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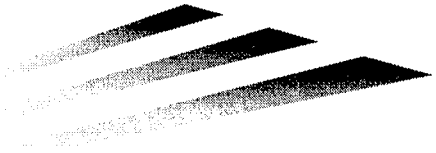
ASSESSMENT AND MODELING OF STREAM MITIGATION PROCEDURES



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Research Report
KTC-99-52

ASSESSMENT AND MODELING OF STREAM MITIGATION PROCEDURES

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16. Abstract

This study evaluates the construction and performance of KyDOH stream disturbance mitigation projects. The initial study tasks were to conduct a literature search, review of stream performance models, a review of Kentucky's and other agency's regulations pertaining to stream mitigation, identification of representative stream mitigation projects, and evaluation of those sites. Th results of this study will produce a tool for evaluating stream mitigation projects after they are constructed.

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EXECUTIVE SUMMARY

Construction of new roadways or modification of existing ones often requires diversion or modification of streams. Stream disturbance requires mitigation of the affected area or compensatory replacement in a similar environment. To date, no studies have been made to assess the execution of the mitigation plans or to determine the performance of mitigation projects. In a move to rectify this situation the Kentucky Transportation Cabinet requested this study.

The initial study tasks were to conduct a literature search, review of stream performance models, a review of Kentucky's and other agency's regulations pertaining to stream mitigation, identification of representative stream mitigation projects, and evaluation of those sites.

A literature search for regulations, federal permits, stream performance models, has been completed. Review of the articles did not reveal any regulations for stream disturbance mitigation that has been promulgated. Several agencies have developed guidelines but there are no hard and fast rules. There are numerous models, but none of them are specifically geared toward stream disturbance mitigation.

Stream mitigation projects have been reviewed and selected by the DEA. An initial site assessment has been conducted on all five sites. The University of Kentucky's Biology Department has agreed to perform the Rapid Bioassessment Protocol (RBP-V) fish assessment on two of the sites.

The next step is to perform an actual site assessment in which field measurements and data will be gathered for analysis. When the data is gathered and analysis has been made, an assessment tool will be developed that will be used for future stream mitigation evaluation.

1.0 INTRODUCTION

Kentucky ranks second in the United States as having the most miles of waterways. As a result, many roadways traverse waterways. Construction of new roadways or modification of existing ones often requires diversion or modification of streams. Stream disturbance requires mitigation of the affected area or compensatory replacement in a similar environment. Therefore, stream mitigation projects have increased in recent years, and consequently have become a significant factor in roadway construction costs. Environmental regulatory agencies have mandates that impact the performance of these projects and require post-construction assessments of their performance.

To date, no studies have been made to assess the execution of the mitigation plans or to determine the performance of mitigation projects.

1.1 STUDY BACKGROUND

The Kentucky Transportation Cabinet (KyTC) approved Research Study KYSPR 9-193, entitled "Assessment and Modeling of Stream Mitigation Procedures" in 1998. The study began July 1, 1998 and ends June 30, 2000. Five recent stream mitigation projects will be evaluated. The two-year study term will permit mitigation project evaluation at high and low water periods. The objectives of the study include:

1. Identifying existing stream mitigation projects,
2. Collecting all documents (general and specific) related to those projects for further review,
3. Classifying the stream mitigation projects into logical categories,
4. Reviewing stream mitigation design models and identifying applicability to specific mitigation projects and pertinent metrics,
5. Conducting field assessments of the existing projects and obtaining relevant data,
6. Assessing the performance of the existing mitigation projects based on review of plans, regulations, field data, etc.,
7. Using the data from one site to test/calibrate the performance of one or more stream performance models,
8. Providing Kentucky Department of Highway (KyDOH) officials with performance assessments of existing mitigation projects and recommendations for repairs and future mitigation efforts, and
9. Preparing guidance documents to facilitate future inspections and tests of mitigation sites by KyDOH district personnel.

2.0 LITERATURE SEARCH

The initial study task was to conduct a literature search. The literature search included a review of stream performance models and a review of Kentucky's and other agency's regulations pertaining to stream mitigation. Other tasks were to identify representative stream mitigation projects and to locate and perform a preliminary evaluation those sites.

The literature search is an important component of any study. A search will uncover the "state-of-the-art" methods and practices being utilized in a particular field. This search focused on regulations, guidelines and models.

2.1 REGULATIONS REVIEW

Review of the applicable regulations was accomplished through researching the World Wide Web. The Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) has not developed Kentucky Administrative Regulations (KARs) for stream mitigation. NREPC has developed general guidelines designed to assist applicants in the preparation and development of mitigation and monitoring plans for streams and wetlands mitigation. The manual is titled "Guidelines for Stream and Wetland Protection in Kentucky" and can be found on the web site at: http://water.nr.state.ky.us/dow/dwwqc.htm. These guidelines should be used in consultation with Kentucky Division of Water, state or federal fish and wildlife agencies, and the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the Natural Resources Conservation Service, or the local state government agencies responsible for stream and wetland protection. NREPC officials indicate that their streambed mitigation performance evaluation would focus on biological performance. Any tool or procedure that KyDOH used to evaluate stream mitigation projects would require the evaluation of other parameters (habitat, hydrology, water quality etc.), that influence the biological performance. The KyDOH does not have formalized procedures for evaluation of stream mitigation.

Other states agencies, both transportation and environmental, have been contacted to ascertain their regulations for stream mitigation. Pennsylvania does not have regulations, but has developed guidelines similar to Kentucky's. Efforts have been initiated to make contact with North Carolina and Tennessee to find if they have regulations.

The following guidelines for stream related impacts have been taken from the NREPC manual "Guidelines for Stream and Wetland Protection in Kentucky".

"Detailed plan and profile drawings that involve more than 200 linear feet of physical disturbance to a blue stream should include this information:

<u>Pre-Disturbance or Reference of the Surface Water:</u>

1. Channel morphology; e.g., channel width, bank height (normal pool to high water mark), bank slope, stream gradient, pool to riffle ratio, run to bend ratio, bottom shape.

2. Location of aquatic habitats; e.g., pools, riffles, woody debris, log jams, rootwads, gravel bars (point bars), in-stream vegetation beds, substrate types, and composition.
3. Hydrology; e.g., stream flow at low flow; average annual flow. In an upper headwater situation, this data may not be generally available.
4. Riparian Zone composition and widths, including botanical species list. Stream shading, which is critical to maintaining water temperatures, and canopy percentage should be addressed.
5. Adjacent wetlands in accordance with the delineation manual currently being used by the U.S. Army corps of Engineers.
6. Sediment and erosion control measures (best management practices) to be used during construction; e.g., retention basins silt fencing, rock check dams, or vegetated buffer zones.

Post-Disturbance -- Mitigation

1. Minimizing net loss of stream length; i.e., replace meanders.
2. New channel morphology, which should be similar to the pre-disturbance morphology.
3. Restoration, creation, or enhancement of aquatic habitat.
4. Restoration of riparian zone including width and species list. For the purpose of protecting water quality and maintaining bank stability, a permanent vegetated buffer zone should be restored along each streambank in the project area. A minimum width of 50 feet on each side of the stream is suggested, but even a width of 15 feet can offer some water quality benefits. The revegetation plan needs to include an immediate herbaceous groundcover mixture, as well as trees and shrubs, which can be planted on a 12 feet by 12 feet spacing. A minimum of four tree species and three shrub species should be planted in the riparian zone. Exotic, invasive and nuisance species should not be planted.
5. Monitoring plans to determine the success of the mitigation should be developed that check habitat structures, bank stability, vegetation plantings, and silt control structures. Aquatic life will need to be monitored after post-construction when the watershed size is greater than one square mile.
6. Contingency plan that addresses possible failure of the various mitigation construction aspects; e.g., spot grading, reseeding, replanting, maintaining bank stability, and replacement of habitat structures.
7. Permanent protection and maintenance of the mitigated stream channel and riparian zone."

2.1 FEDERAL PERMITS

The Federal Government requires that several permits be obtained before a project begins. The majority of these permits "are aimed at protecting natural resources values and the integrity of the nation's water resources" (4, p. 6-13). A list of permits follow (4, p. 6-12).

The U.S. Army Corps of Engineers issues the following permits for the Federal government:

Section 10, Rivers and Harbors Act of 1849. A ***permit*** is required if a project involves the construction of any structure that will change the course, condition, or capacity in the channel or along the banks of navigable water within the US.

Section 404, Federal Clean Water Act. A ***"Letter of Permission"*** is required for work that will have a minimal impact, such as routine maintenance.

Section 404, Federal Clean Water Act. ***Permit 3*** is required when a project will repair, rehabilitate, or replace a structure that was destroyed by storms, fire, or floods within the past two years.

Section 404, Federal Clean Water Act. ***Permit 13*** is required when the sole purpose of a bank stabilization project is for erosion protection and the length of the project is less than 500 feet.

Section 404, Federal Clean Water Act. ***Permit 26*** is required when a project will fill up to 1 acre of non-tidal wetland, or less than 500 linear feet of non-tidal stream that is either isolated from other surface waters, or upstream of the point in a drainage network where the average annual flow is less than 5cfs.

Section 404, Federal Clean Water Act. ***Permit 27*** is required when activities include restoration of natural wetland hydrology, vegetation, and function to altered and degraded non-tidal wetlands, and restoration of natural functions of riparian areas on private lands, provided a wetland restoration or creation agreement has been developed.

U.S. Fish and Wildlife Services issues the following permit for the Federal government:

Endangered Species Act, Incidental Take Permit. This permit is required when an otherwise lawful activity may take listed species.

State agencies issue the following permits for the Federal government:

Section 401, Federal Clean Water Act. The project will require water quality certification. State authority is given under KRS 224.
Section 402, Federal Clean Water Act National Pollutant Discharge Elimination System (NPDES). This permit is required when pollution discharges come from either point source or non-point sources.

The state requires that a Water Quality Certification form be filled out for any project that will cause a stream disturbance. According to Bill Sampson, a NREPC Kentucky Division of Water official, "The Water Quality Certification (Section 401 of the Clean

Water Act) is married to the Section 404 permitting program administered by the Corps of Engineers. Hence, 401/404 is a dual agency process involving the state and federal government. Section 401 provides states authority for activities within their borders. Pursuant to CWA, and federal action within waters of the U.S. may require a certification from the promulgating state agency."

The Commonwealth of Kentucky does not have a set of program specific rules. However, the 401 Water Quality Certification (WQC) often requires stream mitigation or restoration whenever stream relocation, filling of a stream, or similar alterations are proposed (Guidelines for Stream and Wetland Protection in Kentucky, p. 12). Therefore, it is up to the Division of Water to evaluate the project and determine what kind of mitigation will be required.

State and Federal regulations address the following issues:

1) determining the adequacy of the mitigation plans,
2) assessing whether the mitigation projects were properly constructed,
3) assessing whether the mitigation project was performing properly,
4) determining whether follow up maintenance or remedial work is required on those projects.

2.3 STREAM PERFORMANCE MODELS

Data from field observations of streams can be used to model the performance of those and similar streams under observed conditions. Those models can then be used to predict future stream performance under similar conditions. The ability to predict stream performance is important to highway designers, especially where highway construction or maintenance activities result in stream disturbance. Since most highway construction projects are cost driven, the ability to predict stream behavior and thus design stream disturbance mitigation can have significant project cost implications.

This study focuses on post-construction evaluation of stream disturbance mitigation. Past mitigation efforts will be analyzed, but a more significant study product would be the development of a "tool" or a mitigation model to assist KyDOH personnel in evaluating mitigation projects. Numerous stream performance models were reviewed to identify a model well suited to this purpose or to identify the parameters critical to mitigation evaluation.

The literature search and review revealed that no current model adequately addresses all aspects of stream disturbance mitigation. Stream performance models reviewed are as follows:

1. **Erosion Models**
   a) Erosion Productivity Impact Calculator (EPIC)
   b) Soil and Water Assessment Tool (SWAT)
2. **Watershed Models**

a) Agricultural Non-Point Source (AGNPS)
b) Areal Non-point Source Watershed Environmental Response Simulation (ANSWERS)
c) Hydrological Simulation Program-FORTRAN (HSPF)
d) Precipitation-Runoff Modeling System (PRMS)/MMS Model

3. GIS Systems
a) Geographic Resource Analysis Support System (GRASS-GIS) (U.S. Army Corps of Engineers, 1987)
b) GRASS Waterworks
c) GISHYDRO (Maryland State Highway Administrators' Division of Bridge Design in Baltimore)
d) Hydrologic Data Development System GIS
e) GIS Water, Soil, and hydro-Environmental Decision Support System (WATERSHEDSS)

4. Biological Assessment Models
a) Wetland Evaluation Technique (WET)
b) Hollands-Magee Assessment Model
c) Index of Biotic Integrity (IBI)
d) Habitat Quality Index (HQI)
e) Ontario Trout Habitat Classification (OTHC)
f) Habitat Suitability Index (HIS)
g) Instream Flow Incremental Methodology (IFIM)

5. Wetlands Model
a) WDWBM
b) Integrated Lake Watershed Acidification (ILWAS)
c) EXTRAN
d) Evaluation for Planned Wetlands (EPW)

6. Economic Models
a) IMPLAN

The models determine 1) bank erosion, 2) biological impacts, 3) sedimentation, 4) flow characteristics and control (time and spatial variations), and 5) channel morphology. The various parameters that can be used in the models are 1) GIS used to estimate wetland impacts, 2) type of stream, 3) size of mitigation project, 4) type of mitigation, 5) pollutant removal efficiency, 6) storm water impacts, 7) comparison to natural wetlands, 8) benefits and costs, 9) short term and long term, and 10) biological assessments.

After reviewing these models, it was determined that the AGNPS "CONCEPTS" model most closely fit the needs of this study. "CONCEPTS is a distributed, continuous, long-term channel evolution and water quality model for use in ungauged watershed systems" (AGNPS's website). However, the need still exists for the development of a model that deals strictly with stream disturbance mitigation. Data from this literature review and

analyses of the five mitigation projects will be used to develop a mitigation evaluation tool. These preliminary tasks are not complete but some of the parameters, which will probably be involved, are; conformity to mitigation design, habitat assessment, riparian vegetation assessment, hydrological assessment, and a Rapid Bioassessment Protocol-V (RBP-V) for fish assemblages.

3.0 SITE IDENTIFICATION

The Study Advisory Committee requested that five stream mitigation projects be evaluated. All five of the projects should meet the following criteria:

- Have been completed within the last five to ten years
- Be representative of mitigation projects statewide

The Division of Environmental Analysis reviewed stream mitigation projects and identified five sites meeting, as near as possible, that criteria. The five projects were completed within the time frame. Two of the project sites are in Hardin County, one in Boyle County, one in Greenup County, and one in Bracken County. Due to the selection criteria and time constraints, sites in Western and Southeastern Kentucky were not included. The sites are listed below and located on a state map in Figure 1.

Site 1: **KY 313, Cedar Creek, Hardin County (4-168.06)**
Site 2: **KY 313, Cedar Creek, Hardin County (4-168.09)**
Site 3: **U.S. 68, Doctors Fork, Boyle County**
Site 4: **AA Highway, Holts Creek, Bracken County**
Site 5: **KY 827, Coal Branch, Greenup County**

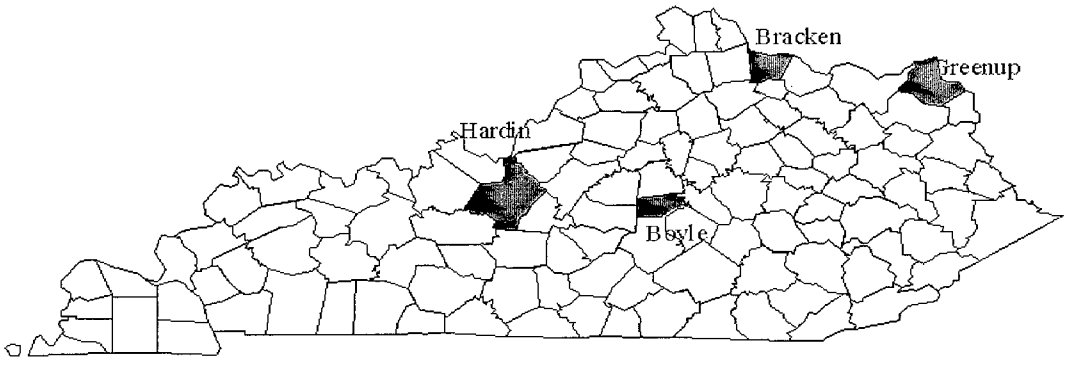

Figure 1. Selected stream mitigation sites in KY.

4.0 PRELIMINARY SITE ASSESSMENT

On March 26th individuals from the University of Kentucky's Biological Science Department and the Kentucky Transportation Center visited three of the five mitigation projects. The other two sites were visited on April 8th. This preliminary visit allowed investigators to see the sites, determine the size of each project and decide what methods of evaluation were needed for each site.

4.1 KY 313, CEDAR CREEK, HARDIN COUNTY (4-168.06)

The construction of KY 313 in Hardin County included modification of first-order and second-order unnamed tributaries of Cedar Creek. This mitigation project includes two pipes, two box culverts, and approximately 10,000 feet of channel change varying in width from two to twelve feet. The channel runs from Station 535+11 to Station 763+00 and is generally parallel to and north of KY 313 (Figure 2). Stone riffles and energy dissipators were constructed as part of the mitigation plan. The channel flows at a depth of about 6 inches at its deepest spot during the spring and is probably an intermittent stream (Figure 3).

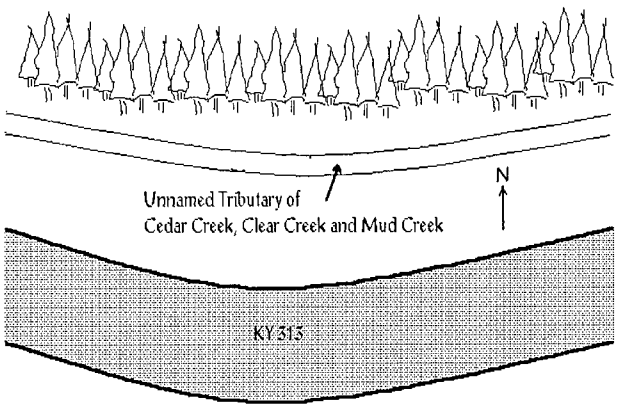

Figure 2. Conceptual drawing of Site 1.

Preliminary Biological Assessment: Minnows, snails and fly larvae were readily observed at the lower reaches of the stream (Figure 4).

Revegetation: Trees and shrubs had been planted and will be inspected in summer.

Figure 3. Water is shallow during the spring season. Riffles are easily visible.

Figure 4. Environmental Team doing Preliminary Biological Assessment.

4.2 KY 313, CEDAR CREEK, HARDIN COUNTY (4-168.09)

This project required a channel modification where the KY 313 bridge crosses Cedar Creek and an unnamed tributary to Cedar Creek north of the bridge (Figures 5 and 6). The mitigation plan involves 410 feet of Cedar Creek, approximately 5,500 feet (Station 478+50 to Station 5353+11) of channel changes of unnamed first and second-order tributaries, and two culverts. Stone riffles and deflectors were constructed. The unnamed stream varies from two-foot to six-foot in width and is very shallow even in the spring wet-season (Figure 7). Some bank erosion has occurred as a result of undercutting on the small branch that parallels the highway (Figure 8). A large pool is located in the main stream, just before the stream enters the forested area, and slightly upstream from where the unnamed stream enters Cedar Creek.

Preliminary Biological Assessment: Minnows, snails and fly larvae were readily observed. It is likely that large fish exist in main portion of the stream.

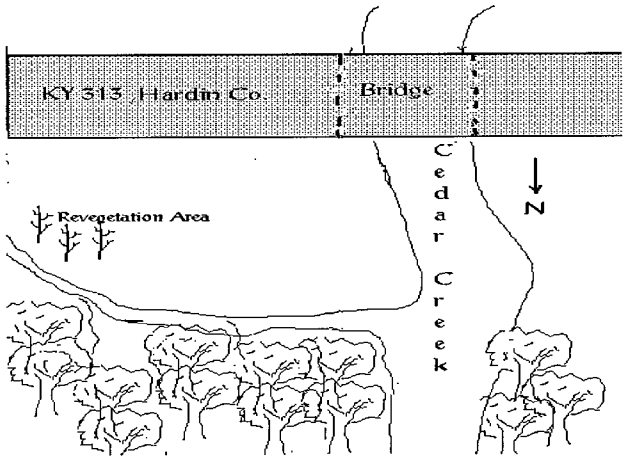

Figure 5. Conceptual drawing of Site 2.

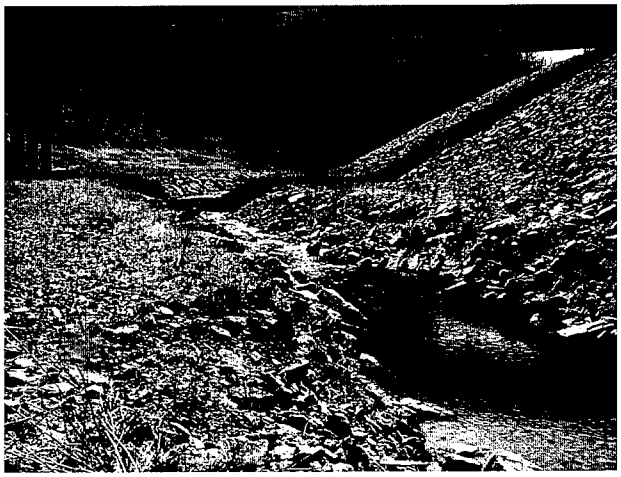

Figure 6. Cedar Creek runs under KY 313.

Figure 7. Shallow unnamed stream flows into Cedar Creek.

Figure 8. Bank erosion results from undercutting.

Revegetation: Trees and shrubs had been planted and will be evaluated in the summer.

4.3 US 68, DOCTORS FORK, BOYLE COUNTY

This project required channel modification of Doctors Fork and unnamed tributaries to Doctors Fork for the realignment of US 68 approximately two miles west of Perryville in Boyle County (Figure 9). The mitigation plan includes four box culverts and approximately 1,000 feet of channel change from Station 23+00 to 231+00. A significant part of the mitigation is 350 feet of 30-foot wide channel change south of relocated US 68 beginning at Station 190+50 (Figure 10). The project is bordered by farmland on the southeast side (Figure 11). Runoff from the farmland is deposited in the stream.

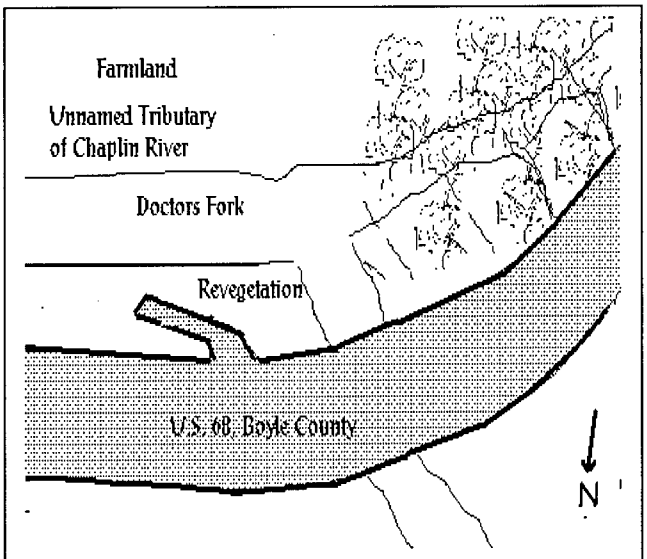

Figure 9. Conceptual drawing of Site 3.

The stream runs west to east and travels through a wooded area. Culvert bottoms were constructed flush with the streambed and outlets were stabilized with stone (Figure 12).

Preliminary Biological Assessment: Minnows, snails and fly larvae were readily observed.

Revegetation: Several small trees had been planted on the highway side of the stream near the box culvert.

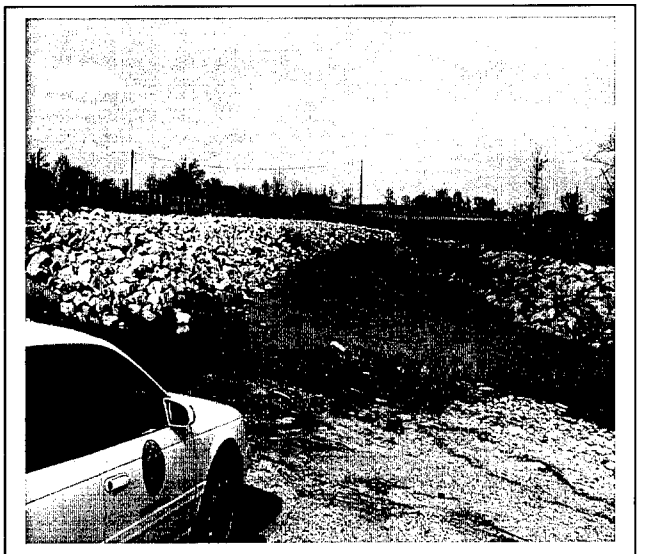

Figure 10. 350 feet of 30 foot channel change.

Figure 11. Doctor's Fork is bordered by farmland on one side and US 68 on the other side.

Figure 12. Riprap is used around box culvert to prevent erosion. The 30-foot channel change is shown in the background.

4.4 AA HIGHWAY, HOLTS CREEK, BRACKEN COUNTY

This site is the largest of the five selected projects and has the most problems. It is located near the confluence of Holts Creek and the Ohio River in Bracken County. This project required modification of Holts Creek and the West Branch of Holts Creek. The project is on the eastern side of the AA Highway, Section 9, between Station 1255+00 and Station 1432+00 (Figure 13).

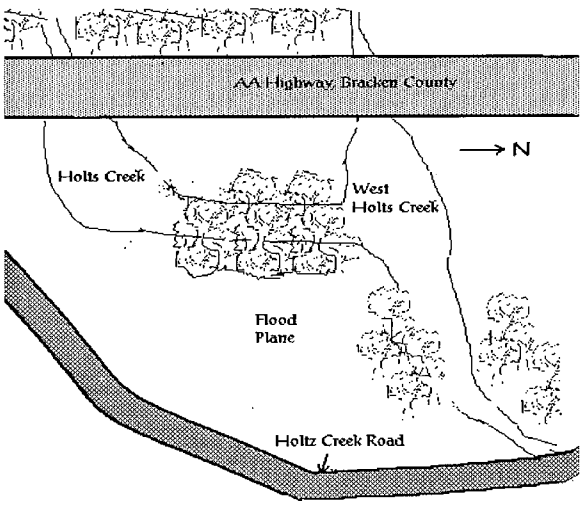

Figure 13. Conceptual drawing of Site 4.

The mitigation plan involved two box culverts, one on Holts Creek and one on West Holts Creek, totaling 761 feet. To mitigate the loss of natural stream bottom, stones were randomly spaced and "walked" into the culvert floor. The culverts and 1085 feet of new channel replaces approximately 1800 feet of old channel. Stone riffles and deflectors were constructed in the new channel.

The mitigation site is situated 70 feet below the highway and rests in a flood plane. Water from the main branch of Holts Creek travels through a wooded area and farmland before it gets to the 11-foot wide box culvert. On both the right and left of the culvert severe erosion has taken place (Figure 14). At the base of the box culvert, a deep pool, approximately 10 feet deep, has formed.

About 50 feet downstream of the culvert the water is shallower and the riprap that's eroded along the culvert is deposited there. (Figure 15)

At this point, Holts Creek joins West Holts Creek that flows from a 10-foot wide box culvert (Figure 16). This culvert has a stone bottom. The purpose is twofold, it allows fish to swim through the culvert and it reduces the water velocity. The box culvert has a winged headwall on both the right and left sides and severe erosion has taken place on both sides (Figure 17). Directly in front of the culvert is a deep pool approximately 10 feet deep. About 150 feet downstream of the West Holts Creek culvert, the two branches join.

After the two streams connect they become significantly more shallow. About 350 feet from the confluence of Holts Creek and West Holts Creek, the combined stream goes underground where the riprap and gravel have been deposited (Figure 18).

While conducting the evaluation, the owner of the farmland on the east side of the creek showed up. Mr. Hubert Nicson stated that, "Before construction, West Holts Creek used to have an island on the right side of the pool, and the creek flowed around it. I've seen the water backed up 30 feet above that headwall. That's a lot of water (5/5/99)." According to Mr. Nicson, the majority of the riprap came from Butler's Rock Quarry in the neighboring town. Some of the boulders weigh about 500 pounds. When the project was first completed those rocks were placed around the

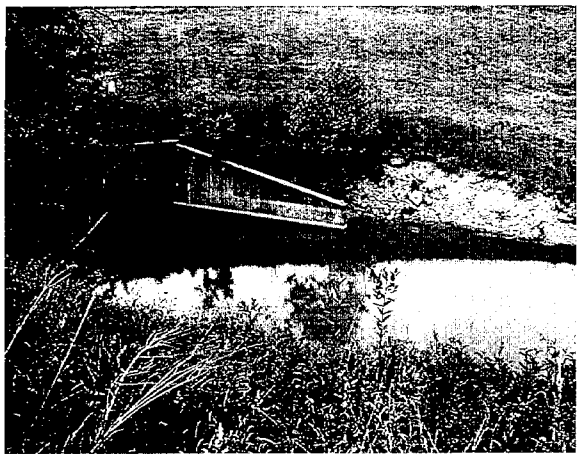

Figure 14. View from above Holts Creek shows severe erosion around wing wall.

Figure 15. View as Holts Creek flows into wooded area with the riprap deposition.

Figure 16. T where Holts Creek meets West Holts Creek.

headwall. They are now in the middle of the channel.

The local residents feel that the headwalls are too small for the amount of water that flows through it during a storm. They requested a larger headwall but were refused. Mr. Nicson said, "Snag's Creek is 3 miles up the road and has an 18 foot circular pipe. However, the State said that they would condemn our land rather than change the headwall as it would be cheaper than making the culvert bigger."

Preliminary Biological Assessment: Minnows, snails and fly larvae were readily observed at the lower reaches of the stream (Figure 19).

Revegetation: Several small trees had been planted on the forested side of the stream. No trees were planted on the highway side of the stream. The riparian zone has Crown Vetch.

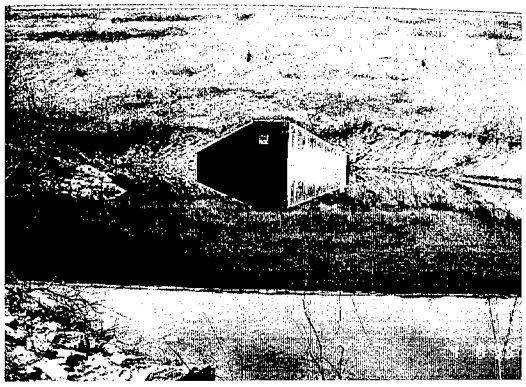

Figure 17. Severe erosion on both sides of box culvert at West Holts Creek.

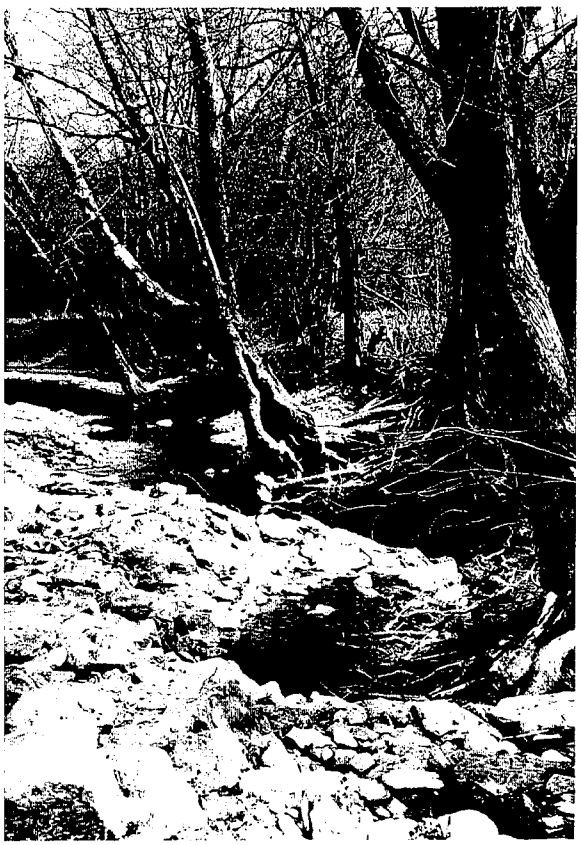

Figure 18. Combined streams go underground. Undercutting has taken place.

Figure 19. Preliminary Biological Assessment.

4.5 KY 827, COAL BRANCH, GREENUP COUNTY

This site is situated in a rural residential area in Greenup County. Stream modification was required for the relocation of KY 827 over Coal Branch. The project runs from Station 10 + 060 to Station 10 + 354 and includes 750 feet of 6-foot wide channel change and an 85-foot long culvert (Figure 20). The project required modification of a backward S-shaped stream. The stream runs parallel to KY 827, crosses under the KY 827, and then parallels the road again running between KY 827 and the access road (Figures 21, 22 & 23).

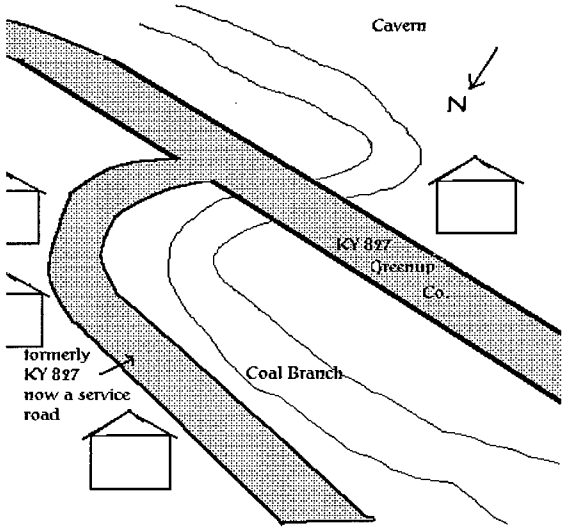

Figure 20. Conceptual drawing of Site 5.

Approximately 500 feet before the start of the project, the stream is joined by another stream that passes through a cavern. The resident living next to this cavern has used it to store various types of machinery (Figure 24).

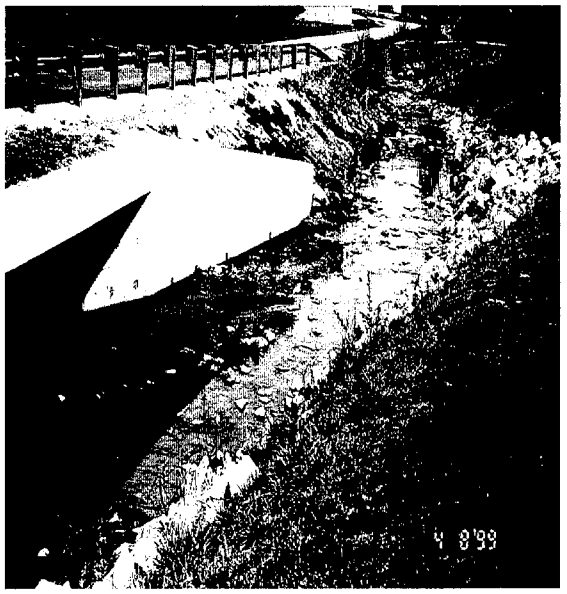

Figure 21. View of downstream end of channel from highway.

Preliminary Biological Assessment: Minnows, snails and fly larvae were readily observed.

Revegetation: The area was seeded. However, grasses along the highway are growing better than the grasses along the access road (Figure 25).

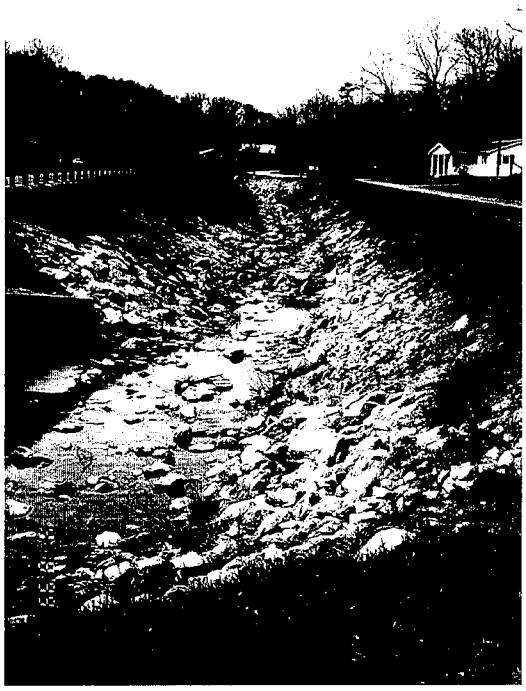

Figure 22. Looking upstream between highway on left and access road on right.

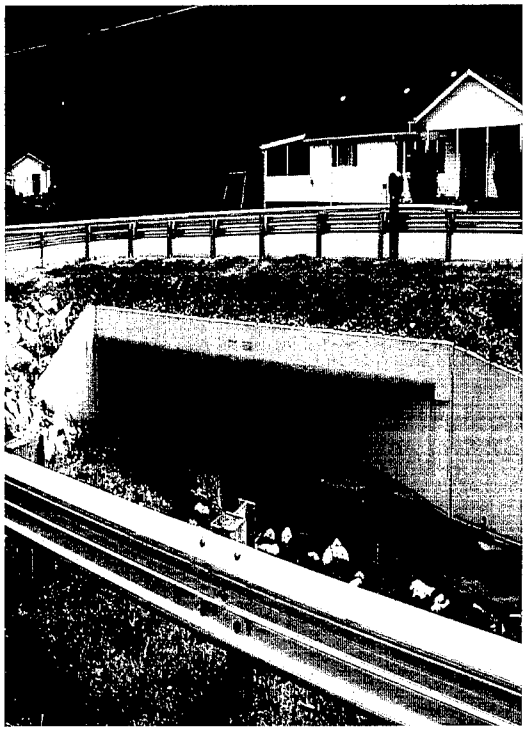

Figure 23. View of culvert from access road.

Figure 24. View of cavern from Highway 827.

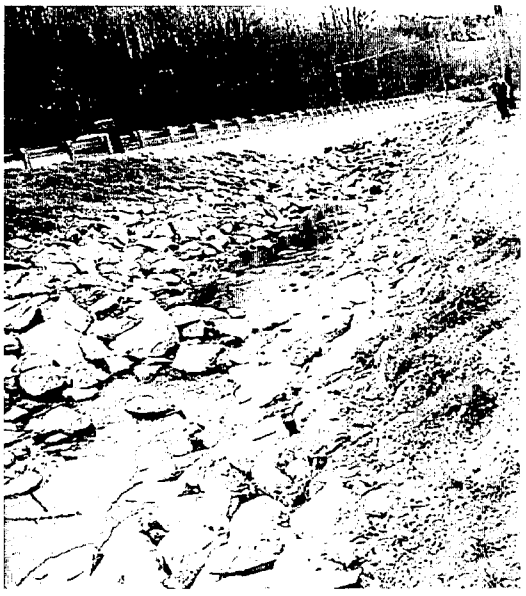

Figure 25. Grass on access road side of stream is sparse.

5.0 RECOMMENDATION FOR SITE ANALYSIS

The Kentucky Transportation Center will collect data from the five sites selected by the KyDOH, Division of Environmental Analysis.

Data that will be collected will include the following:

1. Water quality parameters,
2. Stream flow measurements,
3. Habitat survey, and
4. Physical measurements.

All of the mitigation projects will undergo testing to determine the basic water quality of the streams. Water quality parameters include dissolved oxygen content, conductivity, pH and temperature. Stream flow measurements will be taken at high and low flow periods. Habitat Surveys will be conducted on all five of the projects according to guidelines set by the U.S. Environmental Protection Agency 1999 standards. Physical measurements such as length, width, depth, adherence to original grade line, etc. will be used to determine amounts of erosion and channel changes.

The two larger stream systems are deep enough to sustain fish life year-round. A Rapid Bioassessment Protocol-V (RBP-V) for monitoring fish assemblages will be used at these sites, an Index of Biotic Integrity (IBI) will be calculated. This is done by shocking and seining the fish in the area to determine length, size, and age of fish. This will entail set-up of two field stations, one above and one below the remediation project. This will verify that fish migration patterns are not interrupted. The best time to do an IBI is in spring or early fall. Most IBI's can be completed within a three-week time frame. The steps in performing are:

Survey Strategy:

1. Characterize the habitat
2. Classify habitat using Watershed Protocol 1997
3. Establish 3 to 5 undisturbed reference stations, with at least one downstream recovery site. If a reference site cannot be found on the stream being evaluated, then a nearby comparable stream will be used as the reference station.
   This phase usually takes about two weeks.

Collection:

1. Collection of fish
   This phase usually takes one week.

Only EPA Protocol V (fish) should be performed. If a problem exists, only then should an EPA Protocol 3 (macro-invertebrates) be utilized. Site 2, KY 313, Cedar Creek, in Hardin County (4-168.09) and Site 4, AA Highway, Holts Creek, in Bracken County have been selected for this additional testing.

SUMMARY

The initial study tasks were to conduct a literature search, review of stream performance models, a review of Kentucky's and other agency's regulations pertaining to stream mitigation, identification of representative stream mitigation projects, and evaluation of those sites.

A literature search for regulations, federal permits, stream performance models, has been completed. Review of the articles did not reveal any regulations for stream disturbance mitigation that has been promulgated. Several agencies have developed guidelines but there are no hard and fast rules. There are numerous models, but none of them are specifically geared toward stream disturbance mitigation.

Stream mitigation projects have been reviewed and selected by the DEA. An initial site assessment has been conducted on all five sites. The University of Kentucky's Biology Department has agreed to perform the Rapid Bioassessment Protocol (RBP-V) fish assessment on two of the sites.

The next step is to perform an actual site assessment in which field measurements and data will be gathered for analysis. When the data is gathered and analysis has been made, an assessment tool will be developed that will be used for future stream mitigation evaluation.

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