US Army Corps of Engineers
Louisville District

Banklick Creek Watershed

Kenton County, Kentucky
Flood Damage Reduction / Ecosystem Restoration
Section 905(b) (WRDA 1986) Analysis

September, 2000

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT
600 Dr. Martin Luther King, Jr. Place
Louisville, KY 40201-0059

TABLE OF CONTENTS

1. STUDY AUTHORITY

Authorization for this study is contained in a resolution resolved by the Committee on Environment and Public Works of the United States Senate for the Metropolitan Area of Cincinnati, Ohio dated 17 December 1987.

This study was initiated pursuant to the provision of funds and authorization by the Energy and Water Development Appropriation Act of 2000 (P.L. 106-60).

"The recommendation includes funding for a reconnaissance study of solutions to flooding and related water resource problems along the Banklick Creek, Kenton County, Kentucky."

2. STUDY PURPOSE

The purpose of this analysis is to examine flood damages and ecosystem restoration opportunities along Banklick Creek in Kenton County, Kentucky, while utilizing existing, readily available data and professional and technical judgement to evaluate project alternatives and determine if there is a need for a Federal flood damage reduction project and/or ecosystem restoration project, develop a Project Study Plan to conduct further feasibility studies, and identify a local sponsor to cost share the feasibility study.

3. LOCATION OF PROJECT / CONGRESSIONAL DISTRICT

The Banklick Creek watershed is located primarily in Kenton County, Kentucky. The official county seat is Independence, Kentucky.

Kenton County is located in northern Kentucky and is part of the metropolitan area immediately south of Cincinnati, Ohio. Kenton County is bordered on the east by Campbell County, on the west by Boone County, on the south by Grant and Pendleton Counties, and on the north by the State of Ohio. The Ohio River forms the northern boundary and the Licking River forms the eastern boundary. Banklick Creek enters the Licking River approximately 4.6 miles upstream of the Ohio River in northern Kentucky. The creek extends 18.9 miles in a southwestwardly direction to its headwaters near the Village of Walton in Kenton County. Affected communities include but are not limited to the following: Covington, Fort Wright, Fort Mitchell, Edgewood, Erlanger, Florence, and Independence, Kentucky.

The entire study area lies within Kentucky Congressional District 4. Kenton County has a population of approximately 149,000. Section 14 (Figure 29, page 41) of this report contains a general location and vicinity map of the study area. Figure 1 (below) is a vicinity map of Northern Kentucky.

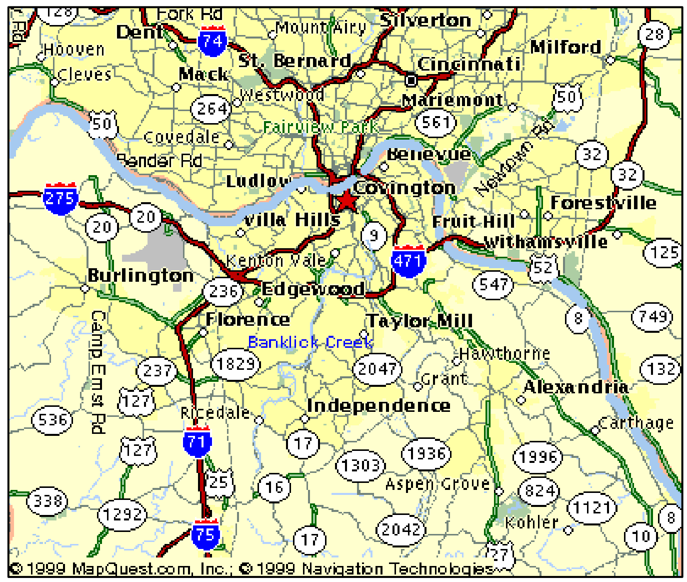

Figure 1: Vicinty Map (Northern Kentucky)

4. DISCUSSION ON PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

4.a Prior Studies

1) U.S. Department of Agriculture Soil Conservation Service - 1971 Banklick Creek Watershed Work Plan

This Study was sponsored by the Boone and Kenton County Soil and Water Conservation Districts and the Kenton County Fiscal Court with technical assistance provided by the SCS (now NRCS), Forest Service and Kentucky Division of Forestry.

Planned improvements included land treatment measures to reduce sediment load to the streams in conjunction with one floodwater retarding structure and three multiple purpose reservoir structures providing flood damage reduction along with recreation and fish and wildlife enhancement.

The four floodwater retarding structures would have controlled runoff from 40 percent of the watershed. The estimated cost of the retarding structures and land treatment measures was $4,930,200. The benefit-cost ratio for these measures was 1.3:1.

Figure 2: Dam # 3 on Bullock Pen Creek

One of the recommended structures, Dam No. 3, on Bullock Pen Creek has been constructed (shown in Figure 2).

2) Federal Emergency Management Agency Flood Insurance Study City of Independence, Kentucky March, 1980

This report provided flood frequency information and flood profiles for portions of Banklick Creek, Fowler Creek and Brushy Fork in Independence, Kentucky.

The report states that the maximum flood of record occurred on July 15, 1962 as a result of 7 to 7.7 inches of rainfall, much of which occurred in a 30-minute period. It suggested that "Many houses in the basin were damaged, and several were destroyed, however, no lives were lost."

The report also noted "Severe flooding along Fowler Creek upstream from McCullum Pike inundates Oliver Road and some buildings along the banks of the stream."

3) Federal Emergency Management Agency Flood Insurance Study Kenton County, Kentucky January 2, 1981

This report also describes the July, 1962 flood on Banklick and notes that one life was lost as a result of the high water.

The report mentions that SCS Reservoir site No. 3 on Bullock Pen Creek was under construction and was expected to be completed in 1982.

4) Louisville District Corps of Engineers Reconnaissance Report Covington–Rosedale, Kentucky February 1982

This study was initiated as a result of the desire of local interests for flood protection in this area.

Total damages were estimated to be $2,939,000 for the 1% (100-year flood) chance exceedance flood, hereinafter referred to as the 1% flood.

Several alternatives were evaluated including levees, flood walls and three combinations of trailer/home buy-outs.

Apparently, as a result of this study, 36 trailer homes near Interstate 275 were removed from the floodplain.

5) Federal Emergency Management Agency Flood Insurance Study City of Covington, Kentucky June 16, 1993

This report noted that "The floodplain of Banklick Creek underwent development and some channel realignment in the 1980's."

The report suggested that the 7.5 inch rainfall event that occurred July 15, 1962 has an estimated recurrence interval of 200 years.

The hydrologic analysis for this study predicted significantly higher estimated flows for Banklick Creek than prior reports.

6) Federal Emergency Management Agency Flood Insurance Study City of Fort Wright, Kentucky June 16, 1993

This report noted that the backwater from the January, 1937 flood on the Ohio River produced a flood elevation of 511.0 at the mouth of Banklick Creek. It also provides frequency data and flood profiles for Banklick Creek, Horse Branch and several smaller tributaries.

7) Louisville District
Corps of Engineers
Interim Letter Report
Metropolitan Region of Cincinnati - Northern Kentucky Area
February 1995

This report was the result of a 1987 Senate resolution calling for an evaluation of additional improvements for flood control and allied purposes in the Metropolitan region of Cincinnati.

The letter report suggests that the 1937 flood on the Ohio River was estimated to exceed a 0.2% flood (500-year) event. It notes that there was major headwater flooding along Banklick Creek in 1962, 1967 and 1979.

The report states that there are 130 structures in the 1% floodplain with a total value of $3,425,000 and estimated damages from a 1% frequency flood of $1,514,000.

The report recommends that "nonstructural solutions, such as flood proofing, should be evaluated for economic feasibility and local sponsor acceptance."

8) Louisville District
Corps of Engineers
Metropolitan Region of Cincinnati-
Northern Kentucky Area
Reconnaissance Report
September, 1996

This study was initiated as a result of the same authorization noted in (7). Funding was provided in the 1994 Water Resources Development Act. The study focused on five problem areas that include Ohio River flooding problems in Silver Grove, Gunpowder Creek watershed flooding, flooding and erosion problems from the Ohio River in vicinity of Rabbit Hash, flooding problems with various bridges in Campbell County, and flooding on Banklick Creek near the Licking River. The Banklick Creek flood damage reduction alternative considered only the permanent relocation of a mobile home park and 22 nearby residential structures at the mouth of Banklick Creek. The mobile homes and residential structures are impacted by backwater from the Ohio River. The total cost of relocation was estimated to be $3.3 million. Annual costs for the relocation plan were estimated to be $250,000. Annual benefits were estimated to be $50,000. The benefit–cost ratio for the plan was 0.2:1. As a result, the report notes that the plan was "economically infeasible by a wide margin."

Apparently, as a result of this report, the mobile homes have subsequently been elevated above most major flood levels (shown in Figure 3).

Figure 3: Elevated Mobile Homes

9) James Berling P.E., R.L.S.
Banklick Creek Dam(s)
June, 1998 – August, 1999

Mr. Berling has provided two letter reports to the Kenton County Fiscal Court describing two possible flood damage reduction proposals.

The first alternative suggested by Mr. Berling would involve a 75-foot high dam on Banklick Creek, 2 miles upstream from the intersection of KY 17 and Wayman Branch Road. The structure would control 21.6 square miles of the 58.3 square mile watershed. Model results performed as part of this study suggest nearly a 50 percent reduction in peak flows for the 1% flood downstream from the site. Estimated costs for this alternative exceed $20,000,000.

A second alternative was proposed, which included 29 small detention structures in the Banklick and Fowler Creek watersheds. Many of these were located near the watershed boundary. The average height was estimated to be 40 feet, with an estimated construction cost of $300,000 per structure.

10) Residents of the Area
The Blue Book
Banklick Creek Flooded Residents

This report, prepared by the local residents in the floodplain, was submitted to Fiscal Court Judge Murgatroyd. The report provides first hand accounts of flooding conditions through interviews with local residents. It provides very valuable information on flooding conditions in 1996, 1997 and 1998.

In addition, the report details the amount of damage sustained to some of the properties and provides map sketches of where many of the people who have experienced significant flooding reside. It also lists streets experiencing flooding problems.

The Blue Book authors interviewed their neighbors and asked them if they would consider a "buy-out" to remove their house from the floodplain. Of the 68 residents contacted, 40 indicated they would be interested in a buy-out, 12 were not and 16 were unsure. Three-fourths of those indicating willingness to a buy-out were concerned with replacement with an "equivalent" structure.

4.b Existing Projects

The Corps of Engineers has completed several water resources projects in the Licking River Watershed and along the main stem Ohio River, including the:

<u>Covington Local Protection Project</u> which includes 1.8 miles of earthen levees, 1.1 miles of concrete wall, 10 pumping stations and 8 traffic closures is shown in Figures 4 and 5. The project was completed in 1965 and protects approximately 400 acres.

Figure 4: Traffic Closures

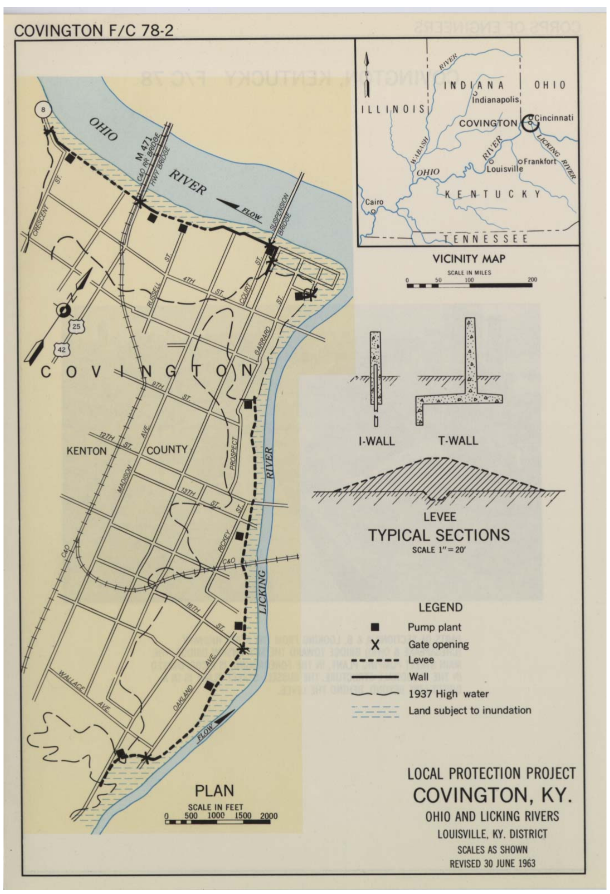

Figure 5: Flood Protection Project

<u>Doe Run Lake (Dam No. 3)</u> was constructed by the U.S. Soil Conservation Service on Bullock Pen Creek, a Banklick Creek tributary, to reduce flood peaks downstream of this facility (See Figure 6.) Total storage capacity is approximately 2500 acre-feet.

Figure 6: Doe Run Lake (Dam No, 3)

5. PLAN FORMULATION

5.a Identified Problems

5.a.1 Existing Conditions

The Banklick Creek Watershed lies in Kenton and Boone County, Kentucky, and has a drainage area of 58.3 square miles. Figure 7 is a map of the watershed with the primary damage areas noted.

Banklick Creek enters the Licking River at River Mile 4.6. The creek extends 18.9 miles in a southwestwardly direction to its headwaters near the Village of Walton in Kenton County.

The topography of the region is characterized by steep slopes and high ridges. As a result, early road and railroad construction followed either the stream channels along the valley bottoms or the ridgelines. As these transportation corridors have developed, residential construction followed, locating many of the early building sites in the bottom of the stream valleys, and in some cases, within the floodplain.

Because of the slope, the railroad right-of-way also followed the stream valleys. The CSX Railroad tracks follow Banklick Creek for almost the entire length of the watershed. The location of this rail line, its need for moderate slopes, and the tremendous cost of relocation of the railroad tracks virtually precludes any suggestion of reservoir construction along the main stem of Banklick Creek.

One of the predominant features within the Banklick Creek watershed is the steepness of slope associated with the adjoining hillsides and tributary streams. Slopes in excess of 100 feet per mile are not uncommon for many of these tributaries.

Recent development in the watershed has been primarily along the ridgelines and hillsides well above the floodplain. A substantial portion of this development occurred prior to any detention basin regulations by local governments. Recent newspaper accounts suggest that more than 3,000 residential units were constructed in the watershed between 1990 and 1995.

Therefore, three primary factors have contributed to flood damages in the watershed, these being:

1. The early development, which occurred along the stream channels.
2. The extremely steep slopes of Banklick Creek and its tributaries.
3. Extraordinary recent development along the watershed's ridgelines and hillsides.

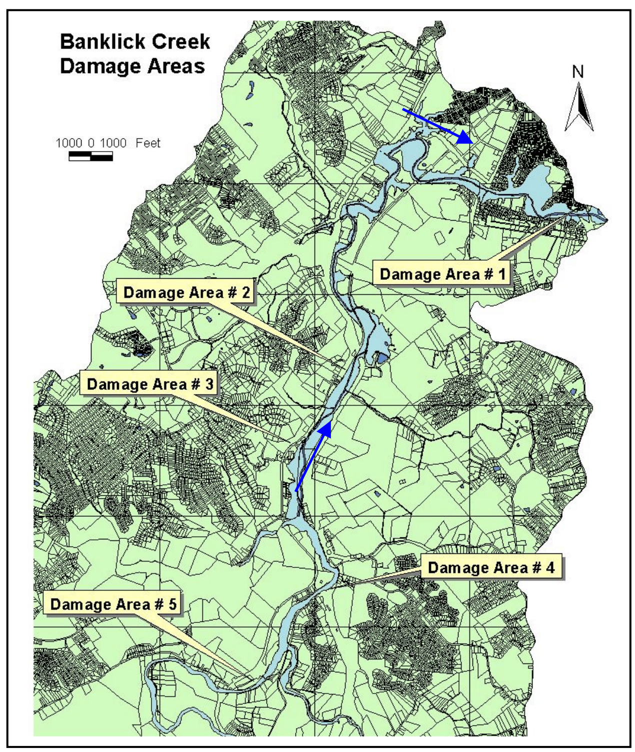

Figure 7: Damage Areas

Based upon a review of available reports, newspaper articles and resident observation, five primary damage areas have been identified along Banklick Creek:

1. Area 1 (DMA#1, Stream mile 0-5.0) is located between the CSX Railroad near the mouth of Banklick Creek and Interstate 275 (I-275), and includes residential properties along Church Street and Grand Avenue. It does not include properties downstream from the CSX Railroad line as these are only subject to backwater flooding from the Ohio River.
2. Area 2 (DMA#2, Stream mile 5.0-5.4) is located along Old Madison Pike between SR 17 and the Railroad underpass.
3. Area 3 (DMA#3, Stream mile 5.4-6.7) is located along Old Madison Pike between the Railroad underpass and Bullock Pen Road.
4. Area 4 (DMA#4, Stream mile 6.7-7.7) continues along Banklick Creek from Bullock Pen Road to Richardson Road. This would also include damage areas along Holds Branch.
5. Area 5 (DMA#5, Stream mile 7.7-10.3) continues upstream along Richardson, Crowe and North Webster Roads.

Flood damages were identified for each of the damage areas by utilizing data from the Geographic Information System (GIS) developed by the Northern Kentucky Area Planning Commission.

This data was complimented with property values obtained from Kenton County. The available GIS data, including two-foot contour topographic mapping, was only available for the northern portion of the watershed. The watershed south of the confluence of Bullock Pen Branch with Banklick Creek was evaluated based on existing USGS quadrangle maps (1:24,000 scale.

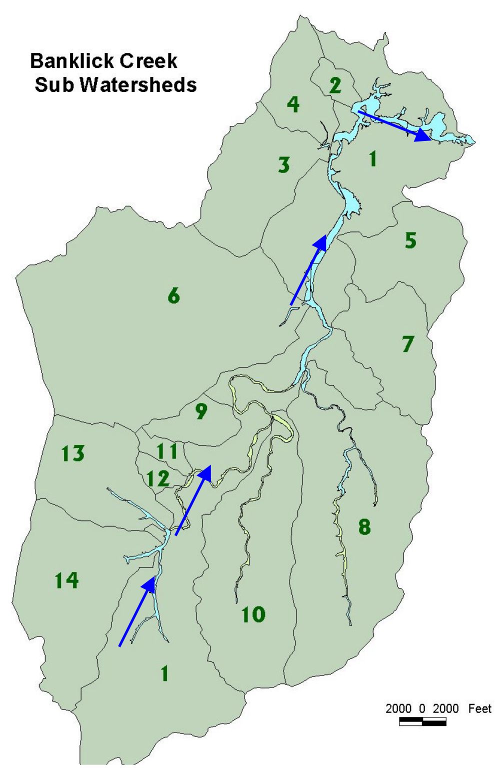

Figure 8: Subwatersheds of Banklick Creek

As described earlier, Flood Insurance Studies were available for Covington, Ft. Wright and Kenton County, which typically included computed profiles for the (10%, 2%, 1%, and 0.2%) frequency flood events. These were supplemented with existing HEC-2 results to estimate flood elevations in damage areas. Due to time and cost restrictions governing this analysis, the existing HEC-2 model was not updated to incorporate the vast amount of changes in this watershed.

Available reports indicate that serious flooding occurred in 1962, 1967 and 1979. More recently, damaging floods and evacuations were reported in 1991, 1992, 1995 and 1996.

The flood of record for this watershed was the July 1962 high water that produced substantial damages to private and public property and resulted in one reported death.

A total development value of over $3,000,000 is estimated for the 95 structures that were inventoried in the floodplain. A recurrence of the 1% flood would cause flood damages of approximately $557,000 (nonresidential) and $869,000 (residential) for a total of nearly $1,500,000.

The existing condition of the ecosystem is as follows. Banklick creek is impaired and does not meet aquatic life and swimmable criteria. Bank erosion has resulted in little bank vegetation and lack of canopy, which in effect has increased water temperatures; thereby, lowering the amount of dissolved oxygen. Bank erosion has also increased bed degradation, turbidity, and sedimentation. Habitat alteration has fragmented the riparian buffer that provides wildlife corridors with forraging opportunities and provides protected acces to water. Degradation of the streambanks has reduced the opportunity for natural filtration of nonpoint source runoff pollution. The existing state of the ecosystem in this watershed is not conducive to the survival, spawning, and prolongation of many bird species, small mammals, and the current fish habitat.

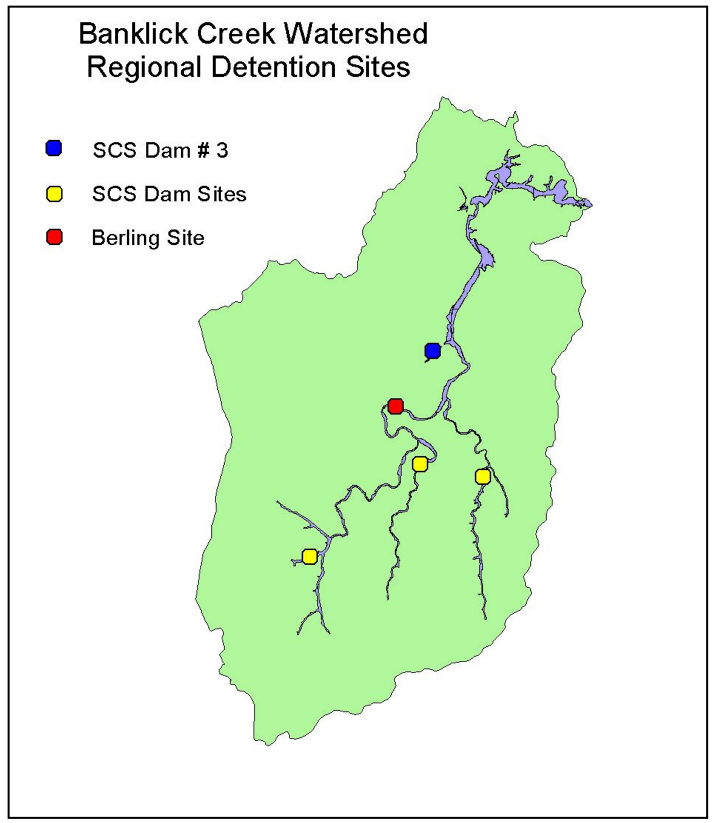

Figure 9: Regional Detention Sites

5.a.2 Expected Future Conditions

Although many local jurisdictions are adopting detention and other stormwater management controls, these often prove to be ineffective without effectual design, experienced technical review, inspection during construction and adequate operation and maintenance. The typical detention basin design deals with maintaining the post-development 10% frequency storm conditions and in many cases are designed utilizing only rudimentary stormwater equations that ignore the relationship between the proposed development and the overall watershed. There is no comprehensive watershed based storm-water management occurring to address Banklick Creek flooding problems. As a result, it can be expected that as further development occurs in the watershed, flood damages for even the smaller storms will increase. Flooding of residential and nonresidential structures will continue and the level of expected annual damages will increase.

Because of the increased and more frequent runoff, stream channels will enlarge increasing erosion of stream banks and deposition of sediments, particularly near the mouth of Banklick Creek where periodic dredging is currently required to maintain navigation. In addition, the bedcutting that is occurring within the stream is causing the channel to become more entrenched. As a result, entrenched channels are inherently unstable and subject to erosion. Without grade control structures to reduce channel bedcutting, the incision of the stream into the valley floor will continue to occur.

The lack of riparian buffers adjacent to the stream will contnue to allow increases in water temperatures and prevents filtering of runoff. Without the benefits of riparian corridor enhancements and introduction of riffle structures, the ecosystem will likely continue to degrade and compromise the remaining wildlife habitat.

5.a.3 Planning Constraints

The CSX Railroad tracks follow Banklick Creek for almost the entire length of the watershed. The location of this rail line and the tremendous cost of relocation of the railroad tracks virtually precludes any suggestion of reservoir construction along the main stem of Banklick Creek. Ohio River Backwater (see Figure 10 on next page) treks nearly 6 miles upstream and hinders an attempt of a channel widening alternative in this area.

5.a.4 Problems and Opportunities

In 1978 FEMA published a FIS for the City of Covington, Fort Wright, and Kenton County. The study, preformed by the USGS, erroneously credited the Corps. Several computational techniques employed were incorrect. As a result the FIS was revised in 1991. This revised version was used in this analysis. Approximately 3,000 residential units were constructed in the watershed between 1990 and 1995. Our professional field evaluation conclusion is that because of the drastric growth in this area and the fact there are approximately 30 structures that are not included in the current hydraulic model, an updated HEC-2 model is prudent. The local sponsor is willing to enter into a cost shared Feasibility study so that we may update this model and more fully comprehend the flooding and degraded ecosystem problems along Banklick Creek. The local sponsor is currently reviewing plans for additional ecosystem restoration type projects within Kenton County. The sponsor's willingness to steward these environmental projects provides many opportunities and benefits for the surrounding communities within Kenton county, Kentucky.

5.b Alternative Plans

Previous studies have evaluated a number of structural alternatives to reduce flood damages. Several of these have been updated and included in the plan formulation process. These include various combinations of reservoirs, along with non-structural measures, such as raise-in-place and evacuation or relocation of structures. In Damage Area 2, removal of an encroachment in the floodplain was reviewed but not evaluated in this analysis.

After several site visits and review of previous reports, local resident's views, and newspaper accounts, it was determined that several alternatives should be considered further.

Regional detention basins were evaluated to assess their impact on current flows, future conditions and sediment reduction. Previous studies had considered a combination of four large basins on tributaries (Figure 9, page 12), a single large site on the main stem of Banklick Creek, and 29 small upland basins.

Previous studies had evaluated other structural measures, such as floodwalls and levees. These had produced benefit/cost ratios far less than 1:1 in prior analyses.

A primary focus of this 905(b) analysis was to evaluate nonstructural measures, such as raise-in-place and permanent evacuation from the floodplain. A database of property ownership, type of structure and tax value for each structure was developed. When combined with depth of flooding data for the 1% flood event, this data could be translated into expected annual flood damages and projected cost to raise-in-place, flood proof or evacuate the structure from the floodplain.

5.b.1 Alternative 1 : Without Project Condition / No Action Plan

The Without Project Condition/No Action Plan is defined as the projected scenario for future land use and related conditions in the study area without a Federal flood damage reduction project. This condition serves as a baseline against which alternative improvements are evaluated. The increment of change between an alternative plan and the Without Project Condition provides the basis for evaluating the beneficial or adverse economic, environmental, and social effects of alternatives. Without a project to alleviate current problems, flooding conditions, ecosystem damage and increased erosion along with corresponding sediment deposition, these conditions can be expected to worsen in the watershed. Repeated flooding and damage to more than 120 buildings during the 1990's illustrates that conditions are worsening.

5.b.2 Alternative 2: Regional Detention

Because of the rapid growth in the Cincinnati metropolitan area, a substantial portion of which is occurring in northern Kentucky and more specifically in Boone, Kenton and Campbell Counties, this watershed will be subjected to continued growth for the foreseeable future. Regional detention structures provide an opportunity to reduce or eliminate current flood damages and provide for future growth. There is a secondary benefit to regional detention as these structures act as sediment traps and thereby reduce downstream sediment load and continued maintenance dredging at the mouth of Banklick Creek, in the Licking River.

Three separate proposals for regional detention were evaluated as part of this 905(b) study. The three detention alternatives are detailed below are entitled SCS Reservoirs, Berling Reservoir, and Berling 29 Reservoirs.

5.b.2.1 SCS Reservoirs

The first of these was the evaluation of the four retarding structures proposed by the Soil Conservation Service (SCS is now NRCS) in the 1971 report. The largest of these, Dam No. 3 on Bullock Pen Creek was completed in 1982. The other three sites were to be located on the primary tributaries of Banklick Creek including Site No. 2 on Fowler Creek, Site No. 8 on Brushy Fork and Site No. 9 on Wolf Pen Branch. These four sites would control almost 50 percent of the contributing drainage area (Figure 9, page 11).

Current GIS mapping does not encompass the area containing the 3 unbuilt SCS Dam Sites. New topographic mapping and land use data is being prepared and will be available by January 2001. The 1987 photorevised U. S. Geological Survey map for Independence, Kentucky was examined and confirmed that these three sites represented the most viable large dam sites in the watershed. Field reconnaissance confirmed that a substantial amount of development has occurred along the rims of the three remaining sites, however, severe encroachment onto the sites does not appear to have occurred. This should be re-evaluated when the new mapping is completed.

The preliminary SCS design for these structures was assumed to be adequate for this study. The SCS had prepared preliminary cost estimates for each structure which were updated to 2000 level costs using the Engineering News Record Construction Cost Index. The current estimated cost is $13,100,000 for the remaining three structures. Because of this estimated cost, this alternative is not recommended for further consideration.

5.b.2.2 Berling Reservoir

The second regional detention reservoir considered was a major structure on the main stem of Banklick Creek proposed by Jim Berling, a local engineer and surveyor. This structure was located approximately two miles upstream from the Richardson Road (Route 1829) Bridge.

This proposed dam site is located at an optimum point with steep narrow valley walls requiring a minimum dam section and maximum dam height. It is also located near the upstream end of the five primary damage areas thus producing maximum benefits. However, this site also has some serious deficiencies including the location of the CSX railroad line just upstream from the proposed dam.

In a meeting with Mr. Berling, he acknowledged that to provide real flood damage reduction for the watershed would also require the construction of a regional basin on Fowler Creek. His estimated cost for the Banklick Creek site alone was in excess of $20 million. Because of the problems described above and the projected cost of this alternative, it is not being recommend for further consideration.

5.b.2.3 Berling 29 Reservoirs

The final regional detention proposal was also suggested by Mr. Berling in a report to the Kenton County Fiscal Court. This plan called for the construction of 29 small detention structures primarily located in the headwaters of Banklick Creek and several of its tributaries including 12 sites in the Fowler Creek watershed.

Mr. Berling suggested that because of their location, these sites could minimize many of the problems associated with larger detention sites in that some could be constructed as part of local development plans. Several are located along the Interstate 75 corridor in areas where large commercial or industrial development is expected in the future. Some of these sites could be incorporated into these development plans.

The report prepared by Mr. Berling's office suggested that these detention structures could be installed for roughly $300,000 per site. Applying this cost to the 29 sites results in an estimated cost of $8,700,000 (excluding LERRDS). Because of the estimated construction costs and potential LERRDS issues, this alternative is not recommended for further consideration.

5.b.3 Alternative 3: Nonstructural Solutions

Per ER 1105-2-100, _Planning Guidance Notebook_, nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding. Damage reduction from nonstructural measures is accomplished by changing the use made of the floodplains, or by accommodating existing uses to the flood hazard. Flood proofing measures may be incorporated that modify structures to minimize damages by such methods as elevating buildings, sealing walls, closing off openings, protecting plumbing and utilities and installing pumps and valves. The primary nonstructural alternatives considered in this analysis include buy-out, raise-in-place, flood proofing, ring walls, and a flood warning emergency evacuation plan (FWEEP).

The only method of flood proofing that will ensure complete safety from flood damage is relocating the building to a site outside of the flood plain. The buy-out option (See Figures 11 & 12) was selected for structures estimated to be within the floodway or where flooding depths are estimated to exceed three feet. According to _The Blue Book_ , approximately 50% of those interviewed were interested in this option. Data compiled by the Public Valuation Administrator included property values. A nominal value of $75,000 per recommended buy-out structure was chosen.
The raise-in-place method (See Figures 13 & 14) was selected for structures estimated to flood at the first floor level (but by less than three feet.) During the Feasibility study, any design for raise-in-place alternatives should refer to EP 1165-2-314, _Flood Proofing Regulations_. Because of the similarity of parameter of the homes selected for this method, a nominal value of $30,000 was chosen. This is consistent with raise-in-place prices per previous Corps projects in Tennessee.

There are two types of flood proofing that can be designed, either dry or wet. In this analysis, only the wet flood proofing option is considered viable. Wet flood proofing allows the structure to flood inside, while ensuring that there is minimal damage to the building and contents. Utilities and appliances may be moved permanently to a place in the building higher that a selected flood level. Per 1165-2-314, where intentional flooding is proposed or where floodwater backflow through the sewer system may occur, backflow preventers should be installed in the sewer lines. A nominal cost of $12,000 per selected structure was chosen based on professional engineering judgement. The wet flood proofing alternative primarily consists of elevating utilities, relocating contents, and installation of proper closure structures and valves.

Figure 11: Example of Buy-out existing condition

Figure 12: Example of Buy-out modified condition

Figure 13: Example of Raise-in-place existing condition

Figure 14: Example of Raise-in-place modified condition

Per 1165-2-314, where the other methods were inappropriate based on site specific circumstances, the alternative chosen to reduce flood damages was detached dikes, berms and/or ring walls. A nominal cost of approximately $125 per linear foot for a six-foot high levee was chosen based on professional engineering judgement.

Per ER 1105-2-100, the typical flood warning system consists of methods for determining the flood threat, methods for disseminating the flood warning, and a preparedness plan detailing the response to that warning. A flood warning system can be recommended as a stand-alone project, or as a component of a more complex, flood damage reduction plan.

Table 5.1 provides an overall summary of the number of each option selected in each of the five damage areas along with their respective costs. All costs include contingencies appropriate for this level of detail. Note: Damage Areas 4 and 5 are not included in the current HEC-2 model and therefore were not economically evaluated in this analysis.

Pages 19-23 display typical structures associated within each of the five damage areas as well as their respective estimated cost. Readily available GIS data was employed to pinpoint structures located within the floodplain.

Table:5.1 Nonstructural Alternatives Number of Structures						
Damage Area	Buy-out	Raise	Flood proof	Other	Total	Estimated Costs
1	0	0	6	0	6	$82,800
2	5	0	3	2	10	$573,300
3	7	17	14	0	38	$1,383,500
4	4	0	12	0	16	$454,300
5	2	1	1	10	14	$468,100
Other	3	2	6	0	11	$410,600
Total	21	20	42	12	95	$3,372,600

5.b.3.1 Buy-outs, Raise-in-place, Flood Proofing, and Ring walls

Damage Area 1 is shown in Figure 15. Damages in this area are primarily associated with homes along Church Street and Grand Avenue located near the center of the figure. The cause of flooding is a combination of backwater from the Ohio and Licking Rivers and headwater flooding from Banklick Creek. Flood proofing measures are recommended to protect these structures. The estimated cost for flood proofing this damage area is $82,800.

Figure 15: Damage Area 1 and Associated Structures

Note: The area in the damage area sitemaps displayed in blue represents the floodplain as provided with the GIS coverages. The floodplain is based on the current FEMA floodplain delineation.

Damage Area 2 is shown in Figure 16. Damages in this area are primarily associated with homes along Old Kentucky 17 (Old Madison Pike). The floodplain shown does not accurately reflect flooding in this area. Homes in the southeast corner of Figure 16 have experienced severe flooding damages during significant rainfall events. Examples of floodprone structures are shown. Based on current information, ten structures representing both homes and businesses would be impacted by the 1% flood.

For purposes of this study, the estimated costs include buy-out, flood proofing and ring walls as alternatives considered depending on the projected potential depth and frequency of flooding. This area should be carefully reevaluated during the Feasibility Study to determine the potential effect on flood elevations of the fill in the left (west) floodplain just downstream from this damage area.

The estimated cost for nonstructural alternatives in Damage Area 2 is $573,300.

Figure 16: Damage Area 2 and Associated Structures

Damage Area 3 is shown in Figure 17 and represents the area between the railroad underpass and Bullock Pen Road.   Damages in this area are primarily associated with homes along Old Kentucky 17. Recent flooding in this area is moresevere and frequent than depicted in the current FEMA Flood Insurance Study. Examples of floodprone structures are shown below.

The $1,383,500 estimated cost includes buy-out, flood proofing or raise-in-place of 38 structures.

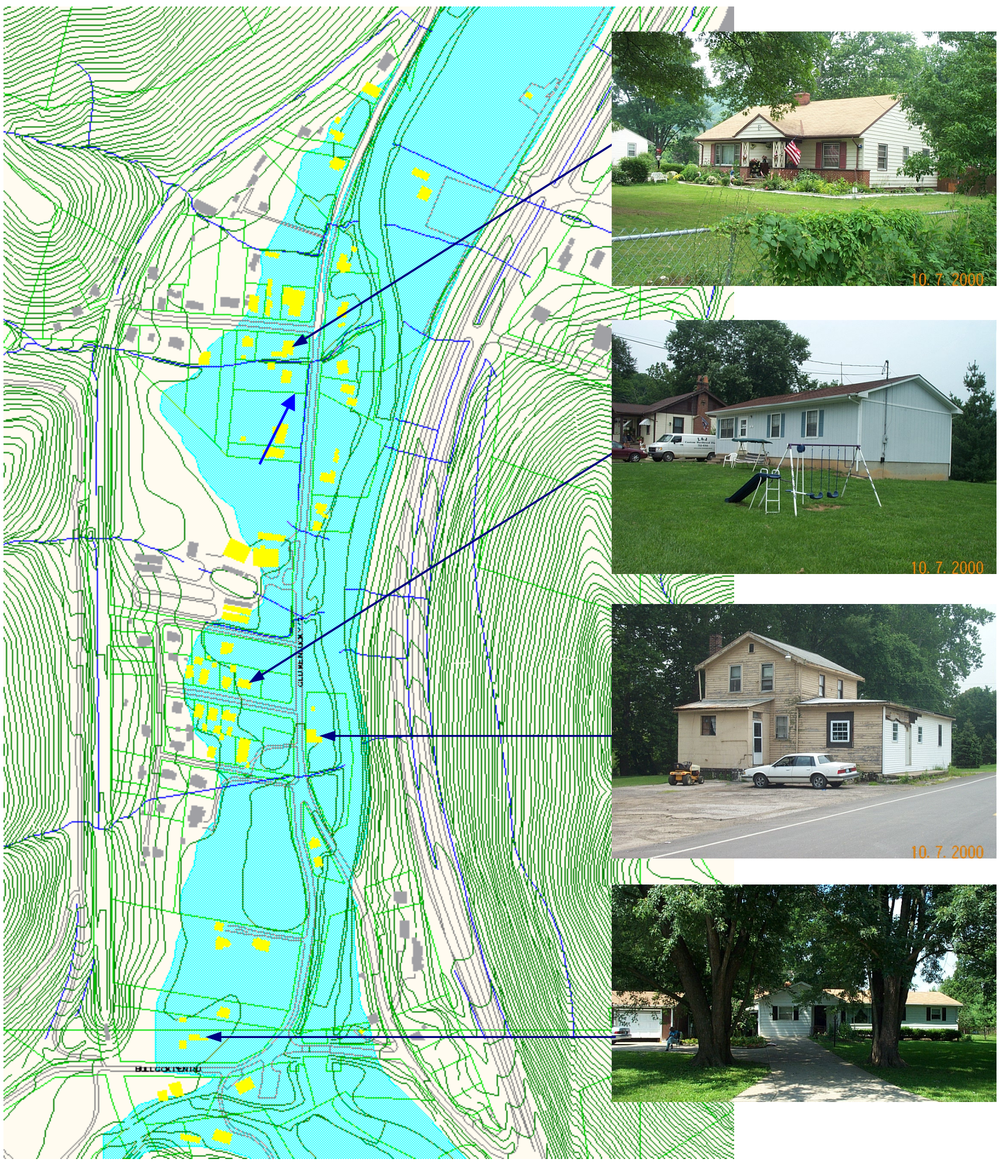

Figure 17: Damage Area 3 and Associated Structures

Damage Area 4 is shown in Figure 18. Damages in this area are associated with homes along Madison Pike and Pleasure Isle Drive. The floodplain shown does not accurately reflect flooding in the area. Based upon field observations and flood information included in *The Blue Book*, the FEMA floodplain is not representative of existing conditions. Examples of floodprone structures are shown. The structures on Pleasure Isle Drive located in the upper right-hand portion of the figure were damaged by floods in the past. The structure shown, located at 286 Madison Pike, reportedly experienced first floor flooding in excess of 4 feet.

Our current hydraulic model only covers from the mouth of Banklick Creek to approximately the end of Damage Area 3; therefore, during the economic evaluation of this alternative only Damage Areas 1 through 3 will be considered.

Sixteen homes were evaluated for buy-out, raise-in-place, or flood proofing. The estimated cost for this Damage Area is $454,300.

Figure 18: Damage Area 4 and 286 Madison Pike

Damage Area 5 is shown in Figure 19. Damages in this area are associated with homes along Richardson Road and Webster Road. Again, the floodplain shown does not accurately reflect flooding in the area. Based on field observation and information contained in *The Blue Book,* the floodplain of Banklick Creek is severely under-estimated. The photos show the creek near properties on Webster Road.

Fourteen structures were included in the estimate for either ring walls, buy-out, raise-in-place or flood proofing. The estimated cost for the nonstructural alternatives in damage area 5 is $468,100.

Our current hydraulic model only covers from the mouth of Banklick Creek to approximately the end of Damage Area 3; therefore, during the economic evaluation of this alternative Damage Areas 1 through 3 will be considered.

There are several other areas suffering flood damages including properties on Orphanage Road, Wilson Road, Oliver Road, Maher Road, Independence Road, Holdsbranch Road and Rust Road. A total of 11 properties were included in a nonstructural alternative at a cost of $410,600.

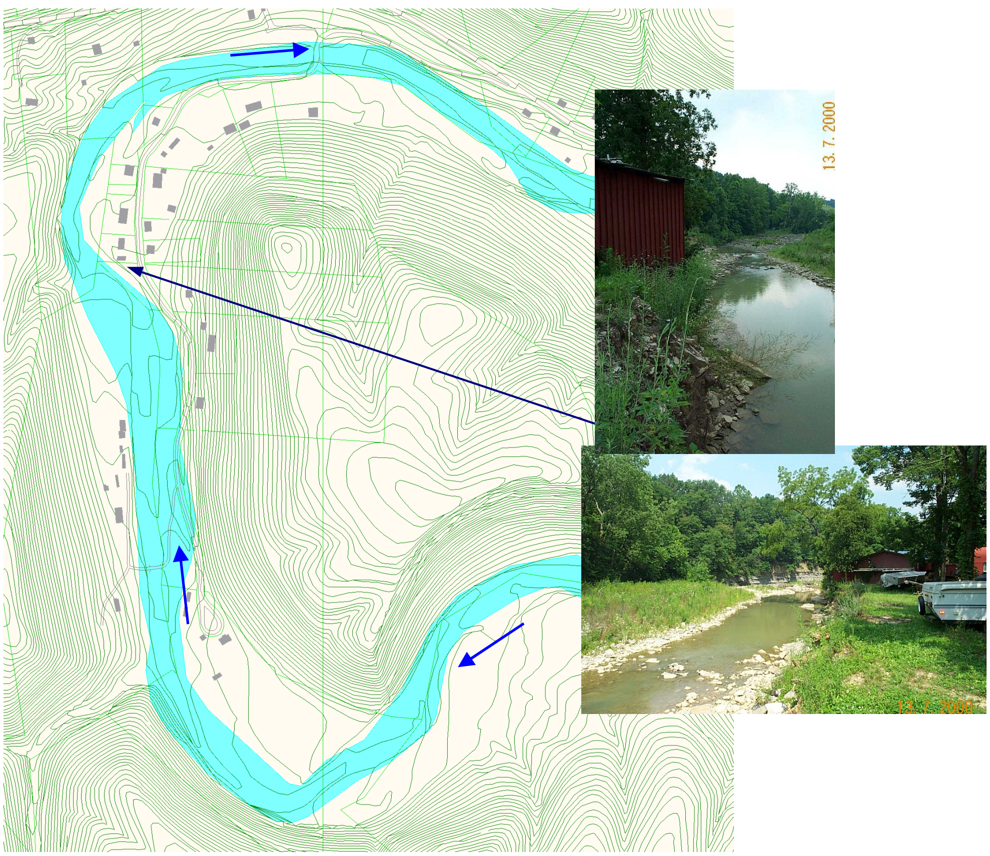

Figure 19: Damage Area 5 and 4895 Webster Road

5.b.3.2 Flood Warning Emergency Evacuation Plan

Per ER 1105-2-100, a typical flood warning system consists of methods for determining the flood threat, methods of disseminating the flood warning, and a preparedness plan detailing the response to that warning. A flood warning system can be recommended as a stand-alone project, or as a component of a more complex, flood damage reduction plan.

Due to the frequency and severity of flooding, a Flood Warning Emergency Evacuation Plan (FWEEP) was evaluated as a means to reduce damages and potential loss of life and injury from intense rainfall events. In addition, flood and rainfall data obtained from such a system is beneficial for flood model calibration and establishing accurate flood frequency, duration and other hydrologic parameters.

Currently, there is a stream gaging station on Banklick Creek at Highway 1829 (Richardson Road) near Erlanger, Kentucky. This station was installed by the United States Geological Survey (USGS) in cooperation with Sanitation District No. 1. The station has been in operation for about one year and provides water surface elevation data along with current rainfall data. This information is transmitted by satellite to the USGS where it is available on their web site. A conversation with a USGS representative indicated that only a limited amount of stream gaging data is available for the site. USGS personnel periodically measure the amount of flow in the stream at various stream levels. This information, when plotted, provides a graph of discharge versus elevation, which can be utilized to estimate peak flood flows or to plot a hydrograph (flow versus time). This station could become a key element in a FWEEP.

Per the *Automated Local Flood Warning System Handbook: Weather Service Hydrology Handbook No. 2*, February 1997, a flash flood alarm system normally consists of a water-level sensor(s) connected to an audible and/or visible alarm device located at a community agency with 24-hour operation. Water levels exceeding one or more preset levels trigger the alarm. If the system is configured to detect two preset levels, the rate of rise can be determined. The water level sensor(s) is set at a predetermined critical water level and is located a sufficient distance upstream of a community to provide adequate lead-time to issue a warning. Rain gages can also be located upstream of a community; each gage is preset with alarms that sound when a predetermined flood-causing rainfall amount is exceeded. Communication between the sensor(s) and a base station can be via radio or telephone.

Considering the rapid time of concentration of runoff in the Banklick Creek watershed, it is recommended that an automated warning system be evaluated further. This would involve establishing 4 to 5 additional automatic rainfall stations at key locations in the watershed and transmitting this precipitation data along with the stream gaging information from the Richardson road gaging station to a centralized location where it could be evaluated and an appropriate alarm given to local residents (see Figure 20 on next page). This central location could be a local police or fire station, where Dispatchers are on call 24-hours per day, or it could be transmitted to the County Emergency Management Coordinator.

The Louisville District is currently working on a FWEEP for the entire Licking River Basin. During a feasibility phase, proper cooridination with Corps staff is essential to link this proposed FWEEP to the Licking River FWEEP. The estimated cost to install five additional rainfall gages, purchase and install a base station computer and radio system, and establish the alarm system is $155,000.

Such a system could be installed early in a Federal project to provide immediate benefits to residents by substantially increasing the warning time and thereby allow residents in the floodplain more time to prepare their structures to minimize damages, remove valuables and evacuate the area before flood conditions close off roads and trap residents.

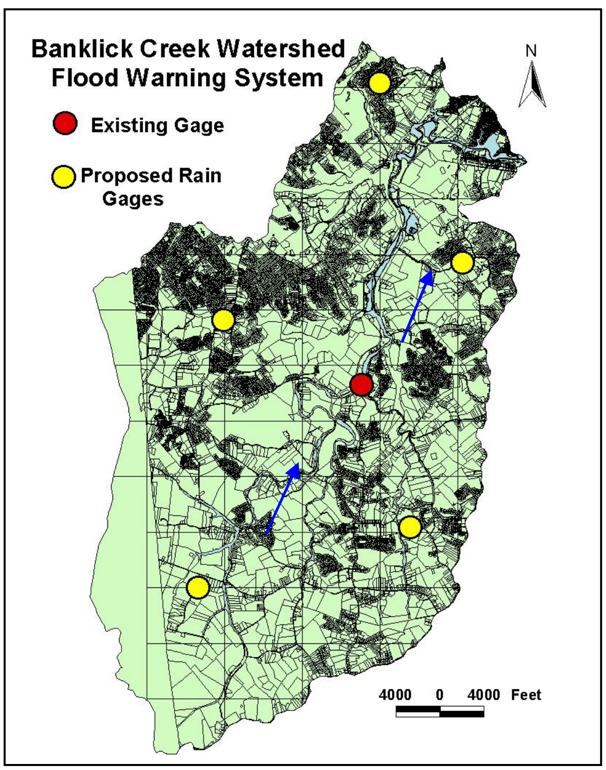

Figure 20: Proposed FWEEP Gages

5.b.4 Alternative 4 Ecosystem Restoration

Per ER 1105-2-100, Ecosystem restoration features shall be considered wherever those restoration features improve the value and function of the ecosystem. The objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition.

To evaluate potential ecosystem benefits associated with ecosystem restoration or enhancement, a geomorphic assessment of the project area was prepared. Although Banklick Creek does exhibit a diversity of flora and fauna and severe erosion is limited, water sampling by others indicates that the stream does exhibit poor water quality. In addition, fragmentation of the riparian buffer has occurred. The following sections provide an overview of the field reconnaissance as well as anticipated benefits associated with ecosystem enhancements.

The Banklick Creek watershed is similar in shape, slope, and drainage density to other surrounding basins draining into the Licking River. The upstream half of the basin generally has low relief and gently sloping hillsides suitable for agricultural development; whereas, the lower portion of the basin is more confined with steeper side slopes and higher relief. Although a range of valley and stream types exist in the watershed, the main stem of Banklick Creek flows through a "Valley Type II" as described by Dave Rosgen in *Applied River Morphology – Wildland Hydrology, Pagosa Springs, Colorado*, 1996. This valley type typically exhibits relatively stable "B" stream types with low sediment supply but does also have "G" stream types under disequilibrium conditions. A field review of the watershed indicated that indeed the predominant stable reaches are "B". However, portions of the stream have been widened and straightened and now exhibit "F" characteristics. In addition, much of the watershed appears to be rejuvenating, creating "G" stream types (gullies) in the tributaries. The mouth of Wayman Creek is a good indicator of watershed rejuvenation. (see Figure 21). The "G" stream types tend to produce most of the colluvial sediment that is transferred to the Licking River as bed material load in Banklick Creek.

Evidence of bed degradation up to four feet in recent years can be seen in Figure 22 where a tire was found in a layer of gravel that formerly composed the streambed but now is above bankfull elevation. Several gravel layers can be found in the banks, indicating that at least two series of headcuts (bed degradation) have occurred in recent history, both having lowered the bed approximately two feet. Bed degradation along this reach tends to cause aggradation at the confluence with the Licking River, as is evidenced by the need for frequent dredging activities at this location to promote safe boating conditions. Dredging costs are estimated to be on the order of $25,000 per year.

Figure 21: Four Foot Headcut at Mouth of Wayman Creek

Figure 22: Evidence of Bed Degradation

Although bed degradation tends to cause bank erosion (as the stream seeks to increase its sinuosity in response to the increased gradient), the majority of stream banks along Banklick Creek are relatively stable. Throughout Banklick Creek, several areas along the channel have been cleared of the natural riparian buffer that tends to stabilize the banks (see figure 23) and localized erosion has occurred. Other eroded areas are due to the localized downwelling and vortex effects caused around constrictions such as bridge crossings and valley hingements, along with sharp bends caused by channelization. Access to these eroded areas is limited, accordingly, treatments that require minimal disturbance such as live staking should be considered in these areas. Near the mouth of Banklick Creek, the channel banks are much steeper and higher. In this area, there is a need to be wary of potential landslide-type failures.

Figure 23: Cross-Section Near Damage Area 2

As part of an ecosystem restoration plan, it is not recommended that extensive natural stream reconstruction be implemented to repair any eroded areas or to stabilize the channel bed. However, the prevention of further bed degradation could result in less sediment production from the stream during extreme runoff events. This could be accomplished by constructing a series of concrete and/or monolithic boulder walls at the current bed elevation that would provide a barrier to headcut migration. A series of these consisting of one barrier per half mile at approximately 75 cubic yards of reinforced concrete per barrier is recommended to control bed degradation along the lower reach. Locations of barriers should be based on detailed hydraulic calculations; therefore, one per half mile is suggested for conservative cost estimates. The barriers would be installed flush with the existing channel bed and could be dressed with large boulders along the surface for a more natural appearance. Additional benefits of these barriers would be an increase in the amount of dissolved oxygen in the water as more turbulent flow is induced. The actual need and locations of barriers should be based on a detailed geomorphological study conducted during the feasibility phase.

Localized erosion control along the banks could be accomplished with the use of live stakes consisting of Willow, Dogwood and Elderberry cuttings collected from nearby harvest sites along Banklick. For cost estimation purposes, approximately 1,000 live stakes harvested and installed with hand labor along the lower reach were considered. The actual number and location of live staking will need to be determined in the feasibility phase.

Examples of erosion on Banklick Creek are shown below in Figures 24 and 25.

Figure 24: Bank erosion due to localized scour

Figure 25: Bank Erosion due to lack of vegetation

The riparian corridor along the lower reach of Banklick Creek varied from completely mowed fields to undisturbed forests. Typical plant species found along the banks are as follows: Thistle, Morning Glory, Queen Ann's Lace, Winter Creeper Ivy, Honey Suckle, Milkweed, Ragweed, Wood Sorrell, Violet, Money Wort, Water Willow, Water Hemlock, Sumac, Potato Vine, Sycamore, Boxelder, Black Willow, Silver Maple, Locust, Walnut, Hickory, Pin Oak, and Ash.

Water quality data, provided by the Kentucky Division of Water, indicates that the stream is impaired and does not meet aquatic life and swimable criteria. Causes of the impairments include nutrients, organic enrichment, low dissolved oxygen, and habitat alteration. Observations of the stream morphology, lack of canopy in certain reaches, and land uses support the water quality results.

The abundance of aquatic and riparian wildlife observed during field reconnaissance indicates that Banklick Creek has the capacity to sustain a thriving ecosystem. Fish, reptiles, crustaceans, invertebrate, waterfowl and other animals were abundant along the lower reach. The shady, riffle-dominated portions of the stream are expected to produce lower temperatures and higher dissolved oxygen concentrations and efforts should be made to preserve these areas.

As mentioned above, areas that had little bank vegetation tended to be associated with erosion problems and increased water temperatures. High water temperatures contribute to low dissolved oxygen levels. Establishment of “no-mow” zones and/or floodplain and riparian plantings to create a streamside buffer would enhance the water quality and wildlife diversity along Banklick Creek by reducing water temperatures, filtering nonpoint source runoff pollution, and providing wildlife corridors with additional foraging opportunities.

In order to achieve these objectives, this proposal suggests the establishment of a riparian corridor twice the active channel width on either side of the stream, (or a total width of approximately 250 feet), wherever possible. Figure 26 illustrates this proposed corridor and highlights areas that already have good quality forest. The areas shown in red in Figure 26 represent the estimated riparian zone deficet, which is 857 acres. Riparian Corridor enhancements could be achieved through active restoration (plantings) or passive restoration (establishment of “no-mow” zones), or through a combination of both. For now it is assumed that passive restoration attempts will be pursued. The need and location of active restoration should be determined during the feasibility phase.

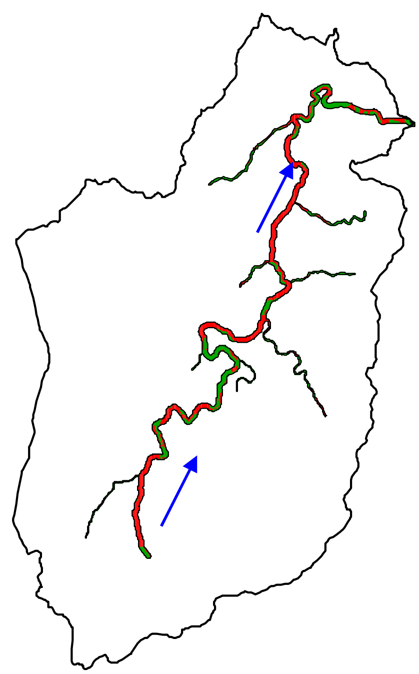

Figure 26: Banklick Creek Watershed Showing Existing Riparian Corridor (green) and Areas Where Riparian Enhancements are Needed (red).

The proposed width of the corridor is limited by the presence of development; however, a literature review suggest that the proposed width will provide a variety of ecosystem restoration benefits as well as meet the recommended standards for riparian buffers proposed by federal agencies.

James MacBroom in The River Book , 1998 suggests that a twenty-meter (66 feet) buffer can effectively reduce nitrogen levels. Buffers between one hundred and three hundred feet have been demonstrated to effectively remove smaller sized particles as well as urban runoff.

The presence of riparian buffers and wildlife corridors are also critical to the management of wildlife populations. Contiguity of plant communities, protected access to water, and the width of riparian corridors directly affect the survival of many bird species, small mammals, and larger herbivores. A review of the Mid Continent's Ecological Science Center literature surveys
indicates that a minimum buffer of 146 feet is required to provide critical habitat. These studies suggest that predation of interior avian species is significantly reduced by surrounding vegetation - a total width of 1,968 feet may provide the maximum benefit for reduction of predation. Other identified factors in habitat conservation include the conservation of upland forest habitat, connections to other streams, and the presence of wetlands within less than one mile of each other. The reintroduction of woody debris in areas where channelization or fragmentation of corridors has significantly reduced existing debris is also profound. In addition to enhancement of fish habitat, this feature also dramatically increases the variability of habitat, says Beth Middleton in *Wetlands Restoration: Flood Pulsing and Disturbence Dynamics*, 1999.

The results of monitoring at the Coyote Creek Restoration Site in Santa Clara, California further support habitat value provided by the establishment of riparian forests in the floodplain following channel enhancement. According to Alvaro Jaramillo in *Volunteers Track Bird Use of Restored Sites, Volunteer Monitor,* ten years of monitoring data indicates that some species were present in greater numbers in restored sites rather than undisturbed areas; foliage gleaners, birds that forage on insects on leaves and twigs, demonstrated the greatest increase in numbers.

The recommended range of effective buffers, suggested by the United States Army Corps of Engineers and Environmental Protection Agency, varies from a minimum of 50-feet for low-order headwater streams to over 300 feet for large streams, says MacBroom. Our recommendation is generally consistent with these standards.

Should active restoration be pursued, restored areas should include approximately 400 trees or herbaceous plants per acre. Native plant species, representative of undisturbed stream reaches, should be utilized wherever possible.

Another opportunity for ecosystem restoration exists at selected buy-out properties. When obtained, these areas could be designed as small-scale constructed wetlands to provide habitat for fish and wildlife. While constructed wetlands are not intended to reproduce or mimic natural wetland wildlife diversity, they do provide areas for water quality improvements due to biological treatment, and additional habitat for aquatic species. Additionally, constructed wetlands typically result in a decrease in suspended solids, and offer habitat for wetlands flora and fauna. It is significant to recognize that waterbirds are often associated with fringe wetlands and interior wetlands and are believed to also benefit from constructed wetlands. The Indiana bat, identified in both Kentucky and Ohio (but generally concentrated in Indiana), utilize wetland areas as summer roosts. Preliminary estimates indicate the potential for 11 acres of wetlands to be created.

A portion of the buy-out properties located in Damage Areas 2 and 3 are located adjacent to Pioneer Park. The park currently has a fine trail system that could be expanded into some of the buy-out areas.

Note: Figures 27 and 28 are included below for the general purpose of displaying various features and characteristics associated with Banklick Creek.

Figure 27: Headcut through bedrock

Figure 28: Cobble Point Bar Formation

Table:5.2 Summary of Ecosystem Recommendations			
Alternative	Location of Impact	Benefits	Estimated Costs
Grade Control Structures	10.5 Stream Miles of Banklick Creek	• Reduced Upstream Bedcutting • Reduced Downstream Sedimentation • Reduced Bank Erosion • Increased Dissolved Oxygen Levels • Increased Aquatic Habitat [2]	$375,000
Expanded Riparian Corridor	10.5 Stream Miles of Banklick Creek [1]	• Increased Terrestrial and Aquatic Habitat • Lower Water Temperatures • Filtering/Trapping of Non-Point Source Pollution [3]	Varies from minimal costs up to 1.7 million [4]
Constructed Wetlands	Buy Out Properties Approx. 11 acres	• Biological Treatment of Water • Reduction of Suspended Solids • Terrestrial and Aquatic Habitat	$100,000
Recreation	Buy Out Properties	• Expanded trail system	$10,000

Table 5.2 summarizes the ecosystem restoration alternatives along with associated costs and benefits.

[1] Refer to Figure 26 for locations of deficient riparian corridor locations.
[2] The installation of grade control structures will reduce the need for dredging which will reduce impacts to mussel populations. In addition, will provide high quality habitat for fish populations.
[3] Past studies indicate riparian buffers increase dissolved oxygen levels; reduce nitrogen levels, sedimentation, and other contaminants associated with non-point source pollution.
[4] Costs for riparian corridor enhancements may vary from negligible costs (initiation of "No-Mow Zones") to significant costs estimated to be on the order of $2,000 per acre for plantings. Actual number of acres considered for riparian corridor enhancements should be determined during detailed feasibility study. Land costs where not considered.

5.C Preliminary Evaluation of Alternatives

Preliminary economic information has been prepared, including benefit-to-cost ratios for the nonstructural alternatives and expected benefits for the ecosystem restoration alternatives. The HEC-FDA program was utilized to complete a Risk and Uncertainty Analysis of both the hydraulic and economic data.

5.C.1 Benefits

ER 1105-2-100 provides the following guidance regarding the nonstructural method of evacuation and relocation (buy-outs).

(a) All damages avoided by flood mitigation measures are beneficial effects. Evacuation and relocation projects provide a special case for economic analysis because the effect of damage reductions are present in measures of both benefit and cost, therefore, double counting of this. ER1105-2-100 22 Apr 2000 benefit must be carefully avoided. IWR Research Report 85-R-1, Assessment of the Economic Benefits from Flood Damage Mitigation by Relocation and Evacuation, provides a comprehensive discussion of NED benefit evaluation procedures for relocation and evacuation projects. In planning for, and evaluation of, relocation and evacuation projects considerable attention should be paid to the with project use of land which is to be evacuated, as the benefit, associated with such use may be crucial to project feasibility.

(b) Benefit from Saving Insurance Costs. One category of costs that can be avoided by a removal plan is public compensation for private flood damages through the subsidized Federal Flood Insurance Program. Expressing savings in these externalized costs as project benefits is appropriate for properties in communities that participate in the Federal Flood Insurance Program or are expected to participate under the without project condition. This benefit is the reduction of insurable flood damages projected over the life of the project with careful attention to the projected without project condition.

(c) Insurable Flood Damages. Base the projection of insurable flood damages on traditional depth-damage-frequency relationships used in projecting total flood damages. Then reduce projected total damages by subtracting: Losses that are noninsurable either because they are in noninsurance loss categories or because they exceed the coverage limits of the subsidized program; the deductible portion of each expected flood damage event; and the annual cost of the insurance premium paid by the policyholders. For this benefit calculation, assume that all eligible parties purchase subsidized insurance. This assumption is appropriate because the market value of properties, which determines project costs, reflects the availability of the program, not the extent of its utilization by current floodplain occupants.

Given this guidance, we did not evaluate the buy-out alternative during this analysis. Instead, we focused upon flood proofing and raise-in-place methods. During the feasibility phase, additional economics should be completed on the buy-out method to determine claimable benefits from flood damage reduction as well as ecosystem restoration.

As table 5.3 below shows, the Expected Annual Benefits (EAB) for the selected structures is $24,000. The NET benefits for the selected structures is $14,000. There were 6 structures in this study area determined to be economically feasible to construct. The modifications will protect the structures against the 1% chance exceedance flood.

5.C.2 Costs

Existing Public Valuation Administrator data was utilized during this economic analysis. During the feasibility phase a more detailed evaluation of property values will be obtained using Marshall & Swift Analysis.

The total cost to protect the 6 structures in this study area is approximately $136,000 as can be seen in table 5.3 below. Total cost to implement the FWEEP is $155,000. Total cost to implement the ecosystem restoration alternative is approximately $500,000 (See Table 5.4). This is assuming that the local sponsor wishes to pursue a passive approach (i.e., implementation of “No Mow Zones” versus tree plantings of nearly 400 per acre.

Per ER 1105-2-100, Benefit-cost ratios can not be properly calculated for environmental projects, and environment specific costs are not considered in the benefit-cost ratio for a multipurpose project. For this reason, only the costs associated with benefits attainable with nonstructural methods of flood damage reduction are considered in this multipurpose project’s benefit-to-cost ratio.

Table:5.3 Banklick Creek Watershed Summary of Annual Benefits and Costs (for nonstructural alternatives) FY 2000 Price Levels (x $1,000) 6 5/8% Interest Rate	
Project Cost	
Construction	$136
Interest During Construction	$3
Total Investment Cost	$139
Annual Charges	
Interest & Amortization	$10
Operation & Maintenance	$0
Total Average Annual Charges	$10
Annual Benefits	$24
Benefits vs. Cost Ratio	2.4
Net Benefits	$14

Note: Depths of first floor flooding for the 1% chance exceedance flood for the six selected structures range from 3.4 to 7.9 feet, with an average of 5.0 feet.

Only physical damages and benefits were evaluated in this effort.
Some of the structures in the floodplain were identified for buy-out; however, benefit analysis for buy-outs is not within the scope of a Section 905(b) Analysis. Potential relocation and evacuation (buy-outs) of properties would be evaluated during the feasibility phase.

Table:5.4 Economic Analysis			
Alternative/Description	Benefits	Estimated Costs	BCR
Alternative No. 1 ***No Action Plan***	$0	$0	0
Alternative No. 3 ***Nonstructural flood damage reduction (w/o FWEEP).*** *This analysis considered nonstructural alternatives such as raise-in-place and floodproofing for Damage Areas 1-3.*	$24,000 (annualized)	$10,000 (annualized)	2.4
Alternative No. 3 ***FWEEP*** *Design, purchase , and Installation of 5 rainfall gages and other necessary system equipment.*	$310,000	$155,000	2.0
Alternative No. 4 ***Ecosystem Restoration*** *Installation of approximately 20 monolithic boulder walls* *Plant 1000+ live tree stakes (Willows, Dogwoods, Elderberry)* *Establishment of approx. 860 acres of "No Mow" zones to create a buffer* *Construction of wetlands*	• Reduced Upstream Bedcutting • Reduced Downstream Sedimentation • Reduced Bank Erosion • Reduce Nitrogren Levels • Increased Dissolved Oxygen Levels • Increased Aquatic Habitat • Increased Terrestrial and Aquatic Habitat • Lower Water Temperatures • Filtering/Trapping of Non-Point Source Pollution • Biological Treatment of Water • Reduction of Suspended Solids • Terrestrial and Aquatic Habitat	$500,000* *This price could escalate three-fold if sponsor wishes to pursue active restoration attempts (tree stakings at approximately 400 per acre) rather than passive restoration efforts (establishment of "No Mow" Zones)	NA

5.C.3 Environmental Impacts

A preliminary environmental evaluation of the alternatives noted above suggests the following:

The nonstructural alternatives, including raise-in-place and permanent evacuation, would have some limited impact during the construction or relocation phase but little long-term impact. In those areas where permanent evacuation of structures is considered, there would be a positive impact as properties purchased could be converted into recreation or open space use for the entire community.

The FWEEP would produce no negative environmental impacts.

Ecosystem restoration projects should produce improved environmental conditions as low flow channels are stabilized and stream banks modified to reduce scour.

A comprehensive environmental evaluation should be performed during the Feasibility Phase, for each potentially viable site. The recommended plan should be coordinated with local public agencies, environmental groups and with the Kentucky Department of Fish and Wildlife along with U.S. Fish and Wildlife.

Summary

Table 5.4 (above) provides a summary of the alternatives considered in this Analysis. Based upon this data the least cost flood damage prevention alternative is the nonstructural plan.

Field observations and the frequency of recent flood events suggest that the hydrologic and hydraulic models should be updated in the Feasibility Study to better reflect current conditions. The Geographic Information System (GIS) currently being developed in combination with projected future land use conditions should be utilized in updated modeling to accurately depict flood elevations and accordingly the number of structures that could be subject to damages and thus included in a nonstructural solution.

Because of the steep slopes and rapid development, it is suggested that a high flow rating be established for the existing stream gage and that high water marks be set during a major flood event to provide a means to calibrate the models.

Consideration should be given to the early establishment of a flood warning and evacuation system.

Although benefits are difficult to quantify with the amount of current data, consideration should be given to implementing the Ecosystem Restoration component to improve the stream habitat, reduce erosion and bed cutting.

By utilizing readily available data, this analysis has determined there is a federal interest in this project, determined cost and benefits for both the flood damage reduction and ecosystem restoration alternatives, and provided a preliminary observation environmental impacts. Through coordination with potential local sponsors, we have obtained a Letter of Intent (LOI) from Kenton County Fiscal Court stating their understanding of the Continuing Authority Program and the respective cost sharing agreements. An economic analysis of the flood damage reduction alternative concludes it is feasible to perform nonstructural measures at a cost of approximately $136,000 to acquire net benefits of approximately $14,000 resulting from a benefit-to-cost ratio of 2.4. It is feasible to construct a FWEEP at a cost of approximately $155,000. Ecosystem restoration alternatives range from $500,000 to nearly $2,000,000. Negotiations with the local sponsor will determine which approach o tproceed with.

6. FEDERAL INTEREST

A multipurpose project consisting of high priority outputs of flood damage reduction and ecosystem restoration measures can be implemented in this study area. The proposed plan involving nonstructural flood damage reduction measures as well as incorporating ecosystem restoration measures is consistent with Federal objectives and has the support of the local sponsor. This Section 905(b) Analysis serves as the basis for budgeting for future project activity. The preliminary economic analysis indicates that the flood damage reduction benefits do outweigh the cost of project construction. Implementation of the nonstructural alternatives in this study area would result in a benefit-to-cost ratio of 2.4. There are approximately 14 other structures that were marginal which, if incorporated with the ecosystem restoration alternatives listed in this analysis, could produce desirable outputs.

7. PRELIMINARY FINANCIAL ANALYSIS

The sponsor, Kenton County Fiscal Court, has the legal capability to enter into a binding contract with the Government. The sponsor has indicated by a Letter of Intent (LOI), dated August 2000, that they understand the cost sharing responsibilities affiliated with the recommended plan and are willing to enter into a cost shared Feasibility Study. The sponsor's LOI is located on the subsequent page.

Offices of
The Fiscal Court

RICHARD L. MURGATROYD, JUDGE/EXECUTIVE
BARBARA BLACK, COMMISSIONER
DAN HUMPERT, COMMISSIONER
ADAM KOENIG, COMMISSIONER

RICHARD S. KIMMICH, DEPUTY JUDGE & CHIEF OF STAFF
IVAN D. FRYE, TREASURER
GARRY EDMONDSON, ATTORNEY
MICHAEL BROWNING, POLICE CHIEF

JOE SHRIVER, HUMAN RESOURCE DIRECTOR
CHRIS WARNEFORD, SUPT. PUBLIC WORKS
ALINE SUMME, DIR., ANIMAL SHELTER
BILL H. GIBBONS, GEN. MGR., GOLF COURSE

August 9, 2000

Chief, Planning Division
US Army Engineer District, Louisville
P.O. Box 59
Louisville, Kentucky 40201-0059

Dear Sir,

The county of Kenton hereinafter called the "sponsor," is interested in obtaining Corps of Engineers assistance in addressing flooding problems in the county of Kenton.

The sponsor is aware of the following non-federal cost sharing requirements associated with the Corps' flood control projects completed under authority of **Sections 205 of the 1948 Flood Control Act**.

a. **Feasibility Study.** The Corps will conduct a Feasibility Study which is 100 % federally funded up to $100, 000. Costs over the $100,000 are cost shared with the non-federal sponsor on a 50/50 basis (up to one-half of the non-federal share can be in the form of in-kind services). An initial assessment early in the Feasibility Study will determine if Section 205 authority appears applicable and provides a basis for determining scope and cost of an entire Feasibility Study.

b. **Preparation of Plans and Specifications.** Detailed design and preparation of plans and specifications are treated as part of total project costs for purposes of sharing and the non-federal cost share for these activities is collected with the construction cost share.

c. **Non-Federal Share of Construction.** The non-federal share of construction consists of provision of lands, easements, right-of-way, relocations and disposal areas necessary for the project (LERRD), plus a cash contribution of 5% of the total project costs; in the event that the value of LERRD furnished, plus 5% cash, does not equal at least 35% of the total project cost, the non-federal sponsor must contribute additional cash to equal 35%. If LERRD plus 5% exceeds 35%, the sponsor is responsible up to a maximum of 50% of the total project costs.

The sponsor is aware of the following:

KENTON COUNTY BUILDING, ROOM 205, 303 COURT STREET, P.O. BOX 792, COVINGTON, KENTUCKY 41012-0792
PHONE: (859) 491-2800
FAX: (859) 491-5226

Operation and Maintenance. The sponsor will be responsible for the operation and maintaining the project upon completion.

Feasibility Study. The sponsor understands that the Corps will undertake the first phase of study when funds are available which may vary 18-24 months depending upon the size of the potential project and the federal budget cycle. An initial assessment at the beginning of the Feasibility Study normally takes 3-6 months and will provide the basis for determining the scope of study and whether the Section 205 authority appears appropriate to address the community's flooding problem.

Expression of Intent. The sponsor is aware that this letter constitutes an expression of intent and not a contractual obligation and that the sponsor or the Corps may opt to discontinue the project development process at each stage as described in "**a**" and "**b**" above.

Richard Murgatroyd
Kenton County Judge Executive

Garry Edmondson
Kenton County Attorney

8. SUMMARY OF FEASIBILITY STUDY ASSUMPTIONS

- Upon HQ approval of this 905(b) analysis, and proper transfer of this project to the Continuing Authority Program, negotiations regarding the PSP will commence.
- The FCSA may be signed as early as February 2001.
- An incremental cost analysis will be performed during the Feasibility study to determine which ecosystem restoration alternatives should be selected.

9. FEASIBILITY PHASE MILESTONES

- Transfer project to CAP program — November 2000
- Preliminary draft PSP — + 30 calendar work days
- FCSA (for CAP Feasibility) signed — + 20 calendar work days
- AFB — + 10 calendar work days
- Award A/E contract — + 30 calendar work days
- District submits final report to Division — + 12 months

10. FEASIBILITY PHASE COST ESTIMATE

A Feasibility Phase study to produce a highly detailed hydraulic model (includes establishing high water marks if a major event occurs during this phase), complete a preliminary design of a FWEEP and all other Nonstructural Alternatives including Ecosystem Restoration alternatives, complete an Environmental Assessment, complete a detailed economic analysis, and coordinate/conduct public meetings is estimated to cost $500,000. This would be cost shared on a 50/50 basis with the local sponsor. $500,000 is the estimated cost had we determined that the the intial set of structures (95) would be recommended for a nonstructural alternative. The outcome of this analysis is that 6 of the 95 structures are economically justified in this study area. At least 14 other structures are marginal as whether we could move forward with nonstructual alternatives. Although, by combining the ecosystem restoration benefits with these additional structures, we feel a viable project with desirable outputs can be implemented. During feasibility study negotiations with the local sponsor, a final determination of the number of structures to pursue during the detailed study will be decided. Also during these negotiations, we will discuss the different ecosytem restoration options which include both active and passive approaches. While we have a reduced amount of structures at this time, a feasibility study for this multipurpose flood damage reduction / ecosystem restoration project is estimated to cost $300,000.

11. RECOMMENDATIONS

Based on the results of this 905(b) Analysis, a viable and implementable multipurpose project including both flood damage reduction and ecosystem restoration measures can be developed that will meet the necessary Federal interest criteria and will be fully supported by the local sponsor. The massive residential growth in this watershed’s upper reaches necessitates an update to the current HEC-2 model. Of the five damage areas highlighted in this analysis, our HEC-2 model only envelops Damage Area 1 through 3; thereby, we were not able to capture additional damages in Damage Area 4 or 5. During a Feasibility study that produces an updated hydraulic model, we predict additional damages will be discovered. The financial scope of this project falls within the limits of the Section 205/206 Continuing Authority Program. Therefore, I recommend that this 905(b) Analysis be approved and certified as a basis for continuing into the Feasibility Phase of the Continuing Authority Program for a Section 205/206 project.

12. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE

There are no known issues that negatively affect initiation of a Feasibility phase study on Banklick Creek; conversely, the local sponsor is currently updating their GIS mapping for the entirety of Kenton County. This mapping will be very valuable during the Feasibility phase.

13. VIEWS OF OTHER RESOURCE AGENCIES

Views of other resource agencies are unknown at this time.

14. PROJECT MAP

A project area map (Figure 29) is attached.

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Robert E. Slockbower
Colonel, Corps of Engineers
Commander and District Engineer

Date:______________________