

high. Below the scarp, a bench was composed of very soft silty soil with many peds on the silt surface. The bench was fairly moist.

Figure 6-106 shows the three measured bank sections and a reduced cross section. The stage at the time of measurement corresponded approximately to the 85% recurrence frequency. The 50% and 25% recurrence stages (see table 6-32) are 422.4 and 425.9 feet above msl, respectively. The base of the scarp at the end of the weed zone was about 422.4 feet above msl.

At the midsection, the d_{50} varied from 0.017 mm at the top surface of the bank to 0.036 mm for a core sample at a water depth of about 2 feet. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 0.143 1V:7.0H to 1V:5.5H. This site can be classified as a combination of types 5 and 4 (figure 6-22 and 6-21, and table 6-4). Apparent erosion mechanisms were emergent to seepage on the subaerial bench, rework and transport by waves and currents at various stages between NP and OHW.

Table 6-32. Site 22

<i>Percentage of occurrence</i>	<i>Stage above msl, in ft</i>	<i>Topographical features</i>	<i>Bank/bed material, mm</i>
90	419.7	<ul style="list-style-type: none"> Bench (underwater) (slopes varied between 1V:7.0H and 1V:5.5H) 	<ul style="list-style-type: none"> d_{50} (core) varied (0.017-0.036)
75	420.2	<ul style="list-style-type: none"> Bench 	<ul style="list-style-type: none"> d_{50} varied (0.007-0.024)
50	422.4	<ul style="list-style-type: none"> Bench/berm/scarp Scarp (slopes varied between 1V:0.5H and 1V:0.14H) Berm slope = 1V:4.2H 	
25	425.9	<ul style="list-style-type: none"> Top of the bank 	<ul style="list-style-type: none"> $d_{50} = 0.017$
10	430.3		
0-9	>430.3		

Note: Gage on the Illinois River at Pearl, IL @ RM 43.2 was used for stage histogram. WSE = 419.9'; OHW: (NA); NP: (NA).

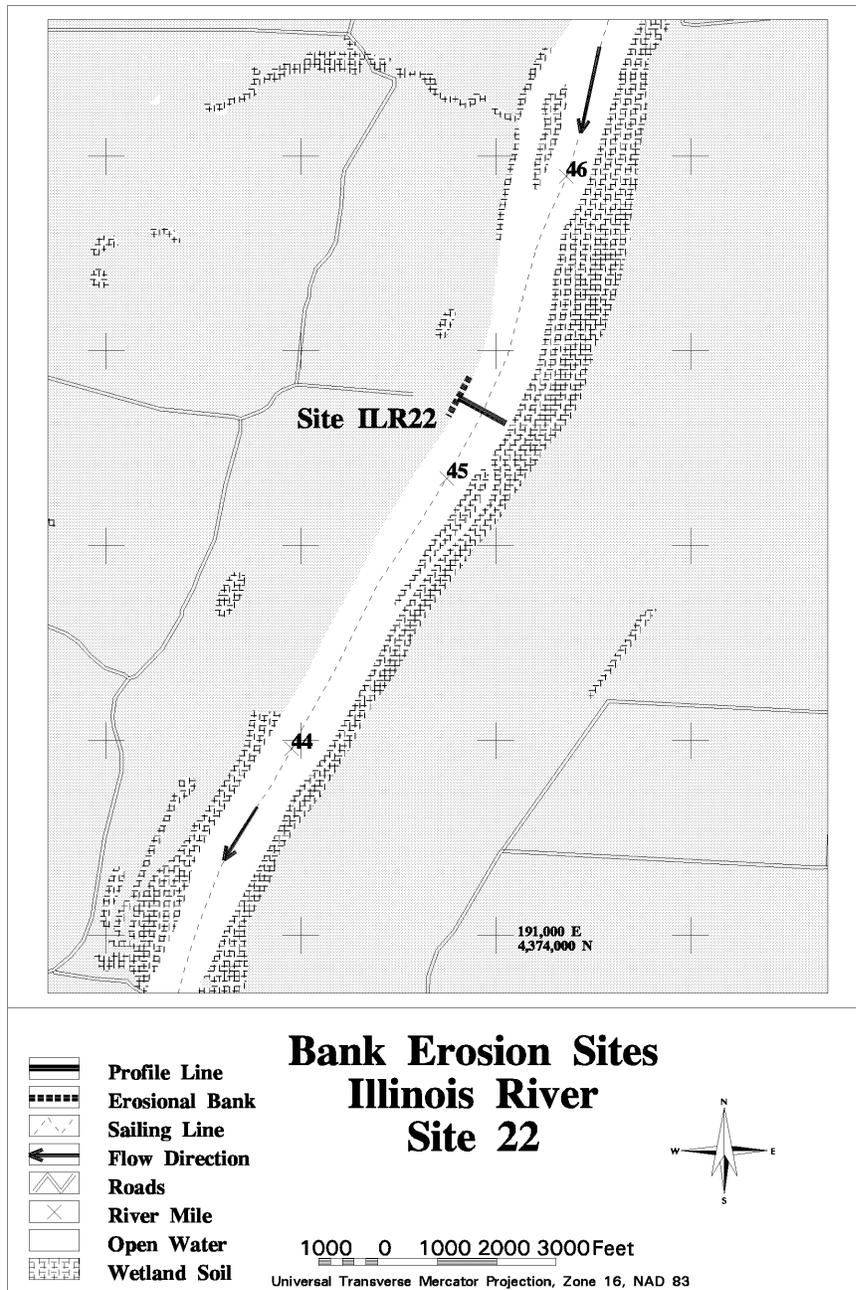


Figure 6-104. Location of site 22 on the Illinois Waterway



Figure 105. Site 22 on the Illinois Waterway

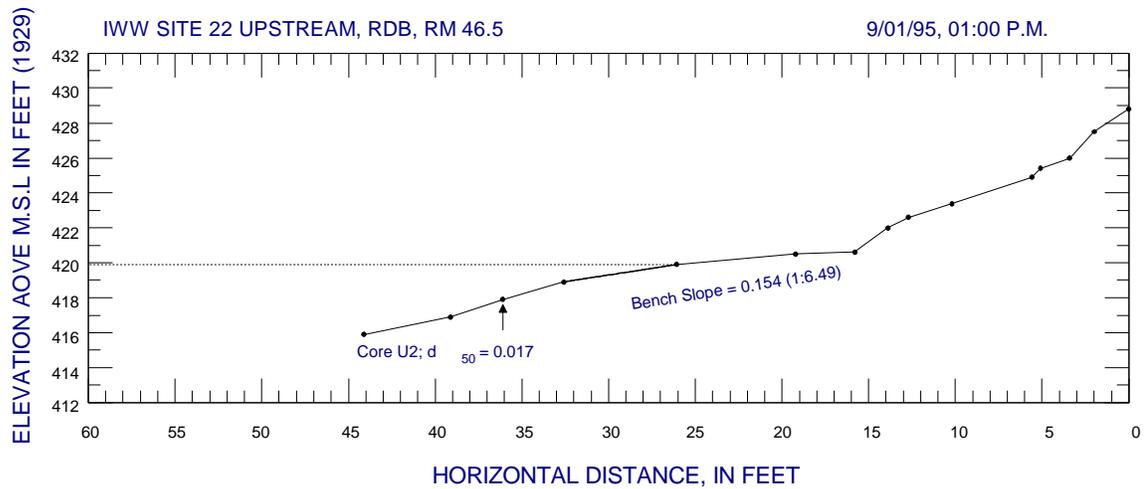


Figure 106. Bank sections at site 22

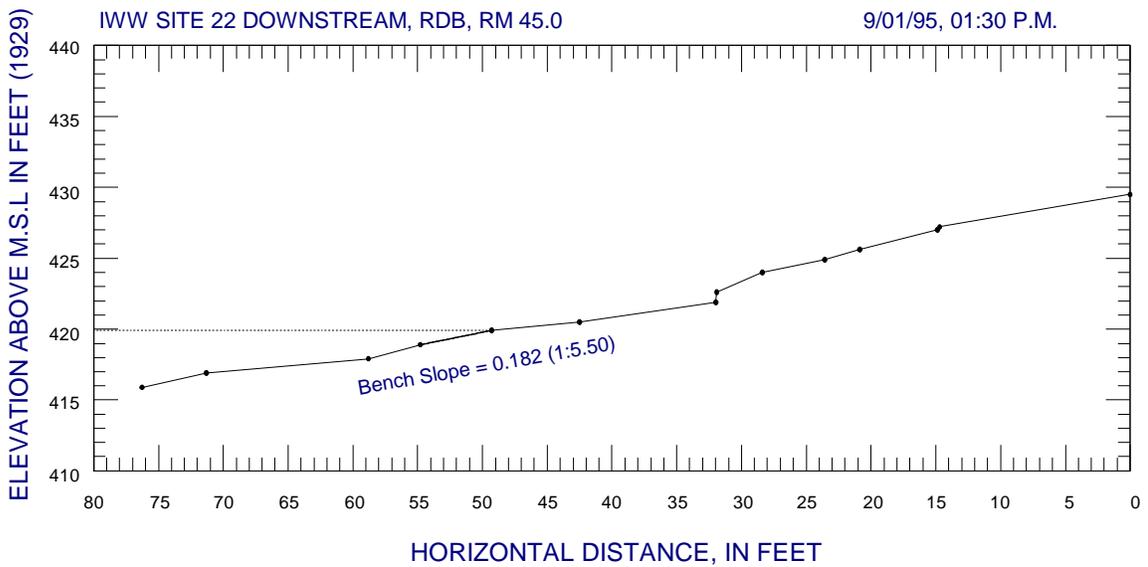
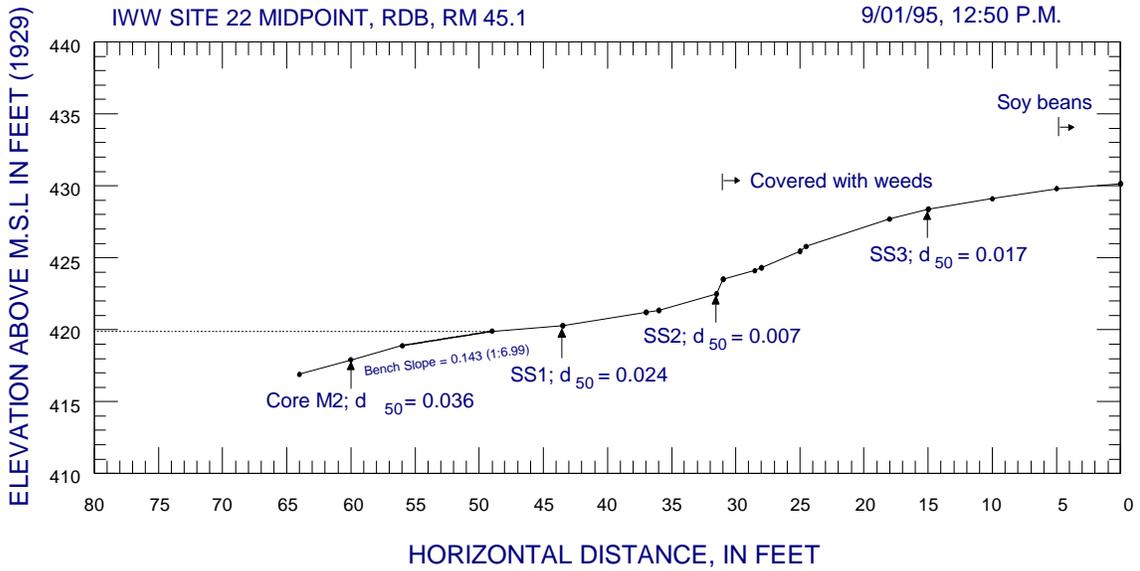


Figure 106. Bank sections at site 22

Site 23, Alton Pool, 9/1/95. This site is located on the RDB at RM 23.5 in a crossover from a gentle bend. This site is near the downstream tail of Diamond Island; Dark Chute runs from the back (west) side of the island and to the confluence with the Illinois River at RM 22.7. Figure 6-107 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-108 shows a photograph of the site.

The navigation channel is close to this site; the bank is about 180 feet from the sailing line. Bhowmik and Schicht's (1980) Reach 1 was located at RM 24.0 on the opposite bank. Hagerty (1988) marked erosion on both bank sections, but eroded reaches were shown in several segments. For this site, Hagerty (1988) noted 6 feet of bare scarp.

Figure 6-109 shows the three measured bank sections and a reduced cross section. The stage at the time of survey was at about the 90% recurrence frequency stage. Dense seasonal vegetation covered the upper portion of the bank face, and the bank slope was steeper downstream. Bank materials were similar to those at other bank sections in the Alton Pool, with a hard clayey layer at the upper part of the bank, and a lower bank covered by moist, soft clayey soil. Algae were growing near the water's edge. As shown in table 6-33, the bare bank face corresponds well to the stage ranging between 50% and 25% recurrence frequencies. The 50% recurrence stage is about 420.3 feet at the base of the scarp.

At the midsection, the d_{50} varied from 0.016 mm at the surface of the bank to 0.020 mm at the upper part of a core sample at a water depth of about 2 feet. The d_{50} values were very uniform at the midsection. Gradation plots of bank soils and nearshore sediment are presented in appendix F. The detailed river cross section and coordinates are shown in appendix G.

Bench slopes varied from 1V:12.5H at the upstream section to about 1V:5.0H at the midsection and downstream section. The upstream section and midsection are classified as type 4 and the downstream section is classified as type 2 (figures 6-21 and 6-19 and table 6-4). There was erosion due to surface drainage; other apparent causes are seepage, rework, and transport by levees and currents at various stages of pool-level fluctuations.

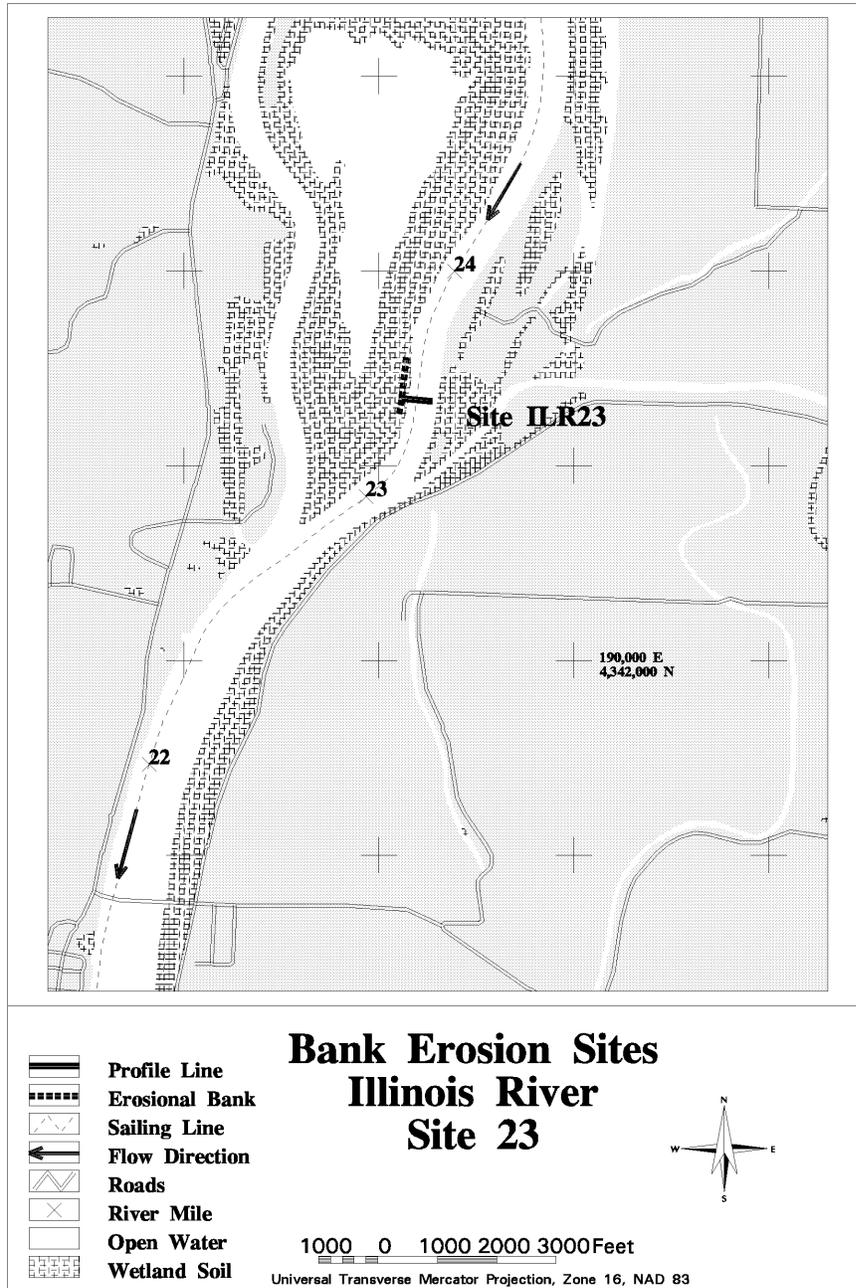


Figure 6-107. Location of site 23 on the Illinois Waterway



Figure 6-108. Site 23 on the Illinois Waterway

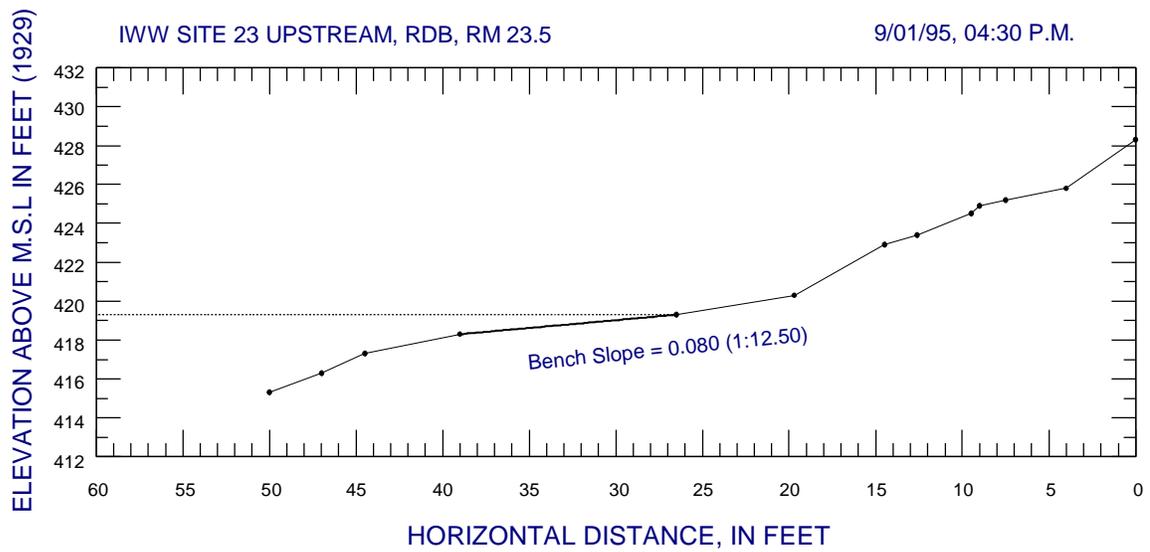


Figure 6-109. Bank sections at site 23

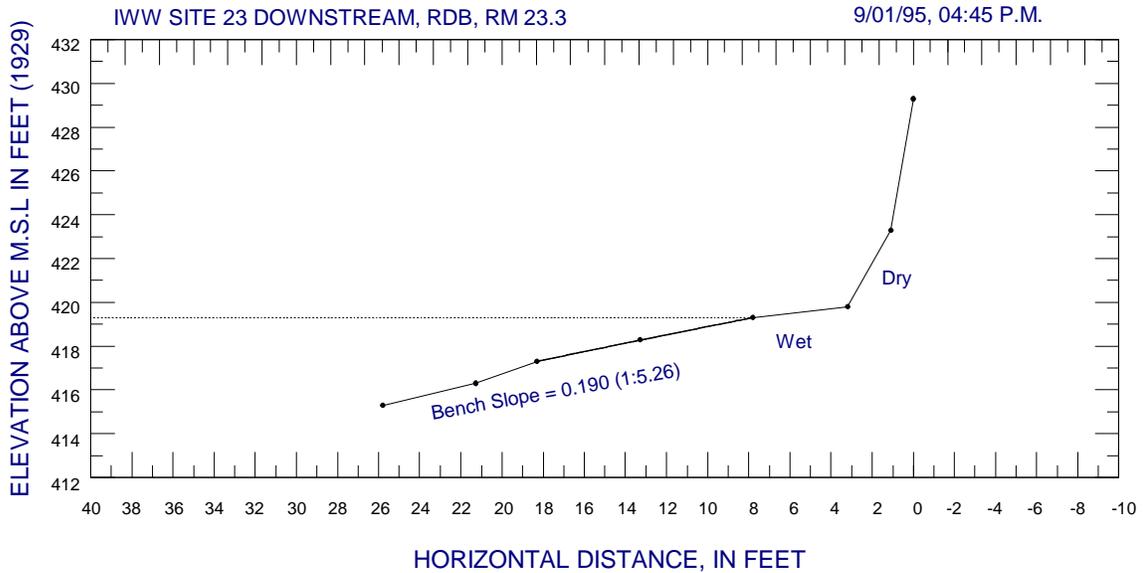
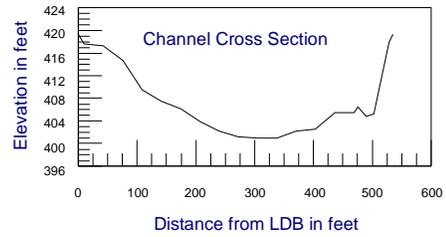
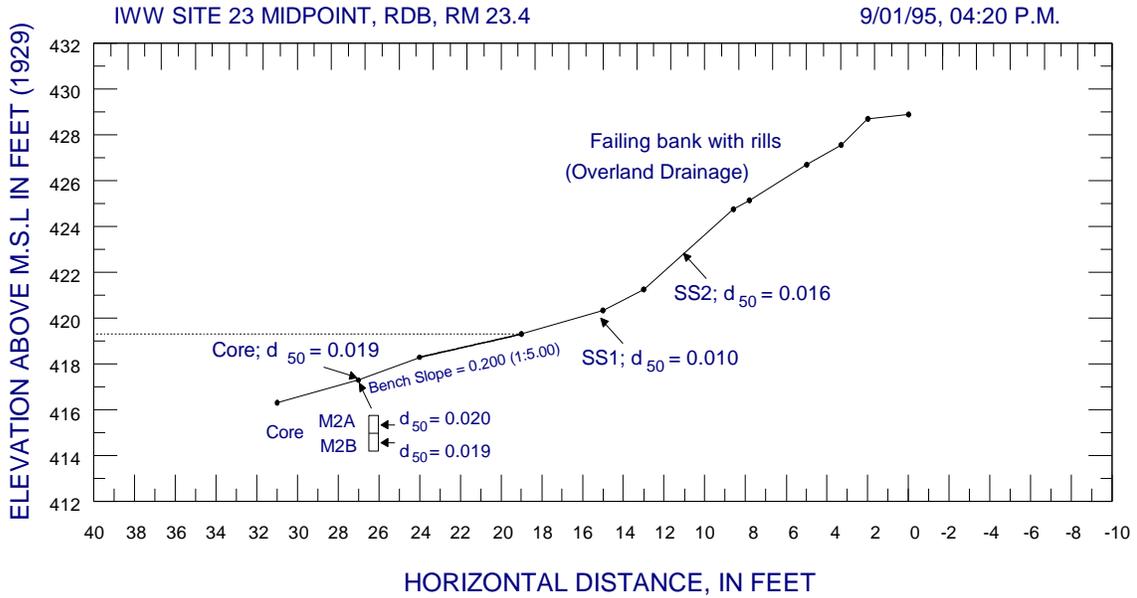


Figure 6-109. Bank sections at site 23 (concluded)

Table 6-33. Site 23

<i>Percentage of occurrence</i>	<i>Stage above msl, in ft</i>	<i>Topographical features</i>	<i>Bank/bed material, mm</i>
90	419.2	<ul style="list-style-type: none"> • Bench (underwater) (slopes varied between 1V:12.5H and 1V:5.0H) 	<ul style="list-style-type: none"> • d_{50} (core) varied (0.019-0.020)
75	419.5	<ul style="list-style-type: none"> • Bench 	<ul style="list-style-type: none"> • $d_{50} = 0.010$
50	420.3	<ul style="list-style-type: none"> • Bench/berm (slope = 1V:2.2.H) 	<ul style="list-style-type: none"> • $d_{50} = 0.016$
25	422.5	<ul style="list-style-type: none"> • Berm/scarp • Scarp (slopes varied between 1V:1.3H and 1V:0.34H) 	
10	426.6	<ul style="list-style-type: none"> • Scarp/Top of the bank 	
0-9	>426.6	<ul style="list-style-type: none"> • Top of the bank 	

Note: Gage on the Illinois River at Hardin, IL @ RM 21.6 was used for stage histogram. WSE = 419.3'; OHW: (NA); NP: (NA).

Site 24, Alton Pool, 9/1/95. This site is located on the RDB at RM 13.1 on the outside of a bend. Upstream on the RDB is the (old) Hadley's Landing (RM 13.4) and across the river is Twelve Mile Island. Figure 6-110 shows the position of the site on a GIS-based map of the Illinois navigation chart, and figure 6-111 shows a photograph of the site.

The site is about 430 feet from the sailing line, and no major tributary enters the IWW at this location. Bhowmik and Schicht (1980) marked the site as a "Wave Study" site. Hagerty's 1988 erosion site was at RM 13.4 immediately downstream from Hadley's Landing.

The bank characteristics are similar to those at other sites in the Alton Pool. Figure 6-112 shows the three measured bank sections and a reduced cross section. Land cover on the top and upper portion of the bank was dense seasonal vegetation, mostly above the water line. The sloping bank below the vegetation zone was bare; the base of the bare area was moist and algae was growing near the water's edge. The stage at the time of the survey was at about the 90% recurrence frequency stage. The subaqueous bench at the site was broader and flatter than the bench at site 23. The bench was covered with a layer of thick sediment in the nearshore area, but farther riverward the bench surface was hard. The stage analysis (table 6-34) indicated that the bare bank face was located between the 50% and 25% recurrence stages. The 50% recurrence stage, 420.3 feet, was at the base of the scarp.

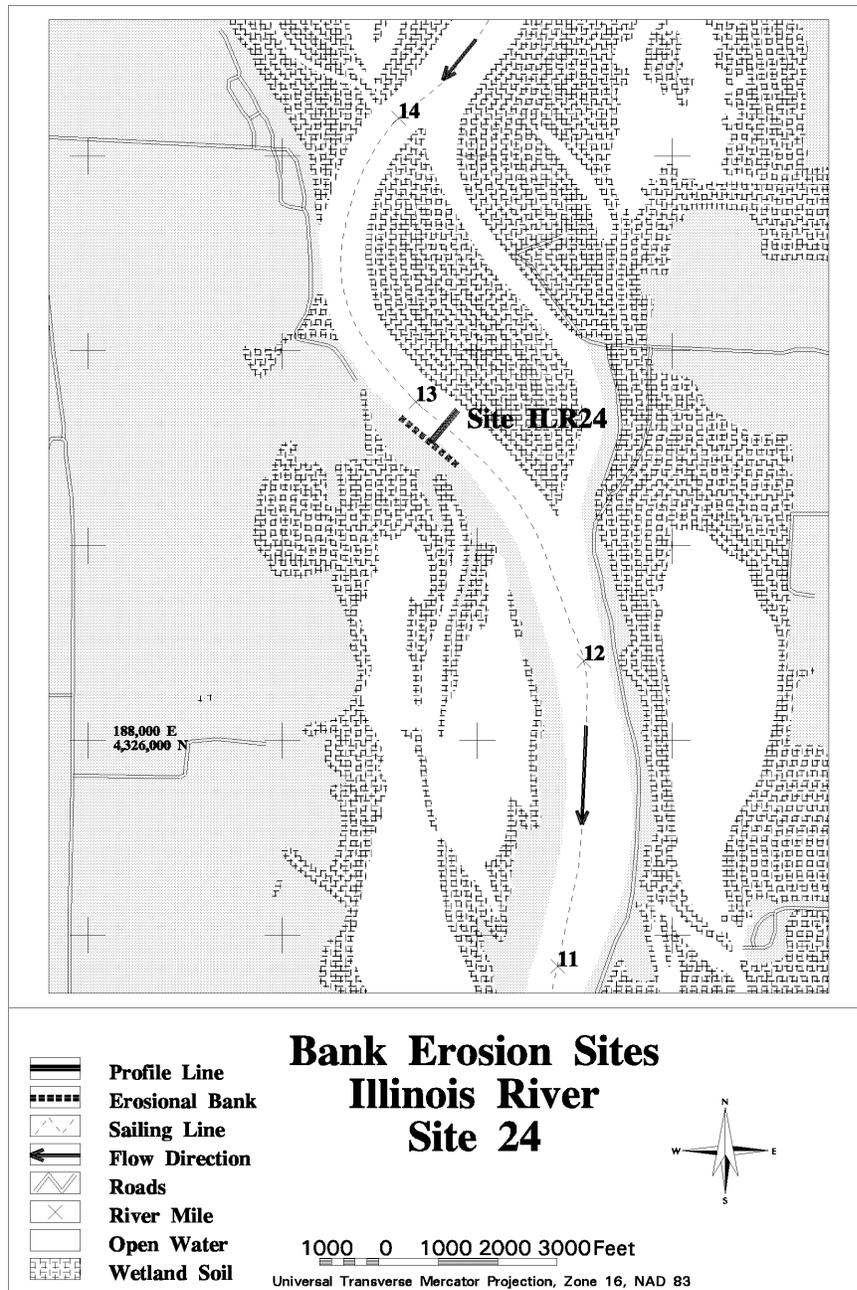


Figure 6-110. Location of site 24 on the Illinois Waterway



Figure 6-111. Site 24 on the Illinois Waterway

At the midsection, the d_{50} varied from 0.019 mm at the surface of the bank to 0.020 mm at the upper portion of a core sample at a water depth of about 2 feet. The d_{50} for the lower core sample is 0.019 mm. A detailed river cross section is shown in appendix G, while gradation plots of bank soils and nearshore sediment are presented in appendix F.

Bench slopes varied slightly from 1V:25.0H to 1V:15.9H in this reach. The bank soils were cohesive. This site can be classified as a combination of types 2 and 5 (figures 6-19, 6-22, and table 6-4). Erosion processes could be traced as initiated by piping; debris-induced local currents and wave wash extend the erosion; rework and transport by waves and currents at various stages of pool-level fluctuation then remove the failed soils or recently deposited sediment.

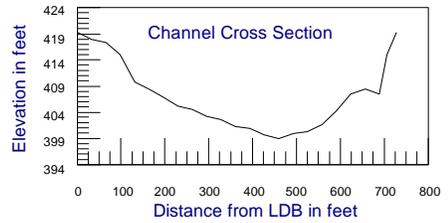
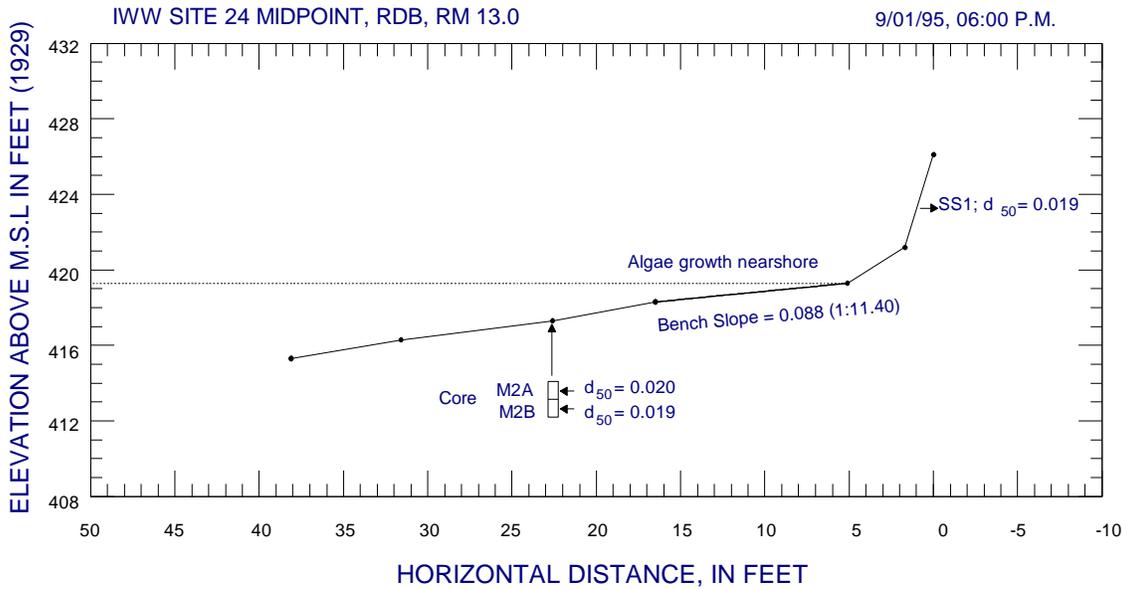
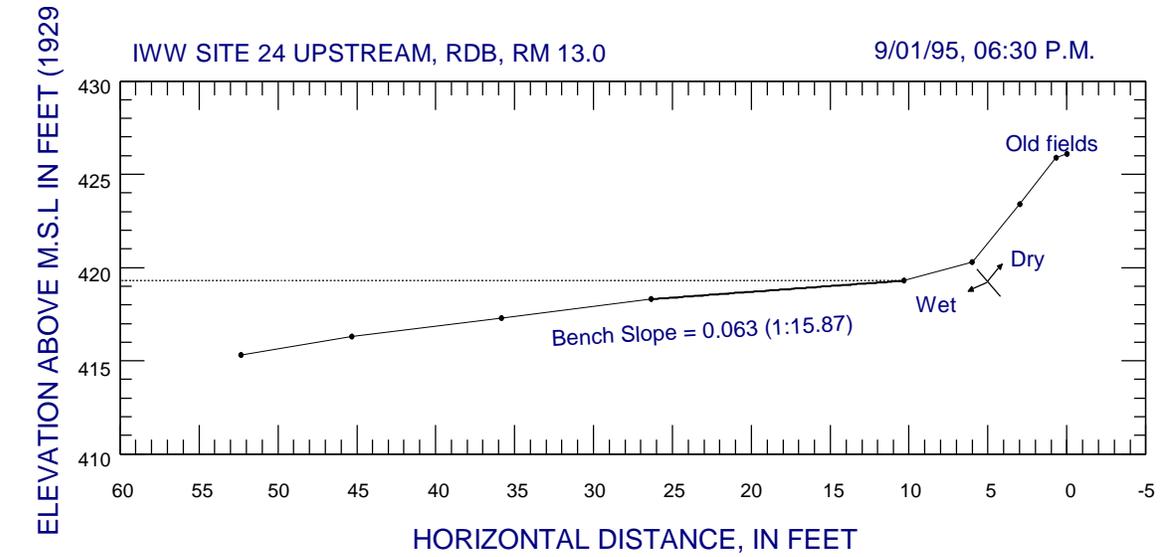


Figure 6-112. Bank sections at site 24

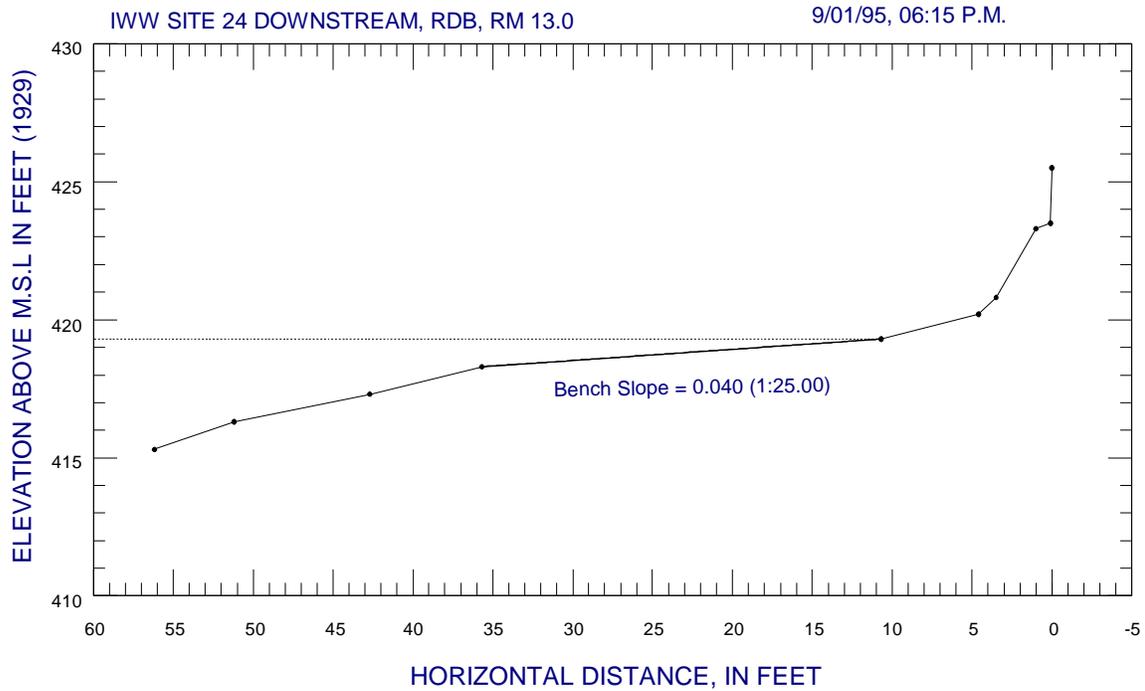


Figure 6-112. Bank sections at site 24 (concluded)

Table 6-34. Site 24

<i>Percentage of occurrence</i>	<i>Stage above msl, in ft</i>	<i>Topographical features</i>	<i>Bank/bed material, mm</i>
90	419.2	<ul style="list-style-type: none"> • Bench (underwater) (slopes varied between 1V:25.0H and 1V:15.9H) 	<ul style="list-style-type: none"> • d_{50} (core) varied (0.019-0.020)
75	419.5	<ul style="list-style-type: none"> • Bench 	
50	420.3	<ul style="list-style-type: none"> • Bench/berm (slopes varied between 1V:1.8H and 1V:1.2H) 	
25	422.5	<ul style="list-style-type: none"> • Scarp/berm • Scarp (slopes varied between 1V:0.34H and 1V:0.05H) 	<ul style="list-style-type: none"> • $d_{50} = 0.019$
10	426.6	<ul style="list-style-type: none"> • Top of the bank 	
0-9	>426.6		

Note: Gage on the Illinois River at Hardin, IL @ RM 21.6 was used for stage histogram. Gauge is 8.6 miles away from the site. WSE = 419.3'; OHW: (NA); NP: (NA).

Summary

This chapter described the data collected from the Illinois Waterway in 1995 in connection with the field survey study of bank erosion. The field visits and data collection were conducted from August 24-31, and from September 18-20, 1995. A summary of information presented in the report is as follows:

- Bank erosion of the entire Illinois Waterway was studied previously by Bhowmik and Schicht (1980) and Hagerty (1988). Warren (1987) also investigated the rate of bank erosion at five selected sites. Their major findings have been summarized.
- Historical data on navigation traffic on the waterway indicated an increasing trend in traffic volumes.
- Dredging summaries for the navigation pools are included in appendix D of this report.
- Fleeting sites, fleeting locations and other related data are included in appendix E of this report.
- Detailed field data were collected a total of 29 study sites and 3 observation sites.
- The distribution of sites with respect to various pools is as follows:
 - Marseilles - 5 sites (pool length = 24.5 miles)
 - Starved Rock - 3 sites (pool length = 15.8 miles)
 - Peoria - 7 sites (pool length = 73.3 miles)
 - La Grange - 9 sites (pool length = 77.7 miles)
 - Alton - 5 sites (pool length = 80.1 miles)
- Observation sites were located as follows: one in Dresden Pool and two in Marseilles Pool. The length of Dresden Pool is 14.3 miles.
- Both of the bank lines from RM 286 to RM 0 have been mapped on navigation charts of the river. Eroded and stable reaches were identified on these charts, and included in appendix J of this report.
- At all the selected sites, bank sections, bank and core samples, and at least one river cross section at the midpoint were obtained. Photographs of the sites, including panoramic and feature-specific were taken. All the sites were located by using a portable GPS system.
- A total of 80 bank sections from 29 eroded sites were measured.
- The river widths varied from 529 to 919 feet, and the maximum depths varied from 12 to 21 feet.
- Bank sections were measured to determine the slopes of scarp, berm, and bench. Scarp slopes varied from about 1V:0.83H to 1V:0.04H, berm slopes varied from 1V:8H to 1V:0.83H, and bench slopes varied from 1V:83.3H to 1V:1H. Scarp and bench slopes did not show too much variation, whereas berm slopes showed quite a bit of variation.

- A total of 174 surficial bank and nearshore bed material samples were analyzed, 93 samples from the riverbanks and 81 core samples. For about 141 of the samples, d_{50} varied from 0.002 mm to 0.696 mm. Surficial bank materials consisted of fine sand and silt within the upper portion of the waterway and became silty and clayey within the lower reach of the waterway. Almost all the surficial bank material samples appeared to be well graded.
- Erosion reaches selected varied from a minimum length of 0.09 mile to a maximum length of 0.95 miles.
- All selected bank sections had natural coverings. Among the 29 study reaches, 17 were located on the Right Descending Bank (RDB) and 12 on the Left Descending Bank (LDB); 13 on the straight reaches of the river, 11 on the outside bank, 3 on the inside bank, and 2 in crossover. The dominant land cover on the bank face was grass or weeds. The dominant land cover on the bank crest was woody vegetation.
- Most of the 1995 bank sections were located within the straight portion of the river. Sites selected from the outside bank are distributed throughout the waterway.
- During field data collection, the field team identified the probable cause or causes of erosion at all the bank sections where bank sections were measured. The probable causes are organized for evaluating the percentage of each cause presented in these 80 bank sections. The data from the 80 bank sections indicated that:
 - ◆ although large floods could be the dominant cause of erosion on natural rivers, this study found erosion at many bank sections located within the normal range of stage fluctuation (between the Ordinary High Water and Normal Pool stages) which cannot completely be attributed to large floods. Among these bank sections, 27% of the bank sections showed erosion occurring only at high stages while 63% had erosion occurring at stages within the normal range of stage fluctuations. The rework and transport processes, as caused by waves and currents, are significant during these stages.
 - ◆ 74% of the bank sections had evidence of seepage effects. About 26% of these bank sections had piping holes or springs, the remaining 48% had wet subaerial benches.
 - ◆ 28% of the bank sections had small scarps on bench that could have been formed by waves, seepage, or a combination of these causes.
 - ◆ 24% of the bank sections showed evidence of traffic-induced disturbance. These include impact from direct contacts and undercut in submerged banklines near fleeting areas.
 - ◆ 10% of the bank sections showed erosion associated with eddy/disturbed flow induced by riparian trees or gravel.
 - ◆ 11% of the bank sections had the presence of surface drainage; five bank sections located adjacent to water bodies (lakes, borrow pit).

- ◆ 4% of the site showed erosion associated with weathering (freeze/thaw) of surficial soils.
- All the measured bank sections were divided into six erosion types on the basis of the height of scarp, types of soils, and widths of subaerial and subaqueous benches. Each measured bank section was subsequently analyzed to determine which type or types describe that particular profile. In this categorization, types 1 and 2 indicate high potential for erosion, types 3 and 4 indicate moderate potential for erosion, and types 5 and 6 indicate active but less severe erosion.
- Analyses of the erosion mechanisms at all the measured bank sections (80 cross section) indicated the following distribution:
 - Type 1: 2 bank sections (i.e., 2.5% of the total measured bank sections)
 - Type 2: 6 bank sections (7.5%)
 - Type 3: 4 bank sections (5.0%)
 - Type 4: 13 bank sections (16.25%)
 - Type 5: 15 bank sections (18.75%)
 - Type 6: 7 bank sections (8.75%)

The remaining bank sections showed some deviation from the types as defined earlier. They are presented as a combination of different types. These are:

- Type 1 and 2: 3 bank sections (3.75%)
- Types 1 and 6: 3 bank sections (3.75%)
- Types 2 and 3: 3 bank sections (3.75%)
- Types 2 and 4: 4 bank sections (5.0%)
- Types 2 and 5: 3 bank sections (3.75%)
- Types 2 and 6: 1 bank section (1.25%)
- Types 3 and 5: 6 bank sections (7.5%)
- Types 4 and 5: 10 bank sections (12.5%)
- Several erosion mechanisms were present at many bank sections, and this field survey was not designed to identify all the specific erosion mechanisms. However, the analysis for potential causes indicated that erosion at approximate 63% of the measured bank sections could be attributed partially to rework and transport processes (waves and currents) associated with stages variations within the normal range of pool fluctuations. The waves can be generated by winds or navigation traffic and the currents can also be part of natural flows or turbulence from traffic or other causes. It is recommended that further studies be conducted to investigate the sources of these causes.

- A classification of all the bank sections indicated that future site-specific field experimentation should include bank sections with the following characteristics: bench slopes: 1V:50H to 1V:20H; berm slopes about 1V:4H; scarp slopes about 1V:0.7H to 1V:0.5H; d_{50} about 0.05 mm, and σ about 2 to 3. It should be noted that bank sections with other similar characteristics would also be suitable for detailed field experimentation.
- Detailed descriptions of all the individual bank sections and related photographs and other data are also included with this report.
- Site-specific field experimentation should be conducted to estimate the rate of bank erosion due to the movement of river traffic at representative bank sections. On the basis of such scientific information, an equation or a set of equations can be developed which could be systematically applied to the entire UMR and IWW and cover the wide variety of bank conditions existing on these two rivers.

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