Max McGraw
Wildlife Foundation
P.O. Box 9
Dundee, Illinois 60118

Fox River Fish Passage Feasibility Study

Final Report

Victor J. Santucci, Jr. and Stephen R. Gephard
Principal Investigators

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Springfield, Illinois 62702

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EXECUTIVE SUMMARY

The Fox River and its surrounding watershed are highly valued ecological and recreational resources. Currently, there are 15 dams on the river's mainstem in Illinois and numerous smaller dams on tributaries. Many of these dams were originally built in the 1800's to provide mechanical power for grist and lumber mills and have since been rebuilt to maintain the flat water ponds or impoundments that form upstream of the dam. Although extremely important in their time, most dams today serve no functional purpose. The Fox River Ecosystem Partnership (FREP) has identified dam removal or modification as an important watershed management tool to effect recovery of the Fox River ecosystem.

This report presents the results of a two-year study of approximately 100 miles of river and 15 mainstem dams located between McHenry and Dayton, Illinois. The report is divided into two main sections and a series of appendices. In Part A, we used historical and current data to determine the effect of dams on the ecological health of the river. Specifically, we examined fish and macroinvertebrate communities, aquatic habitat, and water quality. This section generally provides results summarized across a series of sample stations for the entire study area. In Part B, we discuss fish passage in general and identify specific options for each dam that will facilitate a reconnected river system. Options include complete dam removal and river restoration, dam lowering and in-stream ramping, and the construction of fishways and bypass channels that allow fish to migrate over or around dams. The appendices present site-specific data on fishes, macroinvertebrates, habitat, sediment, and water quality, as well as results from public seminars and a study evaluating use of the Aurora canoe chute and Stratton fishway by migrating fish.

To determine the effects of dams on river ecology, we used IDNR and IEPA approved methodologies to sample fish, macroinvertebrates, and aquatic habitat during July through early September 2000 at 40 stations within the study area. Stations were located directly above (US IMP) and below (DS FF) each of the 15 Fox River dams and at 10 mid segment locations in impounded (MD IMP) and free-flowing (MD FF) areas between dams. Water quality sampling took place during August and September 2001 at 11 free-flowing and 11 impounded stations and 6 to 9 transects spaced throughout four river segments. Sampling included continuous monitoring (readings every 15 min.) of temperature, dissolved oxygen, specific conductance, and pH during 16-, 40-, and 960-hour sampling periods, spot sampling to determine horizontal and vertical variation in these measured parameters, and grab sampling to assess nutrients (phosphorus and nitrogen), algal biomass, (chlorophyll a), total suspended solids, and turbidity. In addition, we quantified macrohabitat (impounded reaches, free-flowing reaches, natural pools, riffles, runs, aquatic vegetation, islands, and streamside wetlands) within the study area and determined the quantity, particle size, and toxic chemical characteristics of bulk sediments accumulated behind dams.

The distribution of fish species among station types during summer indicated that most fishes favored free-flowing portions of river over impounded areas created by dams. Further, we

found higher quality fish communities in the free-flowing river. Index of Biotic Integrity (IBI) scores in free-flowing areas averaged 46, which indicates a "B" quality stream or highly valued aquatic resource. In contrast, mean IBI scores for impounded areas were below 31, indicating a "D" quality stream or limited aquatic resource. On average, the natural flowing river had more species, four times the number of individuals, double the number of harvestable-sized sport fish, more suckers, darters, and intolerant fishes (including the state threatened river redhorse), a higher percentage of insectivorous minnows, and a lower proportion of diseased individuals than impounded areas. Impounded stations typically had lower species richness, low overall and sport fish abundance, more diseased fish, and a predominance of tolerant and omnivorous species, such as common carp, bluntnose minnow, quillback, and green sunfish. The adverse effects of impoundment on non-game and sport fish communities extended well upstream of the dams. Similarly, high quality fisheries were not confined to reaches immediately below dams but extended throughout free-flowing areas.

In addition to altering habitats, dams appear to have altered distributions of nearly one third of Fox River fishes by acting as barriers to upstream fish movement. Data from 1980 to the present showed thirty species of fish having either truncated (only found in the lower river) or discontinuous distributions (absent from the middle river). Sauger, American eel, skipjack herring, mooneye, speckled chub, longnose gar, shortnose gar, and three species of buffalo were collected only below the lowest dam (Dayton), which is located 5.6 miles above the Illinois River confluence. The 15 species with discontinuous distributions were absent from the river between St. Charles and Montgomery. This is a highly urbanized section with a particularly high density of dams (eight dams in 14 river miles) compared to other parts of the Fox River in Illinois (an average of one dam every 9.5 mi.).

Free-flowing reaches supported higher quality macroinvertebrate communities than impounded waters above dams. Mean macroinvertebrate condition index scores (MCI; a multimetric index developed for the Fox River) for stations in free-flowing habitat were more than twice as high as scores for stations in impounded areas. Free-flowing areas typically had higher abundance and richness of mayflies and caddis flies (EPT taxa), more intolerant taxa, lower Macroinvertebrate Biotic Index (MBI) scores, and a higher percentage of clinger organisms than the wadable portions of impoundments. Densities of Chironomini midges, hydropsychid caddis flies, baetid mayflies, and the flatworm *Dugesia tigrina* often were extremely high immediately below dams due to nutrient enrichment and high plankton production in impoundments. Differences between free-flowing and impounded habitats were even more pronounced when we considered samples from open-water impounded areas. Tolerant chironomid larvae and aquatic worms (Oligochaeta) combined to make up over 95% of the organisms sampled from offshore areas of impoundments.

Dams may be preventing freshwater mussels from reestablishing populations in areas where they once were abundant. Although a few large mussel beds exist in the Fox River today, a recent IDNR survey indicates that freshwater mussel diversity and abundance currently is low compared to historical samples. Most mussel species rely on fish to expand their distributions because glochidia (mussel larvae) attach to fish for a period of time in their development. By fragmenting habitat and restricting fish movement, dams in turn may be restricting distributions of this state and nationally imperiled group of invertebrates.

The quality of aquatic habitat available to fish and invertebrate communities differed substantially between free-flowing and impounded portions of river. The Qualitative Habitat Evaluation Index (QHEI) and Stream Habitat Assessment Procedure (SHAP) indicated that habitat at free-flowing stations was of good quality whereas habitat in impounded areas was rated as severely degraded by QHEI and poor to fair by SHAP. In free-flowing areas, there were a variety of water depths, current velocities, and substrate types, abundant cover for fish and invertebrates, and good quality riffle and run habitat. Habitat in impounded areas was more lake-like in that water depths were more uniform and deep, current velocity was low, fine silt deposits were high, and riffles and runs were absent. Habitat quality had a strong positive relation to the quality of fish and macroinvertebrate communities underscoring the importance of habitat to aquatic biota in the river.

Impoundments tended to accumulate large quantities of fine sand and silt, particularly downstream of islands, along impoundment margins, and in the region closest to the dam. The volume of fine grain sediments accumulated in impoundments approximately 1,000 ft. above each Fox River dam was estimated to be between 10,500 (Montgomery Dam) and 292,000 (Elgin Dam) cubic yards. Results of core and surface sediment samples showed undetectable or low levels of heavy metals, PCBs, polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, cyanide, endocrine disruptors, oil and grease. Upstream reaches of many impounded areas accumulated little silt and maintained substrates typical of the free-flowing river.

Like habitat, water quality conditions varied between the impounded and free-flowing river. Dissolved oxygen concentrations fluctuated widely on a daily basis in impounded areas (2.5 to >20 mg/L), but not in free-flowing areas (5 to 10 mg/l). These wide fluctuations resulted in violations of the IEPA standard for dissolved oxygen (<5 mg/L) at 9 of 11 impounded stations, but only 2 of 11 free-flowing stations. Substandard dissolved oxygen occurred throughout impounded reaches (not just immediately above dams), lasted for up to 16 hours in a 24-hour period, and occurred when discharge was low and water temperature was high (or potentially from mid July through mid October each year). Maximum pH values were at or above the upper IEPA standard of 9.0 units at 8 of 11 impounded stations and 4 of 11 free-flowing stations. Maximum pH tended to occur during early evening sampling when oxygen concentrations were at highly supersaturated levels. The duration of elevated pH in a 24-hour period ranged from less than 1 hour at Stolp Island to 11.75 hours in Yorkville and 24 hours in Dayton.

Although not acting alone, impoundments created by dams played an important role in the widespread occurrence of substandard water quality in the Fox River. Our data indicate that most of the river carries a high nutrient load during low flow periods. Total phosphorus and nitrogen were near recommended 25th percentile guidelines at Stratton Dam (high fertility zone Midwestern streams; 0.11 mg/L phosphorus, 1.75 mg/L nitrogen), but were extremely high at all stations below Elgin (~0.50 mg/L phosphorus or 90th percentile; ~3.0 mg/L nitrogen or 50th percentile). High nutrient levels and the lake-like environments that occurred above dams combined to produce excessive algal biomass. Chlorophyll α, an indicator of algal biomass, was extremely high at all sampling stations (75 to 275 μg/L) relative to recommended 25th percentile guidelines (7.3 μg/L). This high algal biomass, in turn, influenced dissolved oxygen and pH through daytime photosynthesis (oxygen is produced) and nighttime respiration (oxygen is consumed). Decomposition of organic material from sediments accumulated in impoundments also may have contributed to low oxygen levels. Through physical processes dams added oxygen to the river at night and caused oxygen to be released to the atmosphere during the day. However, the overall effect of water flowing over dams during a 24-hour period was a net loss in oxygen from the river.

Dissolved oxygen did not reach concentrations low enough to kill fish directly, but it may partially explain the predominance of tolerant species of fish and invertebrates in impoundments. Further, highly fluctuating oxygen levels and extended periods of substandard oxygen and pH occurred at a time of year when other stressors, such as high turbidity, low discharge rates, and high water temperatures might adversely affect fish and invertebrates. Whether from single or multiple sources, stress can indirectly cause mortality by depressing immune system response and increasing susceptibility to epizootic bacterial or viral infections. A stress-induced epizootic event probably was responsible for a widespread channel catfish die-off that occurred throughout the Fox River during summer 2000.

Given the adverse effects of impoundments on habitat, water quality, and aquatic biota in the Fox River, the proportion of impounded waters in the system should give an indication of the overall influence of dams on the river's ecological condition. We found that dams impounded 47% of the river's length and 55% of its surface area between Chain of Lakes and Dayton, Illinois. This high density of impounded habitat suggests that improvements to the ecological health of the river would be realized if some dams were removed and riverine habitat was restored. Further, dams prevented access by fish to important spawning and nursery habitats, such as tributaries and wetlands, which were absent from many sections of the river isolated by dams. Similarly, the Fox River is the third largest tributary to the Illinois River, yet the Dayton Dam prevents access by Illinois River fish to all but the lower 5.6 miles of this important resource.

Based on the strong and consistent nature of our results, we recommend reconnecting the river through the removal or modification of all mainstem and tributary dams. Benefits of a reconnected river may include: elimination of barriers to canoeists and kayakers, enhanced habitat and water quality conditions and corresponding improvements to fish and macroinvertebrate communities, improved access by Fox River and Illinois River fish to important spawning and nursery habitats in tributaries and stream-side wetlands, repopulation of areas where certain species of fish and mussels no longer exist, genetic mixing in fish and invertebrate populations isolated by dams, and improved recreational fishing opportunities provided by enhanced sport fish populations and seasonal migrations of fishes, such as walleye, northern pike, muskellunge, sauger, white bass, skipjack herring, and large sucker species.

Options to reconnect the river include: removing dams completely, lowering dams and ramping the remaining structure, constructing traditional fishways (e.g., Denil fishways), and constructing fish/canoe bypass channels. In many cases, we present more than one option for individual dams. Dam removal is the best option when the ecological health of the river is of prime consideration because removing dams will eliminate barriers to migration for all types and sizes of fish, restore high quality river habitat, and improve water quality. In addition, dam removal is relatively inexpensive compared to other options presented and it eliminates safety risks (people drown at dams) and maintenance costs because the structure is gone.

Lowering and ramping dams provides for reconnection of the river by allowing most fishes to pass upstream and paddle craft downstream, but it does little to improve degraded water quality and habitat conditions. This option probably is not feasible at most dams on the Fox River because they are long (>250 ft.) and the amount of fill (small and large boulders) needed to build a ramp at the proper slope (5%) may be cost prohibitive or unacceptable to regulating agencies. Ramping may be a suitable option for small tributary dams when removal is not an acceptable option.

Fishways and bypass channels will allow many (not all) fish to navigate over or around dams, but will do nothing to improve habitat and water quality conditions in the river. Priority species targeted for fishways or bypass channels include channel catfish, flathead catfish, muskellunge, northern pike, white bass, smallmouth bass, sauger, walleye, goldeye, mooneye, skipjack herring, redhorse suckers (golden, silver, shorthead, and the Illinois threatened river redhorse), buffalos (smallmouth, bigmouth, and black), carpsuckers (highfin and river), and northern hog sucker. Fishways have associated operational and maintenance costs and are relatively expensive to build (~$1,600/linear ft. for Denil fishways). Fishways and bypass channels should be considered only when dam removal is ruled out as a fish passage option.

The Fox River is an important ecological and recreational resource that is worthy of restoration efforts. Based on past work in Wisconsin, dam removal is likely the most cost effective and practical restoration technique available today. Reconnecting the Fox River with fishways and bypass channels at dams also will provide substantial improvement over existing conditions, but these options are less beneficial than dam removal. Although potential benefits are high, removing and modifying dams will not address all problems affecting the river. Additional watershed management practices, such as incorporating Best Management Practices (BMP's) in rural areas, protecting tributaries and wetlands from development, and reducing input of nutrients and non-point source pollutants, will be necessary to ensure that the Fox River remains a vital natural resource for future generations.

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PROJECT INTRODUCTION

The Fox River and its surrounding watershed are highly valued ecological and recreational resources. The river is the third largest tributary to the Illinois River and it drains an area of about 1,720 square miles in northeastern Illinois and an additional 940 square miles in Wisconsin. The Illinois portion of the Fox River basin supports significant and diverse plant and animal communities and the northern region has been designated as a Resource Rich Area (IDNR 1998). The river and its tributaries are known to support a high diversity of aquatic organisms including 32 species of mussels and 96 species of fish. Eighteen lakes and stream segments have been recognized as biologically significant (Page et al. 1992) because they support threatened or endangered species or have high mussel and fish diversity.

Located in close proximity to Chicago, the Fox River and its associated lakes receive much recreational use. About 11% of Illinois' human population resides in the Fox River basin and 8 million people live within 100 miles of the river's banks. Power boating and fishing are very popular activities, especially in the northern half of the watershed. Six Fox River counties accounted for 15% of Illinois boat registrations in 1996 (60,000 registrations) and 16% of fishing license sales in 1993 (128,000 licenses; IDNR 1998). Although some power boating takes place in the impoundments formed behind many Fox River dams, boating is very popular from the dam in Algonquin north into the Chain of Lakes. Canoeing and kayaking also are popular and paddle craft use is likely to increase as the recently created *Northeastern Illinois Regional Water Trail Plan* (NIPC 1999) becomes fully implemented. Other popular river-related recreational activities include waterfowl hunting, snowmobiling, and hiking, bicycling, and bird watching on associated greenway trails.

It was not long ago that the Fox River suffered from serious pollution problems that degraded water quality and altered fish and invertebrate populations. A 1972 study compared the frequency of tumors in fish from the polluted Fox River and a non-polluted Canadian watershed and found a higher incidence of tumors in fish from the Fox River (Brown et al. 1973). Electrofishing samples by Illinois Department of Natural Resources (IDNR) personnel in 1964 indicated a mainstem fish community dominated by tolerant species such as common carp, goldfish, and black bullhead (Muench 1965). Progress in the abatement of point source pollution has led to improved water quality throughout much of the river. Recent IDNR collections indicate that fish populations have responded favorably to improved conditions, although problem areas persist. Freshwater mussels were adversely affected by pollution over the years, but unlike many fish populations, the mainstem Fox River mussel fauna is severely limited today (B. Schanzle, IDNR, personal communication).

Future efforts to restore the Fox River will require watershed-based approaches that further reduce point and non-point source pollution, decrease water and sediment runoff, limit the introduction of invasive exotic species, and enhance and diversify aquatic habitat. The Fox River Ecosystem Partnership (FREP) has identified dam removal or modification as an important watershed management tool to effect recovery of the Fox River ecosystem. Although dam removal or modification is a relatively new idea in Illinois, removing unnecessary dams and retrofitting necessary dams with fishways has received much attention nationwide over the past decade. Ambitious projects have been completed in California, Colorado, Connecticut, Maine, Michigan, Minnesota, North Carolina, New Jersey, Ohio, Pennsylvania, Tennessee, Vermont, and Wisconsin (AR/FE/TU 1999). Wisconsin alone has successfully removed over 70 lowhead dams and has documented improvements to habitat and fish populations as a direct result of dam removal (Kanehl et al. 1997).

The purpose of this project is to provide FREP, IDNR, and other interested parties with information to assist them in their efforts to protect and manage the Fox River ecosystem. Specifically, this report will provide information to assist stakeholders in making informed decisions regarding dam removal or modification projects on the river. It will help improve the public's knowledge of river ecology, the effects dams have on fish, macroinvertebrates, aquatic habitat, and water quality, and potential benefits the river may experience from well-planned dam removal or modification efforts. It also may act as a guide for future dam-related improvement projects on the Fox and other rivers throughout Illinois.

Objectives and Scope

The overall objectives of the project are:

1) Determine the effects of dams on fish and macroinvertebrate populations, aquatic habitat, and water quality in the Fox River between McHenry and Dayton, Illinois.
2) Determine opportunities to enhance fisheries and improve river-based recreational activities through dam removal or modification, and outline options for such actions.

This report presents the results of a two-year study of approximately 100 miles of river and 15 dams located between the Fox Chain of Lakes near McHenry, Illinois and the town of Dayton, Illinois. The report is divided into two main sections and a series of appendices. In Part A, we use historical and current data to determine the effect of dams on the ecological health of the river. Specifically, we examined fish and macroinvertebrate communities, aquatic habitat, and water quality. This section generally provides results summarized across a series of sample stations for the entire study area. In Part B, we discuss fish passage in general and identify specific options for each mainstem dam that will facilitate a reconnected river system. Options include complete dam removal and river restoration, dam lowering and in-stream ramping, and the construction of fishways and bypass channels that allow fish to migrate over or around dams. The appendices present site-specific data on fishes, macroinvertebrates, habitat, sediment, and water quality, as well as results from public seminars and a small study evaluating use of the Aurora canoe chute and Stratton fishway by migrating fish (Appendices A-H).

Site Description

From its source near Waukesha, Wisconsin, the Fox River flows in a southerly direction across the Illinois-Wisconsin state line to a point 3 miles south of Aurora where it flows southwesterly for about 43 mi. to its confluence with the Illinois River near Ottawa (Figure 1).

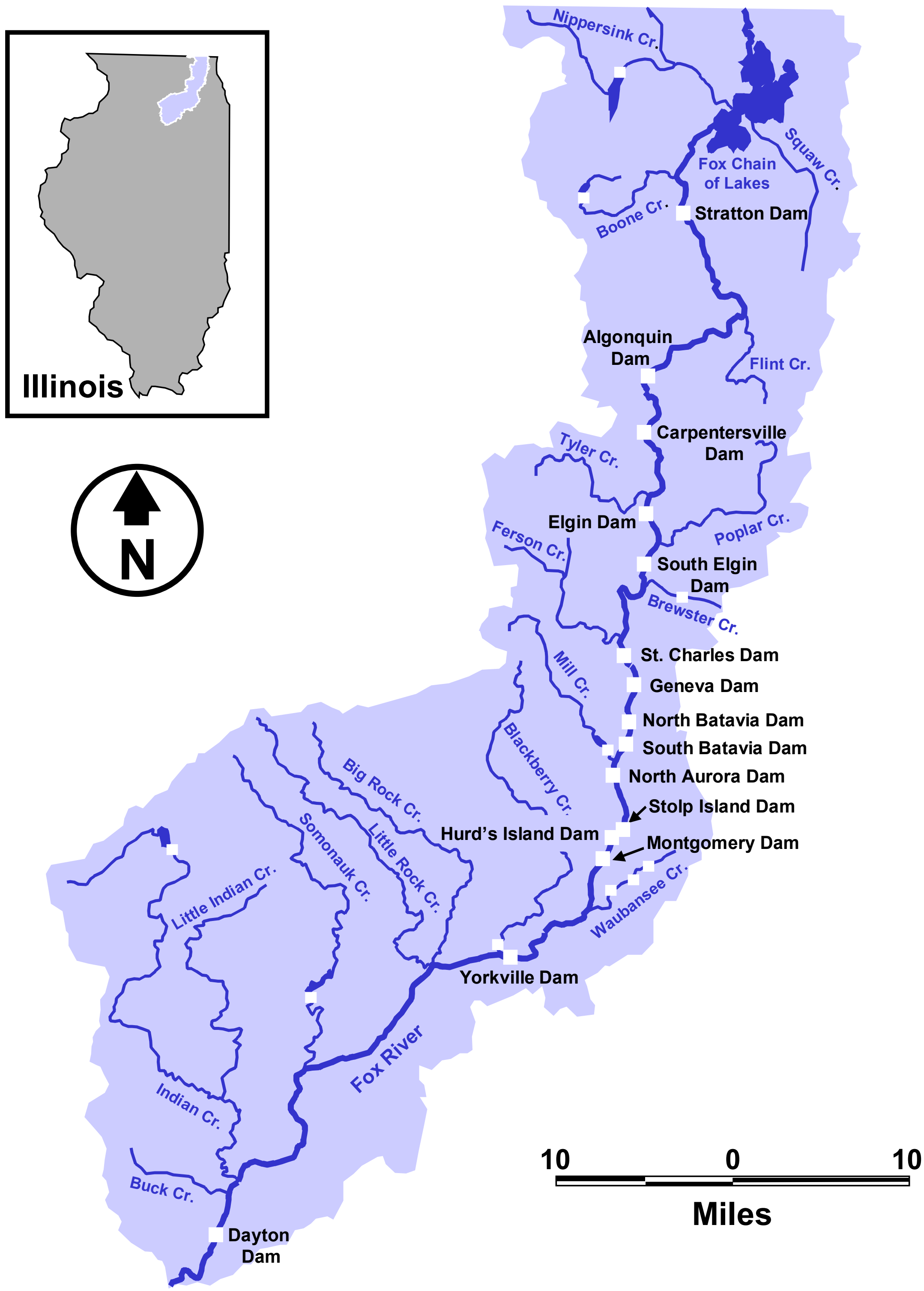


Figure 1. The Fox River watershed showing major tributaries, 15 mainstem dams, and selected tributary dams.

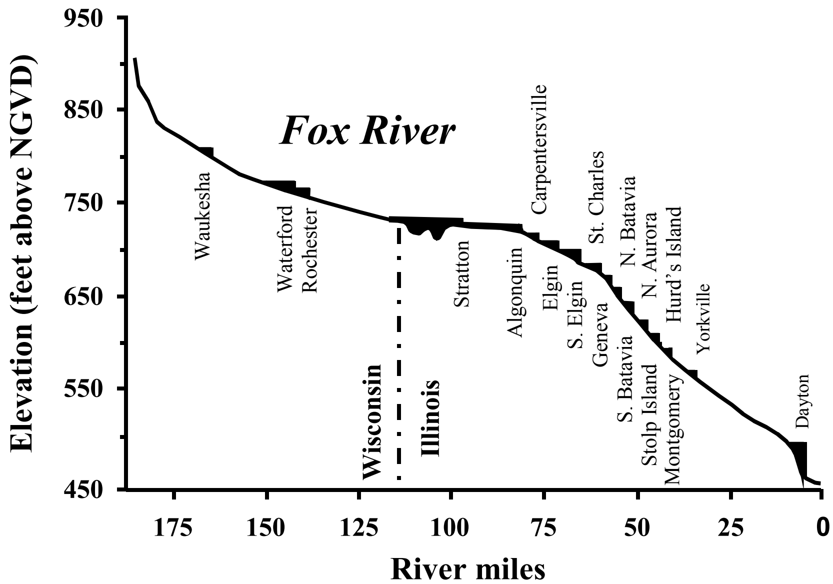


Figure 2. Fox River profile and dams in Wisconsin and Illinois (modified from Knapp 1988).

The total length of the river is 185 mi. and the portion flowing through Illinois is about 115 mi. The mainstem Fox River is a sixth order stream in Illinois. The total fall of the river from headwaters to confluence is about 460 ft., for an average slope of 2.5 ft./mi.

The gradient of the river is atypical in that the slopes are greatest in its downstream reaches (Figure 2). In the northern portion of its Illinois watershed, the river winds through marshy areas and the Chain of Lakes and the channel is often undefined or confined by low banks and wide floodplains. Downstream of Algonquin, the channel is straighter and the slope higher as the river is more deeply cut into the bedrock. Limestone outcrops exist in the central portion between St. Charles and Aurora, and in many of the lower reaches, sandstone bluffs exposed on one or both sides of the river leave little or no floodplain area. The river has an average slope of about 0.3 ft./mi. over the 33-mile stretch from the state line to Algonquin, 2.0 ft./mi. between Algonquin and St. Charles, 4.5 ft./mi. between St. Charles and Yorkville, and 2.7 ft./mi. between Yorkville and Dayton. The steepest gradient once occurred where the Fox River dropped into the Illinois River Valley at Dayton. At this location the river dropped 19.2 ft. in a distance of 6,460 ft. and formed a succession of rapids as it flowed over the sandstone bedrock and a deposit of large granite boulders (Alexander and McCurdy 1915). The rapids are now inundated by the impoundment formed behind the Dayton Dam.

The Fox River watershed occupies portions of McHenry, Lake, Cook, Kane, DuPage, Dekalb, Lee, LaSalle, Kendall, Grundy, and Will counties in northeastern Illinois. The predominant land cover in the basin is agricultural land (66%) and urban/residential land (18%; IDNR 1998). The remainder of the watershed consists of woodlands (9.2%), wetlands (4.5%), and lakes and streams (2.3%). The northern portion of the watershed is diverse in the type and

Table 1. Selected tributaries to the Fox River in Illinois. Drainage area data are from IDNR (1998).

Tributary	River segment	Drainage area (square miles)
Nippersink Creek	Fox Chain of Lakes	205
Squaw Creek	Fox Chain of Lakes	46
Boone Creek	Chain of Lakes – McHenry	23
Flint Creek	McHenry – Algonquin	37
Tyler Creek	Carpentersville – Elgin	40
Poplar Creek	Elgin – South Elgin	44
Brewster Creek	South Elgin – St. Charles	15
Ferson/Otter Creek	South Elgin – St. Charles	54
Mill Creek	Batavia – North Aurora	31
Waubansee Creek	Montgomery – Yorkville	30
Blackberry Creek	Yorkville – Dayton	73
Big Rock/Little Rock Creek	Yorkville – Dayton	194
Somonauk Creek	Yorkville – Dayton	88
Indian/Little Indian Creek	Yorkville – Dayton	264
Buck Creek	Yorkville – Dayton	41

distribution of land covers and this area contains most of the basins lakes and wetlands. The central portion of the basin has the highest concentration of urban/residential land, whereas the southern portion is predominantly row crops and rural grasslands. The basin is about 130 miles long, from north to south, and generally less than 25 miles wide. Due to its narrow shape, the Fox River watershed has only three large tributaries in Illinois (Table 1).

The U.S. Geological Survey (USGS) operates five gaging stations on the mainstem of the Fox River in Illinois and two in Wisconsin (Table 2). All of the stations have 10 or more years of continuous daily records. The Johnsburg, McHenry, and South Elgin stations currently provide stage data only, whereas the others provide stage and streamflow data. Historical streamflow data may be available for the stage-only stations for portions of their periods of operation (USGS 2002). In addition to the USGS, the IDNR Division of Water Resources has operated gaging stations at other locations on the mainstem Fox River for varying periods of time.

Table 2. Stream gaging stations for the mainstem Fox River in Wisconsin and Illinois.

USGS ID	Station name	Type of data	Drainage area (square miles)	Period of record
05543830	Fox River at Waukesha, WI	Stage and flow	126	1963-present
05545750	Fox River near New Munster, WI	Stage and flow	811	1939-present
05548500	Fox River at Johnsburg	Stage	1,205	1939-present
05549500	Fox River near McHenry	Stage	1,250	1941-present
05550000	Fox River at Algonquin	Stage and flow	1,403	1915-present
05551000	Fox River at South Elgin	Stage	1,556	1989-present
05552500	Fox River at Dayton	Stage and flow	2,642	1925-present

Table 3. Mean monthly and annual flow rate (min – max) for the Fox River at the Algonquin and Dayton stream gages, 1980 - 2000.

Month	Algonquin flow (cfs)	Dayton flow (cfs)
January	916 (265 – 2,880)	1,825 (540 – 11,900)
February	1,143 (380 – 3,700)	2,624 (242 – 33,100)
March	1,663 (263 – 4,340)	3,366 (800 – 24,000)
April	1,912 (81 – 6,090)	3,720 (418 – 20,700)
May	1,397 (254 – 4,960)	2,936 (458 – 16,200)
June	1,167 (117 – 5,060)	2,538 (351 – 19,300)
July	815 (77 – 3,780)	1,912 (286 – 46,600)
August	666 (106 – 2,630)	1,364 (213 – 16,200)
September	695 (112 – 5,790)	1,309 (209 – 9,400)
October	818 (179 – 6,130)	1,369 (352 – 9,750)
November	1,178 (195 – 3,170)	2,200 (592 – 16,200)
December	1,195 (235 – 4,300)	2,425 (384 – 22,800)
Annual flow	1,130 (77 – 6,130)	2,299 (209 – 46,600)

The Fox River displays a well-defined seasonal streamflow cycle. Flow at the Algonquin and Dayton gages is typically highest during the spring (March - April) and lowest during summer and early fall (July – October; Table 3). From 1980 through 2000, average daily flow ranged from 77 to 6,130 cubic feet/second (cfs) at Algonquin and 209 to 46,600 cfs at Dayton.

Like many rivers in watersheds with expanding human population, flows in the Fox River have increased over the past century. Higher flows are due in large part to climatic changes that have resulted in increased precipitation in the region and urbanization within the watershed (more impermeable urban land cover and higher municipal wastewater discharges; IDNR 1998). Summer low-flows are largely affected by wastewater discharges and operation of the Stratton Dam. In 1995, water use in the basin was more than 85 million gallons per day (IDNR 1998). Most of this water was discharged to the river after being used and treated. During periods of low flow, estimates suggest that wastewater effluents make up more than one-third of the river's flow in Kane County and downstream areas. The Stratton Dam affects the river during low flow periods because it is operated under a policy of releasing a minimum flow of 94 cfs through its water control gates. During medium and high flow conditions, the Stratton Dam and other dams on the river have minimal effect on discharge and provide no effective flood control benefit (Knapp and Ortel 1992). However, this may change in the future as the Stratton and Algonquin dams have recently been retrofitted with 50-ft. long foster gates (operational in 2002) that will allow more water to be discharged from the upper portion of the river before or during high water events.

There are 15 channel dams on the Fox River in Illinois and an unknown number of tributary dams. Mainstem dam locations range from 5.7 miles above the Fox/Illinois River confluence at Ottawa (Dayton Dam) to river mile 98.9 near McHenry (Stratton Dam; Table 4). The dams range in length from 143 to 600 feet and their height varies from 2.8 to 29.6 feet.

Table 4. Channel dams on the Fox River in Illinois. Data are from IDOT (1976), Butts and Evans (1978), and the present study.

Dam	Owner	River mile above mouth	Spillway characteristics: Length (ft.)	Height (ft.)	Crest elevation (ft. above NGVD)	Original function
Stratton	State of Illinois	98.9	275	7.0	736.8	Navigation
Algonquin	State of Illinois	82.6	308	10.5	730.3	Recreation
Carpentersville	Kane County	78.2	378	9.0	720.7	Milldam/ Hydropower
Elgin	City of Elgin	71.9	325	13.0	708.4	Milldam
South Elgin	State of Illinois	68.2	357	8.3	700.0	Milldam
St. Charles	City of St. Charles	60.6	294	10.3	684.6	Recreation/ Hydropower
Geneva	State of Illinois	58.7	441	13.0	675.4	Milldam
North Batavia	City of Batavia	56.3	244	12.0	665.1	Milldam
South Batavia	Kane County	54.9	143 E 203 W	6.0 5.0	653.9 654.2	Water supply
North Aurora	State of Illinois	52.6	375	9.0	646.0	Milldam
Stolp Island	City of Aurora	48.9	177 E 170 W	11.0 15.0	628.4 628.4	Milldam
Hurd's Island	City of Aurora	48.4	365	2.8	619.0	Increase depth
Montgomery	State of Illinois	46.8	325	8.0	614.0	Navigation
Yorkville	State of Illinois	36.5	530	7.0	575.0	Recreation
Dayton	North American Hydro	5.7	600	29.6	498.8	Hydropower

Many of the dams on the Fox were originally built in the early to mid 1800's to provide mechanical power for grist or saw mills. They have been rebuilt over the years and today most function to maintain high pool levels for recreational use. Exceptions include the Dayton Dam, a hydropower dam, the Elgin Dam, used to store water for the municipal drinking water supply, and the Stratton Dam, used to control pool elevations in the Chain of Lakes.

Past Data Collection Activities

Two comprehensive reviews of existing ecological information are available for the Fox River. One is an IDNR Critical Trends Program document that summarizes data on the natural and human resources found in the Illinois portion of the Fox River basin (IDNR 1997, 1998). It provides extensive summaries of the region's geology, water resources, living resources, socio-economic status, environmental quality, and archeological resources. The other is an extensive review of published and unpublished biological data related to water quality in the upper Illinois River basin (Steffeck and Striegl 1989). This review was completed as part of the pilot phase of the USGS National Water Quality Assessment Program and it summarizes data collected between the late 1800's and 1988 for mainstem and tributary sites on the Fox, DesPlaines and Kankakee rivers. Studies were grouped into four categories: population and community

Table 5. Fish population assessment studies on the Fox River and its tributaries in Illinois, 1878-1999.

Authors	Sample years	Number of studies	Number of sample sites
Forbes and Richardson (1905)	1878-1903	4	20
Muench (1965)	1964	1	16
Brigham et al. (1978)	1976	1	79
Day et al. (1992)	1978-1990	1	4
Bertrand et al. (1982)	1981	1	12
Sallee and Bergmann (1986)	1982	1	23
Heidinger (1993)	1993	1	4
Santucci (1994, and unpublished data)	1994, 1996	2	16
Pescitelli and Rung (unpublished data)	1995-1999	8	45

structure, chemical concentrations in tissues, organism health, and toxicity measurements. The Fox River was studied the least of all of the river systems. The authors identified 48 studies on the river and concluded that data for fish populations were extensive, whereas data were limited for plankton, vegetation, and macroinvertebrates. Likewise, only seven studies assessed organism health or chemical accumulations in tissues and only four studies measured toxicity of Fox River waters.

Ten fish population assessments were conducted in the Fox River between 1878 and 1999 (Table 5). The first recorded sampling occurred around the turn of the 20th century after most of the Fox River dams were already in place. Although interesting, these data are of limited comparative value because sampling methods differed substantially from those used in later years. Extensive basin surveys were conducted in 1964, 1976, 1982, and 1996 (Muench 1965; Brigham et al. 1978; Sallee and Bergman 1986; and Pescitelli 1996, unpublished data). All of these studies included mainstem and tributary sample sites, except for the 1982 report, which summarized only tributaries data. Two IDNR studies sampled the Fox River mainstem at several locations between the Wisconsin state line and Ottawa, Illinois. One study evaluated sportfishing opportunities in the river (Bertrand et al. 1982) and the other summarized data from the State's long-term monitoring program (Day et al. 1992). A number of recent studies of more limited scope have assessed fish populations from individual tributaries or specific reaches of the river (Heidinger 1993; Santucci 1994; Santucci 1996, unpublished data; and Pescitelli and Rung 1995, 1997, 1998, 1999 unpublished data). Until the present study there were several river segments sampled only infrequently or not at all (Table 6).

Past fisheries work shows that the river and its tributaries support a high diversity of fishes (94 species), including two state endangered species (weed shiner and greater redhorse) and one state threatened species (river redhorse). The redhorses were the only endangered and threatened fish species that might be encountered during the present study because the weed shiner has not been observed in the drainage since 1901.

Macroinvertebrates have received limited attention in the Fox River. We are aware of only four surveys of macroinvertebrates from the Illinois portion of the basin; three were basin-wide

Table 6. Occurrence of fish sampling in the Fox River for various river segments and time periods, 1878 - 1999.

River segment	Sample period 1878-1903	1964-1980	1981-1990	1993-1999
Above Stratton	X	X	X	X
Stratton – Algonquin		X	X	X
Algonquin – Carpentersville	X	X	X	X
Carpentersville – Elgin		X	X	X
Elgin – South Elgin		X	X	X
South Elgin – St. Charles		X	X	X
St. Charles – Geneva				
Geneva – North Batavia		X	X	X
North Batavia – South Batavia		X		
South Batavia – North Aurora		X	X	
North Aurora – Stolp Island		X		X
Stolp Island – Hurd's Island				
Hurd's Island – Montgomery				
Montgomery – Yorkville		X	X	X
Yorkville – Dayton	X	X	X	X
Below Dayton	X	X	X	X

surveys (NIPC 1978; IEPA 1987; IEPA 1996 unpublished data) and the other was restricted to the Chain of Lakes (Kothandaraman et al. 1977). NIPC (1978) assessed macroinvertebrates at 36 locations in the basin and found that the community reflected moderate to severe pollution. The other two basin-wide studies were conducted as part of the 1982 and 1996 Fox River basin surveys. These surveys included 23 tributary sites and 12 mainstem sites from the Wisconsin state line to Ottawa, Illinois. The 1982 tributary data are summarized in IEPA (1987) and the mainstem data are available in unpublished form. The 1996-mainstem data are not yet available. Forty-three taxa were found in the 1982 mainstem survey. Chironomids (midges) were the most abundant and diverse group sampled followed in order by trichopterans (caddis flies) and ephemeropterans (mayflies). Chironomids and trichopterans were important components of the fauna at all sites whereas ephemeropterans were important only at sites below Montgomery, Illinois.

Freshwater mussels have received extensive attention in the Fox River drainage. Published literature and the Illinois Natural History Survey collection database document three extensive mussel surveys on the river during the past century. Each survey sampled numerous locations throughout the basin in Illinois. J.A. Eldridge of the U.S. Bureau of Fisheries completed the earliest recorded survey in 1911 (Eldridge 1914). M.R. Matteson of the University of Illinois made another extensive collection in 1957-58. The most recent survey was completed in 1999. In this survey, B. Schanzle revisited most of the sites previously sampled by Matteson in the 1950's. Several other less extensive surveys also sampled mussels in the river, including a braile survey conducted in the deeper pools behind some Fox River dams (B. Schanzle 1982, unpublished data).

Historical data indicate that at one time the Fox River supported a diverse and abundant mussel fauna. Weathered dead and subfossil shells also are abundant in recent collections. Thirty-two species have been collected in the basin, although the diversity of live mussels today is probably much lower. Five state threatened or endangered species are known from the drainage. The species of concern are the spike, slippershell, sheepnose, wavy-rayed lampmussel, and rainbow.

Following a sampling design similar to the one proposed for the current study, IDNR and IEPA sampled fish, macroinvertebrates, and freshwater mussels at three stations above and two stations below the Yorkville Dam (Pescitelli and Rung, unpublished data). Overall, the dam appeared to have a strong negative effect on the communities examined. Fish quality indices (IBI and species richness), sport fish abundance, mussel diversity and abundance, and macroinvertebrate communities were all depressed in the impoundment immediately behind the dam compared to sites located upstream of the impoundment and downstream from the dam. A similar trend in fish population metrics was found above and below the Hoffman Dam on the DesPlaines River (Pescitelli and Rung 1998).

Comprehensive habitat evaluations of the Fox River are limited. One exception is the extensive analysis of streamflows in the basin and factors influencing flow conducted by Knapp (1988). Microhabitat data (substrate, depth, and physical cover) are routinely measured at fish sampling stations during IDNR fisheries surveys (Bertrand et al. 1982; Day et al. 1992; R. Sallee 1982, unpublished data; S. Pescitelli and R. Rung 1996, unpublished data). These data provide useful information on the quality of habitat available to fish at the sampling site, but they do little to assess overall availability of habitat or variations in habitat quality throughout the river.

More detailed habitat evaluations are available for a few river reaches. An extensive survey of microhabitat was made in the river between the North Aurora and Aurora dams and the Elgin and South Elgin dams (Santucci 1996, unpublished data). This survey was completed as part of a telemetry study assessing habitat use and movement by smallmouth bass and channel catfish (Santucci et al. 1997a and 1997b). Depth, current velocity, substrate composition, and cover were measured at 20 locations across 50 transects established in each study reach. In another study, the Illinois State Water Survey evaluated stream flow characteristics (depth, velocity, flow width) and inspected bed materials at five sites between Algonquin and Dayton, Illinois (McConkey et al. 1992). Comparisons were made between impounded areas above channel dams in Elgin and Yorkville and free-flowing areas not affected by the dams. The authors found that the channel dams create sections of wider, deeper, and slower flow. Deep silt deposits were observed only in the river section immediately upstream of the dams. Farther upstream, silt deposits thinned and coarser bed materials were observed. The extreme upper reaches of impoundments were found to have variations in depth and sorting of bed materials typical of riffle and pool sequences observed in natural flow areas of the river.

An extensive database of water quality information is available for the Fox River and its tributaries. IEPA monitors water quality monthly at 20 mainstem sites and 18 additional sites on 16 tributaries. These data are periodically summarized in Illinois water quality reports and raw data are available in the U.S. EPA STORET database. In a recent report (IEPA 1996), the IEPA assessed about 29% of the 2,300 river miles in the basin and classified 84% of assessed river miles as full support for designated uses and 16% as partial support with minor impairment. About 40 miles of the river mainstem were listed as impaired with the largest section of impaired river occurring in the central basin near St. Charles. Sources of impairment include hydrologic modifications, municipal wastewater effluents, and non-point source urban runoff.

Three studies have evaluated water quality in relation to Fox River dams. During the mid-1970's, the Northeastern Illinois Planning Commission (NIPC) conducted a comprehensive study of water supply and use in the Fox River basin (NIPC 1978). They characterized much of the surface water in the basin as slightly to moderately polluted based on measured dissolved oxygen concentrations and phosphorus enrichment. Simulations from a calibrated water quality model suggested that water quality would be of special concern in the Fox River during periods of low flow when algal blooms and subsequent low dissolved oxygen inhibited the waste assimilation capacity of the river. Dams were thought to have a negative impact on water quality because they create lake-like conditions that favor algal growth. Dam removal or notching to increase current velocity and natural aeration was one suggested approach to addressing episodic low dissolved oxygen concentrations in the river (NIPC 1978).

In another study, Butts and Evans (1978) measured dissolved oxygen above and below 55 northeastern Illinois dams (including 14 Fox River dams) to determine the effects of channel dams on dissolved oxygen concentrations. They found that dams had a strong influence on water quality by creating pools that have dissolved oxygen levels above or below those expected in a free flowing stream. When oxygen was depressed above a dam, the dam acted to re-aerate the water flowing over its crest. However, when dissolved oxygen concentrations were extremely supersaturated above dams, as during periods of high algal activity, dams caused excess oxygen to be lost to the atmosphere. This phenomenon was found to occur in the nutrient enriched Fox River. The loss of supersaturated oxygen at dams may adversely effect water quality downstream of the dam during subsequent periods when algal respiration is high and photosynthetic oxygen production is low.

Singh et al. (1995) conducted the most recent evaluation of water use and quality in the Fox River. These authors examined water quality trends based on 20 years of data from 5 sites on the river. They concluded that phosphorus concentrations and fecal coliform bacteria levels had decreased dramatically over 20 years, but chemical oxygen demand increased. No long-term trends in dissolved oxygen were detected, but the authors suggested oxygen concentrations probably had not improved in the river and may drop below desirable levels in impounded areas above dams at night during summer periods of low flow. A detailed evaluation of water quality conditions was conducted in the river above the St. Charles Dam. Results of this study showed that water quality suffered from sediment accumulations and high sediment oxygen demand immediately above the dam and high algal concentrations (up to 43,000 cells /ml) in the backwater pool created by the dam. These conditions resulted in extreme fluctuations in dissolved oxygen levels and pH related to diel variation in algal activity (photosynthesis and respiration).

Information on Fox River channel dams is available in two agency reports. The Division of Water Resources reviewed dams on the Fox River during the 1970's (IDOT 1976). The review included locations, specifications, historical considerations, and description of physical condition for all 15 dams in Illinois and the Wilmot Dam in southern Wisconsin. Butts and Evans (1978) included detailed cross-sectional schematic diagrams of 14 Fox River dams (all but the Dayton Dam) in their assessment of channel dams and dissolved oxygen levels in northeastern Illinois streams. Information on tributary dams is not readily available.

We are aware of no published data on the economics or demographics of fishing, power boating, canoeing or any other recreational uses of the river. Surveys addressing recreational use would provide useful information to river managers, government agencies, and Fox Valley municipalities that would benefit the overall public decision-making process as it relates to management of the river. A plan has recently been developed to improve safety and access to northeastern Illinois waterways for canoeists and kayakers (NIPC 1999). The plan sets forth a vision for a system of water trails for non-motorized craft and prioritizes actions necessary to achieve the vision. The recommended Fox River Water Trail extends from the Illinois-Wisconsin state line to the Kendall County line and consists of two separate trails divided by the Elgin Dam. Two trails are necessary because the Elgin Dam presents an obstacle to public passage and does not have developed or developable portages around it.

Part A. Effects of Multiple Low-head Dams on Fish, Macroinvertebrates, Aquatic Habitat, and Water Quality in the Fox River, Illinois

INTRODUCTION

Free-flowing rivers have been characterized by the river continuum concept (Vannote et al. 1980) as having a gradient of physical conditions that elicit gradual changes in biotic communities from headwaters to mouth. The fact is few rivers in the U.S. remain free flowing throughout their length due to disruptions in natural flow caused by dams and the lentic conditions that form directly behind them (Ward and Stanford 1983). Ecological research related to dams has focused on lotic reaches directly below dams (Ward and Stanford 1979a; Ligon et al. 1985; Bain et al. 1988; Merona and Albert 1999), mainstem reservoirs directly above dams (Ellis 1941; Hall 1971; Hall and Van Den Avyle 1986), fish communities upstream of impoundments (Martinez et al. 1994), fish and invertebrate migration (Netboy 1980; Clay 1995; Benstead et al. 1999; Pringle et al. 2000), and environmental impacts from hydroelectric development (Geen 1974; Efford 1975; Baxter 1977). From this large body of work we know that dams and their associated impoundments can have dramatic effects on rivers and aquatic biota by altering water quality and habitat, disrupting nutrient cycling and sediment transport, and blocking fish movements. However, most past studies examined large dams and impoundments on large riverine ecosystems (many of which supported coldwater salmonid species). Whereas the general effects of dams may remain the same for rivers of different sizes and temperature regimes (i.e., conversion of lotic habitats to lentic habitats and blocking migration), the magnitude of the effect and the degree to which biotic communities are impacted may change with river size (Ward and Stanford 1983).

The ecological consequences of low-head dams (<50 ft.) are poorly understood (Benstead et al. 1999) and few studies have examined their effects on smaller, warmwater rivers and streams. Singh et al. (1995) found that high phytoplankton biomass and sediment oxygen demand in a nutrient enriched impoundment produced substandard dissolved oxygen levels and reduced the river's natural waste assimilation capacity. Filter feeding macroinvertebrates have been shown to be abundant directly below surface-discharging dams on warmwater streams (Spence and Hynes 1971a; Parker and Voshell 1983) and these abundant invertebrates may influence food resources available to downstream communities (Parker and Voshell 1983). Dams on warmwater streams may influence fishes by restricting movements (Porto et al. 1999), altering assemblages in lotic reaches above impoundments (Erman 1973; Spence and Hynes 1971b), and even causing extirpation of certain species from reaches upstream of a dam (Winston et al. 1991). Habitat improvements and recovery of fish and invertebrate communities have been documented following dam removal (Kanehl et al. 1997; Stanley et al. 2002). Although these studies are important, they are limited to evaluations of single dams and one or two parameters (fish, invertebrates, habitat, or water quality). Examining the effects of multiple dams on several components of a river ecosystem may provide additional understanding of the impacts of dams on these systems (Ward and Stanford 1983).

Like other temperate zone locales (Dynesius and Nilsson 1994), dams are prevalent in rivers and streams throughout Illinois. They are especially pervasive in the northeastern portion of the state where multiple dams (up to 15) often exist over relatively short stretches of individual rivers (<100 miles). Most dams are remnant or rebuilt milldams from the 1800's that were important in the early development of the region but now serve little function accept to maintain flat-water pools or impoundments upstream of the dam. The Illinois Department of Natural Resources (IDNR) emphasizes an ecosystem/watershed-based approach to managing rivers and streams (similar to that discussed in Ward and Stanford 1989; Junk et al. 1989; Cummins 1992; Moyle and Yoshiyama 1994), and as such has promoted the development of ecosystem partnerships for many watersheds in the state. The Fox River Ecosystem Partnership (FREP) has identified dam removal or modification as an important watershed-based approach to enhance and restore water quality, aquatic habitat, and fisheries in the Fox River, a mid-sized warmwater river draining portions of Wisconsin and northeastern Illinois (FREP 1999). To successfully remove or modify publicly owned dams like many of those in the Fox River, it is important to have accurate, scientifically based evidence to educate stakeholders about the negative impacts of targeted structures, should these impacts exist (Smith et al. 2000).

Herein, we show that dams are having a negative effect on the ecology of the Fox River in Illinois by reducing biodiversity of fishes, altering macroinvertebrate communities, and degrading habitat and water quality. The study area included 106 river miles and 15 low-head dams that fragmented the waterway into a series of segments having free-flowing and impounded reaches. We determined the influence of dams on river ecology by comparing fish and macroinvertebrate assemblages, habitat, and water quality between free-flowing and impounded reaches and examining relationships among biotic and abiotic parameters. By evaluating the effects of more than one dam on several components of the river ecosystem, we provide information necessary to support informed decision making for river restoration, including dam removal or modification. In addition, we contribute to the general understanding of the influence of dams on warmwater stream ecosystems.

METHODS

Sample Design and Rationale

To adequately assess both free-flowing and impounded reaches of river, we sampled fish and macroinvertebrate communities and evaluated habitat quality concurrently from July through early September 2000 at 40 stations between McHenry and Dayton, Illinois (Figure 3). All sampling stations were about 900 yards in length and encompassed the entire width of the river and adjacent riparian areas. Thirty stations were located within 1,000 yards of Fox River dams; 15 were upstream of dams in impounded habitat and 15 were downstream of dams in free-flowing habitat. Safety considerations precluded sampling within 100 yards of each dam. Ten additional stations were located away from dams in the middle reaches of five river segments (two stations per segment; Table 7). Mid-segment stations were located at about 30% and 60% of total segment length in either free-flowing or impounded habitat. The following abbreviations were used to identify station types:

- DS FF indicates downstream free-flowing stations immediately below dams.
- MD FF indicates mid segment stations in free-flowing reaches away from dams.
- MD IMP indicates mid segment stations in impounded reaches away from dams.
- US IMP indicates upstream-impounded stations immediately above dams.

In addition to habitat quality assessments, we estimated macrohabitat quantity in the river mainstem and characterized accumulated sediments within impoundments. Macrohabitat was quantified along the entire length of river from the Chain of Lakes to Dayton to assess system-wide effects of dams on riverine habitat, determine potential habitat improvements that might be expected with dam removal or modification, and identify changes in habitat accessibility that might occur with fish passage. The U.S. EPA Water Division FIELDS team sampled bulk depositional and surface sediments within 3,000 yd. upstream and downstream of 12 dams (all dams except Stratton, Stolp Island, and Hurd's Island) to estimate volume and chemical and physical characteristics of sediment. Knowing the quantity and contaminant profile of bulk sediments accumulated behind dams is necessary because some sediment may be disturbed during removal or modification. Assessing contaminant characteristics in surface sediments provided estimates of sediment contaminant exposure to benthos, fish, and water.

Water quality monitoring focused on dissolved oxygen and other parameters that might influence oxygen concentrations, such as nutrient levels and algal biomass. Sampling took place

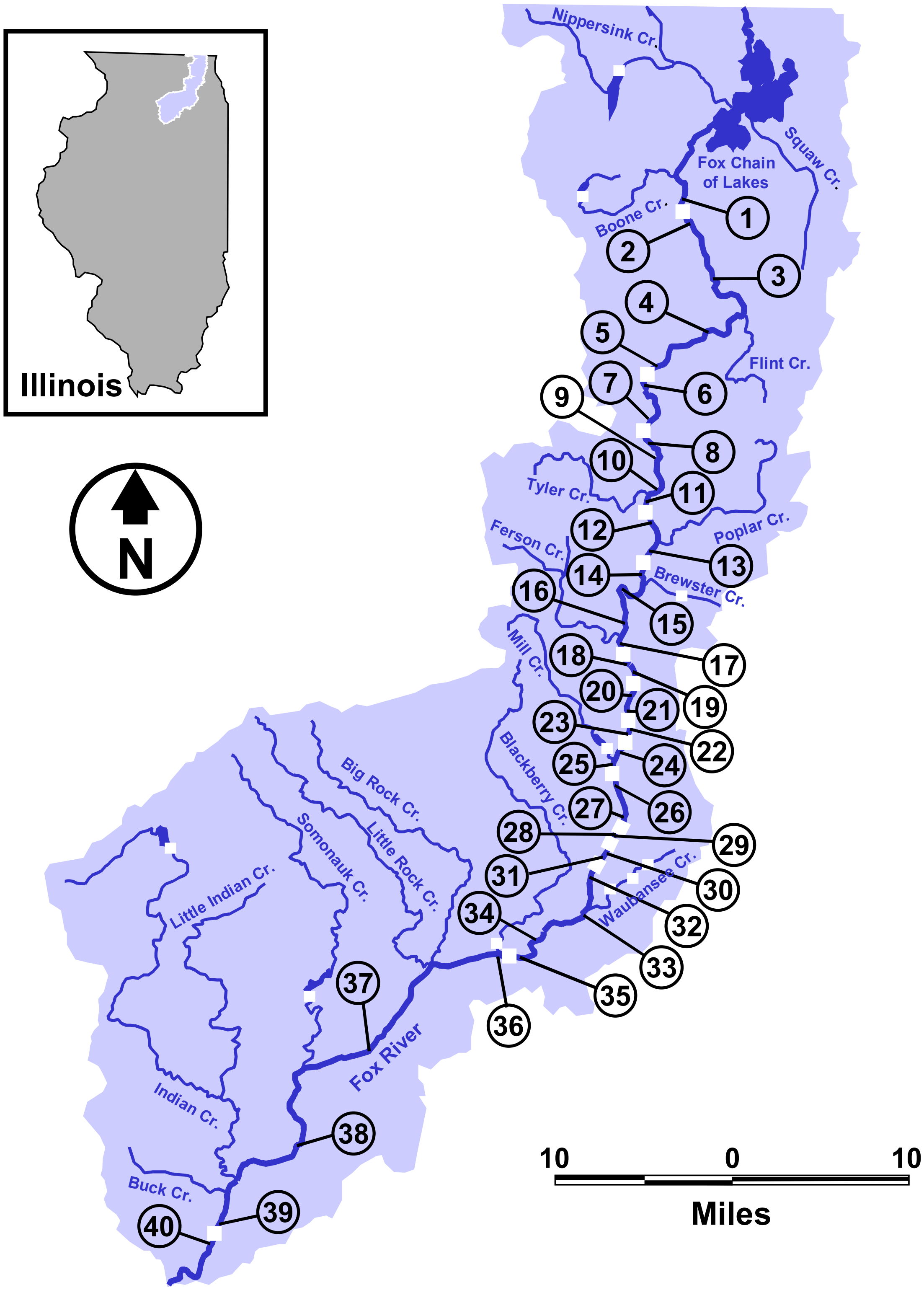


Figure 3. Location of sampling stations on the Fox River between McHenry and Dayton Illinois. White squares represent mainstem and selected tributary dams.

Table 7. Names, types, selected location information, and evaluated components for 40 stations on the Fox River between McHenry and Dayton, Illinois. Station types are downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP). Components are fish (F), macroinvertebrates (M), habitat (H), and water quality (WQ).

Map reference number	Station name	Station type	River mile above mouth	River segment	Evaluated components
1	Stratton above dam	US IMP	98.22	Above Stratton	F, M, H
2	Stratton below dam	DS FF	97.66	Stratton – Algonquin	F, M, H, WQ
3	Algonquin mid segment upper	MD IMP	93.92	Stratton – Algonquin	F, M, H
4	Algonquin mid segment lower	MD IMP	88.18	Stratton – Algonquin	F, M, H
5	Algonquin above dam	US IMP	81.91	Stratton – Algonquin	F, M, H, WQ
6	Algonquin below dam	DS FF	81.23	Algonquin – Carpentersville	F, M, H, WQ
7	Carpentersville above dam	UP IMP	77.49	Algonquin – Carpentersville	F, M, H, WQ
8	Carpentersville below dam	DS FF	76.82	Carpentersville – Elgin	F, M, H, WQ
9	Elgin mid segment upper	MD FF	74.75	Carpentersville – Elgin	F, M, H
10	Elgin mid segment lower	MD IMP	72.90	Carpentersville – Elgin	F, M, H
11	Elgin above dam	US IMP	71.25	Carpentersville – Elgin	F, M, H, WQ
12	Elgin below dam	DS FF	70.59	Elgin – South Elgin	F, M, H, WQ
13	South Elgin above dam	US IMP	67.50	Elgin – South Elgin	F, M, H, WQ
14	South Elgin below dam	DS FF	66.41	South Elgin – St. Charles	F, M, H, WQ
15	St. Charles mid segment upper	MD FF	64.00	South Elgin – St. Charles	F, M, H
16	St. Charles mid segment lower	MD IMP	61.36	South Elgin – St. Charles	F, M, H
17	St. Charles above dam	US IMP	60.00	South Elgin – St. Charles	F, M, H, WQ
18	St. Charles below dam	DS FF	59.40	St. Charles – Geneva	F, M, H
19	Geneva above dam	US IMP	58.00	St. Charles – Geneva	F, M, H
20	Geneva below dam	DS FF	57.46	Geneva – North Batavia	F, M, H, WQ
21	North Batavia above dam	US IMP	55.70	Geneva – North Batavia	F, M, H, WQ
22	North Batavia below dam	DS FF	55.07	North Batavia – South Batavia	F, M, H
23	South Batavia above dam	US IMP	54.34	North Batavia – South Batavia	F, M, H
24	South Batavia below dam	DS FF	53.73	South Batavia – North Aurora	F, M, H, WQ
25	North Aurora above dam	US IMP	52.00	South Batavia – North Aurora	F, M, H, WQ
26	North Aurora below dam	DS FF	51.45	North Aurora – Stolp Island	F, M, H, WQ
27	Stolp Island above dam	US IMP	48.63	North Aurora – Stolp Island	F, M, H, WQ
28	Stolp Island below dam	DS FF	48.12	Stolp Island – Hurd's Island	F, M, H
29	Hurd's Island above dam	US IMP	47.83	Stolp Island – Hurd's Island	F, M, H
30	Hurd's Island below dam	DS FF	47.51	Hurd's Island – Montgomery	F, M, H, WQ
31	Montgomery above dam	US IMP	46.50	Hurd's Island – Montgomery	F, M, H, WQ
32	Montgomery below dam	DS FF	46.00	Montgomery – Yorkville	F, M, H, WQ
33	Yorkville mid segment upper	MD FF	42.33	Montgomery – Yorkville	F, M, H
34	Yorkville mid segment lower	MD FF	38.58	Montgomery – Yorkville	F, M, H
35	Yorkville above dam	US IMP	36.32	Montgomery – Yorkville	F, M, H, WQ
36	Yorkville below dam	DS FF	35.60	Yorkville – Dayton	F, M, H, WQ
37	Dayton mid segment upper	MD FF	25.00	Yorkville – Dayton	F, M, H
38	Dayton mid segment lower	MD FF	14.24	Yorkville – Dayton	F, M, H
39	Dayton above dam	US IMP	5.84	Yorkville – Dayton	F, M, H, WQ
40	Dayton below dam	DS FF	5.27	Below Dayton	F, M, H

during two 10-d periods in August and early September 2001 when water temperatures were >20ºC and flow rates were low (<750 cfs at the Algonquin gage). During the first period, we sampled physical and chemical parameters at 11 DS FF and 11 US IMP stations from McHenry to Dayton (Table 7). By monitoring 4-6 stations simultaneously, we were able to compare between free-flowing and impounded reaches within river segments as well as above and below four dams (Algonquin, Elgin, North Aurora and Yorkville). For the second sampling period, we measured physical water quality parameters at 6-9 transect locations within each of four river segments (Algonquin-Carpentersville, South Elgin-St. Charles, North Aurora-Stolp Island, and Montgomery-Yorkville). This within-segment sampling allowed us to determine the extent of water quality degradation within impoundments formed by Fox River dams. All site location information (Lat-Lon) was obtained from digitized 1:24,000 scale topographical maps and GPS was used to locate sites during field sampling.

Sampling Procedures and Data Analysis

Fish Community Assessment.—We sampled fish with a pulsed-DC boat electroshocker, a generator-powered backpack electroshocker, and a 1/8-in. mesh bag seine (100 ft. long X 6.0 ft. deep). Boat electrofishing runs began at station upstream boundaries and proceeded downstream for 30 min. Both sides of the river were sampled for a total shocking time of 60 min. per station. Backpack electrofishing targeted wadable habitat (riffles, runs, and shoreline areas) for 30 min. Seining took place at three locations within each station and sampled habitats of moderate depth with silt, sand, or gravel substrates. All fish larger than 200 mm total length (TL) were identified to species, measured (nearest mm TL), weighed (nearest g), and examined for anomalies in the field. Anomalies were deformities, eroded fins, lesions, tumors, anchor worms, black spot disease, leeches, blindness, parasites, exophthalmia (bulging eyes), swirled scales, and emaciated body condition. Smaller fish were preserved in 10% buffered formalin and returned to the laboratory for processing. Fish identification was based on the keys of Smith (1979), Becker (1983), and Pflieger (1997). Field-processed fish were returned live to the river, except for voucher specimens. All small fishes and vouchers of larger taxa were sent to the Illinois Natural History Survey for verification and deposition in the state fish collection.

We characterized fish communities based on biological integrity and sport fish abundance. Community integrity was estimated for each station with a version of the Index of Biotic Integrity (IBI) developed for warmwater streams and rivers in Illinois (Bertrand et al. 1996). The IBI compares species richness, trophic composition, abundance, and condition metrics of sampled fish assemblages to component metrics of fish assemblages from high quality reference streams (Karr 1981; Karr et al. 1986). The index has been shown to accurately reflect the biological integrity and ecological health of stream ecosystems (Fausch et al. 1990). The 12 component metrics that make up the Illinois IBI are: the numbers of total species, darters (*Ammocrypta*, *Etheostoma*, and *Percina* species), sunfish (excluding *Micropterus* species), suckers (all catostomids), and intolerant species; the percentages of green sunfish (*Lepomis cyanellus*), omnivores, insectivorous minnows, and piscivores; the combined catch rate (*N*/hour) of all species; and the percentages of hybrids and individuals with DELT anomalies (deformities, eroded fins, lesions, and tumors). Seine data was included in richness metrics but not in composition, abundance, or condition metrics because seining was highly selective for minnow species and effort was not comparable to electrofishing effort. Values for the IBI range from 12 to 60, with higher scores indicating better biotic integrity. Illinois uses the IBI to classify stream segments into A (IBI scores = 51-60), B (41-50), C (31-40), D (21-30), and E (12-20) categories that represent unique, highly valued, moderate, limited, and restricted aquatic resources (Bertrand et al. 1996).

We evaluated sport fish communities because fishing is an important recreational activity on the river. The species and sizes of fish used in this assessment were based on harvestable-size sport fish designations developed by the IDNR (Table 8; Bertrand et al. 1996). Estimates of sport fish abundance were made for each sample station by summing electrofishing catch rates for all sport species collected that were larger than designated length minimums. Harvestable-size sport fish abundance estimates provided a measure of the relative availability of sport species to anglers throughout the study area.

Historic and current (present study) fisheries data were used to examine whether dams may have influenced distribution patterns of fishes in the watershed by acting as barriers to upstream movement. Historic data were obtained from 14 fish assessment studies conducted between 1980-1999 (see Table 5 for data sources). Combined with the present study, data from 112 Fox River mainstem and tributary stations (155 station-years) were included in the analysis. To identify fishes with distributions that might be limited by dams, we first determined presence or absence of species in each between-dam river segment and then examined the distribution pattern of each species relative to each segment along the 106-mile length of river between the Chain of Lakes and Ottawa, Illinois.

Table 8. Harvestable-size sport fish designations for Illinois fish (from Bertrand et al. 1996).

Species	Minimum length (in.)
Walleye	12.0
Sauger and walleye (*Stizostedion* sp.)	12.0
Northern pike and muskellunge (*Esox* sp.)	18.0
Largemouth and smallmouth bass (*Micropterus* sp.)	10.0
Sunfish (*Ambloplites* and *Lepomis* species)	6.0
Yellow perch (*Perca flavescens*)	7.5
Bullhead (*Ameiurus* sp.)	7.5
Crappie (*Pomoxis* sp.)	8.0
Yellow and white bass (*Morone* sp.)	8.0
Catfish (*Ictalurus* and *Pylodictis* sp.)	12.0
Common carp (*Cyprinus carpio*)	12.0
Freshwater drum (*Aplodinotus grunniens*)	10.0
Buffalo (*Ictiobus* sp.)	12.0
Redhorse (*Moxostoma* sp.)	12.0

Macroinvertebrate Community Assessment.—Macroinvertebrates were sampled from wadable habitats by kick netting and hand picking for 1 hour at each station. Kick nets were 10 by 18-in. rectangular steel frames fitted with 60-in. handles and 500-µm mesh bags. Forceps were used when picking invertebrates off of submerged structure, such as rocks and woody debris. Except for impounded stations, we sampled macrohabitat in relative proportion to its abundance at a site. Because wading was limited to near shore areas at impounded stations, we sampled deeper habitat at 16 impounded sites with a petite ponar dredge (6 X 6-inch opening) deployed from a canoe. Five substrate grabs were taken along one upstream transect and five from one downstream transect at each station. Transects ran perpendicular to the river's thalweg in water >4 ft. deep. Grab contents were combined and washed through a sieve having a mesh size of 500 µm.

We preserved all macroinvertebrates in 5% buffered formalin and returned them to the laboratory where dissecting microscopes were used for enumeration and identification. Organisms typically were identified to genus with keys developed by Page (1985), Pennak (1989), Peckarsky et al. (1990), and Merritt and Cummins (1996). All individuals in a sample were identified except for chironomid larvae, which were subsampled for identification. We identified a minimum of 33% of individuals in larger samples and all chironomids from samples containing 15 or fewer larvae. Identification included fixing head capsules and bodies separately on glass microscope slides and examining mouth and other body parts with a compound microscope. Overall, we identified 34% of chironomid larvae from ponar samples ($N = 365$ of 1,073 collected) and 40% of larvae from kick-netting/hand-picking samples ($N = 752$ of 1,890). Names were assigned to all larvae in a sample based on the proportion of taxa in the corresponding identified subsample.

A multi-metric macroinvertebrate condition index was used to characterize macroinvertebrate communities sampled from wadable habitats. Illinois does not have a standardized condition index for macroinvertebrates (a statewide index is currently in development) so we developed a macroinvertebrate condition index (MCI) for the Fox River based on U.S. EPA Rapid Bioassessment Protocols (Barbour et al. 1999). The index has seven component metrics: the numbers of total taxa, EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera), and intolerant taxa; the percentages of EPT individuals, Chironomidae individuals (midge larvae), and clinger organisms; and the Macroinvertebrate Biotic Index (MBI). Intolerant taxa were those with tolerance ratings ≤ 4 (range = 0-11) based on the latest Illinois macroinvertebrate tolerance list (IEPA 1995). Clinger organisms were filter-feeding insects that permanently attach to substrates (Merritt and Cummins 1996). This group of organisms is typically intolerant of poor water quality conditions (Barbour et al. 1999). The MBI is the Illinois version of the Hilsenhoff Biotic Index (Hilsenhoff 1987). It provides an overall community tolerance rating based on the mean of tolerance values weighted by organism abundance. MBI values ≥7.5 represent limited or restricted aquatic resources and a benthic community with moderate or few taxa, absent or few intolerant organisms, and a predominance of tolerant forms (Bertrand et al 1996).

Values for individual MCI metrics were calculated, adjusted to the same scale and direction of expected response to increased perturbation (with 95th percentiles of the data), and summed across metrics to obtain a total condition index score for each station (Barbour et al. 1999). The range of values for the MCI was 0 to 700, with higher scores indicating a higher quality macroinvertebrate community. The MCI was not appropriate for making comparisons to other studies or gauging ecological health relative to other rivers because only Fox River kick-netting and hand-picking data were used in its development. However, the index provided a useful measure for documenting relative differences in macroinvertebrate communities among Fox River sample stations.

Habitat Quality Assessment.—We assessed habitat quality with the Qualitative Habitat Evaluation Index (QHEI), a habitat index designed to provide empirical, quantified evaluations of lotic macrohabitat characteristics important to stream fish communities (Ohio EPA 1989). The QHEI uses six principal metrics (substrate, in-stream cover for fish, channel morphology, riparian zone and bank erosion, pool/glide and riffle/run quality, and gradient) and a number of metric components to evaluate macrohabitat conditions in rivers and streams. The index has been evaluated and shown to generate scores that are strongly correlated with fisheries assessment data (Rankin 1989). QHEI scores range from 0 to100, with higher scores indicating better habitat conditions. Locations with index scores >60 are considered to have good habitat and typically support diverse fish communities, whereas locations with scores <46 have severely degraded habitat and typically do not support quality fisheries (E. Rankin, Ohio EPA, personal communication). Scores between 46 and 60 indicate degraded habitat conditions that may or may not meet warmwater criteria for supporting aquatic life.

To enhance accuracy and precision of Fox River habitat assessments, two members of our field crew completed a 1-day QHEI training course before fieldwork began and followed developed protocols when evaluating habitat during the study (Ohio EPA 1989). Each station was reconnoitered from a canoe or by wading and a map was drawn. A second pass was made and individual metric components were scored. Gradient was calculated from USGS 7.5 minute topographical maps by measuring the elevation drop through the sampled river reach. We added the components of each metric to obtain metric scores, which then were summed to obtain the total QHEI score.

In addition to the QHEI, we evaluated habitat with the Stream Habitat Assessment Procedure (SHAP). SHAP is a semi-quantitative habitat index that evaluates lotic habitat quality based on features considered important to biotic integrity (IEPA 1994). It uses 15 metrics (bottom substrate, deposition, substrate stability, in-stream cover for fish, pool substrate character, pool quality, pool variability, canopy cover, bank vegetative protection, top-of-bank land use, flow-related refugia, channel alteration, channel sinuosity, width/depth ratio, and hydrologic diversity) that are numerically rated and summed across metrics to compute a total score. Total scores for the SHAP range from 15 to 208 and they represent habitat conditions that are poor when <59, fair when ≥59 and <100, good when ≥100 and <142, and excellent when ≥142 (IEPA 1994). SHAP was chosen as a secondary method for assessing habitat because it was developed primarily for smaller streams in Illinois. We compared SHAP and QHEI scores to fisheries assessment data to determine the relative effectiveness of each procedure for evaluating habitat in streams as large as the Fox River.

Water Quality Assessment.—Continuous, point-transect, and grab sampling was used to monitor water conditions at free-flowing (DS FF) and impounded (US IMP) locations during August 6-17, 2001. Continuous sampling with Hydrolab Datasonde water quality monitors measured temperature, dissolved oxygen, pH, and conductivity every 15 min. for 40 hours at each station. Datasondes were calibrated and deployed mid channel at depths ranging from 1-2 ft. above the river bottom. During evening and early morning extremes in the diel oxygen cycle (6:00 to 9:00 p.m. and a.m.), we took point measurements of temperature, dissolved oxygen, pH, and conductivity with a calibrated Datasonde from surface, mid, and near-bottom depths at three sites along a transect (1 transect/station; 9 point measures/station-time period). Transects included mid-channel (same as Datasonde locations), left-of-center, and right-of-center sites. Left-of-center sites were to the left of mid channel (facing downstream) halfway between mid channel and the left bank and right-of-center sites were to the right of mid channel halfway between mid channel and the right bank. Point measurements also were made at Datasonde depths when units were set and retrieved to assess instrument drift (none occurred) and at grab sample depths to provide precise measures of physical parameters for comparison with water chemistry data.

Grab samples ($N = 44$) were collected for water chemistry analysis at each mid-channel site during point-transect sampling (one morning and one evening grab per station). Two clean 0.5 gallon plastic bottles were filled with water from a depth of 1 ft. and placed on ice in a dark cooler. Within 30 min. of collection, water samples either were processed in the field (dissolved phosphorus, chlorophyll a, and turbidity) or transferred to clean, pre-labeled polyethylene bottles and preserved for later laboratory analysis (Table 9). Dissolved phosphorus samples were filtered through 0.45 µm membrane filters before being preserved with sulfuric acid. Turbidity was measured in the field with a portable turbidimeter. Chlorophyll a samples were first fixed with preservative in a dark bottle and then filtered through glass microfiber filters. Filters were wrapped in aluminum foil, labeled, and frozen before being transferred to the Illinois EPA laboratory for analysis. U.S. EPA Region 5 Central Regional Laboratory analyzed all other water quality parameters.

During the second monitoring period (August 28 and September 6, 2001), we used continuous and point-transect sampling to measure temperature, dissolved oxygen, pH, and conductivity within four river segments. Calibrated Datasondes were set at four locations in each segment: below upstream dams at DS FF stations, in the lower reaches of free-flowing habitat, in the upper reaches of impoundments, and above downstream dams at US IMP stations. Datasondes were deployed mid channel at depths of 1-2 ft. above bottom and recorded data every 15 min. for 16 hours. Point-transect sampling (as described previously) took place during evening and early morning hours at two transects in free-flowing habitat and 4-7 transects in each impoundment. Two free-flowing and two impoundment transects were located at

Table 9. Preservation techniques, holding times, and ambient water standards (Illinois EPA) and guidelines (other sources) for 14 parameters measured from the Fox River between McHenry and Dayton, Illinois during August 2001. U.S. EPA guidelines are based on the 25th percentile of all season data from Level III ecoregion VI (U.S. EPA 2000). Guidelines for total phosphorus and nitrogen are based on the 25th percentile of all site data from Midwest Phosphorus Zone 4 and Nitrogen Zone 2 (Robertson et al. 2001). NA indicates not applicable. NG indicates no guideline.

Parameter and unit	Preservation technique	Holding time (days)	Ambient water quality standards and guidelines	Source
Temperature (C)	Field measure	NA	33.7	Illinois EPA
Dissolved oxygen (mg/L)	Field measure	NA	5	Illinois EPA
pH (units)	Field measure	NA	<6.5 or >9.0	Illinois EPA
Conductivity (µS/cm)	Field measure	NA	NG	NA
Turbidity (NTU)	Field measure	NA	9.9	U.S. EPA
Chlorophyll a (µg/L)	< 0 C	30	7.3	U.S. EPA
Total suspended solids (mg/L)	< 4 C	7	NG	NA
Total organic carbon	<4 C, H_2SO_4 to pH < 2	28	NG	NA
Total phosphorus (mg/L)	<4 C, H_2SO_4 to pH < 2	28	0.11	Robertson et al. 2001
Total dissolved phosphorus (mg/L)	<4 C, H_2SO_4 to pH < 2	28	NG	NA
Total nitrogen (mg/L)	Calculated	NA	1.75	Robertson et al. 2001
Total Kjeldahl nitrogen (mg/L)	<4 C, H_2SO_4 to pH < 2	28	0.66	U.S. EPA
Ammonia nitrogen (mg/L)	<4 C, H_2SO_4 to pH < 2	28	temp./pH dependent	NA
Nitrate/nitrite nitrogen (mg/L)	<4 C, H_2SO_4 to pH < 2	28	1.8	U.S. EPA

Datasonde sites whereas the remaining transects were located about 0.1-0.25 mi. apart between the two outermost impoundment transects.

To obtain a temporal measure of temperature, dissolved oxygen, pH, and conductivity, we operated a single Datasonde continuously for 40 days in August and September 2001 at a near-bottom location in the impoundment above the St. Charles Dam. This unit was deployed at a depth of 1.5 ft. above bottom and was retrieved, cleaned, and recalibrated weekly. We also examined the effects of water depth on the diel oxygen cycle by operating a surface Datasonde simultaneously with the near-bottom unit for 48 hours at the St. Charles long-term monitoring site.

We assessed the effects of dams and impoundments on water quality by comparing individual parameters within river segments, among river segments, and across sample times. In addition, we compared measured parameters to accepted ambient water standards for Illinois (Illinois EPA) and recommended 25th percentile guidelines for Midwestern rivers and streams (Table 9; U.S. EPA 2000; Robertson et al. 2001). Guidelines were based on either the 25th percentile of all season data from Level III ecoregion VI (U.S. EPA 2000) or, for total phosphorus and nitrogen, the 25th percentile of all site data from Midwest Phosphorus Zone 4 and Nitrogen Zone 2 (Robertson et al. 2001). These nutrient zones were developed as a regional refinement to U.S. EPA national nutrient ecoregions and are based on nutrient data and environmental characteristics of the watersheds (excluding land-use) of 234 Midwestern sites sampled between 1961 and 1999 (Robertson et al. 2001). The Fox River falls in nutrient zones having the highest phosphorus and nitrogen concentrations in the Midwest. We considered any violations of accepted Illinois EPA standards to indicate degraded water quality whereas guidelines provided less definitive assessment criteria. The 25th percentile guidelines represent a transition point between a range of better to worse water quality conditions such that parameters with measured concentrations at or below the guideline represent better water quality and increasing concentrations above the guideline represent progressively worse water quality.

Macrohabitat Quantification.— During fall 2000, we canoed and boated the entire length of river between the Chain of Lakes and Dayton and recorded macrohabitat features on 1999 color aerial photographs of the river (scale = 1:400). Habitat was categorized based on location in the channel, patterns of water flow, and structures that control flow (after Rabeni and Jacobson 1993). Habitat categories included free-flowing waters, impounded waters, natural pools, riffles, transitional runs, backwaters, and streamside wetlands. We also recorded the presence of submersed or emergent aquatic vegetation in any non-wetland habitat type. Impoundments began at a point below the lowermost riffle in a river segment where current velocity was noticeably lower and water depth higher than in the adjoining upstream free-flowing reach. Habitat categories were defined as follows:

Free-flowing waters – areas of natural flow that are not directly influenced by dams; these areas typically contain natural pool, run, and riffle habitat, have varied current velocities, water depths, and substrate types, and the water surface generally follows the gradient of the riverbed.

Impounded waters – areas of elevated water level resulting from dams; in these areas there are no distinguishable pool, run, and riffle habitats, current velocity is low, water depth is high relative to natural river reaches, and the water surface gradient is nearly zero.

Natural pools – non-impounded areas with low current velocity and water depths greater than riffle and run areas; the streambed is often concave and the water surface slope is nearly zero.

Riffles – areas with high current velocity and shallow depth; the water surface is visibly broken.

Transitional runs – areas that have a rapid, non-turbulent flow; runs have a faster current velocity than pools and are typically deeper than riffles; the streambed is often flat beneath a run and the water surface is not visible broken.

Backwaters –areas of low current velocity that are typically outside the margins of the main channel; backwaters may occur in free-flowing or impounded reaches and include side channels, connected sloughs, and mouths of tributaries.

Streamside wetlands – emergent marshes directly connected to the river and of sufficient size and water level to act as fish spawning or nursery habitat.

Habitat features were converted to Arcview shape files using geo-referenced aerial photos as the base layer and gross estimates of the amount of each habitat feature were made for each between-dam river segment.

We sampled microhabitat (water depth, current velocity, and substrate type) from a subset of macrohabitats (25-207 macrohabitats sampled) to help characterize differences in macrohabitat within the study area. Microhabitat was measured from impoundments, natural pools, riffles and runs in each river segment, if present. We measured water depth with a calibrated sounding rod and velocities at 60% of total depth with a Swoffer Model 2100 current meter. Substrate was sampled with a ponar dredge and dominant and co-dominant substrate types were visually classified according to the modified Wentworth scale (Cummins 1962).

Sediment Volumes and Physical and Chemical Characteristics.—Sediment was sampled during August - September 2000 and July 2001 to estimate accumulated sediment volume in impoundments and determine characteristics of bulk and surface sediments at US IMP and DS FF stations. Sediment volume was estimated by measuring water and sediment depths to the nearest 0.25 ft. with a ½-in. diameter steel probe at 36 to 60 locations above each of 12 dams (no samples were taken at Stolp Island, Hurd's Island, and Stratton dams). Probing began in a near shore area adjacent to each dam and continued upstream in a zigzag pattern across the river channel for distances ranging between 800 and 3,000 ft. Depth data were recorded in an electronic data logger along with corresponding GPS location information. Average depth and volume of sediment was estimated for each study reach with GIS interpolation software (ESRI, Arcview 3.x).

Bulk depositional sediments were sampled by taking lexan tube cores from left-of-center, mid channel, and right-of-center sites along one cross-channel transect located immediately upstream of each of the dams sampled for sediment volume (3 cores/transect). Additional core samples were made at 1-2 locations downstream of three dams (Algonquin, Carpentersville, and Elgin dams); hard substrate prevented coring downstream of other dams. Cores were 2 in. in diameter and were driven to depths of 3-5 ft. either by hand or utilizing a KB Corer. Extension rods were used when water depth was too great to allow collection by tube alone. Physical descriptions of cores (tube length, depth of penetration, and water depth) and specific site information (location description, proximity to outfalls, and GPS coordinates) were recorded for each sample. Individual cores were self-composited into a stainless steel bowl (i.e., vertically homogenized to eliminate all horizon integrity), mixed with a stainless steel spatula, and placed in clean glass jars in the field. Samples were stored on ice in a cooler and transported to the U.S. EPA Region 5 Central Regional Laboratory for chemical and physical analyses.

A stainless steel ponar grab sampler was used to collect surface sediments for contaminant analysis at 5-10 locations upstream of 12 dams. Ponar grabs were collected at left-of-center, mid channel, and right-of-center sites along three cross-channel transects located immediately upstream of each dam and three transects downstream of each dam (5-9 grabs/sample reach). Transects were established in the upper, middle, and lower portions of each sampling reach. Downstream ponar samples sometimes were located away from dams in areas with depositional sediments. At several downstream locations a trowel was used to scoop sediments from between rocks where fine sediments were scarce. Scoop samples were analyzed as ponar samples because both methods sampled the upper 3-6 in. of sediment. Grabs from individual transects were combined (1 sample/transect, 3 samples/reach), placed in clean glass jars, stored on ice, and transported to the U.S. EPA Laboratory for analysis. Laboratory analysis included determination of sediment grain size distributions, specific gravity, and contaminant and nutrient concentrations (80 substances; Table 10).

Two approaches were used to assess the level of pollution of Fox River sediments. In one approach, we compared contaminant concentrations from sediments samples to consensus-based threshold and probable effect concentration guidelines for 26 sediment contaminants in freshwater ecosystems (Table 10; MacDonald et al. 2000). Sediment contaminant levels were characterized as “non-polluted” if the measured concentration of a contaminant was lower than the corresponding threshold effect concentration (TEC) and “elevated” if the measured concentration of a contaminant was higher than the corresponding probable effect concentration (PEC). Samples with measured concentrations between TEC and PEC were considered “indeterminate” because consensus-based guidelines were not intended to provide guidance within this range of concentrations (MacDonald et al. 2000). In the other approach, we compared concentrations of all measured contaminants and nutrients between core and ponar samples from impounded areas above 12 dams to determine whether sediment contamination was higher in accumulated bulk sediments than in surface sediments. To determine whether impoundments accumulated higher levels of sediment contaminants than free-flowing portions of river, we compared concentrations of selected substances (metals, pesticides, cyanide, and oil & grease) between above and below dam ponar samples at 10 dams. Small sample size ($N = 3$ dam locations) precluded comparisons of core samples between above and below dam locations and limited the constituent list for the ponar comparison.

Statistical Analyses

We compared fisheries (IBI and HSSF), macroinvertebrate (MCI), and habitat (QHEI and SHAP) index and individual metric scores among station types with one-way analysis of variance (ANOVA) and Tukey’s multiple comparisons. An arcsine transformation was used on percentages to normalize the variance before statistical analysis (Steel and Torrie 1980). Pearson correlation analysis was used to assess the relation between fish and macroinvertebrate communities and habitat quality and the influence of stream morphology (impoundment length and depth and upstream free-flowing segment length) on impoundment dissolved oxygen concentrations. For water quality field quality assurance and quality control data, we compared nutrient concentrations between duplicate and corresponding grab samples with ANOVA. Repeated-measures analysis of variance (RM ANOVA) was used to compare water quality parameters between habitat types (free-flowing vs. impounded) and among vertical (surface, mid depth, bottom) and horizontal (left, mid, and right channel) sample locations. The model included habitat type (or location) and sample time period as main effects and the habitat type (or location) x time period interaction term. Sediment contaminant levels from core and ponar samples and from above and below dam locations were compared with a randomized complete-block ANOVA (blocked by dam). Statistical significance of $\alpha = 0.05$ was used for all analyses.

Table 10. List of parameters examined from Fox River, Illinois sediments and consensus-based sediment quality guidelines for selected metals, polycyclic aromatic hydrocarbons (PAH'S), polychloronated biphenyls (PCB's), organochlorine pesticides (MacDonald et al. 2000). Sediments were collected between Algonquin and Dayton during June through September 2000. Threshold effect concentrations (TEC) are those below which harmful effects are not likely to be observed. Probable effect concentrations (PEC) are those above which harmful effects are likely to be observed. NG is no guideline.

	Sediment guidelines			Sediment guidelines	
Substance	TEC	PEC	Substance	TEC	PEC
Metals (mg/kg dry weight)			Fluoranthene	423	2,230
Aluminum	NG	NG	Fluorene	77.4	536
Barium	NG	NG	Indeno(1,2,3-cd)pyrene	NG	NG
Beryllium	NG	NG	Napthalene	176	561
Boron	NG	NG	Phenanthrene	204	1,170
Cadmium	0.99	4.98	Pyrene	195	1,520
Calcium	NG	NG	Phthalates	NG	NG
Chromium	43.4	111	PCB's		
Cobalt	NG	NG	(µg/kg dry weight)		
Copper	31.6	149	Total PCB's	59.8	676
Iron	NG	NG	Organochlorine pesticides		
Lead	35.8	128	(µg/kg dry weight)		
Lithium	NG	NG	Aldrin	NG	NG
Magnesium	NG	NG	Chlordane	3.24	17.6
Manganese	NG	NG	Dieldrin	1.9	61.8
Mercury	0.18	1.06	Sum DDD	4.88	28.0
Molybdenum	NG	NG	Sum DDE	3.16	31.3
Nickel	22.7	48.6	Sum DDT	4.16	62.9
Potassium	NG	NG	Endosulfan I	NG	NG
Silver	NG	NG	Endosulfan II	NG	NG
Sodium	NG	NG	Endosulfan sulfate	NG	NG
Tin	NG	NG	Endrin	2.22	207
Titanium	NG	NG	Heptachlor	NG	NG
Vanadium	NG	NG	Heptachlor epoxide	2.47	16.0
Zinc	121	459	Lindane (gamma-BHC)	2.37	4.99
PAH's (µg/kg dry weight)			Methoxychlor	NG	NG
2-Methylnaphthalene	NG	NG	Alkylphenols		
Acenaphthene	NG	NG	(µg/kg dry weight)		
Acenaphthalene	NG	NG	Nonylphenols	NG	NG
Anthracene	57.2	845	Octylphenols	NG	NG
Benz[a]anthracene	108	1,050	NPEO - 1 thru 4	NG	NG
Benzo(a)pyrene	150	1,450	Bisphenol A	NG	NG
Benzo(b)fluoranthene	NG	NG	Nutrients (mg/kg dry wt.)		
Benzo[g,h,i]fluoranthene	NG	NG	Ammonia nitrogen	NG	NG
Benzo(k)perylene	NG	NG	Total Kjeldahl nitrogen	NG	NG
Carbazole	NG	NG	Total Phosphorous	NG	NG
Chrysene	166	1,290	Other (mg/kg dry wt.)		
Dibenz[a,h]anthracene	33	NG	Cyanide	NG	NG
Dibenzofuran	NG	NG	Oil & Grease	NG	NG

Quality Assurance and Quality Control

We used duplicate and blank samples to evaluate sampling and laboratory precision during water quality assessment. One field duplicate and blank was collected for every 10 water quality grab samples. Duplicate samples were discrete samples collected at the same locations and times as corresponding grab samples whereas blanks were samples of deionized water used in sample processing. Duplicates were used to assess variation in constituent concentrations due to sample-collection and field-processing techniques and blanks were used to determine constituent concentrations in processing water and contamination from processing equipment. In addition, we calibrated Datasondes and turbidity meters with reference standards before each field visit to improve accuracy and precision of field measurements. No field duplicates were collected for chlorophyll a samples (none were required by the Illinois EPA chlorophyll a protocols) or sediment samples due to the preliminary nature of the sediment survey. However, laboratories conducted internal quality control checks (laboratory duplicates, matrix spikes, and matrix spike duplicates) during sediment and water quality analyses according to established standard operating procedures.

Field duplicate and blank analyses indicated that water quality sampling error and contamination were within acceptable levels for all measured parameters (Table 11). Constituent concentrations were undetected or very low for blank samples and duplicates were similar to corresponding grab samples for each constituent (Tukey's multiple comparisons, $P > 0.24$).

Table 11. Concentrations of seven water quality parameters in blank, duplicate, and corresponding grab samples from the Fox River between McHenry and Dayton, IL. UD indicates analyte was undetected in the sample.

Station and sample type	Total suspended solids (mg/L)	Total organic carbon (mg/L)	Total phosphorus (mg/L)	Total dissolved phosphorus (mg/L)	Total Kjeldahl nitrogen (mg/L)	Ammonia nitrogen (mg/L)	Nitrate/nitrite nitrogen (mg/L)
Carpentersville below dam							
Blank	UD	UD	UD	UD	UD	UD	0.14
Duplicate	55	11	0.28	0.08	2.05	0.21	0.51
Sample	50	11	0.27	0.07	1.91	0.18	0.50
South Elgin above dam							
Blank	UD	UD	UD	UD	UD	UD	0.14
Duplicate	50	13	0.52	0.26	2.14	UD	1.19
Sample	46	12	0.53	0.25	2.14	UD	1.17
Geneva below dam							
Blank	UD	UD	UD	0.08	UD	UD	0.10
Duplicate	54	13	0.49	0.22	2.20	UD	1.16
Sample	57	12	0.49	0.22	2.26	UD	1.16
Montgomery above dam							
Blank	UD	UD	UD	UD	UD	UD	0.10
Duplicate	50	14	0.49	0.28	2.22	0.19	0.96
Sample	56	14	0.46	0.27	2.16	0.22	0.96
Dayton above dam							
Blank	UD	UD	UD	UD	UD	UD	0.09
Duplicate	36	15	0.40	0.08	2.26	UD	UD
Sample	42	12	0.39	0.09	2.31	UD	UD

RESULTS

Fish Communities

We sampled fish from about 20% of the mainstem Fox River between Stratton and Dayton dams and captured 30,290 individuals from 68 species. Cyprinids (carps and minnows) were the most abundant and diverse group collected ($N = 21{,}113$ individuals and 20 species; Table A1; note that table numbers prefaced by a letter indicate appendix tables). Suckers, perches, sunfishes, and catfishes also were well represented in the samples (Table 12). The fifteen most common taxa in order of abundance were the spotfin shiner, sand shiner, bluntnose minnow, bluegill, bullhead minnow, common carp, largemouth bass, emerald shiner, banded darter, smallmouth bass, channel catfish, green sunfish, brook silverside, spottail shiner, and shorthead redhorse (Table A1). Combined these species made up 92% of sampled fish.

The distribution of species among station types indicates that most fishes favored the natural flowing portions of the river over impounded areas created by dams. Except for one goldfish and pugnose minnow, all species captured at impounded stations also were found at free-flowing stations (Table 12) and species taken from both habitats typically were more abundant in free-flowing habitats (Table A1). Further, there were 24 species (35% of the total) found only in free-flowing portions of the river. Species captured only at free-flowing stations included important game species, such as the sauger and muskellunge, several intolerant minnows, darters, and suckers (including the state threatened river redhorse), and the gars, bowfin, mooneye, stonecat, and smallmouth buffalo (Table 12).

The quality of the fish community as determined by IBI scores was higher in free-flowing reaches of river than in impounded areas above dams (Tukey's multiple comparisons, $P < 0.001$), but communities did not differ between station types within each habitat ($P > 0.95$; Figure 4 and Tables 13). Scores for DS FF and MD FF stations each averaged 46, which indicates a "B" quality stream or highly valued aquatic resource. In contrast, mean IBI scores for MD IMP and US IMP stations were below 31, indicating a "D" quality stream or limited aquatic resource (Table 13). Individual IBI scores for above and below dam stations (excluding mid segment sites) showed a consistent pattern throughout the river of higher quality fish communities in natural flowing reaches and lower quality communities in impoundments (Figure 5). The highest IBI scores ("A" stream segments) occurred below the South Batavia, North Aurora, and Yorkville dams and at the Dayton lower mid segment free-flowing station. The lowest scores (IBI = 24 and 26) occurred in impounded areas above the South Elgin and Yorkville dams and the Algonquin mid segment impounded station (Table A2).

We examined mean scores for individual IBI metrics across station types to characterize differences in the fish community between free-flowing and impounded habitats (Table 13). Compared to impounded stations, free-flowing stations typically had higher species richness, substantially higher overall abundance, and more species of suckers, darters, and fishes that are intolerant of poor water quality and habitat conditions. Samples from these areas also contained a higher percentage of insectivorous minnows, such as spotfin and sand shiners, and a lower proportion of individuals with DELT anomalies (Table 13). In contrast, impounded stations

Table 12. Fish species collected at downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing and seining during July through September 2000.

	Station type			
Family and species	DS FF	MD FF	MD IMP	US IMP
Gars				
Longnose gar	+	–	–	–
Shortnose gar	+	–	–	–
Bowfins				
Bowfin	+	–	–	–
Mooneyes				
Mooneye	+	–	–	–
Herrings				
Gizzard shad	+	+	–	+
Carps and minnows				
Blacknose dace	–	+	–	–
Bluntnose minnow	+	+	+	+
Bullhead minnow	+	+	+	+
Central stoneroller	+	–	–	–
Common shiner	+	–	–	–
Common carp	+	+	+	+
Creek chub	+	+	–	+
Emerald shiner	+	+	+	+
Fathead minnow	+	+	–	+
Golden shiner	+	+	+	+
Goldfish	–	–	–	+
Hornyhead chub	+	+	–	–
Largescale stoneroller	+	+	–	–
Pugnose minnow	–	–	–	+
Rosyface shiner	+	–	–	–
Sand shiner	+	+	–	+
Speckled chub	+	–	–	–
Spotfin shiner	+	+	+	+
Spottail shiner	+	+	+	+
Suckermouth minnow	+	+	–	+
Suckers				
Black redhorse	+	+	–	–
Golden redhorse	+	+	+	+
Northern hog sucker	+	+	–	–
Quillback	+	+	+	+
River carpsucker	+	+	–	–
River redhorse	+	+	–	–
Shorthead redhorse	+	+	–	+
Silver redhorse	+	+	+	–
Smallmouth buffalo	+	–	–	–
White sucker	+	+	+	+
Catfishes				
Black bullhead	+	+	–	+
Channel catfish	+	+	+	+
Flathead catfish	+	+	–	+
Stonecat	+	–	–	–
Tadpole madtom	+	–	+	+
Yellow bullhead	+	+	+	+
Pikes				
Grass pickerel	+	+	–	+
Muskellunge	+	+	–	–
Killifishes				
Blackstripe topminnow	+	+	+	+
Silversides				
Brook silverside	+	+	+	+
Temperate basses				
White bass	+	–	+	+
Yellow bass	+	–	–	+
Sunfishes				
Black crappie	+	+	+	+
Bluegill	+	+	+	+
Bluegill X Green	+	+	+	+
Green sunfish	+	+	+	+
Largemouth bass	+	+	+	+
Orangespotted sunfish	+	+	+	+
Rock bass	+	+	–	+
Smallmouth bass	+	+	+	+
Warmouth	+	–	–	–
White crappie	–	+	–	–
Perches				
Banded darter	+	+	+	+
Blackside darter	+	+	–	+
Fantail darter	–	+	–	–
Johnny darter	+	+	+	+
Logperch	+	+	+	+
Orangethroat darter	+	+	–	–
Sauger	+	–	–	–
Slenderhead darter	+	+	+	+
Walleye	+	+	+	–
Yellow perch	+	+	+	+
Drums				
Freshwater drum	+	+	+	+

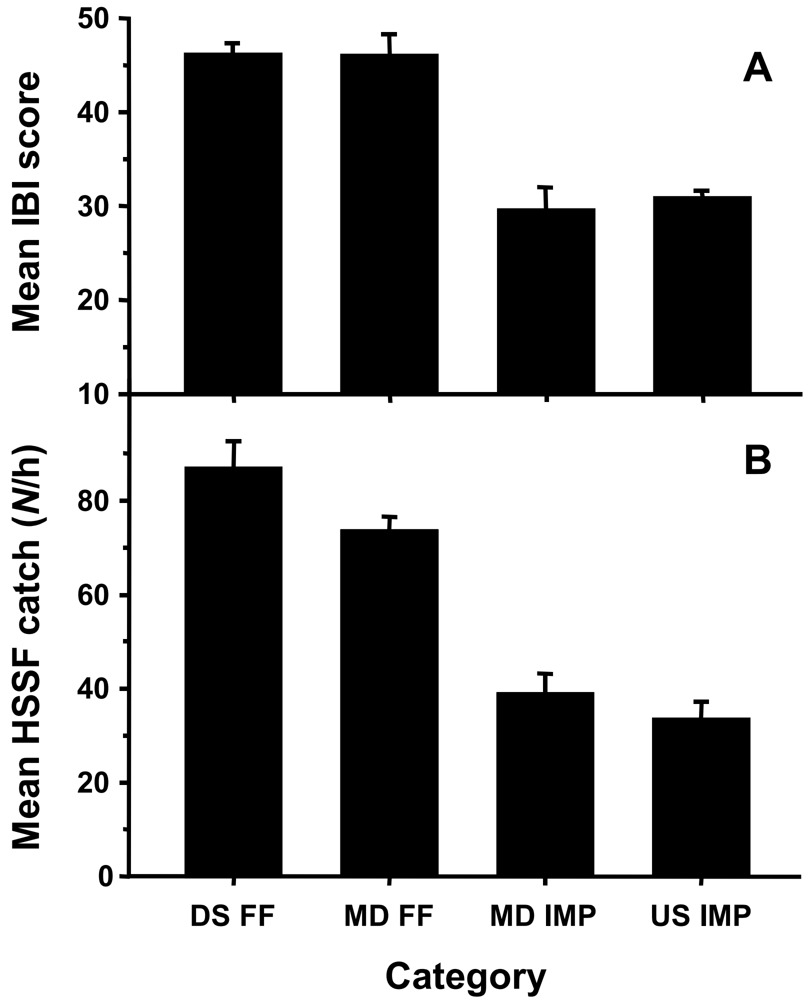


Figure 4. Mean (A) Index of Biotic Integrity (IBI) scores and (B) harvestable-size sport fish (HSSF) catch rates for downstream free-flowing (DS FF), mid segment free-flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing, and seining at 40 stations during July through early September 2000. Vertical lines represent 1 SE.

typically had lower species richness, low overall abundance, more fish with DELT anomalies, and a predominance of tolerant and omnivorous species, such as common carp, bluntnose minnow, quillback, and green sunfish.

Sport species were more abundant at stations in free-flowing habitats than impounded habitats. Mean catch rates for harvestable-sized sport fish were higher at DS FF and MD FF stations than at MD IMP and US IMP stations (Tukey's multiple comparisons, $P < 0.03$; Figure 4). Sport fish catch rates were similar for stations within free-flowing habitats ($P = 0.40$) and within impoundments ($P = 0.48$). Popular sport species like channel catfish and smallmouth bass also were more abundant in the free-flowing river (Table 13). Mean catch rates for channel catfish differed statistically between free-flowing and impounded stations (Tukey's multiple comparisons, $P < 0.04$) whereas catches of smallmouth bass did not differ among station types (ANOVA, $P = 0.12$) due to high variability in catches among river segments.

In addition to altering habitats, dams appear to have altered distributions of nearly one third of Fox River fishes by acting as barriers to upstream fish movement. We identified 15 species of fish that had truncated distributions in the basin and another 15 species with discontinuous distributions (Figure 6). Species with truncated distributions were found only in the lower portions of the river. Ten species were found only below the lowermost dam in Dayton, Illinois. This group includes important sport species (sauger), commercial species (bigmouth, black, and smallmouth buffalo), and highly migratory species (American eel, mooneye, and skipjack herring). Five additional species, including the state threatened river redhorse, have populations that persist above the Dayton Dam, but they are limited to the lower river in Illinois. Species with discontinuous distributions were found in the upper and lower Fox River, but occasionally

Table 13. Index of Biotic Integrity (IBI) and fish community metrics for downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing and seining at 40 stations during July through September 2000. Values are means with 1 SE in parentheses. Letters designate significant differences among station types for each metric (one-way ANOVA, P < 0.05).

	Station type			
Metrics	DS FF	MD FF	MD IMP	US IMP
IBI	46.1 (1.2) z	46.0 (2.3) z	29.5 (2.5) y	30.8 (0.8) y
Biological stream characterization	Highly valued	Highly valued	Limited	Limited
Species composition				
Species richness	28.9 (0.9) z	25.3 (2.1) z	16.2 (3.5) y	17.7 (0.9) y
Number of sucker species	4.5 (0.5) z	4.2 (0.8) z	1.2 (1.0) y	0.9 (0.2) y
Number of sunfish species	3.9 (0.3) z	3.0 (0.8) z	3.5 (0.6) z	3.3 (0.3) z
Number of darter species	3.0 (0.3) z	2.7 (0.7) zy	1.5 (0.6) zyx	0.7 (0.2) x
Number of intolerant species	7.3 (0.6) z	6.7 (1.1) z	3.2 (0.6) y	3.1 (0.3) y
Trophic composition				
Percentage of green sunfish	2.1 (0.3) z	4.0 (3.1) zy	5.5 (2.1) zy	12.5 (3.3) y
Percentage of common carp	9.2 (2.1) z	11.8 (4.8) z	42.7 (7.1) y	16.1 (2.3) z
Percentage of omnivores	17.8 (2.4) z	19.7 (3.9) z	45.2 (6.7) y	25.5 (2.6) z
Percentage of insectivorous minnows	37.0 (4.7) z	43.7 (7.9) z	3.3 (0.8) y	10.8 (3.4) y
Percentage of top carnivores	15.0 (2.2) zy	11.7 (2.5) z	14.1 (1.8) zy	22.8 (2.3) y
Fish condition				
Percentage of hybrids	0.6 ((0.4) z	0.1 (0.1) z	0.6 (0.6) z	1.3 (0.6) z
Percentage of individuals with anomalies	6.6 (1.4) z	3.9 (0.8) z	14.9 (5.9) z	7.0 (1.4) z
Percentage of species with anomalies	35.3 (2.9) z	32.8 (6.8) z	39.3 (6.4) z	46.9 (3.7) z
Percentage of individuals with DELT	2.5 (0.5) zy	1.2 (0.3) z	4.7 (2.3) y	1.2 (0.3) z
Percentage of species with DELT	17.4 (1.3) z	11.6 (2.0) z	19.1 (6.8) z	16.8 (2.6) z
Relative abundance				
All species (*N*/h)	821.6 (110.6) z	756.2 (181.2) z	137.0 (41.5) y	201.2 (26.0) y
Harvestable-sized sport fish (*N*/h)	86.8 (6.0) z	73.5 (3.1) z	38.8 (4.4) y	33.3 (3.9) y
Channel catfish (*N*/h)	17.2 (3.2) z	19.3 (3.4) z	4.0 (1.3) y	2.7 (0.7) y
Smallmouth bass (*N*/h)	34.6 (12.3) z	8.8 (1.6) z	3.2 (2.9) z	11.5 (3.9) z

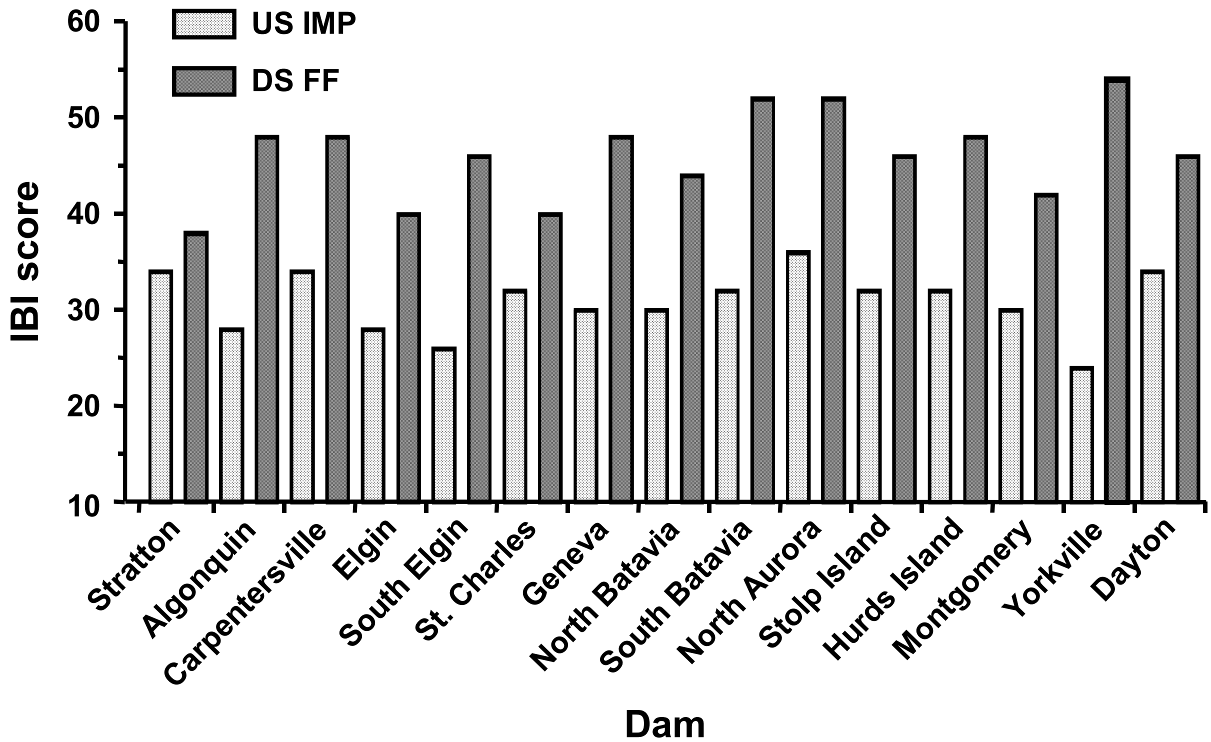


Figure 5. Index of Biotic Integrity (IBI) scores for upstream-impounded (US IMP) and downstream free-flowing (DS FF) stations at 15 Fox River dams between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing, and seining at 40 stations during July through early September 2000.

or not at all in the central river between the St. Charles and Montgomery dams. This section of river is highly urbanized and has a particularly high density of dams (eight dams in 14 river miles) compared to other parts of the Fox River in Illinois (an average of one dam every 9.5 mi.).

The occurrence of anomalies in fishes was low overall for individuals (5.3%) but widespread among species (66.2%; Table 14). Anchor worms, leeches, and the DELT group of anomalies were encountered most frequently. Lesions and eroded fins/barbells were the most common DELT anomalies identified; the occurrence of tumors and deformities was low (<0.2% of individuals). Anomalies were most prevalent in channel catfish, common carp, several centrarchids (bluegill, green sunfish, hybrid sunfish, largemouth bass and smallmouth bass), and the golden and silver redhorse (Table 15). Centrarchids typically had anchor worm and black spot whereas channel catfish, common carp, and the redhorse species had moderately high occurrences of the more serious DELT anomalies. Lesions and eroded fins/barbels were particularly prevalent in channel catfish, a species that experienced an epizootic bacterial or viral outbreak that caused high mortality of juveniles and adults throughout the river during summer 2000. Fishes with anomalies were found throughout the river, but they tended to be encountered most frequently at impounded stations between St. Charles and Batavia, Illinois (Table A3).

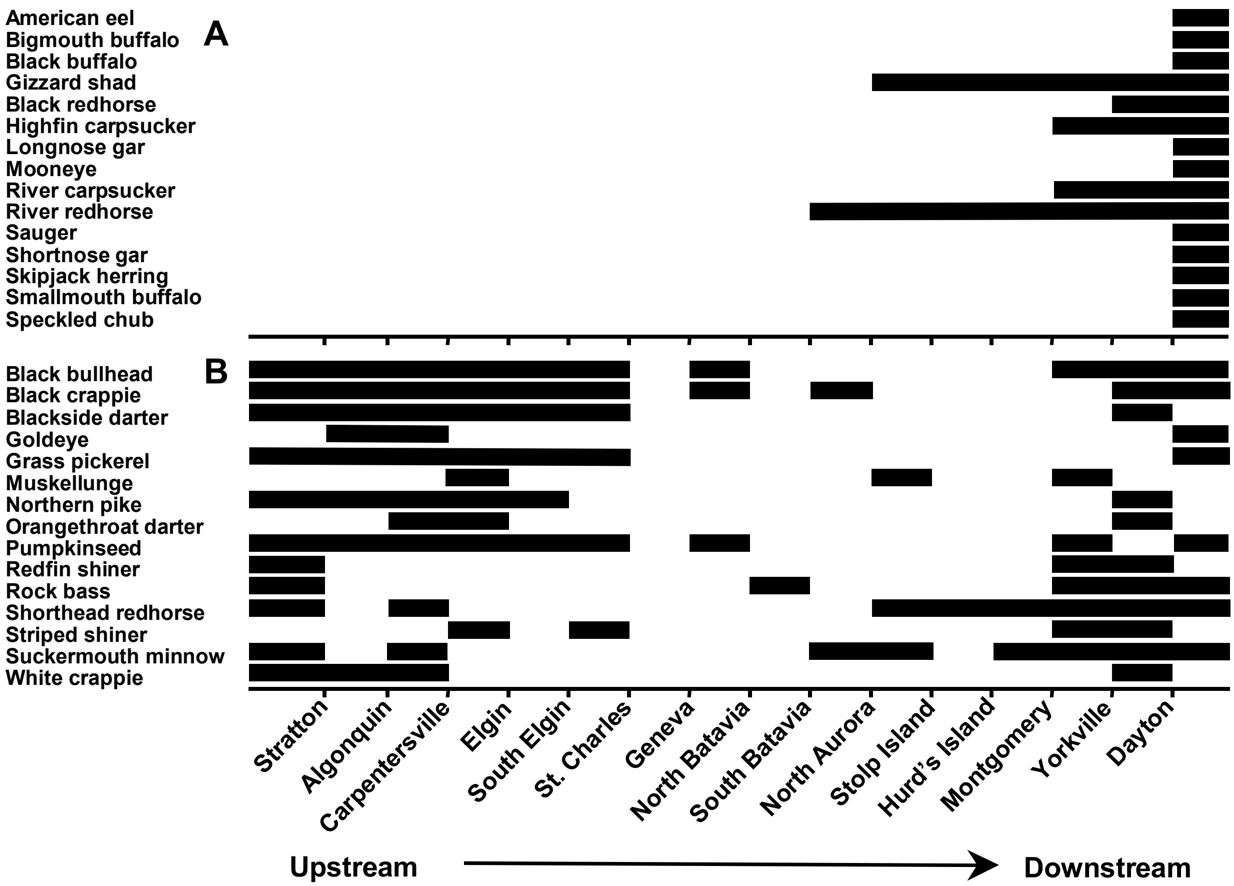


Figure 6. Fox River fishes with (A) truncated distributions (restricted to the lower portion of the watershed) and (B) discontinuous distributions (typically absent from the middle portion of the watershed). Data are from 112 mainstem and tributary stations sampled from 1980-2000. Note that distances between dams are not to scale.

Table 14. Number and percentage of individual fish and species with anomalies from the Fox River between McHenry and Dayton, Illinois. Other anomalies include blindness, parasites, exophthalmia, swirled scales, and emaciated condition.

	Individuals		Species	
Anomalies	Number	Percent	Number	Percent
DELT	375	1.2	25	36.8
Deformities	42	0.1	11	16.2
Eroded fins	106	0.3	10	14.7
Lesions	267	0.9	19	27.9
Tumors	7	<0.1	4	5.9
Multiple DELT	44	0.1	5	7.4
Anchor worm	548	1.8	28	41.2
Black spot	109	0.4	17	25.0
Leeches	333	1.1	13	19.1
Other anomalies	242	0.7	16	23.5
All anomalies	1,607	5.3	45	66.2
Number examined	30,290		68	

Table 15. Number and percentage of individuals with anomalies and DELT anomalies for individual fish species sampled by boat electrofishing, backpack electrofishing and seining at 40 stations on the Fox River between McHenry and Dayton, Illinois during July through September 2000.

	Anomalies		DELT Anomalies			Anomalies		DELT Anomalies	
Species	Number	Percent	Number	Percent	Species	Number	Percent	Number	Percent
Banded darter	1	0.2	0	0.0	Longnose gar	0	0.0	0	0.0
Black bullhead	3	11.1	1	3.7	Mooneye	0	0.0	0	0.0
Black crappie	9	11.8	1	1.3	Muskellunge	0	0.0	0	0.0
Black redhorse	0	0.0	0	0.0	Northern hog sucker	2	4.1	2	4.1
Blacknose dace	0	0.0	0	0.0	Orangespotted sunfish	19	7.9	1	0.4
Blackside darter	0	0.0	0	0.0	Orangethroat darter	0	0.0	0	0.0
Blackstripe topminnow	1	3.3	0	0.0	Pugnose minnow	0	0.0	0	0.0
Bluegill	291	9.0	36	1.1	Quillback	11	7.5	7	4.8
Bluegill X Green	47	78.3	6	10.0	River carpsucker	0	0.0	0	0.0
Bluntnose minnow	39	1.2	1	0.0	River redhorse	1	7.1	1	7.1
Bowfin	0	0.0	0	0.0	Rock bass	2	66.7	0	0.0
Brook silverside	0	0.0	0	0.0	Rosyface shiner	0	0.0	0	0.0
Bullhead minnow	10	0.7	2	0.1	Sand shiner	6	0.1	3	0.1
Central stoneroller	1	5.3	0	0.0	Sauger	0	0.0	0	0.0
Channel catfish	404	66.2	126	20.7	Shorthead redhorse	51	13.4	18	4.7
Common carp	274	23.4	101	8.6	Shortnose gar	0	0.0	0	0.0
Common shiner	0	0.0	0	0.0	Silver redhorse	15	25.0	4	6.7
Creek chub	4	12.9	0	0.0	Slenderhead darter	2	6.1	0	0.0
Emerald shiner	2	0.3	0	0.0	Smallmouth bass	62	10.1	11	1.8
Fantail darter	0	0.0	0	0.0	Smallmouth buffalo	5	12.5	4	10.0
Fathead minnow	3	4.2	0	0.0	Speckled chub	0	0.0	0	0.0
Flathead catfish	9	10.2	4	4.5	Spotfin shiner	47	0.5	5	0.1
Freshwater drum	0	0.0	0	0.0	Spottail shiner	7	1.8	0	0.0
Gizzard shad	5	2.0	5	2.0	Stonecat	0	0.0	0	0.0
Golden redhorse	16	12.4	14	10.9	Suckermouth minnow	5	5.2	0	0.0
Golden shiner	13	9.2	0	0.0	Tadpole madtom	0	0.0	0	0.0
Goldfish	0	0.0	0	0.0	Walleye	3	20.0	0	0.0
Grass pickerel	1	25.0	0	0.0	Warmouth	0	0.0	0	0.0
Green sunfish	79	15.7	7	1.4	White bass	1	2.2	0	0.0
Hornyhead chub	1	4.8	0	0.0	White crappie	1	100.0	0	0.0
Johnny darter	1	0.9	0	0.0	White sucker	4	3.7	4	3.7
Largemouth bass	127	15.7	9	1.1	Yellow bass	1	3.8	0	0.0
Largescale stoneroller	0	0.0	0	0.0	Yellow bullhead	13	26.5	2	4.1
Logperch	5	26.3	0	0.0	Yellow perch	3	12.0	0	0.0

Macroinvertebrate Communities

We sampled 10,482 individuals representing 128 macroinvertebrate taxa from wadable habitats in the free-flowing and impounded river. Taxa richness was highest for the Hemiptera, Coleoptera, and Chironomidae (16-17 genera) followed by the Ephemeroptera, Trichoptera, Hirudinea, Gastropoda, and Pelecypoda (7-11 genera; Table 16). Abundance was highest for the Chironomini midges, hydropsychid caddis flies, corixids, baetid mayflies, and the flatworm

Table 16. Macroinvertebrate taxa collected at downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Macroinvertebrates were sampled by kick netting and hand picking during July through September 2000.

	Station type			
Taxa	DS FF	MD FF	MD IMP	US IMP
Porifera (sponges)	+	+	+	+
Turbellaria (flatworms)				
Dugesia tigrina	+	+	+	+
Bryozoa (moss animalcules)	–	+	–	–
Oligochaeta (aquatic worms)	+	+	+	+
Hirudinea (leeches)				
Erpobdella punctata	+	–	+	+
Mooreobdella microstoma	+	+	–	+
Actinobdella pediculata	+	–	–	–
Gloiobdella elongata	+	+	–	+
Helobdella stagnalis	+	+	+	+
Helobdella triserialis	+	+	+	+
Placobdella montifera	–	–	–	+
Placobdella ornata	+	–	–	+
Isopoda (aquatic sow bugs)				
Asellus intermedius	+	+	+	+
Amphipoda (scuds)				
Gammarus pseudolimnaeus	+	+	+	+
Hyalella azteca	+	+	+	+
Decopoda (crayfish)				
Orconectes rusticus	+	+	–	–
Orconectes virilis	+	+	–	+
Hydrachnidia (water mites)				
Arrenurus sp.	–	–	+	–
Koenikea sp.	–	–	–	+
Krendowskia sp.	–	–	–	+
Limnesia sp.	–	–	+	+
Numania sp.	–	–	–	+
Unionicola sp.	–	–	–	+
Ephemeroptera (mayflies)				
Baetis sp.	+	+	–	–
Cloeon sp.	+	+	+	+
Procloeon sp.	+	+	+	+
Caenis sp.	+	+	+	+
Cercobrachys sp.	–	–	+	+
Hexagenia sp.	–	–	–	+
Stenacron sp.	+	+	–	+
Stenonema sp.	+	+	–	–
I*sonychia* sp.	+	+	–	–
Anthopotamus sp.	+	+	–	+
Tricorythodes sp.	+	+	+	+
Anisoptera (dragonflies)				
Anax sp.	+	–	+	+
Somatochlora sp.	–	–	–	+
Dromogomphus sp.	–	–	–	+
Erpetogomphus sp.	–	+	–	–
Zygoptera (damselflies)				
Hetaerina sp.	+	+	–	–
Amphiagrion sp.	–	–	–	+
Argia sp.	+	+	+	+
Enallagma sp.	+	+	+	+
Ischnura sp.	–	–	–	+
Hemiptera (true bugs)				
Belostoma sp.	+	+	+	+
Corisella sp.	+	+	–	+
Palmacorixa sp.	+	+	+	+
Sigara sp.	–	–	+	–
Trichocorixa sp.	+	+	+	+
Corixidae nymphs	+	+	+	+
Aquarius sp.	+	+	–	–
Gerris sp.	+	+	+	+
Metrobates sp.	+	+	–	+
Rheumatobates sp.	+	+	+	+
Trepobates sp.	+	+	+	+
Mesovelia sp.	+	+	+	+
Ranatra sp.	+	–	+	+
Notonecta sp.	–	+	+	+
Neoplea sp.	+	–	+	+
Salda sp.	–	+	–	–
Rhagovelia sp.	+	+	–	–
Coleoptera (beetles)				
Chlaenius sp.	–	+	–	+
Laccophilus sp.	+	+	–	+
Tropisternus sp.	+	–	–	–
Macronychus sp.	+	+	+	+
Microcylloepus sp.	+	–	–	–
Ordobrevia sp.	+	–	–	–
Stenelmis sp.	+	+	+	+
Dineutus sp.	+	+	+	+
Gyrinus sp.	+	+	+	–
Haliplus sp.	+	+	–	+
Peltodytes sp.	+	+	+	+
Berosus sp.	+	+	+	+
Enochrus sp.	–	+	–	–
Sperchopsis sp.	+	–	–	–
Tropisternus sp.	+	+	+	+
Psephenus sp.	+	+	–	–
Cyphon sp.	–	–	–	+
Megaloptera (dobsonflies)				
Chauliodes sp.	–	–	–	+
Corydalus sp.	–	+	–	–
Sialis sp.	+	–	+	–
Diptera (true flies)				
Ceratopogonidae				
Palpomyia sp.	–	–	–	+
Chironomidae				
Chironomus sp.	+	+	+	+
Cryptochironomus sp.	+	+	+	+
Dicrotendipes sp.	–	–	+	+
Endochironomus sp.	+	–	+	+
Eukieferiella sp.	+	–	–	–
Glyptotendipes sp.	+	+	+	+
Larsia sp.	+	–	–	–
Microtendipes sp.	+	+	–	+

Table 16. Continued.

Taxa	Station type			
	DS FF	MD FF	MD IMP	US IMP
Microtendipes sp.	+	+	–	+
Parachironomus sp.	+	+	–	+
Paracladopelma sp.	+	+	–	–
Polypedilum sp.	+	+	+	+
Procladius sp.	+	–	+	+
Rheotanytarsus sp.	+	–	–	–
Tanypus sp.	+	–	–	+
Tanytarsus sp.	–	–	–	+
Thienemannimyia group	+	+	+	+
Empididae				
Hemerodromia sp.	+	+	–	–
Ephydridae				
Notiphila sp.	+	–	–	–
Simuliidae				
Simulium sp.	+	+	+	–
Stratiomyiidae				
Odontomyia sp.	–	–	–	+
Stratiomys sp.	–	–	+	–
Tabanidae				
Haematopota sp.	+	–	–	–
Tipulidae				
Unknown pupae	+	–	–	–
Trichoptera (caddis flies)				
Helicopsyche sp.	–	+	–	–
Ceratopsyche sp.	+	+	–	+
Cheumatopsyche sp.	+	+	–	+
Hydropsyche sp.	+	+	+	+
Potamyia sp.	+	+	–	+
Chimarra sp.	+	+	–	–
Cyrnellus sp.	–	–	+	+
Paranyctiophylax sp.	+	–	–	–
Lepidoptera (aquatic caterpillars)				
Petrophila sp.	+	–	–	–
Gastropoda (snails and limpets)				
Ferrissia sp.	+	+	–	–
Pomacea sp.	–	+	–	–
Laevapex sp.	–	–	+	+
Lymnaea sp.	+	–	+	+
Physa sp.	+	+	+	+
Gyraulus sp.	+	–	+	+
Goniobasis sp.	+	+	–	+
Pelecypoda (clams and mussels)				
Musculium sp.	+	–	–	–
Pisidium sp.	+	–	–	+
Sphaerium sp.	+	+	+	+
Alasmidonta marginata	–	+	–	–
Lasmigona compressa	+	+	–	+
Leptodea fragilis	+	–	–	–
Quadrula pustulosa	+	–	–	–
Toxolasma parvus	+	–	–	+

Dugesia tigrina (Table B1). Although not accurately reflected by our semi-quantitative sampling technique, densities of these abundant organisms often were extremely high at individual sites. Corixid densities were high in impounded areas whereas densities of the other taxa were high at free-flowing locations, particularly at stations located immediately below dams.

Macroinvertebrate taxa did not show strong patterns in their overall distribution among types of sampling stations. About half (54%) of the taxa occurred at stations in both free-flowing and impounded habitats and the remaining taxa were split 60% to 40% in favor of free-flowing stations (Table 16). Certain families or genera were found in only one habitat type, which probably reflects specific habitat needs of individual groups or genera. Hydrachnidia, burrowing mayflies, certain dragonflies, and the ceratopogonid and stratiomyiid dipterans were found only in impounded areas. Taxa found only in free-flowing areas included among others, eight dipterans, six coleopterans, five mollusks, and three ephemeraopterans, hemipterans, and trichopterans (Table 16).

Free-flowing habitat supported higher quality macroinvertebrate communities than impounded waters above dams (Figure 7 and Table 17). Mean macroinvertebrate condition index (MCI) scores were similar for stations within free-flowing or impounded habitats (Tukey's multiple comparisons, $P > 0.58$) but scores for DS FF and MD FF stations were more than twice as high as scores from MD IMP and US IMP stations ($P < 0.001$). Free-flowing stations typically had higher abundance and richness of mayflies and caddis flies (EPT taxa), more intolerant taxa, lower MBI scores, and a higher percentage of clinger organisms than the wadable portions of impoundments (Table 17). Differences between free-flowing and impounded habitats were even more pronounced when we considered samples from open-water impounded areas. Ponar samples showed an open-water impoundment community of few taxa and a numerical predominance (mean ± 1SE = 96.4±0.8%) of tolerant aquatic worms (Oligochaeta) and chironomid larvae (Figure 8 and Table B2).

Individual metric scores reveal additional patterns in the quality of macroinvertebrate communities within impounded and free-flowing habitats. For example, individual station macroinvertebrate biotic index (MBI) scores indicated limited or restricted invertebrate communities immediately above certain dams; 8 of 11 stations with MBI scores ≥7.5 were US IMP stations (Table B3). In free-flowing habitats, higher mean numbers of intolerant taxa at MD FF than DS FF stations (Tukey's multiple comparisons, $P = 0.008$) suggest that dams may have had an adverse affect on invertebrate communities in areas directly below dams. A similar pattern was evident for other MCI metrics (i.e., highest values at mid segment free-flowing stations) although differences between MD FF and DS FF stations typically were not significant for other metrics (Table 17).

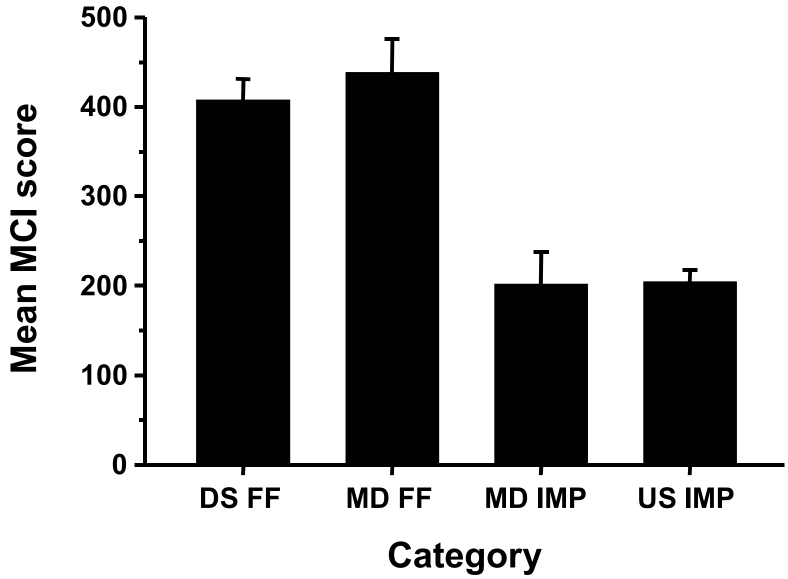


Figure 7. Mean macroinvertebrate condition index (MCI) scores for downstream free-flowing (DS FF), mid segment free-flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Macroinvertebrates were sampled by kick netting and hand picking at 40 stations during July through early September 2000. Vertical lines represent 1 SE.

Table 17. Macroinvertebrate Condition Index (MCI) and component metric scores for downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Macroinvertebrates were sampled by kick netting and hand picking at 40 stations during July through September 2000. The macroinvertebrate condition index was developed with Fox River data following USEPA Rapid Bioassessment procedures (Barbour et al. 1999). Values are means with 1 SE in parentheses. Letters designate significant differences among station types for each metric (one-way ANOVA, $P < 0.05$).

	Station type			
Index and metrics	DS FF	MD FF	MD IMP	US IMP
MCI	417.5 (28.6) z	473.5 (41.1) z	205.8 (42.5) y	203.0 (15.7) y
Richness measures				
Taxa richness	27.7 (1.0) z	33.0 (2.5) z	25.5 (3.0) z	25.8 (1.6) z
Number of EPT taxa	6.4 (0.7) z	9.2 (1.3) z	2.2 (1.3) y	3.1 (0.6) y
Composition measures				
Percentage EPT individuals	44.2 (5.5) z	37.9 (4.6) z	3.6 (2.3) y	3.8 (1.0) y
Percentage Chironomidae	19.6 (3.8) z	17.0 (3.0) z	19.7 (4.5) z	20.5 (3.3) z
Tolerance/Intolerance measures				
Number of intolerant taxa	5.5 (0.3) y	8.7 (1.3) z	3.0 (0.9) y	3.0 (0.4) y
Macroinvertebrate Biotic Index	6.3 (0.2) zx	5.9 (0.2) zx	6.7 (0.4) yx	7.3 (0.2) y
Habit measures				
Percentage of clingers	46.8 (5.8) z	42.0 (6.2) z	5.7 (0.9) y	4.3 (0.9) y

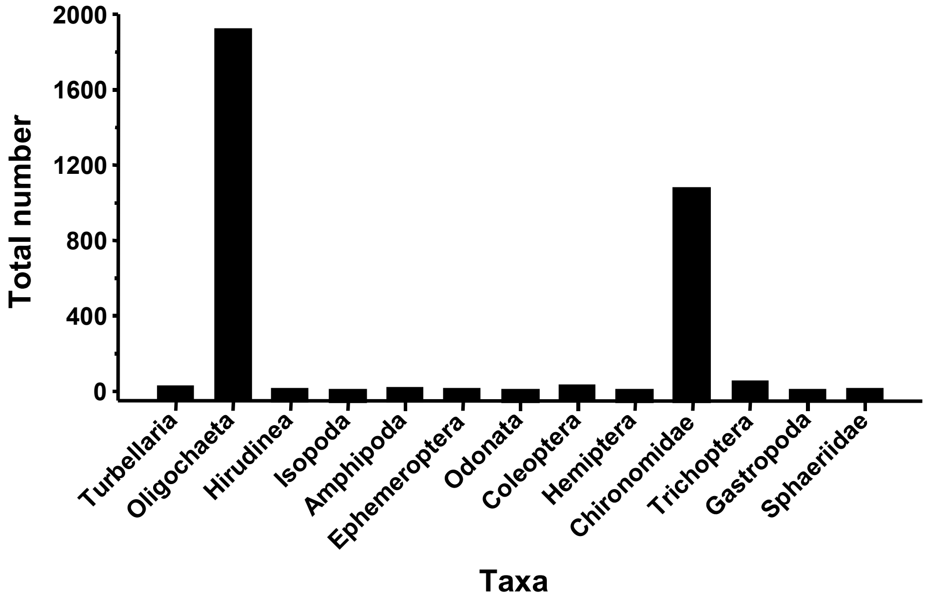


Figure 8. Total numbers of macroinvertebrates from 16 stations located in impounded reaches of the Fox River between McHenry and Dayton, Illinois. Macroinvertebrates were sampled with a petite ponar dredge during July through early September 2000.

Aquatic Habitat Quality

The quality of aquatic habitat available to fish and invertebrate communities differed substantially between free-flowing and impounded portions of river. Mean QHEI scores were higher at DS FF and MD FF stations than MD IMP and US IMP stations (Tukey's multiple comparisons, $P < 0.001$) but scores were not statistically different within free-flowing and impounded habitats ($P > 0.56$; Figure 9 and Table 18). A similar pattern was found between station types for mean SHAP scores, except that DS FF and MD IMP stations were similar ($P = 0.16$; Figure 9 and Table 18). Both the QHEI and the SHAP indicated that habitat at free-flowing stations was of good quality whereas habitat in impounded areas was rated as severely degraded by QHEI and fair to poor by SHAP.

In-stream habitat had a greater effect on overall index scores than bank and riparian metrics (Table 18). Component metrics influencing habitat quality ratings for QHEI were gradient and pool/glide/riffle/run quality. For SHAP, important metrics included pool variability and substrate composition and stability. Riparian zone and bank stability metrics were similar among stations for both indices. Good in-stream habitat was typically available throughout free-flowing portions of river, even in many downtown areas where banks often were stabilized with concrete and riparian vegetation was degraded or absent.

Habitat quality appeared to be an important factor affecting the quality of fish and macroinvertebrate communities in the Fox River. The consistent pattern of high quality biotic communities in free-flowing sections of river and low quality communities in impounded sections mirrored the high and low habitat quality scores that we observed throughout the study area (Tables C1 and C2). Furthermore, strong positive relationships existed between habitat index scores and IBI scores for fish and MCI scores for invertebrates (Figure 10). These strong relations, particularly for the QHEI-IBI and QHEI-MCI comparisons, attest to the validity of these habitat indices as a stream quality measurement tool and the importance of habitat quality to fish and macroinvertebrate communities.

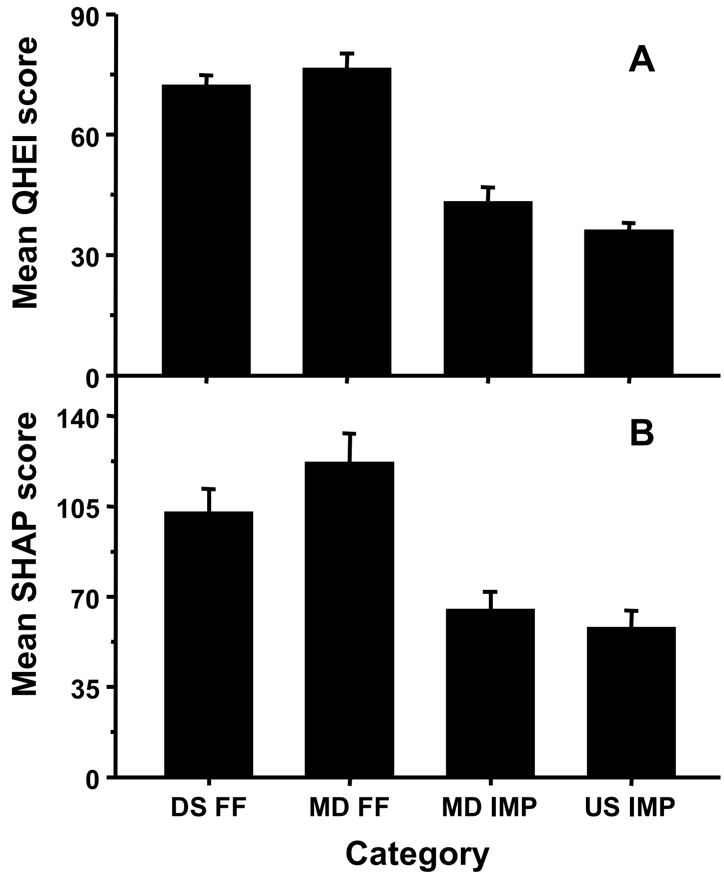


Figure 9. Mean scores for (A) Qualitative Habitat Evaluation Index (QHEI) and (B) Stream Habitat Assessment Procedure (SHAP) from downstream free-flowing (DS FF), mid segment free-flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Habitat quality was evaluated at 40 stations during July-early September 2000. Vertical lines represent 1 SE.

Table 18. Qualitative Habitat Evaluation Index (QHEI), Stream Habitat Assessment Procedure (SHAP), and component metric scores for downstream free flowing (DS FF), mid segment free flowing (MD FF), mid segment impounded (MD IMP), and upstream impounded (US IMP) stations on the Fox River between McHenry and Dayton, Illinois. Habitat was evaluated at 40 stations during July through September 2000. Values are means with 1 SE in parentheses. Letters designate significant differences among station types for each metric (one-way ANOVA, $P < 0.05$).

	Station type			
Index and metrics	DS FF	MD FF	MD IMP	US IMP
QHEI	71.9 (2.9) z	76.0 (4.1) z	42.9 (3.9) y	35.8 (2.1) y
Habitat rating	Good quality	Good quality	Severely degraded	Severely degraded
Component metrics				
Substrate	16.9 (0.4) z	15.8 (0.6) zx	11.8 (1.4) yx	9.1 (0.8) y
Instream cover	13.5 (0.9) zx	16.2 (0.9) z	10.8 (0.8) yx	8.8 (0.8) y
Channel morphology	11.3 (0.9) zx	13.3 (1.2) z	7.2 (0.6) yx	5.4 (0.4) y
Riparian zone and bank erosion	4.2 (0.5) z	6.4 (0.7) z	4.4 (0.9) z	4.7 (0.5) z
Pool/glide quality	9.9 (0.4) z	9.5 (1.2) z	1.8 (0.2) y	1.6 (0.4) y
Riffle/run quality	6.3 (0.5) z	4.8 (1.0) z	0.0 y	0.0 y
Gradient	9.7 (0.3) z	10.0 (0.0) z	7.0 (1.0) y	6.1 (0.1) y
SHAP	102.1 (9.5) zx	121.3 (11.9) z	64.5 (7.4) yx	57.5 (7.1) y
Habitat rating	Good	Good	Fair	Poor
Component metrics				
Substrate	15.3 (1.4) z	15.7 (08) z	5.2 (1.9) y	6.1 (1.4) y
Deposition	7.6 (0.6) z	6.7 (1.2) zy	4.0 (0.7) y	4.3 (0.7) y
Substrate stability	11.2 (0.9) z	11.7 (1.6) z	3.5 (0.9) y	5.2 (1.0) y
Instream cover	6.8 (0.8) z	9.5 (1.2) z	6.8 (1.7) z	5.3 (0.7) z
Pool substrate	9.2 (1.6) z	11.7 (2.3) z	5.5 (1.9) zx	3.4 (0.8) yx
Pool quality	6.0 (1.0) z	9.3 (1.6) z	4.2 (1.0) zx	2.5 (0.7) yx
Pool variability	6.9 (1.4) z	7.5 (1.5) z	2.0 (0.7) y	2.0 (0.8) y
Channel alteration	3.8 (0.5) y	6.0 (0.3) z	2.8 (0.8) yw	2.0 (0.3) xw
Channel sinuosity	4.1 (0.4) zy	5.2 (0.5) z	4.5 (0.6) zy	2.5 (0.2) y
Width/depth ratio	5.3 (0.6) z	5.0 (0.5) z	5.5 (1.0) z	4.2 (0.6) z
Hydrologic diversity	7.2 (0.9) z	7.8 (1.0) z	3.5 (0.3) zx	2.4 (0.5) yx
Canopy	2.1 (0.2) z	2.3 (0.4) z	2.0 (0.7) z	2.0 (0.3) z
Bank vegetative protection/stability	7.0 (1.1) z	11.0 (1.2) z	6.8 (2.0) z	6.6 (1.3) z
Immediate land use	2.8 (0.5) z	3.8 (0.6) z	2.8 (0.8) z	3.1 (0.6) z
Flow-related refugia	6.4 (0.8) z	8.2 (0.9) z	5.5 (1.3) z	5.6 (0.7) z

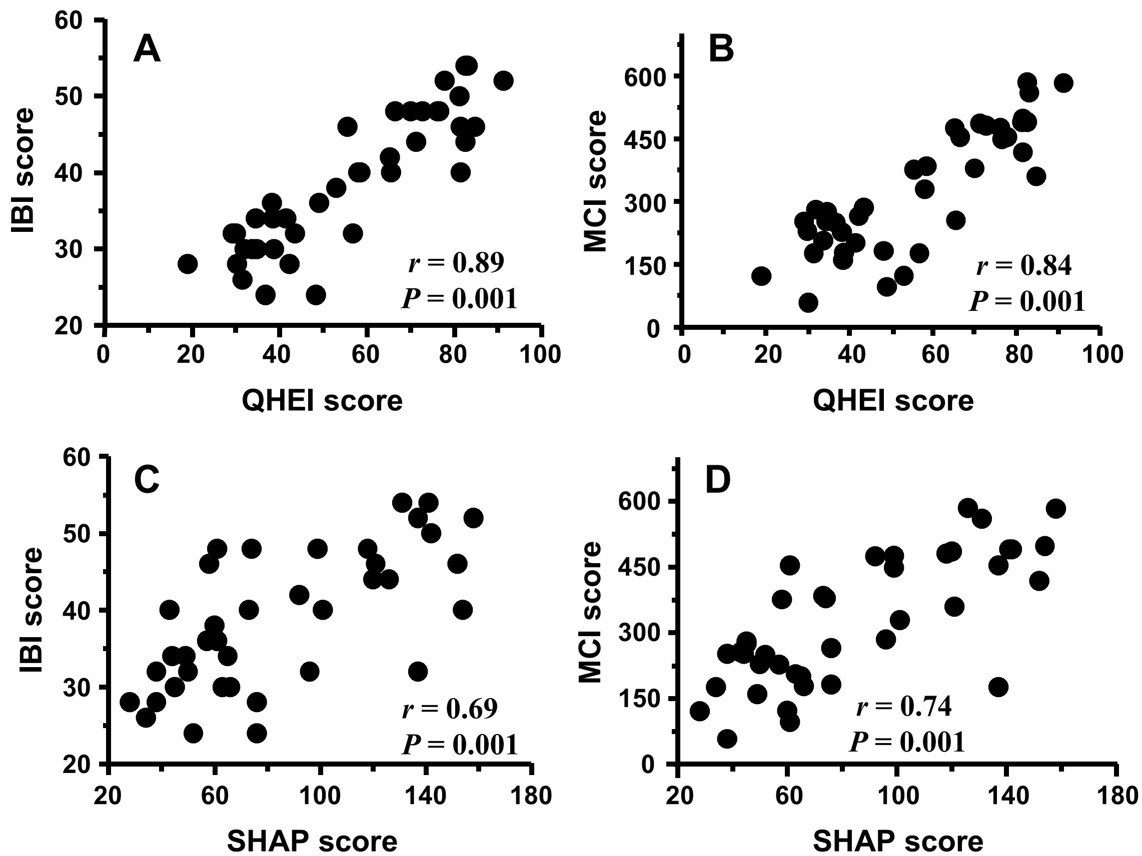


Figure 10. Relationships between (A) the Qualitative Habitat Evaluation Index (QHEI) and the Index of Biotic Integrity (IBI), (B) QHEI and the Macroinvertebrate Condition Index (MCI), (C) the Stream Habitat Assessment Procedure (SHAP) and IBI, and (D) SHAP and MCI. Fish and macroinvertebrate communities and habitat were assessed at 40 stations on the Fox River between McHenry and Dayton, Illinois during July through early September 2000.

Water Quality

Dissolved oxygen varied on a daily basis at all stations such that concentrations increased during the day and declined at night (Table D1). However, the magnitude of these daily fluctuations was substantially higher at impounded stations than free-flowing stations (Figure 11). Dissolved oxygen concentrations in impounded areas were as high as 17.8 mg/L (>200% saturation) and as low as 2.6 mg/L (Table 19). With few exceptions, dissolved oxygen in free-flowing areas varied between 5 and 10 mg/L. On average, maximum dissolved oxygen concentrations were higher for impounded stations than free-flowing stations (13.8±0.8 vs. 9.8±0.4 mg/L; repeated-measures ANOVA, $P = 0.001$) and minimum concentrations were lower in impoundments (4.2±0.7 vs. 5.7±0.7 mg/L; $P = 0.02$).

Although daily extremes in dissolved oxygen varied between free-flowing and impounded portions of river, mean concentrations were similar between habitat types (repeated measures ANOVA, $P = 0.40$; Table 20). Likewise, mean values of other water quality parameters were

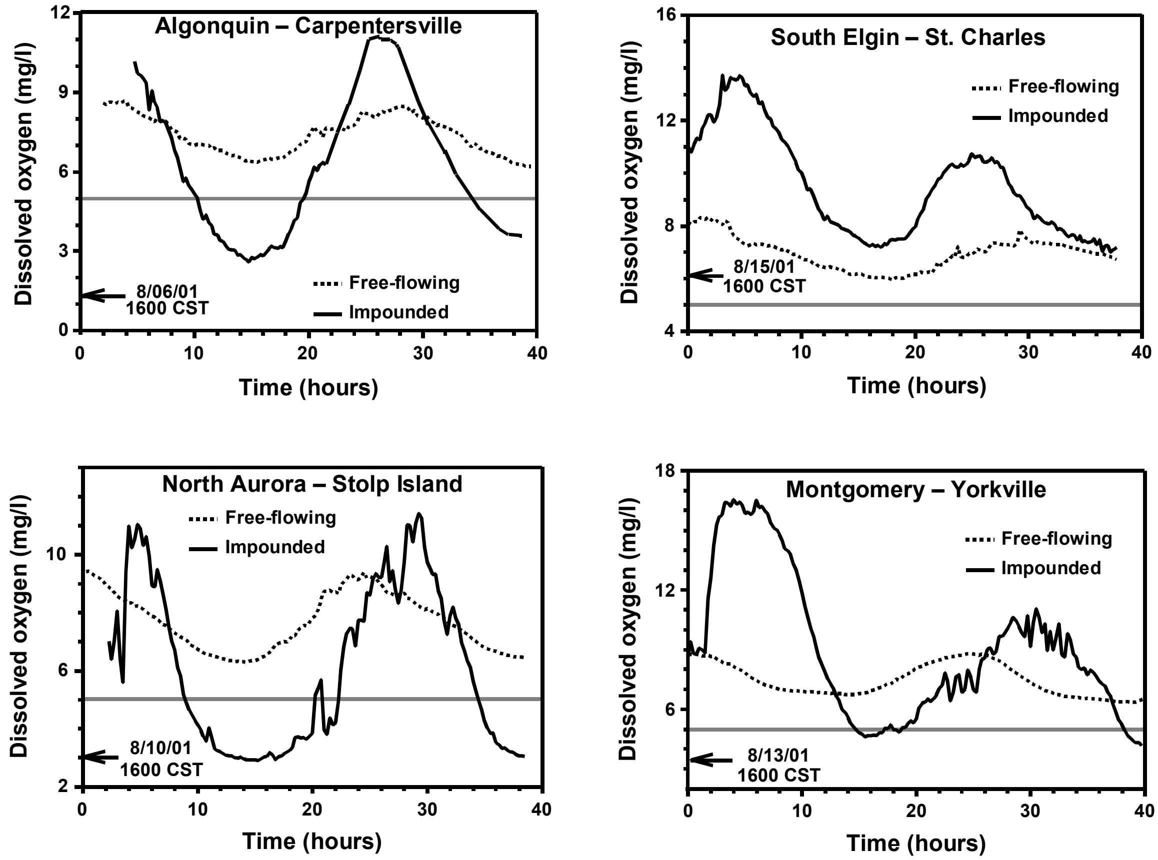


Figure 11. Dissolved oxygen concentrations at free-flowing and impounded stations in four segments of the Fox River, Illinois. Dissolved oxygen was measured at each station with continuous recording Datasondes over a 40-hour period in August 2001. The horizontal line represents the 5-mg/L ambient water standard for dissolved oxygen (Illinois EPA).

similar at free-flowing and impounded locations ($P > 0.13$). In contrast, sampling time had a significant effect on mean values for 9 of 16 parameters (Table 20). Dissolved oxygen and seven additional parameters were higher during p.m. than a.m. sample periods ($P < 0.03$) and nitrate/nitrite nitrogen was lower during p.m. sampling ($P = 0.01$). Seven parameters did not vary with time period ($P > 0.08$). The significant habitat x time interactions observed for dissolved oxygen concentration and % saturation resulted because differences in dissolved oxygen between a.m. and p.m. sample periods were greater for impounded stations than free-flowing stations.

Comparisons of water quality data to recommended guidelines showed that the Fox River was nutrient enriched and supported high algal biomass (Tables 9 and D1). We present means of samples from above and below dam stations and a.m. and p.m. time periods for total phosphorus and nitrogen, chlorophyll a, and turbidity because these parameters either were similar between habitat type and time period (nutrients and turbidity; Table 20) or differences were small relative to the degree that concentrations exceeded guidelines (chlorophyll a; Table D1). Total phosphorus was near the recommended guideline for Phosphorus Zone 4 Midwestern streams at

Table 19. Mean (minimum - maximum) temperature, dissolved oxygen, specific conductance, and pH for free-flowing and impounded habitats in 11 segments of the Fox River between McHenry and Dayton, Illinois. Data were collected from August 6-17, 2001 with continuously recording Datasondes and by point sampling at the beginning, middle, and end of each 40 h monitoring period. Sondes were set mid channel 1-1.5 ft. off bottom and point measurements were made at the surface, mid depth, and bottom of mid channel, left-of-center, and right-of-center locations along cross channel transects that included the sonde location. Battery failure reduced the number of sonde readings for the Carpentersville and Dayton above dam stations.

Segment and station	Habitat	River mile	Number of readings	Temperature (˚ C)	Dissolved oxygen (mg/L)	Dissolved oxygen (% saturation)	Specific conductance (µs/cm)	pH (units)
Stratton - Algonquin								
Stratton below dam	Free-flowing	98.77	173	29.6 (28.8 - 30.7)	6.9 (5.7 - 8.8)	92.5 (76.6 - 119.7)	656 (648 - 731)	8.5 (8.4 - 8.7)
Algonquin above dam	Impounded	82.64	182	29.2 (28.4 - 30.2)	5.8 (3.3 - 11.8)	77.3 (44.5 - 160.9)	777 (709 - 802)	8.3 (8.1 - 8.6)
Algonquin - Carpentersville								
Algonquin below dam	Free-flowing	82.51	175	29.3 (28.4 - 30.2)	7.4 (5.3 - 11.7)	99.7 (70.5 - 154.6)	895 (716 - 993)	8.3 (8.1 - 8.5)
Carpentersville above dam	Impounded	78.27	98	29.4 (28.0 - 30.7)	5.5 (2.6 - 11.3)	74.1 (33.9 - 154.0)	840 (770 - 873)	8.2 (7.5 - 8.6)
Carpentersville - Elgin								
Carpentersville below dam	Free-flowing	78.11	172	29.9 (27.2 - 31.1)	7.3 (4.8 - 9.5)	99.3 (62.7 - 131.6)	852 (730 - 901)	8.3 (8.0 - 8.7)
Elgin above dam	Impounded	71.99	180	29.4 (27.6 - 32.7)	5.4 (3.2 - 15.8)	73.4 (42.9 - 224.4)	909 (812 - 979)	8.4 (8.1 - 9.0)
Elgin - South Elgin								
Elgin below dam	Free-flowing	71.57	174	29.7 (27.8 - 31.3)	7.2 (5.4 - 9.7)	98.6 (71.1 - 135.6)	887 (684 - 926)	8.4 (8.2 - 8.7)
South Elgin above dam	Impounded	68.31	188	29.2 (27.5 - 32.0)	7.7 (3.3 - 14.5)	103.7 (43.2 - 242.0)	938 (846 - 980)	8.4 (8.1 - 9.0)
South Elgin - St. Charles								
South Elgin below dam	Free-flowing	68.08	156	23.4 (21.9 - 24.9)	6.9 (5.9 - 8.3)	83.7 (71.6 - 103.0)	861 (833 - 883)	8.2 (7.0 - 8.5)
St. Charles above dam	Impounded	60.69	181	23.5 (21.8 - 25.5)	9.5 (6.1 - 15.7)	114.7 (71.8 - 195.2)	863 (784 - 873)	8.7 (7.9 - 9.0)
Geneva - North Batavia								
Geneva below dam	Free-flowing	58.56	179	23.4 (21.8 - 24.7)	8.0 (6.8 - 9.5)	95.9 (81.0 - 116.4)	877 (819 - 903)	8.6 (8.2 - 8.8)
North Batavia above dam	Impounded	56.49	189	23.4 (21.9 - 29.9)	6.0 (2.8 - 13.3)	72.1 (34.1 - 178.3)	857 (820 - 903)	8.6 (8.4 - 9.0)
South Batavia - North Aurora								
South Batavia below dam	Free-flowing	54.75	175	27.4 (25.7 - 29.3)	7.2 (4.7 - 10.1)	94.4 (59.5 - 135.4)	831 (798 - 850)	8.9 (8.8 - 9.0)
North Aurora above dam	Impounded	52.69	180	27.0 (25.1 - 29.5)	5.6 (2.8 - 11.1)	72.7 (35.5 - 144.8)	832 (815 - 848)	8.9 (8.7 - 9.0)
North Aurora - Stolp Island								
North Aurora below dam	Free-flowing	52.52	175	27.3 (25.1 - 29.9)	7.7 (6.1 - 9.4)	99.7 (75.7 - 127.7)	826 (804 - 847)	8.8 (8.7 - 9.0)
Stolp Island above dam	Impounded	49.03	180	26.9 (24.8 - 30.4)	6.2 (2.9 - 14.4)	80.4 (36.6 - 197.3)	853 (821 - 879)	8.8 (8.5 - 9.1)
Hurds Island - Montgomery								
Hurd's Island below dam	Free-flowing	48.32	182	23.0 (21.5 - 24.3)	6.8 (5.8 - 8.2)	81.5 (69.5 - 99.6)	874 (789 - 895)	8.5 (8.3 - 8.8)
Montgomery above dam	Impounded	46.85	190	23.0 (21.4 - 24.6)	7.2 (5.2 - 9.2)	85.8 (59.8 - 109.6)	926 (867 - 953)	8.4 (8.2 - 8.7)
Montgomery - Yorkville								
Montgomery below dam	Free-flowing	46.76	181	25.5 (24.2 - 26.9)	7.5 (6.3 - 9.8)	93.5 (78.2 - 112.4)	871 (859 - 887)	8.8 (8.7 - 9.0)
Yorkville above dam	Impounded	36.56	186	24.0 (21.7 - 27.6)	9.1 (4.2 - 16.8)	112.5 (50.0 - 214.9)	905 (861 - 934)	8.9 (8.6 - 9.4)
Yorkville - Dayton								
Yorkville below dam	Free-flowing	36.41	183	25.2 (22.5 - 27.7)	9.6 (6.6 - 12.7)	119.5 (80.1 - 158.6)	853 (819 - 933)	9.0 (8.8 - 9.3)
Dayton above dam	Impounded	5.80	32	25.6 (24.4 - 27.2)	13.2 (10.0 - 17.8)	166.9 (121.7 - 225.2)	839 (828 - 854)	9.3 (9.2 - 9.4)

Table 20. Water quality parameter means (±1 standard error) and results of repeated-measures ANOVA examining the effects of habitat type, time period, and habitat x time interactions on water quality in the Fox River between McHenry and Dayton, Illinois. Water samples were collected from August 6-17, 2001 in free-flowing and impounded habitats during a.m. (0613 - 0940 hours) and p.m. (1830 -2242 hours) time periods. $P \leq 0.05$ indicates significance.

	Habitat type			Time period			Habitat x Time interaction
Parameter	Free-flowing	Impounded	*P*	a.m.	p.m.	*P*	*P*
Temperature (˚C)	26.2±0.6	26.2±0.6	0.98	25.3±0.6	27.1±0.6	0.001	0.92
Dissolved oxygen (mg/L)	7.4±0.3	8.0±0.8	0.40	5.9±0.3	9.4±0.6	0.001	0.01
Dissolved oxygen (% saturation)	93.2±4.3	101.8±10.1	0.33	73.4±3.9	121.6±7.1	0.001	0.02
Specific conductance (µS/cm)	818.2±15.4	835.2±11.0	0.53	830.0±14.4	823.3±12.6	0.25	0.61
pH (units)	8.6±0.1	8.7±0.1	0.54	8.5±0.1	8.8±0.1	0.001	0.56
Turbidity (NTU)	43.2±1.5	40.5±1.7	0.30	42.4±1.5	41.3±1.8	0.61	0.90
Total suspended solids (mg/L)	46.5±2.5	42.1±1.4	0.20	41.8±1.8	46.8±2.3	0.04	0.56
Total organic carbon (mg/L)	12.8±0.5	12.4±0.4	0.62	11.9±0.3	13.2±0.5	0.001	0.53
Chlorophyll a (µg/L)	136.0±9.0	148.1±9.7	0.40	127.5±6.3	156.6±10.9	0.02	0.53
Total phosphorus (mg/L)	0.42±0.03	0.42±0.03	0.96	0.42±0.03	0.41±0.03	0.37	0.34
Total dissolved phosphorus (mg/L)	0.19±0.02	0.19±0.02	0.90	0.19±0.02	0.19±0.02	0.78	0.90
Total nitrogen (mg/L)	2.83±0.12	2.74±0.12	0.69	2.86±0.12	2.71±0.12	0.09	0.09
Total Kjeldahl nitrogen (mg/L)	2.22±0.05	2.14±0.05	0.39	2.17±0.04	2.19±0.06	0.60	0.02
Ammonia nitrogen (mg/L)	0.11±0.01	0.07±0.01	0.14	0.10±0.01	0.09±0.01	0.47	0.72
Unionized ammonia (mg/L)	0.019±0.002	0.016±0.002	0.26	0.014±0.002	0.021±0.002	0.01	0.94
Nitrate/nitrite nitrogen (mg/L)	0.61±0.09	0.59±0.10	0.94	0.69±0.10	0.51±0.09	0.01	0.40

Stratton Dam (0.11 mg/L), increased to the 90th percentile between Stratton and South Elgin (0.54 mg/L), and remained elevated at all downstream stations (Figure 12). A modest decrease in phosphorus concentrations was evident between the Yorkville and Dayton dams, a reach of river with over 26 uninterrupted miles of free-flowing habitat. Total nitrogen followed a pattern similar to total phosphorus except that peak nitrogen concentrations were near the 50th percentile for Nitrogen Zone 2 Midwestern streams (4.0 mg /L) and the decrease in nitrogen at the southernmost stations was more substantial (Figure 12). Total Kjeldahl nitrogen was above the 25th percentile guideline at all sampling stations whereas ammonia nitrogen, unionized ammonia, and nitrate/nitrite nitrogen remained at low to moderate levels throughout the study area (Tables 20 and D1). Like Kjeldahl nitrogen, chlorophyll a concentrations and turbidity were high at all sampling stations relative to recommended guidelines (Figure 13). High organic nitrogen (compared to free ammonia and non-organic forms), chlorophyll a, suspended solids, and turbidity were indicative of the extremely high algal biomass that we observed in the Fox River during summer and fall 2000 and 2001.

Standard violations for dissolved oxygen and pH were widespread and of long duration in impounded reaches throughout the study area, but they occurred infrequently and for shorter time periods in free-flowing habitats. Minimum dissolved oxygen concentrations were below the 5-mg/L standard at 8 of 11 impounded stations during the first sampling event (Figure 14) and all

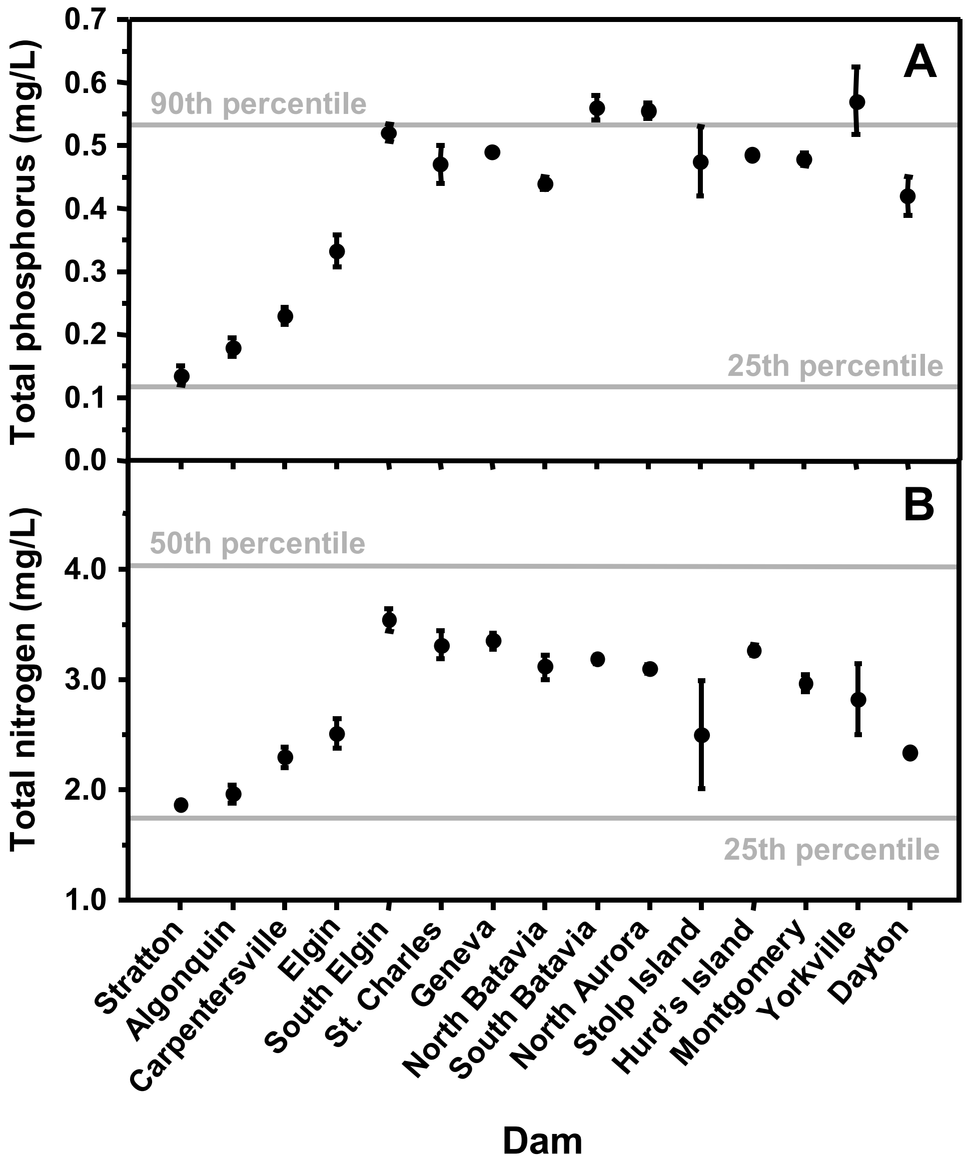


Figure 12. Mean concentrations of (A) total phosphorus and (B) total nitrogen measured at 15 dams on the Fox River between McHenry and Dayton, Illinois. Samples were collected during the early morning and evening at above and below dam stations in August 2001. Percentile guidelines are based on data from over 100 Midwestern streams (Robertson et al. 2001). Vertical lines represent 1 SE.

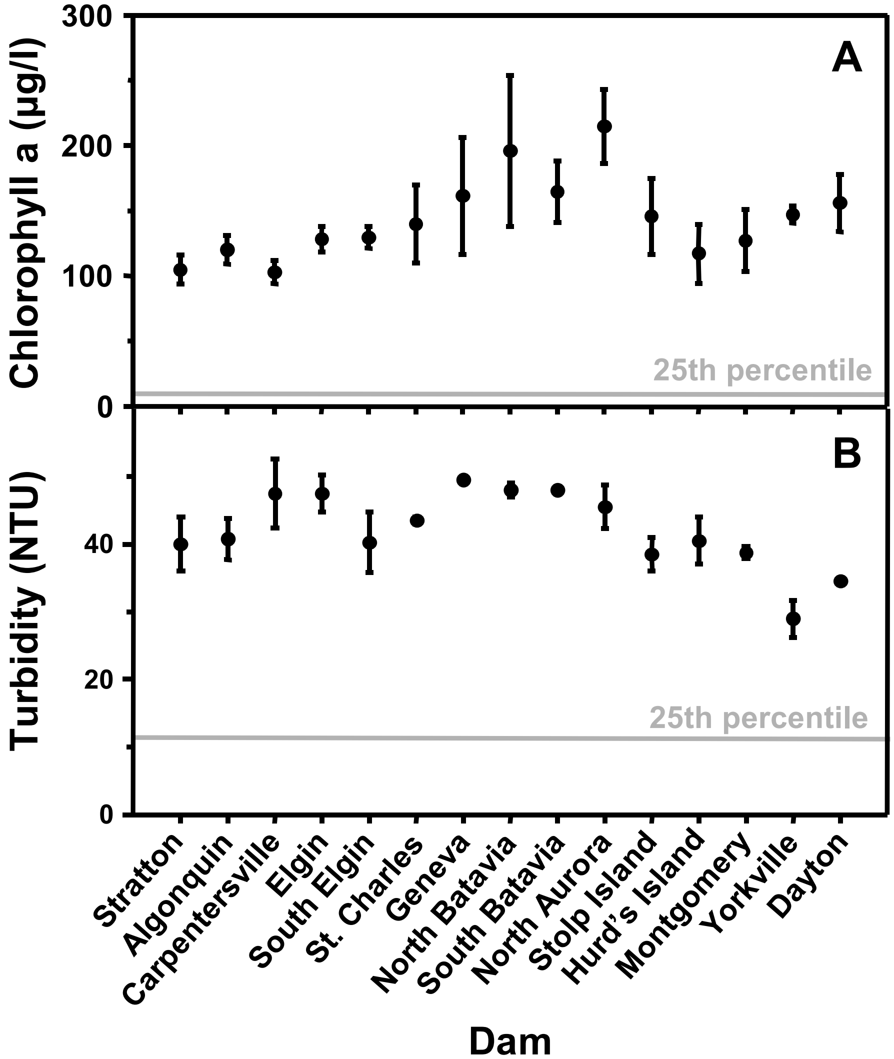


Figure 13. Mean concentrations of (A) chlorophyll a and (B) turbidity measured at 15 dams on the Fox River between McHenry and Dayton, Illinois. Samples were collected during the early morning and evening at above and below dam stations in August 2001. Percentile guidelines are based on all season data from Level III ecoregion VI streams (U.S. EPA 2000). Vertical lines represent 1 SE.

four impoundments monitored during the second event (Table D2). When substandard conditions existed in impounded areas, they typically lasted for more than 8 hours in a 24-hour period (>15 hours at two stations; Table 21). In contrast, dissolved oxygen dipped below the standard at only 2 of 11 stations in the free-flowing river and these conditions lasted for only a short time (<2 hours). Maximum pH was above 9.0 units in the Stolp Island, Yorkville, and Dayton impoundments and near violation in impounded areas from Elgin to North Aurora (maximum pH = 9.0; Figure 14). These maximums tended to occur during p.m. sampling when oxygen concentrations were at highly supersaturated levels. The duration of elevated pH ranged from less than 1 hour at Stolp Island to 11.75 hours in Yorkville and 24 hours in Dayton. The

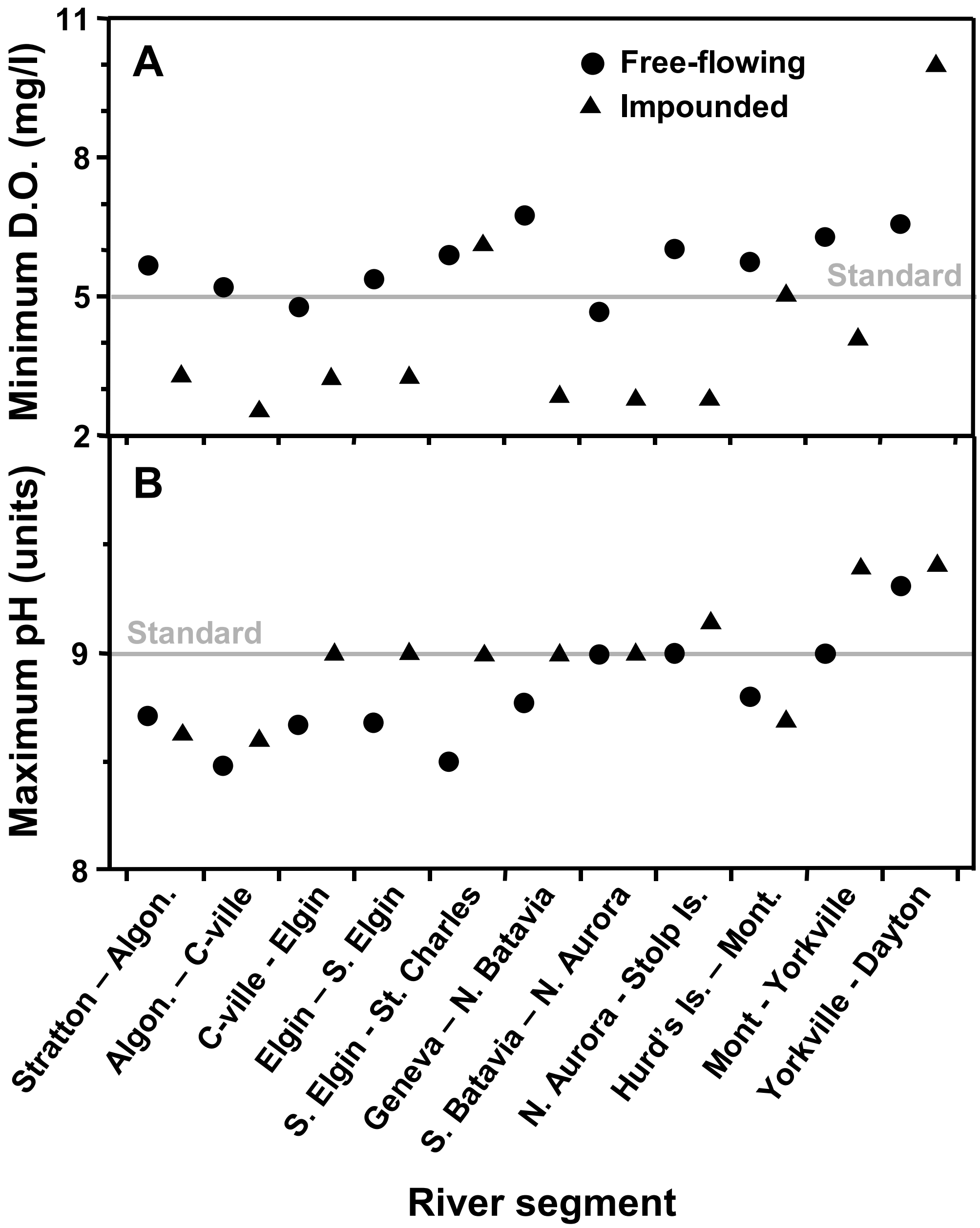


Figure 14. Minimum dissolved oxygen concentrations (A) and maximum pH values (B) for free-flowing and impounded stations in the Fox River between McHenry and Dayton, Illinois. Parameters were measured at each station with continuous recording Datasondes and by point sampling over a 40-hour period in August 2001. Standard lines represent Illinois EPA ambient water quality standards for each parameter.

Yorkville below-dam station was the only free-flowing station with a pH standard violation, although it lasted for 13 hours in a 24-hour period (Table 21).

Substandard oxygen conditions were widespread throughout impoundments monitored during the second sampling event. Low dissolved oxygen concentrations began in the uppermost reaches of impounded areas and, except for the St. Charles pool, continued downstream to the dams (Figure 15). Minimum dissolved oxygen levels dropped below 5 mg/L in the upper

Table 21. Duration of below standard dissolved oxygen concentrations (<5 mg/L) and above standard pH levels (>9.0 units) for free-flowing and impounded habitats in 11 segments of the Fox River between McHenry and Dayton, Illinois. Data were collected from August 6-17, 2001 with continuously recording Datasondes and by point sampling at the beginning, middle, and end of each 40 h monitoring period.

			Duration (hours in 24 h period)	
Segment and station	Habitat	River mile	Dissolved oxygen	pH
Stratton - Algonquin				
Stratton below dam	Free-flowing	98.77	0.00	0.00
Algonquin above dam	Impounded	82.64	15.00	0.00
Algonquin - Carpentersville				
Algonquin below dam	Free-flowing	82.51	0.00	0.00
Carpentersville above dam	Impounded	78.27	9.25	0.00
Carpentersville - Elgin				
Carpentersville below dam	Free-flowing	78.11	1.00	0.00
Elgin above dam	Impounded	71.99	15.50	0.00
Elgin - South Elgin				
Elgin below dam	Free-flowing	71.57	0.00	0.00
South Elgin above dam	Impounded	68.31	1.50	0.00
South Elgin - St. Charles				
South Elgin below dam	Free-flowing	68.08	0.00	0.00
St. Charles above dam	Impounded	60.69	0.00	0.00
Geneva - North Batavia				
Geneva below dam	Free-flowing	58.56	0.00	0.00
North Batavia above dam	Impounded	56.49	8.25	0.00
South Batavia - North Aurora				
South Batavia below dam	Free-flowing	54.75	1.75	0.00
North Aurora above dam	Impounded	52.69	12.75	0.75
North Aurora - Stolp Island				
North Aurora below dam	Free-flowing	52.52	0.00	0.00
Stolp Island above dam	Impounded	49.03	13.50	5.25
Hurds Island - Montgomery				
Hurd's Island below dam	Free-flowing	48.32	0.00	0.00
Montgomery above dam	Impounded	46.85	0.00	0.00
Montgomery - Yorkville				
Montgomery below dam	Free-flowing	46.76	0.00	0.00
Yorkville above dam	Impounded	36.56	3.75	11.75
Yorkville - Dayton				
Yorkville below dam	Free-flowing	36.41	0.00	13.00
Dayton above dam	Impounded	5.80	0.00	24.00

reaches of the St. Charles impoundment, but they remained high (>8 mg/L) in the lower reaches throughout the 16-h sampling event. Comparisons of horizontal and vertical samples at impounded and free-flowing stations showed mean dissolved oxygen concentrations were similar among horizontal locations (left, mid, and right channel; repeated-measures ANOVA, $P > 0.07$; Table 22). Dissolved oxygen also was similar among vertical locations (surface, mid depth, bottom) in free-flowing areas ($P > 0.10$), but it decreased from surface to bottom in impounded areas ($P = 0.001$). Other variables showed patterns similar to dissolved oxygen when comparisons were made among horizontal and vertical locations at free-flowing and impounded

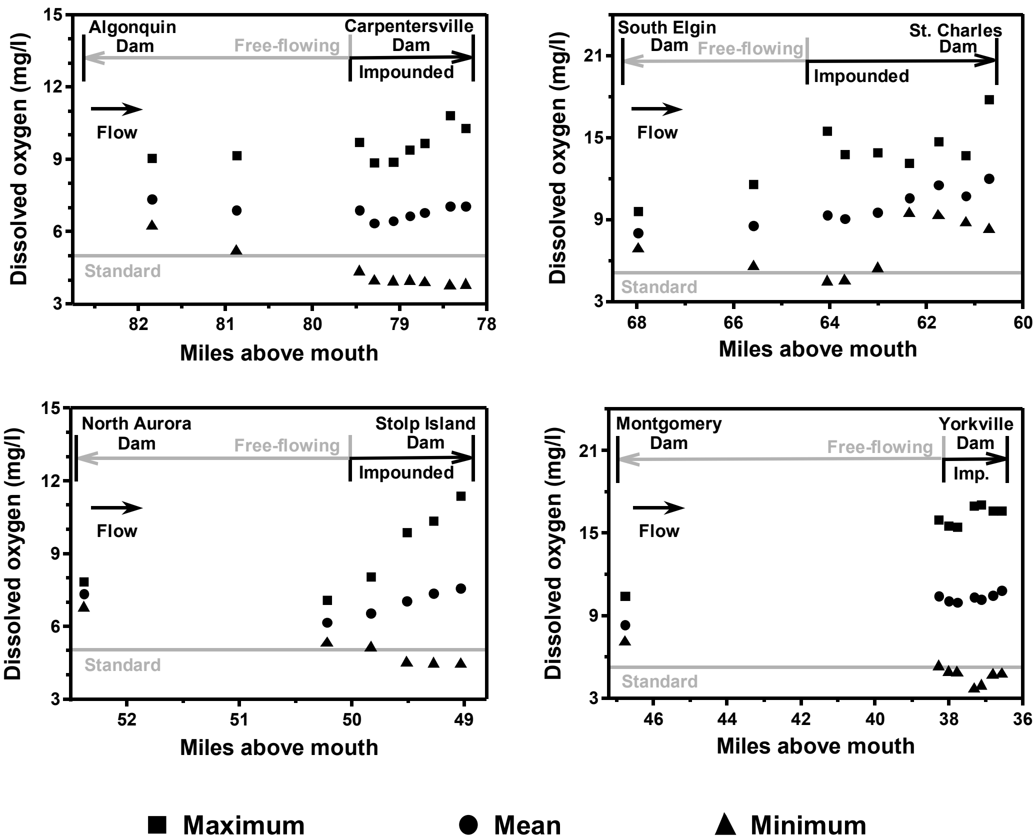


Figure 15. Mean, maximum, and minimum dissolved oxygen concentrations at free-flowing and impounded stations in four segments of the Fox River, Illinois. Dissolved oxygen was measured in each segment with continuous recording Datasondes (four stations) and by point sampling (6-9 transects) over a 16-hour period in August and September 2001.

stations (Table 22). The location x time period interaction was not significant for any measured variables ($P > 0.28$).

Stable low flows in combination with warm water temperatures were necessary for substandard oxygen and pH conditions to occur in Fox River impounded areas. Extremes in measured water quality parameters existed at the St. Charles above dam long-term monitoring station during early August 2001 when flows were stable between 350 and 500 cfs (as measured at the Algonquin gage; Figure 16). Increases in flow above 500 cfs between day 16 and 28 resulted in decreases in water temperature, specific conductance, and pH to more moderate levels and reductions in the magnitude of diel oxygen extremes. Stable low flow conditions between days 28 and 36 again resulted in elevated water quality measures after which measures declined with increased flows on day 36 (Figure 16). Historic flow data suggest that conditions favoring poor water quality may occur annually from mid July through mid October.

Table 22. Mean (±1 standard error) temperature, dissolved oxygen, specific conductance, and pH and results of repeated-measures ANOVA examining the effects of vertical and horizontal sampling locations for free-flowing and impounded habitats in the Fox River between McHenry and Dayton, Illinois. Water samples were collected from August 6-17, 2001 during a.m. (0613 - 0940 hours) and p.m. (1830 -2242 hours) time periods. $P \leq 0.05$ indicates significance.

	Vertical sample location				Horizontal sample location			
Habitat and parameter	Surface	Mid depth	Bottom	*P*	Left of center	Mid channel	Right of center	*P*
Free-flowing								
Temperature (˚C)	26.2±0.6	26.2±0.6	26.2±0.6	0.10	26.1±0.6	26.2±0.6	26.2±0.6	0.17
Dissolved oxygen (mg/L)	7.4±0.3	7.3±0.3	7.3±0.3	0.14	7.3±0.3	7.4±0.3	7.3±0.3	0.29
Dissolved oxygen (% saturation)	94.2±4.1	93.0±4.1	92.3±4.12	0.001	92.6±4.2	93.7±4.4	93.2±4.0	0.65
Specific conductance (µS/cm)	822.0±14.6	821.4±14.7	820.7±14.7	0.63	813.0±16.5	818.1±15.4	833.0±13.5	0.10
pH (units)	8.6±0.1	8.6±0.1	8.6±0.1	0.11	8.6±0.1	8.6±0.1	8.6±0.1	0.62
Impounded								
Temperature (˚C)	26.2±0.6	26.1±0.6	25.9±0.6	0.12	26.0±0.6	26.0±0.6	26.1±0.6	0.31
Dissolved oxygen (mg/L)	8.2±0.8	7.7±0.7	7.2±0.7	0.001	7.7±0.7	7.4±0.7	7.9±0.8	0.08
Dissolved oxygen (% saturation)	104.0±10.2	97.8±9.4	90.7±8.8	0.001	98.1±9.4	94.5±9.2	99.9±9.7	0.07
Specific conductance (µS/cm)	834.2±10.8	836.0±11.0	838.5±11.0	0.03	834.4±11.0	837.4±11.0	837.0±10.9	0.37
pH (units)	8.7±0.1	8.6±0.1	8.6±0.1	0.004	8.6±0.1	8.6±0.1	8.6±0.1	0.28

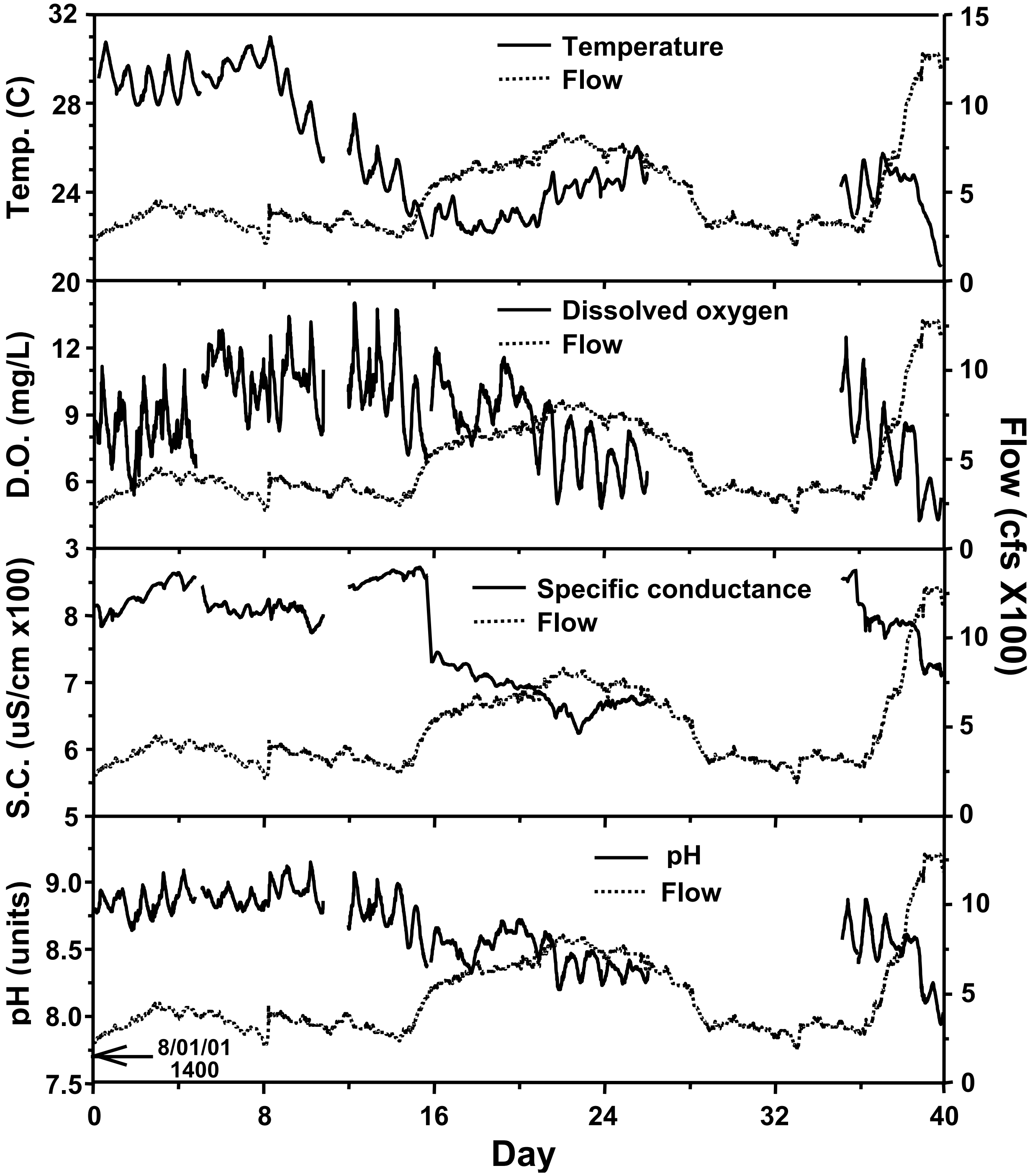


Figure 16. Temperature, dissolved oxygen, specific conductance, and pH for the St. Charles above dam station (US IMP) in the Fox River, Illinois. Water quality variables were measured at a depth of 6.5 ft. with a continuous recording Datasonde from August 1 through September 10, 2001. Flow was recorded at the Algonquin gage (USGS 2002).

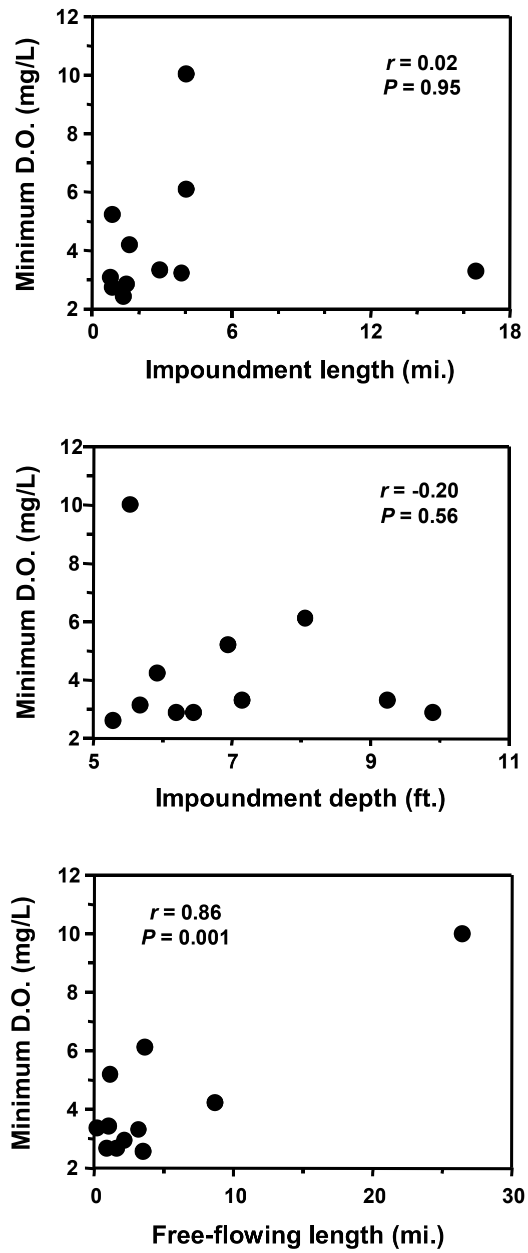


Figure 17. Relationships between minimum dissolved oxygen concentration and impoundment length, impoundment maximum depth, and length of upstream free-flowing habitat for 11 Fox River segments between McHenry and Dayton, Illinois.

Hydrologic conditions appeared to have a greater effect on the occurrence of substandard dissolved oxygen than impoundment morphology. We found no relationship between minimum dissolved oxygen concentration and impoundment length (Pearson correlation, $r = 0.02$, $P = 0.95$) or impoundment depth ($r = -0.02$, $P = 0.56$; Figure 17). Likewise, no relation was observed for duration of oxygen standard violation and impoundment length or depth ($r < 0.32$, $P = 0.35$). In contrast, length of free-flowing habitat above impounded areas was positively correlated with minimum dissolved oxygen concentrations ($r = 0.86$, $P = 0.001$; Figure 17).

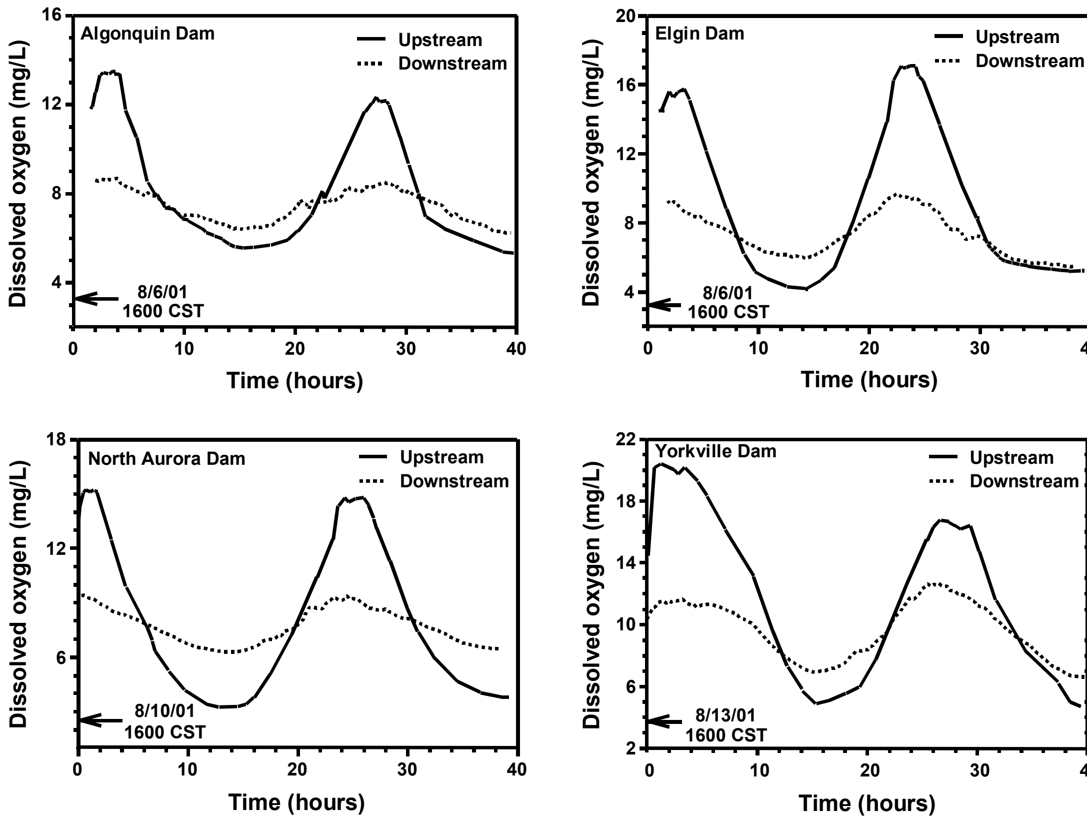


Figure 18. Dissolved oxygen concentrations at upstream impounded and downstream free-flowing stations for four dams in the Fox River, Illinois. Dissolved oxygen was measured at each station with continuous recording Datasondes over a 40-hour period in August 2001. Upstream data has been transformed based on point sampling to reflect surface dissolved oxygen concentrations.

While these data suggest longer free-flowing reaches above impoundments may improve dissolved oxygen conditions in downstream impounded areas, this result must be regarded with caution due to the predominance of short free-flowing reaches within our study area.

Above dam-below dam comparisons showed that dams released oxygen to the atmosphere during the day and added oxygen to the river at night (Figure 18). For example, water flowing over the Algonquin Dam lost about 5 mg/L of dissolved oxygen at 2000 CST on August 10 and gained about 1 mg/L at 0400 CST on August 11 (Figure 18). We used surface estimates for these comparisons because dissolved oxygen concentrations differed between surface and near-bottom impounded locations (Figure 19) and the timing of peaks in the diel oxygen cycle suggested that surface water flowed over dams during the low flow conditions that we monitored. Peaks in dissolved oxygen concentrations occurred at the same time for above-dam surface and below dam locations whereas above-dam near-bottom peaks lagged behind surface peaks by about 2 hours (Figure 19). The amount of oxygen added to the river or lost to the atmosphere by dams appeared to be related to the degree of oxygen saturation in upstream impounded waters and the physical aeration capabilities of each dam. During the day, oxygen

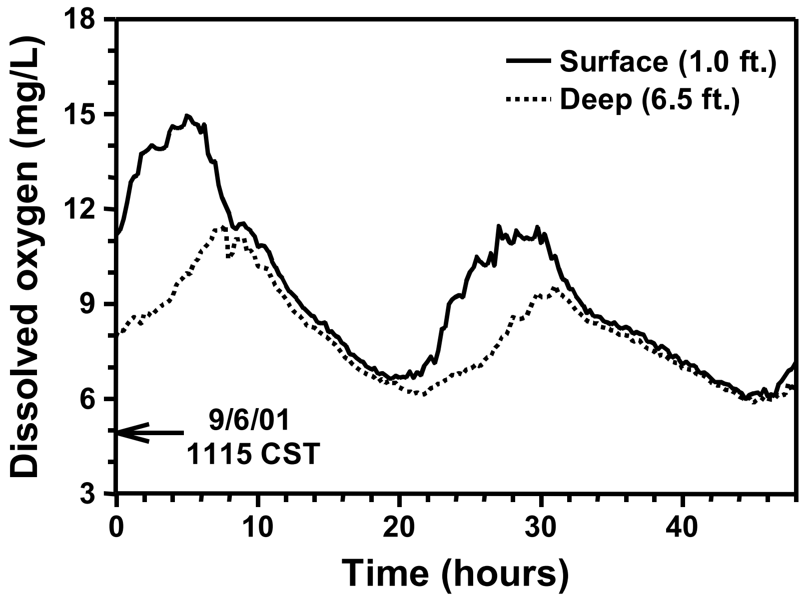


Figure 19. Dissolved oxygen concentrations for depths of 1.0 and 6.5 ft. at the St. Charles above dam station (US IMP) in the Fox River, Illinois. Dissolved oxygen was measured with continuous recording Datasondes set simultaneously for a 48-hour period in September 2001.

was released to the atmosphere as supersaturated water from the impoundments flowed over the dams. Conversely, when oxygen concentrations were low in impoundments at night, oxygen was added to water as it plunged into the river below each dam. The overall effect of water flowing over dams during a 24-hour period was a net loss in oxygen from the river (see area between upstream and downstream curves; Figure 18).

Macrohabitat Quantity

Fifteen mainstem dams impounded 47% of the 100 miles of river between Pistakee Lake and Dayton, Illinois (Table 23). As a result of these dams, 55% of the river's 4,665 acres was classified as impounded habitat. Impoundments ranged in size from 6 to 856 acres and the largest ones formed behind the Algonquin, Stratton, St. Charles, and Dayton dams. Impoundments averaged 250 to 620 ft. in width and typically were less than double the width of free-flowing areas. Free-flowing habitat did not exist above the Stratton Dam, ranged in area from 11 to 179 acres (0.3 to 3.6 mi.) between Stratton and Montgomery, and was most abundant in the lower river below the Montgomery Dam (Table 23).

The distribution of macrohabitat features varied over the river's length, among river segments formed by dams, and between free-flowing and impounded areas. Major tributaries were absent from 7 of 15 segments and occurred most frequently in the lower river below Yorkville (Table 24). No major tributaries were available to fish in the middle portion of river between St. Charles and Montgomery because 6 of 7 segments lacked tributaries and access to Mill Creek (South Batavia-North Aurora segment) was blocked by an insurmountable dam

Table 23. Length, area, and mean width (± 1 SE) of free-flowing and impounded habitat in 15 river segments created by Fox River dams between Pistakee Lake and Dayton, Illinois.

River segment	Length (mi.) Free flowing	Im-pounded	Com-bined	Area (acres) Free flowing	Im-pounded	Com-bined	Mean width (ft.) Free-flowing	Impounded
Pistakee Lake-Stratton Dam	0.0	6.9	6.9	0.0	430.0	430.0		509.8±14.2
Stratton-Algonquin	0.6	15.8	16.4	19.5	836.1	855.6	268.1±25.7	429.0±12.3
Algonquin-Carpentersville	3.1	1.4	4.4	74.2	73.7	147.9	201.1±9.7	442.0±31.6
Carpentersville-Elgin	2.7	3.6	6.3	76.3	196.6	272.9	273.8±22.4	463.9±20.4
Elgin-South Elgin	0.4	3.2	3.7	12.5	169.1	181.6	297.9±7.8	413.4±18.9
South Elgin-St. Charles	3.6	3.9	7.5	178.7	240.9	419.6	417.6±16.5	510.4±17.5
St. Charles-Geneva	1.1	0.9	2.0	37.7	53.9	91.5	298.3±11.9	503.9±25.2
Geneva-North Batavia	0.9	1.5	2.4	36.4	90.5	126.9	330.3±14.4	541.1±25.6
North Batavia-South Batavia	0.8	0.6	1.4	20.9	29.5	50.4	250.7±27.7	428.9±54.4
South Batavia-North Aurora	1.1	1.1	2.2	47.5	70.7	118.2	446.7±33.3	620.1±47.7
North Aurora-Stolp Island	2.4	1.1	3.6	103.6	62.9	166.5	463.5±25.3	562.5±30.6
Stolp Island-Hurd’s Island	0.3	0.2	0.5	11.6	6.5	18.1	595.0±70.8	303.6±20.6
Hurd’s Island-Montgomery	0.7	0.8	1.5	23.1	25.9	49.0	595.2±92.1	415.4±39.0
Montgomery-Yorkville	8.7	1.5	10.2	389.4	86.9	476.3	425.0±15.4	482.7±37.6
Yorkville-Dayton	26.8	4.0	30.8	1070.4	189.7	1260.0	383.7±8.6	390.3±14.9
All segments	52.7	47.1	99.8	2082.2	2582.5	4664.7	382.8±27.4	460.3±27.9
Percent of total	52.8	47.2		44.6	55.4			

Table 24. Number of islands and major tributaries (drainage area >20 mi.^{2}) and area of backwaters, riverside wetlands, natural pools, runs, riffles, and in-stream vegetation for 15 river segments created by Fox River dams between Pistakee Lake and Dayton, Illinois.

River segment	Number (*N*) Major tributaries	Islands	Area (acres) Backwaters	Riverside wetlands	Natural pools	Runs	Riffles	In-stream vegetation
Pistakee Lake-Stratton Dam	1	2	68.5	2.4	0.0	0.0	0.0	0.0
Stratton-Algonquin	1	1	278.5	12.8	0.0	0.0	0.0	0.0
Algonquin-Carpentersville	0	6	2.9	0.0	0.1	73.5	0.7	0.2
Carpentersville-Elgin	1	12	15.6	0.0	0.0	75.3	1.0	0.1
Elgin-South Elgin	1	3	2.1	0.0	0.0	12.5	0.1	0.0
South Elgin-St. Charles	1	11	14.0	0.0	0.0	173.9	4.8	0.7
St. Charles-Geneva	0	1	0.0	0.0	0.0	37.6	0.1	0.0
Geneva-North Batavia	0	4	16.1	0.0	0.0	35.0	1.4	2.2
North Batavia-South Batavia	0	4	0.0	0.0	0.1	20.2	0.5	0.0
South Batavia-North Aurora	1	15	0.0	0.0	0.3	45.3	1.9	0.0
North Aurora-Stolp Island	0	18	0.0	0.0	0.0	99.0	4.6	0.0
Stolp Island-Hurds Island	0	2	0.0	0.0	0.0	11.6	0.1	0.0
Hurds Island-Montgomery	0	4	0.0	0.0	0.0	22.5	0.5	0.0
Montgomery-Yorkville	1	54	0.0	0.0	0.0	369.1	20.3	0.7
Yorkville-Dayton	5	82	1.1	0.0	67.5	969.3	33.6	11.3
All segments	12	219	398.7	15.2	68.0	1944.8	69.4	15.1

0.25 mi. upstream of its confluence with the Fox River. Islands were common throughout the study area but they occurred more frequently in free-flowing areas (83%) than impoundments (17%). Streamside wetlands were found exclusively above the Algonquin Dam and natural backwaters were most common in these upper reaches as well (Table 24). Backwaters below Algonquin typically were associated with impoundments and they all had excessive accumulations of silt. Emergent and floating plants were extremely scarce in the river and we encountered no submersed forms of vegetation. In-stream vegetation was limited to small islands of water willow *Justicia americana* that formed in free-flowing areas from Montgomery to Wedron and small patches of water lily *Nymphaea* sp. that grew at five locations between Algonquin and Batavia.

Free-flowing reaches of the Fox River consisted primarily of run habitat (93% of surface area) and nearly equal amounts overall of riffles and natural pools (Table 24). Riffles occurred intermittently in all free-flowing reaches from Algonquin to Dayton, whereas natural pools were limited almost exclusively to the lower river below Yorkville. We did not observe a consistent pattern in riffle/run/pool development throughout most of the study area. Even below Yorkville, riffles rarely extended from bank to bank and pools typically were not well defined, as they were shallow with sand and gravel substrate. An exception to these pools were the deep natural scour pools that formed at the bases of sandstone bluffs between Sheridan and Wedron, IL. Natural drops in the riverbed where riffles formed, scattered large boulders from glacial deposits, bedrock outcrops, woody debris (logs and deadfalls), and islands were important features creating diversity in habitat (depth, current velocity, and cover) throughout free-flowing portions of river.

Although size and frequency of occurrence of runs, riffles, natural pools and impoundments varied among river segments, microhabitat characteristics of each habitat type generally were similar over the length of the study area (Table 25). As anticipated, average mean water depth increased as the river changed from riffles (0.9 ft.) to runs (2.6 ft.) to natural pools (3.8 ft.) and impoundment (5.6 ft.). Current velocity during the low-flow period that we surveyed was low in natural pools and impoundments (mean = 0.5 ft./s, typically <1.0 ft./s) and several times more rapid in riffles and runs (mean = 1.7 ft./s, typically >2.0 ft./s). Consistent with higher current velocities, riffles and runs had substrates consisting of larger materials (gravels, cobbles, and small boulders) than natural pools and impoundments (typically gravel, sand, and silt; Table 25). Fast water habitats differed in that riffles contained more large materials than runs (large cobbles and small boulders in riffles vs. gravels and small cobbles in runs). Similarly, natural pools had substrates made up of sands and gravels whereas impoundments tended to accumulate large quantities of fine sands and silts, particularly downstream of islands, along the impoundment margins, and in the region closest to the dam. Upstream reaches of many impounded areas accumulated little silt and maintained substrates typical of the free-flowing river.

Table 25. Microhabitat measurements for impounded, natural pool, transitional run, and riffle habitats in 15 river segments created by Fox River dams between Pistakee Lake and Dayton, Illinois. Ranges are in parentheses.

Segment and habitat type	Number of samples	Mean depth (ft.)	Mean velocity (ft./s)	Most common dominant substrate	Most common co-dominant substrate
Pistakee Lake-Stratton					
Impounded	21	5.8 (4.7-6.9)	0.0 (0.0-0.0)	sand (silt-gravel)	sand (silt-cobble)
Stratton-Algonquin					
Impounded	51	6.4 (2.7-10.3)	0.6 (0.0-1.3)	sand (silt-gravel)	sand (silt-gravel)
Algonquin-Carpentersville					
Impounded	6	4.8 (1.6-7.9)	0.7 (0.0-1.2)	sand (sand-cobble)	sand (silt-gravel)
Natural pool	2	2.4 (1.5-3.3)	0.1 (0.0-0.2)	sand (sand-cobble)	gravel (gravel-gravel)
Transitional run	10	3.4 (1.7-7.0)	1.9 (0.4-2.7)	cobble (sand-cobble)	gravel (sand-gravel)
Riffle	5	0.8 (0.5-1.3)	1.9 (0.4-3.5)	cobble (gravel-cobble)	gravel (sand-gravel)
Carpentersville-Elgin					
Impounded	12	4.6 (1.8-7.4)	0.5 (0.0-0.8)	silt (silt-gravel)	silt (silt-sand)
Transitional run	6	2.7 (1.5-4.2)	1.6 (0.9-1.8)	sand (sand-gravel)	sand (sand-gravel)
Riffle	3	0.8 (0.6-1.0)	1.4 (1.2-1.5)	cobble (gravel-cobble)	gravel (sand-gravel)
Elgin-South Elgin					
Impounded	12	6.8 (2.6-10.2)	0.4 (0.1-0.8)	silt (silt-gravel)	silt (silt-gravel)
Transitional run	6	4.7 (3.5-6.3)	1.0 (0.1-1.4)	gravel (sand-cobble)	cobble (sand-cobble)
Riffle	3	0.8 (0.6-1.2)	1.0 (0.6-1.5)	cobble (gravel-boulder)	cobble (gravel-cobble)
South Elgin-St. Charles					
Impounded	12	6.0 (4.2-8.5)	0.4 (0.1-0.6)	sand (silt-bedrock)	sand (sand-bedrock)
Transitional run	17	1.9 (1.0-4.2)	1.7 (0.2-3.8)	gravel (gravel-cobble)	gravel (sand-cobble)
Riffle	10	1.1 (0.6-1.9)	1.9 (1.1-2.6)	cobble (cobble-cobble)	gravel (gravel-bedrock)
St. Charles-Geneva					
Impounded	6	5.4 (3.3-7.3)	0.5 (0.0-1.1)	sand (sand-bedrock)	silt (silt-bedrock)
Transitional run	9	2.3 (1.4-3.7)	1.5 (0.9-2.5)	bedrock (gravel-bedrock)	cobble (gravel-bedrock)
Riffle	3	1.2 (0.5-1.7)	1.0 (0.5-1.7)	boulder (cobble-boulder)	cobble (gravel-cobble)
Geneva-North Batavia					
Impounded	6	5.3 (4.0-8.5)	0.5 (0.2-0.9)	sand (silt-gravel)	silt (silt-gravel)
Transitional run	12	2.2 (1.5-3.0)	1.7 (0.4-3.8)	gravel (gravel-bedrock)	cobble (sand-bedrock)
Riffle	7	1.0 (0.6-1.2)	2.0 (0.5-3.1)	cobble (gravel-boulder)	cobble (sand-boulder)
North Batavia-South Batavia					
Impounded	3	3.3 (1.9-4.8)	0.7 (0.5-0.9)	gravel (gravel-gravel)	sand (sand-gravel)
Natural pool	1	4.5 (4.5-4.5)	0.4 (0.4-0.4)	sand (sand-sand)	silt (silt-silt)
Transitional run	10	3.4 (1.9-6.8)	2.0 (0.8-3.6)	gravel (gravel-boulder)	gravel (gravel-bedrock)
Riffle	3	0.7 (1.6-0.8)	1.6 (1.2-2.3)	cobble (gravel-boulder)	gravel (gravel-cobble)
South Batavia-North Aurora					
Impounded	6	3.9 (0.5-6.5)	0.4 (0.0-1.0)	silt (silt-gravel)	silt (silt-cobble)
Natural pool	2	2.2 (1.7-2.7)	0.4 (0.0-0.9)	gravel (gravel-gravel)	gravel (gravel-cobble)
Transitional run	7	2.3 (1.8-3.5)	1.8 (0.8-2.3)	gravel (gravel-boulder)	gravel (gravel-bedrock)
Riffle	6	0.8 (0.5-1.1)	2.5 (1.5-3.5)	cobble (gravel-bedrock)	cobble (gravel-cobble)
North Aurora-Stolp Island					
Impounded	3	4.8 (3.0-8.5)	0.3 (0.2-0.4)	sand (sand-gravel)	gravel (silt-cobble)
Transitional run	10	2.3 (1.0-3.4)	2.4 (1.2-4.4)	cobble (gravel-bedrock)	cobble (gravel-bedrock)
Riffle	3	0.7 (0.5-0.8)	1.9 (1.1-2.9)	cobble (cobble-cobble)	cobble (gravel-cobble)
Stolp Island-Hurds Island					
Impounded	3	3.2 (3.1-3.5)	1.2 (1.1-1.5)	gravel (gravel-gravel)	gravel (gravel-cobble)
Transitional run	3	2.7 (2.4-3.0)	1.2 (0.8-1.5)	gravel (gravel-cobble)	gravel (gravel-gravel)
Riffle	1	0.8 (0.8-0.8)	1.4 (1.4-1.4)	cobble (cobble-cobble)	cobble (cobble-cobble)

Table 25. Continued.

Segment and habitat type	Number of samples	Mean depth (ft.)	Mean velocity (ft./s)	Most common dominant substrate	Most common co-dominant substrate
Hurds Island-Montgomery					
Impounded	3	5.5 (3.1-7.0)	0.6 (0.1-1.0)	gravel (silt-cobble)	gravel (silt-gravel)
Transitional run	5	2.7 (2.0-3.0)	2.6 (1.6-4.1)	cobble (cobble-cobble)	gravel (gravel-boulder)
Riffle	3	0.9 (0.7-1.3)	2.0 (1.7-2.6)	boulder (cobble-boulder)	cobble (gravel-boulder)
Montgomery-Yorkville					
Impounded	3	5.2 (4.7-5.8)	0.4 (0.2-0.6)	sand (sand-sand)	sand (silt-sand)
Transitional run	10	2.5 (1.0-5.9)	1.5 (0.6-2.5)	cobble (sand-cobble)	gravel (sand-cobble)
Riffle	3	0.9 (0.5-1.7)	1.3 (0.7-2.0)	gravel (gravel-boulder)	gravel (gravel-cobble)
Yorkville-Dayton					
Impounded	15	4.3 (1.0-6.8)	0.6 (0.0-1.1)	sand (sand-sand)	sand (silt-cobble)
Natural pool	20	4.4 (2.1-7.3)	0.7 (0.0-1.2)	sand (sand-bedrock)	sand (sand-bedrock)
Transitional run	78	2.6 (0.9-6.2)	1.7 (0.1-4.0)	cobble (sand-bedrock)	gravel (sand-boulder)
Riffle	23	0.8 (0.5-1.7)	1.5 (0.6-2.7)	cobble (gravel-boulder)	cobble (gravel-boulder)
All segments					
Impounded	165	5.6 (0.5-10.3)	0.5 (0.0-1.5)	sand (silt-bedrock)	sand (silt-bedrock)
Natural pool	25	3.8 (1.5-7.3)	0.5 (0.0-1.2)	sand (sand-bedrock)	sand (silt-bedrock)
Transitional run	207	2.6 (0.5-7.0)	1.7 (0.1-4.4)	gravel (sand-bedrock)	gravel (sand-bedrock)
Riffle	75	0.9 (0.9-1.9)	1.7 (0.4-3.5)	cobble (gravel-boulder)	gravel (sand-bedrock)

Accumulated Sediments

Sediment depths were recorded at 544 probe locations in impounded habitat upstream of 12 Fox River dams (Table E1). Estimates of sediment volume within sampled areas ranged from 416 yds.^{3} in the west channel above Montgomery Dam to about 239,000 yds.^{3} above the Elgin Dam (Table 26). Accumulations of sediment were low upstream of Algonquin, South Elgin, Geneva, and South Batavia dams, high above Elgin and Dayton dams, and intermediate in other impoundments. Although the amount of sediment per area sampled was highest at Dayton, sediment volume may have been underestimated at this location because the dam is about 30 ft. high and water depths immediately upstream of the spillway were <8 ft. deep. Overall, the largest sediment deposits tended to occur downstream of islands and along impoundment margins (see sediment distribution maps in individual dam summaries in Part B of this report). Main channel portions of several impoundments remained relatively free of accumulated sediments.

Grain size analysis was conducted on 38 core and 36 ponar samples from impounded areas upstream of 12 dams and 4 core and 11 ponar samples from free-flowing areas downstream of three dams (Table E2). Medium and fine sand (<0.5 mm) made up between 60% and 65% of core and ponar samples by weight and was the predominant particle size in impoundment sediment deposits (Table 27). Impoundment sediments also consisted of coarse sands (20%), gravels (11 %), and silts (4-7%). Sediment particle size distributions were similar for core and ponar samples in impounded areas and core samples from free-flowing areas. In contrast, ponar samples from free-flowing areas contained higher amounts of gravels and coarse sands (46%) and lower amounts of fine sands and silt (28%; Table 27). Course surface substrate at free-

Table 26. Volume of bulk sediments accumulated upstream of 12 Fox River dams. Sediment depths were determined by probing at 36 to 60 locations within about 1000 yds. of each dam. Sediment volume estimates were made with GIS interpolation software (ESRI, Arcview 3.x). Sediment distribution maps for each dam are presented in Part B of this report.

Dam	Number of probes	Sample area ($ft.^2$)	Mean depth (ft.)	Sediment volume ($yds.^3$)
Algonquin Dam	37	408,371	1.09	16,514
Carpentersville Dam	42	760,083	2.28	64,144
Elgin Dam	40	2,091,302	3.08	238,745
South Elgin Dam	44	764,186	0.78	22,100
St. Charles Dam	47	1,067,096	1.52	59,957
Geneva Dam	45	391,776	0.88	12,735
North Batavia Dam	38	909,906	2.56	86,208
With Depot Pond	60	1,258,848	2.30	107,076
South Batavia Dam	54	604,249	1.16	25,992
North Aurora Dam	46	686,622	2.18	55,316
Montgomery Dam (west)	21	285,599	0.04	416
Montgomery Dam (east)	15	98,414	3.05	11,133
Yorkville Dam	45	494,000	2.00	43,700
Dayton Dam	48	837,000	3.00	104,600

flowing stations reflects erosion of finer materials by the higher current velocities that typically occur at these locations.

Sediment contaminant analysis included 8,854 individual analyses of 80 contaminants in 42 cores and 68 ponar samples (174 ponar grabs) from 12 above-dam and 10 below-dam stations. Concentrations were low for many measured substances and in 65% of analyses constituents were undetected in the sample. Metals were the most routinely detected contaminant group whereas pesticides, polycyclic aromatic hydrocarbons (PAHs), and alkylphenols (endocrine disruptors) had low rates of detection (Table E3). PCBs were undetected in all samples suggesting low levels in sediments. Nutrient concentrations in impoundment sediments generally ranged from low to moderate levels. Sediment Kjeldahl nitrogen was considered low at <870 mg/kg and moderate at <4,790 mg/kg. Sediment phosphorus was considered low at <299 mg/kg and moderate at <2,160 mg/kg. Only 6% of samples from impoundments and 6% of samples from free-flowing stations had phosphorus and organic nitrogen concentrations above the upper guidelines.

Comparing contaminant concentrations in sediment samples to sediment quality guidelines for 26 substances, we found that overall sediment pollution was low in the Fox River. Measured concentrations were below threshold effect concentration (TEC) guidelines for 76-92% of

Table 27. Mean grain size characteristics (percent by weight) and specific gravity (g/m3) of core and ponar sediment samples from 12 stations in impounded habitat and three stations in free-flowing habitat of the Fox River between Algonquin and Dayton, Illinois. U.S. Standard Sieve numbers are in parentheses.

	Core grain size (mean percent by weight)					Core	Ponar grain size (mean percent by weight)					Ponar
Habitat and station	Coarse gravel (4)	Coarse to fine gravel (10)	Coarse to medium sand (35)	Medium to fine sand (200)	Silt and clay (tray)	specific gravity (mean g/cm3)	Coarse to fine gravel (4)	Coarse to medium sand (10)	Medium to fine sand (35)	Medium to fine sand (200)	Silt and clay (tray)	specific gravity (mean g/cm3)
Impounded												
Algonquin above dam	2.5	9.9	19.7	61.1	6.8	2.3	9.3	13.8	22.2	51.1	3.6	2.4
Carpentersville above dam	2.0	2.5	8.8	79.8	6.8	2.4	1.9	4.8	23.6	69.4	0.4	2.6
Elgin above dam	1.4	6.3	18.0	58.7	15.6	2.3	1.9	5.1	12.1	71.3	9.5	2.3
South Elgin above dam	2.7	4.9	20.9	69.4	2.1	2.4	3.0	7.4	20.8	64.2	4.6	2.2
St. Charles above dam	5.3	6.5	18.1	63.2	6.9	2.2	0.0	6.2	24.9	63.3	5.6	2.1
Geneva above dam	1.7	5.0	17.9	68.9	6.5	2.2	1.9	2.9	15.8	77.3	2.1	2.5
North Batavia above dam	0.8	2.9	19.4	69.8	7.2	2.2	1.3	4.7	13.2	77.0	3.7	2.2
South Batavia above dam	7.1	9.2	18.1	57.4	8.3	2.1	14.8	10.9	15.2	56.6	2.4	2.4
North Aurora above dam	1.0	12.1	27.4	49.8	9.6	2.1	1.2	5.6	16.5	71.1	5.6	2.2
Montgomery above dam	2.6	10.4	31.1	50.4	5.5	2.0	6.1	15.5	35.3	37.8	5.3	2.0
Yorkville above dam	1.5	12.4	27.5	53.0	5.5	2.0	3.6	4.7	20.7	69.7	1.3	2.4
Dayton above dam	9.3	9.4	17.0	61.1	3.2	2.3	0.8	2.6	36.9	59.1	0.6	2.6
All impounded areas	3.2	7.6	20.3	61.9	7.0	2.2	3.8	7.0	21.4	64.0	3.7	2.3
Free-flowing												
Algonquin below dam	1.1	1.7	7.2	89.4	0.5	2.6	25.8	21.0	24.5	28.3	0.4	2.6
Carpentersville below dam	7.0	12.9	40.9	36.6	2.6	2.0	19.2	9.9	30.3	39.7	0.9	2.8
Elgin below dam	0.0	8.3	19.1	55.8	16.8	2.3	40.0	24.0	20.3	11.9	3.8	2.7
All free-flowing areas	2.7	7.7	22.4	60.6	6.6	2.3	28.3	18.3	25.0	26.6	1.7	2.7

analyses in core and ponar samples, indeterminate for 8-17% of analyses, and elevated for 0-9% (Table 28). Based on the distribution of samples among contaminant categories, sediment contaminant conditions were generally similar between bulk and surface sediments from impounded areas and between impounded and free-flowing surface sediments. Similar patterns also were observed for individual station contaminant concentrations (Table E4). Except for core samples in the Yorkville impoundment, analyses with an elevated rating typically had concentrations near the recommended probable effect concentration (PEC) guideline. Core samples above Yorkville Dam had concentrations of heavy metals (particularly cadmium, mercury, and lead) and the pesticides DDD and DDE that were more than double PEC guidelines. Elevated concentrations of these substances in all Yorkville core samples indicate that contamination may be widespread in accumulated sediments from this impoundment. However, all measured contaminants in surface sediments from the Yorkville impoundment were low.

We found little difference overall between bulk and surface sediments from impoundments (Table 29). Mean concentrations of 86% of measured substances, including all pesticides, PAH's, PCBs, and alkylphenols and most metals and nutrients were similar between impoundment core and ponar samples. Two constituents (i.e., magnesium and calcium) were higher in ponar samples and nine (i.e., eight metals and ammonia nitrogen) were higher in core samples. Like bulk and surface sediments in impoundments, most contaminants in surface sediments had similar concentrations in impounded and free-flowing portions of river (Table 30). Nearly 75% of measured substances were either similar between impoundments and free-flowing areas below dams (58%) or were higher in downstream free-flowing areas (16%). Twelve substances, including the pesticide DDE and 11 metals were higher in impounded areas. Mean concentrations of most contaminants in impoundment surface sediments were below PEC guidelines.

DISCUSSION

Our results suggest that low-head dams adversely affected the biotic integrity of the Fox River on local and landscape scales. Whereas landscape-level effects arise from fragmentation of the river basin and restricted movements of fish, local effects were largely related to the impoundments that formed upstream of each dam. Impoundments maintained degraded habitat and summer water quality conditions that limited their use by important macroinvertebrates and fishes. We found consistently lower abundance, taxa richness, and biotic integrity scores for fish and invertebrate assemblages in impoundments compared to the free-flowing river. Degraded habitat, water quality, and biotic communities were found throughout impoundments, not just in the most impacted areas immediately above dams. Conversely, good habitat quality, water quality, macroinvertebrate assemblages, and sport and non-game fish communities occurred throughout free-flowing reaches, not just in areas immediately below dams. Differences in fish and invertebrate assemblages may be expected between free-flowing and impounded river reaches (Ruhr 1956; Erman 1973; Baxter 1977; Kanehl et al. 1997; Stanley et al. 2002), but

Table 28. Number of core and ponar sediment samples with non-polluted, indeterminate, and elevated concentrations of contaminants for above and below dam locations in the Fox River between Algonquin and Dayton, Illinois. There were 38 core and 36 ponar samples collected in impounded areas above 12 dams and 4 core (Algonquin, Carpentersville, and Elgin dams only) and 32 ponar samples collected in free-flowing areas below 10 dams. Sample classification was based on consensus-based threshold effect concentrations (TEC) and probable effect concentrations (PEC) described by MacDonald et al. (2000).

	Core samples at above dam stations			Core samples at below dam stations			Ponar samples at above dam locations			Ponar samples at below dam locations		
Substance	Non-polluted (*N*<TEC)	Indeterminate (TEC<*N*<PEC)	Elevated (*N*>PEC)	Non-polluted (*N*<TEC)	Indeterminate (TEC>*N*<PEC)	Elevated (*N*>PEC)	Non-polluted (*N*<TEC)	Indeterminate (TEC>*N*<PEC)	Elevated (*N*>PEC)	Non-polluted (*N*<TEC)	Indeterminate (TEC>*N*<PEC)	Elevated (*N*>PEC)
Heavy metals												
Cadmium	14	13	11	1	3	0	16	17	3	28	4	0
Chromium	29	6	3	4	0	0	34	2	0	32	0	0
Copper	20	15	3	2	2	0	26	10	0	31	1	0
Lead	16	18	4	2	2	0	21	15	0	27	5	0
Mercury	25	11	2	2	2	0	25	10	1	31	1	0
Nickel	23	10	5	4	0	0	30	6	0	32	0	0
Zinc	19	16	3	3	1	0	24	12	0	31	1	0
Pesticides											0	0
alpha-Chlordane	36	1	0	4	0	0	37	0	0	32	0	0
Dieldrin	35	2	0	4	0	0	35	2	0	32	0	0
Endrin	34	4	0	4	0	0	34	3	0	31	1	0
Heptachlor Epoxide	33	1	3	1	3	0	35	1	1	31	1	0
Lindane	35	2	0	4	0	0	37	0	0	32	0	0
p,p'-DDD	19	10	9	4	0	0	21	12	3	21	11	0
p,p'-DDE	18	12	8	2	2	0	17	18	1	25	7	0
p,p'-DDT	32	4	1	4	0	0	34	2	1	26	6	0
PAH's												
Anthracene	36	0	2	4	0	0	33	2	1	32	0	0
Benzo[a]anthracene	33	0	5	4	0	0	28	3	5	27	4	1
Benzo[a]pyrene	32	2	4	4	0	0	24	7	5	27	4	1
Chrysene	32	1	5	4	0	0	24	7	5	26	5	1
Dibenz[a,h]anthracene	37	1	0	4	0	0	36	0	0	32	0	0
Fluoranthene	27	6	5	3	1	0	22	6	8	19	10	3
Fluorene	37	1	0	4	0	0	36	0	0	32	0	0
Naphthalene	38	0	0	4	0	0	36	0	0	32	0	0
Phenanthrene	31	2	5	4	0	0	22	6	8	24	2	6
Pyrene	26	6	6	3	1	0	20	8	8	23	4	5
PCB's	29	0	0	1	0	0	27	0	0	26	0	0
Percent of analyses	76.6	14.8	8.6	83.1	16.9	0.0	78.7	16.0	5.4	89.8	8.1	2.1

Table 29. Sample size, mean concentrations (±1 standard error) of sediment contaminants and nutrients, and results of randomized complete-block ANOVA (blocked by dam) comparing core and ponar samples from impounded areas above 12 Fox River dams between Algonquin and Dayton, Illinois. $P \leq 0.05$ indicates significance.

Substance	*N*	Mean concentration in core samples	Mean concentration in ponar samples	*P*
Heavy metals (mg/kg)				
Aluminum	12	8589.6±552.6	4926.7±519.3	0.002
Barium	12	133.2±15.9	91.6±11.7	0.04
Beryllium	12	0.5±0.01	0.3±0.03	0.01
Boron	12	8.5±0.7	7.7±0.5	0.38
Cadmium	12	5.8±2.0	2.0±0.6	0.08
Calcium	12	65638.9±4856.1	78437.5±5396.6	0.005
Chromium	12	37.1±10.3	16.7±2.6	0.06
Cobalt	12	5.8±0.2	4.5±0.4	0.02
Copper	12	48.0±13.4	24.5±4.0	0.08
Iron	12	26601.4±6484.7	12320.8±1156.5	0.06
Lead	12	62.2±14.2	34.2±5.2	0.06
Lithium	12	9.5±0.5	6.6±0.7	0.004
Magnesium	12	19293.1±677.0	23090.3±1663.8	0.03
Manganese	12	434.2±27.1	352.8±28.6	0.08
Mercury	12	1.2±0.3	1.0±0.3	0.42
Molybdenum	12	7.0±0.0	7.0±0.0	0.99
Nickel	12	26.6±4.7	16.2±2.7	0.04
Potassium	12	932.4±51.1	655.9±58.2	0.006
Silver	12	1.1±0.4	0.5±0.1	0.23
Sodium	12	265.0±13.3	290.2±17.2	0.11
Tin	12	30.0±0.0	30.0±0.0	0.99
Titanium	12	86.7±3.6	78.9±5.0	0.14
Vanadium	12	18.0±0.8	11.2±1.0	0.001
Zinc	12	151.4±31.1	101.0±13.0	0.12
Pesticides (μg/kg)				
Aldrin	12	11.1±3.7	9.0±2.4	0.59
alpha-BHC	12	14.1±8.1	8.2±3.0	0.35
alpha-Chlordane	12	5.9±2.4	2.4±0.2	0.18
beta-BHC	12	3.2±0.5	3.8±0.9	0.56
delta-BHC	12	3.2±0.5	2.6±0.3	0.31
Dieldrin	12	14.6±4.8	14.1±4.5	0.72
Endosulfan I	12	12.3±3.7	7.5±2.6	0.19
Endosulfan II	12	24.0±13.0	23.4±13.0	0.89
Endosulfan Sulfate	12	32.9±13.8	41.5±21.5	0.38
Endrin	12	15.0±4.8	15.6±5.1	0.53
Endrin Aldehyde	12	12.9±7.8	6.3±1.3	0.43
Endrin ketone	12	5.2±0.3	5.0±0.5	0.66
gamma-Chlordane	12	6.7±3.3	2.6±0.3	0.24
Hept Epoxide	12	9.5±3.7	4.2±1.4	0.17
Heptachlor	12	10.3±2.6	8.5±3.0	0.44
Lindane	12	7.6±2.6	8.2±3.0	0.45

Table 29. Continued.

Substance	*N*	Mean concentration in core samples	Mean concentration in ponar samples	*P*
Methoxychlor	12	73.5±24.0	71.0±23.8	0.62
p,p'-DDD	12	31.1±8.3	21.4±5.9	0.30
p,p'-DDE	12	17.7±6.1	9.1±1.4	0.19
p,p'-DDT	12	18.0±4.5	17.3±5.5	0.75
PAH's (µg/kg)				
2-Methylnaphthalene	12	1325.1±83.9	1414.5±131.7	0.45
Acenaphthene	12	1318.8±85.8	1414.5±131.7	0.43
Acenaphthylene	12	1325.1±83.9	1414.5±131.7	0.45
Anthracene	12	1309.0±89.6	1382.8±136.8	0.58
Benzo[a]anthracene	12	1387.1±86.4	1530.9±139.6	0.27
Benzo[a]pyrene	12	1393.1±94.3	1524.4±142.6	0.38
Benzo[b]fluoranthene	12	1439.7±115.2	1664.0±172.8	0.30
Benzo[g,h,I]perylene	12	1320.4±75.6	1383.4±131.5	0.54
Benzo[k]fluoranthene	12	1328.2±82.3	1400.9±126.6	0.48
bis(2-Ethylhexyl)phthalate	12	1924.2±124.1	2088.2±191.6	0.32
Butylbenzylphthalate	12	1326.0±83.6	1414.5±131.7	0.45
Carbazole	12	1356.8±82.5	1401.7±134.6	0.72
Chrysene	12	1402.2±99.8	1511.1±140.3	0.44
Dibenz[a,h]anthracene	12	1313.8±87.6	1414.5±131.7	0.42
Dibenzofuran	12	1325.1±83.9	1414.5±131.7	0.45
Diethylphthalate	12	2004.2±126.8	2113.2±196.4	0.54
Dimethylphthalate	12	2004.2±126.8	2113.2±196.4	0.54
Di-n-butylphthalate	12	1990.3±132.8	2113.2±196.4	0.48
Di-n-octylphthalate	12	2004.2±126.8	2100.7±197.6	0.59
Fluoranthene	12	1739.3±236.4	2312.0±335.6	0.22
Fluorene	12	1332.9±90.2	1414.5±131.7	0.52
Indeno[1,2,3-cd]pyrene	12	1340.3±78.0	1408.7±130.3	0.49
Naphthalene	12	1325.1±83.9	1414.5±131.7	0.45
Phenanthrene	12	1574.7±196.8	1653.1±165.1	0.76
Pyrene	12	1613.9±236.0	1845.5±239.7	0.53
PCB's (µg/kg)	9	0.13±0.11	0.10±0.04	0.68
Cyanide (mg/L)	12	1.01±0.22	1.01±0.27	0.98
Oil and grease (mg/kg)	12	2172.2±315.8	1838.1±194.5	0.33
Alkylphenols (µg/kg)				
Bisphenol A	12	67.6±5.9	71.7±8.6	0.52
Octylphenol	12	79.0±8.0	77.0±9.3	0.86
Total NP	12	363.1±29.2	344.3±41.3	0.65
Total NP1EO	12	652.0±57.2	687.7±82.5	0.56
Total NP2EO	12	1253.8±110.0	1324.2±159.0	0.55
Nutrients (mg/kg)				
Ammonia nitrogen	12	283.5±56.0	87.0±21.7	0.003
Kjeldahl nitrogen	12	2743.7±314.7	1861.6±371.9	0.06
Phosphorus	12	1160.3±148.3	966.8±144.2	0.33

Table 30. Sample size, mean concentrations (±1 standard error) of sediment contaminants, and results of randomized complete-block ANOVA (blocked by dam) comparing ponar samples from upstream impounded and downstream free -flowing areas above and below 10 Fox River dams between Algonquin and Dayton, Illinois. $P \leq 0.05$ indicates significance.

Substance	*N*	Mean concentration in above dam ponar samples	Mean concentration in below dam ponar samples	*P*
Heavy metals (mg/kg)				
Aluminum	10	5135.3±543.9	2861.2±201.4	0.002
Barium	10	97.9±12.1	62.8±8.3	0.03
Beryllium	10	0.3±0.02	0.2±0.02	0.03
Boron	10	8.0±0.4	11.2±0.9	0.004
Cadmium	10	2.2±0.6	1.6±0.2	0.28
Calcium	10	81458.3±5374.7	117316.7±7183.4	0.002
Chromium	10	18.1±2.8	8.0±0.8	0.002
Cobalt	10	4.8±0.4	2.3±0.1	0.001
Copper	10	26.8±4.2	12.0±3.0	0.003
Iron	10	12871.7±1197.1	9461.7±790.5	0.01
Lead	10	36.5±5.4	32.4±9.4	0.68
Lithium	10	6.6±0.6	5.7±0.3	0.18
Magnesium	10	23141.7±1861.5	48913.3±3315.5	0.001
Manganese	10	369.3±27.9	305.1±22.7	0.06
Mercury	10	1.1±0.32	0.1±0.03	0.02
Molybdenum	10	7.0±0.0	9.1±0.5	0.001
Nickel	10	17.7±2.9	6.0±0.5	0.002
Potassium	10	662.8±62.0	482.7±25.0	0.02
Silver	10	0.5±0.1	0.8±0.1	0.04
Sodium	10	302.9±14.0	330.9±19.0	0.32
Titanium	10	81.0±5.1	88.5±9.7	0.52
Vanadium	10	11.4±0.9	12.6±0.8	0.24
Zinc	10	109.0±13.4	62.9±7.9	0.004
Pesticides (µg/kg)				
Aldrin	10	7.4±1.3	5.9±1.0	0.28
alpha-BHC	10	6.6±2.7	6.3±1.5	0.93
alpha-Chlordane	10	2.5±0.3	4.7±0.9	0.04
beta-BHC	10	3.2±0.6	4.7±0.9	0.22
delta-BHC	10	2.8±0.4	4.7±0.9	0.06
Dieldrin	10	11.6±3.7	8.3±3.1	0.57
Endosulfan I	10	5.8±2.0	6.3±1.5	0.87
Endosulfan II	10	12.2±6.0	7.0±1.7	0.45
Endosulfan Sulfate	10	23.2±9.1	8.0±1.9	0.11
Endrin	10	13.4±4.8	8.3±3.1	0.46
Endrin Aldehyde	10	6.7±1.5	5.1±0.7	0.43
Endrin ketone	10	5.2±0.5	5.3±0.7	0.9
gamma-Chlordane	10	2.7±0.4	4.7±0.9	0.05
Hept Epoxide	10	4.6±1.7	4.8±0.8	0.91
Heptachlor	10	7.1±2.7	6.3±1.5	0.84
Lindane	10	6.6±2.7	6.3±1.5	0.93
Methoxychlor	10	58.2±20.7	25.8±16.7	0.28
p,p'-DDD	10	20.3±6.2	9.5±3.1	0.2
p,p'-DDE	10	9.9±1.6	4.0±0.7	0.003
p,p'-DDT	10	15.4±5.4	7.1±3.1	0.26
Cyanide (mg/L)	10	1.0±0.3	0.5±0.1	0.06
Oil and grease (mg/kg)	10	1829.0±234.9	1478.8±215.6	0.29

the magnitude and consistency of differences that we observed indicates that even low-head dams with relatively small impoundments can have profound detrimental effects on the biotic integrity of warm-water rivers.

Although little published literature is available on the ecological effects of impoundments formed by low-head dams, there is growing evidence that results from the Fox River are not unique. Habitat quality and IBI scores were substantially lower in an impoundment than in free-flowing sections of the Milwaukee River, Wisconsin (Kanehl et al. 1997). Habitat and biotic integrity improved, smallmouth bass numbers increased, and common carp numbers declined after the dam was removed and channel restoration was completed. Stanley et al. (2002) found degraded macroinvertebrate communities in impoundments of another Wisconsin river and documented improved assemblages after dam removal. Impoundments formed by low-head dams in other northeastern Illinois rivers also were shown to adversely effect aquatic habitat, fishes, and macroinvertebrates (Pescitelli and Rung 1998; R. Linke, unpublished data). Consistency among studies to date lends credibility to our results for the Fox River and indicates that adverse effects of low-head dams and impoundments may be common, at least for moderate-sized rivers in the Midwest. However, additional descriptive and manipulative research (e.g., dam removal studies) will be needed to further explain potential variation in the effects of these structures within and among river systems.

By impounding water and altering patterns of upstream flow, dams modify upstream habitats and elicit changes in the composition of aquatic biota (Hynes 1970; Baxter 1977). For example, the absence of benthic invertebrates adapted to erosional habitats (e.g., many Ephemeroptera and Trichoptera and some Diptera and Coleoptera taxa) and the predominance of tolerant taxa adapted to depositional habitats (e.g., oligochaetes and chironomids) in Fox River impoundments appears to be a typical response of these organisms to impoundment in temperate rivers (Sprules 1940; Nursall 1952; Paterson and Fernando 1969; Stanley et al. 2002). Fish assemblages also are known to change with impoundment, but unlike in the Fox River, impoundment fisheries often consist of abundant lake-adapted species (e.g, bluegills, crappies, and largemouth bass) that frequently produce high fish yields and exceptional sport and commercial fishing (Ellis 1941; Baxter 1977). Although it is not known whether Fox River impoundments supported high quality fisheries in the past, their present degraded condition suggests that major habitat restoration (e.g., renovation back to free-flowing conditions) will be necessary if these areas are to support high quality fish assemblages and fishing in the future. Impoundments also are known to support large populations of facultative riverine species, such as gizzard shad, common carp, and freshwater drum that invade tributaries and upstream free-flowing reaches of rivers during spring and summer (Ellis 1941; Ruhr 1956; Rodriguez-Ruiz and Granado-Lorencio 1992). High catches of common carp and freshwater drum at many free-flowing and impoundment stations in the Fox River may reflect the abundance of impounded habitat created by dams.

Habitat quality was an important variable explaining differences between free-flowing and impoundment faunal assemblages. We found abundant and diverse macroinvertebrate, non-game, and sport fish communities in the free-flowing river where habitat quality was high and lower numbers of predominantly tolerant taxa in impoundments where habitat quality was low. Differences in habitat quality between areas reflected differences in habitat diversity. Free-flowing areas were made up of a variety of physical features (i.e., rifles, runs, and natural pools) that provided a wide array of water depths, current velocities, substrate types, and cover characteristics. In contrast, impoundment habitat was more homogeneous and typically consisted of extensive deeper open-water areas, low and uniform current velocity, and a substrate dominated by deposited fine silts and sands. Habitat heterogeneity is important to the conservation of aquatic biodiversity in rivers and streams because abundance and distribution of stream fishes (Rabeni and Jacobson 1993) and benthic invertebrates (Rabeni and Minshall 1977; Reice 1980) are strongly affected by individual or combinations of microhabitat variables. By creating impoundments with limited habitat heterogeneity, Fox River dams restricted the distributions of many fish and invertebrate taxa to free-flowing areas during the important summer and fall growing season. By impounding nearly half of the river's length in Illinois, dams were the foremost cause of habitat degradation in the river and likely influenced the abundance and diversity of aquatic biota.

Nutrient loading and impoundments played important roles in the development of degraded water quality conditions during summer and fall low flow periods. The increase in nutrient levels with downstream flow through human population centers suggests municipal wastewater was a primary source of nutrients to the system, although contributions from other sources undoubtedly occurred (e.g., fertile native bed material, agricultural fertilizers, and non-point urban runoff). High nutrient levels caused the entire river below Elgin, Illinois to be ranked among the most enriched rivers in the Midwest (Robertson et al. 2001) and impoundments in this reach to be rated hypereutrophic (based on lake standards; Wetzel 1983). Impoundments may influence water quality directly by reducing a river's natural aeration and waste assimilation capacity (Singh et al. 1995) or indirectly by providing slack water areas ideal for the development of phytoplankton (Talling and Rzoska 1967) and accumulation of organic detritus (Singh et al. 1995). Abundant phosphorus, nitrogen, and organic carbon in the Fox River combined with extensive impoundment to produce heavy algal blooms throughout the summer and fall. These abundant algal populations contributed to low water clarity throughout the river. In addition, the daily cycle of photosynthesis and respiration by abundant algae produced extreme fluctuations in dissolved oxygen and pH that resulted in violations of ambient water quality standards in impoundments and patterns in water chemistry similar to those reported for a shallow hypereutrophic lake (Martin and Saiki 1999; Meyer and Hansen 2002).

The effect of algae on water quality variables was influenced by river discharge rates and the hydraulic conditions found in impoundment and free-flowing habitats. The work of others has shown that impoundments enhance phytoplankton development in rivers (Talling and Rzoska 1967; Imhoff and Albrecht 1982) and that algal abundance is positively related to nutrient levels (i.e., total phosphorus or total nitrogen) in aquatic systems (Soballe and Kimmel 1987). Typically, algal abundance per unit of phosphorus or nitrogen is higher in lakes and impoundments than in rivers (Soballe and Kimmel 1987) and higher in larger rivers than smaller ones (Van Nieuwenhuyse and Jones 1996). Differences among systems are thought to be due to differences in hydraulic flushing rates, where increased residence time reduces algal washout and allows more time for growth in suspension (Talling and Rzoska 1967; Soballe and Kimmel 1987; Lohman and Jones 1999). Increased flow rates had a moderating effect on dissolved oxygen and pH in Fox River impoundments, which probably reflects increased washout and decreased abundance of algae. However, during low flow periods, we found similar chlorophyll concentrations between impoundments and the free-flowing river, but substantial differences between these habitats in the magnitude of daily oxygen cycles. Abundant chlorophyll in natural flowing reaches probably resulted from continual seeding by numerous and widespread impoundments. Lower extremes in dissolved oxygen and pH in free-flowing waters where chlorophyll concentrations were high indicates that natural flow conditions may limit the effects of algal photosynthesis and respiration on water quality (perhaps through increased velocity and mixing) without a substantial reduction in algal abundance.

Like habitat, water quality probably was an important variable influencing abundance and structure of fish and macroinvertebrate assemblages. Extreme fluctuations in dissolved oxygen and pH could have reduced the suitability of impoundments to intolerant taxa, which were usually found in upstream free-flowing areas that offered improved water chemistry. High MBI scores for many impoundments also suggest that poor water quality was a factor affecting invertebrate assemblages in these areas because the MBI is largely a measure of pollution tolerance of invertebrates (Hilsenhoff 1987; Bertrand et al. 1996). These comparisons are based on the assumption that water quality patterns in 2000 (when we sampled habitat and biota) were similar to patterns that we measured in 2001. This assumption seems likely given that nutrient, algae, and water quality conditions similar to those in this study have been reported for the Fox River in recent years (Singh et al. 1995) and low flows necessary for the development of poor water quality occurred during summer and fall in both years (USGS 2001, 2002). In addition, fish and macroinvertebrates from a subset of 10 stations sampled during summer 2001 (V. Santucci, unpublished data) showed patterns in assemblage structure among free-flowing and impounded habitats that were similar to patterns observed in the previous year. Whereas water quality may have influenced aquatic community composition, the absence of improved fish and invertebrate assemblages in impoundments with less severe fluctuations in dissolved oxygen and pH may suggest that habitat was more important than water quality in structuring local distributions. Similarly, habitat quality as determined by QHEI was found to be more important than nutrient concentrations (and associated degraded water quality) in explaining variation in fish and invertebrate biotic integrity among Ohio streams (Miltner and Rankin 1998).

Although dissolved oxygen and pH exceeded water quality standards in impoundments, we found no evidence that these conditions had direct lethal effects on fish or macroinvertebrates. Individual water quality variables may not have exceeded the lethal threshold for individual taxa or sensitive biota may have simply avoided areas with poor water quality. The sub-lethal effect of degraded water quality on tolerant species in impoundments was evident from the higher incidence of lesions and eroded fins for fish in these areas. Chronic exposure to toxicants also may cause sub-lethal responses in fish (Rand et. al. 1995), but undetectable or low levels of contaminants in Fox River surface sediments indicates that sediment contaminant exposure generally was low in the river. Polluted waters also may have indirect effects on fishes and invertebrates. For example, by influencing the abundance of benthic or suspended algae, nutrient enrichment may influence predator-prey interactions by increasing structural complexity of the environment (Power 1990) or decreasing water clarity (Minor and Stein 1996). The epizootic die off of channel catfish in the Fox River during summer 2000 may be another example of an indirect effect of water quality. In this case, physiological stress from chronic exposure to individual or combinations of water quality variables may reduce immune system response and increase susceptibility to lethal bacterial or viral infection (Wedemeyer et al. 1990). Other factors such as high population density or insufficient food availability may have contributed to the catfish die off, but the timing of peak losses during summer when flows were low and water conditions poor suggests water quality influenced the event to some degree.

Local effects of dams on habitat, water quality, and aquatic biota were remarkably similar throughout the river. Current dam theory suggests that response among abiotic and biotic parameters will vary with dam size and function (storage vs. run-of-river dams; Poff and Hart 2002) and location within a river system (e.g., low-order headwaters vs. high-order alluvial river; Ward and Stanford 1983). Our results were consistent with this theory to the extent that all of the dams examined were similar in function and size (i.e., small run-of-river structures with surface spillways and relatively small impoundment areas), and each was located within a 6^{th}-order stream. We might have observed greater response variation had we included tributary dams in our analysis (Ward and Stanford 1983), but those comparisons were beyond the scope of this study.

It has been suggested that environmental variables may respond differently when multiple impoundments occur in a river (Ward and Stanford 1983). Because river transport is largely unidirectional, effects of impoundment might be expected to increase with downstream flow past consecutive dams. Multiple dams have transformed much of the Fox River into a series of alternating lotic (riverine) and lentic (lake-like) reaches. However, we found little variation in effects among impoundments and no evidence that local effects were cumulative. When variation did occur it appeared to be related more to site-specific channel and flow characteristics than location within the series of impoundments. For example, quantities of deposited silts and sands varied considerably among impoundments, but larger sediment accumulations typically occurred at locations with higher dams, wider channels, and flatter bed slopes. Low accumulations of sediment throughout some impoundments, and in main channel and upstream areas of others, indicated that the river has sufficient hydraulic power at peak flows to transport much of the fine sediments through the system despite the high number of dams. In another case, we found considerable differences in IBI values between above- and below-dam stations at all sites except Stratton Dam. Fish assemblages may have been more similar upstream and downstream of Stratton Dam because it was the only dam in the flat northern reach of the study area (average slope of 0.3 ft./mi. vs. >2.0 ft./mi. at other dam locations) and the only one with generally similar habitat and water quality conditions at above- and below-dam stations. The lack of cumulative results suggests that small dams and impoundments may influence rivers more as localized perturbations than cumulative disruptors of downstream transport processes, even when dams are relatively numerous and closely-spaced.

Large dams and impoundments can have significant effects on the flow regime, geomorphology, and ecology of downstream reaches of rivers (Ward and Stanford 1979a; Ligon et al. 1995; Poff et al. 1997). Suppression of hydrologic cycles may influence downstream food webs (Wootten et al. 1996) and riparian vegetation (Stevens et al. 1995); altered temperature regimes from hypolimnetic releases (or surface spillways in cold water streams; Fraley 1979) may change the composition of fish and invertebrate communities (Spence and Hynes 1971a, 1971b; Ward and Stanford 1979b); and disruption of sediment transport processes may lead to downstream channel incision, channel simplification, and reduced floodplain inundation (Ligon et al. 1995; Poff et al. 1997). Furthermore, changes in temperature and transported organic matter below large dams may reset environmental variables and invertebrate communities to conditions found in upstream reaches or headwaters (Hauer and Stanford 1982; Soballe and Bachmann 1984). In contrast, the relatively small dams and impoundments that we examined appeared to have little effect on overall flow and sediment regimes in the river and, therefore, no noticeable downstream effect on channel form and riparian vegetation. However, Fox River dams and impoundments influenced downstream reaches in other ways. The proportion of fish with DELT anomalies appeared to increase and the quality of invertebrate assemblages decrease immediately below dams compared to free-flowing reaches farther down stream. Surface spillways influenced water quality by moderating extremes in dissolved oxygen and pH that developed in impoundments during low-flow periods. Algae and other suspended matter released from impoundments increased turbidity in downstream reaches and provided an abundant source of organic matter that supported high densities of filter-feeding invertebrates. The caddis flies *Cheumatopsyche* and *Hydropsyche* were the most abundant taxa at below-dam stations. These genera are known to tolerate a wide range of environmental conditions, including nutrient enrichment (Gordon and Wallace 1975), and commonly occur in abundance below impoundments (Spence and Hynes 1971a; Parker and Voshell 1983; Fraley 1979). Although less damaging than their larger counterparts, low-head dams and impoundments nevertheless influenced many important aspects of the downstream environment.

Low-head dams had important adverse effects on Fox River environments and biota at local and landscape scales. Landscape effects were more than the combined effect of multiple dams and impoundments, although combined effects were important (e.g., extensive losses of free-flowing habitat and increased algal production reducing water clarity). When viewed as a landscape, the river is seen as a spatially continuous longitudinal and lateral mosaic of habitats (Fausch et al. 2002). Just as important as the river itself are the tributaries, floodplain wetlands, backwaters, natural lakes, riparian zones, and terrestrial uplands within the watershed. Stream fishes move among spatially separated aquatic habitats to complete critical phases of their life histories (Schlosser 1991; Schlosser and Angermeier 1995). For example, fish may move among a mosaic of feeding habitats in the river mainstem that have favorable growth conditions to spawning habitat in tributaries where conditions are favorable to egg incubation and juvenile development. Also essential to long-term survival are movements to habitats providing refuge from harsh environmental conditions (e.g., extreme temperatures, flows, or water quality) or those that enhance colonization (Northcote 1978). Dams imperil fishes and invertebrates and affect regional biodiversity by blocking movements and fragmenting the river landscape (Pringle et al. 2000).

There is extensive evidence of the need for deliberate movements in a wide array of fishes (reviewed in Fausch et al. 2002) and recent studies suggest directional movement is commonplace, even among species previously thought to be non-migratory. Numerous fish (35,000 to100,000 annually) of all life stages and nearly every species were recorded past hydropower stations in the Danube River, Europe (Schmutz and Jungwirth 1999). Similarly, Bunt et al. (2001) reported that Denil fishways passed nearly 12,000 fish and 29 species (including many found in the Fox River) over a small dam in Canada in a 2-year period. We recorded 76 individuals and 10 species past the canoe chute at Stolp Island Dam in just two days of monitoring and over 700 individuals from 15 species attempting to use the non-functional fishway at Stratton Dam (Appendix G). Just as evidence has grown supporting the need for habitat connectivity and fish movement in river landscapes so has our understanding of the detrimental effects of dams on aquatic biota. The most notorious example today is the high number of Pacific coast salmonid stocks that are at risk of extinction due in large part to dams and associated hydrologic alterations (Nehlsen et al. 1991). However, the extirpation of hundreds of species of obligate riverine fishes (e.g., salmonids, shads, sturgeons, American eel, suckers, lakesuckers, minnows, darters, and madtom catfishes) and invertebrates (e.g., freshwater mussels, shrimps, and snails) by large dams has occurred in rivers throughout temperate and tropical regions of the Western Hemisphere (see individual species accounts in Pringle et al. 2000).

Dams imperil fish and invertebrates and effect local biodiversity by blocking migration routes, isolating populations both physically and genetically (Jager et al. 2001), blocking access to refugia and habitats necessary for the completion of life history processes, and preventing recolonization of areas where species have been extirpated (Winston et al. 1991). Historical Fox River fisheries data (1980-2000) indicate dams caused, or currently maintain, restricted distributions for nearly one third of fish species known from the basin. Migration routes have been blocked for species, such as American eel, buffalo fishes, redhorse suckers, carpsuckers, and skipjack herring. A number of species (e.g., black redhorse, river redhorse, river carpsucker, and highfin carpsucker) have isolated populations at the most upstream reaches of their distributions, whereas others (e.g., rock bass, suckermouth minnow, shorthead redhorse, and redfin shiner) may be isolated in all practicality due to the long distance and numerous dams occurring between upstream and downstream populations. To a degree, the Dayton Dam has isolated all fish populations in the Fox River watershed by preventing the influx of new genetic material from outside sources (e.g., other Upper Illinois River Watershed streams). The temporal and geographic scale at which genetic isolation by dams becomes detrimental to fish populations (i.e, through inbreeding depression) currently is not known, but theoretical modeling of white sturgeon populations suggests increased fragmentation by dams will substantially reduce the likelihood of persistence and erode genetic diversity within and among surviving populations (Jager et al. 2001).

The absence or limited occurrence of several fish species from the middle Fox River between St. Charles and Montgomery may be a response to isolation of important habitats by dams. For example, northern pike and grass pickerel spawn in wetland vegetation, which was found only in tributary basins and along the mainstem, backwaters, and connected lakes of the northern portions of the study area. The absence of these vegetation spawners from the middle river may reflect the absence of streamside wetlands and inaccessibility of tributary wetlands in this region (only one major tributary, Mill Creek, and it is dammed near the mouth). Limited connectivity among river segments and between mainstem and tributary habitats also may have restricted distributions of other species in the middle river, such as orangethroat darters and striped shiners that typically inhabit smaller streams or blackside darters and shorthead redhorse that use tributaries for spawning. The persistence of species, such as river redhorse, silver redhorse, northern hog sucker, and smallmouth bass in the middle reach indicates that habitat and water quality conditions presently are sufficient in this urban area to support intolerant species of fish. However, dams are preventing utilization of the reach by other intolerant fishes from downstream river segments (e.g., black redhorse, highfin carpsucker, rock bass, and speckled chub). By blocking fish movements, dams limit access to additional habitat that may allow for population growth and range expansion within the watershed.

Dams or other disturbances (i.e., pollution or habitat degradation) in downstream reaches of rivers may have negative consequences upstream because upstream biota may intercept them when moving downstream (Pringle 1997). For example, the Stratton Dam may influence the number of muskellunge or walleye in the Chain-of-Lakes because fish moving downstream over the dam during high water or spring spawning runs are prevented from swimming back upstream into the lakes. Likewise, dams in downstream reaches may prevent recolonization of upstream reaches where populations have been extirpated. A recent basin-wide survey conducted by the IDNR indicates that freshwater mussels have been extirpated from many portions of the Fox River where they once were abundant and diverse (B. Schanzle, IDNR, personal communication). The specific causes of the loss of mussels from the river are not known, but loss of free-flowing habitat due to extensive impoundment (Bates 1962; Harman 1974) and poor water quality (Aldridge et al. 1987) prior to the Clean Water Act are possible factors. Regardless of the causes, mussels do not appear to be recolonizing areas where they might survive today. Dams may be a factor influencing recolonization by unionids because these invertebrates generally rely on fish hosts to disperse parasitic larvae (i.e., glochidia) and expand population ranges (Watters 1992). By restricting movement of fish hosts, dams and impoundments cause a loss of connectivity between viable populations and potential recolonization habitats and, in turn, may be restricting mussel distribution and range expansion within the watershed. Similarly, dams as small as 3 ft. high were found to restrict distributions of freshwater mussels in several Indiana and Ohio streams by presumably restricting movements of fish hosts (Watters 1996).

MANAGEMENT CONSIDERATIONS

Based on the widespread detrimental effects of dams and impoundments, we recommend reconnecting and restoring the river by removing or modifying all mainstem and tributary dams. Benefits of a reconnected and restored river may include: enhanced habitat and water quality and corresponding improvements to fish and macroinvertebrate communities, improved access by Fox River and Illinois River fish to important spawning and nursery habitats in tributaries and stream-side wetlands, repopulation of areas where species of fish and mussels no longer exist, genetic mixing in fish and invertebrate populations isolated by dams, elimination of barriers to canoeists and kayakers, and improved recreational fishing opportunities provided by enhanced sport fish populations and seasonal migrations of fishes, such as walleye, northern pike, muskellunge, sauger, white bass, skipjack herring, and large sucker species.

Options to reconnect the river include: removing dams completely, lowering dams and ramping the remaining structure, constructing traditional fishways (e.g., Denil fishways), and constructing more natural fish/canoe bypass channels. Dam removal is the best option when the ecological health of the river is of prime consideration because removing dams will eliminate barriers to migration for all types and life stages of fish, restore high quality free-flowing habitat, and improve water quality. In addition, dam removal is relatively inexpensive compared to other options presented and it eliminates safety risks (i.e., drownings) and maintenance costs because the structure is gone (Born et al. 1998). Lowering and ramping dams provides for reconnection of the river by allowing fishes and paddle craft to pass upstream and downstream, but it does little to improve degraded water quality and habitat conditions. This option probably is not feasible at most mainstem dams due to their length (>250 ft.) and height (3-30 ft.), but may be suitable for small tributary dams when removal is not an acceptable option. Fishways and bypass channels will improve connectivity in the river by allowing many species and life stages of fish to navigate over or around dams, but these options will do nothing to improve habitat and water quality because the impoundment remains. Fishways and bypass channels also have associated operational costs and maintenance requirements and are relatively expensive to build (~$1,600/linear ft. for Denil fishways). For these reasons, fishways and bypass channels should be considered only when dam removal is ruled out as an option. An expanded discussion of these options and specific alternatives for individual dams are presented in Part B of this report.

Because dam removals typically result in significant changes to the river environment, the general public may look upon removal projects with apprehension, even after removal has been officially selected as the most appropriate alternative. Our experience at public meetings associated with this study and other projects is that citizen apprehension about dam removal is often driven by a lack of understanding of how the river will respond after a dam is eliminated. Below we address some frequently asked questions regarding dam removal in the Fox River.

- *Why are dams removed?*—Dams are removed or modified for many reasons. For many small, privately owned dams economic realities often tip the balance in favor of removal because it is often far less expensive than costs of repair or fishway construction (Born et al. 1998). The management decision to remove or modify publicly owned dams, like many of those in the Fox River, is more complex often involving numerous stakeholders and a variety of economic, political, social, and environmental issues. For each case, stakeholders must weigh advantages of a dam (e.g., power boating and other recreational benefits of the impoundment, hydropower generation, water storage, or historical significance) against disadvantages (e.g., high maintenance and repair costs, safety risks, loss of habitat, blocked fish migration, or degraded water quality) to come to an informed decision. This report documents adverse effects of dams on Fox River ecology and is intended to assist stakeholders in the decision making process.

- *Will the river dry up after the dam is gone?*—Dams store water, they do not affect flow rates. River flow, or the amount of water passing a given point in a measured amount of time, is largely dependent upon precipitation or groundwater discharge (i.e., artesian springs). After a dam is removed the shoreline of the impoundment will recede as the river establishes a new channel (Stanley et al. 2002), but flow will remain unchanged. A new channel in the area of a preexisting impoundment will be about the same width and depth as the free-flowing river below the dam and upstream of the impoundment. Most impoundments in the Fox River are relatively narrow because the dams are small run-of-river structures and the channel is constrained by bedrock and glacial deposits. The amount of dewatered area in these narrow impoundments will be small compared to impoundments on rivers with large floodplain areas.

- *Will removal of a dam increase flooding?*—With the possible exception of the storage of some spring runoff by Stratton Dam, dams on the Fox River provide no flood control. In fact, removing a dam will result in a lower water level in the area of the old impoundment during a flood. In order for a dam to have flood control value, it must be high (typically > 50 ft.) and have an impounded area that is routinely drawn down to allow for storage of incoming runoff during precipitation events. None of the lower 14 dams on the Fox River meet these criteria.

- *Will the impoundment be replaced by extensive mudflats?*—Fine sediments stored in impoundments will be exposed, particularly along the pond margin, when the water level drops after removal of a dam. In humid regions, these areas typically become vegetated by dense stands of natural vegetation within a matter of weeks (AR/FE/TU 1999). Exposed sediments also may be sloped when necessary to decrease erosion and planted with selected native plants to reduce infestation by aggressive exotic species, such as purple loosestrife and reed canary grass (Shafroth et al. 2002). Some sediments may be used to create islands in the new river channel to increase habitat diversity at the site. After restoration, the exposed pond bottom will become vegetated floodplain or overbank area. Lower portions of the overbank will be inundated periodically during flood events whereas upper portions may support upland plants (e.g., prairie grasses, forbs, and trees) and may be landscaped for public use depending on ownership of the adjacent lands.

- *What about the release of contaminants stored in impoundment sediments?*— Chemicals, such as heavy metals, PCB's, pesticides, herbicides, and PAH's may become bound to the clay particles (i.e., silts) that are deposited in impoundments. Contaminants do not typically bind with larger sand particles. Release of contaminated sediments by dam removal can spread contaminants and have potential deleterious effects to downstream environments (Shuman 1995). Our survey of sediments above and below Fox River dams indicated that sediment pollution generally was low in the river and did not vary between above and below dam locations. Likewise, others have reported low contamination levels in Fox River sediments (IEPA, unpublished data; Milone and McBroom, Inc. 2003; Patrick Engineering Inc. 2001). These results suggest release of some sediment from impoundments will not increase contamination of downstream reaches. Although our survey was extensive in that it sampled many locations throughout the study area, the number of samples at each impoundment was moderate (three cores and nine ponar grabs per impoundment). As a precaution, we recommend sampling additional locations in impoundments where dams are considered for removal to ensure that discrete areas of contamination do not exist. If elevated levels of contaminants are discovered, then sediments from contaminated areas should be dredged from the river and disposed of in an appropriate toxic waste facility before the dam is breached.

- *How will the release of sediments from impoundments effect downstream reaches?*—Managing the release of accumulated silts and sands from impoundments is an important challenge to dam removal (Shuman 1995). Typically, sediments in the portion of the impoundment where the new river channel forms (including some sloughing of adjacent areas) will be transported downstream after the dam is breached. Downstream transport of stored sediments may cause problems when the stream does not have enough hydraulic power to disperse the sediments (Simons and Simons 1991) or it may be beneficial by creating new surfaces for propagation of riparian plants in downstream channel margins (Shafroth et al. 2002). Stanley et al. (2002) reported minimal changes in channel form and no changes in macroinverterbrate assemblages downstream of dams following their removal on the Baraboo River, Wisconsin. Fine silts from the impoundment became part of the river's sediment load and were quickly mobilized out of the study area. Sands were deposited in a thin layer over several kilometers downstream of the dam and in a downstream impoundment. A flood 6 months after the dam breaching further mobilized deposited sands and shifted sediment composition in downstream reaches from sand to gravel dominance. Factors thought to contribute to this longitudinal diffusion of released sediments (vs. transport as a relatively distinct packet or wave) included a large channel size/sediment volume ratio and absence of discrete pool-riffle formation in the channel (Stanley et al 2002). Because the Fox River has generally similar channel and flow characteristics as the Baraboo River (e.g., large channel, absence of discrete pool-riffle formation, restricted floodplain, and moderate gradient and flows), patterns of sediment transport after dam removal may be similar between rivers. Even though we found that silt and sand deposits were absent from mid channel areas of many Fox River impoundments indicating mobilization during floods, it may be necessary to dredge and remove some deposited sands from mid channel areas of impoundments with excessive deposits. An alternative to dredging may be to breach the dam in stages and allow periodic high flow events to remove accumulated sediments over time.

- *Will the release of nutrients stored in impoundments adversely affect the river?* — Release of nutrients stored in sediments from Fox River impoundments should have little effect on nutrient dynamics in the river because, 1) concentrations of total phosphorus and total nitrogen transported by the river were extremely high, and 2) similar nutrient concentrations between impoundment and free-flowing stations indicated nutrient storage in impoundments was low relative to transported concentrations. Likewise, small reductions in nutrients (as low as 2%) have been reported for waters passing through small impoundments in other nutrient-rich rivers (Stanley and Doyle 2001).

- *Will the reduction of impoundment habitat from dam removal reduce denitrofication processes in the river?*—It has been theorized that small impoundments may increase the process of removing nitrogen from aquatic systems and returning it to the atmosphere (i.e., denitrofication) by creating anoxic conditions (through thermal stratification in summer) required for bacterial reduction of NO_3^- to gaseous N_2 or N_2O, and by supporting the development of marginal wetlands with anoxic soils (Stanley and Doyle 2001). Impoundments like those in the Fox River probably do not substantially enhance denitrofication because they do not become anoxic or provide for the development of wetlands and are relatively narrow and shallow. The presence of oxygen in the water column above sediments has been shown to greatly reduce the denitrofication process to near zero (Wetzel 1983).

- *Does dam removal contribute to anoxic conditions in the Gulf of Mexico by allowing more nutrients to flow downstream?*—The hypoxia zone in the Gulf of Mexico is thought to be due in large part to nitrogen loading from agricultural drainages in the Mississippi River Basin (Mitsch et al 2001). Our results suggest that removing dams will contribute little to nutrient levels in the Fox River, which appear to be driven by nutrient input from municipal wastewater treatment facilities. Even reducing nutrients in wastewater effluent to zero would have little effect on the hypoxia zone because municipal point sources make up only about 1% of the total nitrogen discharge to the Gulf of Mexico from the Mississippi Basin (Mitsch et al. 2001).

- *Are dams needed to oxygenate the river?*—Surface spilling dams and other sources of artificial aeration are sometime required to maintain adequate oxygen levels in rivers with excessive nutrient enrichment and little natural aeration capacity (Imhoff and Albrecht 1982). Adequate dissolved oxygen was maintained in free-flowing reaches of the Fox River during the day and night regardless of segment length whereas impoundments created conditions that produced substandard oxygen levels at night even in upstream areas away from the dam. Dams released oxygen to the atmosphere during the day and added it to the water at night and, thus, appeared only to moderate extremes in the daily oxygen cycle that developed in impoundments. Satisfactory oxygen levels in downstream reaches of free-flowing sections suggest that natural aeration is sufficient in the Fox River to maintain adequate dissolved oxygen without artificial aeration by dams. In fact, removing dams and restoring impoundments to free-flowing conditions may benefit the river by eliminating a source of water quality problems. Additional research or modeling of the river's energy budget may be necessary in the future because these findings may be modified by changes in oxygen demand that occur with increased enrichment or the elimination of many dams.

- *There is good fishing below dams. Are dams necessary for good fishing in the river?*—Fish may congregate below dams that block migration routes, but dams are not necessary for good fishing. Our data show that abundant and diverse sport fish communities occur throughout the free-flowing river and that quality riverine habitat (not dams) is necessary for good quality sport and non-game fish assemblages.

- *Should all dams be removed from the river?*—Removing all dams may be beneficial from an ecological point of view, but it is economically and socially impractical. In reality, dams probably will be considered for removal when they are determined to be unsafe, deteriorated beyond repair, and failed or when stakeholders determine that the ecological benefits of removing the dam outweigh the social and economic benefits of maintaining it. Ecological benefits of dam removal may vary among dams and river locations. Removal of the Stratton and Algonquin dams may provide less improvement to habitat and water quality than removal of downstream dams because these northern structures are located in a very low-gradient section of river. However, providing fishways at these dams would increase access by river fish to the Chain-Of-Lakes and low-order reaches of the Fox River in Wisconsin. Potential benefits to habitat and water quality may be highest for dams in the middle river where density of dams and impacts of impoundments are high. For example, removing the South and North Batavia dams will more than double the amount of quality free-flowing habitat available to the population of state threatened river redhorse isolated between the North Aurora and South Batavia dams. Removal of the Dayton Dam may provide the most benefit of any dam removal because it would restore 4 mi. of impoundment to free-flowing river, reconnect the entire lower Fox River (including 31 mi. of river and 5 major tributaries) to the Illinois River, allow for seasonal runs of sport and other fishes from the Illinois and lower Fox rivers at least up to the dam in Yorkville, and restore 1.25 mi. of boulder rapid (Alexander and McCurdy 1915) now inundated by the impoundment and deposited sands. Restoration of the rapid may provide a moderate whitewater run for canoeists and kayakers and spawning habitat for rare fishes like the lake sturgeon, once sampled near the mouth of the Fox River and known to spawn in boulder rapids (Smith 1979).

- *Will removing dams and providing fish passage facilities open up the Fox River to invasions by exotic species?*—By unblocking routes of migration for native fishes, reconnecting the river also will open up corridors for invasive exotic species. However, having dams in place does not preclude exotic species from entering and dispersing throughout the system. For example, common carp were abundant in every segment of the river that we sampled even though they were introduced (albeit years ago) after most dams were in place. More recently, the exotic zebra mussel has been found at several locations in the river without the removal of any dams. Furthermore, Asian carp have moved quickly upstream in the Illinois River despite numerous dams. If we assume that preventing the spread of exotic species is extremely difficult or impossible (e.g., round goby dispersal from the Great Lakes to the Illinois Waterway), then the focus shifts to predicting resistance of native biota to effects of exotic invaders. Past work has shown that there is a positive relationship between invasion resistance and diversity of native assemblages (Ross 1991; Vermeij 1991, Lodge 1993) and that environmental modification, such as suppression of natural disturbance regimes (Moyle and Light 1996) and habitat/water quality degradation caused by dams and impoundments (Martinez et al. 1994; Aparicio et al. 2000) are important factors enhancing exotic invasion and persistence in stream systems. Common carp abundance decreased dramatically in an area of the Milwaukee River after a dam was removed and the impoundment was eliminated (Kanehl et al. 1997). Whereas impacts will undoubtedly vary among introduced species, it appears that healthy natural environments (i.e., free-flowing rivers) and diverse native assemblages may be the best protection against exotic invasions in streams and rivers.

The Fox River is an important ecological and recreational resource that undoubtedly is worthy of restoration efforts. Based on past work in Wisconsin, dam removal is likely the most cost effective and practical restoration technique available today. Reconnecting the Fox River with fishways and bypass channels will provide substantial improvement over existing conditions, but these options clearly are less beneficial than dam removal. Although potential benefits are high, removing and modifying dams will not address all problems affecting the river. Additional watershed management practices, such as reducing nutrient input from point and non-point sources, protecting tributaries and wetlands from development, and incorporating Best Management Practices (BMP's) in rural areas will be necessary to ensure that the Fox River remains a vital natural resource for future generations.

Part B. Fish Passage and Specific Options For a Reconnected Fox River

INTRODUCTION AND OVERVIEW

In this section of the report, we discuss dam removal and modification alternatives for the 15 dams on the Fox River. Part A of the report provided data that underscored the negative impact of the dams on the river ecosystem. Part B will provide some ideas about what can be done to reverse those negative impacts.

What Is Fish Passage?

Fish passage is a generic term referring to the collective actions needed to ensure that wild fish are able to move under their own volition from point A to point B. In this context, it is assumed that there is some structure or condition between points A and B that limits movement. This might include natural falls or rapids, artificial structures such as dams, culverts, and screens, or unnatural conditions such as the de-watering of a streambed due to water diversion. Whatever the reasons, humans have found it necessary to proactively intervene and provide fish passage in natural water bodies so that fish can continue their natural movements or migrations unimpeded.

The Fox River does not possess barrier waterfalls. Historically, fish were able to freely move up and down the river and in and out of the tributaries. The only thing that has impeded fish movement on the Fox River is human-made dams and 15 of them persist today between the mouth of the river and Fox Chain of Lakes. Despite the low height of some of these dams, all block fish runs. Certain species of fish (notably salmon and trout) are able to leap obstacles. Atlantic salmon can leap over falls 12 ft. high (Stuart 1962). However, none of the species that are found in the Fox River have this ability. The species found in the Fox River evolved in Midwestern prairie streams where falls and rapids are uncommon and small and therefore the species did not need to develop leaping skills. It is possible that under certain springtime conditions certain fish (e.g., large suckers) may be able surmount the lowest of the dams (e.g., Hurd's Island Dam in Aurora). However, this type of passage is extremely limited in time and scope and has very limited benefit at the population or ecosystem scale. It is possible that during periods of extreme high water these low dams may become completely inundated and impossible to detect. At this time, it may seem that any fish could easily swim upstream over the dam. However, velocity barriers (areas where the water moves so fast that fish cannot make 'headway' against it) often exist at these sites preventing passage. More importantly, few fish engage in voluntary upstream movement during flood conditions due to the need to conserve energy and avoid the danger of being swept downstream and injured. Moreover, most fish movement is associated with a deliberate migration that is essential to the life history of the species (e.g., spawning migrations) and therefore is time critical. If a fish needs to move upstream to spawn in May, an over-topping of the dam in October has no value to it. Therefore, these flood events do not represent a significant opportunity to the fish community.

History of Fish Passage with a Fox River Perspective

Humans understood the need to allow fish to migrate upstream centuries ago. For example, in England, a decree in the twelfth century by Richard the Lionhearted stipulated that all dams have a gap large enough to allow a well-fed pig to stand sideways to allow fish passage (Netboy 1980). Early efforts focused around Atlantic salmon in Europe and tended to be somewhat successful because the Atlantic salmon is a strong swimming species capable of leaping and negotiating difficult rapids (or challenging fishways) and the dams were relatively low. Therefore, fish passage wasn't a science but a local art practiced by experienced riverkeepers. As dams became higher, fish passage became more difficult. By the 1900s, engineers began to study the problem and design structures specifically to allow fish to migrate around dams. The effort continued to focus on anadromous species such as salmon.

Fish passage took a giant step in the 1930s when the U.S. government began damming the Columbia River in the Pacific Northwest (Clay 1995). The Columbia River has some of the largest salmon runs in the world and the need to protect these runs was well accepted. Huge fishways that pass more water than flows down the Fox River were constructed around the dams. This dam/fishway building continued throughout the U.S./Canadian Northwest until the 1970s. These fishways were the result of intense engineering and biological studies, experimentation, testing, and refinement. Early fishways were a series of pools divided by weirs with plunging water and salmon had to leap from pool to pool. These structures were referred to as 'fish ladders', a term that has stuck with the American public. However, there currently is a wide array of styles of structures including roughened chutes with no pools, pools with slots or submerged openings, fish elevators, and fish locks. Therefore, the term 'fishway' has been adopted to include all styles of devices meant to allow fish to circumvent a dam.

The next step in fish passage occurred in the U.S. Northeast between 1970 and 1990. Programs were launched to restore anadromous fish species to the rivers of New England, which had numerous dams. Early fishways were built that mimicked designs of the Northwest and were suitable for the Atlantic salmon but inadequate for other species such as American shad, alewife, striped bass, and sturgeon (Moffett et al. 1982). Subsequently, a great deal of research was directed at developing designs for fishways that would pass these non-salmonid species. Although the refinement work continues today, great progress has been made and modern fishways are now passing millions of fish annually from South Carolina north to Maine and into Canada.

As the 1990s were drawing to a close, scientists from Canada, the U.S., central Europe, and Australia began to focus on fish passage technology for non-anadromous species, including species of pike, minnows, suckers, and catfishes found in Midwest prairie streams. There are now many fishways around the world successfully passing resident, non-salmonid, riverine fish species (Anon. 1995; Mallen-Cooper 1999; Odeh and Haro 2000).

Currently, there are hundreds of professional fisheries scientists and engineers whose primary interest and responsibility involves fish passage. There is a special Bioengineering Section of the American Fisheries Society and a federal research lab in Massachusetts dedicated to fish passage research. Fish passage has come a long way since the days when anglers used to pile rocks in streams or build simple wooden chutes in an attempt to get fish around dams. There currently are five dams on the Fox River with rudimentary fishways. We did not research the origin of the primitive fishways on Stratton, Carpentersville, Elgin, St. Charles, and South Batavia dams, but it is clear that they were not designed and built by professionals well-versed in modern fish passage technology. The fishway at the Stratton Dam resembled an old-fashioned salmon fish ladder and may be reconstructed to provide adequate fish passage. The designs of the other "fishways" are not even close to being suitable and clearly never have passed any fish nor are they worth modifying (Figure 20). Their design does not provide for suitable water velocities, depths, energy dissipation, resting pools, or attraction flows. The structures are basically steep ramps with ridges on them. The "fishways" appear to have been designed and built by well-motivated individuals who wanted to do something to help the fish but did not have the knowledge or experience to provide a suitable structure. Our point in mentioning this is not to ridicule these early Fox River fish conservationists (clearly ahead of their time), but to rebut suggestions that fishways on Fox River dams have been tried and proven not to work. Effective, science-based fishways never have been installed at any of these dams.

Figure 20. Existing ‘fishway’ at the west bank of Kimball Street Dam in Elgin, Illinois. Reasons for failure to pass fish include: insufficient attraction flow, too steep, insufficient pool size (no energy dissipation), excessive water velocity, and insufficient depth.

One additional dam, the Stolp Island Dam in Aurora, has a more elaborate fishway that was constructed at the time that the dam was built. A flood destroyed the first dam on this site in 1837 (Anon. 1937a). It appears that the western spillway and eastern spillway may have been owned and operated independently with various repairs or replacements occurring over the next 100 years. On March 15, 1936, the eastern spillway, constructed with wood, was swept away by a flood (Anon. 1936a). The only reference in local newspaper about the need for a new dam was: “…(that it will,) in addition to improving the appearance of the Fox River, serve to eliminate the unsanitary conditions which have existed during periods of low water in the past.” (Anon. 1936b). It can be reasonably concluded from these remarks that the dam was restored to hide unsightly water pollution since the mill was gone at that time (Anon. 1937b). The present concrete dam was built during July of 1937 and at that time a so-called ‘fish lock’ was incorporated into the west end of the spillway. All contemporary and present-day references to this device call it a fish lock, but by modern definition, it was not a fish lock but a 'fish lift'. Fish locks were developed but proven ineffectual and never extensively used (Clay 1995). They operated like a lock for boats where fish would enter a chamber with a water level identical to the river below the dam. The chamber would be closed and flooded to bring water up to the level above the dam after which the upstream gate would be opened allowing the fish to exit. The device in Aurora actually was a primitive 'fish lift', in which the fish were collected into a bucket and physically lifted over the dam. One of the first fish lifts to be effectively built and used was installed at the 33-foot high Holyoke dam on the Connecticut River in 1952 (Moffett et al. 1982). The Aurora fish lift, built 15 years earlier, was not only the first (and it is suspected only) of its kind in Illinois, it was probably one of the first in the world! The *Aurora Beacon-News* reported, "The fish lock, Deuchler explained, was invented by a 75 year old Wisconsin angler and has been used successfully in many streams in the Badger state, the first to be developed that would actually "work." It has been approved by the Illinois Department of Conservation, which Deuchler said had spent considerable sums in attempting to develop a means of permitting fish to swim thru *(sic)* dams upstream, but had been unsuccessful." (Anon. 1937c). The fish "lock," which is the rectangular, concrete structure between the spillway and the pedestrian walkway, was a multi-chambered device that consisted of two iron buckets connected to each other on a pivoting arm. One bucket sat full of water on the riverbed beneath the structure and collected fish that were attracted to the location by water issuing from a gate. When the device was activated, the other bucket would fill with water and lower to the streambed by virtue of its increased weight. In response to that bucket descending, the fish bucket on the other end of a pivoting arm would go up and the fish and water would be dumped at the upper level above the dam. In order to lower the fish bucket, the other bucket would have to be drained of water to reverse the weight balance.

On August 3, 2000, we examined the fish "lock" to determine if it had any potential for rehabilitation as an effective fish passage device. Cooperative Public Works officials from the City of Aurora assisted us in our effort. We were not able to enter the upstream chamber, but entered and examined the downstream chamber and found it to be completely useless due to rust and crumbling concrete. There are many reasons to believe that the structure never provided effective fish passage and probably was abandoned shortly after its construction. In fact, no one with whom we have spoken, including life-long Aurora residents and Public Works officials, knew what the structure was. Later in this report, we will make recommendations for implementing effective fish passage at this dam that will not include this structure. However, due to its curious and historic nature, it may be worthwhile to carefully photograph and document this fish lift and provide some public information about it at the site.

Sometime in the early 1980s, a canoe-way or boat bypass was built at the west end of the west spillway of the Stolp Island Dam. It consists of 6 pools and chutes, which divide the approximate 6.5-foot drop into 13-in. drops. The bypass was constructed to expedite canoeing since the dam in downtown Aurora presented great portage challenges to anyone wishing to paddle through the city (Searns 1979). Its location and design resemble a bypass-style fishway, which is becoming a popular design for weak swimming fish. In order to assess its effectiveness, this project studied fish passage over a brief time period. The study is summarized in Appendix G and we concluded that the boat bypass is providing fish passage for the west spillway and no new structure is warranted at that location. However, it has come to our attention that the facility has design flaws that make it difficult for canoe passage. There are also clear design flaws from a fish passage perspective. While providing fish passage on the East Spillway is a higher priority, these deficiencies in the Canoe Chute should be addressed and can be corrected without building a new facility. Our recommendations for a rehabilitation of this facility are included later in this report. A fishway is also needed at the east spillway due to: (1) the long length of Stolp Island, (2) the fact that just as many fish are likely to be attracted to the east spillway as the west spillway, and (3) there is no reasonable way for fish to be expected to move back downstream and locate the fishway at the west spillway.

Philosophy of Fish Passage For a Reconnected Fox River

The goal of reconnecting the Fox River is to allow as many fish as practical to migrate upstream and downstream, uninterrupted by artificial structures or conditions. By this, we mean all species, life stages, sizes, and ages of fish during all times of the day and year. The phrase "as practical" recognizes that the only way to ensure that truly *all* fish can migrate upstream is to remove the dam. There may be compelling socio-political reasons why some dams cannot be removed. In such cases, a fishway must be considered and it is widely accepted that no fishway passes all fish. However, a well-designed fishway can pass over 90% of fish during targeted time periods. Even then, some trade-offs need to be considered. For example, it is possible that a $100,000 fishway will pass 92% of the fish but a $1,000,000 fishway will pass 97% of the fish. In this example, it must be determined whether the extra 5% of the fish is worth an extra $900,000 in cost. In the case where an endangered species is part of the "extra 5%", it may be worth the extra money. In the case where weaker swimming sunfish species that are very common in the watershed constitute the "extra 5%," it probably is not worth the extra money.

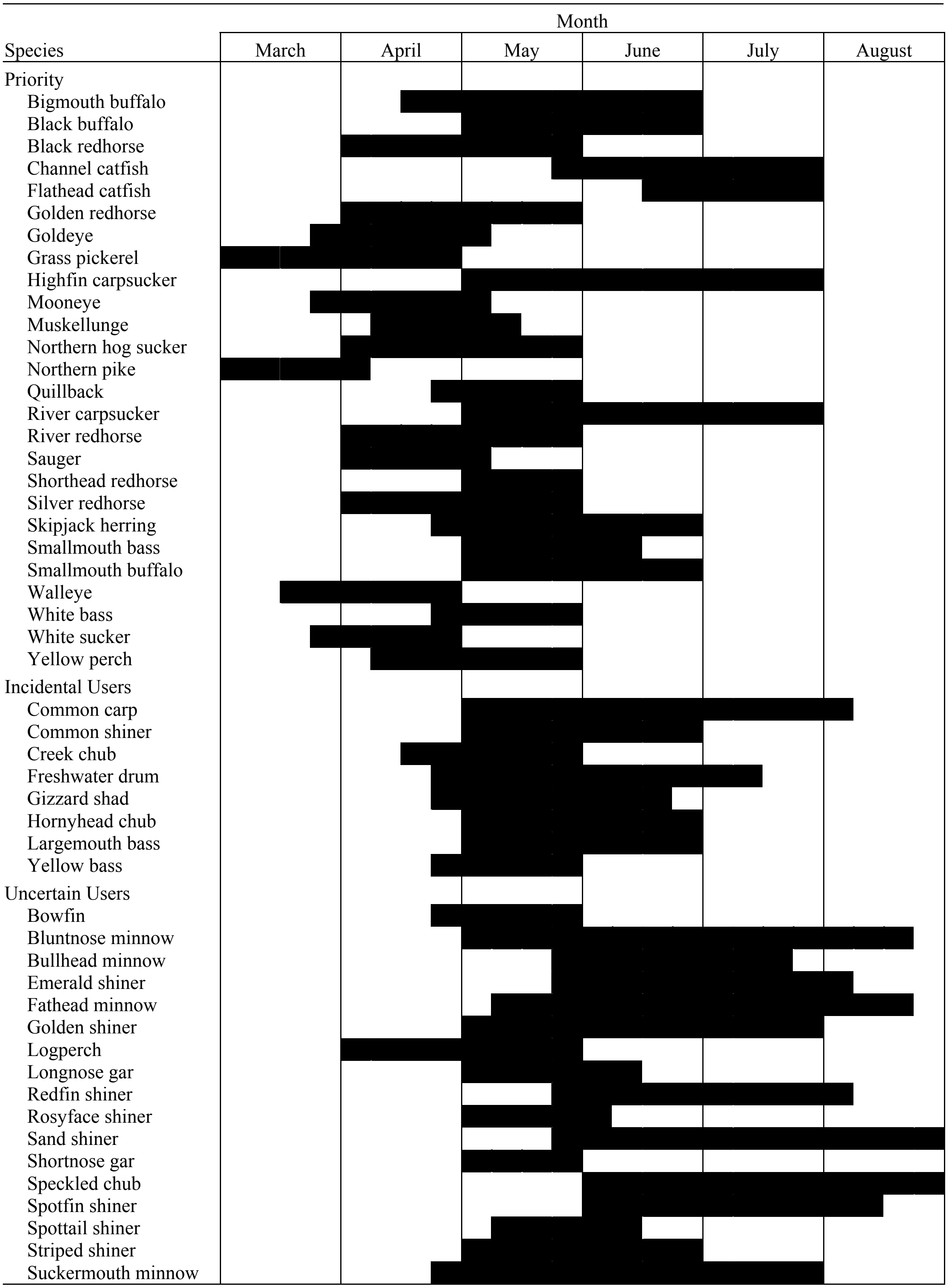
Our approach to fish passage on the Fox River incorporated the following steps:

1. Compile an inventory of all fish species found in the Fox River.
2. Identify those species that are worthy of special attention and protection due to their status as 'endangered' or 'species of special concern' and designate these as top priority species.
3. Identify those species that are popular sport fish and that support important recreational fisheries and designate these as priority species.
4. Characterize and rank the swimming abilities of these priority species and their typical spawning periods.
5. Identify strategies and designs that would effectively pass the weakest swimming priority species, realizing that such strategies and designs would also result in the passage of the stronger swimming priority species.

Table 31. List of fish species targeted for fish passage, swimming capabilities, and importance relative to fish passage planning and design at individual dams. Priority species are those targeted for fish passage, whereas incidental users are species that likely will use fishways. Use of fishways by uncertain users is currently unknown.

Species	Which dams?	Swimming ability	Comments
Priority			
American eel	Dayton	Poor	Requires unique fishway
Bigmouth buffalo	All	Moderate	Design species for Dayton
Black buffalo	All	Moderate	Design species for Dayton
Black redhorse	All	Excellent	
Channel catfish	All	Excellent	
Flathead catfish	All	Excellent	
Golden redhorse	All	Excellent	
Goldeye	All	Good	Design species for Dayton
Grass pickerel	All	Very poor	Very challenging
Highfin carpsucker	All	Moderate	
Mooneye	All	Good	Design species for Dayton
Muskellunge	All	Poor	Design species
Northern hog sucker	All	Excellent	
Northern pike	All	Poor	Design species
Quillback	All	Excellent	
River carpsucker	All	Moderate	
River redhorse	All	Excellent	
Sauger	All	Good	Design species for Dayton
Shorthead redhorse	All	Excellent	
Silver redhorse	All	Excellent	
Skipjack herring	All	Good	Design species for Dayton
Smallmouth bass	All	Good	
Smallmouth buffalo	All	Moderate	Design species for Dayton
Walleye	All	Good	
White bass	All	Moderate	
White sucker	All	Excellent	
Yellow perch	All	Moderate	
Incidental Users			
Common carp	All	Good	
Common shiner	All	Moderate	Function of size
Creek chub	All	Good	
Freshwater drum	All	Good	
Gizzard shad	All	Moderate	Function of size
Hornyhead chub	All	Good	
Largemouth bass	All	Moderate	
Yellow bass	All	Moderate	
Uncertain Users			
Bowfin	All	?	
Bluntnose minnow	All	?	
Bullhead minnow	All	?	
Emerald shiner	All	?	
Fathead minnow	All	?	
Golden shiner	All	?	
Logperch	All	?	
Longnose gar	All	?	
Redfin shiner	All	?	
Rosyface shiner	All	?	
Sand shiner	All	?	
Shortnose gar	All	?	
Speckled chub	All	?	
Spotfin shiner	All	?	
Spottail shiner	All	?	
Striped shiner	All	?	
Suckermouth minnow	All	?	

Table 32. Spawning dates of selected fishes collected from the Fox River mainstem in Illinois during 1980-2000. Spawning dates are approximations based on published data. Priority species are those targeted for fish passage, whereas incidental users are species that likely will use fishways. Use of fishways by uncertain users is currently unknown.



6. Characterize the swimming abilities of non-priority species and determine how many would be likely to be able to pass with the proposed strategies and designs.
7. Re-evaluate the strategies and designs.

A list of fish species from the Fox River that are targeted for fish passage and ranges in spawning dates are provided in Tables 31 and 32. It is fortunate that imperiled species in the river (e.g., the river redhorse) are generally strong swimming fish. However, some of the valued sport fish species are not such strong swimmers or at least they lack the stamina for extended rigorous swimming. Best examples are members of the family Esocidae (pikes and pickerels), which includes northern pike and muskellunge. Because of their low endurance, these species were considered 'design species' in that all fish passage strategies and designs will be developed to pass these species. If the fishway allows northern pike to successfully pass, other species such as river redhorse, creek chub, and smallmouth bass will most certainly be able to pass as well. Our approach led to the consideration of three basic strategies/designs. Each dam is unique and the exact design will differ for each; however, the basics of each design will often remain the same among sites. Basic designs are discussed in detail below to familiarize the reader with them and minimize redundancy later in the report. Multiple options are provided for many dams and advantages and disadvantages of each design are listed to help the decision-making process. Some dams have fewer options because one or two of the designs were not considered suitable for these sites. We have not included discussions of all fish passage strategies and designs that may be used elsewhere in the world because they are not appropriate for use on the Fox River. These include certain fishways that would not be used effectively by our 'design species' and/or designs that are needlessly more expensive than what we have proposed.

Overview of Selected Strategies and Designs

Dam Removal.—Dam removal is a growing movement in the United States (Murr 1999). Since 1912, over 465 dams have been removed in the U.S. (AR/FE/TU 1999; Odeh and Haro 2000). Dam removal usually results in complete fish passage and improved fisheries (AR/FE/TU 1999; Anon. 2000; Kanehl et al. 1999), but at some sites on some rivers removal does not necessarily guarantee full and effective fish passage. Dams are often built atop or downstream of waterfalls or steep rapids. These features remain (or reappear) after the dam is removed and continue to block fish passage. In such cases, it is clear that fish never migrated further upstream, in a historical context, and therefore careful consideration must be given to the need and desire for dam removal if fish passage is the main objective. However, the Fox River is a typical low to medium gradient prairie stream that lacks waterfalls or heavy rapids. These features are usually created when a river cuts through resistant bedrock. Where the Fox River cuts through bedrock it is relatively soft limestone or sandstone, which does not create heavy rapids. There is absolutely no reason to believe that there were ever any natural barriers to fish migration on the mainstem Fox River from its mouth to the Wisconsin border.

In Part A of this report we have presented assessments of the fish community, macroinvertebrate community, quantity and quality of fish habitat, accumulated sediment, and water quality. In each case, it seems apparent that the Fox River ecosystem would be improved by the removal of dams—regardless of the fish passage benefits.

In addition to fish passage, there are two other factors that should be considered when deciding whether a dam should be removed or maintained. The first is public safety. All dams represent some level of risk to public safety. Any structure that impounds water on a natural river is subject to failure and the release of stored water. Such a release can destroy property and take human lives. In addition, many dams may have dangerous conditions (open pits, exposed reinforcing rods, loose stones, etc.) that could injure someone who falls or comes in contact with them. Some dams are attractive nuisances, drawing young people and others to trespass, swim, dive, or apply graffiti in dangerous or bothersome manners.

Perhaps one of the most well known threats of Fox River dams is drowning. Swimmers, anglers, and over-turned boaters sometimes find themselves caught in swift currents underneath a dam. These 'hydraulics' that hold a person in the plunging flow of a dam are known by many names, including "rollers", "suck holes", "souse holes", "keepers", etc. The effect is that the plunging flow creates a strong surface counter-current below the dam that rushes back upstream toward the spillway and prevents swimmers from escaping downstream to safety. Eventually swimmers fatigue and drown. Whether or not a dam possesses these dangerous currents below it depends on water depth below the dam and the design of the spillway. Some Fox River dams do not have them (e.g., Montgomery and Geneva) whereas others are infamous for the number of people that have drowned below them (e.g., Yorkville, Stolp Island, and North Aurora).

Due to public safety issues, there also is a financial liability to dam owners. The structures must be maintained in good condition, which can costs hundreds of thousands of dollars from time to time. Dams also may leave owners exposed to lawsuits from the families of drowning victims.

The second factor to be considered is recreational paddle boating and the need to portage. The Fox River is a popular stream for canoeists and kayakers. Every time a dam is encountered, boaters must get out of their boat and portage around the dam and re-launch. Not only is this physically difficult in some areas (e.g. Dayton, Aurora, Elgin, and Algonquin), it can be dangerous at sites where boaters must get out or get back in too close to the dam. A mistimed paddle stroke or a slip of a foot could put the boater in jeopardy. In both of these cases, dam removal eliminates the problem. These and other advantages to dam removal are reviewed in a publication called "Dam Removal Success Stories" (AR/FE/TU 1999).

Dam removal has the following advantages:

- Most effective method to provide full and complete fish passage.
- No facility to maintain or operate saving staff time and maintenance costs.
- Eliminates public health and safety hazards from falls and injuries, drowning, and dam failure and downstream flooding.
- Eliminates environmental degradation and allows habitat restoration.
- Allows easy canoeing and kayaking in the river.
- Reduces the likelihood of flooding upstream of the dam by lowering the water level.

Dam removal has the following disadvantages:

- If biologists wish to capture migrating fishes or count numbers migrating upstream, there is no convenient way to do that (in comparison with a fishway that has incorporated a viewing window and trap).
- If recreational activities upstream of the dam rely on a deepened pool (e.g., power boating and jet skiing), these activities may be compromised by removal of the dam.

Note that one disadvantage not listed is the elimination of the dam's role in flood protection—because it is a myth! Only very tall dams that are routinely left empty (i.e., gates open with no impounded water behind them) can serve as effective flood control structures (by closing the gates during floods and storing water). With the possible exception of Stratton Dam, no dam on the Fox River has the ability to store excess water. They merely passes all water that enters the headpond over the spillway and downstream. Even the Stratton Dam does not have the storage capacity to provide appreciable flood control except during minimal flood events. Removal of Fox River dams will not have a significant affect on river flood (except possibly the Stratton Dam for smaller floods).

This discussion has focused on complete dam removal where the full height and width of the structure is removed. There are two other types of dam removals that should be mentioned for the sake of completeness. They are dam breaching and dam lowering. *Breaching* refers to the removal of only a section of the length of a dam, such as a portion of the spillway. This is often done in cases where the dam is very long (longer than the typical width of the river) or where there is a very large accumulation of sediment behind the dam that cannot be removed due to high costs. For example, if the eastern 100 feet of a concrete spillway is removed but the western 200 feet is maintained, the river channel upstream of the eastern breach is often dredged down to native streambed material for some distance upstream. This becomes the new main river channel. The new western riverbank is now comprised of former pond sediments held back by the remaining section of dam. In most instances the new bank must be stabilized by flattening the slope of its edges, planting vegetation, and creating hard points (rock jetties or toe protection) to protect highly erosive areas. Over time plants cover and stabilize the former pondbed and it resembles a typical floodplain.

Another partial removal of a dam is *lowering*. In this case, the top of a dam is removed to lower the height of the dam and reduce the size of the headpond. The new top of the dam is often capped with concrete and the dam remains. This is often done to realize some benefits to dam removal but to leave some structure in place to either hold back accumulated sediments or maintain a minimal headpond. When this technique is used, the remaining dam is usually still a barrier to fish migration and in those cases a fishway is still required to pass fish upstream. Lowering has the advantage of reducing costs of constructing a fishway because the dam is lower. However, a disadvantage to the overall project may be the added expense of funding a dam repair (more expensive than a removal) and a fishway construction.

Since most dams on the Fox River are relatively low already, the option of lowering them but not removing them does not appear to make sense and this "hybrid option" will not be recommended as part of this report. Dam breaching will not be recommended either due to its limited benefits, but it may need to be considered by decision-makers trying to balance the needs of a variety of user groups. Further, because lowering and breaching result in the reduction or loss of the headpond, which is what some opponents to dam removal oppose, these options may not be a compromise as much as an option that everyone will be against.

Bypass Channels.—Historically, fish passage facilities have been highly artificial structures constructed of rock, concrete, wood, and metal. These structures often have been installed very close to dams at slopes between 10 and 25%. In recent years, fish passage specialists have been designing and using semi-natural 'bypasses' to allow fish to migrate around dams. These bypass channels resemble natural streams with pools and riffles, gravel and sand substrate, and natural vegetation along the margins. Natural curves and meanders often are incorporated and the course of the channel may pass many feet (sometimes miles) distant from the dam. The slope of the channel is usually between 0.2 to 2.5% (Parasiewicz et al. 1998). Similar "pool-and-riffle" or "rocky ramp" designs used in Canada to successfully pass fish common to Midwestern streams may be constructed at slopes up to 4% (Gaboury et al. 1995). Concrete and metal are rarely used for bypass channels and if used these products are often hidden from view in the completed structure. See Figure 21 for a general depiction of a bypass channel.

The advantages of bypass channels include:

- Allowing more species and life stages to ascend the channel and circumvent the dam due to flatter slopes. Slopes typically mimic those found in the natural river so fish species migrating up the river are able to migrate up the channel.
- Construction with natural substrate (as opposed to concrete or metal) that allows more species and life stages (particularly small fishes) to ascend the channel. Small fishes migrate through and around the cobble and gravel at the margins of the channel.
- Allowing other aquatic organisms (e.g., insects, mussels, amphibians, birds) to prosper in or around the channel.
- Allowing the passage of boats, if designed appropriately.
- Construction costs that often are lower than many other fishway designs, although this varies widely depending on the exact characteristics of the proposed channel.
- Operation and maintenance costs that are extremely low.
- Bypass channels are more aesthetically pleasing than most fishways.
- The dam and impoundment remain.

The disadvantages of the bypass channels are:

- Due to the flatness of slope, bypass channels typically are very long, particularly for taller dams. At some dams, there simply may not be enough land on which to locate bypass channels (e.g., St. Charles Dam).
- Although usually less expensive than traditional fishways, bypasses may be more expensive if land needs to be purchased or old buildings razed to make room for the channel.
- The dam, impoundment, and associated ecological and water quality impacts remain.

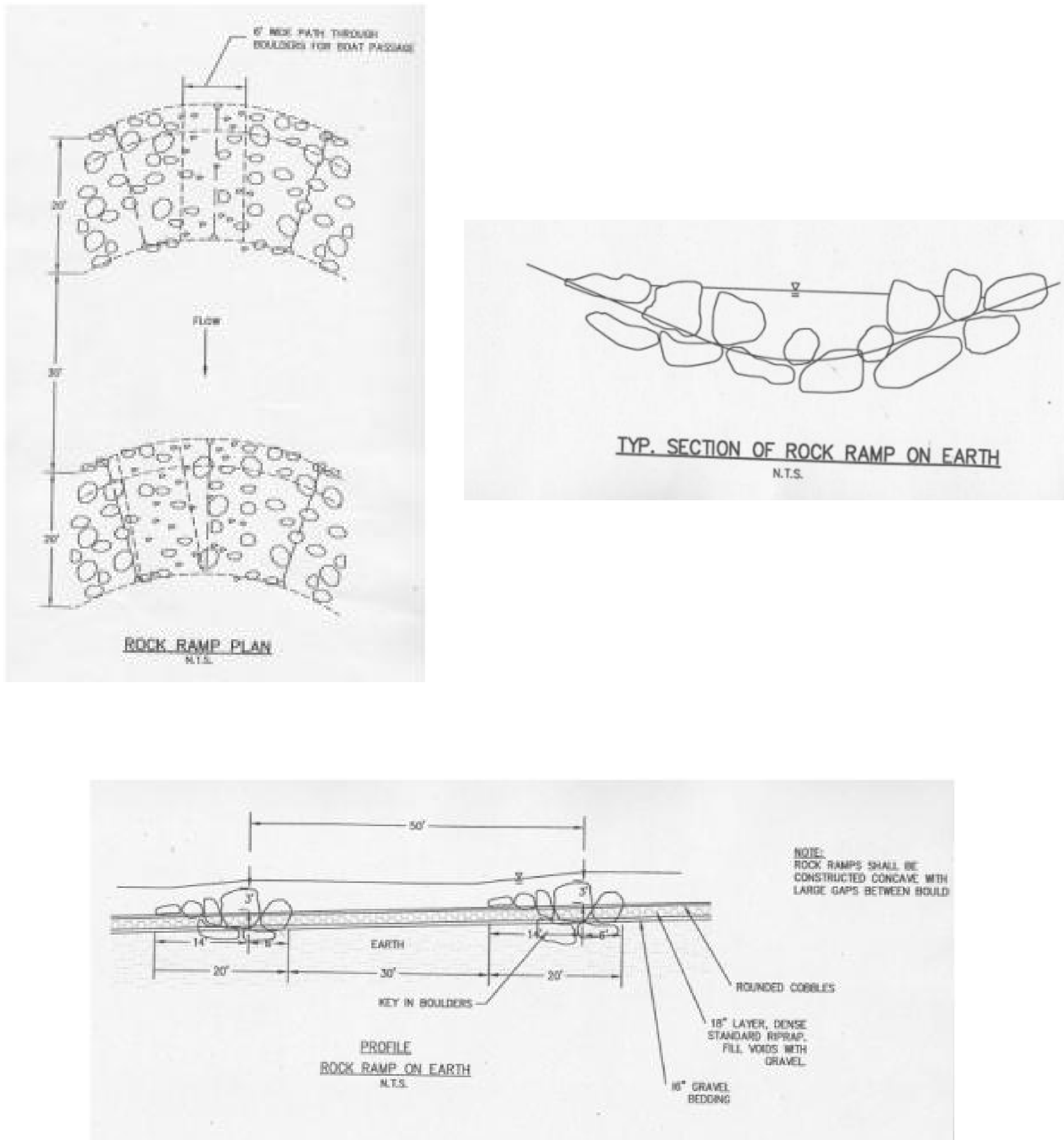


Figure 21. Generalized schematic diagrams of a typical bypass channel.

Conceptual guidelines for bypass channels proposed for Fox River dams include the following:

- Slopes of 1:25 (4%) if proposed only for fish and 1:33 (3%) if proposed for boats.
- Total discharge of 5% of mean annual river flow at the site of construction.
- Minimum widths of 3 ft. if proposed only for fish and 6 ft. if proposed for boats. Actual mean widths can be much larger.
- No vertical drops greater than 6 in.
- Flow characteristics at drops are “streaming” not “plunging.”
- Limited bed permeability, using clay, pond liner, or geotextile mats.
- High variability of natural appearance between sites, depending upon the existing conditions at the sites.

All bypass channels will require site-specific engineering and design studies. We do not provide detailed designs of bypass channels where such facilities are recommended but rather basic site and layout configurations.

Denil Fishways.—This is a common design for traditional fishways and has been used extensively world-wide, including along the East Coast of North America. These fishways have been successfully used to pass a wide variety of riverine (non-anadromous) species like those found in the Fox River (Anon. 1995; Bunt et al. 1999). The name is pronounced “da- NEEL,” after the Belgian hydraulic engineer who developed the basic design in 1909. Nemenyi later evaluated the Denil design in 1941 (Clay 1995). A standard Denil fishway is a 4-ft. wide trough (usually concrete and open on top) set at a slope between 6% and 16%. Wooden, U-shaped baffles are inserted at a 45-degree angle at a regular interval, usually via slots formed into the concrete walls. The water descending this fishway is slowed on the sides and bottom by the presence of the intruding baffles, reducing the velocity to the point where fish are able to ascend the fishway. In the process of reducing the velocity, the baffles create turbulence. Fish can only sustain forward momentum against this turbulent rush of water for a limited time, depending upon the swimming ability of the individual species and the slope of the fishway. For dams higher than 6 or 7 feet, intermediate flat resting pools are needed to allow fatigued fish to recover before resuming their upstream migration through the upper portions of the fishway. Often, resting pools double back on themselves, turning 180-degrees and allowing the fishway to have ‘switchbacks’ so that it fits into a limited space. This feature and the steeper slope relative to a bypass channel allow this design to fit in smaller spaces than bypass channels. See Figure 22 for a general depiction of a Denil fishway.

Denil fishways have the following advantages:

- Ability to ‘fit’ into small areas along spillways.
- Relatively inexpensive to construct (compared to other concrete fishway designs).
- Moderately inexpensive to maintain over the long term.
- Very easy to operate.
- Can be installed at variable slopes to meet specific needs.
- Is used by a wide variety of fish species.
- The dam and impoundment remain.

Disadvantages of Denil fishways include:

- May be ineffective at passing small or very weak swimming fish species.
- Typically more expensive than a bypass channel.
- Someone must take responsibility for routine operation and maintenance (Maloney et al. 2000). Wooden baffles need replacement about every 10 years.
- Do not look natural or aesthetically appealing.
- Do not allow for the passage of canoes or kayaks.
- The dam, impoundment, and associated ecological and water quality impacts remain.

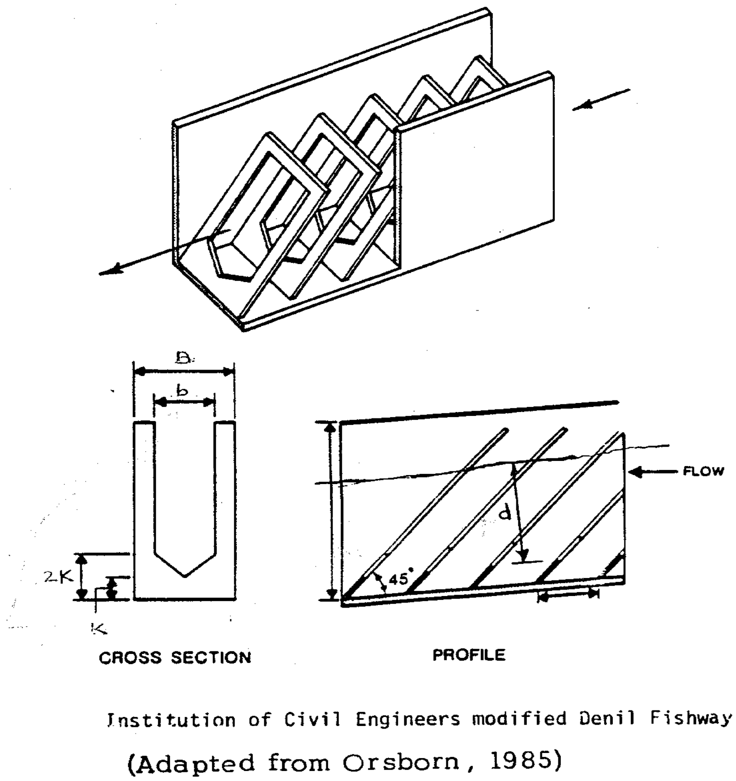
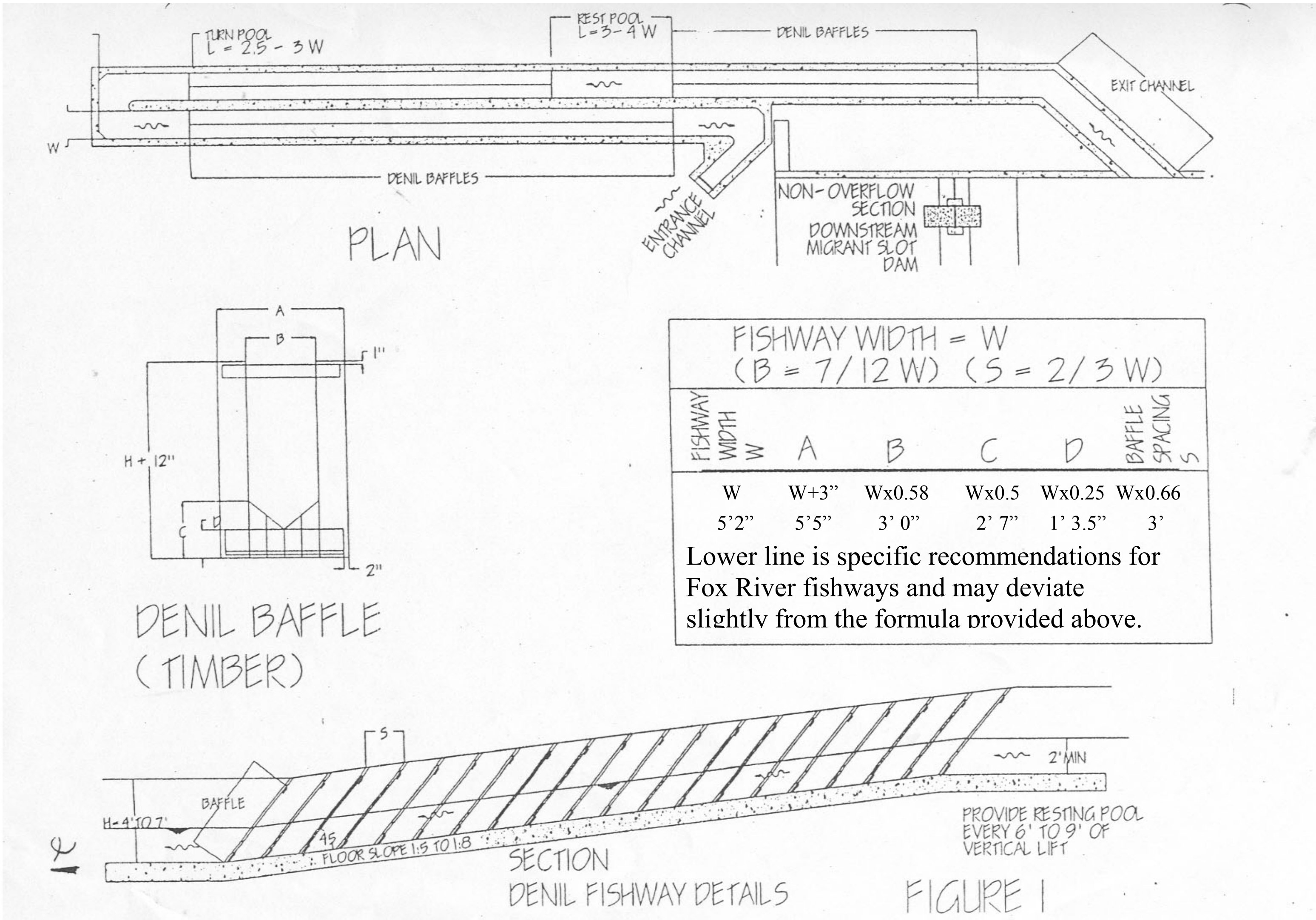


Figure 22. Generalized schematic diagrams of a Denil fishway.

Design parameters can be modified to improve passage of small or weak swimming fish. By making the Denil wider and flatter than the standard design employed for anadromous species in the East, a more diverse group of fishes will pass upstream. The Canada Department of Fisheries and Oceans has been successful in passing a wide variety of fishes in interior western provinces through non-traditional Denil fishways (C. Katapodis, Freshwater Institute, personal communication). The conceptual guidelines to be followed for Denil fishways proposed for Fox River dams (developed with the Canada DFO experience in mind) include the following:

- Slopes of 1:15 (6.6%).
- Widths of 5.2 feet.
- Resting pools every 6 vertical feet.
- Standard Denil baffle dimensions (see Figure 23).
- Total fishway discharge between 2 and 5% of total mean annual flow. If the Denil fishway cannot be built to accommodate all of that water, supplemental 'attraction water' will be added to the fishway entrance via an accessory pipe.
- Typical entrance locations shall be very close to the downstream edge of the whitewater splash zone or roller hydraulic current below a dam.
- A short section of flashboards may need to be provided on the spillway near the fishway to create a 'blackwater' no-splash zone near the fishway entrance to enhance fish attraction.



FISHWAY WIDTH W	A	B	C	D	BAFFLE SPACING S
W	W+3"	Wx0.58	Wx0.5	Wx0.25	Wx0.66
5'2"	5'5"	3' 0"	2' 7"	1' 3.5"	3'

Lower line is specific recommendations for Fox River fishways and may deviate slightly from the formula provided above.

Recommended floor slope for Fox River= 6.6%

Figure 23. Schematic drawings of a typical Denil fishway with measurements for baffle dimensions, including recommendations for Fox River Denil fishways (from U.S. Fish & Wildlife Service, Region 5, Hadley, MA). Also, see photos on page 106 of this report.

Figure 24. Example of a rocky ramp on a Minnesota stream.

Conceptual plans provided for each dam are intended to provide the basic idea for the application of this design. In order to implement these plans, a professional engineer will need to be consulted to provide drawings suitable for construction. Not all of the features described above may be shown on the conceptual plans in Section C (e.g. attraction water, flashboards) but these features will need to be given consideration during the design of all fishways on the river.

Rocky Ramps.—Bypass channels and Denil fishways are structures through which fish migrate that are constructed outside of the river channel. Rocky ramps are streambed modifications that allow fish to stay in the stream and swim over the dam. They are ramps of selected fill material built below the downstream face of the dam and extending at a mild slope (typically 1:20) from the face of the dam downstream. Larger rock roughness elements are typically added to further reduce local flow velocities (Wildman and MacBroom 2000). The material that is added to create the ramp is placed to mimic a natural riffle. The ramps must extend from bank-to-bank, except in rare instances. Rocky ramps can also be used in association with dams that are lowered below their original height. See Figure 24 for an example of a rocky ramp.

Advantages of rocky ramps include:

- Allowing passage of a wide variety of fish species and life stages.
- Low maintenance compared to fishways.
- Often can be a simple project in terms of design and construction since it amounts to simply placing rocks into the stream channel.
- Can create scenic riffles and possibly recreational opportunities.
- The dam and impoundment remain.

Disadvantages of rocky ramps:

- The dam, impoundment, and associated ecological and water quality impacts remain.
- There is a possibility of damage during extreme flooding that may necessitate repair and restoration of the ramp.
- Ramps are only practical for low dams because ramp length increases with dam height.
- Ramps are generally practical only for narrow streams because the amount of material fill needed increases with stream width.
- Ramps represented a filling of inland waters, which is a regulated activity. Small dams may require acceptable amounts of fill whereas larger dams on wide streams may require enormous amounts of fill, to which the regulatory community and river users may object.

The last three bullets under 'disadvantages' are germane to the Fox River. Many of the dams are 300 to 400 ft. wide and 8 to 10 ft. high. This would require a ramp between 160 and 200 ft. long and a footprint between 48,000 and 80,000 square feet. The volume of fill needed to build such a ramp represents a substantial filling of the river channel. Fox River dams that hold the most promise for this option (e.g., South Batavia and Hurd's Island) are likely candidates for removal and therefore a rocky ramp should be considered only as a fallback option. For these reasons, we do not recommend rocky ramps as an option for mainstem dams in this report. However, this design may hold promise for smaller dams on tributaries (e.g., Waubonsee Creek).

RELATIVE COSTS OF SELECTED ALTERNATIVES

Introduction

Providing accurate estimates for various fish passage options along the Fox River is difficult due to the lack of similar projects in the region. Fish passage specialists in the Northeast, Northwest, and other regions where fishways have been built for many years are able to provide fairly accurate cost estimates based upon past experiences. Engineers charge certain rates. Formed concrete work is charged at a certain rate per cubic yard. Such rates and equipment day rates vary significantly among regions. Therefore, listing the cost of fish passage projects from other regions (e.g., the Northeast) is not helpful in providing actual costs for the Fox River dams. Cost estimates can be produced by researching concrete costs per cubic foot, laborer daily rates, costs for a typical cofferdam per linear foot, costs for dredging and disposal of pondbed sediments, etc. Most of these costs can be obtained by using either the Means Costs Data guide or referencing past estimates and actual costs for similar projects in the region. But first, an engineering plan would need to be developed that specified how much concrete is needed for a particular fishway, whether or not a cofferdam is necessary, and how much sediment has to be dredged. Developing such an engineering plan and specific cost estimates are beyond the scope of this report. Instead, we outline typical costs of fish passage alternatives elsewhere, discuss what drives those costs, and provide a wide range of likely costs for certain selected alternatives.

In addition to regional variation of costs, it must be emphasized that costs vary greatly between dams within the same watershed. Some of the factors that influence the costs include: dam height, dam length, dam condition, amount of sediment behind the dam, presence or absence of contamination in the sediment, types of contaminants present, ease of construction access at the dam, land ownership rights and issues, and presence of any other water uses at the dam or in the pool above the dam. A detailed fish passage plan for each dam must include a study of these issues and any other site-specific conditions that apply. The best plans try to address all factors influencing cost so that the project effectively passes fish and meets other needs as well.

Dam Removal

There are no 'hard and fast' guidelines to follow when estimating costs of dam removal. The cost of each project appears to be driven by its own unique set of circumstances. However, past experiences can be offered as a guide. The primary factors that affect dam removal costs are given below.

General Plan.—What is to be removed? Is it only the spillway or will the dam's embankments (the earthen portions of the dam) be removed? Most Fox River dams are primarily composed of a concrete spillway (e.g., Stolp Island and St. Charles dams) or have minimum embankments (e.g., Geneva and Yorkville dams). South Elgin and Montgomery dams are the only dams with a lengthy embankment. Dayton Dam has an extensive earthen dike enclosing a long power canal that could be considered as an extension of the dam's embankment. In many dam removal projects when the spillway spans the majority of the stream width, only the spillways are removed. The restored river easily flows between the abutments and the remnant embankments are left standing and resemble grassy riverside knolls. Ultimately, the volume of material to be hauled away affects the cost of the project. Costs are reduced if portions of the dam can be left in place without negatively impacting the river.

Volume of Material to be Removed.—A spillway consists of a certain number of cubic yards of material, usually concrete. It must be disassembled, placed into dump trucks, and hauled away for disposal. The act of disassembly will cost money (see below) but so will the disposal of the demolition debris. An engineer can estimate the volume of material in the spillway and therefore determine how much debris (number of truck loads) will need to be disposed, and calculate both the dumping fees and the equipment costs. Sometimes the debris can be relocated or reused onsite, thereby reducing the cost of disposal. On one project in the Northeast, the concrete spillway was broken up into relatively small pieces onsite, placed into a scour hole that had been created by the flow over the dam, and covered with natural, rounded, riverbed stone.

Nature of Material to be Removed.—All Fox River dams have some concrete in their spillways. The ones built during the past 50 years will likely be made entirely of reinforced concrete (e.g., Yorkville and Montgomery dams), whereas some of the older ones may have timber cribbing (Carpentersville Dam) or bulldozed rubble (Elgin Dam) underneath a concrete cap without reinforcement. Capped dams are more easily demolished because the timber cribbing may be ripped apart with an excavator after the concrete 'veneer' is broken. Modern concrete dams are well reinforced with rebar and may require not only a hoe ram or jackhammers to break it apart, but also cutting torches to cut the rebar. It should be expected that newer structures will take longer to demolish than older ones. It is important to note that the concrete cured underwater (typical for most dams) can often be stronger than concrete cured in the dry. Therefore, contractors and engineers unfamiliar with this type of work may underestimate the time needed to demolish these concrete structures. The cost of labor and daily cost of necessary equipment will influence the final cost.

Water Control.—The amount of water control and the nature of that control will vary between dams. Clearly it is more difficult to remove dams during high flows. Typically, dam removals are done during the lowest flow periods, or from July through October. During such times it is likely that only mere inches of water are passing over the spillways of the low, wide dams in the Fox River. It is possible that with the right equipment a contractor could create a breach in the end of a spillway (thus draining the pond) without additional control of the water. Once the pond is drained and the entire spillway is de-watered, removing it becomes relatively routine. The breaching technique is feasible on low dams that store little water because the downstream surge of water that occurs after the breach is made is very minor and not dangerous. The removal of a high dam with a large volume of water stored behind it (e.g., Dayton and St. Charles dams) must be preceded by a gradual draining to prevent a large surge of water downstream. In this case, if the dam has gates, they can be opened. If there are no gates, siphons can be used to draw down the pond to safe levels. In some cases, in-stream demolition must be conducted inside cofferdams, which are temporary dikes formed to cut off a portion of the streambed from the rest of the stream. Pumps are often used to keep the work area dry. Often, when the work on that portion of the dam is completed, the cofferdam is moved to encircle the next portion of the dam and the process is repeated. The use of cofferdams is expensive and costs can be reduced if they are not needed.

Dredging.—Every stream carries a suspended sediment load. When water velocities are high, much of the sediment remains in suspension and only the large objects, like large gravel, drops out of suspension. However, dams slow the water velocity so much that even fine sediment (sand and silt) drop from suspension and accumulate on the streambed upstream of dams. The fate of this sediment must be considered when planning a dam removal. There are a few important facts about sediments that must be remembered. First, all sediment is not bad. Every river has and needs sediment. The gradual and punctuated transport of sediment downstream is a natural riverine process. Dams interrupt this process and create two deleterious effects. They trap abnormally large accumulations of sediment in the upstream impoundment and withhold sediment from areas below the dam. Further, some rivers, including the Fox, have too much soil entering the river due to inappropriate land use practices. Once in the river, there is no practical way to remove that soil, which is now sediment. While groups should work together to minimize the influx of more soil, the soil in the river is there to stay and any fish passage project cannot solve the much larger siltation problem. Finally, a river will not let erodable, fine-grained sediment collect in the middle of good gravel habitat. If it has the power to wash sediment away from a former head pond behind a dam, it has the power to wash it away from important mid-channel gravel bars. The sediment will eventually accumulate somewhere downstream, but in predictable locations.

With these facts in mind, it is important to realize that it is not essential to remove all accumulated sediments behind a dam targeted for removal. First, most of the sediments along the edges of the pond will become 'perched', that is, high and dry and out of reach of the river's erosive power. If left alone, these flats will naturally re-vegetate, becoming green and stable, often in one growing season (Figure 25). If preferred, these flats can be seeded with desirable species or planted with trees and shrubs to accelerate the process or control the final appearance. If left alone, the sediment that is deposited along the route of the future streambed will be transported downstream. If the volume is relatively small and the sediment is clean, this can be allowed to happen without negatively impacting the ecosystem (note that the IEPA may have specific policies prohibiting sediment release). If the volume is relatively large, it may be desirable to dredge a new stream channel in the pond bed before the dam is breached. Sometimes, it is necessary to install armoring along the boundary between the new stream channel and the perched sediments and at the upstream point in the channel where pre-emptive dredging ends. All of these considerations will affect the cost of the project. Dredging jobs are bid based on the volume of material to be removed, the method of dredging to be used, and the water controls required for the work.

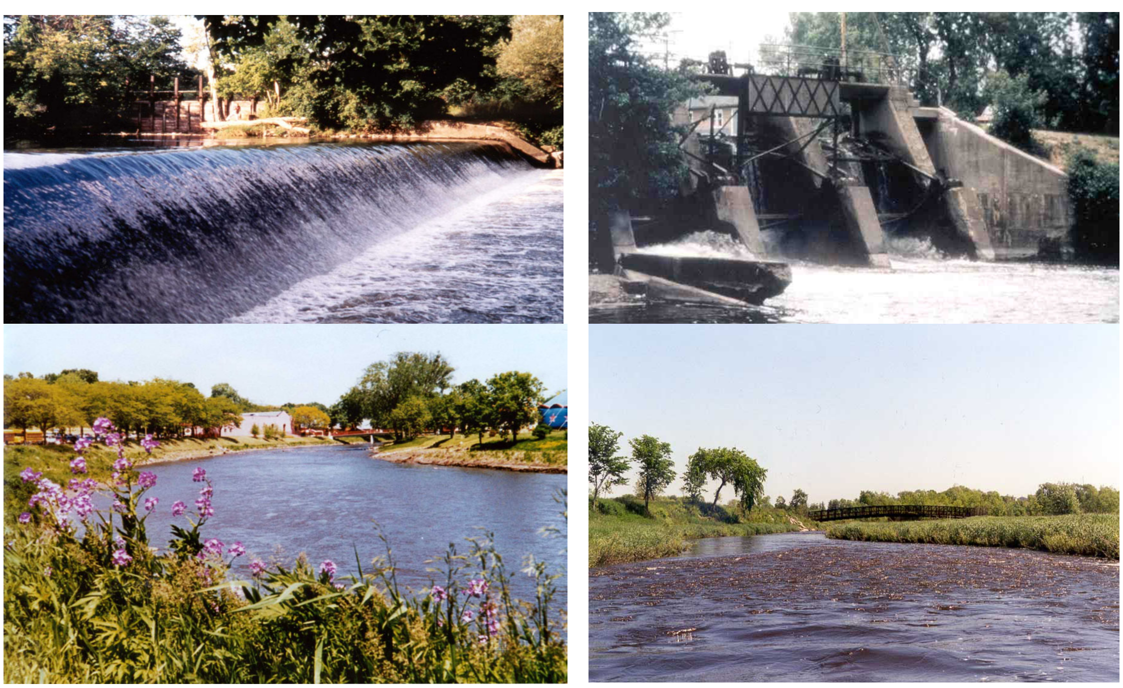


Figure 25. Before and after views of dam removals from the Baraboo River (left) and Milwaukee River (right) in Wisconsin. Note the densely vegetated land in the lower right panel that previously was pond bottom. Photos courtesy of The River Alliance of Wisconsin.

The last important point relative to dredging is the presence of contamination. Due to past industrial activities and discharge practices along the river, it is possible that some contaminants have accumulated and been trapped in the sediments. Sediments are often classified as:

- *Clean* - requiring no special treatment and having no restrictions on possible future uses (e.g., fill, composting, top dressing remediation sites) or natural downstream transport.
- *Contaminated* - containing contaminates that are not particularly dangerous but requiring special treatment such as disposal in a landfill. Some petroleum products fall into this category. Since these sediments must be removed and landfills charge fees for disposal, the presence of this type of sediment increases the cost of a project.
- *Hazardous* - containing dangerous materials such as PCB's, pesticides, or heavy metals. This cannot go into a standard landfill and must be disposed of in special ways, which can significantly increase the cost of a project. In this case, a project for which the cost of removing a dam might be $200,000 might have dredging costs in the millions of dollars. Often, the presence of hazardous materials in the sediment can stop a dam removal project due to cost, and steer the project toward the construction of a fishway.

Construction Access.—Costs can be driven up if the contractor has no practical way to access the dam. A dam surrounded by buildings (e.g., St. Charles and Stolp Island dams) or forbidding terrain (e.g., east bank below Dayton Dam) presents a physical challenge. If the dam is surrounded by private property without a legal right-of-way access, there may be legal challenges—which can be surmounted but only after spending some money. Sometimes access roads need to be developed, e.g., clearing trees, flattening small hills, crossing wetlands, building (and subsequently removing) temporary stone access roadways in the river. If land with a dedicated use is disturbed during the project (like a Kane Country Preserve hike/bike trail), money will need to be budgeted to restore the land to its original condition.

Finally, it is helpful to review costs of dam removals in other states. The State of Connecticut has removed four dams on the Naugatuck River that are very similar to dams on the Fox River. These dams ranged in height from 2 to 8 ft. The Naugatuck River is similar in size (flow and width) to the Fox River but has less suspended sediment and much of the streambed sediment behind the dams is larger than that behind the Fox River dams. None of the sediment was hazardous. The costs were:

- *Anaconda Dam* - $136,000. Timber spillway 9 ft. high and 375 ft. long, constructed access road, one excavator and two workers for 4 days, no dredging, no stabilization of riverbanks. (An additional $250,000 has been planned for site restoration, which has yet to occur.)
- *Union City* Dam - $200,000. Timber spillway encased in concrete and stone 7 ft. high and 210 ft. long, constructed access road, one excavator, three workers, some jack hammering for 2 weeks, minor dredging, no stabilization of riverbanks.

- *Platts Mills Dam* - $164,000. Spillway, 10 ft. high and 231 ft. long, previously breached, stone/earthen dam partially removed and stream re-graded, one excavator, one and a half workers for 1 week, no dredging, no stabilization of riverbanks.
- *Freight Street Dam* - $126,000. Timber spillway capped with concrete, 2 ft. high and 158 ft. long, no access road, one excavator, two men, 4 days, no dredging or bank stabilization.

Based on experiences in the Northeast, a clear trend is evolving with regard to costs of dam removals. The initial cost estimate is often higher than the jobs actual cost. Everyone seems to overestimate the costs of dam removal projects. For example, the engineers' detailed cost estimate for the removal of the Union City Dam ($256,000; Table 33) was within the range of estimates by bidding contractors ($187,000 to $612,000; Table 34) but above the actual removal cost of $200,000 (L. Wildman, American Rivers, personal communication).

Denil Fishways

There is a great deal of experience in building Denil fishways. This is a common design used for small dams on the West Coast and small- to moderate-sized dams on the East Coast of the United States and Canada. Denils also have been used extensively to pass fish over dams in Europe. The main costs of Denil fishways include engineering design, excavation, building of forms with reinforcing rod meshes, and pouring concrete. There are several ways of estimating these costs, but the U.S. Fish & Wildlife Service engineers in the Region 5 office typically use a figure of $1,600 per linear foot as a guideline (C. Orvis, USFWS, personal communication).

Suppose a Denil fishway with a 1:15 slope is prescribed at a 10-foot high dam:

10 ft. (dam height) x 15 (fishway slope)	=	150 ft.
Add one intermediate resting pool	=	20 ft.
Add one 10 ft. entrance and one 10 ft. exit pool	=	20 ft.
Total length	=	190 ft.
Total cost (190 ft. x $1,600)	=	$304,000

Additional considerations for the specific design of the fishway, such as extensive cofferdams, dredging, special construction access, relocation of utilities, etc., can result in added costs to the project. For these reasons, accurate cost estimates cannot be determined until an engineering firm provides conceptual designs. In addition, the same caveats listed at the beginning of this section on the geographic variability of costs holds true for Denil fishways. However, this 'rule of thumb' will allow a rough estimate of the costs and this approach was applied to the basic conceptual plans developed in this report to provide cost estimates for each dam with a Denil fishway option.

Some dam owners in the Northeast are trying alternate approaches to Denil fishways in an effort to reduce construction costs. One promising approach is not to 'pour in place' but to

Table 33. Engineer's detailed cost estimate for the Union City Dam removal on the Naugatuck River, Connecticut (courtesy of L. Wildman, American Rivers).

Specifications Section	Items	Unit	Quantity	Unit Price	Subtotals	Total
Water Control		LS	1		$65,135	$65,200
initial breach		cy	45	$15	$675	
4 temp 60" CMP installed		lf	220	$250	$55,000	
impervious backfill		cy	232	$20	$4,640	
2 riprap pads ~36cy/pad		cy	72	$30	$2,160	
install 4 eyebolts, washer, & chain		LS	1	$400	$400	
floating boom to deter boats		lf	200	$7	$1,400	
dewater for concrete pour	2-2" pumps for 5 days	days	5	$172	$860	
Temporary Sediment & Erosion Control		LS	1		$3,135	$3,200
105 LF FFF		lf	105	$3	$315	
200 LF turbidity Curtain		lf	200	$12	$2,400	
40 ' absorbent boom		ea	1	$120	$120	
temp. vegetation (max ~500sy)		sy	100	$3	$300	
Clearing & Grubbing (~500 sy)		LS	1		$2,000	$2,000
Dam Removal		LS	1		$56,925	$57,000
relocate &/or dispose offsite		cy	1035	$55	$56,925	
Riprap Armoring		LS	1		$46,470	$46,500
stone ~750cy (if none from dam)		cy	750	$40	$30,000	
temporary access road	~48sf*215ft=383cy	cy	382	$15	$5,730	
front of culverts	~112sf*95ft=394cy	cy	394	$15	$5,910	
on land		sy	423	$10	$4,230	
grout for end of dam		cy	20	$30	$600	
General Excavation		LS	1		$12,280	$12,300
sediment relocation		cy	1228	$10	$12,280	
Class A Unsuitable Soil Excavation	no testing	cy	300	$16		$4,800
stockpile, dewater, & measure	time spent	cy	300	$3	$900	
excavate from pile to truck	~ 1/2 of excavation cost	cy	300	$5	$1,500	
disposal of	~5mi trucking round trip	cy	300	$8	$2,400	
Class B Unsuitable Soil Excavation	no testing	cy	300	47		$14,100
stockpile, dewater, & measure	time spent	cy	300	$3	$900	
excavate from pile to truck	~ 1/2 of excavation cost	cy	300	$5	$1,500	
trucking 30mi (Naugatuck to Milford)	16cy/load; 60mi round trip	cy	300	$37	$11,100	
disposal at Silver Sands Landfill	might not cost extra	cy	300	$2	$600	
Restoration	100 plants	ea	100	$30		$3,000
selective plantings						
topsoil & turfing		sy	500	$5		$2,500
Concrete Arch	potential dewatering arch~6cy	lf	60	$100		$6,000
Mobilization		LS	1	$15,000		$15,000
					Sub Total =	$231,600
					Allowance for Class "C" Unsuitable Soil =	$25,000
					Sub Total =	$256,600
					10% Contingency =	$25,660
					Sub Total =	$282,260
					15% Constr. Admin. =	$42,339
					Total =	$324,599
					Total (Rounded) =	**$325,000**
					Plus lab testing =	$4,000
						$329,000

Table 34. Contractors cost estimates from the Union City Dam removal on the Naugatuck River, Connecticut (courtesy of L. Wildman, American Rivers).

Description	Engineers' Estimate	Contractor 1	Contractor 2	Contractor 3	Contractor 4
Clearing & Grubbing	$2,000	$2,470	$16,436	$39,000	$30,000
Temporary Sediment & Erosion Control	$3,200	$14,500	$12,098	$15,000	$15,000
Demolition	$57,000	$26,000	$41,075	$125,000	$124,000
Water Control	$65,200	$22,000	$40,048	$28,000	$80,000
Earthwork	$12,300	$33,475	$22,845	$25,000	$110,000
Unsuitable Soil Excavation - Class "A"	$4,800	$3,600	$300	$9,000	not given
Unsuitable Soil Excavation - Class "B"	$14,100	$4,500	$300	$15,000	$25,000
Unsuitable Soil Excavation - Class "C"	$25,000	$25,000	$25,000	$25,000	$25,000
Mobilization	$15,000	$20,000	$22,440	$30,000	$39,000
Armoring	$46,500	$19,900	$32,701	$35,000	$115,000
Topsoil & Turfing	$2,500	$5,400	$4,325	$5,000	$5,000
Selective Plantings	$3,000	$6,000	$6,000	$5,000	$20,000
Concrete Arch	$6,000	$4,500	$4,785	$18,000	$24,000
Total	**$256,600**	**$187,345**	$228,353	$374,000	$612,000

pre-cast' the structure off-site in 8-foot modular sections. These sections include holes for the insertion of lifting eyes and inside eyes for laterally pulling the sections together. The sections are transported on site and lowered in place within a few inches of the previous section, which is already secure and resting on a prepared bed of crushed stone. A gasket and appropriate grouting products are placed between the two units and winches attached to the internal eyes are used to pull the new section snug against the previous section. Once the new section is firmly in place, the eyes are removed from the section and the holes are filled with grout. The next section is then moved into place following the same procedure. While some contractors feel that this can be done for less money, others still choose to form and pour in place. Decisions on which approach is the most cost efficient for a particular project must be based on specific cost information from contractors and vendors from the geographic area in question. Also, the designing engineer must approve the approach used. If a section of a fishway is going to be resting on bedrock and it will be subject to powerful flood flows, it is likely that the engineer will design the section to be pinned directly to the bedrock, which will require pouring in place.

Bypass Channels

Americans do not have much experience in building bypass channel fishways and therefore cost estimates are not readily available. Most bypass channels have been built in Europe and Australia. An existing channel in Colorado and a planned channel in Connecticut involve blasting through bedrock and therefore the costs cannot be used as a guide for channels at Fox River dams. Bypass channels are less expensive than Denil fishways, per linear foot, because Denils involve the forming and pouring of many yards of concrete, which channels do not. Of course due to the flatter slopes, there are more linear feet of channels than Denils for the same dam. However, most of the costs of bypass channels involve excavation, the importation and placement of stone, and the installation of some kind of upstream water controls. Excavation is relatively inexpensive relative to the construction of concrete and metal structures, as long as bedrock, utilities, or other complicating surprises are not encountered. Some concrete may be necessary to construct a water control structure at the upper end of the bypass channel and some channels may require vehicular bridges to preserve operations and maintenance access to the dam. If soil types are particularly permeable, some clay or geotextile material may need to be laid down as a base of the channel to minimize below ground seepage of water. In the Northeast, rounded boulders and cobbles that are needed to build arched rocky ramps or weirs at regular intervals within the bypass channel are easy to acquire and relatively inexpensive. If such materials are not readily available in Northeastern Illinois and they need to be imported from some distance, the costs may rise relative to costs in the Northeast.

SPECIFIC OPTIONS FOR FOX RIVER DAMS

Introduction

In this section, we present options to reconnect the river for each of the 15 Fox River dams, beginning in the north (Stratton Dam) and proceeding downstream to the Dayton Dam. Field crews visited each dam and took measurements to determine existing physical parameters. Written materials concerning the dams were obtained from many sources, including anonymous field notes from an Illinois Department of Natural Resources (IDNR) field trip along the river on December 2, 1998 and published in-house reports (Anon. 2000). Some data collected for Part A of the study also were included in this portion of the report. Lists of the fish species that are present in each stretch of river were reviewed. Scientific literature and fish passage experts were consulted regarding the swimming ability of various species and fishway designs proven most effective for them.

This section of the report is organized in a standardized format so that similar information is provided for each dam. The section will seem very redundant as similar options are reviewed for dam after dam. It is important for some parties, such as IDNR, to consider all of these proposals at a watershed scale because that is the level at which the benefits will be most noticeable. However, other readers may be interested only in options for the dam in their home community. The report was designed so that sections on each dam act as ‘stand alone’ alternative analysis reports. If the reader copies individual dam sections, it is recommended that the preceding introduction and cost sections be copied as well to assist in the interpretation of the information presented for individual dams.

For each dam, we review the existing conditions at the dam and describe potential fish passage options. Some dams have only one option described whereas others have as many as four options described. The options were chosen for inclusion based on the profession judgment of the authors and the following criteria: 1) effectiveness at passing fish, 2) other ecological benefits to the river, 3) expense, 4) practicality of construction, 5) compatibility with existing uses, 6) miscellaneous factors, such as public safety, future operation and maintenance burdens, and aesthetics.

The sketches provided are not to scale and cannot in any way be viewed as engineering plans. No engineer has contributed to the drafting of these conceptual designs. The sketches are provided to demonstrate that the proposed fish passage designs will fit in the available space at the sites, and to show how they might look when completed. Steve Gephard, the primary author of this part of the report, has 20 years experience in fish passage and is familiar with the application of designs that provide effective fish passage. He has developed many similar conceptual plans for fishways that subsequently were designed by engineers, built, and effectively pass fish. We have confidence that the conceptual plans presented within, if properly developed by qualified engineers and fish passage specialists, can be built at Fox River locations to effectively pass the targeted fish species. The intent of this section of the report is to shed light on possible fish passage alternatives for each dam and help stakeholders make informed decisions. When an option is selected, experienced engineers must be hired to 'add flesh to the bones' and turn these ideas into well-designed projects. Because most civil engineers from the Midwest have no experience in designing fishways, stakeholders should be prepared to look at out-of-state companies for this expertise.

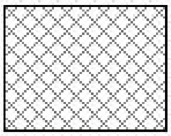
Although dam removal is included for all dams where appropriate, much more space is devoted to fishway and bypass alternatives. This should not be viewed as an indication of the relative importance of the various options. In all cases, removing the dam will provide the most ecological benefits to the river and in most cases (removal is not a realistic alternative for certain dams at this time) such an action should be given paramount consideration. Removing a dam is relatively simple and does not require detailed conceptual design plans beyond those developed by a contractor. The pond is de-watered, access in developed for equipment via one or more riverbanks, equipment accesses the spillway and begins disassembling it usually by battering it into chunks, and the demolition debris is hauled away for appropriate disposal. Other factors, such as the disposition of accumulated sediment from behind the dam, aquatic habitat restoration, and vegetation management should be addressed by designing engineers, restoration experts, and contractors and are beyond the scope of this report. Therefore, it is not necessary to repeat the dam removal process in each section on individual dams. Conversely, it is important to demonstrate how fishway alternatives might fit into the available landscape alongside of dams, particularly because effective fishways are not common in Illinois.

The following section on individual dams contains standardized fishway and dam terminology and repeated references to Denil fishways and bypass channels. It may be helpful to review the photos and sketches of Denil fishways on page 107 and bypass channels on page 108 and 109 before viewing sections on individual dams. These photos and sketches include symbols that are used in schematic diagrams to represent specific components of the fish passage facility. A glossary of commonly used terms is provided on page 110.

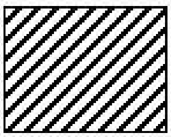
Semi-natural fish and boat bypass channels are excavated from the indigenous soils and bedrock around the dam at a 1:30 (3.3%) slope. Rocky ramps are built into them at regular intervals to break up the slope and create a series of pool and riffle complexes. Landscaping can take many forms, including a 'natural setting' with native trees, shrubs and grasses planted right up against the channel or a ‘park like setting’ with concrete and stone terraces, viewing areas, and picnic sites with ornamental plantings, overhead lighting and signs.

Symbols used in the sketches for Denil fishways.

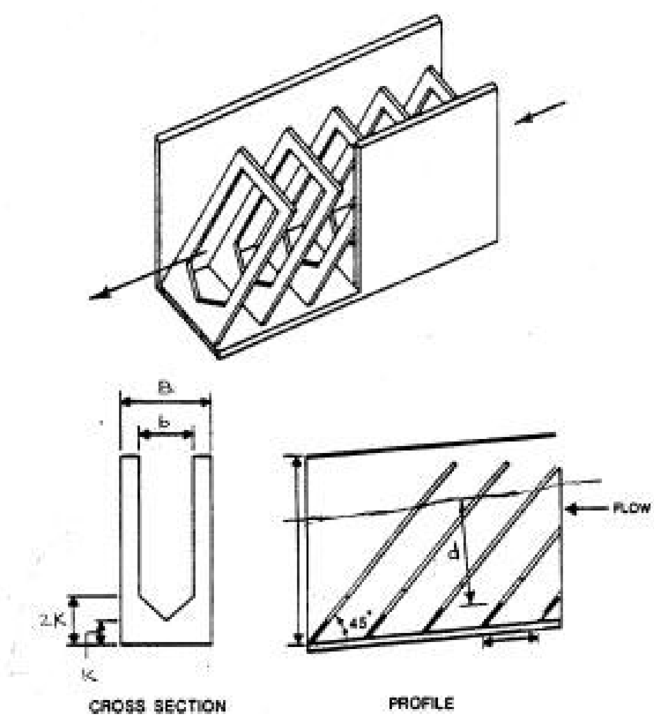
Pool – A flat concrete stretch of fishway with zero slope. Pools are used by fish to rest, turn, enter, and exit fishways and they can accommodate viewing windows and traps.



Protective grating – Aluminum grating over the top of a fishway that allows light to enter (important for fish passage), but keeps trash, ice, and unauthorized persons out.

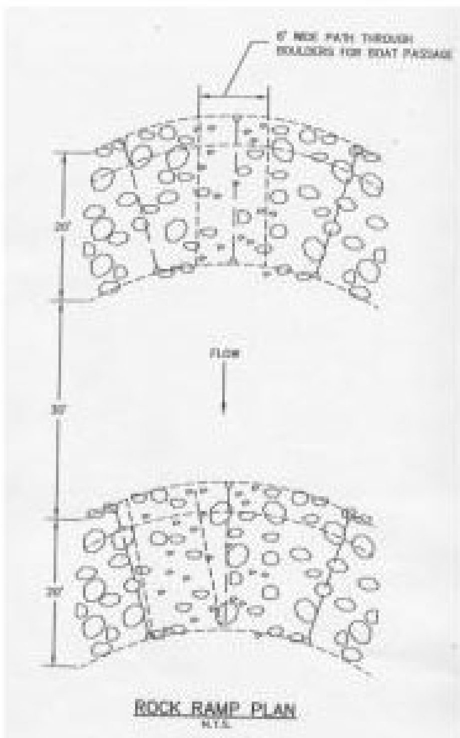


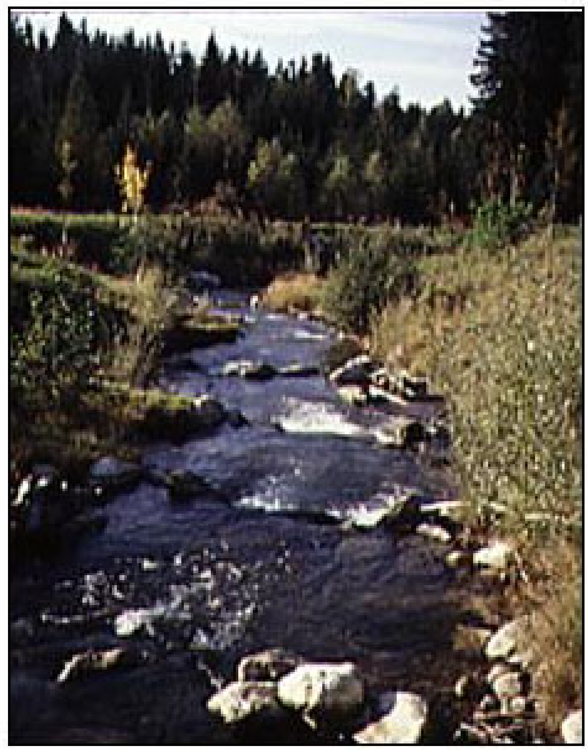
Baffled ramps – The sloped sections of fishways where fish ascend the dam. Ramps are set on a slope of 1:15 and hold special wooden baffles every 2 ft. The cross section of a typical Denil baffled ramp is shown in the sketch below left. The photos to the lower right show a dry Denil fishway looking downward (top) and a similar view with water running through it (bottom). Dimensions and features of a Denil fishway are identical from one fishway to another.



Institution of Civil Engineers modified Denil Fishway.

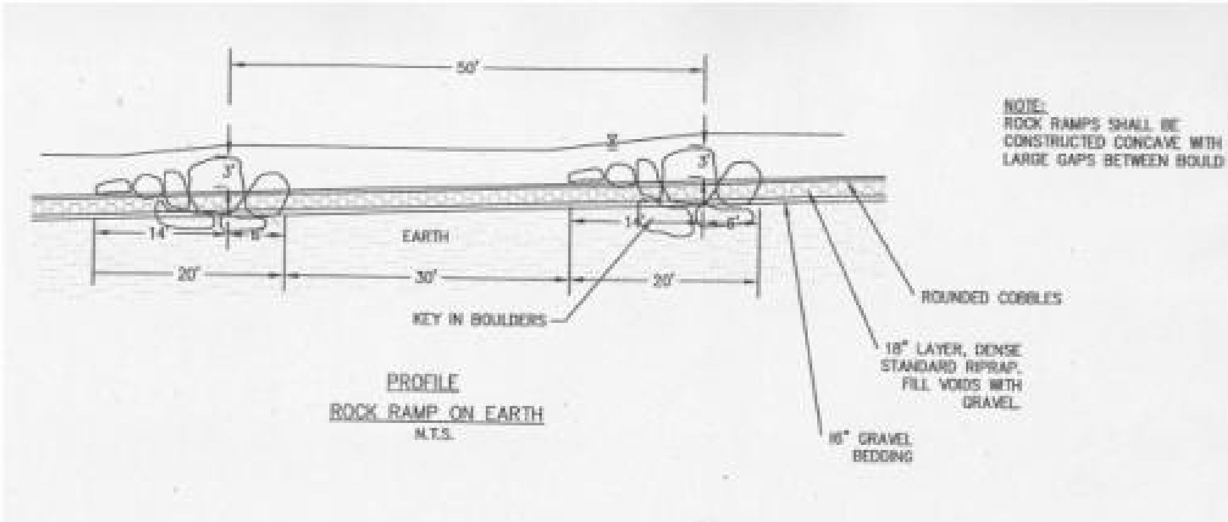
(Adapted from Orsborn, 1985)



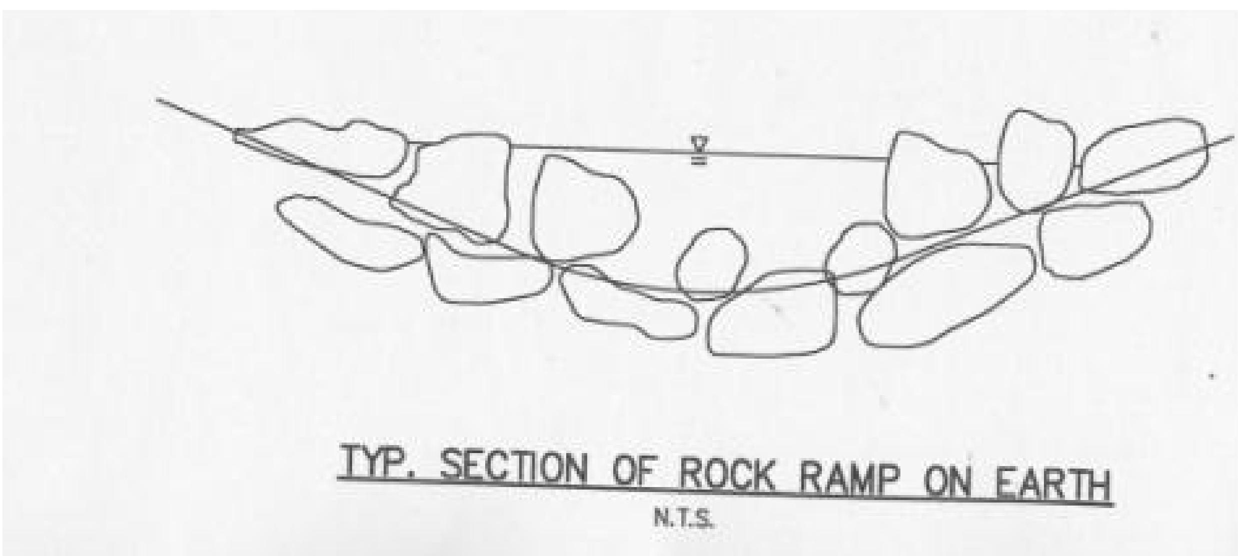


Sketch of a bypass channel with rocky ramps every thirty feet to create pools.

Photo of a operational bypass (looking downstream).



In this sketch, the water is flowing from right to left. The top line is the water level. Twenty-foot long rocky ramps are embedded into the channel bottom every 50 feet (on center) to create stairstep pools 30 feet long. Each pool is less than one foot higher than the previous downstream pool.



This is a typical cross-section view of the rocky ramp that is placed within bypass channels. Rocks of varying sizes create passage opportunities for a variety of species and sizes of fish. The rocky ramp backs up water and creates a pool. Rocks are arranged to allow the passage of canoes and kayaks when that is an objective of the channel.

Glossary

Attraction water - Fish locate the entrance of a fishway by the flow of water issuing out of it. Sometimes if the amount is too small, they cannot find the entrance. Often, fish are assisted by the addition of so-called 'attraction water'. This is extra water that is not in the fishway but is brought down from the headpond via a pipe or trough and added at the bottom of the fishway to augment its flow.

Bypass channel - This is a type of fishway that is excavated out of surrounding land to mimic a natural stream channel. It will have pools and riffles, curves, varying widths and typically will have natural vegetation growing along it with few artificial features like concrete.

Cfs or cubic-feet-per-second - This is a common way for engineers and environmental scientists to measure stream flow. This is different than industrial water users or municipal water suppliers, who often describe flow in millions-of-gallons-per-day. A cubic foot of water is the amount of water that measures one-foot high, one-foot wide, and one-foot depth. This equates to about 7.5 gallons of water. So, a flow down the river of 2,000 cfs equates to 15,000 gallons passing a particular point of the stream bank each second.

Dam - The earthen dam and the spillway collectively can be referred to as the dam.

Denil - A type of fishway (pronounced da-NEEL) named after a Belgian engineer. It is a concrete ramp with wooden baffles inserted on angle every two feet.

Earthen dam - The portion of a dam which no flow passes but has been artificially created to help impound water. While this is not always made from earth, it is at most Fox River dams.

Entrance - This is the lower end of the fishway. The term 'entrance' is from the fish's perspective, not the descending water's perspective.

Exit - This is the upper end of the fishway. See above.

Fishway - Any artificially constructed structure that is used to help fish swim from below a dam to above a dam. May include a variety of designs, including a pool & weir, Denil, a fish elevator or lift, or a bypass.

Headpond - This is the pool of water upstream of the dam that is impounded by the dam.

Headrace - This is a canal that conveys water from the headpond toward the mill or hydroelectric power plant prior to it being used to do work. Also referred to as a millrace or power canal.

Race - This is an old mill term for an artificially created canal or channel that served a mill.

Resting pool - A pool within a fishway that is designed to allow migrating fishes a chance to rest. Unlike the rest of the fishway, these pools are flat and have lower water velocities. They typically are placed every 6-7 vertical feet to prevent fish from become fatigued.

Slope - This is the gradient of the fishway. It can be expressed in percentage or a ratio. For example: a fishway that rises one vertical foot for each fifteen horizontal feet is said to possess a 1 on 15, or 1:15, slope. That could also be described as a 6.6% slope (dividing the height by the length).

Spillway - The concrete or stone portion of the dam over which the stream flows.

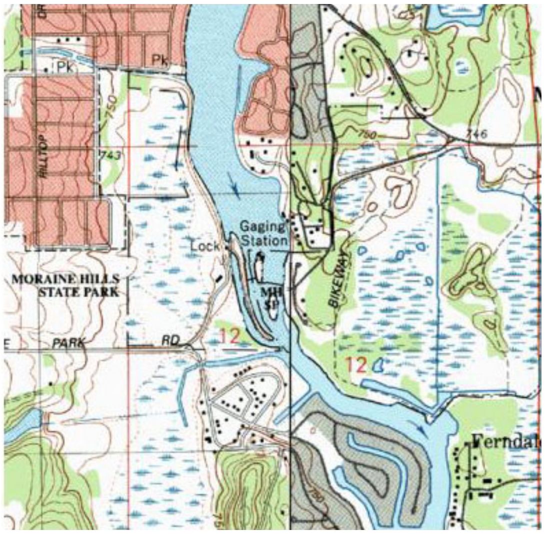
Tailrace - This is a canal that conveys water away from the lower portion of the dam, usually from where a mill or hydroelectric power plant has discharged the water.

Tailwater - This is the section of the river downstream and flowing away from the dam.

Turn pool - A pool within a fishway that is designed to allow the water and fishes to turn, often at 180 degrees. In order to be passable, turns have to be flat. If turns were made in sloped sections of a fishway, the water would have too much energy and turbulence and most fish could not negotiate the turn. Often, turn pools also serve as resting pools.

STRATTON DAM (A.K.A. MCHENRY DAM)

LOCATION



Latitude-longitude (NAD 83): 42.309367˚N 88.2514894˚W
Legal: T44N R8E S12NW
Town: Near McHenry, IL
River mile: 98.9
Comments: First dam below Fox River Chain-O-Lakes.
Next downstream dam (distance): Algonquin Dam (16.34 miles)
Next upstream dam (distance): Beyond the scope of this report. Distance to Pistakee Lake outflow is 6.8 miles.

DESCRIPTION

Height: 6.5 ft.
Spillway elevation: 736.8 ft.
Length: 275 ft.
Dam type: Broad crested
Material: Varied - concrete, stone, earthen, steel
Nature of barrier to fish: Complete
Construction date: Original dam built in 1907 but the existing dam was built in 1939. The boat locks were built in 1960.
Condition of dam: Good, although the State of Illinois has completed modifications to improve its ability to control pool level in the Chain-O-Lakes.
Length of impoundment: 6.8 miles
Appurtenances: Stone spillway, five upward-opening sluice gates, a navigation lock, and a non-functional pool & weir fishway.

LEGAL/SOCIAL ASPECTS

Owner: State of Illinois, Department of Natural Resources - Office of Water Resources

Owner of adjoining land: IDNR/OWR

Present day purpose of dam: Navigation above dam, control of pool level in Chain-O-Lakes, control of downstream water flow.

Uses of impoundment: Recreational power boating

SEDIMENT ACCUMULATION BEHIND DAM

Not investigated.

BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

Note: Recommendations for Stratton Dam were provided to IDNR before the release of this report. These recommendations differ from those of other dams because they focus on repairing an existing fishway. We included them here as they were initially developed rather than re-formatting them to conform to the style of the other dam recommendations.

DESCRIPTION OF THE EXISTING FISHWAY

In the historical overviews of the dam and lock, no mention is made of the date when the fishway was constructed. It is a simple 'pool-and-weir' fishway modeled after the early salmon ladders of the West Coast but without great attention to details. There are seven pools that vary in length from 4 to 8.5 ft. long and all are approximately 8 ft. wide. All weirs (concrete walls that separate the pools) except the first (lowermost) and last (uppermost) have a notch about 2.5 ft. deep and 4 ft. wide to pass the water downstream. These notches alternate from side to side. The fishway is in fair physical condition. The stone sidewalls appear to be sound but the weirs are crumbling and in various stages of disrepair. One weir was recently replaced.

ASSESSMENT OF THE FISHWAY'S PERFORMANCE

The Foundation sampled the fishway for fish in April and May of 2000 and documented 748 individuals representing 15 species in the pools (see Appendix G for more details on fishway investigations). However, there is no evidence that any fish successfully exited the fishway into the headpond. In fact, that occurrence seems highly unlikely due to the excessive head loss maintained at the exit weir, presenting most fish with an insurmountable obstacle. In addition, it is not clear whether some of the observed fish actually descended the fishway rather than ascended it. Problems with the fishway include:

- Irregular drops (head loss) from pool to pool that range from zero (provides fish no opportunity to climb) to 1.23 ft. (impossible for fish to leap).
- Turbulent flows and lack of proper energy dissipation in many pools.
- Inadequate flow regulation.
- Poor attraction to upstream migrants.

OPTIONS FOR CORRECTIVE MEASURES

Abandon the existing fishway and replace it with a Denil fishway:—Pool-and-weir fishways like the one at Stratton Dam work well for salmon and large trout but not for Midwestern riverine species that inhabit the Fox River. The location of the entrance of the existing fishway is too far east from the gates that pass the majority of the flow, which result in many fish not being able to locate it. A new, specially designed Denil style fishway could be constructed a few feet west of the existing fishway with the entrance near the base of the gates and the exit just upstream of the exit of the existing fishway. This option would be the most effective at passing fish, but is the most expensive option discussed. At this time OWR indicated that it did not have the money or time to design for such a fishway.

Convert the existing fishway into a Denil fishway:—This plan would require that the existing fishway be straightened beyond Pool 5 and extended north beyond the location of the existing exit. Again, the OWR indicated that it lacked the money and time to implement this option and part of the new fishway might interfere with portions of the new gate construction.

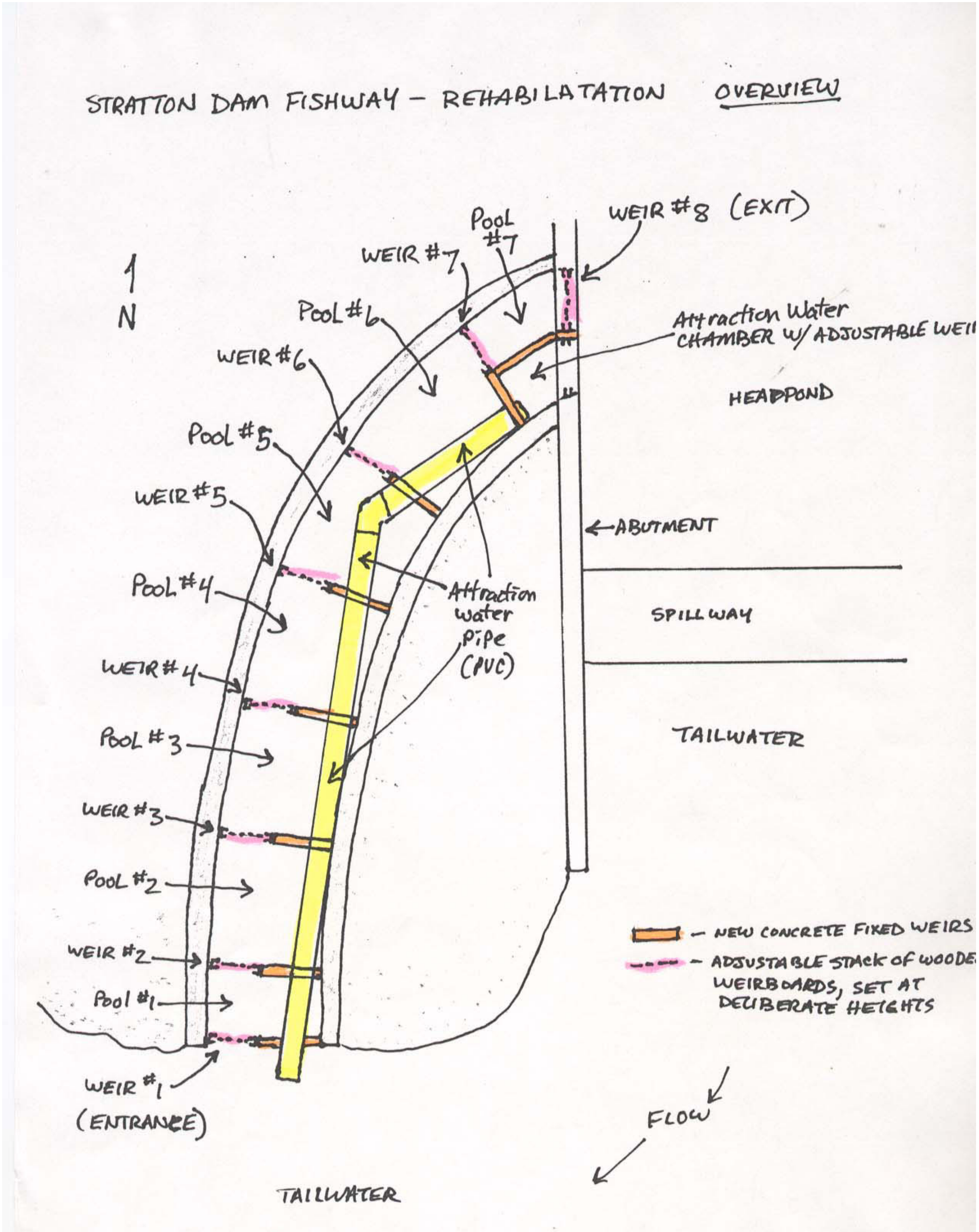
Maintain the existing pool-and-weir fishway but rehabilitate it to correct deficiencies:—Due to the simplicity and relative low cost of this plan, the OWR requested the Foundation provide details for this option and they are presented below. At the time of this report, the addition of a foster gate in the Stratton Dam spillway was completed and modification to the existing fishway was not initiated. If new circumstances change opportunities for fish passage at this dam, we recommend that OWR consider the first option outlined above. However, we do not include detailed conceptual plans for its design.

OVERVIEW OF PLANS

See the accompanying sketch entitled "Stratton Dam Fishway Rehabilitation – Overview." Note that standard fishway terminology is used for this report (see glossary of terms). For example, the entrance is at the bottom and the exit is at the top of the fishway. Pools and weirs are numbered from the bottom up, so Weir 1 is the first weir, Pool 1 is what is impounded by Weir 1 (immediately upstream), and Weir 8 is the top (last) weir.

The basic components to the rehabilitation project are:

- Replacement of all weirs.


STRATTON DAM FISHWAY – REHABILATATION OVERVIEW
N
WEIR #8 (EXIT)
POOL #7
WEIR #7
POOL #6
WEIR #6
POOL #5
WEIR #5
POOL #4
WEIR #4
POOL #3
WEIR #3
POOL #2
WEIR #2
POOL #1
WEIR #1
(ENTRANCE)
Attraction Water
CHAMBER W/ ADJUSTABLE WEI
HEADPOND
ABUTMENT
Attraction water pipe (PVC)
SPILLWAY
TAILWATER
– NEW CONCRETE FIXED WEIRS
– ADJUSTABLE STACK OF WOODE
WEIRBOARDS, SET AT
DELIBERATE HEIGHTS
FLOW
TAILWATER

- Installation of adjustable crests for notches rather than fixed concrete sills. Convert from staggered notches to aligned notches.
- Rebuild the fishway exit to provide adequate flow regulation.
- Rebuild the fishway entrance to provide suitable head loss distribution and attraction.
- Provide supplementary attraction water flow to improve location of fishway by fishes.

It is important to regulate the amount of water entering the fishway and to regulate and standardize the amount of drop experienced at each weir. These tasks are difficult to do with fixed concrete sills. All weirs must have a section (half of the 8-ft. wide walls) that house an adjustable stack of removable weir boards, which shall consist of 2 x 6 in. lumber and smaller boards (e.g., 2 x 4 or 2 x 2) to allow fine-tuning of the height of the stack. Regardless of the varying widths of the pools, the notch (i.e., the adjustable stack of weir boards) must be exactly the same width (4.0 ft.). The widths of the permanent, non-overflow, concrete section of the weirs can vary to compensate for varying pool widths. Currently, Weir 8 (top) has no notch but experiences the full 8.8 ft. of crest spill. This absolutely must be changed to a 4-ft. notch like all of the other weirs. Likewise, Weir 1 (bottom) must be changed to a 4.0-ft. notch from the current no notch condition. In addition, Weir 1 is too low to impound water and therefore is useless for energy dissipation and allowing fish to climb. The walls must be raised to create a head loss at the downstream end.

The adjustable weir boards are slid into place by use of aluminum channels or board slots. These structures are generally fabricated in a machine shop and installed on the fishway. The channel is designed to accept '2 x' lumber comfortably, allowing for water swelling (e.g., 2.5 in. wide), and they should have holes drilled through the backing plate to allow lagging onto walls. In the case of new concrete walls, the channels may be pinned into the form and poured in place. The channels are paired, one on the west end of the new concrete weirs and one on the east end. They must match so that a straight board may easily slide down both channels simultaneously.

The new walls should be 8 in. thick with a 4-in. PVC pipe section inserted through the bottom for drainage and control of water level oscillation. Draft repair plans call for the construction of 12-in. thick weirs but that is excessive. This thickness is not needed to maintain structural integrity of the wall, and the additional 4 in. per weir (and 32 in. for the entire fishway) take up valuable linear space better used in the pools for energy dissipation.

The attraction water system provides additional water to the bottom of the fishway to attract fish. If that extra water were passed down the fishway instead, for the same intention, it would result in too much flow and turbulence and would discourage successful fish passage. By bypassing the fishway in a pipe, the flow can spill down below in a high-energy manner that will attract fish but not interfere with passage. The top intake for the attraction water system (the chamber) should have channels for adjustable weirs so that the amount of water descending the attraction water pipe may be regulated. Previously, it was stated that the water entering the fishway must be restricted to a 4-ft. wide opening at the 8.8-ft. wide exit. The balance of that opening can be used for the attraction water chamber, which would be separated from the main fishway by a wall and floor spanning Weirs 8 and 7. The top of Weir 7 can be modified to house a female coupling for PVC sewer pipe (12-in. diameter) in such a way, that the water entering the fishway can be regulated separately from the water entering the attraction water chamber. Approximately five 10-ft. sections of PVC pipe can be joined together to reach the bottom of the fishway. The pipes can be rested on top of the weirs in whatever manner works. The attached drawings show a pre-formed semi-circular "saddle" in the top of each new weir with a metal 'U-strap' affixing it to the top. However, the saddle may not be necessary. Some angles will be necessary to adapt the straight pipe to the curvilinear fishway and, perhaps to accommodate the slope of the fishway. A "gulper pipe" that allows entrained air to escape might be needed on the top of the attraction water pipe at its upper end. The plans call for all of the notches to be aligned on the west side of the fishway and the attraction water pipe to be supported by the full-height weirs on the east side. If this scheme becomes impractical due to the constraints of the straight pipe, some notches can be staggered (i.e., placed on the east side of the fishway). However, in preparing final designs, the following guidelines should be adhered to:

- Weirs 8 and 7 <u>must</u> be on the west side of the fishway.
- It is strongly recommended that Weir 6 also be on the west side.
- The remaining weirs can be on any side of the fishway, except that Weirs 1 and 2 must be on the same side of the fishway.
- The end of the attraction water pipe should fall between 2 and 5 ft. beyond the end of the fishway entrance.
- The end of the attraction water pipe should have a female or bell end with the ability to accept an angled coupling and be able to retain such a coupling without having it blow off. It is possible that the attraction water could interfere with the flow out of the fishway and need to be angled slightly away from the entrance. This is not anticipated so a coupling is not recommended prior to shut-up and fishway testing.

PROPOSED CONSTRUCTION SEQUENCE

1. Draw down head pond or build a cofferdam to enclose and dewater work area. If a cofferdam is planned instead of a drawdown, the cofferdam should enclose and de-water the area immediately upstream of the fishway exit, so that work can be done in the dry.
2. Build a cofferdam outside of the fishway entrance in the tailwater to allow dry construction on the entrance.
3. Completely gut the fishway by removing timbers in the exit and all existing weir walls. If some weirs appear to be in good condition, consideration can be given to saving them, but it will complicate the installation of the adjustable weirs and channels. Furthermore, if any weirs are to be retained, they must be compatible with the overall scheme outlined in the

previous paragraph about notch alignment. It would probably be simpler to remove all structures down to the stepped fishway floor.

4. Inspect the fishway walls and floor. Make any necessary repairs or patches to the basic channel.
5. If the wall between the fishway and the headpond is in questionable condition, it would be advisable to replace the entire wall as part of this project. If the wall does not need replacing, the OWR should consider cutting a notch out of the west side of the concrete sill to achieve a 734.5 ft. elevation so that the fishway can be operated in April to accommodate early fish runs (e.g., northern pike). Note that operation at winter pool could dictate that all weirs be lowered (or in the least, Weirs 4 through 8). This would require a winter pool weir board stacking scheme and summer pool stacking scheme.
6. Form and pour weir walls 1 through 8 according to design plans. Add height to side walls of Pool 1 as needed to match adjoining walls and allow the pool to impound fishway flow.
7. Weir 7 should be adapted to hold the female coupling for the attraction water pipe. The wall that divides the top of Pool 7 in half should NOT go all the way to the bottom of the pool but only to the top of the concrete sill at Weir 8. The entire Pool 7 (below attraction water chamber) is needed for energy dissipation of water dropping from the Weir 8 notch. The suspended wall and floor may be expensive to pour out of concrete and consideration could be given to making these structures out of pressure-treated 6 x 6 in. lumber. If that is done, the timbers should be bolted into place using metal brackets (not set in concrete) to expedite their replacement in future years when they begin to rot.
8. Pre-fabricated aluminum channels should be bolted to the fishway walls. Channels on the end of the weir walls may have been previously inserted into the forms for the walls prior to pouring.
9. The rest of the PVC pipes are inserted and secured.
10. Weir boards are cut and installed so that the tops of the adjustable stacks achieve targeted elevations. The top board for Weir 8 should be marked for easy identification. Then the rest of the channels for Weir 8 and the attraction water chamber should be filled to the top with additional boards so that when the pond is refilled, the fishway remains dewatered. Weir boards are best made of oak for longevity (~ 10 years) but if oak lumber is not readily available, standard fir can be used. However, fir will rot in two or three years so an accurate weir board diagram needs to be maintained so that as boards need replacing, workers know exactly how many boards (i.e., how many vertical inches of wood) are needed in each notch.
11. If there is accumulated sediment or rubble immediately in front of the entrance of the fishway that might dissuade fish from approaching the fishway entrance, those materials should be pushed aside prior to or during the removal of the cofferdam. There should be a clear, moderately deep ‘approach channel’ between the main river channel where fish approach the dam from downstream areas and the fishway entrance. What is being suggested is not major excavation but simply clearing a path.

12. Prior to the re-watering of the headpond area, consideration should be given to driving two piles for the support of a research fish trap (see below).
13. Re-water the headpond area.

POST-CONSTRUCTION ACTIVITIES

1. When the fishway is ready for operation, remove top boards in Weir 8 down to the marked board and allow water to pass down fishway. If the drop (headloss) at individual weirs differs, top weir boards can be replaced until a uniform drop is observed at each weir.
2. The attraction water boards should be removed and evaluated at full flow. If the pipe cannot accept all of the water or if the flow at the bottom creates problems, boards can be placed in the channels to reduce the flow.
3. The fishway should be closed and de-watered during the winter to minimize ice damage. At this time, workers can remove accumulated trash and sediment and inspect the fishway and weir boards for damage and wear.
4. The OWR should work closely with DNR fisheries biologists to determine the most appropriate seasons for operation.

NOTES ON ACCOMPANYING DRAWINGS

Sheet 1:—The elevations shown at each weir depicts the targeted elevation for the top of each weir board stack. The drawing shows the boards stacked on top of the remnant stub of the existing concrete wall, but it is recommended that these old walls (notches) be totally removed. To achieve these elevations for weir board stacks, it is recommended that the existing concrete sill at Weir 8 be used as a known elevation benchmark (735.45 ft.) and that all of the elevations from the fishway floors of each pool (and notch) be shot and documented. Then, simple arithmetic can be used to determine how many vertical inches of boards are added to each slot to achieve the target elevation. For example, if the floor of Pool 5 is at 732.00 ft. and we know Weir 5 needs to be at 735.00 ft., we add 3 ft. of boards (three 2 x 10s and one 2 x 6). The aluminum channels can be marked with some waterproof mark at the 3-ft. level so that workers know that boards need to be stacked up to that height.

Sheet 2:—The PVC drain pipe shown in sketches A and B is not shown in sketch C. This pipe should be cut flush with the faces of the wall. Its exact location within the wall, horizontally, is not critical. Its vertical placement should be a low as possible and with a slight downward angle to allow full drainage of the pools when the fishway is left dry.

Sheet 3:—No mention is made of the access bridge needed to span the fishway to reach the new spillway gate. It is not envisioned that the fishway plans will interfere with such a bridge. The attraction water chamber and pipe will not extend above the current level of the sidewalls, thus providing plenty of room to the bridge. The bridge should have open grid decking to allow sunlight to pass below. Dark shadows can create behavioral obstacles to migrating fish.

If for some reason such open decking is not possible, the OWR should consider the provision of strong flood lighting to illuminate under the bridge during the day. It may go off automatically after dark. The bridge should also be designed to accommodate workers adjusting the board stacks on Weir 8 and the attraction water channels.
Sheet 4:—No comments.

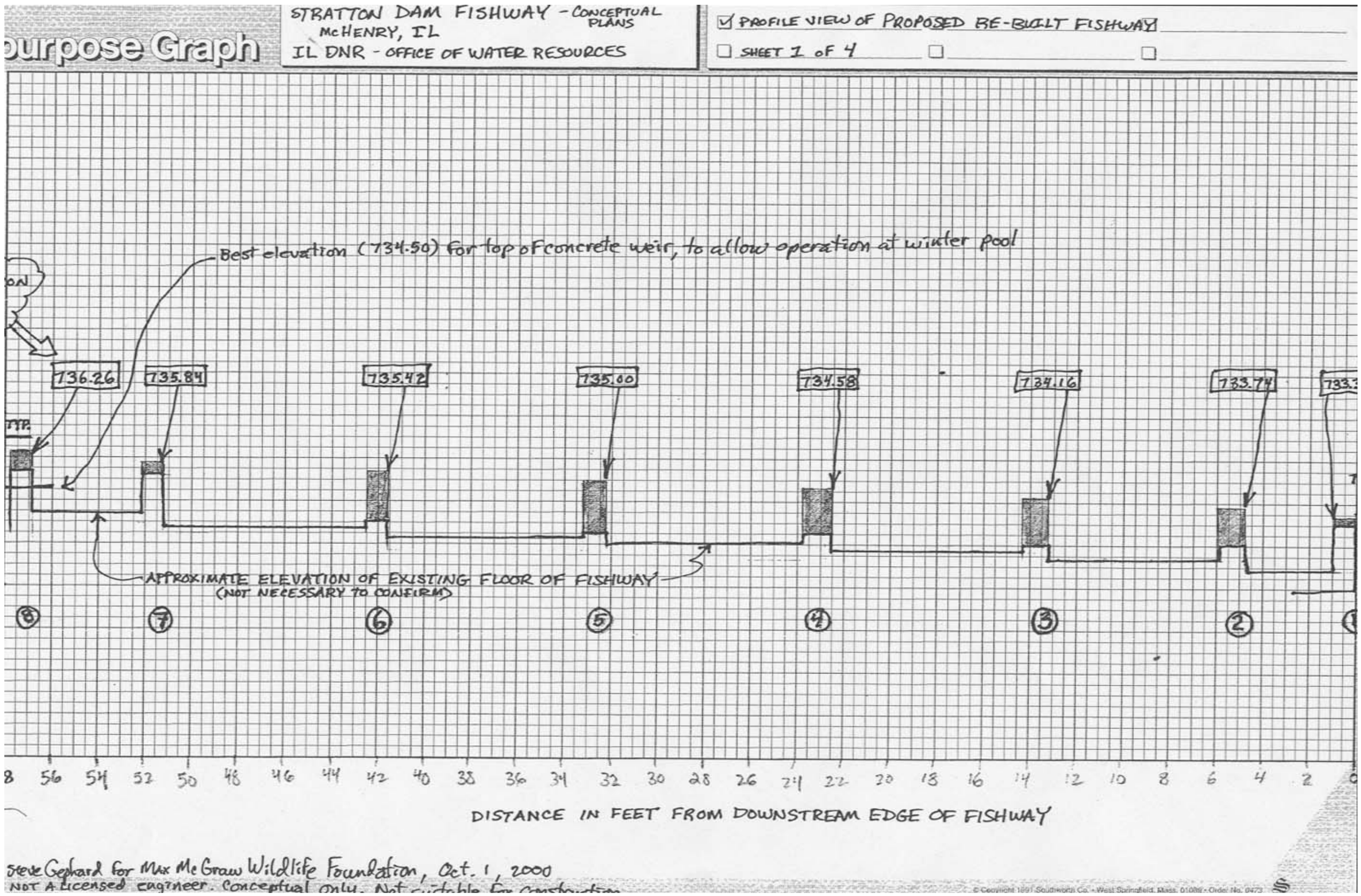
Sheet 5:—The above plans present a scheme to provide effective fish passage at the Stratton Dam. Although research is not part of the mission of the OWR, there is a need to evaluate the effectiveness of the project. The addition of a trap at the exit of the Stratton Dam Fishway provides an excellent opportunity to gather important information on the use of fishways by fish in the Fox River that can provide direction for future work at downstream dams.

Whatever party wishing to conduct the evaluation of the fishway could build the actual fish trap. However, supporting structures from which the trap would be operated (raised and lowered) will be needed and the planned de-watering of the area for fishway repair would be the logical time to install such structures. Three pilings driven into the pondbed, similar to those installed for boat docks, would suffice to support a trap. If ice may pull out or move such pilings, other designs such as mounting poles on large, immovable concrete blocks placed on the pond bed might also work. However installed, a trap will require three support posts out in the water, support beams with pulleys to raise and lower the trap, and an access pier. A lightweight mesh trap could be provided by researchers and suspended upstream of the fishway exit in a manner that ensures exiting fish are retained in the trap. The trap should be inspected regularly by raising it via ropes and pulleys, emptying it with dip nets, and lowering it back into place. It would be removed at the end of the season.

STRATTON DAM – Sheet 1 – Profile View of Proposed Re-built Pool-And-Weir Fishway

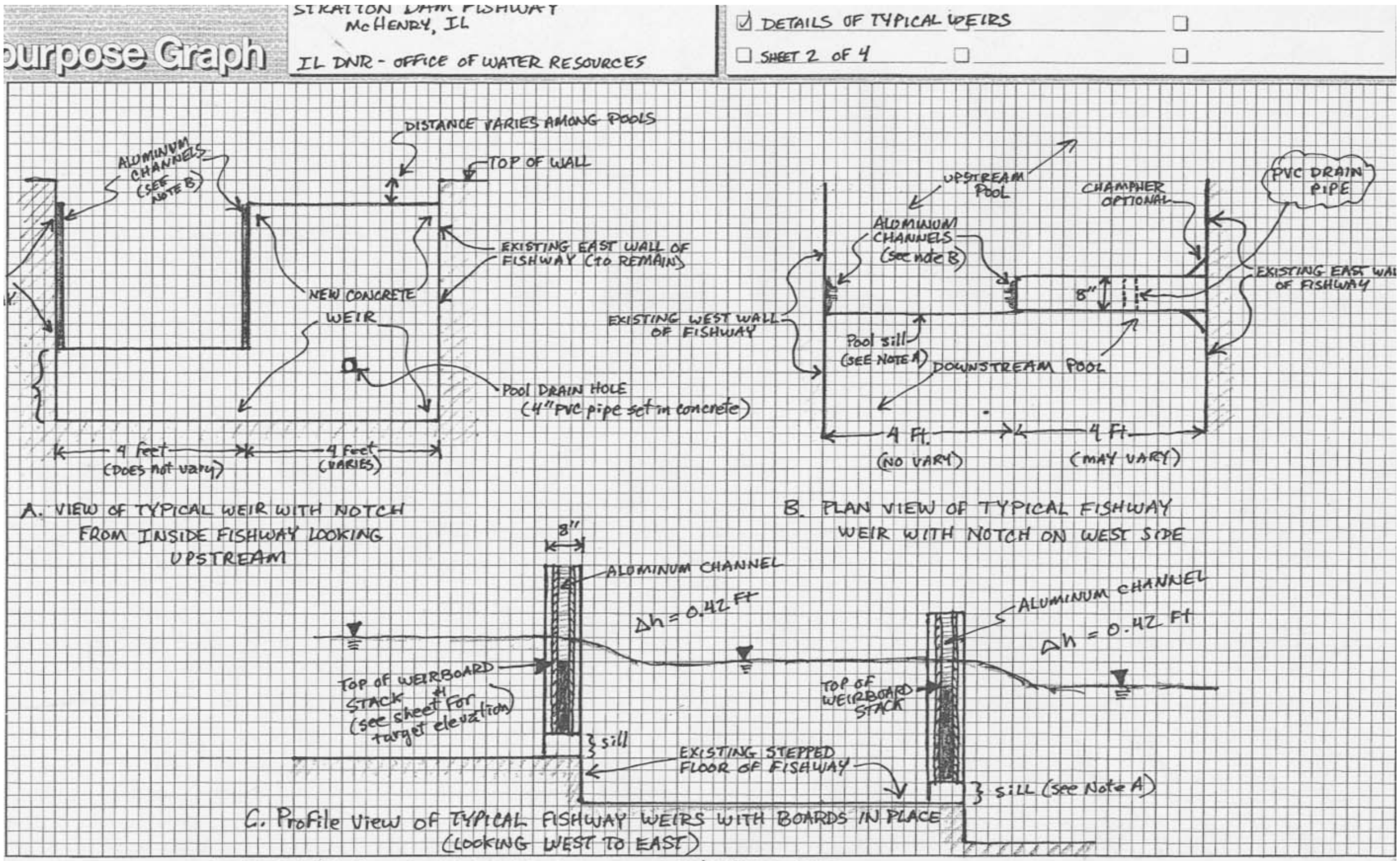
(Numbers in boxes refer to elevations of the crests of the completed weirs.)

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



STRATTON DAM – Sheet 2 – Details of Typical Weirs in the Re-built Pool-And-Weir Fishway

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

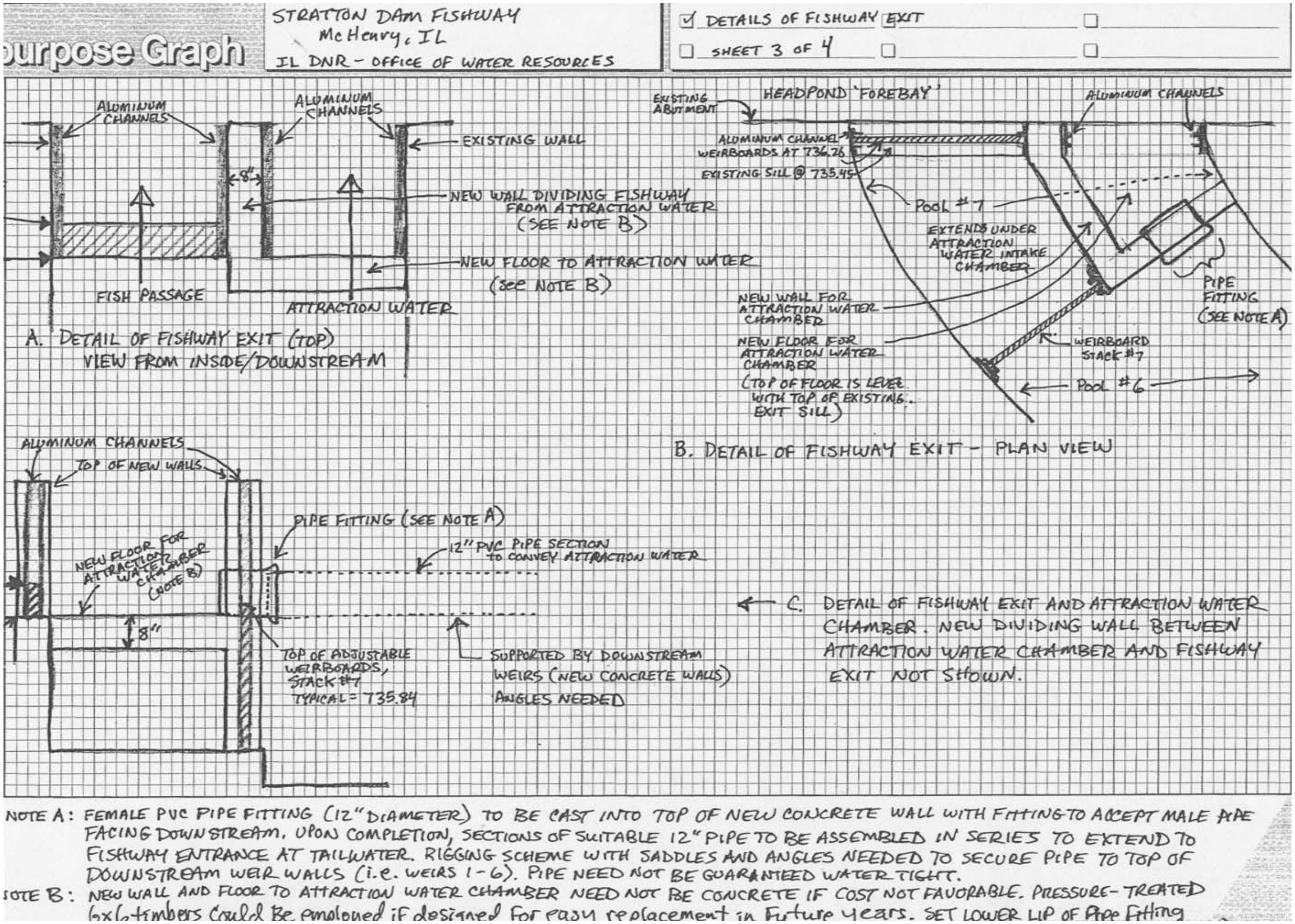


NOTE A: THE BOTTOMS OF THE NOTCHES (NOW PROPOSED TO BE ALL WEST SIDE) ARE TO BE FORMED BY ADJUSTABLE, STACKABLE WEIR BOARDS. NO NEW CONCRETE WALL ON WEST SIDE IS CALLED FOR. SKETCH IN DETAIL A SHOWS RISE OF STEPPED FLOOR (EXISTING). IF ENGINEERS OR CONTRACTORS WISH TO EXTEND PART OF NEW WALL TO WEST WALL FOR STRUCTURAL STABILITY, A MINIMAL "SILL" (SHOWN IN DETAIL C) MAY BE ADDED ON WHICH WOODEN WEIRBOARDS REST.

NOTE B: PRE-FABRICATE ALUMINUM CHANNELS TO ACCEPT 2x Lumber. WEST SIDE CHANNEL SHALL BE DRILLED AND LAGGED IN PLACE WITH SHIELDS. EAST SIDE CHANNELS CAN BE SET IN FORM FOR NEW CONCRETE WEIR.

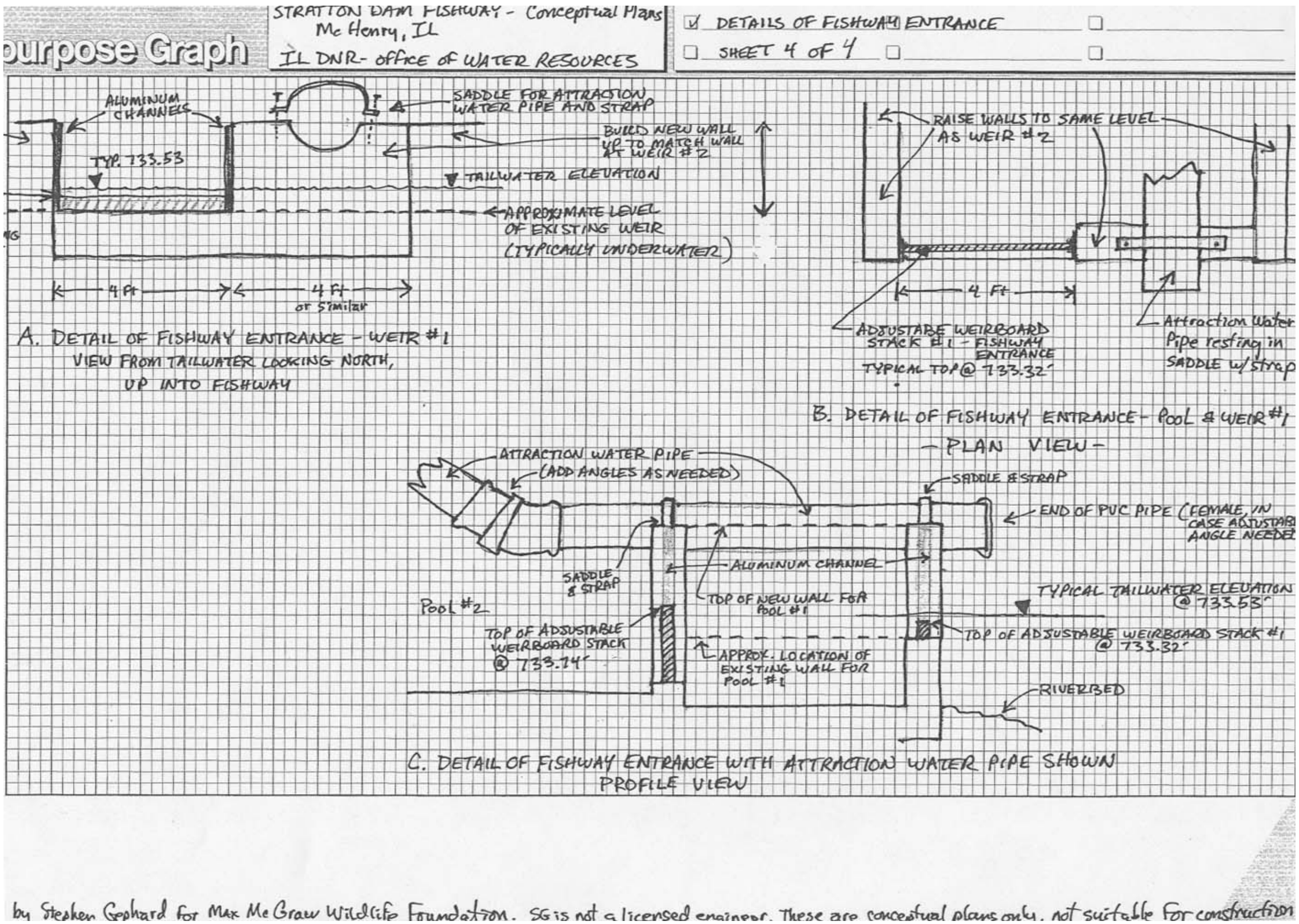
STRATTON DAM – Sheet 3 – Details of Fishway Exits in the Re-built Pool-And-Weir Fishway

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



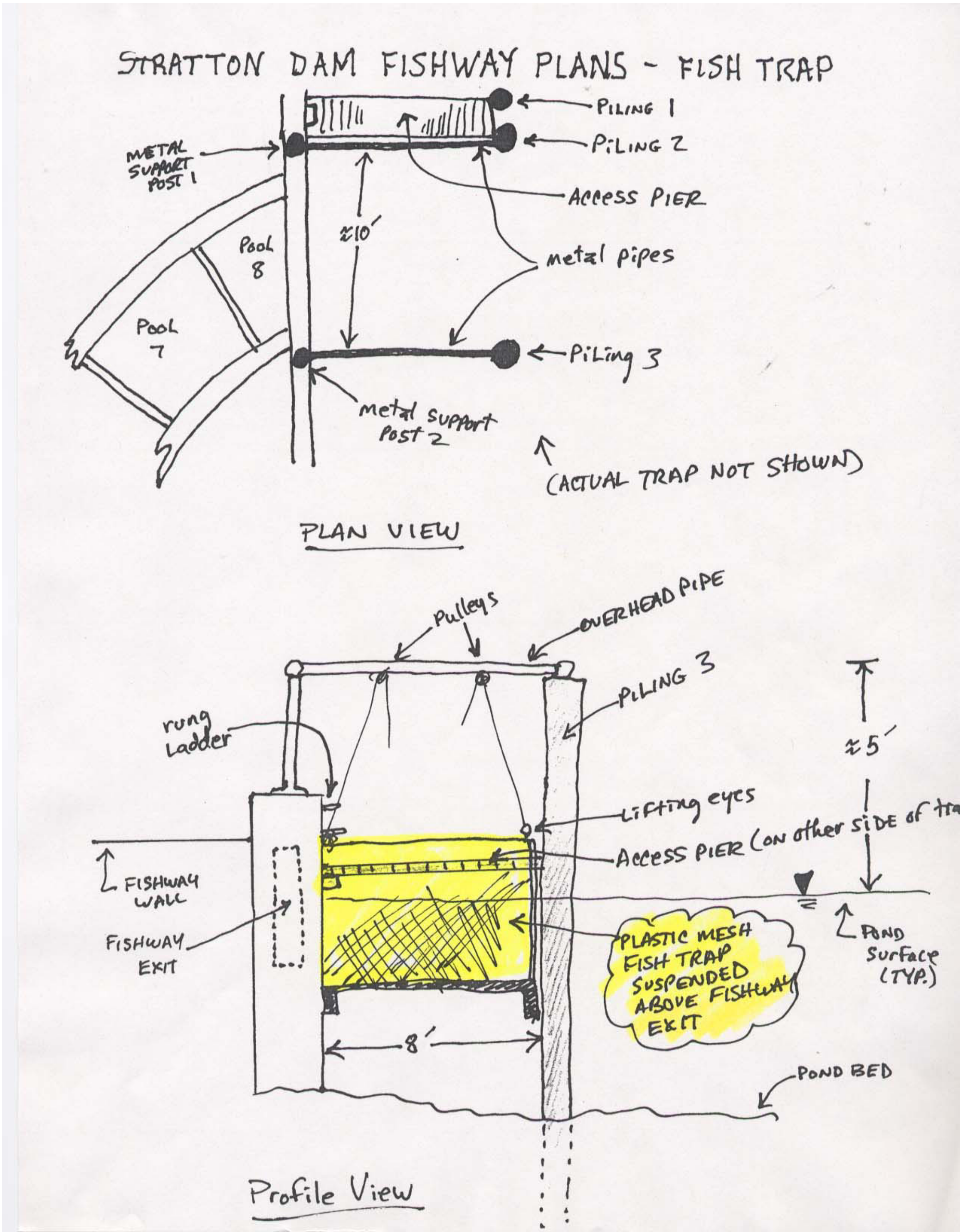
STRATTON DAM – Sheet 4 – Details of Fishway Entrance in the Re-built Pool-And-Weir Fishway

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



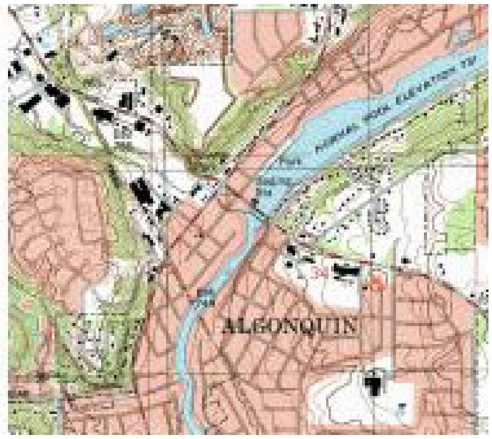
STRATTON DAM – Sheet 5 – Details of Fishway Trap in the Re-built Pool-And-Weir Fishway

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



ALGONQUIN DAM

LOCATION



Latitude-longitude (NAD 83):
42.1657496˚N 88.2901025˚W
Legal: T43N R8E S34NW
Town: Algonquin, IL
River mile: 82.61
Comments: Approximately 100 ft. downstream of IL State Rt. 62 Highway Bridge
Next downstream dam (distance): Carpentersville Dam (4.41 miles)
Next upstream dam (distance): Stratton Dam (16.34 miles)

DESCRIPTION

Height: 9 ft.
Spillway elevation: 730.3 ft.
Length: 300 feet
Dam type: Ogee
Material: Concrete
Nature of barrier to fish: Complete
Construction date: 1947
Condition of dam: Good
Length of impoundment: 16.34 miles
Appurtenances: Tall concrete retaining abutments above and below spillway on both banks.

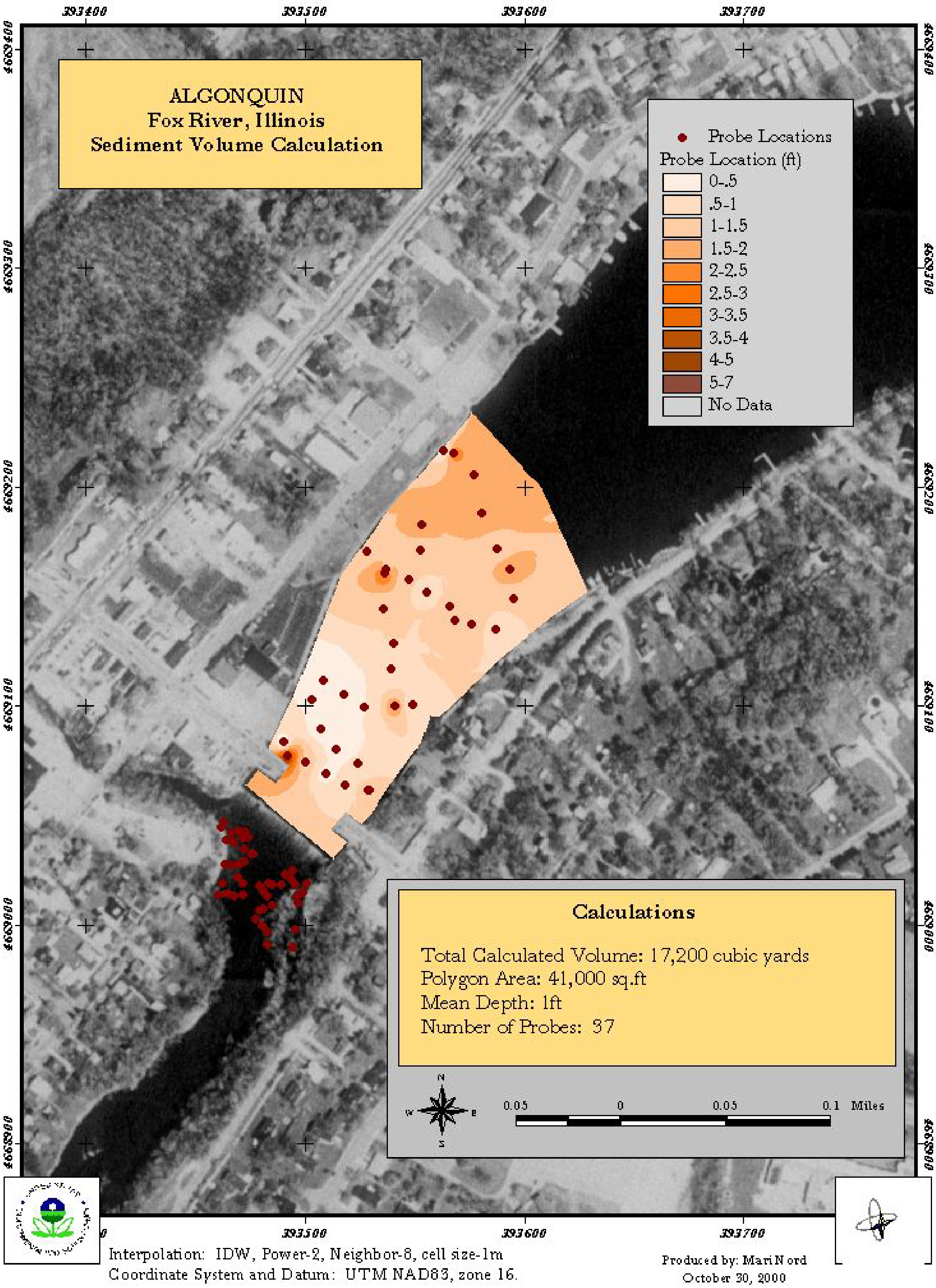
LEGAL/SOCIAL ASPECTS

Owner: State of Illinois, Department of Natural Resources - Office of Water Resources
Owner of adjoining land: IDNR/OWR presumed to own some of west bank
Present-day purpose of dam: Navigation above the dam and flood control
Uses of impoundment: Recreational power boating

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 17,200 cu. yds.
Sediment quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.



BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of drowning by the removal of a dangerous hydraulic current below the spillway.
- Eliminate the need to maintain a costly state facility for many years to come.

Disadvantages:

- Reduce pool depth behind dam and interfere with recreational power boating.
- Eliminate need for the navigational locks at the Stratton Dam.
- Upset upstream waterfront property and boat owners.

BYPASS CHANNEL

No proposal for this option is provided due to the lack of suitable space for this type of fish passage facility. The presence of the highway bridge precludes this option.

DENIL FISHWAY

Advantages:

- The fishway would allow the passage of most targeted species without removing the dam.
- Species in the river that utilize wetlands for spawning and nursery areas (e.g., northern pike) would gain access to the abundant wetlands located above the Algonquin dam.
- The site lends itself well to a fishway. It is hoped that a fishway could be designed to be compatible with the new gate structure.
- This site may be a prime candidate for a public viewing room due to its urban location and potential ease of accessibility to the public.

Disadvantages:

- The dam remains in place along with all of its negative ecological impacts.
- Some fish species and small individuals will not be able to negotiate the Denil fishway.
- The obstacle to paddling and the need to portage remain.
- The risk of drowning in currents below the dam remains.

Estimated costs: A Denil fishway at the Algonquin Dam is estimated to cost about $180,000 as a stand-alone project.

IDNR/OWR has installed a new gate into the existing spillway for the purposes of controlling flow related to flood events. A fishway could be constructed adjacent to the spillway and gate. We have not seen the plans for the gate project and recognize that some configurations of a fishway might interfere with such a project. Therefore, we offer three basic configuration options for the fishway, assuming that one of them will be compatible with the gate project.

Option 1:—Fishway entrances should always enter the river flow at a 45-degree angle and immediately downstream of the upwelling hydraulic or whitewater boil that exists below a spillway. Option 1 shows an entrance pool built on streambed outside (riverward) of the existing abutment and training wall. Like turn and exit pools, the entrance pool is a flat, non-sloped and non-baffled section of fishway. These pools (indicated as solid gray on plan) are simple open troughs with relatively gentle flows to provide turning radius, resting capability, or viewing opportunities. All baffled sections of the fishway (diagonal striping) should have the same slope, which is recommended at 1:15.

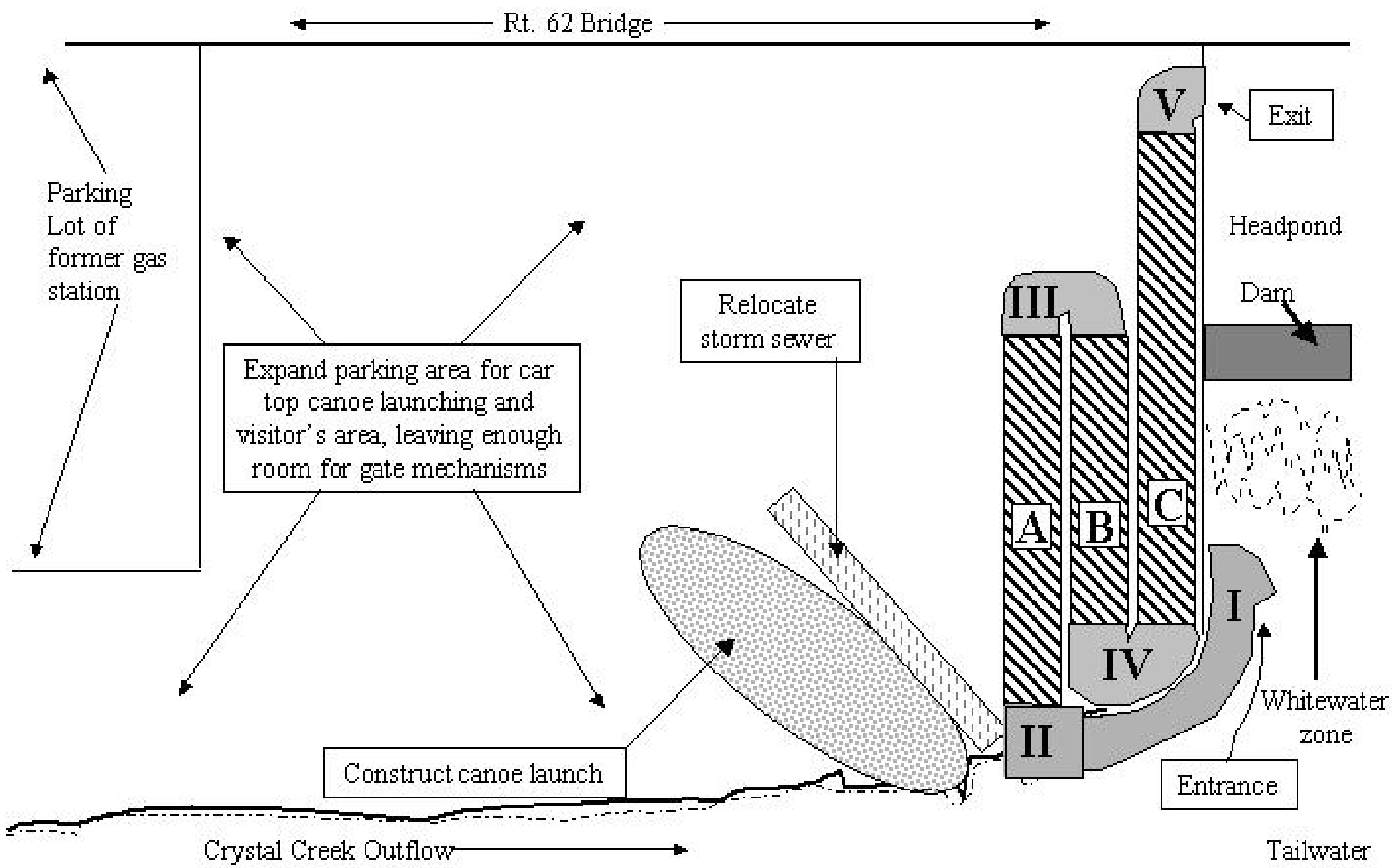
For this option, the fishway is concentrated in one area alongside the abutment wall. This often makes construction easier due to all excavation and concrete work being concentrated in one area. Three turn pools are provided and will offer all of the resting opportunities that the migrant fish will need. The fishway consists of eight sections.

- I - The entrance pool is about 25 ft. long.
- II - The first turn pool has a 90˚ turn and there are about 8 ft. from the bottom of the first baffle in 'A' to the pool's southern wall.
- A - The first run of baffles is about 45 ft. long.
- III - The second 90˚ turn pool is about 8 ft. from the top of the top baffle in 'A' to the northernmost point in the northern curved wall.
- B - The second run of baffles is about 40 ft. long.
- IV - The third turn pool is 180˚ and has the same dimensions as pool III.
- C - The third run of baffles is about 80 ft. long.
- V - The exit pool is about 8 ft. long.

The existing storm sewer that discharges near the confluence of Crystal Creek and the Fox River would need to be relocated to make room for pool 'I'. It would seem appropriate to develop a crushed stone or roughened concrete ramp for a canoe launch to the west of the fishway. This site also offers good opportunities for interpretative displays on dams, fishways, fish, and the river.

ALGONQUIN DAM – Option 1 – Conceptual Plans for a Switchback Denil Fishway on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



The advantage of this option is that the work is concentrated in one area and is conservative on land use, leaving ample land for other purposes, including a pumphouse/utility building for the new gate. The disadvantage of this option may be that it would limit future vehicle and worker access to the new gate.

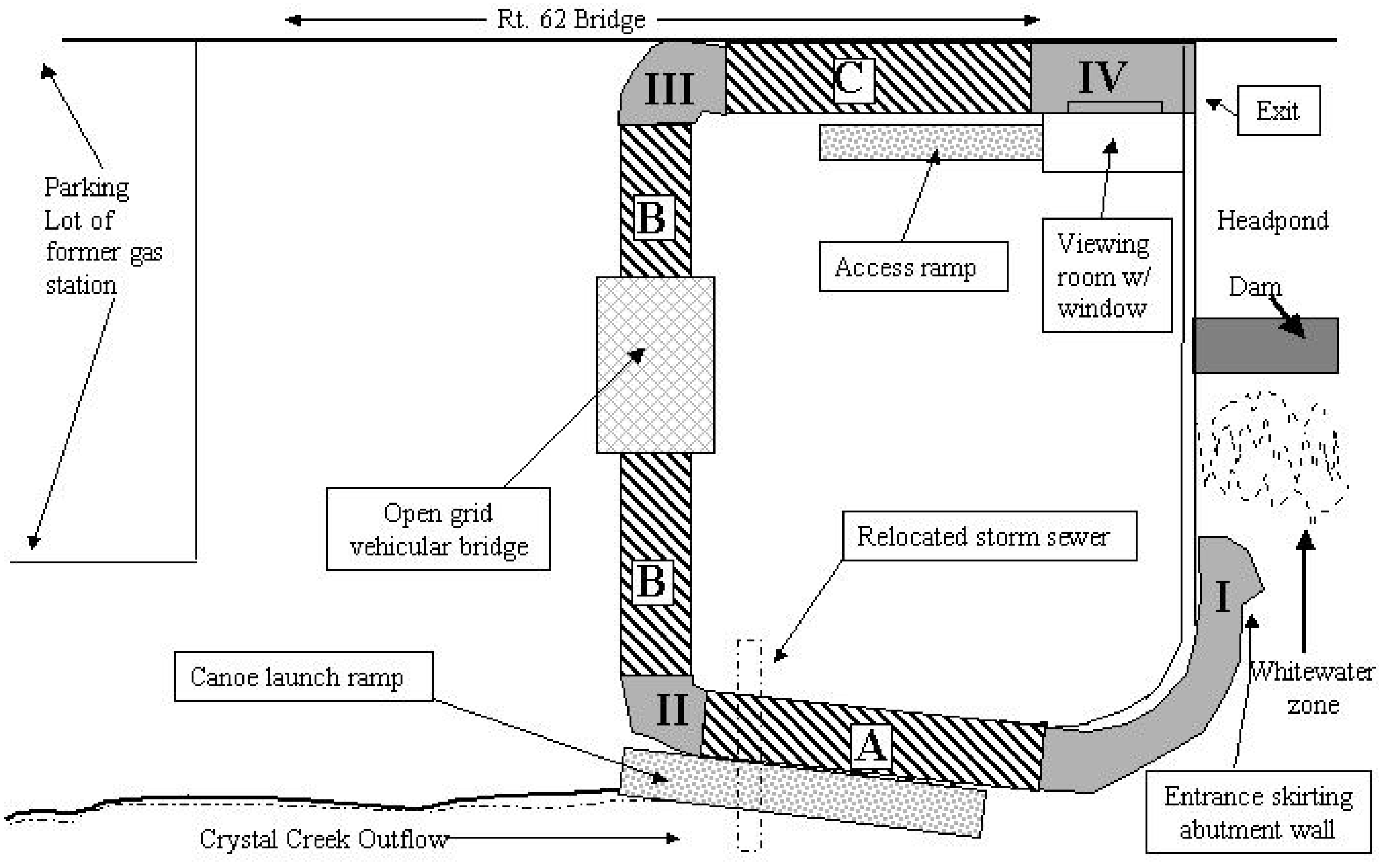
Option 2:—In this option, the fishway entrance and exit are located in the exact locations as in Option 1. However, the path of the fishway is stretched out on the property away from the abutment wall to provide better access to the gate for accessory structures (such as a pumphouse) and ease of worker access. A bridge is provided over the fishway to allow both vehicular and foot traffic. The bridge should be an open metal grid to allow sunlight to pass so that deep shadows are not cast into the fishway. Shadows can discourage upstream passage of fish. Two turn pools are provided and will offer all of the resting opportunities that the migrant fish will need. An optional feature shown in this sketch is the provision of a viewing room and Plexiglas window in the side of the fishway wall. This can be used by DNR fisheries biologists and researchers to document fish utilizing the fishway and can be opened to public visitation during appropriate time periods. Public viewing rooms are extremely popular facilities on the West and East Coasts and are provided by power companies to generate public goodwill toward the dam owners. The fishway consists of seven sections.

I - The entrance pool is about 25 ft. long.
A - The first run of baffles is about 50 ft. long.
II - The first turn pool has a 90˚ turn and there are about 8 ft. from the bottom of the first baffle in ‘A’ to the pool’s southern wall.
B - The second run of baffles is about 70 ft. long.
III - The second turn pool has a 90˚ turn and approximately the same dimensions as ‘II’.
C - The third run of baffles is about 45 ft. long.
IV- The exit pool is about 15 ft. long.

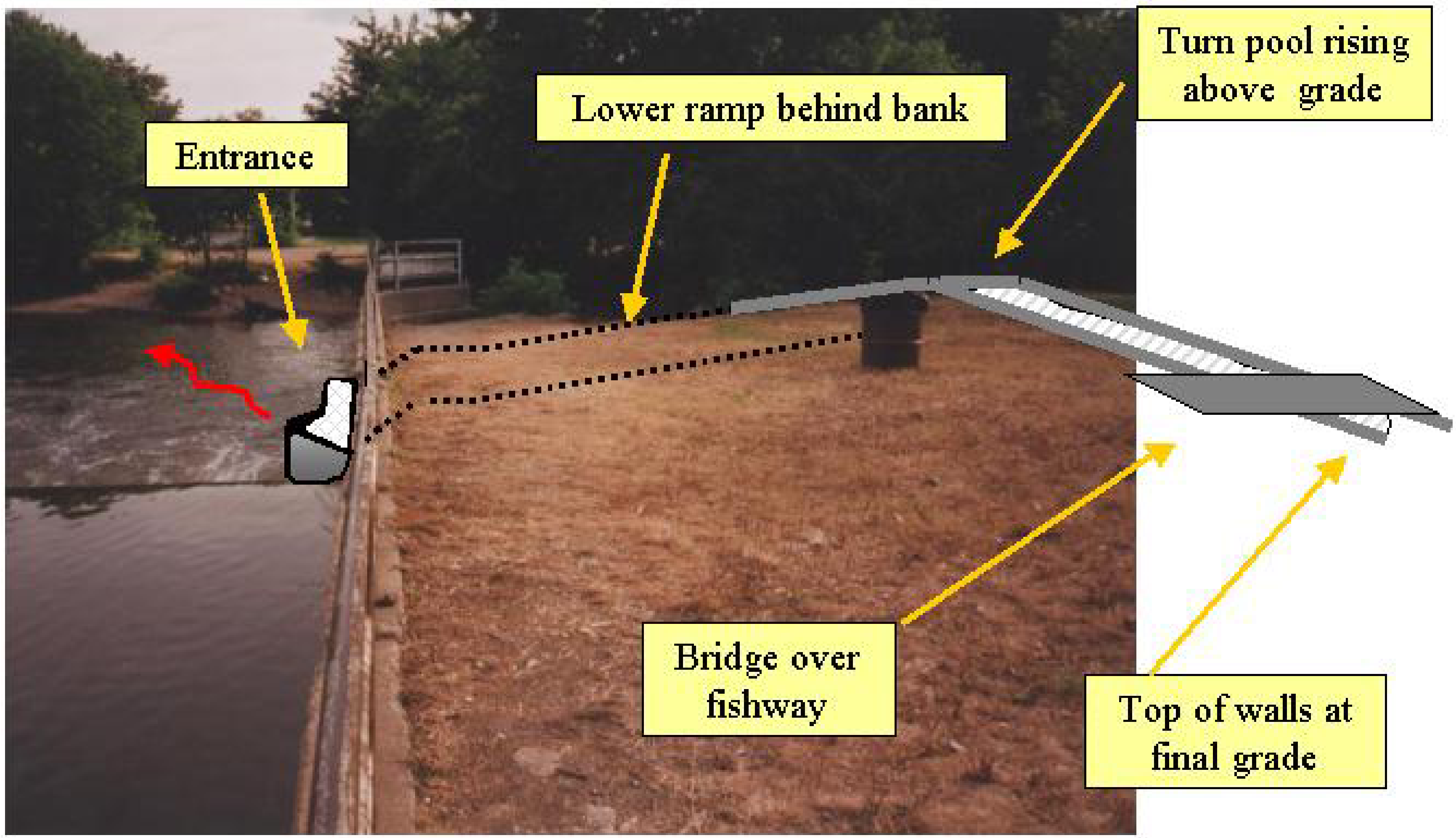
This existing storm sewer that discharges near the confluence of the Crystal Lake Outlet and the Fox River would need to be relocated to make room for ‘I’. In this option, ramp ‘A’ will probably have sufficient elevation at the indicated location to allow the drain to pass underneath the fishway. It would seem appropriate to develop a crushed stone or roughened concrete ramp for a canoe launch to the south of the fishway. For this and all other options, it would seem prudent for the OWR to attempt to purchase the property to the west occupied by the former gasoline station (if not already owned by a government agency or park district). This would expedite the construction process and provide good opportunities for interpretative displays on dams, fishways, fish, and the river and provide parking for visitors to the fishway and people launching canoes.

ALGONQUIN DAM – Option 2 – Conceptual Plans for a U-Shaped Denil Fishway on West Bank

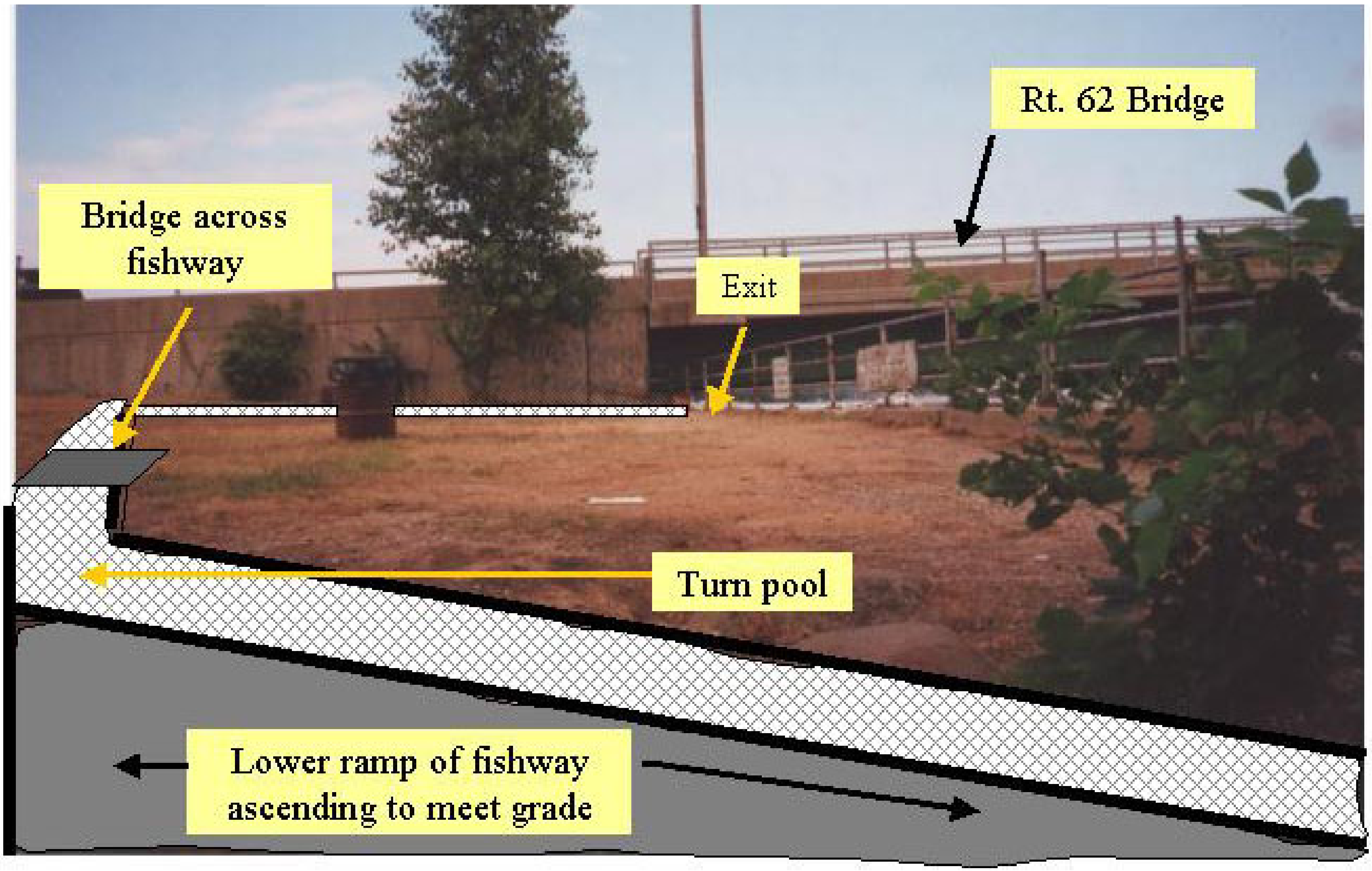
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



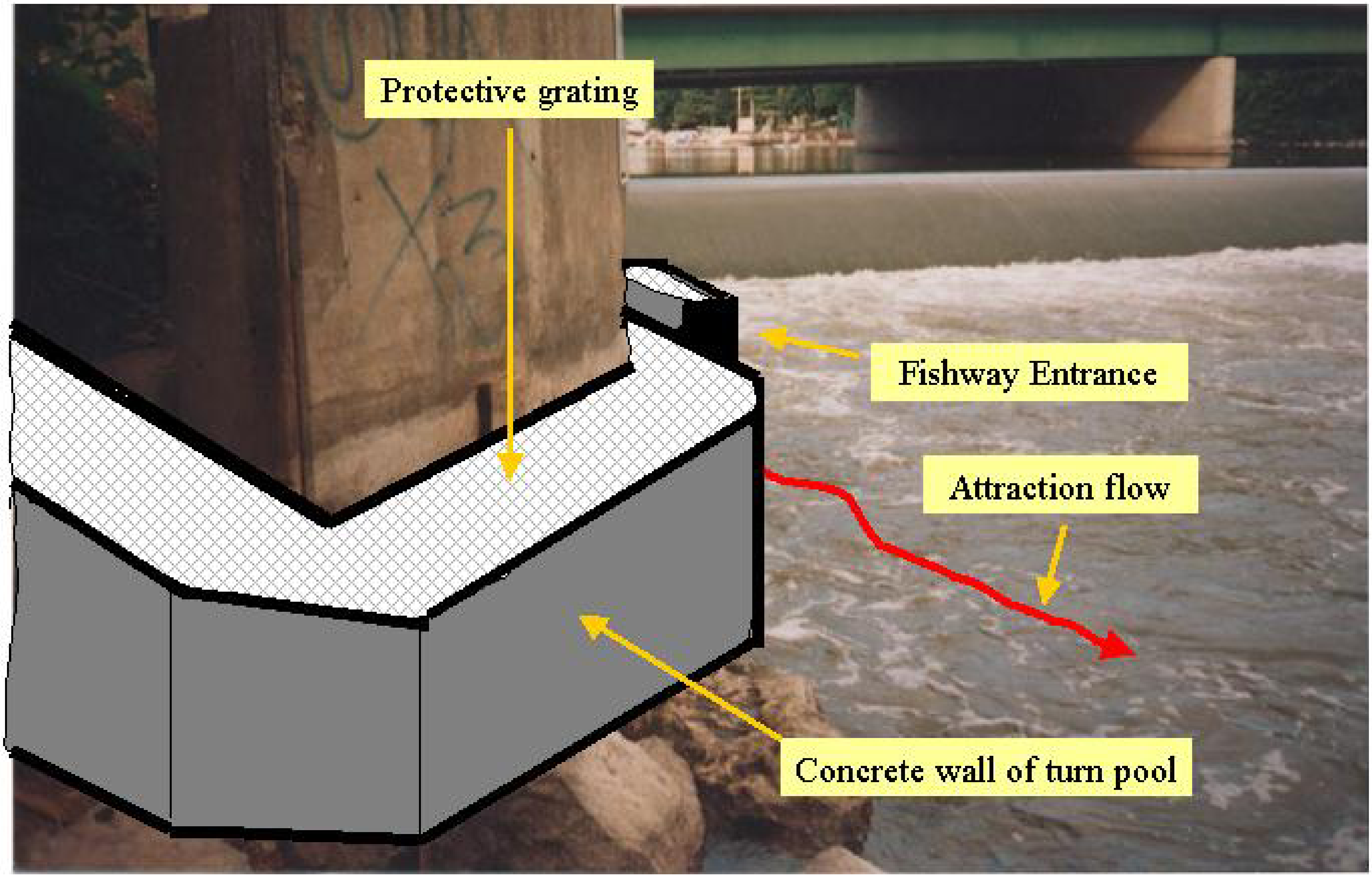
ALGONQUIN DAM – Option 2 – Depiction of Fishway Looking Downstream from the Exit



ALGONQUIN DAM – Option 2 – Depiction of Fishway Looking Upstream from Mouth of Crystal Creek



ALGONQUIN DAM – Option 2 – Depiction of Fishway Entrance Skirting Abutment



The advantage of this option is that it skirts the perimeter of the lot and leaves the center open for dam access and other uses. The main disadvantage may be that the cost is slightly higher because the overall footprint of the work area is larger.

Option 3:—In this option, the fishway is located more-or-less in the same area as in option 2 but the entrance is not built outside of the abutment wall on riverbed but instead passes through an opening in the abutment wall, similar to the exit. Note the angle of the entrance. The fishway consists of seven sections.

I - The entrance pool is about 10 ft. long.
A - The first run of baffles is about 70 ft. long.
II - The first turn pool has a 90˚ turn and there are about 8 ft. from bottom of first baffle in 'A' to the pool's western wall.
B - The second run of baffles is about 48 ft. long.
III - The second turn pool has a 90˚ turn and approximately the same dimensions as 'II'.
C - The third run of baffles is about 48 ft. long.
IV - The exit pool is about 15 ft. long.

The advantages of Option 3 include:

- This entrance location may ease construction by limiting the scope of a cofferdam.
- Such an entrance location will avoid the need to cover it with sturdy grating to protect it from ice and debris.
- No need to relocate the storm drain.
- More room for a canoe launch.
- Many of the same advantages as Option 2.

The disadvantages of the Option 3 include:

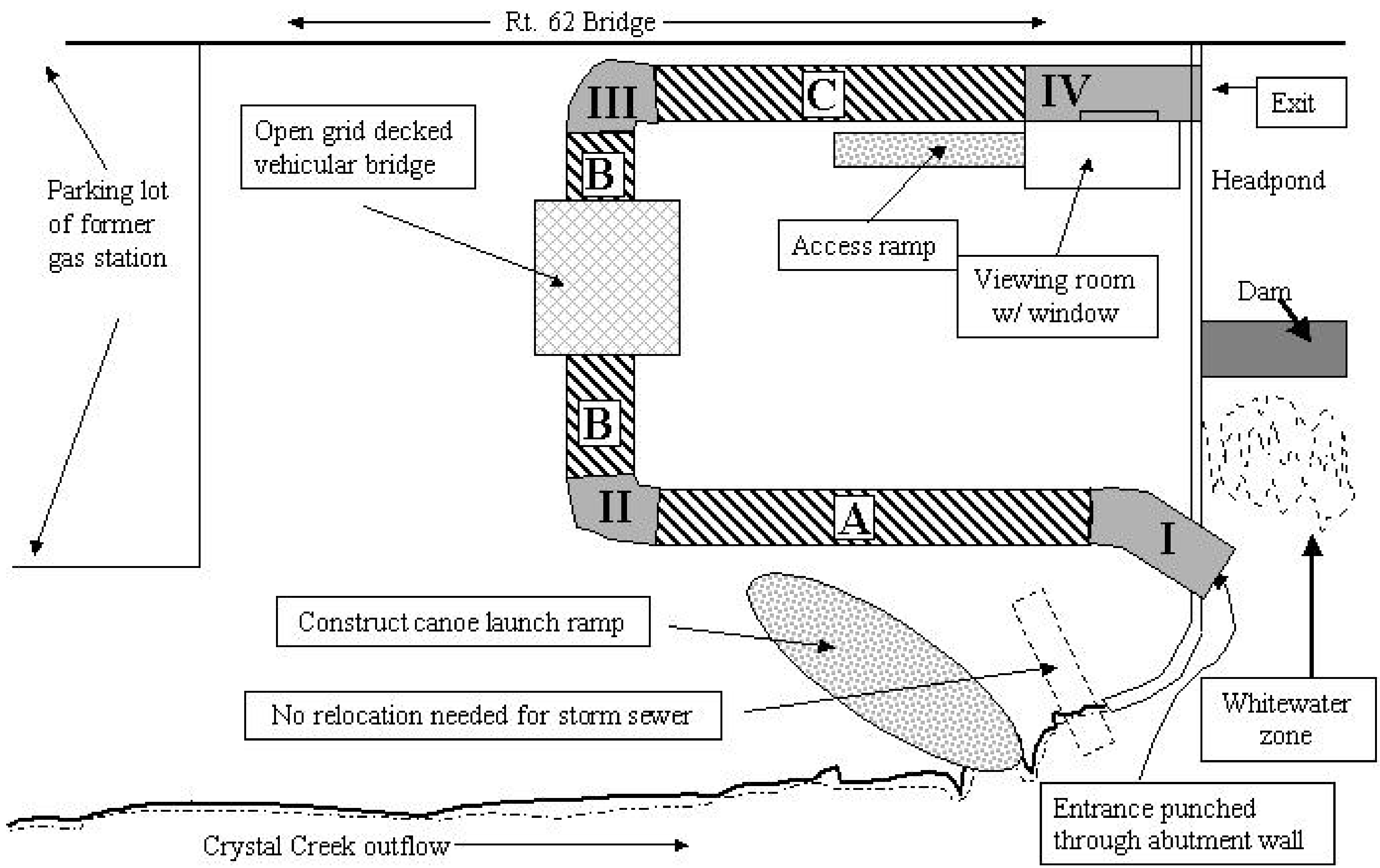
- The footprint of the work area is expanded, perhaps increasing cost.
- The amount of available land in the middle of the lot (between the entrance and exit) is less than in Option 2 and may impede access to dam.

Perhaps the second disadvantage bullet above can be eliminated with a fourth option, not sketched but referred to as Option 4. In this option, the fishway path is the same as in Option 2 but the entrance is located as in Option 3. To blend the two paths together, a 90˚ turn pool is attached to the upstream end of entrance I in Option 3 and that leads to a level connecting pool that travels south for about 10 ft. and then transitions into a 90˚ turn pool (to the west) that connects to baffle run 'A' in Option 2 (only, slightly relocated to the north to avoid the riverbank).

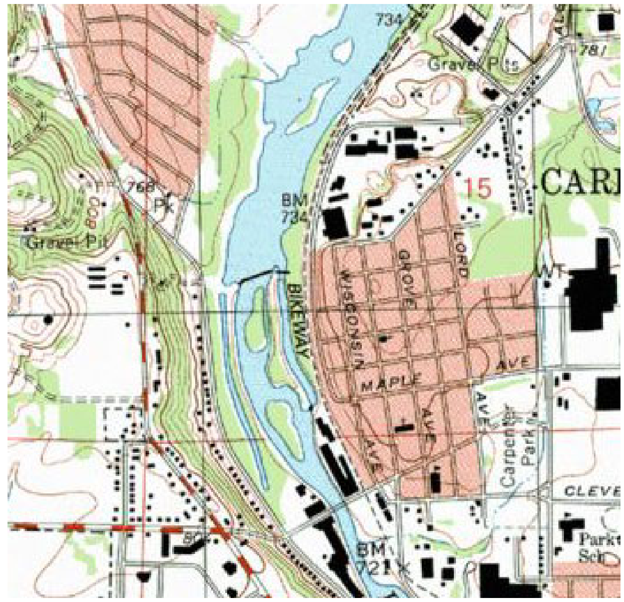
(Note: The preceding text was drafted prior to the gate project being undertaken. It has since been completed without including any work on future fishways.)

ALGONQUIN DAM – Option 3 – Conceptual Plans for a U-Shaped Denil Fishway on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

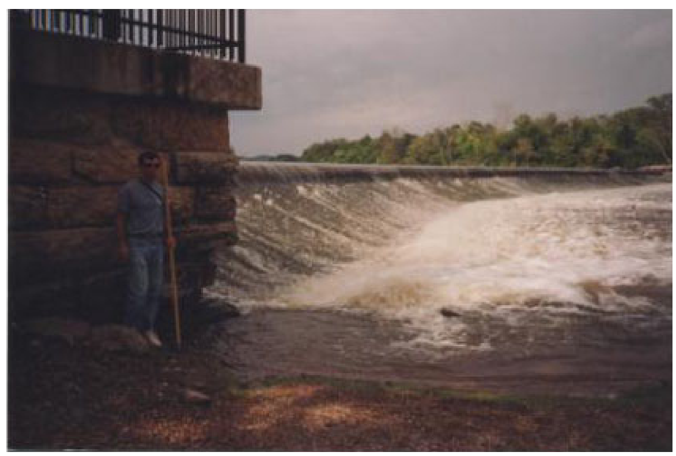


CARPENTERSVILLE DAM



LOCATION

Latitude-longitude (NAD 83):
42.1147115˚N 88.2924146˚W
Legal: T42N R8E S15SW
Town: Carpentersville, IL
River mile: 78.2
Comments: Public access and a small adjacent parking lot on west bank off Lincoln Avenue.
Next downstream dam (distance): Elgin Dam (6.3 miles)
Next upstream dam (distance): Algonquin Dam (4.41 miles)



DESCRIPTION

Height: 9 ft.
Spillway elevation: 720.7 ft.
Length: 378 ft.
Dam type: Broad-crested with a sloping face.
Material: Concrete (Likely to be an original timber structure underneath.)
Nature of barrier to fish: Complete. East bank fishway is non-functional.
Construction date: Reportedly around 1830, but clearly has been rebuilt since that date.
Condition of dam: Uncertain
Length of impoundment: 1.4 miles
Appurtenances:

- Abandoned and non-functional millrace on west bank, extending from headpond to undetermined point downstream. Partially filled and full of aquatic vegetation, deadfalls, etc. Water control structure at head of race but it is unclear whether it is operational.
- Gazebo built atop earthen portion of dam on west bank, near western terminus of the spillway.

- Hiking/bicycle trail extends from gazebo on west bank to undetermined point downstream (presumably connected to county network). Located between the river and the millrace.
- Another millrace is located along the east bank, extending from the headpond down many hundreds of feet to an old and apparently historic powerhouse/gatehouse near the center of the village of Carpentersville.
- Small, artisanal fishway at east end of spillway. Completely inadequate for fish passage.

LEGAL/SOCIAL ASPECTS

Owner: Kane County

Owner of adjoining land: Kane County. Includes the west bank millrace and hiking/bike trails on both west and east banks but *not* the east bank millrace, which is owned by Otto Engineering.

Present day purpose of dam: None.

Uses of impoundment: Canoeing, kayaking, fishing, some recreational power boating.

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 72,000 cu. yds.

Sediment quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.

BIOLOGICAL RESOURCES

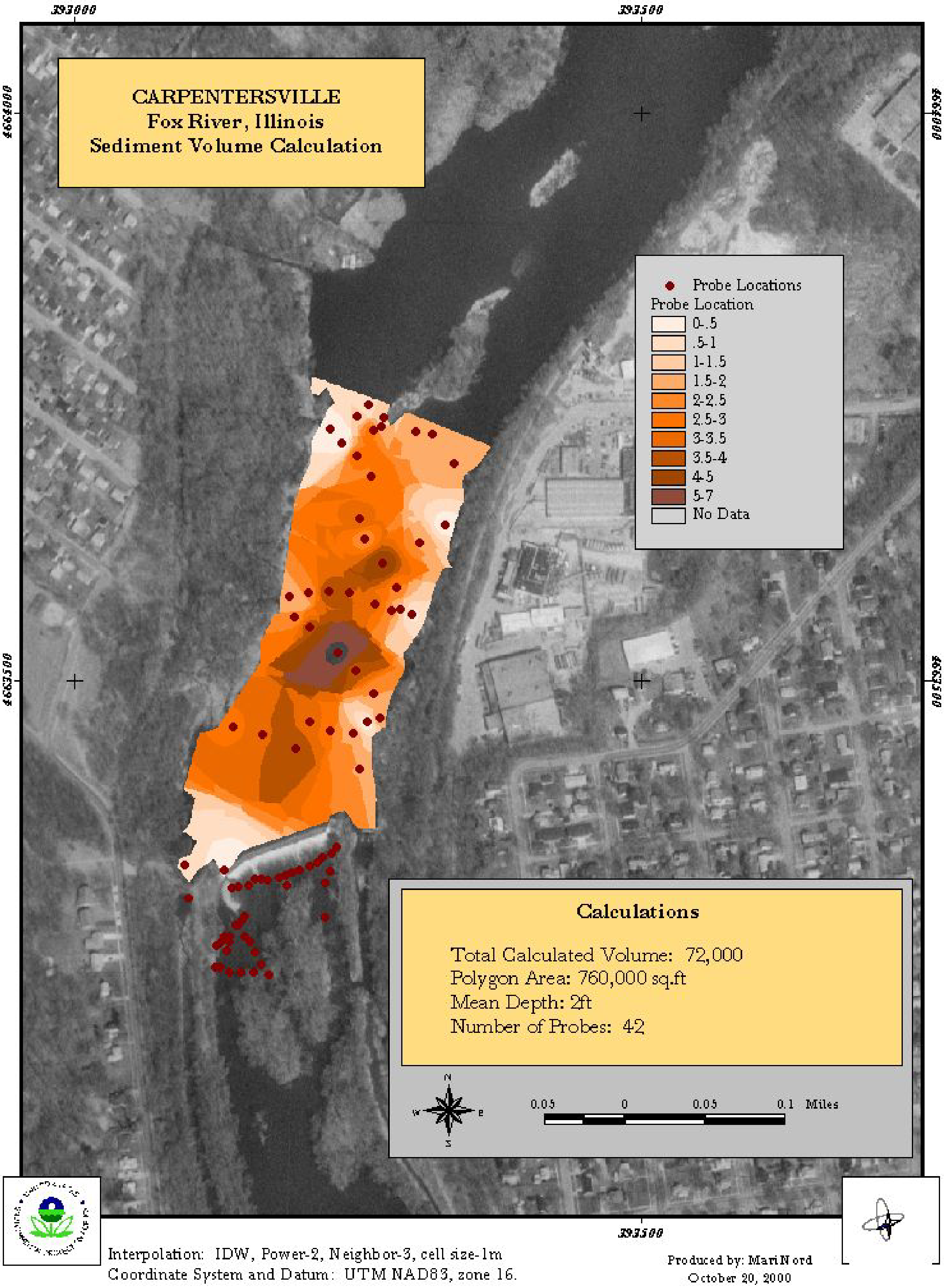
No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the need to maintain a costly facility for many years to come. An engineering study in 1998-1999 revealed a crack in the spillway. This is an old dam and will need frequent maintenance in years to come.
- Does not appear to have many riverfront residences within the impoundment. Much of the land upstream of the dam is owned by Kane County Forest Preserve District and is managed as open space.


393000
393500
4664000
4663500
CARPENTERSVILLE
Fox River, Illinois
Sediment Volume Calculation
Probe Locations
Probe Location
0-.5
.5-1
1-1.5
1.5-2
2-2.5
2.5-3
3-3.5
3.5-4
4-5
5-7
No Data
Calculations
Total Calculated Volume: 72,000
Polygon Area: 760,000 sq.ft
Mean Depth: 2ft
Number of Probes: 42
0.05 0 0.05 0.1 Miles
Interpolation: IDW, Power-2, Neighbor-3, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.
Produced by: Mari Nord
October 20, 2000

Disadvantages:

- Reduce pool size for recreational boating.
- Reduce scenic qualities for visitors who enjoy looking at the headpond. (It seems that the area will still be scenic, even with the removal of the dam, but some people favor ponded water over a free-flowing stream.)

There are three alternatives under the removal option for this dam:
Full removal of spillway:—The comments above refer to this alternative.

Breach of spillway (remove full height of western end):—Only the western end of the spillway would be removed and the eastern end would remain at full height to stabilize accumulated sediments behind the dam. A new concrete 'cap' would have to be constructed on the end of the remnant spillway to stabilize it. Much surveying and engineering work would be needed to determine where the river channel would naturally cut through the headpond sediments, how much sediment would have to be dredged out, how the remaining sediments would be stabilized, and how to cut and stabilize the spillway.

Lowering of spillway:—Only the top three or four feet would be removed and a new concrete cap would be constructed on top of remnant spillway. This would decrease the size of the headpond but not eliminate it. It would reduce the risks associated with potential dam failure in the future. It would not provide fish passage, so a fishway would have to be built, but the fishway would be less expensive since the dam would be lower. This option would require much survey and engineering work. This is probably the most costly alternative of all because it would require survey and engineering work, dam removal activities, dam construction activities, and fishway construction activities.

BYPASS CHANNEL

Advantages:

- Flat slope allows a large percentage of the fish in the river to use the bypass.
- Flat slope and large width allows for safe passage of paddle craft without portaging.
- Semi-natural and reasonably attractive appearance.
- Excellent opportunities for watching fish migrate upstream. Furthermore, it will be located alongside of an existing trail and parking area for good public access.

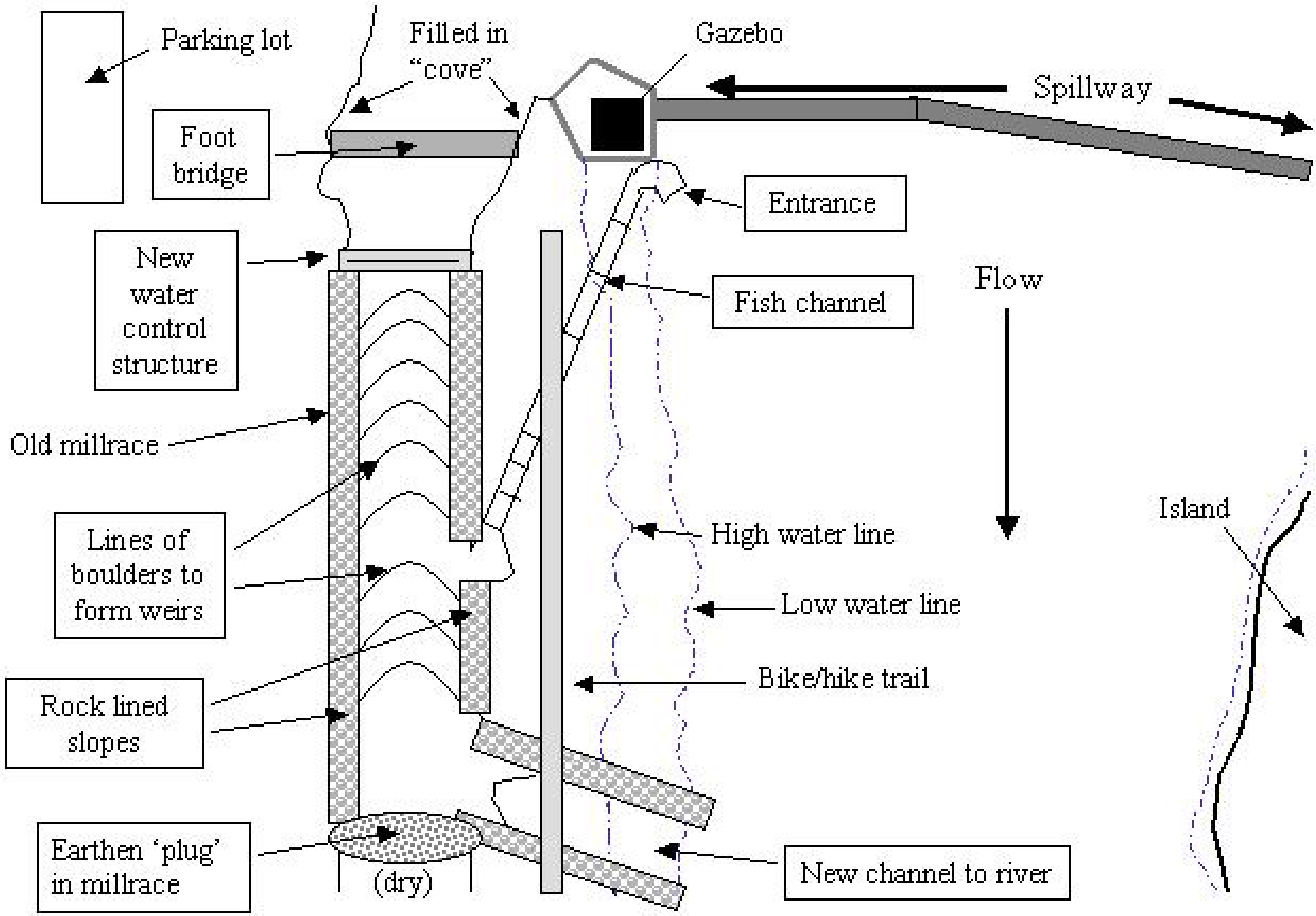
Disadvantages:

- The dam remains in place along with all of its negative ecological impacts.
- Requires much engineering and construction.
- A facility must be maintained at taxpayers' expense.
- May require re-configuration of the bike/hike trail.
- Unclear whether there are historical preservation issues with modifying the millrace.

A bypass channel (slope = 1:30) could be easily installed in the existing west bank millrace (see sketch). This would allow easy upstream migration of fishes and downstream passage of canoes and kayaks without the need to portage the dam. Features include:

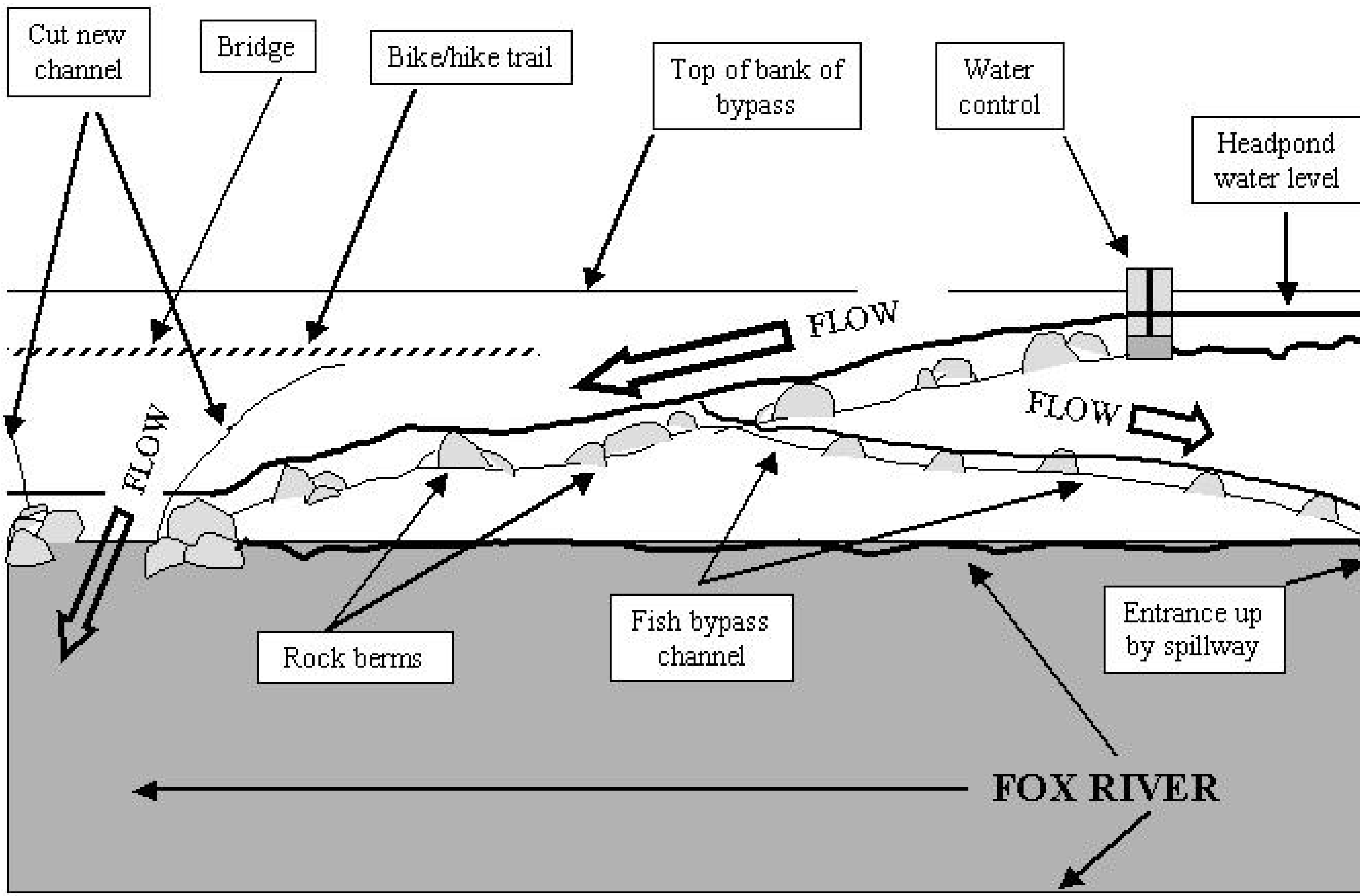
- Dredging area of the headpond to the west of the gazebo and the head of the millrace to provide sufficient depth to allow free passage of fish, boats, and water.
- Removal of existing earth/concrete water control structure. Replace with a concrete sill to accept stop logs, which will be put into place for maintenance and repairs. During most operational periods, no stop logs would be in place allowing free passage of fish, boats, and water.
- Dredging to hard bottom of the millrace in the upper 270 ft. to remove muck, vegetation, dead trees, and other debris.
- Grading bottom of the millrace at an approximate slope of 1:30. The bed of the section at the lower end would be level with the adjacent riverbed. The bed of the section at the top end would be approximately 3 ft. below spillway elevation.
- The bypass would be about 50 ft. wide.
- At the lower end of the modified millrace, an exit channel approximately 30 ft. wide would be cut to the river channel at a 45˚ angle.
- A bridge with open-type grating (to allow sunlight to reach the bypass) would be constructed over the exit channel for the bike/hiking path.
- The sides of all slopes would be stabilized with large rock (preferably rounded).
- The bed of the modified channel may need to be underlain with a layer of impervious material, such as clay or a geotextile material, to minimize loss of water through the bottom.
- The final grade of the modified millrace would be overlain with heavy cobble.
- A series of crescent-shaped rocky ramps would be embedded in the bed at a regular interval to dissipate energy and provide a series of pools at progressively higher elevations.
- There would be a separate fish entrance channel extending in a southerly direction from the base of the spillway near the gazebo to the modified millrace. This fish channel would be about 5 ft. wide and have a slope of 1:20. Its construction and nature of bed would be similar to the main bypass but would be smaller and steeper since it is designed only to pass fish, not boats. This structure is necessary since the bottom of the boat bypass is 270 or more ft. downstream of the spillway area where fish will be congregating and searching for upstream passage. It is likely that fish migrating up the west side of the river will over-shoot the boat bypass and fish migrating up the east side will never sense it. Fish moving back and forth at the base of the dam will sense this fish channel and ascend it. Once in the modified millrace, they will ascend it to the headpond.

CARPENTERSVILLE DAM – Overhead View – Conceptual Plans for a Bypass Channel on West Bank
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



CARPENTERSVILLE DAM – Profile View – Conceptual Plans for a Bypass Channel on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



DENIL FISHWAY

Advantages:

- Easy to build with concrete pinned to existing foundation of gazebo.
- Allows passage of all targeted priority species.
- Construction footprint is compact.
- Minimal disruptions to existing structures and trail and easily bridged.

Disadvantages:

- The dam remains in place along with all of its negative ecological impacts.
- There is no boat passage; portages still required.
- Will not pass as many fish species or life stages as the bypass.
- Not as attractive as the bypass because the fishway will include concrete walls and aluminum grating.
- Not as many opportunities for watching fish migrate upstream.
- Short and long-term maintenance required.

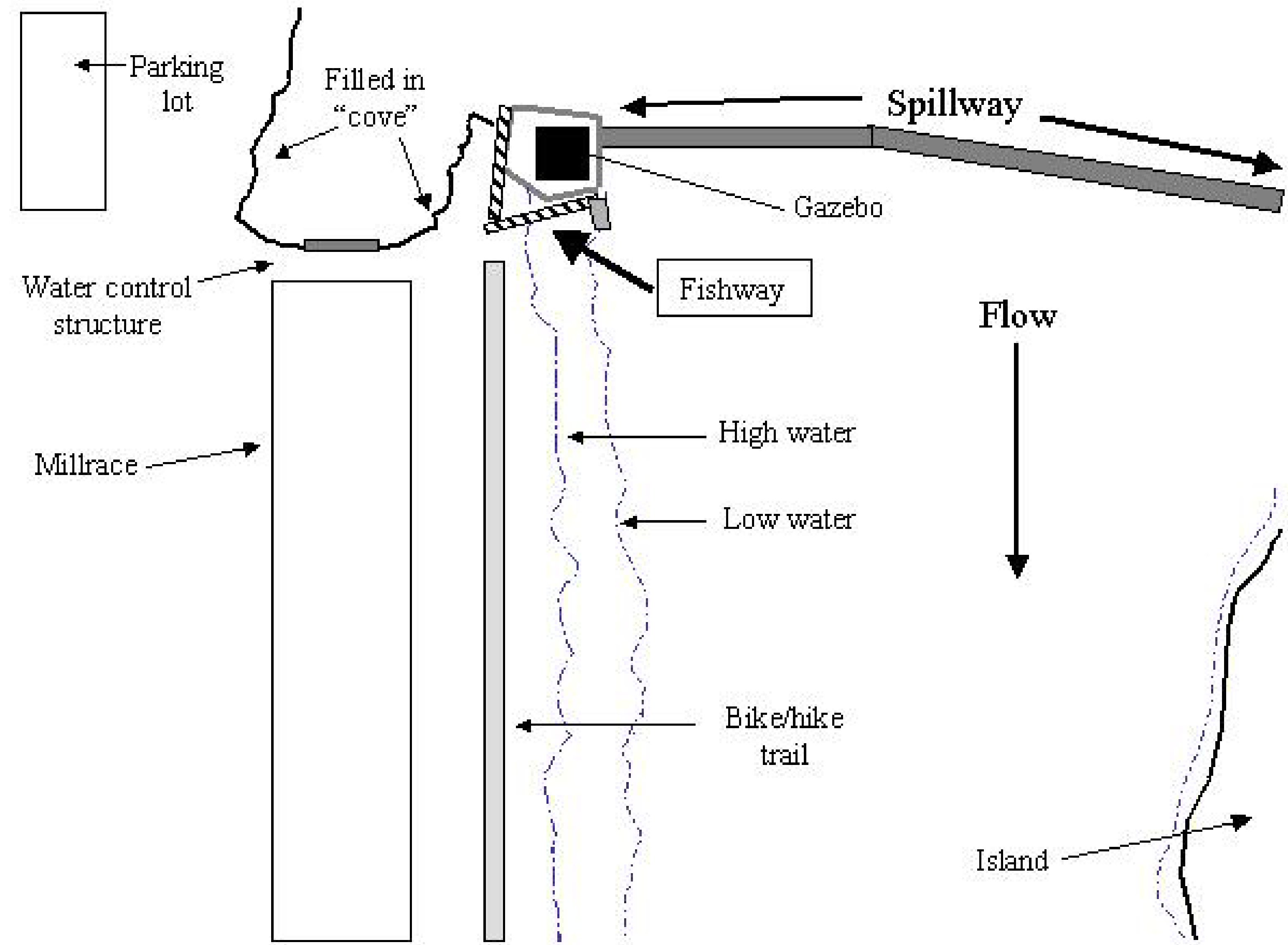
A west bank Denil that wraps around the gazebo is recommended. The structure consists of five sections and a bridge to convey foot traffic over the fishway.

I - The entrance pool is located at the southwest corner of the gazebo, below the spillway.
A - The first run of baffles is about 67 ft. long.
II - A sharply angled turn/resting pool.
B - The second run of baffles is about 67 ft. long.
III - The exit is located at the northwest corner of the gazebo.

Estimated costs: A Denil fishway at the Carpentersville Dam is estimated to cost about $250,000 as a stand-alone project.

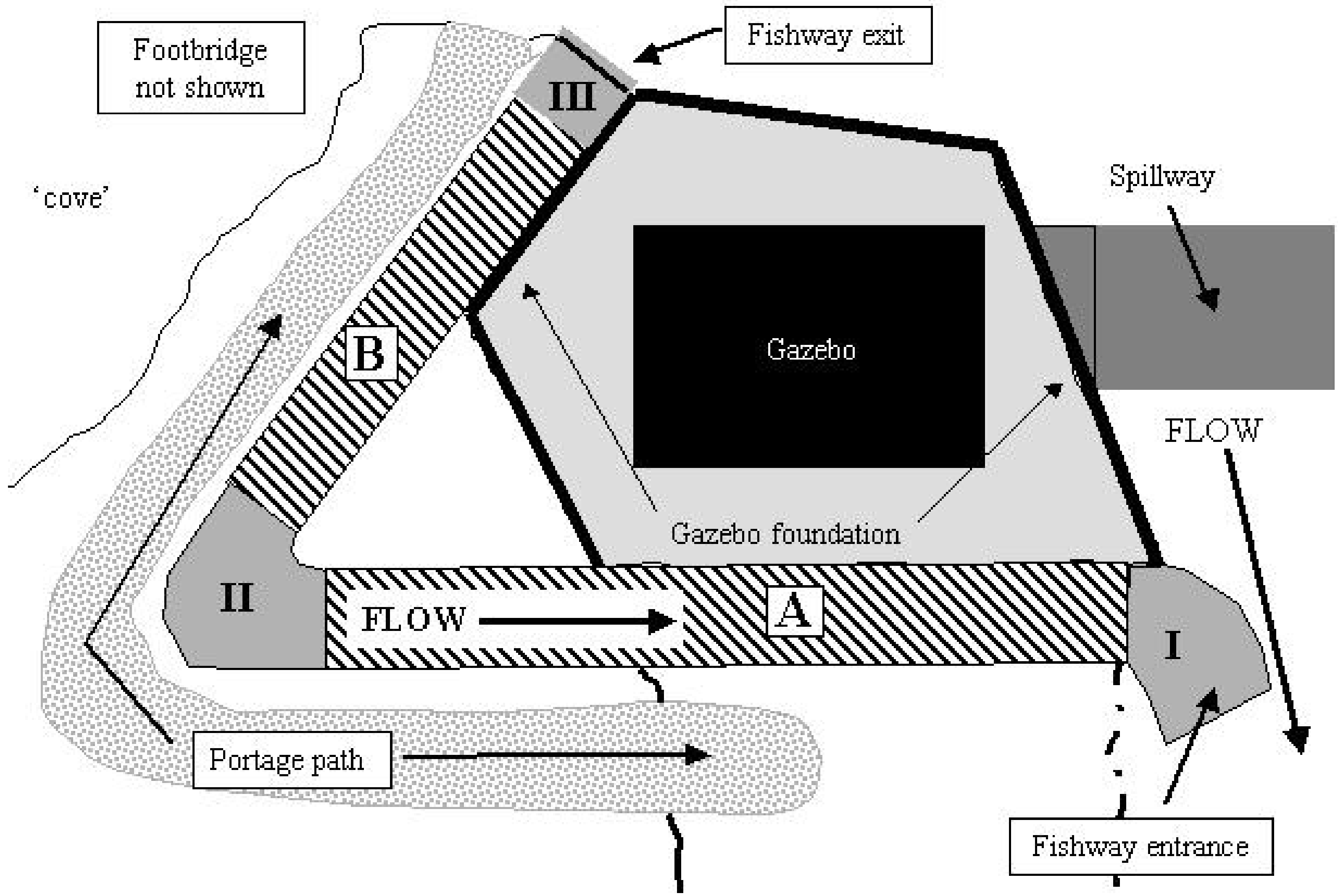
CARPENTERSVILLE DAM – Basic Layout – Conceptual Plans for a Denil Fishway on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



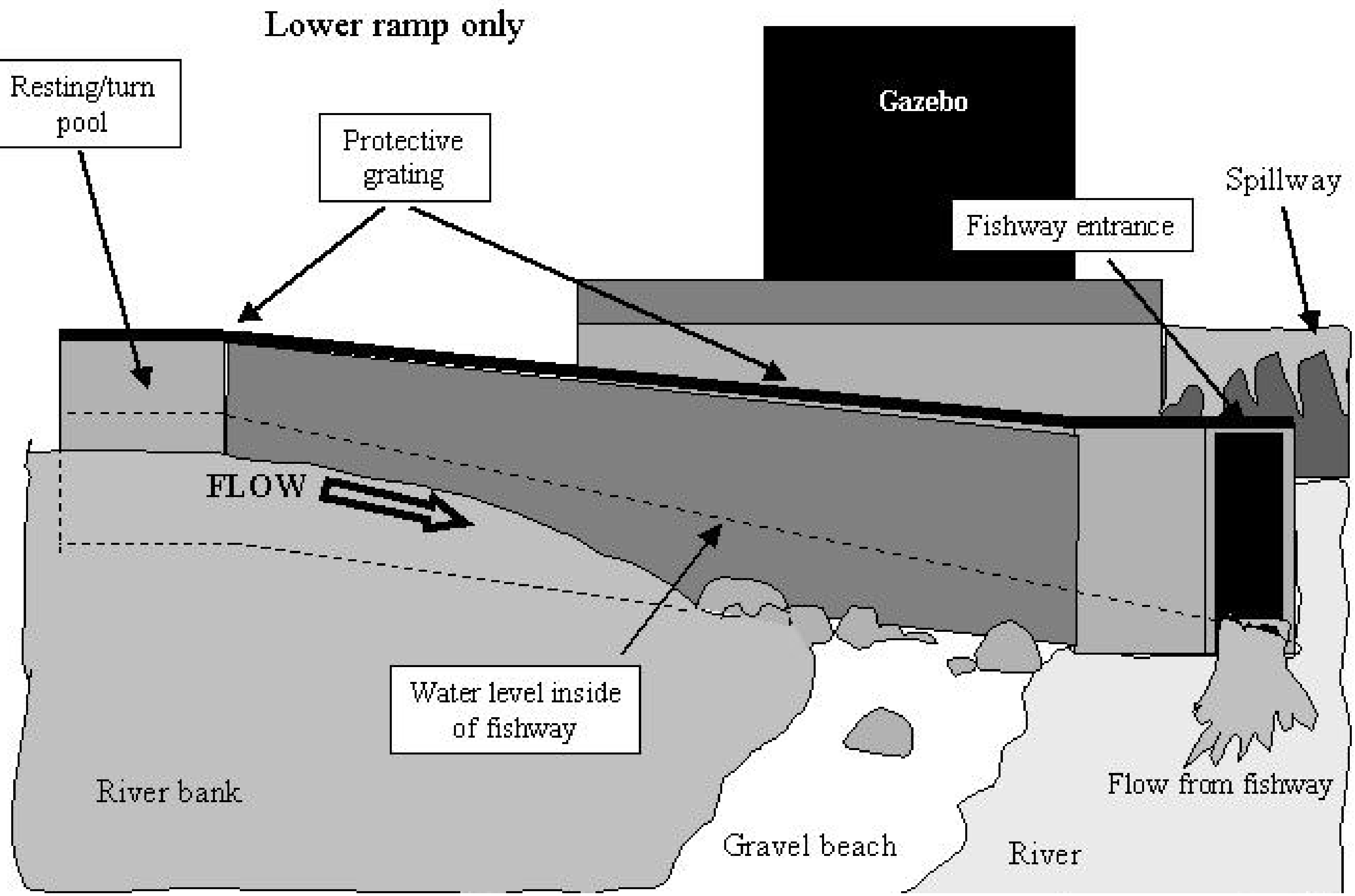
CARPENTERSVILLE DAM – Detailed Layout – Conceptual Plans for a Denil Fishway on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



CARPENTERSVILLE DAM – Profile – Conceptual Plans for a Denil Fishway on West Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



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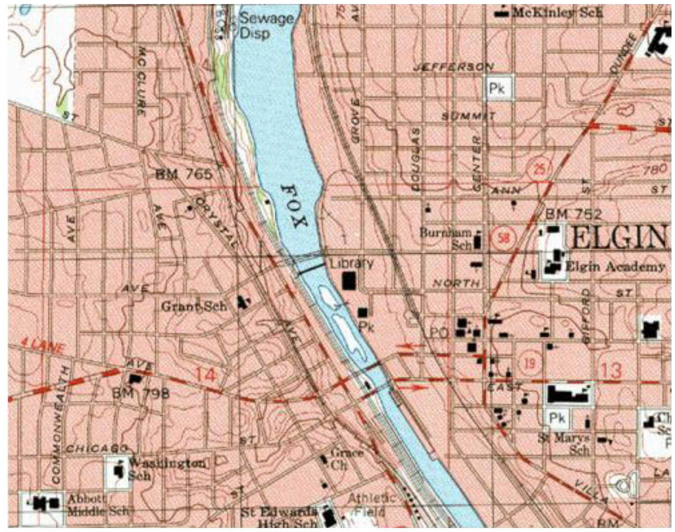
ELGIN DAM (A.K.A. KIMBALL STREET DAM)

LOCATION



Latitude-longitude (NAD 83): 42.0412770˚N 88.2893193˚W
Legal: T41N R8E S14NE
Town: Elgin , IL
River mile: 71.9
Comments: Immediately downstream of Kimball Street.
Next downstream dam (distance): South Elgin Dam (3.7 miles)
Next upstream dam (distance): Carpentersville Dam (6.3 miles)

DESCRIPTION

Height: 13 ft.
Spillway elevation: 708.4 ft.
Length: 325 ft.
Dam type: Broad-crested
Material: Concrete over an original timber structure.
Nature of barrier to fish: Complete. West bank fishway is non-functional.
Construction date: 1901
Condition of dam: Good (repaired in 1999)
Length of impoundment: 3.6 miles
Appurtenances: A non-functional fishway on the west bank and an overlook on the east bank.

LEGAL/SOCIAL ASPECTS

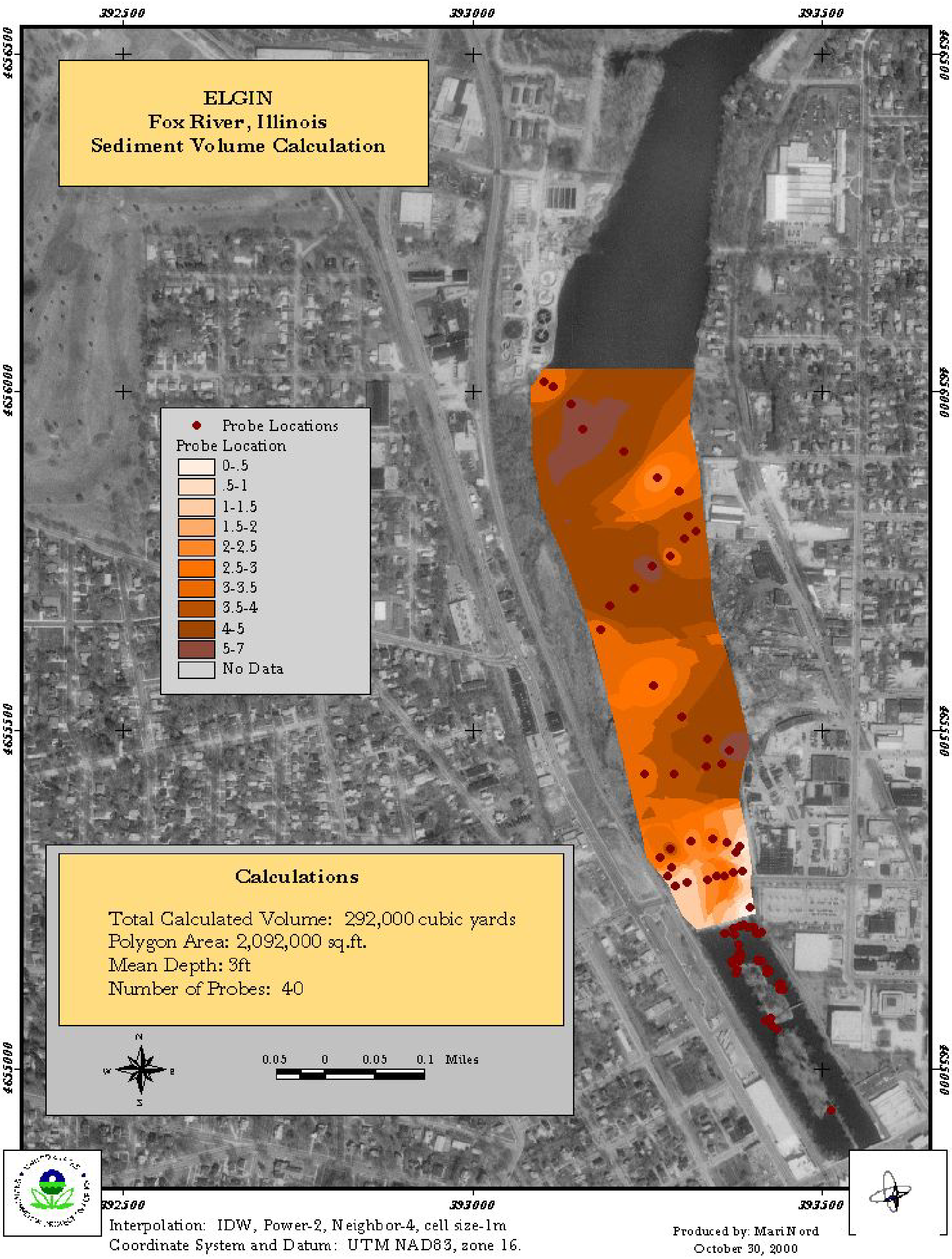
Owner: City of Elgin
Owner of adjoining land: City of Elgin
Present day purpose of dam: Maintain pool for intake of municipal water supply.
Uses of impoundment: Some recreational power boating.

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 292,000 cu. yds.

Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.



BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the need to maintain a costly City facility for many years to come.

Disadvantages:

- Need to reposition water intake to draw from newly formed free-flowing river channel.
- Reduce pool size for recreational power boating.
- Elicit objections among city taxpayers who recently paid to repair the dam.
- Upset upstream waterfront property and boat owners.

If the only purpose for this dam is to expedite the intake of river water for the municipal water system, there are several alternatives that could be considered. First, the entire dam could be removed and an intake pool could be dredged from the riverbed to maintain critical depth for the intake pipe. This assumes the water intake pipe will still be under water if the dam is removed. If the intake is above water level with the dam removed, the dredging could be coupled with a lowering of the intake pipe. A second option would be to only partially lower the dam, making it as low as possible and still allow the intake to remain under water. We do not know the depth of the existing intake pipe and therefore cannot comment on the feasibility of this alternative. However, even if the dam cannot be removed, if it could be lowered by 50%, the cost of fish passage and environmental impact of the impoundment would decrease since the size of the impoundment would be reduced. A third option would be to remove the existing dam and build a new dam immediately downstream of the water intake structure. The advantages would be that the dam could be lower than the existing dam, the impoundment could be smaller than the existing impoundment, and necessary fish passage and canoe portaging could be better designed as part of the new project. All of these options would require careful consultation with the City of Elgin and their plans for the existing water intake system, which are beyond the scope of this report.

BYPASS CHANNEL

No proposal for this option is provided due to the lack of suitable space for this type of fish passage facility. The presence of the highway bridge precludes this option.

DENIL FISHWAY

Advantages:

- Provides best opportunity to pass large numbers of fish over the dam.
- Fits in the available space.
- Land is publicly owned.
- Provides good public outreach/visitation opportunities next to Civic Center parking lot and bike/hike trail.
- Good construction access.

Disadvantages:

- The dam remains with all of its negative ecological impacts.
- Canoe portaging still required and extremely difficult at the site.
- Fishway must be maintained in the future.
- Short and long-term maintenance required.
- The risk of drowning in currents below the dam remains.

An east bank Denil fishway is recommended. The structure consists of five sections and has an overall slope of 1:15.

I - The entrance is a 135˚ turning entrance pool that would discharge water at the downstream edge of the whitewater splash zone below the spillway.

A - The lower ramp of baffles would extend southerly from the entrance pool to the turn pool.

II - At a point approximately adjacent to the south end of the existing Civic Center parking lot, the fishway would have a 180˚ turn pool, turning to the east.

B - The upper ramp of baffles would extend northerly along the existing bike/hike trail and between the trail and the river.

III - The exit pool is located between the bridge and the spillway.

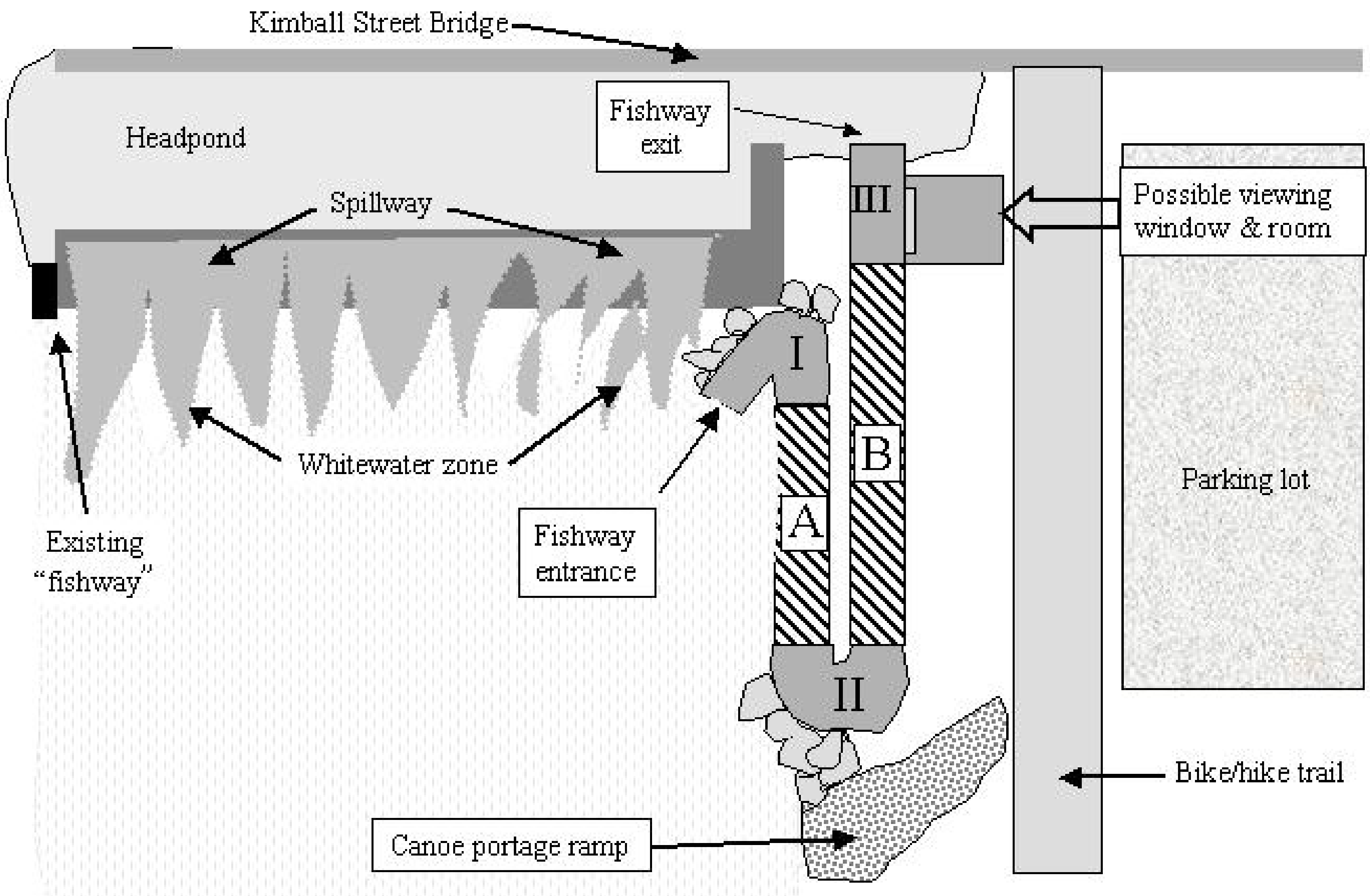
A protective aluminum grating would cover the fishway. Optional features include the provision of (1) a public viewing window and room located in the exit pool north of the spillway (and likely extending below the existing bike/hike trail), and (2) a canoe portage ramp extending from the bike/hike trail down the bank and past the turn pool to the river edge downstream of the fishway.

Estimated costs: A Denil fishway at the Elgin Dam is estimated to cost about $350,000 as a stand-alone project.

Note: The City of Elgin has recently constructed an overlook structure above the east spillway abutment. Some reconfiguring of the layout for the Denil fishway may be necessary to avoid the new overlook.

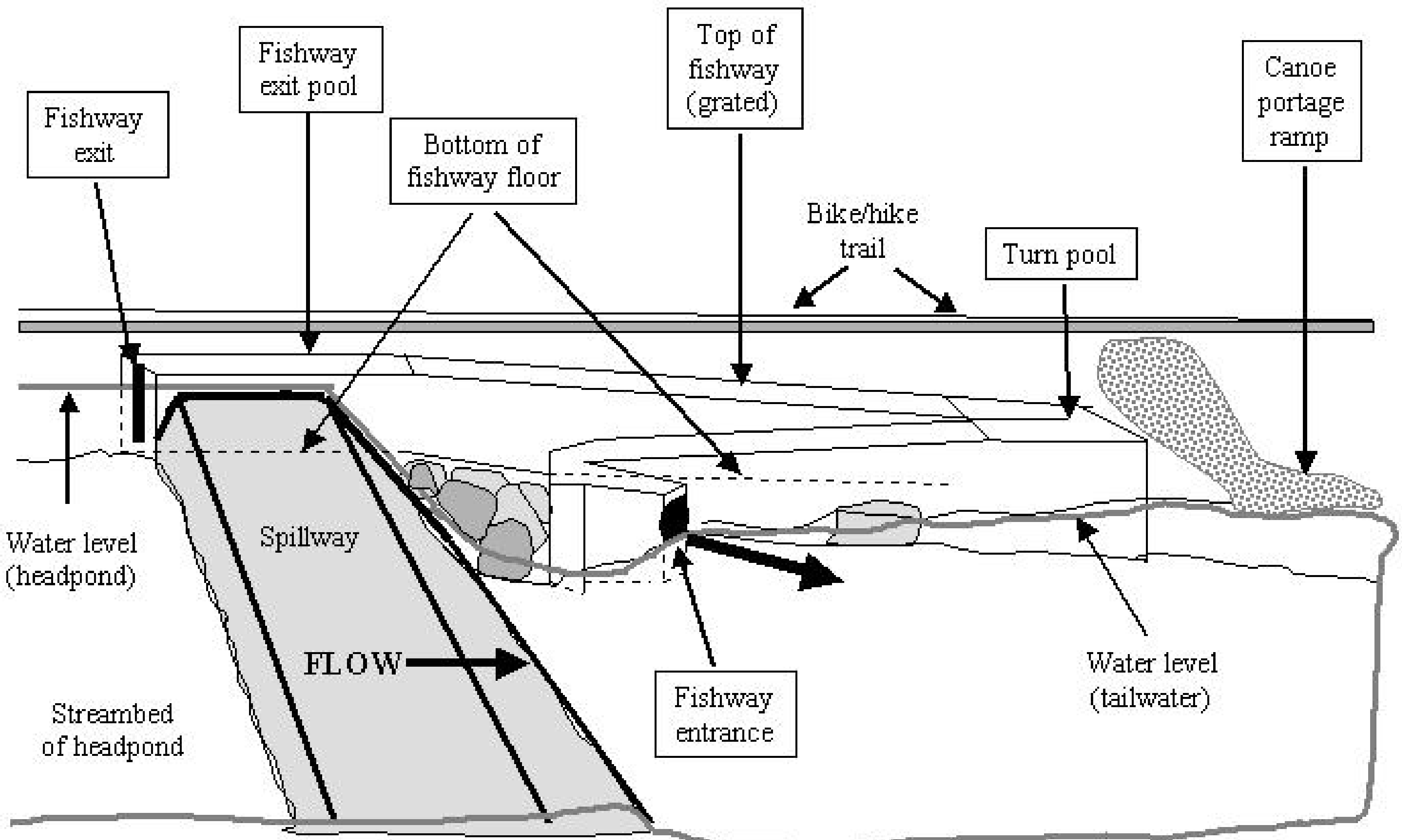
ELGIN DAM – Detailed Layout – Conceptual Plans for a Switchback Denil Fishway on East Bank

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



ELGIN DAM – Profile Looking East – Conceptual Plans for a Switchback Denil Fishway on East Bank

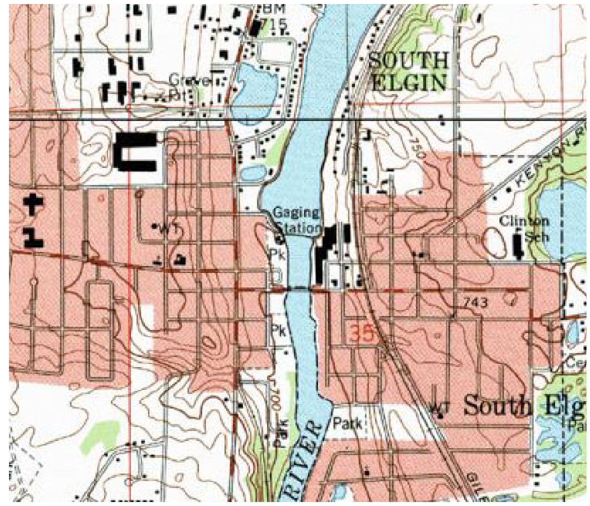
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



SOUTH ELGIN DAM

LOCATION

Latitude-longitude (NAD 83):
41.9961565˚N 88.2943194˚W
Legal: T41N R8E S35NW
Town: South Elgin, IL
River mile: 68.18
Comments: North of State Street Bridge
Next downstream dam (distance): St. Charles Dam (7.53 miles)
Next upstream dam (distance): Elgin Dam (3.7 miles)



DESCRIPTION

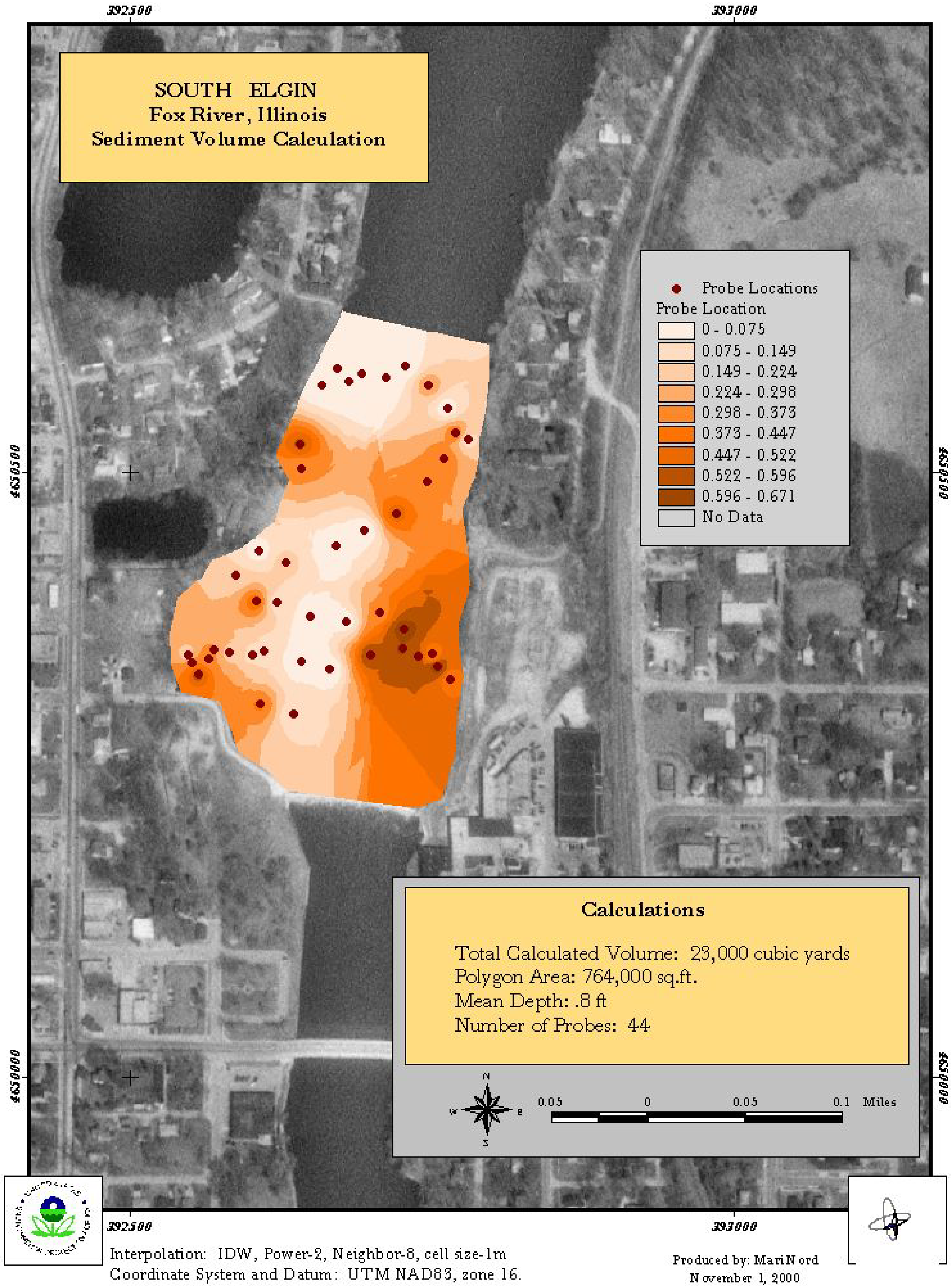
Height: 8.3 ft.
Spillway elevation: 700.0 ft.
Length: 357 ft.
Dam type: Broad-crested
Material: Concrete
Nature of barrier to fish: Complete
Construction date: Prior to 1915. Reconstructed in 1960 – 1961.
Condition of dam: Uncertain. Appears good.
Length of impoundment: 3.2 miles
Appurtenances: Some old mill gate structures on east bank. Not inspected.

LEGAL/SOCIAL ASPECTS

Owner: State of Illinois, Department of Natural Resources - Office of Water Resources
Owner of adjoining land: City of South Elgin (park on west bank)
Present day purpose of dam: None
Uses of impoundment: Some recreational power boating

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 23,000 cu. yds.
Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.
Distribution: See map below.



SOUTH ELGIN
Fox River, Illinois
Sediment Volume Calculation
392500
393000
4650500
4650000
Probe Locations
Probe Location
0 - 0.075
0.075 - 0.149
0.149 - 0.224
0.224 - 0.298
0.298 - 0.373
0.373 - 0.447
0.447 - 0.522
0.522 - 0.596
0.596 - 0.671
No Data
Calculations
Total Calculated Volume: 23,000 cubic yards
Polygon Area: 764,000 sq.ft.
Mean Depth: .8 ft
Number of Probes: 44
N
W
E
S
0.05
0
0.05
0.1
Miles
Interpolation: IDW, Power-2, Neighbor-8, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.
Produced by: Mari Nord
November 1, 2000

BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate a potential hazard of drowning below the spillway.
- Eliminate the need to maintain a costly state facility for many years to come.
- Create additional riverfront open space that could extend the existing park.

Disadvantages:

- Reduce pool size for recreational power boating
- Upset upstream waterfront property (not many upstream residences observed)

This is one of a few dams on the Fox River that include an extensive earthen dam (west bank) in addition to the concrete spillway. Our vision for dam removal would preserve the earthen dam, which is part of the municipal park. Only the spillway would be removed. The restored river channel would be expected to be slightly narrower tan the existing length of the spillway at normal flows. The existing dam abutment walls could remain as retaining walls (with appropriate safety fencing on top) or the walls could be removed and the earth sloped at a moderate angle to remove public safety hazards. The land immediately upstream of the earthen dam would be reclaimed as a grassy strip along the river (with trees planted) that would become an northerly extension of the existing park. After a number of years, most people would never know the dam existed, unless they focused on the unusual grassy ridge (old earthen dam) running perpendicular to the river.

BYPASS CHANNEL

Advantages:

- Pass canoes and kayaks, precluding the need to portage.
- Pass a greater variety of fish species and life stages than a traditional fishway.
- More compatible with the scenic qualities of the park.
- Less maintenance than a Denil fishway.
- Offer good public outreach opportunities with park visitors.

Disadvantages:

- The dam would remain, with all of its negative ecological impacts.
- Requires much engineering and construction.
- Would render portions of existing parkland unusable for current uses by converting it to the bypass channel.
- There are manholes near the top end of the proposed bypass. The purpose of these manholes is unknown and needs to be investigated. If they service utilities, the utilities would have to be relocated.
- Some type of auxiliary fishway (Denil or pool-and-weir spur) would have to be built in addition to the bypass channel to effectively attract migrating fishes.

A bypass channel (slope = 1:30) could be easily installed in the existing parkland west of the spillway (see sketches). This would allow easy upstream migration of fishes and downstream passage of canoes and kayaks without the need to portage the dam. Features include:

- A location similar to that of a once proposed navigational lock.
- The exit of the bypass would be located on the western portion of the earthen dike about 300 ft. west of the west end of the spillway. The channel would extend 437 ft. through the grassy area along the foot of the dike.
- The entrance is located about 100 ft. downstream of the spillway. This is not adequate for effective fish attraction and some type of auxiliary bypass or Denil fishway would have to be added to the design to bring fish from below the dam to the bypass channel (see following section on Denil fishways).
- An approximate width of 50 ft. wide to easily accommodate canoes and kayaks.
- In order to achieve a 1:30 slope, the bypass would have to be 225 ft. long. However, to reach the targeted locations at the headpond and tailwater, the channel would need to be 437 ft. long, equating to a much flatter slope of about 1:50. The flatter slope would make the passage easier for fish and boats. However, the ambient slope of the land is not consistent, being much steeper near the dike than the tailwater. To achieve a consistent slope, fill would have to be added to the middle sections of the channel. A final, more practical design may result in a steeper slope (e.g., 1:30) near the top and a flatter slope (e.g., 1:50) near the bottom. This is acceptable for boats as long as a 1:30 slope is not exceeded and for fish as long as a 1:20 slope is not exceeded.

DENIL FISHWAY

Advantages:

- Will pass most of the targeted fish species.
- Will take up less land than a bypass and cause less impact on the park land.
- Will take advantages of public outreach opportunities with park visitors.

Disadvantages:

- The dam remains, with all of its negative ecological impacts.
- Will not pass as many fish species and life stages as the proposed bypass channel.
- There is no boat passage; portages still required.

A west bank Denil fishway about 150 ft. long (slope = 1:15) and wrapping around the west spillway abutment wall is recommended for this option. This option could be built by itself if no bypass channel for boats was desired or it could be built in conjunction with a bypass channel to allow for effective fish attraction, which the bypass would not do because of the location of its entrance away from the dam. The fishway consists of five sections.

I - The entrance would be located near the southern end of the abutment wall below the spillway, perhaps near the existing tree.
A - The first run of baffles would run along the east side of the abutment wall.
II - A 180° turn pool would be located just beyond the south end of the abutment wall.
B - The second run of baffles would run through the earthen dike west of the abutment wall.
III - The exit would be located somewhere within 50 ft. of the western end of the spillway.

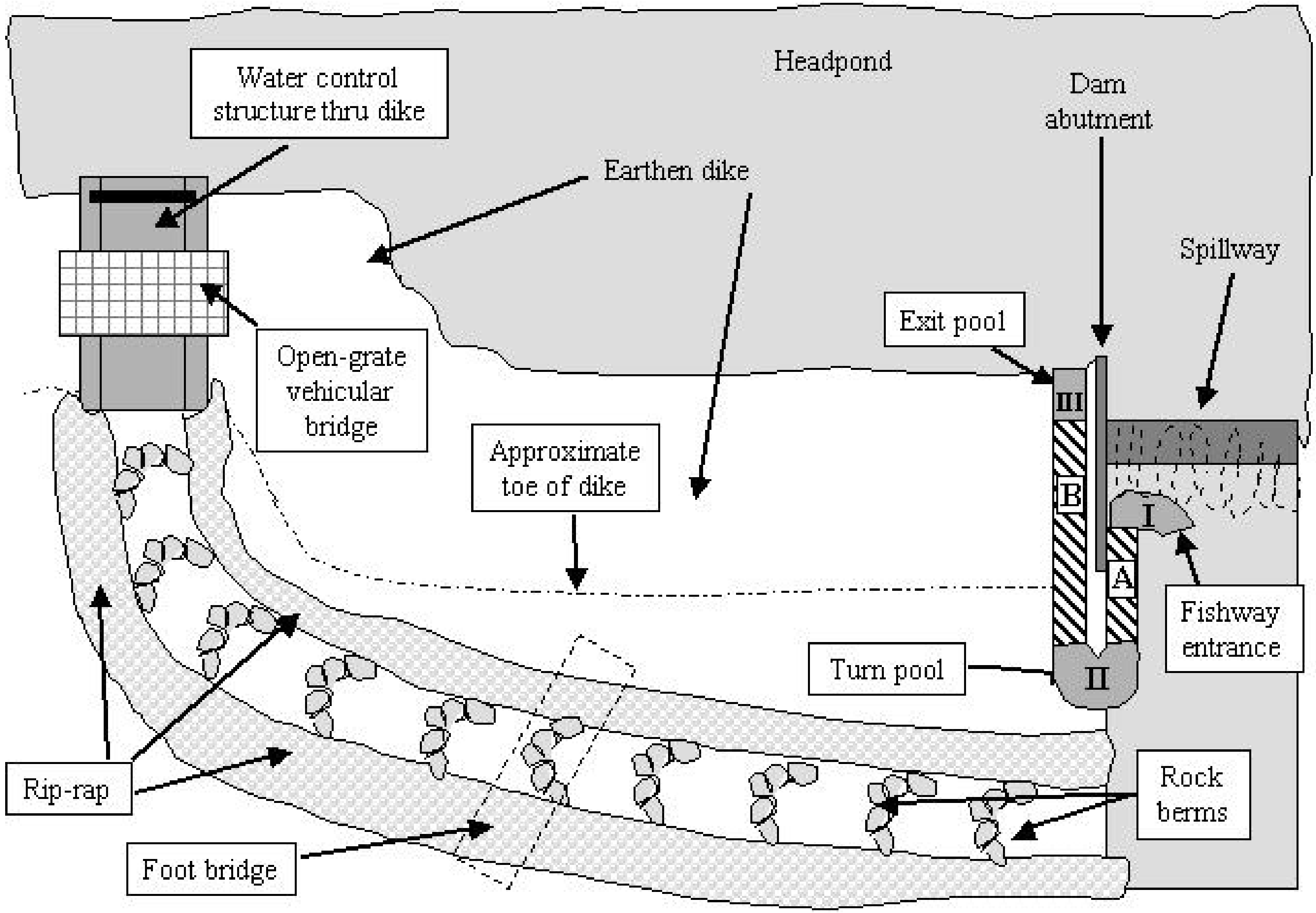
Not shown is the possible need for supplemental attraction water to help fish locate the fishway. This could be provided by the installation of a notch or adjustable gate in the extreme western end of the spillway to spill more water at the west end than the east end, thus drawing fish over to where the fishway entrance is located.

A second Denil option (not shown in any sketches) might consist of an entrance located where the entrance is shown on the above option but instead of the fishway wrapping around the dam's abutment and passing north to the headpond, a small section could be directed southwest to join the bypass channel. This would allow the efficient collection of migrating fish near the toe of the dam, have them pass up a relative short section of Denil (reducing costs), and once in the bypass channel, use that structure to complete their migration up to the headpond. This alternative could be substantially less expensive and would not require the commitment of as much parkland.

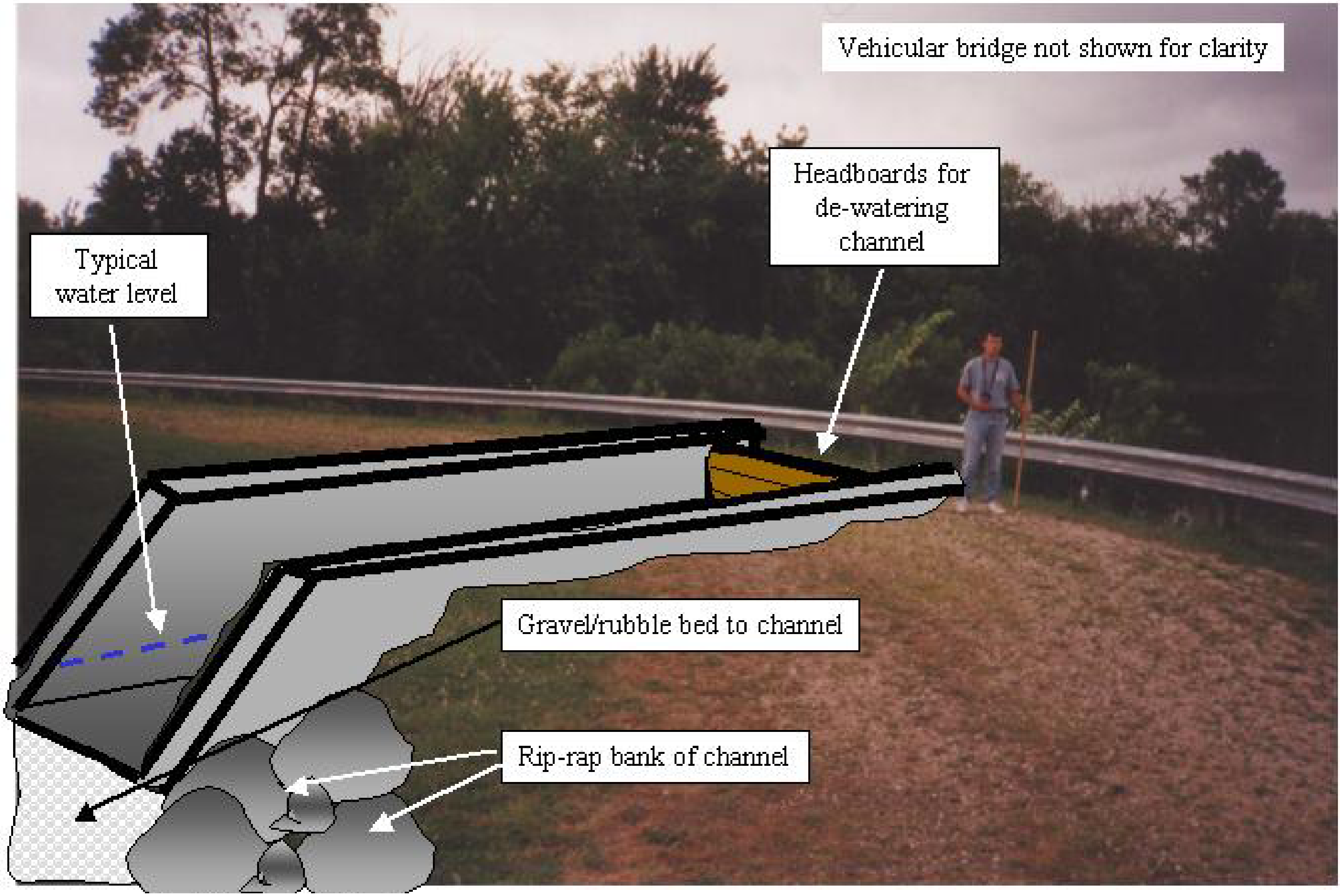
Estimated costs: A Denil fishway at the South Elgin Dam is estimated to cost about $240,000 as a stand-alone project.

SOUTH ELGIN DAM – Conceptual Plans for a Bypass Channel and Denil Fishway on West Bank

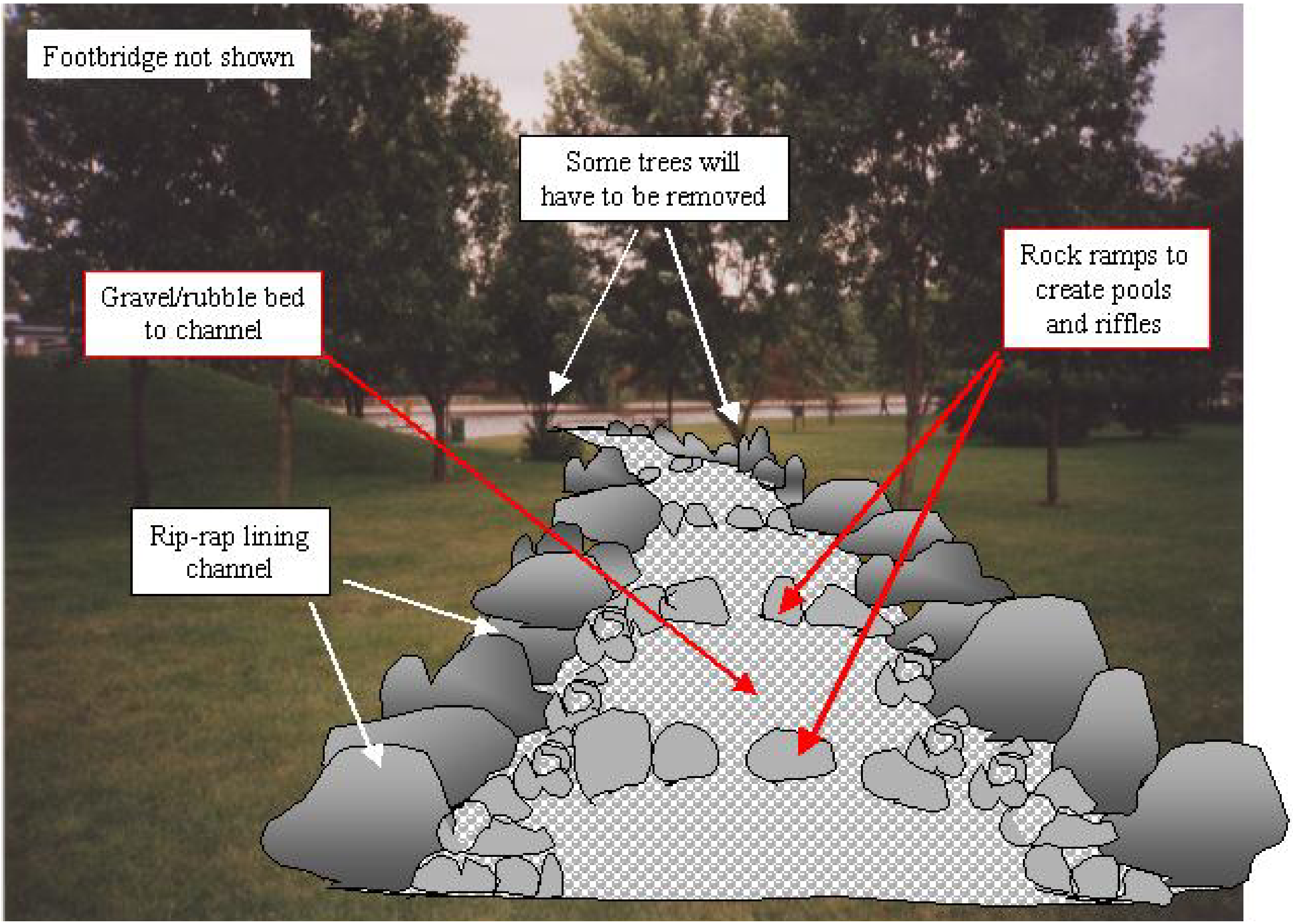
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



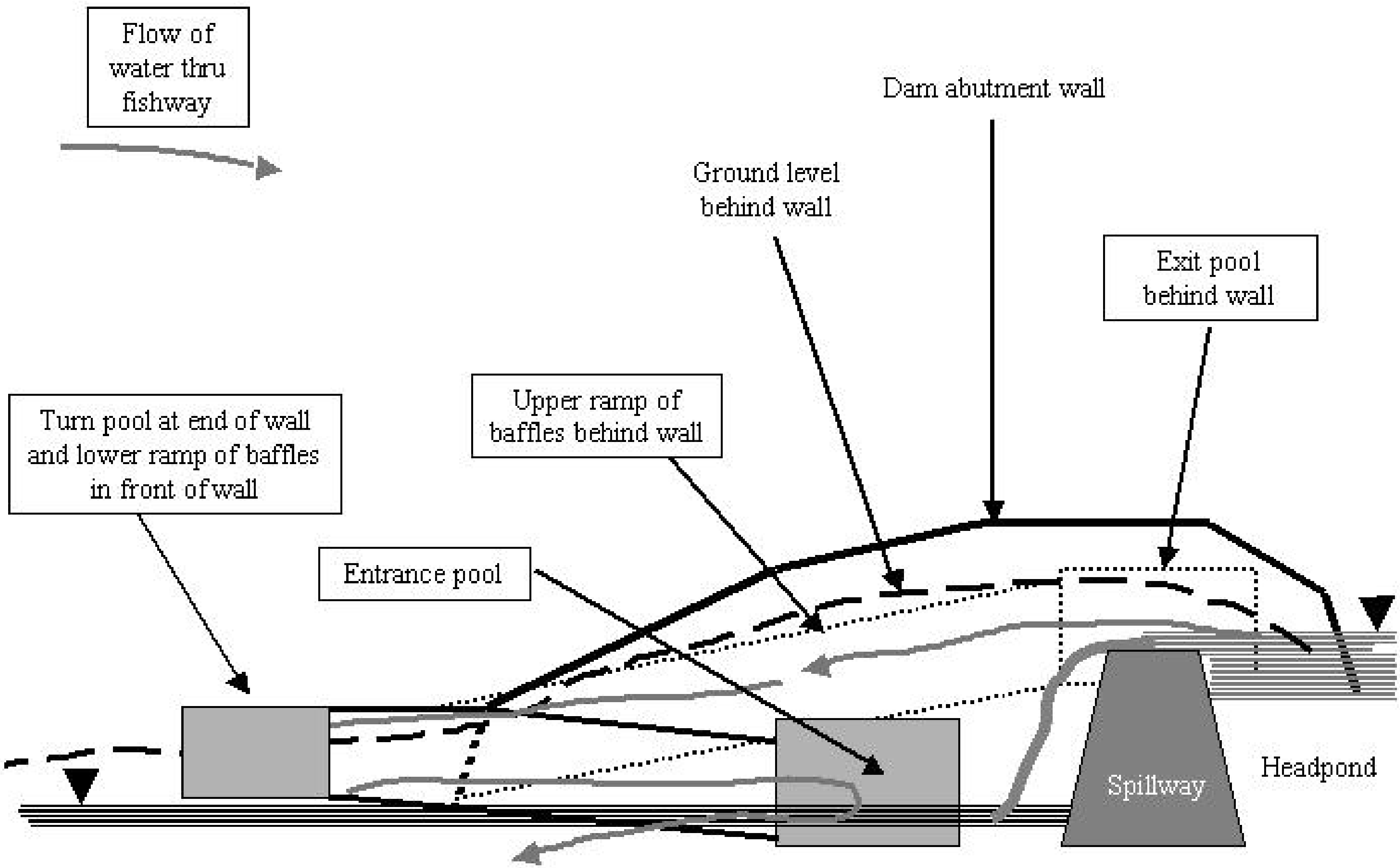
SOUTH ELGIN DAM – Depiction of Water Control Structure of Bypass Channel.



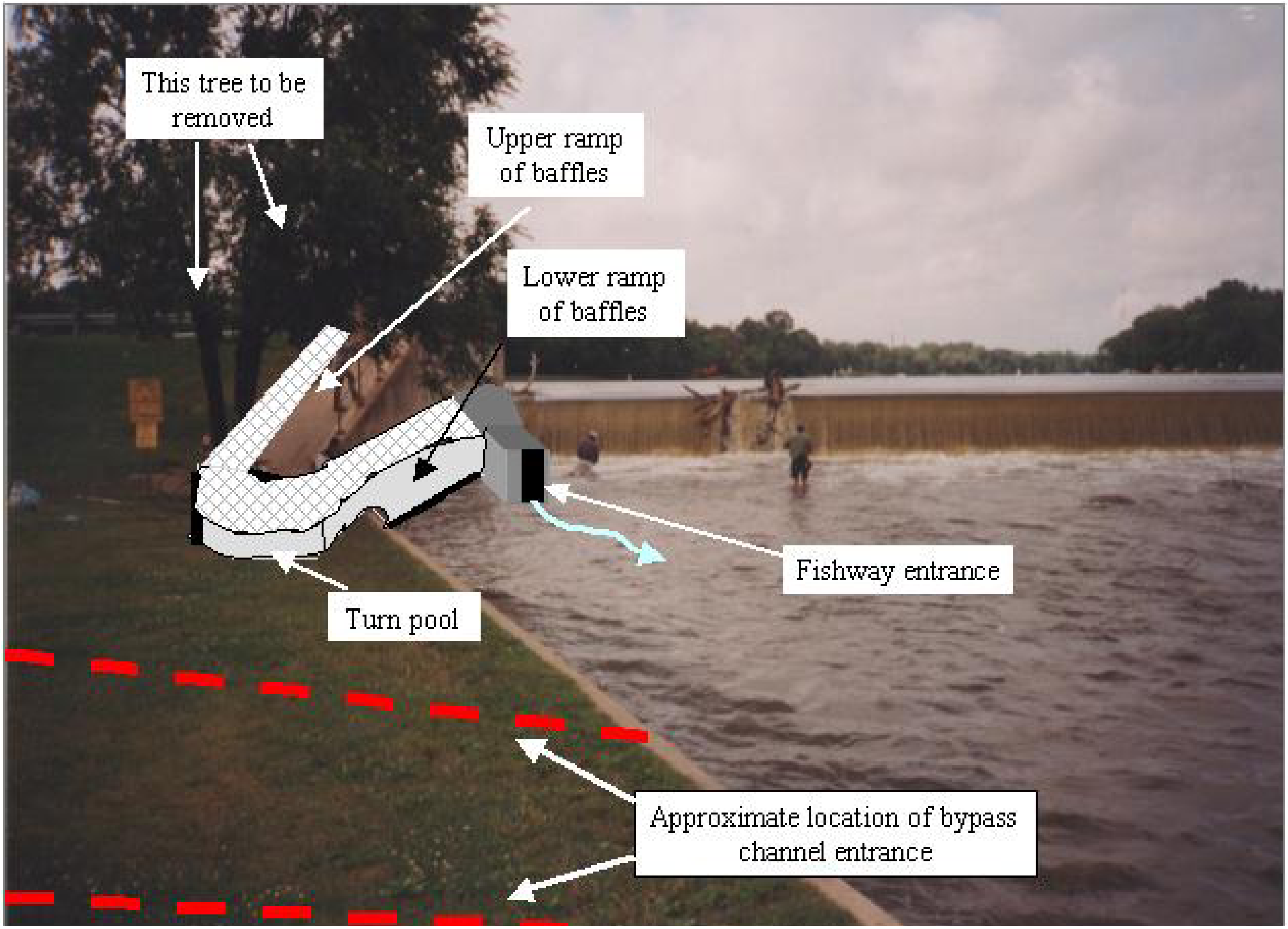
SOUTH ELGIN DAM – Depiction of Bypass Channel Passing Through Park Land.



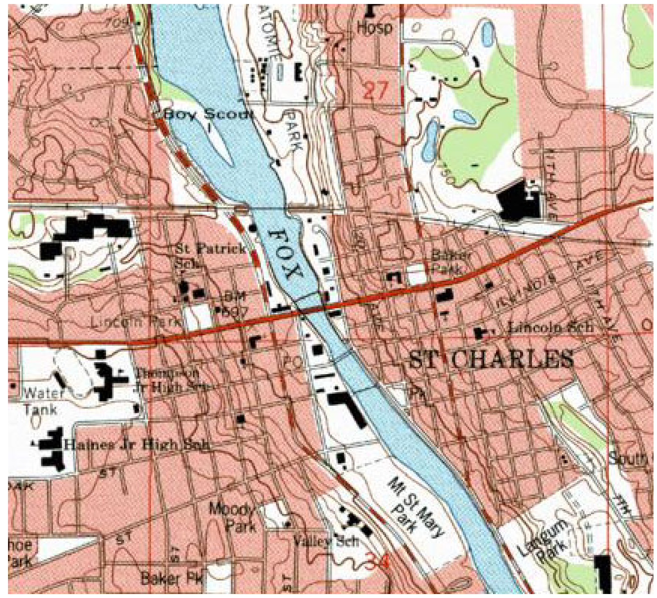
SOUTH ELGIN DAM – Profile View - Conceptual Plans for a Denil Fishway on West Bank
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



SOUTH ELGIN DAM – Depiction of Denil Fishway on West Bank.

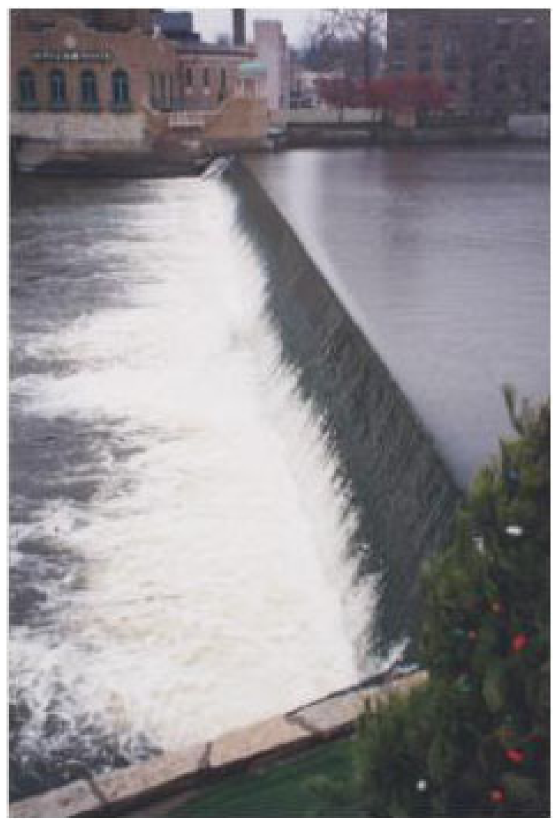


ST. CHARLES DAM



LOCATION

Latitude-longitude (NAD 83):
41.9140628 ˚N 88.23141098˚W
Legal: T40N R8E S27SW
Town: St. Charles, IL
River mile: 60.65
Comments: Approximately 175 ft. upstream of Illinois State Rt. 64 Highway Bridge
Next downstream dam (distance): Geneva Dam (1.9 miles)
Next upstream dam (distance): South Elgin Dam (7.53 miles)



DESCRIPTION

Height: 10.3 ft. Reports of the height of this dam varied between 6.7 and 10.3 ft. Our plans are based on a 10.3 ft. height. As with all dams, final design work for fish passage must begin with a careful survey of the site.
Spillway elevation: 684.6 ft.
Length: 295 ft.
Dam type: Ogee
Material: Concrete
Nature of barrier to fish: Complete. East bank "fishway" is non-functional.
Construction date: 1916 with repairs in 1939
Condition of dam: Good
Length of impoundment: 3.9 miles
Appurtenances:

- Non-functioning concrete fishway on east end of spillway.
- Masonry terrace about 1 ft. above typical tailwater level and extending from downstream edge of the fishway to Rt. 64 Bridge. Used for public access to river.
- Two non-functional water fountains built into the retaining wall above the terrace.
- Concrete stairs leading from terrace up to ground level by the Municipal Center.

LEGAL/SOCIAL ASPECTS

Owner: City of St. Charles.
Owner of adjoining land: Most of east bank presumed to be City of St. Charles (municipal center). Most of west bank presumed to be owned by the Baker Hotel.
Present day purpose of dam: None.
Uses of impoundment: Recreational power boating.

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 56,910 cu. yds. Includes backwater area southwest of boat launch.
Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.
Distribution: See map below.

BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

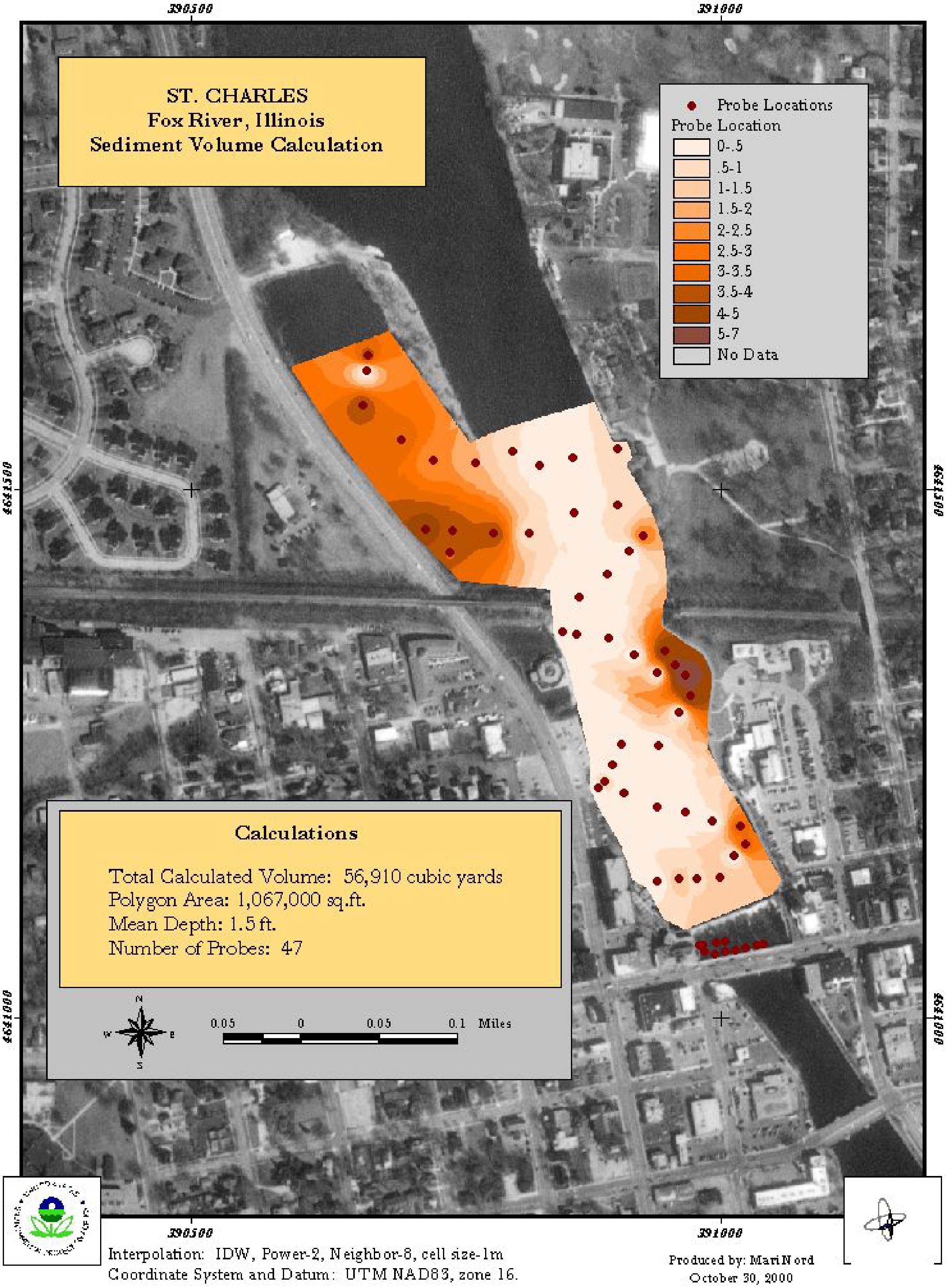
Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate a potential hazard of drowning below the spillway.
- Eliminate the need to maintain a costly structure for many years to come.

Disadvantages:

- Reduce pool depth behind dam and interfere with recreational power boating.
- Upset upstream waterfront property and boat owners.

If there is strong local opposition to full removal of this dam due to the impact on upstream recreation, ‘dam lowering’ should be considered as an option. For example, if the existing spillway were lowered by 5 ft. (leaving a 5-ft. high spillway), there would be some restoration of free flowing river upstream, while maintaining some pool for recreation. Furthermore, the lower dam would allow a much less expensive fishway project (see below), and would allow the construction of a 1:30 slope canoe bypass channel that would eliminate the need to portage. Currently, there is no room for such a canoe pass because of the height of the dam and the close proximity to the bridge. A lower dam also would allow the addition of concrete to the toe of the spillway to eliminate the dangerous hydraulic current and drowning risk.



ST. CHARLES
Fox River, Illinois
Sediment Volume Calculation
Probe Locations
Probe Location
0-.5
.5-1
1-1.5
1.5-2
2-2.5
2.5-3
3-3.5
3.5-4
4-5
5-7
No Data
Calculations
Total Calculated Volume: 56,910 cubic yards
Polygon Area: 1,067,000 sq.ft.
Mean Depth: 1.5 ft.
Number of Probes: 47
0.05 0 0.05 0.1 Miles
390500
391000
4641500
4641000
Interpolation: IDW, Power-2, Neighbor-8, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.
Produced by: Mari Nord
October 30, 2000

BYPASS CHANNEL

No proposal for this option is provided due to the lack of suitable space for this type of fish passage facility. The presence of the highway bridge and important structures close to the dam preclude this option.

DENIL FISHWAY

Advantages:

- The fishway would allow the passage of most targeted species without removing the dam.
- The public access in the center of this City makes this site a prime candidate for a public viewing room.
- The project could incorporate a canoe portage ramp/stairs, greatly improving the existing portage.

Disadvantages:

- The dam remains in place along with all of its negative ecological impacts.
- Some species sizes of fish will not be able to negotiate the fishway to pass the dam.
- The obstacle to paddling and the need to portage remain.
- The risk of drowning in the currents below the dam remains.

A Denil fishway with a slope of 1:15 is proposed for this option. The new fishway will be located on the east end of the spillway with the exit at the same location as the exit of the existing non-functional 'fishway.' The upstream fountain and existing stairs would be removed to make room for the fishway and a new stairway would be installed as part of the project (see sketch). The downstream fountain is not in the way of the proposed fishway but it could be removed or repaired during construction. Construction access is better on the east side than the west side (adjacent to the Hotel Baker), but it will still be challenging and may require the temporary modification of the existing walkways in the area. The proposed fishway is made up of five sections.

I - The entrance pool is about 25 ft. long. The entrance is located below the white water zone of the dam at about a 45˚ angle. The pool makes a turn to allow fish to enter the first run of baffles, which is oriented parallel to river flow.

A - The first run of baffles is about 77 ft. long.

II - A 180˚ turn/resting pool would be located with its outer wall a few feet downstream of the southernmost portion of the stairwell (about at an existing pipe). The turn pool will be at least 20 ft. long but may be lengthened to fit the fishway in the space available.

B - The second run of baffles is about 77 ft. long.

III - The exit pool is about 6 ft. long.

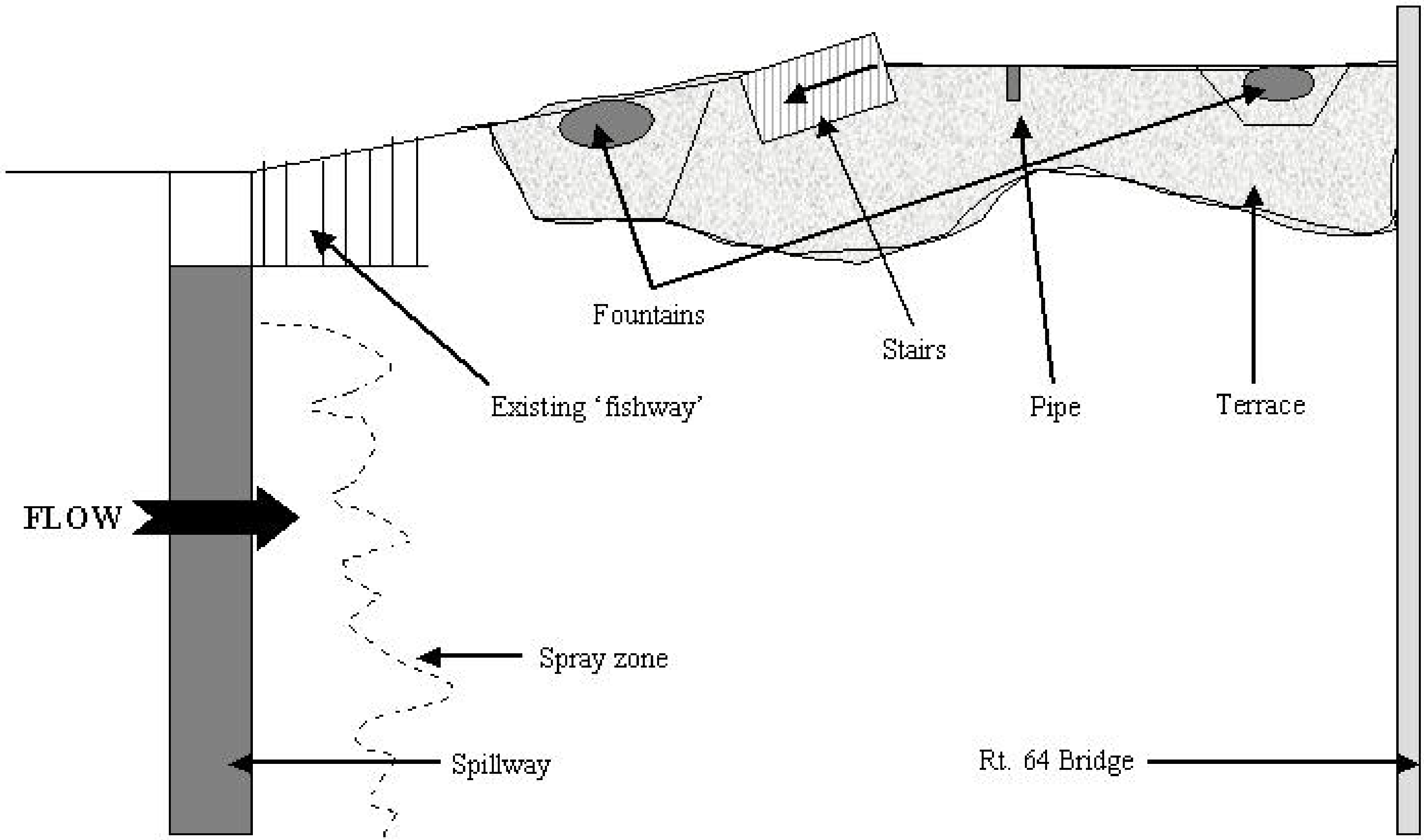
Additional features include:

- A partial grating should cover a portion of the fishway to serve as a walkway for fishway workers removing trash, etc. The lowermost fishway should have a complete grated covering (removable) to exclude trash and ice that wash over the spillway during times of flood. The grating should be made so it is not suitable for use as a portage route because it would be dangerous to draw canoeists that close to the spillway.
- To accommodate portaging canoeists, there is a need for a metal stairwell supported by poles or I-beams that is suspended over the turn pool of the fishway. The stairs would land on the terrace downstream of the fishway. The slope of the new stairway would be much less than the existing one and it would be much wider to make canoe portaging easier.
- An optional feature that could be considered is the provision of a viewing window in the side of the turn pool. IDNR fisheries biologists and researchers could use the window to document use of the fishway by fish and it can be opened to public visitation during appropriate time periods. Public viewing rooms are extremely popular facilities on the West and East coasts and are often provided by power companies to generate public goodwill toward the dam owners.
- Another optional feature is the provision of a simple fish trap in the exit pool. When closed, IDNR fisheries biologists could use the trap to document and capture fish migrating up the fishway. The size of the exit pool may have to be increased slightly to accommodate a trap.

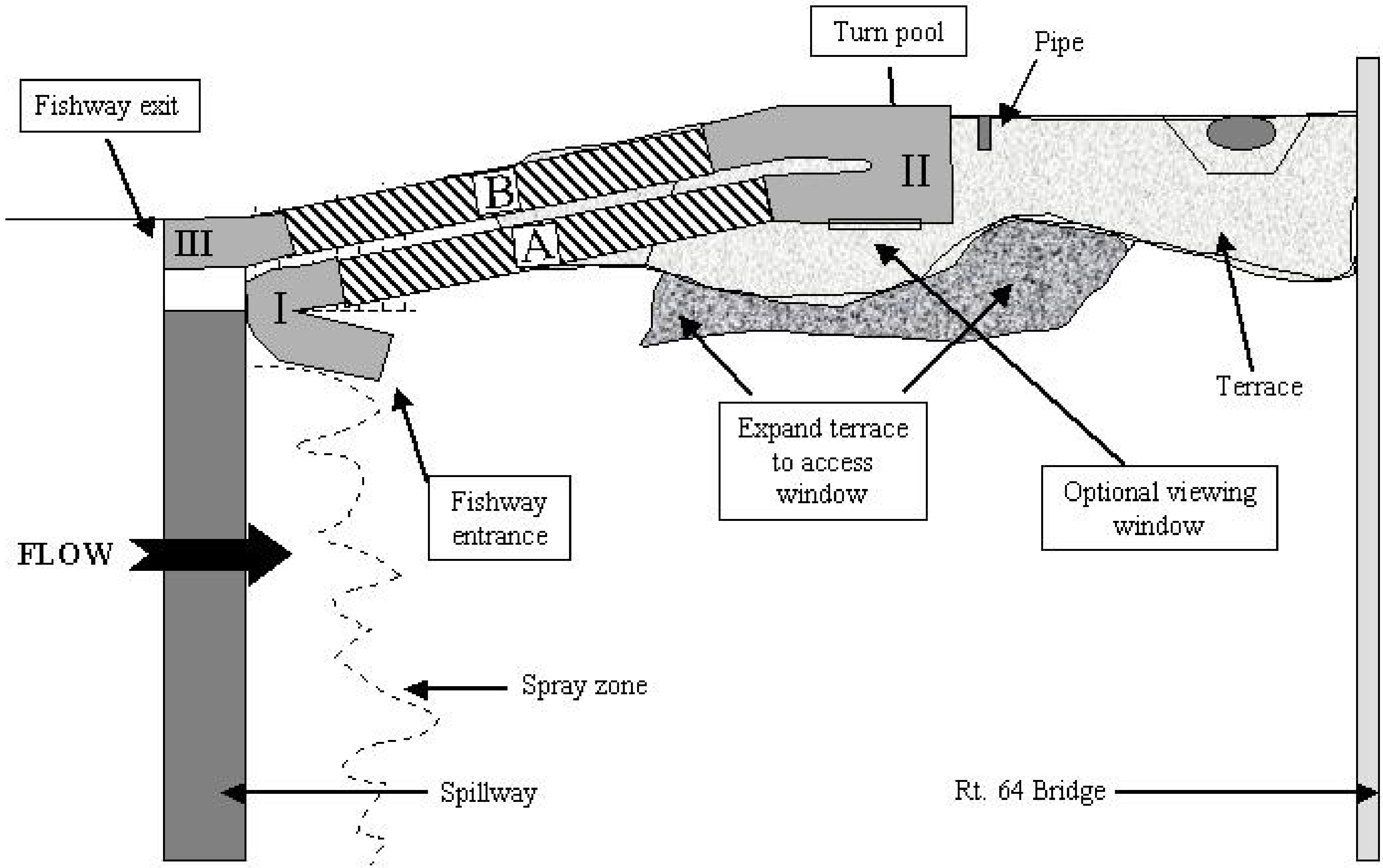
Estimated costs: A Denil fishway at the St. Charles Dam is estimated to cost about $350,000 as a stand-alone project.

ST. CHARLES DAM – Existing Conditions – Location of Denil Fishway at East End of Spillway

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

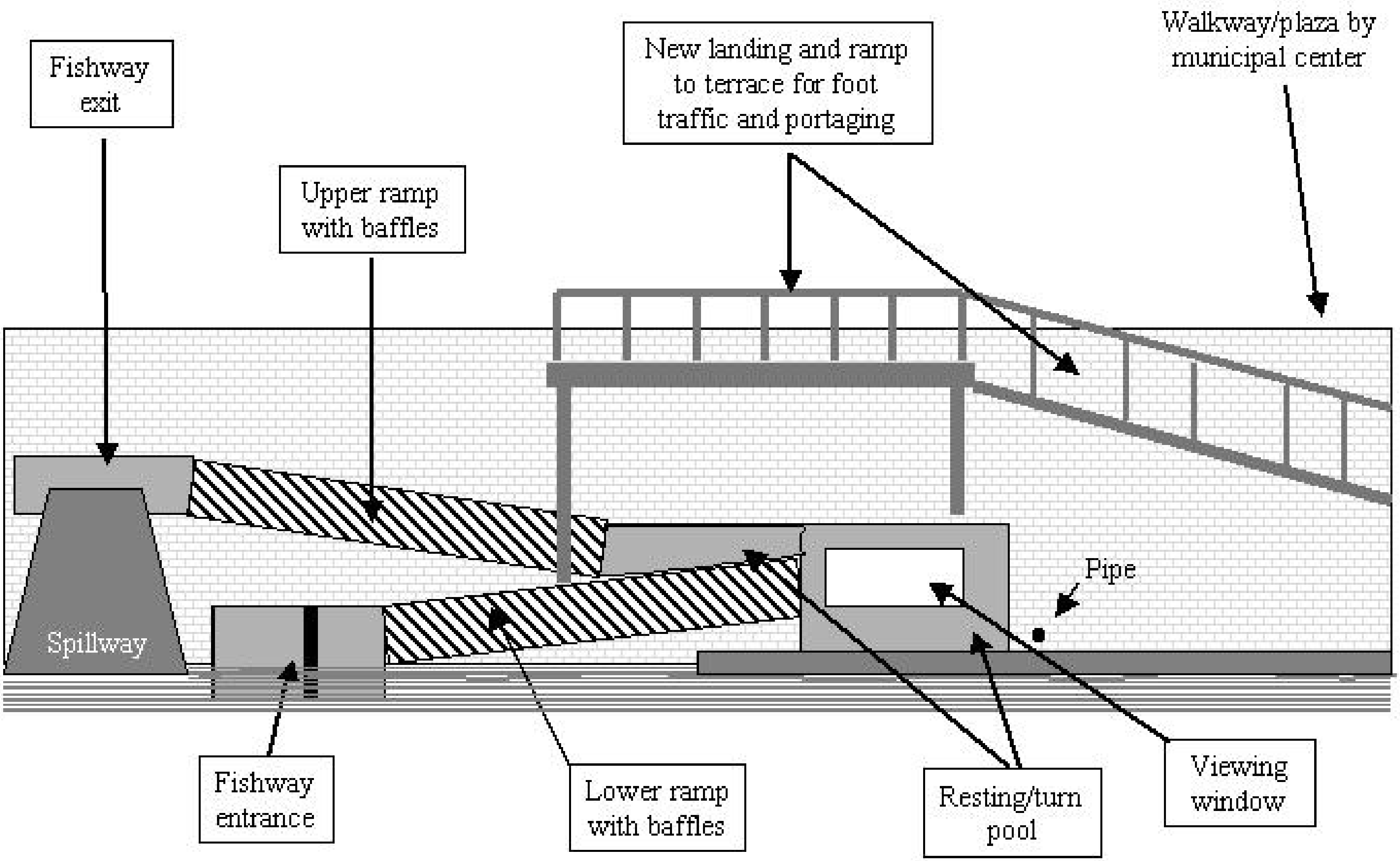


ST. CHARLES DAM – Plan View – Conceptual Plans for a Denil Fishway at East End of Spillway
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

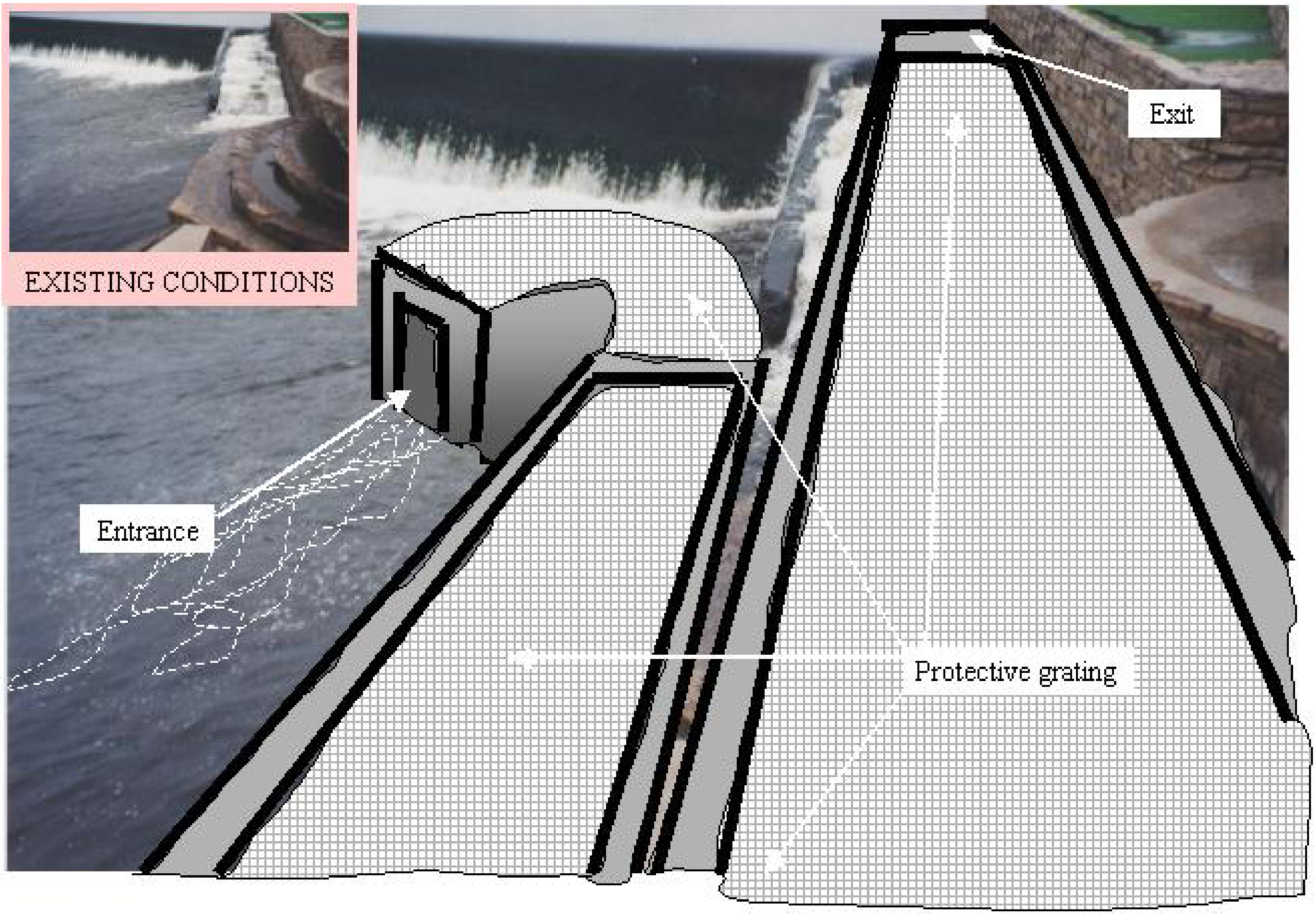


ST. CHARLES DAM – Profile View – Conceptual Plans for a Denil Fishway at East End of Spillway

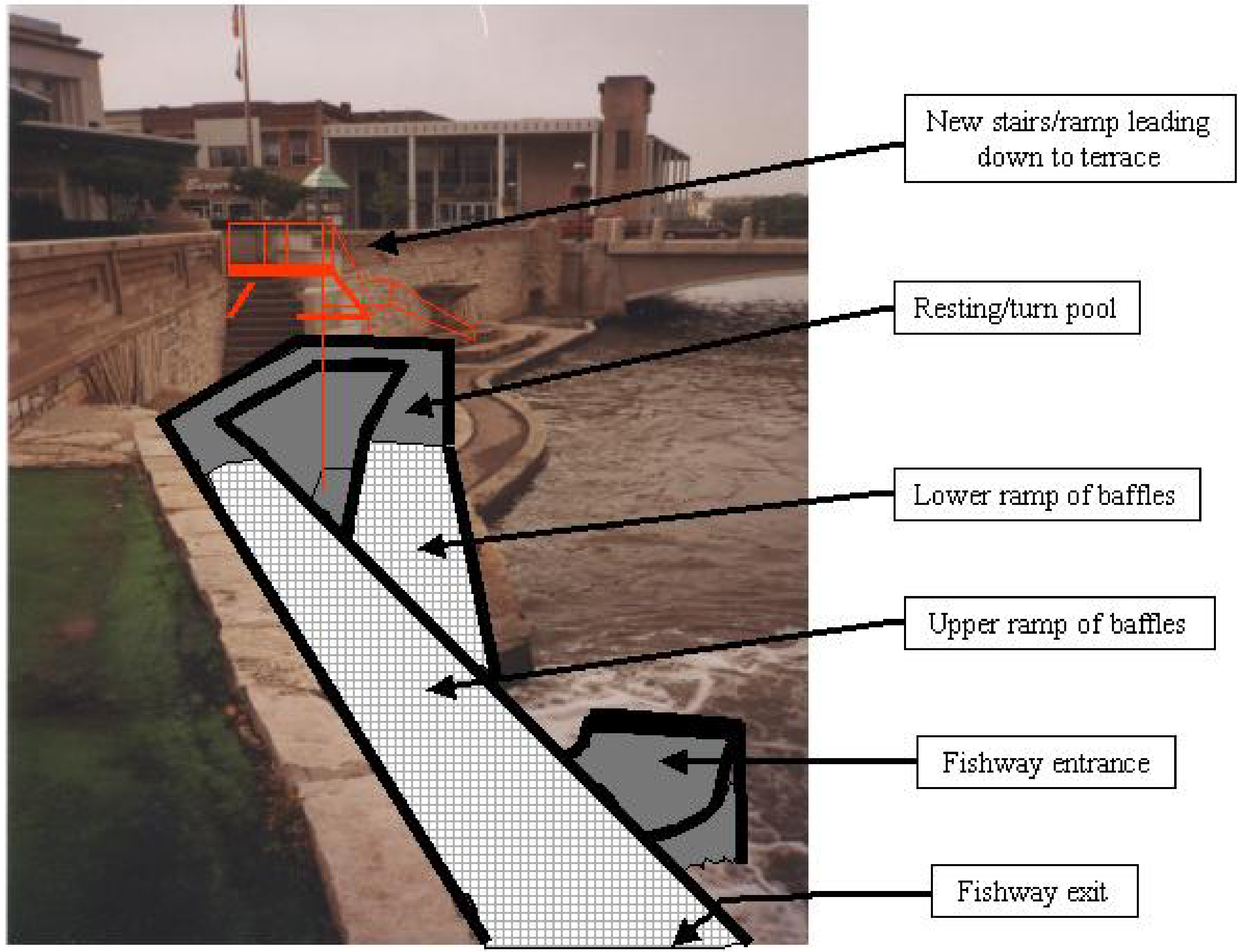
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



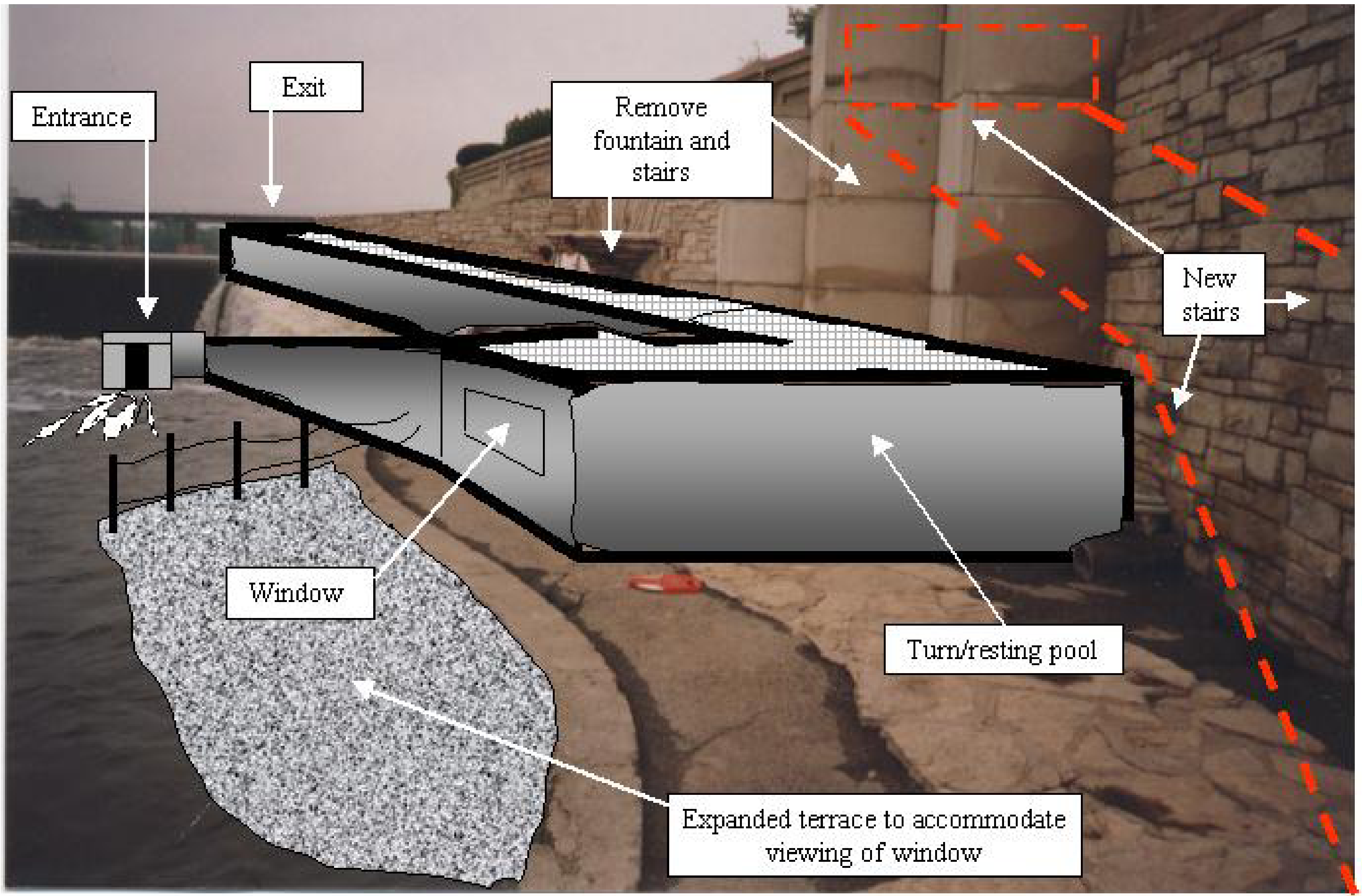
ST. CHARLES DAM – Upstream View – Depiction of Denil Fishway at East End of Spillway.



ST. CHARLES DAM – Downstream View – Depiction of Denil Fishway at East End of Spillway.



ST. CHARLES DAM – Upstream View at Terrace– Depiction of Denil Fishway at East End of Spillway.



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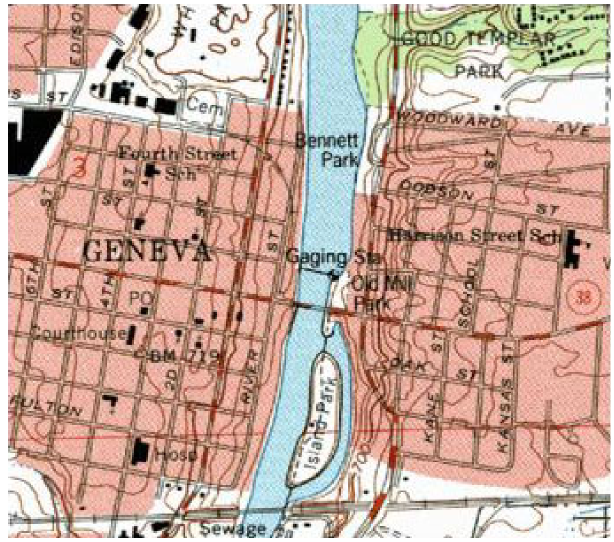
GENEVA DAM

LOCATION

Latitude-longitude (NAD 83): 41.8881459˚N 88.3020909˚W
Legal: T39N R8E S3SE
Town: Geneva, IL
River mile: 58.7
Comments: Upstream of U.S. Rt. 38 Bridge
Next downstream dam (distance): North Batavia Dam (2.4 miles)
Next upstream dam (distance): St. Charles (1.9 miles)



DESCRIPTION

Height: 13 ft.
Spillway elevation: 675.4 ft.
Length: 441 ft.
Dam type: Ogee
Material: Concrete
Nature of barrier to fish: Complete
Construction date: A previous dam existed at this site but the current dam was built in 1961 downstream of a dam that dated back to before 1916. That earlier dam was removed in 1961.

Condition of dam: Good
Length of impoundment: 0.9 miles
Appurtenances: Concrete gauge house on east bank and a concrete abutment wall below the spillway.

LEGAL/SOCIAL ASPECTS

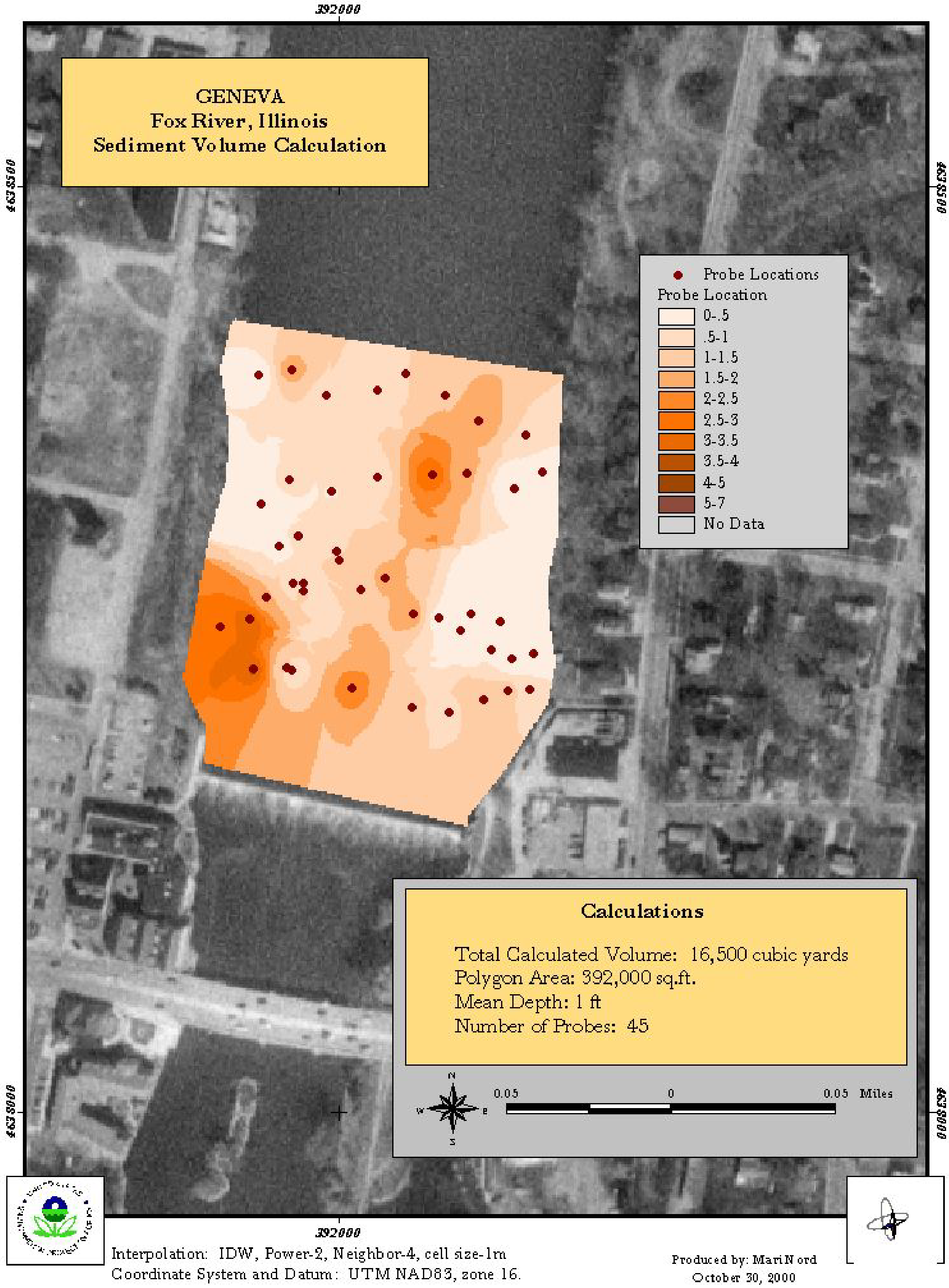
Owner: State of Illinois
Owner of adjoining land: Kane County Park District on immediate east bank
Present day purpose of dam: None
Uses of impoundment: Uncertain

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 16,500 cu. yds.

Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.



BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate a potential hazard of drowning below the spillway.
- Eliminate the need to maintain a costly state facility for many years to come.

Disadvantages:

- Upset upstream waterfront property and boat owners.

BYPASS CHANNEL

Advantages:

- Allows passage of canoes and kayaks without the need to portage.
- Allows the passage of a wide range of fish species and sizes (assuming they locate it).
- Provides a new recreational and viewing opportunity for visitors on the bike/hike trail.

Disadvantages:

- The dam remains with all of its negative ecological impacts.
- To provide effective fish passage, half a Denil fishway would have to be built to get fish from the base of the spillway to the bypass channel. This makes this option redundant and expensive.
- Very disruptive to the existing trail and city park. Need to relocate or replace existing facilities.
- Loss of many trees in the park and along trail.
- Boat bypass probably is not needed, as a good portage currently exists.
- The risk of drowning in currents below the dam remains.

A combined boat and fish bypass located on the east bank on Park District land is one option for this dam. The exit would be near the existing upstream portage area by the fishing sign. The bypass would extend southerly for 470 ft. at a slope of 1:36 and the entrance would be a short distance upstream of the Rt. 38 Bridge (see sketch). The width of the bypass would be 30 ft. and would require existing trail to be relocated. It would be a tight fit between the gazebo/play area and the river so a retaining wall would be needed on both sides of the bypass.

Since the bottom of the bypass would be located a considerable distance downstream of the dam, most fish would ‘overshoot’ the bypass and continue to the dam. That would require a fishway spur between the base of the dam and the bypass. The fishway would be a Denil passing from the base of the dam south, joining the bypass in a resting pool near the location of the existing twin cottonwood trees.

DENIL FISHWAY

Advantages:

- One structure instead of the two that would be needed with a bypass channel.
- Minimally disruptive to park and trees and will not require moving bike trail.
- Will pass most targeted species of fish.
- Compatible with public nature of location and may add interest to visitors.

Disadvantages:

- Will not pass as wide of a diversity of fish as bypass, but then, the bypass option required a Denil section for effective attraction, so this option is no worse off.
- Represents a state facility that will need operation and maintenance into the future.
- The dam remains, with all of its negative ecological impacts.
- The risk of drowning in currents below the dam remains.

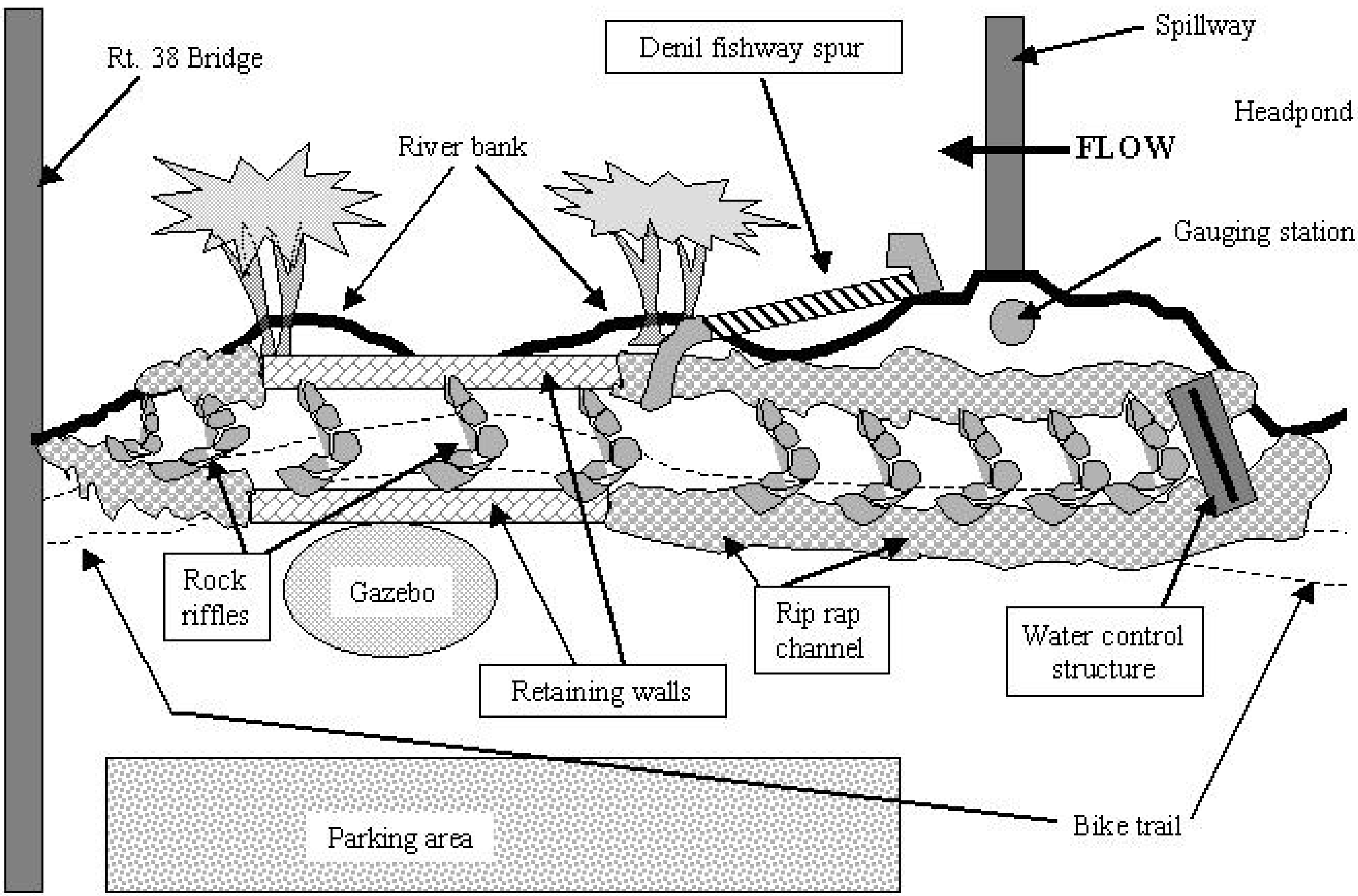
We propose a Denil fishway with a slope of 1:15 for the east end of the spillway. The fishway consists of five sections.

I - The entrance pool is located near the spillway splash zone just west of the abutment wall.
A - The first run of baffles extend south for about 75 ft. past the abutment wall.
II - There is a 180˚ turn/resting pool.
B - The second run of baffles extends north for about 160 ft. to exit near existing upstream portage location.
III - The exit pool is about 6 ft. long. There is opportunity for a public viewing window and fish trap in the exit pool.

Estimated costs: A Denil fishway at the Geneva Dam is estimated to cost about $400,000 as a stand-alone project.

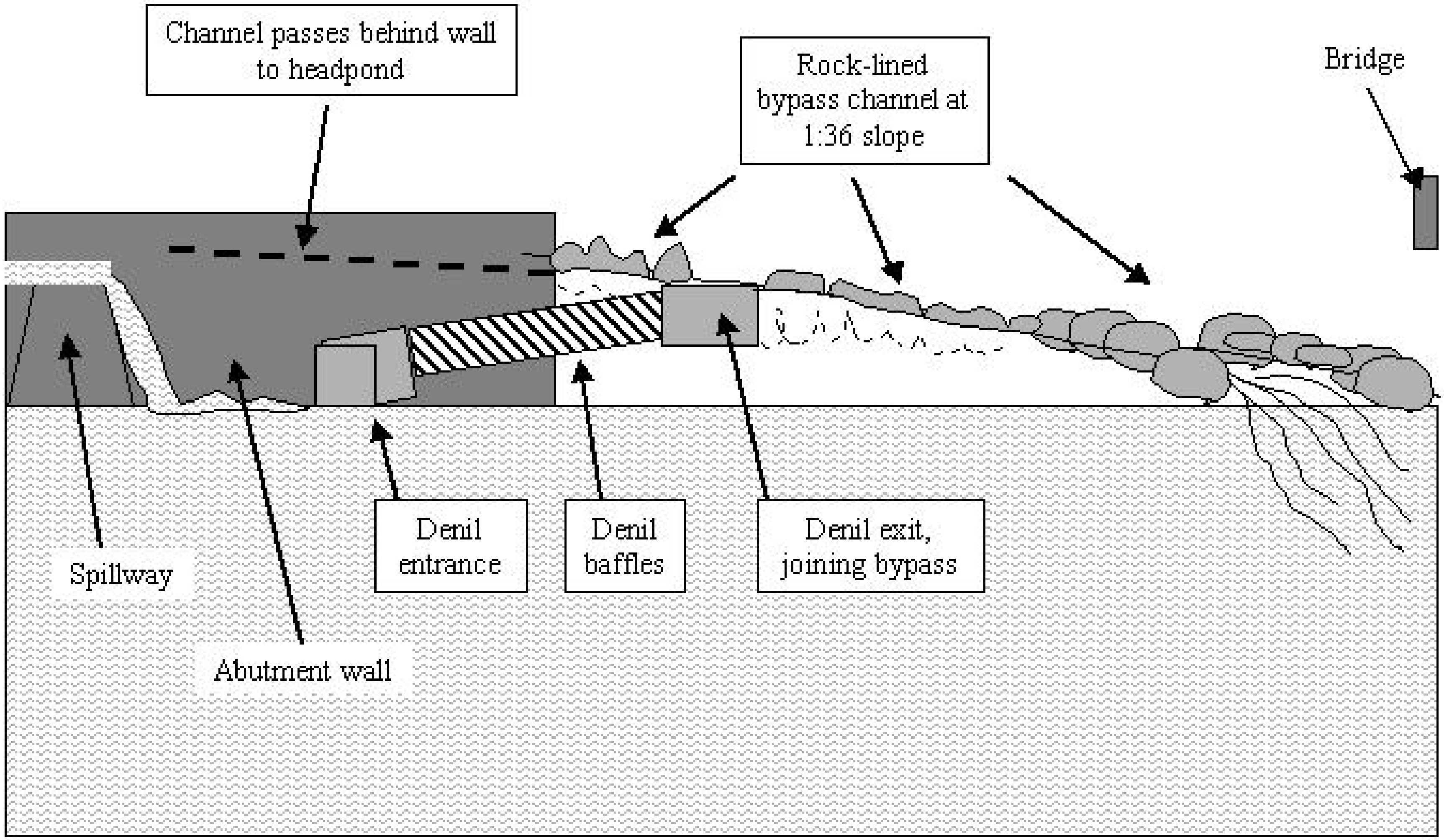
GENEVA DAM – Plan View – Conceptual Plans for a Bypass Channel and Fishway Spur on East Bank.

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

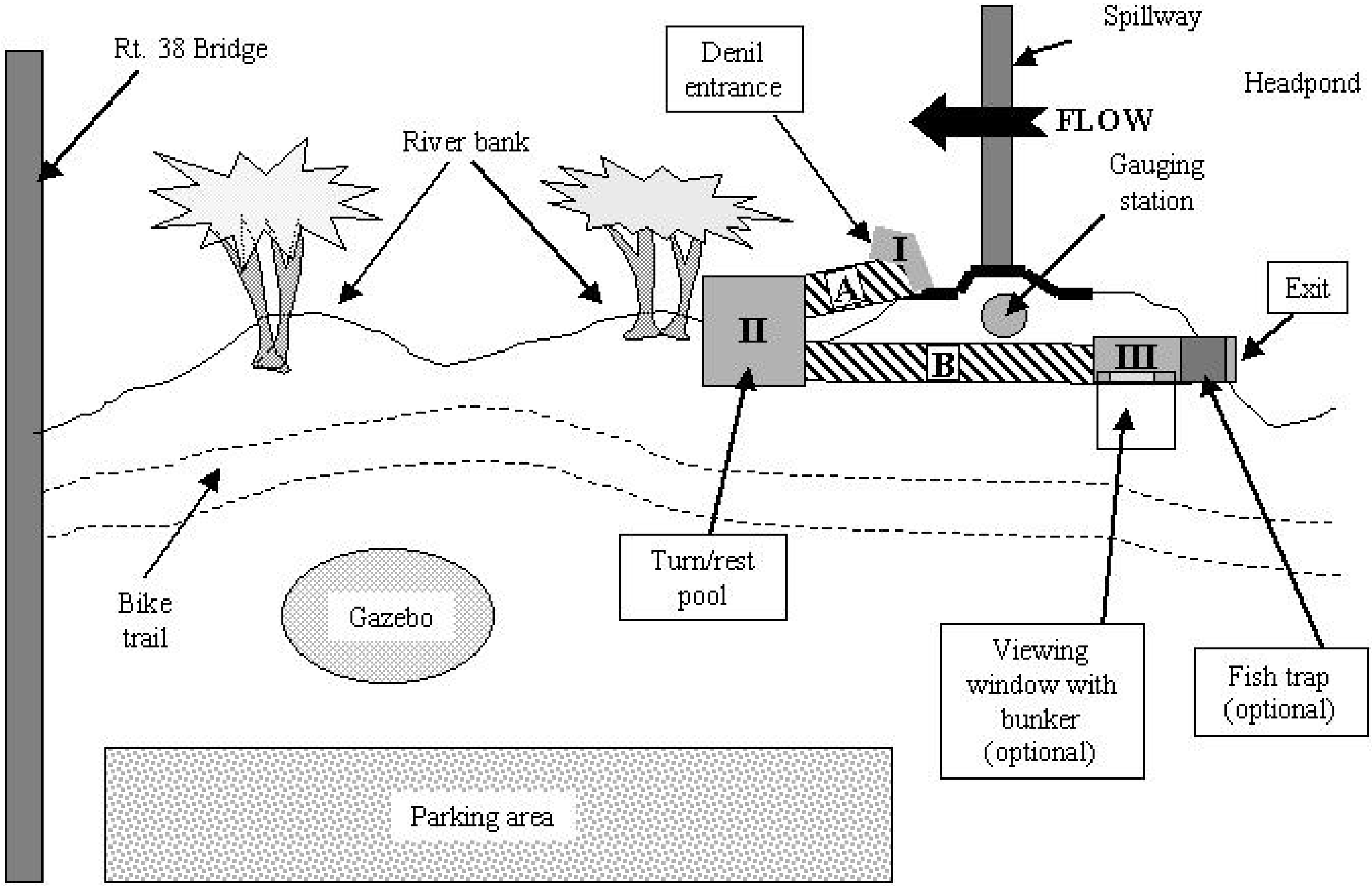


GENEVA DAM – Profile View – Conceptual Plans for a Bypass Channel and Fishway Spur on East Bank.

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

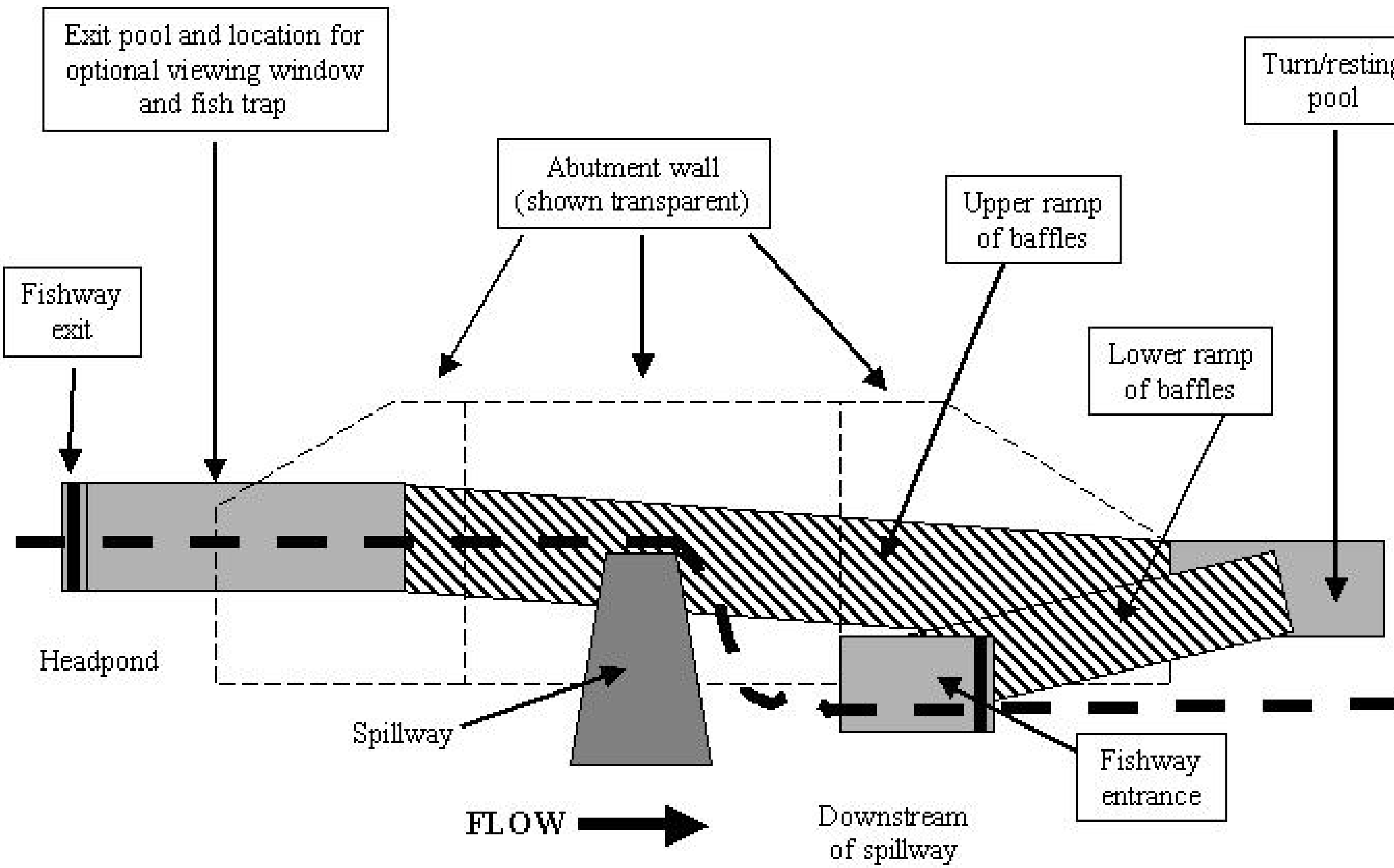


GENEVA DAM – Plan View – Conceptual Plans for a Denil Fishway on East Bank.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.

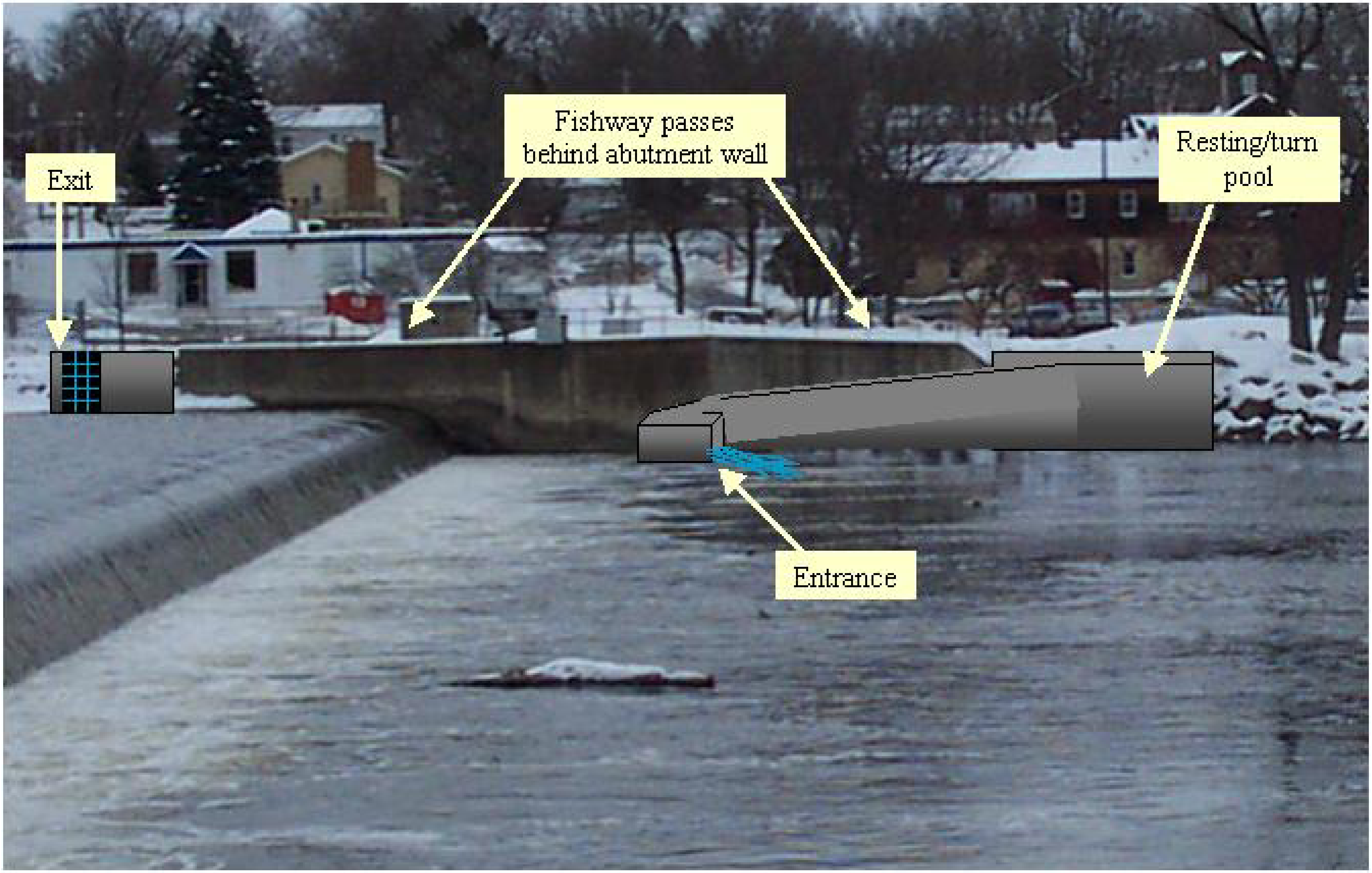


GENEVA DAM – Profile View – Conceptual Plans for Denil Fishway on East Bank.

Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



GENEVA DAM – Depiction of Denil Fishway at East Bank of Spillway.



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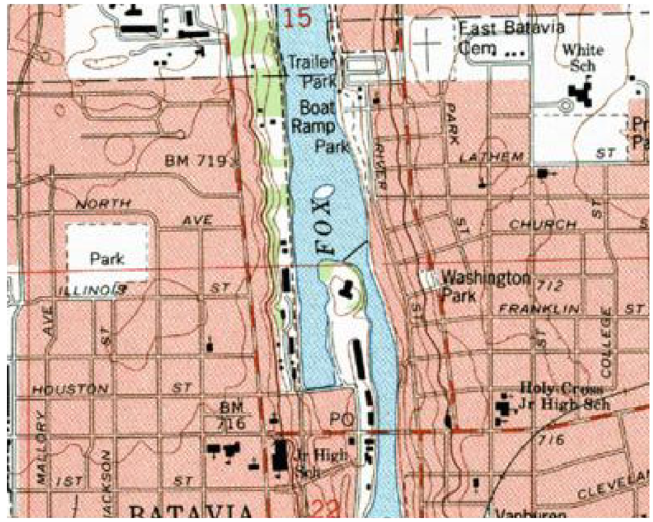
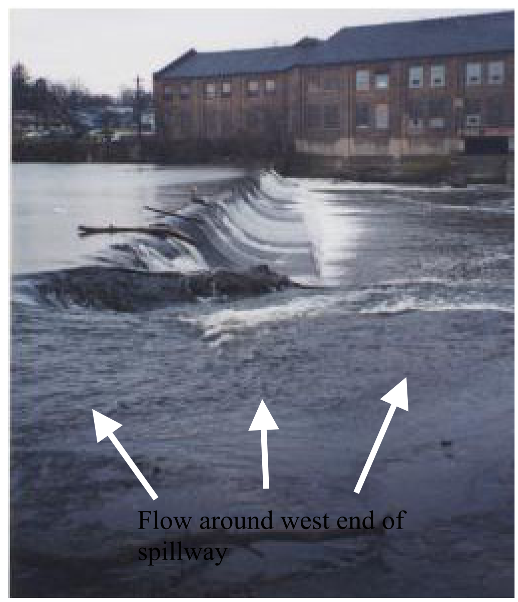
NORTH BATAVIA DAM (A.K.A. UPPER BATAVIA DAM)



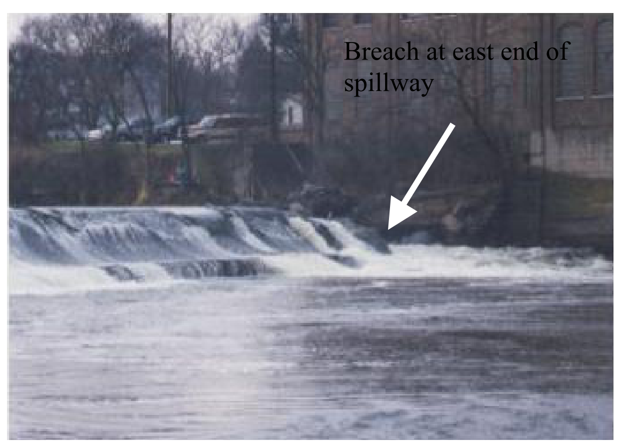
LOCATION

Latitude-longitude (NAD 83):
41.8552097˚N 88.3083696˚W
Legal: T39N R8E S15SE
Town: Batavia, IL
River mile: 56.3
Comments: Upstream of the Wilson Street Bridge
Next downstream dam (distance): South Batavia Dam (1.4 miles)
Next upstream dam (distance): Geneva Dam (2.4 miles)



DESCRIPTION

Height: 12 ft.
Spillway elevation: 665.1 ft.
Length: 328 ft.
Dam type: Ogee
Material: Concrete
Nature of barrier to fish: Complete
Construction date: 1872
Condition of dam: Poor and likely at risk of failure. A 15-ft. section of the spillway at the east end has completely broken away and washed downstream. The breach has been filled deliberately and naturally with rubble and debris, which allows the maintenance of pool height. The entire length of the spillway is eroded and possibly undercut. The river flows around the west end of the spillway and over a natural limestone outcropping.
Length of impoundment: 1.5 miles
Appurtenances: There is an old mill and associated millworks on the east bank.



LEGAL/SOCIAL ASPECTS

Owner: State of Illinois
Owner of adjoining land: Private (east bank) and City of Batavia (west bank)
Present day purpose of dam: None
Uses of impoundment: Canoeing, kayaking, fishing, some recreational power boating

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 89,000 cu. yds. in the main channel; 113,000 cu. yds. including Depot Pond.
Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.
Distribution: See map below.

BIOLOGICAL RESOURCES

No endangered or threatened organisms sampled in river segment above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

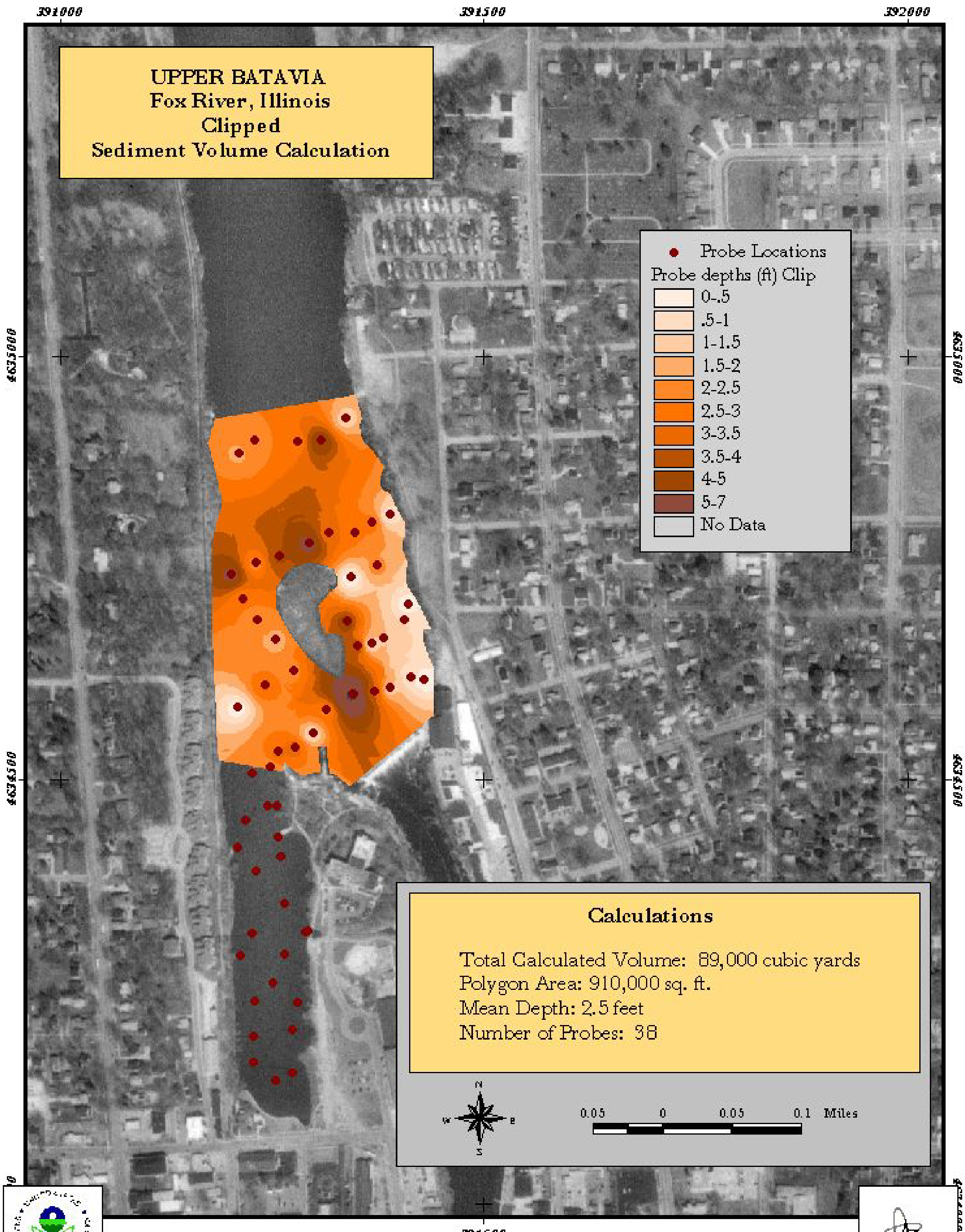
Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of catastrophic failure of dam and coincident loss of property and life.
- Eliminate the need to maintain a costly state facility for many years to come.

Disadvantages:

- Reduce pool size for recreational power boating.
- Upset upstream waterfront property and boat owners.
- Requires a substantial engineering project to maintain Depot Pond.

The North Batavia Dam is currently targeted for complete removal as part of an IDNR/OWR river restoration project. Many stakeholders (city, state, park district, forest preserve district, regulators, non-profits, and the general public) were included in the decision making process for the project and complete removal and river restoration was chosen over several alternatives. We concur that dam removal is by far the most attractive option for this site given the extremely poor condition of the existing dam, the relatively high cost to build a new dam and fish passage facility, future maintenance costs associated with a new facility, and the ecological benefits to be gained by complete removal. No further options are presented for this dam.



Interpolation: IDW, Power-2, Neighbor-8, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.

Produced by: Mari Nord
October 30, 2000

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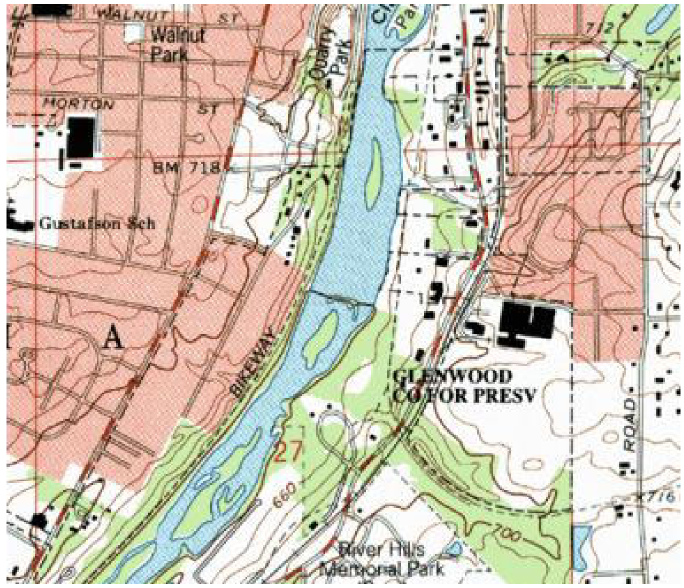
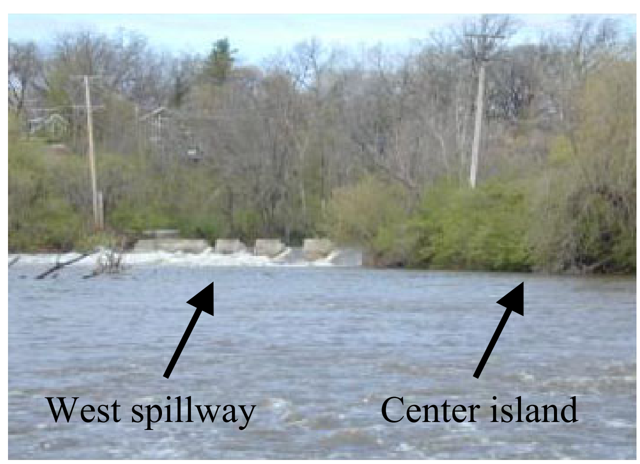
SOUTH BATAVIA DAM (A.K.A. LOWER BATAVIA DAM)



LOCATION

Latitude-longitude (NAD 83): 41.8361998˚N 88.3100561˚W
Legal: T39N R8E S27NE
Town: Batavia, IL
River mile: 54.9
Comments: West of Funway Entertainment off of Rt. 25. The dam consists of two spillways with an earthen island in the center.
Next downstream dam (distance): North Aurora Dam (2.3 miles)
Next upstream dam (distance): North Batavia Dam (1.4 miles)



DESCRIPTION

Height: 6 ft. for the east spillway and 5 ft. for the west spillway
Spillway elevation: 653.9 ft. for the east spillway and 654.2 ft. for the west spillway
Length: 143 ft. for the east spillway and 203 ft. for the west spillway; the center island is about 317 ft. long
Dam type: Broad-crested
Material: Concrete
Nature of barrier to fish: Partial. The height of this dam over streambed is about 4 ft. and at typical flows, the dam is only 2 or 3 ft. above the water level below the dam. At high water, strong swimming fish may surmount the dam. At normal and low flows, no fish can get over it.
Construction date: Conflicting information. Once source says 1904, another 1913, and yet another says 1921. All agree that it was built to provide cooling water for a power plant that

provided electricity for the Chicago, Aurora, & Elgin railroad.

Condition of dam: Poor. Has a breach near the west end of the east spillway on the island. The breach has enlarged and the dam partially failed in early fall 2002.

Length of impoundment: 0.6 miles

Appurtenances: The spillway looks odd due to the presence of many concrete supports for a footbridge on top of the spillway. It gives the appearance that the dam accepted stop logs for adjusting water levels but in fact the structures appear to have served only to support decking for an abandoned bridge.

LEGAL/SOCIAL ASPECTS

Owner: Kane County Forest Preserve

Owner of adjoining land: Kane County Forest Preserve

Present day purpose of dam: Fermilab has a makeup water intake located at the upper end of the impoundment. Removing the dam may require modifications to the intake structure.

Uses of impoundment: Fishing and canoeing.

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 23,500 cu. yds.

Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.

BIOLOGICAL RESOURCES

A population of State threatened river redhorse exists in the free-flowing river below the dam. This represents the northernmost location for this species in the Fox River drainage in Illinois. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

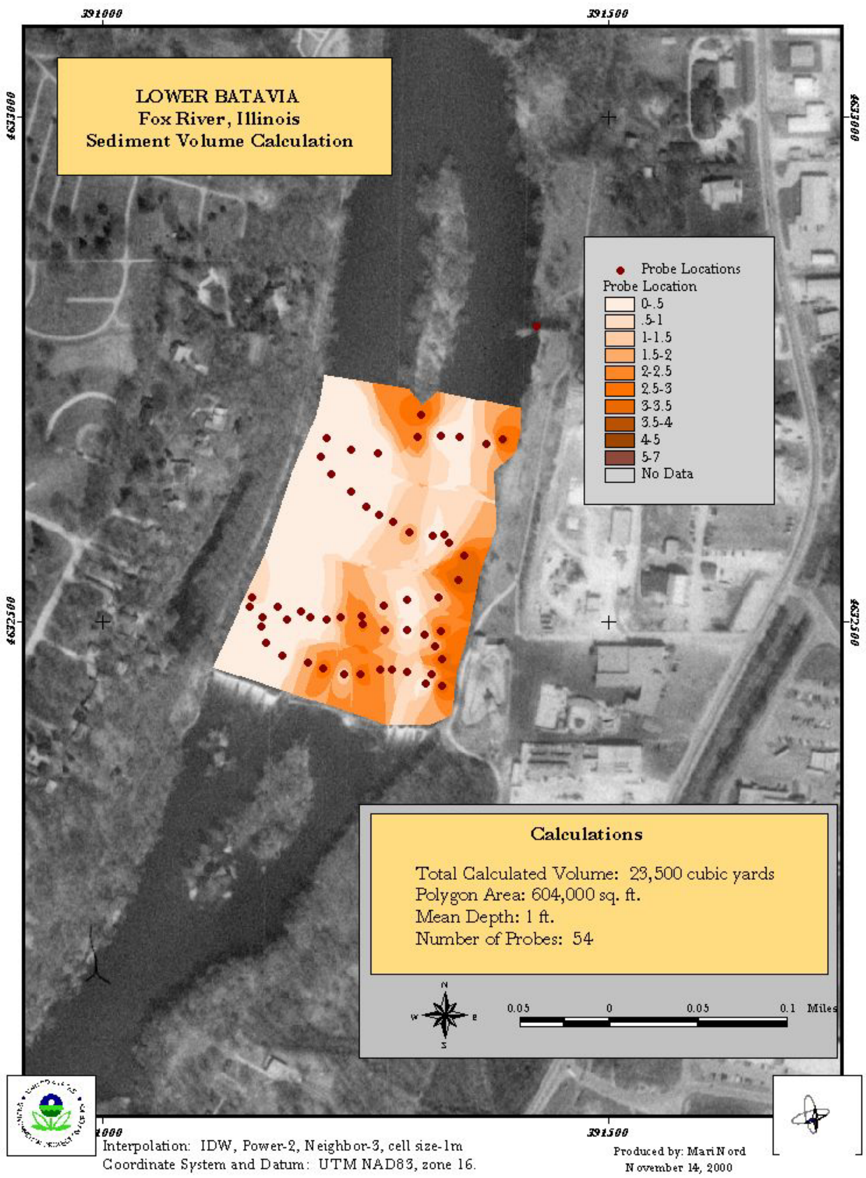
Advantages:

- Allow full, unrestricted passage of all species and sizes of fish (including the State threatened river redhorse) at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of drowning by the removal of a dangerous hydraulic current below the spillway.
- Eliminate the need to maintain a costly state facility for many years to come.
- Eliminate a public safety hazard due to the dangerous condition of this dam.

Disadvantages:

- May need to rework Fermilab water intake structure.
- May impact a small, created wetland at the water treatment plant.

The South Batavia Dam is currently targeted for complete removal as part of a Kane County Forest Preserve project. Many stakeholders (city, state, park district, forest preserve district, regulators, non-profits, and the general public) were included in the decision making process for the project and complete removal and river restoration was chosen over several alternatives. We concur that dam removal is by far the most attractive option for this site given the extremely poor condition of the existing dam, the relatively high cost to build a new dam and fish passage facility, future maintenance costs associated with a new facility, and the ecological benefits to be gained by complete removal. No further options are presented for this dam.



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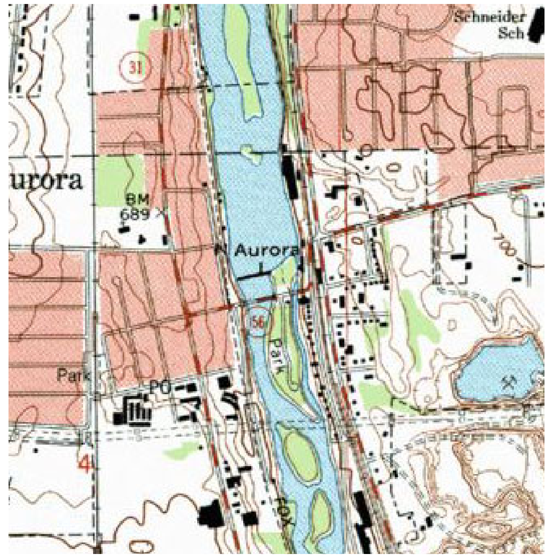
NORTH AURORA DAM

LOCATION



Latitude-longitude (NAD 83):
41.8071646˚N 88.33244258˚W
Legal: T38N R8E S4NE
Town: North Aurora, IL
River mile: 52.6
Comments: Immediately north of Illinois Rt. 56 Bridge
Next downstream dam (distance): Stolp Island Dam (3.7 miles)
Next upstream dam (distance): South Batavia Dam (2.3 miles)

DESCRIPTION

Height: About 6 ft. above riverbed
Spillway elevation: 646.0 ft.
Length: 375 ft.
Dam type: Broad-crested with a stair-stepped face
Material: Concrete
Nature of barrier to fish: Complete
Construction date: A dam existed at this location since 1833 and the previous structure stood from at least 1916 until the mid-1970s, at which time the dam was completely rebuilt in its present form.
Condition of dam: Good
Length of impoundment: 1.82 miles
Appurtenances: An old, so-called "millrace" (associated with a former woodworking mill) extends southerly from the dam along the extreme eastern river bank, underneath State Street, and joins the river over 600 feet below. Maps refer to the land between the spillway and the "race" and upstream and downstream of the bridge as an island. It is not clear if this land is truly a natural island with a natural eastern channel of which the millwrights took advantage, or whether the race (which is actually a 'tailrace'), was hand dug for the mill. The race typically has water flowing down it and flow is regulated via a valve in an intake pipe that runs underground from the headpond to a point in line with the spillway. A staff gauge operated by the State of Illinois is also present near the spillway.

LEGAL/SOCIAL ASPECTS

Owner: State of Illinois

Owner of adjoining land: Kane County Park District

Present day purpose of dam: None

Uses of impoundment: Boating

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 57,000 cu. yds.

Quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.

BIOLOGICAL RESOURCES

The State threatened river redhorse was collected in free-flowing portions of river segments above and below the dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

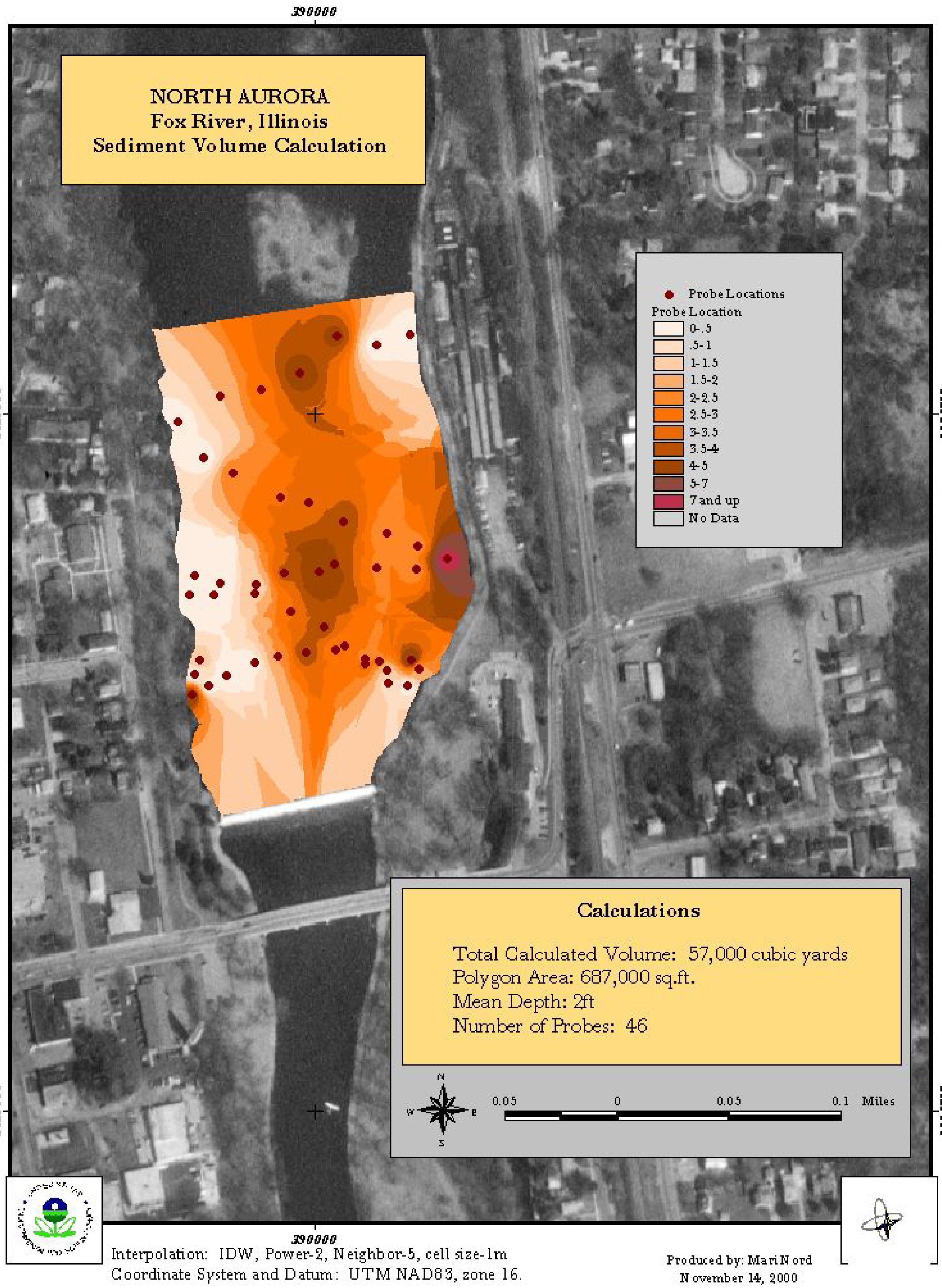
Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate a dangerous set of hydraulic currents that have drowned people in the past.
- Eliminate the need to maintain a costly state facility for many years to come.

Disadvantages:

- Reduce pool size for recreational power boating
- Upset upstream waterfront property and boat owners

A complete removal of the spillway is envisioned with this option, leaving the western and eastern concrete dam abutments to stabilize the riverbanks. A partial lowering does not make sense because the dam is only 6 ft. high. Since the dam is only 375 ft. long, a partial breach (removal of one section of the horizontal length) also is not helpful. Furthermore, the eastern riverbank (or island park) will help stabilize exposed pond bed sediments (upstream) without the need to retain a portion of the spillway for that purpose. Without the dam, there is no reason for the staff gauge and that structure could be removed to enhance the parkland. The draining of the headpond would likely de-water the existing pipe supplying water to the race and the race would be dry except for some water in its lower reach that back-floods from the


NORTH AURORA
Fox River, Illinois
Sediment Volume Calculation
390000
4629500
4629000
Probe Locations
Probe Location
0-.5
.5-1
1-1.5
1.5-2
2-2.5
2.5-3
3-3.5
3.5-4
4-5
5-7
7 and up
No Data
Calculations
Total Calculated Volume: 57,000 cubic yards
Polygon Area: 687,000 sq.ft.
Mean Depth: 2ft
Number of Probes: 46
N
W
E
S
0.05
0
0.05
0.1
Miles
Interpolation: IDW, Power-2, Neighbor-5, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.
Produced by: Mari Nord
November 14, 2000

river. It would require extensive excavation of a channel to reconnect the head of the former race with the river above the former dam site and provide flow down the race. If the race received river water, it might fill up with sediment over time causing reduced flow and an undesirable appearance. The dredging of an intake channel to the race also would work cross-purposes to using the riverbank to stabilize newly exposed pondbed sediments. If the dam is removed and the race is not needed, it could be completely filled (using dredged pondbed sediment), seeded, and restored to parkland.

BYPASS CHANNEL

Advantages:

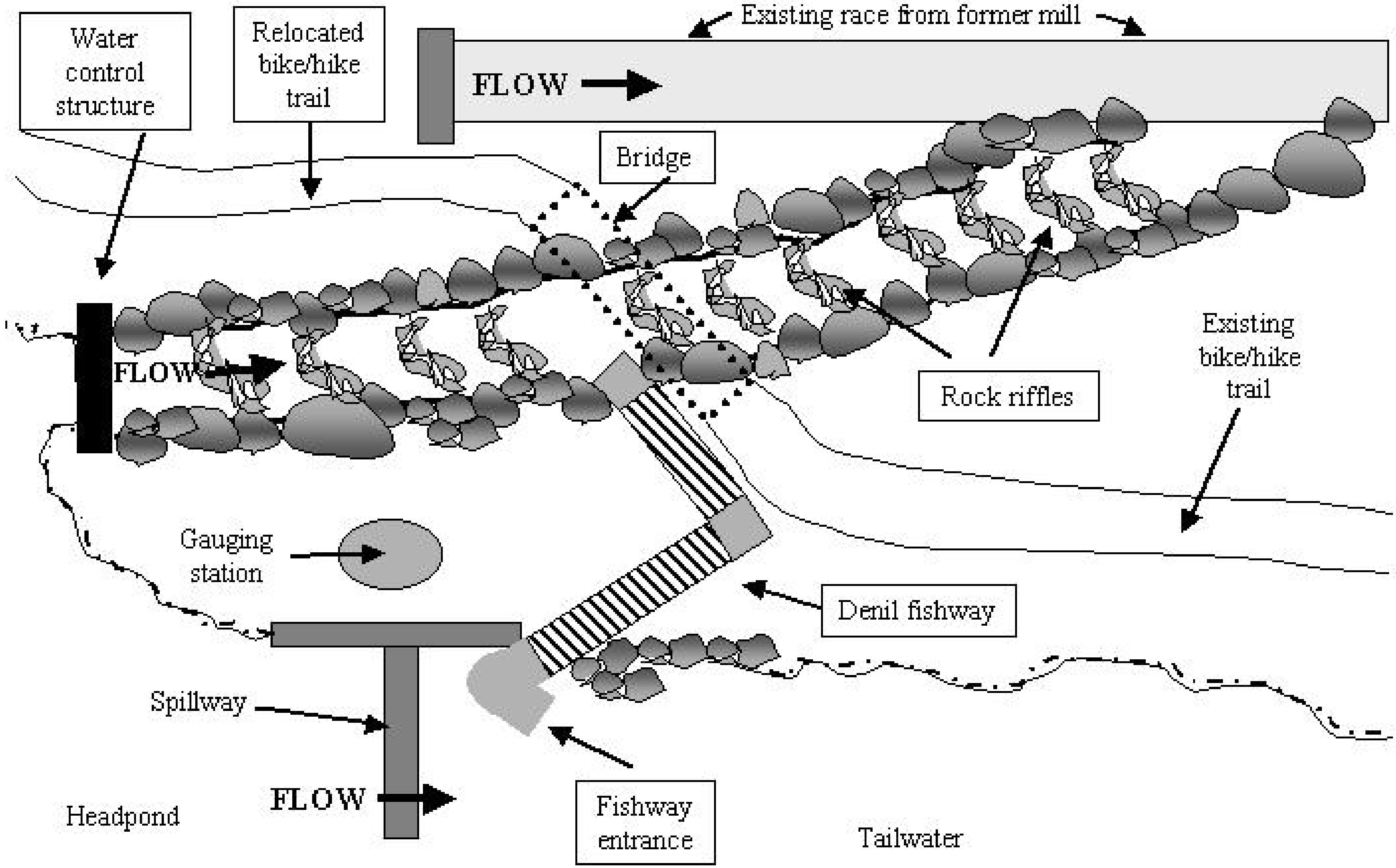
- Flat slope allows a large percentage of fish that locate the bypass to get passed the dam.
- Flat slope and large width allows for safe passage of paddle craft without portaging.
- Would enhance use of the existing park.
- Aesthetically pleasing due to natural appearance compared to a traditional fishway.
- Maintains the old race, if that is considered desirable.
- Maintains the dam, if that is considered desirable.

Disadvantages:

- The dam would remain, with all of its negative ecological impacts.
- Passes fewer species and life stagers of fish than a dam removal project.
- Requires much engineering and construction.
- Requires construction of a fishway or fishway spur to effectively pass large numbers of fish.
- Would remove considerable land in the park from its current use.
- Would necessitate the removal of some mature trees to make room for the channel.
- Would create structures that would expose the State and Park District to liability.
- Would create expensive structures that would have to be maintained.

A semi-natural boat and fish bypass channel would be similar in design to others described for Fox River dams. We recommend a slope of 1:30 and a width of 35 ft. The bypass would be about 180 ft. long. To minimize disruption of the parkland and reduce cost, the boat channel could be designed to flow into the race rather than the river's main channel. It would probably be safer to exit in the race because boaters exiting into the river would have to deal with high water velocities, turbulence, and support piers from the bridge. However, if the bypass discharged into the race, it could not be used as a primary means of upstream fish passage because most fish would ascend the river mainstem to the spillway. A supplementary Denil fishway would be needed with any bypass channel option because even if the bypass re-entered the mainstem river, the entrance for fish would be located downstream by the bridge, much too far downstream from the spillway to expect fish to locate it. A Denil fishway would need to be located near the base of the spillway for effective fish passage to occur. If a boat channel was

NORTH AURORA DAM – Plan View – Conceptual Plans for East Bank Bypass Channel and Fishway.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



constructed, the fishway could join it near the existing bike/hike trail. Without a boat channel, a fishway could be constructed in a more traditional manner.

DENIL FISHWAY

Advantages:

- Would pass many targeted fish species.
- Good construction access and public access.
- Would be less disruptive to existing park than bypass option.
- The dam and impoundment remain, if that is considered desirable.

Disadvantages:

- The dam remains in place along with all of its negative ecological impacts.
- There is no boat passage so portages are still required.
- May necessitate relocating the bike/hike trail.
- Short and long-term maintenance required.

A Denil fishway with a slope of 1:15 and located on the east bank of the river is recommended for this option. The fishway would consist of five components.

I - The entrance would be located near the toe of the spillway and set at a 45-degree angle to river flow. The entrance pool would incorporate two turns to get around the abutment wall.

A - The first run of baffles is about 50 ft. long extending easterly up the riverbank past the end of the abutment wall.

II - A 20 ft. long turn/resting pool located at the bike/hike trail would turn 90˚ to the north.

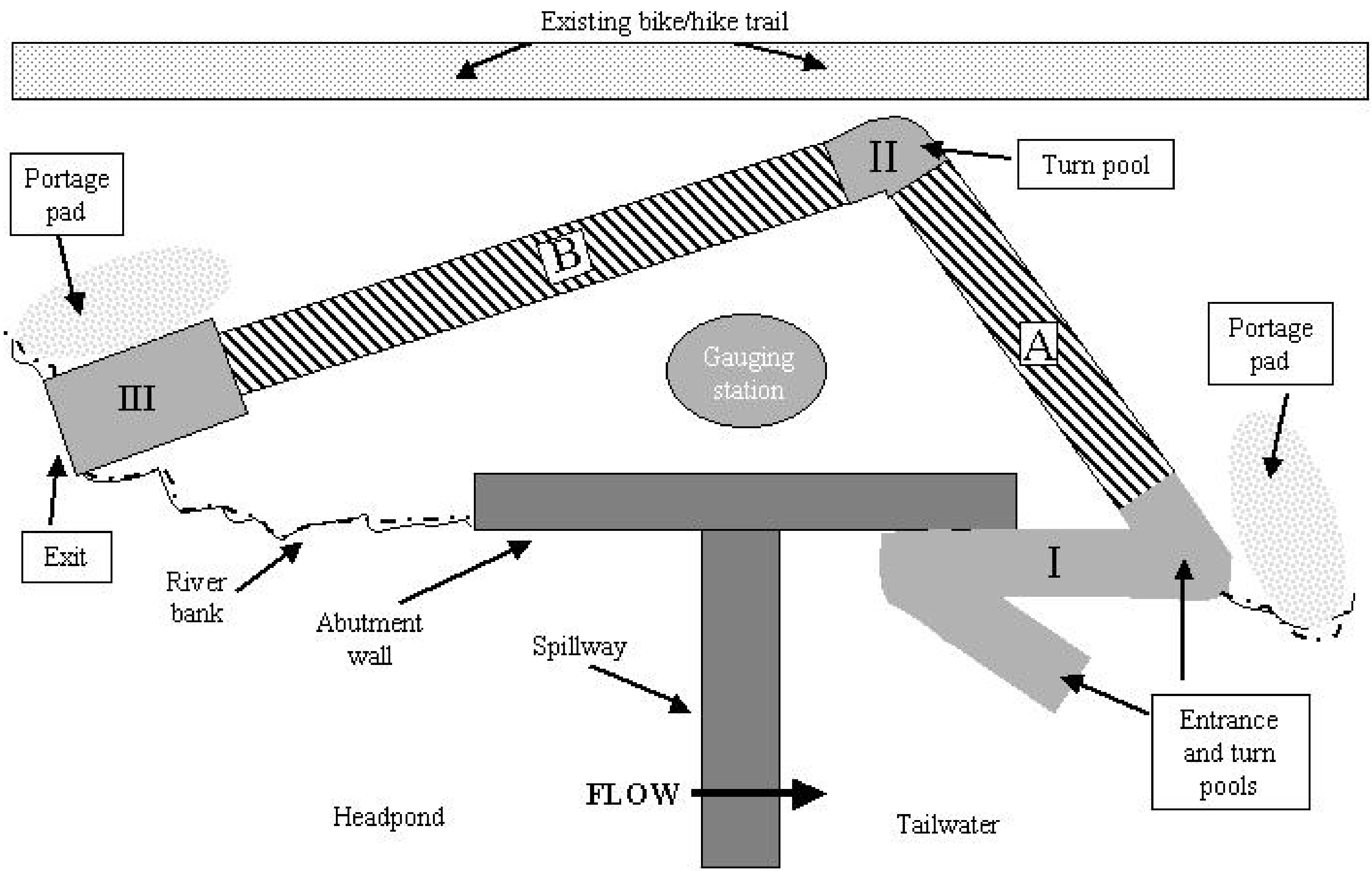
B - The second run of baffles is about 85 ft. long and oriented northwesterly to the riverbank above the dam.

III - The exit pool is about 6 ft. long.

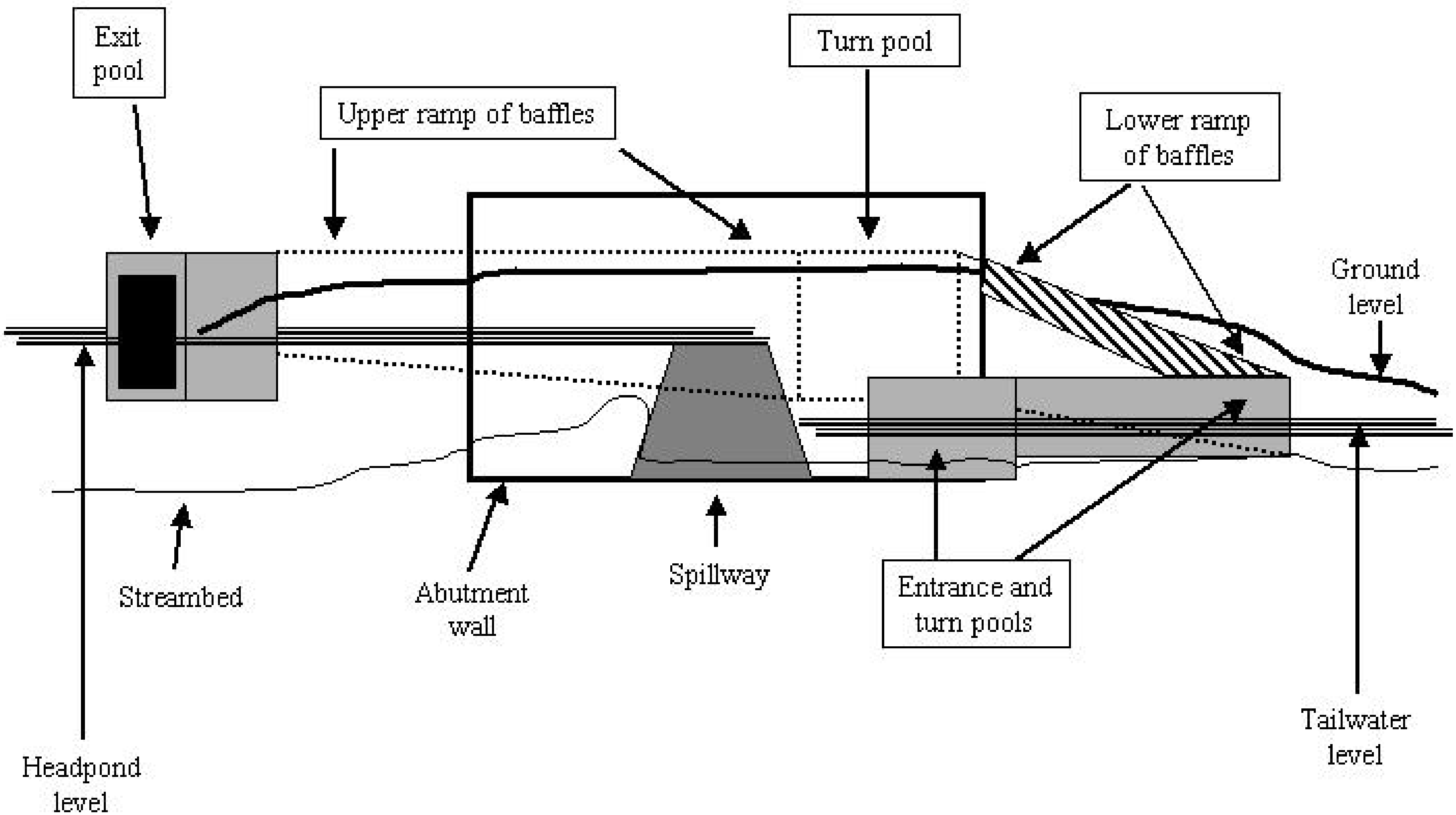
The west riverbank was examined as a fishway location but there was less room on that side and the installation of a fishway would destroy the existing stairs below the dam. If the dam is maintained and a boat channel is not constructed, a good portage route will be needed. We suggest that boaters be encouraged to use the west bank for portaging and use the east bank for fish passage. Put-in and take-out pads could be included on the east bank near the fishway.

Estimated costs: A Denil fishway at the North Aurora Dam is estimated to cost about $250,000 as a stand-alone project.

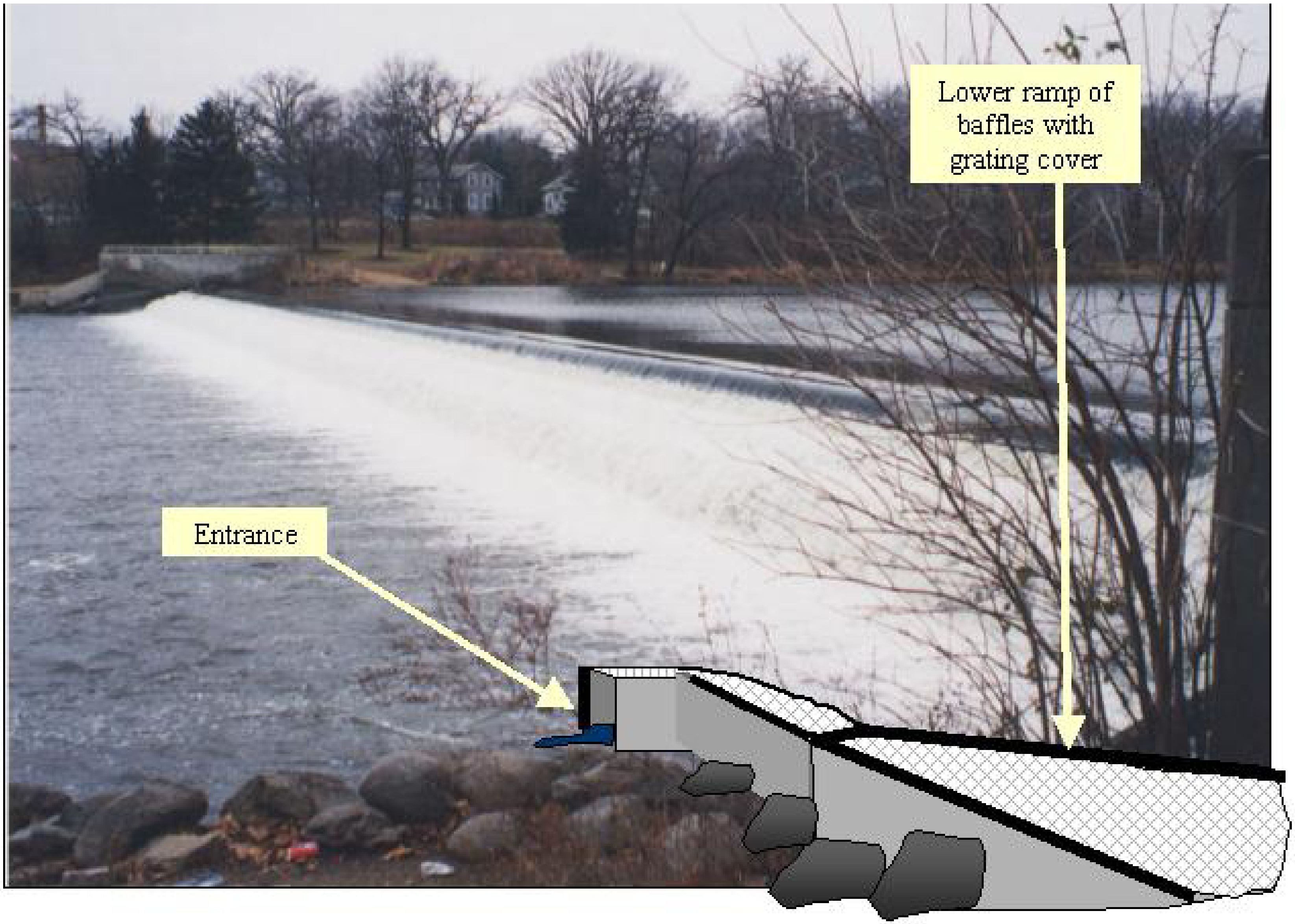
NORTH AURORA DAM – Plan View – Conceptual Plans for Denil Fishway on the East Bank.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



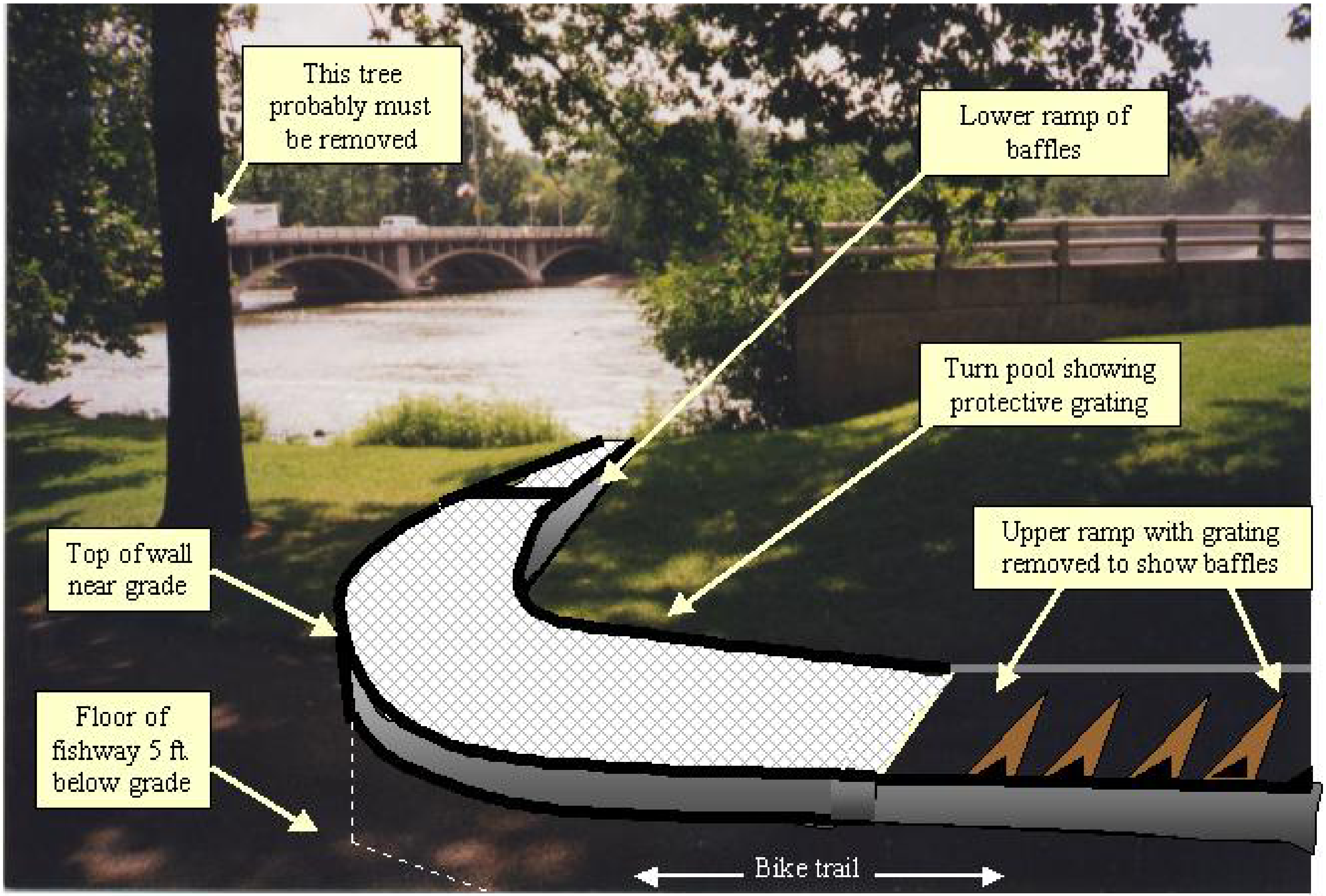
NORTH AURORA DAM – Profile View – Conceptual Plans for Denil Fishway on the East Bank.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



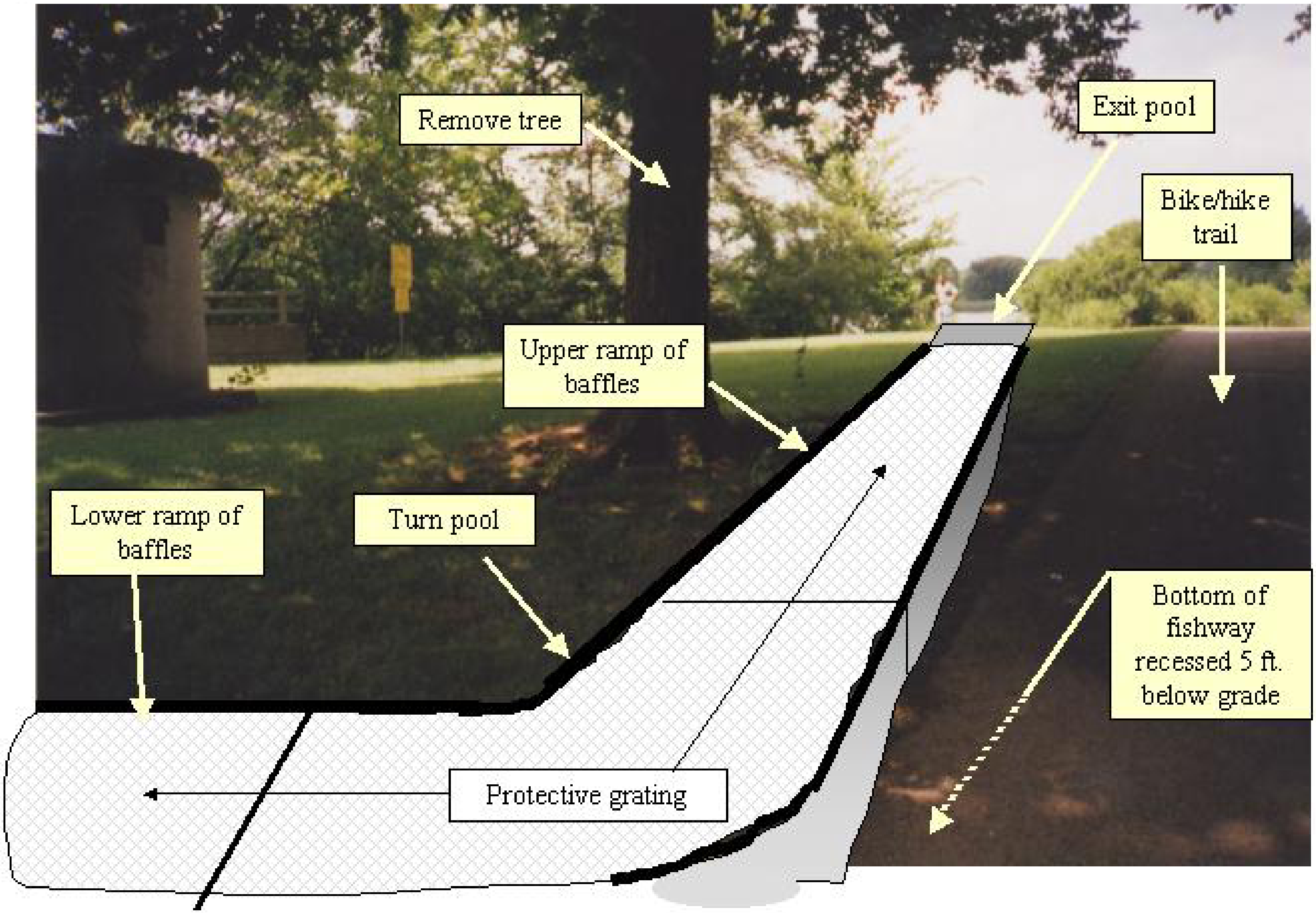
NORTH AURORA DAM – Depiction of Fishway Entrance Skirting Abutment Wall.



NORTH AURORA DAM – Depiction of Lower Ramp of Baffles and Turn Pool of Fishway.



NORTH AURORA DAM – Depiction of Upper Ramp of Baffles, Turn Pool, and Exit of Fishway.



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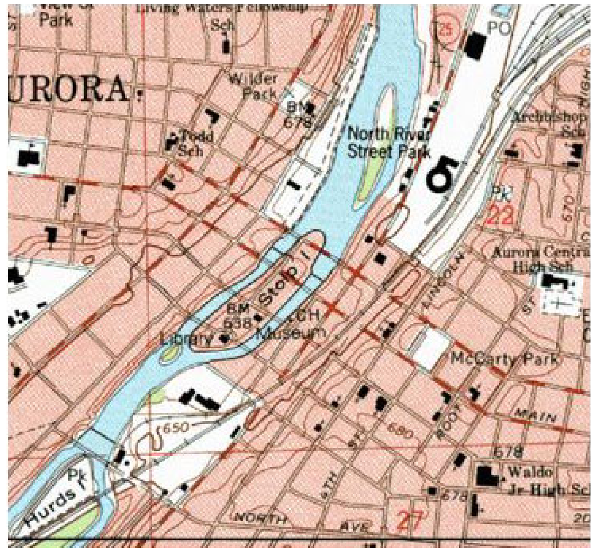
STOLP ISLAND DAM (A.K.A. AURORA DAMS)

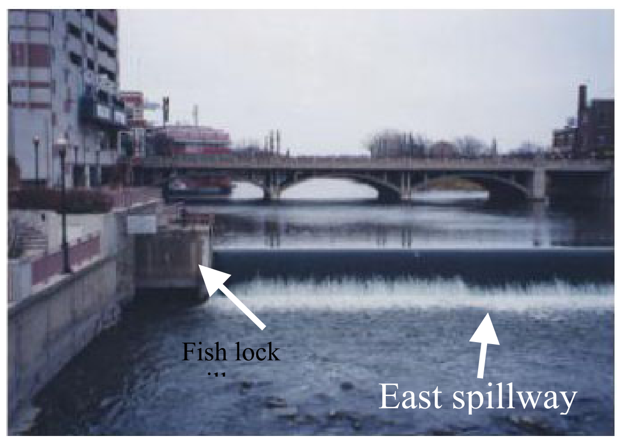
LOCATION

Latitude-longitude (NAD 83): 42.7582683˚N 88.3143578˚W
Legal: T38N R8E S22SW
Town: Aurora, IL
River mile: 48.9
Comments: About 150 ft. upstream of Galena Boulevard Bridge and 250 ft. downstream of New York Street Bridge.
Next downstream dam (distance): Hurd's Island Dam (0.5 miles)
Next upstream dam (distance): North Aurora Dam (3.7 miles)



DESCRIPTION

Height: 11 ft. for east spillway and 15 ft. for west spillway
Spillway elevation: 628.4 ft. for both spillways
Length: 177 ft. for east spillway and 170 ft. for west spillway; the center island is about 360 ft. wide.
Dam type: Modified for the east spillway and Ogee for the west spillway.
Material: Concrete
Nature of barrier to fish: Complete
Construction date: The first dam was built on the east side in 1834 and a dam was first built on the west side in 1841. These dams washed out numerous times and seem to have been rebuilt, owned, and operated independently. Hydraulically, the two spillways act as one dam. By 1923, both were concrete dams and the existing west spillway remains as that pre-1923 structure. The east spillway partially breached in 1936 and was rebuilt in 1937. That structure remains today.



Condition of dam: Good for the east spillway and fair for the west spillway.
Length of impoundment: 1.1 miles
Appurtenances: The east spillway has a non-functional fish lock (or lift) built in 1937 and the west spillway has a canoe chute built in the early 1980s.

LEGAL/SOCIAL ASPECTS

Owner: The State of Illinois owns the east spillway and the City of Aurora owns the west spillway.
Owner of adjoining land: Various parties, including the City of Aurora.
Present day purpose of dam: None.
Uses of impoundment: Power boating, fishing, and a riverboat casino.

SEDIMENT ACCUMULATION BEHIND DAM

Not investigated but much of the impoundment was dredged to a depth of >9 ft. to accommodate the casino riverboats.

BIOLOGICAL RESOURCES

A population of State threatened river redhorse exists in the free-flowing river segment above the dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of drowning by eliminating the dangerous hydraulic current below the spillways.
- Eliminate the need to maintain two costly structures for many years to come.

Disadvantages:

- Reduce size of an already small pool for recreational power boating.
- Upset upstream waterfront property and boat owners.
- Need to remove two spillways, which will increase costs.
- Need for additional engineering and stabilizing work around floating but permanently moored casino.

Both spillways will have to be removed for a dam removal project at this site. Removing one spillway only and maintaining the land behind the other spillway as parkland or parking for the casino may be tempting but is ill advised because the river has used the capacity for flow on both sides of the island historically. There is no reason to believe that only one channel could accommodate peak flows. The issue of the floating casino would need to be addressed if the dams were removed. Legally, the casino is no longer required to cruise, but engineering solutions would be needed to convert a more-or-less floating boat to a semi-land-based casino. Lowering the dams may offer a compromise that would reduce the pool size, decrease the cost of fishways, and perhaps simplify the engineering solutions for the casino.

BYPASS CHANNEL

Advantages:

- Allows passage of canoes and kayaks without the need to portage.
- May allows for the passage of a wide range of species and sizes of fish assuming they locate the channel entrance.
- Provides new recreational and viewing opportunities for visitors to the casino and city center.
- Makes use of existing structures without the need to start new.
- The existing bypass has been shown to pass fish so an improved structure will likely pass a wider variety and larger numbers of fish.

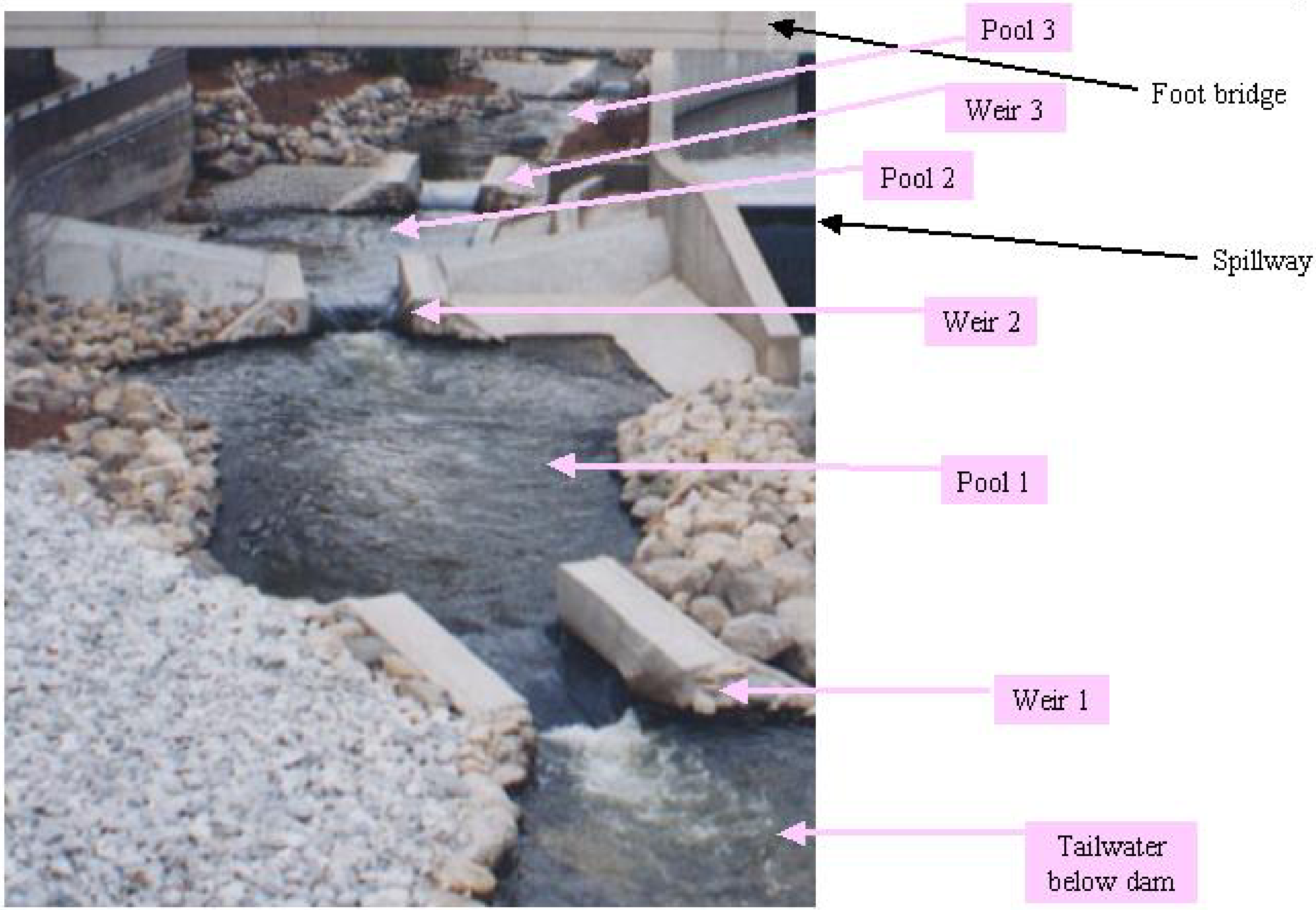
Disadvantages:

- The dam remains with all of its negative ecological impacts.
- Will not pass as wide a variety of species or life stages of fish as removing the dam.
- A facility must be operated and maintained well into the future.
- There is continued public safety risk from drowning.

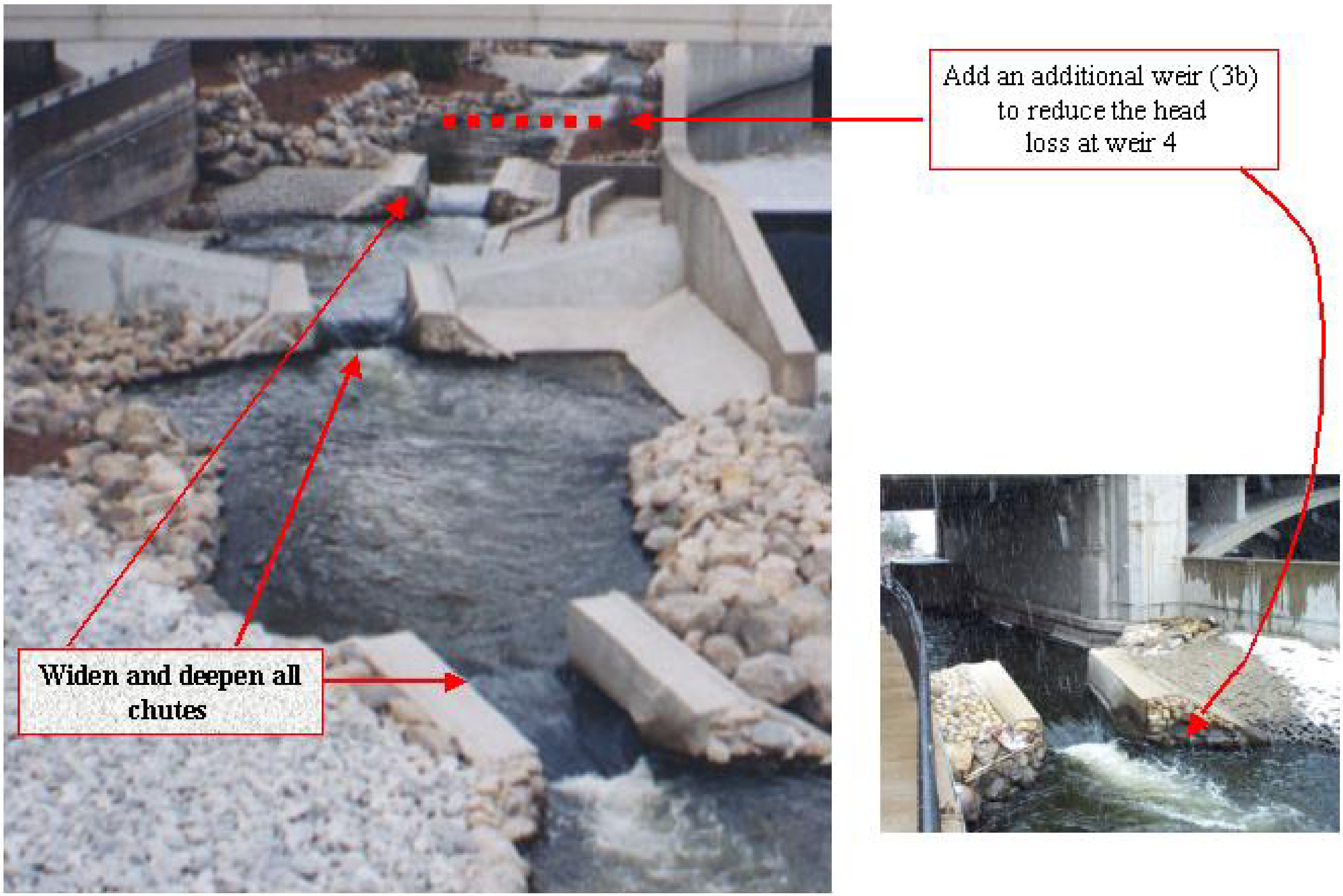
Due to the length of the island, fish passage facilities are needed at both spillways if the dam is not removed. Fish cannot be expected to reach one spillway, find upstream passage blocked, travel back down the entire length of the island, and then ascend the entire length of the island on the other side to the other spillway to find a single fishway. There is not room for a bypass channel at the east spillway but a type of bypass channel currently exists at the west spillway. We suggest improving the bypass channel on that the west spillway and retrofitting the east spillway with a traditional fishway (described in the next section below). No bypass option is offered for the east spillway due to absence of suitable space for this type of structure.

A canoe chute is currently located on the west bank of the west spillway. This structure currently passes fish (see Appendix G), but it does not pass them as well as it should. Furthermore, it does not safely pass canoes very well. Modifications should be completed to improve the structure for the passage of fish and boats. Experienced canoeists and kayakers should be consulted to offer advice on what needs to be done to the existing structure to make

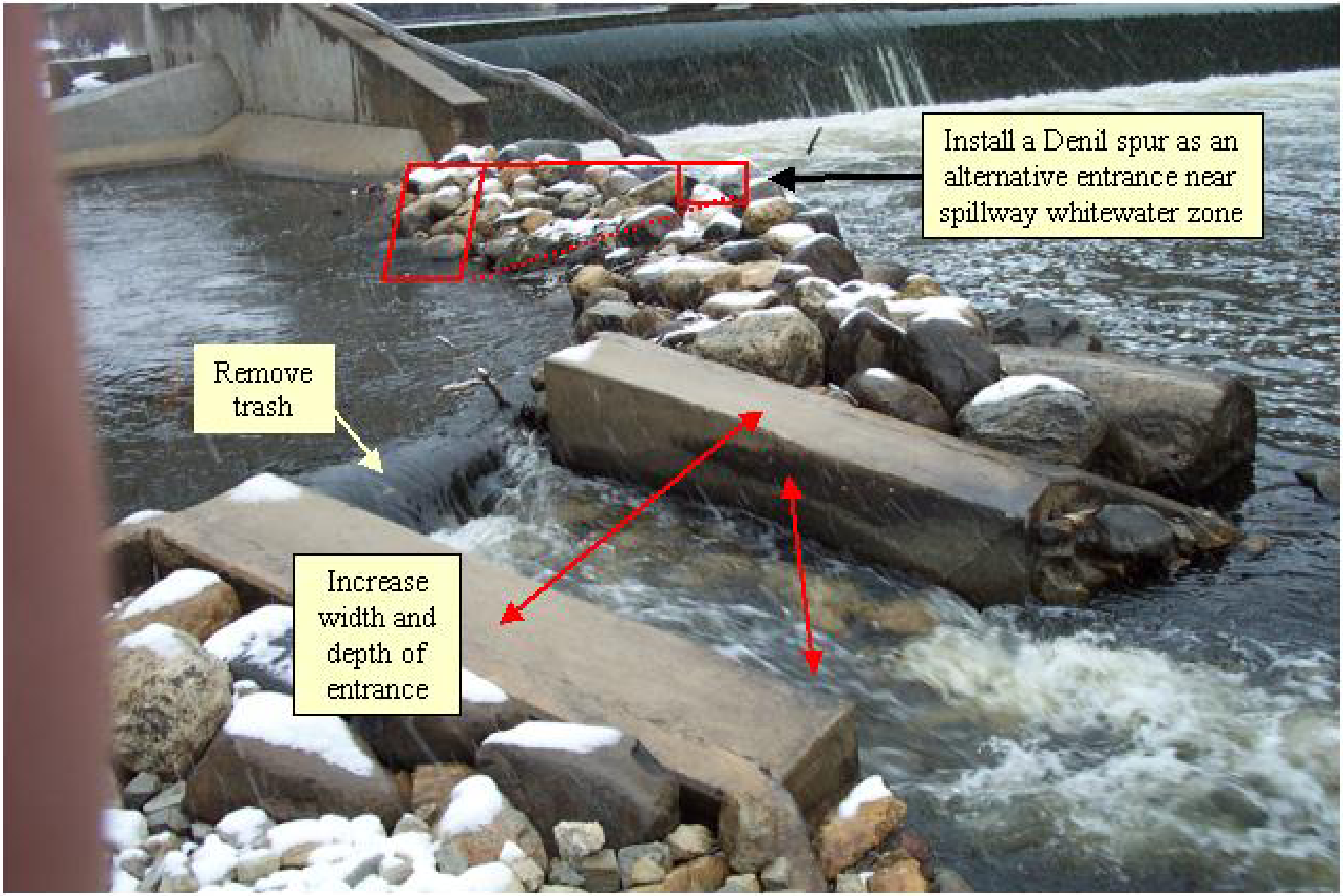
STOLP ISLAND DAM – Existing Canoe Chute on West Bank.



STOLP ISLAND DAM – Recommended Improvements to Canoe Chute Weirs and Pools.



STOLP ISLAND DAM – Recommended Improvements to Canoe Chute Entrance.



it more passable to boats. We offer the following suggestions to improve the canoe chute's ability to pass fish.

- Widen and deepen the exit opening of the channel (at the headpond end) to allow more water to pass down the channel. We anticipate that this action will also improve conditions for boats.
- Change the gate used to close the channel. It is suspected that the gate doesn't work well given its hinged design. Simple vertical galvanized aluminum channels can be installed that will accept 6 x 6 in. stoplogs with eyes lagged into the top near both ends. One worker at each end of the entrance can lower the stoplogs into place with long-handled boat hooks.
- Add an additional weir to reduce the head loss at existing chute Number 4 (see sketch).
- Re-design so that dimensions of all individual chutes are identical and the total headloss of the dam is equally divided among the individual head losses at each chute. The re-design must keep in mind that more water needs to be passed down the channel.
- The approach to the fish channel entrance (downstream of the bottom) should be deepened. This area has filled up with cobble and is relatively shallow, which will discourage fish from approaching the entrance.
- The entrance of the channel is not close to the toe of the spillway, making it difficult for fish to locate. A small section of pre-fabricated aluminum steeppass fishway (pre-fabricated Denil-style fishway) should be installed in the side of the first pool to provide access to the bypass from the area just below the spillway.
- To improve attraction to this fishway spur, a small notch (4 ft. by 6 in.) should be created in the extreme western end of the spillway to allow extra water to pass down, resulting in a large plume of water that will attract migrating fishes. To prevent this plume of water from disrupting the flow of water out of the steeppass fishway spur, an angled concrete wall about 8 ft. long should be installed off of the side of the wall immediately upstream of the entrance of the steeppass fishway.

DENIL FISHWAY

Advantages:

- Will pass most targeted species of fish.
- Compatible with public nature of property and may add interest to visitors.
- Will not disrupt existing property or its current use.
- Will allow the dam to remain.

Disadvantages:

- The dam remains, with all of its negative ecological impacts.
- Will not pass as wide of a diversity of fish as removing the dam.
- Represents a facility that will need operation and maintenance into the future.
- The public safety threat of drowning at the base of the dam remains.

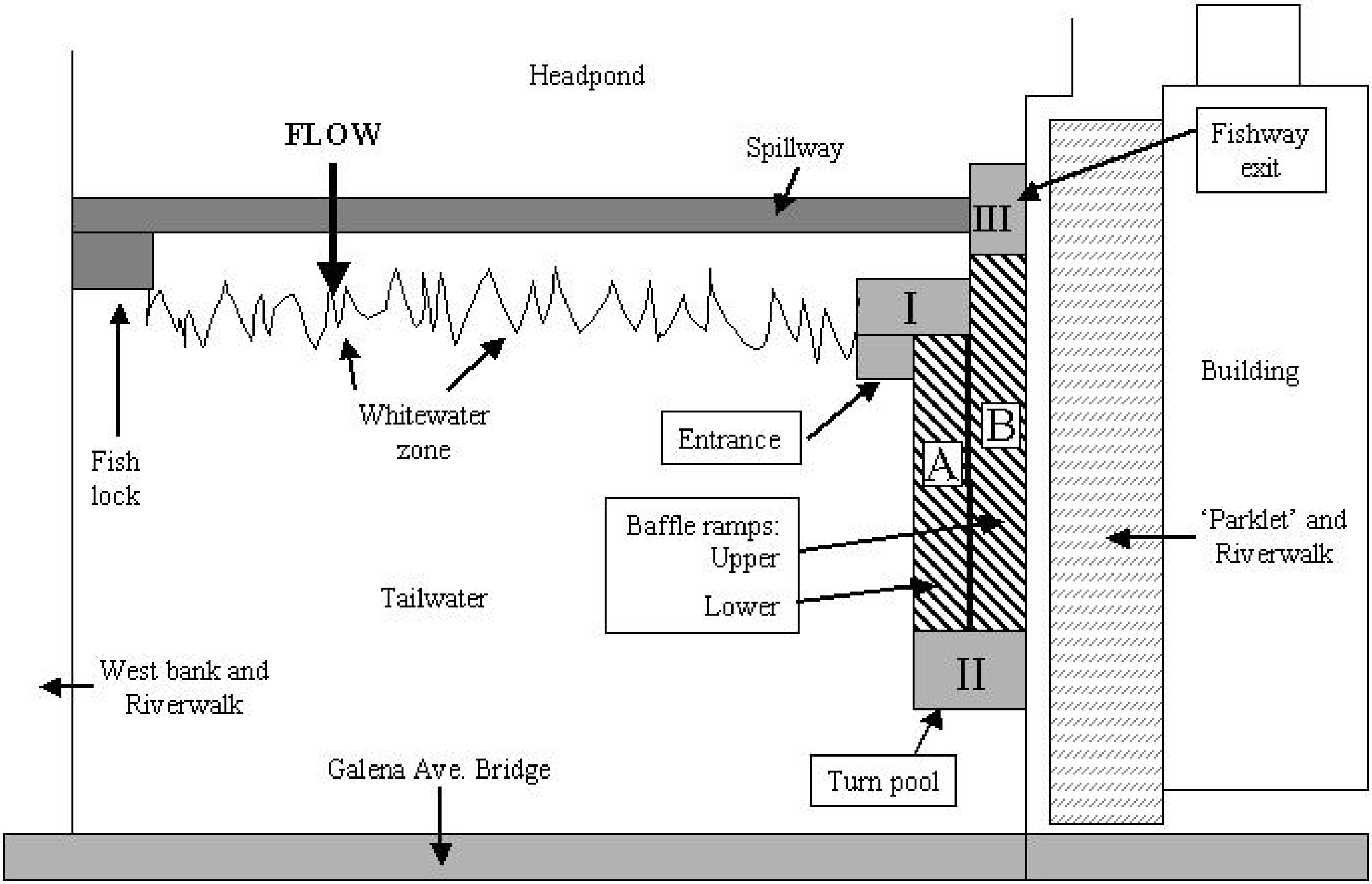
As indicated in the bypass discussion above, fish passage must be provided at both spillways to be effective. The existing canoe chute at the west spillway holds promise for passing fish on that side of the island. There is an antiquated, non-functional fish lift (or 'fish lock') on the west end of the east spillway (see discussion in "History of Fish Passage with a Fox River Perspective" above). A fish lift is not a good fish passage option for this dam for a variety of reasons and there was no consideration given to repairing this structure. However, this structure was investigated to determine if it had potential as a site for a modern Denil fishway. It was determined that no special opportunities existed here and, in fact, the existence of this structure would require prior demolition and make a new fishway more expensive than a comparable structure on the opposite bank. Furthermore, when it was learned that the City of Aurora was planning an ambitious RiverWalk promenade along the east bank, it was determined that it would be appropriate to attempt to link the RiverWalk with a fishway. It is understood that the RiverWalk is a large and expensive proposal that may not proceed, at least immediately. However, if the RiverWalk is conceived in stages, it is possible that a Denil fishway could be designed into the plans for the segment between the New York Street and Galena Boulevard bridges and constructed as part the overall project. The 1:15 slope fishway would be constructed immediately up against the existing seawall at the east side of the east spillway. The fishway consists of five sections.

- I - The entrance pool is located near the toe of the spillway.
- A - The first run of baffles extends south for a distance of about 60 ft.
- II - A 180˚ turn/resting pool separates the first and second baffled runs.
- B - The second run of baffles extends north from the turn pool for about 60 ft.
- III - The exit pool is located at a cutout of the east side of the spillway.

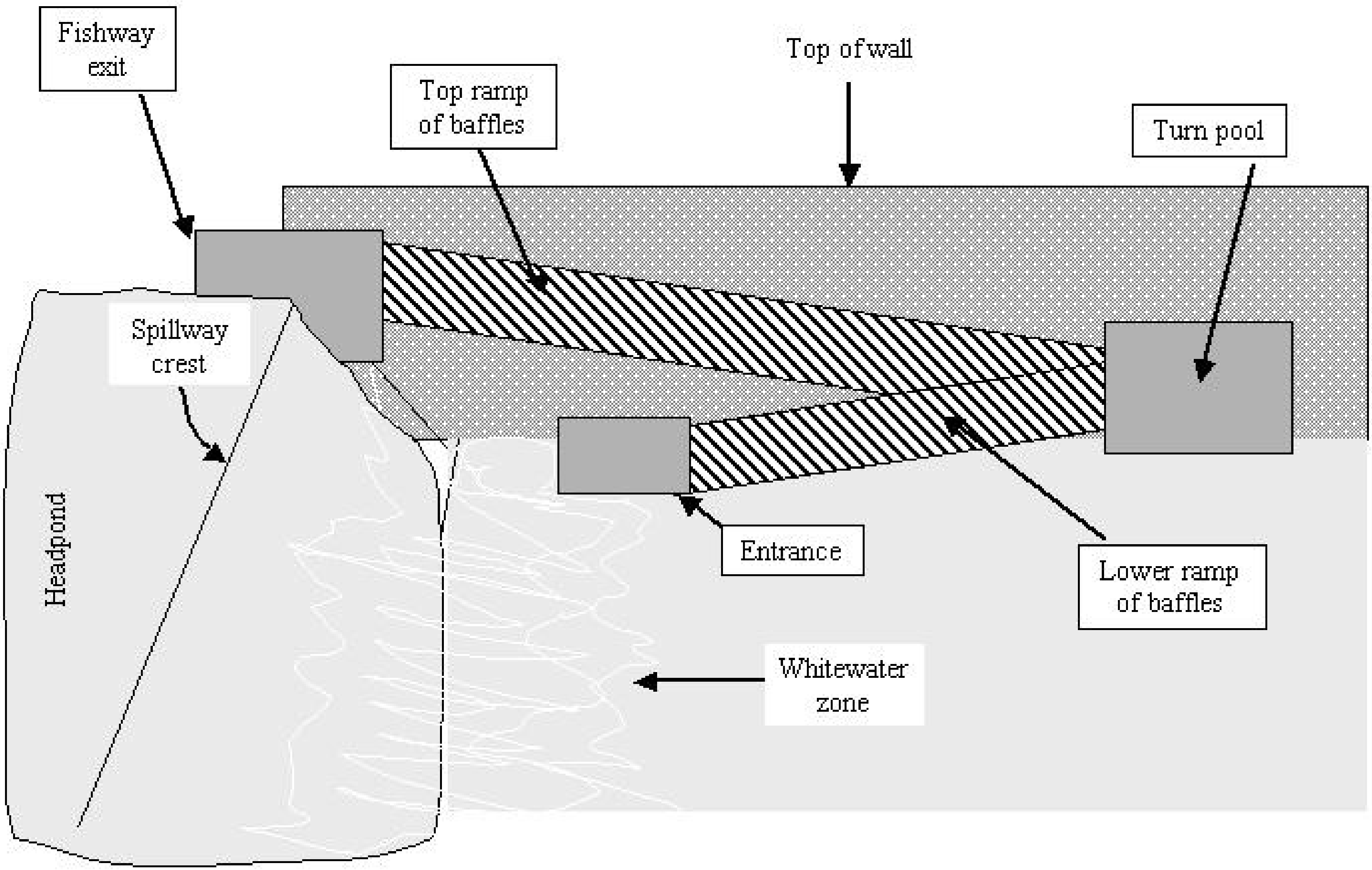
Additional features include steps and walkways from the RiverWalk to allow seasonal access to a parallel walkway allowing visitors to look right down into the fishway to see fish migrating upstream. There is also ample opportunity for interpretative signage and displays to educate visitors about the river and its fish, the need to get migrating fish over the dam, the purpose of the canoe chute on the west spillway, the history of the City Center and its dams, and the historical significance of the fish lock on the west side of the east channel.

Estimated costs: A Denil fishway at the Stolp Island Dam is estimated to cost about $250,000 without any added structures associated with the RiverWalk.

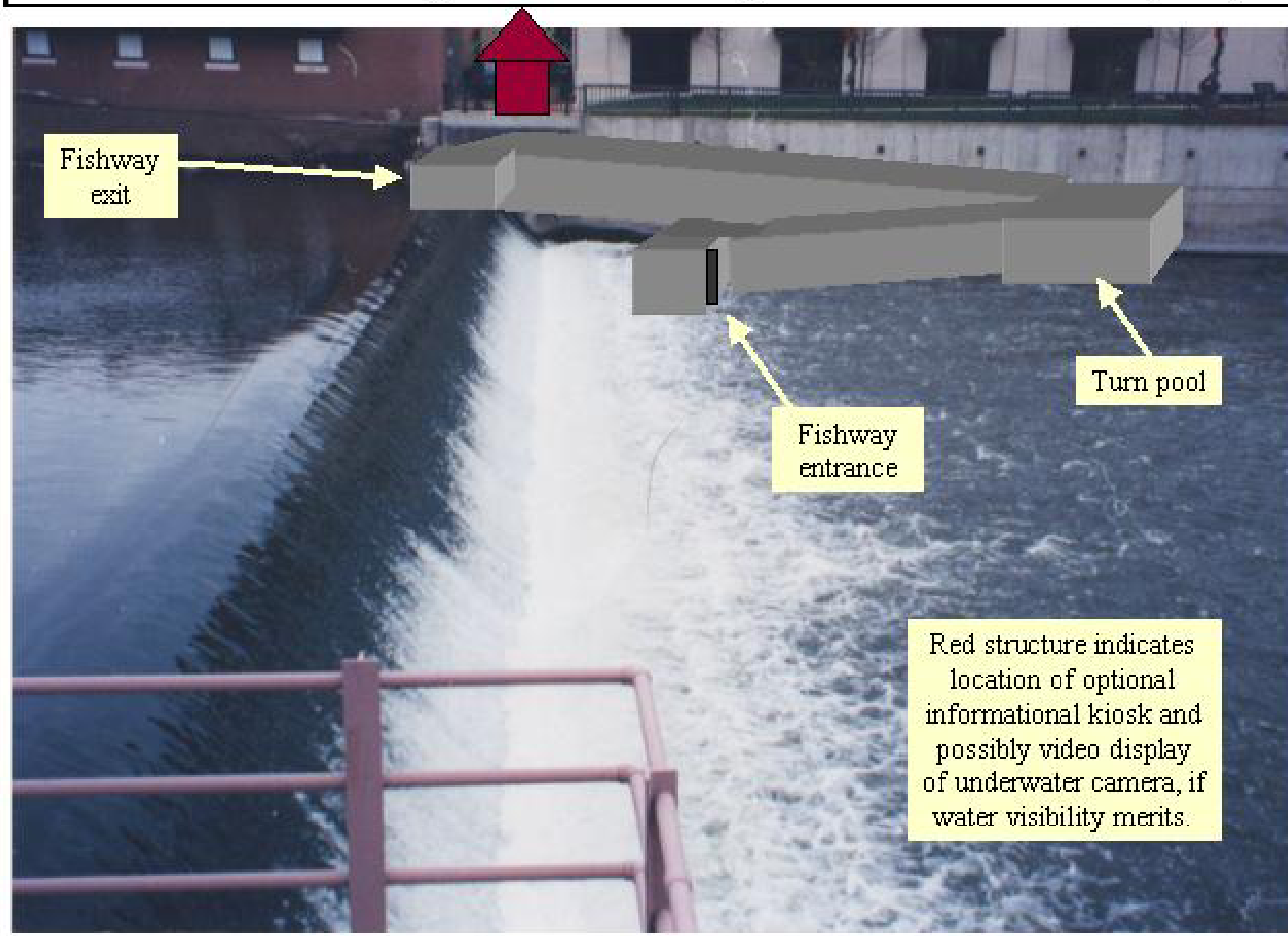
STOLP ISLAND DAM – Plan View – Conceptual Plans for an East Bank Denil Fishway at East Spillway.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



STOLP ISLAND DAM – Profile View – Conceptual Plans for an East Bank Denil Fishway at East Spillway.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



STOLP ISLAND DAM – Depiction of Denil Fishway at the East End of the East Spillway.



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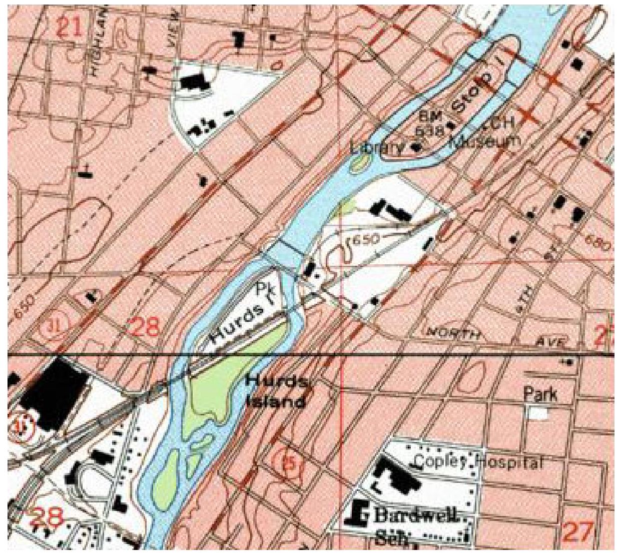
HURD'S ISLAND DAM (A.K.A. NORTH AVENUE DAM)



LOCATION

Latitude-longitude (NAD 83): 42.7531437˚N 88.3220779˚W
Legal: T38N R8E S21SE
Town: Aurora, IL
River mile: 48.4
Comments: Upstream of the North Ave. Bridge
Next downstream dam (distance): Montgomery Dam (1.6 miles)
Next upstream dam (distance): Stolp Island Dam (0.5 miles)

DESCRIPTION

Height: 2.8 ft.
Spillway elevation: 619.0 ft.
Length: 365 ft.
Dam type: Broad-crested
Material: Concrete
Nature of barrier to fish: Partial (some strong swimming species may surmount it in high flows)
Construction date: Uncertain
Condition of dam: Good
Length of impoundment: 0.20 miles
Appurtenances: None

LEGAL/SOCIAL ASPECTS

Owner: City of Aurora
Owner of adjoining land: Uncertain. Private commercial property appears to be located above both banks.
Present day purpose of dam: None
Uses of impoundment: None

SEDIMENT ACCUMULATION BEHIND DAM

Not investigated. Note: Due to its low height, it is suspected that very little sediment has accumulated behind this dam.

BIOLOGICAL RESOURCES

A population of State threatened river redhorse exists in the free-flowing river segment below the dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allows full, unrestricted passage of all species and sizes of fish at the site.
- Restores the free-flowing, natural river and all associated dynamics.
- Eliminates an obstacle to recreational paddlers and the need for a portage.
- Eliminates the hazard of drowning by eliminating moderately dangerous hydraulic currents below the spillway.
- Eliminates the need to maintain a costly state facility for many years to come.

Disadvantages:

- If some debris and trash are exposed due to the elimination of the pool, there may be an interim period when the area is unattractive while the community musters its resources to clean up the river and perhaps develop a river walk or similar amenity.

The Hurd's Island Dam is currently targeted for complete removal and this option appears to make the most sense. There are few homes along the banks of the impoundment, no access for powerboat recreation, and no present function of the dam or impoundment. The construction of any type of fishway would cost much more that the total removal of the dam. Furthermore, this dam has a very dangerous hydraulic and has been the site of numerous drownings over the years.

There are two issues that may arise. First, a partial removal could concentrate high velocity currents at the footings of the North Avenue Bridge and cause some undermining. However, since the partial removal of this dam is not recommended, this is unlikely to be an issue. Full removal of the dam will result in uniform dispersal of water currents downstream and will not threaten the integrity of the bridge. Secondly, there is reason to believe that the dam may have been supported in past years as a way to inundate unsightly riverbanks, trash, and pollution in downtown Aurora. In the late 1960s, raw sewage poured from downtown pipes that were partially hidden by the water level. In the early 21st Century, this does not seem to be a valid reason for maintaining a worthless and dangerous dam. If the removal of the dam reveals unsightly conditions, it is suggested that such conditions be remedied. Debris and trash can be removed and unattractive or exotic riparian vegetation can be removed and replaced with more attractive natural species. In fact, some of the formerly unattractive land might be reclaimed and used for passive recreation (trails, bike path, picnic areas, and extended river walk) and access to the new, free flowing river.

BYPASS CHANNEL

No proposal for this option is provided due to the lack of suitable space for this type of fish passage facility.

DENIL FISHWAY

The construction of a fishway at this site is not recommended. A Denil fishway could be built at either end of the spillway but costs could not be justified for such a small, non-functional dam.

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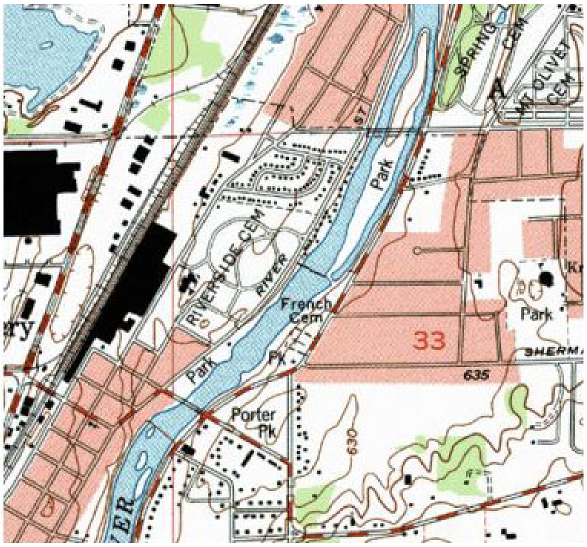
MONTGOMERY DAM



LOCATION

Latitude-longitude (NAD 83): 41.7337046˚N 88.3339231˚W
Legal: T38N R8E S33NW
Town: Montgomery, IL
River mile: 46.8
Comments: Approximate 2,000 ft. upstream of the Mill Street Bridge
Next downstream dam (distance): Yorkville Dam (10.3 miles)
Next upstream dam (distance): Hurd's Island Dam (1.6 miles)

DESCRIPTION

Height: 8 ft.
Spillway elevation: 614.0 ft.
Length: 325 ft.
Dam type: Broad-crested with a stair-stepped face
Material: Concrete
Nature of barrier to fish: Complete
Construction date: 1969. The first dam in this town was built in 1851, approximately ¼ mile downstream of the existing dam, to serve a gristmill. By 1916, an old wooden dam with a west bank millrace existed on that site, but it is not clear whether that was the original dam. It also is not clear when this 1916 dam disappeared, but it was completely gone by the 1960s. The State of Illinois built the existing dam between 1967 and 1969 amidst considerable public protest. This dam was part of a scheme to make the Fox River navigable for commercial shipping (Stratton Plan). The island that exists upstream of the dam, creating a 'back channel' was deliberately created by the project to serve as an earthen dike to close in what was intended to be a future boat lock. The lock was never built.
Condition of dam: Good
Length of impoundment: 0.8 miles
Appurtenances: Back channel with water control gate and drain.

LEGAL/SOCIAL ASPECTS

Owner: State of Illinois
Owner of adjoining land: Fox Valley Park District
Present day purpose of dam: None
Uses of impoundment: Uncertain

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 400 cu. yds. in the main channel and 10,800 cu. yds. in the back channel.
Sediment quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.
Distribution: See map below.

BIOLOGICAL RESOURCES

The State threatened river redhorse was collected in free-flowing portions of river segments above and below the dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of drowning. This dam does not create a particularly dangerous downstream hydraulic below the spillway compared to most Fox River dams, but the risk of drowning or injury remains.
- Increase available parkland, as the back channel likely would dewater if the dam were removed. Some fill may be needed to bring channel up to grade.
- Eliminate the need to maintain a costly state facility for many years to come.

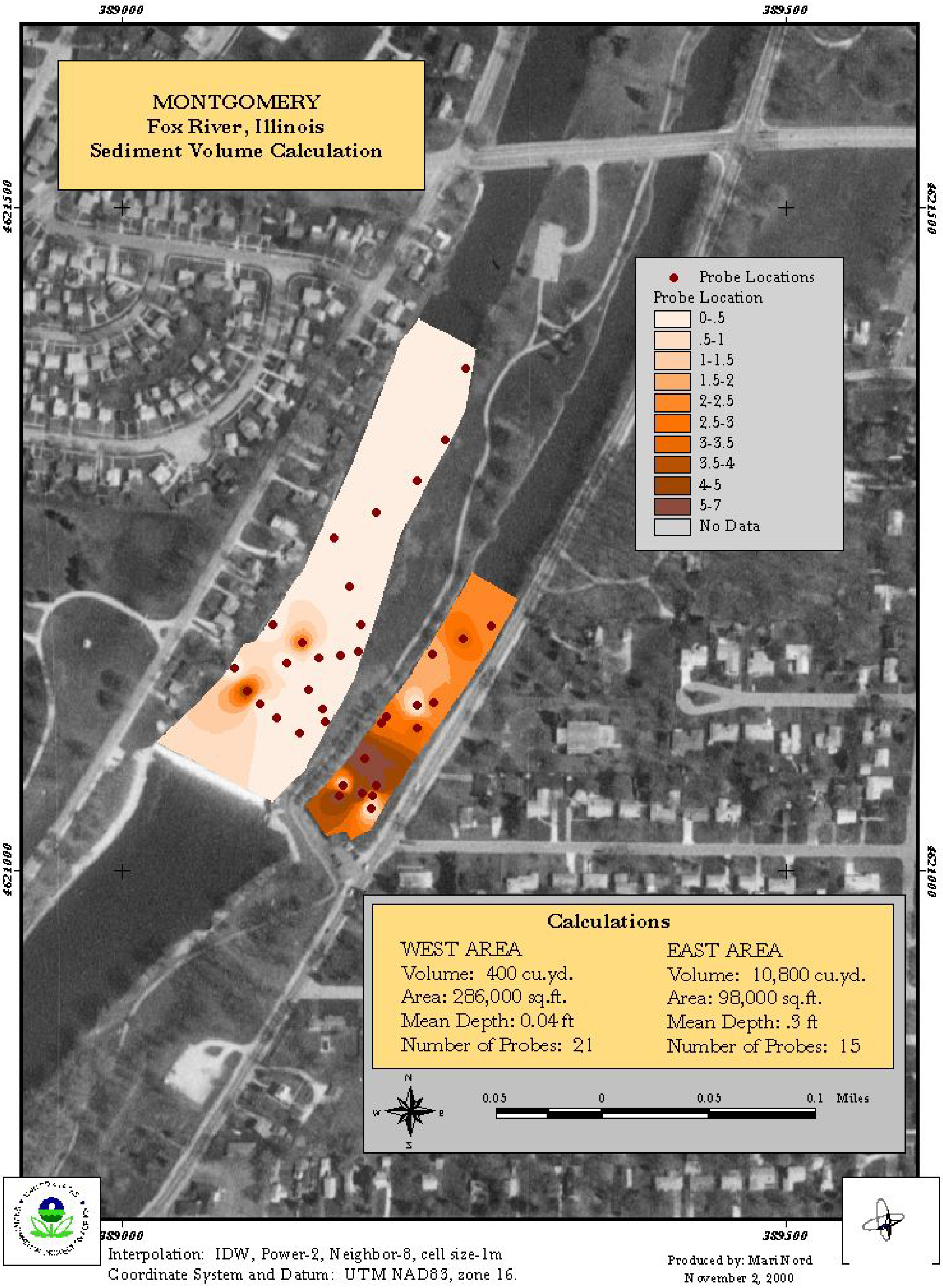
Disadvantages:

- Reduce pool size and perceived aesthetic impacts to hikers, runners, bikers.
- Upset upstream waterfront property owners.

BYPASS CHANNEL

Advantages:

- Allow passage of canoes and kayaks without the need to portage.
- Allow passage of a wide range of species and sizes of fish.
- Semi-natural and reasonably attractive appearance.



389000
389500
4621500
4621000
MONTGOMERY
Fox River, Illinois
Sediment Volume Calculation
Probe Locations
Probe Location
0-.5
.5-1
1-1.5
1.5-2
2-2.5
2.5-3
3-3.5
3.5-4
4-5
5-7
No Data
Calculations
WEST AREA
Volume: 400 cu.yd.
Area: 286,000 sq.ft.
Mean Depth: 0.04 ft
Number of Probes: 21
EAST AREA
Volume: 10,800 cu.yd.
Area: 98,000 sq.ft.
Mean Depth: .3 ft
Number of Probes: 15
0.05 0 0.05 0.1 Miles
Interpolation: IDW, Power-2, Neighbor-8, cell size-1m
Coordinate System and Datum: UTM NAD83, zone 16.
Produced by: Mari Nord
November 2, 2000

- Provide a new recreational and viewing opportunity for visitors to the local park.
- Compatible with existing land use with no disruptions or significant land clearing needed.
- Makes use of existing topography and structure at considerable cost savings.

Disadvantages:

- The dam remains with all of its negative ecological impacts.
- A facility must be maintained at expense of taxpayers.

A combined boat and fish bypass is proposed for the east bank, incorporating the back channel that was originally planned for a navigation lock. The bypass entrance is located near the downstream end of the 'island' near the existing outlet for the water control structure. A shallow approach channel may need to be dredged in the river immediately downstream of the entrance to expedite fish locating the fishway and passing upstream. The bypass extends upstream in the back channel for 240 ft. at a slope of 1:30. The exit passes through a concrete water control structure embedded in an earthen dike extending from the existing island to the riverbank. This dike would be built first as a cofferdam to de-water the downstream portion of the channel. Once the bypass channel was completed, the water level would be raised and released down the channel. The entire width of the existing back channel is needed to create the bypass, although the entire width may not be wetted the entire time. Considerable hydraulic analysis and design by qualified engineers is necessary to develop an appropriate channel that would pass fish and boats. The channel itself incorporates rocky ramps at regular intervals to reduce water velocities, add water depth, and assist fish migrating upstream.

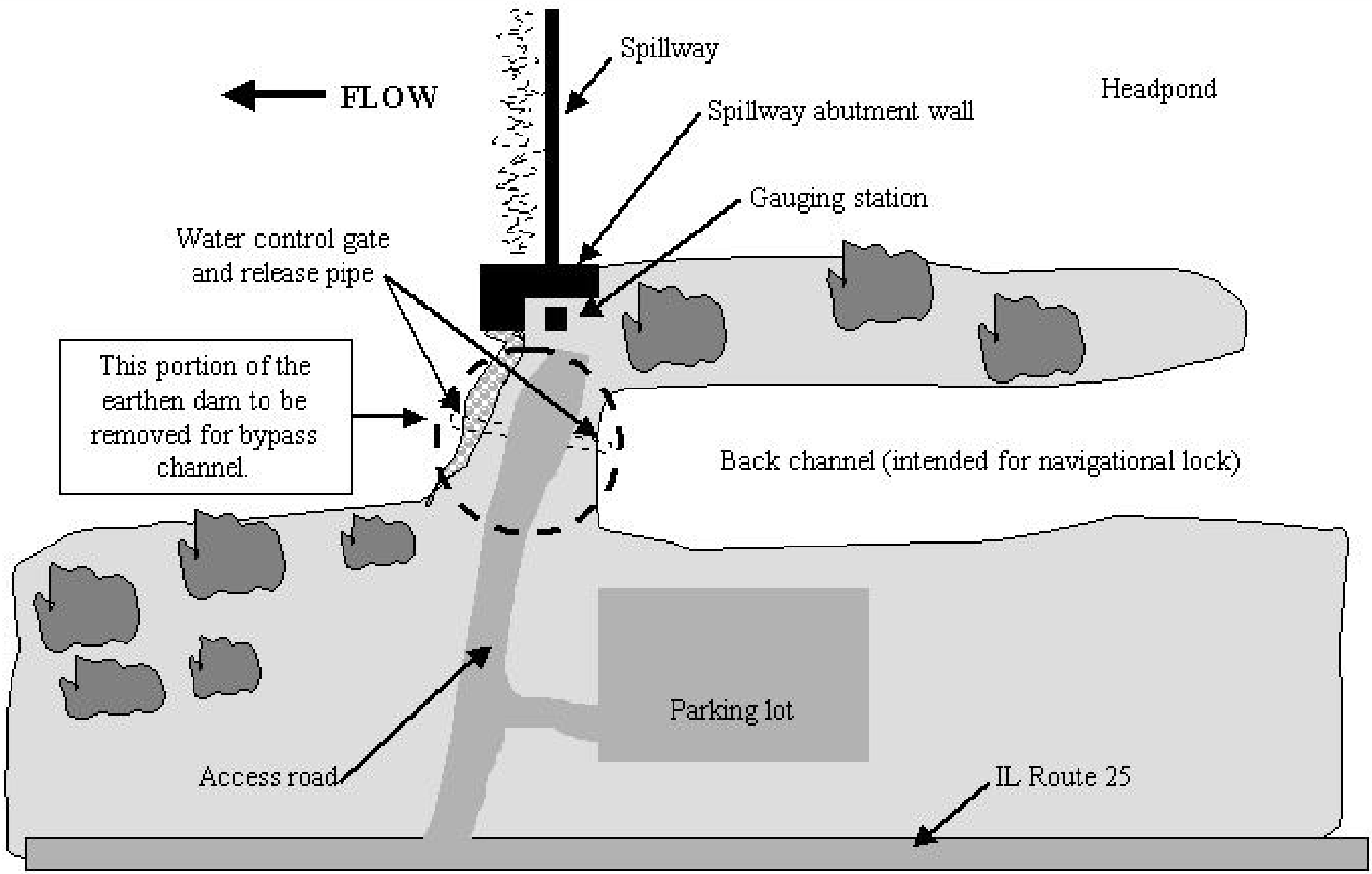
The location includes an existing parking lot, easy access from Rt. 25, and regular visitation from anglers, canoeists, and hikers/bikers. These conditions make this site a natural location for interpretative signage and viewing platforms to allow visitors to watch fish migrating upstream and recreational boaters paddling downstream. The proposed bypass channel will require the a vehicular bridge to allow access to the spillway for maintenance and emergency activities. The bridge should be constructed of some type of open decking so that it does not cast a dark shadow on the channel, which can act as a light barrier to fish migrating upstream during the day.

DENIL FISHWAY

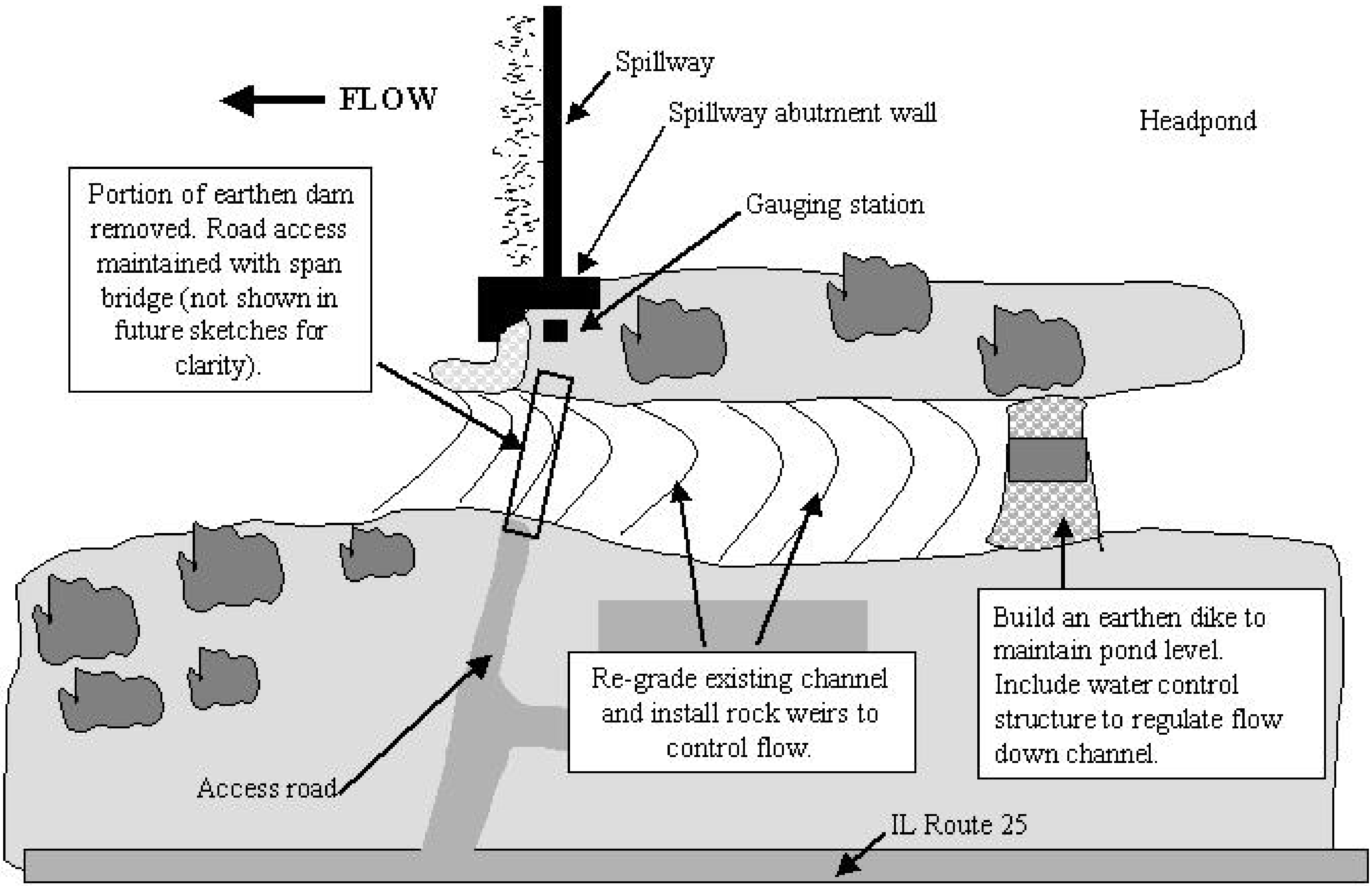
No fishway option is provided because of the performance and cost advantage of the bypass channel described previously. Although a Denil fishway could be built at the downstream end of the back channel, it would be less effective at passing fish, more expensive, would not address canoeing concerns, and less natural. If this dam is not removed (preferred option), the bypass option is strongly recommended over a concrete Denil fishway.

MONTGOMERY DAM – Plan View – Existing Conditions.

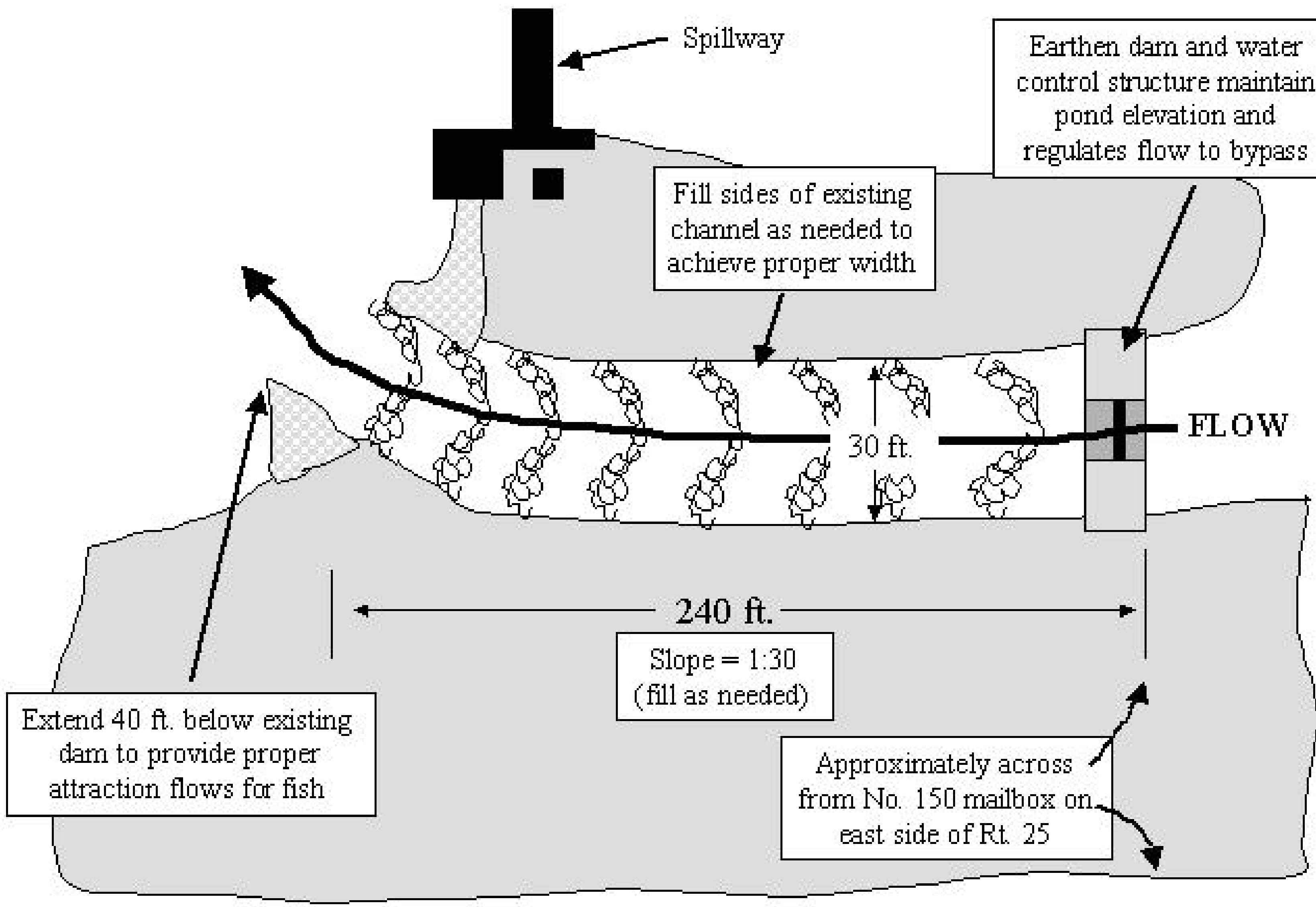
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



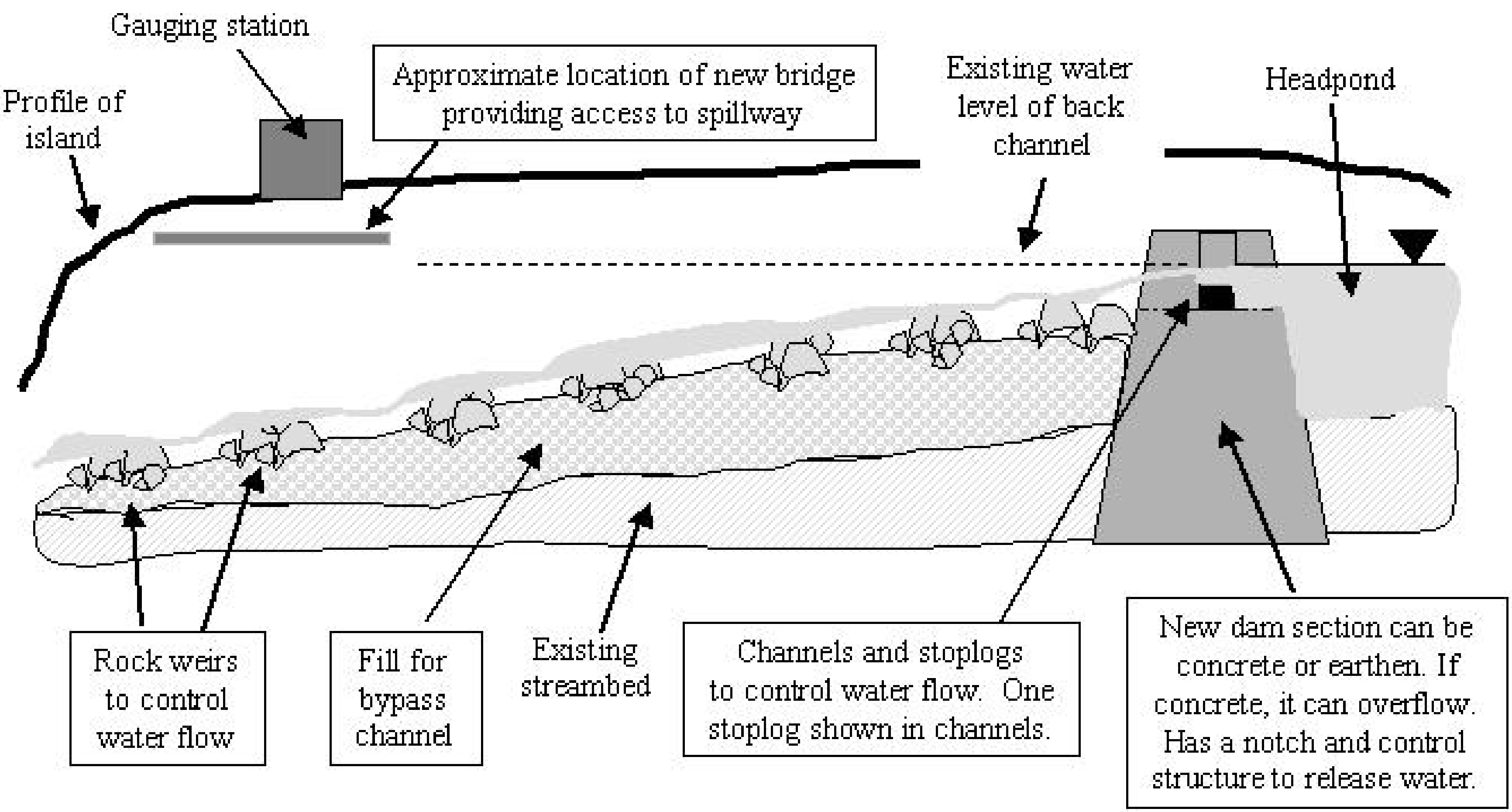
MONTGOMERY DAM – Plan View – Conceptual Plans for a Bypass Channel Through East Side Channel.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



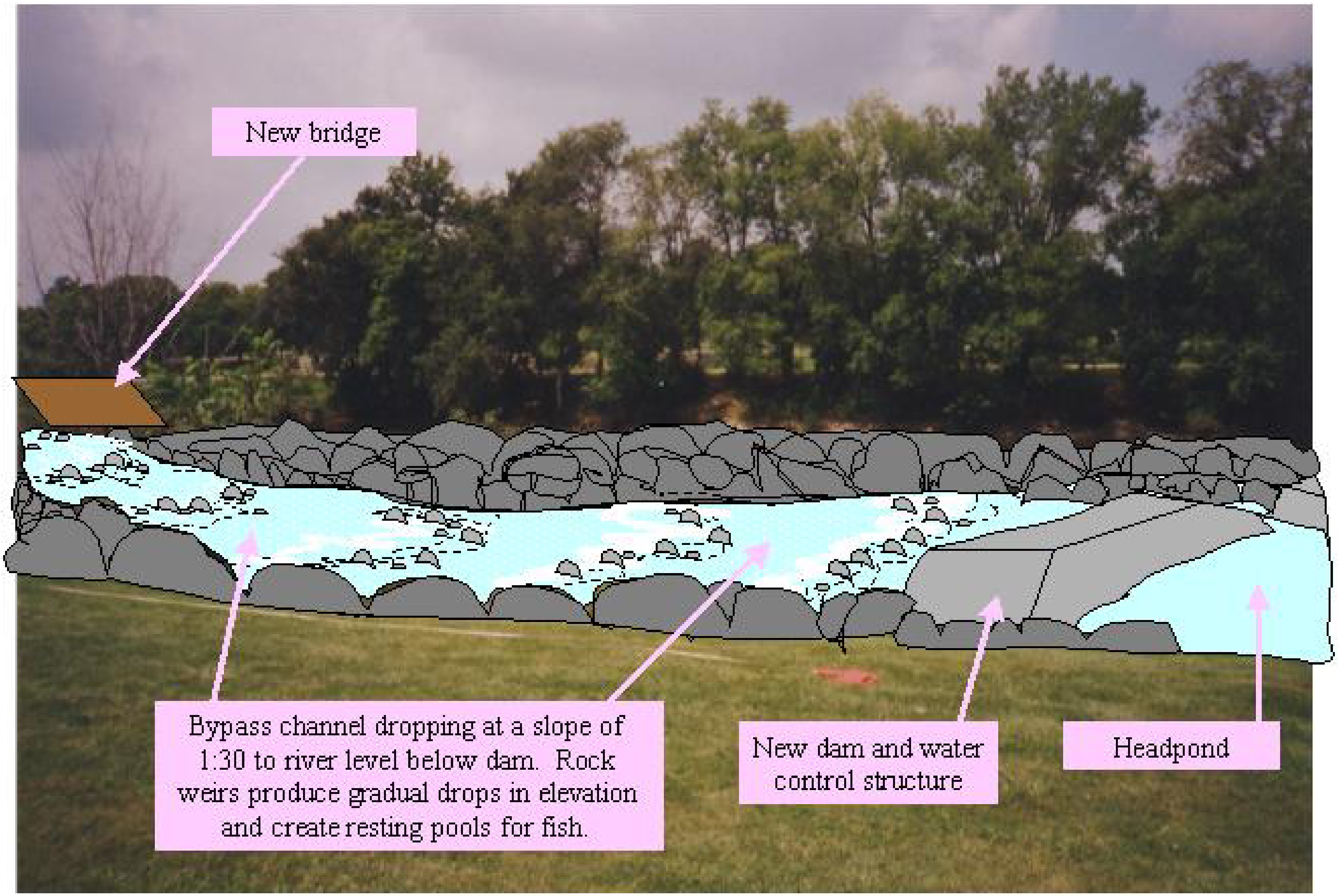
MONTGOMERY DAM – Detailed Plan View – Conceptual Plans for a Bypass Channel Through East Side Channel.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



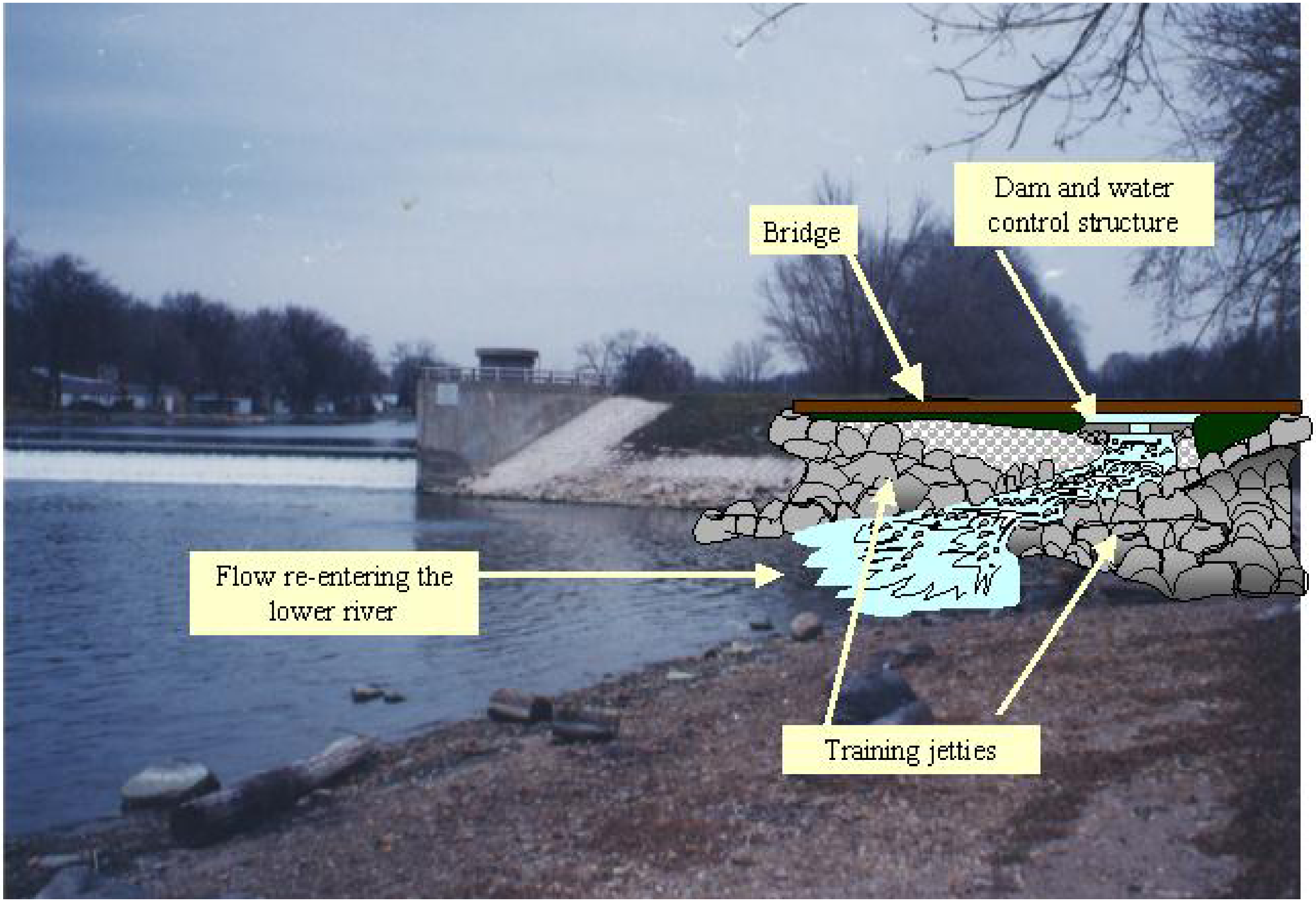
MONTGOMERY DAM – Profile View – Conceptual Plans for a Bypass Channel Through East Side Channel.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



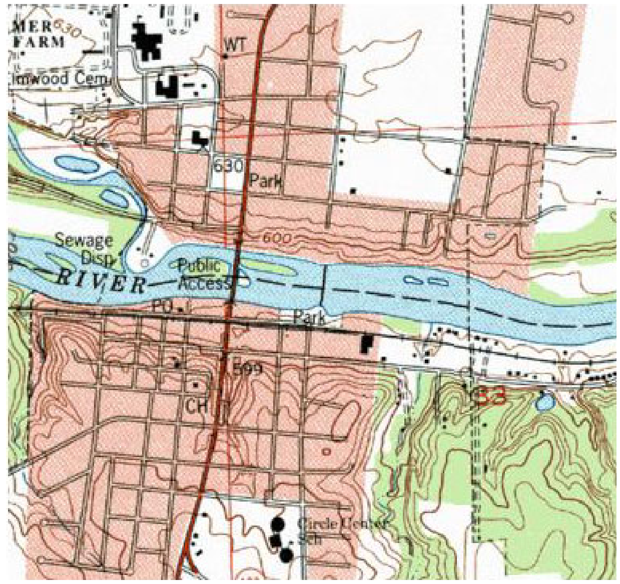
MONTGOMERY DAM – Depiction of Upper Portion of Bypass Channel.



MONTGOMERY DAM – Depiction of Entrance to Bypass Channel Looking North from Below Dam.



YORKVILLE DAM (A.K.A. GLEN PALMER DAM)



LOCATION

Latitude-longitude (NAD 83): 41.6433319˚N 88.4430600˚W

Legal: T37N R7E S33NW

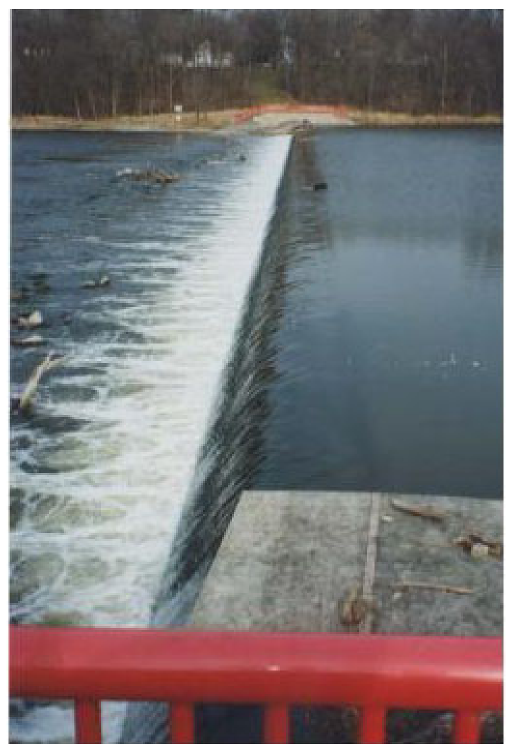
Town: Yorkville, IL

River mile: 36.5

Comments: Upstream of the U.S. Rt. 47 Bridge and adjacent to East Hydraulic Avenue.

Next downstream dam (distance): Dayton Dam (30.8 miles)

Next upstream dam (distance): Montgomery Dam (10.3 miles)



DESCRIPTION

Height: 7 ft.

Spillway elevation: 575.0 ft.

Length: 530 ft.

Dam type: Broad-crested weir

Material: Concrete

Nature of barrier to fish: Complete

Construction date: 1961

Condition of dam: Good

Length of impoundment: 1.5 miles

Appurtenances: Concrete gauge house and canoe portage ramp on south bank and a municipal park along south bank from East Hydraulic Avenue west to Rt. 47 Bridge.

LEGAL/SOCIAL ASPECTS

Owner: State of Illinois

Owner of adjoining land: Town of Yorkville on the south side and State of Illinois on the north side.

Present day purpose of dam: None

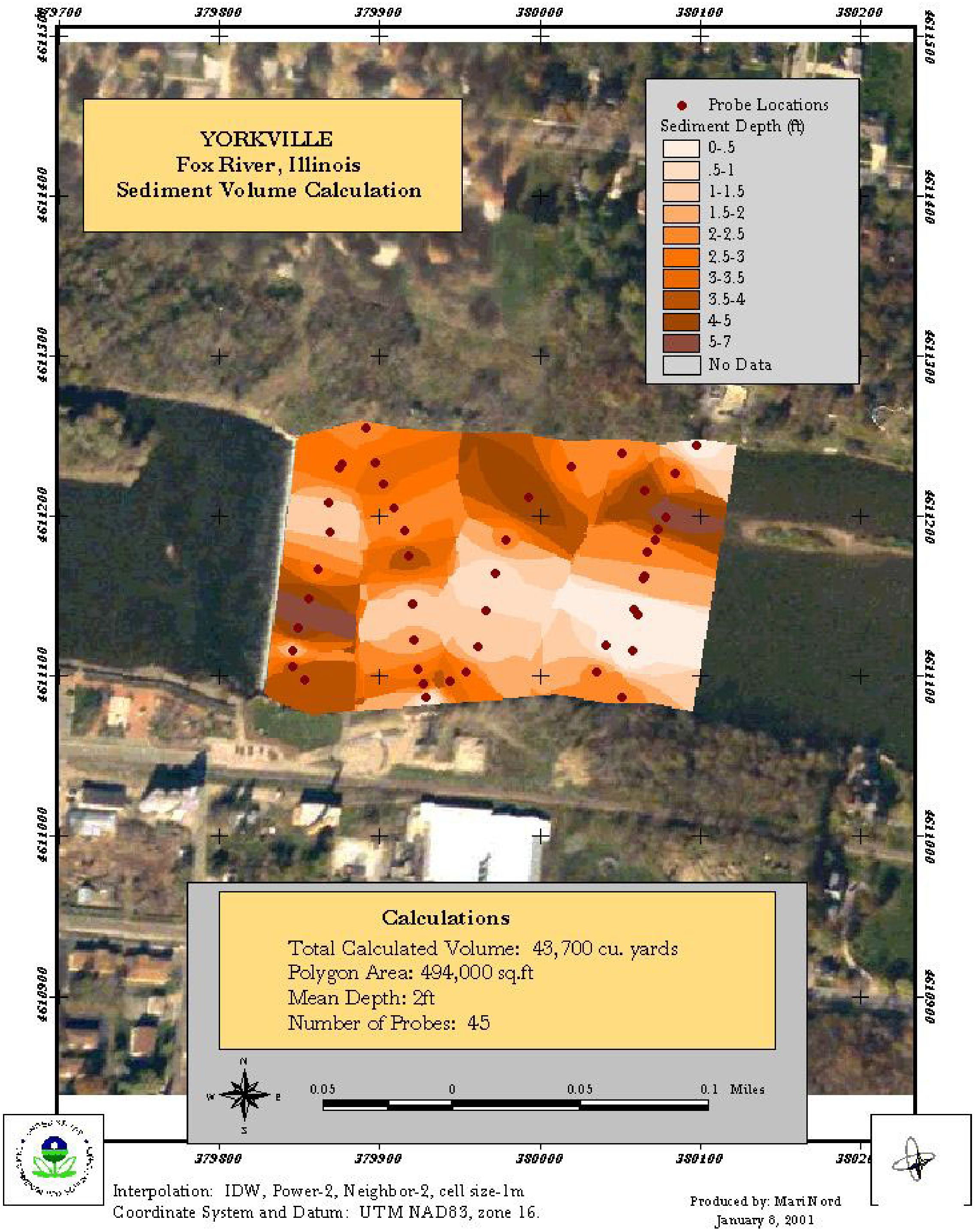
Uses of impoundment: Power boating and fishing.

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 43,700 cu. yds.

Sediment quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.



BIOLOGICAL RESOURCES

The State threatened river redhorse was collected in the free-flowing river above the dam and impoundment. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics. It should be noted that this dam has the longest and second longest free-flowing stretches of river downstream (26.8 miles) and upstream (8.7 miles) of the dam. If this dam were removed, the total length of free-flowing river would amount to 41.1 miles or roughly 41% of the Fox River between the Chain-O-Lakes and Dayton, IL. This would result in a significant reach of natural, healthy river (particularly for this region of Illinois) and would represent a tremendous canoeing resource.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the hazard of drowning by the removal of an extremely dangerous hydraulic current below the spillway. According to a recent article in the Aurora *Beacon News*, 30 people have drowned below this dam. This is a shocking statistic. If this were a highway intersection, the intersection would have been re-designed years ago.
- Eliminate the need to maintain a costly state facility for many years to come.

Disadvantages:

- Reduce pool size for recreational power boating.
- Upset upstream waterfront property and boat owners.

There are earthen dams on both side of the river but our vision for the removal option would preserve these structures. They would resemble grassy knolls alongside the river when the concrete spillway was removed. The existing concrete abutment walls could remain as retaining walls or, for a more scenic option, be removed and the earthen dams cut back at a moderate slope to eliminate the abrupt drop. If the abutment walls remain, safety fences would be needed to ensure visitors could not fall off the walls and injure themselves.

BYPASS CHANNEL

Advantages:

- Allows passage of canoes and kayaks without the need to portage.
- Allows the passage of a wide range of fish species and sizes (assuming they locate it).
- Provides a new recreational and viewing opportunity for visitors.
- Not overly disruptive to existing land or facilities.

Disadvantages:

- The dam remains with all of its negative ecological impacts.
- For safety reasons, the entrance to the bypass should be located well downstream of the spillway. Fish ascending the middle of the river would have to move northerly along the face of the dam and once they reach the end of the spillway, they would have to swim downstream (which is against their migrational instinct) to locate the entrance. The entrance would not be expected to be very effective so a Denil fishway spur must be added from the middle of the bypass channel to the base of the dam. This adds expense and complexity to the project.
- One fishway probably will not provide effective fish passage at this dam. The river is very wide at this location and fish that migrate up the south side of the river may not move laterally across the entire width of the spillway to locate the north bank fishway and bypass. A fishway would also be needed at the south end of the spillway. However, a boat bypass would not be needed on the south bank, so a smaller fishway could be built, but the total cost would still be more than at upriver dams where the river is narrower and fish can be expected to move from bank to bank. This adds expense and redundancy to the project.
- The dangerous hydraulic current below the dam remains. If this option is chosen, it is strongly recommended that additional structural modifications to the spillway be implemented at the same time to eliminate this dangerous situation. Accomplishing this will add expense to the project.

A combined boat and fish bypass channel located on the north bank is recommended for this option. The exit (for fish) is about 50 ft. upstream of the spillway and the channel extends downstream at a slope of 1:30 for about 200 ft. The channel should be at least 30 ft. wide to accommodate larger canoes. The entrance to the Denil fishway spur is at a 45˚ angle to the flow of the river and located just downstream of the whitewater area below the spillway. The spur has a lower ramp of baffles (1:15 slope) running along the abutment wall to a turn/resting pool at the downstream end of the wall. A second ramp of baffles (1:15) continues up the bank to join the bypass channel. There are no structures in the area and the bypass would not interfere with any activity nor require anything to be relocated. However, some of the existing trees on the riverbank would need to be cleared. A sturdy vehicular bridge might be needed to allow access to the spillway for maintenance (this would be determined through design consultation with the State).

DENIL FISHWAY

Advantages:

- Minimally disruptive to parkland and will not require moving portage ramp.
- Will pass most targeted species of fish.

- Compatible with public nature of property and creates added interest to visitors.
- Allows the dam to be maintained, if that is desired.

Disadvantages:

- The dam remains, with all of its negative ecological impacts.
- Will not pass as wide of a diversity of fish as bypass, but then, the bypass option required a Denil section for effective attraction, so this option is no worse off.
- Will require two fishways (one on each side of the dam) or a fishway on the south side and bypass channel/fishway on the north side for effective fish passage. This adds expense and complexity to the project.
- If two fishways are built canoe portaging will still be required at the dam.
- Represents a state facility that will need operation and maintenance into the future.
- The dangerous hydraulic current below the dam remains. If this option is chosen, it is strongly recommended that additional structural modifications to the spillway be implemented at the same time to eliminate this dangerous situation. Accomplishing this will add expense to the project.

We present conceptual plans for a 1:15 slope Denil fishway located at the south end of the spillway. If a two-fishway option is selected the north bank fishway would have similar design features as the one described and its layout would mirror that of the south bank fishway.

The fishway consists of five sections.

I - The entrance pool is located near the spillway splash zone just north of the abutment wall. A long entrance channel without baffles extends along the base of the angled abutment wall for about 25 ft. to the end of the wall. The end of the entrance pool would include a turn to align the entrance pool with the first run of baffles that runs along the east edge of the existing stone portage ramp.

A - The first ramp of baffles extend southerly along the existing portage ramp for 30 ft. to a 90˚ turn pool that turns east adjacent to the north end of the existing brick walkway.

II - There is a 180˚ turn/resting pool that is about 20 ft. long.

B - The second run of baffles extends northeast for about 80 ft. to an exit pool.

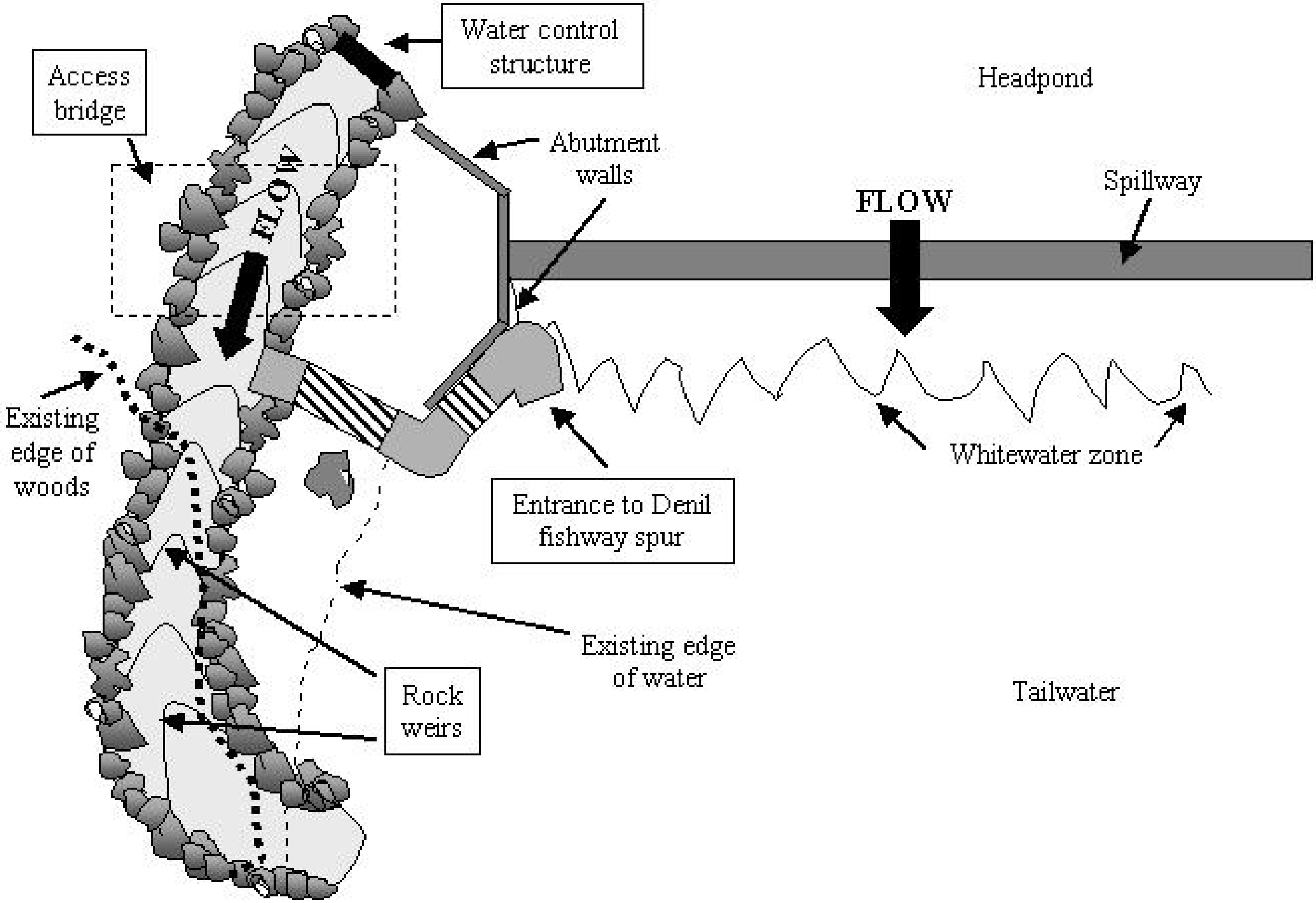
III - The exit pool is about 10 ft. long and located just west of the boat launch.

There is opportunity for a public viewing window and fish trap in the exit pool. Additional attraction water also should be considered for these fishways. A 4-ft. wide and 2-ft. deep notch should be made in both ends of the spillway with removable 6-in. stoplogs to provide extra spill at the ends of the spillway to attract fish toward the fishway entrances.

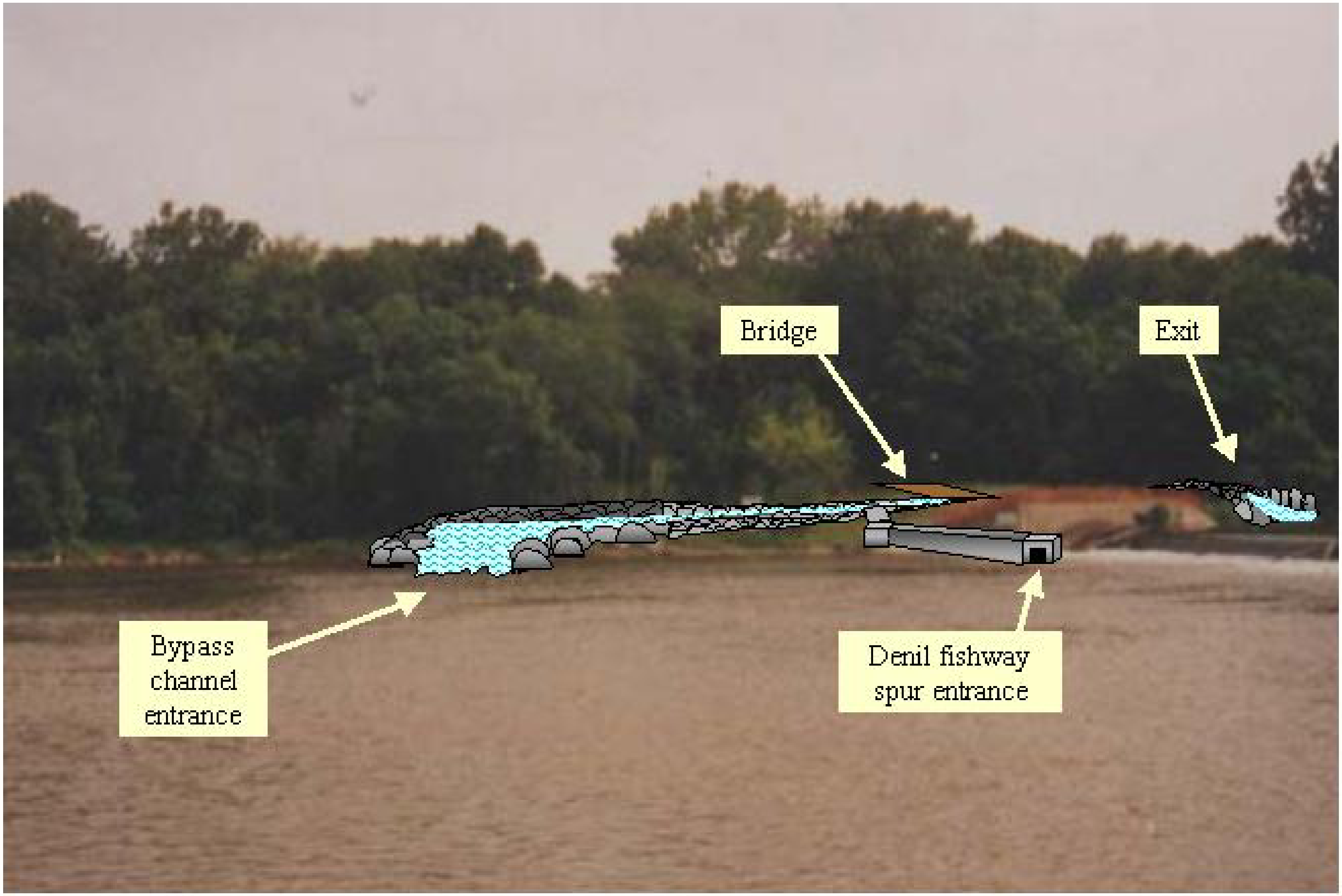
Estimated costs: One Denil fishway at the Yorkville Dam is estimated to cost about $270,000 as a stand-alone project. This estimate would double if a second fishway were built.

YORKVILLE DAM – Plan View – Conceptual Plans for North Bank Bypass Channel and Fishway Spur.

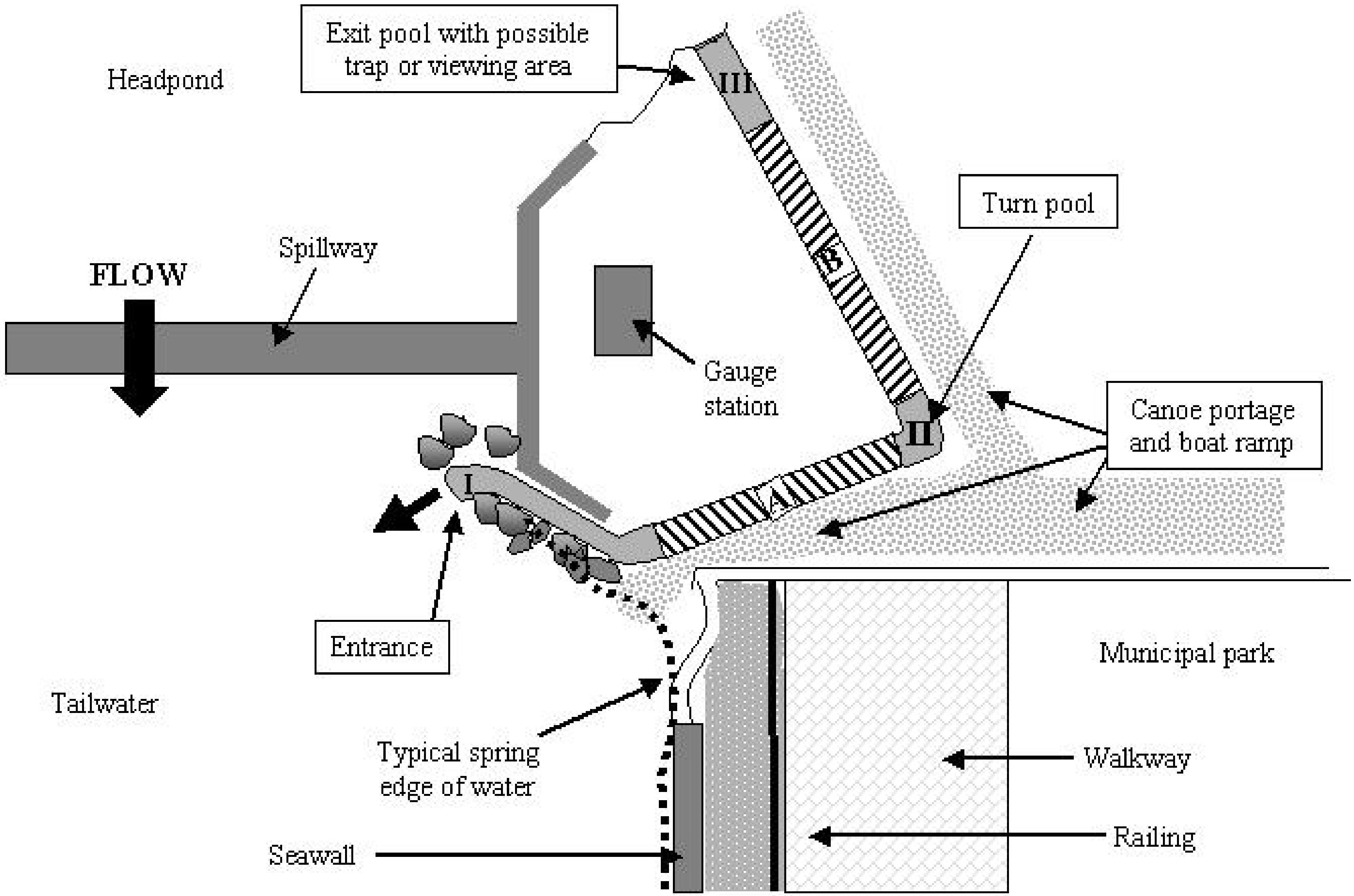
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



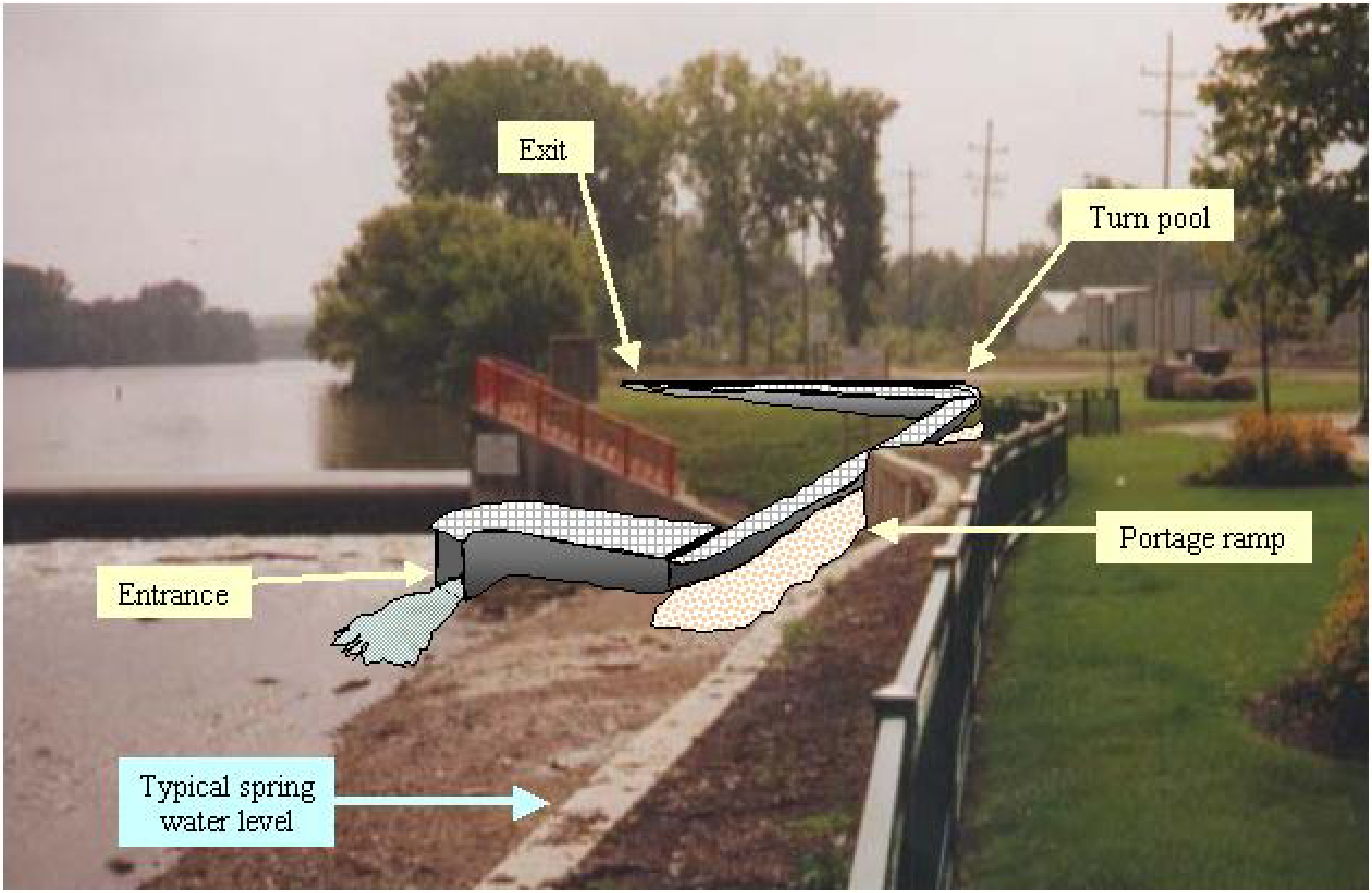
YORKVILLE DAM – Depiction of a Bypass Channel and Fishway Spur on North End of Spillway.



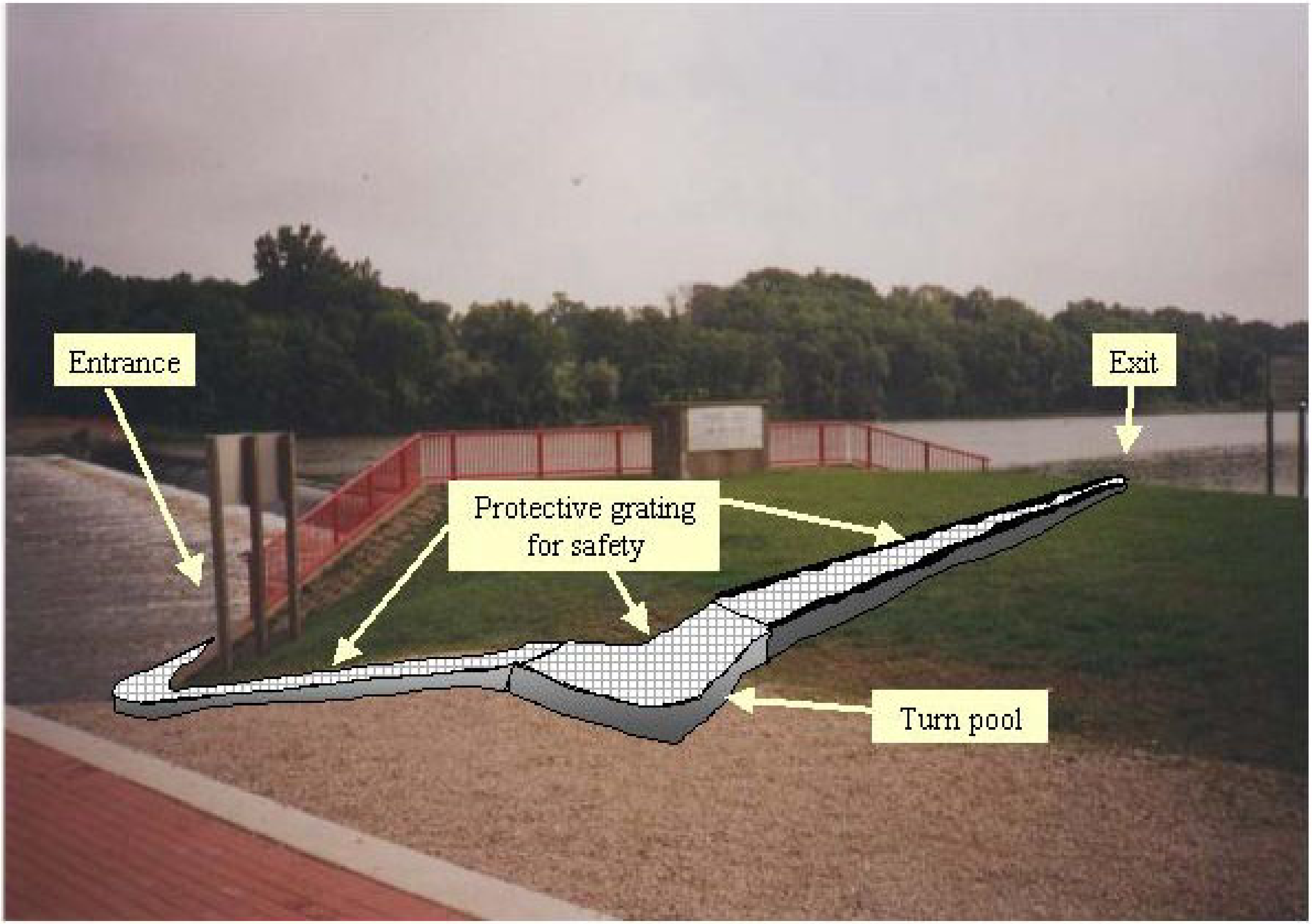
YORKVILLE DAM – Plan View – Conceptual Plans for a South Bank Denil Fishway.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



YORKVILLE DAM – Depiction of a South Bank Denil Fishway Looking Upstream.

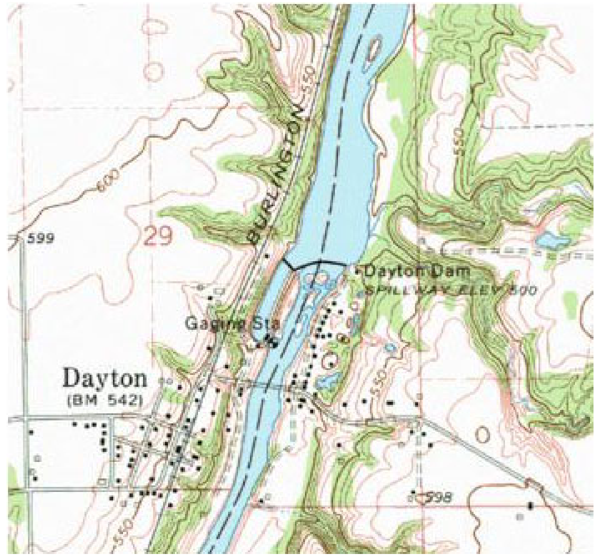


YORKVILLE DAM – Depiction of a South Bank Denil Fishway Looking North.



DAYTON DAM

LOCATION



Latitude-longitude (NAD 83): 41.3900063˚N 88.7876156˚W
Legal: T34N R4E S29SE
Town: Dayton, IL
River mile: 5.7
Comments: Less than a mile upstream of the I-80 Bridge.
Next downstream dam (distance): None (first dam on river)
Next upstream dam (distance): Yorkville Dam (30.8 miles)

DESCRIPTION

Height: 29.6 ft.
Spillway elevation: 498.8 ft.
Length: 600 ft.
Dam type: Ogee
Material: Concrete
Nature of barrier to fish: Complete
Construction date: Uncertain (~1925)
Condition of dam: Unknown, but assumed to be good.
Length of impoundment: 4 miles
Appurtenances: A power canal that is about 800 ft. long, a hydroelectric powerhouse at downstream end of canal, and a gate of unknown purpose or design at eastern end of spillway.

LEGAL/SOCIAL ASPECTS

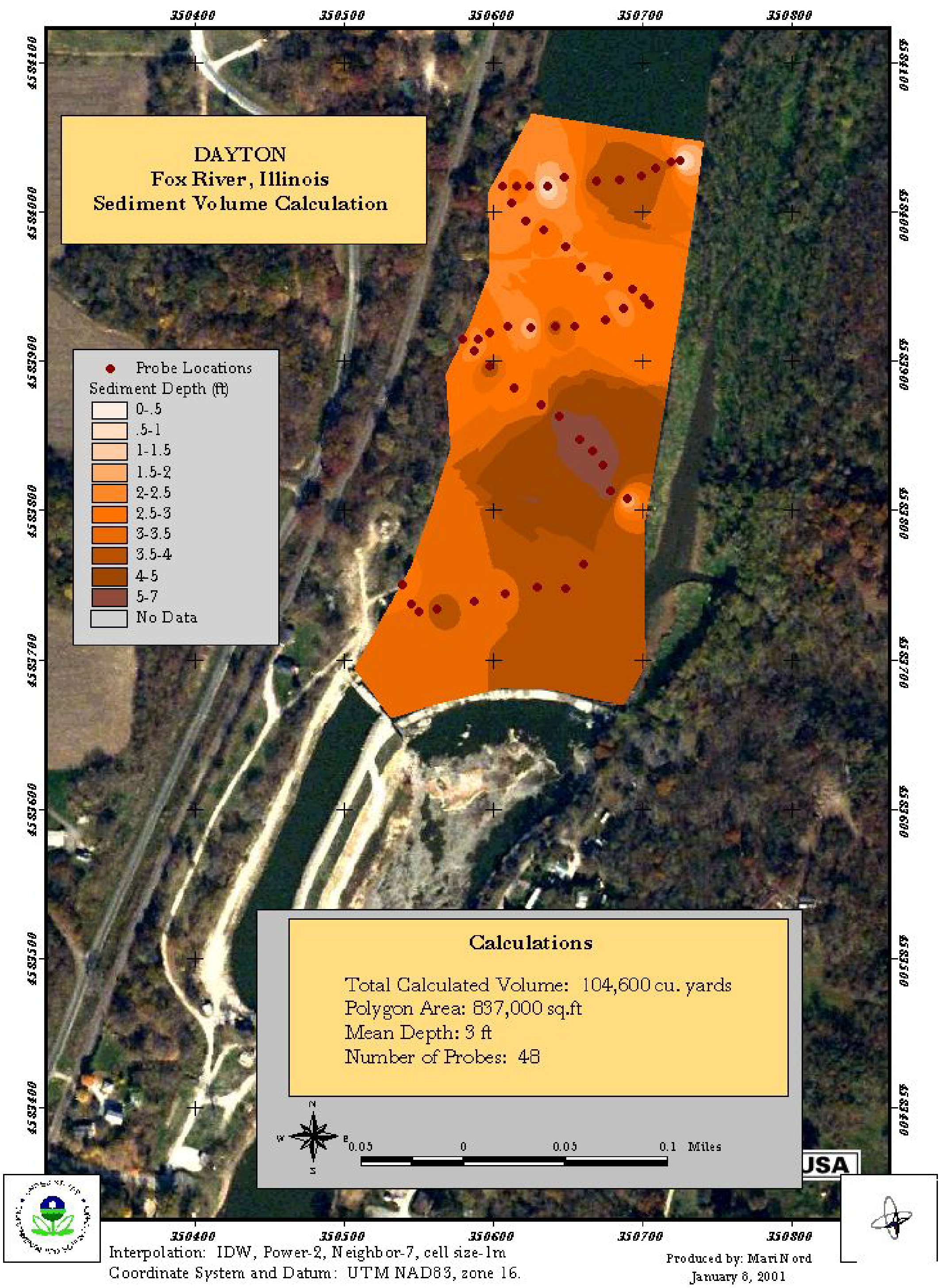
Owner: Midwest Hydro, Inc.
Owner of adjoining land: Midwest Hydro, Inc.
Present day purpose of dam: Hydroelectric generation
Uses of impoundment: Uncertain

SEDIMENT ACCUMULATION BEHIND DAM

Quantity: 104,600 cu. yds. Note that this is likely an underestimate because the impoundment has filled with sand to the point where maximum water depths were <8 ft.

Sediment quality: No contaminant levels of concern in three core and three surface samples. See Appendix E for station specific sediment data.

Distribution: See map below.



BIOLOGICAL RESOURCES

Ten fish species collected below the dam are absent from the rest of the Fox River drainage in Illinois. No endangered or threatened organisms sampled in river segments above or below dam. See Appendix A and B for station specific fish and macroinvertebrate taxa.

FISH PASSAGE CONSIDERATIONS

DAM REMOVAL

Advantages:

- Allow full, unrestricted passage of all species and sizes of fish at the site.
- Reconnect the Fox River to the Illinois River.
- Improve habitat and water quality and realize associated benefits to ecosystem.
- Restore the free-flowing, natural river and all associated dynamics.
- Eliminate an obstacle to recreational paddlers and the need for a portage.
- Eliminate the need to maintain a costly facility for many years to come.
- Re-expose the natural series of rapids that occurred before the dam was built. The rapids occurred in the section of river now inundated by the Dayton Dam impoundment. The river dropped at a rate of about 19 ft. in 1.25 miles to form the rapids (Alexander and McCurdy 1915). If the dam were removed this area might provide an interesting stretch of whitewater for area canoeists and kayakers.
- Re-expose natural sandstone bluffs and formations now inundated by the Dayton Dam impoundment.

Disadvantages:

- Reduce pool size for recreational power boating.
- Upset upstream waterfront property and boat owners.
- Eliminate the hydroelectric company. It is unlikely that this project contributes significant power to the electrical power grid for public benefit but it probably affords a few investors some profit.
- Requires dealing with large quantity of sand in the impoundment.

The last disadvantage point might be dealt with in two ways. Sand could be dredged from the impoundment and sold as a commodity, although it is not known if any profit could be gained from such an operation. A second option would be to lower the dam in stages and let the river gradually carry the sand downstream as part of its bed load during high water events.

BYPASS CHANNEL

Steep topography and the location of the hydroelectric plant do not lend themselves to a bypass channel at this site. At a slope of 1:30, the bypass would be about 900 ft. long and require more land than is available between the spillway and the powerhouse. Switch-backing the 30 ft. wide channel along the power canal dike also is not feasible due to space restrictions and the possibility of compromising the structural integrity of the dike. A bypass channel might be fitted inside the power canal if the plant were de-commissioned, the canal drained, the dike breached, and the powerhouse razed. However, removing the dam is a far more preferable option should the plant license ever be forfeited. We mention this bypass option in the unlikely event that the plant was de-commissioned, but some factor such as contaminated sediments or high project cost prevented the dam from being removed.

DENIL FISHWAY

Advantages:

- Allows the dam to remain, if the continued production of hydroelectricity is considered beneficial.
- Will pass most targeted species of fish.
- Will allow IDNR to monitor and study fish populations in the lower Fox River.
- If opened to the public, could support considerable public goodwill to the dam owner and tourism for the community, which is close to an I-80 exit. There are very few fishways in the Midwest and none that we know of with a public viewing window.

Disadvantages:

- Will pass fewer numbers and less variety of fish species and life stages than removing the dam.
- Represents a facility that will need operation and maintenance into the future.
- The dam remains, with all of its negative ecological impacts.
- High cost for design and construction.

Any fish passage project at this site (other than dam removal) must include a tailrace entrance near the powerhouse and a spillway entrance in order to pass fish that inevitably will congregate at each location. We propose a 1:15 slope Denil fishway located along the west side of the river between the dam and powerhouse tailrace. The fishway will consist of six baffled ramps, four resting pools, two entrance pools, and an exit pool.

I - The tailrace entrance will be located at the training wall of the tailrace, upstream of the powerhouse. It will collect fish that congregate in the tailrace of the power canal, having been attracted by the steady flow of water emanating from the turbines of the powerhouse. The entrance pool may be 20 to 30 ft. long and will have additional attraction water added to it via a pipe from the power canal and screened floor diffusion panels (to create an upwelling flow in the pool).

A - The first ramp of baffles extends north along the base of the power canal dike for about 120 ft.

II - The first resting pool is 20 ft. long and about 8 ft. above the normal river water level.

B - The second run of baffles continues north along the dike for about 120 ft.

III - The second resting pool is about 50 ft. long and it also acts as a junction pool for the spillway spur of the fishway. This pool is about 16 ft. above normal river level. As both lower fishway sections require about 20 cfs of flow, additional make-up water will need to be added through a pipe from the power canal to the junction pool and screened floor diffusion panels. The pool will receive 20 cfs from the upper portion of the fishway and 20 cfs from the power canal and will distribute 20 cfs of flow to each of the lower fishway sections.

C - The third run of baffles continues north along the dike for about 120 ft.

IV - The third resting pool is about 20 ft. long and located about 24 ft. above river level.

D - The fourth run of baffles continues north along the dike for about 120 ft.

V - The exit pool is between 20 and 30 ft. long and extends through the earthen dam to join the headpond. This exit pool will have gates to control the flow of water down the fishway and will be large enough to accommodate a fish trap.

VI - The entrance to the spillway spur of the fishway is located in the extreme western corner of the spillway. It will have additional attraction water piped to it from the headpond and added via screened bottom diffusion panels. This spur will attract fish that overshoot the powerhouse (particularly during times of high flow when there is a lot of water spilling over the dam) and end up at the base of the spillway. The entrance pool is 20 to 30 ft. long.

E - The lowermost ramp of Denil baffles for the spur extends southerly along the base of the power canal dike for 120 ft.

VII - The spur resting pool is 20 ft. long and located at an elevation of 8 ft. above river level.

F - The second ramp of Denil baffles for the spur extends southerly along the side of the power canal dike and connects to the northeast corner of the junction pool described above. The lower section of powerhouse fishway connects to the south end of the junction pool and upper section connects to the northwest corner.

Estimated costs: A Denil fishway at the Dayton Dam is estimated to cost about $2,000,000.

FISH ELEVATOR

Advantages:

- Allows the dam to remain, if the continued production of hydroelectricity is considered beneficial.
- Will pass most targeted species of fish.
- Will allow the natural resource agency to monitor and study fish populations.
- If opened to the public, could support considerable public goodwill toward the dam owner and some tourism for the community, which is close to an I-80 exit. There are very few fishways in the Midwest and even fewer with public viewing window.

- May save money over the Denil option but the costs would have to be carefully researched.

Disadvantages:

- Will pass fewer numbers and less variety of fish species and life stages than removing the dam.
- Represents a facility that will need operation and maintenance into the future.
- The dam remains, with all of its negative ecological impacts.
- High cost for design and construction.

Fish elevators, also referred to as 'fish lifts,' are commonly employed on East Coast rivers that support runs of American shad and river herring. These species often do not effectively use other styles of fishways that are often needed at hydroelectric dams but they will use fish lifts. Fish are attracted to the entrance of the lift just as they are attracted to the entrance of other fishways, which is by strong flows of water issuing out of the fishway entrance. Once inside, the fish pass through a V-gate that effectively prevents them from going back out the entrance. At some interval, a mechanical crowding fence pushes all of the accumulated fish into a constricted area, under which lies the submerged lifting bucket, or 'hopper.' The hopper is raised by means of cables and an overhead motor and it picks up all of the trapped fish along with 500 to 900 gallons of water. It takes the motor about 5 minutes to raise the hopper to the level of the headpond and upon reaching that level, a gate is tripped that discharges the contents of the hopper into a concrete exit pool, or 'flume'. The dumped fish swim out of the flume (often past an optional viewing window or trap) and enter the headpond and continue their migration upstream. The motor then lowers the hopper back into its starting position, the crowding fence is reset and the entrance is reopened and more fish begin to enter for the next cycle. The lifting interval depends upon the amount of fish below the dam. During the peak of the season, it may lift once every ten minutes. During the off-season it may lift once an hour or once a day. Lift cycles can be triggered manually by a human operator or automatically by a computer.

Fish lifts are often built at sites if there is no room for a traditional fishway, such as a Denil, or if cost savings can be realized. Typically, a fish lift is more expensive than a Denil fishway. However, in the case of the Dayton Dam, a Denil fishway is very long and requires lots of concrete and expensive construction access. It may be possible that fish lifts would be cheaper, if they can be adapted to the existing situation. There would have to be two lifts--one at the powerhouse and one at the spillway. Following is a description of the only likely application of this technology at this location.

A powerhouse fish lift requires excavation of a foundation at the north end of the powerhouse, just north of the existing training wall of the tailrace. The lift entrance is located at the same place as the proposed fishway entrance. Fish attracted to flow from the turbines would be subsequently attracted to the flow issuing from the entrance of the fish lift. Fish collected in the hopper are lifted to an elevation about 2 ft. above the water level of the power canal, after which they are discharged into an exit flume that would be a concrete structure that passes along the north wall of the powerhouse and enters the power canal. Construction access could come from the gatehouse end of the canal. A viewing window and fish trap could easily be incorporated in the exit flume.

The entrance to a spillway lift is located at the same place as the proposed fishway spur entrance. Fish collected in this hopper are lifted up over the top of the west abutment wall of the spillway and discharged into a concrete exit flume. The exit flume would pass through the earthen dam and into the headpond. Like the powerhouse lift, construction access could come from the gatehouse end of the canal and viewing windows and traps could be incorporated to monitor runs.

Estimated costs: Unknown.

ADDITIONAL COMMENTS

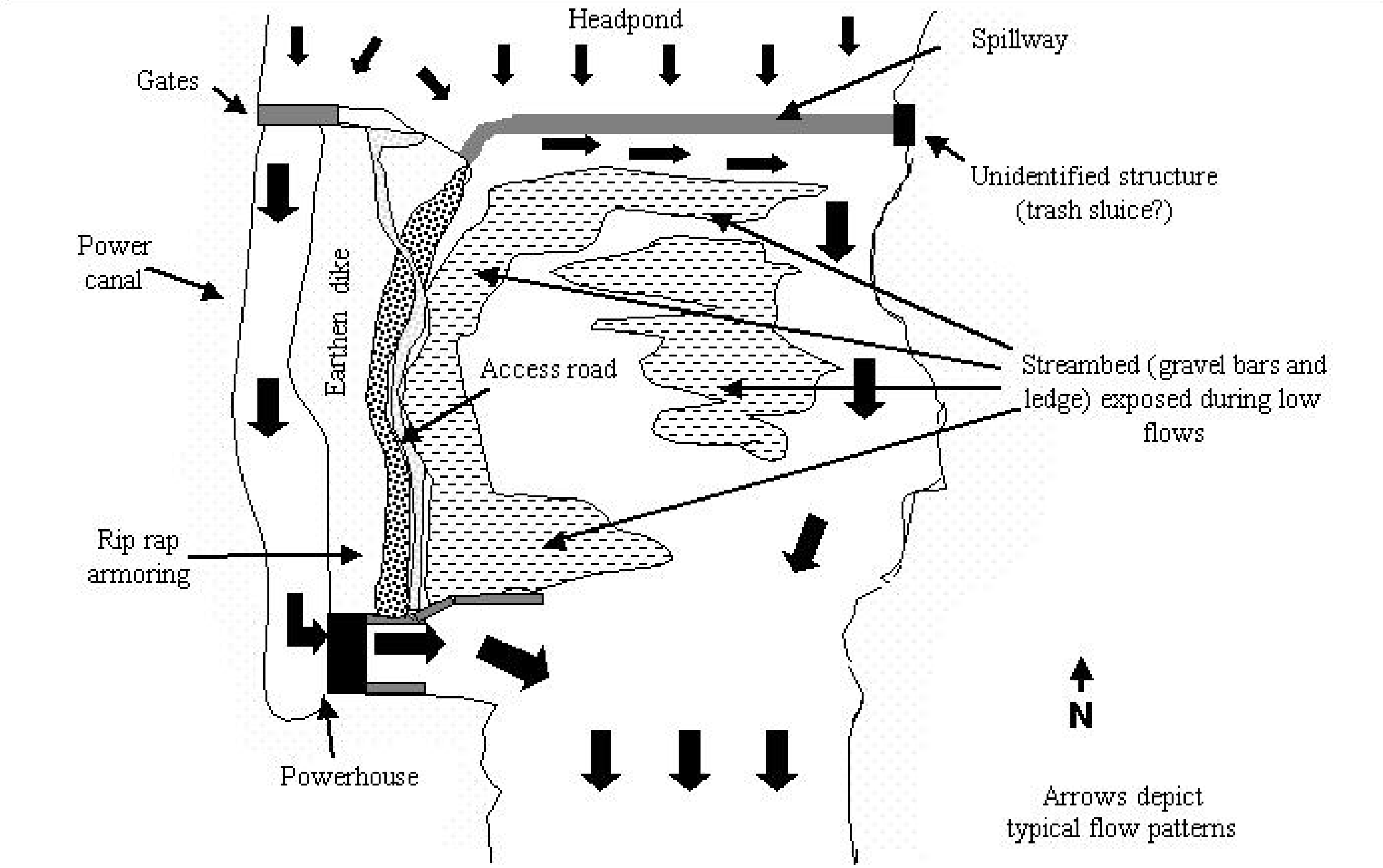
In many respects, the Dayton Dam represents the most critical barrier to fish migration on the Fox River. There is a much larger fish community in the Illinois River, both in terms of the total number of fish and the total number and variety of fish species. Many of those species are not present in the Fox River above the Dayton Dam but still run to the base of the dam. Clearly, the dam is limiting fish biodiversity, fish abundance, and sport fishing opportunities in the Fox River. Furthermore, the river upstream of the Dayton Dam is the longest undammed stretch of the entire river in Illinois. This upstream section also is undeveloped, relatively unpolluted, and holds high quality fish habitat. Illinois River fish certainly would benefit from access to such high quality habitat. In addition, a project to get fish around the next dam at Yorkville would provide access to the second longest free-flowing stretch of river and bring runs of game fish such as sauger, walleye, white bass, and skipjack herring to the edge of Aurora, the largest population center in the Fox Valley.

The Dayton Dam is unique among Fox River dams in that it is the only dam that is used for hydroelectric generation. This raises a number of issues not relevant to the other dams on the river. Foremost is the manner in which it is regulated. The Federal Energy Regulatory Commission (FERC) must license most hydroelectric dams in the U.S. Dayton Dam is licensed to Midwest Hydro, Inc. (License No. 207). The FERC has the ability to place conditions upon its licenses. Beginning in the 1940s, the FERC issued long licenses, such as 50 years. In the 1940s, there was very little environmental awareness and recognition for the needs of aquatic life or recreation so that the FERC did not place many conditions upon these licenses. However, many old licenses came up for renewal in the 1990s, a time when the public was much more conscious of the environmental needs of rivers. There was a growing public recognition of the legal fact that the hydroelectric companies do not own the rivers, the water, or the fish therein. In the United States, these resources are owned by the public and managed in trust for it by the government, specifically state and federal natural resource agencies such as the Illinois Department of Natural Resources and the U.S. Fish & Wildlife Service. When it was shown that hydroelectric company projects were damaging these public trust resources, Congress instructed the FERC to take these things into account when issuing its licenses. Accordingly, the FERC now commonly mandates licensees to provide fish passage around dams if the owner is to retain a license to sell electricity. If the licensee refuses to do so, they surrender their license. The FERC's decision on whether or not to mandate such actions often depends upon the recommendations of the U.S. Fish & Wildlife Service and state natural resource agencies. These agencies base their recommendation to the FERC on studies, data, professional judgment of the ecological impact of the hydroelectric project on fish communities, and public opinion. There are hundreds of fishways operating at hydroelectric dams in the northeastern and western U.S. due to FERC orders, and more are being ordered every year. There is no reason why this cannot happen in Illinois.

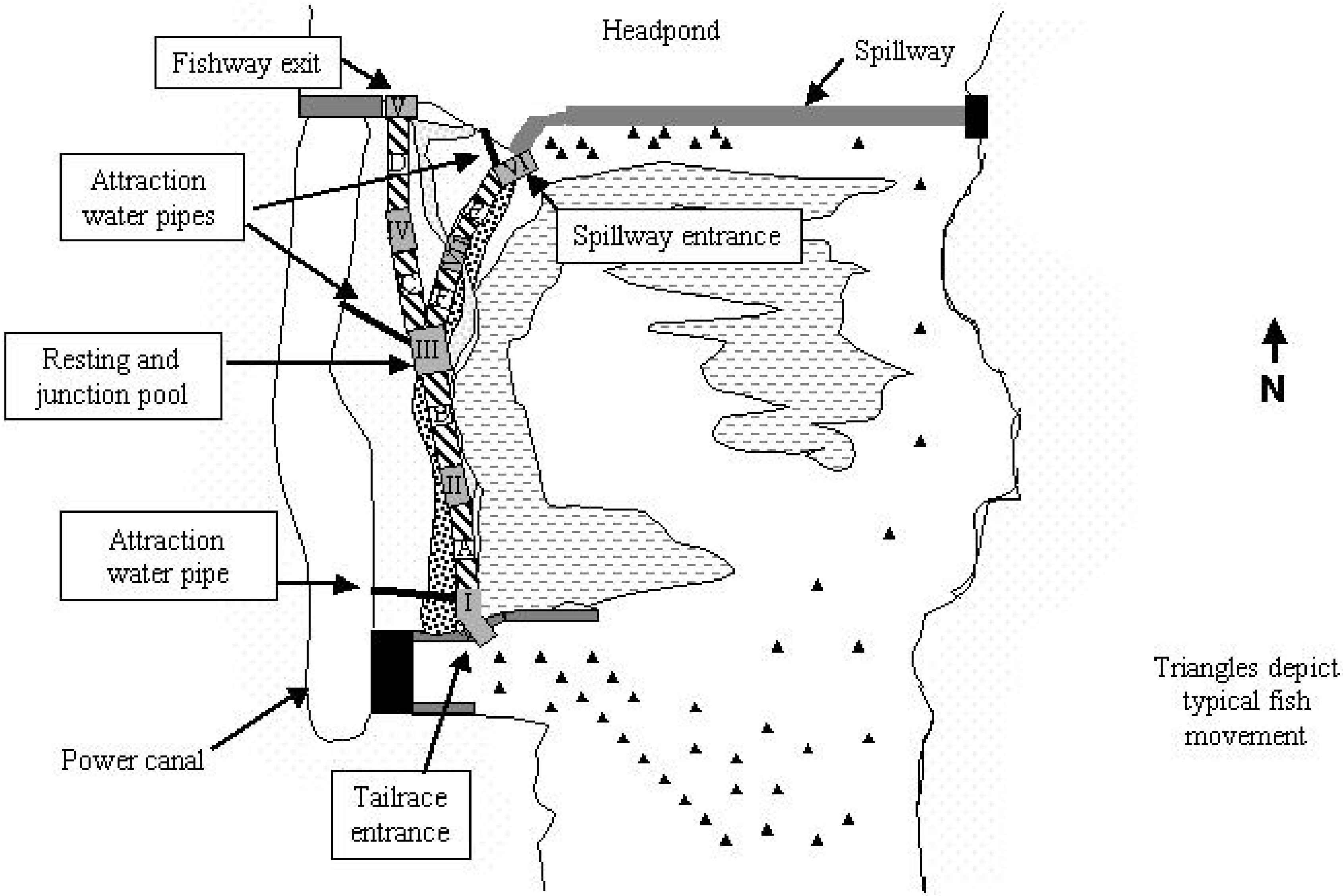
It is beyond the scope of this report to determine or recommend whether or not the agencies should provide a fishway prescription to the FERC for the Dayton Dam. However, an objective of this report is to advise river users of the potential for fish passage at all Fox River dams. We have included the brief regulatory discussion above because many Illinois residents may not be familiar with the FERC and its regulatory powers due to the paucity of hydroelectric dams in the state. Readers who wish to learn more about the FERC licensing process can contact IDNR, U.S. Fish & Wildlife Service, or knowledgeable non-governmental organizations, such as American Rivers of Washington, D.C.

DAYTON DAM – Plan View – Existing Conditions.

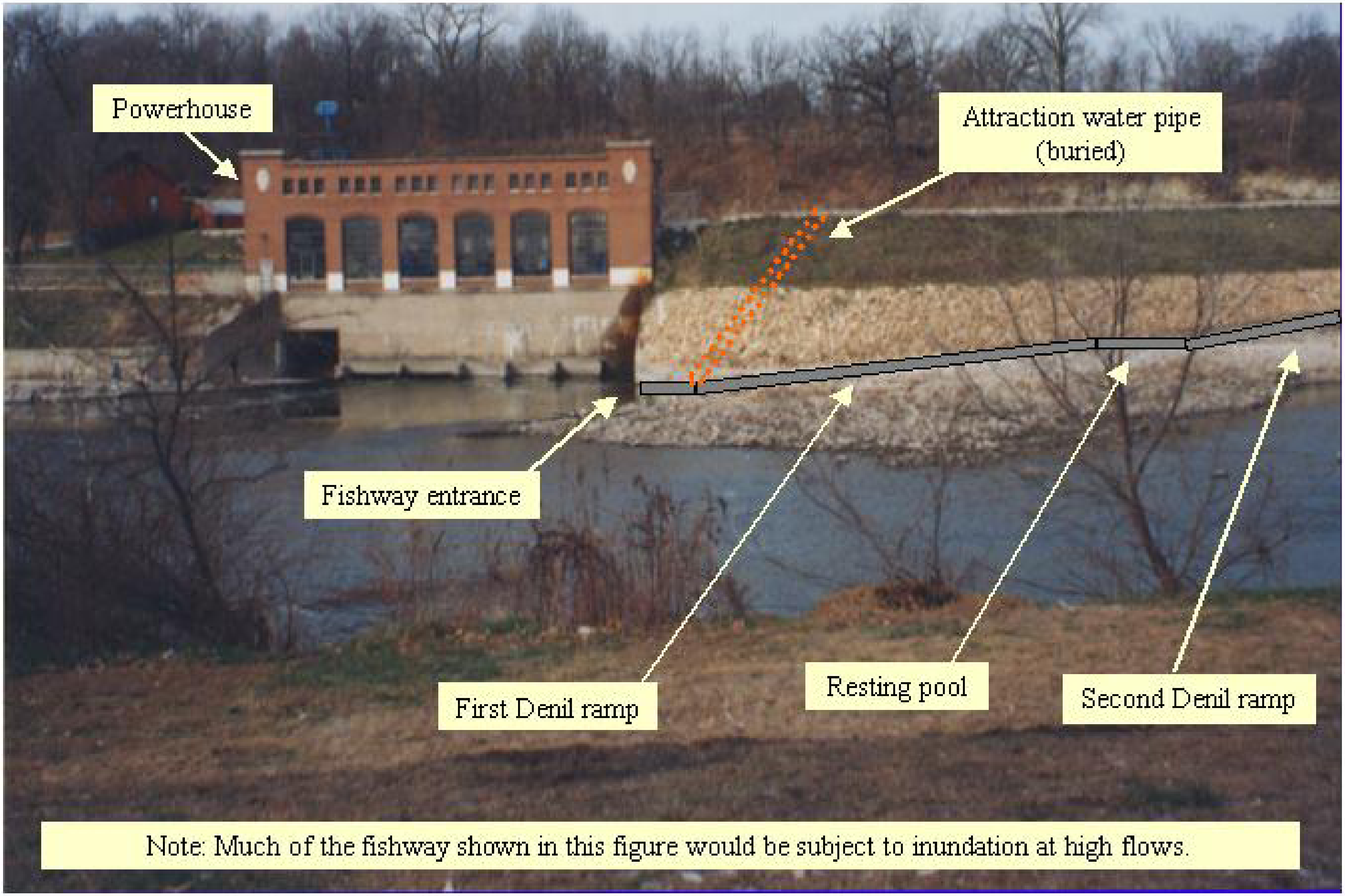
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



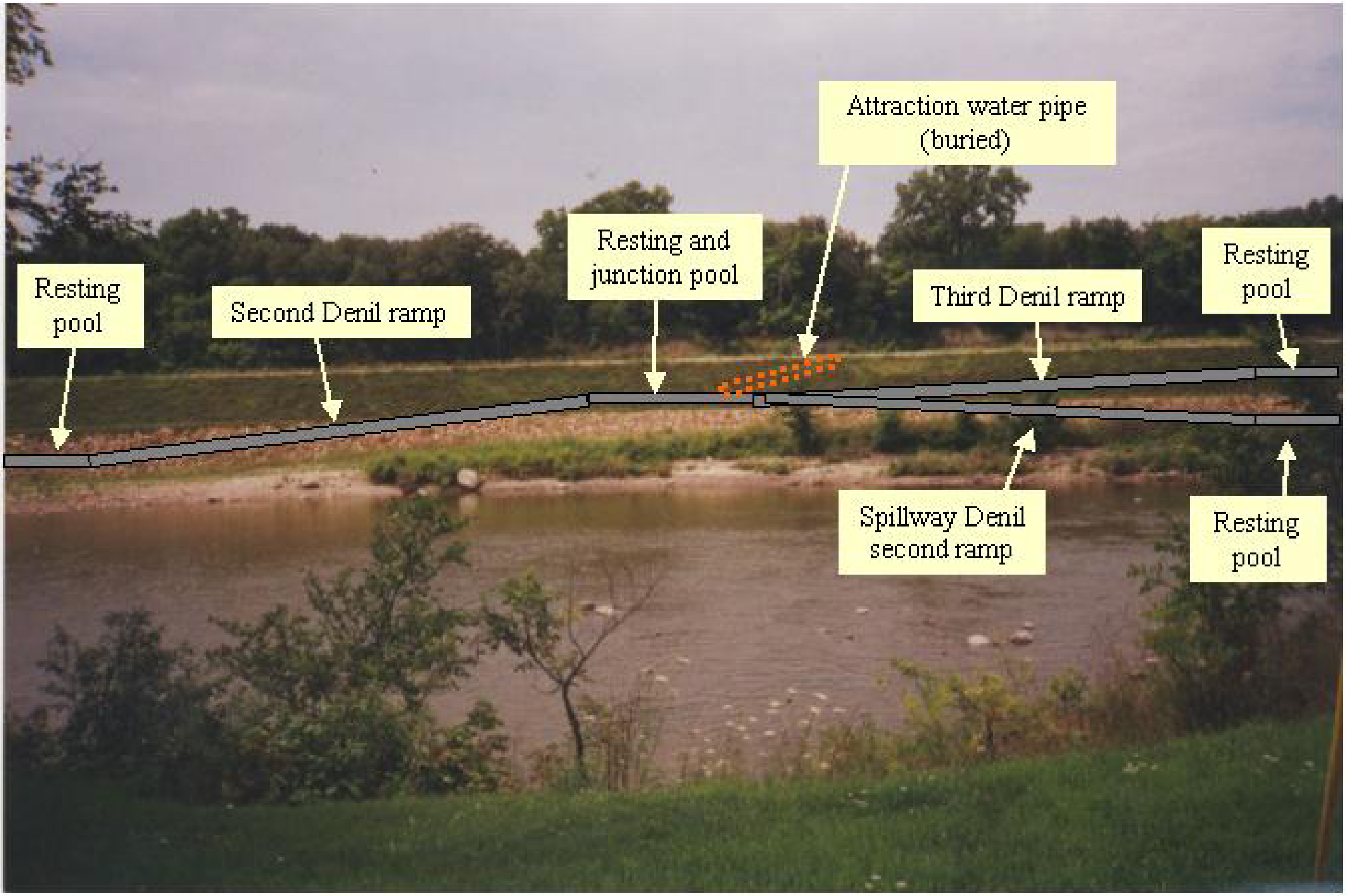
DAYTON DAM – Plan View – Conceptual Plans for a Denil Fishway on the West Bank.
Stephen Gephard, Consultant, Max McGraw Wildlife Foundation – Not a licensed engineer, not suitable for construction. NOT TO SCALE.



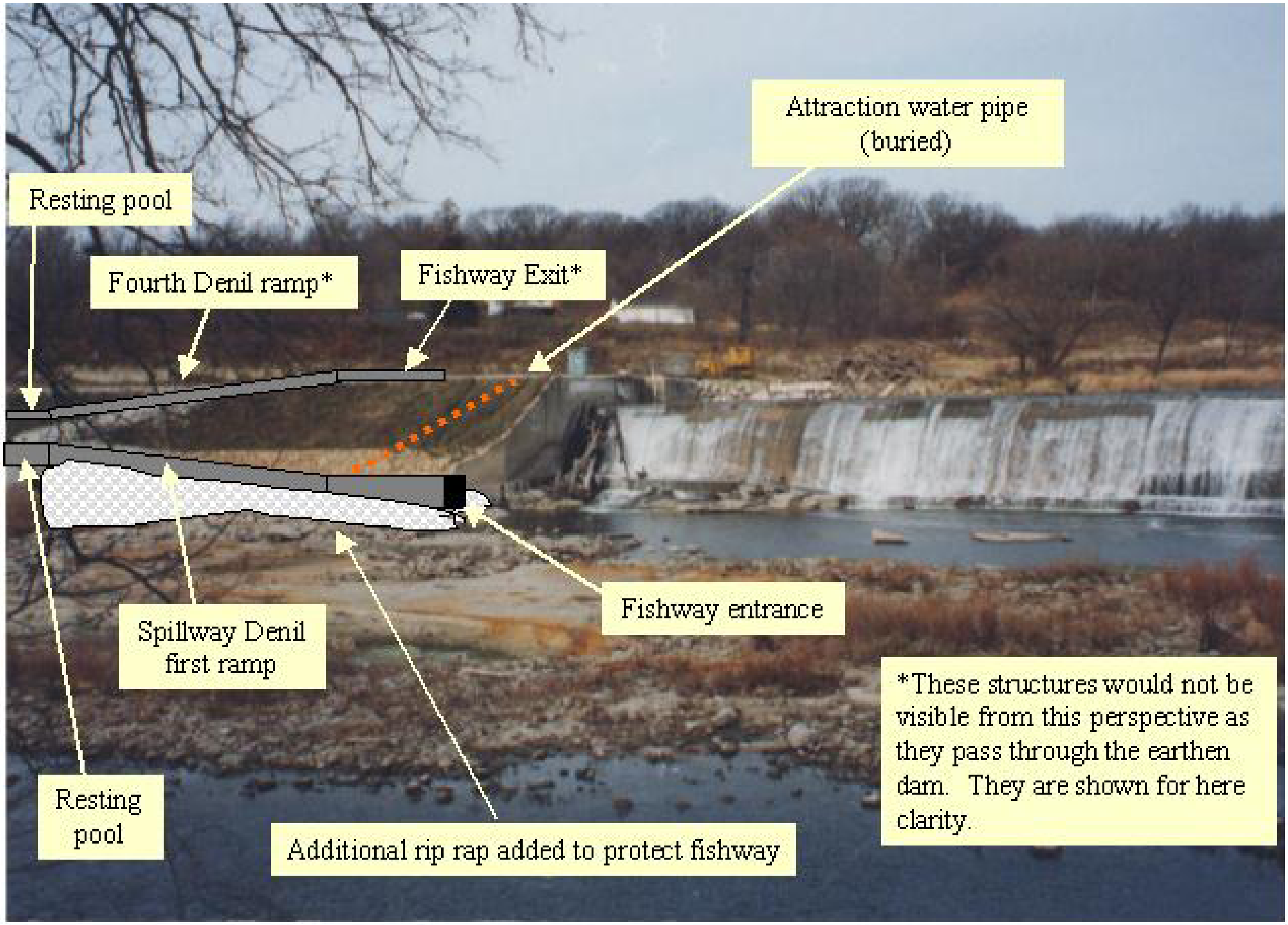
DAYTON DAM – Depiction of Downstream End of Denil Fishway.



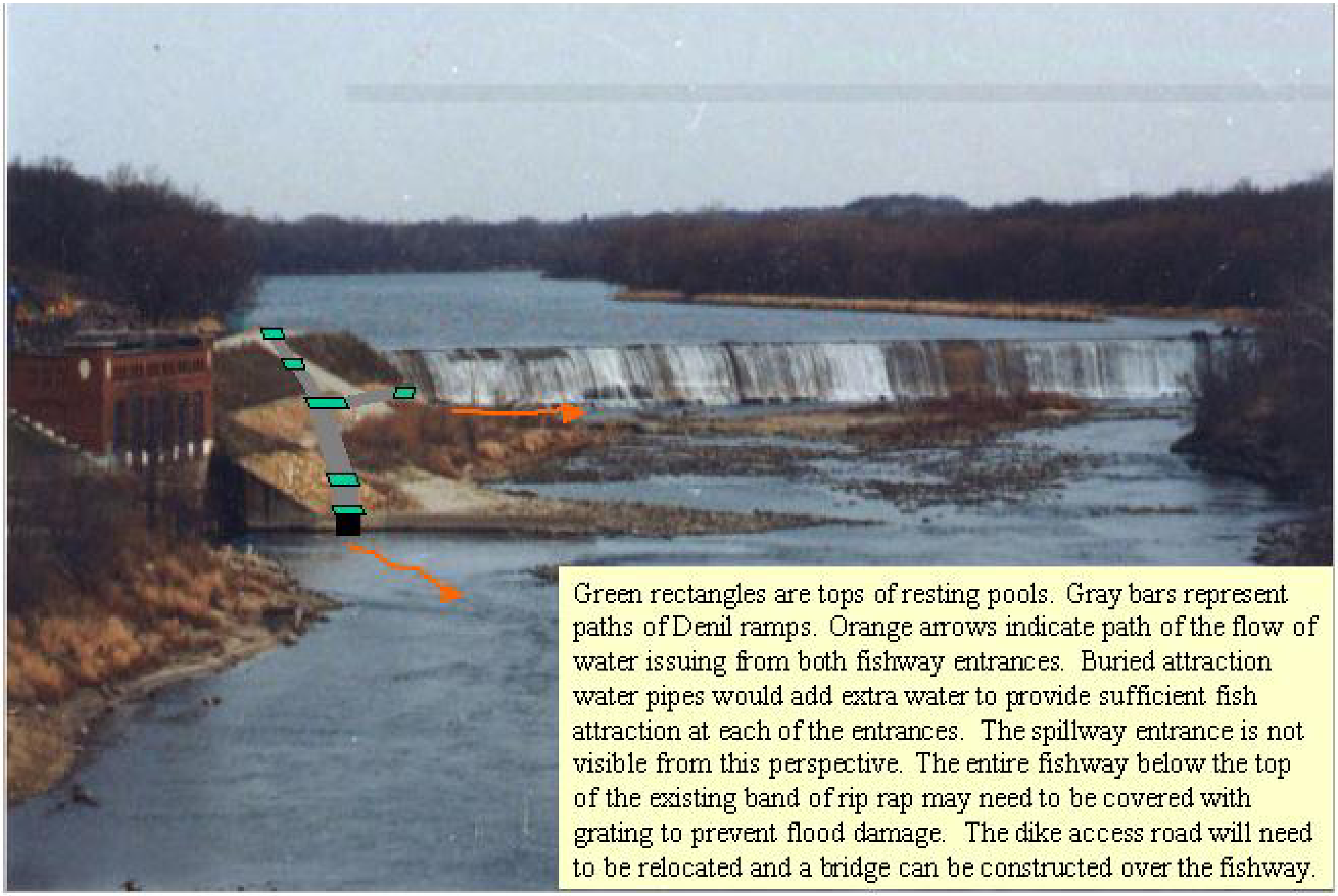
DAYTON DAM – Depiction of Middle Portion of Denil Fishway.



DAYTON DAM – Depiction of Upstream End of Denil Fishway.



DAYTON DAM – Depiction of Denil Fishway Looking Upstream.

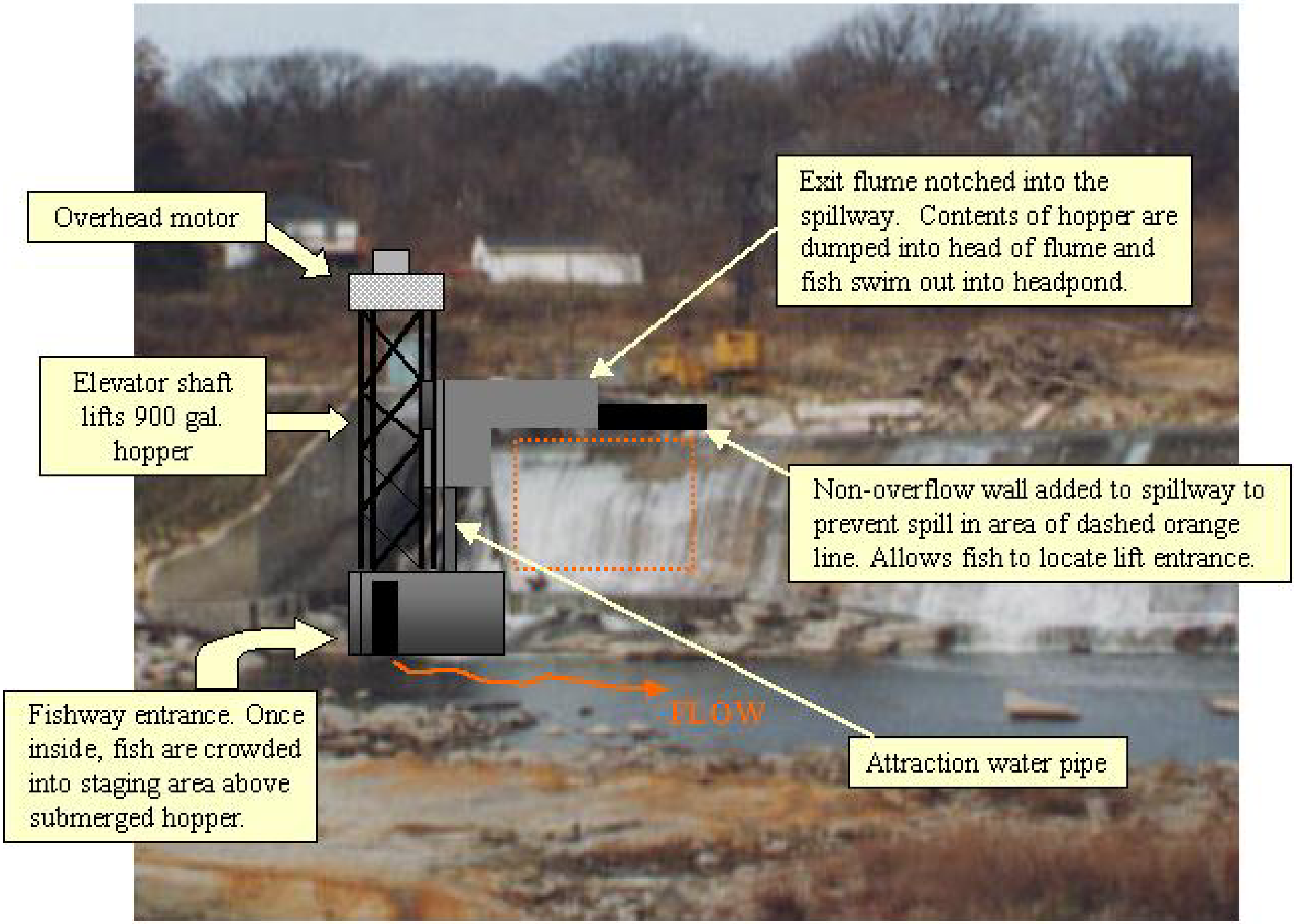


Green rectangles are tops of resting pools. Gray bars represent paths of Denil ramps. Orange arrows indicate path of the flow of water issuing from both fishway entrances. Buried attraction water pipes would add extra water to provide sufficient fish attraction at each of the entrances. The spillway entrance is not visible from this perspective. The entire fishway below the top of the existing band of rip rap may need to be covered with grating to prevent flood damage. The dike access road will need to be relocated and a bridge can be constructed over the fishway.

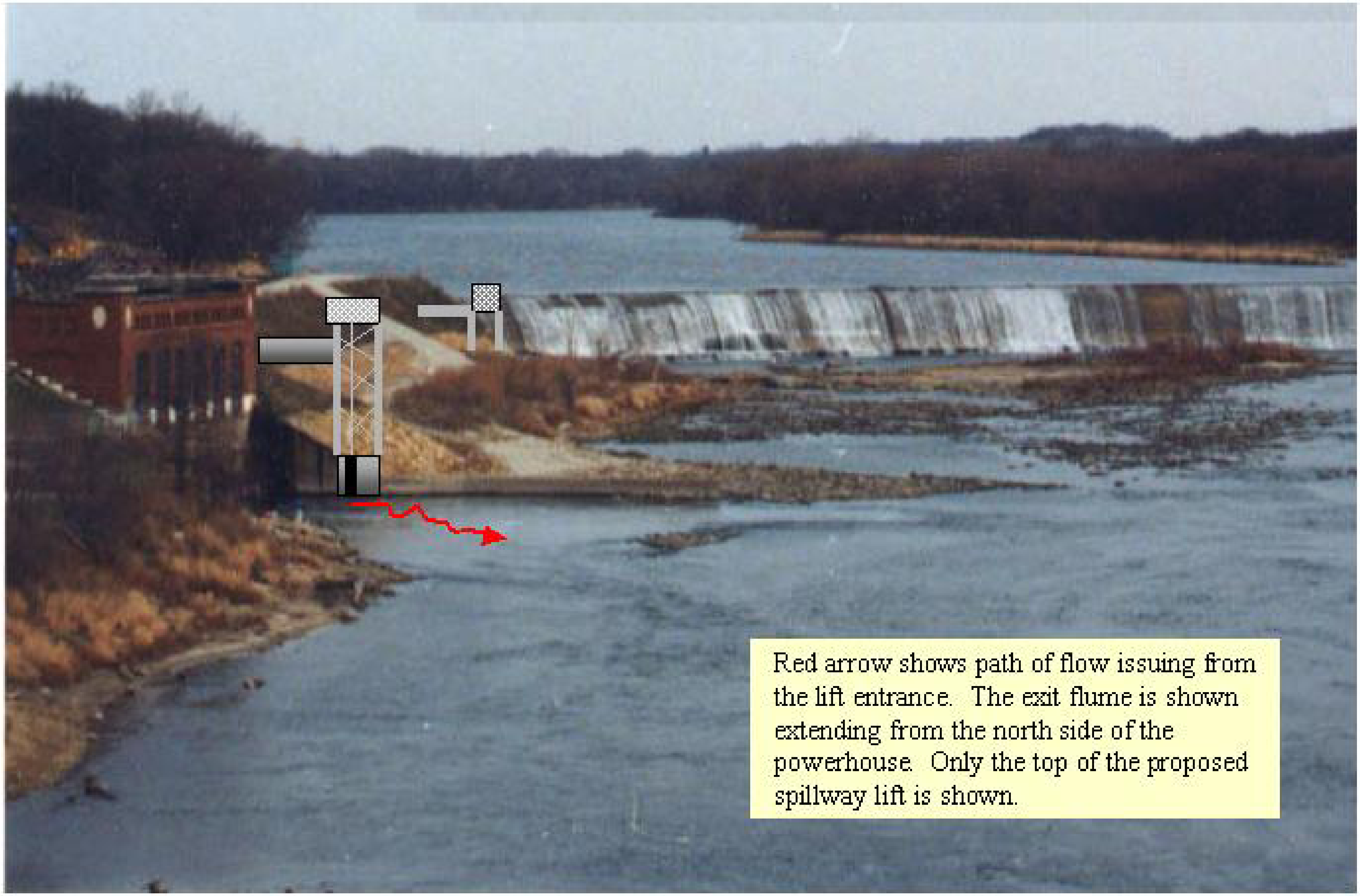
DAYTON DAM – Depiction of a Tailrace Fish Lift.

The entrance is built at toe of the dike behind the training wall. Flow (blue arrow) enters tailrace. The hopper is lifted up an elevator shaft (orange) located east of the powerhouse and discharges into an exit flume (end shown as yellow) that runs east to west to the power canal just north of the powerhouse.

DAYTON DAM – Depiction of Fish Lift at West End of Spillway.



DAYTON DAM – Depiction of Tailrace and Spillway Fish Lifts.



SUMMARY OF OPTIONS FOR ALL MAINSTEM DAMS

Below is a summary table of recommended options presented previously for each of the 15 Fox River dams (Table 35). In many cases, we present more than one option for an individual dam to assist stakeholders in making an informed decision regarding their dam. It must again be emphasized that this study did not take a multi-discipline approach to the subject of dams on the river. No comprehensive effort has been made to analyze the public's attitude toward these dams, the recreational use of the impoundments, or economic impacts of removing the dams. Only cursory cost estimates of fish passage options have been provided, when possible. We focused on the environmental effects of the dams and the impacts they have on the river ecosystem. The analyses of the environmental data lead to clear conclusions: (1) the dams degrade the riverine ecosystem, (2) the dams diminish the river's biodiversity, particularly with respect to the fish and freshwater mussel communities, (3) the river and its biota would be healthier if the dams were gone, (4) if the dams remain in place, the fish population would be healthier if fishways were provided to allow fish to move freely up and down the river.

We recommend consideration of removal of 12 of the 15 dams. Dam removal is the best option when the ecological health of the river is important because removing dams will eliminate barriers to migration for all types and sizes of fish, restore high quality river habitat, and improve water quality. In addition, dam removal is relatively inexpensive compared to other options presented and it eliminates safety risks (people drown at dams) and maintenance costs because the structure is gone. It is neither logistically or financially practical to pursue remedial actions at all dams concurrently. However, if a few dams are removed in the next few years, the greater community will gain experience both in the technique and process to accomplish the task and what it is like to live alongside of a free-flowing river. Many preconceived fears such as the myth of perpetual mudflats, increased flooding, and loss of flow will be dispelled. In that way, support can slowly grow for removing additional dams.

Some dams pose greater challenges than others for removal and it is not realistic to expect that the public will support removal of all dams. Therefore, the 'next-best-option' for improving the river and its fish community is the construction of Denil fishways or bypass channels. It seems unlikely that any segment of the public is opposed to improving the numbers, diversity, and health of the fish community. Fishways cannot do the job as well as dam removal but they can help make substantial improvements. We have identified Denil fishways as a possible option for 11 dams and bypass channels for seven dams (Table 35).

TRIBUTARY DAMS

Fox River tributary streams possess quantities and qualities of habitat that are important to fish in the river. People who care about the river should not focus their attention entirely on the mainstem Fox River. The Fox River, its tributaries, and the surrounding land that the river drains are a functioning watershed. Historically, fish made use of all available habitat in the drainage but that opportunity is currently limited by the presence of dams; dams not just on the mainstem but also on the tributaries. A comprehensive approach to the issue of dams on the Fox

Table 35. Summary of options for a reconnected Fox River.

Dam	Current use	Dam removal	Bypass channel	Denil fishway	Comments
Stratton Dam	Water control Recreation			X	Removal not practical. New or revamped fishway at site of old non-functioning fishway.
Algonquin Dam	Water control Recreation			X	Removal not practical. Plenty of room on west bank for a Denil fishway. Portage difficult.
Carpentersville Dam	None	X	X	X	Old dam. Good candidate for removal or a bypass channel.
Elgin Dam	Water supply	X		X	Removal may be possible with new upstream dam. Portage difficult.
South Elgin Dam	None	X	X	X	Plenty of room and good scenic qualities for a bypass channel.
St. Charles Dam	Recreation			X	Removal not practical. Not many options due to lack of riverfront open space and bridge.
Geneva Dam	None	X	X	X	Bypass channel very disruptive.
North Batavia Dam	None	X			Dam in bad shape. Good candidate for removal.
South Batavia Dam	None	X			Dam in bad shape. Good candidate for removal. May be some water supply issues.
North Aurora Dam	None	X	X	X	Bypass channel ties in with the old mill tailrace. Parkland created if dam removed.
Stolp Island Dam	Riverboat casino Recreation	X	X (W)	X (E)	Improve passage at canoe chute for the west spillway. Denil fishway at east spillway.
Hurd's Island Dam	None	X			Too low to consider anything else.
Montgomery Dam	None	X	X		Good location for a bypass channel if dam remains.
Yorkville Dam	None	X	X	X	North bank bypass and south bank fishway needed for effective fish passage.
Dayton Dam	Hydroelectric	X		X	FERC re-licensing in 2004. Important barrier to fish migration. Portage difficult.

River must include these tributary dams but that is beyond the scope of this report. However, three tributaries are discussed briefly below as examples.

Mill Creek at Mooseheart.—There is good quality habitat between the Fox River and the Dam at Mooseheart. The dam is located a short distance upstream of Rt. 31 and about 0.75 miles upstream of the river. It is 10 ft. high and was repaired after the flood of 1996. Good quality habitat exists upstream of the small pond that formed behind the dam and no other dams are present upstream, at least to Randall Road. The pond is used exclusively by the Mooseheart Community. This dam could be removed if the pond ceases to be useful, or a fishway could be installed to allow fish to access upstream tributary habitat. The fishway could be operated and maintained by Mooseheart and used as an educational tool for students.

Waubonsee Creek at Oswego.—Good quality riffle/pool habitat exists between the Fox River and the site of the former first dam, Stonegate Dam, which is a short distance upstream of Rt. 25. The dam was removed and fish are getting past this site, but are blocked by a small dam a few hundred yards upstream. We recommend full removal of this dam and two additional small dams behind the old shops. A fourth dam was breached in the 1994 flood and is passable to fish. This is a good example of how well a stream can recover and stabilize after a dam is removed. There is good habitat immediately upstream of the old dam that could be further improved by planting trees along the bank to augment stream shading. There is a very small dam at Fox Bend Golf Course that may be needed to store water for irrigation. This dam could be fitted with a simple fishway or rocky ramp to provide effective fish passage. Eroding banks behind the Park District recreation area west of Rt. 34 were brought to our attention during the site visit. Stream bank stabilization and restoration would protect riparian property, stop major sedimentation, and assist fish movements. The use of modern stabilization techniques (e.g., grading slopes and toe protection) is recommended over massive riprap applications.

Blackberry Creek Dam, Yorkville.—There is good quality riffle habitat between the Fox River and the first dam, which is 3 ft. upstream of the River Road Bridge and structurally tied into the bridge support pier. The dam is 11 ft. high and 84 ft. long. This old milldam serves no purpose at present and it could threaten the bridge under flood flows. There are no other dams upstream of this dam and high quality habitat exists upstream. The removal of this dam would open up more tributary stream miles than any other tributary dam in the watershed.

Above are just three examples of tributary streams that would benefit from either dam removals or the construction of fishways or rocky ramps. A comprehensive survey should be undertaken at all significant tributaries to investigate opportunities elsewhere. Important tributaries include Nippersink Creek, Brewster Creek, Boone Creek, Tyler Creek, Otter Creek, Ferson Creek, Big Rock Creek, Little Rock Creek, Somonauk Creek, Indian Creek, and Buck Creek.

CLOSING COMMENTS

This report should not be considered a final product but rather a starting point. The recommendations herein cannot be implemented based solely on the information contained within this report. They will require further study, engineering, and planning. It is likely that implementation may not proceed at the watershed level but instead on a site-by-site basis. Planners should never lose sight of the big picture, but progress may occur only when a community focuses on one dam and conceives, plans, and implements the project. If such projects are pursued sequentially, much progress can be accomplished in a few years. On the East Coast, such projects are usually most successful when undertaken by a team of partners, including government, private and non-governmental organizations (NGO's), and the public.

One purpose of this report was to investigate the feasibility of reconnecting the Fox River through a variety of options. The options reported herein *are* feasible, based upon field measurements and familiarity with the application of these designs elsewhere. The Midwest has lagged behind other parts of the nation as well as other parts of the world (e.g., Europe, Australia, Japan) in the application of fish passage and river restoration projects. Wisconsin has made great gains in dam removal but does not have much experience with fishways. The Fox River Valley and State of Illinois have the opportunity to take the lead in this part of the country by restoring its river and fish community.

REFERENCES

Aldridge, D. W., B. S. Payne, and A.C. Miller. 1987. The effects of intermittent exposure to suspended solids and turbulence on three species of freshwater mussels. Environmental Pollution 45:17-28.

Alexander, H. C., and G. E. McCurdy. 1915. Report of the survey and proposed improvement of the Fox River. Illinois Rivers and Lakes Commission, Springfield.

Anonymous. 1936a. Water carries away part of east river dam. The Aurora Daily Beacon-News, March 16, 1936.

Anonymous. 1936b. River project to employ 150 men at start. The Aurora Daily Beacon-News, April 3, 1936.

Anonymous. 1937a. New east main street dam is now certainty. The Aurora Beacon-News, Jan. 17, 1937.

Anonymous. 1937b. Excavation for new river dam is being rushed. The Aurora Beacon-News, July 9, 1937.

Anonymous. 1937c. Untitled. The Aurora Beacon-News, Sept. 5, 1937.

Anonymous. 1995. Fish passage technologies: protection at hydropower facilities. OTA- ENV-641. U.S. Government Printing Office, Washington D.C., 167 p.

Anonymous. 2000. Kennebec recovery well underway a year after removing Edwards Dam. Bringing Rivers to Life. American Rivers, Washington D. C.

Aparicio, E., M. J. Vargas, J. M., J. M. Olmo, and A. de Sostoa. 2000. Decline of native fishes in a Mediterranean watershed on the Iberian Peninsula: a quantitative assessment. Environmental Biology of Fishes 59:11-19.

AR/FE/TU. 1999. Dam removal success stories: restoring rivers through selective removal of dams that don't make sense. American Rivers, Friends of the Earth, and Trout Unlimited, Washington D.C., 114 p. plus appendices.

Bain, M. B., J. T. Finn, and H. E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69:382-392.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Bates, J. M. 1962. Impact of impoundment on the mussel fauna of Kentucky Reservoir, Tennessee River. American Midland Naturalist 68:232-236.

Baxter, R. M. 1977. Environmental effects of dams and impoundments. Annual Review of Ecology and Systematics 8:255-283.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.

Benstead, J. P., J. G. March, C. M. Pringle, and F. N. Scatena. 1999. Effects of a low-head dam and water abstraction on migratory tropical stream biota. Ecological Applications 9: 656-668.

Bertrand, W. A., H. Brown, J. Ferencak, and J. Langbein. 1982. 1981 electrofishing survey of the Fox River. Illinois Department of Natural Resources, Springfield, 21 p.

Bertrand, W. A., R. L. Hite, and D. M. Day. 1996. Biological stream characterization (BSC): biological assessment of Illinois stream quality through 1993. Illinois Environmental Protection Agency, Springfield.

Born, S. M., K. D. Genskow, T. L. Filbert, N. Hernandez-Mora, M. L. Keefer, and K. A. White. 1998. Socioeconomic and institutional dimensions of dam removals: the Wisconsin experience. Environmental Management 22:359-370.

Brigham, W. U., D. A. McCormick, and M. J. Wetzel. 1978. The watersheds of northeastern Illinois: Quality of the aquatic environment based upon water quality and fishery data. Northeastern Illinois Planning Commission Paper 31, Chicago, 251 p.

Brown, E.R., J. J. Hazdra, L. Keith, I. Greenspan, J .B. G. Kwapinski, and P. Beamer. 1973. Frequency of fish tumors found in a polluted watershed as compared to nonpolluted Canadian waters. Cancer Research 33: 189-198.

Bunt, C. M, C. Katopodis, and R. S. McKinley. 1999. Attraction and passage efficiency of white suckers and smallmouth bass by two Denil fishways. North American Journal of Fisheries Management 19:793-803.

Bunt, C. M., B. T. van Poorten, and L. Wong. 2001. Denil fishway utilization patterns and passage of several warmwater species relative to seasonal, thermal, and hydraulic dynamics. Ecology of Freshwater Fish 10:212-219.
Butts, T. A., and R. L. Evans. 1978. Effects of channel dams on dissolved oxygen concentrations in northeastern Illinois streams. Illinois State Water Survey Circular 132, Urbana, 153 p.
Carpenter, S. J., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, and V. N. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications 8:559-568.
Clay, C. H. 1995. Design of fishways and other fish facilities. Second Edition. CRC Press, Inc., Boca Raton, Florida.
Crunkilton, R. L., and J. M. Czarnezki. 1980. Severe gas bubble disease in a warmwater fishery in the Midwestern United States. Transactions of the American Fisheries Society 109:725-733.
Cummins, K. W. 1962. An evaluation of some techniques for the collection and analysis of benthic samples with special emphasis on lotic waters. American Midland Naturalist 67:477-504.
Day, D. M., H. Brown, K. Clodfelter, J. Ferencak, J. Langbein, and R. Miller. 1992. The Fox River: temporal and spatial relationships in the fish community of an increasingly urbanized watershed (1978-1990). Illinois Department of Natural Resources, Springfield, 35 p.
Dynesius, M. and C. Nilsson. 1994. Fragmentation and flow regulation of river systems in the northern third of the world. Science 266:753-762.
Efford, I. E. 1975. Assessment of the impact of hydro-dams. Journal of the Fisheries Research Board of Canada 32:196-209.
Eldridge, J. A. 1914. The mussel fishery of the Fox River. U.S. Bureau of Fisheries Document 804, 8 p.
Ellis, M. M. 1941. Freshwater impoundments. Transactions of the American Fisheries Society 71:80-93.
Erman, D. C. 1973. Upstream changes in fish populations following impoundment of Sagehen Creek, California. Transactions of the American Fisheries Society 102:626-629.
ESRI, Arcview 3.x. Inverse distance weighting tool and USEPA FIELDS 2.0 cross validation tool.
Fausch, K. D., J. Lyons, J. R. Karr, and P. L. Angermeier. 1990. Fish communities as indicators of environmental degradation. Pages 123-144 *in* S. M. Adams, editor. Biological indicators of stress in fish. American Fisheries Society Symposium, Bethesda, Maryland.
Fausch, K. D., C. E. Torgersen, C. V. Baxter, and H. W. Li. 2002. Landscapes to riverscapes: bridging the gap between research and conservation of stream fishes. Bioscience 52:483-498.
Forbes, S. A., and R. E. Richardson. 1905. The fishes of Illinois. Illinois Natural History Survey, Champaign, 357 p. plus maps.
Fraley, J. J. 1979. Effects of elevated stream temperatures below a shallow reservoir on a cold water macroinvertebrate fauna. Pages 257-272 *in* J. V. Ward and J. A. Stanford, editors. The ecology of regulated streams. Plenum Press, New York.
FREP (Fox River Ecosystem Partnership). 1999. Integrated management plan for the Fox River watershed in Illinois – Draft. Illinois Department of Natural Resources, Springfield, IL.
Gaboury, M. N., R. W. Newbury, and C. M. Erickson. 1995. Pool and riffle fishways for small dams. Manitoba Natural Resources Fisheries Branch, 30 pp.
Geen, G. H. 1974. Effects of hydroelectric development in western Canada on aquatic ecosystems. Journal of the Fisheries Research Board of Canada 31:913-927.
Gordon, A. E., and J. B. Wallace. 1975. Distribution of the Family Hydropsychidae in the Savannah River Basin of North Carolina, South Carolina, and Georgia. Hydrobiologia 46:405-423.
Gore, J. A. 1977. Reservoir manipulations and benthic macroinvertebrates in a prairie river. Hydrobiologia 55:113-123.
Hall, G. E., editor. 1971. Reservoir Fisheries and Limnology. American Fisheries Society Specieal Publication 8.
Hall, G. E., and M. J. Van Den Avyle, editors. 1986. Reservoir fisheries management: strategies for the 80's. Reservoir Committee, Southern Division, American Fisheries Society, Bethesda, Maryland.
Harman, W. N. 1974 The effects of reservoir construction and channelization on the mollusks of the upper Delaware watershed. Bulletin of the American Malacological Union 1974:12-14.
Hauer, F. R., and J. A. Stanford. 1982. Ecological responses of hydropsychid caddisflies to stream regulation. Canadian Journal of Fisheries and Aquatic Sciences 39:1235-1242.
Heidinger, R. 1993. Aquatic survey of the Fox River between Elgin Dam and South Elgin Dam. Contract Report to Hyatt Development Corporation, Elgin, 22 p.
Hillsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomologist 20:31-39.

Hynes, H. B. N. 1970. The ecology of running waters. University of Toronto Press, Toronto.
IDNR. 1997. Fox River area assessment, volume 4, socio-economic profile, environmental quality, archeological resources. Illinois Department of Natural Resources, Springfield, 161 p.
IDNR. 1998. Fox River area assessment, volume 1, geology; volume 2, water resources; volume 3, living resources. Illinois Department of Natural Resources, Springfield, 390 p.
IDOT. 1976. Fox River dams study report 1974 - revised 1976. Illinois Department of Transportation, Springfield, 103 p.
IEPA. 1987. An intensive survey of the Fox River, 1982. Illinois Environmental Protection Agency Report, Springfield, 107 p.
IEPA. 1994. Stream habitat assessment procedures (SHAP). Illinois Environmental Protection Agency, stream habitat SOP, Springfield.
IEPA. 1995. Macroinvertebrate tolerance list. Illinois Environmental Protection Agency, Springfield.
IEPA. 1996. Illinois water quality report. Illinois Environmental Protection Agency Report, Springfield.
Imhoff, K. R., and D. R. Albrecht. 1982. Nutrient and algal growth in an impounded river, consequences for its oxygen balance and nutrient control strategy. Water Science and Technology 14:185-197.
Jager, H. L., Chandler, J. A., K. B. Lepla, and W. Van Winkle. 2001. A theoretical study of river fragmentation by dams and its effects on white sturgeon populations. Environmental Biology of Fishes 60:347-361.
Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110-127 *in* D. P. Dodge, editor. Proceedings of the international large river symposium. Canadian Special Publication in Fisheries and Aquatic Sciences 106.
Kanehl, P. D., J. Lyons, and J. E. Nelson. 1997. Changes in the habitat and fish community of the Milwaukee River, Wisconsin, following removal of the Woolen Mills Dam. North American Journal of Fisheries Management 17: 387-400.
Karr, J. R. 1981. Assessment of biotic integrity using fish communities. Fisheries (Bethesda) 6: 21-27.
Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey Special Publication 5, 28 p.
Knapp, H. V. 1988. Fox River Basin streamflow model: hydrological analysis. Illinois State Water Survey Contract Report 454, 109 p.
Knapp, H. V., and T. W. Ortel. 1992. Effect of Stratton Dam operation on flood control along the Fox River and Fox Chain of Lakes. Illinois Water Survey Contract Report 533, Champiagn.
Kothandaraman, V., R. L. Evans, N.G. Bhowmik, J. B. Stall, D. L. Gross, J. A. Lineback, and G. B. Dreher. 1977. Fox Chain of Lakes investigation and water quality management plan. Illinois State Water Survey and Illinois State Geological Survey Cooperative Resources Report 5, 200 p.
Ligon, F. K., W. E. Dietrich, and W. J. Trush. 1995. Downstream ecological effects of dams. Bioscience 45:183-192.
Lodge, D. M. 1993. Biological invasions: lessons for ecology. Trends in Ecology and Evolution 8:133-137.
Lohman, K., and J. R. Jones. 1999. Nutrient-sestonic chlorophyll relationships in northern Ozark streams. Canadian Journal of Fisheries and Aquatic Sciences 56:124-130.
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.
Mallen-Cooper, M. 1999. Developing fishways for nonsalmonid fishes: a case study from the Murray River in Australia. Pages 173-196 *in* M. Odeh, editor. Innovations in fish passage technology. American Fisheries Society, Bethesda, Maryland.
Maloney, T., S. Gephard, and J. Monroe. 2000. A fishway for your stream-providing fish passage around dams in the Northeast. Connecticut River Watershed Council, Easthampton, Massachusetts, 40 pp.
Martin, B. A., and M. K. Saiki. 1999. Effects of ambient water quality on the endangered lost river sucker in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 128:953-961.
Martinez, P.J., T. E. Chart, M. A. Trammell, J. G. Wullschleger, and E. P. Bergersen. 1994. Fish species composition before and after construction of a main stem reservoir on the White River, Colorado. Environmental Biology of Fishes 40:227-239.
McConkey, S. A., R. S. Larson, and K. P. Singh. 1992. Pilot study: riffle-pool geometry below Algonquin and aquatic habitat assessment. Illinois State Water Survey Contract Report 542, 60 p.
Merona, B., de, and P. Albert. 1999. Ecological monitoring of fish assemblages downstream of a hydroelectric dam in French Guiana (South America). Regulated Rivers: Research and Management 15:339-351.

Merritt, R. W., and K. W. Cummins. 1996. An introduction to the aquatic insects of North America. Kendall/Hunt Publishing company, Dubuque, Iowa.

Meyer, J. S., and J. A. Hansen. 2002. Subchronic toxicity of low dissolved oxygen concentrations, elevated pH, and elevated ammonia concentrations to Lost River suckers. Transactions of the American Fisheries Society 131:656-666.

Milone and McBroom, Inc. 2003. South Batavia Dam Study - Fox River - Batavia, Illinois. Milone and McBroom, Inc., Cheshire, Connecticut, 83 p. plus appendices.

Miltner, R. J., and E. T. Rankin. 1998. Primary nutrients and the biotic integrity of rivers and streams. Freshwater Biology 40:145-158.

Miner, J. G., and R. A. Stein. 1996. Detection of predator and habitat choice by small bluegills: effects of turbidity and alternative prey. Transactions of the American Fisheries Society 125:97-103.

Mitsch, W. J., J.W. Day, J. W. Gilliam, P. M. Groffman, D. L. Hey, G. W. Randall, and N. Wang. 2001. Reducing nitrogen loading to the Gulf of Mexico from the Mississippi River Basin: strategies to counter a persistent ecological problem. Bioscience 51:373-388.

Moffett, C. M., B. Kynard, and S. G. Rideout. 1982. Fish passage facilities and anadromous fish restoration in the Connecticut River Basin. Fisheries 7(6):2-11.

Moyle, P. B., and T. Light. 1996. Fish invasions in California: do abiotic factors determine success? Ecology 77:1666-1670.

Moyle, P. B., and R. M. Yoshiyama. 1994. Protection of aquatic biodiversity in California: a five-tiered approach. Fisheries (Besthesda) 19(2):6-18.

Muench, B. 1965. Inventory of the fishes of four river basins in Illinois, 1964. Illinois Department of Natural Resources Special Fisheries Report Number 8, Springfield, 81 p.

Murr, A. 1999. A river runs through it. Newsweek. July 12, 1999.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16 (Bathesda):4-21.

Netboy, A. 1980. Salmon - the world's most harassed fish. Winchester Press. Tulsa, Oklahoma.

NIPC. 1978. Area wide water quality management plan part II chapter 19 (Fox River basin). Northeastern Illinois Planning Commission, Chicago.

NIPC, Openlands Project, and Illinois Paddling Council. 1999. Northeastern Illinois regional water trail plan. Northeastern Illinois Planning Commission, Chicago, 103 p. plus appendices.

Northcote, T. G. 1978. Migratory strategies and production in freshwater fishes. Pages 326-359 *in* S. D. Gerking, editor. Ecology of freshwater fish production. Blackwell Scientific Publications, Oxford.

Nursall, J. R. 1952. The early development of a bottom fauna in a new power reservoir in the Rocky Mountains of Alberta. Canadian Journal of Zoology. 30:387-409.

Odeh, M., and A. Haro. 2000. Developments in fish passage engineering and technology. Pages 1-12 *in* Odeh, M., editor. Advances in fish passage technology: engineering design and biological evaluation. American Fisheries Society, Bethesda, Maryland.

Ohio EPA. 1989. Biological criteria for the protection of aquatic life: volume III standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Ohio Environmental Protection Agency, Columbus.

Orsborn, J. F., and P. D. Powers. 1985. Fishways - an assessment of their development and design. Final Project Report. Bonneville Power Administration no. 82-14, 161 pp.

Page, L. M. 1985. The crayfishes and shrimps (Decapoda) of Illinois. Illinois Natural History Survey Bulletin 33:335-448.

Page, L. M., K. S. Cummings, C. A. Meyer, S.L. Post, and M. E. Retzer. 1992. Biologically significant Illinois streams: an evaluation of the streams of Illinois based on aquatic biodiversity. Illinois Natural History Survey, Center for Biological Diversity Technical Report, Champaign, 485 p.

Parasiewicz, P., J. Eberstaller, S. Weiss, and S. Schmutz. 1998. Conceptual guidelines for nature-like bypass channels. Page 348-362 *in* Jungwirth, M., S. Schmutz, and S. Weiss, editors. Fish migration and fish bypasses. Fishing News Books, Oxford.

Parker, C. R., and J. R. Voshell, Jr. 1983. Production of filter-feeding Trichoptera in an impounded and free-flowing river. Canadian Journal of Zoology 61:70-87.

Paterson, C. G., and C. H. Fernando. 1969. Macroinvertebrate colonization of the marginal zone of a small impoundment in eastern Canada. Canadian Journal of Zoology 47:1229-1238.

Patrick Engineering, Inc. 2001. Geotechnical engineering report for the Upper Batavia Dam restoration project, Batavia, Illinois. Patrick Engineering, Inc., Lisle, Illinois, 39 p. plus appendices.

Peckarsky, B. L., P. R. Faissinet, M. A. Penton, and D. S. Conklin, Jr. 1990. Freshwater macroinvertebrates of northeastern North America. Cornell University Press, Ithaca, New York.

Pennak, R. W. 1989. Fresh-water invertebrates of the United States.John Wiley and Sons, New York.

Pescitelli, S., and B. Rung. 1998. Effects of Hoffman Dam on local fish communities in the Des Plaines River. Illinois Department of Natural Resources, Plano, Illinois, 4 p.

Pflieger, W. L. 1997. The fishes of Missouri. Missouri Department of Conservation, Jefferson City.

Poff, N. L., J. D. Allen, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks, and J. C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. Bioscience 47:769-784.

Poff, N. L., and D. D. Hart. 2002. How dams may vary and why it matters for the emerging science of dam removal. Bioscience 52:659-668.

Porto, L. M., R. L. McLaughlin, and D. L. G. Noakes. 1999. Low-head barrier dams restrict the movements of fishes in two Lake Ontario streams. North American Journal of Fisheries Management 19:1028-1036.

Power, M. E. 1990. Effects of fish in river food webs. Science 250:811-814.

Pringle, C. M. 1997. Exploring how disturbance is transmitted upstream: going against the flow. Journal of the North American Benthological Society 16:425-438.

Pringle, C. M., M. C. Freeman, and B. J. Freeman. 2000. Regional effects of hydrologic alterations on riverine macrobiota in the new world: tropical-temperate comparisons. Bioscience 50:807-823.

Rabeni, C. F., and R. B. Jacobson. 1993. The importance of fluvial hydraulics to fish-habitat restoration in low-gradient alluvial streams. Freshwater Biology 29: 211-220.

Rabeni, C. F., and G. W. Minshall. 1977. Factors affecting microdistribution of stream benthic insects. Oikos 29:33-43.

Rand, G. M., P. G. Wells, and L. S. McCarty. 1995. Introduction to aquatic toxicology. Pages 3-67 *in* G. M. Rand, editor. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, 2nd edition. Taylor and Francis, Washington, D. C.

Rankin, E. T. 1989. The qualitative habitat evaluation index (QHEI), rationale, methods, and application. Ohio Environmental Protection Agency, Columbus.

Reice, S. R. 1980. The role of substrate in benthic macroinvertebrate microdistribution and litter decomposition in woodland stream. Ecology 61:580-590.

Robertson, D. M., D. A. Saad, and A. M. Wieben. 2001. An alternative regionalization scheme for defining nutrient criteria for rivers and streams. U.S. Geological Survey Water Resources Investigations Report 01-4073, 36 p. plus appendices.

Rodriguez-Ruiz, A., and C. Granado-Lorencio. 1992. Spawning period and migration of three species of cyprinids in a stream with Mediterranean regimen (SW Spain). Journal of Fish Biology 41:545-556.

Ross, S. T. 1991. Mechanisms structuring stream fish assemblages: are there lessons from introduced species? Environmental Biology of Fishes 30:359-368

Ruhr, C. E. 1956. Effect of stream impoundment in Tennessee on the fish populations of tributary streams. Transactions of the American Fisheries Society 86:144-157.

Sallee, R. D., and H. W. Bergmann. 1986. 1982 Fox River basin fisheries assessment. Illinois Department of Natural Resources, Aledo, 48 p.

Santucci, V. J., Jr. 1994. Assessment of fish populations in the Fox River between Algonquin and Elgin, Illinois. Max McGraw Wildlife Foundation Fisheries Research Report, Dundee, Illinois, 16 p.

Santucci, V. J., Jr., J. D. Thompson, D. Stokes, and R. Stockman. 1997a. Post-dredging fishery monitoring in the Fox River between the Elgin and South Elgin dams. Max McGraw Wildlife Foundation Contract Report, Dundee, Illinois, 107 p.

Santucci, V. J., Jr., J. D. Thompson, D. Stokes, and R. Stockman. 1997b. Post-dredging fishery monitoring in the Fox River between the North Aurora Dam and New York Street Dam in Aurora, Illinois. Max McGraw Wildlife Foundation Contract Report, Dundee, Illinois, 104 p.

Schlosser, I. J. 1991. Stream fish ecology: a landscape perspective. Bioscience 41:704-712.

Schlosser, I. J., and P. L. Angermeier. 1995. Spatial variation in demographic processes of lotic fishes: conceptual models, empirical evidence, and implications for conservation. Pages 392-401 *in* J. L. Nielsen, editor. Evolution and the aquatic ecosystem: defining unique units in population conservation. American Fisheries Society, Bethesda, Maryland.

Schmutz, S., and M. Jungwirth. 1999. Fish as indicators of large river connectivity: the Danube and its tributaries. Archiv fur Hydrobiologia 115:329-348.

Searns, R. M. 1979. The Fox River paddleway. Fox River Study V, 1977 – 1978. Urban Edges Corporation, Denver, Colorado.

Shafroth, P. B., J. M. Friedman, G. T. Auble, M. I. Scott, and J. H. Braatne. 2002. Potential responses of riparian vegetation to dam removal. Bioscience 52:703-712.
Shuman, J. R. 1995. Environmental considerations for assessing dam removal alternatives for river restoration. Regulated Rivers: Research and Management 11:249-261.
Simons, R. K., and D. B. Simons. 1991. Sediment problems associated with dam removal – Muskegon River, Michigan. Pages 680-685 *in* Hydraulic engineering. Proceedings of the 1991 National Conference of the Society of American Civil Engineers. ASCE, New York.
Singh, K. P., T. A. Butts, H. V. Knapp, D. B. Shackleford, and R. S. Larson. 1995. Considerations in water use planning for the Fox River. Illinois State Water Survey Contract Report 586, Champaign, 132 p. plus maps.
Smith, P. W. 1979. The fishes of Illinois. University of Illinois Press, Champaign, Illinois.
Smith, L. W., E. Dittmer, M. Prevost, and D. R. Burt. 2000. Breaching of a small irrigation dam in Oregon: a case history. North American Journal of Fisheries Management. 20:205-219.
Soballe, D. M., and R. W. Bachmann. 1984. Influence of reservoir transit on riverine algal transport and abundance. Canadian Journal of Fisheries and Aquatic Sciences 41:1803-1813.
Soballe, D. M., and B. L. Kimmel. 1987. A large-scale comparison of factors influencing phytoplankton abundance in rivers, lakes, and impoundments. Ecology 68:1943-1954.
Spence, J. A., and H. B. N. Hynes. 1971a. Differences in benthos upstream and downstream of an impoundment. Journal of Fisheries Research Board of Canada 28:35-43.
Spence, J. A., and H. B. N. Hynes. 1971b. Differences in fish populations upstream and downstream of a mainstream impoundment. Journal of Fisheries Research Board of Canada 28:45-46.
Sprules, W. M. 1940. The effect of a beaver dam on the insect fauna of a trout stream. Transactions of the American Fisheries Society 70:236-248.
Stanley, E. H., and M. W. Doyle. 2001. A geomorphic perspective on nutrient retention following dam removal. Bioscience 52:693-701.
Stanley, E. H., M. A. Luebke, M. W. Doyle, and D. W. Marshall. 2002. Short-term changes in channel form and macroinvertebrate communities following low-head dam removal. Journal of the North American Benthological Society 21:172-187.
Steel, R. G. D., and J. H. Torrie. 1980. Principles and procedures of statistics: a biometrical approach. McGraw Hill, New York.
Steffeck, D. W., and R. G. Striegl. 1989. An evaluation of biological investigations that relate to stream-water quality in the upper Illinois River basin of Illinois, Indiana, and Wisconsin. U.S. Geological Survey Water-Resources Investigations Report 89-4041, Denver, Colorado, 54 p.
Stevens, L. E., J. E. Schmidt, T. J. Ayers, and B. T. Brown. 1995. Flow regulation, geomorphology, and Colorado River marsh development in the Grand Canyon, Arizona. Ecological Applications 5:1025-1039.
Stuart, T. A. 1962. The leaping behaviour of salmon and trout at falls and obstructions. Freshwater and Salmon Fisheries Research Paper 28. Department of Agriculture and Fisheries for Scotland., 46 pp.
Talling, J. F., and J. Rzoska. 1967. The development of plankton in relation to hydrological regime in the Blue Nile. Journal of Ecology 55:637-662.
USEPA. 2000. Nutrient criteria technical guidance manual rivers and streams. U.S. Environmental Protection Agency, EPA-822-B-00-002, Washington, D. C.
USGS. 2001. Water resources data Illinois water year 2001. U.S. Geological Survey, Denver, Colorado.
USGS. 2002. Water resources data Illinois water year 2001. U.S. Geological Survey, Denver, Colorado.
Van Nieuwenhuyse, E. E., and J. R. Jones. 1996. Phosphorus-chlorophyll relationship in temperate streams and its variation with stream catchment area. Canadian Journal of Fisheries and Aquatic Sciences 53: 99-105.
Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.
Vermeij, G. J. 1991. When biotas meet: understanding biotic interchange. Science 253:1099-1104.
Ward, J. V. 1974. A temperature stressed stream ecosystem below a hypolimnial release mountain reservoir. Archives fur Hydrobiologia 74:247-275.
Ward, J. V., and J. A. Stanford, editors. 1979a. The ecology of regulated streams. Plenum, New York.
Ward, J. V., and J. A. Stanford, editors. 1979b. Ecological factors controlling stream zoobenthos with emphasis on thermal modification of regulated streams. Pages 35-55 *in* J. V. Ward and J. A. Stanford, editors. The ecology of regulated streams. Plenum Press, New York.
Ward, J. V., and J. A. Stanford. 1983. The serial discontinuity concept of lotic ecosystems. Pages 29-42 *in* T.D. Fontain and S. M. Bartell, editors. Dynamics of lotic ecosystems. Ann Arbor Science, Ann Arbor, Michigan.

Ward, J. V., and J. A. Stanford. 1989. Riverine ecosystems: the influence of man on catchment dynamics and fish ecology. Pages 56-64 *in* D. P. Dodge, editor. Proceedings of the international large river symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Watters, G. T. 1992. Unionids, fishes, and the species-area curve. Journal of Biogeography 19:481-490.

Watters, G.T. 1996. Small dams as barriers to freshwater mussels (Bivalvia, Unionida) and their hosts. Biological Conservation 75:79-85.

Wedemeyer, G. A., B. A. Barton, and D. J. McLeay. 1990. Stress and acclimation. Pages 451-489 *in* C. B. Schreck and P. B. Moyle, editors. Methods for Fish Biology. American Fisheries Society, Bethesda, Maryland.

Wetzel, R. G. 1983. Limnology. Holt, Rinehart, and Winston, Inc., Orlando, Florida.

Wildman, L. A., and J. G. McBroom. 2000. Dam removal – a tool for river restoration on the Nuagatuck River. Proceedings of the Joint Conference on Water Resource Engineering and Water Resource Planning and Management. American Society of Civil Engineers, Minneapolis, Minnesota.

Winston, M. R., C. M. Taylor, and J. Pigg. 1991. Upstream extirpation of four minnow species due to damming of a prairie stream. Transactions of the American Fisheries Society 120:98-105.

Wootton, J. T., M. S. Parker, M. E. Power. 1996. Effects of disturbance on river food webs. Science 273:1558-1561.

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APPENDICES

A. Fisheries Data
B. Macroinvertebrate Data
C. Habitat Data
D. Water Quality Data
E. Sediment Data
F. Sampling Locations
G. Existing Fishway Evaluations
H. Education Outreach

Appendix A. Fisheries Data

Table A1. Fish species sampled by boat electrofishing, backpack electrofishing and seining at 40 stations on the Fox River between McHenry and Dayton, Illinois during July through September 2000.

	Station, habitat, and river mile							
Species	Stratton above dam US IMP 98.22	Stratton below dam DS FF 97.66	Algonquin mid upper MD IMP 93.92	Algonquin mid lower MD IMP 88.18	Algonquin above dam US IMP 81.91	Algonquin below dam DS FF 81.23	Carpentersville above dam US IMP 77.49	Carpentersville below dam DS FF 76.82
Banded darter						2		26
Black bullhead							19	2
Black crappie	21	11				1	13	7
Black redhorse								
Blacknose dace								
Blackside darter		1					3	
Blackstripe topminnow							4	1
Bluegill	78	606	27	219	40	115	458	52
Bluegill X Green sunfish hybrid		1						1
Bluntnose minnow						6	5	8
Bowfin		1						
Brook silverside		14		21		60	19	4
Bullhead minnow	207	4	2	39	2	1		17
Central stoneroller								
Channel catfish	10	5	5	4	1	26	4	22
Common carp	18	51	33	20	16	30	24	32
Common shiner								
Creek chub	1					5	3	
Emerald shiner	33	178				1	28	
Fantail darter								
Fathead minnow	2	16			1			3
Flathead catfish					1	1		2
Freshwater drum	6	2	2	6	5	2	3	16
Gizzard shad								
Golden redhorse						2		
Golden shiner	18	61					2	16
Goldfish								
Grass pickerel						1	1	
Green sunfish	1	7		5	3	3	1	2
Hornyhead chub								
Johnny darter							4	8
Largemouth bass	12	118	8	11	47	25	87	50
Largescale stoneroller								
Logperch				1				7
Longnose gar								
Mooneye								
Muskellunge								
Northern hog sucker								
Orangespotted sunfish	3	54	2	5	4	24	35	8
Orangethroat darter						6		
Pugnose minnow							1	
Quillback		2				25	1	4
River carpsucker								
River redhorse								
Rock bass								
Rosyface shiner								
Sand shiner								9
Sauger								
Shorthead redhorse	2					4		
Shortnose gar								
Silver redhorse								1
Slenderhead darter						2		2
Smallmouth bass				1		17	8	15
Smallmouth buffalo								
Speckled chub								
Spotfin shiner	154	226	4	126	75	86	1	570
Spottail shiner		6		7		16	6	17
Stonecat								
Suckermouth minnow								
Tadpole madtom							2	
Walleye				1				
Warmouth		1						
White bass	23	1		2		1		7
White crappie								
White sucker						26	28	23
Yellow bass	4	5				1	3	
Yellow bullhead	1					1		2
Yellow perch		7		1		2	8	
Number of individuals	595	1378	83	469	195	494	771	934
Number of species	19	23	8	16	11	30	27	30

Table A1. Extended.

	Station, habitat, and river mile							
Species	Elgin mid upper MD FF 74.75	Elgin mid lower MD IMP 72.90	Elgin above dam US IMP 71.25	Elgin below dam DS FF 70.59	South Elgin above dam US IMP 67.50	South Elgin below dam DS FF 66.41	St. Charles mid upper MD FF 64.00	St. Charles mid lower MD IMP 61.36
Banded darter	7	3		9		9		
Black bullhead	2				1			
Black crappie	2	3				2	1	3
Black redhorse								
Blacknose dace								
Blackside darter	3		1	1		2		
Blackstripe topminnow	1	4	1		1			
Bluegill	63	61	95	66	80	46	26	65
Bluegill X Green sunfish hybrid				1				2
Bluntnose minnow	8	1				10	30	11
Bowfin								
Brook silverside	4	32	142	1				
Bullhead minnow	2	3	3	3	7	2		
Central stoneroller								
Channel catfish	19	8	3	9	4	11	167	2
Common carp	39	132	18	60	16	75	51	34
Common shiner								
Creek chub								
Emerald shiner		12					323	
Fantail darter								
Fathead minnow	1			2		1		
Flathead catfish	1		2		1	3	4	
Freshwater drum	9	39	4	22	7	1	14	3
Gizzard shad								
Golden redhorse	2	1		6		2	1	
Golden shiner	1	7						
Goldfish								
Grass pickerel	1				1			
Green sunfish	4	8	7	9	36	5	1	8
Hornyhead chub								
Johnny darter	11	5				1		2
Largemouth bass	61	17	12	7	42	4	2	5
Largescale stoneroller								
Logperch	2	1						
Longnose gar								
Mooneye								
Muskellunge	1							
Northern hog sucker				1		1	1	
Orangespotted sunfish	2	6		2		2		3
Orangethroat darter								
Pugnose minnow								
Quillback	5	3		1		1	1	1
River carpsucker								
River redhorse								
Rock bass								
Rosyface shiner								
Sand shiner	58			18	5	55	94	
Sauger								
Shorthead redhorse								
Shortnose gar								
Silver redhorse		1		5				
Slenderhead darter	1			1		3		1
Smallmouth bass	10	14	15	32	22	5	6	1
Smallmouth buffalo								
Speckled chub								
Spotfin shiner	418	76	1	155		203	485	21
Spottail shiner	3			11		209	62	
Stonecat								
Suckermouth minnow								
Tadpole madtom		1	1		16			
Walleye				1		1	1	
Warmouth								
White bass								
White crappie								
White sucker	13	3		2		1		
Yellow bass				2		3		
Yellow bullhead	1		1	1	3	10		1
Yellow perch	1	1					1	
Number of individuals	756	442	306	428	242	668	1271	163
Number of species	32	25	15	26	15	27	19	16

Table A1. Extended.

	Station, habitat, and river mile							
Species	St. Charles above dam US IMP 60.00	St. Charles below dam DS FF 59.40	Geneva above dam US IMP 58.00	Geneva below dam DS FF 57.46	North Batavia above dam US IMP 55.70	North Batavia below dam DS FF 55.07	South Batavia above dam US IMP 54.34	South Batavia below dam DS FF 53.73
Banded darter		22		13		221		25
Black bullhead								
Black crappie				1				
Black redhorse								
Blacknose dace								
Blackside darter								
Blackstripe topminnow							2	
Bluegill	245	36	135	43	61	42	178	14
Bluegill X Green sunfish hybrid	12	18	1	3	3	3	2	
Bluntnose minnow	108	4	7	13	109	106	98	193
Bowfin								
Brook silverside	4	1	4			88		
Bullhead minnow	40	1	1	8				
Central stoneroller						1		6
Channel catfish	1	21		33	1	8	3	43
Common carp	12	30	6	40	14	42	49	12
Common shiner								1
Creek chub	1		1	1	1			3
Emerald shiner	15	8			1	22	7	
Fantail darter								
Fathead minnow	1	1		4		1		2
Flathead catfish	1	4		12	1	9	1	5
Freshwater drum	2	20	1	13	3	6		6
Gizzard shad								
Golden redhorse				8		1		27
Golden shiner		1		1		3	1	1
Goldfish								
Grass pickerel								
Green sunfish	28	10	32	19	3	20	12	6
Hornyhead chub		3						11
Johnny darter				3		1	5	1
Largemouth bass	15	3	13	9	25	12	22	5
Largescale stoneroller		1						
Logperch	1	1		2		1		1
Longnose gar								
Mooneye								
Muskellunge								
Northern hog sucker		5		3				9
Orangespotted sunfish	5	11	1	6	3	16	22	1
Orangethroat darter								
Pugnose minnow								
Quillback		3		6		24	1	12
River carpsucker								
River redhorse								10
Rock bass							1	
Rosyface shiner								1
Sand shiner		1		126	3	208		490
Sauger								
Shorthead redhorse								
Shortnose gar								
Silver redhorse						9		13
Slenderhead darter				4	2	3		1
Smallmouth bass	1	36	5	25	7	28	6	16
Smallmouth buffalo								
Speckled chub								
Spotfin shiner	18	66	17	316	118	471	40	632
Spottail shiner	2	21		2		1		
Stonecat				1				2
Suckermouth minnow								59
Tadpole madtom			2					
Walleye								
Warmouth								
White bass					3			
White crappie								
White sucker				1				3
Yellow bass				6				
Yellow bullhead	1	1	4	4		3		1
Yellow perch					2		1	1
Number of individuals	513	329	230	726	360	1350	451	1613
Number of species	20	26	15	30	18	27	18	33

Table A1. Extended.

Species	North Aurora above dam US IMP 52.00	North Aurora below dam DS FF 51.45	Stolp Island above dam US IMP 48.63	Stolp Island below dam DS FF 48.12	Hurd's Island above dam US IMP 47.83	Hurd's Island below dam DS FF 47.51	Montgomery above dam US IMP 46.50	Montgomery below dam DS FF 46.00
	Station, habitat, and river mile							
Banded darter		23	3	55	1	96		3
Black bullhead								
Black crappie	2							
Black redhorse								
Blacknose dace								
Blackside darter								
Blackstripe topminnow				2	1		8	
Bluegill	53	17	7	2	7	6	56	60
Bluegill X Green sunfish hybrid			2				2	2
Bluntnose minnow	779	294	165	306	64	59	173	191
Bowfin								
Brook silverside	2	4	1					
Bullhead minnow	586	7	19	75	15	4	10	11
Central stoneroller								
Channel catfish	3	18	1	10	5	10		2
Common carp	17	29	23	6	12	15	2	31
Common shiner								
Creek chub	2	3		1	1	3		
Emerald shiner								
Fantail darter								
Fathead minnow		1		5		1	1	
Flathead catfish	2	4	1	2	2	6	1	
Freshwater drum	2	19	2	6	9	3		1
Gizzard shad					1		4	8
Golden redhorse	3	9	1	2	1	15		6
Golden shiner	1		1	2		1		23
Goldfish								
Grass pickerel								
Green sunfish	5	10	4	21	65	2	13	12
Hornyhead chub		2				3		
Johnny darter	2	2						2
Largemouth bass	14	2	17	9	12	1	9	9
Largescale stoneroller		2						
Logperch				1				
Longnose gar								
Mooneye								
Muskellunge								1
Northern hog sucker		10		1				1
Orangespotted sunfish		2	2	3			5	3
Orangethroat darter								
Pugnose minnow								
Quillback	4	11	1	1		3		6
River carpsucker								
River redhorse		1				2		
Rock bass								
Rosyface shiner								
Sand shiner	566	221	44	83	52	232	2	192
Sauger								
Shorthead redhorse		4		49	5	48	1	46
Shortnose gar								
Silver redhorse		13		9		5		
Slenderhead darter		4				2		1
Smallmouth bass	8	52	9	136	38	34	17	14
Smallmouth buffalo								
Speckled chub								
Spotfin shiner	675	296	374	434	75	439	123	269
Spottail shiner		3		14				1
Stonecat		4				1		
Suckermouth minnow	6	8				4		2
Tadpole madtom	2			1				
Walleye		2						2
Warmouth								
White bass		3						
White crappie								
White sucker						2		
Yellow bass				1				
Yellow bullhead		1			4	1		
Yellow perch								
Number of individuals	2734	1081	677	1237	370	998	427	899
Number of species	21	33	19	27	19	27	16	26

Table A1. Concluded.

Species	Yorkville mid upper MD FF 42.33	Yorkville mid lower MD FF 38.58	Yorkville above dam US IMP 36.32	Yorkville below dam DS FF 35.60	Dayton mid upper MD FF 25.00	Dayton mid lower MD FF 14.24	Dayton above dam US IMP 5.84	Dayton below dam DS FF 5.27	All stations
	Station, habitat, and river mile								
Banded darter	29	15		34	20			1	617
Black bullhead									27
Black crappie				1		2		6	76
Black redhorse				4	9	12		13	38
Blacknose dace					1				1
Blackside darter									11
Blackstripe topminnow				5					30
Bluegill	16	2	15	26		66	20	14	3218
Bluegill X Green sunfish hybrid	2		5						60
Bluntnose minnow	62	104	26	63	84	132	149	15	3383
Bowfin									1
Brook silverside							4		405
Bullhead minnow	1	32		13	66	258	56	24	1519
Central stoneroller				12					19
Channel catfish	7	23	1	14	17	64	10	15	610
Common carp	35	40	22	16	15	11	24	19	1171
Common shiner									1
Creek chub						5			31
Emerald shiner		3				3		106	740
Fantail darter	4								4
Fathead minnow	3	21			2			3	72
Flathead catfish	3	3		4	4	4	1	3	88
Freshwater drum	1		3	1	1			11	251
Gizzard shad		2	9	45		60	10	110	249
Golden redhorse				4	12	11	12	3	129
Golden shiner			1						141
Goldfish							1		1
Grass pickerel									4
Green sunfish	70		15	8	2	18	17	10	502
Hornyhead chub	2								21
Johnny darter	7	19	2	4	16	10	1		106
Largemouth bass	15	10	34	12	2	19	30	4	811
Largescale stoneroller	25							1	29
Logperch				1					19
Longnose gar								2	2
Mooneye								3	3
Muskellunge									2
Northern hog sucker				3	9	3		2	49
Orangespotted sunfish						10			240
Orangethroat darter						1			7
Pugnose minnow									1
Quillback		7	1	13	6	3		1	147
River carpsucker				1		6		10	17
River redhorse	1								14
Rock bass				1		1			3
Rosyface shiner				3					4
Sand shiner	147	315	128	411	586	217	170	27	4460
Sauger								2	2
Shorthead redhorse	25	28		82	31	35	5	17	382
Shortnose gar								1	1
Silver redhorse				3	1				60
Slenderhead darter				1	2	1		2	33
Smallmouth bass	10	7		1	8	7	1	1	613
Smallmouth buffalo								40	40
Speckled chub								1	1
Spotfin shiner	132	212	71	385	118	772	190	187	9031
Spottail shiner	1	5		1		1		1	390
Stonecat									8
Suckermouth minnow		1		1	15	1			97
Tadpole madtom				1					26
Walleye	3			1	1			2	15
Warmouth									1
White bass								6	46
White crappie						1			1
White sucker	3	3				1			109
Yellow bass								1	26
Yellow bullhead	4	2	1			1			49
Yellow perch									25
Number of individuals	608	854	334	1175	1028	1736	701	664	30290
Number of species	25	21	15	33	24	31	17	35	68

Table A2. Index of biotic integrity (IBI) scores, fish species richness, and harvestable-sized sport fish (HSSF) catch rates (N/h) for 40 stations on the Fox River between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing, and seining during July through September 2000.

Station	Habitat	River mile	IBI score	Species richness	HSSF (*N*/h)
Stratton above dam	US IMP	98.22	34	19	63.7
Stratton below dam	DS FF	97.66	38	23	67.0
Algonquin mid upper	MD IMP	93.92	24	8	48.0
Algonquin mid lower	MD IMP	88.18	30	16	42.0
Algonquin above dam	US IMP	81.91	28	11	42.0
Algonquin below dam	DS FF	81.23	48	30	78.0
Carpentersville above dam	US IMP	77.49	34	27	35.0
Carpentersville below dam	DS FF	76.82	48	30	57.0
Elgin mid upper	MD FF	74.75	48	32	61.0
Elgin mid lower	MD IMP	72.90	36	25	27.0
Elgin above dam	US IMP	71.25	28	15	23.0
Elgin below dam	DS FF	70.59	40	26	49.9
South Elgin above dam	US IMP	67.50	26	15	37.2
South Elgin below dam	DS FF	66.41	46	27	55.0
St. Charles mid upper	MD FF	64.00	40	19	72.0
St. Charles mid lower	MD IMP	61.36	28	16	38.0
St. Charles above dam	US IMP	60.00	32	20	17.0
St. Charles below dam	DS FF	59.40	40	26	101.0
Geneva above dam	US IMP	58.00	30	15	22.8
Geneva below dam	DS FF	57.46	48	30	133.0
North Batavia above dam	US IMP	55.70	30	18	32.0
North Batavia below dam	DS FF	55.07	44	27	74.0
South Batavia above dam	US IMP	54.34	32	18	57.0
South Batavia below dam	DS FF	53.73	52	33	90.0
North Aurora above dam	US IMP	52.00	36	21	24.9
North Aurora below dam	DS FF	51.45	52	33	93.0
Stolp Island above dam	US IMP	48.63	32	19	26.0
Stolp Island below dam	DS FF	48.12	46	27	92.0
Hurd's Island above dam	US IMP	47.83	32	19	43.0
Hurd's Island below dam	DS FF	47.51	48	27	100.0
Montgomery above dam	US IMP	46.50	30	16	7.0
Montgomery below dam	DS FF	46.00	42	26	97.0
Yorkville mid upper	MD FF	42.33	44	25	81.0
Yorkville mid lower	MD FF	38.58	40	21	82.0
Yorkville above dam	US IMP	36.32	24	15	25.0
Yorkville below dam	DS FF	35.60	54	33	110.0
Dayton mid upper	MD FF	25.00	50	24	73.0
Dayton mid lower	MD FF	14.24	54	31	72.0
Dayton above dam	US IMP	5.84	34	17	44.0
Dayton below dam	DS FF	5.27	46	35	104.8

Table A3. Percentage of individuals and fish species with various types of anomalies for 40 stations on the Fox River between McHenry and Dayton, Illinois. Fish were sampled by boat electrofishing, backpack electrofishing, and seining during July through September 2000.

		River	All anomalies		DELT anomalies		Anchor worm	
Station	Habitat	mile	Individuals	Species	Individuals	Species	Individuals	Species
Stratton above dam	US IMP	98.22	2.2	36.8	0.8	21.1	0.2	5.3
Stratton below dam	DS FF	97.66	2.6	21.7	1.4	17.4	0.4	8.7
Algonquin mid upper	MD IMP	93.92	24.7	50.0	11.1	37.5	3.7	12.5
Algonquin mid lower	MD IMP	88.18	3.8	25.0	0.7	6.3	2.3	12.5
Algonquin above dam	US IMP	81.91	5.8	36.4	1.6	9.1	0.5	9.1
Algonquin below dam	DS FF	81.23	10.3	33.3	3.8	23.3	1.1	10.0
Carpentersville above dam	US IMP	77.49	2.2	25.9	1.0	7.4	0.4	7.4
Carpentersville below dam	DS FF	76.82	4.8	33.3	1.7	16.7	0.6	13.3
Elgin mid upper	MD FF	74.75	3.9	15.6	1.4	12.5	0.1	3.1
Elgin mid lower	MD IMP	72.90	5.7	32.0	2.4	20.0	0.8	8.0
Elgin above dam	US IMP	71.25	12.7	40.0	3.2	26.7	1.9	13.3
Elgin below dam	DS FF	70.59	7.4	26.9	4.5	19.2	1.1	7.7
South Elgin above dam	US IMP	67.50	8.7	46.7	3.2	33.3	1.4	20.0
South Elgin below dam	DS FF	66.41	6.0	29.6	3.4	14.8	0.5	7.4
St. Charles mid upper	MD FF	64.00	4.1	47.4	1.7	15.8	2.2	36.8
St. Charles mid lower	MD IMP	61.36	25.6	50.0	4.5	12.5	21.5	43.8
St. Charles above dam	US IMP	60.00	12.8	50.0	0.4	10.0	11.5	45.0
St. Charles below dam	DS FF	59.40	23.5	46.2	8.8	23.1	11.5	30.8
Geneva above dam	US IMP	58.00	20.2	53.3	1.8	26.7	14.3	53.3
Geneva below dam	DS FF	57.46	10.1	50.0	3.1	13.3	4.9	43.3
North Batavia above dam	US IMP	55.70	10.6	66.7	0.9	11.1	7.7	55.6
North Batavia below dam	DS FF	55.07	4.1	44.4	1.4	25.9	1.7	22.2
South Batavia above dam	US IMP	54.34	6.9	66.7	0.2	5.6	4.0	50.0
South Batavia below dam	DS FF	53.73	3.4	30.3	1.2	12.1	0.5	6.1
North Aurora above dam	US IMP	52.00	1.7	66.7	0.6	38.1	0.9	47.6
North Aurora below dam	DS FF	51.45	3.2	27.3	1.5	21.2	0.6	9.1
Stolp Island above dam	US IMP	48.63	1.6	31.6	0.3	10.5	0.7	15.8
Stolp Island below dam	DS FF	48.12	3.3	44.4	1.1	18.5	0.1	3.7
Hurd's Island above dam	US IMP	47.83	5.8	31.6	1.7	15.8	1.4	15.8
Hurd's Island below dam	DS FF	47.51	2.3	25.9	1.0	18.5	0.1	3.7
Montgomery above dam	US IMP	46.50	3.0	43.8	1.4	18.8	1.4	18.8
Montgomery below dam	DS FF	46.00	10.0	53.8	1.5	19.2	6.2	34.6
Yorkville mid upper	MD FF	42.33	7.1	40.0	1.3	16.0	4.3	20.0
Yorkville mid lower	MD FF	38.58	4.7	52.4	2.4	14.3	1.1	28.6
Yorkville above dam	US IMP	36.32	8.5	66.7	0.3	6.7	6.5	40.0
Yorkville below dam	DS FF	35.60	4.2	45.5	0.4	6.1	2.9	30.3
Dayton mid upper	MD FF	25.00	1.3	12.5	0.2	4.2	0.1	4.2
Dayton mid lower	MD FF	14.24	2.2	29.0	0.5	6.5	0.7	19.4
Dayton above dam	US IMP	5.84	3.3	41.2	0.4	11.8	1.2	29.4
Dayton below dam	DS FF	5.27	4.2	17.1	2.6	11.4	1.8	5.7

Table A3. Extended.

Station	Habitat	River mile	Black spot		Leeches		Parasites	
			Individuals	Species	Individuals	Species	Individuals	Species
Stratton above dam	US IMP	98.22	0.6	5.3	2.8	10.5	0.0	0.0
Stratton below dam	DS FF	97.66	0.7	13.0	0.8	13.0	0.0	0.0
Algonquin mid upper	MD IMP	93.92	0.0	0.0	5.5	12.5	0.0	0.0
Algonquin mid lower	MD IMP	88.18	0.0	0.0	0.8	6.3	0.0	0.0
Algonquin above dam	US IMP	81.91	0.6	9.1	2.8	18.2	0.0	0.0
Algonquin below dam	DS FF	81.23	0.3	3.3	9.9	13.3	0.4	3.3
Carpentersville above dam	US IMP	77.49	0.8	11.1	0.2	3.7	0.0	0.0
Carpentersville below dam	DS FF	76.82	2.1	16.7	3.3	3.3	0.0	0.0
Elgin mid upper	MD FF	74.75	0.3	3.1	6.3	3.1	0.0	0.0
Elgin mid lower	MD IMP	72.90	1.2	8.0	1.6	8.0	0.8	8.0
Elgin above dam	US IMP	71.25	2.1	13.3	1.3	6.7	0.0	0.0
Elgin below dam	DS FF	70.59	0.3	3.8	3.5	3.8	0.5	3.8
South Elgin above dam	US IMP	67.50	2.4	13.3	1.5	20.0	2.0	13.3
South Elgin below dam	DS FF	66.41	0.5	7.4	5.5	7.4	0.6	3.7
St. Charles mid upper	MD FF	64.00	0.2	10.5	3.2	5.3	0.4	5.3
St. Charles mid lower	MD IMP	61.36	0.0	0.0	1.7	12.5	0.0	0.0
St. Charles above dam	US IMP	60.00	0.5	5.0	0.3	5.0	0.0	0.0
St. Charles below dam	DS FF	59.40	0.9	7.7	9.0	23.1	0.6	3.8
Geneva above dam	US IMP	58.00	1.1	6.7	4.1	13.3	0.0	0.0
Geneva below dam	DS FF	57.46	0.0	0.0	12.7	13.3	0.5	3.3
North Batavia above dam	US IMP	55.70	0.3	5.6	1.7	11.1	0.8	5.6
North Batavia below dam	DS FF	55.07	0.6	7.4	2.1	14.8	1.4	7.4
South Batavia above dam	US IMP	54.34	0.5	11.1	0.4	5.6	1.4	16.7
South Batavia below dam	DS FF	53.73	0.1	3.0	24.4	12.1	0.7	3.0
North Aurora above dam	US IMP	52.00	0.1	9.5	4.0	14.3	0.0	0.0
North Aurora below dam	DS FF	51.45	0.2	6.1	5.4	9.1	0.0	0.0
Stolp Island above dam	US IMP	48.63	0.0	0.0	0.0	0.0	1.5	5.3
Stolp Island below dam	DS FF	48.12	0.4	11.1	4.8	44.4	1.2	11.1
Hurd's Island above dam	US IMP	47.83	0.0	0.0	9.0	21.1	0.0	0.0
Hurd's Island below dam	DS FF	47.51	0.0	0.0	3.5	3.7	0.0	0.0
Montgomery above dam	US IMP	46.50	0.3	6.3	2.0	6.3	0.0	0.0
Montgomery below dam	DS FF	46.00	1.2	11.5	2.3	11.5	1.1	3.8
Yorkville mid upper	MD FF	42.33	0.2	4.0	5.9	16.0	0.0	0.0
Yorkville mid lower	MD FF	38.58	0.0	0.0	18.2	9.5	0.8	4.8
Yorkville above dam	US IMP	36.32	0.0	0.0	3.2	20.0	0.0	0.0
Yorkville below dam	DS FF	35.60	0.3	9.1	7.9	9.1	1.7	9.1
Dayton mid upper	MD FF	25.00	0.4	8.3	15.4	4.2	0.0	0.0
Dayton mid lower	MD FF	14.24	0.0	0.0	12.4	3.2	0.0	0.0
Dayton above dam	US IMP	5.84	0.3	5.9	8.8	17.6	0.0	0.0
Dayton below dam	DS FF	5.27	0.0	0.0	10.0	2.9	0.0	0.0

Appendix B. Macroinvertebrate Data

Table B1. Macroinvertebrate taxa sampled by kick netting and hand picking at 40 stations on the Fox River between McHenry and Dayton, Illinois during July through September 2000.

	Station, habitat, and river mile							
Taxa	Stratton above dam US IMP 98.22	Stratton below dam DS FF 97.66	Algonquin mid upper MD IMP 93.92	Algonquin mid lower MD IMP 88.18	Algonquin above dam US IMP 81.91	Algonquin below dam DS FF 81.23	Carpentersville above dam US IMP 77.49	Carpentersville below dam DS FF 76.82
Porifera (sponges)			1					
Turbellaria (flatworms)								
Dugesia tigrina	33	6		7	65	23	19	10
Bryozoa (moss animalcules)								
Oligochaeta (aquatic worms)	47		1	11	26	2	10	1
Hirudinea (leeches)								
Erpobdella punctata			1					4
Mooreobdella microstoma	2							6
Actinobdella pediculata						1		
Gloiobdella elongata								
Helobdella stagnalis	1			3	2	2	2	4
Helobdella triserialis							1	
Placobdella montifera								
Placobdella ornata								
Isopoda (sow bugs)								
Asellus intermedius	1		4	2		2		
Amphipoda (scuds)								
Gammarus pseudolimnaeus	6	8	9	6		4	5	2
Hyalella azteca			1	100	3		73	
Decopoda (crayfish and shrimps)								
Orconectes rusticus								
Orconectes virilis							1	
Hydrachnidia (water mites)								
Arrenurus sp.				1				
Koenikea sp.					3			
Krendowskia sp.					2			
Limnesia sp.				1	2		1	
Numania sp.								
Unionicola sp.	1							
Ephemeroptera (mayflies)								
Baetis sp.						4		5
Cloeon sp.				3				
Procloeon sp.				2				
Caenis sp.				5				
Cercobrachys sp.								
Hexagenia sp.								
Stenacron sp.								
Stenonema sp.								
Isonychia sp.								
Anthopotamus sp.								
Tricorythodes sp.	1			3				
Anisoptera (dragonflies)								
Anax sp.		1		1			3	
Somatochlora sp.								
Dromogomphus sp.								
Erpetogomphus sp.								
Zygoptera (damselflies)								
Hetaerina sp.								
Amphiagrion sp.								
Argia sp.								
Enallagma sp.		3	11	18	1		28	1
Ischnura sp.								
Hemiptera (true bugs)								
Belostoma sp.		2	1				5	
Corisella sp.		3						
Palmacorixa sp.	5	4		1	2	3	18	11
Sigara sp.			1					
Trichocorixa sp.	14	10	9	11	5	3	17	12
Corixidae nymphs	1	3	15	12		3	22	3
Aquarius sp.								
Gerris sp.		2	1	1			1	
Metrobates sp.						4	1	3
Rheumatobates sp.								2
Trepobates sp.		2		1				
Mesovelia sp.		2		6			10	
Ranatra sp.		2		5			2	
Notonecta sp.			1	3			1	
Neoplea sp.	1	4			1		5	
Salda sp.								
Rhagovelia sp.								

Table B1. Continued.

Taxa	Stratton above dam US IMP 98.22	Stratton below dam DS FF 97.66	Algonquin mid upper MD IMP 93.92	Algonquin mid lower MD IMP 88.18	Algonquin above dam US IMP 81.91	Algonquin below dam DS FF 81.23	Carpentersville above dam US IMP 77.49	Carpentersville below dam DS FF 76.82
	Station, habitat, and river mile							
Coleoptera (beetles)								
Chlaenius sp.								
Laccophilus sp.		2					2	
Tropisternus sp.								
Macronychus sp.								
Microcylloepus sp.						1		
Ordobrevia sp.								
Stenelmis sp.						1		1
Dineutus sp.		2		2				
Gyrinus sp.		1	6					
Haliplus sp.								
Peltodytes sp.		1		2	1			
Berosus sp.		7		1			1	
Enochrus sp.								
Sperchopsis sp.								
Tropisternus sp.		3	2			2	12	
Psephenus sp.								
Cyphon sp.								
Megaloptera (dobsonflies)								
Chauliodes sp.							2	
Corydalus sp.								
Sialis sp.								
Diptera (flies and midges)								
Ceratopogonidae								
Palpomyia sp.								
Chironomidae								
Chironomus sp.		3		2		3	6	2
Cryptochironomus sp.		3	1	2			3	4
Dicrotendipes sp.			2					
Endochironomus sp.				5			33	6
Eukieferiella sp.								4
Glyptotendipes sp.	2	47	5	19	13	43	34	9
Larsia sp.								
Microtendipes sp.								
Parachironomus sp.	1	3						
Paracladopelma sp.						3		
Polypedilum sp.		6	3			21	3	4
Procladius sp.				7	4			
Rheotanytarsus sp.								
Tanypus sp.								
Tanytarsus sp.					1			
Thienemannimyia group					1			
Empididae								
Hemerodromia sp.						1		
Ephydridae								
Notiphila sp.								
Simuliidae								
Simulium sp.			1			5		19
Stratiomyiidae								
Odontomyia sp.							3	
Stratiomys sp.				1				
Tabanidae								
Haematopota sp.								
Tipulidae								
Unknown pupae								
Trichoptera (caddis flies)								
Helicopsyche sp.								
Ceratopsyche sp.						98		85
Cheumatopsyche sp.						34		10
Hydropsyche sp.						41		9
Potamyia sp.								
Chimarra sp.								1
Cyrnellus sp.								
Paranyctiophylax sp.						1		
Lepidoptera (aquatic caterpillars)								
Petrophila sp.								

Table B1. Continued.

Taxa	Station, habitat, and river mile Stratton above dam US IMP 98.22	Stratton below dam DS FF 97.66	Algonquin mid upper MD IMP 93.92	Algonquin mid lower MD IMP 88.18	Algonquin above dam US IMP 81.91	Algonquin below dam DS FF 81.23	Carpentersville above dam US IMP 77.49	Carpentersville below dam DS FF 76.82
Gastropoda (snails and limpets)								
Ferrissia sp.								
Pomacea sp.								
Laevapex sp.								
Lymnaea sp.	1		2	1		2		
Physa sp.	34	13	4	13	14	1	13	3
Gyraulus sp.				9				
Goniobasis sp.		2				2		
Pelecypoda (clams and mussels)								
Musculium sp.								
Pisidium sp.						1	1	
Sphaerium sp.								
Alasmidonta marginata								
Lasmigona compressa							1	
Leptodea fragilis								
Quadrula pustulosa		1						
Toxolasma parvus								
Number of individuals	151	146	82	267	146	311	339	221
Number of taxa	16	28	22	34	17	28	33	26

Table B1. Extended.

Taxa	Elgin mid upper MD FF 74.75	Elgin mid lower MD IMP 72.90	Elgin above dam US IMP 71.25	Elgin below dam DS FF 70.59	South Elgin above dam US IMP 67.50	South Elgin below dam DS FF 66.41	St. Charles mid upper MD FF 64.00	St. Charles mid lower MD IMP 61.36
	Station, habitat, and river mile							
Porifera (sponges)					1			
Turbellaria (flatworms)								
Dugesia tigrina	21	5	10	39	11	7	7	36
Bryozoa (moss animalcules)								
Oligochaeta (aquatic worms)	3		1		4			1
Hirudinea (leeches)								
Erpobdella punctata		5				1		
Mooreobdella microstoma	3			2		1		
Actinobdella pediculata								
Gloiobdella elongata								
Helobdella stagnalis		3	8		4	3		
Helobdella triserialis			1			1		1
Placobdella montifera								
Placobdella ornata								
Isopoda (sow bugs)								
Asellus intermedius		1	1	1	5	2		
Amphipoda (scuds)								
Gammarus pseudolimnaeus		9	25	8	31	1	1	8
Hyalella azteca	3	4	2		10			
Decopoda (crayfish and shrimps)								
Orconectes rusticus						2		
Orconectes virilis	1							
Hydrachnidia (water mites)								
Arrenurus sp.								
Koenikea sp.								
Krendowskia sp.								
Limnesia sp.								
Numania sp.								
Unionicola sp.								
Ephemeroptera (mayflies)								
Baetis sp.	2					7	1	
Cloeon sp.						1		2
Procloeon sp.								
Caenis sp.							1	4
Cercobrachys sp.								1
Hexagenia sp.								
Stenacron sp.								
Stenonema sp.				1		1		
Isonychia sp.								
Anthopotamus sp.							2	
Tricorythodes sp.							7	
Anisoptera (dragonflies)								
Anax sp.								
Somatochlora sp.								
Dromogomphus sp.					1			
Erpetogomphus sp.								
Zygoptera (damselflies)								
Hetaerina sp.								
Amphiagrion sp.								
Argia sp.								1
Enallagma sp.		1			2	2		
Ischnura sp.								
Hemiptera (true bugs)								
Belostoma sp.	1	3		4	1			1
Corisella sp.	1		1					
Palmacorixa sp.	10	2	6		14	3	3	
Sigara sp.								
Trichocorixa sp.	22	11	6		4	7	2	15
Corixidae nymphs	16	15	7	2	19	1	5	
Aquarius sp.						1		
Gerris sp.	1				1		1	
Metrobates sp.	1			3		1		
Rheumatobates sp.		1		4				
Trepobates sp.	1			7	1	64	6	2
Mesovelia sp.	3		1			11		
Ranatra sp.				3		2		
Notonecta sp.	1	3						
Neoplea sp.		1		1	1			3
Salda sp.							1	
Rhagovelia sp.								

Table B1. Extended.

Taxa	Elgin mid upper MD FF 74.75	Elgin mid lower MD IMP 72.90	Elgin above dam US IMP 71.25	Elgin below dam DS FF 70.59	South Elgin above dam US IMP 67.50	South Elgin below dam DS FF 66.41	St. Charles mid upper MD FF 64.00	St. Charles mid lower MD IMP 61.36
	Station, habitat, and river mile							
Coleoptera (beetles)								
Chlaenius sp.					1		2	
Laccophilus sp.	1					1		
Tropisternus sp.								
Macronychus sp.				1		3		1
Microcylloepus sp.								
Ordobrevia sp.								
Stenelmis sp.								1
Dineutus sp.	3				2		2	2
Gyrinus sp.	1						1	
Haliplus sp.					2	1		
Peltodytes sp.			1		1			
Berosus sp.		4		3	3	2		5
Enochrus sp.							1	
Sperchopsis sp.								
Tropisternus sp.	2	2		3		4		
Psephenus sp.								
Cyphon sp.								
Megaloptera (dobsonflies)								
Chauliodes sp.								
Corydalus sp.								
Sialis sp.								1
Diptera (flies and midges)								
Ceratopogonidae								
Palpomyia sp.								
Chironomidae								
Chironomus sp.	9				6		2	
Cryptochironomus sp.	3				6			
Dicrotendipes sp.								
Endochironomus sp.								
Eukiefериella sp.								
Glyptotendipes sp.	12	34	52	82	39	44	9	21
Larsia sp.								
Microtendipes sp.	18			6	3			
Parachironomus sp.							2	
Paracladopelma sp.							3	
Polypedilum sp.	54	5		3	3	3	4	2
Procladius sp.								
Rheotanytarsus sp.								
Tanypus sp.								
Tanytarsus sp.								
Thienemannimyia group							3	2
Empididae								
Hemerodromia sp.								
Ephydridae								
Notiphila sp.								
Simuliidae								
Simulium sp.								
Stratiomyiidae								
Odontomyia sp.								
Stratiomys sp.								
Tabanidae								
Haematopota sp.								
Tipulidae								
Unknown pupae						1		
Trichoptera (caddis flies)								
Helicopsyche sp.								
Ceratopsyche sp.	16			3		26		
Cheumatopsyche sp.	23			28	2	7	6	
Hydropsyche sp.	34			19		8	5	1
Potamyia sp.	5			3				
Chimarra sp.								
Cyrnellus sp.								4
Paranyctiophylax sp.								
Lepidoptera (aquatic caterpillars)								
Petrophila sp.								

Table B1. Extended.

	Station, habitat, and river mile							
Taxa	Elgin mid upper MD FF 74.75	Elgin mid lower MD IMP 72.90	Elgin above dam US IMP 71.25	Elgin below dam DS FF 70.59	South Elgin above dam US IMP 67.50	South Elgin below dam DS FF 66.41	St. Charles mid upper MD FF 64.00	St. Charles mid lower MD IMP 61.36
Gastropoda (snails and limpets)								
Ferrissia sp.								
Pomacea sp.	1							
Laevapex sp.					5			2
Lymnaea sp.		1		5				
Physa sp.	14	10	2	12	10	11		6
Gyraulus sp.					2			1
Goniobasis sp.						1	1	
Pelecypoda (clams and mussels)								
Musculium sp.								
Pisidium sp.					1			
Sphaerium sp.	1	1	1			1		
Alasmidonta marginata	1							
Lasmigona compressa	1							
Leptodea fragilis								
Quadrula pustulosa								
Toxolasma parvus								
Number of individuals	289	121	125	243	196	232	78	124
Number of taxa	34	21	16	24	31	34	25	25

Table B1. Extended.

	Station, habitat, and river mile							
Taxa	St. Charles above dam US IMP 60.00	St. Charles below dam DS FF 59.40	Geneva above dam US IMP 58.00	Geneva below dam DS FF 57.46	North Batavia above dam US IMP 55.70	North Batavia below dam DS FF 55.07	South Batavia above dam US IMP 54.34	South Batavia below dam DS FF 53.73
Porifera (sponges)								
Turbellaria (flatworms)								
Dugesia tigrina		3	18	9	40	26	23	2
Bryozoa (moss animalcules)								
Oligochaeta (aquatic worms)	16				8		1	3
Hirudinea (leeches)								
Erpobdella punctata					2	6		2
Mooreobdella microstoma		5		4		4		7
Actinobdella pediculata				1				
Gloiobdella elongata								
Helobdella stagnalis	12	8				10	2	4
Helobdella triserialis								
Placobdella montifera								
Placobdella ornata							1	
Isopoda (sow bugs)								
Asellus intermedius	1	3		1	13	4		
Amphipoda (scuds)								
Gammarus pseudolimnaeus	9	1	24	2	1		7	
Hyalella azteca			13	2	6	7	9	1
Decopoda (crayfish and shrimps)								
Orconectes rusticus								
Orconectes virilis		1						1
Hydrachnidia (water mites)								
Arrenurus sp.								
Koenikea sp.								
Krendowskia sp.								
Limnesia sp.			1					
Numania sp.	1							
Unionicola sp.								
Ephemeroptera (mayflies)								
Baetis sp.		4		12		53		73
Cloeon sp.								
Procloeon sp.	1		2		1			
Caenis sp.	3				1	6	1	
Cercobrachys sp.	5							
Hexagenia sp.	1							
Stenacron sp.	1	4		1		5	1	2
Stenonema sp.		2						
I*sonychia* sp.		1						
Anthopotamus sp.		3						
Tricorythodes sp.		6				3		2
Anisoptera (dragonflies)								
Anax sp.					1			
Somatochlora sp.					1			
Dromogomphus sp.								
Erpetogomphus sp.								
Zygoptera (damselflies)								
Hetaerina sp.								
Amphiagrion sp.							2	
Argia sp.						1		
Enallagma sp.	2		5					
Ischnura sp.					1			
Hemiptera (true bugs)								
Belostoma sp.	1		1		9		1	
Corisella sp.								
Palmacorixa sp.	3		5	3	8	2	11	
Sigara sp.								
Trichocorixa sp.	43	4	15		25	11	9	2
Corixidae nymphs	42		16	2	55	5	41	1
Aquarius sp.								
Gerris sp.								
Metrobates sp.						1	1	
Rheumatobates sp.	25	34					4	
Trepobates sp.					1	1	3	6
Mesovelia sp.					1			
Ranatra sp.								
Notonecta sp.								
Neoplea sp.					2			
Salda sp.								
Rhagovelia sp.				2				

Table B1. Extended.

Taxa	St. Charles above dam US IMP 60.00	St. Charles below dam DS FF 59.40	Geneva above dam US IMP 58.00	Geneva below dam DS FF 57.46	North Batavia above dam US IMP 55.70	North Batavia below dam DS FF 55.07	South Batavia above dam US IMP 54.34	South Batavia below dam DS FF 53.73
	Station, habitat, and river mile							
Coleoptera (beetles)								
Chlaenius sp.								
Laccophilus sp.					2		3	
Tropisternus sp.								
Macronychus sp.								1
Microcylloepus sp.								
Ordobrevia sp.								
Stenelmis sp.	1	3		1	1	2		1
Dineutus sp.					1			
Gyrinus sp.								
Haliplus sp.			4					
Peltodytes sp.						1	1	
Berosus sp.								
Enochrus sp.								
Sperchopsis sp.								
Tropisternus sp.			1				7	
Psephenus sp.								
Cyphon sp.								
Megaloptera (dobsonflies)								
Chauliodes sp.								
Corydalus sp.								
Sialis sp.								
Diptera (flies and midges)								
Ceratopogonidae								
Palpomyia sp.	1							
Chironomidae								
Chironomus sp.		3	1	9	3	4	9	1
Cryptochironomus sp.	6			2				
Dicrotendipes sp.					3			
Endochironomus sp.								1
Eukieferiella sp.								
Glyptotendipes sp.	4	55	18	3	74	13	74	1
Larsia sp.								
Microtendipes sp.						10		2
Parachironomus sp.				2				
Paracladopelma sp.								
Polypedilum sp.				11	3			7
Procladius sp.	14		1		3			
Rheotanytarsus sp.								
Tanypus sp.	6				15	2		
Tanytarsus sp.								
Thienemannimyia group								3
Empididae								
Hemerodromia sp.								
Ephydridae								
Notiphila sp.								
Simuliidae								
Simulium sp.				3				
Stratiomyiidae								
Odontomyia sp.								
Stratiomys sp.								
Tabanidae								
Haematopota sp.								
Tipulidae								
Unknown pupae								
Trichoptera (caddis flies)								
Helicopsyche sp.								
Ceratopsyche sp.				28		16		15
Cheumatopsyche sp.		39	2	63	1	98		178
Hydropsyche sp.		21	1	16		16	3	
Potamyia sp.		3		8			4	8
Chimarra sp.								
Cyrnellus sp.							3	
Paranyctiophylax sp.								
Lepidoptera (aquatic caterpillars)								
Petrophila sp.				1				

Table B1. Extended.

Taxa	Station, habitat, and river mile St. Charles above dam US IMP 60.00	St. Charles below dam DS FF 59.40	Geneva above dam US IMP 58.00	Geneva below dam DS FF 57.46	North Batavia above dam US IMP 55.70	North Batavia below dam DS FF 55.07	South Batavia above dam US IMP 54.34	South Batavia below dam DS FF 53.73
Gastropoda (snails and limpets)								
Ferrissia sp.								
Pomacea sp.								
Laevapex sp.			2		4			
Lymnaea sp.			1					
Physa sp.	1	2	8	1	4	3	6	2
Gyraulus sp.			1		2			
Goniobasis sp.				3	1	1	2	
Pelecypoda (clams and mussels)								
Musculium sp.								
Pisidium sp.								
Sphaerium sp.		4		19		10	1	3
Alasmidonta marginata								
Lasmigona compressa						1		
Leptodea fragilis								
Quadrula pustulosa								
Toxolasma parvus	1					1		
Number of individuals	200	209	140	209	293	323	230	329
Number of taxa	24	22	21	26	32	30	27	26

Table B1. Extended.

Taxa	North Aurora above dam US IMP 52.00	North Aurora below dam DS FF 51.45	Stolp Island above dam US IMP 48.63	Stolp Island below dam DS FF 48.12	Hurd's Island above dam US IMP 47.83	Hurd's Island below dam DS FF 47.51	Montgomery above dam US IMP 46.50	Montgomery below dam DS FF 46.00
	Station, habitat, and river mile							
Porifera (sponges)								
Turbellaria (flatworms)								
Dugesia tigrina	9	56	84	16	70	37	7	25
Bryozoa (moss animalcules)								
Oligochaeta (aquatic worms)	4		1	1	2			3
Hirudinea (leeches)								
Erpobdella punctata			1	3	3	7		
Mooreobdella microstoma		9	1	7	2	14	2	
Actinobdella pediculata								
Gloiobdella elongata							1	1
Helobdella stagnalis	4		4	5	8	4	3	4
Helobdella triserialis				27				
Placobdella montifera					1			
Placobdella ornata					2			1
Isopoda (sow bugs)								
Asellus intermedius	1	3	1	19	18	2	3	
Amphipoda (scuds)								
Gammarus pseudolimnaeus	10			1				
Hyalella azteca	4		9	14	7	14	24	
Decopoda (crayfish and shrimps)								
Orconectes rusticus		2		1		1		
Orconectes virilis								
Hydrachnidia (water mites)								
Arrenurus sp.								
Koenikea sp.								
Krendowskia sp.								
Limnesia sp.								
Numania sp.								
Unionicola sp.								
Ephemeroptera (mayflies)								
Baetis sp.		118				61		12
Cloeon sp.					1			
Procloeon sp.			1				1	1
Caenis sp.			1				5	
Cercobrachys sp.								
Hexagenia sp.								
Stenacron sp.		1	11	21	6	2	12	12
Stenonema sp.				2				
Isonychia sp.								
Anthopotamus sp.				1	1			
Tricorythodes sp.				4	1	2	2	2
Anisoptera (dragonflies)								
Anax sp.								
Somatochlora sp.								
Dromogomphus sp.								
Erpetogomphus sp.								
Zygoptera (damselflies)								
Hetaerina sp.						2		2
Amphiagrion sp.								
Argia sp.	1		5	2	2	4	1	
Enallagma sp.	1				7			
Ischnura sp.								
Hemiptera (true bugs)								
Belostoma sp.	6							
Corisella sp.							1	
Palmacorixa sp.	36	2	20		16		26	1
Sigara sp.								
Trichocorixa sp.	111	7	47	25	15	3	22	6
Corixidae nymphs	51	4	144		17		21	2
Aquarius sp.						1		
Gerris sp.								
Metrobates sp.				1	3	1		
Rheumatobates sp.				2	2			
Trepobates sp.	12	2		6		2		1
Mesovelia sp.	2		2					
Ranatra sp.	13				3		1	
Notonecta sp.								
Neoplea sp.							1	
Salda sp.								
Rhagovelia sp.						4		1

Table B1. Extended.

Taxa	North Aurora above dam US IMP 52.00	North Aurora below dam DS FF 51.45	Stolp Island above dam US IMP 48.63	Stolp Island below dam DS FF 48.12	Hurd's Island above dam US IMP 47.83	Hurd's Island below dam DS FF 47.51	Montgomery above dam US IMP 46.50	Montgomery below dam DS FF 46.00
	Station, habitat, and river mile							
Coleoptera (beetles)								
Chlaenius sp.								
Laccophilus sp.	1				2			
Tropisternus sp.								
Macronychus sp.			1					
Microcylloepus sp.								
Ordobrevia sp.								3
Stenelmis sp.		1	10	5	3	7	6	10
Dineutus sp.	5							
Gyrinus sp.								
Haliplus sp.	1							
Peltodytes sp.								
Berosus sp.								
Enochrus sp.								
Sperchopsis sp.								1
Tropisternus sp.	7					1		1
Psephenus sp.								
Cyphon sp.								
Megaloptera (dobsonflies)								
Chauliodes sp.								
Corydalus sp.								
Sialis sp.						1		
Diptera (flies and midges)								
Ceratopogonidae								
Palpomyia sp.								
Chironomidae								
Chironomus sp.	3	19	4	9	3		3	
Cryptochironomus sp.	3		2				2	
Dicrotendipes sp.								
Endochironomus sp.						1		
Eukieferiella sp.								
Glyptotendipes sp.	53	16	21	3	34		5	8
Larsia sp.								1
Microtendipes sp.					2			
Parachironomus sp.								
Paracladopelma sp.								
Polypedilum sp.	3					15	1	8
Procladius sp.							2	2
Rheotanytarsus sp.						2		
Tanypus sp.							1	
Tanytarsus sp.								
Thienemannimyia group	3					1		2
Empididae								
Hemerodromia sp.								
Ephydridae								
Notiphila sp.								
Simuliidae								
Simulium sp.								
Stratiomyiidae								
Odontomyia sp.								
Stratiomys sp.								
Tabanidae								
Haematopota sp.								1
Tipulidae								
Unknown pupae								
Trichoptera (caddis flies)								
Helicopsyche sp.								
Ceratopsyche sp.	1	4			1			1
Cheumatopsyche sp.	3	108		22	10	126	3	59
Hydropsyche sp.	1	12		10		9		11
Potamyia sp.		1		1		4		
Chimarra sp.								
Cyrnellus sp.	1							
Paranyctiophylax sp.								
Lepidoptera (aquatic caterpillars)								
Petrophila sp.		1						

Table B1. Extended.

Taxa	North Aurora above dam US IMP 52.00	North Aurora below dam DS FF 51.45	Stolp Island above dam US IMP 48.63	Stolp Island below dam DS FF 48.12	Hurd's Island above dam US IMP 47.83	Hurd's Island below dam DS FF 47.51	Montgomery above dam US IMP 46.50	Montgomery below dam DS FF 46.00
	Station, habitat, and river mile							
Gastropoda (snails and limpets)								
Ferrissia sp.								
Pomacea sp.								
Laevapex sp.								
Lymnaea sp.				3				
Physa sp.	6	8	5	27	24	6	17	9
Gyraulus sp.								1
Goniobasis sp.		5		25	13	7	8	2
Pelecypoda (clams and mussels)								
Musculium sp.						3		
Pisidium sp.								
Sphaerium sp.		22		7	7	39		6
Alasmidonta marginata								
Lasmigona compressa	1							
Leptodea fragilis								
Quadrula pustulosa								
Toxolasma parvus								
Number of individuals	357	401	375	270	286	383	181	200
Number of taxa	30	21	21	29	31	31	27	32

Table B1. Concluded.

Taxa	Yorkville mid upper MD FF 42.33	Yorkville mid lower MD FF 38.58	Yorkville above dam US IMP 36.32	Yorkville below dam DS FF 35.60	Dayton mid upper MD FF 25.00	Dayton mid lower MD FF 14.24	Dayton above dam US IMP 5.84	Dayton below dam DS FF 5.27	All stations
	Station, habitat, and river mile								
Porifera (sponges)						1		1	4
Turbellaria (flatworms)									
Dugesia tigrina	29	2	11	5	7	7	4	6	795
Bryozoa (moss animalcules)	1								1
Oligochaeta (aquatic worms)			3		2	2			153
Hirudinea (leeches)									
Erpobdella punctata									35
Mooreobdella microstoma	11	5		1			1		87
Actinobdella pediculata									2
Gloiobdella elongata	1								3
Helobdella stagnalis	1			1					102
Helobdella triserialis				1	1		1		34
Placobdella montifera									1
Placobdella ornata									4
Isopoda (sow bugs)									
Asellus intermedius						2			90
Amphipoda (scuds)									
Gammarus pseudolimnaeus				1		2	1		182
Hyalella azteca	3		43				5		357
Decopoda (crayfish and shrimps)									
Orconectes rusticus	1								7
Orconectes virilis								1	5
Hydrachnidia (water mites)									
Arrenurus sp.									1
Koenikea sp.									3
Krendowskia sp.									2
Limnesia sp.									5
Numania sp.									1
Unionicola sp.									1
Ephemeroptera (mayflies)									
Baetis sp.	16	21		19	5	6		2	421
Cloeon sp.						1	15		23
Procloeon sp.			3	2	1		3		18
Caenis sp.	1		4	3	12	5	1	11	64
Cercobrachys sp.									6
Hexagenia sp.			1						2
Stenacron sp.	9	5	1	12	1	16		2	125
Stenonema sp.	10	5		16	9	4		31	81
Isonychia sp.	2	4		1	3	29		25	65
Anthopotamus sp.	16	37	5	30	25	33	7	6	166
Tricorythodes sp.	5	2		14	30	17	5	25	131
Anisoptera (dragonflies)									
Anax sp.									6
Somatochlora sp.			2				2		5
Dromogomphus sp.							3		4
Erpetogomphus sp.						1			1
Zygoptera (damselflies)									
Hetaerina sp.		6			6	1			17
Amphiagrion sp.			23						25
Argia sp.	2	6	24	6		7	17	3	82
Enallagma sp.	4		6				1	1	94
Ischnura sp.			2						3
Hemiptera (true bugs)									
Belostoma sp.		2	8				3		49
Corisella sp.				1					7
Palmacorixa sp.			10		1		8		234
Sigara sp.									1
Trichocorixa sp.		7	20	16	5	35	30	60	666
Corixidae nymphs	1		21		9	120	29		705
Aquarius sp.	2								4
Gerris sp.									8
Metrobates sp.	16	33		10	14	36		83	212
Rheumatobates sp.					20		11	36	141
Trepobates sp.			20		8				146
Mesovelia sp.	5	5	1		32		3		84
Ranatra sp.			2						33
Notonecta sp.									9
Neoplea sp.									20
Salda sp.									1
Rhagovelia sp.	9	3		2	14	40			75

Table B1. Concluded.

Taxa	Yorkville mid upper MD FF 42.33	Yorkville mid lower MD FF 38.58	Yorkville above dam US IMP 36.32	Yorkville below dam DS FF 35.60	Dayton mid upper MD FF 25.00	Dayton mid lower MD FF 14.24	Dayton above dam US IMP 5.84	Dayton below dam DS FF 5.27	All stations
	Station, habitat, and river mile								
Coleoptera (beetles)									
Chlaenius sp.									3
Laccophilus sp.			2				3		19
Tropisternus sp.				1					1
Macronychus sp.						2			9
Microcylloepus sp.									1
Ordobrevia sp.									3
Stenelmis sp.	6	5	15	21	13	7		12	133
Dineutus sp.			15			31	1		66
Gyrinus sp.						1			10
Haliplus sp.					1				9
Peltodytes sp.					1		2	1	12
Berosus sp.					1	1	4		32
Enochrus sp.									1
Sperchopsis sp.									1
Tropisternus sp.	2	3	3		8	2	16	1	82
Psephenus sp.	3			1					4
Cyphon sp.			1						1
Megaloptera (dobsonflies)									
Chauliodes sp.									2
Corydalus sp.	1					1			2
Sialis sp.									2
Diptera (flies and midges)									
Ceratopogonidae									
Palpomyia sp.									1
Chironomidae									
Chironomus sp.			3	44		76		3	230
Cryptochironomus sp.		6			5			6	54
Dicrotendipes sp.									5
Endochironomus sp.									46
Eukiefferiella sp.									4
Glyptotendipes sp.	5		89		8	6	107	95	1157
Larsia sp.									1
Microtendipes sp.	3				3				47
Parachironomus sp.						3			11
Paracladopelma sp.									6
Polypedilum sp.	30	44	9	3	8	3			256
Procladius sp.									33
Rheotanytarsus sp.									2
Tanypus sp.									24
Tanytarsus sp.									1
Thienemannimyia group	3				16				34
Empididae									
Hemerodromia sp.	1								2
Ephydridae									
Notiphila sp.								1	1
Simuliidae									
Simulium sp.		13		6	4	1		5	57
Stratiomyiidae									
Odontomyia sp.									3
Stratiomys sp.									1
Tabanidae									
Haematopota sp.									1
Tipulidae									
Unknown pupae									1
Trichoptera (caddis flies)									
Helicopsyche sp.	6								6
Ceratopsyche sp.	2	1							297
Cheumatopsyche sp.	104	84	1	27	5	29		47	1119
Hydropsyche sp.	9	12		8	18	37		10	311
Potamyia sp.	1			1	2	6		19	66
Chimarra sp.						1			2
Cyrnellus sp.									8
Paranyctiophylax sp.									1
Lepidoptera (aquatic caterpillars)									
Petrophila sp.									2

Table B1. Concluded.

Taxa	Station, habitat, and river mile								
	Yorkville mid upper MD FF 42.33	Yorkville mid lower MD FF 38.58	Yorkville above dam US IMP 36.32	Yorkville below dam DS FF 35.60	Dayton mid upper MD FF 25.00	Dayton mid lower MD FF 14.24	Dayton above dam US IMP 5.84	Dayton below dam DS FF 5.27	All stations
Gastropoda (snails and limpets)									
Ferrissia sp.	4	6		2					12
Pomacea sp.									1
Laevapex sp.									13
Lymnaea sp.							2		18
Physa sp.	6	6	1	6	3	4	31		346
Gyraulus sp.									16
Goniobasis sp.	6		1	11			1		92
Pelecypoda (clams and mussels)									
Musculium sp.				1					4
Pisidium sp.							1		4
Sphaerium sp.	15	5		20	2	11			175
Alasmidonta marginata									1
Lasmigona compressa									4
Leptodea fragilis								1	1
Quadrula pustulosa									1
Toxolasma parvus									2
Number of individuals	352	328	350	293	303	587	318	494	10482
Number of taxa	39	26	31	32	36	38	30	27	128

Table B2. Macroinvertebrate taxa sampled with a ponar dredge at 16 stations in impounded reaches of the Fox River between McHenry and Dayton, Illinois. Ten grabs were made at each station during July through September 2000.

	Station, habitat, and river mile							
Taxa	Stratton above dam US IMP 98.22	Algonquin mid upper MD IMP 93.92	Algonquin mid lower MD IMP 88.18	Algonquin above dam US IMP 81.91	Carpentersville above dam US IMP 77.49	Elgin mid lower MD IMP 72.90	Elgin above dam US IMP 71.25	South Elgin above dam US IMP 67.50
Turbellaria (flatworms)								
Dugesia tigrina		2	3					
Oligochaeta (aquatic worms)	30	92	171	180	175	109	331	492
Hirudinea (leeches)								
Helobdella stagnalis					2		1	1
Isopoda (sow bugs)								
Asellus intermedius								
Amphipoda (scuds)								
Gammarus pseudolimnaeus	2		1			1		3
Hyalella azteca			1		2			
Ephemeroptera (mayflies)								
Caenis sp.								
Cercobrachys sp.						1		
Hexagenia sp.				1				
Anthopotamus sp.					2			
Anisoptera (dragonflies)								
Somatochlora sp.								
Hemiptera (true bugs)								
Palmacorixa sp.						4	1	
Trichocorixa sp.					1	3		
Corixidae nymph					11	2		
Coleoptera (beetles)								
Lampyridae								
Elmidae								
Stenelmis sp.								
Diptera (flies and midges)								
Chironomidae (midges)								
Ablabesmyia sp.				3				
Chironomus sp.	23	30	10	26	59	9	30	40
Cryptochironomus sp.	3		27	7	6	5	3	3
Dicrotendipes sp.								
Glyptotendipes sp.	4						2	
Paracladopelma sp.						2		
Polypedilum sp.	3	34	17	10				
Procladius sp.	30		6	63		2	3	
Rheotanytarsus sp.								
Tanypus sp.				13				
Tanytarsus sp.		10	17					
Trichoptera (caddis flies)								
Ceratopsyche sp.					1		2	
Cheumatopsyche sp.			15		1			4
Potamyia sp.								
Gastropoda (snails and limpets)								
Physa sp.					1			
Goniobasis sp.		2						
Pelecypoda (clams and mussels)								
Pisidium sp.								
Sphaerium sp.			2				1	
Total number of individuals	95	170	270	303	261	138	374	543
Number of taxa	7	6	11	8	11	10	9	6
Percentage Oligocheata and Chironomidae	98	98	92	100	92	92	99	99

Table B2. Extended.

Taxa	Station, habitat, and river mile St. Charles mid lower MD IMP 61.36	St. Charles above dam US IMP 60.00	Geneva above dam US IMP 58.00	North Batavia above dam US IMP 55.70	North Aurora above dam US IMP 52.00	Stolp Island above dam US IMP 48.63	Yorkville above dam US IMP 36.32	Dayton above dam US IMP 5.84	All stations
Turbellaria (flatworms)									
Dugesia tigrina		1			2				8
Oligochaeta (aquatic worms)	63	10	45	29	112	41	12	11	1903
Hirudinea (leeches)									
Helobdella stagnalis					2				6
Isopoda (sow bugs)									
Asellus intermedius					1				1
Amphipoda (scuds)									
Gammarus pseudolimnaeus	1				1				9
Hyalella azteca					1		1		5
Ephemeroptera (mayflies)									
Caenis sp.						1		1	2
Cercobrachys sp.									1
Hexagenia sp.									1
Anthopotamus sp.									2
Anisoptera (dragonflies)									
Somatochlora sp.					1				1
Hemiptera (true bugs)									
Palmacorixa sp.									5
Trichocorixa sp.	2					3			9
Corixidae nymph				1					14
Coleoptera (beetles)									
Lampyridae					1				1
Elmidae									
Stenelmis sp.							2		2
Diptera (flies and midges)									
Chironomidae (midges)									
Ablabesmyia sp.									3
Chironomus sp.	15	11	44	75	100	20	26	75	593
Cryptochironomus sp.					3	5			62
Dicrotendipes sp.		2							2
Glyptotendipes sp.	4			3	20				33
Paracladopelma sp.	4								6
Polypedilum sp.	38	5		3	3		6		119
Procladius sp.		1		7	3	2			117
Rheotanytarsus sp.									0
Tanypus sp.					7	7			27
Tanytarsus sp.									27
Trichoptera (caddis flies)									
Ceratopsyche sp.									3
Cheumatopsyche sp.					1				21
Potamyia sp.					1				1
Gastropoda (snails and limpets)									
Physa sp.									1
Goniobasis sp.									2
Pelecypoda (clams and mussels)									
Pisidium sp.								1	1
Sphaerium sp.		1					1		5
Total number of individuals	127	31	89	118	259	79	48	88	2993
Number of taxa	7	7	2	6	16	7	6	4	34
Percentage Oligocheata and Chironomidae	98	94	100	99	96	95	92	98	97

Table B3. Macroinvertebrate condition index (MCI), invertebrate taxa richness, and macroinvertebrate biotic index (MBI) scores for 40 stations on the Fox River between McHenry and Dayton, Illinois. Macroinvertebrates were sampled by kick netting and hand picking during July through September 2000. The MCI was developed based on U.S. EPA Rapid Bioassessment Protocols (Barbour et al. 1999).

Station	Habitat	River mile	MCI score	Species richness	MBI score
Stratton above dam	US IMP	98.22	160	16	8.2
Stratton below dam	DS FF	97.66	122	28	8.2
Algonquin mid upper	MD IMP	93.92	182	22	6.0
Algonquin mid lower	MD IMP	88.18	280	34	6.2
Algonquin above dam	US IMP	81.91	121	17	7.6
Algonquin below dam	DS FF	81.23	454	28	5.8
Carpentersville above dam	US IMP	77.49	201	33	6.7
Carpentersville below dam	DS FF	76.82	449	26	5.4
Elgin mid upper	MD FF	74.75	379	34	6.4
Elgin mid lower	MD IMP	72.90	96	21	7.9
Elgin above dam	US IMP	71.25	58	16	7.5
Elgin below dam	DS FF	70.59	255	24	7.5
South Elgin above dam	US IMP	67.50	176	31	7.0
South Elgin below dam	DS FF	66.41	360	34	6.9
St. Charles mid upper	MD FF	64.00	329	25	6.3
St. Charles mid lower	MD IMP	61.36	265	25	6.7
St. Charles above dam	US IMP	60.00	252	24	7.5
St. Charles below dam	DS FF	59.40	384	22	7.2
Geneva above dam	US IMP	58.00	206	21	6.1
Geneva below dam	DS FF	57.46	481	26	5.7
North Batavia above dam	US IMP	55.70	178	32	8.0
North Batavia below dam	DS FF	55.07	486	30	5.9
South Batavia above dam	US IMP	54.34	176	27	8.1
South Batavia below dam	DS FF	53.73	583	26	5.5
North Aurora above dam	US IMP	52.00	227	30	7.9
North Aurora below dam	DS FF	51.45	454	21	5.8
Stolp Island above dam	US IMP	48.63	229	21	6.7
Stolp Island below dam	DS FF	48.12	376	29	6.6
Hurd's Island above dam	US IMP	47.83	285	31	7.0
Hurd's Island below dam	DS FF	47.51	476	31	5.6
Montgomery above dam	US IMP	46.50	275	27	6.6
Montgomery below dam	DS FF	46.00	475	32	6.0
Yorkville mid upper	MD FF	42.33	585	39	5.7
Yorkville mid lower	MD FF	38.58	498	26	5.5
Yorkville above dam	US IMP	36.32	249	31	7.0
Yorkville below dam	DS FF	35.60	490	32	6.2
Dayton mid upper	MD FF	25.00	490	36	5.6
Dayton mid lower	MD FF	14.24	560	38	6.2
Dayton above dam	US IMP	5.84	252	30	8.0
Dayton below dam	DS FF	5.27	418	27	6.6

Appendix C. Habitat Data

Table C1. Qualitative Habitat Evaluation Index (QHEI) scores and component metric scores for 40 stations on the Fox River between McHenry and Dayton, Illinois. Habitat was evaluated following QHEI sampling protocols (Ohio EPA 1989) during July through September 2000.

				Metric score						
Station	Habitat	River mile	QHEI score	Substrate	In-stream cover	Channel morphology	Riparian zone	Pool/glide quality	Riffle/run quality	Gradient
Stratton above dam	US IMP	98.22	38.5	14.0	8.0	5.0	4.5	1.0	0.0	6.0
Stratton below dam	DS FF	97.66	53.0	16.0	12.0	8.0	4.0	7.0	0.0	6.0
Algonquin mid upper	MD IMP	93.92	48.3	12.5	12.0	10.0	5.8	2.0	0.0	6.0
Algonquin mid lower	MD IMP	88.18	32.0	8.5	9.0	5.0	2.5	1.0	0.0	6.0
Algonquin above dam	US IMP	81.91	19.0	2.0	4.0	4.0	2.0	1.0	0.0	6.0
Algonquin below dam	DS FF	81.23	66.5	16.0	10.0	10.5	3.0	10.0	7.0	10.0
Carpentersville above dam	US IMP	77.49	41.5	9.0	12.0	6.0	6.5	2.0	0.0	6.0
Carpentersville below dam	DS FF	76.82	76.5	16.0	15.5	11.0	5.0	11.0	8.0	10.0
Elgin mid upper	MD FF	74.75	70.0	15.0	13.5	10.5	6.0	10.0	5.0	10.0
Elgin mid lower	MD IMP	72.90	49.0	11.0	12.0	8.0	6.0	2.0	0.0	10.0
Elgin above dam	US IMP	71.25	30.3	5.0	9.0	4.0	5.3	1.0	0.0	6.0
Elgin below dam	DS FF	70.59	65.5	16.0	12.0	10.5	3.0	8.0	6.0	10.0
South Elgin above dam	US IMP	67.50	31.5	9.0	7.0	5.0	2.5	2.0	0.0	6.0
South Elgin below dam	DS FF	66.41	84.8	19.0	18.0	14.0	4.8	11.0	8.0	10.0
St. Charles mid upper	MD FF	64.00	58.0	14.0	14.0	8.5	7.5	4.0	0.0	10.0
St. Charles mid lower	MD IMP	61.36	42.3	15.0	10.0	6.0	3.3	2.0	0.0	6.0
St. Charles above dam	US IMP	60.00	29.3	6.0	9.5	5.0	1.8	1.0	0.0	6.0
St. Charles below dam	DS FF	59.40	58.5	19.0	8.5	5.0	2.0	8.0	6.0	10.0
Geneva above dam	US IMP	58.00	33.8	12.0	7.0	4.5	3.3	1.0	0.0	6.0
Geneva below dam	DS FF	57.46	72.8	19.0	13.0	10.0	2.8	11.0	7.0	10.0
North Batavia above dam	US IMP	55.70	38.8	8.0	11.0	5.0	7.8	1.0	0.0	6.0
North Batavia below dam	DS FF	55.07	71.3	17.0	13.0	12.0	2.3	11.0	6.0	10.0
South Batavia above dam	US IMP	54.34	56.8	11.0	16.0	10.5	6.3	7.0	0.0	6.0
South Batavia below dam	DS FF	53.73	91.3	18.0	17.0	18.5	8.8	11.0	8.0	10.0
North Aurora above dam	US IMP	52.00	38.3	9.5	10.0	5.5	6.3	1.0	0.0	6.0
North Aurora below dam	DS FF	51.45	77.8	16.0	16.0	14.0	4.8	11.0	6.0	10.0
Stolp Island above dam	US IMP	48.63	30.0	7.0	8.5	4.5	3.0	1.0	0.0	6.0
Stolp Island below dam	DS FF	48.12	55.5	16.0	7.0	6.0	1.5	9.0	6.0	10.0
Hurd's Island above dam	US IMP	47.83	43.5	14.0	9.0	5.0	6.5	1.0	0.0	8.0
Hurd's Island below dam	DS FF	47.51	76.2	18.5	16.0	10.5	4.7	9.5	7.0	10.0
Montgomery above dam	US IMP	46.50	34.8	12.0	4.0	7.0	3.8	1.0	1.0	6.0
Montgomery below dam	DS FF	46.00	65.3	16.0	10.5	9.5	3.8	8.5	7.0	10.0
Yorkville mid upper	MD FF	42.33	82.5	17.0	19.0	15.5	5.0	11.0	5.0	10.0
Yorkville mid lower	MD FF	38.58	81.5	16.0	16.5	15.5	9.5	9.0	5.0	10.0
Yorkville above dam	US IMP	36.32	36.8	9.0	10.5	5.5	3.8	2.0	0.0	6.0
Yorkville below dam	DS FF	35.60	82.5	17.0	18.0	15.5	6.0	10.0	6.0	10.0
Dayton mid upper	MD FF	25.00	81.3	15.0	18.0	15.0	4.8	12.0	6.5	10.0
Dayton mid lower	MD FF	14.24	83.0	18.0	16.0	15.0	5.5	11.0	7.5	10.0
Dayton above dam	US IMP	5.84	34.5	9.0	7.0	4.0	7.5	1.0	0.0	6.0
Dayton below dam	DS FF	5.27	81.5	14.5	16.0	15.0	7.5	12.0	6.5	10.0

Table C2. Stream Habitat Assessment Procedure (SHAP) scores and component metric scores for 40 stations on the Fox River between McHenry and Dayton, Illinois. Habitat was evaluated following SHAP sampling protocols (Illinois EPA 1994) during July through September 2000.

				Metric score						
Station	Habitat	River mile	SHAP score	Substrate	Deposition	Substrate stability	In-stream cover	Pool substrate	Pool quality	Pool variability
Stratton above dam	US IMP	98.22	49	3	5	6	4	4	3	3
Stratton below dam	DS FF	97.66	60	5	5	5	4	4	3	2
Algonquin mid upper	MD IMP	93.92	76	3	5	3	9	3	7	1
Algonquin mid lower	MD IMP	88.18	45	3	4	2	2	5	3	2
Algonquin above dam	US IMP	81.91	28	1	3	3	3	2	1	1
Algonquin below dam	DS FF	81.23	61	11	7	6	1	1	2	1
Carpentersville above dam	US IMP	77.49	65	4	1	5	8	1	5	1
Carpentersville below dam	DS FF	76.82	99	15	4	9	7	16	4	2
Elgin mid upper	MD FF	74.75	74	12	1	5	4	4	4	4
Elgin mid lower	MD IMP	72.90	61	4	2	3	9	3	3	1
Elgin above dam	US IMP	71.25	38	2	3	2	9	2	1	1
Elgin below dam	DS FF	70.59	43	9	5	7	2	1	1	2
South Elgin above dam	US IMP	67.50	34	7	6	3	2	3	1	1
South Elgin below dam	DS FF	66.41	121	16	9	9	8	7	7	13
St. Charles mid upper	MD FF	64.00	101	16	6	9	9	5	5	4
St. Charles mid lower	MD IMP	61.36	76	11	5	6	7	11	4	4
St. Charles above dam	US IMP	60.00	38	3	2	2	4	2	1	2
St. Charles below dam	DS FF	59.40	73	17	10	10	4	4	3	4
Geneva above dam	US IMP	58.00	63	5	5	5	7	5	2	1
Geneva below dam	DS FF	57.46	118	17	9	13	9	15	9	13
North Batavia above dam	US IMP	55.70	66	5	3	4	7	2	1	2
North Batavia below dam	DS FF	55.07	120	17	10	13	8	9	9	13
South Batavia above dam	US IMP	54.34	137	18	8	14	11	13	11	8
South Batavia below dam	DS FF	53.73	158	18	9	14	11	16	11	13
North Aurora above dam	US IMP	52.00	57	2	2	2	4	1	2	2
North Aurora below dam	DS FF	51.45	137	16	10	14	11	18	11	8
Stolp Island above dam	US IMP	48.63	50	11	4	6	4	6	2	1
Stolp Island below dam	DS FF	48.12	58	19	4	15	3	2	1	1
Hurd's Island above dam	US IMP	47.83	96	17	10	13	8	6	4	4
Hurd's Island below dam	DS FF	47.51	99	15	8	12	8	6	5	4
Montgomery above dam	US IMP	46.50	45	6	7	4	2	1	1	1
Montgomery below dam	DS FF	46.00	92	18	10	13	7	7	5	2
Yorkville mid upper	MD FF	42.33	126	16	8	12	11	13	11	8
Yorkville mid lower	MD FF	38.58	154	17	7	15	11	17	13	14
Yorkville above dam	US IMP	36.32	52	5	4	7	5	1	1	1
Yorkville below dam	DS FF	35.60	141	18	11	14	11	16	7	12
Dayton mid upper	MD FF	25.00	142	16	9	15	12	16	11	8
Dayton mid lower	MD FF	14.24	131	17	9	14	10	15	12	7
Dayton above dam	US IMP	5.84	44	2	2	2	5	2	2	1
Dayton below dam	DS FF	5.27	152	19	8	14	8	16	12	14

Table C2. Extended.

Station	Habitat	River mile	Metric score: Channel alteration	Channel sinuosity	Width/depth ratio	Hydrologic diversity	Canopy	Bank stability	Land use	Flow-related refugia
Stratton above dam	US IMP	98.22	1	3	2	3	2	6	1	3
Stratton below dam	DS FF	97.66	2	4	6	4	2	7	2	5
Algonquin mid upper	MD IMP	93.92	5	6	5	4	4	10	4	7
Algonquin mid lower	MD IMP	88.18	2	5	7	4	1	2	1	2
Algonquin above dam	US IMP	81.91	1	1	3	2	1	2	1	3
Algonquin below dam	DS FF	81.23	4	6	5	5	2	5	2	3
Carpentersville above dam	US IMP	77.49	2	3	3	4	3	12	5	8
Carpentersville below dam	DS FF	76.82	5	6	3	4	3	9	6	6
Elgin mid upper	MD FF	74.75	6	5	4	6	3	8	4	4
Elgin mid lower	MD IMP	72.90	2	4	3	3	2	10	4	8
Elgin above dam	US IMP	71.25	1	1	1	1	1	2	3	8
Elgin below dam	DS FF	70.59	1	2	5	4	1	1	1	1
South Elgin above dam	US IMP	67.50	1	2	2	1	1	1	1	2
South Elgin below dam	DS FF	66.41	6	4	6	11	3	10	5	7
St. Charles mid upper	MD FF	64.00	5	7	4	5	2	11	5	8
St. Charles mid lower	MD IMP	61.36	2	3	7	3	1	5	2	5
St. Charles above dam	US IMP	60.00	2	2	5	3	3	2	2	3
St. Charles below dam	DS FF	59.40	2	2	4	6	1	2	1	3
Geneva above dam	US IMP	58.00	3	3	6	1	5	6	2	7
Geneva below dam	DS FF	57.46	2	2	2	11	2	4	2	8
North Batavia above dam	US IMP	55.70	3	4	8	1	2	12	4	8
North Batavia below dam	DS FF	55.07	4	3	6	12	2	6	1	7
South Batavia above dam	US IMP	54.34	3	4	2	9	3	15	7	11
South Batavia below dam	DS FF	53.73	7	6	7	12	3	14	7	10
North Aurora above dam	US IMP	52.00	1	3	8	2	3	12	6	7
North Aurora below dam	DS FF	51.45	5	6	7	6	2	10	3	10
Stolp Island above dam	US IMP	48.63	1	2	2	1	1	3	2	4
Stolp Island below dam	DS FF	48.12	1	1	3	2	1	2	1	2
Hurd's Island above dam	US IMP	47.83	4	3	4	2	2	12	1	6
Hurd's Island below dam	DS FF	47.51	4	5	6	6	3	8	2	7
Montgomery above dam	US IMP	46.50	2	2	8	2	1	2	2	4
Montgomery below dam	DS FF	46.00	3	4	4	5	2	3	2	7
Yorkville mid upper	MD FF	42.33	6	4	6	10	2	7	2	10
Yorkville mid lower	MD FF	38.58	7	5	5	11	2	15	6	9
Yorkville above dam	US IMP	36.32	2	2	4	2	1	10	3	4
Yorkville below dam	DS FF	35.60	6	5	5	9	3	12	3	9
Dayton mid upper	MD FF	25.00	6	4	7	8	4	13	3	10
Dayton mid lower	MD FF	14.24	6	6	4	7	1	12	3	8
Dayton above dam	US IMP	5.84	3	3	5	1	1	2	7	6
Dayton below dam	DS FF	5.27	5	5	11	11	2	12	4	11

Appendix D. Water Quality Data

Table D1. Data for 16 water quality parameters from free-flowing and impounded habitats in 11 segments of the Fox River between McHenry and Dayton, Illinois. Samples were collected mid channel at a depth of 1 ft. during early morning and late afternoon from August 6-17, 2001. UD indicates analyte was undetected in the sample.

Segment and station	Habitat	River mile	Date	Time	Temperature (˚ C)	Dissolved oxygen (mg/L)	Dissolved oxygen (% saturation)	Specific conductance (µs/cm)
Stratton - Algonquin								
Stratton below dam	Free-flowing	98.77	08-Aug-01	840	29.5	5.9	78.9	677
Stratton below dam	Free-flowing	98.77	07-Aug-01	2110	30.1	6.7	91.8	675
Algonquin above dam	Impounded	82.64	08-Aug-01	940	29.5	5.9	79.6	713
Algonquin above dam	Impounded	82.64	07-Aug-01	2335	29.8	7.5	101.4	709
Algonquin - Carpentersville								
Algonquin below dam	Free-flowing	82.51	08-Aug-01	730	29.3	5.5	73.5	718
Algonquin below dam	Free-flowing	82.51	07-Aug-01	2000	30.0	9.0	121.9	717
Carpentersville above dam	Impounded	78.27	08-Aug-01	655	28.7	3.7	49.0	789
Carpentersville above dam	Impounded	78.27	07-Aug-01	2218	30.3	7.8	106.5	772
Carpentersville - Elgin								
Carpentersville below dam	Free-flowing	78.11	10-Aug-01	613	27.2	5.0	65.0	733
Carpentersville below dam	Free-flowing	78.11	09-Aug-01	1932	30.6	8.6	115.4	792
Elgin above dam	Impounded	71.99	10-Aug-01	730	28.2	5.2	69.1	816
Elgin above dam	Impounded	71.99	09-Aug-01	2150	29.7	8.2	112.3	841
Elgin - South Elgin								
Elgin below dam	Free-flowing	71.57	10-Aug-01	655	27.8	5.9	77.3	804
Elgin below dam	Free-flowing	71.57	09-Aug-01	2054	30.0	7.5	103.7	778
South Elgin above dam	Impounded	68.31	10-Aug-01	826	27.8	4.2	56.1	858
South Elgin above dam	Impounded	68.31	09-Aug-01	2242	29.6	10.2	139.1	876
South Elgin - St. Charles								
South Elgin below dam	Free-flowing	68.08	17-Aug-01	557	22.0	6.7	78.9	840
South Elgin below dam	Free-flowing	68.08	16-Aug-01	1830	23.2	7.2	86.1	853
St. Charles above dam	Impounded	60.69	17-Aug-01	633	22.0	7.7	90.7	853
St. Charles above dam	Impounded	60.69	16-Aug-01	1912	23.4	11.1	131.6	861
Geneva - North Batavia								
Geneva below dam	Free-flowing	58.56	17-Aug-01	703	21.9	7.7	82.8	883
Geneva below dam	Free-flowing	58.56	16-Aug-01	1943	23.3	9.1	110.0	871
North Batavia above dam	Impounded	56.49	17-Aug-01	733	22.1	5.4	62.3	864
North Batavia above dam	Impounded	56.49	16-Aug-01	2013	23.3	8.3	99.8	826
South Batavia - North Aurora								
South Batavia below dam	Free-flowing	54.74	12-Aug-01	632	25.9	5.5	69.9	830
South Batavia below dam	Free-flowing	54.74	11-Aug-01	1954	27.4	8.8	114.7	833
North Aurora above dam	Impounded	52.69	12-Aug-01	723	25.2	3.6	45.6	845
North Aurora above dam	Impounded	52.69	11-Aug-01	2055	27.6	11.0	144.3	846
North Aurora - Stolp Island								
North Aurora below dam	Free-flowing	52.52	12-Aug-01	653	25.1	6.3	79.0	843
North Aurora below dam	Free-flowing	52.52	11-Aug-01	2018	27.4	8.4	108.7	836
Stolp Island above dam	Impounded	49.03	12-Aug-01	802	25.0	3.8	46.6	858
Stolp Island above dam	Impounded	49.03	11-Aug-01	2147	28.3	11.1	146.5	825
Hurds Island - Montgomery								
Hurd's Island below dam	Free-flowing	48.32	17-Aug-01	813	21.7	7.2	84.1	887
Hurd's Island below dam	Free-flowing	48.32	16-Aug-01	2058	23.1	7.8	93.4	881
Montgomery above dam	Impounded	46.85	17-Aug-01	848	21.7	6.0	69.7	891
Montgomery above dam	Impounded	46.85	16-Aug-01	2124	22.8	7.1	85.0	873
Montgomery - Yorkville								
Montgomery below dam	Free-flowing	46.76	15-Aug-01	850	24.3	6.9	84.7	885
Montgomery below dam	Free-flowing	46.76	14-Aug-01	2018	25.9	8.1	102.0	872
Yorkville above dam	Impounded	36.56	15-Aug-01	752	23.6	4.7	57.6	926
Yorkville above dam	Impounded	36.56	14-Aug-01	2124	27.5	16.6	214.9	864
Yorkville - Dayton								
Yorkville below dam	Free-flowing	36.41	15-Aug-01	813	23.6	6.8	82.4	922
Yorkville below dam	Free-flowing	36.41	14-Aug-01	2055	26.7	11.4	146.1	872
Dayton above dam	Impounded	5.80	15-Aug-01	649	24.7	10.7	131.6	828
Dayton above dam	Impounded	5.80	14-Aug-01	1912	26.0	15.8	199.8	841

Table D1. Extended.

Segment and station	Habitat	River mile	Date	Time	pH (units)	Turbidity (NTU)	Total suspended solids (mg/L)	Total organic carbon (mg/L)
Stratton - Algonquin								
Stratton below dam	Free-flowing	98.77	08-Aug-01	840	8.5	44	30	12
Stratton below dam	Free-flowing	98.77	07-Aug-01	2110	8.7	36	35	12
Algonquin above dam	Impounded	82.64	08-Aug-01	940	8.4	47	39	11
Algonquin above dam	Impounded	82.64	07-Aug-01	2335	8.6	33	31	12
Algonquin - Carpentersville								
Algonquin below dam	Free-flowing	82.51	08-Aug-01	730	8.2	39	40	11
Algonquin below dam	Free-flowing	82.51	07-Aug-01	2000	8.3	44	40	12
Carpentersville above dam	Impounded	78.27	08-Aug-01	655	8.1	57	38	11
Carpentersville above dam	Impounded	78.27	07-Aug-01	2218	8.6	34	39	13
Carpentersville - Elgin								
Carpentersville below dam	Free-flowing	78.11	10-Aug-01	613	8.1	53	55	11
Carpentersville below dam	Free-flowing	78.11	09-Aug-01	1932	8.6	46	70	11
Elgin above dam	Impounded	71.99	10-Aug-01	730	8.2	43	42	11
Elgin above dam	Impounded	71.99	09-Aug-01	2150	8.6	48	42	11
Elgin - South Elgin								
Elgin below dam	Free-flowing	71.57	10-Aug-01	655	8.2	44	42	11
Elgin below dam	Free-flowing	71.57	09-Aug-01	2054	8.6	55	61	17
South Elgin above dam	Impounded	68.31	10-Aug-01	826	8.2	32	30	11
South Elgin above dam	Impounded	68.31	09-Aug-01	2242	8.6	47	50	12
South Elgin - St. Charles								
South Elgin below dam	Free-flowing	68.08	17-Aug-01	557	8.0	49	55	13
South Elgin below dam	Free-flowing	68.08	16-Aug-01	1830	8.2	33	31	13
St. Charles above dam	Impounded	60.69	17-Aug-01	633	8.3	44	47	13
St. Charles above dam	Impounded	60.69	16-Aug-01	1912	8.7	43	44	15
Geneva - North Batavia								
Geneva below dam	Free-flowing	58.56	17-Aug-01	703	8.3	50	54	12
Geneva below dam	Free-flowing	58.56	16-Aug-01	1943	8.7	49	48	16
North Batavia above dam	Impounded	56.49	17-Aug-01	733	8.5	49	50	13
North Batavia above dam	Impounded	56.49	16-Aug-01	2013	8.6	47	48	13
South Batavia - North Aurora								
South Batavia below dam	Free-flowing	54.74	12-Aug-01	632	8.9	48	58	10
South Batavia below dam	Free-flowing	54.74	11-Aug-01	1954	9.0	48	67	10
North Aurora above dam	Impounded	52.69	12-Aug-01	723	8.8	36	43	10
North Aurora above dam	Impounded	52.69	11-Aug-01	2055	9.0	50	50	10
North Aurora - Stolp Island								
North Aurora below dam	Free-flowing	52.52	12-Aug-01	653	8.8	47	40	10
North Aurora below dam	Free-flowing	52.52	11-Aug-01	2018	9.0	49	57	10
Stolp Island above dam	Impounded	49.03	12-Aug-01	802	8.7	36	41	10
Stolp Island above dam	Impounded	49.03	11-Aug-01	2147	9.1	41	43	10
Hurds Island - Montgomery								
Hurd's Island below dam	Free-flowing	48.32	17-Aug-01	813	8.3	37	31	14
Hurd's Island below dam	Free-flowing	48.32	16-Aug-01	2058	8.5	44	45	15
Montgomery above dam	Impounded	46.85	17-Aug-01	848	8.3	39	41	13
Montgomery above dam	Impounded	46.85	16-Aug-01	2124	8.5	41	50	14
Montgomery - Yorkville								
Montgomery below dam	Free-flowing	46.76	15-Aug-01	850	8.8	37	39	14
Montgomery below dam	Free-flowing	46.76	14-Aug-01	2018	9.0	38	50	16
Yorkville above dam	Impounded	36.56	15-Aug-01	752	8.8	32	36	15
Yorkville above dam	Impounded	36.56	14-Aug-01	2124	9.4	23	32	16
Yorkville - Dayton								
Yorkville below dam	Free-flowing	36.41	15-Aug-01	813	8.8	35	32	14
Yorkville below dam	Free-flowing	36.41	14-Aug-01	2055	9.3	26	42	17
Dayton above dam	Impounded	5.80	15-Aug-01	649	9.3	35	36	12
Dayton above dam	Impounded	5.80	14-Aug-01	1912	9.4	34	54	16

Table D1. Extended.

Segment and station	Habitat	River mile	Date	Time	Chlorophyll a (µg/L)	Total phosphorus (mg/L)	Total dissolved phosphorus (mg/L)	Total nitrogen (mg/L)
Stratton - Algonquin								
Stratton below dam	Free-flowing	98.77	08-Aug-01	840	116.0	0.15	UD	1.90
Stratton below dam	Free-flowing	98.77	07-Aug-01	2110	93.5	0.12	UD	1.83
Algonquin above dam	Impounded	82.64	08-Aug-01	940	152.0	0.18	UD	2.02
Algonquin above dam	Impounded	82.64	07-Aug-01	2335	101.0	0.14	0.10	1.70
Algonquin - Carpentersville								
Algonquin below dam	Free-flowing	82.51	08-Aug-01	730	117.0	0.20	UD	2.04
Algonquin below dam	Free-flowing	82.51	07-Aug-01	2000	111.0	0.20	UD	2.08
Carpentersville above dam	Impounded	78.27	08-Aug-01	655	78.8	0.22	UD	2.22
Carpentersville above dam	Impounded	78.27	07-Aug-01	2218	119.0	0.21	0.12	2.07
Carpentersville - Elgin								
Carpentersville below dam	Free-flowing	78.11	10-Aug-01	613	101.0	0.27	0.07	2.41
Carpentersville below dam	Free-flowing	78.11	09-Aug-01	1932	113.0	0.22	UD	2.47
Elgin above dam	Impounded	71.99	10-Aug-01	730	125.0	0.29	0.07	2.32
Elgin above dam	Impounded	71.99	09-Aug-01	2150	155.0	0.34	0.12	2.47
Elgin - South Elgin								
Elgin below dam	Free-flowing	71.57	10-Aug-01	655	110.0	0.30	0.10	2.35
Elgin below dam	Free-flowing	71.57	09-Aug-01	2054	123.0	0.40	0.12	2.89
South Elgin above dam	Impounded	68.31	10-Aug-01	826	126.0	0.54	0.30	3.52
South Elgin above dam	Impounded	68.31	09-Aug-01	2242	154.0	0.53	0.25	3.31
South Elgin - St. Charles								
South Elgin below dam	Free-flowing	68.08	17-Aug-01	557	118.0	0.48	0.24	3.51
South Elgin below dam	Free-flowing	68.08	16-Aug-01	1830	120.0	0.53	0.30	3.82
St. Charles above dam	Impounded	60.69	17-Aug-01	633	110.0	0.50	0.25	3.44
St. Charles above dam	Impounded	60.69	16-Aug-01	1912	170.0	0.44	0.20	3.18
Geneva - North Batavia								
Geneva below dam	Free-flowing	58.56	17-Aug-01	703	117.0	0.49	0.22	3.42
Geneva below dam	Free-flowing	58.56	16-Aug-01	1943	206.0	0.49	0.23	3.27
North Batavia above dam	Impounded	56.49	17-Aug-01	733	161.0	0.45	0.18	3.22
North Batavia above dam	Impounded	56.49	16-Aug-01	2013	170.0	0.43	0.18	3.00
South Batavia - North Aurora								
South Batavia below dam	Free-flowing	54.74	12-Aug-01	632	188.0	0.54	0.24	3.14
South Batavia below dam	Free-flowing	54.74	11-Aug-01	1954	141.0	0.58	0.25	3.22
North Aurora above dam	Impounded	52.69	12-Aug-01	723	171.0	0.55	0.25	3.17
North Aurora above dam	Impounded	52.69	11-Aug-01	2055	253.0	0.59	0.26	3.14
North Aurora - Stolp Island								
North Aurora below dam	Free-flowing	52.52	12-Aug-01	653	161.0	0.53	0.24	3.00
North Aurora below dam	Free-flowing	52.52	11-Aug-01	2018	273.0	0.55	0.24	3.06
Stolp Island above dam	Impounded	49.03	12-Aug-01	802	175.0	0.53	0.26	2.99
Stolp Island above dam	Impounded	49.03	11-Aug-01	2147	117.0	0.42	0.22	2.01
Hurds Island - Montgomery								
Hurd's Island below dam	Free-flowing	48.32	17-Aug-01	813	94.4	0.48	0.27	3.31
Hurd's Island below dam	Free-flowing	48.32	16-Aug-01	2058	140.0	0.49	0.27	3.22
Montgomery above dam	Impounded	46.85	17-Aug-01	848	76.3	0.46	0.25	3.07
Montgomery above dam	Impounded	46.85	16-Aug-01	2124	127.0	0.46	0.27	3.12
Montgomery - Yorkville								
Montgomery below dam	Free-flowing	46.76	15-Aug-01	850	113.0	0.49	0.22	2.87
Montgomery below dam	Free-flowing	46.76	14-Aug-01	2018	130.0	0.50	0.22	2.80
Yorkville above dam	Impounded	36.56	15-Aug-01	752	144.0	0.67	0.38	3.51
Yorkville above dam	Impounded	36.56	14-Aug-01	2124	138.0	0.45	0.24	2.11
Yorkville - Dayton								
Yorkville below dam	Free-flowing	36.41	15-Aug-01	813	140.0	0.65	0.36	3.19
Yorkville below dam	Free-flowing	36.41	14-Aug-01	2055	166.0	0.51	0.25	2.47
Dayton above dam	Impounded	5.80	15-Aug-01	649	134.0	0.39	0.09	2.33
Dayton above dam	Impounded	5.80	14-Aug-01	1912	178.0	0.45	0.14	2.34

Table D1. Concluded.

Segment and station	Habitat	River mile	Date	Time	Total Kjeldahl nitrogen (mg/L)	Ammonia nitrogen (mg/L)	Unionized ammonia (mg/L)	Nitrate/nitrite nitrogen (mg/L)
Stratton - Algonquin								
Stratton below dam	Free-flowing	98.77	08-Aug-01	840	1.88	UD	UD	UD
Stratton below dam	Free-flowing	98.77	07-Aug-01	2110	1.81	UD	UD	UD
Algonquin above dam	Impounded	82.64	08-Aug-01	940	2.00	UD	UD	UD
Algonquin above dam	Impounded	82.64	07-Aug-01	2335	1.68	0.06	0.014	UD
Algonquin - Carpentersville								
Algonquin below dam	Free-flowing	82.51	08-Aug-01	730	2.02	0.07	0.008	UD
Algonquin below dam	Free-flowing	82.51	07-Aug-01	2000	2.06	0.16	0.022	UD
Carpentersville above dam	Impounded	78.27	08-Aug-01	655	1.94	0.07	0.006	0.28
Carpentersville above dam	Impounded	78.27	07-Aug-01	2218	1.91	UD	UD	0.16
Carpentersville - Elgin								
Carpentersville below dam	Free-flowing	78.11	10-Aug-01	613	1.91	0.18	0.012	0.50
Carpentersville below dam	Free-flowing	78.11	09-Aug-01	1932	2.08	UD	UD	0.39
Elgin above dam	Impounded	71.99	10-Aug-01	730	2.02	0.08	0.009	0.30
Elgin above dam	Impounded	71.99	09-Aug-01	2150	2.16	UD	UD	0.31
Elgin - South Elgin								
Elgin below dam	Free-flowing	71.57	10-Aug-01	655	2.00	UD	UD	0.35
Elgin below dam	Free-flowing	71.57	09-Aug-01	2054	2.50	0.17	0.042	0.39
South Elgin above dam	Impounded	68.31	10-Aug-01	826	2.01	0.07	0.007	1.51
South Elgin above dam	Impounded	68.31	09-Aug-01	2242	2.14	UD	UD	1.17
South Elgin - St. Charles								
South Elgin below dam	Free-flowing	68.08	17-Aug-01	557	2.12	0.22	0.010	1.39
South Elgin below dam	Free-flowing	68.08	16-Aug-01	1830	2.48	0.17	0.013	1.34
St. Charles above dam	Impounded	60.69	17-Aug-01	633	2.19	UD	UD	1.25
St. Charles above dam	Impounded	60.69	16-Aug-01	1912	2.28	UD	UD	0.90
Geneva - North Batavia								
Geneva below dam	Free-flowing	58.56	17-Aug-01	703	2.26	UD	UD	1.16
Geneva below dam	Free-flowing	58.56	16-Aug-01	1943	2.30	UD	UD	0.97
North Batavia above dam	Impounded	56.49	17-Aug-01	733	2.37	UD	UD	0.85
North Batavia above dam	Impounded	56.49	16-Aug-01	2013	2.30	0.11	0.017	0.70
South Batavia - North Aurora								
South Batavia below dam	Free-flowing	54.74	12-Aug-01	632	2.55	0.13	0.040	0.59
South Batavia below dam	Free-flowing	54.74	11-Aug-01	1954	2.63	UD	UD	0.59
North Aurora above dam	Impounded	52.69	12-Aug-01	723	2.58	0.10	0.025	0.59
North Aurora above dam	Impounded	52.69	11-Aug-01	2055	2.46	UD	UD	0.68
North Aurora - Stolp Island								
North Aurora below dam	Free-flowing	52.52	12-Aug-01	653	2.44	0.11	0.027	0.56
North Aurora below dam	Free-flowing	52.52	11-Aug-01	2018	2.61	UD	UD	0.45
Stolp Island above dam	Impounded	49.03	12-Aug-01	802	2.33	UD	UD	0.66
Stolp Island above dam	Impounded	49.03	11-Aug-01	2147	1.89	UD	UD	0.12
Hurds Island - Montgomery								
Hurd's Island below dam	Free-flowing	48.32	17-Aug-01	813	2.24	0.24	0.019	1.07
Hurd's Island below dam	Free-flowing	48.32	16-Aug-01	2058	2.23	0.20	0.027	0.99
Montgomery above dam	Impounded	46.85	17-Aug-01	848	2.04	0.22	0.018	1.03
Montgomery above dam	Impounded	46.85	16-Aug-01	2124	2.16	0.22	0.027	0.96
Montgomery - Yorkville								
Montgomery below dam	Free-flowing	46.76	15-Aug-01	850	2.15	UD	UD	0.72
Montgomery below dam	Free-flowing	46.76	14-Aug-01	2018	2.20	0.11	0.040	0.60
Yorkville above dam	Impounded	36.56	15-Aug-01	752	2.24	UD	UD	1.27
Yorkville above dam	Impounded	36.56	14-Aug-01	2124	1.85	UD	UD	0.26
Yorkville - Dayton								
Yorkville below dam	Free-flowing	36.41	15-Aug-01	813	2.19	0.11	0.028	1.00
Yorkville below dam	Free-flowing	36.41	14-Aug-01	2055	2.22	UD	UD	0.25
Dayton above dam	Impounded	5.80	15-Aug-01	649	2.31	UD	UD	UD
Dayton above dam	Impounded	5.80	14-Aug-01	1912	2.33	UD	UD	UD

Table D2. Mean (minimum - maximum) temperature, dissolved oxygen, specific conductance, and pH measured during within segment transect sampling in the Fox River between McHenry and Dayton, Illinois. Data were collected from August 28 through September 6, 2001 with continuously recording Datasondes and by point sampling at the beginning and end of each 16 h monitoring period. Sondes were set 1-1.5 ft. off bottom at four mid channel locations per river segment whereas point measurements were made at the surface, middepth, and bottom of mid channel, left-of-center, and right-of-center locations along each transect.

Segment and habitat	Transect	River mile	Number of readings	Temperature (˚C)	Dissolved oxygen (mg/L)	Dissolved oxygen (% saturation)	Specific conductance (µs/cm)	pH (units)
Algonquin - Carpentersville								
Free-flowing	T1	81.84	76	25.0 (24.0 - 26.0)	7.1 (6.2 - 9.1)	88.4 (75.7 - 115.6)	792 (781 - 811)	8.2 (8.1 - 8.5)
Free-flowing	T2	80.87	80	24.7 (23.7 - 26.0)	6.1 (5.1 - 9.2)	76.4 (62.7 - 116.9)	794 (778 - 818)	8.2 (8.0 - 8.5)
Impounded	T3	79.46	75	24.9 (23.5 - 26.6)	6.4 (4.3 - 9.8)	79.8 (52.1 - 125.7)	786 (763 - 808)	8.2 (8.0 - 8.6)
Impounded	T4	79.29	18	24.9 (23.6 - 26.2)	6.4 (3.9 - 8.9)	79.6 (47.8 - 112.7)	798 (787 - 808)	8.3 (8.0 - 8.5)
Impounded	T5	79.07	18	25.0 (23.5 - 26.6)	6.3 (3.9 - 8.9)	81.3 (47.2 - 155.6)	796 (785 - 808)	8.3 (8.1 - 8.6)
Impounded	T6	78.88	18	25.1 (23.5 - 26.6)	6.6 (3.9 - 9.4)	84.0 (47.6 - 121.0)	795 (784 - 807)	8.3 (8.1 - 8.6)
Impounded	T7	78.71	18	25.1 (23.6 - 26.6)	6.8 (3.9 - 9.7)	86.0 (46.8 - 125.0)	795 (783 - 806)	8.3 (8.1 - 8.6)
Impounded	T8	78.42	18	25.0 (23.4 - 26.6)	7.0 (3.7 - 10.8)	89.2 (45.1 - 139.3)	795 (784 - 806)	8.3 (8.1 - 8.6)
Impounded	T9	78.24	85	24.8 (23.4 - 26.7)	6.3 (3.8 - 10.3)	78.9 (45.6 - 132.8)	804 (786 - 817)	8.3 (8.0 - 8.6)
South Elgin - St. Charles								
Free-flowing	T1	67.97	77	23.9 (23.1 - 25.3)	7.5 (6.2 - 9.7)	91.1 (74.0 - 120.3)	898 (836 - 928)	8.2 (8.0 - 8.7)
Free-flowing	T2	65.58	79	23.4 (21.9 - 25.9)	6.9 (5.1 - 11.6)	82.7 (59.8 - 144.0)	881 (833 - 901)	8.3 (7.9 - 8.7)
Impounded	T3	64.05	83	24.2 (21.9 - 27.7)	7.6 (4.0 - 15.5)	93.9 (46.9 - 198.3)	823 (812 - 847)	8.4 (8.0 - 8.8)
Impounded	T4	63.69	18	24.5 (22.3 - 26.8)	9.1 (4.5 - 13.8)	112.8 (53.1 - 174.4)	835 (828 - 843)	8.5 (8.1 - 9.0)
Impounded	T5	63.01	18	23.9 (23.1 - 25.0)	9.5 (5.4 - 13.9)	116.1 (64.3 - 171.4)	836 (827 - 844)	8.5 (8.3 - 8.7)
Impounded	T6	62.35	18	24.3 (23.0 - 25.0)	10.6 (9.4 - 13.1)	128.6 (113.8 - 160.1)	837 (828 - 842)	8.5 (8.3 - 8.7)
Impounded	T7	61.75	18	24.2 (23.4 - 25.6)	11.5 (9.3 - 14.7)	140.1 (112.2 - 181.0)	832 (820 - 838)	8.6 (8.4 - 8.9)
Impounded	T8	61.18	18	23.8 (22.8 - 25.5)	10.7 (8.8 - 13.7)	129.6 (103.7 - 170.1)	831 (821 - 837)	8.6 (8.4 - 8.8)
Impounded	T9	60.70	83	23.9 (22.8 - 27.0)	10.4 (7.8 - 17.8)	125.2 (91.7 - 227.8)	853 (804 - 868)	8.6 (8.3 - 9.1)
North Aurora - Stolp Island								
Free-flowing	T1	52.38	32	25.7 (24.6 - 26.7)	8.1 (6.7 - 9.4)	102.3 (83.6 - 119.9)	917 (898 - 943)	8.5 (8.4 - 8.5)
Free-flowing	T2	50.22	27	25.4 (24.1 - 26.6)	7.1 (5.3 - 9.3)	89.8 (64.9 - 119.6)	902 (881 - 920)	8.4 (8.3 - 8.6)
Impounded	T3	49.83	82	25.1 (23.9 - 26.7)	6.6 (5.0 - 11.0)	82.9 (60.7 - 141.8)	887 (867 - 910)	8.4 (8.2 - 8.6)
Impounded	T4	49.51	18	25.1 (23.8 - 26.6)	7.0 (4.5 - 9.9)	88.2 (54.8 - 126.6)	901 (893 - 908)	8.4 (8.2 - 8.5)
Impounded	T5	49.27	18	25.2 (23.7 - 26.7)	7.4 (4.5 - 10.4)	92.8 (54.4 - 132.7)	900 (890 - 909)	8.4 (8.2 - 8.6)
Impounded	T6	49.03	82	25.3 (23.9 - 26.8)	6.7 (4.0 - 11.4)	84.8 (48.9 - 146.2)	880 (863 - 906)	8.4 (8.2 - 8.6)
Montgomery - Yorkville								
Free-flowing	T1	46.76	77	24.3 (22.9 - 25.4)	7.1 (6.3 - 10.4)	86.8 (75.2 - 128.5)	872 (846 - 887)	8.7 (8.4 - 8.8)
Free-flowing	T2	38.27	73	23.8 (20.5 - 28.1)	8.5 (4.8 - 16.7)	105.1 (55.4 - 209.0)	880 (814 - 933)	8.8 (8.3 - 9.5)
Impounded	T3	38.00	76	23.8 (20.5 - 28.0)	8.7 (4.9 - 15.5)	109.0 (54.6 - 228.2)	881 (822 - 934)	8.7 (8.2 - 9.3)
Impounded	T4	37.77	18	24.3 (20.7 - 27.9)	9.9 (4.8 - 15.4)	125.8 (54.6 - 202.1)	866 (820 - 924)	8.9 (8.4 - 9.3)
Impounded	T5	37.31	18	24.5 (20.9 - 27.9)	10.3 (3.6 - 16.9)	131.1 (41.4 - 220.8)	872 (827 - 925)	8.9 (8.4 - 9.3)
Impounded	T6	37.12	18	24.3 (21.3 - 27.7)	10.1 (3.8 - 17.0)	127.7 (44.2 - 220.1)	870 (830 - 968)	8.9 (8.3 - 9.3)
Impounded	T7	36.81	18	24.5 (22.0 - 27.0)	10.4 (4.7 - 16.6)	131.4 (54.3 - 217.4)	872 (833 - 903)	8.9 (8.6 - 9.3)
Impounded	T8	36.57	77	25.0 (22.0 - 26.7)	11.5 (4.7 - 16.7)	144.5 (55.3 - 211.7)	814 (765 - 886)	9.0 (8.6 - 9.2)

Appendix E. Sediment Data

Table E1. Water and sediment depths and sediment probing locations (UTM) for 12 US IMP and four DS FF stations in the Fox River between Algonquin and Dayton, Illinois. NA indicates not available.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Algonquin above dam	Impounded	8/23/2000	1	5.0	0.0	393432.6	4669045.8
Algonquin above dam	Impounded	8/23/2000	2	5.0	0.0	NA	NA
Algonquin above dam	Impounded	8/23/2000	3	9.0	1.2	NA	NA
Algonquin above dam	Impounded	8/23/2000	4	9.7	0.3	NA	NA
Algonquin above dam	Impounded	8/23/2000	5	8.5	0.5	NA	NA
Algonquin above dam	Impounded	8/23/2000	6	4.5	0.0	NA	NA
Algonquin above dam	Impounded	8/23/2000	7	4.0	2.3	NA	NA
Algonquin above dam	Impounded	8/23/2000	8	2.5	0.0	393555.6	4669268.8
Algonquin above dam	Impounded	8/23/2000	9	5.5	2.5	393563.4	4669266.4
Algonquin above dam	Impounded	8/23/2000	10	6.0	2.0	393578.9	4669250.0
Algonquin above dam	Impounded	8/23/2000	11	6.0	1.9	393584.6	4669220.2
Algonquin above dam	Impounded	8/23/2000	12	7.0	1.0	393596.2	4669193.1
Algonquin above dam	Impounded	8/23/2000	13	8.0	2.0	393606.1	4669177.4
Algonquin above dam	Impounded	8/23/2000	14	9.0	1.0	393609.2	4669155.3
Algonquin above dam	Impounded	8/23/2000	15	9.0	0.5	393595.4	4669131.1
Algonquin above dam	Impounded	8/23/2000	16	8.5	1.5	393576.8	4669135.8
Algonquin above dam	Impounded	8/23/2000	17	8.5	1.3	393564.6	4669138.2
Algonquin above dam	Impounded	8/23/2000	18	8.5	1.3	393560.6	4669149.1
Algonquin above dam	Impounded	8/23/2000	19	7.0	0.5	393542.6	4669160.0
Algonquin above dam	Impounded	8/23/2000	20	8.0	1.0	393528.6	4669169.4
Algonquin above dam	Impounded	8/23/2000	21	8.0	1.0	393511.5	4669178.0
Algonquin above dam	Impounded	8/23/2000	22	4.0	1.0	393496.5	4669191.5
Algonquin above dam	Impounded	8/23/2000	23	6.0	3.0	393510.0	4669174.3
Algonquin above dam	Impounded	8/23/2000	24	8.0	1.0	393509.6	4669147.5
Algonquin above dam	Impounded	8/23/2000	25	9.0	1.0	393517.0	4669121.0
Algonquin above dam	Impounded	8/23/2000	26	9.5	0.5	393515.0	4669101.3
Algonquin above dam	Impounded	8/23/2000	27	9.0	0.5	393531.7	4669073.9
Algonquin above dam	Impounded	8/23/2000	28	8.0	2.0	393518.4	4669073.1
Algonquin above dam	Impounded	8/23/2000	29	9.5	0.5	393495.1	4669072.0
Algonquin above dam	Impounded	8/23/2000	30	10.0	0.0	393479.4	4669082.0
Algonquin above dam	Impounded	8/23/2000	31	8.0	0.0	393463.6	4669092.3
Algonquin above dam	Impounded	8/23/2000	32	6.5	0.5	393454.2	4669077.9
Algonquin above dam	Impounded	8/23/2000	33	10.0	0.0	393461.1	4669055.6
Algonquin above dam	Impounded	8/23/2000	34	10.0	0.2	393473.2	4669040.0
Algonquin above dam	Impounded	8/23/2000	35	8.5	0.5	393490.1	4669028.6
Algonquin above dam	Impounded	8/23/2000	36	6.0	1.5	393498.7	4669008.2
Algonquin above dam	Impounded	8/23/2000	37	7.5	1.0	393497.5	4669008.2
Algonquin above dam	Impounded	8/23/2000	38	9.0	0.8	393479.9	4669012.2
Algonquin above dam	Impounded	8/23/2000	39	9.8	0.2	393465.2	4669021.2
Algonquin above dam	Impounded	8/23/2000	40	9.8	1.2	393449.7	4669029.8
Algonquin above dam	Impounded	8/23/2000	41	8.5	4.5	393435.7	4669034.3
Algonquin above dam	Impounded	8/23/2000	42	8.0	1.0	393537.7	4669191.8
Algonquin above dam	Impounded	8/23/2000	43	6.0	2.0	393538.6	4669212.3
Carpentersville above dam	Impounded	8/14/2000	1	1.5	2.8	393112.2	4663445.9
Carpentersville above dam	Impounded	8/14/2000	2	5.0	3.5	393141.2	4663437.4
Carpentersville above dam	Impounded	8/14/2000	3	5.0	4.0	393174.6	4663424.5
Carpentersville above dam	Impounded	8/14/2000	4	5.0	3.5	393188.9	4663450.6
Carpentersville above dam	Impounded	8/14/2000	5	2.5	2.5	393208.4	4663442.2
Carpentersville above dam	Impounded	8/14/2000	6	3.0	2.0	393231.3	4663438.9
Carpentersville above dam	Impounded	8/14/2000	7	1.5	0.0	393246.3	4663450.2
Carpentersville above dam	Impounded	8/14/2000	8	1.0	2.0	393258.0	4663455.1
Carpentersville above dam	Impounded	8/14/2000	9	2.0	2.0	393252.3	4663478.6
Carpentersville above dam	Impounded	8/14/2000	10	2.5	3.5	393234.5	4663501.9
Carpentersville above dam	Impounded	8/14/2000	11	4.0	8.0	393216.8	4663519.1
Carpentersville above dam	Impounded	8/14/2000	12	5.0	4.0	393188.9	4663544.9
Carpentersville above dam	Impounded	8/14/2000	13	5.0	2.0	393173.6	4663555.8
Carpentersville above dam	Impounded	8/14/2000	14	3.0	2.0	393168.3	4663575.2
Carpentersville above dam	Impounded	8/14/2000	15	5.0	2.0	393187.0	4663579.4
Carpentersville above dam	Impounded	8/14/2000	16	6.0	4.0	393207.3	4663580.2

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Carpentersville above dam	Impounded	8/14/2000	17	5.0	3.5	393228.1	4663579.5
Carpentersville above dam	Impounded	8/14/2000	18	3.0	3.3	393253.0	4663568.0
Carpentersville above dam	Impounded	8/14/2000	19	3.0	2.5	393270.0	4663561.4
Carpentersville above dam	Impounded	8/14/2000	20	2.0	0.3	393290.8	4663557.7
Carpentersville above dam	Impounded	8/14/2000	21	4.0	2.0	393237.5	4663403.6
Carpentersville above dam	Impounded	8/14/2000	22	3.0	1.1	393279.1	4663563.4
Carpentersville above dam	Impounded	8/14/2000	23	3.0	2.5	393275.3	4663584.0
Carpentersville above dam	Impounded	8/14/2000	24	4.0	5.0	393260.8	4663608.6
Carpentersville above dam	Impounded	8/14/2000	25	4.0	2.0	393243.4	4663633.6
Carpentersville above dam	Impounded	8/14/2000	26	1.0	3.5	393238.6	4663653.6
Carpentersville above dam	Impounded	8/14/2000	27	7.0	3.0	393235.9	4663715.6
Carpentersville above dam	Impounded	8/14/2000	28	10.5	0.0	393220.2	4663728.2
Carpentersville above dam	Impounded	8/14/2000	29	1.5	0.0	393208.2	4663742.2
Carpentersville above dam	Impounded	8/14/2000	30	8.5	1.0	393235.7	4663755.6
Carpentersville above dam	Impounded	8/14/2000	31	1.0	1.0	393262.0	4663754.8
Carpentersville above dam	Impounded	8/14/2000	32	5.5	1.0	393246.9	4663766.8
Carpentersville above dam	Impounded	8/14/2000	33	3.0	3.0	393251.6	4663741.1
Carpentersville above dam	Impounded	8/14/2000	34	1.0	1.5	393259.6	4663744.8
Carpentersville above dam	Impounded	8/14/2000	35	0.5	2.5	393249.0	4663695.1
Carpentersville above dam	Impounded	8/14/2000	36	4.0	2.0	393297.8	4663629.2
Carpentersville above dam	Impounded	8/14/2000	37	3.0	0.2	393324.1	4663647.6
Carpentersville above dam	Impounded	8/14/2000	38	6.5	2.0	393331.8	4663708.4
Carpentersville above dam	Impounded	8/14/2000	39	2.0	2.0	393311.1	4663738.1
Carpentersville above dam	Impounded	8/14/2000	40	1.5	2.0	393294.7	4663740.2
Elgin above dam	Impounded	8/15/2000	1	7.5	1.5	393196.6	4655228.6
Elgin above dam	Impounded	8/15/2000	2	6.0	1.0	393209.2	4655211.1
Elgin above dam	Impounded	8/15/2000	3	9.0	1.0	393227.3	4655218.9
Elgin above dam	Impounded	8/15/2000	4	7.5	2.0	393260.4	4655222.8
Elgin above dam	Impounded	8/15/2000	5	9.0	2.0	393275.0	4655228.5
Elgin above dam	Impounded	8/15/2000	6	8.0	3.5	393288.8	4655229.5
Elgin above dam	Impounded	8/15/2000	7	8.0	3.0	393302.0	4655235.3
Elgin above dam	Impounded	8/15/2000	8	5.0	0.0	393316.4	4655236.7
Elgin above dam	Impounded	8/15/2000	9	8.0	1.8	393204.2	4655242.5
Elgin above dam	Impounded	8/15/2000	10	7.0	3.0	393185.4	4655258.6
Elgin above dam	Impounded	8/15/2000	11	6.0	4.0	393201.6	4655274.5
Elgin above dam	Impounded	8/15/2000	12	7.0	2.0	393235.5	4655285.7
Elgin above dam	Impounded	8/15/2000	13	7.0	3.0	393269.8	4655291.6
Elgin above dam	Impounded	8/15/2000	14	7.0	2.3	393292.3	4655284.1
Elgin above dam	Impounded	8/15/2000	15	2.0	0.0	393313.4	4655278.7
Elgin above dam	Impounded	8/15/2000	16	6.0	1.5	393307.4	4655268.3
Elgin above dam	Impounded	8/15/2000	17	4.5	0.0	NA	NA
Elgin above dam	Impounded	8/15/2000	18	7.0	2.0	NA	NA
Elgin above dam	Impounded	8/15/2000	19	5.0	3.0	392997.8	4656051.1
Elgin above dam	Impounded	8/15/2000	20	4.0	3.0	393012.7	4656042.4
Elgin above dam	Impounded	8/15/2000	21	2.5	5.5	393042.2	4656012.9
Elgin above dam	Impounded	8/15/2000	22	2.0	5.5	393060.6	4655973.3
Elgin above dam	Impounded	8/15/2000	23	2.0	5.0	393125.8	4655935.8
Elgin above dam	Impounded	8/15/2000	24	7.0	2.0	393180.1	4655892.6
Elgin above dam	Impounded	8/15/2000	25	6.0	3.0	393215.5	4655868.9
Elgin above dam	Impounded	8/15/2000	26	5.0	4.0	393230.2	4655827.9
Elgin above dam	Impounded	8/15/2000	27	4.0	4.0	393242.0	4655802.1
Elgin above dam	Impounded	8/15/2000	28	5.5	4.0	393223.5	4655789.5
Elgin above dam	Impounded	8/15/2000	29	6.0	3.0	393201.2	4655761.7
Elgin above dam	Impounded	8/15/2000	30	4.0	5.8	393171.3	4655744.1
Elgin above dam	Impounded	8/15/2000	31	3.5	4.5	393143.8	4655707.6
Elgin above dam	Impounded	8/15/2000	32	4.0	4.5	393103.9	4655678.6
Elgin above dam	Impounded	8/15/2000	33	6.0	3.0	393088.6	4655638.0
Elgin above dam	Impounded	8/15/2000	34	4.0	3.0	NA	NA
Elgin above dam	Impounded	8/15/2000	35	5.0	2.5	393175.3	4655545.4
Elgin above dam	Impounded	8/15/2000	36	6.0	4.0	393221.0	4655494.2

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Elgin above dam	Impounded	8/15/2000	37	5.0	4.5	393260.9	4655456.3
Elgin above dam	Impounded	8/15/2000	38	4.0	5.8	393295.6	4655438.0
Elgin above dam	Impounded	8/15/2000	39	5.0	4.0	393284.2	4655414.8
Elgin above dam	Impounded	8/15/2000	40	6.0	4.0	393258.6	4655410.2
Elgin above dam	Impounded	8/15/2000	41	6.0	3.8	393208.0	4655398.2
Elgin above dam	Impounded	8/15/2000	42	6.5	3.3	393160.4	4655398.5
South Elgin above dam	Impounded	9/19/2000	1	1.0	1.0	392664.1	4650280.3
South Elgin above dam	Impounded	9/19/2000	2	2.0	1.0	392666.8	4650273.2
South Elgin above dam	Impounded	9/19/2000	3	1.0	2.0	392672.6	4650263.9
South Elgin above dam	Impounded	9/19/2000	4	2.0	1.0	392680.8	4650277.0
South Elgin above dam	Impounded	9/19/2000	5	2.0	1.0	392685.1	4650284.3
South Elgin above dam	Impounded	9/19/2000	6	3.0	0.0	392698.0	4650281.8
South Elgin above dam	Impounded	9/19/2000	7	3.0	0.0	392716.3	4650279.7
South Elgin above dam	Impounded	9/19/2000	8	4.0	0.0	392726.7	4650283.1
South Elgin above dam	Impounded	9/19/2000	9	9.0	0.0	392756.7	4650274.8
South Elgin above dam	Impounded	9/19/2000	10	8.0	0.0	392780.5	4650268.3
South Elgin above dam	Impounded	9/19/2000	11	6.0	2.0	392814.8	4650279.7
South Elgin above dam	Impounded	9/19/2000	12	6.0	2.0	392840.8	4650284.8
South Elgin above dam	Impounded	9/19/2000	13	6.0	2.0	392853.7	4650278.6
South Elgin above dam	Impounded	9/19/2000	14	4.0	3.0	392869.7	4650270.2
South Elgin above dam	Impounded	9/19/2000	15	1.0	1.0	392880.2	4650260.1
South Elgin above dam	Impounded	9/19/2000	16	4.0	1.0	392865.7	4650280.7
South Elgin above dam	Impounded	9/19/2000	17	6.0	2.0	392842.4	4650301.0
South Elgin above dam	Impounded	9/19/2000	18	7.0	1.0	392821.8	4650314.9
South Elgin above dam	Impounded	9/19/2000	19	8.0	0.0	392794.1	4650307.8
South Elgin above dam	Impounded	9/19/2000	20	8.0	0.0	392764.8	4650311.6
South Elgin above dam	Impounded	9/19/2000	21	5.0	0.0	392737.5	4650323.9
South Elgin above dam	Impounded	9/19/2000	22	3.0	1.0	392719.8	4650324.0
South Elgin above dam	Impounded	9/19/2000	23	3.0	0.0	392703.0	4650345.2
South Elgin above dam	Impounded	9/19/2000	24	1.0	1.0	392722.6	4650366.1
South Elgin above dam	Impounded	9/19/2000	25	5.0	1.0	392744.2	4650356.6
South Elgin above dam	Impounded	9/19/2000	26	8.0	0.0	392786.0	4650369.7
South Elgin above dam	Impounded	9/19/2000	27	8.0	0.0	392808.8	4650382.4
South Elgin above dam	Impounded	9/19/2000	28	6.0	2.0	392836.2	4650397.0
South Elgin above dam	Impounded	9/19/2000	29	7.0	1.0	392861.5	4650423.3
South Elgin above dam	Impounded	9/19/2000	30	6.0	1.0	392875.0	4650442.8
South Elgin above dam	Impounded	9/19/2000	31	4.0	0.0	392894.8	4650458.1
South Elgin above dam	Impounded	9/19/2000	32	6.0	1.0	392884.7	4650463.5
South Elgin above dam	Impounded	9/19/2000	33	7.0	0.0	392877.8	4650483.7
South Elgin above dam	Impounded	9/19/2000	34	6.0	1.0	392862.1	4650503.0
South Elgin above dam	Impounded	9/19/2000	35	7.0	0.0	392843.8	4650519.2
South Elgin above dam	Impounded	9/19/2000	36	8.0	0.0	392827.2	4650509.8
South Elgin above dam	Impounded	9/19/2000	37	8.0	0.0	392796.0	4650505.7
South Elgin above dam	Impounded	9/19/2000	38	4.0	0.0	392774.5	4650502.6
South Elgin above dam	Impounded	9/19/2000	40	7.0	0.0	392787.1	4650516.9
South Elgin above dam	Impounded	9/19/2000	41	8.0	0.0	392807.2	4650512.4
South Elgin above dam	Impounded	9/19/2000	42	3.0	2.0	392756.6	4650454.3
South Elgin above dam	Impounded	9/19/2000	43	5.0	1.0	392757.3	4650434.2
South Elgin above dam	Impounded	9/19/2000	47	3.0	1.0	392723.4	4650239.4
South Elgin above dam	Impounded	9/19/2000	48	7.0	0.0	392750.9	4650230.7
St. Charles above dam	Impounded	8/16/2000	1	4.5	0.0	390955.9	4641105.8
St. Charles above dam	Impounded	8/16/2000	2	7.0	1.5	390977.3	4641108.6
St. Charles above dam	Impounded	8/16/2000	3	8.0	0.7	390996.3	4641108.8
St. Charles above dam	Impounded	8/16/2000	4	7.0	1.5	391019.7	4641110.2
St. Charles above dam	Impounded	8/16/2000	5	8.5	0.0	391034.5	4641133.0
St. Charles above dam	Impounded	8/16/2000	6	5.0	3.5	391046.6	4641145.0
St. Charles above dam	Impounded	8/16/2000	7	4.0	3.5	391040.8	4641163.0
St. Charles above dam	Impounded	8/16/2000	8	8.0	0.0	391012.2	4641168.0
St. Charles above dam	Impounded	8/16/2000	9	8.2	0.0	390984.6	4641177.1
St. Charles above dam	Impounded	8/16/2000	10	8.0	0.2	390955.8	4641182.8

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
St. Charles above dam	Impounded	8/16/2000	11	5.0	0.3	390920.7	4641196.9
St. Charles above dam	Impounded	8/16/2000	12	2.8	1.0	390901.0	4641208.8
St. Charles above dam	Impounded	8/16/2000	13	0.0	0.0	390894.8	4641202.4
St. Charles above dam	Impounded	8/16/2000	14	5.4	0.2	390910.0	4641225.7
St. Charles above dam	Impounded	8/16/2000	15	7.5	0.0	390918.4	4641247.0
St. Charles above dam	Impounded	8/16/2000	16	8.0	0.0	390957.4	4641246.1
St. Charles above dam	Impounded	8/16/2000	17	8.0	0.0	390978.0	4641280.1
St. Charles above dam	Impounded	8/16/2000	18	1.5	5.2	390990.1	4641297.7
St. Charles above dam	Impounded	8/16/2000	19	1.0	6.6	390984.9	4641318.0
St. Charles above dam	Impounded	8/16/2000	20	1.5	5.5	390974.3	4641329.3
St. Charles above dam	Impounded	8/16/2000	21	3.0	5.0	390963.2	4641342.8
St. Charles above dam	Impounded	8/16/2000	22	7.8	0.0	390955.8	4641320.5
St. Charles above dam	Impounded	8/16/2000	23	7.8	0.0	390932.5	4641339.4
St. Charles above dam	Impounded	8/16/2000	24	7.6	0.0	390905.1	4641356.3
St. Charles above dam	Impounded	8/16/2000	25	7.0	0.0	390872.5	4641360.5
St. Charles above dam	Impounded	8/16/2000	26	5.0	0.5	390858.7	4641362.8
St. Charles above dam	Impounded	8/16/2000	27	7.8	0.0	390875.0	4641398.4
St. Charles above dam	Impounded	8/16/2000	28	8.0	0.0	390904.0	4641422.3
St. Charles above dam	Impounded	8/16/2000	29	7.5	0.0	390926.0	4641445.7
St. Charles above dam	Impounded	8/16/2000	30	4.0	2.6	390941.3	4641462.1
St. Charles above dam	Impounded	8/16/2000	31	7.0	0.5	390914.4	4641493.4
St. Charles above dam	Impounded	8/16/2000	32	7.5	0.0	390869.8	4641485.1
St. Charles above dam	Impounded	8/16/2000	33	4.0	0.5	390824.2	4641464.4
St. Charles above dam	Impounded	8/16/2000	34	2.0	4.0	390787.4	4641464.2
St. Charles above dam	Impounded	8/16/2000	35	1.5	4.0	390744.4	4641466.4
St. Charles above dam	Impounded	8/16/2000	36	1.0	4.5	390717.5	4641469.0
St. Charles above dam	Impounded	8/16/2000	37	1.0	3.5	390742.6	4641444.2
St. Charles above dam	Impounded	8/16/2000	38	1.0	4.0	390657.7	4641646.7
St. Charles above dam	Impounded	8/16/2000	31	5.0	0.0	390656.2	4641631.5
St. Charles above dam	Impounded	8/16/2000	40	1.0	4.0	390652.5	4641596.2
St. Charles above dam	Impounded	8/16/2000	41	1.5	3.5	390691.7	4641560.7
St. Charles above dam	Impounded	8/16/2000	42	2.0	2.0	390725.6	4641539.5
St. Charles above dam	Impounded	8/16/2000	43	2.0	1.5	390769.0	4641536.7
St. Charles above dam	Impounded	8/16/2000	44	7.5	0.5	390807.4	4641548.0
St. Charles above dam	Impounded	8/16/2000	45	8.3	0.0	390834.6	4641534.5
St. Charles above dam	Impounded	8/16/2000	46	8.0	0.0	390868.4	4641542.1
St. Charles above dam	Impounded	8/16/2000	47	2.5	1.0	390914.6	4641551.0
Geneva above dam	Impounded	8/24/2000	1	2.0	0.7	392071.0	4638233.1
Geneva above dam	Impounded	8/24/2000	2	2.5	1.2	392060.8	4638232.6
Geneva above dam	Impounded	8/24/2000	3	6.0	1.5	392048.5	4638227.7
Geneva above dam	Impounded	8/24/2000	4	7.0	0.8	392031.8	4638222.0
Geneva above dam	Impounded	8/24/2000	5	7.0	1.0	392013.7	4638224.6
Geneva above dam	Impounded	8/24/2000	6	6.2	2.3	391984.2	4638233.4
Geneva above dam	Impounded	8/24/2000	7	6.0	0.3	391955.2	4638242.2
Geneva above dam	Impounded	8/24/2000	8	4.8	3.6	391936.4	4638242.9
Geneva above dam	Impounded	8/24/2000	9	6.2	1.3	391952.8	4638243.7
Geneva above dam	Impounded	8/24/2000	10	4.5	2.8	391919.8	4638263.4
Geneva above dam	Impounded	8/24/2000	11	5.5	3.3	391934.2	4638267.5
Geneva above dam	Impounded	8/24/2000	12	6.4	1.6	391942.3	4638278.0
Geneva above dam	Impounded	8/24/2000	13	6.4	1.1	391960.7	4638280.9
Geneva above dam	Impounded	8/24/2000	14	6.4	1.0	391988.8	4638281.7
Geneva above dam	Impounded	8/24/2000	15	6.3	1.9	392014.4	4638269.9
Geneva above dam	Impounded	8/24/2000	16	7.3	0.0	392037.5	4638261.6
Geneva above dam	Impounded	8/24/2000	17	5.8	0.4	392052.5	4638252.4
Geneva above dam	Impounded	8/24/2000	18	2.9	0.1	392062.6	4638247.8
Geneva above dam	Impounded	8/24/2000	19	1.9	0.0	392073.0	4638250.5
Geneva above dam	Impounded	8/24/2000	20	5.4	0.4	392057.2	4638266.2
Geneva above dam	Impounded	8/24/2000	21	7.8	0.0	392042.3	4638269.6
Geneva above dam	Impounded	8/24/2000	22	7.1	0.3	392027.0	4638267.9
Geneva above dam	Impounded	8/24/2000	23	6.0	1.7	392000.7	4638287.5

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Geneva above dam	Impounded	8/24/2000	24	6.7	0.8	391977.0	4638300.4
Geneva above dam	Impounded	8/24/2000	25	6.8	0.6	391958.3	4638308.2
Geneva above dam	Impounded	8/24/2000	26	4.8	0.7	391939.8	4638323.4
Geneva above dam	Impounded	8/24/2000	27	6.8	0.6	391954.0	4638335.3
Geneva above dam	Impounded	8/24/2000	28	6.8	0.5	391974.5	4638329.7
Geneva above dam	Impounded	8/24/2000	29	6.4	0.7	391996.9	4638336.8
Geneva above dam	Impounded	8/24/2000	30	6.1	2.9	392023.6	4638338.0
Geneva above dam	Impounded	8/24/2000	31	6.5	1.5	392040.5	4638338.8
Geneva above dam	Impounded	8/24/2000	32	4.5	0.0	392063.6	4638331.4
Geneva above dam	Impounded	8/24/2000	33	3.0	0.0	392077.2	4638339.1
Geneva above dam	Impounded	8/24/2000	34	4.9	1.0	392069.3	4638357.3
Geneva above dam	Impounded	8/24/2000	35	6.5	2.0	392046.6	4638364.1
Geneva above dam	Impounded	8/24/2000	36	6.3	1.4	392029.7	4638377.0
Geneva above dam	Impounded	8/24/2000	37	6.1	1.0	392010.8	4638387.1
Geneva above dam	Impounded	8/24/2000	38	6.6	0.5	391996.7	4638379.1
Geneva above dam	Impounded	8/24/2000	39	6.5	0.8	391972.0	4638376.7
Geneva above dam	Impounded	8/24/2000	40	5.4	1.8	391955.2	4638389.4
Geneva above dam	Impounded	8/24/2000	41	2.2	0.0	391938.6	4638386.5
Geneva above dam	Impounded	8/24/2000	42	7.0	0.3	391948.8	4638302.7
Geneva above dam	Impounded	8/24/2000	43	6.7	0.9	391955.7	4638285.2
Geneva above dam	Impounded	8/24/2000	44	6.7	0.6	391960.8	4638285.1
Geneva above dam	Impounded	8/24/2000	45	7.0	1.3	391978.1	4638296.3
North Batavia above dam	Impounded	8/25/2000	1	9.0	0.1	391431.0	4634619.0
North Batavia above dam	Impounded	8/25/2000	2	8.8	0.6	391416.0	4634622.5
North Batavia above dam	Impounded	8/25/2000	3	7.0	1.2	391391.7	4634609.7
North Batavia above dam	Impounded	8/25/2000	4	5.5	3.5	391373.0	4634605.9
North Batavia above dam	Impounded	8/25/2000	5	0.8	7.7	391348.1	4634602.9
North Batavia above dam	Impounded	8/25/2000	6	1.1	6.9	391349.2	4634602.3
North Batavia above dam	Impounded	8/25/2000	7	4.6	2.4	391318.4	4634584.1
North Batavia above dam	Impounded	8/25/2000	8	5.2	0.8	391303.1	4634558.4
North Batavia above dam	Impounded	8/25/2000	9	6.6	3.4	391282.5	4634541.3
North Batavia above dam	Impounded	8/25/2000	10	3.3	3.2	391263.2	4634536.1
North Batavia above dam	Impounded	8/25/2000	11	4.5	2.1	391233.4	4634511.9
North Batavia above dam	Impounded	8/25/2000	33	3.0	2.0	391253.9	4634519.4
North Batavia above dam	Impounded	8/25/2000	34	3.0	0.2	391216.8	4634587.6
North Batavia above dam	Impounded	8/25/2000	35	7.0	3.1	391248.4	4634613.6
North Batavia above dam	Impounded	8/25/2000	36	4.5	2.3	391280.4	4634629.4
North Batavia above dam	Impounded	8/25/2000	37	5.0	1.8	391260.6	4634664.9
North Batavia above dam	Impounded	8/25/2000	38	7.7	2.0	391239.6	4634687.5
North Batavia above dam	Impounded	8/25/2000	38	6.0	2.5	391222.1	4634712.4
North Batavia above dam	Impounded	8/25/2000	40	3.1	5.4	391209.2	4634740.6
North Batavia above dam	Impounded	8/25/2000	41	6.4	2.2	391237.7	4634754.1
North Batavia above dam	Impounded	8/25/2000	42	3.9	4.1	391264.6	4634761.1
North Batavia above dam	Impounded	8/25/2000	43	3.0	5.6	391298.9	4634776.8
North Batavia above dam	Impounded	8/25/2000	44	5.0	3.3	391320.9	4634787.6
North Batavia above dam	Impounded	8/25/2000	45	9.5	0.0	391346.7	4634737.4
North Batavia above dam	Impounded	8/25/2000	46	1.0	4.5	391341.8	4634685.8
North Batavia above dam	Impounded	8/25/2000	47	4.0	4.1	391354.2	4634658.1
North Batavia above dam	Impounded	8/25/2000	48	8.0	0.9	391370.0	4634660.6
North Batavia above dam	Impounded	8/25/2000	49	7.5	1.5	391384.6	4634667.4
North Batavia above dam	Impounded	8/25/2000	50	9.0	1.0	391408.4	4634687.2
North Batavia above dam	Impounded	8/25/2000	51	4.9	0.1	391412.2	4634706.0
North Batavia above dam	Impounded	8/25/2000	52	7.5	2.2	391376.7	4634750.1
North Batavia above dam	Impounded	8/25/2000	53	5.8	2.6	391351.5	4634787.9
North Batavia above dam	Impounded	8/25/2000	54	7.2	2.8	391371.2	4634800.2
North Batavia above dam	Impounded	8/25/2000	55	3.0	0.5	391392.0	4634808.7
North Batavia above dam	Impounded	8/25/2000	56	6.9	1.9	391217.5	4634879.8
North Batavia above dam	Impounded	8/25/2000	57	5.7	2.2	391236.8	4634893.5
North Batavia above dam	Impounded	8/25/2000	58	4.5	2.6	391284.8	4634893.2
North Batavia above dam	Impounded	8/25/2000	59	4.1	4.8	391312.2	4634893.7

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
North Batavia above dam	Impounded	8/25/2000	60	6.5	1.2	391341.2	4634920.0
North Batavia Depot Pond	Impounded	8/25/2000	12	2.8	1.2	391251.6	4634474.2
North Batavia Depot Pond	Impounded	8/25/2000	13	4.0	2.9	391225.8	4634457.2
North Batavia Depot Pond	Impounded	8/25/2000	14	1.5	0.0	391217.3	4634426.1
North Batavia Depot Pond	Impounded	8/25/2000	15	4.5	4.1	391237.1	4634399.1
North Batavia Depot Pond	Impounded	8/25/2000	16	4.5	1.5	391233.2	4634327.7
North Batavia Depot Pond	Impounded	8/25/2000	17	4.2	0.6	391220.1	4634302.1
North Batavia Depot Pond	Impounded	8/25/2000	18	4.5	1.6	391235.9	4634250.2
North Batavia Depot Pond	Impounded	8/25/2000	19	4.1	1.4	391234.0	4634210.0
North Batavia Depot Pond	Impounded	8/25/2000	20	4.0	0.8	391234.6	4634179.6
North Batavia Depot Pond	Impounded	8/25/2000	21	4.5	2.7	391259.9	4634159.0
North Batavia Depot Pond	Impounded	8/25/2000	22	4.3	3.3	391279.8	4634167.9
North Batavia Depot Pond	Impounded	8/25/2000	23	4.9	2.7	391280.0	4634216.0
North Batavia Depot Pond	Impounded	8/25/2000	24	4.0	0.1	391285.1	4634248.8
North Batavia Depot Pond	Impounded	8/25/2000	25	5.1	4.5	391257.3	4634270.0
North Batavia Depot Pond	Impounded	8/25/2000	26	4.6	1.8	391270.6	4634303.0
North Batavia Depot Pond	Impounded	8/25/2000	27	3.6	2.4	391296.7	4634330.1
North Batavia Depot Pond	Impounded	8/25/2000	28	3.0	1.0	391270.5	4634362.1
North Batavia Depot Pond	Impounded	8/25/2000	29	4.0	1.8	391294.1	4634328.7
North Batavia Depot Pond	Impounded	8/25/2000	30	2.5	1.4	391265.9	4634415.1
North Batavia Depot Pond	Impounded	8/25/2000	31	1.4	0.0	391263.7	4634438.2
North Batavia Depot Pond	Impounded	8/25/2000	32	1.6	1.2	391262.0	4634473.9
South Batavia above dam	Impounded	9/20/2000	1	6.0	0.0	391162.0	4632516.5
South Batavia above dam	Impounded	9/20/2000	2	5.0	0.0	391172.3	4632498.9
South Batavia above dam	Impounded	9/20/2000	3	5.0	0.0	391176.6	4632484.7
South Batavia above dam	Impounded	9/20/2000	4	5.0	0.0	391191.3	4632473.2
South Batavia above dam	Impounded	9/20/2000	5	5.0	1.0	391213.9	4632466.9
South Batavia above dam	Impounded	9/20/2000	6	4.0	3.0	391227.9	4632461.4
South Batavia above dam	Impounded	9/20/2000	7	3.0	1.0	391246.8	4632455.7
South Batavia above dam	Impounded	9/20/2000	8	3.0	3.0	391261.5	4632456.6
South Batavia above dam	Impounded	9/20/2000	9	2.0	3.0	391278.8	4632460.0
South Batavia above dam	Impounded	9/20/2000	10	4.0	1.0	391289.0	4632460.7
South Batavia above dam	Impounded	9/20/2000	11	5.0	1.0	391302.6	4632458.4
South Batavia above dam	Impounded	9/20/2000	12	6.0	0.0	391319.6	4632447.9
South Batavia above dam	Impounded	9/20/2000	13	2.0	4.0	391334.0	4632445.7
South Batavia above dam	Impounded	9/20/2000	14	3.0	2.0	391325.5	4632456.3
South Batavia above dam	Impounded	9/20/2000	15	3.0	4.0	391334.9	4632469.7
South Batavia above dam	Impounded	9/20/2000	16	4.0	2.0	391328.0	4632481.4
South Batavia above dam	Impounded	9/21/2000	17	3.0	3.0	391333.1	4632494.4
South Batavia above dam	Impounded	9/21/2000	18	4.0	1.0	391319.1	4632491.5
South Batavia above dam	Impounded	9/21/2000	19	4.0	0.0	391302.7	4632496.1
South Batavia above dam	Impounded	9/21/2000	20	3.0	2.0	391283.3	4632495.6
South Batavia above dam	Impounded	9/21/2000	21	3.0	3.0	391263.4	4632500.7
South Batavia above dam	Impounded	9/21/2000	22	3.0	2.0	391242.9	4632507.4
South Batavia above dam	Impounded	9/21/2000	23	5.0	0.0	391216.5	4632507.4
South Batavia above dam	Impounded	9/21/2000	24	5.0	0.0	391195.2	4632505.5
South Batavia above dam	Impounded	9/21/2000	25	4.0	0.0	391172.7	4632507.4
South Batavia above dam	Impounded	9/21/2000	26	5.0	1.0	391164.1	4632525.4
South Batavia above dam	Impounded	9/21/2000	27	4.0	0.0	391186.7	4632517.2
South Batavia above dam	Impounded	9/21/2000	28	5.0	0.0	391207.4	4632513.1
South Batavia above dam	Impounded	9/21/2000	29	4.0	1.0	391230.4	4632505.4
South Batavia above dam	Impounded	9/21/2000	30	4.0	2.0	391262.5	4632508.6
South Batavia above dam	Impounded	9/21/2000	31	4.0	1.0	391281.9	4632518.1
South Batavia above dam	Impounded	9/21/2000	32	4.0	0.0	391303.5	4632523.1
South Batavia above dam	Impounded	9/21/2000	33	4.0	1.0	391331.8	4632525.6
South Batavia above dam	Impounded	9/21/2000	34	2.0	4.0	391349.4	4632540.9
South Batavia above dam	Impounded	9/21/2000	36	2.0	3.0	391354.7	4632563.3
South Batavia above dam	Impounded	9/21/2000	37	4.0	1.0	391340.9	4632575.0
South Batavia above dam	Impounded	9/21/2000	38	5.0	0.0	391336.5	4632581.9
South Batavia above dam	Impounded	9/21/2000	39	5.0	0.0	391325.7	4632581.0

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
South Batavia above dam	Impounded	9/21/2000	40	4.0	2.0	391305.5	4632583.8
South Batavia above dam	Impounded	9/21/2000	41	4.0	1.0	391290.6	4632593.4
South Batavia above dam	Impounded	9/21/2000	42	4.0	0.0	391278.0	4632600.1
South Batavia above dam	Impounded	9/21/2000	43	3.0	0.0	391266.3	4632606.6
South Batavia above dam	Impounded	9/21/2000	44	4.0	0.0	391252.3	4632620.8
South Batavia above dam	Impounded	9/21/2000	45	5.0	0.0	391234.6	4632636.7
South Batavia above dam	Impounded	9/21/2000	46	5.0	0.0	391226.0	4632651.9
South Batavia above dam	Impounded	9/21/2000	47	5.0	0.0	391230.3	4632669.1
South Batavia above dam	Impounded	9/21/2000	48	5.0	0.0	391253.2	4632658.5
South Batavia above dam	Impounded	9/21/2000	49	5.0	0.0	391276.4	4632655.6
South Batavia above dam	Impounded	9/21/2000	50	2.0	3.0	391312.9	4632670.2
South Batavia above dam	Impounded	9/21/2000	51	5.0	0.0	391333.6	4632670.4
South Batavia above dam	Impounded	9/21/2000	52	2.0	3.0	391315.7	4632690.2
South Batavia above dam	Impounded	9/21/2000	53	6.0	0.0	391350.5	4632669.5
South Batavia above dam	Impounded	9/21/2000	54	2.0	1.0	391374.7	4632663.4
South Batavia above dam	Impounded	9/21/2000	55	1.0	4.0	391389.2	4632667.3
South Batavia above dam	Impounded	9/21/2000	57	0.0	1.0	391419.7	4632769.4
North Aurora above dam	Impounded	9/22/2000	1	8.0	2.0	389917.4	4629322.5
North Aurora above dam	Impounded	9/22/2000	2	7.0	0.0	389913.6	4629312.4
North Aurora above dam	Impounded	9/22/2000	3	3.0	6.0	389912.0	4629297.3
North Aurora above dam	Impounded	9/22/2000	4	7.0	0.0	389924.1	4629303.8
North Aurora above dam	Impounded	9/22/2000	5	9.0	0.0	389936.7	4629311.3
North Aurora above dam	Impounded	9/22/2000	6	8.0	0.0	389956.7	4629320.3
North Aurora above dam	Impounded	9/22/2000	7	6.0	2.0	389973.3	4629324.5
North Aurora above dam	Impounded	9/22/2000	8	4.0	4.0	389994.0	4629328.1
North Aurora above dam	Impounded	9/22/2000	9	5.0	2.0	390015.0	4629330.0
North Aurora above dam	Impounded	9/22/2000	10	6.0	2.0	390036.0	4629323.6
North Aurora above dam	Impounded	9/22/2000	11	7.0	3.0	390046.1	4629321.2
North Aurora above dam	Impounded	9/22/2000	12	9.0	0.0	390052.8	4629306.1
North Aurora above dam	Impounded	9/22/2000	13	8.0	0.0	390066.7	4629303.5
North Aurora above dam	Impounded	9/22/2000	14	5.0	2.0	390074.9	4629315.8
North Aurora above dam	Impounded	9/22/2000	15	7.0	6.0	390069.4	4629322.3
North Aurora above dam	Impounded	9/22/2000	16	8.0	1.0	390051.5	4629315.1
North Aurora above dam	Impounded	9/22/2000	17	6.0	4.0	390035.8	4629319.6
North Aurora above dam	Impounded	9/22/2000	18	6.0	2.0	390021.0	4629332.5
North Aurora above dam	Impounded	9/22/2000	19	3.0	4.0	390006.5	4629345.9
North Aurora above dam	Impounded	9/22/2000	20	5.0	3.0	389983.2	4629357.5
North Aurora above dam	Impounded	9/22/2000	21	7.0	2.0	389956.7	4629370.0
North Aurora above dam	Impounded	9/22/2000	22	9.0	0.0	389932.0	4629377.0
North Aurora above dam	Impounded	9/22/2000	23	8.0	0.0	389913.7	4629383.1
North Aurora above dam	Impounded	9/25/2000	23	4.0	0.0	389910.2	4629369.2
North Aurora above dam	Impounded	9/25/2000	24	9.0	0.0	389927.6	4629369.2
North Aurora above dam	Impounded	9/25/2000	25	8.0	1.0	389958.1	4629376.0
North Aurora above dam	Impounded	9/25/2000	26	6.0	4.0	389978.5	4629384.9
North Aurora above dam	Impounded	9/25/2000	27	3.0	5.0	390002.9	4629385.7
North Aurora above dam	Impounded	9/25/2000	28	3.0	4.0	390014.1	4629391.2
North Aurora above dam	Impounded	9/25/2000	29	7.0	3.0	390044.3	4629388.6
North Aurora above dam	Impounded	9/25/2000	30	7.0	2.0	390072.6	4629387.1
North Aurora above dam	Impounded	9/25/2000	31	2.0	8.0	390094.8	4629394.4
North Aurora above dam	Impounded	9/25/2000	32	7.0	2.0	390074.0	4629404.5
North Aurora above dam	Impounded	9/25/2000	33	8.0	2.0	390052.0	4629412.9
North Aurora above dam	Impounded	9/25/2000	34	4.0	4.0	390020.8	4629421.1
North Aurora above dam	Impounded	9/25/2000	35	3.0	3.0	389995.7	4629435.0
North Aurora above dam	Impounded	9/25/2000	36	5.0	3.0	389975.2	4629439.3
North Aurora above dam	Impounded	9/25/2000	37	7.0	3.0	389941.1	4629456.4
North Aurora above dam	Impounded	9/25/2000	38	9.0	0.0	389920.4	4629467.1
North Aurora above dam	Impounded	9/25/2000	39	8.0	0.0	389902.0	4629493.2
North Aurora above dam	Impounded	9/25/2000	40	8.0	2.0	389932.4	4629511.4
North Aurora above dam	Impounded	9/25/2000	41	6.0	3.0	389962.1	4629516.4
North Aurora above dam	Impounded	9/25/2000	42	3.0	4.0	389989.1	4629528.1

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
North Aurora above dam	Impounded	9/25/2000	43	3.0	4.0	390015.6	4629554.8
North Aurora above dam	Impounded	9/25/2000	44	9.0	0.0	390044.5	4629548.6
North Aurora above dam	Impounded	9/25/2000	45	8.0	0.0	390068.5	4629556.1
Montgomery above dam west	Impounded	9/25/2000	1	4.0	0.0	389084.3	4621151.9
Montgomery above dam west	Impounded	9/25/2000	2	8.0	0.0	389094.1	4621134.6
Montgomery above dam west	Impounded	9/25/2000	4	8.0	0.0	389104.1	4621124.7
Montgomery above dam west	Impounded	9/25/2000	5	9.0	0.0	389116.3	4621114.2
Montgomery above dam west	Impounded	9/25/2000	6	9.0	0.0	389133.6	4621103.2
Montgomery above dam west	Impounded	9/25/2000	7	2.0	0.0	389153.0	4621111.2
Montgomery above dam west	Impounded	9/25/2000	8	8.0	0.0	389151.5	4621121.6
Montgomery above dam west	Impounded	9/25/2000	9	8.0	0.0	389140.3	4621135.9
Montgomery above dam west	Impounded	9/25/2000	10	9.0	0.0	389123.8	4621156.4
Montgomery above dam west	Impounded	9/25/2000	11	8.0	0.0	389113.4	4621184.3
Montgomery above dam west	Impounded	9/25/2000	12	8.0	0.0	389135.5	4621171.6
Montgomery above dam west	Impounded	9/25/2000	13	8.0	0.0	389148.1	4621159.9
Montgomery above dam west	Impounded	9/25/2000	14	9.0	0.0	389164.8	4621161.3
Montgomery above dam west	Impounded	9/25/2000	15	5.0	0.0	389177.7	4621164.4
Montgomery above dam west	Impounded	9/25/2000	16	7.0	0.0	389179.4	4621184.5
Montgomery above dam west	Impounded	9/25/2000	17	8.0	0.0	389171.6	4621213.6
Montgomery above dam west	Impounded	9/25/2000	18	8.0	0.0	389160.1	4621250.6
Montgomery above dam west	Impounded	9/25/2000	19	9.0	0.0	389191.6	4621269.4
Montgomery above dam west	Impounded	9/25/2000	20	4.0	0.0	389222.4	4621293.6
Montgomery above dam west	Impounded	9/25/2000	21	1.0	0.0	389243.0	4621323.9
Montgomery above dam west	Impounded	9/25/2000	22	2.0	0.0	389258.6	4621378.1
Montgomery above dam east	Impounded	9/25/2000	23	6.0	0.0	389166.8	4621063.9
Montgomery above dam east	Impounded	9/25/2000	24	7.0	6.0	389163.8	4621055.5
Montgomery above dam east	Impounded	9/25/2000	25	7.0	7.0	389180.6	4621057.7
Montgomery above dam east	Impounded	9/25/2000	26	3.0	0.0	389187.2	4621046.4
Montgomery above dam east	Impounded	9/25/2000	27	6.0	0.0	389188.6	4621056.0
Montgomery above dam east	Impounded	9/25/2000	28	7.0	7.0	389191.4	4621063.2
Montgomery above dam east	Impounded	9/25/2000	29	7.0	7.0	389182.5	4621083.3
Montgomery above dam east	Impounded	9/25/2000	30	6.0	3.0	389195.1	4621110.7
Montgomery above dam east	Impounded	9/25/2000	30	6.0	3.0	389198.6	4621115.3
Montgomery above dam east	Impounded	9/25/2000	31	6.0	0.0	389222.5	4621124.1
Montgomery above dam east	Impounded	9/25/2000	32	6.0	3.0	389222.1	4621106.7
Montgomery above dam east	Impounded	9/25/2000	33	6.0	3.0	389234.5	4621125.9
Montgomery above dam east	Impounded	9/25/2000	34	5.0	2.0	389234.0	4621162.7
Montgomery above dam east	Impounded	9/25/2000	35	6.0	3.0	389256.8	4621174.3
Montgomery above dam east	Impounded	9/25/2000	36	5.0	2.0	389277.5	4621184.1
Yorkville above dam	Impounded	9/26/2000	1	5.0	4.0	379852.7	4611096.4
Yorkville above dam	Impounded	9/26/2000	2	6.0	4.0	379845.2	4611105.1
Yorkville above dam	Impounded	9/26/2000	3	6.0	1.0	379845.6	4611115.6
Yorkville above dam	Impounded	9/26/2000	4	6.0	5.0	379848.9	4611129.3
Yorkville above dam	Impounded	9/26/2000	5	6.0	5.0	379855.3	4611147.8
Yorkville above dam	Impounded	9/26/2000	6	6.0	2.0	379860.9	4611165.7
Yorkville above dam	Impounded	9/26/2000	7	6.0	1.0	379868.4	4611189.0
Yorkville above dam	Impounded	9/26/2000	8	7.0	1.0	379868.3	4611207.8
Yorkville above dam	Impounded	9/26/2000	9	6.0	3.0	379874.5	4611229.7
Yorkville above dam	Impounded	9/26/2000	10	6.0	2.0	379876.3	4611232.3
Yorkville above dam	Impounded	9/26/2000	11	5.0	2.0	379891.0	4611254.2
Yorkville above dam	Impounded	9/26/2000	12	6.0	3.0	379897.1	4611232.7
Yorkville above dam	Impounded	9/26/2000	13	6.0	3.0	379901.9	4611219.5
Yorkville above dam	Impounded	9/26/2000	14	6.0	3.0	379909.0	4611204.3
Yorkville above dam	Impounded	9/26/2000	15	6.0	2.0	379915.5	4611190.1
Yorkville above dam	Impounded	9/26/2000	16	5.0	4.0	379917.7	4611174.7
Yorkville above dam	Impounded	9/26/2000	17	7.0	1.0	379920.4	4611144.4
Yorkville above dam	Impounded	9/26/2000	18	7.0	1.0	379921.0	4611122.0
Yorkville above dam	Impounded	9/26/2000	19	6.0	3.0	379924.1	4611103.8
Yorkville above dam	Impounded	9/26/2000	20	4.0	3.0	379927.4	4611094.4
Yorkville above dam	Impounded	9/26/2000	00		0.0	379929.1	4611085.9

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Yorkville above dam	Impounded	9/26/2000	22	4.0	4.0	379943.5	4611096.0
Yorkville above dam	Impounded	9/26/2000	23	6.0	2.0	379953.6	4611101.8
Yorkville above dam	Impounded	9/26/2000	24	7.0	1.0	379961.6	4611118.1
Yorkville above dam	Impounded	9/26/2000	25	7.0	1.0	379966.5	4611140.2
Yorkville above dam	Impounded	9/26/2000	26	6.0	0.0	379972.2	4611163.2
Yorkville above dam	Impounded	9/26/2000	27	6.0	2.0	379978.5	4611184.7
Yorkville above dam	Impounded	9/26/2000	28	3.0	5.0	379993.1	4611211.3
Yorkville above dam	Impounded	9/26/2000	29	6.0	2.0	380019.9	4611229.9
Yorkville above dam	Impounded	9/26/2000	30	6.0	2.0	380051.6	4611239.0
Yorkville above dam	Impounded	9/26/2000	31	4.0	5.0	380065.3	4611215.6
Yorkville above dam	Impounded	9/26/2000	32	3.0	4.0	380074.1	4611190.9
Yorkville above dam	Impounded	9/26/2000	33	6.0	2.0	380067.6	4611177.1
Yorkville above dam	Impounded	9/26/2000	34	6.0	2.0	380065.4	4611162.2
Yorkville above dam	Impounded	9/26/2000	35	7.0	0.0	380059.3	4611141.0
Yorkville above dam	Impounded	9/26/2000	36	8.0	0.0	380041.3	4611118.8
Yorkville above dam	Impounded	9/26/2000	37	6.0	2.0	380035.4	4611101.4
Yorkville above dam	Impounded	9/26/2000	38	3.0	2.0	380051.5	4611086.2
Yorkville above dam	Impounded	9/26/2000	39	8.0	0.0	380058.5	4611115.0
Yorkville above dam	Impounded	9/26/2000	40	7.0	0.0	380061.3	4611138.0
Yorkville above dam	Impounded	9/26/2000	41	6.0	2.0	380065.1	4611160.4
Yorkville above dam	Impounded	9/26/2000	42	4.0	3.0	380072.0	4611184.5
Yorkville above dam	Impounded	9/26/2000	43	2.0	5.0	380078.6	4611198.6
Yorkville above dam	Impounded	9/26/2000	44	6.0	3.0	380085.1	4611226.0
Yorkville above dam	Impounded	9/26/2000	45	3.0	0.0	380098.1	4611243.7
Dayton above dam	Impounded	9/18/2000	1	5.0	2.0	350481.1	4583679.3
Dayton above dam	Impounded	9/18/2000	2	7.0	3.0	350488.9	4583664.5
Dayton above dam	Impounded	9/18/2000	3	7.0	3.0	350494.4	4583658.3
Dayton above dam	Impounded	9/18/2000	4	7.0	4.0	350508.8	4583660.2
Dayton above dam	Impounded	9/18/2000	5	6.0	4.0	350537.8	4583666.2
Dayton above dam	Impounded	9/18/2000	6	5.0	3.0	350562.2	4583672.2
Dayton above dam	Impounded	9/18/2000	7	5.0	4.0	350587.3	4583677.2
Dayton above dam	Impounded	9/18/2000	8	4.0	4.0	350609.6	4583676.2
Dayton above dam	Impounded	9/18/2000	9	4.0	4.0	350623.4	4583696.2
Dayton above dam	Impounded	9/18/2000	10	2.0	1.0	350657.7	4583746.9
Dayton above dam	Impounded	9/18/2000	11	4.0	5.0	350644.6	4583752.9
Dayton above dam	Impounded	9/18/2000	12	4.0	6.0	350638.8	4583773.2
Dayton above dam	Impounded	9/18/2000	13	4.0	5.0	350630.6	4583784.7
Dayton above dam	Impounded	9/18/2000	14	4.0	6.0	350620.4	4583793.2
Dayton above dam	Impounded	9/18/2000	15	6.0	5.0	350604.9	4583811.5
Dayton above dam	Impounded	9/18/2000	16	6.0	3.0	350590.8	4583820.6
Dayton above dam	Impounded	9/18/2000	17	6.0	3.0	350569.7	4583833.6
Dayton above dam	Impounded	9/18/2000	18	7.0	4.0	350549.8	4583851.2
Dayton above dam	Impounded	9/18/2000	19	7.0	2.0	350538.0	4583863.5
Dayton above dam	Impounded	9/18/2000	20	3.0	3.0	350528.7	4583872.3
Dayton above dam	Impounded	9/18/2000	21	7.0	2.0	350541.2	4583872.8
Dayton above dam	Impounded	9/18/2000	22	7.0	3.0	350550.1	4583877.4
Dayton above dam	Impounded	9/18/2000	23	7.0	2.0	350564.1	4583882.1
Dayton above dam	Impounded	9/18/2000	24	7.0	2.0	350582.1	4583881.7
Dayton above dam	Impounded	9/18/2000	25	6.0	4.0	350602.0	4583882.5
Dayton above dam	Impounded	9/18/2000	26	6.0	3.0	350616.6	4583882.2
Dayton above dam	Impounded	9/18/2000	27	7.0	3.0	350640.7	4583887.1
Dayton above dam	Impounded	9/18/2000	28	6.0	2.0	350655.3	4583896.1
Dayton above dam	Impounded	9/18/2000	29	2.0	3.0	350674.9	4583899.2
Dayton above dam	Impounded	9/18/2000	30	4.0	3.0	350671.4	4583905.0
Dayton above dam	Impounded	9/18/2000	31	5.0	2.0	350661.9	4583911.1
Dayton above dam	Impounded	9/18/2000	32	6.0	2.0	350643.2	4583921.7
Dayton above dam	Impounded	9/18/2000	33	6.0	3.0	350621.6	4583929.0
Dayton above dam	Impounded	9/18/2000	34	7.0	2.0	350609.6	4583944.7
Dayton above dam	Impounded	9/18/2000	35	7.0	3.0	350592.7	4583957.7
Dayton above dam	Impounded	9/18/2000	36	7.0	2.0	350578.8	4583965.6

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Dayton above dam	Impounded	9/18/2000	37	7.0	2.0	350566.9	4583978.8
Dayton above dam	Impounded	9/18/2000	38	7.0	2.0	350560.0	4583992.1
Dayton above dam	Impounded	9/18/2000	39	7.0	4.0	350571.6	4583992.0
Dayton above dam	Impounded	9/18/2000	40	8.0	2.0	350581.7	4583991.9
Dayton above dam	Impounded	9/18/2000	41	8.0	0.0	350595.6	4583992.1
Dayton above dam	Impounded	9/18/2000	42	6.0	2.0	350608.7	4583999.5
Dayton above dam	Impounded	9/18/2000	44	6.0	4.0	350633.7	4583996.3
Dayton above dam	Impounded	9/18/2000	45	6.0	4.0	350652.4	4583997.5
Dayton above dam	Impounded	9/18/2000	46	4.0	4.0	350669.0	4584000.2
Dayton above dam	Impounded	9/18/2000	47	3.0	4.0	350680.7	4584006.6
Dayton above dam	Impounded	9/18/2000	48	3.0	4.0	350692.4	4584011.0
Dayton above dam	Impounded	9/18/2000	49	0.0	0.0	350699.6	4584012.4
Algonquin below dam	Free-flowing	8/18/2000	2	0.0	0.0	393389.1	4668969.5
Algonquin below dam	Free-flowing	8/18/2000	3	0.6	0.1	393394.6	4668967.9
Algonquin below dam	Free-flowing	8/18/2000	4	1.6	0.3	393402.6	4668963.1
Algonquin below dam	Free-flowing	8/18/2000	5	3.0	0.0	393408.3	4668959.7
Algonquin below dam	Free-flowing	8/18/2000	6	4.5	0.0	393409.5	4668958.9
Algonquin below dam	Free-flowing	8/18/2000	7	1.3	0.0	393403.1	4668953.0
Algonquin below dam	Free-flowing	8/18/2000	8	0.5	0.1	393398.4	4668951.4
Algonquin below dam	Free-flowing	8/18/2000	9	0.3	0.0	393392.7	4668950.1
Algonquin below dam	Free-flowing	8/18/2000	10	0.0	0.0	393388.5	4668951.1
Algonquin below dam	Free-flowing	8/18/2000	11	0.7	0.0	393397.6	4668941.2
Algonquin below dam	Free-flowing	8/18/2000	12	1.5	0.0	393402.0	4668936.7
Algonquin below dam	Free-flowing	8/18/2000	13	1.8	0.0	393401.9	4668928.3
Algonquin below dam	Free-flowing	8/18/2000	14	1.0	0.0	393394.6	4668926.8
Algonquin below dam	Free-flowing	8/18/2000	15	0.4	0.1	393390.5	4668928.5
Algonquin below dam	Free-flowing	8/18/2000	16	0.6	0.7	393383.3	4668928.2
Algonquin below dam	Free-flowing	8/18/2000	17	0.3	0.2	393385.8	4668937.1
Algonquin below dam	Free-flowing	8/18/2000	18	0.8	0.2	393394.0	4668968.6
Algonquin below dam	Free-flowing	8/18/2000	19	1.7	0.1	393402.0	4668972.0
Algonquin below dam	Free-flowing	8/18/2000	20	3.7	0.3	393405.4	4668972.0
Algonquin below dam	Free-flowing	8/18/2000	21	3.0	0.1	393403.4	4668976.0
Algonquin below dam	Free-flowing	8/18/2000	22	1.9	0.0	393399.1	4668976.7
Algonquin below dam	Free-flowing	8/18/2000	23	0.6	0.2	393393.2	4668976.2
Algonquin below dam	Free-flowing	8/18/2000	24	0.0	0.0	393385.5	4668979.6
Algonquin below dam	Free-flowing	8/18/2000	25	1.4	0.1	393387.3	4668984.1
Algonquin below dam	Free-flowing	8/18/2000	26	2.0	0.5	NA	NA
Algonquin below dam	Free-flowing	8/18/2000	26	0.0	0.0	393447.5	4668930.0
Algonquin below dam	Free-flowing	8/18/2000	27	0.8	0.1	393442.0	4668936.2
Algonquin below dam	Free-flowing	8/18/2000	28	1.8	0.1	393438.8	4668939.6
Algonquin below dam	Free-flowing	8/18/2000	29	3.2	0.4	393434.0	4668943.3
Algonquin below dam	Free-flowing	8/18/2000	30	3.6	0.1	393440.4	4668946.8
Algonquin below dam	Free-flowing	8/18/2000	31	1.3	0.1	393431.6	4668935.7
Algonquin below dam	Free-flowing	8/18/2000	32	1.4	0.1	393424.7	4668936.1
Algonquin below dam	Free-flowing	8/18/2000	33	1.6	0.4	393421.3	4668936.8
Algonquin below dam	Free-flowing	8/18/2000	34	2.5	0.0	393414.4	4668934.4
Algonquin below dam	Free-flowing	8/18/2000	35	1.7	0.0	393417.5	4668930.4
Algonquin below dam	Free-flowing	8/18/2000	36	1.2	0.0	393420.4	4668926.8
Algonquin below dam	Free-flowing	8/18/2000	37	0.3	0.2	393424.3	4668920.1
Algonquin below dam	Free-flowing	8/18/2000	38	1.2	0.0	393417.5	4668916.9
Algonquin below dam	Free-flowing	8/18/2000	39	1.0	0.0	393414.9	4668916.1
Algonquin below dam	Free-flowing	8/18/2000	41	1.3	0.2	393411.8	4668909.4
Algonquin below dam	Free-flowing	8/18/2000	42	0.7	0.0	393416.6	4668904.6
Algonquin below dam	Free-flowing	8/18/2000	43	0.0	0.0	393420.2	4668899.4
Algonquin below dam	Free-flowing	8/18/2000	44	0.6	0.2	393420.4	4668889.5
Algonquin below dam	Free-flowing	8/18/2000	45	1.4	0.1	393439.7	4668887.8
Algonquin below dam	Free-flowing	8/18/2000	46	0.5	0.0	393442.1	4668901.9
Algonquin below dam	Free-flowing	8/18/2000	47	1.3	0.0	393444.0	4668921.7
Algonquin below dam	Free-flowing	8/18/2000	49	0.3	0.1	393442.9	4668927.2
Algonquin below dam	Free-flowing	8/18/2000	50	0.0	0.0	393450.7	4668937.1

Table E1. Continued.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Carpentersville below dam	Free-flowing	8/10/2000	3	1.0	0.0	393117.1	4663285.7
Carpentersville below dam	Free-flowing	8/10/2000	4	1.2	0.0	393127.2	4663288.0
Carpentersville below dam	Free-flowing	8/10/2000	5	1.5	0.0	393133.3	4663294.3
Carpentersville below dam	Free-flowing	8/10/2000	6	1.8	0.0	393139.3	4663293.3
Carpentersville below dam	Free-flowing	8/10/2000	7	1.7	0.1	393146.8	4663292.7
Carpentersville below dam	Free-flowing	8/10/2000	8	2.2	0.0	393157.3	4663295.3
Carpentersville below dam	Free-flowing	8/10/2000	9	1.7	0.0	393164.3	4663297.2
Carpentersville below dam	Free-flowing	8/10/2000	10	1.0	0.3	393170.6	4663299.7
Carpentersville below dam	Free-flowing	8/10/2000	11	1.6	0.0	393178.7	4663302.9
Carpentersville below dam	Free-flowing	8/10/2000	12	1.3	0.1	393188.0	4663306.9
Carpentersville below dam	Free-flowing	8/10/2000	13	1.9	0.0	393195.4	4663310.4
Carpentersville below dam	Free-flowing	8/10/2000	14	1.7	0.0	393201.6	4663315.7
Carpentersville below dam	Free-flowing	8/10/2000	15	0.7	0.0	393209.9	4663320.0
Carpentersville below dam	Free-flowing	8/10/2000	16	0.0	0.0	393215.1	4663325.9
Carpentersville below dam	Free-flowing	8/10/2000	17	1.6	0.0	393208.3	4663301.9
Carpentersville below dam	Free-flowing	8/10/2000	18	2.1	0.1	393203.8	4663290.2
Carpentersville below dam	Free-flowing	8/10/2000	19	1.7	0.1	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	20	2.6	0.3	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	21	2.4	0.1	393203.7	4663256.2
Carpentersville below dam	Free-flowing	8/10/2000	22	2.0	0.0	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	23	3.2	0.1	393165.7	4663287.8
Carpentersville below dam	Free-flowing	8/10/2000	24	0.3	0.0	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	25	1.0	0.0	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	26	0.0	0.0	393123.9	4663257.1
Carpentersville below dam	Free-flowing	8/10/2000	27	1.0	0.1	393117.1	4663247.5
Carpentersville below dam	Free-flowing	8/10/2000	28	0.1	0.6	393107.7	4663236.0
Carpentersville below dam	Free-flowing	8/10/2000	29	1.4	0.2	393099.5	4663229.9
Carpentersville below dam	Free-flowing	8/10/2000	30	0.0	0.0	393095.6	4663227.4
Carpentersville below dam	Free-flowing	8/10/2000	31	1.1	0.3	393105.0	4663222.5
Carpentersville below dam	Free-flowing	8/10/2000	32	1.5	4.5	NA	NA
Carpentersville below dam	Free-flowing	8/10/2000	33	1.4	0.1	393123.8	4663236.1
Carpentersville below dam	Free-flowing	8/10/2000	34	1.8	0.0	393129.0	4663231.5
Carpentersville below dam	Free-flowing	8/10/2000	35	1.8	0.0	393133.9	4663220.5
Carpentersville below dam	Free-flowing	8/10/2000	36	1.3	0.0	393139.7	4663208.7
Carpentersville below dam	Free-flowing	8/10/2000	37	1.2	0.3	393148.0	4663198.0
Carpentersville below dam	Free-flowing	8/10/2000	38	1.5	0.1	393132.5	4663200.9
Carpentersville below dam	Free-flowing	8/10/2000	39	2.3	0.1	393119.3	4663200.8
Carpentersville below dam	Free-flowing	8/10/2000	40	2.0	0.1	393107.8	4663200.5
Carpentersville below dam	Free-flowing	8/10/2000	41	1.6	0.1	393098.7	4663206.4
Carpentersville below dam	Free-flowing	8/10/2000	42	0.0	0.2	393094.0	4663206.4
Carpentersville below dam	Free-flowing	8/10/2000	43	1.2	1.0	393063.8	4663308.0
Carpentersville below dam	Free-flowing	8/21/2000	1	1.0	1.0	393067.6	4663275.3
Carpentersville below dam	Free-flowing	8/21/2000	4	0.2	0.8	393103.3	4663236.1
Carpentersville below dam	Free-flowing	8/21/2000	3	0.4	0.3	393107.9	4663231.7
Carpentersville below dam	Free-flowing	8/21/2000	2	0.1	0.3	393114.8	4663247.7
Carpentersville below dam	Free-flowing	8/21/2000	6	0.3	0.0	393120.9	4663252.8
Elgin below dam	Free-flowing	8/11/2000	1	0.0	0.0	393348.7	4655134.7
Elgin below dam	Free-flowing	8/11/2000	2	3.0	0.3	393345.0	4655134.2
Elgin below dam	Free-flowing	8/11/2000	3	3.8	0.2	393340.4	4655132.2
Elgin below dam	Free-flowing	8/11/2000	4	2.7	0.2	393336.0	4655143.7
Elgin below dam	Free-flowing	8/11/2000	5	2.9	0.0	393331.1	4655143.9
Elgin below dam	Free-flowing	8/11/2000	6	3.9	0.1	393325.3	4655143.3
Elgin below dam	Free-flowing	8/11/2000	7	2.5	0.1	393320.1	4655147.2
Elgin below dam	Free-flowing	8/11/2000	8	2.5	0.1	393312.3	4655144.7
Elgin below dam	Free-flowing	8/11/2000	9	1.8	0.0	393303.8	4655140.5
Elgin below dam	Free-flowing	8/11/2000	10	3.0	0.0	393290.1	4655133.3
Elgin below dam	Free-flowing	8/11/2000	11	4.0	0.0	393287.6	4655132.3
Elgin below dam	Free-flowing	8/11/2000	12	3.3	0.0	393305.0	4655130.2
Elgin below dam	Free-flowing	8/11/2000	13	2.8	0.0	393310.5	4655114.1
Elgin below dam	Free-flowing	8/11/2000	14	2.2	0.0	393313.9	4655102.1

Table E1. Concluded.

Station	Habitat	Date	Probe number	Water depth (ft.)	Sediment depth (ft.)	Easting	Northing
Elgin below dam	Free-flowing	8/11/2000	15	3.8	0.5	393315.0	4655097.7
Elgin below dam	Free-flowing	8/11/2000	16	1.8	0.1	393312.9	4655088.3
Elgin below dam	Free-flowing	8/11/2000	17	4.3	0.0	393300.7	4655082.7
Elgin below dam	Free-flowing	8/11/2000	18	4.0	0.2	393300.0	4655087.2
Elgin below dam	Free-flowing	8/11/2000	19	1.9	0.1	393309.0	4655073.0
Elgin below dam	Free-flowing	8/11/2000	20	4.5	0.1	393306.8	4655066.9
Elgin below dam	Free-flowing	8/11/2000	21	2.0	0.0	393341.8	4655087.2
Elgin below dam	Free-flowing	8/11/2000	22	4.6	0.1	393342.6	4655090.2
Elgin below dam	Free-flowing	8/11/2000	23	3.6	0.7	393347.8	4655086.6
Elgin below dam	Free-flowing	8/11/2000	24	3.2	0.7	393356.3	4655075.3
Elgin below dam	Free-flowing	8/11/2000	25	4.7	0.1	393360.0	4655071.8
Elgin below dam	Free-flowing	8/11/2000	26	0.0	0.0	393355.9	4655067.2
Elgin below dam	Free-flowing	8/11/2000	27	1.8	0.6	393375.3	4655047.4
Elgin below dam	Free-flowing	8/11/2000	28	3.7	0.6	393379.4	4655050.9
Elgin below dam	Free-flowing	8/11/2000	29	1.0	0.0	393375.2	4655047.4
Elgin below dam	Free-flowing	8/11/2000	30	1.6	0.0	393377.1	4655039.4
Elgin below dam	Free-flowing	8/11/2000	31	2.2	0.5	393382.8	4655040.2
Elgin below dam	Free-flowing	8/11/2000	33	0.0	0.0	393363.3	4654992.2
Elgin below dam	Free-flowing	8/11/2000	34	3.5	0.6	393358.6	4654990.9
Elgin below dam	Free-flowing	8/11/2000	35	3.9	0.2	393355.1	4654988.9
Elgin below dam	Free-flowing	8/11/2000	36	3.0	0.2	393364.9	4654978.8
Elgin below dam	Free-flowing	8/11/2000	37	2.7	0.0	393374.1	4654973.8
Elgin below dam	Free-flowing	8/11/2000	39	0.0	0.0	393330.8	4655176.8
Elgin below dam	Free-flowing	8/21/2000	1	2.8	0.2	393316.0	4655097.7
Elgin below dam	Free-flowing	8/21/2000	2	2.5	0.2	393308.5	4655094.3
Elgin below dam	Free-flowing	8/21/2000	3	2.0	0.3	393303.5	4655088.0
Elgin below dam	Free-flowing	8/21/2000	7	1.3	0.8	393461.4	4654838.0
St. Charles below dam	Free-flowing	8/22/2000	1	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	2	1.8	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	3	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	4	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	5	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	6	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	7	2.0	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	8	1.7	0.0	391025.0	4641044.5
St. Charles below dam	Free-flowing	8/22/2000	8.1	1.7	0.0	391024.9	4641044.3
St. Charles below dam	Free-flowing	8/22/2000	9	1.7	0.0	391015.8	4641043.0
St. Charles below dam	Free-flowing	8/22/2000	11	1.8	0.0	391003.3	4641041.0
St. Charles below dam	Free-flowing	8/22/2000	12	1.7	0.0	390999.6	4641041.2
St. Charles below dam	Free-flowing	8/22/2000	20	2.1	0.0	391004.7	4641033.9
St. Charles below dam	Free-flowing	8/22/2000	21	2.4	0.0	391015.3	4641031.6
St. Charles below dam	Free-flowing	8/22/2000	22	2.0	0.0	391024.7	4641033.7
St. Charles below dam	Free-flowing	8/22/2000	24	1.3	0.0	391035.7	4641035.7
St. Charles below dam	Free-flowing	8/22/2000	25	1.7	0.0	391046.0	4641037.9
St. Charles below dam	Free-flowing	8/22/2000	26	1.5	0.0	391057.6	4641040.4
St. Charles below dam	Free-flowing	8/22/2000	27	1.7	0.0	391064.3	4641041.6
St. Charles below dam	Free-flowing	8/22/2000	28	1.6	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	30	1.8	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	31	2.0	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	32	2.3	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	33	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	34	1.6	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	35	1.5	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	36	1.5	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	38	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	39	1.6	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	40	1.0	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	41	1.7	0.0	NA	NA
St. Charles below dam	Free-flowing	8/22/2000	42	2.0	0.0	NA	NA

Table E2. Grain size characteristics and specific gravity of core and ponar sediment samples from 12 stations in impounded habitat and three stations in free-flowing habitat of the Fox River between Algonquin and Dayton, Illinois. U.S Standard Sieve numbers are in parentheses.

				Grain size (percent by weight)					
Station	Habitat	Sample method	Sample number	Coarse gravel (4)	Coarse to fine gravel (10)	Coarse to medium sand (35)	Medium to fine sand (200)	Silt and clay (bottom tray)	Specific gravity (g/cm^3)
Algonquin above dam	Impounded	Core	2000WD01S82	0.0	2.2	18.4	77.8	1.5	2.31
Algonquin above dam	Impounded	Core	2000WD01S85	4.3	8.9	12.6	64.2	9.9	2.42
Algonquin above dam	Impounded	Core	2000WD01S87	3.0	18.5	28.1	41.4	9.0	2.13
Algonquin above dam	Impounded	Ponar	2000WD01S83	0.0	4.3	17.4	73.7	4.6	2.26
Algonquin above dam	Impounded	Ponar	2000WD01S84	16.4	13.3	23.3	41.7	5.2	2.19
Algonquin above dam	Impounded	Ponar	2000WD01S86	11.5	23.7	26.0	37.9	0.9	2.66
Carpentersville above dam	Impounded	Core	2000WD01S49	1.6	6.2	18.0	67.8	6.5	2.37
Carpentersville above dam	Impounded	Core	2000WD01S52	4.5	1.0	5.0	78.6	10.9	2.28
Carpentersville above dam	Impounded	Core	2000WD01S54	0.0	0.5	3.4	92.9	3.2	2.41
Carpentersville above dam	Impounded	Ponar	2000WD01S50	2.4	7.0	33.8	56.0	0.8	2.58
Carpentersville above dam	Impounded	Ponar	2000WD01S51	2.0	5.5	22.5	69.7	0.3	2.64
Carpentersville above dam	Impounded	Ponar	2000WD01S53	1.3	1.7	14.4	82.5	0.0	2.64
Elgin above dam	Impounded	Core	2000WD01S56	4.1	14.7	20.8	52.2	8.2	2.26
Elgin above dam	Impounded	Core	2000WD01S57	0.0	1.8	16.4	60.2	21.7	2.27
Elgin above dam	Impounded	Core	2000WD01S59	0.0	2.3	16.9	63.9	16.9	2.33
Elgin above dam	Impounded	Ponar	2000WD01S55	3.4	12.0	22.0	53.0	9.6	2.14
Elgin above dam	Impounded	Ponar	2000WD01S58	2.4	1.5	7.3	81.0	7.7	2.49
Elgin above dam	Impounded	Ponar	2000WD01S60	0.0	1.8	7.0	80.0	11.3	2.22
South Elgin above dam	Impounded	Core	2000WD02S07	1.1	1.9	9.7	85.9	1.4	2.55
South Elgin above dam	Impounded	Core	2000WD02S10	5.2	6.3	21.9	63.0	3.6	2.24
South Elgin above dam	Impounded	Core	2000WD02S11	1.8	6.5	31.1	59.3	1.3	2.55
South Elgin above dam	Impounded	Ponar	2000WD02S08	7.6	8.9	21.6	59.6	2.2	2.24
South Elgin above dam	Impounded	Ponar	2000WD02S09	1.2	4.1	17.0	70.9	6.7	2.12
South Elgin above dam	Impounded	Ponar	2000WD02S12	0.0	9.2	23.8	62.1	4.9	2.09
St. Charles above dam	Impounded	Core	2000WD01S62	0.0	8.7	24.1	55.9	11.3	2.18
St. Charles above dam	Impounded	Core	2000WD01S64	16.0	7.5	15.7	56.9	3.9	2.32
St. Charles above dam	Impounded	Core	2000WD01S65	0.0	3.4	14.4	76.7	5.5	2.10
St. Charles above dam	Impounded	Ponar	2000WD01S61	0.0	7.9	28.2	59.8	4.0	2.09
St. Charles above dam	Impounded	Ponar	2000WD01S63	0.0	5.2	23.6	64.9	6.3	2.14
St. Charles above dam	Impounded	Ponar	2000WD01S66	0.0	5.5	22.9	65.2	6.4	2.19
Geneva above dam	Impounded	Core	2000WD01S89	0.0	7.6	28.5	58.0	5.9	2.03
Geneva above dam	Impounded	Core	2000WD01S92	1.1	3.3	8.7	76.2	10.7	2.27
Geneva above dam	Impounded	Core	2000WD01S93	4.0	4.1	16.5	72.4	2.9	2.29
Geneva above dam	Impounded	Ponar	2000WD01S88	2.6	3.2	12.8	79.8	1.6	2.47
Geneva above dam	Impounded	Ponar	2000WD01S90	1.5	2.4	17.5	74.7	4.0	2.39
Geneva above dam	Impounded	Ponar	2000WD01S91	1.6	3.3	17.0	77.5	0.7	2.52
North Batavia above dam	Impounded	Core	2000WD01S95	0.0	3.3	31.3	56.2	9.2	2.08
North Batavia above dam	Impounded	Core	2000WD01S97	2.4	2.2	7.8	86.0	1.6	2.31
North Batavia above dam	Impounded	Core	2000WD01S98	0.0	3.0	19.0	67.3	10.7	2.13
North Batavia above dam	Impounded	Ponar	2000WD01S94	1.5	1.7	9.2	83.5	4.0	2.39
North Batavia above dam	Impounded	Ponar	2000WD01S96	2.4	9.1	17.0	68.4	3.1	2.13
North Batavia above dam	Impounded	Ponar	2000WD01S99	0.0	3.4	13.3	79.2	4.1	2.18
South Batavia above dam	Impounded	Core	2000WD02S13	0.0	3.7	11.0	76.0	9.3	2.20
South Batavia above dam	Impounded	Core	2000WD02S15	14.2	14.1	24.9	40.0	6.8	2.09
South Batavia above dam	Impounded	Core	2000WD02S18	6.9	9.9	18.4	56.1	8.7	2.14
South Batavia above dam	Impounded	Ponar	2000WD02S14	1.1	3.8	12.6	78.7	3.8	2.28
South Batavia above dam	Impounded	Ponar	2000WD02S16	8.5	7.1	15.7	66.8	1.9	2.34
South Batavia above dam	Impounded	Ponar	2000WD02S17	1.3	5.3	16.8	73.1	3.5	2.30
South Batavia above dam	Impounded	Ponar	2000WD02S19	48.5	27.5	15.8	7.8	0.3	2.67
North Aurora above dam	Impounded	Core	2000WD02S20	4.1	18.7	34.7	37.7	4.8	1.98
North Aurora above dam	Impounded	Core	2000WD02S22	0.0	10.5	23.8	58.9	6.8	2.08

Table E 2. Continued.

Station	Habitat	Sample method	Sample number	Grain size (percent by weight) Coarse gravel (4)	Coarse to fine gravel (10)	Coarse to medium sand (35)	Medium to fine sand (200)	Silt and clay (bottom tray)	Specific gravity (g/cm^3)
North Aurora above dam	Impounded	Core	2000WD02S25	0.0	11.8	28.8	40.0	19.4	2.09
North Aurora above dam	Impounded	Core	2000WD02S26	0.0	7.6	22.2	62.8	7.5	2.07
North Aurora above dam	Impounded	Ponar	2000WD02S21	1.9	2.9	13.4	78.1	3.6	2.31
North Aurora above dam	Impounded	Ponar	2000WD02S23	1.1	4.8	18.8	69.4	5.9	2.28
North Aurora above dam	Impounded	Ponar	2000WD02S24	0.5	9.2	17.4	65.7	7.2	2.13
Montgomery above dam	Impounded	Core	2000WD02S28	5.3	12.6	37.5	38.8	5.9	1.97
Montgomery above dam	Impounded	Core	2000WD02S30	2.4	8.5	26.2	58.0	4.9	2.09
Montgomery above dam	Impounded	Core	2000WD02S31	0.0	10.2	29.7	54.5	5.6	2.01
Montgomery above dam	Impounded	Ponar	2000WD02S27	12.2	24.9	37.9	20.4	4.6	1.94
Montgomery above dam	Impounded	Ponar	2000WD02S29	0.0	6.1	32.6	55.2	6.0	1.99
Yorkville above dam	Impounded	Core	2000WD02S32	0.0	18.3	31.0	47.6	3.0	1.84
Yorkville above dam	Impounded	Core	2000WD02S34	6.1	11.3	23.4	53.2	6.0	2.03
Yorkville above dam	Impounded	Core	2000WD02S36	0.0	10.8	33.5	49.6	6.0	1.95
Yorkville above dam	Impounded	Core	2000WD02S38	0.0	9.1	22.2	61.7	7.0	2.12
Yorkville above dam	Impounded	Ponar	2000WD02S33	3.8	5.3	24.2	65.6	1.2	2.39
Yorkville above dam	Impounded	Ponar	2000WD02S35	5.3	5.7	17.5	70.9	0.6	2.55
Yorkville above dam	Impounded	Ponar	2000WD02S37	1.6	3.2	20.5	72.5	2.1	2.38
Dayton above dam	Impounded	Core	2000WD02S01	19.8	16.2	22.4	37.7	3.8	2.35
Dayton above dam	Impounded	Core	2000WD02S03	0.0	2.1	7.8	89.1	1.1	2.36
Dayton above dam	Impounded	Core	2000WD02S04	8.0	9.9	20.9	56.5	4.7	2.31
Dayton above dam	Impounded	Ponar	2000WD02S02	0.0	1.3	25.3	73.1	0.3	2.64
Dayton above dam	Impounded	Ponar	2000WD02S05	0.0	1.0	38.5	59.8	0.7	2.62
Dayton above dam	Impounded	Ponar	2000WD02S06	2.4	5.6	46.8	44.3	0.9	2.58
Algonquin below dam	Free-flowing	Core	2000WD01S67	1.1	1.7	7.2	89.4	0.5	2.55
Algonquin below dam	Free-flowing	Ponar	2000WD01S68	12.8	10.3	28.4	48.0	0.5	2.63
Algonquin below dam	Free-flowing	Ponar	2000WD01S69	20.1	16.5	24.6	38.2	0.6	2.61
Algonquin below dam	Free-flowing	Ponar	2000WD01S70	33.8	13.7	19.0	33.2	0.4	2.65
Algonquin below dam	Free-flowing	Ponar	2000WD01S71	29.9	35.4	27.4	7.0	0.4	2.65
Algonquin below dam	Free-flowing	Ponar	2000WD01S72	32.2	29.3	23.0	15.3	0.2	2.64
Carpentersville below dam	Free-flowing	Core	2000WD01S73	14.0	18.0	28.7	36.4	2.9	2.14
Carpentersville below dam	Free-flowing	Core	2000WD01S74	0.0	7.8	53.1	36.8	2.3	1.76
Carpentersville below dam	Free-flowing	Ponar	2000WD01S75	23.1	13.2	39.8	21.7	2.1	2.64
Carpentersville below dam	Free-flowing	Ponar	2000WD01S76	5.3	11.8	45.5	37.1	0.3	3.29
Carpentersville below dam	Free-flowing	Ponar	2000WD01S77	48.3	13.4	27.9	10.4	0.0	2.71
Carpentersville below dam	Free-flowing	Ponar	2000WD01S78	0.0	1.1	8.1	89.4	1.3	2.53
Elgin below dam	Free-flowing	Core	2000WD01S81	0.0	8.3	19.1	55.8	16.8	2.26
Elgin below dam	Free-flowing	Ponar	2000WD01S79	37.4	31.1	21.3	10.2	0.1	2.73
Elgin below dam	Free-flowing	Ponar	2000WD01S80	42.7	16.8	19.4	13.7	7.4	2.65

Table E3. Mean contaminant and nutrient concentrations in core and ponar sediment samples from stations in impounded and free-flowing reaches of the Fox River between Algonquin and Dayton, Illinois. For each station, there were 2-4 core and 3-4 ponar samples (5-10 grabs) in impounded habitat and 1-2 core and 2-5 ponar samples (5-9 grabs) in free-flowing habitat. NA indicates not analyzed. UD indicates substance was undetected in sample.

	Station, habitat, and sample method											
	Algonquin above dam Impounded		Algonquin below dam Free-flowing		Carpentersville above dam Impounded		Carpentersville below dam Free-flowing		Elgin above dam Impounded		Elgin below dam Free-flowing	
Substance	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar
Heavy metals (mg/kg)												
Aluminum	7066.7	4753.3	3300.0	3320.0	5833.3	2600.0	8400.0	2425.0	8766.7	5533.3	5300.0	3000.0
Barium	73.3	59.5	120.0	68.8	60.0	22.3	140.0	22.0	94.3	112.3	83.0	70.0
Beryllium	0.3	0.3	0.2	0.2	0.3	0.1	0.4	0.1	0.4	0.3	0.3	0.2
Boron	7.1	7.7	7.2	7.5	7.1	5.8	13.2	6.1	6.6	7.3	9.0	11.1
Cadmium	0.3	0.3	2.6	1.3	0.8	0.3	1.2	0.3	0.5	0.8	UD	0.3
Calcium	69333.3	104666.7	38000.0	97000.0	58333.3	52666.7	105000.0	85000.0	55000.0	75666.7	84000.0	99500.0
Chromium	12.0	10.3	5.7	8.5	11.7	5.1	20.0	4.5	13.7	14.1	13.0	8.5
Cobalt	4.5	3.6	2.3	2.6	4.5	2.6	5.1	2.2	6.2	5.4	4.5	2.7
Copper	10.9	9.3	11.0	12.1	10.4	3.3	34.0	2.4	22.3	25.3	22.0	10.5
Iron	14000.0	10200.0	7100.0	8800.0	11666.7	7700.0	18000.0	7150.0	17666.7	13333.3	13000.0	12000.0
Lead	31.3	17.6	11.0	15.6	12.6	UD	44.5	5.6	28.3	39.0	34.0	64.2
Lithium	9.0	7.4	4.4	6.5	8.6	5.6	11.0	5.0	12.3	9.0	7.0	8.4
Magnesium	19666.7	37000.0	16000.0	44800.0	20666.7	22666.7	15000.0	39000.0	21000.0	23333.3	25000.0	56000.0
Manganese	346.7	330.0	120.0	286.0	320.0	223.3	355.0	215.0	413.3	376.7	320.0	200.0
Mercury	0.1	0.1	UD	UD	0.1	UD	0.2	UD	0.2	0.2	0.2	UD
Molybdenum	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Nickel	11.3	10.8	9.3	7.7	11.4	4.9	21.5	5.0	13.3	13.9	14.0	7.5
Potassium	743.3	616.7	410.0	512.0	696.7	403.3	1140.0	360.0	1066.7	783.3	740.0	405.0
Silver	UD	UD	0.7	0.4	UD	UD	UD	UD	UD	0.7	0.6	UD
Sodium	246.7	243.3	390.0	290.0	326.7	330.0	375.0	262.5	266.7	360.0	340.0	240.0
Tin	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Titanium	75.0	57.3	100.0	76.4	98.7	73.7	73.0	116.8	95.3	99.3	100.0	108.5
Vanadium	16.0	11.6	11.0	11.8	14.7	7.6	19.5	8.3	19.3	12.3	14.0	17.5
Zinc	61.3	62.3	42.0	54.6	54.0	28.7	135.0	30.3	82.0	97.3	91.0	41.5
Pesticides (μg/kg)												
Aldrin	UD	9.3	17.0	12.6	UD	UD	6.0	3.5	UD	UD	UD	UD
alpha-BHC	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
alpha-Chlordane	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
beta-BHC	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
delta-BHC	UD	2.3	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dieldrin	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endosulfan I	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endosulfan II	UD	UD	65.0	21.4	39.0	12.3	UD	UD	27.7	65.3	UD	UD
Endosulfan Sulfate	41.7	69.0	74.0	23.2	24.0	UD	UD	11.8	78.7	76.0	105.0	UD
Endrin	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endrin Aldehyde	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endrin ketone	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
gamma-Chlordane	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Heptachlor Epoxide	2.7	4.0	UD	UD	UD	UD	7.0	3.3	UD	UD	10.0	UD
Heptachlor	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Lindane	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Methoxychlor	UD	UD	UD	UD	UD	UD	UD	UD	UD	182.7	UD	UD
p,p'-DDD	5.0	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
p,p'-DDE	3.0	4.3	UD	UD	UD	UD	5.5	UD	UD	UD	4.0	UD
p,p'-DDT	UD	UD	UD	UD	UD	UD	UD	UD	UD	54.3	UD	UD
PAH's (μg/kg)												
2-Methylnaphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthylene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Anthracene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Benzo[a]anthracene	1433.3	1283.3	UD	822.0	UD	UD	UD	UD	UD	UD	UD	635.0
Benzo[a]pyrene	1533.3	1383.3	UD	820.0	UD	UD	UD	UD	UD	UD	UD	640.0
Benzo[b]fluoranthene	1700.0	1516.7	UD	894.0	UD	UD	UD	UD	UD	UD	UD	740.0
Benzo[g,h,I]perylene	1240.0	1146.7	UD	732.0	UD	UD	UD	UD	UD	UD	UD	UD
Benzo[k]fluoranthene	1226.7	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
bis(2-Ethylhexyl) phthalate	UD	UD	580.0	UD	UD	UD	UD	UD	UD	UD	UD	UD

Table E3. Continued.

	Station, habitat, and sample method											
	Algonquin above dam Impounded		Algonquin below dam Free-flowing		Carpentersville above dam Impounded		Carpentersville below dam Free-flowing		Elgin above dam Impounded		Elgin below dam Free-flowing	
Substance	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar	Core	Ponar
PAH's (µg/kg)												
Butylbenzylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Carbazole	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Chrysene	1500.0	1350.0	UD	836.0	UD	UD	UD	UD	UD	UD	UD	645.0
Dibenz[a,h]anthracene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dibenzofuran	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Diethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dimethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Di-n-butylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Di-n-octylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Fluoranthene	2266.7	2283.3	710.0	1162.0	UD	UD	UD	UD	UD	1400.0	UD	1215.0
Fluorene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Indeno[1,2,3-cd]pyrene	1283.3	1163.3	UD	762.0	UD	UD	UD	UD	UD	UD	UD	UD
Naphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Phenanthrene	1566.7	1483.3	UD	1010.0	UD	UD	UD	UD	UD	1306.7	UD	825.0
Pyrene	1933.3	1650.0	550.0	920.0	UD	UD	UD	UD	UD	UD	UD	865.0
Alkylphenols (µg/kg)												
Bisphenol A	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Octylphenol	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Total NP	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Total NP1EO	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Total NP2EO	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
PCB's (µg/kg)	NA	NA	UD	UD	UD	UD	NA	NA	UD	UD	NA	NA
Cyanide (mg/L)	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Oil and grease (mg/kg)	1213.0	1865.7	1286.0	1069.0	1154.3	1017.0	2364.0	1183.5	1205.7	990.0	1673.0	1266.0
Nutrients (mg/kg)												
Ammonia nitrogen	120.0	75.2	UD	36.8	72.5	UD	122.2	UD	223.0	44.9	60.6	21.1
Kjeldahl nitrogen	2393.3	1445.7	653.0	400.8	1543.3	482.7	3170.0	369.0	2336.7	1455.0	1420.0	112.0
Phosphorus	649.7	469.0	347.0	371.8	538.3	216.7	692.0	216.3	869.7	994.3	567.0	130.5

Table E3. Extended.

Substance	Station, habitat, and sample method										
	South Elgin above dam Impounded		South Elgin below dam Free-flowing	St Charles above dam Impounded		Geneva above dam Impounded		Geneva below dam Free-flowing	North Batavia above dam Impounded		N. Bat. below Free-flov
	Core	Ponar	Ponar	Core	Ponar	Ponar	Core	Ponar	Core	Ponar	Ponar
Heavy metals (mg/kg)											
Aluminum	6066.7	7533.3	2066.7	10100.0	5666.7	8433.3	4766.7	3533.3	8100.0	5600.0	2433.3
Barium	72.3	143.3	41.7	156.0	95.3	119.0	99.7	71.3	150.0	120.7	56.7
Beryllium	0.3	0.5	0.2	0.5	0.3	0.5	0.3	0.3	0.5	0.3	0.2
Boron	4.5	8.4	12.3	9.1	9.1	8.7	9.3	14.7	8.1	8.4	11.7
Cadmium	1.6	3.9	UD	5.7	1.4	8.0	6.8	UD	7.3	3.5	UD
Calcium	46000.0	76666.7	130000.0	59666.7	82000.0	57333.3	55333.3	129666.7	65666.7	81666.7	130000.0
Chromium	11.9	21.7	10.7	33.3	14.9	57.3	37.0	11.8	47.0	26.7	6.8
Cobalt	4.7	6.9	2.2	6.7	4.6	6.1	5.8	2.6	5.4	5.0	UD
Copper	14.4	38.7	9.8	32.3	22.5	90.0	39.3	13.7	48.3	31.0	5.1
Iron	13466.7	19000.0	14666.7	19333.3	13400.0	17666.7	13333.3	11766.7	85333.3	13333.3	8033.3
Lead	27.0	37.7	22.0	54.0	39.3	55.3	57.0	20.7	62.0	45.7	17.7
Lithium	5.3	8.0	5.2	12.7	9.8	9.6	6.3	6.0	9.0	6.9	5.1
Magnesium	18066.7	20000.0	62666.7	18000.0	28000.0	18333.3	18000.0	55333.3	18033.3	18000.0	56666.7
Manganese	266.7	530.0	353.3	380.0	373.3	410.0	316.7	360.0	470.0	363.3	403.3
Mercury	UD	UD	UD	0.2	0.2	1.1	0.2	0.1	0.4	0.3	0.1
Molybdenum	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Nickel	13.7	26.3	4.5	23.3	13.6	47.7	37.7	8.2	33.3	21.7	4.8
Potassium	600.0	906.7	526.7	1156.7	843.3	1016.7	663.3	616.7	946.7	763.3	480.0
Silver	UD	0.7	UD	0.6	0.3	0.6	0.6	UD	1.2	0.5	UD
Sodium	186.7	313.3	376.7	313.3	303.3	263.3	296.7	430.0	236.7	313.3	313.3
Tin	UD	UD	NA	UD	UD	UD	UD	NA	UD	UD	NA
Titanium	72.0	98.3	71.3	88.7	87.7	98.3	100.3	83.3	104.3	83.7	58.3
Vanadium	13.3	14.0	13.7	21.7	15.3	19.0	11.3	13.7	19.3	12.2	11.7
Zinc	60.0	136.7	55.7	130.3	95.0	130.7	124.7	67.7	163.3	127.0	49.7
Pesticides (µg/kg)											
Aldrin	UD	UD	UD	16.0	31.7	3.7	4.0	UD	8.7	11.0	UD
alpha-BHC	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
alpha-Chlordane	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
beta-BHC	UD	UD	UD	UD	11.3	UD	UD	UD	UD	UD	UD
delta-BHC	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dieldrin	UD	UD	UD	UD	UD	UD	7.3	UD	UD	UD	UD
Endosulfan I	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endosulfan II	UD	UD	UD	163.0	155.3	UD	UD	UD	UD	UD	UD
Endosulfan Sulfate	UD	UD	UD	167.3	262.7	UD	14.3	UD	UD	UD	UD
Endrin	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Endrin Aldehyde	UD	UD	UD	98.7	UD	UD	UD	UD	UD	UD	UD
Endrin ketone	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
gamma-Chlordane	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Heptachlor Epoxide	UD	UD	UD	UD	UD	9.7	UD	UD	17.0	19.3	UD
Heptachlor	UD	UD	UD	UD	UD	UD	UD	UD	6.0	UD	UD
Lindane	UD	UD	UD	UD	UD	UD	UD	UD	2.7	UD	UD
Methoxychlor	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
p,p'-DDD	17.0	UD	4.2	UD	UD	14.0	15.0	13.8	42.0	59.0	8.2
p,p'-DDE	8.7	UD	2.2	6.7	6.0	13.0	12.3	9.2	30.7	19.7	6.1
p,p'-DDT	17.0	UD	3.8	UD	UD	UD	UD	6.5	16.7	22.7	3.9
PAH's (µg/kg)											
2-Methylnaphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthene	1000.0	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthylene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Anthracene	883.3	UD	UD	UD	UD	UD	UD	UD	UD	1166.7	UD
Benzo[a]anthracene	1553.3	UD	UD	UD	2166.7	UD	1570.0	1733.3	UD	1816.7	UD
Benzo[a]pyrene	1653.3	1443.3	UD	UD	2233.3	1046.7	1686.7	1566.7	UD	1866.7	UD
Benzo[b]fluoranthene	2053.3	1533.3	623.3	UD	2533.3	1010.0	2173.3	1966.7	1126.7	2166.7	993.3
Benzo[g,h,I]perylene	1420.0	UD	UD	UD	1633.3	UD	1286.7	UD	UD	1333.3	UD
Benzo[k]fluoranthene	1186.7	UD	UD	UD	1566.7	UD	1253.3	UD	UD	1266.7	UD
bis(2-Ethylhexyl) phthalate	UD	UD	UD	UD	2366.7	UD	UD	UD	1560.0	2033.3	1460.0
Butylbenzylphthalate	1086.7	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Carbazole	1056.7	UD	UD	UD	UD	UD	1000.0	UD	UD	UD	UD
Chrysene	1853.3	1466.7	560.0	UD	2200.0	1023.3	1436.7	1766.7	UD	1833.3	UD
Dibenz[a,h]anthracene	940.0	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD

Table E3. Continued.

	Station, habitat, and sample method										
	South Elgin above dam Impounded		South Elgin below dam Free-flowing	St. Charles above dam Impounded		Geneva above dam Impounded		Geneva below dam Free-flowing	North Batavia above dam Impounded		N. Bat. Below Free-flov
Substance	Core	Ponar	Ponar	Core	Ponar	Core	Ponar	Ponar	Core	Ponar	Ponar
PAH's (µg/kg)											
Dibenzofuran	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Diethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dimethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Di-n-butylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	1600.0
Di-n-octylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Fluoranthene	3586.7	1966.7	893.3	UD	3766.7	1443.3	4033.3	3566.7	1133.3	3933.3	1420.0
Fluorene	936.7	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Indeno[1,2,3-cd]pyrene	1553.3	UD	UD	UD	UD	UD	1353.3	UD	UD	1203.3	UD
Naphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD	UD
Phenanthrene	3220.0	1566.7	760.0	UD	2333.3	1100.0	2253.3	3266.7	UD	2000.0	1360.0
Pyrene	3720.0	1800.0	793.3	UD	2833.3	1086.7	2966.7	2800.0	1040.0	3033.3	1293.3
Alkylphenols (µg/kg)											
Bisphenol A	UD	UD	NA	UD	UD	UD	UD	NA	UD	UD	NA
Octylphenol	UD	UD	NA	85.7	UD	UD	UD	NA	UD	UD	NA
Total NP	UD	UD	NA	UD	UD	UD	UD	NA	UD	UD	NA
Total NP1EO	UD	UD	NA	UD	UD	UD	UD	NA	UD	UD	NA
Total NP2EO	UD	UD	NA	UD	UD	UD	UD	NA	UD	UD	NA
PCB's (µg/kg)	UD	UD	UD	UD	UD	NA	NA	UD	NA	NA	UD
Cyanide (mg/L)	0.27	0.23	0.47	UD	UD	UD	UD	UD	UD	UD	UD
Oil and grease (mg/kg)	1586.7	2355.3	1416.3	2032.3	1987.7	3022.0	1621.0	2880.0	1880.0	1865.0	2253.7
Nutrients (mg/kg)											
Ammonia nitrogen	98.0	141.7	NA	236.7	136.0	152.7	19.8	NA	252.0	61.9	NA
Kjeldahl nitrogen	1615.0	3653.3	NA	2450.0	3196.7	2100.0	932.0	NA	1726.7	1786.7	NA
Phosphorus	693.3	1913.3	NA	977.0	1153.3	934.0	1144.7	NA	1408.0	961.3	NA

Table E3. Extended.

Substance	South Batavia above dam Impounded Core	South Batavia above dam Impounded Ponar	South Batavia below dam Free-flowing Ponar	North Aurora above dam Impounded Core	North Aurora above dam Impounded Ponar	North Aurora below dam Free-flowing Ponar	Montgomery above dam Impounded Core	Montgomery above dam Impounded Ponar	Montgomery below dam Free-flowing Ponar
Heavy metals (mg/kg)									
Aluminum	8100.0	4900.0	2733.3	8700.0	4866.7	3733.3	8300.0	8000.0	3433.3
Barium	163.3	86.3	62.7	192.5	106.3	123.0	160.0	150.0	45.7
Beryllium	0.5	0.4	0.2	0.5	0.3	0.3	0.5	0.5	0.2
Boron	9.2	10.2	11.3	9.7	8.0	15.0	9.9	8.2	9.1
Cadmium	10.4	1.5	2.0	3.0	1.5	UD	4.9	2.0	UD
Calcium	80333.3	86250.0	123333.3	89500.0	93000.0	143333.3	89666.7	96000.0	88666.7
Chromium	42.7	13.7	7.0	28.8	17.0	6.8	30.0	19.5	10.7
Cobalt	6.4	4.4	2.2	6.4	5.2	2.1	6.0	5.6	2.3
Copper	49.3	22.6	7.1	38.8	23.7	21.0	61.7	46.5	33.7
Iron	19000.0	12750.0	7900.0	20250.0	13666.7	9033.3	18666.7	18000.0	7266.7
Lead	79.3	30.9	14.3	77.5	39.0	103.7	98.0	62.5	27.0
Lithium	8.2	5.0	5.6	9.7	5.5	5.7	8.9	9.4	5.0
Magnesium	21000.0	28750.0	48000.0	21750.0	24000.0	57666.7	22000.0	21000.0	30000.0
Manganese	500.0	350.0	300.0	577.5	453.3	383.3	476.7	450.0	230.0
Mercury	UD	UD	UD	UD	UD	UD	UD	UD	UD
Molybdenum	UD	UD	UD	UD	UD	UD	UD	UD	UD
Nickel	31.7	14.4	5.4	25.0	16.7	4.6	24.3	18.5	7.8
Potassium	993.3	657.5	540.0	967.5	600.0	536.7	860.0	920.0	396.7
Silver	1.3	1.0	UD	1.0	0.4	UD	0.9	0.7	UD
Sodium	330.0	367.5	346.7	285.0	276.7	400.0	276.7	295.0	310.0
Tin	UD	UD	NA	UD	UD	NA	UD	UD	NA
Titanium	87.3	94.0	70.0	71.3	72.0	154.3	80.0	64.0	92.0
Vanadium	17.3	10.3	11.7	16.3	10.9	15.0	17.3	16.5	11.3
Zinc	193.3	144.8	63.7	180.0	104.3	118.7	223.3	175.0	89.0
Pesticides (µg/kg)									
Aldrin	14.0	UD	UD	UD	UD	UD	UD	UD	UD
alpha-BHC	3.0	UD	UD	UD	UD	UD	UD	UD	UD
alpha-Chlordane	6.0	UD	UD	UD	UD	UD	UD	UD	UD
beta-BHC	3.0	UD	UD	UD	UD	UD	UD	UD	UD
delta-BHC	2.7	UD	UD	UD	UD	UD	UD	UD	UD
Dieldrin	6.0	UD	UD	UD	UD	UD	6.7	9.0	UD
Endosulfan I	6.3	UD	UD	UD	UD	UD	UD	UD	UD
Endosulfan II	12.0	UD	UD	UD	UD	UD	UD	UD	UD
Endosulfan Sulfate	26.0	UD	UD	UD	UD	UD	UD	UD	UD
Endrin	6.0	UD	UD	7.0	8.7	UD	7.3	10.5	UD
Endrin Aldehyde	5.3	UD	UD	UD	UD	UD	UD	UD	UD
Endrin ketone	7.0	UD	UD	UD	UD	8.1	UD	UD	UD
gamma-Chlordane	7.0	UD	UD	UD	UD	UD	UD	UD	UD
Heptachlor Epoxide	8.7	UD	UD	UD	UD	UD	UD	UD	UD
Heptachlor	5.7	UD	UD	4.0	3.0	UD	12.7	7.5	UD
Lindane	3.0	UD	UD	UD	UD	UD	UD	UD	UD
Methoxychlor	30.0	UD	UD	UD	UD	UD	UD	UD	UD
p,p'-DDD	20.7	7.8	6.6	11.8	13.7	5.3	21.0	6.0	12.1
p,p'-DDE	24.0	7.0	4.1	15.3	11.7	3.1	20.3	14.0	3.0
p,p'-DDT	8.7	4.5	4.9	UD	UD	4.2	UD	UD	2.8
PAH's (µg/kg)									
2-Methylnaphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Acenaphthylene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Anthracene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Benzo[a]anthracene	1533.3	UD	UD	1825.0	UD	UD	UD	UD	746.7
Benzo[a]pyrene	1566.7	1192.5	UD	1850.0	1386.7	UD	UD	UD	773.3
Benzo[b]fluoranthene	1600.0	1257.5	UD	2000.0	1153.3	UD	UD	UD	1040.0
Benzo[g,h,I]perylene	1310.0	UD	UD	1575.0	UD	UD	UD	UD	650.0
Benzo[k]fluoranthene	UD	UD	UD	UD	UD	UD	UD	UD	UD
bis(2-Ethylhexyl) phthalate	1946.7	UD	1453.3	UD	UD	UD	UD	UD	896.7
Butylbenzylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD
Carbazole	UD	UD	UD	UD	UD	UD	UD	UD	UD
Chrysene	1533.3	1190.0	UD	1850.0	1423.3	UD	UD	UD	873.3
Dibenz[a,h]anthracene	UD	UD	UD	UD	UD	UD	UD	UD	UD

Table E3. Continued.

	Station, habitat, and sample method								
	South Batavia above dam Impounded		South Batavia below dam Free-flowing	North Aurora above dam Impounded		North Aurora below dam Free-flowing	Montgomery above dam Impounded		Montgomery below dam Free-flowing
Substance	Core	Ponar	Ponar	Core	Ponar	Ponar	Core	Ponar	Ponar
PAH's (µg/kg)									
Dibenzofuran	UD	UD	UD	UD	UD	UD	UD	UD	UD
Diethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD
Dimethylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD
Di-n-butylphthalate	UD	UD	1653.3	UD	UD	UD	UD	UD	UD
Di-n-octylphthalate	UD	UD	UD	UD	UD	UD	UD	UD	UD
Fluoranthene	2000.0	1457.5	953.3	2850.0	1600.0	UD	UD	UD	1606.7
Fluorene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Indeno[1,2,3-cd]pyrene	1346.7	UD	UD	1600.0	UD	UD	UD	UD	606.7
Naphthalene	UD	UD	UD	UD	UD	UD	UD	UD	UD
Phenanthrene	1533.3	1197.5	UD	2500.0	1396.7	UD	UD	UD	1006.7
Pyrene	1533.3	1082.5	UD	2525.0	1040.0	UD	UD	UD	1273.3
Alkylphenols (µg/kg)									
Bisphenol A	UD	UD	NA	UD	UD	NA	UD	UD	NA
Octylphenol	UD	UD	NA	UD	UD	NA	UD	UD	NA
Total NP	UD	UD	NA	501.3	UD	NA	376.3	UD	NA
Total NP1EO	UD	UD	NA	UD	UD	NA	UD	UD	NA
Total NP2EO	UD	UD	NA	UD	UD	NA	UD	UD	NA
PCB's (µg/kg)	UD	UD	UD	UD	UD	UD	UD	UD	UD
Cyanide (mg/L)	0.43	0.11	UD	0.25	0.17	UD	0.27	0.30	UD
Oil and grease (mg/kg)	2200.0	1541.5	1672.3	3104.3	2980.0	1625.7	3426.3	2974.5	908.3
Nutrients (mg/kg)									
Ammonia nitrogen	250.3	91.3	NA	600.3	133.3	NA	496.0	273.5	NA
Kjeldahl nitrogen	3553.3	1627.0	NA	4397.5	2660.0	NA	4356.7	4200.0	NA
Phosphorus	1586.7	860.3	NA	1640.0	1373.3	NA	1486.7	1485.0	NA

Table E3. Extended.

	Station, habitat, and sample method				
	Yorkville above dam Impounded		Yorkville below dam Free-flowing	Dayton above dam Impounded	
Substance	Core	Ponar	Ponar	Core	Ponar
Heavy metals (mg/kg)					
Aluminum	12275.0	2800.0	1933.3	11333.3	2100.0
Barium	245.0	78.7	66.0	112.7	25.0
Beryllium	0.8	0.2	0.2	0.6	0.2
Boron	14.8	6.6	13.7	6.9	3.1
Cadmium	25.5	1.6	UD	1.3	0.3
Calcium	80500.0	92666.7	146666.7	36333.3	44666.7
Chromium	140.0	16.3	5.0	17.0	3.8
Cobalt	6.5	3.2	2.4	6.6	1.8
Copper	175.0	28.3	4.2	23.0	2.9
Iron	60500.0	7400.0	8000.0	21666.7	5733.3
Lead	195.0	31.3	33.3	25.7	5.5
Lithium	9.9	2.8	5.0	10.4	3.0
Magnesium	19500.0	18666.7	39000.0	13500.0	17666.7
Manganese	520.0	300.0	320.0	530.0	166.7
Mercury	UD	UD	UD	1.9	1.4
Molybdenum	UD	UD	UD	UD	UD
Nickel	65.8	12.1	4.1	18.3	4.0
Potassium	975.0	313.3	453.3	1166.7	400.0
Silver	5.5	0.3	UD	UD	UD
Sodium	255.0	233.3	340.0	193.3	150.0
Tin	UD	UD	NA	UD	UD
Titanium	98.3	67.3	54.3	70.7	49.7
Vanadium	19.0	7.1	11.3	23.0	5.4
Zinc	442.5	89.0	58.3	95.7	26.7
Pesticides (µg/kg)					
Aldrin	UD	UD	UD	5.3	UD
alpha-BHC	UD	UD	UD	UD	UD
alpha-Chlordane	UD	UD	UD	UD	UD
beta-BHC	UD	UD	UD	UD	UD
delta-BHC	UD	UD	UD	UD	UD
Dieldrin	UD	UD	UD	UD	UD
Endosulfan I	UD	UD	UD	UD	UD
Endosulfan II	UD	UD	UD	UD	UD
Endosulfan Sulfate	UD	UD	UD	UD	UD
Endrin	UD	UD	UD	UD	UD
Endrin Aldehyde	UD	UD	UD	UD	UD
Endrin ketone	UD	UD	UD	UD	UD
gamma-Chlordane	UD	UD	UD	UD	UD
Heptachlor Epoxide	UD	UD	UD	UD	UD
Heptachlor	25.5	3.3	UD	UD	UD
Lindane	UD	UD	UD	UD	UD
Methoxychlor	UD	UD	UD	UD	UD
p,p'-DDD	110.0	7.0	3.6	UD	UD
p,p'-DDE	78.0	5.7	2.8	UD	UD
p,p'-DDT	UD	UD	3.3	UD	UD
PAH's (µg/kg)					
2-Methylnaphthalene	UD	UD	UD	UD	UD
Acenaphthene	UD	UD	UD	UD	UD
Acenaphthylene	UD	UD	UD	UD	UD
Anthracene	UD	890.0	UD	UD	UD
Benzo[a]anthracene	UD	1300.0	UD	UD	UD
Benzo[a]pyrene	UD	1473.3	UD	UD	UD
Benzo[b]fluoranthene	1502.5	2006.7	UD	UD	UD
Benzo[g,h,I]perylene	UD	966.7	UD	UD	UD
Benzo[k]fluoranthene	UD	1106.7	UD	UD	UD
bis(2-Ethylhexyl) phthalate	UD	UD	UD	UD	UD
Butylbenzylphthalate	UD	UD	UD	UD	UD
Carbazole	UD	UD	UD	UD	UD
Chrysene	UD	1606.7	UD	UD	UD
Dibenz[a,h]anthracene	UD	UD	UD	UD	UD

Table E3. Concluded.

Substance	Yorkville above dam Impounded Core	Yorkville above dam Impounded Ponar	Yorkville below dam Free-flowing Ponar	Dayton above dam Impounded Core	Dayton above dam Impounded Ponar
PAH's (µg/kg)					
Dibenzofuran	UD	UD	UD	UD	UD
Diethylphthalate	UD	UD	UD	UD	UD
Dimethylphthalate	UD	UD	UD	UD	UD
Di-n-butylphthalate	UD	UD	UD	UD	UD
Di-n-octylphthalate	UD	UD	UD	UD	UD
Fluoranthene	1515.0	3110.0	570.0	973.3	UD
Fluorene	UD	UD	UD	UD	UD
Indeno[1,2,3-cd]pyrene	UD	1183.3	UD	UD	UD
Naphthalene	UD	UD	UD	UD	UD
Phenanthrene	UD	2106.7	UD	890.0	UD
Pyrene	1495.0	2113.3	UD	930.0	UD
Alkylphenols (µg/kg)					
Bisphenol A	UD	UD	NA	UD	UD
Octylphenol	134.3	UD	NA	UD	UD
Total NP	416.8	UD	NA	212.7	UD
Total NP1EO	UD	UD	NA	UD	UD
Total NP2EO	UD	UD	NA	UD	UD
PCB's (µg/kg)	UD	UD	UD	UD	UD
Cyanide (mg/L)	0.55	0.12	UD	0.13	UD
Oil and grease (mg/kg)	4390.0	1080.0	513.0	852.3	1780.0
Nutrients (mg/kg)					
Ammonia nitrogen	652.3	38.3	NA	248.3	UD
Kjeldahl nitrogen	4245.0	517.7	NA	2206.7	382.7
Phosphorus	2260.0	757.3	NA	880.7	273.0

Table E4. Contaminant concentrations in core and ponar sediment samples taken above and below individual Fox River dams between Algonquin and Dayton, Illinois. NA indicates not analyzed. NS indicates not sampled.

Algonquin Dam

	Above dam samples						Below dam samples					
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Ponar 1	Ponar 2	Ponar 3	Ponar 4	Ponar 5
Heavy metals (mg/kg)												
Aluminum	6800	5900	8500	6100	7200	960	3300	1500	2100	2400	3000	7600
Barium	66	58	96	79	91	8.4	120	40	73	82	19	130
Beryllium	0.34	0.3	0.39	0.3	0.37	0.14	0.15	0.14	0.14	0.17	0.18	0.39
Boron	6.9	5.8	8.6	7.6	8.1	7.4	7.2	6.8	8.1	7.5	6.6	8.6
Cadmium	0.31	0.3	0.3	0.33	0.37	0.3	2.6	0.66	1.4	1.7	0.3	2.4
Calcium	83000	45000	80000	94000	100000	120000	38000	100000	120000	95000	87000	83000
Chromium	12	12	12	16	13	1.8	5.7	2.7	3.9	6.2	8.8	21
Cobalt	4.2	4.5	4.8	4.2	5	1.5	2.3	1.1	2.1	1.9	2	6.1
Copper	11	12	9.8	14	13	1	11	1.8	4.9	8.7	16	29
Iron	15000	11000	16000	12000	14000	4600	7100	4700	7300	8200	7800	16000
Lead	28	56	10	28	19	5.9	11	8.1	6.6	9.4	17	37
Lithium	9.6	7.5	10	8.8	9.9	3.4	4.4	3.7	6	5.8	6.9	10
Magnesium	27000	16000	16000	23000	22000	66000	16000	52000	63000	48000	42000	19000
Manganese	360	270	410	400	420	170	120	150	520	180	190	390
Mercury	0.1	0.2	0.1	0.2	0.2	0.03	0.01	0.01	0.03	0.02	0.02	0.02
Molybdenum	7	7	7	7	7	7	7	7	7	7	7	7
Nickel	11	11	12	14	16	2.5	9.3	3.4	4.3	7	5.9	18
Potassium	580	730	920	750	870	230	410	310	500	370	380	1000
Silver	0.3	0.3	0.3	0.3	0.3	0.3	0.74	0.3	0.3	0.62	0.3	0.37
Sodium	260	220	260	260	290	180	390	290	290	250	310	310
Tin	30	30	30	30	30	30	30	30	30	30	30	30
Titanium	51	120	54	65	67	40	100	66	56	90	92	78
Vanadium	16	17	15	13	15	6.9	11	9.1	11	11	13	15
Zinc	58	74	52	82	75	30	42	32	39	42	40	120
Pesticides (µg/kg)												
Aldrin	2	2	3	17	3	8	17	15	11	15	8	14
alpha-BHC	2	2	3	3	3	1	20	14	20	14	20	20
alpha-Chlordane	2	2	3	3	3	1	2	1	2	1	2	2
beta-BHC	2	2	3	3	3	1	2	1	2	1	2	2
delta-BHC	2	2	3	3	3	1	2	1	2	1	2	2
Dieldrin	4	4	6	6	7	3	40	28	40	28	40	40
Endosulfan I	2	2	3	3	3	1	20	14	20	14	20	20
Endosulfan II	4	4	6	6	7	3	65	5	56	9	27	10
Endosulfan Sulfate	37	4	84	197	7	3	74	5	60	9	34	8
Endrin	4	4	6	6	7	3	40	28	40	28	40	40
Endrin Aldehyde	4	4	6	6	7	3	4	2	4	2	4	4
Endrin ketone	4	4	6	6	7	3	4	2	4	2	4	4
gamma-Chlordane	2	2	3	3	3	1	2	1	2	1	2	2
Hept Epoxide	2	3	3	9	2	1	2	1	2	1	2	2
Heptachlor	2	2	3	3	3	1	20	14	20	14	20	20
Lindane	2	2	3	3	3	1	20	14	20	14	20	20
Methoxychlor	21	20	28	30	33	14	200	140	200	140	200	200
p,p'-DDD	4	5	6	6	7	3	40	28	40	28	40	40
p,p'-DDE	1	2	6	6	4	3	4	2	4	2	4	4
p,p'-DDT	4	4	6	6	7	3	40	28	40	28	40	40
PAH'S (µg/kg)												
2-Methylnaphthalene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Acenaphthene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Acenaphthylene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Anthracene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Benzo[a]anthracene	1400	1000	1900	1300	1800	750	980	840	830	780	910	750
Benzo[a]pyrene	1700	1000	1900	1600	1800	750	980	830	830	780	910	750
Benzo[b]fluoranthene	2200	1000	1900	2000	1800	750	980	1200	830	780	910	750
Benzo[g,h,I]perylene	820	1000	1900	890	1800	750	980	390	830	780	910	750
Benzo[k]fluoranthene	780	1000	1900	1600	1800	750	980	730	830	780	910	750
bis(2-Ethylhexyl)phthalate	1600	1500	2900	2400	2700	1100	580	34000	1200	1200	1400	1100
Butylbenzylphthalate	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Carbazole	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Chrysene	1600	1000	1900	1500	1800	750	980	910	830	780	910	750
Dibenz[a,h]anthracene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Dibenzofuran	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Diethylphthalate	1600	1500	2900	2400	2700	1100	1500	1100	1200	1200	1400	1100
Dimethylphthalate	1600	1500	2900	2400	2700	1100	1500	1100	1200	1200	1400	1100
Di-n-butylphthalate	1600	1500	2900	2400	2700	1100	1500	1100	1200	1200	1400	1100
Di-n-octylphthalate	1600	1500	2900	2400	2700	1100	1500	1100	1200	1200	1400	1100
Fluoranthene	3900	1000	1900	4300	1800	750	710	2700	670	780	910	750
Fluorene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Indeno[1,2,3-cd]pyrene	950	1000	1900	940	1800	750	980	540	830	780	910	750
Naphthalene	1000	1000	1900	1600	1800	750	980	730	830	780	910	750
Phenanthrene	1800	1000	1900	1900	1800	750	980	2100	510	780	910	750
Pyrene	2900	1000	1900	2400	1800	750	550	1700	460	780	910	750
Alkylphenols (µg/kg)												
Bisphenol A	79	67	137	121	113	51	71	55	52	61	67	55
Octylphenol	85	72	147	130	121	55	76	59	56	65	72	59
Total NP	318	325	660	584	543	245	341	264	249	292	324	264
Total NP1EO	765	650	1321	1169	1087	489	681	529	498	584	647	529
Total NP2EO	1470	1249	2540	2248	2090	941	1310	1017	957	1124	1244	1019
PCB (µg/kg)	NA	NA	NA	NA	NA	NA	0.072	0.057	0.059	0.057	0.083	0.083
Cyanide (mg/L)	1.6	1.6	2.9	2.4	2.5	1.2	1.5	1.2	1.2	1.2	1.2	1.2
Oil and grease (mg/kg)	837	1297	1505	2037	1780	1780	1286	1415	652	845	1014	1419
Nutrients (mg/kg)												
Ammonia nitrogen	105	33.9	221	81.4	127	17.2	16.1	14.4	50.3	14.8	90.1	14.3
Kjeldahl nitrogen	1170	1240	4770	1730	2260	347	653	262	164	601	571	406
Phosphorus	596	521	832	618	628	161	347	299	601	455	332	172

Table E4. Continued.

Carpentersville Dam

	Above dam samples						Below dam samples					
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Core 2	Ponar 1	Ponar 2	Ponar 3	Ponar 4
Heavy metals (mg/kg)												
Aluminum	4400	7200	5900	3600	1900	2300	7400	9400	2600	3100	1200	2800
Barium	55	76	49	31	16	20	120	160	17	27	11	33
Beryllium	0.25	0.36	0.24	0.17	0.08	0.09	0.39	0.48	0.17	0.13	0.1	0.12
Boron	9.7	6.4	5.3	7.7	4.7	5.1	9.3	17	8.4	6.2	5.1	4.6
Cadmium	1.3	0.65	0.3	0.3	0.3	0.31	0.96	1.4	0.3	0.3	0.3	0.36
Calcium	70000	61000	44000	55000	45000	58000	90000	120000	130000	70000	97000	43000
Chromium	13	14	8	7.8	3.5	4.1	18	22	4.4	5.5	2.3	5.6
Cobalt	4.1	5.5	4	3.9	1.7	2.2	5.1	5.1	2.8	2.7	1.2	1.9
Copper	10	12	9.1	5.3	1.5	3.1	34	34	1.5	2.3	1	4.9
Iron	10000	14000	11000	12000	4800	6300	16000	20000	9500	7700	5200	6200
Lead	16	13	8.8	4.3	5	5	44	45	6.9	5.2	4.1	6.1
Lithium	7.6	10	8.2	7.5	4.3	5	9.9	12	7.8	5.1	3.2	3.7
Magnesium	24000	21000	17000	25000	19000	24000	17000	13000	57000	31000	53000	15000
Manganese	310	330	320	370	150	150	350	360	380	190	140	150
Mercury	0.3	0.1	0.04	0.1	0.002	0.03	0.1	0.2	0.02	0.02	0.01	0.03
Molybdenum	7	7	7	7	7	7	7	7	7	7	7	7
Nickel	13	13	8.1	8.3	2.7	3.6	21	22	6.6	5.8	2.3	5.1
Potassium	580	860	650	530	330	350	980	1300	370	410	240	420
Silver	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Sodium	410	290	280	440	290	260	340	410	380	280	160	230
Tin	30	30	30	30	30	30	30	30	30	30	30	30
Titanium	76	110	110	51	87	83	67	79	140	150	77	100
Vanadium	12	18	14	9.9	6.2	6.7	18	21	9.2	8.6	6.3	9
Zinc	64	58	40	39	21	26	110	160	37	28	27	29
Pesticides (µg/kg)												
Aldrin	2	2	2	2	1	2	8	4	6	4	2	2
alpha-BHC	20	20	20	20	14	20	3	4	2	2	2	2
alpha-Chlordane	2	2	2	2	1	2	3	4	2	2	2	2
beta-BHC	2	2	2	2	1	2	3	4	2	2	2	2
delta-BHC	2	2	2	2	1	2	3	4	2	2	2	2
Dieldrin	40	40	40	40	28	40	6	9	3	3	3	3
Endosulfan I	20	20	20	20	14	20	3	4	2	2	2	2
Endosulfan II	33	43	41	23	4	10	6	9	3	3	3	3
Endosulfan Sulfate	4	4	64	4	2	4	6	9	3	3	3	38
Endrin	40	40	40	40	28	40	6	9	3	3	3	3
Endrin Aldehyde	4	4	4	4	2	4	6	9	3	3	3	3
Endrin ketone	4	4	4	4	2	4	6	9	3	3	3	3
gamma-Chlordane	2	2	2	2	1	2	3	4	2	2	2	2
Hept Epoxide	2	2	2	2	1	2	7	7	3	2	2	6
Heptachlor	20	20	20	20	14	20	3	4	2	2	2	2
Lindane	20	20	20	20	14	20	3	4	2	2	2	2
Methoxychlor	200	200	200	200	140	200	28	44	15	15	15	17
p,p'-DDD	40	40	40	40	28	40	6	9	3	3	3	3
p,p'-DDE	0	4	4	4	2	4	3	8	3	3	3	3
p,p'-DDT	40	40	40	40	28	40	6	9	3	3	3	3
PAH'S (µg/kg)												
2-Methylnaphthalene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Acenaphthene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Acenaphthylene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Anthracene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Benzo[a]anthracene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Benzo[a]pyrene	980	1000	970	930	820	860	1500	2400	720	800	760	900
Benzo[b]fluoranthene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Benzo[g,h,I]perylene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Benzo[k]fluoranthene	980	1000	970	930	820	860	1500	2400	720	800	760	990
bis(2-Ethylhexyl)phthalate	1500	1600	1400	1400	1200	1300	2300	3600	1100	1200	1100	1500
Butylbenzylphthalate	980	1000	970	930	820	860	1500	2400	720	800	760	990
Carbazole	980	1000	970	930	820	860	1500	2400	720	800	760	990
Chrysene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Dibenz[a,h]anthracene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Dibenzofuran	980	1000	970	930	820	860	1500	2400	720	800	760	990
Diethylphthalate	1500	1600	1400	1400	1200	1300	2300	3600	1100	1200	1100	1500
Dimethylphthalate	1500	1600	1400	1400	1200	1300	2300	3600	1100	1200	1100	1500
Di-n-butylphthalate	1500	1600	1400	1400	1200	1300	2300	3600	1100	1200	1100	1500
Di-n-octylphthalate	1500	1600	1400	1400	1200	1300	2300	3600	1100	1200	1100	1500
Fluoranthene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Fluorene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Indeno[1,2,3-cd]pyrene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Naphthalene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Phenanthrene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Pyrene	980	1000	970	930	820	860	1500	2400	720	800	760	990
Alkylphenols (µg/kg)												
Bisphenol A	72	79	64	62	53	54	148	173	52	50	44	66
Octylphenol	78	84	68	67	57	58	159	186	56	53	47	70
Total NP	349	378	307	300	256	261	711	833	251	239	212	316
Total NP1EO	698	756	614	600	513	521	1423	1665	502	477	477	632
Total NP2EO	1342	1454	1180	1153	986	1003	2736	3202	964	918	918	1215
PCB (µg/kg)	0.79	0.076	0.063	0.067	0.054	0.066	NA	NA	NA	NA	NA	NA
Cyanide (mg/L)	1.3	1.3	1.4	1.2	1.2	1.2	1.9	3.5	1	1.1	1.2	1.2
Oil and grease (mg/kg)	929	754	1780	701	1780	570	1556	3172	1780	579	1780	595
Nutrients (mg/kg)												
Ammonia nitrogen	40.3	159	18.3	15.5	15.1	12.6	92.4	152	12.7	14.1	14.4	18.8
Kjeldahl nitrogen	1490	1830	1310	767	281	400	2470	3870	112	245	154	965
Phosphorus	561	643	411	303	159	188	545	839	172	265	162	266

Table E4. Continued.

Elgin Dam

Substance	Above dam samples						Below dam samples		
	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Core 1	Ponar 1	Ponar 2
Heavy metals (mg/kg)									
Aluminum	8300	8800	9200	6600	4400	5600	5300	4100	1900
Barium	92	91	100	120	87	130	83	20	120
Beryllium	0.39	0.39	0.44	0.31	0.18	0.27	0.28	0.21	0.17
Boron	6.8	6.7	6.4	7.4	6.4	8.2	9	8.1	14
Cadmium	0.56	0.47	0.51	0.88	0.44	1.1	0.82	0.3	0.3
Calcium	56000	57000	52000	83000	62000	82000	84000	100000	99000
Chromium	14	13	14	15	9.3	18	13	11	6
Cobalt	6.3	6.1	6.3	5.3	4.4	6.6	4.5	3.4	1.9
Copper	22	18	27	27	12	37	22	8	13
Iron	17000	18000	18000	15000	10000	15000	13000	11000	13000
Lead	36	21	28	26	19	72	34	8.4	120
Lithium	12	13	12	11	7.5	8.6	7	12	4.7
Magnesium	21000	22000	20000	23000	22000	25000	25000	59000	53000
Manganese	360	460	420	430	270	430	320	230	170
Mercury	0.3	0.1	0.3	0.2	0.1	0.3	0.2	0.01	0.01
Molybdenum	7	7	7	7	7	7	7	7	7
Nickel	13	13	14	14	9.8	18	14	11	4
Potassium	1000	1100	1100	910	670	770	740	440	370
Silver	0.3	0.3	0.3	0.87	0.3	0.89	0.58	0.3	0.3
Sodium	280	290	230	350	340	390	340	260	220
Tin	30	30	30	30	30	30	30	30	30
Titanium	97	96	93	88	110	100	100	97	120
Vanadium	19	19	20	14	10	13	14	20	15
Zinc	85	76	85	100	62	130	91	44	39
Pesticides (µg/kg)									
Aldrin	2	2	2	2	2	2	3	1	1
alpha-BHC	250	20	30	30	20	30	3	1	1
alpha-Chlordane	2	2	2	2	2	2	3	1	1
beta-BHC	20	2	2	2	2	2	3	1	1
delta-BHC	20	2	2	2	2	2	3	1	1
Dieldrin	40	40	50	4	40	50	5	3	3
Endosulfan I	20	20	30	2	20	30	3	1	1
Endosulfan II	18	18	47	50	88	58	5	3	3
Endosulfan Sulfate	58	58	120	4	110	114	105	3	3
Endrin	40	40	50	50	40	50	5	3	3
Endrin Aldehyde	4	4	4	50	4	4	5	3	3
Endrin ketone	4	4	4	4	4	4	5	3	3
gamma-Chlordane	2	2	2	2	2	2	3	1	1
Hept Epoxide	2	2	2	2	2	2	10	1	1
Heptachlor	2	20	30	30	20	30	3	1	1
Lindane	20	20	30	30	20	30	3	1	1
Methoxychlor	200	200	250	98	200	250	26	13	14
p,p'-DDD	40	40	50	50	40	50	5	3	3
p,p'-DDE	4	4	4	30	4	4	4	3	3
p,p'-DDT	40	40	50	73	40	50	5	3	3
PAH'S (µg/kg)									
2-Methylnaphthalene	1200	1100	1200	1900	1100	1300	1500	730	850
Acenaphthene	1200	1100	1200	1900	1100	1300	1500	730	850
Acenaphthylene	1200	1100	1200	1900	1100	1300	1500	730	850
Anthracene	1200	1100	1200	1900	1100	1300	1500	730	850
Benzo[a]anthracene	1200	1100	1200	1900	1100	1300	1500	730	540
Benzo[a]pyrene	1200	1100	1200	1900	1100	1300	1500	730	550
Benzo[b]fluoranthene	1800	1100	1200	1900	1100	1300	1500	730	750
Benzo[g,h,I]perylene	1200	1100	1200	1900	1100	1300	1500	730	850
Benzo[k]fluoranthene	1200	1100	1200	1900	1100	1300	1500	730	850
bis(2-Ethylhexyl)phthalate	1800	1700	1800	2800	1600	2000	2200	1100	1300
Butylbenzylphthalate	1200	1100	1200	1900	1100	1300	1500	730	850
Carbazole	1200	1100	1200	1900	1100	1300	1500	730	850
Chrysene	1200	1100	1200	1900	1100	1300	1500	730	560
Dibenz[a,h]anthracene	1200	1100	1200	1900	1100	1300	1500	730	850
Dibenzofuran	1200	1100	1200	1900	1100	1300	1500	730	850
Diethylphthalate	1800	1700	1800	2800	1600	2000	2200	1100	1300
Dimethylphthalate	1800	1700	1800	2800	1600	2000	2200	1100	1300
Di-n-butylphthalate	1800	1700	1800	2800	1600	2000	2200	1100	1300
Di-n-octylphthalate	1800	1700	1800	2800	1600	2000	2200	1100	1300
Fluoranthene	1200	1100	1200	1900	1200	1100	1500	730	1700
Fluorene	1200	1100	1200	1900	1100	1300	1500	730	850
Indeno[1,2,3-cd]pyrene	1200	1100	1200	1900	1100	1300	1500	730	850
Naphthalene	1200	1100	1200	1900	1100	1300	1500	730	850
Phenanthrene	1200	1100	1200	1900	720	1300	1500	730	920
Pyrene	1200	1100	1200	1900	1100	1300	1500	730	1000
Alkylphenols (µg/kg)									
Bisphenol A	78	75	89	134	75	98	112	52	53
Octylphenol	84	81	96	144	80	105	120	56	56
Total NP	376	363	430	645	360	430	537	253	253
Total NP1EO	752	727	859	1290	720	859	1075	505	506
Total NP2EO	1447	1398	1653	2482	1385	1653	2067	971	973
PCB (µg/kg)	0.082	0.079	0.1	0.1	0.23	0.11	NA	NA	NA
Cyanide (mg/L)	1.6	1.5	1.8	2.5	1.4	2.2	1.8	0.8	1.2
Oil and grease (mg/kg)	1127	1780	710	820	128	2022	1673	1780	752
Nutrients (mg/kg)									
Ammonia nitrogen	133	295	241	64.6	21.2	48.9	60.6	24.2	18
Kjeldahl nitrogen	1910	2170	2930	1810	825	1730	1420	62.9	161
Phosphorus	642	1140	827	1000	583	1400	567	145	116

Table E4. Continued.

South Elgin Dam

	Above dam samples						Below dam samples		
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)									
Aluminum	2800	12000	3400	6400	6700	9500	2000	2500	1700
Barium	36	130	51	120	140	170	37	57	31
Beryllium	0.15	0.6	0.15	0.53	0.41	0.62	0.19	0.22	0.18
Boron	2.3	7.1	4.1	6.8	8.4	10	9	11	17
Cadmium	2.4	0.83	1.5	5.2	4.7	1.8	2	2	2
Calcium	24000	56000	58000	64000	76000	90000	130000	120000	140000
Chromium	8.7	17	10	22	22	21	9	13	10
Cobalt	3.2	7	4	7.1	6.8	6.9	2.1	2.6	2
Copper	8.1	25	10	30	51	35	2.9	8.6	18
Iron	6400	22000	12000	17000	19000	21000	14000	19000	11000
Lead	8	30	43	29	41	43	13	43	10
Lithium	2.6	9.3	4.1	6.7	7.5	9.9	5	5.6	5
Magnesium	4200	18000	32000	15000	21000	24000	57000	55000	76000
Manganese	120	430	250	480	550	560	290	480	290
Mercury	1.1	1.9	1	2.4	2.2	2.7	0.04	0.03	0.03
Molybdenum	7	7	7	7	7	7	10	10	10
Nickel	11	18	12	28	28	23	4.3	5.4	3.9
Potassium	330	1100	370	840	780	1100	490	550	540
Silver	0.3	0.3	0.3	0.3	1.5	0.3	1	1	1
Sodium	120	260	180	290	310	340	460	390	280
Tin	30	30	30	30	30	30	NA	NA	NA
Titanium	70	78	68	100	96	99	54	110	50
Vanadium	7.1	23	9.9	12	15	15	12	17	12
Zinc	35	100	45	130	140	140	50	58	59
Pesticides (µg/kg)									
Aldrin	2	3	3	12	3	4	4.9	4.1	4.3
alpha-BHC	2	3	3	3	3	4	4.9	4.1	4.3
alpha-Chlordane	2	3	3	3	3	4	4.9	4.1	4.3
beta-BHC	2	3	3	3	3	4	4.9	4.1	4.3
delta-BHC	2	3	3	3	3	4	4.9	4.1	4.3
Dieldrin	4	6	6	6	8	8	4.9	4.1	4.3
Endosulfan I	2	3	3	3	3	4	4.9	4.1	4.3
Endosulfan II	4	6	6	6	6	8	4.9	4.1	4.3
Endosulfan Sulfate	4	6	5	6	6	8	4.9	4.1	4.3
Endrin	4	6	6	8	11	8	4.9	4.1	4.3
Endrin Aldehyde	4	6	6	6	6	8	4.9	4.1	4.3
Endrin ketone	4	6	6	6	6	8	4.9	4.1	4.3
gamma-Chlordane	2	3	3	3	3	4	4.9	4.1	4.3
Hept Epoxide	2	3	3	3	3	4	4.9	4.1	4.3
Heptachlor	2	3	3	3	3	4	4.9	4.1	4.3
Lindane	2	3	3	3	3	4	4.9	4.1	4.3
Methoxychlor	20	30	30	30	30	40	20.5	4.1	10.5
p,p'-DDD	4	6	41	6	6	8	4.9	3.2	4.4
p,p'-DDE	4	6	16	9	9	8	1.3	4.1	1.1
p,p'-DDT	4	6	41	6	6	8	4.9	4.1	2.3
PAH'S (µg/kg)									
2-Methylnaphthalene	860	1500	870	1600	1700	1800	540	440	630
Acenaphthene	860	1500	640	1600	1700	1800	540	440	630
Acenaphthylene	860	1500	870	1600	1700	1800	540	440	630
Anthracene	860	930	860	1600	1700	1800	540	440	630
Benzo[a]anthracene	860	1100	2700	1600	1700	1800	540	440	590
Benzo[a]pyrene	860	1200	2900	1600	930	1800	540	440	570
Benzo[b]fluoranthene	860	1200	4100	1600	1200	1800	540	440	890
Benzo[g,h,I]perylene	860	1500	1900	1600	1700	1800	540	440	630
Benzo[k]fluoranthene	860	1500	1200	1600	1700	1800	540	440	630
bis(2-Ethylhexyl)phthalate	1300	2200	1300	2400	2500	2700	800	660	940
Butylbenzylphthalate	860	1500	900	1600	1700	1800	540	440	630
Carbazole	860	1500	810	1600	1700	1800	540	440	630
Chrysene	860	1400	3300	1600	1000	1800	540	440	700
Dibenz[a,h]anthracene	860	1500	460	1600	1700	1800	540	440	630
Dibenzofuran	860	1500	870	1600	1700	1800	540	440	630
Diethylphthalate	1300	2200	1300	2400	2500	2700	800	660	940
Dimethylphthalate	1300	2200	1300	2400	2500	2700	800	660	940
Di-n-butylphthalate	1300	2200	1300	2400	2500	2700	800	660	940
Di-n-octylphthalate	1300	2200	1300	2400	2500	2700	800	660	940
Fluoranthene	860	2000	7900	1600	2500	1800	540	440	1700
Fluorene	860	1500	450	1600	1700	1800	540	440	630
Indeno[1,2,3-cd]pyrene	860	1500	2300	1600	1700	1800	540	440	630
Naphthalene	860	1500	870	1600	1700	1800	540	440	630
Phenanthrene	860	2400	6400	1600	1300	1800	540	440	1300
Pyrene	860	2800	7500	1600	2000	1800	540	440	1400
Alkylphenols (µg/kg)									
Bisphenol A	30	49	28	64	66	75	NA	NA	NA
Octylphenol	33	53	30	69	71	80	NA	NA	NA
Total NP	147	236	134	309	319	360	NA	NA	NA
Total NP1EO	293	471	269	618	638	719	NA	NA	NA
Total NP2EO	564	906	517	1189	1227	1383	NA	NA	NA
PCB (µg/kg)	0.06	0.11	0.06	0.12	0.02	0.14	0.1	0.08	0.09
Cyanide (mg/L)	0.06	0.7	0.04	0.2	0.2	0.3	0.1	1.2	0.1
Oil and grease (mg/kg)	1780	1418	1562	1606	2793	2667	1363	1081	1805
Nutrients (mg/kg)									
Ammonia nitrogen	16	219	59	111	162	152	NA	NA	NA
Kjeldahl nitrogen	1400	2820	625	3360	3600	4000	NA	NA	NA
Phosphorus	368	1130	582	1860	2300	1580	NA	NA	NA

Table E4. Continued.

St. Charles Dam

	Above dam samples					
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)						
Aluminum	9400	8900	12000	7300	2900	6800
Barium	220	98	150	140	26	120
Beryllium	0.51	0.42	0.57	0.33	0.19	0.36
Boron	8.7	8.7	10	12	7.7	7.6
Cadmium	10	3.6	3.6	1.7	0.36	2.1
Calcium	70000	54000	55000	87000	95000	64000
Chromium	48	23	29	20	6.7	18
Cobalt	6.4	6	7.8	5.5	2.3	5.9
Copper	48	20	29	35	6.5	26
Iron	20000	17000	21000	16000	9200	15000
Lead	87	26	49	54	32	32
Lithium	12	11	15	11	9.1	9.3
Magnesium	19000	22000	13000	23000	47000	14000
Manganese	510	250	380	450	270	400
Mercury	0.2	0.1	0.2	0.6	0.1	0.02
Molybdenum	7	7	7	7	7	7
Nickel	28	17	25	17	5.7	18
Potassium	1100	970	1400	1100	520	910
Silver	1.3	0.3	0.32	0.3	0.3	0.33
Sodium	280	350	310	350	300	260
Tin	30	30	30	30	30	30
Titanium	79	95	92	100	75	88
Vanadium	20	22	23	15	15	16
Zinc	180	81	130	130	45	110
Pesticides (µg/kg)						
Aldrin	16	11	21	48	26	21
alpha-BHC	20	20	30	30	30	30
alpha-Chlordane	2	2	2	2	2	2
beta-BHC	2	2	2	30	2	2
delta-BHC	2	2	2	2	2	2
Dieldrin	40	40	50	50	50	50
Endosulfan I	20	20	30	30	30	30
Endosulfan II	167	181	141	208	120	138
Endosulfan Sulfate	4	255	243	302	172	314
Endrin	40	40	50	50	50	50
Endrin Aldehyde	288	4	4	4	4	4
Endrin ketone	4	4	4	4	4	4
gamma-Chlordane	2	2	2	2	2	2
Hept Epoxide	2	2	2	2	2	2
Heptachlor	20	20	30	30	30	30
Lindane	20	20	30	30	30	30
Methoxychlor	200	200	250	250	250	250
p,p'-DDD	40	40	50	50	50	50
p,p'-DDE	11	5	4	8	6	4
p,p'-DDT	40	40	50	50	50	50
PAH'S (µg/kg)						
2-Methylnaphthalene	1400	1000	960	2000	1700	1600
Acenaphthene	1400	1000	960	2000	1700	1600
Acenaphthylene	1400	1000	960	2000	1700	1600
Anthracene	1400	1000	960	2000	1700	1600
Benzo[a]anthracene	1400	1000	960	3200	1700	1600
Benzo[a]pyrene	1400	1000	960	3400	1700	1600
Benzo[b]fluoranthene	1400	1000	960	4300	1700	1600
Benzo[g,h,I]perylene	1400	1000	960	1600	1700	1600
Benzo[k]fluoranthene	1400	1000	960	1400	1700	1600
bis(2-Ethylhexyl)phthalate	2100	1600	1400	2100	2600	2400
Butylbenzylphthalate	1400	1000	960	2000	1700	1600
Carbazole	1400	1000	960	2000	1700	1600
Chrysene	1400	1000	960	3300	1700	1600
Dibenz[a,h]anthracene	1400	1000	960	2000	1700	1600
Dibenzofuran	1400	1000	960	2000	1700	1600
Diethylphthalate	2100	1600	1400	3000	2600	2400
Dimethylphthalate	2100	1600	1400	3000	2600	2400
Di-n-butylphthalate	2100	1600	1400	3000	2600	2400
Di-n-octylphthalate	2100	1600	1400	3000	2600	2400
Fluoranthene	1400	1000	960	8000	1700	1600
Fluorene	1400	1000	960	2000	1700	1600
Indeno[1,2,3-cd]pyrene	1400	1000	960	2000	1700	1600
Naphthalene	1400	1000	960	2000	1700	1600
Phenanthrene	1400	1000	960	3700	1700	1600
Pyrene	1400	1000	960	5200	1700	1600
Alkylphenols (µg/kg)						
Bisphenol A	99	70	69	139	115	123
Octylphenol	107	75	75	150	124	132
Total NP	475	335	334	671	554	592
Total NP1EO	949	670	668	1342	1108	1184
Total NP2EO	1825	1289	1285	2580	2131	2277
PCB (µg/kg)	0.2	0.12	0.17	0.13	0.13	0.14
Cyanide (mg/L)	2	1.5	1.3	2.5	2.2	2.2
Oil and grease (mg/kg)	3772	943	1382	2911	1145	1907
Nutrients (mg/kg)						
Ammonia nitrogen	483	118	109	193	121	94
Kjeldahl nitrogen	4070	1690	1590	3330	3340	2920
Phosphorus	1660	641	630	1300	1150	1010

Table E4. Continued.

Geneva Dam

Substance	Above dam samples						Below dam samples		
	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)									
Aluminum	10000	8400	6900	5700	5400	3200	2300	2800	5500
Barium	200	89	68	120	110	69	42	42	130
Beryllium	0.56	0.49	0.35	0.31	0.32	0.26	0.24	0.27	0.33
Boron	11	8	7	8.7	8.2	11	13	20	11
Cadmium	23	0.65	0.42	14	4.7	1.7	2	2	2
Calcium	52000	62000	58000	53000	62000	51000	140000	150000	99000
Chromium	150	12	10	61	35	15	11	6.4	18
Cobalt	7.9	5.3	5	6.4	5.9	5	2.4	2	3.5
Copper	190	59	21	49	43	26	7.3	2.8	31
Iron	22000	17000	14000	15000	15000	10000	13000	8300	14000
Lead	110	35	21	62	50	59	22	10	30
Lithium	11	9.8	8	6.6	7.7	4.7	5	5	8.1
Magnesium	16000	22000	17000	17000	20000	17000	69000	65000	32000
Manganese	410	430	390	330	360	260	360	310	410
Mercury	0.6	0.3	2.3	0.2	0.3	0.1	0.1	0.1	0.1
Molybdenum	7	7	7	7	7	7	10	10	10
Nickel	120	13	10	42	42	29	5.8	5.9	13
Potassium	1200	1000	850	800	740	450	550	510	790
Silver	1.3	0.3	0.3	1.2	0.3	0.3	1	1	1.3
Sodium	250	280	260	260	340	290	330	420	540
Tin	30	30	30	30	30	30			
Titanium	84	91	120	86	95	120	74	88	88
Vanadium	22	19	16	12	13	9	16	12	13
Zinc	240	94	58	160	140	74	52	51	100
Pesticides (µg/kg)									
Aldrin	7	2	2	9	2	1	7.8	13.1	7.8
alpha-BHC	3	2	2	2	2	1	7.8	13.1	7.8
alpha-Chlordane	3	2	2	2	2	1	7.8	13.1	7.8
beta-BHC	3	2	2	2	2	1	7.8	13.1	7.8
delta-BHC	3	2	2	2	2	1	7.8	13.1	7.8
Dieldrin	6	4	4	14	5	3	7.8	13.1	7.8
Endosulfan I	3	2	2	2	2	1	7.8	13.1	7.8
Endosulfan II	6	4	4	4	5	3	7.8	13.1	7.8
Endosulfan Sulfate	6	4	4	35	5	3	7.8	13.1	7.8
Endrin	6	4	4	4	5	3	7.8	13.1	7.8
Endrin Aldehyde	6	4	4	4	5	3	7.8	13.1	7.8
Endrin ketone	6	4	4	4	5	3	7.8	13.1	7.8
gamma-Chlordane	3	2	2	2	2	1	7.8	13.1	7.8
Hept Epoxide	3	2	24	2	2	1	7.8	13.1	7.8
Heptachlor	3	2	2	2	2	1	7.8	13.1	7.8
Lindane	3	2	2	2	2	1	7.8	13.1	7.8
Methoxychlor	31	20	19	22	23	14	18.9	13.1	7.8
p,p'-DDD	36	2	4	35	8	2	5.1	19.8	16.6
p,p'-DDE	33	2	4	19	11	7	3.2	8.9	15.4
p,p'-DDT	6	4	4	4	5	3	3	6.6	9.9
PAH'S (µg/kg)									
2-Methylnaphthalene	1500	1100	1100	1100	1500	860	1200	1900	1200
Acenaphthene	1500	1100	1100	1100	1500	860	1200	1900	1200
Acenaphthylene	1500	1100	1100	1100	1500	860	1200	1900	1200
Anthracene	1500	1100	1100	1100	1500	860	1200	1900	1200
Benzo[a]anthracene	1500	1100	1100	2700	1500	510	1200	2800	1200
Benzo[a]pyrene	940	1100	1100	3500	940	620	1200	2300	1200
Benzo[b]fluoranthene	1300	630	1100	4500	1300	720	1200	3400	1300
Benzo[g,h,I]perylene	1500	1100	1100	1500	1500	860	1200	1900	1200
Benzo[k]fluoranthene	1500	1100	1100	1400	1500	860	1200	1900	1200
bis(2-Ethylhexyl)phthalate	2300	1600	1600	1700	2300	1300	1700	2900	1800
Butylbenzylphthalate	1500	1100	1100	1100	1500	860	1200	1900	1200
Carbazole	1500	1100	1100	640	1500	860	1200	1900	1200
Chrysene	870	1100	1100	2900	870	540	1200	2900	1200
Dibenz[a,h]anthracene	1500	1100	1100	1100	1500	860	1200	1900	1200
Dibenzofuran	1500	1100	1100	1100	1500	860	1200	1900	1200
Diethylphthalate	2300	1600	1600	1700	2300	1300	1700	2900	1800
Dimethylphthalate	2300	1600	1600	1700	2300	1300	1700	2900	1800
Di-n-butylphthalate	2300	1600	1600	1700	2300	1300	1700	1900	1800
Di-n-octylphthalate	2300	1600	1600	1700	2300	1300	1700	2900	1800
Fluoranthene	2300	930	1100	8600	2300	1200	1200	7600	1900
Fluorene	1500	1100	1100	1100	1500	860	1200	1900	1200
Indeno[1,2,3-cd]pyrene	1500	1100	1100	1700	1500	860	1200	1900	1200
Naphthalene	1500	1100	1100	1100	1500	860	1200	1900	1200
Phenanthrene	1100	1100	1100	5000	1100	660	1200	7400	1200
Pyrene	1500	660	1100	6400	1500	1000	1200	5600	1600
Alkylphenols (µg/kg)									
Bisphenol A	108	81	71	78	79	55	NA	NA	NA
Octylphenol	116	87	76	84	85	59	NA	NA	NA
Total NP	522	391	342	375	382	266	NA	NA	NA
Total NP1EO	1043	781	683	749	764	533	NA	NA	NA
Total NP2EO	2006	1502	1314	1441	1469	1024	NA	NA	NA
PCB (µg/kg)	NA	NA	NA	NA	NA	NA	0.16	0.26	0.16
Cyanide (mg/L)	2.1	1.6	1.5	1.3	1.7	1.3	0.2	0.4	0.2
Oil and grease (mg/kg)	6738	1015	1313	2069	1880	914	1959	3779	2902
Nutrients (mg/kg)									
Ammonia nitrogen	348	67.8	42.2	19.7	24.4	15.4	NA	NA	NA
Kjeldahl nitrogen	3790	1500	1010	729	1640	427	NA	NA	NA
Phosphorus	1620	690	492	823	1650	961	NA	NA	NA

Table E4. Continued.

North Batavia Dam	Above dam samples						Below dam samples		
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)									
Aluminum	7200	7100	10000	4400	6900	5500	2700	2600	2000
Barium	160	100	190	92	150	120	52	61	57
Beryllium	0.4	0.39	0.56	0.25	0.41	0.31	0.22	0.21	0.22
Boron	8.9	5.3	10	8.1	8.4	8.6	13	11	11
Cadmium	5.2	4.8	12	1.4	7.3	1.7	2	2	2
Calcium	88000	41000	68000	78000	83000	84000	130000	130000	130000
Chromium	34	34	73	15	46	19	6.8	7.7	6
Cobalt	5.6	3.5	7	5	4.9	5.1	2	2	2
Copper	37	29	79	21	41	31	7	6.2	2.1
Iron	16000	20000	220000	11000	15000	14000	9300	7300	7500
Lead	58	42	86	29	65	43	26	11	16
Lithium	8.9	7.2	11	6	7.8	6.9	5	5	5.4
Magnesium	24000	9100	21000	19000	16000	19000	60000	56000	54000
Manganese	430	430	550	320	350	420	520	330	360
Mercury	0.3	0.2	0.7	0.2	0.4	0.2	0.1	0.1	0.03
Molybdenum	7	7	7	7	7	7	10	10	10
Nickel	25	20	55	17	29	19	4.5	5	5
Potassium	900	740	1200	660	860	770	540	470	430
Silver	1.2	0.34	2.1	0.43	0.72	0.3	1	1	1
Sodium	280	210	220	340	280	320	340	280	320
Tin	30	30	30	30	30	30	NA	NA	NA
Titanium	88	140	85	84	80	87	70	49	56
Vanadium	16	20	22	9.7	15	12	13	11	11
Zinc	150	120	220	91	180	110	49	53	47
Pesticides (µg/kg)									
Aldrin	7	7	12	10	20	3	4.7	11.5	4.5
alpha-BHC	3	2	3	2	3	3	4.7	11.5	4.5
alpha-Chlordane	3	2	3	2	3	3	4.7	11.5	4.5
beta-BHC	3	2	3	2	3	3	4.7	11.5	4.5
delta-BHC	3	2	3	2	3	3	4.7	11.5	4.5
Dieldrin	5	5	5	5	5	6	4.7	11.5	4.5
Endosulfan I	3	2	3	2	3	3	4.7	11.5	4.5
Endosulfan II	5	5	5	5	5	6	4.7	11.5	4.5
Endosulfan Sulfate	5	5	5	5	5	6	4.7	11.5	4.5
Endrin	5	5	5	5	5	6	4.7	11.5	4.5
Endrin Aldehyde	5	5	5	5	5	6	4.7	11.5	4.5
Endrin ketone	5	5	5	5	5	6	4.7	11.5	4.5
gamma-Chlordane	3	2	3	2	3	3	4.7	11.5	4.5
Hept Epoxide	3	35	13	2	53	3	4.7	11.5	4.5
Heptachlor	3	2	13	2	3	3	4.7	11.5	4.5
Lindane	2	2	4	2	3	3	4.7	11.5	4.5
Methoxychlor	26	24	27	23	26	28	4.7	11.5	4.5
p,p'-DDD	26	25	75	33	137	7	3.5	11.6	9.6
p,p'-DDE	19	16	57	12	39	8	2.7	11.2	4.4
p,p'-DDT	5	5	40	5	57	6	5.8	4.2	1.6
PAH'S (µg/kg)									
2-Methylnaphthalene	1400	1200	1400	1300	1400	1500	680	1800	700
Acenaphthene	1400	1200	1400	1300	1400	1500	680	1800	700
Acenaphthylene	1400	1200	1400	1300	1400	1500	680	1800	700
Anthracene	1400	1200	1400	1300	1400	800	680	1800	700
Benzo[a]anthracene	1400	1200	1400	850	1400	3200	680	1800	700
Benzo[a]pyrene	1400	1200	1400	1000	1400	3200	680	1800	700
Benzo[b]fluoranthene	780	1200	1400	1300	1400	3800	680	1600	700
Benzo[g,h,I]perylene	1400	1200	1400	1300	1400	1300	680	1800	700
Benzo[k]fluoranthene	1400	1200	1400	1300	1400	1100	680	1800	700
bis(2-Ethylhexyl)phthalate	780	1900	2000	1900	2000	2200	1000	2600	780
Butylbenzylphthalate	1400	1200	1400	1300	1400	1500	680	1800	700
Carbazole	1400	1900	1400	1300	1400	1500	680	1800	700
Chrysene	1400	1200	1400	1000	1400	3100	680	1800	700
Dibenz[a,h]anthracene	1400	1200	1400	1300	1400	1500	680	1800	700
Dibenzofuran	1400	1200	1400	1300	1400	1500	680	1800	700
Diethylphthalate	2200	1900	2000	1900	2000	2200	1000	2600	1000
Dimethylphthalate	2200	1900	2000	1900	2000	2200	1000	2600	1000
Di-n-butylphthalate	2200	1900	2000	1900	2000	2200	1000	2600	1200
Di-n-octylphthalate	2200	1900	2000	1900	2000	2200	1000	2600	1000
Fluoranthene	1200	1200	1000	2300	1400	8100	550	3100	610
Fluorene	1400	1900	1400	1300	1400	1500	680	1800	700
Indeno[1,2,3-cd]pyrene	1400	1200	1400	710	1400	1500	680	1800	700
Naphthalene	1400	1200	1400	1300	1400	1500	680	1800	700
Phenanthrene	1400	1200	1400	1400	1400	3200	680	2700	700
Pyrene	920	1200	1000	1700	1400	6000	680	2500	700
Alkylphenols (µg/kg)									
Bisphenol A	96	80	110	81	101	100	NA	NA	NA
Octylphenol	103	86	118	87	109	107	NA	NA	NA
Total NP	461	385	529	389	488	480	NA	NA	NA
Total NP1EO	921	769	1058	778	946	960	NA	NA	NA
Total NP2EO	1772	1479	2034	1496	1877	1847	NA	NA	NA
PCB (µg/kg)	NA	NA	NA	NA	NA	NA	0.09	0.23	0.09
Cyanide (mg/L)	1.7	1.4	2.5	1.6	2.8	2.1	0.1	0.3	0.1
Oil and grease (mg/kg)	1293	1714	2633	1584	2201	1810	1452	3857	1452
Nutrients (mg/kg)									
Ammonia nitrogen	123	149	484	19.6	54.1	112	NA	NA	NA
Kjeldahl nitrogen	1570	1120	2490	1110	2740	1510	NA	NA	NA
Phosphorus	1540	504	2180	819	1080	985	NA	NA	NA

Table E4. Continued.

South Batavia Dam

Substance	Above dam samples							Below dam samples		
	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3	Ponar 4	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)										
Aluminum	6900	10000	7400	5000	5200	5500	3900	4200	1800	2200
Barium	130	140	220	100	110	120	15	100	43	45
Beryllium	0.44	0.53	0.43	0.32	0.39	0.37	0.38	0.3	0.2	0.19
Boron	8.3	11	8.3	7.4	9.8	8.4	15	16	8.2	9.7
Cadmium	5.8	9.3	16	2.1	1.7	1.7	0.3	2	2	2
Calcium	80000	72000	89000	87000	93000	69000	96000	120000	120000	130000
Chromium	37	24	67	18	17	16	3.7	13	4.1	4
Cobalt	7.3	6.3	5.7	5.7	4.8	4.7	2.2	2.6	2	2
Copper	48	47	53	30	23	29	8.3	19	1.2	1
Iron	18000	21000	18000	13000	14000	15000	9000	12000	5400	6300
Lead	74	64	100	41	45	31	6.6	23	10	10
Lithium	6.8	10	7.8	5.2	5.5	5.3	4	6.8	5	5
Magnesium	21000	21000	21000	21000	20000	22000	52000	46000	42000	56000
Manganese	480	470	550	400	430	370	200	390	240	270
Mercury	1.7	2.6	1.8	1.9	1.8	2	1.2	0.2	0.03	0.4
Molybdenum	7	7	7	7	7	7	7	10	10	10
Nickel	37	20	38	20	18	15	4.6	8.2	3.7	4.2
Potassium	710	1500	770	710	750	750	420	730	420	470
Silver	1.6	0.9	1.4	3.2	0.3	0.3	0.3	1	1	1
Sodium	300	400	290	340	390	320	420	340	360	340
Tin	30	30	30	30	30	30	30	NA	NA	NA
Titanium	89	100	73	78	110	100	88	65	68	77
Vanadium	17	20	15	11	10	12	8.3	14	10	11
Zinc	180	190	210	220	120	150	89	99	41	51
Pesticides (µg/kg)										
Aldrin	10	8	24	17	18	11	1	9.5	4.1	5.5
alpha-BHC	2	4	3	3	2	2	1	9.5	4.1	5.5
alpha-Chlordane	2	4	12	3	2	2	1	9.5	4.1	5.5
beta-BHC	2	4	3	3	2	2	1	9.5	4.1	5.5
delta-BHC	2	4	2	3	2	2	1	9.5	4.1	5.5
Dieldrin	4	8	6	6	4	4	2	9.5	4.1	5.5
Endosulfan I	2	4	13	3	2	2	1	9.5	4.1	5.5
Endosulfan II	4	26	6	6	4	4	2	9.5	4.1	5.5
Endosulfan Sulfate	4	68	6	6	4	4	2	9.5	4.1	5.5
Endrin	4	8	6	6	4	4	2	9.5	4.1	5.5
Endrin Aldehyde	4	6	6	6	4	4	2	9.5	4.1	5.5
Endrin ketone	7	8	6	6	4	4	2	9.5	4.1	5.5
gamma-Chlordane	2	4	15	3	2	2	1	9.5	4.1	5.5
Hept Epoxide	2	4	20	3	2	2	1	9.5	4.1	5.5
Heptachlor	2	4	11	3	2	2	1	9.5	4.1	5.5
Lindane	2	4	3	3	2	2	1	9.5	4.1	5.5
Methoxychlor	20	40	30	30	20	20	10	9.5	4.1	5.5
p,p'-DDD	25	8	29	10	8	11	2	10.3	4	5.5
p,p'-DDE	9	15	48	10	7	8	3	9.5	1.6	1.2
p,p'-DDT	14	6	6	8	4	4	2	5.2	4.1	5.5
PAH'S (µg/kg)										
2-Methylnaphthalene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Acenaphthene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Acenaphthylene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Anthracene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Benzo[a]anthracene	1400	1800	1400	1800	1300	1300	830	1500	640	820
Benzo[a]pyrene	1500	1800	1400	1800	1300	840	830	1500	640	820
Benzo[b]fluoranthene	1600	1800	1400	1800	1300	1100	830	1500	640	820
Benzo[g,h,I]perylene	730	1800	1400	1800	1300	1300	830	1500	640	820
Benzo[k]fluoranthene	1300	1800	1400	1800	1300	1300	830	1500	640	820
bis(2-Ethylhexyl)phthalate	840	2800	2200	2800	1900	2000	1200	2200	960	1200
Butylbenzylphthalate	1300	1800	1400	1800	1300	1300	830	1500	640	820
Carbazole	1300	1800	1400	1800	1300	1300	830	1500	640	820
Chrysene	1400	1800	1400	1800	1300	830	830	1500	640	820
Dibenz[a,h]anthracene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Dibenzofuran	1300	1800	1400	1800	1300	1300	830	1500	640	820
Diethylphthalate	2000	2800	2200	2800	1900	2000	1200	2200	960	1200
Dimethylphthalate	2000	2800	2200	2800	1900	2000	1200	2200	960	1200
Di-n-butylphthalate	2000	2800	2200	2800	1900	2000	1200	2200	960	1800
Di-n-octylphthalate	2000	2800	2200	2800	1300	2000	1200	2200	960	1200
Fluoranthene	2800	1800	1400	1800	1300	1900	830	1400	640	820
Fluorene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Indeno[1,2,3-cd]pyrene	840	1800	1400	1800	1300	1300	830	1500	640	820
Naphthalene	1300	1800	1400	1800	1300	1300	830	1500	640	820
Phenanthrene	1400	1800	1400	1800	1300	860	830	1500	640	820
Pyrene	2200	1000	1400	1000	1300	1200	830	1500	640	820
Alkylphenols (µg/kg)										
Bisphenol A	48	61	48	56	40	50	23	NA	NA	NA
Octylphenol	52	65	51	60	43	54	25	NA	NA	NA
Total NP	232	292	229	269	193	242	112	NA	NA	NA
Total NP1EO	464	585	458	537	386	484	223	NA	NA	NA
Total NP2EO	892	1125	881	1033	743	931	429	NA	NA	NA
PCB (µg/kg)	0.08	0.13	0.10	0.10	0.09	0.10	0.05	0.19	0.08	0.11
Cyanide (mg/L)	0.4	0.4	0.5	0.1	0.2	0.1	0.04	0.3	0.1	0.2
Oil and grease (mg/kg)	2145	2066	2389	1603	1638	1880	1045	3015	1241	761
Nutrients (mg/kg)										
Ammonia nitrogen	96	399	256	77	107	168	13	NA	NA	NA
Kjeldahl nitrogen	2000	4690	3970	2340	1340	2690	138	NA	NA	NA
Phosphorus	1400	1350	2010	1240	852	1140	209	NA	NA	NA

Table E4. Continued.

North Aurora Dam

	Above dam samples							Below dam samples		
Substance	Core 1	Core 2	Core 3	Core 4	Ponar 1	Ponar 2	Ponar 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)										
Aluminum	11000	9000	7800	7000	4400	5300	4900	4200	5400	1600
Barium	250	180	160	180	89	110	120	160	160	49
Beryllium	0.59	0.47	0.47	0.45	0.29	0.37	0.33	0.32	0.38	0.2
Boron	11	10	9.4	8.3	7.1	8.5	8.5	16	18	11
Cadmium	0.3	3.8	2.9	5	0.3	2	2.2	2	2	2
Calcium	93000	89000	86000	90000	90000	99000	90000	140000	140000	150000
Chromium	32	27	24	32	15	15	21	4.8	13	2.7
Cobalt	6.6	6.2	6.3	6.4	4.8	5	5.9	2	2.3	2
Copper	43	38	38	36	17	24	30	31	12	20
Iron	24000	20000	19000	18000	12000	14000	15000	11000	10000	6100
Lead	91	71	66	82	32	31	54	67	24	220
Lithium	12	9.7	8.9	8	4.8	5.7	6.1	5.9	6.3	5
Magnesium	21000	22000	22000	22000	26000	24000	22000	62000	45000	66000
Manganese	650	570	550	540	410	490	460	360	460	330
Mercury	2.4	1.9	2.3	2	1.6	2.4	1.9	0.1	0.04	0.04
Molybdenum	7	7	7	7	7	7	7	10	10	10
Nickel	27	24	22	27	16	16	18	4.1	7.7	2.1
Potassium	1200	1000	920	750	560	610	630	550	580	480
Silver	1	0.74	0.98	1.1	0.3	0.3	0.46	1	1	1
Sodium	290	330	270	250	260	290	280	610	560	30
Tin	30	30	30	30	30	30	30	NA	NA	NA
Titanium	78	69	68	70	80	68	68	220	200	43
Vanadium	20	15	15	15	9.8	11	12	16	18	11
Zinc	200	180	170	170	93	100	120	160	96	100
Pesticides (µg/kg)										
Aldrin	4	5	8	22	10	9	7	11.4	4.1	4.5
alpha-BHC	4	2	4	3	2	4	3	11.4	4.1	4.5
alpha-Chlordane	4	2	4	3	2	4	3	11.4	4.1	4.5
beta-BHC	4	2	5	3	2	4	3	11.4	4.1	4.5
delta-BHC	4	4	4	3	2	4	6	11.4	4.1	4.5
Dieldrin	8	4	8	6	4	8	6	11.4	4.1	4.5
Endosulfan I	4	2	4	3	2	4	3	11.4	4.1	4.5
Endosulfan II	8	4	8	6	4	8	6	11.4	4.1	4.5
Endosulfan Sulfate	8	4	8	6	4	8	6	11.4	4.1	4.5
Endrin	8	4	10	6	4	8	14	11.4	4.1	4.5
Endrin Aldehyde	8	4	8	6	4	8	6	11.4	4.1	4.5
Endrin ketone	8	4	8	6	4	8	6	11.4	4.1	8.7
gamma-Chlordane	4	4	4	3	4	4	6	11.4	4.1	4.5
Hept Epoxide	4	4	4	3	4	4	5	11.4	4.1	4.5
Heptachlor	4	2	4	6	2	4	3	11.4	4.1	4.5
Lindane	4	2	4	3	2	4	3	11.4	4.1	4.5
Methoxychlor	40	20	40	30	20	40	30	11.4	4.1	4.5
p,p'-DDD	20	6	10	11	14	8	19	7.3	4.1	4.5
p,p'-DDE	25	11	13	12	12	9	14	7	0.9	1.5
p,p'-DDT	8	4	8	6	4	8	6	5.4	4.1	3.1
PAH'S (µg/kg)										
2-Methylnaphthalene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Acenaphthene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Acenaphthylene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Anthracene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Benzo[a]anthracene	2300	1400	1800	1800	1300	1800	1700	1800	640	650
Benzo[a]pyrene	2400	1400	1800	1800	660	1800	1700	1800	640	650
Benzo[b]fluoranthene	3000	1400	1800	1800	860	900	1700	1800	640	650
Benzo[g,h,I]perylene	1300	1400	1800	1800	1300	1800	1700	1800	640	650
Benzo[k]fluoranthene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
bis(2-Ethylhexyl)phthalate	2400	2100	2700	2700	1900	2600	2500	2800	970	970
Butylbenzylphthalate	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Carbazole	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Chrysene	2400	1400	1800	1800	770	1800	1700	1800	640	650
Dibenz[a,h]anthracene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Dibenzofuran	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Diethylphthalate	2800	2100	2700	2700	1900	2600	2500	2800	970	970
Dimethylphthalate	2800	2100	2700	2700	1900	2600	2500	2800	970	970
Di-n-butylphthalate	2800	2100	2700	2700	1900	2600	2500	2800	970	970
Di-n-octylphthalate	2800	2100	2700	2700	1900	2600	2500	2800	970	970
Fluoranthene	6400	1400	1800	1800	1300	1800	1700	1800	640	650
Fluorene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Indeno[1,2,3-cd]pyrene	1400	1400	1800	1800	1300	1800	1700	1800	640	650
Naphthalene	1900	1400	1800	1800	1300	1800	1700	1800	640	650
Phenanthrene	5000	1400	1800	1800	690	1800	1700	1800	640	650
Pyrene	5100	1400	1800	1800	1200	920	1000	1800	640	650
Alkylphenols (µg/kg)										
Bisphenol A	64	46	72	49	45	62	61	NA	NA	NA
Octylphenol	69	50	78	53	48	66	66	NA	NA	NA
Total NP	562	265	783	395	216	297	294	NA	NA	NA
Total NP1EO	617	445	697	476	432	594	589	NA	NA	NA
Total NP2EO	1187	856	1340	914	831	1142	1132	NA	NA	NA
PCB (µg/kg)	0.14	0.10	0.15	0.11	0.08	0.13	0.12	0.23	0.81	0.09
Cyanide (mg/L)	0.3	0.2	0.3	0.2	0.1	0.2	0.2	0.3	0.1	0.1
Oil and grease (mg/kg)	2913	2101	4524	2879	2025	2634	4281	2790	1248	839
Nutrients (mg/kg)										
Ammonia nitrogen	717	391	756	537	96	129	175	NA	NA	NA
Kjeldahl nitrogen	4880	3350	5420	3940	1450	3470	3060	NA	NA	NA
Phosphorus	1770	1390	1800	1600	1200	1530	1390	NA	NA	NA

Table E4. Continued.

Montgomery Dam

Substance	Above dam samples					Below dam samples		
	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)								
Aluminum	8500	6900	9500	8600	7400	2800	4300	3200
Barium	160	120	200	160	140	46	55	36
Beryllium	0.51	0.45	0.51	0.5	0.44	0.18	0.26	0.26
Boron	7.9	9.8	12	8	8.4	7.8	9.4	10
Cadmium	2.5	2.9	9.4	1.9	2.1	2	2	2
Calcium	100000	86000	83000	99000	93000	92000	76000	98000
Chromium	22	21	47	19	20	7	12	13
Cobalt	5.7	5.8	6.5	5.3	5.8	2	3	2
Copper	45	44	96	45	48	16	60	25
Iron	19000	18000	19000	18000	18000	6200	8100	7500
Lead	82	92	120	55	70	20	36	25
Lithium	9.8	7.6	9.2	10	8.8	5	5	5
Magnesium	22000	23000	21000	19000	23000	26000	22000	42000
Manganese	480	400	550	450	450	240	250	200
Mercury	2.7	2.4	2.4	3.1	2.6	0.05	0.1	0.1
Molybdenum	7	7	7	7	7	10	10	10
Nickel	20	20	33	18	19	4.3	9.9	9.1
Potassium	920	760	900	990	850	350	410	430
Silver	0.85	0.51	1.3	0.74	0.59	1	1	1
Sodium	310	240	280	310	280	320	280	330
Tin	30	30	30	30	30	NA	NA	NA
Titanium	61	87	92	64	64	80	100	96
Vanadium	18	18	16	17	16	10	9.8	14
Zinc	190	200	280	170	180	66	120	81
Pesticides (µg/kg)								
Aldrin	15	3	43	7	19	4.4	4.9	4.1
alpha-BHC	4	3	3	5	4	4.4	4.9	4.1
alpha-Chlordane	4	3	25	5	4	4.4	4.9	4.1
beta-BHC	7	3	3	5	10	4.4	4.9	4.1
delta-BHC	4	3	7	7	4	4.4	4.9	4.1
Dieldrin	8	6	6	10	8	4.4	4.9	4.1
Endosulfan I	4	6	34	5	4	4.4	4.9	4.1
Endosulfan II	8	6	6	10	8	4.4	4.9	4.1
Endosulfan Sulfate	8	6	6	85	0.8	4.4	4.9	4.1
Endrin	6	6	10	8	13	4.4	4.9	4.1
Endrin Aldehyde	8	6	6	10	8	4.4	4.9	4.1
Endrin ketone	8	6	6	10	8	4.4	4.9	4.1
gamma-Chlordane	4	3	18	5	4	4.4	4.9	4.1
Hept Epoxide	4	3	30	5	4	4.4	4.9	4.1
Heptachlor	6	3	29	5	10	4.4	4.9	4.1
Lindane	4	3	3	5	4	4.4	4.9	4.1
Methoxychlor	40	30	30	50	40	4.4	4.9	4.1
p,p'-DDD	6	6	51	5	7	12.2	10.7	13.3
p,p'-DDE	19	6	36	12	16	1.3	3.1	4.6
p,p'-DDT	8	6	48	10	8	4.4	2.8	1.3
PAH'S (µg/kg)								
2-Methylnaphthalene	2100	1600	1800	2800	2200	710	710	620
Acenaphthene	2100	1600	1800	2800	2200	710	710	620
Acenaphthylene	2100	1600	1800	2800	2200	710	710	620
Anthracene	2100	1600	1800	2800	2200	710	710	620
Benzo[a]anthracene	2100	1600	1800	2800	2200	710	910	620
Benzo[a]pyrene	2100	1600	1800	2800	2200	810	890	620
Benzo[b]fluoranthene	2100	1600	1800	2800	2200	1200	1300	620
Benzo[g,h,I]perylene	2100	1600	1800	2800	2200	710	620	620
Benzo[k]fluoranthene	2100	1600	1800	2800	2200	710	710	620
bis(2-Ethylhexyl)phthalate	3100	2400	2800	4200	3300	1100	670	920
Butylbenzylphthalate	2100	1600	1800	2800	2200	710	710	620
Carbazole	2100	1600	1800	2800	2200	710	710	620
Chrysene	2100	1600	1800	2800	2200	1000	1000	620
Dibenz[a,h]anthracene	2100	1600	1800	2800	2200	710	710	620
Dibenzofuran	2100	1600	1800	2800	2200	710	710	620
Diethylphthalate	3100	2400	2800	4200	3300	1100	1100	920
Dimethylphthalate	3100	2400	2800	4200	3300	1100	1100	920
Di-n-butylphthalate	3100	2400	2800	4200	3300	1100	1100	920
Di-n-octylphthalate	3100	2400	2800	4200	3300	1100	1100	920
Fluoranthene	2100	1600	1800	2800	2200	2000	2200	620
Fluorene	2100	1600	1800	2800	2200	710	710	620
Indeno[1,2,3-cd]pyrene	2100	1600	1800	2800	2200	610	590	620
Naphthalene	2100	1600	1800	2800	2200	710	710	620
Phenanthrene	2100	1600	1800	2800	2200	1200	1200	620
Pyrene	2100	1600	1800	2800	2200	1500	1700	620
Alkylphenols (µg/kg)								
Bisphenol A	83	56	61	98	78	NA	NA	NA
Octylphenol	89	60	66	106	84	NA	NA	NA
Total NP	401	271	457	474	378	NA	NA	NA
Total NP1EO	801	542	592	948	756	NA	NA	NA
Total NP2EO	1541	1042	1138	1823	1454	NA	NA	NA
PCB (µg/kg)	0.16	0.11	0.12	0.19	0.17	0.09	0.10	0.08
Cyanide (mg/L)	0.2	0.2	0.4	0.4	0.2	0.1	0.1	0.1
Oil and grease (mg/kg)	4240	2609	3430	1591	4358	1090	948	687
Nutrients (mg/kg)								
Ammonia nitrogen	442	385	661	376	171	NA	NA	NA
Kjeldahl nitrogen	5000	3100	4970	4900	3500	NA	NA	NA
Phosphorus	1550	1120	1790	1500	1470	NA	NA	NA

Table E4. Continued.

Yorkville Dam

	Above dam samples							Below dam samples		
Substance	Core 1	Core 2	Core 3	Core 4	Ponar 1	Ponar 2	Ponar 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)										
Aluminum	15000	9100	14000	11000	2700	2100	3600	2100	2100	1600
Barium	290	200	290	200	90	49	97	67	68	63
Beryllium	0.99	0.57	0.83	0.64	0.23	0.14	0.27	0.25	0.23	0.23
Boron	18	14	15	12	8.7	4.8	6.4	13	9.1	19
Cadmium	39	21	26	16	1.4	0.83	2.5	2	2	2
Calcium	74000	100000	71000	77000	99000	81000	98000	170000	120000	150000
Chromium	210	100	150	100	16	9.9	23	2.8	6.1	6
Cobalt	6.9	5.7	7.4	6.1	3.5	2.4	3.7	2	3.2	2
Copper	260	110	200	130	18	26	41	3	6	3.7
Iron	21000	180000	22000	19000	8200	5000	9000	8500	9300	6200
Lead	250	160	220	150	27	20	47	23	33	44
Lithium	11	8.6	11	9.1	2.8	2.1	3.6	5	5	5
Magnesium	19000	21000	18000	20000	18000	17000	21000	51000	30000	36000
Manganese	520	480	580	500	320	200	380	330	290	340
Mercury	2.1	2.5	2.2	1.4	1.1	0.7	1.3	0.03	0.04	0.05
Molybdenum	7	7	7	7	7	7	7	10	10	10
Nickel	92	56	70	45	12	8.4	16	2.2	5.8	4.2
Potassium	1100	840	1100	860	340	230	370	510	510	340
Silver	8.2	5.5	4.6	3.8	0.3	0.3	0.34	1	1	1
Sodium	280	270	230	240	270	210	220	310	360	350
Tin	30	30	30	30	30	30	30	NA	NA	NA
Titanium	120	73	100	100	71	58	73	46	70	47
Vanadium	21	17	19	19	7.5	5.5	8.3	12	12	10
Zinc	600	340	490	340	90	57	120	72	54	49
Pesticides (µg/kg)										
Aldrin	70	45	43	29	10	3	7	3.7	3.8	3.9
alpha-BHC	7	5	5	2	2	2	2	3.7	3.8	3.9
alpha-Chlordane	43	37	29	17	2	2	2	3.7	3.8	3.9
beta-BHC	4	3	3	2	9	2	7	3.7	3.8	3.9
delta-BHC	4	3	3	2	2	3	2	3.7	3.8	3.9
Dieldrin	8	6	6	4	4	4	4	3.7	3.8	3.9
Endosulfan I	58	50	40	23	2	4	2	3.7	3.8	3.9
Endosulfan II	15	15	6	4	4	4	4	3.7	3.8	3.9
Endosulfan Sulfate	8	6	85	4	4	4	4	3.7	3.8	3.9
Endrin	21	6	6	4	4	4	4	3.7	3.8	3.9
Endrin Aldehyde	8	6	6	4	4	4	4	3.7	3.8	3.9
Endrin ketone	8	6	6	4	4	4	4	3.7	3.8	3.9
gamma-Chlordane	63	46	45	16	2	2	2	3.7	3.8	3.9
Hept Epoxide	60	54	47	28	6	2	2	3.7	3.8	3.9
Heptachlor	36	32	24	10	5	2	3	3.7	3.8	3.9
Lindane	4	5	3	2	2	2	2	3.7	3.8	3.9
Methoxychlor	40	45	30	20	20	20	20	3.7	3.8	3.9
p,p'-DDD	150	101	137	52	8	4	9	5.5	3.8	1.6
p,p'-DDE	112	70	95	35	4	4	9	3.7	3.8	1
p,p'-DDT	8	6	6	4	4	4	9	2.2	3.8	3.9
PAH'S (µg/kg)										
2-Methylnaphthalene	1600	1900	1800	1300	990	920	1200	600	580	640
Acenaphthene	1600	1900	1800	1300	990	920	1200	600	580	640
Acenaphthylene	1600	1900	1800	1300	990	920	1200	600	580	640
Anthracene	1600	1900	1800	1300	550	920	1200	600	580	640
Benzo[a]anthracene	1600	1900	1800	1300	2100	920	880	600	580	640
Benzo[a]pyrene	1600	1900	1800	1300	2400	920	1100	600	580	640
Benzo[b]fluoranthene	1600	1900	1800	710	3700	920	1400	600	580	640
Benzo[g,h,I]perylene	1600	1900	1800	1300	1300	920	680	600	580	640
Benzo[k]fluoranthene	1600	1900	1800	1300	1200	920	1200	600	580	640
bis(2-Ethylhexyl)phthalate	2500	2800	2700	1900	1500	1400	1800	900	860	960
Butylbenzylphthalate	1600	1900	1800	1300	990	920	1200	600	580	640
Carbazole	1600	1900	1800	1300	990	920	1200	600	580	640
Chrysene	1600	1900	1800	1300	2900	920	1000	600	580	640
Dibenz[a,h]anthracene	1600	1900	1800	1300	990	920	1200	600	580	640
Dibenzofuran	1600	1900	1800	1300	990	920	1200	600	580	640
Diethylphthalate	2500	2800	2700	1900	1500	1400	1800	900	860	960
Dimethylphthalate	2500	2800	2700	1900	1500	1400	1800	900	860	960
Di-n-butylphthalate	2500	2800	2700	1900	1500	1400	1800	900	860	960
Di-n-octylphthalate	2500	2800	2700	1900	1500	1400	1800	900	860	960
Fluoranthene	1600	1900	1800	760	6300	730	2300	600	580	530
Fluorene	1600	1900	1800	1300	990	920	1200	600	580	640
Indeno[1,2,3-cd]pyrene	1600	1900	1800	1300	1800	920	830	600	580	640
Naphthalene	1600	1900	1800	1300	990	920	1200	600	580	640
Phenanthrene	1600	1900	1800	1300	4400	520	1400	600	580	640
Pyrene	1600	1900	1800	680	4200	540	1600	600	580	640
Alkylphenols (µg/kg)										
Bisphenol A	57	59	58	44	33	29	39	NA	NA	NA
Octylphenol	216	119	124	78	35	31	42	NA	NA	NA
Total NP	545	427	417	278	157	139	189	NA	NA	NA
Total NP1EO	549	571	562	422	313	278	378	NA	NA	NA
Total NP2EO	1056	1098	1080	812	603	534	726	NA	NA	NA
PCB (µg/kg)	0.14	0.12	0.12	0.08	0.07	0.06	0.08	0.07	0.08	0.08
Cyanide (mg/L)	0.7	0.4	0.8	0.3	0.1	0.05	0.2	0.1	0.1	0.1
Oil and grease (mg/kg)	7351	5340	4160	709	1107	1128	1005	582	452	505
Nutrients (mg/kg)										
Ammonia nitrogen	852	395	1020	342	19	16	80	NA	NA	NA
Kjeldahl nitrogen	4730	3820	5030	3400	968	416	169	NA	NA	NA
Phosphorus	2440	2170	2610	1820	656	366	1250	NA	NA	NA

Table E4. Concluded.

Dayton Dam

	Above dam samples					
Substance	Core 1	Core 2	Core 3	Ponar 1	Ponar 2	Ponar 3
Heavy metals (mg/kg)						
Aluminum	12000	11000	11000	1300	1900	3100
Barium	120	120	98	13	26	36
Beryllium	0.67	0.55	0.6	0.23	0.15	0.19
Boron	8.4	6.8	5.5	2.1	3.1	4.2
Cadmium	0.48	2.9	0.59	0.01	0.23	0.59
Calcium	42000	39000	28000	30000	47000	57000
Chromium	14	26	11	2.3	4.1	4.9
Cobalt	6.8	5.4	7.7	1.3	1.8	2.4
Copper	25	25	19	1.4	2.2	5.2
Iron	22000	19000	24000	4000	4800	8400
Lead	29	32	16	5	3.4	8.1
Lithium	12	9.3	10	1.9	3	4
Magnesium	17000	14000	9500	13000	18000	22000
Manganese	580	430	580	110	150	240
Mercury	2.6	1.5	1.5	1.1	1	2
Molybdenum	7	7	7	7	7	7
Nickel	17	20	18	2.5	4	5.6
Potassium	1300	1000	1200	340	360	500
Silver	0.3	0.3	0.3	0.3	0.3	0.3
Sodium	270	160	150	140	150	160
Tin	30	30	30	30	30	30
Titanium	70	77	65	43	39	67
Vanadium	26	21	22	3	5.3	8
Zinc	110	100	77	15	25	40
Pesticides (µg/kg)						
Aldrin	2	12	2	2	2	2
alpha-BHC	2	2	2	2	2	2
alpha-Chlordane	2	7	2	2	2	2
beta-BHC	2	2	2	2	2	2
delta-BHC	2	2	2	2	2	2
Dieldrin	4	4	4	4	4	4
Endosulfan I	2	7	2	2	2	4
Endosulfan II	4	4	4	4	4	4
Endosulfan Sulfate	4	4	4	4	4	4
Endrin	4	4	4	4	4	4
Endrin Aldehyde	4	4	4	4	4	4
Endrin ketone	4	4	4	4	4	4
gamma-Chlordane	2	6	2	2	2	2
Hept Epoxide	2	8	2	2	2	2
Heptachlor	2	2	2	2	2	2
Lindane	2	2	2	2	2	2
Methoxychlor	20	20	20	20	20	20
p,p'-DDD	4	6	4	4	4	4
p,p'-DDE	4	9	4	4	4	4
p,p'-DDT	4	4	4	4	4	4
PAH'S (µg/kg)						
2-Methylnaphthalene	940	1000	1000	780	830	860
Acenaphthene	940	1000	1000	780	830	860
Acenaphthylene	940	1000	1000	780	830	860
Anthracene	940	1000	1000	780	830	860
Benzo[a]anthracene	940	1000	1000	780	830	860
Benzo[a]pyrene	940	1000	1000	780	830	860
Benzo[b]fluoranthene	940	1000	1000	780	830	860
Benzo[g,h,I]perylene	940	1000	1000	780	830	860
Benzo[k]fluoranthene	940	1000	1000	780	830	860
bis(2-Ethylhexyl)phthalate	1400	1500	1500	1200	1200	1300
Butylbenzylphthalate	940	1000	1000	780	830	860
Carbazole	940	1000	1500	780	830	860
Chrysene	940	1000	1000	780	830	860
Dibenz[a,h]anthracene	940	1000	1000	780	830	860
Dibenzofuran	940	1000	1000	780	830	860
Diethylphthalate	1400	1500	1500	1200	1200	1300
Dimethylphthalate	1400	1500	1500	1200	1200	1300
Di-n-butylphthalate	1400	1500	1000	1200	1200	1300
Di-n-octylphthalate	1400	1500	1500	1200	1200	1300
Fluoranthene	920	1000	1000	780	830	860
Fluorene	940	1000	1000	780	830	860
Indeno[1,2,3-cd]pyrene	940	1000	1000	780	830	860
Naphthalene	940	1000	1000	780	830	860
Phenanthrene	670	1000	1000	780	830	860
Pyrene	790	1000	1000	780	830	860
Alkylphenols (µg/kg)						
Bisphenol A	38	35	37	26	29	29
Octylphenol	40	37	40	28	31	31
Total NP	181	277	180	124	141	139
Total NP1EO	363	336	360	248	282	279
Total NP2EO	697	646	692	478	542	536
PCB (µg/kg)	0.07	0.06	0.08	0.06	0.06	0.06
Cyanide (mg/L)	0.2	0.1	0.1	0.01	0.04	0.04
Oil and grease (mg/kg)	1092	778	687	1780	1780	1780
Nutrients (mg/kg)						
Ammonia nitrogen	118	342	285	12	13	17
Kjeldahl nitrogen	2220	2220	2180	107	453	588
Phosphorus	935	865	842	136	358	325

Appendix F. Sampling Locations

Table F1. Location of fish, macroinvertebrate, and habitat sampling stations on the Fox River between McHenry and Dayton, Illinois.

Station	Habitat	River mile	Description	Legal description	Latitude	Longetude	County
Stratton above dam	US IMP	98.2	0.5 km above Stratton Dam at Moraine Hills State Park	T44N R8E S12NW	42.3132784	88.253195 1	McHenry
Stratton below dam	DS FF	97.7	0.5 km below Stratton Dam at Moraine Hills State Park	T44N R8E 12NW	42.3062066	88.2493363	McHenry
Algonquin mid upper	MD IMP	93.9	0.7 km above Rawson Bridge Rd. bridge near Rawson Bridge	T44N R9E S32SW	42.2479479	88.2102997	McHenry
Algonquin mid lower	MD IMP	88.2	At Rt. 14 bridge in Fox River Grove	T43N R9E S18SE	42.2016679	88.2246904	McHenry
Algonquin above dam	US IMP	81.9	0.5 km above Algonquin Dam	T43N R8E S27SE	42.1688633	88.2858984	McHenry
Algonquin below dam	DS FF	81.2	0.5 km below Algonquin Dam	T43N R8E S34SW	42.1612565	88.2939582	McHenry
Carpentersville above dam	US IMP	77.5	0.5 km above Carpentersville Dam	T42N R8E S15NW	42.1194309	88.2908368	Kane
Carpentersville below dam	DS FF	76.8	0.5 km below Carpentersville Dam	T42N R8E S22NW	42.1100505	88.2912685	Kane
Elgin mid upper	MD FF	74.8	0.4 km above mouth of Jelkes Creek in West Dundee	T42N R8E S27SE	42.0878772	88.2795656	Kane
Elgin mid lower	MD IMP	72.9	350 m below I-90 bridge in Elgin	T41N R8E S1NE	42.0636192	88.2737260	Kane
Elgin above dam	US IMP	71.2	0.5 km above Kimball St. Dam in Elgin	T41N R8E S11SE	42.0463175	88.2911102	Kane
Elgin below dam	DS FF	70.6	0.5 km below Kimball St. Dam in Elgin	T41N R8E S14NE	42.0374738	88.2864144	Kane
South Elgin above dam	US IMP	67.5	0.5 km above South Elgin Dam	T41N R8E S35NW	42.0000529	88.2936684	Kane
South Elgin below dam	DS FF	66.4	1.2 km below South Elgin Dam	T40N R8E S2NW	41.9845288	88.2929955	Kane
St. Charles mid upper	MD FF	64.0	At Blackhawk Forest Preserve near Fox River Estates	T40N R8E S3SW	41.9723990	88.3193986	Kane
St. Charles mid lower	MD IMP	61.4	1.0 km above mouth of Ferson Creek in St. Charles	T40N R8E S22NW	41.9362937	88.3154698	Kane
St. Charles above dam	US IMP	60.0	0.5 km above St. Charles Dam	T40N R8E S27SW	41.9183295	88.3165910	Kane
St. Charles below dam	DS FF	59.4	0.5 km below St. Charles Dam	T40N R8E S34NE	41.9104091	88.3108880	Kane
Geneva above dam	US IMP	58.0	0.5 km above Geneva Dam	T39N R8E S3NE	41.8925041	88.3016040	Kane
Geneva below dam	DS FF	57.5	0.5 km below Geneva Dam Dam	T39N R8E S3SE	41.8843484	88.3031316	Kane
North Batavia above dam	US IMP	55.7	0.5 km above North Batavia Dam in Batavia	T39N R8E S15SE	41.8600123	88.3100956	Kane
North Batavia below dam	DS FF	55.1	0.5 km below North Batavia Dam in Batavia	T39N R8E S22NE	41.8510660	88.3071066	Kane
South Batavia above dam	US IMP	54.3	0.5 km above South Batavia Dam in Batavia	T39N R8E S22SE	41.8405376	88.3090446	Kane
South Batavia below dam	DS FF	53.7	0.5 km below South Batavia Dam in Batavia	T39N R8E S27NW	41.8326939	88.3133281	Kane
North Aurora above dam	US IMP	52.0	0.5 km above North Aurora Dam	T38N R8E S4NW	41.8105517	88.3249733	Kane
North Aurora below dam	DS FF	51.4	0.5 km below North Aurora Dam	T38N R8E S4NE	41.8024741	88.3220574	Kane
Stolp Island above dam	US IMP	48.6	0.5 km above Stolp Island Dam in Aurora	T38N R8E S22NW	41.7631919	88.3113273	Kane
Stolp Island below dam	DS FF	48.1	0.5 km below Stolp Island Dam in Aurora	T38N R8E S22SW	41.7571401	88.3175835	Kane
Hurd's Island above dam	US IMP	47.8	0.5 km above Hurds Island Dam in Aurora	T38N R8E S21SE	41.7545275	88.3208483	Kane
Hurd's Island below dam	DS FF	47.5	0.5 km below Hurds Island Dam in Aurora	T38N R8E S28NE	41.7510904	88.3251235	Kane
Montgomery above dam	US IMP	46.5	0.5 km above Montgomery Dam	T38N R8E S33NW	41.7376275	88.3313698	Kane
Montgomery below dam	DS FF	46.0	0.5 km below Montgomery Dam	T38N R8E S33SW	41.7314012	88.3361893	Kane
Yorkville mid upper	MD FF	42.3	At Rt. 34 bridge in Oswego	T37N R8E S17SW	41.6841150	88.3571526	Kendall
Yorkville mid lower	MD FF	38.6	1.3 km above mouth of Morgan Creek near Yorkville	T37N R7E S27NW	41.6578090	88.4143466	Kendall
Yorkville above dam	US IMP	36.3	0.5 km above Yorkville Dam	T37N R7E S33NE	41.6426015	88.4368679	Kendall
Yorkville below dam	DS FF	35.6	0.5 km below Yorkville Dam	T37N R7E S32NE	41.6433404	88.4508587	Kendall
Dayton mid upper	MD FF	25.0	At County Line Rd. bridge in Millington	T36N R5E S25NE	41.5666122	88.6033099	LaSalle
Dayton mid lower	MD FF	14.2	At Fox River Resort, 1.8 km below Rt. 52 bridge in Norway	T35N R5E S30SE	41.4710973	88.6932184	LaSalle
Dayton above dam	US IMP	5.8	0.5 km above Dayton Dam	T34N R4E S29NE	41.3944360	88.7865252	LaSalle
Dayton below dam	DS FF	5.3	0.5 km below Dayton Dam	T34N R4E S29SE	41.3865357	88.7895014	LaSalle

Table F2. Location of water quality sampling stations for 11 river segments in the Fox River between McHenry and Dayton, Illinois.

Segment and station	Location in channel	Habitat	River mile	Date	Latitude	Longitude
Stratton - Algonquin						
Stratton below dam	Center	Free-flowing	98.77	8/72001	42.3073247	88.2504324
Stratton below dam	Left	Free-flowing	98.77	8/72001	42.3073591	88.2502702
Stratton below dam	Right	Free-flowing	98.77	8/72001	42.3072903	88.2505945
Algonquin above dam	Center	Impounded	82.64	8/72001	42.1664062	88.2893631
Algonquin above dam	Left	Impounded	82.64	8/72001	42.1662342	88.2890860
Algonquin above dam	Right	Impounded	82.64	8/72001	42.1666126	88.2897325
Algonquin - Carpentersville						
Algonquin below dam	Center	Free-flowing	82.51	8/72001	42.1641699	88.2908868
Algonquin below dam	Left	Free-flowing	82.51	8/72001	42.1640667	88.2905174
Algonquin below dam	Right	Free-flowing	82.51	8/72001	42.1641355	88.2907483
Carpentersville above dam	Center	Impounded	78.27	8/72001	42.1159334	88.2922484
Carpentersville above dam	Left	Impounded	78.27	8/72001	42.1160138	88.2916047
Carpentersville above dam	Right	Impounded	78.27	8/72001	42.1160675	88.2926936
Carpentersville - Elgin						
Carpentersville below dam	Center	Free-flowing	78.11	8/9/2001	42.1130085	88.2929578
Carpentersville below dam	Left	Free-flowing	78.11	8/9/2001	42.1129741	88.2930040
Carpentersville below dam	Right	Free-flowing	78.11	8/9/2001	42.1130085	88.2927272
Elgin above dam	Center	Impounded	71.99	8/9/2001	42.0424776	88.2898928
Elgin above dam	Left	Impounded	71.99	8/9/2001	42.0426152	88.2894322
Elgin above dam	Right	Impounded	71.99	8/9/2001	42.0423399	88.2904456
Elgin - South Elgin						
Elgin below dam	Center	Free-flowing	71.57	8/9/2001	42.0373530	88.2861147
Elgin below dam	Left	Free-flowing	71.57	8/9/2001	42.0374218	88.2859305
Elgin below dam	Right	Free-flowing	71.57	8/9/2001	42.0372498	88.2863450
South Elgin above dam	Center	Impounded	68.31	8/9/2001	41.9982377	88.2942605
South Elgin above dam	Left	Impounded	68.31	8/9/2001	41.9981346	88.2934777
South Elgin above dam	Right	Impounded	68.31	8/9/2001	41.9983064	88.2949512
South Elgin - St. Charles						
South Elgin below dam	Center	Free-flowing	68.08	8/16/2001	41.9947082	88.2943727
South Elgin below dam	Left	Free-flowing	68.08	8/16/2001	41.9947404	88.2940938
South Elgin below dam	Right	Free-flowing	68.08	8/16/2001	41.9947780	88.2946463
St. Charles above dam	Center	Impounded	60.69	8/16/2001	41.9153256	88.3147790
St. Charles above dam	Left	Impounded	60.69	8/16/2001	41.9152880	88.3144249
St. Charles above dam	Right	Impounded	60.69	8/16/2001	41.9152398	88.3151866
Geneva - North Batavia						
Geneva below dam	Center	Free-flowing	58.56	8/16/2001	41.8858022	88.3027828
Geneva below dam	Left	Free-flowing	58.56	8/16/2001	41.8856645	88.3024605
Geneva below dam	Right	Free-flowing	58.56	8/16/2001	41.8859743	88.3030590
North Batavia above dam	Center	Impounded	56.49	8/16/2001	41.8575427	88.3097412
North Batavia above dam	Left	Impounded	56.49	8/16/2001	41.8576804	88.3090502
North Batavia above dam	Right	Impounded	56.49	8/16/2001	41.8574738	88.3103862
South Batavia - North Aurora						
South Batavia below dam	Center	Free-flowing	54.75	8/11/2001	41.8340717	88.3118555
South Batavia below dam	Left	Free-flowing	54.75	8/11/2001	41.8338997	88.3115331
South Batavia below dam	Right	Free-flowing	54.75	8/11/2001	41.8341405	88.3121779
North Aurora above dam	Center	Impounded	52.69	8/11/2001	41.8087063	88.3241914
North Aurora above dam	Left	Impounded	52.69	8/11/2001	41.8089129	88.3235009
North Aurora above dam	Right	Impounded	52.69	8/11/2001	41.8085341	88.3249279

Table F2. Continued.

Segment and station	Location in channel	Habitat	River mile	Date	Latitude	Longitude
North Aurora - Stolp Island						
North Aurora below dam	Center	Free-flowing	52.52	8/11/2001	41.8060899	88.3241881
North Aurora below dam	Left	Free-flowing	52.52	8/11/2001	41.8060846	88.3239360
North Aurora below dam	Right	Free-flowing	52.52	8/11/2001	41.8060578	88.3243705
Stolp Island above dam	Center	Impounded	49.03	8/11/2001	41.7599184	88.3129980
Stolp Island above dam	Left	Impounded	49.03	8/11/2001	41.7596931	88.3123864
Stolp Island above dam	Right	Impounded	49.03	8/11/2001	41.7601652	88.3133467
Hurds Island - Montgomery						
Hurd's Island below dam	Center	Free-flowing	48.32	8/16/2001	41.7525739	88.3235479
Hurd's Island below dam	Left	Free-flowing	48.32	8/16/2001	41.7524018	88.3233642
Hurd's Island below dam	Right	Free-flowing	48.32	8/16/2001	41.7527116	88.3236857
Montgomery above dam	Center	Impounded	46.85	8/16/2001	41.7343650	88.3332144
Montgomery above dam	Left	Impounded	46.85	8/16/2001	41.7342274	88.3330310
Montgomery above dam	Right	Impounded	46.85	8/16/2001	41.7345026	88.3334895
Montgomery - Yorkville						
Montgomery below dam	Center	Free-flowing	46.76	8/14/2001	41.7331607	88.3341284
Montgomery below dam	Left	Free-flowing	46.76	8/14/2001	41.7330319	88.3338441
Montgomery below dam	Right	Free-flowing	46.76	8/14/2001	41.7332894	88.3344449
Yorkville above dam	Center	Impounded	36.56	8/14/2001	41.6429258	88.4417494
Yorkville above dam	Left	Impounded	36.56	8/14/2001	41.6426737	88.4418191
Yorkville above dam	Right	Impounded	36.56	8/14/2001	41.6434301	88.4417923
Yorkville - Dayton						
Yorkville below dam	Center	Free-flowing	36.41	8/14/2001	41.6431411	88.4444401
Yorkville below dam	Left	Free-flowing	36.41	8/14/2001	41.6428659	88.4443942
Yorkville below dam	Right	Free-flowing	36.41	8/14/2001	41.6434851	88.4443943
Dayton above dam	Center	Impounded	5.80	8/14/2001	41.3913063	88.7871978
Dayton above dam	Left	Impounded	5.80	8/14/2001	41.3912373	88.7863762
Dayton above dam	Right	Impounded	5.80	8/14/2001	41.3914097	88.7879282
Dayton above dam	Center	Impounded	5.80	8/14/2001	42.3073247	88.2504324

Table F3. Location of water quality transect-sampling stations for four river segments between Algonquin and Yorkville, Illinois.

Segment and habitat	Transect	Location in channel	River mile	Date	Latitude	Longitude
Algonquin - Carpentersville						
Free-flowing	T1	Center	81.84	8/29/2001	42.1557293	88.2930665
Free-flowing	T1	Left	81.84	8/29/2001	42.1557776	88.2929270
Free-flowing	T1	Right	81.84	8/29/2001	42.1555791	88.2932006
Free-flowing	T2	Center	80.87	8/29/2001	42.1459499	88.2870315
Free-flowing	T2	Left	80.87	8/29/2001	42.1460787	88.2869993
Free-flowing	T2	Right	80.87	8/29/2001	42.1458534	88.2871119
Impounded	T3	Center	79.46	8/29/2001	42.1302000	88.2803152
Impounded	T3	Left	79.46	8/29/2001	42.1301035	88.2802723
Impounded	T3	Right	79.46	8/29/2001	42.1302590	88.2804601
Impounded	T4	Center	79.29	8/29/2001	42.1282903	88.2820265
Impounded	T4	Left	79.29	8/29/2001	42.1281347	88.2818012
Impounded	T4	Right	79.29	8/29/2001	42.1284780	88.2822947
Impounded	T5	Center	79.07	8/29/2001	42.1259192	88.2849984
Impounded	T5	Left	79.07	8/29/2001	42.1257261	88.2848213
Impounded	T5	Right	79.07	8/29/2001	42.1260962	88.2851486
Impounded	T6	Center	78.88	8/29/2001	42.1237413	88.2872514
Impounded	T6	Left	78.88	8/29/2001	42.1235696	88.2869832
Impounded	T6	Right	78.88	8/29/2001	42.1239183	88.2875518
Impounded	T7	Center	78.71	8/29/2001	42.1214238	88.2886033
Impounded	T7	Left	78.71	8/29/2001	42.1212092	88.2881687
Impounded	T7	Right	78.71	8/29/2001	42.1216169	88.2889573
Impounded	T8	Center	78.42	8/29/2001	42.1176580	88.2913177
Impounded	T8	Left	78.42	8/29/2001	42.1176205	88.2909314
Impounded	T8	Right	78.42	8/29/2001	42.1177385	88.2917951
Impounded	T9	Center	78.24	8/29/2001	42.1159307	88.2922457
Impounded	T9	Left	78.24	8/29/2001	42.1160111	88.2916020
Impounded	T9	Right	78.24	8/29/2001	42.1160648	88.2926909
South Elgin - St. Charles						
Free-flowing	T1	Center	67.97	9/5/2001	41.9947377	88.2940911
Free-flowing	T1	Left	67.97	9/5/2001	41.9947753	88.2946436
Free-flowing	T1	Right	67.97	9/5/2001	41.9947055	88.2943700
Free-flowing	T2	Center	65.58	9/5/2001	41.9697074	88.3080117
Free-flowing	T2	Left	65.58	9/5/2001	41.9694821	88.3080064
Free-flowing	T2	Right	65.58	9/5/2001	41.9699327	88.3080064
Impounded	T3	Center	64.05	9/5/2001	41.9615105	88.3153020
Impounded	T3	Left	64.05	9/5/2001	41.9615856	88.3149479
Impounded	T3	Right	64.05	9/5/2001	41.9614462	88.3155863
Impounded	T4	Center	63.69	9/5/2001	41.9563714	88.3137141
Impounded	T4	Left	63.69	9/5/2001	41.9563017	88.3133761
Impounded	T4	Right	63.69	9/5/2001	41.9563446	88.3141111
Impounded	T5	Center	63.01	9/6/2001	41.9466135	88.3124320
Impounded	T5	Left	63.01	9/6/2001	41.9465921	88.3121370
Impounded	T5	Right	63.01	9/6/2001	41.9466028	88.3128880
Impounded	T6	Center	62.35	9/6/2001	41.9376120	88.3149908
Impounded	T6	Left	62.35	9/6/2001	41.9374297	88.3145295
Impounded	T6	Right	62.35	9/6/2001	41.9378213	88.3153234
Impounded	T7	Center	61.75	9/6/2001	41.9292918	88.3177374
Impounded	T7	Left	61.75	9/6/2001	41.9292704	88.3173834
Impounded	T7	Right	61.75	9/6/2001	41.9293347	88.3180539

Table F3. Continued.

Segment and habitat	Transect	Location in channel	River mile	Date	Latitude	Longitude
Impounded	T8	Center	61.18	9/6/2001	41.9216100	88.3186601
Impounded	T8	Left	61.18	9/6/2001	41.9215885	88.3182309
Impounded	T8	Right	61.18	9/6/2001	41.9216153	88.3191429
Impounded	T9	Center	60.70	9/5/2001	41.9153229	88.3147763
Impounded	T9	Left	60.70	9/5/2001	41.9152853	88.3144222
Impounded	T9	Right	60.70	9/5/2001	41.9152371	88.3151839
North Aurora - Stolp Island						
Free-flowing	T1	Center	52.38	8/29/2001	41.8060872	88.3241854
Free-flowing	T1	Left	52.38	8/29/2001	41.8060819	88.3239333
Free-flowing	T1	Right	52.38	8/29/2001	41.8060551	88.3243678
Free-flowing	T2	Center	50.22	8/29/2001	41.7765454	88.3108495
Free-flowing	T2	Left	50.22	8/29/2001	41.7766741	88.3105008
Free-flowing	T2	Right	50.22	8/29/2001	41.7764113	88.3115093
Impounded	T3	Center	49.83	8/29/2001	41.7710844	88.3100395
Impounded	T3	Left	49.83	8/29/2001	41.7710683	88.3097283
Impounded	T3	Right	49.83	8/29/2001	41.7710576	88.3102970
Impounded	T4	Center	49.51	8/29/2001	41.7664764	88.3102970
Impounded	T4	Left	49.51	8/29/2001	41.7664227	88.3099966
Impounded	T4	Right	49.51	8/29/2001	41.7665568	88.3106403
Impounded	T5	Center	49.27	8/29/2001	41.7631612	88.3116059
Impounded	T5	Left	49.27	8/29/2001	41.7630592	88.3112947
Impounded	T5	Right	49.27	8/29/2001	41.7632470	88.3119063
Impounded	T6	Center	49.03	8/29/2001	41.7599157	88.3129953
Impounded	T6	Left	49.03	8/29/2001	41.7596904	88.3123837
Impounded	T6	Right	49.03	8/29/2001	41.7601625	88.3133440
Montgomery - Yorkville						
Free-flowing	T1	Center	46.76	9/4/2001	41.7331580	88.3341257
Free-flowing	T1	Left	46.76	9/4/2001	41.7330292	88.3338414
Free-flowing	T1	Right	46.76	9/4/2001	41.7332867	88.3344422
Free-flowing	T2	Center	38.27	9/4/2001	41.6486577	88.4155576
Free-flowing	T2	Left	38.27	9/4/2001	41.6487435	88.4153859
Free-flowing	T2	Right	38.27	9/4/2001	41.6485718	88.4157239
Impounded	T3	Center	38.00	9/4/2001	41.6451440	88.4150372
Impounded	T3	Left	38.00	9/4/2001	41.6450581	88.4148924
Impounded	T3	Right	38.00	9/4/2001	41.6451708	88.4151713
Impounded	T4	Center	37.77	9/4/2001	41.6434274	88.4187601
Impounded	T4	Left	37.77	9/4/2001	41.6432664	88.4187494
Impounded	T4	Right	37.77	9/4/2001	41.6435776	88.4187762
Impounded	T5	Center	37.31	9/4/2001	41.6433898	88.4274934
Impounded	T5	Left	37.31	9/4/2001	41.6431484	88.4274505
Impounded	T5	Right	37.31	9/4/2001	41.6435829	88.4276007
Impounded	T6	Center	37.12	9/4/2001	41.6423169	88.4310607
Impounded	T6	Left	37.12	9/4/2001	41.6421077	88.4310500
Impounded	T6	Right	37.12	9/4/2001	41.6425476	88.4311305
Impounded	T7	Center	36.81	9/5/2001	41.6427032	88.4370689
Impounded	T7	Left	36.81	9/5/2001	41.6423759	88.4371011
Impounded	T7	Right	36.81	9/5/2001	41.6430358	88.4368650
Impounded	T8	Center	36.57	9/5/2001	41.6429231	88.4417467
Impounded	T8	Left	36.57	9/5/2001	41.6426710	88.4418164
Impounded	T8	Right	36.57	9/5/2001	41.6434274	88.4417896

Table F4. Sediment core and ponar locations (UTM) and sample numbers for 12 US IMP and 10 DS FF stations in the Fox River between Algonquin and Dayton, Illinois. Within stations, ponar samples followed by the same letter were composited into one sample. Analyses are: G = grain size, S = specific gravity, M = metals, Pe = pesticides, Pa = PAHs, Pc = PCBs, C = cyanide, Og = oil and grease, A = alkylphenols, and N = nutrients. NA indicates not available.

Station	Habitat type	Date	Type	Sample number	Analyses	Easting	Northing
Algonquin above dam	US IMP	08/23/00	Core 1	2000WD01S82	G, S, M, Pe, Pa, C, Og, A, N	393563.4	4669266.4
Algonquin above dam	US IMP	08/23/00	Core 2	2000WD01S85	G, S, M, Pe, Pa, C, Og, A, N	393498.7	4669008.2
Algonquin above dam	US IMP	08/23/00	Core 3	2000WD01S87	G, S, M, Pe, Pa, C, Og, A, N	393538.6	4669212.3
Algonquin above dam	US IMP	08/23/00	Ponar 1a	2000WD01S83	G, S, M, Pe, Pa, C, Og, A, N	393563.5	4669267.5
Algonquin above dam	US IMP	08/23/00	Ponar 2a	2000WD01S83	G, S, M, Pe, Pa, C, Og, A, N	393595.5	4669192.2
Algonquin above dam	US IMP	08/23/00	Ponar 3a	2000WD01S83	G, S, M, Pe, Pa, C, Og, A, N	393608.8	4669153.6
Algonquin above dam	US IMP	08/23/00	Ponar 4b	2000WD01S84	G, S, M, Pe, Pa, C, Og, A, N	393498.4	4669187.7
Algonquin above dam	US IMP	08/23/00	Ponar 5b	2000WD01S84	G, S, M, Pe, Pa, C, Og, A, N	393511.4	4669175.0
Algonquin above dam	US IMP	08/23/00	Ponar 6b	2000WD01S84	G, S, M, Pe, Pa, C, Og, A, N	393515.3	4669096.2
Algonquin above dam	US IMP	08/23/00	Ponar 7c	2000WD01S86	G, S, M, Pe, Pa, C, Og, A, N	393494.4	4669006.4
Algonquin above dam	US IMP	08/23/00	Ponar 8c	2000WD01S86	G, S, M, Pe, Pa, C, Og, A, N	393447.5	4669029.7
Algonquin above dam	US IMP	08/23/00	Ponar 9c	2000WD01S86	G, S, M, Pe, Pa, C, Og, A, N	393435.6	4669034.5
Algonquin below dam	DS FF	08/18/00	Core 1	2000WD01S67	G, S, M, Pe, Pa, Pc, C, Og, A, N	393390.7	4668996.7
Algonquin below dam	DS FF	08/18/00	Ponar 1a	2000WD01S68	G, S, M, Pe, Pa, Pc, C, Og, A, N	393382.4	4668937.0
Algonquin below dam	DS FF	08/18/00	Ponar 2b	2000WD01S69	G, S, M, Pe, Pa, Pc, C, Og, A, N	393398.3	4668959.7
Algonquin below dam	DS FF	08/18/00	Ponar 3b	2000WD01S69	G, S, M, Pe, Pa, Pc, C, Og, A, N	393402.0	4668956.1
Algonquin below dam	DS FF	08/18/00	Ponar 4b	2000WD01S69	G, S, M, Pe, Pa, Pc, C, Og, A, N	393390.2	4668969.1
Algonquin below dam	DS FF	08/18/00	Ponar 5c	2000WD01S70	G, S, M, Pe, Pa, Pc, C, Og, A, N	393383.4	4668928.1
Algonquin below dam	DS FF	08/18/00	Ponar 6d	2000WD01S71	G, S, M, Pe, Pa, Pc, C, Og, A, N	393441.9	4668877.3
Algonquin below dam	DS FF	08/18/00	Ponar 7e	2000WD01S72	G, S, M, Pe, Pa, Pc, C, Og, A, N	393450.9	4668936.8
Carpentersville above dam	US IMP	08/14/00	Core 1	2000WD01S49	G, S, M, Pe, Pa, Pc, C, Og, A, N	393112.2	4663445.9
Carpentersville above dam	US IMP	08/14/00	Core 2	2000WD01S52	G, S, M, Pe, Pa, Pc, C, Og, A, N	393237.5	4663403.6
Carpentersville above dam	US IMP	08/14/00	Core 3	2000WD01S54	G, S, M, Pe, Pa, Pc, C, Og, A, N	393262.0	4663754.8
Carpentersville above dam	US IMP	08/14/00	Ponar 1a	2000WD01S50	G, S, M, Pe, Pa, Pc, C, Og, A, N	393112.2	4663445.9
Carpentersville above dam	US IMP	08/14/00	Ponar 2a	2000WD01S50	G, S, M, Pe, Pa, Pc, C, Og, A, N	393174.6	4663424.5
Carpentersville above dam	US IMP	08/14/00	Ponar 3a	2000WD01S50	G, S, M, Pe, Pa, Pc, C, Og, A, N	393231.3	4663438.9
Carpentersville above dam	US IMP	08/14/00	Ponar 4b	2000WD01S51	G, S, M, Pe, Pa, Pc, C, Og, A, N	393187.0	4663579.4
Carpentersville above dam	US IMP	08/14/00	Ponar 5b	2000WD01S51	G, S, M, Pe, Pa, Pc, C, Og, A, N	393207.3	4663580.2
Carpentersville above dam	US IMP	08/14/00	Ponar 6b	2000WD01S51	G, S, M, Pe, Pa, Pc, C, Og, A, N	393253.0	4663568.0
Carpentersville above dam	US IMP	08/14/00	Ponar 7c	2000WD01S53	G, S, M, Pe, Pa, Pc, C, Og, A, N	393279.1	4663563.4
Carpentersville above dam	US IMP	08/14/00	Ponar 8c	2000WD01S53	G, S, M, Pe, Pa, Pc, C, Og, A, N	393260.8	4663608.6
Carpentersville above dam	US IMP	08/14/00	Ponar 9c	2000WD01S53	G, S, M, Pe, Pa, Pc, C, Og, A, N	393238.6	4663653.6
Carpentersville below dam	DS FF	08/21/00	Core 1	2000WD01S73	G, S, M, Pe, Pa, C, Og, A, N	393062.5	4663305.1
Carpentersville below dam	DS FF	08/21/00	Core 2	2000WD01S74	G, S, M, Pe, Pa, C, Og, A, N	393067.3	4663265.1
Carpentersville below dam	DS FF	08/21/00	Ponar 1a	2000WD01S75	G, S, M, Pe, Pa, C, Og, A, N	393114.8	4663248.9
Carpentersville below dam	DS FF	08/21/00	Ponar 2a	2000WD01S75	G, S, M, Pe, Pa, C, Og, A, N	393107.9	4663232.8
Carpentersville below dam	DS FF	08/21/00	Ponar 3a	2000WD01S75	G, S, M, Pe, Pa, C, Og, A, N	393102.7	4663236.3
Carpentersville below dam	DS FF	08/21/00	Ponar 4b	2000WD01S76	G, S, M, Pe, Pa, C, Og, A, N	393107.0	4663638.8
Carpentersville below dam	DS FF	08/21/00	Ponar 5c	2000WD01S77	G, S, M, Pe, Pa, C, Og, A, N	393120.9	4663252.8
Carpentersville below dam	DS FF	08/21/00	Ponar 6d	2000WD01S78	G, S, M, Pe, Pa, C, Og, A, N	393122.7	4663238.2
Elgin above dam	US IMP	08/15/00	Core 1	2000WD01S56	G, S, M, Pe, Pa, Pc, C, Og, A, N	393307.4	4655268.3
Elgin above dam	US IMP	08/15/00	Core 2	2000WD01S57	G, S, M, Pe, Pa, Pc, C, Og, A, N	392997.8	4656051.1
Elgin above dam	US IMP	08/15/00	Core 3	2000WD01S59	G, S, M, Pe, Pa, Pc, C, Og, A, N	393242.0	4655802.1
Elgin above dam	US IMP	08/15/00	Ponar 1a	2000WD01S55	G, S, M, Pe, Pa, Pc, C, Og, A, N	393260.4	4655222.8
Elgin above dam	US IMP	08/15/00	Ponar 2a	2000WD01S55	G, S, M, Pe, Pa, Pc, C, Og, A, N	393275.0	4655228.5
Elgin above dam	US IMP	08/15/00	Ponar 3a	2000WD01S55	G, S, M, Pe, Pa, Pc, C, Og, A, N	393204.2	4655242.5
Elgin above dam	US IMP	08/15/00	Ponar 4b	2000WD01S58	G, S, M, Pe, Pa, Pc, C, Og, A, N	392997.8	4656051.1
Elgin above dam	US IMP	08/15/00	Ponar 5b	2000WD01S58	G, S, M, Pe, Pa, Pc, C, Og, A, N	393060.6	4655973.3
Elgin above dam	US IMP	08/15/00	Ponar 6b	2000WD01S58	G, S, M, Pe, Pa, Pc, C, Og, A, N	393215.5	4655868.9
Elgin above dam	US IMP	08/15/00	Ponar 7c	2000WD01S60	G, S, M, Pe, Pa, Pc, C, Og, A, N	393088.6	4655638.0
Elgin above dam	US IMP	08/15/00	Ponar 8c	2000WD01S60	G, S, M, Pe, Pa, Pc, C, Og, A, N	393221.0	4655494.2
Elgin above dam	US IMP	08/15/00	Ponar 9c	2000WD01S60	G, S, M, Pe, Pa, Pc, C, Og, A, N	393295.6	4655438.0
Elgin below dam	DS FF	08/21/00	Core 1	2000WD01S81	G, S, M, Pe, Pa, Pc, C, Og, A, N	393364.4	4654979.7
Elgin below dam	DS FF	08/21/00	Ponar 1a	2000WD01S79	G, S, M, Pe, Pa, Pc, C, Og, A, N	393316.0	4655097.6
Elgin below dam	DS FF	08/21/00	Ponar 2a	2000WD01S79	G, S, M, Pe, Pa, Pc, C, Og, A, N	393308.5	4655094.1
Elgin below dam	DS FF	08/21/00	Ponar 3a	2000WD01S79	G, S, M, Pe, Pa, Pc, C, Og, A, N	393303.9	4655087.9
Elgin below dam	DS FF	08/21/00	Ponar 4b	2000WD01S80	G, S, M, Pe, Pa, Pc, C, Og, A, N	393373.6	4655047.0
Elgin below dam	DS FF	08/21/00	Ponar 5b	2000WD01S80	G, S, M, Pe, Pa, Pc, C, Og, A, N	393382.2	4655041.8
South Elgin above dam	US IMP	09/19/00	Core 1	2000WD02S07	G, S, M, Pe, Pa, Pc, C, Og, A, N	392869.7	4650270.2
South Elgin above dam	US IMP	09/19/00	Core 2	2000WD02S10	G, S, M, Pe, Pa, Pc, C, Og, A, N	392757.3	4650434.2
South Elgin above dam	US IMP	09/19/00	Core 3	2000WD02S11	G, S, M, Pe, Pa, Pc, C, Og, A, N	394065.6	4651960.1

Table F4. Continued.

Station	Habitat type	Date	Type	Sample number	Analyses	Easting	Northing
South Elgin above dam	US IMP	09/19/00	Ponar 1a	2000WD02S08	G, S, M, Pe, Pa, Pc, C, Og, A, N	392869.7	4650270.2
South Elgin above dam	US IMP	09/19/00	Ponar 2a	2000WD02S08	G, S, M, Pe, Pa, Pc, C, Og, A, N	392880.2	4650290.1
South Elgin above dam	US IMP	09/19/00	Ponar 3a	2000WD02S08	G, S, M, Pe, Pa, Pc, C, Og, A, N	392719.8	4650324.0
South Elgin above dam	US IMP	09/19/00	Ponar 4b	2000WD02S09	G, S, M, Pe, Pa, Pc, C, Og, A, N	392836.2	4650397.0
South Elgin above dam	US IMP	09/19/00	Ponar 5b	2000WD02S09	G, S, M, Pe, Pa, Pc, C, Og, A, N	392884.7	4650463.5
South Elgin above dam	US IMP	09/19/00	Ponar 6b	2000WD02S09	G, S, M, Pe, Pa, Pc, C, Og, A, N	392756.6	4650454.3
South Elgin above dam	US IMP	09/19/00	Ponar 7c	2000WD02S12	G, S, M, Pe, Pa, Pc, C, Og, A, N	392700.9	4650256.6
South Elgin above dam	US IMP	09/19/00	Ponar 8c	2000WD02S12	G, S, M, Pe, Pa, Pc, C, Og, A, N	392723.8	4650238.6
South Elgin above dam	US IMP	09/19/00	Ponar 9c	2000WD02S12	G, S, M, Pe, Pa, Pc, C, Og, A, N	392754.7	4650238.5
South Elgin below dam	DS FF	07/10/01	Ponar 1a	2001WD04S01	G, S, M, Pe, Pc, C, Og	392762.8	4650070.7
South Elgin below dam	DS FF	07/10/01	Ponar 2a	2001WD04S01	G, S, M, Pe, Pc, C, Og	392811.4	4650058.0
South Elgin below dam	DS FF	07/10/01	Ponar 3a	2001WD04S01	G, S, M, Pe, Pc, C, Og	392841.7	4650063.5
South Elgin below dam	DS FF	07/10/01	Ponar 4b	2001WD04S02	G, S, M, Pe, Pc, C, Og	392760.0	4649980.0
South Elgin below dam	DS FF	07/10/01	Ponar 5b	2001WD04S02	G, S, M, Pe, Pc, C, Og	392834.3	4649985.2
South Elgin below dam	DS FF	07/10/01	Ponar 6c	2001WD04S03	G, S, M, Pe, Pc, C, Og	392750.3	4649937.0
St. Charles above dam	US IMP	08/16/00	Core 1	2000WD01S62	G, S, M, Pe, Pa, Pc, C, Og, A, N	390984.9	4641318.0
St. Charles above dam	US IMP	08/16/00	Core 2	2000WD01S64	G, S, M, Pe, Pa, Pc, C, Og, A, N	390742.6	4641444.2
St. Charles above dam	US IMP	08/16/00	Core 3	2000WD01S65	G, S, M, Pe, Pa, Pc, C, Og, A, N	390657.7	4641646.7
St. Charles above dam	US IMP	08/16/00	Ponar 1a	2000WD01S61	G, S, M, Pe, Pa, Pc, C, Og, A, N	391046.6	4641145.0
St. Charles above dam	US IMP	08/16/00	Ponar 2a	2000WD01S61	G, S, M, Pe, Pa, Pc, C, Og, A, N	390901.0	4641208.8
St. Charles above dam	US IMP	08/16/00	Ponar 3a	2000WD01S61	G, S, M, Pe, Pa, Pc, C, Og, A, N	390990.1	4641297.7
St. Charles above dam	US IMP	08/16/00	Ponar 4b	2000WD01S63	G, S, M, Pe, Pa, Pc, C, Og, A, N	390941.3	4641462.1
St. Charles above dam	US IMP	08/16/00	Ponar 5b	2000WD01S63	G, S, M, Pe, Pa, Pc, C, Og, A, N	390869.8	4641485.1
St. Charles above dam	US IMP	08/16/00	Ponar 6b	2000WD01S63	G, S, M, Pe, Pa, Pc, C, Og, A, N	390717.5	4641469.0
St. Charles above dam	US IMP	08/16/00	Ponar 7c	2000WD01S66	G, S, M, Pe, Pa, Pc, C, Og, A, N	390725.6	4641539.5
St. Charles above dam	US IMP	08/16/00	Ponar 8c	2000WD01S66	G, S, M, Pe, Pa, Pc, C, Og, A, N	390769.0	4641536.7
St. Charles above dam	US IMP	08/16/00	Ponar 9c	2000WD01S66	G, S, M, Pe, Pa, Pc, C, Og, A, N	390914.6	4641551.0
Geneva above dam	US IMP	08/24/00	Core 1	2000WD01S89	G, S, M, Pe, Pa, C, Og, A, N	391919.8	4638263.4
Geneva above dam	US IMP	08/24/00	Core 2	2000WD01S92	G, S, M, Pe, Pa, C, Og, A, N	391955.2	4638389.4
Geneva above dam	US IMP	08/24/00	Core 3	2000WD01S93	G, S, M, Pe, Pa, C, Og, A, N	391978.1	4638296.3
Geneva above dam	US IMP	08/24/00	Ponar 1a	2000WD01S88	G, S, M, Pe, Pa, C, Og, A, N	392047.9	4638224.1
Geneva above dam	US IMP	08/24/00	Ponar 2a	2000WD01S88	G, S, M, Pe, Pa, C, Og, A, N	392011.8	4638220.9
Geneva above dam	US IMP	08/24/00	Ponar 3a	2000WD01S88	G, S, M, Pe, Pa, C, Og, A, N	391951.6	4638245.8
Geneva above dam	US IMP	08/24/00	Ponar 4b	2000WD01S90	G, S, M, Pe, Pa, C, Og, A, N	391999.3	4638286.3
Geneva above dam	US IMP	08/24/00	Ponar 5b	2000WD01S90	G, S, M, Pe, Pa, C, Og, A, N	391957.5	4638303.4
Geneva above dam	US IMP	08/24/00	Ponar 6b	2000WD01S90	G, S, M, Pe, Pa, C, Og, A, N	391940.0	4638324.2
Geneva above dam	US IMP	08/24/00	Ponar 7c	2000WD01S91	G, S, M, Pe, Pa, C, Og, A, N	391977.3	4638328.3
Geneva above dam	US IMP	08/24/00	Ponar 8c	2000WD01S91	G, S, M, Pe, Pa, C, Og, A, N	392023.7	4638336.7
Geneva above dam	US IMP	08/24/00	Ponar 9c	2000WD01S91	G, S, M, Pe, Pa, C, Og, A, N	392045.0	4638363.3
Geneva below dam	DS FF	07/11/01	Ponar 1a	2001WD04S07	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 2a	2001WD04S07	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 3a	2001WD04S07	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 4b	2001WD04S08	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 5b	2001WD04S08	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 6b	2001WD04S08	M, Pe, Pc, C, Og	NA	NA
Geneva below dam	DS FF	07/11/01	Ponar 7c	2001WD04S09	M, Pe, Pc, C, Og	NA	NA
North Batavia above dam	US IMP	08/25/00	Core 1	2000WD01S95	G, S, M, Pe, Pa, C, Og, A, N	391348.1	1634602.9
North Batavia above dam	US IMP	08/25/00	Core 2	2000WD01S97	G, S, M, Pe, Pa, C, Og, A, N	391294.1	4634328.7
North Batavia above dam	US IMP	08/25/00	Core 3	2000WD01S98	G, S, M, Pe, Pa, C, Og, A, N	391263.7	4634415.1
North Batavia above dam	US IMP	08/25/00	Ponar 1a	2000WD01S94	G, S, M, Pe, Pa, C, Og, A, N	391391.8	4634608.5
North Batavia above dam	US IMP	08/25/00	Ponar 2a	2000WD01S94	G, S, M, Pe, Pa, C, Og, A, N	391371.9	4634605.9
North Batavia above dam	US IMP	08/25/00	Ponar 3a	2000WD01S94	G, S, M, Pe, Pa, C, Og, A, N	391348.3	4634602.7
North Batavia above dam	US IMP	08/25/00	Ponar 4b	2000WD01S96	G, S, M, Pe, Pa, C, Og, A, N	391317.9	4634583.8
North Batavia above dam	US IMP	08/25/00	Ponar 5b	2000WD01S96	G, S, M, Pe, Pa, C, Og, A, N	391224.9	4634458.1
North Batavia above dam	US IMP	08/25/00	Ponar 6b	2000WD01S96	G, S, M, Pe, Pa, C, Og, A, N	391259.7	4634159.5
North Batavia above dam	US IMP	08/25/00	Ponar 7c	2000WD01S99	G, S, M, Pe, Pa, C, Og, A, N	391208.5	4634846.0
North Batavia above dam	US IMP	08/25/00	Ponar 8c	2000WD01S99	G, S, M, Pe, Pa, C, Og, A, N	391298.5	4634775.8
North Batavia above dam	US IMP	08/25/00	Ponar 9c	2000WD01S99	G, S, M, Pe, Pa, C, Og, A, N	391341.6	4634686.7
North Batavia below dam	DS FF	07/13/01	Ponar 1a	2001WD04S13	M, Pe, Pc, C, Og	391432.1	4634360.4
North Batavia below dam	DS FF	07/13/01	Ponar 2a	2001WD04S13	M, Pe, Pc, C, Og	391438.0	4634359.5
North Batavia below dam	DS FF	07/13/01	Ponar 3a	2001WD04S13	M, Pe, Pc, C, Og	391442.8	4634384.1
North Batavia below dam	DS FF	07/13/01	Ponar 4b	2001WD04S14	M, Pe, Pc, C, Og	391436.5	4634389.3
North Batavia below dam	DS FF	07/13/01	Ponar 7c	2001WD04S15	M, Pe, Pc, C, Og	391430.2	4634408.1
South Batavia above dam	US IMP	09/20/00	Core 1	2000WD02S13	G, S, M, Pe, Pa, Pc, C, Og, A, N	391227.9	4632461.9
South Batavia above dam	US IMP	09/20/00	Core 2	2000WD02S15	G, S, M, Pe, Pa, Pc, C, Og, A, N	391334.0	4632445.7
South Batavia above dam	US IMP	09/21/00	Core 3	2000WD02S18	G, S, M, Pe, Pa, Pc, C, Og, A, N	391350.5	4632669.5

Table F4. Continued.

Station	Habitat type	Date	Type	Sample number	Analyses	Easting	Northing
South Batavia above dam	US IMP	09/20/00	Ponar 1a	2000WD02S14	G, S, M, Pe, Pa, Pc, C, Og, A, N	391227.9	4632461.9
South Batavia above dam	US IMP	09/20/00	Ponar 2a	2000WD02S14	G, S, M, Pe, Pa, Pc, C, Og, A, N	391278.8	4632460.0
South Batavia above dam	US IMP	09/20/00	Ponar 3a	2000WD02S14	G, S, M, Pe, Pa, Pc, C, Og, A, N	391334.0	4632445.7
South Batavia above dam	US IMP	09/21/00	Ponar 4b	2000WD02S16	G, S, M, Pe, Pa, Pc, C, Og, A, N	391319.1	4632491.5
South Batavia above dam	US IMP	09/21/00	Ponar 5b	2000WD02S16	G, S, M, Pe, Pa, Pc, C, Og, A, N	391283.3	4632495.6
South Batavia above dam	US IMP	09/21/00	Ponar 6b	2000WD02S16	G, S, M, Pe, Pa, Pc, C, Og, A, N	391230.4	4632505.4
South Batavia above dam	US IMP	09/21/00	Ponar 7c	2000WD02S17	G, S, M, Pe, Pa, Pc, C, Og, A, N	391303.5	4632523.1
South Batavia above dam	US IMP	09/21/00	Ponar 8c	2000WD02S17	G, S, M, Pe, Pa, Pc, C, Og, A, N	391349.4	4632540.9
South Batavia above dam	US IMP	09/21/00	Ponar 9c	2000WD02S17	G, S, M, Pe, Pa, Pc, C, Og, A, N	391340.9	4632575.0
South Batavia above dam	US IMP	09/21/00	Ponar 10d	2000WD02S19	G, S, M, Pe, Pa, Pc, C, Og, A, N	391419.7	4632769.4
South Batavia below dam	DS FF	07/16/01	Ponar 1a	2001WD04S19	M, Pe, Pc, C, Og	391114.4	4632170.7
South Batavia below dam	DS FF	07/16/01	Ponar 4b	2001WD04S20	M, Pe, Pc, C, Og	391060.9	4632249.5
South Batavia below dam	DS FF	07/16/01	Ponar 5b	2001WD04S20	M, Pe, Pc, C, Og	391095.1	4632249.1
South Batavia below dam	DS FF	07/16/01	Ponar 6b	2001WD04S20	M, Pe, Pc, C, Og	391123.4	4632238.4
South Batavia below dam	DS FF	07/16/01	Ponar 7c	2001WD04S21	M, Pe, Pc, C, Og	391131.0	4632230.6
South Batavia below dam	DS FF	07/16/01	Ponar 8c	2001WD04S21	M, Pe, Pc, C, Og	391185.7	4632232.9
South Batavia below dam	DS FF	07/16/01	Ponar 9c	2001WD04S21	M, Pe, Pc, C, Og	391161.6	4632287.8
North Aurora above dam	US IMP	09/22/00	Core 1	2000WD02S20	G, S, M, Pe, Pa, Pc, C, Og, A, N	389912.0	4629297.3
North Aurora above dam	US IMP	09/22/00	Core 2	2000WD02S22	G, S, M, Pe, Pa, Pc, C, Og, A, N	390069.4	4629322.3
North Aurora above dam	US IMP	09/25/00	Core 3	2000WD02S25	G, S, M, Pe, Pa, Pc, C, Og, A, N	390094.8	4629394.4
North Aurora above dam	US IMP	09/25/00	Core 4	2000WD02S26	G, S, M, Pe, Pa, Pc, C, Og, A, N	389989.1	4629528.1
North Aurora above dam	US IMP	09/22/00	Ponar 1a	2000WD02S21	G, S, M, Pe, Pa, Pc, C, Og, A, N	389956.7	4629320.3
North Aurora above dam	US IMP	09/22/00	Ponar 2a	2000WD02S21	G, S, M, Pe, Pa, Pc, C, Og, A, N	389973.3	4629324.5
North Aurora above dam	US IMP	09/22/00	Ponar 3a	2000WD02S21	G, S, M, Pe, Pa, Pc, C, Og, A, N	390036.0	4629323.6
North Aurora above dam	US IMP	09/22/00	Ponar 4b	2000WD02S23	G, S, M, Pe, Pa, Pc, C, Og, A, N	390021.0	4629332.5
North Aurora above dam	US IMP	09/22/00	Ponar 5b	2000WD02S23	G, S, M, Pe, Pa, Pc, C, Og, A, N	389956.7	4629370.0
North Aurora above dam	US IMP	09/25/00	Ponar 6c	2000WD02S24	G, S, M, Pe, Pa, Pc, C, Og, A, N	389958.1	4629376.0
North Aurora above dam	US IMP	09/25/00	Ponar 7c	2000WD02S24	G, S, M, Pe, Pa, Pc, C, Og, A, N	390014.1	4629391.2
North Aurora above dam	US IMP	09/25/00	Ponar 8c	2000WD02S24	G, S, M, Pe, Pa, Pc, C, Og, A, N	390094.8	4629394.4
North Aurora below dam	DS FF	07/17/01	Ponar 1a	2001WD04S25	M, Pe, Pc, C, Og	390040.1	4629107.1
North Aurora below dam	DS FF	07/17/01	Ponar 2a	2001WD04S25	M, Pe, Pc, C, Og	389967.3	4629100.6
North Aurora below dam	DS FF	07/17/01	Ponar 3a	2001WD04S25	M, Pe, Pc, C, Og	389966.5	4629104.1
North Aurora below dam	DS FF	07/17/01	Ponar 4b	2001WD04S26	M, Pe, Pc, C, Og	390023.1	4629132.5
North Aurora below dam	DS FF	07/17/01	Ponar 5b	2001WD04S26	M, Pe, Pc, C, Og	390039.5	4629134.3
North Aurora below dam	DS FF	07/17/01	Ponar 6b	2001WD04S26	M, Pe, Pc, C, Og	390032.6	4629181.6
North Aurora below dam	DS FF	07/17/01	Ponar 7c	2001WD04S27	M, Pe, Pc, C, Og	389950.6	4629169.4
North Aurora below dam	DS FF	07/17/01	Ponar 8c	2001WD04S27	M, Pe, Pc, C, Og	389997.1	4629183.1
North Aurora below dam	DS FF	07/17/01	Ponar 9c	2001WD04S27	M, Pe, Pc, C, Og	390001.8	4629186.5
Montgomery above dam	US IMP	09/25/00	Core 1	2000WD02S28	G, S, M, Pe, Pa, Pc, C, Og, A, N	389222.1	4621106.7
Montgomery above dam	US IMP	09/25/00	Core 2	2000WD02S30	G, S, M, Pe, Pa, Pc, C, Og, A, N	389277.5	4621184.1
Montgomery above dam	US IMP	09/25/00	Core 3	2000WD02S31	G, S, M, Pe, Pa, Pc, C, Og, A, N	389477.3	4621935.7
Montgomery above dam	US IMP	09/25/00	Ponar 1a	2000WD02S27	G, S, M, Pe, Pa, Pc, C, Og, A, N	389163.8	4621055.5
Montgomery above dam	US IMP	09/25/00	Ponar 2a	2000WD02S27	G, S, M, Pe, Pa, Pc, C, Og, A, N	389180.6	4621057.7
Montgomery above dam	US IMP	09/25/00	Ponar 3a	2000WD02S27	G, S, M, Pe, Pa, Pc, C, Og, A, N	389182.5	4621083.3
Montgomery above dam	US IMP	09/25/00	Ponar 4b	2000WD02S29	G, S, M, Pe, Pa, Pc, C, Og, A, N	389234.5	4621125.9
Montgomery above dam	US IMP	09/25/00	Ponar 5b	2000WD02S29	G, S, M, Pe, Pa, Pc, C, Og, A, N	389234.0	4621162.7
Montgomery below dam	DS FF	07/19/01	Ponar 1a	2001WD04S31	M, Pe, Pc, C, Og	389035.1	4620943.2
Montgomery below dam	DS FF	07/19/01	Ponar 2a	2001WD04S31	M, Pe, Pc, C, Og	389063.9	4620963.4
Montgomery below dam	DS FF	07/19/01	Ponar 3a	2001WD04S31	M, Pe, Pc, C, Og	389065.6	4620960.4
Montgomery below dam	DS FF	07/19/01	Ponar 4b	2001WD04S32	M, Pe, Pc, C, Og	388973.6	4620993.4
Montgomery below dam	DS FF	07/19/01	Ponar 5b	2001WD04S32	M, Pe, Pc, C, Og	388981.9	4621005.2
Montgomery below dam	DS FF	07/19/01	Ponar 6b	2001WD04S32	M, Pe, Pc, C, Og	388990.3	4621014.5
Montgomery below dam	DS FF	07/19/01	Ponar 7c	2001WD04S33	M, Pe, Pc, C, Og	389077.8	4620977.8
Montgomery below dam	DS FF	07/19/01	Ponar 8c	2001WD04S33	M, Pe, Pc, C, Og	389109.9	4621003.4
Montgomery below dam	DS FF	07/19/01	Ponar 9c	2001WD04S33	M, Pe, Pc, C, Og	389114.2	4621006.0
Yorkville above dam	US IMP	09/26/00	Core 1	2000WD02S32	G, S, M, Pe, Pa, Pc, C, Og, A, N	379845.2	4611105.1
Yorkville above dam	US IMP	09/26/00	Core 2	2000WD02S34	G, S, M, Pe, Pa, Pc, C, Og, A, N	379891.0	4611254.2
Yorkville above dam	US IMP	09/26/00	Core 3	2000WD02S36	G, S, M, Pe, Pa, Pc, C, Og, A, N	379927.4	4611094.4
Yorkville above dam	US IMP	09/26/00	Core 4	2000WD02S38	G, S, M, Pe, Pa, Pc, C, Og, A, N	380078.6	4611198.6
Yorkville above dam	US IMP	09/26/00	Ponar 1a	2000WD02S33	G, S, M, Pe, Pa, Pc, C, Og, A, N	379845.2	4611105.1
Yorkville above dam	US IMP	09/26/00	Ponar 2a	2000WD02S33	G, S, M, Pe, Pa, Pc, C, Og, A, N	379848.9	4611129.3
Yorkville above dam	US IMP	09/26/00	Ponar 3a	2000WD02S33	G, S, M, Pe, Pa, Pc, C, Og, A, N	379874.5	4611229.7
Yorkville above dam	US IMP	09/26/00	Ponar 4b	2000WD02S35	G, S, M, Pe, Pa, Pc, C, Og, A, N	379915.5	4611190.1
Yorkville above dam	US IMP	09/26/00	Ponar 5b	2000WD02S35	G, S, M, Pe, Pa, Pc, C, Og, A, N	379917.7	4611174.7
Yorkville above dam	US IMP	09/26/00	Ponar 6b	2000WD02S35	G, S, M, Pe, Pa, Pc, C, Og, A, N	379921.0	4611122.0
Yorkville above dam	US IMP	09/26/00	Ponar 7c	2000WD02S37	G, S, M, Pe, Pa, Pc, C, Og, A, N	379993.1	4611211.3

Table F4. Continued.

Station	Habitat type	Date	Type	Sample number	Analyses	Easting	Northing
Yorkville above dam	US IMP	09/26/00	Ponar 8c	2000WD02S37	G, S, M, Pe, Pa, Pc, C, Og, A, N	380051.6	4611239.0
Yorkville above dam	US IMP	09/26/00	Ponar 9c	2000WD02S37	G, S, M, Pe, Pa, Pc, C, Og, A, N	380065.4	4611162.2
Yorkville below dam	DS FF	07/20/01	Ponar 1a	2001WD04S37	M, Pe, Pc, C, Og	379671.2	4611118.0
Yorkville below dam	DS FF	07/20/01	Ponar 2a	2001WD04S37	M, Pe, Pc, C, Og	379656.7	4611124.4
Yorkville below dam	DS FF	07/20/01	Ponar 3a	2001WD04S37	M, Pe, Pc, C, Og	379655.9	4611126.3
Yorkville below dam	DS FF	07/20/01	Ponar 4b	2001WD04S38	M, Pe, Pc, C, Og	379696.6	4611130.7
Yorkville below dam	DS FF	07/20/01	Ponar 5b	2001WD04S38	M, Pe, Pc, C, Og	379681.9	4611160.6
Yorkville below dam	DS FF	07/20/01	Ponar 6b	2001WD04S38	M, Pe, Pc, C, Og	379673.0	4611169.7
Yorkville below dam	DS FF	07/20/01	Ponar 7c	2001WD04S39	M, Pe, Pc, C, Og	379769.2	4611199.9
Yorkville below dam	DS FF	07/20/01	Ponar 8c	2001WD04S39	M, Pe, Pc, C, Og	379745.5	4611215.4
Yorkville below dam	DS FF	07/20/01	Ponar 9c	2001WD04S39	M, Pe, Pc, C, Og	379725.9	4611222.0
Dayton above dam	US IMP	09/18/00	Core 1	2000WD02S01	G, S, M, Pe, Pa, Pc, C, Og, A, N	350481.1	4583679.3
Dayton above dam	US IMP	09/18/00	Core 2	2000WD02S03	G, S, M, Pe, Pa, Pc, C, Og, A, N	350657.7	4583746.9
Dayton above dam	US IMP	09/18/00	Core 3	2000WD02S04	G, S, M, Pe, Pa, Pc, C, Og, A, N	350528.7	4583872.3
Dayton above dam	US IMP	09/18/00	Ponar 1a	2000WD02S02	G, S, M, Pe, Pa, Pc, C, Og, A, N	350488.9	4583664.5
Dayton above dam	US IMP	09/18/00	Ponar 2a	2000WD02S02	G, S, M, Pe, Pa, Pc, C, Og, A, N	350562.2	4583672.2
Dayton above dam	US IMP	09/18/00	Ponar 3a	2000WD02S02	G, S, M, Pe, Pa, Pc, C, Og, A, N	350623.4	4583696.2
Dayton above dam	US IMP	09/18/00	Ponar 4b	2000WD02S05	G, S, M, Pe, Pa, Pc, C, Og, A, N	350550.1	4583877.4
Dayton above dam	US IMP	09/18/00	Ponar 5b	2000WD02S05	G, S, M, Pe, Pa, Pc, C, Og, A, N	350582.1	4583881.7
Dayton above dam	US IMP	09/18/00	Ponar 6b	2000WD02S05	G, S, M, Pe, Pa, Pc, C, Og, A, N	350674.9	4583899.2
Dayton above dam	US IMP	09/18/00	Ponar 7c	2000WD02S06	G, S, M, Pe, Pa, Pc, C, Og, A, N	350560.0	4583992.1
Dayton above dam	US IMP	09/18/00	Ponar 8c	2000WD02S06	G, S, M, Pe, Pa, Pc, C, Og, A, N	350608.7	4583999.5
Dayton above dam	US IMP	09/18/00	Ponar 9c	2000WD02S06	G, S, M, Pe, Pa, Pc, C, Og, A, N	350669.7	4584001.2

Appendix G. Existing Fishway Evaluations

Table G1. Stratton fishway dimensions, water depths, and velocities recorded on May 5, 2000. Drop length is measured from the top of the weir notch to the water level in the downstream pool. Weirs, drops, and pools are numbered consecutively from upstream to downstream. Velocity was measured at three locations at each weir, at one location in each drop, and at six locations in each pool. Discharge for the sample date was 989 cfs recorded at the Algonquin guage (USGS 05550000). NA is not applicable.

Weir/drop/pool	Length (ft.)	Width (ft.)	Height (ft.)	Notch height (ft.)	Notch length (ft.)	Water depth (ft.)	Mean velocity (ft./s)
W1		8.80	2.15 (3.38)	NA	NA	0.20	0.43
W2		8.10	5.95	2.74	4.09	0.30	1.96
W3		8.12	5.69	2.78	4.05	0.25	2.60
W4		7.92	5.16	2.62	3.91	0.30	1.30
W5		7.95	4.71	2.75	3.97	0.30	2.43
W6		7.96	4.44	2.75	3.92	0.30	2.12
W7		8.14	3.32	1.77	4.02	0.20	2.27
W8		8.10	0.92	NA	NA	0.60	NA
D1	1.00	8.80					4.80
D2	0.40	4.09					6.07
D3	0.45	4.05					6.11
D4	0.20	3.91					2.39
D5	0.30	3.97					4.13
D6	0.70	3.92					3.84
D7	0.30	4.02					4.96
P1	4.67	8.10				2.40	0.23
P2	8.50	8.12				2.30	1.09
P3	8.42	7.92				2.30	0.84
P4	8.33	7.95				2.50	0.41
P5	8.28	7.96				2.50	0.44
P6	8.50	8.14				1.50	0.40
P7	4.08	8.10				1.50	0.31

Table G2. Aurora canoe chute dimensions, water depths, and velocities recorded on May 2, 2000. Chutes and pools are numbered consecutively from upstream to downstream. Velocity was measured at three water column and bottom locations in each chute and 10 locations in each pool. Discharge for the sample date was 1,620 cfs recorded at the Algonquin guage (USGS 05550000).

Chute/pool	Length (ft.)	Width (ft.)	Water depth (ft.)	Mean velocity 60% depth (ft/s)	Maximum velocity 60% depth (ft/s)	Mean velocity bottom (ft/s)	Maximum velocity bottom (ft/s)
C1	5.50	7.40	1.20	4.5	5.6	4.7	5.6
C2	5.28	7.50	1.07	4.7	5.7	3.9	4.5
C3	5.36	6.83	1.07	6.0	8.9	3.8	4.1
C4	5.11	6.92	1.10	5.9	9.1	5.2	7.4
C5	4.33	6.63	1.10	3.6	4.1	3.2	3.5
C6	3.38	10.83	1.27	3.9	4.0	3.6	4.5
P1	21.00	55.00	1.83	2.1	2.13		
P2	18.03	34.88	2.04	1.5	2.58		
P3	17.17	91.75	2.32	1.3	2.41		
P4	17.06	58.88	2.71	1.2	2.99		
P5	18.24	57.17	2.67	0.8	4.19		

Table G3. Observation time and water temperature for Stratton Dam fishway and Aurora canoe chute fisheries surveys conducted during April and May 2000.

Site	Date	Observation time (min.)	Time of day	Water Temperature (°C)
Aurora	4/13/2000	35	Day	11.0
Aurora	4/17/2000	30	Day	11.5
Aurora	4/18/2000	30	Day	11.0
Aurora	4/19/2000	30	Day	10.8
Aurora	4/27/2000	30	Day	16.0
Aurora	4/28/2000	60	Day	16.8
Aurora	5/3/2000	45	Day	19.0
Aurora	5/4/2000	180	Day	22.0
Aurora	5/4/2000	110	Night	22.0
Aurora	5/5/2000	60	Day	20.0
Aurora	5/9/2000	50	Day	21.5
Stratton	4/13/2000	30	Day	8.0
Stratton	4/17/2000	30	Day	10.0
Stratton	4/18/2000	30	Day	11.0
Stratton	4/24/2000	30	Day	11.0
Stratton	4/27/2000	30	Day	14.0
Stratton	4/28/2000	60	Day	15.0
Stratton	5/1/2000	35	Day	16.0
Stratton	5/2/2000	50	Night	16.2
Stratton	5/3/2000	80	Night	19.0
Stratton	5/5/2000	60	Day	21.6
Stratton	5/9/2000	30	Night	20.5
Stratton	5/10/2000	45	Day	19.8
Stratton	5/16/2000	40	Day	17.0
Stratton	5/16/2000	40	Night	18.5

Table G4. Species and numbers of fish that used the Aurora canoe chute to bypass the Stolp Island Dam during May 3-5, 2000 and May 3, 2001. Fish were sampled with a fyke net set at the upstream entrance to the canoe chute. Mean discharge (min - max) recorded at the Algonquin guage (USGS 05550000) during the sample period was 1106 cfs (989 – 1280) in 2000 and 865 cfs in 2001. Sampling in 2001 was subsequent to the sucker spawning run.

	Number captured	
Species	2000	2001
Bluegill	4	1
Channel catfish	11	32
Common carp	24	2
Freshwater drum	3	10
Golden redhorse	3	0
Gizzard shad	1	1
Green sunfish	0	1
Quillback	20	3
Shorthead redhorse	1	0
Smallmouth bass	4	0
Walleye	5	0
Total	76	50

Table G5. Species and numbers of fish sampled from the Stratton fishway between April 27 and May 16, 2000. Fish were sampled with a dip net and do not represent total numbers of fish utilizing the fishway. Some fish may have washed into the fishway from the upstream exit. Mean discharge (min - max) recorded at the Algonquin guage (USGS 05550000) during the sample period was 1673 cfs (596 - 2930).

Species	Number captured
Black crappie	1
Black bullhead	2
Bluegill	145
Brook silverside	1
Channel catfish	20
Common carp	5
Emerald shiner	451
Fathead minnow	1
Freshwater drum	1
Green sunfish	9
Golden shiner	2
Largemouth bass	1
Quillback	12
Spottail shiner	96
White sucker	1
Grand Total	748

Appendix H. Education Outreach

Table H1. List of professional and public presentations, seminars and workshops where results of the study were disseminated.

Presentation type and organization	Date	Location	Estimated attendance
Workshops and seminars			
St. Charles Park Distric's "Learn From The Experts" adult education series	3/19/2003	St. Charles, IL	35
Illinois Indiana Sea Grant River Restoration Practices and Concepts Workshop	4/18/2002	Hammond, IN	100
Friends of the Fox River	1/31/2002	Dundee, IL	75
Friends of the Fox River	1/29/2002	Aurora, IL	100
St. Charles Park Distric's "Learn From The Experts" adult education series	1/24/2002	St. Charles, IL	35
The Legacy of Low Head Dams, IIT Environmental Engineering Seminar Series	5/2/2001	Wheaton, IL	15
Professional meetings			
Annual Meeting of the American Fisheries Society.	8/20/2002	Baltimore, MD	150
Annual Meeting of the Illinois Chapter of the American Fisheries Society	2/21/2002	Moline, IL	75
Midwest Fish and Wildlife Conference	12/11/2001	Des Moines, IA	150
Public Presentations			
North Batavia Dam Project Public Meeting	3/10/03	Batavia, IL	50
Batavian's For a Healthy River	2/27/03	Batavia, IL	35
Illinois Audubon Society	1/8/2003	Geneva, IL	45
Yorkville Dam Committee	11/7/2002	Yorkville, IL	25
Elgin Izaak Walton League	11/5/2002	Elgin, IL	35
Illinois Smallmouth Bass Alliance	10/29/2002	West Chicago, IL	35
Batavia Main Street Economic Restructuring Committee	6/13/2002	Batavia, IL	15
Fox Valley Chapter of the Sierra Club	3/11/2002	Geneva, IL	25
Fox River Ecosystem Partnership Noon Network	2/20/2002	Dundee, IL	25
Fox River Ecosystem Partnership Quarterly Meeting	3/21/2001	Genoa, IL	20
North Batavia Dam Project Public Meeting	10/23/2000	Batavia, IL	45