater area. An overall recommendation for this cannot be made as this study also showed that the plant community at placement sites covered the gamut from significant deviation from reference sites to being virtually indistinguishable. This study also indicated placement sites can recover from placement activities as shown by the variable “time from placement” and was less important on vegetation community development than soil/sediment variables.

Despite the complex nature of the biological response to dredged material placement indicated in this study, attempts to utilize the results and modify placement design should be continued. The depth of placement is one factor that can be controlled in a placement. Establishing a placement depth shallow enough to be covered or mostly inundated by floodwaters may help augment the more sterile nature of sandier material. Johnson Island in Pool 18, a mound and swale placement, provides some anecdotal support to this theory. Since placement in 2002, the lower portions of the mounds have had several inches of silty material deposited from several smaller high water events. This ring has flourished with typical floodplain vegetation including poison ivy, nettle and woody seedlings like silver maple and American elm. Comparing the depth of placement to allow for inundation by floodwaters to the operational constraints of the placement will have to be evaluated on a case-by case basis. Capping

sites with fine material is another previously utilized placement option worthy of continued consideration. The fine material is intended to help establish desired vegetation on site.

The Rock Island District will continue to share information and data on best management practices and successes (e.g. mound and swale placement at Johnson Island) with all appropriate resource agencies, and continue to solicit their input to reduce impacts from dredged material placement.

C. MACROINVERTEBRATE COMPONENT

Objectives. Macroinvertebrates are an important component in aquatic food webs because many are primary consumers that convert plant energy into animal matter that is consumed by most fish and many water birds. They also break down organic matter and contribute to important waste decomposition and assimilation functions. They are an extremely diverse group of organisms, with forms adapted to the many types of aquatic habitats present in large river systems. They include insects that are aquatic all or part of their life cycle as well as snails, aquatic worms, and scuds. The macroinvertebrate community of interest to the 404 Study Team was the unstructured shoreline community typical of bankline dredged material placement sites. Site characteristics range from shifting unstructured sandy banks to quieter silty clay substrates that meet forested banklines or form channel border areas. Frequently, a few specially adapted species dominate the community and may even occur at high densities.

The 404 Team's goal was to identify the potential impacts of dredged material placement on macroinvertebrate communities in the UMR and IWW. The primary objective was to identify differences between communities found in placement sites and those from similar bankline reference sites where placement had not occurred. The studies were also designed to provide insight into the relationship of macroinvertebrate densities to substrate type.

Methods. Since 1997, five related studies have been conducted to address impacts of dredged material placement on macroinvertebrate communities. Studies were completed on the La Grange Pool of the IWW during 1997 (Stevenson et al. 1998), 1998 (Stevenson and Koel 1999), and 2005 (Lambrecht and Elzinga 2006). The Stevenson et al. study focused on the comparison of macroinvertebrate samples from 161 randomly selected sites during spring of 1997, and 35 randomly selected sites during late fall of 1997. The Stevenson and Koel study focused on the comparison of macroinvertebrate samples from late fall 1997 sampling and a new sampling of 36 randomly selected sites in late fall of 1998. The Lambrecht and Elzinga study concentrated on two sites (Devil's Elbow IWW), a placement site and reference site, where 30 samples were collected from each. The Devil's Elbow sites were sampled in Jan 2005. The placement site last had dredged material placed on it in 2002, and the reference site was last used for dredged material placement in 1995.

Macroinvertebrate impact assessments in the UMR were conducted during 2001 and 2002 at a Pool 21 channel border area at Hogback Island that had previously been used for dredged material placement (Vile and Elzinga 2002, Elzinga 2003). Prior to taking the substrate samples for this study, Hogback Island had dredged material placed there August 2000. A bankline section of Long Island, undisturbed by dredged material placement, was selected as the reference site. The UMR studies collected 30 randomly spaced bottom samples from each of the two sites.

Substrate type for each sample was noted in the field. In the first two IWW studies, samples were washed in the field through a 1-mm mesh sieve. Macroinvertebrates were then sorted from the substrate and detritus and preserved. All identification and enumeration was completed in the field. In the subsequent studies, samples were washed in the field through a #30 (approximately 0.6 mm) mesh sieve and preserved; macroinvertebrates were sorted from substrate and detritus in the laboratory under a 2x illuminated magnifier. Taxonomic identification, enumeration, and recording of data were completed in the lab. This work included more detailed taxonomic analysis than the first IWW studies to determine the community present in the main channel bankline habitats. Analyses included community composition, abundance, and relation to sediment type. Placement and reference sites were compared.

Results. The results of the Stevenson et al and the Stevenson and Koel studies on the IWW indicated macroinvertebrate densities were highest at sites which had never received dredged material (reference) and lowest at sites that had received dredged material (placement) during the year of sampling. Based on results from both studies, the overall abundance (table 3) and diversity of macroinvertebrates were higher at reference sites that had never received dredged material. These studies also noted difference in total macroinvertebrate density relative to substrate type, noting that while the differences varied somewhat among different species, higher densities of macroinvertebrates were generally found in silt/clay substrates as compared to sandy ones. Macroinvertebrate densities were extremely low in all IWW sites indicating sampling methods were not applicable to the environment or that the IWW has extremely low macroinvertebrate density. Macroinvertebrate densities are lower in the La Grange Reach compared to other Long Term Resource Monitoring Program sites (Sauer 2004). However, the methods were considered inappropriate to site conditions considered by the 404 investigations; the large mesh allowed organisms in sand habitats to wash through during rinsing.

Work in the IWW was conducted once more during 2005 using different methods (Lambrecht and Elzinga 2006). Sampling used smaller mesh to rinse samples, and picking in the lab, to determine the relative density of IWW macroinvertebrates in dredged material bankline placement sites and reference sites. Results from the Devil's Elbow, IWW showed much higher macroinvertebrate densities at the placement and reference site (table 3) than previous IWW studies. There was a significantly higher density of macroinvertebrates at the placement site compared to the reference site. Both placement site and reference site were relatively high in total abundance and mean densities, and had moderate richness and diversity. Without conducting detailed spatial analysis, the distribution of invertebrates seemed even throughout the placement and reference sites (figure 11). To summarize, although mean densities differed somewhat between placement and reference areas, similar richness and diversity levels, and similar taxonomic compositions were noted from each. The results did not suggest that markedly different macroinvertebrate communities were present in the two Devil's Elbow study areas. Both areas contained macroinvertebrate communities adapted to disturbance, so dredging activities likely have minimal adverse effects.

Table 3. Macroinvertebrate Densities in IWW Channel Border Sites Receiving Dredged Material (Placement) or Not (Reference) During Three Sampling Events

Year	Placement	Reference
1997 (November)	$3.5/m^2$	$7.9/m^2$
1998	$30/m^2$	$72/m^2$
2005 *	$999/m^2$	$671/m^2$

* change in methods

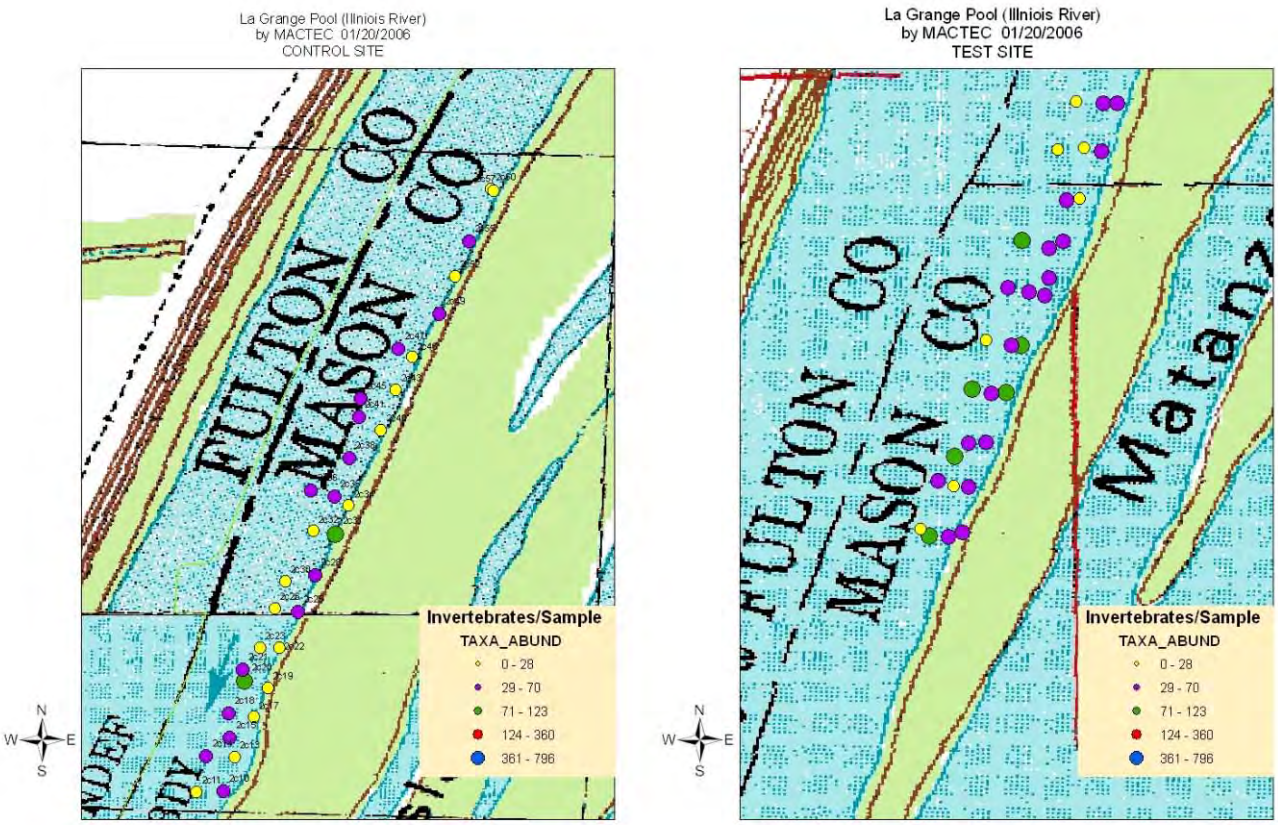

Figure 11. Distribution of Total Macroinvertebrate Abundance in Samples Collected at the La Grange Pool Placement Site and Reference Site During Spring 1997, Fall 1997, Fall 1998 and 2005 Sampling Events

The results of the UMR studies differed from those of the first IWW studies because of differences in sampling procedures. Macroinvertebrate densities were two orders of magnitude higher on the UMR sites—less than $10/m^2$ in La Grange Pool to more than $1{,}000/m^2$ in Pool 21. The pre-placement study in Pool 21 found that the placement site (Hogback Island) was characterized by a higher abundance (table 4), with a more diverse macroinvertebrate population than the reference site. This study also did not find a correlation between overall population abundance and substrate type; although it notes that the abundance of individual species such as flat worms and caddis flies was significantly related to substrate type. The post-placement study in Pool 21 indicated no significant difference between the placement and reference site. However, this study did find a strong correlation between macroinvertebrate density and substrate composition. Relative abundances of invertebrate samples were quite variable from 2002 Hogback Island and Long Island collections (figures 12 and 13).

Table 4. Macroinvertebrate Densities at Placement Sites Where Dredged Material Was Placed and Reference Sites Where No Material Was Placed in Pool 21 Channel Border Areas During Pre-Placement and Post-Placement Periods

Site	2001 Pre-Placement	2002 Post-Placement
Long Island (reference)	917/m^2	1,744/m^2
Hogback Island (placement)	4,014/ m^2	1,381/ m^2

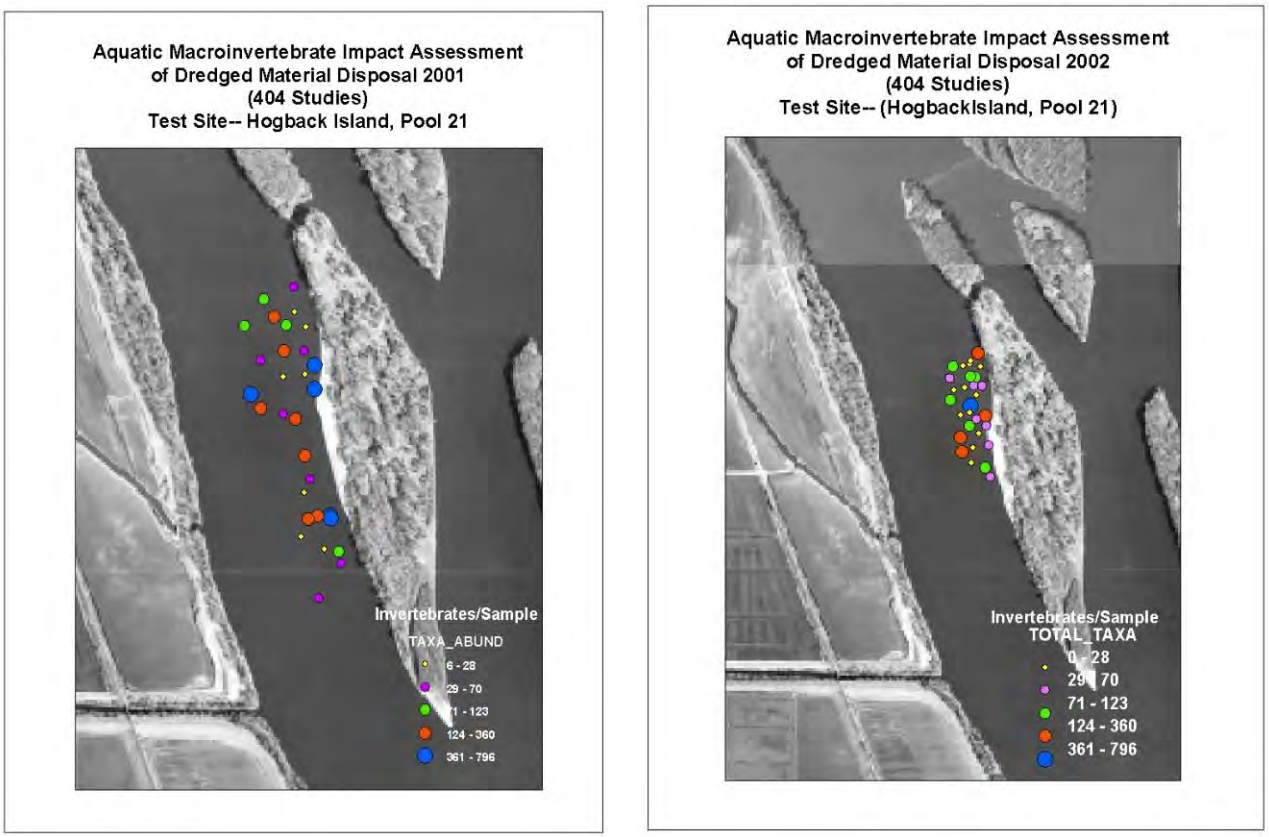

Figure 12. Distribution of Total Macroinvertebrate Abundance in Samples Collected at Hogback Island Pool 21 Placement Site During Pre-Placement (2001) and Post-Placement (2002) Sampling Events (Total abundance is the same as total taxa.)

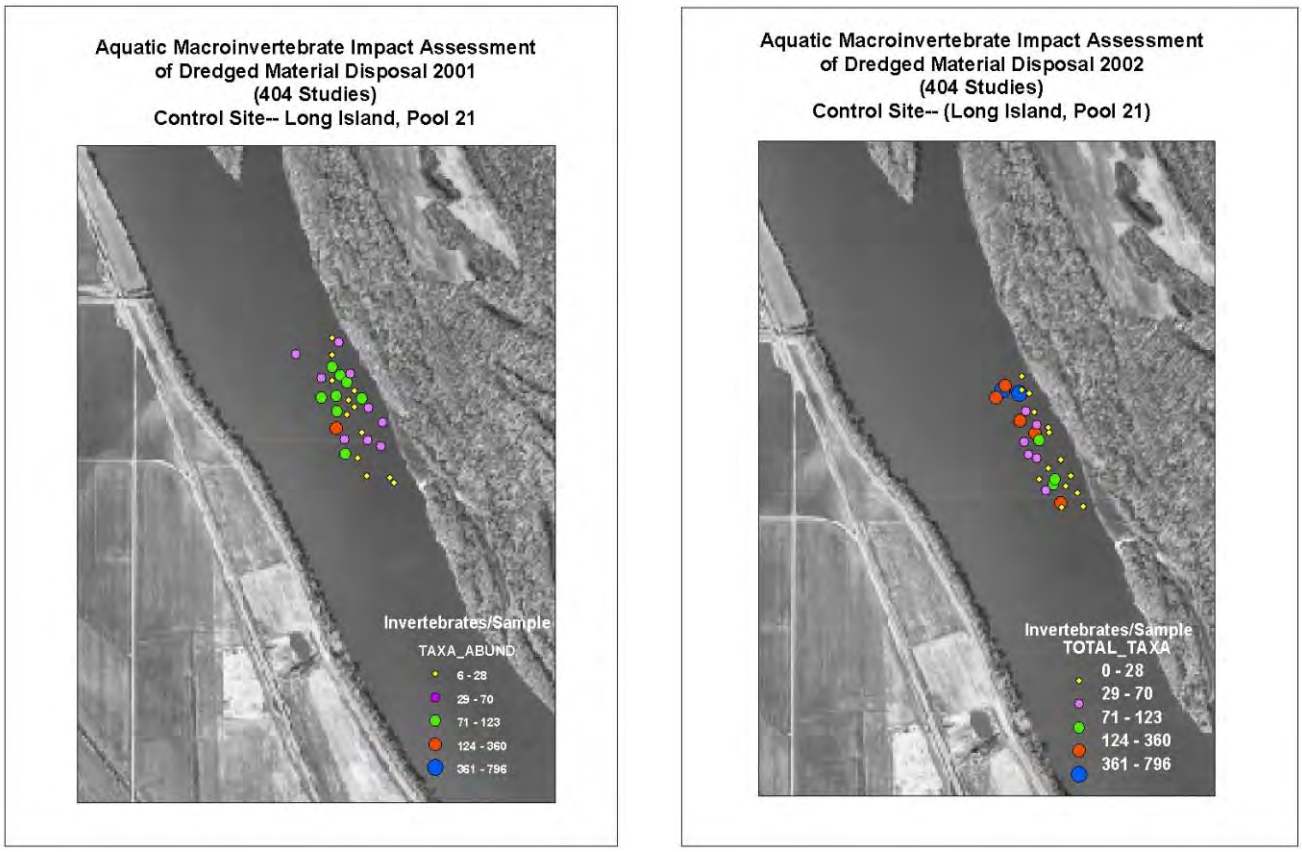

Figure 13. Distribution of Total Macroinvertebrate Abundance in Samples Collected at Long Island Pool 21 Reference Site During Pre-Placement (2001) and Post-Placement (2002) Sampling Events (Total abundance is the same measure as total taxa.)

Conclusions and Recommendations. Differences in sampling methods between the first La Grange Pool studies and the UMR and last La Grange Pool study played an important role in the results obtained. The 404 Study Team acknowledged the use of the larger mesh screen to wash the samples in the field caused a significant number of smaller macroinvertebrates to be washed away. Studies using fine meshed sieves detected much higher densities of invertebrates in both Pool 21 and La Grange pools than initial studies in La Grange Pool.

Results comparing macroinvertebrate density were mixed. The first studies on the IWW detected significantly more macroinvertebrates at reference sites than placement sites. Significant differences detected in later studies, using more appropriate methods, showed significantly more macroinvertebrates at some placement sites. Differences in Pool 21 were diminished and not detected following dredged material placement because macroinvertebrate density at the placement site declined to a level similar to the reference site. While precise ecological significance changes in channel border macroinvertebrate communities is unknown, the absolute range of changes is relatively small. This suggests that placement of sandy material on top of substrate that is primarily composed of sand is less detrimental than depositing sandy material on non-sandy substrates. This is further supported in the "weight of evidence" approach that the District's principle of placing "sand-on-sand" is preferable whenever feasible. Further studies focusing on placement sites where sandy material

must be placed on non-sandy substrate would be beneficial but extensive studies over multiple years would be needed to adequately assess placement and reference sites to achieve scientifically valid results. The team recommends that resources be focused elsewhere as the impact to invertebrates appears to be much less than originally thought. The 404 Team recommends resources be directed elsewhere, since impacts appear less/lower than expected.

D. MUSSEL COMPONENT

Objectives. Freshwater mussels are relatively immobile creatures that live part buried on the bottom of rivers and streams where they siphon water and suspended matter. In the United States, 69 of 304 (23 percent) mussel species are listed as federally endangered or threatened, making freshwater mussels one of the most imperiled groups of animals in North America (U.S. Fish and Wildlife Service, http://www.fws.gov/midwest/mussel/faq.html). On the UMR, there are currently four federally listed species, the Higgins' Eye pearly mussel (*Lampsilis higginsi*), winged maple leaf (*Quadrula fragosa*), fat pocketbook (*Potamilus capax*), and the scaleshell (*Leptodea leptodon*). Two more species are candidates for listing, the spectaclecase (*Cumberlandica monodonta*), and the sheepnose (*Plethobasus cyphyus*). Aggregations of sensitive mussel species may indicate good conditions, and vice versa because freshwater mussels are considered good indicators of water quality. Mussels species are sedentary and span a wide range of hydrogeomorphical conditions. Important hydrogeomorphical factors include water depth, current velocity, substrate type, and water quality. An area must also provide adequate food supply for mussel beds to develop. Recently, competition with non-native species, especially zebra mussels (*Dreissena polymorpha*) and Asiatic clams (*Corbicula fluminea*) has become important. The U.S. Fish and Wildlife Service has issued a jeopardy finding against the Corps for navigation mediated dispersal of zebra mussels up the UMR from the IWW. In the UMR, impoundment for navigation, channel training, dredging and material placement can alter significant components of mussel habitat. Dredging, placement, or changed water quality can have large impacts if that activity occurs on or near mussel beds. The 404 Study Team proposed studies to characterize mussel assemblages by site type, evaluate impacts between placement areas and other areas, and evaluate colonization rates.

Methods. Investigations of dredging and material placement impacts were designed to assess placement sites and reference sites (adjacent to placement sites) population characteristics in dredged areas, placement areas of various ages, and reference sites. The studies used similar rapid assessment timed diver survey methods, but differed in sampling strategies (figure 14). The first study (Eckblad 1999) could be viewed as a reconnaissance survey that targeted a few (four samples per site) short duration dives at 36 historic placement sites to identify presence or absence of mussels. The second study (ESI 2000) concentrated on increased diving effort (eight samples per site) at 14 dredged material placement areas to quantify abundance. The third study allocated similar effort (10 samples at 10 sites) but concentrated on thalweg sites (the deep centerline of the main channel). Each study had high sample variance because freshwater mussels have clumped distributions, but each study also tried to increase power to detect differences by increasing sample size within study sites. A fourth study conducted entirely in Pool 18 was designed to: 1) characterize mussel assemblages at dredged material placement sites and compare them to adjacent "non-impacted" sites; 2) evaluate impacts from placement; and 3) evaluate recolonization rates based on age and assemblage structure.

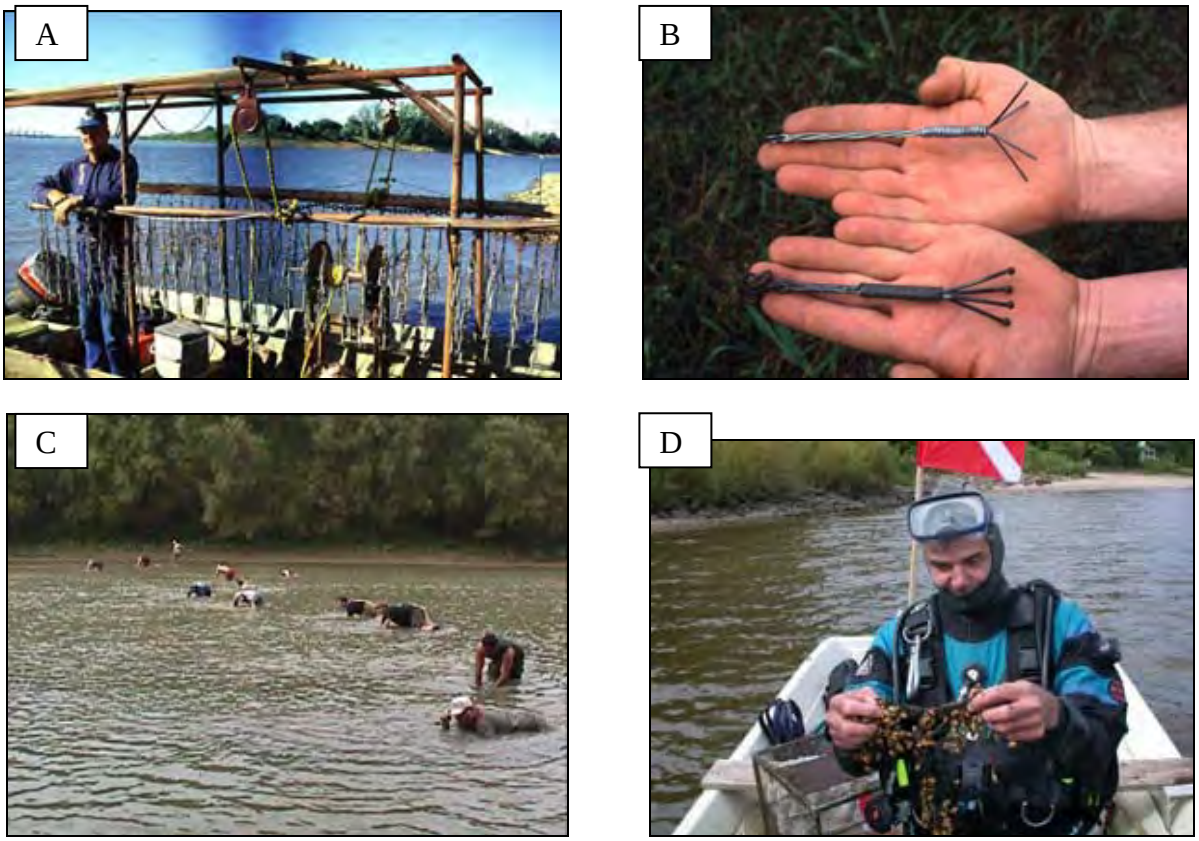

Figure 14. (A) Typical Brailing Set Up for Sampling Freshwater Mussels; (B) Two Types of Brail Hooks Used To Collect Mussels; (C) Shallow Water Sampling of Mussels; (D) Divers

Results. The first study found no significant correlation between mussel colonization of dredged material placement areas and the number of years since placement (figure 15) however, the overall numbers of mussels collected was low. In most cases, there were one to three dominant mussel species, which resulted in relatively steep initial relative abundance curves (both placement site and reference site) from all three site categories. The highest species evenness was seen at Category III sites, for both the placement (slope = - 0.071) and the adjacent reference site (slope = -0.099) samples (figure 15). Species diversity calculations ranged widely at the 36 sites with the highest total category values recorded for Category III (figure 15). The reconnaissance survey confirmed the clumped distribution of freshwater mussels, finding 80 percent in only 9 percent of the samples. Eckblad (1999), like the others, encountered high variance and could not make strong conclusions, but he did find that mussel distributions appeared correlated with current velocity, substrate, and depth, and that major groups of species were differently distributed along these characteristics. The 404 Study Team agreed that although this study provided useful insight into post-placement colonization trends, the sample size needed to be increased to produce statistically reliable results.

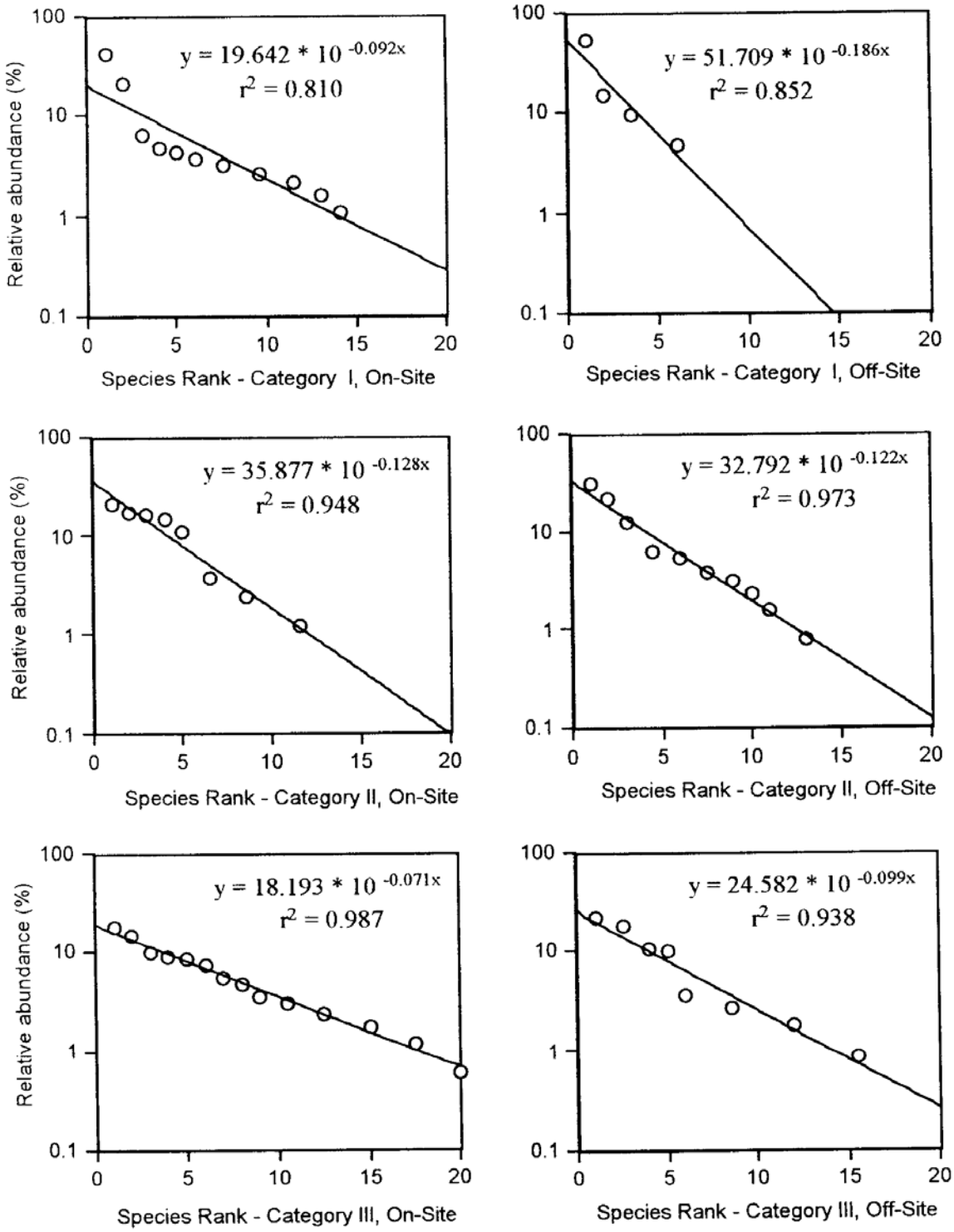

Figure 15. Mussel Species Rank and Percent Relative Abundance Plots for Placement and Adjacent Reference Locations from Category I-III Sites

Category I = material placement within 5 years
Category II = material placement within 5-10 years
Category III = material placement > 15 years

The second study captured more mussels and found that mussel abundance and diversity was similar between placement and reference sites (table 5). Sample variance was high, but few differences were detected between placement and reference sites. The report concluded "[w]hile support for most hypotheses positing that dredge maintenance activities impact unionid communities was generally weak, qualifying factors and contrary trends are sufficient to caution concluding that unionids are minimally affected by dredging" (ESI 2000). It also identified separate communities of mussels more tolerant of shifting substrates. This reiterates the Districts' approach that site conditions should be considered in all dredging activities. The study suggested that larger sample sizes were needed to achieve statistical reliability.

Table 5. Paired T-Test Statistics for the Significance of the Mean Difference Within Species Between Material Placement and Reference CPUE [1]

Species	Mean Difference[2]	Mean SD	Df	P
Amblema p. plicata	-3.67	15.48	11	0.43
Fusconaia flava	2.00	5.37	7	0.33
Magalonaias nervosa	-.75	2.06	3	0.52
Quadrula matanevra	-1.67	2.31	2	0.34
Quadrula nodulata	-3.17	10.63	5	0.50
Quadrula p. pustulosa	-2.88	3.92	8	0.06
Quadrula quadrula	2.20	25.24	9	0.79
Arcidens confragosus	1.25	3.30	3	0.50
Lasmigona c. complanata	0.40	3.78	4	0.83
Pyganodon grandis	1.83	6.15	5	0.50
Utterbackia imbecillis	Na	na	Na	na
Ellipsaria lineolata	-19.25	29.02	3	0.28
Lampsilis cardium	4.80	9.93	9	0.16
Lampsilis higginsi	Na	na	Na	na
Leptodea fragilis	2.22	9.22	8	0.49
Liqumia recta	0.25	2.22	3	0.84
Obovaria olivaria	1.13	9.89	7	0.76
Obliquaria reflexa	-2.25	15.78	11	0.63
Potamilus alatus	Na	na	Na	na
Potamilus ohiensis	-3.60	6.66	4	0.29
Truncilla donaciformis	-2.50	4.95	1	0.61
Truncilla truncata	Na	na	Na	na

[1] 10 min search effort
[2] negative mean differences significantly larger mean CPUE in reference searches
Sites without a given species in both categories were omitted;
na - insufficient data to test

The third study found that there were some differences in mussel communities in thalweg placement sites versus thalweg sites undisturbed by dredged material placement, but that the differences appeared

to be due to environmental factors rather than the direct placement of dredged material. The study also found that thalweg colonization tends to be sparse, individuals found were "probably represent transient individuals rather than stable unionid communities" (Harding/ESE, Inc 2003). A primary conclusion was: "Since none of the thalweg sites supports a stable unionid community, dredge material placement at any of the thalweg sites is not likely to severely impact UMR unionid communities. However, impacts at some sites could be greater than others." This highlights the need to consider site-specific information before initiating dredging activities.

The Pool 18 study concluded that unionid assemblages on dredge material placement sites contained a higher number and diversity than reference areas (table 6). The study hypothesis that unionid assemblages on dredged material placement sites would be less abundant or diverse in adjacent reference areas was not supported at any of the three test sites (Jacoby, Camp, and Huron Islands). Differences in the catch rates of subfamily groups or major species did not differ statistically between placement sites and reference locations at any of the three sampling areas. Finally, mussel assemblages at placement sites and reference locations were relatively similar at Jacoby and Huron Islands; only at Camp Island was the placement site mussel assemblage inferior to the reference mussel assemblage. Sampling effort differed markedly at Camp Island site, with four of nine transects, but only 12 of 103 transect intervals, considered to be representative of dredged material placement conditions. Thus, the unionid patterns at Camp Island may be as attributable to effort variation as to the effects of dredged material placement.

Variation in unionid assemblage was related to habitat variables such as water depth and substrate composition, but the associations differed at different study sites; this suggests that these types of variables are important at the microhabitat level, but that patterns of association are not predictable on a large geographic scale (table 7). This study, like past studies on the UMR, did not have sufficient sample sizes in all treatment groups to definitively support or refute the hypotheses considered. However, it provided evidence of unionid colonization in areas where dredge material has been placed in the UMR. No federally-listed threatened or endangered species were found during the study.

Table 6. Summary of Kruskal-Wallis Tests of Differences in Total Abundance and Species Richness Between Areas With and Without Material Placement at Each Study Site, 2005

Study Area / Variable	Material Placement (n)	Reference (n)	H-value	P	Result
Jacoby Island					
Total Abundance	35	97	7.13	0.008	Higher in placement
Species Richness	35	97	5.81	0.016	Higher in placement
Camp Island					
Total Abundance	12	91	0.24	0.625	No difference
Species Richness	12	91	0.20	0.658	No difference
Huron Island					
Total Abundance	23	47	25.02	0.000	Higher in placement
Species richness	23	47	24.77	0.000	Higher in placement

Table 7. Correlations Between Unionid Assemblage Variables (Total Abundance and Species Richness) and Habitat Variables at Each of the Three Study Areas, 2005

Study Area	Assemblage Variable	Abiotic Variable	R	p	Assemblage Variable	Abiotic Variable	R	p
Jacoby Island (n=132)	Abundance	Sample depth	0.039	0.656	Richness	Sample depth	0.038	0.662
		% Sand	0.311	0.000		% Sand	0.349	0.000
		% Silt/clay	-0.306	0.000		% Silt/clay	-0.351	0.000
		% Gravel/cobble	-0.032	0.717		% Gravel/cobble	0.009	0.919
Camp Island (n = 103)	Abundance	Sample depth	-0.267	0.006	Richness	Sample depth	-0.372	0.000
		% Sand	-0.206	0.037		% Sand	-0.179	0.071
		% Silt/clay	0.278	0.004		% Silt/clay	0.274	0.005
		% Gravel/cobble	-0.151	0.128		% Gravel/cobble	-0.208	0.035
Huron Island (n = 70)	Abundance	Sample depth	-0.377	0.001	Richness	Sample depth	-0.475	0.000
		% Sand	-0.320	0.007		% Sand	-0.445	0.000
		% Silt/clay	0.294	0.014		% Silt/clay	0.355	0.003
		% Gravel/cobble	0.112	0.357		% Gravel/cobble	0.227	0.059

Conclusions and Recommendations. These studies represent a systematic review of mussel resources at Rock Island District dredging locations. The stepwise progression from reconnaissance to more specific studies followed the 404 Study Team recommendations. Despite high sampling variability, the results were in general, sufficiently consistent to identify important sites and reinforce some beliefs regarding conditions favorable to mussel communities. The studies indicate that thalweg placement is a lower-risk option where mussels are concerned because mussels are uncommon and may be transient species. The thalweg area typically has high shear stress and therefore does not support a stable mussel community. Channel border areas were found to be more suitable habitat than the thalweg, as indicated by abundance, but mussel distribution was quite patchy. Specific sediment factors determining mussel abundance or colonization could not be conclusively identified.

Another positive although tentative result was the evidence that mussels use placement sites in numbers similar to reference sites. This provides an important line of evidence that aquatic species use placement sites and such sites do not remain barren. The Rock Island District should perform mussel surveys at historic bankline placement sites prior to placement, if 5 years or more has elapsed since the last previous placement.

E. FISHERIES COMPONENT

Objectives. Upper Mississippi River fishes have been scientifically investigated for more than a century, but none of the studies examined the effect of channel maintenance dredging on fish. Prior to the 404 Studies, the best available information regarding fish abundance was a standing stock assessment of Pools 5a, 6, 8, 13, 14, 18, 22 and the Open River based on rotenone and primacord work done at 25 sites (Pitlo 1987). These results have been extrapolated to channel border placement sites to demonstrate potential impact to fisheries, but the 404 Study Team studied the site-specific effects of dredged material placement on the fish community at several locations to determine if the response was similar in separate parts of the river system. Fish are highly mobile, and thus can move from the impact area and return following the dredging event or else find similar nearby habitat. The 404 Fish Studies were done to improve the assessment of fisheries impacts from bankline dredged material placement on individual fish species and assemblages through a series of targeted studies to examine fish displacement and habitat alteration over time.

Methods. Yess et al. (1999, 2000, 2001) sampled fish at two sites on the UMR – Island 241 near RM 562 (placement site) and Hale Island near RM 563 (reference site). Island 241 was selected for this study because it had been greater than 7 years since dredged material placement had occurred and channel maintenance requirements made it likely that dredging and placement at this location would be considered in the near future. Hale Island was a reference site that shared similar physical characteristics with Island 241, providing the opportunity to compare pre- and post-placement assemblages to a nearby reference site. The 1998 and 1999 studies focused on sample collections to establish pre-placement characteristics of the fish assemblages. In October 1999, channel maintenance dredging and placement took place at Island 241 prior to fish sampling. Thus, the October 1999 sample and the following samples taken in 2000 provided post-placement data.

Sampling gear included electrofishing, mini-fyke nets and baited hoop nets (figure 16) using techniques standardized for the Long Term Resources Monitoring Program (LTRMP, Gutreuter et al. 1995). Fisheries data were collected at the placement and reference sites over a 4 to 5 day sampling

period each month from March - October 1998, and April - October 1999, and 2000. Sampling locations were fixed over the study (e.g., electrofishing runs occurred in the same location each month). Fish habitat was subjectively quantified within 50 m of shore at both sites and petite ponar grab samples were used to characterize substrate changes along transects perpendicular to shore. Water temperature, dissolved oxygen, current velocities, secchi disk transparency, and conductivity were measured daily during each sampling event. Depth profile surveys were also performed by the District once during the pre-placement period and once post-placement.

Figure 16. Field Crews Retrieving Hoop Nets

Temporal and gear related catch statistics, (e.g., catch per unit effort [CPUE]), were prepared to estimate several population characteristics of certain fish species and guilds of species at the placement and reference study sites. These included species and relative family abundance, species composition, diversity, length frequency distributions, biomass composition, and length-weight relationships. The 404 Team pre-selected "key" species analyzed in this and the following fish studies. Key species were common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*), mimic shiner (*Notropis vollucellus*), shorthead redhorse (*Moxostoma macrolepidotum*), bluegill (*Lepomis macrochirus*), white bass (*Morone chrysops*), sauger (*Sander canadense*), freshwater drum (*Aplodinotus grunniens*), and three guilds (forage, rough, and sport fish).

A second 3-year study to assess the short-term effects of dredged material placement took place from 2001 through 2003 at Senate Island on the IWW, (RM 130.0L) and at Hogback/Long Island (RM 331.7L) on the UMR, each with a placement and reference site, to investigate whether the results from the Island 241 study apply in other parts of the system. Conover et al. (2002) and Caswell et al. (2003, 2004) collected fisheries and water quality data at each site once a month from April through October 2001; April through November 2002; and April through October 2003. Dredged material was placed at both study areas in September 2002. Post-placement sampling on both rivers was initiated within 24 hours after completion of the placement. Therefore, 3 months of post-placement sampling took place in 2002 and 7 months of post-placement sampling took place in 2003. Sampling methods and

data analysis for the new study were similar to those used in the previous study, except that netting was limited to mini-fyke nets. The 404 Team recommended the same guild designations as the previous study although key species targeted for analysis changed to include only bluegill, white bass, and freshwater drum. In addition, effects of dredged material placement at both sites were evaluated using pre- and post-placement data with Before-After Control-Impact (BACI) analyses on species richness, diversity, and the abundance of selected species (Stewart-Oaten et al. 1986).

In 2004 (Bowler et al. 2005), the 404 studies returned to the first study sites (Island 241 and Hale Island) to determine whether long term effects on post-placement fish assemblages could be detected. Since the earlier study, dredged material was placed at the same location on Island 241 during late August 2002. Again, sampling methods followed earlier studies and was conducted from March to October 2004. Data analysis was also similar to the previous 404 studies regarding abundance, diversity, size distribution and catch composition. Additionally, Bowler et al. (2005) assessed guild-based abundance, guild-based biomass and diversity indices using a BACI paired model (BACIP, Smith 2002).

In a final study, the 404 Team wanted to incorporate Long-Term Resource Monitoring Program (LTRMP) fish data (Irons and Pegg 2006) with historical dredged material placement areas in the La Grange Reach, IWW and Pool 13, UMR to investigate dredged material placement effects at a larger scale. The LTRMP fisheries data were mined for the time period 1993-2004 from the two reaches. Geo-referenced data identifying placement areas was integrated with geo-referenced LTRMP fish sampling from sites fished with shoreline gears on main channel border habitat. In total, 1,968 sites from both study areas over more than 10 years were located within the main channel border area where placement occurs. Two data sets were created from the placement site and LTRMP fish sampling site locations, designated as modern (1990-2003 placement) or historical (pre-1990 placement). Fish catches from the LTRMP were compared between placement areas and reference areas to determine if there was a difference. As with the previous studies, data from the two sample reaches were not combined for analysis because previous studies have indicated different fish assemblages are present in each reach (Chick et al. 2005). Analysis of the entire fish assemblage was performed with an Analysis of Similarity (ANOSIM) test for differences in dredged material placement versus non-placement assemblages. These analyses were further corroborated using Non-metric Multidimensional Scaling (NMDS).

Results. The initial 3-year study at Island 241 primarily showed no significant differences in relative abundance of fish between pre- and post-placement years or between placement and reference sites. Catch-per-unit-effort for guilds and key species indicate very few differences between runs or study sites. The few observed differences favored the reference sites. Species diversity was generally found to be greater at the reference site than the placement site in pre- and post-placement sampling. Total abundance of fish, species diversity, and biomass of sport fish were all greatest at the reference site. A short-term reduction in the abundance of forage fish such as minnows, shiners, and darters was observed at the placement site but showed a fairly rapid recovery. There was generally high variability in CPUE leading to no conclusive evidence of negative impacts upon other components of the fish assemblage (table 8). The overall composition of fish assemblages was essentially similar between sites and years of the study and at both the placement and reference sites.

Table 8. Mean Catch Per Unit Effort of Fish Guilds Caught by Day Electrofishing (8a) and Night Electrofishing (8b) During Spring Sampling in UMR Pool 12 at the Placement and Reference Study Sites Prior to (1998, 1999) and After (2000) Dredging Occurred at the Placement Site Provide an Example of Catch Variability Observed at all Study Sites

Table 8a

	Placement Site		Reference Site		
Guild	**Pre-dredge**	**Post-dredge**	**Guild**	**Pre-dredge**	**Post-dredge**
Sport	1.40	2.25	Sport	2.40	8.25
Rough	2.50	0.25	Rough	3.60	4.75
Forage	11.00a	48.50b	Forage	9.00a	21.00b

Note: Means with different letters are significantly different.

Table 8b

	Placement Site		Reference Site		
Guild	**Pre-dredge**	**Post-dredge**	**Guild**	**Pre-dredge**	**Post-dredge**
Sport	4.60a	11.50b	Sport	7.40	20.00b
Rough	5.90	7.00	Rough	6.60	7.75
Forage	11.60	29.75	Forage	2.70a	16.75b

Note: Means with different letters are significantly different.

The second study, investigating immediate and short-term effects, conducted by Conover (2002) and Caswell (2003, 2004) had similar results for both the UMR and IWW to the Island 241 study. The study specifically noted that there were no detectable changes in species relative or rank abundances, diversity, size distribution or composition between placement and reference sites during pre- and post-placement (table 9). The BACI analyses performed by Caswell (2004) using diversity and the abundance of individual species were used to confirm the results of the analyses on other assemblage measures. The BACI did suggest significant negative effects of dredged material placement on the abundance of red shiners, Mississippi silvery minnows, and river shiners at the UMR placement site. These results were likely attributed to decrease in water depth and increased velocity as a result of placement (Aadland 1993, Etnier and Starnes 1993).

Table 9. Summary of Statistics Calculated for Fish Captured at the UMR and IWW Placement and Reference Sites During the Pre- and Post-Placement Periods 2001-2003
Entries with asterisks (*) are statistically different (P<0.05).

IWW

	Pre-Placement		**Post-Placement**	
	Placement	**Reference**	**Placement**	**Reference**
Total Catch	96,164	182,151	25,129	21,688
Relative abundance (%)				
Sport	5.2	3.1	14.1	17.5
Rough	3.2	2.8	38.7	26.4
Forage	91.6	94.1	47.2	56.1
Richness (#spp.)	64	64	54	51
Evenness (slope)	-0.1196	-0.1247	-0.1245	-0.1464
Simpsons (Ds)	0.3689*	0.2822*	0.7507*	0.8045*
Shannon (H')	1.361*	1.0276*	2.8458*	3.0480*

UMR

	Pre-Placement		**Post-Placement**	
	Placement	**Reference**	**Placement**	**Reference**
Total Catch	62,629	93,602	22,012	37,897
Relative abundance (%)				
Sport	4.3	1.8	10.2	3.6
Rough	1.1	1.2	3.1	8.3
Forage	94.6	97	86.7	88.1
Richness (#spp.)	51	60	54	53
Evenness (slope)	-0.1586	-0.1467	-0.151	-0.1664
Simpsons (Ds)	0.6990*	0.3905*	0.6821*	0.6631*
Shannon (H')	2.2934*	1.4177*	2.5354	2.5251

The long-term study conducted by Bowler et al. (2005) also recorded few differences between the placement and reference sites and concurred with previous studies that evidence of negative impacts to fish assemblages is lacking. There were statistical differences between the Island 241 and Hale Island sites (figure 17); however, there was little power to infer that these differences are ecologically significant because of the high variability in monthly catch (figure 18). In terms of the BACI analysis, the data suggested there was no evidence of dredged material placement impacts upon forage fish or rough fish abundance and biomass, but there was modest evidence of negative impact to sport fish abundance and biomass. It was further concluded that negative short-term (< 3 years) impacts upon fish assemblage diversity and richness immediately following dredged material placement appear modest. Some of the differences observed were attributed to changes in the abundance of rare species and the total number of species immediately following material placement.

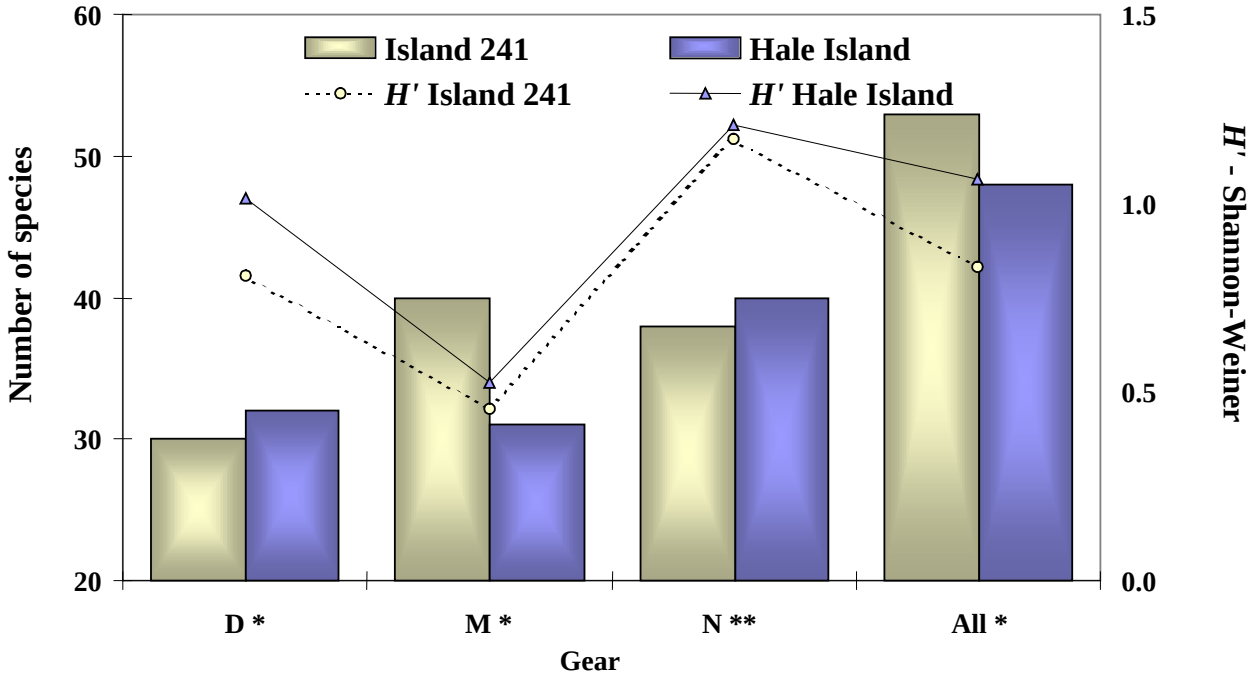

Figure 17. Shannon-Weiner Diversity (H') Collected by Day Electrofishing (D); Mini-Fyke Netting (M); Night Electrofishing (N); and All Gears Combined in Pool 12 of the Mississippi River at the Placement Site (Island 241 and the Reference Site (Hale Island), March through October, 2004

* Denotes significant difference, alpha = .05
** Denotes significant difference, alpha = .20

The result of the Irons and Pegg (2006) study of fish displacement from habitat change suggest that few overall changes or long-term impacts on fish assemblages due to dredged material placement activity could be detected using the LTRMP fisheries data for either the modern or historical placement data. Of the species showing significant differences in their data, four of the nine were minnows (Cyprinidae), two were suckers (Catostomidae), which feed in association with the substrate, two were catfish (Ictaluridae) which live in close proximity with the substrate, and one gar (Lepisosteidae) known to feed on minnows (Pflieger 1997). Further, they support the speculations of Caswell et al. (2004) that any significant differences that might be detected are likely due to species responding to alterations of the substrate (i.e., food source). These species primarily eat macroinvertebrates; macroinvertebrates in separate 404 studies were shown to be highly correlated with substrate type. A shift in substrate type is likely to shift the macroinvertebrate community and the fish community that feeds upon them.

Not unexpectedly, it should be noted that both long-term and short-term studies reported considerable differences in substrate type and habitat characteristics between the reference and placement sites. In general, sediments at the reference sites were softer with more silt/sand and more woody debris was present. After placement, near shore velocities were noticeably greater and changes in depth much sharper. In addition, each study showed considerable degrees of temporal variation within and

between samples in terms of gear CPUE, which, in turn, influenced the variation in abundances, diversity measures, size distributions, and assemblage composition

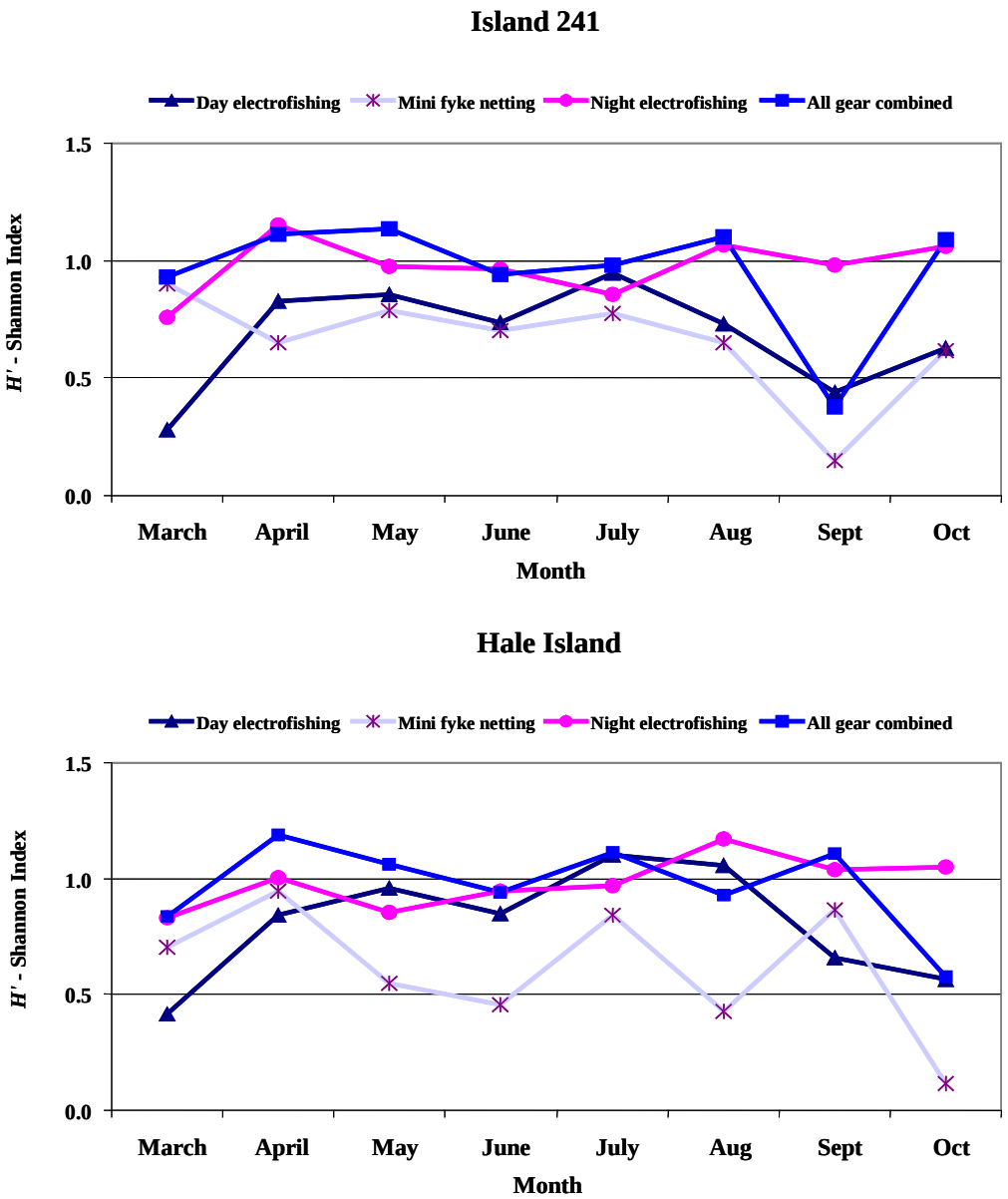

Figure 18. Example of Monthly Variation in Diversity Indices at Island 241 (Placement Site) and Hale Island (Reference Site) 2004

Conclusions and Recommendations. Four studies conducted to investigate fish community response to dredged material placement resulted in similar conclusions that placement has little long-term impact on fish community structure in channel border habitats. The first short-term study in Pool 12 showed no difference in catch-per-unit-effort between pre- and post-placement sampling events. A short-term change in some forage fish species abundance was observed but abundance quickly

returned to baseline. The short-term study in Pool 21 showed very similar results as Pool 12, with no detectable changes in species relative or rank abundances, diversity, size distribution or composition. Similar to the Pool 12 study, forage fish exhibited the greatest effect, but those effects were short-lived. The long-term impacts investigated in Pool 13 were consistent with short-term impacts investigated elsewhere in that no significant changes were detected. There was modest evidence of impacts to sport fish abundance and biomass, but that may have been driven by changes in the occurrence of rare species and total species abundance.

After conducting studies in Pool 21 and the IWW, Caswell et al. (2004) provided the following management recommendation regarding dredge material placement: "...if further studies are not conducted and shoreline dredged material placement is to occur in the future, impacts to fish communities can be minimized by restricting placement activities to *existing* sites." The 404 Team concurs with this recommendation. Fisheries communities in areas with sand substrate appear to be more resilient to channel maintenance dredged material placement that those with non-sand substrate. These studies showed that the impacts to the fishery from dredged material placement can be minimized by re-using placement sites with sand substrate. The 404 Team recommends that resources be directed elsewhere, as impacts to fishery communities from dredged material placement appear less than anticipated.

F. TURTLE COMPONENT

Objectives. Turtles were studied during summer 2005 at the request of the River Resources Coordinating Team. The Study Team was concerned that dredged material sites may be a "sink" for turtle reproduction if the turtles are attracted to nest at these sites but the eggs are not hatched because of predation, human disturbance, or further dredging impacts. The objective of the study was to learn more regarding turtle use of frequently used dredged material placement sites. The 404 Turtle Study specifically assessed turtle nesting activity in a historic dredged material placement site and a comparable nearby natural channel border area in Pool 13.

Methods. The study area included a placement site, Savanna Bay Beach (RM 539.1-539.3 L) and a reference site (RM 541.2-541.3L). The District placed dredged material on Savanna Bay Beach (~ 1 acre) most recently in 2002. The site was sparsely vegetated. The reference site (~ 0.1 acre) was heavily vegetated and was used as a dredged material placement site during the 1950s. Each site was overlaid with a conceptual grid of transects, each transect was spaced 5 meters apart and perpendicular to the axis of the nesting area and other transects. Mean nest density, species abundance, hatching success, number of predated nests, clutch size, and recreation use were summarized for each site along with distance of nest to nearest vegetation and nest condition (active, with live eggs or hatchlings; inactive, with remnant eggshells; inactive, without eggshells or predated. Biologists took twice daily samples during the nesting phase (mid-June to mid-July) to observe turtle nesting activity. The same sites were visited twice weekly through August during egg incubation. Sampling was increased to daily visits during the hatching phase. Turtles observed at any time were collected by hand, identified to species, sexed, weighed, measured for total carapace length, and marked for recapture efforts. Turtles with any abnormalities or unusual morphological characteristics were noted and photo documented.

Data analysis was primarily based on the mean density of turtle nests observed at each sample site. Data were summarized to compare parameters such as mean nest density, species abundance, hatching success and number of predated nests between sites. Mean nest density was calculated by dividing the number of nests for each sample site by the specific site area, the numbers of nests per m^2 for each sample site was then added together and divided by the total number of sample sites at each respective location. Because some sample sites were not the same size, the density per m^2 was adjusted for the correct area for a particular sample site.

Clutch size was measured as total number of eggs, hatchlings, and combination of eggs/hatchlings counted for a given nest (figure 19). In most instances, the clutch size for an active nest could not be accurately determined without negatively impacting incubating eggs. As a result, clutch size observations were made semi-quantitatively and were mainly based on the following:

- the collection of recently hatched turtles
- egg counts upon nest discovery (to confirm the existence of an active nest it was necessary to hand dig areas that resembled a concealed nest) and
- observations immediately after completion of egg laying by a nesting turtle

Clutch size of predated nests could not be done because eggs were either removed altogether from a nest area or the remnant shells were too sparsely scattered to conclude an association with a particular nest.

Figure 19. Hatchling Turtles

Results. The area of suitable nesting habitat at the placement site was 4,278.1 m^2, which was 91.0 percent greater than at reference site, where only 385.2 m^2 of suitable nesting habitat was available (table 10). There were 84 nests recorded at the placement site and 38 at the reference site. Of the 84 nests at the test site, the condition of 17 were described as active, seven were inactive with remnant egg shells, 30 were inactive without egg shells, and 30 were predated (table 10). Of the 38

nests at the reference site, one nest was recorded as active, 12 were inactive without remnant egg shells, and 25 had been predated.

Table 10. Turtle Nest Density and Nest Condition Observed at Both Placement and Reference Sites, Pool 13, UMR, June through September 2005

	Placement Site (Savanna Bay Beach, UMR RM 539.1-539.3)	**Reference Site (UMR RM 541.2-541.3)**
Nest Abundance	84	38
Site Area (m^2)	4,278.1	385.2
Nest Condition		
Active	17	1
Inactive with Remnant Egg Shells	7	0
Inactive without Remnant Egg	30	12
Predated	30	25
Total	**84**	**38**

Source: *MACTEC, 2006*

Species composition of adult turtles between placement and reference sites differed significantly. Twenty-six adult turtles were observed at the placement site, compared to only one at the reference site. Of the 26 turtles at the test site, 18 were identified as false map turtles (*Graptemys pseudogeographica*) and eight were identified as painted turtles (*Chrysemys picta*), the one turtle observed at the reference site was identified as a false map turtle (*Graptemys pseudogeographica*) (table 11). Adult smooth softshell (*Apalone mutica*) were viewed just offshore at the placement site on numerous occasions, but could not be collected; in addition, smooth softshell eggs and hatchlings were observed.

Table 11. Relative Species Abundance for Adult Turtles Observed at Both Placement and Reference Sites, Pool 13, UMR, June through September 2005

	Number	**Abundance (%)**
Placement Site (Savanna Bay Beach, UMR RM 539.1-539.3)		
Painted turtle (*Chrysemys picta*)	18	69.23
False map (*Graptemys pseudogeographica*)	8	30.77
Total Placement Site	**26**	**100.0**
Reference Site (UMR RM 541.2-541.3)		
Painted turtle (*Chrysemys picta*)	0	0
False map (*Graptemys pseudogeographica*)	1	100.0
Total Reference Site	**1**	**100.0**

Source: *MACTEC, 2006*

Turtle nest mean densities observed from reference and placement sites were tested for significant

differences using a two sample t-test assuming unequal variances. There were 84 nests sampled at the placement site with 203 subsample locations, and 38 nests at the reference site where there were 23 subsample locations. The placement site has been historically used for dredged material placement, and it was observed to be more heavily used for recreational purposes when compared to the reference site. Results of the two sample t-test assuming unequal variances indicated the mean nest density of 0.16 m^2 at the reference site was not significantly different than the mean density of 0.02 m^2 at the placement site (t=1.59, df=22, P=0.06) (table 12). However, due to the abundance of sites with zero densities the data were heavily skewed to the left, thus violating the assumptions of normality required for a parametric test. Therefore, the t-test assuming unequal variances would not be able to detect any statistical difference. To resolve this issue, a Wilcoxen's Rank-Sum test, which does not violate the assumptions of normality because it is a non-parametric test, was used to analyze the densities for both sites. The results of the Wilcoxen's Rank-Sum test indicate a significant difference between mean densities for both sites (z=3.5196, P<0.0004) indicating the mean density of turtle nests between sites differs significantly.

Table 12. Results of a Two-Sample Unpaired t-Test Assuming Unequal Variances, and a Wilcoxen's Rank-Sum Test, Based on Turtle Nest Data Collected from Both Placement and Reference Sites in Pool 13, UMR, June through September, 2005

Month	**Placement Site (Savanna Bay Beach UMR RM 539.1-539.3)**	**Reference Site (UMR RM 541.2-541.3)**
Mean	0.021	0.159
Variance	0.004	0.174
Observations	203	23
Hypothesized Mean Difference		0
Df		22
t Stat		1.588ns
P(T<=) Two-Tail		0.127

Wilcoxen's Rank-Sum Test
Ws = 3656.5
W's = 1564.5
z = 3.5196
p < 0.0004 *
*p < α = 0.05

* Assuming unequal variances, based on turtle nest data; ns $|t| = 1.59$ = not significant

Nest success rates were estimated to be 20 percent at the placement site and 3 percent at the reference site. Because determinations of clutch size often involve negatively impacting incubating eggs, clutch size was only recorded when a nesting turtle was directly observed in the process of laying and the eggs were exposed enough to be counted or when hatchlings were observed leaving the nest. No clutch estimates were collected from the reference site and only six estimates were available for the dredge placement site. Clutch size ranged from 5-12 eggs or hatchlings. Predation and human disturbance were very common at both sites. Predation was greater at the reference site (66 percent) compared to the test site (36 percent). Human disturbance at the beach site was observed on 25 days compared to only 1 day at the reference site.

Conclusions and Recommendations. When compared to the reference site, the placement site was found to have greater hatching success, lower nest predation, and a greater relative abundance of false map turtles and painted turtles. The reference site had higher nest predation and a lower hatching success. Because the study was started relatively late during the nesting season and did not continue for the entire length of the hatching season, the study was not able to definitively answer questions regarding the effects of dredged material placement on turtle reproduction but it did demonstrate that turtles and humans are both using dredged material placement sites. The 404 Study Team believed the turtle study provided interesting information, but introduced many new questions beyond the scope of the 404 Studies. At this time, the 404 Team is not recommending additional turtle studies.

III. 404 STUDY CONCLUSIONS AND RECOMMENDATIONS

Previous placement activities have altered habitat by enhancing sand flora communities and changing near shore substrate from a softer silt/sand to more sand with less woody debris. Faster near shore currents may also be expected at placement sites. Consequently, continued use of these areas should be a lower risk alternative because habitat has already been altered and biota have adjusted to these changes as evidenced by short-term shifts in the fish and macroinvertebrate communities as well as in turtle use of placement sites.

Impacts that can be anticipated from future dredged material placement on floodplain habitats are expected to be minor and short-term based on these studies. Dredging projections indicate the majority of future placement will occur in open water (defined as bankline to bankline). This placement type will be, whenever possible, limited to deepwater thalweg area where native mussels are less abundant. Thalweg areas are mostly historical placement sites, with the exception of two areas in Pool 13, UMR that are under development. Thalweg placement is not likely to affect mussel populations and should not affect highly mobile species such as fish or organisms adapted to sandy substrates with well developed bioturbidation abilities.

The landward side of existing levees is also projected to see increased use for placement. Sand/mud and scrub/shrub habitats are often observed in levee and historical placement areas. These habitats are characterized by sandy soils. Development of vegetation and vegetation community structure is a function of many processes including soil/sediment conditions (siltation, soil development) and flood frequency. One would expect that placement of primarily sandy material would shift the vegetation community to sand flora and material placement would least affect taller vegetation such as trees while exerting a greater affect on smaller, shorter vegetation such as scrub-shrub plants because they are more likely to be covered by material. Generally, exotic species may be expected to colonize new placement sites as they are biologically more suited to take advantage of disturbed, barren soils than some native species. One might also expect that placement sites would contain fewer wetland or hydric species because placement activities can decrease rate/frequency of inundation and the site's ability to retain water. These changes would be expected to increase significantly with increasing frequency and quantities of dredged material placement.

Indeed these assumptions were borne out by the vegetation studies. Flooding, siltation and soil development were greater factors influencing vegetation than time since dredged material placement. This is because placement had a substantial effect on decreasing the rate/frequency/length of

inundation, thereby decreasing silt and clay texture. Therefore, placement sites had lower nutrient and organic matter content. Placement of dredged sand also enhanced the potential for the establishment of sand prairie communities.

Because sand flora communities possess similar soil/sediment characteristics to placement sites and other shoreline habitat types, the effects of sand placement are not as destructive in the long term to this habitat type. This report recommends that placement activities be monitored for depth and frequency at which material is placed to reduce loss of low growing vegetation. Inactive placement sites will become vegetated through natural selection. In those areas where exotic vegetation is likely to encroach, monitoring or selective mowing, spraying, etc. may be necessary to prevent undesirable vegetation from reaching invasive status.

The District has historically operated its dredge placement under the principle that placing like material on top of like substrate (e.g., sandy dredged material on top of sand), whenever practicable, is less detrimental than placing unlike material on dissimilar soil types. These studies supported this philosophy through multiple lines of evidence. The first line of evidence comes from the sediment transport study. Sedimentation and erosion follow predictable hydraulic rules: low currents result in coarse sediments such as sand being deposited, whereas, high velocities move coarse sediment and can transport it substantial distances. This study confirmed the same processes occur with dredge material. The sediment transport study showed that under certain hydraulic conditions (this study at Camp Island represented a worse case scenario) sand can migrate from the shoreline to secondary channels as well as migrate downstream. The fact that dyed sand was recovered for over a year after placement, suggests that the movement of bed material occurs sporadically, during periods of high discharge. Also, the amount of sand that migrates from a placement site is small compared to the total bedload of the river and is essentially indistinguishable from it.

Near-field sand movement from a shoreline placement site was reasonably well predicted from the Surface Water Modeling System numerical model. This report recommends that the most efficient and economical method to predict movement of material placement is to use model studies with limited field verification. It further suggests that hydrogeomorphic factors that could lead to migration of dredged material be considered in selecting potential sites.

Another line of evidence used was the macroinvertebrate and mussel components. Macroinvertebrate abundance and diversity varies widely on both temporal and spatial scales. It is impossible to make definitive conclusions regarding the effects of dredge placement based on the macroinvertebrate data because different methods were used on the UMR and IWW and methods inappropriate to site conditions were initially used on the IWW. Even after implementation of appropriate methods it is still difficult to make statistically valid conclusions because of the extreme variability of the results. There was a trend of historic dredged material placement sites having higher abundances of macroinvertebrates than reference sites on both the UMR and IWW, as long as the last placement of dredged material was at least 1 year prior to sampling.

After placement, the IWW placement site continued to have higher abundances whereas the abundances dropped to similar reference levels on the Mississippi placement site. The ecological significance of this is unknown but changes in abundance were less than an order of magnitude, which given the natural variability and patchy distribution of macroinvertebrates may be ecologically negligible. The effect of sampling methods strongly suggests that future work involving invertebrates

requires careful *a priori* assessment of habitat conditions to tailor sampling methods. The variability within pre- and post- placement sites also suggests that multiple year assessments will be required to gather scientifically valid results. However, these data do suggest that dredged material placed along historic bankline placement sites does adversely impact the resident macroinvertebrate community for at least 1 year post placement. These data also suggest that all placement sites studied have recovered. One bankline study site (Hogback UMR) "recovered" to the point of having more macroinvertebrates than the control site that never received dredged material (Long Island, UMR), even though the sample was taken only 15 months after the previous placement event. It is not anticipated that continued use of historic UMR and IWW historic bankline placement sites would have a significant impact on resident macroinvertebrates at the placement site, the pool, or the UMR.

The mussel studies represented the most systemic approach of all the 404 Studies from reconnaissance to specific studies. Mussels exhibit a patchy distribution, forming beds, consequently, one expects high variability for any single study. These studies were no exception but despite high variability results showed trends that allow for generalized conclusions. The studies indicate that because the thalweg typically has high shear stress it is unlikely to support a sustainable population of mussels. Therefore one recommendation from this study is that in areas where mussels are common, placement of material in the thalweg is a low-risk option for these species. Channel border areas were found to provide more suitable habitat as indicated by mussel abundance although distribution was, as expected, very patchy. Some data from these studies suggest that mussel assemblages in placement sites were as abundant and diverse as adjacent non-placement sites; differences in catch rates did not differ statistically from non-placement sites; and mussel assemblage compositions at placement sites were relatively similar to non-placement sites. Any thalweg placement should be done carefully in order to minimize the potential for accidental placement in channel border areas.

The sand-on-sand placement philosophy was validated with regards to mussels because these species overall appear poorly adapted to the shifting sand habitats that occur in repetitive dredge cut and placement areas**.** It is not anticipated that continued use of historic UMR and IWW historic bankline placement sites would have a significant impact on resident mussels at the placement site, the pool, or the UMR. For new placement sites, the District will continue to work with the OSIT through the DMMP process to minimize impacts

The 404 studies also used fish response to placement activities as a line of evidence. Fish are an important ecological, recreational, sport, and for some species, commercial resource in the UMR and IWW. Fish are an excellent measurement endpoint for examining the effect of dredge material placement in open water (includes bankline and thalweg placement) – the prevalent habitat to be used for placement in 40-year projections. Four studies resulted in similar conclusions that because fish are highly mobile, placement has little long-term impact on community structure in channel border habitats. Forage fish exhibited the most effects but those effects were short-lived and most likely due to species responding to alterations of the substrate and perhaps subsequent changes in food type and availability. It is recommended that if future shoreline placement of dredge material occurs that impacts to fish communities can be minimized by using existing/historic dredged material placement sites. The major reason for this recommendation is sediments at reference sites were more favorable to macroinvertebrate colonization (soft silts/sand and more woody debris).

The final line of evidence was turtle work. The 404 Study Team was concerned that dredge placement sites may be providing "sink" habitat for turtles if turtles were attracted to these sites for nesting. A

limited study was done that did not include the entire nesting and hatching period and only examined a spatially small area. The placement site appeared to attract false map and painted turtles as they occurred in greater numbers compared to the nearby reference site. Lower nest predation and greater hatching success occurred on the placement site, despite also having greater human recreational use. Turtle use of placement sites has been previously observed (ESE 1985)This citation need to be in reference section.. This study provided interesting information but also generated many questions.

A summary of the six component studies is shown in table 13. The major findings from collective studies is that dredge material placement does have short-term ecological impacts but that mobile organisms such as fish and turtles or organisms with well developed burrowing abilities are little affected. Sessile organisms such as mussels can potentially be adversely affected by placement. The use of existing placement sites, which are already disturbed, or sites that do not possess favorable conditions for mussels, such as the thalweg, greatly reduce the risk of negatively impacting mussels. Vegetation can also be negatively impacted both by the type and the depth of placed material. The District will continue to need to balance depth of placement against total area of placement for a given volume of material. This decision is best made on a case-by-case basis that includes consideration of other site characteristics including existing vegetation, desired future vegetation, and hydrogeomorphical conditions that influence material migration. Responsible placement of dredge material will always remain a high priority of the District.

These Study data suggest that continued use of UMR and IWW historic dredged material placement sites would not cause significant adverse impacts to any of the resource categories studied for this report, directly, indirectly or cumulatively. No other studies evaluating the impacts from dredged material placement, utilizing historic placement sites have been planned or scheduled at this time.

Table 13: Summary of the Effects of Dredged Material Placement as Identified Through the 404 Studies

	Sediment Transport	Vegetation	Macroinvertebrate	Mussels	Fisheries	Turtles
Study Location	Bankline	Bankline and Floodplain	Bankline	Bankline and Thalweg	Bankline and Thalweg	Bankline
Component Findings	Sediment began moving within weeks of placement despite low to moderate flows. Tagged sediment was found as far as 1 mile from the placement site. Numerical model simulation agreed well with the physical study.	Environmental factors have the most impact on soils and vegetation, (such as increasing elevation, and changing inundation frequency and depth), followed by increasing placement depth and time since placement. The main result of placement on the herbaceous community on both UMR and IWW was to reduce seedling abundance, increase numbers and abundance of exotic species, replace wetland herb community with an upland community, and decrease evenness. Placement had an adverse impact on seedling sprouts and shrubs on the UMR; but had a positive impact on seedling sprouts and shrubs on the IWW. Placement had an adverse impact on understory and canopy trees on the UMR sites; but had a positive impact on understory and canopy trees on the IWW sites.	Earlier studies suggested that sites which had never received dredged material showed higher overall abundance and diversity than historic placement sites. Later studies, with more appropriate sampling methods, showed higher abundance and diversity at placement sites, or no significant difference.	Recolonization of dredge sites may occur within the first five years after placement. Larger sample sizes are required to achieve statistically reliable results. In general, thalweg areas do not support stable unionid mussel communities.	Although a short-term negative impact on the abundance of forage fish was noted, overall abundance was similar in pre-placement and post-placement sampling.	Nest success rates were estimated to be 20% at dredged material placement site and 3% at reference site.

	Sediment Transport	Vegetation	Macroinvertebrate	Mussels	Fisheries	Turtles
Systemic Inferences	Component findings from Camp Island, UMR Pool 18, are considered site specific due to highly erosive nature of the placement site. At this time, no additional dye tracer studies are planned. Comparisons made between results of the dye tracer study and micromodel and numerical model studies suggest it is possible, and more efficient to predict localized sediment transport from placement sites through use of model studies.	While placement can drastically alter floodplain vegetation, there were equally as many instances in which placement communities were compositionally very similar to floodplain vegetation. Placement does not always change the plant community type. Flooding was extremely variable on both the UMR and IWW floodplains. Consequently, with respect to inundation, dredged material placement cannot create more variation than already exists naturally. Establishing a placement depth shallow enough to be covered or mostly inundated by flood waters may help augment the more sterile nature of sandier material. Capping sites with fine material is another option worthy of continued consideration.	"Sand-on-sand" placement is preferable whenever feasible. Because macroinvertebrate densities were low in the initial IWW studies, the 404 Team recommended a change in methods to capture smaller invertebrates. Impacts of dredged material placement appear to be much less than originally thought.	Thalweg placement is a low-risk option if shallower, slower-flowing areas of the thalweg are avoidable. Further study in non-thalweg areas may be necessary due to low collection numbers in the early studies	No significant differences in abundance found between pre- and post-placement sampling or between the test and control sites. Species diversity was generally greater at the reference site. Growth and condition were similar in target species after placement.	While the study indicated more turtle use on dredged material placement sites, the study had certain limitations. These limitations prevented researchers making any conclusions regarding the effects of dredged material placement on turtle reproduction.
Years Studied	2001, 2002, 2003	1996, 1997, 1999, 2000, and 2001 - Field monitoring of herbaceous and shrubby vegetation, soil samples, elevation surveys and tree species. 1950 - present -Hydrologic records	1997 ,1998, and 2005 IWW – La Grange Pool 2001, 2002 UMR – Hogback Island, Pool 21	1998, 1999, 2001, 2005	1998, 1999, 2000, 2004 UMR, Island 241, Pool 12 2001, 2002, 2003 IWW, Senate Island UMR, Hogback Island, Pool 21	2005

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