2012

Kickapoo Creek Stream Restoration Project - Phase 3

FY 2010 State Wildlife Grant

Final Report

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Submitted by:

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FY 2010 State Wildlife Grant (SWG) Program
State of Illinois
Final Report (05/01/11 to 09/30/12)

GRANT NO.: T-74-D-1

GRANT TITLE: Kickapoo Creek Stream Restoration Project - Phase 3

INTRODUCTION: The Bloomington-Normal area in McLean County in Central Illinois is experiencing rapid development rates. The majority of this development is occurring eastward. As Kickapoo Creek flows north-to-south along the eastern boundaries of this urban center, a large portion of this stream basin will imminently be developed in the near future. This is a serious situation as Kickapoo Creek is a listed "Biologically Significant Stream" with most segments attaining "Highly Valued Aquatic Resource" status. Kickapoo Creek is the gem of the Sangamon River Basin with regards to biological diversity with a current count of 51 fish species and 23 mussel species. Included in the aquatic assemblage of Kickapoo Creek are at least four mussel species in greatest need of conservation (slippershell-ST, creek heelsplitter, pondhorn, and rainbow-SE) and three fish species in greatest need of conservation (American brook lamprey, largescale stoneroller, and highfin carpsucker).

In this first wave of urbanization, a group of six developers came together to build the largest subdivision in Bloomington-Normal history. Their plans call for 1,000 homes and a public school to be built on the banks of Kickapoo Creek. After reconsidering their original idea to dam the stream to impound 67 acres of water to form a shallow lake, they initiated the plan and partnerships to create one of the largest stream restoration projects in the state of Illinois to be the focal point of this development. The stream restoration project site is situated at the headwaters of the Kickapoo Creek basin and will provide biological protection and benefits near its source. Additionally, the project presented itself as a great opportunity to establish a working relationship with the city and developers. As expansion continues, this relationship can ensure that development is conducted in an ecologically sound manner to the extent possible.

The pre-restoration conditions at the site were two channelized drainage ditches converging amidst agriculture land. An 88-acre park around these straight channels would have some inherent value. However, biological benefits and true environmental improvements would not have been realized without the restoration work.

Phase 3 builds upon the first two phases of this very successful stream restoration project that addresses Actions 2-3 and 6-10 of the Streams Campaign (IWAP 60-65), Actions 1-7 of the Farmland and Prairie Campaign (IWAP 71-76), all Actions of the Wetlands Campaign (IWAP 77-80), Actions 1-4 and 6 of the Land & Water Stewardship Campaign (IWAP 84-87), and all Actions of the Green Cities Campaign of the Illinois Wildlife Action Plan (IWAP 88-91). Phases

1 and 2 re-meandered over a mile of stream channel, implemented several constructed riffle structures, fully stabilized the banks, lowered the floodplain and re-established its functionality (Streams Campaign Actions 2-3 (IWAP 61-62)), incorporated 9 riparian wetlands, and re-established native vegetation throughout (Farmland and Prairie Campaign Actions 1-7 (IWAP 73-76), Wetlands Campaign Actions 1-6 (IWAP 78-80), and Green Cities Campaign Actions 1-2 (IWAP 89). Highlights of improvements to the fish population already being realized at this site as a result of Phase 1 and 2 work include: significant increases in total number of fish, catch rates of the largescale stoneroller (Species in Greatest Need of Conservation (IWAP 316)), bigmouth shiner (Intolerant Species), sand shiner, creek chub, central stoneroller, bluntnose minnow, white sucker, green sunfish, johnny darter, and the introduction of the banded darter to this reach.

Phase 3 is situated on the uppermost reach of the west branch of this project site. This phase incorporates another innovative conservation practice, the 2-stage ditch design. This project has served as a demonstration site for several innovative conservation practices to address multiple stressors contributed to urbanization and agricultural production. The 2-stage ditch follows suit with far-reaching applicability for addressing problems with altered hydrology due to channelization, loss of aquatic habitat, and nutrient loading throughout the state and Midwest (Streams Campaign Actions 1 and 3 (IWAP 61-62) and Farmland and Prairie Campaign Actions 1-2 and 4 (IWAP 73-75).

Phase 3 is the final stage of this massive restoration project. The project now encompasses approximately 88 acres of restored riparian ground, functioning floodplain, wetlands, and native prairie. The property is owned by the City of Bloomington and managed as a passive park by the Bloomington Parks & Recreation Department (Green Cities Campaign Actions 1-6 (IWAP 89-91)).

Large scale stream restoration is a costly venture, and this project is being funded with federal grant money matched by the developers and the City of Bloomington. In addition to this State Wildlife Grant from the U.S. Fish and Wildlife Service (USFWS), federal funding for the project was also obtained from the USFWS National Fish Habitat Restoration Fund and the U.S. Environmental Protection Agency's (USEPA) Section 319 Grant.

An intensive monitoring and evaluation component has already been implemented with this restoration project (Streams Campaign Actions 7-9 (IWAP 64-65), Farmland and Prairie Campaign Actions 6-7 (IWAP 76), Wetlands Campaign Action 6 (IWAP 80), Land and Water Stewardship Campaign Action 3 (IWAP 86), Green Cities Campaign Actions 3 and 5 (IWAP 90)). Prior to the initial construction activities in 2007, we collected two years of baseline fish population data from the site in which to gauge post-restoration data. 6 sites (4 treatment reaches and 2 control reaches) have been sampled twice per year, every year to monitor changes in the fish population. This sampling regime is planned to continue for several more years as part of the EPA's National NPS Monitoring Program (Research, Monitoring, and Evaluation (IWAP 98-99)).

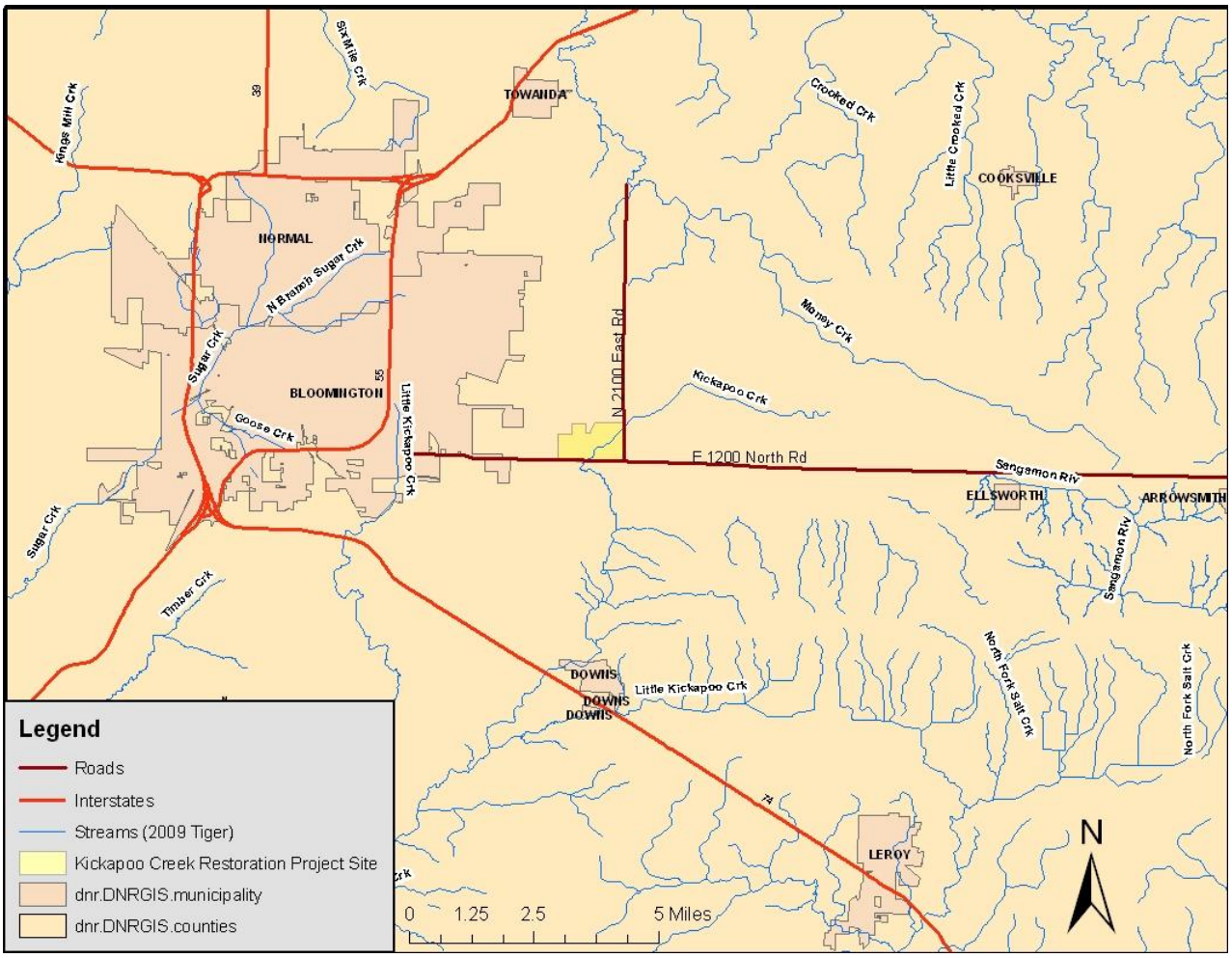


Figure 1.SITE LOCATION: The restoration site is located on Kickapoo Creek of the Sangamon River Basin in McLean County in Central Illinois. The site lies approximately two miles east of Bloomington on Ireland Grove Road (1200 N). T23N R3E Sec. 9.

OBJECTIVES:

1. Implement in-stream habitat restoration practices within 3000 feet of a 2-stage ditch demonstration project on the unnamed west branch of the Kickapoo Creek headwaters (Figure 2).

    A. 12 rock riffles will be constructed within the Phase 3 reach (Figure 3).

    B. 600 feet of bank will be protected with rip rap within the Phase 3 reach (Figure 3).

2. Monitor the fish population for post-restoration evaluation and documentation of the project.

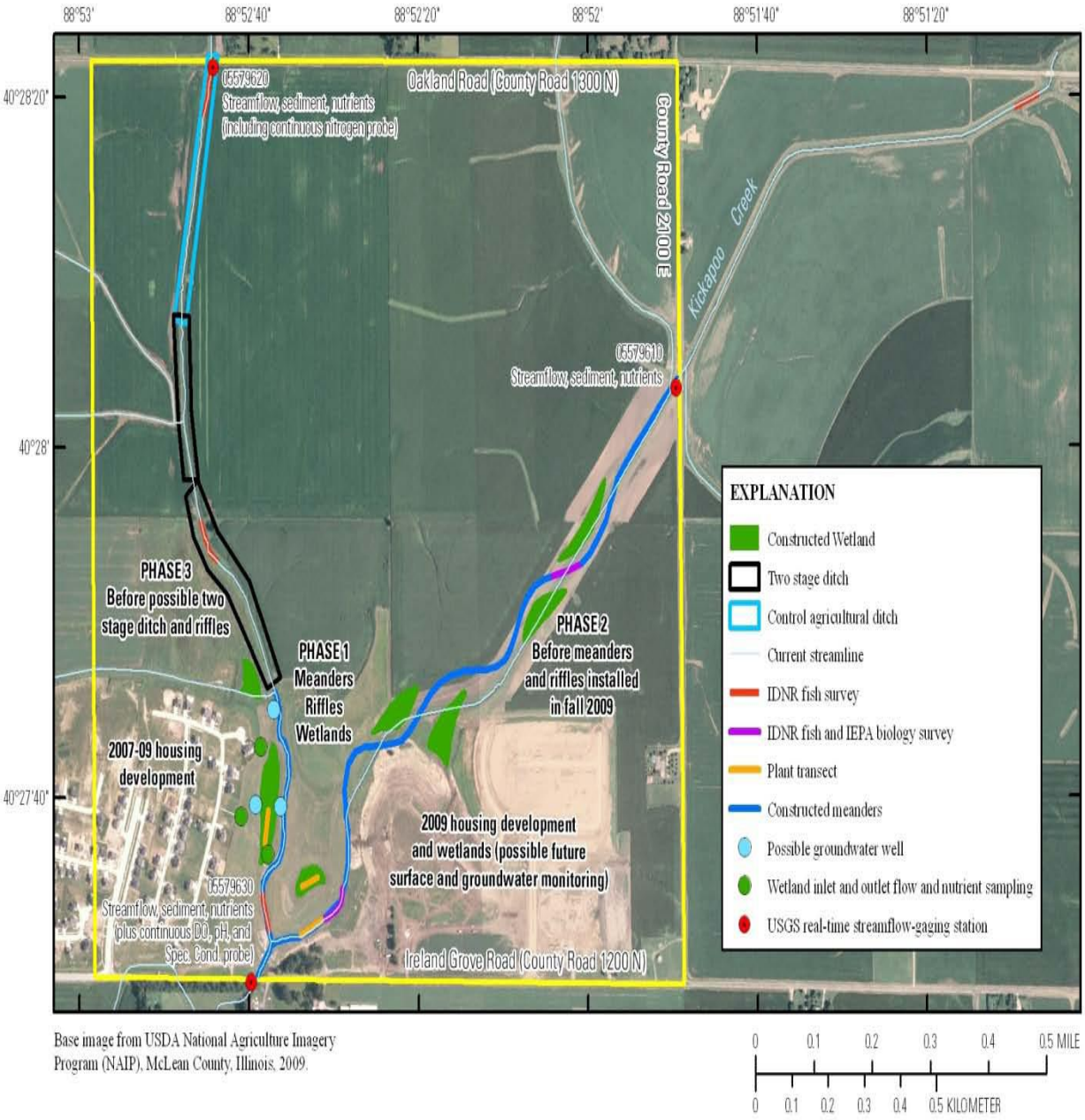


Figure 2. Aerial photograph of the Kickapoo Creek Stream Restoration site, showing the location of the 2-stage ditch on the unnamed west branch tributary outlined in black. Other features of the restoration work completed in the previous two phases and the monitoring infrastructure is also labeled on the photograph.

b/ the intended location of the 12 rock riffles and the 600 feet of rip-rapping.

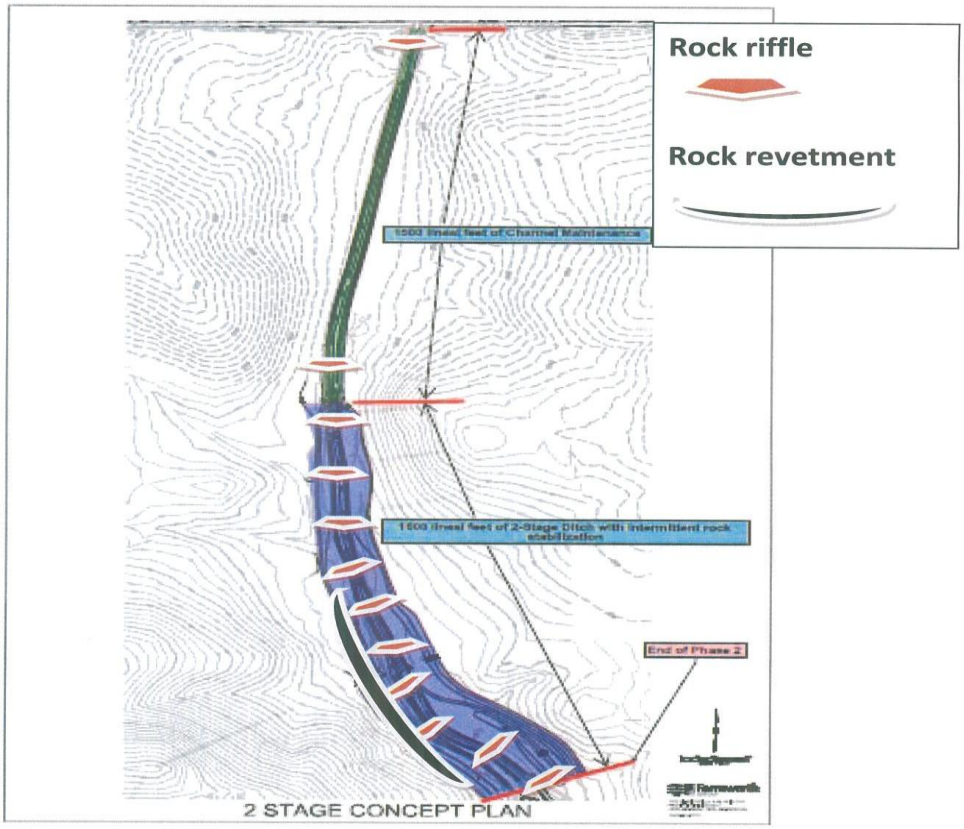


Figure 3. Schematic drawing showing the location of the rock riffles and bank stabilization within the 2-stage ditch Phase 3 reach.

Job 1. In-stream restoration practices, rock riffles (Figures 5 and 6) and bank stabilization (Figure 7), were implemented within 3000 feet of a 2-stage ditch demonstration project (Figure 4) on the unnamed west branch of the Kickapoo Creek headwaters. All work was completed under the direction of well-known stream restoration specialist, Don Roseboom of the USGS. This Phase 3 work builds upon and complements the first two phases of the Kickapoo Creek Stream Restoration Project completed in 2008 and 2009 (see Kickapoo Creek Restoration Project – Phase 1 T-46-D-1 SWG Final Report). Construction work for the project was awarded through a confidential bid process conducted by the City of Bloomington.

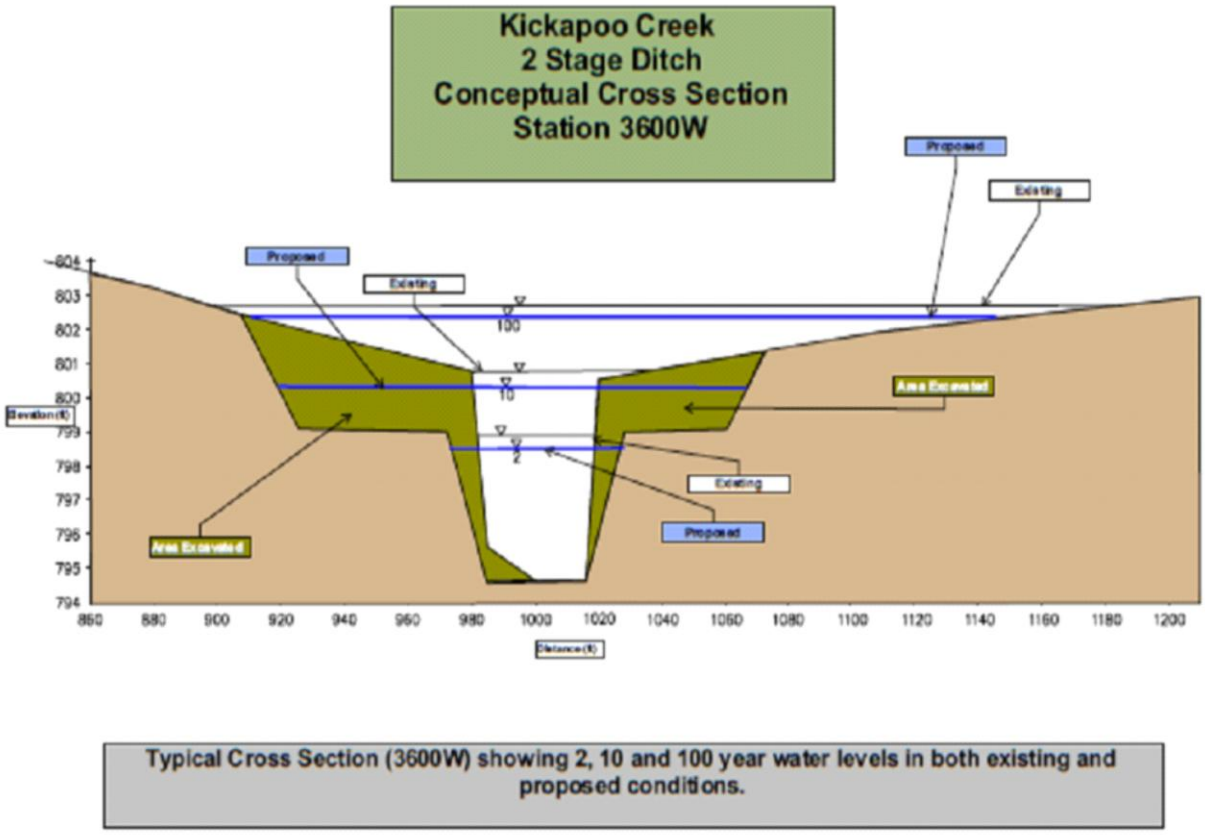


Figure 4. Schematic drawing of a 2-stage ditch design, as referenced in Rebecca M. Gorney, Dawn R. Ferris, Andy D. Ward, Lance R. Williams. 2011. Assessing Channel-Forming and Equilibrium Characteristics of an Impacted Headwater Stream in Ohio, USA. *Ecological Engineering*. No. 37: 418-430.

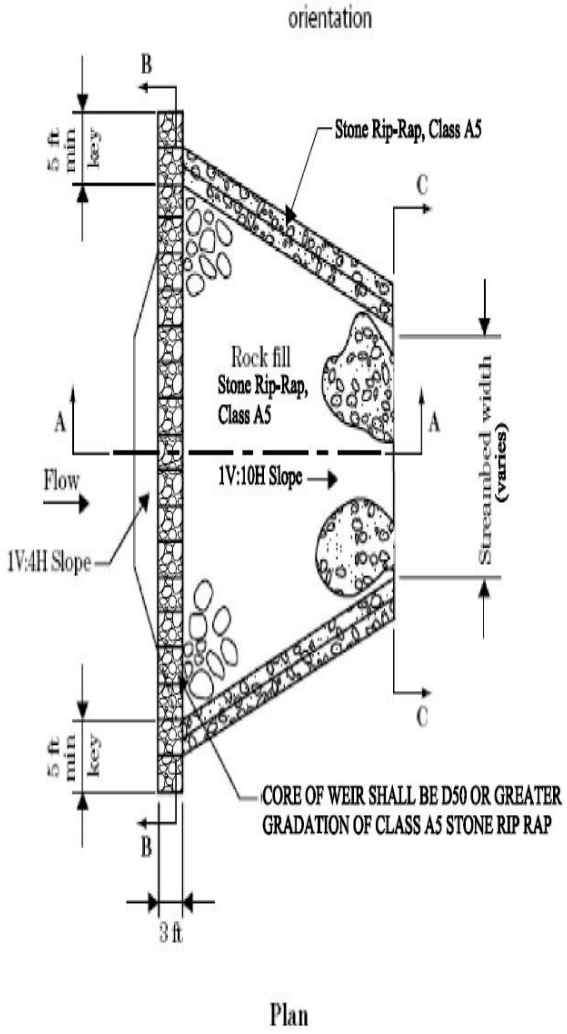


Figure 5. Schematic drawing of rock riffle.

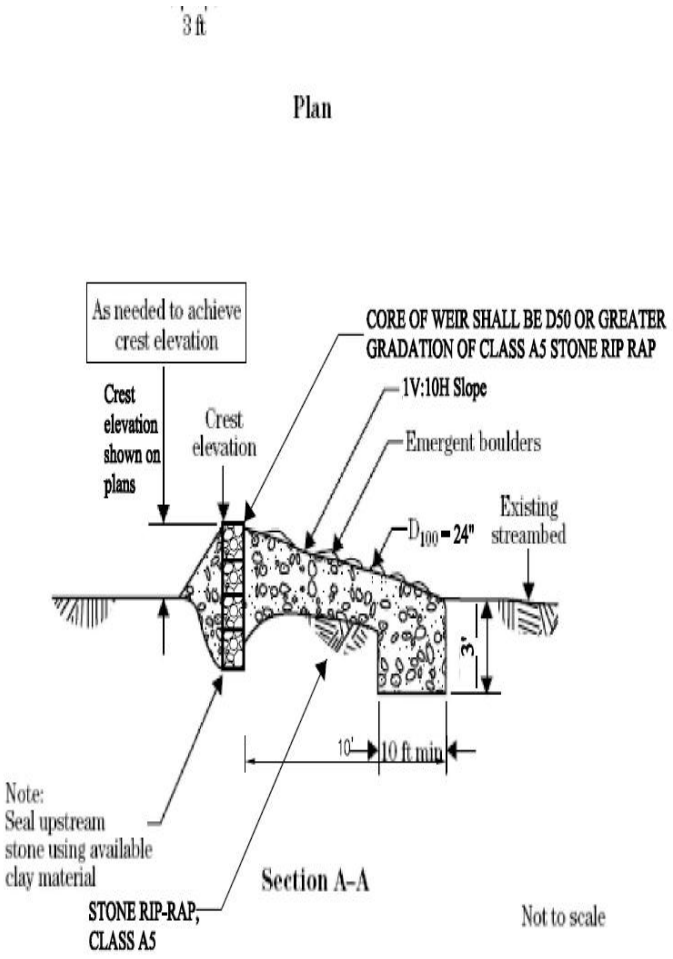


Figure 6. Schematic drawing of rock riffle.

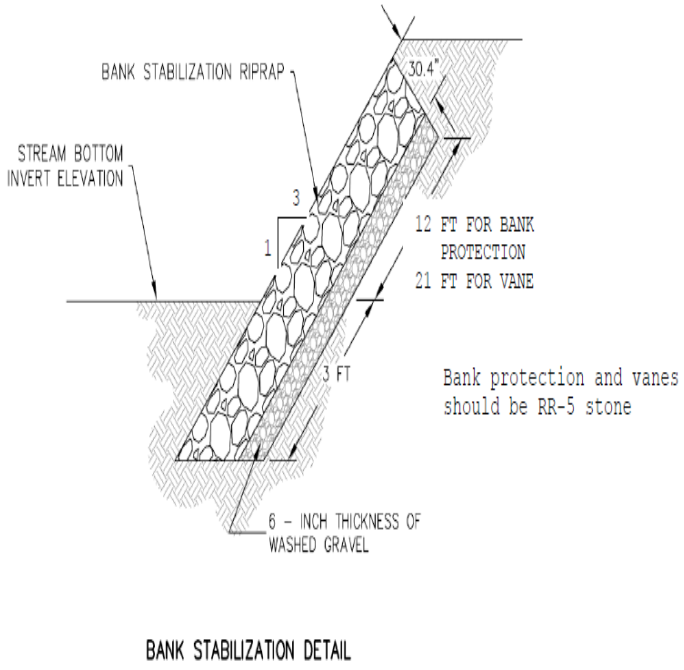


Figure 7. Schematic drawing of bank stabilization.

Figure 8. Sediment benches in the drainage ditch and in the two stage drainage ditch with a larger excavated sediment bench.

With Bloomington's Stormwater funding ($500,000), the city matched the federal funding of the State Wildlife Grant ($144,000) for habitat enhancement and NRCS's Conservation Innovation Grant ($75,000) for nutrient management in agricultural runoff.

Bloomington selected the two stage ditch as the practice to be applied in Phase 3 of the Grove Restoration on the West Branch of Kickapoo Creek. The typical agricultural two stage ditch is widened at the elevations of sediment benches deposited in the bed of normal agricultural ditch (Figure 8).

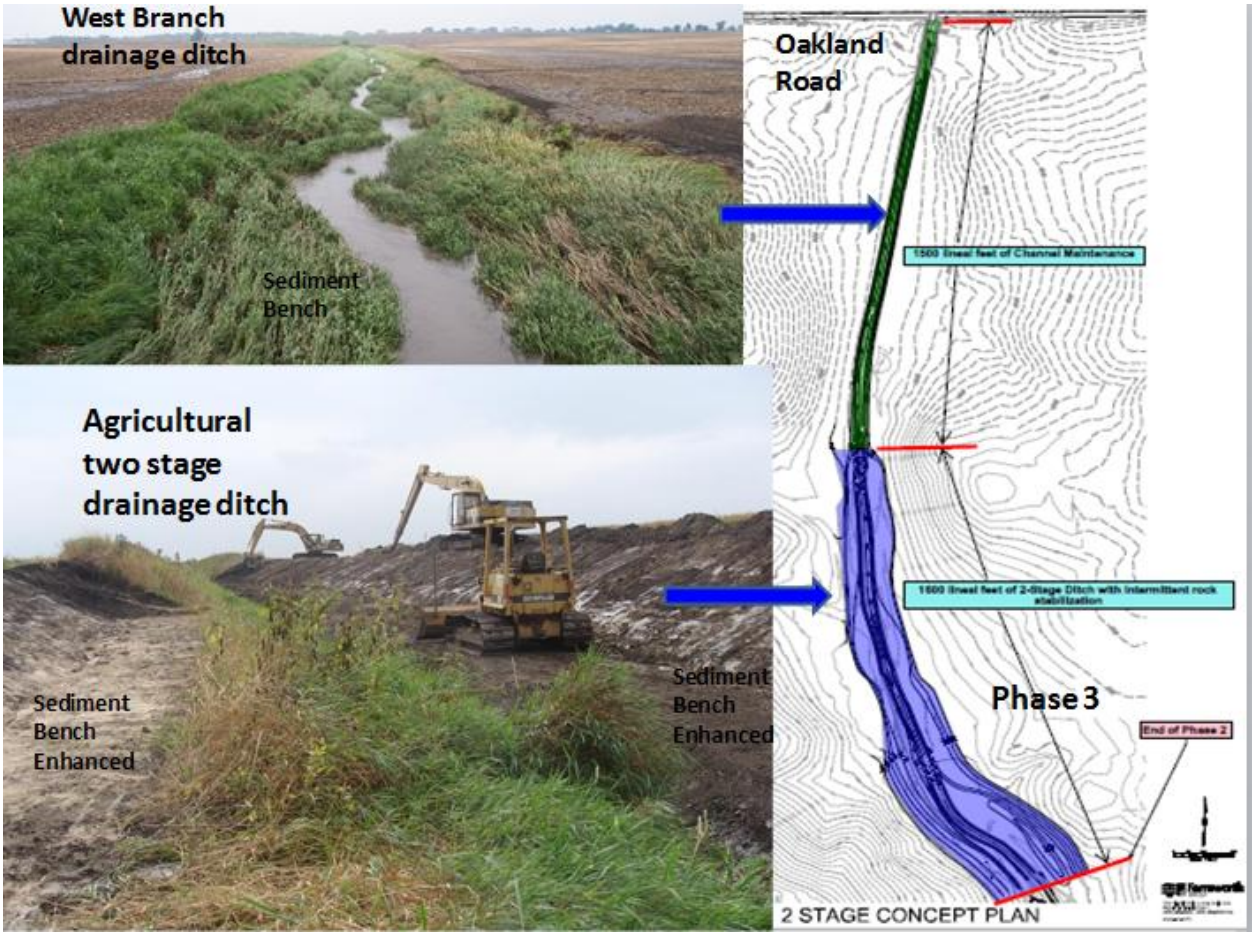


Figure 9. The drainage ditch was excavated to a wider ditch with a larger and lower floodplain area, which was seeded with prairie grasses.

The two stage ditch practice was modified to include significant stormwater storage (36 acre ft.) in the prairie wetland complex adjacent to the ditch (Figure 9).

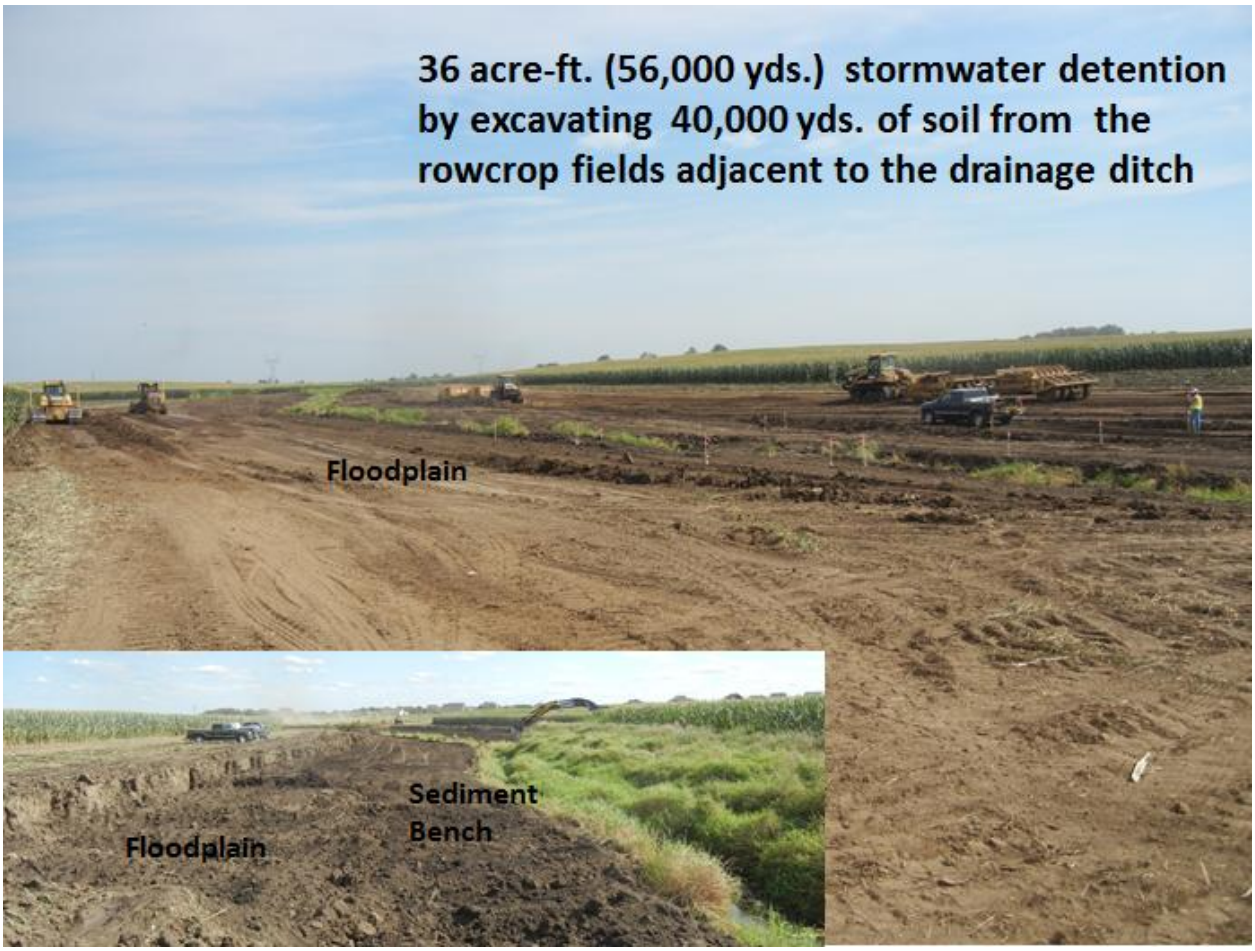


Figure 10. Excavation lowered the rowcrop fields to form the sediment benches and floodplain required for stormwater detention in Phase 3.

In Phase 3 of the restoration, the banks of the two stage ditch were lowered and widened at the floodplain elevations to meet the city's required 36 acre-ft. storage for residential runoff of 1000 new homes for the Phase 3 area of the park (Figure 10).

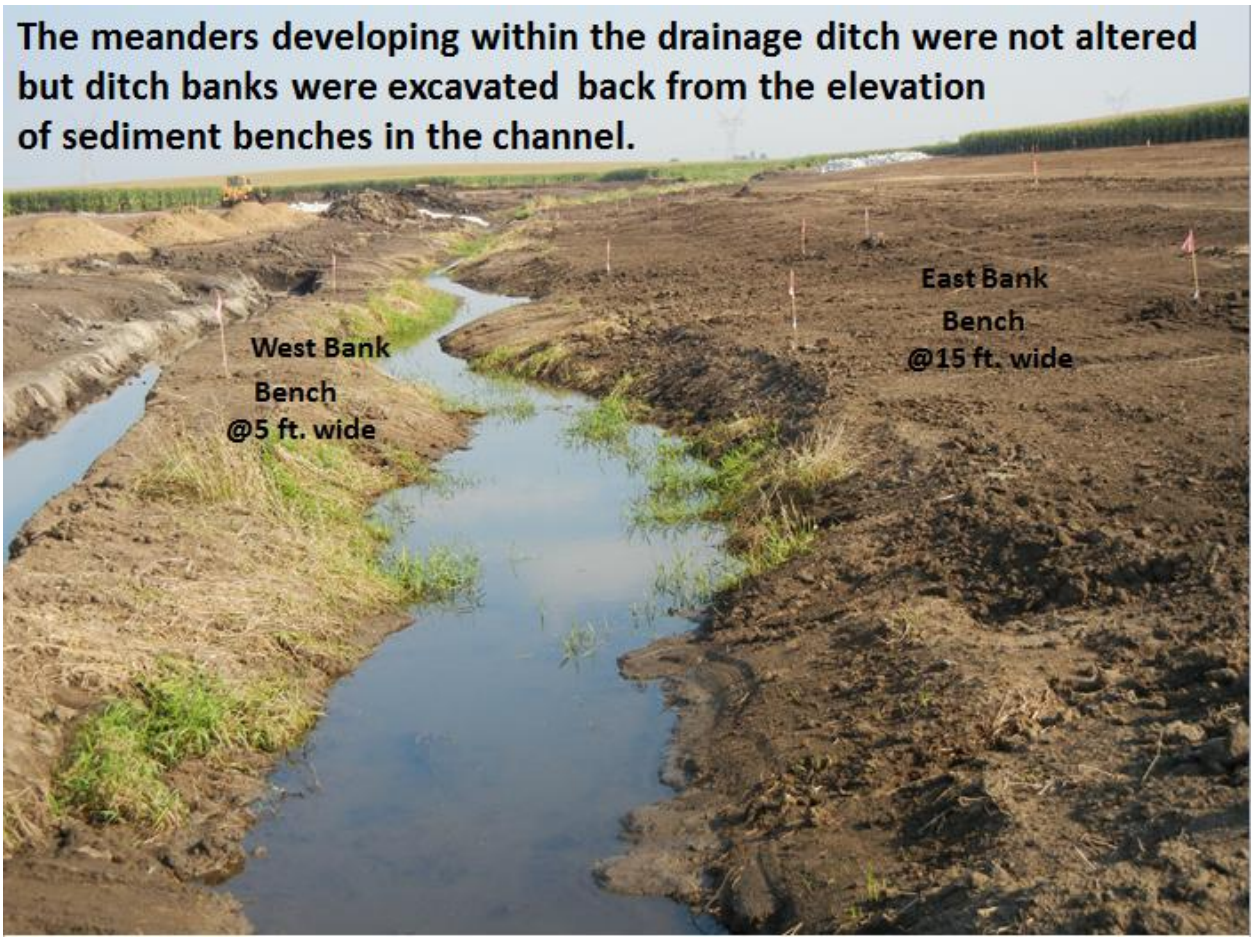


Figure 11. Survey stakes set elevations for the excavation of rowcrop fields to form the sediment benches of the two stage ditch and the prairie floodplain required for stormwater storage in Phase 3.

With the exception of areas adjacent to the rock chute and the wetland outlet, the east bank had no rock bank protection. The ditch channel will meander across the sediment benches within the rock limitations on migration.

Figure 12. Rock keys extend 12 ft. into the east sediment bench (15 ft. wide) to limit meander migration.

12 rock riffles were constructed as instream habitat enhancements within the two stage ditch. Rock keys were extended across the sediment bench for 12 ft. (Figure 12).

Figure 13. Soil was compacted over the riprap in preparation for prairie seeding and mulching blankets for plant growth.

Figure 14. Gravel and sands are placed into the voids in the rock riffles to decrease subflow through the riprap.

Figure 15. Cover crops of oats and winter wheat quickly grow through the mulch blankets to protect prairie seed until spring growth.

A wetland was excavated to capture runoff from future housing and increase water quality by wetland plant uptake of nutrients. The wetland was excavated in late August and planted in September (Figure 16).

Figure 16. The east wetland was excavated in late August and a thick sand layer allowed groundwater to seep to surface.

The outlet overflow of the east wetland was stabilized with riprap and vegetation (Figure 17).

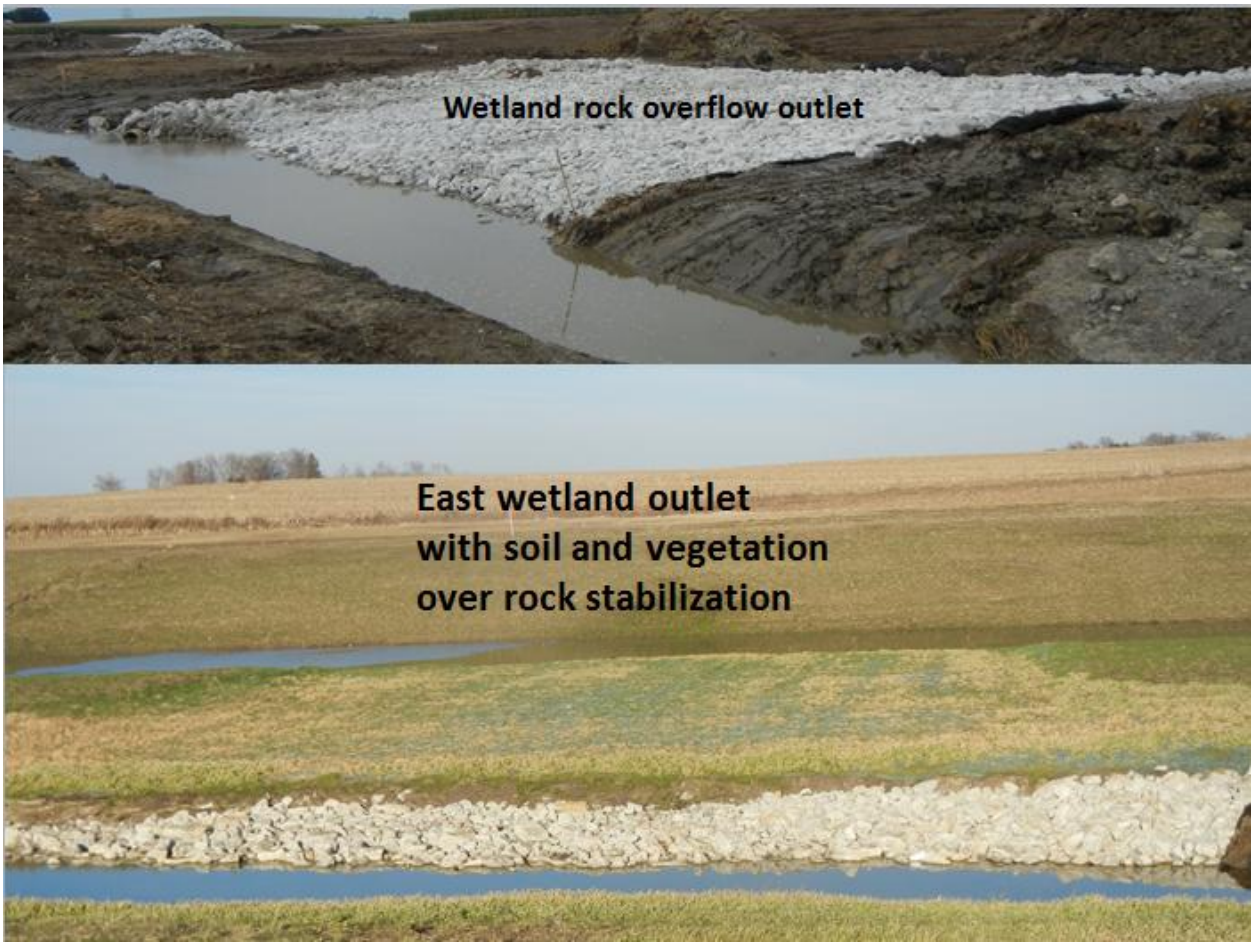


Figure 17. With surface runoff from a large area of rowcrops or future housing entering the wetland, the wetland overflow required both rock and vegetative stabilization.

Figure 18. With the warm and early spring, cover crops grew rapidly and wetland plants began to emerge even in the drought.

Figure 19. Aerial photographs show only stream banks and wetland had good growth of prairie and wetland plants by late summer of 2012.

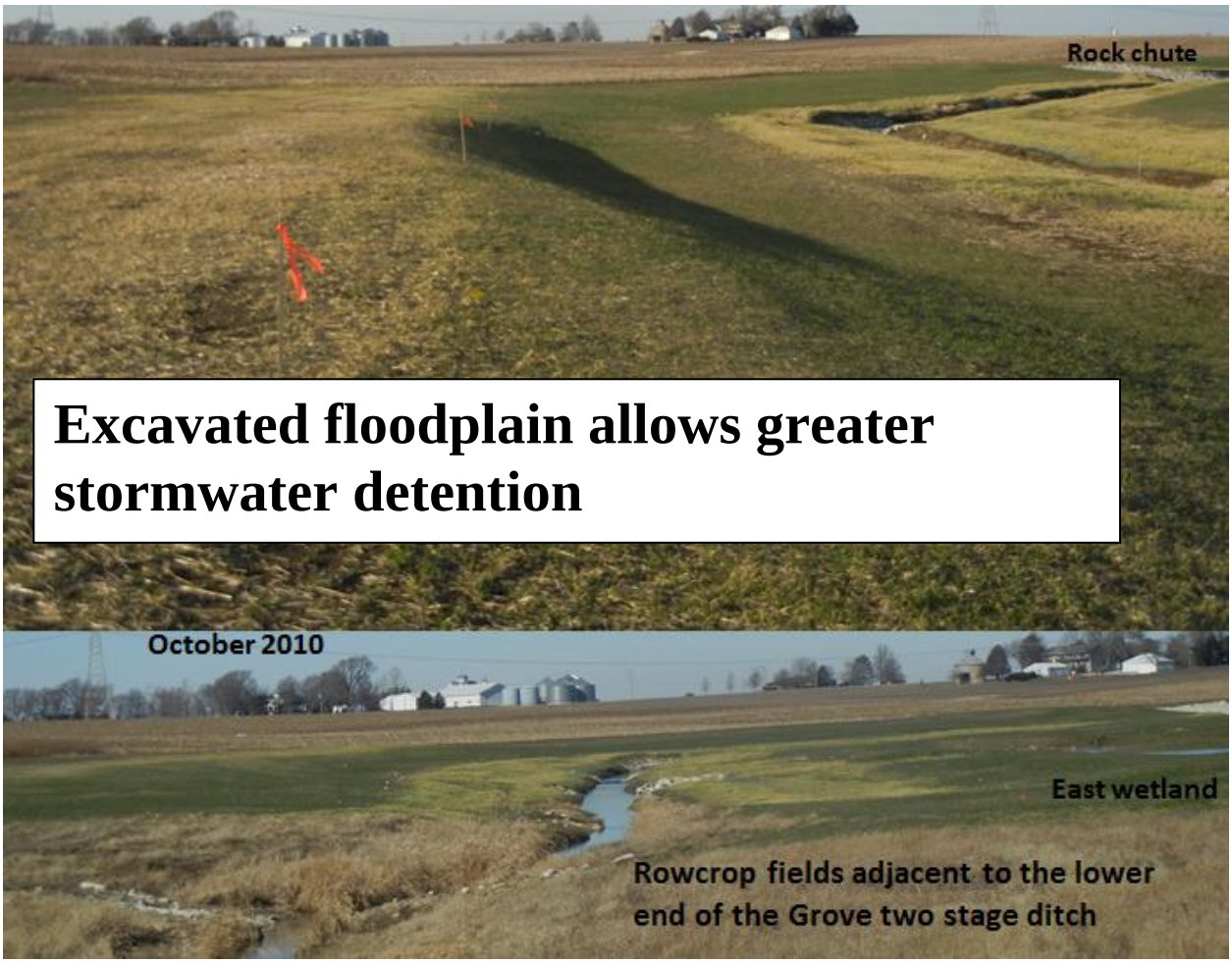


Figure 20. Until the housing market returns, corn and soybean fields will supply the majority of surface water runoff into Phase 3.

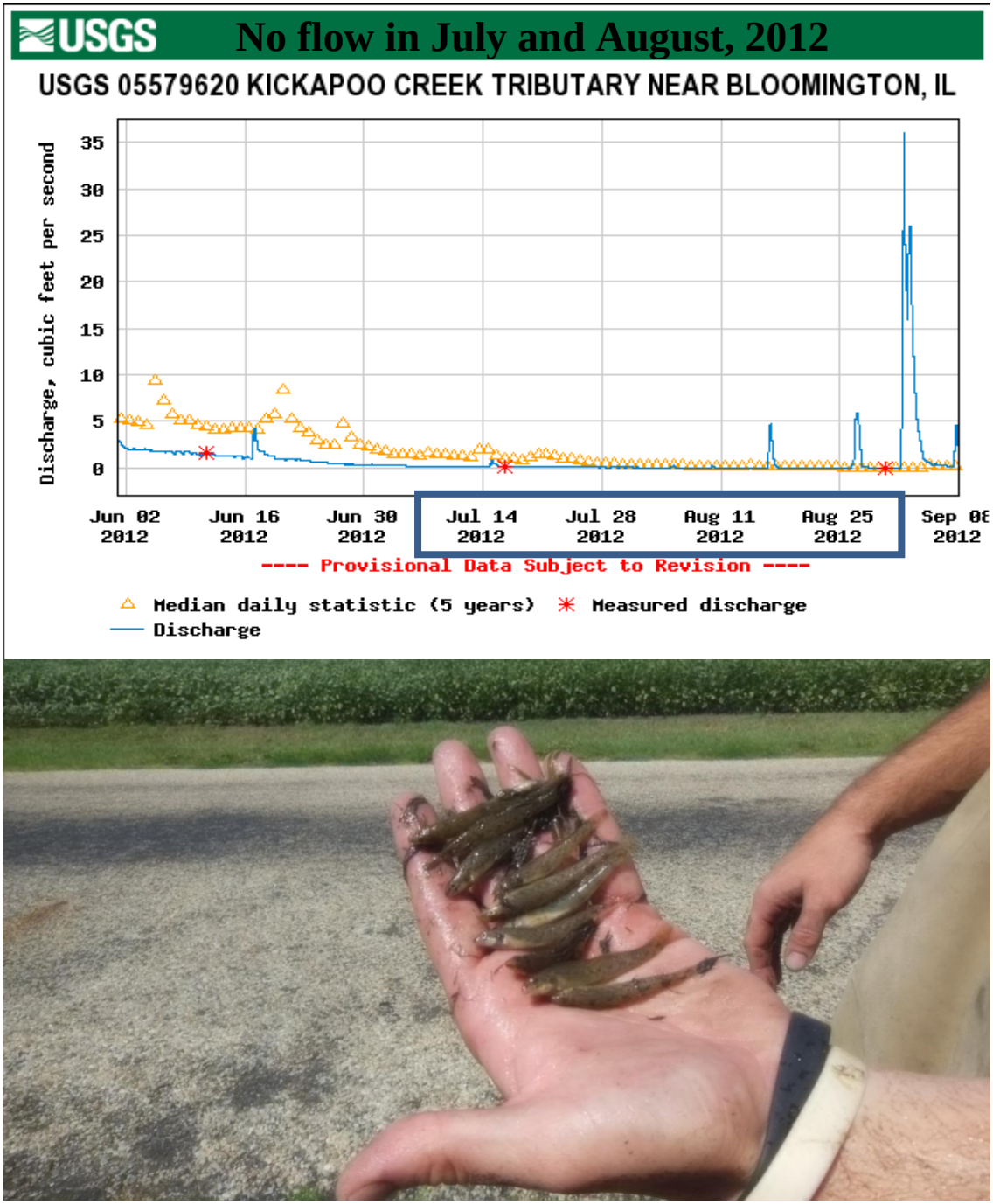
The city utilizes green infra-structure practices to increase nutrient reduction and have modified the agricultural practice to increase stormwater storage and increase water quality of agricultural and residential runoff. The West Branch of Kickapoo Creek receives runoff from 2500 acres of rowcrop in the park.

Figure 21. Cover crop growth was rapid in spring of 2012.

Prairie and wetland vegetation is planted in Phase 3 to increase nutrient uptake in the modified two stage ditch practice. The prairie vegetation will require 3 growing seasons to achieve a mature effective plant community.

Figure 22. The Phase 3 area provides a suitable site for monitoring nutrient reduction and fishery increases in this two stage ditch application.

Figure 23. The 2012 drought pooled water and exposed dry bed in July and August.



Figures 24- 25. During low flow conditions, sensitive species found refuge in the pools that developed downstream of the constructed riffles.

Figure 26. Severe drought and two months of 90 degree plus temperatures allowed vegetation growth in the channel.

Figure 27. Phase 3 with 12 rock riffles, wetland overflow, and large waterway rock chute.

The US Geological Survey will monitor discharge, sediment loadings and nutrient loading of large floods and normal stream flows to determine water quality.

IDNR stream fishery staff will monitor stream fish populations as the two stage ditch evolves during flooding and the maturing prairie vegetation.

Bloomington Park staff and their consultants will determine the maturity of the prairie and wetland plant community.

Job 2. Monitor the fish population for post-restoration evaluation and documentation of the project.

Fish population monitoring efforts have been successfully implemented as scheduled. The monitoring efforts have been designed to include two sites within the restoration reach with a control site upstream of the project on the West Branch and two sites within the restoration reach with a control site upstream of the project on the East Branch, for a total of six sampling sites. These six sites are scheduled to be sampled twice per year in late June and early September for the duration of the project and once per year for several years following completion of the project. In addition to these six core sites, a sampling reach immediately downstream of the project site was surveyed in June 2007 and July 2011.

To date, the six core sites have been surveyed twice per year since 2006 (prior to grant cycle) through 2011. In 2012, sampling frequency was reduced to once per year. Additional data on water quality, habitat measures, and macroinvertebrates is also being collected by Illinois Environmental Protection Agency staff on the three East Branch sites that will bolster information gained from the fisheries data collection effort.

From the pre-permitting surveys in May 2005 through the pre- and post-restoration monitoring of 2011, 69 fish population surveys have been conducted for this project. These surveys have accounted for over 33 hours of electrofishing effort. To date, 31,868 fish of 33 species have been collected.

There is no question that several species of the fish population have responded favorably to the stream restoration work. Several species of the resident pre-restoration population have increased their numbers substantially, indicating an increased rate of production and survival for these species. Other species have become present with regularity in the post-restoration fish samples, indicating additions to the resident population.

This stream restoration project has implemented a variety of channel enhancement practices, and the response of the fish population has been variable among these practices. Phase 1, the downstream southernmost portion of the project site, created relatively flat widened stream channels with heavy vegetation growth that possesses characteristics resembling a permanent wetland. In Phase 2, the upper reach of the East Branch, the stream channel is more strongly defined and allowed for more intense hydraulic jumps to occur at the constructed riffles. This has resulted in the development and maintenance of deep scour pools below the riffles. In Phase 3, the upper reach of the West Branch, the two stage ditch with constructed riffles was implemented.

The fish population monitoring program was designed to capture the responses to these various practices. The East Branch Downstream Treatment (EIE-18) and West Branch Downstream Treatment (EIEM-01) sites are located within Phase 1. The East Branch Upstream Treatment site

(EIE-19) is within Phase 2. The West Branch Upstream Treatment site (EIEM-02) is within Phase 3. The East Branch Upstream Control (EIE-20) and West Branch Upstream Control (EIEM-03) were established as reference sites that have received no channel enhancement work. An additional Downstream Reference site (EIE-22) has been surveyed prior to restoration work and following Phase 3 work in 2011 to monitor downstream off-site changes to the fish population over time.

All monitoring stations consisted of 300-foot stream reaches isolated with block nets. However, the Downstream Reference site was a 500-foot reach. Stations were sampled by electrofishing with a single pass in an upstream direction. The Phase 1 sites (EIE-18 and EIEM-01) and Downstream Reference site were sampled by electric seine. All other sites were sampled by backpack electrofisher. The East Branch Upstream Treatment site (EIE-19) was switched to pushboat electrofishing post-restoration due to the deep scour pool that developed.

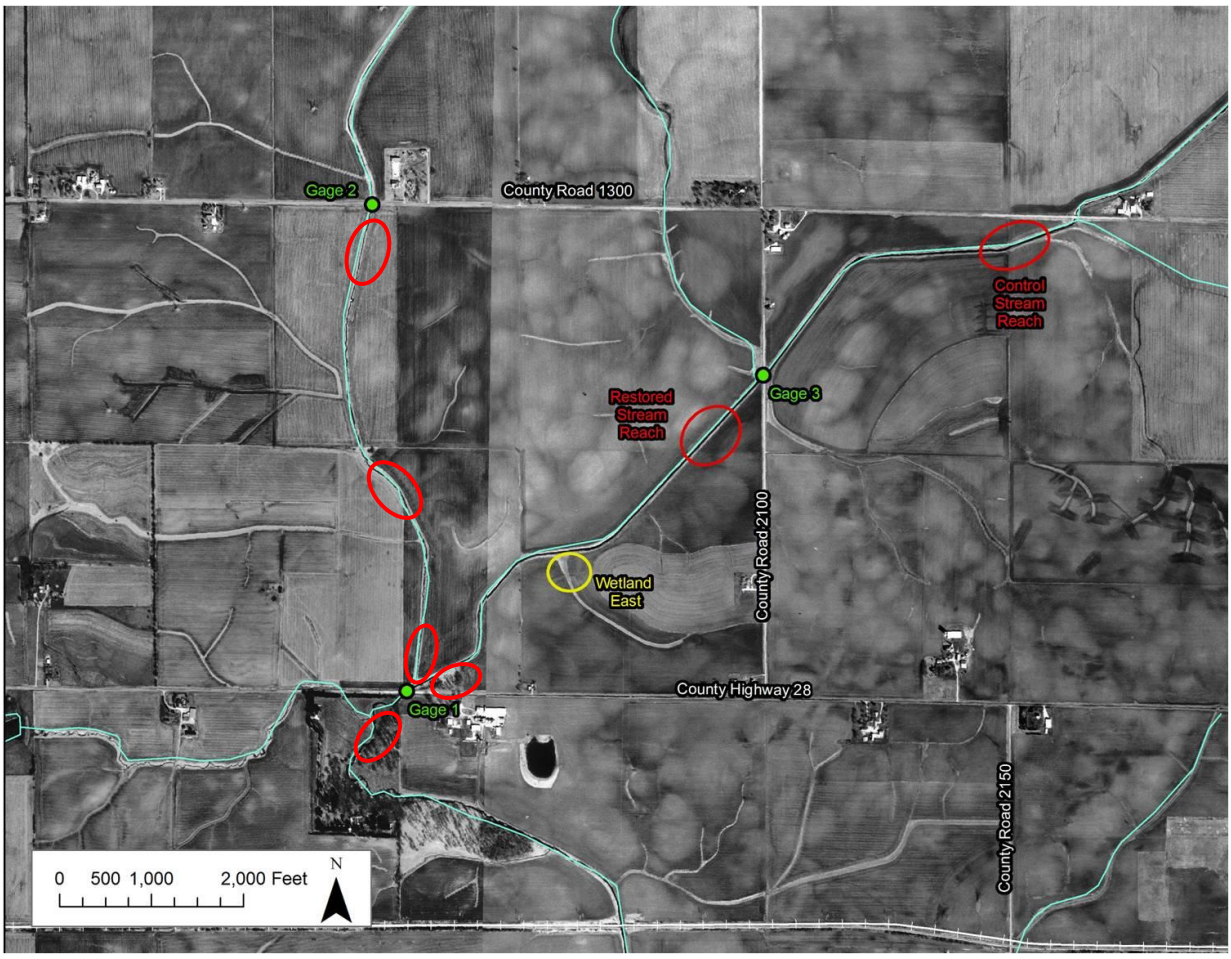
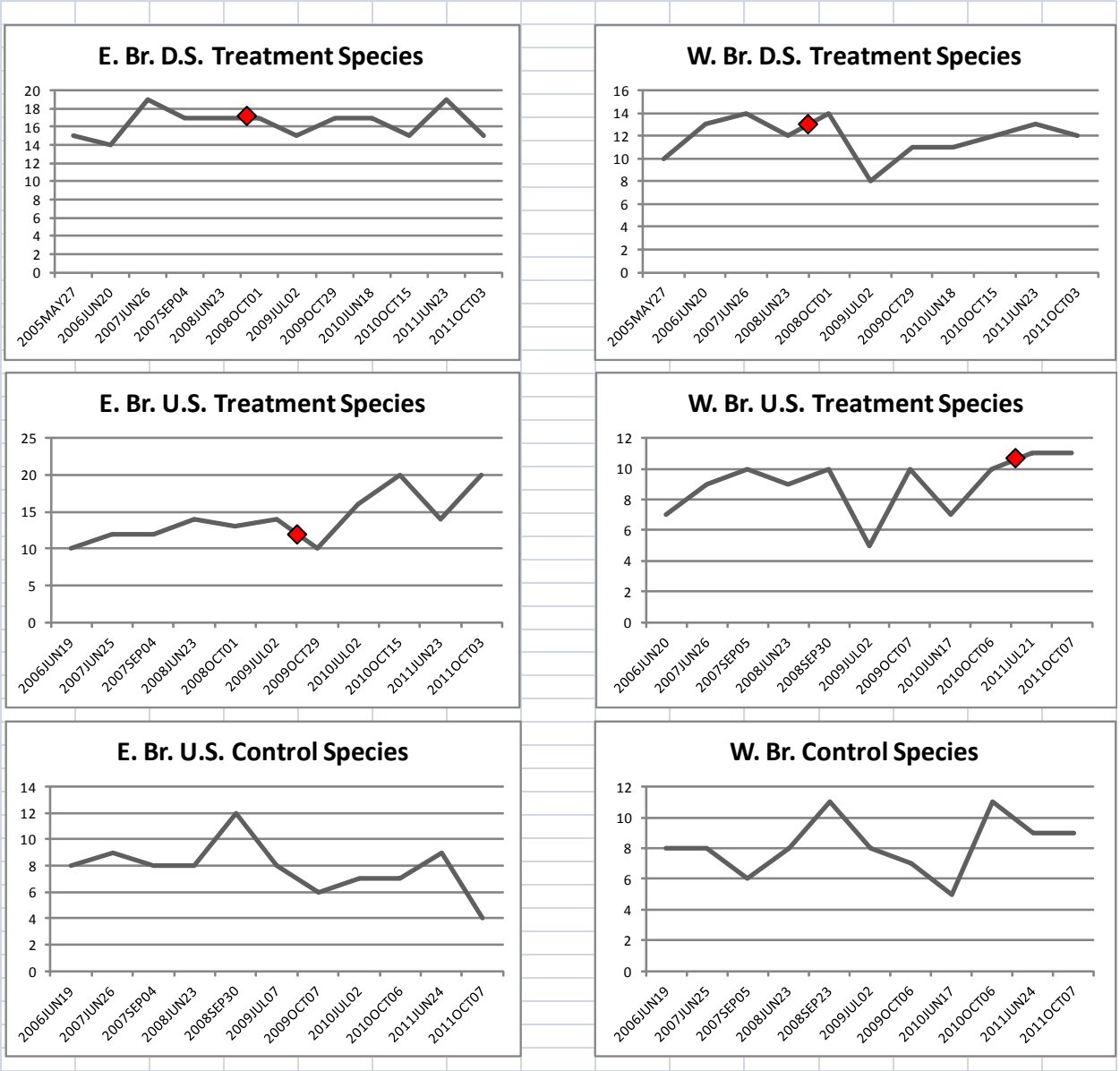
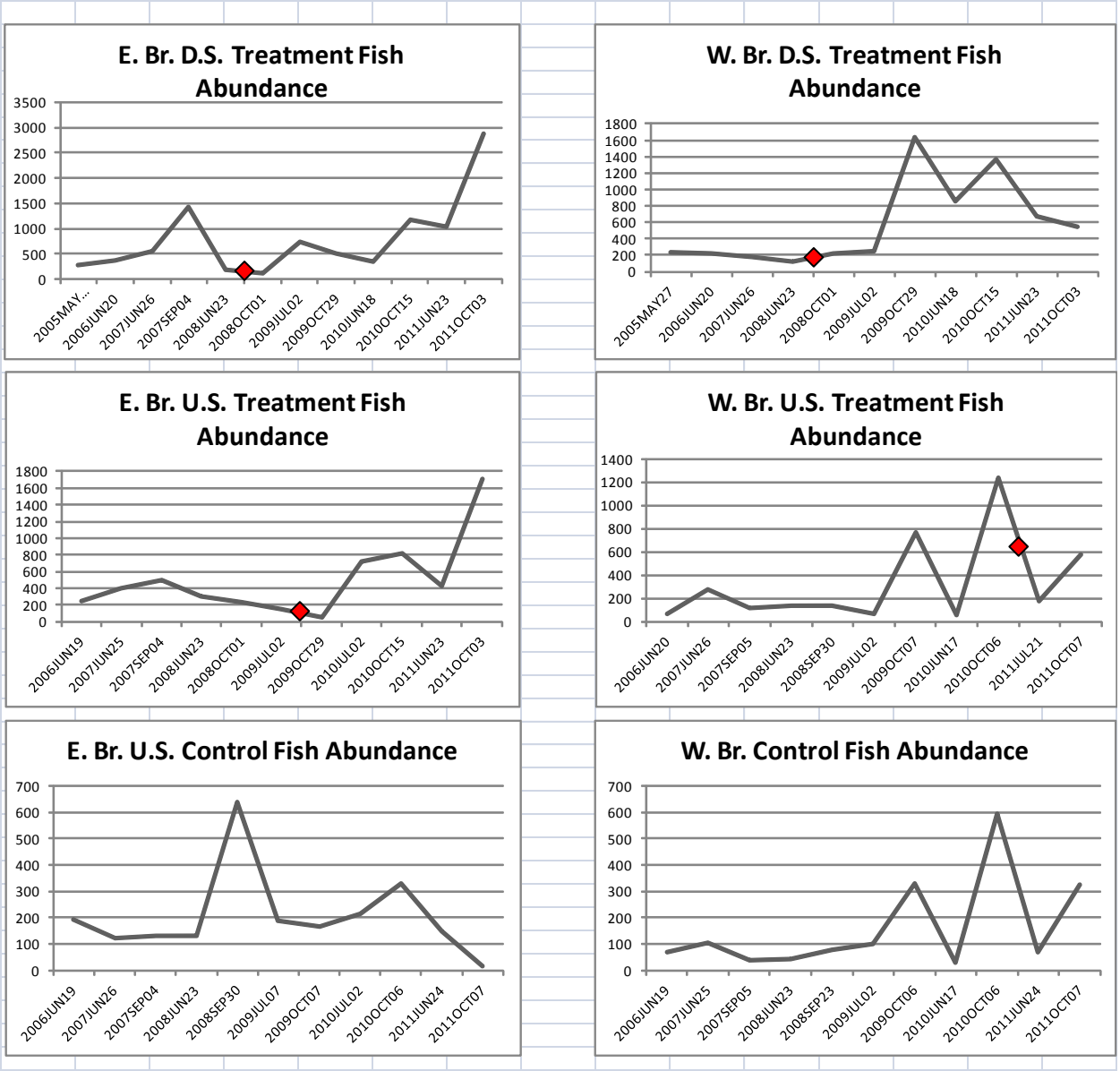


Figure 28. An aerial view of the pre-restoration project area showing the location of the fish population monitoring stations, indicated by red ovals.

Results:



Figures 29-34. Species Abundance graphs for the six monitoring stations. Red diamonds indicate the point of restoration work that directly impacted each of the stations.



Figures 35-40. Fish Abundance graphs for the six monitoring stations. Red diamonds indicate the point of restoration work that directly impacted each of the stations.

	SPECIES				
	Pre-restoration	Post-restoration			
E. Br. D.S. Treatment			Change	% Change	**PHASE 1**
Maximum	19	19	0	0	
Average	16.4	16.4	0	0	
Minimum	14	15	1	7.1	
W. Br. D.S. Treatment					
Maximum	14	14	0	0	
Average	12.2	11.6	-0.6	-4.9	
Minimum	10	8	-2	-20	
E. Br. U.S. Treatment					**PHASE 2**
Maximum	14	20	6	42.8	
Average	12.5	16	3.5	28	
Minimum	10	10	0	0	
W. Br. U.S. Treatment					**PHASE 3**
Maximum	10	11	1	10	
Average	8.6	11	2.4	27.9	
Minimum	5	11	6	120	
E. Br. U.S. Control					**Reference**
Maximum	12	x			
Average	7.8	x			
Minimum	4	x			
W. Br. U.S. Control					
Maximum	11	x			
Average	8.2	x			
Minimum	5	x			
D.S. Reference					
Actual	18	23	5	27.8	

Table 1. Summary table for Species Richness.

	FISH ABUNDANCE				
	Pre-restoration	Post-restoration			
E. Br. D.S. Treatment			Change	% Change	**PHASE 1**
Maximum	1426	2865	1439	100.9	
Average	566.4	972.4	406	71.7	
Minimum	186	129	-57	-30.6	
W. Br. D.S. Treatment					
Maximum	239	1638	1399	585.4	
Average	192.5	791.9	599.4	311.4	
Minimum	127	221	94	74	
E. Br. U.S. Treatment					**PHASE 2**
Maximum	493	1709	1216	246.7	
Average	303.7	746.4	442.7	145.8	
Minimum	149	56	-93	-62.4	
W. Br. U.S. Treatment					**PHASE 3**
Maximum	1237	582	-655	-53	
Average	319.3	382.5	63.2	19.8	
Minimum	55	183	128	232.7	
E. Br. U.S. Control					**Reference**
Maximum	639	x			
Average	208.1	x			
Minimum	18	x			
W. Br. U.S. Control					
Maximum	594	x			
Average	162.2	x			
Minimum	29	x			
D.S. Reference					
Actual	931	1719	788	84.6	

Table 2. Summary table for Fish Abundance.

			Annual Totals 2005	Annual Totals 2006	Annual Totals 2007	Annual Totals 2008	Annual Totals 2009	Annual Totals 2010	Annual Totals 2011
Total fish		31868	527	1177	3847	2368	4956	7756	8587
Electrode minutes		1986.8	65	128	317	318.6	359.29	410.91	325
Gizzard shad	Dorosoma cepedianum	11	0	0	0	11	0	0	0
Carp	Cyprinus carpio	28	0	2	6	0	2	12	0
Creek chub	Semotilus atromaculatus	5237	68	221	464	417	853	1717	1297
Hornyhead chub	Nocomis biguttatus	2036	41	118	266	250	205	350	628
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4	0	0	2	0	1	1	0
Central stoneroller	Campostoma anomalum	6546	119	194	819	525	1132	1531	1640
Largescale stoneroller	Campostoma oligolepis	27	0	0	1	11	11	2	0
Striped shiner	Luxilus chrysocephalus	3906	100	335	918	412	326	548	817
Redfin shiner	Lythrurus umbratilus	170	2	13	37	12	14	28	30
Spotfin shiner	Cyprinella spiloptera	8	0	0	0	0	0	0	8
Red shiner	Cyprinella lutrensis	39	0	5	1	5	0	0	2
Fathead minnow	Pimephales promelas	1	0	0	0	0	0	1	0
Bluntnose minnow	Pimephales notatus	3665	102	135	827	136	455	460	1092
Bigmouth shiner	Notropis dorsalis	3716	0	15	20	17	1236	1225	1137
Sand shiner	Notropis ludibundus	1363	1	14	70	75	379	149	372
Quillback	Carpiodes cyprinus	4	0	0	0	0	4	0	0
White sucker	Catostomus commersoni	997	33	36	137	136	33	291	260
Northern hog sucker	Hypentelium nigricans	39	0	0	3	2	4	1	2
Golden redhorse	Moxostoma erythrurum	12	0	0	4	3	0	0	2
Yellow bullhead	Ameiurus natalis	126	8	4	18	13	10	30	31
Black bullhead	Ameiurus melas	4	1	0	0	0	1	2	0
Stonecat	Noturus flavus	1	0	0	0	0	0	0	0
Blackstripe topminnow	Fundulus notatus	366	0	0	3	3	5	52	285
Brook silverside	Labidesthes sicculus	6	0	0	0	0	0	4	0
Black crappie	Pomoxis nigromaculatus	1	0	0	0	0	1	0	0
Rock bass	Ambloplites rupestris	71	9	4	16	14	3	8	9
Largemouth bass	Micropterus salmoides	53	2	0	1	14	0	23	6
Green sunfish	Lepomis cyanellus	1465	12	8	93	144	148	547	438
Bluegill	Lepomis macrochirus	180	3	6	3	12	3	111	37
Redear sunfish	Lepomis microlophus	1	0	0	0	0	0	0	1
Blackside darter	Percina maculata	26	0	1	7	1	0	0	6
Johnny darter	Etheostoma nigrum	1746	26	66	131	155	130	661	481
Banded darter	Etheostoma zonale	12	0	0	0	0	0	2	5
Fantail darter	Etheostoma flabellare	1	0	0	0	0	0	0	1

Table 3. Summary table for annual collections of the individual fish species. Totals in the first column include fish collected from the Downstream Reference site, but the Annual Totals do not.

Discussion:

Phase 1 channel restoration work consisted of widening the existing drainage ditch and flattening the banks. Aquatic vegetation, both introduced and voluntary, has become successfully established throughout the Phase 1 reach to the point that it now resembles a wetland in which the channel is now frequently poorly defined among the heavy growth of vegetation. Constructed riffles were introduced to this reach as well, but the lack of concentrated flows prevents the

development of scour pools. This was by design to acquire flood storage capacity for the overall project site. Phase 1 restoration has not translated to increased species richness, remaining fairly consistent with pre-restoration numbers, although species composition has changed somewhat. This appears to be mostly due to the loss of habitat provided by the deeply undercut banks of the unstable pre-restoration channel. However, fish abundance has increased dramatically at both Phase 1 sites. Fish abundance within the East Branch Downstream Treatment site appears to continue to increase over time. Fish abundance within the West Branch Downstream Treatment site appears to have increased greatly initially and is now showing signs of decreasing to a lower stable level, which is still significantly higher than pre-restoration numbers, as conditions in the new channel mature and aquatic vegetation becomes well established.

In Phase 2, the restored channel is well-defined. The concentrated flows over the constructed riffles have developed and maintained deep scour holes downstream of the riffles. These deep pools have attracted additional resident and visiting fish species to this restored reach, resulting in a six-species increase in the two most recent fall surveys over the maximum recorded number of species in the pre-restoration samples. The Phase 2 restoration work has also resulted in significantly higher fish abundance numbers, orders of magnitude higher than pre-restoration numbers.

Phase 3 restoration work consisted of the implementation of the two stage ditch design with the introduction of constructed riffles. Post-restoration results are still rather preliminary with only one season of post-restoration sampling completed. Results to date have produced a modest increase of one species over the highest number recorded from pre-restoration samples. Fish abundance within the West Branch Upstream Treatment site declined initially after the channel work and is now showing signs of rebounding. I believe it is still too early to tell where numbers will stabilize for this reach.

Also showing indications of promise, are the results collected from the Downstream Reference site. This site was surveyed in 2007 prior to upstream restoration work and again in 2011 following the Phase 3 restoration work. Species abundance within that sampling reach increased by five species, from 18 to 23, in that time period. Fish abundance increased comparably by 84.6% over the pre-restoration sample. These results indicate benefits stemming from the restoration work that transcend the boundaries of the project site.

As the fisheries response to the various restoration practices implemented within this project site has not been consistent, individual species' response has also not been consistent. Several species have responded spectacularly to the restoration work, increasing their numbers significantly, indicating higher rates of production and survival for these species. 2011 totals show significant increases in population numbers over the highest recorded pre-restoration samples for the following species: creek chub (179.5%), hornyhead chub (136.1%), central stoneroller (100.2%), bluntnose minnow (32.0%), bigmouth shiner (5585%), sand shiner (431.4%), white sucker

(89.8%), yellow bullhead (72.2%), blackstripe topminnow (9400%), green sunfish (371.0%), bluegill (516.7%), johnny darter (267.2%), and banded darter (500%).

Fish species that have shown up for the first time in collection samples following restoration work include gizzard shad, spotfin shiner, fathead minnow, quillback, brook silversides, black crappie, redear sunfish, banded darter, and fantail darter. Most of these appear to be temporary visitors to the project site, depending on water levels, and have not taken up permanent residence. However, the banded darter has begun to show up consistently. Spotfin shiners and the fantail darter appeared in the most recent samples, and it is yet to be seen if they will establish resident populations.

Fish species demonstrating inconsistent results, but averaging higher than pre-restoration numbers, are common carp (31.2%), largescale stonerollers (2300%), northern hogsucker (125%), black bullhead (125%), and largemouth bass (975%). These species have yet to establish permanent residence within the restoration project site.

Fish species that the restoration work appears to have had little to no impact on their consistent collection numbers are striped shiner, redfin shiner, red shiner, golden redhorse, rock bass, and blackside darter. The stonecat has been collected from the Downstream Reference site, but it has not been collected from within the restoration project site boundaries yet.

Overall, the response of the fish population has been impressively positive. Continued monitoring at this site will further track the ongoing changes in the fish population. The project will also serve as a model learning tool that will help guide potential stream restoration work and expected fisheries response in comparable situations in other locations.

Appendix A. Fish collection data.

East Branch Downstream Treatment

Water body		TOTALS	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.
Date			2005MAY27	2006JUN20	2007JUN26	2007SEP04	2008JUN23	2008OCT01	2009JUL02	2009OCT29	2010JUN18	2010OCT15
Station code			EIE-18	EIE-18	EIE-18	EIE-18	EIE-18	EIE-18	EIE-18	EIE-18	EIE-18	EIE-18
Species			15	14	19	17	17	17	15	17	17	15
Total fish		31868	288	371	561	1426	186	129	741	501	346	1185
Electrode minutes		1986.8	40	18	24	36	16.8	19.2	30.33	20	20	27
Gizzard shad	Dorosoma cepedianum	11						11				
Carp	Cyprinus carpio	28			6					1	4	
Creek chub	Semotilus atromaculatus	5237	17	32	25	110	17	2	39	17	49	48
Hornyhead chub	Nocomis biguttatus	2036	16	58	18	56	9	2	68	12	25	168
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4										1
Central stoneroller	Campostoma anomalum	6546	53	55	65	243	26	5	346	23	113	330
Largescale stoneroller	Campostoma oligolepis	27						1	5	6		1
Striped shiner	Luxilus chrysocephalus	3906	46	79	172	371	54	12	55	78	37	236
Redfin shiner	Lythrurus umbratilus	170	2	7	22	8	9	1	11			
Spotfin shiner	Cyprinella spiloptera	8										
Red shiner	Cyprinella lutrensis	39		4	1			1				
Fathead minnow	Pimephales promelas	1										
Bluntnose minnow	Pimephales notatus	3665	87	94	178	474	24	10	73	129	17	26
Bigmouth shiner	Notropis dorsalis	3716			1	8	3	7	98	114	19	5
Sand shiner	Notropis ludibundus	1363	1	7	12	48	10	26	13	80	32	
Quillback	Carpiodes cyprinus	4										
White sucker	Catostomus commersoni	997	32	20	14	56	4	22	1	21	10	31
Northern hog sucker	Hypentelium nigricans	39				3	1	1	3		1	
Golden redhorse	Moxostoma erythrurum	12			4		2	1				
Yellow bullhead	Ameiurus natalis	126	3	3	2	3	1		2	1	2	23
Black bullhead	Ameiurus melas	4	1							1		
Stonecat	Noturus flavus	1										
Blackstripe topminnow	Fundulus notatus	366				3	2			2	3	21
Brook silverside	Labidesthes sicculus	6										
Black crappie	Pomoxis nigromaculatus	1										
Rock bass	Ambloplites rupestris	71	7	3	3	6	6		1	1	2	
Largemouth bass	Micropterus salmoides	53	2		1			5				21
Green sunfish	Lepomis cyanellus	1465	12	2	18	26	10	18	14	11	22	208
Bluegill	Lepomis macrochirus	180	2	1	1	2	1	4		1	3	34
Redear sunfish	Lepomis microlophus	1										
Blackside darter	Percina maculata	26			1	2						
Johnny darter	Etheostoma nigrum	1746	7	6	17	7	7		12	3	6	31
Banded darter	Etheostoma zonale	12									1	1
Fantail darter	Etheostoma flabellare	1										

East Branch Upstream Treatment

Water body		TOTALS	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.
Date			2006JUN19	2007JUN25	2007SEP04	2008JUN23	2008OCT01	2009JUL02	2009OCT29	2010JUL02	2010OCT15	2011JUN23
Station code			EIE-19	EIE-19	EIE-19	EIE-19	EIE-19	EIE-19	EIE-19	EIE-19	EIE-19	EIE-19
Species			10	12	12	14	13	14	10	16	20	14
Total fish		31868	252	394	493	304	230	149	56	717	822	428
Electrode minutes		1986.8	35	44	34	32.8	43.9	32	22.6	75.08	24	28
Gizzard shad	Dorosoma cepedianum	11										
Carp	Cyprinus carpio	28							1	6	2	
Creek chub	Semotilus atromaculatus	5237	66	42	40	35	11	9	1	127	53	95
Hornyhead chub	Nocomis biguttatus	2036	21	37	61	45	32	28	6	28	28	20
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4			2			1				
Central stoneroller	Campostoma anomalum	6546	30	142	180	17	63	9	26	44	163	16
Largescale stoneroller	Campostoma oligolepis	27					5				1	
Striped shiner	Luxilus chrysocephalus	3906	106	80	106	144	59	52	8	37	107	47
Redfin shiner	Lythrurus umbratilus	170	6	4		1	1	1		10	18	11
Spotfin shiner	Cyprinella spiloptera	8										
Red shiner	Cyprinella lutrensis	39				1	1					
Fathead minnow	Pimephales promelas	1									1	
Bluntnose minnow	Pimephales notatus	3665	10	30	42	13	21	7		78	140	89
Bigmouth shiner	Notropis dorsalis	3716			1					56	13	11
Sand shiner	Notropis ludibundus	1363			2	5	3		1	17	8	8
Quillback	Carpiodes cyprinus	4										
White sucker	Catostomus commersoni	997	5	23	11	24	15	6	1	71	73	34
Northern hog sucker	Hypentelium nigricans	39						1				
Golden redhorse	Moxostoma erythrurum	12										
Yellow bullhead	Ameiurus natalis	126		6	1	3	6	4	3	2	2	
Black bullhead	Ameiurus melas	4								1	1	
Stonecat	Noturus flavus	1										
Blackstripe topminnow	Fundulus notatus	366				1					8	10
Brook silverside	Labidesthes sicculus	6									4	
Black crappie	Pomoxis nigromaculatus	1						1				
Rock bass	Ambloplites rupestris	71	1	2	3	6		1		6		3
Largemouth bass	Micropterus salmoides	53									2	
Green sunfish	Lepomis cyanellus	1465	2	18	20	7	2	26	8	63	131	66
Bluegill	Lepomis macrochirus	180						2		8	64	4
Redear sunfish	Lepomis microlophus	1										
Blackside darter	Percina maculata	26		1								
Johnny darter	Etheostoma nigrum	1746	5	9	24	2	11	1	1	163	3	14
Banded darter	Etheostoma zonale	12										
Fantail darter	Etheostoma flabellare	1										

East Branch Upstream Control

Water body		TOTALS	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.	Kickapoo Cr.
Date			2006JUN19	2007JUN26	2007SEP04	2008JUN23	2008SEP30	2009JUL07	2009OCT07	2010JUL02	2010OCT06	2011JUN24
Station code			EIE-20	EIE-20	EIE-20	EIE-20	EIE-20	EIE-20	EIE-20	EIE-20	EIE-20	EIE-20
Species			8	9	8	8	12	8	6	7	7	9
Total fish		31868	192	121	131	131	639	189	168	217	332	151
Electrode minutes		1986.8	27	29	17	28.2	37.1	35	37.5	42.17	32	29
Gizzard shad	Dorosoma cepedianum	11										
Carp	Cyprinus carpio	28										
Creek chub	Semotilus atromaculatus	5237	45	37	26	40	134	57	90	118	123	53
Hornyhead chub	Nocomis biguttatus	2036	12	13	20	12	111	24	17	18	45	17
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4										
Central stoneroller	Campostoma anomalum	6546	47	23	47	28	259	66	44	32	64	49
Largescale stoneroller	Campostoma oligolepis	27					4					
Striped shiner	Luxilus chrysocephalus	3906	40	27	14	29	28	11	14	22	30	5
Redfin shiner	Lythrurus umbratilus	170										
Spotfin shiner	Cyprinella spiloptera	8										
Red shiner	Cyprinella lutrensis	39										
Fathead minnow	Pimephales promelas	1										
Bluntnose minnow	Pimephales notatus	3665		5	4	2	16	2	1	4		1
Bigmouth shiner	Notropis dorsalis	3716	1							2	1	
Sand shiner	Notropis ludibundus	1363					1					
Quillback	Carpiodes cyprinus	4										
White sucker	Catostomus commersoni	997	3	5	9	8	15	3			9	2
Northern hog sucker	Hypentelium nigricans	39										
Golden redhorse	Moxostoma erythrurum	12										
Yellow bullhead	Ameiurus natalis	126	1									
Black bullhead	Ameiurus melas	4										
Stonecat	Noturus flavus	1										
Blackstripe topminnow	Fundulus notatus	366										
Brook silverside	Labidesthes sicculus	6										
Black crappie	Pomoxis nigromaculatus	1										
Rock bass	Ambloplites rupestris	71										
Largemouth bass	Micropterus salmoides	53					3					
Green sunfish	Lepomis cyanellus	1465		1		3	2	1				3
Bluegill	Lepomis macrochirus	180										
Redear sunfish	Lepomis microlophus	1										
Blackside darter	Percina maculata	26		1	2		1					2
Johnny darter	Etheostoma nigrum	1746	43	9	9	9	65	25	2	21	60	19
Banded darter	Etheostoma zonale	12										
Fantail darter	Etheostoma flabellare	1										

West Branch Downstream Treatment

Water body		TOTALS	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT
Date			2005MAY27	2006JUN20	2007JUN26	2008JUN23	2008OCT01	2009JUL02	2009OCT29	2010JUN18
Station code			EIEM-01	EIEM-01	EIEM-01	EIEM-01	EIEM-01	EIEM-01	EIEM-01	EIEM-01
Species			10	13	14	12	14	8	11	11
Total fish		31868	239	222	182	127	221	247	1638	861
Electrode minutes		1986.8	25	14	19	18.7	12.8	23.5	22.2	15
Gizzard shad	Dorosoma cepedianum	11								
Carp	Cyprinus carpio	28		2						
Creek chub	Semotilus atromaculatus	5237	51	33	18	29	5	31	59	148
Hornyhead chub	Nocomis biguttatus	2036	25	15	5	9	6		29	6
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4								
Central stoneroller	Campostoma anomalum	6546	66	17	16	6	56	81	136	148
Largescale stoneroller	Campostoma oligolepis	27			1		1			
Striped shiner	Luxilus chrysocephalus	3906	54	88	42	22	30		91	4
Redfin shiner	Lythrurus umbratilus	170			2					
Spotfin shiner	Cyprinella spiloptera	8								
Red shiner	Cyprinella lutrensis	39					2			
Fathead minnow	Pimephales promelas	1								
Bluntnose minnow	Pimephales notatus	3665	15	28	47	10	12	19	182	57
Bigmouth shiner	Notropis dorsalis	3716		14	5	3	2	61	875	392
Sand shiner	Notropis ludibundus	1363		7	7	4	26	33	247	60
Quillback	Carpiodes cyprinus	4						3	1	
White sucker	Catostomus commersoni	997	1	5	15	7	25			8
Northern hog sucker	Hypentelium nigricans	39								
Golden redhorse	Moxostoma erythrurum	12								
Yellow bullhead	Ameiurus natalis	126	5		2					
Black bullhead	Ameiurus melas	4								
Stonecat	Noturus flavus	1								
Blackstripe topminnow	Fundulus notatus	366							2	
Brook silverside	Labidesthes sicculus	6								
Black crappie	Pomoxis nigromaculatus	1								
Rock bass	Ambloplites rupestris	71	2		2	2				
Largemouth bass	Micropterus salmoides	53					3			
Green sunfish	Lepomis cyanellus	1465		3	9	21	47	12	4	18
Bluegill	Lepomis macrochirus	180	1	5		2	5			1
Redear sunfish	Lepomis microlophus	1								
Blackside darter	Percina maculata	26		1						
Johnny darter	Etheostoma nigrum	1746	19	4	11	12	1	7	12	19
Banded darter	Etheostoma zonale	12								
Fantail darter	Etheostoma flabellare	1								

West Branch Upstream Treatment

Water body		TOTALS	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT
Date			2006JUN20	2007JUN26	2007SEP05	2008JUN23	2008SEP30	2009JUL02	2009OCT07	2010JUN17
Station code			EIEM-02	EIEM-02	EIEM-02	EIEM-02	EIEM-02	EIEM-02	EIEM-02	EIEM-02
Species			7	9	10	9	10	5	10	7
Total fish		31868	71	280	114	140	140	73	764	55
Electrode minutes		1986.8	14	39	33	30	33.1	22.66	53.5	38.33
Gizzard shad	Dorosoma cepedianum	11								
Carp	Cyprinus carpio	28								
Creek chub	Semotilus atromaculatus	5237	19	92	43	44	64	34	253	33
Hornyhead chub	Nocomis biguttatus	2036	9	31	6	17	4		21	
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4								
Central stoneroller	Campostoma anomalum	6546	23	61	28	28	15	6	379	5
Largescale stoneroller	Campostoma oligolepis	27								
Striped shiner	Luxilus chrysocephalus	3906	9	62	20	19	7	4	7	4
Redfin shiner	Lythrurus umbratilus	170			1					
Spotfin shiner	Cyprinella spiloptera	8								
Red shiner	Cyprinella lutrensis	39								
Fathead minnow	Pimephales promelas	1								
Bluntnose minnow	Pimephales notatus	3665	2	15	8	6	9		6	3
Bigmouth shiner	Notropis dorsalis	3716			3		1		70	1
Sand shiner	Notropis ludibundus	1363		1					2	
Quillback	Carpiodes cyprinus	4								
White sucker	Catostomus commersoni	997	3	4		11	3			
Northern hog sucker	Hypentelium nigricans	39								
Golden redhorse	Moxostoma erythrurum	12								
Yellow bullhead	Ameiurus natalis	126		1	2	1				
Black bullhead	Ameiurus melas	4								
Stonecat	Noturus flavus	1								
Blackstripe topminnow	Fundulus notatus	366							1	
Brook silverside	Labidesthes sicculus	6								
Black crappie	Pomoxis nigromaculatus	1								
Rock bass	Ambloplites rupestris	71								
Largemouth bass	Micropterus salmoides	53					2			
Green sunfish	Lepomis cyanellus	1465			1	3	18	14	15	8
Bluegill	Lepomis macrochirus	180								
Redear sunfish	Lepomis microlophus	1								
Blackside darter	Percina maculata	26								
Johnny darter	Etheostoma nigrum	1746	6	13	2	11	17	15	10	1
Banded darter	Etheostoma zonale	12								
Fantail darter	Etheostoma flabellare	1								

West Branch Upstream Control

Water body		TOTALS	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT	Kickapoo Cr. UT
Date			2006JUN19	2007JUN25	2007SEP05	2008JUN23	2008SEP23	2009JUL02	2009OCT06	2010JUN17
Station code			EIEM-03	EIEM-03	EIEM-03	EIEM-03	EIEM-03	EIEM-03	EIEM-03	EIEM-03
Species			8	8	6	8	11	8	7	5
Total fish		31868	69	104	41	42	79	100	330	29
Electrode minutes		1986.8	20	21	21	16	30	24	36	32.33
Gizzard shad	Dorosoma cepedianum	11								
Carp	Cyprinus carpio	28								
Creek chub	Semotilus atromaculatus	5237	26	19	12	13	23	36	227	8
Hornyhead chub	Nocomis biguttatus	2036	3	12	7	1	2			
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4								
Central stoneroller	Campostoma anomalum	6546	22	13	1	4	18	7	9	
Largescale stoneroller	Campostoma oligolepis	27								
Striped shiner	Luxilus chrysocephalus	3906	13	20	4	3	5	6		
Redfin shiner	Lythrurus umbratilus	170						2		
Spotfin shiner	Cyprinella spiloptera	8								
Red shiner	Cyprinella lutrensis	39	1							
Fathead minnow	Pimephales promelas	1								
Bluntnose minnow	Pimephales notatus	3665	1	20	4	9	4	19	17	6
Bigmouth shiner	Notropis dorsalis	3716		2			1		18	
Sand shiner	Notropis ludibundus	1363							3	
Quillback	Carpiodes cyprinus	4								
White sucker	Catostomus commersoni	997				1	1	1		1
Northern hog sucker	Hypentelium nigricans	39								
Golden redhorse	Moxostoma erythrurum	12								
Yellow bullhead	Ameiurus natalis	126		1			2			
Black bullhead	Ameiurus melas	4								
Stonecat	Noturus flavus	1								
Blackstripe topminnow	Fundulus notatus	366								
Brook silverside	Labidesthes sicculus	6								
Black crappie	Pomoxis nigromaculatus	1								
Rock bass	Ambloplites rupestris	71								
Largemouth bass	Micropterus salmoides	53					1			
Green sunfish	Lepomis cyanellus	1465	1			4	9	11	32	8
Bluegill	Lepomis macrochirus	180								
Redear sunfish	Lepomis microlophus	1								
Blackside darter	Percina maculata	26								
Johnny darter	Etheostoma nigrum	1746	2	17	13	7	13	18	24	6
Banded darter	Etheostoma zonale	12								
Fantail darter	Etheostoma flabellare	1								

Downstream Reference

Water body		TOTALS	Kickapoo Cr.	Kickapoo Cr.
Date			2007JUN25	2011JUL19
Station code			EIE-22	EIE-22
Species			18	23
Total fish		31868	931	1719
Electrode minutes		1986.8	32	31
Gizzard shad	Dorosoma cepedianum	11		
Carp	Cyprinus carpio	28	6	
Creek chub	Semotilus atromaculatus	5237	26	174
Hornyhead chub	Nocomis biguttatus	2036	81	97
Hornyhead chub x Striped shiner hybrid	N. biguttatus x L. chrysocephalus	4		
Central stoneroller	Campostoma anomalum	6546	246	340
Largescale stoneroller	Campostoma oligolepis	27		2
Striped shiner	Luxilus chrysocephalus	3906	170	280
Redfin shiner	Lythrurus umbratilus	170	20	14
Spotfin shiner	Cyprinella spiloptera	8		
Red shiner	Cyprinella lutrensis	39	7	19
Fathead minnow	Pimephales promelas	1		
Bluntnose minnow	Pimephales notatus	3665	162	296
Bigmouth shiner	Notropis dorsalis	3716	12	54
Sand shiner	Notropis ludibundus	1363	85	218
Quillback	Carpiodes cyprinus	4		
White sucker	Catostomus commersoni	997	24	47
Northern hog sucker	Hypentelium nigricans	39	14	13
Golden redhorse	Moxostoma erythrurum	12	1	2
Yellow bullhead	Ameiurus natalis	126	8	4
Black bullhead	Ameiurus melas	4		
Stonecat	Noturus flavus	1		1
Blackstripe topminnow	Fundulus notatus	366		18
Brook silverside	Labidesthes sicculus	6		2
Black crappie	Pomoxis nigromaculatus	1		
Rock bass	Ambloplites rupestris	71	8	
Largemouth bass	Micropterus salmoides	53		7
Green sunfish	Lepomis cyanellus	1465	38	37
Bluegill	Lepomis macrochirus	180		5
Redear sunfish	Lepomis microlophus	1		
Blackside darter	Percina maculata	26	4	7
Johnny darter	Etheostoma nigrum	1746	19	77
Banded darter	Etheostoma zonale	12		5
Fantail darter	Etheostoma flabellare	1		